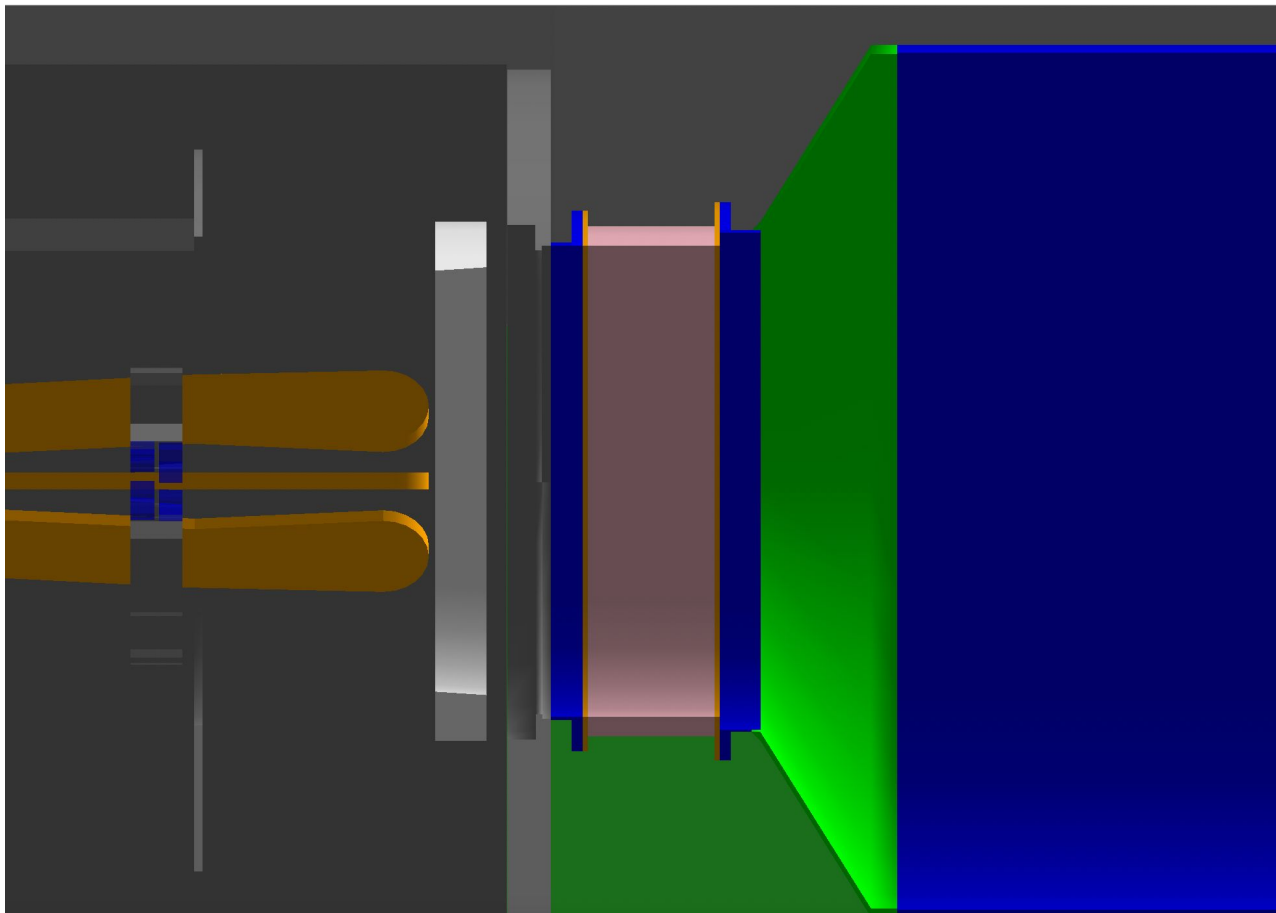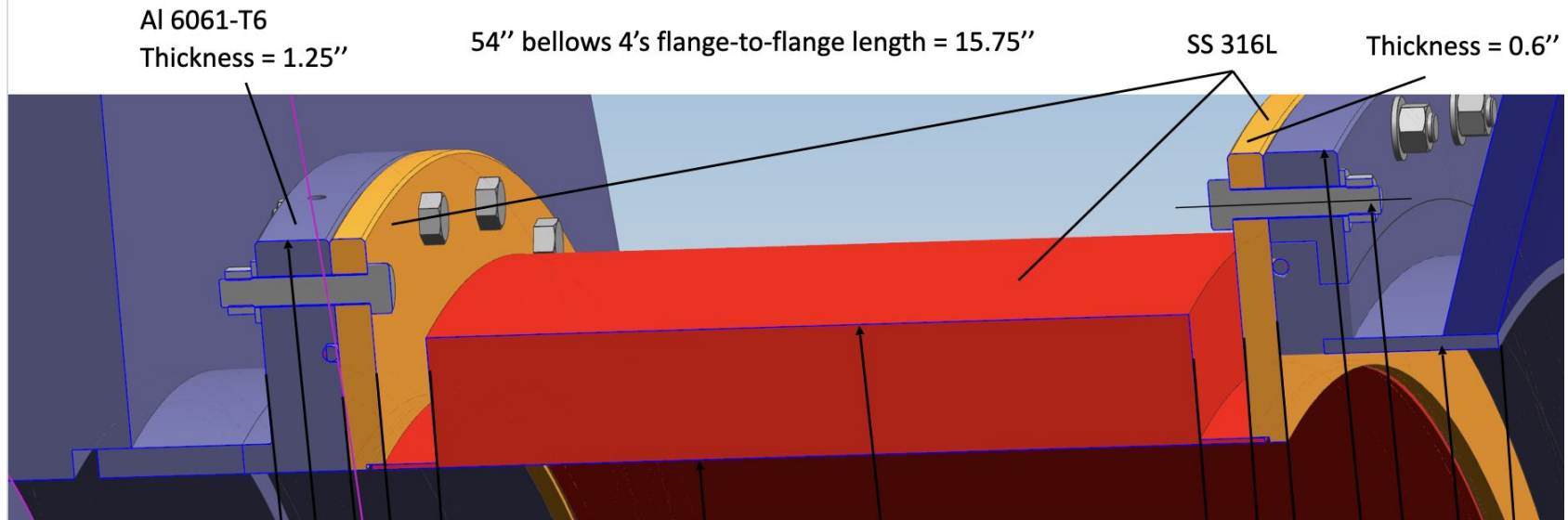# Collar 1 Optimization

Ryan Richards

Bellows 4 Region. Collar 1 must keep rays off bellows 4 and connection pipe

Al 6061-T6
Thickness = 1.25''

54'' bellows 4's flange-to-flange length = 15.75''

SS 316L

Thickness = 0.6''

Z0 = -480.785''
Z1 = -482.035''
Z2 = -482.635''
Z3 = --483.513''
Z4 = --496.313''
Z5 = -497.185''
Z6 = -497.785''
Z7 = -502.453''

Z0   Z1
Z2
Z3
D4

D1
D2

D1 (diameter) = 54''
D2 (diameter) = 58.5''
D3 (diameter) = 64''
D4 (diameter) = 62''
D5 (diameter) = 62.25''
D6 (diameter) = 57''

Z4
Z5
Z6
D5
D3
D6
Z7

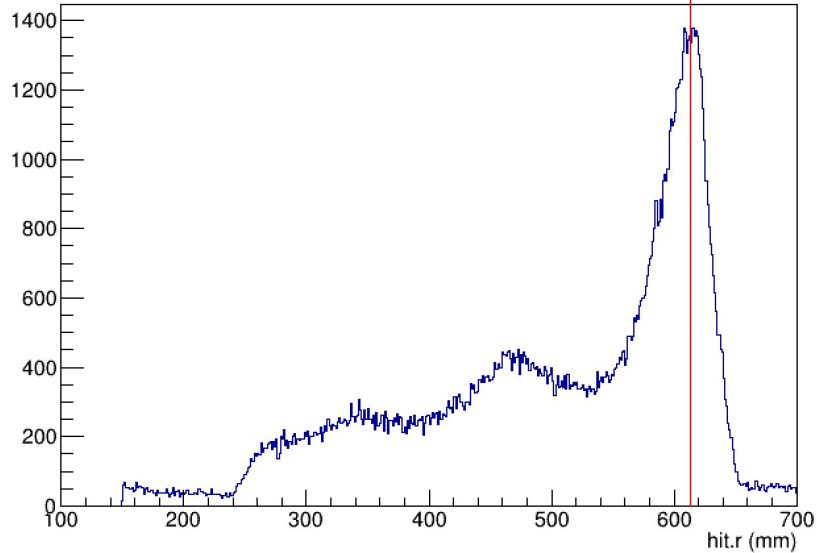Bellows 4 region z positions and diameters. This is what was simulated

Optimization Strategy

- Simulated 100 M beam events with IR = 613 on the US face of collar 1. The DS face of collar 1 had IR = 623 (3.8 degree taper). The OR for both faces is ~ 756 mm. These were not changed.
- We want to design collar 1 to minimize its background contribution on detector 28 as well as keep rays of bellows 4 and the connection pipe. Of course, we want to optimize the Moller flux as well.

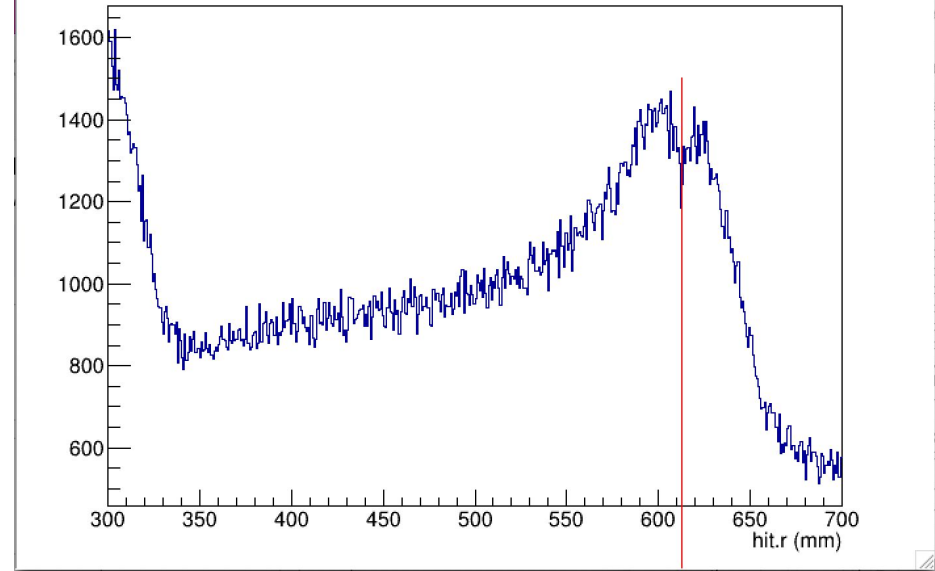# Radial Hit Distributions of What Hits Collar 1 Entrance Plane

Electrons

Photons

Red Line: Maximum inner radius (IR = 613 mm) that keeps the background from the bellows 4 region. It is also the maximum of the incident flux, suggesting to use a smaller IR without cutting useful signal

What hits collar 1 Angle and Energy

Before optimizing the inner radius on the front face of collar 1, we optimized the taper to minimize the edge scattering.

Cut +/- 1 cm around the peak → 1 GeV charged particles incident at 4.5º
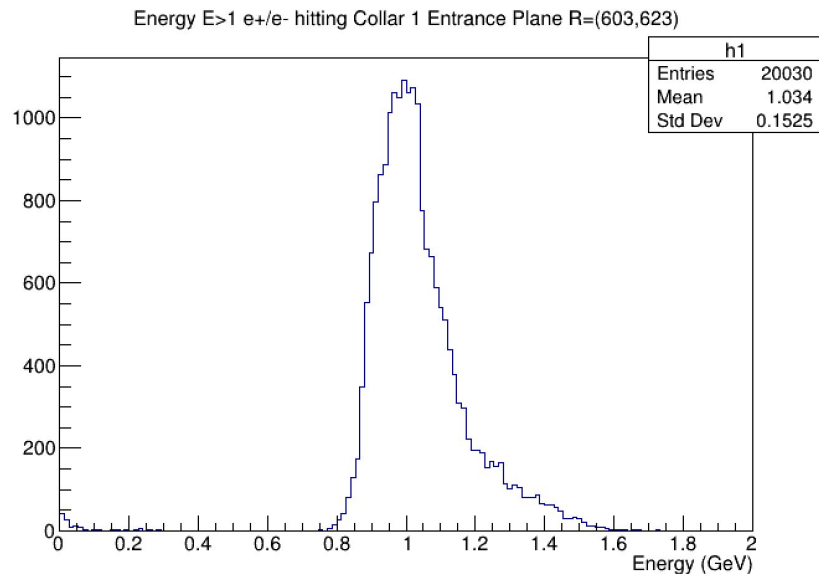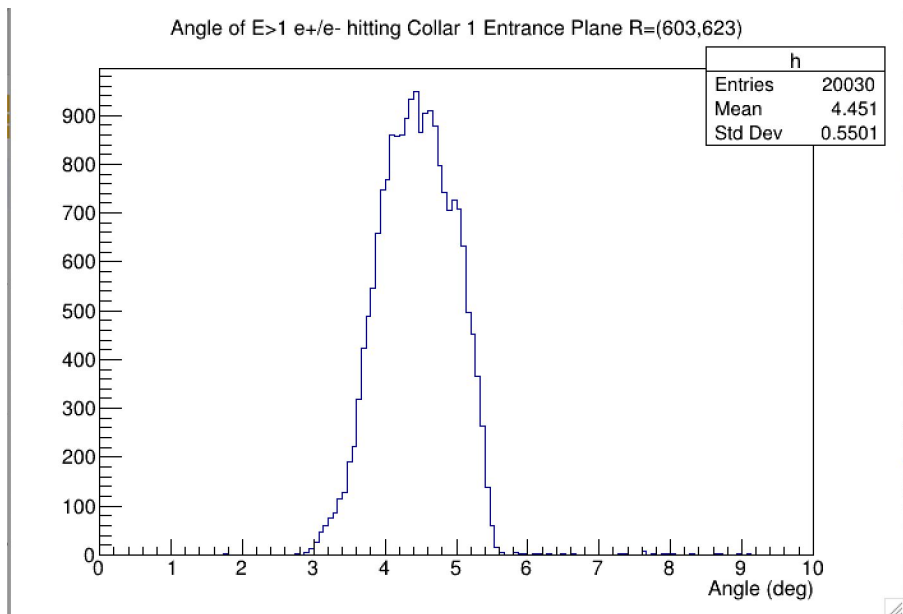
Initial idea is to put the taper at the peak and scan around that as well

Studying the Taper

|	Taper = 4.5 deg	Taper = 5 deg
KE < 1 MeV	1,115	1,111
KE 1-10 MeV	4,885	4,921
KE 10-100 MeV	12,384	11,121
KE 0.1-1 GeV	4,556	3,730
KE 1-10 GeV	8	8
KE > 10 GeV	0	0
Total	22,928	20,891

Looped over primaries many times to evaluate what was making Ring 5.

Looked at other angles as well- 5^0 was consistently the best

~ 1.6% of the Moller Rate (too big)

Photon rate is about 10x larger
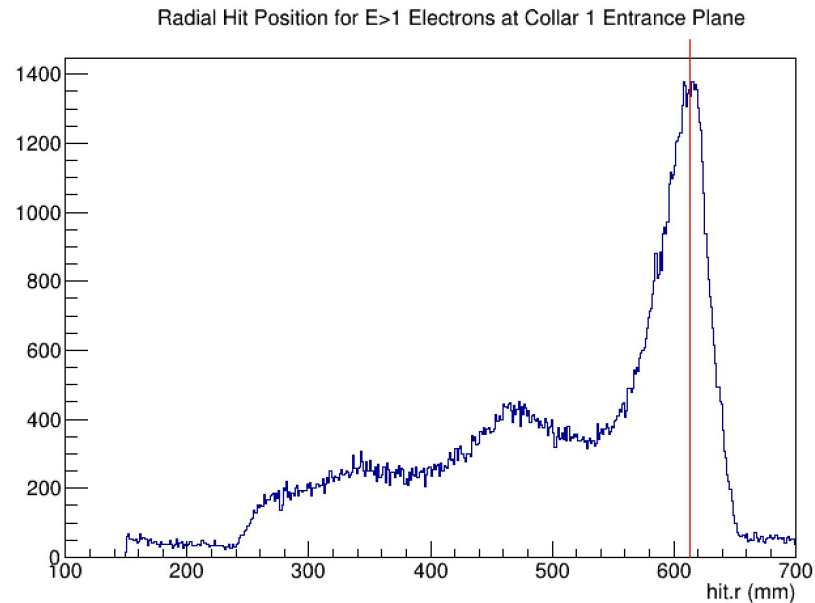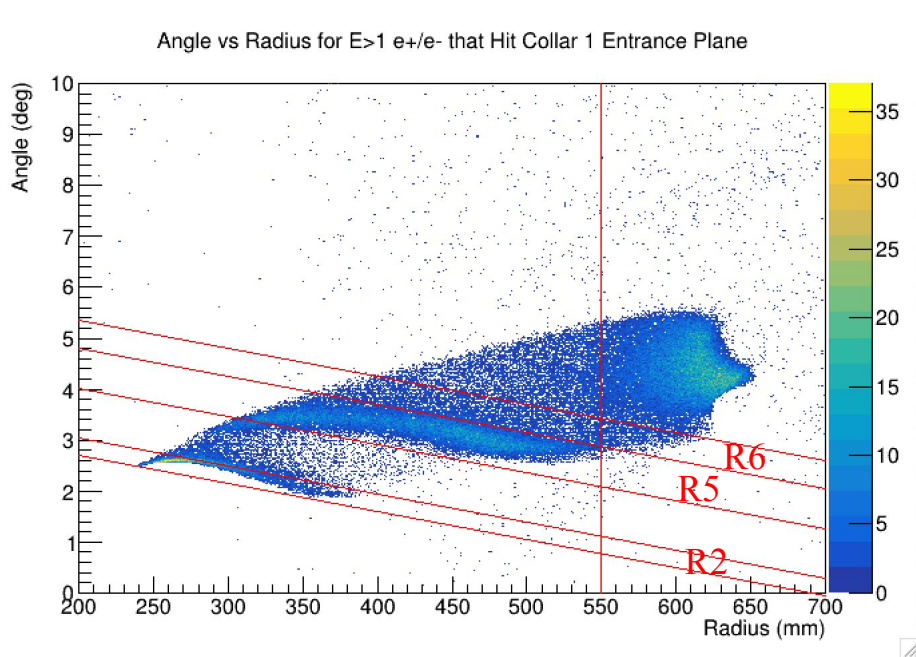
What kind of Background?

Vertex Radius vs Vertex z e+/e- Ring 5

Vertex Radius vs Vertex Z γ Ring 5
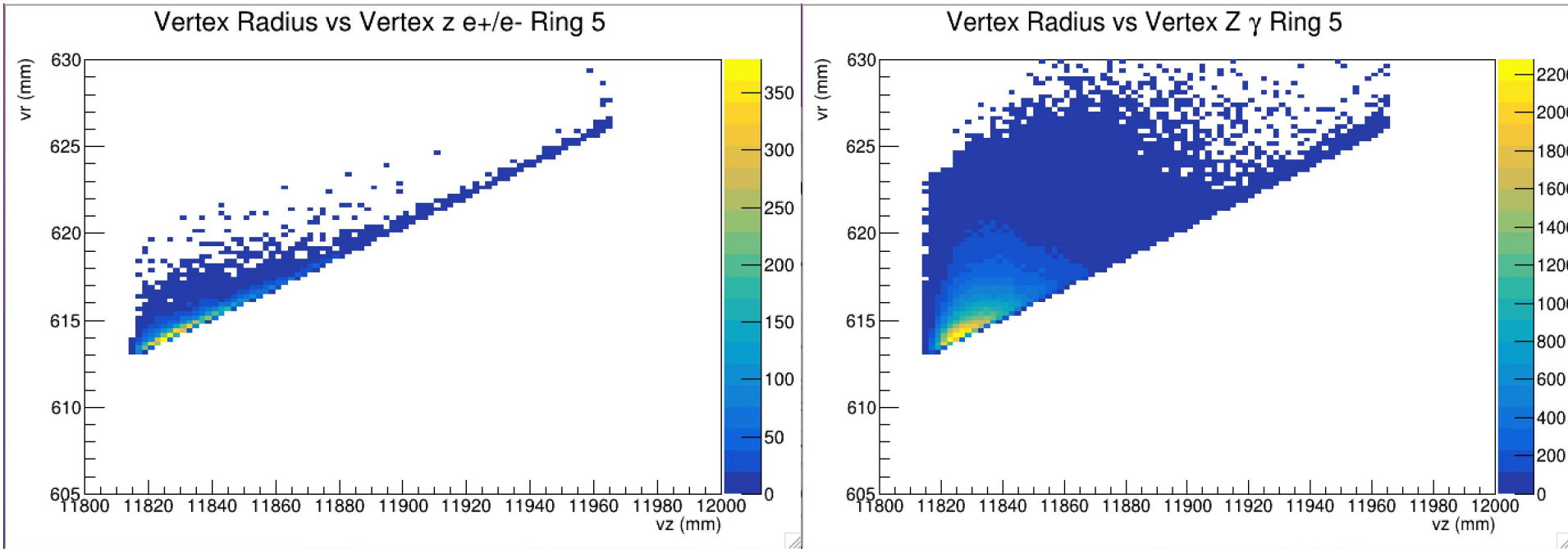
See that it's slit scattering at the edge and not punchthrough, so collar 1 is thick enough
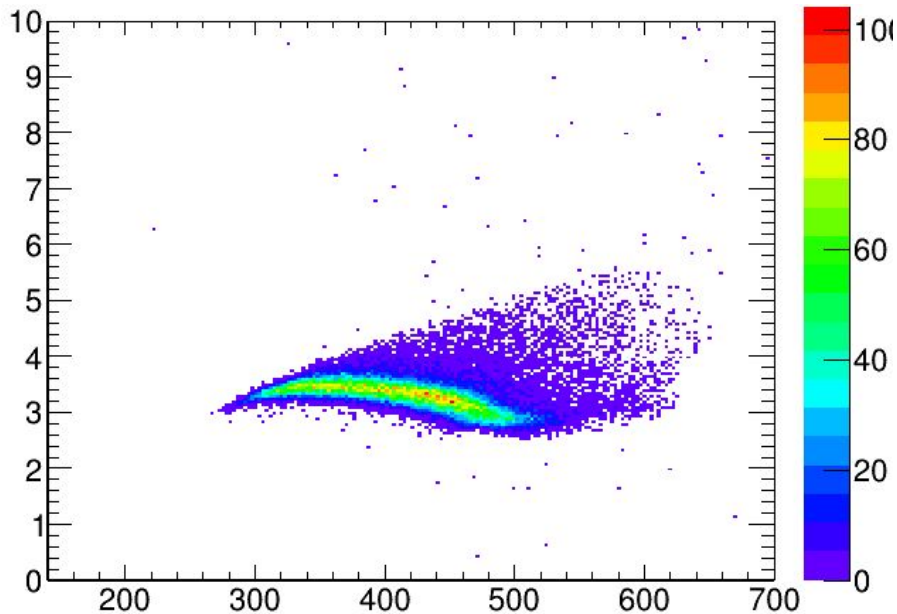
Chose 5^0 taper

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# Mollers, ep visible in angle vs R at collar 1, with beam gen

IR =550 on front face of collar 1 seems like a good choice without removing irradiated Moller rate and keeping most of signal in Ring 6

With IR = 550 → 0.3% background in Ring 5. Started with ~ 1.6%

How would Shrinking the Collar 1 IR affect the Moller Rate?

These are the e+/e- hitting collar 1 entrance using the Moller generator. Vertical axis is angle, horizontal axis is the radius
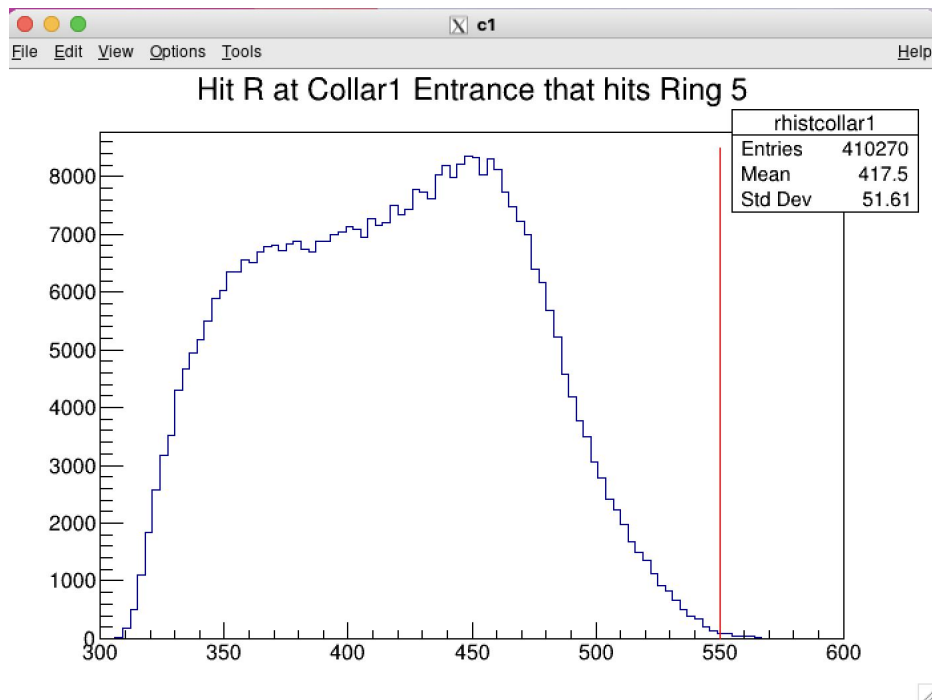
Here I cut on trackID == 1 or 2. Seems like we wouldn't lose much rate. We tried to predict the rate as a function of r at collar 1

Moller/ep Generator Results with IR = 550 and 5º Taper

	Rates (GHz) IR = 623 (Moller)	Rates (GHz) IR = 550 (Moller)	Rates (GHz) IR = 613 (ep Gen)	Rates (GHz) IR = 550 (ep Gen)
Ring 2	0.0108	0.040	18.189	17.875
Ring 5	117.309	117.549	8.203	8.284
Ring 6	21.505	19.141	8.757	7.04831

Cut on primary tracks i.e. track ID = 1 or 2 at Detector 28
**2.36 GHz of Moller rate and 1.71 GHz in ep rate lost in Ring 6**

Summary and Next Steps

- Proposing collar 1 have IR = 550 mmon US end with 5 degree taper(~0.3% charged background along the edge with little to no rate in Ring 5). Increase in mass (~½ ton, this is ok)
- Exploring what to do with OR of collar 1.
- Seeing like 0.3% background from stuff coming over the top of collar 1
- Photon backgrounds

Backups

Collar 1 Proposed Design
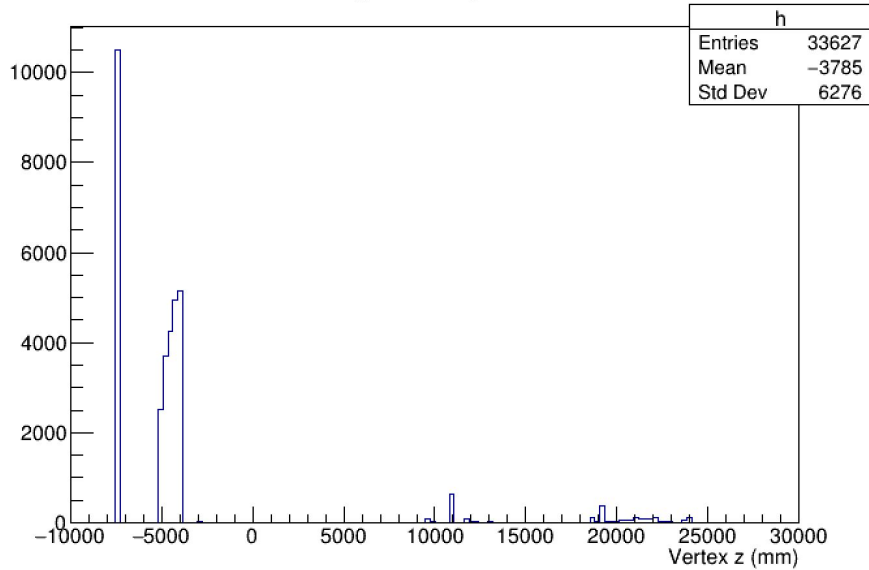
Outer Radius = 755.8659 mm
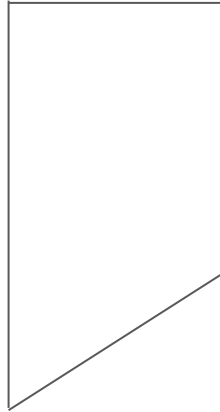
Made from Pb
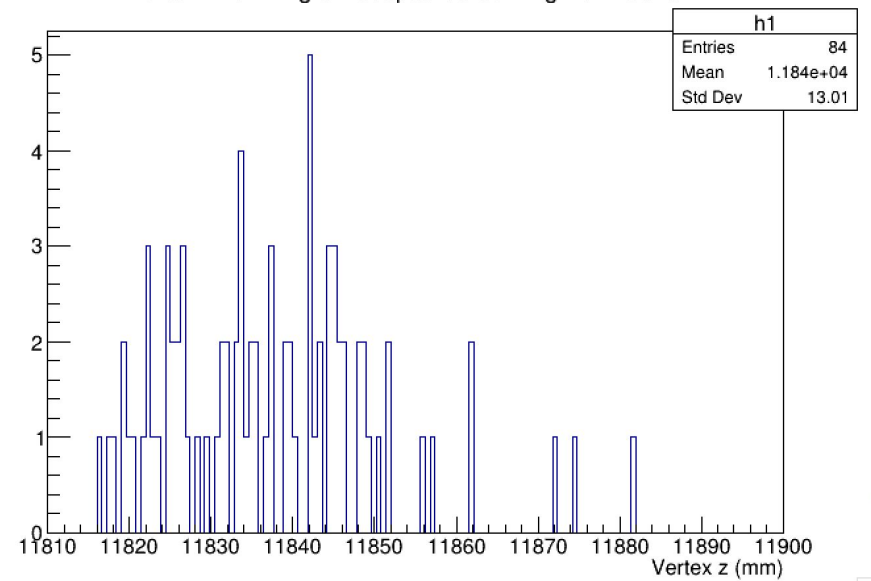
Inner Radius 2 = 563.1233 mm

Z2 = 11965.4958 mm

Inner Radius 1 = 550 mm

Z1 = 11815.4958

Vertex z for Ring 5 Acceptance

h	
Entries	33627
Mean	−3785
Std Dev	6276

Vertex z for Ring 5 Acceptance coming from Collar 1

h1	
Entries	84
Mean	1.184e+04
Std Dev	13.01

Simulated 100M beam events with the collar 1 IR = 550, 5^0 taper. Here I am showing the hit vertex z for everything that hits ring 5. Cutting on the vertex for the collar 1 region (**right plot**),

1/3300 beam electrons is a Moller, 1e8 beam electrons so 30,303 Mollers, 84 from collar 1 -> 0.28%

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