Laboratório de Instrumentação e Física Experimental de Partículas

Relatório de Actividades

2008

Contents

Chapter 1

Overview

LIP activities in 2008 are fully described in the report that follows. Here we will summarize only a few topics.

Areas of Research:

Experimental Particle Physics

In spite of the incident that took place at the LHC, the program of LIP for 2008 was dominated by the accelerator start-up, and the CMS and ATLAS communities at Lisbon and Coimbra were highly motivated.
Obviously our commitments towards the other accelerator activities where we are involved both at CERN (COMPASS) and the GSI (HADES) were not affected and are fully described in the report. Special mention is due to the NA60 experiment, where the LIP group stopped its activities during 2008. During 8 years, the Portuguese participation in the NA60 project provided summer internships at CERN to more than 10 undergraduate Portuguese students and doctoral degrees to 3 Portuguese students.

Experimental Astroparticle Physics

During 2008 the strong involvement of LIP in Experimental Astroparticle Physics has been consolidated and reinforced. Our involvement now covers topics from Dark Matter to Neutrinos and High Energy Cosmic Rays: we are now full members of well established international collaborations.
2008 was marked by the publication by the Pierre Auger Collaboration of important scientific results and the discovery of a remarkable number of high energy cosmic ray sources.

Instrumentation and Detectors R&D

R&D activities related to the detectors continued to be centred in Coimbra where the work on gas swarm parameters was continued as well as the collaboration with the CBM experiment at the GSI. The research done in high-rate ceramic RPCs and ageing was continued. Work went on, in the framework of an FP6 project and in the preparation of an FP7 proposal with the goal of developing detectors for neutron imaging based on gaseous devices with light readout, a domain where the Coimbra team has a leading role. Contacts were also pursued in view of our involvement in large scale detector implementations in HEP (High Energy Physics). Contacts have been made to consider the continuation of our involvement in large scale detector implementations in HEP (High Energy Physics).

Medical Physics

Our involvement in Medical Physics has continued. The equipment developed by the LIP-led PET Consortium entered in clinical tests at the Instituto Português de Oncologia at Porto. The work done in Coimbra in the area of Positron Emission Tomography (PET) with an alternative approach gave encouraging results.

Computing

During 2008 LIP has completely renewed and upgraded its Grid computing facilities both in Lisbon and Coimbra. The number of CPU units, the storage capacity and the gigabit connectivity already installed puts LIP in the frontline of computing support for the LHC era.

Together with this effort LIP was responsible for the installation and is responsible for the operation of the largest computing facility ever installed in Portugal: the Grid Central Node at the National Laboratory of Civil Engineering. This implementation has been done in collaboration with FCCN (National Foundation for Scientific Computing).

Outreach, Dissemination and Training

The initiatives like CERN School for Physics Teachers, Masterclasses and Radiation and Environment are now implemented as regular activities in our laboratory.

Other:

- The Associated Laboratory: LIP has prepared during 2008 the full documentation necessary for the evaluation by an International panel to be appointed by FCT (National Foundation for Science and Technology). The continuous delay on this evaluation (already 3 years late than originally foreseen) is a matter of strong concern.
- The Consortium FISICA-N: the call for the consortium program has been postponed to 2009 by FCT. Meanwhile the four proponents of the FISICA-N Consortium (LIP, ITN, IPFN and FCCN) have already prepared all the documents needed and are ready to present a proposal when asked.
- Recruiting: taking advantage of the FCT programs Ciência 2007 and Ciência 2008 LIP was able to recruit and contract 10 senior researchers. These contracts have a 5 year term.

1.1 Sources of Funding for LIP Lisboa

Project	Code	Funding	Entity	Start	End
ATLAS	CERN/FP/83551/2008	285.000 €	FCT	2008-10-01	2009-09-30
	POCI/FP/81934/2007	225.000 €	FCT	2007-07-01	2008-09-30
CMS	POCI/FP/81930/2007	260.000 €	FCT	2007-09-01	2008-10-31
	CERN/FP/83516/2008	290.000 €	FCT	2008-10-01	2009-09-30
COMPASS	CERN/FP/83542/2008	140.000 €	FCT	2008-10-01	2009-09-30
	POCI/FP/81973/2007	150.000 €	FCT	2007-07-01	2008-09-30
	010.6/B009/2005	252.000 €	EU	2004-01-01	2008-12-31
GRID	GRID 233/7.2/C/NAC	671.125 €	FCT	2007-06-01	2009-06-30
	GRID/GRI/81842/2006	180.700 €	FCT	2007-09-10	2010-09-09
	int.eu.grid (IST-7-0 31857)	154.000 €	EU	2006-05-01	2008-04-30
	EGEE-III	307.000 €	EU	2008-05-01	2010-04-30
	EGEE-II (RI-031688)	274.888 €	EU	2006-04-01	2008-04-30
HECR	CERN/FP/83484/2008	125.000 €	FCT	2008-10-01	2009-09-30
	POCI/FP/81914/2007	125.000 €	FCT	2007-07-01	2008-09-30
	PTDC/FIS/65308/2006	155.000 €	FCT	2007-04-22	2009-04-21
MC in Medical Physics	POCI/FP/81924/2007	25.000 €	FCT	2007-12-18	2008-12-17
Mobilidade	HELEN	19.800 €	EU	2007-01-01	2008-12-31
NA60	POCI/FP/81945/2007	15.000 €	FCT	2007-09-01	2008-10-31
OUTREACH	2006-204/176	56.000 €	Ciência Viva	2007-04-01	2008-06-01
	PTP 2008 CERN	37.500 €	Ciência Viva	2008-04-01	2008-10-31
	OCJF 2008	950 €	Ciência Viva	2008-05-01	2008-09-30
PET - Mammography	PET - Mammography II	768.280 €	AdI	2007-01-01	2008-06-30
	Pet - Mammography II -b	504.344 €	AdI	2008-07-01	2009-12-31
SNO	CERN/FP/83548/2008	10.000 €	FCT	2008-11-01	2009-10-31
Space	ESA:19770/06/NL/JD	78.200 €	ESA	2006-07-01	2008-05-31
	ESA:18121/04/NL/CH	100.000 €	ESA	2006-11-01	2009-02-28
	PDCTE/CTE-SPA/81678/ 2003	69.552 €	FCT	2008-01-01	2010-12-31

1.2 Sources of Funding for LIP Coimbra

Project	Code	Funding	Entity	Start	End
Air Scintillation	CERN/FP/83527/2008	15.000 €	FCT	2008-10-01	2009-09-30
	POCI/FP/81944/2007	20.000 €	FCT	2007-07-01	2008-09-30
ATLAS GRID	GRID/GRI/81727/2006	140.000 €	FCT	2007-04-12	2010-04-11
ATLAS TDAQ	CERN/FP/83515/2008	30.000 €	FCT	2008-11-01	2009-10-31
	POCI/FP/81940/2007	95.000 €	FCT	2007-07-01	2008-06-30
GEMs	POCI/FP/81974/2007	15.000 €	FCT	2007-07-01	2008-06-30
HADES	LIP-GSI contract	414.000 €	GSI	2005-10-01	2009-09-30
	POCI/FP/81982/2007	20.000 €	FCT	2007-07-01	2008-06-30
	CERN/FP/83560/2008	15.000 €	FCT	2008-10-01	2009-09-30
	EU Contract 515876 D IRAC-Phase-1	52.000 €	EU	2005-10-01	2009-09-30
Human PET	POCI/SAU-OBS/61642/2 004	47.160 €	FCT	2005-01-01	2008-06-30
Physics at LHC	POCI/FP/81950/2007	30.000 €	FCT	2007-07-01	2008-06-30
	CERN/FP/83588/2008	35.000 €	FCT	2008-10-01	2009-09-30
RPCs	CERN/FP/83524/2008	20.000 €	FCT	2008-10-01	2009-09-30
	POCI/FP/81981/2007	25.000 €	FCT	2007-07-01	2008-12-31
ZEPLIN and n-TOF	POCI/FP/81928/2007	75.000 €	FCT	2007-07-01	2008-09-30
	CERN/FP/83501/2008	75.000 €	FCT	2008-10-01	2009-09-30

1.3 Scientific Statistical data

Project	Publications			Conferences			Semi-	Outr.	Theses			Evts.
	Jrn-I	Jrn-II	other	int.o	int.p	nat.	nars	Sem.	G	M	D	
ATLAS	1	1	4		1		1	1		1	2	
ATLAS TDAQ	1	1				2				3		
CMS	5	5	12	12			6	3				
COMPASS	6	6	5	4		3	1					
HADES	5	3	1	1	1							
NA60	1	1									1	
Physics at LHC	3	3										
GRID	2	2	13	9			3	3				5
ATLAS GRID			2	1						1		
AMS				1		2					1	
SNO	1	1										
ZEPLIN and n-TOF	5	4	1	1	2					1		
HECR	4	1	13	6			2			1		1
Air Scintillation						1				1		
Space	1	1	1		1						1	
PET - Mammography			5	2	3					1		
Human PET	1	1		1					1	1		
MC in Medical Physics	2	2	4		1	2		4	1	1		
RPCs	3	3	1	1	1		1					
GEMs												
RD51												
OUTREACH							2	19				7
Scientific Conferences and Seminars												
Totals:	41	35	62	39	10	10	16	30	2	11	5	13

Legend:

Publications:

Jrn-I: Publications in international journals with scientific peer review co-authored by LIP members

Jrn-II: Subset of publications Jrn-I in which LIP members had a major responsibility

Other: Internal notes, conference proceedings, etc. with direct involvement of LIP members

Conferences:

Int.o: Oral presentations by LIP members in international conferences

Int.p: Poster presentations by LIP members in international conferences

Nat.: Presentations by LIP members in national conferences

Seminars: Invited seminars in Institutes or Universities

Outr. Sem.: Seminars for students or general public

Theses: Theses concluded during this year (G - Graduation, M - Master, D - PhD)

Evts: Organisation of events (conferences, workshops, collaboration meetings, etc.)

1.4 Human resources (people)

Project	Researchers	Technicians	Post-Docs	Students			
				D	M	G	O
ATLAS	9	8	3	6	1	4	5
ATLAS TDAQ	10						4
CMS	3	2	6	6		3	2
COMPASS	4	2		2			
HADES	6	9					
NA60	1		1	2			
Physics at LHC	9	1	2	2	1	3	1
GRID	6	5					
ATLAS GRID	9		2	2	1	1	
AMS	3		1	1			
SNO	3	1		1			1
ZEPLIN and n-TOF	7	2	1	3	2		
HECR	13	2	1	3		1	
Air Scintillation	8	3	1			1	
Space	5		3		2		
PET - Mammography	1	3	2	2	5	1	
Human PET	11	6					
MC in Medical Physics	4			3	3	2	
RPCs	7	9					
GEMs	4	4		2			
RD51	3						
OUTREACH	12	2		4			1
Scientific Conferences and Seminars							
Totals:	79	26	14	29	15	15	13

Legend:

Students: D - PhD, M - Master, G - Graduation, O - Other

FTE: Full Time Equivalent

1.5 Human resources (FTE)

Project	Researchers	Technicians	Post-Docs	Students				total
				D	M	G	O	
ATLAS	4.25	2.31	1.90	4.02	0.22	1.75	2.42	17.00
ATLAS TDAQ	3.04						3.17	6.21
CMS	2.26	1.09	4.26	4.57		1.24	0.99	14.41
COMPASS	4.00	2.00		2.00				8.00
HADES	1.24	0.72						1.96
NA60	0.24		0.08	1.00				1.32
Physics at LHC	1.57	0.05	0.32	0.66	0.50	1.00	1.00	5.35
GRID	5.75	5.00						10.75
ATLAS GRID	1.94		0.20	0.35	0.27	0.50		3.76
AMS	0.75		0.20	1.00				1.95
SNO	0.42	0.02		1.00			0.10	1.54
ZEPLIN and n-TOF	2.47	0.39	1.00	2.88	1.50			8.24
HECR	5.40	1.05	0.80	2.90		0.16		10.31
Air Scintillation	1.05	0.40	0.16			0.81		2.42
Space	0.90		1.10		1.17			3.17
PET - Mammography	0.25	1.16	1.90	2.00	3.66	0.92		9.89
Human PET	0.55	0.24						0.79
MC in Medical Physics	1.30			1.10	0.68	1.21		4.50
RPCs	1.09	0.77						1.86
GEMs	0.49	0.22		0.50				1.21
RD51								
OUTREACH	1.63	0.24		0.28			0.42	4.45
Scientific Conferences and Seminars								
Totals:	40.59	15.66	11.92	24.26	8.00	7.59	8.10	

Legend:

Students: D - PhD, M - Master, G - Graduation, O - Other

FTE: Full Time Equivalent

1.6 Economic and Financial Situation

The financial statements of LIP, in the attached document "Relatório de Contas 2008", reflect the position of the financial year ended 31 December 2008.
As verifiable in the "Demonstração de Resultados", the activity of LIP in 2008 had an increase of about 28% in relation to the previous year.
In particular, this increased activity was due to:

- A significant increase of Fundo CERN 2007 and 2008, when compared with the recent past;
- An enlargement of FCT funding for other fields, particularly with the GRID and GAW projects, and the contract of PhDs in the Ciência 2007 Program;
- The execution of (most of) the GRID project - Central Node, and the re-equipment of the LIP Computing Centre, in collaboration with FCCN;
- The execution of most of the DIRAC project, in collaboration with ESTG of Instituto Politécnico de Leiria;
- The closure by FCT of the Medida V Projects.

It was important for this result the continuation of the PET project and the maintenance of significant European projects: EGEE III, INTEUGRID and DIRAC. Essentially, these activities within the European projects where the reason for the net result of 242 K€.
All this, coupled with the fact that FCT has settled most of the long standing debts, that practically removed the financial constraints to the steady use of funds, rendered the year of 2008 a very positive one for LIP, both financially and economically.
Despite of the increase in the overall value subsidized (with a consequent increase in the activity and the resulting record of excellent scientific results) and the financial relief of LIP, there were also negative factors conditioning the activity. In particular fort LIP-Coimbra, the lack of CERN Fund projects between July and September forced LIP to bear all costs associated with the continuation of scientific research in this period. Specifically, expenses of around 22 k€ for direct investment in projects (carefully analysed cases of payment for missions, scholarships and other costs) were assumed by LIP without reimbursement, in order to not jeopardize the ongoing work.
Particularly in the last two years, the financing support from FCT ("base" and "programmatic" components) has fallen short of current needs and LIP was just able to keep its activity thanks to surplus funds from previous years. However, since these funds were exhausted, LIP will no longer be able to do the same in 2009, raising a primary concern for next year. In addition, although the process is under way (at a low pace), to date, there have not been opened talks for renegotiation of the contract of Associated Laboratory, which ended in 2006. This overshadows the vision of the optimistic scenario that the results from 2008 appear to indicate. Also the values that the LIP can count upon for the CERN Fund projects in 2009 remain unknown at the present time. What is already known, and negative, is the decrease of EU funded projects for 2009.
Thus, it is prudent to note that, like in previous years, LIP is conditioned in the planning/budget for 2009. It would be a good practice that LIP is timely informed about the amounts of subsidies that will be allocated for the coming year(s), allowing for greater economic and financial efficiency and ensuring the steady execution of its scientific projects.

1.7 Application of Results

LIP proposes to transfer the net profit for the year 2008, amounting to 242.157 €, for the Social Fund.

Chapter 2

Particle Physics with Accelerators

2.1 Collaboration in the ATLAS experiment at CERN

2.1.1 Activity Report

Resumo:

Ao longo do ano de 2008, o grupo Português envolvido no projecto ATLAS prosseguiu as suas actividades, centradas na preparação do *commissioning* do detector ATLAS utilizando acontecimentos de Física de LHC e no *commissioning* do Tilecal. Destacamos a medição da secção eficaz do bosão W, o estudo das propriedades do quark top, a calibração em energia de jactos, a utilização de muões cósmicos e os primeiros acontecimentos do LHC para o *commissioning* do detector. As actividades de construção estão quase concluídas, com excepção do detector de luminosidade ALFA que ainda está em produção.
Na finalização da construção e instalação de componentes ópticas, ao nível do painel de ligação foi terminado o encaminhamento e identificação dos cabos de fibras ópticas de 125 m que conduzem a luz do laser (sistema de monitorização) até aos módulos do Tilecal. Os conectores foram ajustados e o sistema completo foi testado com luz de LEDs e laser. No DCS do Tilecal a máquina de estados finitos (FSM), foi actualizada na semana de *Milestone* M6, para melhor ter em conta as dependências que existem ao nível do hardware, e a partir dessa data o sistema manteve-se bastante estável.
Em 2008 iniciaram-se as operações no LHC e por isso as actividades de *commissioning* de ATLAS intensificaram-se. Tivemos responsabilidades acrescidas na tomada de dados, tanto com muões cósmicos nas semanas de *Milestone* M6 a M8 como na longa tomada de dados desde finais de Agosto a meados de Novembro, em que se tomaram os primeiros dados do LHC e infelizmente devido à avaria do mesmo tivemos que prosseguir o *commissioning* apenas com muões cósmicos. Um dos membros da equipa ocupou a posição de vice-coordenador de run do Tilecal e posteriormente a de coordenador. Entretanto continuou-se a manutenção e melhoramento do software de reconstrução TileMuonFitter, e a validação da calibração em tempo com muões cósmicos, agora complementada com a utilização de dados do feixe inicial do LHC.
Na calibração de jactos no segundo nível do trigger estudámos o desempenho da calibração estimando a resolução em energia utilizando amostras de dados *realistas* que simulam o conhecimento imperfeito do detector que teremos no início da tomada de dados. Estudámos também acontecimentos do tipo Z(->mumu) + jactos para fazer a calibração *in situ*, concluindo que o balanço das energias não é suficientemente bom para cones de 0.4 e acontecimentos de Z + 1 jacto. Foram também utilizados dados reais (muões) para o *debugging* dos algoritmos de jactos no segundo nível do trigger, nomeadamente na identificação de problemas relacionados com o mascarar de canais ruidosos e para a monitorização da escala de energia.
A nossa participação na preparação do *commissioning* da Física continuou. Para a determinação da secção eficaz de produção de W usando o canal de decaimento W->munu foi desenvolvida a estratégia para selecção do sinal e rejeição dos fundos principais a ser utilizada nas primeiras colisões do LHC. Um pequeno número de critérios de selecção foram optimizados permitindo uma eficiência de selecção de 40% para o sinal, mantendo o ruído de fundo em 9%. Ao mesmo tempo estão a ser desenvolvidas técnicas de análise multivariáveis para tentar obter ainda melhores números.
Os decaimentos FCNC do quark top (t-> qgamma, t-> q Z and t-> q g) produzidos em LHC aos pares, foram estudados utilizando a simulação detalhada do detector ATLAS. O software de análise foi desenvolvido para todos os canais, optimizando a razão sinal-ruído. Um estudo cuidado dos erros estatísticos e sistemáticos permitiu extrair limites a 95% de nível de confiança na ausência de sinal.
As actividades de I&D no envelhecimento de fibras ópticas e cintiladores plásticos prosseguiram, tendo como motivação extra os cenários de Super-LHC com níveis de radiação até 10 vezes mais elevados do que os previstos

em LHC, e um tempo de vida do detector mais extenso. As estimativas mais pessimistas de perda de luz ao longo dos anos prevêem no final do SLHC 30% da luz inicial, o mínimo necessário para o bom funcionamento do calorímetro.
Relativamente ao detector de luminosidade, ALFA, participámos na montagem e tomada de dados dos testes em feixe que decorreram no CERN em Agosto, e a partir daí, na análise dos dados, que apesar de ainda não estar concluída, já deu algumas orientações para melhorar o terceiro protótipo que está a ser construído.
O projecto inclui também uma componente de divulgação, que foi intensa ao longo de 2008, com vários dos membros deste projecto a participarem no *Master Class* organizado pela EPPOG, na escola para professores portugueses no CERN, em actividades do programa Ciência Viva para jovens estudantes do Verão e em exposições destinadas ao público em geral.

Report

The activities related with the construction and commissioning of the ATLAS detector and Physics studies proceeded. They were centred in the Physics commissioning of the ATLAS detector, with the preparation of the measurement of the W boson cross section, and top quark properties. Calibration of jets in trigger Level 2 was also studied. The commissioning of Tilecal and the complete ATLAS detector with cosmic muons proceeded. The Tilecal DCS was completed and commissioned, being now operational. The involvement in the construction of the ALFA luminosity detector and in optics ageing studies continued. The LHC started operation in September 2008 and for a few days single beam data was taken. Detailed progress in the several tasks that we are involved is reported in the following sections.

Construction and mounting of components for the Laser calibration system
The laser monitoring system for the Tilecal photomultipliers is installed at the ATLAS experimental area. Bundles of 125 m long clear optical fibres for light transport to the Tilecal extended barrel modules were produced, installed in place and tested. The connectors were cleaned, repaired and installed in the modules, and all the fibers and connectors went through a quality control procedure. A patch panel for the adjustable connectors was installed, and used to ensure the uniformity of light being sent to the different modules. Finally the routing and labelling of all the fibers in the patch panel was carried out. The complete system was tested with light from LEDs and laser. The connectors were adjusted in such a way to ensure uniformity on the light sent to each TileCal module. Some faulty connectors and fibers were repaired and the system is commissioned and working according to specifications.

Scintillating fibres for the ALFA luminosity detector
A set of more than 7000 square 0.5x0.5 mm2 scintillating fibres was aluminized in the top and sent to CERN. The respective quality control shows a gain in light output due to the aluminium mirror of the order of 70%.
We have participated in the test beam setup and data taking of the ALFA detector in August 2008. It was the first time that the full detector was tested. The test had as main objective to validate the second electronics prototype and test the detector with the final mechanical setup (the roman pot) and get data to allow the determination of the efficiency, resolution and cross talk. We are, currently, participating in the production of software for the data analysis and also in the analysis of the test beam data. There are not yet final results, but the preliminary analysis already performed already gave input for improvements in the third prototype of ALFA that is in production.

Tilecal Detector Control System (DCS)
The development, installation and commissioning of the Tilecal Detector Control System (DCS) proceeded. The FSM was upgraded again for the ATLAS Milestone Week M6 in March 2008. Several missing panels were added or corrected to have the required functionality. Several configurations were tried in order to get a better description of the hardware dependencies in the code used for the switch on and off of the Low Voltage Power Supplies and HV. The current configuration still requires about half an hour to start one partition of the calorimeter after a power cut or global switch off, but since those situations will not happen frequently and it is the only way to have a safe power on, it is acceptable. The system has been stable during the last Milestone Weeks M7 (May) and M8 (July) and is ready for operation.

Commissioning of Tilecal/ATLAS
2008 was the year of the start of the LHC operations, and so we intensified our activities in this area. We continued our work in TileCal software and calibrations from previous years, and also took on more responsibilities in terms of data-taking operations. Even if the beam running period was shorter than what everyone wished for, the activity in cosmic muon data taking with the whole ATLAS detector in combined mode was intense

and challenging, during the Milestone weeks M6 to M8, but especially in first long period of continuous 24/7 data taking operations (from end of August to early November), and several data processing campaigns.
Operations
In addition to the participation in data taking and data quality shifts throughout the whole year, we contributed for the ATLAS Operations, by taking responsibility as TileCal Deputy Run Coordinator (in October and November), and TileCal Run Coordinator (in December). This involved the coordination of the day-to-day TileCal activities at CERN, in an especially intense period in which, following the single beam period, there was 24/7 combined ATLAS running in October, and repairs/calibrations until the end of the year.
Software
Our group took a leading role in the maintenance and development of the TileCal data reconstruction software. This involved the release validation and bug-fixing of the Tile software in preparation for the centralized data reconstruction campaigns that happened in 2008 (one for each of the M6-8 weeks, and two more in September and December).
The TileMuonFitter algorithm (developed by our group) is used not only in TileCal data analysis and monitoring (online and offline), but also in combined ATLAS performance studies, in selecting regions of interest and comparisons with tracking parameters. Several developments were implemented during 2008 in this tool:

- the calculation of the energy in a cylindrical cluster around the track;
- the calculation of the path length traveled within the calorimeter, using the geometry parameters loaded from the database.
- the implementation in the ATLAS software framework of a new track fitting method based on the Hough Transform, and developed by the Rio de Janeiro group;
- adaptation of the method for almost horizontal tracks, so that it can be applied to single beam data as well, and not only for the downward going cosmic muons;
- adaptation of the framework for multi-track events, such as in beam data or in air shower events;

We also started to implement software infra-structure tools to render the conversion between transient (memory) and persistent (disk) representations of TileCal data more efficient and flexible. This involves the adaptation of existing ATLAS data structure tools to the TileCal data objects. One of the goals is to render possible the storage of a part of the raw data in the analysis files, which will be very important for the validation and data quality control of the first data.
Calibration
We have continued the work on the validation of the time calibration with cosmic ray data. A few problems in the algorithm were found and corrected, namely the removal from the set of equations of those corresponding to tower pairs with empty or corrupted data. This allowed for the determination of the timing offsets at the level of towers. While there is still a significant bias for the horizontal modules, there is good agreement, within 2 ns, with the offsets measured with single beam data for the most vertical modules . In addition, we started using the data collected with the 2008 LHC single beam run to improve the timing calibration.
And, since September 2008, our group has also taken responsibility for the creation and coordination of the TileCal Timing Calibration Task Force, convening regular meetings to discuss the analysis and establish the calibration constants updates.

Characterization of scintillators, WLS fibres and ageing
The ATLAS detector is planned to have an operational life of about 7 years (LHC), followed by about 1 year of shutdown, with a possible extension of 5 years (SLHC). The period of detector construction and commissioning spanned about 10 years. From previous measurements, the expected light loss in the fibres and scintillators due to natural ageing, is about 1% per year. So, in this extended operation scenario, the natural and accelerated ageing studies play a central role in predicting the evolution of the detector performance throughout its operational life, at the end of which the optical components will be more than 20 years old.
We followed the optical ageing, performing the optical quality control of reference fibres, aluminized and non-aluminized mass production fibres and irradiated fibres.
After following for 6 years (8 years for the reference fibres) the light output and transmission of these sets of WLS fibres, we reached these conclusions:

- The fibre-to-fibre light output variations in each group of 16 fibres are at the level of 5% or less, the typical precision level of this measurement setup, as requested for the Tilecal performance.
- Degradation on the attenuation length due to natural ageing for 4 years is lower than 5%.

- No degradation of the mirror reflectivity is observed, within the experimental accuracy of 5%.
- Global degradation, combining emission and transmission losses, for non-irradiated fibres can in some cases be up to 2% per year
- Natural ageing of irradiated fibres and fibres under mechanical stress is of the same order of the natural ageing of other fibres.

With these results, estimates of total light loss for LHC + SLHC scenarios were done, combining light loss due to natural ageing and light loss due to irradiation. In the worst case scenarios, for the most irradiated tiles, the light loss after 22 years (end of 5 year period of SLHC) is expected to be of the order of 70%. With this light loss, the number of npe/GeV is expected to be of the order of 20, the minimum needed to keep acceptable performance of the calorimeter.

Jet Calibration at the Second Level Trigger

The Second Level Trigger of ATLAS (LVL2) runs simple reconstruction algorithms with the aim of accepting or rejecting the signals provided by the first hardware trigger, in about 10 ms processing time. Given the fact that the dominant background for jets are also jets, the main difficulty of the jet trigger consists on measuring correctly the jet energy scale, with the best possible resolution, allowing to reject low energetic jets while keeping high efficiency for the jets above threshold. Therefore, the calibration is the main problem for the LVL2 jet reconstruction.

Our group is involved in the jet calibration for the LVL2.

Last year we finished the study of the performance of the LVL2 calibration on realistic data samples, that simulate the expected imperfect knowledge of the detector that we will have at the beginning of the data taking and provide a realistic estimation of our expected resolution when starting. Our results were summarized in an ATLAS internal note that was part of the ATLAS Performance Book, recently published.

We have also started developing the methods that will allow us to extract or validate the calibration constants with real data, once the LHC starts. In particular, we are studying a calibration procedure that uses events where jets are produced recoiling against a Z decaying to two muons. The energy of the Z, measured at electromagnetic scale, could be used as an estimation of the truth energy of the jet, allowing to extract the calibration constants. The first naïve approach, considering only events where there is one single jet in the event, showed that the energy balance is not good enough for the jets reconstructed with a cone of radius 0.4. All the jets in the event should be combined.

During the last three months of the year, we have used the real data taken during fall 2008 to debug the LVL2 jet algorithms. We have used mainly events triggered by a cosmic muon that interacts in the detector, leaving part of its energy in the calorimeters. These events were useful to identify problems in the masking of noisy channels or in the data unpacking. We have used them also to monitor the jet energy scale, preparing the tools to be used with collisions data, once it is available.

In fall 2008, we have also taken remote shifts as trigger experts, during the run with cosmic muons, helping to set up the procedures and the infrastructure needed for the remote shifts once the LHC starts its operation.

W->munu production cross section measurement

One of the first expected measurements at ATLAS will be the production cross sections of the electroweak bosons W,Z. Our group is involved in the preparation for these first physics studies using Monte Carlo simulated data to develop a procedure to measure the W production cross section in the decay channel W ->munu.

The work started with the optimization of the signal selection requirements and the implementation of the software tools that were necessary. It continued with the preparation of the methods to extract the muon reconstruction efficiencies (tracking, muon identification and trigger) with real data, that are needed for the calculation of the cross section. We have evaluated the performance of these methods using a realistic MC data sample, that included residual misalignments and miscalibrations as expected at the beginning of the data taking. The method was demonstrated to be reliable, providing an efficiency compatible to the one obtained by using the MC truth information. A strategy for signal selection and main backgrounds rejection (bbbar, ttbar, Z->mumu, W->taunu) in the first collisions data was prepared. A small number of selection criteria were optimized allowing 40% selection efficiency for the signal, keeping the background at 9%. Our results appeared in an ATLAS internal note and are also part of the ATLAS Performance Book.

Currently, we are continuing the studies with newer data samples that have the expected nominal ATLAS geometry. We are studying the systematic uncertainties in the estimation of the acceptance due to the MC generators and we are developing multivariate analysis techniques that will allow us to improve the signal selection efficiency while having a better background rejection.

Top quark physics
In the top quark physics, the work was concentrated in angular asymmetries and Flavour Changing Neutral Currents (FCNC) for the Compute System Commissioning (CSC) analysis which intended to establish the sensitivity of the ATLAS experiment for 1fb-1 at 14 TeV of centre-of-mass energy. The LHC will be a top factory with a total t-tbar production cross-section of around 800 pb and single top production of about 300 pb. This fact allows to measure with high precision the Wtb vertex and the couplings of the top quark. Although the double top production is insensitive to the Vtb CKM matrix element, the angular asymmetries between the top quark decay products can nevertheless give valuable information on the structure of the Wtb vertex, in particular in placing limits on the amplitude of possible anomalous couplings. For the top quark FCNC processes, the main goal is to study signals of physics beyond the Standard Model (SM) associated to top quark rare decays at the LHC. The FCNC decays t -> qgamma, t -> q Z and t -> q g, were studied in the double top production channel. The analysis software was developed for all the channels, optimizing the signal to background ratios, using a probabilistic approach. A careful study of the statistical and systematic errors allowed to extract the 95% confidence level limits in the different channels. In these studies the full simulation of the ATLAS detector was used, which implied a new level of complexity in the software development, and in the access to the generated data samples via the Grid computing and data sharing facility. The main goal was to estimate the sensitivity of the ATLAS experiment in these physics channels with the first samples of data acquired after the start of LHC. These studies were presented in several meetings and conferences, and were published as ATLAS notes and in international scientific journals.

Members in ATLAS management positions

Members of the Portuguese ATLAS team in management positions:
P. Conde Muiño - Convener of Trigger Jet slice group
A. Gomes - Tilecal DCS coordinator and member of Tilecal Management Board
J. Maneira - Tilecal Deputy /Run Coordinator (2/1 months), convener of Tilecal Timing Task force and member of Tilecal Management Board
A. Onofre - Convener of Top Properties subgroup and member of ATLAS Publications Committee

2.1.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81934/2007	225.000 €	2007-07-01	2008-09-30
CERN/FP/83551/2008	285.000 €	2008-10-01	2009-09-30

2.1.3 Team

Project coordinator: Amélia Maio

Name	Status	%of time in project
Agostinho Gomes	Researcher (LIP)	98
Alberto Palma	Graduate student (LIP)	100
Amélia Maio	Researcher (LIP/FCUL)	55
Américo Pereira	Technician (LIP)	1
António Morais	Student (LIP)	100
António Onofre	Researcher (LIP)	40
Fernando Moita Ribeiro	Technician	11
Filipe Martins	Graduate student (LIP)	25
Filipe Veloso	Post-Doc (LIP/FCT) *	60
Helmut Wolters	Researcher (LIP)	10
Inês Firmo	Graduate student (LIP)	25
Joana Miguéns	Student (LIP)	17
João Bastos	Post-Doc (LIP)	30
João Carvalho	Researcher (LIP/FCTUC)	33
João Faustino	Technician (LIP)	100
João Gentil	PhD student (LIP/FCUL/FCT)	25
João Pina	PhD student (LIP/FCUL/FCT)	100
João Santos	Master student (LIP)	22
Joaquim Oliveira	Technician (LIP)	1
Jorge Moita	Technician	14
José Maneira	Researcher (LIP)	74
José Pinhão	Technician (LIP)	4
José Silva	PhD student (LIP/FCUL)	50
Liliana Amorim	Graduate student (LIP)	25
Luís Gurriana	Technician (LIP)	97
Luís Seabra	Student (LIP)	100
Manuel Maneira	Researcher (FCTUNL)	20
Miguel Fiolhais	Student (LIP)	8
Nuno Anjos	Post-Doc (LIP/FCT)	100
Nuno Castro	PhD student (LIP/FCT)	52
Nuno Ribeiro	Student (LIP)	17
Patricia Conde	Researcher (LIP/FCT) *	75
Paulo Martins	(LIP)	13
Pedro Jorge	PhD student (LIP/FCT)	75
Rita Monteiro	PhD student (LIP)	100
Rui Alves	Technician (LIP)	3
Yuri Nunes	Researcher (LIP)	20

2.1.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *The ATLAS Experiment at the CERN Large Hadron Collider*
  G. Aad et al
  JINST 3 S08003, 2008

International Conference Proceedings

- *Commissioning of the ATLAS offline software with cosmic rays*
  J. Maneira (on behalf of the ATLAS collaboration)
  Conference Record of the 2007 IEEE Nuclear Science Symposium & Medical Imaging Conference

Internal Notes

- *Fake Missing Transverse Energy from ATLAS Calorimeter Cosmic Ray Data*
  J. Maneira, J. Gentil (+ 11 authors)
  ATL-COM-CAL-2008-002

- *15 years of experience with quality control of WLS fibres for the ATLAS Tile Calorimeter*
  M. David et al
  ATL-TILECAL-PUB-2008-003

- *Radiation hardness of WLS fibres for the ATLAS Tile Calorimeter*
  M. David, A. Gomes, A. Maio
  ATL-TILECAL-PUB-2008-002

2.1.5 Presentations

Poster presentations in international conferences

- *Hadronic Calibration for the ATLAS Jet Trigger*
  presented by Nuno Anjos
  at Physics at LHC 2008 in Split, Croacia.

Oral presentations in collaboration meetings

- *Trigger workshop preparation*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.

- *W->mu nu status*
  presented by Alberto Palma
  at ATLAS SM Meeting in CERN.

- *Trigger workshop preparation*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.

- *Discussion of the Jet Slice Feedback for the Trigger EDM workshop*
  presented by Patricia Conde
  at TAPM Jet Trigger meeting in CERN.

- *Jet Slice Feedback*
  presented by Patricia Conde
  at ATLAS Trigger EDM Workshop in CERN.

- *TileMuonFitter update*
  presented by José Maneira
  at ATLAS TileCal Week in CERN.

- *Experience with cosmics on assessing data quality*
  presented by José Maneira
  at ATLAS TileCal Week in CERN.

- *Overview of Si reconstruction and results for ALFA*
  presented by António Morais
  at ALFA Test Beam Analysis Meeting in CERN.

- *Schedule release 14*
  presented by Patricia Conde
  at TAPM Jet Trigger meeting in CERN.

- *In-situ validation of the LVL2 Jet Energy Scale with Z+jet events*
  presented by António Morais
  at ATLAS Jet Trigger Meeting in CERN.
- *L2 EDM*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *LVL2 Calibration*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *Tile analysis runs 42843, 43050*
  presented by José Maneira
  at ATLAS offline commissioning in CERN.
- *Jet Slice Report*
  presented by Patricia Conde
  at Trigger Core Software, Slices & Performance Coordination Group in CERN.
- *M6: Preliminary results from reconstructed data*
  presented by José Maneira
  at Tilecal Performance meeting in CERN.
- *L2 Calibration*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *Tile M6 analysis and re-processing status*
  presented by
  at ATLAS Offline Commissioning in Cern.
- *Status of L2 Calibration*
  presented by Nuno Anjos
  at Jet Trigger Meeting in CERN.
- *Tile M7 feedback and readiness for future runs*
  presented by
  at ATLAS offline commissioning in CERN.
- *M7 preliminary analysis: cosmic muons*
  presented by João Gentil
  at TileCal Performance meeting in CERN.
- *Tile calorimeter cosmic data analysis*
  presented by João Gentil
  at Level-1 Calorimeter Trigger Joint Meeting in CERN.
- *Comparison of L1Cal and TileTrigger events*
  presented by João Gentil
  at TileCal Week in CERN.
- *A remote DQ experiment*
  presented by João Gentil
  at TileCal Week in CERN.
- *M8 Cosmics Analysis*
  presented by João Gentil
  at TileCal Performance meeting in CERN.
- *Jet Slice Report*
  presented by Patricia Conde
  at Trigger Core Software, Slices & Performance Coordination Group in CERN.

- *Discussion on goals and taks*
  presented by José Maneira
  at Tile Timing Group meeting in CERN.
- *Tile offline reconstruction and analysis status*
  presented by José Maneira
  at Data Preparation / Data Quality meeting in CERN.
- *Timing check with cosmics*
  presented by João Gentil
  at Tile Timing group meeting in CERN.
- *Jet Slice Report*
  presented by Patricia Conde
  at Trigger Core Software, Slices & Performance Coordination Group in CERN.
- *Follow-up items from last meeting*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *Follow up items from last meeting*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *Update on cosmics*
  presented by João Gentil
  at Tile Timing group meeting in CERN.
- *Timing Strategy for Beam*
  presented by José Maneira
  at Detector Operations and Maintenance in CERN.
- *Muon 89610 Run Analysis*
  presented by Joana Miguéns
  at Jet Trigger Meeting in CERN.
- *Status report: slice expert on call*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *Status of LVL2 Hadronic Calibration,*
  presented by Nuno Anjos
  at Jet Trigger Meeting in CERN.
- *Summary of Operations*
  presented by José Maneira
  at TileCal Operations Weekly Meeting in CERN.
- *Jet Slice Work Plan*
  presented by Patricia Conde
  at Trigger Core Software, Slices & Performance Coordination Group in CERN.
- *Cosmic Muon 89956 Run Analysis*
  presented by Joana Miguéns
  at Jet Trigger Meeting in CERN.
- *Status report: slice expert on call*
  presented by Patricia Conde
  at ATLAS Jet Trigger Meeting in CERN.
- *Jet Slice Report*
  presented by Patricia Conde
  at ATLAS Trigger Open Meeting in CERN.

- *Discussion on schedule*
  presented by José Maneira
  at Tile Timing Group meeting in CERN.
- *Test beam data on the GRID, Lisbon Tier2*
  presented by António Morais
  at ALFA Test Beam Analysis Meeting in CERN.
- *Validating the LVL2 Jet Trigger Calibration,*
  presented by Nuno Anjos
  at TAPM Jet Trigger meeting in CERN.
- *TileCal time calibration with single beam*
  presented by Nuno Ribeiro
  at Tile Timing group meeting in CERN.
- *Update on cosmics timing*
  presented by João Gentil
  at Tile Timing group meeting in CERN.
- *Hadron calorimetry and jet/Etmiss, studies with data*
  presented by José Maneira
  at ATLAS Week plenary in CERN.
- *TAPM Jet Meeting*
  presented by Nuno Anjos
  at TAPM Jet Trigger meeting in CERN.
- *News from cosmic studies*
  presented by João Gentil
  at TileCal Week Performance in Rio de Janeiro, Brasil.
- *Cosmics Slice Overview*
  presented by Patricia Conde
  at ATLAS HLT Slice Monitoring Review in CERN.
- *Discussion on Timing*
  presented by José Maneira
  at TileCal Calibration Performance and Tools in CERN.
- *Status of Si reconstruction*
  presented by António Morais
  at ALFA Test Beam Analysis Meeting in CERN.
- *Summary of Operations*
  presented by José Maneira
  at TileCal Operation Weekly Meeting in CERN.

Seminars

- *Using Jets to Trigger ATLAS at LHC*
  presented by Nuno Anjos
  at LIP seminar in LIP, Lisboa.

Outreach seminars

- *A experiência ATLAS no LHC - em busca dos segredos da matéria*
  presented by Agostinho Gomes
  at in NUCLIO - Centro de Interpretação Ambiental da Ponta do Sal, S. Pedro do Estoril.

2.1.6 Academic Training

PhD Theses

- *Study of top quark decays and the structure of the Wtb vertex"*
  Nuno Castro, 2008-10-17
- *Production and decay of top quarks via FCNC at the LHC"*
  Filipe Veloso, 2008-11-12
- *O sistema de controlo do detector TILECAL/ATLAS"*
  João Pina, (on-going)
- *Measurement of the W -> mu nu production cross section with the ATLAS detector"*
  Pedro Jorge, (on-going)
- *Calibração do Calorímetro TileCal com muões cósmicos e jactos de partículas"*
  João Gentil, (on-going)

Master Theses

- *Prospects for the cross section(pp->W->munu) at ATLAS/LHC/CERN"*
  Alberto Palma, 2008-10-16
- *Measurement of efficiency and resolution of the prototype 2 fibre detector for the ALFA/ATLAS project in the LHC"*
  António Morais, (on-going)
- *Performance of the ATLAS Tile calorimeter with first beam and cosmic muons"*
  Nuno Ribeiro, (on-going)
- *Evolution of calibration and overall trigger performance using comsic muons and intercalibration in eta"*
  Joana Miguéns, (on-going)

2.1.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
International Conference Proceedings	1
Internal Notes	3
Poster presentations in international conferences	1
Oral presentations in collaboration meetings	53
Seminars	1
Outreach seminars	1
PhD Theses	2
Master Theses	1

2.2 Information Systems and Data Acquisition for ATLAS

2.2.1 Activity Report

Objectives

The main purpose is to support the collaboration in the Trigger and Data Acquisition system of the ATLAS experiment.
While the team´s work was always considered, since its beginning, very innovative and able to deliver very effective solutions, we have more recently focussed on establishing our work on the grounds of reliability, providing maintenance and user support in a very efficient manner.
At the same time the research program establishes ambitious new tasks that are more physics oriented and are mainly associated with the optimization of the alignment and calibration studies towards an efficient ATLAS trigger processing.
One main focus is to support and further develop the TDAQ applications, developed within our group, that are responsible for collecting all online control and configuration system information in a highly optimized way, and store the information in the main ATLAS databases. These are very well defined responsibilities of the team in the ATLAS collaboration. In parallel we focus on delivering an improved and redesigned ONASIC + OKS_COOL application set with more powerful and user-friendly steering and improved performance.
Another priority is the participation in the ID Calibration stream development and the contribution to the prompt calibration ATLAS facility.
The groups expertise on database systems also led to the development of the database histogram browser NODE for ATLAS. The first release of this performance demanding application has pinpointed several difficulties that will be address by the NODE2 re-implementation based on a client/server architecture that will be carried out in the framework of the present proposal.
Other goals are to fully deploy the ATLAS Offline software interfaces necessary to gain access to the information collected by the online applications developed by our team, and to support the participation in the development of specialized boards for the ATLAS First Level System electronics.
The project started more than 10 years ago coordinated by FCUL (Lisbon), and has been integrated in LIP in July 2007.

Main Achievements

The project team has a long-standing collaboration in the Trigger and DAQ system for the ATLAS experiment. Our continuous participation has accumulated expertise, understanding and deep involvement in the problems and challenges facing the ATLAS TDAQ, in particular in what relates to the database systems technologies. This work is complemented by efforts on the FLT electronics and the online alignment procedures relevant for the HLT.
The expertise that the team has gradually accumulated on the ATLAS TDAQ over several years, together with the more general knowledge on information systems, control, data acquisition and electronics, has gained the trust of the ATLAS/TDAQ community that relies on us to support and continue development of several systems that are important for the imminent ATLAS data taking.
The main tasks that reflect our responsibilities are:

1. Within the Monitoring and Configurations groups, the official support and extension of the interface for the storage at the central conditions databases of the information available online - ONASIC and ONASIC2.

2. Within the Monitoring group, the development finalization, the deployment and the support for the visualization tool for the ATLAS monitoring DB archive: NODE.

3. Within the FLT electronics group, the continuation of the deployment and testing of the programing electronics of the routing module for the ATLAS central trigger processors.

4. Within the Inner Detector and HLT communities, the continuing development and deployment of the ATLAS/ID calibration streams for TDAQ facilities.

5. Within the online Database group, the further consolidation of the group's tool for object embedding and visualization tools for LCG/COOL databases: TIDB.

2.2.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81940/2007	95.000 €	2007-07-01	2008-06-30
CERN/FP/83515/2008	30.000 €	2008-11-01	2009-10-31

2.2.3 Team

Project coordinator: António Amorim

Name	Status	%of time in project
António Amorim	Researcher (FCUL)	28
Belmiro Pinto	Researcher	100
Bruno Jesus	Student	17
Diana Urbano	Researcher (FEUP)	7
Guiomar Evans	Researcher (FCUL)	10
Helmut Wolters	Researcher (LIP)	33
Jaime Villate	Researcher (FEUP)	30
João Batista	Researcher	50
João Simões	Researcher	28
José Soares Augusto	Researcher (IST/INESC/FCUL)	10
Lourenço Lopes	Student (FCUL)	100
Miguel Oliveira	Researcher (LIP)	8
Paulo Pereira	Student (FCUL)	100
Ricardo Neves	Student (FCUL)	100

2.2.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Alignment of the Pixel and SCT Modules for the 2004 ATLAS Combined Test Beam*
  A. Ahmad et. al., including Belmiro Pinto
  Journal of Instrumentation 2008 Vol 3, P09004

2.2.5 Presentations

Presentations in national conferences

- *ID Alignment Stream at Tier0, B Physics Algorithms for ATLAS HLT, and DQ and Monitoring Histograms with NODE*
  presented by Belmiro Pinto
  at Jornadas do LIP 2008 in Luso, Portugal.

- *Interfaces para a TDAQ Conditions database*
  presented by Lourenço Lopes
  at Jornadas do LIP 2008 in Luso, Portugal.

Oral presentations in collaboration meetings

- *ONASIC / OKS2COOL Status and preparation for M6 technical run*
  presented by Paulo Pereira
  at ATLAS Configuration and Controls Workgroup meeting in CERN.

- *ID alignment stream status/plans*
  presented by Belmiro Pinto
  at FDR planning meeting in .

- *Jpsiee algorithm*
  presented by Ricardo Neves
  at B-Trigger Worgroup, phone meeting in CERN.

- *Jpsiee algorithm*
  presented by Ricardo Neves
  at Jpsiee group meeting in CERN.

2.2.6 Academic Training

Master Theses

- *1. Analise de limites ao espaço de parâmetros de modelos supersimetricos através de quebra de simetrias de carga e cor"*
  Paulo Pereira, 2008-12-18

- *1. The ATLAS Conditions Data Model and Interfaces, their use in Calibration and Alignment for Event Reconstruction"*
  Lourenço Lopes, 2008-12-18

- *1. Developments for ATLAS online data processing: quality access tools and B-physics trigger algorithms for j/Psi -> e+ e-"*
  Ricardo Neves, 2008-12-18

2.2.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
Presentations in national conferences	2
Oral presentations in collaboration meetings	4
Master Theses	3

2.3 Collaboration in the CMS experiment at CERN

2.3.1 Activity Report

Resumo:

O LIP é membro da experiência Compact Muon Solenoid (CMS) no acelerador Large Hadron Collider (LHC) actualmente em construção no CERN. O objectivo da experiência é o estudo de colisões de protões e núcleos pesados a muito alta energia. Pretende-se investigar as propriedades fundamentais da matéria e, em particular, estudar a natureza da quebra de simetria na interacção electrofraca e a origem da massa das partículas. A actividade do LIP tem três componentes principais: 1) O desenvolvimento, operação e manutenção do trigger e do sistema de leitura de dados do calorímetro electromagnético; 2) Física das colisões protão-protão, em particular a física do quark top, o estudo dos eventos W-gamma e a pesquisa de dimensões suplementares e explorando as possibilidades de descoberta proporcionadas pela energia do LHC; 3) Física de iões pesados, em particular o estudo do plasma de quarks e gluões através da análise da produção de quarkonia.

Summary:

LIP is a member of the Compact Muon Solenoid (CMS) experiment at the Large Hadron Collider (LHC), presently in preparation at CERN. The experiment will study very high energy collisions of proton and nuclear beams. The experiment scope is the investigation of the most fundamental properties of matter, in particular the study of the nature of the electroweak symmetry breaking and the origin of mass. The LIP activity has three main components: 1) Development of hardware and software for the trigger and the readout system of the electromagnetic calorimeter; 2) Proton-proton physics, in particular top physics studies, study of the events W-gamma and extra-dimension searches, exploiting the discovery opportunities offered by the new LHC energy; 3) Heavy-ion physics, in particular the study of the QGP through measurements of quarkonia production.

Project Coordination:

- Group coordinator: João Varela
  - Detector and computing coordinator: João Varela
    - DAQ/trigger coordinator: Andé David
    - Electronics coordinator: José Carlos Silva
    - Computing coordinator: Nuno Almeida
  - Proton-proton physics coordinator: Michele Gallinaro
  - Heavy-ion physics coordinator: João Seixas

Summary of Activities:

The ECAL trigger and readout electronics system reached the final commissioning phase. The final commissioning with the ECAL barrel started in June 2007 and was pursued in 2008. The LIP group has important responsibilities in the project. The Synchronization and Link Boards (SLB, 1210 boards), which are required to synchronize and transmit the ECAL and HCAL trigger data, are operational. The Data Concentrator Cards (DCC, 70 boards), used for the data acquisition of the ECAL detector (and also of the RPC detector) have been proved to work at the maximum trigger rate of 100 kHz. The group has a major role in the development and coordination of the ECAL online software, and in the commissioning of the ECAL Off-Detector electronics in the underground service cavern USC55.
The LIP group has a team of six people in permanence at CERN dedicated to the commissioning and operation of the ECAL data acquisition and online monitoring, in particular during the CMS Global Runs (cosmics runs). The group is actively participating in the commissioning of the CMS ECAL trigger system. In the last year the following tasks were undertaken: a) installation and commissioning of ECAL Off-Detector Crates in USC55; b) deployment of the online software in the underground PCs; c) integration tests with CMS DAQ and Trigger; d) developments of the data acquisition software; e) developments of the online monitoring software; f) operation and data taking during CMS Global Runs. The group was directly involved in the ECAL and Trigger operation during the first LHC beams.
The LIP group is responsible for the operation of the ECAL data acquisition hardware and software in several integration setups and test beams at CERN since 2004. In 2008, this included the final detector assembling of ECAL endcap in the ECAL Detector Integration Center, the integration tests of ECAL Off-Detector Crates

in the CMS Electronics Integration Center and ECAL Detector Calibration (H4 beam area). Activities in the off-line CMSSW software were pursued, in particular the maintenance of the ECAL raw-data unpacking software.
In the last year LIP/CMS GRID activities were focused in the deployment of the LIP Tier-2, which is a federated center between Lisbon and Coimbra sites. Following these efforts the LIP/CMS group joined the CMS Debugging Data Transfer (DDT) program and the CMS Monte Carlo production activities. Fully debugged and operational links between the Portuguese Tier-2 and other CMS Tiers (PIC and CERN) have been delivered to the collaboration. The functionality of the LHC Grid computing system as a whole was tested during the Common Computing Readiness Challenge (CCRC08). The CMS dataflow and data processing workflows were tested at the LIP Tier-2 with the available computational resources.
The preparation for physics analysis is becoming a major area of activities in the LIP/CMS group. Proton-proton physics activities at LIP include Top quark physics, W-gamma physics and Extra Dimension (ED) searches. The Top quark physics studies aim to perform a measurement of the SM and compare with expectations, in a channel with two leptons in the final state, which represents the background for the ED process. The W-gamma study aims at the test the three-boson SM couplings, in W-events with one energetic photon. The aim of the Extra Dimension searches is to exploit the potential of reaching for new physics at the LHC in a process with four leptons in the final state. The work in these topics is strongly correlated. The analysis of Universal Extra-Dimensions models (4-lepton events) was ported from the old ORCA framework to the new CMSSW analysis framework. The detailed study of backgrounds was one of the main areas of activity. The group contributed with the tau-dilepton analysis which was approved by the CMS collaboration in early 2008. The analysis of the heavy flavour content in top events is ready for approval. The LIP group was involved in developing the electron and tau identification algorithms, and estimate the background contribution directly from data.
The Heavy Ion Physics group is largely composed by elements which up to now have worked in NA60. Investigations of quarkonia production in p-p collisions were carried out in 2008, namelly the study of J/psi polarisation measurements, the study of feed-down sources of J/psi production in proton-proton and proton-nucleus collisions and the study of nuclear effects in charmonium production in proton-nucleus collisions.
In 2008, members of the group presented results in international conferences and other seminars (19 talks) and in meetings of the CMS collaboration (43 talks). Group members were main authors in 19 publications (6 papers in international scientific journals, 3 papers in conference proceedings and 10 CMS notes).
LIP/CMS group members have the following CMS management positions:

- CMS Trigger Project Manager, member of the CMS Management Board (J. Varela, convener of 45 trigger meetings in 2008)
- ECAL Data Acquisition and Trigger Coordinator, member of the CMS Commissioning Technical Board member (A. David, convener of 29 ECAL DAQ meetings in 2008)
- ECAL Electronics Deputy Coordinator (J. C. Silva).
- In 2008, A. David was also CMS Run Field Manager during CRAFT and Shift Leader during LHC first beam circulating.

A series of seminars on LHC Physics (Physics on the road to discovery) was organized in collaboration with CFTP/IST. Eight seminars by invited speakers took place in 2008.
A visit of one week by a group of master students of IST to CERN took place in 2008 organized by the LIP/CMS team. Three other outreach seminars were also organized.

2.3.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81930/2007	260.000 €	2007-09-01	2008-10-31
CERN/FP/83516/2008	290.000 €	2008-10-01	2009-09-30

2.3.3 Team

Project coordinator: João Varela

Name	Status	%of time in project
Ana Vila Verde	Student	83
André Tinoco Mendes	Post-Doc (LIP/IST/FCT)	93
Hermine Wöhri	Post-Doc (LIP/FCT)	75
João Pela	Graduate student (LIP/IST)	60
João Seixas	Researcher (LIP/IST)	50
João Varela	Researcher (LIP/FCT)	76
José Carlos Silva	Technician (LIP)	88
Marcelo Jordão	Graduate student (LIP)	60
Michal Bluj	Post-Doc (LIP)	67
Michal Husejko	Student (LIP)	16
Michele Gallinaro	Researcher (LIP) *	100
Miguel Ferreira	Technician (LIP)	21
Nuno Almeida	Post-Doc (LIP/FCT)	100
Pasquale Musella	PhD student (LIP/FCT)	100
Pedro Manuel Silva	PhD student (LIP/FCT)	100
Pedro Martins	PhD student (LIP/IST)	40
Pedro Parracho	PhD student (LIP/AdI)	100
Pedro Ramalhete	PhD student (LIP/AdI)	17
Pedro Ribeiro	PhD student (LIP/FCT)	100
Pietro Faccioli	Post-Doc (LIP/FCT)	67
Renata Rodrigues	Post-Doc (LIP)	24
Sérgio Sampaio	Graduate student (LIP/IST)	4

2.3.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Data filtering in the readout of the CMS Electromagnetic Calorimeter*
  N Almeida, P Silva, J C Da Silva, M Husejko, A Jain, P Musella, A Mendes, M Gallinaro, J Varela et al.
  J. Inst. 3 No 02 (February 2008) P02011

- *Energy dependence of J/psi absorption in proton-nucleus collisions*
  19. C. Lourenco, R. Vogt, H.K. Woehri
  JHEP 02 (2009) 014, CERN-PH-EP-2008-019

- *The Terabit/s Super-Fragment Builder and Trigger Throttling System for the Compact Muon Solenoid Experiment at CERN*
  G. Bauer et al.
  IEEE Transactions On Nuclear Science, Vol. 55, No. 1, February 2008

- *Study of psi- prime and chi(c) decays as feed-down sources of J/psi hadro-production*
  P. Faccioli, C. Lourenco, J. Seixas, H.K. Woehri
  JHEP 10 (2008) 004, CERN-PH-EP-2008-023

- *Intercalibration of the barrel electromagnetic calorimeter of the CMS experiment at start-up*
  The CMS Electromagnetic Calorimeter Group
  2008 JINST 3 P10007

International Conference Proceedings

- *Design of a Data Concentrator Card for the Compact Muon Solenoid Electromagnetic Calorimeter Readout*

José Carlos da Silva, Michal Husejko, João Varela
DELTA, 2008, Hong-Kong, 25 January 2008

- *New Physics at the LHC: A Les Houches Report. Physics at Tev Colliders 2007 – New Physics Working Group*
  P. Ribeiro et al.
  arXiv:0802.3715

- *Spanish and Portuguese contributions to CMS WLCG computing Grid activities*
  Nuno Almeida et al.
  IBERGRIG Conference 2008

Collaboration notes with internal referee

- *Probing the heavy flavor content of the ttbar dilepton channel in pp collisions at sqrts=10 TeV*
  P. Silva, M. Gallinaro , J.Varela
  CMS AN-2008/112

- *A cut based method for electron identification in CMS*
  J. Branson, M. Gallinaro, P. Ribeiro, R. Salerno, M. Sani
  CMS AN-2008/082

- *Discovery potential for Universal Extra Dimensions in the four leptons final state in pp collisions at sqrts=14*
  P. Ribeiro, M. Gallinaro, M. Kazana, J. Pela, J. Varela
  CMS AN-2008/035

- *Towards the measurement of the ttbar cross section in the etau and mutau dilepton channel in pp collisions at sqrts=14 TeV*
  N. Almeida, M. Bluj, M. Gallinaro, M. Jordao, P. Ribeiro, P. Silva, J. Varela
  CMS AN-2008/13

- *Towards the measurement of the ttbar cross section in the etau and mutau dilepton channel in pp collisions at sqrts=14 TeV*
  CMS collaboration (approved)
  CMS PAS TOP-08-004

- *The CMS Electromagnetic Calorimeter Data Acquisition System at the 2006 Test Beam*
  P. Musella et al.
  CMS NOTE-2008/021

- *Data filtering in the readout of the CMS Electromagnetic Calorimeter*
  Almeida, P. Silva, J.C. Da Silva, M. Husejko, A. Jain, P. Musella, A. Mendes, M. Gallinaro, J.Varela et al.,
  CMS Note-2008/002

- *Measurement of the t tbar cross section in the electron tau and muon tau dilepton channel in pp collisions at sqrt(s) = 14 TeV*
  M. Gallinaro et al.
  CMS-AN 2008/013

Internal Notes

- *Trigger efficiency evaluation and validation for top events*
  M. Bluj, E. Chabert, R. Chierici, J. Cuevas Maestro, M. Felcini, M. Gallinaro, S. Goy Lopez, G. Heath, P. Lobelle Pardo, S. Perries,
  CMS IN-2008/039

2.3.5 Presentations

Oral presentations in international conferences

- *Design of a Data Concentrator Card for the Compact Muon Solenoid Electromagnetic Calorimeter Readout*
  presented by José Carlos Silva
  at DELTA 2008 in Hong-Kong.

- *Cold nuclear matter effects in charmonium production and absorption*
  presented by Hermine Wöhri
  at 3rd International Conference on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions (Hard Probes 2008) in A Toxa, Galicia, Sp.

- *Feed-down sources of J/psi production in proton-proton and proton- nucleus collisions*
  presented by Pietro Faccioli
  at 3rd International Conference on Hard and Electromagnetic Probes of High-Energy Nuclear Collisions (Hard Probes 2008) in A Toxa, Galicia, Spain.

- *CDF experimental results on diffraction*
  presented by Michele Gallinaro
  at Multi-Parton Interaction workshop in Perugia, Italy, October 28-31, 2008, Michele Gallinaro.

- *Nuclear effects in charmonium production in proton-nucleus collisions*
  presented by Hermine Wöhri
  at 6th International Workshop on Heavy Quarkonia in Nara, Japan.

- *Study of psi-prime and chi(c) decays as feed-down sources of J/ psi hadro-production*
  presented by Pietro Faccioli
  at 6th International Workshop on Heavy Quarkonia in Nara, Japan.

- *J/psi polarisation measurements revisited*
  presented by Pietro Faccioli
  at 6th International Workshop on Heavy Quarkonia in Nara, Japan.

Oral presentations in international meetings

- *Preparing for Top quark physics at the LHC*
  presented by Michele Gallinaro
  at 12th RDMS workshop - Minsk, Belarus, September 15-18, 2008 in Minsk, Belarus.

- *Discovery potential for Extra Dimensions in the four lepton final state at the LHC*
  presented by João Pela
  at in .

- *Measurement of the ttbar cross section in the etau and mutau dilepton channel at the LHC*
  presented by Nuno Almeida
  at PASC Winter School in Sesi.

- *Measuring Vtb in CMS*
  presented by Pedro Manuel Silva
  at PASC Winter School in Sesimbra.

- *Study of the WW-gamma gauge coupling with the CMS detector at the LHC*
  presented by Pasquale Musella
  at PASC Winter School in Sesimbra.

Oral presentations in collaboration meetings

- *Introduction/Planning*
  presented by João Varela
  at CMS Trigger Meeting in .
- *Daq Online DB Package*
  presented by Pasquale Musella
  at CMS-ECAL DAQ meeting in CERN.
- *QCD multi-jet background studies from data*
  presented by Nuno Almeida
  at Top Physics meeting in CERN.
- *Cut-based electron ID: status and plans*
  presented by Pedro Ribeiro
  at Electron POG meeting in CERN.
- *Preparing for the QPLL lock tests (proposal)*
  presented by Pedro Manuel Silva
  at ECAL/DAQ meeting in CERN.
- *Level-1 Trigger*
  presented by João Varela
  at CMS WEEK Opening Plenary Session in .
- *L1 Trigger*
  presented by João Varela
  at Opening Session - Selected Reports CMS Week in CERN.
- *Introduction/Planning*
  presented by João Varela
  at CMS Trigger Meeting in .
- *UED search in the 4 lepton final state*
  presented by Pedro Ribeiro
  at SUSY meeting in CERN.
- *Data-driven technique (tau channel)*
  presented by Nuno Almeida
  at Top Physics meeting in CERN.
- *Tau fake probability from QCD multi jet samples and photon+jets samples*
  presented by Nuno Almeida
  at Top Physics meeting in CERN.
- *UED search in the 4 lepton final state*
  presented by Pedro Ribeiro
  at SUSY meeting in CERN.
- *B(t->Wb) using the top di-leptonic channel*
  presented by Pedro Manuel Silva
  at Top Physics meeting in CERN.
- *Taus in Top decays*
  presented by Michele Gallinaro
  at Top Physics meeting (pre-approval) in CERN.
- *Taus in Top decays*
  presented by Michele Gallinaro
  at Top Physics meeting (approval) in CERN.
- *Update on performance of cut-based electron ID*
  presented by Pedro Ribeiro
  at Electron POG meeting in CERN.

- *Tau dileptons: Current analysis flow*
  presented by Michele Gallinaro
  at Top Physics meeting in CERN.

- *Update of the tau channel cross section analysis*
  presented by Nuno Almeida
  at Top Physics meeting in CERN.

- *Update of the tau channel cross section analysis*
  presented by Nuno Almeida
  at Top Physics meeting in CERN.

- *Discovery potential for Universal Extra Dimensions signal in the four leptons final state in pp collisions at sqrt(s)=14 TeV*
  presented by Pedro Ribeiro
  at SUSY meeting in CERN.

- *CMS-HI plans at LIP*
  presented by Hermine Wöhri
  at Heavy-Ions PAG Meeting in CERN.

- *L1 Trigger/DAQ*
  presented by João Varela
  at Opening Session CMS Week In Cyprus in Cyprus.

- *Update on B(t->Wb) measurement in the top di-leptonic*
  presented by Pedro Manuel Silva
  at Top Physics meeting in CERN.

- *Photon ID studies for Wgamma*
  presented by Pasquale Musella
  at EWK Multiboson Meeting in CERN.

- *ECAL DAQ*
  presented by André Tinoco Mendes
  at ECAL readiness: online & offline meeting in CERN.

- *Probing the heavy flavor content of the top di-leptonic*
  presented by Pedro Manuel Silva
  at Top Physics meeting in CERN.

- *Fitting the heavy flavor content in the dilepton channel*
  presented by Pedro Manuel Silva
  at B-physics PAG meeting in CERN.

- *Report on first beam in ECAL*
  presented by Pasquale Musella
  at Run organization Meeting in CERN.

- *Update on UED search in the four lepton final state*
  presented by Michele Gallinaro
  at SUSY meeting in CERN.

- *Lv1-1 Trigger*
  presented by João Varela
  at Plenary Session CMS WEEK in CERN.

- *Update on UED search in the 4 lepton channels*
  presented by Pedro Ribeiro
  at SUSY meeting in CERN.

- *Reconstruction of Wgamma with W->mu nu*
  presented by Pasquale Musella
  at EWK Multiboson Meeting in CERN.

- *Discovery potential for Universal Extra Dimensions in the four lepton final state*
  presented by Michele Gallinaro
  at SUSY meeting in CERN.

- *Discovery potential for Universal Extra Dimensions signal in the four leptons final state in pp collisions at sqrt(s)=14 TeV*
  presented by Pedro Ribeiro
  at SUSY meeting in CERN.

- *Update on the WGamma studies in muon channel*
  presented by Pasquale Musella
  at EWK Multiboson Meeting in CERN.

- *Probing Heavy Flavor content of the dilepton channel*
  presented by Pedro Manuel Silva
  at Top Physics meeting in CERN.

- *ECAL Calibration Sequence*
  presented by José Carlos Silva
  at ECAL/DAQ meeting in CERN.

- *Level 1 trigger reliability*
  presented by João Varela
  at CMS November Electronics Days in CERN.

- *Tau fake rate estimates from data*
  presented by Nuno Almeida
  at Top Physics meeting in CERN.

- *Remarks on J/psi polarisation measurements*
  presented by Pietro Faccioli
  at B-physics PAG meeting in CERN.

- *Heavy flavor content of dilepton channel*
  presented by Pedro Manuel Silva
  at Top Physics meeting in CERN.

- *J/psi polarisation measurements*
  presented by Pietro Faccioli
  at B-physics PAG meeting in CERN.

- *B-tags in the dilepton channel*
  presented by Pedro Manuel Silva
  at B-physics PAG meeting in CERN.

Seminars

- *Physics at the LHC with the CMS experiment*
  presented by Michele Gallinaro
  at in LIP Jornadas, Luso, Portugal.

- *LIP and the finalization of the CMS detector*
  presented by André Tinoco Mendes
  at in Jornadas LIP, Luso, Portugal.

- *CMS Electromagnetic Calorimeter Online Software*
  presented by Pasquale Musella
  at in LIP Lisbon.

- *Feed-down sources of J/psi production in proton-proton and proton- nucleus collisions*
  presented by Pietro Faccioli
  at in LIP Lisbon.

- *Cold nuclear matter effects in quarkonium production*
  presented by Hermine Wöhri
  at in LIP Lisbon.

- *Experience with pile-up at the Tevatron*
  presented by Michele Gallinaro
  at in .

Outreach seminars

- *What is CERN? What is the LHC?*
  presented by André Tinoco Mendes
  at in 7th General Assembly for the World Blind Union, Geneva, Switzerland.

- *O LHC - 15 anos de espera, 15 razões para esperar*
  presented by André Tinoco Mendes
  at in Escola de Verão de Física da Universidade do Porto, Porto, Portugal.

- *Lightbulbs aren't improved candles, what the LHC already did for you and me*
  presented by André Tinoco Mendes
  at in Science Society and Technology class, University of the Philippines Diliman, Quezon City, The Philippines.

2.3.6 Academic Training

PhD Theses

- *Search for Universal Extra-Dimensions in proton-proton collisions at 14 TeV center-of-mass energy"*
  Pedro Ribeiro, (on-going)

- *Study of Universal Extra Dimensions signals with two photons and missing energy in the final state"*
  Pedro Manuel Silva, (on-going)

- *Physics Simulation and Reconstruction of Universal Extra Dimensions Processes in the CMS Experiment"*
  Pasquale Musella, (on-going)

- *Trigger de electrões e fotões na experiência CMS no SLHC"*
  Pedro Parracho, (on-going)

Master Theses

- *Tau lepton identification with the CMS detector"*
  Marcelo Jordão, (on-going)

2.3.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	5
International Conference Proceedings	3
Collaboration notes with internal referee	8
Internal Notes	1
Oral presentations in international conferences	7
Oral presentations in international meetings	5
Oral presentations in collaboration meetings	43
Seminars	6
Outreach seminars	3

2.4 Collaboration in the COMPASS experiment at CERN

2.4.1 Activity Report

Sumário

A experiência COMPASS dedica-se ao estudo da estrutura da matéria, nomeadamente à polarização do gluão Delta_G/G (através da fotoprodução de charme e da física de elevado pT), às funções de estrutura relativas às componentes transversas e longitudinais do spin, e às funções de fragmentação. Com um feixe de hadrões, tem por objectivo o estudo de algumas questões espectroscópicas de actualidade, como a produção de novos mesões e bariões, nomeadamente exóticos, híbridos e partículas com charme duplo.
COMPASS usa feixes de alta intensidade, de muões polarizados (ou de hadrões) interagindo com um alvo polarizado longitudinalmente ou transversalmente (ou um alvo de hidrogénio líquido) ao qual se segue um espectrómetro duplo: a primeira parte tem uma grande aceitância angular, e é seguida a jusante por outra de aceitância reduzida, concebida para a detecção de partículas ultrapassando os 100 GeV/c. Cada espectrómetro é formado por um magnete rodeado por detectores de posição, um conjunto de calorímetros electromagnético e hadrónico, filtros de muões e um detector de Cherenkov do tipo RICH para identificação de partículas.
O sistema de aquisição de dados baseia-se na leitura em paralelo da electrónica de front-end e num sistema distribuído de event-builders, especialmente concebidos para tratar grandes volumes de dados. De facto, todo o programa de muões que decorreu de 2002 a 2007 perfez um total de 1700 TB. O programa de 2008 foi dedicado ao programa de hadrões.
A farm de processamento de dados de COMPASS tem um desempenho do nível requerido em LHC, pelo que a experiência é usada pelos grupos técnicos de apoio do CERN em vários domínios relativos à aquisição e ao controlo dos dados como um ambiente de teste em grande escala de soluções futuras.
Neste contexto, a aposta do grupo do LIP-Lisboa de, ao ingressar em COMPASS em finais de 2002, tomar a total responsabilidade do Sistema de Controlo de Detectores (DCS), revelou-se muito importante para a estratégia de evolução do grupo no plano tecnológico. Daí o notável esforço de recursos humanos que foi necessário.
O objectivo principal do grupo do LIP, atingido em anos anteriores, era o desenvolvimento de uma nova arquitectura para o DCS de COMPASS. Mas continuadas evoluções e adaptações têm sido necessárias.
Na verdade, o DCS não pode ser um sistema estático ou um produto finalizado pois é constituído por várias camadas de packages cujas versões têm de ser compatíveis entre si, pelo que a alteração de um deles, muitas vezes com aspectos incompatíveis em relação à sua versão precedente, implica em geral a adaptação de todos os outros, o que é uma tarefa muito pesada.
Por outro lado, devido à contínua instalação de novos detectores específicos das próximas tomadas de dados com feixes de hadrões, o software do DCS (bem como o seu hardware de interface) tem vindo a aumentar constantemente o seu grau de complexidade (interfaces de novo tipo, novos drivers), devido à não uniformidade dos detectores e do seu hardware.
Paralelamente, o grupo tem feito um grande reforço de recursos humanos, tanto em offline, no estudo de geradores físicos e da sua simulação no detector, como em relação à análise de dados, nomeadamente estudos da polarização do gluão através do processo de charme aberto ou de eventos de grande pT, e ainda sobre as assimetrias de sabor do mar do nucleão e do mesão Psi.
Nos últimos meses o grupo do LIP-Lisboa tem assumido um papel de destaque na preparação da futura Proposta de COMPASS, na secção relativa a estudos de transversidade através do processo de Drell-Yan polarizado.

Summary

COMPASS experiment is dedicated to the study of the structure of matter, namely the gluon polarisation (from open charm photoproduction and high physics), the longitudinal and the transverse spin structure and fragmentation functions. With a hadron beam, COMPASS aims to study some spectroscopy issues, as the production of new mesons and baryons, namely exotics, hybrids and double charmed particles.
COMPASS uses high intensity beams, that is, a polarised muon (or hadron) beam impinging on a longitudinally or transversely polarized target (or liquid hydrogen target) followed by a two stage spectrometer: a first one with a large angular acceptance, followed downstream by a second one with a reduced acceptance, designed to detect particles up to more than 100 GeV/c. Each spectrometer is equipped with a magnet sorrounded by trackers, a set of electromagnetic and hadronic calorimeters, muon filters and a Cerenkov detector (RICH) for particle identification.
The data acquisition system is based in a parallel read-out of the front-end electronics plus a distributed set of event-builders, specially designed to cope with huge data volumes. In fact, during the whole muon program, from 2002 till 2007, COMPASS collected a total of 1700 TeraByte of data. The year 2009 was dedicated to the hadron program.

COMPASS data processing farm also requires a LHC-like performance. That is why the experiment is used as large scale test environment for future solutions by some CERN support technical groups in several data acquisition and data control domains.
In this context, the fact that when the LIP-Lisbon group ingressed in COMPASS in the late 2002, we took the full responsibility of the Detector Control System (DCS), was very important to the evolving strategy of the group on a technological ground. In that view, a big effort in human resources was undertaken.
The main purpose of our group was the development a new DCS architecture, which has been previously achieved. But a constant evolution of the system is needed.
In fact, DCS can not be a static system or a finalised product, because it is formed by a set of several packages, disposed in layers but strongly interacting. This means that the packages versions must be compatible among them. Thus, changing one package version, which may even be not backward compatible with its previous one, may imply the change of all other packages versions. This is usually a heavy task.
On the other hand, COMPASS continues its hardware upgrade, namely in what concerns new detectors specific to the hadron beam runs, which are presently being installed for the 2009 data taking. In view of this, the DCS is always increasing in complexity (new types and number of hardware interfaces with the detectors, new drivers), namely due to the non uniformity of the COMPASS detectors hardware.
In parallel, a great effort in human resources for offline and data analysis is being done. It includes the development of new physics generators and their simulation through the detector, as well as the analysis of physics channels, namely studies on the gluon polarisation from the open charm process or high events and the flavour asymmetries of the nucleon sea and of the psi meson.

Summary of the Activities

LIP has the full responsibility of the Detector Control System (DCS) of the experiment, since it has been accepted as a member of the COMPASS Collaboration, in September 2002.
During 2008, the COMPASS experiment LIP group carried on the matters related with the working activities, namely:

- General activities
- Full responsibility of the Detector Control System (DCS)
- Offline and data analysis.

General Activities

COMPASS LIP-Lisbon members participated in the following general activities:

- Participation in the Collaboration meetings
- Participation in the Steering Committee meetings (the Project Leader)
- Participation in the monthly offline and analysis meetings
- Participation in the technical friday meetings
- Participation in the data taking periods and their preparation

Detector Control System

In view of the preparation of the 2009 hadron run, new detectors were installed in the experimental area. These detectors are being included in the new DCS sheme. The DCS has also proceeded with the study of the issues for the integration of some already existing standalone detectors, as the LV systems for the RICH and Straw chambers.
One should stress that the DCS has to deal with a vast variety of COMPASS equipments that are being or will be controlled or monitored. While for some devices commercial supervision solutions exist (like OPC servers), for many others these solutions do not. That is why case-by-case solutions must be applied, namely by writing the drivers to control/monitor such devices, and integrate them in PVSS, whenever necessary.
It is worth noting that the DCS system works practically 12 months per year. In fact, during the no beam part of the year, several DCS sub-systems run, in order to control some devices, as is the case of detectors gas systems. While this requires the permanent presence of one DCS expert, it also prevents the system to run in standalone mode (as everytime a sub-system is controling some detector).

Offline and Data Analysis

Simulation and reconstruction studies dealing with different event generators used as a tool to the analyses of the gluon polarisation and of the polarised Drell-Yan process were done.
The 2006 data was analysed in all physics channels. Its merge with the previous 2002-2004 data analyses in deep inelastic scattering inclusive asymmetries is being performed.
Also, semi-inclusive asymmetries studies, in view of the separation of the spin flavour components, has pursued.
Both physics channels concerning the gluon polarisation, namely its extraction from high p_T events, as well as from the open charm mesons production, have been pursued.
The Psi meson spin asymmetries have been extracted.

2.4.2 Sources of Funding

Code	Funding	Start	End
010.6/B009/2005	252.000 €	2004-01-01	2008-12-31
POCI/FP/81973/2007	150.000 €	2007-07-01	2008-09-30
CERN/FP/83542/2008	140.000 €	2008-10-01	2009-09-30

2.4.3 Team

Project coordinator: Paula Bordalo

Name	Status	%of time in project
Catarina Quintans	Researcher (LIP)	100
Celso Franco	PhD student (LIP/IST)	100
Christophe Pires	Technician	100
Helena Santos	Researcher (LIP/IST)	100
Luis Silva	PhD student (LIP/IST)	100
Paula Bordalo	Researcher (LIP)	100
Sérgio Ramos	Researcher (LIP)	100
Sofia Nunes	Technician (LIP)	100

2.4.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Direct Measurement of the Gluon Polarisation in the Nucleon via Charm Meson Production*
  P. Bordalo, C. Franco, C. Quintans, S. Ramos, H. Santos, L. Silva et al.
  CERN-PH-EP/2008-003 (accepted)

- *Read-out electronics for fast photon detection with COMPASS RICH-1*
  P. Bordalo, L. Silva et al.
  NIMA 587 (2008) 371

- *The Polarised Valence Quark Distribution from semi-inclusive DIS*
  P. Bordalo, C. Franco, C. Quintans, S. Ramos, H. Santos, L. Silva et al.
  PLB 660 (2008) 458-465

- *Pattern recognition and PID for COMPASS RICH-1*
  P. Bordalo, L. Silva et al.
  NIMA 595 (2008) 233

- *The fast readout system for the MAPMTs of COMPASS RICH-1*
  P. Bordalo, L. Silva et al.
  NIMA 595 (2008) 204

- *The COMPASS RICH-1 fast photon detection system*
  P. Bordalo, L. Silva et al.
  NIMA 595 (2008) 23

International Conference Proceedings

- *Recent COMPASS results on the gluon polarization*
  C. Quintans et al., for COMPASS Colaboration
  Proc. of Diffraction2008, September 2008, La-Londe-Les-Maures, France

- *Gluon polarization from high-pt hadron pair production*
  L. Silva et al., for COMPASS Colaboration
  Procs. of SPIN-Praha-2008, Prague, Czech Republic, July 20-26, 2008.

- *DG/G Open charm results from COMPASS*
  C. Franco et al., for COMPASS Colaboration
  Procs. of SPIN-Praha-2008, Prague, Czech Republic, July 20-26, 2008.

- *New COMPASS results on semi-inclusive polarised DIS*
  H. Santos et al. on behalf of COMPASS
  Proc. of PANIC08 (accepted)

Collaboration notes with internal referee

- *Direct Measurement of the Gluon Polarisation in the Nucleon via Charm Meson Production*
  P. Bordalo, C. Franco, C. Quintans, S. Ramos, H. Santos, L. Silva et al.

2.4.5 Presentations

Oral presentations in international conferences

- *DG/G Open charm results from COMPASS*
  presented by Celso Franco
  at SPIN-Praha-2008 - Advanced Studies Institute, Symmetries and Spin in Prague, Czech Republic.

- *Gluon polarization from high-pt hadron pair production*
  presented by Luis Silva
  at SPIN-Praha-2008 - Advanced Studies Institute, Symmetries and Spin in Prague, Czech Republic.

- *Recent COMPASS results on the gluon polarization*
  presented by Catarina Quintans
  at International Workshop on Diffraction in High-Energy Physics in La Londe-les-Maures, France.

- *New COMPASS results on SIDIS*
  presented by Helena Santos
  at PANIC 2008 - International Conference on Particles And Nuclei in Eilat, Israel.

Presentations in national conferences

- *Contribuição do Gluão para o Spin do Nucleão via produção de D0 e D**
  presented by Celso Franco
  at Jornadas LIP in Luso, Portugal.

- *Gluon polarisation from high transverse momentum hadrons production @ COMPASS*
  presented by Luis Silva
  at Jornadas LIP in Luso, Portugal.

- *LIP Activities in the COMPASS Experiment*
  presented by Catarina Quintans
  at Jornadas LIP in Luso, Portugal.

Seminars

- *A new polarized Drell-Yan experiment at CERN*
  presented by Catarina Quintans
  at in LIP, Lisbon.

2.4.6 Academic Training

PhD Theses

- *COMPASS - Contribution of the gluon to the nucleon spin via D0 e D* production"*
  Celso Franco, (on-going)
- *COMPASS - Gluon Polarisation through high PT hadron production"*
  Luis Silva, (on-going)

2.4.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	6
International Conference Proceedings	4
Collaboration notes with internal referee	1
Oral presentations in international conferences	4
Presentations in national conferences	3
Seminars	1

2.5 Collaboration in the HADES experiment at GSI

2.5.1 Activity Report

Resumo do projecto

A colaboração HADES (www-hades.gsi.de), acrónimo de "High Acceptance Di-Electron Spectrometer", é uma experiência internacional de Física das Partículas, onde participam 17 instituições de 9 países europeus entre os quais Portugal, através do Laboratório Associado LIP. Esta experiência está instalada no laboratório GSI (www.gsi.de), situado em Darmstadt, na Alemanha.
Fazendo colidir núcleos pesados acelerados no acelerador SIS18 do GSI, a experiência pretende criar um estado nuclear muito mais denso que o habitual. Essa densidade acrescida, ao provocar alterações mensuráveis nas propriedades das forças nucleares, permitirá estudar algumas propriedades destas forças que são responsáveis pela maior parte da massa da matéria comum.
A participação portuguesa nesta experiência, assegurada por uma equipa do LIP (www.lip.pt), consiste no projecto, construção e operação de um detector de partículas de concepção original que ajudará a identificar com mais rigor o tipo de partículas que emergem das referidas colisões nucleares. Este novo sistema será capaz de medir o tempo de voo das partículas (desde o ponto da colisão até ao detector) com uma precisão equivalente ao tempo que demora a luz a percorrer uma distância de 3 cm (100 picosegundos, isto é 0,0000000001 s). Esta informação permite por sua vez determinar a velocidade das partículas, o que é um passo importante para identificar o tipo de partícula de que se trata.
Realizados já nos anos transactos os diversos passos de I&D, neste momento o detector encontra-se em fase final de produção, devendo ser instalado em HADES ao longo do ano de 2009.
Uma vez em funcionamento, o que deverá acontecer em 2010, pretendemos também estudar um aspecto particular da Física Nuclear que pode ter relevância para a estabilidade das estrelas de neutrões - objectos celestes exóticos de grande interesse para a Astronomia e a Astrofísica.

Production of the RPC TOF wall

The production of the detectors has started in earnest during this year. By December 2 sectors (out of 6) had been cosmic-ray tested, 2 were produced and were under conditioning and 1 was in mid-production. This activity will be financed by the EU CNI project (DIRAC).

Feasibility study of anti-Kaon physics with the ToF wall

The particle identification capabilities of the HADES spectrometer, as supplemented by the RPC ToF wall under construction at LIP Coimbra, have been simulated within the HADES-Geant framework. In particular the final geometry was implemented, with all the relevant passive and active materials down to the level of each RPC gap, but not a digitizer. The status of the framework allowed to fully concluding the preliminary feasibility study with quite encouraging results. The reactions considered were Ni+Ni collisions at 1.93 AGeV with a selection on the 20% most central cross section. The proposed double layer coincidence, possible in the HADES RPC ToF wall, will eliminate the problem of the experimentally observed non-Gaussian tails in the time response and allow to isolate kaons with a purity in excess of 90% from normalized rapidities of -0.5 up to mid-rapidity. The fraction of kaons going through at least one layer, accepted by requiring a coincidence changes between 30% and 60% over the RPC ToF wall. This effect is not too severe and can be corrected with an appropriate filter matrix. The wall occupancy, around 5-7% and roughly constant over the RPC ToF wall, will not distort the reconstructed directed flow and will only bias the extracted elliptic flow by at most 10%.

Participation in the physics program of HADES

LIP researchers participated in the data-taking period of September 2008 as general-purpose operators. In recognition of our efforts in the realization of the RPC TOF Wall, the LIP group has started to author the physics papers of HADES.
A project concerning the involvement of the group in the physics program (beamtimes, physics studies), not covered by the construction grants, was granted by FCT's program of "Projects in collaboration with CERN".

2.5.2 Sources of Funding

Code	Funding	Start	End
EU Contract 515876 DIRAC-Phase-1	52.000 €	2005-10-01	2009-09-30
LIP-GSI contract	414.000 €	2005-10-01	2009-09-30
POCI/FP/81982/2007	20.000 €	2007-07-01	2008-06-30
CERN/FP/83560/2008	15.000 €	2008-10-01	2009-09-30

2.5.3 Team

Project coordinator: Paulo Fonte

Name	Status	%of time in project
Alberto Blanco	Technician (LIP)	26
Alessio Mangiarotti	Researcher (LIP)	52
Alexandre Moita	Technician (LIP)	1
Américo Pereira	Technician (LIP)	3
Carlos Capela	Researcher (ESTGL)	10
Carlos Neves	Researcher (ESTGL)	3
Carlos Silva	Technician (LIP)	1
Carlos Sousa	Researcher (ESTGL)	15
Joaquim Oliveira	Technician (LIP)	1
Luís Lopes	Technician (LIP)	20
Milena Vieira	Researcher (ESTGL)	15
Nuno Carolino	Technician (LIP)	16
Orlando Cunha	Technician (LIP)	3
Paulo Fonte	Researcher (LIP/ISEC)	29
Rui Alves	Technician (LIP)	1

2.5.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *In-beam measurements of the HADES-TOF RPC wall*
  A.Blanco, P.Cabanelas, D.Belver, E.Castro, J.Diaz, P.Fonte, A.Gil, J.A.Garzon, D.Gonzalez-Diaz, T.Heinz, W.Koenig, L.Lopes, C.Muentz, M.Palka, J.Pietraszko, A.Rustamov, E.Schwab, Y.Sobolev, A.Tarantola,K.Teilab,M.Traxler,R
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

- *The identification of rare charged kaons in heavy ion collisions at relativistic energies by time-of-flight with the HADES spectrometer*
  A.Mangiarotti, P.Fonte, A.Blanco
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

- *The HADES RPC inner TOF Wall*
  D.Belver, A.Blanco, P.Cabanelas, N.Carolino, E.Castro, J.Diaz, P.Fonte, J.A.Garzón, D.Gonzalez-Diaz, A.Gil, W.Koenig, L.Lopes, A. Mangiarotti, O.Oliveira, A.Pereira, C.Silva, C.C.Sousa, M.Zapata
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

Articles in international journals (with indirect contribution from LIP members)

- *Study of dielectron production in C+C collisions at 1 AGeV*
  The Hades Collaboration
  Physics Letters B

- *Dielectron spectroscopy at 1-2 AGeV with HADES*
  The HADES collaboration

Eur. Phys. J. A 38 163-166 (2008)

Institute reports

- *HADES upgrade: in-beam results from a fully instrumented RPC sextant*
  A.Blanco,D.Belver,P.Cabanelas,E.Castro,P.Fonte,,A.Gil,D.Gonzalez-Diaz,T.Heinz,W.Koenig,C.Muentz,M.Palka,J.Pietraszk
  and the HADES-RPC group
  GSI scientific report 2007

2.5.5 Presentations

Oral presentations in international conferences

- *The HADES RPC inner TOF Wall*
  presented by Paulo Fonte
  at 9th International Workshop on Resistive Plate Chambers and Related Detectors (RPC2007) in 13 to 16 February 2008, Mumbai, India.

Poster presentations in international conferences

- *The identification of rare charged kaons in heavy ion collisions at relativistic energies by time-of-flight with the HADES spectrometer*
  presented by Paulo Fonte
  at 9th International Workshop on Resistive Plate Chambers and Related Detectors (RPC2007) in 13 to 16 February 2008, Mumbai, India.

Oral presentations in collaboration meetings

- *The HADES system performance*
  presented by Paulo Fonte
  at 11th CBM Collaboration Meeting in GSI Darmstadt, February 26 29, 2008.
- *RPC upgrade status*
  presented by Paulo Fonte
  at HADES Collaboration Meeting XIX in GSI, Darmstadt, Germany.

2.5.6 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	3
Articles in international journals (with indirect contribution from LIP members)	2
Institute reports	1
Oral presentations in international conferences	1
Poster presentations in international conferences	1
Oral presentations in collaboration meetings	2

2.6 Participation in the NA60 experiment at CERN

2.6.1 Activity Report

Report

During the year 2008, The NA60 group from LIP has concentrated on the finalization of analyses and dismantling of the experiment.
The doctoral thesis of Pedro Ramalhete has been finalized and submitted for approval and the analysis by Pedro Martins reached last stages of preparation.
On the dismantling side, the LIP group has repatriated much of the IT material it had contributed to the experiment and is now hosting the 2004 proton-nucleus data. Most of the detector hardware funded through this group´s projects has also been repatriated and will be used for public display and in outreach activities.
After almost 10 years of involvement in this experiment, the NA60 LIP group will be dissolved. Modulo persons leaving research almost all the NA60 LIP group members moved on to the CMS experiment in the last 3 years.
During the NA60 project´s lifetime, the NA60 LIP group has provided summer internships at CERN to more than 10 undergraduate Portuguese students, doctoral degrees to 3 Portuguese students supervised through very fruitful collaborations with foreign post-docs hired by the group. All former students from this group are now employed in research or industry at a fraction of roughly 50/50.
There will be no further request for funding for participation in the NA60 experiment, though, as is usual in this field, persons holding the know-how will still collaborate with those needing the expertise.

2.6.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81945/2007	15.000 €	2007-09-01	2008-10-31

2.6.3 Team

Project coordinator: João Seixas

Name	Status	%of time in project
André Tinoco Mendes	Post-Doc (LIP/IST/FCT)	8
João Seixas	Researcher (LIP/IST)	24
Pedro Martins	PhD student (LIP/IST)	33
Pedro Ramalhete	PhD student (LIP/AdI)	67

2.6.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Evidence for Radial Flow of Thermal Dileptons in High-Energy Nuclear Collisions*
  NA60 Collaboration
  Phys. Rev. Lett. 100, 022302 (2008)

2.6.5 Academic Training

PhD Theses

- *In-In ultra-peripheral collisions in NA60"*
  Pedro Ramalhete, 2008-12-31

2.6.6 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
PhD Theses	1

2.7 Physics at LHC

2.7.1 Activity Report

Resumo

Um importante esforço conjunto de preparação da comunidade experimental e teórica de Física de Partículas Elementares é necessário por forma a responder ao desafio do LHC. Este esforço deve ser concentrado não apenas no estudo dos melhores observáveis em LHC que permitam realizar testes de precisão do Modelo Padrão (SM) da Física Elementar de Partículas, mas também no desenvolvimento de novas ideias de Física para além do SM. Com o objectivo de concretizar uma estreita colaboração entre a comunidade de Físicos Experimentais e Teóricos de Partículas, foram propostas várias tarefas no âmbito do presente projecto, e cujo estado actual se passa a descrever.
A primeira tarefa envolveu o estudo de processos associados a correntes neutras com troca de sabor (FCNC) na produção simples de quarks top em LHC. Para o efeito foi desenvolvido um modelo teórico efectivo e estudado o impacto de novos acoplamentos em observáveis físicos em LHC. Os novos processos foram incluidos em geradores Monte Carlo de LHC (TopRex) e verificou-se que a sua importância não pode ser ignorada em LHC face aos canais normais de produção directa.
Outra tarefa desenvolvida no âmbito deste projecto, envolveu o estudo de assimetrias angulares em decaimentos do quark top. No SM o vértice Wtb é considerado puramente esquerdo com uma intensidade proporcional ao elemento Vtb da matriz de Cabibbo-Kobayashi-Maskawa (CKM). Apesar da secção eficaz de produção dupla de quarks top em LHC não ser sensível ao valor de Vtb, as correlações angulares dos produtos de decaimento destes quarks podem dar informação valiosa sobre a estrutura do vértice Wtb. Novas assimetrias foram introduzidas (A_+ e A_-) bem como novas razões entre as polarizações dos bosões W (ρ_R e ρ_L). Foi possível verificar que os novos observáveis introduzidos são mais sensíveis aos acoplamentos anómalos vectoriais e tensoriais do que os previamente utilizados em LHC. Foram estudadas as correlações entre os vários observáveis e desenvolveu-se o programa (designado por TopFit) que permite fazer o ajuste global de todos os observáveis em função dos novos acoplamentos anómalos.
No âmbito do presente projecto tem sido ainda estudada a radiação dos quarks tops (para gluões, fotões e Z´s). Esta pesquisa incide numa primeira fase, no estudo da produção dupla de quarks top acompanhados de um fotão energético que vai permitir estudar os factores de forma do quark top em LHC.

Summary of the Activities

In order to address the physics potential of the LHC program, a significant joint effort of the experimental and theoretical particle physics community is required. This effort must consider not only the study of the best physical observables to perform a precise test of the Standard Model (SM) of Elementary Particle Physics at LHC, but also to develop new ideas for physics beyond the SM. Several tasks were proposed in the present project to implement a strong collaboration between experimental and theoretical particle physicists. The status of such tasks is summarized in what follows.

1. Single Top Production at the LHC via FCNC

The main goal of this task is to study signals of physics beyond the SM in single top quark Flavour Changing Neutral Currents (FCNC) processes at LHC. Following the development of a model independent analysis for single top production via FCNC (where dimension 5 and 6 effective flavour changing and flavour conserving quark-gluon vertices were considered), the impact of these new couplings on the physical observables at LHC were studied.
Current status of the present task: the theoretical model is well developed (with publications in international scientific journals and presentations in conferences) and its implementation within the framework of the TOPREX generator is done. New contributions associated to the electroweak sector were calculated and the amplitudes will be included in the Monte Carlos generators (MadGraph). Studies already performed show that these new contributions cannot be ignored at the LHC when compared to the direct process: they give the same order of magnitude contributions to the overall single top production cross-section via FCNC.

2. Study of Top Quark Anomalous Couplings and TopFit

The LHC will be a top factory with a total $t\bar{t}$ production cross-section of around 800pb and single-top production of around 300pb. This fact allows to measure with high precision the Wtb vertex and the couplings of the top quark. Although the double top production is insensitive to the Vtb CKM matrix element, the angular

asymmetries between the top quark decay products can nevertheless give valuable information on the structure of the Wtb vertex. New right-handed couplings can be introduced within an effective lagrangian approach which can be probed at the LHC.
Current status of the present task: New asymmetries (A_+ and A_-) and new W polarization states ratios (ρ_R and ρ_L) were introduced and tested at the LHC. The studies performed with several Monte Carlo generators (TOPREX, ALPGEN, MC@NLO, etc.) have shown that the new observables are more sensitive to vector and tensor like (right and left) anomalous top couplings. The program, TopFit was upgraded to perform a global fit of all relevant observables (taking into account the correlations between them) in order to set the most stringent limits to the anomalous couplings. The $t\bar{t}$ and single top physics were combined to get a global fit from both channels at the LHC.

3. Electroweak Top Quark Couplings

The study of the electroweak couplings of the top quark is performed with the pp->tt process which is the more promising channel at the moment. This study allows to probe the top quark charge and will lead to a better understanding of the form factors associated to the top quark.
Current status of the present task: this task is under way. A new Monte Carlo generator at parton level was developed to generate the $t\bar{t}$ physics process and the interface with other generators is performed. This generator will allow a comparative study of the $t\bar{t}$ production cross-sections (with and without energetic photons) at the LHC.

4. Theoretical Models

One of the fundamental tasks of this project is the development of theoretical models which allow a better comprehension of the SM and physics beyond the SM.
Current status of the present task: although several models have already been developed (see tasks 1 and 2 of the project) associated either to the single top quark production via FCNC or with the top quark decays (and the study of the Wtb vertex), this task is still in development: it is still necessary to introduce a new interpretation of the electroweak couplings associated to the top quark, as well as the measurement of the angular asymmetries in the top quark decays. The contribution of the Higgs channel started but the study is not yet complete.

2.7.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81950/2007	30.000 €	2007-07-01	2008-06-30
CERN/FP/83588/2008	35.000 €	2008-10-01	2009-09-30

2.7.3 Team

Project coordinator: António Onofre

Name	Status	%of time in project
Amélia Maio	Researcher (LIP/FCUL)	2
António Onofre	Researcher (LIP)	30
Augusto Barroso	Researcher (FCUL)	20
Filipe Veloso	Post-Doc (LIP/FCT) *	17
Helmut Wolters	Researcher (LIP)	7
Inês Ochoa	Graduate student (LIP)	25
João Bastos	Post-Doc (LIP)	15
João Carvalho	Researcher (LIP/FCTUC)	27
João Silva	Technician (LIP)	5
Juan Aguilar-Saavedra	Researcher (LIP)	20
Matilde Castanheira	Master student (LIP)	50
Miguel Fiolhais	Student (LIP)	100
Miguel Won	Graduate student (LIP)	50
Nuno Castro	PhD student (LIP/FCT)	41
Orlando Oliveira	Researcher (LIP/FCTUC)	15
Paulo Martins	(LIP)	25
Pedro Martins Ferreira	Researcher (LIP/FCUL)	16
Rita Monteiro	PhD student (LIP)	25
Rui Santos	Researcher (LIP/FCUL)	20
Susana Santos	Graduate student (LIP)	25

2.7.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *ATLAS sensitivity to Wtb anomalous couplings in top quark decays*
  J. A. Aguilar-Saavedra, J. Carvalho, N. Castro, A. Onofre and F. Veloso
  Eur.Phys.J. C53 (2008) 689-699

- *Collider aspects of flavour physics at high Q*
  T. Lari et al
  arXiv:0801.1800 [hep-ph] (2008) (accepted)

- *Combined effects of strong and electroweak FCNC effective operators in top quark physics at the LHC*
  P.M. Ferreira, R.B. Guedes, R. Santos
  arXiv:0802.2075 [hep-ph] (2008) (accepted)

2.7.5 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	3

Chapter 3

Computing

3.1 Grid Computing

3.1.1 Activity Report

Relatório de Actividades

Durante 2008 o LIP participou em diversas actividades na área da computação grid. Estas actividades tiveram por objectivo consolidar os meios de cálculo do LIP preparando-os para o arranque do LHC, e contribuir para o desenvolvimento e expansão da computação grid a nível nacional e internacional.
A nível internacional o LIP participou nos projectos Europeus int.eu.grid e EGEE-II que terminaram no primeiro semestre, iniciou o projecto EGEE-III, e participou no Worldwide LHC Computing Grid (LCG) e na iniciativa IBERGRID. O LIP contribuiu ainda para a coordenação e expansão da computação grid na Europa através da participação no e-Infrastructures Reflection Group (e-IRG) e no European Grid Infrastructure Design Study (EGI-DS).
A nível nacional o LIP colaborou activamente na Iniciativa Nacional Grid tanto ao nível da coordenação como ao nível técnico. Neste âmbito o LIP trabalhou no planeamento de um serviço nacional de computação grid, e no reforço das infra-estruturas e meios de computação associados à iniciativa que englobam o Tier-2 Português para o LHC.

Activity Report

The LIP participation in the LHC programme has been the main driven force behind the grid computing activities developed by the laboratory in the last years. Initially centred in providing the environment for the LHC computing at LIP this work was extended to cover other fundamental areas such as contributing to the development of the grid computing technologies and promoting the expansion of grid computing in Portugal and at large. Only by pushing for the expansion of this technology can we ensure the long term support for the LHC Computing Grid (LCG), a key component for the success of the LHC experiments. Simultaneously grid computing is having a positive impact in global science. At LIP, some non-LHC experiments have already adopted the technology and the others are indirectly benefiting from the overall improvements of the LIP computing infrastructure that resulted from the participation in grid computing projects.
During 2008 the activities were highly focused at improving the LIP computing infrastructure and services in order to be ready for the LHC. The LIP datacenters in Lisbon and Coimbra were upgraded and a new datacenter was built in consortium with the Portuguese national research network (FCCN) and the Portuguese Civil Engineering Laboratory (LNEC).
Simultaneously LIP continued to participate in grid computing projects at national and international level. In this context LIP participated in the EU funded projects int.eu.grid, EGEE-II and EGEE-III, provided resources and support for the EELA project, participated in the Iberian grid initiative (IBERGRID), and in the Portuguese national grid initiative (INGRID). LIP also contributed to the coordination and guidance of grid computing in Europe through the participation in the e-Infrastructures Reflection Group (IRG) and European Grid Initiative Design Study (EGI-DS).

National Grid Initiative
LIP has a technical coordination role in this government initiative that aims to support the development of grid computing in the country. The initiative is funding several projects in areas such as middleware and pilot applications. Two of these projects are being executed by LIP they include the “Atlas grid” and the “support

for grid middleware test and validation". The later project is also under the responsibility of the LIP computing group and has the objective of provide a platform for middleware test activities to be used by several other projects such as EGEE, IBERGRID and INGRID itself. The project started in the mid of 2008 with the acquisition of dedicated hardware to implement the platform. Virtualization technologies were evaluated and used to create a flexible yet powerful solution. In the end of 2008 several activities began using this facility including the deployment of a new EGEE pré-production site at LIP, the creation and test of virtual grid services to be deployed at the main node for grid computing, tests of the Grid Engine batch system, partial tests of lustre and StoRM, and the deployment and testing of virtual grid services for IBERGRID.
In addition LIP played a technical coordination role in the initiative. In this context LIP worked towards the creation of a long-term sustainable national grid service. The most important step in this direction is the "main node for grid computing" a project that aims to establish the core of this service.

Main node for grid computing
This project started in the fall of 2007 and is being executed by LIP, FCCN and LNEC in consortium. The project includes the creation of a large datacenter providing grid storage and processing capacity to the Portuguese Scientific community. A considerable fraction of these resources will be usable by the LIP federated Tier-2. LIP is responsible for the grid computing resources housed at this center.
During 2008 LIP worked with the consortium partners to plan and build the datacenter. LIP has participated in the tender processes for the civil engineering, AVAC and electrical installation. LIP was responsible for designing the site architecture, coordinate the public tender for computing equipments and oversee the physical installation of these equipments. The site architecture is based on blade centers providing high density computing capacity interconnected with storage servers using ten gigabit Ethernet. In addition FCCN installed a tape library for scientific data-repositories. The physical installation of all equipment was finished in December of 2008, and the software installation is ongoing.
Also in the context of this project LIP has upgraded its two datacenters in Lisbon and Coimbra that together with the main node constitute the core of a future national grid service including the Portuguese federated Tier-2 for the LHC. In Coimbra the old "centopeia" cluster was decommissioned and replaced by a complete new cluster including storage capacity and new network switching equipment. In Lisbon the cluster was upgraded and a completely new storage system was deployed. The core of the network infrastructure was also replaced. In both sites the tape storage capacity for backups was also improved. To accomplish these upgrades significant changes at the level of the AVAC, power systems, monitoring and datacenter organization were required. In collaboration with FCCN the network connectivity for the cloud constituted by the three centers is being improved.
The overall dimension of these three sites under the management of the LIP computing group including LIP and INGRID systems, LHC and non-LHC resources, grid, batch processing, interactive processing, site management and grid core services is about: 1920 CPU cores and 1.1 PetaBytes of online storage capacity.

EGEE-II and EGEE-III
The Enabling Grids for E-sciencE (EGEE) is the largest multidisciplinary grid for scientific research worldwide. The EGEE project is supporting a wide range of research domains including High Energy Physics. In Europe the Worldwide LHC Computing Grid is built on top of EGEE. The EGEE II project finished successfully in April of 2008 and was immediately followed by the EGEE III project that started in May. EGEE III continues to enhance, expand and operate this grid infrastructure but has also the mission of preparing the grounds for a future sustainable grid infrastructure in cooperation with other projects and initiatives.
During 2008 LIP was responsible for coordinating the EGEE infrastructure in Portugal and by providing services and support for the whole infrastructure. During this period the Portuguese EGEE grid has grown to 8 sites. LIP provided ticket management services for the SWE federation (Portugal and Spain), ticket management and first level of support for the EGEE Global Grid User Support (GGUS), site managers support, user support, user training, operation of grid core services, operation of a pre-production site, security coordination for Portugal, management of the Portuguese Certification Authority, site certification, project dissemination, and coordination with other national and regional grid projects. LIP participates in the overall coordination of the SWE infrastructure operations and federation management.

Worldwide LHC Computing Grid
LIP is responsible for the Portuguese federated Tier-2 for the LHC, a grid computing facility integrated in the WLCG that provides resources to the ATLAS and CMS collaborations. The Tier-2 is currently composed of two LIP resource centers in Lisbon and Coimbra. During 2008 these sites were significantly upgraded and restructured. A third site sharing resources with the Portuguese main node for grid computing was designed and prepared. Besides these activities a substantial component of the team workload was related with the

daily maintenance of the Tier-2 facility. This activity is performed in collaboration with the ATLAS and CMS computing contacts at CERN, LIP and in the Southwest cloud. In this sense the setup of the tier-2 was tuned and improved to provide a suitable production service for these collaborations. The file transfer mechanisms between Tier-1s and the Tier-2 was established and tested. As part of this work LIP also participated in the relevant LCG coordination bodies.

Int.eu.grid
The Interactive European Grid (int.eu.grid) project operates a grid computing infrastructure for demanding applications with interactive and parallel processing needs. The project demonstrated successfully that grid computing technologies and middleware such as gLite can be used as an integration layer for both High throughput and high performance computing resources enabling transparent and uniform access. The project provided a production quality environment for applications from several scientific domains (fusion, HEP, meteorology, medical imaging, biomedicine, astronomy). Although the European funding finished in May of 2008 the infrastructure is yet operational and the project developments and knowledge are being used by other international and regional projects such as EGEE, grid Ireland, Spanish national grid initiative, Polish grid, Baltic Grid, EELA and many more. The int.eu.grid framework to support MPI in the grid environment has been widely adopted. These developments will be used by LIP in the context of both IBERGRID and the Portuguese national grid initiative.
During 2008 LIP continued to be responsible for the overall coordination of the int.eu.grid international infrastructure. LIP coordinated the grid operations, provided support for users and sites, coordinated and performed middleware certification tests, managed the authorization and authentication systems, developed enhancements for gLite, and finally contributed to the overall project coordination in collaboration with IFCA (Santander).

EELA
Although not a funded member of the EELA-II project, LIP continued to collaborate with this project that aims to extend the grid coverage to Latin America. During this period LIP provided computing resources and hosted the VOMS central authorization service for the whole EELA project.

IBERGRID
The IBERGRID initiative aims to foster the cooperation between Portugal and Spain in the areas of grid computing, high performance computing and networking. In this context this initiative aims to deploy a grid infrastructure for resource sharing in the Iberian region.
LIP is responsible for the IBERGRID coordination in Portugal. During 2008 the LIP grid team worked with their Spanish colleagues to establish the grid architecture and define a plan for the integration of resources. Thanks to a tighter integration of the Portuguese and Spanish research networks also achieved in the context of IBERGRID it will be possible to fully integrate the national grid infrastructures of both countries that are now being setup. An understanding towards a unified approach to the European Grid Infrastructure was also achieved. This is a first step to enable an Iberian federation of grid resources in EGI.

e-IRG, EGI and EGI-DS
The e-Infrastructures Reflection Group was created to define and recommend best practices for the pan-European electronic infrastructure efforts and consists of official delegates from all EU countries. During 2008 LIP continued to participate in the e-IRG activities with a special focus in the country and European wide grid development.
Simultaneously LIP also participated to the European Grid Infrastructure Design Study a project that aims to identify processes, mechanisms and the structure to establish a long term sustainable European wide grid infrastructure. LIP represents Portugal in the EGI policy board and chairs this body. The work during 2008 was aimed at prepare the EGI blueprint a document describing the proposal to establish the EGI infrastructure including its organisation based on the national grid infrastructures, the functions of EGI, and the financing model.

3.1.2 Sources of Funding

Code	Funding	Start	End
EGEE-II (RI-031688)	274.888 €	2006-04-01	2008-04-30
int.eu.grid (IST-7-031857)	154.000 €	2006-05-01	2008-04-30
GRID 233/7.2/C/NAC	671.125 €	2007-06-01	2009-06-30
GRID/GRI/81842/2006	180.700 €	2007-09-10	2010-09-09
EGEE-III	307.000 €	2008-05-01	2010-04-30

3.1.3 Team

Project coordinator: Jorge Gomes

Name	Status	%of time in project
Carlos Manuel	Technician (LIP)	100
Gaspar Barreira	Researcher (LIP)	75
Gonçalo Borges	Researcher (LIP)	100
Hugo Gomes	Technician (LIP)	100
João Martins	Researcher (LIP)	100
Jorge Gomes	Researcher (LIP)	100
José Aparício	Technician (LIP)	100
Manuel Montecelo	Technician (LIP)	100
Mário David	Researcher (LIP/FCT) *	100
Miguel Oliveira	Researcher (LIP)	100
Nuno Dias	Technician (LIP)	100

3.1.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *The Interactive European Grid: Project Objectives and Achievements*
  J.Marco, I.Campos, I.Coterillo, I.Diaz, A.Lopez, R.Marco, C.Martinez-Rivero, P.Orviz, D.Rodriguez, J.Gomes, G.Borges, M.Montecelo, M.David, B.Silva, N.Dias, J.P.Martins, et al
  Computing anf Informatics Vol 27, 2008, pp.161-171

- *A Grid Infrastructure for Parallel and Interactive Applications*
  J.Gomes, G.Borges, M.Montecelo, M.David, B.Silva, N.Dias, J.P.Martins, et al
  Computing and Informatics, vol 27, 2008, pp.173-185

International Conference Proceedings

- *The Int.Eu.Grid experience as an interoperable infrastructure between Portugal and Spain*
  G. Borges, M. Montecelo, J. Gomes, M. David, A. Lopez, and P. Orviz
  IBERGRID 2008 (2nd Iberian GRID Infrastructure Conference Proceedings), Ed. F. Silva et al, pp.200-211

- *Resource integration in gLite based grid infrastructures*
  G. Borges, M. David, J. Gomes, J.P. Martins, M. Montecelo, N. Dias J. Lopez, A. Simon, and E. Garcia
  IBERGRID 2008 (2nd Iberian GRID Infrastructure Conference Proceedings), Ed. F. Silva et al, pp.67-78

- *Spanish and Portuguese contributions to CMS computing Grid activities*
  J,Flix, G.Merino, N.Colino, J.Hernandez, F.Matorras, M.David, N.Almeida, M.Oliveira et al
  IBERGRID 2008 (2nd Iberian GRID Infrastructure Conference Proceedings), Ed. F. Silva et al., pp.31-42 (2008)

- *Interactivity and Parallelism in grids: support of advanced applications across distributed infrastructures*
  J. Marco and the int.eu.grid collaboration
  ADVCOMP 2008 (The 2nd International Conference on Advanced Engineering Computing and Applications in Sciences), pp.117-122

- *The Portuguese Grid Initiative; Advanced Engineering Computing and Applications in Sciences, 2008*
  G. Barreira, J. Gomes, G. Borges
  ADVCOMP 2008 (The 2nd International Conference on Advanced Engineering Computing and Applications in Sciences), pp.27-32

Collaboration notes with internal referee

- *int.eu.grid Infrastructure Operation Report*
  J. Gomes, G. Borges, Alvaroi Garcia, Ariel Garcia

- *LIP CA Certificate Policy and Certification Practice Statement V4.2*
  N. Dias, J. Gomes

Internal Notes

- *int.eu.grid: 6th quarterly report*
  J. Marco, R, Pajak, I. Campos, J. Gomes, M. Senar

- *int.eu.grid: 7th Quarterly Report*
  J. Marco, R. Pajak, I. Campos, J.Gomes, M.Senar

- *EGEE SA1 QR1 quarterly report*
  G. Borges, J. Gomes

- *EGEE SA1 QR2 quarterly report*
  G. Borges, J. Gomes

- *EGEE NA2 QR2 quarterly report*
  G. Borges

- *EGEE Definition and Documentation of the Revised Software Life-Cycle*
  Olliver Keeble, G. Borges

3.1.5 Presentations

Oral presentations in international conferences

- *int.eu.grid: A grid infrastructure for interactive applications*
  presented by Gonçalo Borges
  at Instrumenting the GRID ´08 in Ischia, Italy.

- *Resource integration in gLite based grid infrastructures*
  presented by Gonçalo Borges
  at IBERGRID 2008 - 2nd Iberian Grid Infrastructure Conference in University of Porto, Portugal.

- *Overview of the Portuguese National Grid Initiative*
  presented by Jorge Gomes
  at Cracow Grid Workshop 2008 in Cracow Poland.

- *The Portuguese Grid Initiative*
  presented by Gaspar Barreira
  at Engineering Computing and Applications in Sciences, 2008. ADVCOMP in Valencia Spain.

Oral presentations in international meetings

- *The Portuguese National Grid Initiative*
  presented by Jorge Gomes
  at IBERGRID comission meeting in Madrid Spain.

- *Grid Computing in Portugal*
  presented by Jorge Gomes
  at R-ECFA Workshop 2008 in Lisbon.

- *Grid Computing*
  presented by Jorge Gomes
  at ASPERA meeting in Fundação para a Ciência e a Tecnologia , Portugal.

- *The Int.Eu.Grid experience as an interoperable infrastructure between Portugal and Spain*
  presented by Gonçalo Borges
  at IBERGRID 2008 - 2nd Iberian Grid Infrastructure Conference in University of Porto, Portugal.

- *The Portuguese National Grid Initiative*
  presented by Jorge Gomes
  at 2ª Reunión Plenaria Red Española de e-Ciencia in Sevilla, Spain.

Oral presentations in collaboration meetings

- *The LIP Coimbra site*
  presented by Miguel Oliveira
  at LIP Workshop 2008 in Luso, Portugal.

- *Computing at LIP*
  presented by Jorge Gomes
  at LIP Workshop 2008 in Luso, Portugal.

- *LIP Data Storage Infrastructure*
  presented by Mário David
  at LIP Workshop 2008 in Luso, Portugal.

- *The Portuguese T2: Lisbon and Coimbra*
  presented by Mário David
  at Southwest T1T2 meeting in PIC, Barcelona, Spain.

- *The i2g Grid Infrastructure*
  presented by Jorge Gomes
  at int.eu.grid final review in Poznan, Supercomputer Center (PSNC) Poland.

- *TPM tutorial*
  presented by Gonçalo Borges
  at EGEE training in SARA, Amsterdam, Netherlands.

Seminars

- *The Worldwide LHC Computing Grid*
  presented by Jorge Gomes
  at TACC Summer Supercomputing Institute in University of Coimbra, Portugal.

- *Boosting e-Science in Portugal Iberia and in Europe*
  presented by Gonçalo Borges
  at LIP seminar in LIP Lisboa.

- *Advanced Computing: How and Why*
  presented by Miguel Oliveira
  at LIP seminar in LIP Lisboa.

Outreach seminars

- *The future of computing*
  presented by Miguel Oliveira
  at Quark initiative in Coimbra.

- *grid: uma visão*
  presented by Jorge Gomes
  at Ciência 2008 Encontro com a Ciência em Portugal in Fundação Calouste Gulbenkian em Lisboa.

- *Computing: Past, Present & Future*
  presented by Miguel Oliveira
  at Physics@UC in Coimbra.

3.1.6 Events

- *14th EUGridPMA Meeting*
  Workshop, LNEC, Lisbon, 2008-10-06

- *4th gLite and INT.EU.GRID training for end-users*
  Seminar organization, University of Coimbra, 2008-01-31

- *Supercomputing and Parallel Programming*
  Seminar organization, University of Coimbra, 2008-05-05

- *gLite and int.eu.grid training for end users at the 2nd IBERGRID conference*
  Seminar organization, University of Porto, 2008-05-15

- *Good practices on how to keep secrets over the internet... guidelines for LIP users*
  Seminar organization, LIP Lisboa, 2008-10-30

3.1.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	2
International Conference Proceedings	5
Collaboration notes with internal referee	2
Internal Notes	6
Oral presentations in international conferences	4
Oral presentations in international meetings	5
Oral presentations in collaboration meetings	6
Seminars	3
Outreach seminars	3
Workshops	1
Seminar organizations	4

3.2 GRID para simulação e análise de dados de ATLAS/LHC

3.2.1 Activity Report

Resumo

As necessidades de computação da colaboração ATLAS implicam a necessidade de adopção do paradigma de computação GRID. Para isso foi instalado, durante 2008, novo equipamento para o cluster Tier 2 de Grid de LHC (LCG/EGEE), numa federação entre os laboratórios de Coimbra e de Lisboa. Foram adquiridas novas máquinas de instalação em rack, e nova capacidade de armazenamento, no sistema Lustre. Este novo sistema está agora a voltar à produção e testes para a colaboração ATLAS. Foi ainda continuado o trabalho na área da execução de trabalhos remotos em máquinas mais poderosas e/ou com o software requerido instalado, de uma forma anónima, tendo sido assegurada uma ligação fiável entre as máquinas.

Report

The ATLAS production activities of the LIP-Coimbra site are well integrated in the ATLAS activity within the Iberian cloud, which makes part of the Worldwide Large Hadron Collider Computing Grid (WLCG), with infrastructures in Spain and Portugal, including a Tier-1 at PIC, in Barcelona, with several Tier-2s in Spain and the federated Tier-2 at LIP in Coimbra and Lisbon.
In the Atlas computing model, the Atlas production system makes use of the LCG for simulation and analysis of experimental data. The ATLAS production system provides a common framework where any grid flavour may be integrated. It is formed from several individual elements which provide the required functionality for the submission, tracking, recovery and validation of the jobs.
The ATLAS Full Dress Rehearsal (FDR-2), in which representative data samples were used to test the whole of the ATLAS infrastructure, including the LIP Tier-2 for analysis and storage, was a good success, namely for the Iberian Cloud around the Tier1 at PIC in Barcelona, and it was the first big test were the LIP-Coimbra node participated at 100%, and with very good efficiency. These extended test operations are aligned with the WLCG Common Computing Readiness Challenge activities (CCRC-2).
At the end of 2008, the GRID tier 2 site at LIP-Coimbra suffered an important upgrade. The existing infrastructure of around 100 PC boxes, inherited by the former Centopeia parallel computer, was replaced by a new rack based infrastructure, with 60 TB of storage and 160 CPU cores available for ATLAS. A new storage system was implemented using Lustre. There are still tests going on inside the Iberian cloud to bring back the Coimbra node to 100% production level for Atlas. There are still some issues to be solved concerning minor compatibility issues on the operating system level, due to the big change in hardware and upgrades of middleware components, but the last tests show again a good integration of the Coimbra site in the Iberian cloud and thus in the world-wide ATLAS production system.
Data distribution is a basic and most critical service for the ATLAS distributed computing project. Both simulated production and data replication rely on it to spread the data over the sites allowing physicists to perform their analysis on the data. The network connection of the Coimbra node has been switched over to a dedicated 1 Gbit/s fibre connection directly linked to RCCN, which now is shared only between the Grid node and the Milipeia parallel supercomputer. This upgrade solved the limitations of network bandwidth due to the old connection, which was the Gbit/s connection of the university campus.
Members of the project have attended several seminars at CERN that have been instrumental at achieving the main goal. Participation on international conferences [IBERGRID2008] has allowed presentation of the work being carried out on site.

Self-organizing clusters
The progress of the work in the task "self-organizing clusters"can be divided into two parts. One part, regarding the work in the software "RMrun", to support the remote execution of applications, the other concerning the M. Sc. thesis of David Santiago, entitled "Comparison of Peer-to-Peer Searching Schemes". The result of the work on the RMrun software was published in the IBERGRID 2008 international conference.
After this publication, the work on RMrun, during the grants of Luis Pinto and Tiago Santos, was focused on solving the problem of ensuring a reliable connection between peers during the execution of an application. This was work was later resumed by a M. Sc. candidate, Pedro Milheiro.
The M. Sc. thesis of David Santiago was finished in September 2008. The purpose of this thesis was to make a comparison of searching schemes in peer-to-peer networks and adopt state-of-the-art solutions for the location of information in the RMrun software.

3.2.2 Sources of Funding

Code	Funding	Start	End
GRID/GRI/81727/2006	140.000 €	2007-04-12	2010-04-11

3.2.3 Team

Project coordinator: João Carvalho

Name	Status	%of time in project
António Onofre	Researcher (LIP)	20
David Santiago	Master student (FCTUC)	27
Délio Almeida	Researcher (Critical Software)	30
Filipe Araújo	Researcher (FCTUC)	10
Filipe Veloso	Post-Doc (LIP/FCT) *	10
Helmut Wolters	Researcher (LIP)	50
João Bastos	Post-Doc (LIP)	10
João Brito	Researcher (Critical Software)	10
João Carvalho	Researcher (LIP/FCTUC)	25
Luís Moura Silva	Researcher (FCTUC)	2
Miguel Oliveira	Researcher (LIP)	22
Miguel Won	Graduate student (LIP)	50
Nuno Castro	PhD student (LIP/FCT)	10
Patricia Conde	Researcher (LIP/FCT) *	25
Paulo Martins	(LIP)	50
Pedro Jorge	PhD student (LIP/FCT)	25

3.2.4 Publications

International Conference Proceedings

- *Distributed ATLAS computing activities in IBERIA*
  X. Espinal, H.Wolters, et al.
  IBERGRID 2008 (2nd Iberian GRID Infrastructure Conference Proceedings), Ed. F. Silva et al., pp.19-30 (2008)

- *RMrun: peer-to-peer sharing of applications*
  Luis Pinto, Tiago Santos, and Filipe Araujo
  IBERGRID 2008 (2nd Iberian GRID Infrastructure Conference Proceedings), Ed. F. Silva et al., pp.19-30 (2008

3.2.5 Presentations

Oral presentations in international conferences

- *Distributed ATLAS computing activities in IBERIA*
  presented by Helmut Wolters
  at IBERGRID 2008 (2nd Iberian GRID Infrastructure Conference) in Porto.

3.2.6 Academic Training

Master Theses

- *Comparison of Peer-to-Peer Searching Schemes"*
  David Santiago, 2008-07-09

3.2.7 Project Summary

	number
International Conference Proceedings	2
Oral presentations in international conferences	1
Master Theses	1

Chapter 4

Astroparticle Physics

4.1 Collaboration in AMS - Alpha Magnetic Spectrometer

4.1.1 Activity Report

Resumo:

O modelo standard da cosmologia (modelo do Big Bang) baseia-se na expansão do Universo a partir de um estado inicial muito quente e denso e tem como suporte experimental as descobertas do movimento de recessão das galáxias por Hubble em 1929 e da radiação cósmica de fundo por Penzias e Wilson em 1964. No estado inicial do Universo, iguais quantidades de matéria e antimatéria terão sido produzidas. No entanto, o que se observa actualmente nos raios cósmicos que são detectados na Terra é uma clara assimetria na sua composição no que respeita a matéria e antimatéria. A procura de eventuais aglomerados de antimatéria no Universo e o entendimento do mecanismo que produziu esta assimetria são questões essenciais na astrofísica actual. Outra questão fundamental é a compreensão da natureza da matéria que compõe o Universo. Mais de 90% da matéria existente é não-luminosa, isto é, matéria escura, mas a sua composição permanece um mistério. Os raios cósmicos são compostos de partículas neutras e carregadas que atravessam a galáxia em todas as direcções. Um melhor entendimento dos mecanismos de aceleração e propagação requer uma medida dos fluxos de raios cósmicos tão precisa quanto possível e abrangendo o maior intervalo de energias. O detector AMS, a ser instalado na Estação Espacial Internacional por um período de três anos em 2010, permitirá prospectar a existência de antimatéria e matéria escura com uma precisão nunca antes alcançada.

Activities Foreseen:

AMS (Alpha Magnetic Spectrometer) is a particle physics experiment to be installed in the International Space Station Facility (ISS). The main physics objective 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, compared to the one which flew in the Discovery shuttle in 1998, were largely improved and extended through the inclusion of new detectors: a Ring Imaging Cerenkov Detector (RICH), an Electromagnetic Calorimeter (ECAL) and a Transition Radiation Detector (TRD). The RICH will provide an independent measurement of both the particle velocity and the electric charge. A velocity goal resolution for singly charged particles of the order of per mil is envisaged. Such a resolution, together with an improved measurement of the particle rigidity due to a higher magnetic field (0.9T), will allow to obtain a very good isotopic separation on a large kinetic range (up to 10 GeV per nucleon).
The RICH is a conical shaped detector with a dual radiator index configuration on the top made of aerogel (n=1.05) and sodium fluoride (n=1.33), a matrix of photo-detectors on the bottom and an enveloping outer mirror of very large reflectivity. A RICH prototype made of a radiator and 96 photomultipliers separated by an expansion volume similar to the final one, was assembled at the Institut de Sciences Nucléaires (Grenoble). Following previous tests with cosmic data (2001,2002) and a fragmented Lead ion beam of 20 GeV per nucleon (October 2002, CERN), a new prototype run was performed with a fragmented Indium beam of 158 GeV per nucleon (October 2003, CERN). New readout electronics and new readout settings (tuning of the signal peaking time) were tested. The physics program included the testing of different aerogel radiators, the testing of the mirror material and the reconstruction of inclined particles.
The Portuguese team is involved in the RICH simulation and developed algorithms for velocity and charge reconstruction. In addition, the team worked on isotope identification, relying in the AMS full simulation and on the RICH detector skills. Reconstruction of particle velocity has to deal with an essentially flat background

from photomultipliers noise and photon scattering on aerogel radiator. Additionally, complex photon patterns can be set at the detector plane due to the mirror. A least squares and a likelihood method were developed and tested.
A method for charge reconstruction with the RICH detector was also developed. The existence of background photons, uncorrelated with the Cerenkov photon ring, which differ from event to event due to the ring geometrical acceptance and event kinematics implied a charge reconstruction method based on an overall efficiency estimation on a event by event basis. The efficiency estimation relies on a semi-analytical method. A typical charge resolution (DZ) of the order of 20% is obtained for protons.
The AMS detector status on 2008 is as follows:

- the RICH detector was fully assembled and moved to Cern
- a clean room on Cern building 867 was set for receiving the different AMS detector components
- the AMS detector was pre-assembled (excluding the superconducting magnet) and the electronics was integrated
- cosmic data was gathered during three months

During 2008 the group participated in the following activities:

- RICH reconstruction:

The LIP reconstruction algorithms were implemented in the AMS full simulation and reconstruction framework. The data objects were implemented on the tree and ntuple ROOT outputs.

- RICH cosmics data analysis:

The AMS detector, after its assembling on building 867, was for the first time exposed to cosmic data. A large sample of essentially relativistic muons were collected and reconstructed. Such events allow for detector checks and performance evaluations. In the case of the RICH an analysis of a substantial data sample and after a fine tuning of the aerogel tiles refractive index showed a reconstructed velocity resolution of the order of 1.4 per mil. In addition, a further analysis will allow to check non uniformities on the reflectivity of the mirror and to evaluate other detector effects as aerogel clarity and light guide pipes efficiency.

- RICH physics analysis:

The good identification capabilities of the RICH detector were explored on the antideuteron channel where a dominant antiproton background had to be rejected. Studies for optimizing the rejection power were performed.

Talks and Publications

- "Antimatter and Dark Matter search in space with AMS-02"

AMS-02 collaboration
Proceedings of the 34th International Conference on High Energy Physics, Philadelphia, 2008
arXiv:0810.3831

- "LIP contribution to the AMS experiment"

(Jornadas LIP, Luso, 11-01-2008)

- "AMS cosmic data tests: Reconstruction of cosmic muons using the RICH detector"

(2nd PASC Winter School, Sesimbra, 18-12-2008)

Collaboration meetings

- "Implementation of LIP reconstructions in AMS software"

(Madrid, 29-04-2008)

- "LIP reconstructions in AMS software: update"

(Madrid, 17-06-2008)

- "Analysis of the 2008 cosmic-ray data using the AMS RICH"

(Madrid, 13-10-2008)

- "Aerogel light yield characterization in the 2002 and 2003 beam tests"

(Madrid, 14-10-2008)

PhD Thesis

- "Charge and Velocity Reconstruction with the RICH detector of the AMS experiment: analysis of the RICH prototype data", Luisa Arruda.

Instituto Superior Tecnico, Technical University of Lisbon.
January 18, 2008

4.1.2 Sources of Funding

Code	Funding	Start	End

4.1.3 Team

Project coordinator: Fernando Barão

Name	Status	%of time in project
Fernando Barão	Researcher (LIP/IST)	65
Gaspar Barreira	Researcher (LIP)	5
Luisa Arruda	Post-Doc (LIP) *	20
Patrícia Gonçalves	Researcher (LIP)	5
Rui Faísca Pereira	PhD student (LIP/FCT)	100

4.1.4 Presentations

Oral presentations in international conferences

- *AMS cosmic data tests: Reconstruction of cosmic muons using the RICH detector*
  presented by Rui Faísca Pereira
  at 2nd PASC Winter School in Sesimbra, Portugal.

Presentations in national conferences

- *LIP contribution to the AMS experiment*
  presented by Rui Faísca Pereira
  at Jornadas LIP 2008 in Luso, Portugal.
- *AMS and RICH status: Activity report*
  presented by Fernando Barão
  at Jornadas LIP 2008 in Luso, Portugal.

Oral presentations in collaboration meetings

- *Implementation of LIP reconstructions in AMS software*
  presented by Rui Faísca Pereira
  at AMS RICH meeting in Madrid, Spain.
- *LIP reconstructions in AMS software: update*
  presented by Rui Faísca Pereira
  at AMS RICH meeting in Madrid, Spain.
- *Analysis of the 2008 cosmic-ray data using the AMS RICH*
  presented by Rui Faísca Pereira
  at AMS RICH meeting in Madrid, Spain.
- *Aerogel light yield characterization in the 2002 and 2003 beam tests*
  presented by Rui Faísca Pereira
  at AMS RICH meeting in Madrid, Spain.

4.1.5 Academic Training

PhD Theses

- *Charge and velocity reconstruction with the RICH detector of the AMS experiment: Analysis of the RICH prototype data"*
  Luisa Arruda, 2008-01-18
- *Deuterium and light isotopes measurements and Dark matter searches with the AMS experiment"*
  Rui Faísca Pereira, (on-going)

4.1.6 Project Summary

	number
Oral presentations in international conferences	1
Presentations in national conferences	2
Oral presentations in collaboration meetings	4
PhD Theses	1

4.2 Collaboration in the SNO and SNO+ experiments

4.2.1 Activity Report

Sumário

Em 2008 o grupo de Física de Neutrinos do LIP concentrou-se na análise de fluxo total de neutrinos solares do Boro-8 e física das oscilações em SNO e na preparação de SNO+. Os recursos humanos dedicados ao projecto cresceram ligeiramente. Integrámos também uma estudante de licenciatura nas actividades de SNO+, no âmbito do programa de Bolsas de Integração na Investigação da FCT.
Depois de um ano sem financiamento, o projecto SNO+ teve apoio do fundo CERN em 2008, e estamos à espera do financiamento por três anos no quadro do concurso geral da FCT.

SNO

Em SNO, foram concluídas duas tarefas que vinham a ser desenvolvidas nos anos anteriores, e deu-se início às análises de física de neutrinos:

- Terceira fase de SNO Os resultados da terceira fase de SNO, para a qual o nosso grupo deu uma forte contribuição para a calibração óptica, foram publicados e, mesmo usando uma técnica muito diferente para a medição das correntes neutras, confirmam os resultados das fases anteriores.

- Melhorias na calibração óptica Foi concluído também o trabalho de melhorias na calibração óptica para a análise combinada das três fases, tendo sido feito um estudo das reflexões da luz nos contadores proporcionais presentes na fase 3, usando simulações Monte-Carlo. Verificámos que os resultados do método existente, que usa uma correcção analítica do efeito das reflexões nos parâmetros ópticos, são compatíveis com a análise mais detalhada, baseada em simulação, o que estabelece a fiabilidade da correcção de reflexões da calibração óptica da fase 3 de SNO.

- Oscilações de neutrinos Foi iniciada a actividade em Física de oscilações de neutrinos em SNO. Tendo como objectivo final a adaptação das ferramentas existentes à análise combinada das três fases de SNO, neste ano foram realizados estudos da sensibilidade aos parâmetros de oscilação de uma possível nova análise dos dados da fase 3, com separação entre dia e noite e entre bins de energia. Um dos membros da equipa (NB) visitou o grupo da Universidade de Carleton (Canadá) por dois meses, de modo a ganhar familiaridade com os detalhes do software já existente para o efeito. No âmbito da adaptação dos algoritmos foi já desenvolvido um novo método para extrair dos dados uma função que parametrize a probabilidade de sobrevivência dos neutrinos do electrão, a qual permite efectuar uma comparação alternativa ao modelo solar e ao modelo de oscilações. A vantagem deste método advém do facto de permitir uma integração mais simples e imediata das diferentes fases da experiência nos algoritmos finais de medida dos parâmetros de oscilação.

- Fluxo total de neutrinos do Boro-8 Foi também iniciada uma análise alternativa de medição do fluxo total de neutrinos solares do Boro-8, baseada na subtracção dos espectros de energia normalizados de fases diferentes de SNO. Não se espera que esta análise tenha uma precisão no fluxo de neutrinos superior à análise standard, em que todas as distribuições são tomadas em conta. Será antes uma verificação de consistência, com um método bastante mais simples.

SNO+

As actividades do grupo em SNO+ centraram-se até aqui no software de simulação, mas também contribuímos para a calibração e estudos de fenomenologia.
Em SNO+, o detector de SNO será reutilizado substituindo o alvo/meio activo de água pesada por cintilador, e o plano da experiência prevê uma fase dedicada à procura do declínio beta duplo sem neutrinos com o isótopo Neodímio-150, e outra à Física dos neutrinos solares de baixa energias (pep e CNO), geo-neutrinos, neutrinos de reactor e de supernovas.
A preparação de SNO+ está em fase avançada, prevendo-se a instalação das adaptações necessárias ao uso de cintilador durante 2009 e 2010 e é previsto começar a tomar dados em 2011.
Em detalhe, as actividades em SNO+ foram:

- Software de simulação O código de simulação de SNO, em FORTRAN, foi adaptado para SNO+, e um novo código baseado em GEANT4 irá substituí-lo a longo prazo. O grupo trabalhou na implementação

de geometria necessária em ambos os programas. Implementámos no novo código a geometria base de SNO - balão de acrílico, placas e cordas de suporte, pontos de ancoragem (dos contadores proporcionais usados na fase 3 de SNO) e tubagem - que está agora a ser completado por outros grupos de SNO+. Por outro lado, na simulação em FORTRAN, introduzimos o único novo elemento geométrico de SNO+: o sistema de cordas de ancoragem do balão de acrílico (necessário devido à baixa densidade do cintilador). Com esta implementação, foi possivel determinar que as sombras introduzidas por cordas de até 5cm de diâmetro reduzem a eficiência de colecção de luz em cerca de 5%, mas apenas para acontecimentos na parte superior do detector, o que é aceitável dentro dos parâmetros esperados. Por outro lado, o limite aceitável da contaminação radioactiva nas cordas (1 ppm de Potássio-40) foi também determinado por nós usando um outro software dedicado (da experiência Borexino), tendo um impacto directo na construção de SNO+. Neste momento, o software de simulação está bastante avançado, e começamos a concentrar-nos no software de reconstrução e análise de dados. E a planear as aplicações para os diversos canais de física acessíveis a SNO+.

- Fenomenologia Em termos de fenomenologia, depois de em 2007 termos estudado a sensibilidade de SNO+ à física de neutrinos solares e à distinção entre o fenómeno de oscilação de neutrinos e contribuições anómalas, estamos agora a estudar a sensibilidade de SNO+ à oscilação de anti-neutrinos de reactor.

- Calibração Em termos de hardware e funcionamento do detector, a contribuição do LIP para SNO+ mantém-se focada na calibração óptica e no desenvolvimento de um novo sistema de calibração em tempo, menos intrusivo do que o utilizado em SNO. Para tal, colaboramos com a Universidade de Sussex, no desenho e caracterização de um sistema de fibras ópticas que possam iluminar todos os PMTs, sem introduzir fontes externas no cintilador. Em Agosto de 2008, participámos em turnos de recolha de dados de calibração óptica no laboratório SNOLAB. O objectivo dessa tomada de dados era a análise do estado actual do detector, de modo a permitir caracterizar melhor a evolução no tempo da resposta dos PMTs de SNO e fornecer um primeiro ponto de calibração para SNO+. No entanto, no segundo dia de tomada de dados registou-se uma falha da electrónica do detector, despoletada por uma tempestade de relâmpagos. Devido a esse problema, a tomada de dados teve de ser cancelada, e entretanto a água teve de ser removida do detector. No entanto, prevê-se repetir esta calibração óptica em água leve imediatamente antes do enchimento com cintilador, em 2010. A monitorização do estado do detector ao longo do tempo continua uma das preocupações centrais, e a calibração óptica continuará a ser uma das responsabilidades do grupo em SNO+.

Summary

In 2008 the LIP Neutrino Physics group has focused on the total Boron-8 solar neutrino flux analysis and oscillation Physics in SNO and in the preparation of the SNO+ experiment. The human resources dedicated to the project have slightly increased. We have integrated an undergraduate student in the SNO+ activities, within the scope of the new FCT program of "Integration into Research"grants. After one year with no funding, the SNO+ project had some support from the CERN fund in 2008, and we have applied for 3-year funding in the general FCT call for projects.

SNO

In SNO, we have concluded two tasks that had been developed in previous years, and have started the Neutrino Physics analyses:

- Third phase of SNO The results from the third phase of SNO, for which our group gave a strong contribution to the optical calibration, were published and, even using a very different technique for the neutral current measurement, confirm the previous results.

- Optical calibration improvements We also concluded the work on improvements for the optical calibration for the combined 3-phase analysis. Using Monte Carlo simulations, a study on the light reflections in the proportional counters in phase 3 was carried out, in order to take them into account in the optical parameter measurements. We verified that the results of the existing method, that used an ad-hoc analytical correction for this purpose, were compatible with the more detailed Monte Carlo approach, confirming the soundness of the reflection correction in the SNO phase 3 optical calibration.

- Neutrino oscillations We started the activity of Neutrino Oscillation Physics in SNO. Having the final goal of adapting the existing tools to the combined 3-phase analysis of SNO, in this year we carried out

sensitivity studies to the oscillation parameters from a possible new phase 3 data analysis, with day/night flux separation, and an energy spectrum extraction. One of the team members (NB) visited the Carleton University (Canada) group for two months in order to gain familiarity with the details of the existent analysis software. In the context of the this algorithm adaptation, a new method was already developed to extract from the data a function to parameterize the electron neutrino survival probability, which would allow an alternative comparison to the solar model and to oscillation predictions. The advantage of this method comes from the fact that it allows a simpler integration of the different phases of the experiment in the final algorithm for oscillation parameter measurement.

- Total flux of Boron-8 neutrinos We have also started an alternative analysis for the measurement of the total Boron-8 solar neutrino flux, based on the subtraction of the normalized energy spectra from different phases of SNO. We do not expect this analysis to have a better precision than the standard analysis, in which all the distribution are taken into account. It will be a consistency cross-check, with a much simpler method.

SNO+

The group´s activities in SNO+ have been centered so far on the simulation software, but we have also contributed to the calibration and phenomenology studies. In SNO+, the SNO detector will be reused by replacing the target/active medium of heavy water by liquid scintillator, and the experiment plan foresees a phase dedicated to the neutrinoless double beta decay search with the Neodymium-150 isotope, and another phase dedicated to the Physics of low energy solar neutrinos (pep and CNO), geo-neutrinos, reactor and supernova neutrinos.
The preparation of SNO+ is in an advanced phase: the adaptations needed for the use with scintillator will be installed during 2009 and 2010, and the expected data-taking start-date is 2011.
In detail, the SNO+ activities were:

- Simulation software. The SNO simulation code, written in FORTRAN, was adapted to SNO+, and a new code based on GEANT4 will replace it in the long run. The group has worked in the implementation of the necessary geometry in both programs. In the new code we have implemented the basic SNO geometry - acrylic vessel, support plates and ropes, anchor points (for the proportional counters used in the third phase of SNO) and piping - that is now being completed by other SNO+ groups. On the other hand, in the FORTRAN simulation, we have introduced the only new geometrical element for SNO+: the acrylic vessel hold-down rope system (needed because of the low density of the scintillator). With this improvement, we were able to determine that the shadows due to the new ropes (if they have no more than 5 cm diameter) will reduce the light collection efficiency by about 5%, but only for events on the top part of the detector, which is acceptable within the expected performance parameters. In addition, the acceptable limit for radioctive contamination on the rope material (1 ppm of Potassium-40) was also determined by us using another dedicated software (from the Borexino experiment), having a direct impact on the construction of SNO+. At this time, the simulation software is quite advanced, and we start to focus more on the software for reconstruction and data analysis, and planning the application to the several Physics channels accessible to SNO+.

- Phenomenology In terms of phenomenology, after having studied in 2007 the sensitivity of SNO+ to solar neutrino physics and the distinction between neutrino oscillations and anomalous contributions, we are now studying the sensitivity of SNO+ to the oscillation of reactor anti-neutrinos.

- Calibration In terms of hardware and detector operation, the LIP contribution to SNO+ keeps focused on the optical calibration and the development of a new timing calibration system, less intrusive than the one used in SNO. To that purpose, we collaborate with the University of Sussex in the design and characterization of an optical fiber system that can illuminate all the PMTs, without introducing external sources in the scintillator volume. In August 2008, we participated in data taking shifts of optical calibration at SNOLAB. The goal of these data was the analysis of the present detector status, in order to allow a better charaterization of the time evolution of the PMT response and supply a first point of calibration for SNO+. However, in the second day of data taking, a detector electronics failure occurred, caused by a thunderstorm. Due to that problem, the data taking was cancelled, and in the meanwhile the water had to be removed from the detector. We expect to repeat this measurement with light water immediately before the filling with liquid scintillator, in 2010. The monitoring in time of the detector status is still a central issue, and the optical calibration will remain one of the responsibilities of our group in SNO+.

4.2.2 Sources of Funding

Code	Funding	Start	End
CERN/FP/83548/2008	10.000 €	2008-11-01	2009-10-31

4.2.3 Team

Project coordinator: José Maneira

Name	Status	%of time in project
Amélia Maio	Researcher (LIP/FCUL)	6
João Rodelo	Student (LIP)	10
José Maneira	Researcher (LIP)	26
Luís Gurriana	Technician (LIP)	2
Nuno Barros	PhD student (LIP/FCT)	100
Sofia Andringa	Researcher (LIP/FCT) *	10

4.2.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Independent Measurement of the Total Active 8B Solar Neutrino Flux Using an Array of 3He Proportional Counters at the Sudbury Neutrino Observatory*
  SNO Collaboration (includes J. Maneira, N. Barros)
  Phys. Rev. Lett. 101, 111301 (2008)

4.2.5 Presentations

Oral presentations in collaboration meetings

- *NCD Optics Improvements*
  presented by Nuno Barros
  at SNO 3-phase workshop in SNOLAB, Sudbury, Canada .
- *Preliminary NCD phase day/night/lower threshold PhysInt ... and plans for subtraction*
  presented by Nuno Barros
  at SNO 3-phase workshop in SNOLAB, Sudbury, Canada .
- *Preliminary NCD Phase PhysInt results with day/night*
  presented by Nuno Barros
  at SNO Collaboration Meeting in SNOLAB, Sudbury, Canada .
- *SNO+ geometry implementation in RAT*
  presented by Nuno Barros
  at SNO+ Monte Carlo meeting in SNOLAB, Sudbury, Canada .
- *Rope and external background studies*
  presented by José Maneira
  at SNO+ Collaboration Meeting in SNOLAB, Sudbury, Canada .

4.2.6 Academic Training

PhD Theses

- *Optical calibration and neutrino oscillation measurements at the Sudbury Neutrino Observatory (SNO)"*
  Nuno Barros, (on-going)

4.2.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
Oral presentations in collaboration meetings	5

4.3 Development of liquid xenon detectors for WIMPs search and CERN experiment PS213

4.3.1 Activity Report

During 2008 the LIP team strengthened and extended its participation in the ZEPLIN III Collaboration. Moreover the R&D program regarding liquid xenon detectors for dark matter search and related topics was continued at LIP Laboratory in Coimbra.

Participation in ZEPLIN-III experiment

In 2008 the underground commissioning of ZEPLIN-III and the ancillary systems was completed. This included gas handling, cooling, shielding, external levelling, data acquisition system, slow control, data pipeline and calibration delivery setup. Calibrations with Am-Be, 137Cs, 57Co and 60Co were used to confirm the performance of the detector and optimise operation parameters. The first science run was carried out from 27 February 2008 to 20 May 2008. From 84 day live run, the total exposure following the application of fiducial cuts and efficiency correction was 120 kg.day. In December 2008, the ZEPLIN-III Collaboration submitted its first science results for publication. These rule out the scalar and the spin-dependent WIMP-nucleon interactions with world competitive sensitivity (7.7x10-8 pb at 55GeVc-2), in fact similar to those of the world's leading experiments, CDMS-II and XENON10, which are both US-led. ZEPLIN-III has out-performed all European experiments by a significant margin.
Meanwhile, the ZEPLIN-III engineering upgrade in view of a second and longer science run was started. This upgrade includes the replacement of the photomultipliers by very low background ones, the upgrade of the detector in view of applying higher electric fields, the installation of a scintillator veto and the improvement of the safety systems. With this second set of data, a sensitivity of 5.6x10-9 is expected to be achieved.
In 2008, the main responsibilities of LIP-Coimbra team in the ZEPLIN-III experiment were the following:

Slow Control and Date Acquisition System
LIP-Coimbra team continued to have full responsibility for the slow control system and the DAQ Software. In view of the second science run, an upgrade of the slow control was started with the aim of improving reliability and flexibility of the system. A new temperature monitor, more reliable and with less power consumption, was designed by LIP-team and built by LIP electronics workshop. As for the data acquisition system, a new machine with 4 CPU cores, 4 Gb RAM memory and 4.5 Tb storage has already been bought and the DAQ software started to be updated in order to take advantage of this new hardware, one of the main objectives being to minimize the DAQ dead time.

Data Reduction and Analysis software (ZE3RA)
The development, maintenance and upgrade of the software application that carries out that task - ZE3RA (ZEplin 3 Reduction and Analysis) - is one of the responsibilities of the LIP team in the Collaboration.
ZE3RA reads the files from the DAQ system and outputs a set of numeric parameters describing each pulse found on each waveform. The software comprises the reduction algorithms that process the waveforms from each channel and an event viewer.
In 2008 the data analysis algorithms were improved along the following lines:

- Improvement of the identification of after-pulses and their separation from S1 pulse;
- Better identification of saturation tails following large secondary scintillation pulses. Those tails produced by the amplifiers cause severe distortion of the signals registered on the 31 high sensitivity channels. The efficient flagging of all saturation scenarios allowed to recover events that would be discarded otherwise.
- Upgrade the baseline recovery algorithm. The previous one besides being too slow to use with real time data analysis did not present a satisfactory behaviour either for very low energy deposits or in the occurrence of saturation tails. These two extreme situations fall respectively in the region of interest for WIMP search and instrument stability assessment/calibration using radioactive sources (57Co, 60Co, 137Cs).
- Improvement of the equalization of the photomultiplier array response. This allowed to optimize the results from the implemented pulse matching algorithm.

The data reduction software suite (ZE3RA) was fully created, implemented and optimized by LIP-Coimbra team. It processed many millions of events (tens of terabytes of data) in the first stage of data analysis. This is a very critical task in rare event searches, in particular those looking for very small signals. ZE3RA has been a key part of the success of the first science run.

Data Analysis
LIP-Coimbra also had a strong participation in the analysis of the data from the first science run. Namely:

- Developed and implemented the position reconstruction code which allowed the knowledge of the interaction position in the horizontal plane (in the perpendicular direction, the position is obtained from the drift time). Position reconstruction algorithm uses the converged response profiles in a simultaneous least-squares minimisation to all channels. The position reconstruction improves the energy resolution and allows the maximization of the fiducial volume and detector exposure, which ultimately greatly improved the final sensitivity of the detector.
- Developed of a novel method for calibrating arrays of photomultiplier tubes. This allowed us to establish the response linearity of our experiment to small signals. This work will be submitted for publication very soon. The technique developed is already attracting the interest of others who want to apply it to detector arrays.
- Carried out a rigorous statistical characterization of the gamma-ray background population. This analysis strongly contributed to the tight limits we went on to place on the hypothetical presence of a WIMP signal in the data.
- Array flat-fielding: the 31 PMTs have different responses (gains and quantum efficiencies), which have to be equalized in order to make the trigger efficiency uniform throughout the sensitive volume. This information can also be used to minimize the overall systematic bias on the reconstructed interaction position.

In 2008, our team provided about 120 man.days at Boulby Mine Underground Laboratory during re-commissioning, calibration and science run.

R&D Activities

For the LIP-Coimbra team was a priority to contribute to the effort to finalize the commissioning of ZEPLIN-III and carry out the scientific run. Nevertheless, the team managed to carry out simultaneously the R&D program that was planed, although at a slower pace that was expected. The main activities and respective results can me summarized as:

1. The muon-induced neutron flux at the Boulby Underground Laboratory was measured and simulated. The experimental results and their comparison with the predictions obtained by simulation were already published and a detailed description of the simulation was submitted for publication.
2. The measurements of reflectance of materials employed in liquid xenon detectors were continued. Both the reflection profile and the absolute value of the reflectivity were measured at wavelengths from 175 nm to 420 nm. The data has was analysed and compared with the Monte Carlo simulation of the reflection processes implemented in GEANT4. The results were presented at 2008 IEEE Nuclear Science Symposium, Dresden, and published in its proceedings.
3. The operation of GEM (Gaseous Electron Multipliers) in the gas phase of a two-phase xenon chamber as studied in view of assessing the GEM as an alternative readout for two-phase detectors. Stable operation (more than 1 hour) of the GEM with the visible gain up to 150 was achieved. Results were presented at 10th Intern. Conf. on Instrumentation for Colliding Beam Physics, Russia, and they were also published.

4.3.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81928/2007	75.000 €	2007-07-01	2008-09-30
CERN/FP/83501/2008	75.000 €	2008-10-01	2009-09-30

4.3.3 Team

Project coordinator: Isabel Lopes

Name	Status	%of time in project
Alessio Mangiarotti	Researcher (LIP)	15
Alexandre Lindote	PhD student (LIP)	100
Américo Pereira	Technician (LIP)	25
Ana Patrícia Eliseu	Master student	75
Armando Policarpo	Researcher (LIP/FCTUC)	7
Cláudio Silva	PhD student (LIP/FCT) *	100
Edward Santos	Master student (LIP)	75
Filipa Balau	PhD student (LIP)	88
Francisco Neves	Post-Doc (LIP)	100
Isabel Lopes	Researcher (LIP/FCTUC)	55
José Pinto Da Cunha	Researcher (LIP/FCTUC)	29
Nuno Carolino	Technician (LIP)	14
Rui Marques	Researcher (LIP/FCTUC)	7
Vitaly Chepel	Researcher (LIP/FCTUC)	34
Vladimir Solovov	Researcher (LIP)	100

4.3.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *The ZEPLIN II dark matter detector: Data acquisition system and data reduction*
  G.J. Alner et al.
  Nuclear Instruments and Methods in Physics Research A 587 (2008) 101-166

- *Measurements of neutrons produced by high-energy muons at the Boulby Underground Laboratory*
  H.M. Araujo et al.
  Astroparticle Physics 29 (2008) 471-481

- *Measurement of single electron emission in two-phase xenon*
  B.Edwards,H.M.Araujo, V.Chepel, D.Cline,T.Durkin, et al.
  Astroparticle Physics 30 (2008) 54-57

- *GEM operation in double-phase xenon*
  F. Balau, V. Solovov, V Chepel, A. Pereira, M I Lopes
  Nuclear Instruments and Methods A 598 (2009) 126-129

Articles in international journals (with indirect contribution from LIP members)

- *Neutron capture cross section of 90Zr: Bottleneck in the s-process reaction flow*
  G. Tagliente,et al.
  10.1103/PhysRevC.77.035802

International Conference Proceedings

- *Refection of the Xenon Scintillation Light from Polytetrafuoroethylene (PTFE)*
  C. Silva, J. P. da Cunha, A. Pereira, V. Chepel, M. I. Lopes, V. Solovov

4.3.5 Presentations

Poster presentations in international conferences

- *GEM operation in double-phase xenon*
  presented by Filipa Balau
  at 10th Intern. Conf. on Instrumentation for Colliding Beam Physics in Novosibirsk, Russia.
- *Reflection of the Xenon Scintillation Light from Polytetrafuoroethylene (PTFE)*
  presented by Cláudio Silva
  at 2008 Nuclear Science Symposium in Dresden, Germany.

Oral presentations in international meetings

- *Condensed Noble Gases for Direct Dark matter Search*
  presented by Isabel Lopes
  at in Melbourbe, Australia.

Oral presentations in collaboration meetings

- *DAQ and data pipeline*
  presented by Alexandre Lindote
  at ZEPLIN III Collaboration Meeting in Boulby Mine, UK.
- *SPE calibrations*
  presented by Francisco Neves
  at ZEPLIN III Collaboration Meeting in Boulby Mine, UK.
- *Compton Calibrations*
  presented by Vitaly Chepel
  at ZEPLIN III Collaboration Meeting in Boulby Mine, UK.
- *ZE3RA status and SPE Analysis*
  presented by Francisco Neves
  at in ITEP, Moscow, Russia.
- *Mercury v1.05*
  presented by Vladimir Solovov
  at in ITEP, Moscow, Russia.

4.3.6 Academic Training

PhD Theses

- *Data acquisition and analysis of ZEPLIN detectors"*
  Alexandre Lindote, (on-going)
- *Liquid xenon detectors for WIMP search"*
  Cláudio Silva, (on-going)

Master Theses

- *Estudo de funcionamento dos GEMs em detectores de xénon líquido"*
  Filipa Balau, 2008-04-01
- *Study of Multi-Pixel Photon Counters at low temperature and for UV light"*
  Ana Patrícia Eliseu, (on-going)

4.3.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	4
Articles in international journals (with indirect contribution from LIP members)	1
International Conference Proceedings	1
Poster presentations in international conferences	2
Oral presentations in international meetings	1
Oral presentations in collaboration meetings	5
Master Theses	1

4.4 High Energy Cosmic Rays

4.4.1 Activity Report

Resumo

A física dos raios cósmicos de alta energia, tanto carregados como neutros, tem vivido nos últimos anos um período de intensa actividade. O Observatório Pierre Auger publicou recentemente resultados que abrem novas perspectivas tanto em astronomia como na física de partículas a energias acima do LHC. Por outro lado, os telescópios de raios gama têm vindo a descobrir um número notável de fontes de muito alta energia. O LIP participa neste esforço como membro do Observatório Pierre Auger e do projecto GAW - Gamma Air Watch. As actividades do grupo do LIP em Auger desenvolveram-se em torno de dois pólos principais: a análise dos dados recolhidos pelos detectores de fluorescência e o programa de extensão e melhoria das capacidades do Observatório. Em GAW, o grupo do LIP tem responsabilidades na simulação e no desenho e implementação dos sistemas de aquisição de dados, sincronização e trigger. Por último, foi ainda desenvolvido trabalho de fenomenologia nesta área.

Summary

The field of High Energy Cosmic Rays (HECR), both charged and neutral, has witnessed an impressive activity in the last few years. The Pierre Auger Observatory (Auger) has recently published several results on the extreme HECR which may open a new window both in astronomy and in particle physics at energies above the LHC. On the other hand, gamma ray telescopes have recently discovered a remarkable number of very high energy sources. LIP participates in this effort being a full member of the Pierre Auger Observatory and of the Gamma Air Watch project (GAW). LIP´s activities in the Pierre Auger Observatory were centered on the analysis of the fluorescence detector data and on the observatory enhancement program. In GAW, LIP has responsibilities in the detector simulation, data acquisition and trigger firmware. Finally, phenomenological work on this field has also been pursued.

Participation in Auger

The Pierre Auger Observatory is a worldwide collaboration for research on ultra high energy cosmic rays. The Southern site in Mendoza, Argentina, is now completed. The AMIGA and HEAT enhancement projects are under way. The design of the northern site in Colorado, USA, should be ready soon.
The first results on the energy spectrum and on the arrival directions of the highest energy cosmic rays, based on data acquired with a variable acceptance during the installation period, showed the enormous capabilities of the Observatory, and had a large impact within the scientific community. A GZK-like cut-off is clearly established, and the arrival directions of the highest energy cosmic rays were shown not to be isotropic. A correlation with the locations of nearby galaxies with active nuclei, and the idea that protons are the primary particles, are favoured by these data. Meanwhile, results on the elongation rate of the extensive air showers at these energies were also presented and are in contradiction with the current expectations assuming a light composition. On the other hand, the Auger surface detector data show that the muon content of air showers is not described by the models. We are thus in a very interesting period, with new data constantly arriving and challenging puzzles to be solved.
The Portuguese participation in Auger is built around the Fluorescence Detectors (FD) data and the detector enhancements projects. The main topics of our work in the Auger FD were part of the common effort of the collaboration to better control issues related to air shower development. These topics included:

- The maintenance and user support of the GEANT4 simulation of the FD developed in previous years by the LIP group and now part of the Auger offline software;
- The development of a 3-dimensional simulation tool with an accurate treatment of the light production and scattering in air showers;
- Several studies of FD data based on the existence of a relatively universal shower profile, namely a new parameterization of the longitudinal profile, which may give information on the interactions constituting the hadronic core of the shower;
- A detailed study of the light collection efficiency of the FD camera pixels using simulated data and laser events;
- The development of analysis tools to exploit events with a sizable amount of direct Cherenkov light arriving at the FD telescope;

- The first studies on the searches for exotic physics at these extreme energies.

Concerning the enhancements, the LIP team is involved in AMIGA (Auger Muon Infill for the ground array, which will decrease the energy threshold of the experiment and provide muon identification capabilities) and in HEAT (High Elevation Atmospheric Telescope, increasing the FD coverage up to 60°). Amiga is in preparation phase, and the LIP group actively participated in the simulation studies for the detector design optimisation. A master thesis on the subject was completed in 2008.
The HEAT telescopes were installed in 2008. During this year the LIP team has actively worked on the development of analysis tools and ideas relevant for the enhanced detector capabilities for nearby showers provided by HEAT. This is in particular the case of the 3D simulation and reconstruction tools mentioned above, as well as of the studies with Cherenkov-rich events.

Participation in GAW

The Gamma Air Watch (GAW) project is a path-finder experiment to test the feasibility of a new generation of Imaging Air Cherenkov Telescopes (IACT), aiming at combining the high sensitivity typical of IACTs with a large field-of-view presently only achievable with particle shower detection techniques. This project explores the potential of refractive optics, using Fresnel lenses, instead of the presently adopted mirror based optics, and a new technique for light detection at the focal surface based on the single photoelectron counting mode. The GAW telescopes (three, in the complete version) will be installed at the Spanish-German Astronomical Centre at Calar Alto, in Andalucia, Spain.
The first GAW telescope is being installed. The civil engineering work at the Calar Alto site is well advanced and, in particular, the construction of the building to house the telescope is finalized. The telescope mechanical structure, including the spider support for the lens petals was manufactured by a specialized company (ASTELCO Systems) and, after the acceptance tests carried at the ASTELCO headquarters, was sent to the Calar Alto site.
The LIP team has responsibilities in the detector simulation, in the design and implementation of the data acquisition, synchronization and trigger systems. Concerning the optical system, LIP contracted with a leading manufacturer of molded plastics and Fresnel lenses the base study required to select the acrylic lens material. In addition, after freezing the design through detailed Geant4-based simulations, LIP also contracted with an Italian company the construction of the mold and the production of the required pieces for the lightguides.
The implementation of an end-to-end framework simulation for GAW composed of several modules, each corresponding to a well defined part of the physics and detector simulation, has been pursued.
In order to test and develop the trigger firmware, a test bench was developed at LIP. The system is composed by a board (CTRIG) that simulates the connection with the Trigger Generation Board and the control and read-out system. The Board converts the data from the LVDS and MLVDS protocols to TTL levels. The front-end electronics is simulated using an interface board (LIP-Excite) and external signal generators based on a commercially available FPGA development board. After validation tests carried on prototype versions of the two boards, the design of the final version was implemented and tested at 200 MHz.

HECR Phenomenology

In 2008, a model for net-baryon rapidity in high energy proton-proton and nucleus-nucleus collisions was developed. The basic ingredients of the model are valence string formation based on standard PDFs with QCD evolution and string fragmentation via the Schwinger mechanism. A good fit to the data at different centre-of-mass energies and centralities was obtained within this model, showing that the main features of net-baryon are well described. The evolution with the centre-of-mass energy was accessed, predicting that a sizable amount of energy may be associated to the net-baryon, even at very high energies. This work was carried out in a close collaboration with theoreticians from CENTRA.

4.4.2 Sources of Funding

Code	Funding	Start	End
PTDC/FIS/65308/2006	155.000 €	2007-04-22	2009-04-21
POCI/FP/81914/2007	125.000 €	2007-07-01	2008-09-30
CERN/FP/83484/2008	125.000 €	2008-10-01	2009-09-30

4.4.3 Team

Project coordinator: Mário Pimenta

Name	Status	%of time in project
Alessandro de Angelis	Researcher	10
Bernardo Tomé	Researcher (LIP)	80
Catarina Espírito Santo	Researcher (LIP)	95
Eva Santos	PhD student (LIP) *	100
Fernando Barão	Researcher (LIP/IST)	30
João Carvalho	Researcher (LIP/FCTUC)	6
Jorge Dias de Deus	Researcher (LIP/IST)	10
Jorge Romão	Researcher (IST)	10
José Carlos Silva	Technician (LIP)	5
José Milhano	Researcher	10
Luís Mendes	Technician (LIP)	100
Luisa Arruda	Post-Doc (LIP) *	80
Mário Pimenta	Researcher (LIP/IST)	80
Miguel Pato	Graduate student (LIP)	16
Patrícia Gonçalves	Researcher (LIP)	50
Pedro Abreu	Researcher (LIP/IST)	50
Pedro Assis	PhD student (LIP/FCT)	90
Pedro Brogueira	Researcher (LIP/IST)	20
Ruben Conceição	PhD student (LIP/FCT)	100
Sofia Andringa	Researcher (LIP/FCT) *	89

4.4.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Observation of the Suppression of the Flux of Cosmic Rays above 4 x 10ˆ19 eV*
  J. Abraham, et. al., The Pierre Auger Collaboration.
  Phys. Rev. Let. 101, 061101 (2008)

Articles in international journals (with indirect contribution from LIP members)

- *Upper limit on the cosmic-ray photon flux above 10ˆ19 eV using the surface detector of the Pierre Auger Observatory.*
  J. Abraham, et. al., The Pierre Auger Collaboration.
  Astroparticle Physics 29 (2008) 243256

- *Correlation of the highest-energy cosmic rays with the positions of nearby active galactic nuclei.*
  J. Abraham, et. al., The Pierre Auger Collaboration.
  Astroparticle Physics 29 (2008) 188204

- *Upper Limit on the Diffuse Flux of Ultrahigh Energy Tau Neutrinos from the Pierre Auger Observatory.*
  J. Abraham, et. al., The Pierre Auger Collaboration.
  Phys. Rev. Let. 100, 211101 (2008)

International Conference Proceedings

- *3D reconstruction of extensive air showers in the Pierre Auger Laboratory*
  S. Andringa, M. Pato and M. Pimenta
  Proc. 6th Int. Workshop on New Worlds in Astroparticle Physics, September, 6 - 8, 2007, Faro, Portugal.

- *Trigger and data acquisition in GAW.*
  P. Assis

Proc. 6th Int. Workshop on New Worlds in Astroparticle Physics, September, 6 - 8, 2007, Faro, Portugal.

- *Gamma/hadron separation in IACTs using 3D EAS variables.*
  S. Andringa, P. Assis, M. Pimenta, A. Pina, B. Tomé
  Proc. 6th Int. Workshop on New Worlds in Astroparticle Physics, September, 6 - 8, 2007, Faro, Portugal.

- *3D Reconstruction of Extensive Air Showers from Fluorescence Data*
  S. Andringa, M. Pato, M. Pimenta
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *AMIGA, Auger Muons and Infill for the Ground Array*
  The Pierre Auger Collaboration (with co-authorship of P. Abreu, S. Andringa, P. Assis, P. Brogueira, R. Conceição, M.C. Espírito-Santo, P. Gonçalves, M. Pimenta, B. Tomé)
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *A Geant4 based engineering tool for Fresnel lenses*
  J. Costa, M. Pimenta, B. Tomé
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *Gamma Air Watch (GAW): the electronics and trigger concept*
  P. ASSIS, G. AGNETTA, P. BROGUEIRA, O. CATALANO, G. CUSUMANO, N. GALLÌ, S. GIARRUSSO, G. LA ROSA, M. PIMENTA, G. PIRES, F. RUSSO, B. SACCO
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *Gamma/hadron separation in IACTs using 3D EAS variables*
  S. Andringa, P. Assis, M. Pimenta, A. Pina, B. Tomé
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *Expected performance of the GAW Cherenkov Telescopes Array. Simulation and Analysis*
  M. C. MACCARONE, P. ASSIS, O. CATALANO, G. CUSUMANO, M.C. ESPIRITO SANTO, P. GONÇALVES, M. MOLES, M. PIMENTA, A. PINA, B. SACCO, B. TOMÉ
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *GAW - An Imaging Atmospheric Cherenkov Telescope with Large Field of View*
  GAW Collaboration (with co-authorship of P. Assis, P. Brogueira, M.C. Espírito Santo, M. Pimenta, A. Pina, B. Tomé)
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *HEAT Enhancement Telescopes for the Pierre Auger Southern Observatory*
  The Pierre Auger Collaboration (with co-authorship of P. Abreu, S. Andringa, P. Assis, P. Brogueira, R. Conceição, M.C. Espírito-Santo, P. Gonçalves, M. Pimenta, B. Tomé)
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *The string percolation model and the interpretation of cosmic ray data above 10ˆ17 eV.*
  J. Alvarez-Muñiz, P. Brogueira, R. Conceição, J. Dias de Deus, M.C. Espírito Santo, M. Pimenta
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

- *Detection of the Cherenkov light diffused by SeaWater with the ULTRA Experiment.*
  The ULTRA collaboration (with co-authorship of P. Assis, P. Brogueira, M.C. Espírito Santo, L. Melo, M. Pimenta, J.C. Silva, B. Tomé)
  Proc. 30th Int. Cosmic Ray Conf. (ICRC2007), July 3 - 11, 2007, Mérida, México.

4.4.5 Presentations

Oral presentations in international conferences

- *Net-Baryon Physics Basic Mechanisms*
  presented by Ruben Conceição
  at 21st European Cosmic Ray Symposium in Koice, Slovakia.

- *Ultra High Energy Cosmic Rays at Auger - Recent results*
  presented by Mário Pimenta
  at NEW TRENDS IN HIGH-ENERGY PHYSICS in Yalta, Crimea, Ukraine.

Oral presentations in international meetings

- *The GAW project*
  presented by Luisa Arruda
  at PASC Winter School in Sesimbra, Portugal.

- *GAW: trigger and data acquisition*
  presented by Pedro Assis
  at PASC Winter School in Sesimbra, Portugal.

- *Universal Shower Profile*
  presented by Ruben Conceição
  at PASC Winter School in Sesimbra, Portugal.

- *The AMIGA project*
  presented by Eva Santos
  at PASC Winter School in Sesimbra, Portugal.

Oral presentations in collaboration meetings

- *Update on 3D reconstruction*
  presented by Sofia Andringa
  at Auger Collaboration Meeting in Malargue, Argentina.

- *FD simulations at Lisboa*
  presented by Pedro Assis
  at Auger Collaboration Meeting in Malargue, Argentina.

- *Universal shower profile in data and simulation*
  presented by Ruben Conceição
  at Auger Collaboration Meeting in Malargue, Argentina.

- *GAW Firmware*
  presented by Bernardo Tomé
  at GAW Coll. Meeting in Madrid, Spain.

- *8x8 Light Guide Simulation with GEANT4 - Optimization studies*
  presented by Luisa Arruda
  at GAW Coll. Meeting in Madrid.

- *Status of the Universal Shower Profile analyses.*
  presented by Catarina Espírito Santo
  at Auger Collaboration Meeting in Malargue, Argentina.

- *3D simulation of EAS for the FD.*
  presented by Patrícia Gonçalves
  at Auger Collaboration Meeting in Malargue, Argentina.

- *Energy Evolution of Universal Shower Profile*
  presented by Ruben Conceição
  at Auger Collaboration Meeting in Malargue, Argentina.

- *Mapping the FD pixel non-uniformities with simulation, laser and shower events*
  presented by Ruben Conceição
  at Auger Collaboration Meeting in Malargue, Argentina.

- *3D EAS Simulation*
  presented by Patrícia Gonçalves
  at Auger Collaboration Meeting in Malargue, Argentina.

- *Update on Direct Cherenkov analysis*
  presented by Catarina Espírito Santo
  at Auger Collaboration Meeting in Malargue, Argentina.

- *Universal Shower Profile Variables*
  presented by Sofia Andringa
  at Auger Collaboration Meeting in Malargue, Argentina.

- *Exotics at Lisbon*
  presented by Bernardo Tomé
  at Auger Collaboration Meeting in Malargue, Argentina.

Seminars

- *Luz de Cerenkov em AUGER e GAW*
  presented by Catarina Espírito Santo
  at Ciclo de palestras "Café com Física"in Departamento de Fisica, Faculdade de Ciencias e Tecnologia da Universidade de Coimbra.

- *Astronomia de Raios Cósmicos*
  presented by Mário Pimenta
  at 4ª Escola de Astrofísica e Gravitação, CENTRA, IST. in Lisboa, Portugal.

4.4.6 Academic Training

PhD Theses

- *Data acquisition and control systems in cosmic ray experiments"*
  Pedro Assis, 2009-01-14

- *Hadronic Models in EAS"*
  Ruben Conceição, (on-going)

- *Cosmic rays in the ankle region at the Pierre Auger Observatory"*
  Eva Santos, (on-going)

Master Theses

- *Design optimization of muon counters for Auger Observatory"*
  Eva Santos, 2008-10-28

4.4.7 Events

- *PASC Winter School 2008*
  Workshop, Sesimbra, 2008-12-17

4.4.8 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
Articles in international journals (with indirect contribution from LIP members)	3
International Conference Proceedings	13
Oral presentations in international conferences	2
Oral presentations in international meetings	4
Oral presentations in collaboration meetings	13
Seminars	2
Master Theses	1
Workshops	1

4.5 Study of the primary air scintillation in air for cosmic ray detection

4.5.1 Activity Report

During 2008 activities have been developed following two lines:
A. Experimental measurements and analysis;
B. Development of simulation tools and theoretical models in attempt to understand the excitation and de-excitation mechanisms leading to air fluorescence emission.
A. Experimental studies were carried out in Coimbra in an attempt to measure the time evolution of the emitting species in pure nitrogen. The electronic circuit was optimized and the set-up improved but measurements were limited by the activity of the excitation source. Another set-up was assembled that allows the gas to flow slowly through the chamber at a constant pressure (< Patm), to avoid the poisoning of the gas. The trigger signal is produced by the interaction of the electrons with a plastic scintillator (5 cm diameter).
Meanwhile, collaboration was established with the group of Prof. Ulrich of the TU Munich and one of our collaborators participated in the data taking. The data analysis has started in Munich and went on in Coimbra. In this set-up, excitation is produced by a pulsed electron beam of 12 keV. Due to the much higher excitation rate, it was possible to record the time spectra as a function of P and T, in pure N2 and in N2/O2 mixtures, with high statistics. The results for the temperature dependence of the collisional deactivation rate constant of the N2(C,v'=0) state by N2 (X) showed a very good agreement with our previous data using a different experimental approach (band intensity measurement versus T). The temperature dependence of the collisional deactivation rate constants of the N2(C,v'=0) state by O2 (X) and of the N2(C,v'=1) state by N2 (X) were also obtained. Comparison of these data with band intensity measurements vs T in dry air are under way. The preliminary analysis confirm that the physical model that is presently used in the reconstruction codes of the air fluorescence data (Auger) is a poor model; we developed a modified model that is supported by the experimental results and simulations.
The electron gun technique is now under development in our Lab.
B) Simulation and modelling:
Studies were also developed in order to understand the mechanisms of excitation and de-excitation. These studies include the optimization of a Monte Carlo simulation code that takes into account the energy losses of 10 keV electrons in nitrogen and nitrogen/oxygen mixtures. The code estimates the relative populations of the different excited states, the time evolution of the energy distribution functions, the time the electrons take to lower their energy below the excitation potential of the C state. Presently, it is being updated in order to include the anisotropy of collisions and to estimate the dimensions of the emission volume.
A Master thesis has resulted from these studies.
Two papers in international journals with referee are under preparation and will result from this project. A poster was presented at the Conf. Nacional de Física, Lisbon, Sept. 2008, and two oral communications will be presented at the 6th Air Fluorescence Workshop, Italy, February 2009.

4.5.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81944/2007	20.000 €	2007-07-01	2008-09-30
CERN/FP/83527/2008	15.000 €	2008-10-01	2009-09-30

4.5.3 Team

Project coordinator: Margarida Fraga

Name	Status	%of time in project
Américo Pereira	Technician (LIP)	20
Andreas Ulrich	Researcher (LIP)	1
Andrey Morozov	Researcher (LIP)	6
António Onofre	Researcher (LIP)	8
Armando Policarpo	Researcher (LIP/FCTUC)	12
Francisco Fraga	Researcher (LIP/FCTUC)	13
João Bastos	Post-Doc (LIP)	16
João Silva	Technician (LIP)	5
Luís Pereira	Graduate student (LIP)	81
Margarida Fraga	Researcher (LIP/FCTUC)	50
Mário Pimenta	Researcher (LIP/IST)	5
Nuno Carolino	Technician (LIP)	15
Rui Marques	Researcher (LIP/FCTUC)	10

4.5.4 Presentations

Presentations in national conferences

- *Influência da temperatura na secção eficaz de desactivação colisional do estado C3Πu, v=0 do N2*
  presented by Luís Pereira
  at Fisica 2008 in Monte da Caparica, Lisboa.

Oral presentations in collaboration meetings

- *Status of L2 Calibration*
  presented by Nuno Anjos
  at Jet Trigger Meeting in CERN.

4.5.5 Academic Training

Master Theses

- *Temperature Dependence of Nitrogen Fluorescence"*
  Luís Pereira, 2008-11-19

4.5.6 Project Summary

	number
Presentations in national conferences	1
Oral presentations in collaboration meetings	1
Master Theses	1

4.6 Radiation interaction simulations for space missions

4.6.1 Activity Report

Resumo

As actividades desenvolvidas no âmbito da actividade Space (ESA) tiveram início no LIP no contexto da aplicação da ferramenta de simulação Geant4 às experiências de astropartículas em que o LIP se encontrava envolvido em 2003: EUSO e AMS. O primeiro contrato celebrado entre o LIP e a ESA, intitulou-se *Radiation Interaction Simulation for High-Energy Astrophysics Experiments EUSO and AMS*, data de 2003, e foi celebrado no contexto de um pedido de propostas pela ESA no âmbito do desenvolvimento de aplicações em Geant4 para experiências no espaço. Após este contrato inicial, vários contratos têm vindo a ser celebrados entre o LIP e a ESA, todos centrados no desenvolvimento de aplicações em Geant4 tendo em vista o estudo e a simulação do ambiente de radiação na heliosfera, os seus efeitos em componentes electrónicos e a sua medição.
A área de estudos do ambiente de radiação na heliosfera foi complementada em 2008 com o início do projecto "Participação portuguesa na rede heliosférica"em que o LIP participa, em colaboração com Dalmiro Maia da Faculdade de Ciências da Universidade do Porto. Este é um projecto com a duração de 3 anos, financiado pela FCT e tem como objectivo o desenvolvimento de modelos do ambiente de radiação na Heliosfera. A participação do LIP centra-se no desenvolvimento de aplicações em Geant4 para simulação de monitores de radiação que se encontram a bordo das missões Ulysses e ACE e também no desenvolvimento de conceitos de monitores de radiação para futuras missões espaciais, com base nos modelos desenvolvidos no âmbito do projecto.
Em 2008 foi concluido um contrato com a ESA, intitulado *MarsREM: Martian Radiation Environment Models*, iníciado em Julho de 2006, encontrando-se um segundo contrato, *Integrated Radiation Environment, Effects and Component Degradation Simulation Tool* em fase de finalização, com data de conclusão prevista para Fevereiro de 2009.

Summary of Activities

The activities developed in the framework of the Space (ESA: European Space Agency) activity were initiated at LIP in the context of the application and development of the GEANT4 simulation toolkit to the astroparticle experiments in which LIP was involved: AMS and EUSO. LIP celebrated its first contract with ESA, entitled *Radiation Interaction Simulation for High-Energy Astrophysics Experiments EUSO and AMS* in 2003, in the context of an ESA call for proposals concerning the development of Geant4 applications for space experiments. The objective of the contract consisted in the development of a software framework based on the GEANT4 toolkit, integrating detector and particle transport simulation, event reconstruction and data analysis capabilities. The contract was successfully concluded and ESA considered that all requirements and deadlines were met by LIP with a very professional approach. After this first contract, LIP has celebrated several contracts with ESA, all concerning the application of the Geant4 simulation toolkit to space experiments and studies, namely, in simulations of the radiation environment in the heliosphere, in the study of its effects in electronic components relevant for ESA future space missions, as well as in design studies of radiation monitors for future space missions. The study of the radiation environment in the Heliosphere has recently been complemented by LIP participation in the *Heliospheric Network*, in collaboration with Dalmiro Maia from Faculdade de Ciências da Universidade do Porto, this 3 year project aims at developing *Heliosphere Radiation Environment Models* using the Interplanetary Data available from the Heliospheric Network missions, in which LIP responsibility is centered in the Geant4 simulation of a radiation monitor aboard the ACE and Ulysses missions.
The activities developed are spin-offs of the application and development the Geant4 simulation toolkit, in this case, applied to space experiments. These activities have enabled the integration of new students in LIP, for whom the planetary and interplanetary radiation environment studies are an attractive subject and are also a source of collaboration between LIP and external institutions and scientists.
The contract *MarsREM: Martian Radiation Environment Models*, celebrated between LIP and QinetiQ, supported by ESA contract 19103/05/NL/JD, which started in the 1st of July 2006 and had a duration of 18 months (extended in the meanwhile by another 4 months) was completed in the end of October 2008.
In 2008 the contract *Integrated Radiation Environment, Effects and Component Degradation Simulation Tool* : CODES II, has reached its completion phase, foreseen for February 2009.

MarsREM: Martian Radiation Environment Models

The contract *MarsREM: Martian Radiation Environment Models*, corresponding to the reference ESA:19770/06/NL/JD, was finalised in 2008. There were three technical work packages under this contract, followed by a 2 year software maintenance period, corresponding to a fourth work package, to be undertaken after delivery all software and acceptance of the Final Contract Report.

LIP was responsible by one of the three technical work packages, work package 2, whose breakdown is listed below:

- Mars Energetic Radiation Environment Model framework definition (WP2100);
- Definition of Mars primary particle source (WP2200);
- Definition of atmospheric and surface environments (WP2300): development of the pre-processor;
- Development of detailed radiation model for in-orbit and surface(WP2400), dMEREM;
- Development of engineering model for in-orbit and surface environments (WP2500), eMEREM;
- Implementation of models into SPENVIS (WP2600)
- Validation and application to example cases (WP2700)

The activities corresponding to WP2300, WP2400 and WP2700 were of executive responsibility of LIP whereas the remainder WP2 activities were contractual responsibilities, whose execution was not at LIPs charge. WP2300 and WP2400 were successfully completed during 2007. WP2700 was completed in 2008.
The final technical tasks of the contract, corresponding to WP2700, were performed in 2008, and consisted of the validation and optimization of the detailed Martian Radiation Environment Model (dMEREM). Its objectives were to assess the performance of dMEREM and eMEREM models through inter-comparison and comparisons with experimental data, and to assess the performance of the MEREM framework in meeting the User Requirements Document.

Optimisation of the simulation
Whilst a detailed radiation transport model may provide very accurate results, it usually does so at the expense of computation time. Along dMEREM development there were several procedures followed and software upgrades in order to reduce CPU time spent by dMEREM while keeping code performance stability and consistency on the results.
The different optimization procedures included implementation of cuts per regions according to region density, implementation of cuts depending on particle position and direction (removing particles that would never affect a sensitive detector and energies lower than secondary production thresholds). Moreover, and in order to optimize CPU time spent dMEREM depending on the objective of the user, three benchmark physics scenarios were assessed, in what concerned their capabilities of providing the required description of the radiation environment versus the CPU time spent in the process, which is of importance in the case of the implementation of dMEREM under SPENVIS.
dMEREM is consistent running with high statistics, and, in particular, it is has a stable performance for processing GCR spectra which have more than five orders of magnitude difference between low and high energy fluxes (from a few MeV to 100GeV or higher), corresponding to a wide range of physics processes involved which are being chosen among different Geant4 physics lists used under different benchmark combinations.

Validation and application to example cases
The validation task consisted both of the internal and general validation of MarsREM. Comparisons were performed to assess consistency of the engineering and detailed radiation models in MarsREM. Specific examples were chosen for the surface of Mars, as well as Mars orbit for GCR and SEPE protons and α-particles, and solar X-rays.
Comparisons of MEREM models results with results from NASA Langley Research Centre model and predictions and results of the MARIE mission were performed.
There was a general agreement between the predictions of the MEREM and the other models although future detailed analyses of Mars data should be performed in order to fully exploit the capabilities of the MEREM framework.
WP4000 consists of software maintenance. It started after delivery all software and acceptance of the Final Contract Report in November 2008 and will last for two years. LIP is responsible for maintaining the code developed under WP2000, and the major activities will consist of: assessing the resources required to change written software, advising ESA if greater than in provision; modifying the software and validate the modification, if needed; updating the software documents if required; committing updated code to the Geant4 repository.
Finally, a contribution for the International Academy of Astronautics (http://iaaweb.org/) study *Particle Radiation Hazards en route to and at Mars*, in which the MarsREM project achievements are summarised was prepared by the LIP team.

Integrated Radiation Environment, Effects and Component Degradation Simulation Tool

The contract *CODES: COmponent DEgradation Simulation tool* was an extension of the MarsREC tool developed under the ESA contract number 18121/04/NL/CH. This contract had a completion date foreseen for October 2008, which was extended by 4 months to February 2009.
The CODES activity aimed at developing a framework (proposed in the context of MarsREC activity) for prediction of component radiation-induced degradation. By the end of the MarsREC project, in September 2006, a statistic approach had been developed, providing a comprehensive method to predict SEU Rates for EEE components by convolving radiation environment spectra at component level with a statistical description of SEU test data. It took into account secondary particles generated in various shielding configurations and radiation environment conditions.
The current activity was proposed to extend the initial framework to include a microscopic approach and evaluate to which extent a GEANT4 application, based on simple assumptions on charge collection geometry, could be used to explain the experimental single event upset cross-section dependency on LET. The microscopic approach, developed under the current contract, is capable of microdosimetry in device sensitive volumes. By using the GEANT4 application interfaced with device analysis techniques this method enables the fit of sensitive volume shape and dimensions, as well as the path length distribution. The microscopic approach consists of three main modules to perform SEU rate prediction of memory devices. The three modules are Geometry Description (GD), Efficiency Matrix (EM), and Analysis Module (AM). SV-FIT is an iterative process that by employing the three modules GD, EM and AM, calculates a function for the Sensitive Volume and subsequently calculates the cross-section versus LET curve required to predict SEU rates. SV-FIT Modules employ device geometry data and irradiation test data to generate: path length distributions, SEU cross-section reconstruction, estimate the critical energy, and return the best fit SV shape. The framework was tested with the Reference SEU Monitor, ATMEL 4Mbit AT60142 device
CODES was therefore designed as a flexible framework in order to predict radiation effects on EEE components when exposed to various radiation environments. CODES interfaces information on the EEE device with a Geant4 based Monte Carlo application for tracking primary and secondary particles at component level. A framework, allowing interactivity for fitting device sensitivity, based on ground level irradiation tests, was developed. In order to improve the quantitative analysis of the physics mechanisms involved, further work is needed, including experimental quantification of diffusion mechanisms, including LET-dependent sensitive area enhancement through the efficiency matrix method and generalization.
The PhD thesis of Ana Oliveira Braga Keating, with title *A model for Mars Radiation Environment Characterization and Effects on Components*, whose content is central to the projects MarsREC, MarsREM and CODES, was successfully finalized in September 2008.

Participation in the Heliospheric Network

The heliospheric network is a dedicated group of researchers addressing the challenges and puzzles raised by the data collected in the previous and present solar cycles by the extended and expanded set of heliospheric missions: IMP8, Voyager I and II, SOHO, ACE, Ulysses, WIND, Cluster and Stereo. A proposal for a three year project, entitled *Portuguese participation in the Heliospheric Network*, was approved by *Fundação para a Ciência e a Tecnologia* (FCT) and started in 2008. This project is a collaboration between LIP and Dalmiro Maia from Faculdade de Ciências da Universidade do Porto with the finality of developing Heliosphere Radiation Environment Models from Interplanetary Data.
The proposed work is to study the effects of radial distance from the Sun on SEP properties by comparing SEP measures from the instruments on board the Ulysses spacecraft, during its cruise from the Earth to Jupiter, that took place from the end of 1990 to February 1992, but also during the high latitude orbits, with the properties of SEPs seen near the Earth by the EPAM instrument on the ACE spacecraft. The EPAM and HISCALE instruments are based on the same design. The GEANT4 toolkit will be used to simulate in particular the performance of the LEFS detector systems of the EPAM/HISCALE instruments in order to more accurately understand their response to electrons. The results from the models will be convolved with the instrumental response and possible sources of contamination in electron data will be addressed. This issue is important for only the removal of systematic effects in the average anisotropies allows for a meaningful comparison with models. The research team will then compare the flux profiles, pitch angle distributions and fluences of the events with the model results, to check which particle propagation models explain the observations in the most adequate way.
Within this project the LIP team is responsible for the development of a Geant4 application for the simulation of the HISCALE/EPAM detectors, their response, by the analysis of the simulated data and by the comparison with real data collected with the HISCALE/EPAM detectors. LIP is also in charge of the studies concerning future configurations of radiation monitors using the Geant4 toolkit and the SEP developed model.

During 2008 a first GEANT4 application for the simulation of the HISCALE/EPAM detector was developed and it is currently undergoing validation with data from detector calibration with radioactive sources, performed prior to the lauch of the Ulysses and EPAM missions.

4.6.2 Sources of Funding

Code	Funding	Start	End
ESA:19770/06/NL/JD	78.200 €	2006-07-01	2008-05-31
ESA:18121/04/NL/CH	100.000 €	2006-11-01	2009-02-28
PDCTE/CTE-SPA/81678/2003	69.552 €	2008-01-01	2010-12-31

4.6.3 Team

Project coordinator: Patrícia Gonçalves

Name	Status	%of time in project
Ana Keating	Post-Doc (LIP/FCT) *	100
Andreia Trindade	Post-Doc (LIP/FCT)	5
Bernardo Tomé	Researcher (LIP)	20
Bruno Morgado	Master student (LIP)	17
Catarina Espírito Santo	Researcher (LIP)	5
Mário Pimenta	Researcher (LIP/IST)	15
Patrícia Gonçalves	Researcher (LIP)	45
Pedro Brogueira	Researcher (LIP/IST)	5
Pedro Rodrigues	Post-Doc (LIP/FCT)	5
Sara Valente	Master student (LIP)	100

4.6.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *The Mars Energetic Radiation Environment Models*
  Pete Truscott, Fan Lei, Ana Keating, Sara Valente, Patricia Gonçalves, Laurent Desorgher, Daniel Heynderickx, Norma Crosby, Hilde de Witte, Gerald Degreef, Petteri Nieminen and Giovanni Santin
  (accepted)

International Conference Proceedings

- *The Mars Energetic Radiation Environment Models*
  P.Truscott, F.Lei, A.Keating, S.Valente, P.Gonçalves, L.Desorgher, D.Heynderickx, N.Crosby, H.de Witte, G.Degreef, P.Nieminen & G.Santin
  (accepted)

4.6.5 Presentations

Poster presentations in international conferences

- *CODES a SEU Prediction Tool*
  presented by Ana Keating
  at NSREC 08 in Tucson, Arizona.

4.6.6 Academic Training

PhD Theses

- *A model for Mars Radiation Environment Characterization and Effects on Components"*
  Ana Keating, 2008-09-16

4.6.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
International Conference Proceedings	1
Poster presentations in international conferences	1
PhD Theses	1

Chapter 5

Medical Physics

5.1 Development of Positron Emission Mammography

5.1.1 Activity Report

Resumo:

O projecto de investigação científica e tecnológica Development of PET Technologies é realizado no âmbito do Consórcio PET-Mamografia e liderado cientificamente pelo LIP. Os equipamentos de imagem médica em desenvolvimento exploram tecnologias desenvolvidas para experiências de física de altas energias.

Summary:

The research and development project Development of PET Technologies is carried out in the frame of the PET Mammography Consortium under LIP scientific leadership. The medical imaging equipment under development exploit technologies developed for accelerator experiments.

Project Coordination:

- Project Director: João Varela
  - TagusLIP Coordination: Pedro Rodrigues
  - Integration and new detectors: Pedro Rodrigues
  - Detector Commissioning and Simulation: Andreia Trindade

Summary of Activities:

The PET Consortium pursued the PET technologies development program, in the frame of the projects PET II and PET IIb funded (75%) by AdI. The activity is carried out by eight national institutions and about forty researchers. In parallel the Consortium is developing the strategy for transferring the technology to the market. The collaboration with the company PETsys Medical PET Imaging Systems, SA, was pursued. PETsys is responsible for 25% of the PETIIb project funding.
In summary the status of the PET project is the following:

Line 1) Consolidation of the breast cancer detection PET technologies
The aim of this R&D line was to bring the laboratory PET prototype developed previously, from the technology demonstration stage to a final PET product capable to be operated in a real clinical environment, particularly during a long and solid clinical trial.
The major step required to achieve the PET product stage was to multiply the number of detector channels by a factor of 20, still keeping the individual detector channel performance demonstrated in the first prototypes. This step proved to be more challenging than anticipated. It required:
a.The development and production of the frontend ASIC with 192 channels (ASICv3), which extended the capabilities of the 8-channel ASICv2 prototype.
b.The development of the frontend detector electronics based on the ASICv3 to operate about 12000 detecting channels.

The solutions found had side effects in other areas of the project, in particular in the design of the PET robot and detector heads. The revision of the distribution of low voltages, APD biasing high-voltages and high-speed digital signals to the detector heads, required to achieve sufficiently low electronics noise in the full scanner, coupled to additional shielding for noise immune data transmission, obliged to re-build parts of the robot for additional cabling paths. The off-detector data acquisition system required the change of the high-speed data link to the acquisition computer, due to a failure of the previous solution.
Successful operation of the final PET scanner detectors with the designed performance has been achieved. A successful mechanical integration of full scanner was achieved in its final location (hospital IPO Porto). The clinical tests will be carried-on in 2009.

Line 2) ClearPEM-Sonic project
Another aim of the project was the preparation for the construction of a second ClearPEM prototype and integration with ultrasound imaging equipment (ClearPEM-Sonic), in collaboration with CERN and French institutes and companies. A clinical trial is foreseen in 2010 in the Hospital Universitaire of Marseille, France. This test will complement the trial in Portugal and will exploit PET-ultrasound multimodality.
The design of the second ClearPEM scanner is largely based in the first one. However important modifications have been introduced based on the experience acquired with the construction of the first machine.
The development of a dedicated system for systematic quality control of avalanche photodiodes was concluded. Four hundred APD arrays for ClearPEM-Sonic have been acquired and tested. The acquisition of all service sub-systems (high-voltage, power supplies, etc.) as well as all computing servers was done. All scintillation crystals were produced and the matrix assembling in currently on-going. The other components for the detector modules were produced. All electronics components needed for the frontend boards and service electronics were purchased. The production of the data acquisition electronics is well advanced. Major components for the cooling system, scanner robot and examination table were acquired. A revised mechanical structure is under design.

Line 3) Investigation of new nuclear imaging technologies
The investigations carried in this line are part of a longer term research program in new nuclear imaging technologies. In summary, the results achieved by the consortium at this point have been the following:
a.Development and laboratory tests of a new PET detector module with LYSO crystals with improved packing fraction.
b.Development by RMD, Inc of a new APD array providing an alternative to the present single producer of the APD arrays suitable for ClearPEM (Hamamatsu).
c.Initial study of a new photodetector (silicon photomultiplier) suitable for time-of-flight PET and installation of an evaluation setup in the laboratory.
d.Specification and design of a new PET ASIC with new programming capabilities and adequate to APDs with different gains and signal polarity.
e.Initial study and simulations of a collimator adding SPECT imaging capability to the ClearPEM scanner.
f.Development of the architectural design of a high-performance data acquisition system.
g.Engineering design and start of production of a new high-speed data acquisition optical link.
h.Development and production of a prototype of a new service board for high voltage regulation, clock and control distribution and detector head monitoring.
i.Specification and design of the new small animal imaging platform, adapted to small animal PET-SPECT, and allowing expansion to CT.
j.Initial studies towards a PET-MRI prototype.

5.1.2 Sources of Funding

Code	Funding	Start	End
PET - Mammography II	768.280 €	2007-01-01	2008-06-30
Pet - Mammography II-b	504.344 €	2008-07-01	2009-12-31

5.1.3 Team

Project coordinator: João Varela

Name	Status	%of time in project
Andreia Trindade	Post-Doc (LIP/FCT)	95
Bruno Carriço	Master student (LIP)	100
Catarina Ortigão	PhD student (LIP)	100
Cláudia Sofia Ferreira	Graduate student (LIP)	92
Inês Rolo	Master student (LIP)	33
João Pinheiro	Master student (LIP)	100
João Varela	Researcher (LIP/FCT)	25
José Carlos Silva	Technician (LIP)	10
Mário Frade	Master student (LIP)	33
Miguel Ferreira	Technician (LIP)	75
Pedro Rodrigues	Post-Doc (LIP/FCT)	95
Ricardo Bugalho	Master student (LIP)	100
Rui Moura	PhD student (LIP)	100
Rui Silva	Technician (LIP)	31

5.1.4 Publications

International Conference Proceedings

- *Performance Evalution of a Highly Integrated ADP/ASIC Double Readout Supermodule with 768 Channels for Clear-PEM*
  E. Albuquerque et al.
  IEEE08 Nuclear Science Symposium and Medical Imaging Conference

- *Experimental Validation and Performance Analysis of the Clear-PEM Data Acquisition Electronics*
  R. Bugalho et al
  IEEE08 Nuclear Science Symposium and Medical Imaging Conference

- *Development of a High Packing Fraction Detector Module with DOI Measurement Capability for High-Resolution PET*
  F. G. Almeida et al
  IEEE08 Nuclear Science Symposium and Medical Imaging Conference

- *Memory Management and Synchronism Issues in a Complex System Implemented in FPGA Technology*
  C. Leong et al
  XXIII Conference on Design of Circuits and Integrated Systems DCIS 08

National Conference Proceedings

- *FPGA Based Implementation, Test and Validation of a Very Complex Hw/Sw System for Medical Imaging*
  C. Leong et al
  IV Jornadas sobre Sistemas Reconfiguráveis REC 2008

5.1.5 Presentations

Oral presentations in international conferences

- *An Overview of the CLear-PEM Breast Imaging Scanner*
  presented by João Varela
  at Fourth International Workshop on the Molecular Radiology of Breast Cancer in Dresden, Germany.

- *Applying the ClearPEM technology to PET-MR*
  presented by João Varela
  at IEEE Workshop MR-PET in Juelich, Germany.

Poster presentations in international conferences

- *Performance Evalution of a Highly Integrated ADP/ASIC Double Readout Supermodule with 768 Channels for Clear-PEM*
  presented by Andreia Trindade
  at IEEE08 Nuclear Science Symposium and Medical Imaging Conference in Dresden, Germany.
- *Experimental Validation and Performance Analysis of the Clear-PEM Data Acquisition Electronics*
  presented by Ricardo Bugalho
  at IEEE08 Nuclear Science Symposium and Medical Imaging Conference in Dresden, Germany.
- *Development of a High Packing Fraction Detector Module with DOI Measurement Capability for High–Resolution PET*
  presented by Pedro Rodrigues
  at IEEE08 Nuclear Science Symposium and Medical Imaging Conference in Dresden, Germany.

Oral presentations in collaboration meetings

- *ClearPEM Integration Status*
  presented by Pedro Rodrigues
  at Crystal Clear Collaboration General Meeting in Heidelberg, Germany.
- *Status of ClearPEM-Sonic production*
  presented by Andreia Trindade
  at Crystal Clear Collaboration General Meeting in Heidelberg, Germany.
- *Calibration Strategies in ClearPEM*
  presented by João Pinheiro
  at Crystal Clear Collaboration General Meeting in Heidelberg, Germany.
- *Status of the Clear-PEM Project*
  presented by João Varela
  at Crystal Clear Collaboration General Meeting in CERN.

5.1.6 Academic Training

PhD Theses

- *Development and Experimental Study of a Detector Module for Positron Emission Mammography"*
  Catarina Ortigão, (on-going)
- *Estudo da localização espacial de tumores cancerígenos na glândula mamária com um detector PET dedicado"*
  Rui Moura, (on-going)
- *Estudo do tomógrafo Clear-PEM no diagnóstico do cancro da mama"*
  Cláudia Sofia Ferreira, (on-going)

Master Theses

- *Protótipo do Intelligent Frontend Board para aquisição de dados em tomógrafos PET"*
  Ricardo Bugalho, (on-going)
- *Desenvolvimento do sistema de controlo e calibração do tomografo ClearPEM"*
  João Pinheiro, 2008-11-01
- *Avaliação do scanner ClearPEM em ambiente clínico"*
  Mário Frade, (on-going)
- *Caracterização de Silicon PhotoMultipliers aplicados a imagem médica PET-SPECT"*
  Inês Rolo, (on-going)

5.1.7 Project Summary

	number
International Conference Proceedings	4
National Conference Proceedings	1
Oral presentations in international conferences	2
Poster presentations in international conferences	3
Oral presentations in collaboration meetings	4
Master Theses	1

5.2 Human PET

5.2.1 Activity Report

Sumário do projecto

OBJECTIVO
A Tomografia de Emissão de Positrões (PET) é uma técnica poderosa de imagiologia molecular funcional. O nosso objectivo é o desenvolvimento um tomógrafo baseado numa tecnologia radicalmente nova de TOF-PET, que envolve todo o corpo do paciente, com resolução espacial a atingir os limites físico da técnica PET e sensibilidade uma ordem de grandeza superior à dos sistemas comerciais correntes, sem aumento de preço. Uma tal inovação fornecerá aos clínicos capacidades superiores de diagnosticar e detectar doenças oncológicas e de outros tipos, bem como de estudar mecanismos de doença, constituindo uma mudança de paradigma no uso clínico de PET. Realizados já os estudos básicos de viabilidade, neste projecto pretende especificamente desenhar, construir, testar e desenvolver um primeiro protótipo de dimensão real de um tomógrafo para corpo inteiro, com um campo de visão axial (AFOV) de 2m e uma abertura de 90 cm (Fig. 1).
A demonstração desta tecnologia, radicalmente diferente da dos cristais tradicionalmente usados na detecção de raios gama, pode, aliás, abrir perspectivas totalmente novas na detecção de raios gama em áreas extensas, para lá das aplicações médicas.
ESTRATÉGIA
A nossa proposta para PET de alta sensibilidade a custo moderado envolve a técnica TOF-PET e o aumento dramático do AFOV até uma dimensão de corpo inteiro (2 m) graças a um detector de radiação com custo por unidade de área moderado, capaz de fornecer excelente resolução espacial, uniforme ao longo do FOV, sensível à profundidade de interacção e com uma resolução de 300 ps para tempo de vôo.
Um campo de visão muito extenso, capaz de abranger todo o corpo dum paciente ("single bed"), tem ainda outras vantagens sobre os sistemas com AFOV reduzido. Entre elas, está a possibilidade de, obtendo imagens simultâneas de todo o corpo, permitir o estudo completo de processos dinâmicos graças a uma segmentação temporal melhorada. Outra vantagem está na possibilidade de obter uma melhor quantificação da actividade através duma melhor correcção de difusão ("scatter"), dado não haver actividade fora do FOV.
APROXIMAÇÃO INOVADORA
A nossa aproximação baseia-se numa tecnologia de detecção já em uso na Física de Partículas para a medida de tempo de vôo de partículas elementares carregadas: as "timing Resistive Plate Chambers" (tRPCs). Esses detectores gasosos foram desenvolvidos para cobrir áreas de mais de uma centena de metros quadrados a preços moderados, fornecendo ao mesmo tempo resolução temporal excelente, abaixo dos 100 ps rms.
Há alguns anos este grupo propôs a aplicação destes detectores à tecnologia TOF-PET, tanto para tomógrafos de corpo inteiro para humanos, como para pequenos animais. Tal aplicação baseia-se no princípio das "placas conversoras" e tira partido da estrutura natural "em camadas" das tRPCs e de a sua construção em áreas grandes ser económica. A baixa eficiência naturalmente esperada para os fotões de 511 keV é mais que compensada pela possibilidade de alcançar campos de visão extensos, que poderão ir até 2 m.
O conceito foi revisto independentemente por outros autores, embora assumindo condições diferentes, confirmando-se que poderá para corpo inteiro substituir com vantagem os tomógrafos de cristais que constituem o "state-of-the-art".

Report 2008

The FCT-funded project entitled "Affordable, very-high sensitivity human PET: feasibility studies" that has financed this activity for the last 3 years was concluded with positive results. A summary of the results is given below.

Conclusions of the project "Affordable, very-high sensitivity human PET: feasibility studies"

Task 1: Development of RPC detectors for large-area gamma imaging
A realistic prototype of the gamma-photons detection system and front-end analogue electronics was designed built and tested.
Its fundamental characteristics were measured:

- time resolution of 300 ps FWHM
- efficiency of 0.22% per gas gap, in full accordance with the simulations

- sub-millimetric position resolution capability

Such results clearly show that the proposed RPC-PET scanner is feasible from the point of view of the radiation detector.

Task 2: Data acquisition and electronics
One difficult aspect of the PET-RPC camera, due to its large area, is the number of acquisition channels involved and the need of implementing an appropriate coincidence trigger to reduce the overall amount of data to save and process. A solution to this problem was developed, implemented in a FPGA, and simulated. The use of specialized coincidence trigger validation schemes has been discussed and possible implementations studied, as well as the throughput of the coincidence-detection system.

Task 3: Simulation of a very large Axial Field of View PET scanners based on RPCs
Development of simulation setups and programs: accurate geometry of long PET scanners based on crystals and RPCs has been defined in GEANT4, and programs have been developed to simulate both scanners for the purpose of comparison.
Simulations of scanner sensitivity based on the NEMA 94 norm have been performed both for RPC- and crystal-based scanners. The results show that the RPC PET scanner will yield a 20-fold larger sensitivity than current crystal-based scanners such as the GE ADVANCE, taken as a reference.
Such sensitivity advantage may allow a paradigm-shift in the medical uses of the PET technique, with strong gains in administered dose, examination time and/or image quality.

Task 4: Image Reconstruction and Data Corrections for large Axial Field-Of-View (AFOV) Scanners
A practical image reconstruction scheme based on data rebinning was implemented and tested. Rebinning is a process where coincidence events from planes that are oblique relative to the scanner´s axis are rebinned into coincidence data on planes perpendicular to the scanner´s axis, allowing the independent reconstruction of each plane. Different rebinning methods were implemented in the IDL language (SSRB, MSRB, FORE, FOREJ). The FOREJ algorithm was the preferred choice for reconstructing data from very large polar angles, as is the case of the PET-RPC system where data are acquired in a system with a very long axial Field Of View (AFOV). A scatter correction method based on a model of a single scatter simulation was implemented (SSS - Single Scatter Simulation) using some characteristics specific to the PET-RPC human system. Data simulated with Monte Carlo was used in the assessment of this algorithm, which gave promising results. Image reconstruction and scatter correction in a RPC-based PET system appears feasible with the approach chosen. The remaining data corrections are not expected to pose problems to the feasibility of the system.

5.2.2 Sources of Funding

Code	Funding	Start	End
POCI/SAU-OBS/61642/2004	47.160 €	2005-01-01	2008-06-30

5.2.3 Team

Project coordinator: João Lima

Name	Status	%of time in project
Alberto Blanco	Technician (LIP)	5
Américo Pereira	Technician (LIP)	2
Antero Abrunhosa	Researcher (IBILI)	2
Armando Policarpo	Researcher (LIP/FCTUC)	2
Carlos Correia	Researcher (FCTUC)	2
Custódio Loureiro	Researcher (FCTUC)	5
Filomena Clemêncio	Researcher (IBILI)	10
João Lima	Researcher (LIP/IBILI)	12
João Silva	Technician (LIP)	5
José Pinhão	Technician (LIP)	5
Luís Lopes	Technician (LIP)	2
Miguel Couceiro	Researcher (LIP/ISEC)	10
Nuno Carolino	Technician (LIP)	5
Nuno Fonseca	Researcher (LIP/IBILI)	5
Paulo Crespo	Researcher (LIP)	0
Paulo Fonte	Researcher (LIP/ISEC)	5
Rui Marques	Researcher (LIP/FCTUC)	2

5.2.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *Efficiency of RPC detectors for whole-body human TOF-PET*
  A. Blanco, M. Couceiro, P. Crespo, N. C. Ferreira, R. Ferreira Marques, P. Fonte, L. Lopes, J. A. Neves
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

5.2.5 Presentations

Oral presentations in international conferences

- *Efficiency of RPC detectors for whole-body human TOF-PET*
  presented by Miguel Couceiro
  at 9th International Workshop on Resistive Plate Chambers and Related Detectors (RPC2007) in 13 to 16 February 2008, Mumbai, India.

5.2.6 Academic Training

PhD Theses

- *Study of PET systems of very wide field of view"*
  Miguel Couceiro, (on-going)

Master Theses

- *Desenvolvimento de um protótipo RPC-PET"*
  Jorge Neves, 2008-07-31

Graduation Theses

- *Simulação da biodistribuição, aniquilação e escape de fotões PET no corpo humano"*
  , 2008-07-31

5.2.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	1
Oral presentations in international conferences	1
Master Theses	1
Graduation Theses	1

5.3 Monte Carlo methods applied to dosimetry in medical radiologic exposures

5.3.1 Activity Report

Summary

The proposal aims are the study of doses delivered by several radiation ionization sources of clinical application using dosimetric and Monte Carlo simulation programs and the development new dosimeters. These methods are applied in this project in several different tasks.

1. Development of geometrical and optical photon transport packages for open-based Monte Carlo code systems

The Ulysses package is a new geometry package that allows a user to follow a particle in a complex volume. The package is divided in 2 modules ullib (the package library with routines not to be modified by the user) and a group of routines to be modified by the user (geometry, radiation source and other input parameters for Penelope). The geometry structure is similar to the one used in GEANT3 and GEANT4.
Simulations of radiation transport in material systems involve two different kinds of operations, namely, physical (determination of the path length to the next interaction, random sampling of the different interactions) and geometrical (space displacements, interface crossings, ...). In the case of ionizing particles Ulysses deals only with the second type of operation. This is a important part of the program since in the case of material systems with complex geometries, geometrical operations can take a large fraction of the simulation time [1].
The Ulysses system of tracking and geometry is different from the one in Penelope. While Penelope defines the material bodies though quadratic surfaces, Ulysses has pre-defined volumes that are used to construct the bodies. Unlike to Penelope, Ulysses has a histogram package that has a lot of functions. The package has been tested against published simulations and the obtained ULYSSES results are consistent with them [2].
[1] F. Salvat et al., PENELOPE, a Monte Carlo Code System for Monte Carlo Simulation of Electron and Photon Transport, OECD-NEA Data Bank, 2003
[2] Ana Farinha, Desenvolvimento de um pacote de geometria e aplicação ao calculo de dose em braquiterapia, Master Thesis, November 2008, University of Lisbon.

2. Monte Carlo and Dosimetry in Brachytherapy Implants

Permanent brachytherapy implants are performed at IPOFG-CROC S.A. (Coimbra Cancer Hospital), with iodine-125 radioactive seeds to treat prostate early stage tumors. For each treatment, around 100 seeds can be implanted. Commercially available treatment planning systems give dose in water and do not account for inter-source perturbations.
PENELOPE+ULYSSIS MC packages have been used for the calculation of the dose distribution produced by this kind of seeds with a particular emphasis on the dose anisotropy produced along each source longitudinal axis and on patient dependent information.
So far the work has been focused in the comparison with early works made by other groups. The preliminary results are rather good, although some small discrepancies have been found at the level of the anisotropy function at small distances from the radioactive seed. The problem is under investigation, and the most plausible explanation is an overestimation of low energy fluorescence photons generated by PENELOPE.

3. Scintillating optical fibers dosimetry

Present dosimeters are made of several materials: air (ionizing chambers), silicon, LiF (TLDs), etc. All of these dosimeters have radiological properties distinct from biologic tissue or water. As a result, the measured dose must be corrected by the appropriate factors to give the correspondent dose in water. Moreover this procedure, should only be applied when “electronic equilibrium” conditions are met. For instance in build-up regions, near interfaces, measurements are more problematic. Also the dosimeter it self can significantly distort the point dose measurement, if its dimensions are not small enough.
A dosimeter in almost water radiologic-equivalent material, like plastic scintillators, would be desirable and could overcome some of the referred problems. But plastic scintillator dosimeters also pose some problems. The Cherenkov radiation produced in the scintillator has been seen as a major drawback for these kind of dosimeter, introducing a strong “noise” in the collected signal. Some strategies have been investigated in the past on how

to overcome the problem [1], but more recently some research have been made that suggests a practical way to implement an efficient system based in optical scintillating fibers [2]. Nevertheless, for the energy range interesting to radiology and some braquitherapy applications this is not a problem since the beam energy is below the Cherenkov production threshold.
In our work we investigate the efficiency of high performance scintillating plastic fibers used in high energy calorimeters, (polystyrene core with PMMA cladding) as radiation dosimeters. For light detection, the PDA 58s-MU photodiodes from Detection Technology [3] and the S9195 photodiodes from Hamamastu [4] were employed. These UV sensitive photo-detectors are a competitive choice for the fibers readout when compared to PMTs. They have lower dark current and don´t need any bias voltage. The small current produced in the photo-detector (in the range of pA to nA) was directly read by a Standard Imaging Max 4000 electrometer [5]. Fibers were placed inside a black-perspex box and hold against the photo-detector with the help of a PVC holder. The optical coupling of the fibers with the photo-detector surface was made by BC-630 optical grease (from Saint-Gobain). The box exterior is shielded from radiation by a metal sandwich of 1 mm lead + 1 mm aluminum. A hole of 15 mm in diameter was drilled in the shield allowing radiation to pass by and irradiate a fiber length of about 15 mm. The irradiations were performed with a Philips PW2184/00 X-ray tube with accelerating potentials ranging from 20 to 100 kV and anode currents from 10 to 50 mA. The results show a good linearity of the scintillating optical fiber + photo-detector system response to X-rays in this kilovoltage range, demonstrating the use of optical scintillating fibers as dosimeters in the 20-100 kVp range.
[1] D. Fluhs et al., "Direct reading measurement of absorbed dose with plastic scintillators The general concept and applications to ophthalmic plaque dosimetry", Med. Phys. 23 (3) (1996) 427.
[2] A. S. Beddar et al., " Plastic scintillation dosimetry: optimization of light collection efficiency", Phys. Med. Biol. 48 (2003) 1141-1152.
[3] http://www.deetee.com
[4] http://www.hamamatsu.es
[5] http://www.standardimaging.com

4. Photodiode dosimetry

Although not design for dosimetry, several low cost commercial photodiodes could be used as dosimeters. Moreover these photodiodes can be found in different shapes and sizes and are widely available. Other groups [1] have already demonstrated the suitably of commercial photodiodes for dosimetry in the mamography energy range. In this work we studied the response of Hamamatsu S1337 Si photodiodes [2] for X-ray tube potentials in the 20 to 40 kVp range and the signal stability for temperatures in the 0 to 50 °C range.
The tested photodiodes were the S1337-16BR, 33BR, 66BR and 1010BR from Hamamatsu with effective areas of 5.9, 5.7, 33 and 100 mm2 respectively. The S1337 series photodiodes have a 40-micron active layer which is enough to absorb at least 1% of photon beam in the 2040 keV range and the window is of resin coating. Since these diodes are manufactured to detect visible light a thin aluminium foil (≈0.1 mm) was glued to their window to make them light tight.
For the temperature tests the photodiodes were placed inside an aluminium box containing a plastic sample holder and irradiated with an 241Am radioactive source. The photodiode to be tested was connected through a triaxial BNC connector to a Standard Imaging Max 4000 Electrometer [3]. No bias voltage was applied to the photodiodes and direct charge measurements were obtained with the electrometer. The temperature inside the sample box was set by a continuous flow of dry air and could vary from 0 to 50 °C.
The bigger photodiode (S1337-1010BR) showed a good temperature stability with a maximum variation of 3% over the entire range, while the smaller photodiodes (S1337-16BR and 33BR) showed a strong temperature dependence in the 25-50 °C range. The medium size photodiode (S1337-66BR) displays an intermediate behaviour between the bigger and smaller photodiodes, with a good temperature stability up to 31 °C, followed by a drop in the response for higher temperatures.
Beam tests were made using a Philips PW2184/00 X-ray tube with accelerating potentials ranging from 20 to 40 kV and anode currents of 10, 20 and 30 mA. The photodiodes where placed inside an acrylic phantom at a depth of 1 mm and the measurements were made at a distance of 70 cm from de X-ray tube exit window. The dose measurement in the acrylic was made replacing at the same position the photodiode by a PTW 23342 soft X-ray ionizing chamber. The results show that, the response of the photodiode is proportional to the dose measured by the ionizing chamber, for different tube accelerating potentials in the studied range. From these results the sensitivity of the photodiode, define has the signal gradient (ie. the current in the photodiode per unit dose) can be derived. When plotted against the accelerating potential, the photodiode sensitivity gives us a measure of the energy dependence of the device. The sensitivity shows a 10 to 25% increase in the 20-30 kVp range while in the 30-40 kVp range a smaller dependence of the order of 10% is seen.

These preliminary results show that even low cost commercial photodiodes could be used for some dosimetry tasks, provided a careful calibration is made.
[1] E. Batista et al., The Performance of Commercial Photodiodes for Dosimetry in Mammography, Radiation Protection Dosimetry 115 (2005) pp 391-393
[2] http://www.hamamatsu.com
[3] http://www.standardimaging.com

5.3.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81924/2007	25.000 €	2007-12-18	2008-12-17

5.3.3 Team

Project coordinator: Luis Peralta

Name	Status	%of time in project
Amélia Maio	Researcher (LIP/FCUL)	10
Ana Catarina Farinha	Graduate student (LIP)	97
Ana Filipa Ferreira	Master student	48
Conceição Abreu	Researcher (LIP/UALG)	34
Florbela Rego	PhD student (LIP)	79
Luis Peralta	Researcher (LIP/FCUL)	36
Mafalda Gomes	(LIP)	2
Margarida Fragoso	On leave	19
Maria do Anjo Albuquerque	PhD student (LIP)	2
Patrick Sousa	PhD student (UALG)	29
Rui Carvalhal	Graduate student (LIP)	24
Sandra Soares	Researcher (LIP/UBI)	50
Sónia Rodrigues	Master student (UALG)	19
Vera Durão	Master student (UBI)	1

5.3.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *X-ray detection visits the classroom*
  L. Peralta, A. Farinha, A. Pinto
  Phys. Educ. 43 (2008) 351-352

- *What are the 50 cent Euro coins made of?*
  L. Peralta, A. Farinha, F. Rego
  European Journal of Physics 29 (2008) 901-909

Articles in national journals

- *Radioactividade Aspirada*
  Carmen Oliveira e Luis Peralta
  Gazeta de Física Vol. 31 N1/2 (2008) p.39-40

International Conference Proceedings

- *Scintillating Optical Fiber Dosimetry with Photodiode Readout*
  Florbela Rego, Luis Peralta
  Proceedings of the IEEE Nuclear Science Symposium and Medical Imaging Conference, Dresden, 19-25 October 2008, paper N02-259

Internal Notes

- *Ulysses manual*
  L. Peralta, A. Farinha

- *Ulhistos manual*
  L. Peralta, A. Farinha

5.3.5 Presentations

Poster presentations in international conferences

- *Scintillating Optical Fiber Dosimetry with Photodiode Readout*
  presented by Florbela Rego
  at IEEE Nuclear Science Symposium and Medical Imaging Conference in Dresden, Alemanha.

Presentations in national conferences

- *De que são feitas as moedas de 50 cêntimos de Euro?*
  presented by Florbela Rego
  at 16a Conferência Nacional de Física in Costa da Caparica.

- *Utilização de semicondutores comerciais em dosimetria*
  presented by Florbela Rego
  at 16a Conferência Nacional de Física in Costa da Caparica.

Outreach seminars

- *Radioactividade Ambiente*
  presented by Luis Peralta
  at in Escola Secundária D. Sancho II, Elvas.

- *Do Big-bang ao interior do átomo*
  presented by Luis Peralta
  at in Colégio do Sagrado Coração de Maria, Lisboa.

- *Explorando o Sistema Solar*
  presented by Luis Peralta
  at in Escola Secundária de Casquilhos, Barreiro.

- *Colidir para Descobrir*
  presented by Luis Peralta
  at in Escola Secundária Ferreira Dias, Cacém.

(unspecified Communications)

- *A aventura do Universo*
  presented by Luis Peralta
  at in Escola Secundária de Vendas Novas.

5.3.6 Academic Training

PhD Theses

- *Desenvolvimento de dosímetros de estado sólido para dosimetria em radiologia e braquiterapia"*
  Florbela Rego, (on-going)

Master Theses

- *Desenvolvimento de um pacote de geometria e aplicação ao calculo de dose em braquiterapia"*
  Ana Catarina Farinha, 2008-12-02

Graduation Theses

- *Desenvolvimento de uma aplicação computacional com base na metodologia proposta pelo NCRP 147 para a determinação das barreiras de protecção em radiodiagnóstico"*
  Rui Carvalhal, 2008-12-31

5.3.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	2
Articles in national journals	1
International Conference Proceedings	1
Internal Notes	2
Poster presentations in international conferences	1
Presentations in national conferences	2
Outreach seminars	4
(unspecified Communications)	1
Master Theses	1
Graduation Theses	1

Chapter 6

Detectors

6.1 Applications of Timing Resistive Plate Chambers - RPC

6.1.1 Activity Report

Resumo:

Neste projecto pretendemos desenvolver uma tecnologia de detecção de partículas elementares denominada "Câmaras de Placas Resistivas". Estes detectores têm aplicação em experiências de Física das Partículas e estamos a desenvolver também aplicações na Imagiologia de Radioisótopos.

Summary of the Activities:

The work started last year on gas swarm parameters was continued. The LIP researcher Alessio Mangiarotti spent 3 months with our collaborators at IPEN, São Paulo, Brasil and elaborated the detailed calculations necessary for the elaboration of our first article on the subject, which will be submitted to NIM soon.
Collaboration with the CBM experiment at GSI was continued, with research going on in high-rate ceramic RPCs and ageing. The work on aging counts now with the important involvement of chemists from the U. of Coimbra. For the development of ceramic RPCs we started collaboration with REVIGRES (a commercial ceramic tiling company), which has developed a line of antistatic ceramic floor tilling that may very well be suited for detector construction.
Several possibilities for the continuation of large-scale detector implementation in HEP beyond HADES were investigated. Besides our present involvement on the CBM experiment, which may be re-evaluated in the future, contacts were made with the experiments PANDA and R3B at GSI with generally negative results.
A very important development for the future of this activity was the integration of parts of it in CERN's RD51 project, which may be seen favourably as it is a bona-fide "Project in collaboration with CERN". The possibility for involvement in future CERN experiments will be investigated.
A project was approved by FCT call by "Projects in collaboration with CERN 2009".

6.1.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81981/2007	25.000 €	2007-07-01	2008-12-31
CERN/FP/83524/2008	20.000 €	2008-10-01	2009-09-30

6.1.3 Team

Project coordinator: Paulo Fonte

Name	Status	%of time in project
Alberto Blanco	Technician (LIP)	22
Alessio Mangiarotti	Researcher (LIP)	19
Alexandre Moita	Technician (LIP)	1
Américo Pereira	Technician (LIP)	10
Carlos Silva	Technician (LIP)	1
Joaquim Oliveira	Technician (LIP)	1
Luís Lopes	Technician (LIP)	22
Margarida Fraga	Researcher (LIP/FCTUC)	2
Miguel Couceiro	Researcher (LIP/ISEC)	13
Nuno Carolino	Technician (LIP)	3
Nuno Fonseca	Researcher (LIP/IBILI)	5
Orlando Cunha	Technician (LIP)	16
Paulo Crespo	Researcher (LIP)	13
Paulo Fonte	Researcher (LIP/ISEC)	44
Rui Alves	Technician (LIP)	1
Rui Marques	Researcher (LIP/FCTUC)	13

6.1.4 Publications

Articles in international journals (with direct contribution from LIP members)

- *A long-run study of aging in glass timing RPCs with analysis of the deposited material*
  S. Gramacho, L. Lopes, M. Pineiro, P. Fonte, A. M. d´A. Rocha Gonsalves
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

- *Custom Pulse Generator for RPC Testing*
  A.Gil, E.Castro, J.Díaz, P.Fonte, J.A.Garzón, N.Montes, M.Zapata
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

- *Progress in Developing Hybrid RPC: GEM-like Detectors with Resistive*
  P.Fonte, P.Martinenengo, E.Nappi, R. Oliveira, V.Peskov
  Nucl. Instrum. and Meth. in Phys. Res. A (accepted)

Collaboration notes with internal referee

- *System studies for the CBM-TOF detector at FAIR*
  A. Blanco, P. Cabanelas, M.Ciobanu, I.Deppner, P.Fonte, D.Gonzalez-Diaz, N.Herrmann, K.D.Hildenbrand, T.I Kang, M.Kis, P.Koczon, Y.Leifels, K.Piasecki, M.S.Ryu, A.Schuettauf, N.Zernezki, and the CBM Collaboration
  CBM report 2007

6.1.5 Presentations

Oral presentations in international conferences

- *A long-run study of aging in glass timing RPCs with analysis of the deposited material*
  presented by Luís Lopes
  at 9th International Workshop on Resistive Plate Chambers and Related Detectors (RPC2007) in 13 to 16 February 2008, Mumbai, India.

Poster presentations in international conferences

- *Progress in Developing Hybrid RPC: GEM-like Detectors with Resistive Electrodes*
  presented by Paulo Fonte
  at 9th International Workshop on Resistive Plate Chambers and Related Detectors (RPC2007) in 13 to 16 February 2008, Mumbai, India.

Oral presentations in collaboration meetings

- *The physics of streamers and discharges*
  presented by Paulo Fonte
  at 2nd RD51 collaboration meeting in Paris, 13-15 October 2008.
- *RPCs from Coimbra: HADES and more*
  presented by Paulo Fonte
  at R3B collaboration meeting in Gothemburg, Sweden, 13-16 October 2008.

Seminars

- *Timing Resistive Plate Chamber applications in HADES and in Medical Imaging*
  presented by Paulo Fonte
  at NUSTAR seminar in GSI, Darmstadt, Alemanha,.

6.1.6 Academic Training

PhD Theses

- *Construccion y evaluacion de un prototipo de tomografo de emision de positrones basado en la tecnologia de camaras de placas resistivas"*
  Alberto Blanco, (on-going)

6.1.7 Project Summary

	number
Articles in international journals (with direct contribution from LIP members)	3
Collaboration notes with internal referee	1
Oral presentations in international conferences	1
Poster presentations in international conferences	1
Oral presentations in collaboration meetings	2
Seminars	1

6.2 Microstructure Gas Detectors

6.2.1 Activity Report

O projecto em curso envolve o desenvolvimento de detectores de radiação gasosos com sistemas de leitura ópticos, neste caso fotomultiplicadores. A cintilação é emitida pelas avalanches produzidas em microestruturas e permite a localização das interacções. Foram considerados especialmente um detector para imagiologia com neutrões térmicos (32x32 cm2 e resolução de 1 mm) e uma câmara de traços (TPC).
Estes trabalhos são em parte desenvolvidos numa actividade financiada pelo 6º Quadro Comunitário de Apoio - JRA2 - MILAND: Millimetre resolution Large Area Neutron Detector NMI3 - HII3-CT-2003-505925 e POCI/FP/81974/2007 Optimization and readout of gaseous active scintillators.
Foi submetido um novo projecto ao 7º Quadro Comunitário de Apoio.
Report 2008
The activity on this project was reduced in 2008, as FP6 for fundings for the MILAND project ended at the beginning of 2008 and fundings from the new project submitted to FP7 will be available only n 2009. FCT funding for this activity was also very limited.
1.Transparent MSGC charge and light measurements
At the end of 2007 a new type of MSGC has been developed by the Graduate School of Engineering, of the University of Tokyo by Dr. Hiroyuki Takahashi (who has the status of MILAND observer and has participated in most of its meetings) using ITO electrode technology. This microstructure has transparent electrodes and is 90% transparent, and can be read optically from the substrate side. Dr. Takahashi has supplied LIP with some ITO multigrid MSGC plates and some preliminary measurements were made with ArCF4 and pure CF4. Both charge and light modes were tested. In Coimbra The X-ray resolution at 5.9 KeV was found to be around 28% with 1 bar CF4 using a PMT readout without any tails or similar artifacts at for low energies. The photon yield dependency on the grid voltage was studied with pure CF4 and typical photon yield varied between 0.1 and 0.16 photons per secondary electron. The light signals were very short, typically 60 nS.
This microstructure could be used with great advantage in neutron Anger Cameras, eliminating the problems introduced by the drift zone gap depth in classical MSGCs operated in scintillation that must be read from the electrode side.
2.Optical TPC developements
Measurements were made with a scanning source for two PMT assemblies- a 3x3 square mount and 2-3-2 hexagonal close packing. These results, that will be of great use in the coming FP7 project are being analysed and are the final part of a student PhD thesis .
3. Neutron detectors.
During 2008 we participated in the elaboration of a detector project entitled "Integrated Infrastructure Initiative for Neutron Scattering and Muon Spectroscopy"to be submitted to Framework Project 7. Our team integrated the detector Joint Research Activity on detectors and after long discussions the only project forseen in detectors aims to the development of new detector technologies based on Gaseous Scintillation Proportional Counters (GSPC), improving the performance of high resolution detectors used in reflectometry or time resolved SANS. This technique was pioneered at LIP and was tested in FP6 in two protypes. We are now members of Task 22.2 that will explore the perspectives of Gaseous Scintillation Proportional Counters based on 3He-CF4 gas mixtures at high pressure and various charge amplifying structures (MSGC, ITO-MSGC, GEM) read out by position sensitive light detecting devices.

6.2.2 Sources of Funding

Code	Funding	Start	End
POCI/FP/81974/2007	15.000 €	2007-07-01	2008-06-30

6.2.3 Team

Project coordinator: Francisco Fraga

Name	Status	%of time in project
Alexandre Moita	Technician (LIP)	5
Américo Pereira	Technician (LIP)	5
Armando Policarpo	Researcher (LIP/FCTUC)	7
Francisco Fraga	Researcher (LIP/FCTUC)	25
Joaquim Oliveira	Technician (LIP)	5
Luís Margato	PhD student (LIP)	10
Margarida Fraga	Researcher (LIP/FCTUC)	10
Orlando Cunha	Technician (LIP)	7
Rui Marques	Researcher (LIP/FCTUC)	7
Susete Fetal	PhD student (LIP/ISEC)	40

6.2.4 Presentations

Oral presentations in collaboration meetings

- *General considerations to build Neutron position sensors based on gaseous Photo-luminiscence*
  presented by Francisco Fraga
  at MILAND public final meeting in Ajjacio - Corsiga.

6.2.5 Project Summary

	number
Oral presentations in collaboration meetings	1

6.3 RD51

6.3.1 Activity Report

Prosseguindo a tradicional linha de trabalho no desenvolvimento de detectores gasosos de radiação, o LIP aderiu em Abril ao programa RD51. Trata-se de uma vasta colaboração internacional que visa o desenvolvimento de detectores de microestrutura, tendo em vista, muito particularmente, responder às necessidades de upgrade das experiências LHC.
O LIP tem em vista participar em duas linhas de actividade deste fórum de troca de experiências e de ferramentas: detectores de RPC com resolução sub-milimétrica e detectores de xénon de dupla fase.
Não se pensa, tornar esta actividade um projecto autónomo, mas continuar os desenvolvimentos no âmbito dos projectos respectivos, nomeadamente RPC PET e pesquisa de matéria negra (ZEPLIN).

Activity Report

We participated in the spring meeting in Amsterdam (16-18 April), where LIP has been accepted as a partner. The tasks to be carried out were defined as follows:
WG1: Technological Aspects and Development of New detector Structures
WG2: Common Characterization and Physics Issues
WG3: Applications
WG4: Simulations and Software Tools
WG5: MPGD Related Electronics
WG6: Production
WG7: Common Test Facilities
LIP is expected to contribute to tasks within WG2, WG3 and WG4.
In the next meeting, October 13-15 in Paris, one of us reported on work carried on in Coimbra both on RPCs with sub-millimetric position resolution and on the stability of operation of double phase xenon detectors, with a microstrip structure used in the gas phase. Another member of the LIP team was invited to give a plenary talk on the physics of discharge processes,
Some clarification was also achieved concerning the organizational matters of the collaboration. The MoU has made important advancements and it is expected to be signed by the member institutes in the first half of 2009.

6.3.2 Sources of Funding

Code	Funding	Start	End

6.3.3 Team

Project coordinator: Rui Marques

Name	Status	%of time in project
Paulo Fonte	Researcher (LIP/ISEC)	0
Rui Marques	Researcher (LIP/FCTUC)	0
Vitaly Chepel	Researcher (LIP/FCTUC)	0

6.3.4 Project Summary

(no values to report)

6.4 Oficina-Coimbra

6.4.1 Activity Report

The final (ancillary) equipment obtained through the FCT Program for Scientific Re-Equipment has been installed, thus bringing this project to an end. The technicians received the basic training (CAD/CAM) foreseen in the framework of the acquisition of the two CNC machine tools.
The mechanical workshop (MO) has responded to requests for services, both in the area of project and of production, from LIP projects, mainly, but also from the Physics Department of the University of Coimbra (according to the existing contract) and other research institutions. We can stress the work performed for a new "customer", the Laboratory of Energy and Environment of Universidade Fernando Pessoa, a private university from Porto.
The main "customers"along 2008 were LIP projects: HADES, ZEPLIN, ATLAS and Fluorescence of the air. Outside LIP, the main users were the Physycs Department, the Museum of the Physics Department, Universidade Fernando Pessoa, IPO (the Cancer Institute of Coimbra) and ISR (Institute for Systems and Robotics - Coimbra). The following graph shows the distribution of the work performed by the MO (4488 man.hours in total) among LIP (Coimbra and Lisbon), the Physics Department and the external institutions. The fraction corresponding to external institutions, the only which is the object of invoices, added to 25385.70 €(the total invoiced by the workshop in 2008, actually amounts to 48.331,66 €, but this includes an important slice of work performed during 2007).

Distribution of the work among types of institutions

DF	14%
LIP-C	40%
LIP-L	24%
external	22%

Some effort was put in the development of a new webpage for the MO, as well as a new program for the management of tools, and a data base that will allow the electronic management of the work flow. This was possible thanks to the collaboration with three institutions (the Department of Mechanical Engineering (DEM) of FCTUC, the Department of Computer Science of ISEC and the professional school Novotecna) which had students carrying out their training at the MO, under co-supervision of its present coordinator.
During this year the staff of the workshop was the following:

Rui Alves	Mechanical Engineer	Coordinator and project engineer
Alexandre Moita	Technical Engineer	Technician (till September 2008 *)
Joaquim Oliveira	technician	
Carlos Silva	technician	

*) This technician left the MO in October to take a job in the industry.

Chapter 7

Outreach

7.1 Particle physics education and public outreach

7.1.1 Activity Report

Relatório de Actividades

A actividade de divulgação do grupo de Outreach do LIP desenvolveu-se em 2008 segundo vários vectores.

- Foram realizadas as Masterclasses 2008, no âmbito do grupo EPPOG - European Particle Physics Outreach Group, com a participação recorde de 550 participantes em cinco institutos: Instituto Superior Técnico (IST) e Faculdade de Ciências da Universidade de Lisboa (FCUL) em Lisboa, e LIP+Faculdade de Ciências e Tecnologia da Universidade de Coimbra (FCTUC) em Coimbra, e pela primeira vez na Universidade da Beira Interior na Covilhã e na Universidade do Algarve em Faro. Para permitir um número tão elevado de participantes, contámos com o apoio voluntário e entusiástico de 13 cientistas nas palestras e aproximadamente 30 cientistas a apoiar a actividade de análise de dados.

- Foram co-organizados em Lisboa os "Dias Nacionais de Portugal"no âmbito de ASPERA, a rede europeia de agências de financiamento para a Física de Astropartículas.

- Foi realizado o 1º Encontro Nacional do Projecto Radão, que reuniu em Vendas Novas cientistas do LIP e mais de 100 alunos e professores, provenientes das 11 escolas participantes no projecto, e onde foram apresentados e avaliados os trabalhos realizados pelos alunos. Na sequência da 2ªEscola de Física no CERN para Professores Portugueses (ver em baixo), este projecto foi alargado para 25 Escolas em todo o país.

- Foram realizados 4 estágios no âmbito da Ocupação Científica de Jovens em Férias, em parceria com o IST, com a FCUL, e com a Universidade do Algarve.

- Foram prosseguidas as actividades no âmbito do Telescópio de Raios Cósmicos, tendo sido estudados e desenvolvidos procedimentos de calibração, e realizados testes de calibração dos detectores no IST e em algumas escolas. Foram realizados vários seminários de divulgação em Escolas e no IST. Em particular foi realizada uma sessão de divulgação para crianças de 5 anos (num infantário).

- As actividades de Outreach do LIP foram apresentadas na 22ª e 23ª Reuniões do grupo EPPOG, que tiveram lugar em Praga em Abril de 2008 e no CERN em Outubro de 2008, respectivamente.

- Finalmente foi co-organizada com o CERN a 2ª Escola de Física do CERN para Professores Portugueses ("CERN´s Portuguese Teachers Program 2008"). Foram levados ao CERN 45 Professores de escolas portuguesas (de 242 candidatos), e durante uma semana tiveram aulas, sessões experimentais e visitas acompanhadas por investigadores portugueses. Esta escola foi ainda acompanhada por um jornalista e um fotógrado do Expresso, que originou duas reportagens de 2 páginas nas semanas seguintes. Esta escola teve um grande sucesso junto dos participantes, e potenciou o estabelecimento de contactos muito próximos com Professores de escolas remotas no Continente e nas Regiões Autónomas.

- Por ocasião do arranque do LHC, estabeleceram-se muitos contactos com jornalistas da televisão e imprensa escrita, e foram gravados programas e entrevistas sobre Física de Partículas e sobre a participação portuguesa no CERN, que foram depois transmitidos ou impressos. Em particular, a notícia do arranque do acelerador foi a primeira notícia dos telejornais das 20h00 nos principais canais televisivos, e teve honras

de primeira página em jornais de referência e houve a participação de cientistas portugueses em debates televisos nessa altura. Quase toda a imprensa escrita deu ampla cobertura do acontecimento.

- Finalmente houve uma participação importante no Fórum "Ciência Viva 2008", e uma contribuição para a Mostra "Portugal Tecnológico 2008", a pedido e sob orientação do Ministério da Ciência, Tecnologia e Ensino Superior.

Activity Report

The outreach activities of LIP in 2008 followed several directions.

- The EPPOG European Masterclasses in Particle Physics were organized in five institutes in Portugal - LIP + Instituto Superior Técnico (IST) and Faculdade de Ciências da Universidade de Lisboa (FCUL) in Lisbon, and at LIP + Faculdade de Ciências e Tecnologia da Universidade de Coimbra (FCTUC) in Coimbra, and also at Universidade of Beira Interior at Covilhã and Universidade of Algarve at Faro, with a record number of nearly 550 participants. This high participation and interest is a direct consequence of the CERN´s Portuguese Teachers Program organized in 2007.

- In May 2008 were co-organized the "Portugal National Days"in the scope of ASPERA, the AStroparticle Physics for the ERAnet, a network of financing agencies for astroparticle physics.

- In the scope of Ciência Viva´s Ocupação Científica de Jovens em Férias, 4 stays (of about 2 weeks each) for portuguese students were organized at IST and FCUL.

- The first national meeting of "Projecto Radão- a project started in 2007 to work with secondary schools in the activities of characterising the radiation in the environment - took place in Vendas Novas in May 2008, and gathered LIP Scientists and over 100 high-school students and teachers, originating in the 11 schools participating in the project. In this meeting the works performed by the students were presented and evaluated. Following the 2nd CERN´s Portuguese Teachers Program, this project was enlarged to 25 schools all over the country.

- The activities in the framework of the TRC Project - Telescópio de Raios Cósmicos were carried out, namely calibration studies and procedures, and calibration tests were performed at IST and at some schools.

- Several outreach seminars were given in secondary schools and at IST.

- The Outreach activities of LIP were presented in the EPPOG´s 22nd and 23rd meetings at Prague in April 2008 and at CERN on October 2008, respectively.

- The second school of Physics for Portuguese Teachers was co-organized at CERN ("CERN´s Portuguese Teachers Program 2008"). 45 Portuguese Teachers were selected among 242 candidates, to spend a week at CERN, having update classes of particle physics and the Universe, experimental hands-on sessions, and visits to the CERN´s complex and experiments, accompanied by portuguese researchers at CERN. This school had again an enormous success among its participants, and we collected more important contacts with remote schools in Portugal (including the Atlantic Islands).

- The LHC Start-up day was a major news hit at CERN and in Europe and, thanks to LIP efforts and help from EPPCN - The European Particle Physics Communication Network, also in Portugal. The school of physics was accompanied by a journalist and a photographer from "Expresso", which originated two stories 2-pages long published in the following weeks. TV programs - news and debates - were recorded with participation of LIP scientists, and interviews were performed and printed in major newspapers. In particular, the news item of the startup of LHC was the lead news in the national TV´s main newsjournal at primetime (20h00), and was honoured with frontpage cover in reference newspapers. Almost all written press gave a broad coverage of the event.

- Finally there was an important and significative participation in Forum "Ciência Viva 2008", with two large stands, and a contribution to the Show "Portugal Tecnológico 2008", following a request and supervision from the Ministry of Science, Technology and Higher Education.

7.1.2 Sources of Funding

Code	Funding	Start	End
2006-204/176	56.000 €	2007-04-01	2008-06-01
PTP 2008 CERN	37.500 €	2008-04-01	2008-10-31
OCJF 2008	950 €	2008-05-01	2008-09-30

7.1.3 Team

Project coordinator: Pedro Abreu

Name	Status	%of time in project
Agostinho Gomes	Researcher (LIP)	2
Amélia Maio	Researcher (LIP/FCUL)	15
Américo Pereira	Technician (LIP)	20
Ana Rodrigues		20
Ana Fernandes		20
Ana Pinho		20
Ana Pinto		20
António Onofre	Researcher (LIP)	10
Bruna Rico		20
Carlos Bernardino		20
Carmen Oliveira		28
Conceição Abreu	Researcher (LIP/UALG)	27
Fernando Barão	Researcher (LIP/IST)	5
Florbela Rego	PhD student (LIP)	10
Gaspar Barreira	Researcher (LIP)	3
João Carvalho	Researcher (LIP/FCTUC)	4
João Gentil	PhD student (LIP/FCUL/FCT)	2
José Silva	PhD student (LIP/FCUL)	6
Lina Moniz	Student (LIP)	42
Luis Peralta	Researcher (LIP/FCUL)	16
Marco Quinteiro	Researcher	20
Miguel Ferreira	Technician (LIP)	4
Paula Pinho		20
Paulo Nunes		20
Pedro Abreu	Researcher (LIP/IST)	42
Pedro Assis	PhD student (LIP/FCT)	10
Sandra Soares	Researcher (LIP/UBI)	18
Sofia Andringa	Researcher (LIP/FCT) *	1

7.1.4 Presentations

Seminars

- *Como Compreender o Universo*
  presented by
  at LIP in Escola Secundária de Avelar Brotero.
- *Como Compreender o Universo*
  presented by
  at LIP in Escola Secundária José Falcão.

Outreach seminars

- *Raios cósmicos e câmara de faíscas*
  presented by João Carvalho
  at in Auditório Municipal da Lousã.
- *Do infinitamente grande ao infinitamente pequeno*
  presented by João Carvalho
  at in Escola Secundária de Cantanhede.

- *Raios cósmicos e a construção e operação de uma câmara de faíscas*
  presented by Paulo Martins
  at in Escola Secundária de Cantanhede.
- *O que fazem os Físicos no CERN?*
  presented by Pedro Abreu
  at in Academia de Música de Santa Cecília, Lisboa.
- *O que fazem os Físicos no CERN?*
  presented by Pedro Abreu
  at in Insituto Superior Técnico, Lisboa (Visita de Escolas ao IST).
- *O Universo é tão Grande! - Sessão Infantil (5 anos)*
  presented by Pedro Abreu
  at in Associação Escola 31 de Janeiro, Parede.
- *Do infinitamente grande ao infinitamente pequeno*
  presented by João Carvalho
  at in Escola C+S de Condeixa.
- *Raios cósmicos e a construção e operação de uma câmara de faíscas*
  presented by Paulo Martins
  at in Escola C+S de Condeixa.
- *Os prós e os contras da radiação*
  presented by Sandra Soares
  at XIV Encontro de Jovens Investigadores in Guarda.
- *Radão, o Inquilino Silencioso*
  presented by Sandra Soares
  at Semana Europeia de Mobilidade - "O ar que respiramos"in Guarda.
- *Ao Encontro do Infinito*
  presented by Pedro Abreu
  at in Escola Secundária Vergílio Ferreira, Lisboa.
- *Ao Encontro do Infinito*
  presented by Pedro Abreu
  at in Centro de Congressos da Câmara Municipal de Portalegra.
- *Nós e as Radiações*
  presented by Sandra Soares
  at in Escola Secundária da Sé, Guarda.
- *Como detectar a radiação*
  presented by Sandra Soares
  at in Escola Secundária da Sé, Guarda.
- *Ao Encontro do Infinito*
  presented by Pedro Abreu
  at in Colégio Moderno, Lisboa.
- *À descoberta...*
  presented by Sandra Soares
  at Dia da Cultura Científica in Escola Secundária da Sé, Guarda.
- *Ao Encontro do Infinito*
  presented by Pedro Abreu
  at in Escola Secundária Mouzinho da Silveira, Portalegre.
- *Ao Encontro do Infinito*
  presented by Pedro Abreu
  at in Auditório da Câmara Municipal de Proença-a-Nova.
- *Radiação versus Radioactividade*
  presented by Sandra Soares
  at in Escola Secundária do Fundão.

7.1.5 Events

- *Com as Mãos nas Partículas - Masterclasses 2008*
  Outreach Event, Lisboa, Coimbra, Covilhã, Faro - Portugal, 2008-03-01
- *Estágio "Radioactividade na Serra da Estrela"*
  Outreach Event, LIP e U.B.I., Covilhã, 2008-06-30
- *Estágio "Chuva de Raios Cósmicos no Verão"*
  Outreach Event, LIP e Instituto Superior Técnico, 2008-07-08
- *Estágio "Colaboração na Experiência ATLAS em LHC"*
  Outreach Event, LIP e FCUL/CFNUL, Lisboa, 2008-07-15
- *Estágio "A curta vida dos muões"*
  Outreach Event, LIP e FCUL/CFNUL, Lisboa, 2008-07-15
- *Visita ao CERN 2008 - Professores de Escolas Portuguesas*
  Outreach Event, , 2008-08-31
- *Acção de Formação para Professores*
  Seminar organization, Universidade da Beira Interior, Covilhã, 2008-10-04

7.1.6 Project Summary

	number
Seminars	2
Outreach seminars	19
Outreach Events	6
Seminar organizations	1

Chapter 8

Scientific Conferences and Seminars

Relatório

Como em anos anteriores, o LIP continuou a promover e organizar Conferências Científicas em Portugal, em colaboração com várias universidades e centros de investigação. A PASC Winter School teve a sua segunda edição este ano em Sesimbra. A reunião da R-ECFA e o Dia Nacional ASPERA (Astropartículas) tiveram lugar em Lisboa em 2008. Além disso, foram organizados três encontros sobre computação GRID: a Conferência Ibérica sobre Infraestrutura GRID no Porto, uma sessão de treino GRID em Coimbra e a reunião eugridpma em Lisboa.
Em Janeiro de 2008, oerganizámos as bienais "Jornadas do LIP"no Luso. A reunião apresentou uma panorâmica das actividades científicas do LIP e teve uma participação de mais de 100 membros do LIP.
Prosseguimos também com um programa de seminários de oradores internos e convidados, com o objectivo de manter uma boa regularidade. O programa de seminários "Café com Física"é organizado pelo Departamento de Física da Universidade de Coimbra e pelo LIP-Coimbra.

Report

As in previous years, LIP has carried on promoting and organizing Scientific Conferences in Portugal, in partnership with several Universities and Research Centers. The PASC Winter School had its second edition this year in Sesimbra. The R-ECFA meeting and the ASPERA national day took place at Lisbon in 2008. In addition, three GRID-related meetings were organized: the Iberian GRID Infrastructure Conference at Porto, a GRID training session at Coimbra, and the eugridpma meeting at Lisbon.
In January 2008, we held the biennual "Jornadas do LIP"at Luso. The meeting presented a scientific overview of all the LIP research and was well attended by over 100 LIP members.
A program of scientific seminars by "internal"and invited speakers was also pursued, with the aim of making it as regular as possible. The seminar "Café com Física"is a joint venture of the Department of Physics of the University of Coimbra and LIP Coimbra.

8.1 Seminars

Seminars

- *Very High Energy from Very far Away*
  presented by Alessandro de Angelis on 2008-01-17
  at in LIP Lisboa.
- *Cracking the code of star formation*
  presented by João Alves on 2008-02-21
  at in LIP Lisboa.
- *The CMS Electromagnetic Calorimeter Online Software*
  presented by Pasquale Musella on 2008-04-03
  at in LIP Lisboa.
- *Like-sign dileptons from heavy neutrinos at LHC*
  presented by Juan Aguilar-Saavedra on 2008-04-18
  at in LIP Lisboa.

- *Listening to the Universe with gravitational waves*
  presented by Vitor Cardoso on 2008-04-24
  at in LIP Lisboa.
- *Radioterapia de elevada precisão com iões*
  presented by Paulo Crespo on 2008-05-15
  at in LIP Lisboa.
- *Using Jets to Trigger ATLAS at the LHC*
  presented by Nuno Anjos on 2008-06-05
  at in LIP Lisboa.
- *Charmonium production and absorption in proton-nucleus collisions*
  presented by Hermine Wöhri on 2008-06-17
  at in LIP Lisboa.
- *The first year of Borexino data*
  presented by Davide Franco on 2008-07-10
  at in LIP Lisboa.
- *AUGER: from South to North*
  presented by Hans Klages on 2008-09-11
  at in LIP Lisboa.
- *Dosimetros de estado sólido para aplicações médicas*
  presented by Florbela Rego on 2008-10-10
  at in LIP Lisboa.
- *Good practices on how to keep secrets over the internet... guidelines for LIP users*
  presented by Gonçalo Borges, Nudo Dias on 2008-10-30
  at in LIP Lisboa.
- *Um estudo das práticas informacionais dos físicos experimentais de partículas: o caso LIP*
  presented by Maria Leonor Coimbra on 2008-11-27
  at in LIP Lisboa.
- *A new polarized Drell-Yan experiment at CERN*
  presented by C. Quintans for COMPASS-LIP on 2008-12-04
  at in LIP, Lisbon.
- *Measuring heavy flavor in heavy ion collisions with a Data-push silicon pixel Detector*
  presented by Gerd J. Kunde on 2008-12-15
  at in LIP Lisboa.