# Beam window in Geant4: Update

Matt Kramer (UC Berkeley)
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Update of slides shown on Nov 10

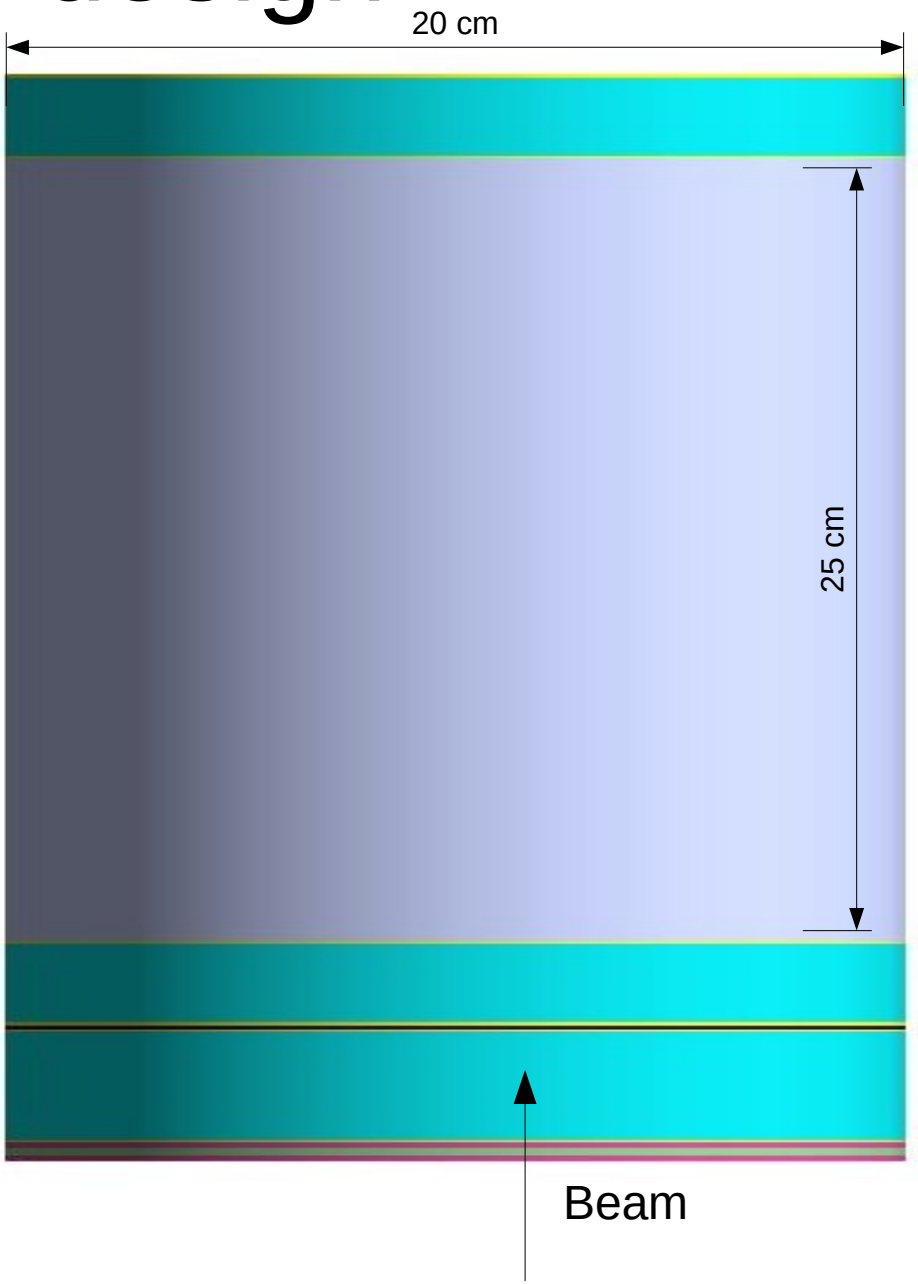
*Fixed “X-ray” plots*
*Fixed “electron” momentum/angle plots that mistakenly showed gammas*

# Outline

- Latest geometry, materials
- Radiation length calculation
- “X-ray” validation
- Dead layer studies
  - Basic summary plots
  - Momentum distributions
- Summary
- Backup
  - Angle distributions (dead layer studies)

# Window design

| | g/cc | |
|---|---|---|
| Rear surface of plug | 1.8 | G10 60/40 fiber/epoxy (1mm) |
| | 0.1 | Korex (low-density polyaramid) (25 mm) |
| | 1.8 | G10 (1 mm) |
| Plug interior | | Dry $N_2$ @ “STP” (25 cm) |
| Front surface of plug | 1.8 | G10 (1 mm) |
| | 0.1 | Korex (25 mm) |
| | 1.8 | G10 (1 mm) |
| Membrane | 8.0 | Stainless steel (1.2 mm) |
| Carbon puck | 1.8 | G10 (0.5 mm) |
| | 0.1 | Korex (35 mm) |
| | 1.8 | G10 (0.5 mm) |
| End of Insulon can | 1.4 | Vespel SP-1 (2 mm) |
| | | Vacuum (2mm) |
| | 1.4 | Vespel SP-1 (2 mm) |




Standard disclaimer:
This is not necessarily the final design

# Radiation length

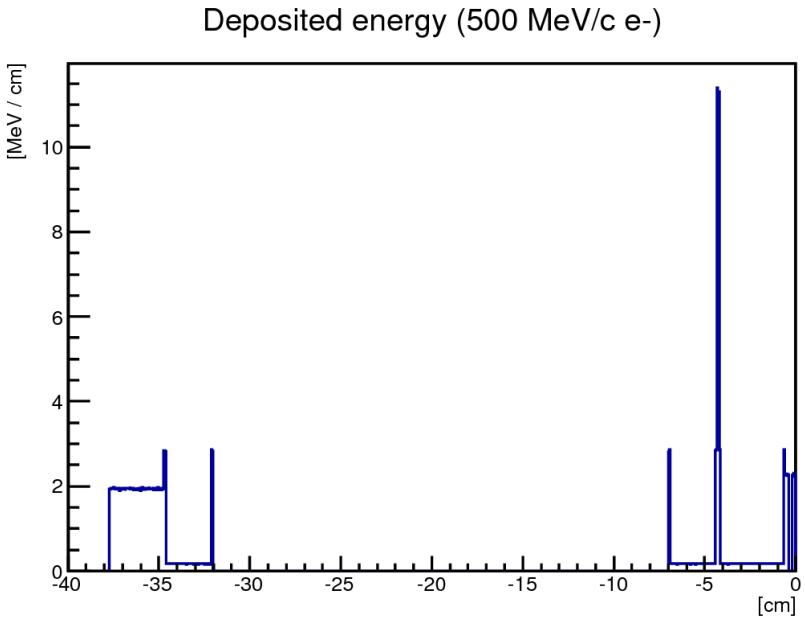
| Material | $X_0$ (cm) | Amount (mm) | Result | Total |
|---|---|---|---|---|
| SS (primary membrane) | 1.7 | 1.2 | 0.07 $X_0$ | |
| G10 | 17 | 5 | 0.03 $X_0$ | |
| Korex | 430 | 85 | 0.02 $X_0$ | |
| SP-1 | 22* | 4 | 0.02 $X_0$ | |
| **Window total** | | | | **0.14 $X_0$** |
| **+ LAr** | 14 | 10 | 0.07 $X_0$ | **0.21 $X_0$** |
| **+ LAr** | 14 | 30 | 0.21 $X_0$ | **0.35 $X_0$** |
| **+ LAr** | 14 | 50 | 0.35 $X_0$ | **0.49 $X_0$** |

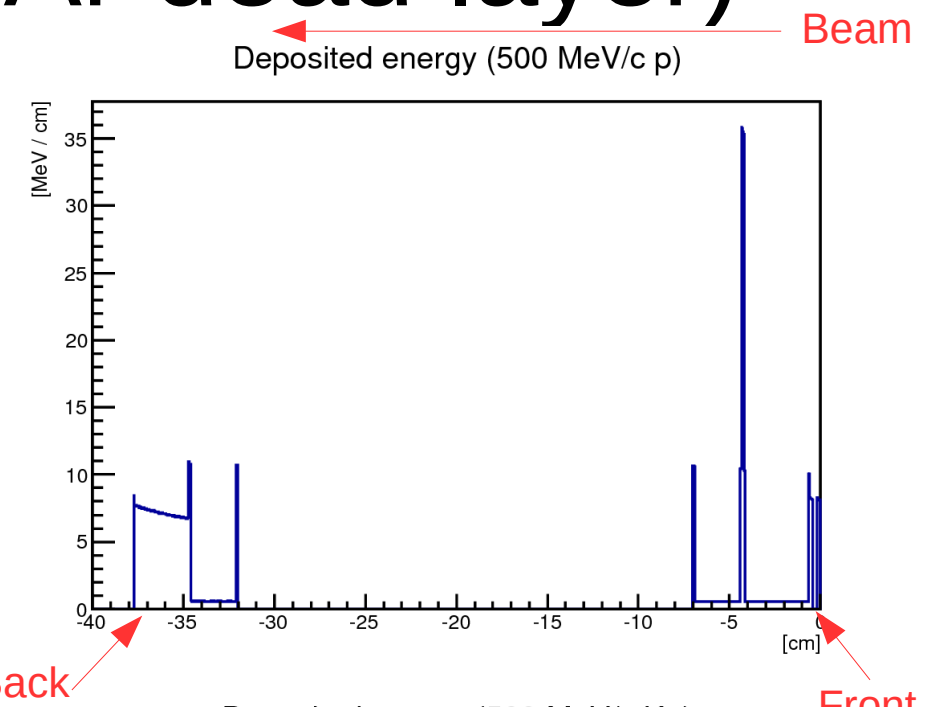
* SP-1 $X_0$ unknown; estimated from G10 by scaling per density

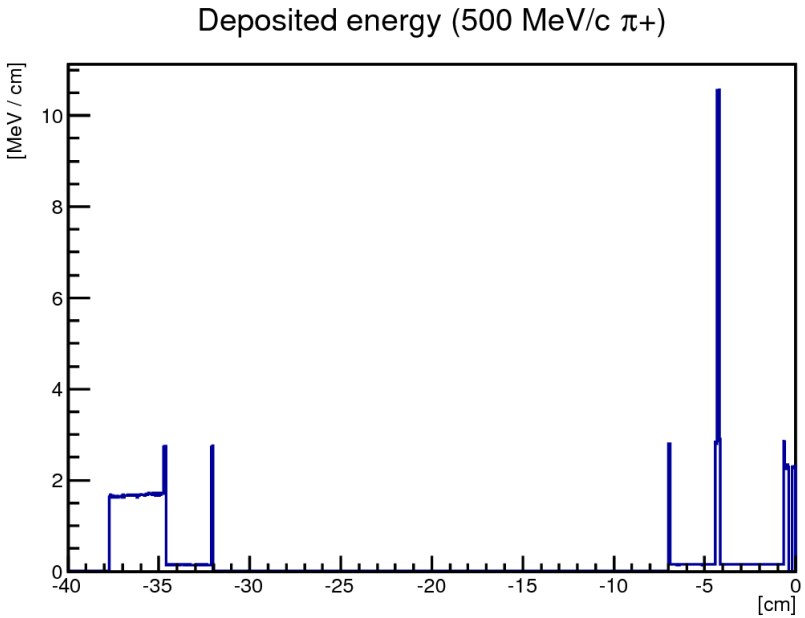
# “X-ray” plots

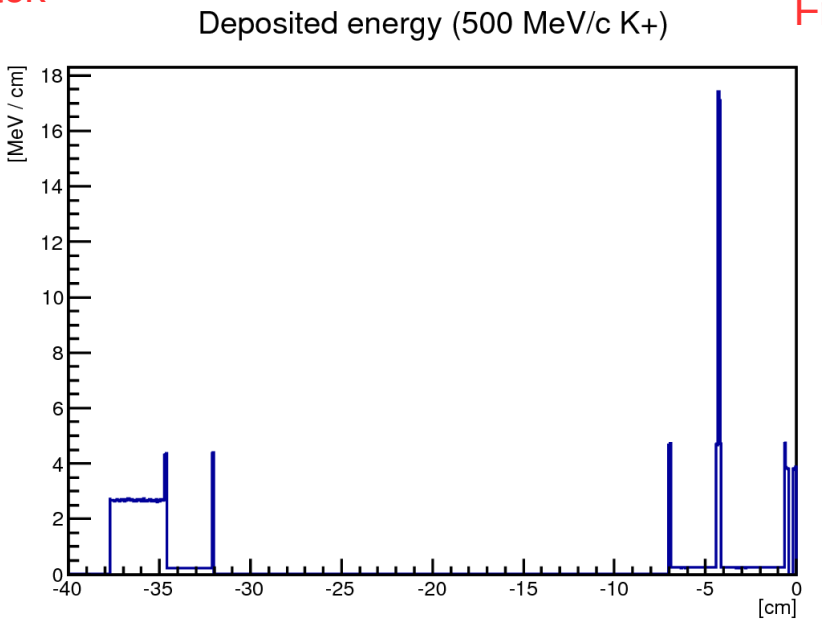
- Goal: See where (and how often) interactions are occurring, to compare with expectations
- For each tracking step of primary particle, record position and (ionization) energy deposit
  - Ignore energy that goes into secondaries; good enough for our goal of simply peering into the window
  - Geant4 max step size was set to 0.1 mm
    - Allows resolving thin layers
- At end of run:
  - Sum up total deposited energy for each position bin, normalize by # events, plot
- Compare to window design

# “X-ray” (3 cm LAr dead layer)

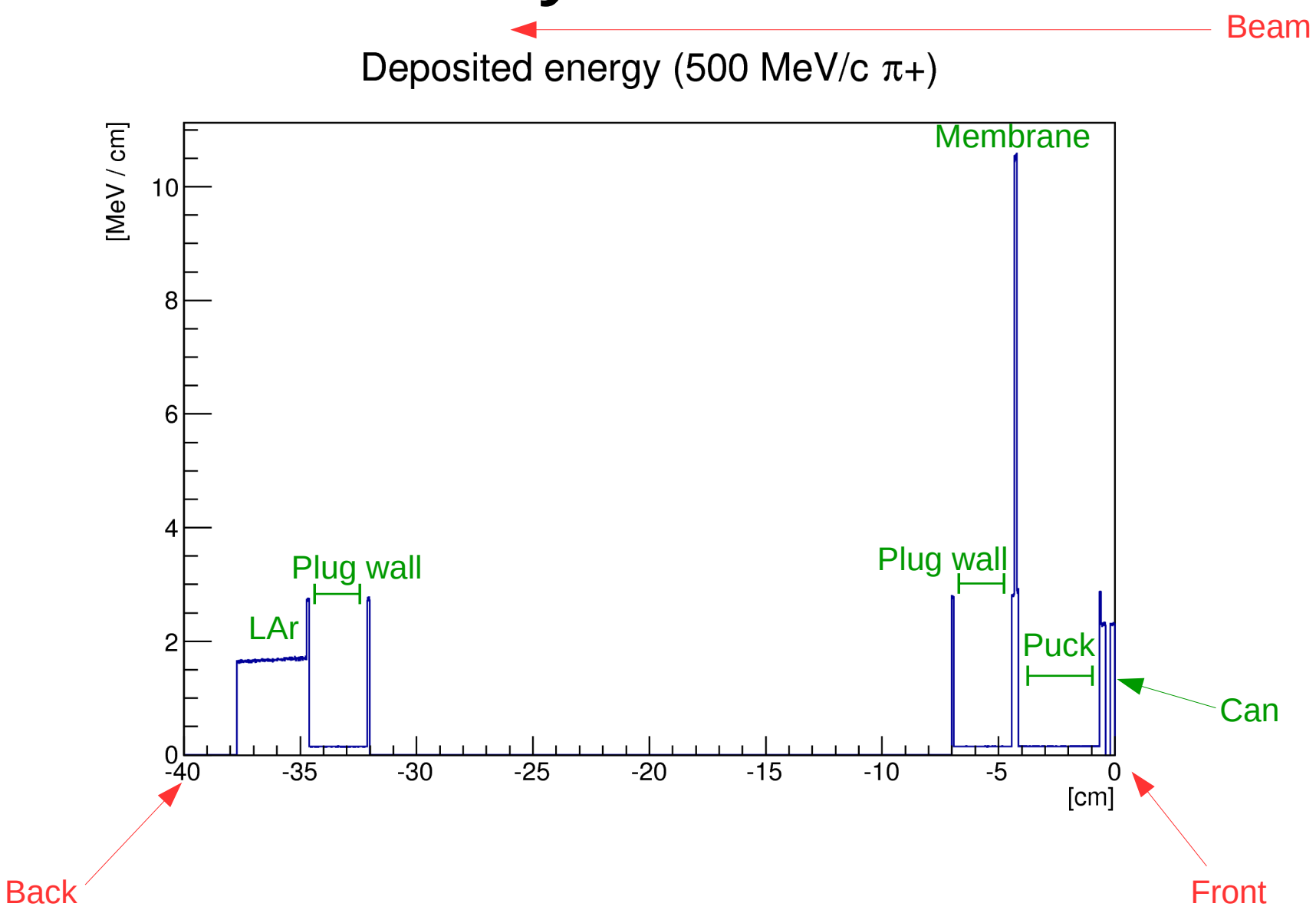


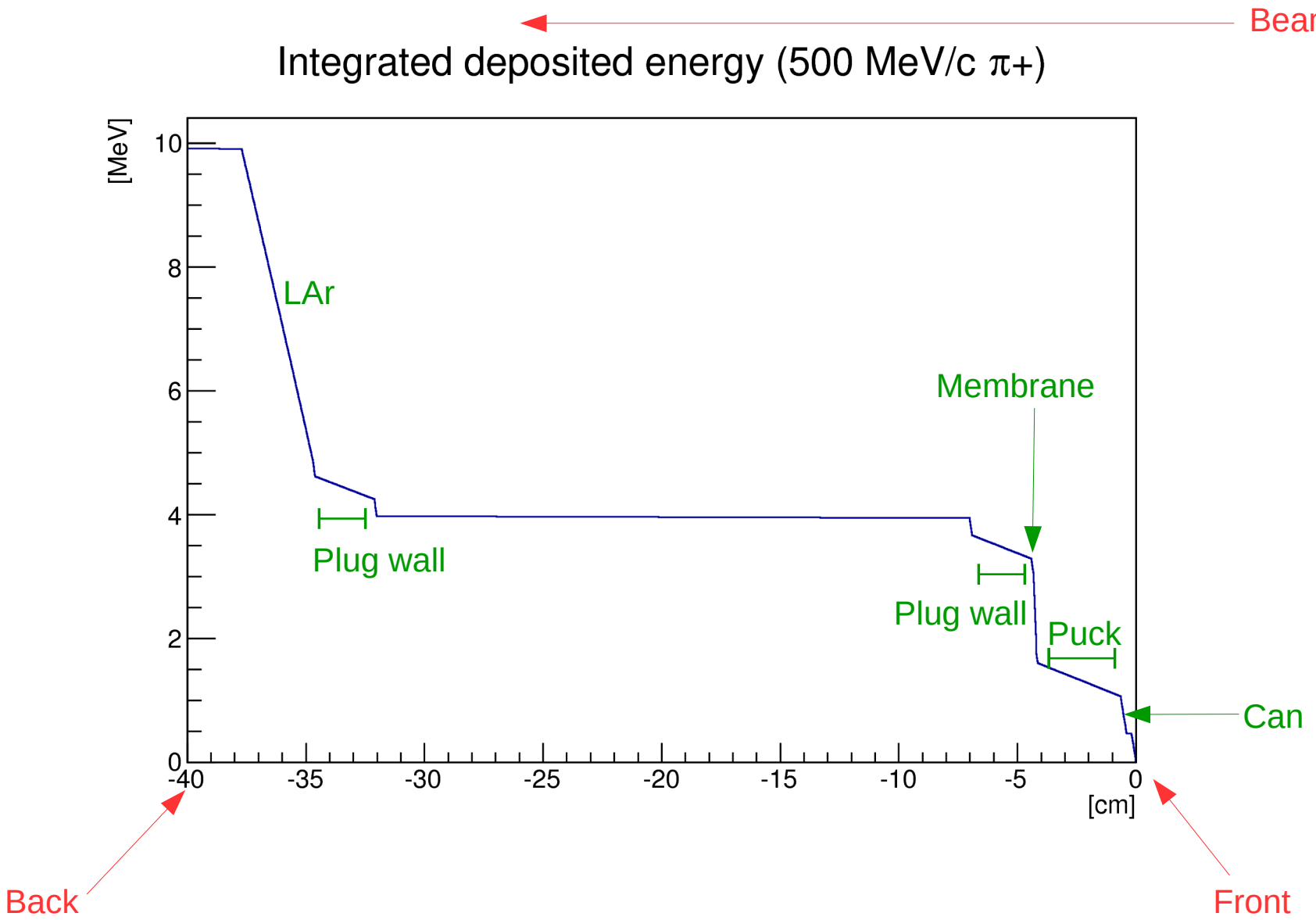



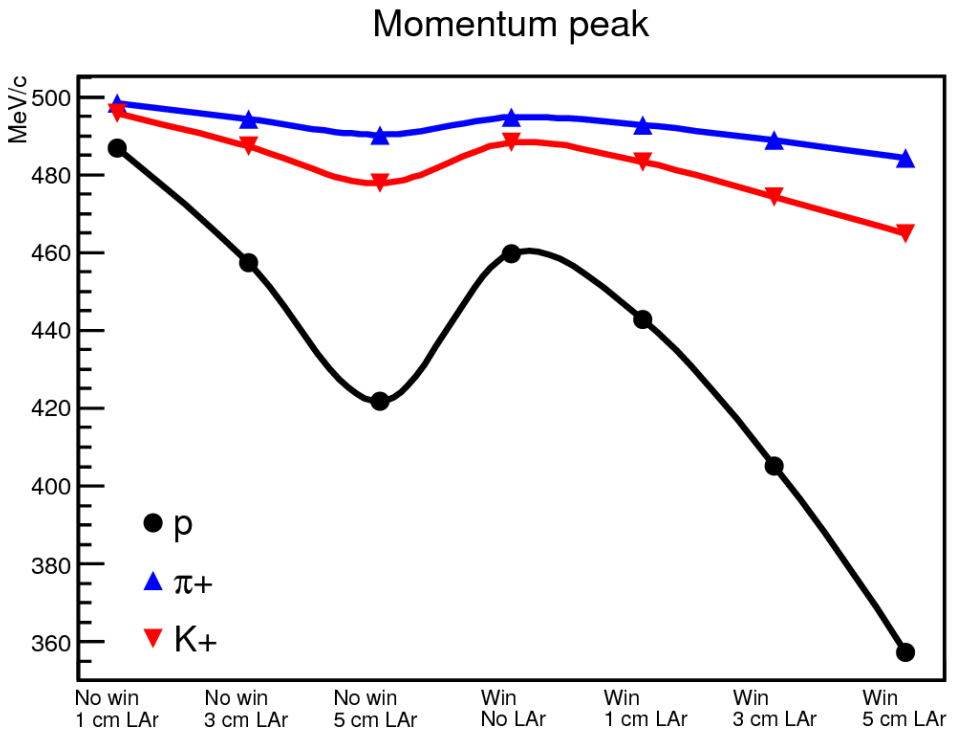
# “X-ray” zoomed

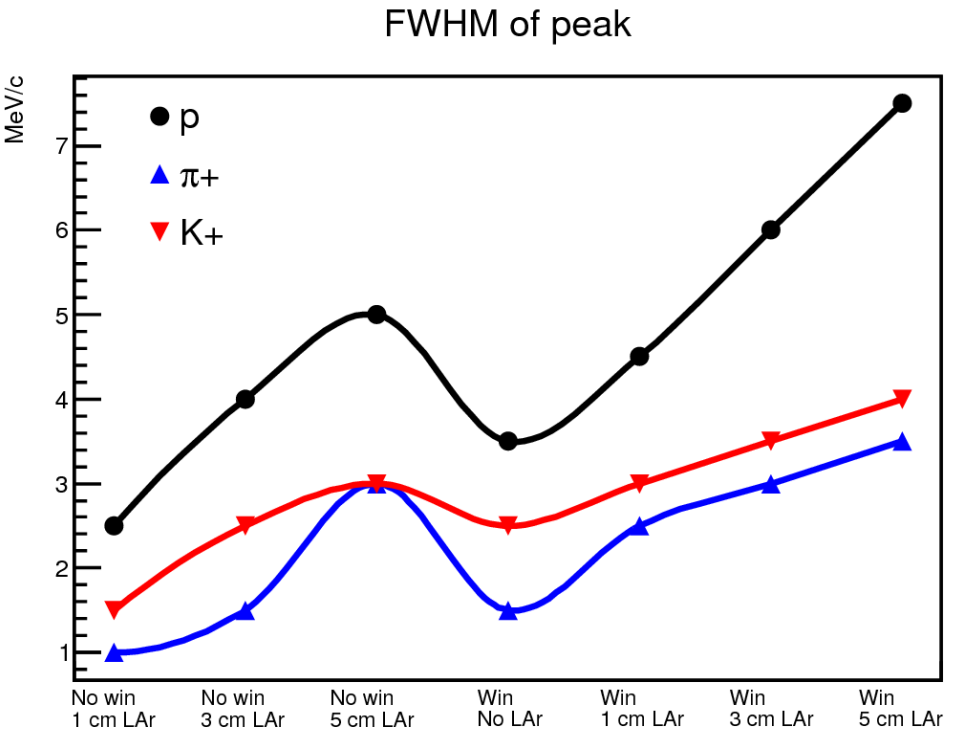

Beam
Deposited energy (500 MeV/c π+)
[MeV / cm]
10
8
6
4
2
0
-40
-35
-30
-25
-20
-15
-10
-5
0
[cm]
Membrane
Plug wall
LAr
Plug wall
Puck
Can
Back
Front

# “X-ray” zoomed and integrated



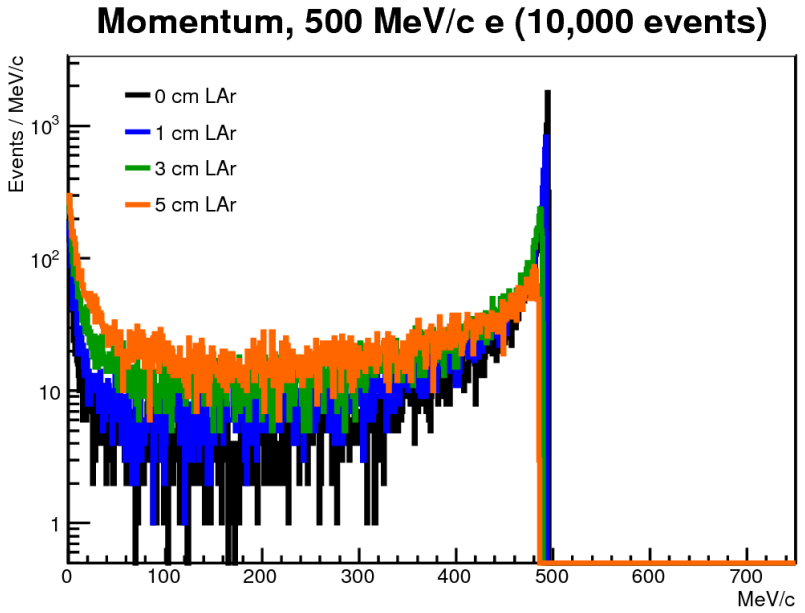
# Dead layer studies (500 MeV/c, 10k events)

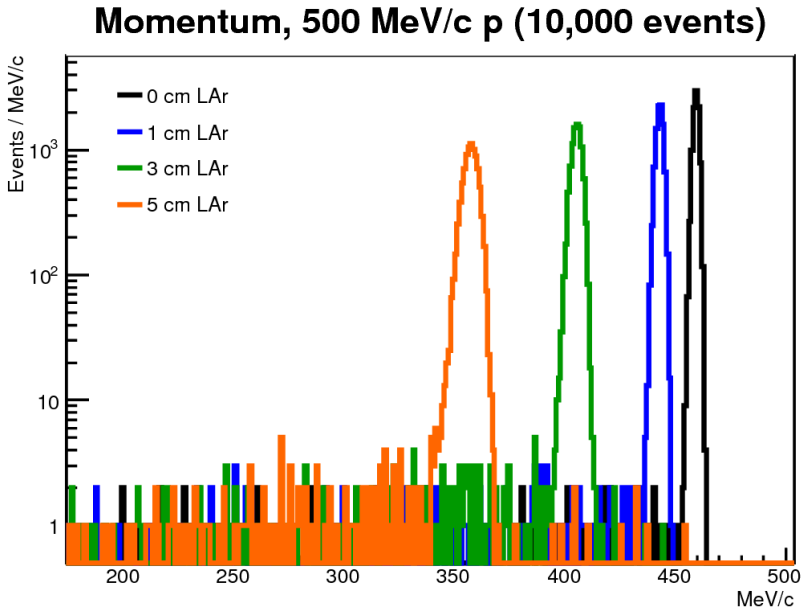


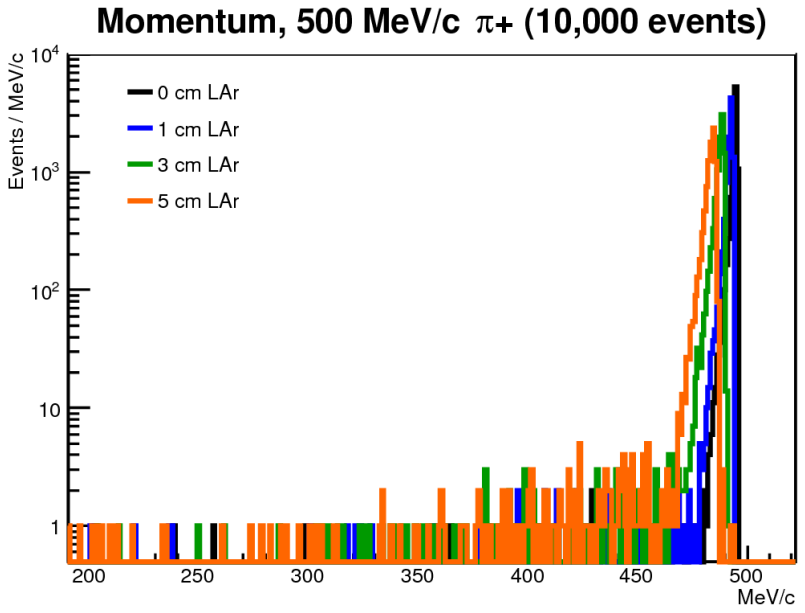



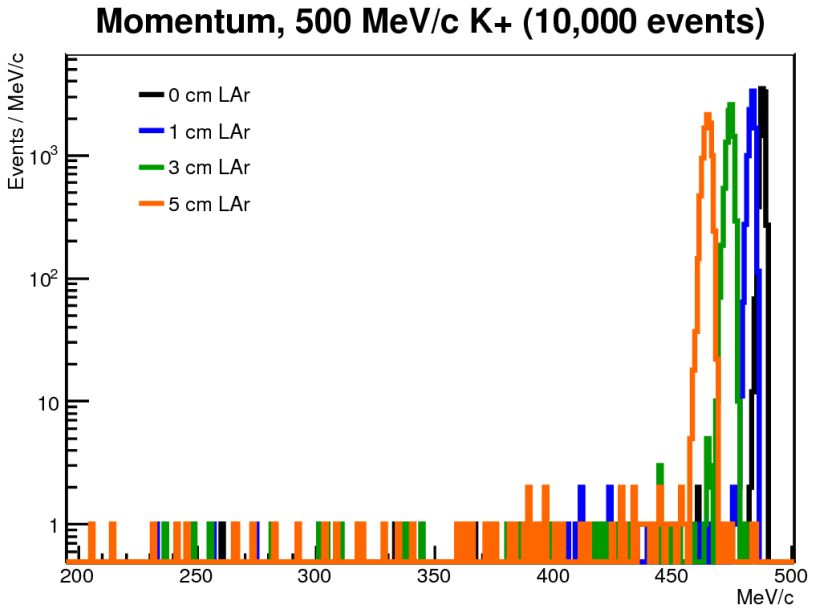

Similar plots, showing probability of (non)-interaction, next time!

# Dead layer studies: Momentum dists (w/ win)

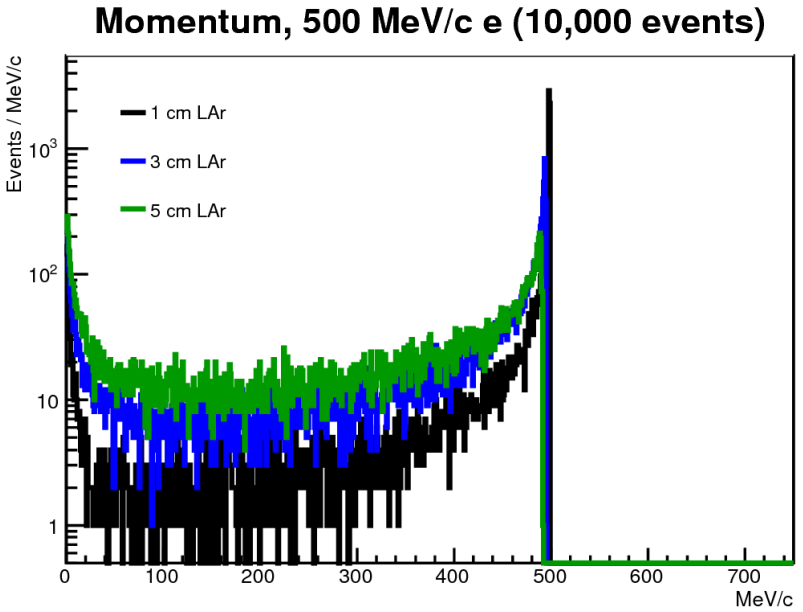


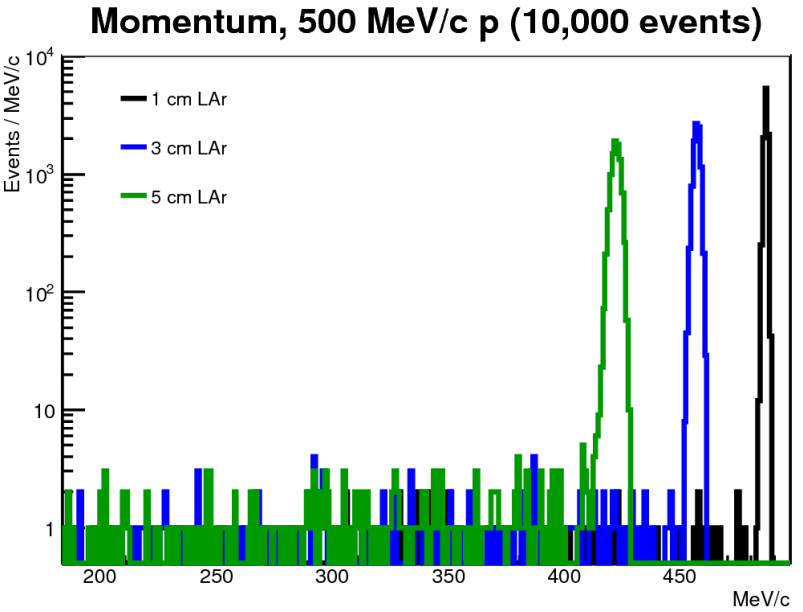



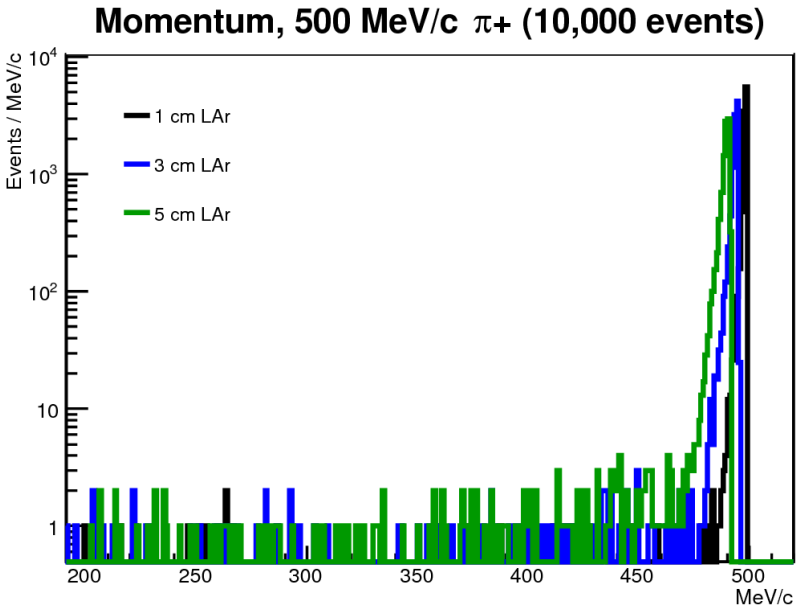



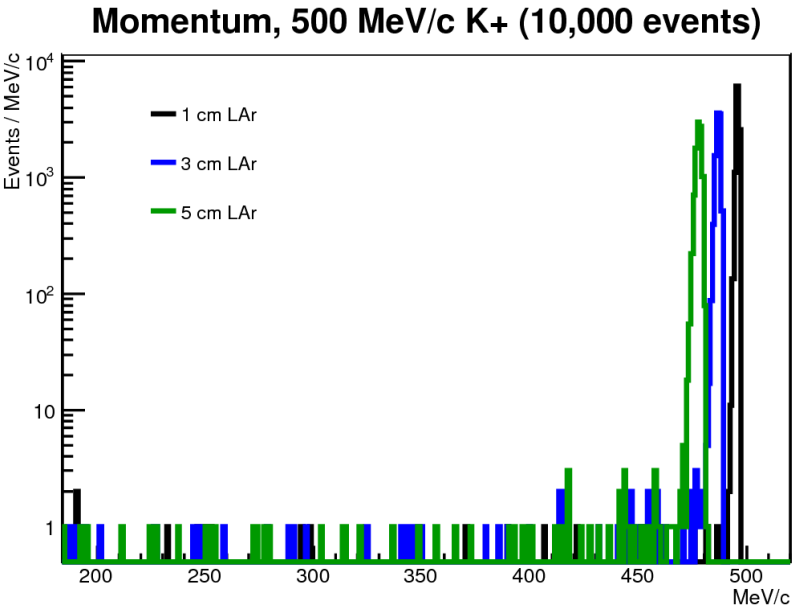



# Dead layer studies: Momentum dists (no win)



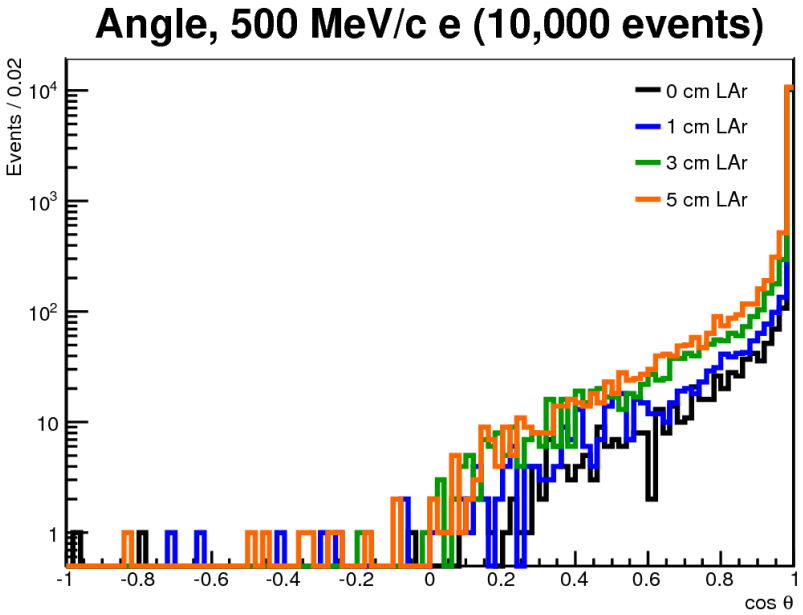



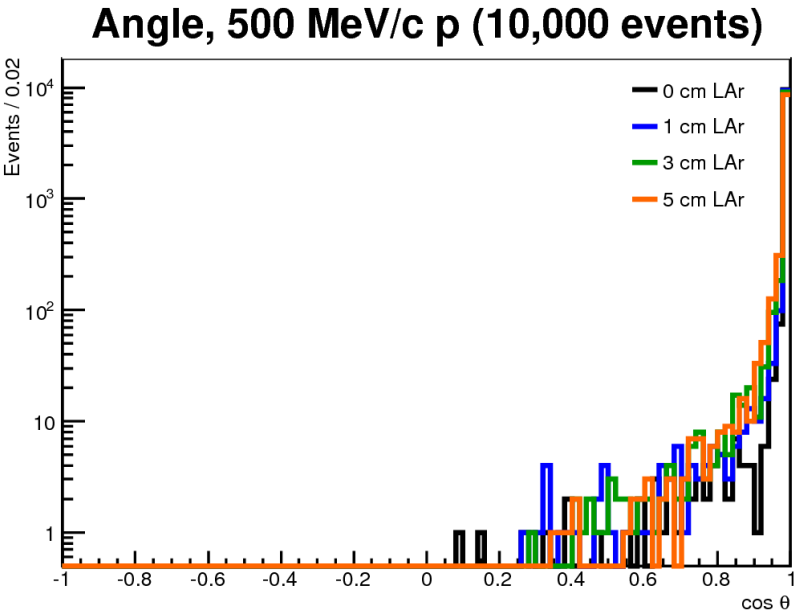
# Summary

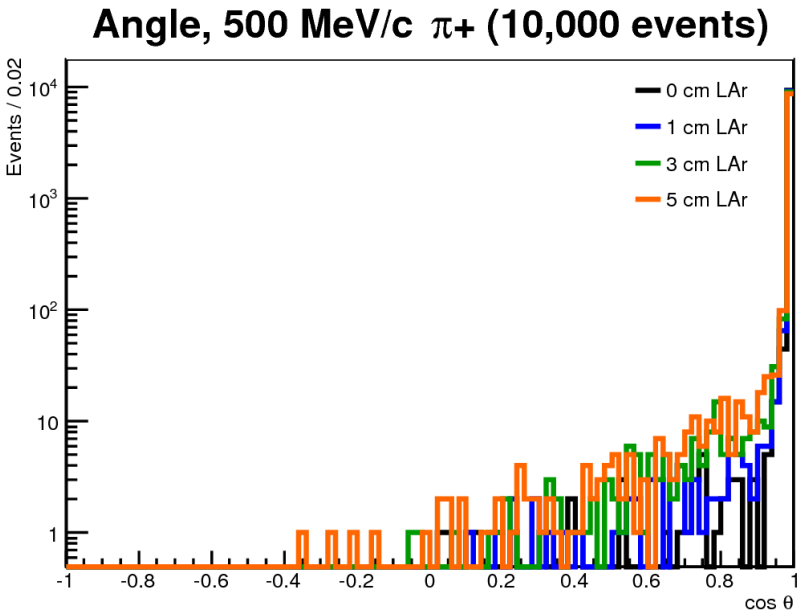
- SS membrane dominates window materials (in terms of rad. length, energy loss)
  - Might be a good reason to replace it with an aluminum cutout?
- Window + membrane equivalent to 2-3 cm LAr
- LAr dead layer dominates total, if not displaced
  - Displace it all!
- Next time: Plots showing probability of interaction

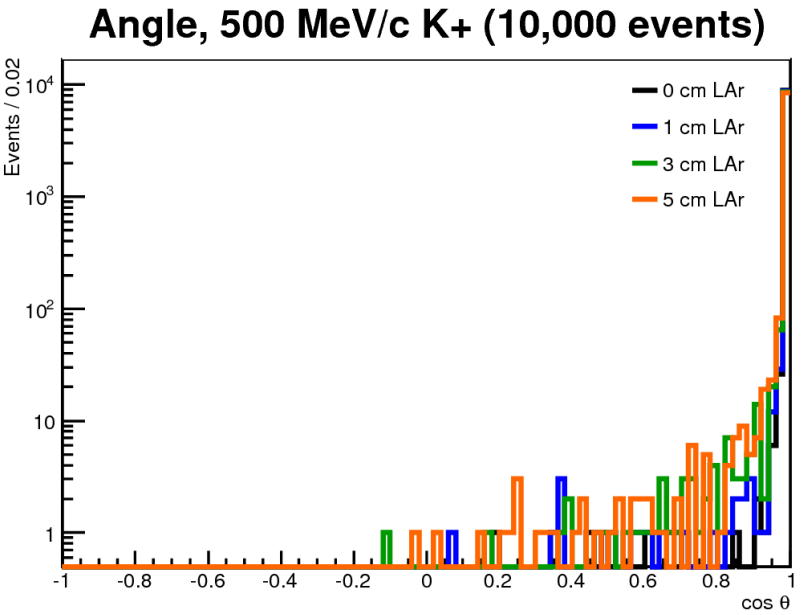
# Backup

# Dead layer studies: Angular dists (w/ win)



# Dead layer studies: Angular dists (no win)