

DS Rebar (Revisited)

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Review – Ferrous Backgrounds

$$A_{\text{false}} = f_r P_e P_f A_n$$

P_f : Polarization of ferrous material

A_n : Average analyzing power of polz'd scattering processes

P_e : Polarization of the electron

f_r : fraction of detector Moller signal (Adjust by 10^{-4} 'ish for per e.o.t rate)

Design Parameter for MOLLER:

$$\Delta A_{\text{raw}}[\text{ppb}] \approx 0.54$$

We'd like two orders of magnitude cushion on a false asymmetry.

$$A_{\text{false}} \sim 0.1[\text{ppb}](10^{-2})(10^{-4}) \sim 10^{-16}$$

We do make some safe conservative approximations:

$$P_e \sim 1 \quad [\text{beam polarization}]$$

$$A_n \sim 10^{-3} \quad [\text{transmission analyzing power}]$$

What we're left with is:

$$f_r \propto \frac{A_{\text{false}}}{\chi_f}$$

Material
Magnetic
Susceptibility

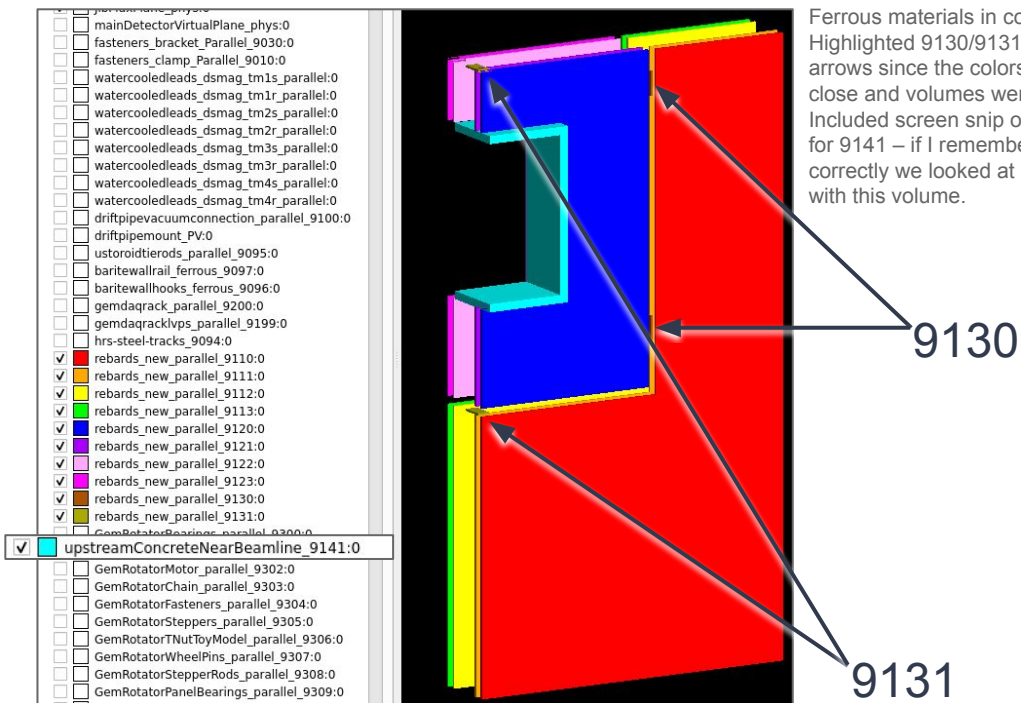
Takeway

$$\chi_f f_r \iff A_{\text{false}}$$

Tungsten, too →

Material	χ_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

Original Simulations



Ferrous materials in concrete.
Highlighted 9130/9131 with
arrows since the colors were
close and volumes were small.
Included screen snip of name
for 9141 – if I remember
correctly we looked at scraping
with this volume.

9141 not used here but was used to investigate
surface scattering at some point.

Looking at these historic results it looks as if the
events all come from the upstream rebar planes.

Updated Results – April 2025

- Additional material added in simulation since the simulations in July '22.
 - DS toroid magnet vacuum box
 - GEM Rotator and detector materials.
- Used the same geometry as in July '22 so I would at least have a clean comparison.

Primary Hits Summary

#	Det\mTrid	0	1	TOTAL
	9110	0	0	0
	9111	0	1	1
	9112	384	392	776
	9113	6544	4928	11472
	9120	0	0	0
	9121	0	0	0
	9122	13	8	21
	9123	2071	933	3004
	9130	0	0	0
	9131	0	0	0

Total of 15274 primary hits

Updated Results – April 2025

- Additional material added in simulation since the simulations in July '22.
 - DS toroid magnet vacuum box
 - GEM Rotator and detector materials.
- Used the same geometry as in July '22 so I would at least have a clean comparison.

Each simulation was 100K events.

Secondary Sims for 9111 & 9123 did not produce any secondary hits. I've not included them for space reasons but they were also 100K events each.

500K events total.

Secondary Hits Summary

Secondary Simulation Hit on Sensitive Detectors

Ferrous Vol: 9112

eHitDist9928: 0

gHitDist9928: 7

eHitDist9911: 0

gHitDist9911: 4

Secondary Simulation Hit on Sensitive Detectors

Ferrous Vol: 9113

eHitDist9928: 0

gHitDist9928: 4

eHitDist9911: 0

gHitDist9911: 3

Secondary Simulation Hit on Sensitive Detectors

Ferrous Vol: 9122

eHitDist9928: 0

gHitDist9928: 1

eHitDist9911: 0

gHitDist9911: 0

New Results – DS Rebar

Sens Volume:	Rebar DS -- 9110-9131
Sim Date:	3/16/2025
Detector #:	9110

Rebar DS -- 9110-9131 -- Unweighted By BField

Total Prim's: 3,000,000,000

Total Sec's: 500,000 (per sens det)

<== 100000 x 5 volumes with primary events

Primary Counts		
Primaries	0	O&1
9110		15274

Primary Fractional		
Primaries	0	O&1
9110		5.09E-06

(9928 Main Det) Secondary Counts O&1		
Secondaries	Electrons	Gammas
9110	0	12

(9928 MainDet) Secondary Fractional - O&1		
Secondaries	Electrons	Gammas
9110	0.00E+00	2.40E-05

(9928 MainDet) Total Fractional - O&1		
Secondaries	Electrons	Gammas
9110	0.00E+00	1.22E-10

O&1		
Secondaries	Electrons	Gammas
9110	0	7

(9911 PMT Region) Secondary Fractional - O&1		
Secondaries	Electrons	Gammas
9110	0.00E+00	1.40E-05

(9911 PMT Region) Total Fractional - O&1		
Secondaries	Electrons	Gammas
9110	0.00E+00	7.13E-11

Old Results

Comments:

Primary events scale reasonably well (between new and old sims), the number of primary events in 2025 sims was a factor of ~21.8 greater than 2022 sims and number of detected primaries is ~20.8 greater.

No charges were detected from secondaries in 2022 nor now. A few gammas.

Final background fractions are reasonably similar given the very few events in the secondary sims in the original work.

*Secondary sims run with beam and beam-daughter electrons from primary sim

DS Rebar Symm Fields

Total Events	242750000		
det\mTrid	0	1	TOTAL
9110	0	0	0
9111	0	0	0
9112	27	27	54
9113	321	228	549
9120	0	0	0
9121	0	0	0
9122	0	0	0
9123	117	14	131
9130	0	0	0
9131	0	0	0
Sum	465	269	734

Primary Sim Results

Secondary Sim Results

Charges – Primary and Secondary Electrons						
DetNo	1-10MeV	10-100MeV	100-1000MeV	>1GeV	Total	Norm P&S
9110	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9111	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9112	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9113	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9120	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9121	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9122	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9123	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9130	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9131	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sum	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00

Gammas – Primary and Secondary Electrons						
DetNo	1-10MeV	10-100MeV	100-1000MeV	>1GeV	Total	Norm P&S
9110	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9111	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9112	1.0E-05	0.0E+00	0.0E+00	0.0E+00	1.0E-05	1.1E-12
9113	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9120	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9121	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9122	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9123	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9130	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
9131	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Sum	1.0E-05	0.0E+00	0.0E+00	0.0E+00	1.0E-05	1.9E-11

DS Rebar Verdict

- Main Detector charge rates: $< 10^{-11}$
- Main Detector gamma rates:
~ $1.22(10^{-10})$
 - 10% response $\Rightarrow 1.22(10^{-11})$
- PMT Region charge rates: $< 10^{-11}$
- PMT Region gamma rates: $7.1(10^{-11})$
 - 10% response $\Rightarrow 7.1(10^{-12})$

\Rightarrow Rates would be tolerable even if we used the tolerable backgrounds for carbon steel; SS rebar not an issue.