Meson Productions for Target System with GA/HG Jet and IDS120h Configuration

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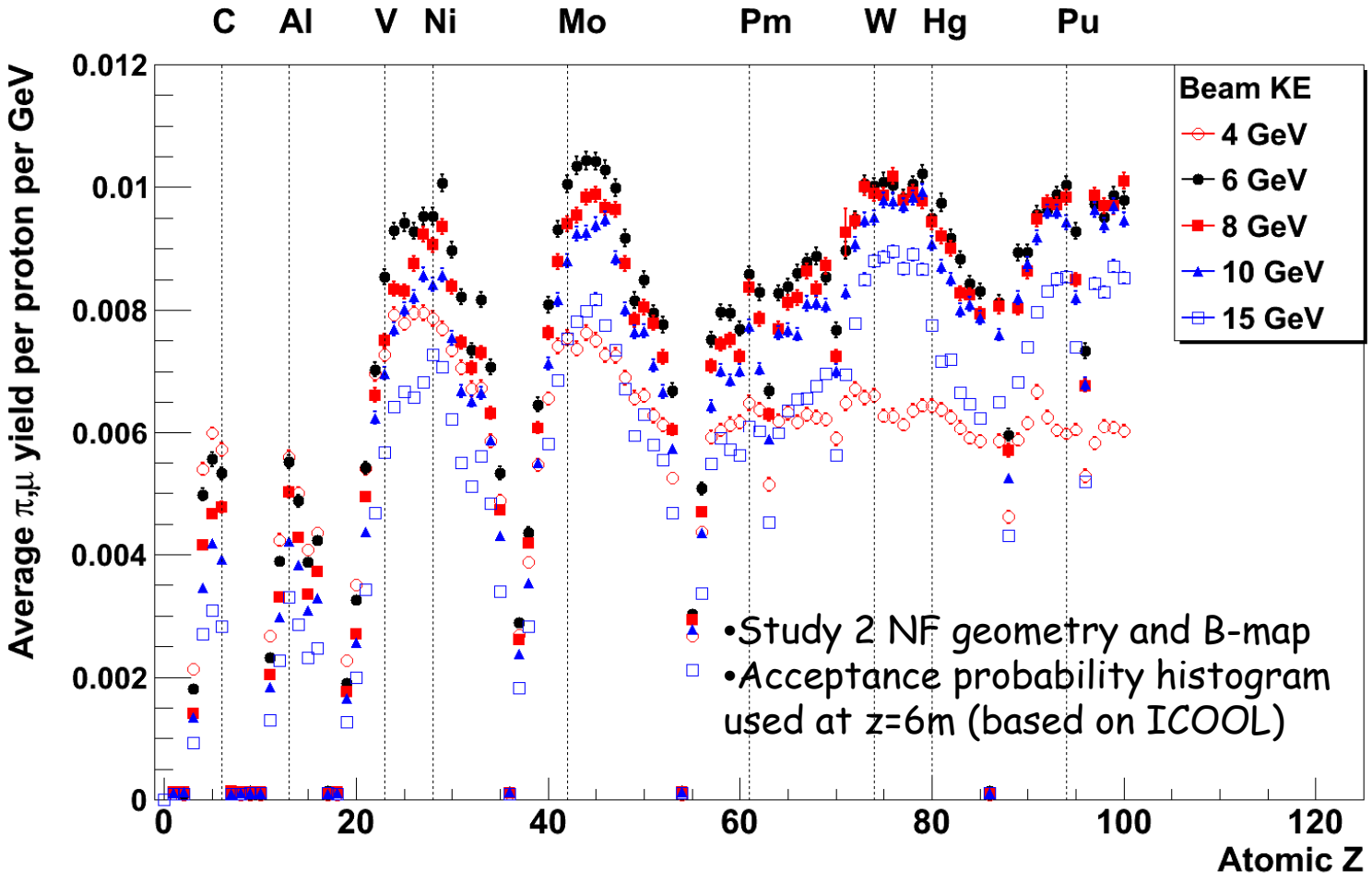
Muon Accelerator Program Collaboration Meeting
SLAC, March 5, 2012

Outline

- Motivation of optimization of GA target
- Introduction of IDS120h Configuration
  (Target/Collection system, fieldmap and target geometry)
- Optimization methods
- Optimized target parameters and meson productions at proton KE of 8 GeV
- Optimized target parameters and meson productions at different proton KE (Comparison between HG/GA Jet, between IDS120h/Study2a with HG jet)
- Focused Incident Proton Beam
- Summary

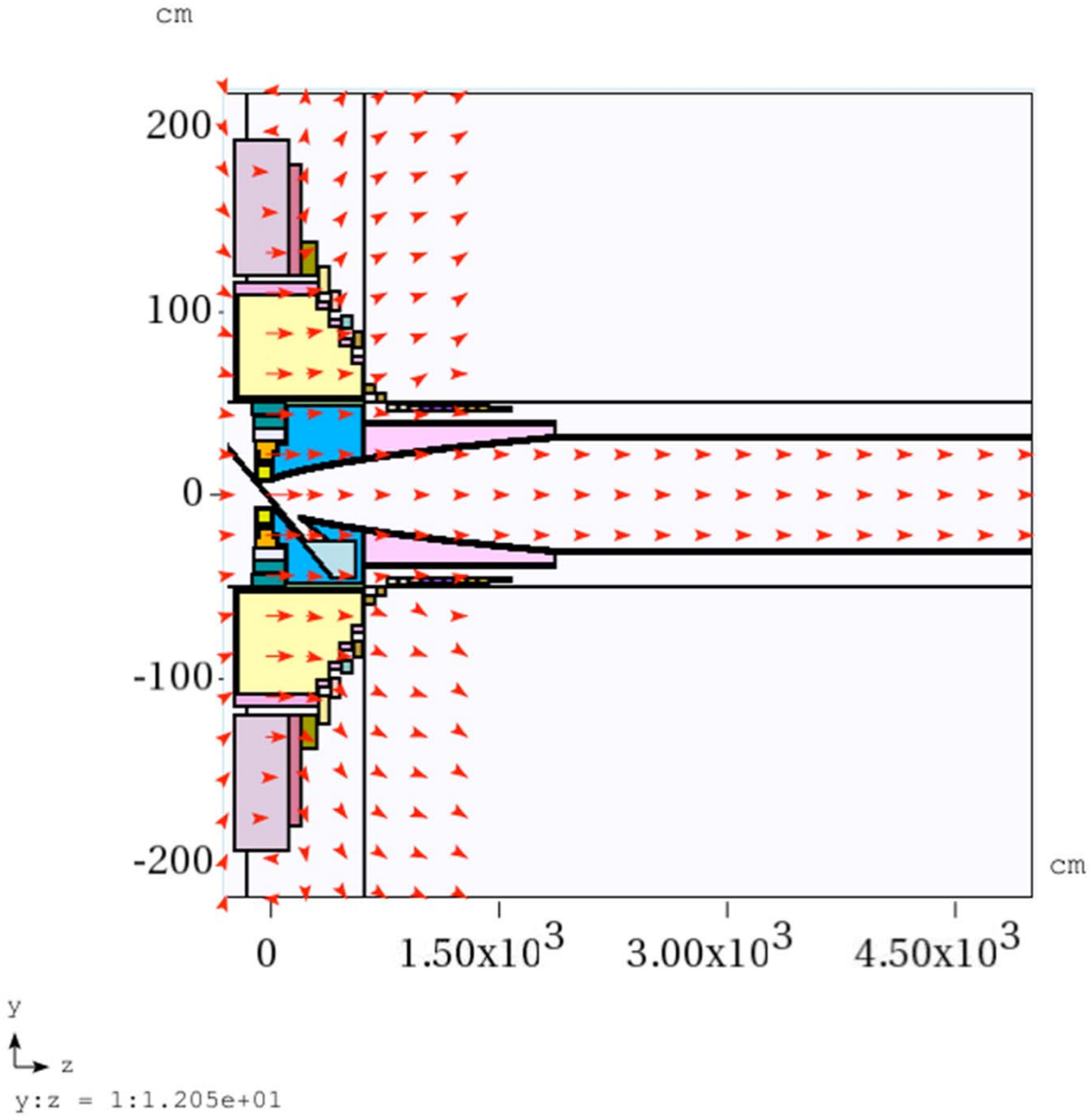
Motivation to Optimize GA Target

(Possible target alternative of HG)



Pion/muon yields for different atomic Z's and beam energies (J. Back/X. Ding); Advantages of Gallium: relative efficient meson production (near the NI Peak), liquid state at relatively low temperature (**Melting Point** = 29.8^0 C) and potential for easier handling (H. Kirk).

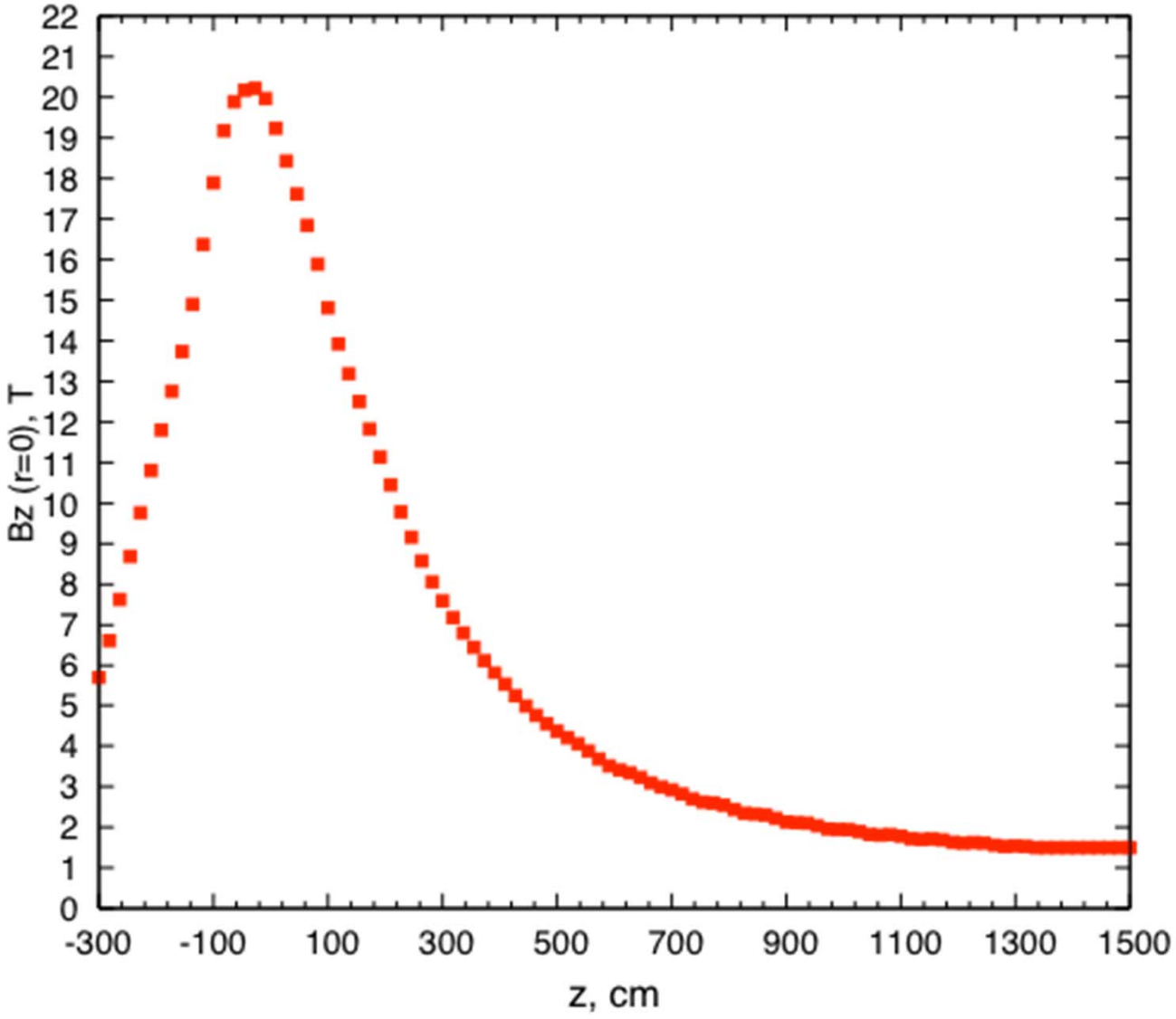
Target/Collection System of IDS120h



Count all the pions and muons that cross the transverse plane at z=50m.

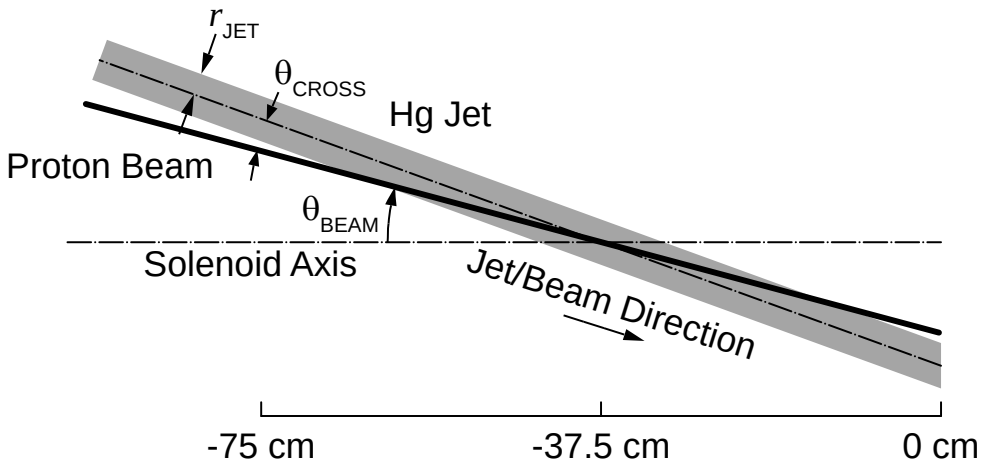
For this analysis we select all pions and muons with 40 < KE < 180 MeV.

Axis Field (Bz at r=0) with IDS120h



HG/GA Target Geometry

(New Setting Procedure)



The mercury jet target geometry. The proton beam and mercury jet cross at z=-37.5 cm.

1. Put beam exactly below the HG/GA jet at z=-37.5 cm (see above y-z plot), fix beam/jet intersection point at (0, 0, -37.5 cm) and project beam back to z=-200cm. (Difference: In previous simulation for study 2a, beam launching point is at z=-75 cm.)
2. Initial target parameters at proton KE of 8 GeV: target radius of 5 mm, beam angle of 67 mrad at z=-37.5 cm, beam/jet crossing angle of 33 mrad at z=-37.5 cm.
3. The SC coils, resistive Cu and Shielding are deleted in MARS code for speeding up simulation (Difference: not so in simulation for study2a).

Optimization Method

- Take 3 runs in each cycle:

  1) Vary jet radius with initial beam angle and beam/jet crossing angle;

  2) Vary beam/jet crossing angle with new target radius while keeping jet fixed - always project beam back to z=-200 cm;

  3) Vary jet angle with new target radius and beam/jet crossing angle-always keep crossing angle constant-both jet and beam must be rotated about intersection point together and always project beam back to z=-200 cm.

- Repeat above cycle until convergence.

Optimized Target Parameters at 8 GeV at z = -37.5 cm

	HG			GA		
	Target radius, mm	Crossing angle, mrad	Beam angle, mrad	Target radius, mm	Crossing angle, mrad	Beam angle, mrad
Initial	(5mm, 33mrad, 67mrad)			(5mm, 33mrad, 67mrad)		
1st Cycle	4.6	23	120	6.7	21	112
2nd Cycle	4.15	23	117	5.5	17	94
3rd Cycle	4.15	21.6	120	4.9	13.2	92
4th Cycle	4.04	**20.6**	117	4.5	13	90
5th Cycle				4.4	12.8	86
6th Cycle				4.4	**13**	88

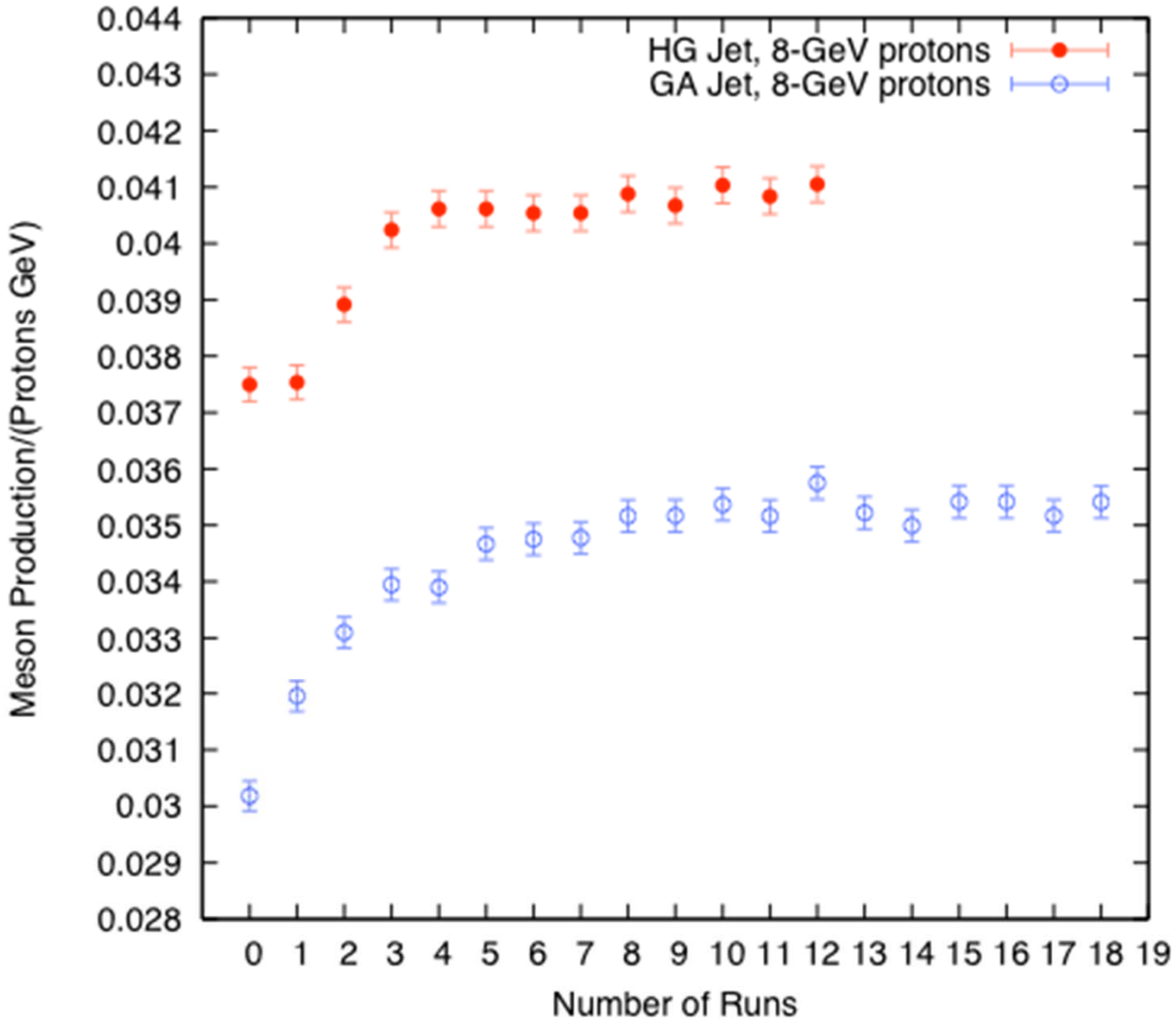
Nuclear interaction length: HG/14.58 cm, GA/23.92 cm.

Meson Productions at 8 GeV (400,000 events)

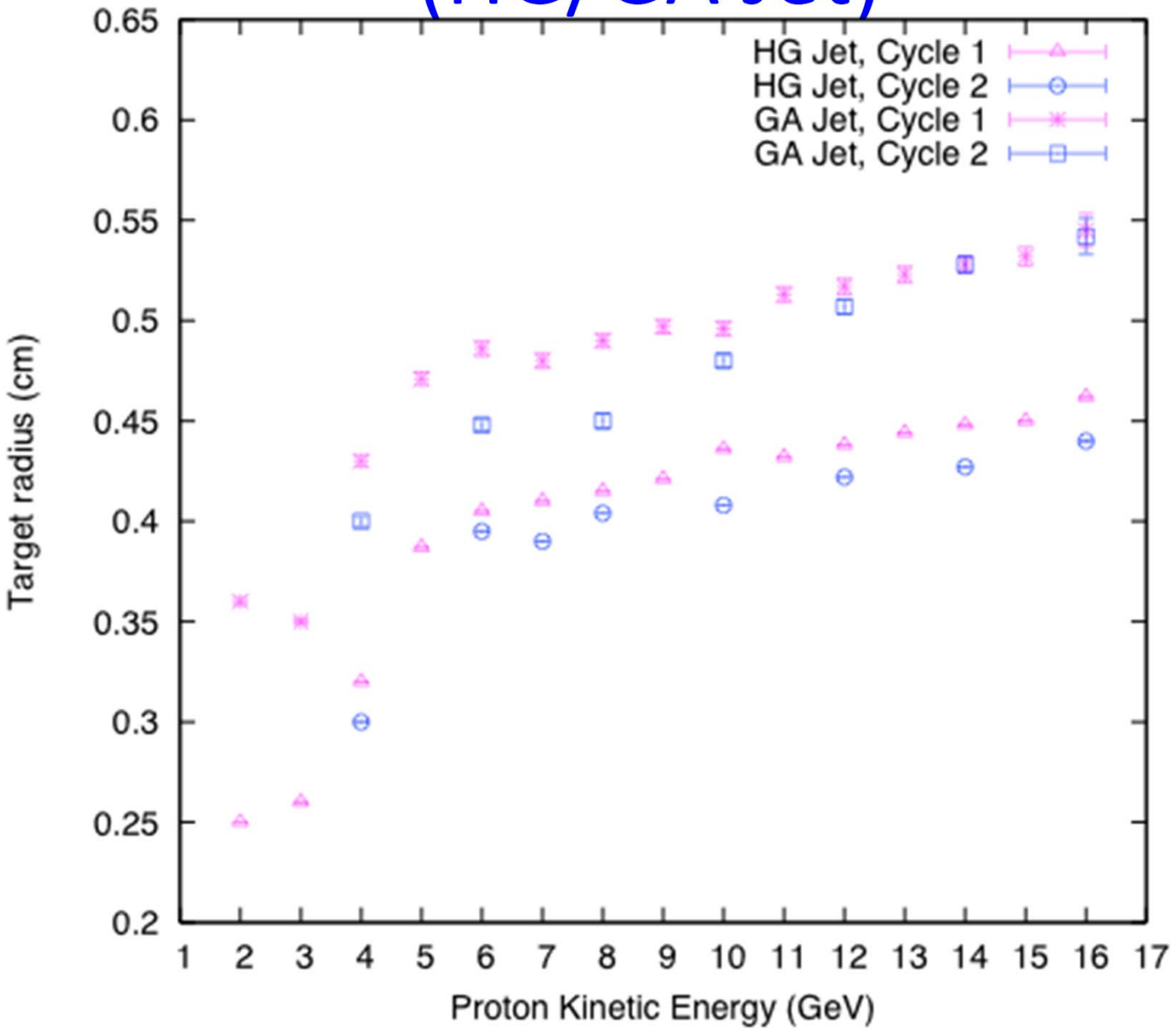
	HG	GA	[N(GA)-N(HG)]/N(HG)
Before optimization (Target radius/beam angle/crossing angle)	108528 (5mm/67mrad/33mrad, Initial)	96586 (5mm/67mrad/33 mrad, Initial)	-11% (w/t opt)
After optimization (Target radius/beam angle/crossing angle)	131362 (4.04mm/117mrad/ 20.6mrad, end of 4th Cycle)	114401 (4.5mm/90mrad/ 13mrad, end of 4th Cycle)	**-12.9%** (opt)
[N(opt)-N(w/t opt)]/N(w/t opt)	+21%	+18.4%	

Meson Productions Vs. Run No. at 8 GeV

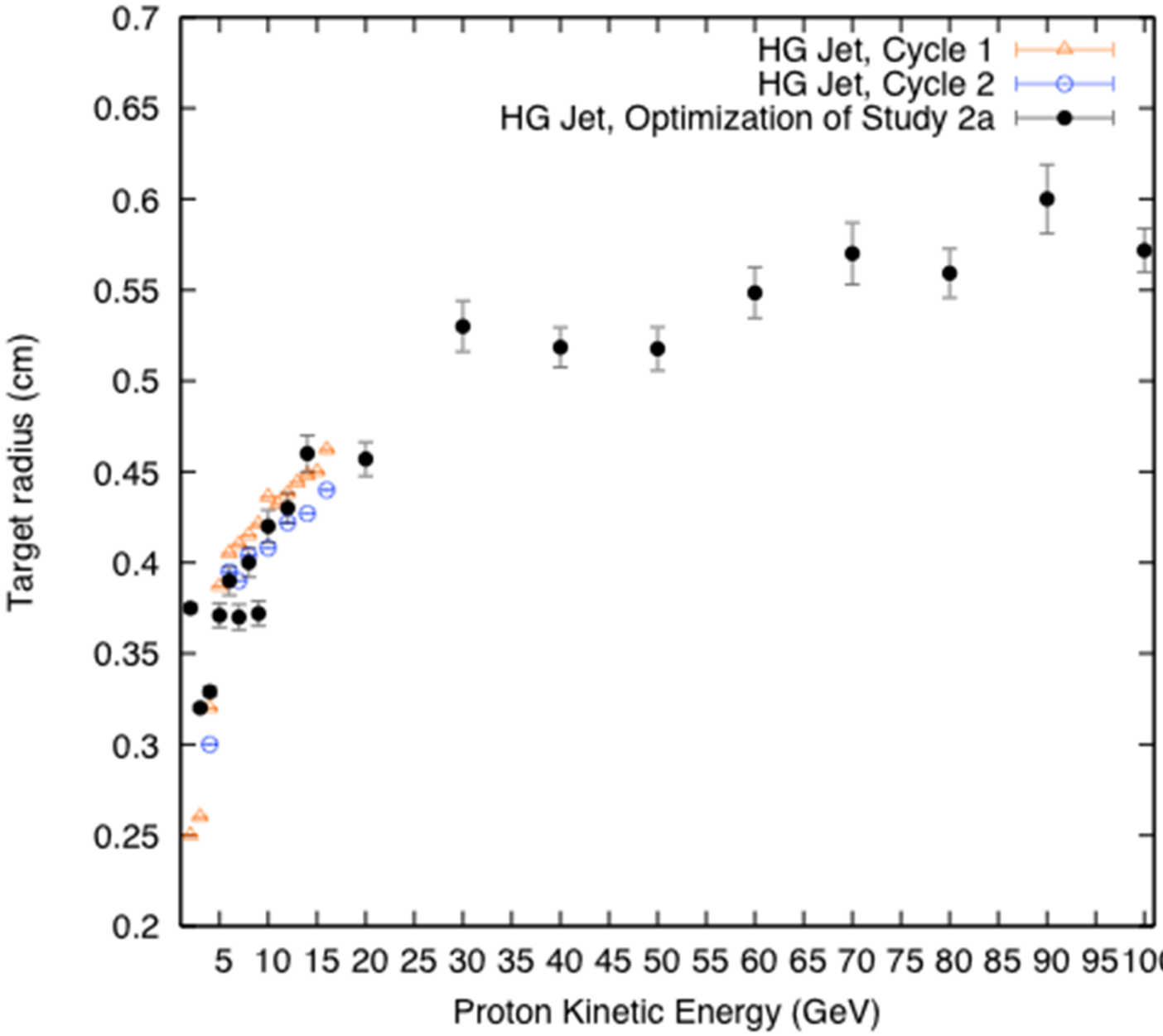
(Number of runs: 0-Initial, 1,4,7,10,13,16-optimized target radius, 2,5,8,11,14,17-optimized crossing angle, 3,6,9,12,15,18-optimized beam angle)



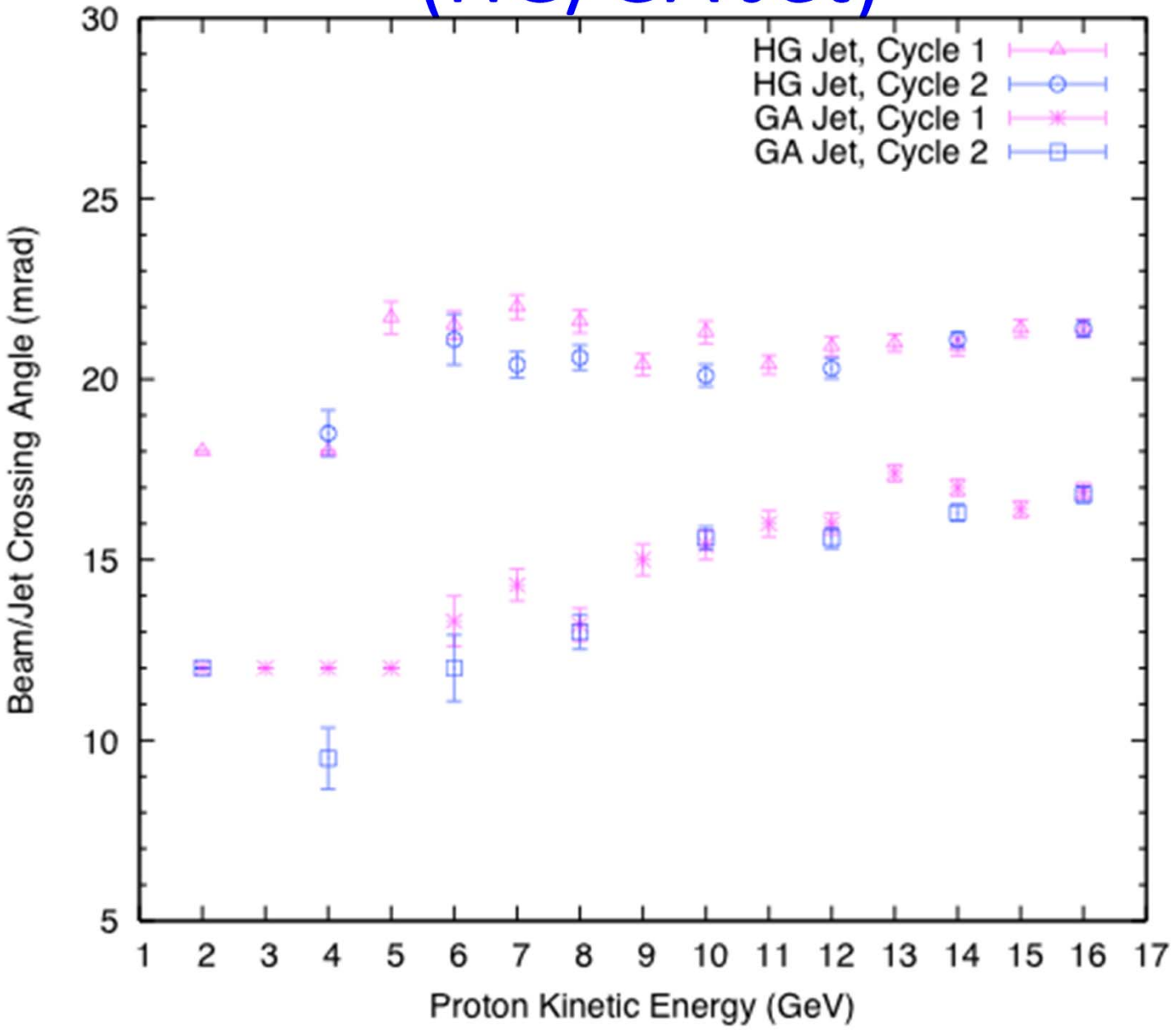
Target Radius vs. KE (HG/GA Jet)



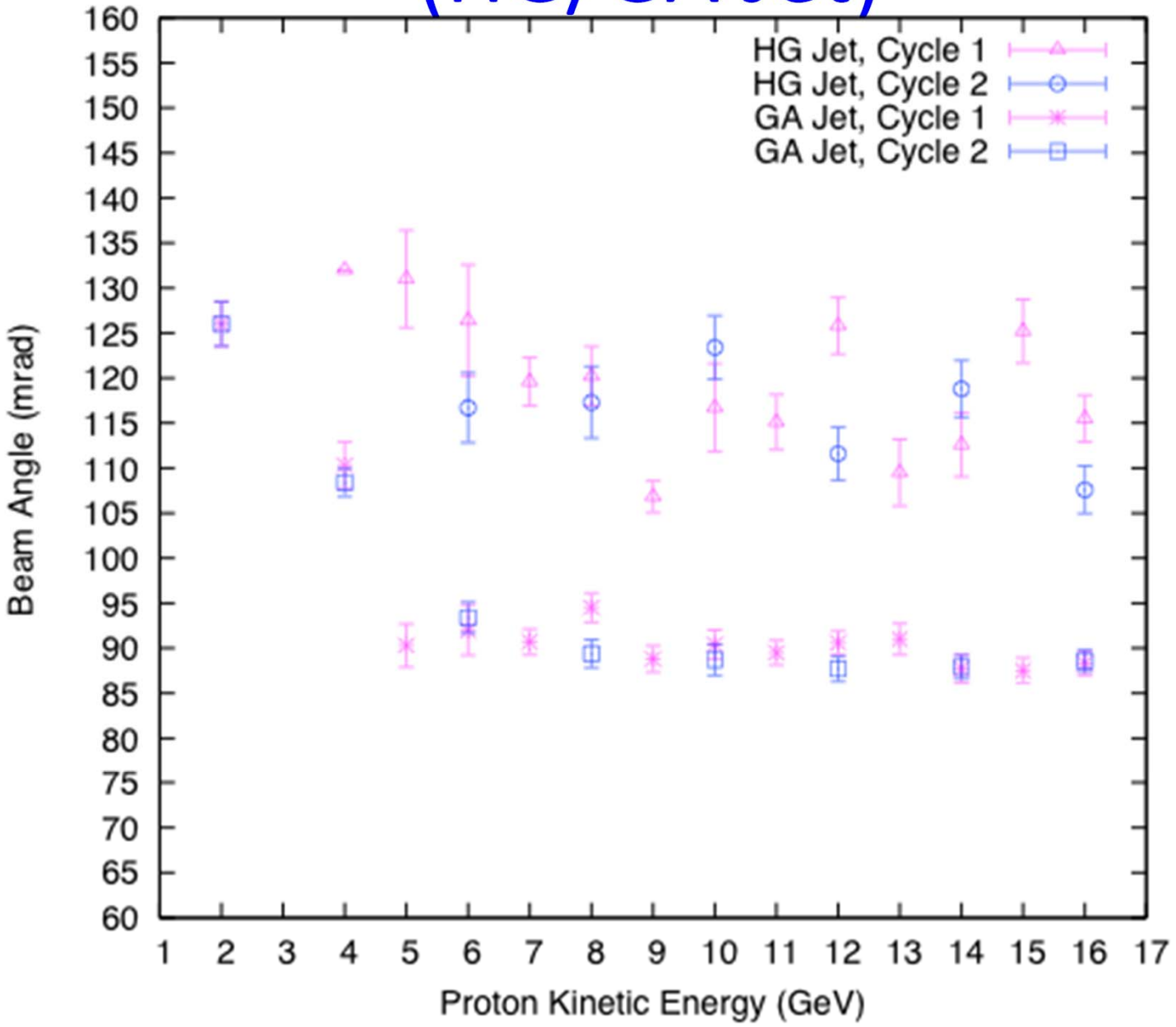
Target Radius vs. KE (IDS120h/Study2a, HG Jet)



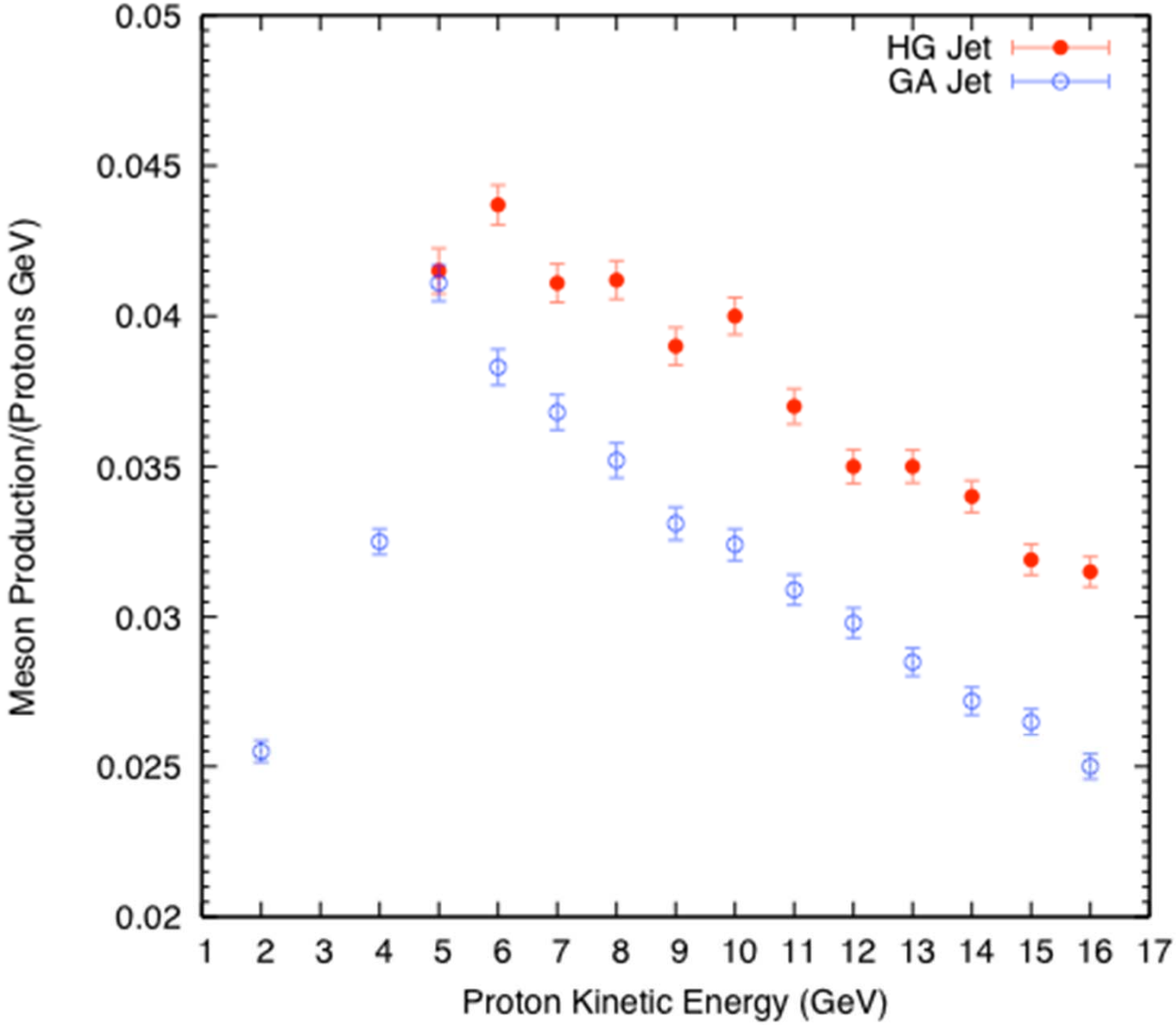
Beam/Jet Crossing Angle vs. KE (HG/GA Jet)



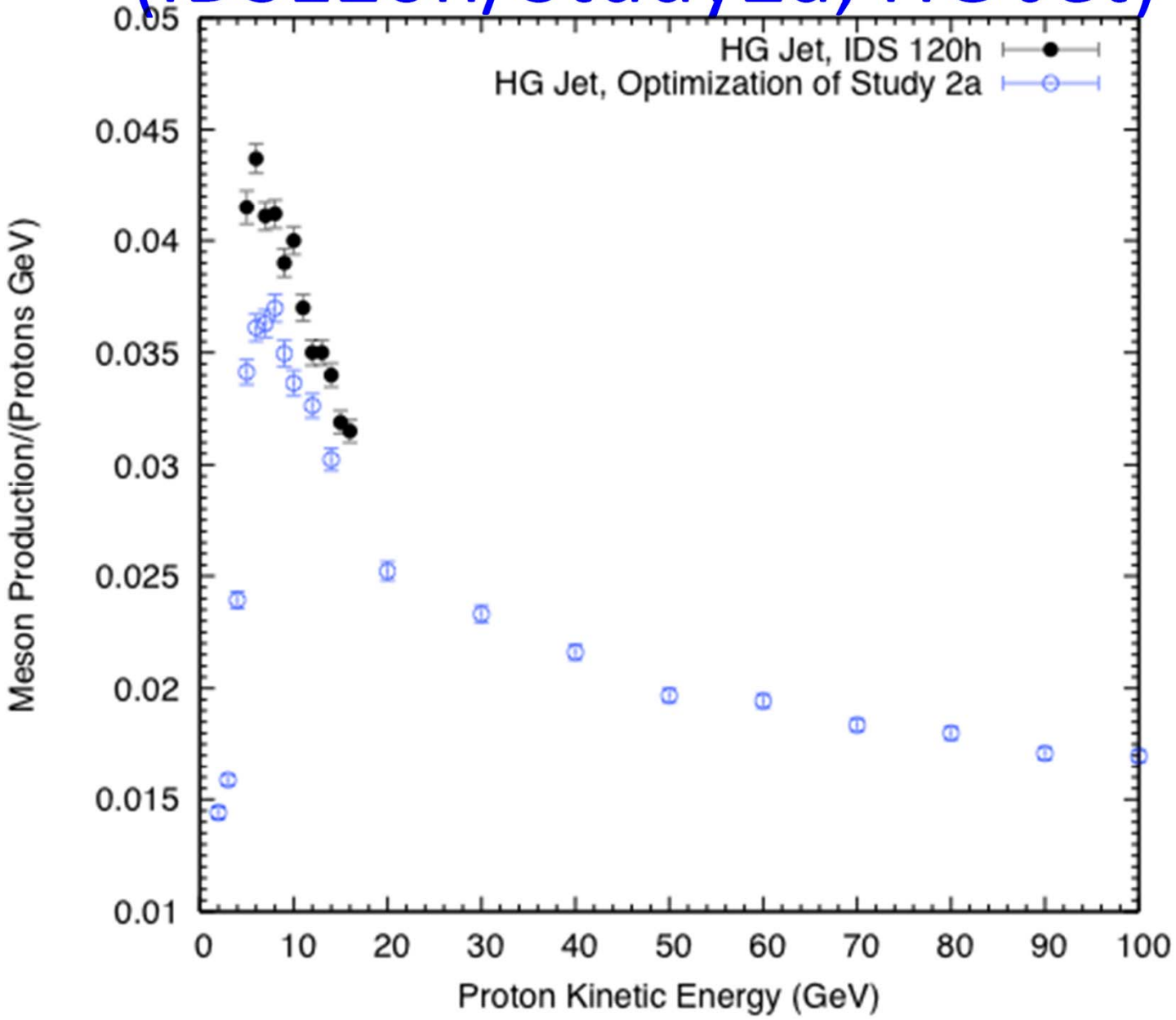
Beam Angle vs. KE (HG/GA Jet)



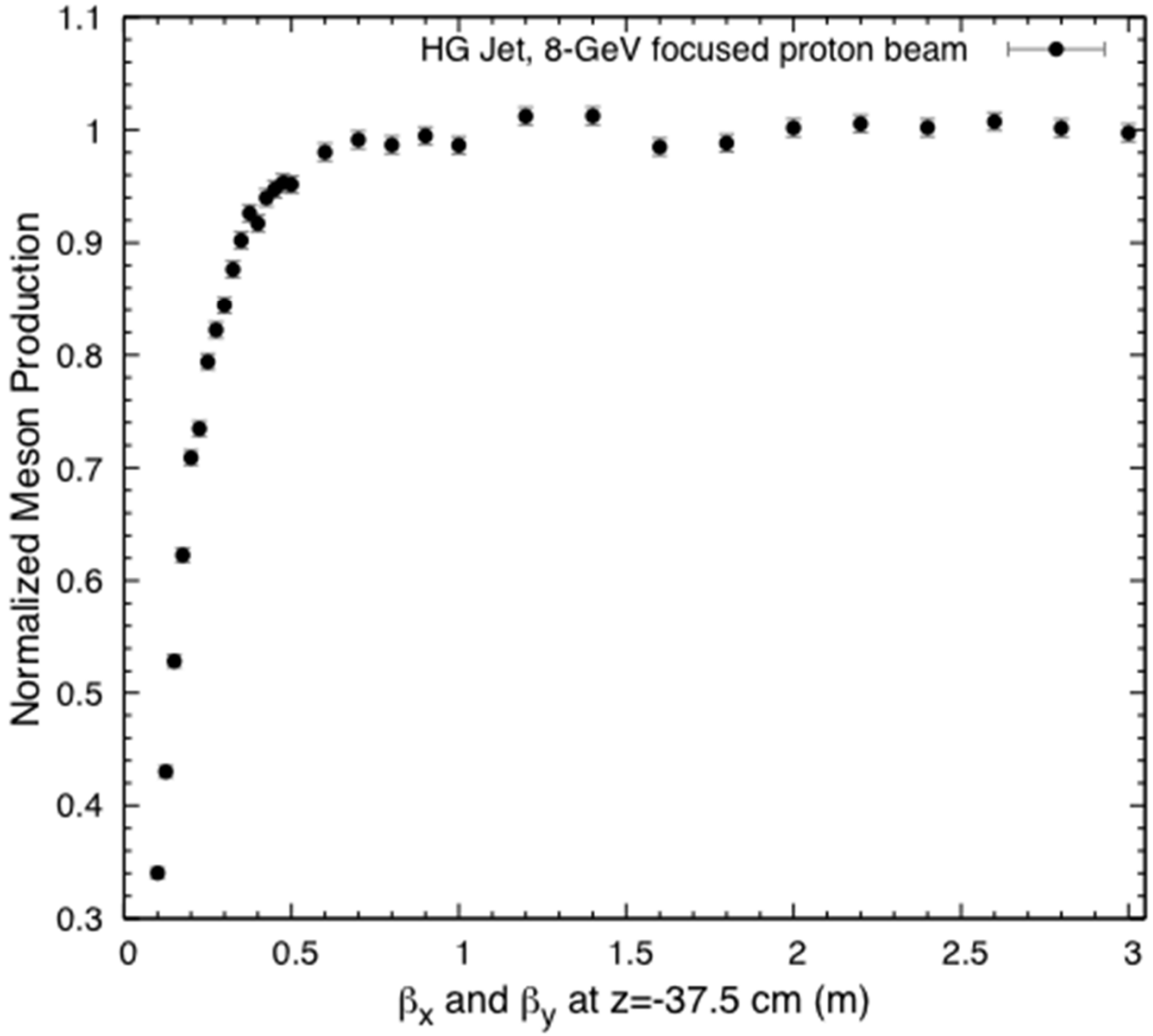
Meson Production vs. KE (HG/GA Jet)



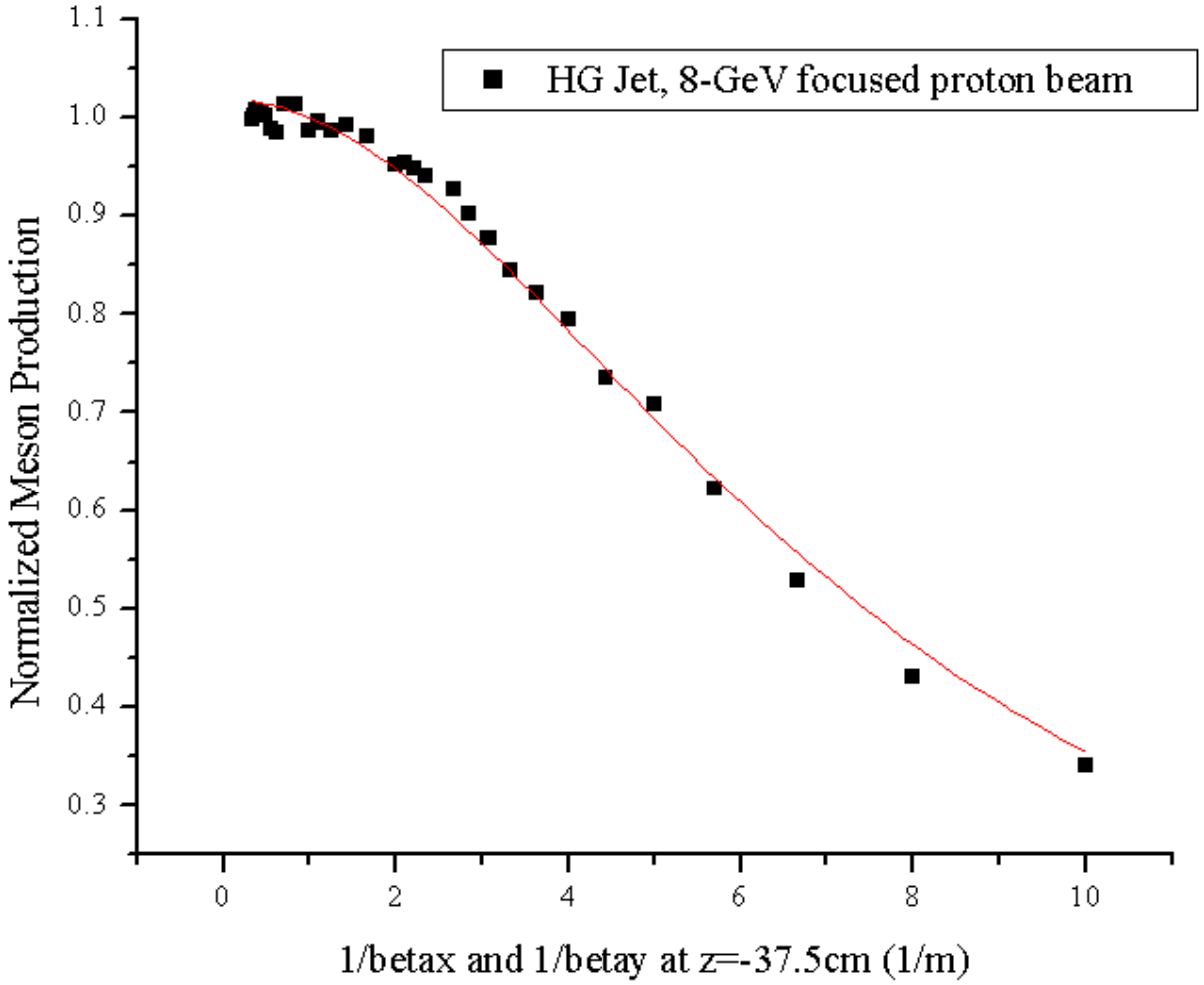
Meson Production vs. KE (IDS120h/Study2a, HG Jet)



Focused Incident Proton Beam at 8 GeV



Focused Incident Proton Beam at 8 GeV (Cont'd)



Non-Linear Fit

$Y=N/(1+K2/beta^{-2})$
N=1.018
Sqrt(K2)=0.1368

Proton beam emittance is 4.8 μm with beam radius of 0.12 cm and β* of 0.3 m.

Summary

- 8 GeV optimized parameters:
  - Hg r=4.04 mm; beam/jet crossing angle=20.6 mrad ; beam angle = 117 mrad.
  - Ga r= 4.4 mm; beam/jet crossing angle = 13 mrad; beam angle of 88 mrad.
- 8GeV meson production for Ga is 12.9% less than for Hg.

Summary (Cont'd)

- Ga production peaks near KE = 5 GeV and is comparable to Hg at that KE.
- For Hg, meson production is reduced by 15% for a proton beam emittance of 5 μm compared to a 0 μm emittance beam.