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

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Target Studies
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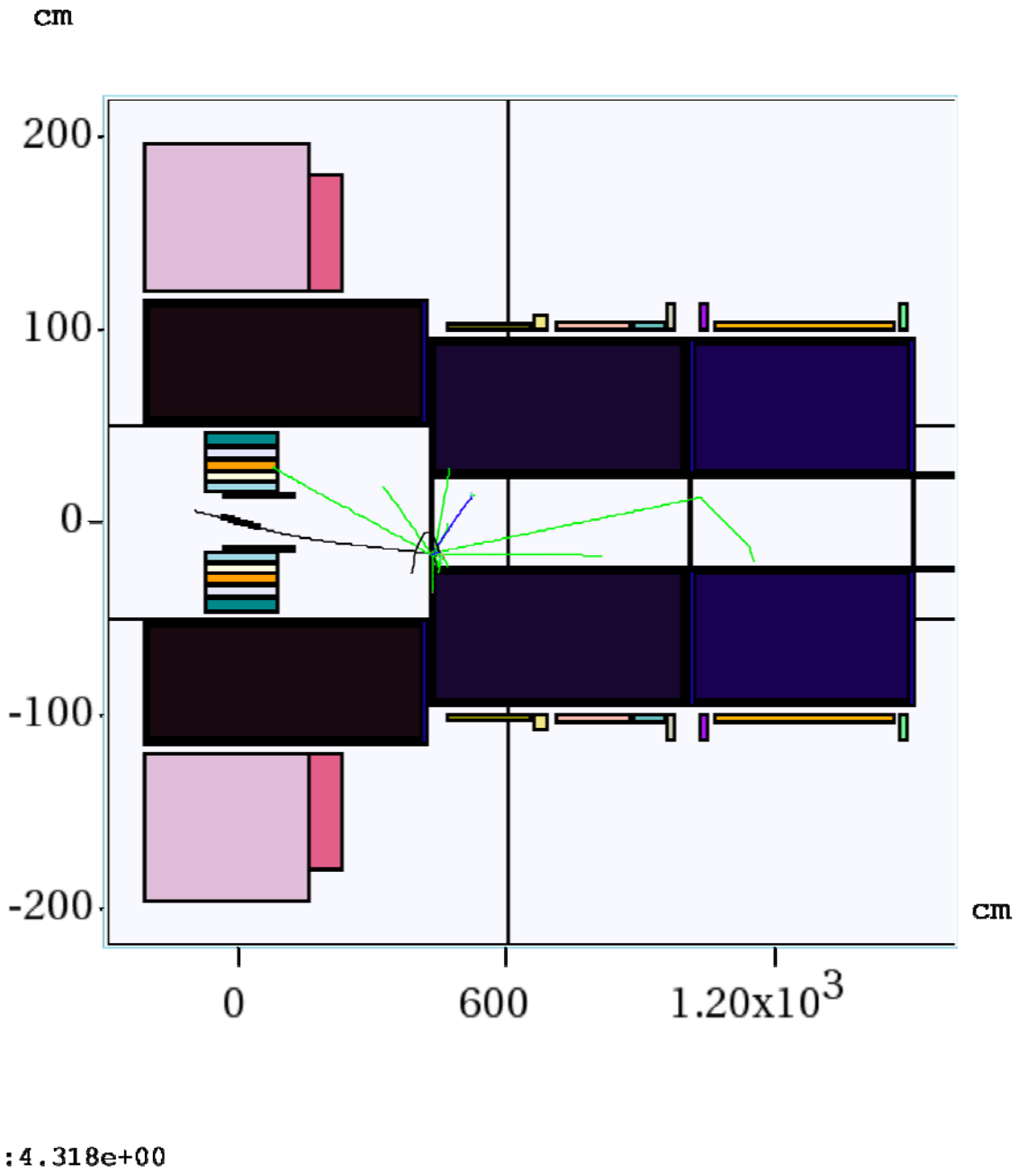
Target Setting

- 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: (5 m, 10 m, 16 m and 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)

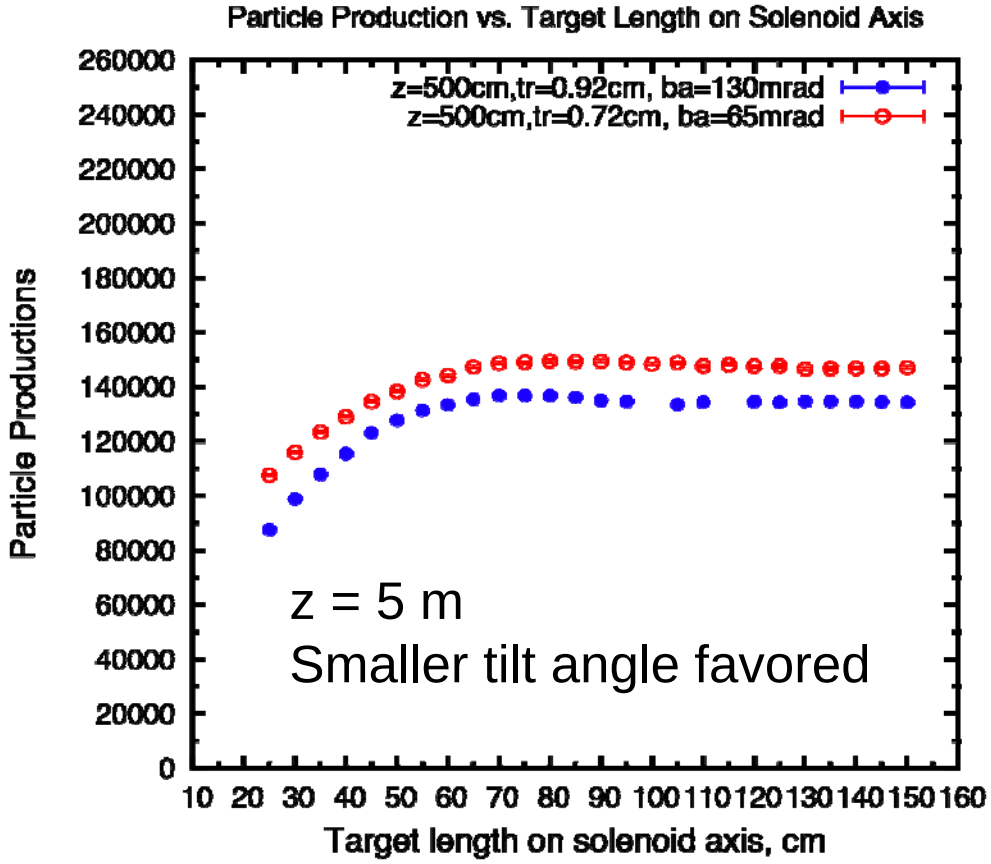
  EMIGA: The threshold energy for γ (Default:10^{-4} GeV);

  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)

With beam angle = 130 mrad, the dump rod may conflict with the target containment vessel, so compare with beam angle = 65 mrad.



Co-linear target and beam. TR/BR=4

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

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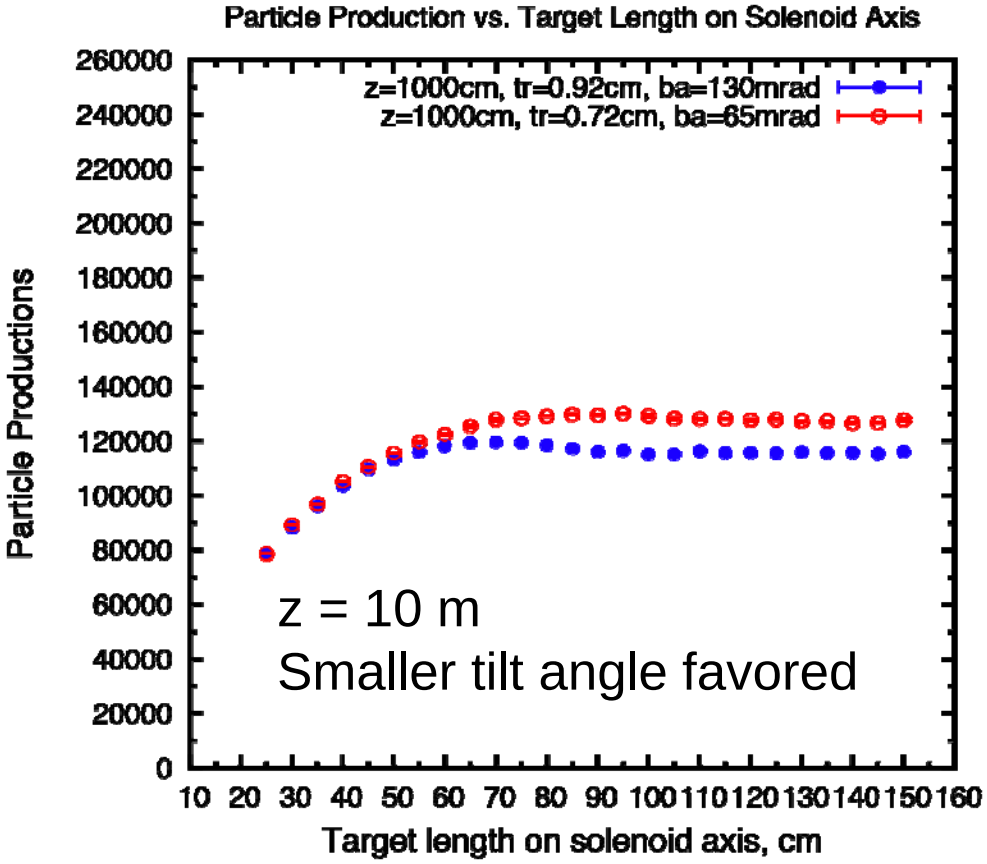
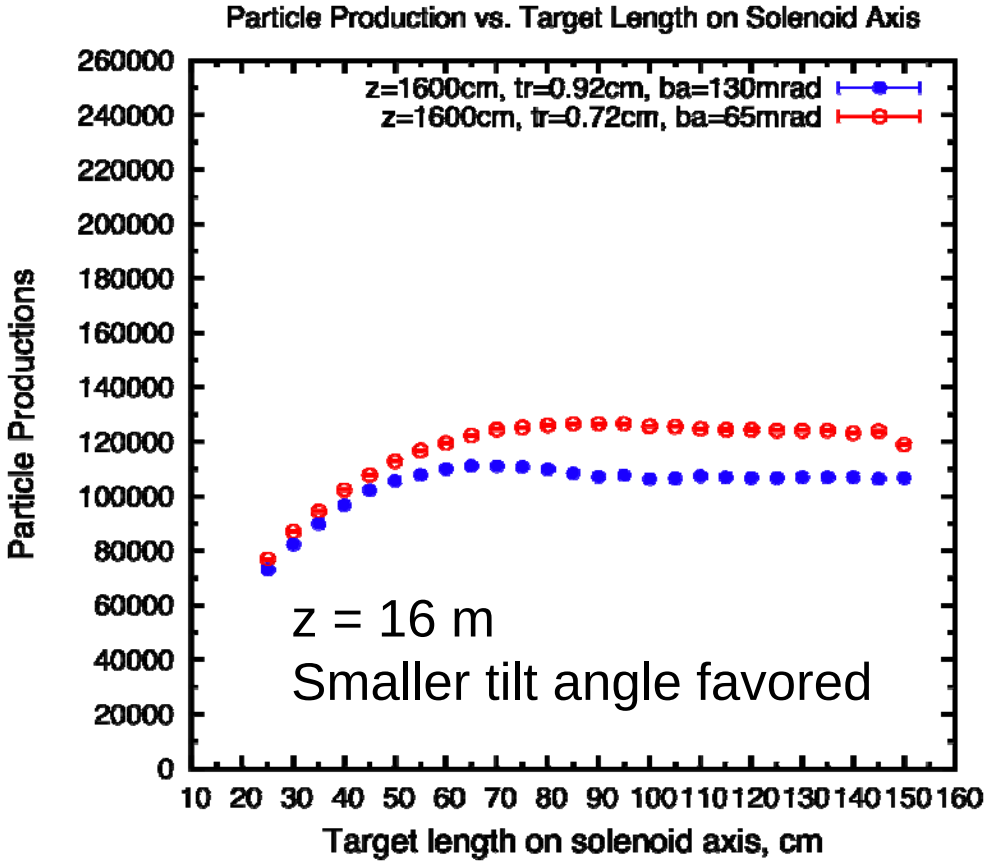
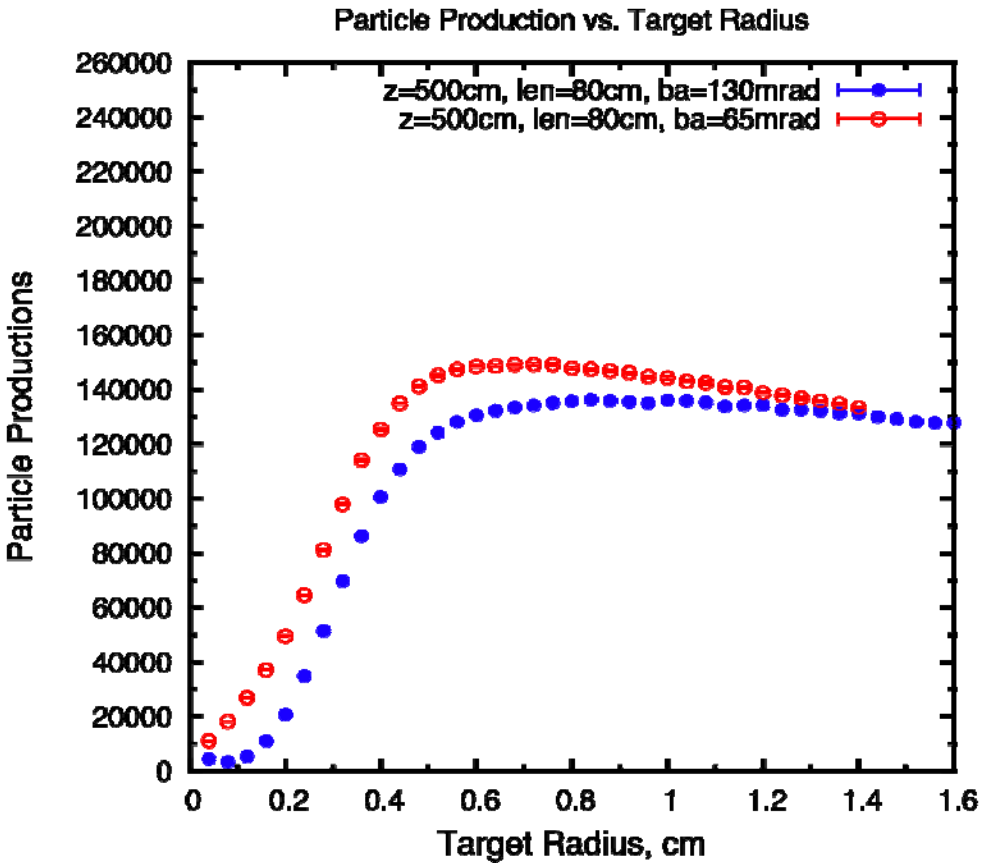




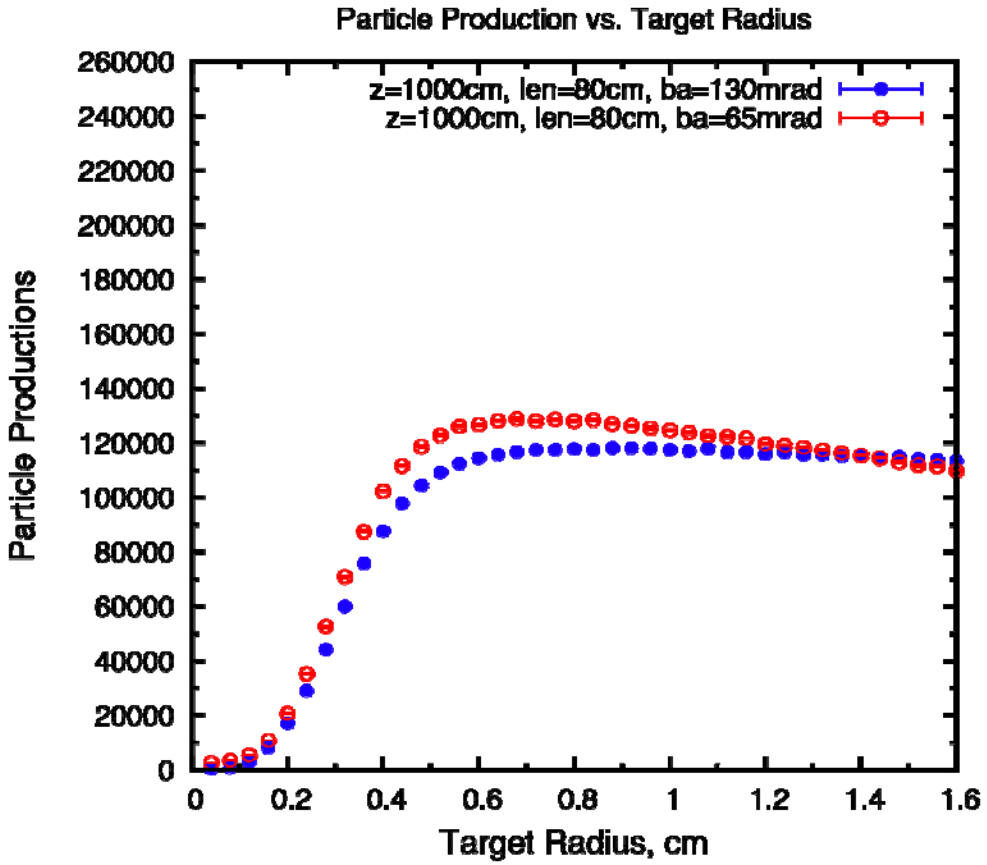
Co-linear target and beam. TR/BR=4

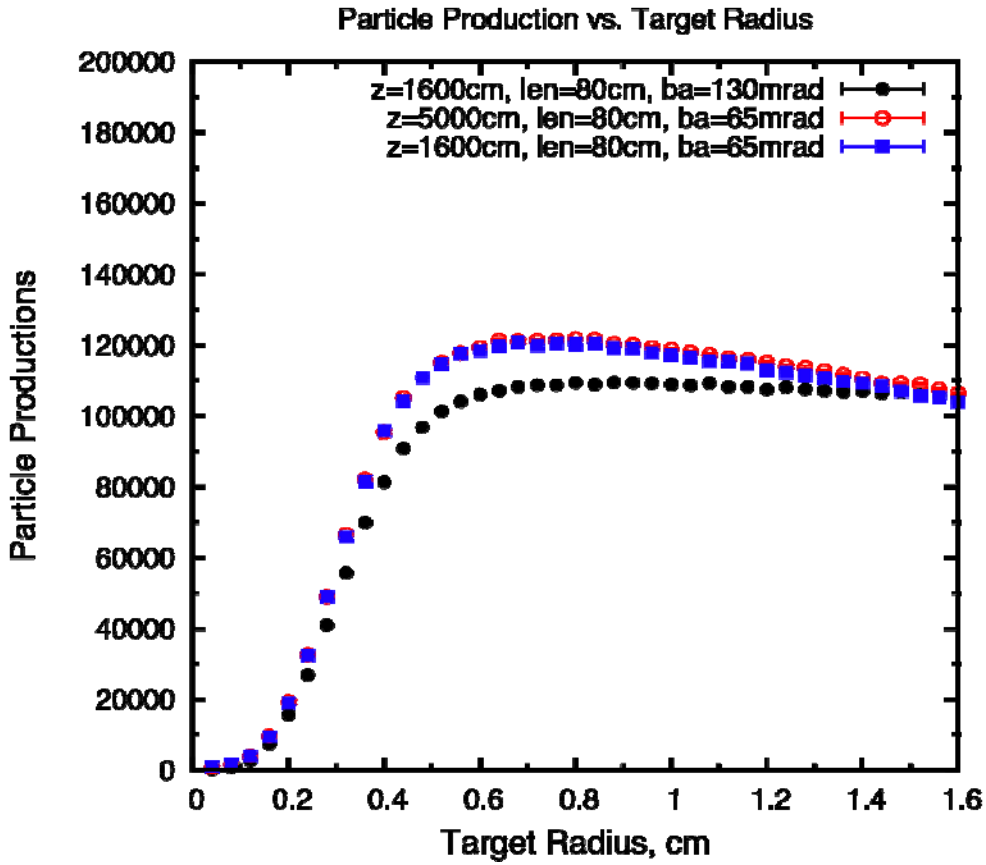
Particle Production *vs.* Target Radius (10^6 events, no beam dump)



Co-linear target and beam. TR/BR=4

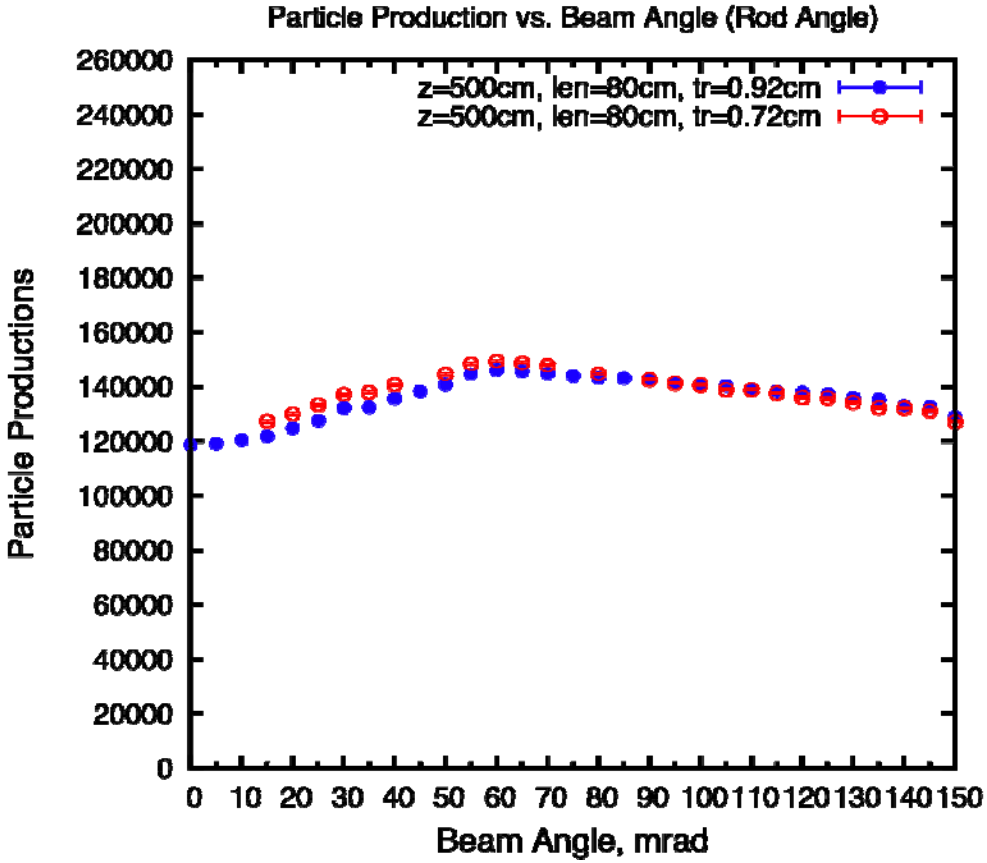
Particle Production *vs.* Target Radius (10^6 events, no beam dump)





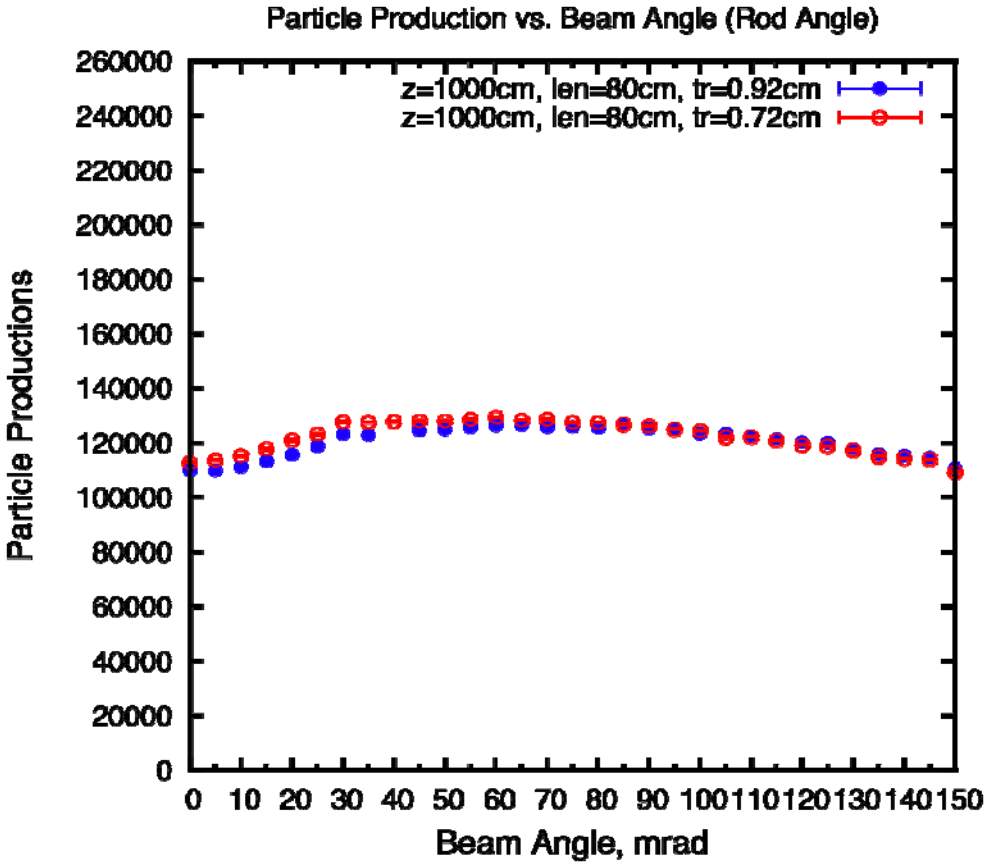
Co-linear target and beam. TR/BR=4

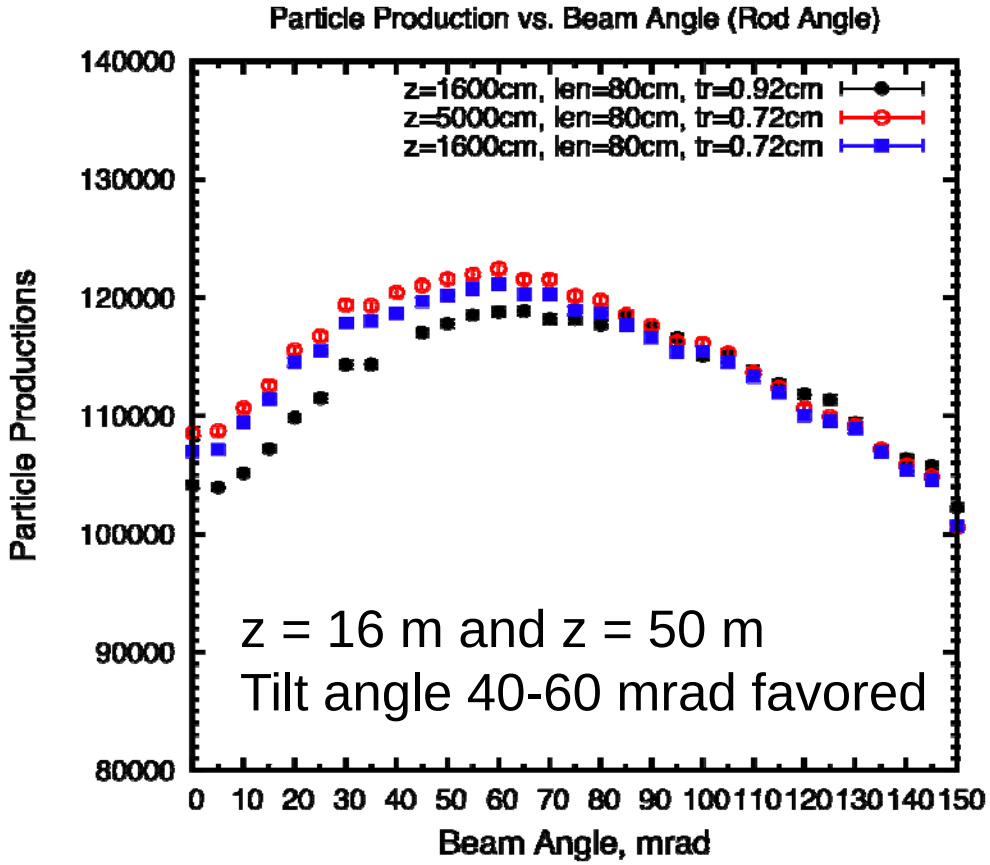
Particle Production *vs*. Beam Angle (10^6 events, no beam dump)



Co-linear target and beam. TR/BR=4

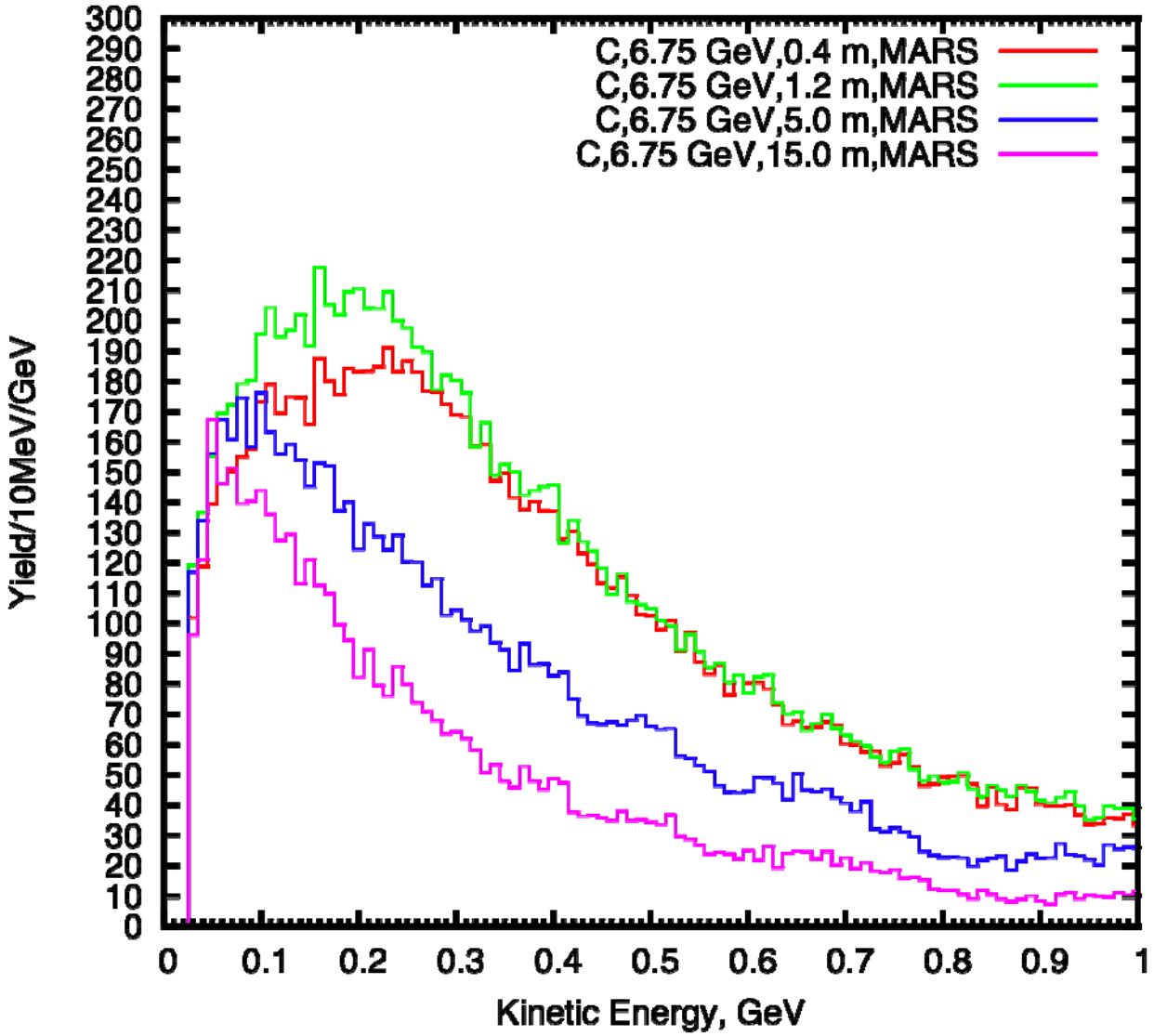
Particle Production *vs*. Beam Angle (10^6 events, no beam dump)





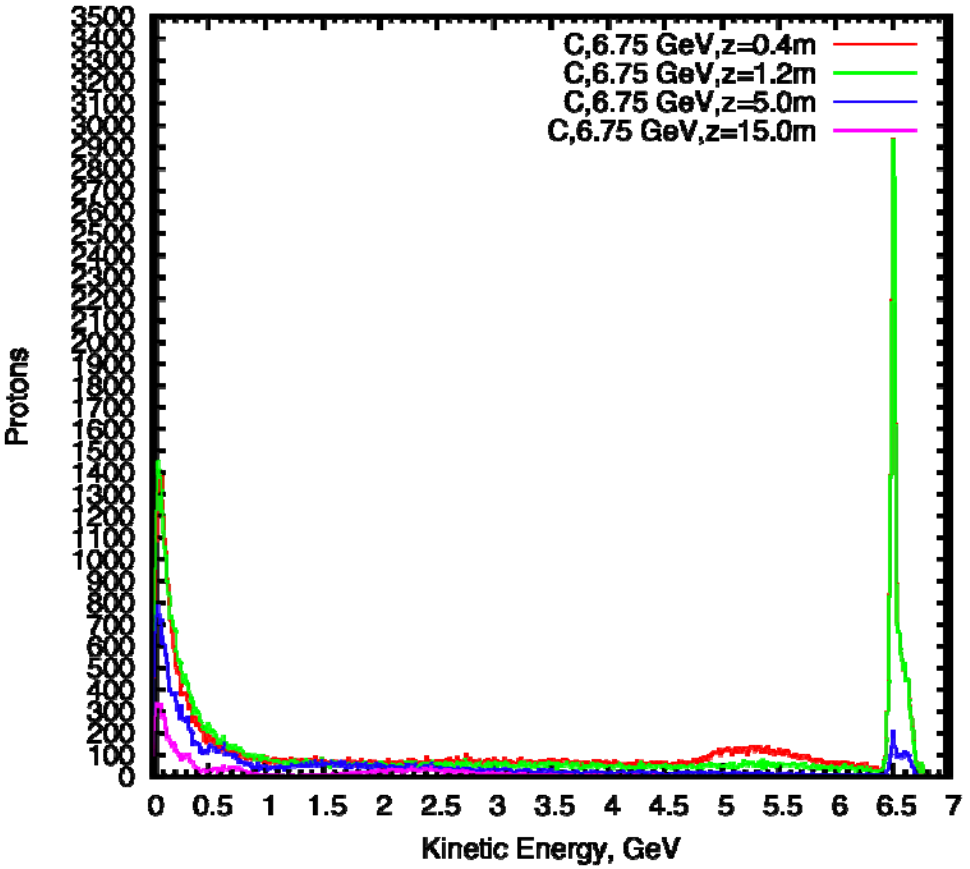
Co-linear target and beam. TR/BR=4

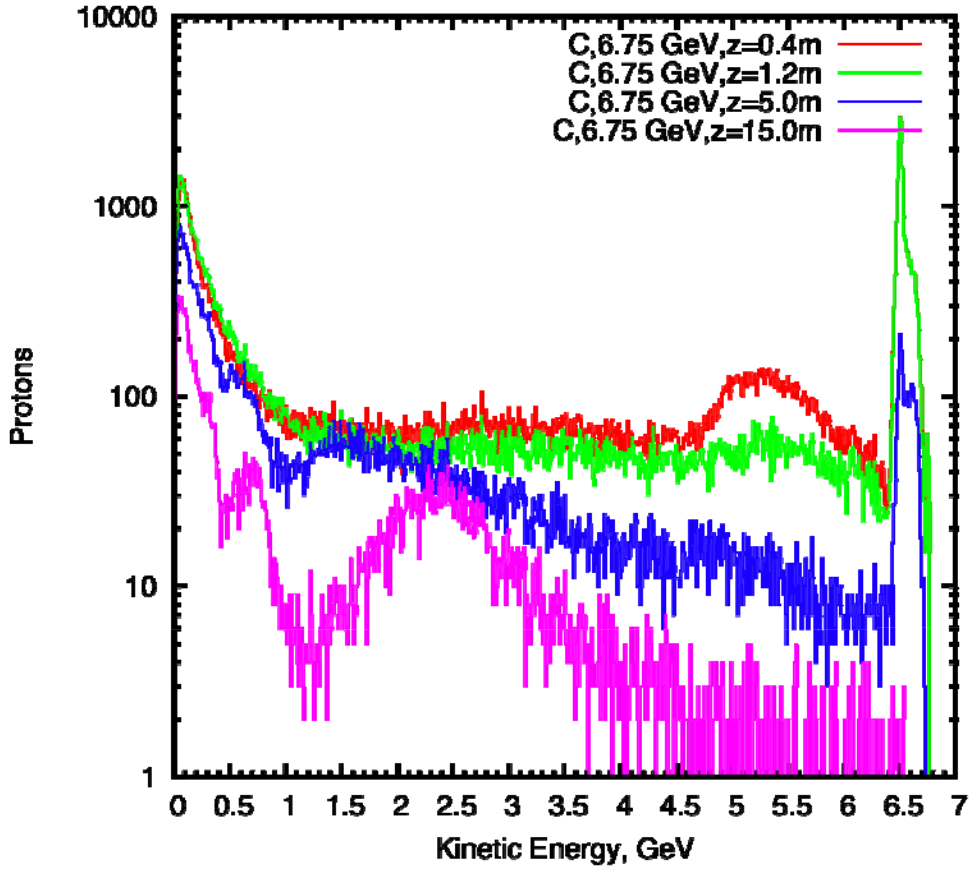
Energy Spectra of $\pi^{\pm}$, $K^{\pm}$, $\mu^{\pm}$ (10^5 events, no beam dump)



Target length: 80 cm
Target radius: 0.72 cm
Beam angle: 65 mrad
Co-linear target and beam
TR/BR=4

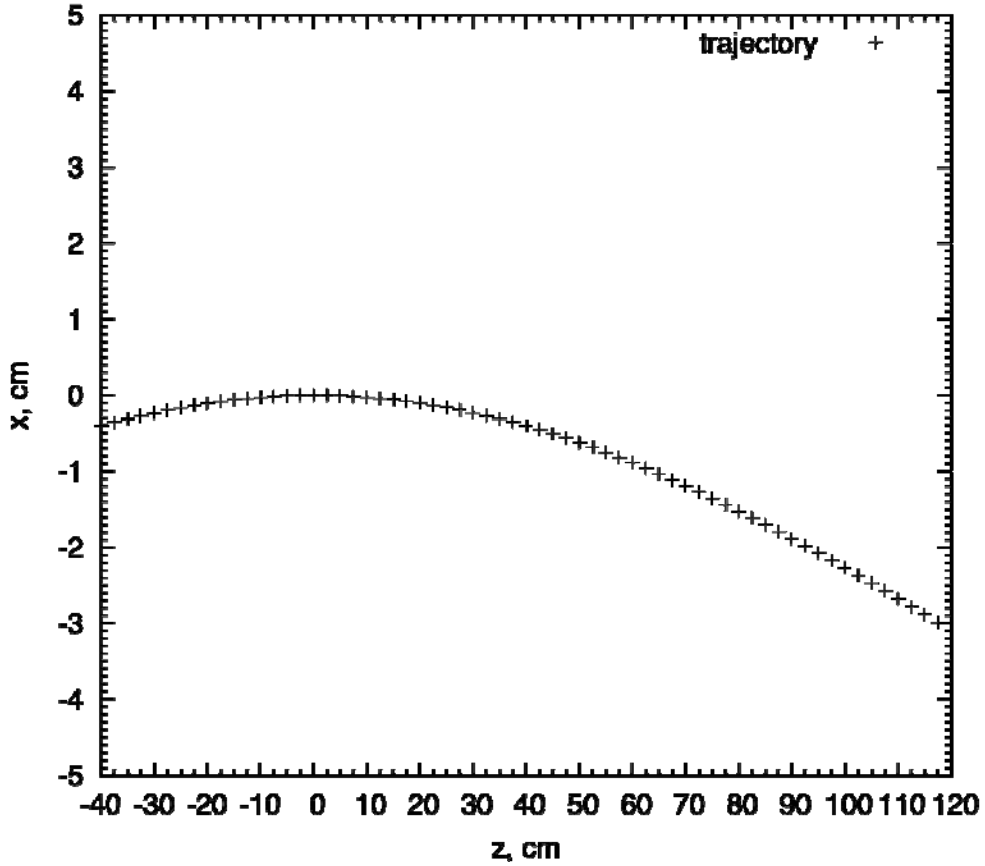
Remaining Protons
(10^5 events, no beam dump)

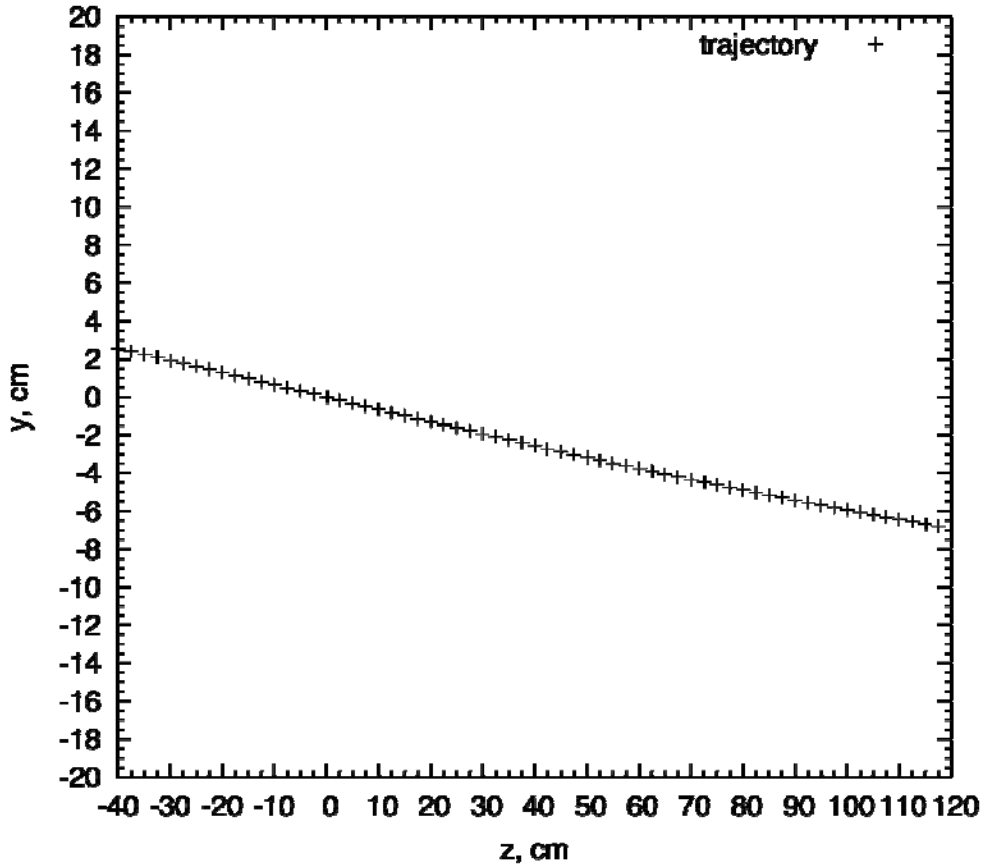




Target length: 80 cm Target radius: 0.72 cm Beam angle: 65 mrad
Co-linear target and beam TR/BR=4

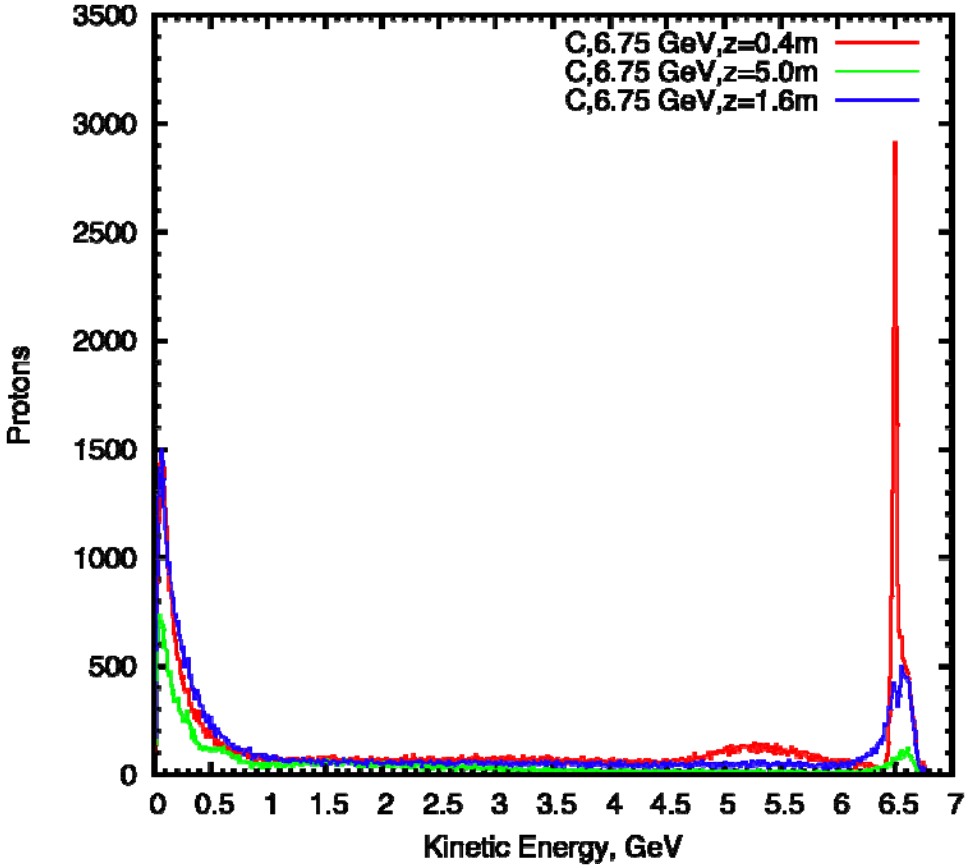
Single Particle Tracking in XZ/YZ plane (no target and beam dump)

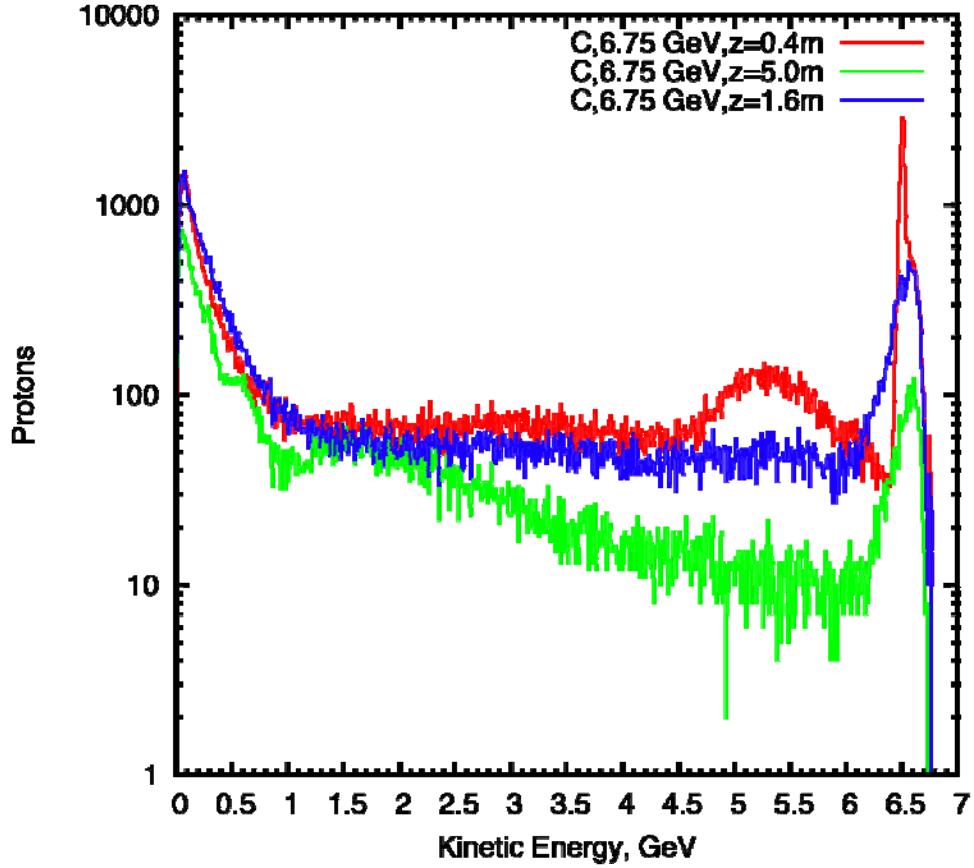




Target length: 80 cm, Target radius: 0.72 cm, Beam angle: 65 mrad
Co-linear target and beam, TR/BR=4
Z=40 cm, x=-0.4 cm, y=-2.562 cm; Z=120 cm, x=-3.097 cm, y=-6.909 cm
X=-tan(0.0337)*(z-40)-0.4; Y=-tan(0.05428)*(z-40)-2.562

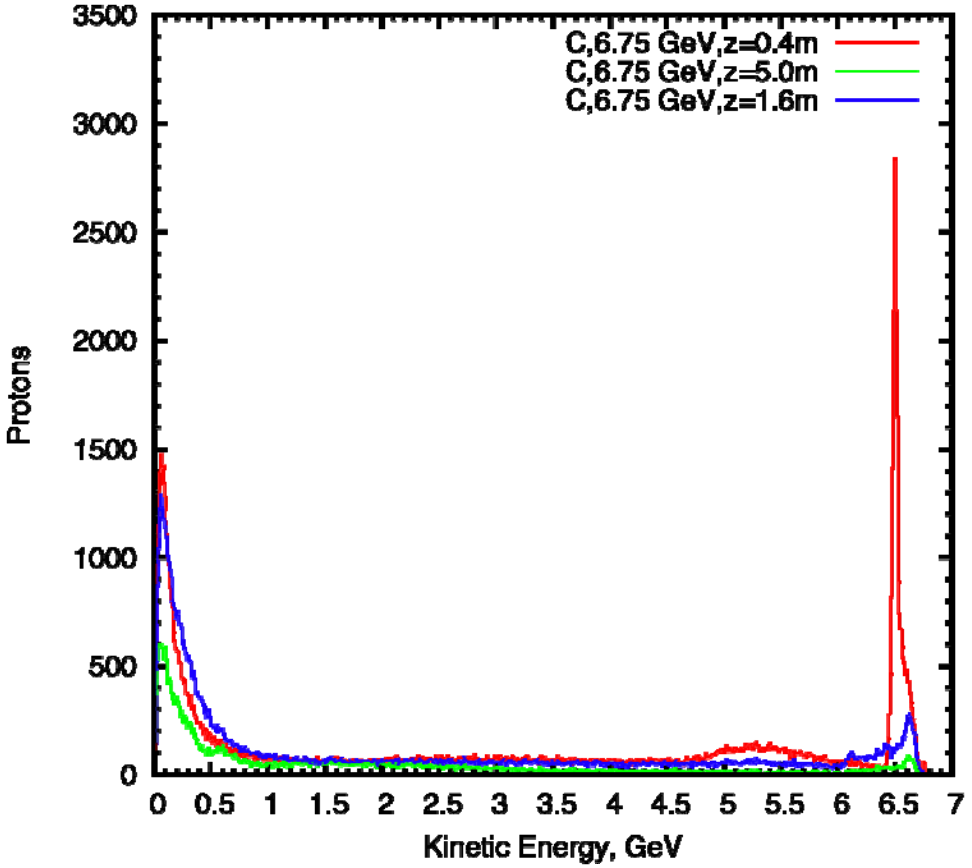
Remaining Protons with Beam Dump (10^5 events)

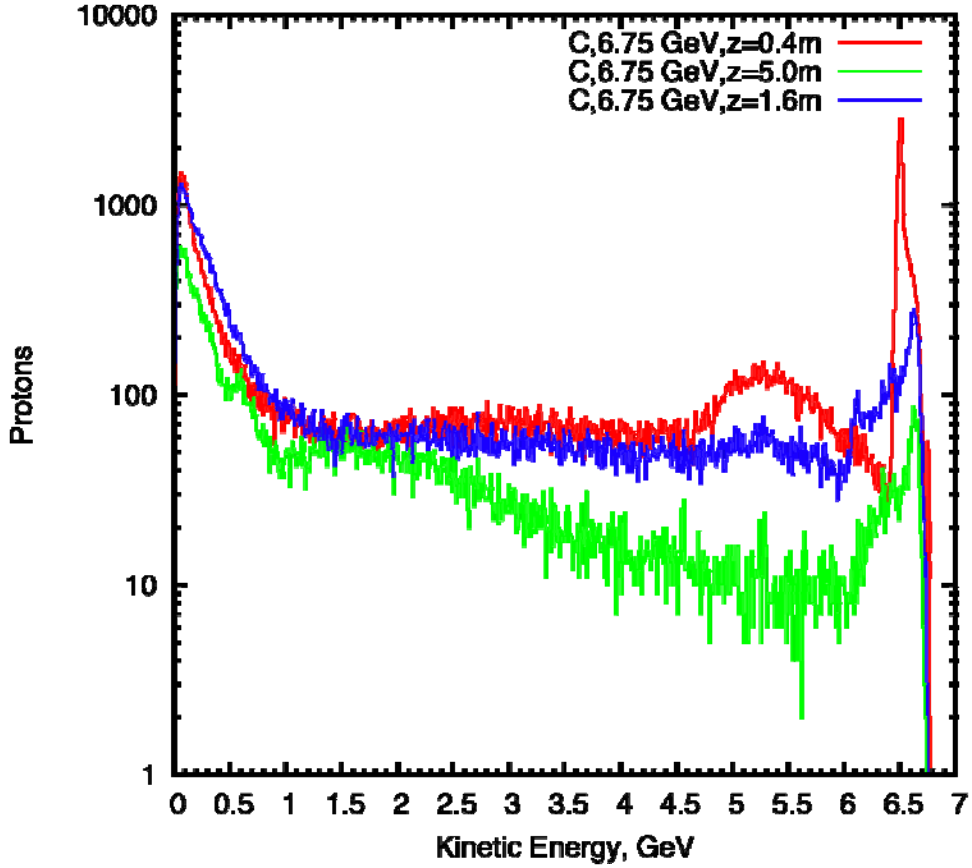




Target length: 80 cm (z=-40 cm to z=40 cm) Target radius: 0.72 cm
Beam angle: 65 mrad Co-linear target and beam TR/BR=4
Beam dump is 120 cm long (z=40 cm to z=160 cm)
Beam dump and target have same radius

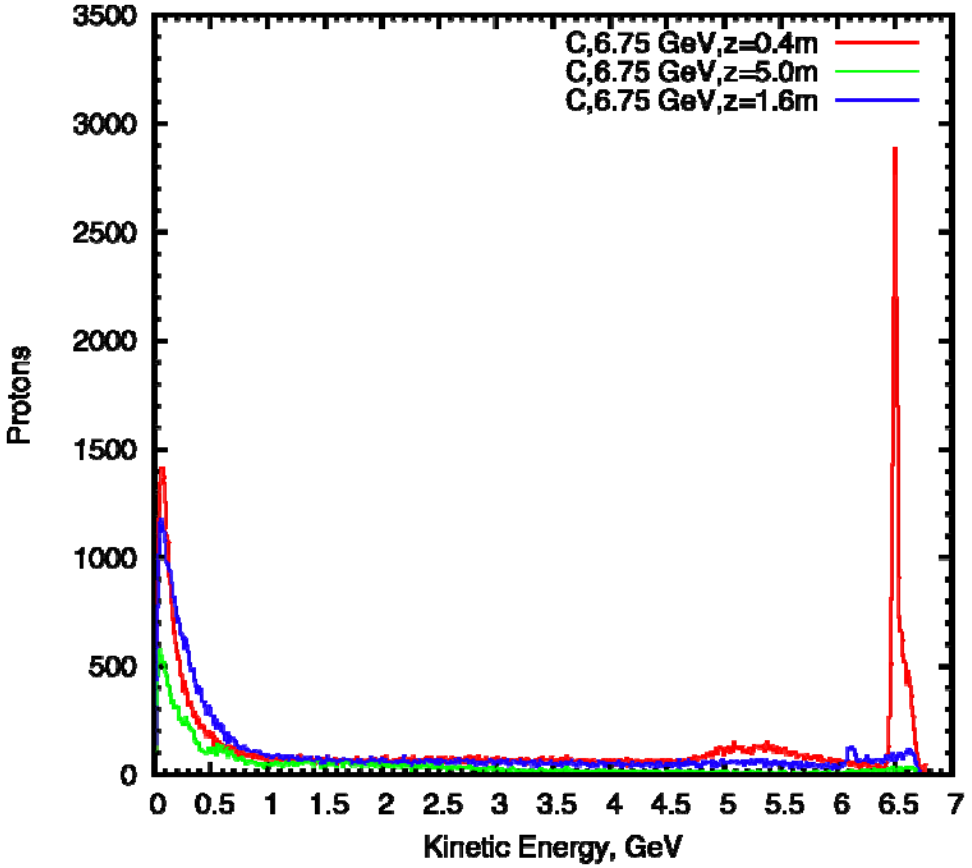
Remaining Protons with Beam Dump (10^5 events)

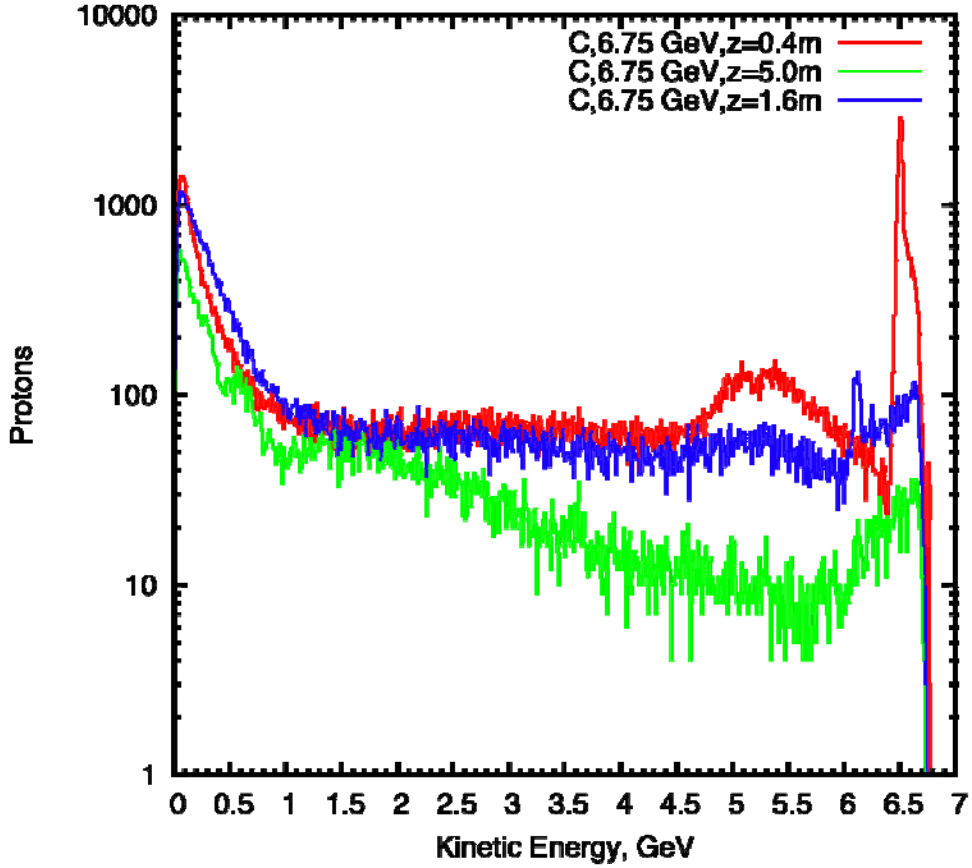




Target length: 80 cm (z=-40 cm to z=40 cm) Target radius: 0.72 cm
Beam angle: 65 mrad Co-linear target and beam TR/BR=4
Beam dump is 120 cm long (z=40 cm to z=160 cm)
The radius of beam dump is twice that of the target

Remaining Protons with Beam Dump (10^5 events)





Target length: 80 cm (z=-40 cm to z=40 cm) Target radius: 0.72 cm
Beam angle: 65 mrad Co-linear target and beam TR/BR=4
Beam dump is 120 cm long (z=40 cm to z=160 cm)
The radius of beam dump is triple that of the target

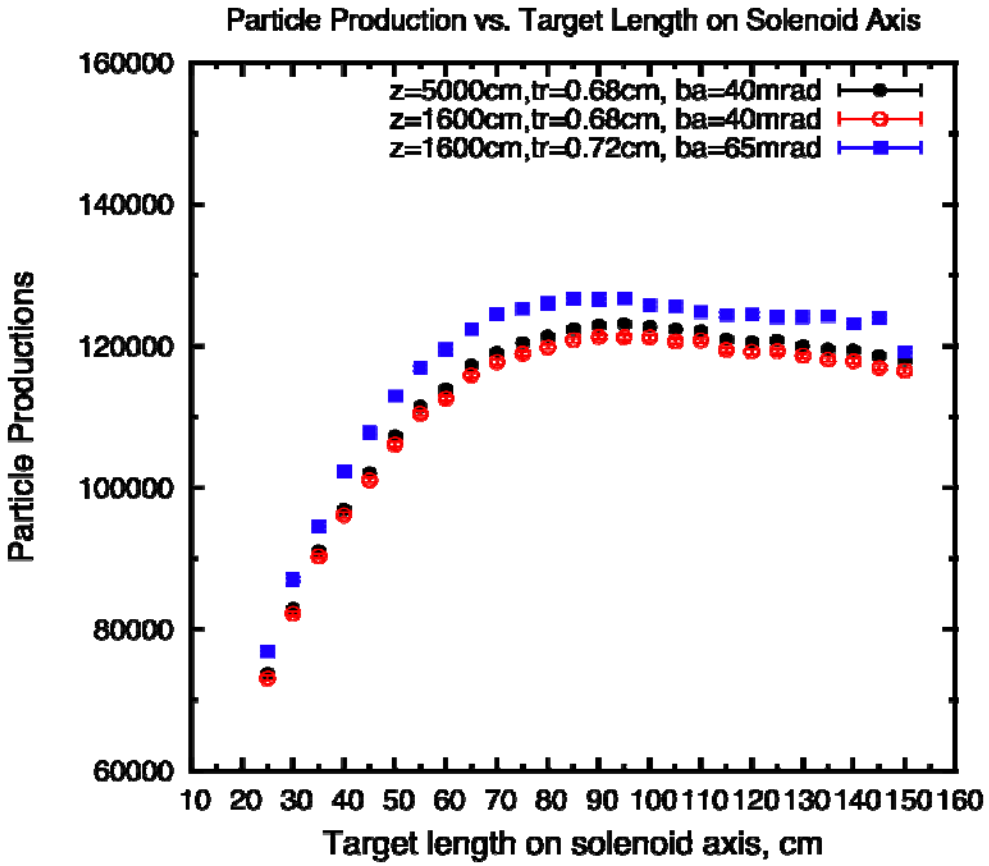
Yield Comparison at z=5 m (10^5 events)

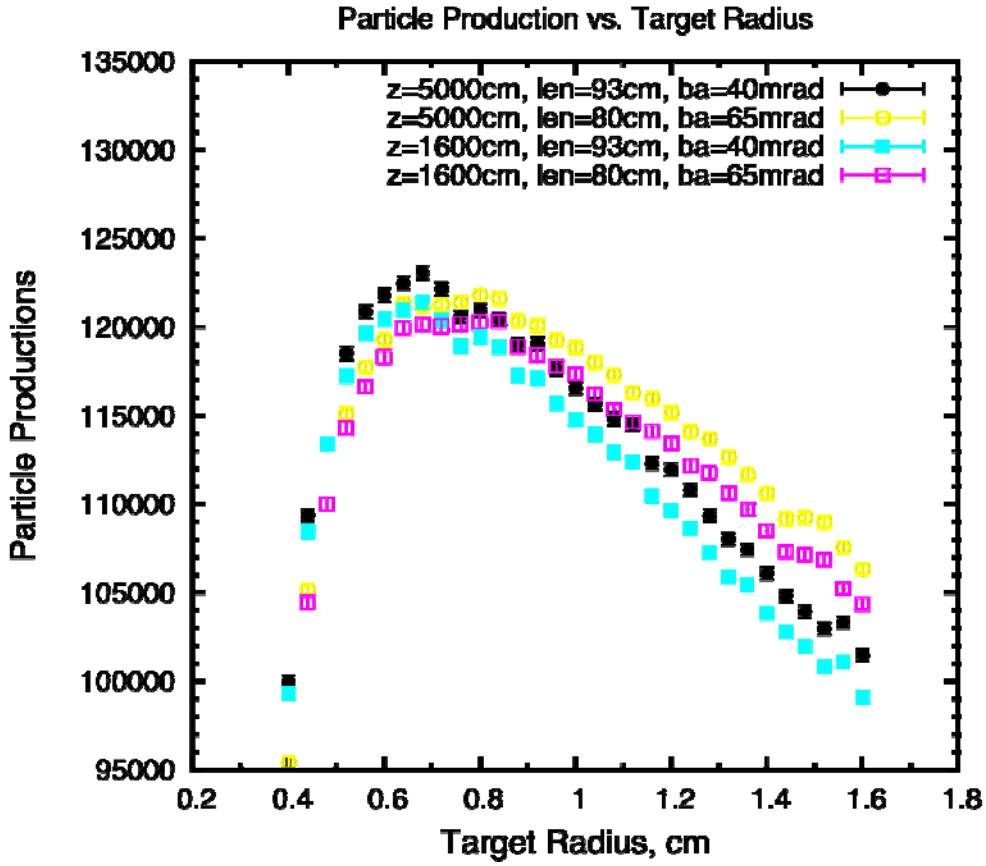
No beam dump	Beam dump (same as target radius)	Beam dump (twice target radius)	Beam dump (triple target radius)
14941	15688	14850	13550

Target length: 80 cm, Target radius: 0.72 cm, Beam angle: 65 mrad
Co-linear target and beam, TR/BR=4

Target parameters

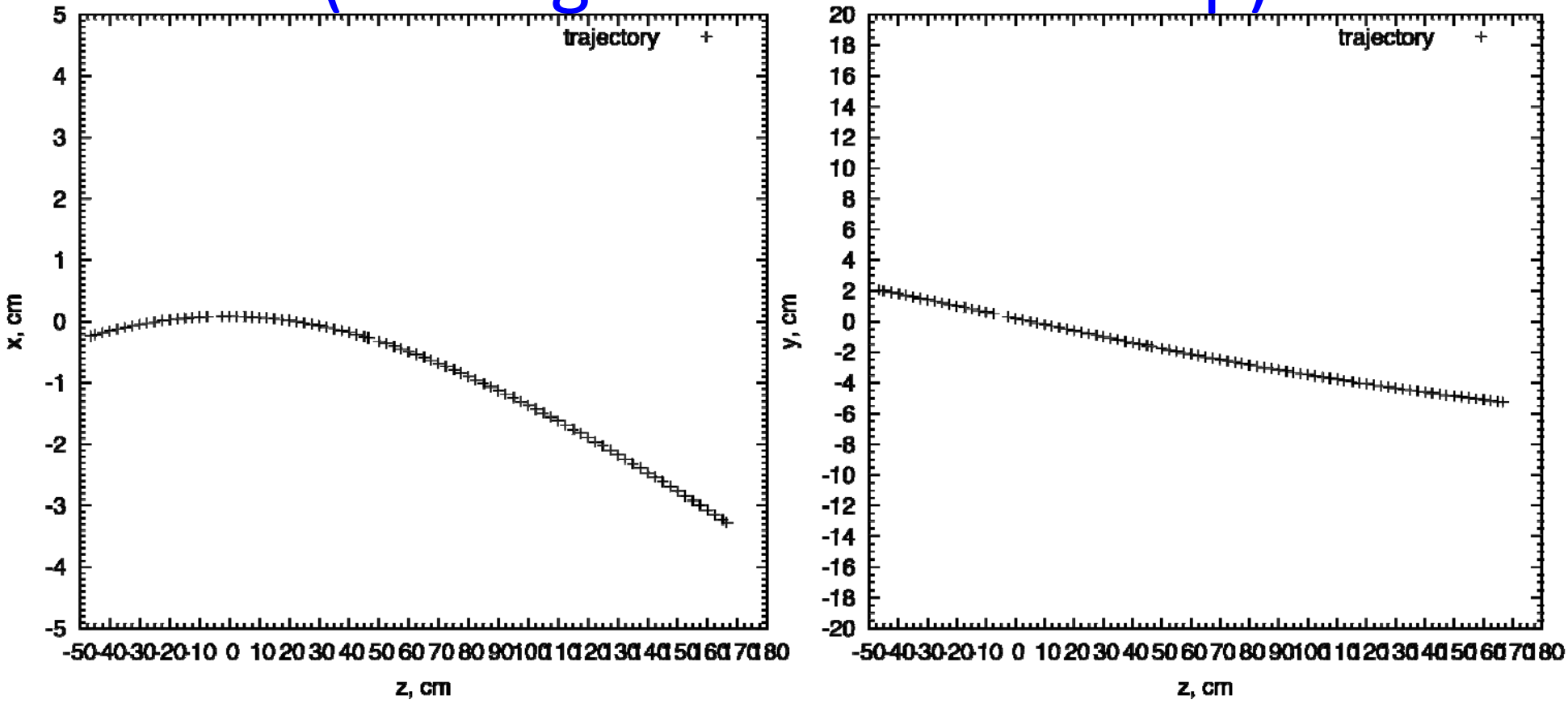
(Beam angle = 40 mrad)





Optimized target length is 93 cm and target radius is 0.68 cm when beam angle is fixed at 40 mrad.
Co-linear target and beam. TR/BR=4

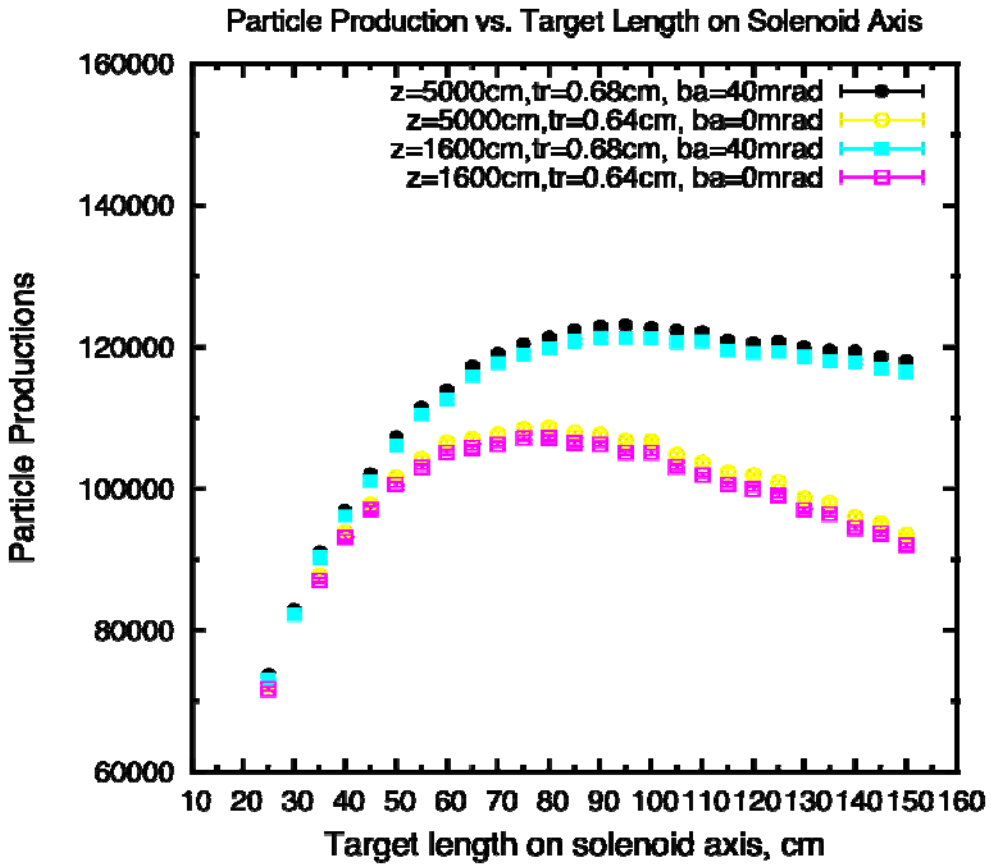
Single Particle Tracking in XZ/YZ plane (no target and beam dump)

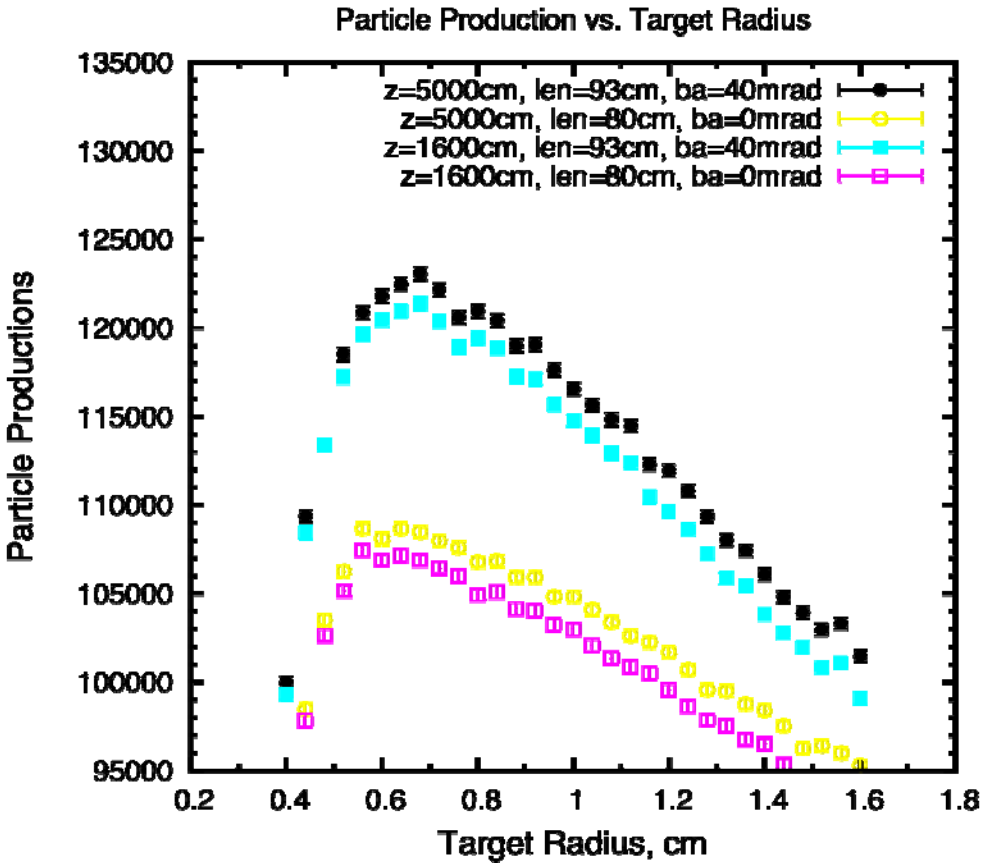


Target length: 93 cm, Target radius: 0.68 cm, Beam angle: 40 mrad
Co-linear target and beam, TR/BR=4
Z=46.5 cm, x=-0.268 cm, y=-1.628 cm; Z=166.5 cm, x=-3.273 cm, y=-5.242 cm
X=-tan(0.025)*(z-46.5)-0.268; Y=-tan(0.0301)*(z-46.5)-1.628

Target parameters

(Beam angle = 0 mrad)





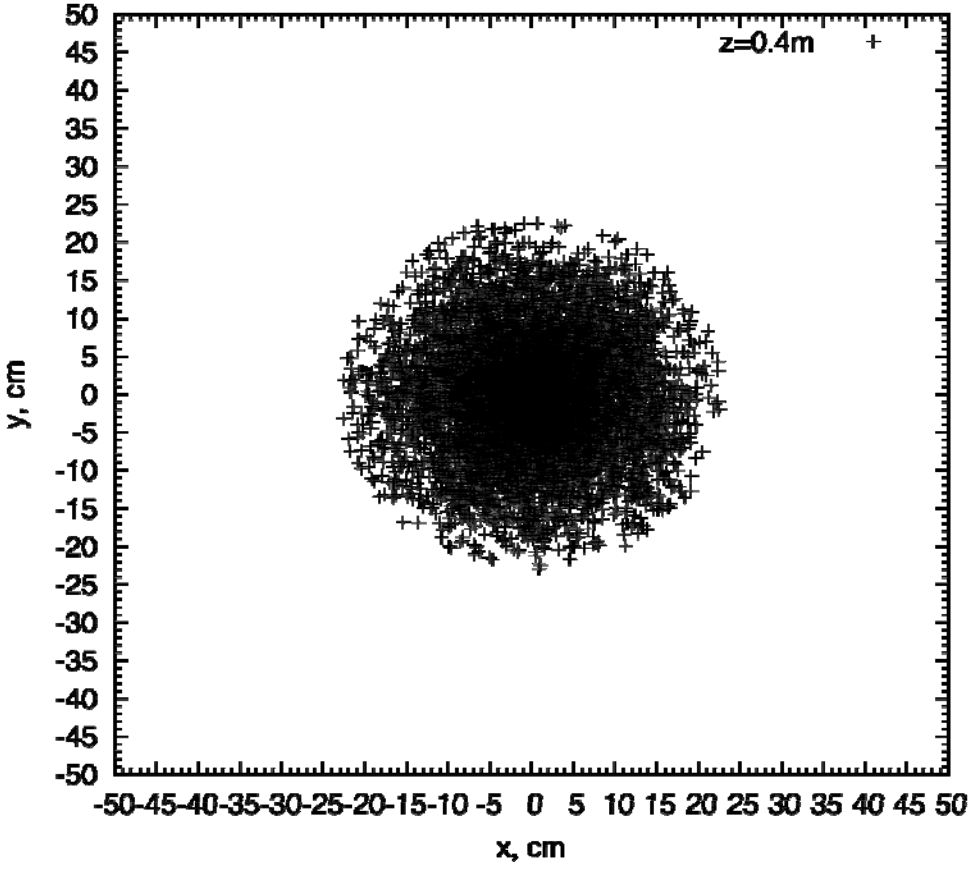
Optimized target length is 80 cm and target radius is 0.64 cm when beam angle is fixed at 0 mrad.

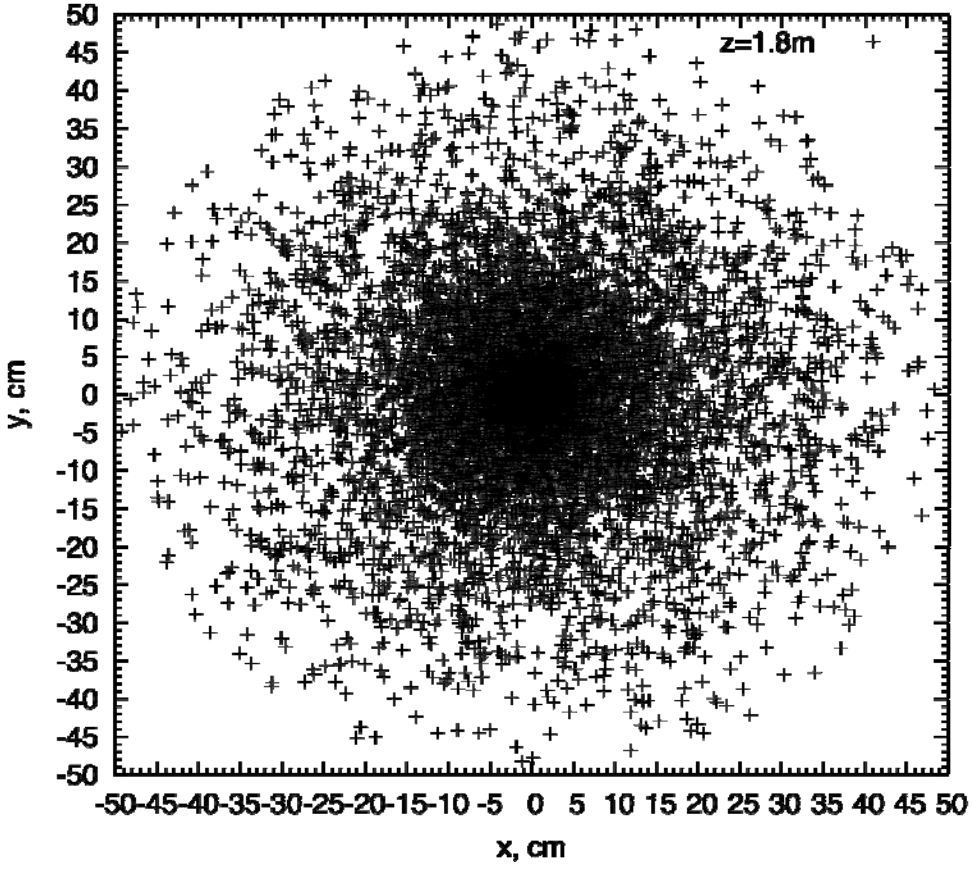
Co-linear target and beam. TR/BR=4

Remaining Protons (KE > 0)

10^4 events, no beam dump

Beam angle = 0 mrad

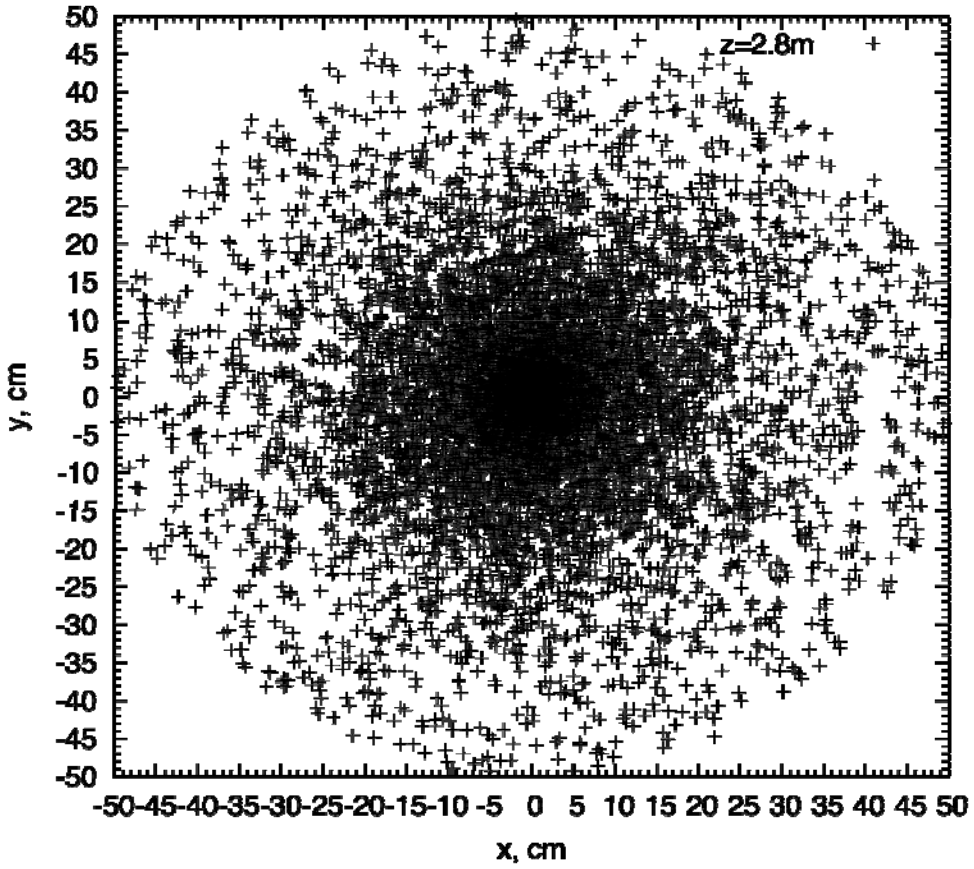


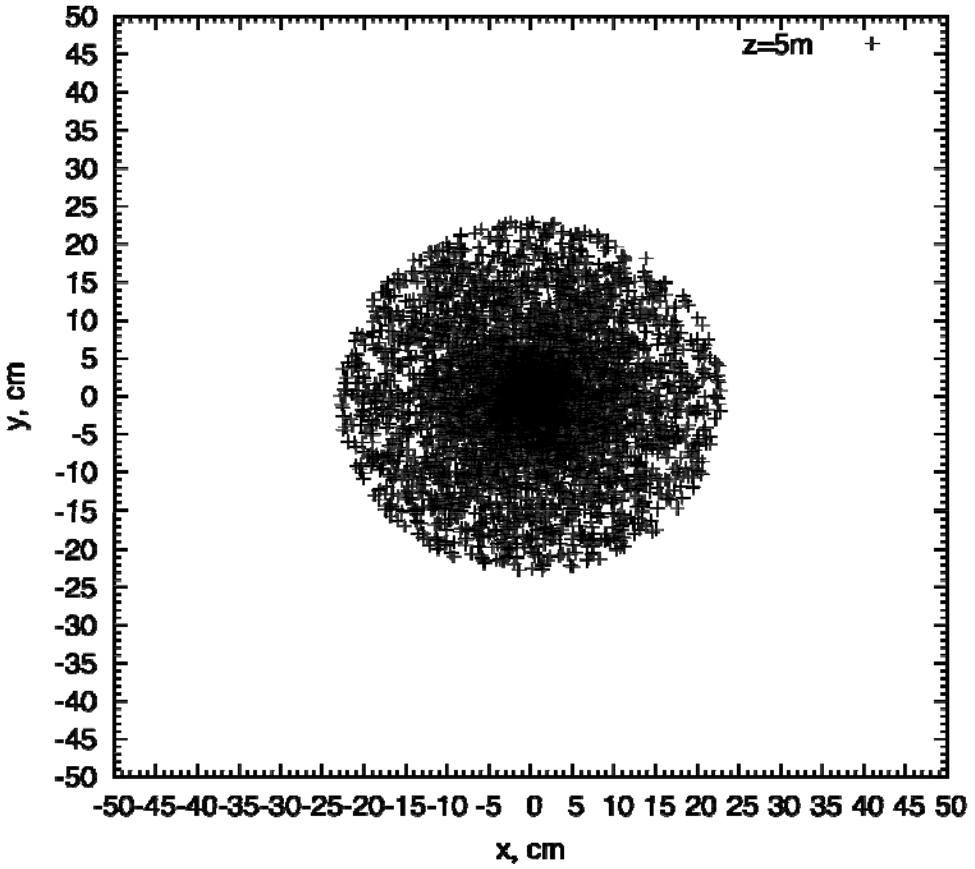


Remaining Protons (KE > 0)

10^4 events, no beam dump

Beam angle = 0 mrad

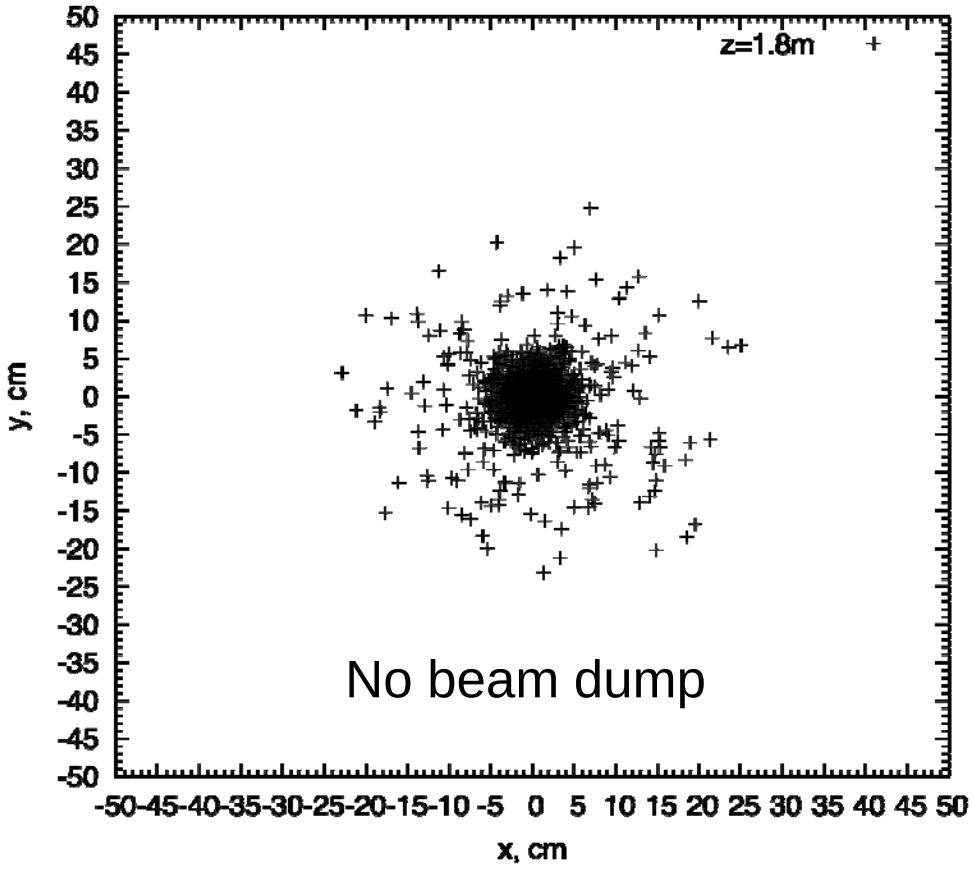


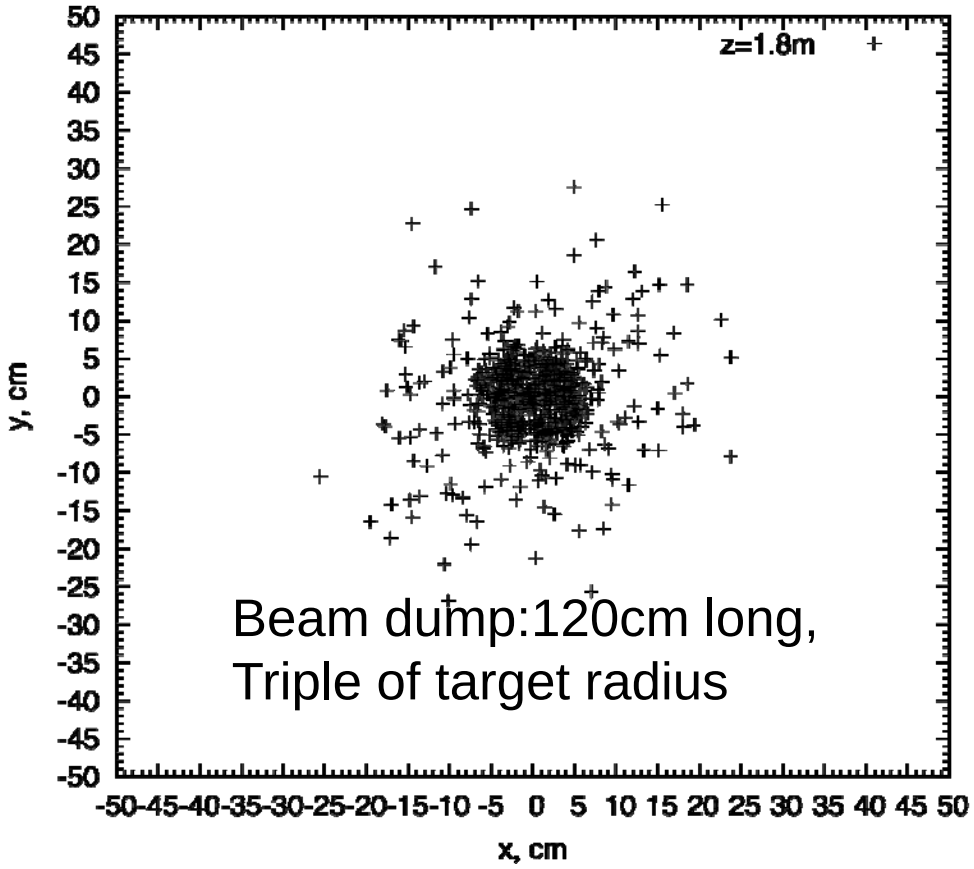


Remaining Protons (KE > 6 GeV)

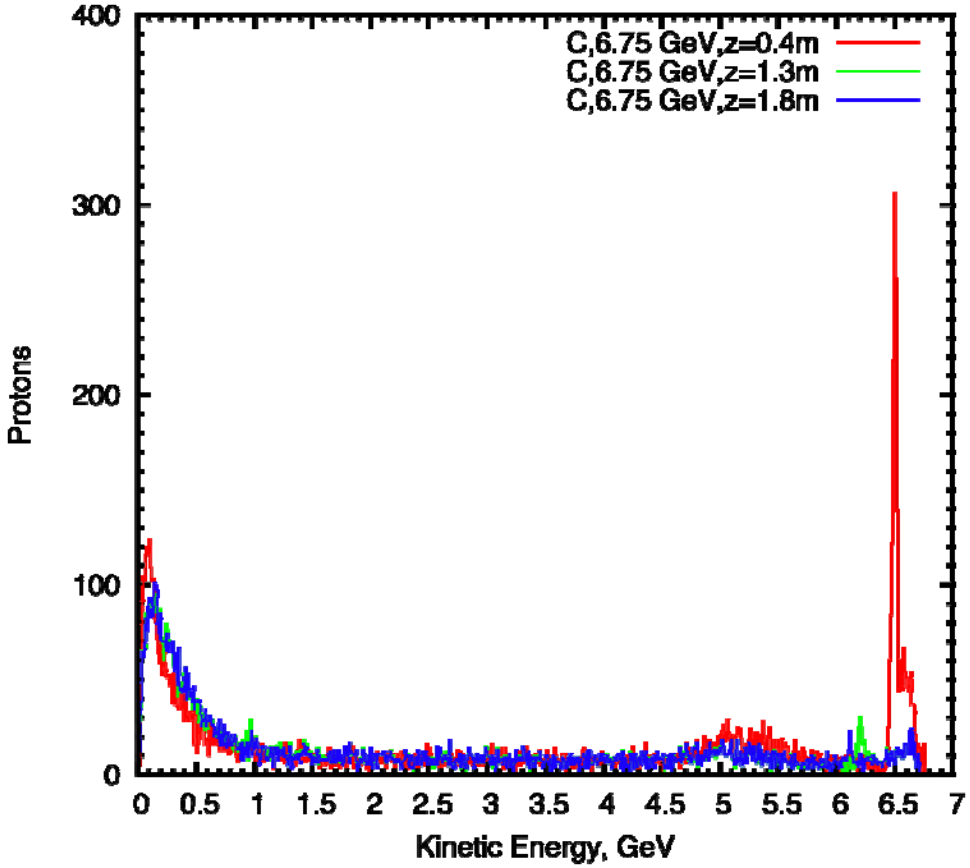
10^4 events, Beam angle = 0 mrad

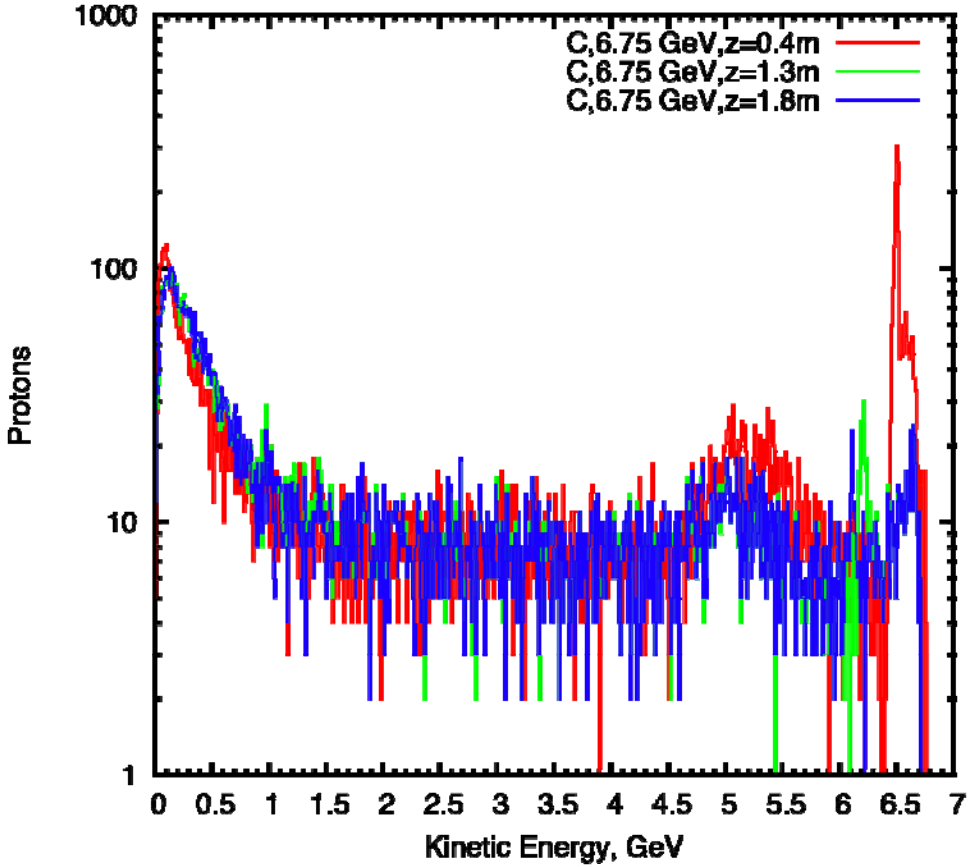
Target radius = 0.64 cm





Remaining Protons with Beam Dump (10^4 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 is 120 cm long (z=40 cm to z=160 cm)
The radius of beam dump is triple that of the target

Comparison of remaining protons 10^4 events, Beam angle = 0 mrad

L_{dump} (cm)	R_{dump}/R_{target}	Z	KE>6	KE>4.5
0	0	5m	2130	2342
40	1	5m	1596	1817
80	1	5m	1410	1626
120	1	5m	1348	1584
40	2	5m	1225	1439
80	2	5m	886	1099
120	2	5m	893	1088
40	3	5m	997	1185
80	3	5m	639	846
120	3	5m	524	1740