

O-PGI: orthogonal prompt-gamma imaging for monitoring proton therapy treatments



LABORATÓRIO DE INSTRUMENTAÇÃO E
FÍSICA EXPERIMENTAL DE PARTÍCULAS

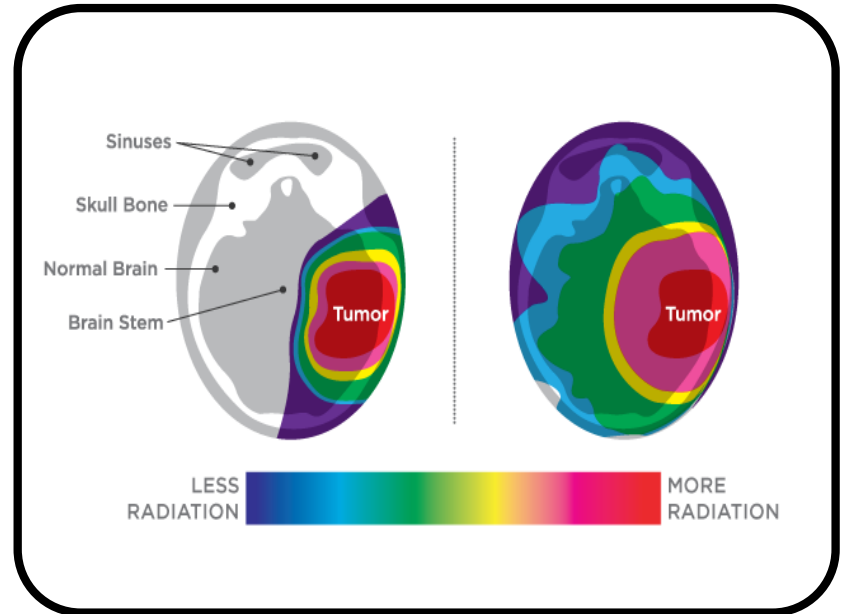
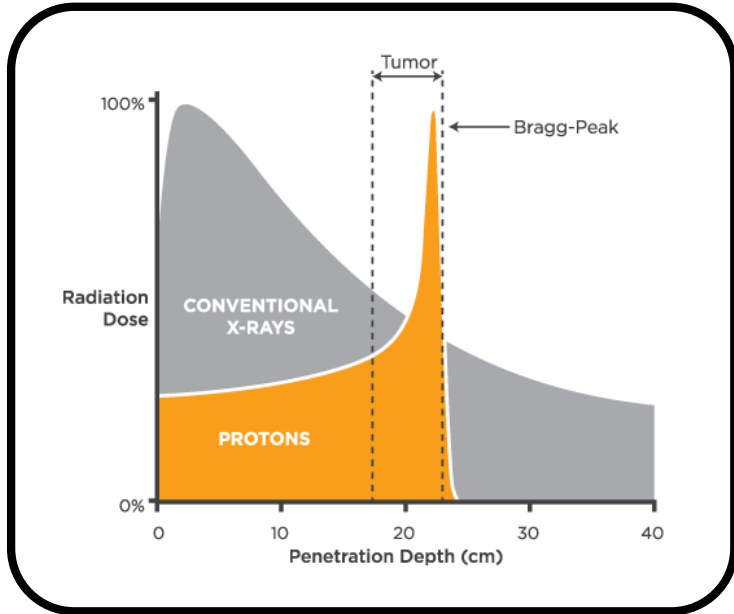
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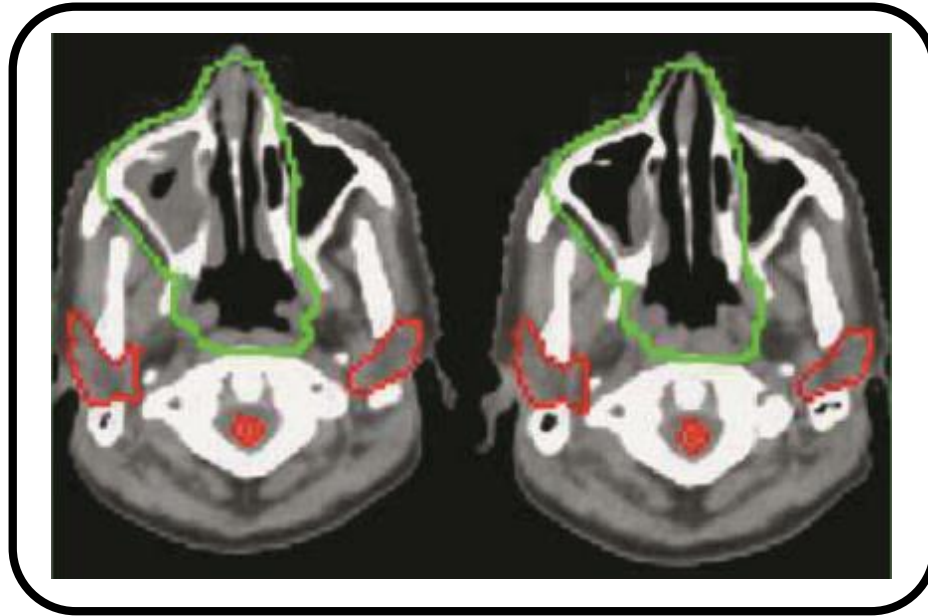
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Proton therapy vs. conventional (x-rays) radiotherapy



Challenges in proton therapy

Example of a morphological change which can compromise the treatment output

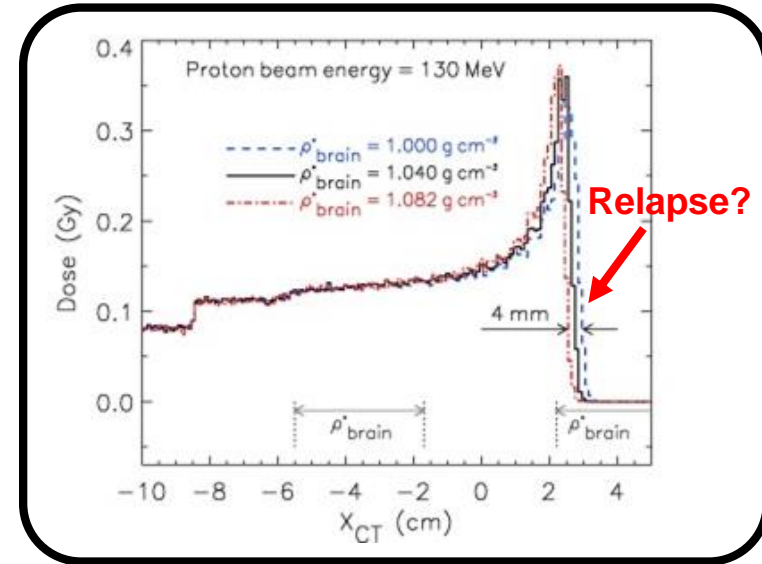
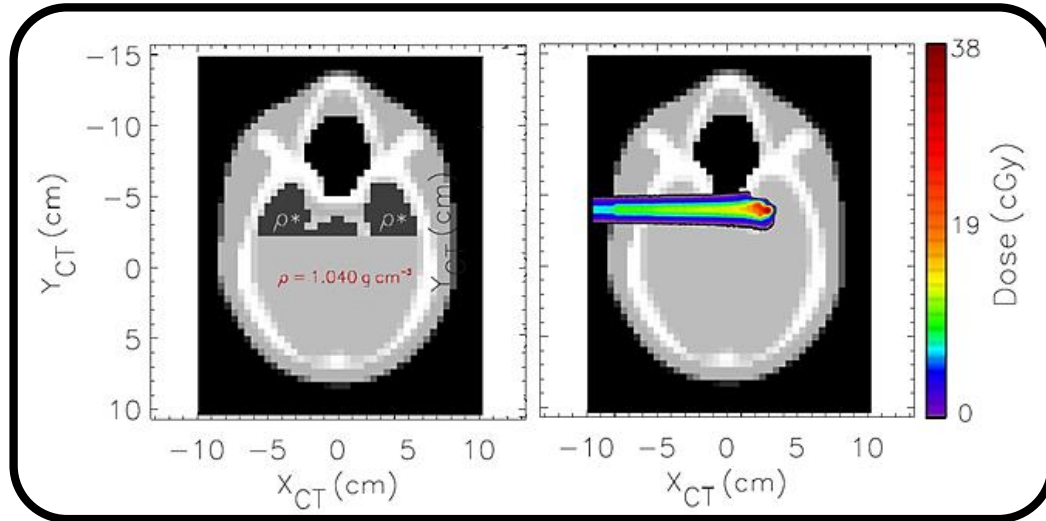


(Engelsman and Bert 2011)

Challenges in proton therapy

Change in brain density due to fractionated RT?

- Conjecture: brain tissue hypo/hyperdense due to fractionated RT

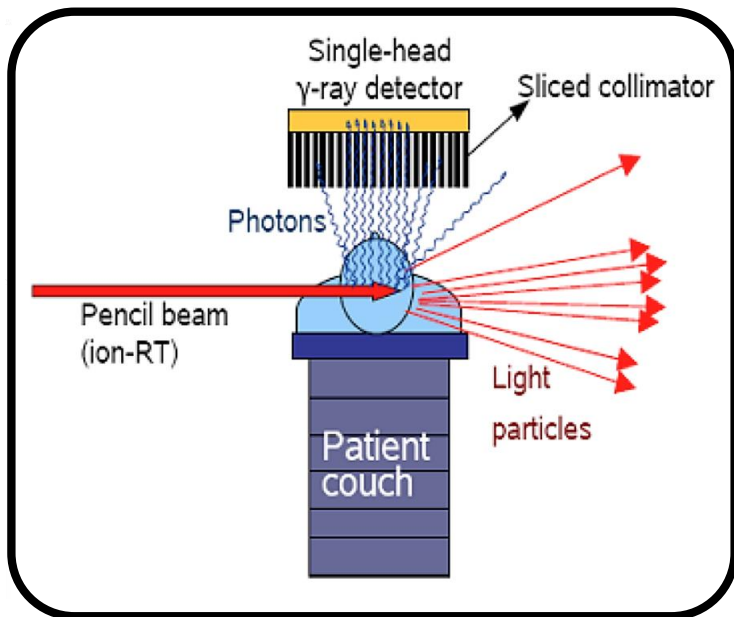


- A change of $\pm 4\%$ in the brain density leads to a variation of $\pm 2 \text{ mm}$ in the Bragg peak position

(Cabraia Lopes *et al*, *Physica Medica* 2018)

Multi-sliced detector for orthogonal prompt-gamma imaging

O-PGI concept

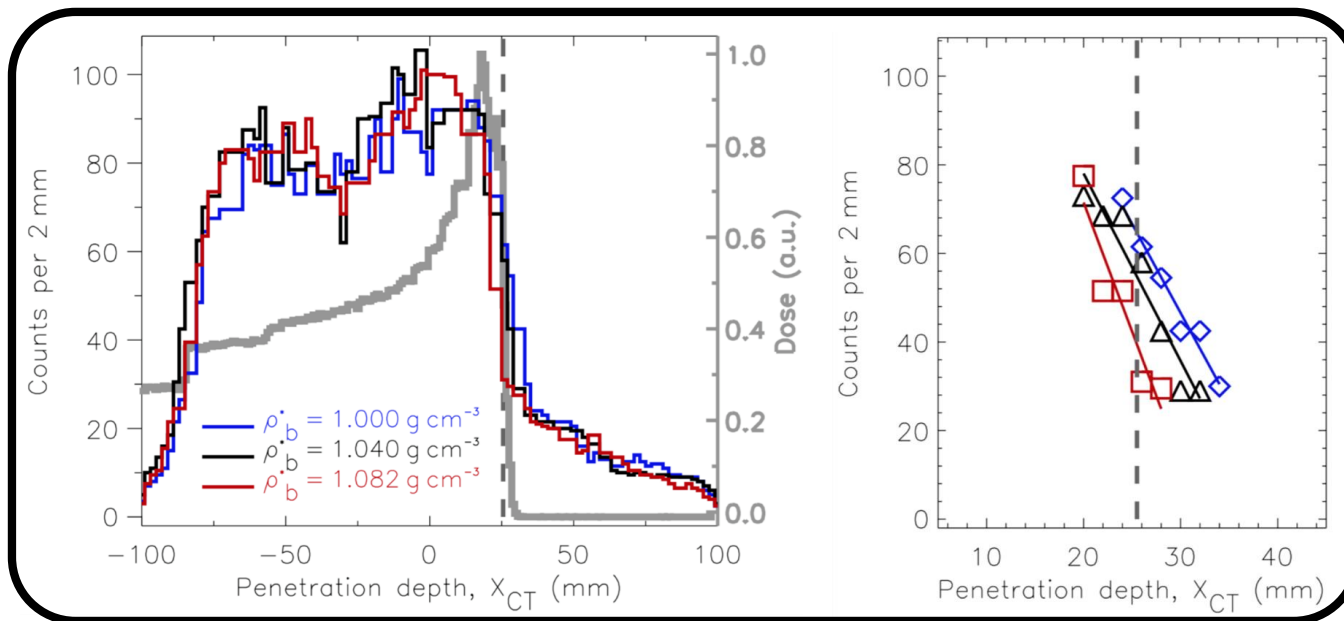


- Provides images of selected region without rotation of beam source
- Image with prompt gammas “stops” at beam range

(Cabraia Lopes *et al*, *Physica Medica* 2018)

Multi-sliced detector for orthogonal prompt-gamma imaging

Monte Carlo results with proposed detector (GEANT4)

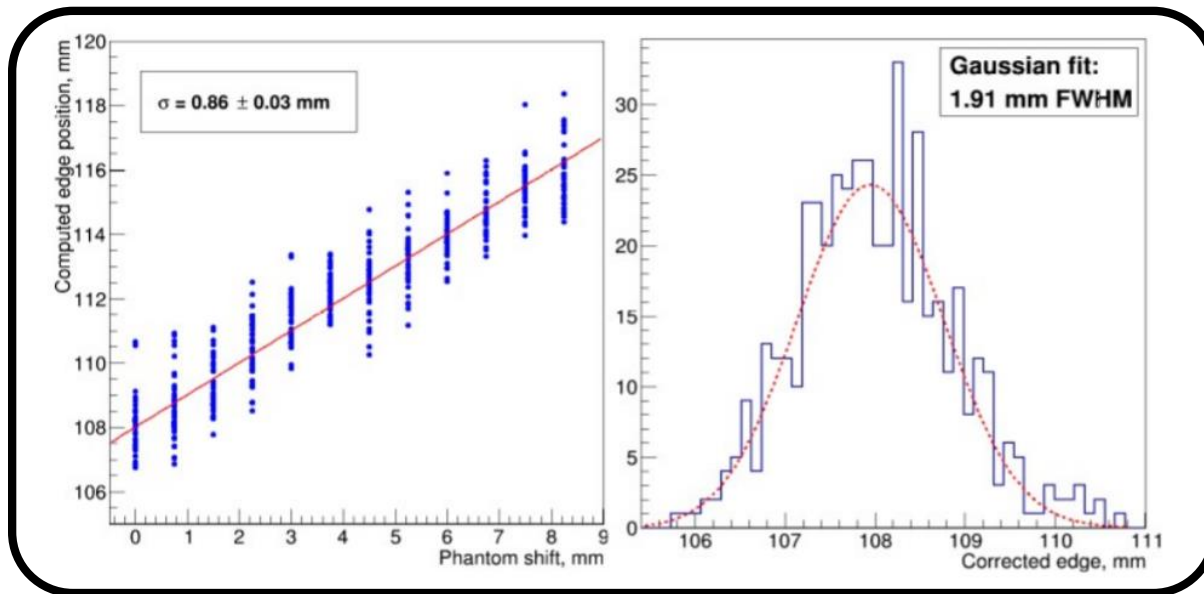


- Deviations in the Bragg peak position are visible in the O-PGI counts profiles (perfect detectors)

(Cabraia Lopes *et al*, *Physica Medica* 2018)

Multi-sliced detector for orthogonal prompt-gamma imaging

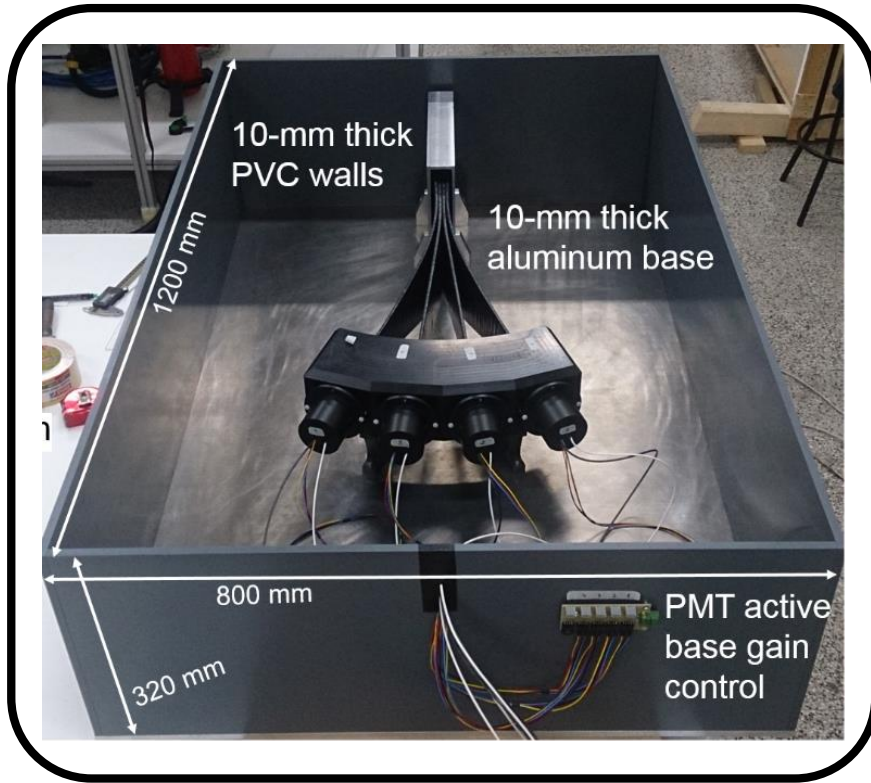
Comprehensive simulation and optimization of the detection system



- A precision of about 2 mm FWHM in the distal edge of the Bragg peak position was obtained (even taking into account optical photons)

(Morozov *et al*, *Physica Medica* 2021)

O-PGI prototype to test in the PTCHolland proton therapy facility (Delft, The Netherlands)



- A fast digital storage oscilloscope with 4 channels was acquired
- Data processing routines were already developed and validated in our simulation studies.

Prototype already tested in X-ray radiotherapy environment

Thank you for your attention.

