

Optimization of BNCT dosimetry in patients using AI contouring and new radiobiological models

Cristina Pezzi

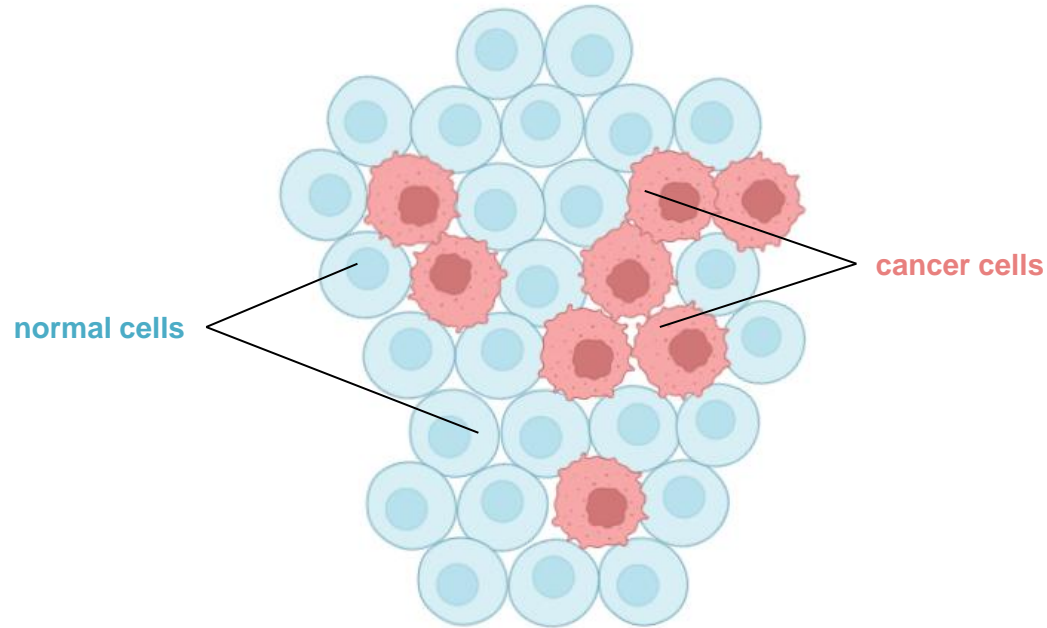
Università degli Studi di Pavia

12th June 2025

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PhD Project by Cristina Pezzi

State of Art : Boron Neutron Capture Therapy (BNCT)

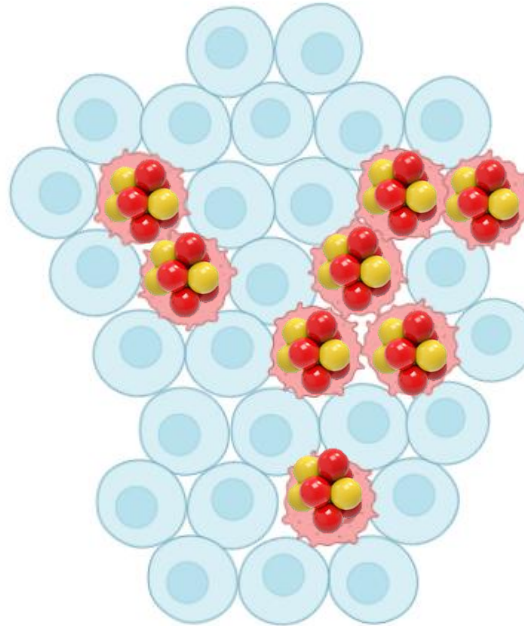


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State of Art : Boron Neutron Capture Therapy (BNCT)

✓ Boron-10 atoms



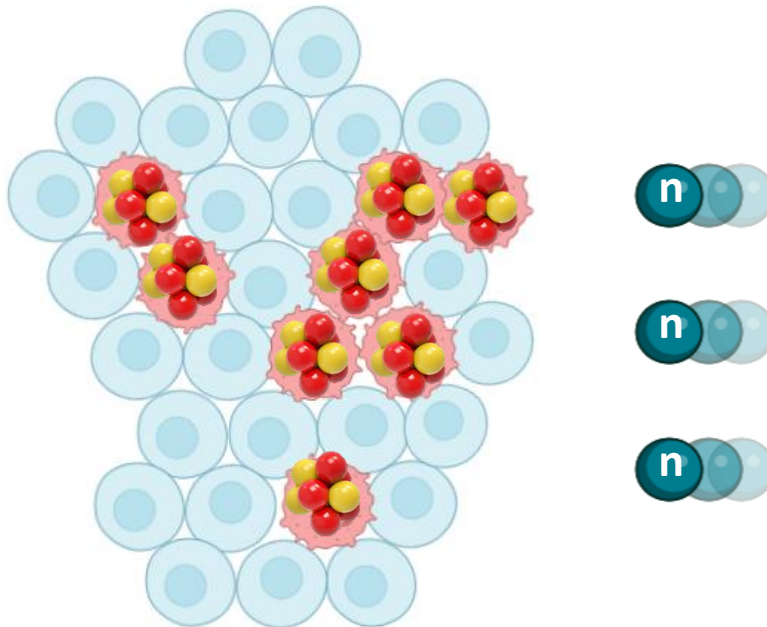
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✓ Thermal
neutron beam



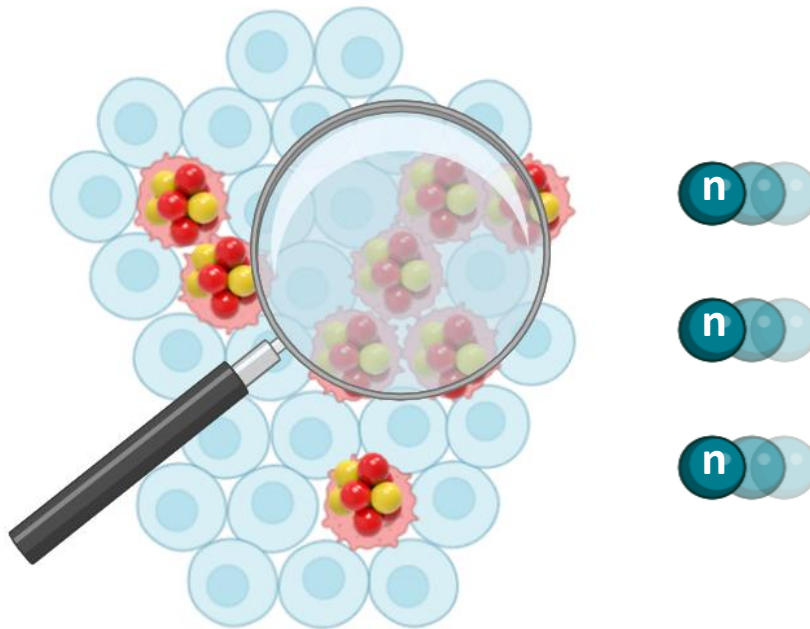
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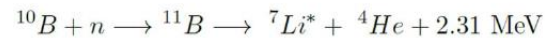
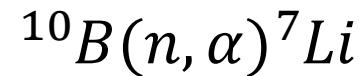
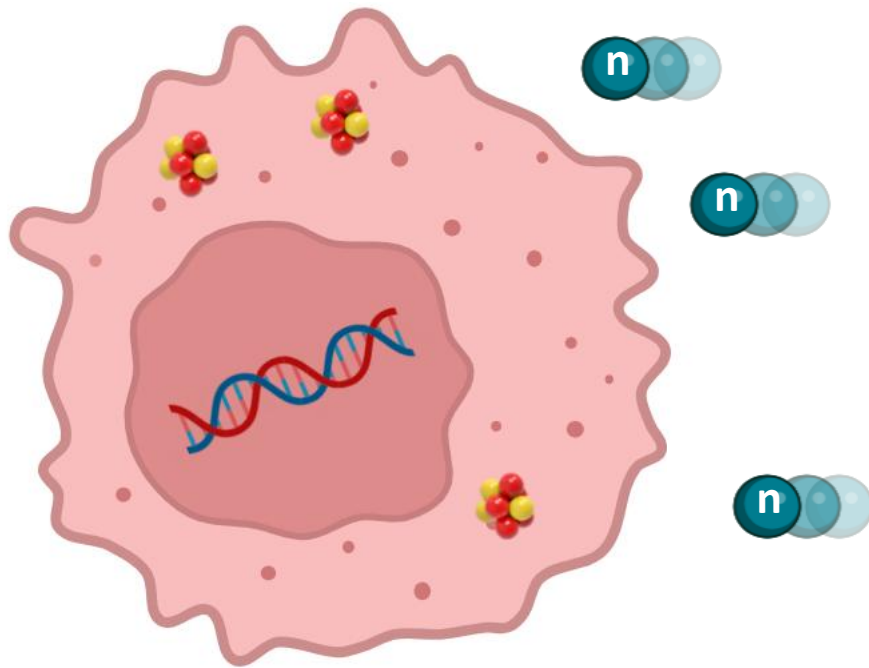
✓ Thermal
neutron beam



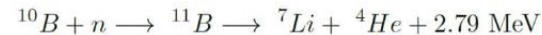
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[BR = 93.9%]

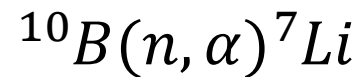
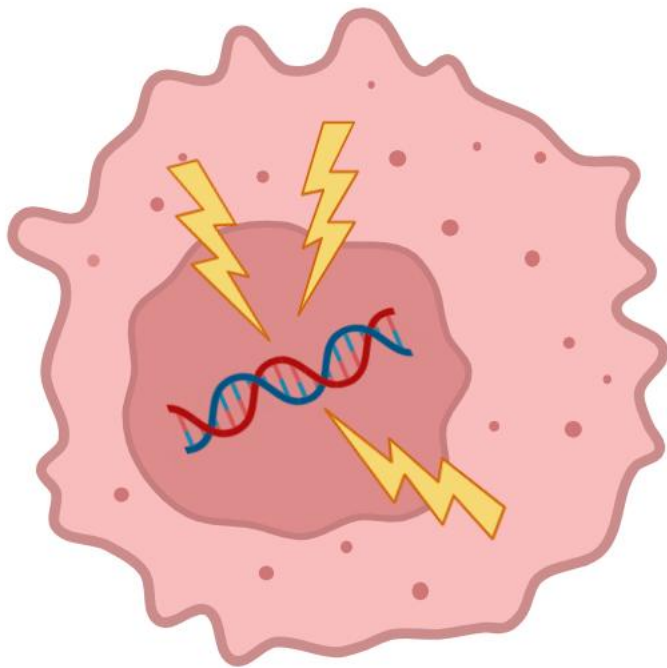


[BR = 6.1%]

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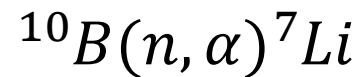
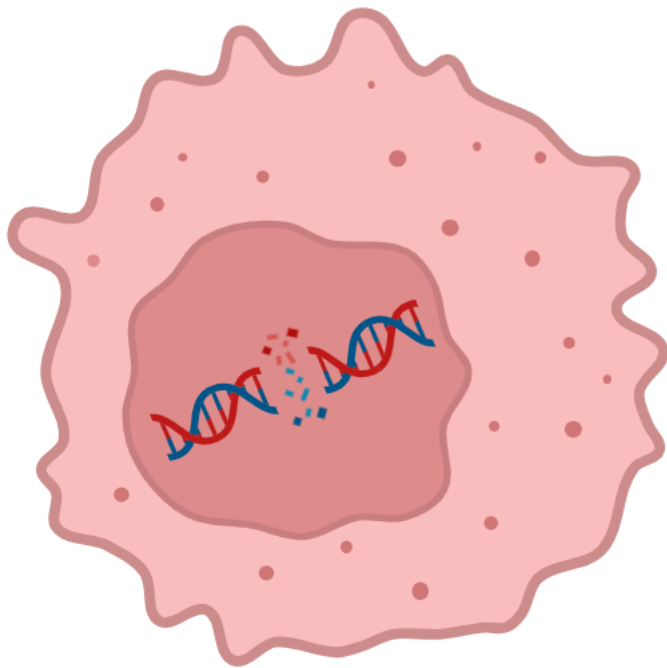


High LET radiations

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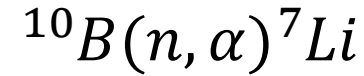


High LET radiations

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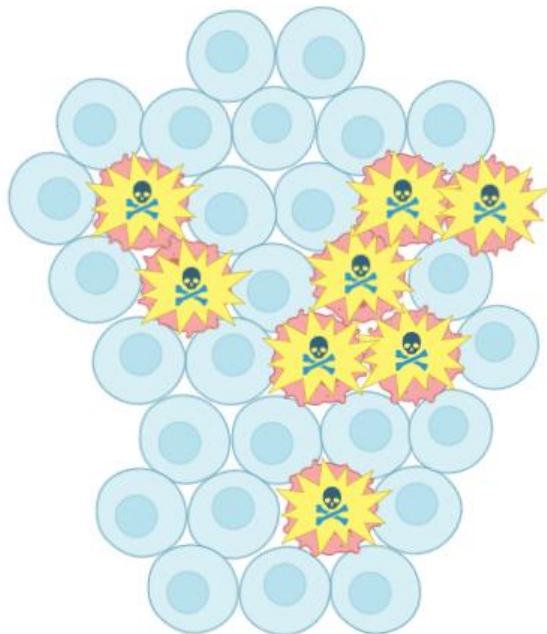
High LET radiations

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Short range radiations

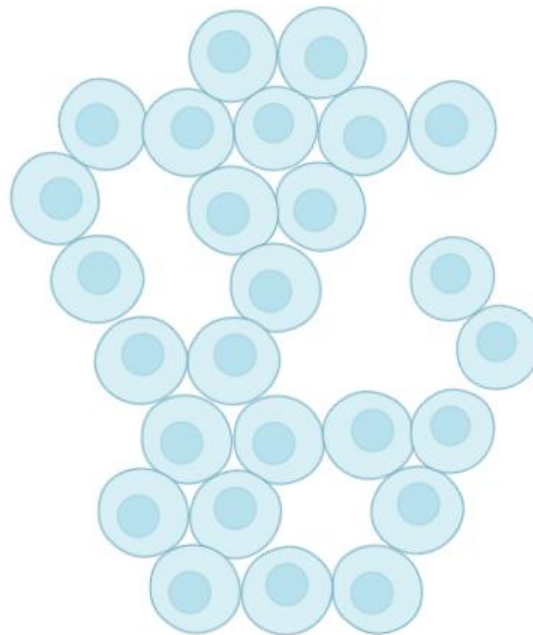
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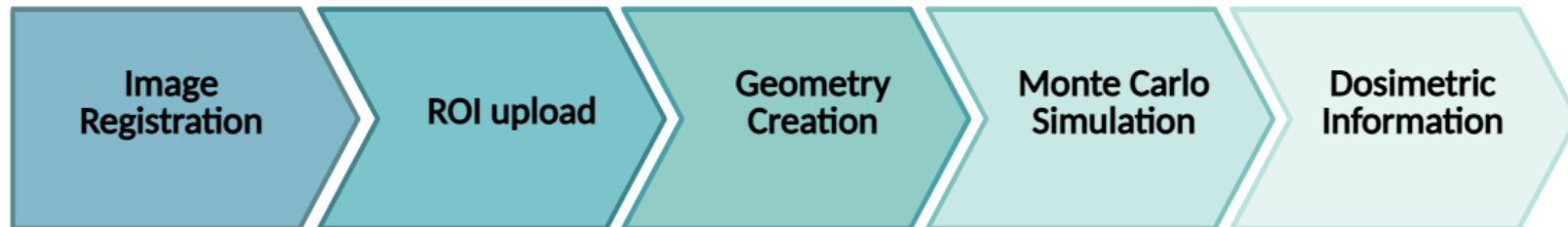
Short range radiations

High Selectivity

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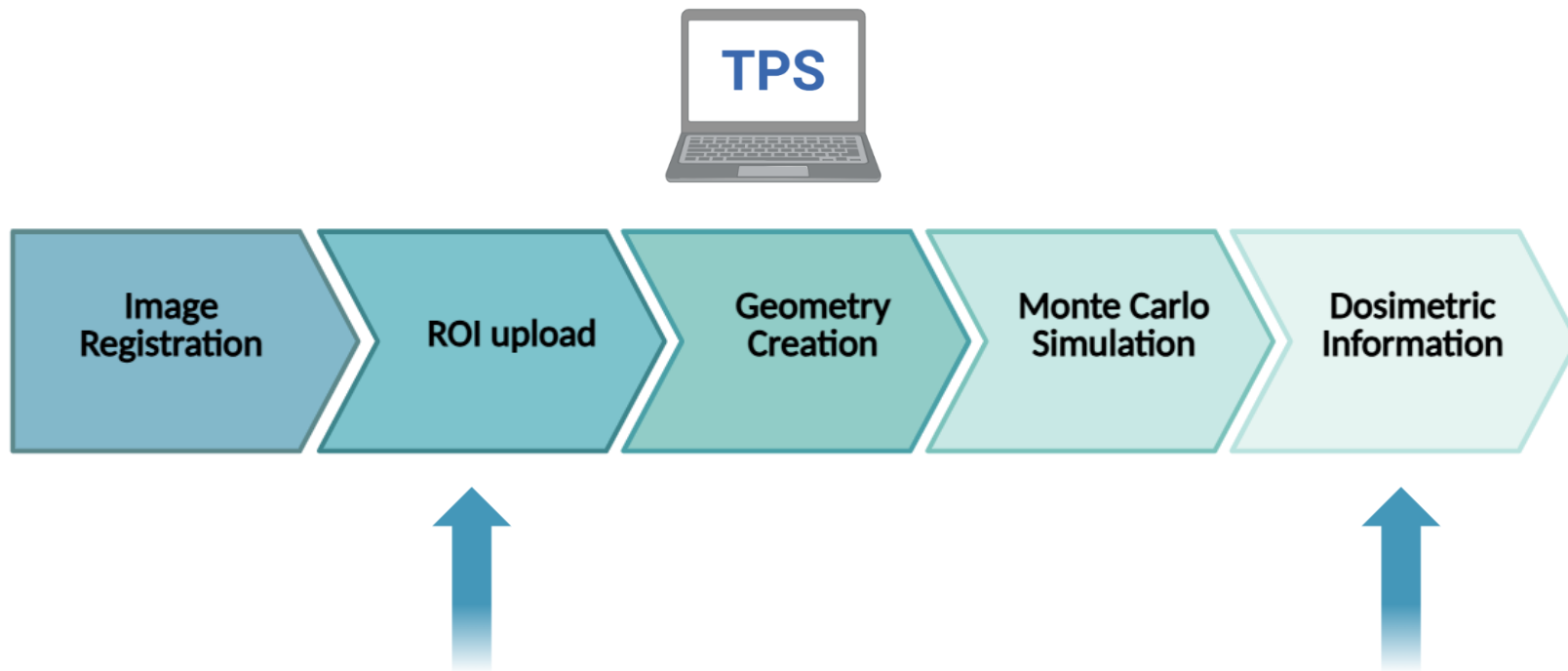
State of Art : Treatment Planning System (TPS)



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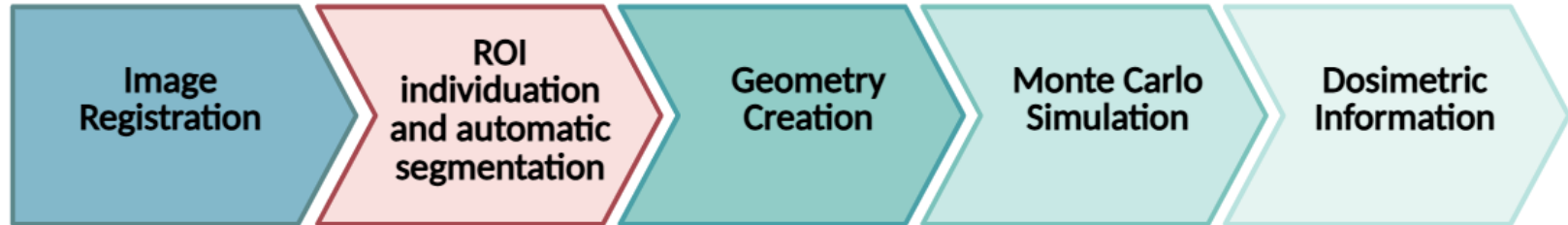
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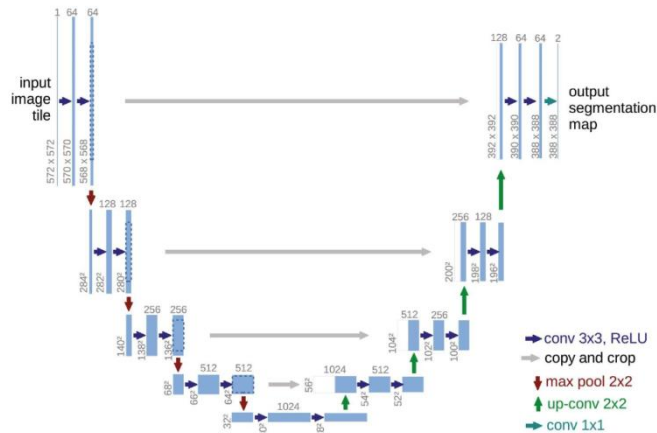


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PhD Project by Cristina Pezzi

ROI individuation and segmentation

nnU-NET



GLIOBLASTOMA
MULTIFORME

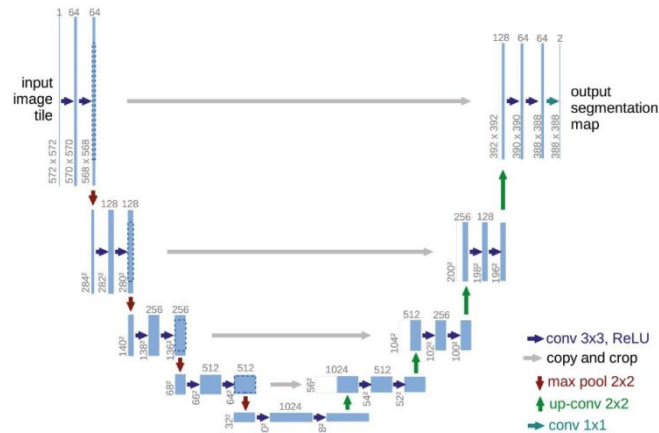


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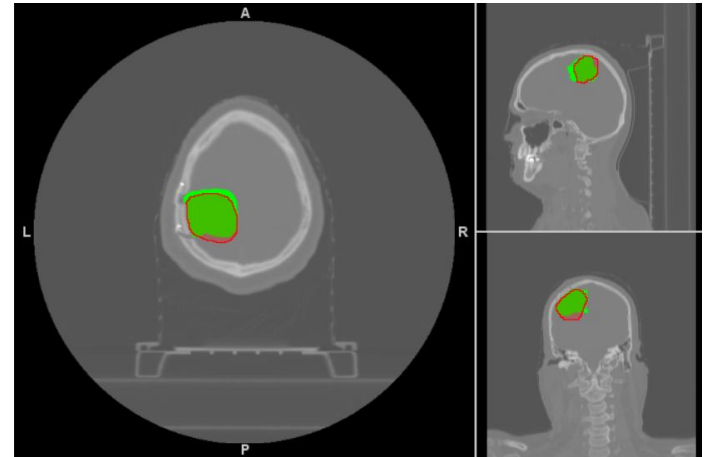
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ROI individuation and segmentation

nnU-NET



GLIOBLASTOMA MULTIFORME



True Segmentation

Predicted Segmentation

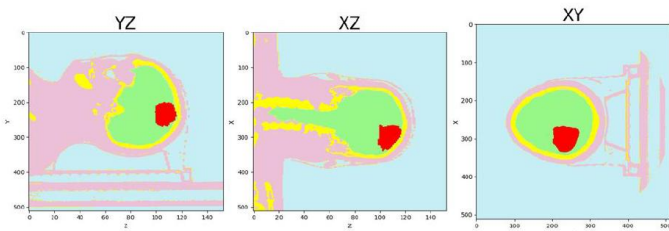
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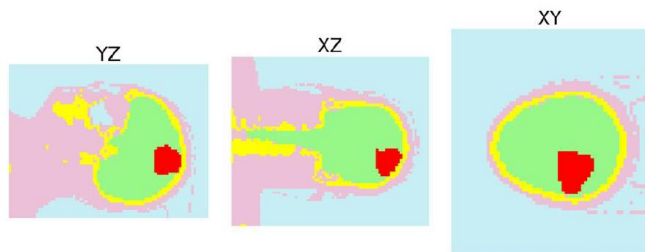
Dosimetric Analysis



Masks
generation



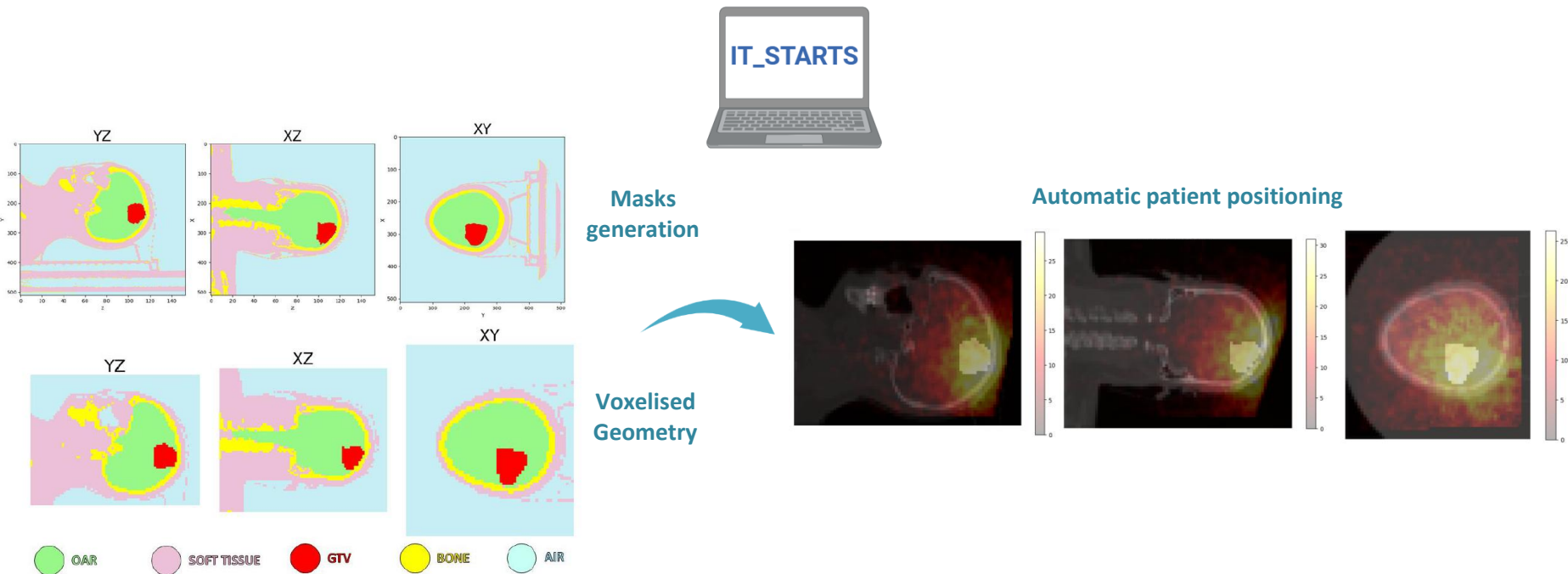
Voxelised
Geometry



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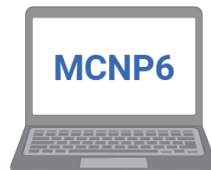
Dosimetric Analysis



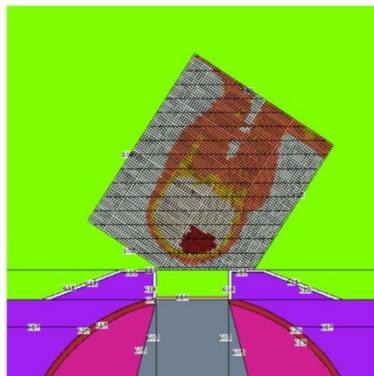
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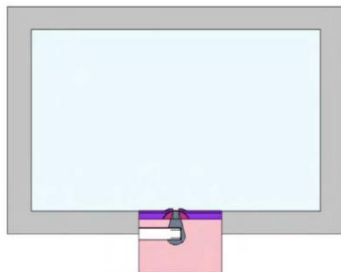
Dosimetric Analysis



Patient positioning



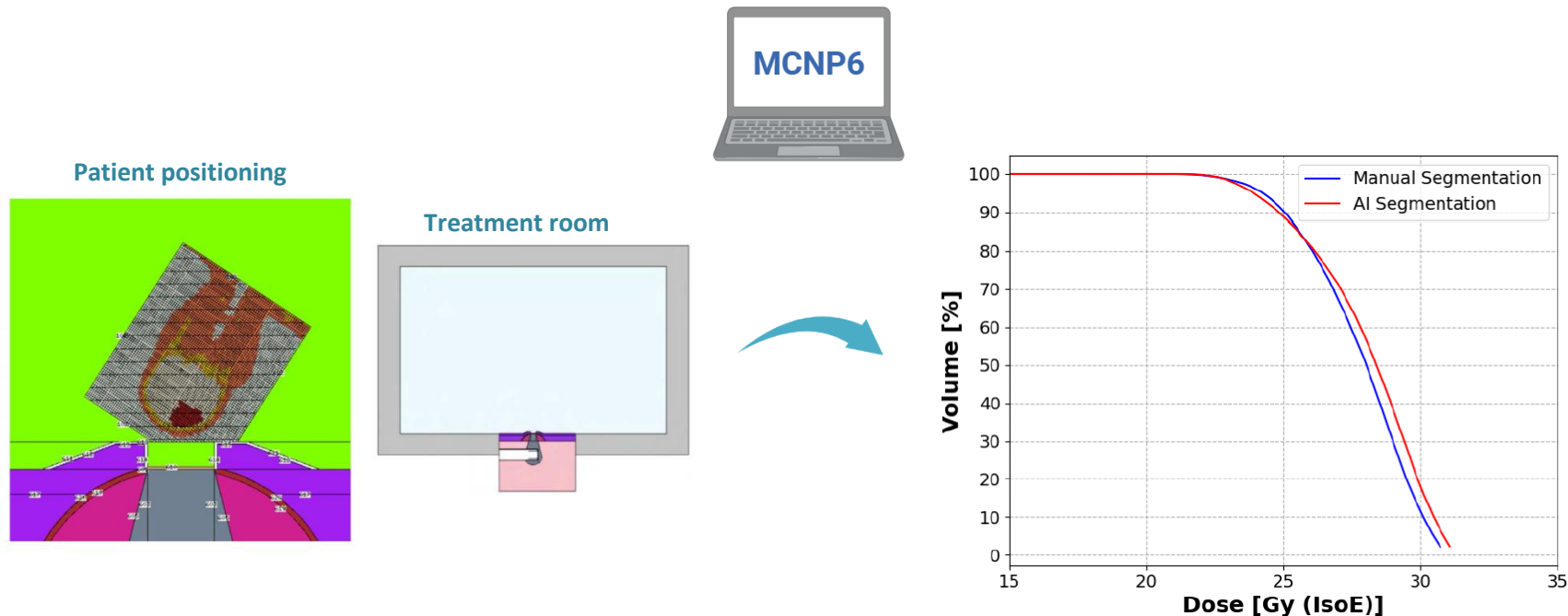
Treatment room



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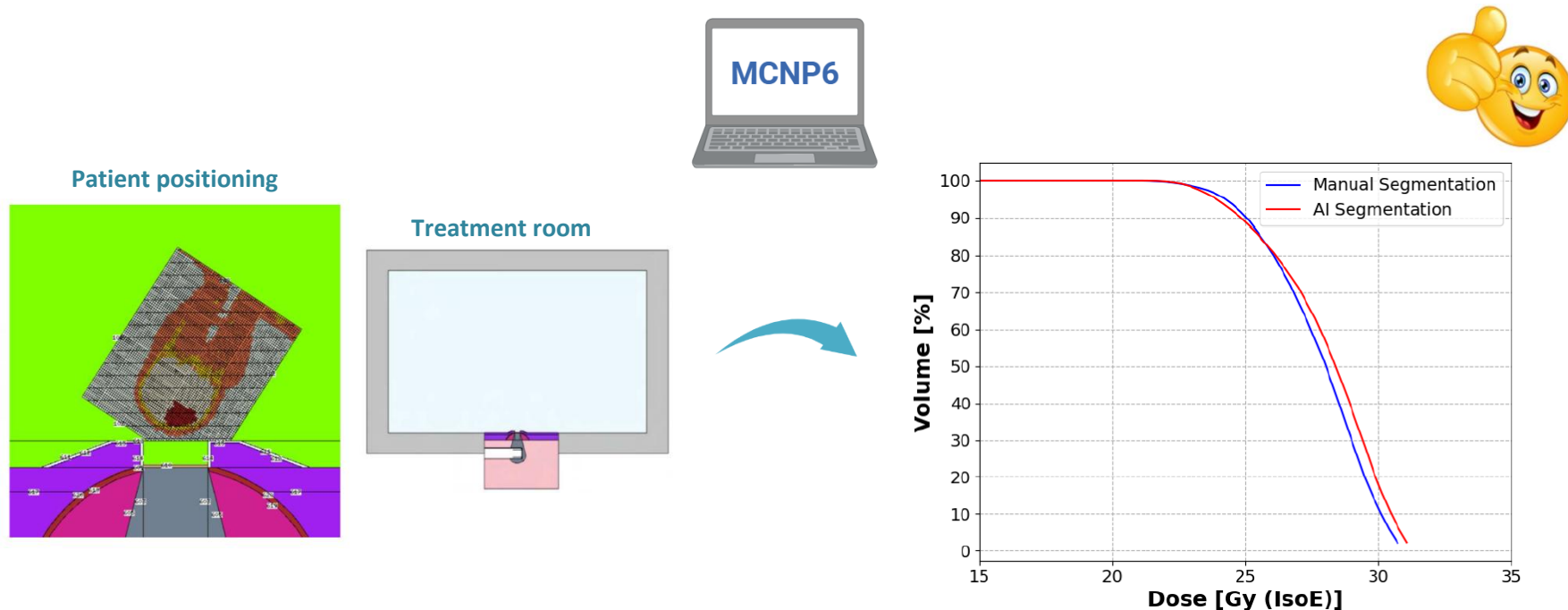
Dosimetric Analysis



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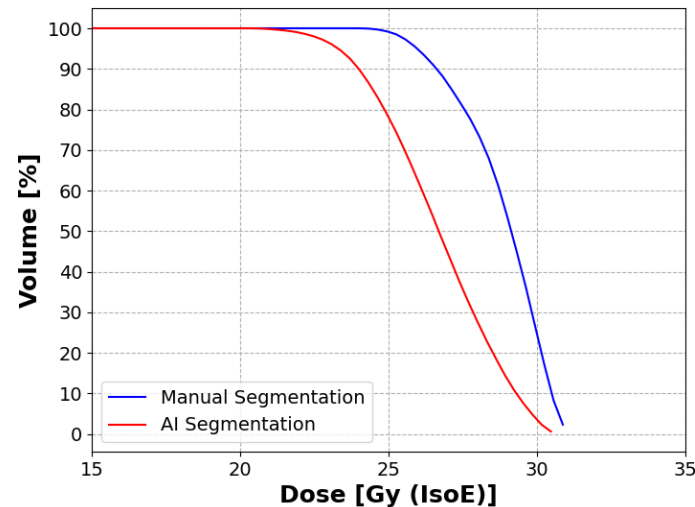
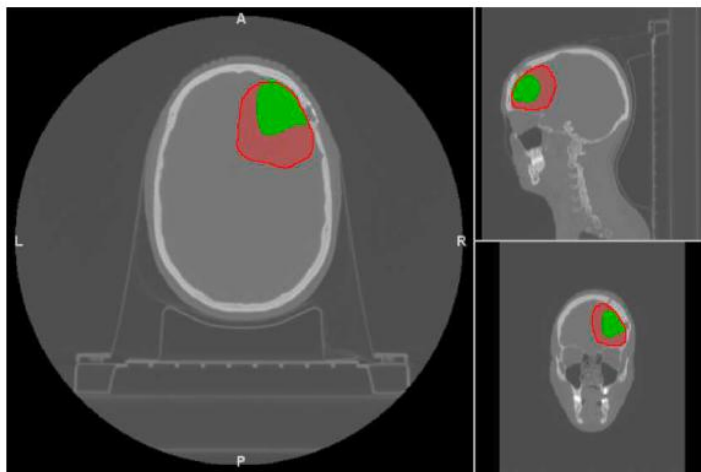
Dosimetric Analysis



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Dosimetric Analysis



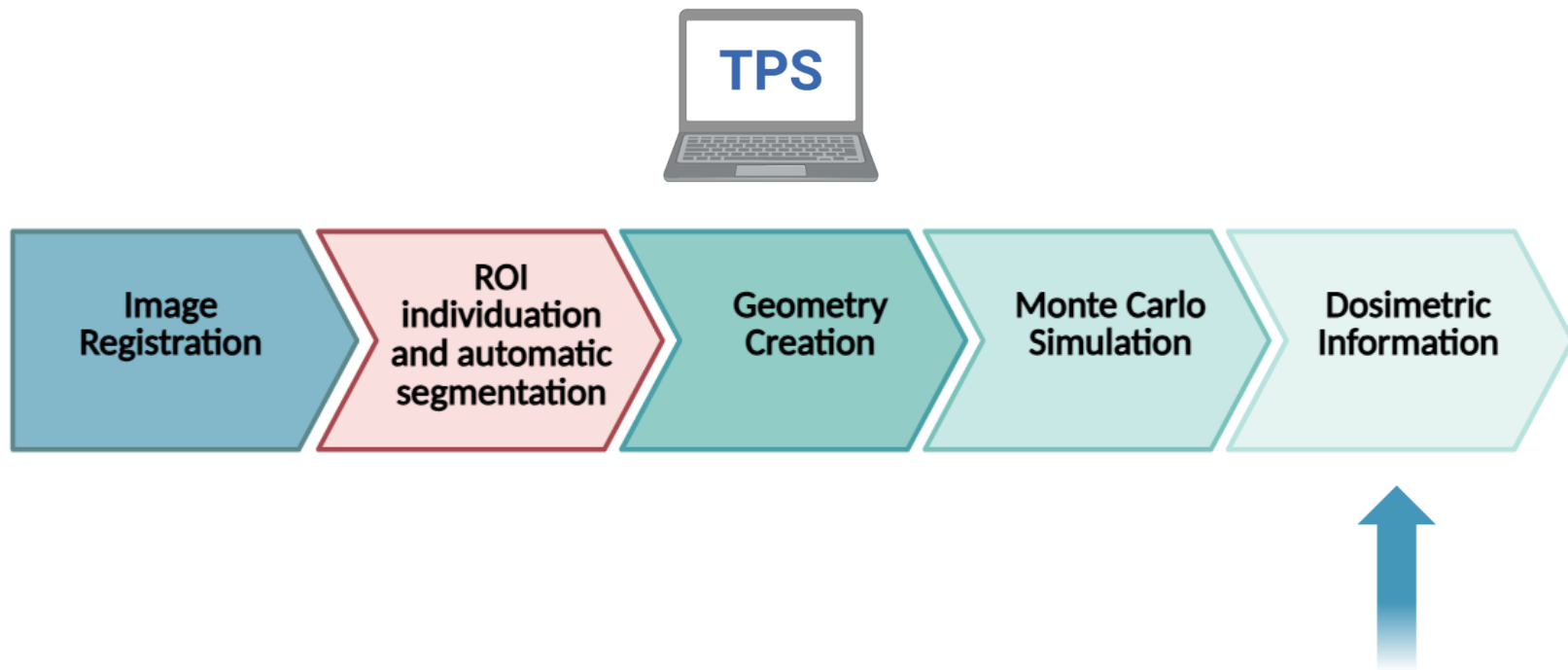
True Segmentation

Predicted Segmentation

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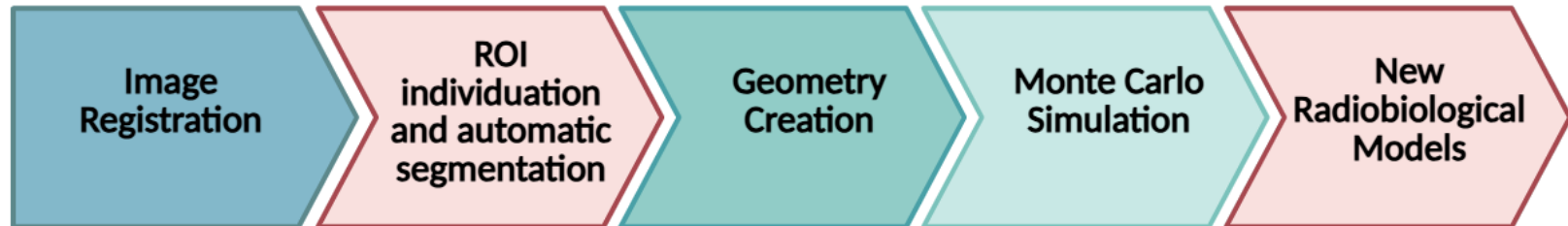
State of Art : Treatment Planning System (TPS)



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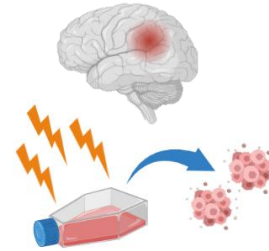
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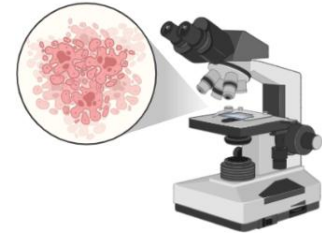
New Radiobiological Models

Photon Isoeffective Dose Model

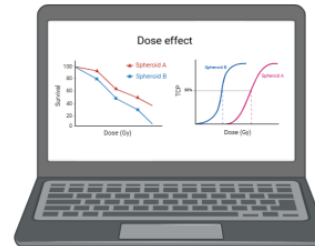
$$D_R(D_1, \dots, D_4) = \frac{1}{2} \frac{\left(\frac{\alpha}{\beta}\right)_R}{G_R} \times \left(\sqrt{1 + \frac{4G_R}{\alpha_R \left(\frac{\alpha}{\beta}\right)_R} \left(\sum_{i=1}^4 \alpha_i D_i + \sum_{i=1}^4 \sum_{j=1}^4 G_{ij}(\theta) \sqrt{\beta_i \beta_j} D_i D_j \right)} - 1 \right)$$



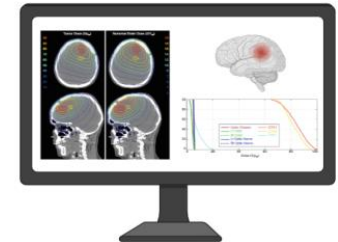
Generation and irradiation of GBM spheroids



Analysis of dose-effect correlation



Refinement of photon isoeffective dose model



Development of Tumor Control Probability model

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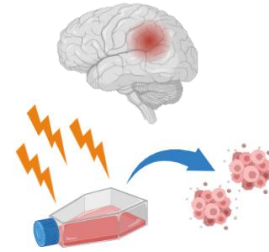
New Radiobiological Models



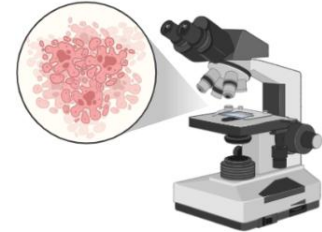
TRIGA Mark II Reactor (Pavia)



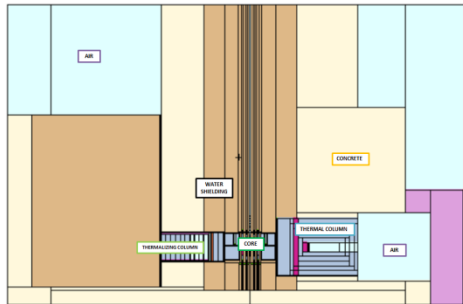
THUNDER Imager Live Cell with Incubator



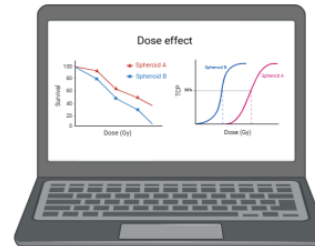
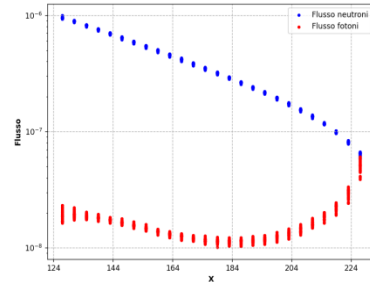
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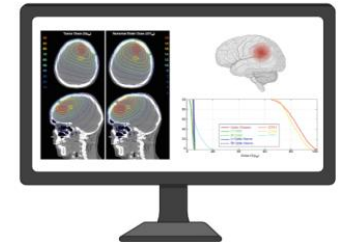
Analysis of dose-effect correlation



Reactor Geometry (MCNP6)



Refinement of photon isoeffective dose model



Development of Tumor Control Probability model

Thanks for the attention !

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