Monte Carlo

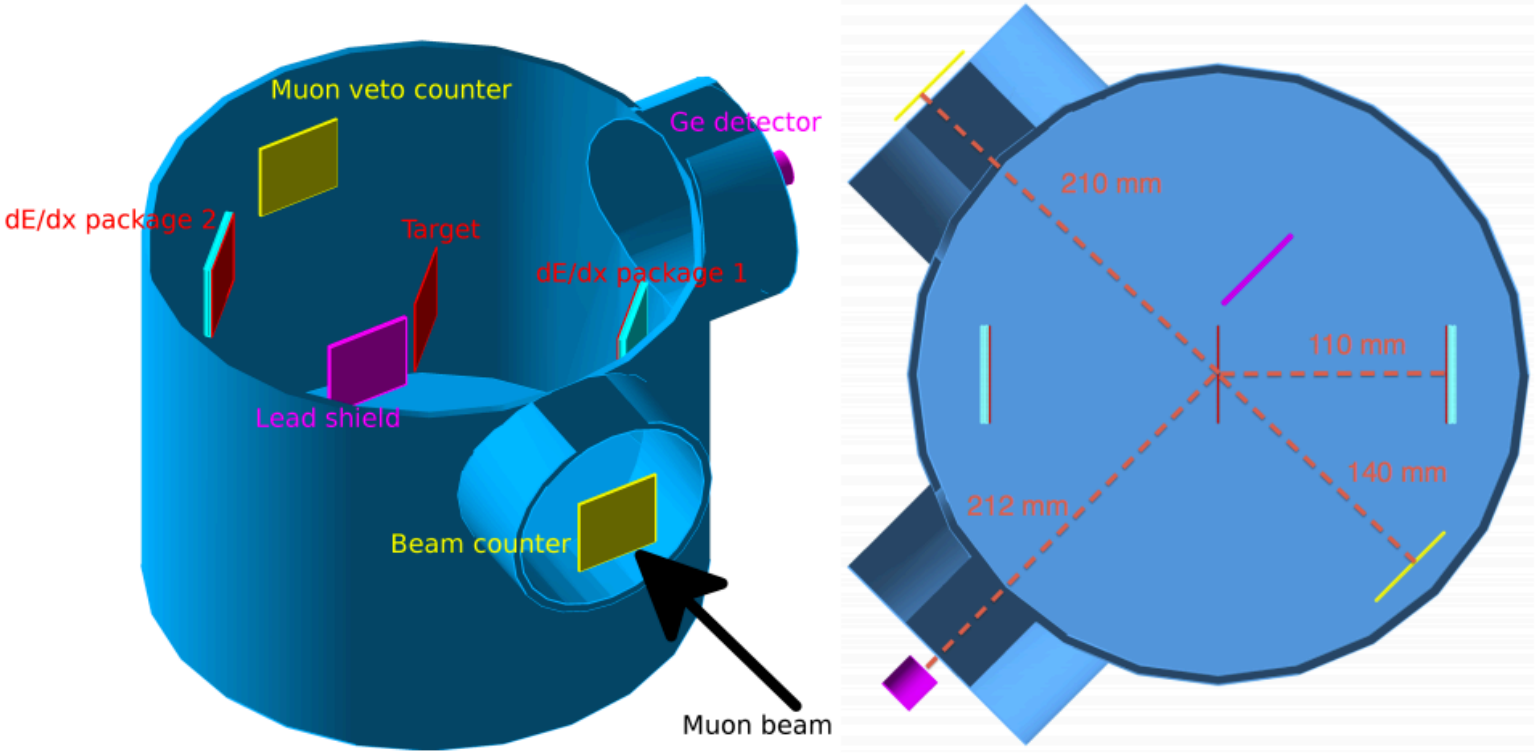
MC Status and Plans
Presented by Wu Chen and John Quirk
On behalf of the AlCap Collaboration
To the AlCap Collaboration
At Fermlilab National Accelerator Laboratory
In Wilson Hall
March, 2014

Why MC?

- Planning for next run
- Check sanity of analysis

History

Original Geometry

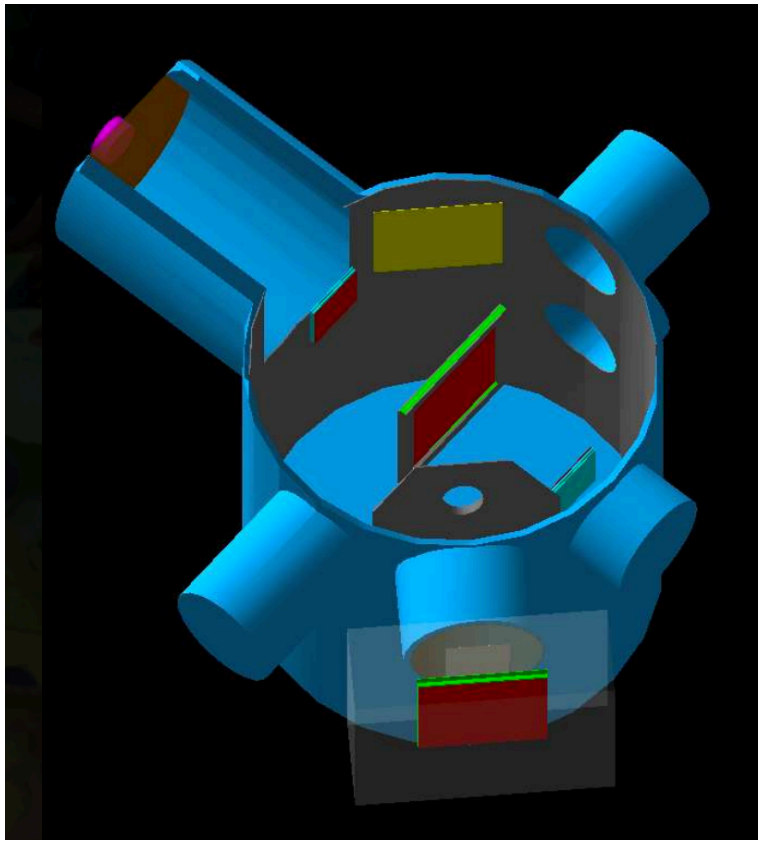


History

- Beam
  - 30 MeV/c
  - 4% spread
  - Centered on target, +/- 5mm in *x* and *y*

History

Beam Veto increased to 10 cm by 10 cm
Shielding added to back wall
Shielding and PCB board added to target
Collimator added
Chamber ports added
Upstream trigger modified
Germanium moved



History

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Tracking cost proportional to number of boolean solids; each port adds another 2 solids

Nam simplified this

History

Beam

- Information form the MuSun simulation
- 1.1% momentum spread, +/- 0.83 degrees
- +/- 8.33 mm horizontal, +/- 5.992 mm vertical

Studies Before Run

Beam counter thickness
Shielding downstream detector package
Collimator
Wall Lining
Detector orientations
Beam counter placement

Studies Before Run

Beam counter thickness

Shielding downstream detector package

Collimator

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Beam counter placement

Beam counter thickness (mm)	% stop in beam counter	% get to target	% stop in target (among those get to the target)	total stopping eff. % (compare to all muons)
0.7	0.02	64	34	22
0.8	0.04	57	66	40
0.9	0.06	51	89	45
1.0	0.09	43	98	42
1.1	0.2	35	99.4	35
1.2	1.4	24	99.7	24
1.3	12	12	99.7	12
1.4	43	3	99.8	3
1.5	79	0.5	99.9	0.5

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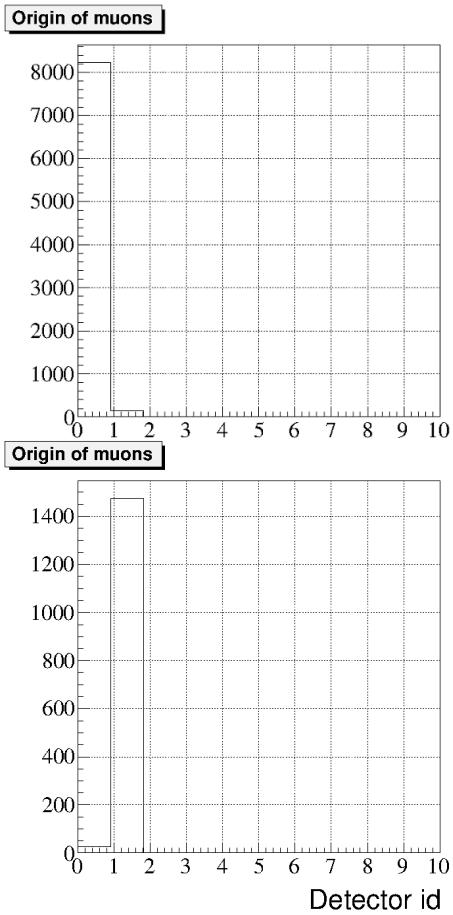
Beam counter placement



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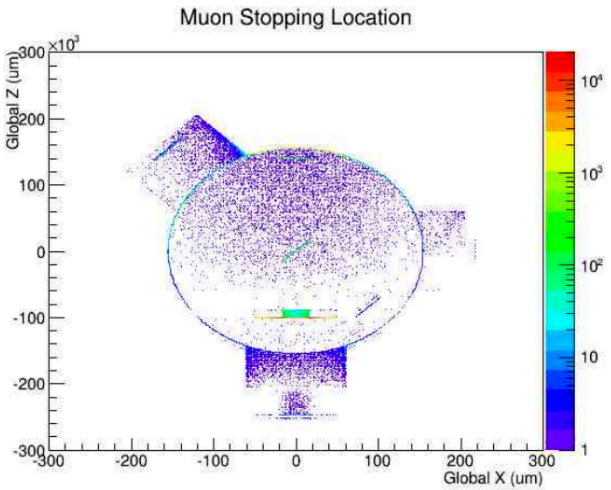

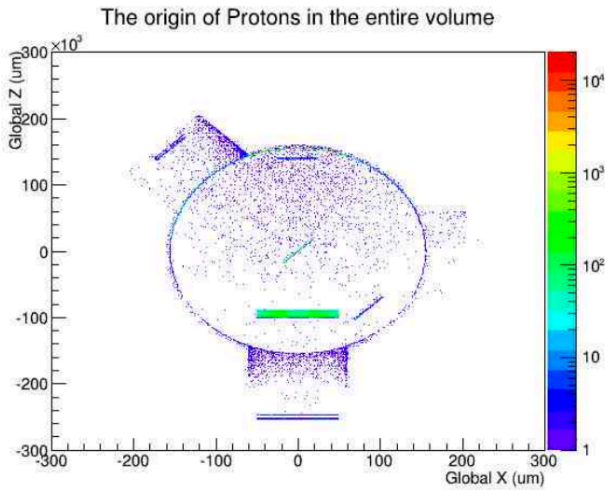

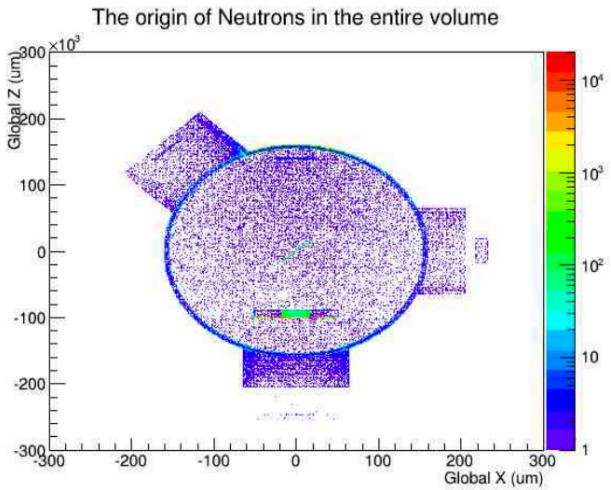

Studies Before Run

Beam counter thickness
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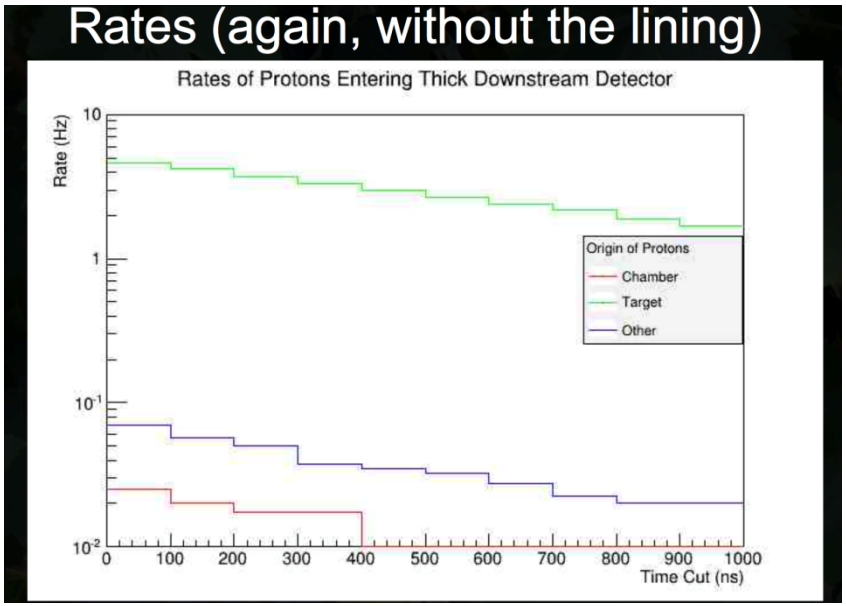
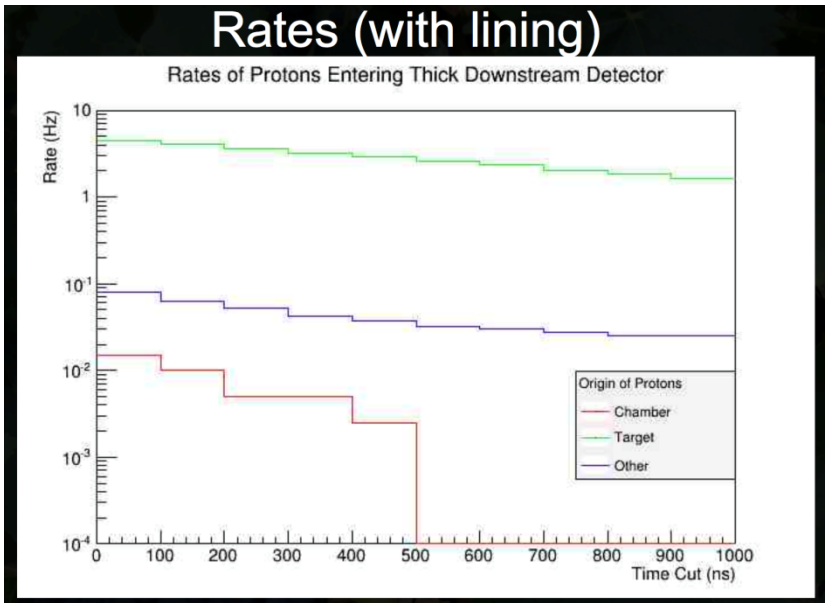
Collimator
Wall Lining
Detector orientations
Beam counter placement

Rates (again, without the lining)



Rates (with lining)



Studies Before Run

Beam counter thickness
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Number of Muons Scattered Into Downstream

Angle	Normalized to Pileup Protection and Beam Vetos	Normalized to Primary Stops in Target
135 deg	86.9571E-5	56.2194E-3
90 deg	3.7938E-5	02.4545E-3

Studies Before Run

Beam counter thickness
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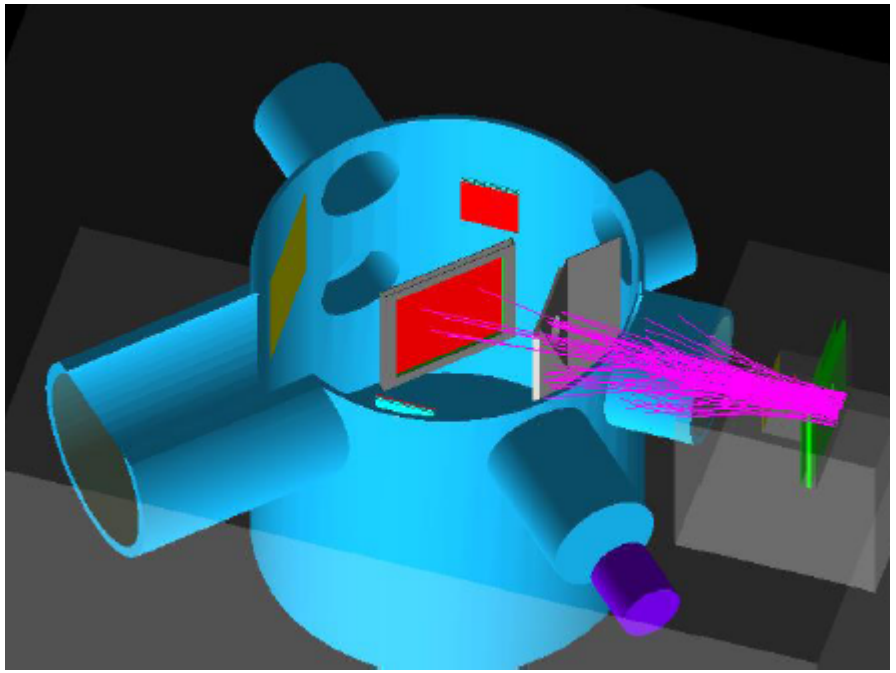
Detector orientations
Beam counter placement

- ~25% as many muons stop in MuSC as in Target (for beam momentum maximizing stops in thin target)

- If valid event := !(muSCA | muVeto | ScL | ScR) & muSc
  - 15% primary stops in target per valid event when beam counter outside chamber
  - 75% primary stops in target per valid event when beam counter inside chamber

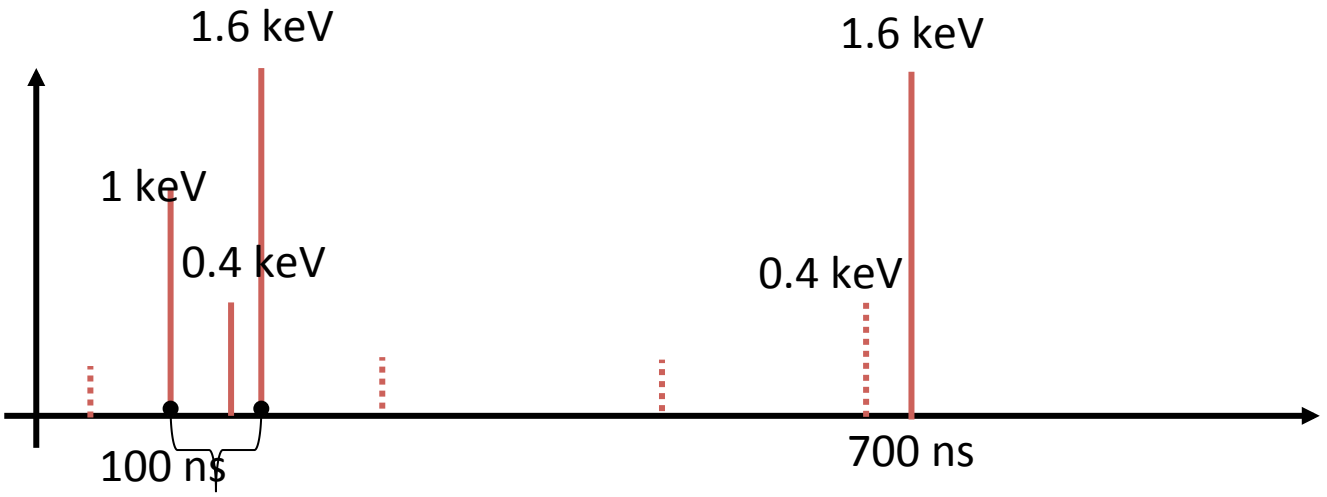
Modifications During the Run

- Geometry Setup
  - Based on the geometry set by John.
  - Did some tuning in the upstream geometry.
- Muon Beam
  - Initial momentum: Gaussian/Uniform distribution, peak @ 28.5 MeV*ScalingFactor, sigma = FWHM/2.35



Detector Response

- Detector (silicon) response in my simulations:
- Pulse width considered no smaller than 10ns: hits within 10ns would be considered as one.
- Threshold of deposit energy: 0.5 keV
- Energy resolution not included: Record the total deposit energy within pulse width as pulse height.
- Pulse time: hit time in simulation. No delay effect or pulse width included.



One hit: 100ns, 3 keV

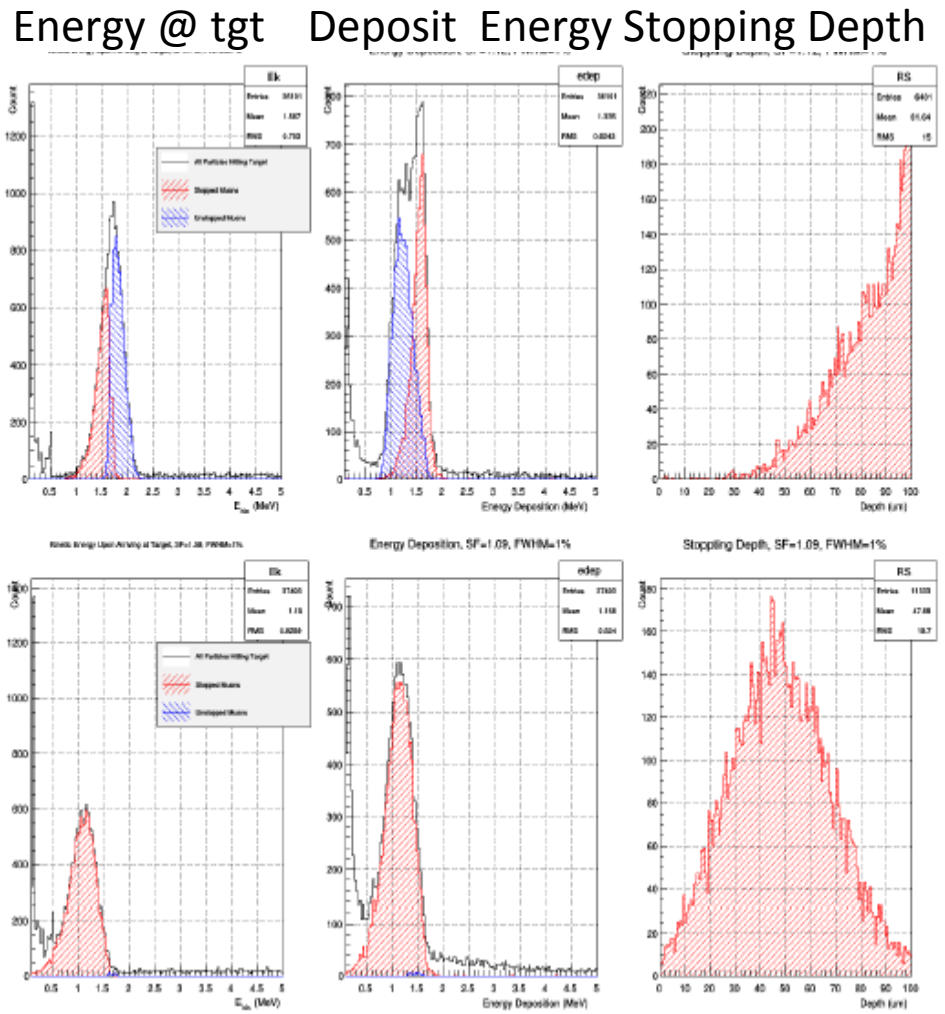
Another hit: 700ns, 1.6 keV

Interpreting Data

- By doing simulation from beginning or target, try to achieve consistency between MC and data.
  - Can help us understand the beam before target
    - What we got is only Turtle data before beam monitor, and information from beam monitor is not enough to describe the beam.
    - For normalization and unfolding
  - Can help us understand geometry acceptance
    - For normalization

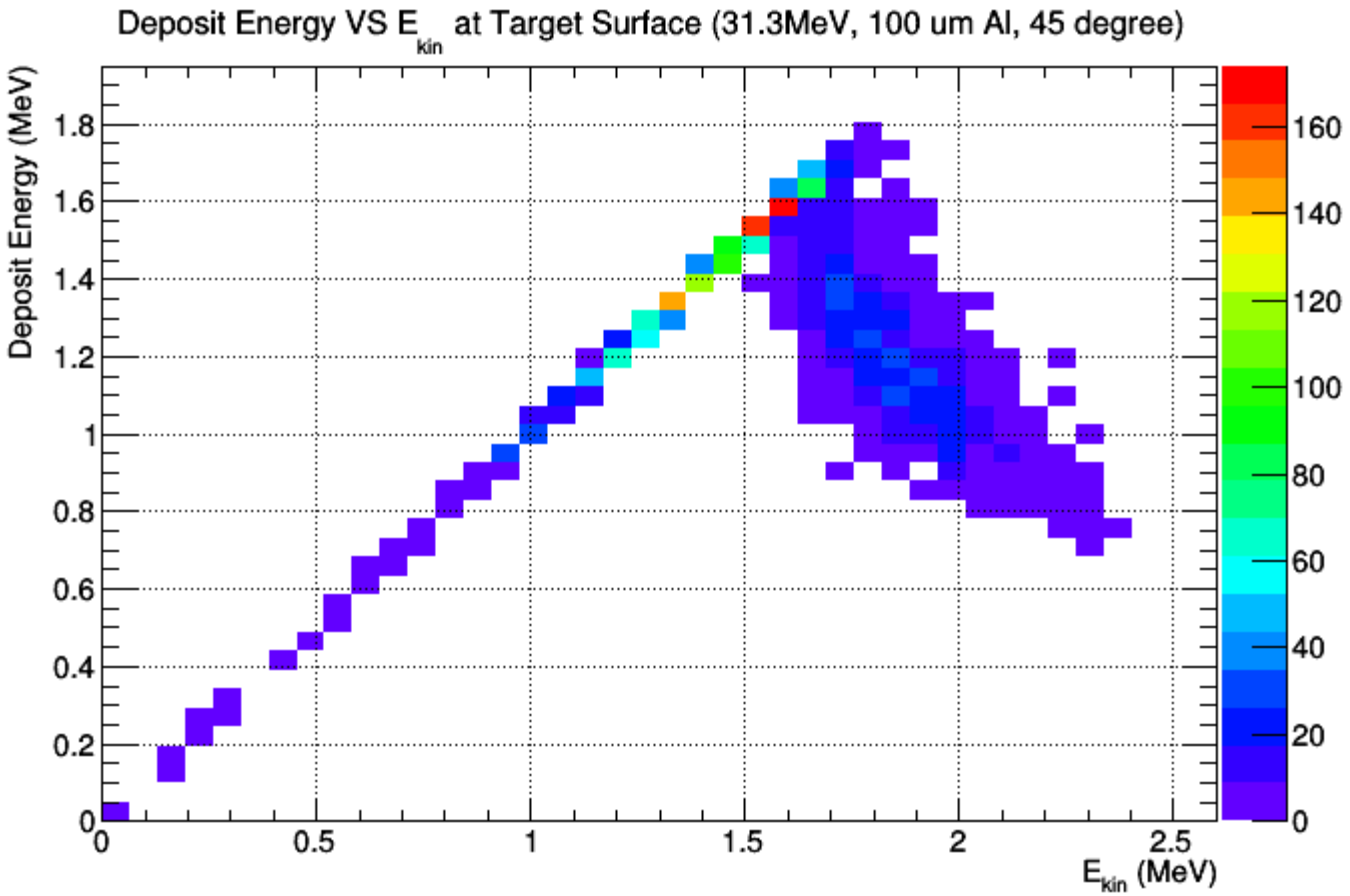
Interpreting Data

- MC Simulation Starts from beginning
  - Results in Elog 388, 445, 503, 591
  - Deposit energy does not match what we got in active target.
    - Change beam profile
    - Change geometry
    - Change detector response
    - Start from target?



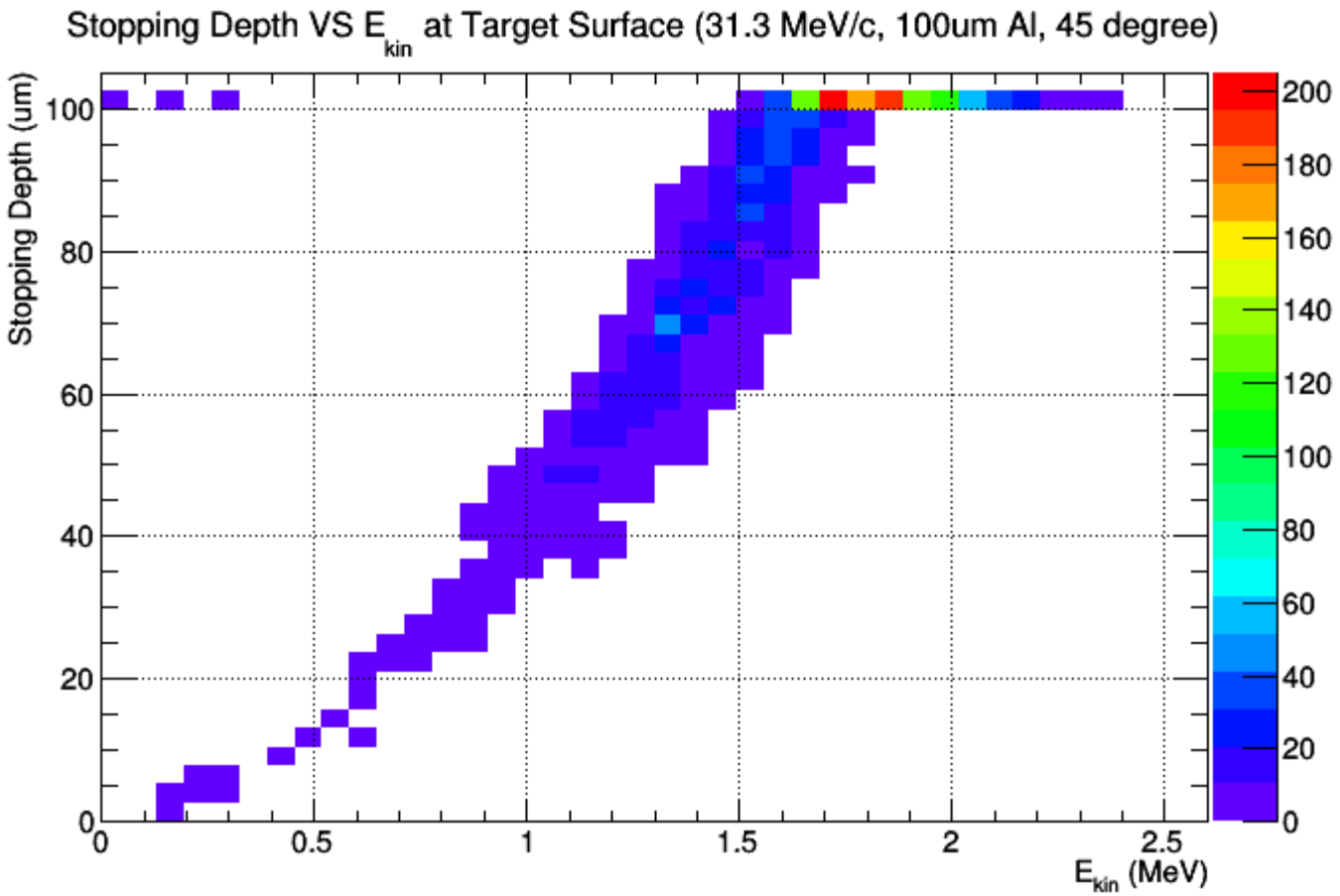
Issues of Starting from Target

- From deposit energy to beam energy before target.
  - No info about beam spot
  - No info about incident angle
  - Divide contributions from stopped muons and passing through muons



Issues of Starting from Target

- From deposit energy to beam energy before target.
  - Stopping depth depends on incident angle also



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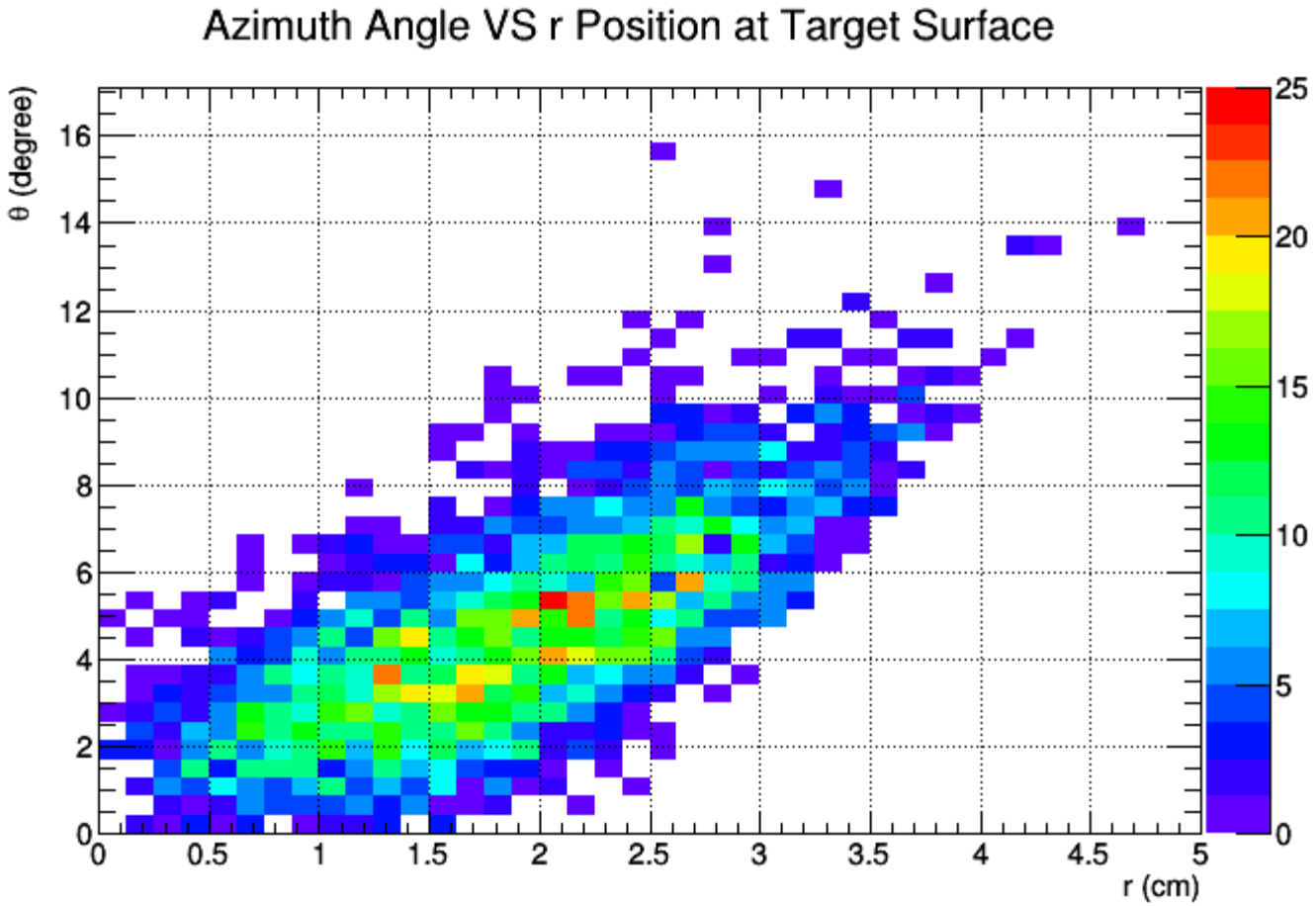
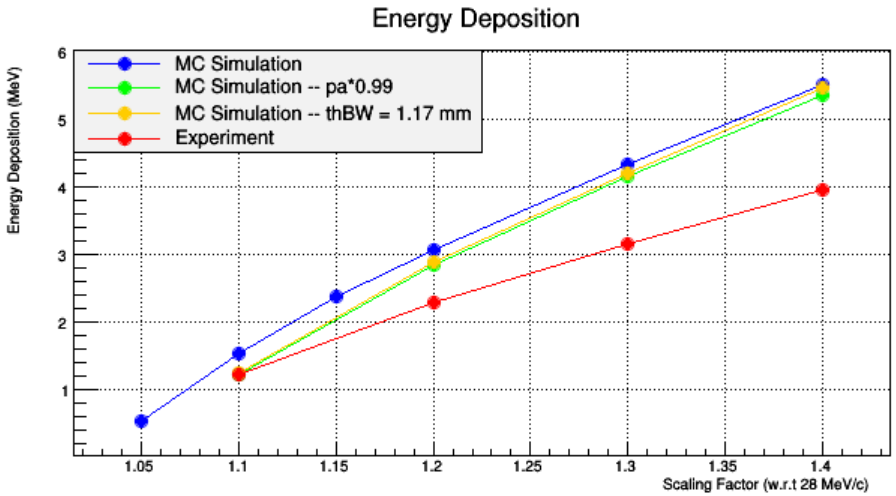
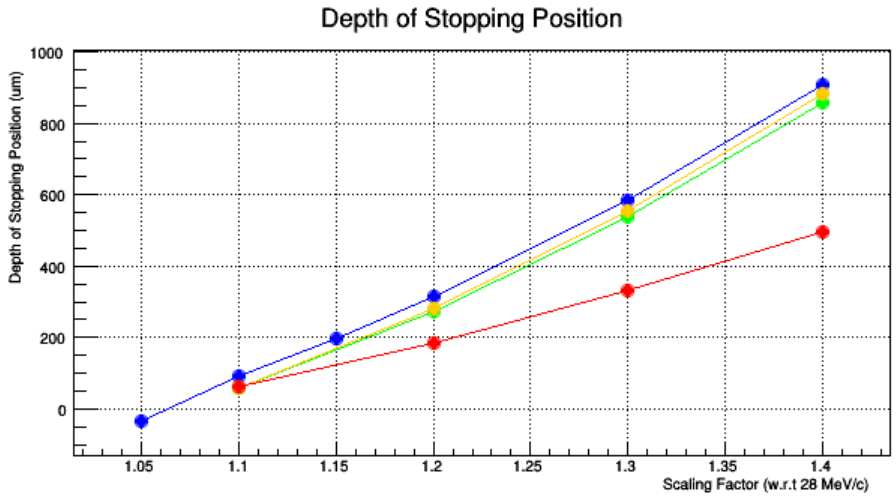
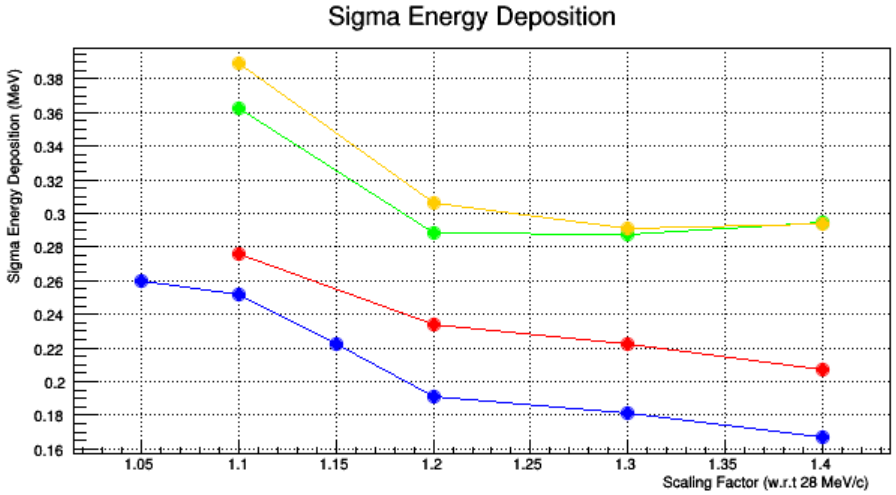
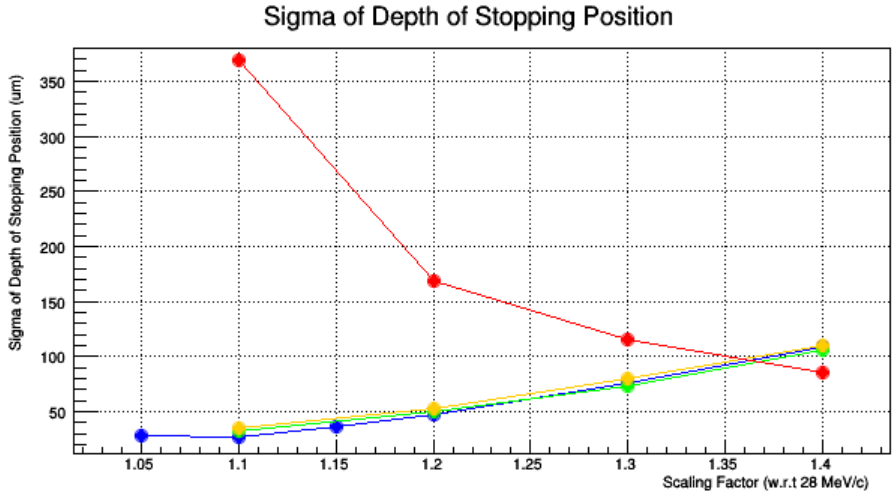


Change beam profile & Change geometry – Helped little

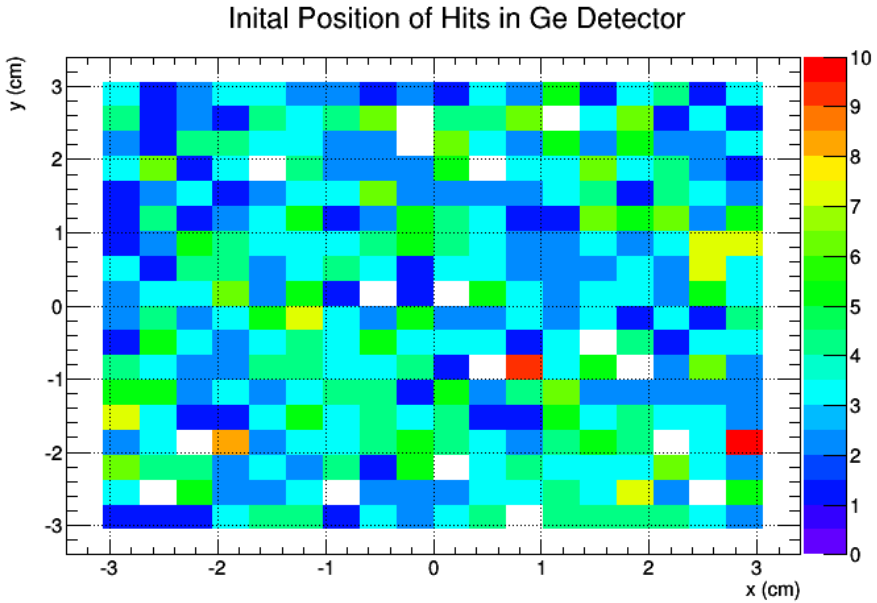


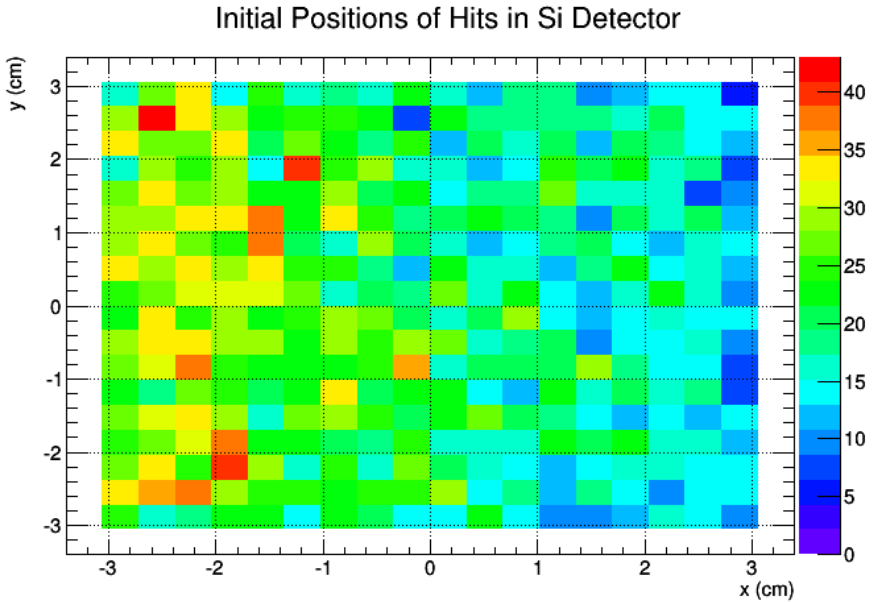


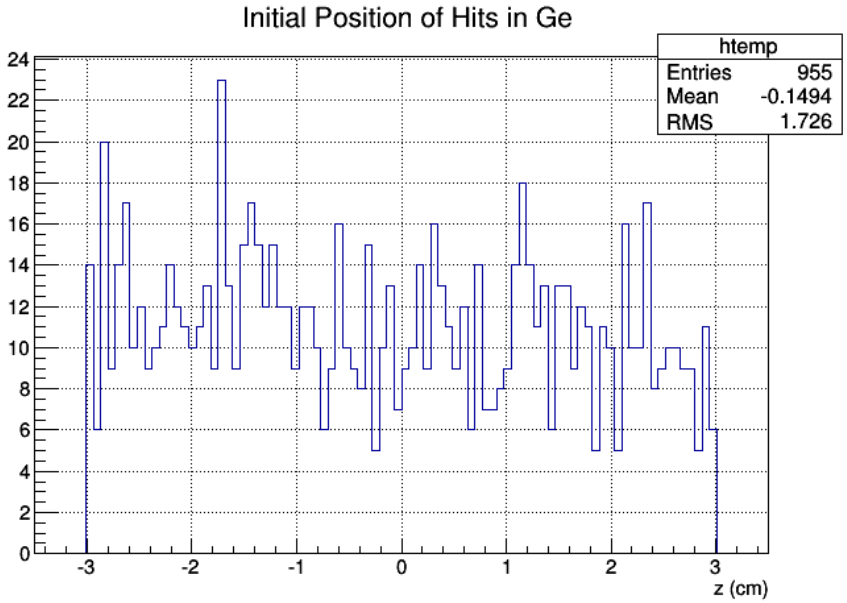


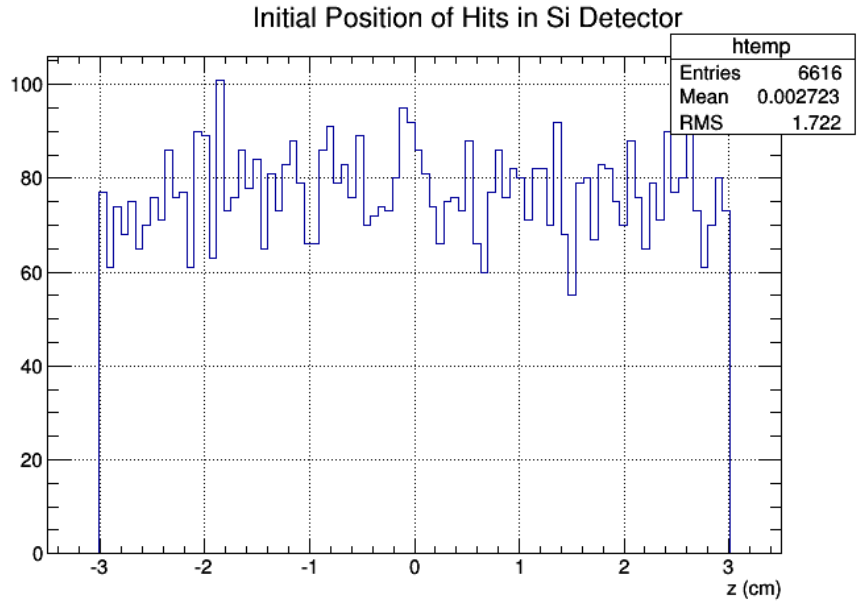


Check Geometry Acceptance









Next to Do

- How good we should be:
  - By assuming different stopping position distribution:
    - Check how much it helps us with normalization
    - Check how much it helps us with unfolding
- How to become better:
  - Change beam profile:
    - Use Turtle data, and consider the beam spot at MuPC
    - Come up with beam profiles @ target for different scaling factors.
  - Change geometry:
    - Check the geometry before target with alignment measurement.
  - Change detector response:
    - Consider overlap, resolution, efficiency, etc.

Plans for MC

- Is Ge efficiency in agreement with Nam's measurement or the geometric acceptance?
- Does *x'* or *y'* matter much, or does scattering dominate the distribution?
- Proton efficiency?
- Beam Properties
  - Veto ratio
  - SiR target ratio
  - Scattering to silicon package
- Vary beam momentum until matches *E* distribution inside active target
- Plug in the known Si spectrum from that old paper, are the rates now consistent with what we observe?
- Alignment effect