

## M.SC. IN PHYSICAL SCIENCES

# BIOMEDICAL PHYSICS

- General link :

<https://scienzefisiche.cdl.unipv.it/en>

- Link Biomedical Physics :

<https://scienzefisiche.cdl.unipv.it/en>

- Presentation webinar :

[https://thestudyabroadportal.com/open-day/biomedical-physics-at-the-university-of-pavia-exploring-the-life-phenomenon-through-the-principles-of-physics/?utm\\_source=University/](https://thestudyabroadportal.com/open-day/biomedical-physics-at-the-university-of-pavia-exploring-the-life-phenomenon-through-the-principles-of-physics/?utm_source=University/)

- More information :

[https://apply.unipv.eu/en\\_GB/courses/course/172-masters-program-physical-sciences--biomedical-physics-curriculum](https://apply.unipv.eu/en_GB/courses/course/172-masters-program-physical-sciences--biomedical-physics-curriculum)

<https://fisica.cdl.unipv.it/en/node/185>

<https://scienzefisiche.cdl.unipv.it/it/informazioni-pratiche/guida-dello-studente/guida-dello-studente-laurea-scienze-fisiche-202425>

- Study plan :

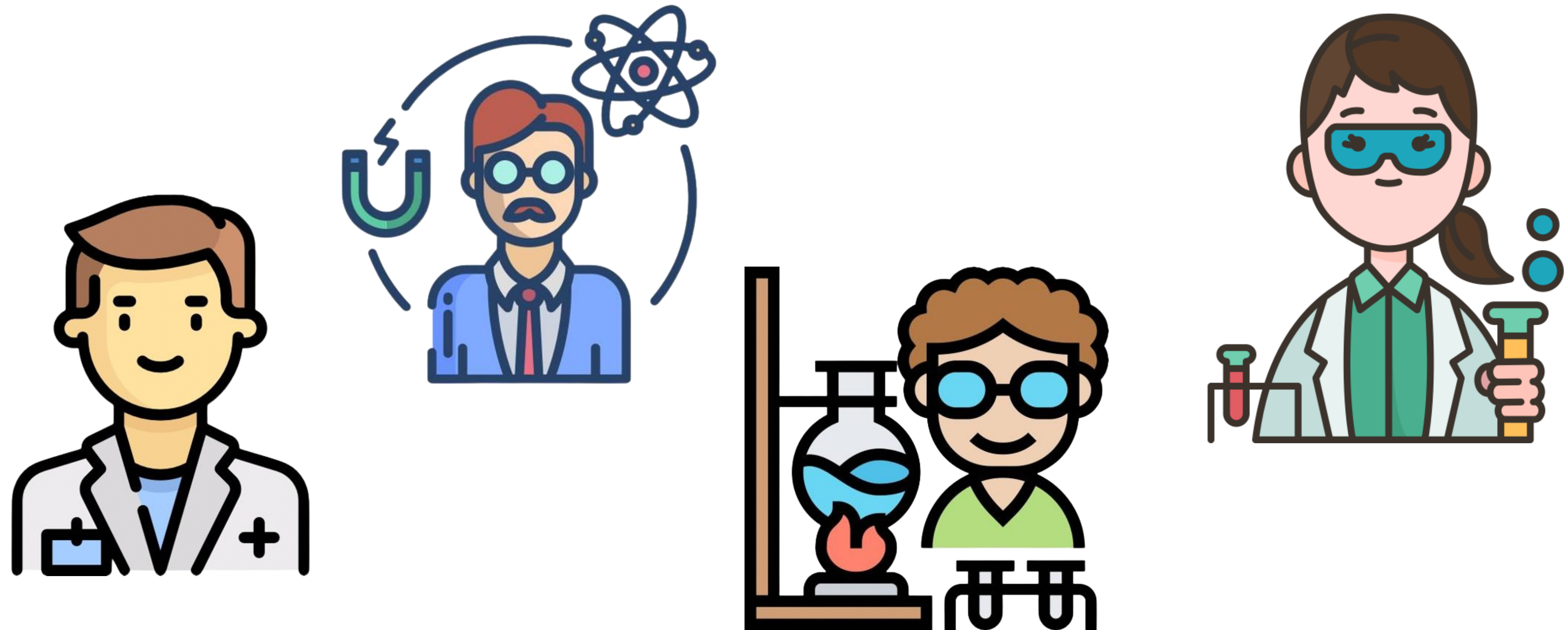
<https://scienzefisiche.cdl.unipv.it/en/practical-information/study-plan>

# BIOMEDICAL PHYSICS

IT IS A MULTIDISCIPLINARY FIELD THAT APPLIES PRINCIPLES AND TECHNIQUES OF PHYSICS TO THE STUDY OF MEDICINE, BIOLOGICAL SYSTEMS AND PHENOMENA

BIOLOGY  
MEDICINE  
CHEMISTRY  
ENGINEERING  
MATHEMATICS  
INFORMATICS  
STATISTICS

.....



...to advance physics knowledge, technology, biomedical science and healthcare!

MEDICAL DIAGNOSTIC AND THERAPEUTIC TECHNIQUES ARE ADVANCING AT A HIGH RATE

WHEN RADIATION (IONIZING AND NOT) IS USED IN MEDICINE, PHYSICISTS PLAY A PIVOTAL ROLE



## WHY PHYSICISTS IN THE BIOMEDICAL FIELD?

PHYSICISTS BRING CRUCIAL TECHNICAL AND THEORETICAL SKILLS, ENHANCING COLLABORATION WITH PROFESSIONALS SUCH AS PHYSICIANS, ENGINEERS, BIOLOGISTS, MATHEMATICIANS, CHEMISTS, STATISTICIANS, INFORMATICIANS AND OTHERS.

# BIOMEDICAL PHYSICS PROGRAM

THE PROGRAM FOCUSES ON THE USE OF BASIC AND APPLIED RESEARCH IN :

## MEDICAL DIAGNOSTICS

IMAGING TECHNIQUES  
MRI - CT - PET - SPECT -  
ULTRASOUNDS

MEDICAL SENSORS

## CLINICAL THERAPY

CANCER THERAPIES  
CONVENTIONAL & NEW  
RADIOTHERAPY TECHNIQUES

hadron therapy  
neutron capture therapy  
hyperthermia

## HEALTH PROTECTION

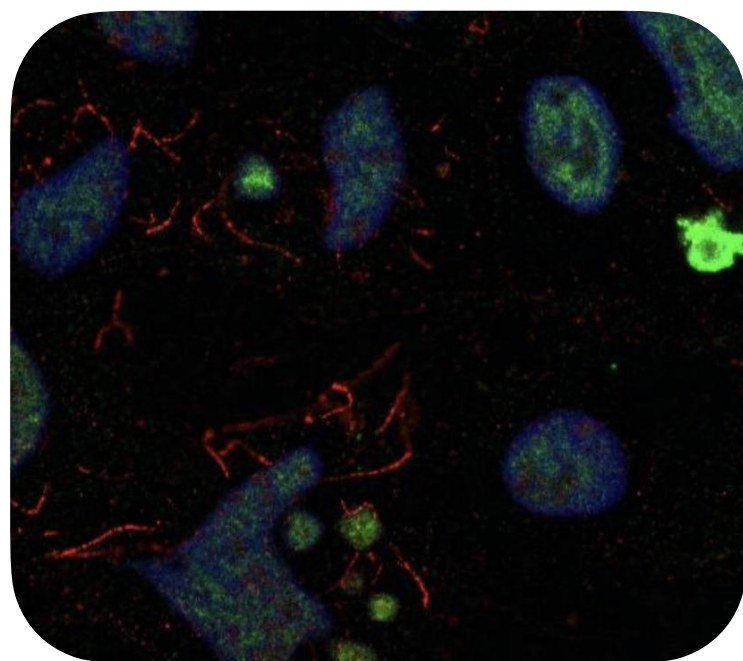
DOSIMETRY  
RADIATION PROTECTION  
RADIATION BIOLOGY

***PHYSICAL PRINCIPLES AND MODELS***

# SKILLS ACQUIRED

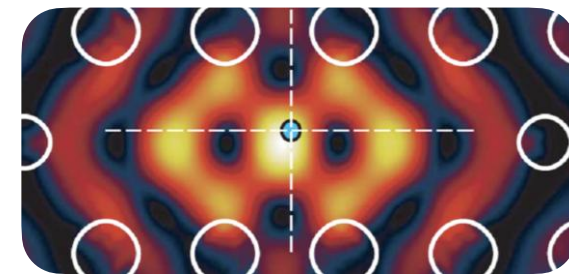
## PHYSICAL & BIOLOGICAL KNOWLEDGE

PRINCIPLES AND MODELS  
BIOMARKERS  
RADIOBIOLOGY



## PHYSICAL TECHNIQUES

NUCLEAR PHYSICS  
SOLID-STATE PHYSICS



## INSTRUMENTATION

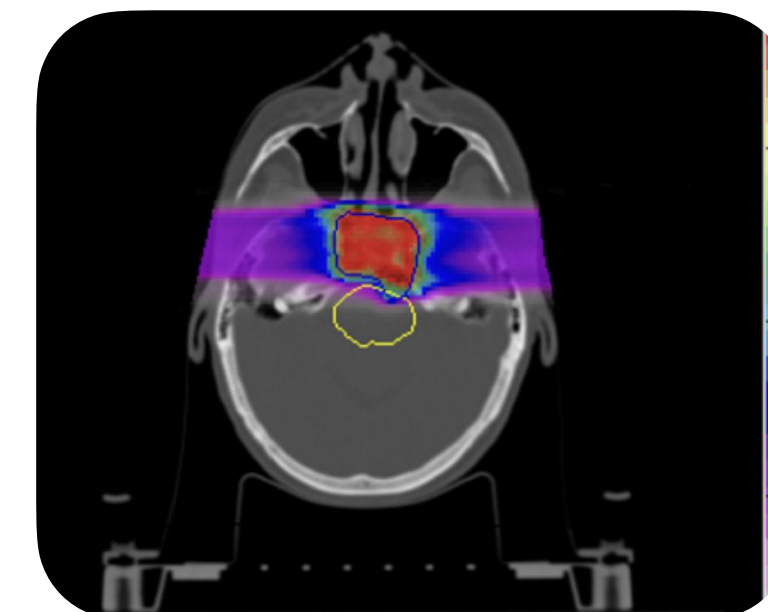
DIAGNOSTICS INSTRUMENTS

DETECTORS  
DOSIMETERS



## MATHEMATICAL & COMPUTATIONAL METHODS

SIMULATIONS  
PHYSICAL MODELS  
AI  
STATISTICS



## EXAMPLES OF OUR RESEARCH LABS

### Radiobiology Laboratory

(G Baiocco, I Guardamagna)

*Cellular/Molecular biology*, in vitro cells and ex-vivo (from patients). Measurements and models of the effects of ionizing radiation on biological structures (e.g.: DNA damage and repair, cell-to-cell communication, immune system response)



### Ionizing Radiation Laboratory

(N Protti)

Use of scintillation detectors, solid-state detectors and instrumentation used in health/environmental physics.



### NMR/MRI & SQUID Lab: MRI, nuclear hyperpolarization, nanoparticles for theranostics

(F Brero, P Carretta, M Filibian, A Lascialfari, M Mariani, G. Prando)

Hyperpolarization technique and use of magnetic nanoparticles to enhance MRI images contrast → more effective and/or personalized diagnosis

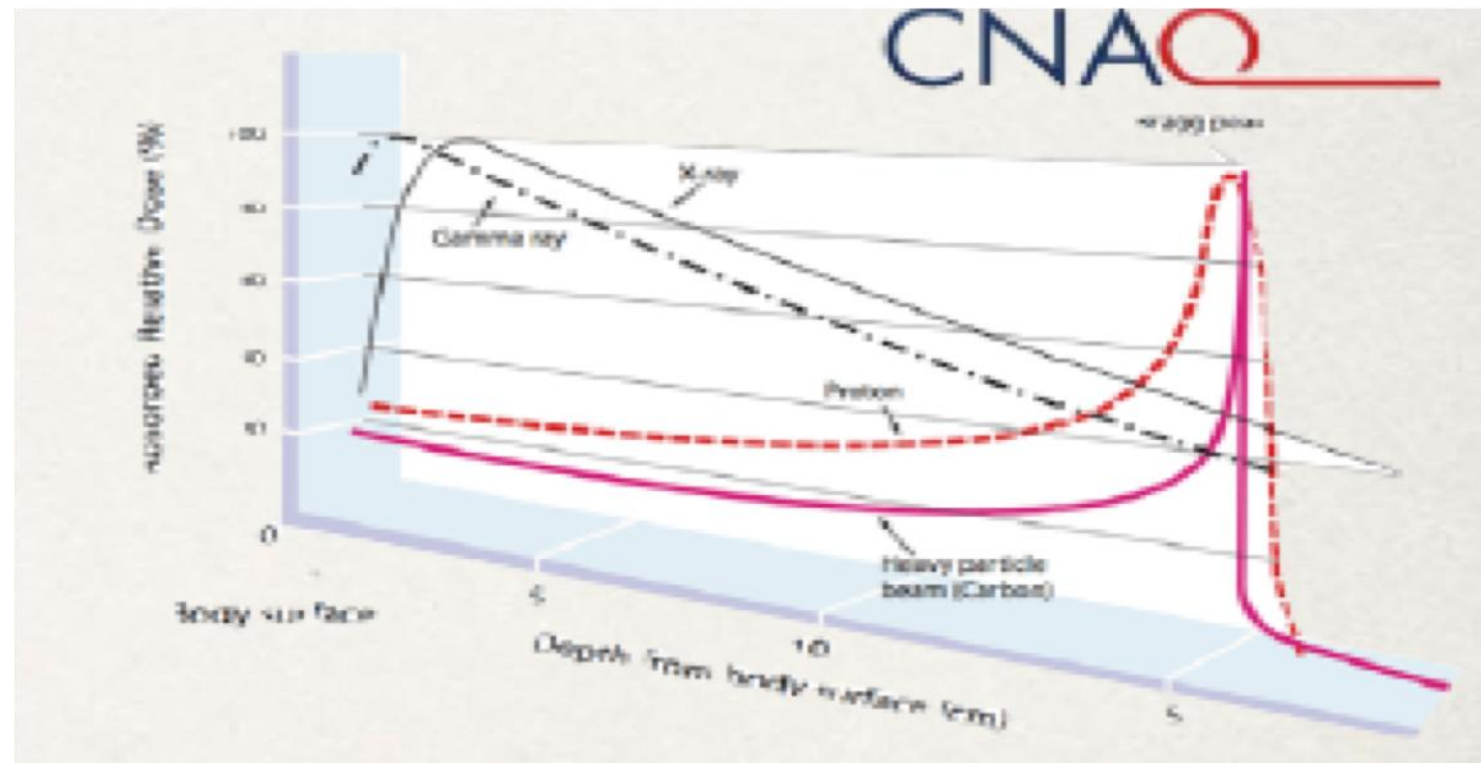


# EXAMPLES OF OUR RESEARCH ACTIVITIES (ONCOLOGIC THERAPY)

## Simulations for Hadron Therapy

(F Ballarini, M Carante, R Ramos)

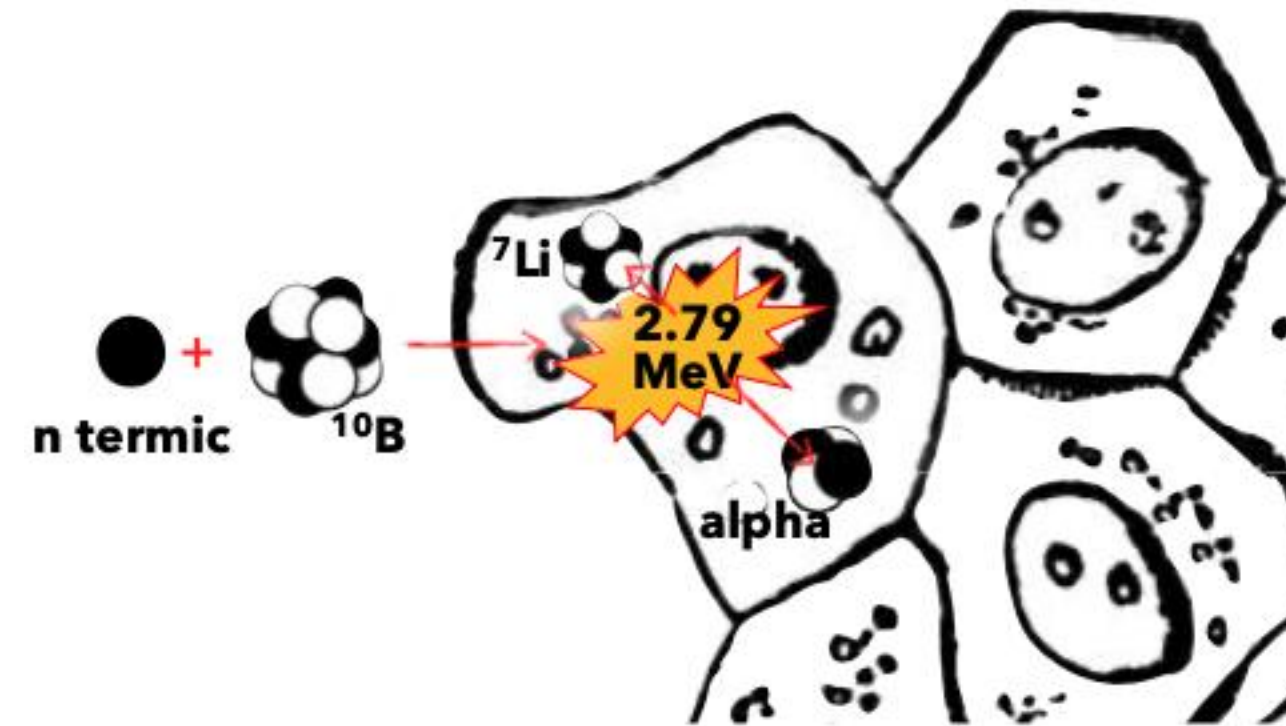
Calculation of effectiveness in eliminating tumor cells (and the probability of damaging healthy cells) for ion beams used in hadron therapy (protons, C ions, and He ions)



## Boron Neutron Capture Therapy

(S Bortolussi, N Protti, I Postuma, S Fatemi)

Cell-selective radiotherapy via neutron capture on  $^{10}\text{B}$



## Magnetic Fluid Hyperthermia

(F Brero, A Lascialfari, M Mariani, P Carretta)

A technique that uses magnetic nanoparticles with therapeutic properties, thanks to the local release of heat that weakens tumor cells

Optimization of cancer therapy with in-vitro experiments, mathematical modeling, bioinformatics analysis of -omics data  
(G Baiocco, I Guardamagna)

## Plasmonic nanostructures for photothermal therapy and SERS imaging

(M Patrini, P Galinetto)

### INTERNATIONAL GEANT4 SCHOOL

*Free participation for LM students !!*

Educational event aimed at exploring the advancements of the Geant4 toolkit in the field of medical physics with special lectures dedicated to Geant4\_DNA.

<https://agenda.infn.it/event/37741/>

# EXAMPLES OF OUR RESEARCH ACTIVITIES (DIAGNOSTICS)

## Magnetic Resonance Imaging (MRI)

(F Brero, P Carretta, M Filibian, A Lascialfari, M Mariani)

Research on new materials, software, and technology for MRI for diagnostic and therapeutic purposes



## Radioisotopes for theranostics

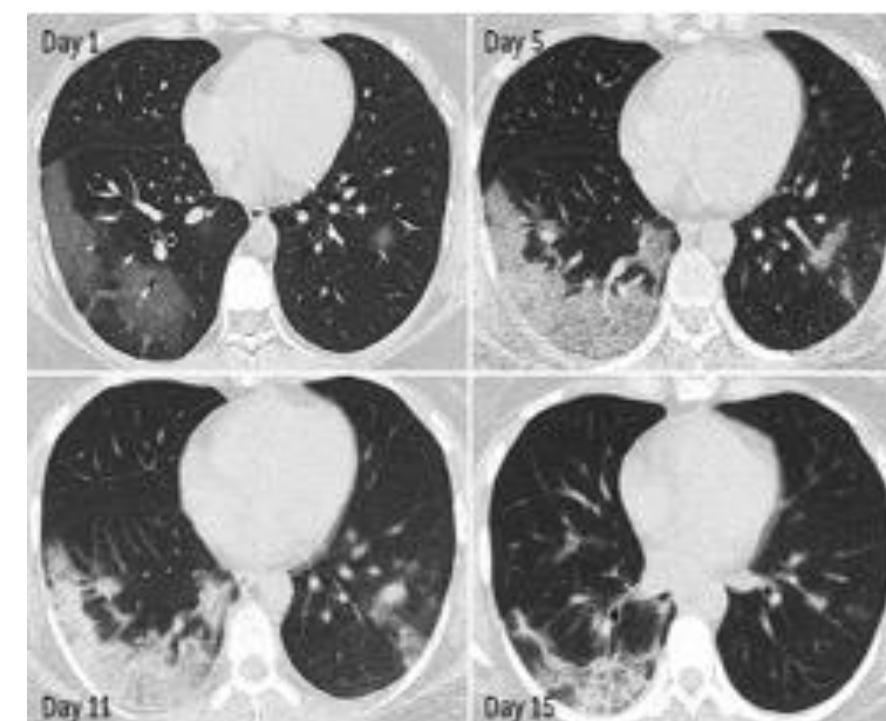
(A Fontana, M Carante)

Study of cross sections for the identification of new radioisotopes suitable both as therapeutic agents and as diagnostic agents.

## Imaging data analysis, Artificial Intelligence, and Radiomics

(F Brero, S Bortolussi, S Fatemi, M Filibian, A Lascialfari, I Postuma)

Physical/statistical analysis of diagnostic images to obtain quantitative information on disease progression



## Production of radioisotopes for imaging

(LENA –Applied Nuclear Energy Laboratory)

The LENA cyclotron produces F-18 daily, used for PET (Positron Emission Tomography) imaging



# EXAMPLES OF OUR RESEARCH ACTIVITIES (RADIO-PROTECTION)

## Radiation protection in industry

(E Giroletti)

Issues relating to the use of radiation in industry and the consequent radiation protection of workers are addressed



## Radiation protection in space

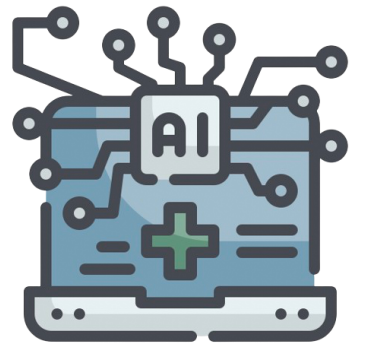
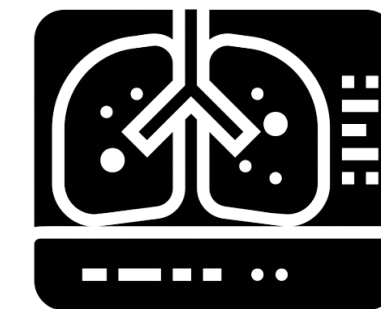
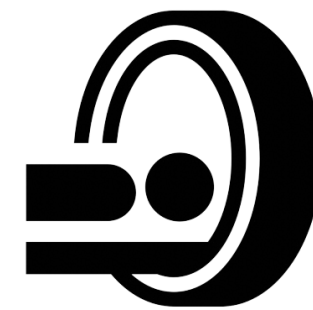
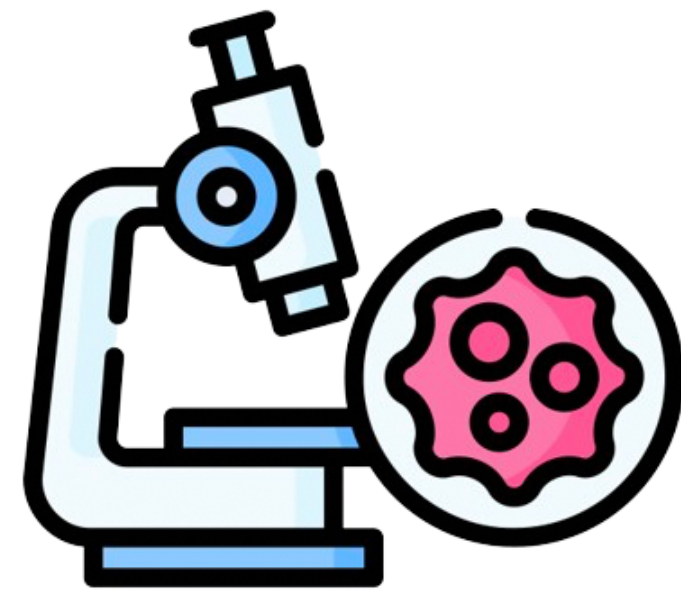
(G Baiocco, I Guardamagna, F Ballarini, M Carante, R Ramos)

Dose calculations to astronauts in various space radiation exposure scenarios, with attention to the role of shielding



# AN EXAMPLE OF RESEARCH TOPICS (SKILLS ACQUIRED)

## RESEARCH IN ONCOLOGY



AN IMPORTANT COLLABORATION  
WITH NATIONAL INSTITUTE FOR  
NUCLEAR PHYSICS



IMAGING

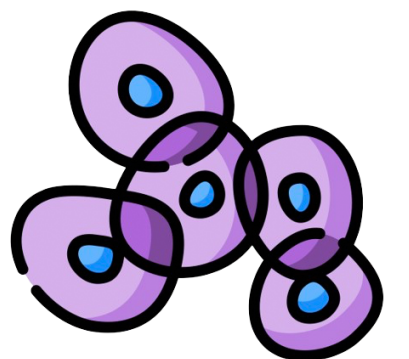
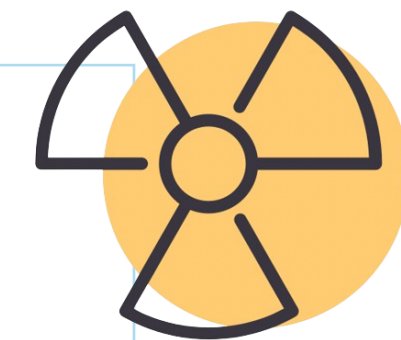
IMAGE ANALYSIS AND TREATMENT (AI)

SENSORS FOR BIOMARKERS

INNOVATIVE RADIATION TREATMENTS

EFFECTS AT CELLULAR AND SUBCELLULAR LEVEL

COMPUTATIONAL RADIOBIOLOGY & BIOPHYSICS



**ENTIRELY IN ENGLISH**

# STUDY PLAN – 120 ECTS – 2 YEARS

1 ECTS credit = 1 CFU credit

**48 CFU** (of which : 6 CFU in FIS/02 or FIS/08, 1 class ; 12 CFU in FIS/04 or FIS/03, 2 classes ; 30 CFU in FIS/01 or FIS/07, 5 classes ) **to be acquired by 8 classes from the following table:**

Nome insegnamento	Sector	CFU	Semester
Quantum electrodynamics *	FIS/02	6	I
Computational methods in Physics *	FIS/02	6	II
Particle physics *	FIS/04	6	I
Physics of ionizing radiations *	FIS/04	6	I
Laboratory of ionizing radiations *	FIS/04	6	II
Statistical methods in physics *	FIS/01	6	I
Artificial Intelligence for Experimental and Applied Physics *	FIS/01	6	II
Particle detectors *	FIS/01	6	II
Rheology and Diagnostic Techniques: Theory and Practice *	FIS/07	6	I
Physics of innovative oncological therapy techniques *	FIS/07	6	I
Simulations in experimental and applied physics *	FIS/07	6	I
Physics of medical imaging *	FIS/07	6	I
Medical diagnostic techniques with ionizing radiations *	FIS/07	6	II
Introduction to ionizing radiation protection *	FIS/07	6	II

**12 CFU, 2 classes, from the following table :**

Nome insegnamento	Settore	CFU	Semestre
General biology, anatomy and human physiology	BIO/06	6	I
Radiation biophysics and radiobiology	MED/36	6	II
Machine learning	ING-INF/05	6	II
MRI Physics for Neuroscience	M-PSI/02	6	II
Bioinformatics	ING-INF/06	6	II

**12 CFU, 2 classes, to be acquired with electives.**

*For example one can choose transversal classes :*

Agile Project Management	3 CFU - II semester
Entrepreneurship	3 CFU – I semester
Italian language for foreign students	3 CFU – II semester
Presentation making	3 CFU – II semester

**36 CFU Thesis training**

**6 CFU Other activities**

**6 CFU Final exam**

## THESIS & INTERNSHIPS - COMPANIES AND HOSPITALS

STELAR SRL

LENA

FONDAZIONE CNAO

OTHER HOSPITALS

BRACCO SPA

BRUKER SRL

National/International networks of research groups  
*(also within collaborations for Italian/European Projects)*

LM+

INTERNSHIP AT CENTERS/COMPANIES

Prof. Pietro Galinetto - Coordinator ([pietro.galinetto@unipv.it](mailto:pietro.galinetto@unipv.it))

EXAMPLES : BRACCO IMAGING - FONDAZIONE CNAO

# AFTER THE MASTER'S DEGREE?

PhD

With possibility to stay abroad up to 1.5 years ([daniela.rebuzzi@unipv.it](mailto:daniela.rebuzzi@unipv.it))  
*Double PhD with Universidad San Martin – Buenos Aires*

SPECIALIZATION SCHOOL IN  
MEDICAL PHYSICS

To work in hospital/health facilities

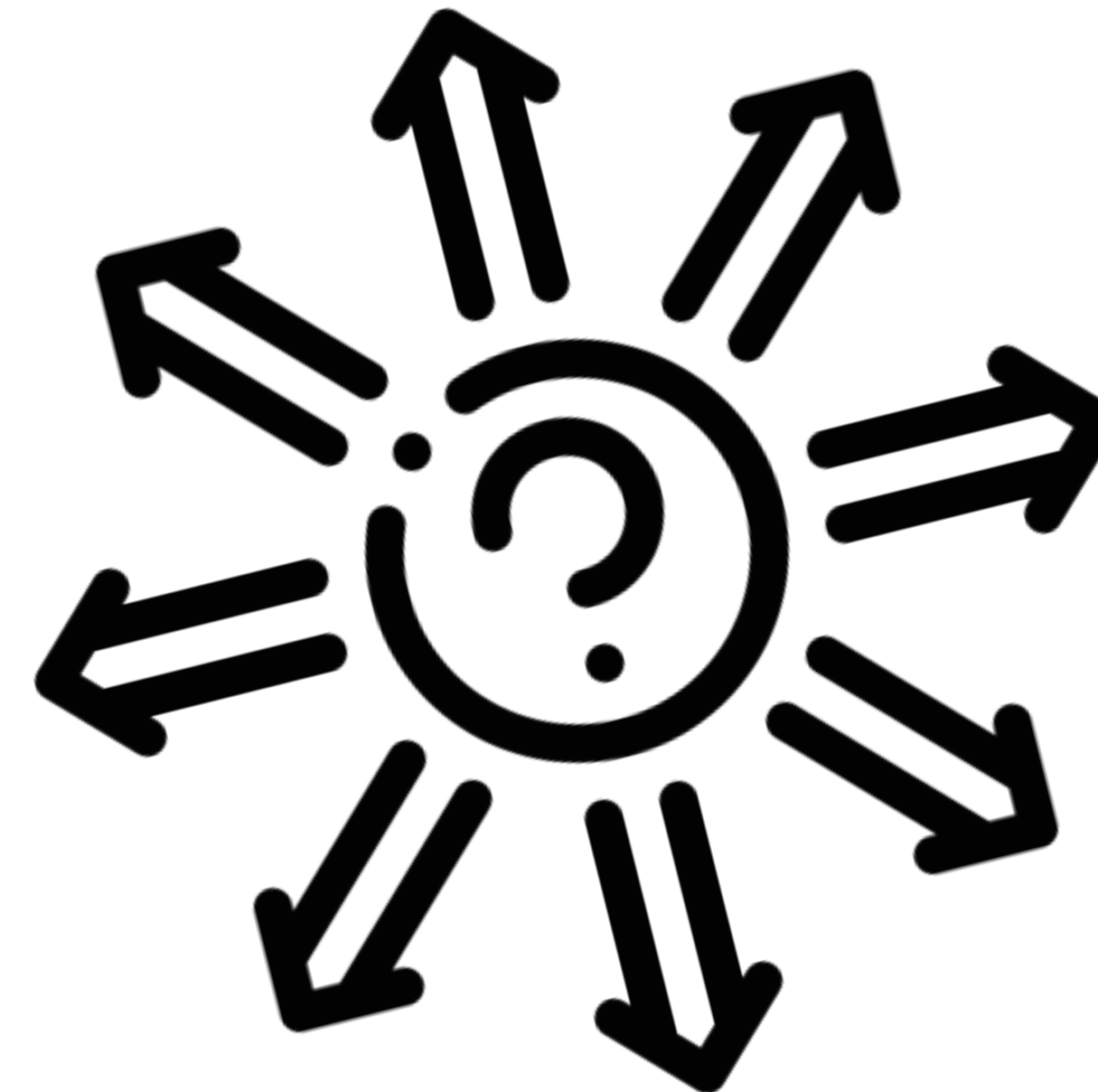
RADIATION PROTECTION  
EXPERT

COMPANIES

developing medical technologies

FREELANCE  
& CONSULTING

...and more!



SECONDARY AND  
HIGH SCHOOL TEACHING

2° LEVEL MASTER DEGREE ([asalvini@unipv.it](mailto:asalvini@unipv.it),  
[nicoletta.protti@unipv.it](mailto:nicoletta.protti@unipv.it))

to carry on tasks regarding radiation  
safety compliance

<https://lena.unipv.it/en/master-of-radiation-protection/>

**DO YOU WANT TO KNOW MORE ?**  
**...FEEL FREE TO CONTACT US!**

**TEACHING STAFF**

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[ian.postuma@pv.infn.it](mailto:ian.postuma@pv.infn.it)  
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THE END