

# Proton hit rate estimations

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pCT – WP1 meeting

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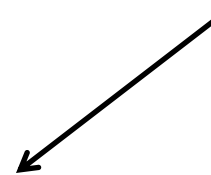
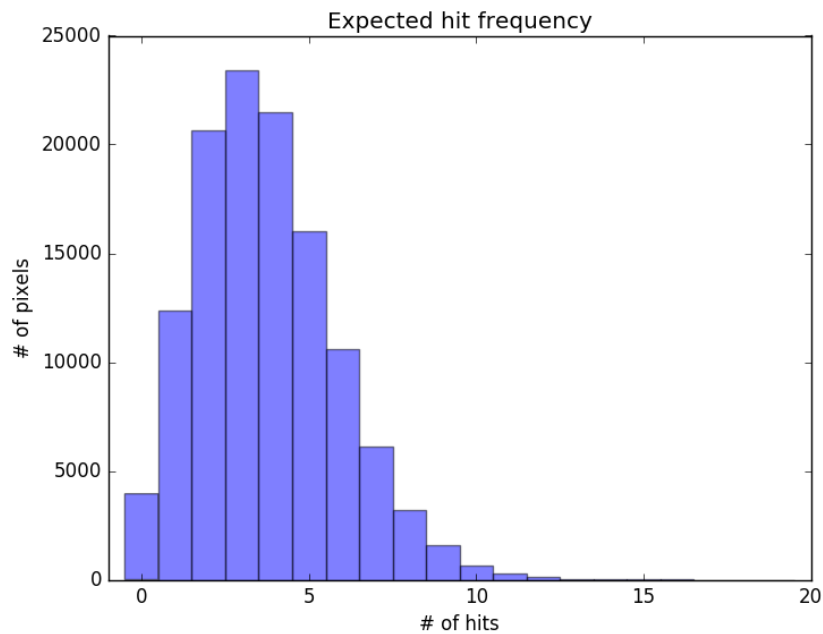
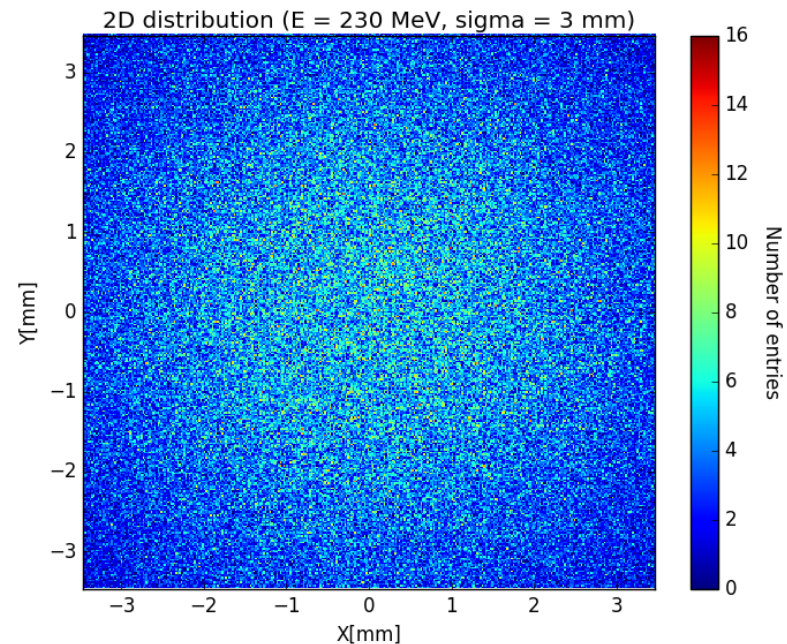
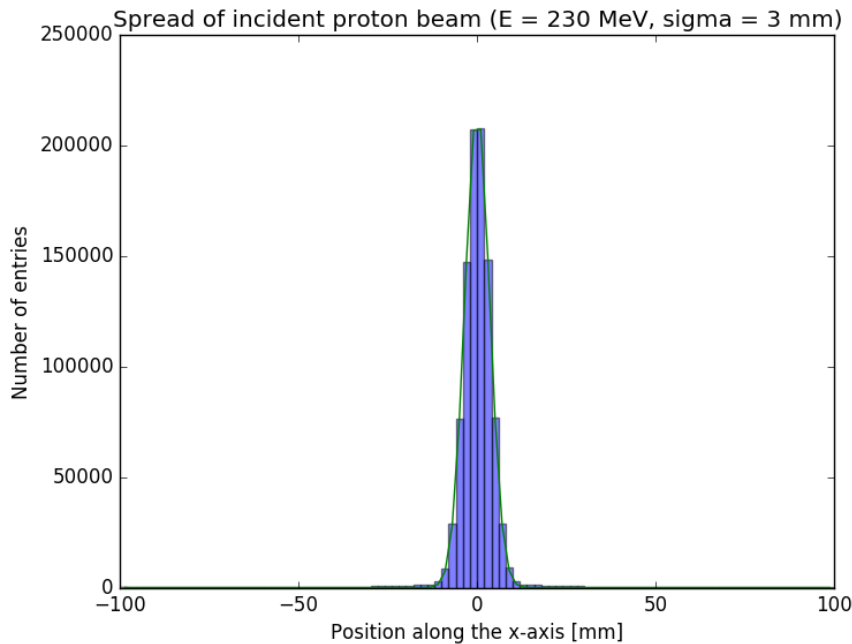
# Background

- In one spill
  - $10^9$  protons / s
- If we assume 1000 spots
  - $10^6$  protons / spot / ms
- Goal
  - On the average, 1 proton-hit / pixel / ms on the first layer
- Monoenergetic proton beam
  - $E = 230$  MeV
- Gaussian spatial distribution
  - $\sigma = 3.0$  mm
- MCNP6.1 by LANL

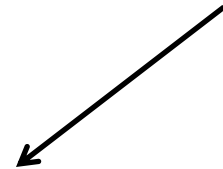
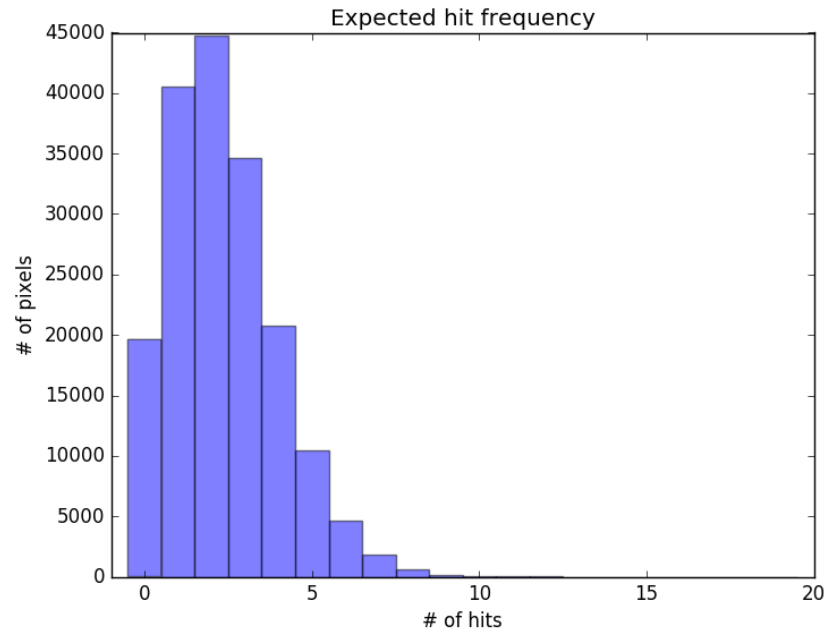
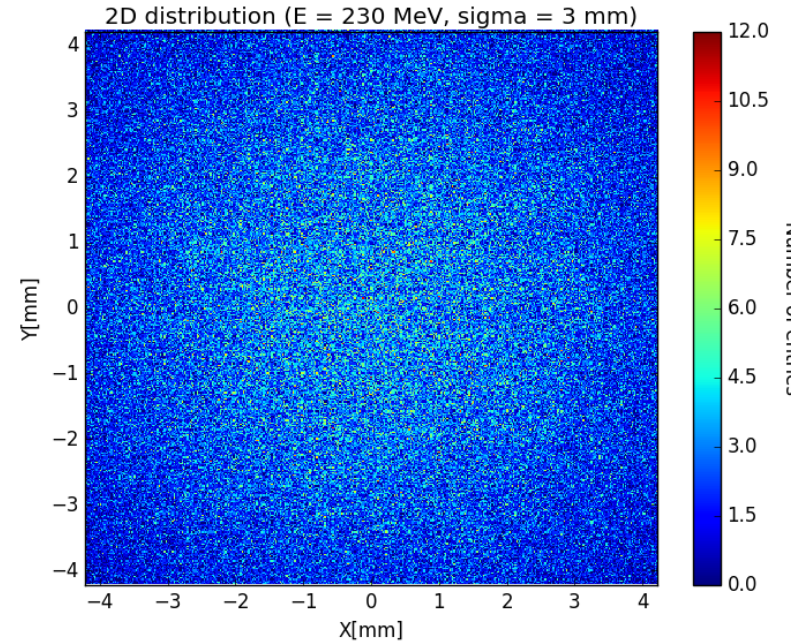
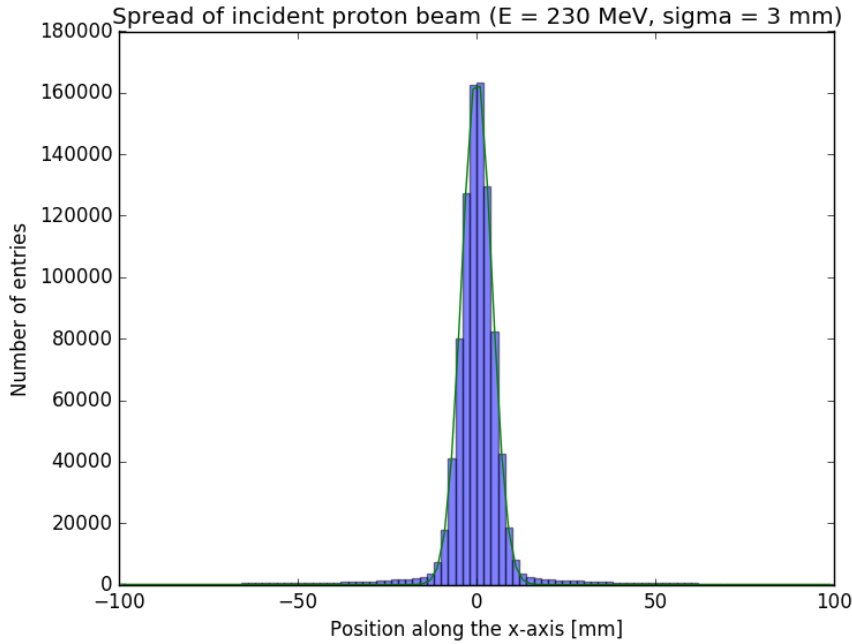
# The current approach

- Analysis steps
  - Generate 1D distribution on the first layer
  - Gaussian fit
    - Determine  $\sigma_{\text{beam}}$  on the first layer
  - Generate 2D histogram on the first layer
    - $x : [-\sigma_{\text{beam}}, \sigma_{\text{beam}}]$ ,  $y : [-\sigma_{\text{beam}}, \sigma_{\text{beam}}]$
    - Set bin-size to  $20 \mu\text{m} \rightarrow$  pixel-size :  $20 \times 20 \mu\text{m}^2$
  - Calculate and plot ( $x, y$  as given above)
    - Hit distribution / Avg. hit rate / Multiple-hit fractions / Single-hit fractions / Single-to-Multiple hit ratios
  - Repeat for water phantoms [50 mm, 250 mm, 50 mm] and phantom – detector distances [0 mm, 500 mm, 50 mm]

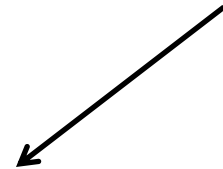
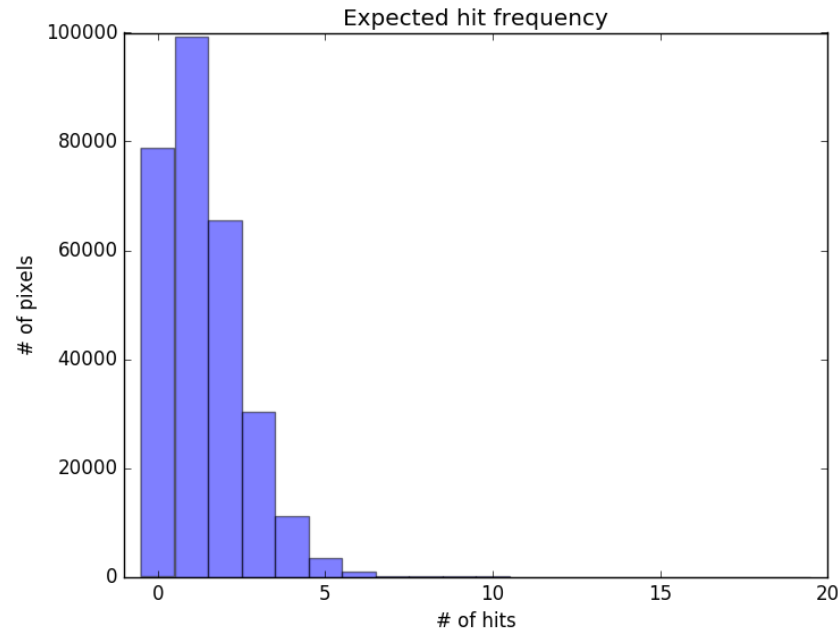
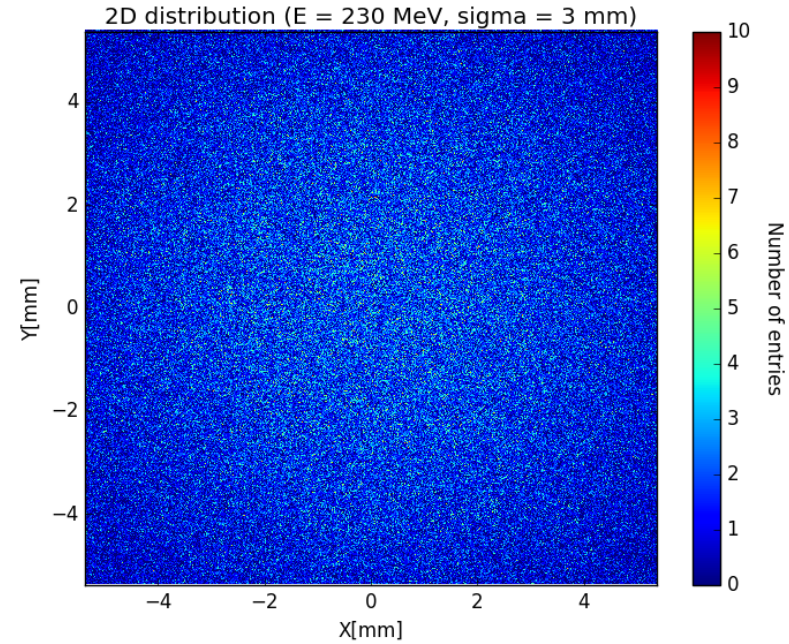
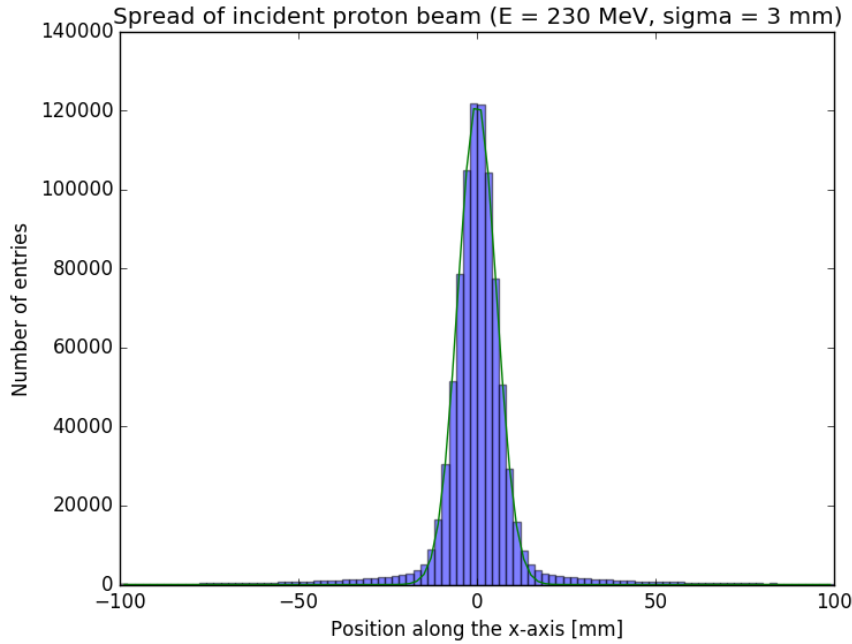
$d_{\text{detector}} = 100 \text{ mm}$  ,  $t_{\text{phantom}} = 50 \text{ mm}$



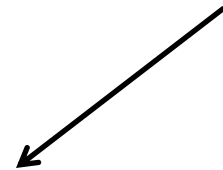
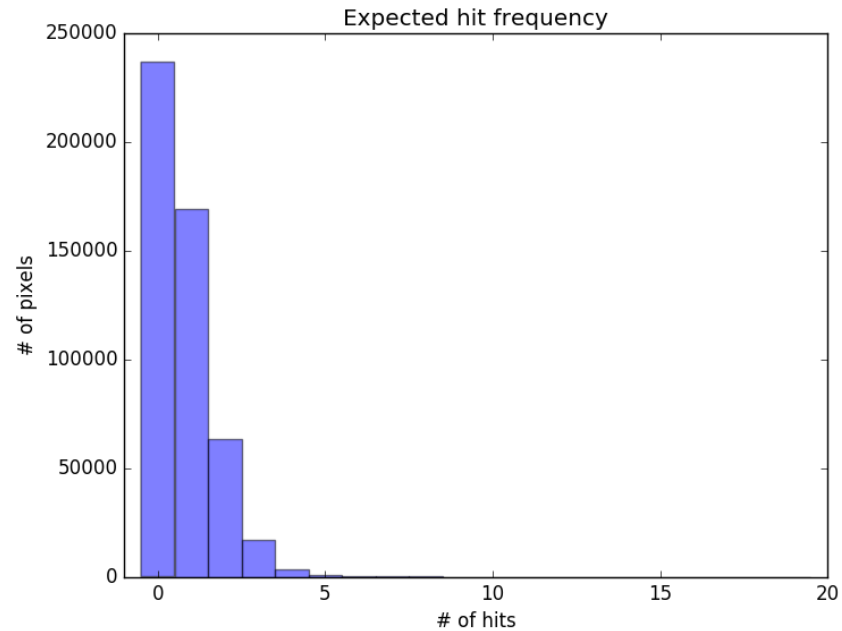
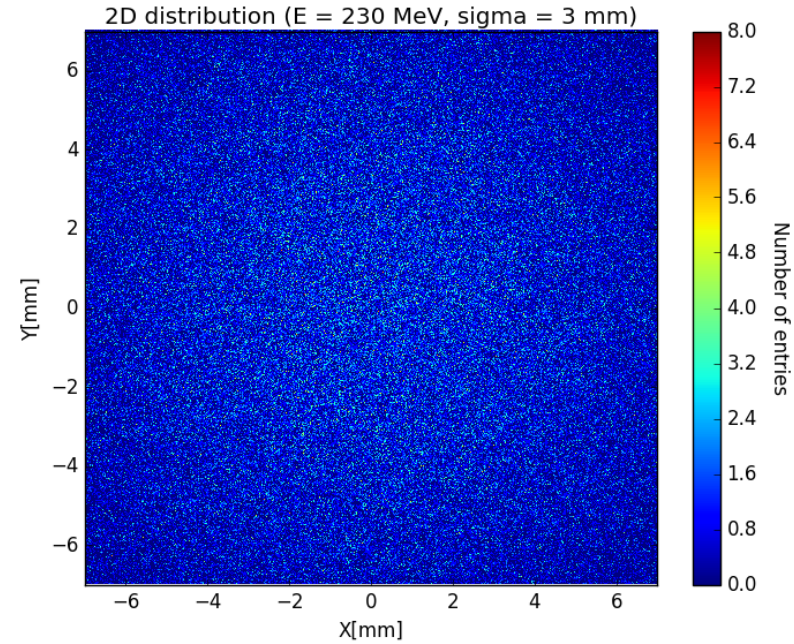
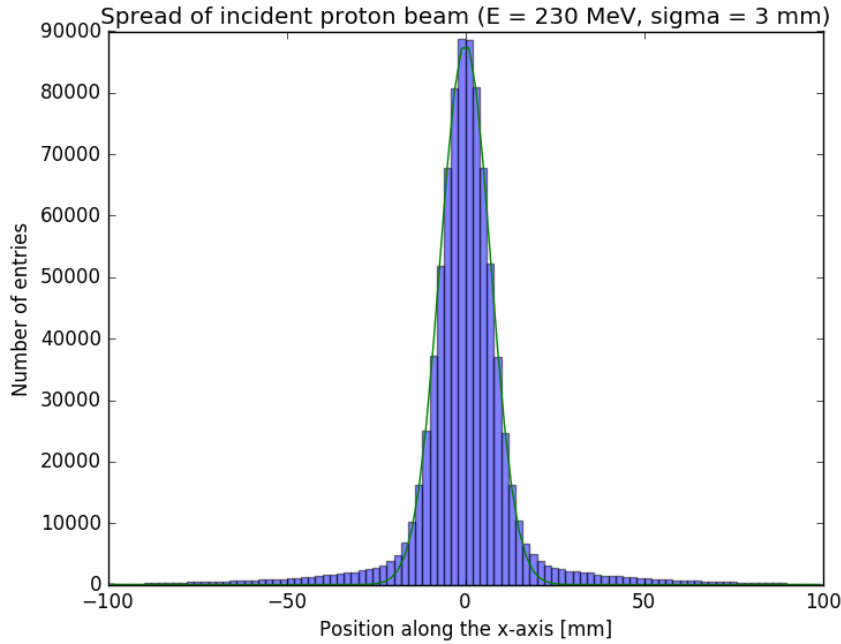
$d_{\text{detector}} = 100 \text{ mm}$  ,  $t_{\text{phantom}} = 100 \text{ mm}$



$d_{\text{detector}} = 100 \text{ mm}$  ,  $t_{\text{phantom}} = 150 \text{ mm}$

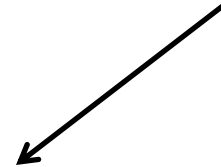
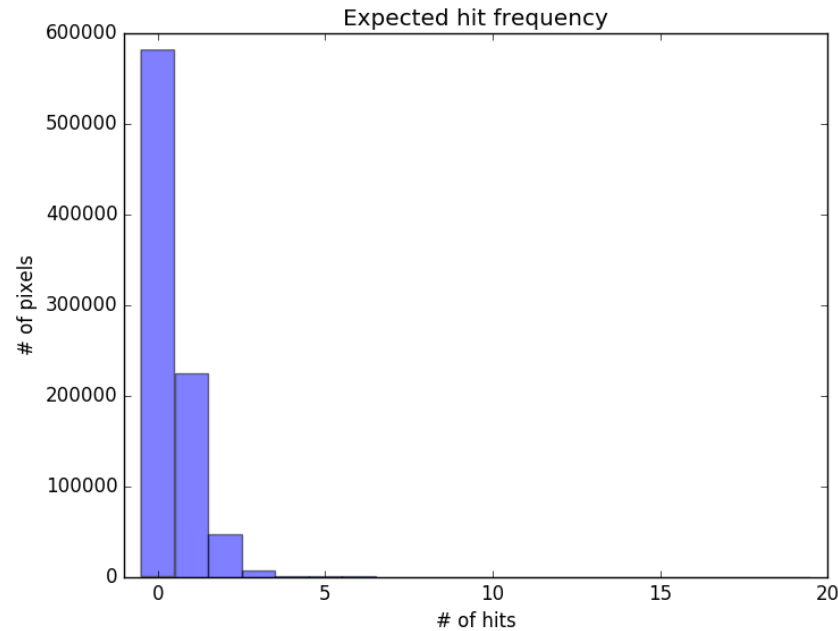
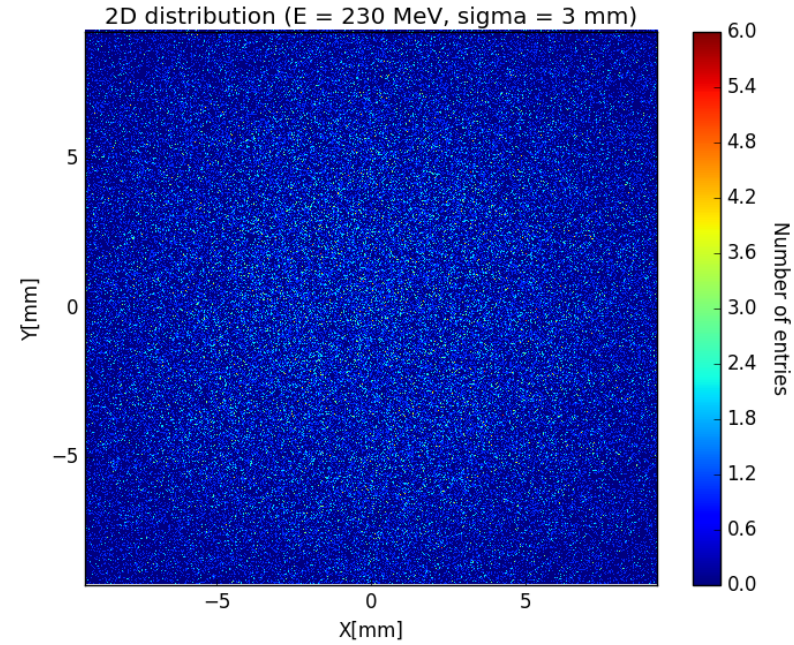
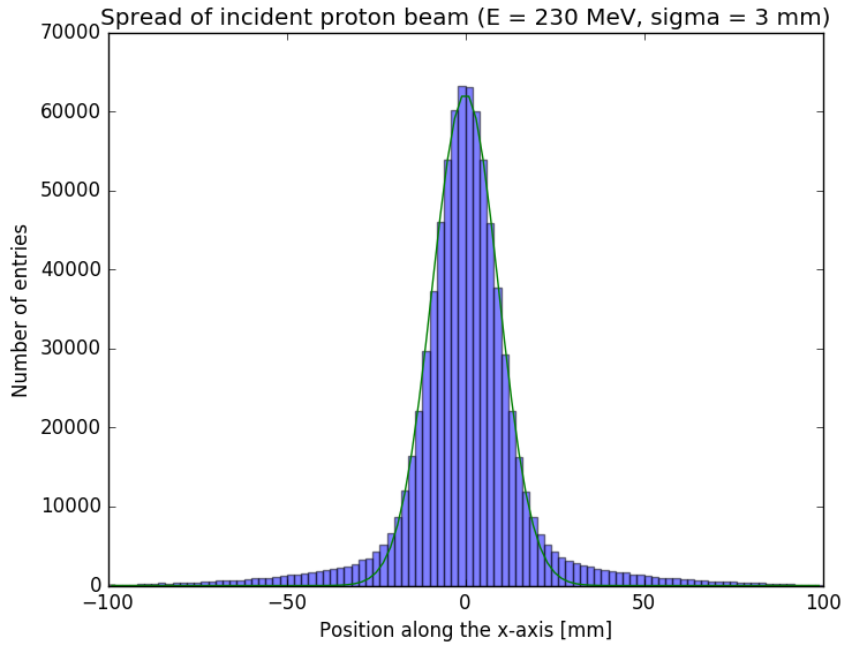


$d_{\text{detector}} = 100 \text{ mm}$  ,  $t_{\text{phantom}} = 200 \text{ mm}$



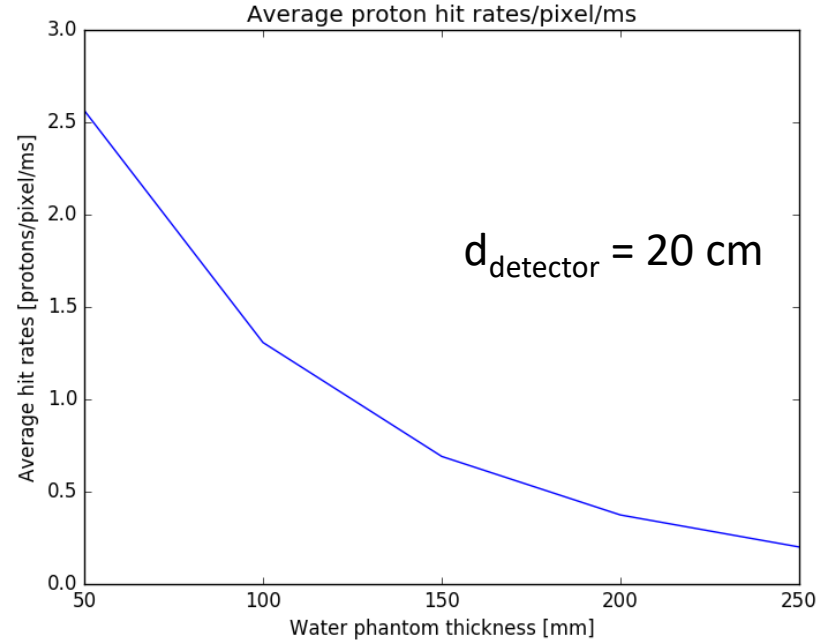
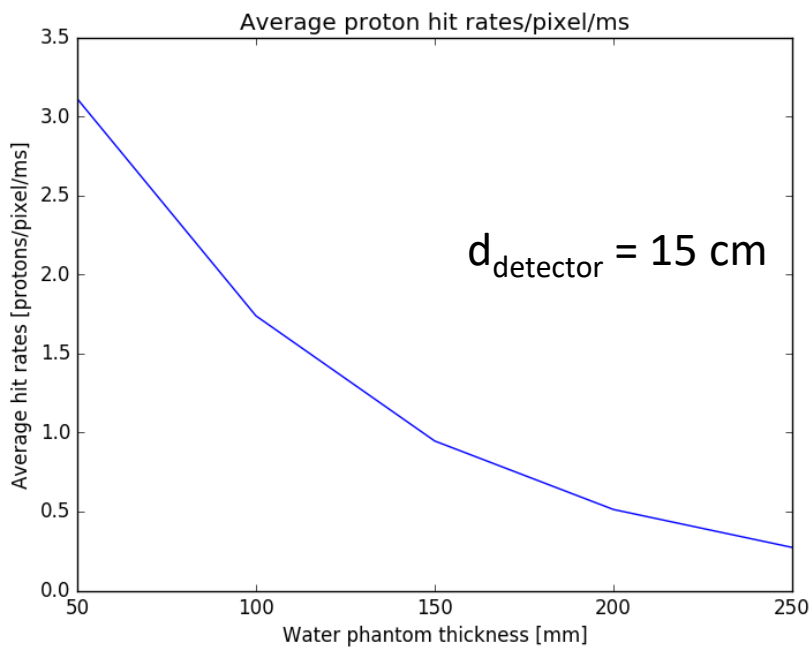
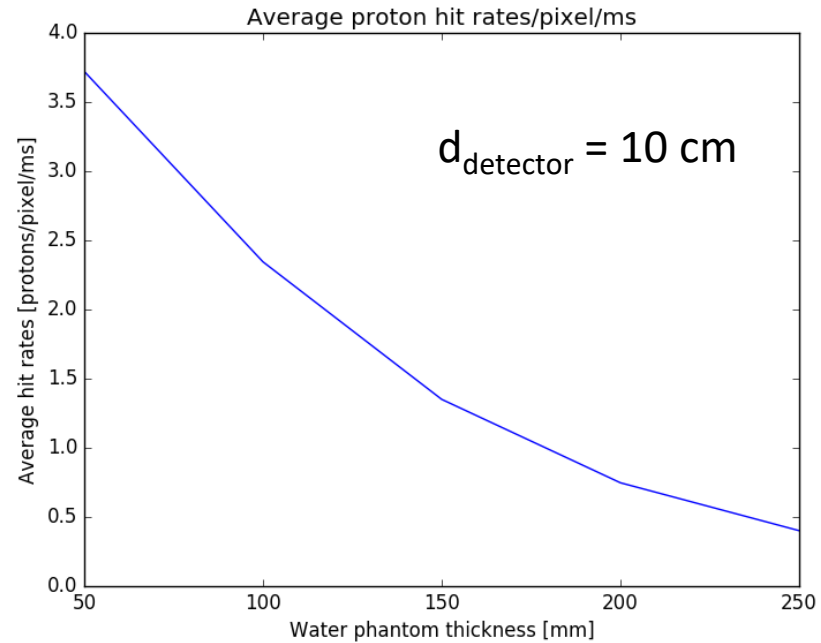
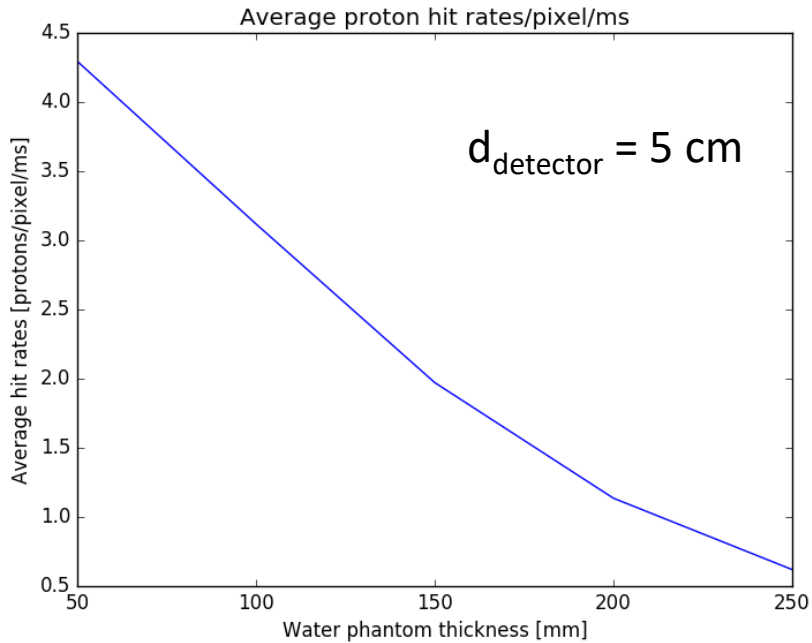


$d_{\text{detector}} = 100 \text{ mm}$  ,  $t_{\text{phantom}} = 250 \text{ mm}$

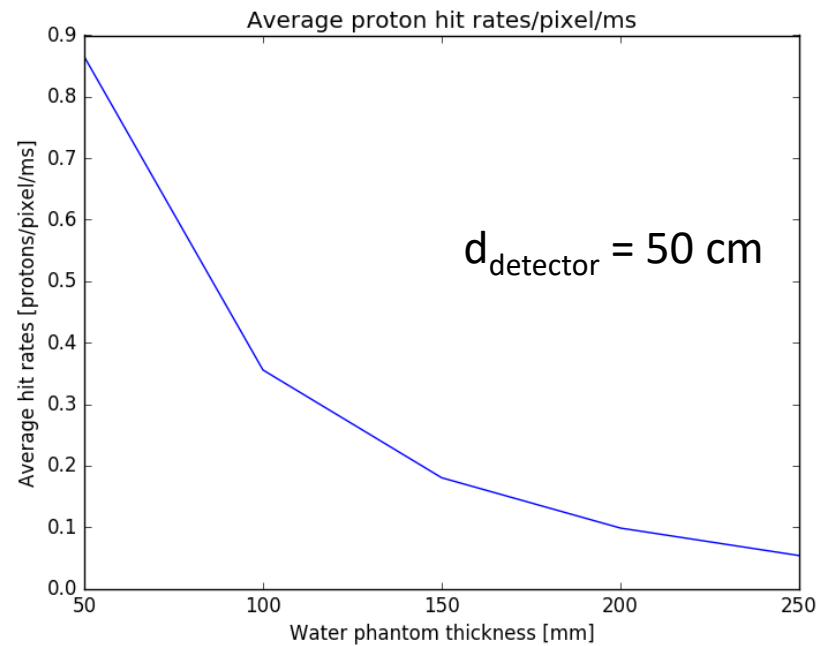
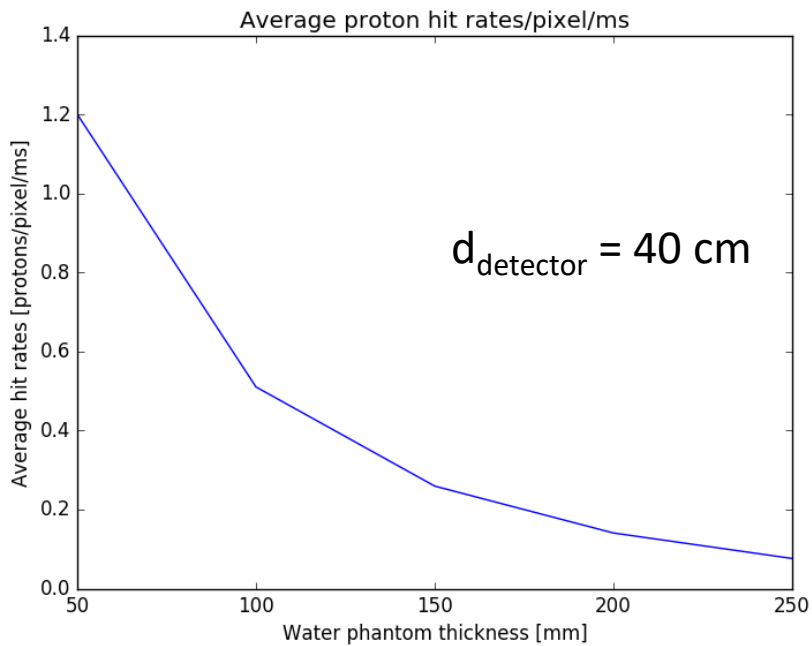
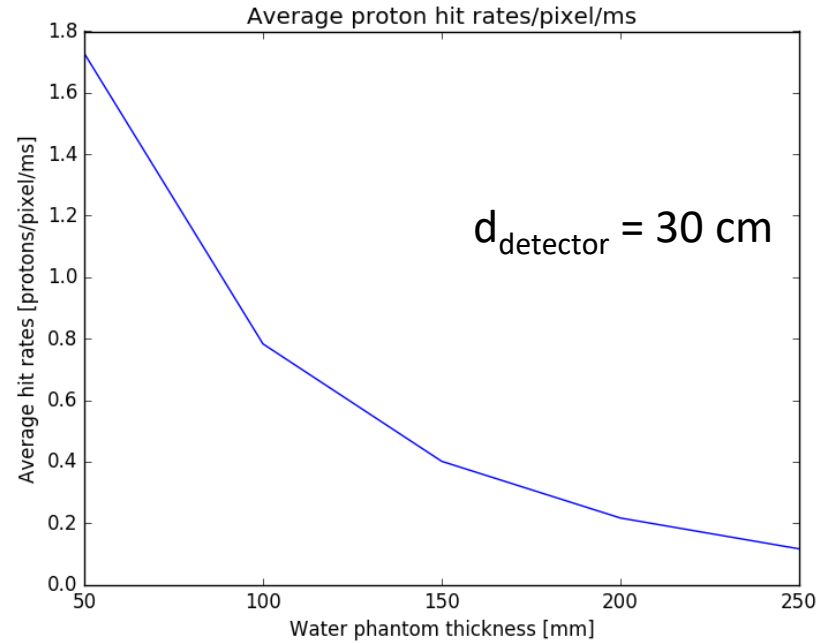
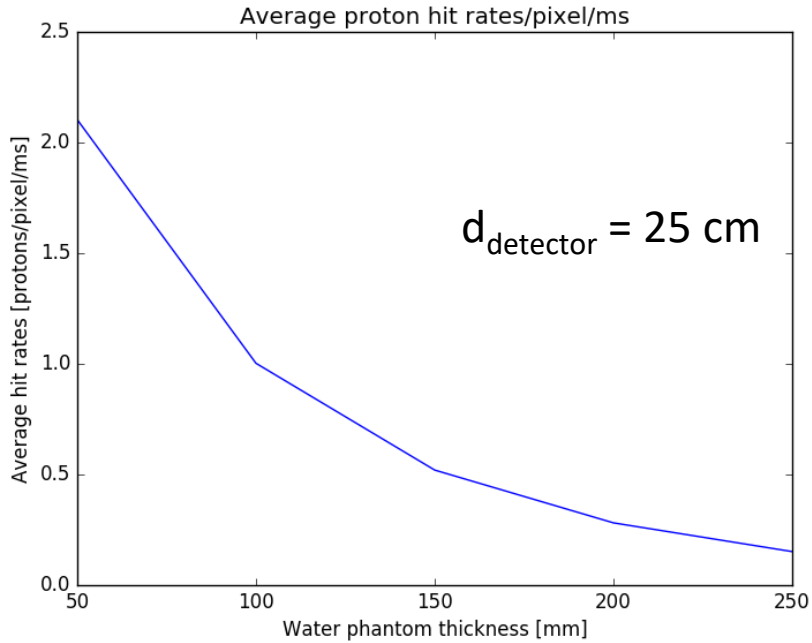




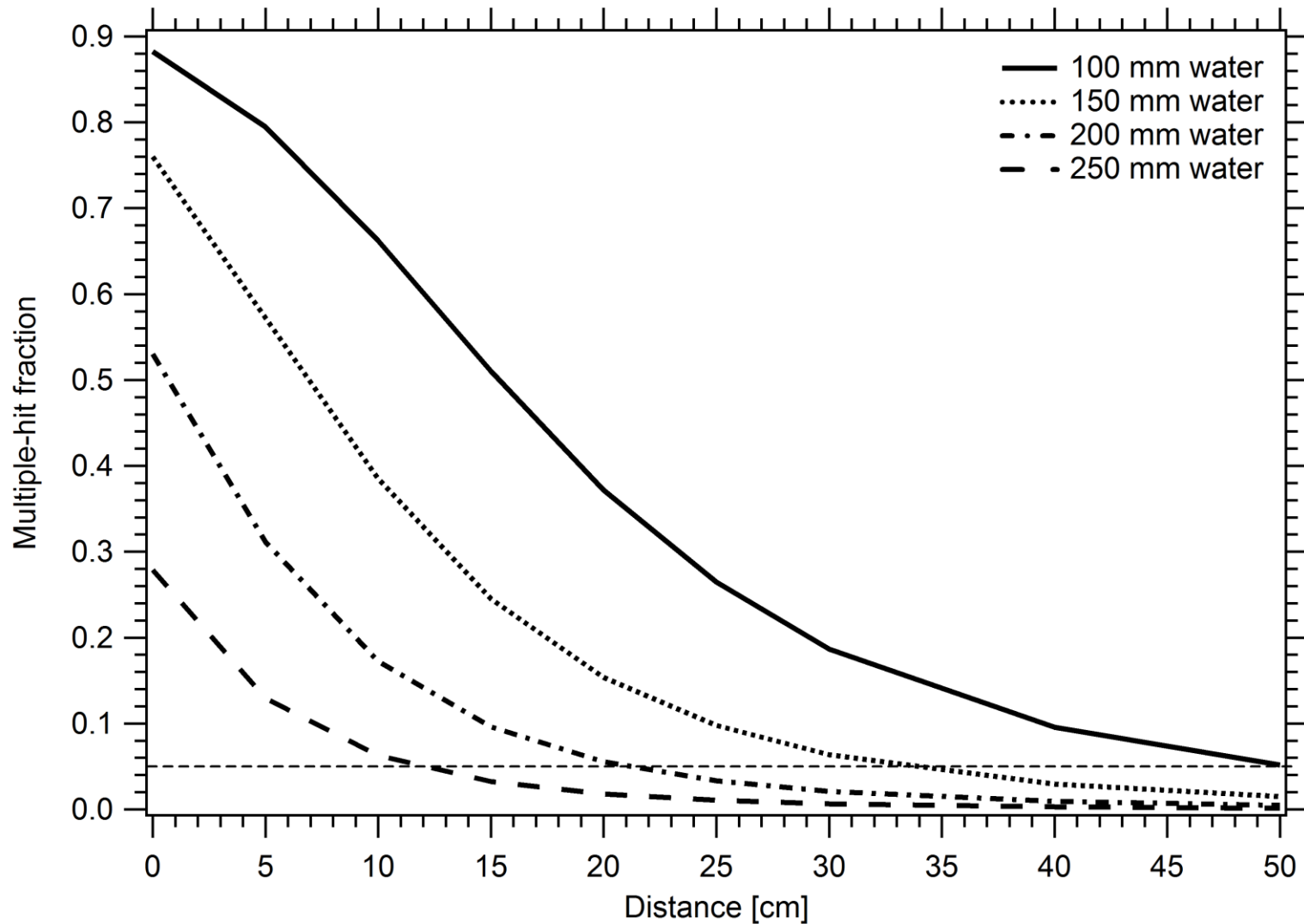
# Average hit rates



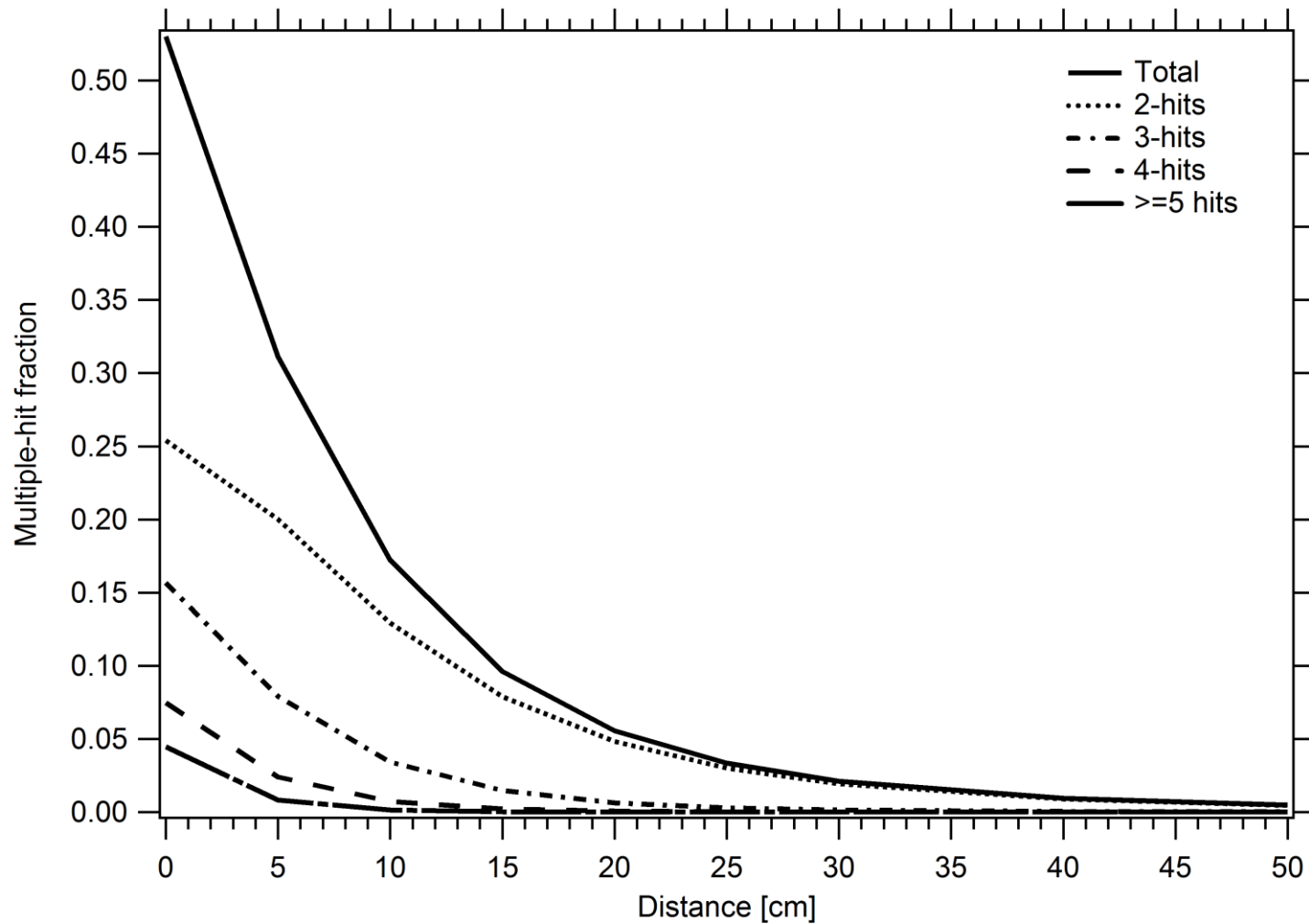
# Average hit rates



# Multiple-hit fractions



# Multiple-hit contributions (200 mm water phantom)



# Hit contributions (200 mm water phantom)

d [cm]	Zero-hit fraction	Single-hit fraction	Double-hit fraction	Triple-hit fraction	Quad-hit fraction	> = 5 hits fraction
0	0.178	0.292	0.254	0.157	0.075	0.045
5	0.334	0.355	0.200	0.079	0.024	0.008
10	0.483	0.345	0.129	0.034	0.007	0.001
15	0.603	0.301	0.079	0.015	0.002	0.000
20	0.692	0.252	0.048	0.006	0.001	0.000
25	0.758	0.208	0.030	0.003	0.000	0.000
30	0.806	0.173	0.019	0.002	0.000	0.000
40	0.869	0.121	0.009	0.000	0.000	0.000
50	0.907	0.089	0.004	0.000	0.000	0.000