

# Nuclear Instruments and Methods

João B. Manteigas

The strategy of the group involves activities in the following lines:

1. Modelling of radiation fields, calculation of neutron physic parameters, measurement of neutron cross-sections;
2. Development of software for control;
3. Design of electronic instrumentation for nuclear applications;
4. Instrumentation and technical assistance.

## ***Modelling of radiation fields, calculation of neutron physic parameters***

The MCNP code is being used to calculate the perturbation of the neutron thermal flux by a sample in the presence of a moderator.

Monte Carlo calculations have been carried out in the field of the project POCI/FP/63433/2005 “Participação do ITN na Experiência n\_TOF (PS213) no CERN (Quarto ano)” and EUROTRANS Project (IP EUROTRANS, 516520).

## ***Measurement of neutron cross-sections***

The analysis of the data for cross-section measurement, taken in the TOF spectrometer installed at the CERN, was carried out.

## ***Development of software for control***

- Control of EPA detector movements;

- Control of analytical balance.

## ***Design of electronic instrumentation***

Some electronic devices have been designed and produced for energy measurements at the DPRSN Sector and for the EPA motor control at the RPI Sector.

## ***Instrumentation and Technical Assistance***

The main objectives are the development of equipment for internal groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.

The technical assistance takes mainly the forms of specialised consultant engineering advice, installation of nuclear gauges, including calibration maintenance and repair and recharging of gauges with imported radioactive sources.

## ***Co-operation with other institutions***

The Group is involved in the following collaborations:

1. n\_TOF collaboration, a consortium of 40 laboratories in Europe and USA;
  2. Accelerator Driven System (PDS-XADS – FIS5-2001-00089);
  3. Sociedade Ponto Verde
  4. Institute of Fluid-Flow Machinery, Poland.
- EUROTRANS project, an integrated project with 48 institutes and universities in Europe.

## Research Team

### Researchers

J. MANTEIGAS, Aux., Group Leader  
C. CRUZ, Aux.  
I.F. GONÇALVES, Aux.  
J. NEVES, Aux.  
N. PINHÃO, Aux. (20%)  
F.G. CARVALHO, Coord. (15%)

### Students

L.C. MARQUES, Ph.D. Student  
C.M. CARRAPIÇO, Undergraduate student, FC/UA  
A.C. TRIGO, BIC/FCT  
C. SANTOS, MSc. student, FCT/UNL

### Technical Personnel

T. JESUS  
N. INÁCIO  
M. CABAÇA

## Technical Assistance in the Field of Engineering Applications of Radiation and Radioisotopes

*J.B. Manteigas, J. Neves, C. Cruz, F.G. Carvalho*

### Objectives

The main objectives are the development of equipment for internal groups, fabrication of equipment for specific applications and assistance to industrial companies and scientific institutions as well as technical consulting.

### Results

A summary of the more relevant work carried out is:

- (i) Technical and scientific participation in the n-TOF (PS213) experiment at CERN.
- (ii) Optimisation of the instrument movements control software. Development of software for analysis control. User's manual for an analytical balance.
- (iii) Technical support (maintenance and set up operations) for the Small Angle Neutron Scattering instrument and EPA installed at the RPI.
- (iv) Development and maintenance of electronic equipment to RPI, Physics, Chemical, UTR and DPRSN Sectors.



### Summary of the more relevant services rendered in 2005

Activity	Quantity	Client	Price (Eur)
Supply of radioactive sources and source containers	4	CIMPOR/Alhandra	9222,50
<i>Technical assistance to</i> RAD X 100	4	Marinha/Arsenal do Alfeite	85,00
<i>Technical assistance to</i> - Source Containers	6 5	PORTUCEL/Cacia Siderurgia Nacional	1800,00 500,00
Measuring and control of source activities	12	PORTUCEL/Cacia	1620,00
Laboratory equipment for the determination of radioactive element traces by electro-deposition	1	NATS/Kuwait	1600,13
Fellowship training	1	Centro de Emprego de Moscavide	1410,12
<b>Prices including TAX (VAT)</b>		<b>Total Amount (EUR):</b>	<b>16 237,75 €</b>

**Participation of ITN in the n-TOF experiment (PS213) at CERN (third and fourth years)**

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The n-TOF Collaboration, a consortium of 40 laboratories in Europe and U.S.A., has proposed an ambitious programme to perform high accuracy measurements of neutron cross-sections in the range from 1 eV to 250 MeV. An experimental programme (PS213) is being carried out since 2001 at the neutron time of flight (TOF) facility at CERN, using the CERN/PS accelerator complex. A single proton pulse of  $7 \cdot 10^{12}$  protons of 20 GeV impinges on a lead target every 2.4 seconds. After collimation, a neutron flux of the order of  $10^5$  neutrons/cm<sup>2</sup>/pulse is available for cross section measurements in the detectors station located 185 m downstream the target area.

These cross-section measurements are required in many emerging applications that require the use of high-intensity and medium-energy (in the hundreds of MeV) proton beams impinging on a thick target of a heavy element. These applications range from the design of innovative Accelerator Driven Systems (ADS) for incineration of nuclear waste and energy production, radioisotope production for medical and industrial applications and to many other subjects in Astrophysics, Nuclear Physics and Nuclear Technology. New or improved measurements of neutron cross-sections will also be very valuable for Radiation Shielding, Dosimetry and Monte Carlo Radiation Transport calculations.

This project deals with the following issues: i) radiation transport calculations using state-of-the-art Monte Carlo programs, ii) radiation detection and measurement techniques iii) particle detectors and associated electronics iv) high-precision measurements of neutron cross sections and v) physics analysis and nuclear data evaluation

During 2005, ITN researchers in cooperation with researchers from CIEMAT/Madrid and INFN/Bari:

- Participated in the analysis of the resonance parameters for the <sup>237</sup>Np, <sup>240</sup>Am, <sup>243</sup>Cm isotopes
- Continued the analysis of the data for the <sup>94</sup>Zr isotope, initiated during 2004
- Participated in the checks of the time stability of the behaviour of the the TAC calorimeter and the Silicon monitors and assessed the quality of the data taken during 2004

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<sup>1</sup> – Centro de Instrumentação / U. Coimbra

