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Range Verification in Proton Therapy: On the Way to Clinical Translation

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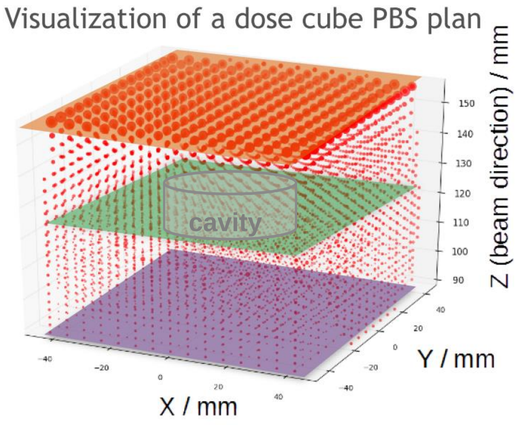
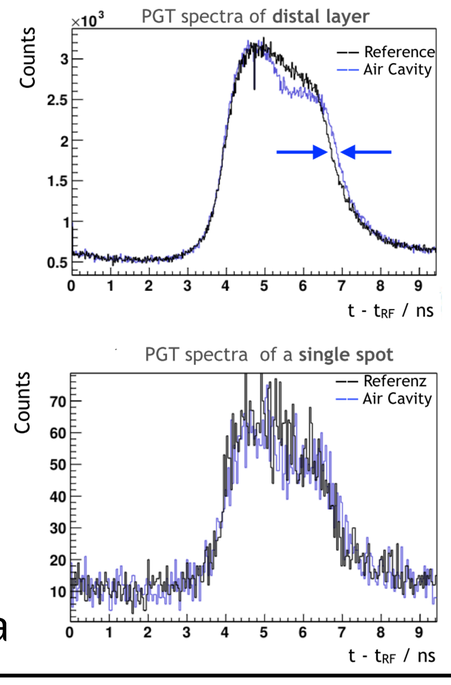
Visualization of a dose cube PBS plan



- PBS plan structure visible
- Layers and spots can be identified
- Spot-wise assignment of PGT data



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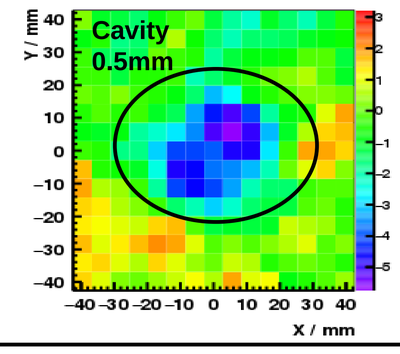
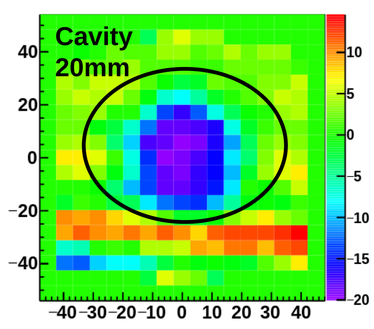
- Spot wise analyzing of statistical moments
- Mean difference in single spots of 1 Gy plan
- Increase of statistic by overlay of 22 similar layers
- Visibility of inhomogeneities

Δ Standard Deviation PGT spectra



Δ Mean PGT spectra



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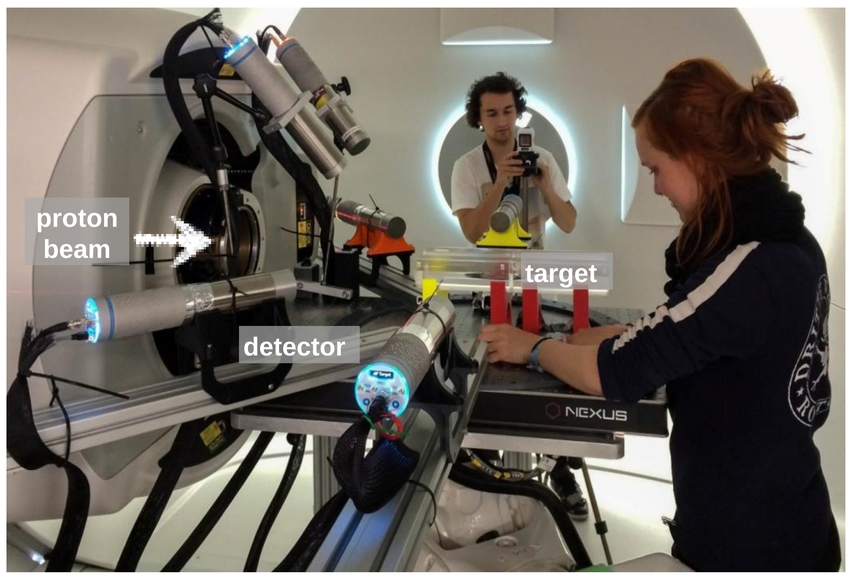

- PGT experiments under clinical conditions
- 3D PBS plan cubic volume (5 Gy and 1 Gy)
- Hollow PMMA target with inserts (e.g. air, bone)

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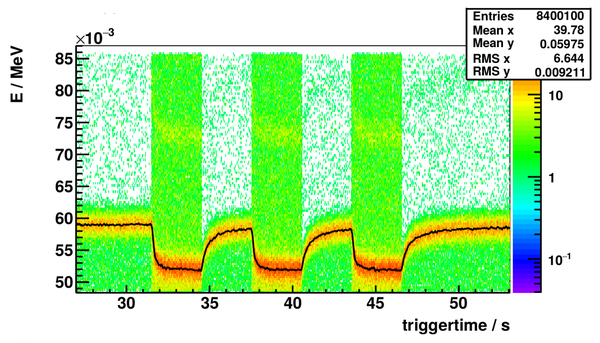
- Technical challenges
- Gain drifts due to load variations
- Time corrections of non-linearities



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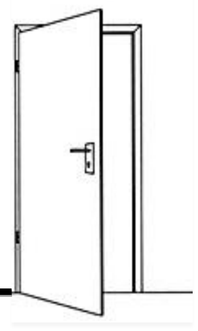


6 Application

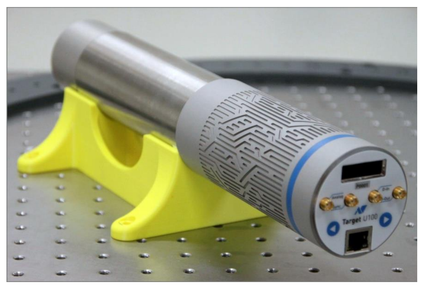
Clinical integration

5 Translation

Technical and experimental solution towards clinical applicability

4 Proof of Principle

Preliminary experiments - Verification of method



PGT detection unit

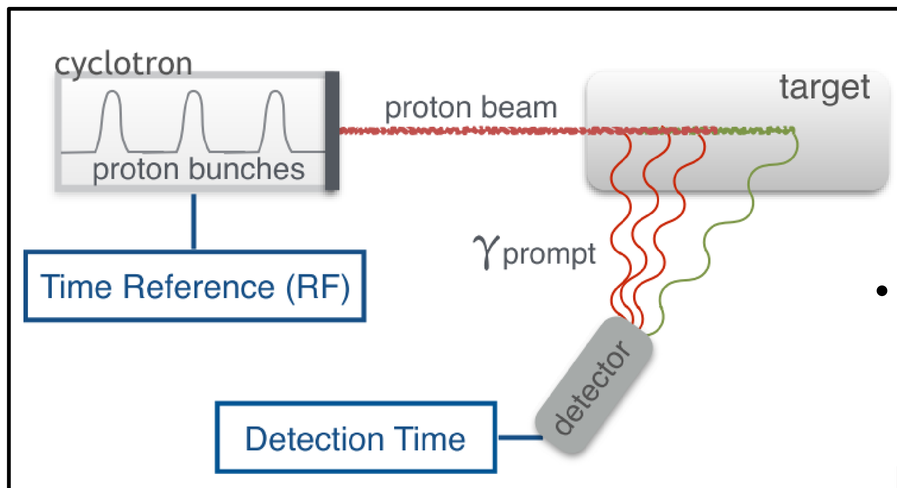
- Compact electronics providing fast timing and energy spectroscopy

3 Method

Principle of Prompt Gamma-ray Timing (PGT)

2 Approach

How to measure the Range?



- Protons enter the tissue and excite nuclei
- Production of prompt gammas along particle track
- Record time resolved emission profile

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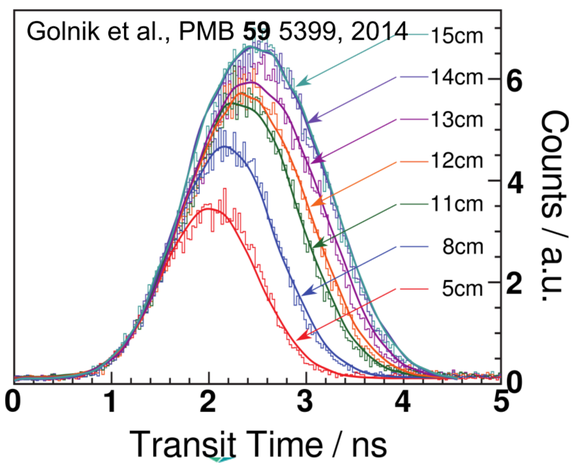
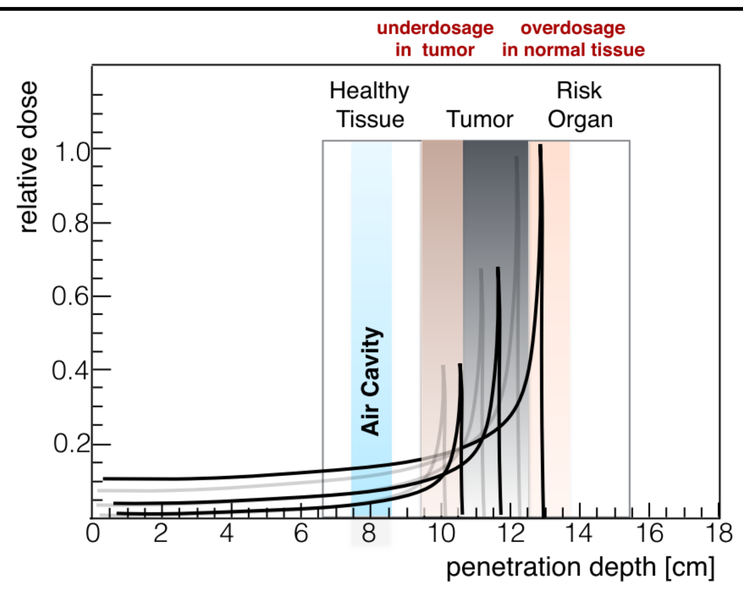
- Longer range is reflected in longer period of prompt gamma emission



1 Problem

Why do we need Range Verification?



- Precision is limited by range uncertainties (e.g. changes of tissue composition)

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