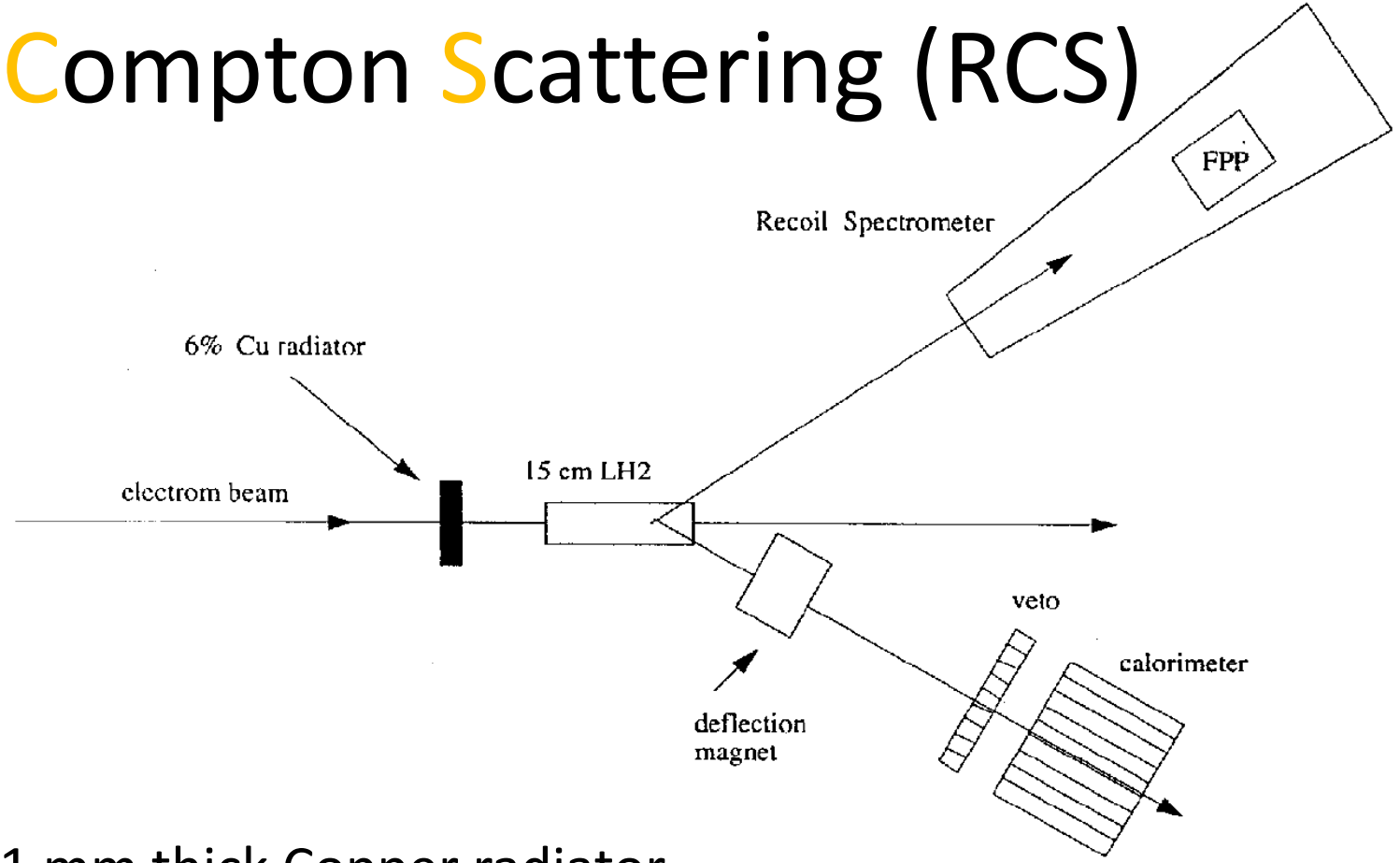
GEANT4 Simulation of background radiation study for APEX

Maduka Kaluarachchi

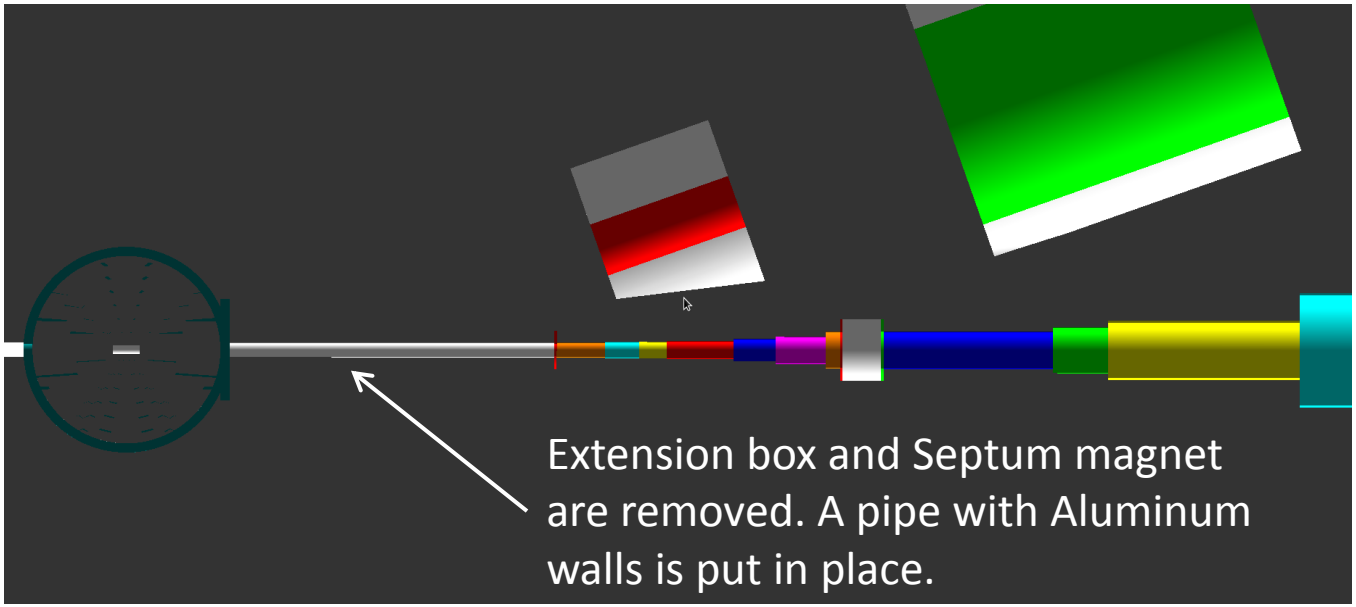
- Simulated Real Compton Scattering experiment
- Study how dose rates differ within HRS electronics area

Real Compton Scattering (RCS)



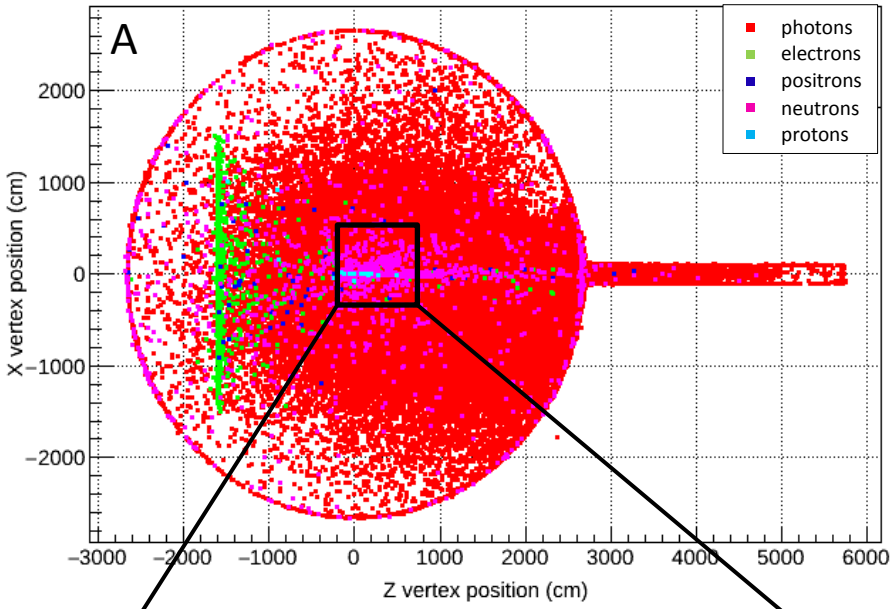
- $Target$: 0.81 mm thick Copper radiator
  15 cm LH_2 target
- $Beam$: 3.481 GeV
- $Left\ HRS$: $positioned\ at$ 19.47^o

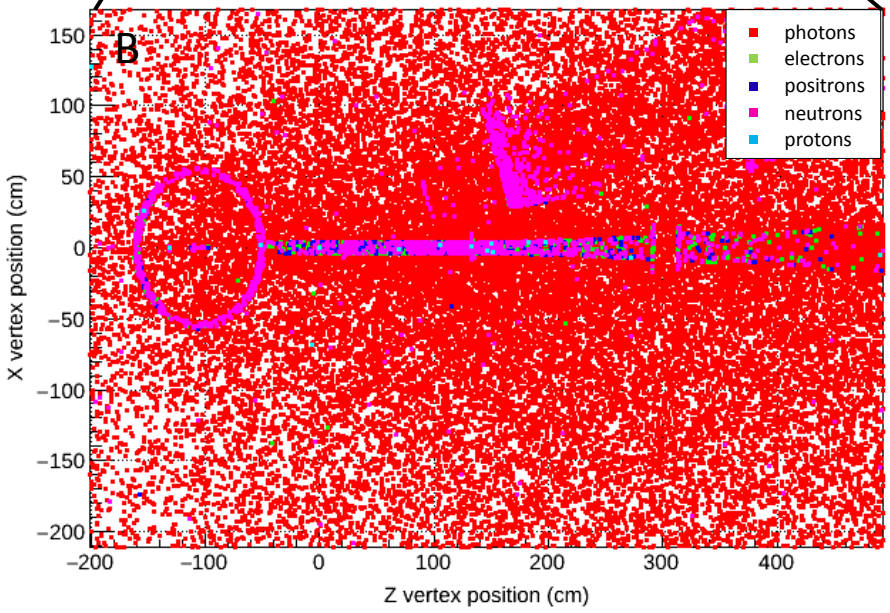
RCS experiment



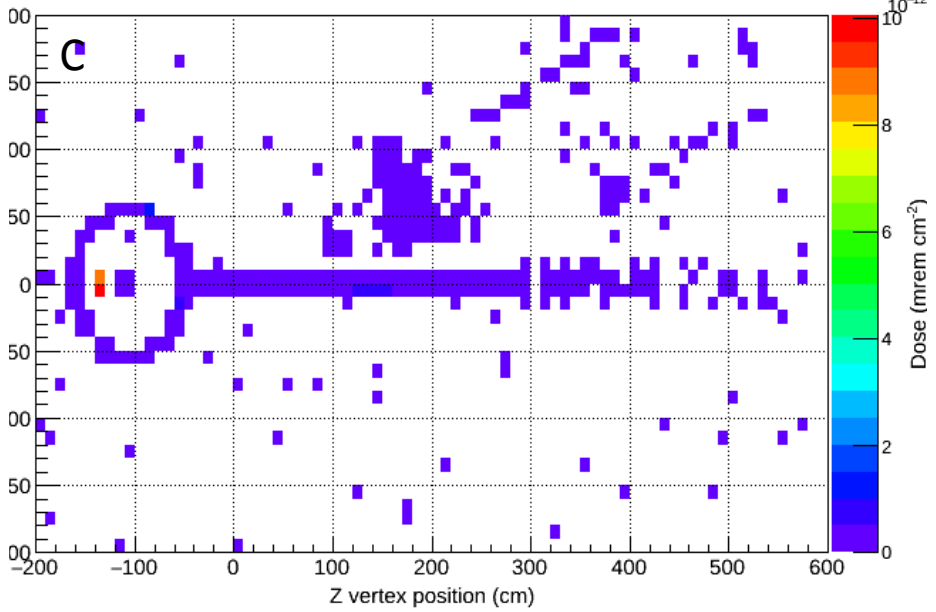
- $Target$: 0.81 mm thick Copper radiator
  15 LH2 target
- $Beam$: 3.481 GeV
- $Left\ HRS$: $positioned\ at\ 19.47^{o}$
- No photon arm.

Origins of particles entering Upstream detector, 6% Cu, 15 cm LH_2

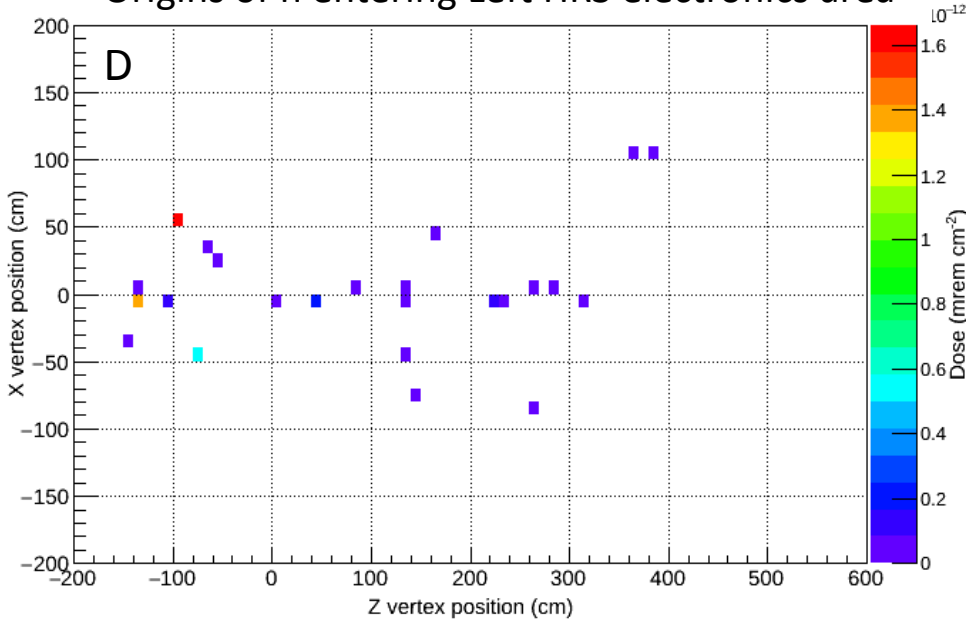




Origins of n entering Upstream detector



Origins of n entering Left HRS electronics area



RCS Radiation Evaluation Results

RCS E, Current GeV, μA	Target X_0, t % r.l, mg/cm^2	Dose Rates: Upstream Detector (rem/h)	Dose Rates: Left HRS electronics area detector (rem/h)
3.481 GeV, 100 μA	Cu radiator 6% r.l. LH_2 target 15 cm	e: under study γ: 1.08 n: 1.10	e: under study γ: 3.62 n: 0.98

APEX and RCS Radiation

APEX E, Current GeV, μA	Target X_0, t % r.l, mg/cm^2	Dose Rates: Upstream Detector (rem/h)	Dose Rates: Left HRS electronics area detector (rem/h)
1.1 GeV, 100 μA	Carbon 0.7 % r.l. 298.9 mg/cm^2	e: under study γ: 0.12 n: 0.20	e: under study γ: 0.53 n: 0.11
2.2 GeV, 100 μA	Tungsten 4.0 % r.l. 270.4 mg/cm^2	e: under study γ: 0.34 n: 0.82	e: under study γ: 1.88 n: 0.41
3.3 GeV, 100 μA	Tungsten 8.0 % r.l. 540.8 mg/cm^2	e: under study γ: 0.76 n: 1.77	e: under study γ: 4.11 n: 0.97
4.4 GeV, 100 μA	Tungsten 8.0 % r.l. 540.8 mg/cm^2	e: under study γ: 0.65 n: 1.57	e: under study γ: 2.93 n: 0.72
RCS – Real Compton Scattering			
3.481 GeV, 100 μA	Cu radiator 6% r.l. LH_2 target 15 cm	e: under study γ: 1.08 n: 1.10	e: under study γ: 3.62 n: 0.98

Comparison of upstream detector dose rates

Neutron dose rates produced from APEX $<$ Neutron dose rates produced from PREX. → Good

factor of 3.5 less

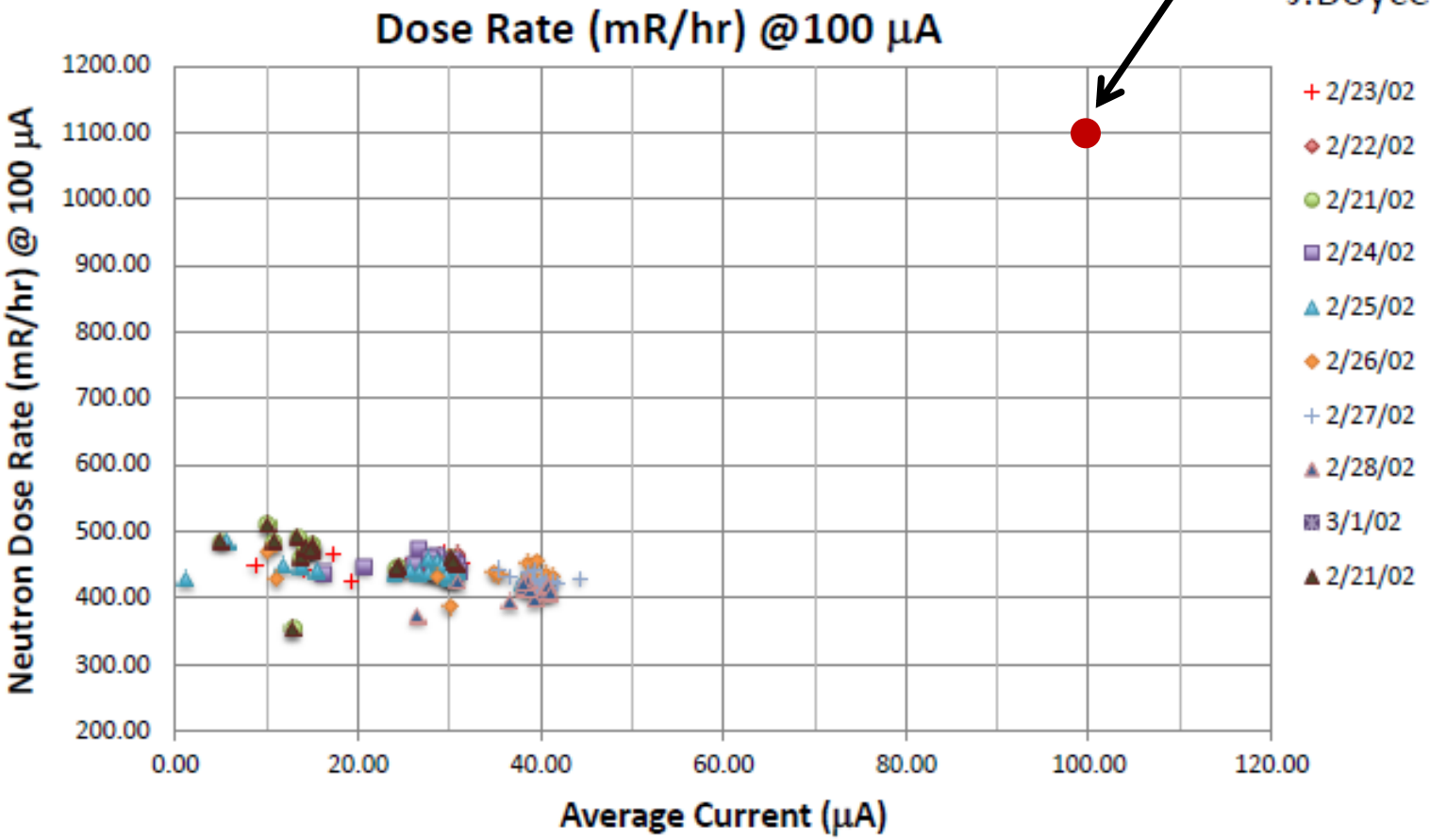
Neutron dose rates produced from APEX $>$ Neutron dose rates produced from RCS. → Need additional shielding

factor of 1.6 higher

My result with roughly a factor of 2.5 higher.

RCS - Feb. 2002: E_{e-} = 3.48 GeV

J.Boyce, 2011

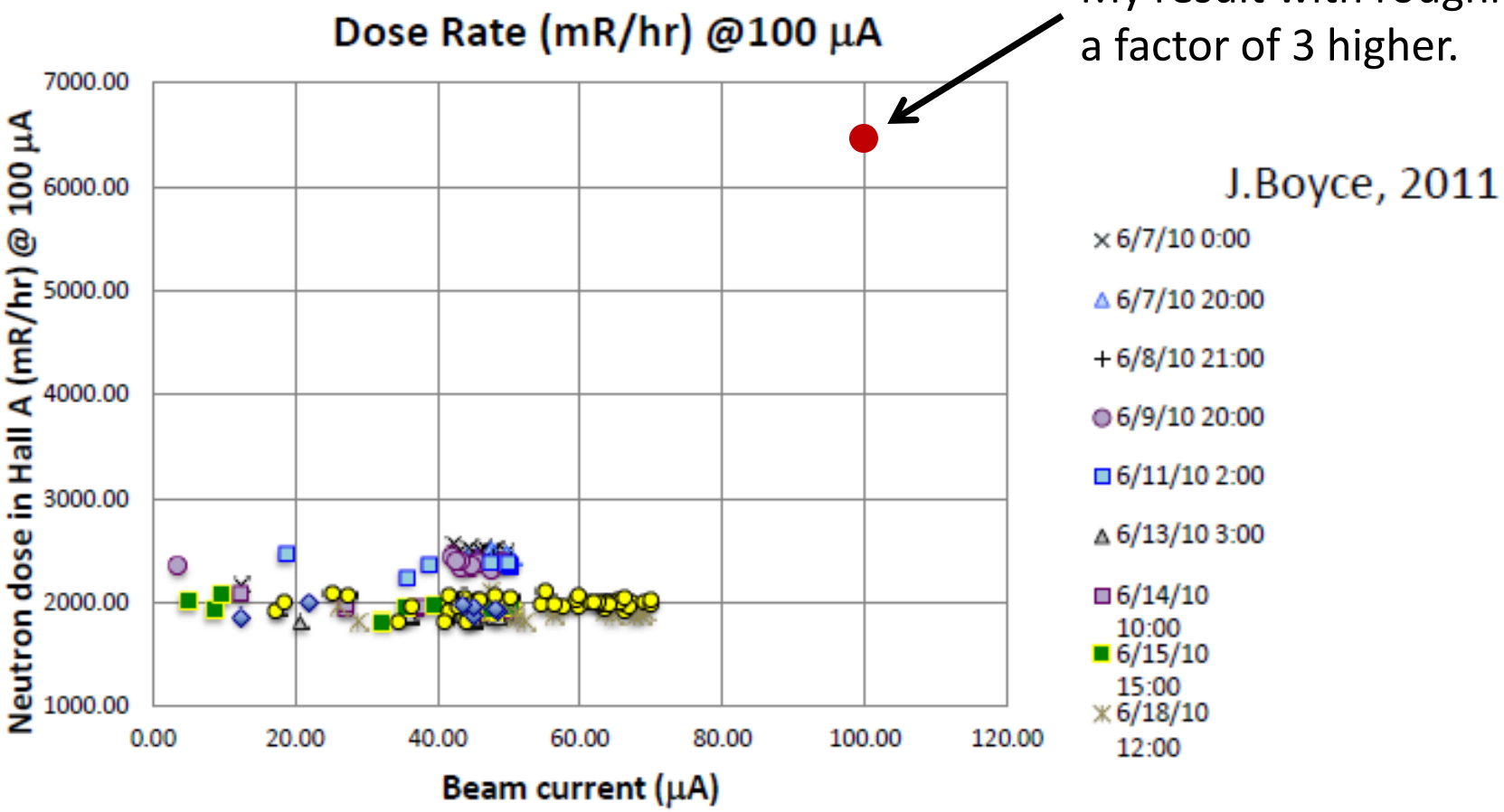


Target thickness = 637 mg/cm² (Cu) + 1040 mg/cm² (H)

Average Dose Rate = 440 mR/hr at 100 µA

PREX – June 2010: E_{e^-} = 1.06 GeV

My result with roughly a factor of 3 higher.

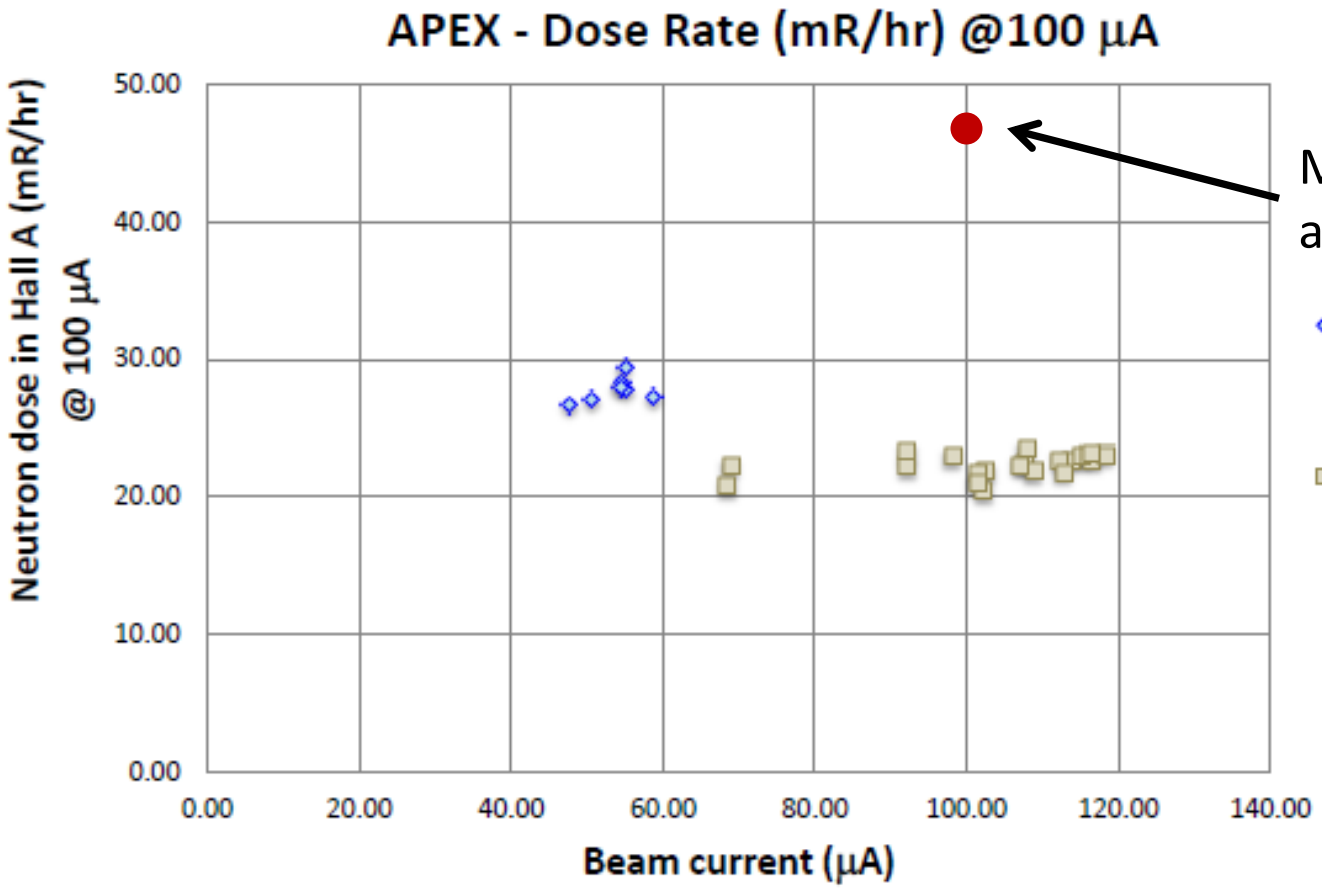


Target thickness = 637 mg/cm² (Pb)

Average Dose Rate = 2080 mR/hr at 100 μA

APEX (test) – July 2010: E_{e^-} = 2.26 GeV

J.Boyce, 2011



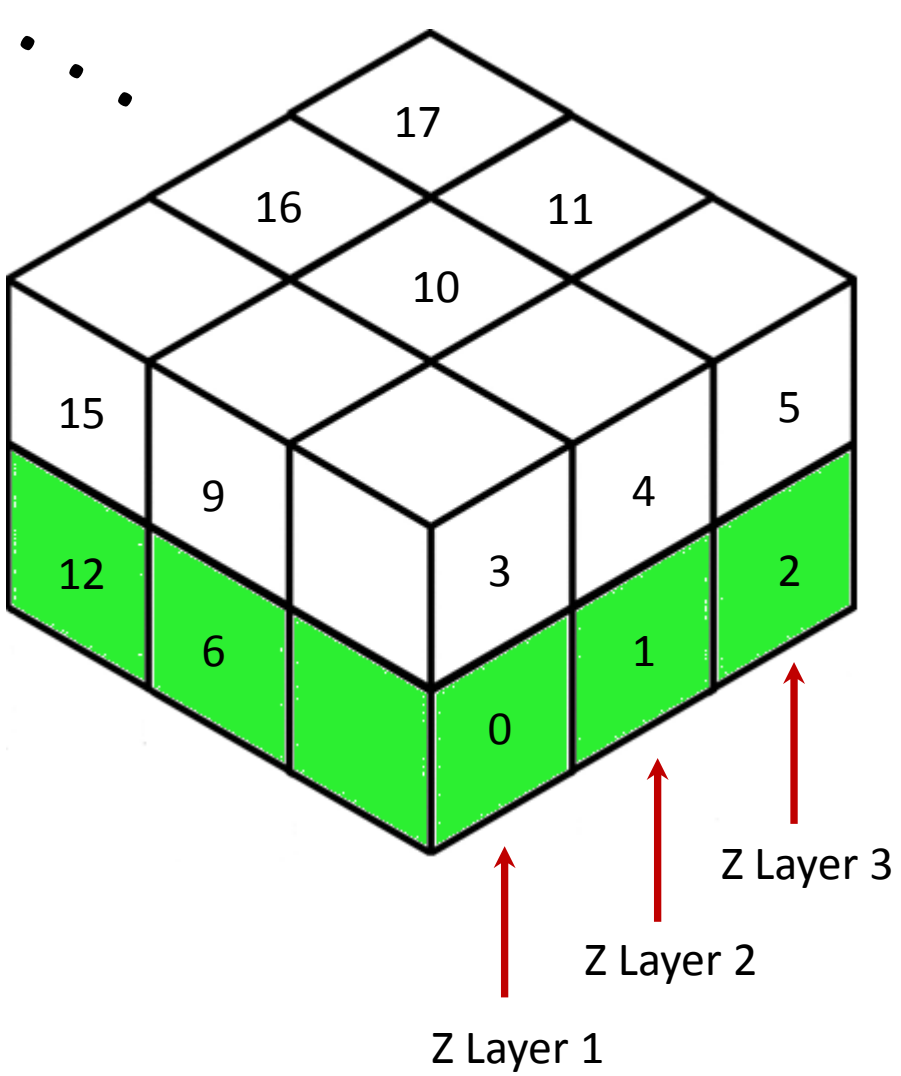
My result with roughly a factor of 2 higher.

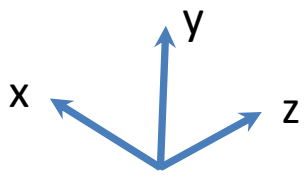
Target thickness = 22 mg/cm^2 (Ta)

Average Dose Rate = 24 mR/hr at 100 μA

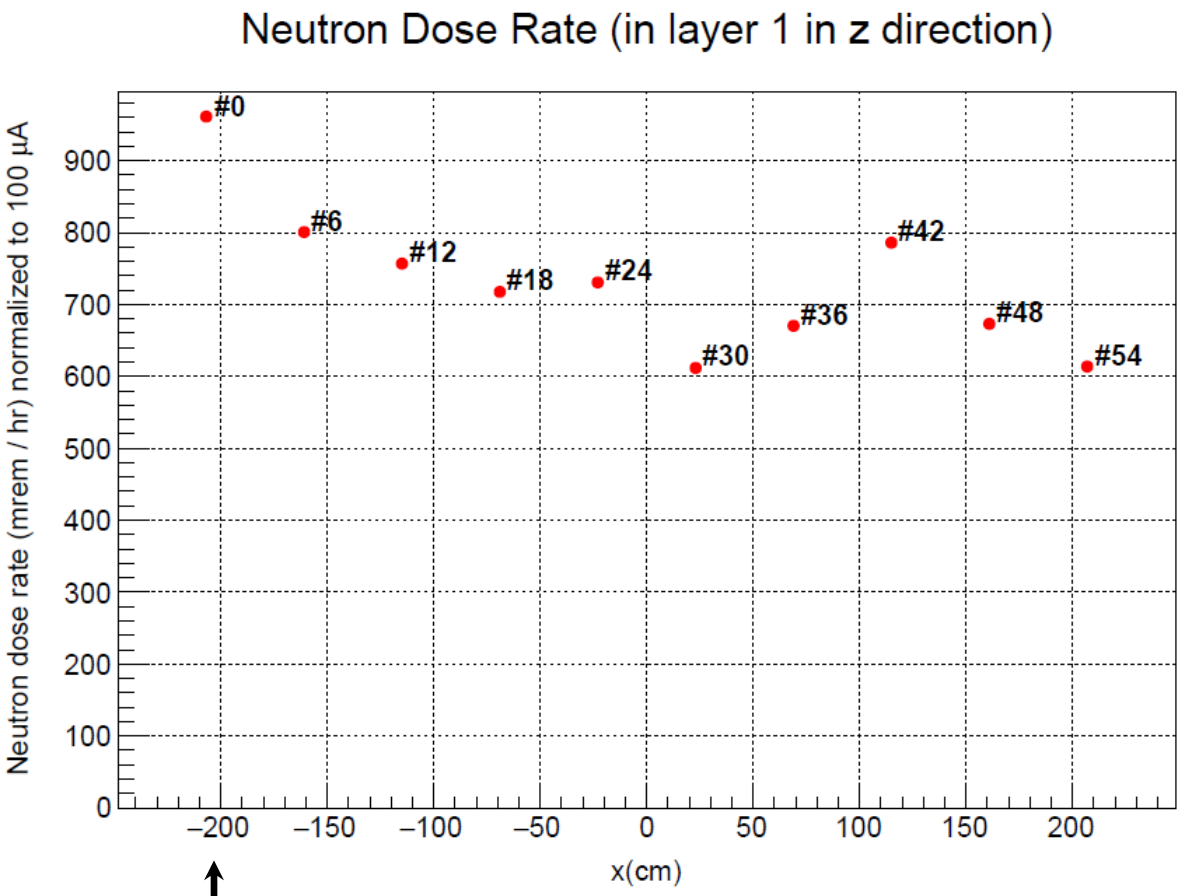
HRS electronics area detector assembly

10 blocks in x direction

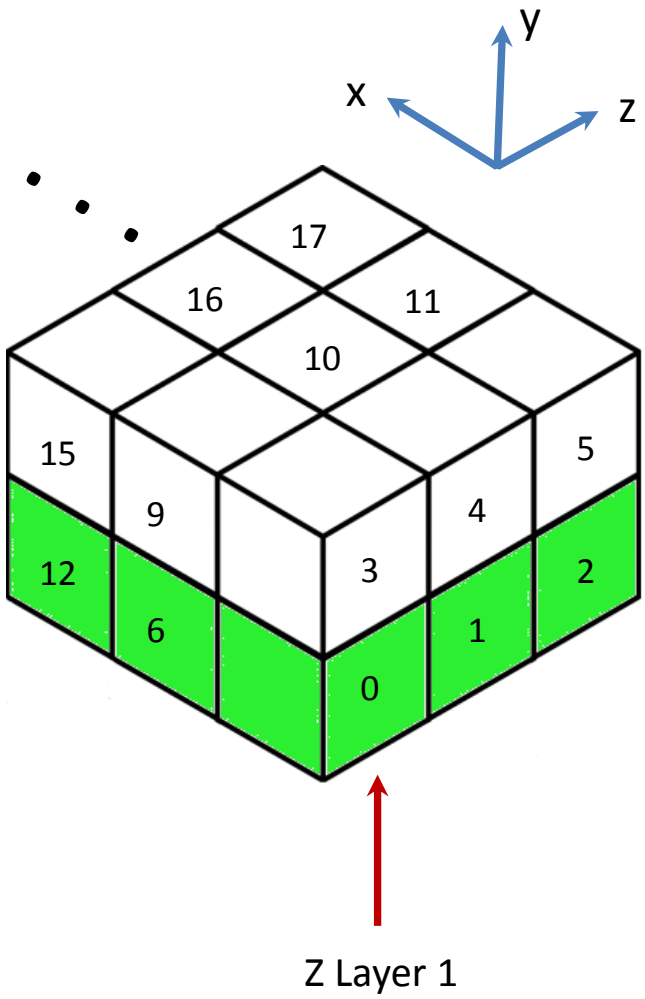




Neutron Dose rate in HRS electronics area



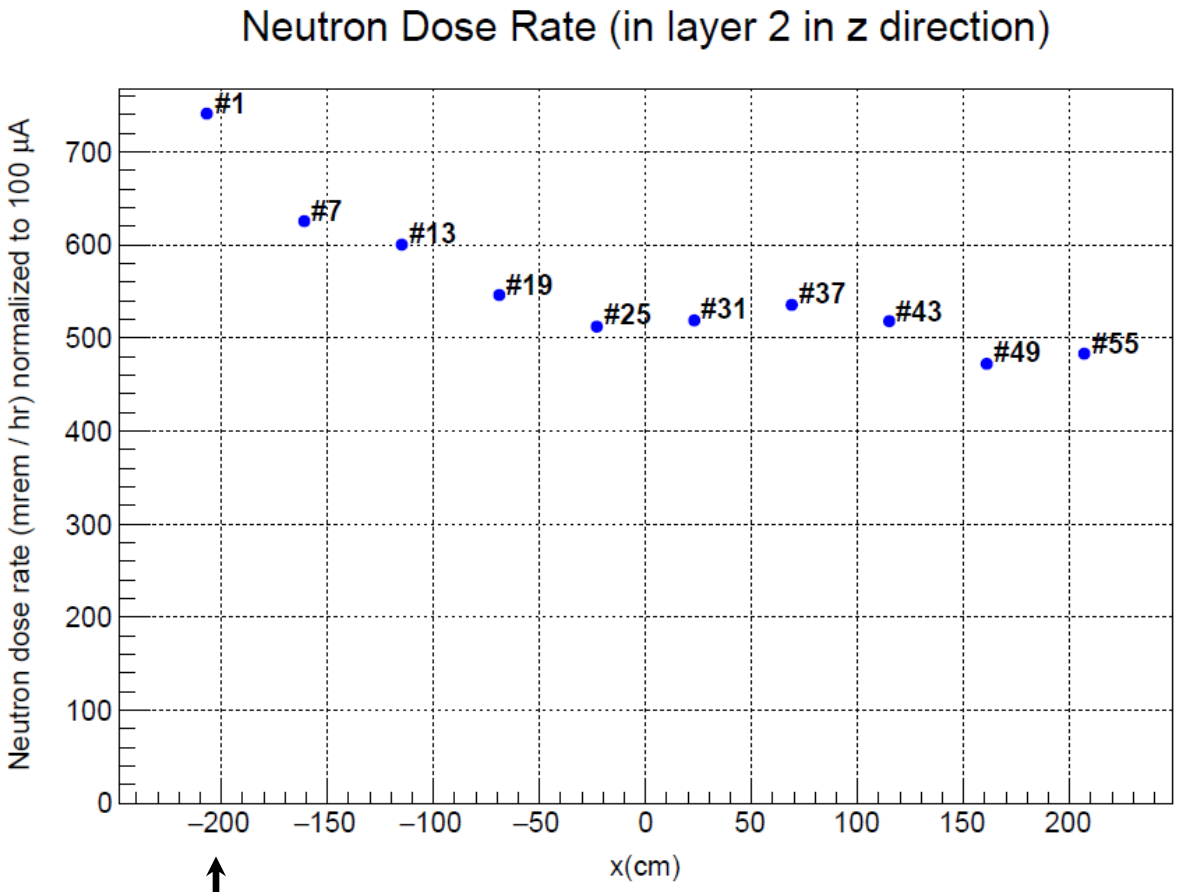
Closer to Beam line



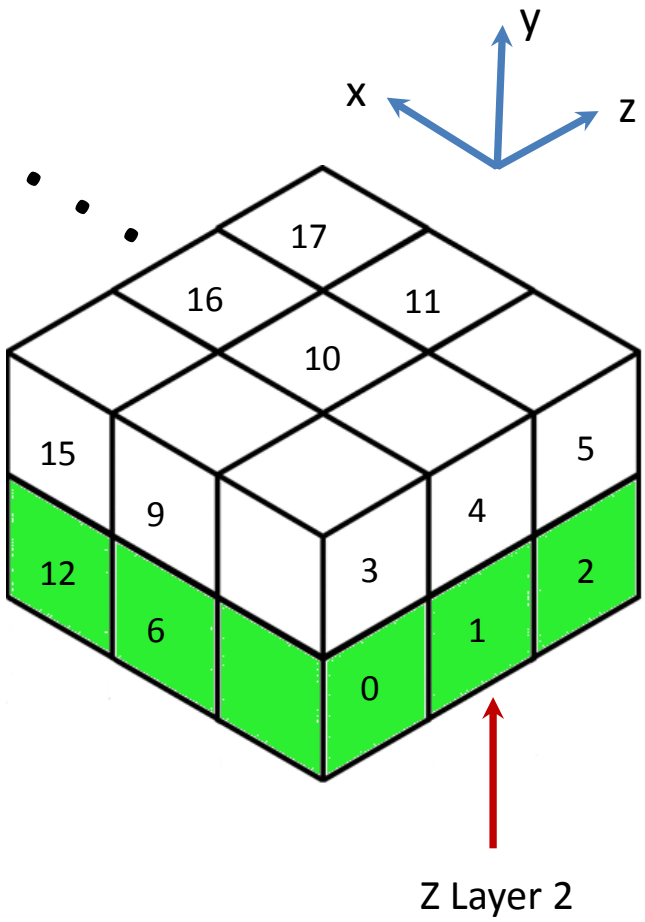
Z Layer 1

4% rad length W target
2.2 GeV beam energy

Neutron Dose rate in HRS electronics area



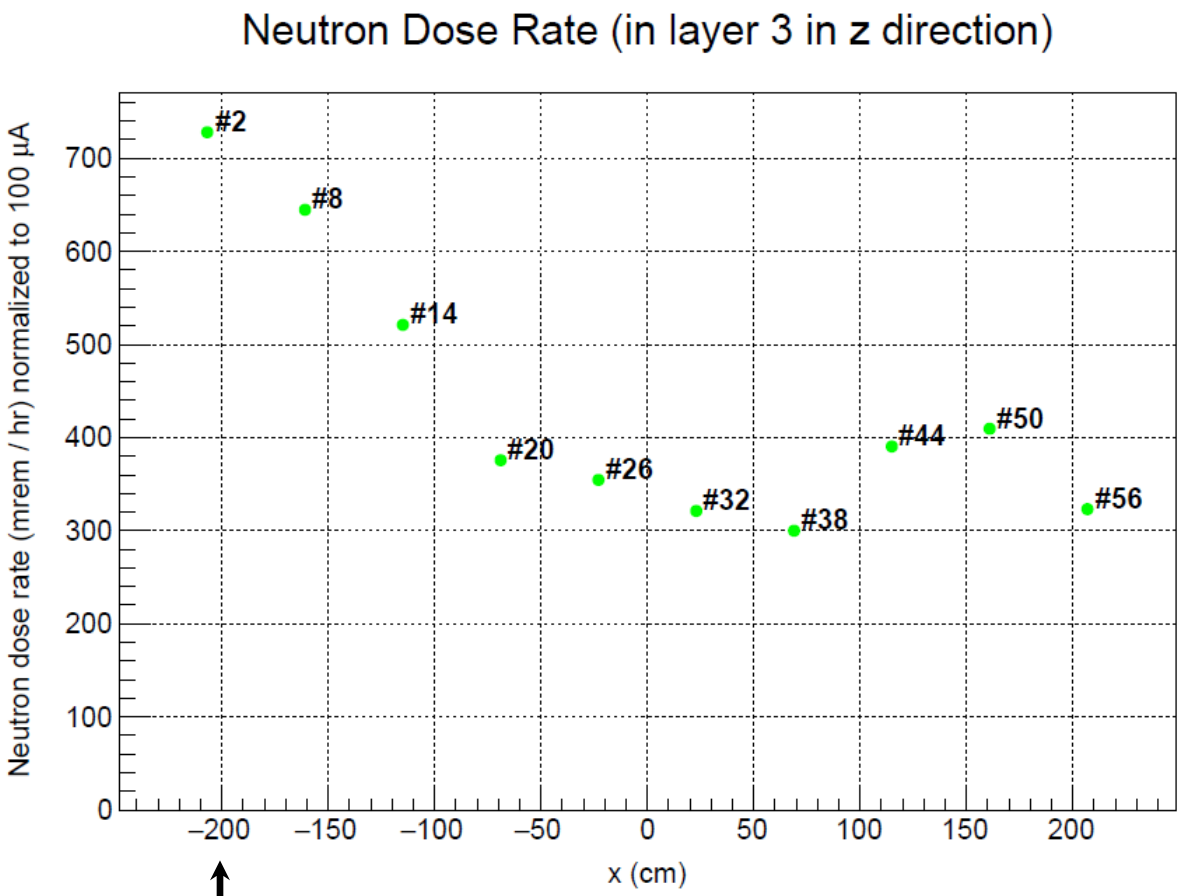
Closer to Beam line



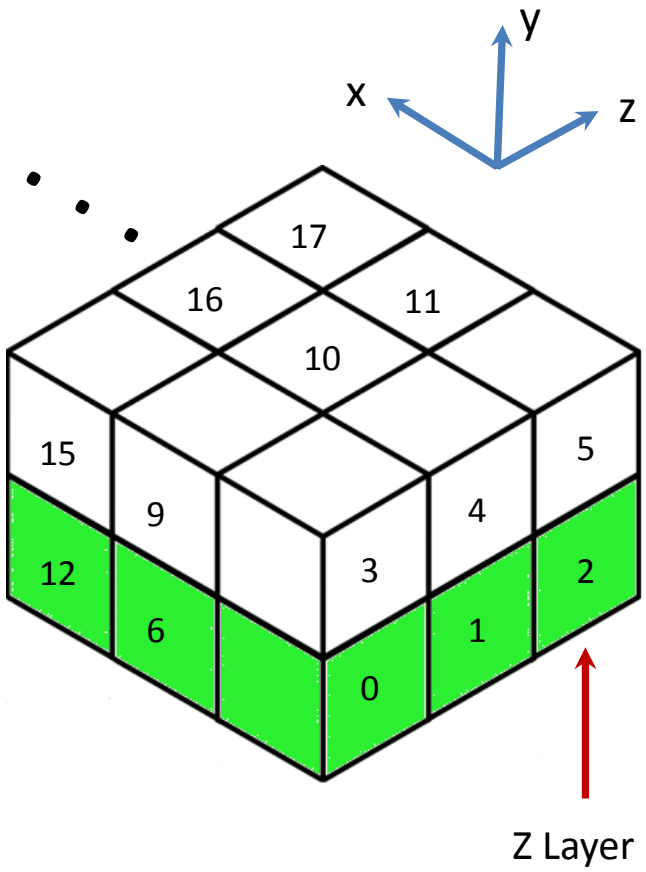
Z Layer 2

4% rad length W target
2.2 GeV beam energy

Neutron Dose rate in HRS electronics area



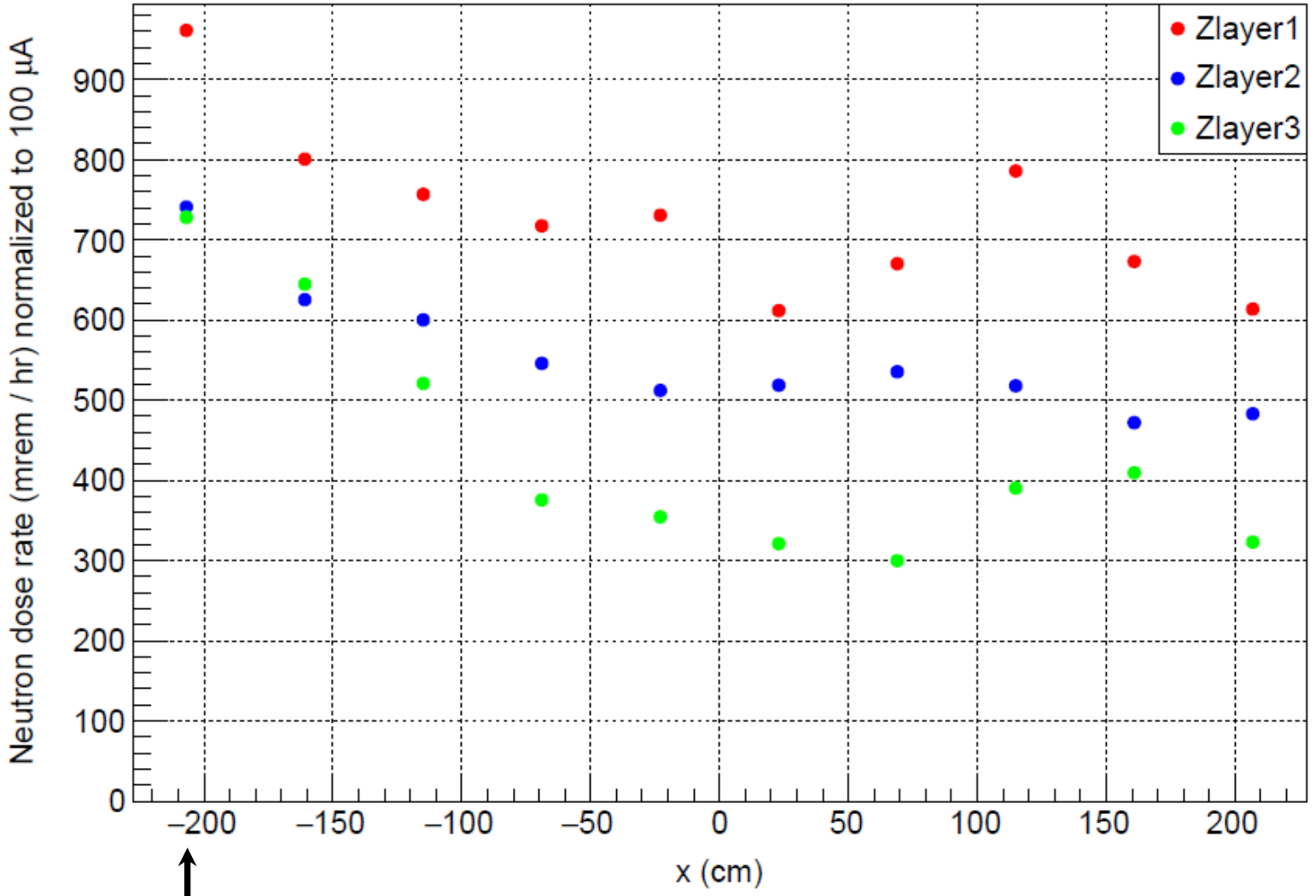
Closer to Beam line



Z Layer 3

4% rad length W target
2.2 GeV beam energy

Neutron Dose rate in HRS electronics area



Closer to Beam line

4% rad length W target
2.2 GeV beam energy