

# SmartPhantom: Current State of Simulation

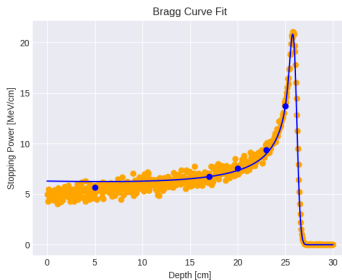
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# Summary

## Simulation

- The simulation at the moment simulates an arbitrary distribution passing through the phantom.
- Measures at several scintillating fibre stations positioned prior to the peak of the Bragg curve.
- Fit Bortfeld's equation to the measurements (blue points) to model Bragg curve.



**Figure:** Orange represents the energy deposition in just water, blue represents measurements recorded at scintillating fibres. Hope to make a fit to predict the stopping power at a downstream position (i.e. bragg peak).

## Expected Output from Beam

Particle	Energy	# Particles	Spot Sizes (at Isocenter)
Proton	Min: 62.4 MeV Max: 252.7 MeV	$\sim 1.8 \times 10^{10}$ particles/spill	Min: $7 \times 7 \text{ mm}^2$ Max: $20 \times 20 \text{ mm}^2$
Carbon ( $\text{C}^{6+}$ )	Min: 120.0 MeV/u Max: 402.8 MeV/u	$\sim 4.5 \times 10^8$ particles/spill	Min: $6.5 \times 6.5 \text{ mm}^2$ Max: $8 \times 8 \text{ mm}^2$

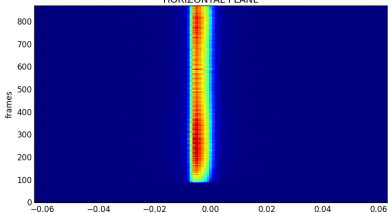
Table: Table of beam specifications for IR1 which will be used for the SmartPhantom at MedAustron.

- A degrader is likely to be used to reduce the intensity.
- Length of a spill varies, but usually is 4 to 5 seconds.

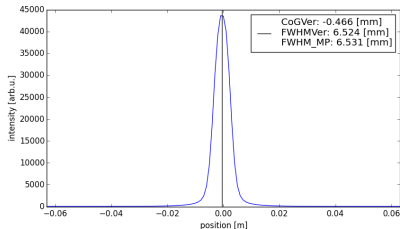
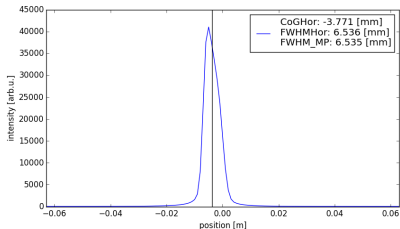
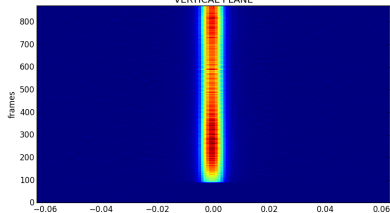
# Preliminary Carbon Beam 402.8 Mev/u with Strip Detector at Isocenter

IC00000ICM PRELIMINARY DATA ANALYSIS (NO NOISE/BKGD HANDLING!) - 2019/03/24 16:15:38  
R:\ACC\BC\MEAS\2019\IR1\#14716\_Carbon\_HEBT\#14935\_SpotSize\21energies\_verification\_third\FBC.sv  
FWHMavg: 6.53 [mm], FWHMdelta: 0.09 [mm], roundness: 1.44 [%]

HORIZONTAL PLANE

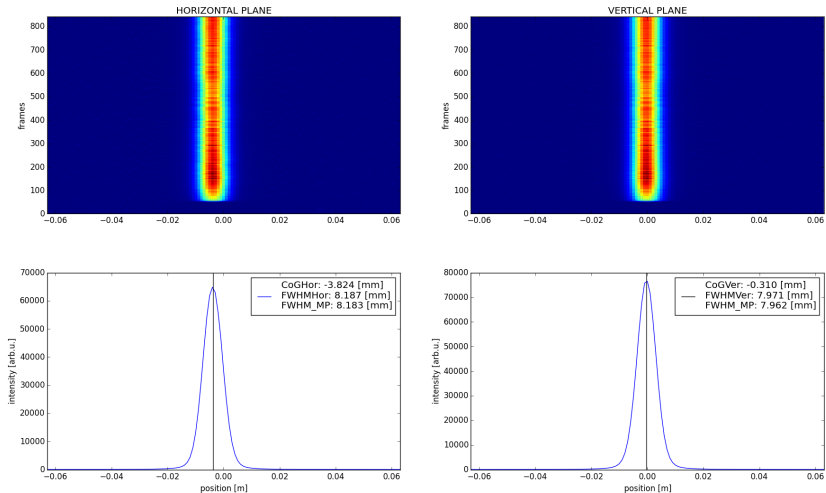


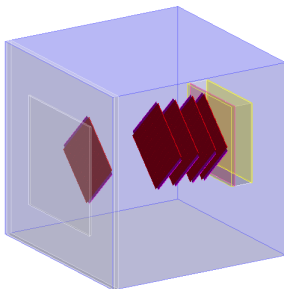
VERTICAL PLANE



# Preliminary Carbon Beam 120.0 Mev/u with Strip Detector at Isocenter

IC00000ICM PRELIMINARY DATA ANALYSIS (NO NOISE/BKGD HANDLING!) - 2019/03/24 16:22:41  
R:\ACC\BC\MEAS\2019\IR1\#14716\_Carbon\_HEBT\#14935\_SpotSize\21energies\_verification\_third\4B0.csv  
FWHMavg: 8.08 [mm], FWHMdelta: 0.21 [mm], roundness: 2.66 [%]





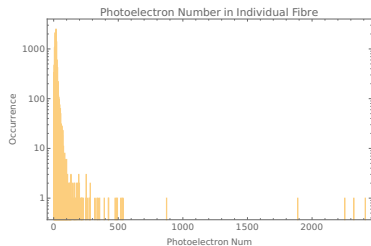
**Figure:** Visualization of simulation of water phantom. Beam comes from left passing through 5 scintillating fibre stations into an arbitrarily sized flask.

## Procedure to Get Photoelectron Number from Simulation

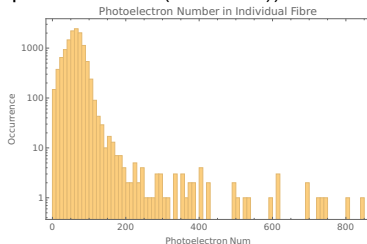
- Geant4 simulation measures the energy deposition within the scintillating fibre layers.
- Use the MAUS conversion factor to convert from energy deposition → photoelectron number.
- Take this value as the mean value of a Poisson distribution, and randomly select a value to represent the number of photoelectrons detected.

# Very Rough Number of Photoelectrons – Proton 200

If simulations can be trusted, the number of photoelectrons according to the procedure in previous slide. (10,000 proton events (200 MeV))



**Figure:** Histogram of number of photoelectrons detected in a single fibre in 5 cm depth. (Log Scale)

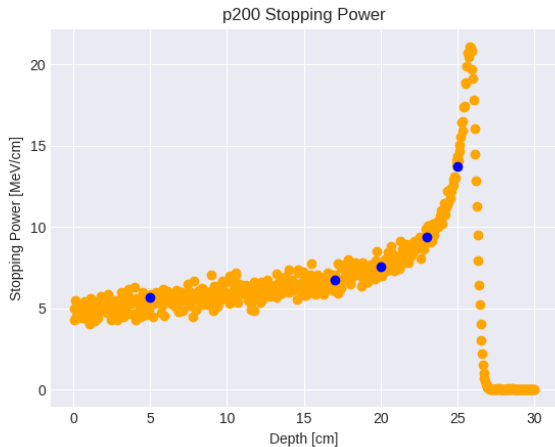


**Figure:** Histogram of number of photoelectrons detected in a single fibre in 25 cm depth. (Log Scale)



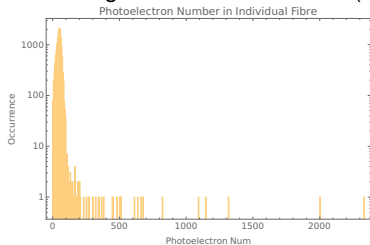
## p200 – Pristine Bragg Curve

Stopping power of p200 MeV simulated for reference of SciFi references:

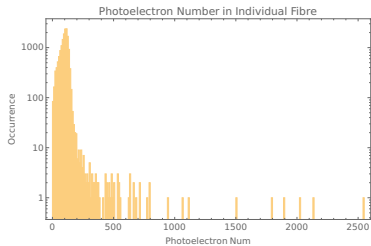


# Very Rough Number of Photoelectrons – Proton 62.4

Simulating 10000 carbon events (120.0 MeV/u):



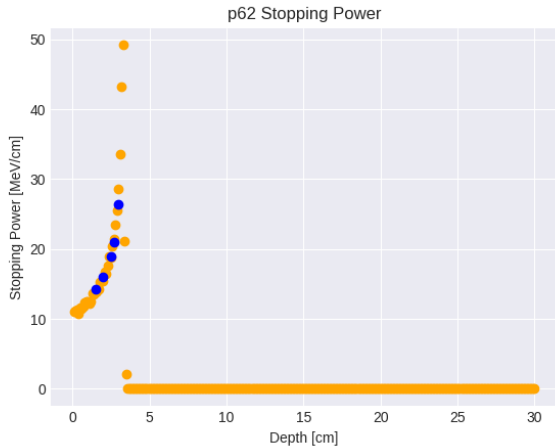
**Figure:** Histogram of number of photoelectrons detected in a single fibre at 1.5 cm depth. (Log-scale)



**Figure:** Histogram of number of photoelectrons detected in a single fibre at 3 cm depth. (Log-scale)

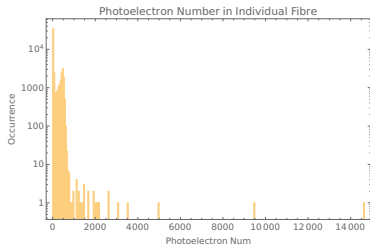
## p62.4 – Pristine Bragg Curve

Stopping power of p62 MeV simulated for reference of SciFi references:

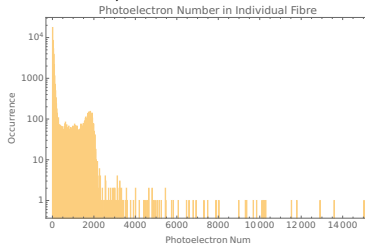


# Very Rough Number of Photoelectrons – Carbon 402.8

Simulating 10000 carbon events (402.8 MeV/u):



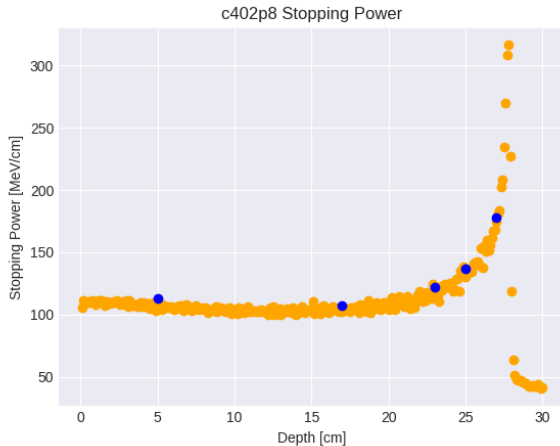
**Figure:** Histogram of number of photoelectrons detected in a single fibre at 5 cm depth. (Log-scale)



**Figure:** Histogram of number of photoelectrons detected in a single fibre at 27 cm depth. (Log-scale)

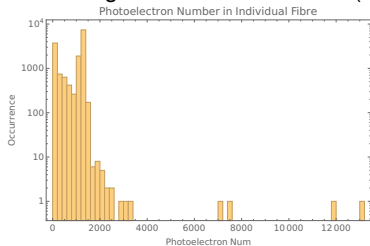
## c402p8 – Pristine Bragg Curve

Stopping power of c402.8 MeV simulated for reference of SciFi references:

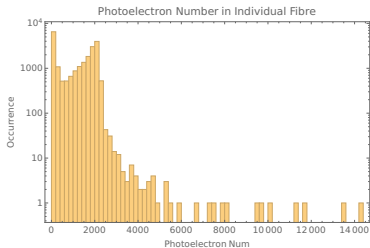


# Very Rough Number of Photoelectrons – Carbon 120.0

Simulating 10000 carbon events (120.0 MeV/u):



**Figure:** Histogram of number of photoelectrons detected in a single fibre at 1.5 cm depth. (Log-scale)



**Figure:** Histogram of number of photoelectrons detected in a single fibre at 3 cm depth. (Log-scale)

## c120p0 – Pristine Bragg Curve

Stopping power of c120.0 MeV simulated for reference of SciFi references:

