Counter Monte Carlo

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Why MC?

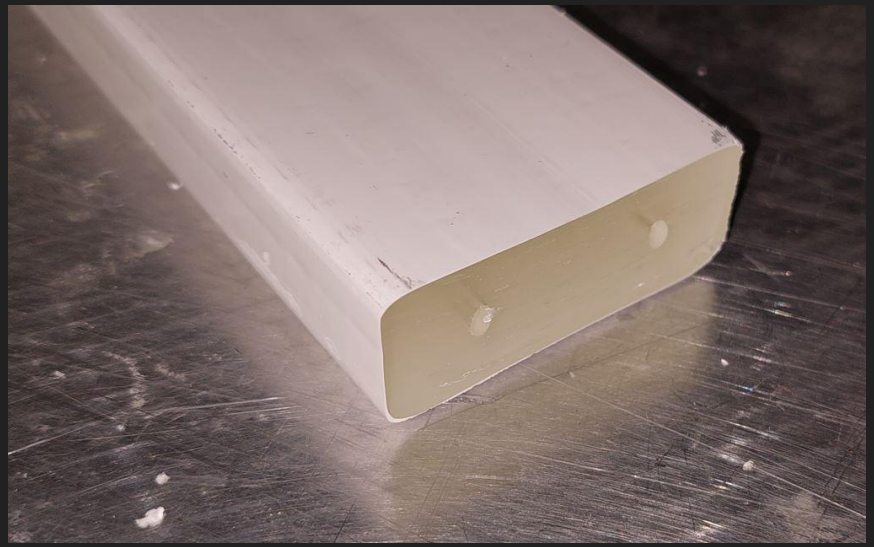
- For best reconstruction, must maximize photon yield in counters
- Highly susceptible to counter geometry, choice of materials, material properties, etc.
- Creating all possible counter designs? Difficult
- Simulating? Easier

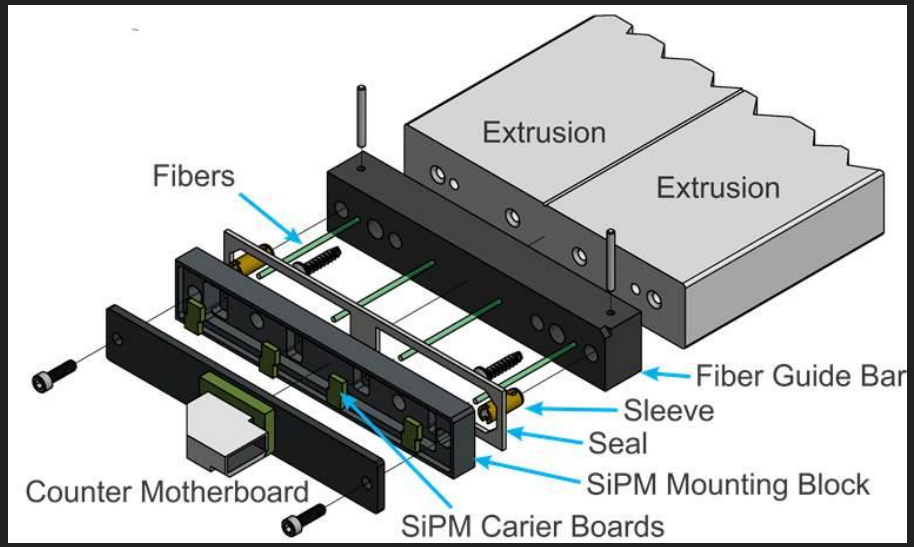
Status of MC

- Iterating — including more and more quantities relevant to simulation
- E.g. Mu2e polymer absorption length, TiO_2 reflectivity, POPOP emission spectrum

MC Sims

- 48 physical configurations (not including beam distance)
- Using 120 GeV protons 1 m away from read out, shot from bottom to top, fiber radius of 0.7 mm
- Counter is 3 m long
- For this short talk, will focus mainly on Mu2e geometry





Left: One cunter used in Mu2e showing fibers
Right: Full Mu2e counter assembly

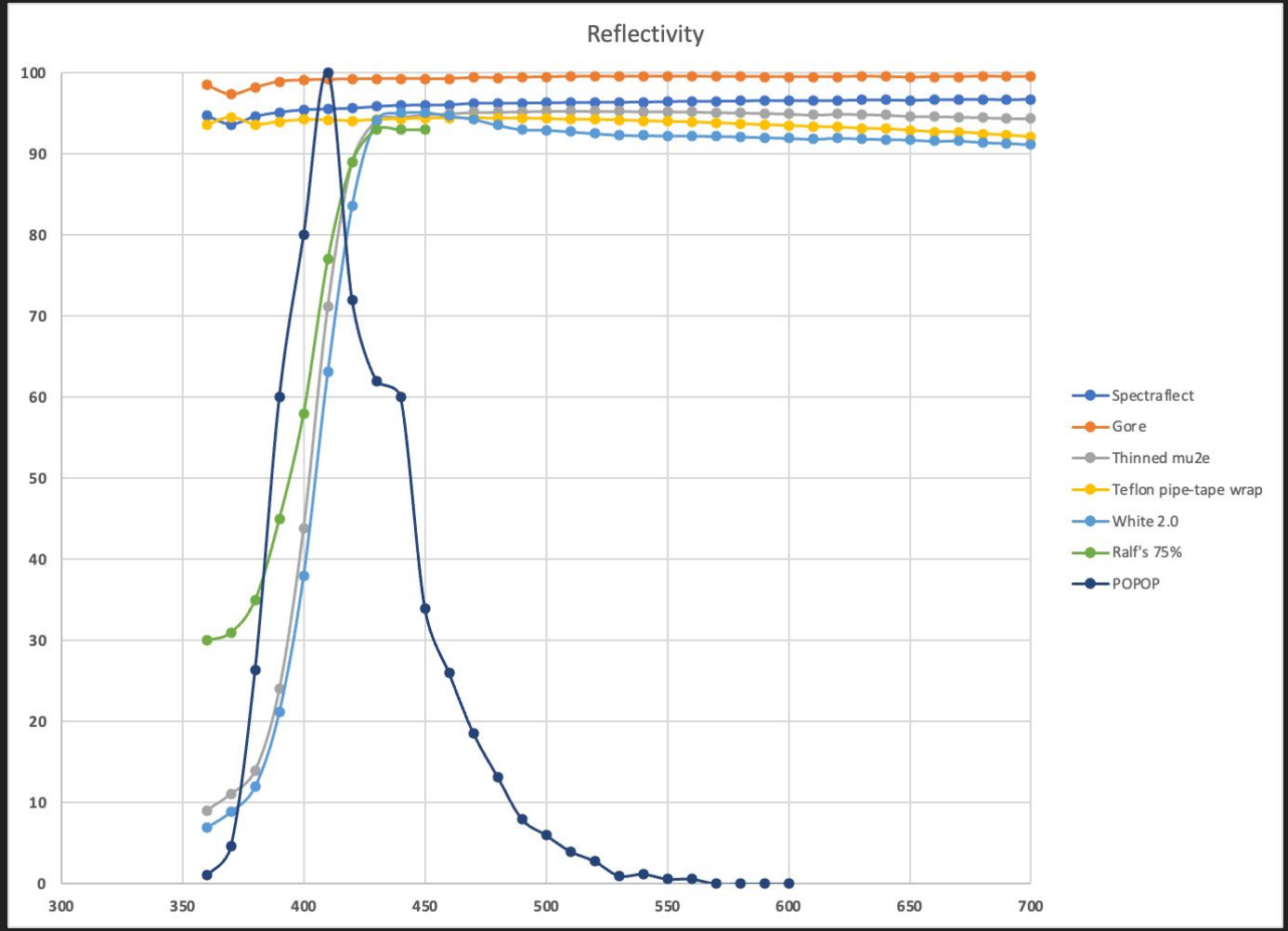
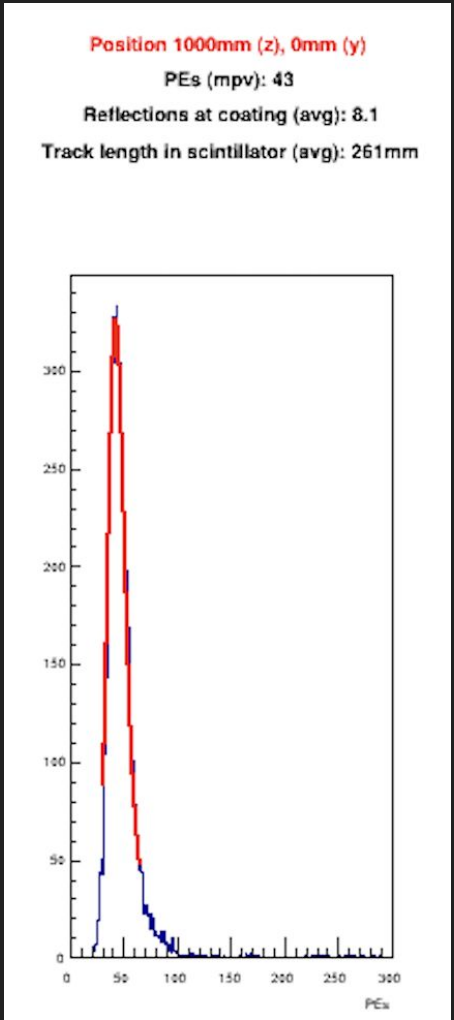


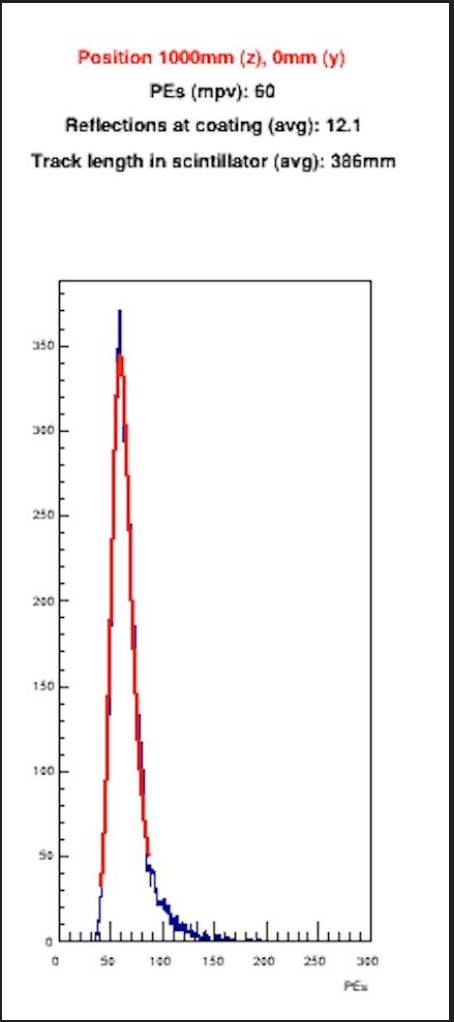
Image: Plot from Alan showing reflectivity values of different materials as well as POPOP emission spectrum

Mu2e Polymer, New TiO_2 Coating

PEs histogram for Mu2e geometry with TiO_2 coating with measured reflectivities

PEs = 43





PEs histogram for Mu2e geometry with coating of 98% reflectivity

PEs = 60

Mu2e Polymer, Solaris

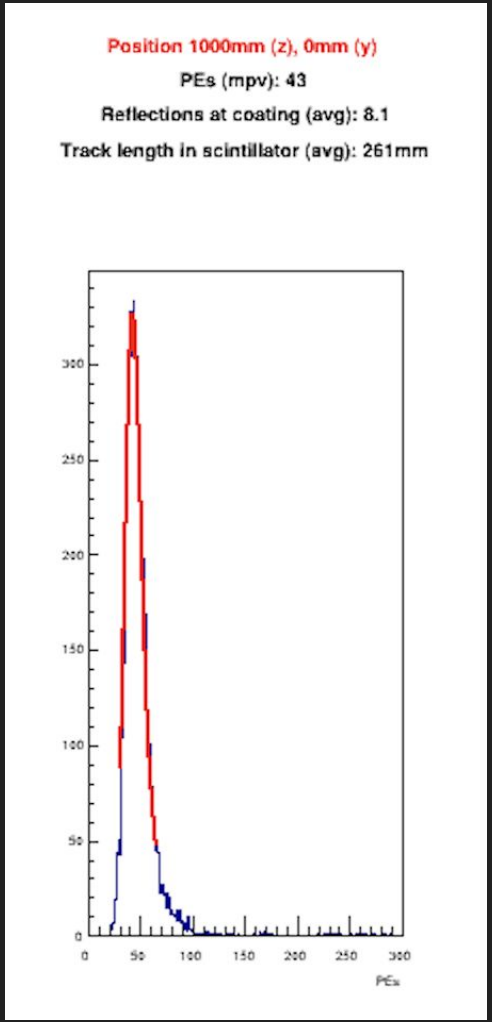
Solaris?

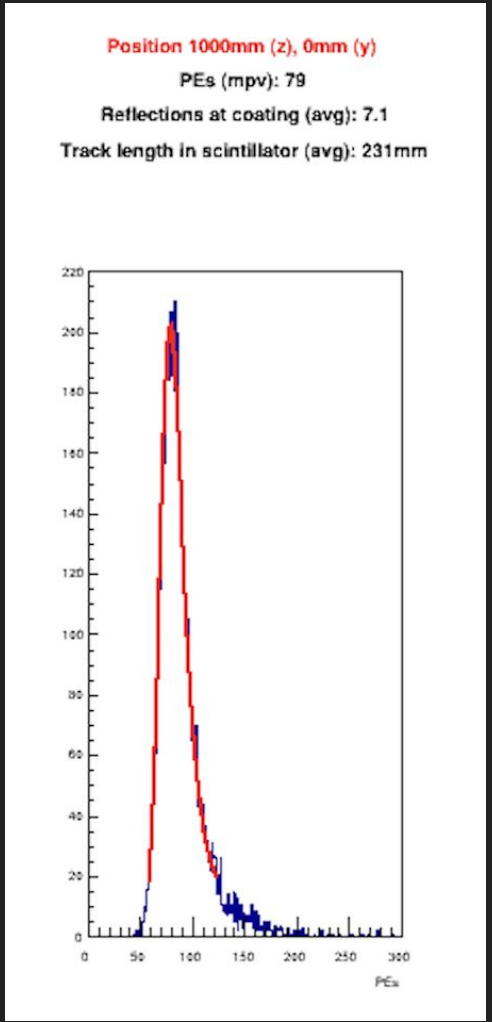
- Fiber holes can be larger than fibers
- If fiber hole > fiber size then a choice
- Can fill hole with Solaris
  - Solaris = pure, silicone rubber compound
- Can leave empty with vacuum

PEs histogram for Mu2e geometry with TiO_2 coating with measured reflectivities

Fiber hole rad. = 0.9 mm, hole filled with air

PEs = 43





PEs histogram for Mu2e geometry with with measured reflectivities

Fiber hole rad. = 0.7 mm, no hole

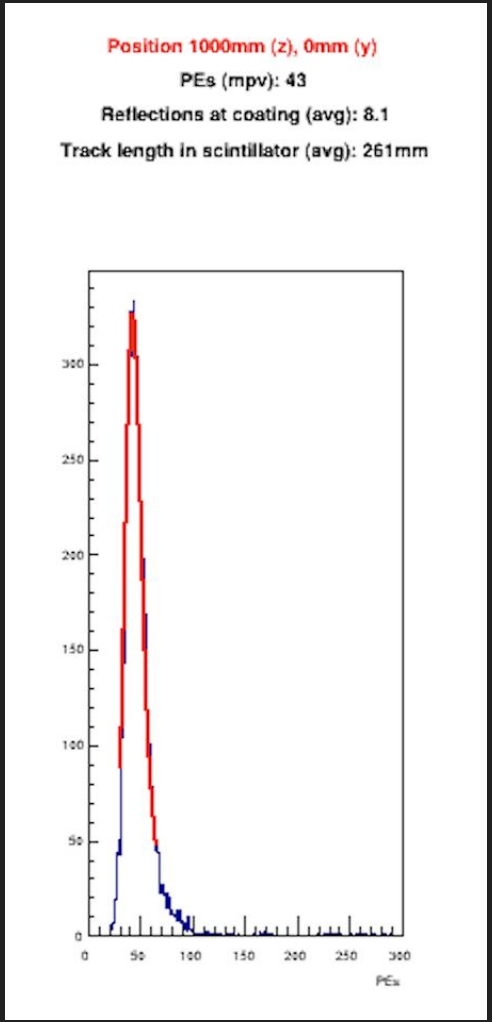
PEs = 79

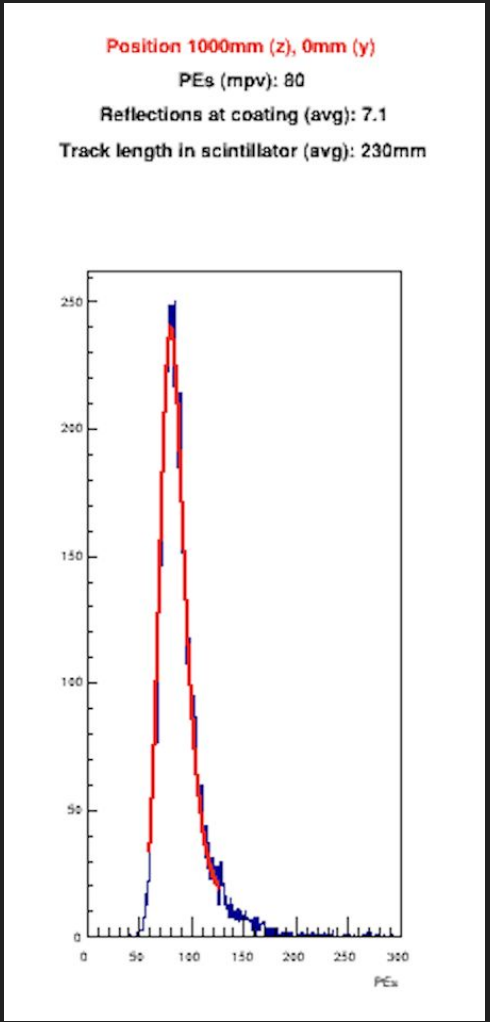
Now, with Solaris

PEs histogram for Mu2e geometry with TiO_2 coating with measured reflectivities

Fiber hole rad. = 0.9 mm, hole filled with air

PEs = 43





PEs histogram for Mu2e geometry with TiO_2 coating with measured reflectivities

Fiber hole rad. = 0.9 mm, hole filled with Solaris

PEs = 80

Brief Overview of Other Configurations

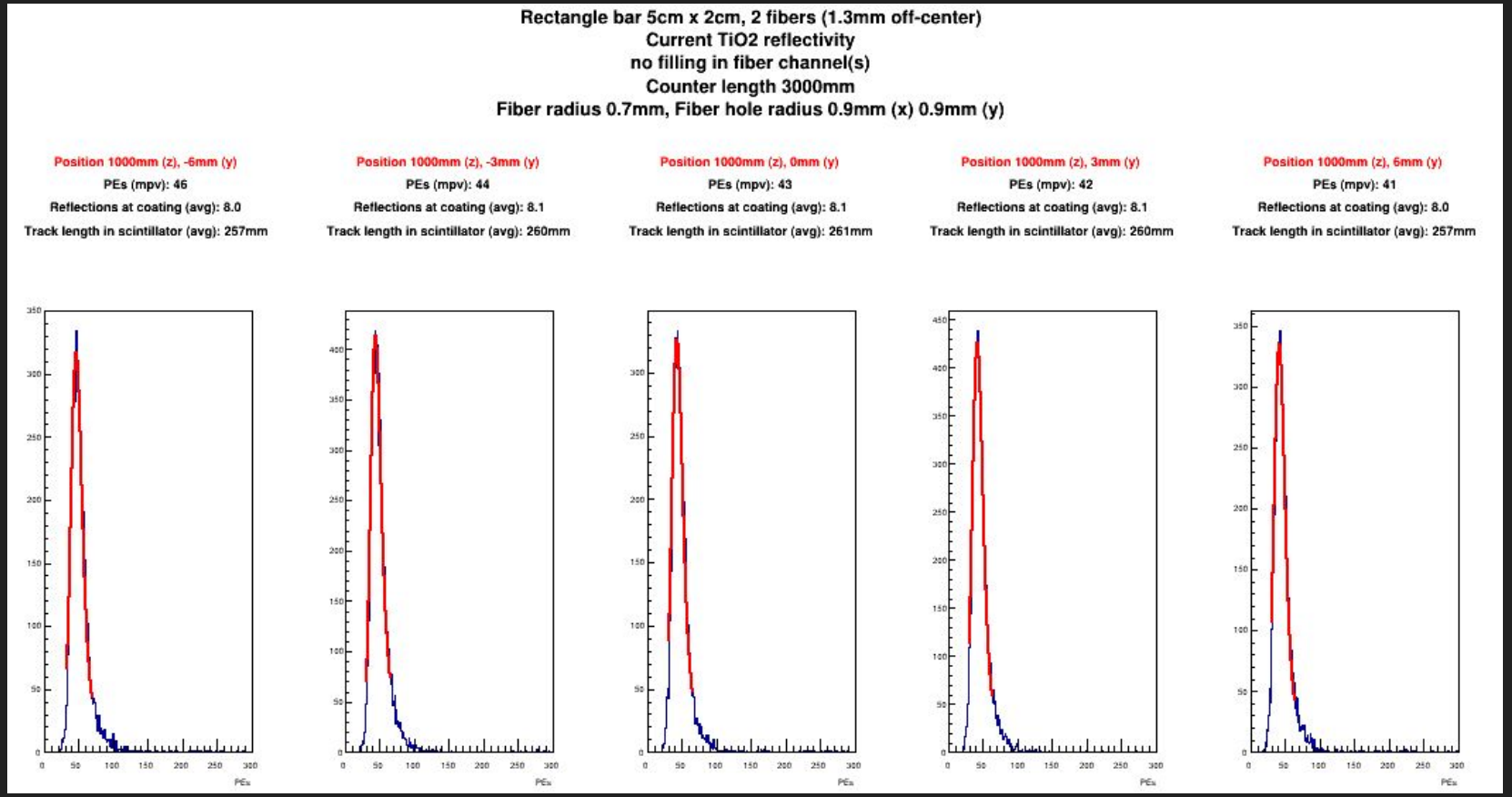


Image: Histograms generated for one configuration of the mu2e geometry, including variations in beam location

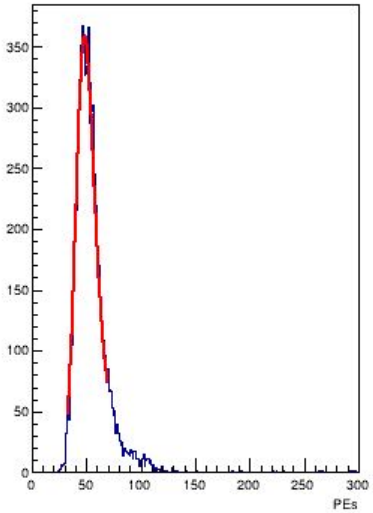
Note: We read out fiber on left side (-13 mm), so PE drops the further from this location

Different configurations

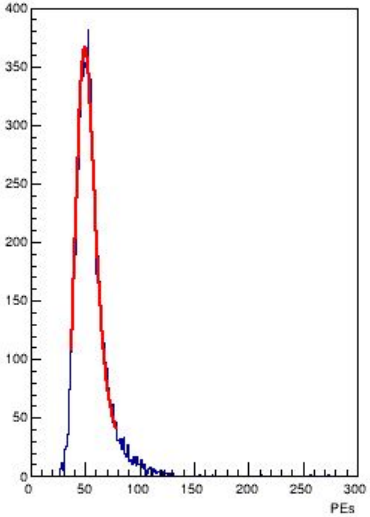
Results are consistent across geometries and beam location

Rectangle bar 5cm x 2cm, 1 fibers (at center)
Current TiO2 reflectivity
no filling in fiber channel(s)
Counter length 3000mm
Fiber radius 0.7mm, Fiber hole radius 0.9mm (x) 0.9mm (y)

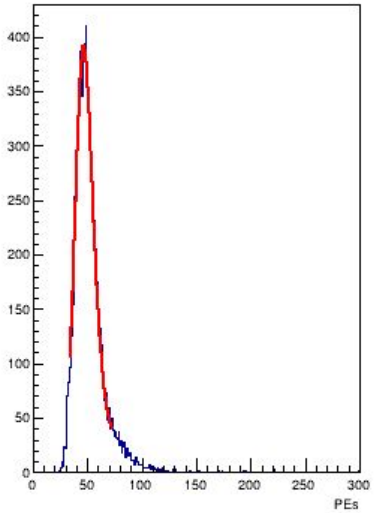
Position 1000mm (z), 0mm (y)
PEs (mpv): 49
Reflections at coating (avg): 6.8
Track length in scintillator (avg): 218mm



Position 1000mm (z), 3mm (y)
PEs (mpv): 50
Reflections at coating (avg): 7.3
Track length in scintillator (avg): 237mm



Position 1000mm (z), 6mm (y)
PEs (mpv): 47
Reflections at coating (avg): 7.9
Track length in scintillator (avg): 254mm



Position 1000mm (z), 10mm (y)
PEs (mpv): 44
Reflections at coating (avg): 8.3
Track length in scintillator (avg): 267mm

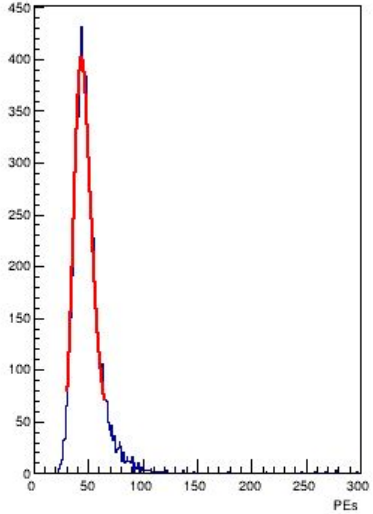


Image: Histograms generated for one configuration of 1 fiber rectangle bar geometry with 0.9 mm fiber hole: no Solaris, measured TiO2 reflectivities

Note: For this geometry, fiber is at 0 mm.

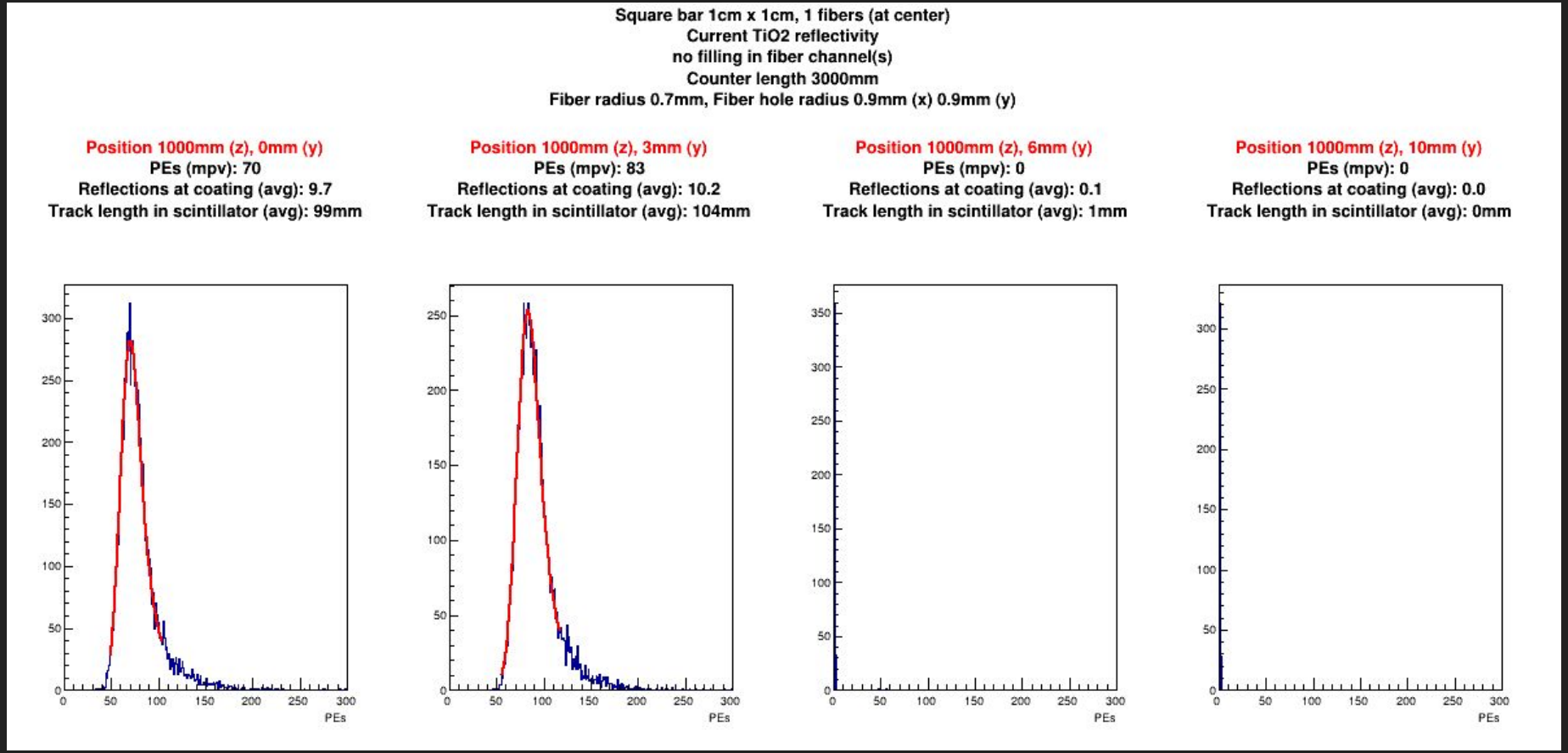
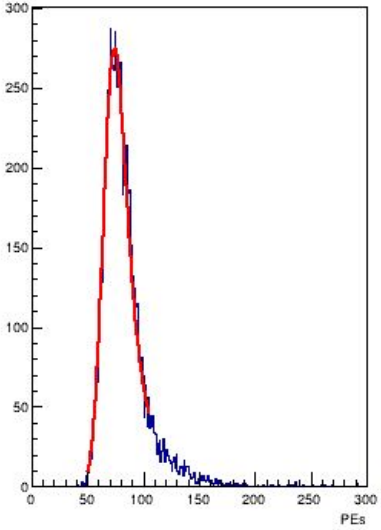


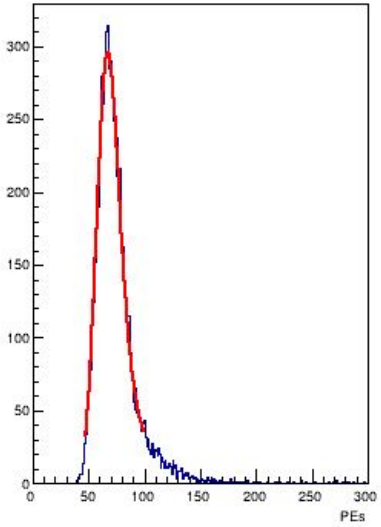
Image: Histograms generated for one configuration of 1 cm x 1 cm geometry with 0.9 mm fiber hole, no Solaris, measured TiO2 reflectivities

Triangle bar 4cm (base) x 2cm (height), 1 fibers (at center)
Current TiO2 reflectivity
no filling in fiber channel(s)
Counter length 3000mm
Fiber radius 0.7mm, Fiber hole radius 0.9mm (x) 0.9mm (y)

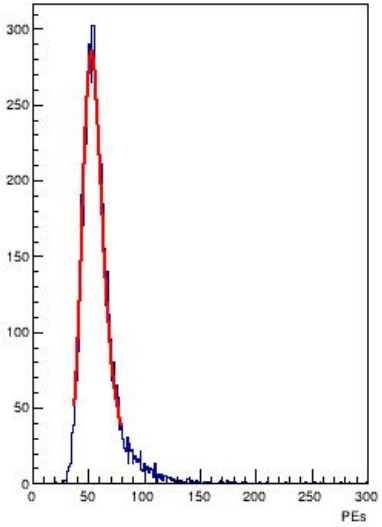
Position 1000mm (z), 0mm (y)
PEs (mpv): 74
Reflections at coating (avg): 8.7
Track length in scintillator (avg): 172mm



Position 1000mm (z), 3mm (y)
PEs (mpv): 67
Reflections at coating (avg): 9.1
Track length in scintillator (avg): 180mm



Position 1000mm (z), 6mm (y)
PEs (mpv): 53
Reflections at coating (avg): 9.6
Track length in scintillator (avg): 190mm



Position 1000mm (z), 10mm (y)
PEs (mpv): 36
Reflections at coating (avg): 10.0
Track length in scintillator (avg): 198mm

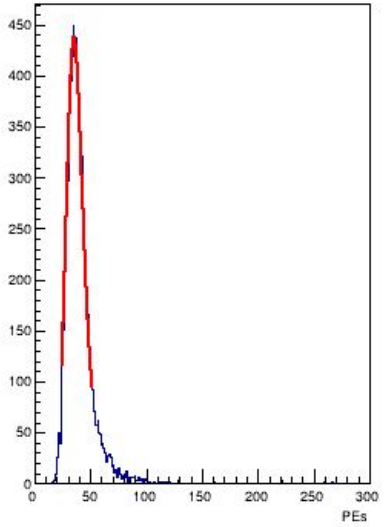


Image: Histograms generated for one configuration of triangle geometry with 0.9 mm fiber hole, no Solaris, measured TiO2 reflectivities

Note: For this geometry, PEs drop b/c of triangle shape

Next steps

- Changing beam location
- Testing different polymers (not just Mu2e)
- Testing with infinite absorption length to isolate impact of coating
- Testing bismuth-207 source: produces 1 MeV electrons