Feasibility study to achieve ultra-fast treatment delivery to treat moving targets using universal and dynamic ridge-filter and high-intensity beams

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Feasibility study to achieve **ultra-fast** treatment delivery using a **universal and dynamic ridge-filter** and **high-intensity** beams

Vivek Maradia, Isabella Colizzi, David Meer, Damien C Weber, Tony Lomax, Oxana Actis, Serena Psoroulas

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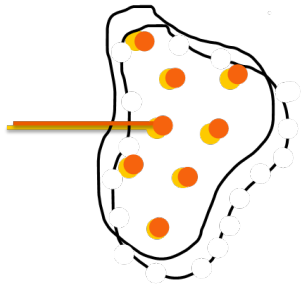
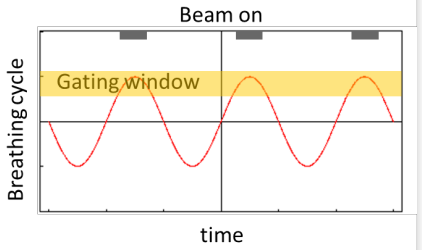
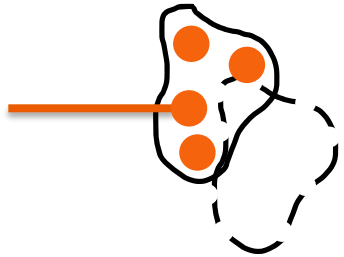
Introduction: motion mitigation techniques



Rescanning



Gating

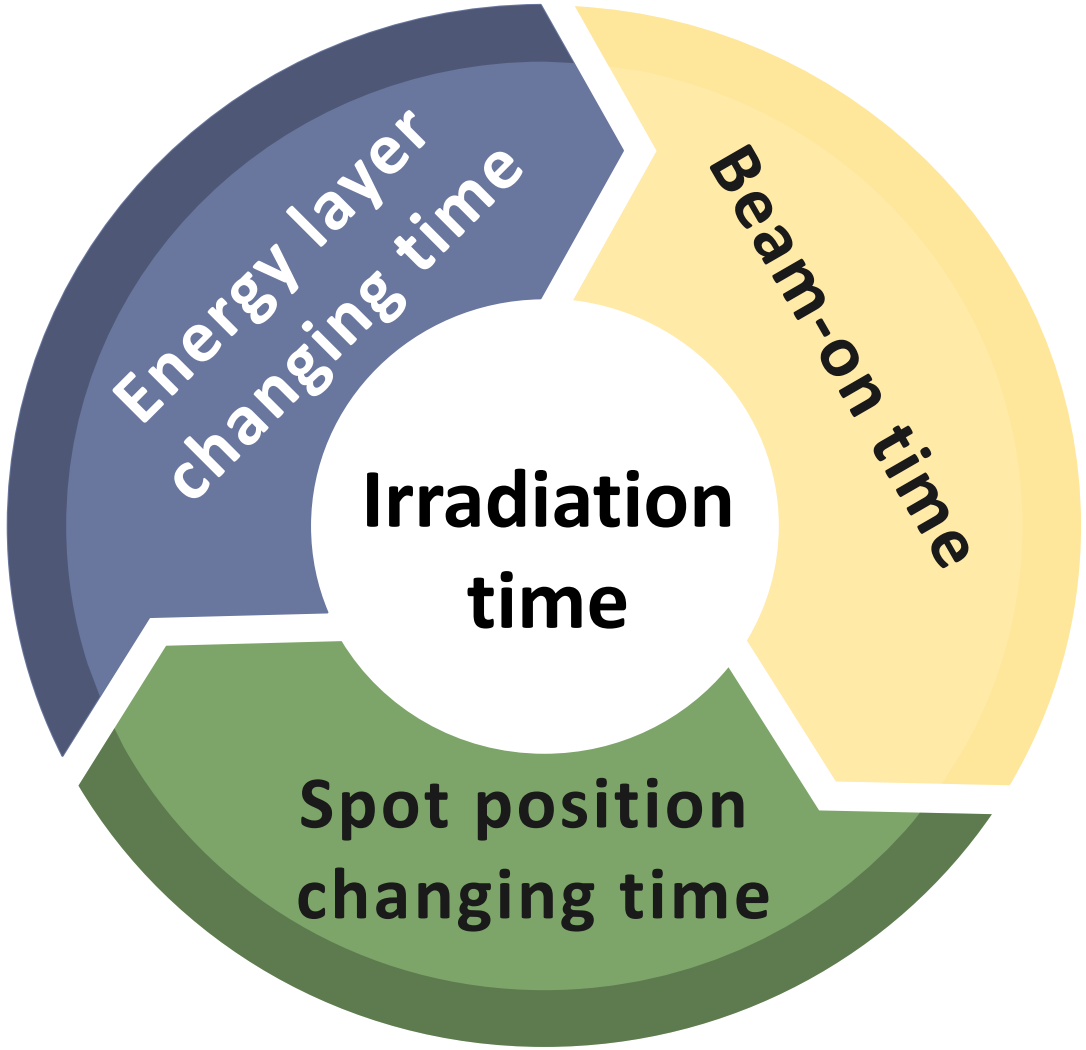


Breath Hold

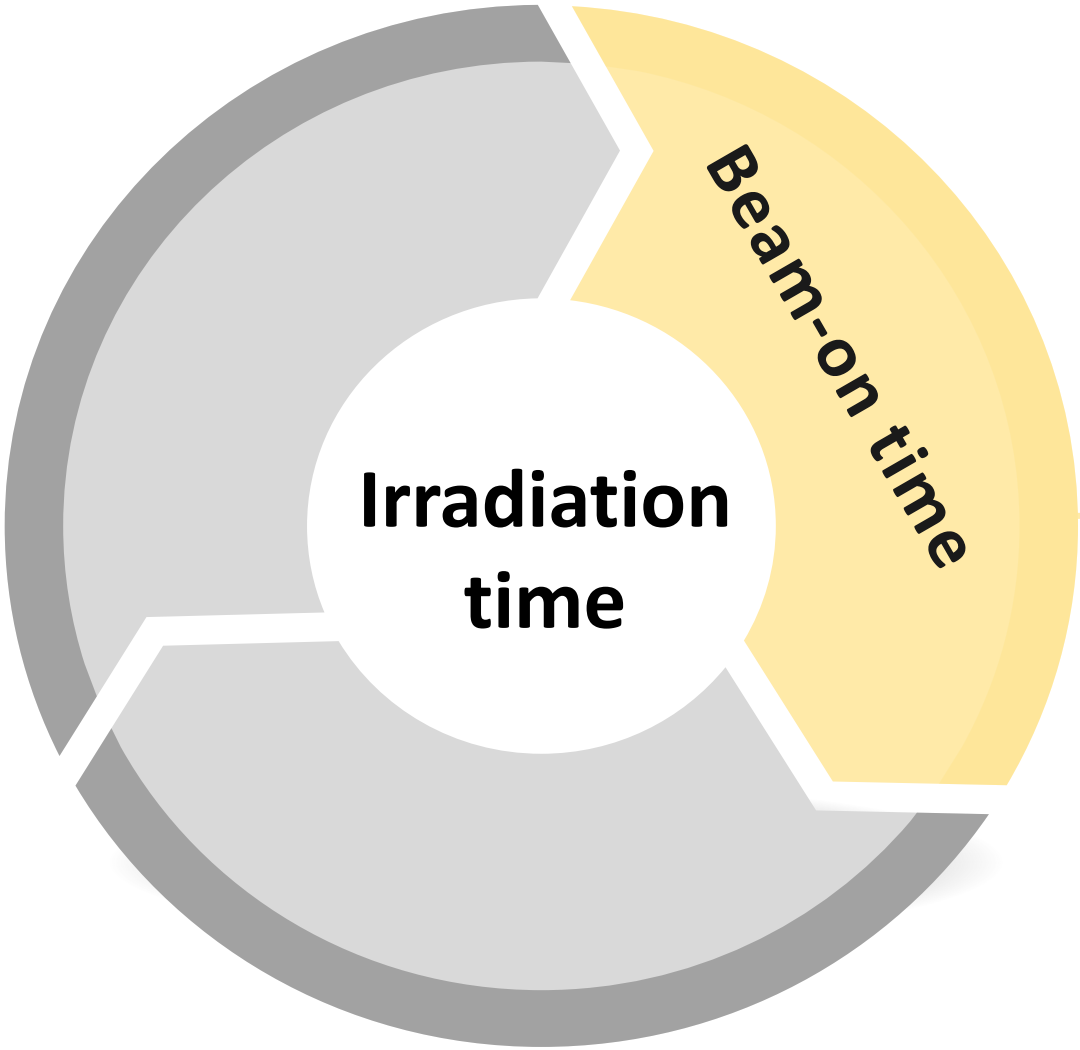
Not efficient in terms of **irradiation time**

Ultra-fast treatment delivery

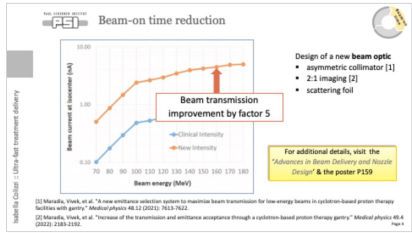
Irradiation time in PBS



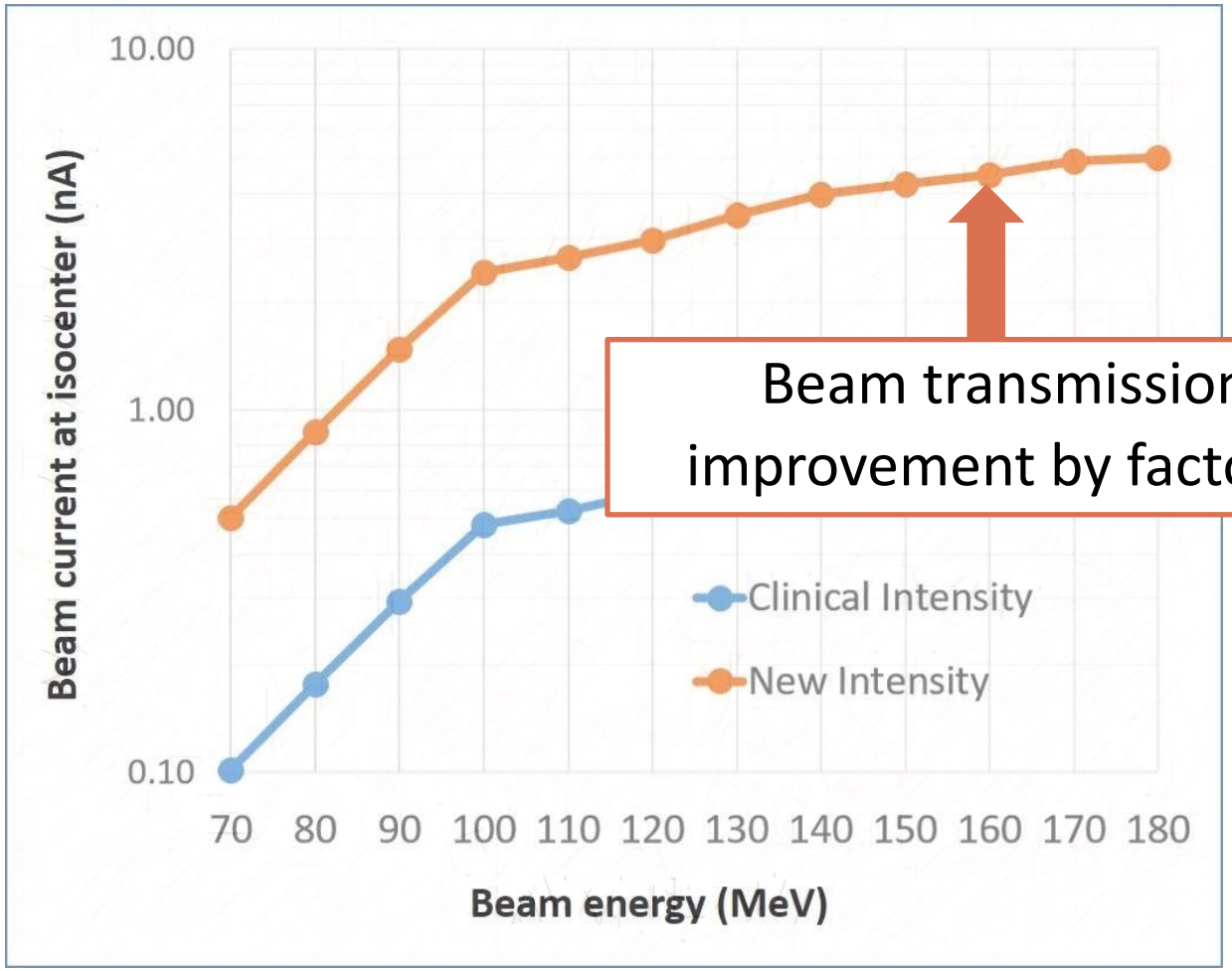
Irradiation time **reduction** in PBS



Beam-on time reduction with high intensity beams



Beam-on time reduction



Beam transmission improvement by factor 5

Design of a new **beam optic**

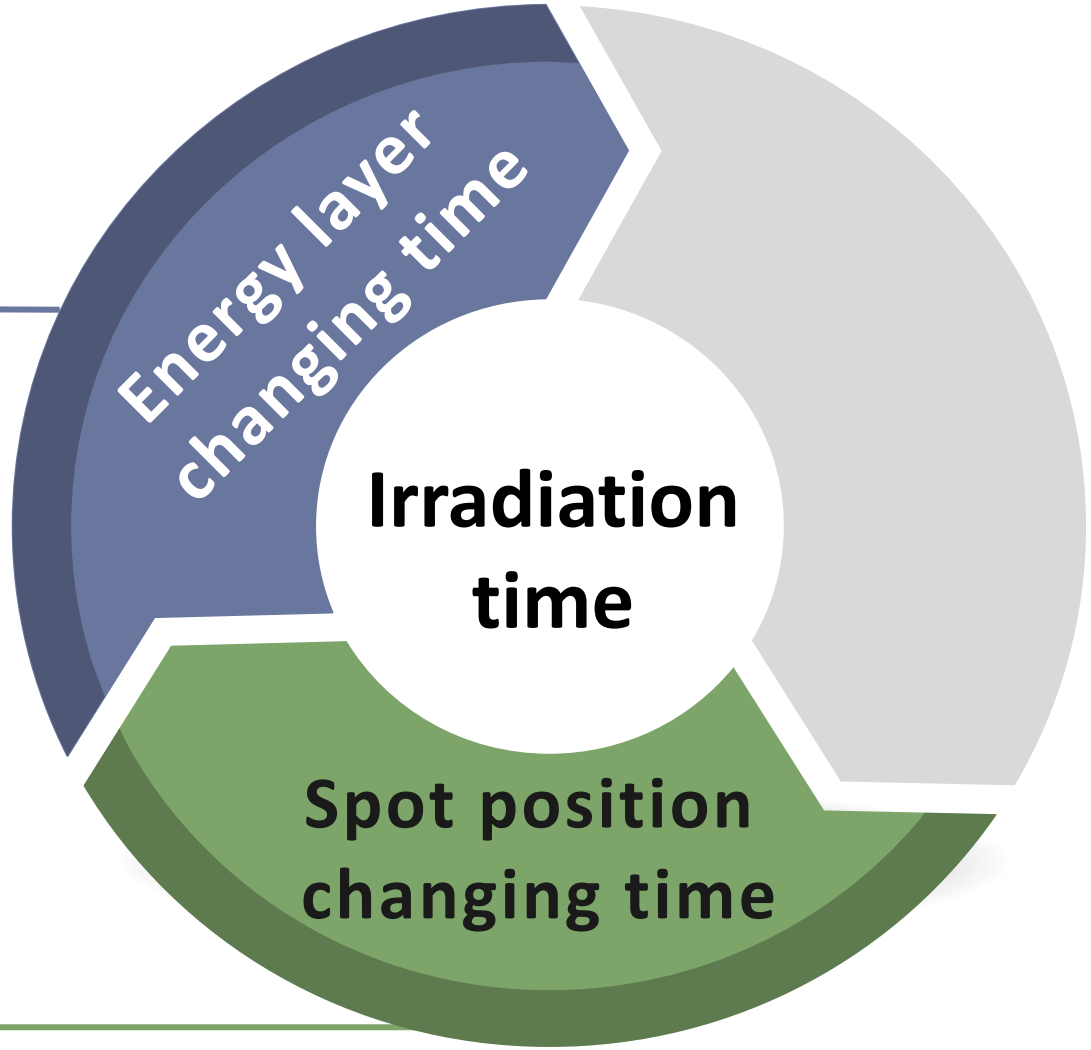
- asymmetric collimator [1]
- 2:1 imaging [2]
- scattering foil

For additional details, visit the '*Advances in Beam Delivery and Nozzle Design*' & the poster P159

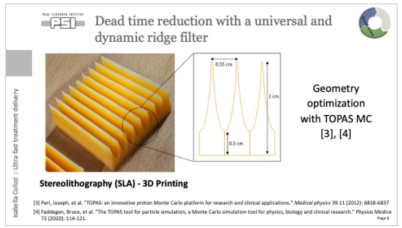
[1] Maradia, Vivek, et al. "A new emittance selection system to maximize beam transmission for low-energy beams in cyclotron-based proton therapy facilities with gantry." *Medical physics* 48.12 (2021): 7613-7622.

[2] Maradia, Vivek, et al. "Increase of the transmission and emittance acceptance through a cyclotron-based proton therapy gantry." *Medical physics* 49.4 (2022): 2183-2192.

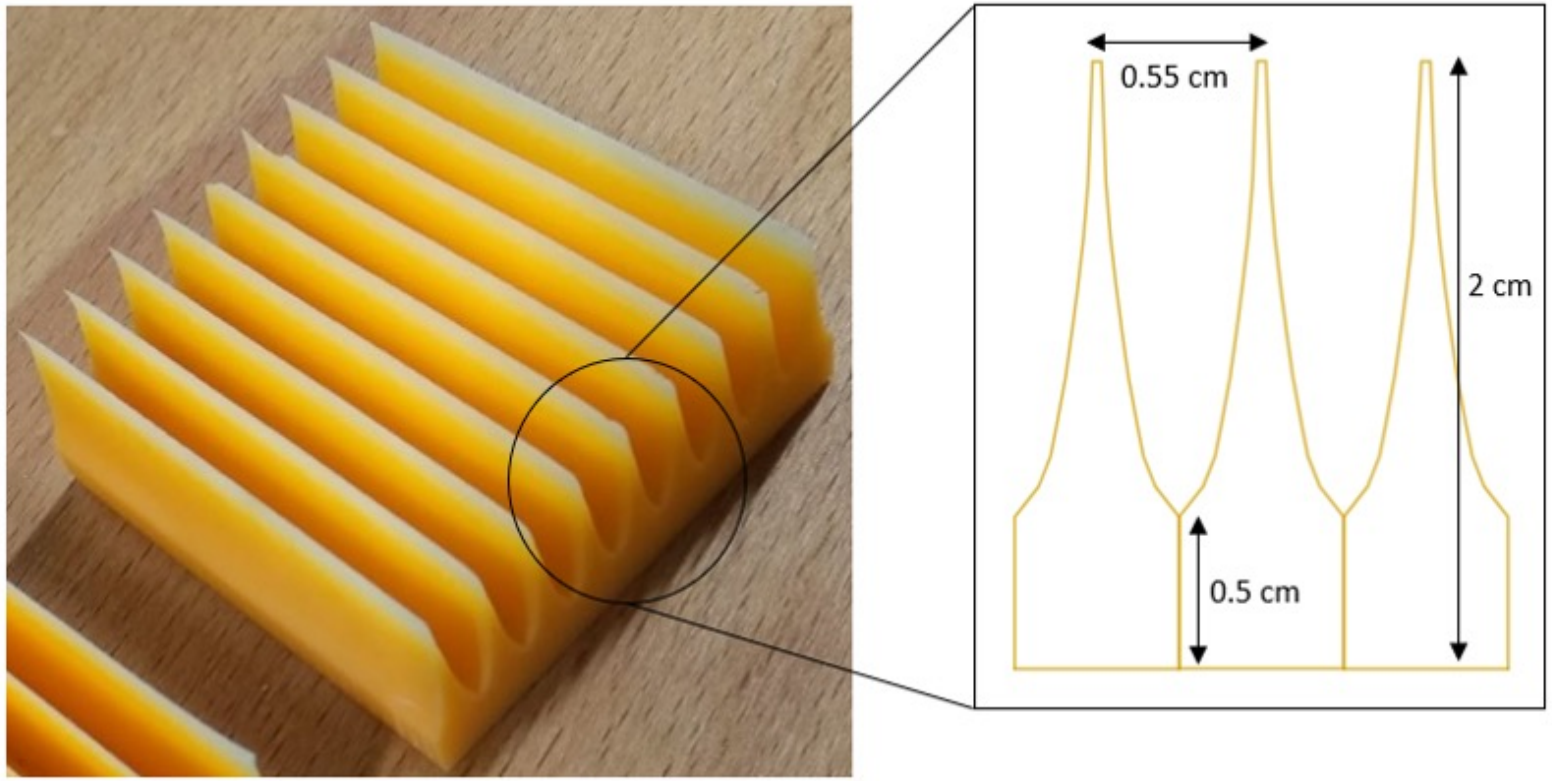
Irradiation time **reduction** in PBS



Dead time reduction with a universal and dynamic ridge filter



Dead time reduction with a universal and dynamic ridge filter



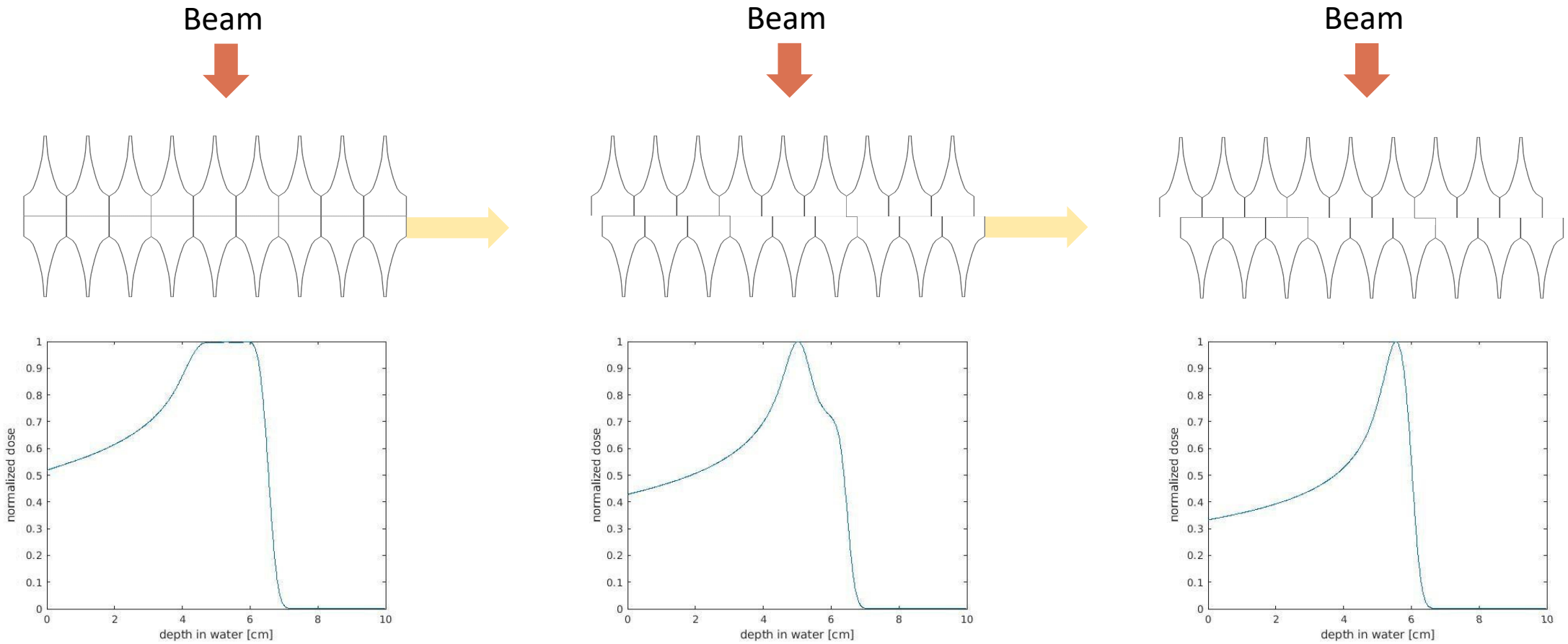
Geometry optimization with TOPAS MC [3], [4]

Stereolithography (SLA) - 3D Printing

[3] Perl, Joseph, et al. "TOPAS: an innovative proton Monte Carlo platform for research and clinical applications." *Medical physics* 39.11 (2012): 6818-6837

[4] Faddegon, Bruce, et al. "The TOPAS tool for particle simulation, a Monte Carlo simulation tool for physics, biology and clinical research." *Physica Medica* 72 (2020): 114-121.

A **dynamic** ridge filter

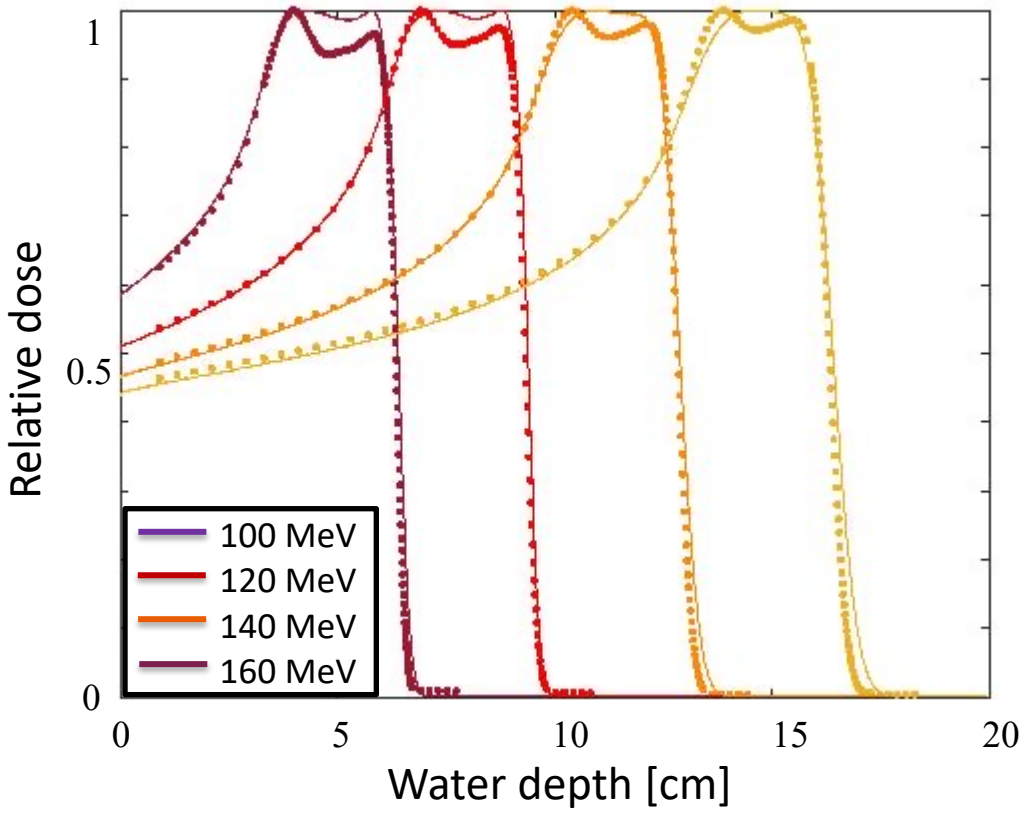


Maximum broadening

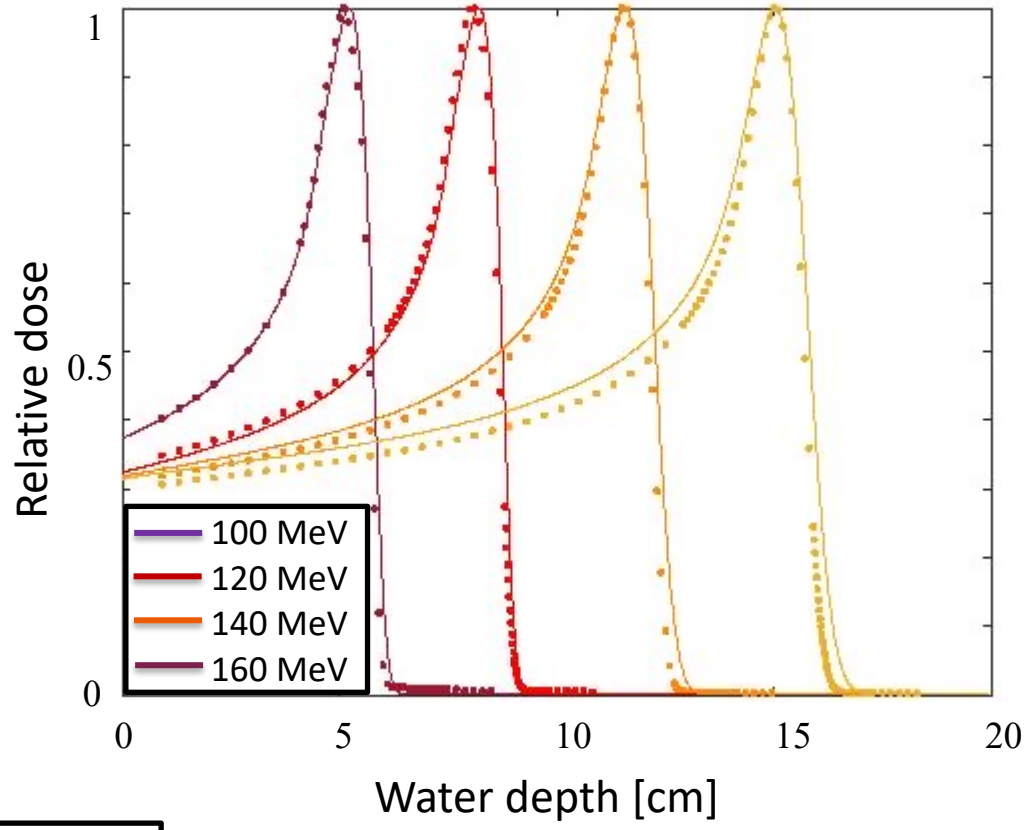
Minimum broadening

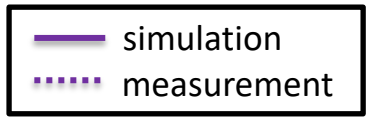
A **universal** ridge filter

Maximum broadening



Minimum broadening



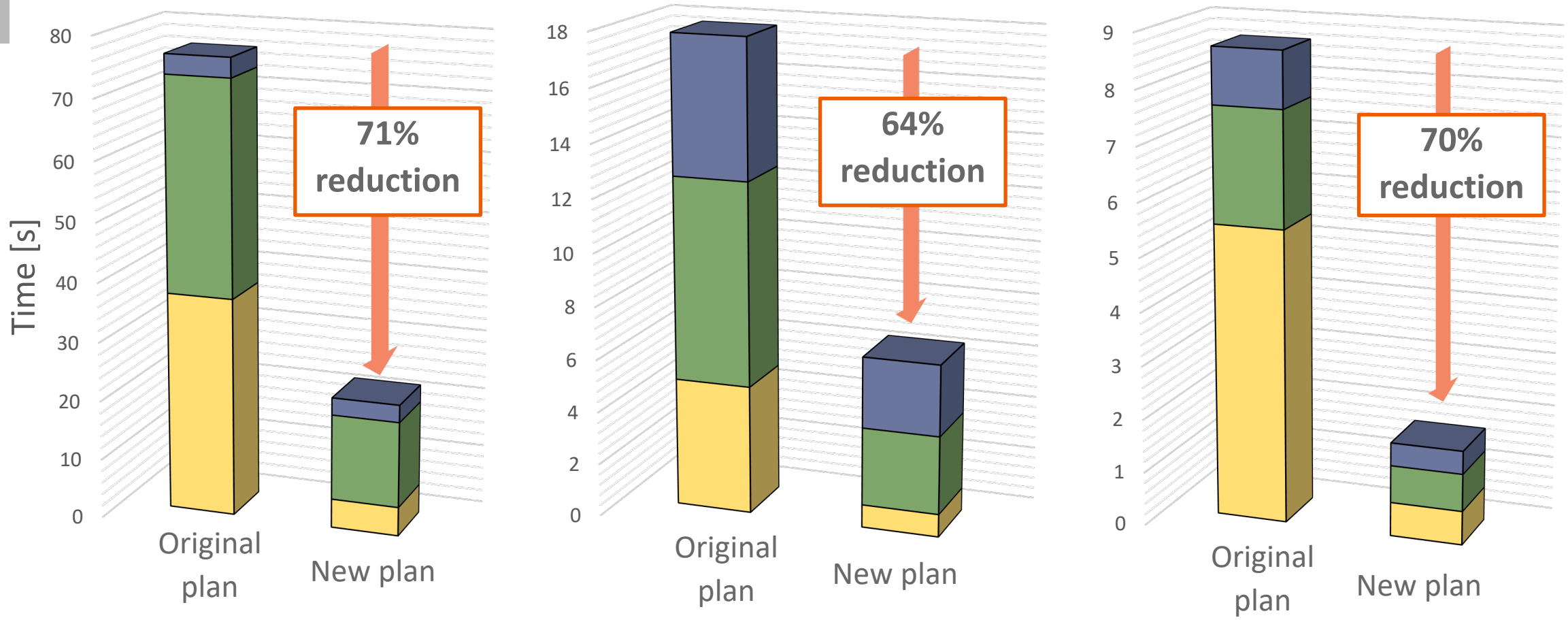


Experimental delivery of geometrical shapes

Sphere (904 cm^3
10 cm depth)

Cylinder (214 cm^3
h=17 cm, 12.5 cm depth)

Box (64 cm^3
L=4 cm, 11 cm depth)



Conclusion & Outlook

✓ Increase of the beam intensity by factor 5

Irradiation time reduction

✓ Design and experimental validation of a universal and dynamic ridge filter

~70% reduction in irradiation time

Experimental validation

for simple geometrical targets

Development of TPS for the dynamic

Outlook

ridge filter and planning study on real cases

Thank you for your attention!

Many thanks go to:

- Vivek Maradia
- David Meer
- Oxana Actis
- Serena Psoroulas
- Antony J. Lomax
- Damien C. Weber

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