A pilot study on the possibility of RadICAL in in-vivo range verification and neutron detection in proton therapy

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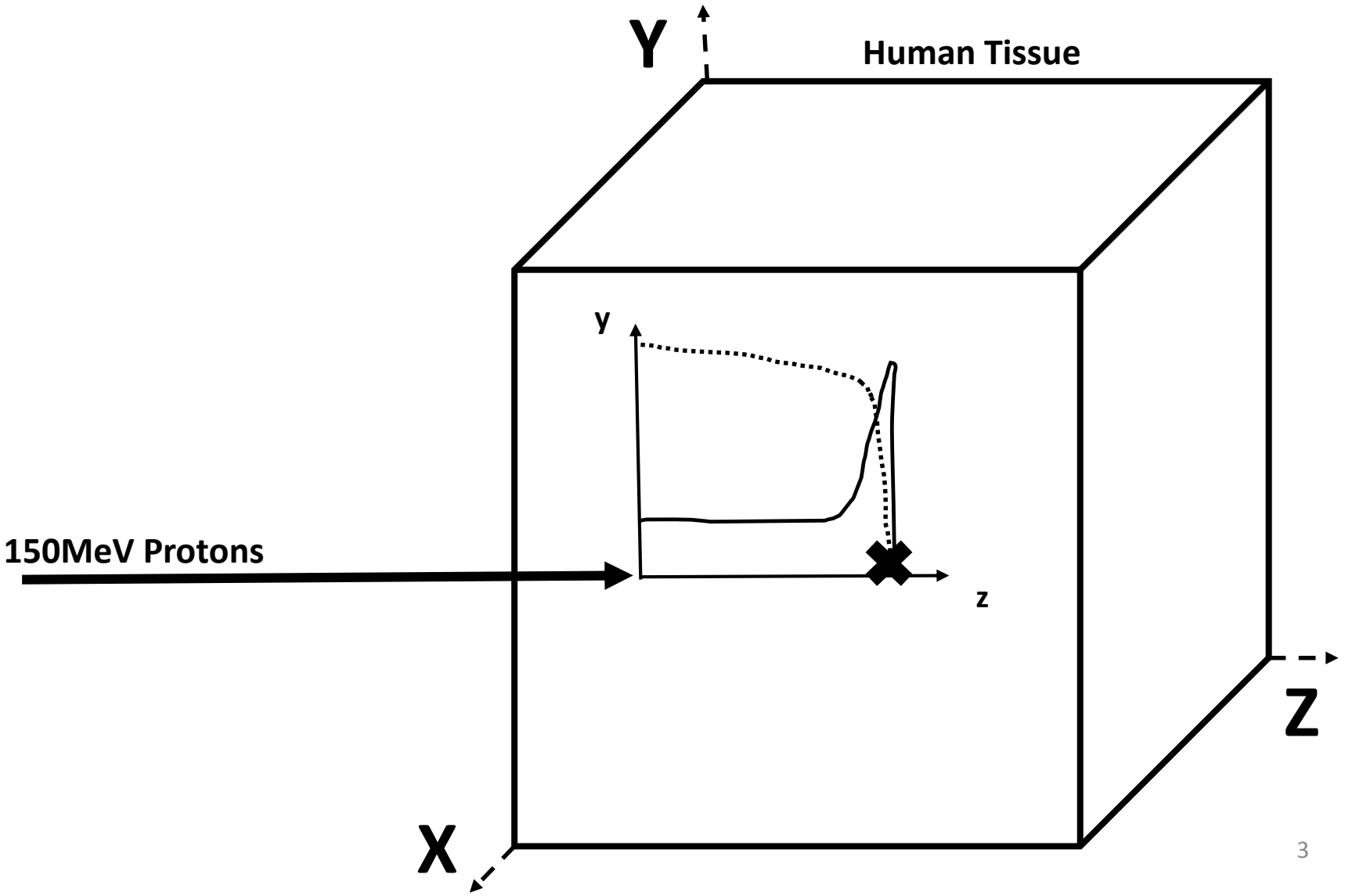
Outline

- Motivation
- Part1: RadICAL Measurement with Cs 137
- Part2: Geant4 Simulation for secondary neutrons
- Conclusion

Motivation



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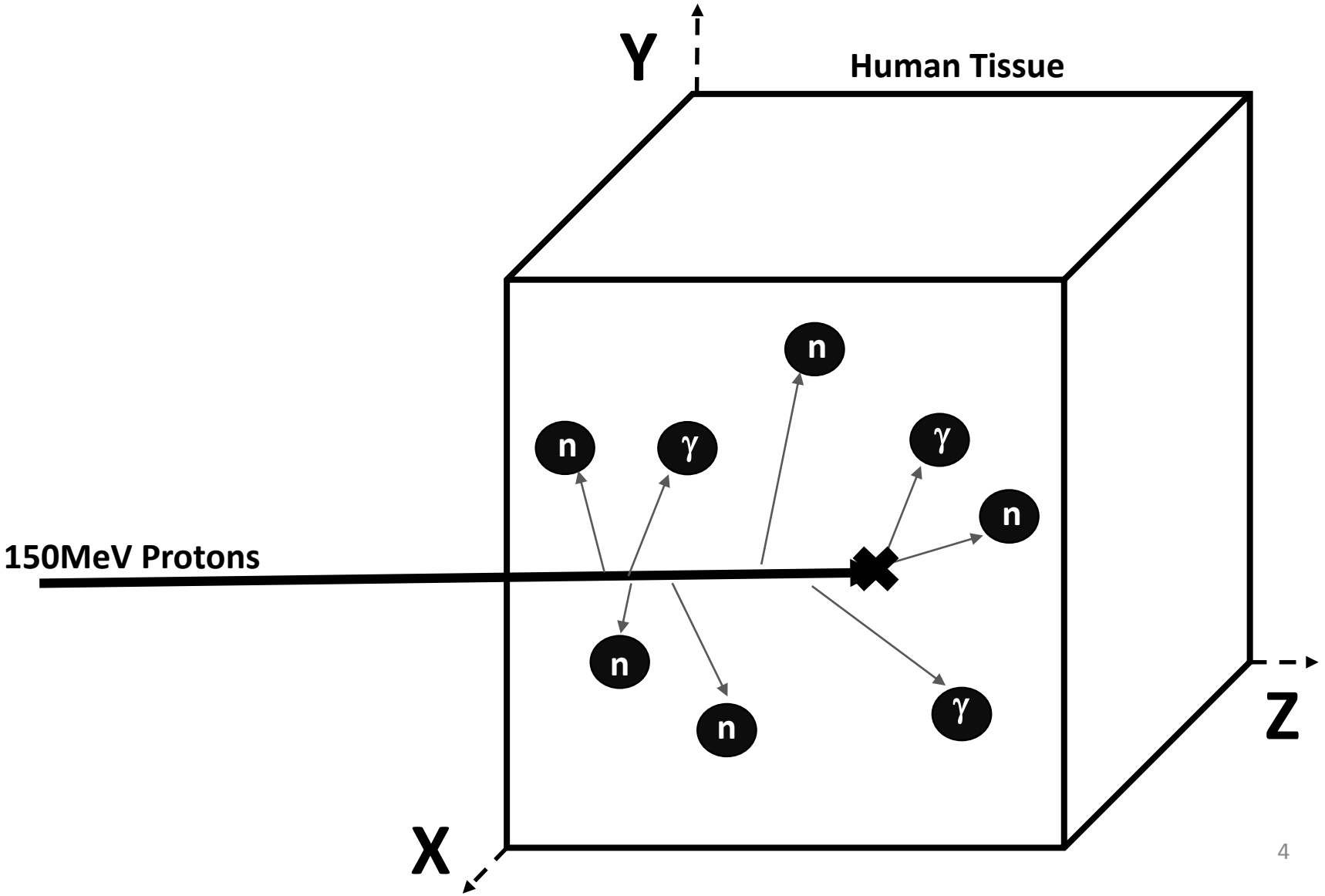

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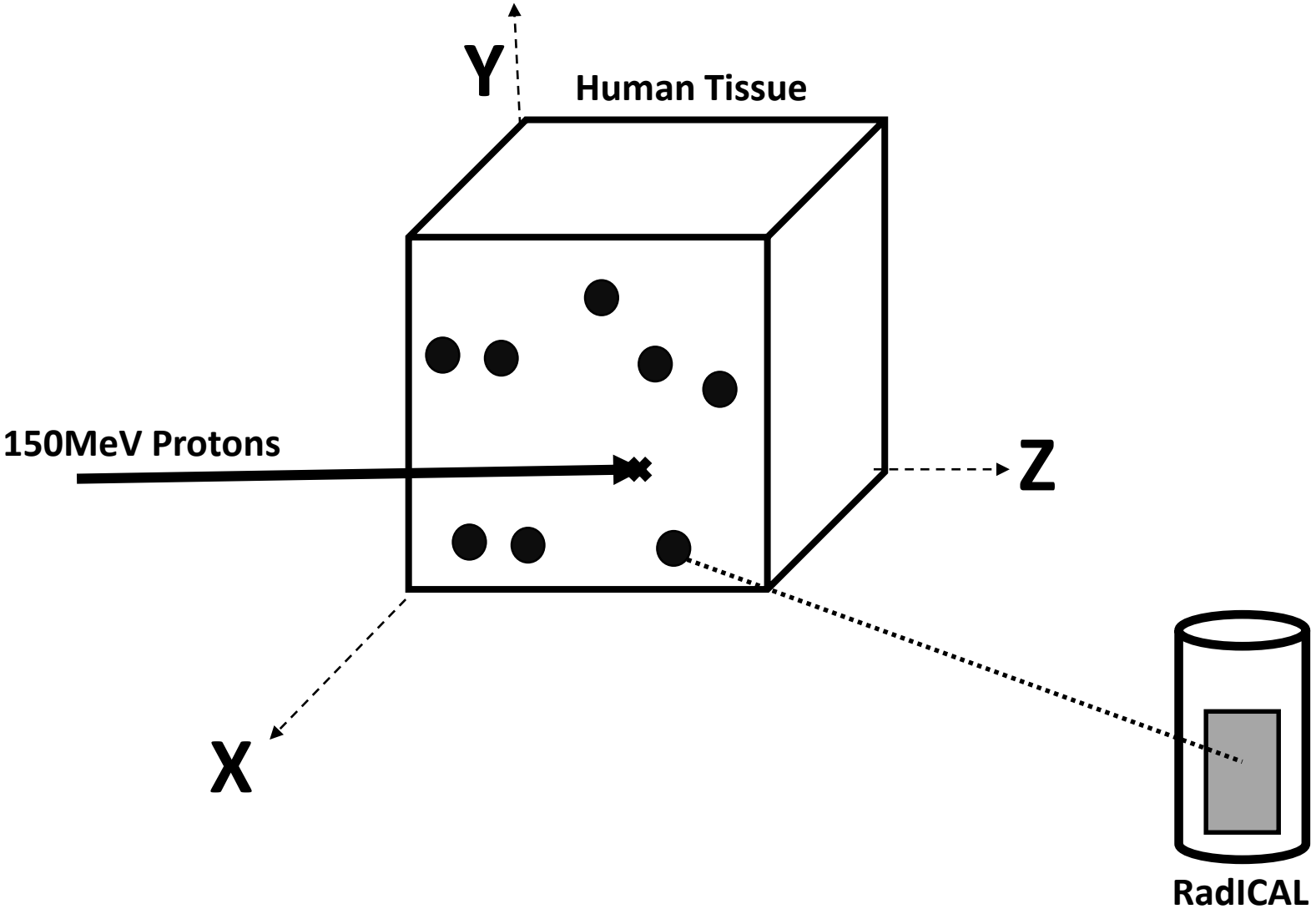
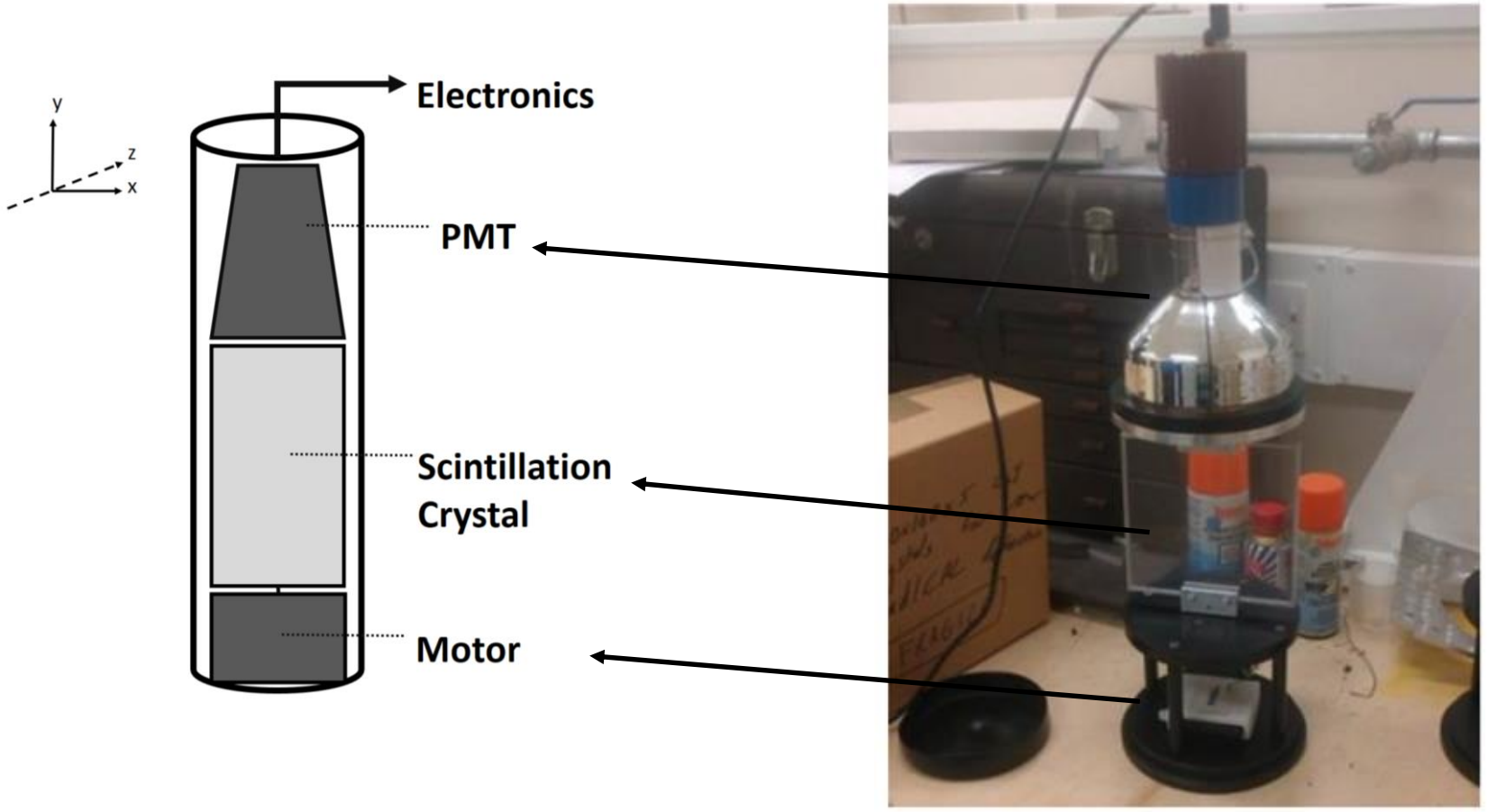


Part 1: RadICAL Measurement

RadICAL = Radiation Imaging Cylinder Activity Locator



(Randall et al., 2014)

RANDALL, G. L., IGLESIS, E., WONG, H. F. & SPELLER, R. S. 2014. A method of providing directionality for ionising radiation detectors - RadICAL. *Journal of Instrumentation,* 9.

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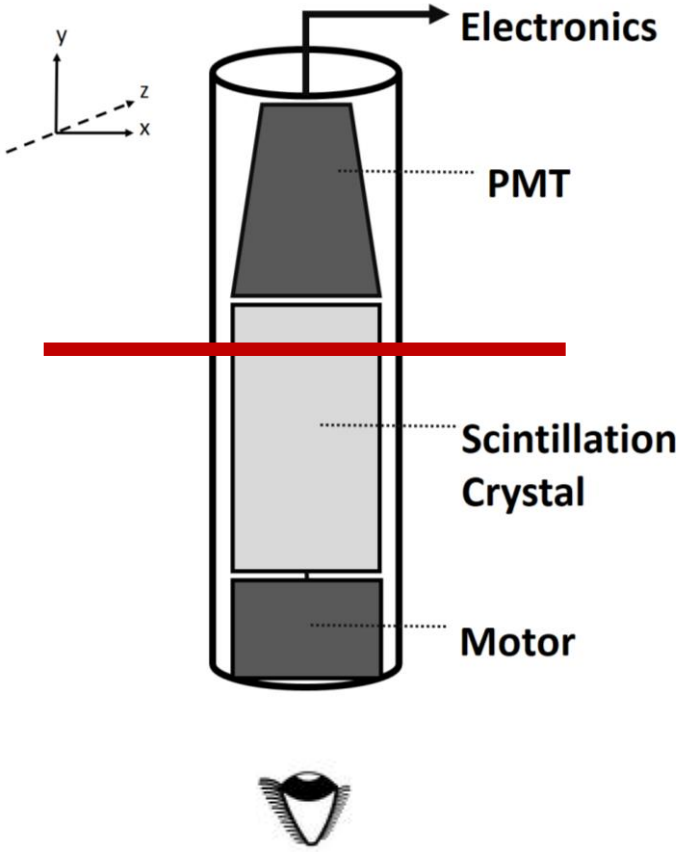

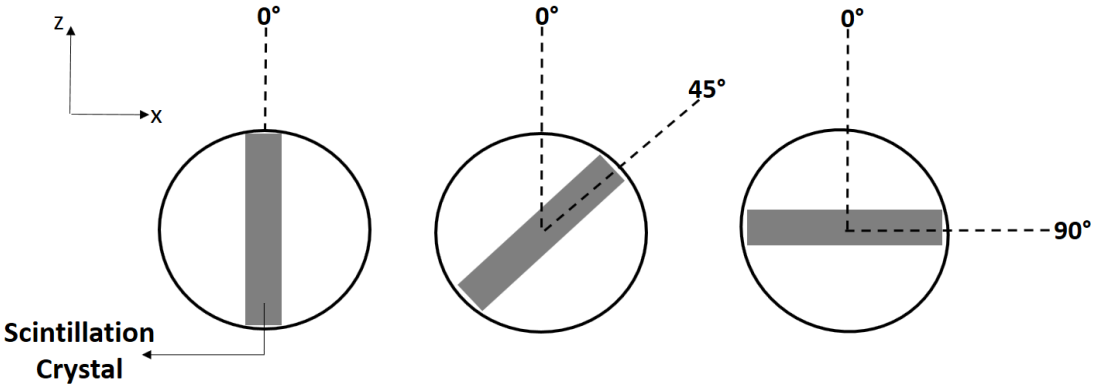

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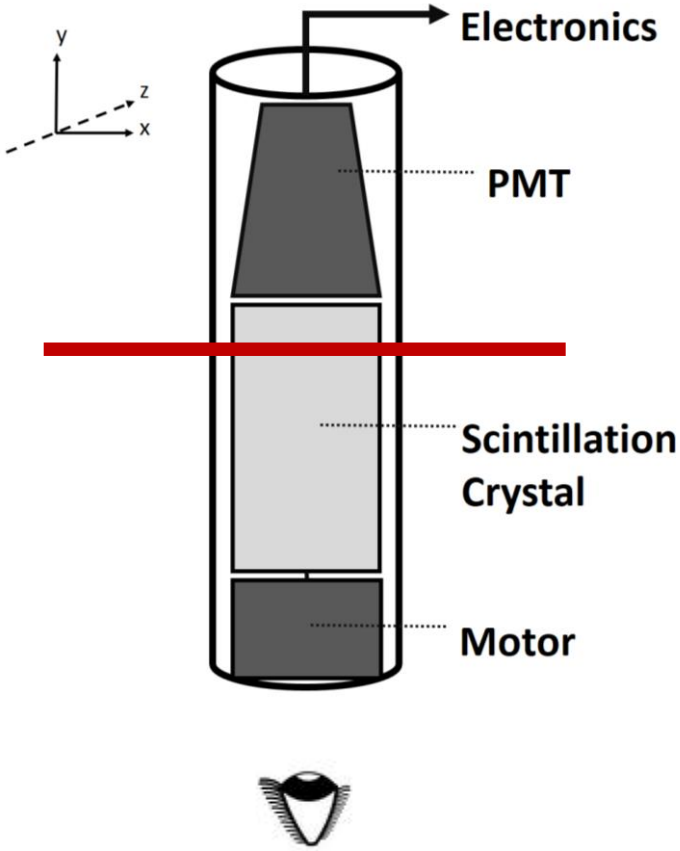

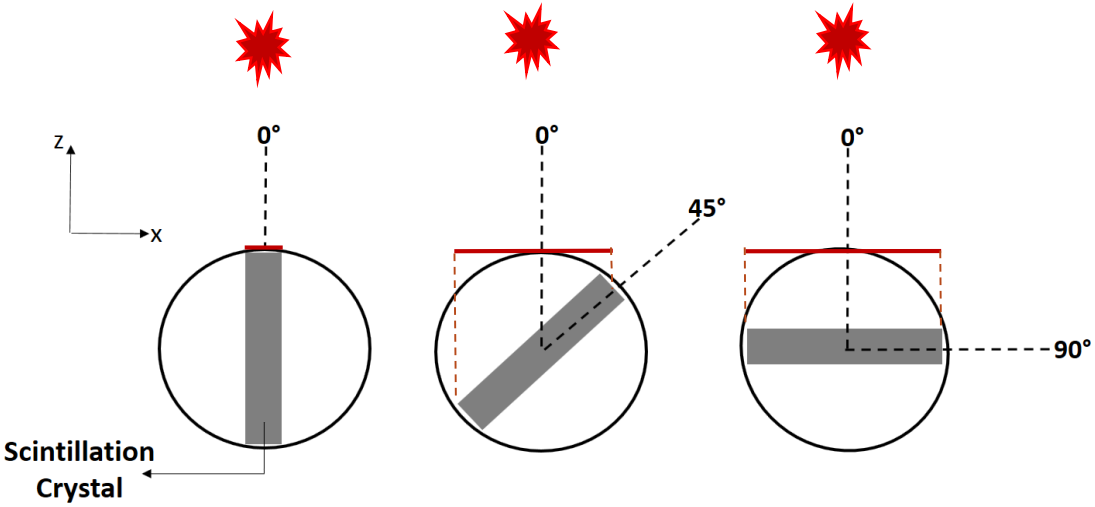

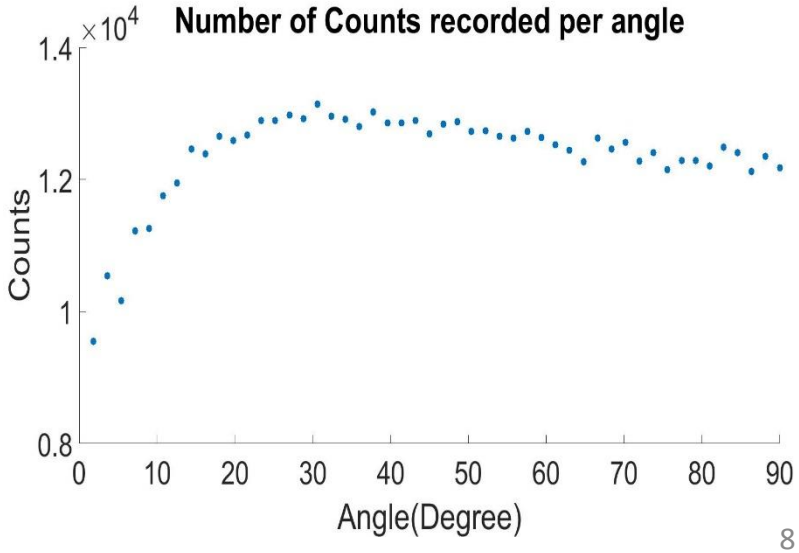

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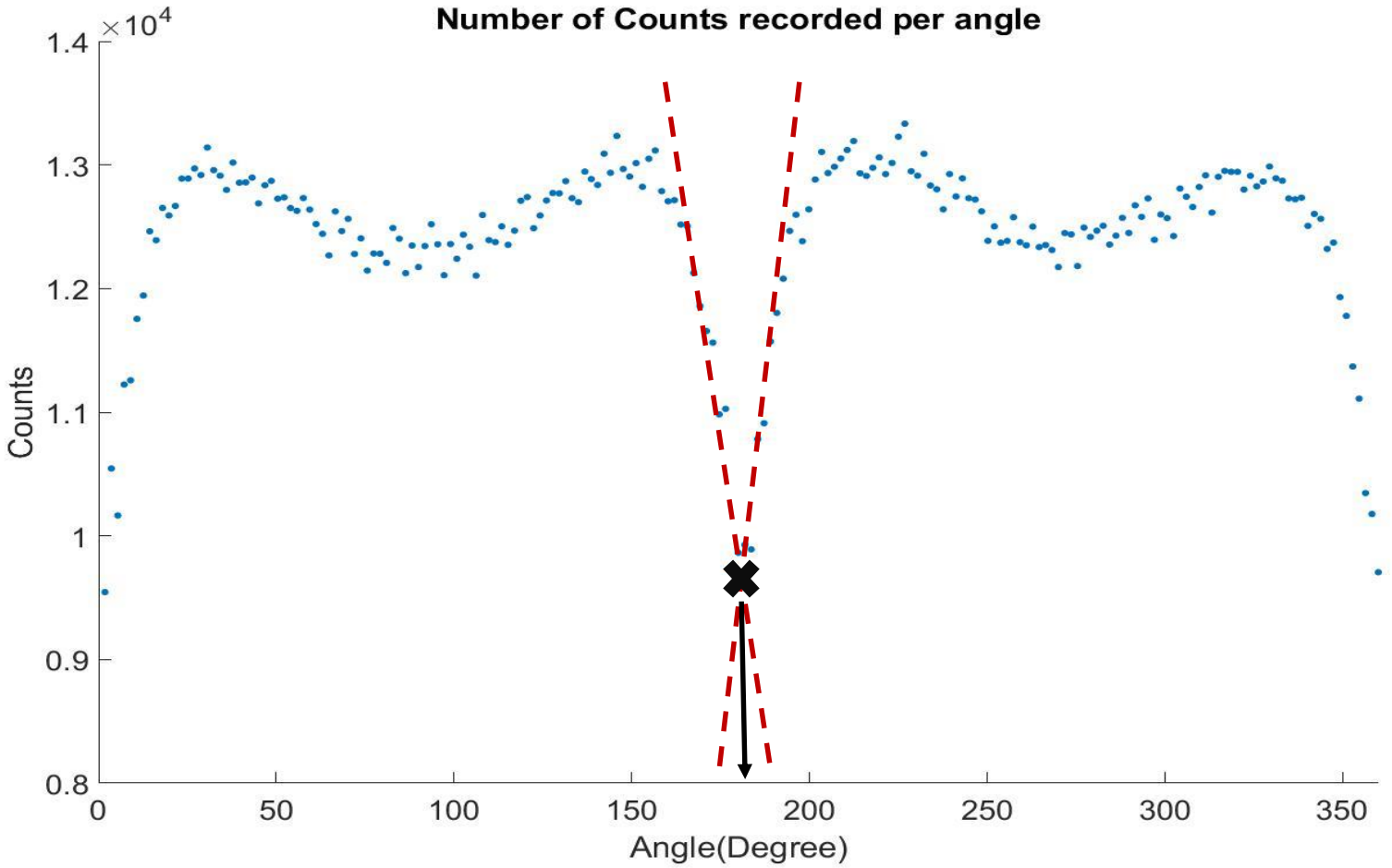
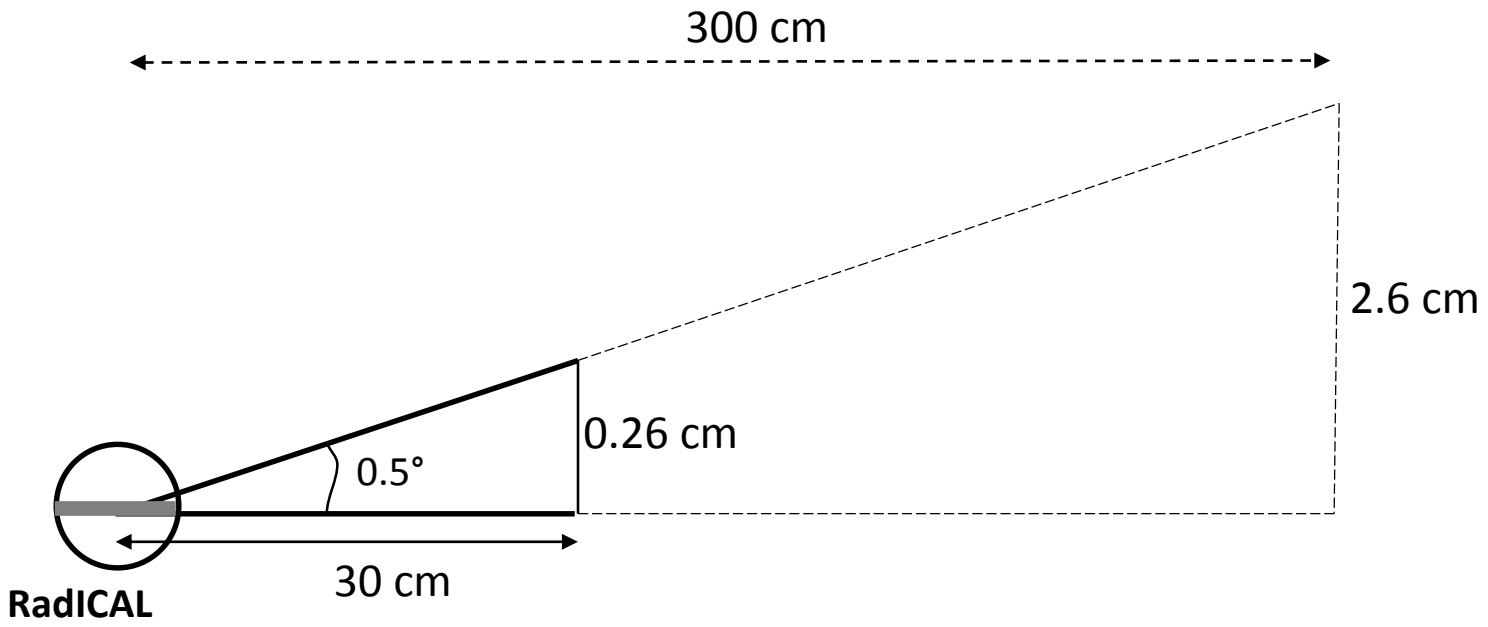
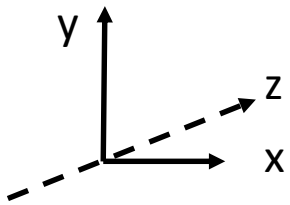


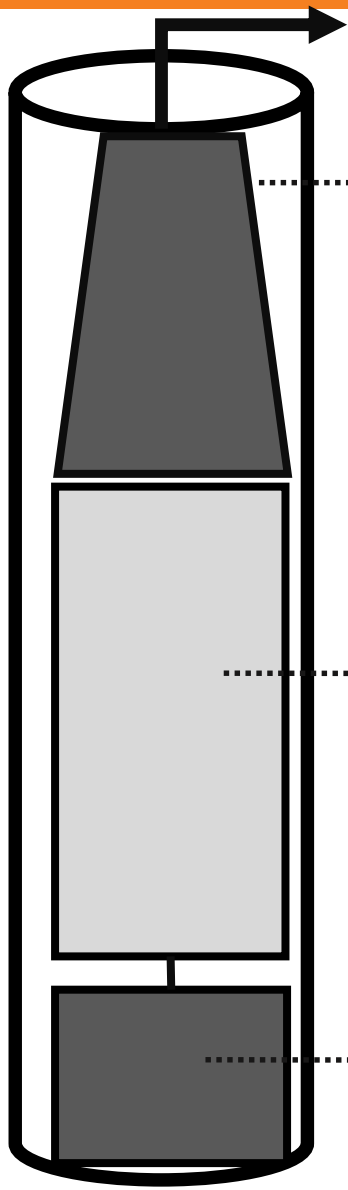
RadICAL could resolved 0.51° ± 0.01° angular difference.

Part 1: RadICAL Measurement



Potential Neutron Detection with RadICAL





Electronics

PMT

Neutrons Detection

+ Pulse Shape Discrimination technique

Organic Scintillation Crystal

Motor

Neutron Capture

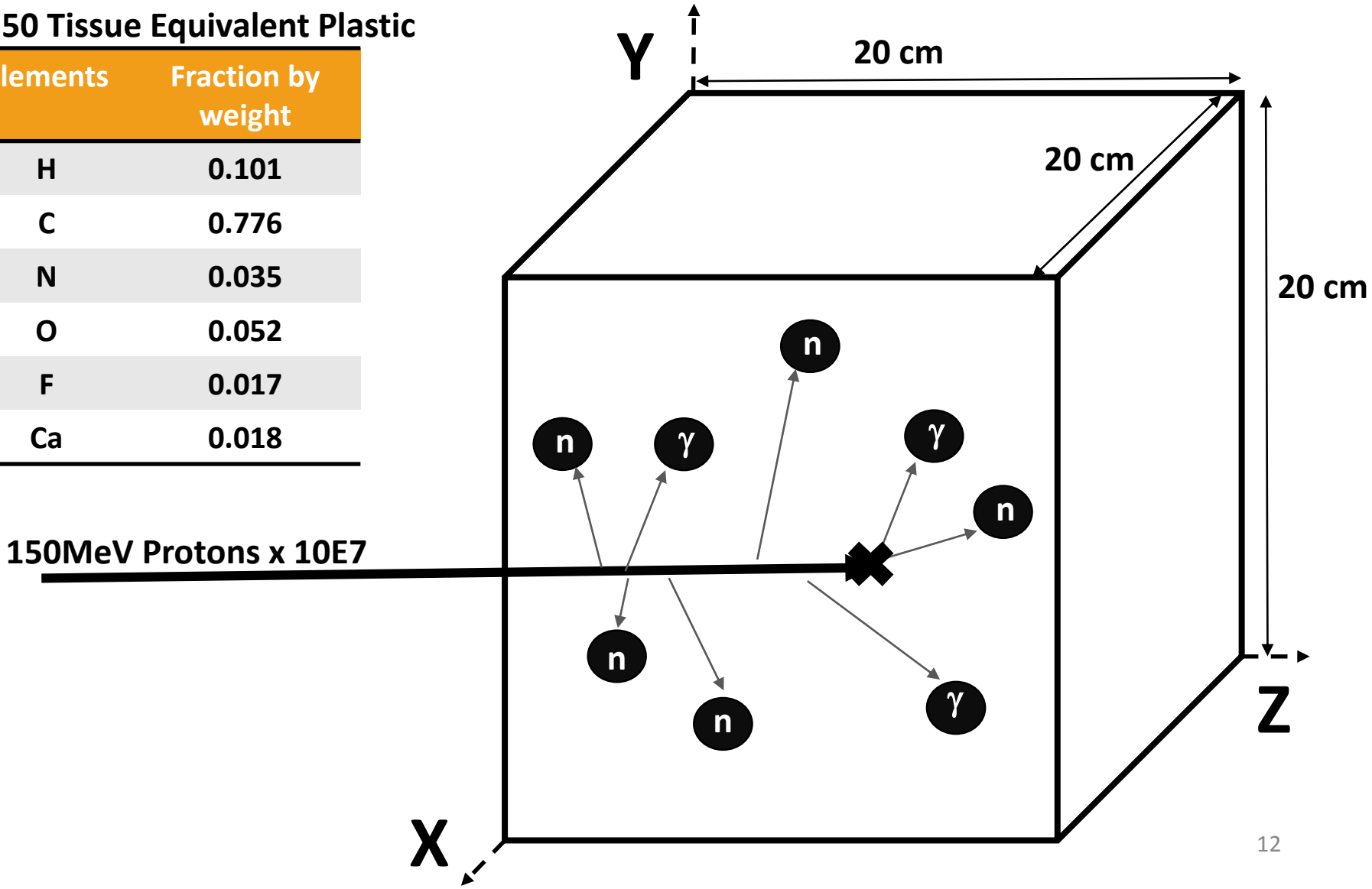
e.g. 1H(n,γ)2H
Q=2.2MeV

Gamma

Part 2: Geant4 Simulation

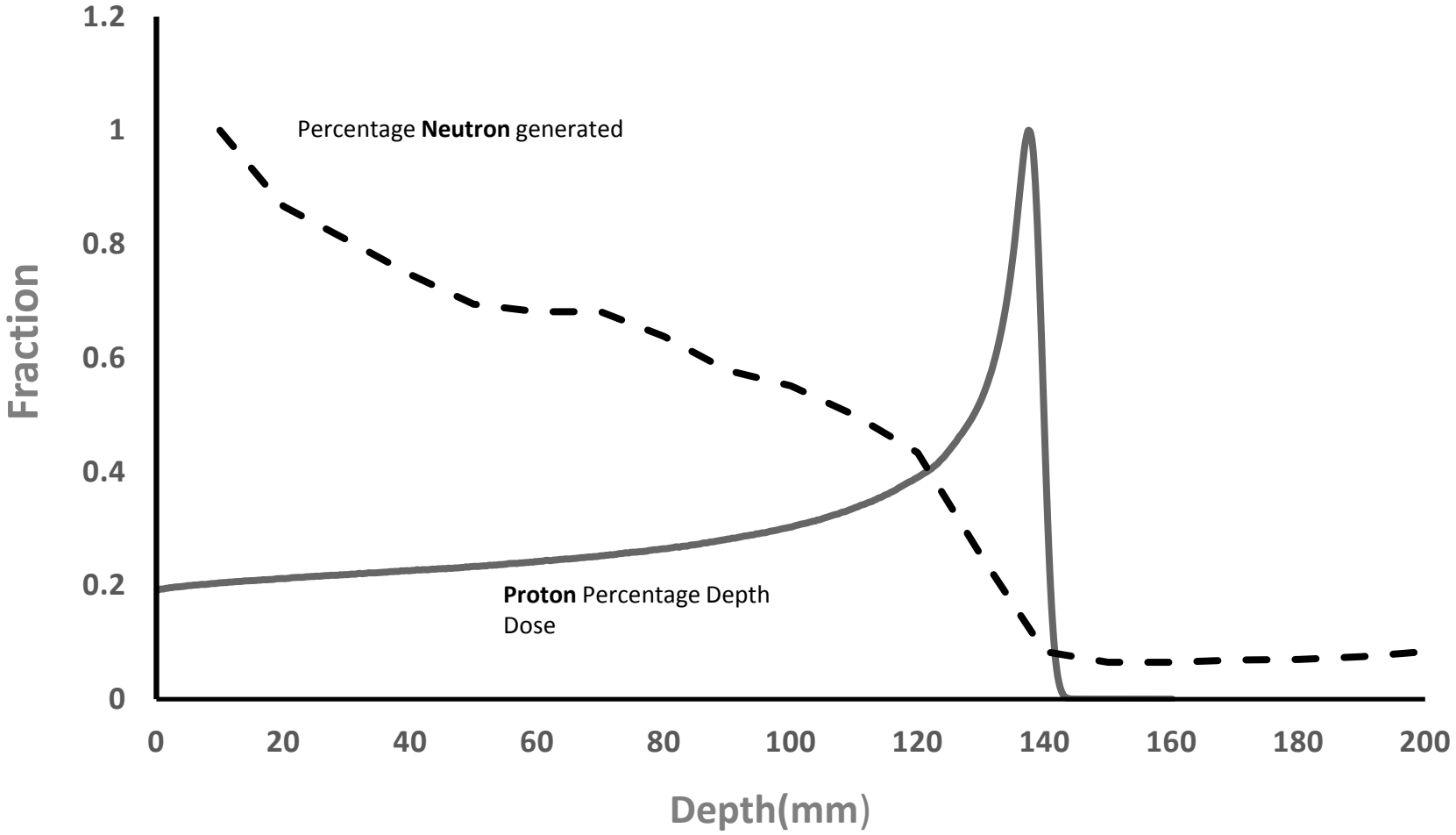
A-150 Tissue Equivalent Plastic

Elements	Fraction by weight
H	0.101
C	0.776
N	0.035
O	0.052
F	0.017
Ca	0.018



Part 2: Geant4 Simulation

The neutron creation counts along proton path of a 150MeV proton beam



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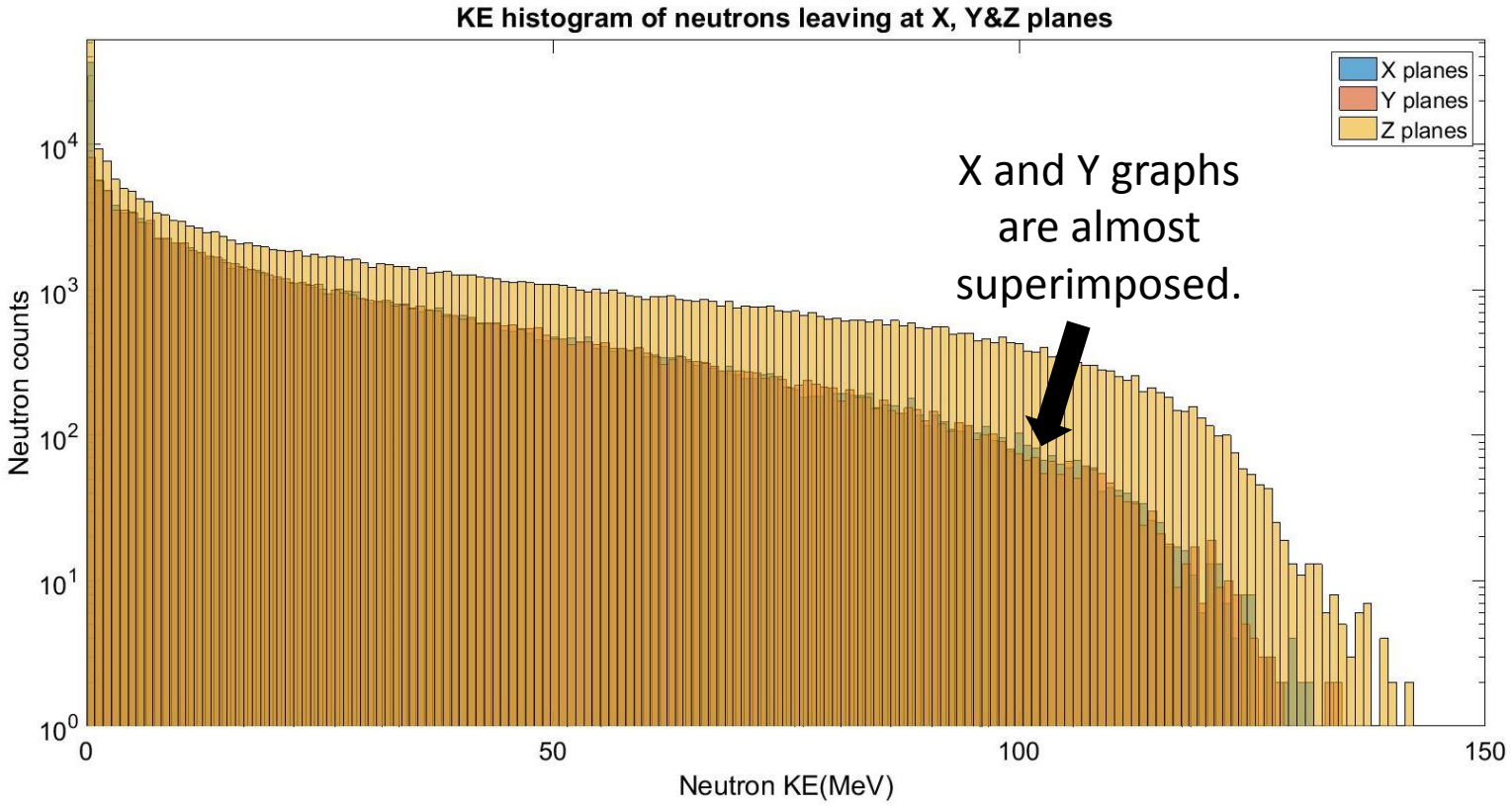

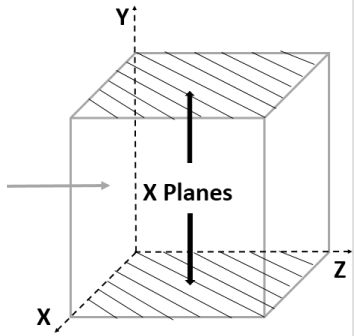

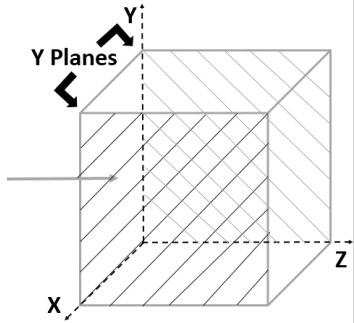

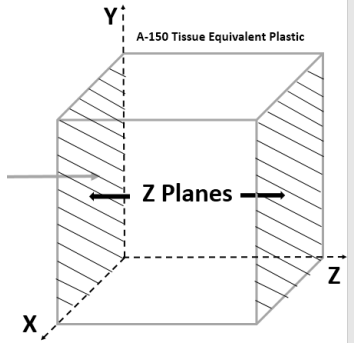

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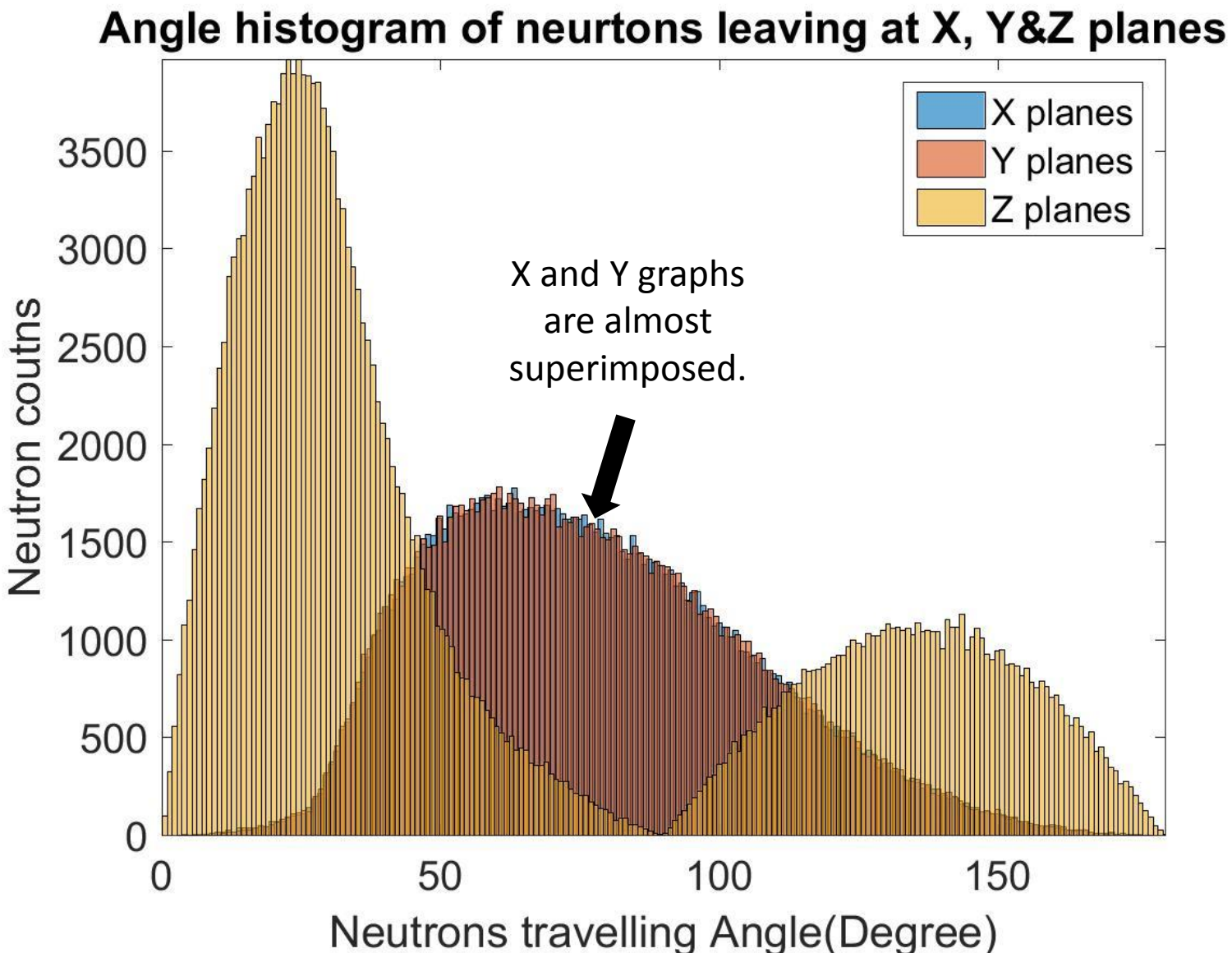
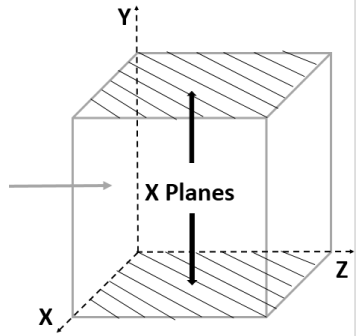
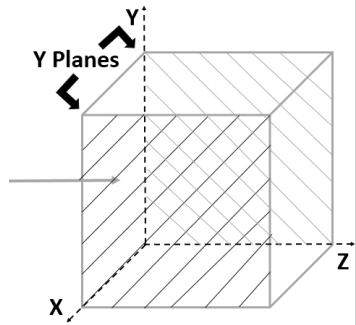
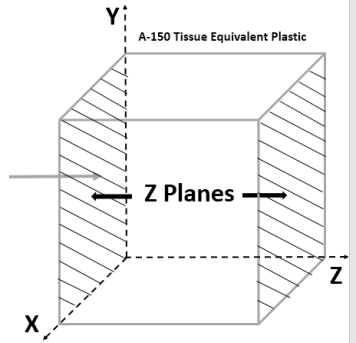








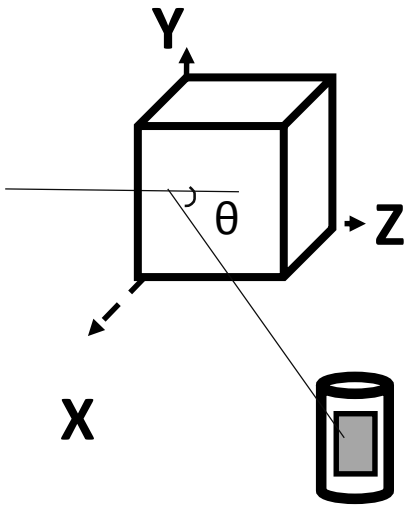
Conclusion

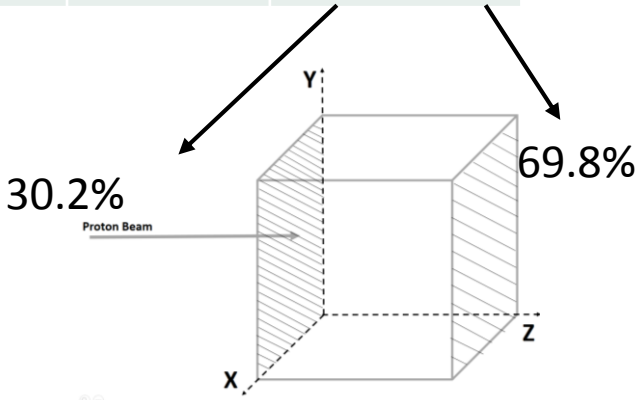
RadICAL

- **Smallest angle resolved ~= 0.5 -> put the detector ACAP**
- **Organic Scintillator + PSD -> Neutron detection**

Geant4 Simulation

Planes	Median KE	Counts
X & Y	E	~26.7%
Z	EE	~46.3%



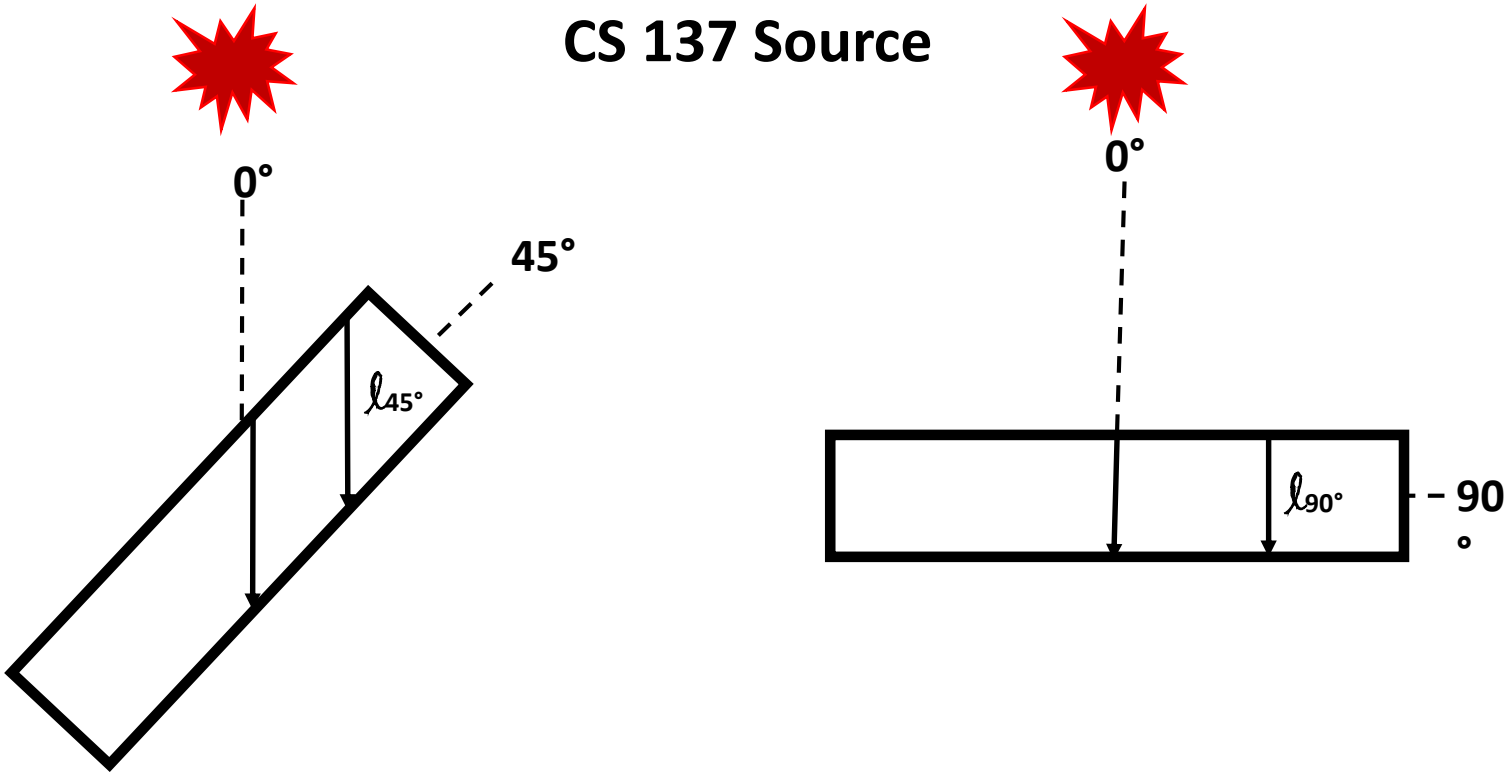


Acknowledgement

- Thanks for guidance from my supervisors

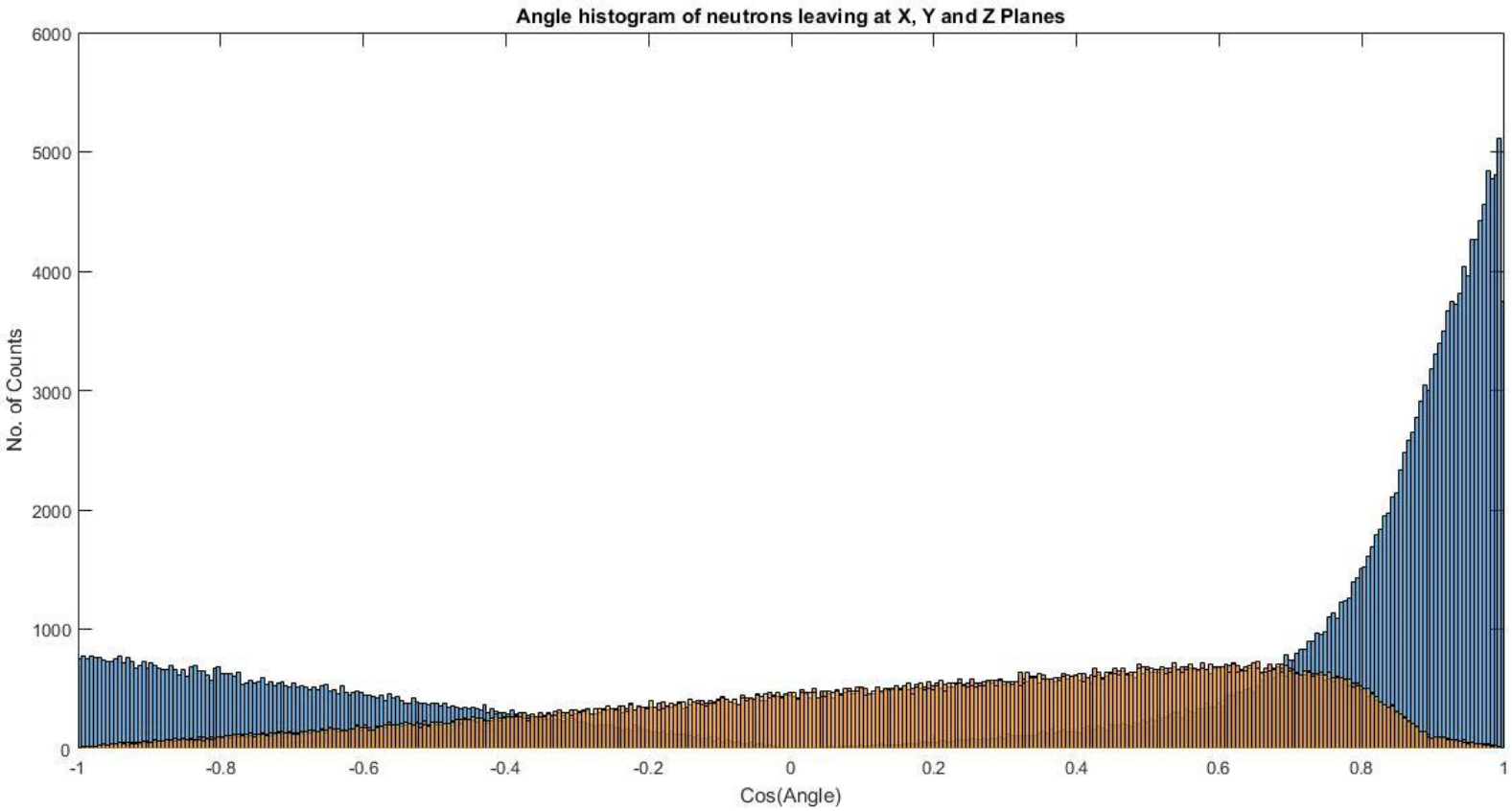
- Enormous support from Radiation Physics and Proton therapy research groupmates, special thanks given to Andrea and Reem for technical support in Geant4

Thanks :)



$\ell 45° >> \ell 90°$

Counts produced at 45° >> Counts produced at 90°


Angle histogram of neutrons leaving at X, Y and Z Planes
No. of Counts
Cos(Angle)
6000
5000
4000
3000
2000
1000
0
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1