

Compact Photon Source: Update

Carbon Target &
Real Compton Scattering
Experiment with **FLUKA**

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 **Jefferson Lab**



SAINT MARY'S
UNIVERSITY SINCE 1802

Summary of Updates from last Meeting

1. Performed FLUKA consistency check with carbon target.
2. Recreated RCS experiment for radiation level comparisons.



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P.Reid 03/13/18

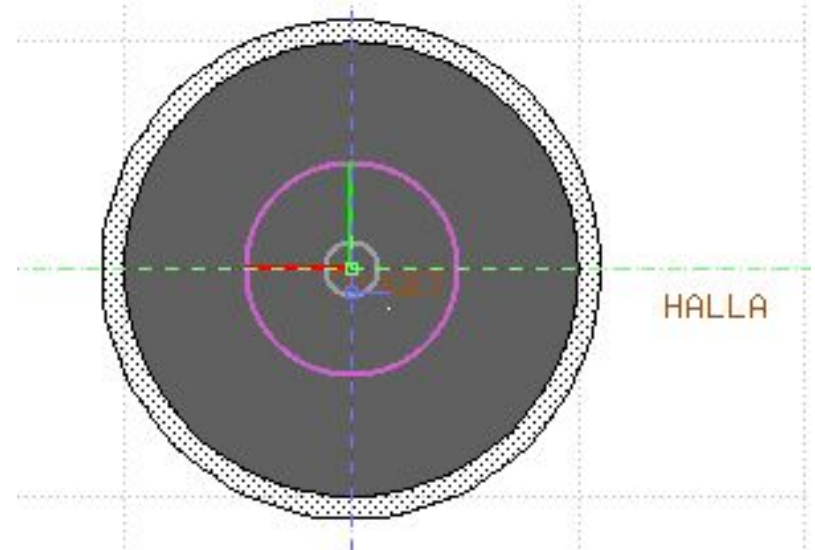
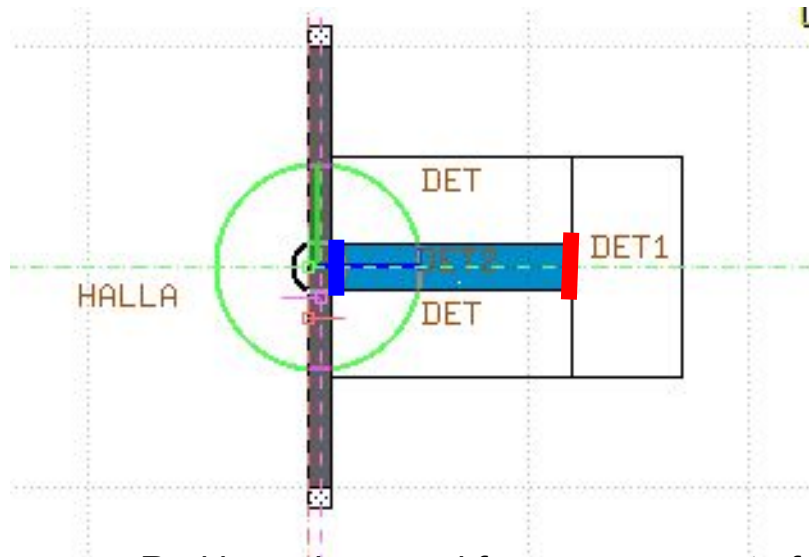
Carbon Electron Experiment (1/5)



- Performing a consistency check with previously known data.
- Ensure FLUKA is working as intended
- Data obtained in 2001 with 1% carbon radiator at 12 GeV
- Replicated within FLUKA.
- Will look at Neutron, e^+ , e^- , and photon production

Carbon Electron Experiment (2/5)

12 Gev Electron beam incident on 0.1 cm carbon.



Red boundary used for measurement of electrons and Photons, Blue for Neutrons

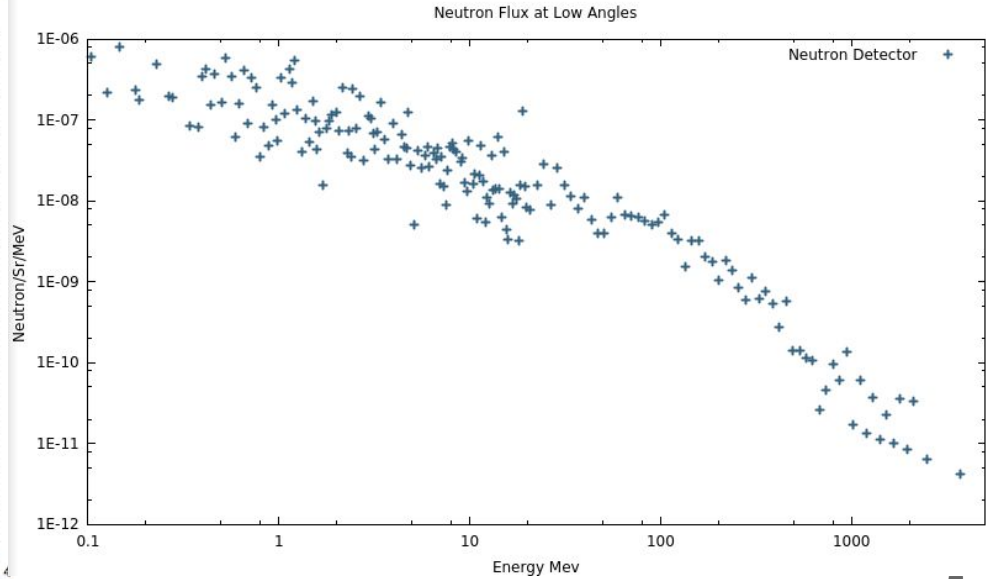
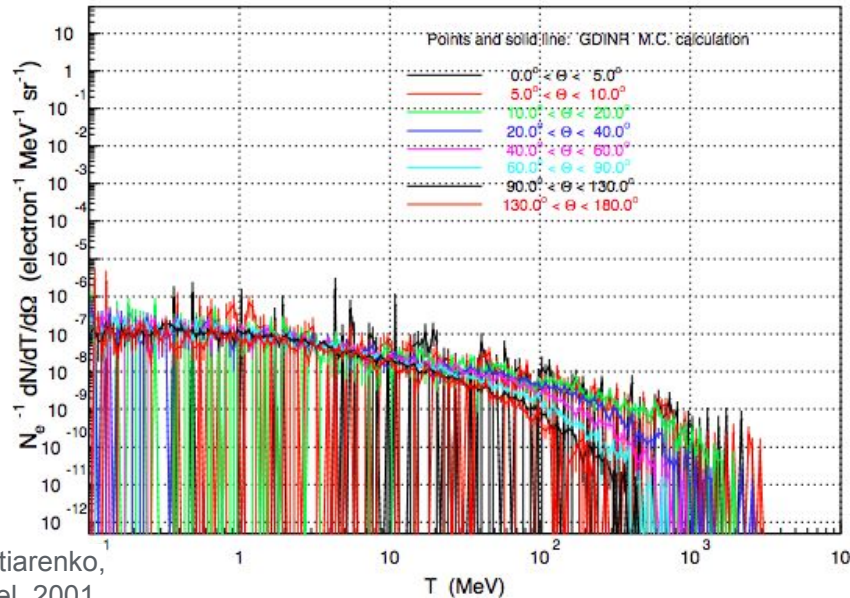
Carbon Electron Experiment (3/5)

Neutron Production

Neutron acceptance
In FLUKA theoretically
90° Comparison only
applicable at low
energies

	1 Mev	10 Mev	1000 Mev
P. Degtiarenko 2001(/electron/MeV/sr)	$\sim 10^{-7}$	$\sim 10^{-8}$	N/A
FLUKA (/electron/MeV/sr)	$\sim 10^{-7}$	$\sim 10^{-8}$	$\sim 10^{-11}$

$e + C \rightarrow n + X$ at $E_e = 12$ GeV (0.1 cm target)
2001/04/26 09:20



Carbon Electron Experiment (4/5)

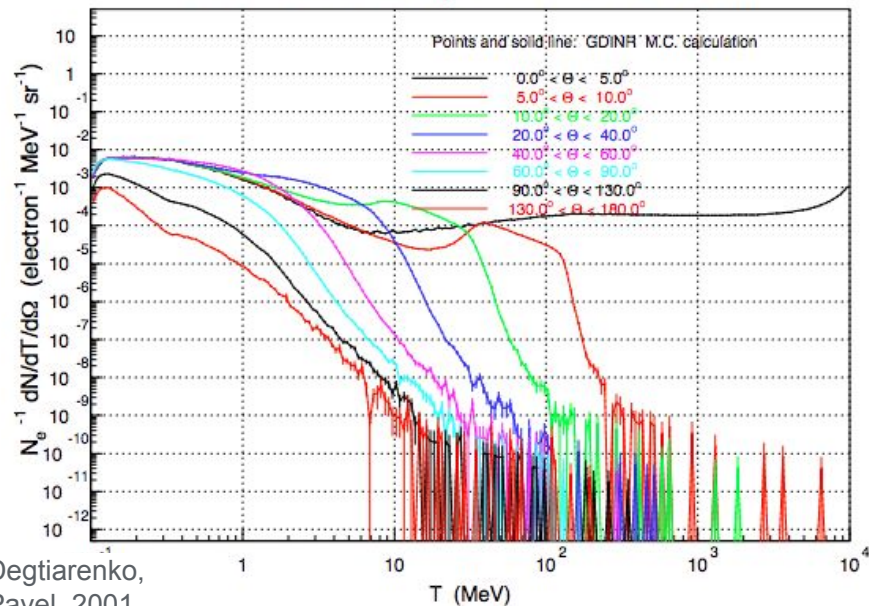
Electron Production ($<5^\circ$)



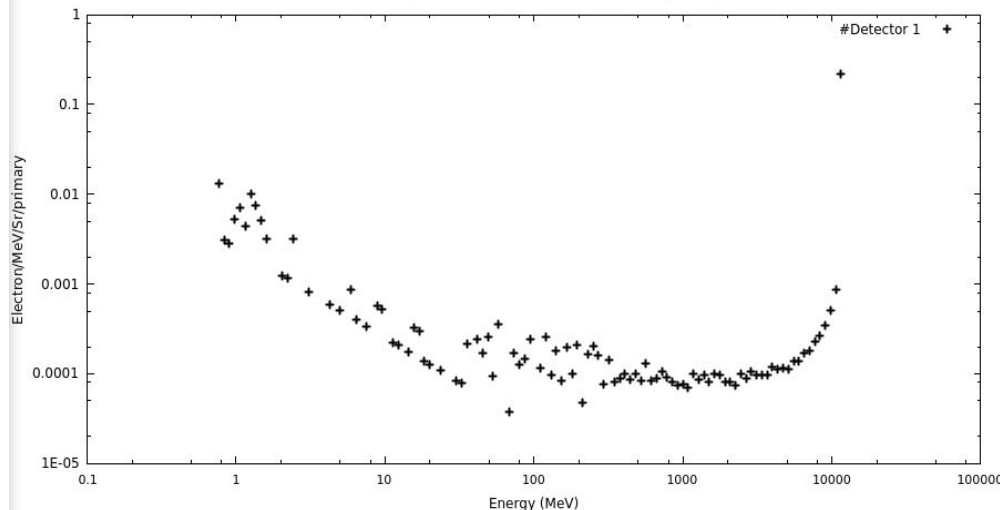
Some discrepancies up to **factor of 3** in production

	1 Mev	10 Mev	1000 Mev
P. Degtiarenko 2001 (/electron/MeV/sr)	$\sim 2 \times 10^{-3}$	$\sim 7 \times 10^{-5}$	$\sim 2 \times 10^{-4}$
FLUKA (/electron/MeV/sr)	$\sim 5 \times 10^{-3}$	$\sim 2 \times 10^{-4}$	$\sim 1 \times 10^{-4}$

$e + C \rightarrow e^- + X$ at $E_e = 12$ GeV (0.1 cm target)



Low angle Electron Production (<5 degrees)



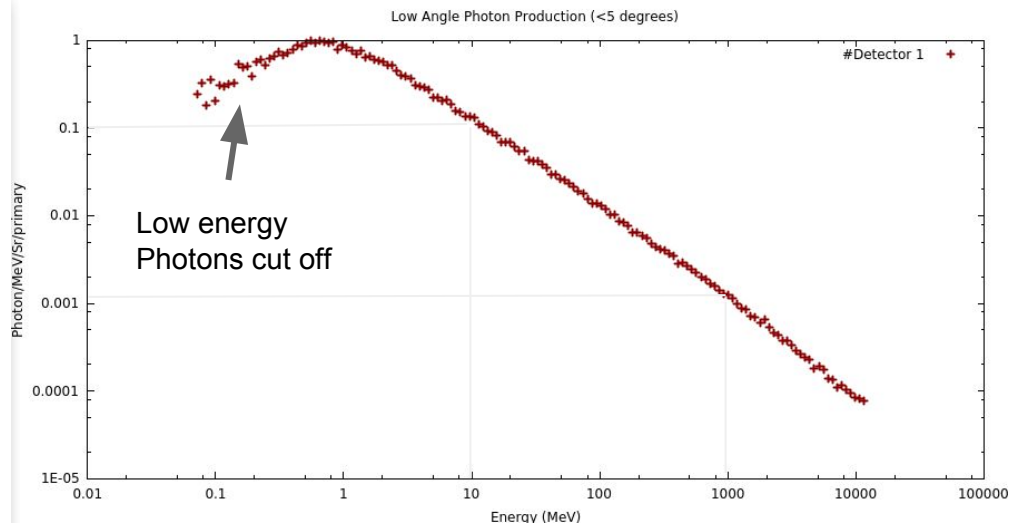
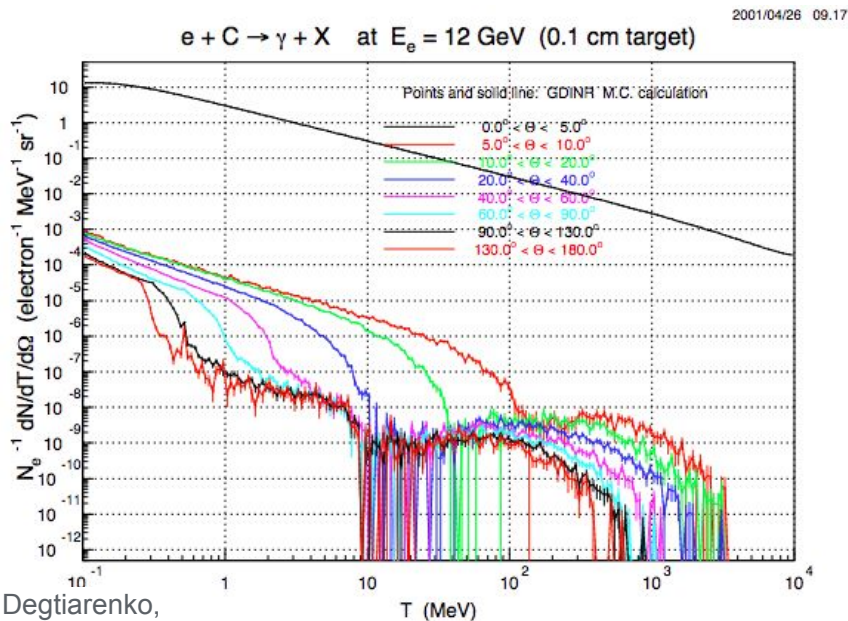
FLUKA MC

Carbon Electron Experiment (5/5)

Photon Production ($<5^\circ$)

Varying
under/overproduction
of photons

	1 Mev	10 Mev	1000 Mev
P. Degtiarenko 2001 (/electron/MeV/sr)	~2	~0.3	~ 2×10^{-3}
FLUKA (/electron/MeV/sr)	~0.75	~0.5	~ 1×10^{-3}



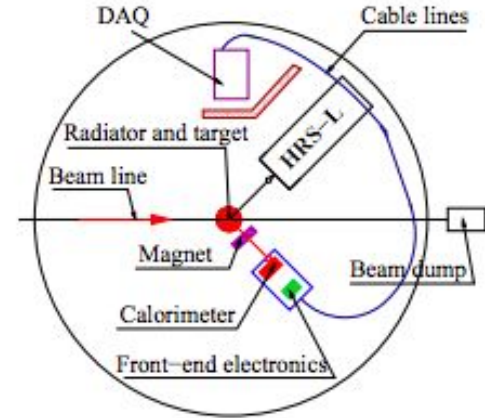
FLUKA MC

Real Compton Scattering

Experiment is a good benchmark for radiation levels

Electronics precision from 5% to only 10% by the end of RCS experiment lifetime.

A good reference when looking to implement new radiation sources.



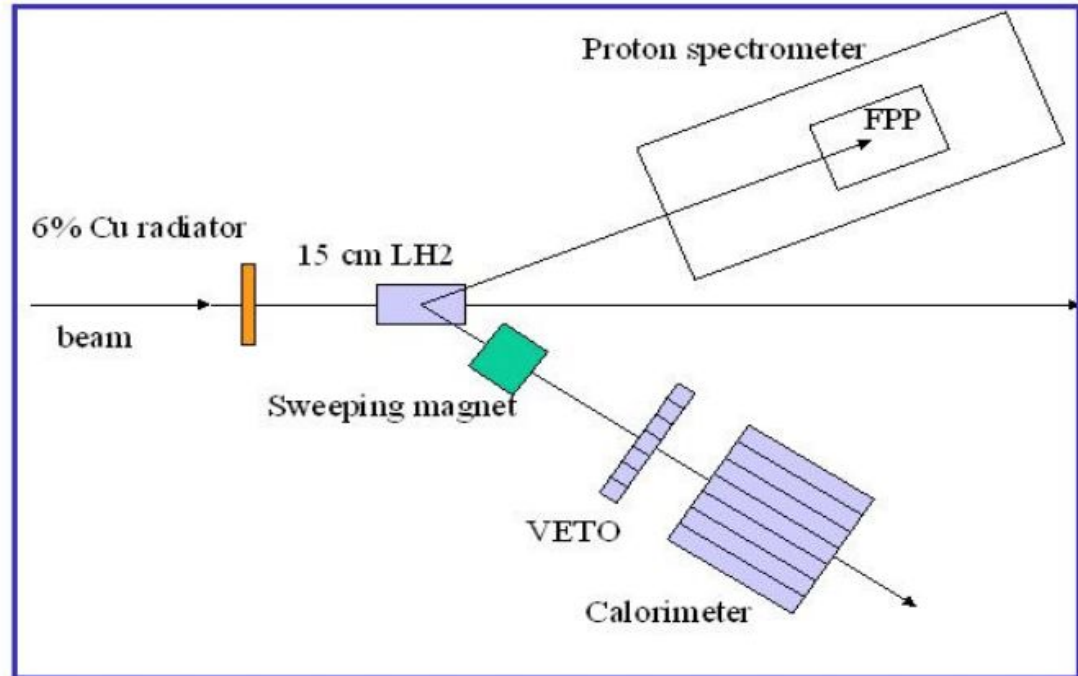
D. J. Hamilton, , A. Shahinyan , B. Wojtsekhowski , et al

Basic RCS Reproduction

15cm LH2 Target

6% copper radiator.

Previous simulation data
obtained with energy 3.48 GeV

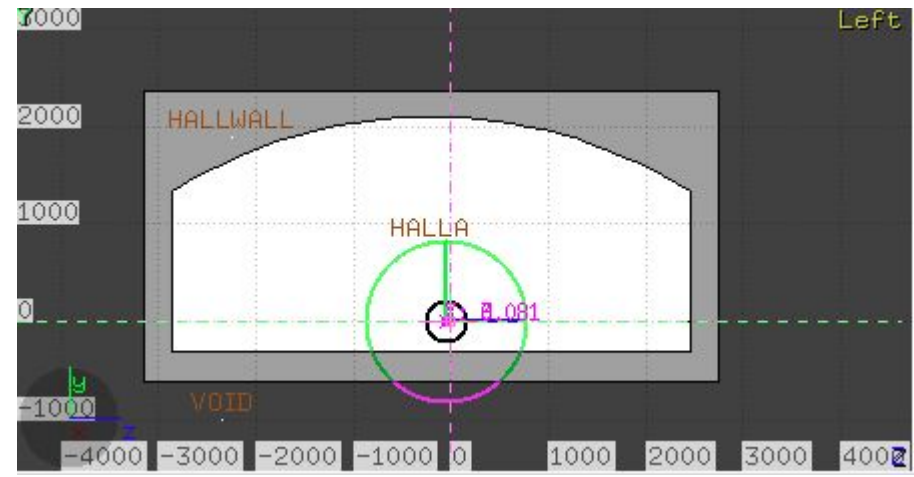
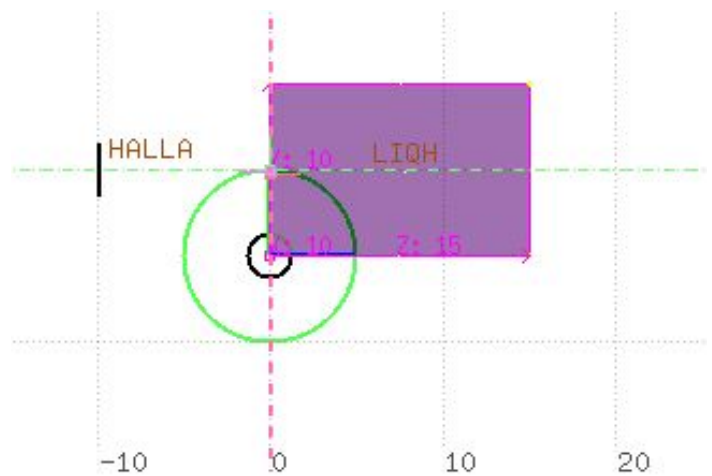


“Exclusive Compton Scattering, Sabatie 1999”

Simple Geometry, No beamline shielding

Placed near center of Hall A

All Lengths in cm

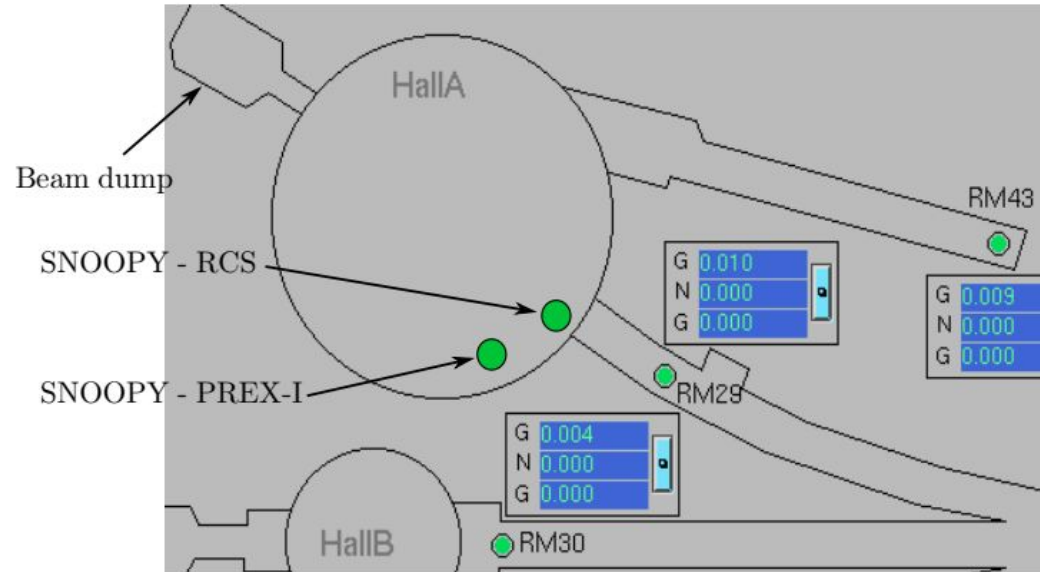


Radiation Comparison

RCS experiment has benefit of experimental, and simulated Data.

GEANT4 Model has scoring model 16m upstream from center of Hall

SNOOPY (Neutron dose detector) approximately same location



RCS Results, Comparison

1 Mev neutron-EQ comparison

RCS GEANT simulation

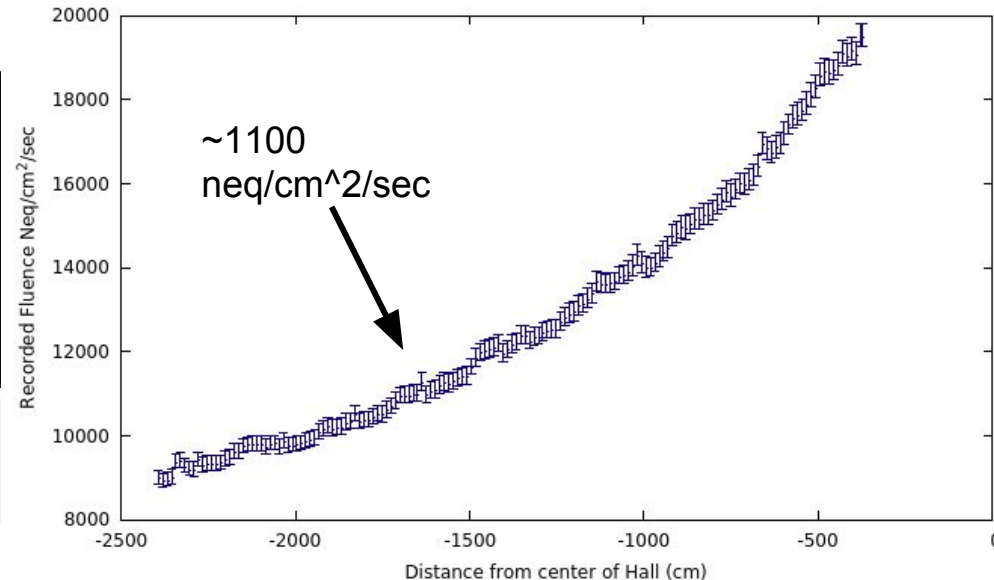
Experiment	Days	Radiation type	1 MeV neutron equivalent fluence rate ($n_{eq}cm^{-2}s^{-1}$)	Total 1 MeV neutron fluence ($n_{eq}cm^{-2}$)
RCS, 3.481 GeV 40 μ A	16 effective days	e^+/e^- neutrons	1.8E+03 5.1E+03	2.5E+09 7.0E+09

Combined 1 MeV Fluence rate

Combined expectation $\sim 7,000$ neq/cm²/sec

Almost **Factor of 2** increase

Silicon Fluence in RCS Upstream Region



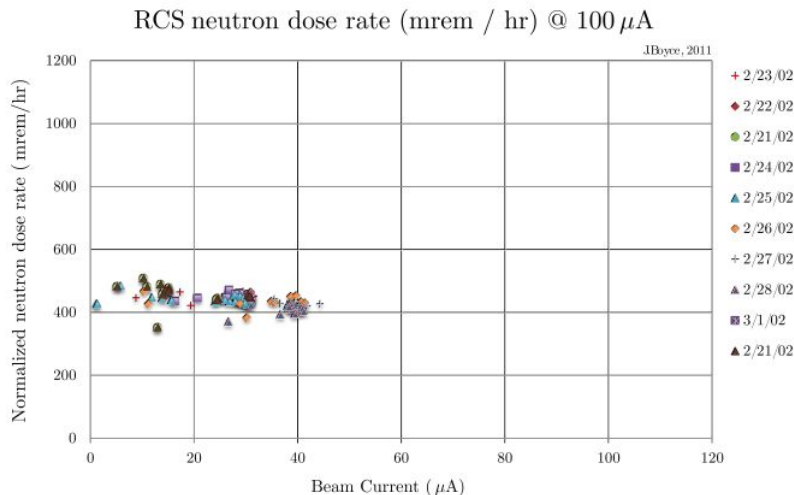
RCS Results, Comparison

Dose Rate mrem/hr

Factor of 8 difference from published
SNOOPY data.

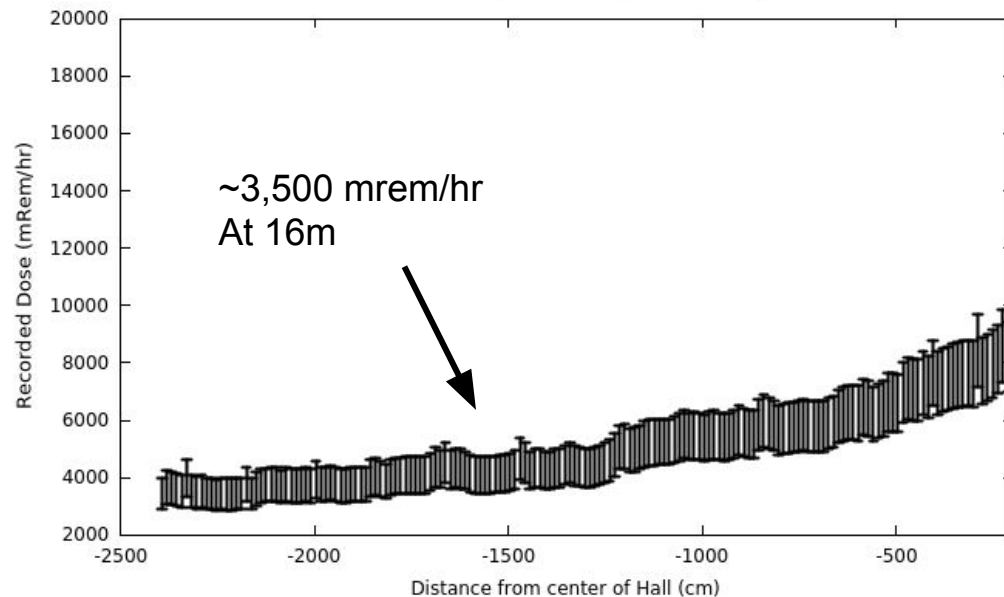
Clearly an issue with FLUKA
understanding

Dose Recording in RCS Upstream Region



Average measured dose rate: 440 mrem/hr at 100 μ A

Geant4 simulated dose rate: 1275 mrem/hr at 100 μ A



J. Boyce 2011

Moving Forward....

Insufficient agreement with FLUKA and published RCS results. Cannot proceed until understood further.

1. Fix RCS simulation. Ensure FLUKA understanding is correct
2. Compare RCS to CPS baseline
3. Continue with Shielding optimization as planned

Questions/Comments/Concerns?

As always, FLUKA insight is greatly appreciated!



Thank you