Optimized Target Parameters and Meson Production by IDS120h with Focused Gaussian Beam and Fixed Emittance (Update)

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Target Studies
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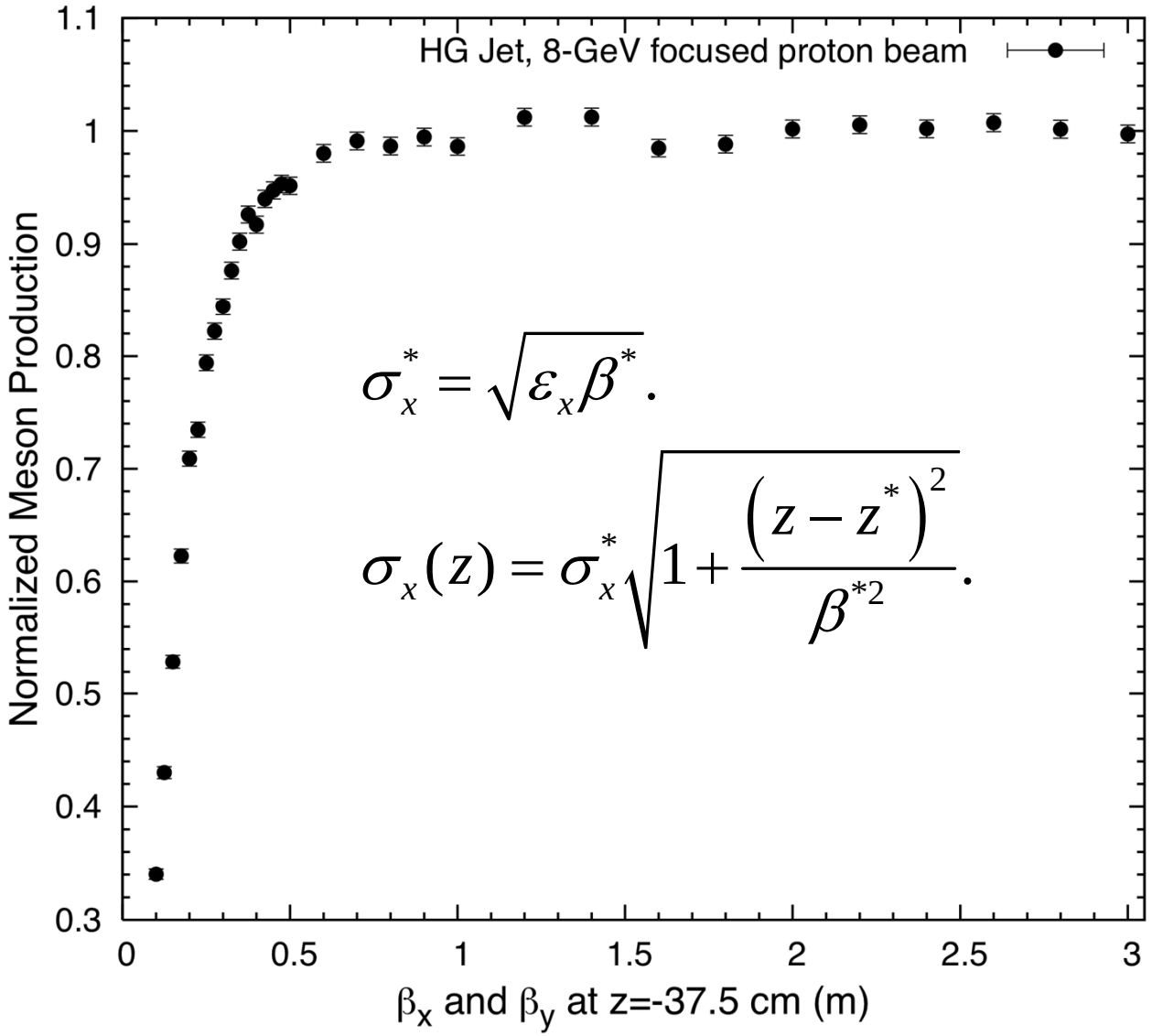
Focused Incident Proton Beam at 8 GeV

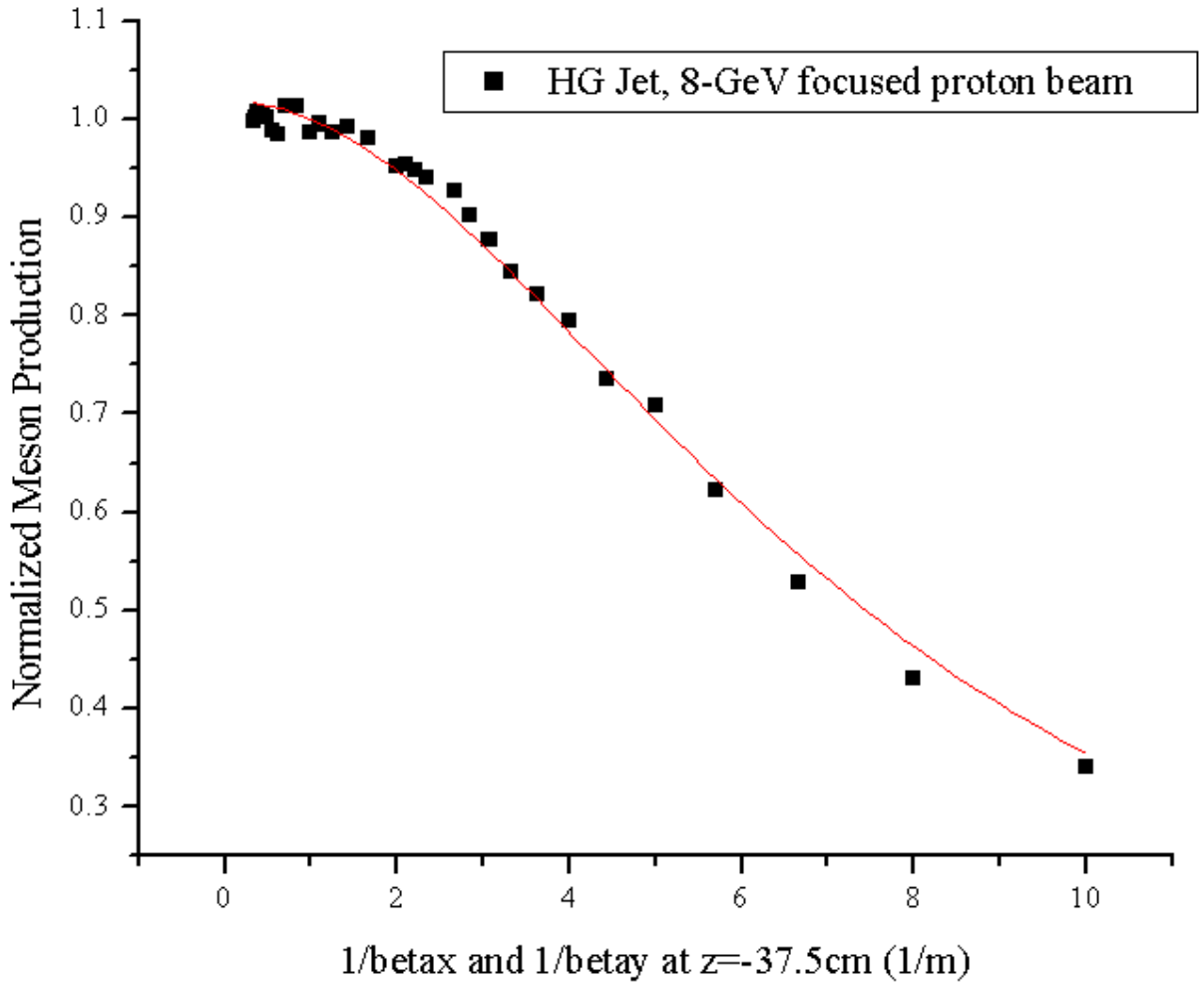
(Beam radius is fixed at 0.12 cm at z=-37.5 cm)



Relative normalized meson production is 0.84 of max at β* of 0.3 m for $\varepsilon_x = \varepsilon_y = 5$ μm.

For low β* (tight focus) the beam is large at the beginning and end of the interaction region, and becomes larger than the target there.

Focused Incident Proton Beam at 8 GeV (Cont'd) (Beam radius is fixed at 0.12 cm at z=-37.5 cm)



Non-Linear Fit
(Growth/sigmoidal, Hill)

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

Linear emittance is 5 μm with beam radius of 0.1212 cm and β* of 0.3 m.

Optimization of target parameters

- Fixed beam emittance ($\varepsilon_{K\sigma}$) to σ^2/β
- Optimization method in each cycle

  (Vary beam radius or beam radius σ^*, while vary the β^* at the same time to fix the beam emittance; Vary beam/jet crossing angle; Rotate beam and jet at the same time)

  We also optimized the beam radius and target radius separately (not fixed to each other).

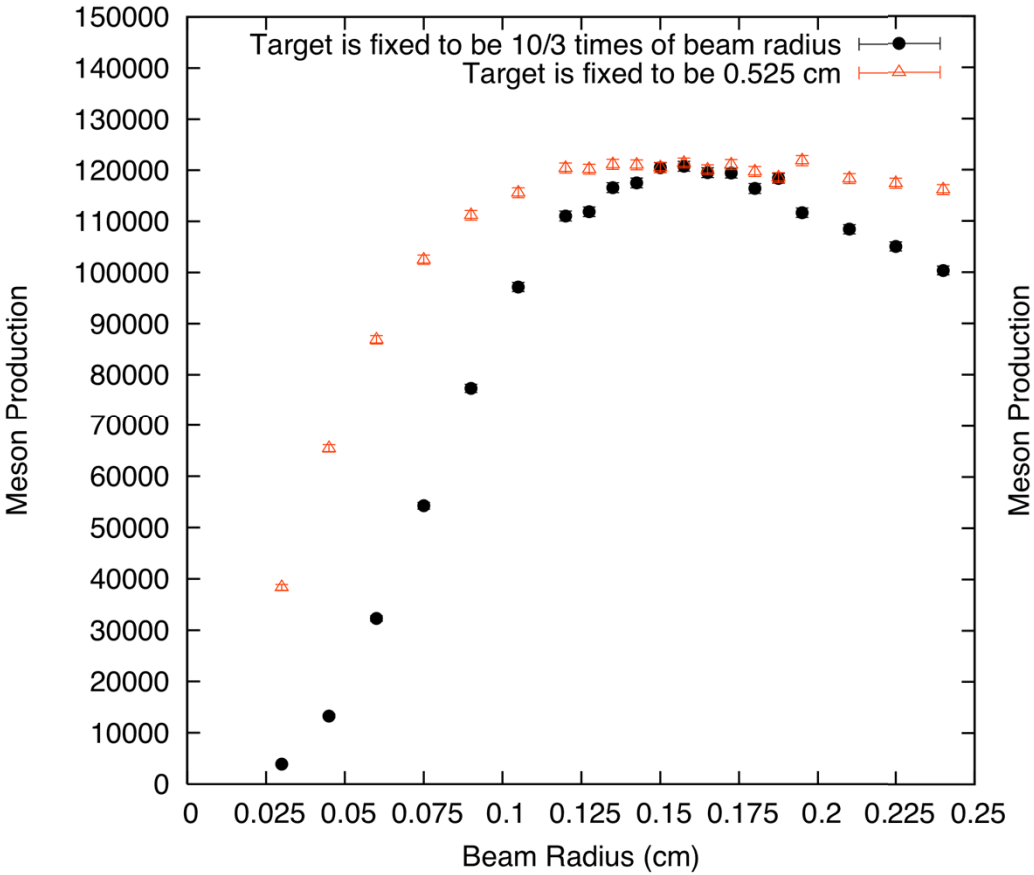
Optimized Target Parameters and Meson Productions at 8 GeV

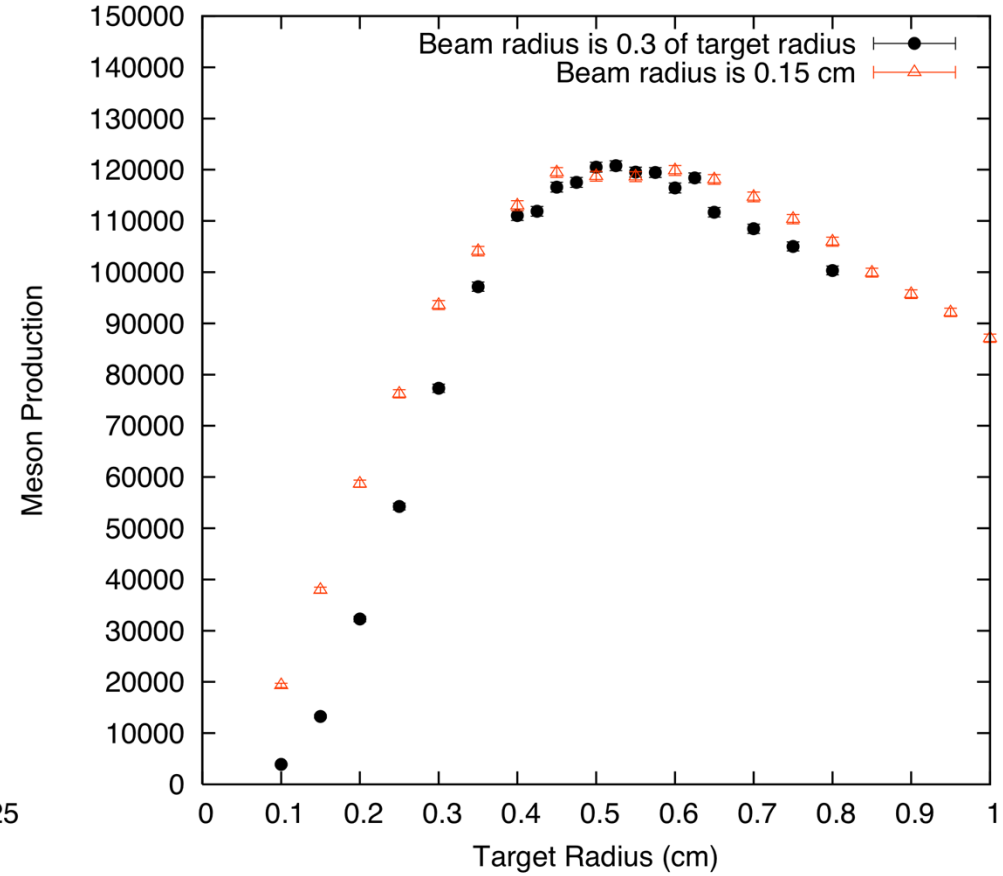
(Linear emittance is fixed to be 5 μm)

	Radius (cm)	Beam/jet crossing angle (mrad)	Beam angle/Jet angle (mrad)
Initial	0.404 (target)	20.6	117/137.6
1st Run	0.525 (target)	25	120/145
Old 2nd Run (vary target radius and beam radius is fixed to be 0.3 of target radius)	0.544 (target)	25.4	120/145.4
New 2nd Run (vary beam radius with fixed target radius of 0.525 cm; vary target radius with fixed beam radius of 0.15 cm.)	Beam radius: 0.15 Target radius: 0.548	26.5	127/153.5

Optimize beam radius and target radius separately

(Linear emittance is fixed to be 5 μm)





We found almost no improvement in optimized meson production if the beam radius is not fixed at 30% of target radius and optimized separately!

Optimized Meson Productions at 8 GeV

(10^5 events of proton, Linear emittance is fixed to be 5 μm)

Gaussian Distribution	Meson Production
Zero emittance (0.404cm/20.6mrad/117mrad)	32563
Focused beam radius of 0.1212 cm at z=-37.5 cm and linear emittance of 5 μm) (0.404cm/20.6mrad/117mrad)	27489 (-15.6% less than that at zero emittance)
Optimization with fixed emittance at 5 μm (0.15 cm (beam)/0.54cm (target)/26.5mrad (crossing)/127mrad (beam)	30187 (-7.3% less than that at zero emittance) (9.8% more than focused beam of radius at 0.1212 cm)

Optimized Target Parameters and Meson Productions at 8 GeV

(10^5 events of proton, Linear emittance is fixed to be 2.5 μm)

	Beam Radius (cm)	Target Radius (cm)	Beam/jet crossing angle (mrad)	Beam angle/Jet angle (mrad)
Initial	0.404*0.3	0.404	20.6	117/137.6
1st Run	0.12	0.45	23	115/138
2nd Run	0.135	0.47	23	118/141

Gaussian Distribution	Meson Production
Optimization with fixed emittance at 2.5 μm (0.135 cm (beam)/0.47 cm (target)/23 mrad (crossing)/118 mrad (beam)	31494 (3.28% less than zero emittance)

Optimized Target Parameters and Meson Productions at 8 GeV

(10^5 events of proton, Linear emittance is fixed to be 7.5 μm)

	Beam Radius (cm)	Target Radius (cm)	Beam/jet crossing angle (mrad)	Beam angle/Jet angle (mrad)
Initial	0.404*0.3	0.404	20.6	117/137.6
1st Run	0.2025	0.56	26.7	120/146.7
2nd Run	0.2025	0.60	29.3	131/160.3

Gaussian Distribution	Meson Production
Optimization with fixed emittance at 7.5 μm (0.2025 cm (beam)/0.60 cm (target)/29.3 mrad (crossing)/131 mrad (beam)	28768 (11.93 less than that at zero emittance) (24.6% more than focused beam of radius at 0.1212 cm)

Optimized Target Parameters and Meson Productions at 8 GeV

(10^5 events of proton, Linear emittance is fixed to be 10 μm)

	Beam Radius (cm)	Target Radius (cm)	Beam/jet crossing angle (mrad)	Beam angle/Jet angle (mrad)
Initial	0.404*0.3	0.404	20.6	117/137.6
1st Run	0.2325	0.60	29	124/153
2nd Run	0.2325	0.65	32	135/167

Gaussian Distribution	Meson Production
Optimization with fixed emittance at 10 μm (0.2325 cm (beam)/0.65cm(target)/32mrad(crossing)/135 mrad(beam)	27641 (-15% less than that at zero emittance) (60 % more than focused beam of radius at 0.1212 cm)

Optimized Target Parameters and Meson Productions at 8 GeV (HG Jet Case)

Emittance/μm	0	2.5	5	7.5	10
Beam radius/cm	0.404	0.47	0.548	0.60	0.65
Target radius/cm	0.1212	0.135	0.15	0.2025	0.2325
Crossing Angle/mrad	20.6	23	26.5	29.3	32
Beam angle/mrad	117	118	127	131	135
Jet angle/mrad	137.6	141	153.5	160.3	167
Meson production (100000 protons)	32563	31494	30187	28768	27641

Optimization with Fixed Emittance