

Clinical validation of Fred Monte Carlo code in Krakow proton beam therapy centre

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3rd Symposium on Positron Emission Tomography, 12.09.18



Republic
of Poland



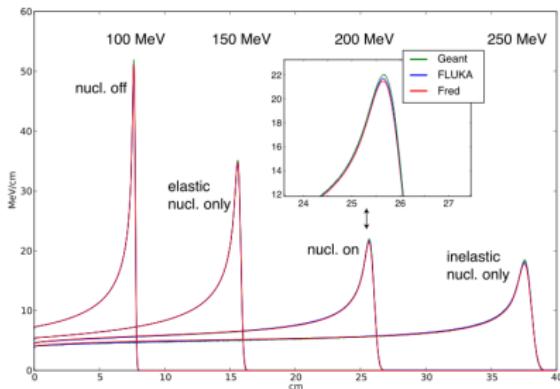
Foundation for
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FRED MC

First FRED validation with standard MC codes...

- „FRED” : MC code working on GPU cards.
- Depth-dose profiles obtained with MC FRED are in agreement on level 1–2% (in Bragg peak region) with standard MC codes.

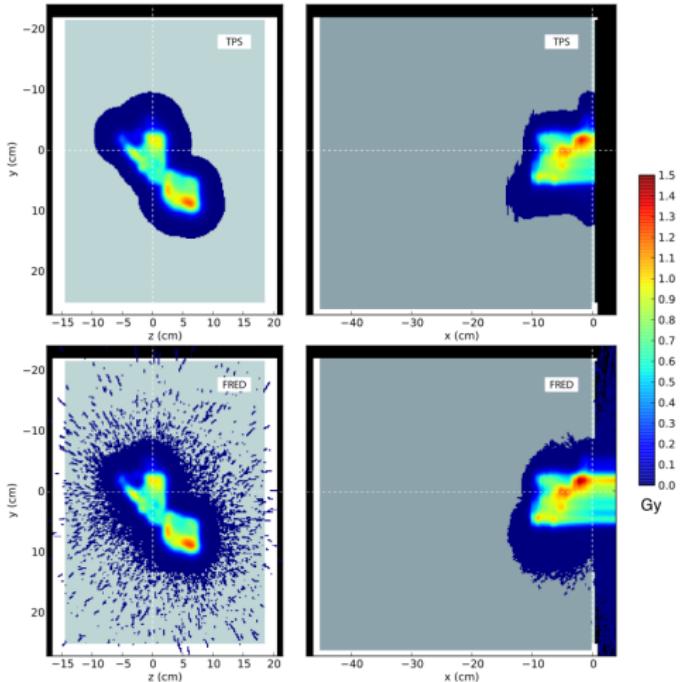


Source : Schiavi et al. (2017)

Schiavi et al : Fred : a GPU-accelerated fast-Monte Carlo code for rapid treatment plan recalculation in ion beam therapy. Phys. Med. Biol. 62 7482, (2017)

FRED MC

... and first clinical validation @CNAO



Source : Schiavi et al. (2017)

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Validation procedures applied at CCB Krakow

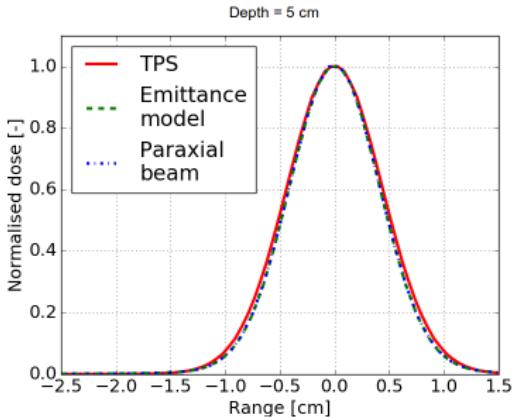
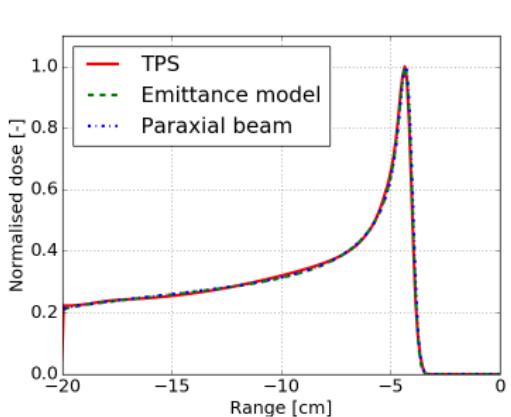
- Comparing profiles of dose distribution from simulation with TPS
- Gamma index (GI) analysis
- Measurements (work in progress)



Profiles

Single beams

Proton beam with energy 150 MeV



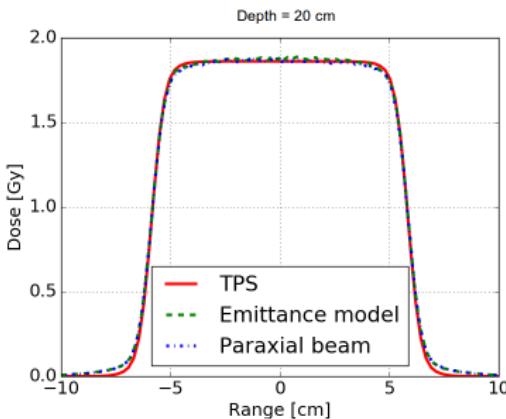
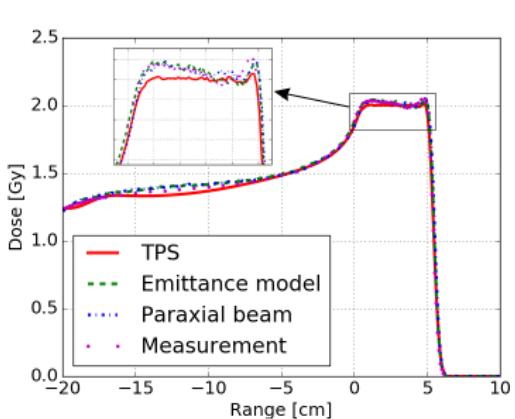
- (1) Emittance model – beam envelope defined by measurements of the beam size in air
- (2) Paraxial beam – assumed constant beam size based on measurements in water



Profiles

Dose cubes

Range 25 cm, modulation 5 cm

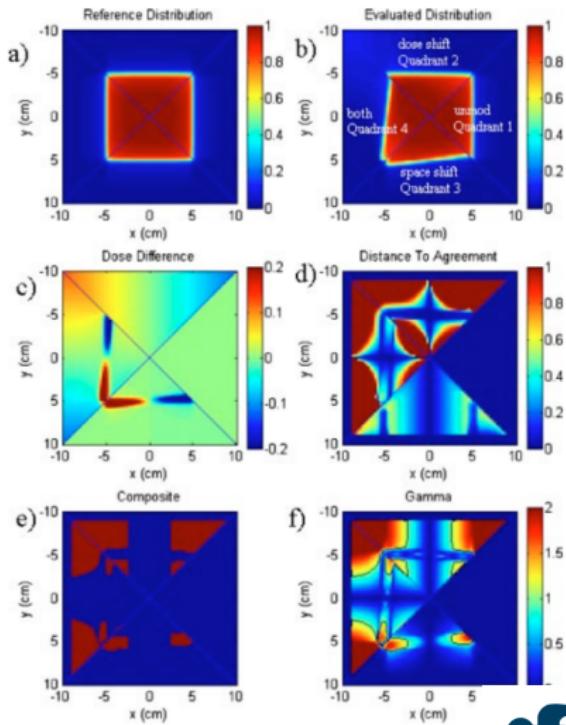


- (1) Emittance model – beam envelope defined by measurements of the beam size in air
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Gamma index analysis

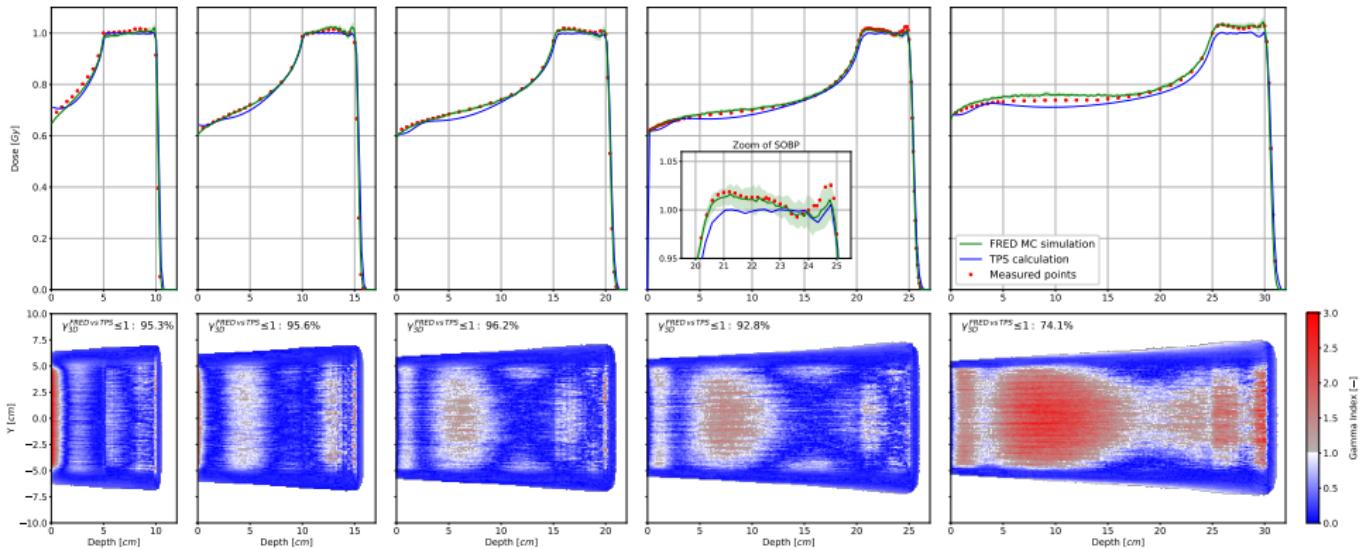
The standard method for dose verification which is based on dose difference (DD) and distance to agreement (DTA) criteria to evaluate the agreement between two dose distribution.



Daniel A. Low, James F. Dempsey, Evaluation of the
gamma dose distribution comparison method, Med Phys.
30(9) :2455-64, (2003)

Gamma index analysis

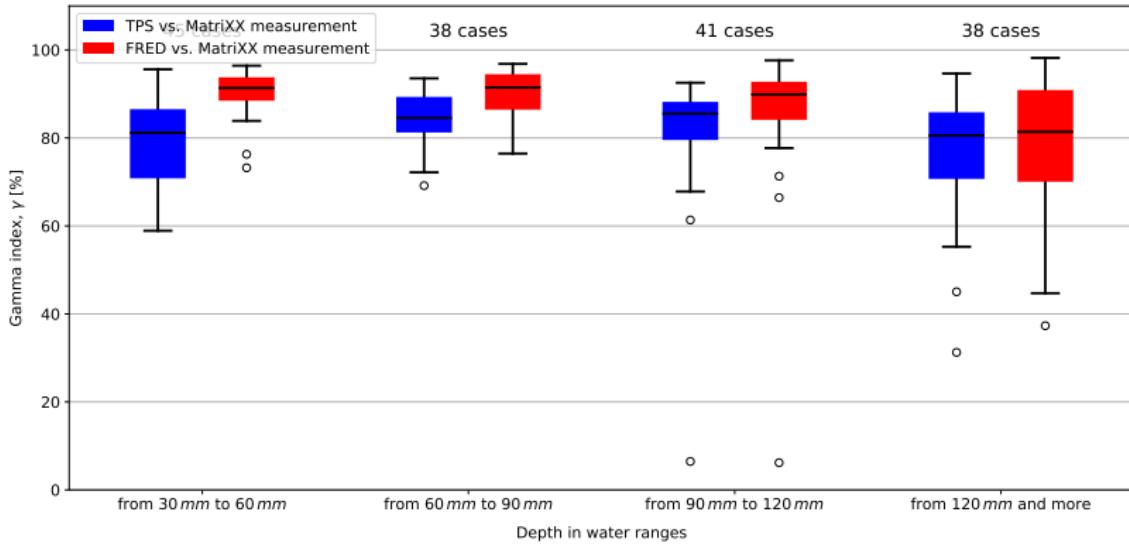
Dose cubes



Gamma index analysis

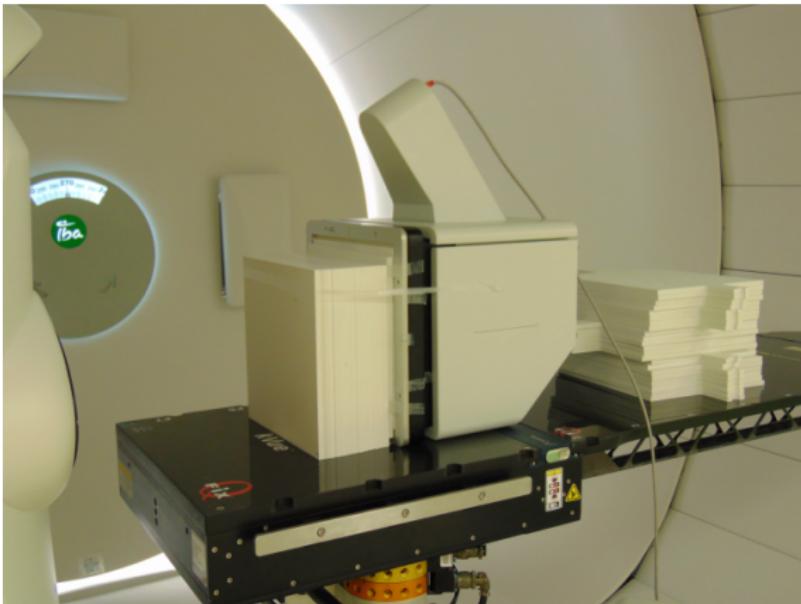
Patient data

2%/2mm passing criteria



Measurements

Spot size in RW3 slab phantom

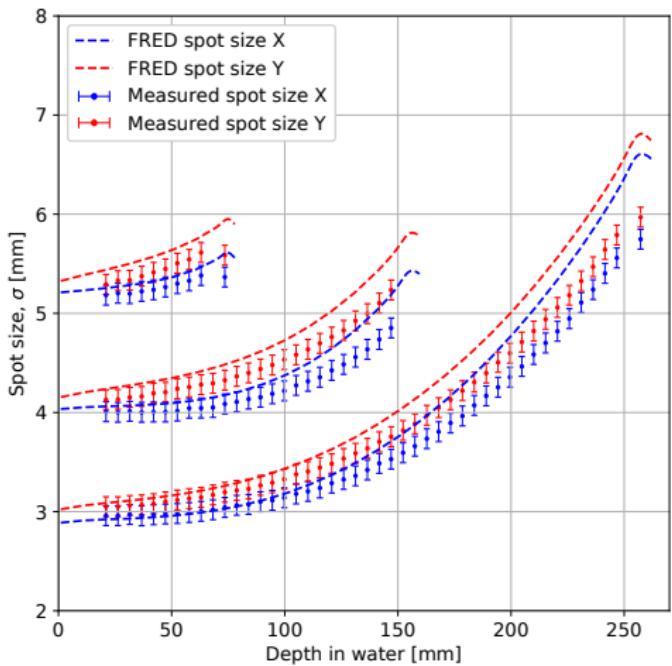


Courtesy of Natalia Mojzeszek



Measurements

Spot size in RW3 slab phantom



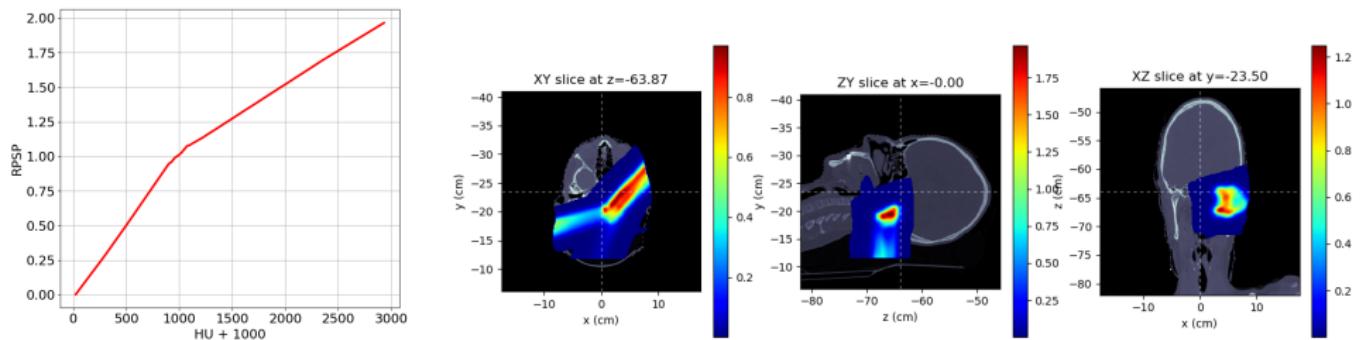
Courtesy of Jan Gajewski

Conclusions

- Implemented beam model was validated with dosimetric and clinical cases.
- Over 95% passing rate score for most of 3D dose distribution of dose cubes and over 90% for all patient cases considering 2D images.
- Measured data confirmed a high precision of FRED MC dose recalculation.

Next validation steps

- Include calibration curve from CCB Krakow.
- Perform simulations on patient CT images.



Other future plans

- Perform simulation in RW3 material.
- Experimental beam characterization (1st and 2nd Gaussian profile).
- Include measurements for dosimetric calibration.
- Development of treatment plan optimization methods for FRED MC code.

Research partners



Acknowledgments

... for my colleagues :

- Antoni Ruciński,
- Jan Gajewski,
- Agata Skrzypek,
- Jakub Baran,

... and my supervisor :

- prof. Paweł Olko.



Thank you for your attention !

