Ferrous Materials:

Detector wall

(Formerly known as the barite wall)

Eric King

Updated:

March 6th, 2024

Detector wall

Procurement of barite for the detector wall is uncertain.

Model detector wall with barite, ilmenite, and a 3cm layer of stainless steel embedded in it.

Compare to barite punch-through to start.

- Material set in remoll for barite wall was barite. There is a “BariteConcrete” material which bears much more similarity to Zuhal’s formulation for the Ilmenite concrete (called “barite” in her slides).
    - I’m going to re-simulate using the “BariteConcrete” material so that we have a better apples-to-apples comparison for the change. I’ll leave both results in slides but I think the latter is the one we want.

Information – Ilmenite

Also, barite and BariteConcrete materials in remoll…

Ilmenite – Zuhal's slide

Table 1. Percentage composition of ordinary (1), hematite-serpentine (2), ilmenite-limonite (3), basalt-magnetite (4), ilmenite (5), steel-scrap (6) and steel-magnetite (7) concretes

	Concrete number						
Raw materials	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Portland cement	11.82	13.19	12.44	12.42	08.30	08.81	07.55
Sand	26.71	—	—	—	—	26.08	—
Gravel	54.96	—	—	—	—	—	—
Hematite	—	56.88	—	—	—	—	—
Serpentine	—	21.03	—	—	—	—	—
Ilmenite	—	—	68.50	—	86.00	—	—
Limonite	—	—	14.75	—	—	—	—
Basalt	—	—	—	38.51	—	—	—
Magnetite	—	—	—	41.62	—	—	26.19
Steel scrap	—	—	—	—	—	60.70	61.73
Water	06.51	08.90	04.30	07.45	05.00	04.41	04.53

Table 2. Elemental composition as a percentage by weight of ordinary (1), hematite–serpentine (2), ilmenite–limonite (3), basalt–magnetite (4), ilmenite (5), steel–scrap (6) and steel–magnetite (7) concretes

	Concrete number						
Element	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hydrogen	00.94	01.29	00.66	00.83	00.57	00.70	00.51
Carbon	00.09	—	—	—	—	00.09	—
Oxygen	53.66	43.51	36.45	42.30	35.93	21.09	15.70
Sodium	00.46	—	—	01.06	00.06	00.45	—
Magnesium	00.12	6.64	00.15	02.20	01.31	00.09	00.58
Aluminium	01.32	1.67	00.80	04.22	00.61	01.20	00.66
Silicon	36.74	10.53	03.06	13.20	02.40	10.49	02.68
Phosphorus	—	—	—	00.20	—	—	00.08
Sulphur	00.08	00.09	00.08	00.09	00.07	00.06	00.06
Chlorine	—	—	—	—	00.02	—	—
Potassium	00.31	—	—	00.29	00.03	00.30	—
Calcium	05.65	05.97	05.83	08.88	03.88	04.28	03.95
Titanium	—	—	16.03	00.60	19.64	—	—
Manganese	—	—	—	00.12	—	—	00.07
Iron	00.63	30.31	36.93	26.01	34.78	61.25	75.73

```
<material name="ilmenite" state="solid">
        <D value="3.79" unit="g/cm3"/>
        <fraction n="0.0057" ref="G4_H" />
        <fraction n="0.3593" ref="G4_O"/>
        <fraction n="0.0006" ref="G4_Na" />
        <fraction n="0.0131" ref="G4_Mg"/>
        <fraction n="0.0061" ref="G4_Al"/>
        <fraction n="0.0240" ref="G4_Si" />
        <fraction n="0.0007" ref="G4_S"/>
        <fraction n="0.0002" ref="G4_Cl"/>
        <fraction n="0.0003" ref="G4_K"/>
        <fraction n="0.0388" ref="G4_Ca"/>
        <fraction n="0.1964" ref="G4_Ti"/>
        <fraction n="0.3478" ref="G4_Fe"/>
</material>
<material name="barite" state="solid">
        <D value="3.5" unit="g/cm3"/>
        <fraction n="0.083" ref="cement"/>
        <fraction n="0.05" ref="G4_WATER"/>
        <fraction n="0.86" ref="ilmenite"/>
</material>
```

```
<material name="barite" state="solid">
  <D value="4.05" unit="g/cm3"/>
  <fraction n="0.04800" ref="G4_CALCIUM_OXIDE"/>
  <fraction n="0.00649" ref="G4_MAGNESIUM_OXIDE"/>
  <fraction n="0.00027" ref="Na2O"/>
  <fraction n="0.00024" ref="G4_POTASSIUM_OXIDE"/>
  <fraction n="0.00229" ref="G4_FERRIC_OXIDE"/>
  <fraction n="0.00019" ref="P2O5"/>
  <fraction n="0.03293" ref="G4_SILICON_DIOXIDE"/>
  <fraction n="0.03913" ref="G4_WATER"/>
  <fraction n="0.01366" ref="G4_ALUMINUM_OXIDE"/>
  <fraction n="0.00205" ref="SO2"/>
  <fraction n="0.83132" ref="G4_BARIUM_SULFATE"/>
  <fraction n="0.00090" ref="G4_MAGNESIUM_CARBONATE"/>
  <fraction n="0.00090" ref="NaCl"/>
  <fraction n="0.01803" ref="G4_CALCIUM_CARBONATE"/>
  <fraction n="0.00180" ref="MnO2"/>
  <fraction n="0.00180" ref="NiO"/>
</material>
```

```
<material name="ilmenite" state="solid">
  <D value="3.79" unit="g/cm3"/>
  <fraction n="0.0057" ref="G4_H"/>
  <fraction n="0.3593" ref="G4_O"/>
  <fraction n="0.0006" ref="G4_Na"/>
  <fraction n="0.0131" ref="G4_Mg"/>
  <fraction n="0.0061" ref="G4_Al"/>
  <fraction n="0.0240" ref="G4_Si"/>
  <fraction n="0.0007" ref="G4_S"/>
  <fraction n="0.0002" ref="G4_Cl"/>
  <fraction n="0.0003" ref="G4_K"/>
  <fraction n="0.0388" ref="G4_Ca"/>
  <fraction n="0.1964" ref="G4_Ti"/>
  <fraction n="0.3478" ref="G4_Fe"/>
</material>

<material name="barite" state="solid">
  <D value="3.5" unit="g/cm3"/>
  <fraction n="0.083" ref="cement"/>
  <fraction n="0.05" ref="G4_WATER"/>
  <fraction n="0.86" ref="ilmenite"/>
</material>
```

Why is the simulation material for the detector wall "barite" rather than the "barite concrete" (which is in the materials.xml file)???

- Implemented a new elemental composition for barite concrete Reference paper is here. ⇒ https://www.sciencedirect.com/science/article/abs/pii/S0306454997000030

Can't access paper through Temple. :/

Remoll “barite” Material & “BariteConcrete” Material

```
<material name="barite" state="solid">
  <D value="4.05" unit="g/cm3"/>
  <fraction n="0.04800" ref="G4_CALCIUM_OXIDE"/>
  <fraction n="0.00649" ref="G4_MAGNESIUM_OXIDE"/>
  <fraction n="0.00027" ref="Na2O"/>
  <fraction n="0.00024" ref="G4_POTASSIUM_OXIDE"/>
  <fraction n="0.00229" ref="G4_FERRIC_OXIDE"/>
  <fraction n="0.00019" ref="P2O5"/>
  <fraction n="0.03293" ref="G4_SILICON_DIOXIDE"/>
  <fraction n="0.03913" ref="G4_WATER"/>
  <fraction n="0.01366" ref="G4_ALUMINUM_OXIDE"/>
  <fraction n="0.00205" ref="SO2"/>
  <fraction n="0.83132" ref="G4_BARIUM_SULFATE"/>
  <fraction n="0.00090" ref="G4_MAGNESIUM_CARBONATE"/>
  <fraction n="0.00090" ref="NaCl"/>
  <fraction n="0.01803" ref="G4_CALCIUM_CARBONATE"/>
  <fraction n="0.00180" ref="MnO2"/>
  <fraction n="0.00180" ref="NiO"/>
</material>

<material name="BariteConcrete" state="solid">
  <D value="3.36" unit="g/cm3"/>
  <fraction n="0.0829" ref="cement"/>
  <fraction n="0.0593" ref="G4_WATER"/>
  <fraction n="0.8578" ref="barite"/>
</material>
```

Material used in simulation is “barite” rather than “BariteConcrete”. The “BariteConcrete” material was allegedly added by Chandan but not much else is known.

However, “BariteConcrete” is much more similar to the ilmenite concrete material used by Zuhal (see previous slide)–both of which are roughly 8% cement and 5%’ish water.

⇒ **I believe the proper comparison is to use “BariteConcrete”.**

⇒ Also, any other simulations pertinent to the wall might want to be repeated.

Side-by-side of the Materials

To avoid back and forth:

Zuhal's ilmenite concrete (called barite here to avoid going through geometry to change material names) is cement and the ilmenite material.

The "barite" material set in remoll as the material of the barite wall seems to just be barite and not barite concrete.

The "BariteConcrete" material seems to be the proper comparison and probably what should have been used.

```
<material name="ilmenite" state="solid">
  <D value="3.79" unit="g/cm3"/>
  <fraction n="0.0057" ref="G4_H"/>
  <fraction n="0.3593" ref="G4_O"/>
  <fraction n="0.0006" ref="G4_Na"/>
  <fraction n="0.0131" ref="G4_Mg"/>
  <fraction n="0.0061" ref="G4_Al"/>
  <fraction n="0.0240" ref="G4_Si"/>
  <fraction n="0.0007" ref="G4_S"/>
  <fraction n="0.0002" ref="G4_Cl"/>
  <fraction n="0.0003" ref="G4_K"/>
  <fraction n="0.0388" ref="G4_Ca"/>
  <fraction n="0.1964" ref="G4_Ti"/>
  <fraction n="0.3478" ref="G4_Fe"/>
</material>
```

```
<material name="barite" state="solid">
  <D value="3.5" unit="g/cm3"/>
  <fraction n="0.083" ref="cement"/>
  <fraction n="0.05" ref="G4_WATER"/>
  <fraction n="0.86" ref="ilmenite"/>
</material>
```

```
<material name="barite" state="solid">
  <D value="4.05" unit="g/cm3"/>
  <fraction n="0.04800" ref="G4_CALCIUM_OXIDE"/>
  <fraction n="0.00649" ref="G4_MAGNESIUM_OXIDE"/>
  <fraction n="0.00027" ref="Na2O"/>
  <fraction n="0.00024" ref="G4_POTASSIUM_OXIDE"/>
  <fraction n="0.00229" ref="G4_FERRIC_OXIDE"/>
  <fraction n="0.00019" ref="P2O5"/>
  <fraction n="0.03293" ref="G4_SILICON_DIOXIDE"/>
  <fraction n="0.03913" ref="G4_WATER"/>
  <fraction n="0.01366" ref="G4_ALUMINUM_OXIDE"/>
  <fraction n="0.00205" ref="SO2"/>
  <fraction n="0.83132" ref="G4_BARIUM_SULFATE"/>
  <fraction n="0.00090" ref="G4_MAGNESIUM_CARBONATE"/>
  <fraction n="0.00090" ref="NaCl"/>
  <fraction n="0.01803" ref="G4_CALCIUM_CARBONATE"/>
  <fraction n="0.00180" ref="MnO2"/>
  <fraction n="0.00180" ref="NiO"/>
</material>

<material name="BariteConcrete" state="solid">
  <D value="3.36" unit="g/cm3"/>
  <fraction n="0.0829" ref="cement"/>
  <fraction n="0.0593" ref="G4_WATER"/>
  <fraction n="0.8578" ref="barite"/>
</material>
```

Simulation Results

9400: Detector Wall (Barite Composition)

Material	X_r	Spin Polarization (P_f)	Frac e- on Target	Frac of events Per Moller
Mild 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

Punch through on Detector wall with previous barite composition.

Considering these numbers as a baseline.

Sens Volume:	Detector Wall (as-is barite)
Sim Date:	3/6/3034
Detector #:	9400

Detector Wall (as-is barite) -- Unweighted By BField

Total Prim's:	9,993,750,000	Total Sec's:	1,000,000 (per sens det)

Primary Counts		
Primaries	0	0&1
9400		94875

Primary Fractional		
Primaries	0	0&1
9400		9.49E-06

(9928 MainDet) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	114	2587

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	1.14E-04	2.59E-03

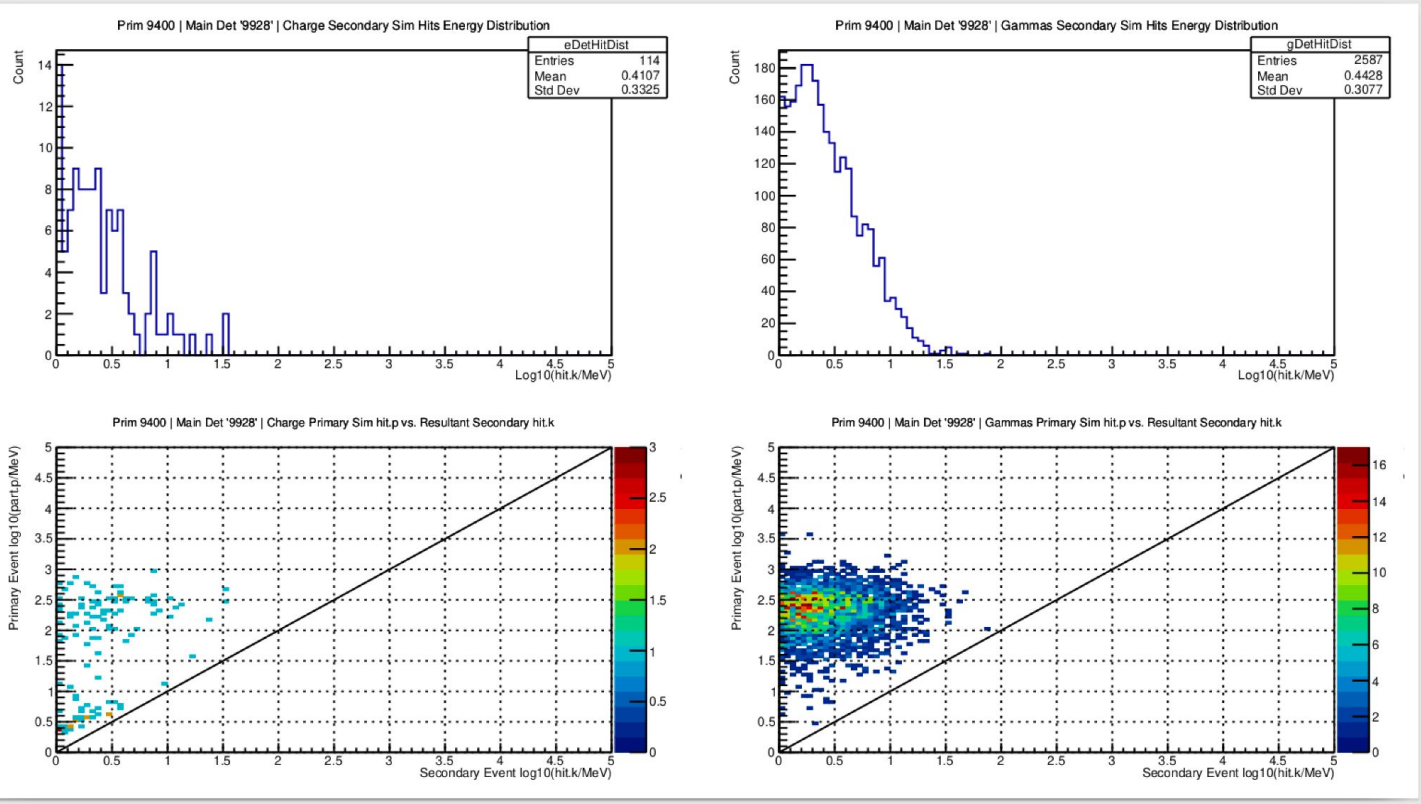
(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	1.08E-09	2.46E-08

(9911 PMT Region) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	425	7556

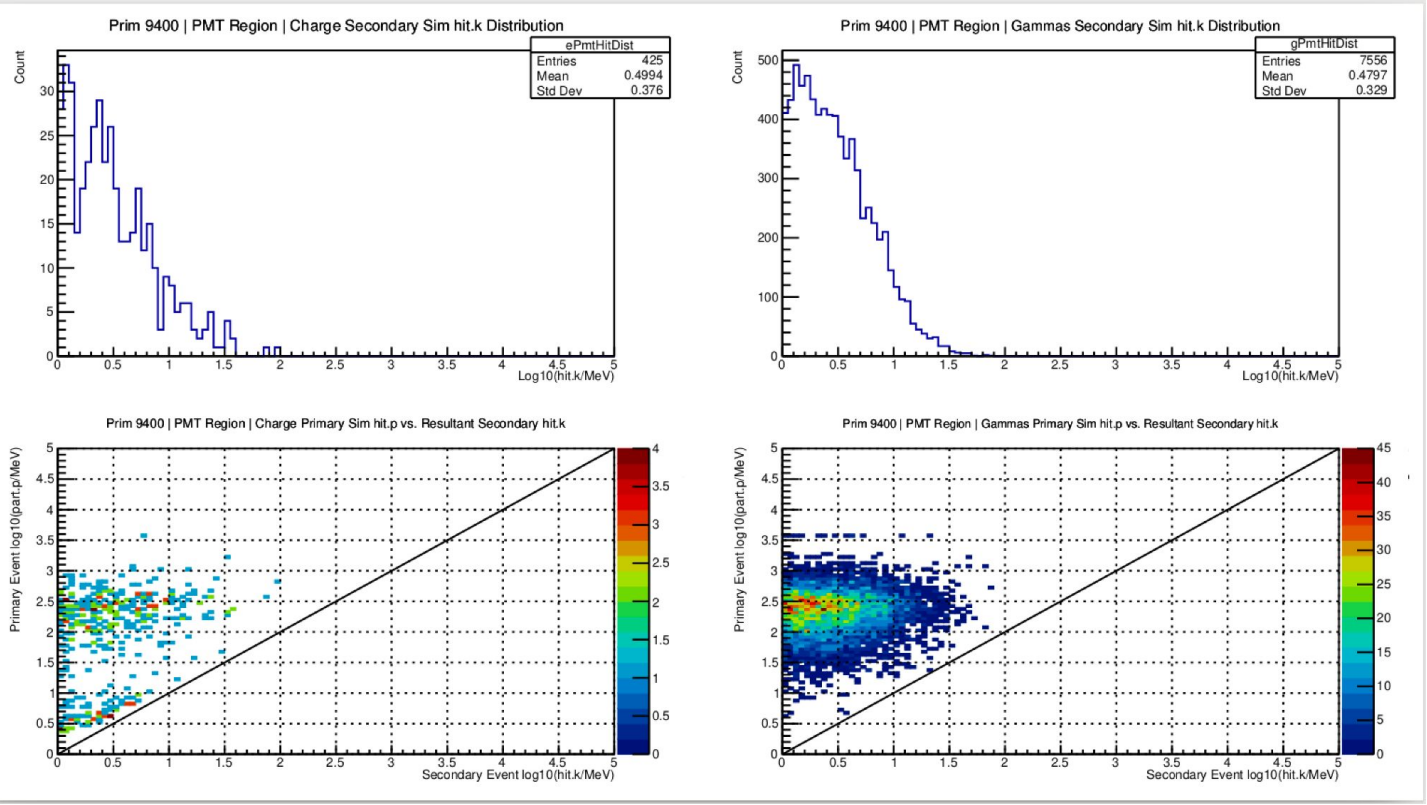
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	4.25E-04	7.56E-03

(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	4.03E-09	7.17E-08

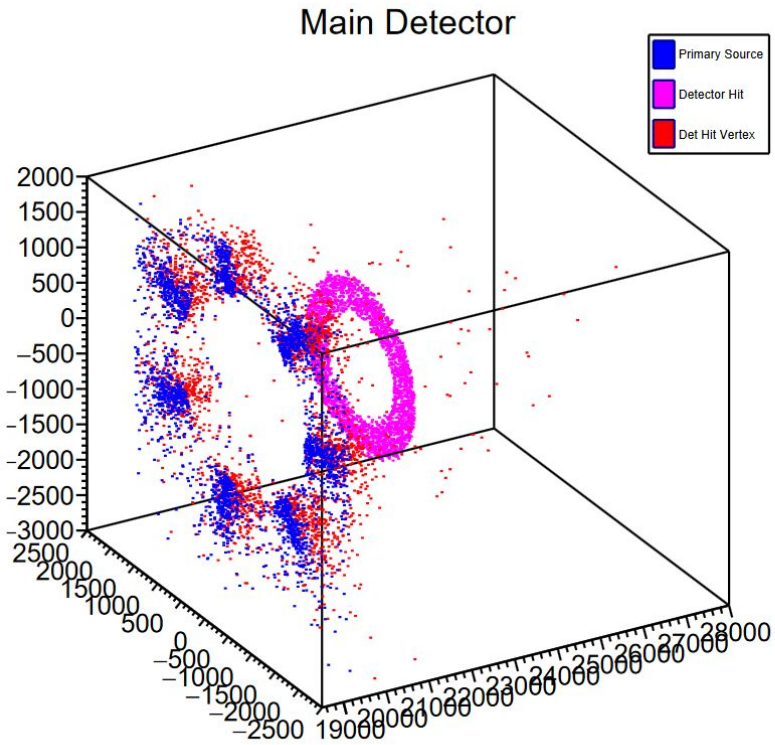
9400 – Detector Wall (Barite Composition)

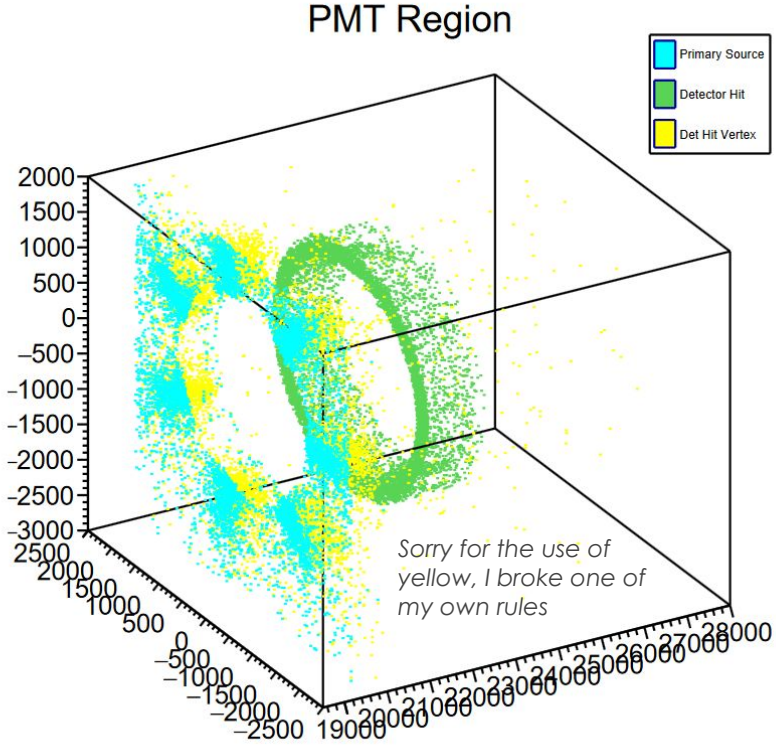


9400 – Detector Wall (Barite Composition)



9400 – Detector Wall (Barite Composition)





9400: Detector Wall (Barite Composition)

Material	X_r	Spin Polarization (P_f)	Frac e- on Target	Frac of events Per Moller
Mild 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

Sens Volume:	Detector Wall (BariteConcrete)
Sim Date:	3/13/3034
Detector #:	9400

Detector Wall (BariteConcrete) -- Unweighted By BField

Total Prim's:	9,993,750,000	Total Sec's:	1,000,000	(per sens det)

Primary Counts		
Primaries	0	0&1
9400		94875

Primary Fractional		
Primaries	0	0&1
9400		9.49E-06

(9928 MainDet) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	169	3676

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	1.69E-04	3.68E-03

(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	1.60E-09	3.49E-08

(9911 PMT Region) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	674	11205

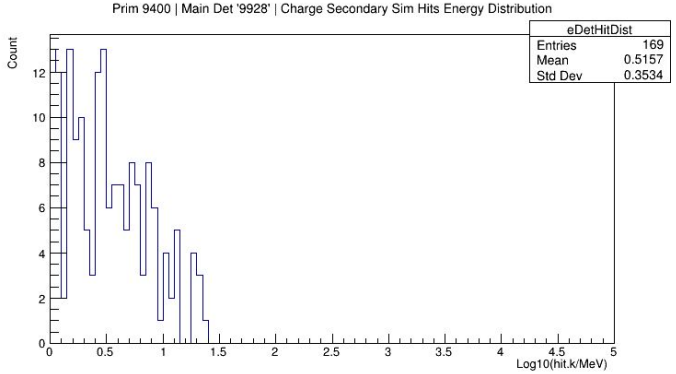
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	6.74E-04	1.12E-02

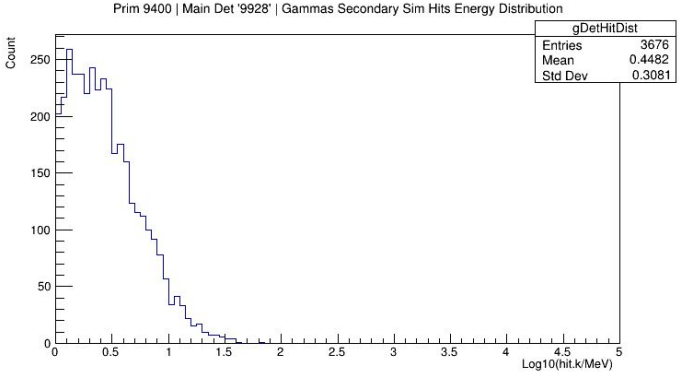
(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	6.40E-09	1.06E-07

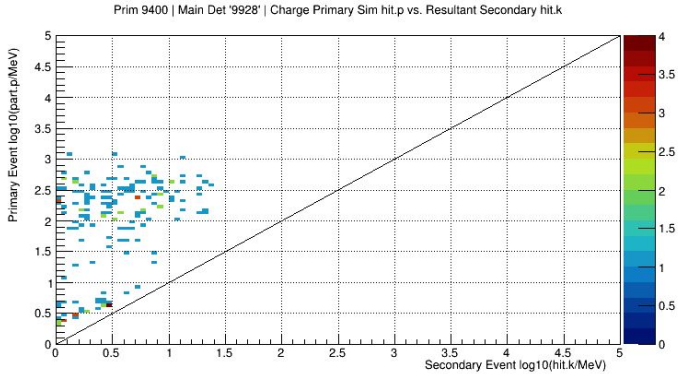
Punch through on Detector wall with the “BariteConcrete” material.

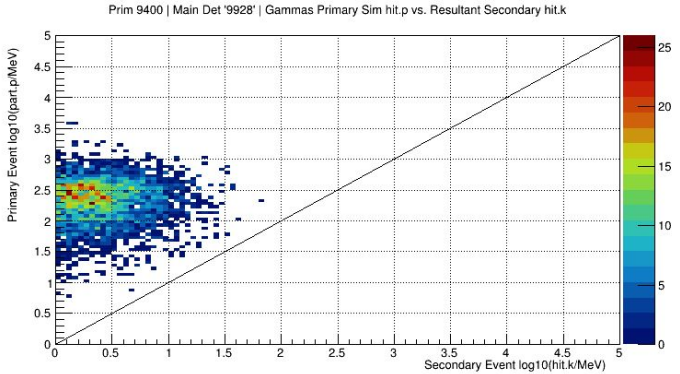
This material seems to be a far better comparison to the ilmenite concrete (named “barite” for simplicity) material used by Zuhal in her slide.

9400 – Detector Wall (Barite Composition)

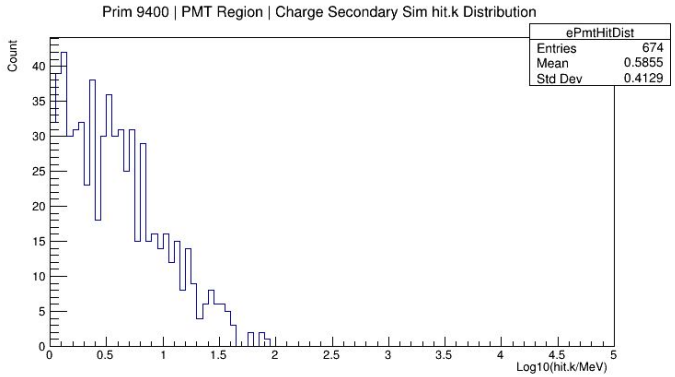


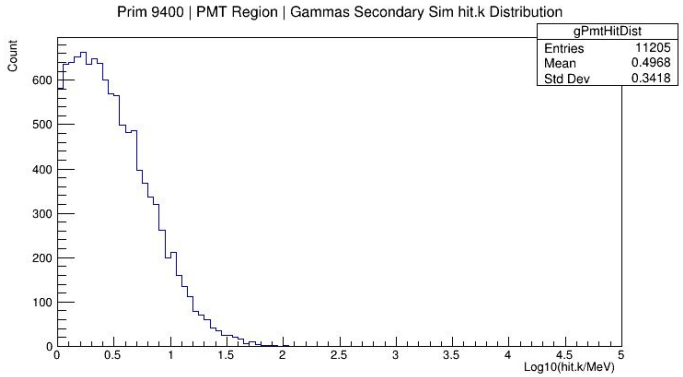


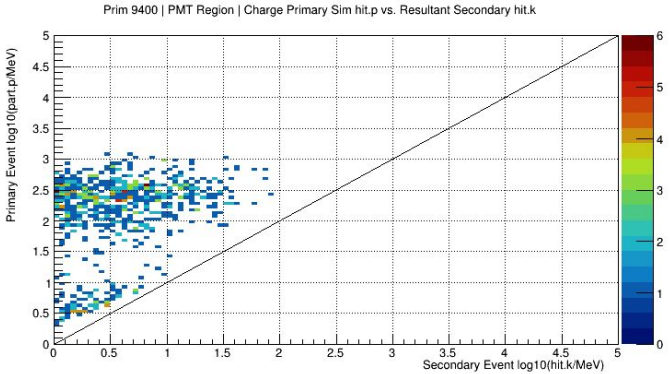


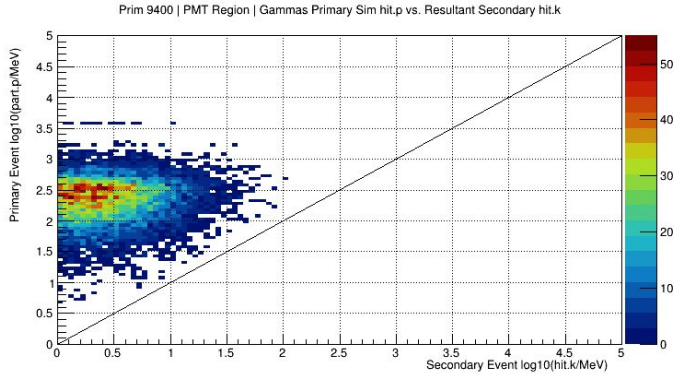


9400 – Detector Wall (Barite Composition)

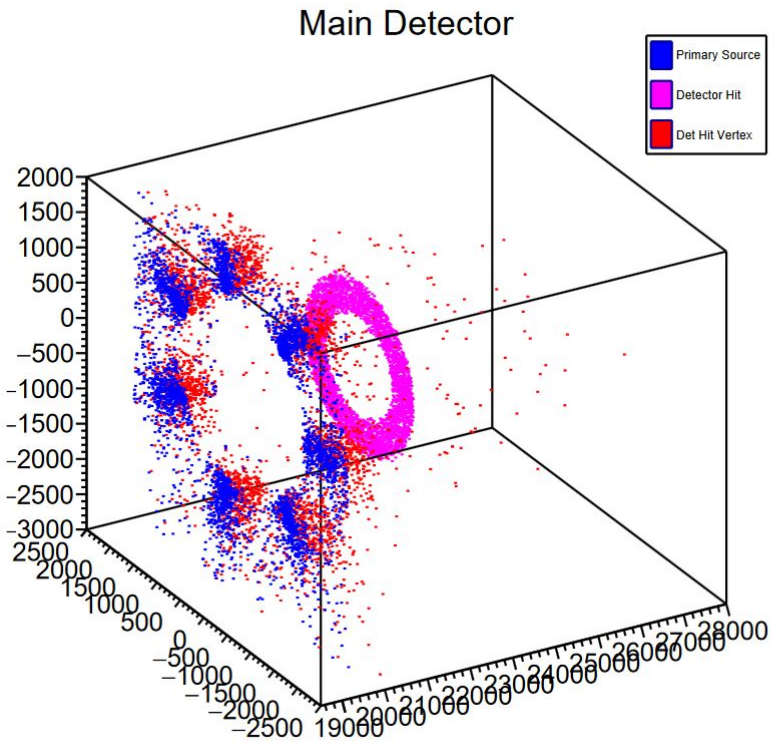


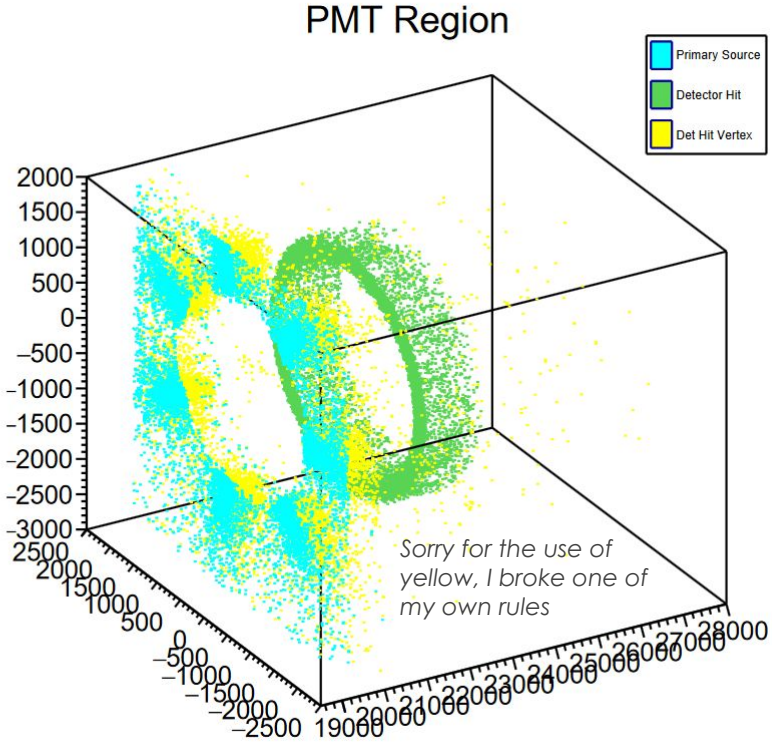






9400 – Detector Wall (Barite Composition)





Ilmenite

2.9 g/cm3 – Per Cip’s Supplier

9400: Detector Wall
(Ilmenite 2.9g/cm**3 Composition)

Material	X_r	Spin Polarization (P_f)	Frac e- on Target	Frac of events Per Moller
Mild 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

This is the density that's available from our supplier of the concrete.

Sens Volume:	Detector Wall (ilmenite 2.9g/cm3)
Sim Date:	3/10/2024
Detector #:	9400

Detector Wall (ilmenite 2.9g/cm3) -- Unweighted By BField

Total Prim's:	9,993,750,000	Total Sec's:	1,000,000	(per sens det)

Primary Counts		
Primaries	0	0&1
9400		94875

Primary Fractional		
Primaries	0	0&1
9400		9.49E-06

(9928 MainDet) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	482	7476

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	4.82E-04	7.48E-03

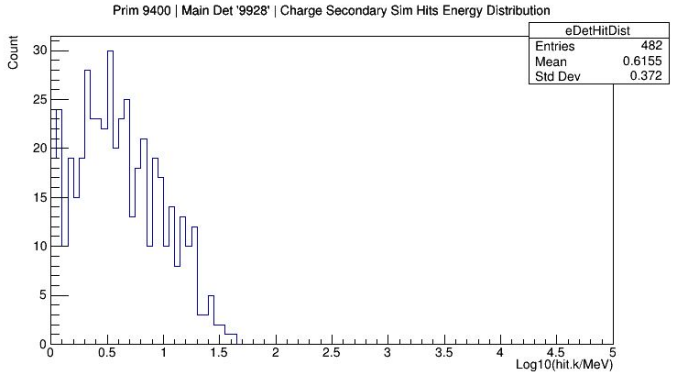
(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	4.58E-09	7.10E-08

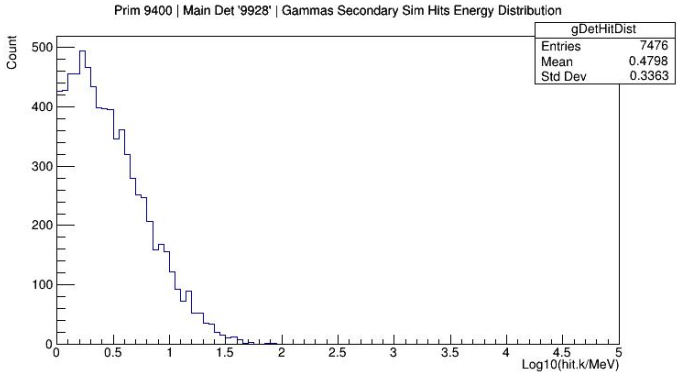
(9911 PMT Region) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	2306	25352

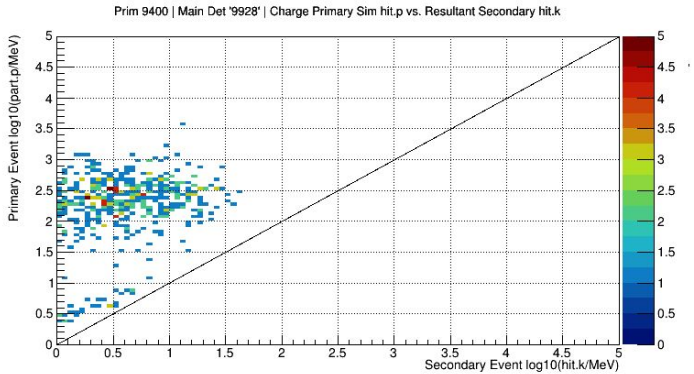
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	2.31E-03	2.54E-02

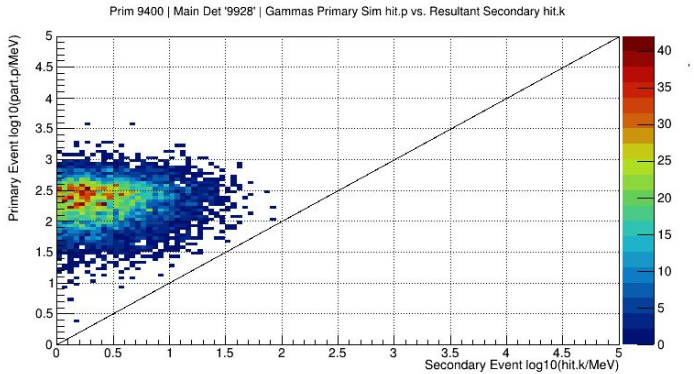
(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	2.19E-08	2.41E-07

9400 – Detector Wall (Ilmenite 2.9g/cm**3 Composition)

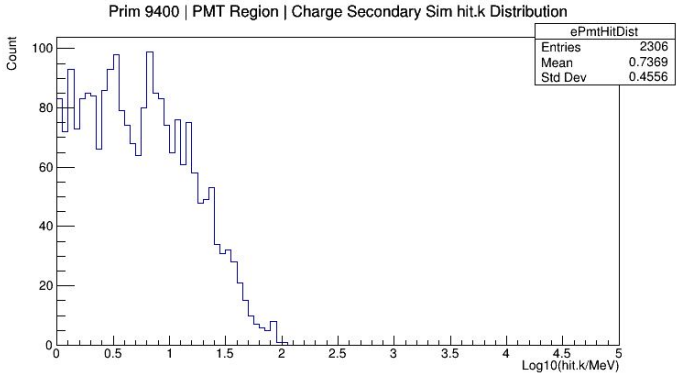


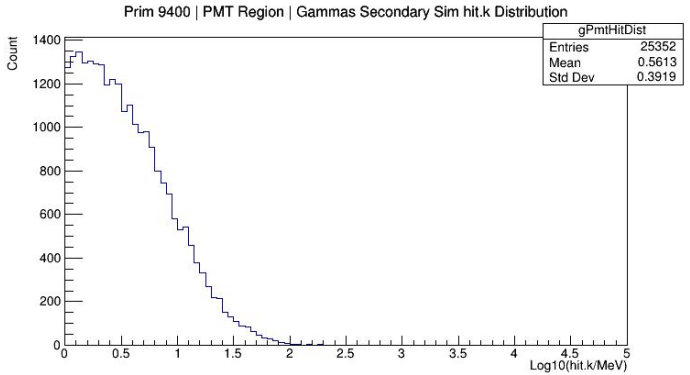


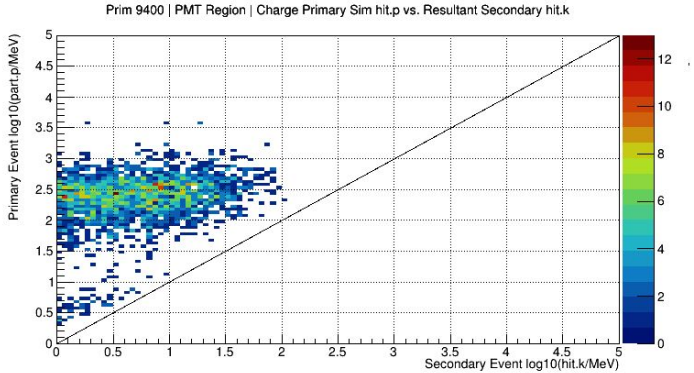


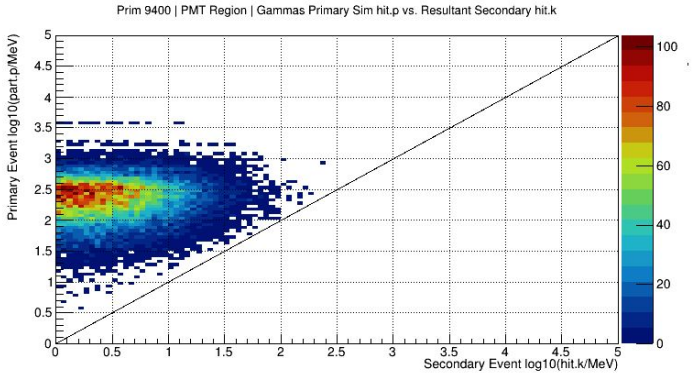


9400 – Detector Wall (Ilmenite 2.9g/cm**3 Composition)

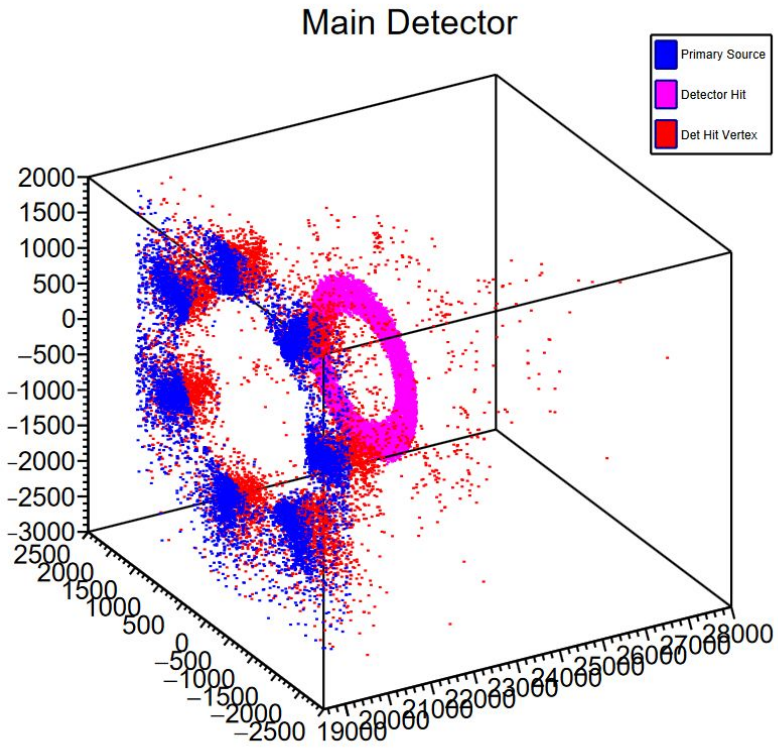


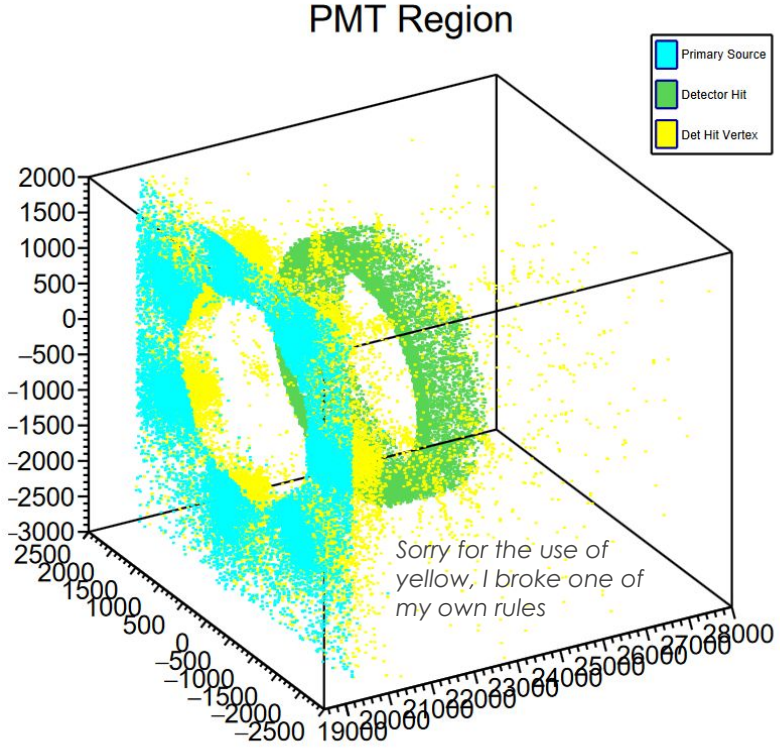






9400 – Detector Wall (Ilmenite 2.9g/cm**3 Composition)

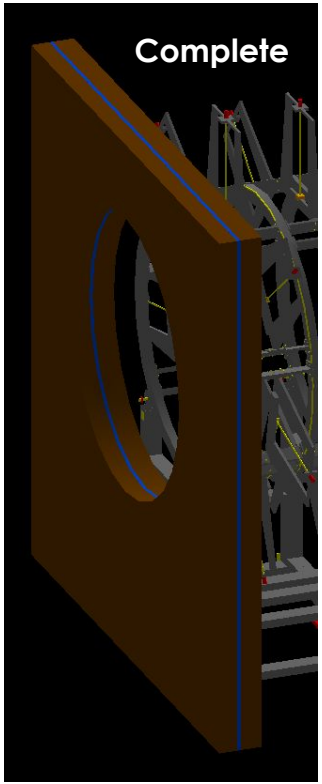


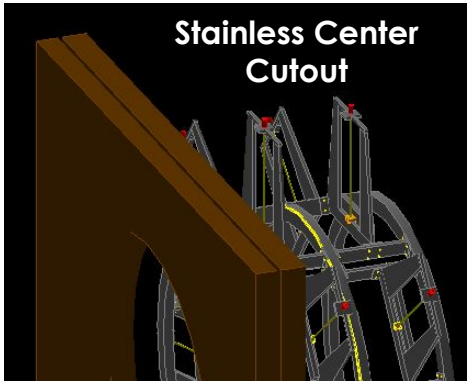


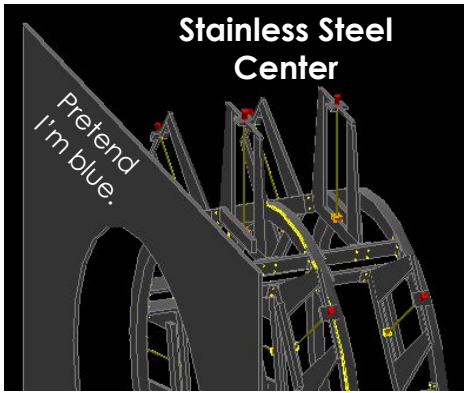
3cm of G4_STAINLESS-STEEL & Ilmenite (2.9g/cm^3)

17cm ilmenite + 3cm stainless + 20cm ilmenite

3cm of G4_STAINLESS-STEEL & Ilmenite (2.9g/cm^3)







Per Cip's request modeled 3cm of steel inside the wall.

17cm concrete + 3cm steel + 20cm concrete

```
<box lunit="mm" name="Barite_Collar2_solid" x="4000+600" y="5000-100" z="400"/>
<cone name="Collar2_tube" lunit="mm" aunit="rad" startphi="0" deltaphi="2*pi" rmin1="0" rmax1="1315+1" rmin2="0" rmax2="1315+1" z="400+1"/>
<box lunit="mm" name="Barite_Collar2_insert_cutout_solid" x="4000+600+10" y="5000-100+10" z="30"/>
<box lunit="mm" name="Barite_Collar2_insert_solid" x="4000+600" y="5000-100" z="30"/>

<subtraction name="Barite_Collar2_sub0">
<first ref = "Barite_Collar2_solid"/>
<second ref = "Collar2_tube"/>
<position name ="Barite_Collar2_sub_pos" lunit="mm" x="0" y="960/2-50" z="0" />
</subtraction>
<subtraction name="Barite_Collar2_insert_sub">
<first ref = "Barite_Collar2_insert_solid"/>
<second ref = "Collar2_tube"/>
<!--must move the collar subtraction by 15mm--><position name ="Barite_Collar2_sub_pos" lunit="mm" x="0" y="960/2-50" z="15" />
</subtraction>
<subtraction name="Barite_Collar2_sub">
<first ref = "Barite_Collar2_sub0"/>
<second ref = "Barite_Collar2_insert_cutout_solid"/>
<!--must move the ss insert subtraction by -15mm--><position name ="Barite_Collar2_sub_pos" lunit="mm" x="0" y="960/2-50" z="-15" />
</subtraction>

<volume name="Barite_Collar2_log">
<materialref ref="barite"/>
<solidref ref="Barite_Collar2_sub"/>
<auxiliary auxtype="Color" auxvalue="Brown"/>
<auxiliary auxtype="Alpha" auxvalue="1.0"/>
</volume>
<volume name="Barite_Collar2_insert_log">
<materialref ref="G4_STAINLESS-STEEL"/>
<solidref ref="Barite_Collar2_insert_sub"/>
<auxiliary auxtype="Color" auxvalue="Gray"/>
<auxiliary auxtype="Alpha" auxvalue="1.0"/>
</volume>

<physvol name="Barite_Collar2_phys">
<volumeref ref="Barite_Collar2_log"/>
<position name="Barite_Collar2_pos" unit="mm" x="0" y="-960/2+50" z="24016.09-16012.5-125.-150./2.+241.6-400/2+11287.5"/>
</physvol>
<physvol name="Barite_Collar2_insert_phys">
<volumeref ref="Barite_Collar2_insert_log"/>
<position name="Barite_Collar2_insert_pos" unit="mm" x="0" y="-960/2+50" z="24016.09-16012.5-125.-150./2.+241.6-400/2+11287.5-15"/>
</physvol>
```

Code just in case I have to revisit.

9400: 3cm of G4_STAINLESS-STEEL & Ilmenite (2.9g/cm^3)

Material	X_r	Spin Polarization (P_f)	Frac e- on Target	Frac of events Per Moller
Mild 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

Average density of wall ~3.28g/cm^3

Sens Volume:	Detector Wall (3cm SS / ilmenite 2.9)
Sim Date:	3/11/2024
Detector #:	9400

Detector Wall (3cm SS / ilmenite 2.9) -- Unweighted By BField

Total Prim's:	9,993,750,000	Total Sec's:	1,000,000 (per sens det)

Primary Counts		
Primaries	0	0&1
9400		94875

Primary Fractional		
Primaries	0	0&1
9400		9.49E-06

(9928 MainDet) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	333	5942

(9928 MainDet) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	3.33E-04	5.94E-03

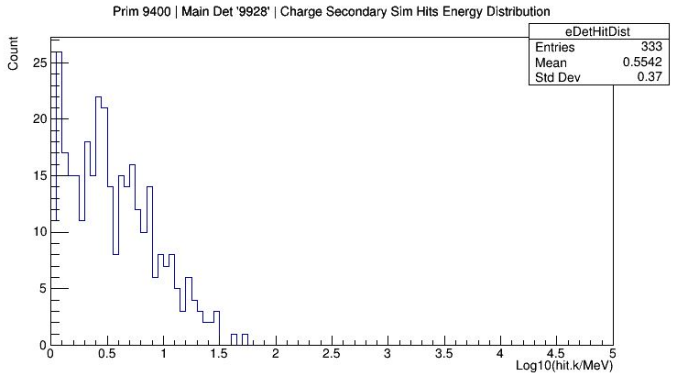
(9928 MainDet) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	3.16E-09	5.64E-08

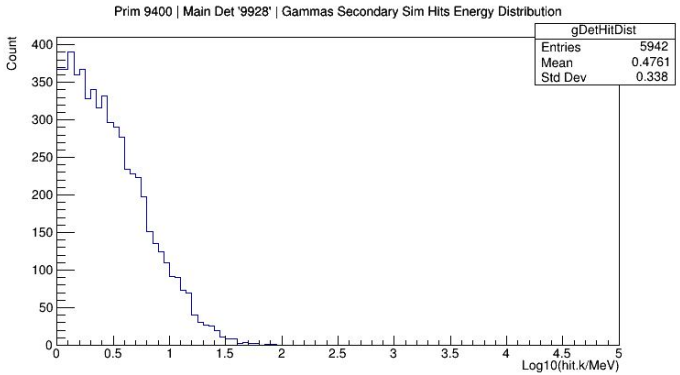
(9911 PMT Region) Secondary Counts - 0&1		
Secondaries	Electrons	Gammas
9400	1516	25352

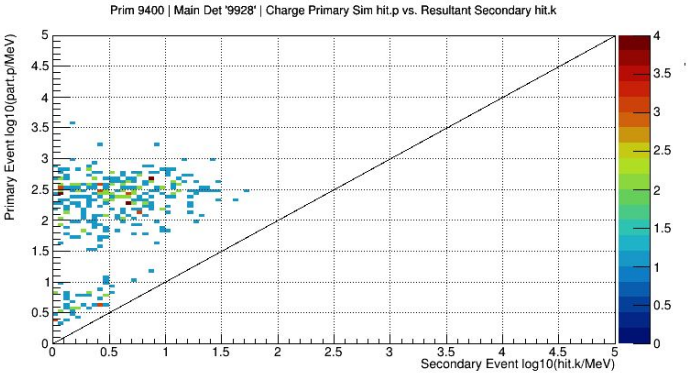
(9911 PMT Region) Secondary Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	1.52E-03	2.54E-02

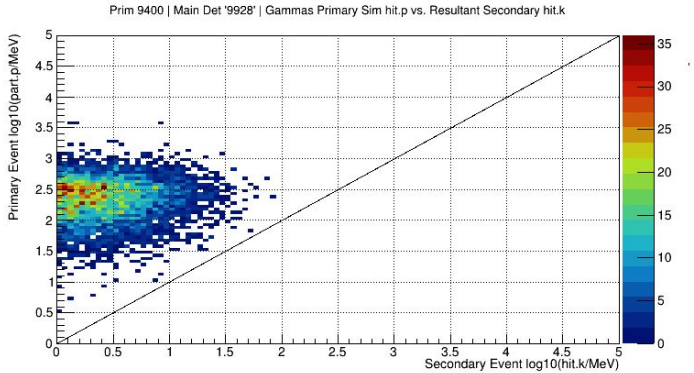
(9911 PMT Region) Total Fractional - 0&1		
Secondaries	Electrons	Gammas
9400	1.44E-08	2.41E-07

9400: 3cm of G4_STAINLESS-STEEL & Ilmenite (2.9g/cm^3)

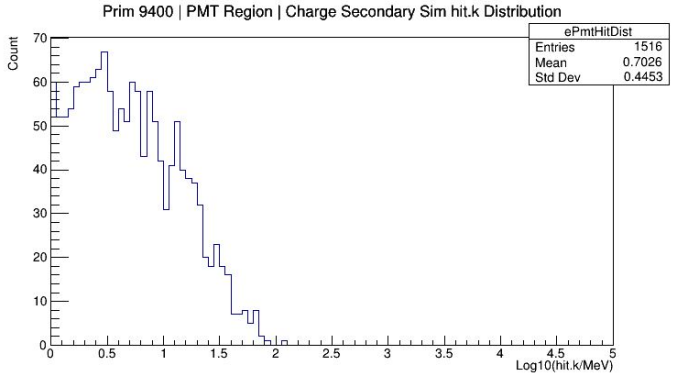


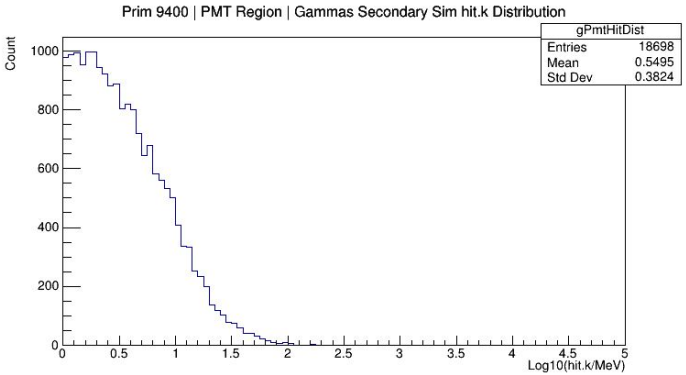


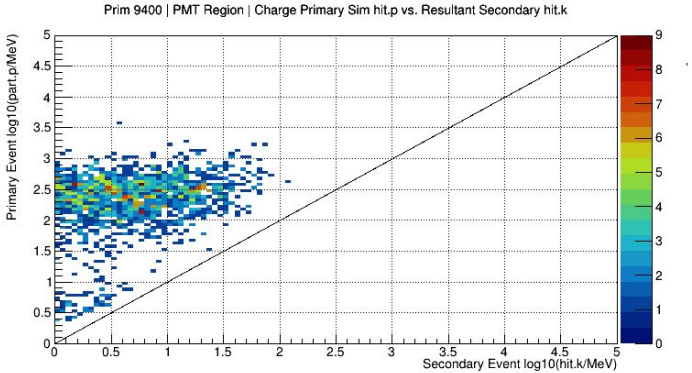


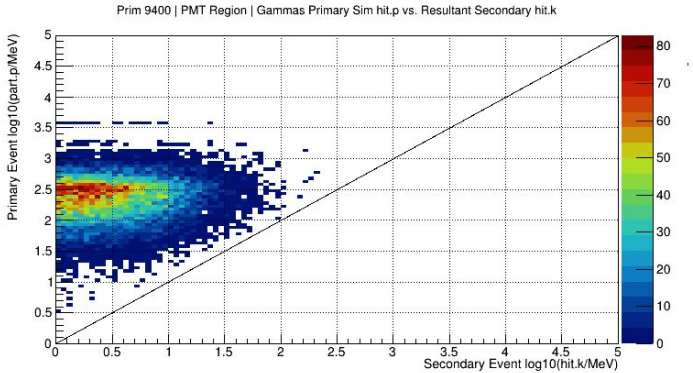


9400: 3cm of G4_STAINLESS-STEEL & Ilmenite (2.9g/cm^3)

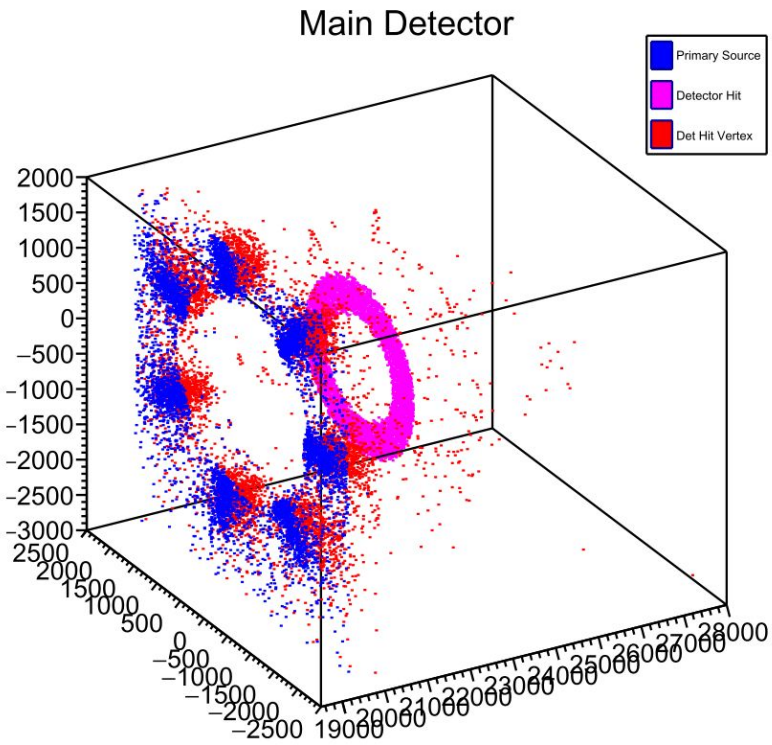


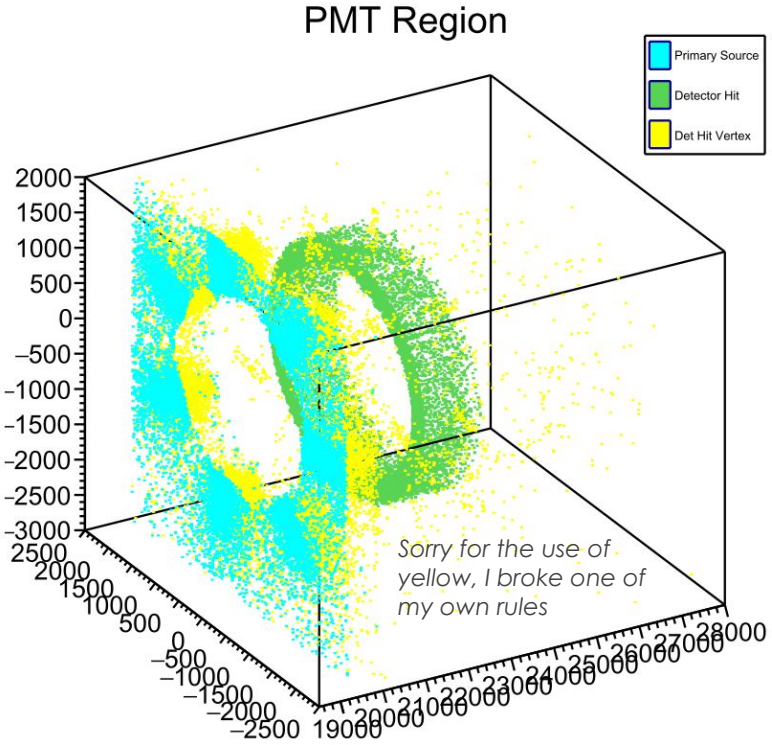






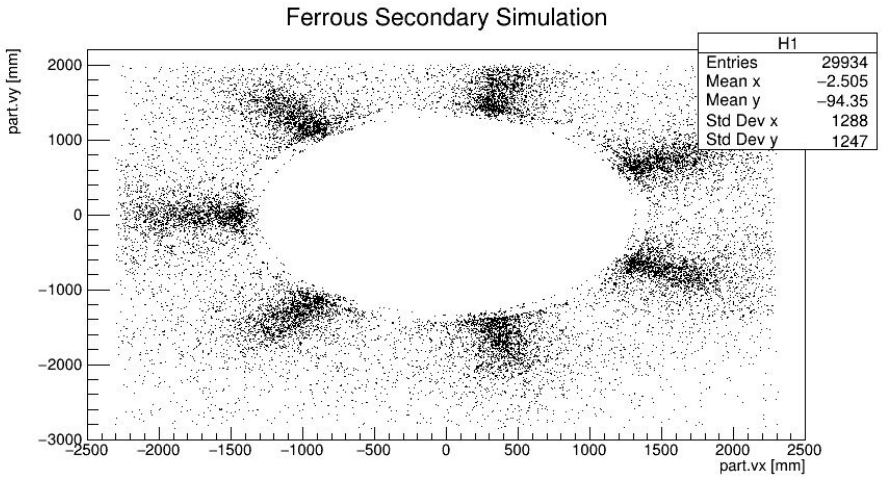
9400: 3cm of G4_STAINLESS-STEEL & Ilmenite (2.9g/cm^3)

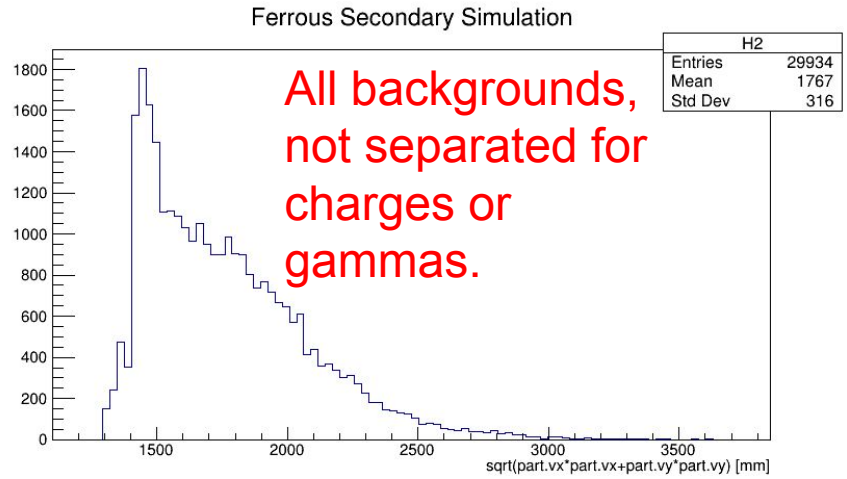


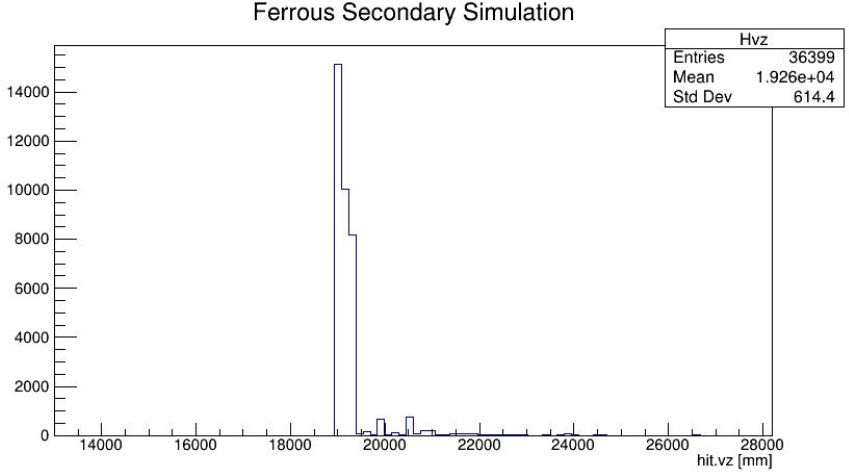


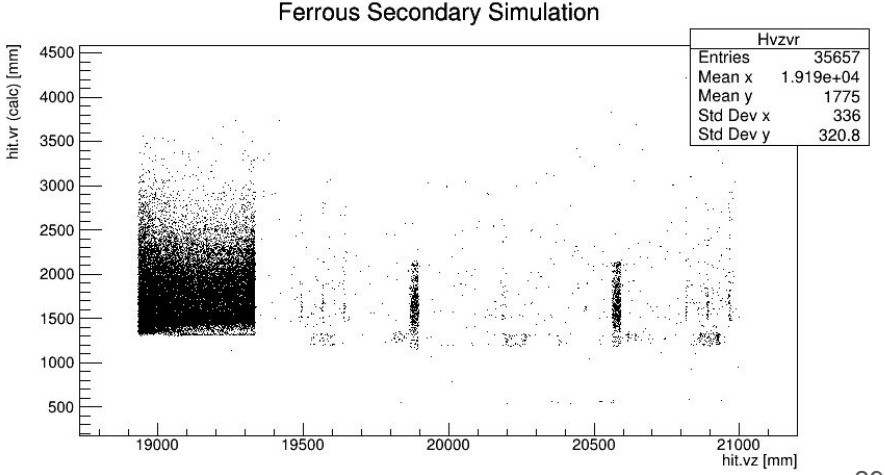
Hits Detail

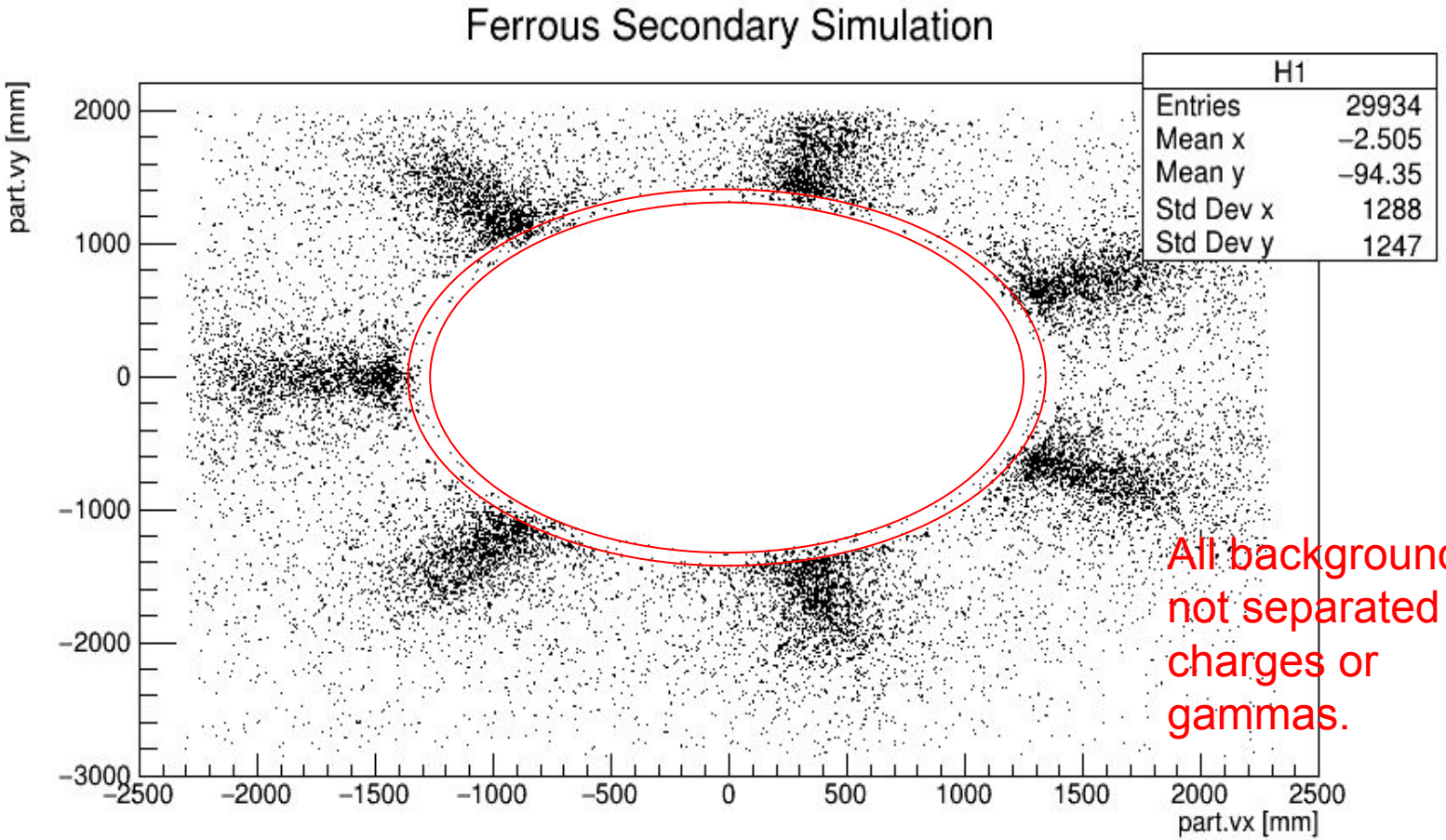
Slides purely for curiosity.

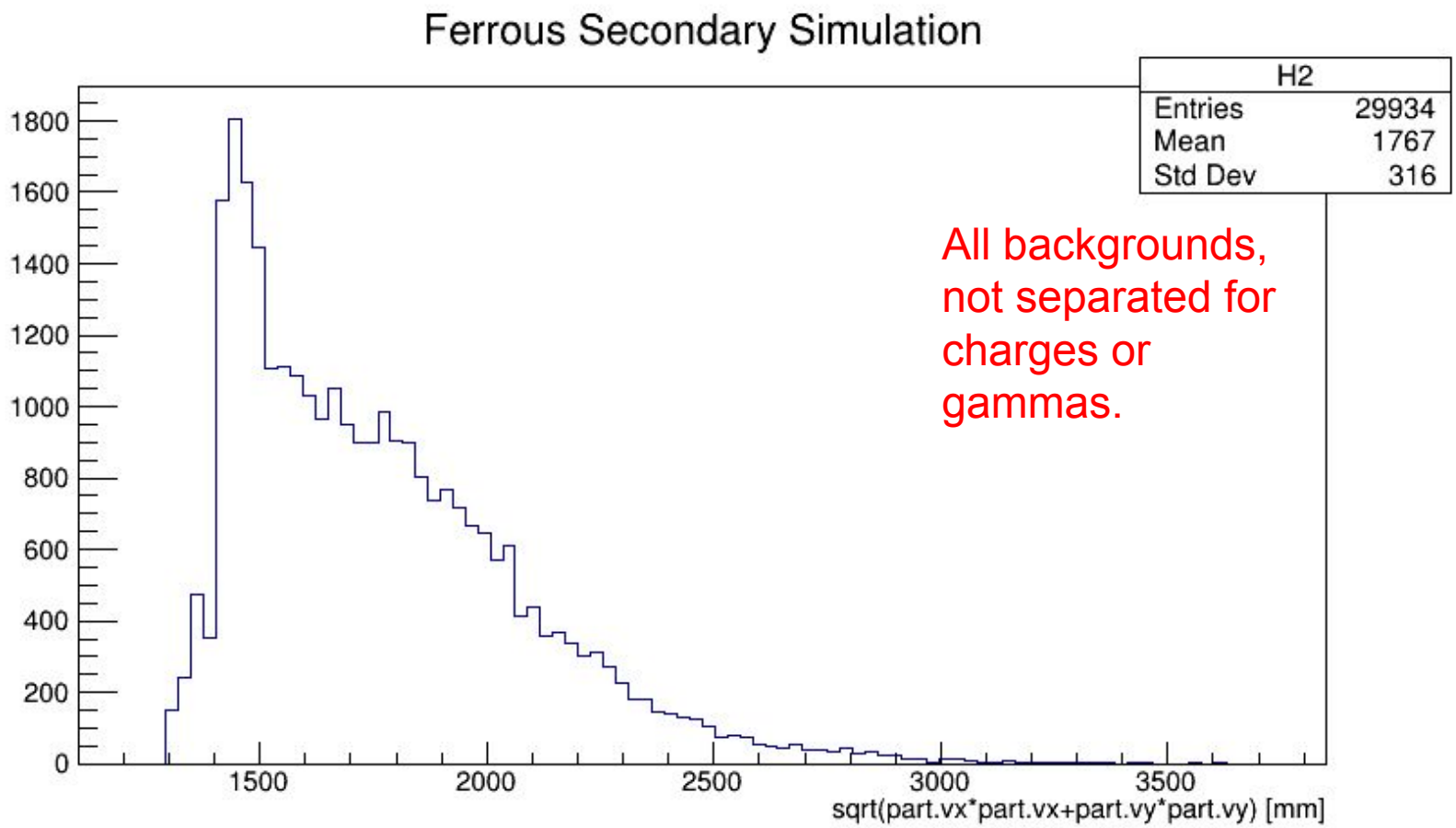

Ferrous Secondary Simulation
H1
Entries 29934
Mean x −2.505
Mean y −94.35
Std Dev x 1288
Std Dev y 1247
part.vy [mm]
part.vx [mm]

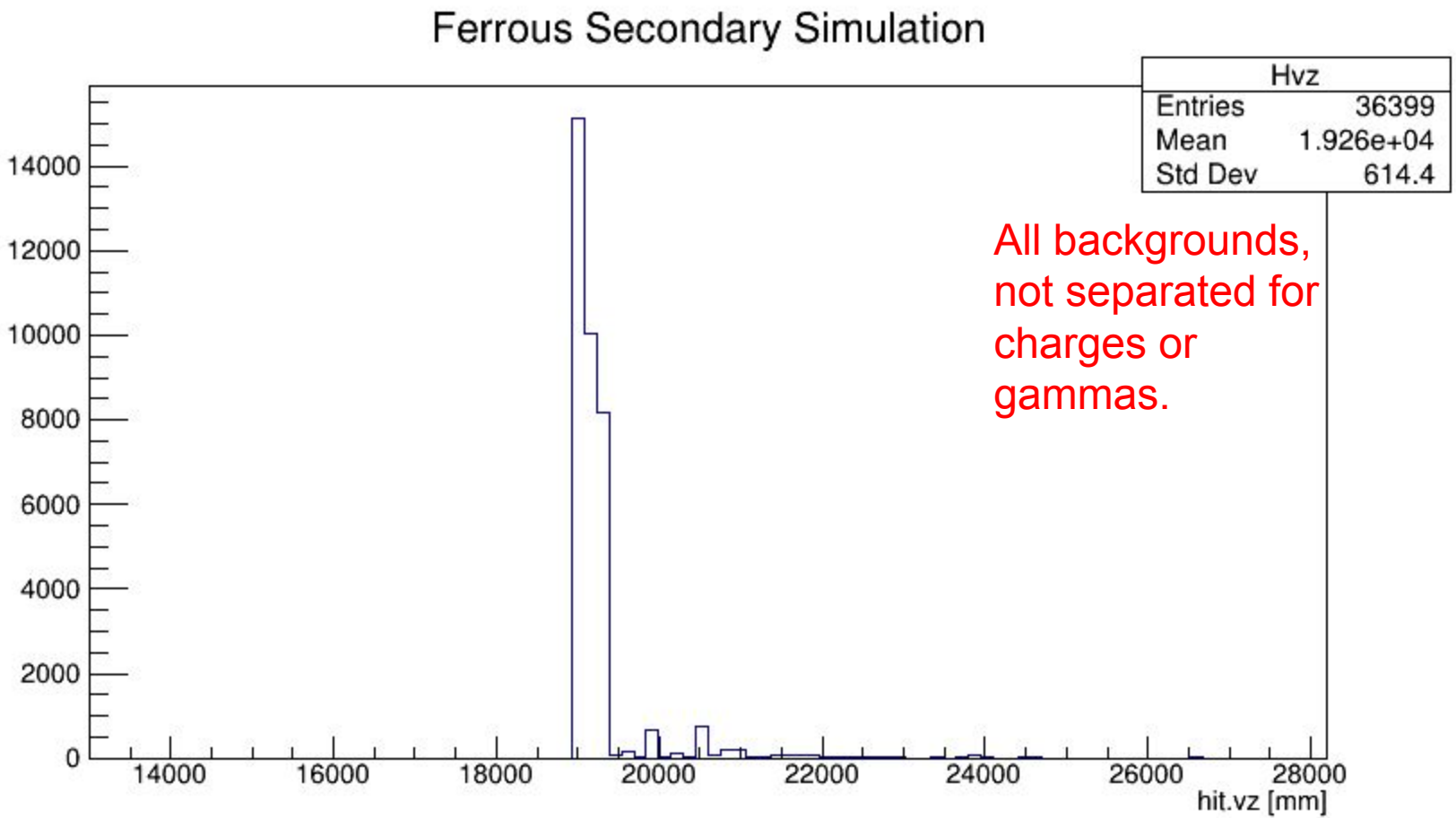

Ferrous Secondary Simulation
H2
Entries 29934
Mean 1767
Std Dev 316
All backgrounds, not separated for charges or gammas.
sqrt(part.vx*part.vx+part.vy*part.vy) [mm]

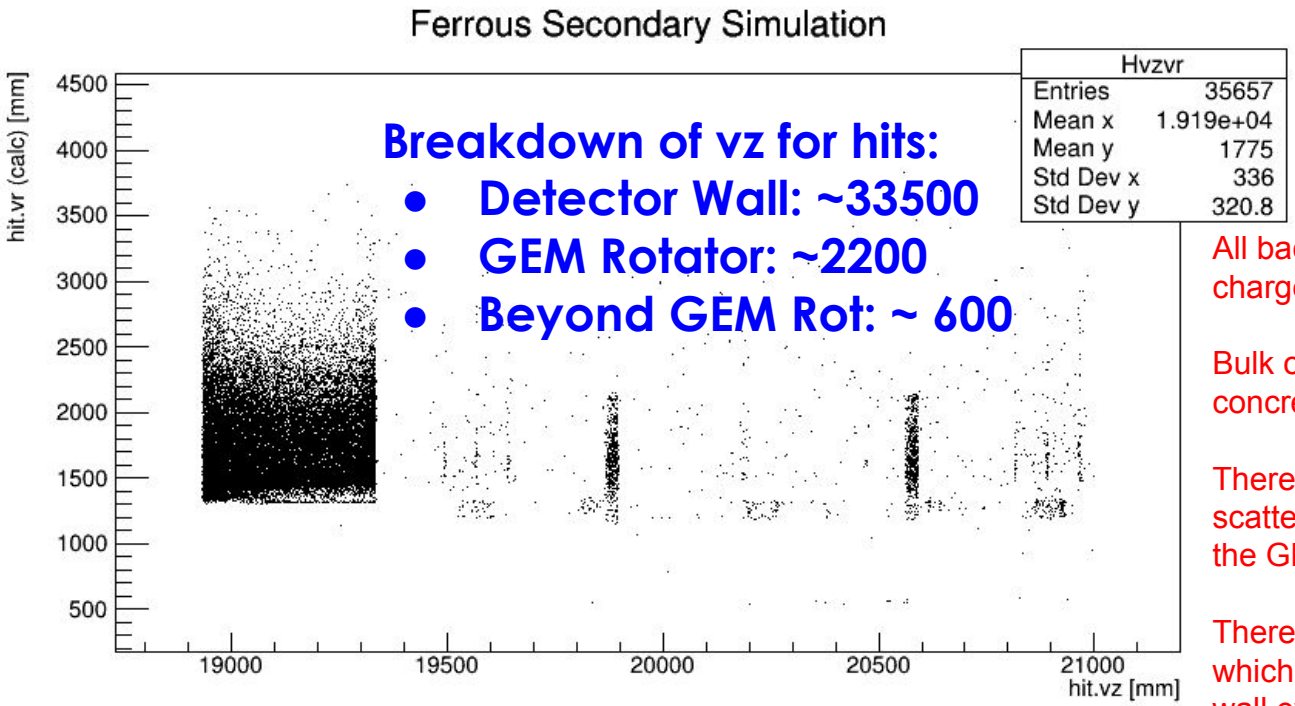

Ferrous Secondary Simulation
Hvz
Entries 36399
Mean 1.926e+04
Std Dev 614.4
hit.vz [mm]


Ferrous Secondary Simulation
Hvzvr
Entries 35657
Mean x 1.919e+04
Mean y 1775
Std Dev x 336
Std Dev y 320.8
hit.vr (calc) [mm]
hit.vz [mm]


Ferrous Secondary Simulation
H1
Entries 29934
Mean x −2.505
Mean y −94.35
Std Dev x 1288
Std Dev y 1247
part.vy [mm]
part.vx [mm]
2000
1000
0
−1000
−2000
−3000
−2500
−2000
−1500
−1000
−500
0
500
1000
1500
2000
2500
All backgrounds, not separated for charges or gammas.


Ferrous Secondary Simulation
H2
Entries 29934
Mean 1767
Std Dev 316
All backgrounds, not separated for charges or gammas.
1800
1600
1400
1200
1000
800
600
400
200
0
1500
2000
2500
3000
3500
sqrt(part.vx*part.vx+part.vy*part.vy) [mm]


Ferrous Secondary Simulation
Hvz
Entries 36399
Mean 1.926e+04
Std Dev 614.4
All backgrounds, not separated for charges or gammas.
14000
12000
10000
8000
6000
4000
2000
0
14000
16000
18000
20000
22000
24000
26000
28000
hit.vz [mm]



All backgrounds, not separated for charges or gammas.

Bulk of backgrounds originate within the concrete wall.

There are some (<10%) secondary scatters of backgrounds from the wall in the GEM rotator apparatus.

There are other background events (< 2% which are rescatters of backgrounds from wall events from downstream of the detector front.

No reason to cut these out from results as total overall backgrounds fall within tolerable limits.

Summary

Summary Table

[Backgrounds from primaries that hit the wall, no ferrous considerations yet.]

Material	Density (g/cm^3)	Main Det Charges (ppb)	Main Det Gammas (ppb)	PMT Region Charges (ppb)	PMT Region Gammas (ppb)
Barite	4.05	1.08	24.6	4.03	71.7
⇒ BariteConcrete ⇐ [BETTER REFERENCE]	3.36	1.60	34.9	6.4	106
Ilmenite 2.9g/cm3	2.9	4.58	71	21.9	241
3cm-Stainless 37cm ilmenite concrete @ 2.9g/cm3	3.29 [mean]	3.16	56.4	14.4	178

Summary
Ilmenite/Barite

Material	X_r	Spin Polarization (P_f)	Frac e- on Target	Frac of events Per Moller
Mild 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

⇒ Charge backgrounds on the main detector from the ilmenite concrete wall are ~5 ppb.

The limit on the susceptibility of the material (refer to susceptibility and fractional background table above) would be around 2.

Ilmenite susceptibility is 1.06, material is fine.
https://moller.jlab.org/cgi-bin/DocDB/private/ShowDocument?docid=1206

Material	Density (g/cm^3)	Main Det Charges (ppb)	Main Det Gammas (ppb)	PMT Region Charges (ppb)	PMT Region Gammas (ppb)
Barite	4.05	1.08	24.6	4.03	71.7
⇒ BariteConcrete ⇐ [BETTER REFERENCE]	3.36	1.60	34.9	6.4	106
Ilmenite 2.9g/cm3	2.9	4.58	71	21.9	241
3cm-Stainless 37cm ilmenite concrete @ 2.9g/cm3	3.29 [mean]	3.16	56.4	14.4	178

Summary
3cm Stainless

Material	X_r	Spin Polarization (P_f)	Frac e- on Target	Frac of events Per Moller
Mild 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

⇒ Similar ferrous backgrounds from charges on the main detector as the ilmenite, with the concrete and stainless we're at 3.16 ppb.

This would put us in the rage of a susceptibility maximum of around ~3.

The material, in total, would have to be worse than the worst stainless and be worse susceptibility of crete.

This design would also be fine.

Material	Density (g/cm^3)	Main Det Charges (ppb)	Main Det Gammas (ppb)	PMT Region Charges (ppb)	PMT Region Gammas (ppb)
Barite	4.05	1.08	24.6	4.03	71.7
⇒ BariteConcrete ⇐ [BETTER REFERENCE]	3.36	1.60	34.9	6.4	106
Ilmenite 2.9g/cm3	2.9	4.58	71	21.9	241
3cm-Stainless 37cm ilmenite concrete @ 2.9g/cm3	3.29 [mean]	3.16	56.4	14.4	178