

# FCT Fundação para a Ciência e a Tecnologia

MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Concursos de Projectos de I&D  
Proposals for R&D Projects

▶ [Voltar à descrição do projecto](#)  
**Back to project description**

▶ [Instruções para consultar e imprimir esta página](#)  
**Instructions to view and print this page**

▶ [Imprimir esta página](#)  
**Print this page**

## Visão global da candidatura Application form overview

Ocultar todos os formulários da candidatura  
**Hide all forms for this application**

### Referência do projecto Project reference

POCI/FP/81921/2007

1. Identificação do projecto  
1. Project description

### Financiamento solicitado Requested funding

113.924,00 Euros

### Área científica principal Main Area

Física das Partículas

### Área científica Secundária Secondary area

### Título do projecto (em português)

#### Project title (in portuguese)

Experiências de Correlações Angulares Perturbadas e de Canalização de Electrões no ISOLDE-CERN

### Título do projecto (em inglês)

#### Project title (in english)

Perturbed Angular Correlations and Electron Channeling Solid State Physics Experiments at ISOLDE

### Palavra-chave 1

Caracterizacao de Materiais `a Escala Nanoscopica

### Palavra-chave 2

Tecnicas Nucleares, Novos Detectores

### Palavra-chave 3

Dopagem de Novos Semicondutores

### Palavra-chave 4

Magnetismo, Supercondutividade

### Objectivos sócio-económicos

#### Socio-economic objectives

Promoção geral dos conhecimentos (investigação fundamental sem objectivo sócio-económico discriminado)

### Data de início do projecto Starting date

01-11-2007

### Keyword 1

Nano Scale Material´s Characterisation

### Keyword 2

Nuclear Techniques, New Detectors

### Keyword 3

Doping of New Semiconductors

### Keyword 4

Magnetism, Superconductivity

### Duração do projecto em meses

#### Duration in months

12

2. Instituições participantes  
2. Participating institutions

### Instituição Proponente

#### Principal Contractor

#### Instituto Tecnológico e Nuclear (ITN/MCTES)

Estrada Nacional 10  
2686-953Sacavém

### Instituições Participantes

#### Participating Institutions

Fundação da Universidade de Lisboa (FUL/UL)

Reitoria da Universidade de Lisboa - Alameda da Universidade  
1649-004Lisboa

**Unidade de Investigação**

**Principal Research Unit**

**Instituto Tecnológico e Nuclear (ITN/MCTES)**

Estrada Nacional 10  
2686-953Sacavém

**Instituição de Acolhimento**

**Host Institution**

**Instituto Tecnológico e Nuclear (ITN/MCTES)**

Estrada Nacional 10  
2686-953Sacavém

3. Orçamento

3. Budget

-

**Instituição Proponente**

**Principal Contractor**

**Instituto Tecnológico e Nuclear**

DESCRIÇÃO

DESCRIPTION

Recursos Humanos

Human resources

Missões

Missions

Consultores

Consultants

Aquisição de serviços e manutenção

Acquisition of services and maintenance

Outras despesas correntes

Other current expenses

Despesas gerais

Overheads

Equipamento

Equipment

**TOTAL**

	2007	2008	2009	2010	2011	TOTAL
Recursos Humanos	4683	23485	0	0	0	28168
Missões	1500	10000	0	0	0	11500
Consultores	0	3090	0	0	0	3090
Aquisição de serviços e manutenção	2000	8500	0	0	0	10500
Outras despesas correntes	500	3000	0	0	0	3500
Despesas gerais	1736	11923	0	0	0	13659
Equipamento	0	11540	0	0	0	11540
<b>TOTAL</b>	<b>10419</b>	<b>71538</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>81957</b>

**Instituições Participantes**

**Participating Institutions**

**Fundação da Universidade de Lisboa**

DESCRIÇÃO

DESCRIPTION

Recursos Humanos

Human resources

Missões

Missions

Consultores

Consultants

Aquisição de serviços e manutenção

Acquisition of services and maintenance

Outras despesas correntes

Other current expenses

Despesas gerais

Overheads

Equipamento

Equipment

**TOTAL**

	2007	2008	2009	2010	2011	TOTAL
Recursos Humanos	1849	9290	0	0	0	11139
Missões	0	4000	0	0	0	4000
Consultores	0	0	0	0	0	0
Aquisição de serviços e manutenção	500	2500	0	0	0	3000
Outras despesas correntes	500	2000	0	0	0	2500
Despesas gerais	570	4758	0	0	0	5328
Equipamento	0	6000	0	0	0	6000
<b>TOTAL</b>	<b>3419</b>	<b>28548</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>31967</b>

**Orçamento Global**

**Global budget**

DESCRIÇÃO

DESCRIPTION

Recursos Humanos

Human resources

Missões

Missions

	2007	2008	2009	2010	2011	TOTAL
Recursos Humanos	6532	32775	0	0	0	39307
Missões	1500	14000	0	0	0	15500

Consultores	0	3090	0	0	0	3090
Consultants						
Aquisição de serviços e manutenção	2500	11000	0	0	0	13500
Acquisition of services and maintenance						
Outras despesas correntes	1000	5000	0	0	0	6000
Other current expenses						
Despesas gerais	2306	16681	0	0	0	18987
Overheads						
Equipamento	0	17540	0	0	0	17540
Equipment						
<b>TOTAL</b>	<b>13838</b>	<b>100086</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>113924</b>

**Plano de financiamento**

**Finance plan**

DESCRIÇÃO	2007	2008	2009	2010	2011	TOTAL
Financiamento solicitado à FCT	13838	100086	0	0	0	113924
Requested funding						
Financiamento próprio	0	0	0	0	0	0
Own funding						
Outro financiamento público	0	0	0	0	0	0
Other public-sector funding						
Outro financiamento privado	0	0	0	0	0	0
Other private funding						
<b>Total do Projecto</b>	<b>13838</b>	<b>100086</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>113924</b>
<b>Total of the project</b>						

4. Justificação do orçamento

4. Budget justification

-

**4.1. Justificação dos recursos humanos**

**4.1. Human resources justification**

Tipo	Nº de pessoas	Duração	Custo envolvido (€)
(BI) Bolsa de Investigação (Lic. ou Bacharel)	1	12	9889

Justificação

- sample's preparation and characterization
- analysis of data obtained during 2007 & 2008
- data acquisition and analysis for IS368.

NOTE 1: (Other Costs regards Voluntary Social Insurance (Seguro Social Voluntario) of 77 euros/month in 2007 and of 79.5 euros/month in 2008)

NOTE 2: the reason why there are two types of scholarships with similar tasks aims financing people with different qualifications, from previous years experience.

Tipo	Nº de pessoas	Duração	Custo envolvido (€)
(BI) Bolsa de Investigação (Mestre)	1	12	12709

Justificação

- sample's preparation and characterization
- analysis of data obtained during 2007 & 2008
- data acquisition and analysis for IS368.

NOTE: (Other Costs regards Voluntary Social Insurance (Seguro Social Voluntario) of 77 euros/month in 2007 and of 79.5 euros/month in 2008)

Tipo	Nº de pessoas	Duração	Custo envolvido (€)
(BIC) Bolsa de Iniciação à Investigação Científica	3	12	16708

Justificação

Introducing young students mainly to the scientific aspects and applied use of the PAC and EC techniques. At CFNUL two of such students will construct & implement specific new basis for the electron lenses of the e-gamma spectrometer. For its gamma channel, they will construct two new LYSO detectors for gamma detection with high energy & time resolution. The third student will work on implementing new simulation programs for fitting pac data with time dependent hamiltonians of the hyperfine interactions, required for transient electronic phenomena in material's studies.

**Custo total: 39306**

**4.2. Justificação de missões**

**4.2. Mission justification**

Tipo	Local	Nº de deslocações	Custo envolvido (€)
Participação em congressos	Europe & USA	4	5000

Justificação

Participation on conferences with presentation of work.  
 Fee, traveling and subsistence allowance estimates:  
 EUROPE -1000 euros p/person x 2  
 USA -1500 euros p/person x 2

Tipo	Local	Nº de deslocações	Custo envolvido (€)
------	-------	-------------------	---------------------

Trabalho de campo CERN-ISOLDE 9 10500

Justificação

Participation on beam times at ISOLDE & Implementation at CERN, of work (detectors) developed at CFNUL.  
 Single week estimated costs, by considering 80 euros/day (hotel and food) plus 400 euros travel Portugal-CERN-Portugal gives ~1000 euros per week per person.  
 9 (one person) weeks are considered. Extra 1500 euros were included to support a student's housing for 4 months at ISOLDE, while sharing apartment with other students at CERN. Such more cheap solutions have been found before for longer periods, within students.

**Custo total: 15500**

**4.3. Justificação de consultores**

**4.3. Consultants justification**

Nome	Instituição	Fase do projecto	Custo envolvido (€)
Carlos Lacasta LLacer , Carlos.Lacasta@uv.es	INSTITUTO DE FÍSICA CORPUSCULAR , Edificio Institutos de Investigación, Paterna. Valencia, Spain	first half	725

Justificação

In situ - at ISOLDE - discussion of the necessary upgrades of the data acquisition program for the emission channeling experiments with the new electron detector, mainly developed by Carlos Lacasta group. (5 days x 85 euros + 300 euros travel)

Nome	Instituição	Fase do projecto	Custo envolvido (€)
Heinz Haas ; heinz.haas@cern.ch	ISOLDE - CERN & ITN (collaborator)	full period	1275

Justificação

Heinz Haas was a former ISOLDE group leader and a nuclear & solid state physicist of the HMI Berlin institute. He is a regular collaborator of our group since ever, working on the EFG simulations. The funds are requested for mobility while providing discussion, presentations and advising work. We estimate the costs at the CERN daily allocation of 134CHF (85 euros), for 15 days.

Nome	Instituição	Fase do projecto	Custo envolvido (€)
Pedro Alexandre Ferreira ; pedro.ferreira@univ-evry.fr	Universite d'Evry -Val d'Essone, France	full period	1090

Justificação

Support to our linux systems. Main reason: - the new emission channeling detector has a linux operating data acquisition system. The data handling and analysis are also done under linux and must be optimized to handle terabytes of information. Other reason: advising on optimizing our pc linux cluster where emission channeling and wien simulations are performed. (10 days x 85 euros + 2 x 120 euros (TGV Paris- Geneva))

**Custo total: 3090**

**4.4. Justificação de aquisição de serviços e manutenção**

**4.4. Acquisition of services and maintenance justification**

Tipo	Custo envolvido (€)
MAINTENANCE AND DEVELOPMENT OF EQUIPMENT HARDWARE AT CFNUL	3000

Justificação

MAINTENANCE OF :

- 1) Electronics of the g-g spectrometer
- 2) Evaporator for depositing Hafnium Oxide thin films

NOTE: this is the laboratory where students are formed in hyperfine (PAC) nuclear techniques, running long lived isotopes mainly produced at the ITN Nuclear reactor or implanted abroad in Bonn and ISOLDE. Part of its working program with long lived isotopes complement the ISOLDE experiments and proposals with short lived isotopes.

Tipo	Custo envolvido (€)
MAINTENANCE OF EQUIPMENT HARDWARE (OUR PROJECT INFRASTRUCTURE) AT ISOLDE/CERN	4800

Justificação

MAINTENANCE OF :

- 1) Eight vacuum systems
- 2) Electronics of the e-g spectrometer
- 3) Electronics of the three emission channeling detectors and of the new fast EC PAD detector.
- 4) Two offline furnaces
- 5) Two closed cycle refrigerators with temperature controllers
- 6) EC simulation cluster (fifteen PCs)
- 7) Seven office and experiment controlling PCs.

Tipo	Custo envolvido (€)
MECHANICAL DEVELOPMENT - NEW ONLINE CHAMBER FOR EC EXPERIMENTS	5000

Justificação

Mechanical work required for a) adapting the new EC vacuum chamber to the ISOLDE beam line and b) implement the cooled sample holder into the goniometer used for emission channeling experiments.

Tipo	Custo envolvido (€)
transport of radioactive samples of short lived isotopes	700

Justificação

Rent of a CERN car during three beam times (eight days each) for transporting of samples implanted with short lived isotopes, between ISOLDE - building 170 - and the measurement labs in - building 275.

**Custo total: 13500**

**4.5. Justificação de outras despesas correntes**

**4.5. Current expenses justification**

Tipo de despesa	Custo envolvido (€)
CONSUMABLES	6000
Justificação	
<ul style="list-style-type: none"> <li>- semiconductor samples for IS368</li> <li>- gloves for glove boxes</li> <li>- protective clothes</li> <li>- chemical compounds</li> <li>- high pure annealing gases</li> <li>- rent (at CERN) of nuclear electronic components</li> <li>- security signs, talk powder, plastic bags, plastic tubes, electrical plugs and cables</li> <li>- sample's containers</li> <li>- heating "barquettes" at the evaporator for thin films deposition.</li> <li>- shipping expenses of samples and goods</li> <li>- posters, papers publication costs</li> <li>- transport insurances.</li> </ul>	
<b>Custo total: 6000</b>	

**4.6. Justificação do Equipamento**

**4.6. Equipment justification**

**4.6.1. Equipamento já disponível para a execução do projecto**

**4.6.1 Available equipment**

Tipo de equipamento	Fabricante	Modelo	Ano
AT ISOLDE: THREE EMISSION CHANNELING SETUPS	CERN prototipes	old (slow) PAD Si detector	1997
AT ISOLDE: NEW FAST PAD Si detector	CERN prototipe	NEW PAD Si detector with VTAGP3 readout	2006
AT ISOLDE: TWO 6-DETECTOR GAMMA-GAMMA PAC SPECTROMETERS	University of Leipzig	University prototipes	1995
AT ISOLDE: ELECTRON-GAMMA PAC SPECTROMETER	Karlheinz Siegbahn Spectrometer	Unique reliquary from the fifties. There is no other of such machines, still working in the world. Re-mounted at CERN (from Bonn) in 1987.	1988
AT ISOLDE: SIMULATION 15 PC CLUSTER	ICO-europe	designed by us for EC & Wien EFG simulations	1999
AT ISOLDE: 2 CLOSED CYCLE TWO-STAGE HE REFRIGERATORS, ONE FOR THE E-G PAC SETUP, THE OTHER SPECIFIC TO POWDER SAMPLES AT THE 6D-GAMMA GAMMA PAC SPECTROMETER, PLUS CONTROLLERS FROM LAKE-SHORE.	Criophysics	CTI-22	1997
AT ITN: Laboratory of Ion beams. Includes a Van de Graaff 2,5 MV accelerator for RBS/Channeling characterization studies, one high current stable ion implanter of 210 kV, and an ionic microprobe (2x4 µm x µm).	Several equipment assembled together	Several models	1989
AT CFNUL: two gamma-gamma PAC spectrometers for training and perform experiments with long lived isotopes activated at the ITN nuclear reactor or implanted at Bonn or ISOLDE.	Several manufacturers	Several models	1986
AT Aveiro, Porto and Braga Universities several equipment for producing samples and to perform structural, electro-, magneto- and optical measurements are available.	Several manufacturers	Several models	1999

**4.6.2. Discriminação do equipamento a adquirir**

**4.6.2. List of new equipment requested**

Tipo de equipamento	Fabricante	Modelo	Custo envolvido (€)
LYSO CRYSTALS	PHOTONIC MATERIALS LIMITED, STRATHCLYDE BUSINESS PARK, ML4 3BF BELLSHILL (PML-01, MA01)	conical plus cilinder	6000
Justificação			
<p>COSTS estimated for TWO LYSO detectors to be coupled to the electron lenses of the e-gamma PAC spectrometer at ISOLDE. Tests to be done at the CFNUL laboratory.</p> <p>Energy resolution improvement of PAC detector spectrometer. The aim is to have a PAC setup with improved energy resolution, but still keeping the sub nanosecond time resolution for energies above 100keV. This development is particularly relevant at ISOLDE where a variety of PAC probe isotopes exist with complicate cascades.</p>			
Digital oscilloscope Tektronix TDS 3032B, phosphor screen, 300 MHz, 2 channels	Tektronix	TDS 3032B phosphor	5000
Justificação			
Our previous & old oscilloscopes got damaged without possible recovery since two years			
+/-12V Power supply with current limiter	TRACO POWER	TRACO POWER TMS PCB mount SMPSU, +/- 12 V, 10 W AC-DC	350

Justificação

(cost quoted for 5 units)

+/-12V Power supply for powering the emission channeling detectors. With these units we can easily obtain +/-12V , +/-6V and +/-2 V current limited to 200 - 300 mA. Actually we are renting PS units at CERN that are not foreseen for such constant use, with an annual renting price that exceeds the cost of the new units.

High Voltage supply	ORTEC	428	3750
---------------------	-------	-----	------

Justificação

(cost quoted for 3 units)

These high voltage power supplies intend replacing rented electronics, actually used for the emission channeling detector bias.

RAID STORAGE DATA	LaCie	Biggest F800 2TB RAID hard drives	1000
-------------------	-------	-----------------------------------	------

Justificação

2 tera bytes storage disks for the new emission channeling fast detector. This is a must where the amount of information stored per spectra reaches 3 gigabytes (about 20 spectra are needed per experiment).

pc LCD screen	HP	17" LCD - HP L1740 (résolution 1280 x 1024)	1440
---------------	----	---	------

Justificação

(cost quoted for 8 units) - this is a must to replace our present screens at the lab, which stand all on big UPSs together with the measuring equipment. UPSs are needed due to thunderstorms power faults, in particular, and it is an essential feature to keep them running as much time as possible, allowing us to save data and properly shutdown equipment. LCDs screens will significantly reduce power consumption.

**Custo total: 17540**

5. Equipa de investigação

5. Research team

-
---

**5.1 Lista de membros (23)**

**5.1. Members list (23)**

Nome Name	Função Role	Grau académico Academic degree	%tempo %time
<a href="#">João Guilherme Martins Correia</a>	Inv. Responsável	DOUTORAMENTO	100
<a href="#">Katharina Lorenz</a>	Investigador	DOUTORAMENTO	10
<a href="#">António Cândido Lampreia Pereira Gonç...</a>	Investigador	DOUTORAMENTO	10
<a href="#">Eduardo Jorge da Costa Alves</a>	Investigador	DOUTORAMENTO	10
<a href="#">João Pedro Esteves de Araújo</a>	Investigador	DOUTORAMENTO	20
<a href="#">Armandina Maria Lima Lopes</a>	Investigador	DOUTORAMENTO	50
<a href="#">Luis Manuel dos Santos Redondo</a>	Investigador	DOUTORAMENTO	20
<a href="#">Manuel Ribeiro da Silva</a>	Investigador	DOUTORAMENTO	50
<a href="#">José Carvalho Soares</a>	Investigador	AGREGAÇÃO	50
<a href="#">Ulrich Wahl</a>	Investigador	DOUTORAMENTO	70
<a href="#">João Cunha de Sequeira Amaral</a>	Bolseiro	MESTRADO	20
<a href="#">Tânia Manuela Melo Mendonça</a>	Bolseiro	MESTRADO	80
<a href="#">Andre Miguel Trindade Pereira</a>	Bolseiro	MESTRADO	10
<a href="#">Ana Cláudia Lourenço Santana Marques</a>	Bolseiro	LICENCIATURA	100
<a href="#">Stefan Decoster</a>	Bolseiro	Licentiaat Natuurkunde / Master in Physics	80
<a href="#">João Nuno Santos Gonçalves</a>	Bolseiro	LICENCIATURA	20
<a href="#">Célia Tavares de Sousa</a>	Bolseiro	MESTRADO	100
<a href="#">Ricardo Pedro de Vilhena Roque Ribeir...</a>	Bolseiro	BACHARELATO	50
<a href="#">Rúdi Henrique Cavaleiro Soares</a>	Bolseiro	BACHARELATO	50
<a href="#">Pedro Jorge Dias Tavares</a>	Outro	LICENCIATURA	50
<a href="#">Lino Miguel da Costa Pereira</a>	Outro		20
<a href="#">Marcelo Baptista Barbosa</a>	Outro		20
<a href="#">Fernando Joaquim Ganhão Pereira</a>	Outro	LICENCIATURA	50

*(O curriculum vitae de cada membro da equipa está disponível clicando no nome correspondente)*

*(Curriculum vitae for each research team member is available by clicking on the corresponding name)*

**5.2. Lista de membros a contratar durante a execução do projecto (5)**

**5.2. Members list to hire during project's execution (5)**

Membro da equipa Team member	Função Role	Duração Duration	%tempo %time
(BI) Bolseiro de Investigação (Lic. ou Bacharel) 1	Bolseiro	12	100
(BI) Bolseiro de Investigação (Mestre) 1	Bolseiro	12	100
(BIC) Bolseiro de Iniciação à Investigação Científica 1	Bolseiro	12	100
(BIC) Bolseiro de Iniciação à Investigação Científica 2	Bolseiro	12	100
(BIC) Bolseiro de Iniciação à Investigação Científica 3	Bolseiro	12	100

6. Projectos financiados

6. Funded projects

-
---

**Lista de projectos financiados (2)**

**Funded projects list (2)**

Referência	Título	Estado
<a href="#">POCI/FP/63435/2005</a>	Experiências de Correlações An...	Em curso
<a href="#">PDCT/FP/63911/2005</a>	Experiências de Correlações An...	Em curso

(Os detalhes de cada projectos estão disponíveis clicando na referência correspondente)  
(Details for each project are available by clicking on the corresponding reference)

7. Indicadores previstos -  
7. Expected indicators

**Indicadores de realização previstos para o projecto**  
**Expected output indicators**

DESCRIÇÃO DESCRIPTION	2007	2008	2009	2010	2011	Total
<b>A - Publicações</b>						
<b>Publications</b>						
Livros Books	0	0	0	0	0	0
Artigos em revistas internacionais Papers in international journals	0	10	0	0	0	10
Artigos em revistas nacionais Papers in national journals	0	0	0	0	0	0
<b>B - Comunicações</b>						
<b>Communications</b>						
Comunicações em encontros científicos internacionais Communications in international meetings	0	10	0	0	0	10
Comunicações em encontros científicos nacionais Communications in national meetings	0	5	0	0	0	5
<b>C - Relatórios</b>						
<b>Reports</b>						
<b>D - Organização de seminários e conferências</b>						
<b>Organization of seminars and conferences</b>						
<b>E - Formação avançada</b>						
<b>Advanced training</b>						
Teses de Doutoramento PhD theses	0	2	0	0	0	2
Teses de Mestrado Master theses	0	0	0	0	0	0
Outras Others	0	2	0	0	0	2
<b>F - Modelos</b>						
<b>Models</b>						
<b>G - Aplicações computacionais</b>						
<b>Software</b>						
<b>H - Instalações piloto</b>						
<b>Pilot plants</b>						
<b>I - Protótipos laboratoriais</b>						
<b>Prototypes</b>						
<b>J - Patentes</b>						
<b>Patents</b>						
<b>L - Outros</b>						
<b>Other</b>						
proposals científicos aprovados INTC proposals científicos aprovados INTC	3	3	0	0	0	6
novos proposals científicos a submeter ao INTC novos proposals científicos a submeter ao INTC	1	1	0	0	0	2
	0	0	0	0	0	0

**Ações de divulgação da actividade científica**  
**Scientific activity spreading actions**

This subject is a crucial issue of our activities. So far we work on this direction but only at the universities and institutes, even pushing undergraduate students to participate, starting to do some collaboration work. The interface research-public is mainly due by the universities, while advertising courses and degrees. With few exceptions, when research is mentioned, the message is quite uncoordinated with running work, as defined on research project applications. One specific issue that we could invest (but will require specific funds) is the creation of an updated web site that centralizes information of APPLIED NUCLEAR TECHNIQUES IN DAILY LIFE. It should be made/presented to the general public, but at the same time, when searching deeper, it should provide detailed and centralized scientific information to make easy exchange of such information, at the researcher level, between the research centers. This would be a useful tool, helping on demystifying the mining of "nuclear" wording, and a source of information for high schools, and researchers.

Dados temporariamente indisponíveis

8. Anexo técnico -  
8. Technical addendum

**8.1. Resumo**

## 8.1. Abstract

### Resumo (em português)

### Abstract (in portuguese)

Desde 1986, que o Grupo de Física do Estado Sólido Nuclear do CFNUL-ITN trabalha no ISOLDE, tendo sido exclusivamente apoiado pelos projectos CERN da FCT. Após submissão e aprovação de uma proposta científica no comité científico do ISOLDE (INTC-CERN), o trabalho é executado com ênfase na formação e integração de jovens Portugueses nas aplicações da física nuclear em ambientes de grande qualidade e originalidade. Com uma linha de acção que procura a complementaridade em estudos de propriedades microscópicas de materiais, o projecto conta hoje com a participação de cientistas e estudantes com formações muito diferentes em física nuclear e dos materiais, essencialmente das universidades de Lisboa, Aveiro, Porto e Braga, assim como de Lovaina, Bona, e ISOLDE.

DA APROVAÇÃO DESTE PROJECTO DEPENDE O FUNCIONAMENTO DE UMA INFRA-ESTRUTURA EXPERIMENTAL E DE CÁLCULO, CONSTRUÍDA AO LONGO DOS ANOS, ONDE SE EXECUTAM OS TRABALHOS APROVADOS E DE DESENVOLVIMENTO.

### EXEMPLOS RECENTES:

IS453 – “Localização de Elementos com Isótopos de Vidas Curtas por Canalização de Electrões de Emissão”, Proposta recentemente aprovada onde usando uma nova câmara experimental montada em linha com o feixe do ISOLDE, é possível efectuar medidas de isótopos de vidas curtas e investigar o comportamento de metais de transição Ni (2.5 h) e Co (1.6 h) e de dopantes aceitadores 27Mg (9.5 min) e 8Li (838 ms) em ZnO e GaN.

IS390 – “Estudos de óxidos com magnetoresistência colossal com isótopos radioactivos” - Demonstra-se a coexistência de fases mediada por um fenómeno de percolação livre, onde coexistem polarões (deformações) não correlacionados em LaMnO<sub>3</sub>.12. Começam-se agora a estudar efeitos isotópicos com materiais enriquecidos em O18. Trabalho liderado por Aveiro e Porto.

IS360 - “Estudos de supercondutores de alta temperatura Hg-Ba-Ca-Cu-O (TC >130 K) com isótopos radioactivos” – Mostra-se a formação de stripes atómicas de flúor dopante em Hg1201. Estudam-se presentemente estes fenómenos em Hg1212 e Hg1223 altamente dopado com Oxigénio para verificar se ha correlação entre ordenamento de carga e ordenamento do dopante.

IS368 – “Localização de Metais de Transição e elementos Terras-Raras em Semicondutores” – (proposta terminada) Mostrámos ser possível introduzir Fe em alta dose em posições substitucionais do ZnO por implantação iónica, com obtenção de ferromagnetismo. Apresentamos a primeira medida directa de uma impureza dopante num “antisite” em semicondutores, As:ZnO.

### NOVOS TRABALHOS EM CURSO E PERSPECTIVAS :

Implementação em linha do novo detector de canalização de electrões de Si PAD – rápido e de baixo ruído- aplicado a estudos de localização nas redes cristalinas de elementos dopantes, só acessíveis com recurso a isótopos de vidas curtas: Mg, Li, Ni, Co... .

Continuação de estudos em materiais com aplicações em spintronic, ZnO, GaN, AlN e SiC. Aqui salientamos o estudo da localização dos dopantes e o conhecimento da sua dinâmica de relaxação na rede hospedeira. A técnica de canalização de electrões, aplicada a sistemas implantados a BAIXA TEMPERATURA, poderá estudar a interacção rede-impureza-defeitos em semicondutores, e particularmente, estudar a relaxação dos átomos de Cu em supercondutores monocristalinos na transição de fase supercondutora.

Num domínio diferente, a comparação de resultados obtidos com a técnica de pac g-g e e-g permite estudar localmente a mobilidade de carga na vizinhança da impureza em isoladores e semicondutores. No caso concreto de 111mCd : CdS ou 111mCd : CdSe podemos estudar o papel do Cd na existência de estados localizados que podem ser excitados por iluminação laser. Propõem-se medidas de constantes de tempo de difusão de carga, na vizinhança do Cd. A informação que se obtém não é acessível por outras técnicas, em particular ao nível da interacção electrónica dopante – rede.

Ainda no campo do estudo de propriedades electrónicas microscópicas, o Óxido de Háfnio, é um material de particular interesse, que recentemente revelou possuir propriedades magnéticas, sem que sejam compreendidos os mecanismos responsáveis. Usando os recursos e infra-estruturas do CFNUL, ITN e ISOLDE, estudamos filmes finos de 1 a 500 nm crescidos por ablação laser e por evaporação com canhão de electrões. Diferentes substratos e condições de deposição são usadas para o estudo das fases combinando interacções hiperfinas e análises de raios X.

No CFNUL introduzimos jovens engenheiros em desenvolvimentos de electrónica nuclear específicos com vista à melhoria da resolução em energia em experiências de PAC com o estudo e implementação de novos detectores com cintiladores de LYSO.

Actualmente efectua-se cinco teses de doutoramento, uma tese de mestrado e duas de licenciatura, no âmbito da nossa infra-estrutura e propostas científicas no ISOLDE, CFNUL e ITN.

### Resumo (em inglês)

### Abstract (in english)

Since 1986 that the Nuclear Solid State Physics group of CFNUL-ITN works at ISOLDE, only financed by FCT - CERN projects, on scientific proposals approved by the ISOLDE scientific committee (INTC-CERN). There, the work is executed with emphasis on the formation and integration of young Portuguese students to Applied Nuclear Physics, in original and high quality working environments. Being the director action line, the complementary research on materials microscopic properties, the project counts today with the participation of scientists and students with different backgrounds from nuclear physics to materials science, essentially from the Universities of Lisbon, Aveiro, Porto, Braga, as well as from Leuven, Bonn and ISOLDE.

FROM THE APPROVAL OF THIS PROJECT DEPEND THE MAINTENANCE AND RUNNING OF THE EXPERIMENTAL AND CALCULATION INFRASTRUCTURE, BUILT ALONG THE YEARS, WHERE ARE DEVELOPED AND EXECUTED THE APPROVED ACTIVITIES :

### RECENT EXAMPLES:

IS453 – “Emission Channeling Lattice Location Experiments wth Short-Lived Isotopes”. With this new approved proposal we will make use of new on-line emission channeling setups at ISOLDE to investigate the lattice location of elements with short lived isotopes, e.g., the transition metals Ni



(2.5 h) and Co (1.6 h) in ZnO and GaN semiconductors, the acceptor dopants 27Mg (9.5 min) in GaN and of 8Li (838 ms) in ZnO. We further explore low-energy electrons below 40 keV, in particular Auger electrons, for lattice location purposes.

IS390 - "Studies of Colossal Magnetoresistive Oxides with Radioactive Isotopes" – It is shown the existence of phase coexistence mediated by a free percolation phenomenon, with uncorrelated polaron (local deformations) slow dynamics on LaMnO<sub>3</sub>. Isotopic effect studies are now starting in materials enriched with O18. Coordination of Aveiro and Porto.

IS360 - "Studies of High-Tc Superconductors Hg-Ba-Ca-Cu-O (TC>130K) with radioactive isotopes" – It is shown the formation of fluorine dopant atomic stripes in Hg1201, which do not induce charge ordering in the superconducting planes. Presently, these phenomena are studied in highly oxygen doped Hg1212 and Hg1223.

IS368 – "Lattice site location of Transition Metals and Rare-earth elements in Semiconductors" – (closed proposal) It was shown the feasibility of implanting high Fe doses into substitutional lattice sites of ZnO with generation of ferromagnetism. The first direct measurement of an "antisite" impurity in semiconductors was found for As:ZnO.

#### UNDERGOING NEW WORK AND PERSPECTIVES:

Commissioning, at the ISOLDE beam line, of the new self-triggered low-noise fast Si pad electron detector. Emission channeling studies of lattice location of elements, which have only short lived isotopes: Mg, Li, Ni, Co..., will be done.

Continuation of studies in materials with applications to spintronics, ZnO, GaN, AlN and SiC. Here we stress the measurements, with the emission channeling technique, of dopant lattice sites and the study of their relaxation dynamics into the host lattices. Low temperature implantation & measurements will allow, particularly, the study of the interaction between the impurity, the host atoms and the implantation defects, while frizzing their mobility. With the same technique we aim studying the copper atomic relaxation across Tc on high Tc superconductors.

On a different domain, we aim to study dopant elements or lattice elements participating at polaron phenomena, which originate localized charge states in insulators and semiconductors. By combining g-g PAC with e-g PAC local carrier life times can be studied at the specific element. A concrete case study will be 111mCd: CdS or CdSe where we intend studying the role of Cd in the existence of excited states triggered by laser illumination. The measurement of local conductivity shall be done, in particular. Such type of information is not accessible by other techniques, particularly, of the dopant – defect – host interactions.

Still in the field of microscopic electronic properties, Hafnium oxide is a material of particular interest that recently revealed to be ferromagnetic, by some not yet understood mechanism. Combining the resources of CFNUL, ITN and ISOLDE we propose to study hafnium oxide thin films with 1 to 500 nm, grown by laser ablation and evaporation with electron gun. Different substrates and deposition conditions will be used to study the tetrahedral and monoclinic phases, with hyperfine interactions and x-ray analysis.

At CFNUL we introduce young engineers into the development of nuclear electronics, with the aim of implementing new detectors with LYSO scintillators, for improved energy resolution in complicated PAC cascades, studied at ISOLDE.

Actually five PhD, one MSc. and two diploma students accomplish their work within our infrastructure and proposals at ISOLDE, CFNUL and ITN.

## 8.2. Objectivos

### 8.2. Objectivos

#### Descrição dos Objectivos do Projecto

##### Project Objectives (description)

- To support the Nuclear Solid State Physics research infrastructure at ISOLDE and CFNUL-ITN, where the scientific programs IS368, IS360 and IS390 are executed, prepared and complemented.
- To support people participation and formation at ISOLDE beam times and conferences.
- To publish in high quality scientific journals and participate in international conferences.
- To mount the new emission channeling & new pad detector on-line at the ISOLDE beam line.
- To finish & test the cooling station for low temperature emission channeling experiments that is an essential feature to probe for new material physics.
- To develop new electronic detector equipment (basis and new scint.) for PAC e-g experiments.
- To pursue national education and training in applied nuclear physics and techniques.

#### Descrição dos Objectivos do Investigador Responsável

##### Principal Investigator Objectives (description)

- Coordinate the activities as a central link for bringing people together for discussion, supervising the proper execution and completion of the tasks.
- Actively participate in the scientific work.
- Maintain, develop and optimize the synergy between the different collaborators and facilities.
- Promote visibility of the project aims and results.
- Manage the proper funding of the project.
- Organize reports.

## 8.3. Estado da Arte

### 8.3. State of the Art

#### Descrição do Estado da Arte

##### State of the Art (description)

ON-GOING WORK CAN BE SEEN AT REFERENCE LINKS AND PUBLICATION LIST (at the time of the closure of this application):

1) General work report up to July 2006:

[http://cern.ch/~joao/Report\\_POCI-FP-63435-2005\\_10-07-2006\\_1st-half.pdf](http://cern.ch/~joao/Report_POCI-FP-63435-2005_10-07-2006_1st-half.pdf)

2) ITN resume report 2006:

[http://tilde-joao.web.cern.ch/~joao/Fisica\\_MCRNT\\_group\\_ALL\\_2006.pdf](http://tilde-joao.web.cern.ch/~joao/Fisica_MCRNT_group_ALL_2006.pdf)

3) other links are on text

4) a live-view of the new EC chamber being assembled at ISOLDE 275 <https://webh12.cern.ch/sslpl/webcam.php> --> "spy 2" web cam.

APPROVED PROPOSALS:

IS453 – EMISSION CHANNELING LATTICE LOCATION EXPERIMENTS WITH SHORT-LIVED ISOTOPES

– For a deep understanding of the electrical or optical dopant element properties in semiconductors it is essential to know the lattice sites that these elements occupy as well as their position changes due to temperature relaxation phenomena. Emission channeling with position-sensitive detectors is a well-established technique at ISOLDE for studying the lattice location of radioactive impurities implanted into single crystals. In the case of electron emitting isotopes, however, due to count rate and noise-related limitations of the detection systems, the technique was restricted to isotopes with half lives above 6 h and electron energies above 40 keV. Recently, major technical developments have been realized and new equipment has been acquired which has allowed these limitations to be overcome and made feasible electron emission channeling experiments with short-lived isotopes and at low electron energies. As first application, making use of two new on-line emission channeling setups at ISOLDE, we propose to investigate the lattice location of the transition metals Ni (2.5 h) and Co (1.6 h) in semiconductors, in particular in ZnO and GaN, by means of on-line  $\beta^-$  emission channeling experiments. In addition, we would like to study the lattice location of the acceptor dopants  $^{27}\text{Mg}$  (9.5 min) in GaN by means of  $\beta^-$  and of Li (838 ms) in ZnO by means of  $\beta^-$  emission channeling. A number of test isotopes are requested as well in order to explore the possibilities for using low-energy electrons below 40 keV, in particular Auger electrons, for lattice location purposes.

In parallel, applications of this technique continue in materials with potential technical interest: a) SPINTRONICS - Ion implantation is currently studied as a route to produce room-temperature ferromagnetic semiconductors [S.J.Pearnton et al., PhysicaB340 (2003) 39]. Materials of interest are ALL wide band gap semiconductors: ZnO, GaN, AlN and SiC, [T.Dietl Science287 (2000) 1019, S.J.Pearnton J.P.Cond. Matter16 (2004) R209]. So far we approach these questions with  $^{59}\text{Fe}$ , where relatively high doses are desirable, since DMS contains high concentrations of TM. To increase Fe concentration, some samples are pre-implanted with stable Fe at ITN and, in the future, possibly also with other impurities such as Sn [D.P.Norton...APL82(2003)239]; b) "INSULATORS" –  $\text{SrTiO}_3$  is being studied as a material foreseen to act as a dielectric gate on Si devices [K.Eisenbeiser...APL76(2000)1324]. Currently investigated by many groups, little is known about ion implantation doping. Interesting dopants are Fe (possible ferromagnetism, possible acceptor on Ti site) Bi and Ca (dielectric and ferroelectric relaxors) [C.Ang,Z.Yu, JAP91(2002)1487], La (donor on Sr site) [D.Olaya...APL78(2001)1676], Nb, As, Sb (donors on Ti site) [H.H.Wang...APL80(2002)3545], Na, K (acceptor on Sr site), Ga, In (acceptors on Ti) [S.Dai...APL80(2002)3545]. We have started experiments with several RE, Fe, Cu, and several others are foreseen, e.g.,  $^{73}\text{As}$ ,  $^{24}\text{Na}$ ,  $^{43}\text{K}$ ,  $^{89}\text{Sr}$ ,  $^{72}\text{Ga}$ ,  $^{111}\text{In}$ , etc.

[http://tilde-joao.web.cern.ch/~joao/EC\\_SLI.pdf](http://tilde-joao.web.cern.ch/~joao/EC_SLI.pdf)

[http://tilde-joao.web.cern.ch/~joao/UWahl\\_ISW-02-2007.pdf](http://tilde-joao.web.cern.ch/~joao/UWahl_ISW-02-2007.pdf)

[http://tilde-joao.web.cern.ch/~joao/AMarques\\_ISW-02-2007.pdf](http://tilde-joao.web.cern.ch/~joao/AMarques_ISW-02-2007.pdf)

[http://tilde-joao.web.cern.ch/~joao/NoiseTriggerEffCooledSiPadDet\\_NIMA572-2007-1056.pdf](http://tilde-joao.web.cern.ch/~joao/NoiseTriggerEffCooledSiPadDet_NIMA572-2007-1056.pdf)

IS360 - STUDIES OF HIGH- $T_c$  SUPERCONDUCTORS WITH RADIOACTIVE ISOTOPES

– We study superconductors of the family  $\text{HgBa}_2\text{Can-1Cu}_n\text{O}_{2n+2+d}$ , with the aim of understand and separate local lattice distortions due to oxygen doping, from distortions originated by the electron-spin coupling that is responsible for the superconductor transition [[http://cern.ch/~joao/IS360\\_add-II.pdf](http://cern.ch/~joao/IS360_add-II.pdf)]. These effects are poorly resolved by x-ray, neutron diffraction or EXAFS [A.Lanzara...PRB59 (1999) 3851, P.Bordet...PhysicaC282-287 (1997) 1081], where it was not possible to conclude if the observed effects are due to the superconductivity mechanism or to dopant-lattice relaxation interactions. By measuring the electric field gradients (EFG) at the Hg site we show that fluorine orders, when under high concentration in  $\text{Hg}_{1201}$  [[http://cern.ch/~joao/F-Hg1201\\_PRB72-2005-1\\_proof.pdf](http://cern.ch/~joao/F-Hg1201_PRB72-2005-1_proof.pdf)].

With a similar aim we are studying the oxygen ordering at the Hg planes of  $\text{Hg}_{1212}$  and  $\text{Hg}_{1223}$ . The results are now under analysis. Simulations, i.e., first principle calculations of charge distribution in materials done with WIEN, are being implemented to interpret the PAC results for different oxygen dopant configurations.

[http://tilde-joao.web.cern.ch/~joao/TMendonca\\_ISW-02-2007.pdf](http://tilde-joao.web.cern.ch/~joao/TMendonca_ISW-02-2007.pdf)

IS390- STUDIES OF COLOSSAL MAGNETORESISTIVE OXIDES WITH RADIOACTIVE ISOTOPE

- While using this project infrastructure at ISOLDE, the organization is of the direct responsibility of an independent project, POCTI/FP/63438/2005, of the responsibility of Aveiro & Porto Universities.

[http://cern.ch/~joao/IS390\\_add1.pdf](http://cern.ch/~joao/IS390_add1.pdf)

[http://tilde-joao.web.cern.ch/~joao/ALopes\\_ISW-02-2007.pdf](http://tilde-joao.web.cern.ch/~joao/ALopes_ISW-02-2007.pdf)

[http://tilde-joao.web.cern.ch/~joao/Percolative\\_Lopes\\_PRB73-2006-100408.pdf](http://tilde-joao.web.cern.ch/~joao/Percolative_Lopes_PRB73-2006-100408.pdf)

RELATED NEW SUBJECTS:

a) Dielectric, ferroelectric, ferromagnetic and superconductor phenomena often are related and accompanied by atomic relaxation, below room temperature. Consequently, emission channeling experiments performed as a function of temperature, scanning over low temperatures ranges, can provide precious information of the individual behavior of specific elements on the lattices. In the particular case of the superconductors, theory predicts changes in the local symmetry of the internal parameters during the superconducting transition. These may reveal the opening of a pseudo-gap into the band structure, but only scarce data can be obtained with standard ion channeling experiments [T.Haga...PRB41(1990)826]. For these experiments, single crystals of the high- $T_c$  superconductor cuprate families could be probed with the electron emitters  $^{67}\text{Cu}$ , and  $^{45}\text{Ca}$  isotopes.

b) Another branch of research we point concerns Lanthanides and actinide intermetallic compounds, which are characterized by partially occupied f-electron states. The physical properties of actinide compounds are, in general, quite different from their lanthanide intermetallic counterparts. The 4f electrons are usually deeply confined in the core of the lanthanide ion, having a weak interaction with their environment, being considered in most of the cases as localized. In contrast, the more extended 5f wave functions of light-actinides overlap with the wave functions belonging to their neighbors. The bonding participation of 5f electrons, and their consequent hybridization with the valence states of neighboring atoms in the crystal structure, leads to a delocalization of the 5f states, which resembles the formation of the d band in the transition metals. This hybridization has serious consequences in the physical properties of light-actinide intermetallic compounds. As an example, itinerant magnetism can be observed in these materials and the existence of magnetic moments can not be taken as evidence of localized 5f states. In concrete, the nature of the 5f states of light-actinide compounds is strongly affected by the nature of the ligands. Intermetallic compounds and alloys of light-actinides,  $\text{UX}_3$  (X = p element) crystallize in the simple cubic  $\text{AuCu}_3$ -type structure (space group  $\text{Pm}\bar{3}\text{m}$ ). In particular, all the  $\text{UX}_3$  (X = Al, Ga, In, Tl, Si, Ge, Sn and Pb) compounds display a large variety of electronic properties, from the completely localized up to the itinerant limits. Due to their simple crystal structure, weak 5f-5f direct interactions and wide range of hybridization strengths, these compounds provide an excellent opportunity to study the role of the 5f-spd hybridization in the physical properties of actinide intermetallics. Consequently, each particular compound should be studied by combining bulk with local atomic scale techniques. Therefore these are ideal cases to study with the PAC technique, using  $^{204}\text{mPb}$ ,  $^{204}\text{Bi}$ ,  $^{111}\text{In}$  and  $^{111\text{m}}\text{Cd}$  probes that are the subject of a forthcoming research proposal at ISOLDE.

c) One oxide of great impact today is HfO<sub>2</sub>. Being characterized by a high refractive index with a wide bandgap ( $i \ll 5.5$  eV), it provides transparency from the ultraviolet to the mid-infrared, being widely used in optical coating applications. In microelectronics it is envisaged as a high-k gate dielectric, replacing silicon oxide as the insulator in metal oxide–semiconductor sensors. Of unknown origin, ferromagnetism has been recently found in thin films [M. Vencatesan... Nat430(2004)630]. It is attempted the presence of defects that lead to unpaired electrons, with magnetism being enhanced by oxygen transfer of polarization. Ion implantation and characterization techniques are just being exploited in this material, therefore it appears as an ideal case to keep studying with the combined resources of our institutes infrastructures.

#### 8.4. Resultados e Repercussões

#### 8.4. Results and Repercussions

##### Divulgação de Resultados (descrição)

##### Diffusion of Results (description)

- PUBLICATIONS ON INTERNATIONAL MAGAZINES WITH REFEREEING.
- PARTICIPATION ON INTERNATIONAL CONFERENCES.
- DIPLOMA, MASTER AND PHD. THESIS.
- ANNUAL REPORTS.

##### Repercussões (descrição)

##### Repercussions (description)

- EDUCATION AND TRAINING OF STUDENTS IN APPLIED NUCLEAR PHYSICS.
- UNIQUE SCIENTIFIC AND TECHNICAL RESULTS ARE EXPECTED, DUE TO THE SPECIFICITY OF THE TECHNIQUES AND OF THE ISOLDE LABORATORY.
- IMPROVED FORMATION, VISIBILITY AND NEW RESEARCH POSSIBILITIES ARE FORESEEN, DUE TO THE SYNERGETIC INTERACTION OF PEOPLE WITH DIFFERENT TECHNICAL & SCIENTIFIC BACKGROUNDS.

#### 8.5. Regionalização

#### 8.5. Regionalization

Região	Percentagem
Region	Percent
Norte	30
Centro	0
Lisboa e Vale do Tejo	70
Alentejo	0
Algarve	0
Região Autónoma dos Açores	0
Região Autónoma da Madeira	0

##### Descrição

##### Description

BY MOTIVATION AND WORKING PROCEDURES THIS PROJECT IS TODAY, DE FACTO, A NON-REGIONALISED PROJECT.

At the beginning, the existing and developing heavy infrastructures, i.e., the national experimental reactor and the laboratory of ion implantation doping and material's characterization with ion beams at ITN-Sacavém and the laboratory of hyperfine nuclear techniques at CFNUL-Lisboa, with strong relationship to Lisboa University, have promoted the group experiments at ISOLDE.

Supported by SUCH FCT projects, our participation at ISOLDE was clearly defined with the mission of accomplish original scientific results and complementary educational background on applied nuclear physics, within an international environment of excellence.

Along the years, the research possibilities revealed to be very broad. Consequently, at the experimental infrastructure here presented, run today projects handled by people with affiliations much abroad the Lisboa region, so far from Aveiro, Porto and Minho, promoting the formation of students, some times within the CERN "summer students" programs. It is our aim to improve contacts and bring more "users" from interdisciplinary fields and universities to work at "our" national facility at ISOLDE.

Actually, this project is one of the very few in Portugal that promotes NUCLEAR PHYSICS applications with still innovative techniques on actual research subjects in material science, of international relevance.

#### 8.6. Tarefas

#### 8.6. Tasks

##### Lista de tarefas (5)

##### Task list (5)

Designação da tarefa	Data de início	Data de fim	Pessoas * mês
Task denomination	Start date	End date	Person * months
<a href="#">Experimental and simulation work at CERN...</a>	01-11-2007	31-10-2008	30
<a href="#">Implementation and tests of of the new c...</a>	01-11-2007	31-10-2008	12
<a href="#">Sample characterization at ITN, Aveiro a...</a>	01-11-2007	31-10-2008	12
<a href="#">e-gamma spectrometer nuclear electronic ...</a>	01-11-2007	31-10-2008	22
<a href="#">Manganites, Intermetallic and UX3 compou...</a>	01-11-2007	31-10-2008	12

(Os detalhes de cada tarefa estão disponíveis clicando na designação correspondente)

(Details for each task are available by clicking on the corresponding denomination)

#### 8.7. Referências Bibliográficas

#### 8.7. Bibliographic references

##### Ano Publicação

##### Year Publication

2006 B. De Vries, A. Vantomme, U. Wahl, J.G. Correia, J.P. Araújo, W. Lojkowski, D. Kolesnikov, and the ISOLDE collaboration: "Lattice site location and annealing behaviour of Ca and Sr implanted GaN", Journal of Applied Physics 100 (2006) 023531/1-6

2005 U. WAHL, E. RITA, J.G. CORREIA, E. ALVES; J.C. SOARES, AND THE ISOLDE COLLABORATION: "Direct evidence for As as a Zn-site impurity in ZnO", Physical Review Letters 95 (2005) 215503/1-4

2005 J.G. Correia, H. Haas, V. S. Amaral, A. M. L. Lopes, J.P. Araújo, S. Le Floch, P. Bordet, E. Rita, J.C. Soares, W. Tröger, ISOLDE collaboration: "Atomic ordering of fluorine dopant in high-TC superconductor", Phys. Ver. B72 (2005) 1-10. the HgBa2CuO4+

2005 U. Wahl, J.G. Correia, E. Rita, J.P. Araújo, J.C. Soares, and the ISOLDE collaboration: "Lattice sites of implanted Fe in Si", Phys. Ver. B 72 (2005) 014115/1-8

2004 E. Rita, U. Wahl, J.G. Correia, E. Alves, J.C. Soares and The ISOLDE Collaboration: Lattice location and thermal stability of implanted Fe in ZnO, Appl. Phys. Lett. 85 (2004) 4899

**8.8. Artigos Anteriores**

**8.8. Previous Articles**

Ano	Artigo (endereço na Internet - URL)
Year	Paper (Link in the Internet - URL)
2004	<a href="http://tilde-joao.web.cern.ch/~joao/OC-Er-GaN_APL84-2004-4304.pdf">http://tilde-joao.web.cern.ch/~joao/OC-Er-GaN_APL84-2004-4304.pdf</a>
2003	<a href="http://tilde-joao.web.cern.ch/~joao/RE-ZnO_APL_2003_82_01173.pdf">http://tilde-joao.web.cern.ch/~joao/RE-ZnO_APL_2003_82_01173.pdf</a>
2001	<a href="http://tilde-joao.web.cern.ch/~joao/Fe_GaN_APL78-2001-3217.pdf">http://tilde-joao.web.cern.ch/~joao/Fe_GaN_APL78-2001-3217.pdf</a>
2000	<a href="http://tilde-joao.web.cern.ch/~joao/Hg1201_PRB61-2000-11769.pdf">http://tilde-joao.web.cern.ch/~joao/Hg1201_PRB61-2000-11769.pdf</a>
2000	<a href="http://tilde-joao.web.cern.ch/~joao/Cu_Si_PRL84-2000-1495.pdf">http://tilde-joao.web.cern.ch/~joao/Cu_Si_PRL84-2000-1495.pdf</a>

9. Ficheiros Anexos

9. Attachments



04-03-2007 15:41:13



Financiamento de Fundos Estruturais e de Fundos Nacionais do MCTES

