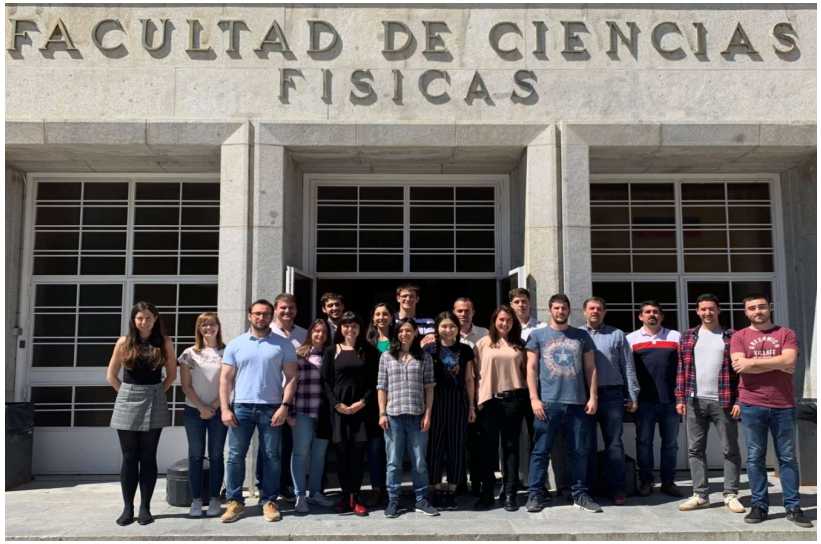
PhD opportunities in the Nuclear Physics Group at Complutense Univ. of Madrid



https://www.ucm.es/gfn









UCM was founded in Alcalá in 1499 (before relocating to Madrid in 1836)

UCM is **one of the oldest operating universities in the world** and the largest Spanish University (>80k students).

NUCLEAR PHYSICS GROUP AT UCM (GFN-UCM)

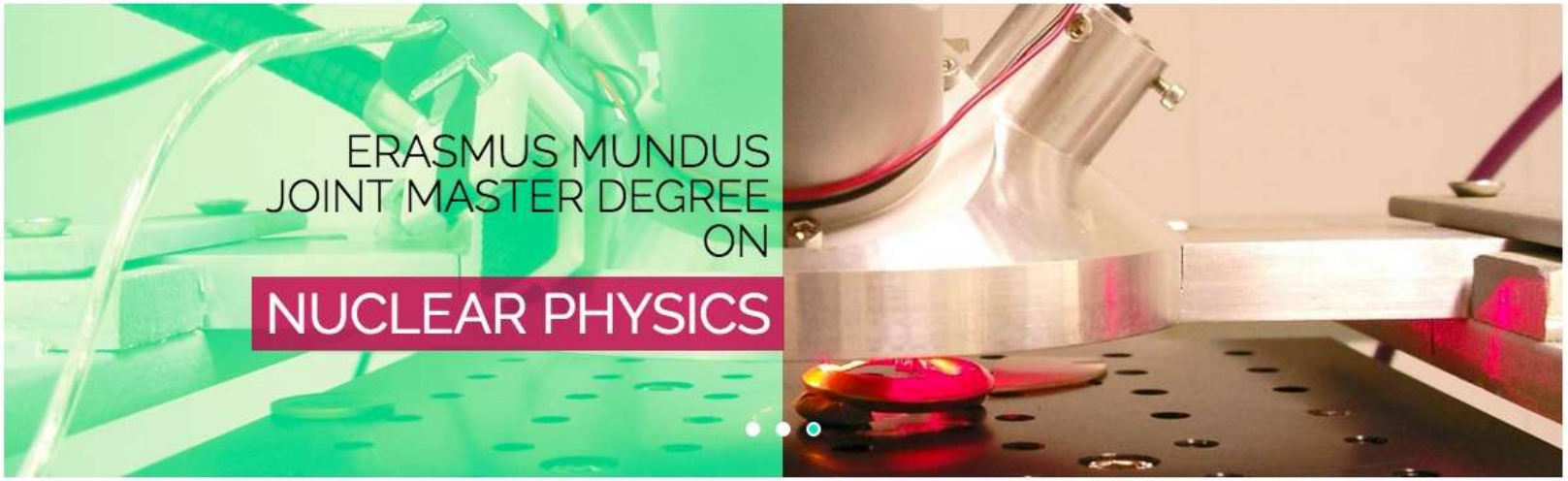
https://www.ucm.es/gfn

1) Theoretical Nuclear Physics

2) Experimental Nuclear Physics

3) Applied Nuclear Physics (Biomedicine)

Erasmus Mundus
JMD on
Nuclear Physics



Several other groups around Madrid, at CSIC and CIEMAT, involved in Master and PhD projects

Erasmus Mundus JMD on Nuclear Physics

gfn UCM Grupo de Física Nuclear

+800 students BSc Physics

+150 Master Students

+250 PhD Students

M.Sc Projects in Nuclear Physics from UCM:

Possibilities open. Look at the Ms projects we have advised in past years.

https://nuclear.fis.ucm.es/master

Possibilities open. Look at the PhD we have advised in past years.

https://produccioncientifica.ucm.es/grupos/4934/tesis

https://produccioncientifica.ucm.es/grupos/4934/detalle

- UCM contact jmudiasm@ucm.es
- Very involved in experimental projects at ISOLDE@CERN josebriz@ucm.es, lmfraile@ucm.es
- Applications in medicine, nuclear imaging, radiotherapy, protontherapy, AI methods jlopezhe@ucm.es
- Nuclear structure (see Tomás at Seville) and neutrino-nucleus scattering (see Raúl at Seville too)
- Radiotherapy: Paula Ibáñez pbibanez@ucm.es, Daniel Sánchez dsparcerisa@ucm.es

- PhD regulations: similar all over Spain

- 4-5 PhD 4-year grants given by UCM, in physics, (14x1400 euros per year+3000 euros travel grant)
- Also PhD contracts from Comunity of Madrid
- The general FPU program by the Spanish governement
- Further: 'Industrial PhD programs', in collaboration with companies, funded by the Spanish Government or the Comunity of Madrid

- Overall, currenlty we have 7 PhD grantees in the Nuclear Physics Group, plus one Industrial PhD program, out of 14 PhD students,

Our Background (GFN-UCM)

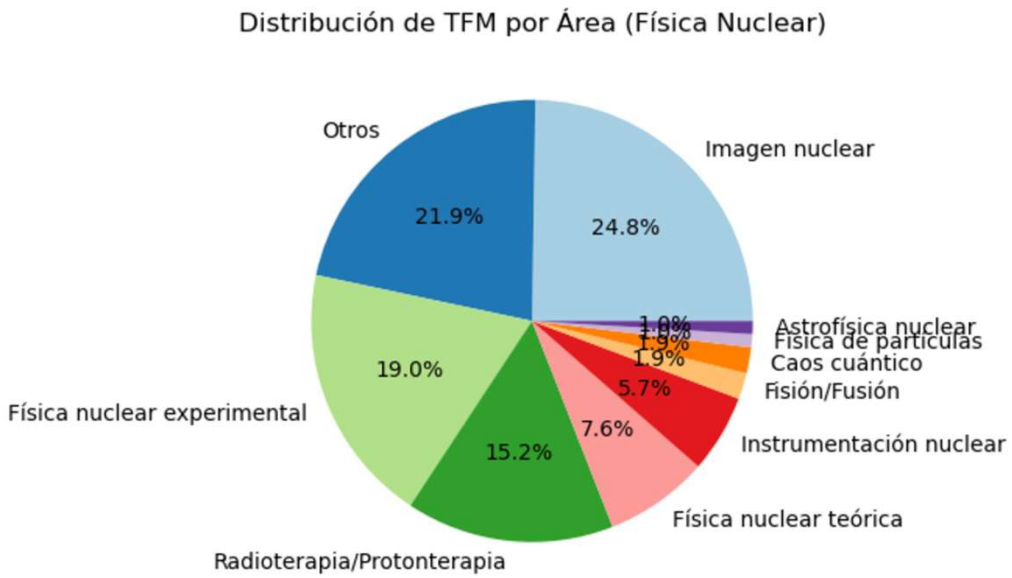
- 1996: First Theoretical Nuclear Physicist at UCM
- 2000: First Experimental Nuclear Physicist in the group (working with ISOLDE@CERN)
- 2002: First PhD students in the field of Applied Nuclear Physics
- 2004: First Technology Transfer agreement (Preclinical PET)

In the last 10 years:

> 50 TFG

> 100 Master Projects

> 20 PhD Thesis



Areas of work

Instrumentation & DAQ

Low-cost data acquisition systems and smart detectors

AI algorithms for timing and signal pickup

Proton therapy & FLASH

Conventional proton therapy modelling and Monte Carlo

FLASH radiotherapy at CMAM and Quirónsalud

O_2 mechanisms in controlled atmospheres

Multimodality imaging

Dual ultrasound / photoacoustic imaging

Guided ultrasound for astronaut self-imaging (ALISSE)

AI-assisted tomography reconstruction

Brain-dedicated PET

Helmet-PET (SEDECAL/CDTI) deployed at La Fe

NeuroSphere PET insert for 7 T MRI (Martinos / MGH)

RETIMAGER laser-engraved hexagonal detectors

Preclinical scanners

SISAR-6R installed at MSK

In-house production with SEDECAL

PETRUS — Integrated PET+UFUS prototype

Spin-offs & other transfer

Q-RAS — m-PET multiplexed add-on

INVENTOR — portable X-ray FLASH irradiator

Industry partnerships across Europe and US

Experimental Nuclear Physics



- Nuclear Structure with Exotic Nuclei
- Nuclear Reactions with Radiactive Beams
- Fast-timing Techniques
- Beta decay in Exotic Nuclei
- Nuclear Instrumentation

Fast Timing



ββγ experimental set up for fast timing technique

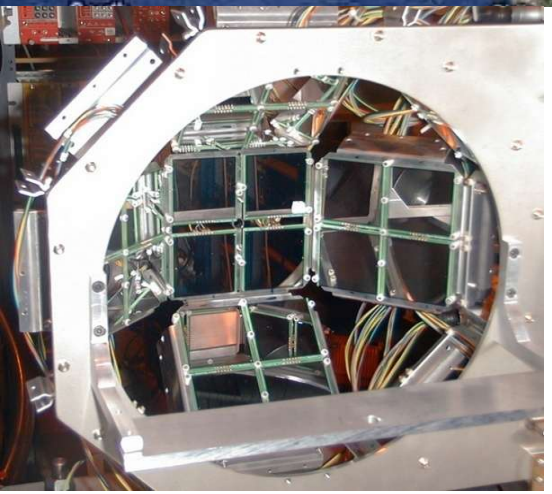


FAIR-GSI facilities

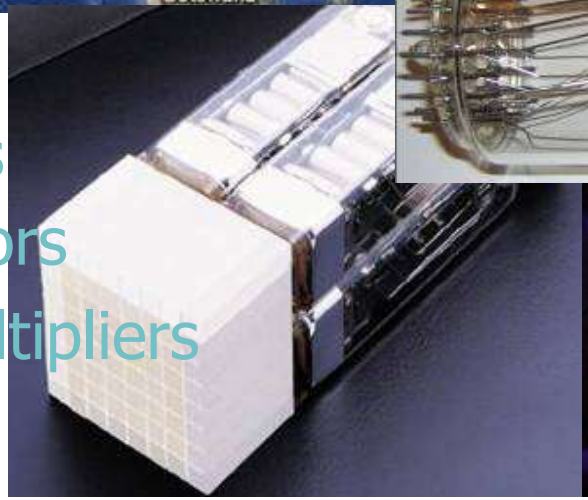
Experience in large experimental facilities



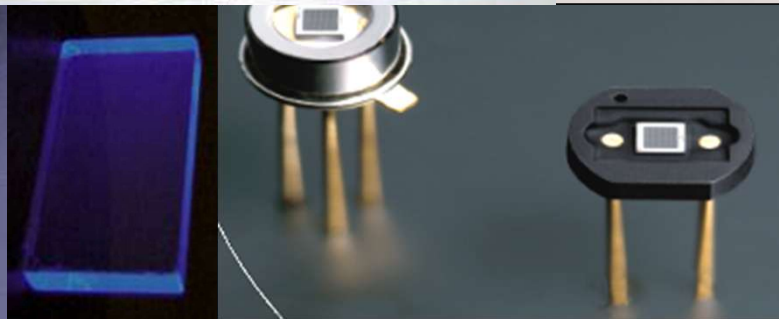




- Particle detectors
- Scintillators
- Photomultipliers
- SiPM







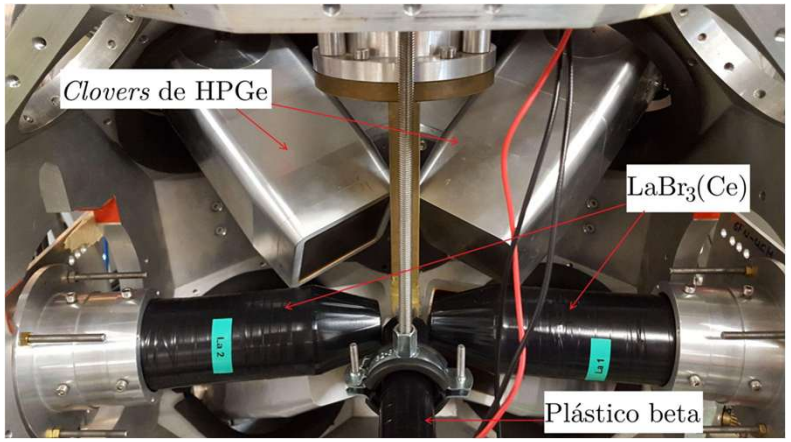
Experimental Nuclear Physics: Topic Examples

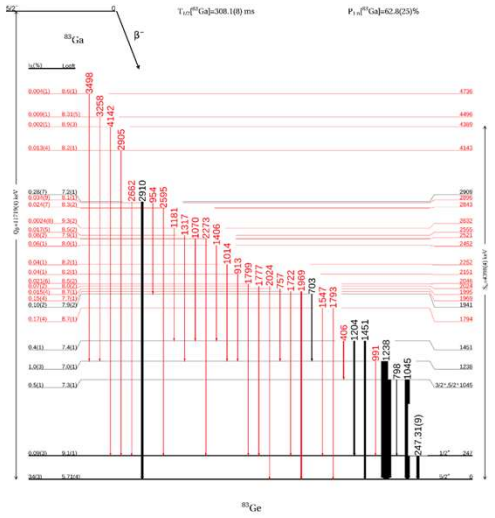
Data Analysis from ISOLDE Experiments (CERN)

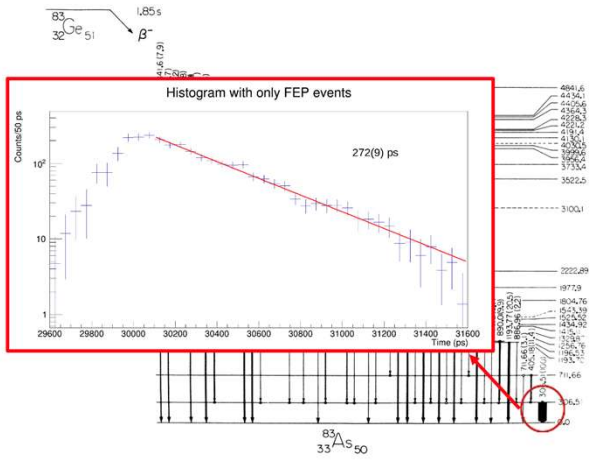




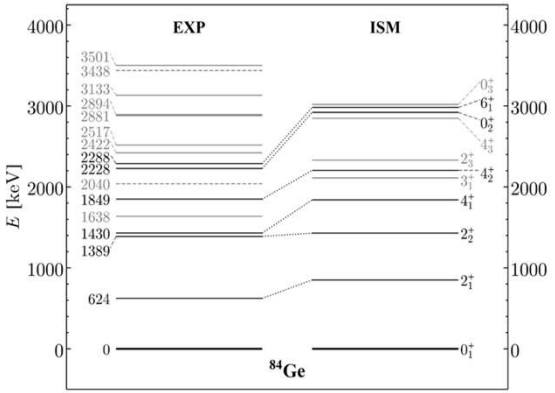
Gamma-Ray Spectroscopy and Lifetime measurements of excited states with Fast Timing

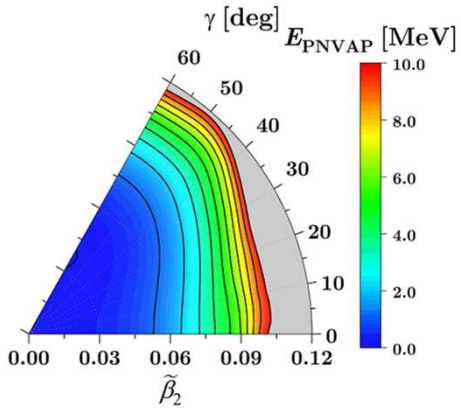






Vida media del primer estado excitado del ^{83}As



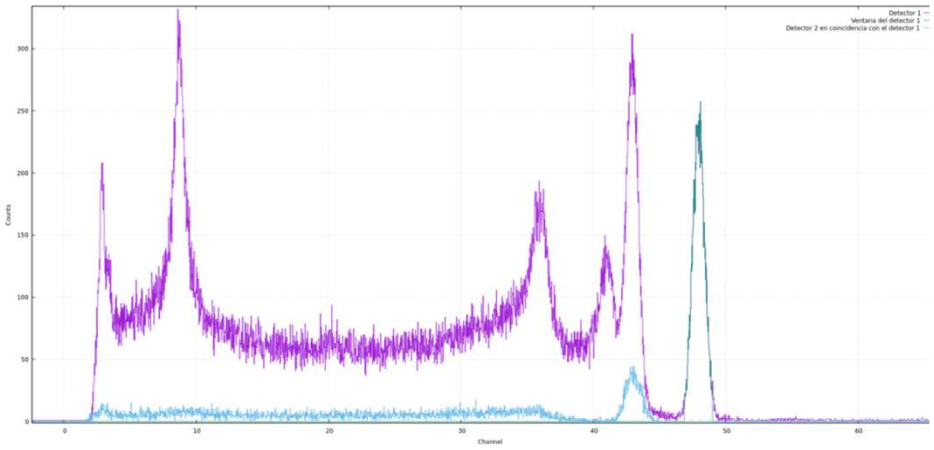


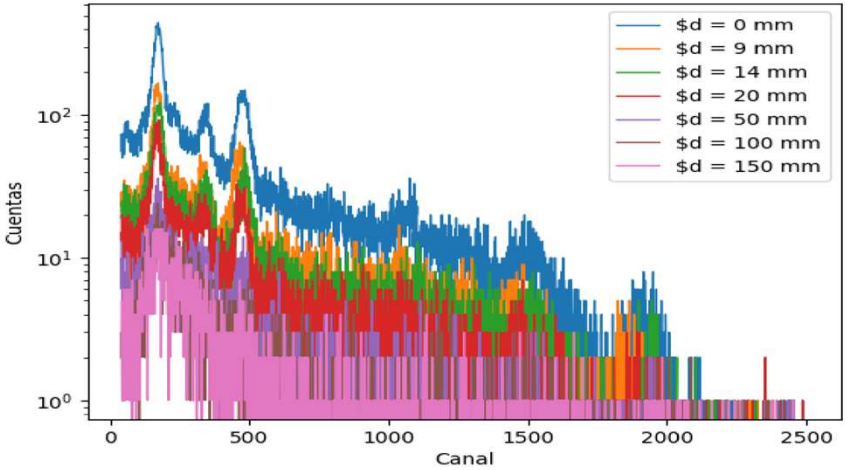
Experimental Nuclear Physics: Topic Examples

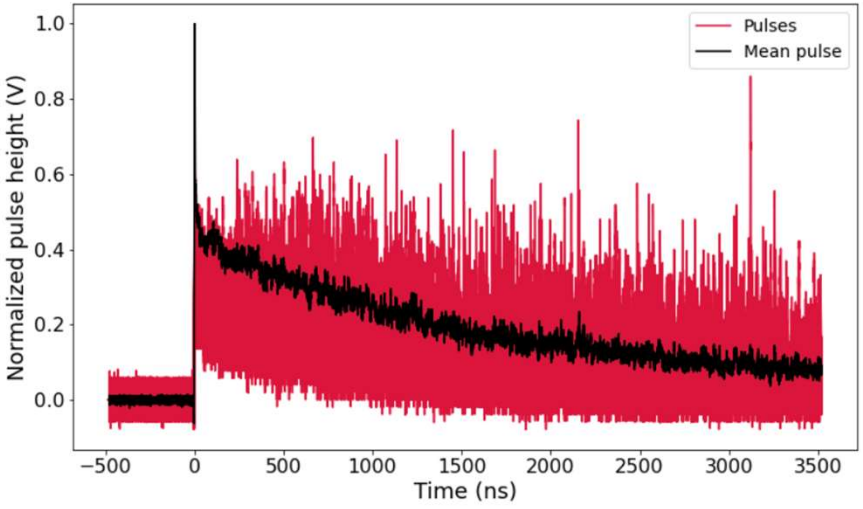
Characterization of a LaCl3 detector

- Study of the Timing properties
- Study of the Energy Resolution
- Study of the Linearity
- Study of the Efficiency











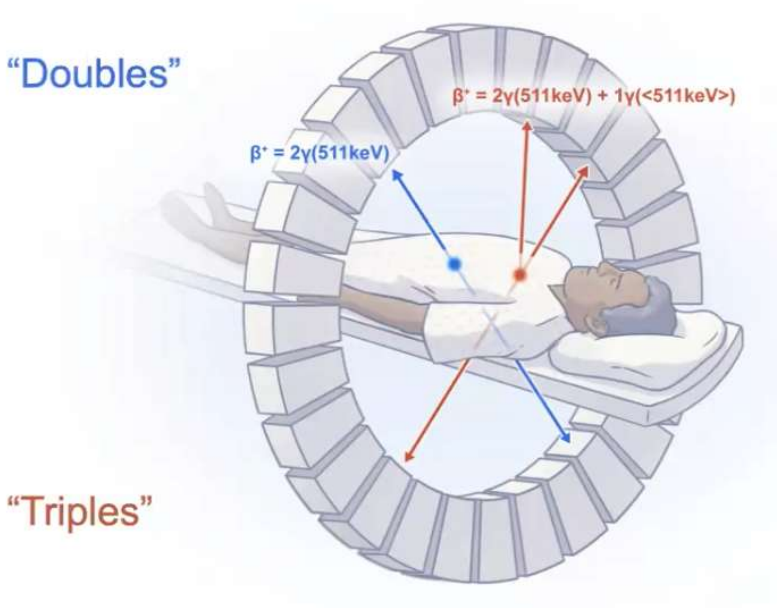
Instrumentation & DAQ

Smart detectors, low-cost electronics, AI for timing and corrections. *Inexpensive and flexible DAQ electronics for radiation detectors. Funded by TAU-CM project (MRR) and providing the basics for a HISTAR DAQ system and some of the PET devices in which the GFN collaborates.*

UNIVERSIDAD COMPLUTENSE MADRID

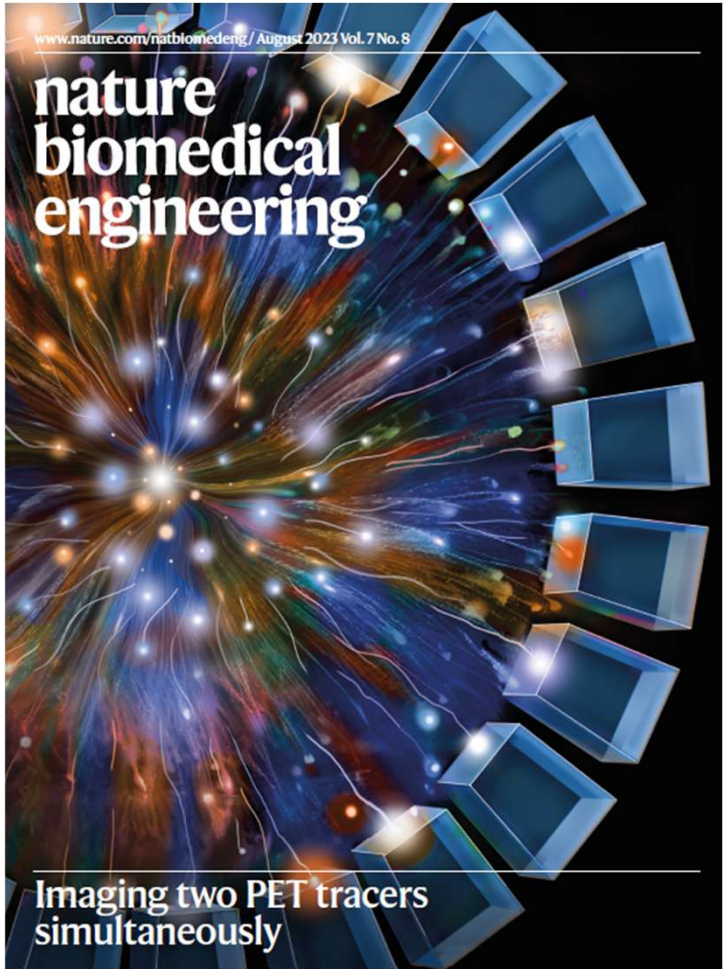
Applied Nuclear Physics: PET software and hardware

Multiplexed Positron Emission Tomography

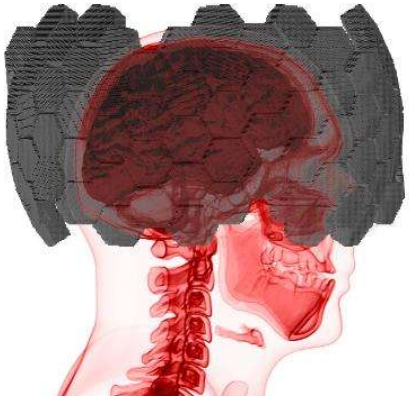


PhD Thesis of Alejandro Lopez-Montes
Awarded as best nuclear physics tesis
(2025 Award)

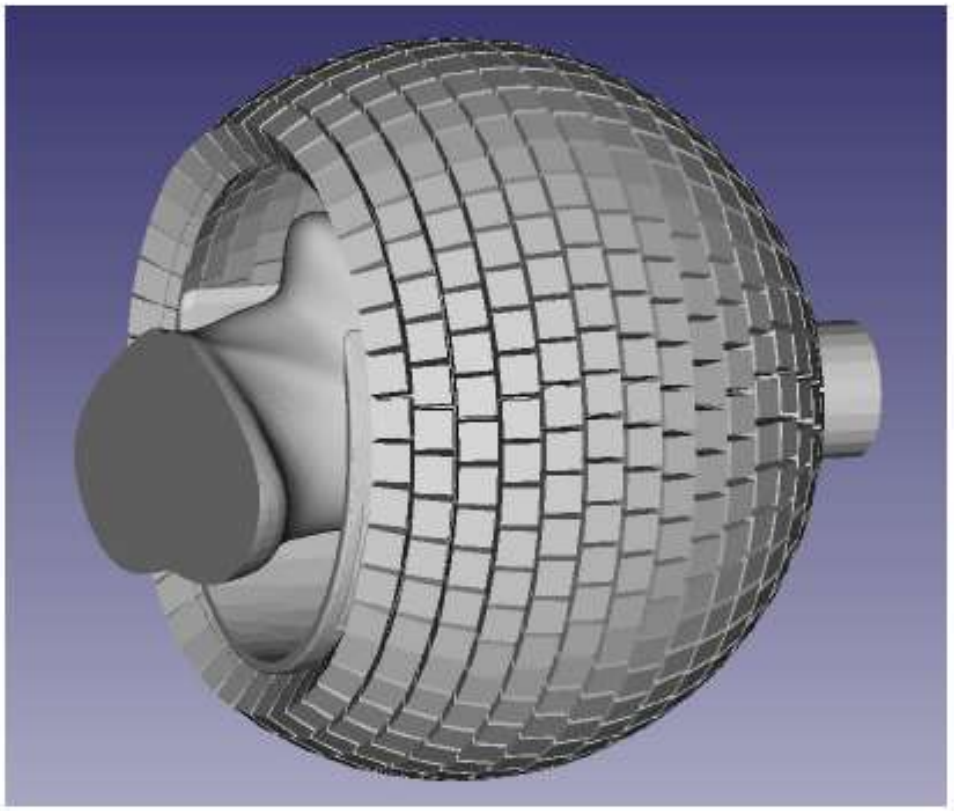




Applied Nuclear Physics: PET scanners







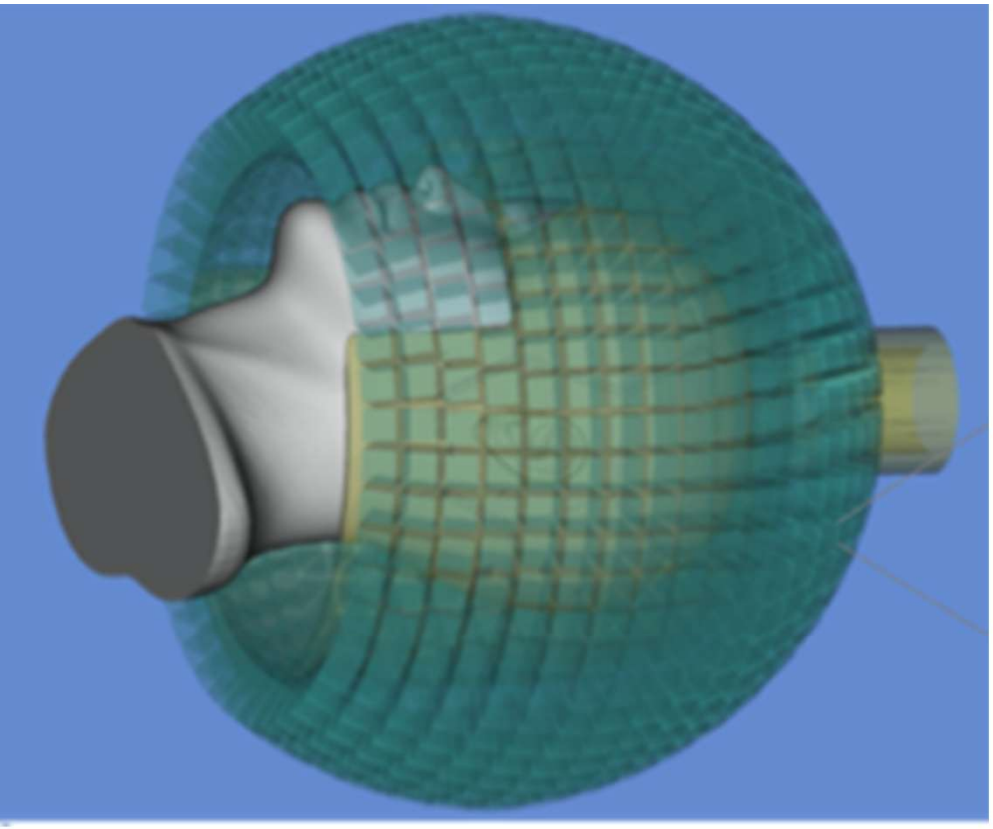
Brain-dedicated PET SCANNER 1:

Helmet-PET (funded by CDTI / CIBER)



- Helmet geometry, brain-dedicated
- Based on a design of GFN-UCM (electronics, detector, geometry) and buily by SMI/SEDECAL/GFN, with national funds from CDTI.
- Under clinical validation at Hospital La Fe (Valencia)

https://www.cdti.es/noticias/cdti-innovacion-entrega-ciber-prototipo-PET-Cerebral-CPP:



Brain-dedicated PET SCANNER 2:

NeuroSphere PET Insert for 7T-MRI

Already built, under commissioning and calibration. First patients due this summer

CSIC
Consejo Superior de Investigaciones Científicas

Instituto de Tecnologías Físicas y de la Información

Ministerio de Ciencia, Innovación y Universidades

Agencia Estatal de Investigación

gfn UCM
Grupo de Física Nuclear

Athinoula A. Martinos Center For Biomedical Imaging

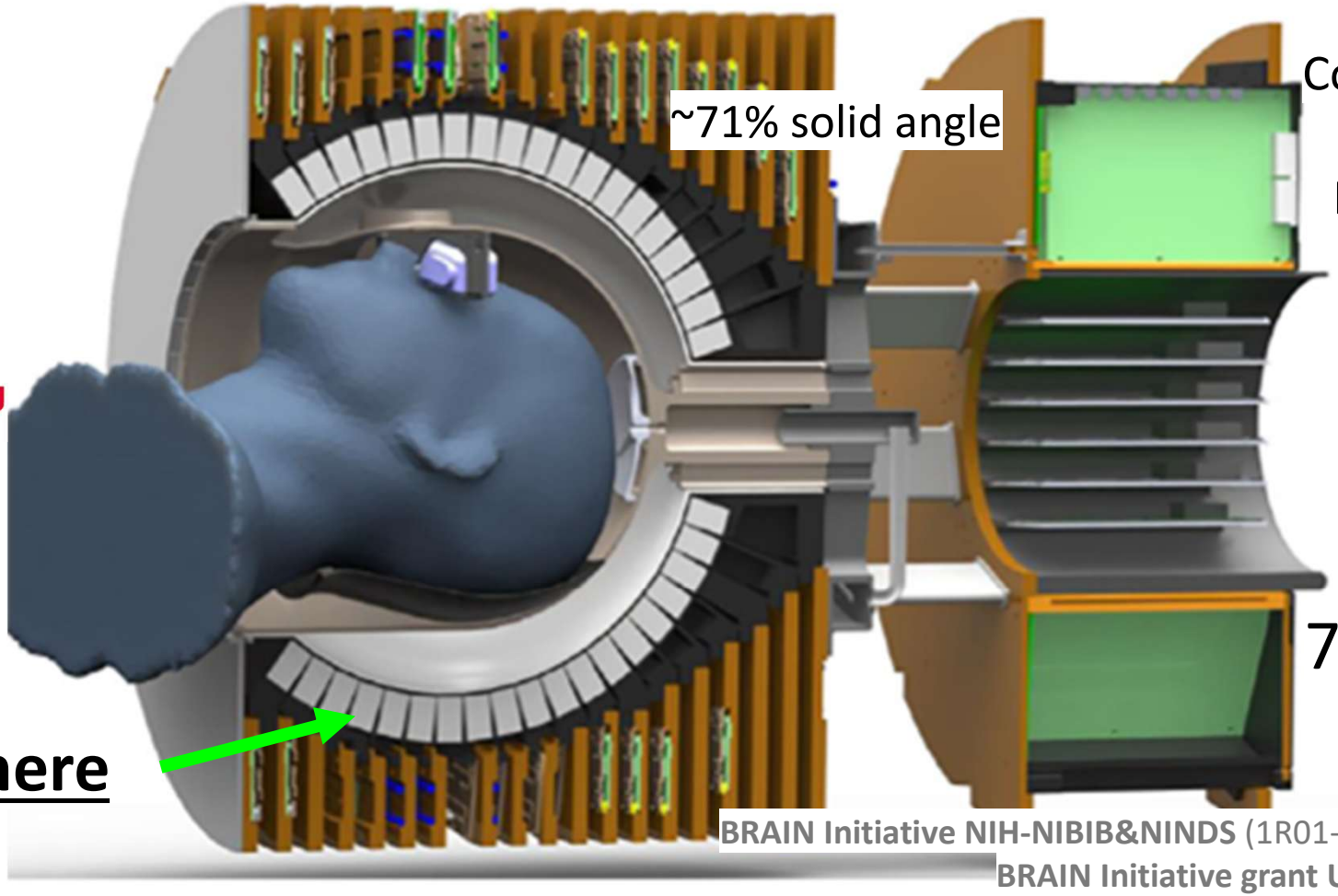
Massachusetts General Hospital

Harvard Medical School

NeuroSphere

Scipioni M, et al. 2023 IEEE NSS-MIC RTSD
Scipioni M, et al. 2024 IEEE NSS-MIC RTSD

L. U. Rauscher et al., IEEE Trans Rad Plasma Medical Sciences, 2026, doi: 10.1109/TRPMS.2025.3624609.
Pizzichemi M, et al. 2016 Phys. Med. Biol. 61 4679–98



Compatible with 7T Siemens Magnetom Terra

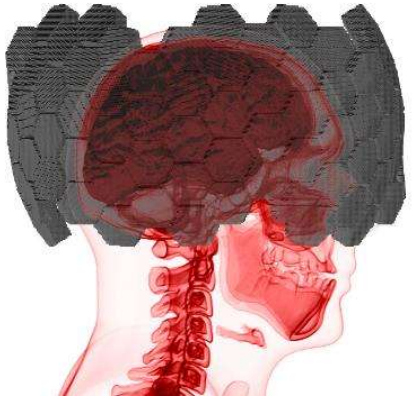
7T RF coil

NeuroSphere

BRAIN Initiative NIH-NIBIB&NINDS (1R01-EB026995-01; PI: **Catana**)
BRAIN Initiative grant U01EB029826 (PI: **Catana**)

Brain-dedicated PET SCANNER 3:

RETIMAGER: A new concept in PET BRAIN SCANNERS. Laser engraved hexagonal detectors



Funded by EU under the OpenFET/Pathfinder Project. Consortium lead by UC3M, with UCM, PARCC (Paris), Weeroc (France), and Jülich. Ends by feb. 2027. RETIMAGER brain scanner to be deployed in Jülich by this fall, 2026. It is being assembled in Madrid, at UC3M.

Applied Nuclear Physics: Radiotherapy

X-rays Intra-Operative Radiation Therapy (XIORT)

- Mobile accelerator:
  - 50 keV electron beam into a target
  - Low energy X-Rays (up to 50 kV)
  - Needle, spherical, flat and surface applicators:

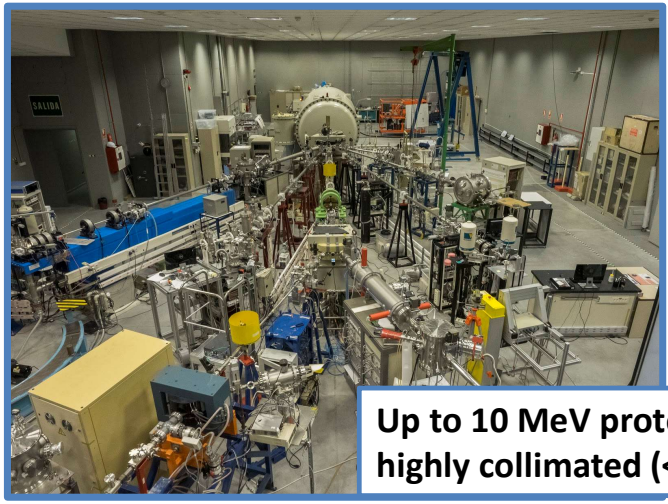




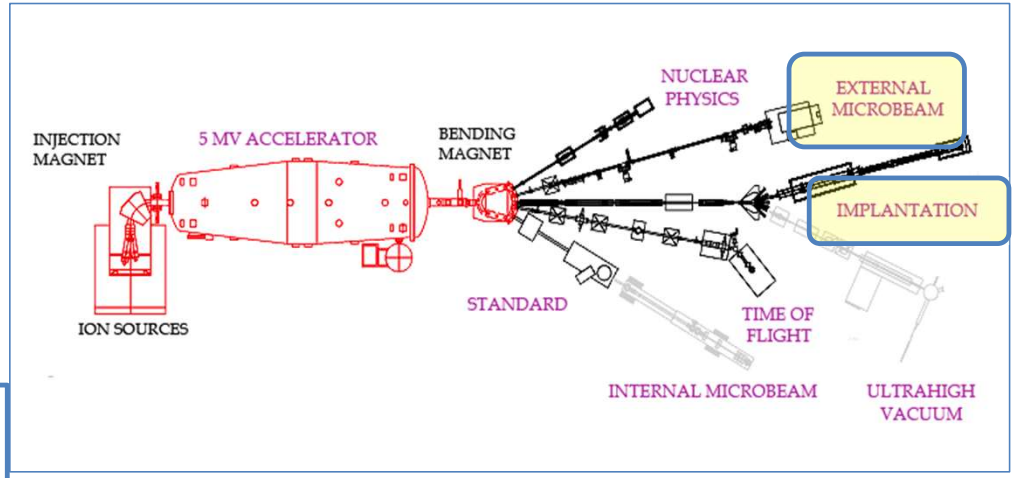
Intrabeam (Carl Zeiss Meditec)

- Objectives:
  - To generate optimized Phase-space files for each applicator
  - To compute fast and accurate dose from simple data
  - To validate the whole dose calculation process against simulations and measurements (homogeneous and heterogeneous phantoms)

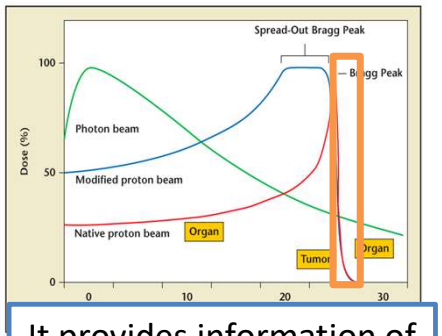
Applied Nuclear Physics: Protontherapy



Low-energy proton Accelerators (CMAM, CNA)



Up to 10 MeV protons (1.2 mm range in water), highly collimated (< 1mm), up to µA



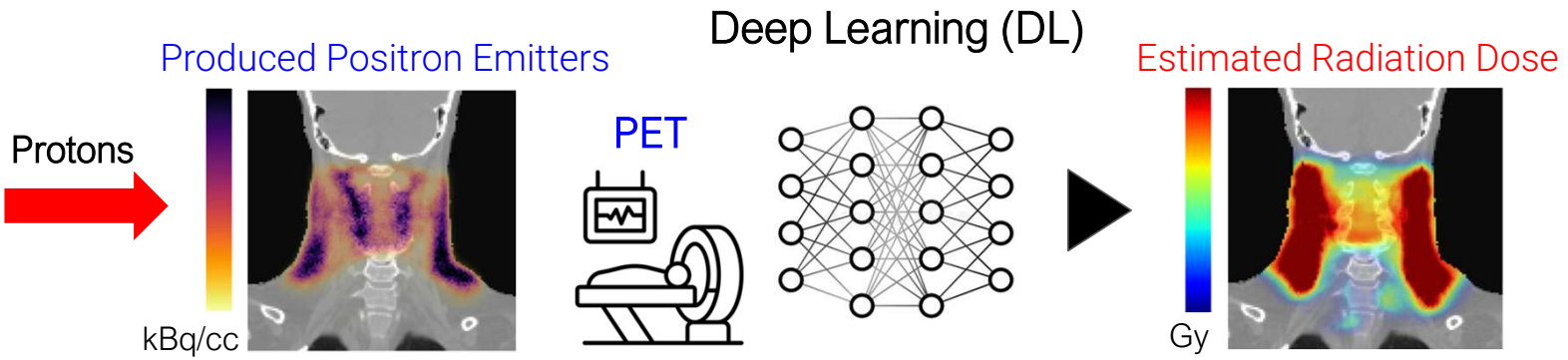
It provides information of the end of a clinical proton irradiation

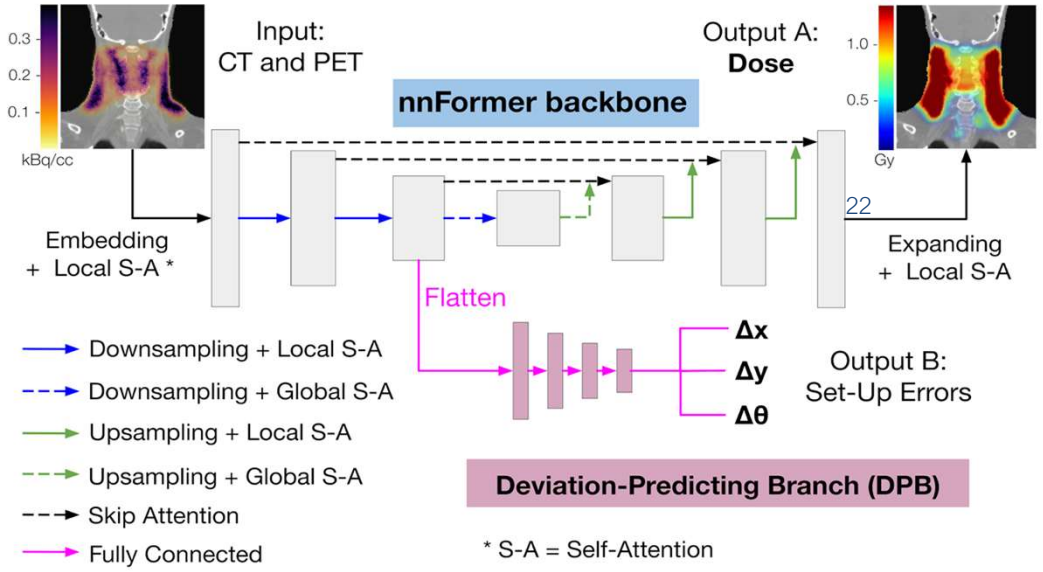


FLASH radiotherapy: initial experiments with protons

- Aceleradores de p de baja energía
- Centros clínicos de PT (Quironsalud, CUN)
- Haces clínicos de e- modificados
- Aceleradores dedicados de e- (Institut Curie)

Applied Nuclear Physics: Artificial Intelligence





IdISSC
INSTITUTO de
INVESTIGACIÓN SANITARIA
Hospital Clínico San Carlos

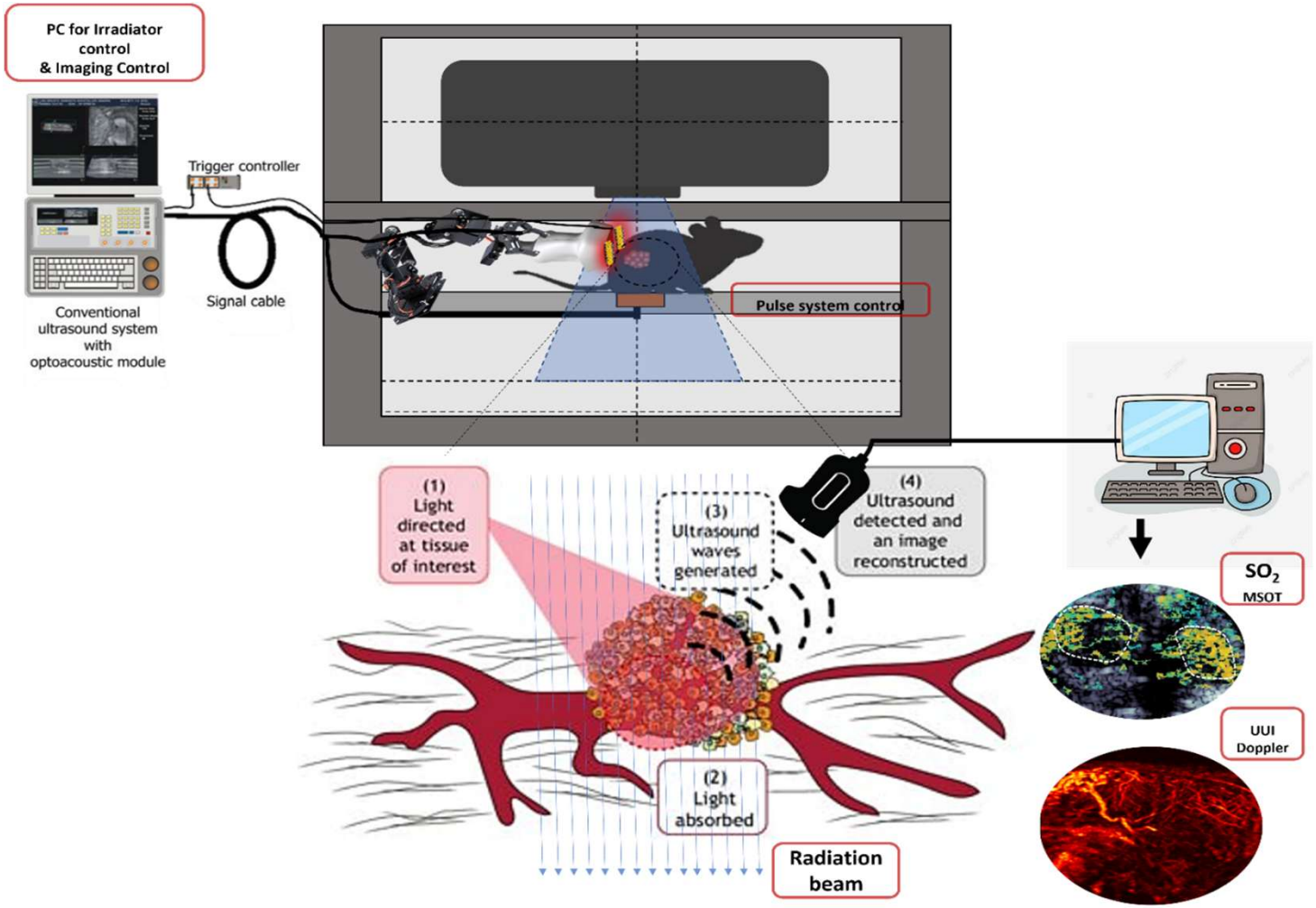
IPARCOS

Multimodality imaging

AI-guided ultrasound, photoacoustics, and assistive imaging

UNIVERSIDAD
COMPLUTENSE
MADRID

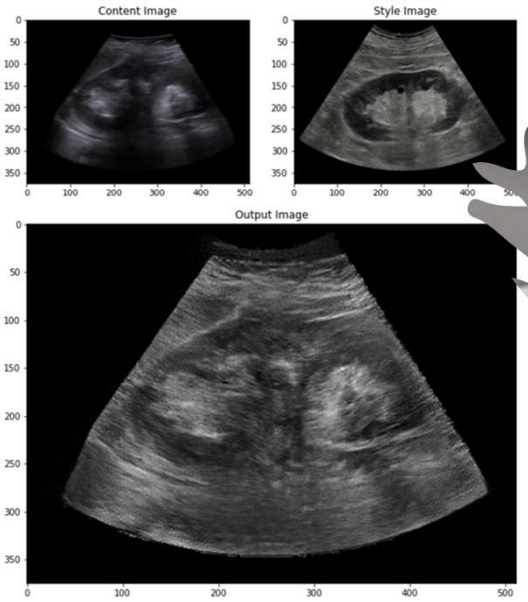
INVENTOR: In vivo Examination of the Tissue Response to Radiation (Mailyn PL, Paula IG)



Guided Ultrasound For Astronauts (funded by ESA)

Project ALISSE (JL Herraiz)

Autonomous uLtrasound Image improvement SyStEm





3) Applied Nuclear Physics: Translational Research



Fast Iterative Reconstruction Algorithm for PET (FIRST): licensed to SEDECAL for the Argus small animal PET/CT scanner, distributed in nearly 50 research centers worlwide.
For several years it settled a world record for spatial resolution (< 1 mm) with scintillator-based PET scanners. Ongoing collaboration with SEDECAL for the new SuperArgus scanner
http://www.sedecal.com/sedecal.com/es/divisiones/division_prod.php?p=52&c=5



UltraMC dose calculation and phase space generation tools developed at the GFN-UCM for IOERT and Intrabeam (Carl Zeiss Meditec) radiotherapy licensed to the company GMV, who has initiated the distribution of those algorithms within ©Radiance, the first world-wide available platform for dose planning and simulation in intraoperatory radiotherapy. FDA and UE approved
http://www.gmv.com/en/Healthcare/radiance/

Aproved in 2015 by the EU and the FDA to treat patients. Present in more than 50 hospitals in the world.

Transl. Cancer Res, 42, 196-209 (2015)

PhD opportunities in the Nuclear Physics Group at Complutense University of Madrid



Professors

José Manuel Udías

Óscar Moreno Díaz

Joaquín L. Herraiz

Daniel Sánchez-Parcerisa

Jose Antonio Briz

Paula Ibáñez

Laura Muñoz

3 Postdocs

+15 PhD students

URL: https://www.ucm.es/gfn

Email: jmudiasm@ucm.es