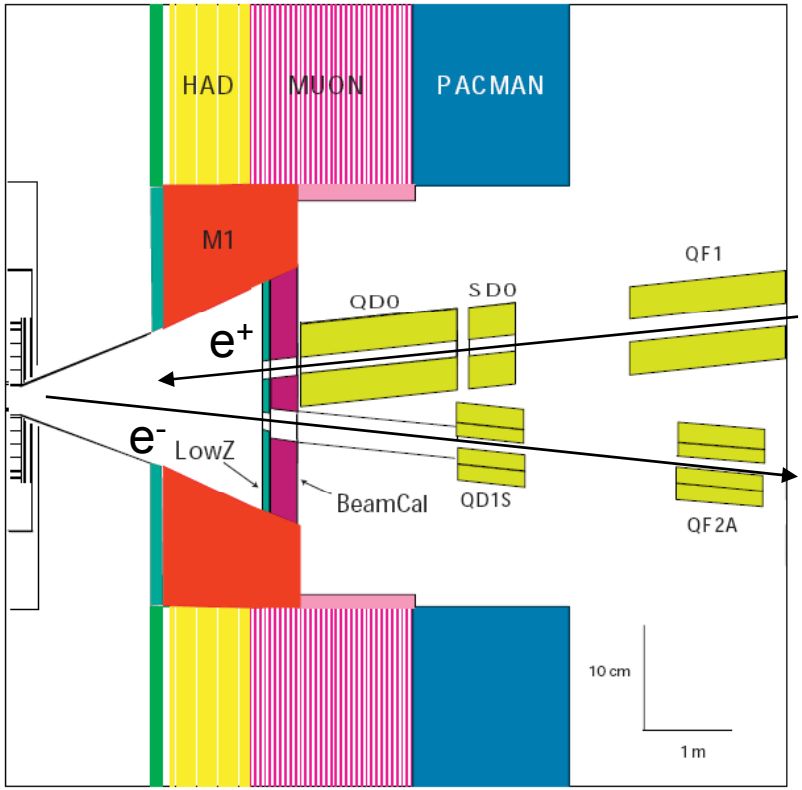
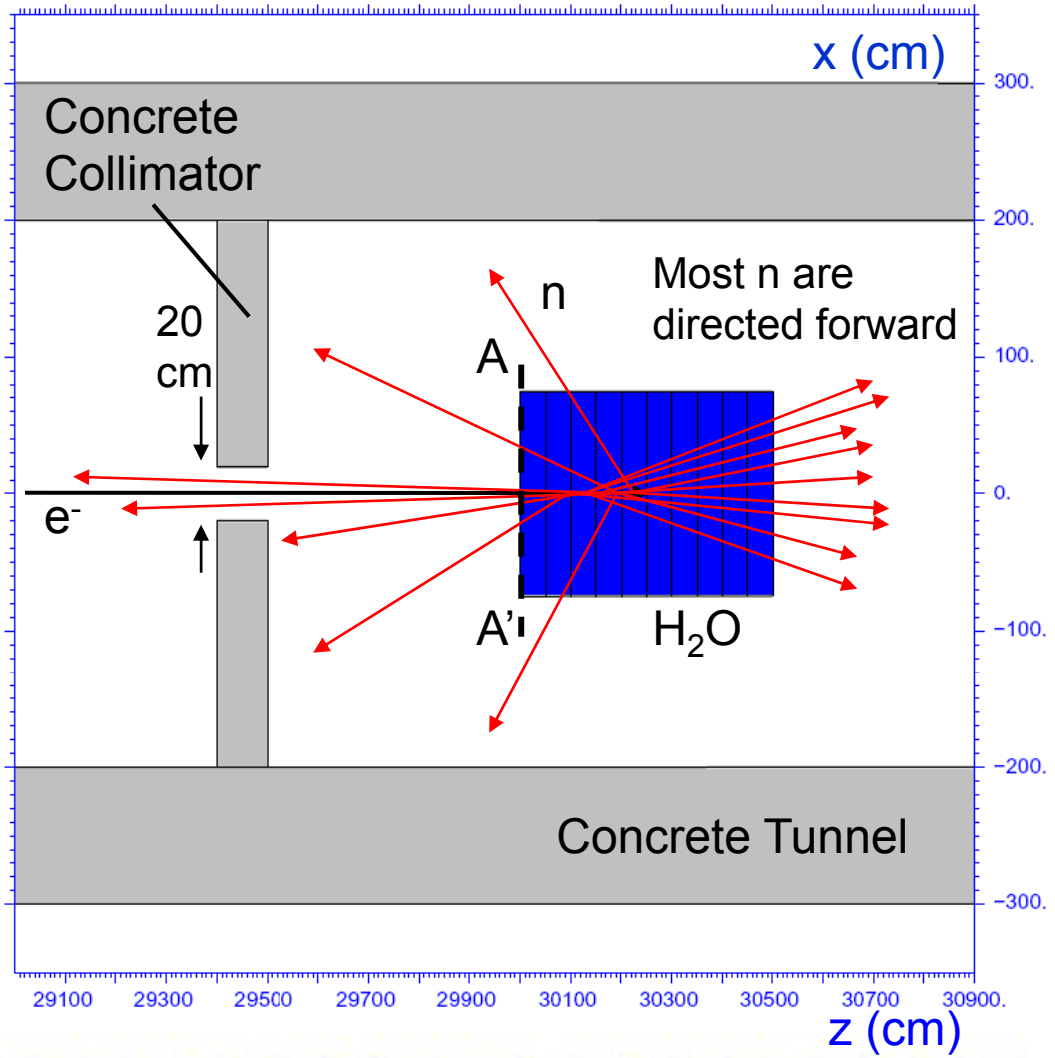
Simulation of Neutron Backgrounds in the ILC Extraction Line Beam Dump

Siva Darbha

Supervisors: Lewis Keller and Takashi Maruyama

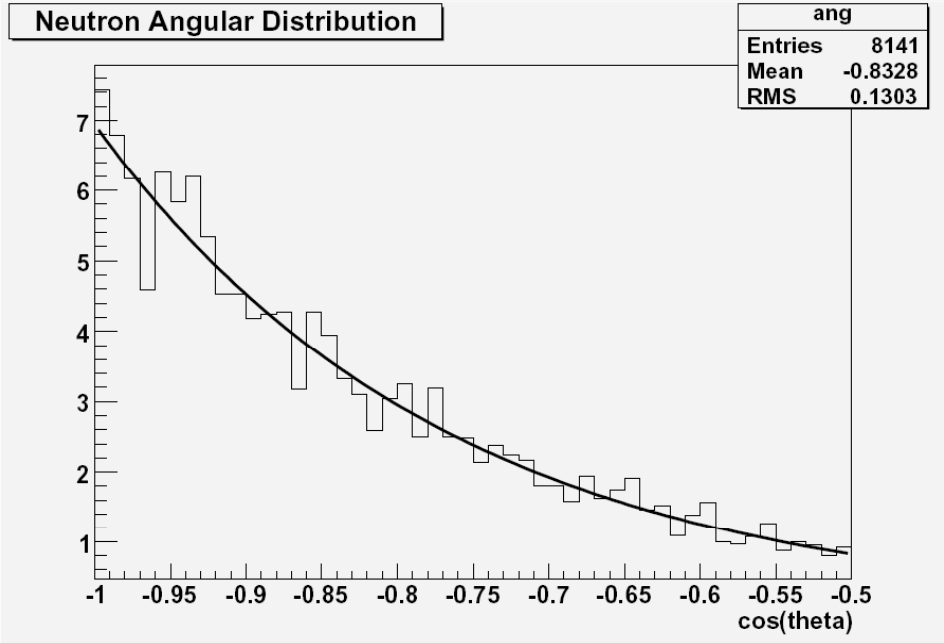
Extraction Line and Water Dump





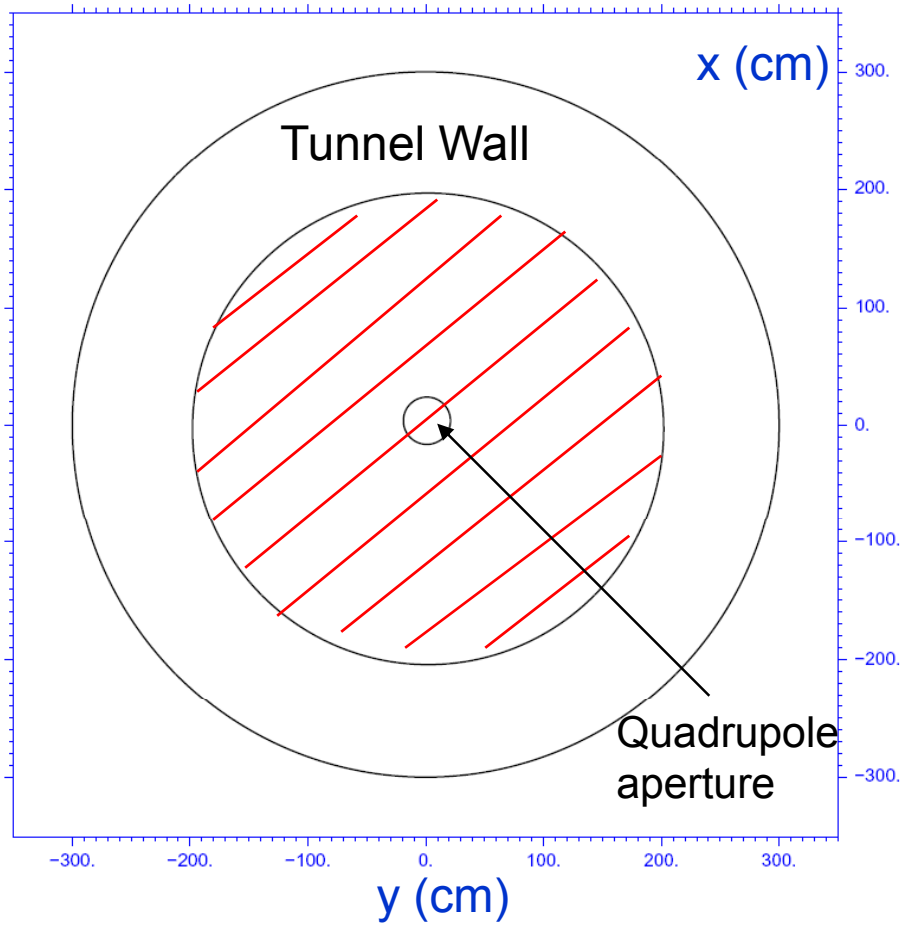
FLUKA was used for all simulations, ROOT for analysis and some particle generation

Fluence at IP



At A-A' (on the surface of the dump)

- Flux was treated as isotropic from $-1 < \cos\theta < -0.99$
- Flux for 1.5 cm radius scoring plane at z=0 was found from flux in 2 m radius scoring plane



Scoring plane at z=0

Particle Biasing

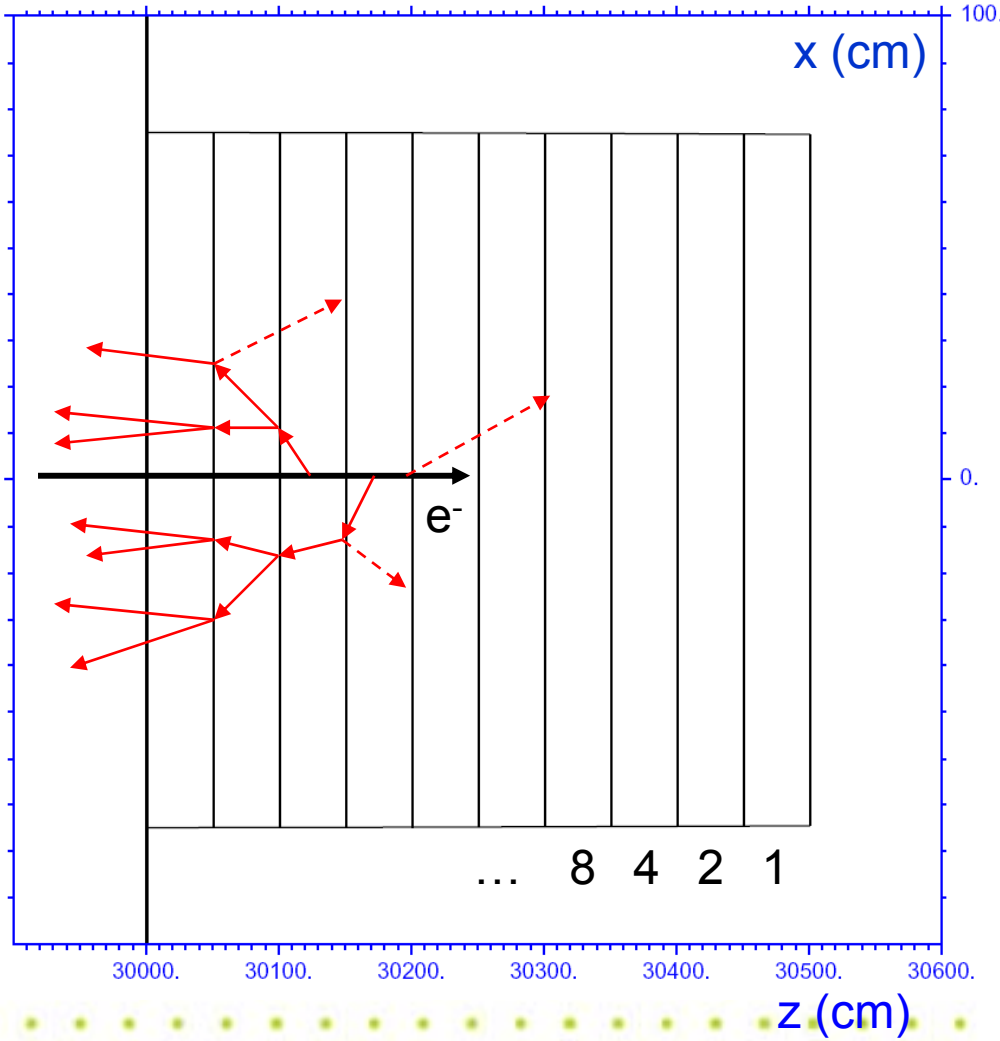
- Three types of biasing were used:
  1. Leading particle biasing
     - simulating a full EM shower requires long CPU time
     - to save time, take only the most energetic secondary and remove all others
     - applied to e^+,e^-, and γ's < 2.5 GeV
  2. Photonuclear interaction length

     $\gamma A \rightarrow n + X$ $\quad (\sigma, \ell)$

     - #n produced proportional to $\ell\sigma$
     - σ was increased by a factor of 50
     - 'weight' associated with each n produced from this was decreased by a factor of 50 to compensate

Particle Biasing (continued)

3. Splitting/Russian roulette
   - Dump divided into 10 regions
   - Each region given a factor of 2 larger importance
   - As e^+, e^-, or γ crosses a boundary, their number is increased or decreased on average by the ratio of importances on either side of the boundary
   - 'weight' is adjusted accordingly



Computation Time

6000 incident e^-			n total 'weight'		n total number	
Run #	Type of Bias	CPU time	At z=300m	At z=0	At z=300m	At z=0
1	None	23 h 35 min	82	2	82	2
2	LPB	1 h 36 min	102.9	0	87	0
3	Interaction length	6 h 46 min	103.4	0.7813	5008	49
4	Splitting/RR	6 h 22 min	96.40	1.085	16619	117

Fluence at IP

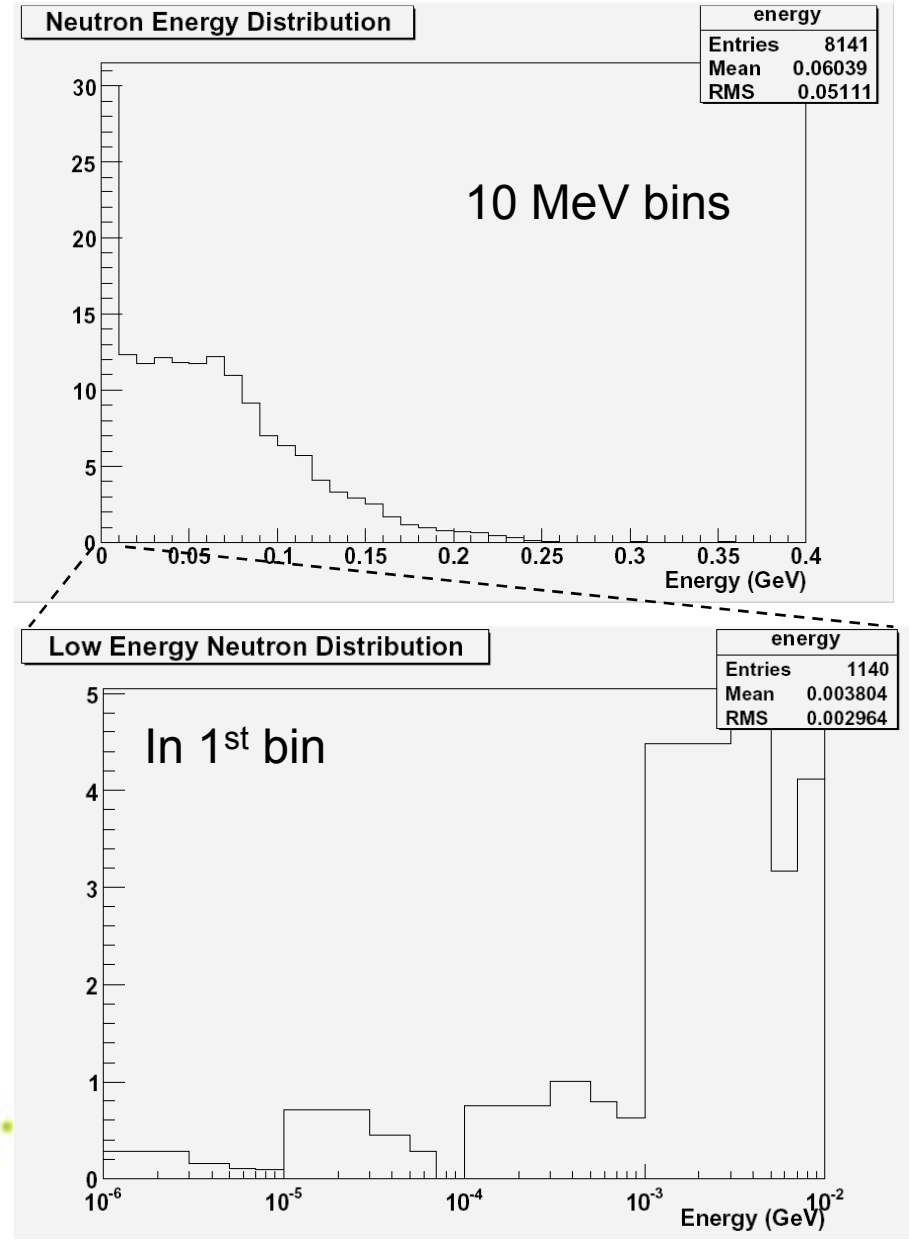
	n's/cm^2/year at IP (z=0)	
	Mean (10 runs)	RMS
No tunnel or collimator	$8.33*10^{10}$	$1.50*10^{10}$
Collimator	$3.73*10^{10}$	$3.34*10^{10}$
Tunnel and Collimator	$3.65*10^{10}$	$2.34*10^{10}$

10^{10} n/cm^2 at the VXD would cause displacement damage to CCD Si detectors

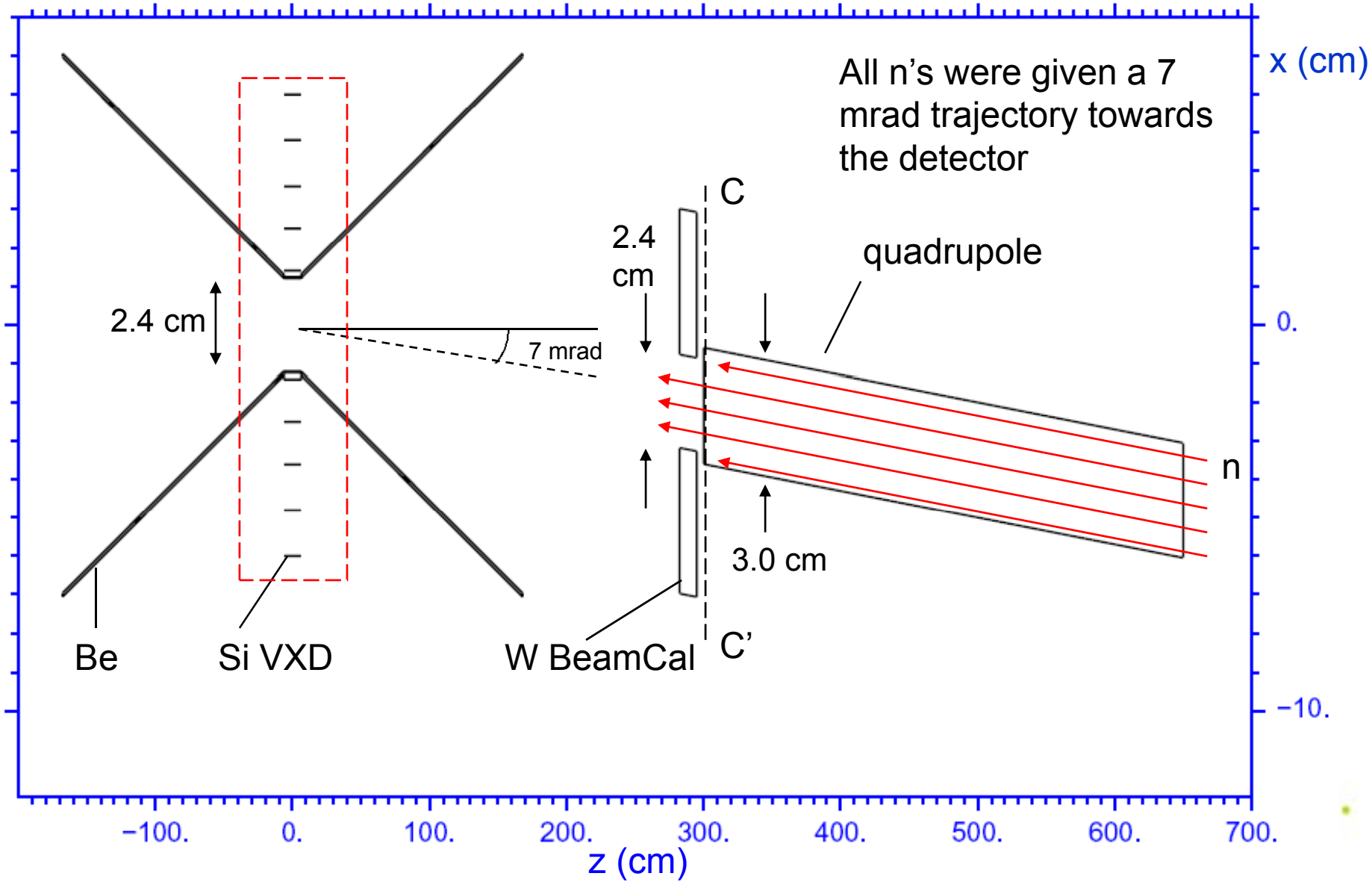
However, not all neutrons that reach the IP will hit the inner detector

Neutron Energy Distribution

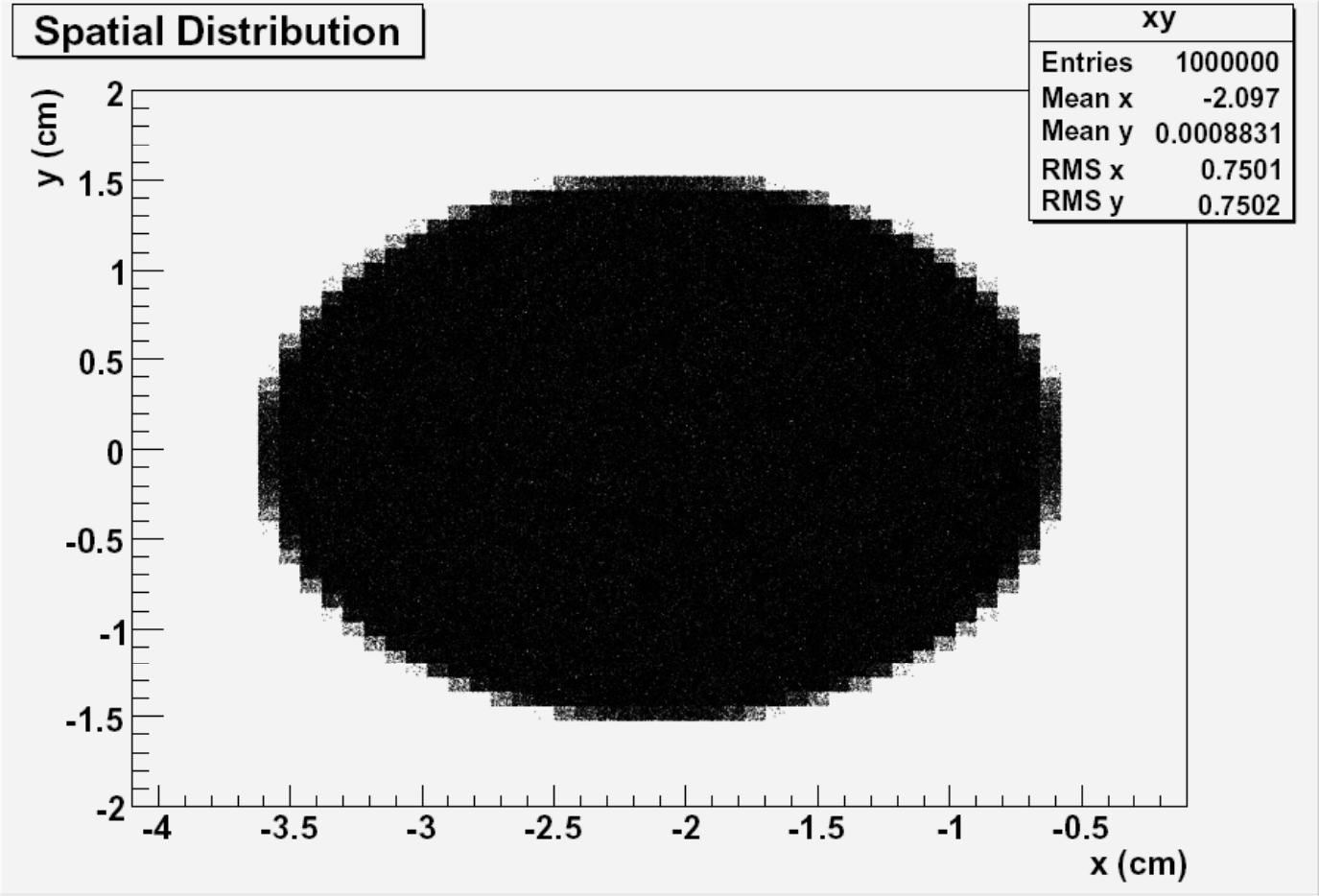
- Information was gathered on the neutron distribution in the backward direction and was used to generate 10^6 neutrons to study the real flux at the VXD



Detector


All n's were given a 7 mrad trajectory towards the detector
x (cm)
z (cm)
2.4 cm
7 mrad
C
2.4 cm
quadrupole
n
3.0 cm
C'
Be
Si VXD
W BeamCal
0.
−10.
−100.
0.
100.
200.
300.
400.
500.
600.
700.

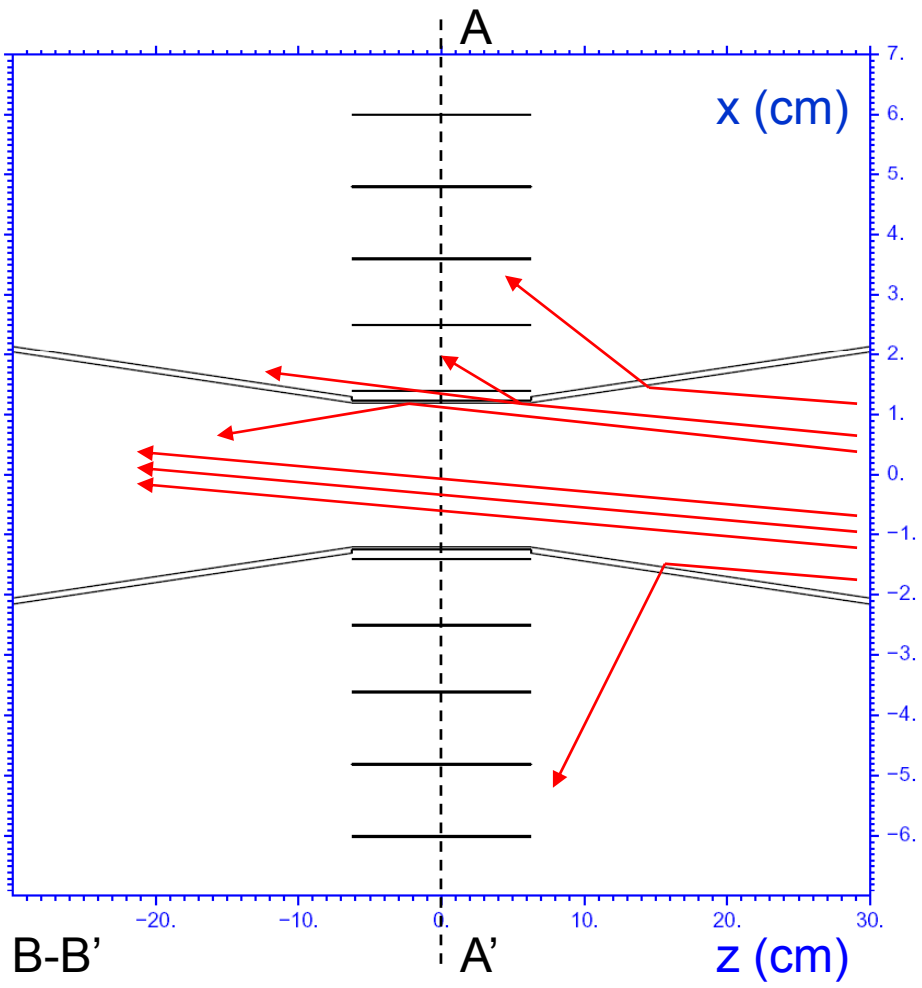
Initial position of n's

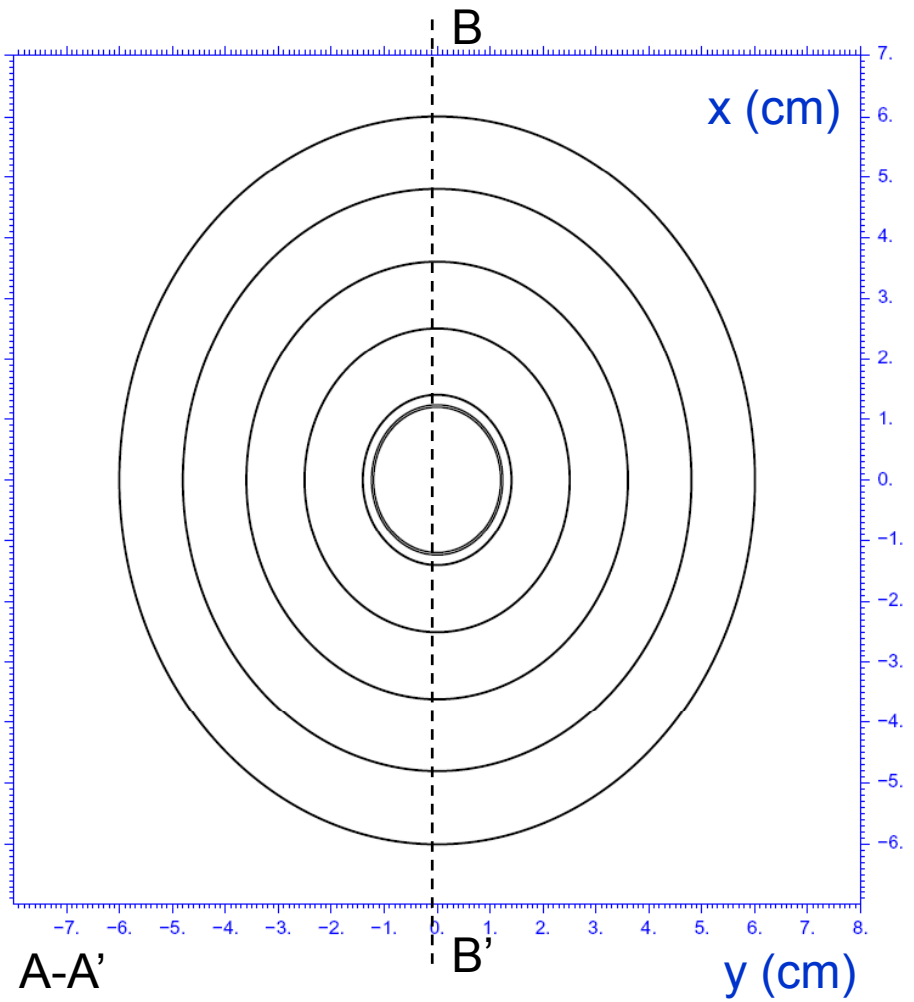


- n's randomly and uniformly distributed within the quadrupole bore

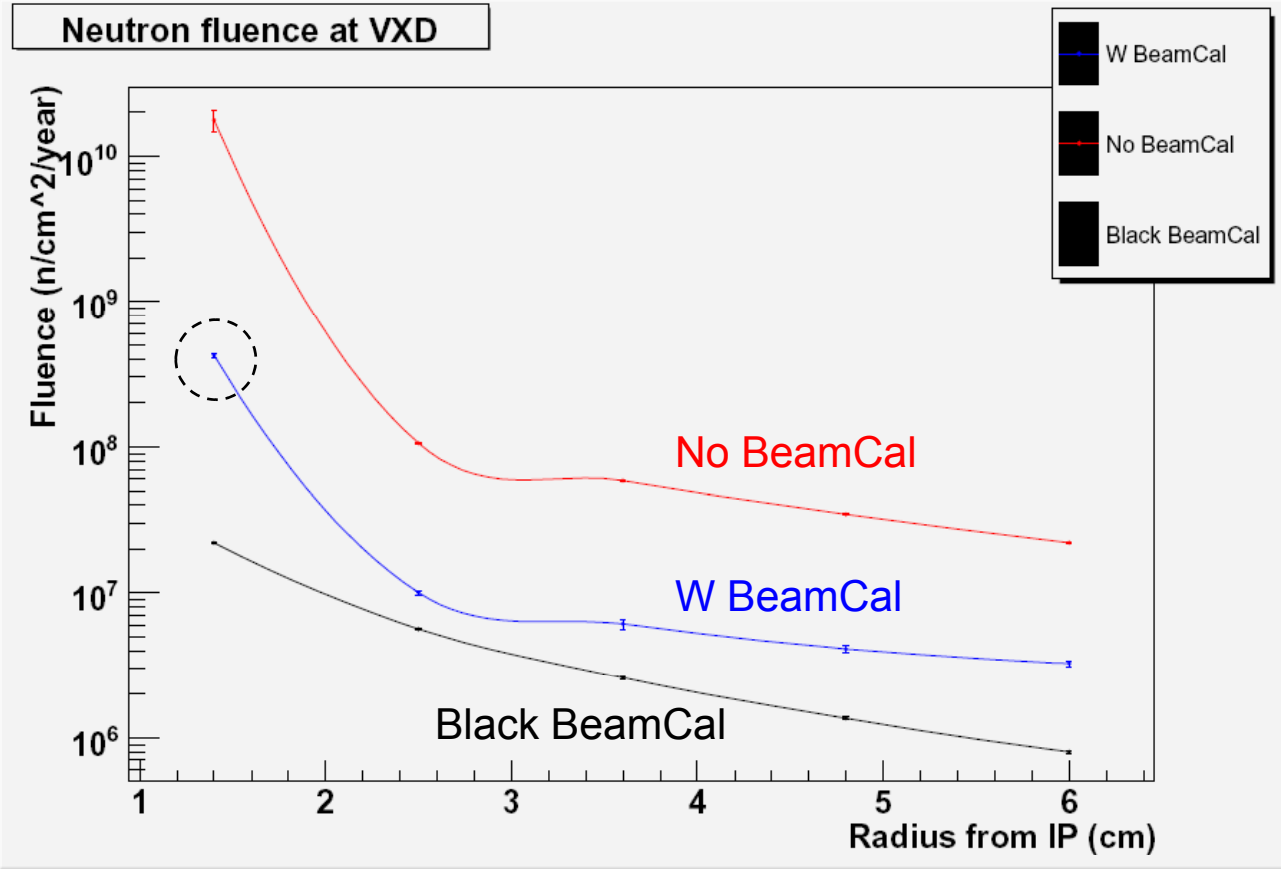
C-C'

CCD Si VXD with Be beampipe





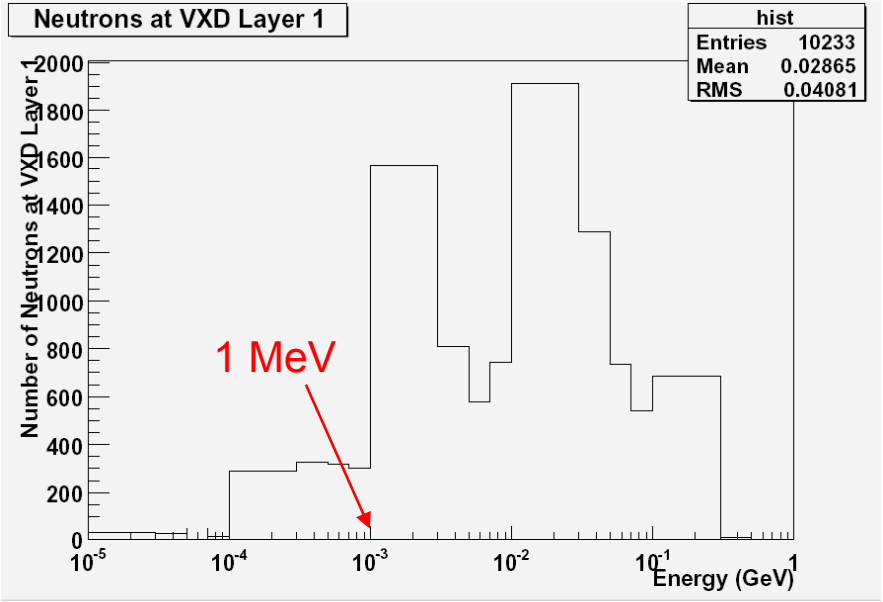
Results: Fluence at VXD

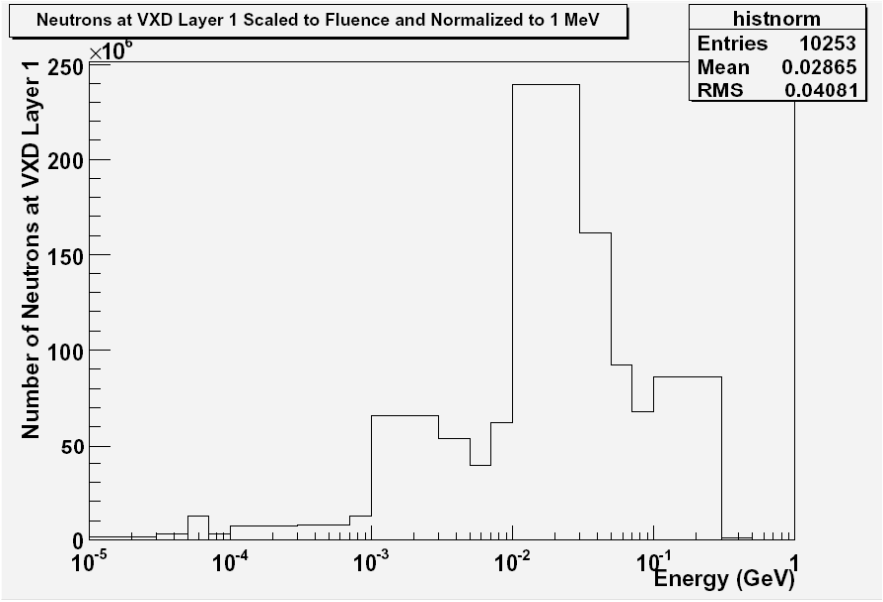


- The BeamCal acts as a collimator for neutron backscattering from dump

- With the W BeamCal, the nominal fluence at Layer 1 of VXD is: $4.277*10^8$ n/cm^2/year

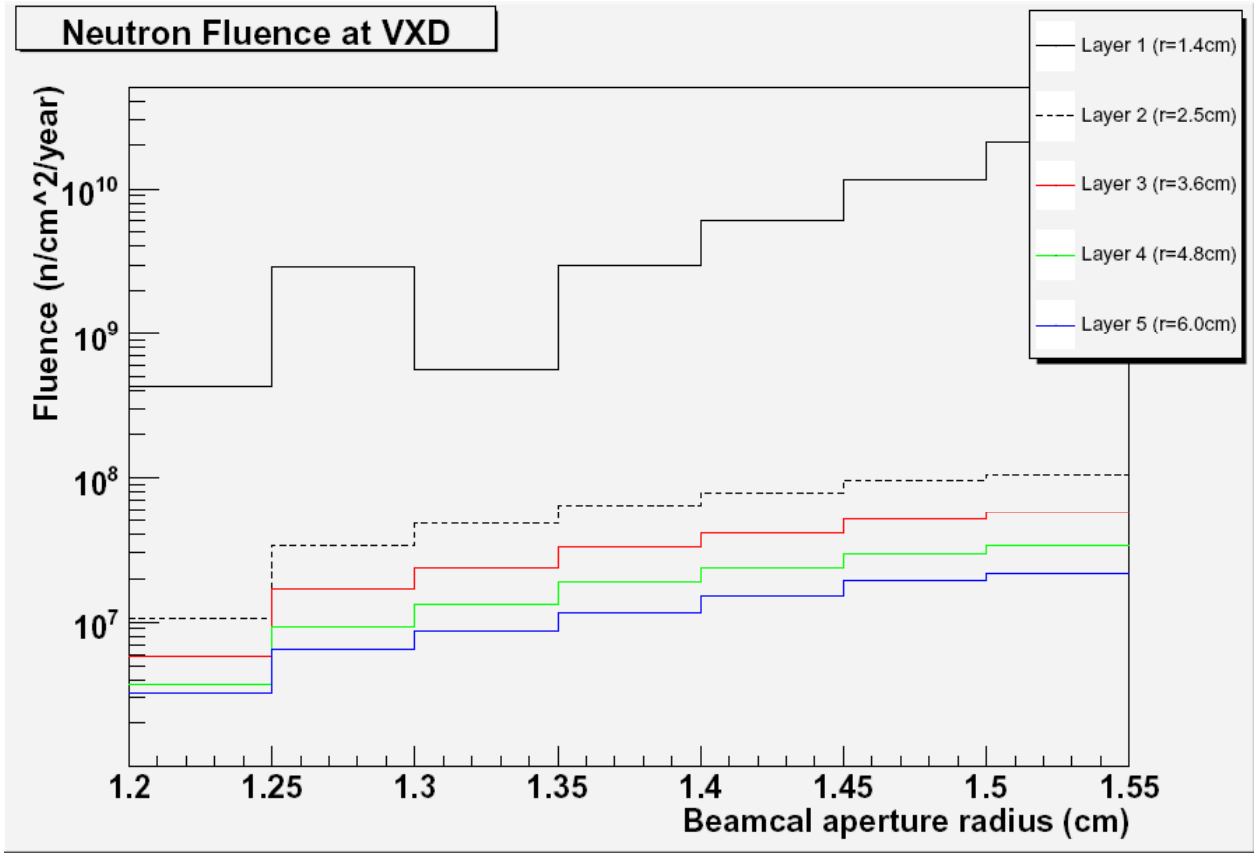
1 MeV Neutron Equivalent Fluence



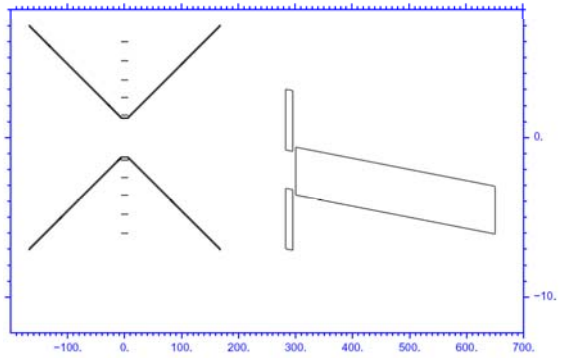


- However, the amount of displacement damage done to CCD Si detector by neutrons is a function of neutron energy
- When relative damage to Si is considered, normalized to 1 MeV, the fluence is: $9.265*10^8$ n/cm^2/year
- A value of 10^{10} n/cm^2 would damage the CCD Si detector by this measure
- The other fluences calculated in this study can be normalized similarly

BeamCal Radius Dependence



- Values are not normalized to 1 MeV equivalent fluence



Acknowledgements

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