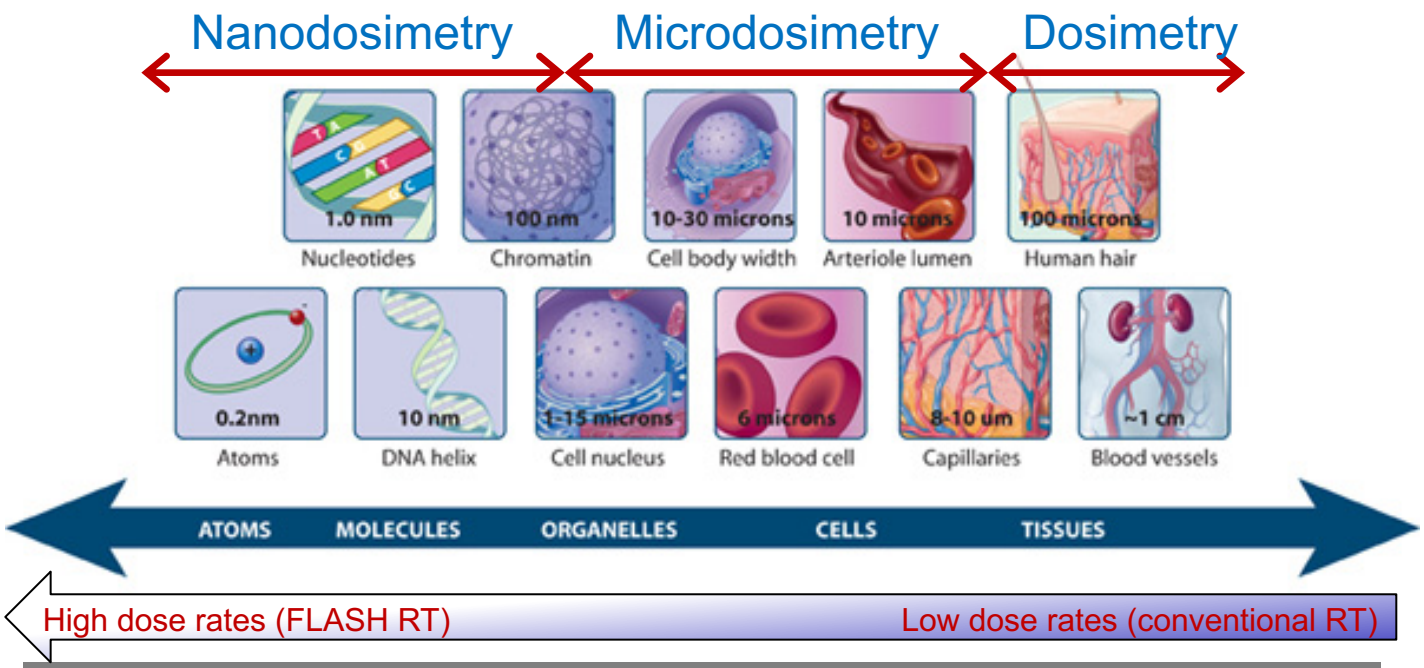
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia

Development of new instruments and methods for dosimetry in proton therapy

// Jorge Sampaio on behalf of the **Dosimetry group**

Relate physical quantities to biological effects



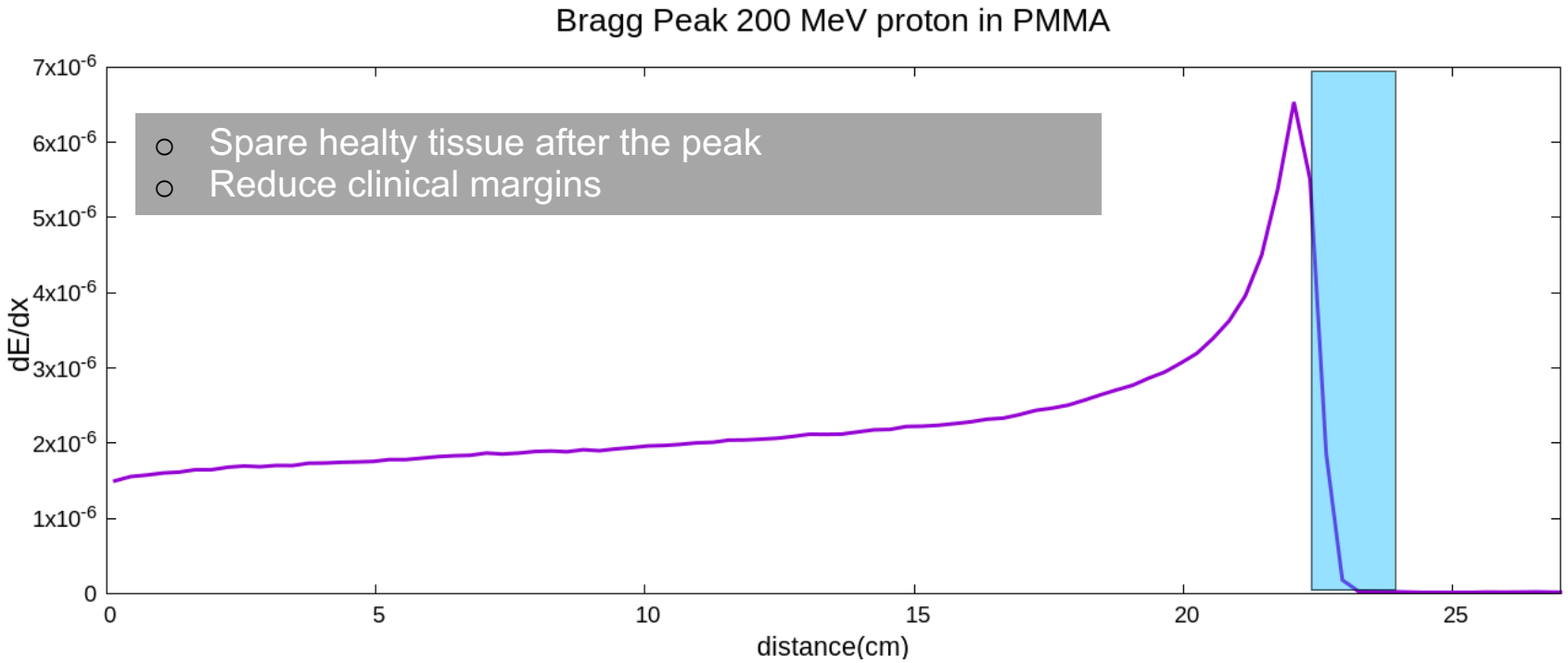
// Measure energy deposition structure at subcellular scale;

// Measure doses at high rates (> 40 Gy/s) and simulate the effects;

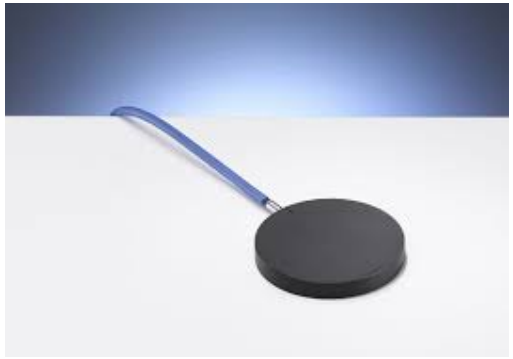
// Model and simulate radiation effects in biological systems.

Proton dosimetry

// Measure the Bragg peak with good accuracy

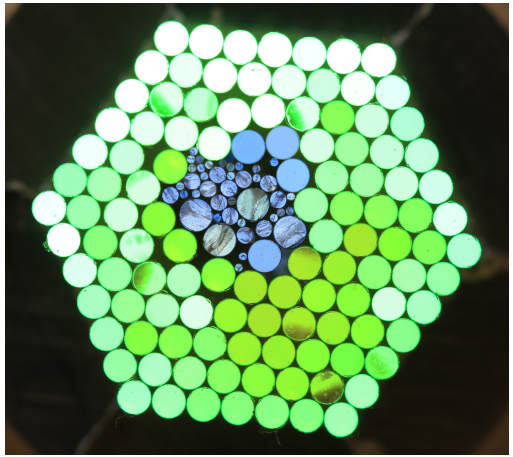


Proton dosimetry



// Plane-parallel chambers (Waterproof PTW 34073)

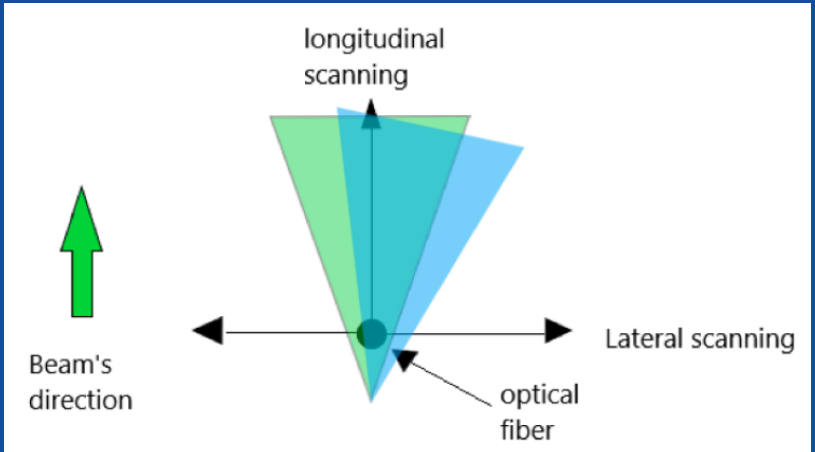
- Air-filled chamber;
- Tissue-equivalente window (PMMA, grafite and varnish);
- SV depth: 2 mm; Radius: 19.8 mm;
- 95% saturation dose rate: 21 Gy/s; 0.9 mGy/pulse



// Plastic Scintillating Fibers (PSF)

- Core of plastic material (Polystylene) doped with fluorescente dyes;
- Cladding of plastic material (PMMA)
- Excelent Tissue-equivalence
- Cross-section: 0.2 – 2 mm;
- Cheap.

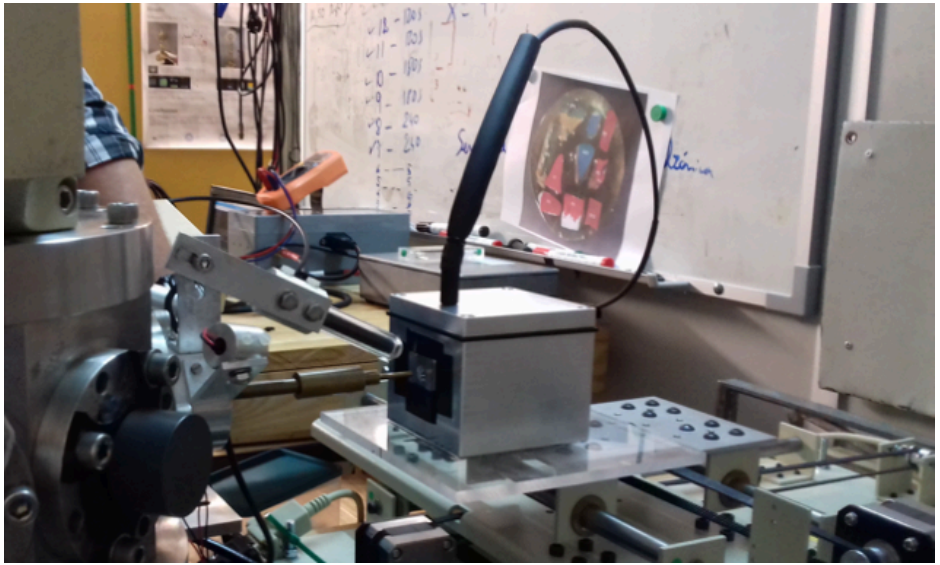
Response of PSF to low energy protons



// Strong dependence in the beam alignment

- Lateral scanning: **Just one direction!**

// Experimental setup



- 2 MeV proton microbeam at **CTN/IST** (5-10% variation**)**;
- Max. current: 1000 pA;
- Irradiation dark box built at **LIP's MW**;
- 250 μm Ag window built **at LIP Thin film & target lab**.
- Stepper motor table.

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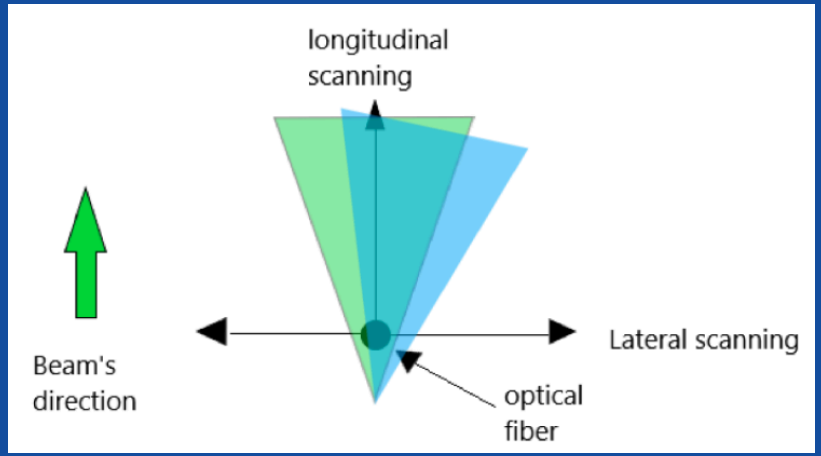
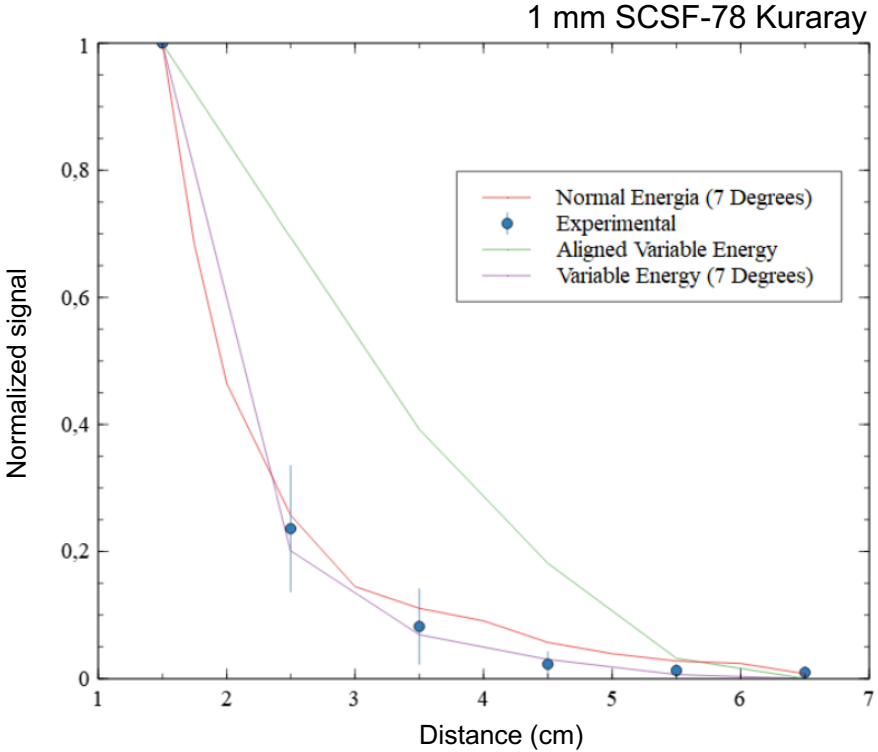
Response of PSF to low energy protons



// Strong dependence in the beam alignment

- Lateral scanning: **Just one direction!**

// Results



- Misalignment: ~7 degrees
- Effect of energy beam spread (1.8 – 2 MeV)

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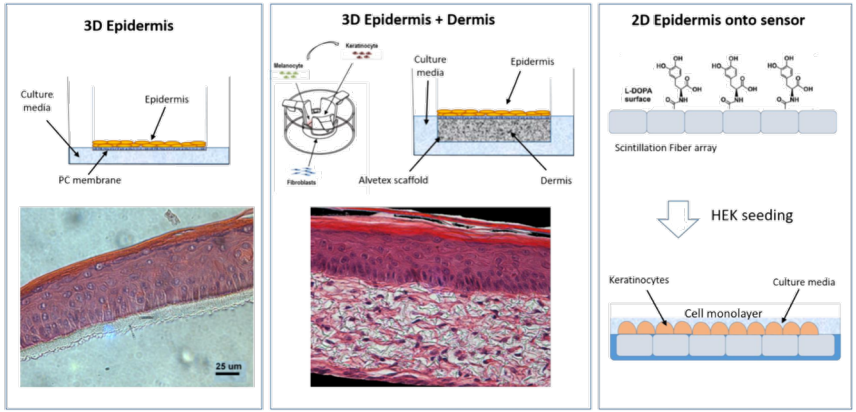
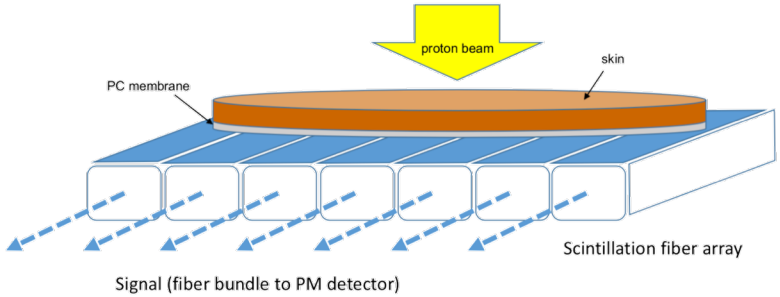
3d-DosSkin Project

- Array of juxtaposed very thin square PSFs;
- Optically coupled to a multi-anode PMT;
- PMMA cladding treated to form a single-molecule-functionalized surface;
- Allow adhesion of the cells to the surface fo the PMMA;
- Human Epidermal Keratinocytes differentiation into mature skin;
- Calibration at the proton beam at the MDACC.

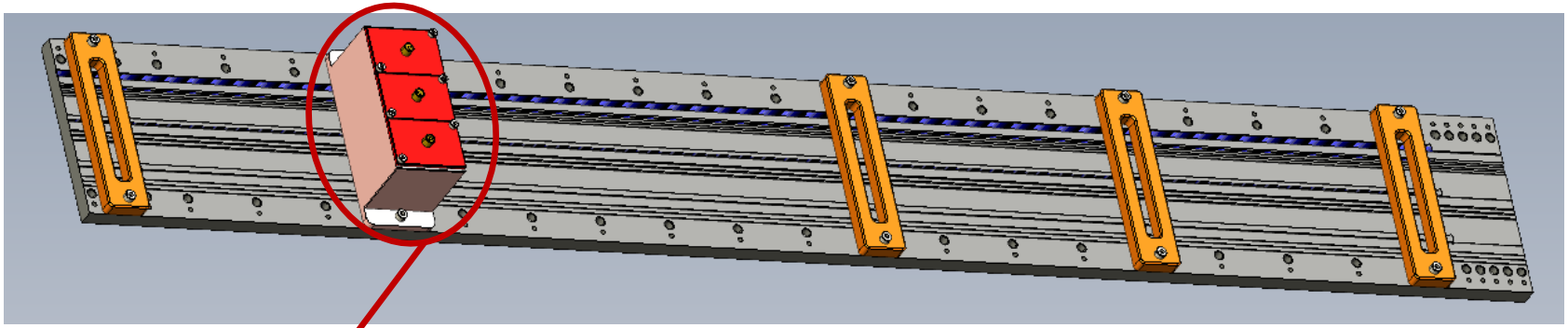
// New detector for high-resolution radiobiology experiments with protons

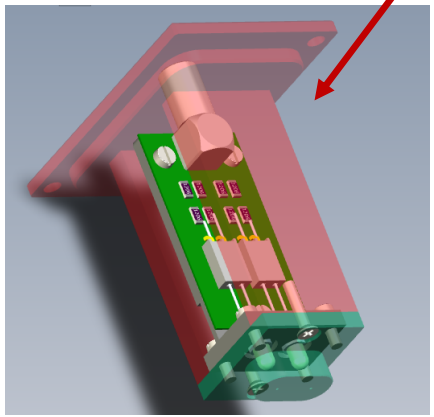


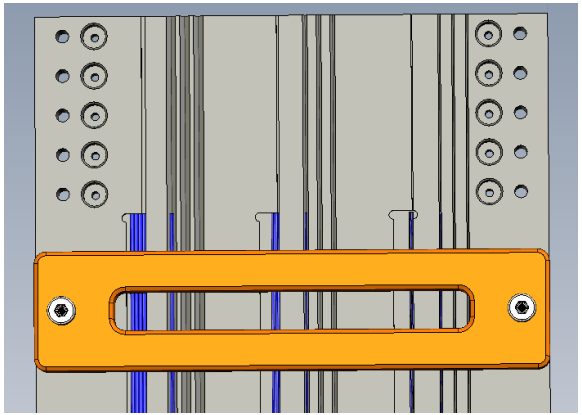


Optical characterization of the fibers

// Development of a testbench for cross-talk tests







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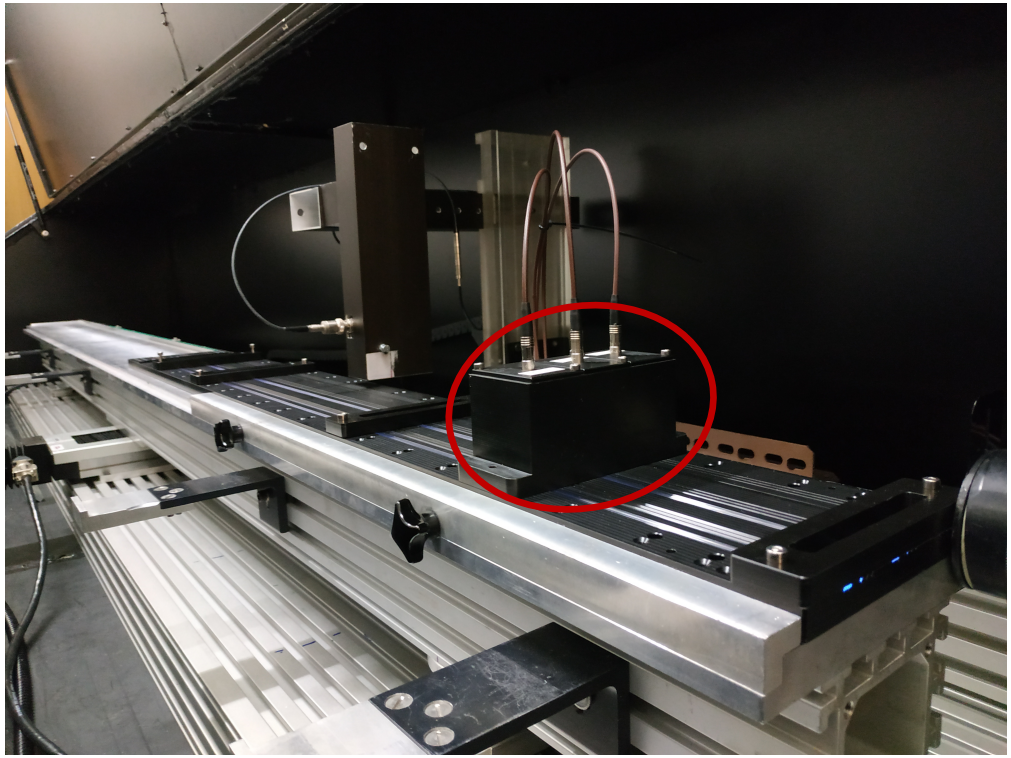
Optical characterization of the fibers

// Development of a testbench for cross-talk tests



- Now built at **LIP's MW;**
- Mounted in the Fibrometer at **LoMAC**.

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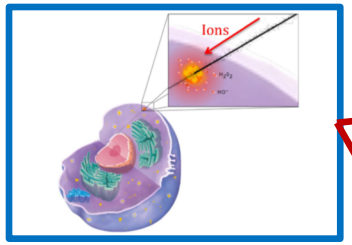
Enhance dose effects in tumour

Reduce dose effects in healthy tissues

// Nanoparticles RT



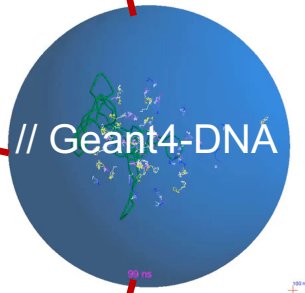
M.Sc. Thesis of J. Antunes, started

TOPAS nBio

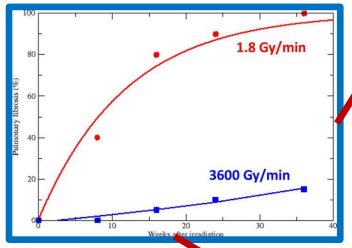
See poster!

// Simulations

- Dose distributions at nm scale
- ROS space-time distributions



// FLASH RT



// Instrumentation

- High-dose rates (> 40 Gy/s)
- Very short pulses (< 500 ms)

- Ionization cross-sections
- Atomic transitions
- Auger emission spectra

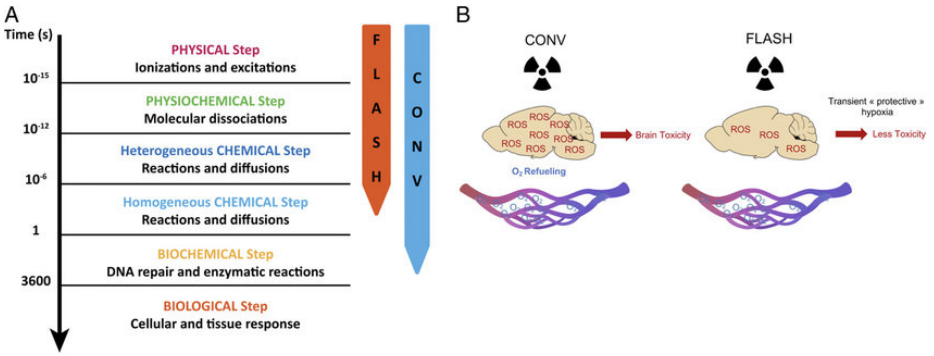
// Fundamental parameters

Proton-FLASH Project

LIP THE UNIVERSITY OF TEXAS MD Anderson Cancer Center

- Implement a new methodology to determine high dose rates;
- Develop a physicochemical simulation of the FLASH effect based on Geant4-DNA;
- Perform radiobiology studies in lung cancer cells and neurons with specific radiation induced markers for different oxygen levels;
- Correlate results with simulations.

// Why FLASH RT works?



FLASH induces rapid depletion of oxygen (transient local hypoxia)

➽ **Reduces radical oxygen species (**ROS

2019 Call for Exploratory Research Projects (ERPs)

UTAustin Portugal

Fundamental parameters

// Improving physics data

- New atomic transitions data shows significant differences to the old data (EADL)
- State-of-the-art calculations are more consistent between them.

M.Sc. Thesis of D. Pires, finishing

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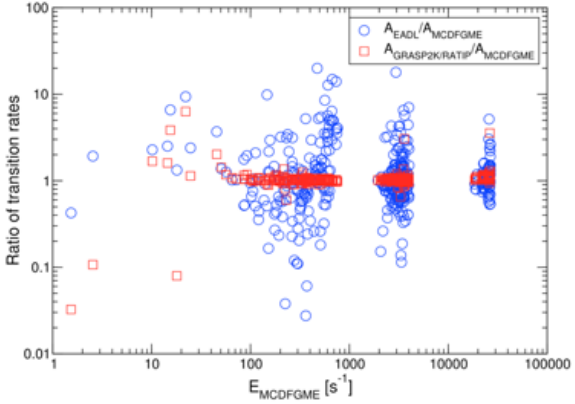

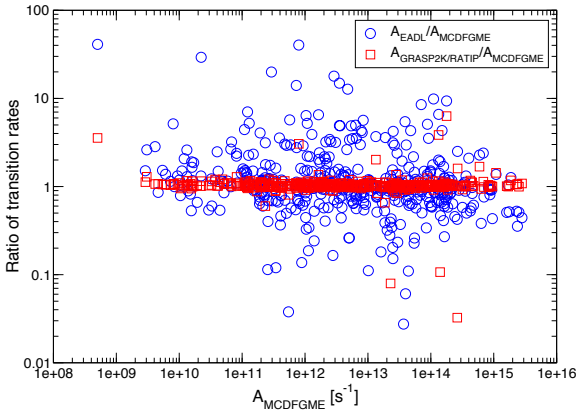

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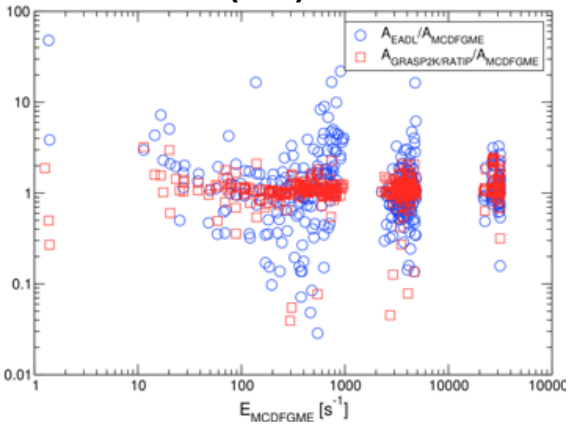

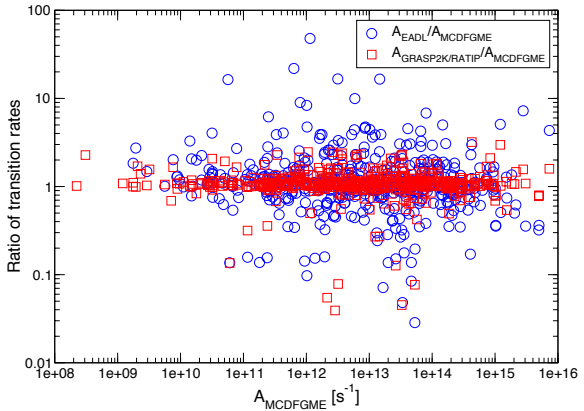

Team

Name	Position	%	Status	Year
Luís Peralta	Group leader	50	Ongoing	
Jorge Sampaio	Researcher	30	Ongoing	
Patrícia Gonçalves	Researcher	10	Ongoing	
João Gentil	Researcher	10	Ongoing	
Pamela Teubig	Ph.D. student	20	Ongoing	
Dalila Mateus	Ph.D. student	50	Ongoing	
Duarte Guerreiro	Master student	100	Finished	2019
José Miguel Venâncio	Master student	100	Finished	2019
Filipa Carvalho	Master student	100	Finished	2019
Ana Campos	Master student	20	Ongoing	
Joana Antunes	Master student	100	Starting	
Catarina Pimenta	Summer student		Finished	2019

Thank you for your attention!