Neutron Detector for the Study of SRC@HADES

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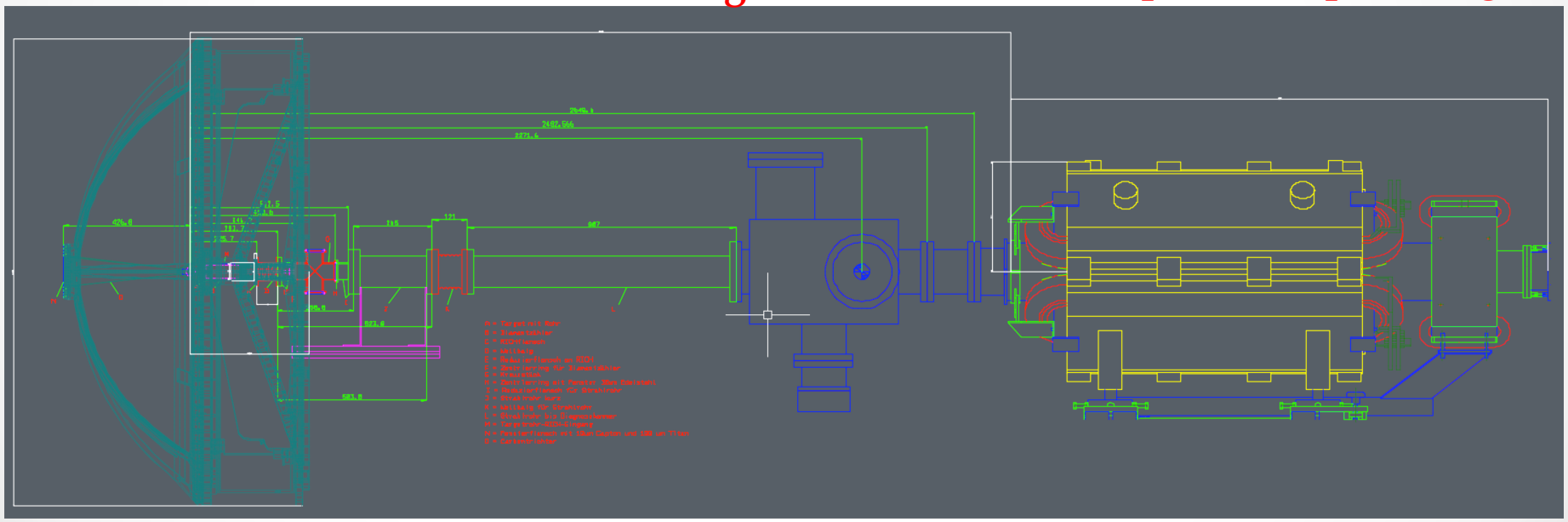
Outline

- Neutron Detector Design
- Available Plastic Scintillators
- Detector Implementation in GEANT
- Magnetic Field Studies
- Detector Requirements
- Electronics
- Open Issues and Next Steps

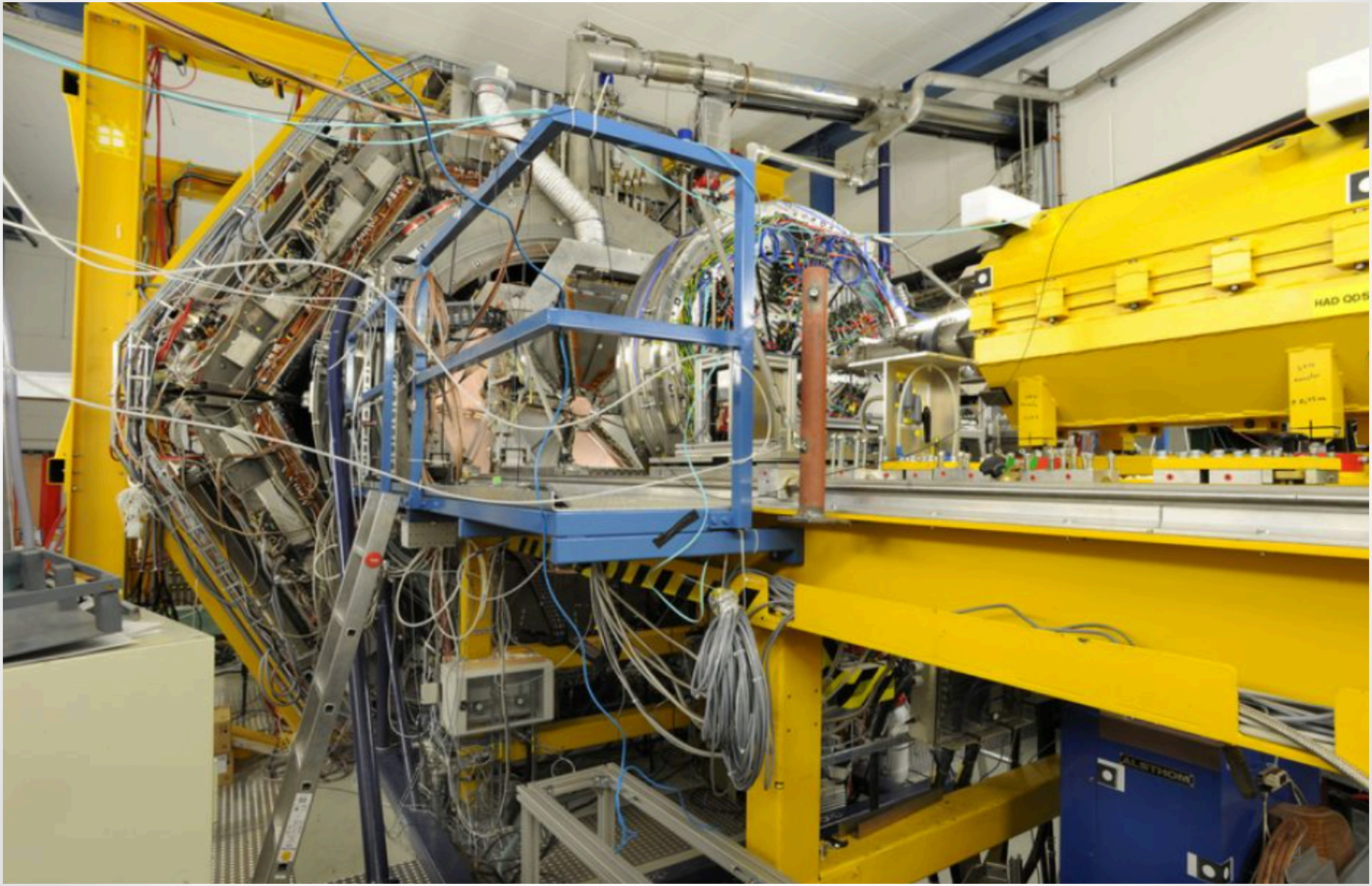
Mechanical Design

RICH Neutron Detector Region Quadrupole & Dipole Magnet

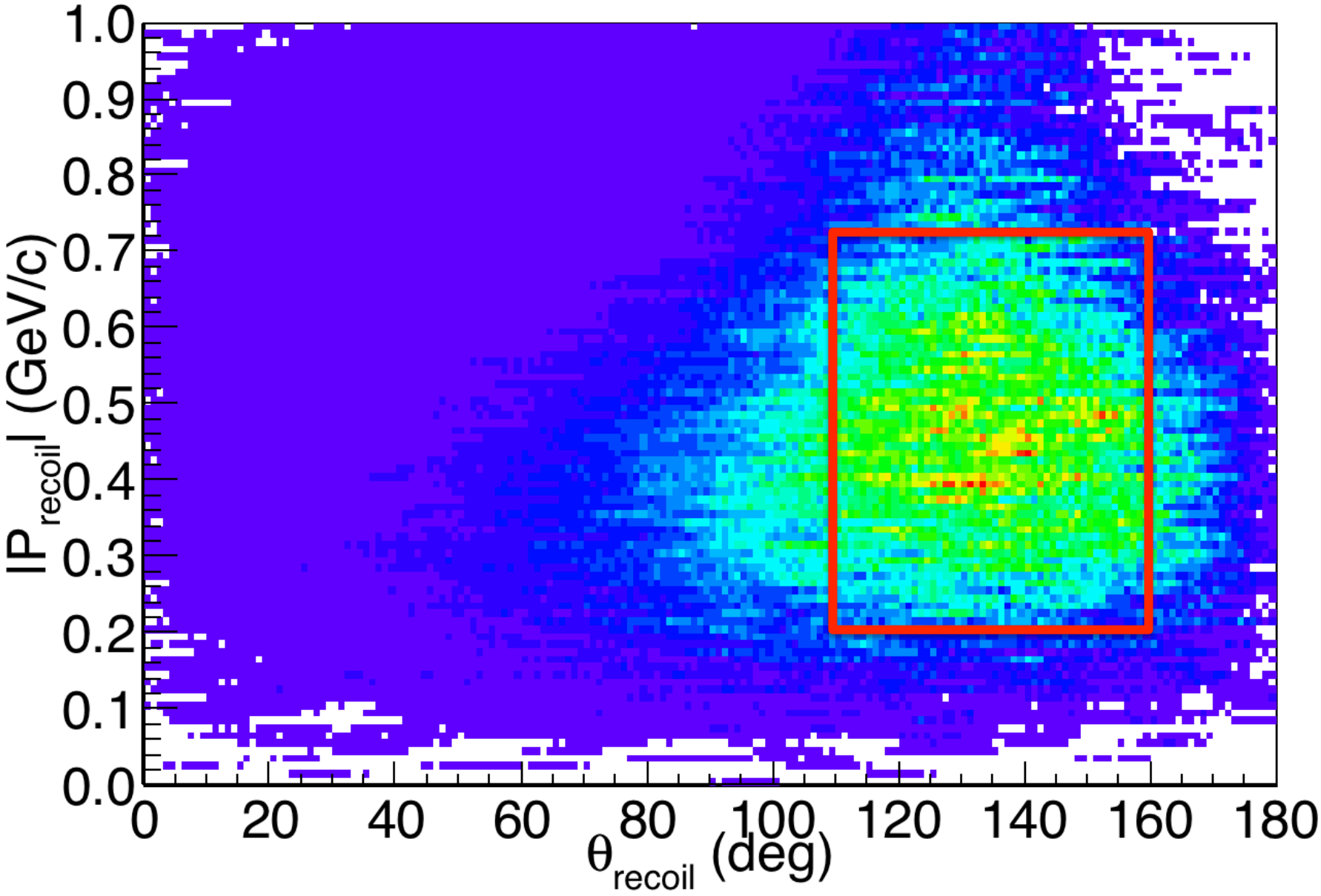


Beam Diagnostics Box

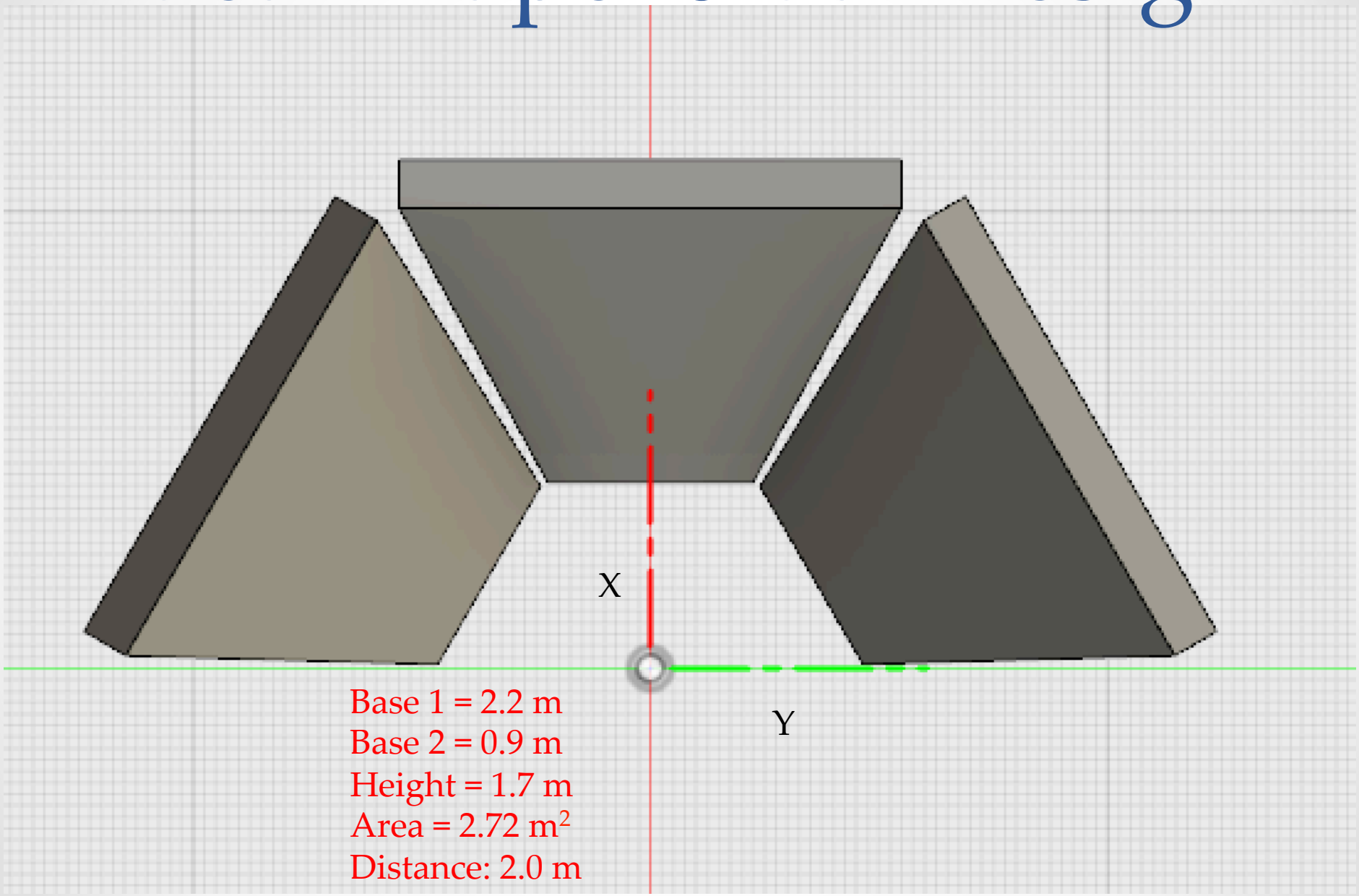
HADES Cave



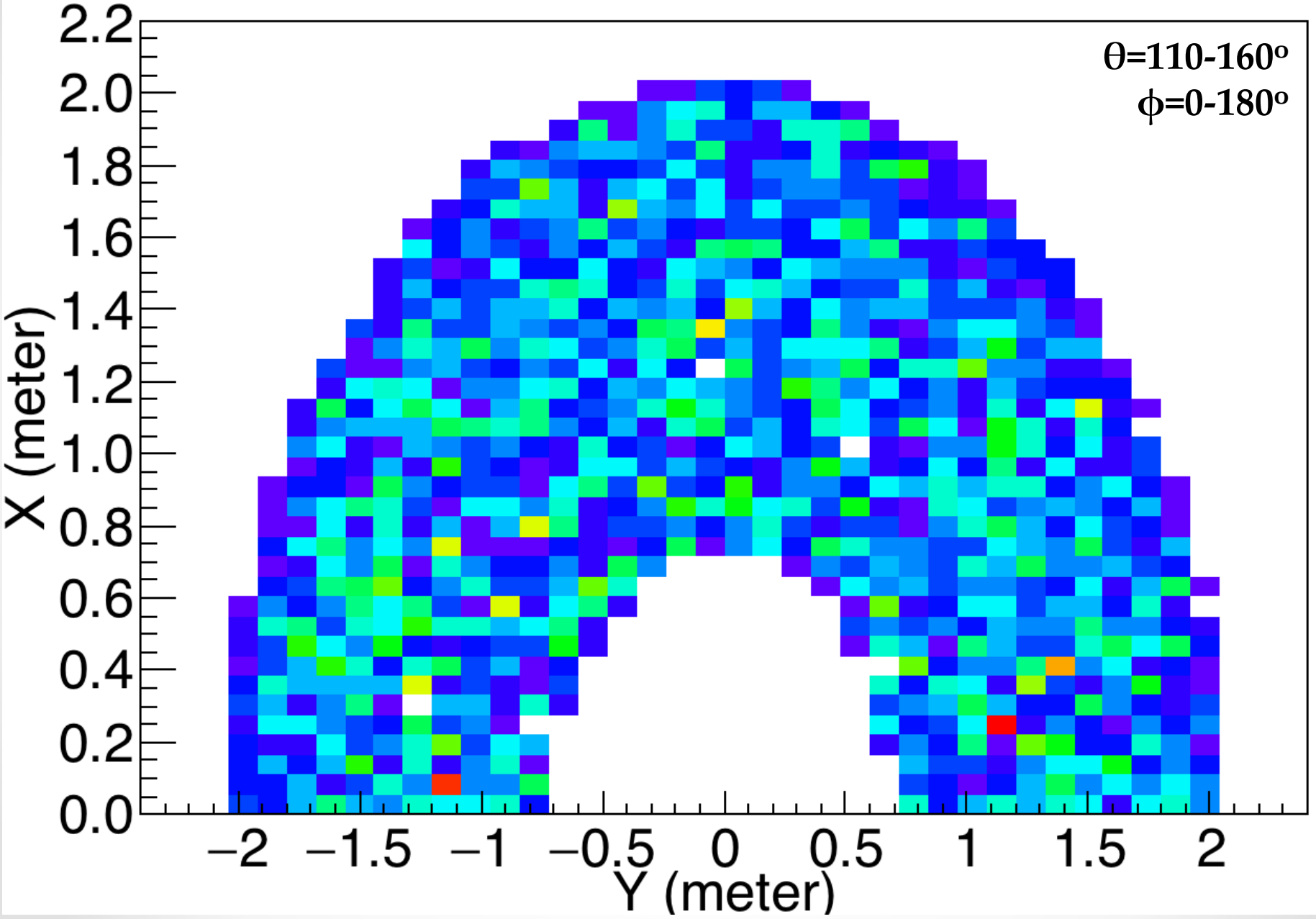
Kinematics for 4 GeV beam



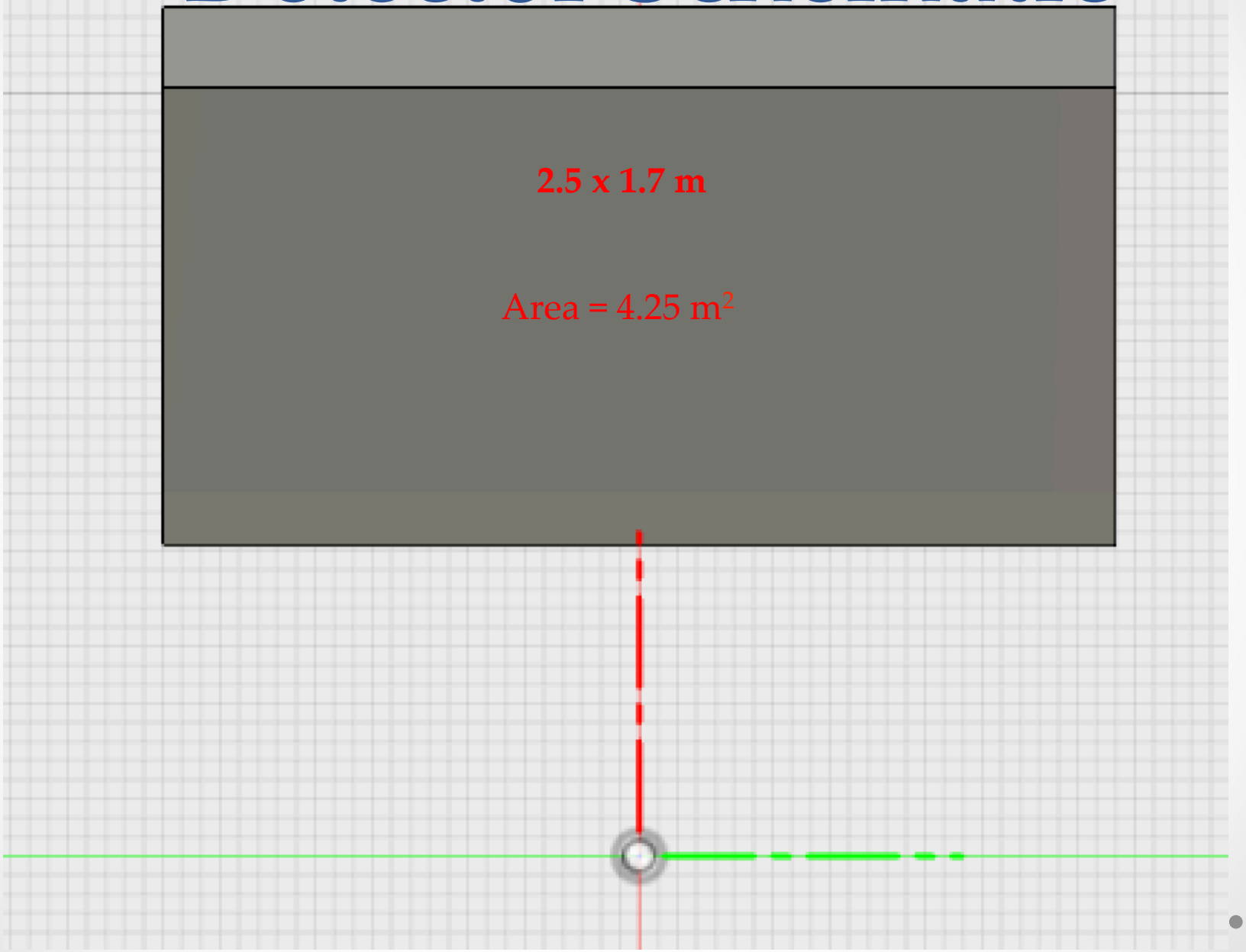
Ideal Trapezoidal Design

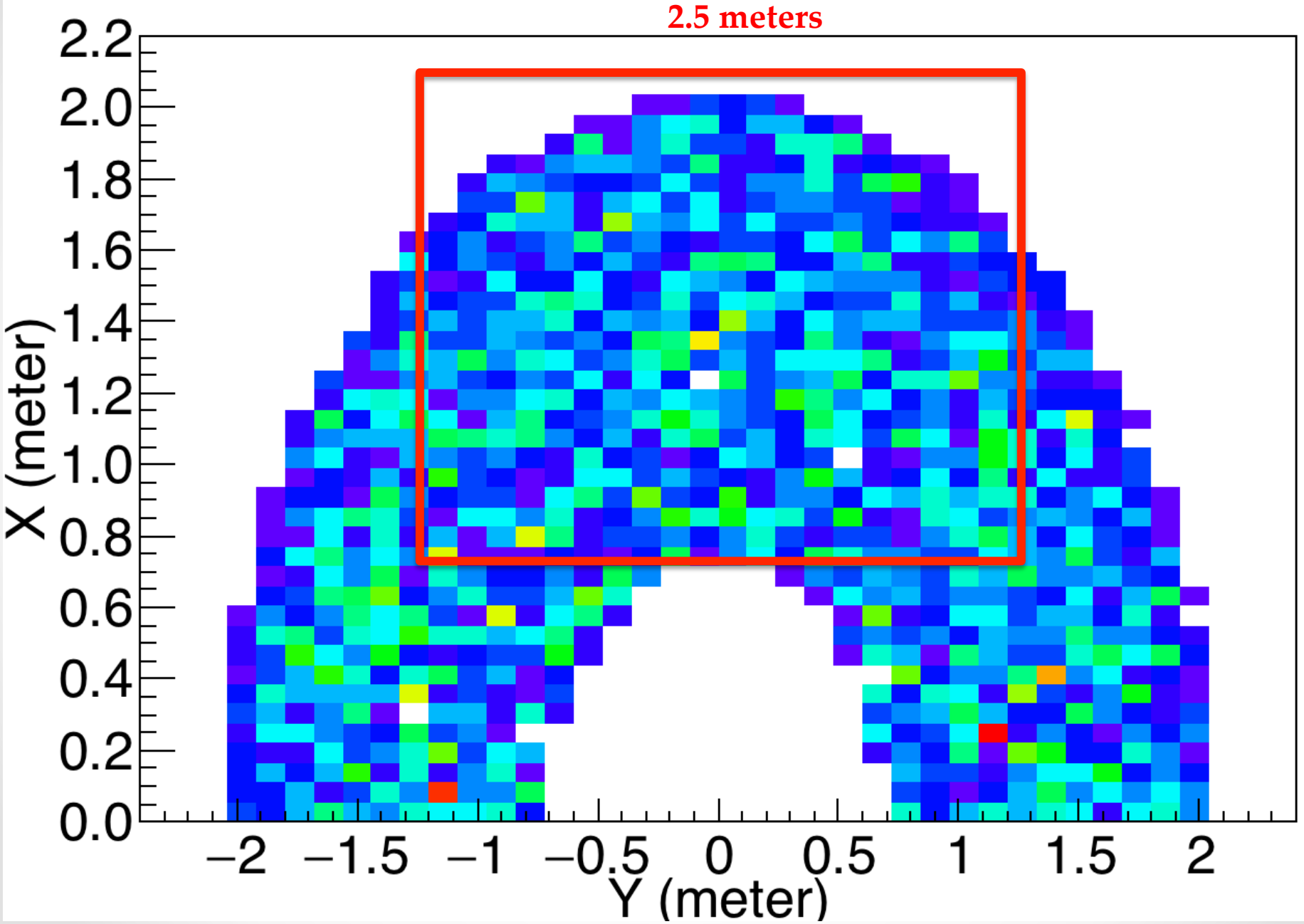


Base 1 = 2.2 m
Base 2 = 0.9 m
Height = 1.7 m
Area = 2.72 m^2
Distance: 2.0 m

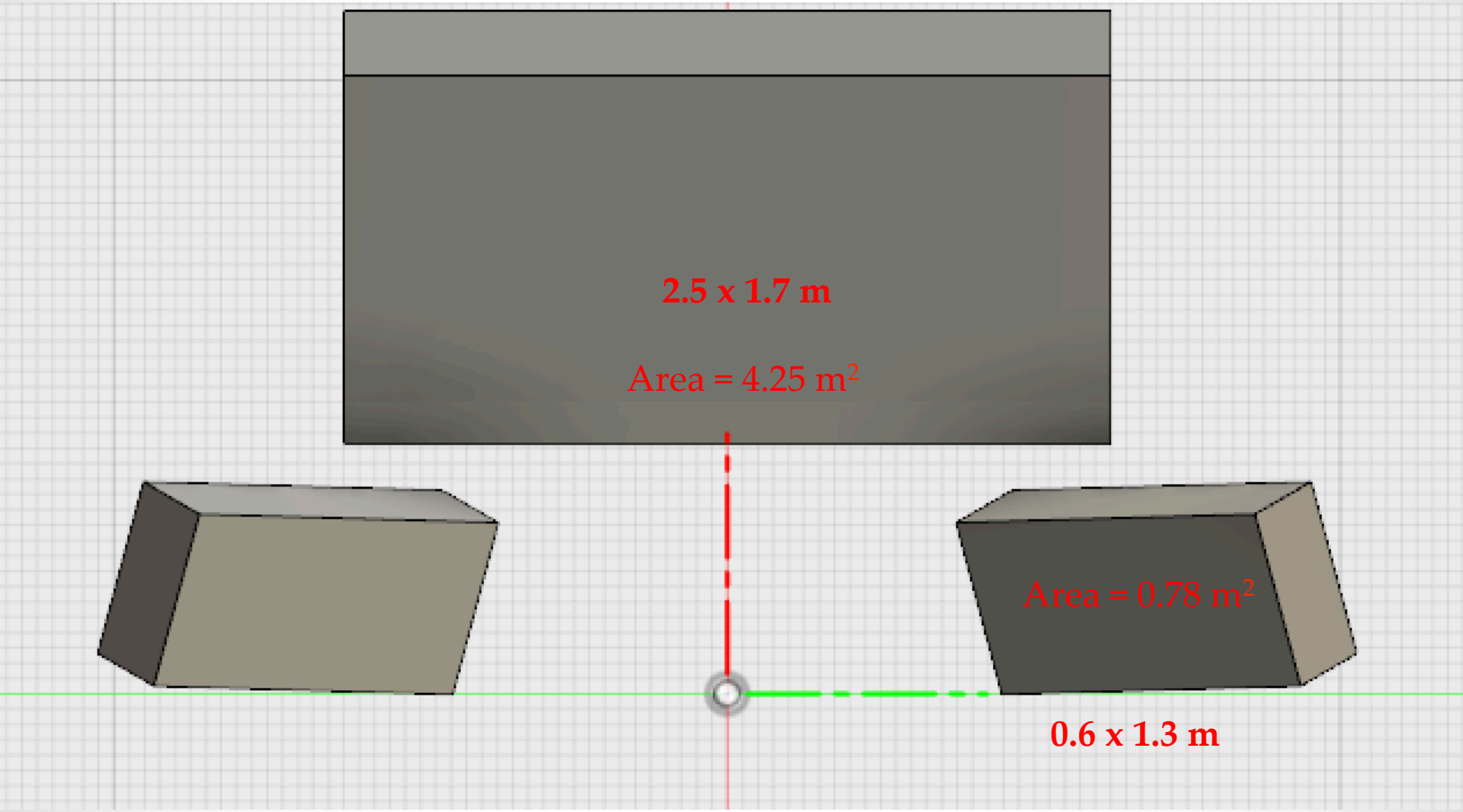

θ=110-160°
ϕ=0-180°
X (meter)
Y (meter)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2

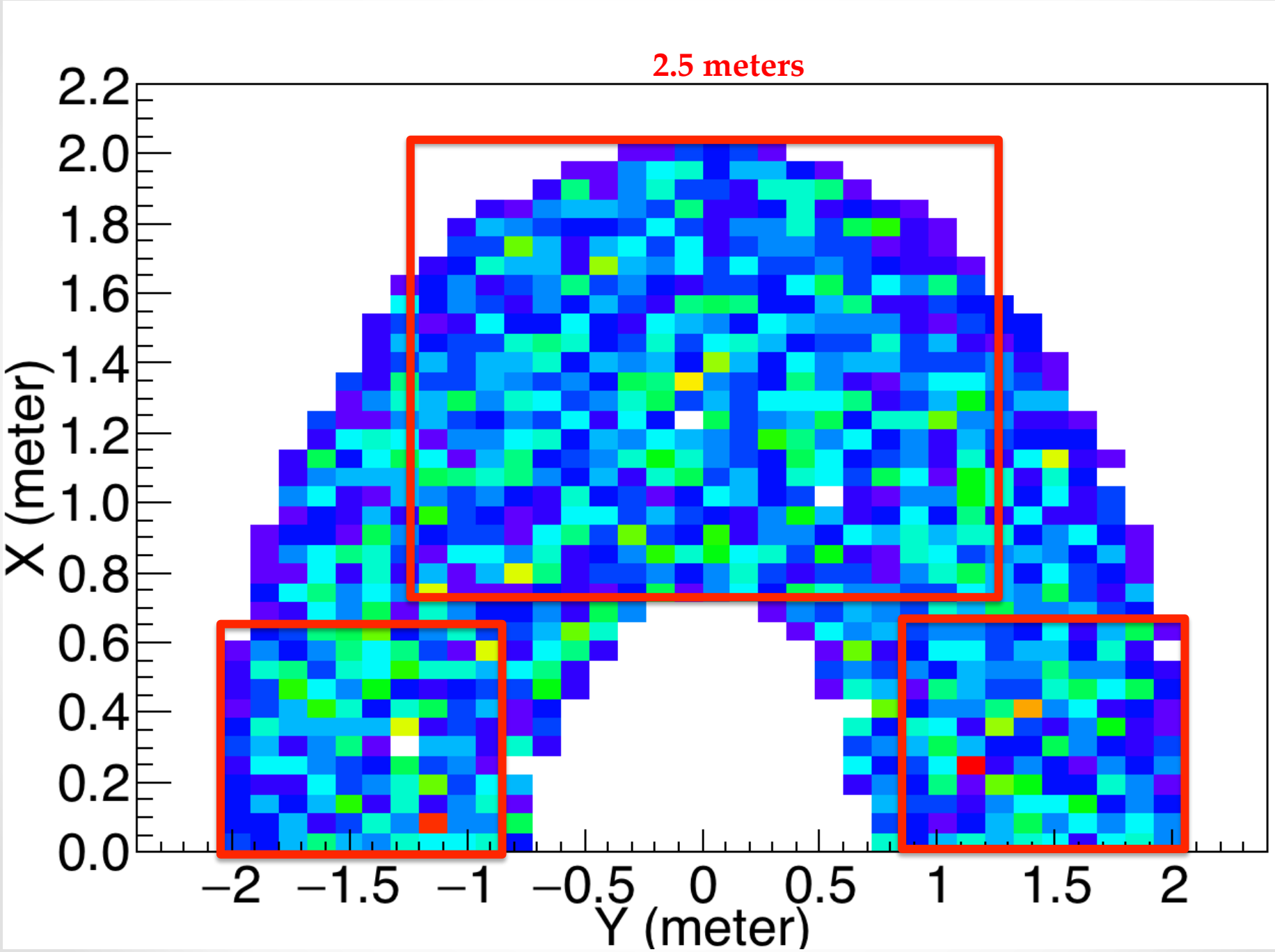
Detector Schematic



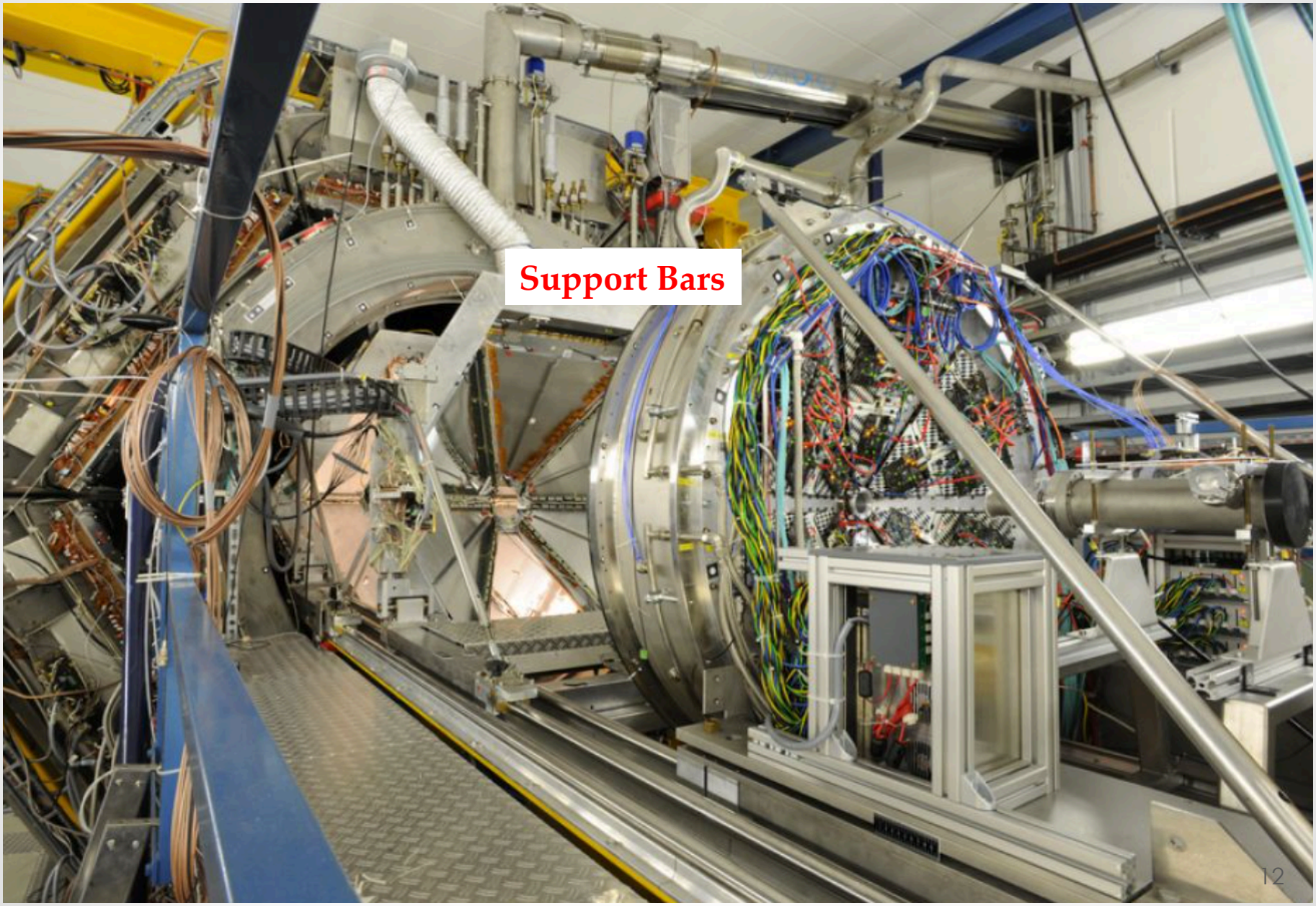

2.5 meters
X (meter)
Y (meter)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2

Detector Schematic

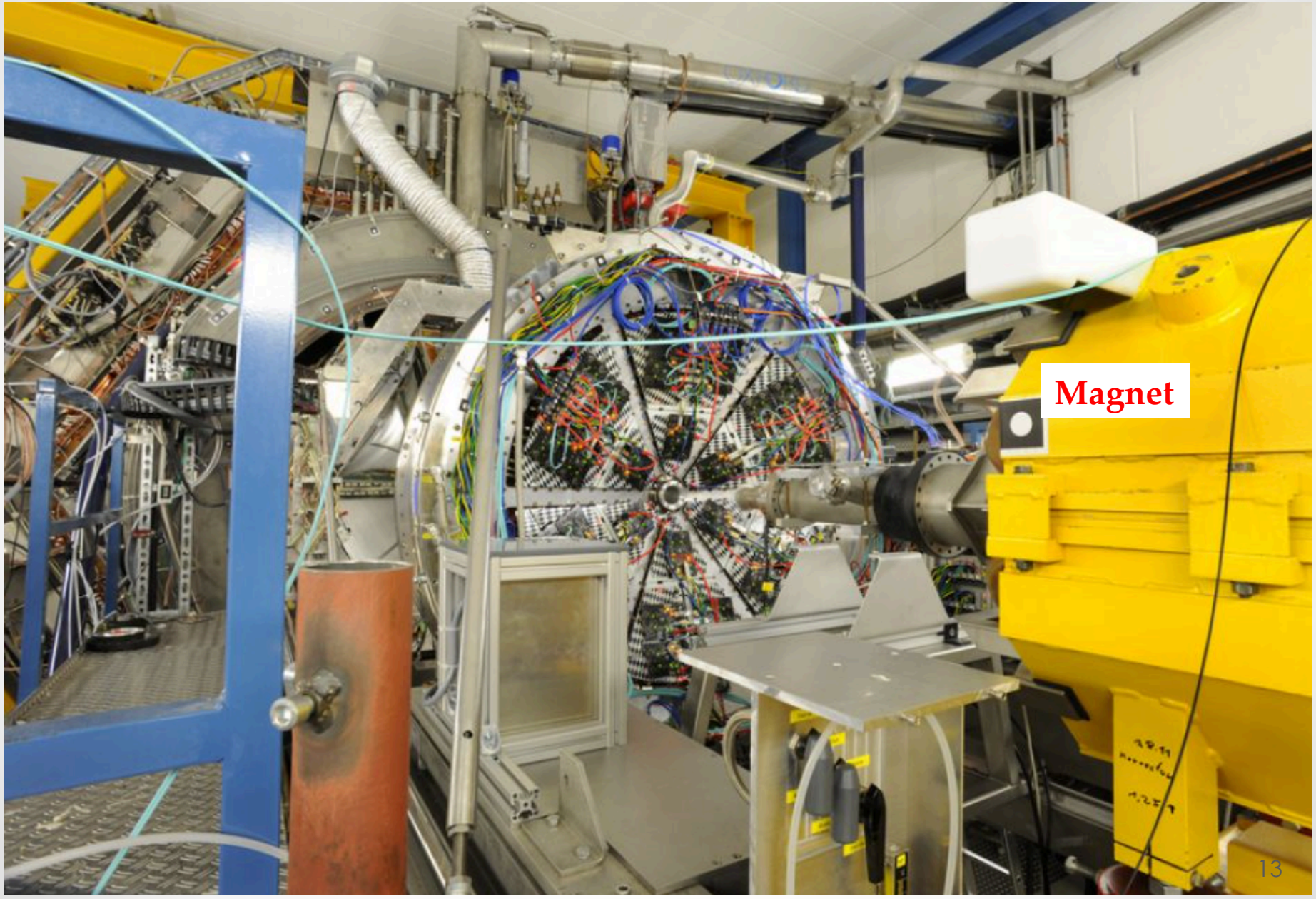



2.5 meters
X (meter)
Y (meter)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−2
−1.5
−1
−0.5
0
0.5
1
1.5
2

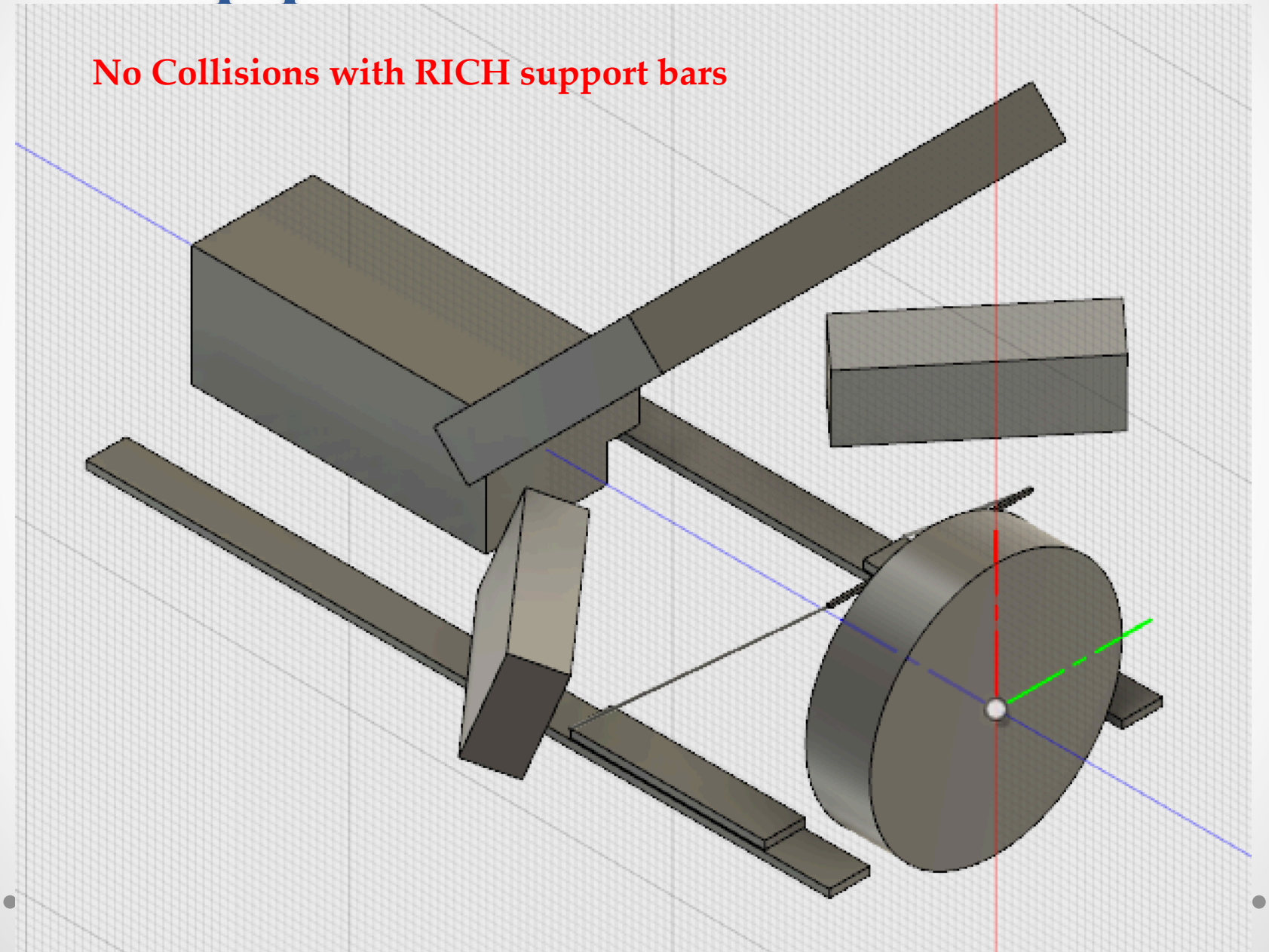
HADES Cave



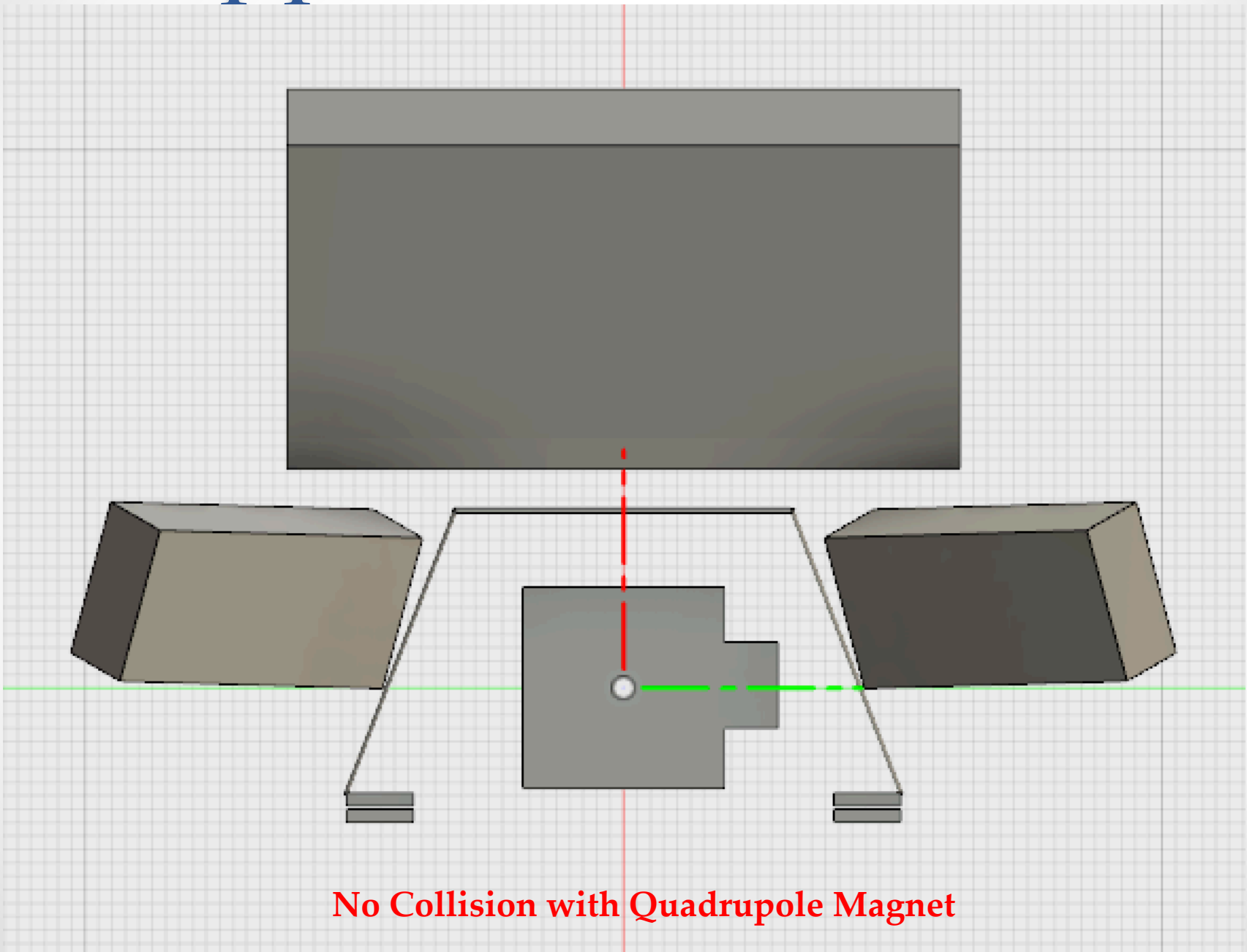
HADES Cave



Apparatus Schematic

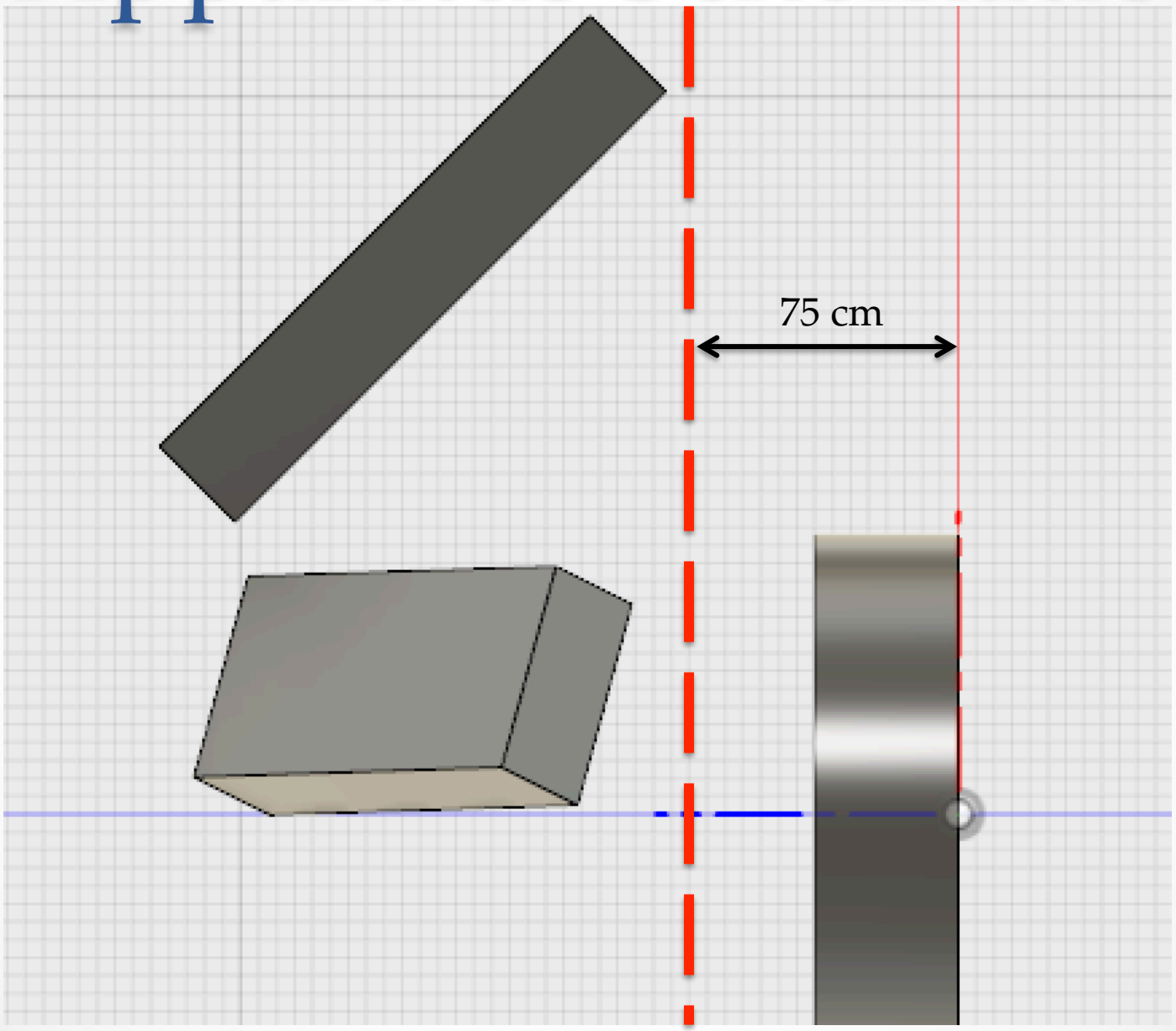


Apparatus Schematic



No Collision with Quadrupole Magnet

Apparatus Schematic



Comparison of Acceptances

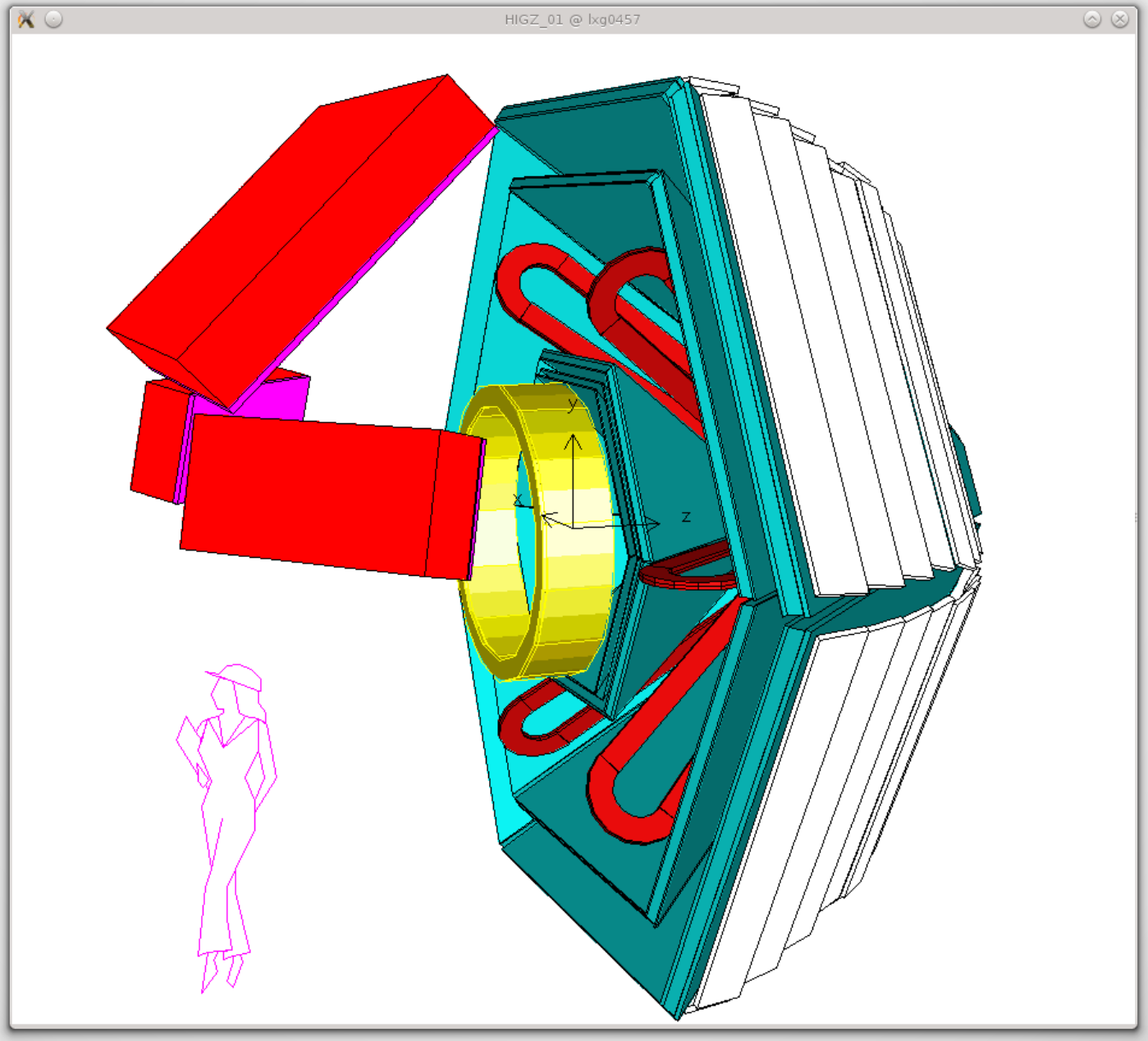
Detector	Comparison (%)
Design 1 (Trapezoid)	Maximum possible acceptance
Design 2 (2.5 m wall)	52
Design 3 (2.5 m wall + 2x0.6 m walls)	(52+2*1/3*Area of side wall/Area of Trapezoid=) **71**

Available Plastic Scintillators

- Ohio: 2x(180 x 20 x 400) cm
  (Rectangular Bars)
  - 2 walls. Each: 8 bars (10 x 22.5 x 400) cm

- LADS: 2x(130 x 20 x 160) cm & 2x(190 x 15 x 160) cm
  (Trapezoidal Bars)
  - 2 walls. Each: 14 bars, 11.4(7) cm wide, 20 cm deep, 160 cm long
  - 2 walls. Each: 14 bars, 15(12) cm wide, 15 cm deep, 160 cm long

Simulation



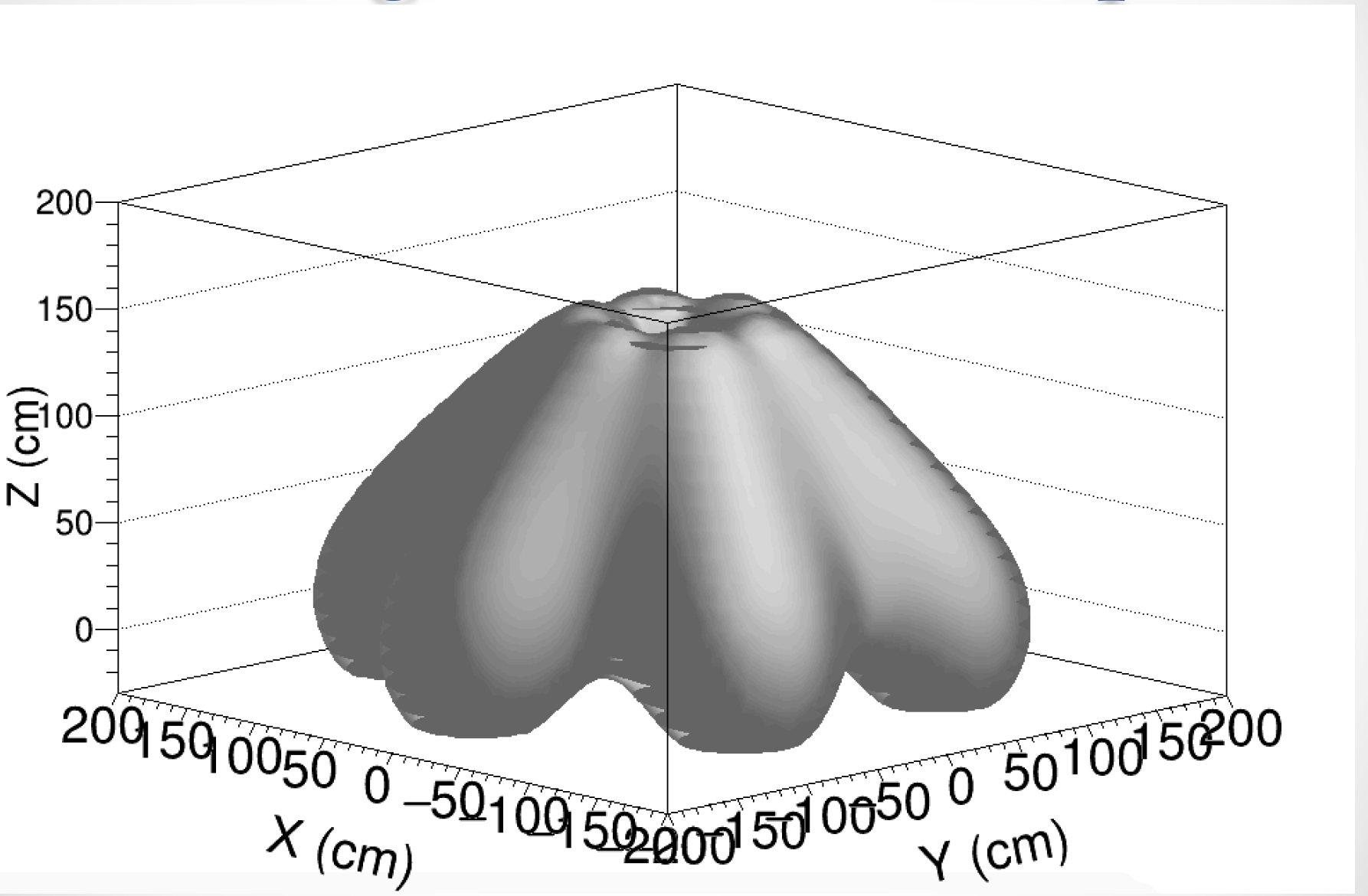
Detector Characteristics

- Detector thickness: **~30 cm**
- Longitudinal segmentation: **10-15 cm**
- Distance from target to detector: **2.0 m**

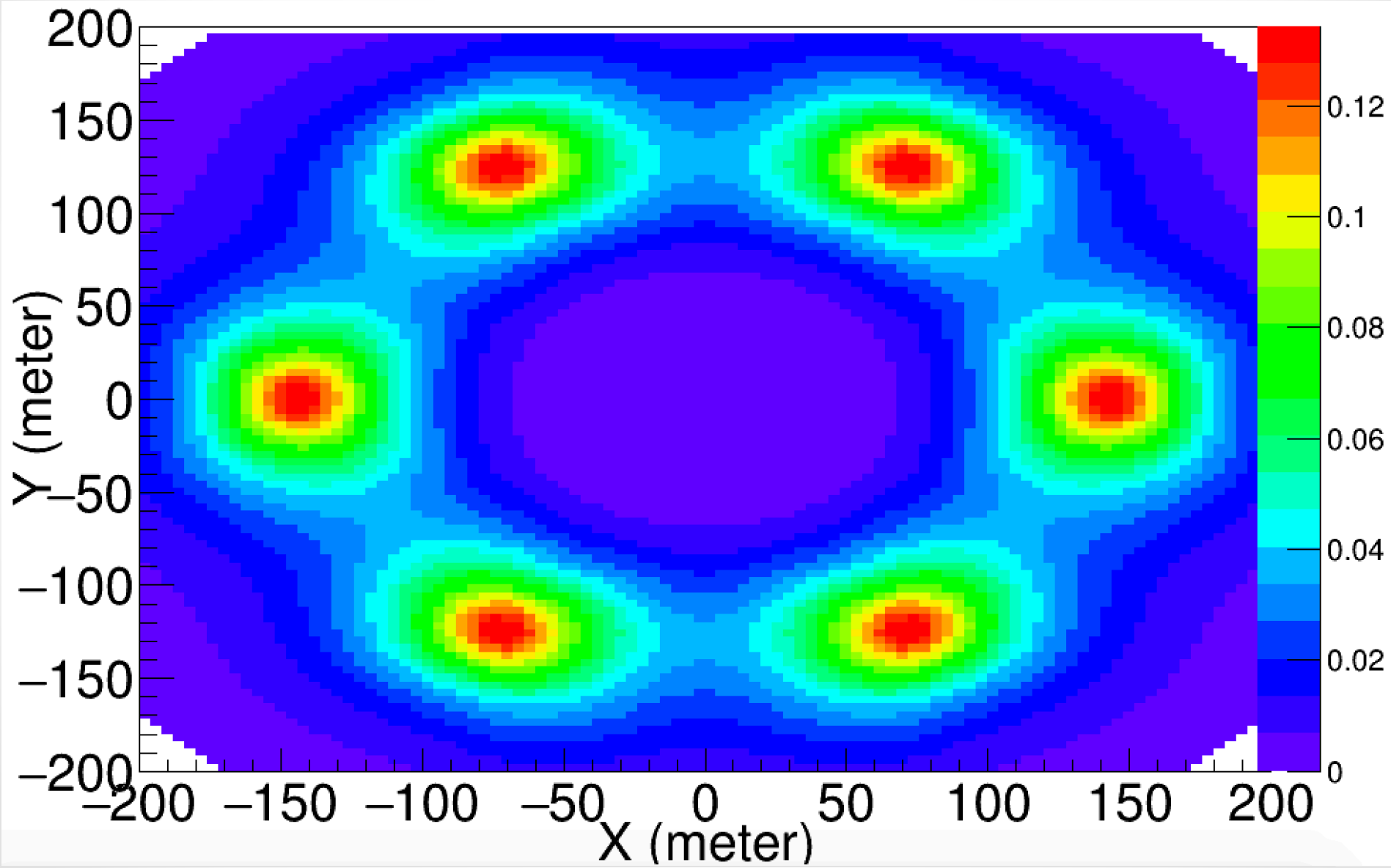
Resolutions

- Longitudinal resolution: **7.5 cm (max)**
- Time resolution: **(δt) = 200 psec**
- Momentum resolution: **$(\delta P/P)$ = ~4.5% @ 0.5 GeV/c**
- Energy Resolution: **$(\delta E/E)$ = ~1.0% @ 0.5 GeV/c**
- Position Resolution: **$(\delta x) = 3$ cm**

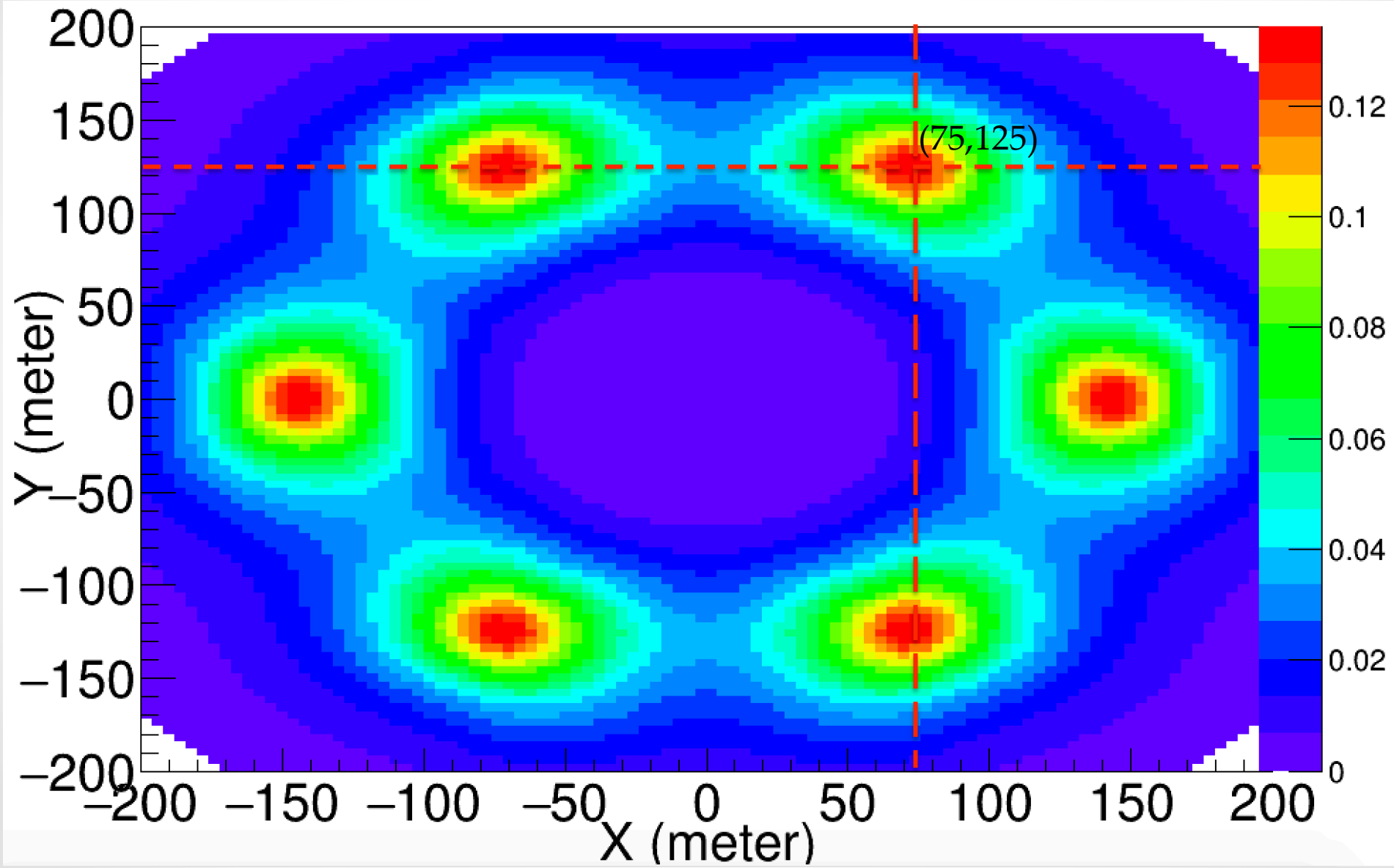
Magnetic field Map



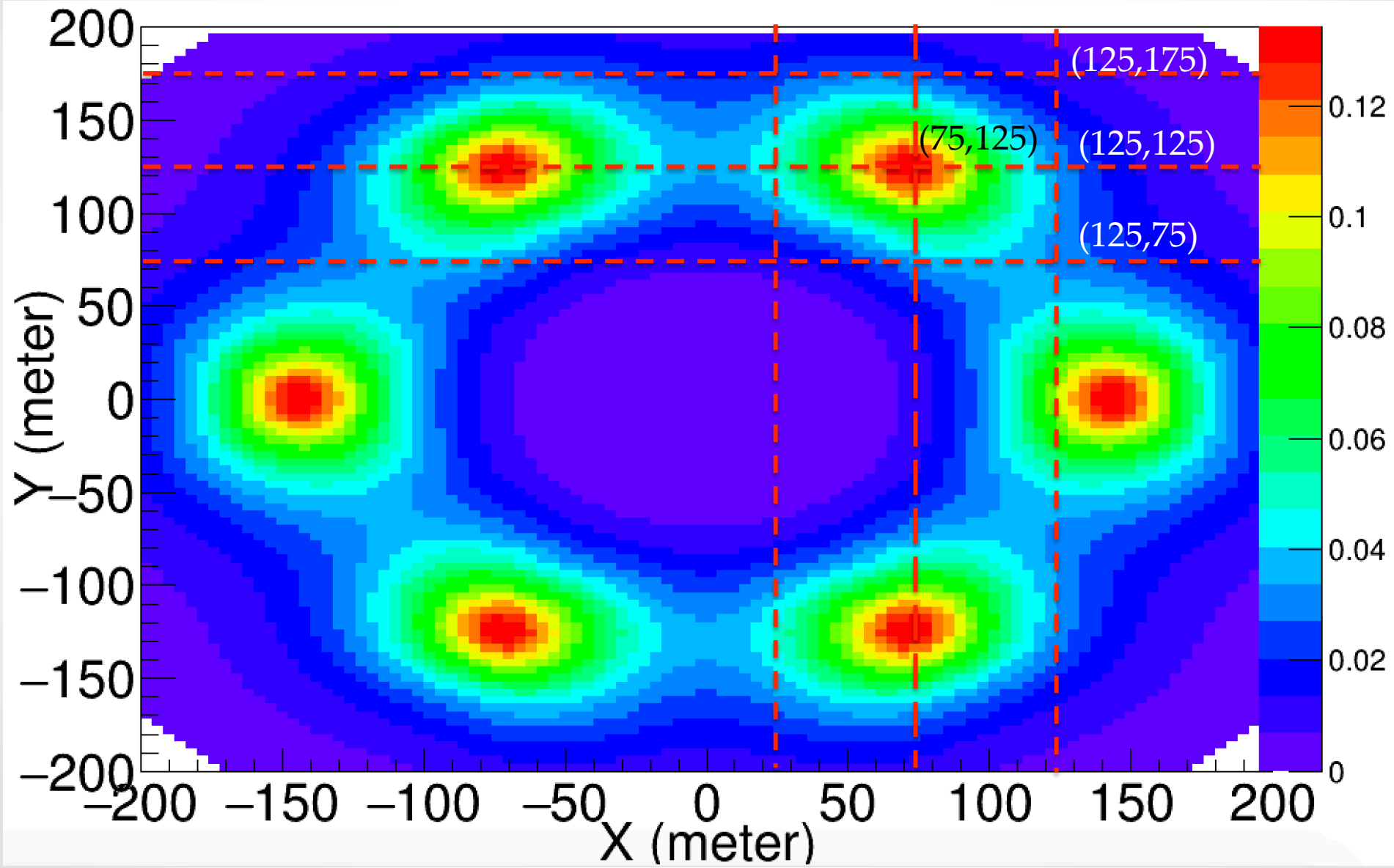
Magnetic field at x-y plane for z=-30 cm



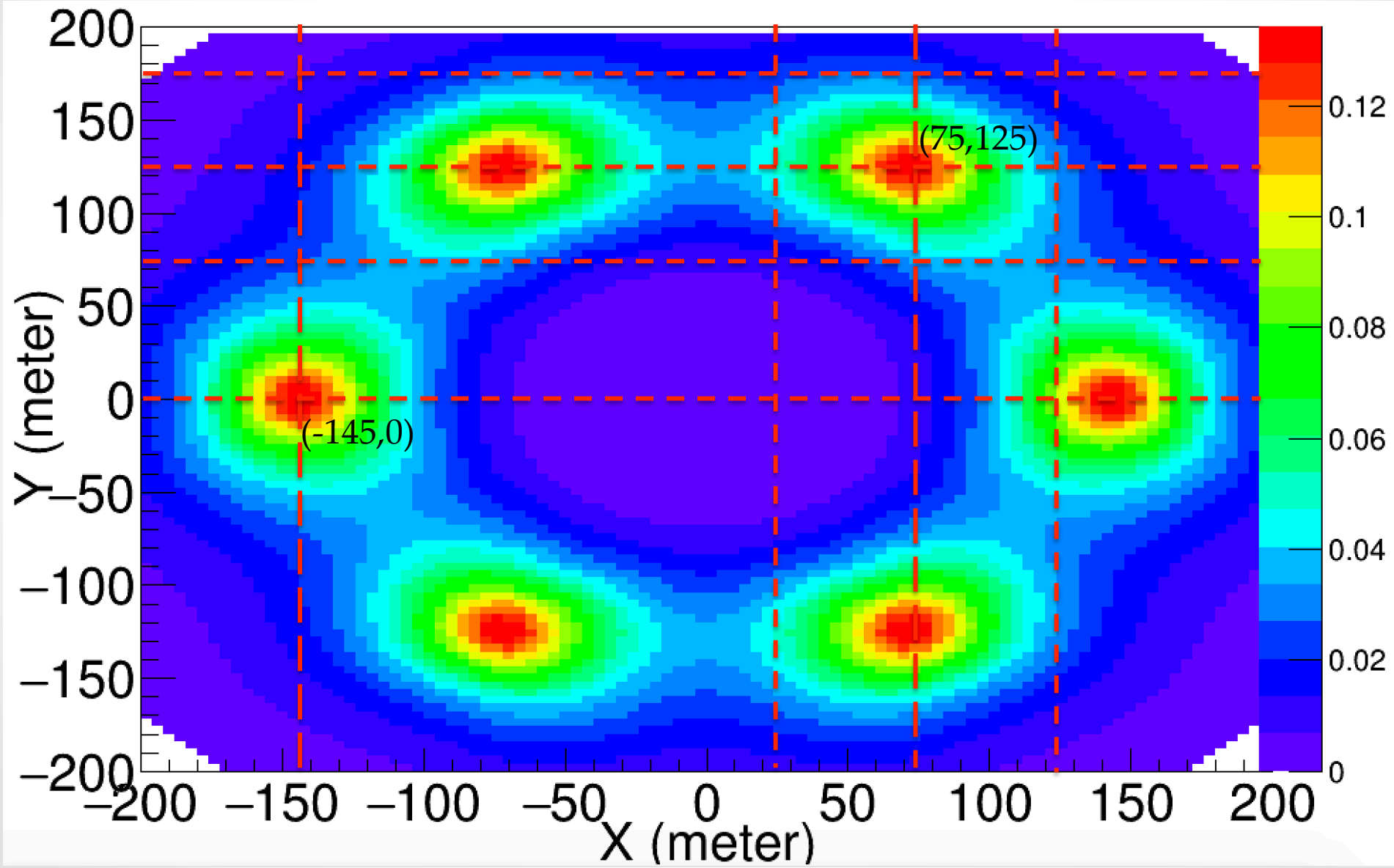
Magnetic field at x-y plane for z=-30 cm

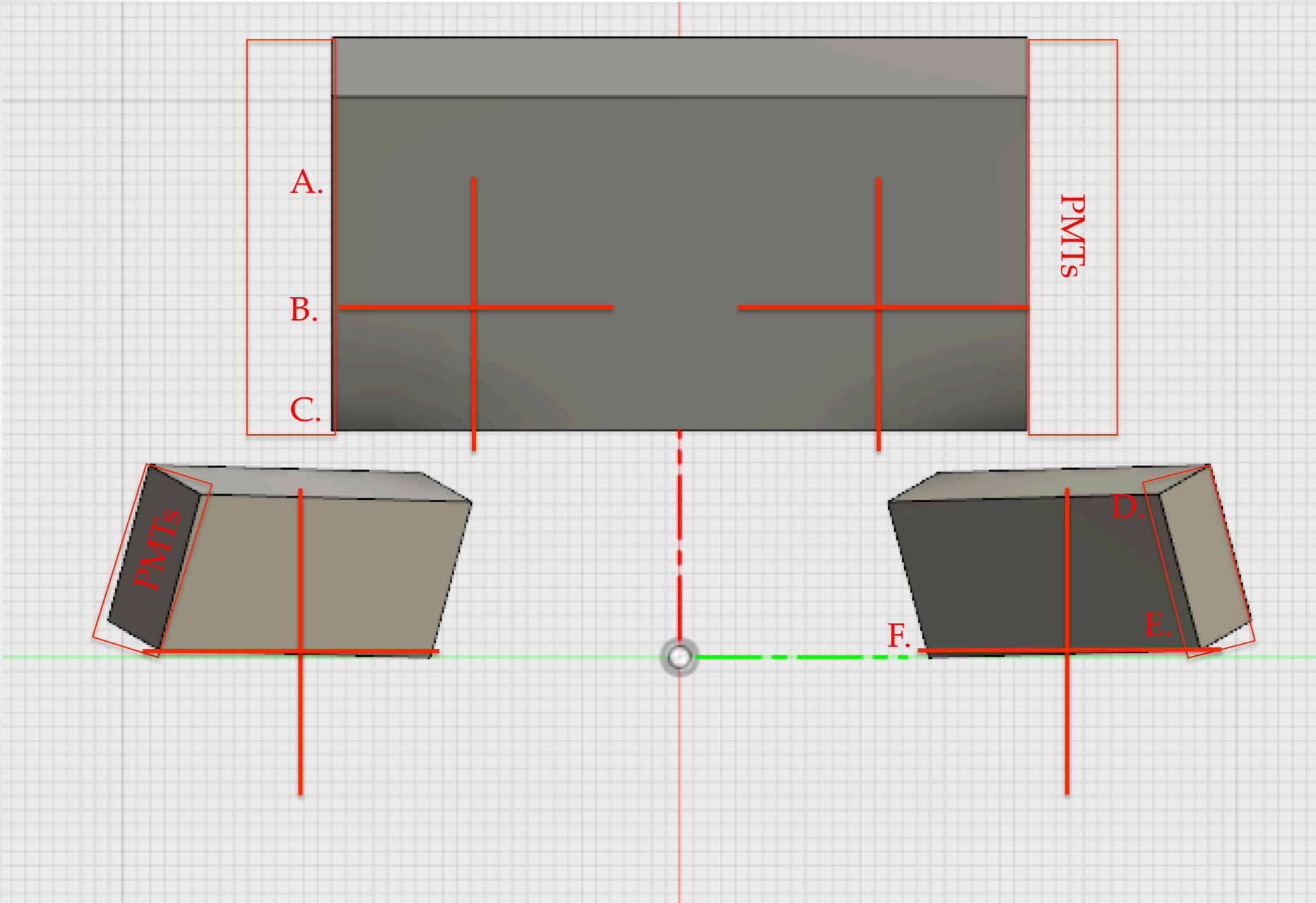


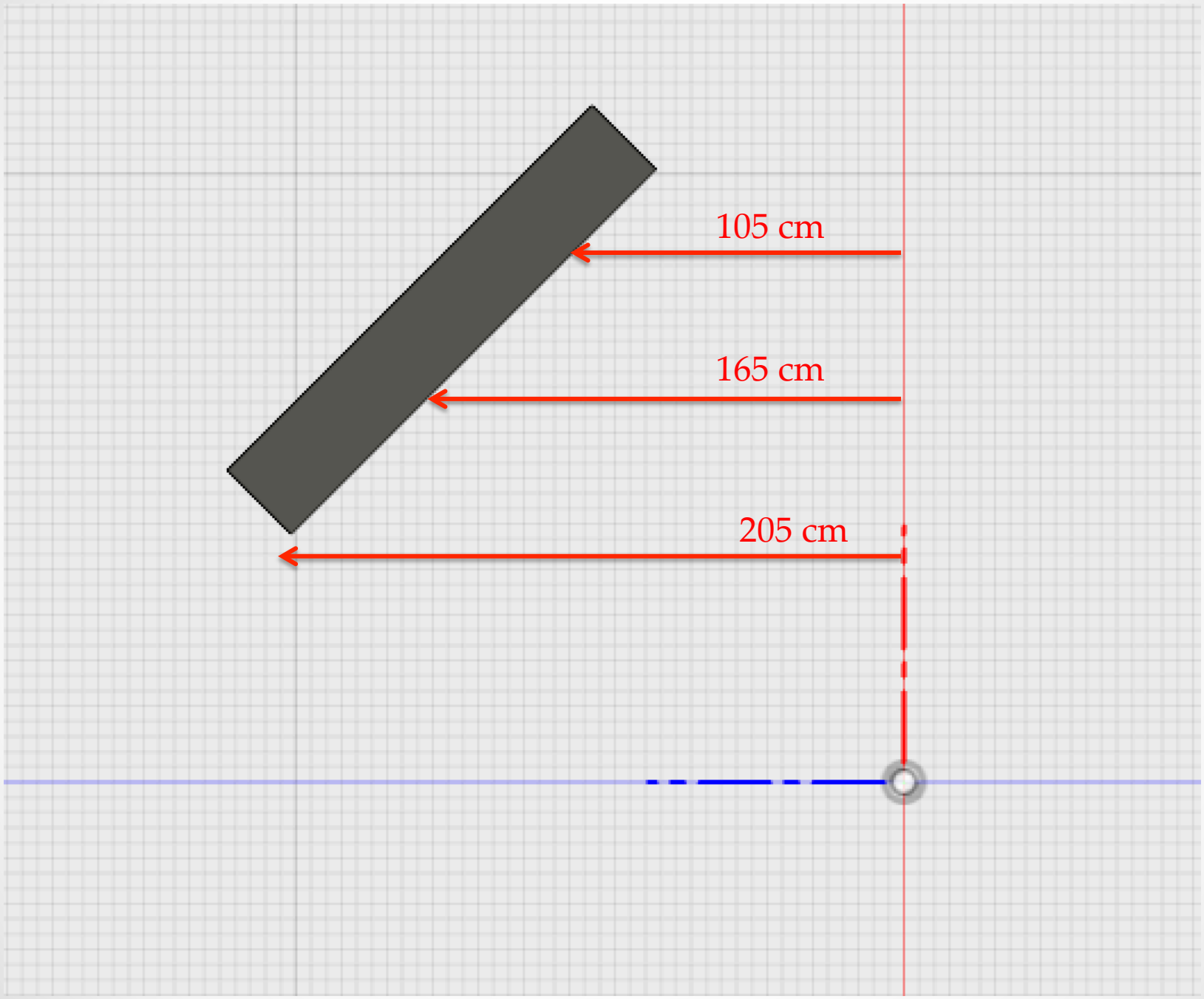
Magnetic field at x-y plane for z=-30 cm

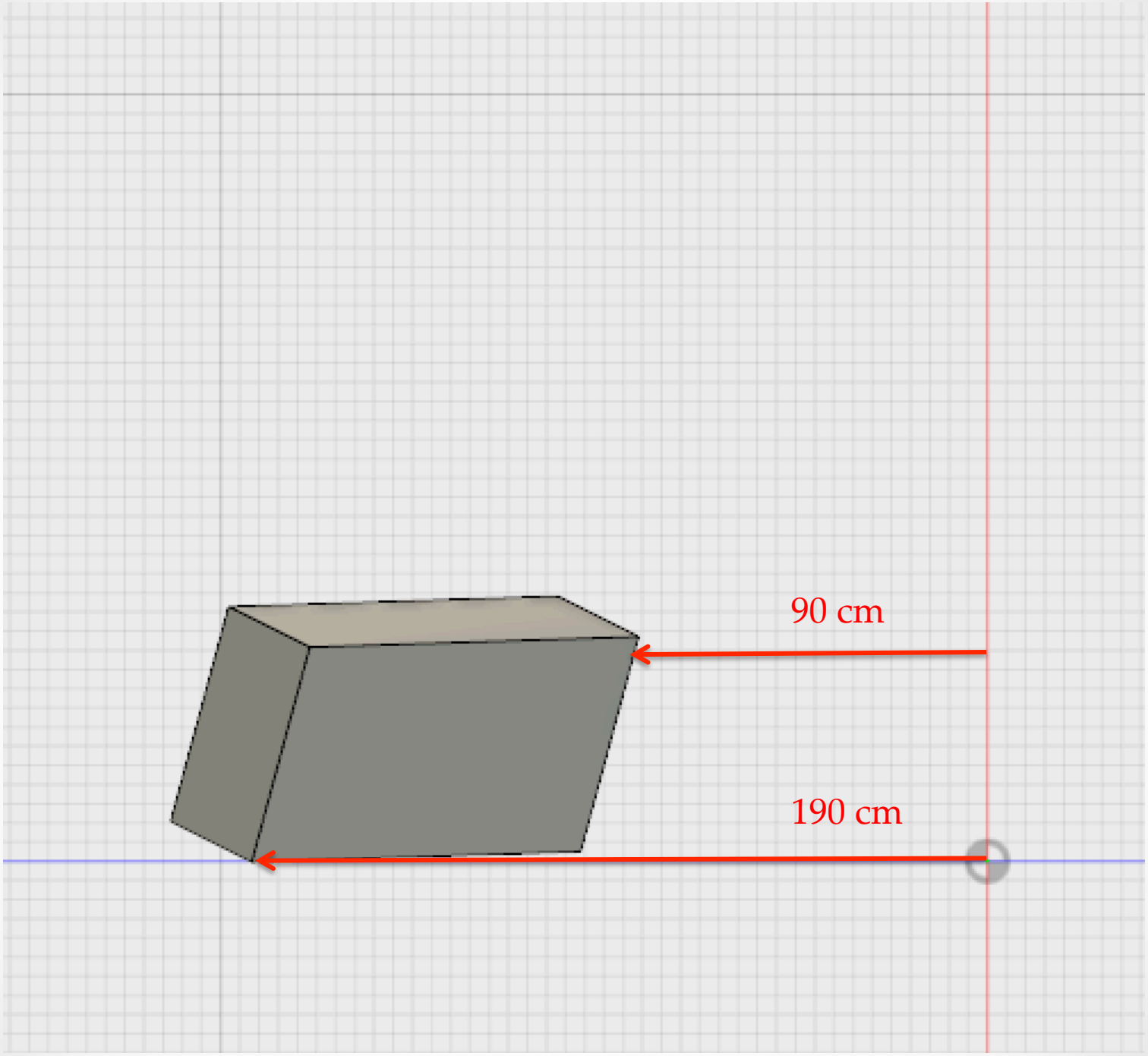


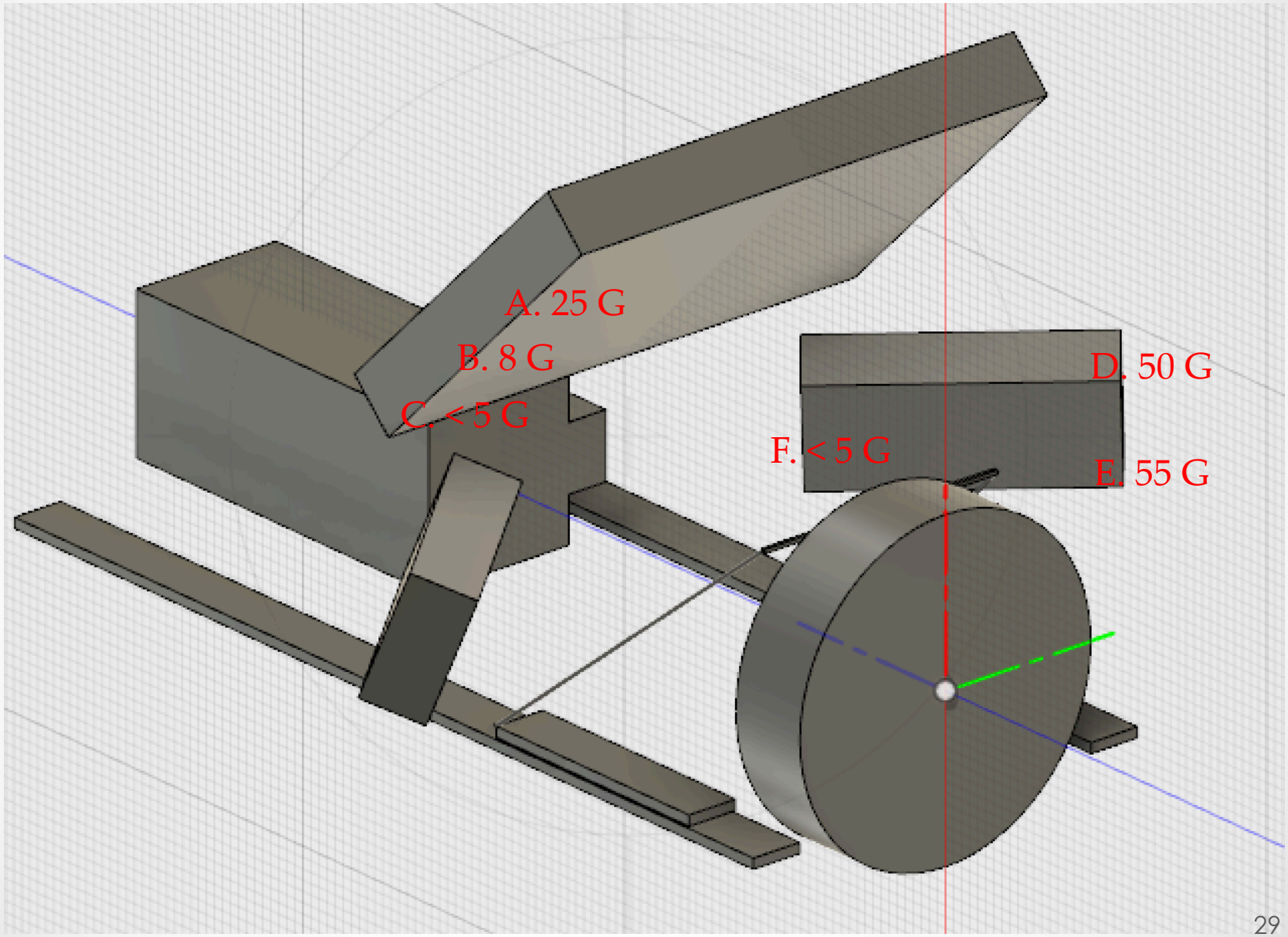
Magnetic field at x-y plane for z=-30 cm



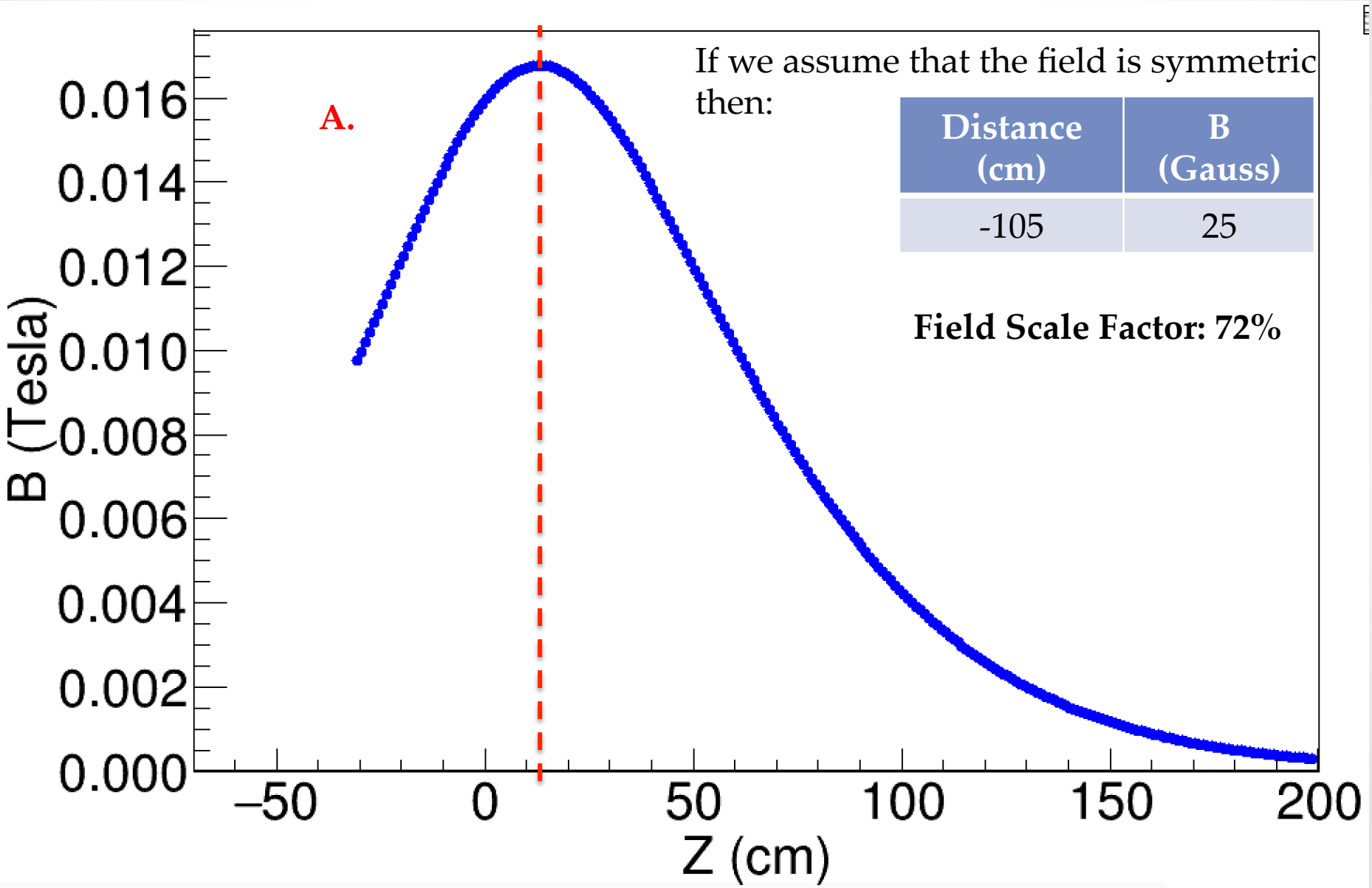

A.
B.
C.
PMTs
PMTs
D.
E.
F.


105 cm
165 cm
205 cm

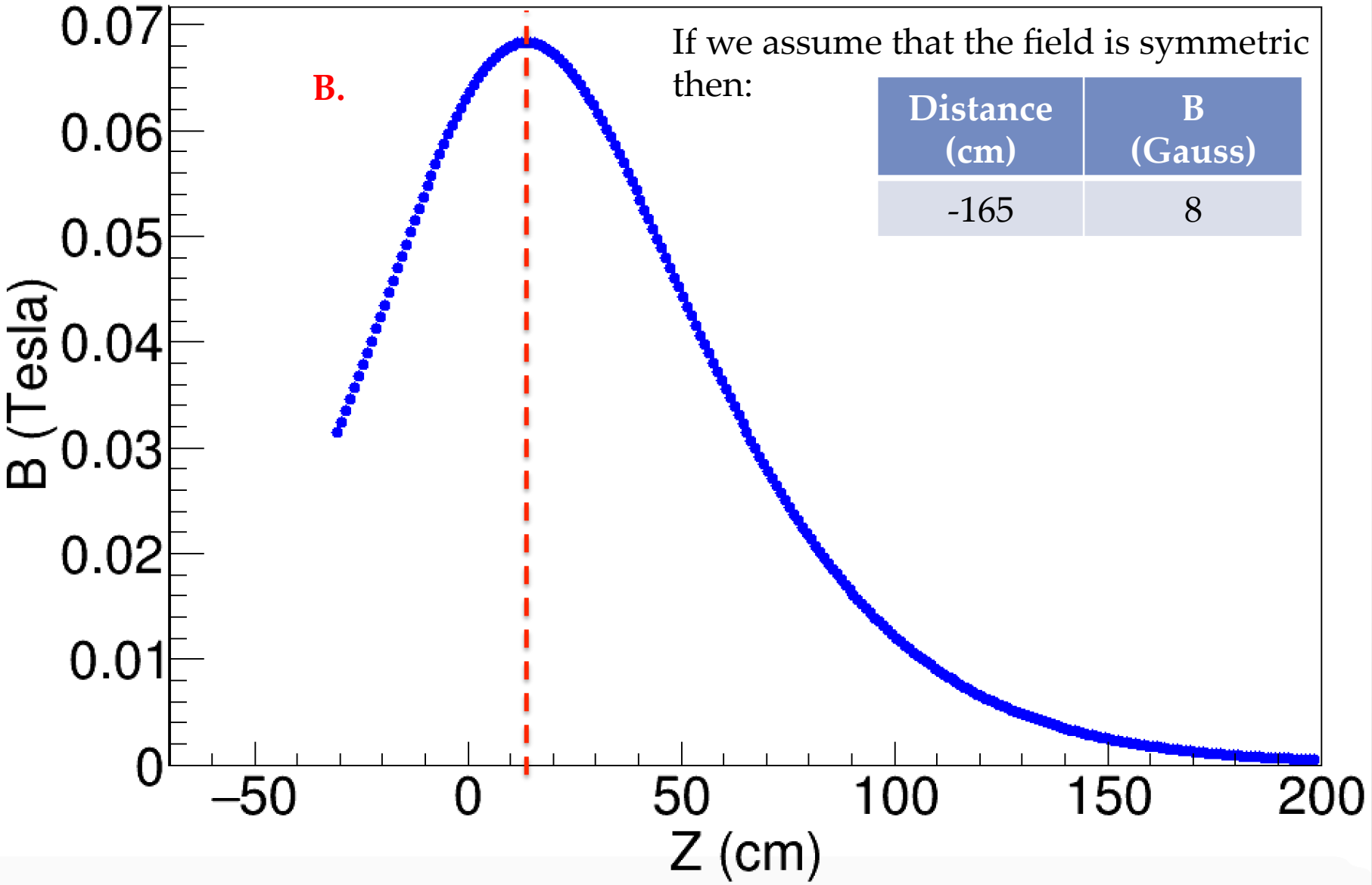

90 cm
190 cm


A. 25 G
B. 8 G
C. < 5 G
D. 50 G
E. 55 G
F. < 5 G

Magnetic field at (x=125,y=175,z)



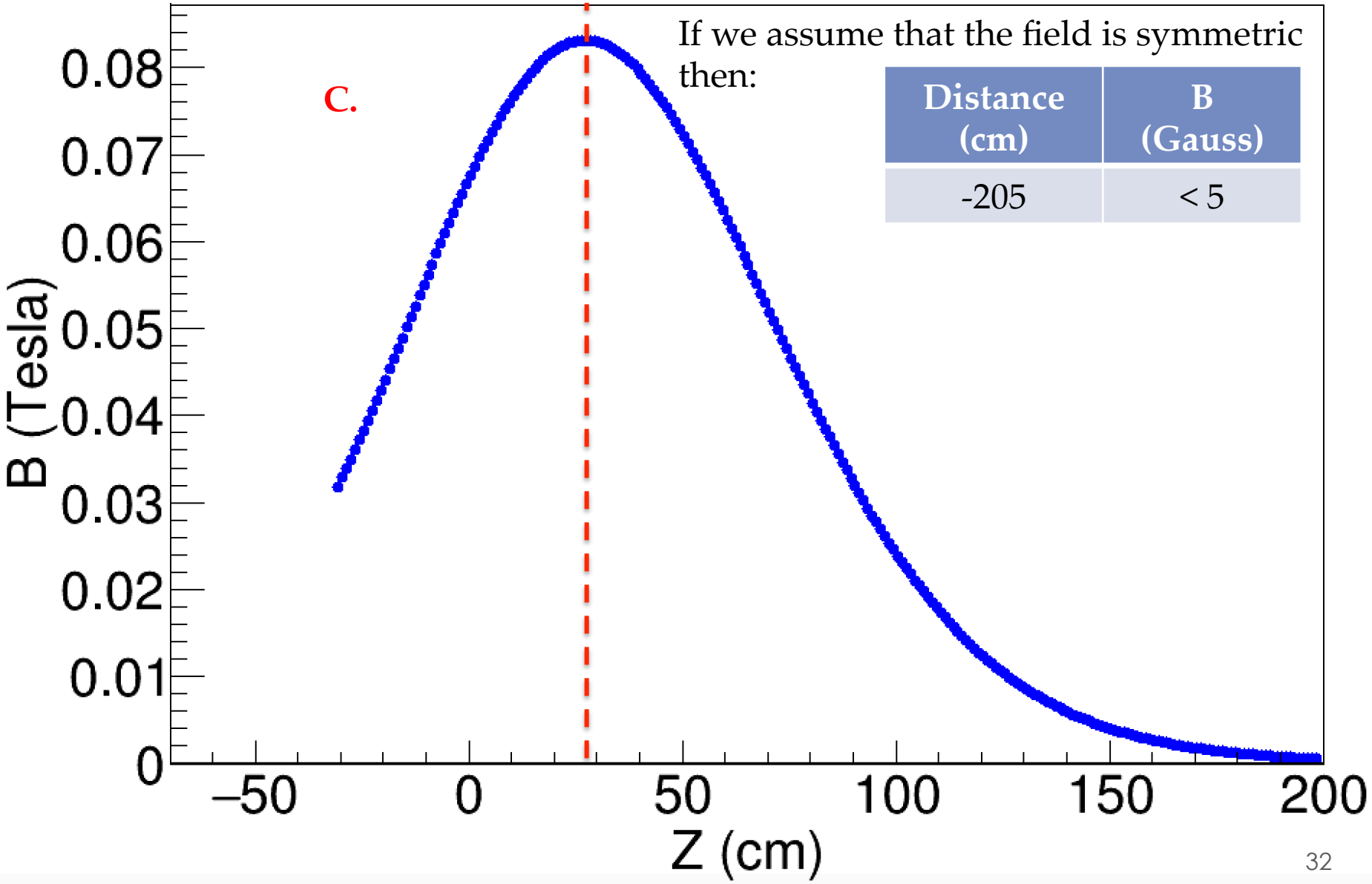
Magnetic field at (x=125,y=125,z)



If we assume that the field is symmetric then:

Distance (cm)	B (Gauss)
-165	8

Magnetic field at (x=125,y=75,z)

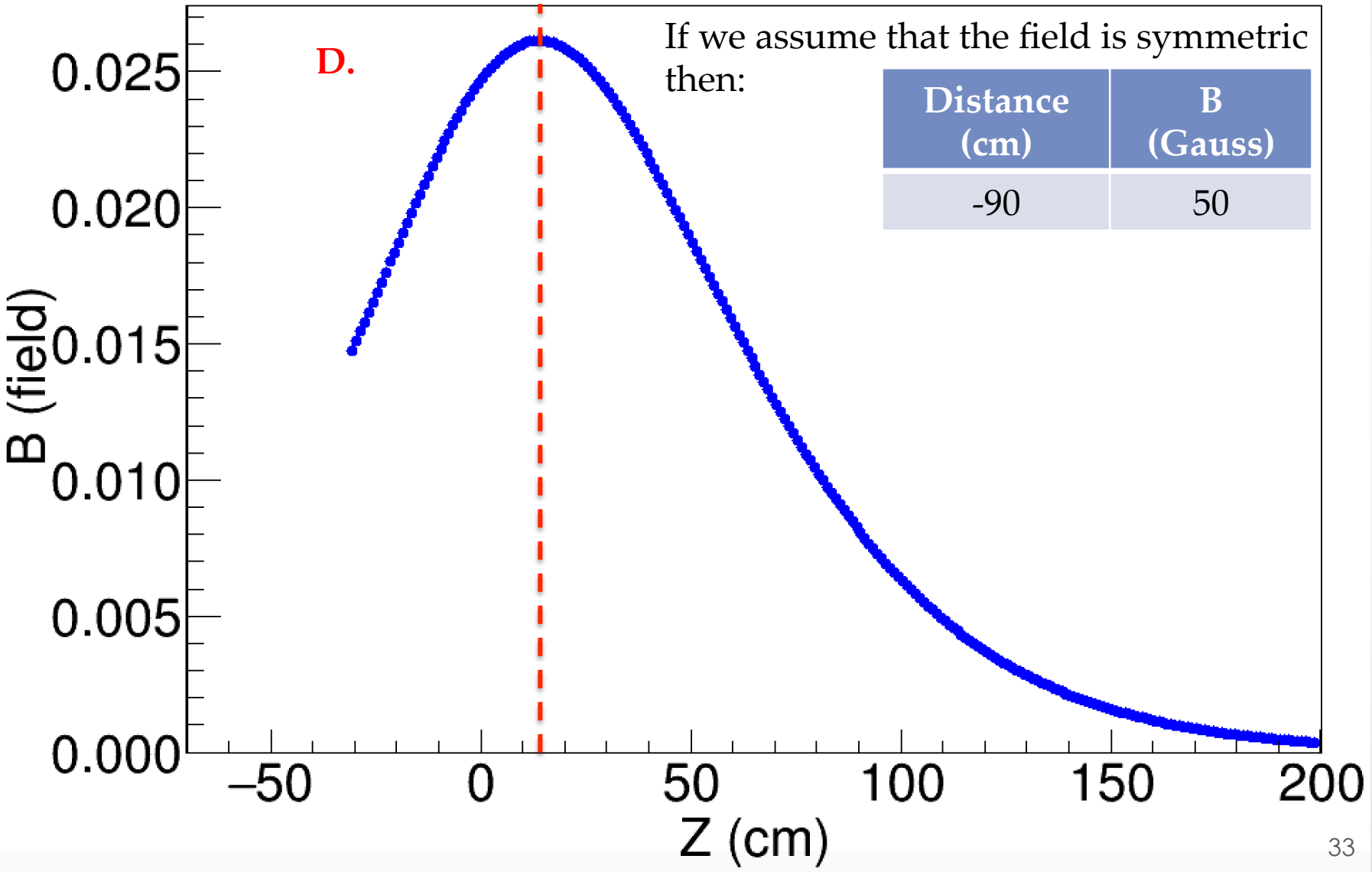


C.

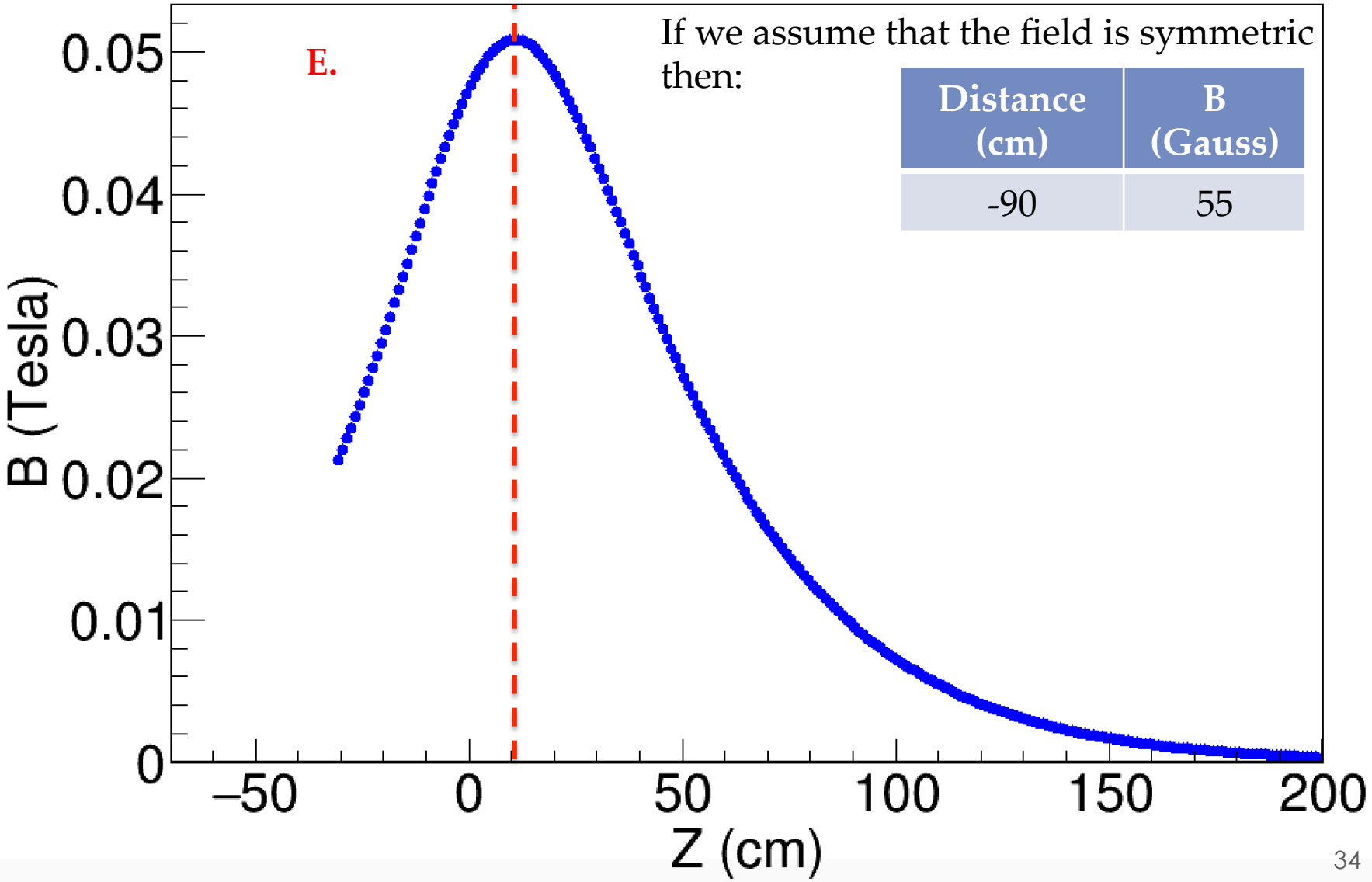
If we assume that the field is symmetric then:

Distance (cm)	B (Gauss)
-205	< 5

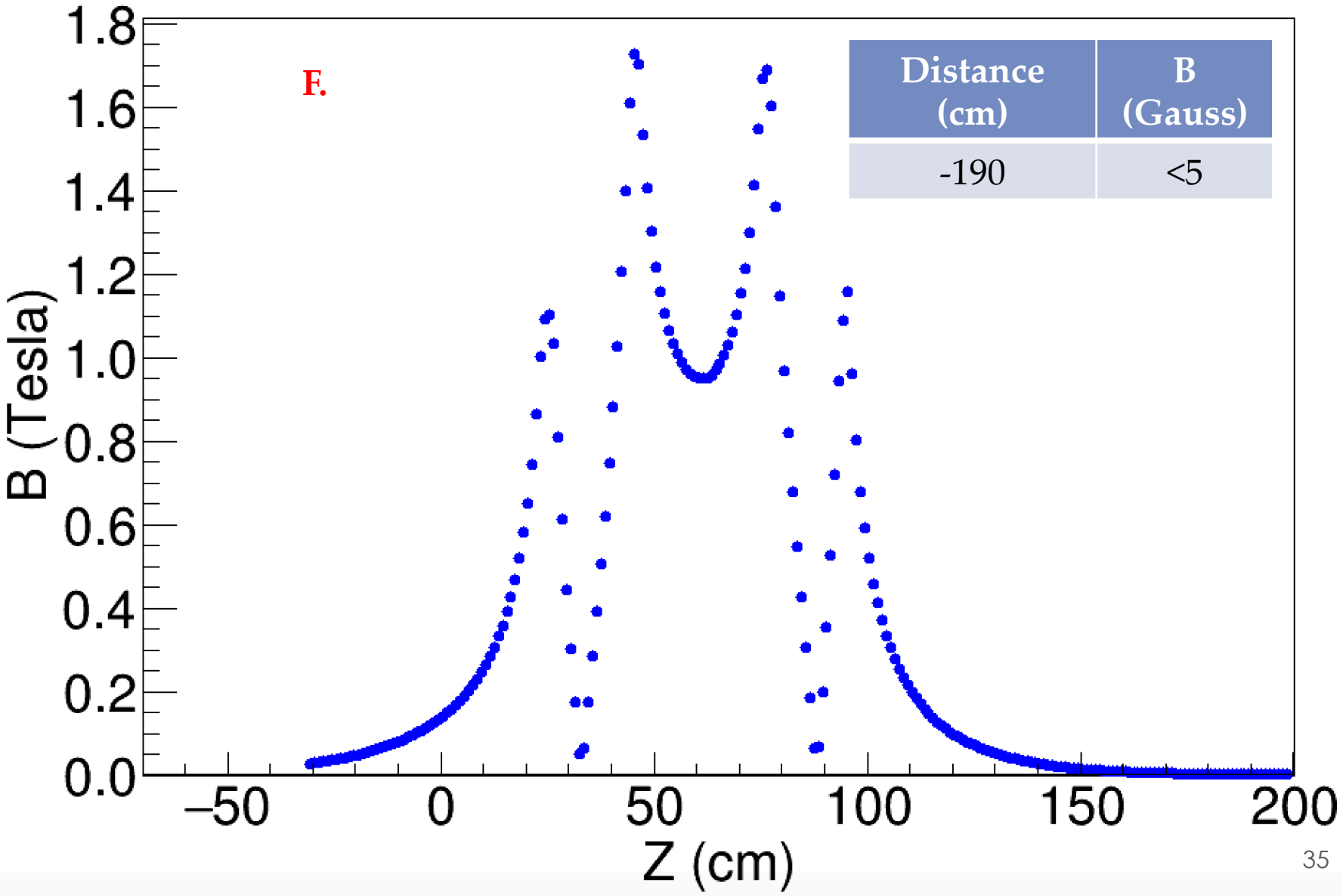
Magnetic field at (x=195,y=50,z)



Magnetic field at (x=195,y=0,z)



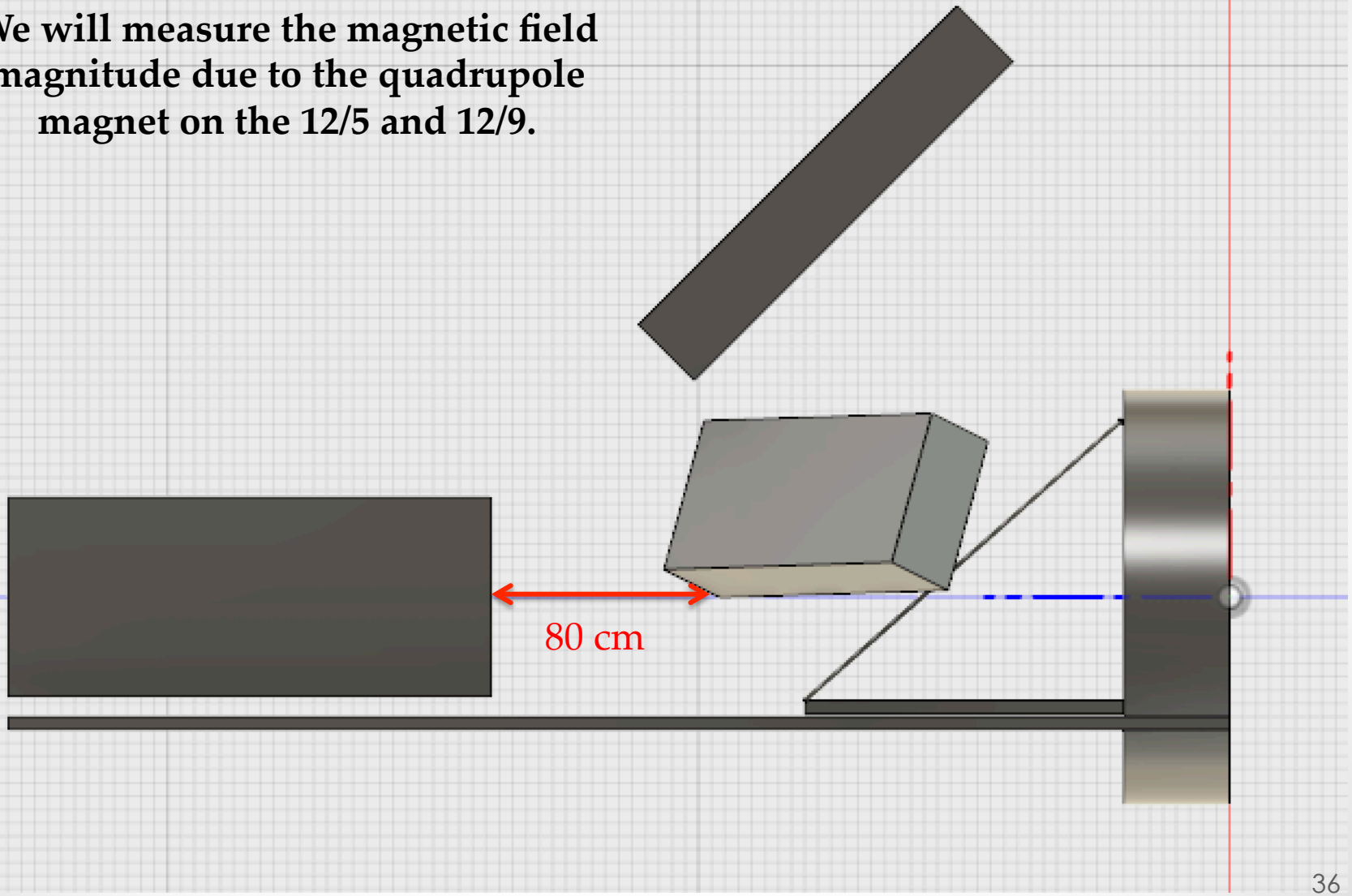
Magnetic field at (x=95,y=0,z)



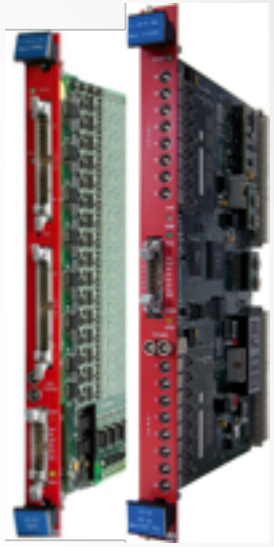
Distance (cm)	B (Gauss)
-190	<5

Effect of Quadrupole Magnet

We will measure the magnetic field magnitude due to the quadrupole magnet on the 12/5 and 12/9.



DAQ for SRC@HADES



- We usually use ***VME***-based modules
  - CAEN TDC (best performance: **V1290N**)
    - 25 ps LSB, 21 bit resolution.
    - 52 μs full scale range.
    - NIM standard.
    - 5 ns Double Hit Res., Leading & Trailing Edge.
  - mesytec / CAEN QDC (e.g. **V792**)
    - 12-bit resolution.
    - 5.7 μs / 32 ch conversion time.
    - 600 ns fast clear time.
    - ±1.5% differential (±0.1% integral) non linearity.

DAQ for SRC@HADES

Known issues:
1. Fastest capability: ~ few 10kHz' trigger readout, might slow down the whole HADES DAQ system.
2. Requires both ADCs and TDCs.

Solution: use **HADES** experts' DAQ based on **PADIWA**
- We have recently started working with PADIWA-TRB3 platforms for the MUSE project as TDCs with fast and reliable performance.
- PADIWA-AMPs, developed for ECAL, provide ADC measurements as well.

⇨ **Best rely on HADES experts to lead this part…**

Open Issues and Next Steps

- Open Issues
  - Best way to use available scintillators
  - B-field and μ-shielding
  - Veto Detector and particle-shielding (?)
  - Electronics
- Next Steps
  - Determine final geometry of detector holder
  - Integrate Veto etc. in geometry
  - Figure out the B-field and μ-shielding
  - Decide on electronics and how to integrate them in cave
  - Simulation for background, multi-scattering etc.

Backup slides

1st case (rectangular at main wall and trapezoidal at small walls)

- Cut the 4m bars into pieces of 1.7m
- 32 bars (10 x 22.5 x 170) cm
  - Main wall: (170 x 30 x 247.5) cm (one bar missing)
- 24 bars (18.4 x 20 x 160) cm
  - 2 small wall (60 x 36.8 x 160) cm
- 4 bars (18.4 x 20 x 160) cm, 28 bars (27 x 15 x 160) cm left outside
- Not equal distances from center

3rd case (rectangular at main wall and trapezoidal at small walls)

- Cut the 4m bars into pieces of 2.0m
- 32 bars (10 x 22.5 x 200) cm
  - Main wall: (180 x 40 x 200) cm
- 24 bars (18.4 x 20 x 160) cm
  - 2 small wall (60 x 36.8 x 160) cm
- 4 bars (18.4 x 20 x 160) cm, 28 bars (27 x 15 x 160) cm
- Not equal distances from center, 2.0 m instead of 2.5 m

5th case (rectangular at small walls and trapezoidal at main wall)

- 28 bars (27 x 15 x 160) cm
  - Main wall: (160 x 27 x 210) cm
- 18 bars (10 x 22.5 x 130) cm
  - 2 small walls (67.5 x 30 x 130) cm
- 10 bars (10 x 22.5 x 400) and 28 bars (18.4 x 20 x 160) cm left outside
- 27 cm instead of 30 cm, 210 cm instead of 250 cm
- Can add also 14 bars (10 x 22.5 x 200) cm front and back of Main wall crossed -> total thickness 37 cm and 6 bars (10 x 22.5 x 200) cm at the front of small walls->total thickness 40 cm

7th case (trapezoidal at small walls and trapezoidal at main wall)

- 28 bars (27 x 15 x 160) cm
  - Main wall: (160 x 27 x 210) cm
- 24 bars (18.4 x 20 x 160) cm
  - 2 small wall (60 x 36.8 x 160) cm
- 16 bars (10 x 22.5 x 400) and 4 bars (18.4 x 20 x 160) cm left outside
- Not equal distances from center, 27 cm instead of 30 cm, 210 cm instead of 250 cm
- Can add also 14 bars (10 x 22.5 x 200) cm front and back of Main wall crossed -> total thickness 37 cm and 12 bars (10 x 22.5 x 200) cm front and back of
- small walls->total thickness 46.8 cm