NPS Simulation Status

Ho San KO

Institut de Physique Nucléaire d'Orsay

NPS Collaboration Meeting 2019

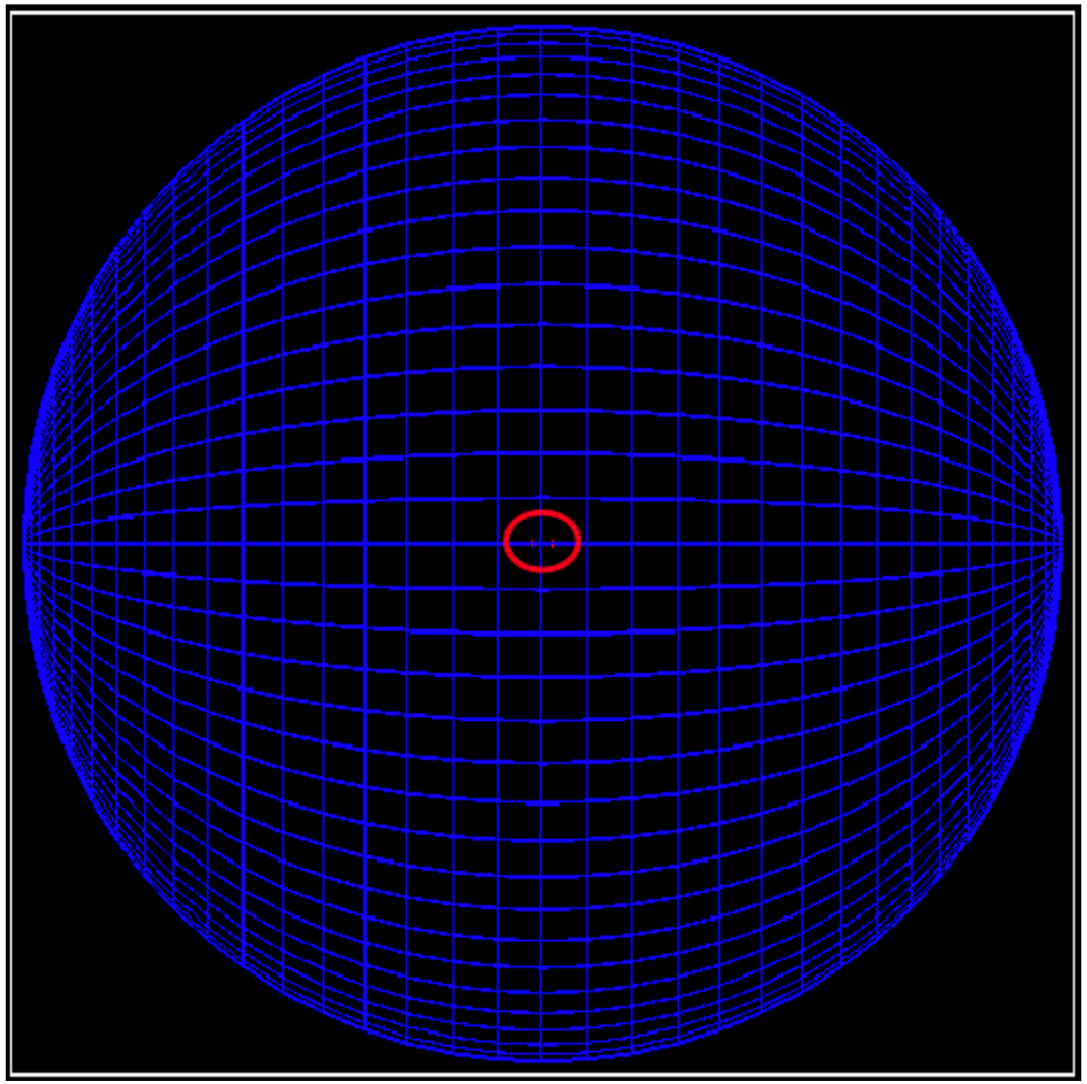
Outline

- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010
- NPS energy resolution simulation
  - Decision of the design of the calorimeter
- NPS offline software reconstruction and acceptance calculation
  - Work in progress

Outline

- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010
- NPS energy resolution simulation
  - Decision of the design of the calorimeter
- NPS offline software reconstruction and acceptance calculation
  - Work in progress

Background Distribution Comparison

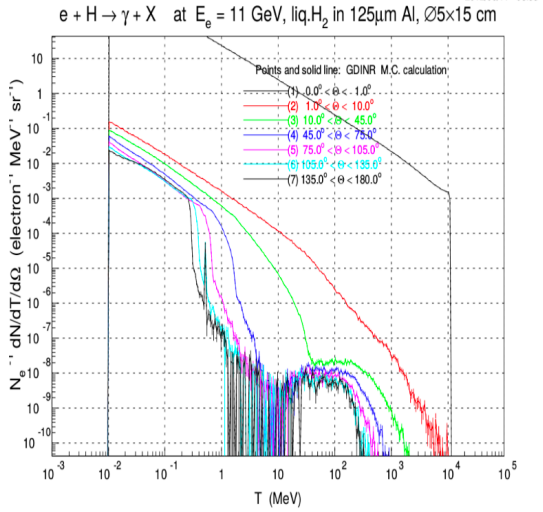


- Simplest & most essential validity check
  -Compare with Pavel Degtiarenko's background rates calculations

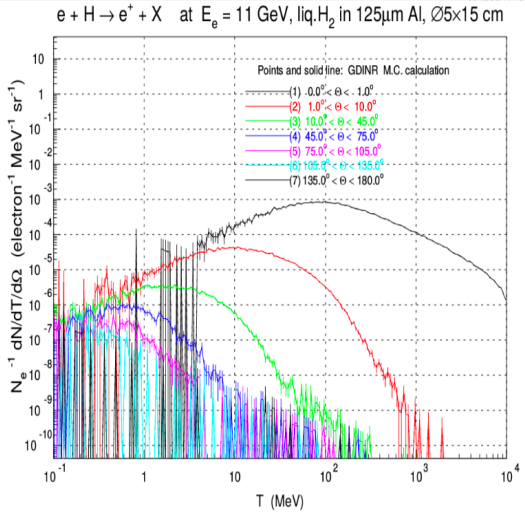
- Geometry
  -$\phi 5 \times 15 cm^2$ liquid hydrogen target
  -125μm Al cover
  -4π acceptance (pseudo) detector

Background Distribution Comparison

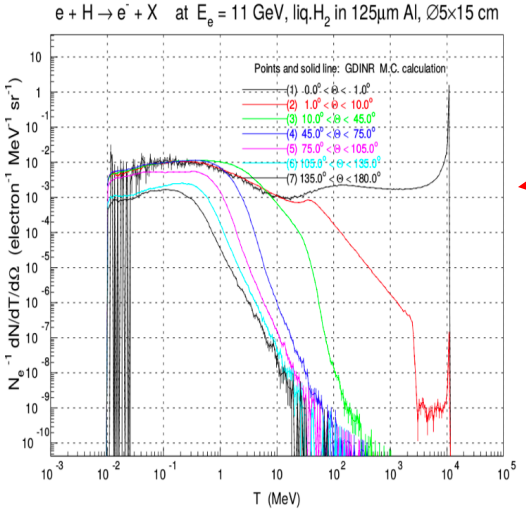
Energy distribution



(a) RadCon gamma



(b) RadCon positron

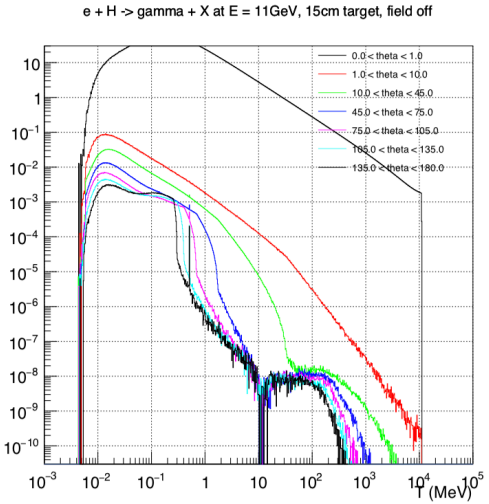


(c) RadCon electron

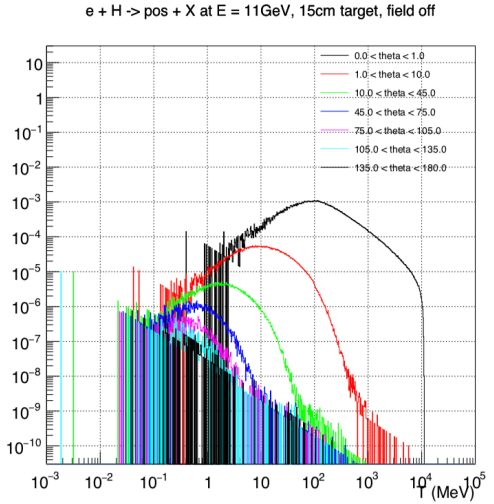
Upper part : Pavel's

Pavel's simulation :

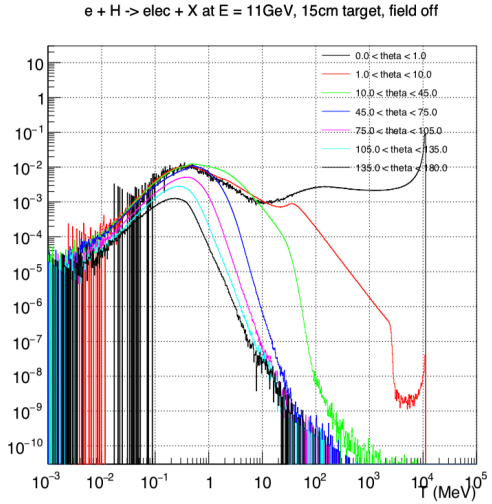
Energy cut at 10keV
- Particles with very low energy are not very welly simulated
- However, they should be absorbed by any thickness of material



(d) Geant4 gamma



(e) Geant4 positron

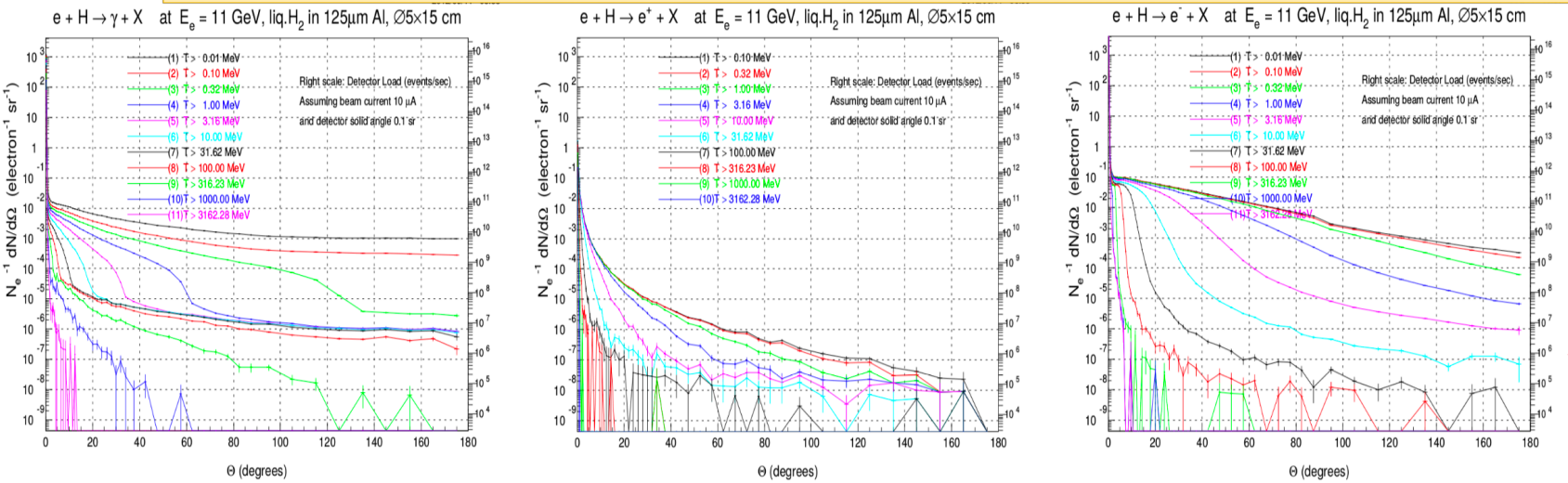


(f) Geant4 electron

Lower part : Geant4

Background Distribution Comparison

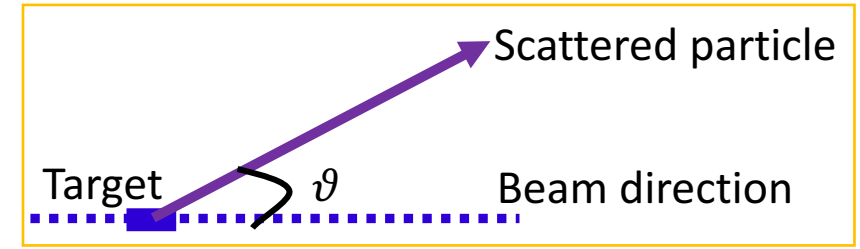
Angular distribution



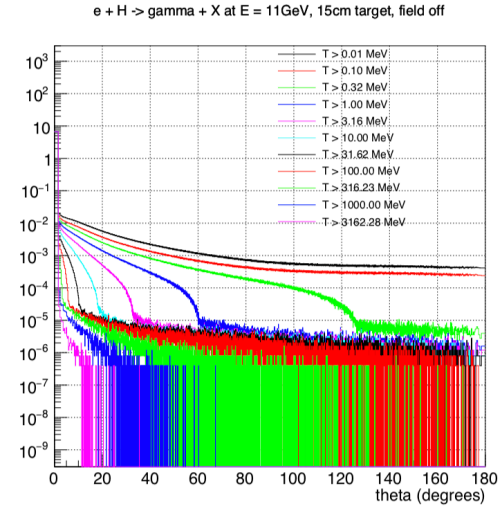
(a) RadCon gamma

(b) RadCon positron

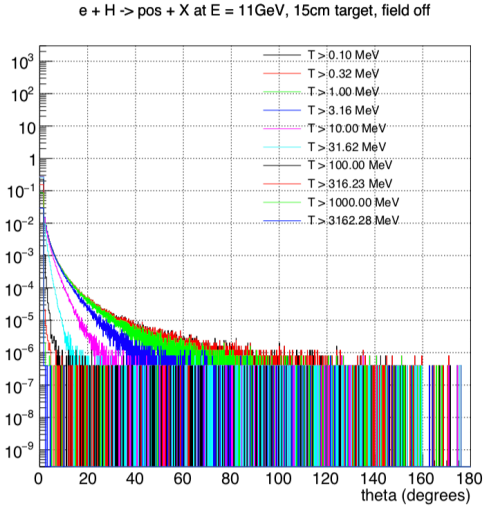
(c) RadCon electron



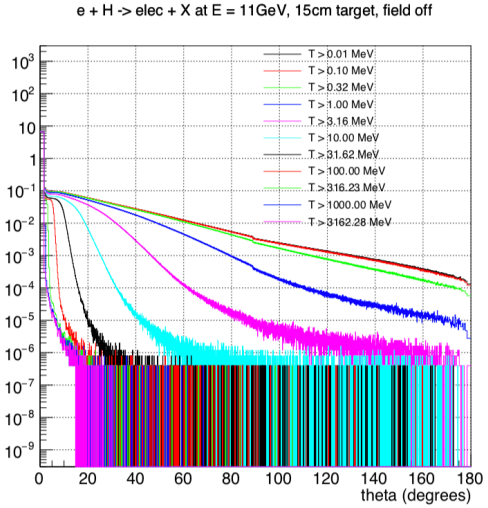
Upper part : Pavel's



(d) Geant4 gamma



(e) Geant4 positron



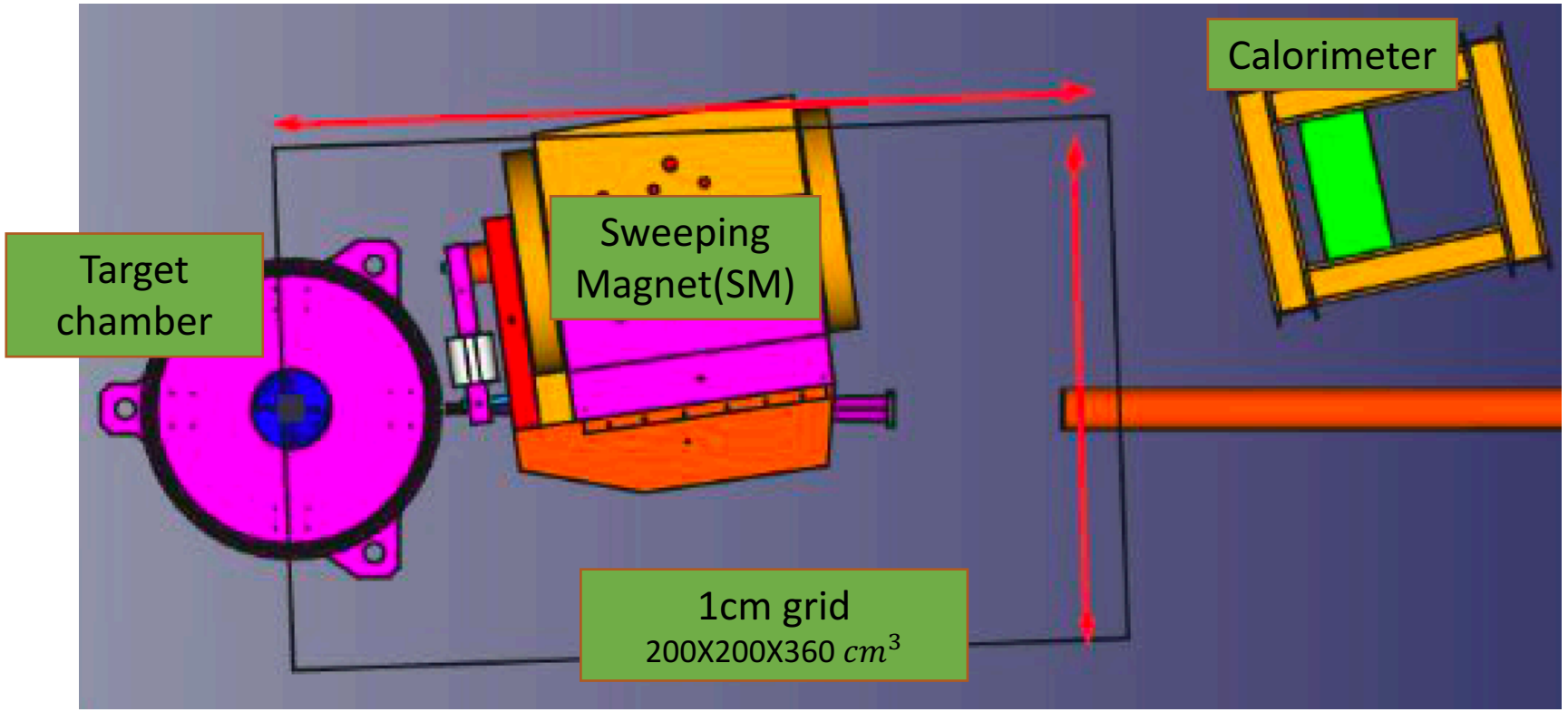
(f) Geant4 electron

Lower part : Geant4

Geant4's background generation is reliable

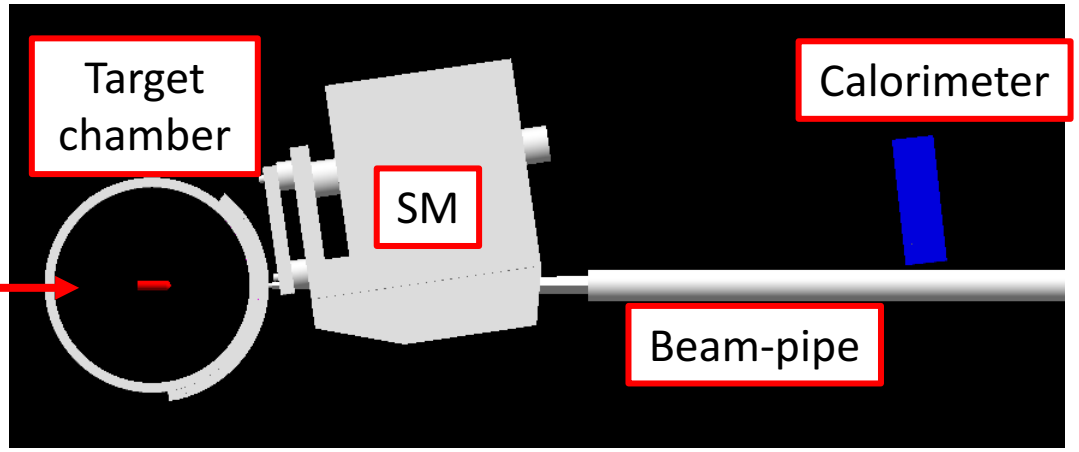
Sweeping Magnet's Magnetic Field Comparison

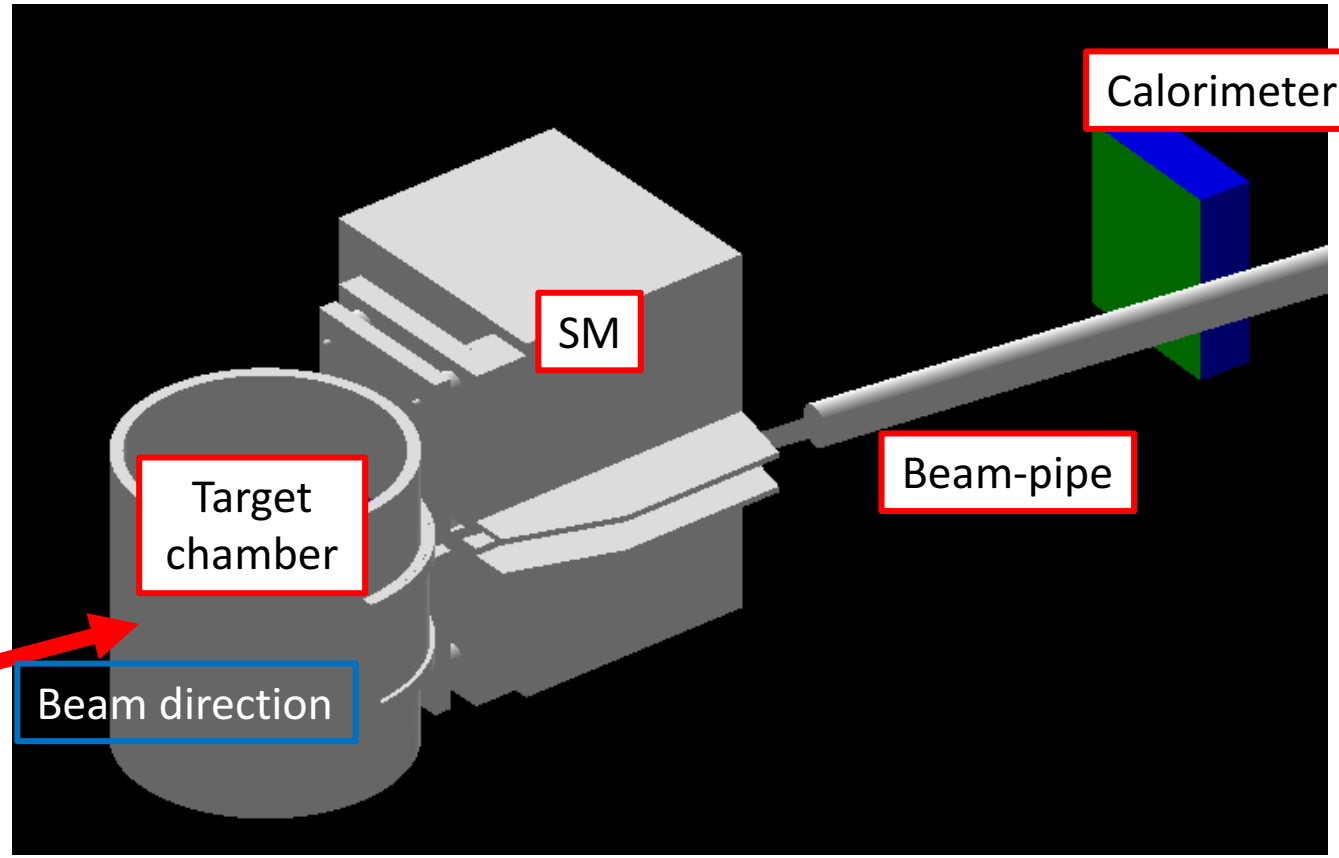
<<picture : stp. file. Mike Fowler>>



1cm grid magnetic field table was used for the simulation

Geant4 NPS Geometry



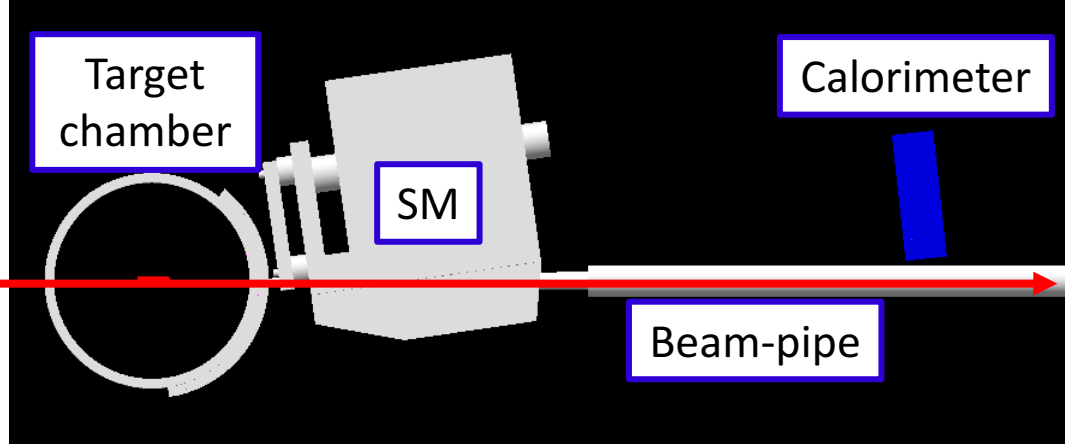


Simulation geometry contains:

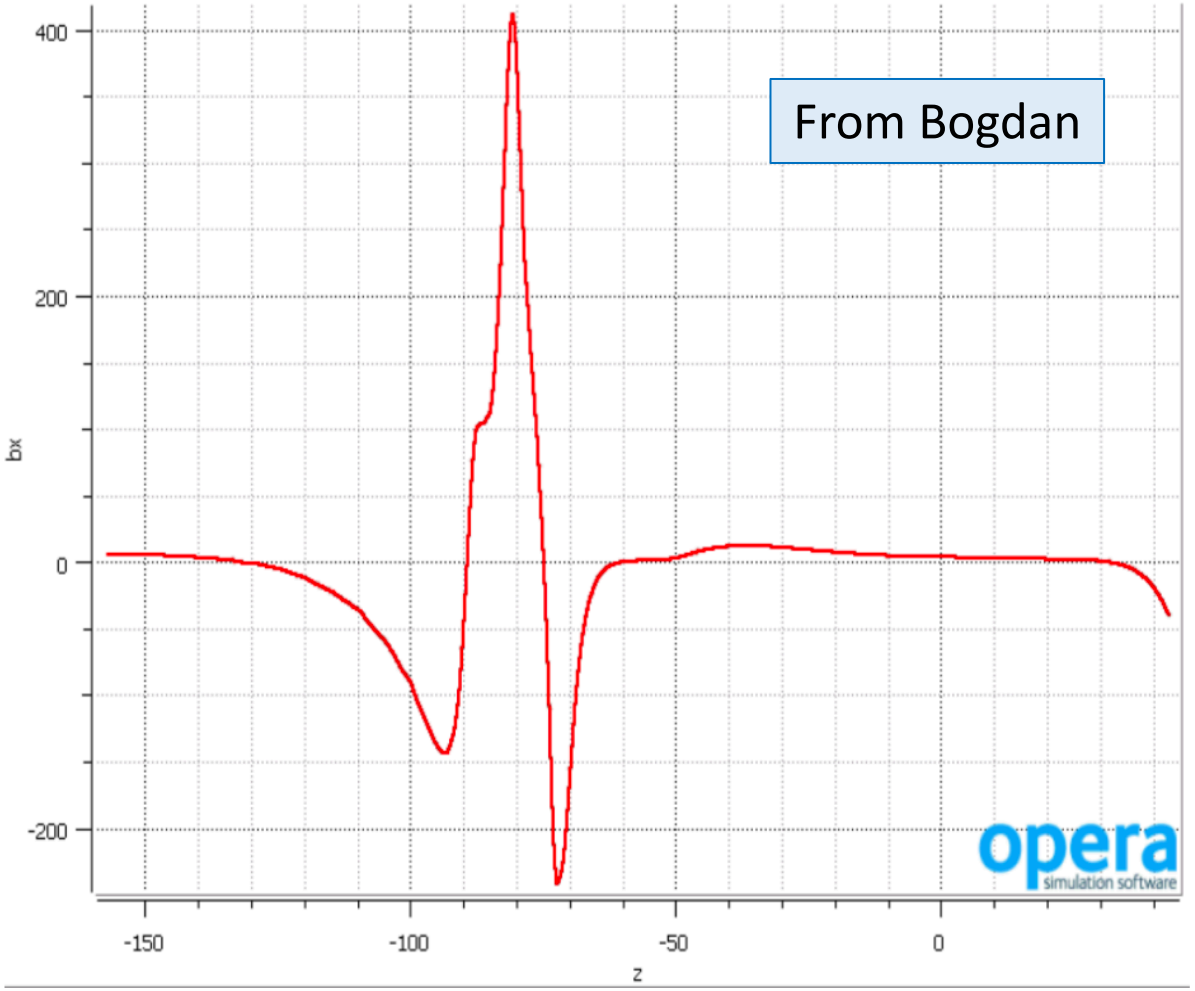
- Liquid hydrogen target(red), and its chamber
- NPS(blue & green)
- Beam-pipe
- Sweeping Magnet(SM)(0.3T·m)
  - stp. file from Mike Folwer
  - Magnetic field from Bogdan Wojtsekhowski

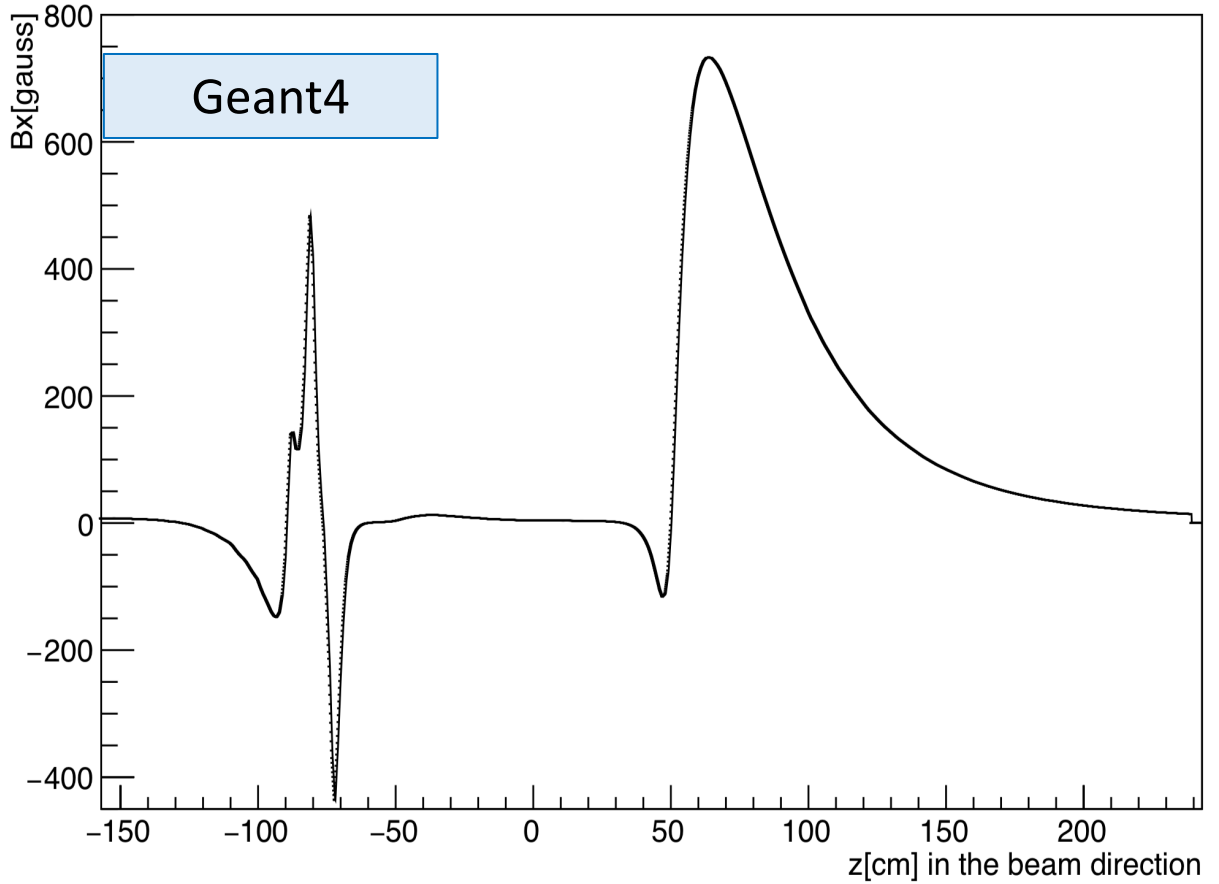
Basic geometry is ready

Magnetic Field Comparison

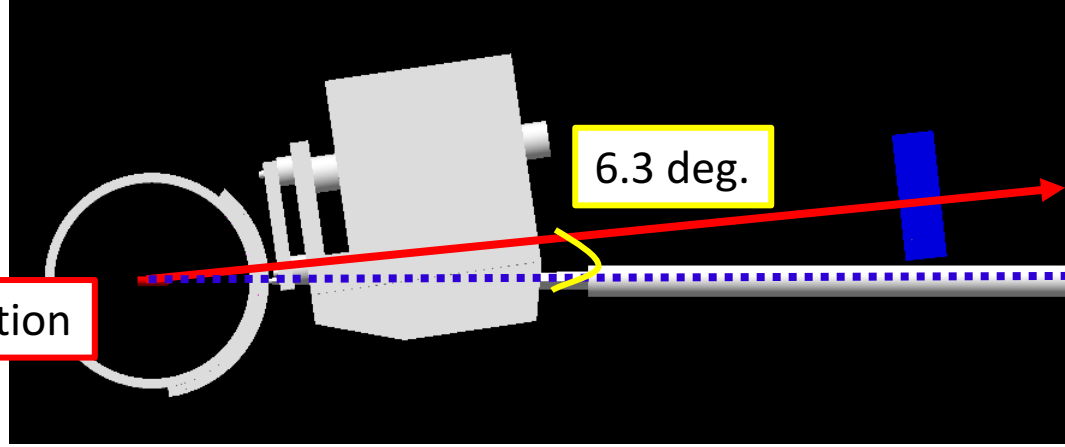


<<Bx [gauss] along the beam-direction>>

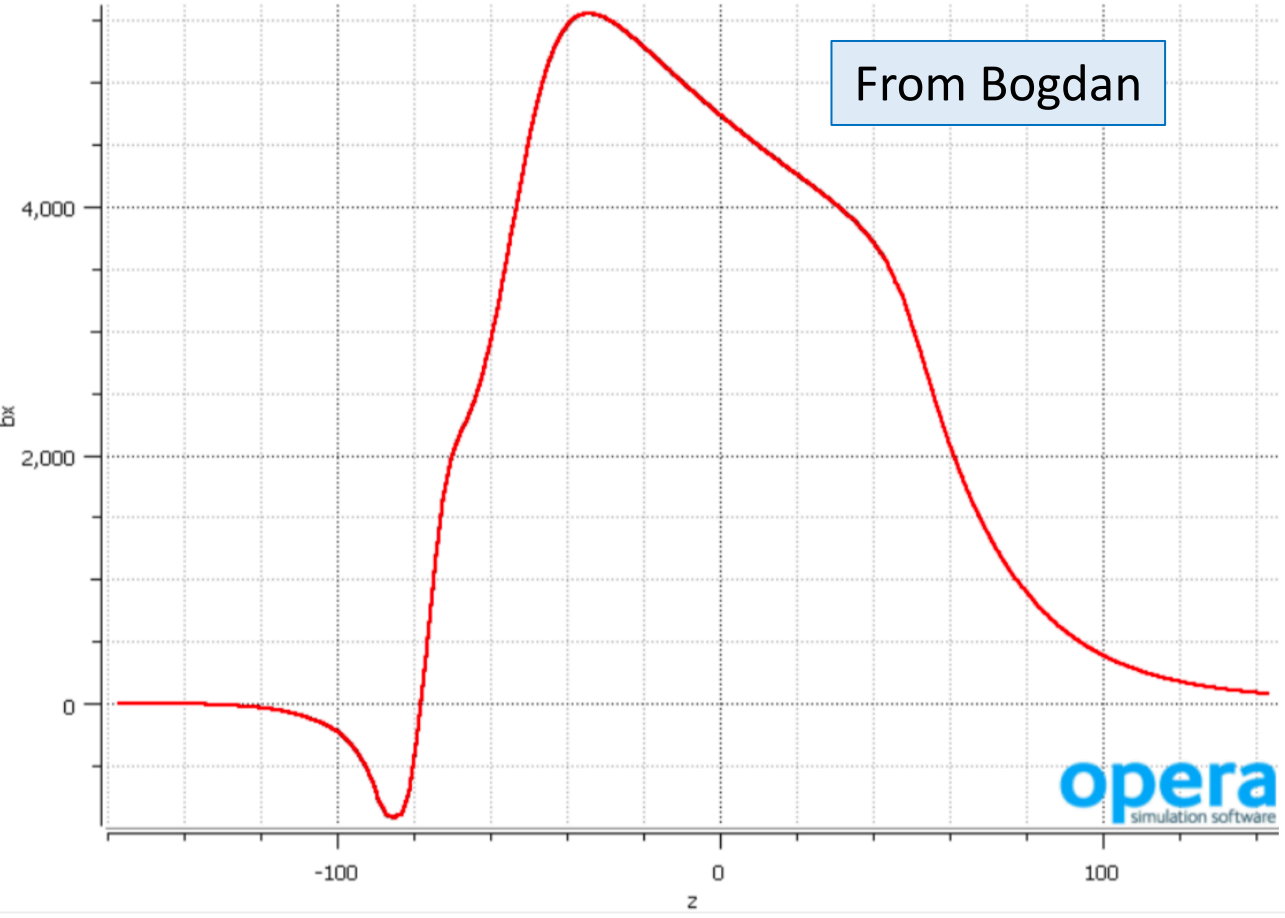


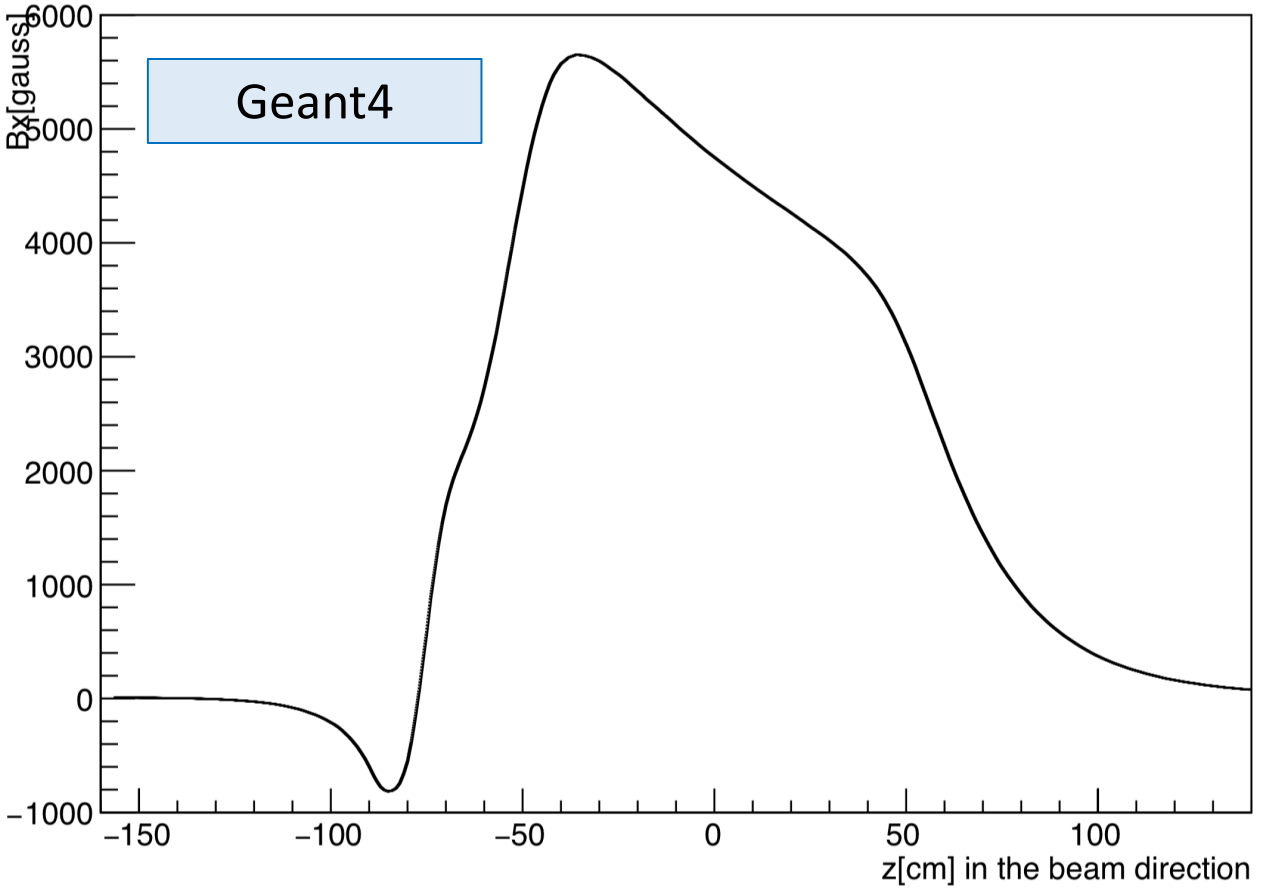


Magnetic Field Comparison

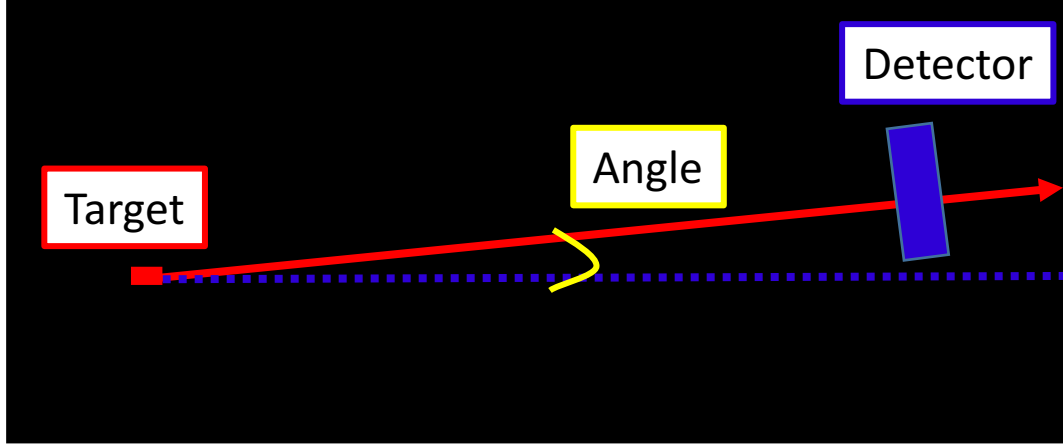


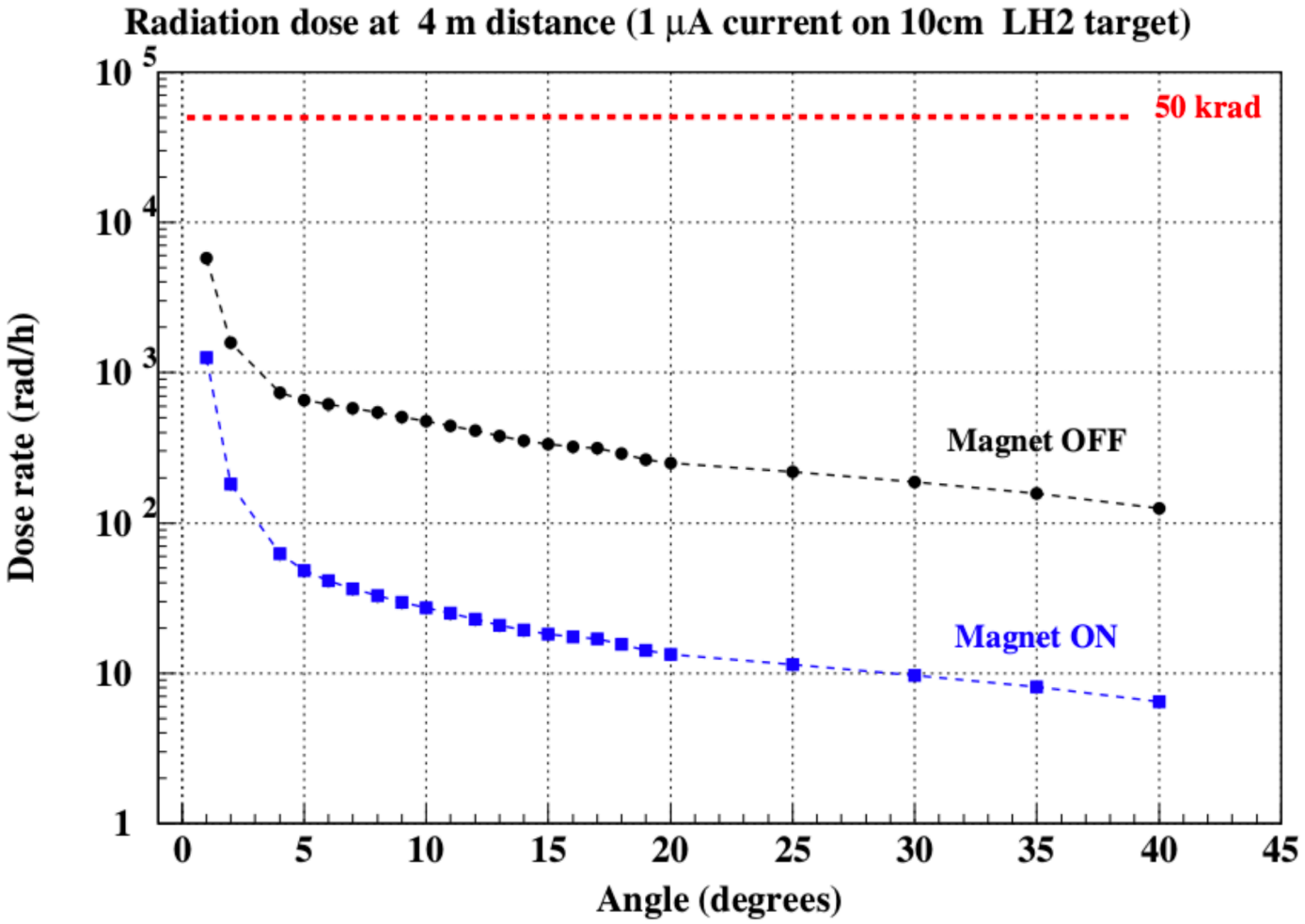
<<Bx [gauss] along the calorimeter's center direction>>





NPS Dose Rate Comparison





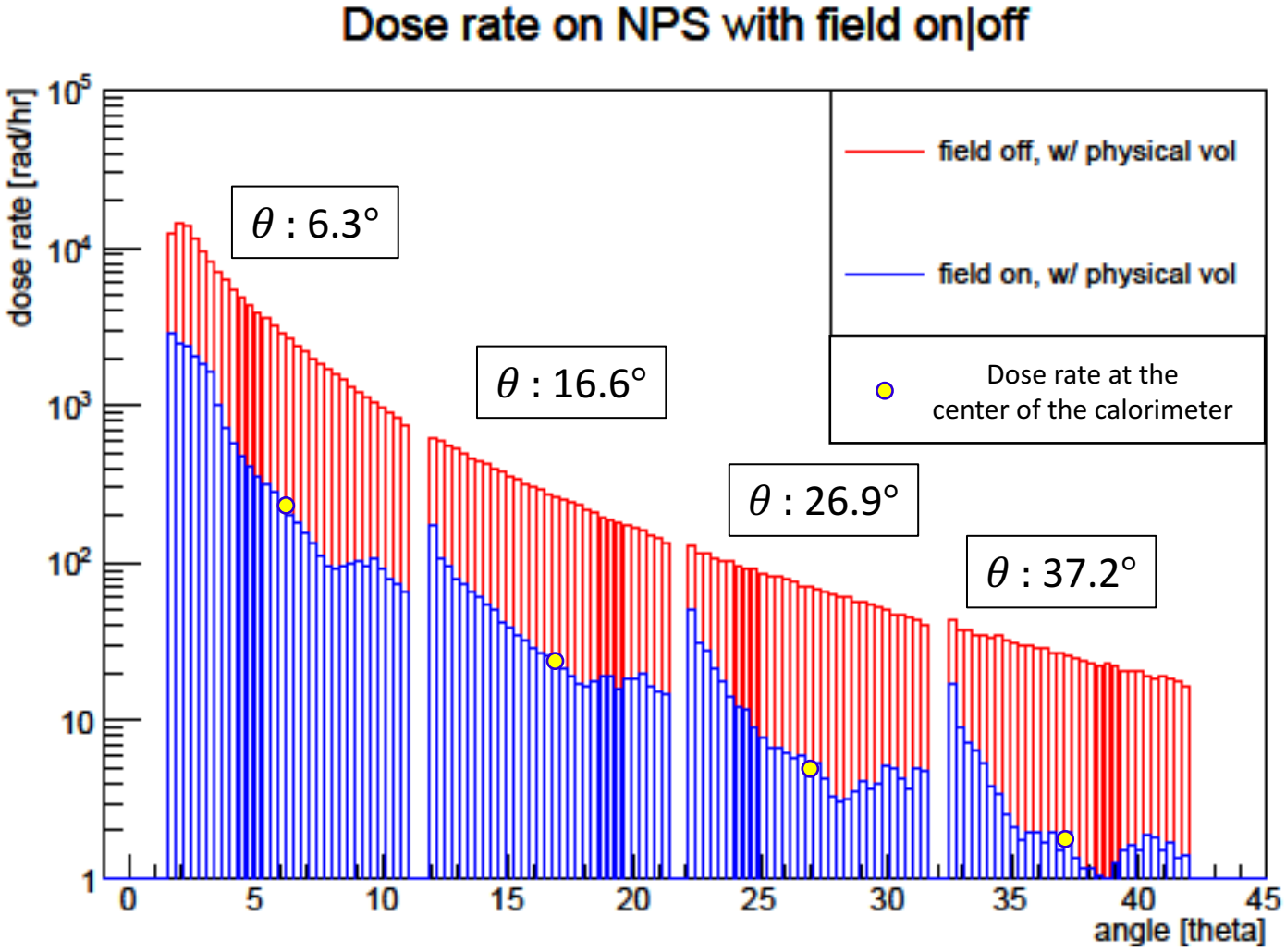
1μA beam in 15cm Liquid hydrogen target
(approximate luminosity : ~$2\times10^{36}cm^{-2}s^{-1}$)
NPS placed 4m away from the target

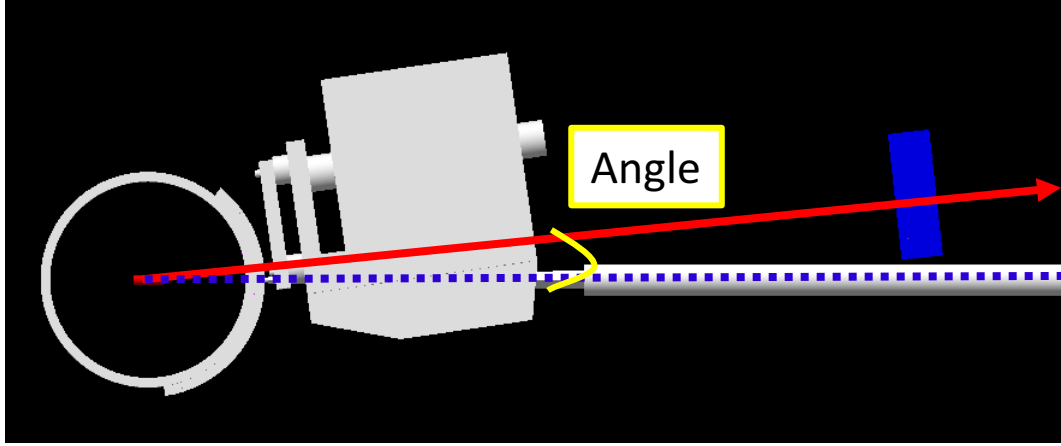
Sweeping magnet :

- Reduces the dose rate about an order magnitude

<<plot from Hamlet Mkrtchyan in PR12-13-010>>
<<Vertical bend magnetic field>>

NPS Dose Rate Comparison



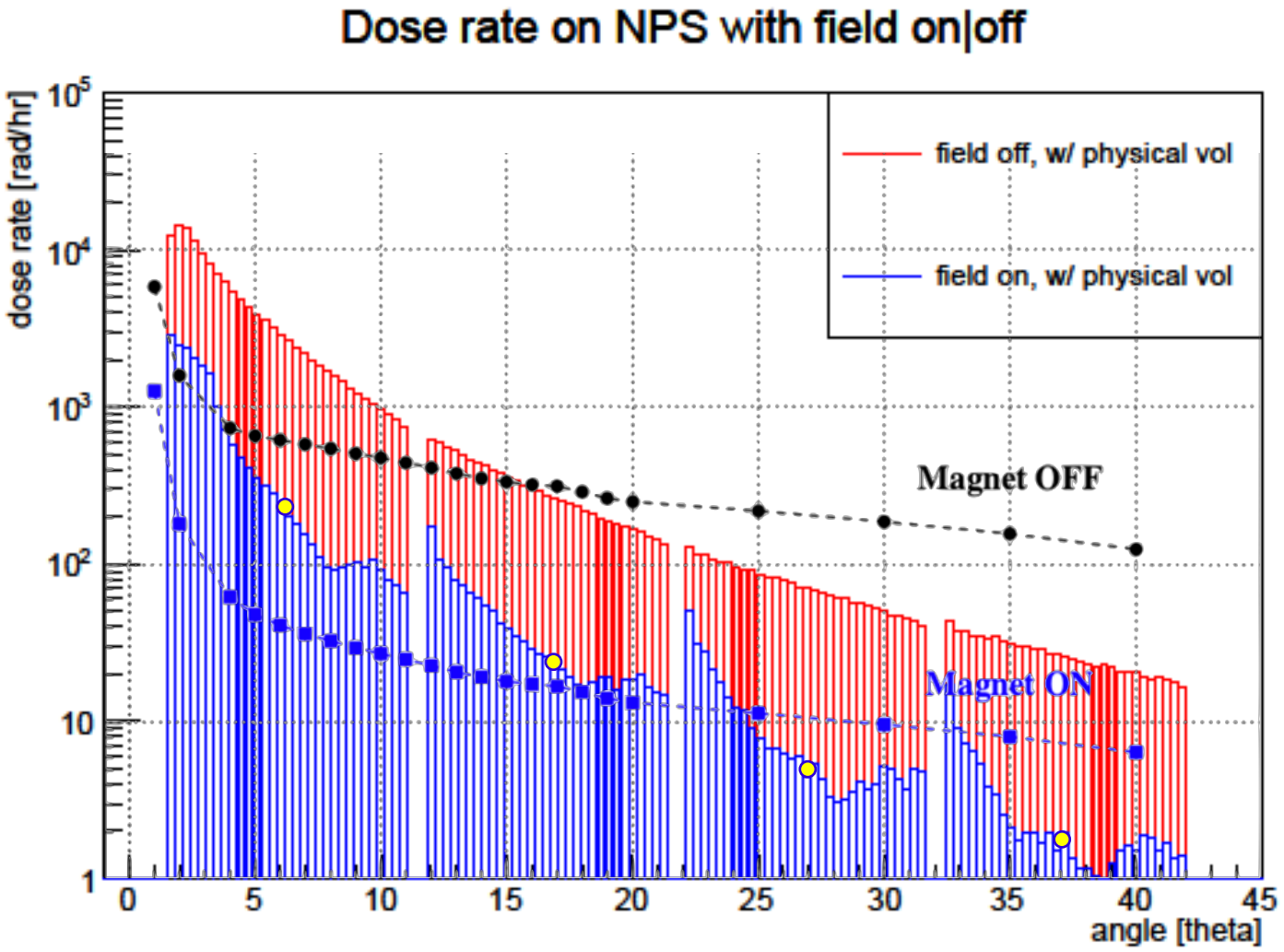


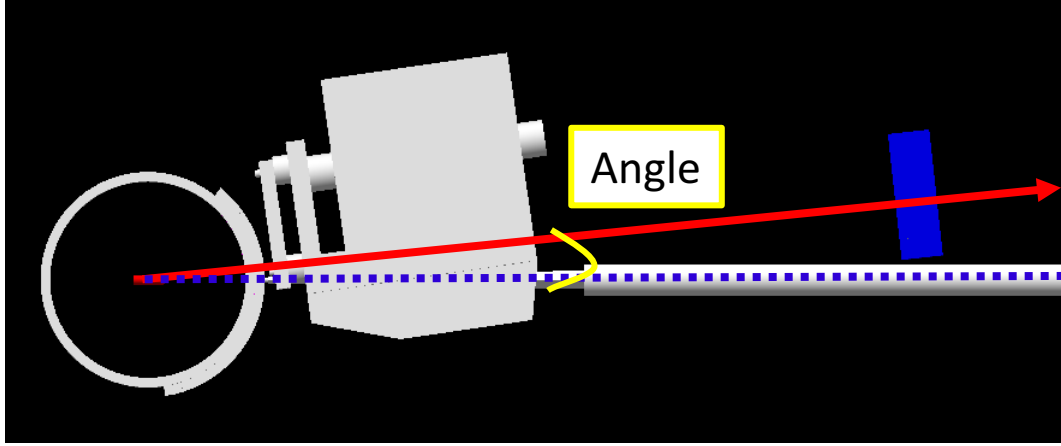
Sweeping magnet :

- Reduces the dose rate about an order or more of magnitude

- Structure exists in dose rate (Field ON)
  - Speculations
    - Physical volumes in simulation
    - Relative positions of crystals to the magnet's
    - Realistic magnetic field

NPS Dose Rate Comparison





Sweeping magnet :

- Reduces the dose rate about an order or more of magnitude

- Structure exists in dose rate (Field ON)
  - Speculations
    - Physical volumes in simulation
    - Relative positions of crystals to the magnet's
    - Realistic magnetic field

Outline

- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010

→ Geant4 setup is ready

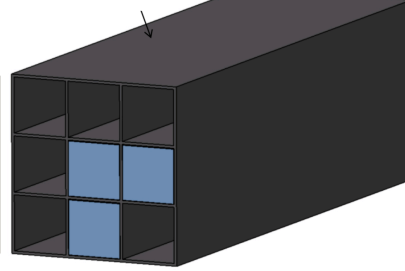
- NPS energy resolution simulation
  - Decision of the design of the calorimeter

- NPS offline software reconstruction and acceptance calculation
  - Work in progress

Outline

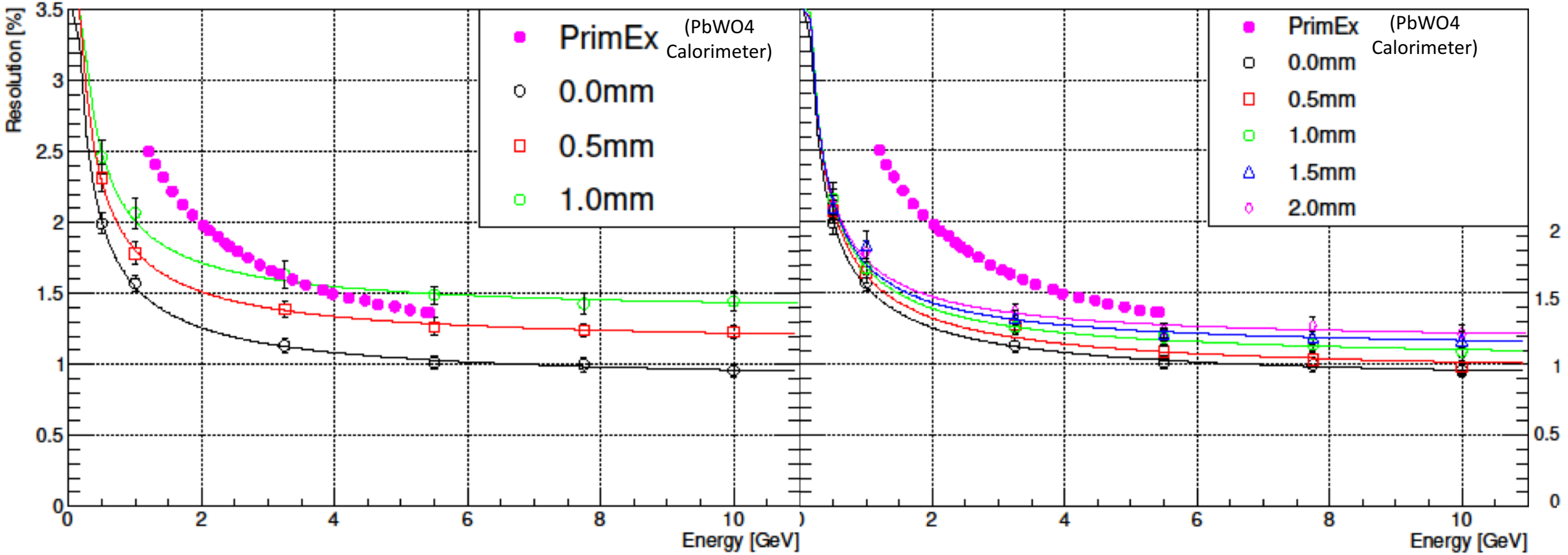
- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010
- NPS energy resolution simulation
  - Decision of the design of the calorimeter
- NPS offline software reconstruction and acceptance calculation
  - Work in progress

NPS Energy Resolution Simulation Result



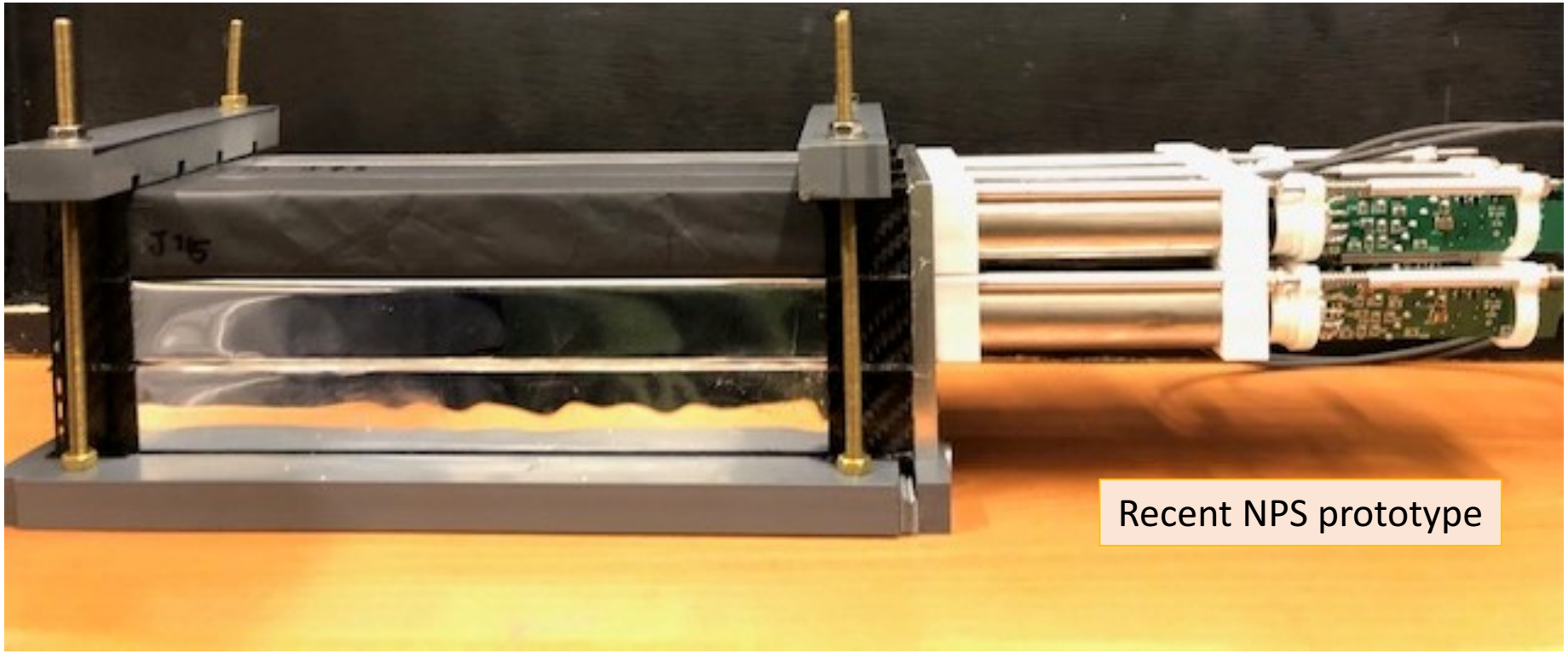
Gap between the crystal : Carbon material

Gap between the crystal : Air



The less material between the crystals, the better energy resolution

NPS Energy Resolution Simulation Result



Based on the simulation result : No material in the middle part of the crystal

Outline

- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010

- NPS energy resolution simulation
  - Decision of the design of the calorimeter

→ Example of simulation usage

- NPS offline software reconstruction and acceptance calculation
  - Work in progress

Outline

- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010
- NPS energy resolution simulation
  - Decision of the design of the calorimeter
- NPS offline software reconstruction and acceptance calculation
  - Work in progress

(Near) Future Plan

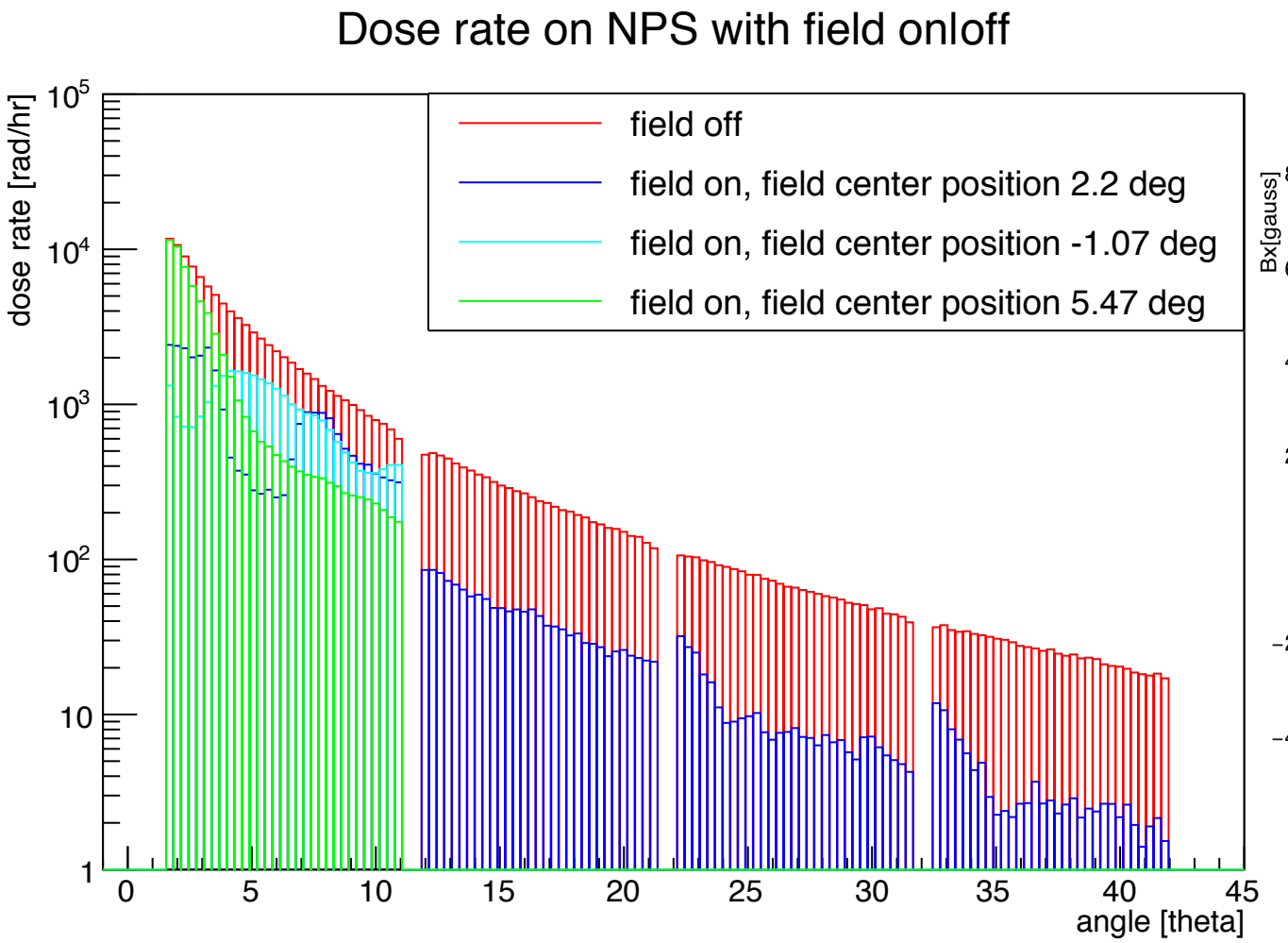
- Offline software reconstruction and NPS acceptance calculation
  - Simulation package is functional
  - Offline reconstruction software is not yet very advanced
    - Copy Hall A DVCS experiment software & adapt it to Hall C
      - Should be done quickly

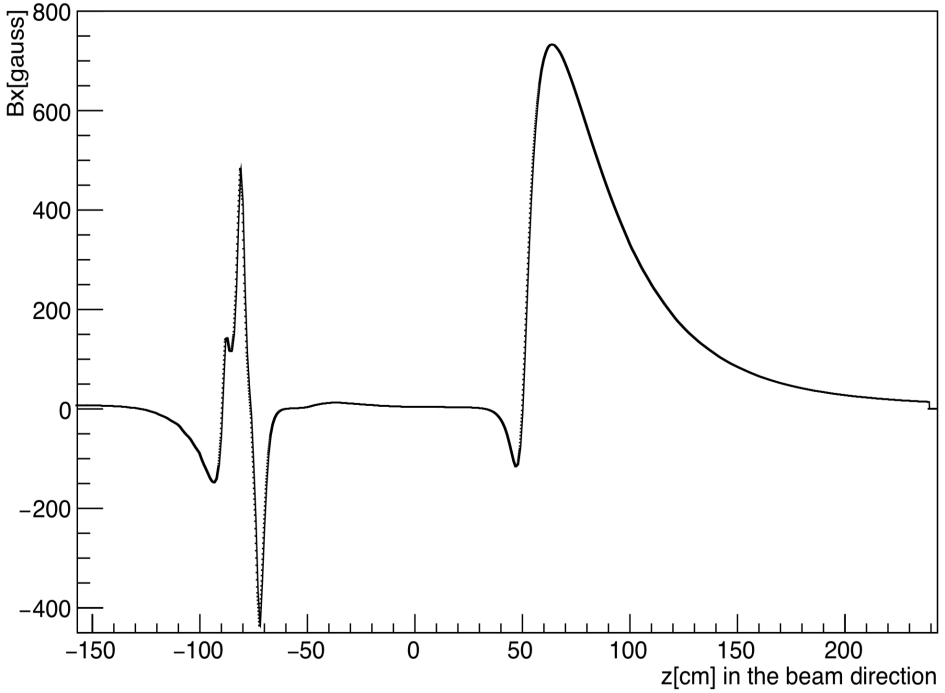
Summary

- NPS Geant4 simulation validity check
  - Background comparison with Pavel's
  - Magnetic field comparison with Bogdan's
  - Dose rate comparison with Hamlet's in PR12-13-010
    - Geant4 setup is ready
- NPS energy resolution simulation
  - Decision of the design of the calorimeter
    - Detector structure : 1mm carbon material only in the front and the back side of the crystals
- NPS offline software reconstruction and acceptance calculation
  - Work in progress
    - Sould be done quickly

Backups

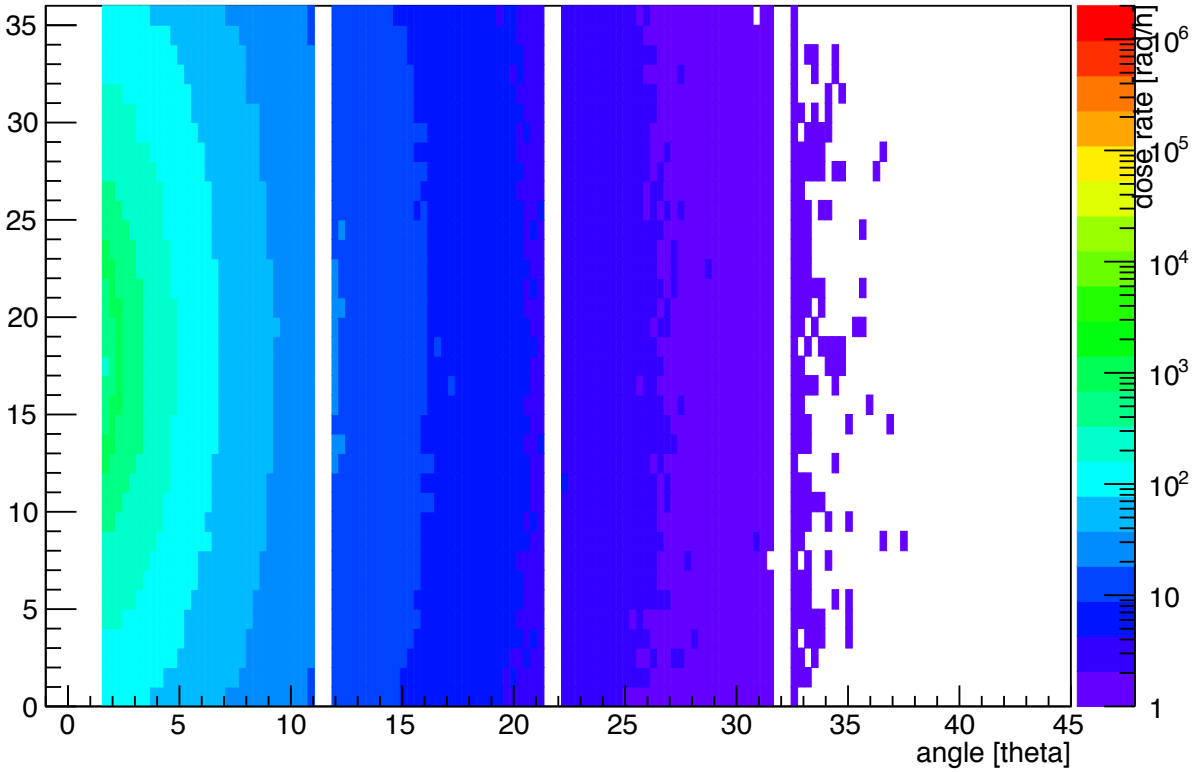
Dose rate calculation with only target & NPS



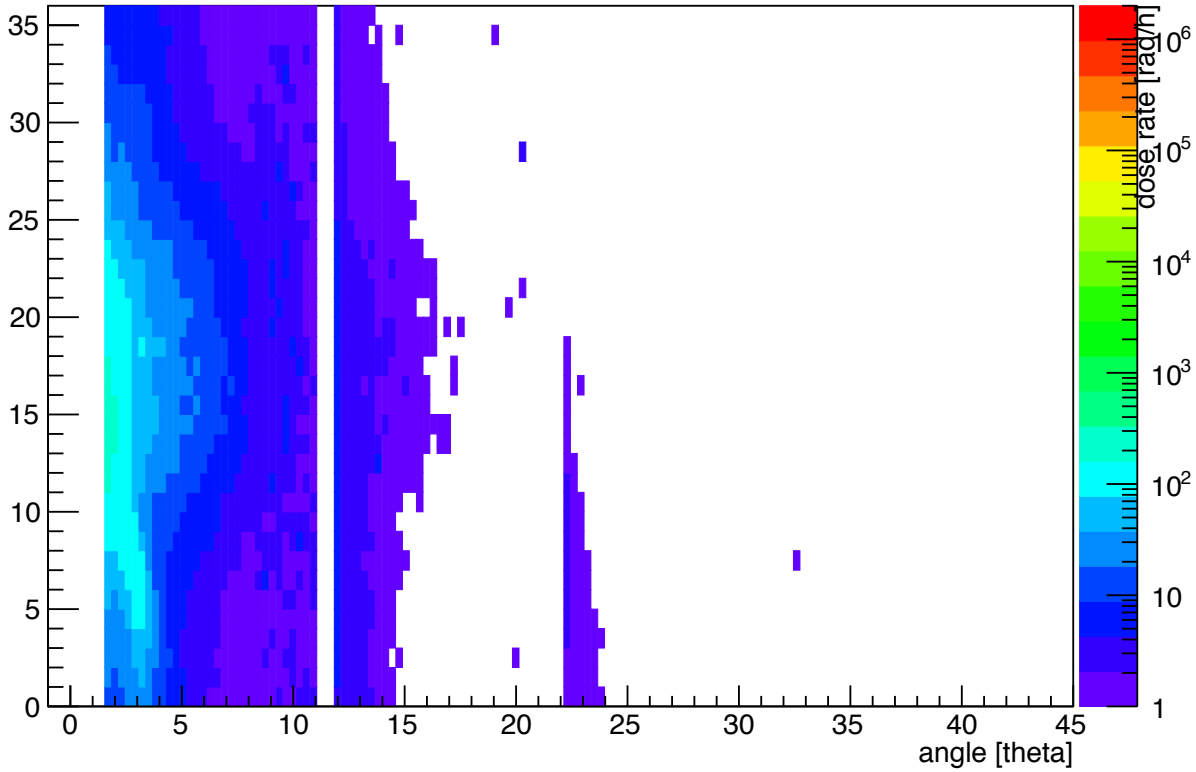


Dose rate of each crystals

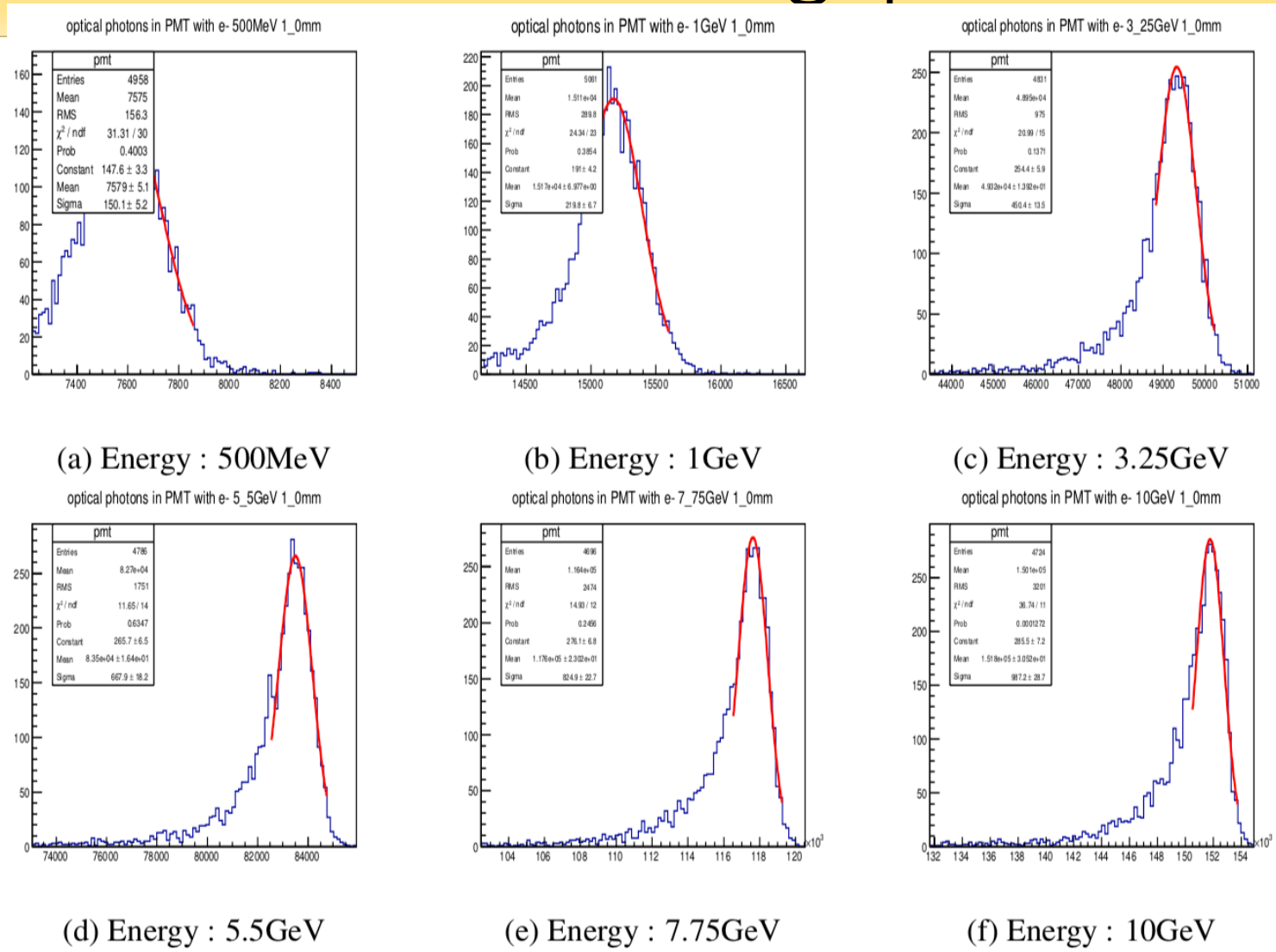
dose rate on each crystals, field off



dose rate on each crystals, field on



Energy resolution with Air gap

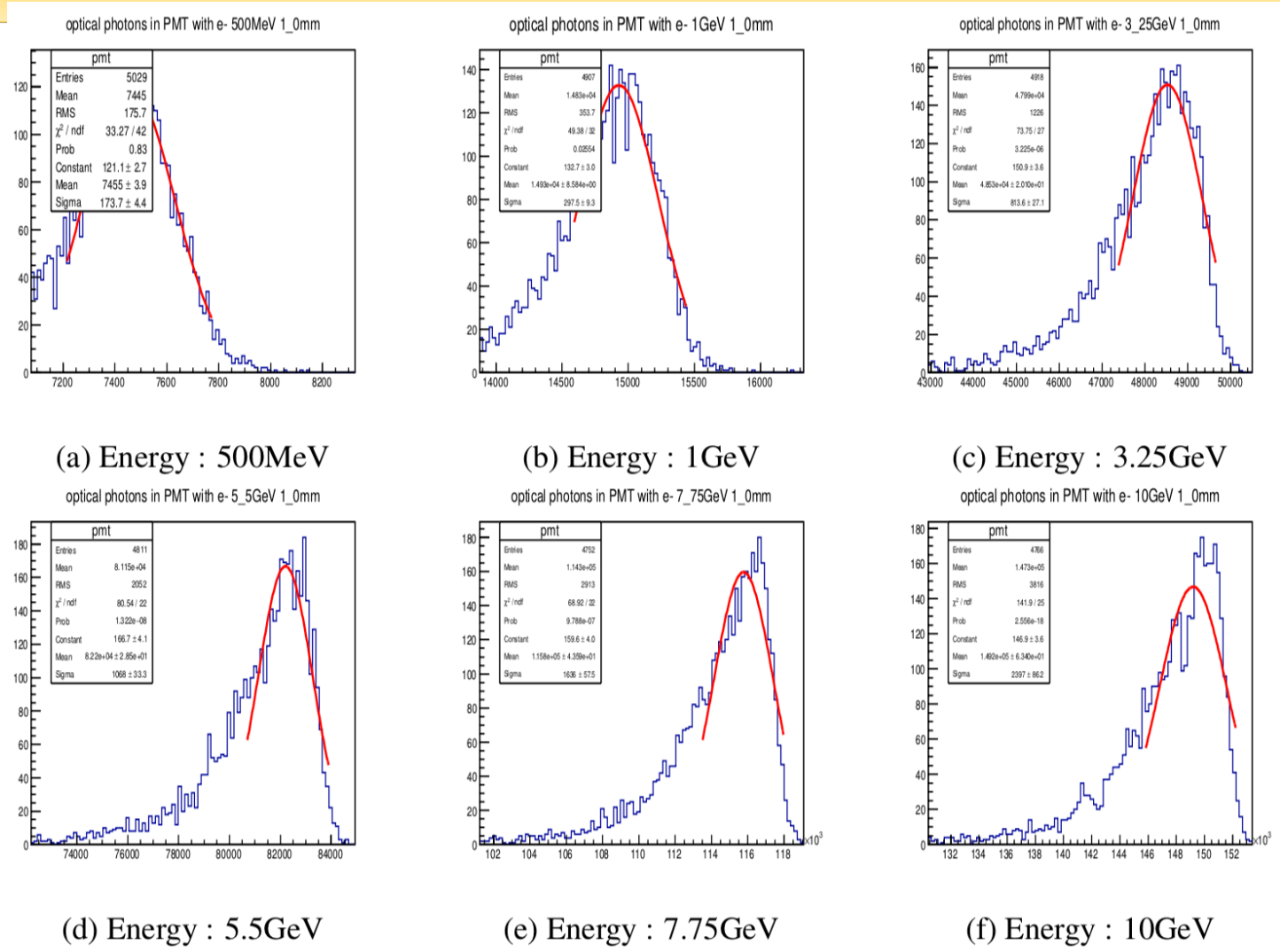


(a) Energy : 500MeV (b) Energy : 1GeV (c) Energy : 3.25GeV

(d) Energy : 5.5GeV (e) Energy : 7.75GeV (f) Energy : 10GeV

Figure A.3: Energy deposition. Number of photons collected at the PMT. Gap : 1mm

Energy resolution with Carbon gap



(a) Energy : 500MeV (b) Energy : 1GeV (c) Energy : 3.25GeV

(d) Energy : 5.5GeV (e) Energy : 7.75GeV (f) Energy : 10GeV

Figure B.3: Energy deposition. Number of photons collected at the PMT. Gap : 1mm