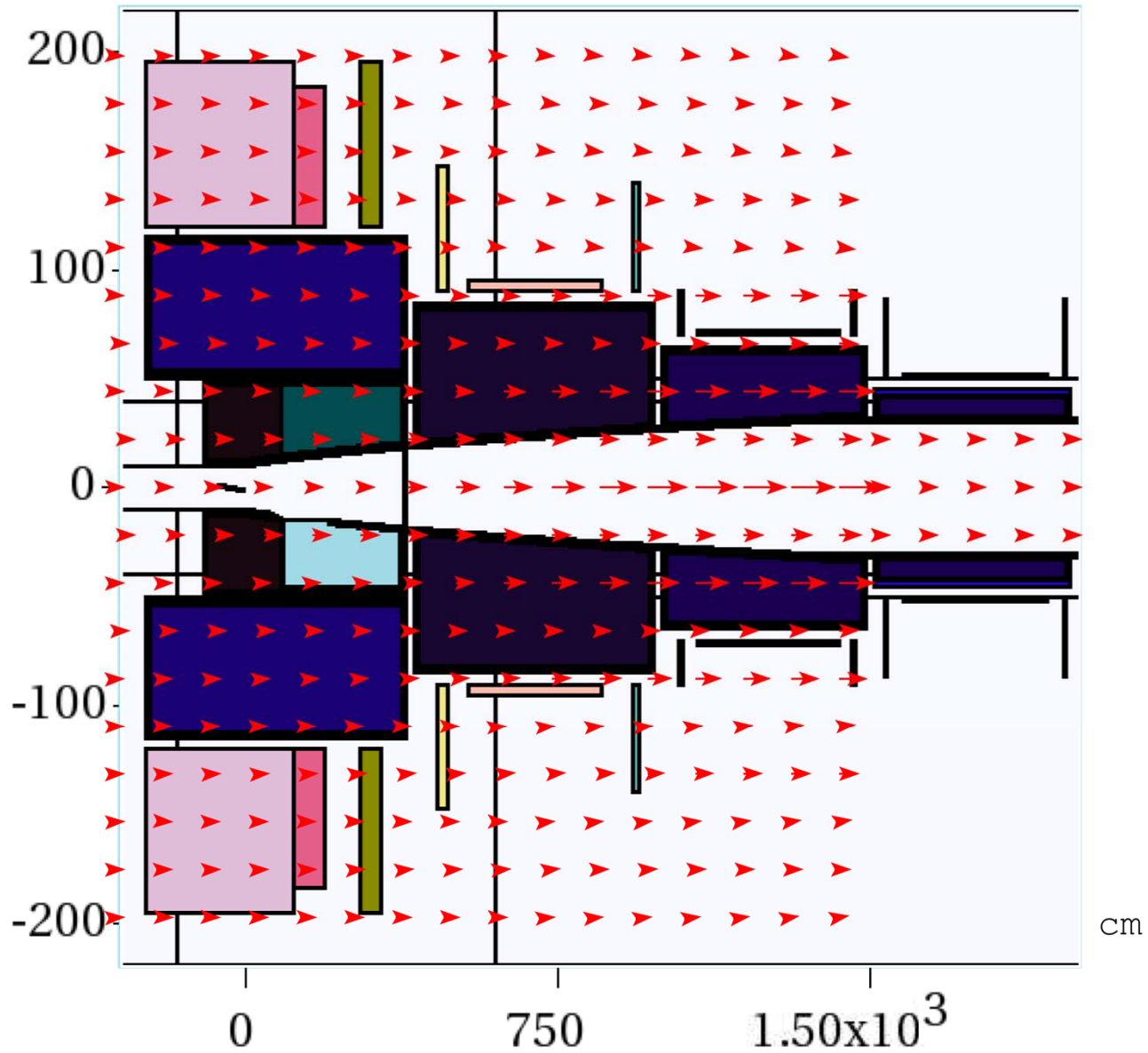# Particle Production with Carbon Target and IDS120j Configuration at 7 GeV

X. Ding, UCLA
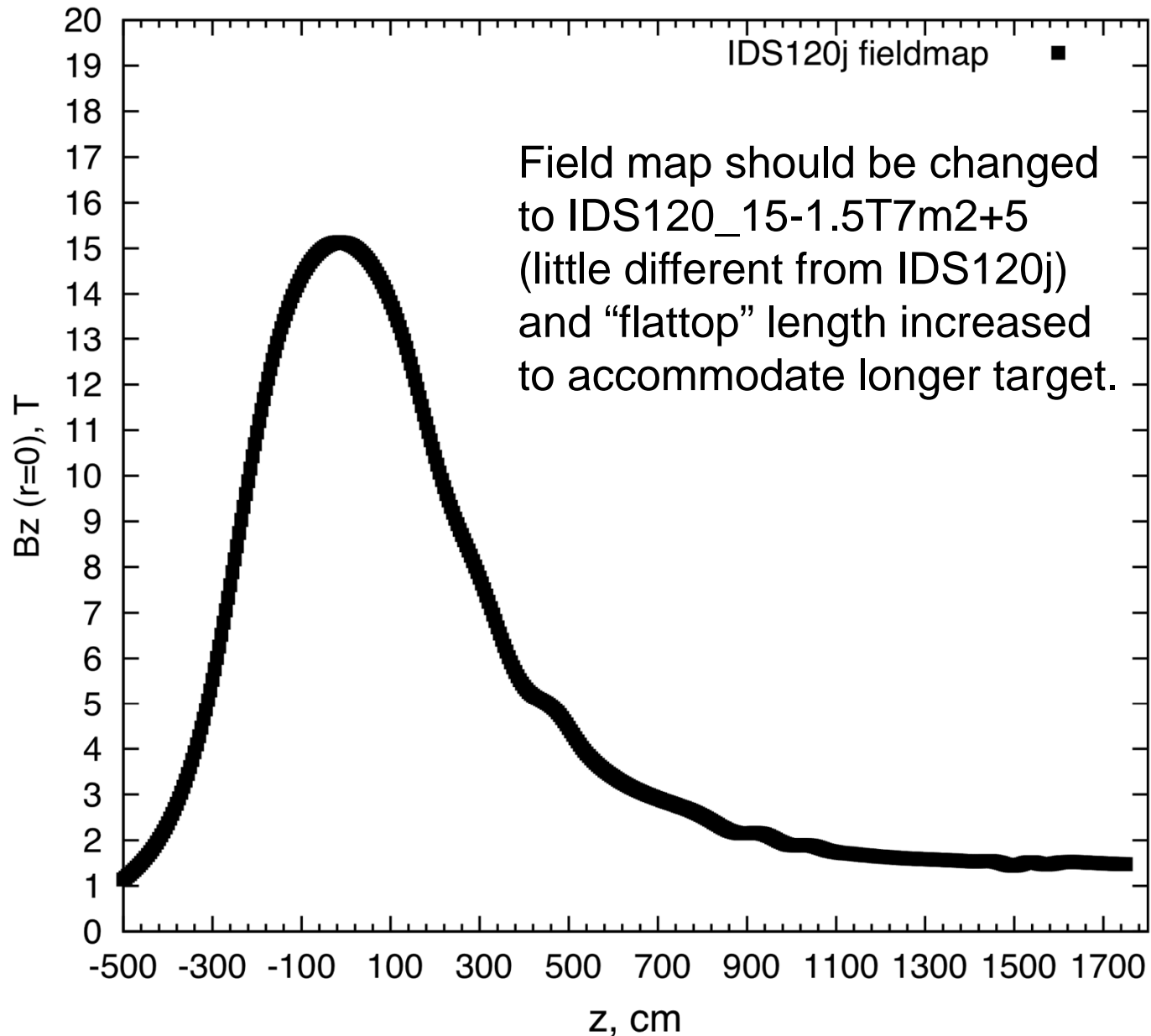
Target Studies
Dec. 30, 2013

IDS120j Geometry

y

Fieldmap

Field map should be changed to IDS120_15-1.5T7m2+5 (little different from IDS120j) and "flattop" length increased to accommodate longer target.

Target Station Setting

- IDS120j Configuration and Fieldmap (15T➔1.5T);

- Mode: MARS15(2012) ICEM 4=1;

- Proton beam: 7 GeV (KE) and launched at z = -100 cm;

- Carbon Target setting: with or without tilt angle to SC axis;

- Production Collection: (50 m downstream, 40 MeV < KE < 180 MeV).

Incident Particle Energy and the threshold in matter for subsequent generated particles

- **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)

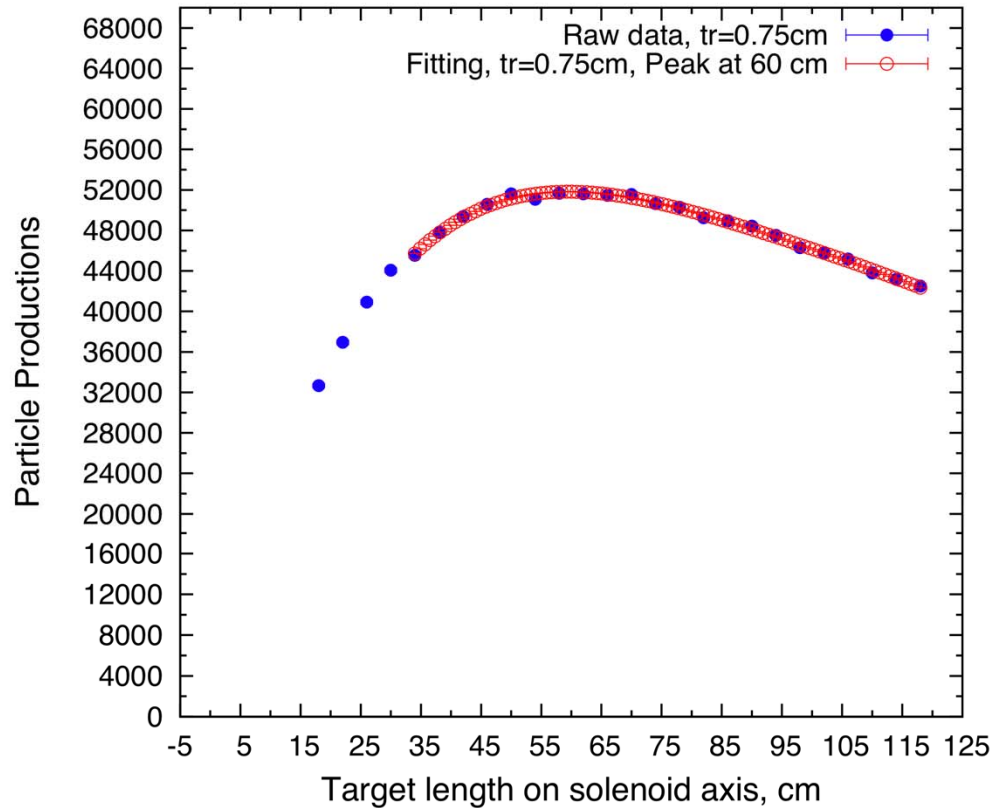 EMIGA: The threshold energy for γ (Default:10^{-4} GeV);

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

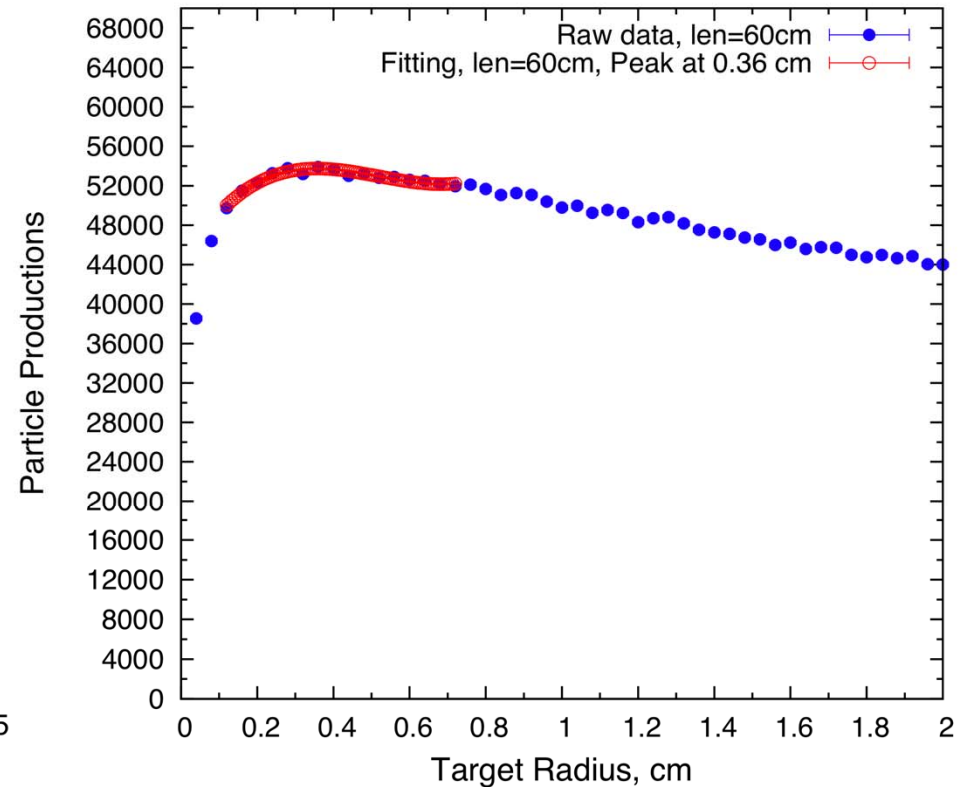 Use non-default setting: ENRG 1=7 2=0.02 3=0.3 4=0.01 5=0.05 6=0.01 7=0.01

Carbon Target without Tilt Angle
(7 GeV, 400000 events)

Particle Production vs. Target Length on Solenoid Axis

Raw data, tr=0.75cm
Fitting, tr=0.75cm, Peak at 60 cm

Particle Production vs. Target Radius

Raw data, len=60cm
Fitting, len=60cm, Peak at 0.36 cm

Use target radius/beam radius ≡ 4.
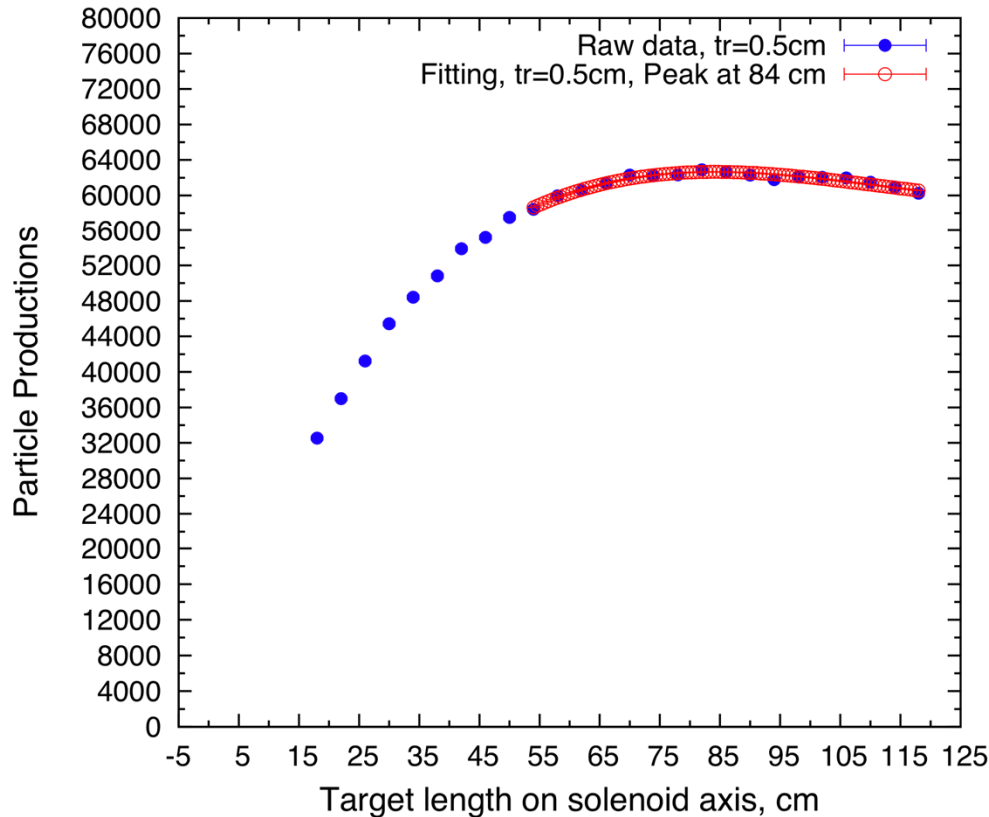Optimized target length is 60 cm for target radius fixed at 0.75 cm.
Optimized target radius is 0.36 cm for target length fixed at 60 cm.
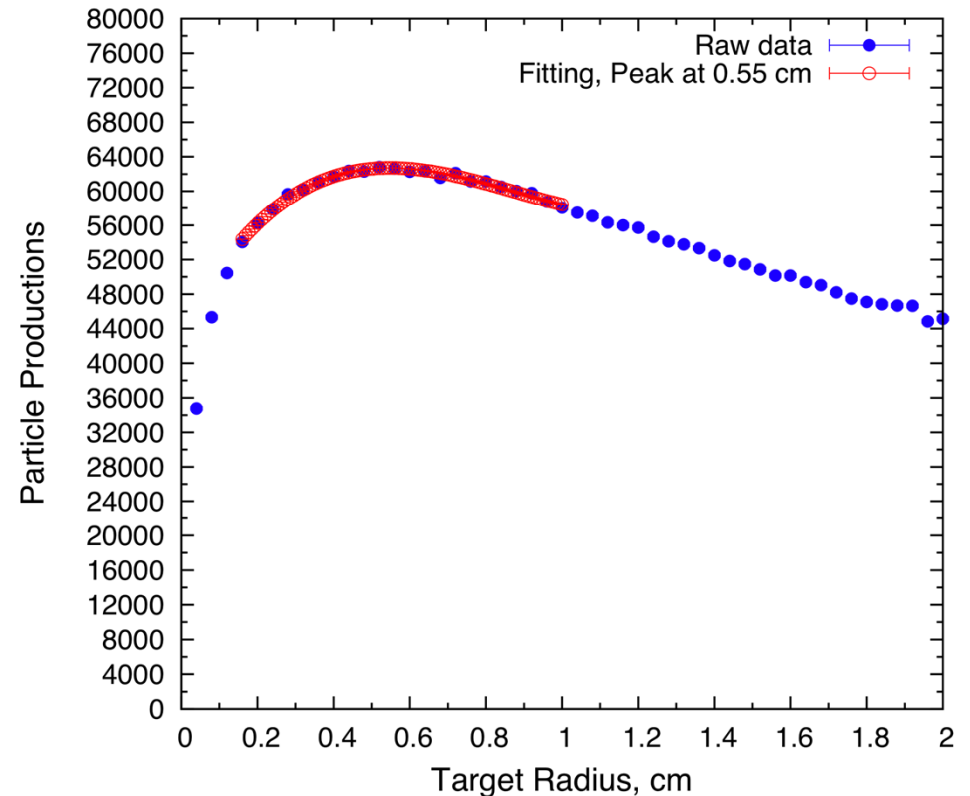Yield is 0.0192 per proton and per GeV.

Carbon Target with Tilt Angle
(7 GeV, 400000 events)

Study with radii of target and beam in ratio 4:1.
Beam and target have same angle at z = -37.5 cm, value = 50 mrad.
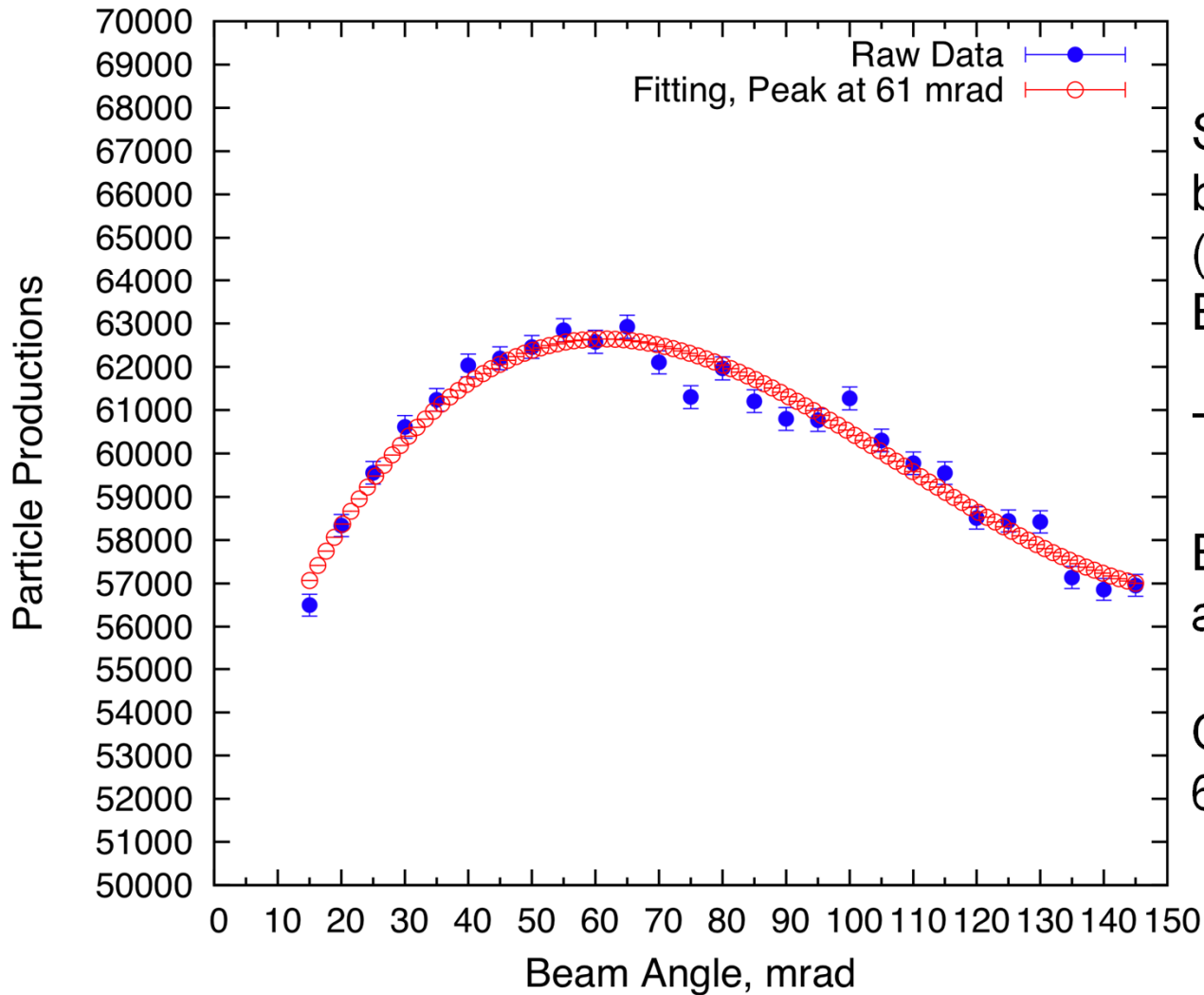Optimized target length is 84 cm for target radius fixed at 0.5 cm.
Optimized target radius is 0.55 cm for target length fixed at 82 cm
Yield is 0.0224 per proton and per GeV. About 17% higher in particle production than the case without tilt angle.

Carbon Target with Tilt Angle
(7 GeV, 400000 events)

Particle Production vs. Beam Angle (Rod Angle)

Study with radii of target and beam in ratio 4:1.
(Target radius is set to 0.5 cm. Beam radius is set to 0.125 cm.)
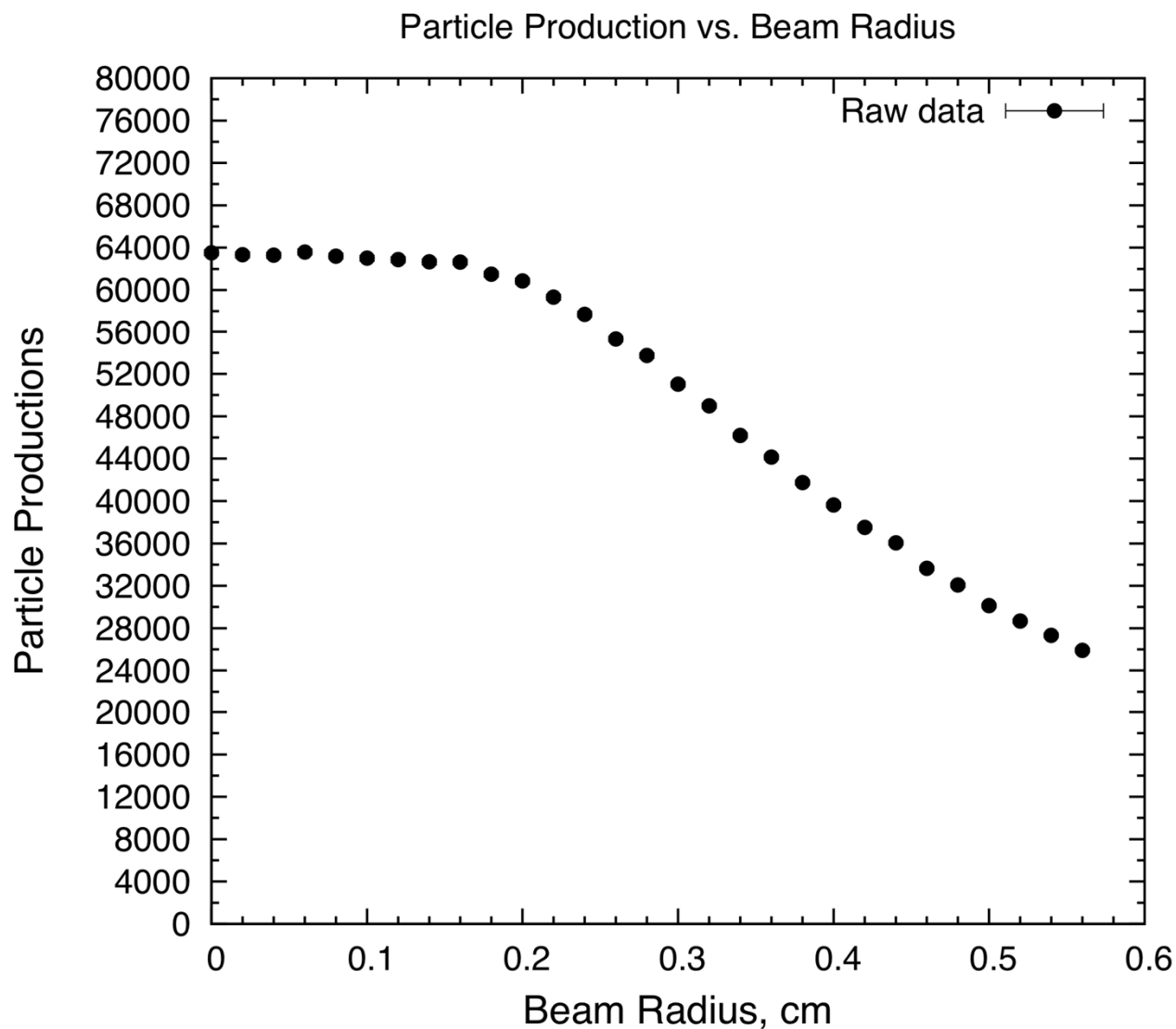
Target length is set to 82 cm.

Beam and target have same angle at z = -37.5 cm.

Optimized beam (target) angle is 61 mrad to SC axis.

Carbon Target with Tilt Angle
(7 GeV, 400000 events)

Particle Production vs. Beam Radius

Target radius is set to 0.5 cm. Beam radius is varied.)
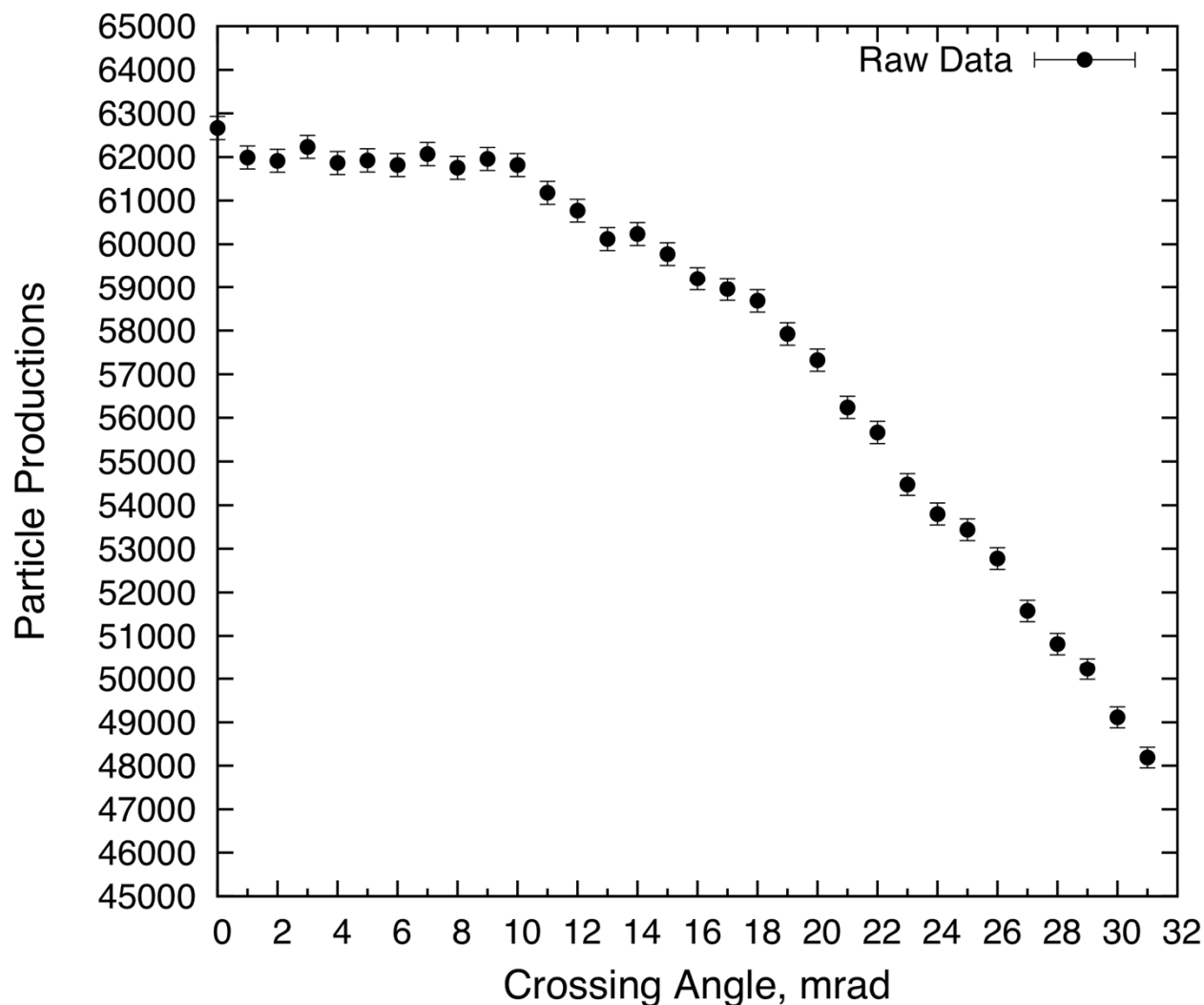
Target length is set at 82 cm.

Beam angle is set to 60 mrad to SC axis at z = -37.5 cm

Beam and target have same angle at z = -37.5 cm

Carbon Target with Tilt Angle
(7 GeV, 400000 events)
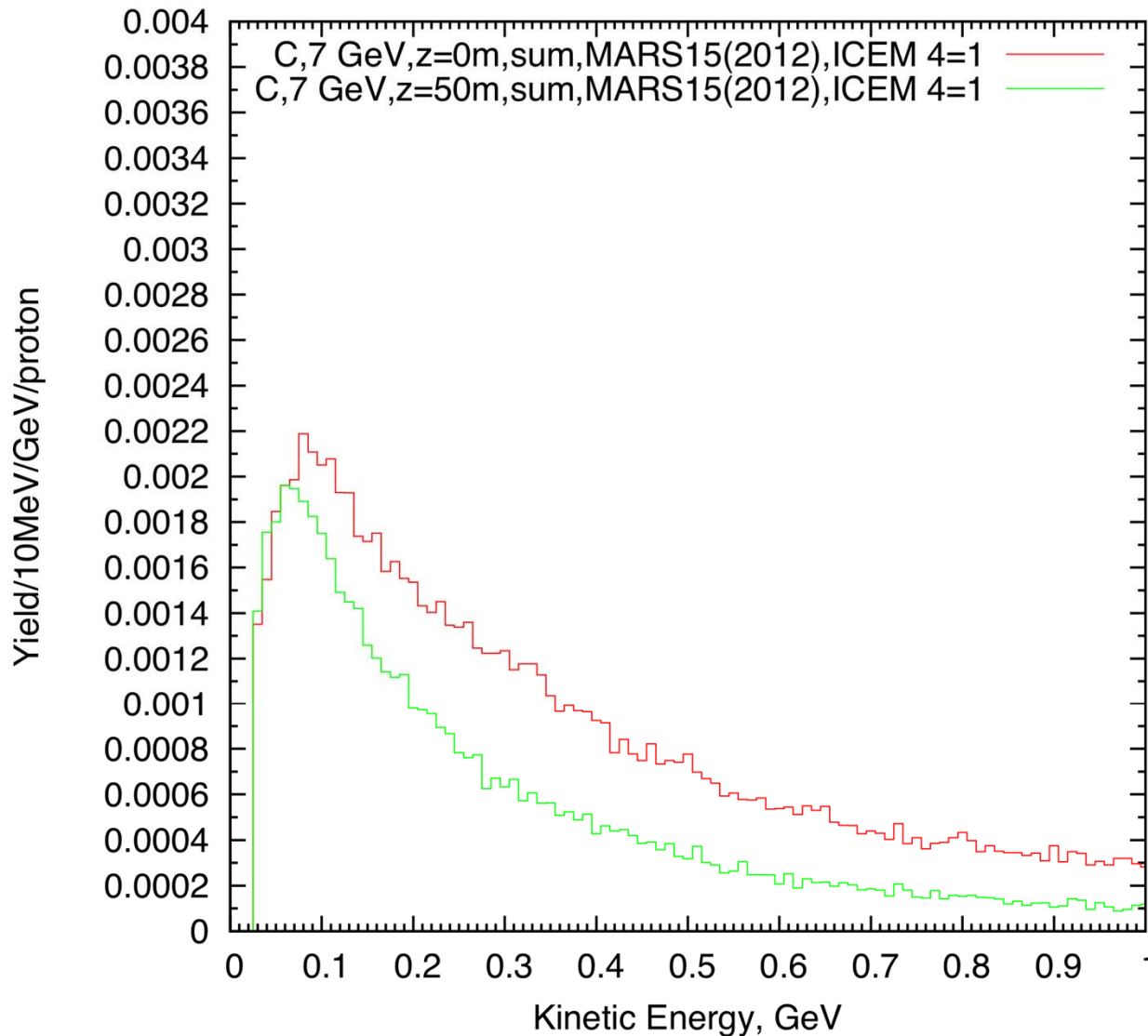
Particle Production vs. Crossing Angle

Study with radii of target and beam in ratio 4:1.
(Target radius is set to 0.5 cm. Beam radius is set to 0.125 cm.)
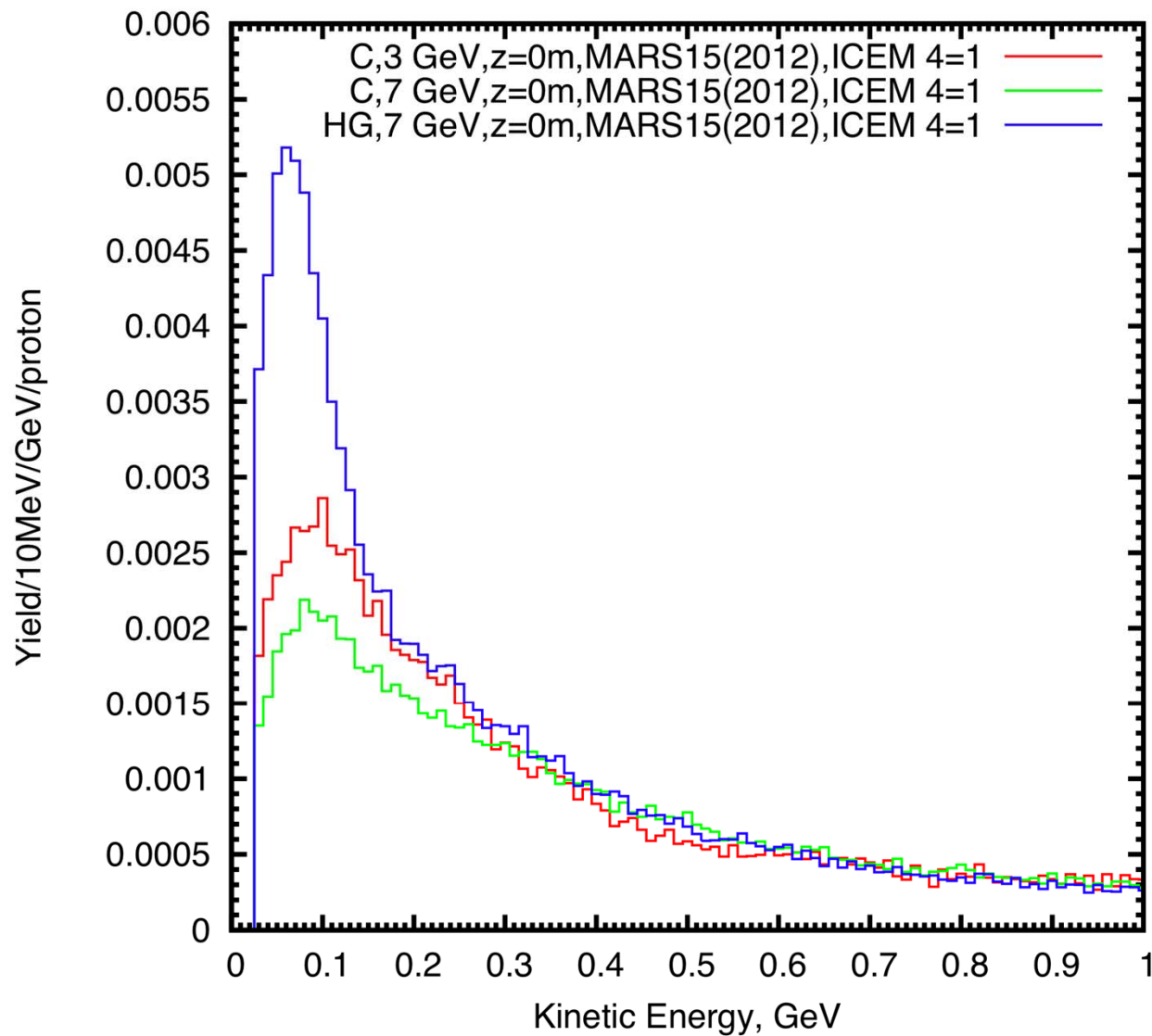
Target length is set at 82 cm.

Beam angle is set to 60 mrad to SC axis at z = -37.5 cm (rod angle of carbon target is varied from 60 mrad to 91 mrad).

Yield at z = 0m and z = 50m
(Carbon, 7 GeV)
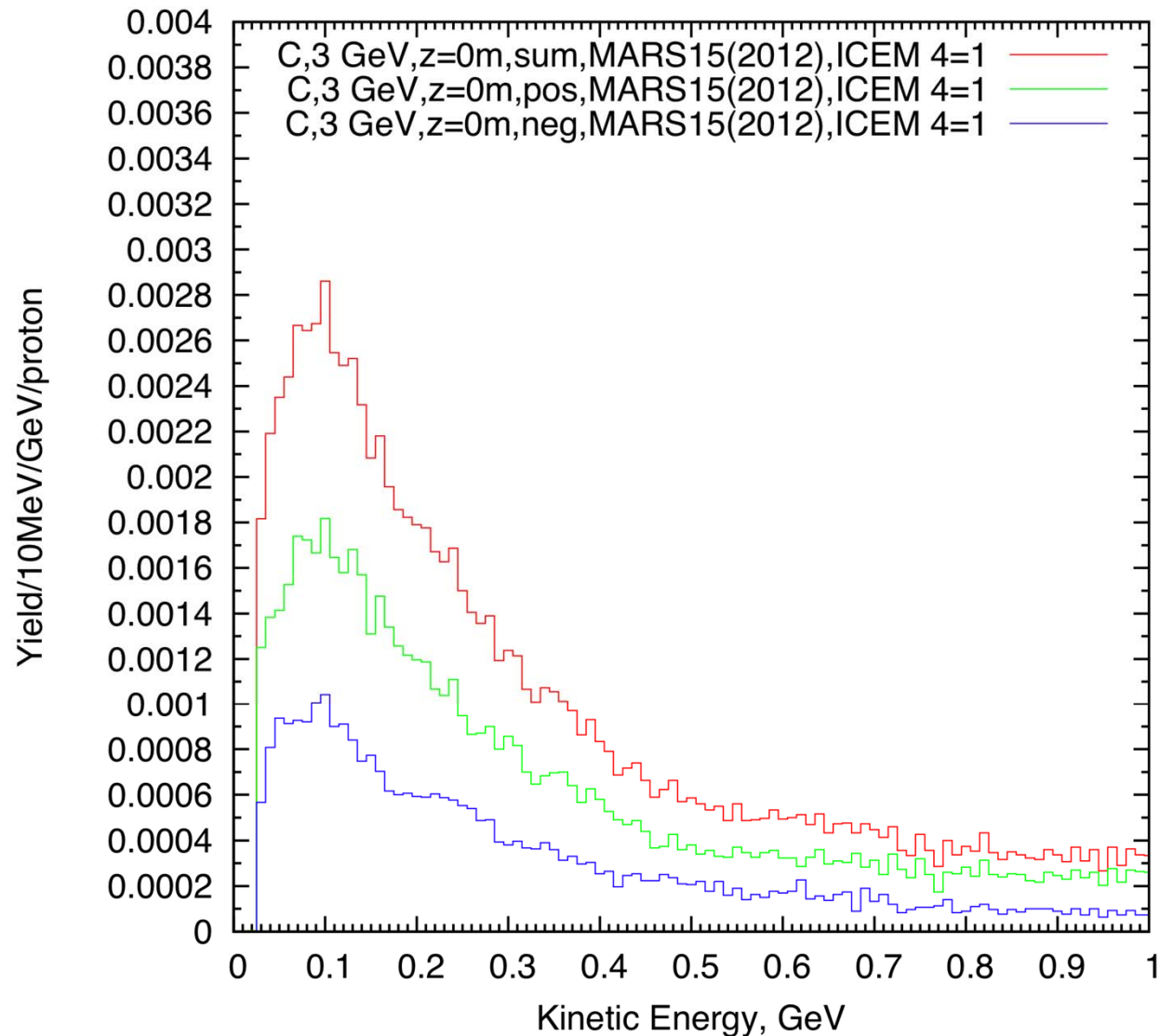
Yield Comparison at z = 0m
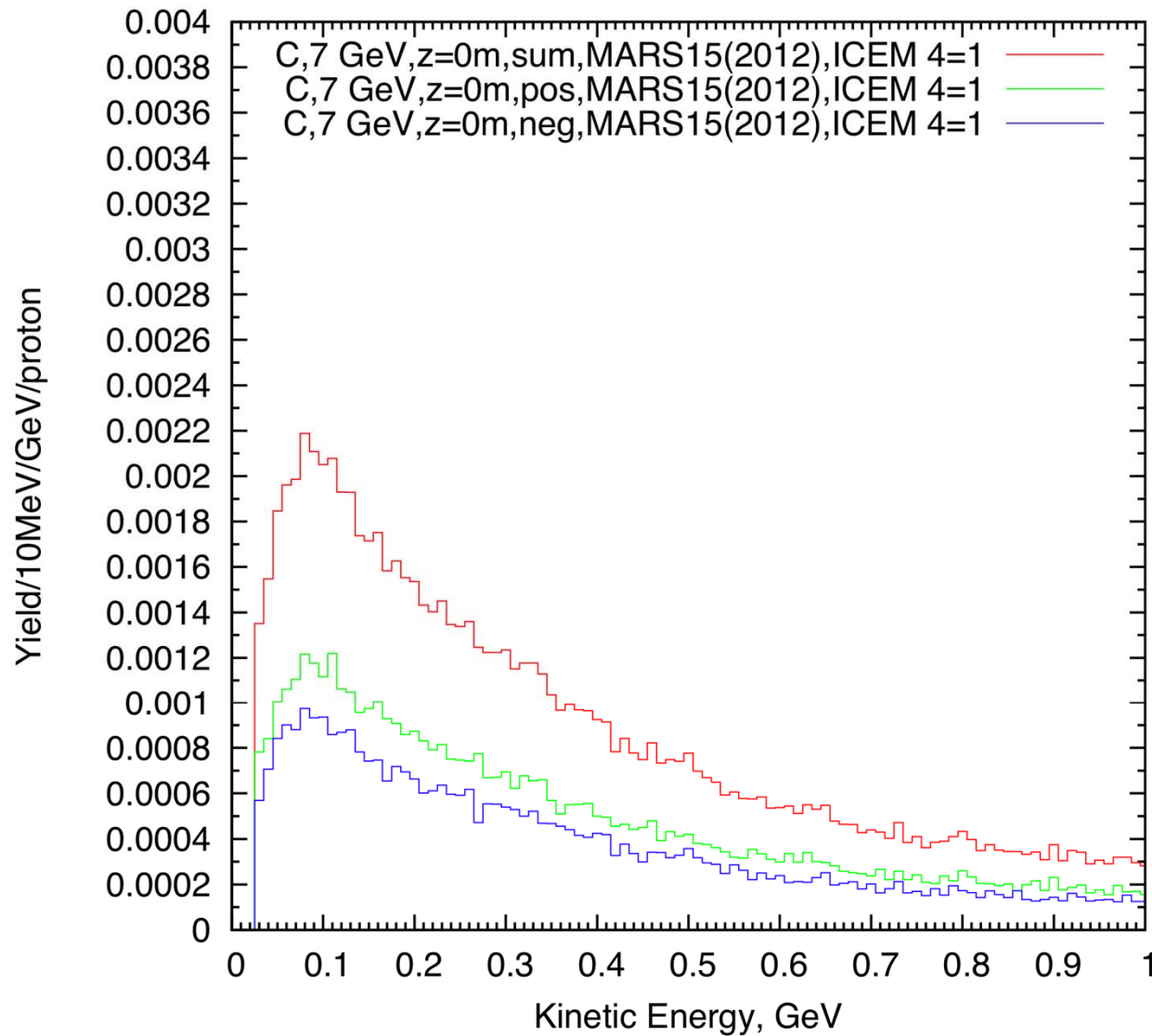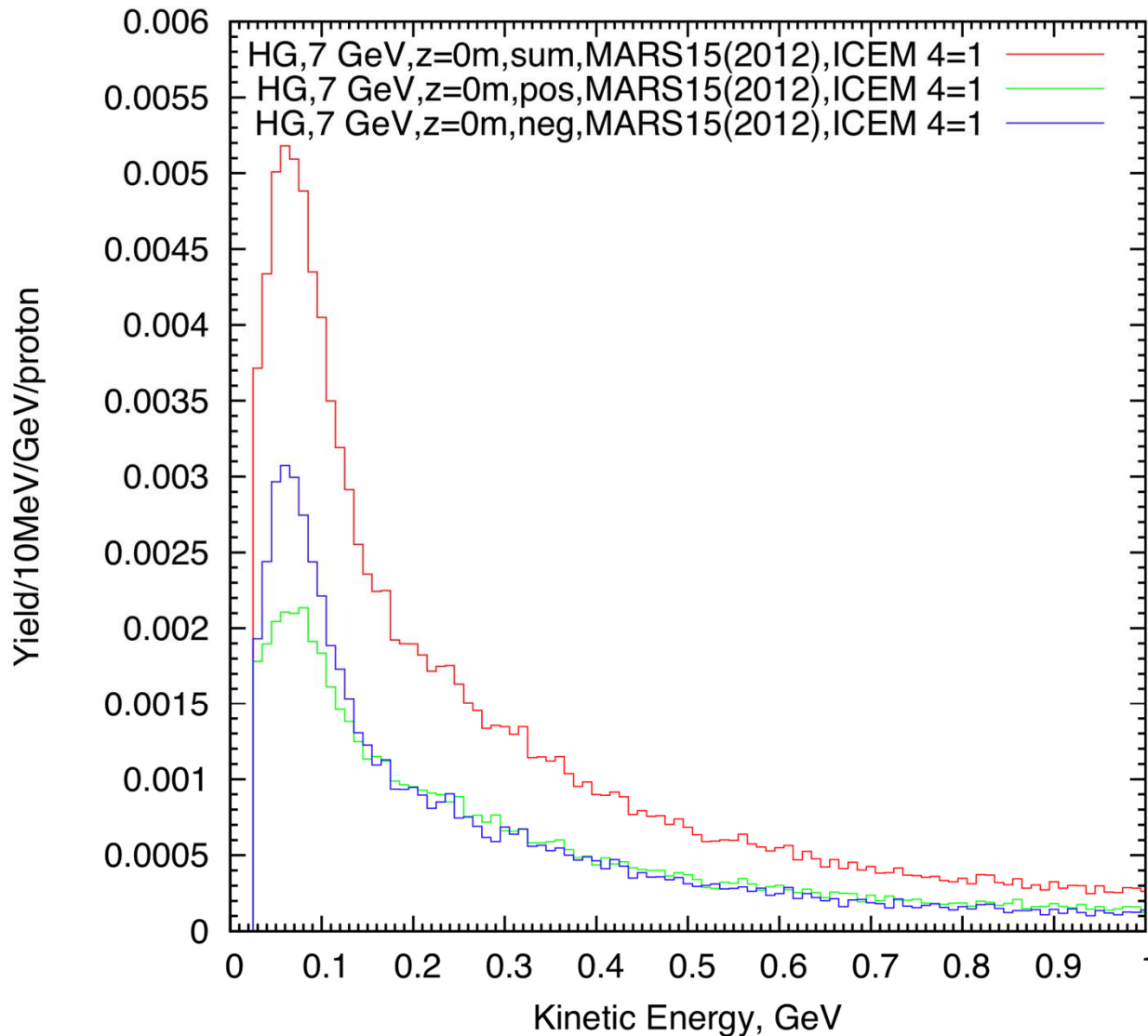## (Carbon: 3 GeV & 7 GeV; Mercury: 7 GeV)

Positive vs. Negative Yield at z = 0m
(Carbon, 3 GeV)

Positive vs. Negative Yield at z = 0m
(Carbon, 7 GeV)

Positive vs. Negative Yield at z = 0m
(Mercury, 7 GeV)

Particle Productions
(100,000 events)

	Z=0 m			Z= 50 m		
	pos	neg	sum	pos	neg	sum
C, 3 GeV	6483.4 (64.5%)	3564.2 (35.5%)	10047.6 (100%)	5598.0 (65.7%)	2918.0 (34.3%)	8516.0 (100%)
C, 7 GeV	10347.0 (55.9%)	8196.9 (44.1%)	18516.9 (100%)	8561.1 (55.9%)	6766.1 (44.1%)	15327.2 (100%)
HG, 7 GeV	15555.6 (44.9%)	19085.8 (55.1%)	34641.4 (100%)	11957 (45.2%)	14476.3 (54.8%)	26433.3 (100%)

Carbon, 3 GeV, z = 50m: 0.0284 Yield/GeV/proton
Carbon, 7 GeV, z = 50m: 0.0219 Yield/GeV/proton
Mercury, 7 GeV, z = 50m: 0.0378 Yield/GeV/proton

Summary

- Optimized target parameters for carbon target at 7 GeV:

  Target length at 82 cm, target radius at 0.56 cm, beam radius at 0.14 cm, beam angle at 60 mrad to SC axis, crossing angle at 0 mrad between beam and target.
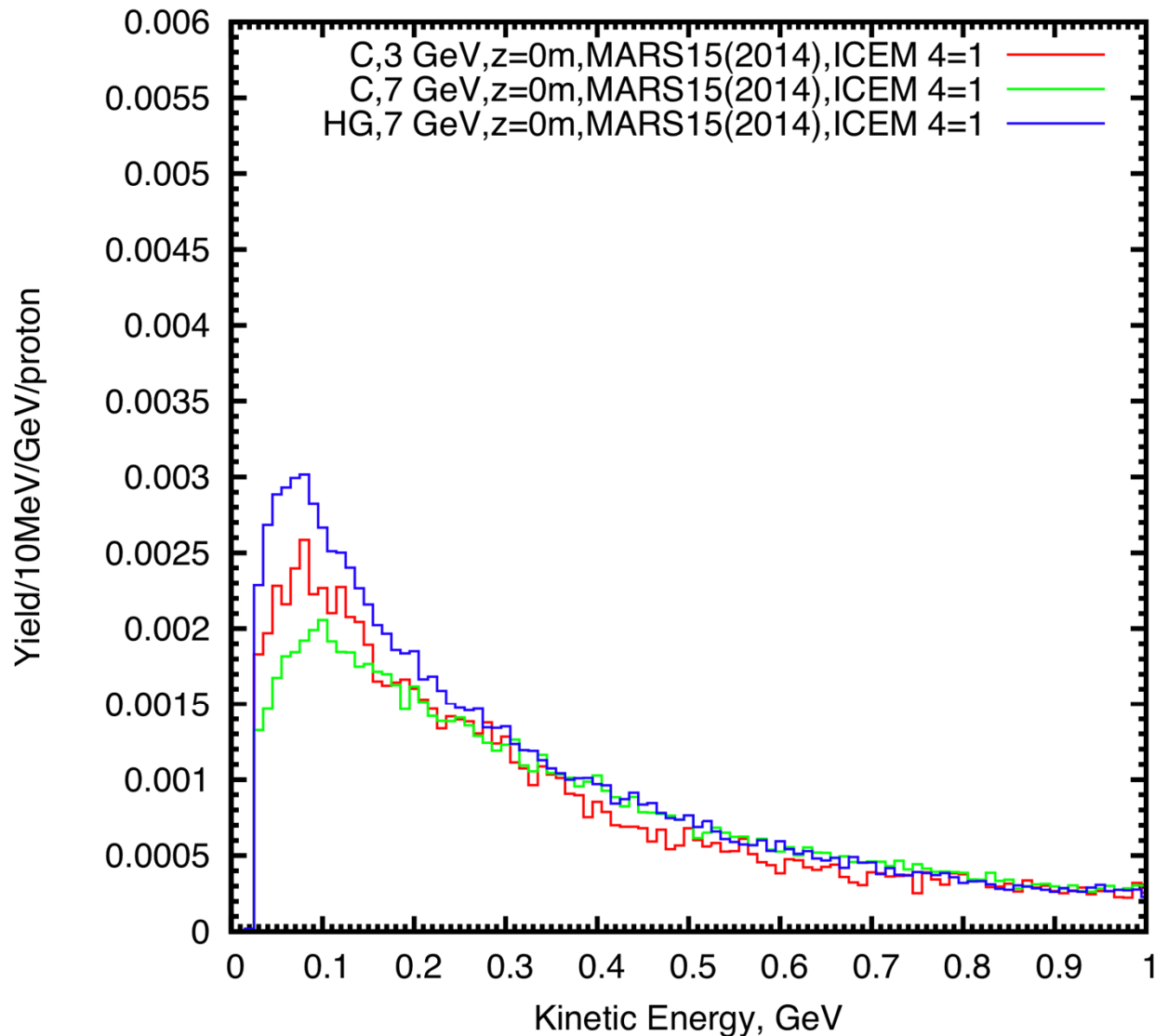
- Carbon target at 7 GeV:

  0.0219 Yield/proton/GeV at z = 50 m

  Yield (pos) ≈ 1.27*Yield (neg)

Yield Comparison at z = 0m
(Carbon: 3 GeV & 7 GeV; Mercury: 7 GeV)
(MARS15(2014), ICEM 4=1)

Particle Productions

(100,000 events, MARS15(2014), ICEM 4=1)

	Z=0 m			Z= 50 m		
	pos	neg	sum	pos	neg	sum
C, 3 GeV	5388 (61.4%)	3381 (38.6%)	8769 (100%)	4018.3 (61.1%)	2561.4 (38.9%)	6579.7 (100%)
C, 7 GeV	9711.2 (54.5%)	8117.3 (45.5%)	17828.5 (100%)	7382.6 (54.2%)	6226.3 (45.8%)	13608.9 (100%)
HG, 7 GeV	12301.2 (48.1%)	13290.7 (51.9%)	25591.9 (100%)	7950.7 (46.2%)	9269.6 (53.8%)	17220.3 (100%)

Carbon, 3 GeV, z = 50m: 0.0225 Yield/GeV/proton
Carbon, 7 GeV, z = 50m: 0.0194 Yield/GeV/proton
Mercury, 7 GeV, z = 50m: 0.0246 Yield/GeV/proton