Memorandum of the Portuguese participation in the LHC experimental program

1992–2012 A scientific journey in twenty years
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Introduction

This document provides a summary of the Portuguese participation in the LHC experimental program in the period 1992 to 2012. This scientific effort was undertaken by LIP (Laboratório de Instrumentação e Física Experimental de Partículas) in coordination with and supported by the Ministério da Ciência e Tecnologia (MCTES) and the agency Fundação para a Ciência e a Tecnologia (FCT). The extent and diversity of the program organized around the LHC \textit{Leitmotiv}, its long duration and the excellence of the results obtained, are the reflex of a mature and consistent scientific policy representing a particular success case for science and technology in Portugal. In this document an attempt is made to describe the major lines of the program and the results obtained, providing an assessment of this area of fundamental research in our country and disclosing paths towards the future.

The LHC physics program

The LHC physics program is arguably one of the largest and most complex scientific undertakings of mankind up to date. The scientific motivations of the research at LHC are at the heart of our quest for understanding the fundamental physics laws of the universe, following an historical trajectory initiated with Galileo and Newton. The very fact that the European countries, and among them Portugal, in cooperation with all other major nations in the globe, are successfully accomplishing a major scientific and technological enterprise to address fundamental questions in physical science speaks loudly for the high value of science in our society as a major element of human identity. CERN is increasingly becoming a global initiative welcoming more nations to join its activities, a movement that reflects the strong motivation of scientists world-wide to be part of this extraordinary adventure.

The standard theory of the elementary particles and their interactions, constructed along the XX century, is a major success of science. Initiated by the early attempts to understand the world of quantum phenomena, this theory is the result of many experimental results and theoretical ideas accumulated along decades. Several generations of accelerators with increasing energy provided a rich diversity of experimental data, which supported the theoretical development carried in parallel. The result is a mathematical framework describing the fundamental particles and interactions, whose predictions match with very high precision hundreds of experimental results. In this respect, the standard model of particle physics is probably the most successful theory in modern science.

However, two major problems remained unsolved:

1) the Higgs field and associated particle, an essential piece at the core of the theory that explains why elementary particles have mass, remains unobserved;

2) the theory is inconsistent at high energy, which strongly suggests the existence of “new physics” at a scale accessible at the LHC;

In a sense, despite its success at low energy, the standard model contains the seeds of its failure at high energy. Historical examples show that this situation is symptomatic of the existence of a new and more complete theory that could explain possible new physics accessible at the LHC energies.

These reasons motivated the world’s community of high energy physics to join efforts in the LHC physics program.

The LHC is colliding proton beams at 7 TeV since March 2010. The performance of the LHC machine and of the experiments has been outstanding. The LHC luminosity in 2010 increased by several orders of magnitude, and in 2011 the LHC delivered an integrated luminosity in excess of 5 fb$^{-1}$ per experiment. The ATLAS and CMS detectors are operating with very high efficiency and are providing data of excellent quality for physics analysis.

A very broad spectrum of known processes in proton collisions were already studied, including jet production, low mass resonances, $b$-quark production, W and Z vector boson production, and top quark production. All the results appear to be compatible with the predictions of the Standard Model. Very interesting new results were also obtained in heavy ion collisions, in particular in the suppression of upsilon states and of jets.
The experiments are now engaged in the search for new physics. Many different searches already established limits for different models more stringent than those obtained at the Tevatron collider in Chicago. Results presented in December 2011 on the search for the SM Higgs boson excluded its existence in a wide range of masses, leaving still open the window between 115 and 127 GeV.

**On July 4, 2012, the experiments announced the discovery of a new particle with mass 125-126 GeV compatible with the Standard Model Higgs boson.**
Historical perspective

The proposals for the LHC collider and the associated experimental program gained momentum in the beginning of the nineties. In 1992 the CMS and ATLAS proto-collaborations submitted to the CERN scientific committee Letters of Intent for experiments at the LHC. Technical Proposals followed in 1994. Portuguese groups in CMS and ATLAS, led respectively by João Varela and Amélia Maio, were among the signatories of these initial proposals. Gaspar Barreira, director of LIP, is the Portuguese representative in the ATLAS and CMS Resources Review Boards since 1995.

The R&D necessary to build the complex detectors proposed by the two collaborations was initiated at the same time. Both LIP groups were involved in this R&D effort. The LHC accelerator and experiments were approved in 1995. The LIP groups participated actively in the design of the experiments, described in detail in the Technical Design Reports approved in 1998-2000, and in the detector construction, installation and commissioning pursued until 2008. In 2009 the LHC collided the first beams and in 2010-12 both experiments accumulated a large amount of data. The Portuguese groups have been deeply involved in the operation of the detectors and in the physics analysis of the data.

Initial detector R&D

LIP was involved in the initial R&D activities in view of the LHC experimental program since 1990. This work was developed in the framework of the Detector Research and Development Committee (DRDC). LIP participated in the projects RD1 (Scintillating fiber calorimetry at LHC) and even previously in SPACAL (Spaghetti Calorimeter), RD10 (Proposal to study and improve the radiation hardness of gaseous detectors for use at very high luminosities), RD11 (Embedded architectures for second-level triggering in LHC experiments), RD13 (A scalable data taking system at a test beam for LHC), RD14 (Liquid xenon calorimetry), RD28 (Development of gas micro-strip chambers for high radiation-rate detection and tracking), RD34 (Development for a scintillator tile sampling hadron calorimeter with "longitudinal" tile configuration) that was in the origin of ATLAS Tilecal, and RD36 (Shashlik calorimeter: a combined shashlik plus preshower detector for LHC). R&D activities on first level calorimeter trigger systems were started in the framework of the CMS and RD12 collaborations. Groups from LIP-Lisbon and LIP-Coimbra in collaboration with other Portuguese institutes were involved in these activities.

Left: The ATLAS Letter of Intent, CERN/LHCC/92-4, 1992, with the participation of LIP. Signed by A. Amorim, A. Henriques, G. Barreira, A. Maio, A. Gomes, L. Peraita

Program components

The scientific and technological activities developed in Portugal in the framework of the LHC program had multiple components. These include:

- the participation in the two major experiments at the LHC, namely ATLAS and CMS
- the participation in the GRID computing project
- the development of technology transfer projects in medical applications
- the program for training of Portuguese engineers at CERN
- the industry sales of goods and services to CERN
- the outreach activities

The LIP participation in the experiments ATLAS and CMS was proposed to FCT in 1995 and approved by the Minister of Science and Technology. In the same year FCT and CERN signed the Memorandum of Understanding (MoU) that defined the Portuguese responsibilities in the design and construction of the CMS and ATLAS detectors.

The MoU agreements established a total contribution to the ATLAS and CMS experiment of about 2.5 MCHF each, representing about 0.5% of the cost of the experiments. The funding profile was spread over a period of 10 years, from 1996 to 2006.

In 2002 was established the agreement between FCT and CERN that defined the Portuguese contribution to the Maintenance and Operation (M&O) of the detectors in the period 2002-07. The M&O agreement was renewed for a new 5-year term between 2008 and 2012. In the year 2011 the Portuguese contribution to the M&O budget of each experiment was around 0.3 MCHF.

Since 1990 the LIP groups in the ATLAS and CMS experiments have submitted annually to the CERN program in FCT the research project and funding request for the following year. The projects involved collaborations of LIP with groups of a large number of other national institutes, including Instituto Superior Técnico, Faculdade de Ciências da Universidade de Lisboa, Fac. Ciências e Tecnologia da Univ. Nova de Lisboa, Fac. de Ciências e Tecnologia da Univ. Coimbra, Faculdade de Engenharia do Porto, Universidade do Minho, INESC Lisboa, INEGI Porto. Each project involved annually between 20 and 30 physicists, engineers and research students. The funding was at the level of 0.3 M€ per experiment and per year, covering expenditure in R&D, traveling and stays at CERN, and personnel.

LIP is part of the Worldwide LHC Computing Grid (WLCG) project undertaken by CERN in collaboration with all major HEP institutes in the world. In the context of the WLCG MoU, signed by the Portuguese government, LIP operates the Portuguese Tier-2. The objective was to provide enough computing power to "everybody and everywhere in the planet", making possible the analysis of the huge amounts of data produced by the LHC experiments. The GRID is a new networking and computing technology which federates hundreds of local computing centers into a unique computational infrastructure. In this program, LIP deployed the largest Computer Centre ever built in Portugal, with a central node at LNEC (NCG-INGRID-PT) and peripheral nodes at UPorto, UMinho-CP, IEETA, CFP-IST, LIP-Lisbon and LIP-Coimbra. This implementation has been done in collaboration with FCCN (National Foundation for Scientific Computing) and was funded by the Portuguese National Grid Initiative (NGI).

In 2003, LIP initiated an activity aiming at the transfer to medical applications of technology developed for the LHC project. A national Consortium integrating eight research institutes and one company was created to develop Positron Emission Tomography (PET) prototypes for medical imaging. An innovative PET technology dedicated to breast cancer high-resolution imaging was fully developed in Portugal, from the initial concept and laboratory experimentation up to complete PET machines now installed and operating at the Institute for Nuclear Science Applied to Health (ICNAS) in Coimbra and at the Hôpital Nord et Université de la Méditerranée in Marseille. For the first time a complex medical imaging instrument competitive worldwide was fully developed in Portugal.

The Advanced Training Programme for Portuguese Engineers was negotiated with CERN at the end of the nineties and later extended to other International Scientific Organisations (ESA and ESO). The selection process is conducted
by the Agência de Inovação (ADI) and financed by FCT. The objectives are focused on the advanced training of engineers for industry. About 230 engineers participated during the last 10 years in the development of the LHC machine, under this program.

By participating in the scientific activities at CERN, all the Member States can benefit from an industrial return that is proportional to its financial contribution to the organization. In order to boost sales by national industry to CERN, Industrial Liaison Officers were established at AdI and FCT since 1997. Until 2006, Portuguese companies exported to CERN goods and services worth over 76 million Swiss francs (around 53 million euros). Our position in terms of Industrial Goods is quite stable, oscillating around a central position in the group of Member States. In terms of Services, we have achieved a much higher position, with an industrial benefit that has maintained a steady second place after Switzerland, which is one of the host states of CERN. These figures reflect the technological development of the suppliers, their international competiveness and the importance for them of the experience gained in an institution where the required standards are always higher than the highest market standards.

In parallel to the scientific activity, LIP developed a large number of outreach initiatives to motivate the public to be interested in Particle Physics, in particular by engaging the schools, teachers and students. These included the Master Classes dedicated to high school students and the CERN School for physics teachers, realized in collaboration with the Agência Ciência Viva, which has been attended also by physics teachers from other countries with Portuguese as official language: Brazil, Mozambique, Angola, Cape-Verde, São Tomé and Príncipe, Guiné-Bissau and East Timor.

Amélia Maio (left), Gaspar Barreira (center) and João Varela (right) were the initiators of the Portuguese participation in the LHC experimental program in 1992. Amélia Maio and João Varela are the coordinators of the ATLAS and CMS groups respectively, and Gaspar Barreira, director of LIP, is the Portuguese representative in the ATLAS and CMS Resources Review Boards and initiator of the GRID project in Portugal.
Discovery of a new heavy boson

The LHC community achieved a major discovery in particle physics, with profound consequences for this field of science. The ATLAS and CMS experiments observed a new heavy boson with mass of approximately 125-126 GeV, compatible with the Higgs boson predicted in the Standard Model. LIP is proud to have been full partner of this achievement, through the scientific work developed consistently in the past twenty years, summarized in this report.

The Higgs boson was postulated nearly five decades ago within the framework of the Standard Model of particle physics and has been the subject of numerous searches at accelerators around the world. Its discovery would verify the existence of a scalar field that permeates the entire universe thought to give mass to three of the carriers of the electroweak force – the $W^+$, $W^-$ and $Z^0$ bosons – as well as to the fundamental quarks and leptons.

The ATLAS and the CMS experiments have observed, with a statistical significance above five standard deviations each, a new particle produced in proton-proton collisions at the Large Hadron Collider at CERN. The evidence is strongest in the diphoton and four-lepton (electrons and/or muons) final states, which provide the best mass resolution in the detectors. The probability of the observed signal being due to a random fluctuation of the background is smaller than $10^{-7}$. While its measured properties are, within the uncertainties of the present data, consistent with those expected of the Higgs boson, more data are needed to establish whether this new particle has all the properties of the SM Higgs boson or whether some do not match. The latter may imply new physics beyond the SM. This particle has the potential to be a portal to a new landscape of physical phenomena that is still hidden from us. The LHC experiments are in an excellent position to undertake this research in the years to come.

The discovery of a new Higgs-like boson opens a new chapter in the history of particle physics. The LHC and the experiments are preparing upgrades for operation with energy 14 TeV and luminosity up to 2x10^{34} cm^{-2}s^{-1} in the decade up to 2022. A broader picture of physics at the TeV scale should emerge from the precision measurements of the properties of the Higgs boson and direct searches for new physics. In this decade, the LHC together with its experiments will be the only facility able to carry out these studies.

Results of the ATLAS and CMS experiments in the search for the Higgs boson as a function of the Higgs mass for the observed (full lines) and expected (dotted lines) local significance based on the estimated background from SM processes. The significance exceeds 5 standard deviations in both experiments for a mass around 125 GeV.
1 Participation in the CMS experiment

LIP is member of the Compact Muon Solenoid (CMS) Collaboration at the Large Hadron Collider at CERN since 1992. The Collaboration has about 3500 members from 179 institutes in 41 nations. The CMS experiment studies very high energy collisions of proton and nuclear beams to investigate the most fundamental properties of matter.

The LIP group has been active in many areas of the CMS experiment in the past twenty years, having contributed significantly to all phases of its long trajectory. In this section we will review these contributions, including the responsibilities in the detector construction, the present responsibilities in the maintenance and operation of the experiment and the participation in the physics program.

Presently the LIP activity in CMS is organized in four main lines:

1) The operation and maintenance of the trigger and data acquisition system of the CMS Electromagnetic Calorimeter
2) Proton-proton physics analysis, exploiting the discovery opportunities offered by the new LHC energy
3) Heavy-ion and quarkonium physics analysis, including the study of the quark-gluon plasma
4) Research and development in view of the Upgrade of the CMS detector at High Luminosity

The CMS detector installed in the experimental cavern
Detector construction responsibilities

The Portuguese responsibilities in the construction of the CMS Experiment were the following:

1) Design and construction of the Data Acquisition System of one of the five major CMS Sub-Detectors, namely the Electromagnetic Calorimeter (ECAL) used for the measurement of electrons and photons. More specifically:
   • Leading contributions to the concept and architectural design of the ECAL Trigger and Data Acquisition System.
   • Leading responsibility in the development, construction and operation of the ECAL Data Acquisition Modules (construction of eighty DCC modules).
   • Leading responsibility in the concept, architectural design, development and operation of the Online Data Acquisition Software for the Electromagnetic Calorimeter.

2) Study, design, construction, installation and commissioning of the Level-1 Trigger System responsible for the first level of event selection:
   • Leading contributions to the study, design and specification of the Calorimeter Trigger System, used to select events with energetic electrons, photons, particle jets and events with large missing energy.
   • Leading responsibility in the development, construction and operation of the trigger synchronization circuits and high-speed links (construction of one thousand SLB modules for the Electromagnetic and Hadronic Calorimeter detectors).
   • Leading contributions to the design and specification of the Trigger Control System, an hardware based system used to control the delivery of triggers and fast control signals to all CMS Sub-detectors.

3) Design, prototyping and production of one hundred thousand integrated circuits in 0.25 micron CMOS technology performing 12-bit Analog-to-Digital Conversion (ADC) in the front-end readout system of the Electromagnetic Calorimeter.

4) Study, design and construction of prototypes Muon Alignment Barrel carbon fiber structures, used in the alignment system of the Muon Detectors.

5) Construction of the Grease Pads for fine displacements for final positioning of the five Barrel Wheels of the CMS Detector.
These developments were conducted by LIP in collaboration with several national institutes and industries, namely INESC Lisbon (ECAL electronics), Chipidea (12-bit ADC), INEGI Porto (Muon MAB), and EUROISO (Grease Pad).

**ECAL Data Acquisition System**

Portugal was responsible for the development of the Data Acquisition System of the Electromagnetic Calorimeter. The Electromagnetic Calorimeter (ECAL) is an electron and photon detector composed by eighty-thousand high purity PbWO₄ crystals. The crystal scintillation light is converted by avalanche photo-diodes (APD), digitized and transferred from the detector through high speed (1 Gbit/s) optical links. The Data Acquisition System is responsible for collecting data from about 5000 optical links, data filtering and selection, data formatting and data transmission to the Central DAQ system.

The system is composed by twenty VME-9U crates housing Data Concentrator modules (DCC) and trigger boards. The DCC has high-speed optical inputs based on six 12-channel optical receivers, followed by 72 de-serializer circuits integrated in 9 large FPGAs. These FPGAs include also the data filtering algorithms and the input memory. Three event-builders working in parallel allow an integrated bandwidth of 4.2 Gbit/s. The board collects also trigger data through LVDS high-speed links. A dedicated VME-9U board called DCC-Tester was built and was used in the DCC production tests. The DCC-Tester emulates all the inputs of the DCC in particular the 72 high-speed optical links.

A high degree of innovation was required in this project. For the first time a large number of optical data links was used in HEP. The required integration scale and the complexity of the on-line data selection was a challenge for the electronics development. The dimension of the system required the use of the most advanced quality control and testing techniques. A model at system level of its constituting modules was developed and simulated, allowing to validate the system design parameters. In large systems, error detection and diagnosis is a major challenge and motivated the development of dedicated tools.

The development of ECAL Online Data Acquisition Software was also a major responsibility of the LIP group. The development span several years and followed the various stages of the development, test and commissioning of the ECAL Detector. It includes complete software packages for the hardware test systems (DCC and SLB test
systems), for the ECAL test-beam data acquisition system used to the test and calibration of ECAL super-modules, and finally the on-line software used in the CMS experiment to control and monitor the operation of the ECAL sub-detector. These packages include remote control capabilities and access through graphical user interfaces, access to remote configuration and equipment management databases, automatic hardware scan and configuration, hardware monitoring, local data acquisition and monitoring, and data quality monitoring.

Picture of the ECAL data acquisition and trigger crates. The full system is composed of 18 crates.

**CMS Level-1 Trigger System**

The calorimeter trigger system of the CMS experiment is a high performance electronics and computing system which processes on-line the detector data, about one hundred thousand calorimeter channels, to select events with high energy electrons, photons, jets and neutrinos. The level-1 trigger system performs the first selection step in the search for rare physics reactions. The scale of the problem was several orders of magnitude above the trigger systems developed previously. In summary, the CMS calorimeter trigger system is a massive parallel processor working in pipeline synchronous mode.

LIP led the initial study, simulation and design of the CMS Calorimeter Trigger. The algorithms used to identify electrons and photons have been developed by LIP, in particular the fine-grain electron-photon algorithm.

LIP has conducted a long-term effort aiming at a Synchronization Circuit for the calorimeter trigger data. This circuit is the heart of a method developed by LIP for synchronization of the calorimeter trigger pipeline system. This circuit is integrated in the Synchronization and Link Board (SLB), together with the giga-bit trigger link. About one thousand SLB modules are used in CMS to synchronize the trigger of the ECAL and HCAL calorimeters.

LIP led the design and specification of the Trigger Control System, an hardware based system used to control the delivery of triggers and fast control signals to all CMS Sub-detectors.

The group performed various studies of the trigger performance with data obtained in test beams at CERN or with cosmic data. Beam data taken in 2006 was used to obtain the following published results:

a) analysis of the H2 beam data to study the efficiency and selectivity of the electron trigger algorithms;

b) analysis of the trigger data and validation of the SLB synchronization methods. The LIP group took the full responsibility in these studies. In 2009 the group was responsible for the analysis of the electron trigger efficiency using cosmic data obtained with the complete CMS detector.
Analog-to-Digital Converter for ECAL

A 12-bit Analog-to-Digital Converter (ADC) in 0.25-micron radiation hard technology was developed by the Portuguese company Chipidea under contract with LIP established in 2002. The Chipidea IP block was integrated in an ASIC with 4 ADCs and a dynamic digital range selector. This component matches the 4-fold preamplifier with different gains developed at RAL in UK. LIP and CERN followed the design work. The production of the test samples as well as the final production was organized by CERN, under a special agreement established between LIP and CERN.

This development occurred in the framework of the major re-design of the ECAL electronics system aimed at replacing the previous electronics (Floating-Point Pre-Amplifier) which was facing serious problems of bandwidth and noise. Given the impact of the electronics on the ECAL detector construction schedule, the ADC chip development had very severe schedule and quality constraints, representing an enormous challenge and substantial risk.

The success of the development was highly appreciated by the CMS Collaboration. For this achievement the company Chipidea has received a CMS Gold Award.
Carbon fiber MABs

LIP in collaboration with INEGI Porto performed the study, design and construction of prototypes of the Muon Alignment Barrel carbon fiber structures, used in the alignment system of the Muon Detectors.

The Alignment System of the Muon Detectors required large composite structures which should be light, highly stable, stiff and radiation tolerant. In the Muon alignment system there are 36 structures each made of Carbon Fiber composite tubes connected together in a complex structure with overall dimensions of 4x1 m². The needed rigidity was achieved by the construction and choice of the material, providing precision and stability at the level of 30 microns.

The construction of the MAB prototype and its full static and dynamic characterization was performed by LIP in collaboration with INEGI Porto.

![Muon Alignment Supports (MAS). High precision carbon fiber.](image)

Grease Pads for the CMS Magnet

The CMS detector is designed around a large superconducting magnet, which is basically composed of a superconducting coil, surrounded by an iron yoke that return a 4 Tesla magnetic flux. Particle detectors are inserted inside the coil and between the iron plates of the yoke.

The barrel yoke is divided in five independent rings, each one weighting about 2000 tons. The rings are supported by two Grease Pads each, which allow fine displacements for final positioning of the detector.

The Grease Pad is composed of different iron pieces with a total weight of about 9 tons. The overall dimensions are 2500x1070x480 mm. Pressurised grease is injected between the upper and lower plates to allow the movement of the upper plates that support the detector.

Following the Market Survey and the Invitation to Tender LIP/CMS/CP 001/1999, LIP selected the Portuguese company EUROISO Indústria Metalomecânica Lda which made the lowest bid (207 thousand Swiss francs) for the production of the CMS Grease Pads.
Detector operation and maintenance responsibilities

Following the construction responsibilities, the LIP group participates in the Maintenance and Operation (M&O) of the detector, and in particular is responsible for the M&O of the ECAL Data Acquisition system.

During the detector construction the LIP group had a team of six people in permanence at CERN dedicated to the installation and commissioning of the ECAL data acquisition and online monitoring. This group is now reduced to four people which is required for the normal detector maintenance and operation. The group is responsible for the following tasks:

a) maintenance of the ECAL Data Acquisition hardware in the experiment;

b) operation of two test setups installed at CERN for the maintenance of the SLB, DCC and test modules;

c) upgrades and maintenance of the firmware of the Data Acquisition modules;

d) maintenance and updates of the Online Data Acquisition Software;

e) integration tests with the central Data Acquisition and Trigger systems.

The LIP group is directly involved in the ECAL and Trigger operation during the LHC beams. Several members of the group are "experts on-call" available during LHC runs to intervene in case of system faults. The group assured a number of data taking Shifts both in ECAL and in the central Trigger, as required by the Collaboration. Members of the group also served as Run Field Manager, Shift Leader and Trigger Field Manager at several occasions during the data taking periods.

The LIP group is also responsible for the operation of the ECAL data acquisition hardware and software in the CMS Electronics Integration Center (904) and at the H2/H4 test-beam lines, where the spare ECAL Super-module is installed.
Participation in the CMS experiment

LIP/CMS group members installing the ECAL Data Acquisition and Trigger System in the underground experimental hall.

In the CMS control room when the first LHC proton beams collided in 2009. In the first rows are André David and Pasquale Musella from LIP.

Responsibilities held by members of the LIP-CMS group within top CMS management structures.
Responsibilities held by members of the LIP-CMS group within CMS ECAL management structures.

Participation of LIP-CMS members in the CMS central and ECAL running structures. Responsibilities are varied, ranging from CMS-wide coordination positions to experts on call.
Physics analysis

The participation in the detector operation and physics analysis of the first LHC data was a major goal of the LIP group in 2010-12, which was fully achieved. The group had major roles in the commissioning with data of the electromagnetic calorimeter and of the associated trigger system. These included the study of electromagnetic physics objects and photon reconstruction and identification with first LHC data, as well as many studies of trigger synchronization and efficiency.

The LIP group has been actively involved and/or had a leading role in various physics analysis. These included:

1) The measurement performed by the LIP group of the top quark mass in the dilepton channel, which was the first top quark measurement at LHC;

2) The participation in the measurement of top-quark pair production cross section in the dilepton channel, contributing with the independent cross-section measurement in events with one jet;

3) The measurement performed by the LIP group of the cross section of production of top quark pair in the dilepton channel with one hadronically decaying tau;

4) The measurement led by the LIP group of the isolated prompt photon cross section based on the cluster shape analysis method developed in the group;

5) The measurement led by the LIP group of the limits in the branching ratio of top decay in charged Higgs, using events with one lepton (electron or muon) and one hadronic decaying tau;

6) The measurement of the J/Psi prompt and non-prompt cross sections in pp collisions and in the measurement of the J/Psi polarization;

7) The measurement of Upsilon polarization in pp collisions;

8) The search for the Higgs boson in the two-photons decay channel;
9) The search for the supersymmetric partner of the top quark.

A more detailed description of these studies will be included in the next sections. The CMS references PAS (Physics Analysis Summary) are public. The references AN (Analysis Note) are detailed analysis documents internal to the Collaboration.

**Top Quark Physics**

**Top quark mass:**

- Measurement of the Top quark mass in the dilepton channel in pp collisions at sqrt(s)=7 TeV: top quark mass measurement by the LIP group using the KINb method in the dilepton channel. This is the single most precise measurement in the dilepton channel to date.
  
  Ref: CMS AN-2012/009, CMS PAS TOP-11-016, CMS AN-2010/374, CMS AN-2010/311, CMS PAS TOP-10-006

- Study of the mass distributions in Top quark dilepton events with early sqrt(s) = 7 TeV data: detailed results by the LIP group of the top quark mass determination with the first top events.
  
  Ref: CMS AN-2012/267

- Top quark mass and jet energy scale in dilepton events in pp collisions at sqrt(s) = 7 TeV with early data: detailed study by the LIP group with simulation data of methods of top quark mass measurement.
  
  Ref: CMS AN-2010/198

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Top quark mass reconstruction with KINb method: numerical solutions are found for the kinematic equations for a tt decay with two charged leptons in the final state.

---

**Top pair production cross section:**

- Measurement of the Top quark pair production cross section in the e-tau and mu-tau dilepton channels in pp collisions at sqrt(s)=7 TeV: measurement performed by the LIP group of the t-bar cross section with tau leptons in the final state. This is the first t-bar cross section measurement explicitly including tau leptons at the LHC, and the most accurate in this final state to date.
  
  Ref: CMS AN-2011/245, CMS AN-2011/421, CMS PAS TOP-11-006

- Measurement of the ttbar production cross section in the dilepton channel at sqrt(s)=7 TeV: top dilepton
Participation in the CMS experiment

- Analysis by the LIP group, including optimized event selection and data-driven background estimation methods.
  Ref: CMS AN-2010/200, CMS AN-2010/414

- First Measurement of Top-Quark Pair Production Cross Section in Proton-Proton Collisions at \( \sqrt{s} = 7 \) TeV, includes the determination of the top quark mass by the LIP group.
  Ref: CMS PAPER TOP-10-001, 1010.599

- Selection of Top-Like Events in the Dilepton and Lepton-plus-Jets Channels in Early 7 TeV Data
  Ref: CMS PAS TOP-10-004

Top branching fractions

- Probing the heavy flavor content of the ttbar dilepton channel in proton-proton collisions at \( \sqrt{s} = 7 \) TeV: measurement by the LIP group with data of the methods of measurement of the top quark branching ratio.
  Ref: CMS AN-11-394

- Probing the heavy flavor content of the ttbar dilepton channel in proton-proton collisions at \( \sqrt{s} = 10 \) TeV (CMS-PAS-TOP-09-001): detailed study by the LIP group with simulation data of the methods of measurement of the top quark branching ratio.
  Ref: CMS PAS TOP-09-001

![Higgs candidate events in CMS. Left: Two photon event. Right: Two muon and two electrons](image)

Higgs Physics

Charged Higgs boson in the top lepton-tau channel

- Search for the charged Higgs boson in the decays of top quark pairs in pp collisions at \( \sqrt{s} = 7 \) TeV: measurement performed by the LIP group on the limits in the search for the charged Higgs boson, using events with one lepton (electron or muon) and one hadronically decaying tau lepton, and events with two leptons (electron and muon). These are currently the world’s best limits to date.
  Ref: CMS AN-2011/175, CMS PAS HIG-11-008, CMS AN-2011/422, CMS PAS HIG-11-019, CMS AN-2011/015, CMS PAS HIG-11-002

- Prospects for the measurement of the t-tbar cross section ratio of the e-tau and mu-tau dilepton channel in pp collisions at \( \sqrt{s} = 10 \) TeV: detailed study by the LIP group with simulation data of the measurement of the top cross-section in the tau-dilepton channel.
  Ref: CMS AN-2009/177

- Study of tau reconstruction algorithms using pp collisions data collected at \( \sqrt{s} = 7 \) TeV: commission the algorithms for reconstruction and identification of tau lepton hadronic decays.
  Ref: CMS AN-2010/207, approved as PAS PFT-10-004
• Search for the charged Higgs boson in proton-proton collisions at 10 TeV (CMS AN-2010/135): study with simulation data of the possible observation of decays of the top quark in charged Higgs bosons coupling to tau lepton.

Ref: CMS AN-2010/135

(Left) First measurement of the cross section in the $t\bar{t}$bar tau dilepton channel at LHC. (Right) Upper exclusion limit on charged Higgs ($H^+$) production on $BR(t \rightarrow Hb)$ assuming $BR(H^+ \rightarrow \tau + \text{neutrino}) = 1$ as a function of the Higgs mass.

Search for Higgs in two photon decays

In 2011, the LIP group participated in the search for the Higgs boson in the diphoton channel. The group led the development of the vertex identification algorithms in the multi pile-up environment, an important ingredient to achieve the best two-photon mass resolution. Members of the LIP group were in charge of editing the analysis documentation and managing the common analysis code. The experimental search for the Standard Model Higgs boson has been updated several times during 2011 and submitted for publication in January 2012.


Exclusion limit on the cross section of a SM Higgs boson decaying into two photons as a function of the boson mass relative to the SM cross section, where the theoretical uncertainties on the cross section have been included in the limit setting. The limit is calculated using the frequentist CLs method. The expected limit obtained in the earlier analysis of the same dataset is shown for comparison.
SuperSymmetry Physics

Search for the scalar top quark

The LIP group has activities in the area of SUSY performing a search for the stop s-quark. The topology of these events is top-like and therefore the top mass reconstruction methods already developed find here a good application since top production is the main background in stop searches.

Physics with photons

Electron/photon physics objects

- Electromagnetic physics objects commissioning with first LHC data: reconstruction of electromagnetic clusters in the ECAL and comparison to Monte-Carlo simulation.
  
  Ref: CMS-PAS-EGM-10-001

- Photon reconstruction and identification at sqrt(s)=7 TeV: reconstruction and photon ID with early CMS data.
  
  Ref: CMS-PAS-EGM-10-005

QCD photon physics

- Measurement of the Isolated Prompt Photon Cross Section in pp Collisions at sqrt(s)=7 TeV: paper led by the LIP group based on the cluster shape method developed in the group to determine the signal and background fractions from data.
  

- Prediction of Isolated Photon Cross Section at sqrt(s)=7 TeV from JetPhox and Correction of Underlying Event Effects. Ref: CMS AN-2010/272

- Measurement of isolated photon production cross section in pp collisions at sqrt(s)=7 TeV: detailed analysis describing the measurement of the prompt photon cross-section with CMS data.
  
  Ref: CMS AN-2010/268, CMS AN-2010/221, CMS AN-2010/114

W-gamma physics

- Towards the measurement of W-gamma coupling in the muon channel in pp collisions at sqrt(s)=10 TeV: study with simulation data.
  
  Ref: CMS AN-2010/065
Heavy-ion physics

In 2010-11 the group was actively involved in the quarkonia and b-physics analysis group and contributed significantly to the following studies:

- J/Psi prompt and non-prompt cross sections in pp collisions at sqrt(s) = 7 TeV: first measurement with CMS data.
  Ref: CMS-PAS-BPH-10-002

- Inclusive total and differential production cross section of J/ψ and b-hadron production in pp collisions at √s = 7 TeV with the CMS experiment.
  Ref: CMS AN-2010/138

- Upsilon production cross section in pp collisions at sqrt(s) = 7 TeV
  Ref: CMS-PAS-BPH-10-003

The group was also very active in the setting up of the quarkonia polarization analysis and published several papers devoted to new methods for polarization measurements:


- Model-independent constraints on the shape parameters of dilepton angular distributions. Published in Phys. Rev. D83 (2011) 056008


- Spin alignment of prompt and non-prompt J/Psi mesons in pp collisions at sqrt(s) = 7 TeV (AN-2011/091)

- Studies of the J/psi polarization fit with a toy Monte Carlo program (AN-2011/087)
Participation in the CMS experiment

- A Fitting Routine for Extracting the Spin Alignment of J/ψ mesons (AN-2011/092)
- A new procedure for the extraction of angular distribution parameters in dilepton vector meson decays’
  (AN-11-535)

This work was entirely developed by the CMS LIP Lisbon Quarkonia Group, in collaboration with Carlos Lourenco
(CERN).

Participation in CMS paper reviews

Member of the LIP group have been selected to participate in many Analysis Review Committees (ARC) which review
and finally approve the physics results obtained in the Collaboration.

![Energy distribution of electromagnetic clusters in ECAL](image_url)

Detector upgrade program

R&D for the Trigger Upgrade

CMS has submitted the Technical Report on the first large Detector Upgrade in view of the High Intensity LHC. This
Upgrade concerns the Hadronic Calorimeter, the Muon Detectors, the Pixel Detector and the Trigger, and it is
expected to take place during the first two LHC long shut-downs (2013-4 and 2018).

The upgrade in the Trigger system is aimed at improving the trigger algorithms such that the trigger is able to sustain
the high luminosity and event pile-up in HL-LHC. It is foreseen that after 2014 the LHC luminosity could exceed
its initial specifications (10^{24} cm^{-2}s^{-1}) by a factor up to 3 or 4. Therefore there is a strong motivation for
a partial upgrade of the Trigger system in 2013-14, which would concern the calorimeter trigger, and a second
upgrade phase in 2018 involving the muon and global triggers. The upgrade of the calorimeter trigger in 2013-
14 would allow to keep acceptable trigger rates of the electron/photon and tau triggers with the relatively low
thresholds required by physics analysis.

The data from about five thousand trigger towers (both ECAL and HCAL) is presently transmitted to the calorimeter
trigger by high-speed electrical links. These links are incompatible with the requirements of the Trigger Upgrade
and need to be replaced by optical connections of 5 Gbit/s each. The LIP group has been involved in the system
upgrade design and in the development of prototypes of an optical trigger interface (oSLB) between the ECAL and
HCAL calorimeters and the regional calorimeter trigger, replacing the SLB interface that was developed in the past
by our group.
Coordination positions

The LIP group members had the following management and coordination positions in the CMS experiment structure:

- **CMS Deputy Spokesperson**, 2012-13, J. Varela
  Top management position, second to the Spokesperson that leads the Collaboration

- **Trigger Project Manager**, 2007-10 J. Varela
  Level 1 management position, responsible for the CMS Trigger Project.

- **Member of the CMS Executive Board**, since 2007, J. Varela
  The CMS Executive Board is composed by the Level 1 managers and meets weekly

- **ECAL Run Coordinator**, since 2010, A. David
  Level 2 management position, responsible for the Operation of the ECAL Detector

- **ECAL Electronics Coordinator**, since 2011, J. C. Silva
  Level 2 management position, responsible for the Electronics of the ECAL Detector

- **ECAL Electronics Deputy Coordinator**, 2009-10, J. C. Silva.
  Deputy of L2 management position

- **ECAL Data Acquisition Coordinator**, 2008-10, A. David;
  Level 2 management position, responsible for the Data Acquisition of the ECAL Detector

- **ECAL Data Acquisition Deputy Coordinator**, 2009-10, P. Musella;
  Deputy of L2 management position

- **ECAL Data Stream Hardware Coordinator**, 2009-10, J. C. Silva.
  Level 3 management position, responsible for the DCC hardware

- **Trigger Technical Coordinator**, 2001-07, J. Varela
  Responsible for the technical coordination of the Trigger System

- **Detector Control System Coordinator**, 2002-06, J. Varela
  Responsible for the technical coordination of the Detector Control System

  Responsible for the management of resources for the construction and M&O of the central Trigger and Data Acquisition systems

- **Calorimeter Trigger Coordinator**, 1993-99, J. Varela
  Level 2 management position, responsible for the coordination of the Calorimeter Trigger development.

- **Chairperson of the CMS Conferences Committee**, 1995-98, J. Varela
  Chairperson of the committee associated to the Collaboration Board responsible for the selection of CMS speakers in International Conferences.

Awards

Two members of the group have been awarded with the "CMS Achievement Award":

- **P.Musella**: award for important contributions to ECAL Data Acquisition (2007)
- **A.David**: award for key efforts on the ECAL DAQ and central CMS operations (2008)
Participation in the CMS experiment

In 2010 the group member José Carlos da Silva has been awarded with a "CMS Lifetime Achievement Award", for outstanding contributions to the ECAL and HCAL Trigger/DAQ electronics.

In 2011 Pasquale Musella receives the CMS Thesis Award for the best PhD thesis in the CMS collaboration defended this year.

Research team

The membership and composition of the LIP/CMS team has evolved with time. On average the group has twenty members, with the following typical structure:

- 2 faculty
- 3 senior researchers
- 5 postdoc
- 10 research students (Master and PhD)

Coordination structure

Group coordinator: João Varela
Detector and computing coordinator: João Varela
ECAL coordinator: André David
Electronics coordinator: José Carlos Silva
Computing coordinator: Nuno Almeida
Proton-proton physics coordinator: Michele Gallinaro
Heavy-ion physics coordinator: João Seixas
Scientific production

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Scientific production of the LIP/CMS group

Organization of meetings, workshops and seminars

A series of seminars on LHC Physics ("Physics on the road to discovery") was organized in collaboration with CFTP/IST since 2008. A total of 33 seminars by leading scientists covered a wide range of topics on the physics at LHC (list in appendix).

A one-day workshop on “Top Physics at LHC” was organized in collaboration with the LIP/ATLAS team and the theory group CFTP/IST.

A one-day Workshop on “Multi-lepton final states in search of New Physics at the LHC” was organized in collaboration with the LIP/ATLAS team and the theory group of CFTP/IST.

The LHC Symposium dedicated to students and faculty members at IST with the participation of L. Evans, P. Jenni, M. Mangano and J. Virdee was organized in November 2010.

Co-organization of Workshop on Quarkonium Production: Probing QCD at the LHC, April 2011, Vienna, Austria.
Program funding

The Memorandum of Understanding for the CMS Construction established a total Portuguese contribution of 2.5 Million CHF, representing about 0.5% of the cost of the experiment. The funding profile was spread over a period of 10 years, from 1996 to 2006.

This contribution had two components:

1) in-kind detector components provided by LIP (equivalent to 1.7 MCHF);
2) in-cash contribution to the experiment Common Fund (0.8 MCHF);

In 2002 was established the agreement between FCT and CERN that defined the Portuguese contribution to the Maintenance and Operation (M&O) of the detectors in the period 2002-07. The M&O agreement was renewed for a new 5-year term between 2008 and 2012.

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M&O funding in the period 2008-2012

Since 1990 the LIP group in the CMS experiments in collaboration with other institutes in Portugal have submitted annually to the CERN program in FCT the research project and funding request for the following year to cover expenditure in R&D, traveling and stays at CERN and personnel. The next table summarizes the approved funding since 2002.

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Funding of the project “Collaboration in the CMS experiment” from the FCT CERN Program
Participation in the ATLAS experiment

The Portuguese participation in the ATLAS experiment is coordinated by LIP, and has included several universities and other institutes over the years. The ATLAS collaboration was established in 1992 with LIP as a founding member, and has more than 3500 members from 174 institutes from 38 countries. The ATLAS experiment studies very high energy collisions of proton beams or heavy ion beams to investigate the fundamental properties of matter.

The start of this journey were the first applications of scintillating optical fibers in calorimetry in the early 80’s. We had participated in R&D projects for the construction of calorimeters based on scintillating fibers, SPACAL and RD1, at the time oriented for the LHC and SSC projects. The RD34 project was especially relevant, with a new calorimeter concept that became the ATLAS option for the TileCal barrel hadron calorimeter.

Our activities in the ATLAS experiment in the last twenty years covered many areas, with very significant contributions and responsibilities in the R&D phase, construction, commissioning and operation. In this section we will review these contributions, including the present responsibilities in the maintenance and operation of the experiment and the participation in the physics program.

Presently the activities in ATLAS are organized as follows:

- The operation and maintenance of the Tilecal hadron calorimeter and of the ALFA luminosity detector;
- The operation and maintenance of the jet Trigger calibration and one of the online monitoring tools (NODE);
- Proton-proton physics analyses, exploiting the discovery opportunities offered by the new LHC energy;
- Heavy-ion physics analyses, in particular the study of the quark-gluon plasma;
- Research and development in view of the upgrade of the ATLAS detector for collisions at high luminosity.

The accumulated know-how and experience of more than 20 years led to the training and graduation of many MSc and PhD students, to the on-job training at CERN of many engineers and scientists, to the production of several components in Portuguese industry, the integration of Portugal in an extremely dynamic European and worldwide community and, last but not least, a strong contribution to one of the most important current scientific efforts in the world.

Construction of the ATLAS detector. View of the calorimeter surrounded by the coils of the barrel toroid
Detector construction responsibilities

Since the beginning several responsibilities were assigned to the Portuguese team. In general, each assigned task started with R&D and was followed by the construction and deployment phases. In summary, the Portuguese responsibilities in the R&D and construction of the ATLAS Experiment were the following:

- Design and construction of the optics of the Tilecal calorimeter, which is the barrel hadron calorimeter of ATLAS (part of the work is shown in the movie “Portugal in Tilecal”, available for download at [http://www.lip.pt/experiments/tilecal](http://www.lip.pt/experiments/tilecal)).
- Leading responsibility in the WLS optical fibers project, including the design and development of tools and techniques for the fiber preparation and instrumentation of the calorimeter and the respective implementation. The WLS optical fiber project was split in several subprojects:
  - fibers preparation;
  - fibers aluminization;
  - WLS fibers insertion, including:
    - design, development and production of guiding channels;
    - design, development and construction of a robot for fiber insertion;
  - cell desing and fibers routing;
  - Major role in the design and development of the scintillator system;
  - R&D for scintillator production and test of western raw materials;
  - Design and development of the wrapping and masks for the scintillators;
- Design and construction of the Tilecal laser system:
  - Leading role in the design of the light distribution system from the laser to the individual cells;
  - Design and construction of optical fiber connectors, patch pannels and light distribution box;
- Design, development and implementation of Tilecal Detector Control System (DCS):
  - Leading role in the design and implementation of the low voltage power supply system DCS;
  - Leading role in the implementation of the Finite State Machine and user interface of the Tilecal DCS system;
- Development of the Trigger and Data Acquisition (TDAQ) system:
  - Leading role in the R&D for the conditions database framework;
  - Leading role in the development and implementation of the online histogram browsing tool NODE;
  - Level 1 trigger boards;
  - Leading role in the jet trigger calibration in the level 2 trigger system;
- Design and construction of the ALFA detector
  - Important contribution in the scintillating fiber aluminization, prototype tests and reconstruction software;
- Design and construction of the FPIAA system
  - Conceptual design, development and implementation of the system
The following subsections describe in detail each of these activities.

Left: Set of WLS fibers ready for aluminization, after being polished. Right: Aluminization machine to mirror aluminize one end of the WLS fibers. It was developed in cooperation with UNL and is installed at the CFNUL in Lisbon.

Main activities of the Portuguese team during the construction of the Tilecal calorimeter.
Tilecal hadron calorimeter

Tilecal is the barrel hadron calorimeter of ATLAS. Its main goal is the measurement of hadronic showers. It is made of steel as absorber and plastic scintillators as active material. The light produced in the scintillators is collected by WLS fibers and is then transported to photomultiplier tubes where it is converted into an electronic signal.

Tilecal WLS fibers

The projects that would lead to the ATLAS Tilecal massive optical fiber activities in Portugal had their roots in RD34. The technology for coating the fiber end with aluminum was mastered, and a robot to insert fibers in special plastic channels was built. A large station for fiber preparation and aluminization was installed in Lisbon. Aluminization of the 600000 WLS fibers was done in Lisbon and insertion of them in the profiles was done first in Lisbon and later in Coimbra.

The fibrometer and Quality Control of the WLS fibers

One of the key pieces of the WLS optical fiber program is the device used for the measurement of the optical properties of the fibers and quality control (QC), the fibrometer. The system was designed for coping with up to 3m long fibers, and started operations in 1992 both for Tilecal and Delphi STIC luminosity monitor (WLS fibers in both). It proved to be very robust and flexible and was used later also for the ATLAS ALFA luminosity detector (scintillating fibers), SNO+ (clear fibers) and ILC candidate Superdream (scintillating fibers). In the 20 years of operation, it worked already for 5 detectors in 4 experiments.

The quality control of the Tilecal 600K WLS fibers was done twice, first an acceptance QC at arrival from the producer and later, after the aluminization, a second QC was performed.

WLS fibers R&D

The WLS fibers candidates for the calorimeter were available from 3 companies worldwide. Due to the requirements of the Tilecal environment, in addition to good light output and attenuation length, the fibers should be radiation hard and flexible. The last two requirements were part of specific R&D by the producers in close collaboration with our team. The WLS fibers selection process was led by our team. The chosen supplier was Kuraray from Japan.

WLS fibers preparation

Our team adopted the bundling and polishing techniques from SPACAL, essential for the aluminization of one end of the fibers. A total of more than 500 bundles of fibers were produced and polished in Lisbon in a facility at CFNUL.
WLS fibers aluminization

The aluminization technology using magnetron sputtering technique was developed in a R&D project in collaboration with CEFITEC/FCTUNL (Fac. Ciências e Tecnologia da Univ. Nova de Lisboa), and it was a success, producing reflection coefficients above 70%. A facility for aluminization was built and installed at CFNUL, and it was used to aluminize 600K WLS fibers.

WLS fibers insertion – the profiles and the robot

The insertion of the fibers in the calorimeter was one of the most difficult problems to be solved, since 600K fibers with 1 mm diameter and with more than 30 different lengths (in the range 70-230 cm) had to be inserted in 150K calorimeter grooves.

The solution required the development of a plastic “profile” invented by the portuguese team, at the limits of the plastic extrusion technology, and developed in collaboration with the portuguese company Irmãos Bernardos SA. Solutions for opaque, very reflective and long lived painting were found, and a hole drilling and a painting station were set up at the LIP workshop in Coimbra.

At the same time, a robot to insert the fibers in the profiles was developed in collaboration with IDMEC/IST. It was a major engineering project since it required the accurate insertion of fragile WLS fibers in the long plastic profiles without damaging both the components and the respective surfaces. Both R&D projects were successful. A total of about 600000 fibers were inserted in 150000 profiles. The work started in Lisbon at IST during the commissioning of the robot and later it was transferred to the LIP workshop in Coimbra.

WLS fibers routing

After insertion of the fibers they needed to be routed to the face of the PMTs, to make the calorimeter cells structure. The cells were designed by our team, as well as the methodology for the routing. It required the production of mockups to be used during the construction phase. The fiber bundles needed to be glued using a special optical glue, and the gluing method was also designed by our team at the LIP workshop of Coimbra, which designed and produced also the tools to insert the profiles with fibers in the grooves of the calorimeter modules.

Instrumentation of the Tilecal modules at CERN. The routing of the WLS fibers was designed by the Portuguese team, and mock-ups were used to ensure correct copy of the routing in all the 64 modules that form each Tilecal cylinder.
Scintillators

*Scintillator backup and R&D*

The scintillator production was a critical issue, since it was assigned to IHEP Protvino (Russia). Due to the economical and political turmoil in Russia in the nineties, it was decided to prepare a backup solution for the scintillator production, in Portugal and in the USA at Michigan State University (MSU). An R&D with collaboration of IHEP Protvino and Univ. Minho was established to produce scintillators using the injection molding technique and alternative raw materials (polystyrenes from BASF), and a testbench was set up in Lisbon to characterize the plastic scintillators. That R&D was a success even if the backup was not needed for the production. During production, the Russian supplier went bankrupt and polystyrene from BASF was used to finish the scintillators, using the information from the portuguese R&D.

*Scintillators masks*

A parallel R&D was done to select material and design masks for the wrapping of the scintillators, in order to get a more uniform light signal. It involved laboratory tests of materials and masks and computer simulations.

Photomultipliers quality control acceptance

A test-bench for PMT quality control was built and a few hundred PMTs were tested in Portugal.

Early simulations

Early Monte Carlo simulations were done to estimate the calorimeter performance and degradation under very demanding radiation conditions of LHC and to study calibration methods. Our team performed simulations to estimate the effects of Tilecal radiation damage in the jet energy resolution and also proposed calorimeter calibration methods based on the reconstruction of W decaying to jets using top-antitop events.

![Left - Scintillator R&D at LIP and U. Minho, cover of CERN COURRIER in April 1997. Right - Photo of one of our collaborators seen through a set of 3 mm thick scintillators](image)

**Tilecal Laser system**

The Tilecal laser light distribution system includes a box to adjust the global light level using a system of filters and a beam expander, clear optical fibers, and connectors to distribute light and regulate the intensity of light to be sent to each module. All these elements were designed by the Coimbra workshop of LIP and produced in the local industry, except the optical fibers that were bought from Mitsubishi. Each Tilecal module requires 2 or 4 bundles of a few meters long clear optical fibers, and in addition 100 meter long bundles are used to send the light from the laser box sitting in the electronics room to the calorimeter in the cavern.
Tilecal DCS

A large fraction of the Detector Control System (DCS) of Tilecal was developed by the portuguese team, that also made the implementation and maintenance in testbeam setups and in the detector. The development of most of the control and monitoring of the Low Voltage Power Supply (LVPS) system and the implementation of the Finite State Machine (FSM) were done by our team, as well as the tool to transfer the DCS data to the offline data analysis software framework.

Tilecal software, commissioning and performance studies

The portuguese ATLAS group was strongly involved in the data analysis and performance studies of the Tile calorimeter since the beginning of the project, along the various phases of design, construction, installation, commissioning, and production data-taking:

- Test beam studies of the first calorimeter prototypes;
- 2004 combined test beam, with all ATLAS subdetectors;
- Cosmic muon data taking in the experimental cavern in 2005-2008;
- Single-beam data taking in 2008-2010;
- Proton-proton collision data since 2010.

The initial focus was to measure fundamental detector parameters, such as the energy scale with different particle types, resolution, linearity, response uniformity, leakage, etc. In the combined test beam studies, where a full slice of the ATLAS detector was operated, our group carried out studies of hadronic shower models, to validate the simulation, and studies of the calorimeter energy response, clarifying the contribution of optical photon counting statistics to the resolution.

The Tile calorimeter was the first subdetector of ATLAS to be installed in the experimental cavern (in 2005), and so for a long period of time until the start of the LHC (in 2008), cosmic muons were the only high energy particles that could be used to commission and test the detector. For brief periods in 2008, 2009 and 2010, useful data for calibration was also taken with LHC proton beams hitting the collimators and producing horizontal muons. Our group took a leading role in this effort, and contributed in several ways:

- provided the first analyses of cosmic muon data, just a few days after the first data taking, this work was highlighted in "Nature";
- developed an innovative calorimeter-based muon track reconstruction algorithm. Later, this was complemented with sophisticated noise-reduction methods brought by a group with whom we closely collaborated, from the Federal University of Rio de Janeiro. This algorithm was extensively used by the TileCal community throughout the whole commissioning phase, both for online data quality monitoring and validation of the detector performance and energy calibration.
- we were responsible for the maintenance and development of TileCal data reconstruction software during the muon commissioning period (see list of responsibility tasks).
- we developed methods for measuring time calibration offsets from the muon data and from single-beam data. These studies allowed the calorimeter to start beam data-taking already with a very good time calibration.
Participation in the ATLAS experiment

With the start of the LHC collisions, the performance studies have shifted into overall calorimetry performance issues. One of these is the problem of correlated noise in the calorimeter electronics, and our group has developed and implemented a correction method to deal with it. With the increase of instant luminosity, one of the dominant sources of performance degradation is the pile-up of different events. Our group is now active in studying and developing correction tools for the effect of pile-up on the Missing Transverse Energy calculation.

"First 'data' from LHC", commissioning of Tilecal with cosmics, in the Research Highlights of Nature Physics (2005)

TDAQ: databases and Level 1 trigger

The group has participated actively in the development of the ATLAS Trigger and Data Acquisition (TDAQ) system by developing components of the TDAQ prototype that included the Online Bookkeeper system, which was fully developed under the responsibility of the Portuguese team.

Databases developments

- An open software implementation of the Conditions Database service (Lisbon Conditions Database), that became a cornerstone in the definition of the main specifications of the full ATLAS conditions database;
- Development of the Configurations Database persistence solution: the computing tools to access monitoring information from the database is a final service presently maintained by the Portuguese TDAQ software team, including the online histogram browsing tool NODE2;

Level 1 trigger firmware

- A contribution to the ATLAS first level Central Trigger Processor (CTP) subsystem was provided by the electronics team of FCUL. They developed several firmware modules, the firmware for managing the Local Trigger Processor Interface Module and the firmware for the Muon Interface CTP module of the first level of the event filter of the ATLAS detector;
**ALFA – Absolute Luminosity for ATLAS**

ALFA is the subdetector of ATLAS responsible for the measurement of the absolute luminosity with high precision. We contributed to this project due to our knowledge in scintillating fibers preparation and aluminization. Our participation in the project was always modest but relevant. We participated in the aluminization of the fibers for the prototypes and detector modules, in the analysis of performance in beam tests, and we are currently working in the development of the infrastructure for the data reconstruction.

Left: Luis Gurrjana during the Tilecal maintenance operations in the ATLAS cavern during 2011-12 winter shutdown. Right - Set of 0.5 mm square scintillating fibers polished to be aluminized for the ALFA detector.

**FPIAA – Find Persons Inside Atlas Area**

ATLAS is a very large detector with small hidden corners and for safety matters it is necessary to monitor the human presence inside during the accesses for repairs. A system implementing a large network for scanning and monitoring the presence of people in remote areas was developed in collaboration with IDMEC/IST and deployed in the ATLAS detector. People’s presence is monitored by infrared and ultrasonic sensors, that need to operate in an environment of a strong magnetic field and are irradiated when the detector is operating.

Industry participation in R&D and construction, main participants

Irmãos Bernardes SA (profiles), 3D Tech (fiber connectors and plastic pieces), and A. Silva Matos (ATLAS helium tanks) were the main Portuguese industrial partners in the preparation of the ATLAS experiment.
Detector operation and maintenance responsibilities

As a follow-up of the construction responsibilities, the Portuguese group participates in the Maintenance and Operation (M&O) of the detector, and in particular is responsible for the M&O of the Tilecal laser distribution system, Tilecal DCS system, TDAQ NODE2 and level 2 trigger jet calibration.

During the detector construction the Portuguese group had typically two to three people (rotating among the group members and splitting by several activities) at CERN dedicated to the installation and commissioning of several systems, complemented by two to four training engineers of the ADI program.

The group is responsible for the following tasks, which require the presence at CERN of three people:

- a) maintenance of the Tilecal laser light distribution system;
- b) maintenance of the Tilecal DCS system;
- c) upgrades and maintenance of the NODE2 histogram browser;
- d) upgrades and maintenance of the level 2 trigger jet calibration;
- e) configuration and maintenance of the heavy ion jet data quality monitoring.

Several members of the group are “experts on-call” available during LHC runs to intervene in case of system faults. The group assured a high number of data taking Shifts in Tilecal, Trigger and Tier-0, as required by the Collaboration. Members of the group also served as Run Coordinators and Data Quality Leaders in the subdetectors at several occasions during the data taking periods.

Robot for fiber insertion. It was developed in cooperation with IDMEC/IST and the commissioning with insertion of fibers for the first modules was done in Lisbon at IST (left), before being transferred to the LIP workshop in Coimbra (right) where most of the WLS fibers insertion took place.
Physics analysis

During the design phase of the ATLAS experiment, several physics processes were studied as benchmarks to define the ultimate goals of the detector and in particular the ones related with calorimeter calibration. The first studies using hadronic decays of top quarks produced at the LHC, were performed at that time. The possibility of using the last longitudinal layer of TileCal to help on muon trigger identification was also explored during that phase. Later on, during the detector construction and commissioning phases, the group started the studies of the properties of the top quarks produced abundantly at the LHC, the measurements of the W mass and production cross sections, and also jets calibration. Due to the outstanding performance of the LHC collider, a new window was opened for the quest for the Higgs boson, a search the group is heavily involved in nowadays. The group’s heavy-ion program started at about the same time.

Standard Model physics

W boson properties

Our involvement in Standard Model Physics studies started long before the first LHC data was collected, developing the analysis methods and tools for the measurement of the W boson properties, some of the first measurements done with the LHC data and a very important benchmark process to understand the detector and trigger performance. Our main responsibilities were the following ones:

- Early studies for the precision measurement of the W boson mass.
- Data-driven methods to estimate the muon trigger and reconstruction efficiencies using realistic simulations. With these studies, we participated in the preparation of an ATLAS wide publication in 2008, the ATLAS expected Physics and performance book (CERN-OPEN-2008-20).
- Development and maintenance of the WtoMuonNeutrino Benchmark analysis software, a set of simple but complete analysis code to be used as a reference W analysis, that was ready and used for the first production of ntuples dedicated to the W cross sections studies.
- Once the data taking started, our involvement focused on calculation of the theoretical cross section at NNLO using the FEWZ calculator and evaluation the expected acceptance (the efficiency for the geometrical and kinematical selection conditions) and its systematic uncertainty due to the theoretical model (CERN-PH-EP-2010-037).

![Distribution of the W transverse mass obtained using the benchmark tool.](image)
Di-boson studies

The study of di-boson production at the LHC tests SM predictions, that we have recently started, constrains New Physics models and allows the exploration of anomalous Triple Gauge Couplings, that might provide the first indication of Physics Beyond the Standard Model. This process is also an important background in Higgs searches, particularly in the associated production of a Higgs with a W/Z boson and in the H-WW decay channel that we are studying.

Higgs searches

The search for the Higgs boson, responsible for the Electroweak Symmetry Breaking mechanism, is the main goal of the LHC experiments. We have participated in the ATLAS Higgs searches in two different analysis channels that contribute to different mass ranges. Last year there was a huge progress in the Higgs search at the LHC, with the exclusion of a very large range of masses, restraining the possible mass range of the Higgs boson mainly to a small window around 120 GeV, where this year a Higgs-like particle was found with a mass near 125 GeV. However, the discovery of the Higgs is not the only goal, since its properties need to be measured and the H->bb channel will be important to test the Yukawa couplings predictions.

Higgs decaying in bb

H->bb is the dominant decay mode in the mass region currently allowed by the direct searches at LEP and LHC and also favored by the SM precision measurements. In what corresponds to the H->bb, our efforts concentrated in the following lines:

- To avoid the overwhelming QCD background, the signal significance can be improved by requiring an associated W boson, and that the Higgs boson is highly boosted. In this regime, the two b quarks from the Higgs decay form one single fat jet, that can be separated from the background with a careful jet substructure study. We studied the performance and the weak points of different substructure techniques.
- Cut-based, non-boosted, analysis, for the study of the first data taken in 2011 and in 2012.
- Main responsibility: we edited the first ATLAS public note that summarized the searches for a Standard Model Higgs boson, produced in association to a W boson and decaying to b-quark pairs (ATLAS-CONF-2011-103), sharing duties with two colleagues from Birmingham and Liverpool universities.

Left: Exclusion limit on the cross section of a SM Higgs boson for associated production with W and decaying in a pair of bottom quarks, as a function of the SM cross section. Right: Higgs transverse mass distribution for the search in the WW channel.
Higgs decaying to WW

- The channel H→WW has provided most of the exclusion power of ATLAS in the intermediate mass range of the Higgs boson −120 GeV < mH < 240 GeV and was one of the 3 channels that participated in the discovery of the new Higgs-like particle in ATLAS.
- In the H→WW channel, we developed an alternative data-driven method to measure two of the main backgrounds, Z+jets and Drell-Yan. Our method allowed to better estimate the systematic uncertainties in the determination of these backgrounds in 2011 and it was essential to reduce the Z+jets/Drell-Yan contribution in the same flavour final state in 2012. These resulted in major contributions in the 2011 and 2012 H→WW results.

Hope these events are really what we are looking for! Higgs candidate events, the left one decaying in four leptons and the right one in two photons.

Top quark

The top quark was discovered already 17 years ago by the CDF and D0 experiments in 1995. It is the heaviest known elementary particle and because of its large mass, it is natural to think that it may well play a fundamental role in the electroweak symmetry breaking mechanism of the Standard Model. Although the mass of the top quark is known very precisely, no other property of this quark is known with such precision. The measurement of the top quark properties becomes then, a key issue of the measurements performed at the LHC. Not only as a test of the Standard Model itself but also as a test of new Physics beyond the Standard Model. The group has consistently developed the highest level of expertise in the field, with publications in peer reviewed journals and presentations in Schools, Workshops and Conferences. A series of International Workshops was started by the group in 2006, in Coimbra, Portugal, which was enthusiastically accepted by the International community. Since then the Workshop has been held initially every two years from 2006 to 2010 and then every year, upon request of the Top Quark community all over the world. The main objective of such workshops is to allow the development of a world-wide experimental and theoretical community dedicated to the study of the properties of the top quark and its main role within the Standard Model.

The LIP group has been involved and/or had a leading role in several top quark physics analysis (within and beyond the Standard Model). The most significant contributions are:
Top quark properties

The Top Quark Physics chapter of the book "Expected performance of the ATLAS Experiment, Detector, Trigger and Physics" (CERN-OPEN-2008-20) contains the contributions from the group on the expected measurements of the a) top quark charge, b) the top quark spin, c) the top quark polarization and spin correlations, d) the top quark rare decays and e) reconstruction of t\(\bar{t}\) resonances.

Pair Production Cross Section


Top Quark Decays Through the Dominant Decay Mode \(t\rightarrow Wb\)

Measurement of the W-boson polarisation in top quark decays in pp collision data at 7 TeV using the ATLAS detector (ATLAS-CNF-2011-037). Measurement of the W boson polarisation in top quark decays in 0.70 fb-1 of pp collisions at 7 TeV with the ATLAS detector (ATLAS-CNF-2011-122)

Rare Top Quark decays:


New Physics Processes Associated to Top Quark Production at the LHC:

Search for same-sign top-quark production and fourth-generation down-type quarks, JHEP 04 (2012) 069.

Production of Top Quark Tools for the LHC community:


PROTOS: (PROgram for TOp Simulations + Triada) a new Monte Carlo generator for top quark physics at the LHC, (http://www-ftae.ugr.es/prootos/).

METOP: a New (NLO) Top Quark FCNC Event Generator, in preparation.

Search for new heavy quarks:

The search for fermions beyond the Standard Model has recently started. The LIP group is involved in the development of multilepton analysis devoted to the search of new heavy quarks couplings mainly to the third generation of Standard Model. The results of such analysis will be interpreted within different new physics models. The team members were also responsible for the integration and validation of the Protos Monte Carlo generator the within the ATLAS simulation framework.
Heavy Ions

Quantum Chromodynamics predicts that matter should exhibit two distinct phases - a hadronic phase at lower temperatures, where the degrees of freedom are composite bound states of quarks and gluons, and a partonic phase at extreme conditions of energy densities or temperatures. The latter corresponds to a deconfined system and it is thought to be equivalent to a plasma of quarks and gluons. Such a deconfined system would have occurred a few microseconds after the Big Bang, and it is expected to set in the core of the neutron stars. The Heavy Ion (HI) program of the LHC started in 2010 with the first data acquisition taking place at the fall of the year and has been followed by a new period in November 2011, in which a factor of 10 higher statistics was achieved.

ATLAS has observed the first asymmetric dijet events and heavy bosons in heavy ion collisions and LIP is deeply involved in the analysis of the former observation (CERN-PH-EP-2010-062). Beyond physics analysis, LIP performs jet reconstruction performance studies, namely jet energy scale, resolution and reconstruction efficiencies, which show to be largely dependent on the dense environment created in the Pb+Pb collisions and, so, needs careful control. LIP is also involved in the validation of the so-called overlay which consists in the embedding of simulated dijets in real Pb+Pb events, instead of the mostly used embedding in the MC heavy ion event generator HIJING. The goal is to overcome the non-perfect description of the heavy ion events by the later. LIP is responsible for the configuration and maintenance of the heavy ion jet data quality monitoring.
Jet Trigger

Our group played a major role in the reconstruction and calibration of jets at the Second Level Trigger (LVL2) since 2006.

The jet trigger is an essential tool to select, in real time, data for many QCD measurements and searches for Physics Beyond the SM. Given the fact that the dominant background for events with jets are other events with jets, the main difficulty of the jet trigger consists in measuring correctly the jet energies, with the best possible resolution, in the very short time interval allowed online (40 ms for the Second Level Trigger, LVL2).

Our main responsibilities during these years were the following:

- Development of calibration tools and study of the appropriate techniques to be applied at the LVL2 jet trigger, with focus on the robustness and reliability.
- Debugging of the jet trigger with cosmic muon data. This data was used to identify and design methods to deal with problems in the data preparation, like noisy channels.
- Validation of the LVL2 jet trigger and its calibration constants with the first pp collisions data with in-situ methods and detailed performance studies. Thanks to this work the LVL2 jet trigger was declared validated on September 2010 (ATLAS-CONF-2010-094).
- Improvements of the jet trigger: we proposed an innovative idea to improve the performance of the LVL2 jet trigger by re-using the first level trigger information. This method was implemented by collaboration colleagues and was one of the major improvements of the LVL2 jets in 2012, opening new configuration possibilities to better handle the different physics requirements and data taking conditions.
- Study the performance and optimize the Hadronic Calibration triggers. They are essential to validate the calorimeter response to hadrons and to estimate the jet energy scale uncertainty, that is one of the largest systematic uncertainties affecting many analysis (including our Higgs and di-boson studies).

Another task that was started this year was the study of the performance and optimization of the Hadronic Calibration (HadCalib) triggers. They are essential to validate the calorimeter response to hadrons and to estimate the jet energy scale uncertainty, that is one of the largest systematic uncertainties affecting many analysis (including our Higgs and di-boson studies).

![Graph](image_url)

Trigger jets turn on curve obtained with 2011 data.
ATLAS GRID

The main objective of the Portuguese group in the ATLAS Grid is the operation and monitoring of the local Tier-2 and Tier-3 clusters with respect to the ATLAS production activities. These include the transfer, storage, processing, reconstruction, distribution and analysis of large volumes of data, and also the production of simulated samples. It also supports the users from the Portuguese ATLAS team and has a fruitful interaction with the European South West Grid cloud (the Iberian cloud) in order to monitor and solve the common issues of operation and integration of activities. Within the worldwide ATLAS collaboration, the Portuguese group is actively involved in the management of the Iberian Cloud, which is one of the 11 regional clouds that make up the worldwide computing Grid for the ATLAS experiment. It involves the Tier2 centres in Valencia, Barcelona, Madrid, Lisbon and Coimbra and the Tier1 in Barcelona. The current coordinator of the Iberian Cloud is a member of the Portuguese group.

The Iberian cloud and the Portuguese Tier2 have shown excellent results in the operation during the last year. The reliable operation of the Grid infrastructure contributed to the great success of the first years of LHC operation, with data processed and available a short time after data taking. During the heavy data flow, after the start of the LHC collision operation mode in March 2010, the Iberian cloud and, in particular, the Portuguese Tier2, have shown excellent performance. All three sites in the Portuguese Tier2 delivered a capacity that exceeded the requirements for ATLAS and exhibited good reliability and availability metrics. Recently all three centres achieved 100% in the monthly reliability reports. The Portuguese Tier2 was the 10th largest European provider in WLCG.

Detector upgrade program

After successfully running and exploiting the LHC in its current setup for a few years, the ATLAS Collaboration is preparing to pursue the unprecedented physics opportunities offered by the exploration of a completely new energy domain at a luminosity beyond the LHC nominal design value. The determination of the Higgs properties, precise measurement of top quark properties and searches for physics beyond the Standard Model will be the main goals. To achieve them, a plan to consolidate and improve the physics capabilities of the current detector was devised, to be executed along the next 10 years. The improvement of the ATLAS trigger system to cope with the new luminosity, while still retaining the current physics performance, is one of the crucial interventions.

For the upgrade of the Tile hadron calorimeter, several projects are in progress or are planned to be incorporated during the several upgrade phases up to 2023. Here the ones in which we are working will be presented. The trigger scintillators, placed in the Tile crack region, will be replaced and we will prepare the WLS fibers for their readout. In parallel, all the electronics systems will be renewed. New Low Voltage Power Supplies are in production for installation during the 2013 LHC shutdown. A mobile tester called MobiDICK 4 is being developed to be used during the installation.

The communication links to be used between the front-end and back-end electronics will go through a major upgrade. The increased luminosity (5x) implies a consequent increase in the amount of data being transferred among the many units (detectors, trigger systems, databases, DCS…) in ATLAS. To cope with that, a new inclusive communication link, called GBT (GigaBit Transceiver) was developed by CERN staff and collaborators. Our group has already studied the performance of the implementation of the GBT protocol in new generation FPGAs (Xilinx Virtex-6). A Luxtera transceiver/modulator device is currently under evaluation as an alternative for the optical links.

The DCS will need to be upgraded in parallel. Since most of the data and commands will also be transmitted using the optical links, a system to decode and route this information, compatible with the current system, will be needed. We will participate in the implementation of the communication with the hardware devices, in the definition and implementation of the automatic actions required to ensure the safety of the detector and in the design and implementation of the user interface and definition of the states of several components.

Prototype “demonstrator” modules of Tilecal using most of the new electronics will be produced and installed in...
the detector by 2014 for testing.

With respect to the High Level ATLAS trigger system, several improvements are under consideration in the ATLAS trigger group. The core software infrastructure is being re-designed simplifying the data flow infrastructure. The Second Level Trigger, the Event Building and the Event Filter (third level trigger) will be run in the same processing unit, saving time from the data transmission and data preparation steps. The trigger processors will be upgraded in 2017 and although the architecture is not decided yet, they will use a larger number of cores/CPU, possibly with Grafical Processing Units (GPUs) or Many Integrated Core (MIC) systems. We will work on the development and improvement of jet trigger algorithms to take advantage of the new trigger architecture and the possible new hardware, by parallelizing repetitive parts and optimizing the trigger selection chains for either pp or heavy ion collisions.

We will contribute also to the ATLAS Forward Proton (AFP) detectors that will be installed 220 m upstream and downstream of the ATLAS interaction point to detect intact final state protons scattered at small angles and with small momentum loss. The capability to detect both outgoing protons in diffractive and photoproduction processes in conjunction with the ATLAS central detector enables a rich QCD, electroweak and beyond the Standard Model experimental program. The addition of a second AFP station will allow the measurement of the Higgs in Central Exclusive Production. We will contribute to the AFP project in the development of appropriate triggers to detect Central Exclusive Processes by combining the central detector and the forward proton tagging.

![Image of ATLAS team members]

Some of the current members of the ATLAS team.

**Institutions**

LIP (Lisbon and Coimbra), FCUL, CFNUL, FCTUC, IDMEC/IST, CEFITEC/UNL, Un. Minho, Un. Católica Figueira da Foz

**Research Team**

The membership and composition of the ATLAS team has evolved with time. On average the group has near 30 members, and currently its distribution is as follows:

- 4 faculty
- 5 senior researchers
Participation in the ATLAS experiment

- 4 postdocs
- 13 research students (Master and PhD)

Coordination structure

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
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<tbody>
<tr>
<td>Project leader</td>
<td>Amélia Maio</td>
</tr>
<tr>
<td>Higgs physics</td>
<td>Patricia Conde Muiño</td>
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<tr>
<td>Top physics</td>
<td>António Onofre</td>
</tr>
<tr>
<td>Heavy Ions</td>
<td>Helena Santos</td>
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<tr>
<td>Exotic physics</td>
<td>Nuno Castro</td>
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<td>Trigger/DAQ</td>
<td>Patricia Conde Muiño</td>
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<td>Tilecal DCS and Upgrade</td>
<td>Agostinho Gomes</td>
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<td>Tilecal laser</td>
<td>Filipe Veloso</td>
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<tr>
<td>Tilecal software</td>
<td>José Maneira</td>
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<td>ALFA:</td>
<td>Amélia Maio</td>
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Coordination positions in the ATLAS Collaboration

- Tilecal Run coordinator, 2012, J. Gentil Saraiva
- Tilecal Software and Computing co-Coordinator, 2009-2010, J. Maneira
- Publications Committee, 2008-2010, A. Onofre
- Tilecal Timing Task Force Coordinator, 2008-2010, J. Maneira
- Chairperson of Hadronic Calibration Workshop, 2009, P. Conde Muiño
- Trigger Jet Slice Coordinator, 2008-2009, P Conde Muiño
- Chairperson of Tilecal Speakers Committee, 2008-2009, A. Gomes
- Tilecal Run Coordinator, 2008, J. Maneira
- Phase 3 Commissioning co-Coordinator, 2006-2008, J. Maneira
- Tilecal DCS Coordinator, 2003-2008, A. Gomes

Organization of meetings, workshops, seminars

- IDPASC Higgs School, 6-9 September 2011, Foz do Arelho, Portugal
- The Standard Model of Elementary Particles, course at Fac. Sciences of Univ. Lisbon, 14 June-5 July 2011, Lisbon, Portugal
- 5th ATLAS Hadronic Calibration Workshop, 23-27 June 2009, Foz do Arelho, Portugal
- CALOR99, VIII Int. Conf. on Calorimetry in High Energy Physics, 13-19 June 1999, Lisbon, Portugal
- Series of International Top Quark Workshops initiated by the ATLAS group.
Participation in the ATLAS experiment

Series of International Top Quark Workshops initiated by the ATLAS group.

ATLAS Outreach

The participation in the ATLAS outreach program was always part of our project. Our group has been the leading one in ATLAS in the introduction of animated movies to describe some of the activities that later derived in the production by the experiment of several movies explaining how the detector is made, how it works, and the physics it intends to search, and also other multimedia material. A movie made by the portuguese team reported the main activities in the R&D and production of the optical components for TileCal (“Portugal in Tilecal”).

We have also participated every year in the program “Ocupação Científica dos Jovens nas Férias”, having 4 to 8 young students of secondary schools working in our labs during 2 weeks in the summer.

Scientific production

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Program Funding

The MoU agreements established a total contribution to the ATLAS experiment of 2.5 MCHF, representing about 0.5% of the cost of the experiment. The funding profile was spread over a period of 11 years, from 1997 to 2008. This contribution had two components: 1) in-kind detector components provided by LIP; 2) in-cash contribution to the experiment Common Fund.

In 2002 was established the agreement between FCT and CERN that defined the Portuguese contribution to the Maintenance and Operation (M&O) of the detectors in the period 2002-07. The M&O agreement was renewed for a new 5-year term between 2008 and 2012.

Since 1990 the LIP group in the ATLAS experiments in collaboration with other institutes in Portugal have submitted annually to the CERN program in FCT the research project and funding request for the following year to cover expenditure in R&D, traveling and stays at CERN and personnel. The next table summarizes the approved funding since 2002.

<table>
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<tr>
<th>Code</th>
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<td>CERN/FP/83515/2008</td>
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<td>Waiting</td>
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Seminars organizations
Workshops/Conferences
Outreach Seminars
Total 6 31 38 39 68 75 93 156

Memorandum of the Portuguese participation in the LHC experimental program | LIP 47
The LHC computing GRID

The LHC experiments produce a data deluge roughly 15 million gigabytes per year or the equivalent to 1.7 million dual-layer DVDs. This data needs to be processed and analysed by more than 8000 scientists spread over 35 countries. The processing of the LHC data requires massive computing and storage capacity. Upon the design of the LHC computing it become obvious that this capacity could not be attained at CERN. However most of the research institutes in the LHC programme had access to local or national computing facilities which if improved and interconnected could provide the necessary capacity. A new computing concept called grid matched perfectly the LHC requirements for resource integration and distributed analysis. The LHC community research around grid technologies ultimately lead in 2002 to the Worldwide LHC Computing Grid (WLCG), a global collaboration linking grid infrastructures and computer centres worldwide.

The grid computing paradigm refers to the integration of heterogeneous distributed computing resources from multiple administrative domains into a coherent infrastructure. According to this paradigm, the execution of applications can be carried out taking advantage of geographically distributed computing resources interconnected by very high speed data networks that enable the transmission of large data sets and distributed software coordination.

The Worldwide LHC Computing Grid has today more than 140 computing centres across 35 countries. WLCG sits on top of two large grid infrastructures the Open Science Grid in the United States, and the European Grid Initiative. Smaller regional grids in other geographic areas are also members either directly or through EGI.

The WLCG infrastructure has a tiered hierarchical topology that comprises four levels. The Tier-0 is CERN where the raw data is produced and a first copy is performed. The CERN computer centre provides less than 20% of the total WLCG capacity. The Tier-1s are eleven large computer centres that provide permanent safe-keeping and reprocessing of the raw data. The Tier-2s are medium centres that provide data analysis, simulation and reconstruction. There are about 140 Tier-2 centres worldwide. In the context of the WLCG Memorandum of Understanding signed by the Portuguese government, LIP operates the Portuguese Tier-2. The Portuguese Tier-2 is fully integrated in WLCG and serves the ATLAS and CMS experiments. Finally the Tier-3s are small computing centres close to the researchers aimed at supporting local data analysis. LIP also operates Tier-3 facilities to support the Portuguese ATLAS and CMS researchers.
Participation in computing R&D programs

CERN and the LHC community have pioneered the use of grid computing technologies in Europe. With the aid of the European Union framework programs a series of projects developed technologies and built large grid computing infrastructures for data intensive applications. These projects demonstrated the feasibility of joining resources from computing centres worldwide to enable extreme scientific computing. LIP has been deeply committed to this effort and participates actively in major grid computing R&D projects since 2001.

DataGrid - Research and Technological Development for an International Data Grid
2001-2004 36 months
The DataGrid project (lead by CERN) developed the architectural basis for data intensive grids. LIP participated as unfunded partner in pilot activities validating the suitability and advantages of these technologies both for High Energy Physics and other scientific domains.

CrossGrid - Development of Grid Environment for Interactive Applications
2002-2005 36 months
The CrossGrid project expanded on DataGrid by developing support for MPI applications, creating new tools and services and introducing new scientific applications. LIP had an important contribution in the middleware validation and pilot infrastructure activities.

EELA – e-Infrastructure shared between Europe and Latin America
2006-2007 24 months
The EELA project introduced grid computing in Latin America. LIP had a major role in technology transfer, was a member of the joint infrastructure, and coordinated the creation of grid certification authorities in Brazil, Argentina, Mexico, Chile and Venezuela. LIP was also responsible for the core infrastructure services supporting authentication, authorization and security.

Int.Eu.Grid – Interactive European Grid
2006-2008 24 months
The Int.Eu.Grid project developed much further the support for parallel and interactive applications in data-grid environments. LIP was responsible for the coordination of a production quality grid infrastructure composed of twelve data-centres spanning seven countries and had a major role in software integration and project coordination.

EGEE – Enabling Grids for e-Science (I, II and III)
2004-2010 72 months
The EGEE project series (lead by CERN) operated a large worldwide multidisciplinary grid infrastructure supporting multiple scientific domains such as life sciences, chemistry, earth sciences, civil protection, fluid dynamics, condensed matter physics, astronomy, astrophysics, high energy physics including WLCG, geophysics, finance and others. Along six years EGEE-I, II and III established the basis for a permanent pan-European grid. LIP participated actively in EGEE coordinating the first national grid infrastructure joining resources from Portuguese universities and research centres.

INGRID - National Grid Initiative (NGI)
2006-
In 2006 the Portuguese Ministry of Science launched the national grid initiative (NGI) which aims to support the development of resource sharing for demanding computing applications and to ensure the enhancement of strategic competences and capacities of special interest for this type of computing. Today more than 30 national grid initiatives exist in Europe. They operate national grid infrastructures that support demanding scientific applications.

LIP has a major role in the Portuguese national grid initiative, coordinating the national infrastructure and operating the grid core services that integrate of Portuguese grid sites into a seamless infrastructure making possible the coordinated participation in the European grid and in WLCG. The Portuguese NGI infrastructure is composed of 7 centres: UPorto, UMinho-CP, IEETA, CFP-IST, LIP-Lisbon, LIP-Coimbra, and NCG-INGRID-PT.

NCG - Portuguese Central Node for Grid Computing 2007-2009

In the NGI context LIP in partnership with the Portuguese academic research network (FCCN) and the civil engineering laboratory (LNEC) have created the main node for grid computing (NCG), a national computing facility that provides computing capacity to the Portuguese research community. The NCG computing room is managed by FCCN, while the NCG computing and storage services are managed by LIP. NCG provides resources to the Portuguese WLCG Tier-2 and to a wide range of scientific applications from multiple scientific domains. The Portuguese NGI infrastructure is supporting: laser plasma simulations, genomic sequence assembly, brain imaging, endoscopy imaging, protein folding, wave modelling for oil spills simulation, astroparticles, turbulent plain jets, and morphodynamics of coastal systems, among others.

G-CAST – Grid Computing on Coastal Morphodynamics 2008-2010

In the g-CAST project the Portuguese Civil Engineering Laboratory (LNEC) used grid technology to perform coastal morphodynamic simulations. LIP provided consultancy, training and performed the integration of the LNEC parallel computing cluster into the NCG grid environment.

Support for grid middleware test and validation activities 2007-2010

This project provided the support for the middleware test and validation activities performed by LIP in the context of several national and international projects and initiatives. The project included R&D in the use of virtualization technologies applied to the provisioning of grid services.

IBERGRID – Iberian grid initiative 2007-

Resulting from agreements between the governments of Portugal and Spain, the Iberian grid initiative (IBERGRID) joins the NGI infrastructures from both countries into a single grid. The IBERGRID initiative has been very successful both at the technical and strategic levels. Both the computing capacity and the effort required to operate the infrastructures are shared across borders. IBERGRID maximizes the return of the Iberian installed capacity and reduces significantly the operations effort allowing for better service quality and resilience. IBERGRID is also providing the collaborative framework under which Portugal and Spain participate in the European Grid Initiative (EGI) as a unified regional infrastructure. LIP coordinates the Portuguese infrastructure in IBERGRID.

EGI-InSPIRE - European Grid Initiative: Integrated Sustainable Pan-European Infrastructure for Researchers in Europe 2010-2014

Built on EGEE and previous projects and joining the national grid initiatives, the European Grid Initiative (EGI) aims
to ensure the long-term development and sustainability of European grid services and infrastructure. EGI maintains a sustainable pan-European infrastructure to support European research communities and their international collaborators. The EGI infrastructure is backed by a four-year project designated EGI-InSPIRE which supports and co-funds EGI operations with a common goal – to create a seamless system ready to serve the demands of present and future scientific endeavours. The Worldwide LHC Computing Grid uses the EGI infrastructure to access its Tier centres in Europe.

The Portuguese and Spanish NGIs under the IBERGRID framework participate together as a regional grid in the EGI infrastructure. In addition LIP has strategic roles in the EGI-InSPIRE project management board where it represents Portugal and Spain.

![EGI and its associated regional infrastructures](image)

Through these projects LIP gained extensive expertise in the field of grid computing infrastructures operation and deployment. Currently in the IBERGRID, NGI and EGI contexts LIP provides professionally managed grid services for Portuguese and Spanish researchers and coordinates the Portuguese grid. LIP also operates the “LIP CA” a certification authority accredited by the “International Grid Trust Federation” (IGTF) that provides grid authentication credentials accepted worldwide to the Portuguese research community.

Along the past eleven years LIP created a core of competence in the e-Science domain that is unique in the country. LIP is managing the largest distributed computing infrastructure ever built in Portugal and has successfully engaged with partners in Portugal and Spain to establish a truly Iberian computing infrastructure through which Portugal participates in the Worldwide LHC Computing Grid and in the European Grid Initiative. The knowledge and capacity acquired is of vital importance to sustain the international commitments assumed by LIP in the LHC and other experiments.
The Portuguese Tiers-2 and 3

The Portuguese federated Tier-2 is composed of three datacentres located in Lisbon and Coimbra which are interconnected via a high speed ten-gigabit Ethernet network provided by FCCN. Each centre contains a processing cluster interconnected by a high speed Ethernet network and a high-performance distributed file-system. The Tier-3 is attached to the Tier-2 and uses the same technologies. The combined capacity across the sites for both experiments is about 1150 CPU cores and 628 TB.

- **LIP-Lisbon:** located at the LIP facilities in Lisbon is a highly dense 40m² datacentre.
- **LIP-Coimbra:** housed at the University of Coimbra sharing space with the CFC cluster.
- **NCG:** national computing service located at the LNEC campus in Lisbon.
## ATLAS

<table>
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<tr>
<th>Tier Type</th>
<th>LIP-Lisbon</th>
<th>LIP-Coimbra</th>
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## CMS

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![Portugal (Tier2) Cumulative Total number of jobs by SITE and DATE (Excluded dteam and ops VOs)](image-url)
Research teams

Team coordinator: Jorge Gomes

Current team composition:

- PhD: 4
- Pos-doc: 1
- BsC: 4
- Technicians: 2

Total people that participated in the program: 19

Team Members:

- Jorge Gomes
- Gaspar Barreira
- Carlos Manuel
- Gonçalo Borges
- Hugo Gomes
- João Martins
- João Pina
- José Aparício
- Mario David
- Miguel Oliveira
- Nuno Dias

Old Team Members:

- Henrique Matos
- Sara Valente
- Manuel Montecelo
- Bruno Silva
- Helmut Wolters
- Luis Morgado
- José Nogueira
- Ana Simões
Coordination positions

- Member of the European Grid Initiative Council, 2010 - , J. Gomes
- Member of the EGI Project Management Board representing Portugal and Spain, 2010 - , J. Gomes
- Member of the WLCG Grid Deployment Board, 2005 - , J. Gomes
- Portuguese Federated Tier-2 Coordinator, 2008 - , J. Gomes
- Portuguese Federated Tier-2 Deputy Coordinator, 2008 - , M. David
- Interactive European Grid - Project Deputy Manager, 2006-2008, J. Gomes
- Interactive European Grid - International Infrastructure Coordination, 2006-2008, G. Borges
- Interactive European Grid – Middleware Validation Coordination, 2006-2008, M. David
- Enabling Grids for E-SciencE - South West Federation Deputy, 2006-2010, J. Gomes
- Enabling Grids for E-SciencE – ROC deputy manager, 2008-2010, G. Borges
- Iberian Grid Initiative - Portuguese Grid Coordinator, 2008- , J. Gomes
- EGI Middleware Rollout Coordinator, 2010 - , M. David
- EGI Technical Services Coordinator, 2010-2011, G. Borges
- EGI Technical Outreach Global Task Coordinator, 2011, G. Borges
- PT NGI International Liaison, 2011 - , G. Borges
- PT NGI Security Officer, 2010 - , N. Dias
- PT NGI Operations Managers, 2006 - , G. Borges and M. David
- Member of the European Grid Policy Management Authority, 2000- , N. Dias and J. Gomes
## Scientific production

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Technology transfer to medical applications

LIP has a long tradition in the development of medical applications based on technologies originally used in High Energy Physics experiments. We do not attempt in this document an exhaustive description of these efforts. Rather we concentrate on a specific case, the development of a PET scanner for breast cancer detection, which resulted from direct application of technology developed for the CMS experiment.

The development in the nineties of new scintillating crystals for the Electromagnetic Calorimeter of the CMS experiment by the Crystal Clear Collaboration (RD18) was at the origin of the search for new crystals for PET applications. Complementary, the experience with avalanche photo-detectors and the developments at LIP in the areas of integrated front-end electronics and high-performance data acquisition systems, created the conditions to develop in Portugal an innovative PET technology dedicated to breast cancer high-resolution imaging.

The ClearPEM instrumentation program

The development of PET (Positron Emission Tomography) technology applied to the detection of breast cancer (ClearPEM) was started in 2003 by the consortium PET, under LIP scientific leadership and sponsored by Taguspark. The research was co-financed by Agência de Inovação and by the start-up company PETsys which joined the consortium in a later phase.

The high incidence of breast cancer and the relative inefficiency of the conventional detection methods (X-ray and ultrasound mammography) suggested the need for better imaging techniques. The project tried to answer this need by developing new equipment with higher sensitivity for breast cancer detection.
PET (Positron Emission Tomography) is an image technique used in the detection and characterization of malign carcinoma. It consists in the injection of a substance labeled with a positron emitter (usually 18F-fluoro-deoxy-glucose, FDG) and in the detection of photons emitted in opposite directions. The detection of the emitted photons allows the reconstruction of an image revealing the dimension and position of the tumor.

Relative to conventional whole-body PET, dedicated Positron Emission Mammography improves the sensitivity to breast cancer in particular to small tumors. Compact PET detectors allow breast images with resolution of the order of 1 mm in the full field-of-view and with high sensitivity. This was made possible in ClearPEM by combining various developments in different areas, in particular high density and fast scintillation crystals, compact silicon photodetectors, low-noise electronics and high-rate data acquisition systems, which boosted the sensitivity in a compact mechanical construction.

The first phase of the clinical trials with the ClearPEM equipment was concluded in December 2009 at IPO Porto (Portuguese Institute of Oncology). The data collected was used to improve the image reconstruction algorithms providing images of good quality. In 2010 the equipment was moved to ICNAS (Instituto de Ciências Nucleares Aplicadas à Saúde) Coimbra, to perform the next phases of the clinical tests. Studies with phantoms and exams with small animals were performed showing excellent performance. Clinical tests are presently being continued.
Technology transfer projects in medical applications

Examples of the technologies developed for the ClearPEM scanner. From left to right and top to bottom: LYSO crystal; Crystal matrix; Avalanche Photodiode arrays; ClearPEM detector modules; ASIC prototype; ClearPEM supermodules; Detection plate; Data acquisition electronics; Computing servers.

Pursuing the activities initiated in the Crystal Clear Collaboration, LIP joined the ClearPEM-Sonic project, a collaboration between CERN and several institutes aiming at the development of combined PET-Ultrasound technologies. In this context, a second ClearPEM prototype for integration with an ultra-sound probe was built in Portugal, introducing important modifications based on the experience obtained with the first machine. The equipment was installed at Hopital Nord, Université Provence Méditerranée, Marseille, in 2010. Clinical tests are being pursued.

PET images of a patient with breast cancer obtained with ClearPEM at ICNAS, Coimbra

The PET Consortium

The PET consortium is formed by several institutions specialized in the areas of nuclear medicine, radiation detector physics, biophysics, medical engineering, electronics, computing and mechanical engineering.

LIP (Laboratory of Instrumentation and Particle Physics) assures the scientific coordination. Taguspark (Science and Technology Park) was the initial consortium promoter later replaced by the company PETsys. Medical and clinical expertise is presently provided by ICNAS (Institute of Nuclear Science Applied to Health) Coimbra. IBEB (Institute of Biophysics and Biomedical Engineering) of the Lisbon Faculty of Sciences and IBILI (Institute for Research in Medical
Imaging) of the Coimbra Faculty of Medicine contribute with expertise in PET image reconstruction algorithms. INOV (Institute of New Technologies) and INESC-ID (Institute of Systems and Computers Engineering - Research and Development) develop the electronics and data acquisition systems, and INEGI (Institute of Industrial Engineering) is responsible for the mechanical and electro-mechanical systems. About 40 people, medical doctors, physicists, engineers and research students, were involved in the project in Portugal.

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<td>INESC-ID</td>
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<td>INEGI</td>
<td>Design and construction of the mechanical structures.</td>
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Functions of the members of the consortium PET

The consortium collaborates with CERN in the framework of an international scientific collaboration named Crystal Clear, which was organized as a federation of national projects exchanging expertise and information. The main members of the Crystal Clear Collaboration during the ClearPEM project development were:

- Vrije Universiteit Brussel, Belgium
- Forschungszentrum Juelich Gmbh, Germany
- Cancer Research Centre, Heidelberg, Germany
- LIP, Lisbon, Portugal, representing the PET-Mammography Consortium
- CERN, Geneva, Switzerland

The LIP/PET group in 2008. From left to right: Miguel Ferreira, João Filipe, João Varela, José Carlos Silva, Rui Moura, Andreia Trindade, Catarina Ortigão, Bruno Carriço, Ricardo Bugalho, Pedro Rodrigues

Some members of the PET–Mammography Consortium
Scientific production

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Scientific production of the LIP/ClearPEM group

Program funding

Public funding from QREN/AdI and FCT complemented the private funds available for the development of PET technology.

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Public funding for the development of the PET technology and the construction of the ClearPEM and ClearPEM-Sonic prototype scanners
Training of Portuguese engineers at CERN

The objectives of the programme of Training of Portuguese Engineers are focused on the advanced training of engineers for industry. An examination of the statistics lead to the conclusion that while the participants opt for a wide range of different careers after training, the vast majority are employed in the private sector at home and abroad.

This is the first and most significant characteristic of a programme which provides a response to the core demands of the national business sector: the need to have extremely competent engineers trained to the highest standards in the application of cutting-edge technology which is capable of creating the necessary conditions for competitiveness and innovation in the business sector.

In fact, the training programme, given its length (two years) and the fact that it involves active participation in major international projects, allows candidates to learn to use, and to do so effectively, instruments and technology that are at the forefront of all the engineering sectors.

The second main characteristic of this programme is fostering the transfer of technology by means of its most effective component: people. Finally, the programme has allowed Portuguese engineers to take an active part in projects as ambitious as the construction of the LHC accelerator at CERN, the large new European telescopes in the southern hemisphere, and the ESA’s challenging and exciting space programmes.

Portuguese engineers have joined their fellow engineers and science researchers who have already reaped the benefit of Portugal’s becoming a member of the large European investigation institutes, thus affording yet another advantage to the internationalization process of the Portuguese science and technology community.

Program structure

The ADI signed protocols with the international scientific and technological organizations CERN (27 September 1996), ESA (12 May 1997) and ESO (15 May 2001) with a view to holding training programmes at these institutions for young engineers in strategic technological fields in order to increase the competitiveness of Portuguese companies.

The training courses, which run for a minimum of 12 and a maximum of 24 months, are selected by technological field, with particular emphasis on the project, the pedagogical framework and the future employment of the trainees in Portuguese companies.

The scholarships are awarded by the FCT and the ADI is responsible for promoting the programme, selecting the candidates and monitoring the work carried out by the scholarship winners.

Statistics

Evolution of the Number of Application – 1996 to 2009

There was a significant rise in the number of applications submitted from 2002, which was the result of positive feedback from the initial trainees and greater investment in publicizing the programme.

Between 1996 and 2009, the ADI received a total of 584 applications for traineeships at CERN, 194 of which were approved. In all, 135 traineeships were held at CERN.
Technological traineeship areas

The technological traineeship areas, just like the training areas, vary according to the technical skills required by the organizations to implement their scientific projects. However, the technological areas for which training opportunities are offered to national applicants are filtered by the assessment panel with a view to meeting the needs of national industry and the professional development of the young trainees.

For example, CERN provides hundreds of training opportunities each year, so those chosen are the ones that are of greatest interest, taking into account factors such as projects in which Portuguese workers are already participating and the technical skills that will be acquired.

![Graph showing the distribution of applications, number of approved candidates, and trainees at CERN](image)

![Bar chart showing the distribution of trainees by technological area at CERN](chart)
Post-traineeship

All the trainees were interviewed directly to discover their opinion about the traineeship and ask about their post-traineeship status. A significant number of replies were obtained: 69.2% of those contacted.

Most of the former trainees are already working in the private sector. A significant number are studying again; most of these are taking post-graduate courses, including 22 doctorate courses. Only three are in teaching positions. In the “Others” category, only 7 were looking for employment at the time and most of these were trainees who had recently completed the traineeship.

In the case of CERN and the ESA, which are the organizations where the largest number of traineeships are held, the percentage of trainees is significant and symptomatic of the interest and the quality of the work done by the candidates. 24% of the trainees remained at CERN and 10% at the ESA. The presence of these trainees may have played an important role at other relationship levels with the institutions where they trained.

![Distribution of the former CERN trainees by type of activity](image-url)
Industry: sales of goods and services to CERN

Portugal became a member of CERN in 1985, although it was only in 1986 that it became a full Member-State. By participating in the scientific activities at CERN, all the Member-States can benefit, in addition to the scientific and training benefits gained, from an industrial benefit that is proportional to its contribution to the organization. In order to boost sales by national industry to CERN, the ADI was the Industrial Liaison Officer to CERN from 1997 to 2007.

This function included fostering the supply of goods and services by Portuguese companies to CERN and the transfer of technologies developed by and belonging to the organization to Portuguese companies.

From the time it joined until 2006, Portuguese companies exported to CERN goods and services worth over 76 million Swiss francs, that is, around 53 million euros.

The first graph shows the trend in these exports for both industrial goods and services. The second graph contains the industrial benefit rates, which show the performance of our percentage position in CERN purchases in relation to the size of our contribution to the CERN budget.

Our position in terms of Industrial Goods is quite stable, oscillating around a central position in the group of Member-States. In terms of Services, we have achieved a much higher position, with an industrial benefit that has maintained a steady second place after Switzerland, which along with France, is one of the host states for CERN.

Of the twenty Member States involved in the international science laboratory, Portugal comes second to Switzerland in the provision of services and ninth in the sale of industrial goods.

What is even more important than measuring the Industrial Benefit gained from our participation in CERN is that these figures represent the technological development of the suppliers, their international competitiveness and the importance for them and for their country’s image of the experience gained in an institution where the required standards are always higher than the highest market standards.
It should be noted that a substantial part of these sales is in turn associated with the transfer of CERN technology to Portuguese companies and, in some cases, joint development to respond to specific challenges.

Fig. 25 – Industrial Benefit (IB) of Portugal at CERN.

Helium tanks in the CMS experiment supplied by the Portuguese Industry
The HEP Outreach activities at LIP

The LIP Outreach Group (LIP-OR) has the tasks of motivating the public and the young to be interested in science, of promoting the field of Experimental Particle and Astroparticle Physics, in particular the activities carried at LIP, and of conveying the importance and excitement of taking part in the development of science at large international research facilities and international collaborations.

The group has kept its main focus in the scholar public, through actions directed at students and teachers, and in the media through press releases on specific events or the adaptation into portuguese of the press releases relevant to Portugal from the InterActions group (www.interactions.org, including CERN). The general public is however not forgotten, with LIP participating in public exhibitions showing detectors in operation, like the popular Spark Chamber, and the LIP activities in its different areas of expertise.

The LIP Outreach Group reports its activities in two international forums: the International Particle Physics Outreach Group (IPPOG), a group created in 1997 emanating from ECFA – European Committee on Future Accelerators and from the HEPP (High Energy and Particle Physics) panel of the EPS (European Physics Society); and the European Particle Physics Communication Network, a group of scientists and communication professionals created by the CERN Council in 2006 to address the efficient communication of Particle Physics in the Member States.

From a start-up with very few people involved, participating in the meetings of the then European Particle Physics Outreach Group, or presenting LIP activities to the public in a few international conferences organized in Portugal, the group grew to include almost all LIP researchers and students that, at one time or another, voluntarily participate in the outreach activities organized by LIP towards high school students and the general public. Many of these activities occur on Saturdays and holidays, and take place not only in cities with LIP delegations/sections as Lisboa, Coimbra or Braga, but also spread throughout the country at Faro, Covilhã, Vila Real, Beja, Porto, Bragança, Aveiro, São Tomé and Príncipe, Moimenta da Beira, Évora, São Pedro do Sul, Amares, Vendas Novas, Carregal do Sal, Barreiro, etc.

Very briefly, the outreach activities organized by LIP-OR include the International Masterclasses in Particle Physics, the CERN Portuguese Language Teachers Programmes, the Radiation and the Environment project with schools, public sessions in important international conferences or large collaboration meetings, featuring the LIP Coimbra’s Spark Chamber, public exhibitions (as in Ciência Viva Forums and at the Portuguese Technological Forums), and several seminars at schools spread around the country. The first two topics will be detailed below, as they are closely related to the portuguese participation at CERN and at the LHC.

Outreach activities related to LHC and to CERN

The activities directly related to LHC and to CERN include the International Masterclasses in Particle Physics, the CERN Portuguese Language Teachers Programme, and school seminars about CERN and the LHC, usually before a school visit to CERN.

International Masterclasses in Particle Physics

“Be a Scientist for a day...with Hands-on Particles”. These Masterclasses started in the United Kingdom at the turn
of the century, and were launched internationally by IPPOG in 2005, to celebrate the International Year of Physics and the 100 years of Einstein’s revolutionary papers. Portugal participated in 2005 with 3 institutes and around 100 students and for this year’s 8th edition in 12 sites/14 days, around 2100 students and 250 school teachers from North to South and from West to East have participated. One of the sites/day has taken place in São Tomé and Príncipe, at the Instituto Superior Politécnico de São Tomé e Príncipe with 40 high-school students, with the help of the santomense teachers that have participated in the CERN Portuguese Language Teachers Programmes in 2010, 2011, and 2012.

Portugal is the country with more participants in the international program, and being Portugal a peripheral and small country (pop. 10 million people), these numbers are proportionally very large. Although the Portuguese program is financially supported by Ciência Viva Agency, we chose to move the particle physics researchers towards a closer university or polytechnic institution to co-organize such a day, so that the students no longer have to travel 200 km early in the morning to reach a participating institution. This has enabled us to greatly extend the reach of this activity, geographically as well as from the socio-economical viewpoint, namely also reaching the poorer and more isolated interior regions of the country.

CERN Portuguese Language Teachers Programme

The CERN Portuguese Language Teachers Programme is a programme of teacher professional development, credited by the Portuguese competent authority, that is held at CERN and that involves now teachers for all the countries with Portuguese as official language. This very successful programme aims at inspiring the next generation of scientists, through their teachers and professional educators.

Portugal, through LIP, and with the financial support of the Ciência Viva Agency, proposed a Portuguese Teachers Programme in 2007, and in 2009, extended the programme to participants from Brazil and Mozambique, following a request from UNESCO and CERN. In 2010 the programme expanded further to receive participants from Cape Verde and São Tomé and Príncipe, and in 2011 we finally welcomed participants from all countries with Portuguese as official language, in a total of 73 teachers: 41 portuguese, 20 brazilians, 4 mozambicans, 4 angolans, 1 capeverdian, 1 santomense, 1 from Guiné-Bissau and 1 from East Timor. The programme was repeated in 2012 with more brazilian teachers (30 in total) and more santomense teachers (3), although the Angolan teachers could not participate due to the coincidence of dates of the programme with the Angolan general elections. Guiné-Bissau did also not participate in 2012 due to internal problems.
Through the 6 yearly editions already organized by LIP and CERN, there were 253 portuguese teachers (out of 943 applicants), 82 from Brazil, 17 from Mozambique, 4 from Angola, 3 from Cape-Verde, 3 from São Tomé and Príncipe, 1 from Guiné-Bissau and 4 from East Timor. Brazilian and Angolan teachers had the support of the Brazilian and the Angolan Governments, respectively, the Santomense teachers had the travels from Dili to Geneva supported by the East-Timor Government, and all the other teachers had the support of CERN and Ciência Viva Agency.

Seminars at Schools

On the occasion of school visits to CERN or to ESA, or as part of the Science (& Technology) weeks, or on direct request by a school, LIP Scientists go often to schools to speak to the students. These outreach talks range from themes in particle physics or astroparticle physics, the universe, matter/antimatter, what are the scientists doing at CERN, radiation and the environment, medical physics, etc. If related to a visit to CERN in preparation at the school, we speak about CERN and about the LHC, and this enhances greatly their experience at CERN. But more than the contents, it is usually the interaction with the scientist that engages many of the students, and motivates them to follow later a scientific or technological career.

Students at a day in the Masterclasses in 2011
Appendices

List of Collaborators

1. List of all Collaborators in the LIP/CMS group

2. List of all Collaborators in the LIP/ATLAS group

3. List of all Collaborators in the LIP/GRID group
   Jorge Gomes, Gaspar Barreira, Carlos Manuel, Gonçalo Borges, Hugo Gomes, João Martins, João Pina, José Aparício, Mário David, Miguel Oliveira, Nuno Dias, Henrique Matos, Sara Valente, Manuel Monteceio, Bruno Silva, Helmut Wolters, Luís Morgado, José Nogueira, Ana Simões.

4. List of all Collaborators in the LIP/PET group

Seminars "Physics on the road to discovery"

1. Joe Incandela (University of California Santa Barbara, USA), "In search of the generic code of our universe: The status of physics at the LHC" (December 15, 2011) abstract, slides.
2. Aleandro Nisati (Sapienza University, INFN, Rome), "Searches for Exotics Physics at the Large Hadron Collider" (November 23, 2011) abstract, slides.
3. Christoph Paus (MIT, USA), "Unveiling the Mystery of Mass" (October 19, 2011) abstract, slides.
4. Dan Green (Fermilab, USA), "Recent results for the CMS Experiment at the CERN LHC" (September 7, 2011) abstract, slides.
5. Giacomo Polesello (Pavia, INFN), "Searches for Supersymmetry at the Large Hadron Collider" (May 11, 2011) abstract, slides Pierreucci Campagna (Frascati National Laboratory, INFN), "The LHCb experiment" (April 20, 2011) abstract, slides.
6. Cesare Bini (University of Rome, La Sapienza), "Physics with muons at the LHC" (Feb. 23, 2011) abstract, slides.
8. Lyn Evans (Imperial College/CERN), "The Large Hadron Collider" (Nov. 29, 2010) abstract, slides.
Publications

CMS group publications

1. Measurement of jet fragmentation into charged particles in pp and PbPb collisions at $\sqrt{s_{NN}} = 2.76$ TeV / CMS Collaboration
Jet fragmentation in pp and PbPb collisions at a centre-of-mass energy of 2.76 TeV per nucleon pair was studied using data collected with the CMS detector at the LHC. [...] arXiv:1205.5872 ; CMS-HIN-11-004 ; CERN-PH-EP-2012-143. - 2012. - 29 p.

2. Search for a light charged Higgs boson in top quark decays in pp collisions at $s = 7$ TeV / CMS Collaboration
Results are presented on a search for a light charged Higgs boson that can be produced in the decay of the top quark to charged H and b quark and which, in turn, decays into tau and tau neutrino. [...] arXiv:1205.5736 ; CMS-HIG-11-019 ; CERN-PH-EP-2012-123. - 2012. - 37 p.

3. Measurement of the pseudorapidity and centrality dependence of the transverse energy density in PbPb collisions at $\sqrt{s_{NN}} = 2.76$ TeV / CMS Collaboration
The transverse energy ET in PbPb collisions at 2.76 TeV nucleon-nucleon center-of-mass energy sqrt(s_{NN}) has been measured over a broad range of pseudorapidity eta and collision centrality using the CMS detector at the LHC. [...] arXiv:1205.2488 ; CMS-HIN-11-003 ; CERN-PH-EP-2012-116. - 2012. - 27 p.

4. Measurement of the $\Lambda_b$ cross section and the $\Lambda \rightarrow b \Lambda_b$ ratio with J/ψΛ decays in pp collisions at $s = 7$ TeV / CMS Collaboration
The Lambda(b) differential production cross section and the cross-section ratio for anti-Lambda(b)/Lambda(b) production are measured as functions of transverse momentum pT(Lambda(b)) and rapidity y(Lambda(b)) in pp collisions at sqrt(s) = 7 TeV using data collected by the CMS experiment at the LHC. [...] arXiv:1205.0594 ; CMS-BPH-11-007 ; CERN-PH-EP-2012-124. - 2012. - 33 p.

5. Search for heavy long-lived charged particles in pp collisions at $s = 7$ TeV / CMS Collaboration

6. Studies of jet quenching using isolated-photon+jet correlations in PbPb and pp collisions at $\sqrt{s_{NN}} = 2.76$ TeV / CMS Collaboration

7. Observation of an excited $\Xi_b$ baryon / CMS Collaboration
The observation of an excited b baryon via its strong decay into $\Xi^-/\Xi^0$ (plus charge conjugates) is reported. [...] arXiv:1204.5955 ; CMS-BPH-12-001 ; CERN-PH-EP-2012-118. - 2012. - 25 p.

8. Search for anomalous production of multilepton events in pp collisions at $s = 7$ TeV / CMS Collaboration
A search for anomalous production of events with three or more isolated leptons in pp collisions at $s = 7$ TeV is presented. [...]

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9. **Search for leptonic decays of W⁺ bosons in pp collisions at s=7 TeV / CMS Collaboration**
A search for a new heavy gauge boson W⁺ decaying to an electron or muon, plus a low mass neutrino, is presented. [...]  

10. **Search for physics beyond the standard model in events with a Z boson, jets, and missing transverse energy in pp collisions at s=7 TeV / CMS Collaboration**
A search is presented for physics beyond the standard model (BSM) in events with a Z boson, jets, and missing transverse energy (MET). [...]  

11. **Shape, transverse size, and charged hadron multiplicity of jets in pp collisions at s=7 TeV / CMS Collaboration**
Measurements of jet characteristics from inclusive jet production in proton-proton collisions at a centre-of-mass energy of 7 TeV are presented. [...]  

12. **Measurement of the mass difference between top and antitop quarks / CMS Collaboration**
A measurement of the mass difference between the top and the antitop quark (\( \Delta m(t) = m(t) - m(\text{anti-t}) \)) is performed using events with a muon or an electron and at least four jets in the final state. [...]  

13. **Search for anomalous H⁻ production in the highly-boosted all-hadronic final state / CMS Collaboration**
A search is presented for a massive particle, generically referred to as a Z⁻, decaying into a t-bar pair. [...]  

14. **Azimuthal anisotropy of charged particles at high transverse momenta in PbPb collisions at \( \sqrt{s_{\text{NN}}}=2.76 \text{ TeV} / \text{CMS Collaboration} \)**
The azimuthal anisotropy of charged particles in PbPb collisions at nucleon-nucleon center of mass energy of 2.76 TeV is measured over an extended transverse momentum (pt) range up to approximately 60 GeV. [...]  

15. **Measurement of the Z/γ⁺+b-jet cross section in pp collisions at s=7 TeV / CMS Collaboration**
The production of b-jets in association with a Z/\( \gamma/\text{boson} \) is studied using proton-proton collisions delivered by the LHC at a centre-of-mass energy of 7 TeV and recorded by the CMS detector. [...]  

16. **Measurement of the underlying event in the Drell-Yan process in proton-proton collisions at s=7 TeV / CMS Collaboration**
A measurement of the underlying event (UE) activity in proton-proton collisions at a centre-of-mass energy of 7 TeV is performed using Drell–Yan events in a data sample corresponding to an integrated luminosity of 2.2 inverse femtobarns, collected by the CMS experiment at the LHC. [...]  
17. Measurement of the elliptic anisotropy of charged particles produced in PbPb collisions at nucleon-nucleon center-of-mass energy = 2.76 TeV / CMS Collaboration


18. Search for heavy bottom-like quarks in 4.9 inverse femtobarns of pp collisions at \( s = 7 \) TeV / CMS Collaboration

Results are presented from a search for heavy bottom-like quarks, pair-produced in pp collisions at \( \sqrt{s} = 7 \) TeV, undertaken with the CMS experiment at the LHC. [...] arXiv:1204.1088; CMS-EXO-11-036; CERN-PH-EP-2012-100. - 2012. - 29 p.


20. Ratios of dijet production cross sections as a function of the absolute difference in rapidity between jets in proton-proton collisions at \( s = 7 \) TeV / CMS Collaboration

A study of dijet production in proton-proton collisions was performed at \( s = 7 \) TeV for jets with \( p_T > 35 \) GeV and abs(\( y \)) < 4.7 using data collected with the CMS detector at the LHC in 2010. [...] arXiv:1204.0696; CMS-FWD-10-014; CERN-PH-EP-2012-088. - 2012. - 25 p.

21. Measurement of the top quark pair production cross section in pp collisions at \( s = 7 \) TeV in dilepton final states containing a \( \tau \) / CMS Collaboration

The top quark pair production cross section is measured in dilepton events with one electron or muon, and one hadronically decaying tau lepton from the decay \( t \rightarrow (b\tau)\bar{b}b'\bar{b} \), where \( \tau \) can be either an electron or a muon. [...] arXiv:1203.6810; CMS-TOP-11-006; CERN-PH-EP-2012-078. - 2012. - 31 p.

22. Search for heavy, top-like quark pair production in the dilepton final state in pp collisions at \( s = 7 \) TeV / CMS Collaboration

The results of a search for pair production of a heavy, top-like quark, \( t' \), in the decay mode \( t' \to (b\text{-anti-}W\text{-anti-}b' W) \) to \( (b\text{-anti-lepton neutrino-anti-lepton neutrino}) \) are presented. [...] arXiv:1203.5410; CMS-EXO-11-050; CERN-PH-EP-2012-081. - 2012. - 27 p.

23. Search for \( B_0 \to \mu^-\mu^+ \) and \( B_0 \to \mu^-\mu^- \) decays / CMS Collaboration

A search for the rare decays \( B_0 \to \mu^-\mu^+ \) and \( B_0 \to \mu^-\mu^- \) is performed in pp collisions at \( s = 7 \) TeV, with a data sample corresponding to an integrated luminosity of 5 inverse femtobarns collected by the CMS experiment at the LHC. In both decays, the number of events observed after all selection requirements is consistent with the expectation from background plus standard model predictions. [...] arXiv:1203.3976; CMS-BPH-11-020; CERN-PH-EP-2012-086. - Geneva: CERN, 2012. - 35 p. - Published in: J. High Energy Phys. 04 (2012) 033 Springer Open Access article: PDF; External link:

24. Measurement of the cross section for production of b b-bar X, decaying to muons in pp collisions at \( s = 7 \) TeV / CMS Collaboration

A measurement of the inclusive cross section for the process pp to b b-bar X to muon muon X' at \( s = 7 \) TeV is presented, based on a data sample
corresponding to an integrated luminosity of 27.9 inverse picobarns collected by the CMS experiment at the LHC. [...] 

25. Search for microscopic black holes in pp collisions at $\sqrt{s} = 7$ TeV / CMS Collaboration
A search for microscopic black holes in pp collisions at a center-of-mass energy of 7 TeV is presented. The data sample corresponds to an integrated luminosity of 4.7 inverse femtobarns recorded by the CMS experiment at the LHC in 2011. [...] 

26. Search for quark compositeness in dijet angular distributions from pp collisions at $\sqrt{s} = 7$ TeV / CMS Collaboration
A search for quark compositeness using dijet angular distributions from pp collisions at $\sqrt{s} = 7$ TeV is presented. [...] 

27. Jet momentum dependence of jet quenching in PbPb collisions at $\sqrt{s_{NN}}=2.76$ TeV / CMS Collaboration
Dijet production in PbPb collisions at a nucleon-nucleon center-of-mass energy of 2.76 TeV is studied with the CMS detector at the LHC. A data sample corresponding to an integrated luminosity of 150 inverse microbarns is analyzed. [...] 

28. Inclusive b-jet production in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration
The inclusive b-jet production cross section in pp collisions at a center-of-mass energy of 7 TeV is measured using data collected by the CMS experiment at the LHC. The cross section is presented as a function of the jet transverse momentum in the range $18 < p_T < 200$ GeV for several rapidity intervals. [...] 

29. Search for the standard model Higgs boson decaying to bottom quarks in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration
A search for the standard model Higgs boson (H) decaying to a b-quark pair when produced in association with weak vector bosons (V) is reported for the following modes: $W(\mu\mu)H$, $W(\tau\tau)H$, $Z(\mu\mu)H$, $Z(e\mu)H$ and $Z(\mu\mu)H$. The search is performed in a data sample corresponding to an integrated luminosity of 4.7 inverse femtobarns, recorded by the CMS detector in proton-proton collisions at the LHC with a center-of-mass energy of 7 TeV. [...] 

30. Search for neutral Higgs bosons decaying to tau pairs in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration
A search for neutral Higgs bosons decaying to tau pairs at a center-of-mass energy of 7 TeV is performed using a dataset corresponding to an integrated luminosity of 4.6 inverse femtobarns recorded by the CMS experiment at the LHC. The search is sensitive to both the standard model Higgs boson and to the neutral Higgs bosons predicted by the minimal supersymmetric extension of the standard model (MSSM). [...] 

31. Search for large extra dimensions in dimuon and dielectron events in pp collisions at $\sqrt{s} = 7$ TeV / CMS Collaboration
Results are presented from a search for large, extra spatial dimensions in events with either two isolated muons or two isolated electrons. The data are from proton-proton interactions at $\sqrt{s} = 7$ TeV collected with the CMS detector at the LHC. [...]
32. Search for the standard model Higgs boson in the $H\to ZZ\to l^+l^−τ^+τ^−$ decay channel in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration

A search is reported for the standard model Higgs boson in the decay mode $H\to ZZ$, where the leptons are either electrons or muons, in proton-proton collisions at $\sqrt{s}=7$ TeV, corresponding to an integrated luminosity of 4.7 inverse femtobarns collected with the CMS detector at the LHC. No evidence is found for a significant deviation from the background expectation. [...] arXiv:1202.3617; CMS-HIG-11-028; CERN-PH-EP-2012-038 - Geneva: CERN, 2012 - 29 p. - Published in: *Phys. Lett. B 711 (2012) 15-34* Elsevier Open Access article: *PDF*; External link:

33. Search for the standard model Higgs boson in the $H\to ZZ\to 2l2ν$ channel in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration

A search for the standard model Higgs boson in the $H\to ZZ\to 2l2ν$ decay channel, where $l=e$ or $μ$, in pp collisions at a center-of-mass energy of 7 TeV is presented. The data were collected at the LHC, with the CMS detector, and correspond to an integrated luminosity of 4.6 inverse femtobarns. [...] arXiv:1202.3478; CMS-HIG-11-026; CERN-PH-EP-2012-033 - Geneva: CERN, 2012 - 31 p. - Published in: *J. High Energy Phys. 03 (2012) 081* Springer Open Access article: *PDF*; External link:

34. Study of high-$p_T$ charged particle suppression in PbPb compared to pp collisions at $\sqrt{s_{NN}}=2.76$ TeV / CMS Collaboration

The transverse momentum spectra of charged particles have been measured in pp and PbPb collisions at $\sqrt{s_{NN}}=2.76$ TeV by the CMS experiment at the LHC. In the transverse momentum range $p_T=5-10$ GeV/c, the charged particle yield in the most central PbPb collisions is suppressed by up to a factor of 5 compared to the pp yield scaled by the number of incoherent nucleon-nucleon collisions. [...] arXiv:1202.2554; CMS-HIN-10-005; CERN-PH-EP-2012-043 - Geneva: CERN, 2012 - 33 p. - Published in: *Eur. Phys. J. C 72 (2012) 1945* Springer Open Access article: *PDF*; External link:

35. Search for the standard model Higgs boson in the decay channel $H\to ZZ\to 4l$ in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration


36. Search for the standard model Higgs boson decaying into two photons in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration


37. Search for the standard model Higgs boson decaying to $W^+W^-$ in the fully leptonic final state in pp collisions at $\sqrt{s}=7$ TeV / CMS Collaboration


38.
Search for a Higgs boson in the decay channel \(H \rightarrow ZZ(\rightarrow q\bar{q}l\bar{l})\) in pp collisions at \(s = 7\) TeV / CMS Collaboration

A search for the standard model Higgs boson decaying into two Z bosons with subsequent decay into a final state containing two quark jets and two leptons, \(H \rightarrow ZZ(\rightarrow q\bar{q}l\bar{l})\) is presented. Results are based on data corresponding to an integrated luminosity of 4.6 inverse femtobarns of proton-proton collisions at \(s = 7\) TeV, collected with the CMS detector at the LHC. [...] 

39. Combined results of searches for the standard model Higgs boson in pp collisions at \(s = 7\) TeV / CMS Collaboration

Combined results are reported from searches for the standard model Higgs boson in proton-proton collisions at \(s = 7\) TeV in five Higgs boson decay modes: gamma pair, b-quark pair, tau lepton pair, W pair, and Z pair. The explored Higgs boson mass range is 110-600 GeV. [...] 

40. Measurement of the inclusive production cross sections for forward jets and for dijet events with one forward and one central jet in pp collisions at \(s = 7\) TeV / CMS Collaboration

The inclusive production cross sections for forward jets, as well for jets in dijet events with at least one jet emitted at central and the other at forward pseudorapidities, are measured in the range of transverse momenta \(p_T = 35-150\) GeV/c in proton-proton collisions at \(s = 7\) TeV by the CMS experiment at the LHC. [...] 
CMS-FWD-11-002 (1-11-2011)

41. Suppression of non-prompt J/ψ, prompt J/ψ, and Y(1S) in PbPb collisions at \(s_{NN} = 2.76\) TeV / CMS Collaboration

Yields of prompt and non-prompt J/ψ, as well as Y(1S) mesons, are measured by the CMS experiment via their dimuon decays in PbPb and pp collisions at \(s_{NN} = 2.76\) TeV for quarkonium rapidly \(|y| < 2.4\). [...] 
CMS-HIN-10-006 (2012-01-25) - Full text -

42. Centrality dependence of dihadron correlations and azimuthal anisotropy harmonics in PbPb collisions at \(s_{NN} = 2.76\) TeV / CMS Collaboration

Measurements from the CMS experiment at the LHC of dihadron correlations for charged particles produced in PbPb collisions at a nucleon-nucleon centre-of-mass energy of \(2.76\) TeV are presented. [...] 
CMS-HIN-11-006 (20-12-2011)

43. Measurement of isolated photon production in pp and PbPb collisions at \(s_{NN} = 2.76\) TeV / CMS Collaboration

Isolated photon production is measured in proton-proton and lead-lead collisions at nucleon-nucleon centre-of-mass energies of \(2.76\) TeV in the pseudorapidity range \(|\eta| < 1.44\) and transverse energies \(E_T\) between 20 and 80 GeV with the CMS detector at the LHC. The measured \(E_T\) spectra are found to be in good agreement with next-to-leading-order perturbative QCD predictions. [...] 

44. Measurement of the charge asymmetry in top-quark pair production in proton-proton collisions at \(s = 7\) TeV / CMS Collaboration

The difference in angular distributions between top quarks and antiquarks, commonly referred to as the charge asymmetry, is measured in pp collisions at the LHC with the CMS experiment. The data sample corresponds to an integrated luminosity of 1.09 inverse femtobarns at a centre-of-mass energy of 7 TeV. [...]
45. Search for signatures of extra dimensions in the diphoton mass spectrum at the Large Hadron Collider / CMS Collaboration

A search for signatures of extra dimensions in the diphoton invariant-mass spectrum has been performed with the CMS detector at the LHC. No excess of events above the standard model expectation is observed using a data sample collected in proton-proton collisions at sqrt(s) = 7 TeV corresponding to an integrated luminosity of 2.2 inverse femtobarns. [...] arXiv:1112.5688; CMS-EXO-11-038; CERN-PH-EP-2011-173 - Geneva: CERN, 2012 - 27 p. - Published in: Phys. Rev. Lett. 108 (2012) 111801 APS Open Access article: PDF; CMS-EXO-11-038 (2011-12-03): PDF; Fulltext: PDF (PDFA); External link:

46. Exclusive $\gamma\gamma\to\mu^+\mu^-$ production in proton-proton collisions at $s\sqrt{ } = 7$ TeV / CMS Collaboration

A measurement of the exclusive two-photon production of muon pairs in proton-proton collisions at $s\sqrt{ }=7$ TeV, pp $\to \mu^+\mu^- p$, is reported using data corresponding to an integrated luminosity of 40 pb$^{-1}$. For muon pairs with invariant mass greater than 11.5 GeV, transverse momentum $p_T (\mu) > 4$ GeV and pseudorapidity $|\eta(\mu)| < 2.1$, a fit to the dimuon $p_T (\mu + \mu^-)$ distribution results in a measured cross section of $\sigma(p \to \mu^+\mu^-) = 338\pm58\pm55$ (stat) $\pm 0.16$ (syst) $\pm 0.14$ (lumi) pb, consistent with the theoretical prediction evaluated with the event generator Lp. [...] arXiv:1111.5536; CMS-PWD-10-005; CERN-PH-EP-2011-187 - Geneva: CERN, 2012 - 35 p. - Published in: J. High Energy Phys. 01 (2012) 052 Springer Open Access article: PDF; External link:

47. J/$\psi$ and $\psi(2S)$ production in pp collisions at $s\sqrt{ } = 7$ TeV / CMS Collaboration


48. Measurement of the Production Cross Section for Pairs of Isolated Photons in pp collisions at $s\sqrt{ } = 7$ TeV / CMS Collaboration


49. Measurement of the Rapidity and Transverse Momentum Distributions of Z Bosons in pp Collisions at $s\sqrt{ }=7$ TeV / CMS Collaboration

Measurements of the normalized rapidity (y) and transverse momentum (q_T) distributions of Drell-Yan muon and electron pairs in the Z-boson mass region (60-M(0))120 GeV) are reported. The results are obtained using a data sample of proton-proton collisions at a center-of-mass energy of 7 TeV, collected by the CMS experiment at the LHC, corresponding to an integrated luminosity of 36 inverse picobarns. [...] arXiv:1110.4973; CMS-EWK-10-010; CERN-PH-EP-2011-169 - Geneva: CERN, 2012 - 37 p. - Published in: Phys. Rev. D 85 (2012) 032002 APS Open Access article: PDF; External link:

50. Jet Production Rates in Association with W and Z Bosons in pp Collisions at $s\sqrt{ } = 7$ TeV / CMS Collaboration

Measurements of jet production rates in association with W and Z bosons for jet transverse momenta above 30 GeV are reported, using a sample of proton-proton collision events recorded by CMS at sqrt(s) = 7 TeV, corresponding to an integrated luminosity of 36 inverse picobarns. The study includes the measurement of the normalized inclusive rates of jets $\sigma(V+n jets)/\sigma(V)$, where $V$ represents either a W or a Z. [...] arXiv:1110.3226; CMS-EWK-10-012; CERN-PH-EP-2011-125 - Geneva: CERN, 2012 - 45 p. - Published in: J. High Energy Phys. 01 (2012) 010 Springer Open Access article: PDF; External link:
51. Measurement of the weak mixing angle with the Drell-Yan process in proton-proton collisions at the LHC / CMS Collaboration

52. Measurement of energy flow at large pseudorapidities in pp collisions at √s = 0.9 and 7 TeV / CMS Collaboration

53. Forward Energy Flow, Central Charged-Particle Multiplicities, and Pseudorapidity Gaps in W and Z Boson Events from pp Collisions at √s = 7 TeV / CMS Collaboration

54. Performance of τ-lepton reconstruction and identification in CMS / CMS Collaboration
The performance of tau-lepton reconstruction and identification algorithms is studied using a data sample of proton-proton collisions at sqrt(s)=7 TeV, corresponding to an integrated luminosity of 36 inverse picobarns collected with the CMS detector at the LHC. The tau leptons that decay into one or three charged hadrons, zero or more short-lived neutral hadrons, and a neutrino are identified using final-state particles reconstructed in the CMS tracker and electromagnetic calorimeter. [...] arXiv:1109.6034; CMS-TAU-11-001; CERN-PH-EP-2011-137. - Geneva: CERN, 2012 - 33 p. - Published in: J. Instrum. 7 (2012) P01001. CMS-TAU-11-001 (2011-09-27): PDF; SISSA/IOP Open Access article: PDF; External link:

55. Search for a Vectorlike Quark with Charge 2/3 in t + Z Events from pp Collisions at √s = 7 TeV / CMS Collaboration
A search for pair-produced heavy vector-like charge-2/3 quarks, T, in pp collisions at a center-of-mass energy of 7 TeV, is performed with the CMS detector at the LHC. Events consistent with the flavor-changing-neutral-current decay of a T quark to a top quark and a Z boson are selected by requiring two leptons from the Z boson decay, as well as an additional isolated charged lepton. [...] arXiv:1109.4985; CMS-EXO-11-005; CERN-PH-EP-2011-139. - Geneva: CERN, 2011 - 25 p. - Published in: Phys. Rev. Lett. 107 (2011) 271802. APS Open Access article: PDF; CMS-EXO-11-005 (2011-09-26): PDF; External link:

56. Search for Supersymmetry at the LHC in Events with Jets and Missing Transverse Energy / CMS Collaboration

57. Measurement of the ℓ+ℓ− Production Cross Section in pp Collisions at 7 TeV in Lepton + Jets
Events Using b-quark Jet Identification / CMS Collaboration
A new measurement of the inclusive production cross section for pp to t\bar{b} is performed at a center-of-mass energy of 7 TeV using data collected by the CMS experiment at the LHC. The analysis uses a data sample corresponding to an integrated luminosity of 36 inverse picobarns, and is based on the final state with one isolated, high transverse momentum muon or electron, missing transverse energy, and hadronic jets. [...] arXiv:1108.3773; CMS-TOP-10-003; CERN-PH-EP-2011-085. - Geneva : CERN, 2011 - 39 p. - Published in: Phys. Rev. D 84 (2011) 092004. APS Open Access article: PDF; CMS-TOP-10-003 (2011-08-18): PDF; External link:

58.

Measurement of the Differential Cross Section for Isolated Prompt Photon Production in pp Collisions at 7 TeV / CMS Collaboration

59.

Measurement of the Drell-Yan Cross Section in pp Collisions at \sqrt{s} = 7 TeV / CMS Collaboration
The Drell-Yan differential cross section is measured in pp collisions at \sqrt{s} = 7 TeV, from a data sample collected with the CMS detector at the LHC, corresponding to an integrated luminosity of 36 inverse picobarns. The cross section measurement, normalized to the measured cross section in the Z region, is reported for both the dimuon and dielectron channels in the dilepton invariant mass range 15-600 GeV. [...] arXiv:1108.0566; CMS-EWK-10-007; CERN-PH-EP-2011-093. - Geneva : CERN, 2011 - 37 p. - Published in: J. High Energy Phys. 10 (2011) 007. CMS-EWK-10-007 (2011/08/03): PDF; Springer Open Access article: PDF; External link:

60.

Search for B_0\rightarrow\mu^+\mu^- and B_0\rightarrow\mu^+\mu^- decays in pp collisions at \sqrt{s} = 7 TeV / CMS Collaboration
A search for the rare decays B(0)\rightarrow\mu^+\mu^- to dimuons and B_0 to dimuons is performed in pp collisions at \sqrt{s}=7 TeV, with a data sample corresponding to an integrated luminosity of 1.14 inverse femtobarns, collected by the CMS experiment at the LHC. In both cases, the number of events observed after all selection requirements is consistent with expectations from background and standard-model signal predictions. [...] arXiv:1107.5834; CMS-BPH-11-002; CERN-PH-EP-2011-120. - Geneva : CERN, 2011 - 27 p. - Published in: Phys. Rev. Lett. 107 (2011) 191802. APS Open Access article: PDF; CMS-BPH-11-002 (2011-07-28): PDF; External link:

61.

Dependence on pseudorapidity and on centrality of charged hadron production in PbPb collisions at \sqrt{s_{NN}} = 2.76 TeV / CMS Collaboration
A measurement is presented of the charged hadron multiplicity in hadronic PbPb collisions, as a function of pseudorapidity and centrality, at a collision energy of 2.76 TeV per nucleon pair. The data sample is collected using the CMS detector and a minimum-bias trigger, with the CMS solenoid off. [...] arXiv:1107.4800; CMS-HIN-10-001; CERN-PH-EP-2011-092. - Geneva : CERN, 2011 - 35 p. - Published in: J. High Energy Phys. 08 (2011) 141. Springer Open Access article: PDF; External link:

62.

Search for Resonances in the Dijet Mass Spectrum from 7 TeV pp Collisions at CMS / CMS Collaboration

63.

Measurement of the Inclusive W and Z Production Cross Sections in pp Collisions at \sqrt{s} = 7 TeV with the CMS experiment / CMS Collaboration
Determination of Jet Energy Calibration and Transverse Momentum Resolution in CMS / CMS Collaboration

Measurements of the jet energy calibration and transverse momentum resolution in CMS are presented, performed with a data sample collected in proton-proton collisions at a centre-of-mass energy of 7 TeV, corresponding to an integrated luminosity of 36 inverse picobarns. The transverse momentum balance in dijet and gamma/Z+jets events is used to measure the jet energy response in the CMS detector, as well as the transverse momentum resolution. [...] arXiv:1107.4277; CMS-JME-10-011; CERN-PH-EP-2011-102. Geneva: CERN, 2011 - 67 p. - Published in: J. Instrum. 6 (2011) P11002 CMS-JME-10-011 (2011-07-22): PDF; IOP Open Access article: PDF; External link:

Search for Three-Jet Resonances in pp Collisions at \( \sqrt{s} = 7 \) TeV / CMS Collaboration


Search for supersymmetry in pp collisions at \( \sqrt{s} = 7 \) TeV in events with a single lepton, jets, and missing transverse momentum / CMS Collaboration

Results are reported from a search for physics beyond the standard model in proton-proton collisions at a center-of-mass energy of 7 TeV, focusing on the signature with a single, isolated, high-transverse-momentum lepton (electron or muon), energetic jets, and large missing transverse momentum. The data sample comprises an integrated luminosity of 36 inverse picobarns, recorded by the CMS experiment at the LHC. [...] arXiv:1107.1870; CMS-SUS-10-006; CERN-PH-EP-2011-084. Geneva: CERN, 2011 - 41 p. - Published in: J. High Energy Phys. 08 (2011) 156 CMS-SUS-10-006 (2011-07-10): PDF; Springer Open Access article: PDF; External link:

A search for excited leptons in pp Collisions at \( \sqrt{s} = 7 \) TeV / CMS Collaboration

A search for excited leptons is carried out with the CMS detector at the LHC, using 36 inverse picobarns of pp collision data recorded at \( \sqrt{s} = 7 \) TeV. The search is performed for associated production of a lepton and an oppositely charged excited lepton pp to \( l \) l gamma, resulting in the \( l \) l gamma final state, where \( l = \) electron or muon. [...] arXiv:1107.1773; CMS-EXO-10-016; CERN-PH-EP-2011-081. Geneva: CERN, 2011 - 29 p. - Published in: Phys. Lett. B 704 (2011) 143-162 Elsevier Open Access article: PDF; Fulltext: PDF; External link:

Inclusive search for squarks and gluinos in pp collisions at \( \sqrt{s} = 7 \) TeV / CMS Collaboration

A search is performed for heavy squark pairs produced in \( \sqrt{s} = 7 \) TeV proton-proton collisions with 35 inverse picobarns of data collected by the CMS experiment at the LHC. The search is sensitive to squarks and gluinos of generic supersymmetry models, provided they are kinematically accessible, with minimal assumptions on properties of the lightest superpartner particle. [...] arXiv:1107.1279; CMS-SUS-10-009; CERN-PH-EP-2011-099. Geneva: CERN, 2012 - 42 p. - Published in: Phys. Rev. D 85 (2012) 012004 APS Open Access article: PDF; CMS-SUS-10-009 (2011-07-07): PDF; External link:

Measurement of the Underlying Event Activity at the LHC with \( \sqrt{s} = 7 \) TeV and Comparison with \( \sqrt{s} = 0.9 \) TeV / CMS Collaboration

A measurement of the underlying activity in scattering processes with a hard scale in the several GeV region is performed in proton-proton collisions at \( \sqrt{s} = 0.9 \) and 7 TeV, using data collected by the CMS experiment at the LHC. The production of charged particles with pseudorapidity \( \eta \) < 2 and transverse momentum \( p_T > 0.5 \) GeV/c is studied in the azimuthal region transverse to that of the leading set of charged particles forming a track-jet. [...] arXiv:1107.0330; CMS-QCD-10-010; CERN-PH-EP-2011-059. Geneva: CERN, 2011 - 28 p. - Published in: J. High Energy Phys. 09 (2011) 109 CMS-QCD-10-010 (2011-07-01): PDF; Springer Open Access article: PDF; External link:
Missing transverse energy performance of the CMS detector / CMS Collaboration
During 2010 the LHC delivered pp collisions with a centre-of-mass energy of 7 TeV. In this paper, the results of comprehensive studies of missing transverse energy as measured by the CMS detector are presented. [...] 

71. Search for New Physics with a Monojet and Missing Transverse Energy in pp Collisions at $s = 7$ TeV / CMS Collaboration

A study of events with missing transverse energy and an energetic jet is performed using pp collision data at a centre-of-mass energy of 7 TeV. The data were collected by the CMS detector at the LHC, and correspond to an integrated luminosity of 36 inverse picobarns. [...] 

72. Search for New Physics with Jets and Missing Transverse Momentum in pp collisions at $s = 7$ TeV / CMS Collaboration

A search for new physics is presented based on an event signature of at least three jets accompanied by large missing transverse momentum, using a data sample corresponding to an integrated luminosity of 36 inverse picobarns collected in proton–proton collisions at $\sqrt{s} = 7$ TeV with the CMS detector at the LHC. No excess of events is observed above the expected standard model backgrounds, which are all estimated from the data. [...] 

73. Measurement of the $B_{sl}^0$ Production Cross Section with $B_{sl}^0 \rightarrow J/\psi \phi$ Decays in pp Collisions at $s = 7$ TeV / CMS Collaboration

The $B_{sl}^0$ differential production cross section is measured as functions of the transverse momentum and rapidity in pp collisions at $\sqrt{s} = 7$ TeV, using the $J/\psi \phi$ decay, and compared with predictions based on perturbative QCD calculations at next-to-leading order. The data sample, collected by the CMS experiment at the LHC, corresponds to an integrated luminosity of 40 inverse picobarns. [...] 

74. Search for Supersymmetry in Events with $b$ Jets and Missing Transverse Momentum at the LHC / CMS Collaboration

A search for supersymmetry is presented using a sample of events with $b$ jets and missing transverse momentum. The search uses a data sample of proton-proton collisions at a centre-of-mass energy of 7 TeV, corresponding to an integrated luminosity of 35 inverse picobarns, collected with the CMS detector. [...] 

75. Measurement of the t-channel single top quark production cross section in pp collisions at $s = 7$ TeV / CMS Collaboration

Electroweak production of the top quark is measured in pp collisions at $\sqrt{s} = 7$ TeV, using a dataset collected with the CMS detector at the LHC and corresponding to an integrated luminosity of 36 inverse picobarns. With an event selection optimized for t-channel production, two complementary analyses are performed. [...] 

76. Search for Light Resonances Decaying into Pairs of Muons as a Signal of New Physics / CMS Collaboration

A search for groups of collimated muons is performed using a data sample collected by the CMS experiment at the LHC, at a centre-of-mass energy of 7 TeV, and corresponding to an integrated luminosity of 35 inverse picobarns. The analysis searches for production of new low-mass states decaying

77.

Search for Same-Sign Top-Quark Pair Production at $s\sqrt{^7}$ = 7 TeV and Limits on Flavour Changing Neutral Currents in the Top Sector / CMS Collaboration


78.

Search for Physics Beyond the Standard Model Using Multilepton Signatures in $pp$ Collisions at $s\sqrt{^7}$ = 7 TeV / CMS Collaboration


79.

Measurement of the $tt$- Production Cross Section in $pp$ Collisions at $s\sqrt{^7}$=7 TeV using the Kinematic Properties of Events with Leptons and Jets / CMS Collaboration

A measurement of the top-antitop production cross section in proton-proton collisions at a centre-of-mass energy of 7 TeV has been performed at the LHC with the CMS detector. The analysis uses a data sample corresponding to an integrated luminosity of 36 inverse picobarns and is based on the reconstruction of the final state with one isolated, high transverse-momentum electron or muon and three or more hadronic jets. [...] arXiv:1106.0902; CMS-TOP-10-002; CERN-PH-EP-2011-060. - Geneva: CERN, 2011 - 39 p. - Published in: _Eur. Phys. J. C_ **71** (2011) _1721_ CMS-TOP-10-002 (2011-06-05): _PDF_; Springer Open Access article: _PDF_; External link:

80.

Measurement of the Ratio of the 3-jet to 2-jet Cross Sections in $pp$ Collisions at $s\sqrt{^7}$ = 7 TeV / CMS Collaboration

A measurement of the ratio of the inclusive 3-jet to 2-jet cross sections as a function of the total jet transverse momentum, HT, in the range $0.2 < HT < 2.5$ TeV is presented. The data have been collected at a proton-proton centre-of-mass energy of 7 TeV with the CMS detector at the LHC, and correspond to an integrated luminosity of 36 inverse picobarns. [...] arXiv:1106.0647; CMS-QCD-10-012; CERN-PH-EP-2011-044. - Geneva: CERN, 2011 - 28 p. - Published in: _Phys. Lett. B_ **702** (2011) _336-354_ CMS-QCD-10-012 (2011-06-03): _PDF_; Elsevier Open Access article: _PDF_; External link:

81.

Measurement of the Inclusive Jet Cross Section in $pp$ Collisions at $s\sqrt{^7}$ = 7 TeV / CMS Collaboration


82.

Measurement of the $t\bar{t}$ production cross section and the top quark mass in the dilepton channel in $pp$ collisions at $s\sqrt{^7}$=7 TeV / CMS Collaboration

The $t\bar{t}$ production cross section and top quark mass are measured in proton-proton collisions at $\sqrt{s}=7$ TeV in a data sample corresponding to an integrated luminosity of 36 inverse picobarns collected by the CMS experiment. The measurements are performed in events with two leptons (electrons or muons) in the final state. [...] arXiv:1105.5561; CMS-TOP-11-002; CERN-PH-EP-2011-055. - Geneva: CERN, 2011 - 44 p. - Published in: _J. High Energy Phys._ **07 (2011)** _049_ CMS-TOP-11-002 (2011-05-27): _PDF_; Springer Open Access article: _PDF_; External link:
83. Search for First Generation Scalar Leptoquarks in the evj Channel in pp Collisions at \( s = 7 \) TeV / CMS Collaboration

A search for pair-production of first generation scalar leptoquarks is performed in the final state containing an electron, a neutrino, and at least two jets using proton-proton collision data at \( \sqrt{s} = 7 \) TeV. The data were collected by the CMS detector at the LHC, corresponding to an integrated luminosity of 36 inverse picobarns. [...] 


84. Indications of Suppression of Excited Y States in Pb-Pb Collisions at \( \sqrt{NN} = 2.76 \) TeV / CMS Collaboration

A comparison of the relative yields of Upsilon resonances in the \( \mu^+ \mu^- \) decay channel in PbPb and pp collisions at a centre-of-mass energy per nucleon pair of 2.76 TeV, is performed with data collected with the CMS detector at the LHC. Using muons of transverse momentum above 4 GeV/c and pseudorapidity below 2.4, the double ratio of the Upsilon(2S) and Upsilon(1S) excited states to the Upsilon(1S) ground state in PbPb and pp collisions, \( \text{Upsilon}(2S)/\text{Upsilon}(1S) \) \text{PbPb}/(\text{Upsilon}(2S)/\text{Upsilon}(1S)) \text{pp} \), is found to be 0.31 \pm 0.15 \pm 0.19 (stat.) \pm 0.03 (syst.) [...] 


85. Measurement of Wγ and Zγ production in pp collisions at \( s = 7 \) TeV / CMS Collaboration

A measurement of W-gamma and Z-gamma production in proton-proton collisions at \( \sqrt{s} = 7 \) TeV, based on a data sample recorded by the CMS experiment at the LHC, and corresponding to an integrated luminosity of 36 inverse picobarns, is presented. The electron and muon decay channels of the W and Z are used. [...] 


86. Long-range and short-range dihadron angular correlations in central PbPb collisions at \( \sqrt{NN} = 2.76 \) TeV / CMS Collaboration

First measurements of dihadron correlations for charged particles are presented for central PbPb collisions at a nucleon-nucleon center-of-mass energy of 2.76 TeV over a broad range in relative pseudorapidity, \( \Delta \eta \), and the full range of relative azimuthal angle, \( \Delta \phi \). The data were collected with the CMS detector, at the LHC. [...] 


87. Search for supersymmetry in events with a lepton, a photon, and large missing transverse energy in pp collisions at \( s = 7 \) TeV / CMS Collaboration

A search is performed for an excess of events, over the standard model expectations, with a photon, a lepton, and large missing transverse energy in pp collisions at \( \sqrt{s} = 7 \) TeV. Such events are expected in many new physics models, in particular a supersymmetric theory that is broken via a gauge-mediated mechanism, when the lightest charged and neutral gauginos are mass degenerate. [...] 


88. Measurement of the Polarization of W Bosons with Large Transverse Momenta in W+Jets Events at the LHC / CMS Collaboration

A first measurement of the polarization of W bosons with large transverse momenta in pp collisions is presented. The measurement is based on 36 inverse picobarns of data recorded at \( \sqrt{s} = 7 \) TeV by the CMS detector at the LHC. [...] 

89.

**Charged particle transverse momentum spectra in pp collisions at $s^{\sqrt{s}} = 0.9$ and 7 TeV / CMS Collaboration**

The charged particle transverse momentum (pT) spectra are presented for pp collisions at $\sqrt{s}=0.9$ and 7 TeV. The data samples were collected with the CMS detector at the LHC and correspond to integrated luminosities of 231 inverse microns and 2.96 inverse picobarns, respectively. [-]


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89.

**Search for new physics with same-sign isolated dilepton events with jets and missing transverse energy at the LHC / CMS Collaboration**

The results of searches for new physics in events with two same-sign isolated leptons, hadronic jets, and missing transverse energy in the final state are presented. The searches use an integrated luminosity of 35 inverse picobarns of pp collision data at a centre-of-mass energy of 7 TeV collected by the CMS experiment at the LHC. [-]


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90.

**Measurement of the $B_0$ Production Cross Section in pp Collisions at $s^{\sqrt{s}} = 7$ TeV / CMS Collaboration**

Measurements of the differential production cross sections in transverse momentum and rapidity for $B_0$ mesons produced in pp collisions at $\sqrt{s}=7$ TeV are presented. The dataset used was collected by the CMS experiment at the LHC and corresponds to an integrated luminosity of 40 inverse picobarns. [-]


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90.

**Measurement of the differential dijet production cross section in proton-proton collisions at $s^{\sqrt{s}}=7$ TeV / CMS Collaboration**

A measurement of the double-differential inclusive dijet production cross section in proton-proton collisions at $\sqrt{s}=7$ TeV is presented as a function of the dijet invariant mass and jet rapidity. The data correspond to an integrated luminosity of 36 inverse picobarns, recorded with the CMS detector at the LHC. [-]


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91.

**Search for Neutral Minimal Supersymmetric Standard Model Higgs Bosons Decaying to Tau Pairs in pp Collisions at $s^{\sqrt{s}}=7$ TeV / CMS Collaboration**

A search for neutral MSSM Higgs bosons in pp collisions at the LHC at a center-of-mass energy of 7 TeV is presented. The results are based on a data sample corresponding to an integrated luminosity of 36 inverse picobarns recorded by the CMS experiment. [-]


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92.

**Measurement of the Inclusive Z Cross Section via Decays to Tau Pairs in pp Collisions at $s^{\sqrt{s}}=7$ TeV / CMS Collaboration**

A measurement of inclusive $Z \to \tau^+ \tau^-$ production in pp collisions is presented, in the final states $\mu^+ \mu^-$, $e^+ e^-$, $\tau^+ \tau^-$, $\tau^- \tau^-$, $\mu^+ \tau^-$, and $\mu^- \tau^+$. The data sample corresponds to an integrated luminosity of 36 inverse picobarns collected with the CMS detector at the LHC. [-]


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95. Search for Large Extra Dimensions in the Diphoton Final State at the Large Hadron Collider / CMS Collaboration
A search for large extra spatial dimensions via virtual-graviton exchange in the diphoton channel has been carried out with the CMS detector at the LHC. No excess of events above the standard model expectations is found using a data sample collected in proton-proton collisions at \( \sqrt{s} = 7 \text{ TeV} \) and corresponding to an integrated luminosity of 36 inverse picobarns. [...] arXiv:1103.4279; CMS-EXO-10-026; CERN-PH-EP-2011-020.- Geneva : CERN, 2011 - 26 p. - Published in : *J. High Energy Phys. 05 (2011) 085* CMS-EXO-10-026 (2011-03-21); PDF; Fulltext: PS.GZ; Springer Open Access article: PDF; External link:

96. Measurement of the lepton charge asymmetry in inclusive W production in pp collisions at \( \sqrt{s} = 7 \text{ TeV} \) / CMS Collaboration
A measurement of the lepton charge asymmetry in inclusive pp to WX production at \( \sqrt{s} = 7 \text{ TeV} \) is presented based on data recorded by the CMS detector at the LHC and corresponding to an integrated luminosity of 36 inverse picobarns. This high precision measurement of the lepton charge asymmetry, performed in both the W to e nu and W to mu nu channels, provides new insights into parton distribution functions. arXiv:1103.3470; CMS-EWK-10-006; CERN-PH-EP-2011-024.- Geneva : CERN, 2011 - 28 p. - Published in : *J. High Energy Phys. 04 (2011) 050* CMS-EWK-10-006 (2011/03/17); PDF; Fulltext: PS.GZ; Springer Open Access article: PDF; External link:

97. Search for Physics Beyond the Standard Model in Opposite-sign Dilepton Events in pp Collisions at \( \sqrt{s} = 7 \text{ TeV} \) / CMS Collaboration
A search is presented for physics beyond the standard model (SM) in final states with opposite-sign isolated lepton pairs accompanied by hadronic jets and missing transverse energy. The search is performed using LHC data recorded with the CMS detector, corresponding to an integrated luminosity of 34 inverse picobarns. [...] arXiv:1103.1348; CMS-SUS-10-007; CERN-PH-EP-2011-016.- Geneva : CERN, 2011 - 30 p. - Published in : *J. High Energy Phys. 06 (2011) 026* CMS-SUS-10-007 (2011-03-04); PDF; Fulltext: PS.GZ; Springer Open Access article: PDF; External link:

98. Search for Resonances in the Dilepton Mass Distribution in pp Collisions at \( \sqrt{s} = 7 \text{ TeV} \) / CMS Collaboration
A search for narrow resonances at high mass in the dimuon and dielectron channels has been performed by the CMS experiment at the CERN LHC, using pp collision data recorded at \( \sqrt{s} \approx 7 \text{ TeV} \). The event samples correspond to integrated luminosities of 40 inverse picobarns in the dimuon channel and 35 inverse picobarns in the dielectron channel. [...] arXiv:1103.0981; CMS-EXO-10-013; CERN-PH-EP-2011-002.- Geneva : CERN, 2011 - 32 p. - Published in : *J. High Energy Phys. 05 (2011) 093* CMS-EXO-10-013 (2011-03-04); PDF; Fulltext: PS.GZ; Springer Open Access article: PDF; External link:

99. Search for Supersymmetry in pp Collisions at \( \sqrt{s} = 7 \text{ TeV} \) in Events with Two Photons and Missing Transverse Energy / CMS Collaboration
A search for supersymmetry in the context of general gauge-mediated (GGM) breaking with the lightest neutralino as the next-to-lightest supersymmetric particle and the gravitino as the lightest is presented. The data sample corresponds to an integrated luminosity of 36 inverse picobarns recorded by the CMS experiment at the LHC. [...] arXiv:1103.0953; CMS-SUS-10-002; CERN-PH-EP-2011-007.- Geneva : CERN, 2011 - 26 p. - Published in : *Phys. Rev. Lett. 106 (2011) 211802* APS Open Access article: PDF; CMS-SUS-10-002 (2011-03-07); PDF; Fulltext: PS.GZ; External link:

100. Search for a W' boson decaying to a muon and a neutrino in pp collisions at \( \sqrt{s} = 7 \text{ TeV} \) / CMS Collaboration
160–179 EXO-10-015 (2011-02-28): PDF; Elsevier Open Access article: PDF; Fulltext: PS.GZ; External link:

101. Study of Z boson production in PbPb collisions at $\sqrt{s} = 2.76$ TeV / CMS Collaboration
A search for Z bosons in the $\mu^+\mu^-$ decay channel has been performed in PbPb collisions at a nucleon-nucleon centre of mass energy $\sqrt{s}$ = 2.76 TeV with the CMS detector at the LHC, in a 7.2 inverse microbarn data sample. The number of opposite-sign muon pairs observed in the 60–120 GeV/c$^2$ invariant mass range is 39, corresponding to a yield per unit of rapidity (y) and per minimum bias event of $(3.8 \pm 0.7 \text{ (stat)} \pm 0.4 \text{ (sys)}) \times 10^{−3}$, in the $|y|$$\leq$2.0 range. [...] arXiv:1102.5435; CMS-HIN-10-003; CERN-EP-2011-003. Geneva: CERN, 2011 - 24 p. - Published in: Phys. Rev. Lett. 106 (2011) 212301 APS Open Access article: PDF; CMS-HIN-10-003 (2011-02-26): PDF; Fulltext: PS.GZ; External link:

102. Measurement of $W^+W^-$ Production and Search for the Higgs Boson in pp Collisions at $s^\sqrt{=} = 7$ TeV / CMS Collaboration

103. Search for a Heavy Bottom-like Quark in pp Collisions at $s^\sqrt{=} = 7$ TeV / CMS Collaboration
A search for pair-produced bottom-like quarks in pp collisions at $\sqrt{s}$ = 7 TeV is conducted with the CMS experiment at the LHC. The decay $b^0 \to t\bar{t}$ is considered in this search. [...] arXiv:1102.4746; CMS-EXO-10-018; CERN-EP-2011-009. Geneva: CERN, 2011 - 26 p. - Published in: Phys. Lett. B 701 (2011) 204–223 CMS-EXO-10-018 (2011-02-23): PDF; Elsevier Open Access article: PDF; Fulltext: PS.GZ; External link:

104. Strange Particle Production in pp collisions at $s^\sqrt{=} = 0.9$ and 7 TeV / CMS Collaboration
The spectra of strange hadrons are measured in proton-proton collisions, recorded by the CMS experiment at the CERN LHC, at centre-of-mass energies of 0.9 and 7 TeV. The $K_0$, Lambda, and Xi$^-$ particles and their antiparticles are reconstructed from their decay topologies and the production rates are measured as functions of rapidity and transverse momentum. [...] arXiv:1102.4282; CMS-QCD-10-007; CERN-EP-2010-0094. Geneva: CERN, 2011 - 38 p. - Published in: J. High Energy Phys. 05 (2011) 064 CMS-QCD-10-007 (2011-02-22): PDF; Fulltext: PS.GZ; Springer Open Access article: PDF; External link:

105. Measurement of $BB^\rightarrow$ angular correlations based on secondary vertex reconstruction at $s^\sqrt{=} = 7$ TeV / CMS Collaboration
A measurement of the angular correlations between beauty and anti-beauty hadrons (B B$^\bar{\text{g}}$) produced in pp collisions at a centre-of-mass energy of 7 TeV at the CERN LHC is presented, probing for the first time the region of small angular separation. The B hadrons are identified by the presence of displaced secondary vertices from their decays. [...] arXiv:1102.3319; CMS-BPH-10-010; CERN-EP-2010-093. Geneva: CERN, 2011 - 33 p. - Published in: J. High Energy Phys. 03 (2011) 136 CMS-BPH-10-010 (2011-02-15): PDF; Springer Open Access article: PDF; External link:

106. Measurement of Dijet Angular Distributions and Search for Quark Compositeness in pp Collisions at $s^\sqrt{=} = 7$ TeV / CMS Collaboration
107. 
Observation and studies of jet quenching in PbPb collisions at \( s_{NN} \) = 2.76 TeV / CMS Collaboration
Jet production in PbPb collisions at a nucleon-nucleon center-of-mass energy of 2.76 TeV was studied with the CMS detector at the LHC, using a data sample corresponding to an integrated luminosity of 6.7 inverse microns. Jets are reconstructed using the energy deposited in the CMS calorimeters and studied as a function of collision centrality. [-]

108. 
First Measurement of Hadronic Event Shapes in pp Collisions at \( s = 7 \) TeV / CMS Collaboration
Hadronic event shapes have been measured in proton-proton collisions at \( s = 7 \) TeV, with a data sample collected with the CMS detector at the LHC. The sample corresponds to an integrated luminosity of 3.2 inverse picobarns. [-]

109. 
Dijet Azimuthal Decorrelations in pp Collisions at \( s = 7 \) TeV / CMS Collaboration
Measurements of dijet azimuthal decorrelations in pp collisions at \( s = 7 \) TeV using the CMS detector at the CERN LHC are presented. The analysis is based on an inclusive dijet event sample corresponding to an integrated luminosity of 2.9 inverse picobarns. [-]

110. 
Measurement of Bose–Einstein Correlations in pp Collisions at \( s = 0.9 \) and 7 TeV / CMS Collaboration
Bose-Einstein correlations between identical particles are measured in samples of proton-proton collisions at 0.9 and 7 TeV centre-of-mass energies, recorded by the CMS experiment at the LHC. The signal is observed in the form of an enhancement of number of pairs of same-sign charged particles with small relative momentum. [-]

111. 
Inclusive b-hadron production cross section with muons in pp collisions at \( s = 7 \) TeV / CMS Collaboration
A measurement of the b-hadron production cross section in proton-proton collisions at \( s = 7 \) TeV is presented. The dataset, corresponding to 85 inverse nanobarns, was recorded with the CMS experiment at the LHC using a low-threshold single-muon trigger. [-]

112. 
Search for Heavy Stable Charged Particles in pp collisions at \( s = 7 \) TeV / CMS Collaboration
The result of a search at the LHC for heavy stable charged particles produced in pp collisions at \( s = 7 \) TeV is described. The data sample was collected with the CMS detector and corresponds to an integrated luminosity of 3.1 inverse picobarns. [-]

113. 
Search for Supersymmetry in pp Collisions at 7 TeV in Events with Jets and Missing Transverse Energy / CMS Collaboration
A search for supersymmetry with R-parity conservation in proton-proton collisions at a centre-of-mass energy of 7 TeV is presented. The data
114. Measurement of the $B^*$ Production Cross Section in pp Collisions at $s = 7$ TeV / CMS Collaboration

Measurements of the total and differential cross sections with respect to transverse momentum and rapidity for $B^*$ mesons produced in pp collisions at $s = 7$ TeV are presented. The data correspond to an integrated luminosity of 5.8 inverse picobarns collected by the CMS experiment operating at the LHC. [...] 


115. Search for a heavy gauge boson $W'$ in the final state with an electron and large missing transverse energy in pp collisions at $s = 7$ TeV / CMS Collaboration

A search for a heavy gauge boson $W'$ has been conducted by the CMS experiment at the LHC in the decay channel with an electron and large transverse energy imbalance, using proton-proton collision data corresponding to an integrated luminosity of 36 inverse picobarns. No excess above standard model expectations is seen in the transverse mass distribution of the electron-(missing ET) system. [...] 


116. Upsilon production cross section in pp collisions at $s = 7$ TeV / CMS Collaboration

The Upsilon production cross section in proton-proton collisions at $s = 7$ TeV is measured using a data sample collected with the CMS detector at the LHC, corresponding to an integrated luminosity of 3.1 +/- 0.3 inverse picobarns. Integrated over the rapidity range $|y|=2$, we find the product of the Upsilon(1S) production cross section and branching fraction to dimuons to be $\sigma(pp \rightarrow Upsilon(1S) X) \times B[Upsilon(1S) \rightarrow \mu^+ \mu^-] = 7.3^{+9}_{-7}$ fb. [...] 


117. Search for Pair Production of Second-Generation Scalar Leptoquarks in pp Collisions at $s = 7$ TeV / CMS Collaboration

A search for pair production of second-generation scalar leptoquarks in the final state with two muons and two jets is performed using proton-proton collision data at $\sqrt{s} = 7$ TeV collected by the CMS detector at the LHC. The data sample used corresponds to an integrated luminosity of 34 inverse picobarns. [...] 


118. Search for Pair Production of First-Generation Scalar Leptoquarks in pp Collisions at $s = 7$ TeV / CMS Collaboration

A search for pair production of first-generation scalar leptoquarks is performed in the final state containing two electrons and two jets using proton-proton collision data at $\sqrt{s}=7$ TeV. The data sample used corresponds to an integrated luminosity of 33 inverse picobarns collected with the CMS detector at the CERN LHC. [...] 


119. Search for Microscopic Black Hole Signatures at the Large Hadron Collider / CMS Collaboration

A search for microscopic black hole production and decay in pp collisions at a center-of-mass energy of 7 TeV has been conducted by the CMS Collaboration at the LHC, using a data sample corresponding to an integrated luminosity of 35 inverse picobarns. Events with large total transverse energy are analyzed for the presence of multiple high-energy jets, leptons, and photons, typical of a signal expected from a microscopic black hole. [...] 

120. Measurements of Inclusive W and Z Cross Sections in pp Collisions at $s^\sqrt{}=7$ TeV / CMS Collaboration

Measurements of inclusive W and Z boson production cross sections in pp collisions at $\sqrt{s}=7$ TeV are presented, based on 2.9 pb$^{-1}$ of data recorded by the CMS detector at the LHC. The measurements, performed in the electron and muon decay channels, are combined to give $\sigma(pp\rightarrow W)\times\sigma(W\rightarrow lnu)$ = 9.95 $\pm$ 0.07 (stat.) $\pm$ 0.28 (syst.) nb and $\sigma(pp\rightarrow Z)\times\sigma(Z\rightarrow ll) = 0.931 $ $\pm$ 0.026 (stat.) $\pm$ 0.023 (syst.) nb, where we stands for either $e$ or $\mu$. [...] arXiv:1012.2446; CERN-PH-EP-2010-050; CMS-EWK-10-002. Geneva: CERN, 2011 - 36 p. Published in: *J. High Energy Phys. 01 (2011) 080* Springer Open Access article: PDF; External link:

121. Measurement of the Isolated Prompt Photon Production Cross Section in pp Collisions at $s^\sqrt{}=7$ TeV / CMS Collaboration


122. Search for Stopped Gluinos in pp collisions at $s^\sqrt{}=7$ TeV / CMS Collaboration


123. Charged particle multiplicities in pp interactions at $s^\sqrt{}=0.9, 2.36, and 7$ TeV / CMS Collaboration

Measurements of primary charged hadron multiplicity distributions are presented for non-single-diffractive events in proton-proton collisions at centre-of-mass energies of $\sqrt{s}=0.9, 2.36, and 7$ TeV, in five pseudorapidity ranges from $|\eta|=0.5$ to $|\eta|=2.4$. The data were collected with the minimum-bias trigger of the CMS experiment during the LHC commissioning runs in 2009 and the 7 TeV run in 2010. [...] arXiv:1011.5531; CERN-PH-EP-2010-048; CMS-QCD-10-004. Geneva: CERN, 2011 - 35 p. Published in: *J. High Energy Phys. 01 (2011) 079* Springer Open Access article: PDF; External link:

124. Prompt and non-prompt J/$\psi$ production in pp collisions at $s^\sqrt{}=7$ TeV / CMS Collaboration


125. First Measurement of the Cross Section for Top-Quark Pair Production in Proton-Proton Collisions at $s^\sqrt{}=7$ TeV / CMS Collaboration

The first measurement of the cross section for top-quark pair production in pp collisions at the LHC at center-of-mass energy $\sqrt{s}=7$ TeV has been performed using 3.1 (3.0) inverse pb of data recorded by the CMS detector. This result utilizes the final state with two isolated, highly energetic charged leptons, large missing transverse energy, and two or more jets. [...] arXiv:1011.5594; CERN-PH-EP-2010-039; CMS-TOP-10-001. Geneva: CERN, 2011 - 35 p. Published in: *Phys. Lett. B 695 (2011) 424-443* Elsevier Open Access article: PDF; External link:

126. Search for Quark Compositeness with the Dijet Centrality Ratio in pp Collisions at $s^\sqrt{}=7$ TeV / CMS Collaboration

A search for quark compositeness in the form of quark contact interactions, based on hadronic jet pairs (dijets) produced in proton-proton collisions...
at sqrt(s)=7 TeV, is described. The data sample of the study corresponds to an integrated luminosity of 2.9 inverse picobarns collected with the CMS detector at the LHC. [...] 


127. 

Search for Dijet Resonances in 7 TeV pp Collisions at CMS / CMS Collaboration 

A search for narrow resonances in the dijet mass spectrum is performed using data corresponding to an integrated luminosity of 2.9 inverse pb collected by the CMS experiment at the LHC. Upper limits at the 95% confidence level (CL) are presented on the product of the resonance cross section, branching fraction into dijets, and acceptance, separately for decays into quark-quark, quark-gluon, or gluon-gluon pairs. [...] 


128. 

Observation of Long-Range, Near-Side Angular Correlations in Proton-Proton Collisions at the LHC / CMS Collaboration 

Results on two-particle angular correlations for charged particles emitted in proton-proton collisions at center-of-mass energies of 0.9, 2.36, and 7 TeV are presented, using data collected with the CMS detector over a broad range of pseudorapidity (η) and azimuthal angle (φ). Short-range correlations in η, which are studied in minimum bias events, are characterized using a simple "independent cluster" parametrization in order to quantify their strength (cluster size) and their extent in η (cluster decay width). [...] 


129. 

CMS Tracking Performance Results from Early LHC Operation / CMS Collaboration 

The first LHC pp collisions at centre-of-mass energies of 0.9 and 2.36 TeV were recorded by the CMS detector in December 2009. The trajectories of charged particles produced in the collisions were reconstructed using the all-silicon Tracker and their momenta were measured in the 38 T axial magnetic field. [...] 


130. 

First Measurement of the Underlying Event Activity at the LHC with √s = 0.9 TeV / CMS Collaboration 

A measurement of the underlying activity in scattering processes with pT scale in the GeV region is performed in proton-proton collisions at √s = 0.9 TeV, using data collected by the CMS experiment at the LHC. Charged hadron production is studied with reference to the direction of a leading object, either a charged particle or a set of charged particles forming a jet. [...] 


131. 

Measurement of the charge ratio of atmospheric muons with the CMS detector / CMS Collaboration 


132. 

Transverse-momentum and pseudorapidity distributions of charged hadrons in pp collisions at √s = 7 TeV / CMS Collaboration 

Charged-hadron transverse-momentum and pseudorapidity distributions in proton-proton collisions at √s = 7 TeV are measured with the inner tracking system of the CMS detector at the LHC. The charged-hadron yield is obtained by counting the number of reconstructed hits, hit-pairs, and fully reconstructed charged-particle tracks. [...] 


133.
First Measurement of Bose-Einstein Correlations in proton-proton Collisions at $s\sqrt{s}$ = 0.9 and 2.36 TeV at the LHC / CMS Collaboration

Bose-Einstein correlations have been measured using samples of proton-proton collisions at 0.9 and 2.36 TeV center-of-mass energies, recorded by the CMS experiment at the CERN Large Hadron Collider. The signal is observed in the form of an enhancement of pairs of same-sign charged particles with small relative four-momentum. [...] arXiv:1005.3294; CMS-QCD-10-003; CERN-PH-EP-2010-010; Geneva: CERN, 2010 - 24 p. - Published in: Phys. Rev. Lett. 105 (2010) 032001 APS Open Access article: PDF; External link:

134.

Transverse momentum and pseudorapidity distributions of charged hadrons in pp collisions at $s\sqrt{s}$ = 0.9 and 2.36 TeV / CMS Collaboration

Measurements of inclusive charged-hadron transverse-momentum and pseudorapidity distributions are presented for proton-proton collisions at sqrt(s) = 0.9 and 2.36 TeV. The data were collected with the CMS detector during the LHC commissioning in December 2009. [...] arXiv:1002.0621; CMS-QCD-09-010; CERN-PH-EP-2010-003; Geneva: CERN, 2010 - 33 p. - Published in: J. High Energy Phys. 02 (2010) 041 Springer Open Access article: PDF; Supplemental material: TXT; External link:

135.

Commissioning and Performance of the CMS Pixel Tracker with Cosmic Ray Muons / CMS Collaboration

The pixel detector of the Compact Muon Solenoid experiment consists of three barrel layers and two disks for each endcap. The detector was installed in summer 2008, commissioned with charge injections, and operated in the 3.8 T magnetic field during cosmic ray data taking. [...] arXiv:0911.1543; CMS-PFT-09-001; Geneva: CERN, 2010 - 37 p. - Published in: J. Instrum. 5 (2010) T03007 SISSA/IOP Open Access article: PDF; External link:

136.

Measurement of the Muon Stopping Power in Lead Tungstate / CMS Collaboration

A large sample of cosmic ray events collected by the CMS detector is exploited to measure the specific energy loss of muons in the lead tungstate of the electromagnetic calorimeter. The measurement spans a momentum range from 5 GeV/c to 1 TeV/c. [...] arXiv:0911.1533; CMS-PFT-09-005; 2010 - 31 p. - Published in: J. Instrum. 5 (2010) P03007 SISSA/IOP Open Access article: PDF; External link:

137.

Performance of the CMS Level-1 Trigger during Commissioning with Cosmic Ray Muons and LHC beams / CMS Collaboration

The CMS Level-1 trigger was used to select cosmic ray muons and LHC beam events during data-taking runs in 2008, and to estimate the level of detector noise. This paper describes the trigger components used, the algorithms that were executed, and the trigger synchronisation. [...] arXiv:0911.1542; CMS-PFT-09-013; 2010 - 49 p. - Published in: J. Instrum. 5 (2010) T03002 SISSA/IOP Open Access article: PDF; External link:

138.

Performance of CMS Muon Reconstruction in Cosmic-Ray Events / CMS Collaboration

The performance of muon reconstruction in CMS is evaluated using a large data sample of cosmic-ray muons recorded in 2008. Efficiencies of various high-level trigger, identification, and reconstruction algorithms have been measured for a broad range of muon momenta, and were found to be in good agreement with expectations from Monte Carlo simulation. [...] arXiv:0911.1499; CMS-PFT-09-014; 2010 - 47 p. - Published in: J. Instrum. 5 (2010) T03022 SISSA/IOP Open Access article: PDF; External link:

139.

Commissioning and Performance of the CMS Silicon Strip Tracker with Cosmic Ray Muons / CMS Collaboration

During autumn 2008, the Silicon Strip Tracker was operated with the full CMS experiment in a comprehensive test, in the presence of the 3.8 T magnetic field produced by the CMS superconducting solenoid. Cosmic ray muons were detected in the muon chambers and used to trigger the readout of all CMS sub-detectors. [...] arXiv:0911.1498; CMS-PFT-09-002; 2010 - 45 p. - Published in: J. Instrum. 5 (2010) T03008 SISSA/IOP Open Access article: PDF; External link:
140. Performance of the CMS Cathode Strip Chambers with Cosmic Rays / CMS Collaboration

The Cathode Strip Chambers (CSCs) constitute the primary muon tracking device in the CMS endcaps. Their performance has been evaluated using data taken during a cosmic ray run in fall 2008. [...] arXiv:0911.4992; CMS-CFT-09-011; 2010 - 39 p. - Published in: J. Instrum. 5 (2010) T03018 SISSA/IOP Open Access article: PDF; External link:

141. Performance of the CMS Hadron Calorimeter with Cosmic Ray Muons and LHC Beam Data / CMS Collaboration

The CMS Hadron Calorimeter in the barrel, endcap and forward regions is fully commissioned. Cosmic ray data were taken with and without magnetic field at the surface hall and after installation in the experimental hall, hundred meters underground. [...] arXiv:0911.4991; CMS-CFT-09-009; 2010 - 35 p. - Published in: J. Instrum. 5 (2010) T03012 SISSA/IOP Open Access article: PDF; External link:

142. CMS Data Processing Workflows during an Extended Cosmic Ray Run / CMS Collaboration

The CMS Collaboration conducted a month-long data-taking exercise, the Cosmic Run At Four Tesla, during October-November 2008, with the goal of commissioning the experiment for extended operation. With all installed detector systems participating, CMS recorded 270 million cosmic ray events with the solenoid at a magnetic field strength of 3.8 T. [...] arXiv:0911.4842; CMS-CFT-09-007; 2010 - 43 p. - Published in: J. Instrum. 5 (2010) T03006 SISSA/IOP Open Access article: PDF; External link:

143. Performance of the CMS Drift Tube Chambers with Cosmic Rays / CMS Collaboration

Studies of the performance of the CMS drift tube barrel muon system are described, with results based on data collected during the CMS Cosmic Run at Four Tesla. For most of these data, the solenoidal magnet was operated with a central field of 3.8 T. [...] arXiv:0911.4855; CMS-CFT-09-012; 2010 - 47 p. - Published in: J. Instrum. 5 (2010) T03015 SISSA/IOP Open Access article: PDF; External link:

144. Calibration of the CMS Drift Tube Chambers and Measurement of the Drift Velocity with Cosmic Rays / CMS Collaboration

This paper describes the calibration procedure for the drift tubes of the CMS barrel muon system and reports the main results obtained with data collected during a high statistics cosmic ray data-taking period. The main goal of the calibration is to determine, for each drift cell, the minimum time delay for signals relative to the trigger, accounting for the drift velocity within the cell. [...] arXiv:0911.4895; CMS-CFT-09-023; 2010 - 39 p. - Published in: J. Instrum. 5 (2010) T03016 SISSA/IOP Open Access article: PDF; External link:

145. Commissioning of the CMS Experiment and the Cosmic Run at Four Tesla / CMS Collaboration

The CMS Collaboration conducted a month-long data-taking exercise known as the Cosmic Run At Four Tesla in late 2008 in order to complete the commissioning of the experiment for extended operation. The operational lessons resulting from this exercise were addressed in the subsequent shutdown to better prepare CMS for LHC beams in 2009. [...] arXiv:0911.4845; CMS-CFT-09-008; 2010 - 37 p. - Published in: J. Instrum. 5 (2010) T03001 SISSA/IOP Open Access article: PDF; External link:

146. Identification and Filtering of Uncharacteristic Noise in the CMS Hadron Calorimeter / CMS Collaboration

Commissioning studies of the CMS hadron calorimeter have identified sporadic uncharacteristic noise and a small number of malfunctioning calorimeter channels. Algorithms have been developed to identify and address these problems in the data. [...] arXiv:0911.4881; CMS-CFT-09-019; 2010 - 31 p. - Published in: J. Instrum. 5 (2010) T03014 SISSA/IOP Open Access article: PDF; External link:

147.
Commissioning of the CMS High-Level Trigger with Cosmic Rays / CMS Collaboration
The CMS High-Level Trigger (HLT) is responsible for ensuring that data samples with potentially interesting events are recorded with high efficiency and good quality. This paper gives an overview of the HLT and focuses on its commissioning using cosmic rays. [...] arXiv:0911.4889; CMS-CFT-09-020 - 2010 - 31 p. - Published in: J. Instrum. 5 (2010) T03005 SISSA/IOP Open Access article: PDF; External link:

148.
Aligning the CMS Chambers with the Muon Alignment System during an Extended Cosmic Ray Run / CMS Collaboration
The alignment system for the muon spectrometer of the CMS detector comprises three independent subsystems of optical and analog position sensors. It aligns muon chambers with respect to each other and to the central silicon tracker. [...] arXiv:0911.4770; CMS-CFT-09-017 - 2010 - 35 p. - Published in: J. Instrum. 5 (2010) T03019 SISSA/IOP Open Access article: PDF; External link:

149.
Performance of the CMS drift-tube chamber local trigger with cosmic rays / CMS Collaboration
The performance of the Local Trigger based on the drift-tube system of the CMS experiment has been studied using muons from cosmic ray events collected during the commissioning of the detector in 2008. The properties of the system are extensively tested and compared with the simulation. [...] arXiv:0911.4879; CMS-CFT-09-022 - 2010 - 33 p. - Published in: J. Instrum. 5 (2010) T03003 SISSA/IOP Open Access article: PDF; External link:

150.
Fine Synchronization of the CMS Muon Drift-Tube Local Trigger using Cosmic Rays / CMS Collaboration
The CMS experiment uses self-triggering arrays of drift tubes in the barrel muon trigger to perform the identification of the correct bunch crossing. The identification is unique only if the trigger chain is correctly synchronized [...] arXiv:0911.4900; CMS-CFT-09-025 - 2010 - 33 p. - Published in: J. Instrum. 5 (2010) T03004 SISSA/IOP Open Access article: PDF; External link:

151.
Performance of CMS hadron calorimeter timing and synchronization using test beam, cosmic ray, and LHC beam data / CMS Collaboration
This paper discusses the design and performance of the time measurement technique and of the synchronization systems of the CMS hadron calorimeter. Timing performance results are presented from the Cosmic Run At Four Tesla and LHC beam runs taken in the Autumn of 2008. [...] arXiv:0911.4877; CMS-CFT-09-018 - 2010 - 33 p. - Published in: J. Instrum. 5 (2010) T03013 SISSA/IOP Open Access article: PDF; External link:

152.
Alignment of the CMS Muon System with Cosmic-Ray and Beam-Halo Muons / CMS Collaboration
The CMS muon system has been aligned using cosmic-ray muons collected in 2008 and beam-halo muons from the 2008 LHC circulating beam tests. After alignment, the resolution of the most sensitive coordinate is 80 microns for the relative positions of superlayers in the same barrel chamber and 270 microns for the relative positions of endcap chambers in the same ring structure. [...] arXiv:0911.14022; CMS-CFT-09-016 - 2010 - 41 p. - Published in: J. Instrum. 5 (2010) T03020 SISSA/IOP Open Access article: PDF; External link:

153.
Performance Study of the CMS Barrel Resistive Plate Chambers with Cosmic Rays / CMS Collaboration
In October and November 2008, the CMS collaboration conducted a programme of cosmic ray data taking, which has recorded about 270 million events. The Resistive Plate Chamber system, which is part of the CMS muon detection system, was successfully operated in the full barrel. [...] arXiv:0911.14045; CMS-CFT-09-010 - 2010 - 33 p. - Published in: J. Instrum. 5 (2010) T03017 SISSA/IOP Open Access article: PDF; External link:

154.
Time Reconstruction and Performance of the CMS Electromagnetic Calorimeter / CMS
Collaboration

The resolution and the linearity of time measurements made with the CMS electromagnetic calorimeter are studied with samples of data from test beam electrons, cosmic rays, and beam-produced muons. The resulting time resolution measured by lead tungstate crystals is better than 100 ps for energy deposits larger than 10 GeV. [...] arXiv:0911.4044; CMS-CFT-09-006.- 2010 - 27 p. - Published in: *J. Instrum. 5 (2010) T03011* SISSA/IOP Open Access article: PDF; External link:

155.

**Precise Mapping of the Magnetic Field in the CMS Barrel Yoke using Cosmic Rays / CMS Collaboration**
The CMS detector is designed around a large 4 T superconducting solenoid, enclosed in a 12000-tonne steel return yoke. A detailed map of the magnetic field is required for the accurate simulation and reconstruction of particles in the CMS detector, not only in the inner tracking region inside the solenoid but also in the large and complex structure of the steel yoke, which is instrumented with muon chambers. [...] arXiv:0910.5530; CMS-CFT-09-015.- 2010 - 37 p. - Published in: *J. Instrum. 5 (2010) T03021* SISSA/IOP Open Access article: PDF; External link:

156.

**Performance and Operation of the CMS Electromagnetic Calorimeter / CMS Collaboration**
The operation and general performance of the CMS electromagnetic calorimeter using cosmic-ray muons are described. These muons were recorded after the closure of the CMS detector in late 2008. [...] arXiv:0910.3423; CMS-CFT-09-004.- 2010 - 39 p. - Published in: *J. Instrum. 5 (2010) T03010* SISSA/IOP Open Access article: PDF; External link:

157.

**Alignment of the CMS Silicon Tracker during Commissioning with Cosmic Rays / CMS Collaboration**
The CMS silicon tracker, consisting of 1440 silicon pixel and 15148 silicon strip detector modules, has been aligned using more than three million cosmic ray charged particles, with additional information from optical surveys. The positions of the modules were determined with respect to cosmic ray trajectories to a precision of 3-4 microns RMS in the barrel and 3-14 microns RMS in the endcap in the most sensitive coordinate. [...] arXiv:0911.02505; CMS-CFT-09-003.- 2010 - 41 p. - Published in: *J. Instrum. 5 (2010) T03009* SISSA/IOP Open Access article: PDF; External link:

158.

**The CMS experiment at the CERN LHC / CMS Collaboration**
2008 - 361 p. - Published in: *J. Instrum. 3 (2008) S08004* SISSA/IOP Open Access article: PDF; Presented at: The CERN Large Hadron Collider - CERN library copies
ATLAS group publications

1. Search for a Standard Model Higgs boson in the $H \rightarrow ZZ \rightarrow \text{lnunu}$ decay channel using $4.7 \text{ fb}^{-1}$ of $\sqrt{s} = 7 \text{ TeV}$ data with the ATLAS detector
A search for a heavy Standard Model Higgs boson decaying via $H \rightarrow ZZ \rightarrow \text{lnunu}$, where $l$ represents electrons or muons, is presented [...] CERN-PH-EP-2012-120. - 2012.

2. Evidence for the associated production of a W boson and a top quark in ATLAS at $\sqrt{s} = 7 \text{ TeV}$ / ATLAS Collaboration
This letter presents evidence for the associated production of a W boson and a top quark using $2.05 \text{ fb}^{-1}$ of pp collision data at $\sqrt{s} = 7 \text{ TeV}$ accumulated with the ATLAS detector at the LHC [...] arXiv:1205.5764 ; CERN-PH-EP-2012-117. - 2012. - 23 p.

3. A search for $t\bar{t}$ resonances with the ATLAS detector in $2.05 \text{ fb}^{-1}$ of proton-proton collisions at $(\sqrt{s}) = 7 \text{ TeV}$ / ATLAS Collaboration
A search for top quark pair resonances in final states containing at least one electron or muon has been performed with the ATLAS experiment at the CERN Large Hadron Collider. [...] arXiv:1205.5371 ; CERN-PH-EP-2012-122. - 2012. - 25 p.

4. Search for $tb$ resonances in proton-proton collisions at $\sqrt{s} = 7 \text{ TeV}$ with the ATLAS detector / ATLAS Collaboration

5. Measurement of the t-channel single top-quark production cross section in pp collisions at $\sqrt{s} = 7 \text{ TeV}$ with the ATLAS detector / ATLAS Collaboration
We report a measurement of the cross section of single top-quark production in the t-channel using $1.04 \text{ fb}^{-1}$ of pp collision data at $\sqrt{s} = 7 \text{ TeV}$ recorded with the ATLAS detector at the LHC. [...] arXiv:1205.3130 ; CERN-PH-EP-2012-082. - 2012. - 27 p, Phys. Lett. B.

6. Measurement of $W\gamma$ and $Z\gamma$ production cross sections in pp collisions at $\sqrt{s} = 7 \text{ TeV}$ and limits on anomalous triple gauge couplings with the ATLAS detector / ATLAS Collaboration
This Letter presents measurements of $l+\gamma$ and $l+\gamma(E,e,\mu)$ production in $1.02 \text{ fb}^{-1}$ of pp collision data recorded at $\sqrt{s} = 7 \text{ TeV}$ with the ATLAS detector at the LHC during 2011. [...] arXiv:1205.2531 ; CERN-PH-EP-2012-059. - 2012. - 24 p.

7. Measurement of the $W$ boson polarization in top quark decays with the ATLAS detector
This paper presents measurements of the polarization of $W$ bosons in top quark decays, derived from $t\bar{t}$ events with missing transverse momentum, one charged lepton and at least four jets, or two charged leptons and at least two jets. [...] arXiv:1205.2484 ; CERN-PH-EP-2012-112. - 2012.

8. Measurement of the top quark pair cross section with ATLAS in pp collisions at $\sqrt{s} = 7 \text{ TeV}$ using final states with an electron or a muon and a hadronically decaying tau lepton / ATLAS Collaboration
A measurement of the cross section of top quark pair production in proton-proton collisions recorded with the ATLAS detector at the LHC at a centre-of-mass energy of $7 \text{ TeV}$ is reported. [...]
9. **Search for lepton flavour violation in the emu continuum with the ATLAS detector in $s^\sqrt{\ } = 7$ TeV pp collisions at the LHC / ATLAS Collaboration**

This paper presents a search for the $\tau$-channel exchange of an R-parity violating scalar top quark ($t_2$) in the emu continuum using 2.1 fb$^{-1}$ of data collected by the ATLAS detector in $s^\sqrt{\ } = 7$ TeV pp collisions at the Large Hadron Collider. [...] arXiv:1205.0725 ; CERN-PH-EP-2012-108. - 2012. - 19 p.

10. **Search for scalar top quark pair production in natural gauge mediated supersymmetry models with the ATLAS detector in pp collisions at $s^\sqrt{\ } = 7$ TeV / ATLAS Collaboration**

The results of a search for pair production of the lighter scalar partners of top quarks in 2.05 fb$^{-1}$ of pp collisions at $s^\sqrt{\ } = 7$ TeV using the ATLAS experiment at the LHC are reported. [...] arXiv:1204.6736 ; CERN-PH-EP-2012-097. - 2012. - 20 p.

11. **Measurement of $\tau$ polarization in $W\rightarrow\tau\nu$ decays with the ATLAS detector in pp collisions at $s^\sqrt{\ } = 7$ TeV / ATLAS Collaboration**

In this paper, a measurement of tau polarization in $W\rightarrow\tau\nu$ decays is presented. [...] arXiv:1204.6720 ; CERN-PH-EP-2012-075. - 2012. - 25 p.

12. **Search for supersymmetry in events with three leptons and missing transverse momentum in $s^\sqrt{\ } = 7$ TeV pp collisions with the ATLAS detector / ATLAS Collaboration**


13. **Searches for TeV-scale Gravity Signatures in Final States with Leptons and Jets with the ATLAS Detector at $s^\sqrt{\ } = 7$ TeV / ATLAS Collaboration**

The production of events with multiple high transverse momentum particles including charged leptons and jets is measured, using 1.04 fb$^{-1}$ of proton-proton collision data recorded by the ATLAS detector during the first half of 2011 at $s^\sqrt{\ } = 7$ TeV. [...] arXiv:1204.4646 ; CERN-PH-EP-2012-046. - 2012. - 23 p.

14. **Search for supersymmetry with jets, missing transverse momentum and at least one hadronically decaying tau lepton in proton-proton collisions at $s^\sqrt{\ } = 7$ TeV with the ATLAS detector / ATLAS Collaboration**


15. **Search for charged Higgs bosons decaying via $H_{\pm}\rightarrow\tau\nu$ in top quark pair events using pp collision data at $s^\sqrt{\ } = 7$ TeV with the ATLAS detector / ATLAS Collaboration**


16. **Search for resonant WZ production in the $WZ\rightarrow{\ell\nu}{\ell'\nu'}$ channel in $s^\sqrt{\ } = 7$ TeV pp collisions with the
ATLAS detector / ATLAS Collaboration

17. Search for pair production of a new quark that decays to a $Z$ boson and a bottom quark with the ATLAS detector / ATLAS Collaboration
A search is reported for the pair production of a new quark, $b'$, with at least one $b'$ decaying to a $Z$ boson and a bottom quark. [...] arXiv:1204.1265; CERN-PH-EP-2012-073. - 2012. - 18 p.

18. Search for the decay $B_{s} \rightarrow \mu^{+}\mu^{-}$ with the ATLAS detector / ATLAS Collaboration
A blind analysis searching for the decay $B_{s} \rightarrow \mu^{+}\mu^{-}$ has been performed using proton-proton collisions at a centre-of-mass energy of 7 TeV recorded with the ATLAS detector at the LHC. [...] arXiv:1204.0735; CERN-PH-EP-2012-067. - 2012. - 24 p.

19. Search for a fermiophobic Higgs boson in the diphoton decay channel with the ATLAS detector / ATLAS Collaboration

20. Search for events with large missing transverse momentum, jets, and at least two tau leptons in 7 TeV proton-proton collision data with the ATLAS detector / ATLAS Collaboration
A search for events with large missing transverse momentum, jets, and at least two tau leptons has been performed using 2 fb$^{-1}$ of proton-proton collision data at $\sqrt{s}=7$ TeV recorded with the ATLAS detector at the Large Hadron Collider. [...] arXiv:1203.6580; CERN-PH-EP-2012-054. - 2012. - 19 p.

21. Measurement of the WW cross section in $\sqrt{s} = 7$ TeV pp collisions with the ATLAS detector and limits on anomalous gauge couplings / ATLAS Collaboration

22. Search for supersymmetry in pp collisions at $\sqrt{s} = 7$ TeV in final states with missing transverse momentum and b-jets with the ATLAS detector / ATLAS Collaboration
The results of a search for supersymmetry in events with large missing transverse momentum and heavy flavour jets using an integrated luminosity corresponding to 2.05 fb$^{-1}$ of pp collisions at $\sqrt{s} = 7$ TeV recorded with the ATLAS detector at the Large Hadron Collider are reported. [...] arXiv:1203.6193; CERN-PH-EP-2012-052. - 2012. - 28 p.

23. Search for gluinos in events with two same-sign leptons, jets and missing transverse momentum with the ATLAS detector in pp collisions at $\sqrt{s} = 7$ TeV / ATLAS Collaboration

24. Measurement of the top quark mass with the template method in the top antitop → lepton + jets channel using ATLAS data / ATLAS Collaboration
25.

Search for heavy neutrinos and right-handed W bosons in events with two leptons and jets in pp collisions at $s^{\sqrt{\,}} = 7$ TeV with the ATLAS detector / ATLAS Collaboration

This letter reports on a search for hypothetical heavy neutrinos, N, and right-handed gauge bosons, W_R, in events with two high transverse momentum leptons and at least one high transverse momentum hadronic jet. [...]  

26.

Measurement of $tt\bar{t}$ production with a veto on additional central jet activity in pp collisions at $s^{\sqrt{\,}} = 7$ TeV using the ATLAS detector / ATLAS Collaboration

A measurement of the jet activity in $tt\bar{t}$ events produced in proton-proton collisions at a centre-of-mass energy of 7 TeV is presented, using 2.05 fb$^{-1}$ of integrated luminosity collected by the ATLAS detector at the Large Hadron Collider. [...]  

27.

Jet mass and substructure of inclusive jets in $s^{\sqrt{\,}} = 7$ TeV pp collisions with the ATLAS experiment / ATLAS Collaboration

Recent studies have highlighted the potential of jet substructure techniques to identify the hadronic decays of boosted heavy particles. [...]  

28.

Measurement of the charge asymmetry in top quark pair production in pp collisions at $s^{\sqrt{\,}} = 7$ TeV using the ATLAS detector / ATLAS Collaboration

A measurement of the top-antitop production charge asymmetry $A_C$ is presented using data corresponding to an integrated luminosity of 1.04 fb$^{-1}$ of pp collisions at $s^{\sqrt{\,}} = 7$ TeV collected by the ATLAS detector at the LHC. [...]  

29.

Observation of spin correlation in $tt\bar{t}$ events from pp collisions at $s^{\sqrt{\,}} = 7$ TeV using the ATLAS detector / ATLAS Collaboration

A measurement of spin correlation in $tt\bar{t}$ production is reported using data collected with the ATLAS detector at the LHC, corresponding to an integrated luminosity of 2.1 fb$^{-1}$. [...]  

30.

Determination of the strange quark density of the proton from ATLAS measurements of the $W\rightarrow l\nu$ and $Z\rightarrow ll$ cross sections / ATLAS Collaboration

A QCD analysis is reported of ATLAS data on inclusive W and Z boson production in pp collisions at the LHC, jointly with ep deep inelastic scattering data from HERA. [...]  

31.

Search for second generation scalar leptoquarks in pp collisions at $s^{\sqrt{\,}} = 7$ TeV with the ATLAS detector / ATLAS Collaboration

The results of a search for the production of second generation scalar leptoquarks are presented for final states consisting of either two oppositely charged muons and at least two jets or a muon plus missing transverse momentum and at least two jets. [...]  

32.

Measurement of the production cross section of an isolated photon associated with jets in...
proton-proton collisions at $s\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
A measurement of the cross section for the production of an isolated photon in association with jets in proton-proton collisions at a center-of-mass energy $s\sqrt{s} = 7$ TeV is presented. [...] 

33. Forward-backward correlations and charged-particle azimuthal distributions in pp interactions using the ATLAS detector / ATLAS Collaboration
Using inelastic proton-proton interactions at $s\sqrt{s} = 900$ GeV and 7 TeV, recorded by the ATLAS detector at the LHC, measurements have been made of the correlations between forward and backward charged-particle multiplicities and, for the first time, between forward and backward charged-particle summed transverse momentum. [...] 

34. Measurement of the azimuthal anisotropy for charged particle production in $s\sqrt{s}=2.76$ TeV lead-lead collisions with the ATLAS detector / ATLAS Collaboration
Differential measurements of charged particle azimuthal anisotropy are presented for lead-lead collisions at $s\sqrt{s}=2.76$ TeV with the ATLAS detector at the LHC, based on an integrated luminosity of approximately 8 $\mu$b$^{-1}$. [...] 

35. Measurement of the polarisation of W bosons produced with large transverse momentum in pp collisions at $s\sqrt{s} = 7$ TeV with the ATLAS experiment / ATLAS Collaboration
This paper describes an analysis of the angular distribution of $W\rightarrow e\nu$ and $W\rightarrow \mu\nu$ decays, using data from pp collisions at $s\sqrt{s} = 7$ TeV recorded with the ATLAS detector at the LHC in 2010, corresponding to an integrated luminosity of about 35 pb$^{-1}$. [...] 

36. Search for a light Higgs boson decaying to long-lived weakly-interacting particles in proton-proton collisions at $s\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
A search for the decay of a light Higgs (120 - 140 GeV) to a pair of weakly-interacting, long-lived particles in 1.94 fb$^{-1}$ of proton-proton collisions at $s\sqrt{s} = 7$ TeV recorded in 2011 by the ATLAS detector is presented. [...] 

37. Single hadron response measurement and calorimeter jet energy scale uncertainty with the ATLAS detector at the LHC / ATLAS Collaboration
The uncertainty on the calorimeter energy response to jets of particles is derived for the ATLAS experiment at the Large Hadron Collider (LHC). [...] 

38. Search for new particles decaying to ZZ using final states with leptons and jets with the ATLAS detector in $s\sqrt{s} = 7$ TeV proton-proton collisions / ATLAS Collaboration
A search is presented for a narrow resonance decaying to a pair of Z bosons using data corresponding to 1.02 fb$^{-1}$ of integrated luminosity collected by the ATLAS experiment from pp collisions at $s\sqrt{s} = 7$ TeV. [...] 

39. Search for FCNC single top-quark production at $s\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
A search for the production of single top-quarks via flavour-changing neutral-currents is presented. [...] 

40.
Measurement of the azimuthal ordering of charged hadrons with the ATLAS detector / ATLAS Collaboration

41. Search for down-type fourth generation quarks with the ATLAS detector in events with one lepton and high transverse momentum hadronically decaying W bosons in $s\sqrt{s} = 7$ TeV pp collisions / ATLAS Collaboration
This Letter presents a search for pair production of heavy down-type quarks decaying via $b \rightarrow W$ in the lepton + jets channel as $bb \rightarrow W^- W^+ \rightarrow l^+ l^- b b \rightarrow q\bar{q}^* q\bar{q}^*(-)$. [...] arXiv:1202.6540 ; CERN-PH-EP-2011-230. - 2012. - 17 p.

42. Search for same-sign top-quark production and fourth-generation down-type quarks in pp collisions at $s\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
A search is presented for same-sign top-quark production and down-type heavy quarks of charge $-1/3$ in events with two isolated leptons (electrons or muons) that have the same electric charge, at least two jets and large missing transverse momentum. The data are selected from pp collisions at $s\sqrt{s} = 7$ TeV recorded by the ATLAS detector and correspond to an integrated luminosity of 1.04 inverse femtobarns. [...] arXiv:1202.5520 ; CERN-PH-EP-2012-020. - Geneva : CERN, 2012 - 46 p. - Published in : J. High Energy Phys. 04 (2012) 069
Springer Open Access article: PDF; External links:

43. Measurement of the cross section for top-quark pair production in pp collisions at $s\sqrt{s} = 7$ TeV with the ATLAS detector using final states with two high-pt leptons / ATLAS Collaboration

44. Search for anomaly-mediated supersymmetry breaking with the ATLAS detector based on a disappearing-track signature in pp collisions at $s\sqrt{s} = 7$ TeV / ATLAS Collaboration
In models of anomaly-mediated supersymmetry breaking (AMSb), the lightest chargino is predicted to have a lifetime long enough to be detected in collider experiments. This letter explores AMSb scenarios in pp collisions at $s\sqrt{s} = 7$ TeV by attempting to identify decaying charginos which result in tracks that appear to have few associated hits in the outer region of the tracking system. [...] arXiv:1202.4847 ; CERN-PH-EP-2011-210. - Geneva : CERN, 2012 - 20 p. - Published in : Eur. Phys. J. C 72 (2012) 1993
Springer Open Access article: PDF; External links:

45. Search for pair-produced heavy quarks decaying to Wq in the two-lepton channel at $s\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
A search is presented for heavy-quark pair production (QQbar) under the decay hypothesis QQbar to WqWq with $q = u,d,c,s,b$. [...] arXiv:1202.23389 ; CERN-PH-EP-2012-008. - 2012. - 23 p.

46. Search for pair production of a heavy quark decaying to a W boson and a b quark in the lepton+jets channel with the ATLAS detector / ATLAS Collaboration
A search is presented for production of a heavy up-type quark (t*) together with its antiparticle, assuming subsequent decay to a W boson and a b quark, $t^*_c \rightarrow W^+ b$. [...] arXiv:1202.3076 ; CERN-PH-EP-2012-007. - 2012. - 18 p.

47. Search for the Standard Model Higgs boson in the decay channel $H \rightarrow ZZ(\gamma) \rightarrow 4l$ with 4.8 fb$^{-1}$ of pp collisions at $s\sqrt{s}=7$ TeV with ATLAS / ATLAS Collaboration
This Letter presents a search for the Standard Model Higgs boson in the decay channel $H \rightarrow ZZ(*) \rightarrow 4l$, where $l = e$ or $\mu$, using proton-proton collisions at $\sqrt{s} = 7$ TeV recorded with the ATLAS detector and corresponding to an integrated luminosity of 4.8 fb$^{-1}$. The four-lepton mass distribution is compared with Standard Model background expectations to derive upper limits on the cross section of a Standard Model Higgs boson with a mass between 110 GeV and 600 GeV which exclude the mass ranges 134-156 GeV, 182-233 GeV, 256-265 GeV and 266-415 GeV at the 95% confidence level. [...]


Elsevier Open Access article: PDF; External links:

- 48.
  Combined search for the Standard Model Higgs boson using up to 4.9 fb$^{-1}$ of pp collision data at $\sqrt{s} = 7$ TeV with the ATLAS detector at the LHC / ATLAS Collaboration
  A combined search for the Standard Model Higgs boson with the ATLAS experiment at the LHC using data sets corresponding to integrated luminosities of 1.04 fb$^{-1}$ to 4.9 fb$^{-1}$ of pp collision data collected at $\sqrt{s} = 7$ TeV is presented. The Higgs boson mass ranges 112.9-115.5 GeV, 131-238 GeV and 251-466 GeV are excluded at the 95% confidence level (CL), while the range 124-519 GeV is expected to be excluded in the absence of a signal. [...]


Elsevier Open Access article: PDF; External links:

- 49.
  Search for the Standard Model Higgs boson in the diphoton decay channel with 4.9 fb$^{-1}$ of pp collisions at $\sqrt{s} = 7$ TeV with ATLAS / ATLAS Collaboration
  A search for the Standard Model Higgs boson is performed in the diphoton decay channel. The data used corresponds to an integrated luminosity of 4.9 fb$^{-1}$ collected with the ATLAS detector at the Large Hadron Collider in proton-proton collisions at a center-of-mass energy of $\sqrt{s} = 7$ TeV. [...]


APS Open Access article: PDF; External links:

- 50.
  Search for decays of stopped, long-lived particles from 7 TeV pp collisions with the ATLAS detector / ATLAS Collaboration
  New metastable massive particles with electric and colour charge are features of many theories beyond the Standard Model. A search is performed for long-lived gluino-based R-hadrons with the ATLAS detector at the LHC using a data sample corresponding to an integrated luminosity of 31 pb$^{-1}$. [...]


Springer Open Access article: PDF; External links:

- 51.
  Measurement of inclusive two-particle angular correlations in pp collisions with the ATLAS detector at the LHC / ATLAS Collaboration
  We present a measurement of two-particle angular correlations in proton-proton collisions at $\sqrt{s} = 900$ GeV and 7 TeV. [...]


- 52.
  Measurement of inclusive two-particle angular correlations in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
  The ATLAS detector is used to search for excited leptons in the electromagnetic radiative decay channel $l^+ \rightarrow l\gamma\gamma$. Results are presented based on the analysis of pp collisions at a center-of-mass energy of 7 TeV corresponding to an integrated luminosity of 2.05 fb$^{-1}$. [...]


APS Open Access article: PDF; External links:

- 53.
  Search for excited leptons in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration
  The ATLAS detector is used to search for excited leptons in the electromagnetic radiative decay channel $l^+ \rightarrow l\gamma\gamma$. Results are presented based on the analysis of pp collisions at a center-of-mass energy of 7 TeV corresponding to an integrated luminosity of 2.05 fb$^{-1}$. [...]


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54. Measurement of the top quark pair production cross-section with ATLAS in the single lepton channel / ATLAS Collaboration
A measurement of the production cross-section for top quark pairs ($t\bar{t}$) in pp collisions at $\sqrt{s}$ = 7 TeV is presented using data recorded with the ATLAS detector at the Large Hadron Collider. Events are selected in the single lepton topology by requiring an electron or muon, large missing transverse momentum and at least three jets. [..]
Elsevier Open Access article: PDF; External links:

55. Study of jets produced in association with a W boson in pp collisions at $\sqrt{s}$ = 7 TeV with the ATLAS detector / ATLAS Collaboration
We report a study of final states containing a W boson and hadronic jets, produced in proton-proton collisions at a center-of-mass energy of 7 TeV. The data were collected with the ATLAS detector at the CERN LHC and comprise the full 2010 data sample of 36 pb$^{-1}$. [..]
APS Open Access article: PDF; External links:

56. Search for anomalous production of prompt like-sign muon pairs and constraints on physics beyond the Standard Model with the ATLAS detector / ATLAS Collaboration
An inclusive search for anomalous production of two prompt, isolated muons with the same electric charge is presented. The search is performed in a data sample corresponding to 1.6 fb$^{-1}$ of integrated luminosity collected in 2011 at $\sqrt{s}$ = 7 TeV with the ATLAS detector at the LHC. [..]
APS Open Access article: PDF; External links:

57. Jet energy measurement with the ATLAS detector in proton-proton collisions at $\sqrt{s}$ = 7 TeV / ATLAS Collaboration
The jet energy scale (JES) and its systematic uncertainty are determined for jets measured with the ATLAS detector at the LHC in proton-proton collision data at a centre-of-mass energy of $\sqrt{s}$ = 7 TeV corresponding to an integrated luminosity of 38 inverse pb. [..]

58. Measurement of inclusive jet and dijet production in pp collisions at $\sqrt{s}$ = 7 TeV using the ATLAS detector / ATLAS Collaboration
Inclusive jet and dijet cross sections have been measured in proton-proton collisions at a centre-of-mass energy of 7 TeV using the ATLAS detector at the Large Hadron Collider. [..]

59. Search for heavy vector-like quarks coupling to light quarks in proton-proton collisions at $\sqrt{s}$ = 7 TeV with the ATLAS detector / ATLAS Collaboration
This letter presents a search for singly produced vector-like quarks, $Q$, coupling to light quarks, $q$. [..]

60. Observation of a new $\chi_s$ state in radiative transitions to Y(1S) and Y(2S) at ATLAS / ATLAS Collaboration
The $\chi_s$(nP) quarkonium states are produced in proton-proton collisions at the Large Hadron Collider (LHC) at $\sqrt{s}$ = 7 TeV and recorded by the ATLAS detector. Using a data sample corresponding to an integrated luminosity of 4.4 fb$^{-1}$, these states are reconstructed through their radiative decays to Y(1S2S) with $Y \rightarrow \mu^+\mu^-$. [..]
APS Open Access article: PDF; External links:
61. **Search for first generation scalar leptoquarks in pp collisions at $\sqrt{s}=7$ TeV with the ATLAS detector / ATLAS Collaboration**

We report a search for first generation scalar leptoquarks using 1.03 fb$^{-1}$ of proton-proton collisions data produced by the Large Hadron Collider at $\sqrt{s}=7$ TeV and recorded by the ATLAS experiment. Leptoquarks are sought via their decay into an electron or neutrino and a quark, producing events with two oppositely charged electrons and at least two jets, or events with an electron, missing transverse momentum and at least two jets. [...] arXiv:1112.4828; CERN-PH-EP-2011-202; Geneva: CERN, 2012 - 20 p. - Published in: *Phys. Lett. B* 709 (2012) 158-176 - Published in: *Phys. Lett. B* 711 (2012) 442-455 [Erratum] Elsevier Open Access article: [PDF]; Elsevier Open Access article (Erratum): [PDF]; External links:

62. **Search for contact interactions in dilepton events from pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration**

This Letter presents a search for contact interactions in the dielectron and dimuon channels using data from proton-proton collisions produced by the LHC at $\sqrt{s} = 7$ TeV and recorded by the ATLAS detector. [...] arXiv:1112.4462 ; CERN-PH-EP-2011-198; - 2011 - 21 p.

63. **Measurement of $D_{s\ast}^{+}$ meson production in jets from pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration**

This paper reports a measurement of $D_{s\ast}^{+}$ meson production in jets from proton-proton collisions at a center-of-mass energy of $\sqrt{s} = 7$ TeV at the CERN Large Hadron Collider. The measurement is based on a data sample recorded with the ATLAS detector with an integrated luminosity of 0.30 pb$^{-1}$ for jets with transverse momentum between 25 and 70 GeV in the pseudorapidity range $|\eta| < 2.5$. [...] arXiv:1112.4432; CERN-PH-EP-2011-180; Geneva: CERN, 2012 - 21 p. - Published in: *Phys. Rev. D* 85 (2012) 052005 APS Open Access article: [PDF]; External links:

64. **Search for scalar bottom pair production with the ATLAS detector in pp Collisions at $\sqrt{s} = 7$ TeV / ATLAS Collaboration**

The results of a search for pair production of the scalar partners of bottom quarks in 2.05 fb$^{-1}$ of pp collisions at $\sqrt{s} = 7$ TeV using the ATLAS experiment are reported. Scalar bottoms are searched for in events with large missing transverse momentum and two jets in the final state, where both jets are identified as originating from a b-quark. [...] arXiv:1112.3832; CERN-PH-EP-2011-195; Geneva: CERN, 2012 - 18 p. - Published in: *Phys. Rev. Lett.* 108 (2012) 181802 APS Open Access article: [PDF]; External links:

65. **Search for production of resonant states in the photon-jet mass distribution using pp collisions at $\sqrt{s} = 7$ TeV collected by the ATLAS detector / ATLAS Collaboration**


66. **Search for the Higgs boson in the $H \rightarrow WW(\gamma) \rightarrow l^+l^-\nu\bar{\nu}$ decay channel in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration**

A search for the Higgs boson has been performed in the $H \rightarrow WW(\gamma) \rightarrow l^+l^-\nu\bar{\nu}$ channel ($l=e/\mu$) with an integrated luminosity of 2.05 fb of pp collisions at $\sqrt{s}=7$ TeV collected with the ATLAS detector at the Large Hadron Collider. No significant excess of events over the expected background is observed and limits on the Higgs boson production cross section are derived for a Higgs boson mass in the range 110<mH<300 GeV. [...] arXiv:1112.2577; CERN-PH-EP-2011-190; Geneva : CERN, 2012 - 19 p. - Published in: *Phys. Rev. Lett.* 108 (2012) 111802 APS Open Access article: [PDF]; External links:

67. **Search for Extra Dimensions using diphoton events in 7 TeV proton-proton collisions with the ATLAS detector / ATLAS Collaboration**

Using data recorded in 2011 with the ATLAS detector at the Large Hadron Collider, a search for evidence of extra spatial dimensions has been
performed through an analysis of the diphoton final state. The analysis uses data corresponding to an integrated luminosity of 2.12 fb^-1 of sqrt(s) = 7 TeV proton-proton collisions. [...] 


68. Measurement of the WZ production cross section and limits on anomalous triple gauge couplings in proton-proton collisions at s√ = 7 TeV with the ATLAS detector / ATLAS Collaboration

This Letter presents a measurement of WZ production in 1.02 fb^-1 of pp collision data at s√ = 7 TeV collected by the ATLAS experiment in 2011. Doubly leptonic decay events are selected with electrons, muons and missing transverse momentum in the final state. [...] 


69. Search for Diphoton Events with Large Missing Transverse Momentum in 1 fb^-1 of 7 TeV Proton-Proton Collision Data with the ATLAS Detector / ATLAS Collaboration

A search for diphoton events with large missing transverse momentum has been performed using 1.07 fb^-1 of proton-proton collision data at s√ = 7 TeV recorded with the ATLAS detector. No excess of events was observed above the Standard Model prediction and 95% Confidence Level (CL) upper limits are set on the production cross section for new physics: σ < (22-129) fb in the context of a generalised model of gauge-mediated supersymmetry breaking (GGM) with a bino-like lightest neutralino. σ < (27-91) fb in the context of a minimal model of gauge-mediated supersymmetry breaking (SPSB) and (15-27) fb in the context of a specific model with one universal extra dimension (UED). [...] 


70. Measurement of the production cross section for Z/γ* in association with jets in pp collisions at s√ = 7 TeV with the ATLAS detector / ATLAS Collaboration

Results are presented on the production of jets of particles in association with a Z/gamma* boson, in proton-proton collisions at sqrt(s) = 7 TeV with the ATLAS detector. The analysis includes the full 2010 data set, collected with a low rate of multiple proton-proton collisions in the accelerator, corresponding to an integrated luminosity of 36 pb^-1. [...] 


71. K0s and Λ production in pp interactions at s√ = 0.9 and 7 TeV measured with the ATLAS detector at the LHC / ATLAS Collaboration

The production of Kshort and Lambda hadrons is studied in inelastic pp collisions at sqrt(s) = 0.9 and 7 TeV collected with the ATLAS detector at the LHC using a minimum-bias trigger. The observed distributions of transverse momentum, rapidity, and multiplicity are corrected to hadron level in a model-independent way within well defined phase-space regions. [...] 


72. Search for strong gravity signatures in same-sign dimuon final states using the ATLAS detector at the LHC / ATLAS Collaboration

A search for microscopic black holes has been performed in a same-sign dimuon final state using 1.3 fb^-1 of proton-proton collision data collected with the ATLAS detector at a centre of mass energy of 7 TeV at the CERN Large Hadron Collider. The data are found to be consistent with the expectation from the Standard Model and the results are used to derive exclusion contours in the context of a low scale gravity model. 


73. A study of the material in the ATLAS inner detector using secondary hadronic interactions / ATLAS Collaboration

The ATLAS inner detector is used to reconstruct secondary vertices due to hadronic interactions of primary collision products, so probing the location and amount of material in the inner region of ATLAS. Data collected in 7 TeV pp collisions at the LHC, with a minimum bias trigger, are used for comparisons with simulated events. [...]
74. Searches for supersymmetry with the ATLAS detector using final states with two leptons and missing transverse momentum in $s^{\sqrt{7}}$ TeV proton-proton collisions / ATLAS Collaboration

Results of three searches are presented for the production of supersymmetric particles decaying into final states with missing transverse momentum and exactly two isolated leptons, e or mu. The analysis uses a data sample collected during the first half of 2011 that corresponds to a total integrated luminosity of 1 fb^{-1}. A search at $\sqrt{s}$ = 7 TeV proton-proton collisions recorded with the ATLAS detector at the Large Hadron Collider. [...] arXiv:1110.6191; CERN-PH-EP-2011-147; Geneva: CERN, 2012 - 41 p. - Published in: *J. Instrum.* 7 (2012) P01013 IOP Open Access article; PDF; External links:

75. Measurement of the ZZ production cross section and limits on anomalous neutral triple gauge couplings in proton-proton collisions at $s^{\sqrt{7}}$ TeV with the ATLAS detector / ATLAS Collaboration

A measurement of the ZZ production cross section in proton-proton collisions at $\sqrt{s}$ = 7 TeV using data recorded by the ATLAS experiment at the LHC is presented. In a data sample corresponding to an integrated luminosity of 1.02 fb^{-1} collected in 2011, 12 events containing two Z boson candidates decaying to electrons and/or muons are observed. [...] arXiv:1110.5016; CERN-PH-EP-2011-166; Geneva: CERN, 2012 - 18 p. - Published in: *Phys. Rev. Lett.* 108 (2012) 041804 APS Open Access article; PDF; External links:

76. Electron performance measurements with the ATLAS detector using the 2010 LHC proton-proton collision data / ATLAS Collaboration


77. Search for Massive Colored Scalars in Four-Jet Final States in $s^{\sqrt{7}}$ TeV proton-proton collisions with the ATLAS Detector / ATLAS Collaboration


78. Search for new phenomena in final states with large jet multiplicities and missing transverse momentum using $s^{\sqrt{7}}$ TeV pp collisions with the ATLAS detector / ATLAS Collaboration

Results are presented of a search for any particle(s) decaying to six or more jets in association with missing transverse momentum. The search is performed using 1.34 fb^{-1} of $\sqrt{s}$=7 TeV proton-proton collisions recorded by the ATLAS detector during 2011. [...] arXiv:1110.2299; CERN-PH-EP-2011-155; Geneva: CERN, 2011 - 20 p. - Published in: *J. High Energy Phys.* 11 (2011) 099 Springer Open Access article; PDF; External links:

79. Performance of the ATLAS Trigger System in 2010 / ATLAS Collaboration

Proton-proton collisions at $\sqrt{s}$=7 TeV and heavy ion collisions at 2.76 TeV were produced by the LHC and recorded using the ATLAS experiment’s trigger system in 2010. The LHC is designed with a maximum bunch crossing rate of 40 MHz and the ATLAS trigger system is designed to record approximately 200 of these per second. [...] arXiv:1110.1530; CERN-PH-EP-2011-078; Geneva: CERN, 2012 - 63 p. - Published in: *Eur. Phys. J. C* 72 (2012) 1849 Springer Open Access article; PDF; External links:

80.
Measurement of the inclusive and dijet cross-sections of b-jets in pp collisions at $s = 7$ TeV
with the ATLAS detector / ATLAS Collaboration
The inclusive and dijet production cross-sections have been measured for jets containing
b-hadrons (b-jets) in proton-proton collisions at a centre-of-mass energy of $\sqrt{s} = 7$ TeV,
using the ATLAS detector at the LHC. The measurements use data corresponding to
an integrated luminosity of 34 fb$^{-1}$. […]
Springer Open Access article: PDF; External links: ; Previous draft version

81.
Search for supersymmetry in final states with jets, missing transverse momentum and one
isolated lepton in $\sqrt{s} = 7$ TeV pp collisions using 1 fb$^{-1}$ of ATLAS data / ATLAS Collaboration
We present an update of a search for supersymmetry in final states containing jets, missing transverse momentum, and one isolated electron or muon, using 1.04 fb$^{-1}$ of proton-proton collision data at $\sqrt{s} = 7$ TeV recorded by the ATLAS experiment at the LHC in the first half of 2011. The analysis is
carried out in four distinct signal regions with either three or four jets and variations on the (missing) transverse momentum cuts, resulting in
optimized limits for various supersymmetry models. […]
APS Open Access article: PDF; External links:

82.
Search for squarks and gluinos using final states with jets and missing transverse momentum
with the ATLAS detector in $\sqrt{s} = 7$ TeV proton-proton collisions / ATLAS Collaboration
A search for squarks and gluinos in events containing jets, missing transverse momentum and no electrons or muons is presented. The data were
recorded in 2011 by the ATLAS experiment in $\sqrt{s} = 7$ TeV proton-proton collisions at the Large Hadron Collider. […]
Elsevier Open Access article: PDF; External links:

83.
Search for the Standard Model Higgs boson in the decay channel $H \rightarrow ZZ(\gamma) \rightarrow 4l$ with the ATLAS
detector / ATLAS Collaboration
A search for the Standard Model Higgs boson in the decay channel $H \rightarrow ZZ(\gamma) \rightarrow 4l + 1 l + 1 \ell$, where $l=e,\mu$, is presented. Proton-proton collision data at
$sq t(s) > 7$ TeV recorded with the ATLAS detector and corresponding to an average integrated luminosity of 2.1 fb$^{-1}$ are compared to the Standard
Model expectations. […]
Elsevier Open Access article: PDF; External links:

84.
Measurement of the jet fragmentation function and transverse profile in proton-proton
collisions at a center-of-mass energy of 7 TeV with the ATLAS detector / ATLAS Collaboration
The jet fragmentation function and transverse profile for jets with 25 GeV < $p_T$ < 500 GeV and $\Delta$R$<$1.2 produced in proton-proton collisions with a
center-of-mass energy of 7 TeV are presented. The measurement is performed using data with an integrated luminosity of 36 pb$^{-1}$. […]
Springer Open Access article: PDF; External links:

85.
Measurement of the inclusive $W\pm$ and $Z/\gamma$ cross sections in the electron and muon decay
channels in pp collisions at $s = 7$ TeV with the ATLAS detector / ATLAS Collaboration
The production cross sections of the inclusive Drell-Yan processes $W \rightarrow l\nu$ and $Z/\gamma \rightarrow l^+l^-$ ($l=e,\mu$) are measured in proton-proton collisions at
$sq t(s) = 7$ TeV with the ATLAS detector. The cross sections are reported integrated over a fiducial kinematic range, extrapolated to the full range and
also evaluated differentially as a function of the W decay lepton pseudorapidity and the Z boson rapidity, respectively. […]
APS Open Access article: PDF; External links:

86.
Search for New Phenomena in $t\bar{t}$– Events With Large Missing Transverse Momentum in Proton-
Proton Collisions at $s = 7$ TeV with the ATLAS Detector / ATLAS Collaboration
A search for new phenomena in $t\bar{t}$ events with large missing transverse momentum in proton-proton collisions at a center-of-mass energy of 7 TeV
is presented. The measurement is based on 1.04 fb⁻¹ of data collected with the ATLAS detector at the LHC. [...]


APS Open Access article: PDF; External links:

87.

Search for the Higgs boson in the \(H \rightarrow WW \rightarrow h\eta j\eta j\) decay channel in pp collisions at \(s^{\sqrt{\sigma}} = 7\) TeV with the ATLAS detector / ATLAS Collaboration

A search for a Higgs boson has been performed in the \(H \rightarrow WW \rightarrow h\eta j\eta j\) channel in 1.04 fb⁻¹ of pp collision data \(\sqrt{s} = 7\) TeV recorded with the ATLAS detector at the Large Hadron Collider. No significant excess of events is observed over the expected background and limits on the Higgs boson production cross section are derived for a Higgs boson mass in the range 240 GeV < mH < 600 GeV. [...]

APS Open Access article: PDF; ATLAS-HIGG-2011-09 (2011-08-11); PDF; External links:

88.

Search for a heavy neutral particle decaying into an electron and a muon using 1 fb⁻¹ of ATLAS data / ATLAS Collaboration

A search is presented for a high mass neutral particle that decays directly to the emu final state. The data sample was recorded by the ATLAS detector in \(\sqrt{s} = 7\) TeV pp collisions at the LHC from March to June 2011 and corresponds to an integrated luminosity of 1.07 fb⁻¹. [...]

Springer Open Access article: PDF; External links:

89.

Search for a Standard Model Higgs boson in the \(H \rightarrow ZZ \rightarrow l\ell l\ell\) decay channel with the ATLAS detector / ATLAS Collaboration

A search for a heavy Standard Model Higgs boson decaying via \(H \rightarrow ZZ \rightarrow ll\nu\nu\), where \(l = e,\mu\), is presented. It is based on proton-proton collision data at \(\sqrt{s} = 7\) TeV, collected by the ATLAS experiment at the LHC in the first half of 2011 and corresponding to an integrated luminosity of 1.04 fb⁻¹. [...]

APS Open Access article: PDF; External link:

90.

Measurement of the \(W \rightarrow \tau\nu\nu\) Cross Section in pp Collisions at \(s^{\sqrt{\sigma}} = 7\) TeV with the ATLAS experiment / ATLAS Collaboration

The cross section for the production of W bosons with subsequent decay \(W\) to \(\tau\nu\) is measured with the ATLAS detector at the LHC. The analysis is based on a data sample that was recorded in 2010 at a proton-proton center-of-mass energy of \(\sqrt{s} = 7\) TeV and corresponds to an integrated luminosity of 34 pb⁻¹. [...]

Elsevier Open Access article: PDF; External links:

91.

Search for displaced vertices arising from decays of new heavy particles in 7 TeV pp collisions at ATLAS / ATLAS Collaboration

We present the results of a search for new, heavy particles that decay at a significant distance from their production point into a final state containing charged hadrons in association with a high-momentum muon. The search is conducted in a pp-collision data sample with a center-of-mass energy of 7 TeV and an integrated luminosity of 33 pb⁻¹ collected in 2010 by the ATLAS detector operating at the Large Hadron Collider. [...]

ATLAS-SUSY-2011-02 (2011-08-11); PDF; Elsevier Open Access article: PDF; External links:

92.

Measurement of the cross section for the production of a W boson in association with b-jets in pp collisions at \(s^{\sqrt{\sigma}} = 7\) TeV with the ATLAS detector / ATLAS Collaboration

A measurement is presented of the cross section for the production of a W boson with one or two jets, of which at least one must be a b-jet, in pp collisions at \(\sqrt{s} = 7\) TeV. Production via top decay is not included in the signal definition. [...]

ATLAS-STD-M-2011-21 (2011-08-11); PDF; Elsevier Open Access article: PDF; External links:
93. Measurement of the cross-section for b-jets produced in association with a Z boson at \( \sqrt{s} = 7 \text{ TeV} \) with the ATLAS detector / ATLAS Collaboration

A measurement is presented of the cross-section for b-jet production in association with a Z boson in pp collisions at a centre-of-mass energy of \( \sqrt{s} = 7 \text{ TeV} \). The analysis uses the data sample collected by the ATLAS experiment in 2010, corresponding to an integrated luminosity of approximately 36 pb\(^{-1}\). [...]

Elsevier Open Access article: [PDF]; External links:

94. Measurements of the electron and muon inclusive cross-sections in proton-proton collisions at \( \sqrt{s} = 7 \text{ TeV} \) with the ATLAS detector / ATLAS Collaboration

This paper presents measurements of the differential cross-sections for inclusive electron and muon production in proton-proton collisions at a centre-of-mass energy of \( \sqrt{s} = 7 \text{ TeV} \), using data collected by the ATLAS detector at the LHC. The muon cross-section is measured as a function of \( p_T \) in the range \( 4 < p_T < 100 \text{ GeV} \) and within pseudo-rapidity \( |\eta| < 2.5 \). [...]

ATLAS-STD-M-2011-07 (2011-07-07): [PDF]; Elsevier Open Access article: [PDF]; External links:

95. Search for New Physics in the Dijet Mass Distribution using 1 fb\(^{-1}\) of pp Collision Data at \( \sqrt{s} = 7 \text{ TeV} \) collected by the ATLAS Detector / ATLAS Collaboration

Invariant mass distributions of jet pairs (dijets) produced in LHC proton-proton collisions at a centre-of-mass energy \( \sqrt{s} = 7 \text{ TeV} \) have been studied using a data set corresponding to an integrated luminosity of 1.0 fb\(^{-1}\) recorded in 2011 by ATLAS. Dijet masses up to \( \sim 4 \text{ TeV} \) are observed in the data, and no evidence of resonance production over background is found. [...]

ATLAS-EXOT-2011-07 (2011-08-04): [PDF]; Elsevier Open Access article: [PDF]; External links:

96. Measurement of the Transverse Momentum Distribution of W Bosons in pp Collisions at \( \sqrt{s} = 7 \text{ TeV} \) with the ATLAS Detector / ATLAS Collaboration

This paper describes a measurement of the W boson transverse momentum distribution using ATLAS pp collision data from the 2010 run of the LHC at \( \sqrt{s} = 7 \text{ TeV} \), corresponding to an integrated luminosity of about 31 pb\(^{-1}\). Events from both W -> e nu and W -> mu nu are used, and the transverse momentum of the W candidates is measured through the energy deposition in the calorimeter from the recoil of the W. [...]

APS Open Access article: [PDF]; ATLAS-STD-M-2011-15 (2011-08-15): [PDF]; External links:

97. Measurement of the centrality dependence of the charged particle pseudorapidity distribution in lead-lead collisions at \( \sqrt{s_{\text{NN}}} = 2.76 \text{ TeV} \) with the ATLAS detector / ATLAS Collaboration

The ATLAS experiment at the LHC has measured the centrality dependence of charged particle pseudorapidity distributions over \( |\eta| < 2 \) in lead-lead collisions at a nucleon-nucleon centre-of-mass energy of \( \sqrt{s_{\text{NN}}} = 2.76 \text{ TeV} \). In order to include particles with transverse momentum as low as 30 MeV, the data were recorded with the central solenoid magnet off. [...]

ATLAS-HIN-2010-01 (2011-07-20): [PDF]; Elsevier Open Access article: [PDF]; External links:

98. Measurement of the pseudorapidity and transverse momentum dependence of the elliptic flow of charged particles in lead-lead collisions at \( \sqrt{s_{\text{NN}}} = 2.76 \text{ TeV} \) with the ATLAS detector / ATLAS Collaboration

This paper describes the measurement of elliptic flow of charged particles in lead-lead collisions at \( \sqrt{s_{\text{NN}}} = 2.76 \text{ TeV} \) using the ATLAS detector at the Large Hadron Collider (LHC). The results are based on an integrated luminosity of approximately 7 ub\(^{-1}\). [...]

Elsevier Open Access article: [PDF]; External links:
Search for the Standard Model Higgs boson in the two photon decay channel with the ATLAS detector at the LHC / ATLAS Collaboration
Elsevier Open Access article: PDF; External links:

100.
Performance of Missing Transverse Momentum Reconstruction in Proton-Proton Collisions at \(s = 7\text{ TeV}\) with ATLAS / ATLAS Collaboration
Springer Open Access article: PDF; External links:

101.
Search for a heavy Standard Model Higgs boson in the channel \(H \rightarrow ZZ \rightarrow l^+l^-qq^-\) using the ATLAS detector / ATLAS Collaboration

102.
A measurement of the ratio of the W and Z cross sections with exactly one associated jet in pp collisions at \((\sqrt{s}) = 7\text{ TeV}\) with ATLAS / ATLAS Collaboration
The ratio of production cross sections of the W and Z bosons with exactly one associated jet is presented as a function of jet transverse momentum threshold. The measurement has been designed to maximize cancellation of experimental and theoretical uncertainties, and is reported both within a particle-level kinematic range corresponding to the detector acceptance and as a total cross-section ratio. [...] arXiv:1108.4908; CERN-PH-EP-2011-126- Geneva: CERN, 2012 - 22 p. - Published in: Phys. Lett. B 708 (2012) 221-240
Elsevier Open Access article: PDF; External links:

103.
Measurement of the top quark pair production cross section in pp collisions at \(s = 7\text{ TeV}\) in dilepton final states with ATLAS / ATLAS Collaboration
Elsevier Open Access article: PDF; External links; Previous draft version

104.
Measurement of the \(Z\rightarrow\tau\tau\) Cross Section with the ATLAS Detector / ATLAS Collaboration
The Z to tau tau cross section is measured with the ATLAS experiment at the LHC in four different final states determined by the decay modes of the tau leptons: muon-hadron, electron-hadron, electron-muon, and muon-muon. The analysis is based on a data sample corresponding to an integrated luminosity of 36 pb\(^{-1}\), at a proton-proton center-of-mass energy of \(s=7\text{ TeV}\). [...] arXiv:1108.2016; CERN-PH-EP-2011-097- Geneva: CERN, 2011 - 28 p. - Published in: Phys. Rev. D 84 (2011) 112006 APS Open Access article: PDF; External links:

105.
Search for dilepton resonances in pp collisions at \(s = 7\text{ TeV}\) with the ATLAS detector / ATLAS Collaboration
This Letter reports on a search for narrow high-mass resonances decaying into dilepton final states. The data were recorded by the ATLAS experiment in pp collisions at \(s = 7\text{ TeV}\) at the LHC and correspond to a total integrated luminosity of 1.08 fb\(^{-1}\) (1.21 fb\(^{-1}\)) in the ee (mumu) channel. [...] arXiv:1108.1582; CERN-PH-EP-2011-123- Geneva: CERN, 2011 - 18 p. - Published in: Phys. Rev. Lett. 107 (2011) 272002
APS Open Access article: PDF; External links:

106.

Search for a heavy gauge boson decaying to a charged lepton and a neutrino in 1 fb–1 of pp collisions at √s = 7 TeV using the ATLAS detector / ATLAS Collaboration
The ATLAS detector at the LHC is used to search for high-mass states, such as heavy charged gauge bosons (W*), decaying to a charged lepton (electron or muon) and a neutrino. Results are presented based on the analysis of pp collisions at a center-of-mass energy of 7 TeV corresponding to an integrated luminosity of 1.04 fb–1. [...] arXiv:1108.1316; CERN-PH-EP-2011-121; Geneva : CERN, 2011 - 21 p. - Published in : Phys. Lett. B 705 (2011) 28-46 ATLAS-EXOT-2011-05 (2011-07-26): PDF; Elsevier Open Access article: PDF; External links:

107.

Inclusive search for same-sign dilepton signatures in pp collisions at √s = 7 TeV with the ATLAS detector / ATLAS Collaboration
An inclusive search is presented for new physics in events with two isolated leptons (electron or muon) having the same electric charge. The data are selected from events collected from pp collisions at √s = 7 TeV by the ATLAS detector and correspond to an integrated luminosity of 34 inverse picobarns. [...] arXiv:1108.0366; CERN-PH-EP-2011-094; Geneva : CERN, 2011 - 43 p. - Published in : J. High Energy Phys. 10 (2011) 107 Springer Open Access article: PDF; External links:

108.

Measurement of the inclusive isolated prompt photon cross-section in pp collisions at √s = 7 TeV using 35 pb–1 of ATLAS data / ATLAS Collaboration

109.

Search for neutral MSSM Higgs bosons decaying to τ+τ− pairs in proton-proton collisions at √s = 7 TeV with the ATLAS detector / ATLAS Collaboration

110.

Properties of jets measured from tracks in proton-proton collisions at center-of-mass energy √s = 7 TeV with the ATLAS detector / ATLAS Collaboration
Jets are identified and their properties studied in center-of-mass energy √s = 7 TeV proton-proton collisions at the Large Hadron Collider using charged particles measured by the ATLAS inner detector. Events are selected using a minimum bias trigger, allowing jets at very low transverse momentum to be observed and their characteristics in the transition to high-momentum fully perturbative jets to be studied. [...] arXiv:1107.3311; CERN-PH-EP-2011-110; Geneva : CERN, 2011 - 28 p. - Published in : Phys. Rev. D 84 (2011) 054001 APS Open Access article: PDF; External links:

111.

Measurement of the transverse momentum distribution of Z/γ* bosons in proton-proton collisions at √s=7 TeV with the ATLAS detector / ATLAS Collaboration
112. Measurement of multi-jet cross sections in proton-proton collisions at a 7 TeV center-of-mass energy / ATLAS Collaboration

113. Measurement of dijet production with a veto on additional central jet activity in pp collisions at √s = 7 TeV using the ATLAS detector / ATLAS Collaboration

114. Measurement of the isolated diphoton cross section in pp collisions at √s = 7 TeV with the ATLAS detector / ATLAS Collaboration
The ATLAS experiment has measured the production cross-section of events with two isolated photons in the final state, in proton-proton collisions at √s = 7 TeV. The full data set acquired in 2010 is used, corresponding to an integrated luminosity of 37 pb⁻¹. [...] arXiv:1107.0581; CERN-PH-EP-2011-086; Geneva: CERN, 2012 - 27 p. - Published in: Phys. Rev. D 85 (2012) 012003 APS Open Access article: PDF; External links:

115. Search for Diphon Events with Large Missing Transverse Energy with 36 pb⁻¹ of 7 TeV Proton-Proton Collision Data with the ATLAS Detector / ATLAS Collaboration
Making use of 36 pb⁻¹ of proton-proton collision data at √s = 7 TeV, the ATLAS Collaboration has performed a search for diphoton events with large missing transverse energy. Observing no excess of events above the Standard Model prediction, a 95 % Confidence Level (CL) upper limit is set on the cross section for new physics of σγγ < 0.38 - 0.65 pb in the context of a generalised model of gauge-mediated supersymmetry breaking (GMM) with a bino-like lightest neutralino, and of σγγ < 0.18 - 0.23 pb in the context of a specific model with one universal extra dimension (UED). [...] arXiv:1107.0561; CERN-PH-EP-2011-091; Geneva: CERN, 2011 - 21 p. - Published in: Eur. Phys. J. C 71 (2011) 1744: PDF; Springer Open Access article: PDF; External links:

116. Measurement of the Y(1S) Production Cross-Section in pp Collisions at √s = 7 TeV in ATLAS / ATLAS Collaboration

117. Search for new phenomena with the monojet and missing transverse momentum signature using the ATLAS detector in √s = 7 TeV proton-proton collisions / ATLAS Collaboration
A search for new phenomena in events featuring a high energy jet and large missing transverse momentum in proton-proton collisions at √s = 7 TeV is presented using a dataset corresponding to an integrated luminosity of 33 pb⁻¹ recorded with the ATLAS detector at the Large Hadron Collider. The number of observed events is consistent with the Standard Model prediction and this result is interpreted in terms of limits on a model of Large Extra Dimensions. arXiv:1106.5327; CERN-PH-EP-2011-090; Geneva: CERN, 2011 - 19 p. - Published in: Phys. Lett. B 705 (2011) 294-312 ATLAS-EXOT-2010-13 (2011-06-14): PDF; Elsevier Open Access article: PDF; External links:

118. Search for Heavy Long-Lived Charged Particles with the ATLAS detector in pp collisions at √s = 7 TeV / ATLAS Collaboration
A search for long-lived charged particles reaching the muon spectrometer is performed using a data sample of 37 pb⁻¹ from pp collisions at \( \sqrt{s} = 7 \) TeV collected by the ATLAS detector at the LHC. No excess is observed above the estimated background [...]


ATLAS-SUSY-2011-03 (2011-05-27): [PDF](http://example.com); Elsevier Open Access article: [PDF](http://example.com); External links:

119.

**Limits on the production of the Standard Model Higgs Boson in pp collisions at \( s^{1/2} = 7 \) TeV with the ATLAS detector / ATLAS Collaboration**

A search for the Standard Model Higgs boson at the Large Hadron Collider (LHC) running at a centre-of-mass energy of 7 TeV is reported, based on a total integrated luminosity of up to 40 pb⁻¹ collected by the ATLAS detector in 2010. Several Higgs boson decay channels: \( H \rightarrow \gamma \gamma; H \rightarrow ZZ \rightarrow 4l; H \rightarrow ZZ \rightarrow 4\nu; H \rightarrow WW \rightarrow l\nu l\nu \) and \( H \rightarrow WW \rightarrow l\nu q\bar{q} \) \((l = e, \mu)\) are combined in a mass range from 110 GeV to 600 GeV. [...] arXiv:1106.2748; CERN-PH-EP-2011-076; Geneva: CERN, 2011 - 32 p. - Published in: *Eur. Phys. J. C* 71 (2011) 1728

ATLAS-HIGG-2011-01 (2011-05-22): [PDF](http://example.com); Springer Open Access article: [PDF](http://example.com); External links:

120.

**Measurement of Wγ and Zγ production in proton-proton collisions at \( s^{1/2} = 7 \) TeV with the ATLAS Detector / ATLAS Collaboration**

We present studies of W and Z bosons associated with high energy photons produced in pp collisions at \( \sqrt{s} = 7 \) TeV. The analysis uses 35 pb⁻¹ of data collected by the ATLAS experiment in 2010. [...] arXiv:1106.1592; CERN-PH-EP-2011-079; Geneva: CERN, 2011 - 46 p. - Published in: *J. High Energy Phys.* 09 (2011) 072: [PDF](http://example.com); Springer Open Access article: [PDF](http://example.com); External links:

121.

**Measurement of the \( W^{+}W^{-} \) cross section in \( s^{1/2} = 7 \) TeV pp collisions with ATLAS / ATLAS Collaboration**

This Letter presents a measurement of the \( W^{+}W^{-} \) production cross section in \( s^{1/2} = 7 \) TeV pp collisions by the ATLAS experiment, using 34 pb⁻¹ of integrated luminosity produced by the Large Hadron Collider at CERN. Selecting events with two isolated leptons, each either an electron or a muon, 8 candidate events are observed with an expected background of 1.7 ± 0.6 events. [...]

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122.

**Search for pair production of first or second generation leptoquarks in proton-proton collisions at \( s^{1/2} = 7 \) TeV using the ATLAS detector at the LHC / ATLAS Collaboration**

This paper describes searches for the pair production of first or second generation scalar leptoquarks using 35 pb⁻¹ of proton-proton collision data recorded by the ATLAS detector at \( \sqrt{s} = 7 \) TeV. Leptoquarks are searched in events with 0 to 2 opposite charged muons or electrons and at least two jets, and in events with one muon or electron, missing transverse momentum and at least two jets [...]

APoS Open Access article: [PDF](http://example.com); [PDF](http://example.com); External links:

123.

**Search for Contact Interactions in Dimuon Events from pp Collisions at \( s^{1/2} = 7 \) TeV with the ATLAS Detector / ATLAS Collaboration**

A search for contact interactions has been performed using dimuon events recorded with the ATLAS detector in proton-proton collisions at \( \sqrt{s} = 7 \) TeV. The data sample corresponds to an integrated luminosity of 42 pb⁻¹ [...]

APoS Open Access article: [PDF](http://example.com); [PDF](http://example.com); [PS](http://example.com); [GZ](http://example.com); External links:

124.

**Measurement of the differential cross-sections of inclusive, prompt and non-prompt \( J/\psi \) production in proton-proton collisions at \( s^{1/2} = 7 \) TeV / ATLAS Collaboration**

The inclusive \( J/\psi \) production cross-section and fraction of \( J/\psi \) mesons produced in B-hadron decays are measured in proton-proton collisions at \( s^{1/2} = 7 \) TeV with the ATLAS detector at the LHC, as a function of the transverse momentum and rapidity of the \( J/\psi \), using 2.3 pb⁻¹ of integrated luminosity. The cross-section is measured from a minimum \( p_T \) of 1 GeV to a maximum of 70 GeV and for rapidities within \( |y| < 2.4 \) giving the widest reach of any measurement of \( J/\psi \) production to date. [...]

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125. Measurement of the Inelastic Proton-Proton Cross-Section at $s = 7$ TeV with the ATLAS Detector / ATLAS Collaboration

Elsevier Open Access article: [PDF](#) : [PDF](#) : External links:

126. Search for high mass dilepton resonances in pp collisions at $s = 7$ TeV with the ATLAS experiment / ATLAS Collaboration

This article presents a search for high mass $e\mu$ or $\mu\mu$ resonances in pp collisions at $s = 7$ TeV at the LHC. The data were recorded by the ATLAS experiment during 2010 and correspond to a total integrated luminosity of 40 pb$^{-1}$. [...] arXiv:1104.3037; CERN-PH-EP-2011-045 - Geneva: CERN, 2011 - 19 p. - Published in: *Nature Commun. 2 (2011) 463*
ATLAS-STDM-2010-11 (2011-04-02); [PDF](#) : [PS.GZ](#); NPG Open Access article: [PDF](#) : [PS.GZ](#); External links:

127. Search for supersymmetric particles in events with lepton pairs and large missing transverse momentum in $\sqrt{s} = 7$ TeV proton-proton collisions at the ATLAS experiment / ATLAS Collaboration

ATLAS-EXOT-2010-09 (2011-03-31); [PDF](#) : [PS.GZ](#); Elsevier Open Access article: [PDF](#) : [PS.GZ](#); External links:

128. Search for an excess of events with an identical flavour lepton pair and significant missing transverse momentum in $\sqrt{s} = 7$ TeV proton-proton collisions with the ATLAS detector / ATLAS Collaboration

Results are presented of a search for supersymmetric particles decaying into final states with significant missing transverse momentum and exactly two identical flavour leptons (e,$\mu$) of opposite charge in $\sqrt{s} = 7$ TeV collisions at the Large Hadron Collider. This channel is particularly sensitive to supersymmetric particle cascade decays producing flavour correlated lepton pairs. [...] arXiv:1103.6208; CERN-PH-EP-2011-039 - Geneva: CERN, 2011 - 19 p. - Published in: *Eur. Phys. J. C 71 (2011) 1682*
ATLAS-SUSY-2011-05 (2011-04-01); [PDF](#) : [PS.GZ](#); Springer Open Access article: [PDF](#) : [PS.GZ](#); External links:

129. Search for a heavy particle decaying into an electron and a muon with the ATLAS detector in $s = 7$ TeV pp collisions at the LHC / ATLAS Collaboration

This Letter presents the first search for a heavy particle decaying into an e$\mu$ final state in $\sqrt{s} = 7$ TeV pp collisions at the LHC. The data were recorded by the ATLAS detector during 2010 and correspond to a total integrated luminosity of 35 pb$^{-1}$. [...] arXiv:1103.5559; CERN-PH-EP-2011-031 - Geneva: CERN, 2011 - 18 p. - Published in: *Phys. Rev. Lett. 106 (2011) 251801*
APS Open Access article: [PDF](#) : [PS.GZ](#); External links:

130. Search for supersymmetry in pp collisions at $\sqrt{s} = 7$ TeV in final states with missing transverse momentum and b-jets / ATLAS Collaboration

Results are presented of a search for supersymmetric particles in events with large missing transverse momentum and at least one heavy flavour jet candidate in $\sqrt{s} = 7$ TeV proton-proton collisions. In a data sample corresponding to an integrated luminosity of 35 pb$^{-1}$ recorded by the ATLAS experiment at the Large Hadron Collider no significant excess is observed. [...] arXiv:1103.4344; CERN-PH-EP-2011-038 - Geneva: CERN, 2011 - 21 p. - Published in: *Phys. Lett. B 701 (2011) 398-416*
131. A search for new physics in dijet mass and angular distributions in pp collisions at $\sqrt{s} = 7$ TeV measured with the ATLAS detector / ATLAS Collaboration

A search for new interactions and resonances produced in LHC proton-proton (pp) collisions at a centre-of-mass energy $\sqrt{s} = 7$ TeV has been performed with the ATLAS detector. Using a dataset with an integrated luminosity of 36 pb$^{-1}$, dijet mass and angular distributions have been measured up to dijet masses of $\sim 3.5$ TeV and found to be in good agreement with Standard Model predictions. [...] arXiv:1103.3864; CERN-PH-EP-2011-030; Geneva: CERN, 2011 - 51 p. - Published in: New J. Phys. 13 (2011) 053044

132. Measurement of the W charge asymmetry in the W$\rightarrow\mu$ν decay mode in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration


133. Search for Stable Hadronising Squarks and Gluinos at the ATLAS Experiment at the LHC / ATLAS Collaboration

If hitherto unobserved long-lived massive particles with electric and/or colour charge are predicted by a range of theories which extend the Standard Model. In this paper a search is performed at the ATLAS experiment for slow-moving charged particles produced in proton-proton collisions at 7 TeV centre-of-mass energy at the LHC, using a data set corresponding to an integrated luminosity of $34$ pb$^{-1}$ [...] arXiv:1103.1984; CERN-PH-EP-2011-026; Geneva: CERN, 2011 - 26 p. - Published in: Phys. Lett. B 701 (2011) 1-19

134. Measurements of underlying-event properties using neutral and charged particles in pp collisions at $s_N = 900$ GeV and $s_N = 7$ TeV with the ATLAS detector at the LHC / ATLAS Collaboration


135. Search for high-mass states with one lepton plus missing transverse momentum in proton-proton collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector / ATLAS Collaboration

The ATLAS detector is used to search for high-mass states, such as heavy charged gauge bosons (W', W_\alpha), decaying to a charged lepton (electron or muon) and a neutrino. Results are presented based on the analysis of pp collisions at a center-of-mass energy of 7 TeV corresponding to an integrated luminosity of 36 pb$^{-1}$. [...] arXiv:1103.1391; CERN-PH-EP-2011-023; Geneva: CERN, 2011 - 22 p. - Published in: Phys. Lett. B 701 (2011) 50-69

136. Search for squarks and gluinos using final states with jets and missing transverse momentum with the ATLAS detector in $\sqrt{s} = 7$ TeV proton-proton collisions / ATLAS Collaboration
A search for squarks and gluinos in final states containing jets, missing transverse momentum and no electrons or muons is presented. The data were recorded by the ATLAS experiment in $\sqrt{s} = 7$ TeV proton-proton collisions at the Large Hadron Collider [...] arXiv:1102.2590; CERN-PH-EP-2011-022; Geneva : CERN, 2011 - 17 p. - Published in : Phys. Lett. B 701 (2011) 186-203 ATLAS-SUSY-2010-05 (2011-02-25): PDF; Elsevier Open Access article: PDF; External links: ; Previous draft version

137.
Measurement of Dijet Azimuthal Decorrelations in pp Collisions at $\sqrt{s} = 7$ TeV / ATLAS Collaboration
Azimuthal decorrelations between the two central jets with the largest transverse momenta are sensitive to the dynamics of events with multiple jets. We present a measurement of the normalized differential cross section based on the full dataset (L dt = 36 pb$^{-1}$) acquired by the ATLAS detector during the 2010 $\sqrt{s} = 7$ TeV proton-proton run of the LHC [...] arXiv:1102.2357; CERN-PH-EP-2011-014; Geneva : CERN, 2011 - 18 p. - Published in : Phys. Rev. Lett. 106 (2011) 172002 APS Open Access article: PDF; ATLAS-STM-D-2010-13: PDF; External links: ; Previous draft version

138.
Search for supersymmetry using final states with one lepton, jets, and missing transverse momentum with the ATLAS detector in $\sqrt{s} = 7$ TeV pp collisions / ATLAS Collaboration
This paper presents the ATLAS collaboration’s first search for supersymmetry in final states containing jets, missing transverse momentum and one isolated electron or muon from $\sqrt{s} = 7$ TeV proton-proton collisions at the LHC. The data have been collected during 2010 and correspond to a total integrated luminosity of 35 pb$^{-1}$. [...] arXiv:1102.2045; CERN-PH-EP-2011-013; Geneva : CERN, 2011 - 19 p. - Published in : Phys. Rev. Lett. 106 (2011) 131802 APS Open Access article: PDF; ATLAS-SUSY-2010-01 (2011-02-11): PDF; External links: ; Previous draft version

139.
Search for Massive Long-lived Highly Ionizing Particles with the ATLAS detector at the LHC / ATLAS Collaboration

140.
Luminosity Determination in pp Collisions at $\sqrt{s} = 7$ TeV using the ATLAS Detector at the LHC / ATLAS Collaboration
Measurements of luminosity obtained using the ATLAS detector during early running of the Large Hadron Collider (LHC) at sqrt(s) = 7 TeV are presented. The luminosity is independently determined using several detectors and multiple algorithms, each having different acceptances, systematic uncertainties and sensitivity to background. [...] arXiv:1102.1218; CERN-PH-EP-2010-069; Geneva : CERN, 2011 - 61 p. - Published in : Eur. Phys. J. C 71 (2011) 1630 ATLAS-DAE-2010-01 (2011-01-12): PDF; Springer Open Access article: PDF; External links: ; Previous draft version

141.
Study of Jet Shapes in Inclusive Jet Production in pp Collisions at $\sqrt{s} = 7$ TeV using the ATLAS Detector / ATLAS Collaboration
Jet shapes have been measured in inclusive jet production in proton-proton collisions at sqrt(s) = 7 TeV using 3 pb$^{-1}$ of data recorded by the ATLAS experiment at the LHC. Jets are reconstructed using the anti-kt algorithm with transverse momentum 30 GeV < pT < 600 GeV and rapidity in the region |y| < 2.8. [...] arXiv:1101.0070; CERN-PH-EP-2010-077; Geneva : CERN, 2011 - 35 p. - Published in : Phys. Rev. D 83 (2011) 052003 APS Open Access article: PDF; ATLAS-STM-2010-10 (2011-01-04): PDF; External link: 

142.
Measurement of the centrality dependence of J/$\psi$ yields and observation of Z production in lead-lead collisions with the ATLAS detector at the LHC / ATLAS Collaboration

126
Using the ATLAS detector, a centrality-dependent suppression has been observed in the yield of \(J/\psi\) mesons produced in the collisions of lead ions at the Large Hadron Collider. In a sample of minimum-bias lead-lead collisions at a nucleon-nucleon centre of mass energy \(\sqrt{s_{\text{NN}}} = 2.76\ \text{TeV}\), corresponding to an integrated luminosity of about 6.7 \(\mu\text{b}^{-1}\), \(J/\psi\) mesons are reconstructed via their decays to \(\mu^+\mu^-\) pairs [...] arXiv:1012.2541v9; CERN-PH-EP-2010-090- Geneva: CERN, 2011 - 46 p. - Published in: *Phys. Lett. B 697 (2011) 294-312* ATLAS-HION-2010-03 (2010-12-24): PDF; Elsevier Open Access article: PDF; External links; Previous draft version

143.
**Measurement of the production cross section for W bosons in association with jets in pp collisions at \(\sqrt{s} = 7\ \text{TeV} with the ATLAS detector / ATLAS Collaboration**

This Letter reports on a first measurement of the inclusive \(W\)+jets cross section in proton-proton collisions at a centre-of-mass energy of 7 TeV at the LHC, with the ATLAS detector. Cross sections, in both the electron and muon decay modes of the W boson, are presented as a function of jet multiplicity and of the transverse momentum of the leading and next-to-leading jets in the event [...] arXiv:1012.2427v2; CERN-PH-EP-2010-076- Geneva: CERN, 2011 - 26 p. - Published in: *Phys. Rev. Lett. 106 (2011) 121803* APS Open Access article: PDF; ATLAS-EXOT-2010-06 (2010-12-13): PDF; External links; Previous draft version

144.
**Search for Diphoton Events with Large Missing Transverse Energy in 7 TeV Proton-Proton Collisions with the ATLAS Detector / ATLAS Collaboration**

A search for diphoton events with large missing transverse energy is presented. The data were collected with the ATLAS detector in proton-proton collisions at \(\sqrt{s} = 7\ \text{TeV}\) at the CERN Large Hadron Collider and correspond to an integrated luminosity of 3.1 \(\mu\text{b}^{-1}\). [...] arXiv:1012.2438v9; CERN-PH-EP-2010-068- Geneva: CERN, 2011 - 33 p. - Published in: *Phys. Rev. D 83 (2011) 052005* APS Open Access article: PDF; ATLAS-STDMD-2010-08 (2010-12-22): PDF; External links; Previous draft version

145.
**Measurement of the inclusive isolated prompt photon cross section in pp collisions at \(\sqrt{s} = 7\ \text{TeV} with the ATLAS detector / ATLAS Collaboration**

A measurement of the cross section for the inclusive production of isolated prompt photons in pp collisions at a centre-of-mass energy \(\sqrt{s} = 7\ \text{TeV}\) is presented. The measurement covers the pseudorapidity range \(|\eta| < 1.37\) and \(1.52 < |\eta| < 1.81\) in the transverse energy range \(15 < E_T < 100\ \text{GeV}\). [...] arXiv:1012.2510v4; CERN-PH-EP-2010-079- Geneva: CERN, 2011 - 70 p. - Published in: *New J. Phys. 13 (2011) 053033* ATLAS-STDMD-2010-06 (2010-12-27): PDF; IOP Open Access article: PDF; External links; Previous draft version

146.
**Charged-particle multiplicities in pp interactions measured with the ATLAS detector at the LHC / ATLAS Collaboration**

Measurements are presented from proton-proton collisions at centre-of-mass energies of \(\sqrt{s} = 0.9, 2.36\) and 7 TeV recorded with the ATLAS detector at the LHC. Events were collected using a single-arm minimum-bias trigger [...] arXiv:1012.2179v2; CERN-PH-EP-2010-064- Geneva: CERN, 2011 - 50 p. - Published in: *Eur. Phys. J. C 71 (2011) 1577* Springer Open Access article: PDF; External links; Previous draft version

147.
**Measurement of the top quark-pair production cross section with ATLAS in pp collisions at \(\sqrt{s} = 7\ \text{TeV} / ATLAS Collaboration**

A measurement of the production cross-section for top quark pairs \(t\bar{t}\) in pp collisions at \(\sqrt{s} = 7\ \text{TeV}\) is presented using data recorded with the ATLAS detector at the Large Hadron Collider. Events are selected in two different topologies: single lepton (electron \(e\) or muon \(\mu\)) with large missing transverse energy and at least four jets, and dilepton \((e\mu, \mu\mu\) or \(e\mu\)) with large missing transverse energy and at least two jets. [...] arXiv:1012.1792v2; CERN-PH-EP-2010-064- Geneva: CERN, 2011 - 50 p. - Published in: *Eur. Phys. J. C 71 (2011) 1577* Springer Open Access article: PDF; External links; Previous draft version

148.
**Studies of the performance of the ATLAS detector using cosmic-ray muons / ATLAS Collaboration**
Muons from cosmic-ray interactions in the atmosphere provide a high-statistics source of particles that can be used to study the performance and calibration of the ATLAS detector. Cosmic-ray muons can penetrate to the cavern and deposit energy in all detector subsystems. [...] arXiv:1011.6665; CERN-PH-EP-2010-070; 2011 - 33 p. - Published in: Eur. Phys. J. C71 (2011) 1593 Springer Open Access article: PDF; External links: ; Previous draft version

149.
Measurement of underlying event characteristics using charged particles in pp collisions at \( s^\sqrt{s} = 900 \text{ GeV} \) and 7 TeV with the ATLAS Detector / ATLAS Collaboration
Measurements of charged particle distributions, sensitive to the underlying event, have been performed with the ATLAS detector at the LHC. The measurements are based on data collected using a minimum-bias trigger to select proton-proton collisions at center-of-mass energies of 900 GeV and 7 TeV [...] arXiv:1012.8791; CERN-PH-EP-2010-063; Geneva: CERN, 2011 - 65 p. - Published in: Phys. Rev. D 83 (2011) 112001 APS Open Access article: PDF; PDF; External link:

150.
Observation of a Centrality-Dependent Dijet Asymmetry in Lead-Lead Collisions at \( s_{NN} = 2.76 \text{ TeV} \) with the ATLAS Detector at the LHC / ATLAS Collaboration
Using the ATLAS detector, observations have been made of a centrality-dependent dijet asymmetry in the collisions of lead ions at the Large Hadron Collider. In a sample of lead-lead events with a per-nucleon center of mass energy of 2.76 TeV, selected with a minimum bias trigger, jets are reconstructed in fine-grained, longitudinally segmented electromagnetic and hadronic calorimeters. [...] arXiv:1011.6182; CERN-PH-EP-2010-062; Geneva: CERN, 2010 - 19 p. - Published in: Phys. Rev. Lett. 105 (2010) 252303 APS Open Access article: PDF; External link:

151.
Measurement of the \( W \to l\nu \) and \( Z/\gamma^* \to ll \) production cross sections in proton-proton collisions at \( s^\sqrt{s} = 7 \text{ TeV} \) with the ATLAS detector / ATLAS Collaboration
First measurements of the \( W \to l\nu \) and \( Z/\gamma^* \to ll \) production cross sections in proton-proton collisions at \( s^\sqrt{s} = 7 \text{ TeV} \) are presented using data recorded by the ATLAS experiment at the LHC. The results are based on 2250 \( W \to l\nu \) and 179 \( Z/\gamma^* \to ll \) candidate events selected from a data set corresponding to an integrated luminosity of approximately 320 nb^{-1}. [...] arXiv:1012.0210; CERN-PH-EP-2010-037; Geneva: CERN, 2010 - 57 p. - Published in: J. High Energy Phys. 12 (2010) 060 Springer Open Access article: PDF; External links: ; Previous draft version

152.
Measurement of inclusive jet and dijet cross sections in proton-proton collisions at 7 TeV centre-of-mass energy with the ATLAS detector / ATLAS Collaboration

153.
Search for Quark Contact Interactions in Dijet Angular Distributions in pp Collisions at \( s^\sqrt{s} = 7 \text{ TeV} \) Measured with the ATLAS Detector / ATLAS Collaboration
Dijet angular distributions from the first LHC pp collisions at center-of-mass energy \( s^\sqrt{s} = 7 \text{ TeV} \) have been measured with the ATLAS detector. The dataset used for this analysis represents an integrated luminosity of 3.1 pb^{-1}. [...] arXiv:1009.5506; CERN-PH-EP-2010-033; Geneva: CERN, 2011 - 22 p. - Published in: Phys. Lett. B 694 (2011) 327-345 Elsevier Open Access article: PDF; External links: ; Previous draft version

154.
Search for New Particles in Two-Jet Final States in 7 TeV Proton-Proton Collisions with the ATLAS Detector at the LHC / ATLAS Collaboration
A search for new heavy particles manifested as narrow resonances in two-jet final states is presented. The data were produced in 7 TeV proton-proton collisions by the Large Hadron Collider (LHC) and correspond to an integrated luminosity of 315 nb^{-1} collected by the ATLAS detector. [...] arXiv:1008.2461; CERN-PH-EP-2010-026; Geneva: CERN, 2010 - 20 p. - Published in: Phys. Rev. Lett. 105 (2010) 161801 APS Open Access article: PDF; External links: ; Previous draft version
155.

Readiness of the ATLAS Tile Calorimeter for LHC collisions / ATLAS Collaboration
The Tile hadronic calorimeter of the ATLAS detector has undergone extensive testing in the experimental hall since its installation in late 2005. The readout, control and calibration systems have been fully operational since 2007 and the detector successfully collected data from the LHC single beams in 2008 and first collisions in 2009. […]
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156.

Commissioning of the ATLAS Muon Spectrometer with Cosmic Rays / ATLAS Collaboration
The ATLAS detector at the Large Hadron Collider has collected several hundred million cosmic ray events during 2008 and 2009. These data were used to commission the Muon Spectrometer and to study the performance of the trigger and tracking chambers, their alignment, the detector control system, the data acquisition and the analysis programs. […]

157.

Performance of the ATLAS Detector using First Collision Data / ATLAS Collaboration
More than half a million minimum-bias events of LHC collision data were collected by the ATLAS experiment in December 2009 at centre-of-mass energies of 0.9 TeV and 2.36 TeV. This paper reports on studies of the initial performance of the ATLAS detector from these data. […]
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158.

The ATLAS Simulation Infrastructure / ATLAS Collaboration
The simulation software for the ATLAS Experiment at the Large Hadron Collider is being used for large-scale production of events on the LHC Computing Grid. This simulation requires many components, from the generators that simulate particle collisions, through packages simulating the response of the various detectors and triggers. […]

159.

The ATLAS Inner Detector commissioning and calibration / ATLAS Collaboration
The ATLAS Inner Detector is a composite tracking system consisting of silicon pixels, silicon strips and straw tubes in a 2 T magnetic field. Its installation was completed in August 2008 and the detector took part in data-taking with single LHC beams and cosmic rays. […]

160.

Charged-particle multiplicities in pp interactions at $\sqrt{s} = 900$ GeV measured with the ATLAS detector at the LHC / ATLAS Collaboration
The first measurements from proton-proton collisions recorded with the ATLAS detector at the LHC are presented. Data were collected in December 2009 using a minimum-bias trigger during collisions at a centre-of-mass energy of 900 GeV. […]
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161.

Drift Time Measurement in the ATLAS Liquid Argon Electromagnetic Calorimeter using Cosmic Muons / ATLAS Collaboration
The ionization signals in the liquid argon of the ATLAS electromagnetic calorimeter are studied in detail using cosmic muons. In particular, the drift time of the ionization electrons is measured and used to assess the intrinsic uniformity of the calorimeter gaps and estimate its impact on the constant term of the energy resolution. […]
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162.
Readiness of the ATLAS Liquid Argon Calorimeter for LHC Collisions / ATLAS Collaboration
The ATLAS liquid argon calorimeter has been operating continuously since August 2006. At this time, only part of the calorimeter was readout, but since the beginning of 2008, all calorimeter cells have been connected to the ATLAS readout system in preparation for LHC collisions. [...] arXiv:0912.2642; CERN-PH-EP-2010-041; Geneva: CERN, 2010 - 31 p. - Published in: Eur. Phys. J. C 70 (2010) 723-753
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The ATLAS Experiment at the CERN Large Hadron Collider / ATLAS Collaboration
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Expected performance of the ATLAS experiment: detector, trigger and physics, v.1:
Performance; v.2: Standard model, top quark, B-physics; v.3: Higgs boson, supersymmetry, exotic processes. / Aad, G
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