

# Investigating Stopping Power influence on Dmax determination in proton beam microdosimetry

\*J. J. N. Pereira<sup>1,2</sup>, F. Matias<sup>2</sup>, P. C. G. Antunes<sup>1,2</sup>, J. M. B. Shorto<sup>2</sup>, P. T. D. Siqueira<sup>2</sup>, T. F. Silva<sup>1</sup>, C. L. Rodrigues<sup>1</sup>, A. Z. Freitas<sup>2</sup>, L. Otubo<sup>2</sup>, G. A. Machado<sup>2</sup>, P. L. Grande<sup>3</sup>, H. Yoriyaz<sup>2</sup>

<sup>1</sup>University of São Paulo, São Paulo, Brazil

<sup>2</sup>Nuclear and Energy Research Institute, IPEN-CNEN/SP, Brazil

<sup>3</sup>Federal University of Rio Grande do Sul, Porto Alegre, Brazil

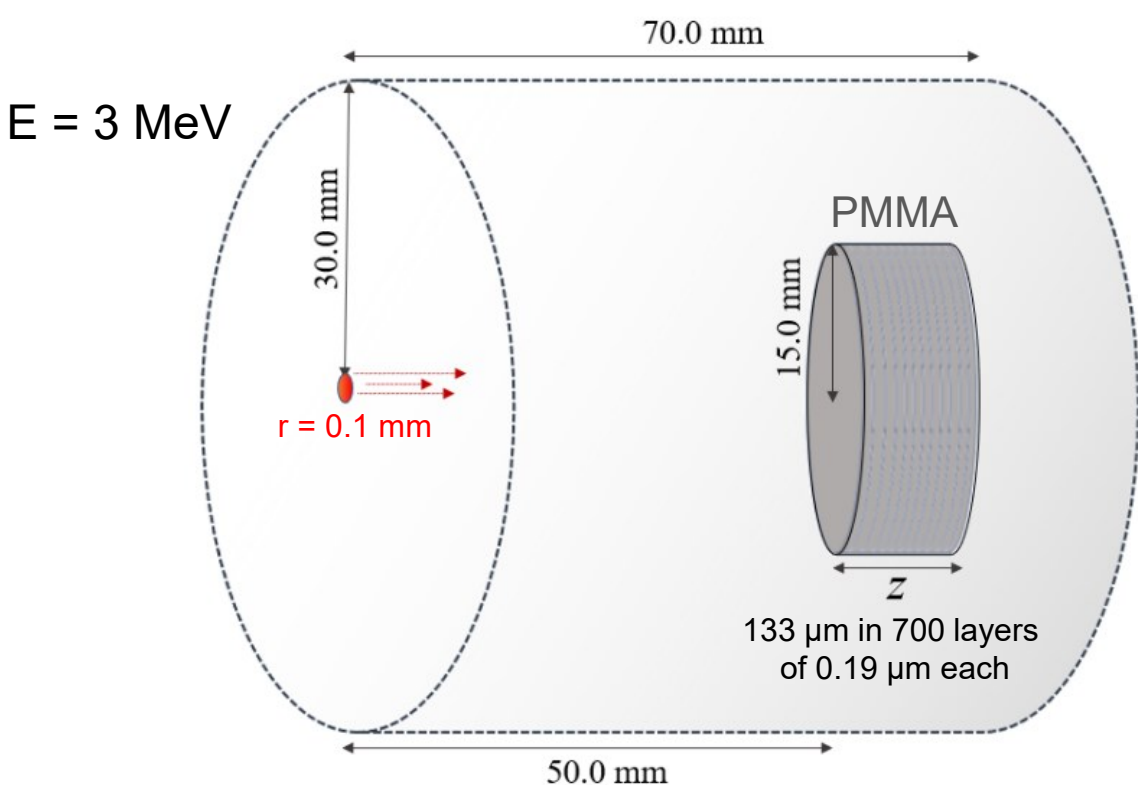
E-mail: juliojose-jj@usp.br

## Introduction

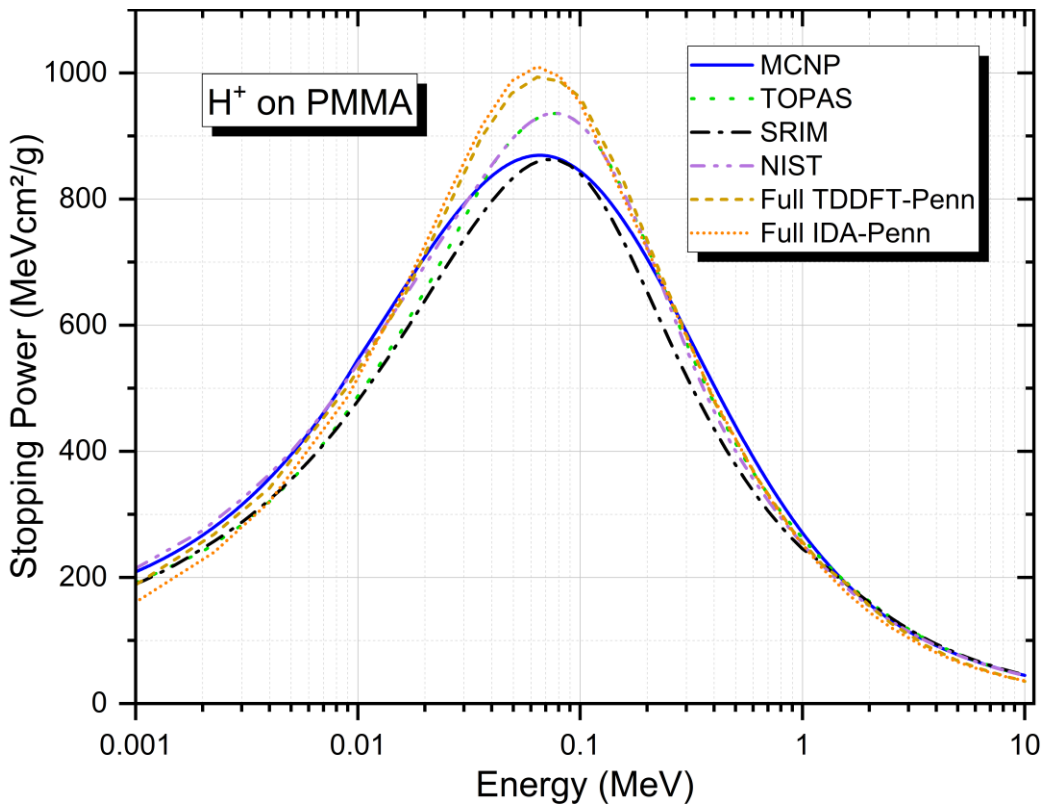
Charged particles, such as protons, lose energy when interacting with atoms as they penetrate a material, and the stopping power plays a significant role in the process of energy loss per unit distance traveled. Therefore, this study aimed to investigate the influence of stopping power on the determination of Dmax, which represents the maximum energy deposition depth at the Bragg Peak, and which is equivalent to the energy depth of the beam.

## Methodology

Monte Carlo simulations were conducted using the TOPAS and MCNP 6.2 codes, with the latter employing six different Stopping Power models.



Representation of the geometry used in the simulations.



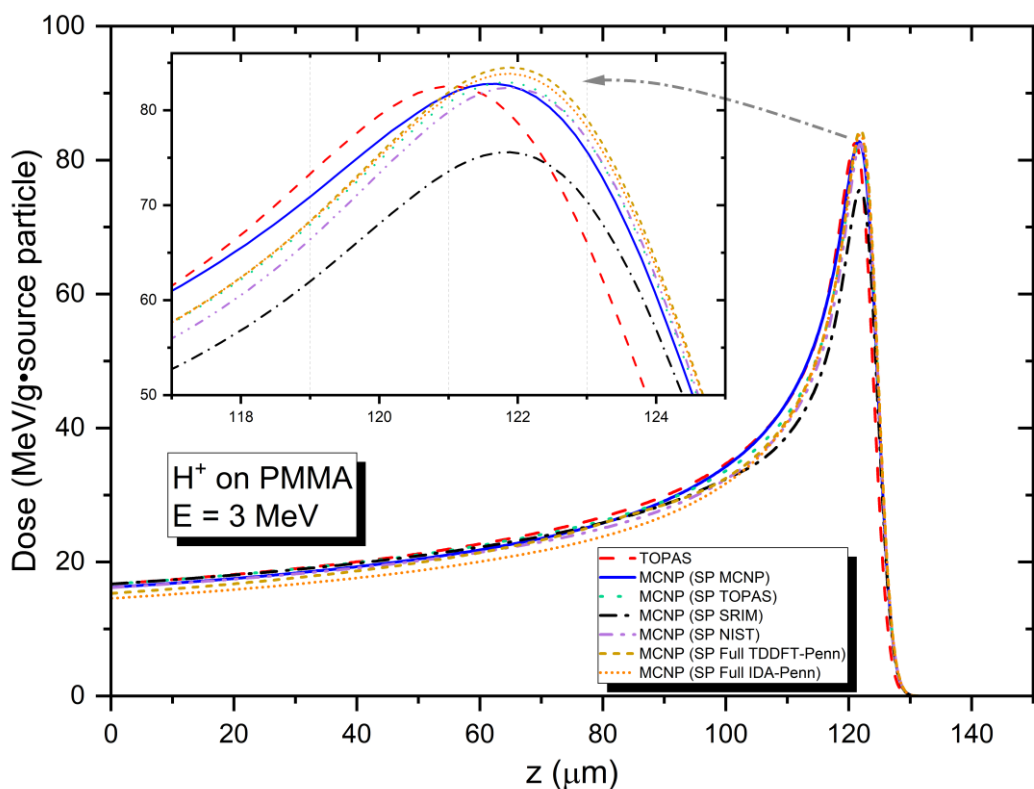
Stopping Power Models used in MCNP 6.2.

Tally used in TOPAS: “EnergyDeposit” | Unit: MeV/source particle.

Tally used in MCNP 6.2: F4 • DE DF | Unit: MeV/g•source particle.

In addition to the Monte Carlo simulations, experimental irradiations of PMMA samples took place at LAMFI-USP, followed by characterisation using a scanning electron microscope at LMM-IPEN to obtain Dmax measurements.

## Results and Discussions

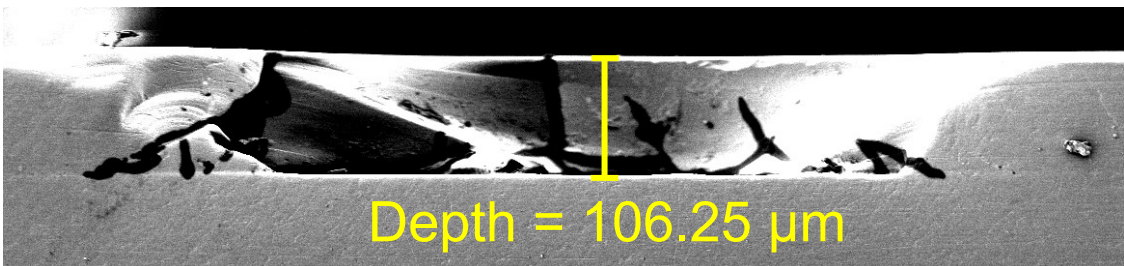
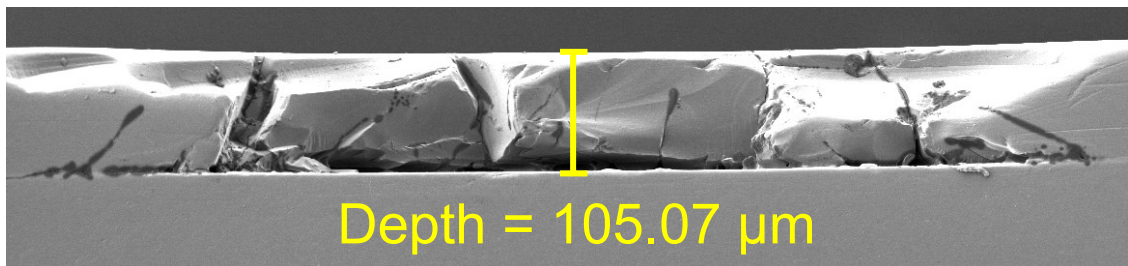


Bragg Peaks found in the simulations.

Dmax (μm)		Differences	
TOPAS	MCNP 6.2	AD (μm)	RD (%)
121.13	SP MCNP	121.70	- 0.57
	SP TOPAS	121.89	- 0.76
	SP SRIM	121.89	- 0.76
	SP NIST	121.89	- 0.76
	SP FTP	121.89	- 0.76
	SP FIP	121.89	- 0.76

Observation for all simulations: Relative Error ≤ 0.05 %

Values of Dmax found in the simulations.



Depth values for two PMMA samples exposed to a 3 MeV energy beam.

## Conclusions

- Modifying the Stopping Power model does not have a significant impact on the Dmax values, but it demonstrates the ability to influence the behavior of the Bragg peak.
- Conclusive experimental results will directly validate simulated outcomes, providing a solid foundation for interpretation and application of the simulations

## Acknowledgements

To CAPES for granting the scholarship under process 88887.704665/2022-00, and to IPEN for funding project 2020.06.IPEN.32.