ENHANCING GAMMA PRODUCTION FOR ONLINE Dose verification in proton therapy

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RADIOTHERAPY



PHYSICS CHALLENGES IN PARTICLE THERAPY

Treatment Optimization:

- 4D beam delivery technologies including patient motion
- New ions: 4He for pediatrics and 160 for radioresistant tumors

Treatment Verification:

- Online monitoring of treatment dose and particle range
- Reduction of range uncertainties



PROTON RANGE UNCERTAINY



PROTON RANGE UNCERTAINY

Caused by:

- Dose calculation uncertainties
- Patient anatomy
- Patient positioning

Proton Beam



protons (Bragg Peak)



RANGE UNCERTAINY: STATE OF THE ART



Secondaries are produced by **nuclear interactions** between projectile and target nuclei



CLINICAL APPLICATION

PROMPT GAMMA (PG): IBA KNIFE EDGE SLIT CAMERA

CHARGED PARTICLES: INSIDE PROJECT





- Installed at CNAO, Pavia
- **Dose profiler**: charge particle tracker
- **PET**: Coincidence detection of annihilation gammas

A DIFFERENT APPROACH

What if the tumor could be loaded with a "enhancement element" that can not only enhance the production of PG but also emit a signature spectrum?



Similar principle with molybdenum tumour marker: **Burbadge et al Phys. Med. Biol.** (2020)

FROM EXPERIMENT TO CLINICAL APPLICATION

Enhancement element **requirements**:

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 Production of high energetic PGs (to increase detection probability) Production of a signature spectrum (different from the background spectrum)
Non toxicHigh selectivity for the tumor vs normal tissue

• Maximum **concentration** achievable









EXPERIMENTAL SETUP

- Charge and Time of Flight measurements for gamma detection
- Detectors: Nal(Tl), LYSO and LaBr3
- **Final Goal:**
- Development of a gamma tracker detector



CONCLUSIONS AND FUTURE PERSPECTIVE:

- Prompt gamma enhancement in the tumor is possible
- 63Cu and 89Y are promising candidates as tumor label elements
- Experimental measurements are necessary to quantify the enhancement and validate MC simulations
- To simulate and measure the PG enhancement with realistic element concentration







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THANK YOU







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