Aplicaciones tecnológicas de la Física Nuclear

Current status of the CPAN groups research

Begoña Quintana

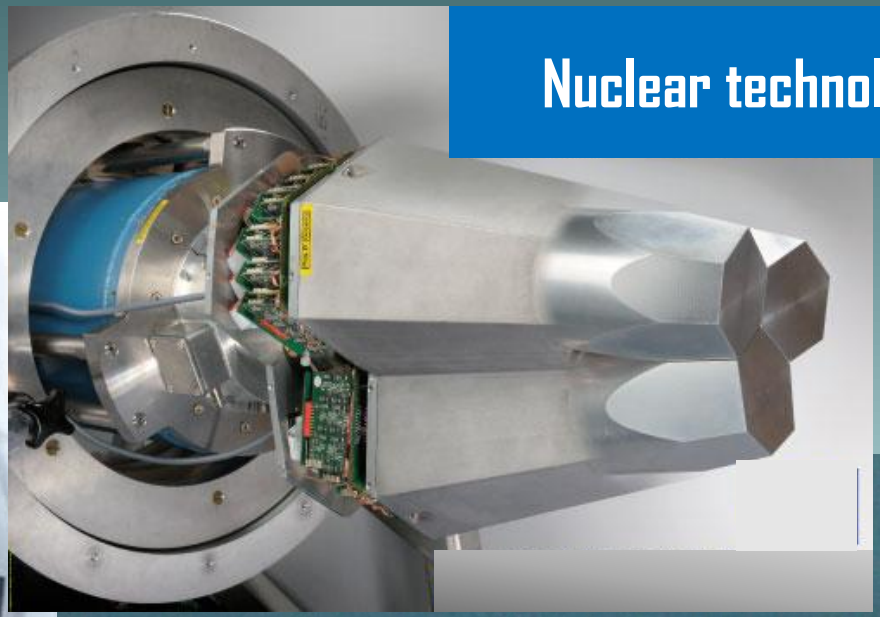
Universidad de Salamanca

The groups

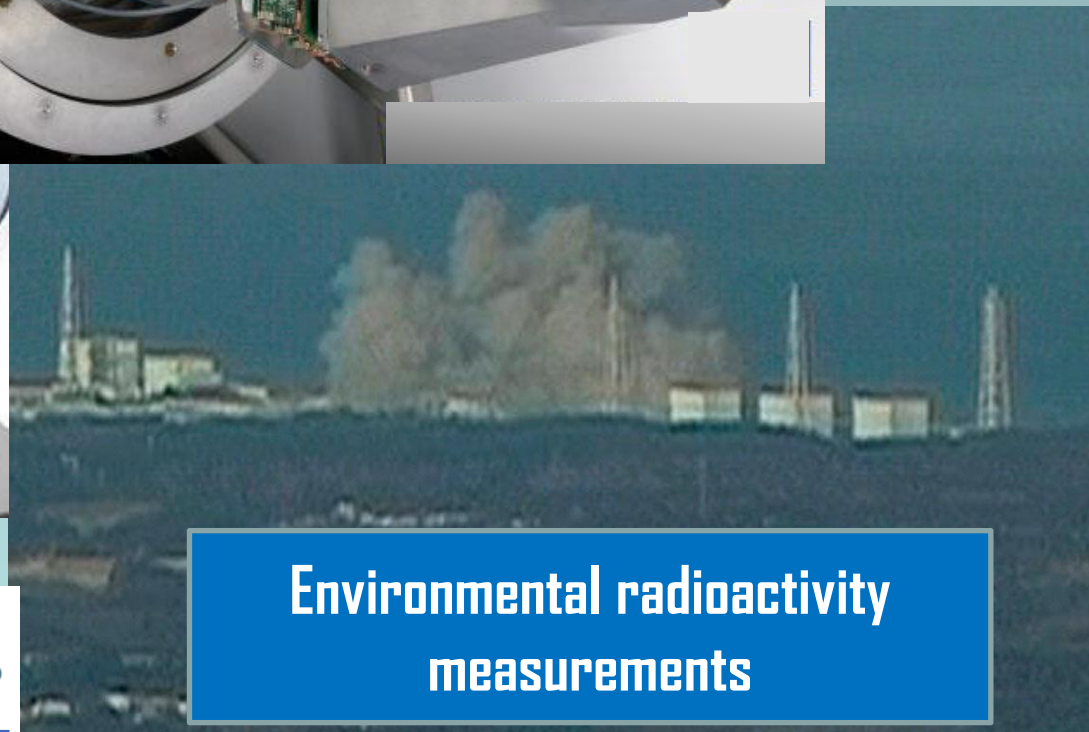
The activities

Medical physics

Nuclear technology



Environmental radioactivity measurements



GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
CPAN
Ingenio 2010

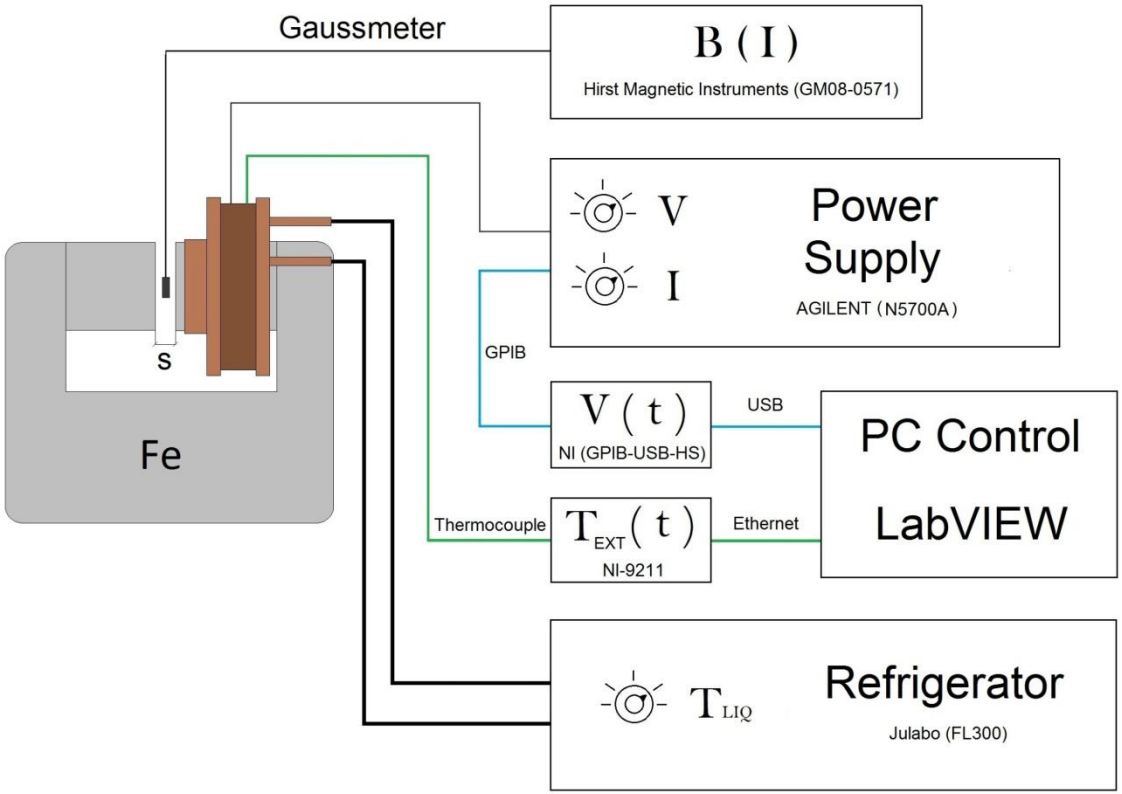
RESEARCH RELATED TO NUCLEAR TECHNOLOGY

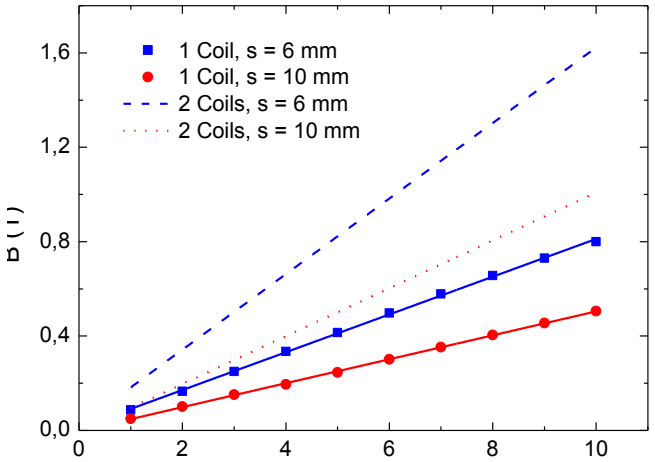
III Jornadas CPAN, Barcelona 2011

Construction of a set of electromagnets to produce monochromatic electron beams

J. M. Cornejo (TGM CPAN),
D. Rodríguez, A. M. Lallena

UGR





Maximum magnetic field as a function I(A) of for 1 or 2 coils

NOW AND NEXT:

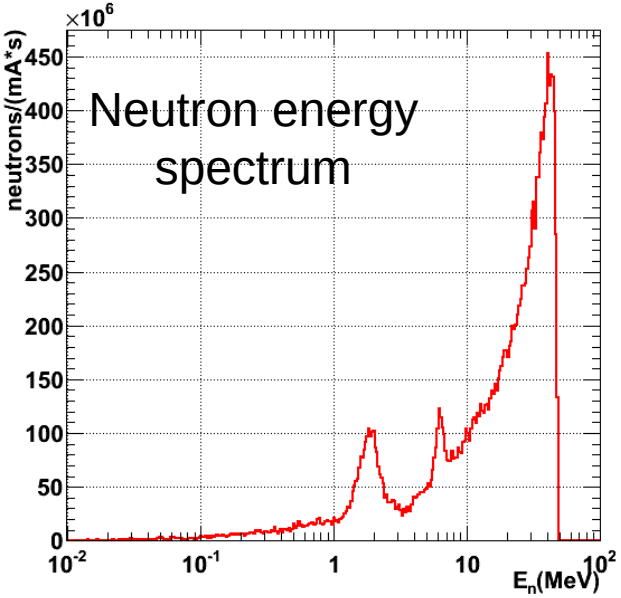
Design and construction of the cooling mechanism

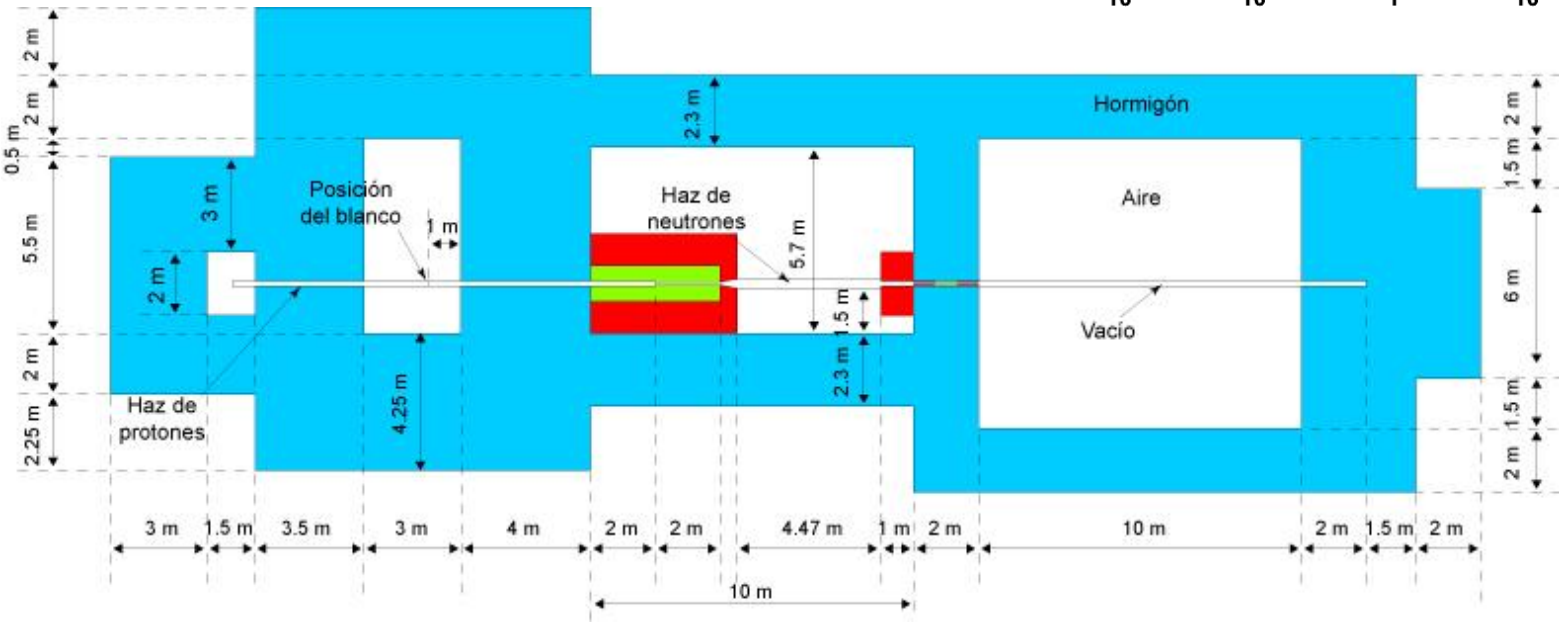
GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
CPAN
Ingenio 2010

Conceptual design of a neutron time of flight facility for the ESS – Bilbao site

CIEMAT has completed the design of neutron time of flight facility driven by the ESS – Bilbao proton LINAC. The design includes:

-Shielding elements
-Two experimental areas
-Neutron production target area: (p,n) reactions on Be
-Neutron beam dump
-Collimators for a high energy neutron beam (E_n > 100 keV)





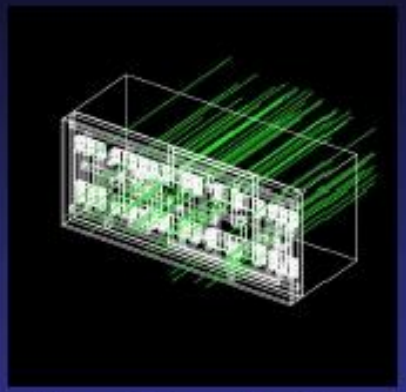
Radiation hardness en sensores de fibra óptica utilizados en experimentos de física de partículas (detectores del "Large Hadron Collider"-CERN) Collaboration IFCA - CNA

LINEA HAZ EXTERNO CICLOTRÓN CNA

Fotos: Linea haz externo del Ciclotrón y dispositivo experimental utilizado

GETERUS: Microdosimetry in electronic devices irradiations at CNA

"Funnel" application: cylinder with variable-size radius to estimate the range of secondaries



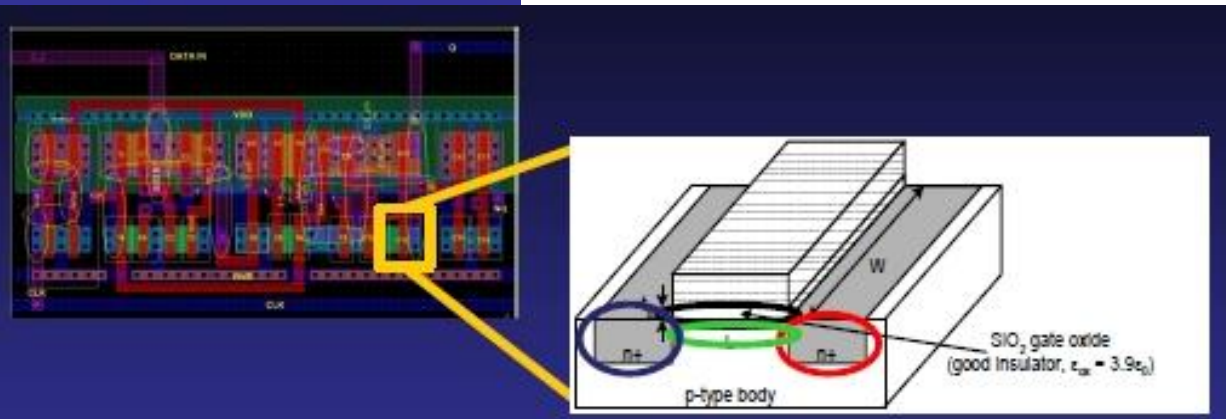
"Irrad" application: uniform irradiation of flip-flop following experimental conditions

- Microdosimetry Monte Carlo simulations with GEANT4 of a realistic flip-flop under ion, proton, neutron and gamma irradiation
- GEANT4 can be used as a tool to evaluate the energy deposited in key element of the circuit, and to
- Give support to the experimental results (upsets, failures, pulses...)

Miguel A. Cortés-Giraldo, Francisco R. Palomo, Esther García-Sánchez, José M. Quesada,

- "GEANT4 microdosimetry study of ionizing radiation effectsin digital ASIC's"
- "Evaluation of the effects of gamma irradiation from a 9Be neutron source in digital ASIC's with GEANT4"

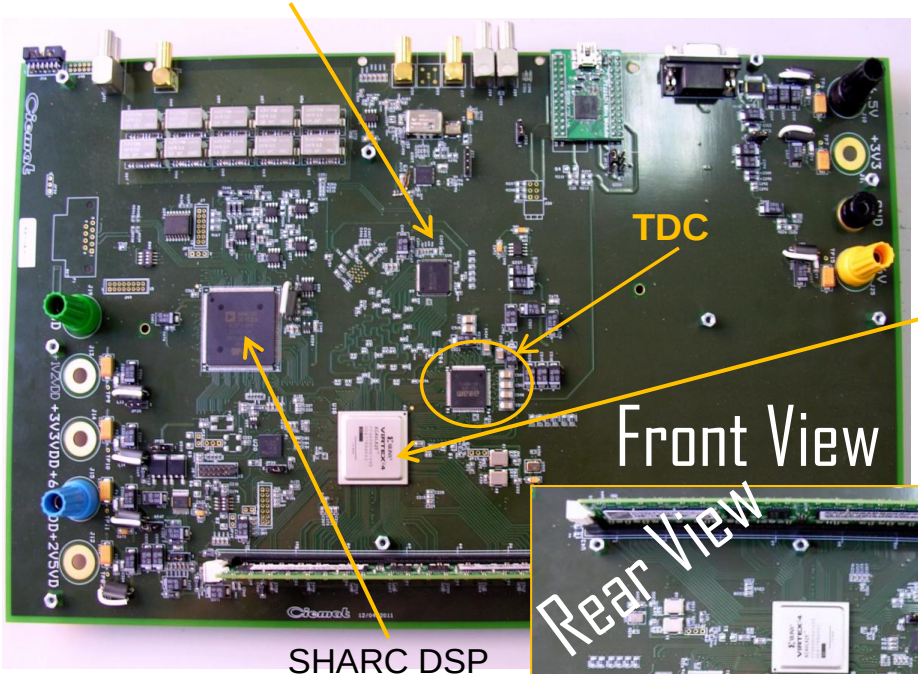
Joint International Conference of the 7th Supercomputing in Nuclear Application and the 3rd Monte Carlo (SNA + MC2010) Tokyo, Japan, 17-21 October, 2010

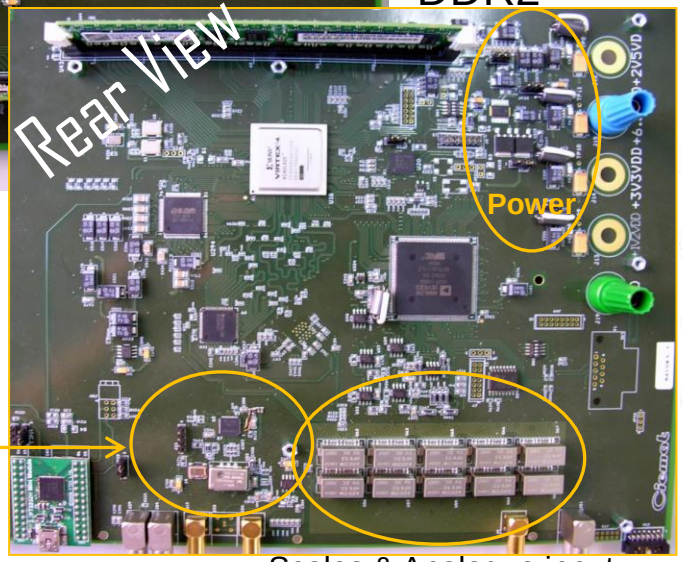


The goal of the simulation is to calculate the energy deposition in each element composing every MOS transistor

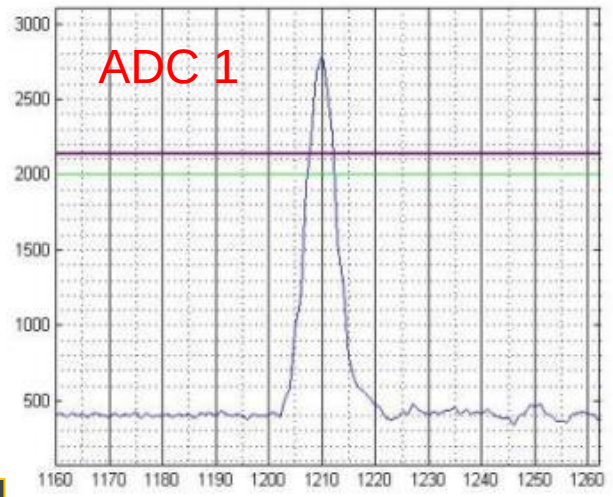
Development of a high performance digitizer at Ciemat

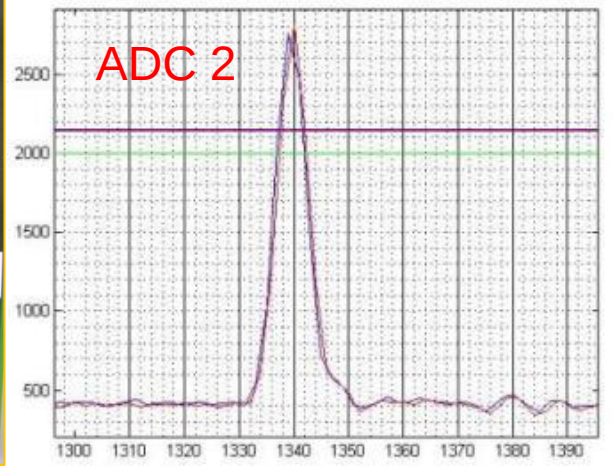
12 bit, 500 MHz ADC, 10,4 ENOB





Digitised pulses

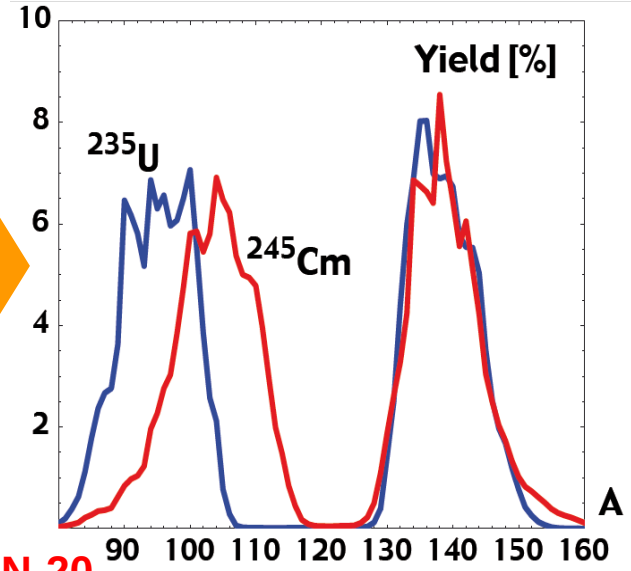




Next evolution with all functionalities operative in spring 2012

Delayed neutron measurements for advanced reactor technologies

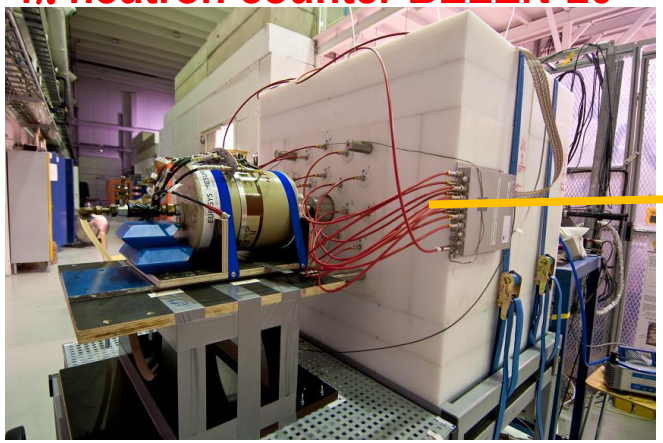
- P_n, the neutron emission probability, determines the delayed neutron fraction β_{eff}, critical control parameter in reactors
- More accurate measurements will improve summation calculations for GenIV reactors with MA containing fuel

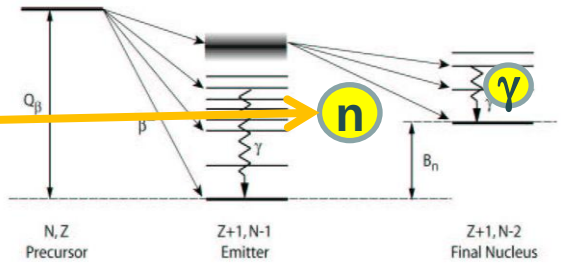


FF distribution

JYFL IGISOL Separator
+Ion Guide Source
+Penning Trap

4π neutron counter BELEN-20





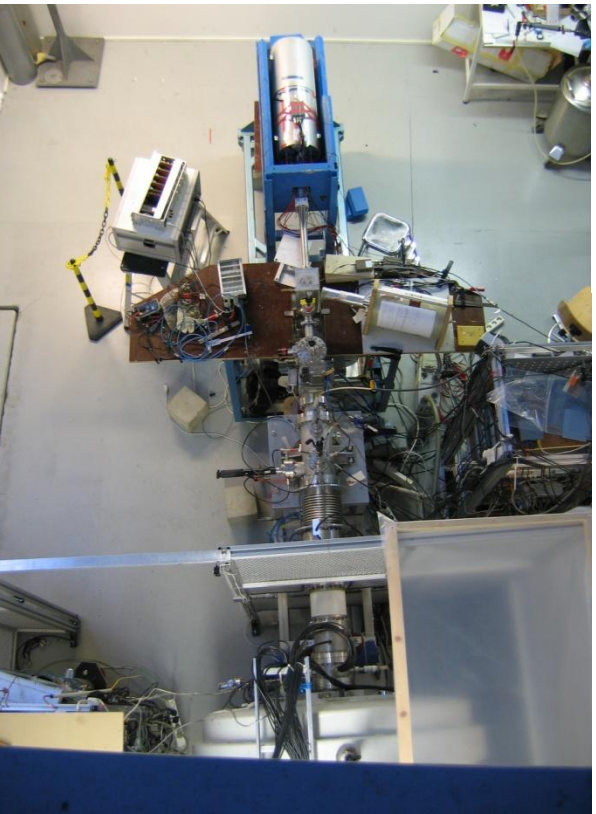
How reactor decay heat predictions can be improved?

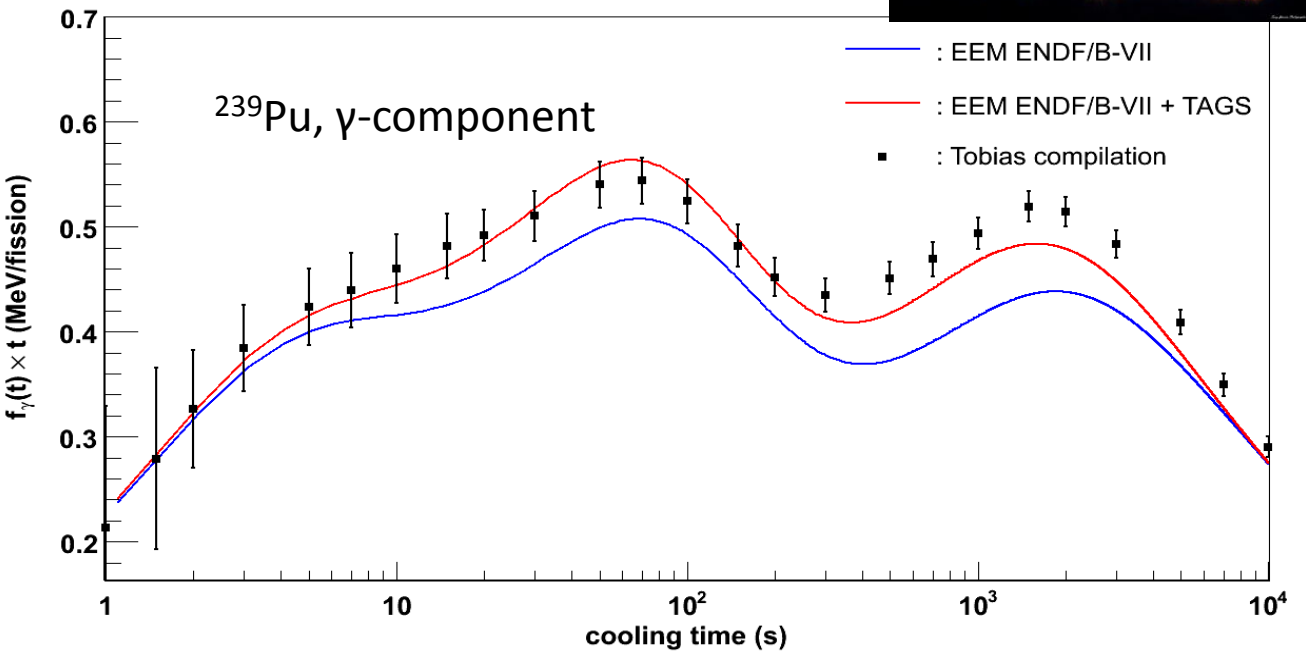
$$f(t) = \sum_i E_i \lambda_i N_i(t)$$

E_i mean values

λ_i decay const.

N_i number of nucl.





Measured decays: ^{101}Nb, ^{105}Mo, ^{102,104,105,106,107}Tc

Combination of techniques: IGISOL + JYFLTRAP+ TAS

First trap assisted TAS measurement

D. Jordan, PhD Thesis, Valencia, 2010

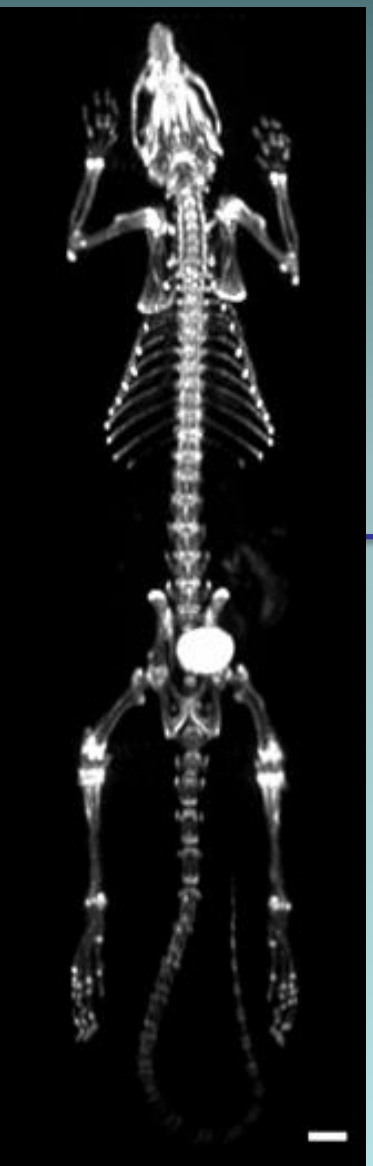
Algora *et al.* PRL105, 202501 (2010), D. Jordan *et al.*,in preparation

(this publication was selected for an article in viewpoint in Physics 3, 94 (2010))

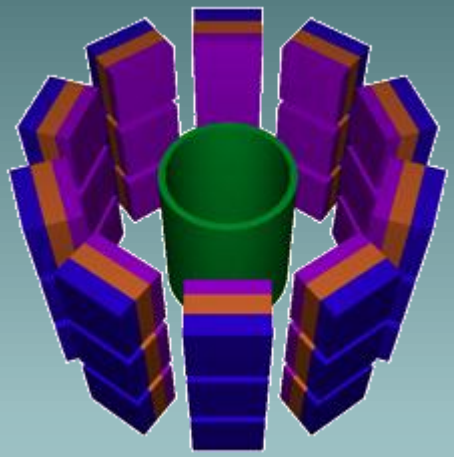
RESEARCH OF APPLICATION IN MEDICAL PHYSICS

III Jornadas CPAN, Barcelona 2011

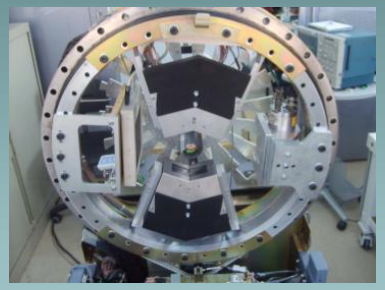
GFN-UCM: Nuclear imaging



TASK 1: Scanner design and optimization



TASK 2: Scanner characterization and calibration



TASK 3: (Tomographic) image reconstruction

FBP

2D OSEM

3D OSEM

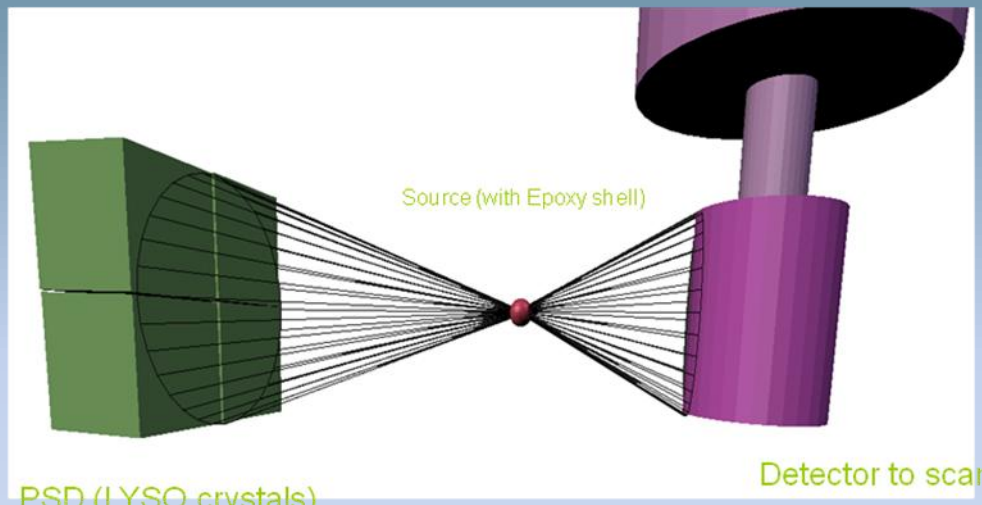
The SAlamanca Lyso-based Scanning Array

SALSA

LABORATORIO DE RADIACIONES IONIZANTES USAL
FACULTAD DE CIENCIAS • Plaza de la Merced, s/n • 37008 SALAMANCA
Tel.: 923 294 434 • Fax: 923 294 484 • lri@usal.es • http://www.usal.es/lri

PURPOSE: To associate interaction position in the Ge crystal to the electrical signal shapes

CRITICAL ISSUE
the position resolution



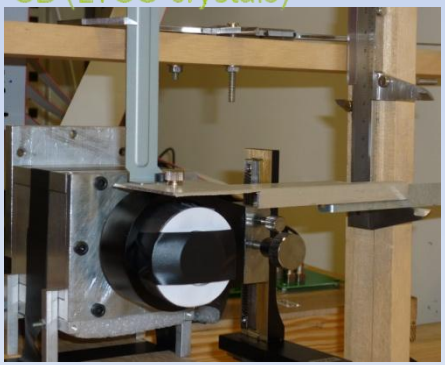


Figure. Scanning System CAD Design

Ge characterization method based on the comparison of Ge signals by F. Crespi NIMA 593 (2008)

"Towards a deep characterization of a 64-fold-pixilated Position Sensitive Detector for a new Gamma-Scanning System of HPGe segmented detectors". Oral contribution to ANNIMA 2011 and IEEE-Valencia

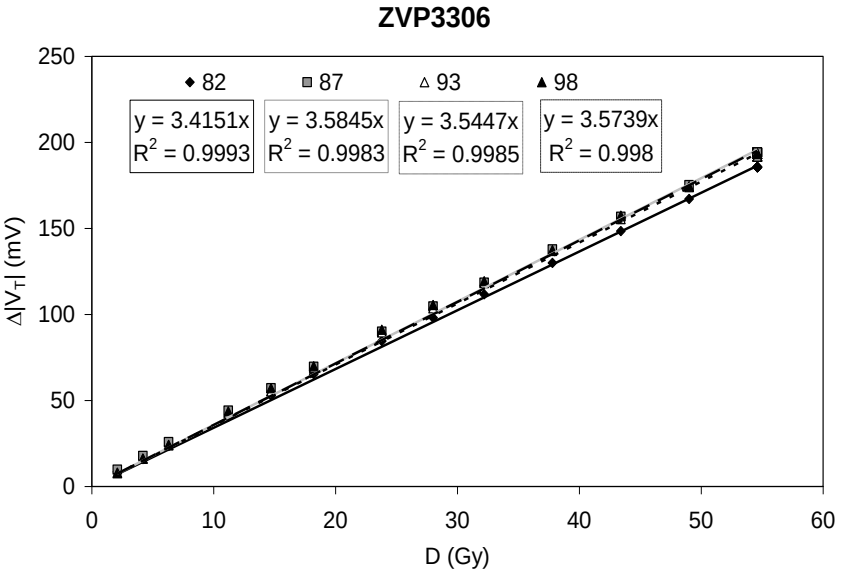
Funded by FPA2008

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
CPAN Ingenio 2010

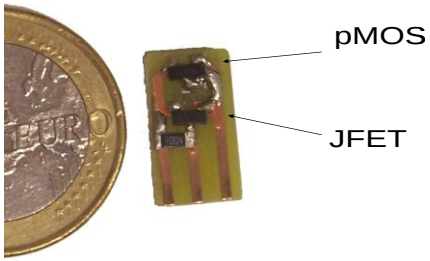
UGR: MOSFET dosimeter for photons and electron dosimetry (Proyecto Excelencia Junta de Andalucía P09.FQM.5341)

- Photon dosimetry
  - Physical characterization done
  - Clinical in-vivo application: in progress
- Electron dosimetry
  - Commercial pMOS: 3 models analyzed

    BS250F, ZVP3306 y ZVP4525
    - Non metallic encapsulation
    - Maximum drain-source voltage
    - Sensitivity
    - Linearity of the response



	Sen (mV/Gy)	
	Media	**SD**
ZVP3306	3.71	0.27
BS250F	3.14	0.37
ZVP4525	3.38	0.44

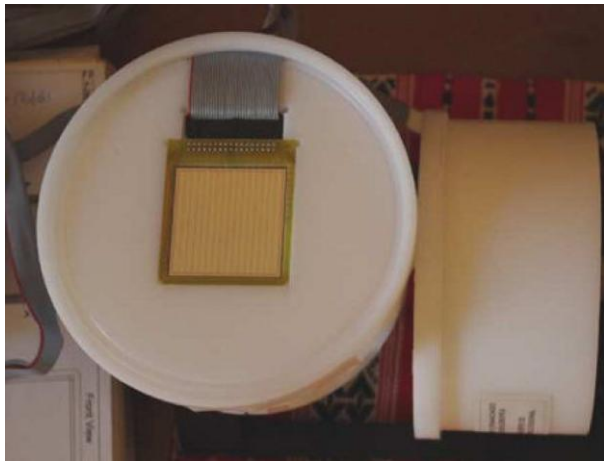


Characterization of ZVP3306 in progress

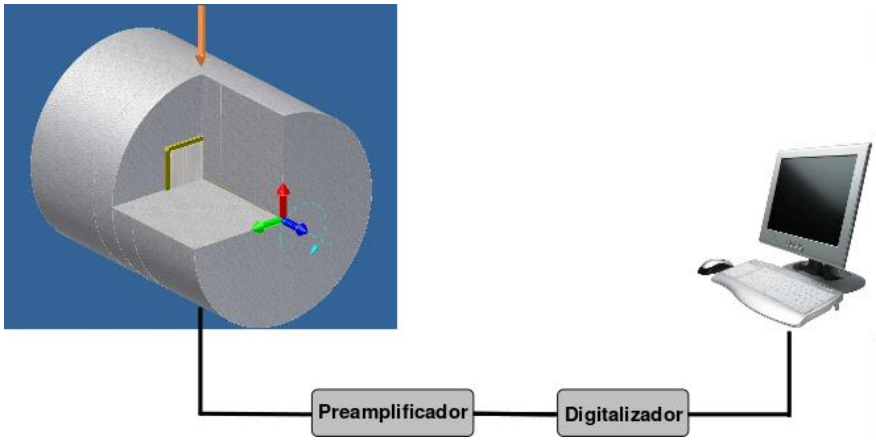
Characterization of a strip Si detector for Radiotherapy dosis measurement

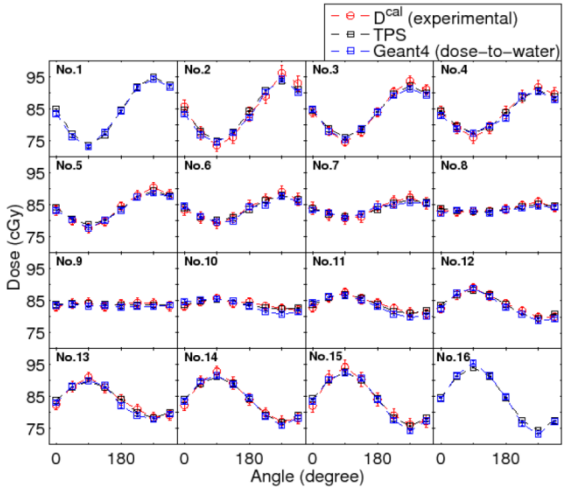
+ INABENSA-HUVM-ESII

M. Ovejero: Contrato CPAN



Si strip detector inside a cilindrical phantom





Dose measured in the different strips vs simulations

Measurement with a clinical electron accelerator

Patent application submitted

GOBIERNO DE ESPAÑA
MINISTERIO DE CIENCIA E INNOVACIÓN
CPAN ingenio 2010

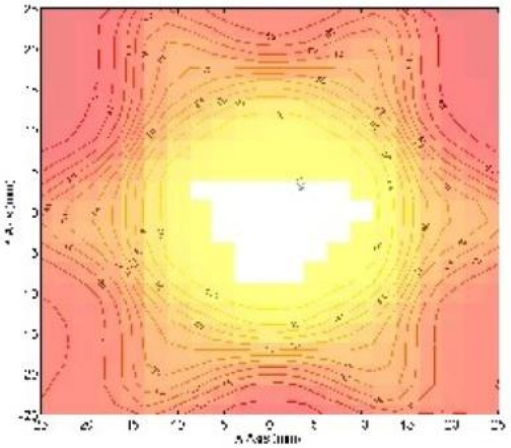
Monte Carlo simulations in radiotherapy

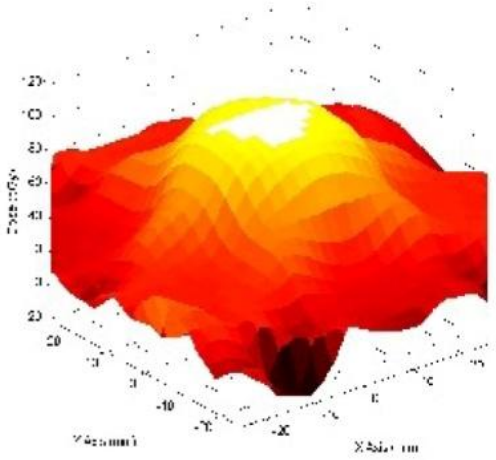
MEDICAL PHYSICS

III Jornadas CPAN, Barcelona
2011

GETERUS

RADIA project: treatment verification system for intensity modulated radiotherapy (IMRT)



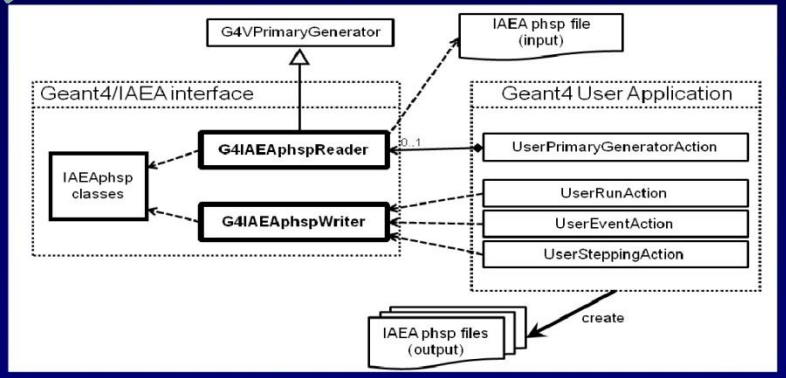


IAEA phase space interface for Geant4 and application to full MonteCarlo simulation of a medical linac

GETERUS

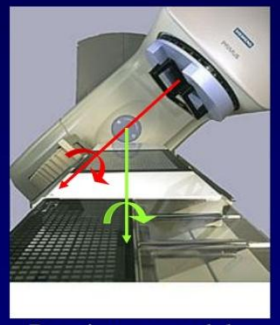
phsp CLASSES FOR GEANT4

Design and Main Relationships of the Classes



Utilities

- Correlations between particles are kept, making possible the realization of a proper statistical analysis.
- Particle recycling is included. Axial symmetry will be included in next release.
- n_stat variable used.
- Phase-space file can be divided for MC simulations divided into parallel runs.
- Arbitrary translations and rotations are supported. Rotations around the isocentre can be defined as well.

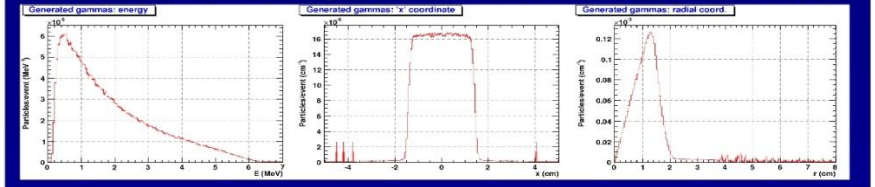


Rotations around the mechanical isocentre

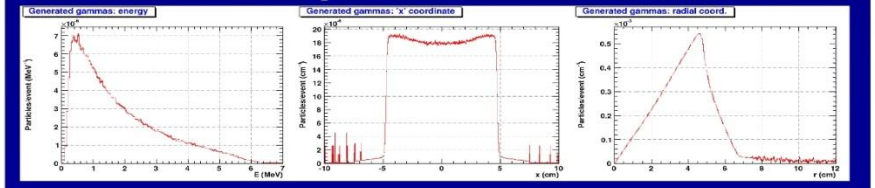
3. RESULTS

Analysis of Phase-Space Files Stored in the IAEA Database

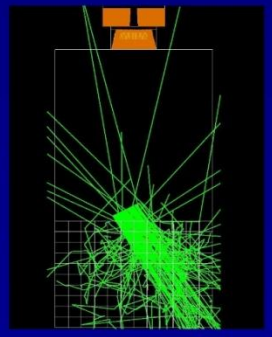
SIEMENS PRIMUS 6-MV photon mode; 3 × 3 cm² field (IAEA index 109)



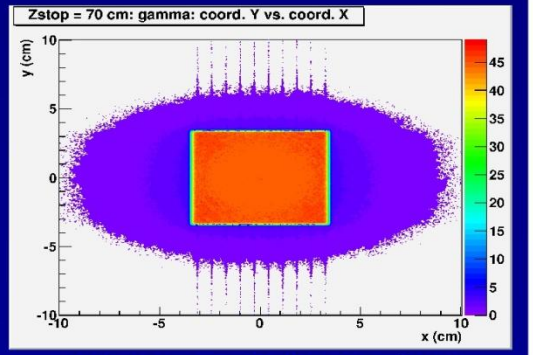
SIEMENS PRIMUS 6-MV photon mode; 10×10 cm² field (IAEA index 100)



Application in a GEANT4 Model of a SIEMENS PRIMUS Linac



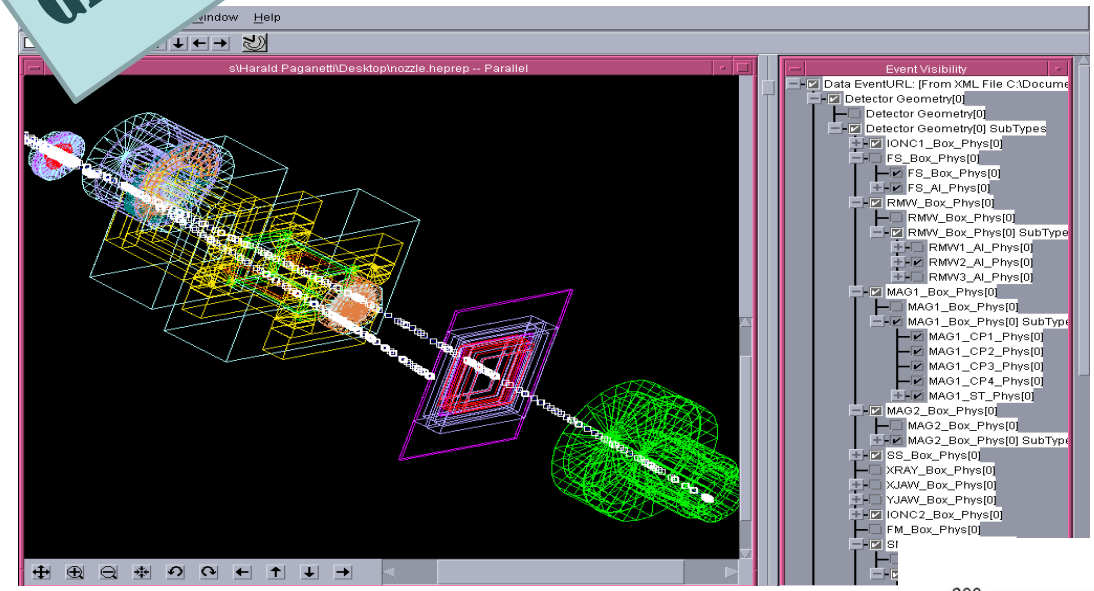
Example of irradiation field rotated 30 deg with respect to the gantry axis



6-MV photon mode; 10 × 10 cm² field (*SSD* = 70 cm)

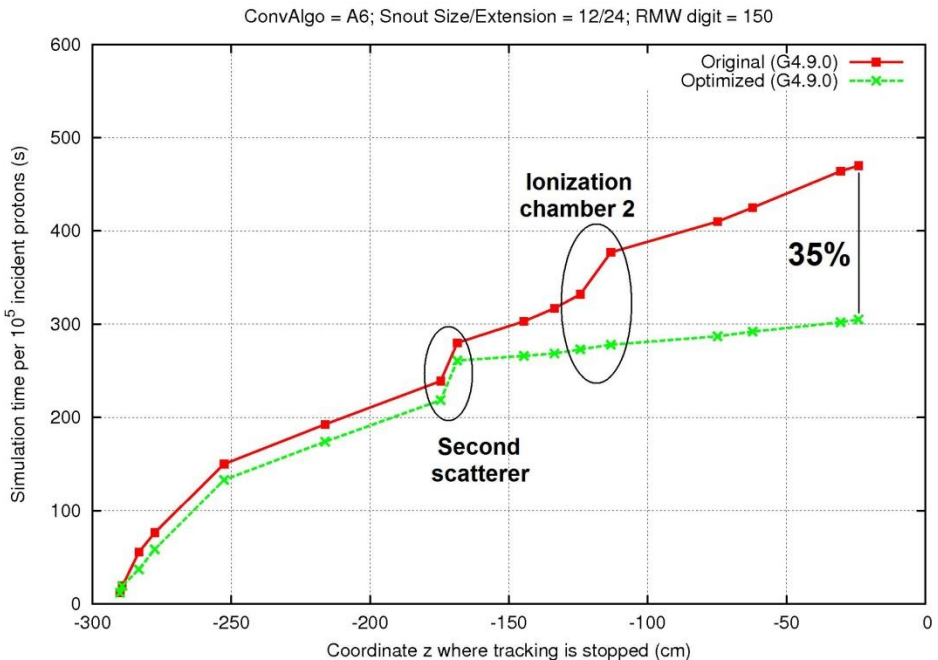
M.A. Cortés-Giraldo, J. M. Quesada,, M. I. Gallardo and R. Capote, "A simple implementation to read and write IAEA phase-space in Geant4 based simulations", MC2010-Stockholm, Sweden, 9-12 November, 2010.

Improving computational efficiency in Monte Carlo simulations of a passive scattering proton therapy nozzle (Massachusetts General Hospital, Cancer Center, Boston, U.S.A.)



- To decrease the CPU time needed to generate a phase-space file in Monte Carlo simulations of a passive scattering proton therapy nozzle.
- Development of speed-up techniques useful for other nozzles with a similar geometry.

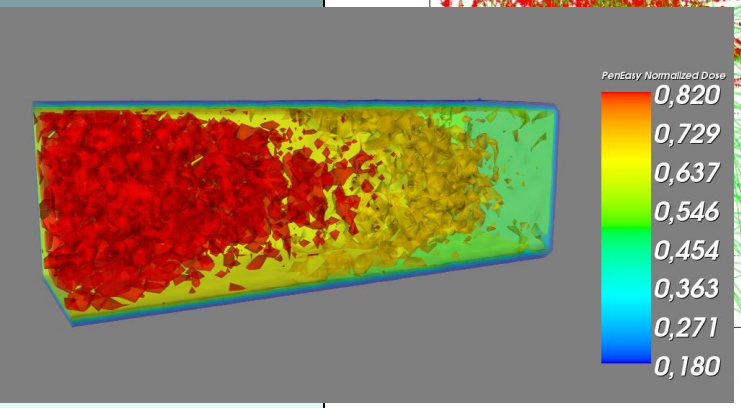
- Speed-up techniques developed to increase the efficiency of Geant4 Monte Carlo simulations of the passive scattering proton therapy nozzle (30% faster in typical situation).
- Most of these methods can be considered in other nozzles, especially geometrical and tracking optimizations.

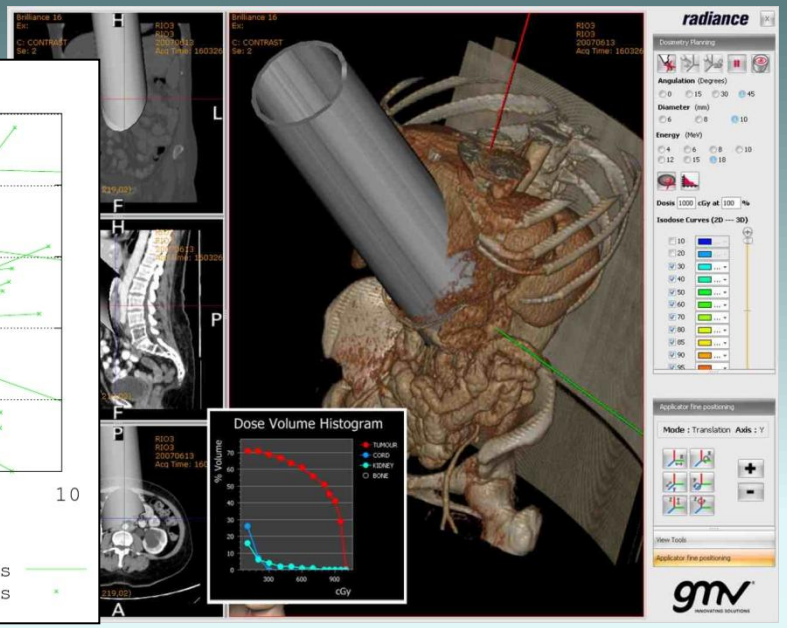


M.A. Cortés-Giraldo, J.M. Quesada, M.I. Gallardo and H. Paganetti, Medical Physics 37, 3467 (2010)

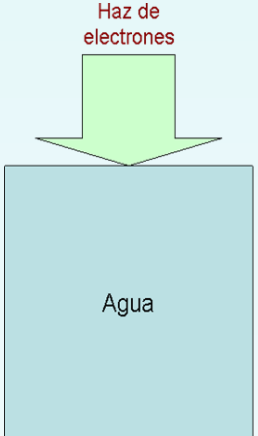
GFN-UCM: Radiotherapy

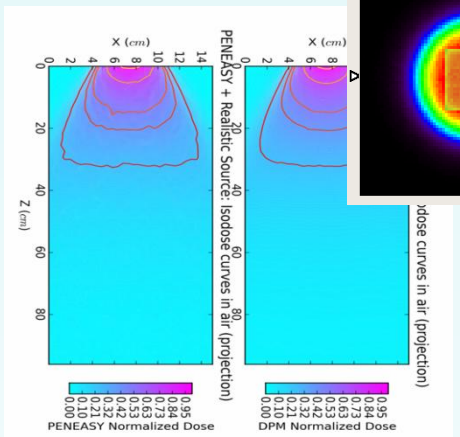
DOSE PLANING (GMV-GFN collaboration contract)
MC DOSE COMPUTATION

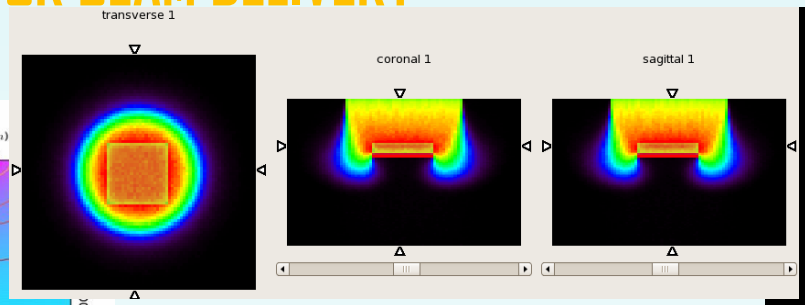


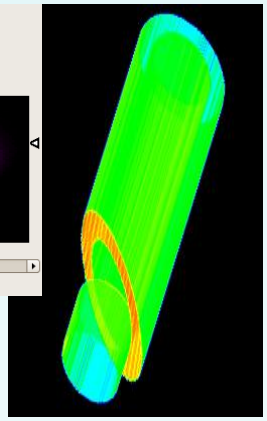


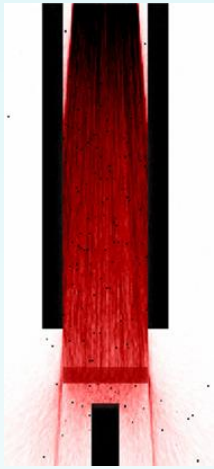
DESIGN OF APPLICATORS FOR BEAM DELIVERY











UGR: Monte Carlo simulation of different problems related to radiotherapy

- **Description of linacs in terms of source models**
  (MICIIN IPT-300000-2010-3)
- **Acceleration of simulations using ant colony algorithms**
  [S. García-Pareja, et al. Med. Phys. 37 (2010) 3782-3790]
- **Calculation of doses due to neutrons in therapy linacs**
  [Martínez-Ovalle et al., Radiat. Protect. Dosim(2010) doi:10.1093
- **Analysis of small and/or irregular radiation fields**
  (IAEA Doctoral CRP E2.40.15)
- **PENELOPE applications for users**
  (collaboration with Prof. Salvat, U. Barcelona)
- **Potential use of ^{33}S to enhance BCNT efficiency**
  [Porras, Appl. Radiat. Isotopes (2011) in press

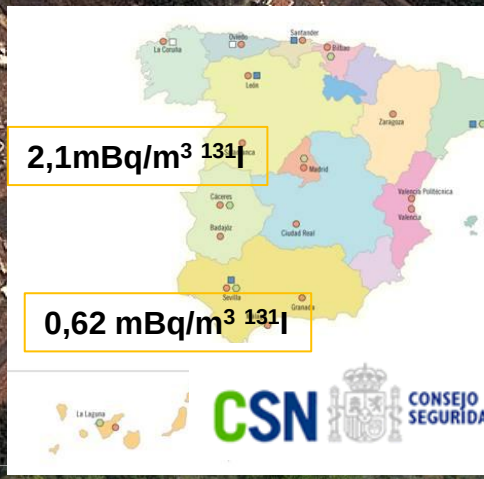
GETERUS: Heavy charged particle therapy

- **IAEA Coordinated Research Project** : ***Heavy charged- particle interaction data for radiotherapy*** http://www-nds.iaea.org/charpar/public.html
- **Optimization of Geant4 application for simulation of the proton therapy nozzle**, in collaboration with the Protontherapy Group of the Massachussets General Hospital)
- **FIRST experiment** for extensive study of nuclear reactions of interest in medical and space applications at GSI.

ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS

III Jornadas CPAN, Barcelona 2011

Environmental radiological surveillanc

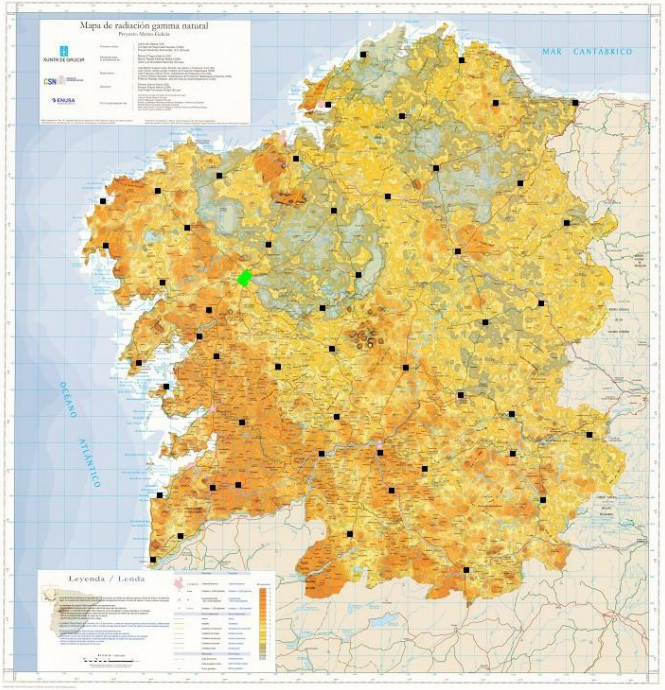


III Jornadas CPAN, Barcelona 2011

LAR-USC:

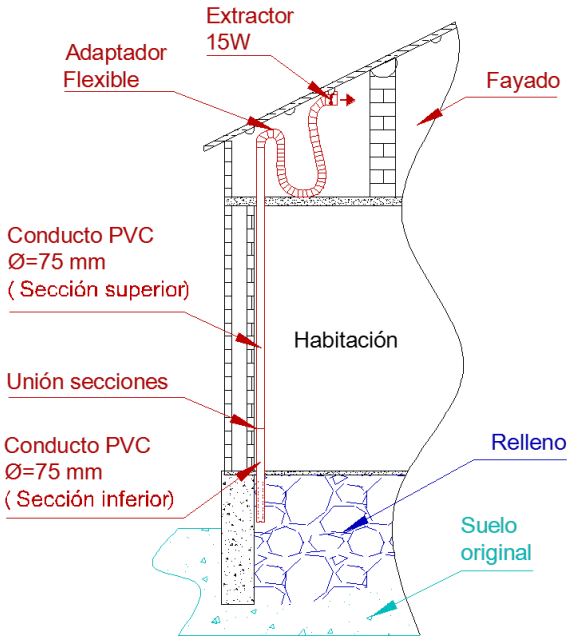
- An approach to the subslab depressurization remedial action in a high ^{222}Rn concentration dwelling.
  Journal of Environmental Radioactivity.
  Volume 101 - 3, March 2010, Pages 219-225.

- ^{222}Rn concentration in public secondary schools in Galicia. Journal of Environmental Radioactivity, 101 - 11, November 2010, Pages 931-936.



Charcoal canister (48 h)

Alpha track (1-2 months)



- Certificación ISO 9001

Líneas de trabajo actuales:

En la LINEA MICROSONDA EN EL ACELERADOR TANDEM:

Caracterización de partículas calientes con protones de alta energía mediante PIXE y RBS.

Medida de actínidos en la instalación de AMS de 1 MV del CNA:

Estudio del $^{239,240}Pu$ en un testigo de sedimento pelágico procedentes del *Porcupine Abyssal Plain* (Atlántico Norte)

Estudio de la relación isotópica $^{240}Pu/^{239}Pu$ en muestras de agua de mar de la IAEA: fase inicial de evaluación de resultados.

Estudio de las posibilidades que ofrece el sistema de AMS de 1 MV para la medida de ^{236}U

^{14}C en la instalación de AMS de 1 MV del CNA

Medida de ^{129}I en la instalación AMS de 1 MV del CNA

Objetivo: Evaluar el impacto de los vertidos de las plantas de reprocesamiento de Sellafield y La Hague en la zona en estudio Evaluar la utilidad del ^{129}I como trazador de corrientes marinas

LABORATORIO DE RADIACIONES IONIZANTES USAL

Universidad de Salamanca

Implantación del Servicio de Dataciones de la Universidad de Salamanca. Proyecto de Infraestructura UNAS08-3E-015

Novel Compton-supressed low-background double HPGe gamma spectrometer for the measurement of natural radionuclides of interest in paleoclimatic dating.

Thanks for your attention