Ferrous Materials

Detector Region – Bearings and Brake Pieces

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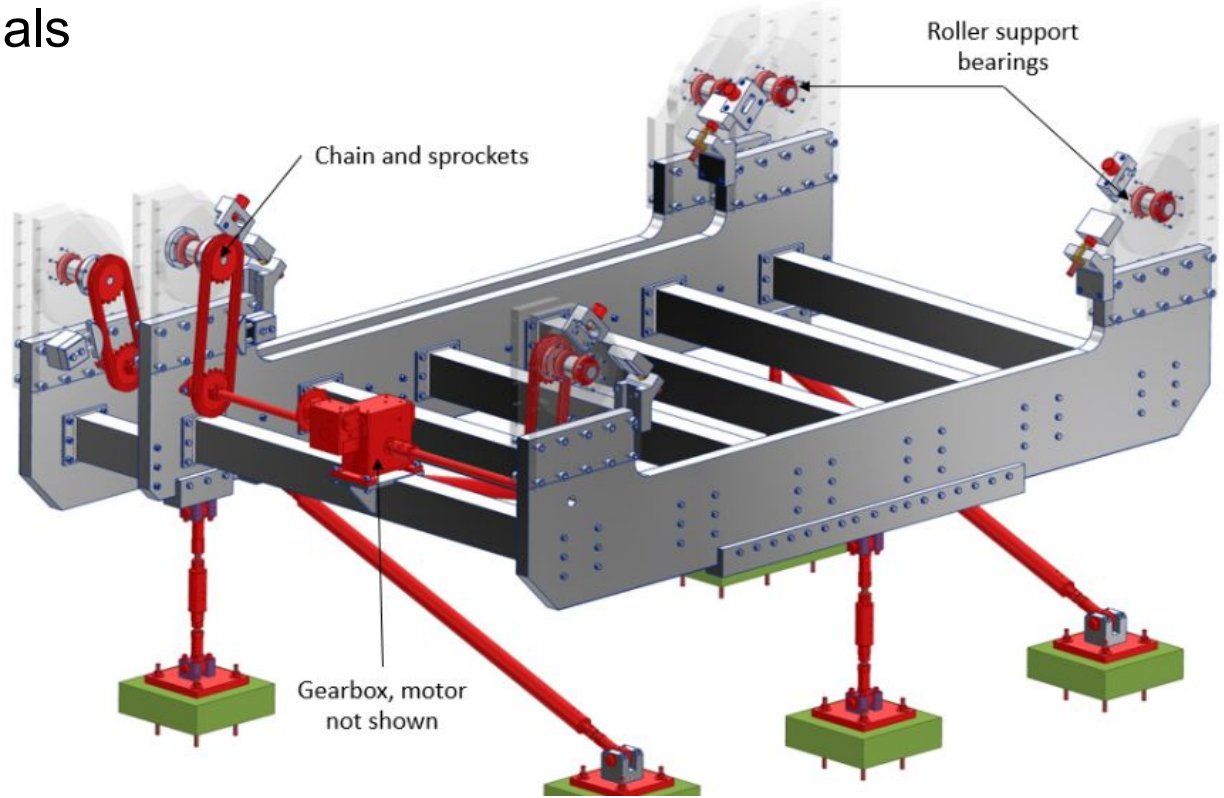
2024 / 11 / 08

Main Detector Support Structure Steel Materials

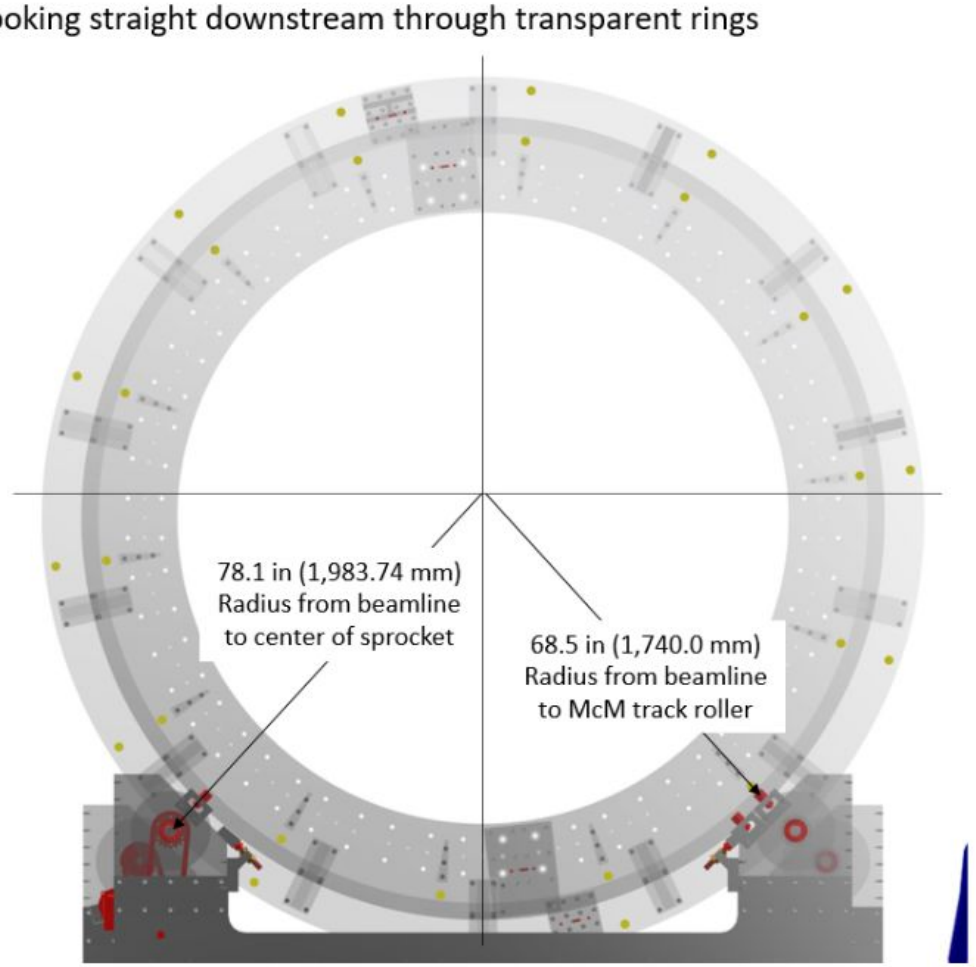
Steel materials in the lower support structure

(Image from Larry's slides)



Main Detector Support Structure Steel Materials

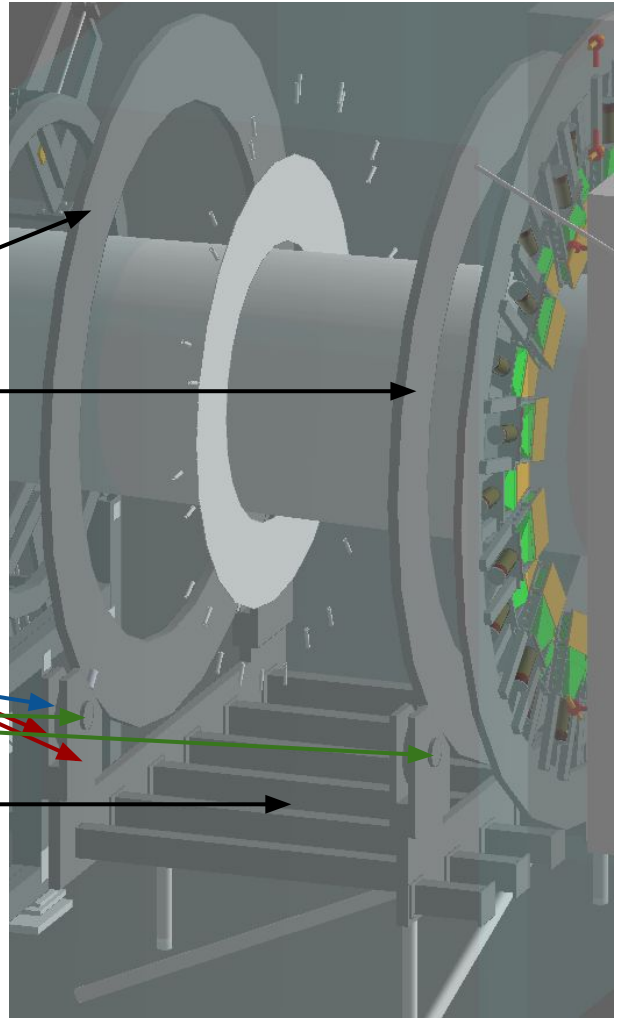
(Image from Larry's slides)



Ferrous: Detector Region Mass

Non-ferrous masses added:

- Detector ring front and back faces
- Plates that hold bearings
- Aluminum wheels
- Caps over bearings
- Support framing on bottom



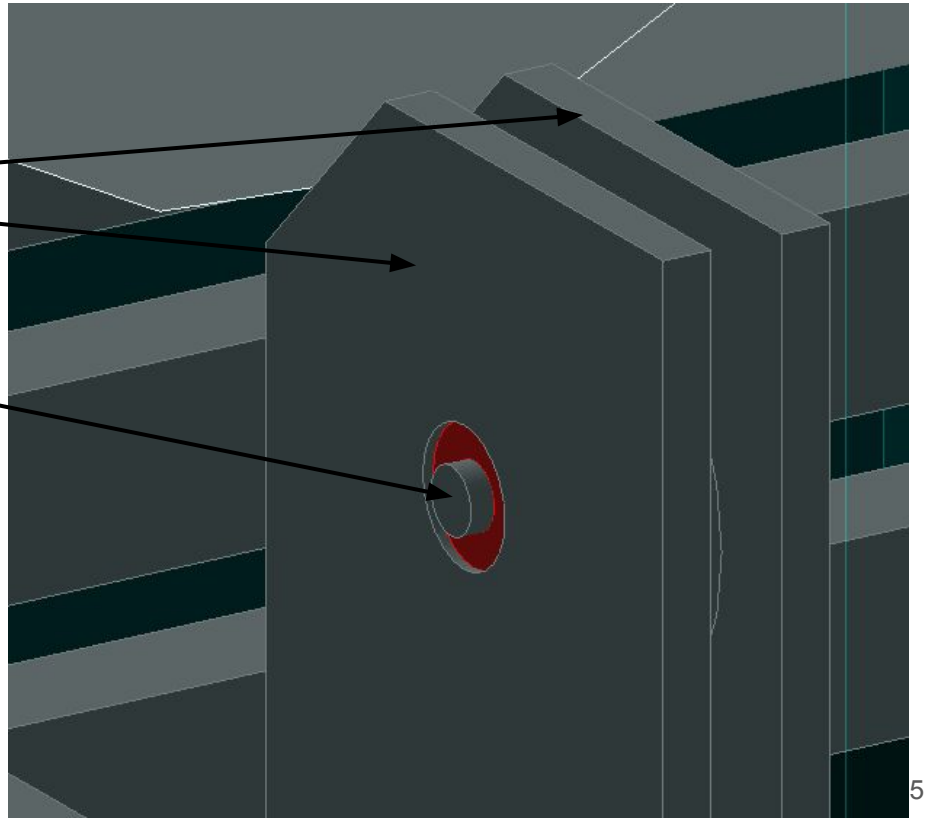
Ferrous: Detector Region Mass

Non-ferrous masses added:

- Plates that hold bearings
- Bearing pins

Ferrous mass:

- Bearing (shown in red)



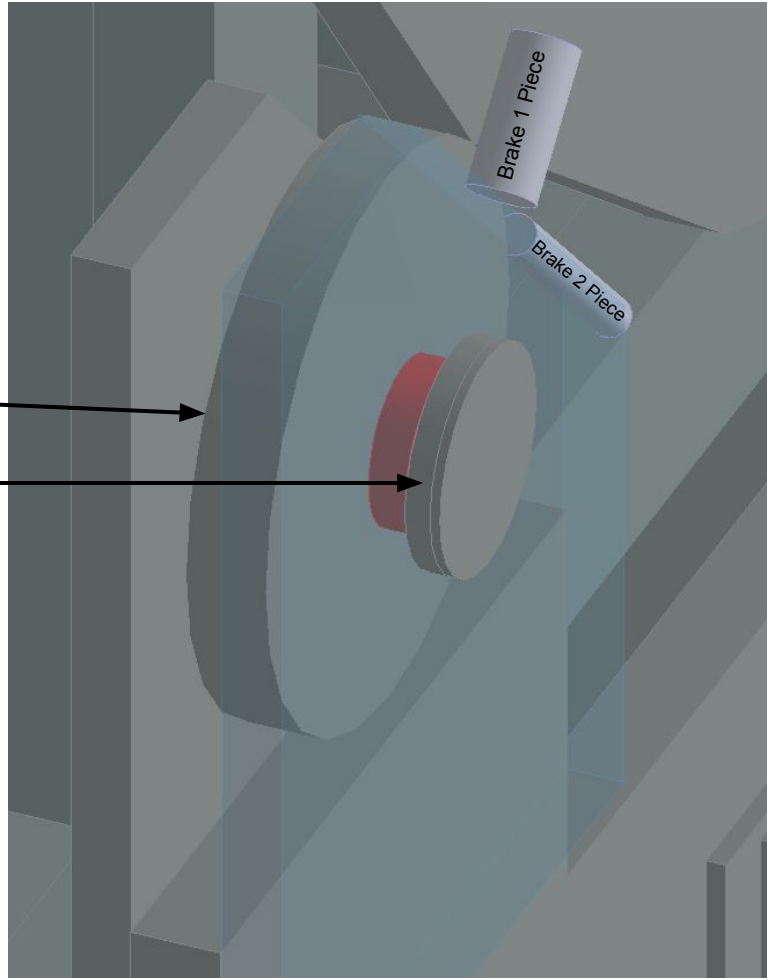
Ferrous: Detector Region Mass

Non-ferrous masses added (plate see thru):

- Aluminum wheels
- Caps over bearings

Ferrous mass:

- Bearing (shown in red)
- Brake piece 1 (labeled)
- Brake piece 2 (labeled)



Ferrous: Detector Region Mass

Non-ferrous mass

Bearings: Effort made to incorporate any mass which would attenuate incoming flux or outgoing ferrous backgrounds.

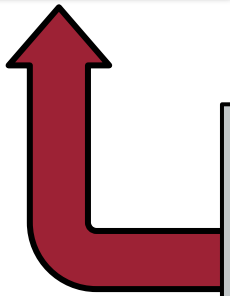
Brake Pieces: There are other non-ferrous mass materials that can be added. I'll look at numbers first.

Detector supports: Not re-run yet with new mass; will run that ASAP.

Tolerable limits for Ferrous Scattering Backgrounds

Material	X_r	Spin Polarization P_f	Fraction per e.o.t.	Fraction per Moller
Carbon Steel	2000	1E-02	1E-11	1E-07
Stainless Steel (Worst)	1	1E-05	1E-08	1E-04
Stainless Steel (Ideal)	0.01	1E-07	1E-06	1E-02
Aluminum	0.0001	1E-09	1E-04	1E+00
Inconel 625	0.001	1E-08	1E-05	1E-01
Brass/Bronze (Worst)	0.001	1E-08	1E-05	1E-01

- These are the limits that we've set for normalized ferrous materials scattering backgrounds.
- I'm going to try to persuade you into agreeing these are very reasonable upper limits.



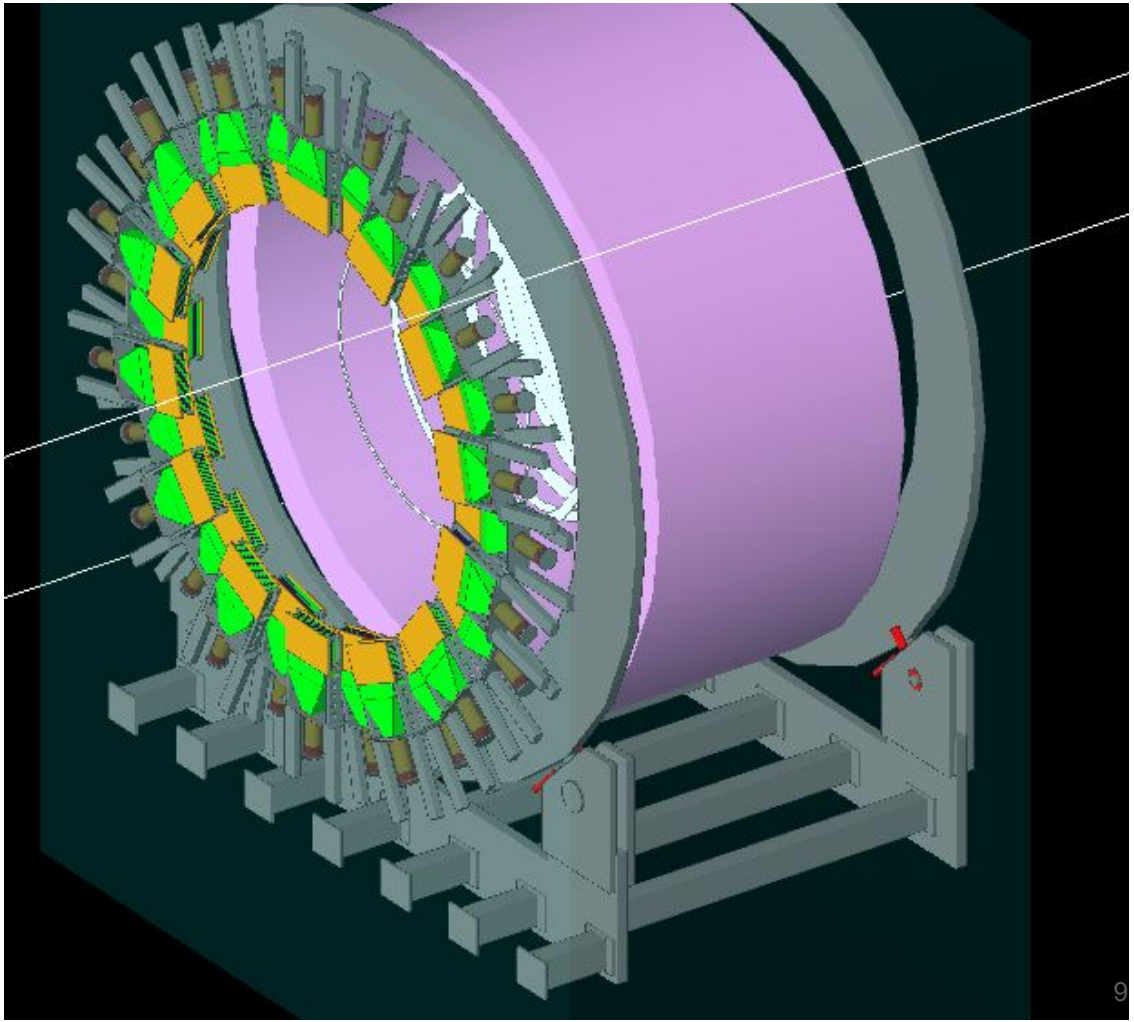
These are the quantities of interest as upper-bounds for ferrous materials scattering in our studies.

Detector 9911

Detector 9911 is a parallel world plane that wraps around the PMT region.

There is a barrier of aluminum and lead before the quartz rings which is not present here but spans between the two circular rings of the wheel.

⇒ The sensitive detector volume of interest is therefore 9911



9355: MD Bearings

Sens Volume:	MD Bearings
Sim Date:	11/5/2024
Detector #:	9355

MD Bearings -- Unweighted By BField

Total Prim's:	9,995,000,000	one failed sim

Total Sec's:	5,000,000	(per sens det)

Primary Counts		
Primaries	0	0&1
9355		6

Primary Fractional		
Primaries	0	0&1
9355		6.00E-10

(9928 Main Det) Secondary Counts 0&1		
Secondaries	Electrons	Gammas
9250	315	3395

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9355	6.30E-05	7.19E-04

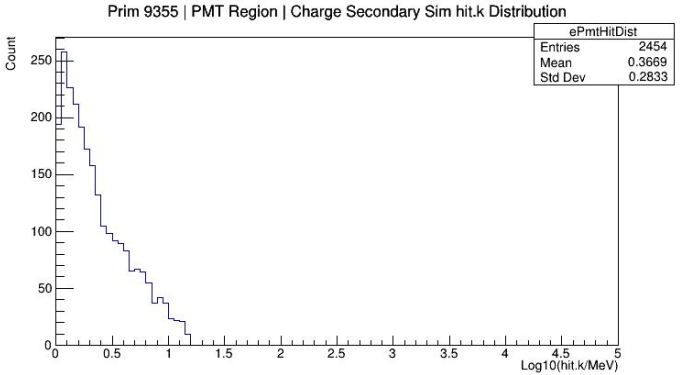
(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9355	3.78E-14	4.32E-13

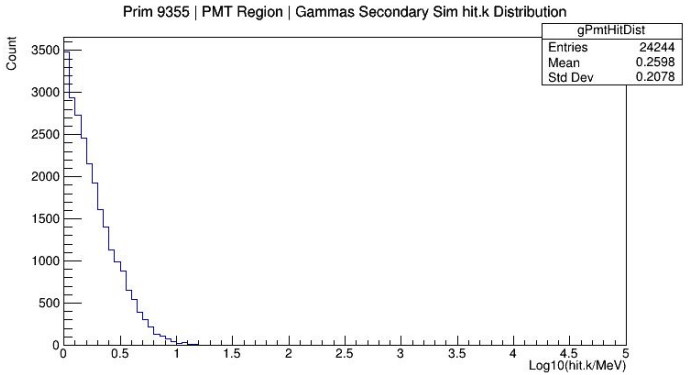
(9928 PMT Region) Secondary Counts		
Secondaries	Electrons	Gammas
9355	2454	24244

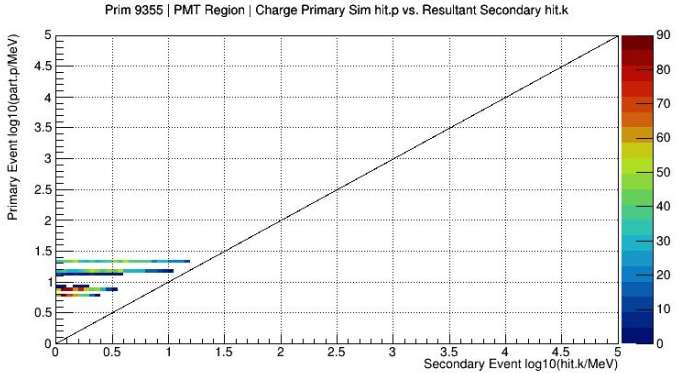
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9355	4.91E-04	4.85E-03

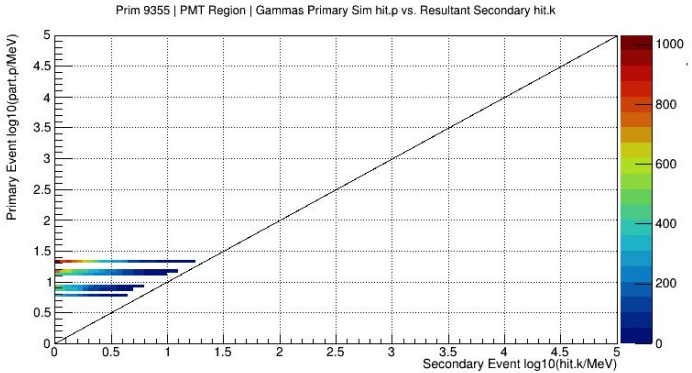
(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9355	2.95E-13	2.91E-12

9355: MD Bearings









9356: MD Brake 1 Piece

Sens Volume:	MD Brake 1
Sim Date:	11/5/2024
Detector #:	9356

MD Brake 1 -- Unweighted By BField

Total Prim's:	9,995,000,000	one failed sim

Total Sec's:	5,000,000	(per sens det)

Primary Counts		
Primaries	0	0&1
9356		48

Primary Fractional		
Primaries	0	0&1
9356		4.80E-09

(9928 MainDet) Secondary Counts 0&1		
Secondaries	Electrons	Gammas
9250	8061	1789

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9356	1.61E-03	3.58E-04

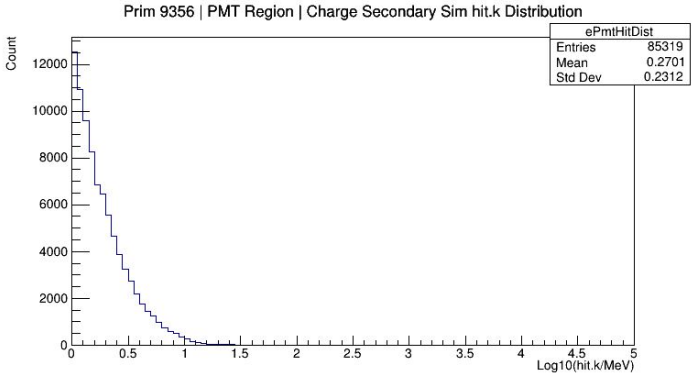
(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9356	7.74E-12	1.72E-12

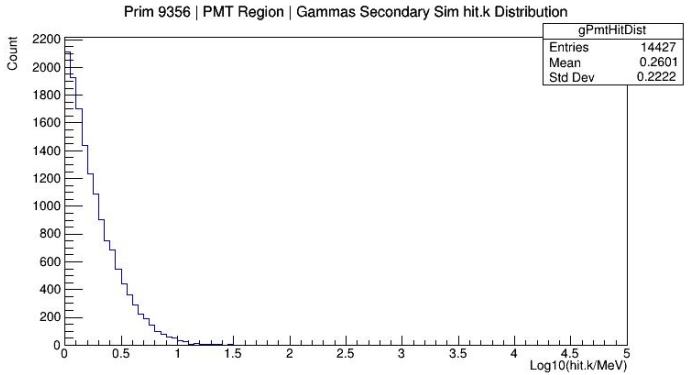
(9928 PMT Region) Secondary Counts		
Secondaries	Electrons	Gammas
9356	85319	14427

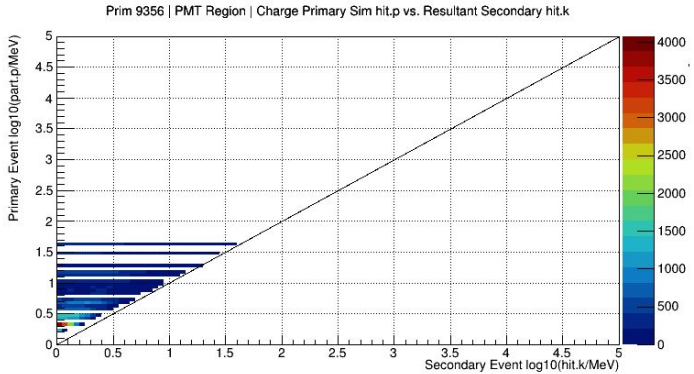
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9356	1.71E-02	2.89E-03

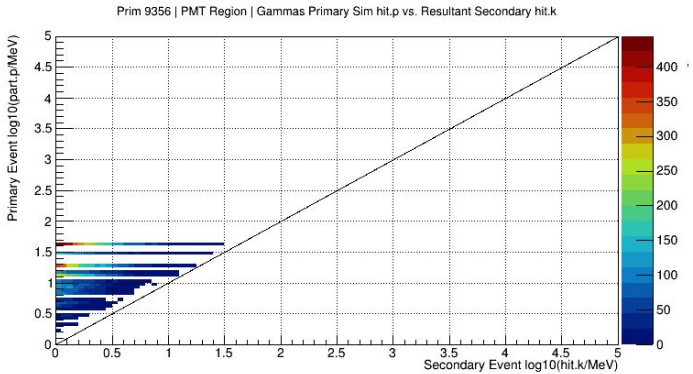
(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9356	8.19E-11	1.39E-11

9356: MD Brake 1 Piece









9356: MD Brake 2 Piece

Sens Volume:	MD Brake 2
Sim Date:	11/5/2024
Detector #:	9357

MD Brake 2 -- Unweighted By BField

Total Prim's:	9,995,000,000	one failed sim

Total Sec's:	5,000,000	(per sens det)

Primary Counts		
Primaries	0	0&1
9357		59

Primary Fractional		
Primaries	0	0&1
9357		5.90E-09

(9928 MainDet) Secondary Counts 0&1		
Secondaries	Electrons	Gammas
9250	5893	3224

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9357	1.18E-03	6.45E-04

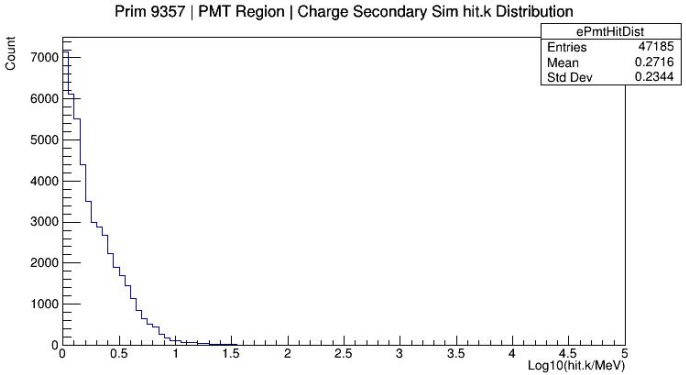
(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9357	6.96E-12	3.81E-12

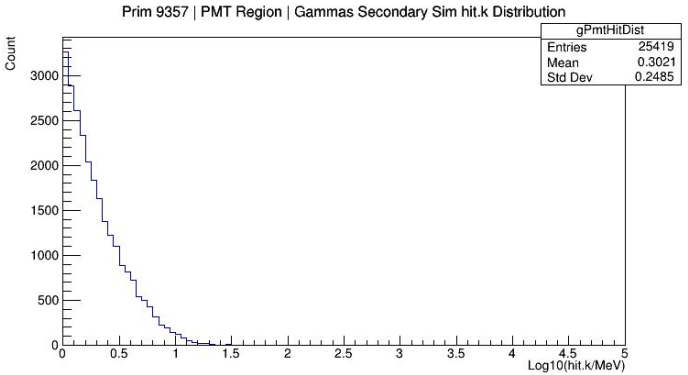
(9928 PMT Region) Secondary Counts		
Secondaries	Electrons	Gammas
9357	47185	25419

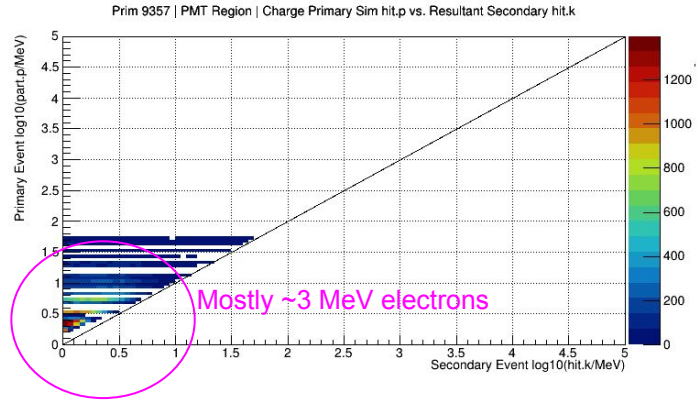
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9357	9.44E-03	5.08E-03

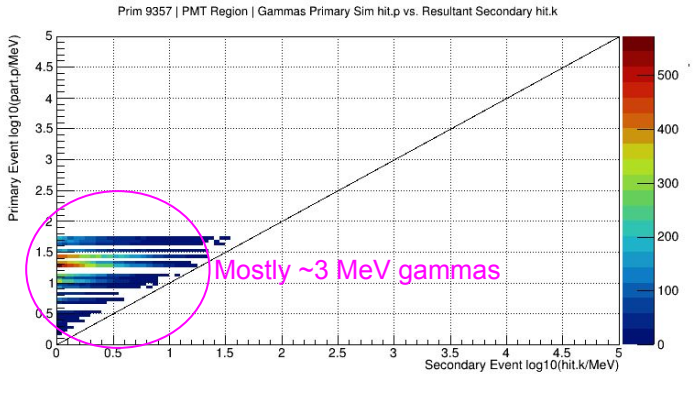
(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9357	5.57E-11	3.00E-11

9357: MD Brake 2 Piece









Summary of Results

Going with a 10-11 tolerable limit for these components.

Ferrous Volume	Material	Ferrous Bkgd (per e.o.t.)	Comment
MD Bearings	Steel, Alloy	~3(10^{-13})	Bearings seem to be sufficiently shielded by material.
MD Brake Piece 1 (See slide for ref)	SS, Mild/Carbon	~8(10^{-11})	This isn't ideal but with considerations, depolarization and PMT area, I think this is borderline fine.
MD Brake Piece 2 (See slide for ref)	SS, Mild/Carbon	~6(10^{-11})	This isn't ideal but with considerations, depolarization and PMT area, I think this is borderline fine.

Material Comments

Bearings: Area well modeled.

Brakes: I don't know if additional non-ferrous materials placed in sim will make much difference here. Brake piece 1 is behind the ring and brake piece 2 is largely exposed.

I'm not even sure if I've gotten all of the relevant pieces BUT i think that we're close enough. *Pictures in Larry's sheet help a little but which pieces are which isn't quite clear.*

General: GEM Rotator mass was included in simulations to attenuate simulated "primary" electrons.

Simulation Comments

PMTs do not take up entire portion of the sensitive detector surface. Some accounting can be taken for that.

Depolarization is a factor to be considered.

⇒ Brake piece 2 really isn't well shielded and while there is some material that can be added, I'm not sure that will make a major difference.

Final Conclusion

- Small area covered by the pmt quartz windows compared to simulated sensitive detector.
    - Low likelihood of efficient light collection from those.
- Low energy distribution (majority less than 3 MeV) which should also reduce the light produced

Other Possible Concerns & To-do

Concern:

1. McMaster Carr item 5968K91 listed on materials sheet and lists a quantity of 3. Made of cast iron housing and steel bearings. Not sure where these are. I didn't take an exhaustive look at the JT file. 2 lbs each.
2. Sprockets 45 lbs of steel (3x7.5 & 3*6.68)
3. Drive shafts are 26 lbs of steel (about 10 & 16 lbs)
4. Turnbuckle body 77.67 lbs of steel
5. I've got to imagine that the plan is to at least remove the motor when not in use.

To Do:

1. Struts and tie-rod support structures need to be modeled better.
    a. Floor plates added for this (geometry done) … tie rods need to be updated from previous toy model.
2. Sprockets and rods need to be simulated
    a. These have a much larger surface area than the brakes and the results of the brakes may suggest this stuff is problematic to leave in during running.
    b. Will run sims for final numbers.