L I P

Laboratório de Instrumentação e Física Experimental de Partículas

ACTIVITY PLAN

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LIP-Coimbra

- Applications of timing resistive plate chambers
- Collaboration in the HERA-B experimental
- Development of liquid xenon and liquid argon detectors for WIMPs search and CERN experiment PS213
- Developments and applications of gaseous active scintillators to neutron and other radiation detectors

LIP-Lisboa

- Calorimetry for ATLAS/LHC
- Collaboration in the CMS experiment at CERN
- Collaboration in the CMS experiment at CERN - development of the CMS alignment system
- Collaboration in the DELPHI experiment
- Collaboration in the EUSO experiment
- Collaboration in the NA50 experiment
- Data acquisition, processing and transmission technologies for the LHC experiments (LHC computing GRID)
- Development of radiation hard silicon detectors
- Monte Carlo techniques and detector development applied to medical physics
- Portuguese participation in the AMS experiment
- Robotization of optical fiber insertion in the TileCal calorimeter mass production

WORKING PLAN

Project Title: Applications of timing Resistive Plate Chamber

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Team:

Armando José Ponce de Leão Policarpo, Rui Ferreira Marques, Isabel Lopes, Paulo Jorge Ribeiro da Fonte

Project Coordinator: Paulo Jorge Ribeiro da Fonte

PhD:

Students: Alberto Blanco, Luís Lopes

Technical Staff: José Manuel Anastácio Pinhão, Nuno Miguel de Vasconcelos da Costa Carolino.

Activities Foreseen:

The project aims to explore applications of the novel radiation detection technique of timing RPCs: TOF-PET imaging and, upon approval by the collaboration, an experimental study for the construction of the HADES (GSI, Germany) forward TOF wall.

A first small animal PET prototype comprising two 32´1 cm^2 PET heads each with 16 detector layers readout by 96 analog electronic channels is in an advanced completion stage and it is expected to yield first results in the framework of the project.

Simulation studies concerning the performance of the RPC TOF-PET technique to whole body human PET studies is to be also actively pursued.

The HADES experiment at GSI, Germany, is a new and competitive experiment in the field of nuclear research, hosted by a prestigious institute. Our involvement will be important for the development and training of our scientific and technical staff in the construction and commissioning of large HEP detectors, building upon our accumulated prototyping experience in the novel field of timing RPCs.

Training program:

Attendance to two conferences have been requested and partially granted.

WORKING PLAN

Project Title: Collaboration in the HERA-B experiment

Team

Project Coordinator: João Carlos Carvalho

PhD: Armando J.P.L.Policarpo, António Amorim, Helmut Wolters

Students: João A. Bastos, Vasco Amaral, António Oliveira, João Batista, Luis Silva

Technical Staff:

Activities Foreseen:
In 2002 the HERA machine finishes its luminosity upgrade activities and HERA-B will have a very long run (about nine months) were it will take data enough to fulfill its priority measurements: the b-bbar cross section, the A dependence of the charmonium production and charm physics.

The main tasks of the Portuguese team for 2002 are:

RICH. Operation of the detector during the experiment running time. This means to solve any problems that eventually arise from the high and low voltage systems, the photomultiplier tubes and the associated front end electronics, the gas system and the data acquisition system. The RICH must be monitored at all times both by the slow control system and the data quality histograms. Some work is also planned in the particle identification tasks, starting with the selection of pure samples of different particles, as pions, electrons and muons. The different particle identification algorithms use the RICH information and the track momentum to assign a probability for each particle hypothesis, which is then written in the event tables for offline analysis.

Database system. The database is a crucial system for the experiment, in particular for the data acquisition and analysis. It must be always working as required so it would not compromise the data acquisition efficiency. Its operation must be monitored by a full time expert to detect any possible problem. Also a user friendly database interface must be developed in order to help non-experts to access the database information. There will be also a study of the possibility of upgrade the database servers to use the new BerkleyDB features of crash recovery and multiple pointers, as a possible solution to increase both the robustness and the speed of the database. A priority task will be the comparison and prototyping of different technologies based in ROOT, DB2 and Oracle to build up a robust and efficient framework system, to support the analysis phase of the experiment. This effort is an important step to the usage of the real data and real analysis queries available in the experiment, and follows the international GRID effort in the HEP community.

Data Analysis. HERA-B will collect a very large data sample during the long 2002 run. The data analysis will be important not only for physics measurements but also to monitor the data quality and the detector performance. The portuguese group will concentrate its efforts in three tasks. The first is the measurement of the $\omega \rightarrow \mu^+\mu^-$ branching ratio, which was never published. The best way to estimate it is to compare the number of events in this channel with one of the channels already measured, as the $\omega \rightarrow \mu^+ \mu^- \pi^0$. Then the relative detector and selection acceptances are estimated using simulated data. The second main task is the measurement of the b-bbar cross section at the HERA energy. This is poorly known, as the results of previous experiments are not consistent. The measurement will be done using the B meson semileptonic decay. Even if the decay is not fully reconstructed its branching ratio is higher than the other channels and it contains at least one high momentum lepton track, and then it is selected by the HERA-B trigger system. The backgrounds to this channel will be estimated using Monte Carlo data. The measurement of the acquired luminosity is essential for the determination of absolute cross sections. One of the team members in the convener of this analysis sub-group. Different methods will be tested to be used online and offline, which combine the information of some sub-detectors. The statistical method will be further developed and tested, and then applied to the new data.

Training program:

João Bastos - Ph.D. thesis conclusion foreseen in 2002.
Vasco Amaral - Ph.D. thesis conclusion foreseen in 2003.
António Oliveira - M.Sc. thesis conclusion foreseen in 2002.
João Batista - M.Sc. Thesis conclusion foreseen in 2003.

WORKING PLAN

Project Title: Development of liquid xenon and liquid argon detectors for WIMPs Search and CERN experiment PS213

Project Coordinator: M. Isabel Lopes

PhD Researchers: Armando José Ponce de Leão Policarpo, Vitaly Chepel, José Pinto da Cunha, Rui Ferreira Marques, Paulo Mendes, M. Isabel Lopes.

PhD Students: Vladimir Solovov, Francisco Neves

Research Student: Alexandre Lindote

Undergraduated Student: João Abrantes

Technical Staff: José Manuel Anastácio Pinhão, Américo Pereira

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Activities Foreseen:

We proposed a liquid Xe 4-pi gamma detector for n-capture cross section measurements by the n-TOF collaboration at CERN (PS213). Such detector would offer fast response that is essential for the high count rates expected. First tests on a neutron beam aiming at assessing some important parameters of the proposed detector are planned .
As for the development of a liquid xenon detector for WIMPS search (in collaboration with the UK Dark Matter Collaboration, one intends to study the scintillation signals from liquid Xe exposed to neutrons of suitable energies, i.e. producing recoils similar to WIMPs of mass ~100 GeV. The resulting signal will be compared to the recoiling energy determined from the change in the neutron momentum, to study the i) linearity of the detector response, ii) ratio of scintillation yields due to recoils and to e-, iii) topology of the events, iv) light collection, v) neutron/gamma scintillation pulse shape discrimination, and vi) rejection of n-inelastic and n-capture events.
This data should give also valuable input to the detailed Monte Carlo simulation which is under development. This simulation is of prime importance for the design of any further detector solutions, either for WIMPs or to n-TOF project.
Hence, simulation studies concerning the performance of the detector for n-TOF, as well as the experiment planned in the framework of the development of a liquid xenon/liquid argon detector for WIMPs search, will be continued.

Training program:
Francisco Neves will continue his PhD studies.
Alexandre Lindote will start the scholar part of her MsC.
João Abrantes will finish his graduation thesis work and plans to continue to work in this project as a research student.

WORKING PLAN

Project Title: Developments and applications of gaseous active scintillators to neutron and other radiation detectors

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Project Coordinator: Francisco Amaral Fortes Fraga
PhD Researchers : Armando JosÈ Ponce de Le„o Policarpo, Maria Alice Furtado Alves, Rui Ferreira Marques, Ermelinda Pedroso de Lima, Maria Margarida Feteira Ribeirete de Fraga, Paulo Jorge Baeta Mendes
PhD Students: LuÌs Manuel Silva Margato
MsC Student: Susete Fetal
Undergraduate Students: Filipa Balau
Technical Staff: Americo Pereira, Nuno Carolino

Activities Foreseen:

Development of applied detectors using active gas scintillators using microstuctures (GEMs) operating in the UV, visible and NIR and state of the art optical readout techniques - fast CCDs, position sensitive PMs and arrays of APDs:
1. Large area (20x 20 cm) gaseous detector 3He capable of high background rejection using photon counting devices for thermal neutron imaging.
2. Recoil detector for fast neutron (1-20 MeV) spectroscopy with single event energy resolution. The energy of the recoil target will be measured from the amount of scintillation and the direction of emission will be computed from the estimated real length of the track and the length of the projection. Efficiency is expected to be 10-100 better than current Li foil detectors.
3. Scintillation (30x30cm) screen for 2D-dosimetry in proton radiation therapy free of quenching effects at the Bragg peak.
These studies include the optimization of gas mixtures for high efficiency and high light yield (also pressurized) and alternative devices such as microchannel plates and laser driller ceramic GEMs.

Training program:
LuÌs Manuel Silva Margato : PhD. Conclusion foreseen in 2003
Susete Fetal : MSc. Conclusion foreseen 2002
Filipa Balau : Final Graduation Project. Conclusion foreseen in 2002

WORKING PLAN

Project Title: Calorimetry for ATLAS/LHC

Team:

Project Coordinator: Amélia Maio

PhD:

Amélia Maio	63%
António Amorim	4%
João Carvalho	25%
António Onofre	50%
Helmut Wolters	4%
Agostinho Gomes	95%
José Martins	10%
Viriato Esteves	25%
Manuel Maneira	4%
Carlos Cardeira	8%
Zlatan Denchev	10%
Orlando Oliveira	10%

Students:

Maria de Jesus Varanda	95%
José Silva	100%
João Santos	42%
João Gentil Saraiva	100%
João Pina	100%
Pedro Amado	50%
Fernando Esteves	29%
Carlos Marques	95%
Sandra Soares	38%

Technical Staff:

José Pinhão	5%
Rui Alves	10%
Fernando Moita Ribeiro	20%
Joaquim Oliveira	10%
Carlos Silva	10%
Américo Pereira	10%
Jorge A. Moita	10%
Marc Stielau	5%
Joaquim Patriarca	25%
Luís Raposeiro	15%

Activities Foreseen:

The activities for 2002 include the production of optical components for the instrumentation of the calorimeter modules. It is our responsibility to prepare and aluminize the remaining 10% of the WLS fibres, to insert about 20% of the fibres into the profiles and to deliver the profiles with fibres to the instrumentation plants at CERN, Barcelona and United States (ANL and Michigan). The insertion and delivery of the profiles with fibres is object of another project.

It is planned to do the optical quality control of the profiles and scintillator tiles at the LOMAC lab at the CFNUL in Lisbon.
The production and quality control of connectors and bundles of clear fibres for the laser monitoring system will go on at LIP-Coimbra. The connectors will be installed at the modules at CERN.
During this year the calibration of the calorimeter is one of our main tasks. The calibration of several modules in the test beam is planned. Work is in progress in order to optimize the calibration technique.

The data collected in the calibration of the modules with beam of high energy particles and Cs source, will also be used to monitor the ageing of the modules. Complementary tests of accelerated ageing of the calorimeter optical components have been done in Lisbon.

MC simulation is in progress in order to study the possibility to use the signal of the third layer of the calorimeter in the muon trigger, to improve the efficiency for some B-physics channels.

Studies to find if there are persons inside the area of the Atlas detector started (sub-project FPIAA by IDMEC).

The test bench for quality control of the photomultipliers (PMTs) is practically ready to operate. Batch nr. 9 (with 250 PMTs) will arrive in April and batch nr. 10 will arrive in July. The quality control of those PMTs will be done in Lisbon.

Training Program:

PhD students
Maria J. Varanda, "Muon detection in ATLAS and its relevance on semi-leptonic decays", in progress
José Silva, "Monitorization and intercalibration of the Tilecal/ATLAS calorimeter, and PMT qualification", starting

Master students
João Pina, "Ageing effects in the optics of the Tilecal calorimeter", in progress
João G. Saraiva, "Improving the calibration of the Tilecal calorimeter", in progress
Carlos Marques, “Simulation of performance of the Tilecal detector”, starting

WORKING PLAN

Project Title: Collaboration in the CMS Experiment

Project Coordinator: João Varela

Activities Foreseen:

1. Trigger Synchronization Circuit

This circuit is the heart of a method developed and demonstrated by LIP to achieve synchronization of the calorimeter trigger pipeline system. Initially developed in the context of the electromagnetic calorimeter (ECAL), the circuit will also be used by the hadronic calorimeter (HCAL) US project.

a) Validation of the final version of the Trigger Synchronization circuit
The circuit developed in 2001 will be subject in the first months of 2002 to extensive testing, completing the work already done. Special attention will be given to BuiltIn-SelfTest (BIST) validation.

b) Circuit final review
The Technical Documentation will be completed. A final internal review of the project will be organized. The review committee will include LIP and INESC members.

2. Synchronization and Link Board

The Sync/Link Board is an interface card between the Calorimeters Readout/Trigger systems and the Regional Trigger. The Sync/Link Board synchronizes the trigger primitives (synchronizer circuit) and sends serialized data at high speed (1.2 Gbit/s) through the trigger link to the Regional Trigger.

a) SLB Testing
Extensive tests of the new Sync/Link Board prototype will be carried out after the tests of the Sync Circuit. The main issue will be the test and validation of the Trigger Links. Link receivers will be housed in the test board being developed in Wisconsin. A test system integrating the various components will be installed at CERN. The tests, to be carried out by the LIP and Wisconsin groups, will measure the link error rate, synchronization loss rate and related parameters. In the final system, about 2000 links will be used (ECAL and HCAL combined).

b) SLB final review
The Technical Documentation will be completed. A final internal review of the project will be organized. The review committee will include LIP and INESC members.

c) SLB Testability
The requirements for SLB production test shall be defined. The production test systems will be installed.

d) Integration in HCAL
The portuguese group in CMS has no responsibilities in the HCAL project. However the HCAL has decided to use the ECAL Synchronization and Link Board. In consequence, during 2001, we have integrated the HCAL requirements in our design. Next year some limited support will be given by our group to the HCAL activity.

3. Data Concentrator Cards

The Data Concentrator Card is a 9U VME module responsible for collecting data from 18 sources, performing event formatting, data integrity checking, and transmission to the central Data Acquisition System. The final system will include 60 DCCs, one per ECAL readout/trigger crate.

a) ECAL Data Concentrator prototype
The design of the DCC card will be concluded, following the parameters defined by the hardware simulation. In particular the internal bandwidth is now specified at 528 Mbytes/s.
A prototype will be built with full performance and complete functionality. The design will use large programmable FPGAs allowing small corrections to the functionality at a later stage.
The software needed for the tests is developed in Task 4.

b) Design of the Trigger Data Concentrator
The Trigger Concentrator Module (TCM) will be based on the DCC, and its design will benefit from the experience acquired with the DCC. Next year, the TCM input/output must be specified allowing design work by other groups to continue. In consequence, our work will be focused in the definition and design of the TCM input/output interfaces.

c) DCC Testability
A study of the in-system testability of the DCC will be performed looking for the best compromise between BIST and external tests. For the DCC prototype tests, a dedicated board acting as data source has to be built. This module will be integrated in the DCC production test system.
The requirements for DCC production test shall be defined.

4. Readout and Control Software

a) DCC Class Library
The development of the object class library for the DCC module is an important goal next year. This class library will implement the DCC software interfaces for configuration, operation and test.

b) DCC Test Package
A dedicated test package to support the DCC hardware tests will be developed.

c) Crate Software
We intend to pursue the development of Trigger Readout and Control Software, aiming at a demonstrator of a single crate system (Elementary Partition), including data base remote access and SCADA control. This work is carried out in collaboration with the CMS Detector Control and DAQ groups in the framework of the Trigger Software Working Group.

5. Modeling and Simulation

In order to guarantee that the entire functionality of the ECAL readout/trigger system, as well as the required performance, is taken into consideration at the specification phase, a model, at system level, of its constituting modules or units, has to be developed and simulated. This need comes from the fact that it is not possible to prototype all modules and interfaces of such a complex system. Thus, the use of system-level simulation is mandatory for achieving this purpose. Last year, particular attention was given to the simulation of event building in the ECAL DCC, putting emphasis on the validation of the event builder design and communication protocols. This work was successfully concluded at INESC. The input data for the simulations was generated with the CMS detector simulation package ORCA, for various physics scenarios.

a) Validation of bandwidth specifications
Detailed modeling and simulation of the Readout/Trigger module will be carried out next year. This work will allow the validation of the design bandwidth of the Readout/Trigger board and of its interface to the DCC.

b) Study of error detection and diagnosis
In large systems, error detection and diagnosis is a major challenge. Using the system simulation tools we will perform a systematic study of error conditions and its effects on the system. The completeness of the diagnosis data defined in the design will be checked, studying in particular multi-error situations.

6. Boundary Scan

The development of boundary scan tools, that we have been consistently pursuing in the last years, will reach the final phase next year. The set of hardware and software boundary scan tools produced in this sub-project will be extremely valuable for testing and diagnosing hundreds of electronics modules under our responsibility, in the production phase and latter when installed in the experiment.

a) Boundary Scan Controller Core
The main objective of this task next year is to redesign the boundary scan controller in order to make a portable module to be used in each DCC board, thus enabling the application of a boundary scan test to the sub-system during the idle time, or when a maintenance operation is required.
This work will be documented and made available to other groups in the CMS collaboration.

b) Boundary scan review
A formal final review of the Boundary Scan test system will be organized.

7. Test Beam ECAL Monitoring

The LIP/CMS group is participating in the ECAL test beam pre-calibration program. A large experimental infrastructure, including readout electronics, data acquisition, trigger, cooling, test systems, etc. is being installed in the CERN North Area to allow the completion of this program. The size of this experimental setup is typical of any fixed target experiment. Many experimental aspects related to the physics behavior of the CMS electromagnetic calorimeter will be studied in this environment.

Our group is mainly involved in the development of the JAVA-based monitoring system of the ECAL test beam setup. This development is complementary to other parts of our project (hardware modules, readout and control software).

8. Physics Reconstruction and Selection

The development of the off-line reconstruction and analysis software of the CMS experiment is a major project. In order to be able to explore the physics potential of the CMS experiment in Portugal we shall initiate a strong effort to participate in this development. In 2002, we plan to hire the manpower required:

- to install in Lisbon the simulation and reconstruction CMS software framework and guarantee its updates.
- in collaboration with the LIP GRID project, to adapt the CMS off-line software tools to the Portuguese GRID environment.
- to collaborate in the general CMS effort towards the development of off-line core software

These tasks represent a major effort that shall be pursued consistently in the coming years.

WORKING PLAN

Project Title: Collaboration in the CMS Experiment "Development of the CMS Alignment System"

Project Coordinator: João Varela

Activities Foreseen:
The project aims to complete the engineering work for the construction of the 36 carbon fibre structures of the CMS muon alignment system. These structures are the subject of a delicate engineering and prototyping work concluded in 2001. In 2002 we want to define and test the assembly and manufacturing procedure. Given the high stability requirements of these structures, we will continue the R&D on shape control of composite structures using piezoelectric sensors and actuators.

1. Study of the manufacturing procedure
Definition of the manufacturing sequence needs must be clearly understood and documented prior to any other task. For the completion of this task we will use the knowledge acquired by our engineering team on the assembly and test of the MAB prototype to setup a manufacturing procedure. This will be done also in collaboration with the CERN team. This first step will influence all the others and a good understanding of all the details is clearly needed. This will require short term visits from our team members to CERN and short term visits from CERN collaborators to Portugal.
The outcome of this task should be a clear definition of the manufacturing procedure to be used and implemented as foreseen in the rest of the tasks.

2. Design and manufacture of the assembly prototype plant
The design and assembly of the prototype plant follows the results from task 1, "Study of the manufacturing procedure". It has in it several steps needed for its completion:

a) study and production of the technical drawings of all the gigs and of the assembly table;
b) buy the needed material for the construction of some parts;
c) outsource some of the mechanical gigs;
d) assembly of all the parts.

For the above breakdown we will heavily use our design engineers for step a), then, under their supervision the expensive material and consumables will be acquired. Please note that the MABs are 4 meter long objects with tight dimensional and assembly tolerances. Mechanical gigs will be mainly outsourced. Once all the needed parts are

available, careful assembly procedure will involve our staff as well as the expertise of CERN survey team that should collaborate on the levelling and survey of the assembly plant. This will require their visit to our facilities for a short period.

3. Manufacture and assembly of the embedded mechanical elements

For the prototypes we will outsource the manufacture of the embedded mechanical elements. For some of them we should supply the raw material. Once we have all the pieces in hand, we should start the delicate assembly on the MAB using the assembly facility we built in task 2. For this part we will use all of the technical manpower available under the supervision of an experienced engineer.

4. Study and use of shape control for large structures

Ongoing R&D on an innovative approach to shape control of small structures was successfully proved in small structures. We will concentrate our studies on the possible extension of these methodologies to large structures. Also the use of novel techniques to measure stability and deformations will be evaluated.

WORKING PLAN

Project Title: Collaboration in the DELPHI Experiment

Team

Project Coordinator: Mário Pimenta

PhD:

Mário Pimenta	50%
Amélia Maio	10%
Alessandro de Angelis	10%
Luis Peralta	40%
António Onofre	35%
Fernando Barão	10%
Pedro Abreu	60%
Bernardo Tomé	90%
Maria Catarina Espirito Santo	40%

Students:

Patricia Gonçalves	40%
Sofia Andringa	100%
Sandra Moreno	100%
Nuno Miguel Anjos	100%
Filipe Veloso	100%
Nuno Castro	100%

Activities Foreseen:

After eleven successfully years, LEP ended the data taking in November 2000.

The heritage of LEP is of outmost relevance, but it is not yet fully accomplished. An huge quantity of real and simulated data are now under the final reprocessing which will enable the reduction of the systematic errors. In most of the channels, final papers are foreseen during the next two years. The joint effort of the four LEP collaborations to put together the results covers now a large set of subjects (Electroweak precision measurements, Higgs searches, SUSY, Exotic Physics, QCD, …) and will produce in many cases the best possible results in many, many years.

LEP data is being organized in such a way that it will be possible, even for a future generation of students and physicists, to fully exploit it. Since 1986, LIP has a major activity at DELPHI. In the last years, LIP group was responsible for a considerable amount of articles, communications to conferences and DELPHI reports, covering a wide range of Physics Channels (Supersymmetry, Compositness, Leptoquarks, Higgs Anomalous Couplings and Decays, QCD, …).

Final DELPHI articles in many of the physics channels are expected to be ready during the next two years. LIP has a particular responsibility in the following subjects: Non fermionic neutral Higgs couplings; Composite fermions; $\gamma\gamma$ final states; Leptoquarks; Flavour changing neutral currents; Quantic Gauge couplings; Average multiplicities, dispersion and inclusive distributions in hadronic events; interconnection effects in WW events; differences in average charged multiplicities in b-quarks events or in light quark events. Several developments are foreseen in each of these subjects either improving the analyses efficiencies or covering related topics. New subjects, such as the search for Heavy new fermions, are under consideration. LEP is a very good and exciting environment for the formation on Experimental High Energy Physics.

Searches:

The LIP DELPHI members are convenors of six Physics Teams (SUSY LSP, Flavour Changing Neutral Currents, Fermiophobic Higgs bosons, Heavy and Excited fermions, Leptoquarks and Collinear gamma gamma) and one research line (Exotica). They also participate in the LEP Higgs, LEP Exotica and LEP Electroweak Working groups, which combine results and limits from the four LEP experiments.

Search for non fermionic neutral Higgs bosons
Many of the proposed extensions of the Standard Model change the properties of the Higgs bosons, either by the effect of higher energy interactions or directly assuming a non-minimal sector. Two of these extensions are explored; the introduction of anomalous couplings between the Higgs and the gauge bosons, due to the presence of higher order corrections, and the introduction of a second Higgs doublet in a scenario where a light Higgs boson with suppressed couplings to fermions arises (fermiophobic Higgs).

Search for SUSY particles
In the framework of the Minimal Supersymmetric extension of the Standard Model (SUSY), assuming R-parity conservation, the lightest supersymmetric particle is stable, and SUSY developed with minimal assumptions, and the selection criteria employed depends primarily on the masses of the particles involved.

Search for Heavy and Excited Leptons
Sequential, non-canonical excited leptons could be produced singly or in pairs, and would decay promptly by radiating a photon, a Z or a W boson, giving rise to different topologies. Limits are derived as functions of its masses and couplings.

Search for Flavour Changing Neutral Currents
Flavour Changing Neutral Currents (FCNC) are absent at tree levels and severely suppressed at one loop level in the Standard Model, but present in many of its extensions. Single top quark production at LEP would be an indication of such anomalous FCNC couplings. A very general procedure considers an effective lagrangian approach with four-fermion contact interactions.

Search for Leptoquarks
Leptoquarks are colored spin 0 or spin 1 particles which carry both baryon and lepton

quantum numbers. A search for singly produced leptoquarks decaying both in charged and neutral modes is performed within two distinct frameworks: the direct mechanism and the resolved photon mechanism.

Search for $\gamma\gamma(\gamma)$ ***events***
Final states with two photons are mainly produced by the standard process e+e- → g g (g). This reaction is an almost QED process and therefore any significant deviation between the measured and the QED cross-section could unambiguously be interpreted as the result of non-standard physics.

In the scope of the above activities, we have a training program with three students preparing their PhDs, and two students preparing a Master thesis.

Hadronic Decays:

Multiplicity differences with respect to the mass of the quarks
One of the most interesting predictions of QCD, in Modified Leading Logarithm Approximation and assuming Local Parton-Hadron Duality, is that the number of charged particles produced in an hadronic event should be only dependent on the mass of the fragmenting primary quarks. In particular, the difference of average charged multiplicity in light quark initiated events to heavy quark initiated events, is constant with respect to the center of mass energy. LEP2, with its center of mass energy ranging from 130 to 209 GeV, along with the precise results of LEP1 at center of mass energies around the Z mass (91 GeV), gives a marvelous set of data to make comparisons at different center of mass energies, using always the same detectors and thus reducing systematic errors.

Color reconnection effects in events containing a pair of W bosons
The W bosons are produced at pairs in the LEP 2 machine, and may both decay hadronically, in the very short lifetime of 3.1x10-25 s, travelling no more than about 0.1 fm. This time and distances are much smaller than the typical hadronisation time and distance scales of about 1 fm, thus allowing for both partons and or hadrons in the decay of the W bosons into quarks to interact with each other. Being a challenging observable to understand the properties of QCD, this effect needs also careful study in order to assess the modifications to the reconstructed W mass in the fully hadronic channel. We are working in this area, in tight collaboration with other LEP experiments.

In the scope of the above activities, we have a training program with one student preparing his PhD.

Academic Training:

"Study of $\gamma\gamma(\gamma)$ events at LEP I" – PhD Thesis – Patricia Gonçalves. Conclusion in 2002.

"Exotic Higgs at LEP II" – PhD Thesis – Sofia Andringa. Conclusion foreseen in 2002/2003.

"Hadronic final states at LEP II" – PhD Thesis – Nuno Anjos. Conclusion foreseen in 2003.

"Search for Heavy leptons at LEP" - PhD Thesis – Sandra Moreno – Conclusion foreseen in 2003.

"Search for single top production at LEP via four-fermion contact interactions at sqrt(f) = 189-208 GeV" - Master thesis – Filipe Veloso. Conclusion foreseen in 2002/2003.

"Search for Quark *b'* in Delphi experiment"- Master thesis – Nuno Castro. Conclusion foreseen in 2002/2003.

WORKING PLAN

Project Title: Collaboration in the EUSO Experiment

Team

Project Coordinator: Mário Pimenta

PhD:

Mário Pimenta	35%
Gaspar Barreira	10%
Catarina Espirito Santo	60%
Pedro Abreu	30%
António Onofre	10%
Alessandro de Angelis	10%
Luis Melo	10%
Pedro Brogueira	10%
Jorge Gomes	10%
Bernardo Tomé	10%

Students:

Pedro Assis	100%

Activities Foreseen:

The main goal of EUSO, Extreme Universe Space Observatory, is to detect Extreme Energy Cosmic Rays (EECR) and neutrinos, indicative of unknown particle production and acceleration mechanisms in the universe. When a high-energy cosmic particle enters the earth atmosphere, a shower of billions of relativistic particles is produced. The interaction of the shower particles with atmosphere produces ultraviolet (UV) fluorescence light. EUSO, to be installed as external payload in the Columbus module of the International Space Station (ISS), will look downwards to the earth atmosphere, detecting the faint ultraviolet traces produced by the EECR. About one thousand events per year are expected. The observation of meteors and atmospheric phenomena producing UV light are other scientific objectives of the EUSO mission.

The EUSO experiment has been proposed to ESA on January 2000 and selected a few months later for an accommodation study on the ISS. The project has been approved for a one-year Phase A study, starting in March 2002. During this period, the mission feasibility should be established. All aspects should be addressed, from the detailed instrument design to its installation and operation on the ISS.

The challenging aspects, scientific and technical, of the EUSO mission, motivate a group of several PhD, engineers and students at LIP. The activities of the Portuguese team cover different aspects.

During Phase A, LIP is responsible for the co-ordination of the EUSO Science Operations and Data Center Subsystem (EUSO-SODC). The SODC must generate EUSO specific commands, monitor the instrument health and performance, and notify any relevant scientific/monitoring events. It will also be responsible for the preliminary calibration of the EUSO instrument, and for establishing, in co-ordination with the EUSO Scientific Data Analysis Center, the EUSO archive and providing data to the users. The main topics to be addressed in Phase A are: telemetry requirements evaluation; identification of the operation requirements; definition of the main SODC components/functionalities (general architecture). The SODC should be located in one of the participating European countries. The possibility of Portugal being the host country will be explored during Phase A.

LIP also participated in a program of experimental support activities performing various studies of critical parameters for EUSO. In particular, the determination of the UV light diffusion coefficients at the surface of the earth (in different types of media) is the subject of the ULTRA project (ULTRA - UV Light Transmission and Reflection in the Atmosphere). The ULTRA detector is a hybrid system consisting of an UV optical detector and an array of scintilators. The development of the position determination and synchronization system is a responsibility of the Portuguese group.

The group will also take part in simulation and analysis software development and in education and public outreach programs.

Academic Training:

Undergraduate Thesis – Pedro Assis. Conclusion foreseen in 2002.

WORKING PLAN

Project Title: **Collaboration in the NA50 Experiment**

Team:

Project Coordinator

Paula Bordalo

PhD

Paula Bordalo	analysis and trigger	70%
Sérgio Ramos	analysis and acquisition	70%
Pedro Rato	hardware	17%
Ruben Shahoyan	analysis	17%

Students

Catarina Quintans	analysis	100%
Teresa Claudino	analysis	100%
Helena Santos	analysis	100%
Gonçalo Borges	analysis	100%
João Cruz	analysis	20%

Technical Staff

Jorge Gomes	Systems Engineering	30%

Activities Foreseen

The goals of the LIP-Lisbon group working program concerning its participation in NA50
Collaboration will be, from now on, a carefull analysis of the different physics aspects of the data, namely:

- Comparative study of ψ and ψ' production and of the ratio ψ'/ψ, in p-A interactions, using different targets
- Study of vector-meson production in lead-lead collisions
- Study of the dimuon continuum production, namely its Drell-Yan and charm components, in lead-lead collisions
- Study of ϕ production compared with $\rho+\omega$ in lead-lead interactions, as a function of centrality and of P_T.

WORKING PLAN

Project Title: Data Acquisition, Processing and Transmission Technologies for LHC Experiments (LHC Computing GRID)

Team

Project Coordinator: Jorge Gomes

PhD:

Students:

Technical Staff: João Martins, José Aparício, José Nogueira, Mário David

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Activities Foreseen:

Transparent integration of the distributed computing resources is a fundamental requirement for the simulation, reconstruction and analysis of LHC data. The huge dimension of this computing fabric poses novel challenges in terms of scalability, authentication, co-ordination and optimization of resources. This project aims to obtain the know-how and skills required to implement, operate and maintain the grid computing infrastructure required to support Portuguese LHC research activities, and provide the basis for other activities such as the development and testing of LHC applications in the context of the Portuguese participation in the ATLAS and CMS experiments.
In this context close collaboration with CERN and other High Energy Physics laboratories has been established in the framework of international projects. The Portuguese Minister of Science and Technology has approved the Portuguese participation in the CERN Computing Grid project. The project aims to integrate the results of the several Grid initiatives to build the LHC computing infrastructure. LIP will continue to be the coordinating institution in the country.
LIP will also participate in two European Union research projects in the field of grid technologies, namely LIP is a member of CROSSGRID and a non-funded member of DATAGRID.DATAGRID is a three year project aiming to demonstrate the effectiveness of the GRID technology through the deployment of applications involving real users, and demonstrate the ability to build connect and manage large HEP data intensive computing clusters.

Participation in the European Union project CROSSGRID as an official partner will start in March 2002. CROSSGRID is basically a complement of DATAGRID extending the testbed processing fabric to more countries and research institutes. CROSSGRID will also address new issues such as portals, programming environments and mobility.
LIP will collaborate with the Portuguese national research network to provide the network services required for LIP Grid sites.

The objectives for 2002 are:

- Fulfill the LIP responsibilities as Portuguese representative in the “CERN Computing Grid Project".
- Obtain the technological knowledge and experience to provide a future computing production service for the Portuguese LHC research groups.
- Provide the support for the development and testing of LHC applications.
- Develop, deploy and maintain local facilities and Grid support services.
- Integrate national computing infrastructures into the global grid.
- Promote coordination with other relevant participants.
- Identify resources and services required for a future production service.
- Follow the developments in the field of LHC computing.
- Participate in international testbeds and data challenge activities.
- Validate Grid components and LHC applications.
- Participate in Grid development activities.
- Extend the LIP grid infrastructure to a second site in Coimbra.

The project will focus on six tasks:

- Authentication, Authorization and Security.
  - Maintenance the infrastructures required for authentication of Grid users and systems, namely the LIP X.509 certification authority.
  - LIP participation in the Certification Authorities Task Force.
- Grid Testbed.
  - Installation and maintenance of the LIP Grid infrastructure.
  - Evaluation of grid toolkits and components.
  - Installation and maintenance the LIP and National Grid information services.
- Networking.
  - Collaborate with FCCN in the specification and implementation of network services required by Data Grids
  - Collaborate with the CERN Computing Grid, DATAGRID and CROSSGRID network work packages.
- Applications and user support.
  - Support users in application development and testing.
  - Participation in Grid data challenges.
  - Installation and maintenance of LHC libraries and applications.
  - Environment compatibility with other LHC site.
- Farms and storage.
  - Deployment and maintenance of local farms based on open schedulers.
  - Integration of local farms within the global Grid.
  - Deploy and maintain local storage system.
- LHC Computing Tracking
  - Interface with LHC experiments.
  - Interface with other grid projects.
  - Interface with HEP/LHC Computing related committees.

WORKING PLAN

Project Title: Development of radiation hard silicon detectors

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Team

Project Coordinator: Pedro F. P. Rato Mendes, Ph.D.

PhD: Maria da Conceição Abreu, Pedro Rato Mendes

Students: Patrick E. Sousa, Sónia I. Rodrigues

Technical Staff: José Mariano

Activities Foreseen:

The project "Development of radiation hard silicon detectors" will be carried out by LIP as part of the activities of the LIP instrumentation laboratory at the University of Algarve in Faro.

The objective of this project is to continue the laboratory's effort in the development of radiation hard silicon detectors for the experiments that will operate at the future CERN accelerator, the Large Hadron Collider (LHC), starting at 2005.

Calculations predict that large numbers of charged particles will be produced at LHC collisions, and in order to fully exploit the opportunities available to study new physics, these particles need to be tracked with extremely high accuracy close to the interaction point, where the highest radiation levels are expected. Silicon detectors provide the only reliable technology capable of delivering the required spatial and time resolutions, but tend to degrade their performance as they become more and more irradiated. The impossibility to replace them during the experiment's lifetime (high cost and difficult access to interaction point) imposes that radiation resistant detectors and front-end electronics must be used at LHC applications.

The RD39 Collaboration at CERN aims at developing radiation hard detectors by operating them at cryogenic temperatures. The observation of the so-called "Lazarus effect" [1,2] by members of the collaboration in 1998 eventually led to the result that heavily irradiated detectors (up to 20 times the levels expected for 10 years at LHC experiments) were still able to operate at 130 K [3,4]. Intense research work is going on in order to increase as much as possible the charge collection efficiencies of irradiated detectors, keeping their good tracking capabilities.

The present RD39 team from LIP has several years of experience working in the field of highly segmented silicon detectors [5] and radiation damage [6,7]. More recently, the

research activities at the laboratory in the University of Algarve (started in 1999) resulted in the construction and implementation of an automated setup for precision charge collection efficiency measurements at low temperatures of irradiated detectors [8], with which the team has been systematically characterizing various types of samples for RD39 ever since.

This project proposes to continue the growing effort of the LIP group within RD39, by upgrading the present setup - based on, and dependent on University of Algarve equipment - to an independent measuring system fully dedicated to research activities. This upgrade is foreseen to occur during the first 6 months of the project, while a smaller scale upgrade to the cryogenic equipment is also foreseen during the second year of the project. Measurements will take place throughout the 24 months of project duration, according to the availability of the existing setup in the first 6 months, and continuously afterwards.

The contribution of this project's work to RD39 efforts will allow a deeper understanding of the silicon radiation damage mechanisms, and will help choosing the best and more radiation resistant detectors which will be used in the future LHC experiments at CERN. Moreover, it will also provide advanced training for an undergraduate and a graduate student.

Cited references:

[1] "Evidence for charge collection efficiency recovery in heavily irradiated silicon detectors operated at cryogenic temperatures", V. Palmieri et al., Nucl. Instr. Meth. in Phys. Res. A 413 (1998) 475-478
[2] "Radiation hard position-sensitive cryogenic silicon detectors: the Lazarus effect", V. G. Palmieri, M. C. Abreu, P. Rato Mendes, P. Sousa et al. (RD39 Collaboration), Physica B 280 (2000) 532-534
[3] "Charge collection efficiency of irradiated silicon detectors operated at cryogenic temperatures", K. Borer et al. (RD39 Collaboration), Nucl. Instr. Meth. in Phys. Res. A 440 (2000) 1-16
[4] "Charge collection efficiency and resolution of an irradiated double sided silicon microstrip detector operated at cryogenic temperatures", K. Borer et al. (RD39 Collaboration), Nucl. Instr. Meth. in Phys. Res. A 440 (2000) 17-37
[5] "A fast, high-granularity silicon multiplicity detector for the NA50 experiment at CERN", B. Alessandro, P. Rato Mendes et al., Nucl. Instr. Meth. in Phys. Res. A 360 (1995) 189-192
[6] "Analysis of radiation effects on silicon strip detectors in the NA50 experiment", B. Alessandro, P. Rato Mendes et al., Nucl. Instr. Meth. in Phys. Res. A 432 (1999) 342-357
[7] "Radiation damage of silicon strip detectors in the NA50 experiment", B. Alessandro, P. Rato Mendes et al., Nucl. Instr. Meth. in Phys. Res. A 419 (1998) 556-569
[8] "RecuperaÁ„o da eficiÍncia de recolha de carga de um detector de silÌcio fortemente irradiado - o efeito L·zaro", P. E. Sousa, Graduation Thesis, University of Algarve, 2000

Training program:

1 Ph. D. student, 1 graduation student

WORKING PLAN

Project Title: Monte Carlo Techniques And Detector Development Applied To Medical Physics

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Team

Project Coordinator: Luis Peralta

PhD:

Luis Peralta	40%
Maria do Carmo Lopes[ß]	50%
Maria Conceição Abreu	25%
Pedro Rato Mendes	20%

Students:

Adérito Chaves[ß]	70%
Carla Alves Oliveira[ß]	70%
Andreia Trindade	100%
Pedro Rodrigues	100%
Catarina Ortigão	100%
Patrick Sousa	50%

ß CROC IPOFG, Coimbra

Activities Foreseen:

The proposal aims are the development of Monte Carlo (MC) simulation programs in the computation of doses delivered by radiation ionization sources, and the development of solid state detectors for digital gamma-ray imaging in nuclear medicine, within the scope of the ISPA Collaboration. This is an important technological transfer from the High-Energy domain to the Medical Physics Sciences.

Monte Carlo techniques are now recognized as being an important tool in the computation of absorbed radiation doses in several medical problems. Nevertheless, many of the physicists working in these areas are not familiar to these techniques. The necessary expertise can be found inside the high-energy community, where some of the Monte Carlo simulation techniques and programs currently used can also be used in Medical Physics. As an example, radiotherapy is a field that can benefit from these techniques. The Monte Carlo technique can help in a more accurate determination of the doses effectively delivered to the target volume (tumor), thus contributing for a more effective struggle against cancer. But radiation therapy in oncology is not the only field

of application. Other techniques using ionizing radiation sources can benefit by using Monte Carlo simulation programs to compute delivered doses.

Together with MC simulations, this project proposes to develop and build a prototype hybrid gamma-ray detector for use in medical diagnosis, profiting from the know-how in detector technology acquired by the members of the research team and the opportunity given by the ISPA Collaboration at CERN. In recent years there has been a significant and continuously growing development of detectors for medical applications using technologies and techniques matured in experimental high energy physics. An example of this is the use of silicon detectors and special scintillators for X-ray and gamma-ray imaging. These materials, extensively used and applied in high energy physics environments, can provide a significant improvement in both contrast (better energy resolution) and sharpness (better spatial resolution) compared to standard medical imaging sensors, with the additional improvement of requiring lower radiation doses and the benefit of allowing an easy and straightforward digital treatment of the images, with all its inherent advantages.

During this project the know-how from a prototype currently under construction will be used for the development and implementation of a dual imaging system based on ISPA detectors, with radiation sensors for both x-rays and gamma-rays, allowing the simultaneous acquisition of high resolution morphological and functional images. The modularity of the system and the use of a single readout electronics chain will allow an easy and straightforward integration, overlapping and treatment of both images types.

Monte Carlo in the Radiotherapy

The objectives of the Monte Carlo developments for radiotherapy are: 1) MC simulation of the X-rays and electron spectra produced by the two linear accelerators, Siemens KD-2 and Varian Clinac 600C. 2) MC study of the narrow beams used in Radiosurgery. 3) Application of MC techniques in the establishment of quality control procedures for the computerized treatment planning systems. 4) Development of 3D Voxel MC for the computation of doses delivered in real cases assessed by CT image data. 5) Study of dose deposition in small fields, 6) Evolution to multi-beam plans, 7) Dose statistics studies with MC

Detectors for Medical Physics - Participation in the ISPA Collaboration

The objectives are the development and building of a working prototype dual x-ray and for gamma-ray digital imaging. This prototype will consist of a gamma camera (sensor) with embedded front-end electronics, connected to a PC with an internal control and readout card. ISPA cameras (Imaging Silicon Pixel Array) will be used as sensors and the main developments to be addressed by the team regard the testing and implementation of the front-end and readout cards, and the full instrumentation of the prototype.

Training program:

Adérito Chaves PhD . Conclusion foreseen in 2003
Carla Alves - PhD. Concluded in 2004

Pedro Rodrigues - MSc. Conclusion foreseen in 2002
Andreia Trindade - MSc. Conclusion foreseen in 2002
Catarina Ortigão – MSc. Conclusion foreseen in 2002

WORKING PLAN

Project Title: AMS

Team

Project Coordinator: Fernando Barão

PhD:
Gaspar Barreira
Mário Pimenta
Patrícia Gonçalves
Ana Mourão
J. Dias Deus

Students:
João Borges (Master)
Luísa Arruda (Master)
Fernando Carmo (Master)

AMS (alpha Magnetic Spectrometer) is a particle physics experiment to be installed in the future International Space Station Facility (ISS). The main physics objectives will be the search for Antimatter and Dark Matter. In addition, it will study the propagation and confinement of cosmic rays in the galaxy.

The capabilities of the AMS spectrometer will be improved and extended through the inclusion of the new detectors such as a RICH (Ring Imaging Cerenkov). The RICH will provide an independent measurement of the particle velocity with a goal resolution of the order of 10^{-3} . Such a resolution together with an improved measurement of the particle momenta (1% up to 10 Gev/c) due to a higher magnetic field (~0.9T), will allow an electron-proton separation up to 10 Gev/c. Moreover, the presence of the RICH will be essential for Isotopes separation.

For the year 2002 the group intends to continue the studies on the velocity and charge reconstruction. Additionally, Rich reconstruction studies will be extended to a full AMS simulation.

On the beginning of 2002, the rich prototype assembling was finished and is actually being prepared for cosmic rays data taking. It is made of 96 multi-pixel photomultipliers equipped with light guides and an aerogel radiator three centimeters thick. The Portuguese group has participated on the photomultipliers calibration and is sharing task.

Possible changes to the radiator configuration are currently being studied in order to

optimize the detector efficiency. The final configuration will be tested with the prototype.

WORKING PLAN

Project Title: Robotization of optical fiber insertion in the Tilecal calorimeter mass production

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Team:

Project Coordinator: Amélia Maio

PhD:	
Amélia Maio	25%
José M. S· da Costa	5%
Carlos B. Cardeira	5%
Agostinho Gomes	5%

Students:	
Maria de Jesus Varanda	5%
Carlos Marques	5%

Technical Staff:	
José Pinhão	5%
Rui Alves	50%
Fernando Moita Ribeiro	20%
Joaquim Oliveira	10%
Carlos Silva	30%
Américo Pereira	30%
Jorge A. Moita	90%
Joaquim Patriarca	5%
Jorge Vaz	100%

Activities Foreseen:

By the autumn of 2002 the robotized insertion of the WLS fibers into the profiles will be finished. The activities underway are the following: drilling the holes in the profiles, painting and quality control of the profiles, insertion of the fibers into the profiles and the respective quality control, delivery of the profiles with fibers to the instrumentation plants at CERN, Barcelona and United States (ANL and Michigan), and instrumentation of modules with profiles at CERN. It is expected that about 35% of the total production is done this year. It is planned to produce a video of the robot operations.