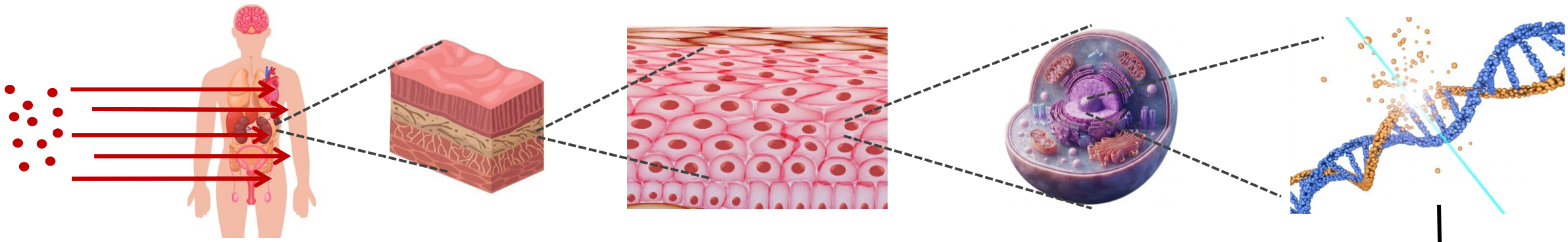
Radiobiology at DONES: Current Status and Future Perspectives

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Marta Oteo (**CIEMAT**)

What is the relationship between neutrons and Biomedicine?



Key determinants of biological damage

Absorbed dose | Neutron Energy Spectrum | Cell type

Neutrons as a "double-edged sword"

Health risk



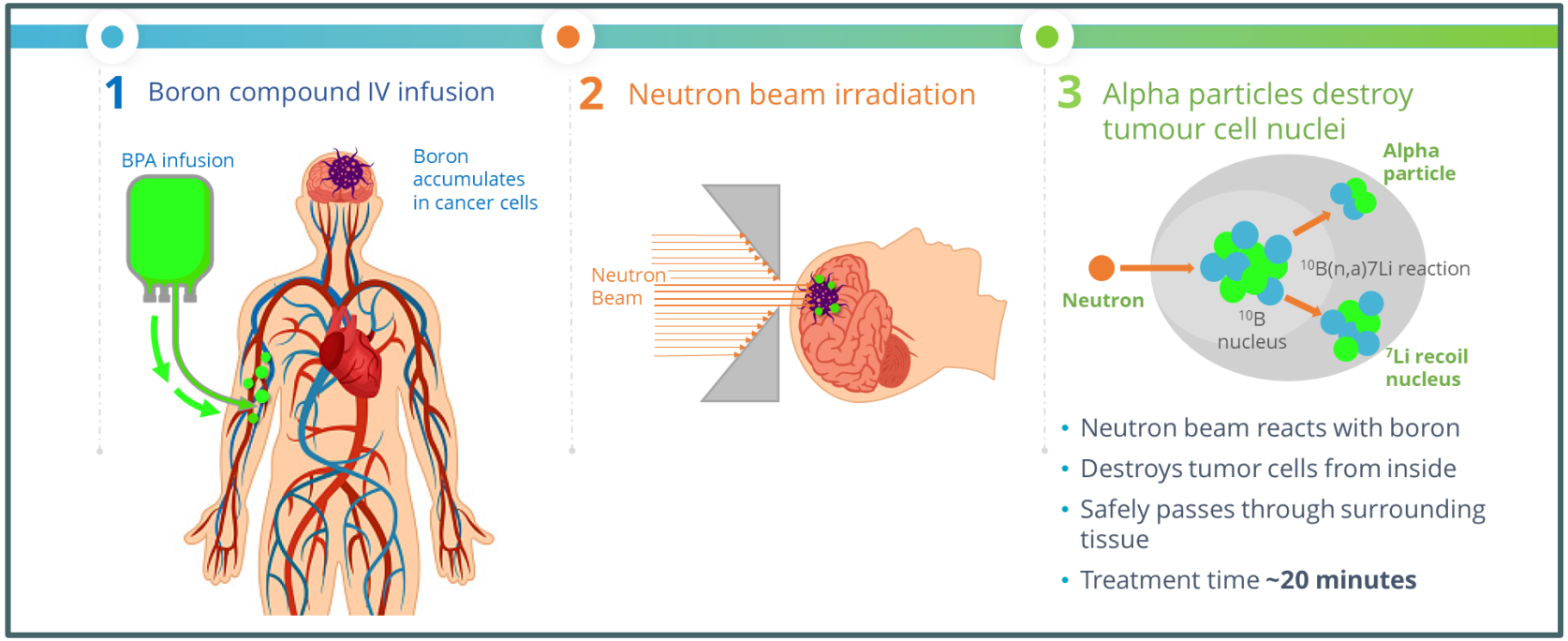


Therapeutic tool

Boron **Neutron** Capture Therapy



How does BNCT work?



Studied **since the 1960s**

2020: **approval** from **health-insurance** in Japan for head and neck cancer

2023: Helsinki, **Finland**: accelerator-based facility and first clinical trial completed





Yakamoto et al., 2013



Li et al., 2026

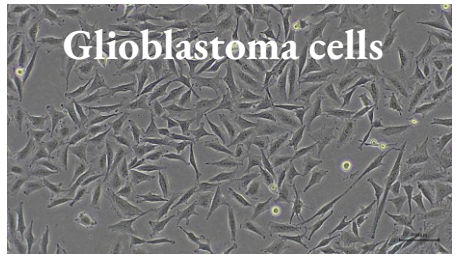


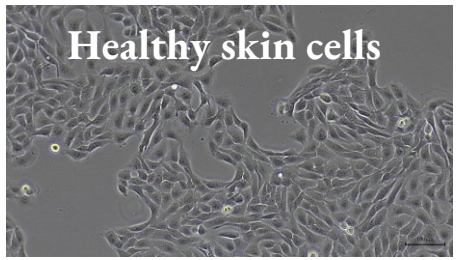
Porra et al., 2023

Next research priorities

- New boron compounds
- Other tumor types
- Non-targeted effects: bystander and abscopal effects

Our experience: neutron effects on Human Cells





Human cell lines

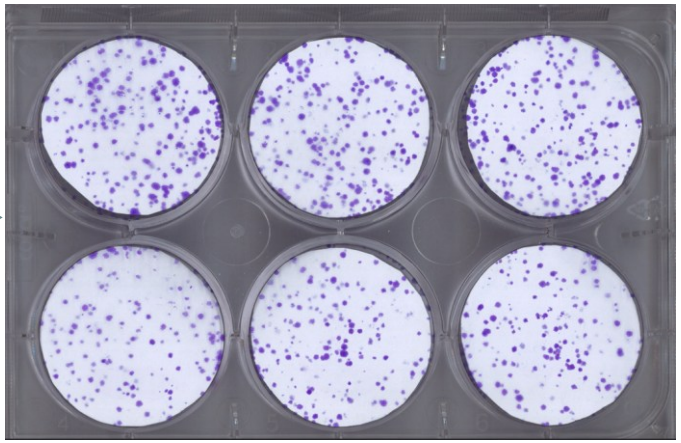
Tumor and healthy

Neutron irradiation

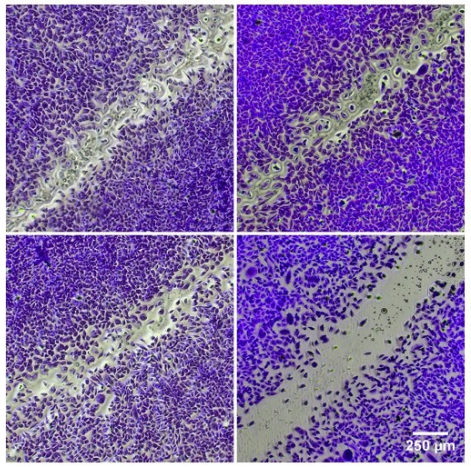
Different energy ranges

Experimental analysis

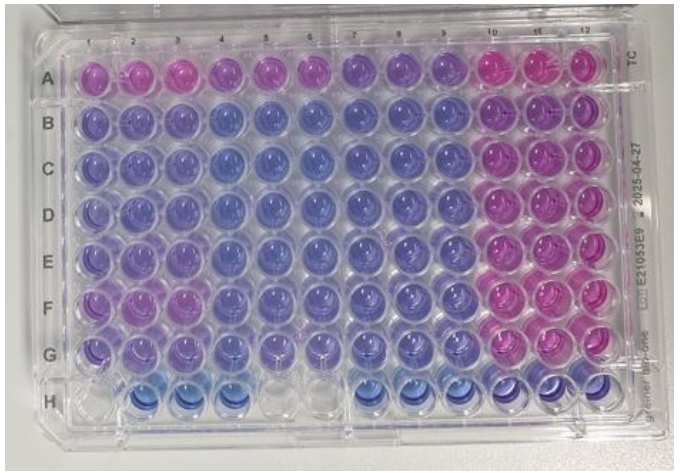
Biological effects



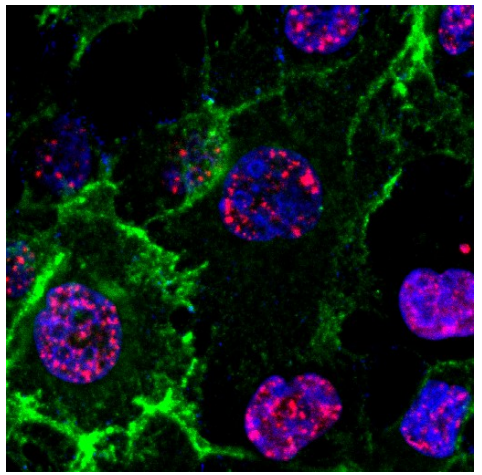
Clonogenic assay



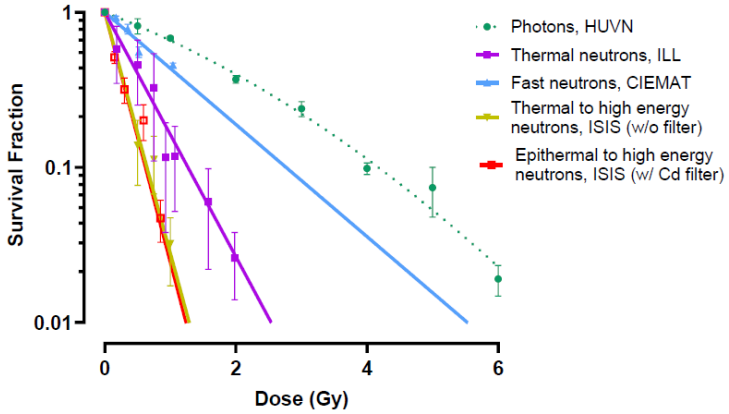
Invasion assay



Viability assay

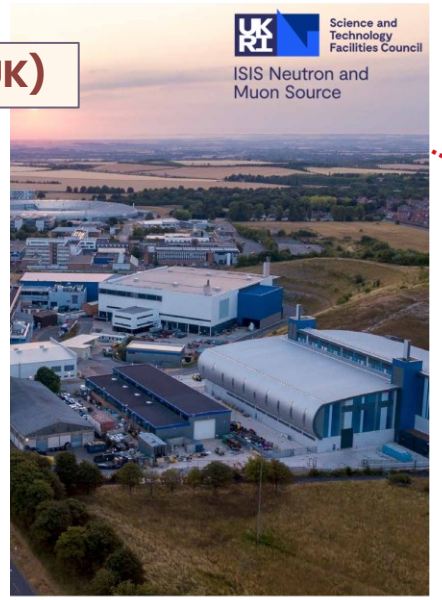


DNA-damage assay



Facilities used for cell irradiation

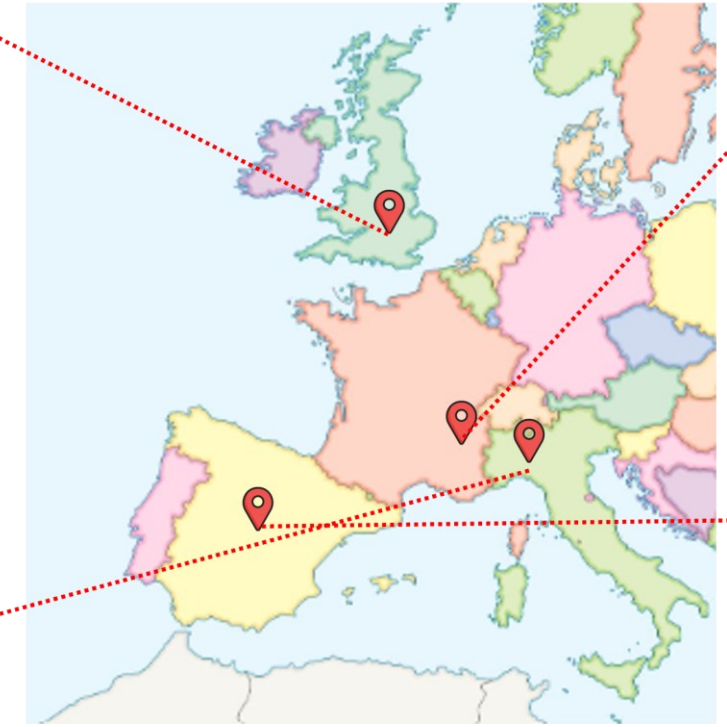
(Oxfordshire, UK)



In progress...

(Pavia, Italy)







(Grenoble, France)

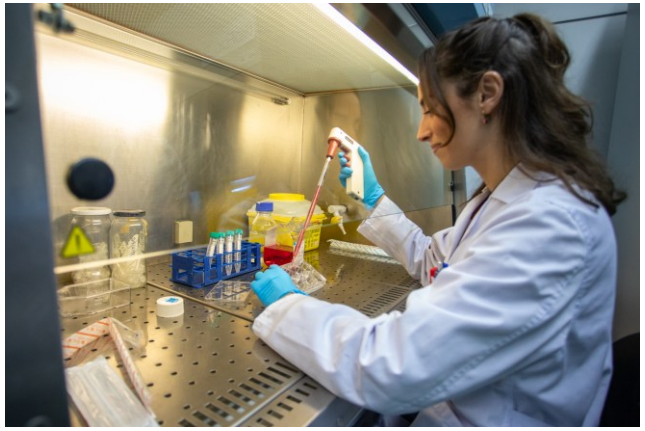


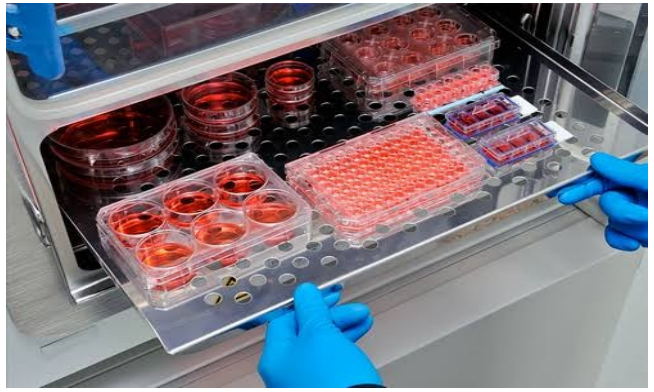
(CIEMAT, Madrid)

Irradiating biological samples in facilities that were **not initially designed** or equipped to carry out these types of experiments is certainly no easy task.

We move from this...

CIBM (Granada)

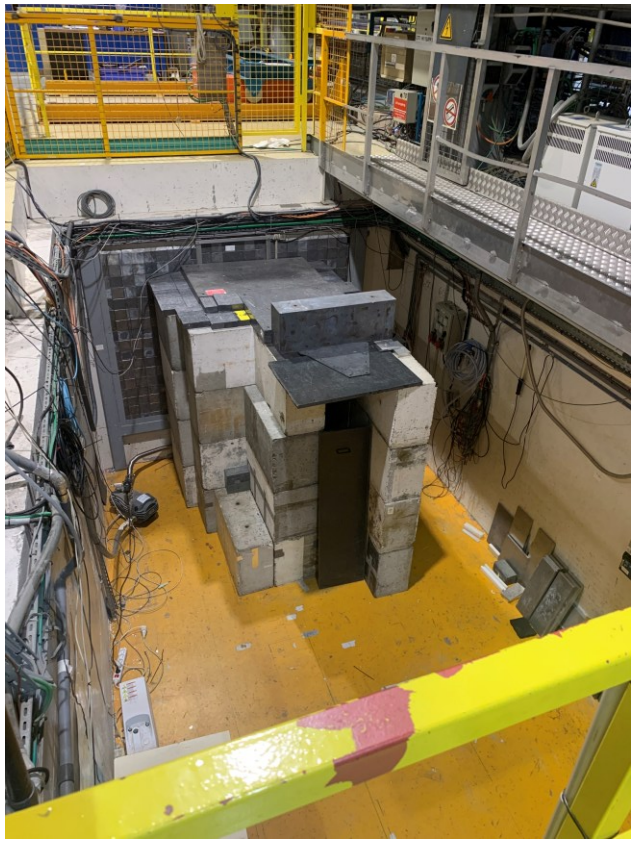




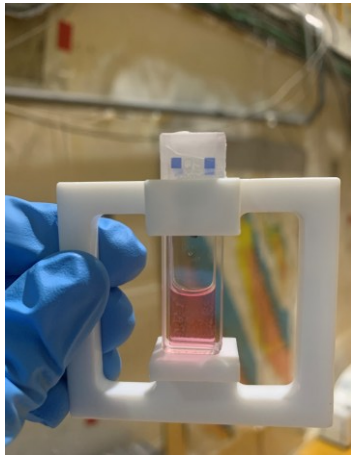
Controlled conditions

To this...

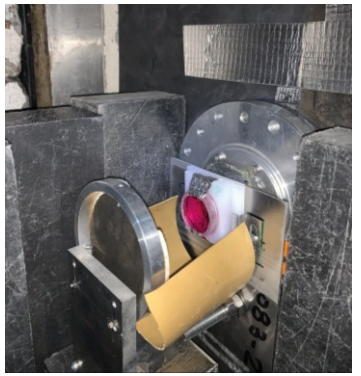
Institute Laue-Langevin (France)









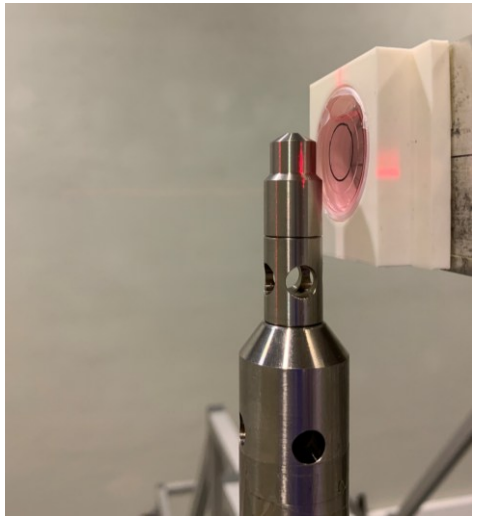


Irradiating biological samples in facilities that were **not initially designed** or equipped to carry out these types of experiments is certainly no easy task.

To this...

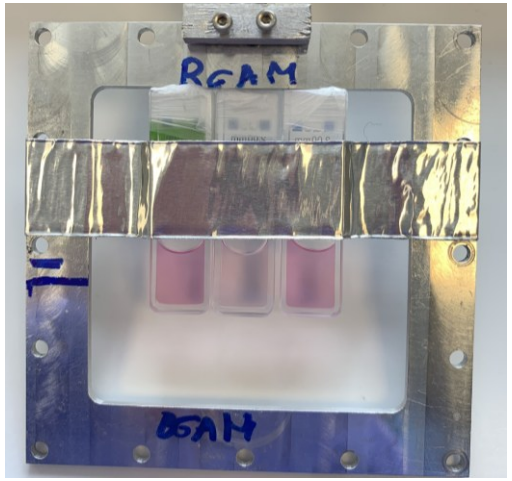
CIEMAT (Madrid)

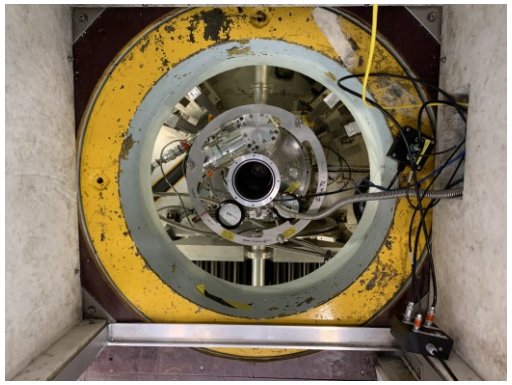






ISIS (UK)

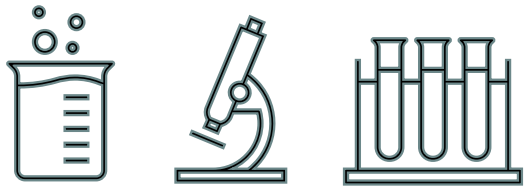






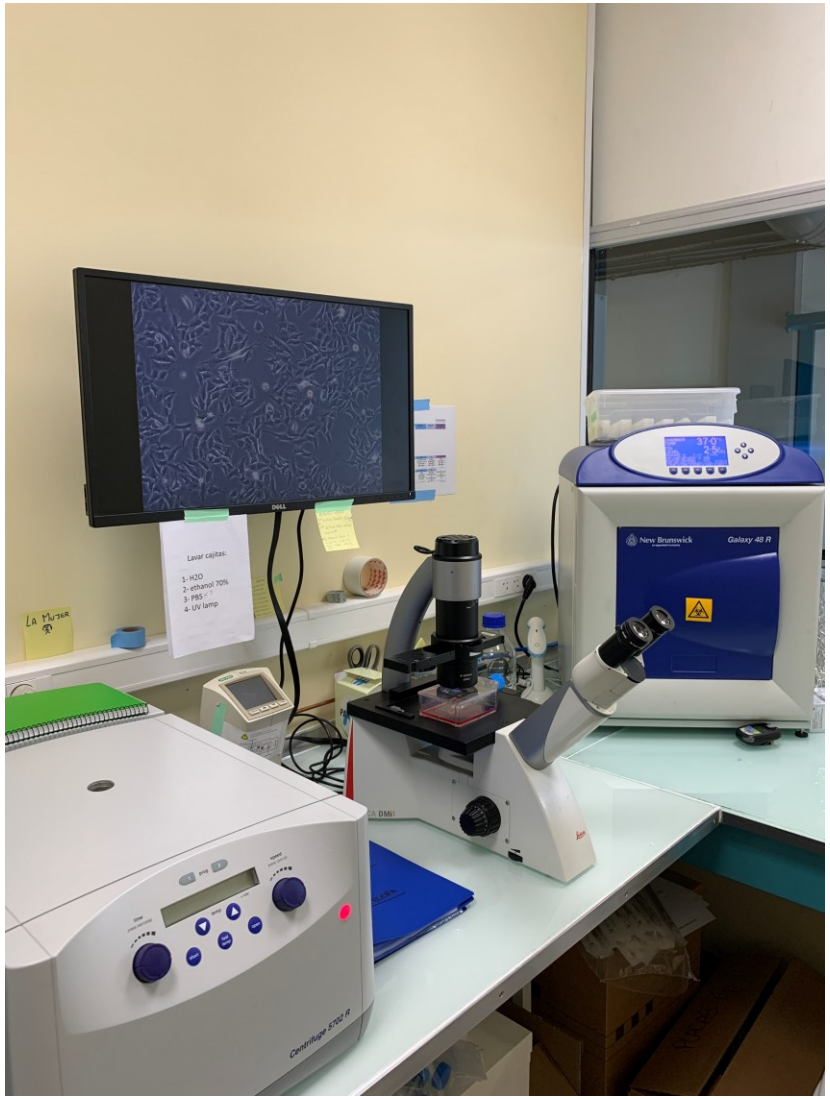
(Grenoble, France)

Installation of a 4 m² bio-laboratory inside the nuclear reactor



Institute Laue-Langevin (France)

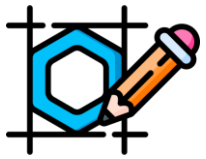




LIMITATION



There is a **lack** of operational **neutron sources** suitable for **radiobiology studies**. This is due to the global trend toward decommissioning many of the nuclear reactors



Despite the valuable facilities we have used, radiobiology studies were not considered during their initial design. Consequently, these facilities present significant constraints when attempting to perform this type of experimental work





That is why it is essential to have new neutron sources available to carry out this type of research, in order to advance in both neutron radioprotection and neutron-based therapies

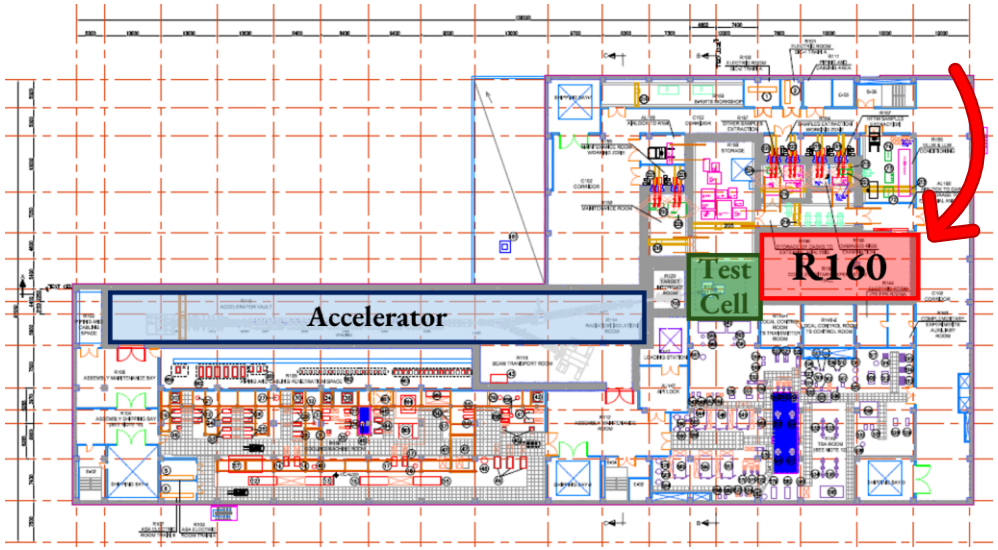


DONES **opens up unique opportunities** to advance in the study of the **radiobiological** effects of **neutrons**

Objectives

- To identify the most suitable room for cells irradiations
- To design a Radiobiology Laboratory within the IFMIF-DONES facility equipped with the necessary material

1 Evaluation of the facility layout to identify the **optimal room for sample irradiation**



Luque et al., 2025

- Continuous high neutron flux
- Beam diameter ~ 8 cm

2 **Designing a radiobiology laboratory** and study the best place to site it

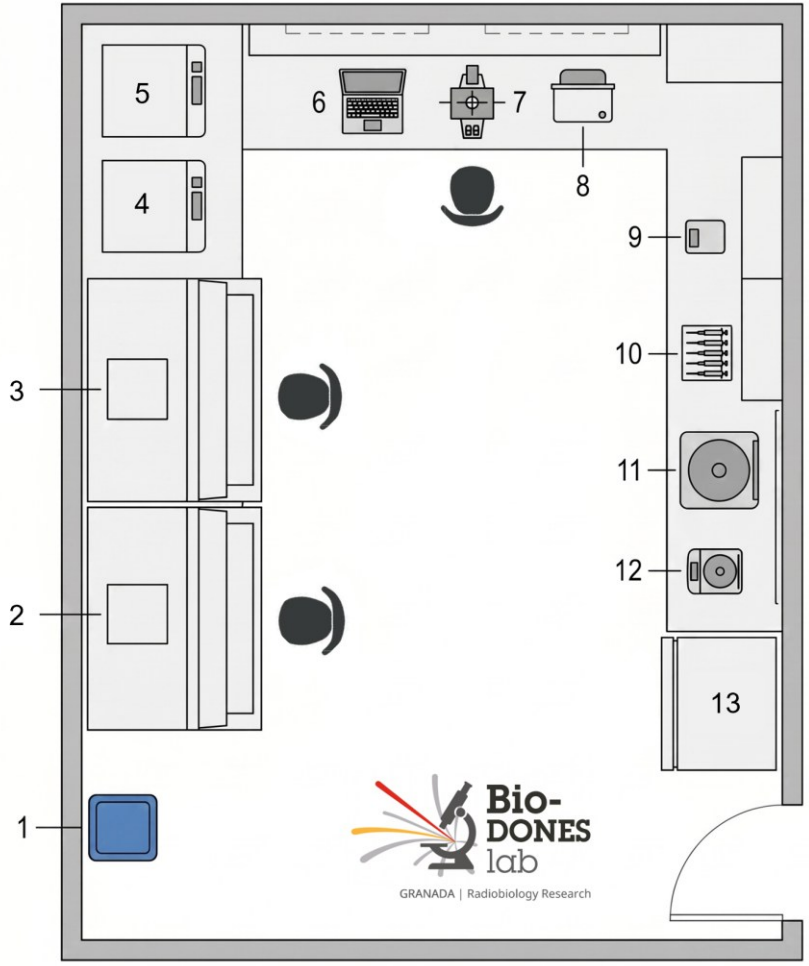
Evaluation of the location of the laboratory based on two main criteria:

- **Radiological safety:** handling of radioactive samples.
- **Physical proximity to the irradiation room:** quick processing of the biological samples and study early endpoints (such as DNA damage)

Bio-DONES lab
GRANADA | Radiobiology Research

Main Building – Basement floor (-1)

2 **Design a radiobiology laboratory** and study the best place to site it



LEGEND

1. Biological Waste Container
2. BSC Class II (Unit 1)
3. BSC Class II (Unit 2)
4. CO_2 Incubator 1
5. CO_2 Incubator 2
6. Laptop Computer
7. Inverted Microscope
8. Water Bath
9. Vortex Mixer
10. Micropipette Set
11. Benchtop Centrifuge
12. Microcentrifuge
13. Refrigerator (4°C)
    Freezer (-20°C)



Proposed design for the Bio-DONES lab

First preliminary proposal!

It will require iterative revisions, and it will need to be confirmed once the facility becomes operational.





DONES will bridge a critical gap in neutron radiobiology

- The biological effects of 14 MeV neutrons remain largely unstudied.
- By using moderators and filters, irradiations can be conducted across a wide range of energy spectra.
- The high neutron flux and larger beam diameter will significantly increase sample throughout, expanding our overall research scope.

To conclude…

1. Understanding the radiobiological effects of **neutrons** is essential for **radioprotection** and **neutron-based therapies**.
2. The advance in this **research field** progress has been limited by the decommissioning of traditional nuclear reactors.
3. **IFMIF-DONES** offers a unique facility to **overcome this limitation** and carry out radiobiology studies that have not been possible.
4. This work provides a **conceptual framework** for biological sample irradiation at DONES, alongside a proposal for an on-site **radiobiology laboratory**.



Thanks for your attention!





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HuVn HOSPITAL UNIVERSITARIO VIRGEN DE LAS NIEVES

NEUTRONS FOR SCIENCE Institut Laue-Langevin

ISIS Neutron and Muon Source

Cátedra Universitaria Neutrones para Medicina

IFMIF-DONES ESPAÑA