LIP

Laboratório de Instrumentação e Física Experimental de Partículas

ACTIVITY PLAN

2003

LIP-COIMBRA

Introduction

The scientific activities of LIP-Coimbra in coming years, will depend dramatically on what is going to happen in 2003. Our concerns are threefold:

In the short-term, there is a very serious financial problem, due to delays in receiving from FCT funds for projects, either those already finished or current ones (~160 k€ in January 2003).

The mid-term uncertainty deals with the late announcement of the funds allocated to the projects submitted to the "CERN Fund" in 2002, and already analysed by the Portugal-CERN Committee in November.
The main long-term concern has to do with the need for a definition of the scientific policy of FCT towards the large international institutions, particularly the Portugal-CERN agreement. Related to this general question, there is a particular need for the urgent clarification about the availability of funds to support the national contributions for the coming FP6 programmes in which we plan to participate.

We can identify two strategic aspects to concentrate on during 2003:

- The lack of post-docs in our team, mentioned in the report of 2002, is an important "bottle neck" of our activity. This depends strongly on a policy definition, as the opening of positions considered in the contract of "Associate Laboratory" is essential to the prosecution of our projects and to the strengthening of our scientific and training programmes.
- As for the definition of scientific goals, we consider that in the coming period, because of the lower activity for ATLAS (since last summer) and the end of HERA-b approaching, we should intensify our commitments with Astroparticle Physics (the collaboration with the "UK Dark Matter Collaboration" opens such a possibility), while keeping the "spin-offs" of Instrumentation for Medicine as important components of our activity.

One aspect that deserves permanent attention is the activity of the mechanical workshop. In the report of 2002 we point out that about 1/3 of the workshop activity was related to ATLAS. With the end of the "production" for ATLAS, occurred last summer, we can from now on recover from some delay in projects like liquid xenon and, at the same time, work for new projects. This is the case of the CAMCAO, with the construction starting in spring 2003, but also the (most probable) construction of one sector of the TOF wall for the HADES Experiment. Also from next year, we foresee the involvement of the workshop in the construction of parts for COMPASS, but this of course depends from the funds to be allocated to the project. Altogether, these projects guarantee that the request of services remains high, thus justifying fully the investment in personnel.

As for the equipment of the workshop, it seems wise, despite of the present economical constraints, to start upgrading very soon some of the main machine tools and improve the quality control instrumentation in order to maintain (and even improve) the quality of the service supplied. The study of such a programme, made about one year ago, should therefore be presented to the competent authorities seeking in order to find adequate financing opportunities.

WORKING PLAN

Project Title: Construction of CAMCAO – an infrared camera for the Very Large Telescope of the European Southern Observatory

FCT, Programa Operacional "Ciência, Tecnologia, Inovação" – ESO/FNU/43843/2001

Team

Project Coordinator: Armando J.P.L.Policarpo

PhD: R. Ferreira Marques

Students:

Technical Staff: J. A. Pinhão, R. Fernandes

Activities Foreseen:

Milestones for 2003:

- Finishing of the technical drawings, upon discussions with ESO and possible adjustments;
- Order parts that, due to technical constraints, have to be manufactured by the industry, namely the optical box;
- Construction of most of the parts at the LIP Workshop (~9 man.months);
- Thermal treatment (optical box and components);
- Beginning of assembly of parts (vacuum and cryogenic tests), prior to final assembly.

WORKING PLAN

Project Title: Active gaseous scintillators for detecting neutron and other radiations CERN/FNU/437735/2001 (2nd year)

Project Coordinator: Francisco Amaral Fortes Fraga
PhD Researchers : Armando José Ponce de Leão Policarpo, Rui Ferreira Marques, Ermelinda Pedroso de Lima, Maria Margarida Feteira Ribeirete de Fraga, Paulo Jorge Baeta Mendes
PhD Students: Luís Manuel Silva Margato, Susete Fetal
Ungraduate Students: Filipa Balau
Technical Staff: Americo Pereira, Nuno Carolino

Activities Foreseen:

Development of applied detectors, using active gas scintillators, with microstructures (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. Thermal neutron gaseous detectors with ^{3}He capable of high background rejection using photon counting devices for thermal neutron imaging - evaluation of light and charge signals produced by the thermal neutron capture by ^{3}He in a detector using a 10x10cm GEM. Signals will digitized with a fast scope and the correlation between the light and charge signals and the track orientation will be studied. This work will be done partially at the ILL Grenoble and is part of the PhD studies of a local student.
2. Recoil detector for fast neutrons (1-20 MeV) spectroscopy with single event energy resolution. The accuracy of the measurement of the energy deposits and angle determination are being measured with a purposely designed variable angle precision collimator system and once these results are analyzed, a readout system will be chosen. A small detector prototype will be built and we will carry out measurements at Democritos Institute at Athens on the beginning of 2004.
3. Scintillation (30x30cm) screen for 2D-dosimetry in proton radiation therapy free of quenching effects at the Bragg peak. This work will go on in collaboration with the Delft group, considering specially the correction of the GEM non uniformity and space charge effects under high flux proton irradiation.
4. Low energy track imager. We will continue our measurements towards the development of an X-ray polarimeter based on a GEM detector CCD imaging system. Also, simulation and experimental measurements on localization and track orientation using light distribution are currently being done and this technique will complement the CCD images. Our recent results using wavelength shifters using GEMs were a major point in this project.

The team is currently taking part in a the elaboration of two FP6 proposals (Advanced TPC Tracking For Particle Astrophysics, including 23 leading Institutions of Astrophysics research in Europe, and a thermal neutron detector development in the framework of the Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy, coordinated by the ILL Grenoble) and it is foreseen that the activities referred above will be continued during the years of 2004-7 with the support of the FP6 program. Several topics of these programs include strong emphasis on gaseous detectors using GEMs with optical readout.

Training program:

Luís Manuel Silva Margato : PhD. Conclusion foreseen at the end of 2003
Susete Fetal : PhD started in late 2002
Filipa Balau : Final Graduation Project. Conclusion foreseen in 2003

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, João Batista, Luis Silva

Technical Staff:

Activities Foreseen:

In 2003 HERA-B will have its last data taking run (for about two months). It is foreseen to fulfil the "priority measurements": the b-bbar cross section, the A dependence of the charmonium production, and charm physics. The HERA machine will stop in March for luminosity upgrade and detector repair activities.

The main tasks of the portuguese team for 2003 are:

RICH. Operation of the detector during the running time. This means to solve any problems that eventually arises 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.

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. New techniques of data analysis using database technologies and query languages are being developed. This effort is an important step to the usage of queries of databases within real data analysis 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 2002-3 run. The data analysis will be focused in the priority physics measurements. The portuguese group will concentrate its efforts in three tasks. The first is the measurement of the $\omega \rightarrow \mu^+\mu^-$ branching ratio, whose published value can be improved due to the higher statistics available. The number of events selected in this channel is compared with the channels whose branching ratios were already measured. 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 B meson semileptonic decays. 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, J. Carvalho, is the convener of this analysis sub-group. The different methods already developed for the luminosity determination will be applied to the new data.

Training program:

João Bastos - Ph.D. Examination, early 2003.
Vasco Amaral - Ph.D. thesis conclusion foreseen in 2003.
João Batista - M.Sc. Thesis conclusion foreseen in 2004.
Luis Silva - M.Sc. thesis conclusion

WORKING PLAN

Project title: Applications of timing Resistive Plate Chambers-II
CERN/P/FIS/43723/2001

Project coordinator: Paulo J. R. Fonte.

PHD: Paulo Fonte, M. Isabel Lopes, Rui Ferreira Marques, and Armando Policarpo.

Students: Luis Lopes, Miguel Couceiro.

Technical: Alberto Blanco, José Pinhão, Rui Alves, Nuno Carolino.

Activities foreseen

This plan concerns the activities foreseen for 2003.

Developments in RPC-PET

The existing small animal PET will be fully explored. It is expected that position resolutions lower than 0.5 mm FWHM are possible.

Efforts towards a human full-body field of view TOF-PET detector will initiate.

Developments for the HADES experiment (GSI)

Counters will be built, commissioned and beam-tested in April at GSI.

Upon satisfactory results, the proposal will be reapreciated by the collaboration and, probably, the construction of only 2 sextants (~1,5 m^2) of the Inner TOF Wall will be carried out. This minimum detector will allow HADES to do physics at high multiplicity and may be within the range of available funding.

Very high rate timing RPCs

A working detector with rate capability $\geq 2 \cdot 10^3$ Hz/cm^2 seems to be within reach, already in 2003.

Aging in timing RPCs

The physical and chemical nature of the deposits found over the glass electrodes will be investigated. Other types of glass will also be tested.

Physics studies

Physics studies aiming to completely clarify the working mode of timing RPCs will continue.

Participation in the I3HP project within FP6

Our group is expected to be involved in an RPC-development JRP within the I3 Hadron Physics project of the EU Sixth Framework Program, named "NEWTOF: New techniques for time of flight particle identification in nuclear collision experiments".

Training

Luis Lopes is expected to finish his diploma work and initiate a master degree. Another student, Miguel Couceiro, will start a PhD program.

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: M. Isabel Lopes
Vitaly Chepel
José Pinto da Cunha
Paulo Mendes
Rui Ferreira Marques
Armando Policarpo

Students: Vladimir Solovov
Francisco Neves
Alexandre Lindote

Technical Staff:
José Pinhão
Américo Pereira

Activities Foreseen:

Position determination and event reconstruction in liquid xenon detectors for WIMPs search and (n,γ) reactions

To continue the event reconstruction studies and their application to both the test chamber under construction and the ZEPELIN III detector being assembled by the UKDMC;
Participation in the simulation studies of ZEPELIN III in the framework of the UKDMC;

Monte-Carlo simulation of the liquid xenon/liquid argon detector for neutron capture measurements at nTOF facility, CERN

To pursue the simulation of the performance of the liquid xenon or liquid argon detector proposed for the neutron capture cross-sections: study of the effect on the performance of the detector of the neutron background (both correlated and uncorrelated with the neutron capture in the sample).

Study of Large Area Avalanche Photodiodes (LAAPDs)

Study of LAAPDs as photodetectors for liquid xenon scintillation: linearity for different values of the bias voltage and thus of the gain, measurement of the detection efficiency in single photon regime.
Investigate the possibility of detection of ionization electrons created in liquid xenon with LAAPDs.

Studies on the transport of scintillation photons in liquid xenon

Search for experimental evidence of Rayleigh scattering of scintillation photons in liquid xenon and measurement of the mean free path of the photons associated to this process: besides its interest from the fundamental point of view, this is a crucial issue for the development of scintillation based liquid xenon detectors with 3D position reconstruction, as those recently purposed for direct WIMP search.

Large liquid xenon chamber

Cleaning the parts and assembling chamber
Leak, pressure and low temperature tests of chamber
Outgassing of chamber

Cryogenic system for chamber

Construction, assembly and tests of the cryogenic system for condensing and keeping stable the liquid xenon temperature.

The team is currently taking part in the elaboration of a FP6 proposal on "Advanced TPC Tracking For Particle Astrophysics", including 23 leading Reasearch Institutions in Europe. The activities forseen in the framework of this proposal will take place between 2004 and 2007.

Training program:

Alexandre Lindote will present his Master Thesis. He will probably start his PhD work programme in the framework of this project.
Francisco Neves will continue the work programme in view of the PhD degree.

LIP LISBOA
and ALGARVE POLE

Introduction

During 2003, LIP-Lisboa will continue its effort in collaborating with the CERN experiments where it has been present in the past years and pursue a policy of diversifying its activity outside CERN.

At CERN, LIP will pursue its involvement in LHC ATLAS and CMS collaborations, and we will be still active in DELPHI, NA50 and RD39. In space, AMS and EUSO will represent again a solid commitment. In which concerns Computing for LHC, CrossGrid will enter its second year and, at CERN, we will be in close contact with the Computing for LHC project. Medical applications and radiation hardness will continue in Lisbon and Algarve.

Also, the project Silicon Detectors will enter its second year and concerning Outreach will have a focal point in the Cosmic Ray Project for Secondary Schools (CIÊNCIA VIVA).

New areas of interest or of increased interest are described below:

- As a consequence of LIP involvement in the space projects, ESA has contracted LIP to develop the GEANT4 simulation package relevant to space activities. ESA will contribute with 50.000€ to this project.

- LIP is a full partner in the international consortium that will present the proposal "Enabling Grids for E-Science and Industry in Europe" (EGEE). This proposal will be presented to the 6th Framework Program of the European Union and will be the largest project in Information Technology with a total expenditure of 200 M€. LIP will contribute to the area of Quality Assurance and will be involved in Security Implementation.

- LIP has been accepted as a member of the CERN Compass collaboration where the heavy-ion LIP team plans to gradually transfer the core of its present activities. This participation, however, is conditioned by the approval of external funding

- Finally, an ambitious project for Positron Emission Tomography for Mammography using technology developed at CERN has been prepared and a large consortium involving LIP Lisbon, Coimbra and Algarve, hospitals, universities and industry was established. Although the project has already been approved by the Portuguese Innovation Agency (Agência de Inovação), negotiations of the final contract are still under way (February 2003).

WORKING PLAN

Project Title: AMS

Team

Project Coordinator: Fernando Barão

PhD: Gaspar Barreira, Mário Pimenta, Patrícia Gonçalves, Jorge Dias Deus

Students: João Borges, Luísa Arruda, Fernando Carmo

Technical Staff:

Activities Foreseen:

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 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 of 2003 the group intends to continue the studies on the velocity and charge reconstruction. Additionally, the velocity and charge reconstruction algorithms will be integrated in the full AMS simulation.

The RICH prototype was tested at the CERN facility with a beam of 20 GeV/c protons and heavier nuclei. A large amount of data was taken corresponding to different conditions (radiators, expansion volume, etc.). The group is participating in the analysis of these data.

On 2003, the photomultipliers to be included on the RICH detector will be tested and calibrated. The Portuguese group will participate on this task.

Training program:
Master Thesis

Development of a velocity reconstruction method for the RICH detector of the AMS experiment, João Borges, Instituto Superior Técnico (to be presented in 2003)

Determination of the photon ring acceptance of events in the RICH and optimization of its radiator configuration, L. Arruda, Instituto Superior Técnico (to be presented in 2003)

Study of the possibility of using the light guide signal for electric charge determination in RICH, F. Carmo, Instituto Superior Técnico

WORKING PLAN

Project Title: Calorimetry for ATLAS/LHC

Team

Project Coordinator: Amélia Maio

PhD:

Amélia Maio	45%
António Amorim	5%
João Carvalho	20%
António Onofre	50%
Helmut Wolters	5%
Agostinho Gomes	100%
Viriato Esteves	25%
Manuel Maneira	4%

Students:

Maria de Jesus Varanda	100%
José Silva	100%
João Santos	10%
João Gentil Saraiva	100%
João Pina	100%
Carlos Marques	100%

Technical Staff:

José Pinhão	10%
Rui Alves	40%
Américo Pereira	40%
Jorge A. Moita	40%
Luís Raposeiro	5%

Activities Foreseen:

The activities for 2003 include the production of optical components for the instrumentation of the calorimeter modules. Relative to the aluminization of the WLS fibres and respective insertion into the profiles, we just keep the machinery ready to use for the eventuality of extra profiles being needed.
The production and quality control of adjustable connectors and patch pannels for the laser monitoring system will continue at LIP-Coimbra. The connectors and patch pannels will be installed at the modules at CERN. Long clear fibres that will connect the laser box in the electronics control room to the modules in the pit will be purchased.

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 and to get maps of the response of the modules. Some of the calibration methods require simulation of the calorimeter performance. Currently the Tilecal testbeam setup is simulated using Geant3. The setup is being implemented in Geant4. The objective for the near future is the certification of Geant4 through the comparison with events taken from the Tilecal testbeam.
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. It is also planned to measure properties of the scintillators at the lab to re-evaluate the tile-fibres light budget and the uniformity of the tiles. Additionally, we intend to prepare a setup to follow the ageing of scintillators and fibres along several years.
It is being finished a MC simulation in order to study the possibility to use the signal of the third layer of the Tilecal calorimeter to tag low p_T muons, to improve the efficiency for some B-physics channels. A new method was proposed, to gain robustness in the rejection of background. Physics studies to better determine the mass and width of the W using the Atlas detector are under way, and studies of non-standard top quark couplings started.
We will continue working in the Tilecal detector control system (DCS). Our participation involves the control of the cooling system, the setup of the distributed system and the coordination of the Tilecal DCS. We are participating in the design of the global Tilecal DCS, and will work in the implementation of the new DCS in the calibration/certification setup in building 175 (Atlas like DCS), and in the upgrade of the DCS used in the testbeam.

Training program:

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

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”, in progress

WORKING PLAN

Project Title: Collaboration in the CMS Experiment

Project Coordinator: João Varela

Introduction

Due to cost limitations, a major re-design of the ECAL electronics took place in 2002 aiming at a substantial reduction of the number of optical links. This re-design does not affect our deliverables, but implies a new cycle of prototypes to adapt to the new functionality.

The main objective of the project is then to pursue the development and prototyping work towards fulfillment of the Portuguese construction responsibilities in the CMS experiment.

We plan also to increment the activity on Physics Reconstruction software, and in particular to start the development of alignment algorithms based on information provided by the MAB optical elements. This activity is the natural continuation of the MAB project in previous years.

LIP will be involved in the development of a 40 MHz, 12-bit ADC for CMS/ECAL sub-contracting a Portuguese company.

Finally, the responsibility of the CMS Trigger Technical Coordination and CMS Detector Controls Coordination will continue to be assured.

Planned Activities:

1. Synchronization and Link Board

a). Introduction

In the year 2002 we should have concluded a long term effort aiming at a circuit for synchronization of the calorimeter trigger primitive data. This circuit is the heart of a method developed and demonstrated by LIP to achieve 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 (Vitesse 7216). A prototype SLB was built and tested successfully.

The major re-design of the ECAL electronics decided in 2002 obliges to introduce a few modifications to the synchronization circuit. In the new ECAL electronics architecture, the SLB remains a well defined item, keeping the same functionality. However a new SLB implementation, with a more compact form factor, will be needed.

b) Validation of the final version of the Trigger Synchronization circuit

The modified circuit will be subject to extensive testing, completing the work already done. Special attention will be given to BIST validation. The final BIST solution, adapted to a programmable device (FPGA) technology implementation, requires low area overhead, low speed degradation and low power BIST application.

c) SLB prototype production and testing

The new SLB PMC will be produced and tested. We do not foresee any special difficulty, based on our past experience.

The main issue remains the test and validation of the Trigger Links. Tests done in 2002 showed that a very good clock is needed, which motivated the development of a clock clean-up circuit at CERN. This circuit should be available in the beginning of 2003, allowing a new round of tests.

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).

d) 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.

e) SLB preparation for final production

The requirements for SLB production test shall be defined. The production test setup will be installed at INESC, where the full production will be tested.

f) 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, and is already adapting for the new SLB form factor. Next year some limited support will be given by our group to the HCAL activity.

3. Data Concentrator Cards

a) Introduction

The Data Concentrator Card is a 9U VME module responsible for collecting data from 68 sources, performing data selection and integrity checking, event formatting and transmission to the central Data Acquisition System. The final system will include 52 DCCs. A detailed document of specifications is already available.

Following the major redesign of the ECAL electronics system which occurred in 2002, the specifications and design of the DCC were reviewed. Relative to design developed by

our group in 2001, the new module will receive 68 optical links from the detector front-end boards (instead of electrical input) and will include an additional input stage responsible for data reduction (zero suppression and selective readout). This board will be the major component of the ECAL data acquisition system.

b) ECAL Data Concentrator prototype

The design of the new DCC card is already started, following the parameters defined by the hardware simulation (task 5). In particular the internal bandwidth is kept 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.

c) Test beam integration

The DCC module will be a key component of the ECAL test beam data acquisition system in 2003. A major effort will be needed to guarantee a successful integration in the test beam. Software for the test beam is developed in Task 4.

d) DCC testability and preparation for production

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 is now being built by our group. This module will integrate the DCC production test system. The requirements for DCC production test will be defined.

4. Readout, Control and Monitoring Software

a) DCC Test Package

The development of the DCC test package to support the DCC prototype tests will be pursued. The same package will then be extended for production tests.

b) Crate Controller Package

The development of the Crate Controller Package will be pursued. This package is a crucial element for the ECAL testbeam data acquisition system next year.

c) Software integration in the ECAL testbeam

The LIP/CMS group is participating in the ECAL test beam program. A large experimental infrastructure, including readout electronics, data acquisition, trigger, cooling, test systems, etc. is 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 behaviour of the CMS electromagnetic calorimeter will be studied in this environment.

A substantial effort has to be developed to guarantee a successful integration of our data acquisition software in the ECAL testbeam in 2003.

In parallel we will pursue the development of the JAVA-based monitoring system of the ECAL test beam setup.

5. Modelling and Simulation

In order to guarantee that the entire functionality of the system under development, 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.

The purpose of this task is to pursue the work on system-level modeling and simulation of the ECAL read-out and trigger chain, exploring new domains.

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. Physics Reconstruction and Selection

We plan to extend this activity and to integrate more deeply the efforts of the CMS Physics, Reconstruction and Selection (PRS) group. This activity should be done in collaboration with the Portuguese GRID project.

Electron and photon reconstruction algorithms is one area of interest following our past activities, in particular in the 1st level trigger algorithms.

In previous years a LIP team in collaboration with INEGI has successfully developed the engineering and prototype of carbon fiber structures of the CMS alignment system (MAB structures). The final MAB production, planned for 2003, is outside the scope of this project. Next year we plan to pursue the activity around the development of alignment algorithms based on information provided by the MAB optical elements in the framework of the physics reconstruction software.

This activity is subject to the availability of new manpower.

7. Boundary Scan

In the past two years we have built a VME based boundary scan controller board, developed the software implementing the bi-directional link between the SVF format and the VME BS controller and installed the commercial BS software adopted by CERN. Special attention was paid to the application of boundary scan to in-situ re-programming of FPGAs. Two VME test boards, emulating real readout/trigger boards, were built and used to validate our boundary scan test system.

A formal final review of the Boundary Scan test system will be conducted this year. After this step, we plan to organize in 2003 the production and test of the VME Boundary Scan Controller boards needed in the ECAL system (20 modules). A number of extra boards will be produced following the requests of other subdetectors in CMS.

8. CMS Trigger Technical Coordination and Detector Controls Coordination

The CMS Trigger Control System designates the set of interfaces, protocols and dedicated central control hardware and software modules, which aims the integration in a coherent system of the various trigger components and subdetector readout systems in the overall CMS experiment.

This integration activity is coordinated by the CMS Trigger Technical Coordinator in the framework of working groups with representatives of the various sub-detectors.

The CMS Detector Control System (DCS) is responsible to provide the tools necessary to operate the CMS detector and monitor its performance. It is organized as a coherent set of sub-systems each corresponding to the major CMS sub-detectors. The development of DCS is coordinated by the Detector Controls Coordinator.

9. ECAL 40 MHz 12-bit ADC

In the framework of the major re-design of the ECAL electronics system under way, the ECAL community has decided to sub-contract the design of IP block with a 40 MHz 12-bit ADC in 0.25 micron radhard technology. This IP block is intended to integrate an analog-digital ASIC with 4 ADCs and a dynamic digital range selector. This component will match a new 4-fold preamplifier with different gains under development at RAL, replacing the present FPPA (Floating-Point PreAmplifier) which is facing serious problems of bandwidth and noise.

LIP is participating in this new program contracting the design work to the Portuguese company Chipidea. The contract between LIP and Chipidea was established in September 2002. LIP and CERN will follow the design work. The production of the test samples as well as the final production will be organized by CERN, under a special agreement to be established between LIP and CERN.

Working Plan

Project Title: Cosmic Rays Telescope - Ciência Viva

Team

Project Coordinator: João Varela LIP/IST

PhD:
Fernando Barão LIP/IST

Technical Staff:
Miguel Ferreira LIP
José Carlos da Silva LIP
José Carlos Nogueira LIP

Summary:
The objective of the project is the construction, installation and operation of a cosmic rays detector network, interconnected by the internet, covering a number of secondary schools. The detector network allows the measurement of the characteristics of high-energy particles impinging our planet, looking for correlations between data collected by the network stations.

Project Goals:
1. To reinforce experimental physics teaching in secondary schools, using relatively simple research equipment;
2. To introduce front-line research topics in particle physics, astrophysics and cosmology to secondary school students, based on an experimental approach;
3. To promote a practice of collaboration between researchers and secondary school professors;
4. To give secondary school students an opportunity of participation in a scientific project.

Scientific Motivation:
The observation and measurement of high energy particles impinging the Earth is a recent research topic, which has motivations both from cosmology and particle physics. The origin of very high energy cosmic rays ($>10^{18}$eV) is unknown and mysterious. Gigantic cosmologic events, like collisions of galaxies, relics of ultra-heavy particles created in the first moments of the Universe expansion or large scale topologic structures in the universe have been proposed to explain its origin. However, none of these models fully account for the observations.

Several large scale scientific projects (Auger, Euso) are now in construction or in preparation to study the phenomenon in more detail. Our project fits in this context, mimicking in a smaller scale these large research enterprises. Very high energy cosmic

rays can be detected by the Cosmic Ray Telescope providing an opportunity for confrontation of results.

Participating Institutes:
Escola Secundária D. Pedro V
Escola Secundária Gomes Ferreira (Benfica)
Escola Secundária Gil Vicente
Escola Secundária Maria Amália Vaz de Carvalho
Escola Secundária da Amadora
Escola Secundária Herculano de Carvalho
Escola Secundária Paço de Arcos
Escola Secundária Mem Martins
Escola Secundária Diogo de Gouveia (Beja)
Escola D.Manuel I (Beja)
IST- Instituto Superior Técnico
LIP- Laboratório de Instrumentação e Física Experimental de Partículas

WORKING PLAN

Project Title: Collaboration in the COMPASS experiment

Team

Project Coordinator: Paula Bordalo

PhD:	Paula Bordalo	LIP Researcher / IST Professor	60%
	Sérgio Ramos	LIP Researcher / IST Professor	60%
	Catarina Quintans	LIP Researcher	83%
Students:	Student	PhD Student	100%
Technical Staff:	Engineer	Software engineer	100%

Our LIP-Lisbon group has been accepted by the COMPASS Leader Board to become a member and is thus participating in COMPASS activities at CERN since September 2002. COMPASS Leader Board has also attributed to LIP members the full responsibility of the Detector Control System (DCS) of the experiment, which was very slow and not reliable. In this context, LIP-Lisbon members already took part in the last month of the COMPASS data taking period, in order to get acquaintanced with the experimental setup and to make a first evaluation of the existent DCS and to study ways to improve it.

Activities Foreseen:

The main tasks the LIP-Lisbon group intends to carry on are the following:

- to redesign the COMPASS Detector Control System, in order to meet the Collaboration requirements concerning reliabitily and speed;
- to integrate the missing detectors in the slow-control system;
- to participate in the four months data taking period of 2003;
- to participate in the offline effort, namely in the development of the analysis tools, and in the first technical studies (alignments, acceptances, efficiencies).

WORKING PLAN

Project Title: Collaboration in the DELPHI experiment at CERN

Team

Project Coordinator: Mário Pimenta
Representative to the DELPHI Collaboration Board: Pedro Abreu

PhD:

Mário Pimenta,	30%
António Onofre,	35%
Pedro Abreu,	60%
Maria Catarina Espírito Santo,	25%
Bernardo Tomé,	25%
Patrícia Gonçalves,	25%

Students:

Sofia Andringa,	100%
Nuno Anjos,	100%
Nuno Castro,	100%
Filipe Veloso,	100%

Technical Staff:

Activities Foreseen: *Analysis of DELPHI data*

In 2003, the analysis and extraction of the best results from the DELPHI data will proceed, after the last reprocessing of the complete datasets in 2002, towards the final publications.
In most of the channels and analyses the final papers are already in advanced stage of preparation, and in some cases review papers have started. Nevertheless there is room and opportunities for new ideas to pop up and new analyses to be launched. DELPHI is still one of the most active LEP Collaborations, and the data collected in the eleven years of LEP operation are still the best clean sample needed in many analyses, for many years to come. DELPHI has also started to develop methods to save the data and analyses programs in a format easily accessible in the future.

LIP members of the DELPHI Collaboration have taken important responsibilities in the Collaboration, namely the coordination of two main areas of research ("Research Lines"), *Searches for New Exotic Physics* and *QCD*. While the former addresses the searches in non-standard topics (not standard model Higgs and not Supersymmetric models, but basically all other possible extensions to the Standard Model), the later aims at the very precise measurements of standard and/or exquisite properties of Quantum

ChromoDynamics. The discussion of physics analysis in DELPHI proceeds in Physics Teams (within Research Lines), of which several are coordinated by LIP members. The combination of the DELPHI results with the other LEP experiments takes place in special groups, the LEP Working Groups, aiming at extracting the most precise results from the bulk of the LEP data. Several LIP members are representing the DELPHI Collaboration in these LEP Working Groups.

In the following, the plan of activities is detailed by subject.

Searches:

The LIP DELPHI members are convenors of 6 Physics Teams – SUSY/LSP, Flavour Changing Neutral Currents, Fermiophobic Higgs bosons, Heavy and Excited fermions, Leptoquarks and Collinear photon-photon – and one Research Line – Exotica. They also participate in the LEP Higgs, LEP Exotica and LEP Electroweak Working Groups.

Search for non fermionic neutral Higgs boson
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 Supersymmetric (SUSY) particles
In the framework of the Minimal Supersymmetric extension to the Standard Model (SUSY), assuming R-Parity conservation, the lightest supersymmetric particle is stable, and the selection criteria employed depends primarily on the masses of the particles probed, and the mass differences with respect to the lightest supersymmetric particle.

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 level 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 coloured 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 4th Generation b'-quarks

Data collected at LEP 1 has excluded the possibility of an extra family of particles with mass less than half of the Z boson mass and coupling to the Z boson. However, for masses above $M_Z/2$, the regions excluded become strongly model and analysis dependent. A natural and simple general extension is an extra family of particles, and a quark of bottom type, *b'*, is searched for in this new analysis.

Search for $\gamma\gamma(\gamma)$ events

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

QCD:

The LIP DELPHI members are co-responsible of the QCD Research Line and participate in the LEP QCD and W Physics Working Groups.

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 difference of the number of charged particles produced in hadronic events initiated by heavy quarks, with respect to the events initiated by light quarks, should be only dependent on the mass of the fragmenting primary quarks. LEP 2, with its very broad range of centre of mass energies from 130 to 209 GeV, along with the precise measurements from LEP 1 at centre of mass energy around 91 GeV, and with powerful b-tagging techniques available in DELPHI, gives a marvellous set of data to make comparisons at different centre of mass energies, using always the same detector and thus reducing systematic errors, and allows the exclusion of more naïve models.

Charged particle multiplicities and inclusive distributions

The study of inclusive charged particle distributions has enabled to test with great precision the predictions of QCD for the evolution with energy of several observables, among them the mean and the dispersion of the charged multiplicity distributions. The ratio of these two and its evolution with energy, from 80 GeV (in WW events) to 209 GeV in qqbar events, enables also to test the 30 year old scaling property proposed by Koba, Nielsen and Olesen (1972).

Colour Reconnection effects in events containing a pair of W bosons

The W bosons are produced in pairs at LEP2, and may both decay hadronically, in the very short lifetime of 3.1×10^{-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 evolving hadronic systems to interact with each other, at the parton or at the hadron level. Begin a challenging probe to understand the properties of QCD, this effect needs also careful study in order to assess the modifications to the reconstructed W boson mass in the fully hadronic channel. We are working in this area in tight cooperation with the other LEP experiments.

Review of DELPHI QCD results

One of the ambitious projects launched recently in DELPHI, is the preparation for publication of a review of all the results in the QCD area of research, that enables for a reader to find in one paper the most important results in this area. Sometimes, a result in some analysis was superseded in a more recent published paper, but without an obvious relating title, and thus difficult to be found by the unaware reader. In this final publication, it is expected to have also the latest results, collected at the highest centre of mass energies, that in themselves do not constitute material original enough to make a standalone publication. A LIP member is co-responsible of the QCD/Softer section.

Training program:

Within the LIP/DELPHI group, there already presented and defended with success a total of 3 graduation thesis, 9 Master thesis or equivalent reports and 9 PhD thesis.
We still have in progress two PhD thesis and two Master thesis:

"Exotic Higgs at LEP II" – PhD thesis – Sofia Andringa, conclusion foreseen in 2003.

"Hadronic final states at LEP II" – PhD thesis – Nuno Anjos, conclusion foreseen in 2003/04.

"Search for 4^{th} Generation *b'*-quarks in the DELPHI experiment" – Master thesis - Nuno Castro, conclusion foreseen in 2003.

"Search for single top quark production at LEP via four-fermion contact interaction at $\sqrt{s}$=189-209 GeV" – Master thesis - Nuno Castro, conclusion foreseen in 2003.

WORKING PLAN

Project Title: Collaboration in the EUSO experiment

Team

Project Coordinator: Mário Pimenta

PhD:

Mário Pimenta,	50%
Maria Catarina Espírito Santo,	55%
Pedro Abreu,	40%
Bernardo Tomé,	40%
António Onofre,	10%
Luís Melo,	10%
Pedro Brogueira,	10%
Jorge Gomes,	10%

Students:

Pedro Assis,	100%

Technical Staff:

Activities Foreseen:

The participation of Portugal in EUSO is a responsibility of LIP – Laboratory for Instrumentation and Particle Physics. EUSO is until September 2003 in the so-called phase A of ESA, which should establish the requirements and feasibility of the project, addressing aspects ranging from the detailed instrument design to its installation and operation on the ISS. According to the schedule foreseen, phase A will be followed by a Phase B of approximately 2 years, dedicated to the detector design and to the conception of testing of prototypes; a Phase C/D of approximately 3 years, dedicated to the final detector design, construction, testing and calibration. The EUSO experiment will be accommodated on the ISS in 2008/2009, for a nominal period of three years.

The main activities of the LIP/EUSO team are:

- Coordination of the EUSO Science Operations and Data Centre Subsystem (SODC), addressing the issues of data collection, monitoring, certification, distribution and archiving. The main topics for the SODC phase A study are: identification of the Columbus/ISS operation context; preliminary evaluation of data volumes; identification of the operation modes and procedures; conceptual design of the ground data handling facilities; preliminary planning of archives and databases; preliminary evaluation of costs and manpower.

- Participation in the program of calibration activities studying different parameters that are critical for EUSO. The project ULTRA – UV Light Transmission and Reflection in the Atmosphere – is based in a hybrid system consisting of an UV optical detector and an array of scintillators. The development of the GPS-based position determination and synchronisation system is a responsibility of the Portuguese group. The group is also involved in the analysis of the data collected by the BABY balloon and is interested in the fluorescence yield measurement to be performed in an accelerator beam (McFly).

- Participation in simulations and analysis software development and in education and public outreach programs.

In the following the planned activities will be described by subject.

SODC – Scientific Operations and Data Centre

The EUSO Science Operations and Data Centre (SODC) constitutes the EUSO scientific Ground Segment that will ensure the scientific mission control and planning and addresses the issues of data collection, monitoring, distribution and archiving. The design of the SODC depends critically on all the aspects that influence the types and the volumes of data. EUSO will operate in different modes collecting several types of scientific data. The need to characterize the atmosphere may lead to important volumes of ancillary data from atmospheric sounding. In the SODC, telemetry is received, processed and monitored. Mission activity planning is carried out, taking into account the safety of the instrument and the scientific requirements, and leads to the generation of command sequences for uplink, which are prepared and verified. Autonomous operations imply a particular care with ground based test and validation facilities for software and commands. The mission archive, user interface and interface to external databases are maintained. The SODC life cycle will accompany the mission life cycle and can be generically divided into the following phases: definition, design, implementation, validation, commissioning, in-flight operations and post-operation. The SODC should in all phases provide adequate support to the user community.
In 2003, the definition of the requirements and structure for the SODC will be completed, as part of the Phase A study. The operational SODC will eventually be located in one of the participating European countries, with Portugal being a potential host. The proposal of Portugal as a possible geographic location will be developed during this study phase.

ULTRA – Uv Light Transmission and Reflection in the Atmosphere

As part of the calibration activities envisaged for the EUSO experiment, ULTRA aims at measuring the diffusion coefficients at the Earth's surface for the Ultraviolet light, as emitted by the fluorescence of nitrogen in the atmosphere due to the passage of cosmic rays. It consists of a ground array of scintillators, to count the incoming particles from the shower produced by the interaction of the cosmic ray with the atmosphere, and a Ultraviolet optical system to measure the Ultraviolet light reflected in the Earth's surface. The LIP team is taking care of the data acquisition of the experiment. A system for determining the time of arrival of the shower, in each cell, and the precise position of the cells of the array, is currently being developed. This system uses GPS receivers and a

board with 6 analog acquisition channels, to perform the acquisition, shaping, amplification and digitisation of the signals, and implements several online trigger conditions. The first physics run of the experiment is foreseen for June 2003, at Mont-Cenis in the French Alpes.

BABY – Balloon experiment for background measurements

A detector with eight photomultipliers, with different wavelength filters, was successfully flown in a balloon in 2002 over the Mediterrean Sea. The data is being analysed, with collaboration of LIP members, and the possibility of new flights is being considered.

McFly – Measurement of the Fluorescence Yield in Air

The McFly project aims at measuring the fluorescence yield in air as a shower of charged particles passes through. In 2003, the possibility of setting up a small system, in an accelerator beam at CERN, Geneva, Switzerland, will be studied. The system envisaged consists of a chamber, filled with air under controlled conditions (pressure and temperature), a subsystem to collect the ultraviolet light produced, and a pre-shower for producing a shower of charged particles. One hopes to study the dependence of the light produced with pressure, temperature, energy and intensity of the incoming beam, etc.

Atmosphere Sounding – Studying the Atmosphere properties as an active medium

The knowledge of the atmosphere properties, in particular of the presence and height of clouds, which may obscure part of the fluorescence signal and of the _erenkov signal, are crucial for the accurate measurements of the cosmic ray energy and arrival direction.
In 2003, it is planned to study a complementary system for cloud detection, consisting of one or two infrared cameras, with significantly different filters for temperature measurement and validation of the results.

Public Education and Outreach

The education and public outreach activities will play an important role in this period, covering both science (cosmic ray physics, EUSO) and general aspects related to space (ISS, ground operations). The target audience will be general public, teachers, university and high school students. The EUSO experiment is a project of fundamental science that implies, simultaneously, technical development in the area of electronics, software and detection. The public outreach potential of the EUSO mission is, thus, very high and immediate.

Training program:

“Data Acquisition system of the Ultra experiment” – Master thesis – Pedro Assis. Conclusion foreseen in 2004.

WORKING PLAN

Project Title: Radiation Interaction Simulation Tools for ISS High-Energy Astrophysics Experiments EUSO and AMS

Team

Project Coordinators: Mário Pimenta and Bernardo Tomé

PhD:

Mário Pimenta,	20%
Maria Catarina Espírito Santo,	20%
Bernardo Tomé,	35%
Patrícia Gonçalves,	20%

Students:

Pedro Rodrigues,	10%
Andreia Trindade,	10%

Activities Foreseen:

During the past twenty years, several programs have been developed for radiation transport simulation, such as the EGS4, MCNP4 and GEANT3 codes. GEANT3 has been a reference in the high energy physics experiments. However, to cope with the needs of the next generation of experiments, an entirely new program, GEANT4, was developed. GEANT4 was built using advanced Software Engineering techniques and Object Oriented technology to achieve the transparency of the physics implementation, providing functionalities and a flexibility that made it widely used by the nuclear, accelerator, space and medical physics communities.
The GEANT4 code has several enhanced capabilities in optical photon production and tracking. Optical photons inside GEANT4 are produced when a charged particle traverses a dielectric material with velocity above the Cherenkov threshold, in scintillating material or by transition radiation process. At optical wavelengths, photons undergo three kinds of interactions: elastic (Rayleigh) scattering, bulk absorption and medium boundary interactions (reflection and refraction). The boundary surface models have been enlarged in comparison with GEANT3 and different surface finishing descriptions are possible.

The following paragraphs detail the plans for GEANT4 LIP activities during the year 2003 in applications related to EUSO and AMS.

Framework design, simulation cross-checks and improvements

Design of a dedicated framework for space applications based in GEANT4, integrating simulation, reconstruction and data analysis capabilities. Different analysis tools and persistency options will be evaluated and tested. A prototype version or proof-of-concept version will be used to cross-check with the previous GEANT3 based simulation packages. These milestones constitute the starting point and will allow the framework development with new tools and features needed to extend the activities to a wide range of space applications.

EUSO Analysis and Simulations

EUSO is basically a UV telescope looking downwards to the Earth in moonless nights. The performance of the optical system, its evolution during the mission lifetime and the accurate estimation of the UV background light sources are therefore crucial. In the framework of this proposal, the specific issues of the effect of the deposition of a layer of condensed material in the surface of the lens and of the light production by the interaction of trapped particles, via Cherenkov effect or scintillation, as a function of the ISS orbit, will be considered.
The ULTRA project aims at measuring the UV light diffusion coefficients at the surface of the Earth, in the framework of the EUSO supporting experiments .
The GEANT4 based full simulation of one of the ULTRA ground array detectors is foreseen.

AMS Radiator and Light Guide Simulations

RICH's are complex detectors which performance depends critically on the correct modelling of the light production, transmission and collection. The final design of the AMS RICH detector is now under optimisation. The possibility of having two radiators of different refraction indices is being considered. Small light guides will match the focal plane surface. In the framework of this proposal detailed simulation of both radiators and of the light guides will be made. The issues of light production, propagation, attenuation and multiscattering inside the radiator will be addressed..

WORKING PLAN

Project Title: Low Energy Bremsstrahlung Models for GEANT4

Team

Project Coordinator: Luis Peralta

PhD:

Luis Peralta	25%

Students:

Andreia Trindade	40%
Pedro Rodrigues	40%

Activities Foreseen:

The project objective is the development of low energy bremsstrahlung models for the GEANT4 package. The GEANT4 code is developed by an international collaboration where CERN is one of the main partners. This project is the first participation in the work of the GEANT4 collaboration

The bremstrahlung cross-section formulas and related data have been reviewed by Koch and Motz in a paper (RMP V31, 1959, 920). Different approaches are presented in this paper, with different accuracies and range of validity. These different scenarios where classified by Koch and Motz according to their physical approximations. Most of the general purpose Monte Carlo packages adopt one of these approximations in their codes, namely the 2BS approximation (2 dimensional, Born Screened potential). When migrating from GEANT3 (Fortran 77 code) to GEANT4 a simplification of GEANT3 bremsstrahlung generator have been adopted. This parameterization is faster and gives a better agreement with the so called Koch and Motz 2BS (2 dimensional, Born Screened potential) angular distribution for 20-100 MeV electrons. Nevertheless it has been known for sometime that the 2BS distribution gives rise to a wrong angular photon distribution for energies below 500 keV. This is severe problem for low energy applications (like the applications in medicine) where the generation of low angle bremsstrahlung photons can be greatly overestimated. In the Koch and Motz paper a more accurate distribution 2BN (2 dimensional, Born Non-screened potential), which agrees well with data down to much lower energies, is also described. This distribution presents technical difficulties in its Monte Carlo implementation which results in a much slower code.

Our aim is to implement in GEANT4 a module to simulate the bremsstrahlung emission according to the 2BN distribution, but with a faster algorithm, than the sampling

algorithm used by other codes. To achieve this goal a set of alternative algorithms will be studied. The implementation of the 2BN distribution in GEANT4 will be an important improvement in the code for Low Energy applications

Objectives

We propose to contribute to the activities of the Geant4 Low Energy Electromagnetic PhysicsWorking Group(s).

The project objective is the development and implementation in GEANT4 of a more accurate Bremsstrahlung generator for low energies. This project is a first commitment with the GEANT4 collaboration at CERN. We aim for a more deep participation in the GEANT4 collaboration activities in the future.

The Geant4-related projects as are now foreseen are:

1. Development of a Low Energy Bremsstrahlung Model
2. Testing of the algorithm with available experimental data

Programme of work and timescale

Work on the projects will start at 01/01/2003

2003 – Program development and testing

2004 and on – Program maintenance and development of other Low Energy applications/enhancements

WORKING PLAN

Project Title: The GRID paradigm: processing and transmission technologies for physics experiments

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Team

Project Coordinator: Jorge Gomes

PhD: Mario David, Luis Bernardo

Students:

Technical Staff: João Martins, José Aparicio

Activities Foreseen:

The LIP Computer Centre team will continue deeply involved in grid research and deployment activities in the context of both the CERN project LHC Computing Grid (LCG), and the European Union projects CrossGrid and DataGrid.

There shouldn't be a major change in the areas of involvement. Therefore LIP will continue maintaining a local grid infrastructure integrated in the international testbeds of DataGrid and CrossGrid. The LIP Computer Centre will continue to provide and maintain the central production and validation services for the CrossGrid project. Also in the CrossGrid context the involvement in the Certification Authorities work group, integration team and security group will continue. The participation effort in the test and validation tasks as well as testbed support and integration will increase as result of the expected testbed extension and also due to the release of the first CrossGrid middleware, tools and applications.

The development emphasis for the LIP participation in the second year of CrossGrid will be put on critical issues such as network QoS, parallel scheduling, stress testing of the testbed infrastructure, deployment of the development testbed, improvement of the statistics and test software and improvement of site installation and configuration methods and tools.

In DataGrid the participation will be centered on testbed integration and compatibility issues that may appear with the new Globus Toolkit release. The test and validation of middleware in collaboration with DataGrid will continue. The participation in DataGrid and CrossGrid will be coordinated with LCG in order to maximize the resources available.

At national level LIP will deploy a second grid site infrastructure at the Coimbra facilities. The site will be integrated in the CrossGrid validation testbed, and used in the

context of the test activities. These activities will include test of grid middleware and MPI applications with QoS.

LIP will also contribute in the measure of its possibilities to the dissemination and deployment of grid technologies in the country.

LIP is involved in the EGEE proposal to the EU sixth framework. The aim of EGEE is to deploy Grid technologies to enable the widespread uptake of e-Science applications throughout the European Research Area. EGEE will be focused on: establish a European wide Grid infrastructure for science and industry, integrating Grid technological developments and expertise. The project will be managed and coordinated by CERN.

In EGEE LIP is mostly interested in pursuing activities that follow up to the ones performed inside CrossGrid covering the areas where know-how and expertise are locally available and therefore where a better contribution can be provided. These areas are in a first approach: testbed quality assurance and security. LIP is currently involved in the preparation of the proposal.

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[1]	50%
Maria Conceição Abreu	25%
Pedro Rato	20%

Students:

Adérito Chaves[1]	70%
Carla Alves Oliveira[1]	70%
Andreia Trindade	50%
Pedro Rodrigues	50%
Catarina Ortigão	100%
Patrick Sousa	75%
Marco Quinteiro	50%
Sónia Rodrigues	25%

[1] CROC-IPOFG

Activities Foreseen:

The project aims are the development of Monte Carlo simulation programs in the computation of radiation transport problems applied to medicine, and the development of solid-state detectors for digital gamma ray imaging in nuclear medicine.

Dosimetry of radiosurgery narrow beams using Monte Carlo simulations

Dose measurements of narrow photon beams used in radiosurgery are complicated by the lack of lateral electron equilibrium which is a requirement namely for ionometric methods. The details of basic dosimetry for these narrow beams are still quite unknown. To overcome this difficulty Monte Carlo simulation is a privileged tool to assess the processes of the energy deposition phenomena in such narrow photon beams. Several simulations had already been performed to calculate percent depth doses in a water phantom of the narrows beams used in our hospital (Centro Regional de Oncologia de

Coimbra-Portugal) and the agreement with experimental data was good. More specific analysis using anthropomorphic phantoms is under way.

Dosimetry in prostate braquitherapy using Monte Carlo simulations

The treatment of prostate cancer can be done using radioactive seeds, implanted in the tumour. This technique rises several interesting problems since the prostate is an organ that changes its volume during the treatment. Using radiography or echographic images it's possible to get information on the seed's location after implantation, and thus a more accurate dose computation will be possible.

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 Design of electronics cards for detector front-end and data readout

The set-up at CERN used for testing and characterising the radiation detectors consists of a full-custom front-end readout card, a VME-based data acquisition board and a Linux workstation, together with several low and high-voltage modules and cables. This laboratory set-up is very useful for testing but it is obviously too large and complex to allow an easy portability and installation, for instance, on a clinical environment. With the purpose of having a portable and compact detector system, a new readout has been designed within the ISPA Collaboration, consisting of full-custom front-end and data acquisition boards. This solution is being implemented. Our timetable is to start the tests of the ISPA camera with small animals in the beginning of October, 2003.

Training program:
Catarina Ortigão, PhD thesis – Conclusion in 2007
Adérito Chaves, PhD thesis - Conclusion foreseen in 2003
Carla Alves, PhD thesis - Conclusion foreseen in 2005
Patrick Sousa, PhD thesis – Conclusion foreseen 2005
Pedro Rodrigues, PhD thesis – Conclusion foreseen 2006
Andreia Trindade, PhD thesis – Conclusion foreseen 2006
Marco Quinteiro, Master Thesis – Conclusion foreseen 2004

WORKING PLAN

Project Title: Collaboration in the NA50 experiment

Team

Project Coordinator: Paula Bordalo

PhD:	Paula Bordalo	LIP Researcher / IST Professor	35%
	Sérgio Ramos	LIP Researcher / IST Professor	35%
	Catarina Quintans	LIP Researcher	17%
	Pedro Rato	LIP Researcher	17%
	Ruben Shahoyan	LIP Researcher	17%

Students:	Teresa Claudino	PhD Student	100%
	Helena Santos	PhD Student	100%
	Gonçalo Borges	PhD Student	100%
	João Cruz	LIP Research Assistant	25%

Technical Staff:

Activities Foreseen:

The LIP-Lisbon group working program concerning its participation in NA50 Collaboration will continue to focus on carefull analyses 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 and S-U interactions
- Study of charmonia suppression in lead-lead collisions
- Study of the dimuon continuum production, namely its Drell-Yan and charm components, in lead-lead collisions
- Study of vector-meson multiplicities in ion induced reactions.

WORKING PLAN

Project Title: Development of radiation hard silicon detectors

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Team

Project Coordinator: Pedro F. P. Rato Mendes

PhD: Maria da Conceição Abreu, Pedro Rato Mendes

Students: Patrick Sousa, Sónia Rodrigues

Technical Staff: Dário Passos

Activities Foreseen:

During year 2003 it is foreseen to continue the work program exposed in detail in the Status Report, namely the study of heavily irradiated silicon diodes through the measurement of the charge collection efficiency (CCE) and other device characteristics.

The set of samples under study includes oxygenated, edgeless, Float-Zone (FZ) and Czochraslki (CZ) grown devices, with the objectives of better understanding the radiation damage processes in silicon, and of devising the best radiation-hard material for tracking detectors in future high-luminosity colliders.

The data collected are analysed and discussed within the RD39 Collaboration, adding to further development and refinement of the Lazarus Effect [1] and its theoretical modelling [2], validating CCE measurements at low temperatures also as a precise technique for deep level spectroscopy of defects in silicon.

Cited references

[1] V. G. Palmieri et al., "Evidence for charge collection efficiency recovery in heavily irradiated silicon detectors operated at cryogenic temperatures", Nucl. Instr. and Meth. in Phys. Res. A 413 (1998) 475-478

[2] E. Verbitskaya et al. (RD39 Collaboration), "The effect of charge collection recovery in silicon p-n junctions irradiated by different particles", invited talk at the 4th International Conference on Radiation Effects on Semiconductor Materials, Detectors and Devices – RESMDD'02, Florence, July 2002 (proceedings to appear in Nucl. Instr. and Meth. in Phys. Res. A)

Training program:

- one Ph.D. student
- one graduated student