# Particle Production of Carbon Target with 20Tto2T5m Configuration at 6.75 GeV (Updated)

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Target Studies
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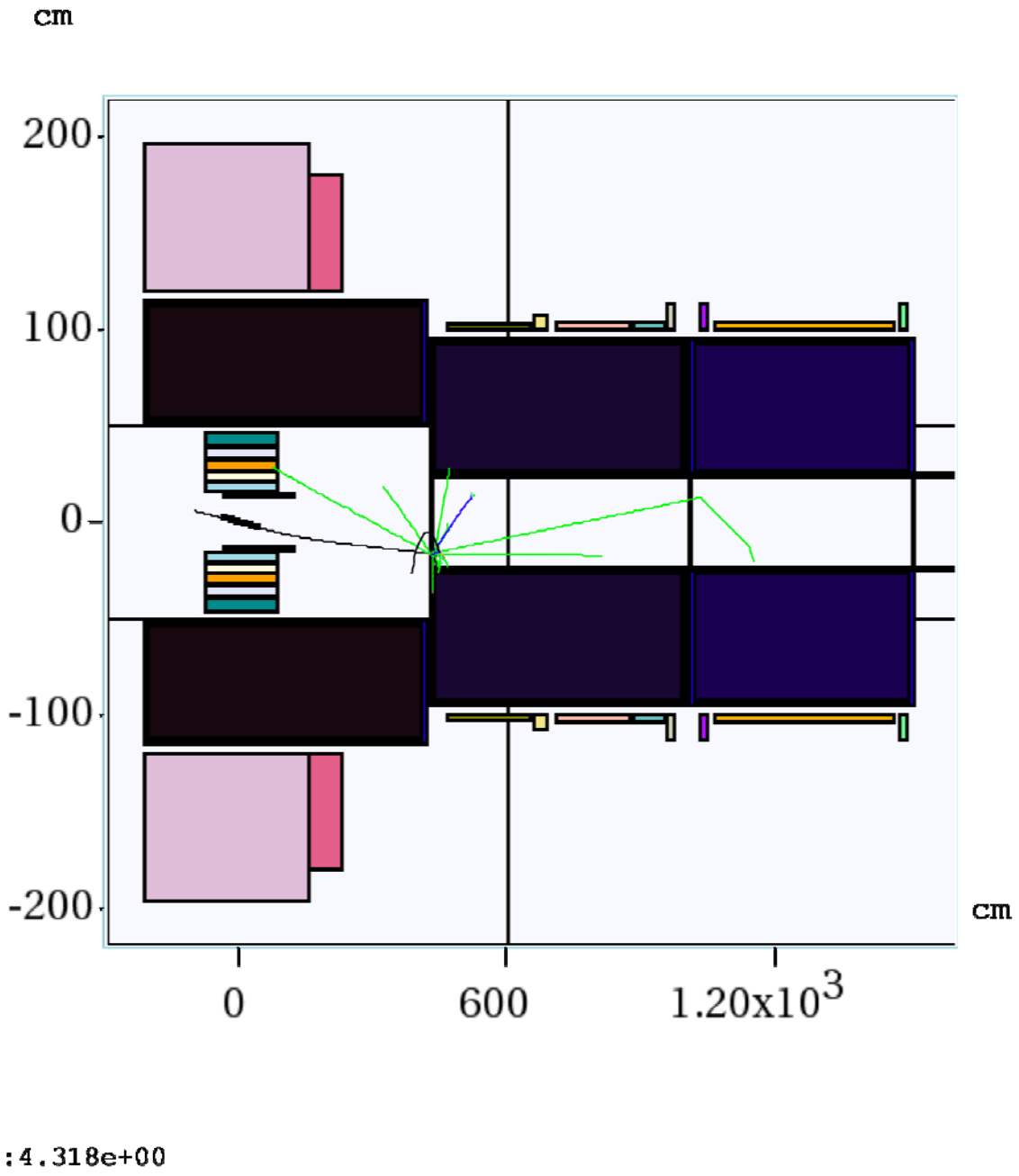
# Target Setting

- 20Tto2T5m Configuration (initial beam pipe radius of 13 cm) and Fieldmap (20T➔2T);
- Code: MARS15(2014) with ICEM 4 = 1;
- Proton beam: 6.75 GeV (KE) and launched at z = -100 cm,

  Focal beam with waist at z= 0 m and emittance of 5 μm;
- Production Collection: (50 m downstream, 40 MeV < KE < 180 MeV).
- Graphite density = 1.8

# Configuration



# Energy Card Setting

- ENRG E0 EM EPSTAM EMCHR EMNEU EMIGA EMIEL

  E0: The incident particle kinetic energy;

  EM: The hadron threshold energy (Default:0.0145 GeV);

  EPSTAM: The star production threshold kinetic energy (Default:0.03 GeV);

  EMCHR: The threshold energy applied collectively to muons, heavy ions and charged hadrons (Default: 0.001 GeV);

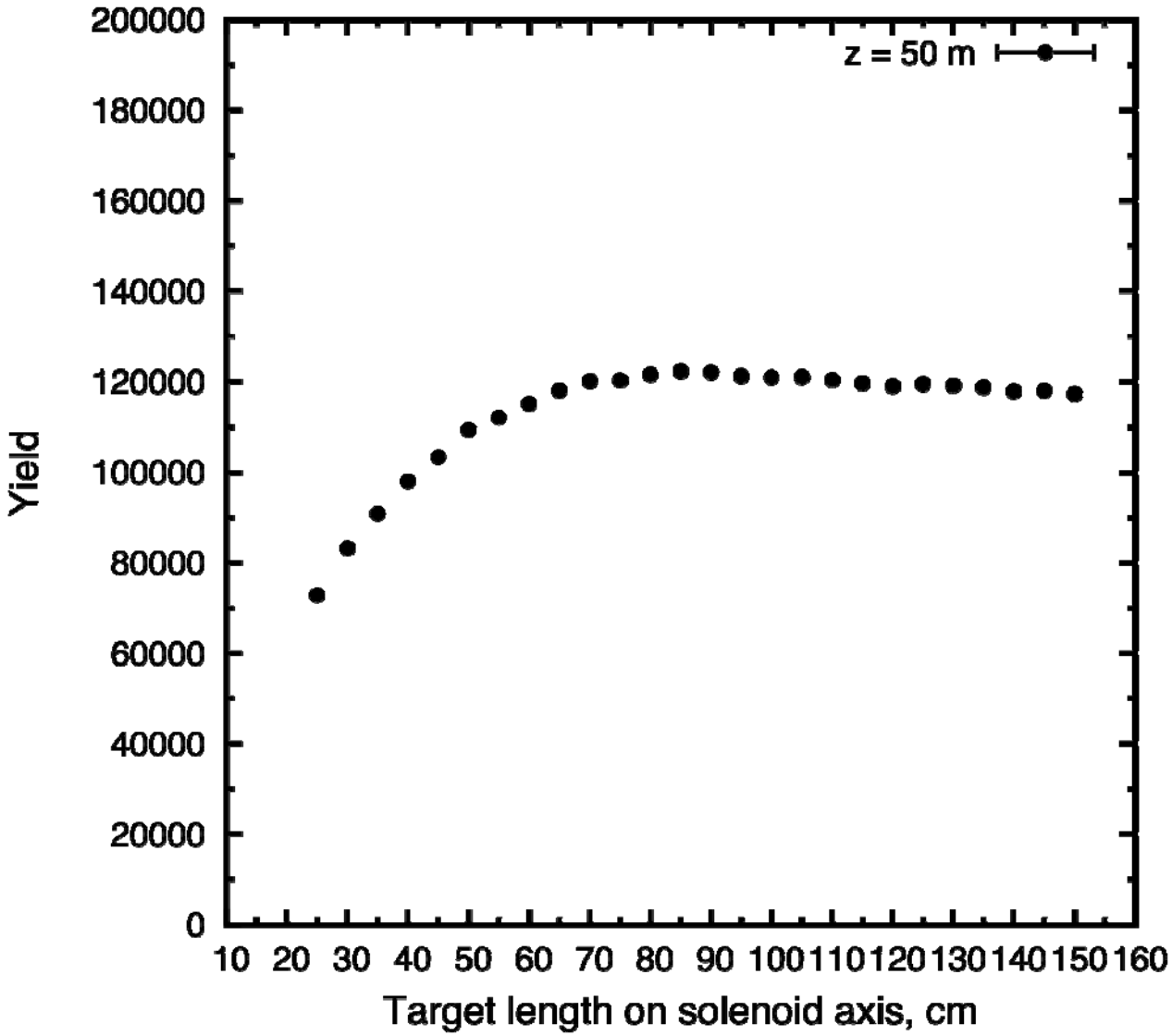
  EMNEU: The threshold energy for neutrons (Default:$10^{-4}$ GeV)

  EMIGA: The threshold energy for γ (Default:$10^{-4}$ GeV);

  EMIEL: The threshold energy for $e^{\pm}$ (Default: $5*10^{-4}$ GeV)

  Use non-default setting: ENRG 1=6.75 2=0.02 3=0.3 4=0.01 5=0.05 6=0.01 7=0.01

# Particle Production *vs.* Target Length ($10^6$ events, no beam dump)



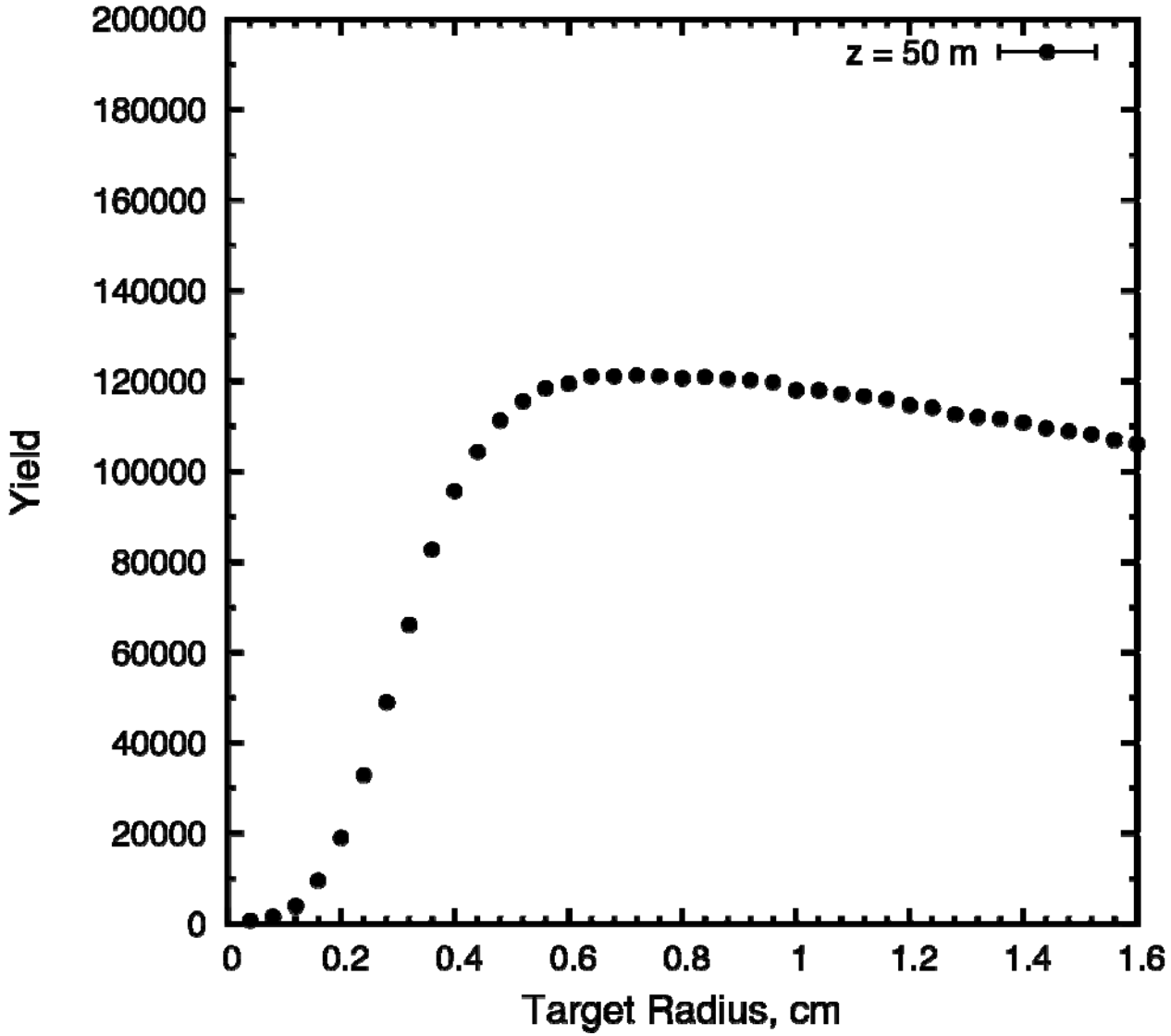

Target radius: 0.80 cm

Beam angle to SC axis: 65 mrad

Co-linear target and beam

TR/BR=4

# Particle Production *vs.* Target Radius ($10^6$ events, no beam dump)



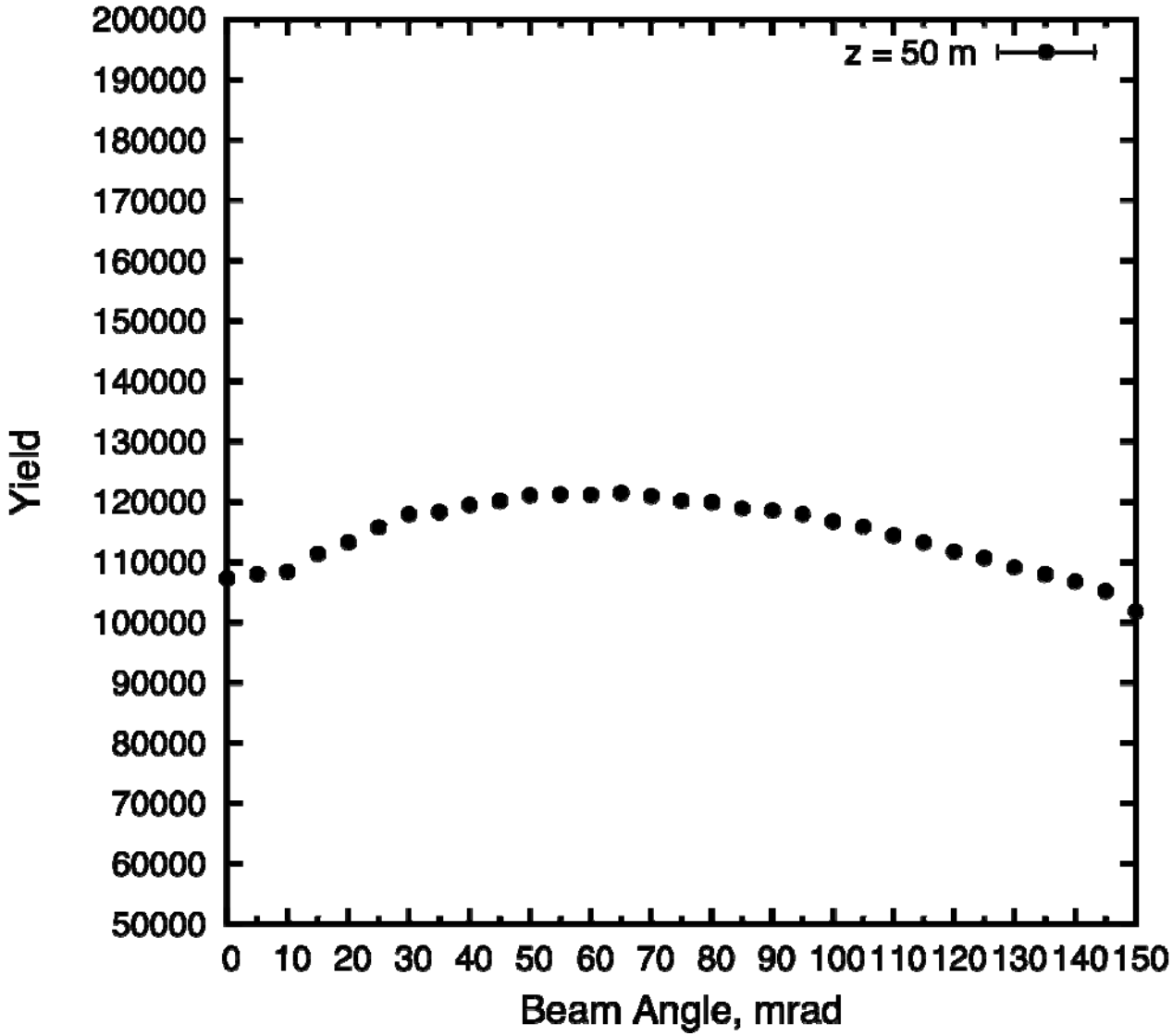

Target length: 80 cm

Beam angle to SC axis: 65 mrad

Co-linear target and beam

TR/BR=4

# Particle Production *vs*. Beam Angle ($10^6$ events, no beam dump)



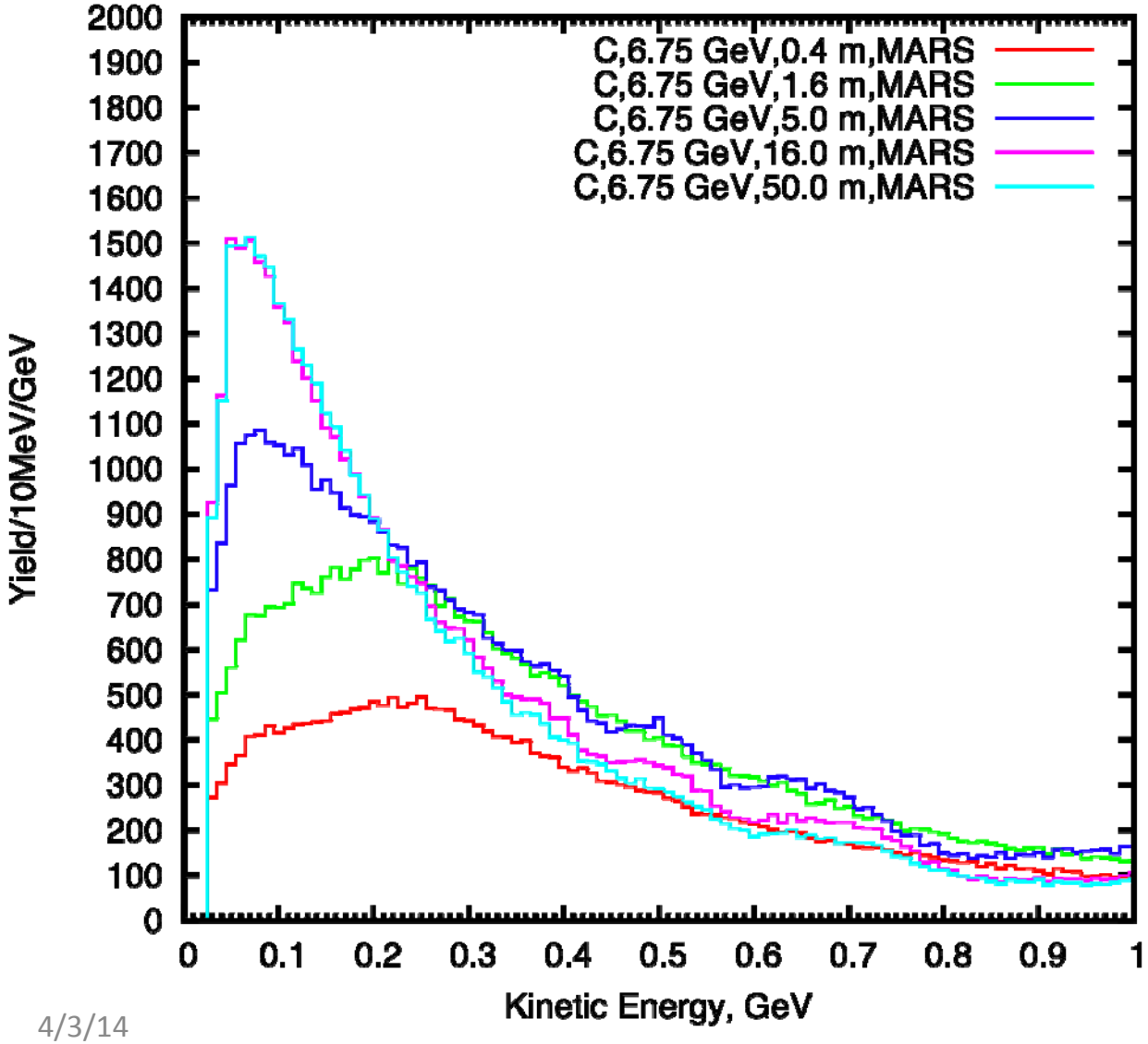

Target length: 80 cm

Target radius: 0.80 cm

Co-linear target and beam

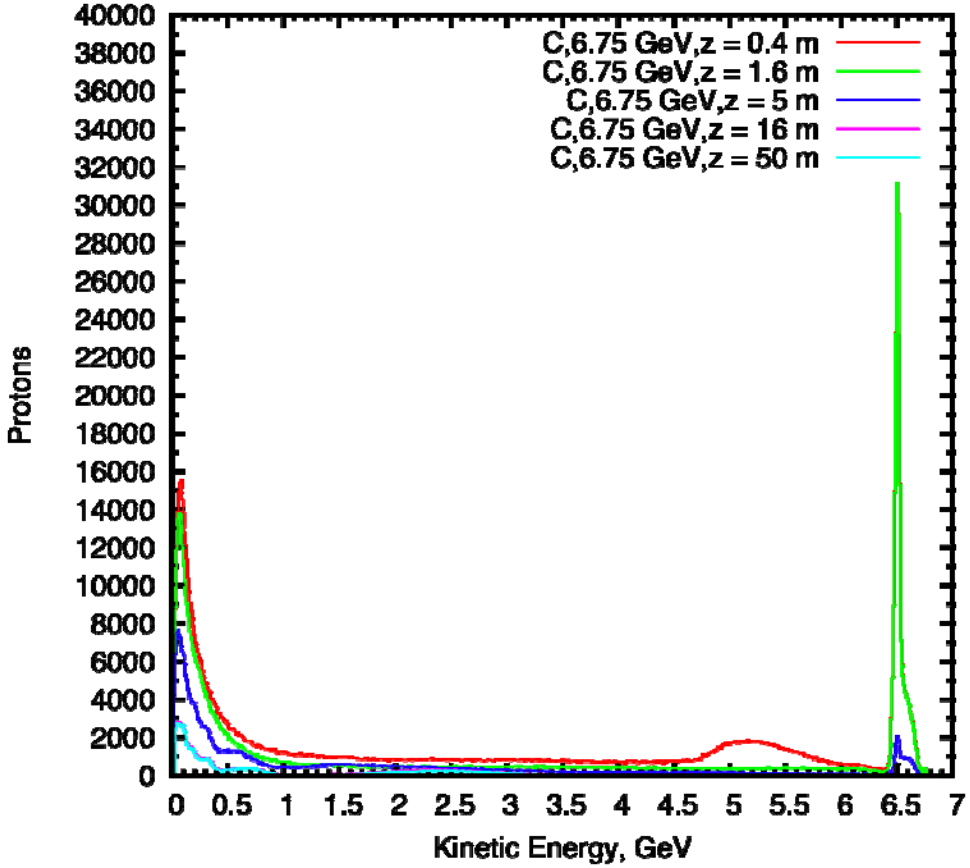
TR/BR=4

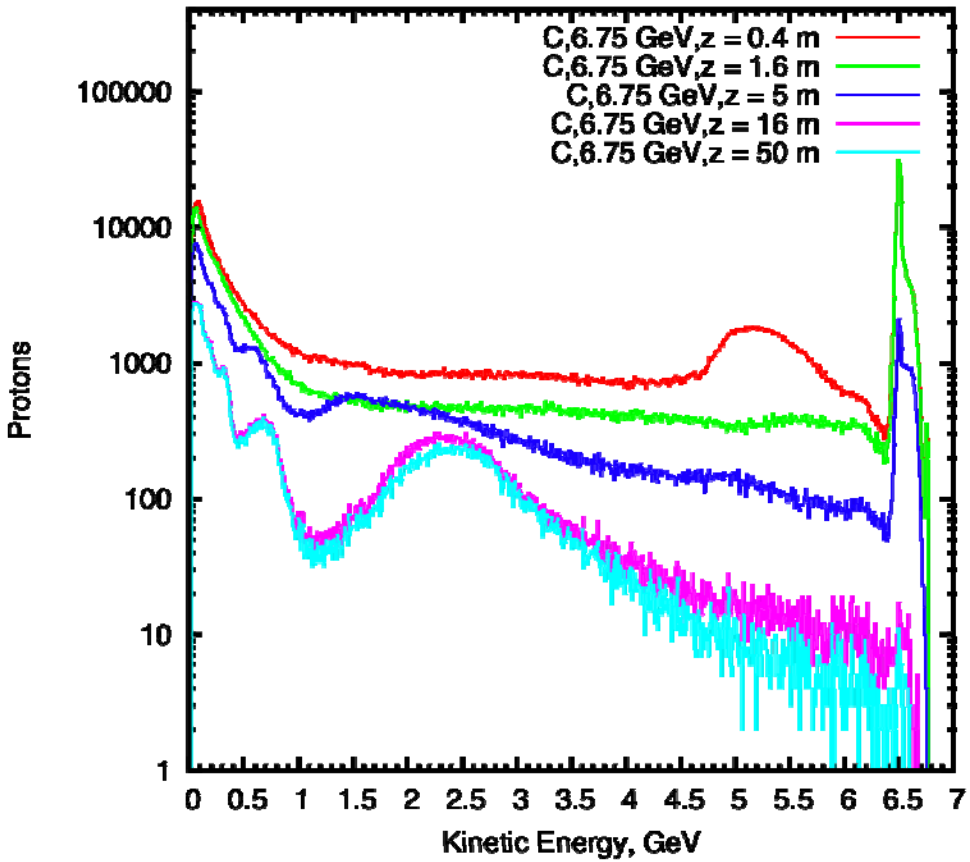
# Energy Spectra of $\pi^{\pm}$, $K^{\pm}$, $\mu^{\pm}$ ($10^6$ events, no beam dump)




Best parameters:
Target length: 80 cm
Target radius: 0.80 cm
Beam angle: 65 mrad
Co-linear target and beam
TR/BR=4

# Remaining Protons
## ($10^6$ events, no beam dump)



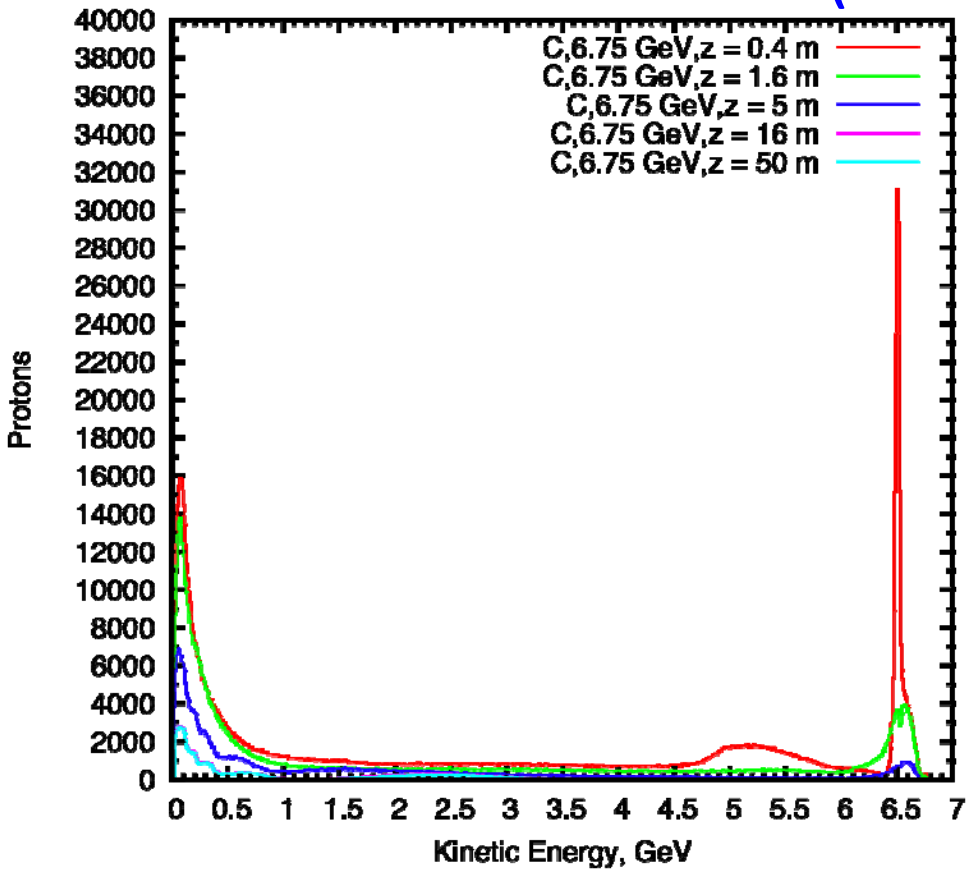



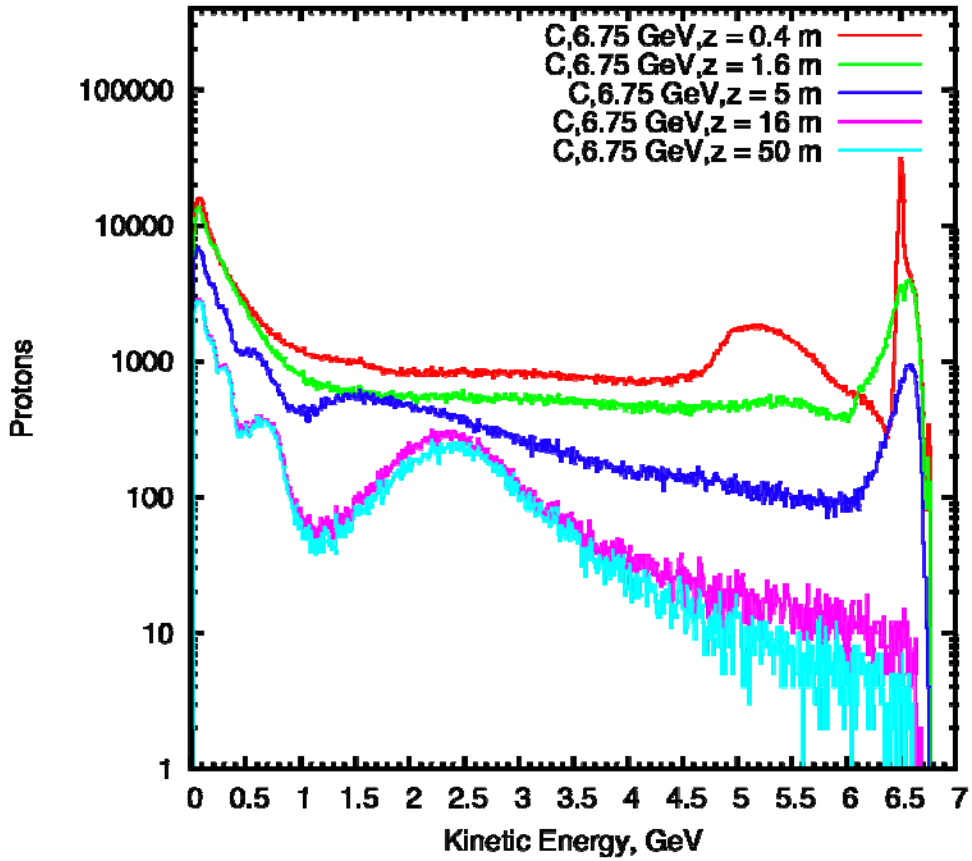

Target length: 80 cm Target radius: 0.80 cm Beam angle: 65 mrad
Co-linear target and beam TR/BR=4

Peak of protons(?) at 6.5 GeV gone at z = 16, 50 m.
If true, no need for beam dump.

# Remaining Protons with Beam Dump

## ($10^6$ events)



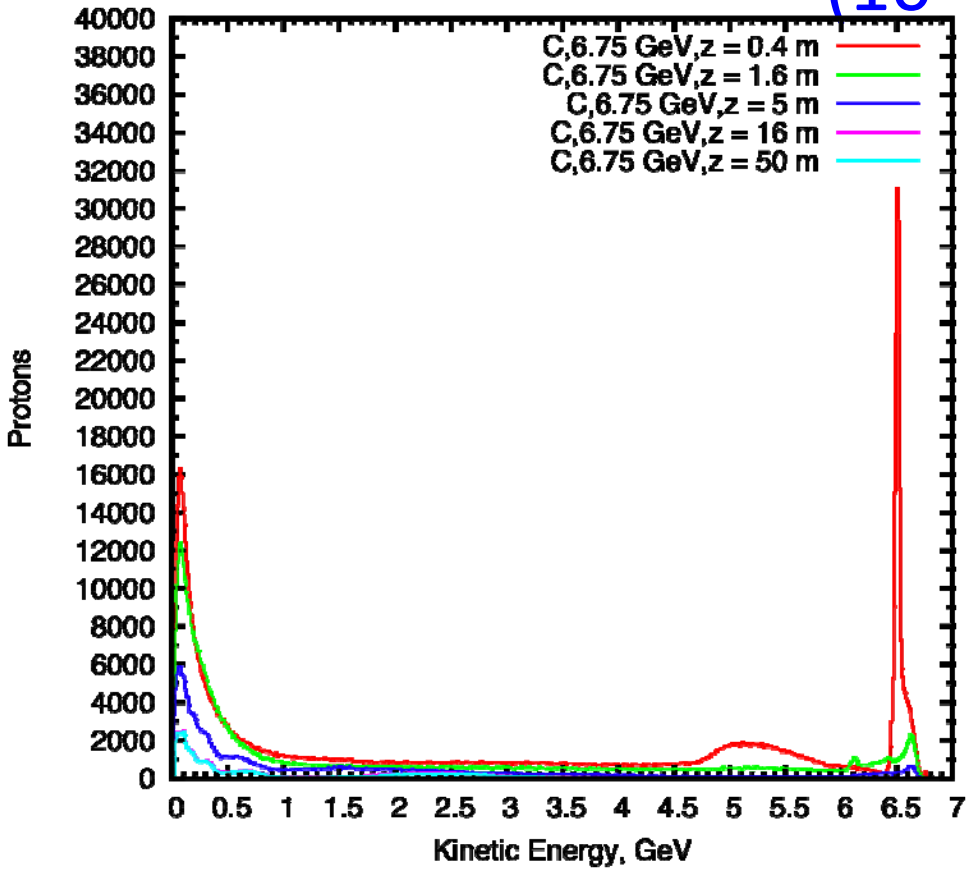



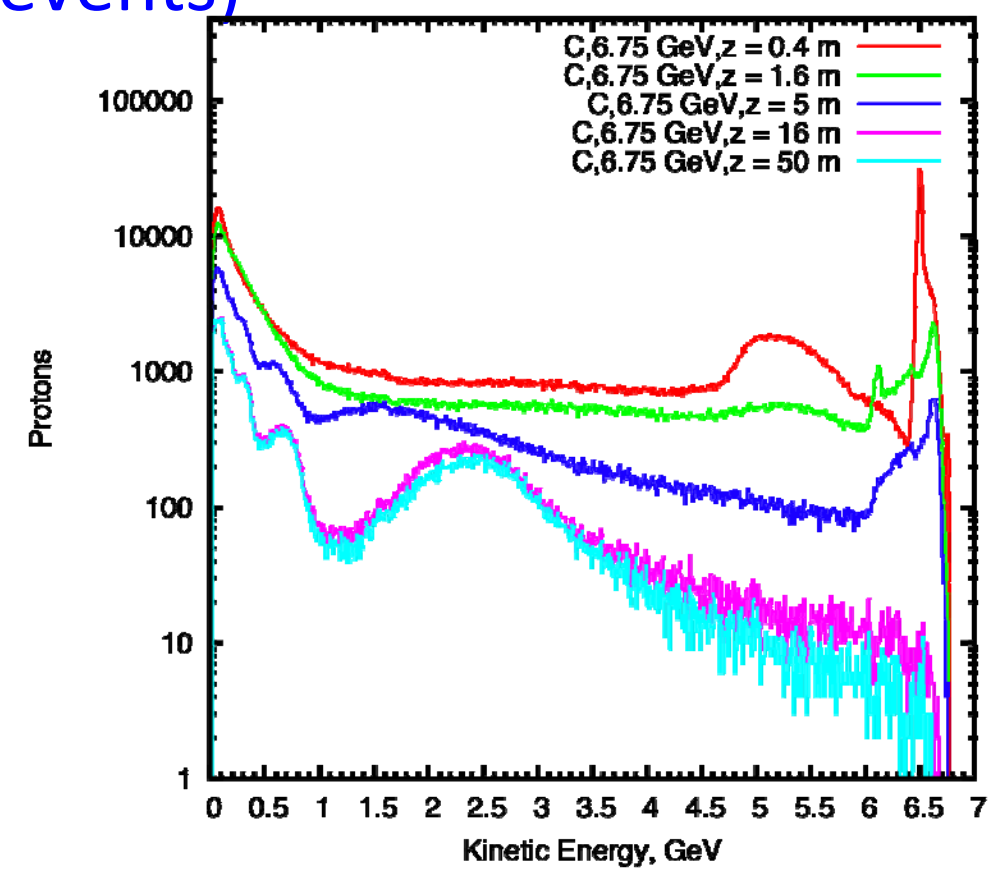

Target length: 80 cm (z=-40 cm to z=40 cm)  Target radius: 0.80 cm
Beam angle: 65 mrad  Co-linear target and beam  TR/BR=4
Beam dump rod: (z=40 cm to z=160 cm, horizontal tilt: 33.7 mrad, vertical tilt: 54.28 mrad)

**The radius of beam dump is same that of the target**

# Remaining Protons with Beam Dump

## ($10^6$ events)



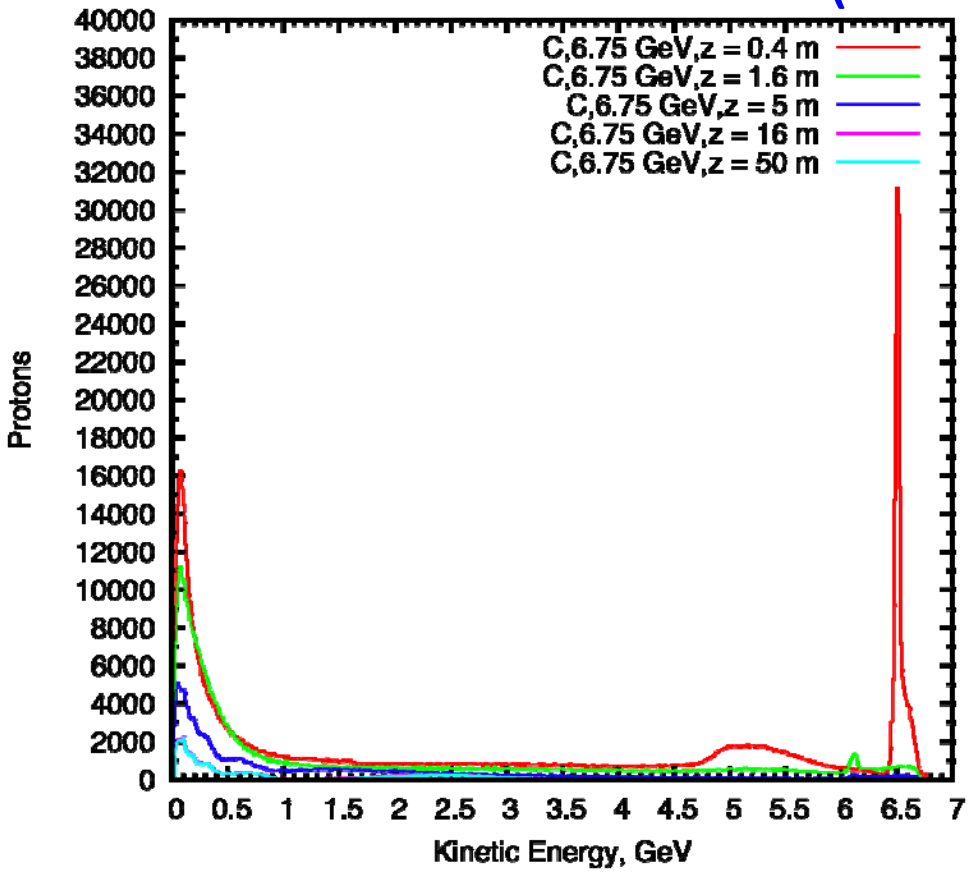



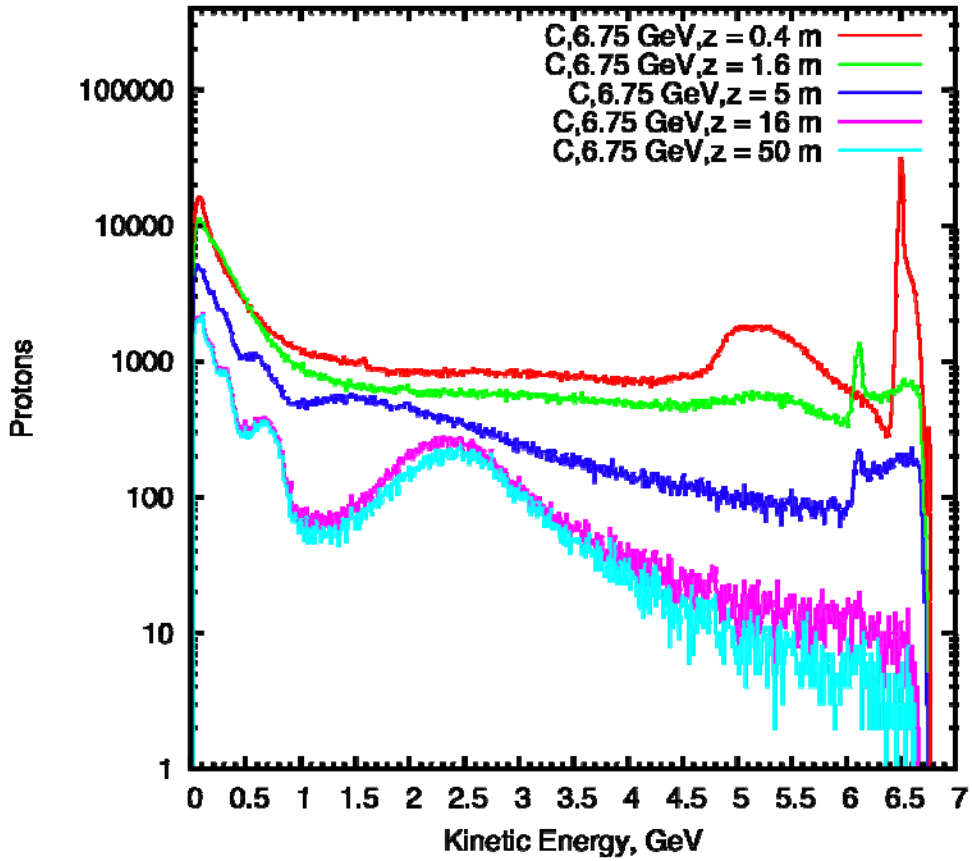

Target length: 80 cm (z=-40 cm to z=40 cm)  Target radius: 0.80 cm
Beam angle: 65 mrad  Co-linear target and beam  TR/BR=4
Beam dump rod (z=40 cm to z=160 cm, horizontal tilt: 33.7 mrad, vertical tilt: 54.28 mrad)

**The radius of beam dump is twice that of the target**

# Remaining Protons with Beam Dump

## ($10^6$ events)



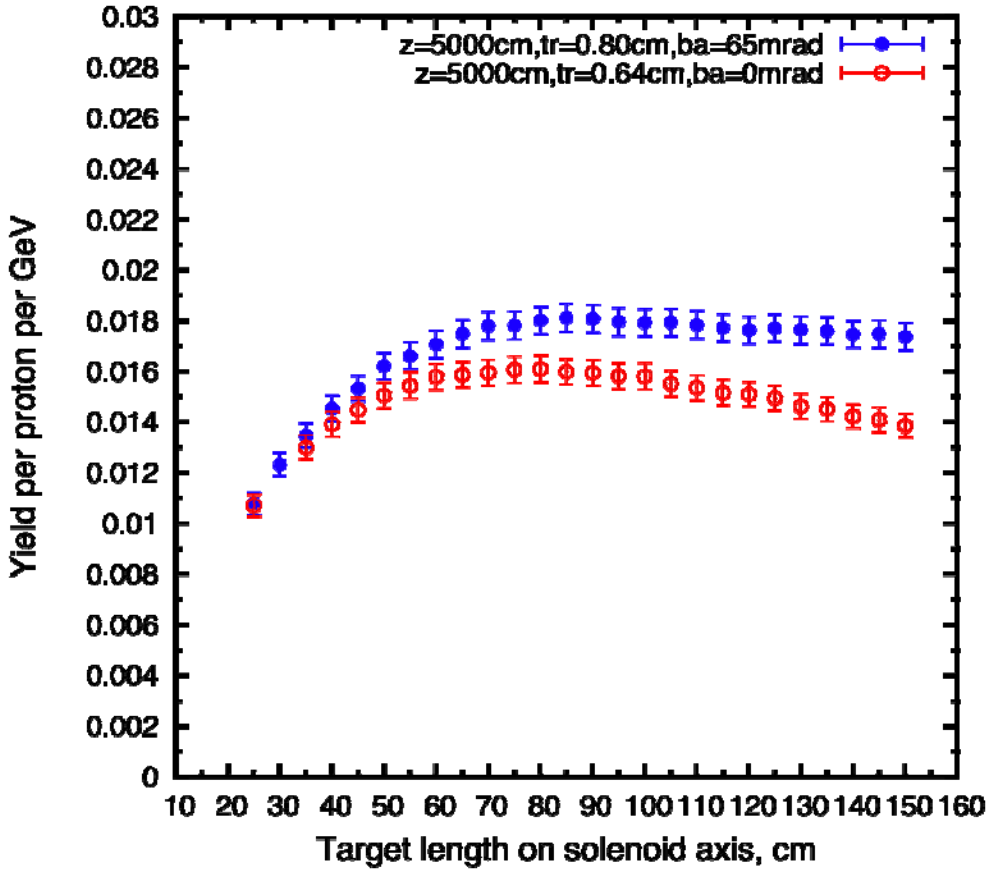



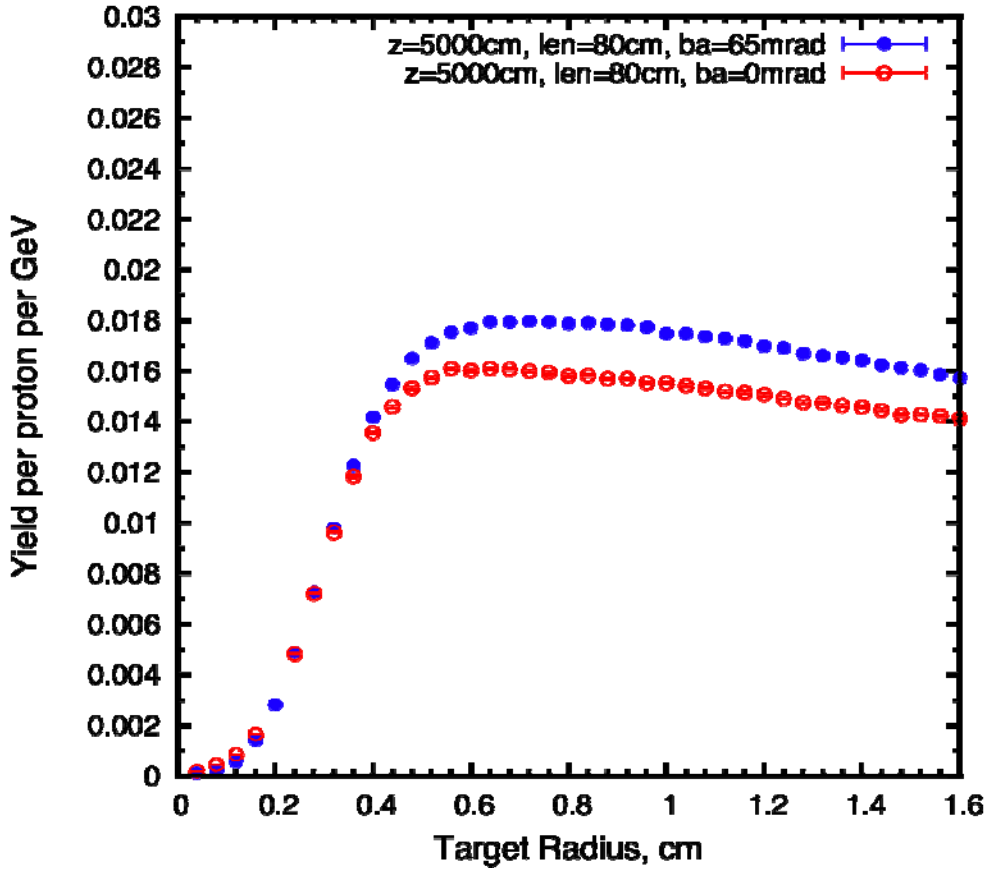

Target length: 80 cm (z=-40 cm to z=40 cm) Target radius: 0.80 cm
Beam angle: 65 mrad Co-linear target and beam TR/BR=4
Beam dump rod (z=40 cm to z=160 cm, horizontal tilt: 33.7 mrad, vertical tilt: 54.28 mrad)

**The radius of beam dump is triple that of the target**

# Yield Comparison

## (no-tilt vs. tilt of proton beam to SC axis)



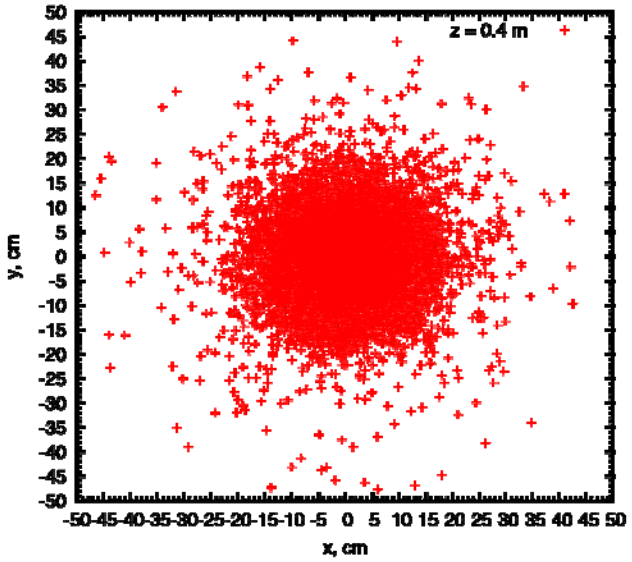

Optimized target length is 80 cm and target radius is 0.64 cm when beam angle is fixed at 0 mrad.
Co-linear target and beam. TR/BR=4

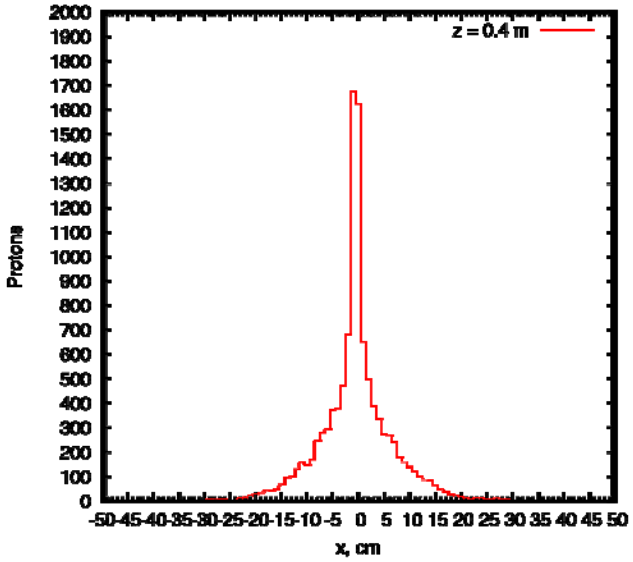
~ 13% advantage to tilting the beam/target

# Remaining Protons (KE > 0)

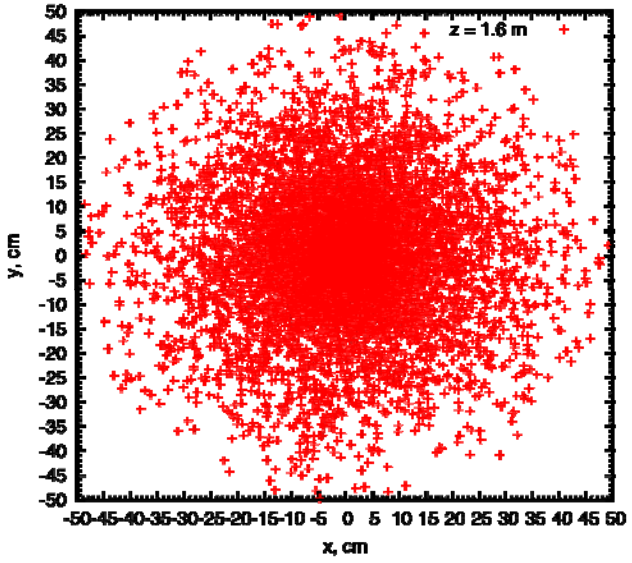
## $10^4$ events, no beam dump, beam angle = 0 mrad

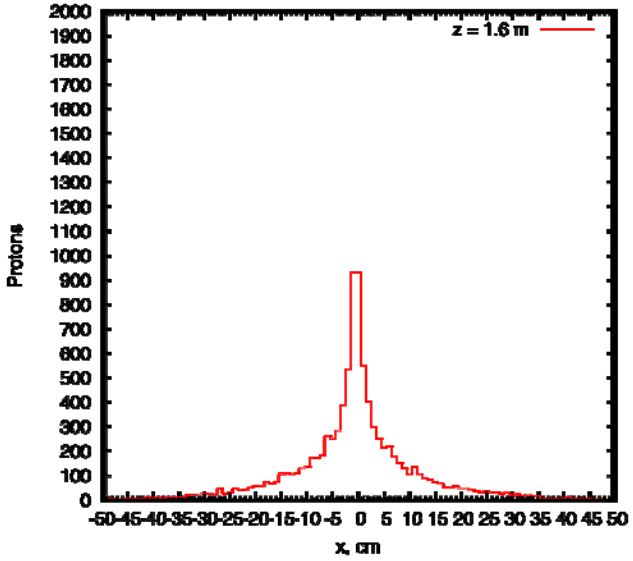
z = 0.4 m




z = 1.6 m

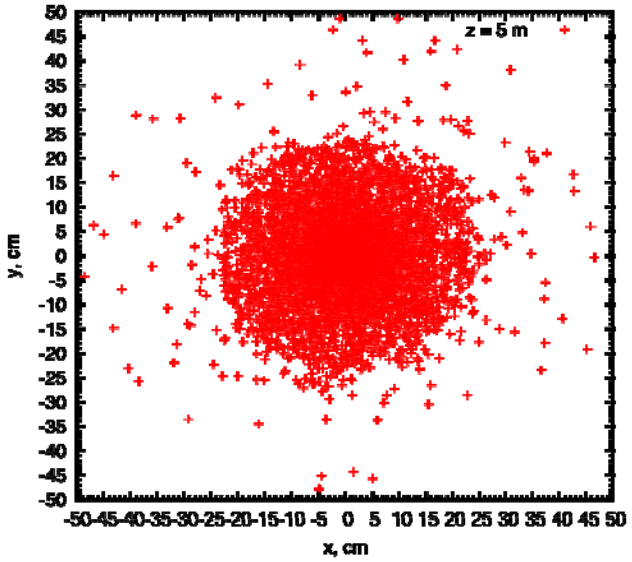


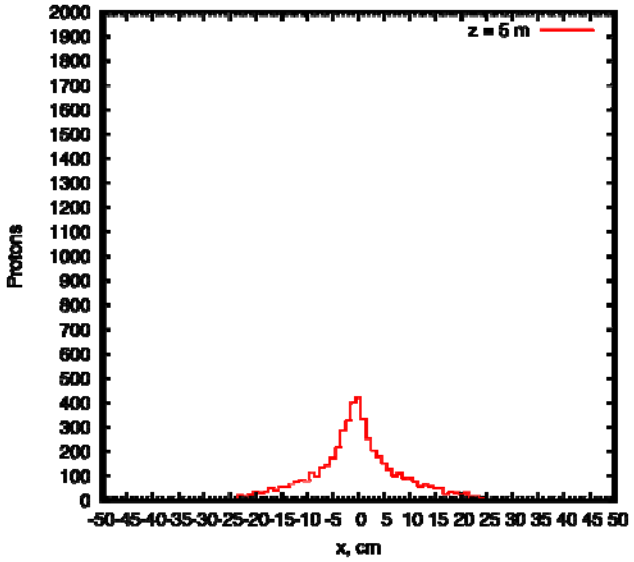



# Remaining Protons (KE > 0)

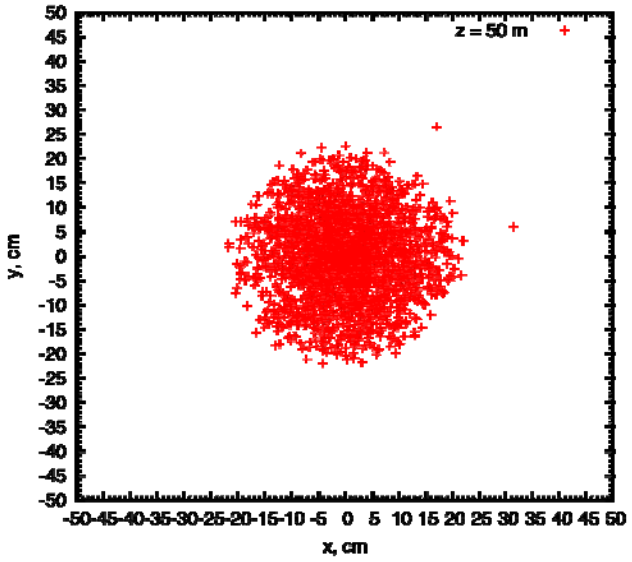
## $10^4$ events, no beam dump, beam angle = 0 mrad

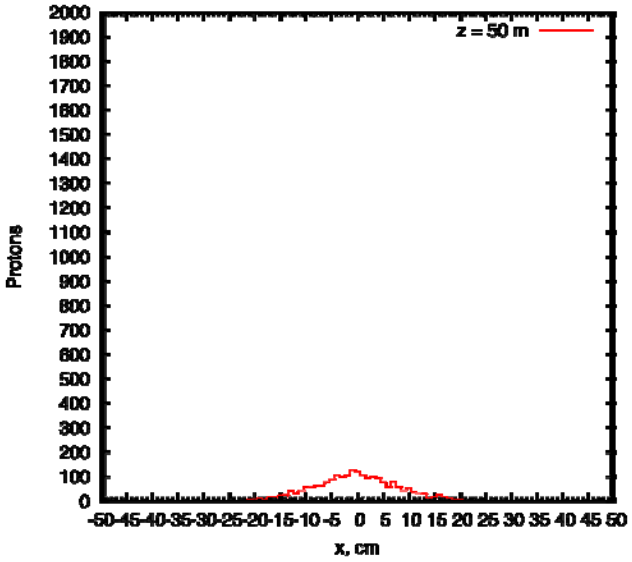
z = 5 m




z = 50 m

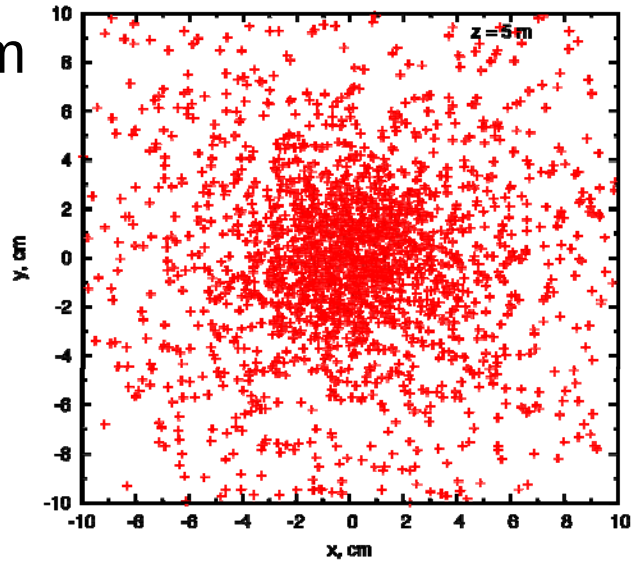


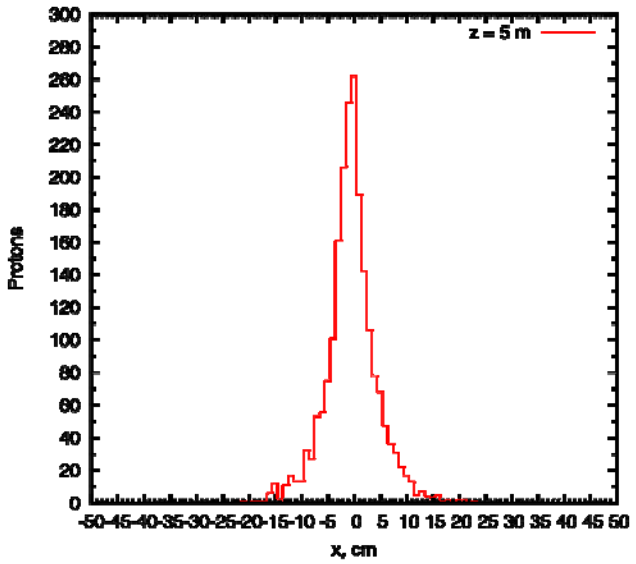



# Remaining Protons (KE > 6 GeV)

## $10^4$ events, Beam angle = 0 mrad, target radius = 0.64 cm

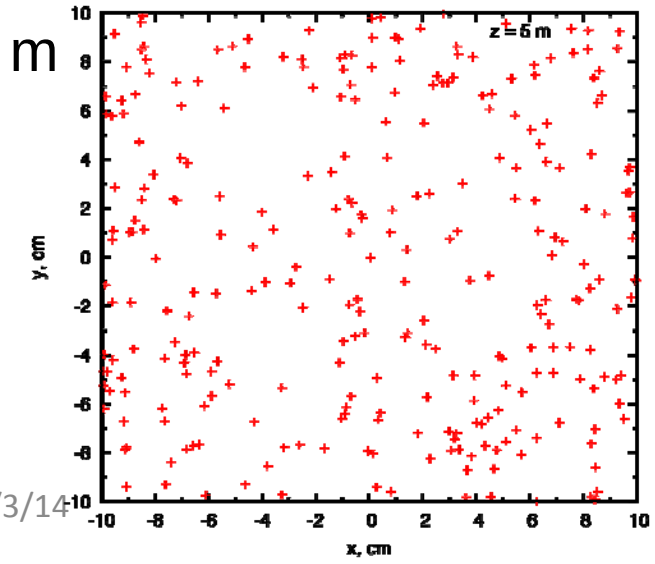
z = 5 m

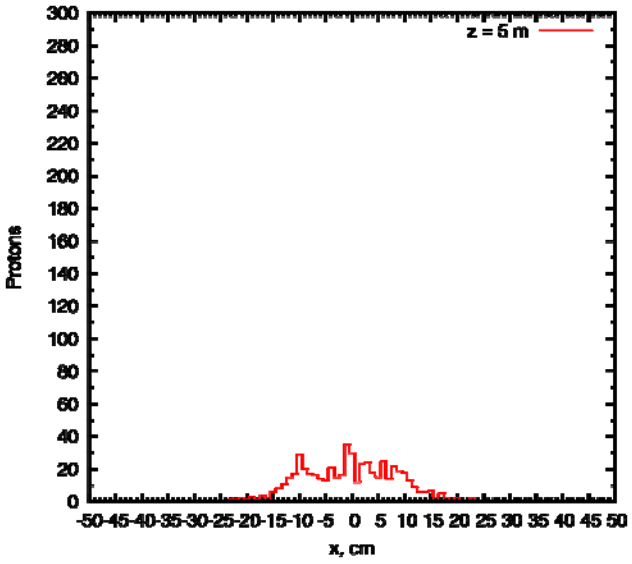



No beam dump

z = 5 m

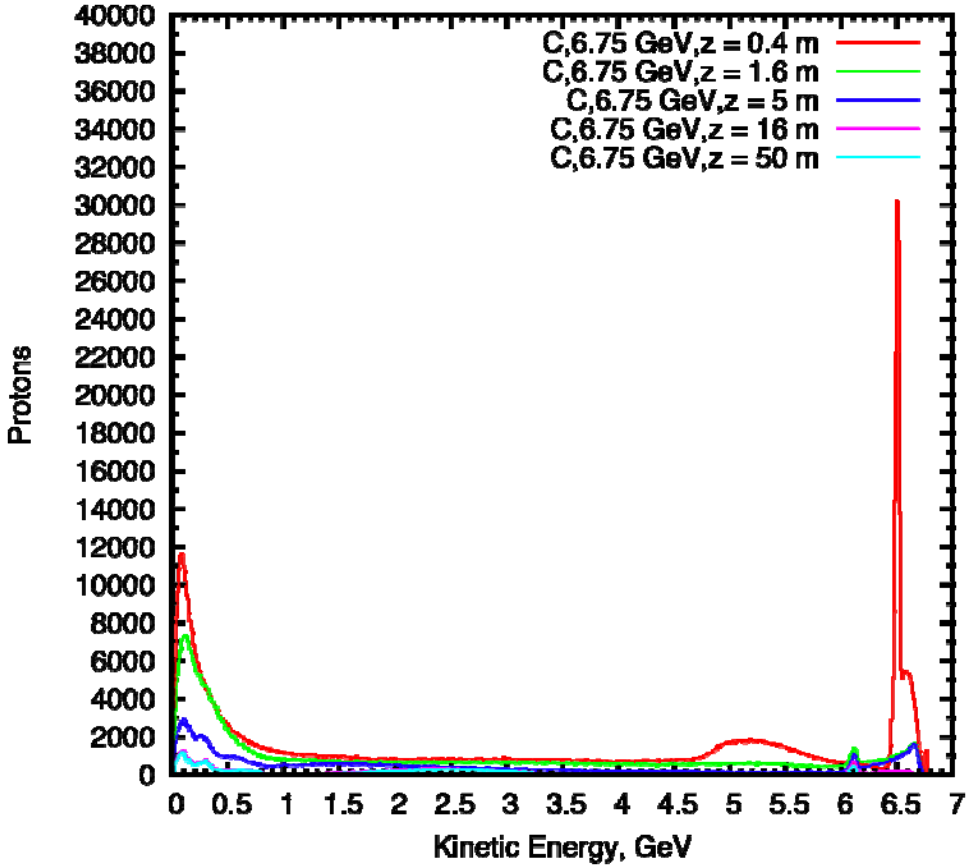


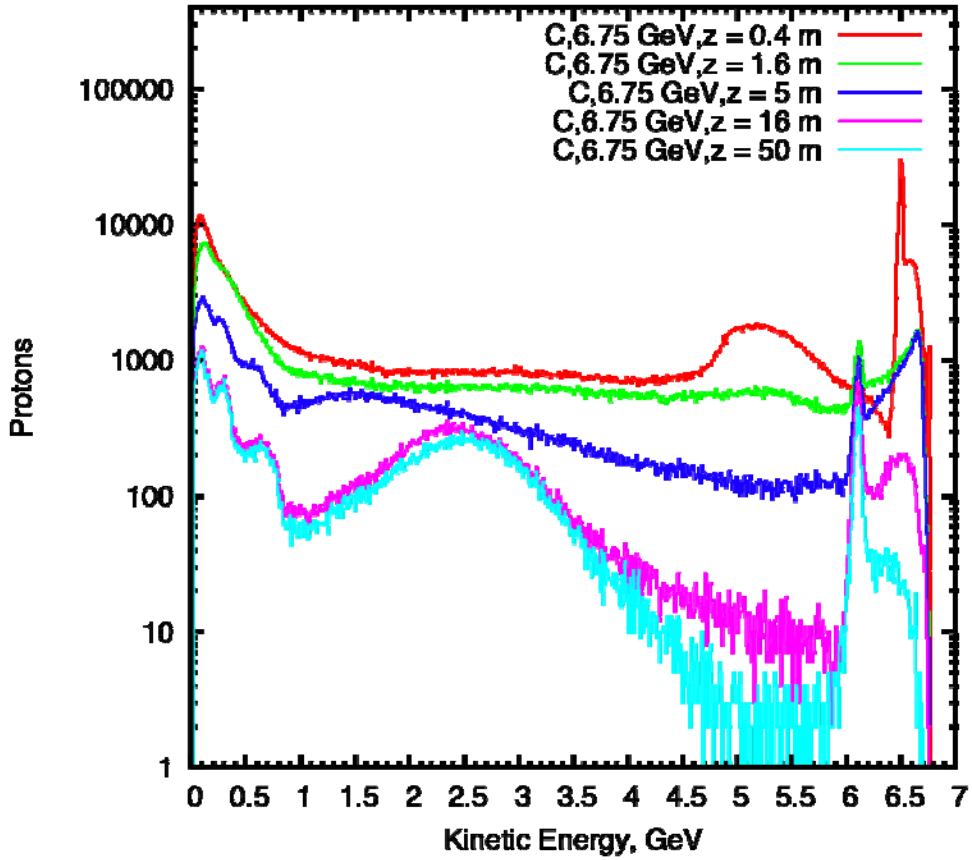




Beam dump:
120cm long (z=40 to 160 cm),
Triple of target radius

# Remaining Protons with Beam Dump

## ($10^6$ events, Beam angle = 0 mrad)




Target length: 80 cm (z=-40 cm to z=40 cm) Target radius: 0.64 cm
Beam angle: 0 mrad Co-linear target and beam TR/BR=4
Beam dump rod is 120 cm long (z=40 cm to z=160 cm)
**The radius of beam dump is triple that of the target**

? This plot shows a peak at 6-6.5 GeV for z = 16, 50 m ??

# Counting

## $10^4$ events, 1MW beam, beam angle = 0 mrad

| $L_{dump}$ (cm) | $R_{dump}$/ $R_{target}$ | Z | Total KE (protons) ( r <23 cm) GeV | Total KE (non-protons) GeV | Protons KE>6 | Protons KE>4.5 | Yield at Z=50m |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 5m | 22734.3 | 8656.28 | 2078 | 2310 | 1063.4 |
| 40 | 1 | 5m | 18780.7 | 9067.21 | 1543 | 1787 | 987 |
| 80 | 1 | 5m | 17825.1 | 8880.17 | 1419 | 1668 | 927 |
| 120 | 1 | 5m | 17752.8 | 8464.49 | 1452 | 1695 | 868.8 |
| 40 | 2 | 5m | 16036.4 | 8975.79 | 1213 | 1419 | 938 |
| 80 | 2 | 5m | 13756.6 | 8683.37 | 909 | 1114 | 780.3 |
| 120 | 2 | 5m | 13788.8 | 8562.08 | 870 | 1134 | 743 |
| 40 | 3 | 5m | 14884.7 | 9012.11 | 1044 | 1260 | 852.7 |
| 80 | 3 | 5m | 11258.5 | 8672.15 | 607 | 811 | 680.2 |
| 120 | 3 | 5m | 11007.2 | 8035.5 | 542 | 767 | 590 |