MUON TARGET PARTICLE PRODUCTION STUDY: TAPERED FIELD PROFILE

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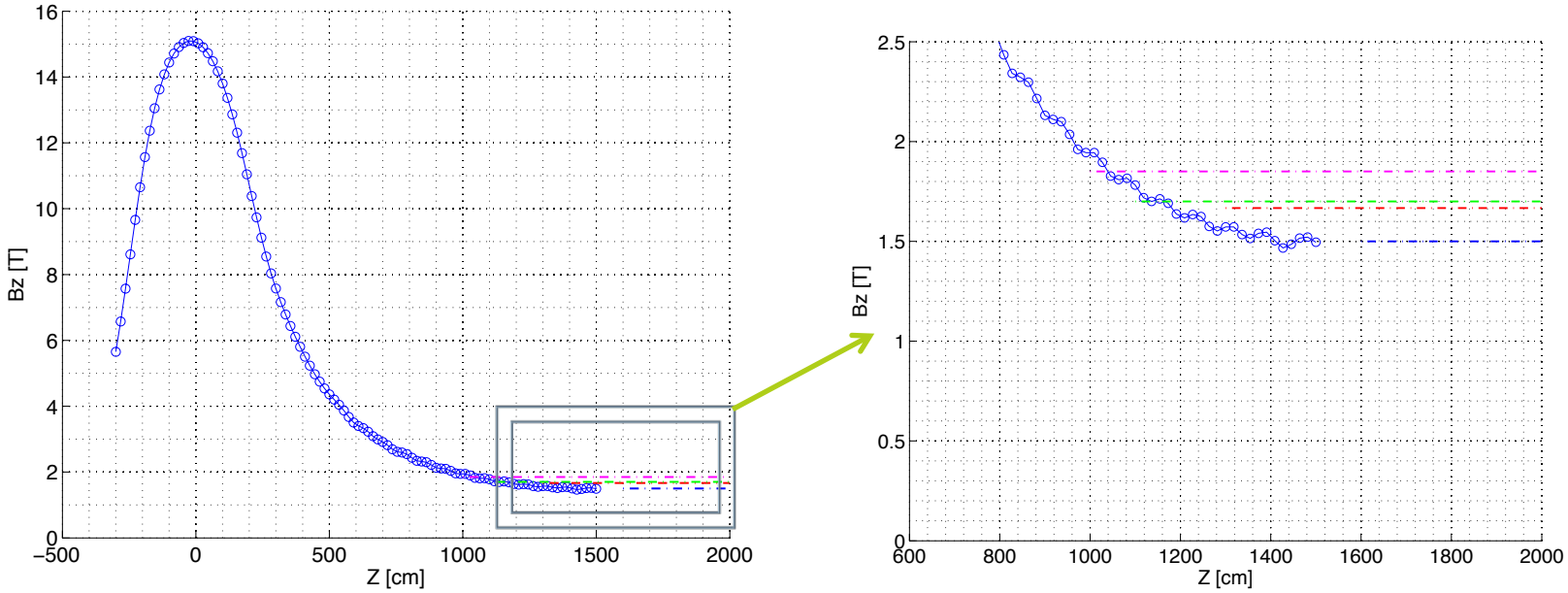
Ding's Optimized Parameters

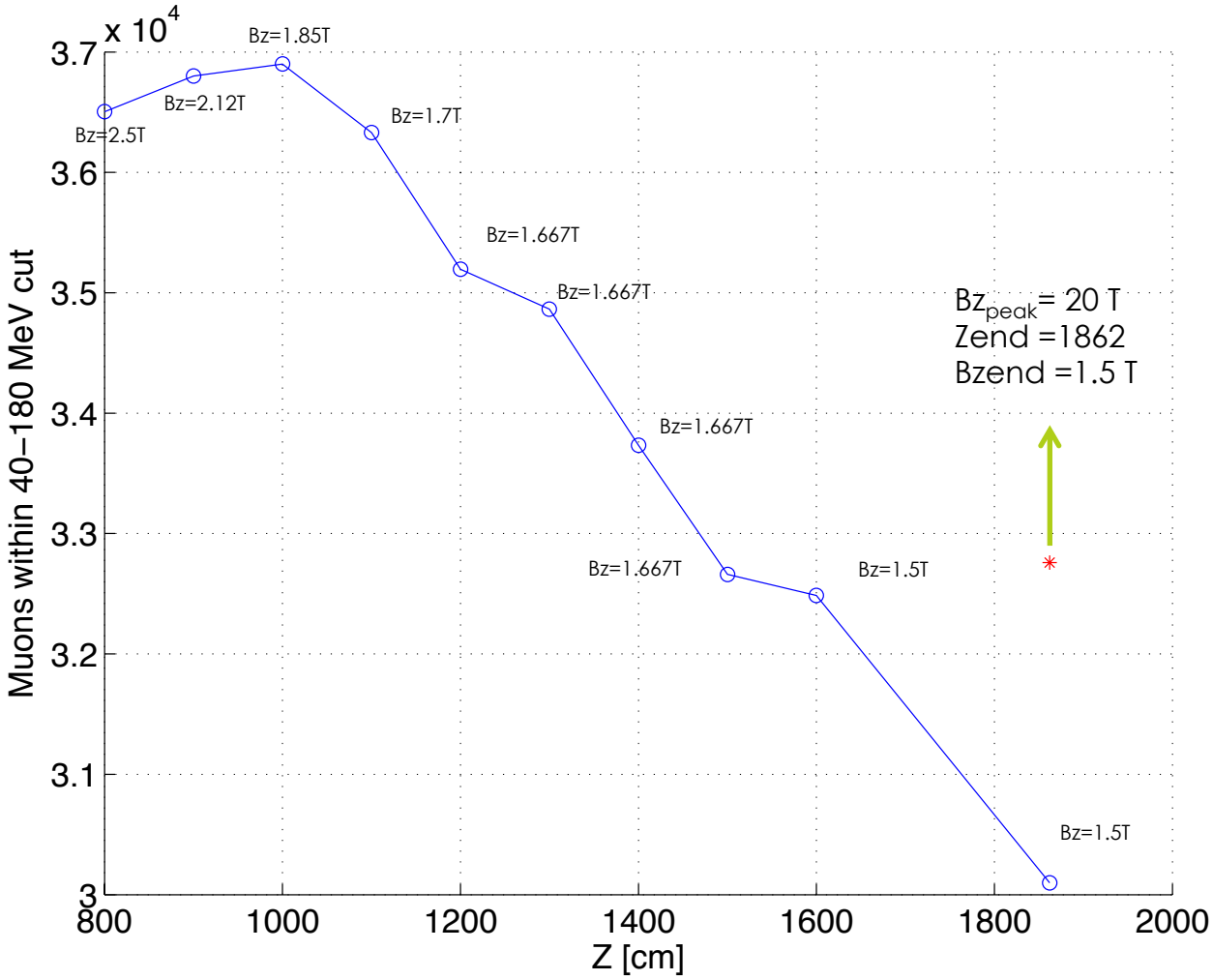
- Hg Target
  - θ_{Target} = 0.137 rad
  - R_{Target} = 0.404 cm
- Proton Beam
  - E = 8 GeV
  - θ_{Beam}= 0.117 rad
  - $\sigma_x = \sigma_y$= 0.1212 cm (Gaussian Distribution)
- Solenoid Field
  - IDS120h → 20 T peak field at target position (Z=0)
  - Aperture at Target R = 7.5 cm - End aperture R = 30 cm
  - Fixed Field Z = 1862.0 → Bz =1.5 T
- Production: Muons within energy KE cut 40-180 MeV
- 3.27 X 10^4 (N_{ini} =10^5)

Target Particle Production with 15 T Peak Solenoid Field

- Particle Capture requirement (P_t ~ 0.225 GeV/c)
- B r = 20 T x **7.5** cm = 150 T cm ----- B r = 15 T x **10** cm = 150 T cm
- Fixed flux requirement (Aperture Requirement)
- B r^2 = 20 x 7.5^2 =1125 T cm^2 ------ B r^2 = 15 x 10^2 =1500 T cm^2
- MARS simulations with 15 T peak field & new aperture settings (Taper R =10-30 cm)



Muon Production IDS120h 15 T



Analytic form for Tapered Solenoid (K. McDonald)

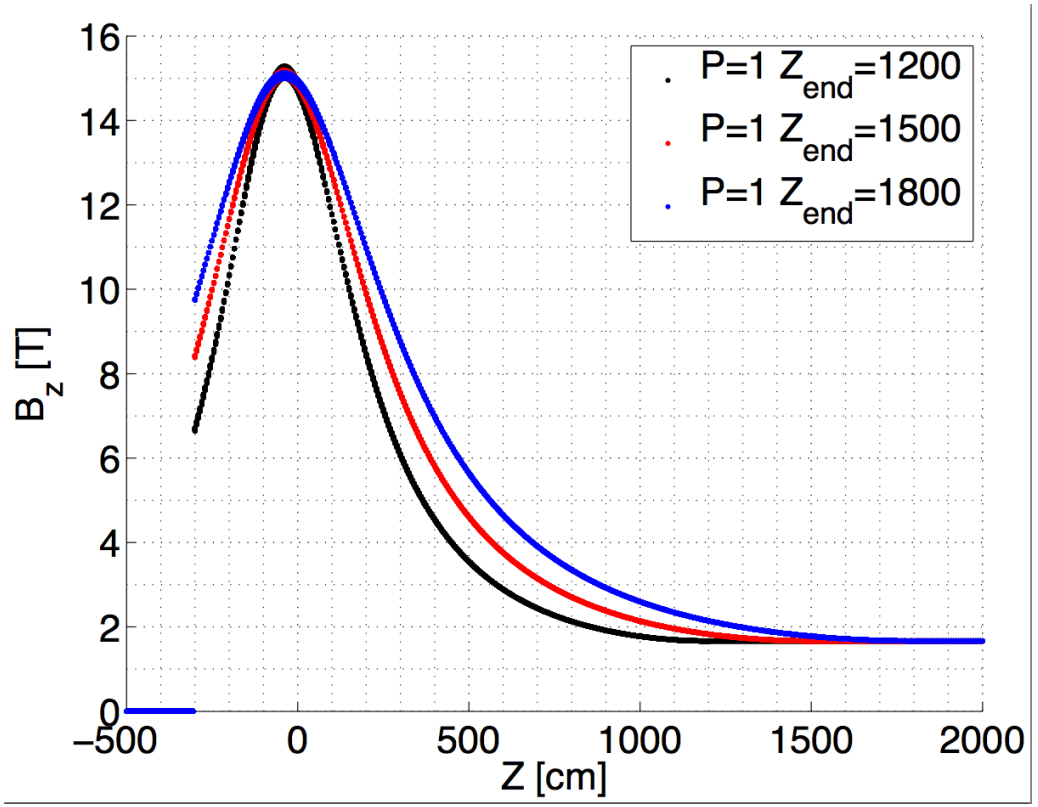
- Inverse-Cubic Taper

$$B_z(0, z_i < z < z_f) = \frac{B_1}{[1 + a_1(z - z_1) + a_2(z - z_1)^2 + a_3(z - z_1)^3]^p}$$

$$a1 = -\frac{B_1'}{pB_1} \qquad a_2 = 3\frac{(B_1/B_2)^{1/p} - 1}{(z_2 - z_1)^2} - \frac{2a_1}{z_2 - z_1}$$

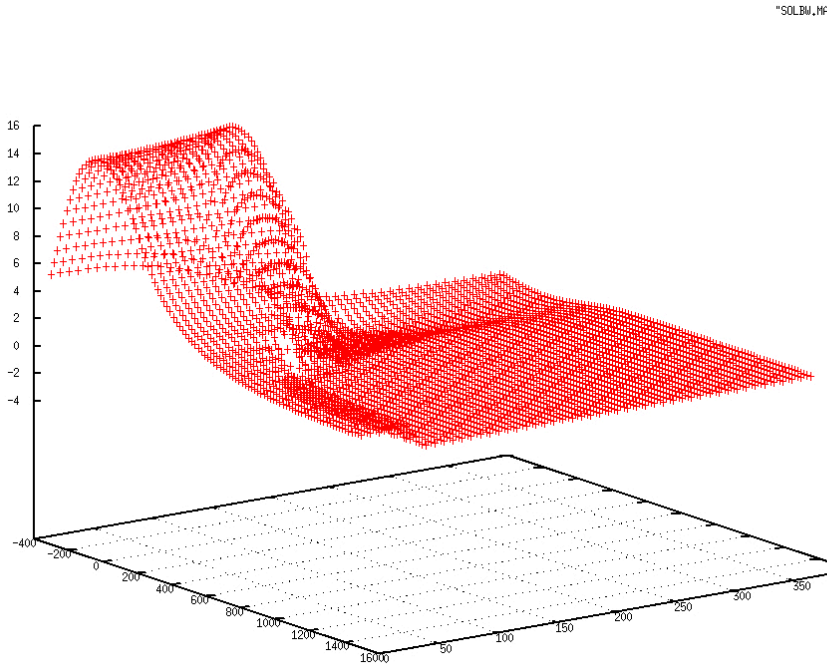
$$a_3 = -2\frac{(B_1/B_2)^{1/p} - 1}{(z_2 - z_1)^3} + \frac{a_1}{(z_2 - z_1)^2}$$

Field at R = 0

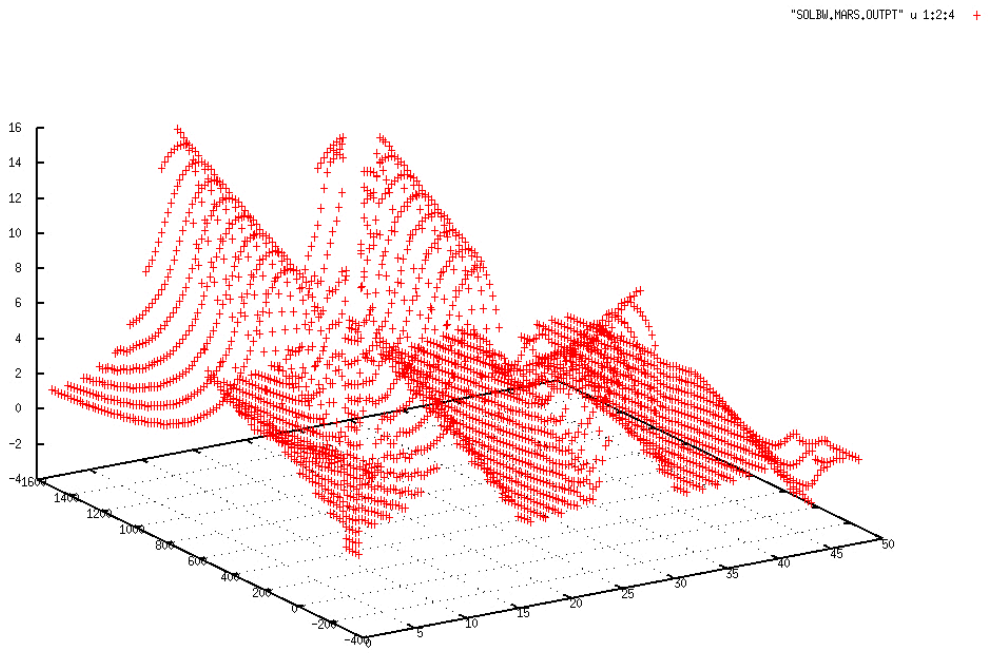


IDS120H Field Map

IDS120H Input Field Map



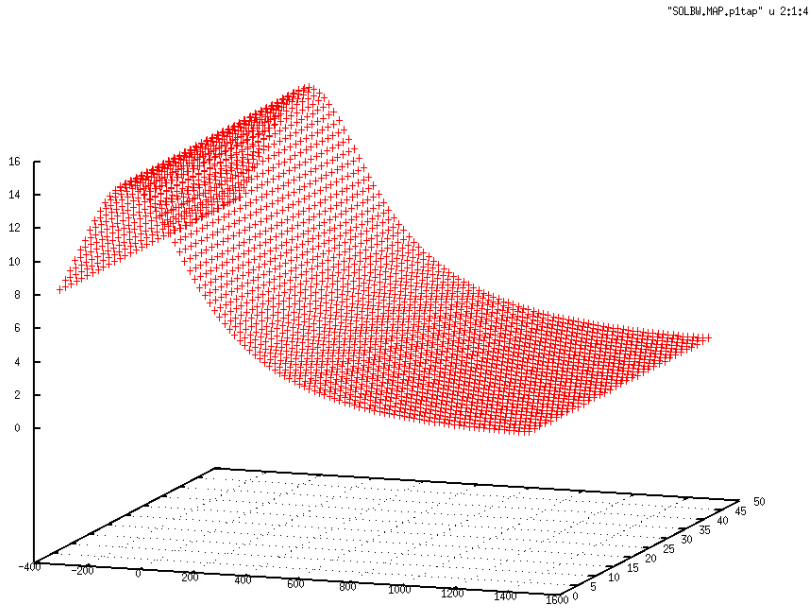
IDS120H MARS FIT2D Output Field Map



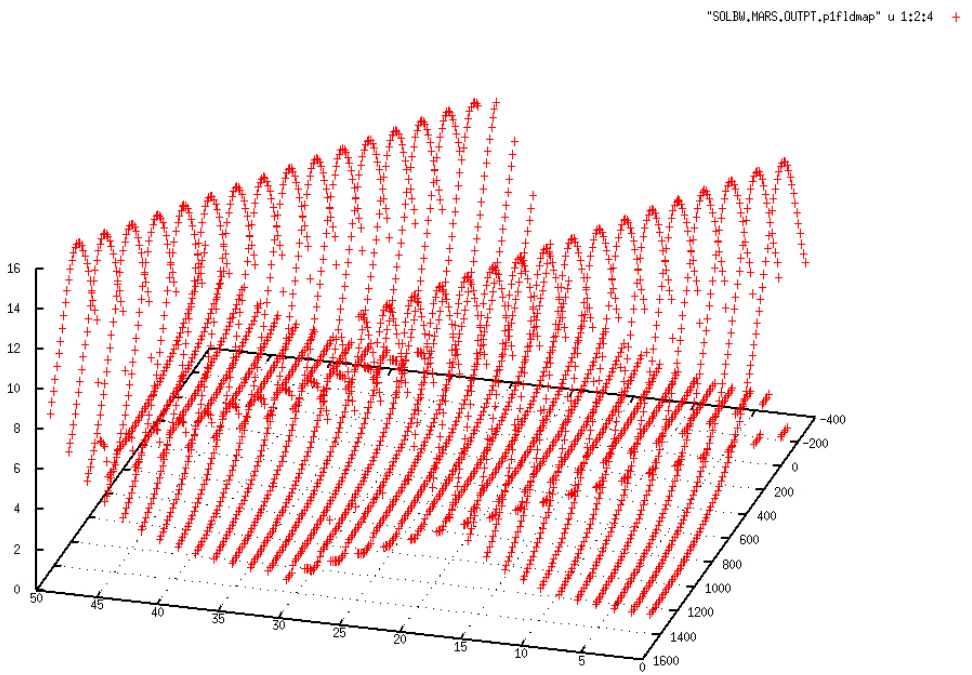
In case MARS reads field map up to R = 50 [cm]

INVERSE CUBIC Fit (ICP1) FIELD MAP

ICP1 Input Field Map

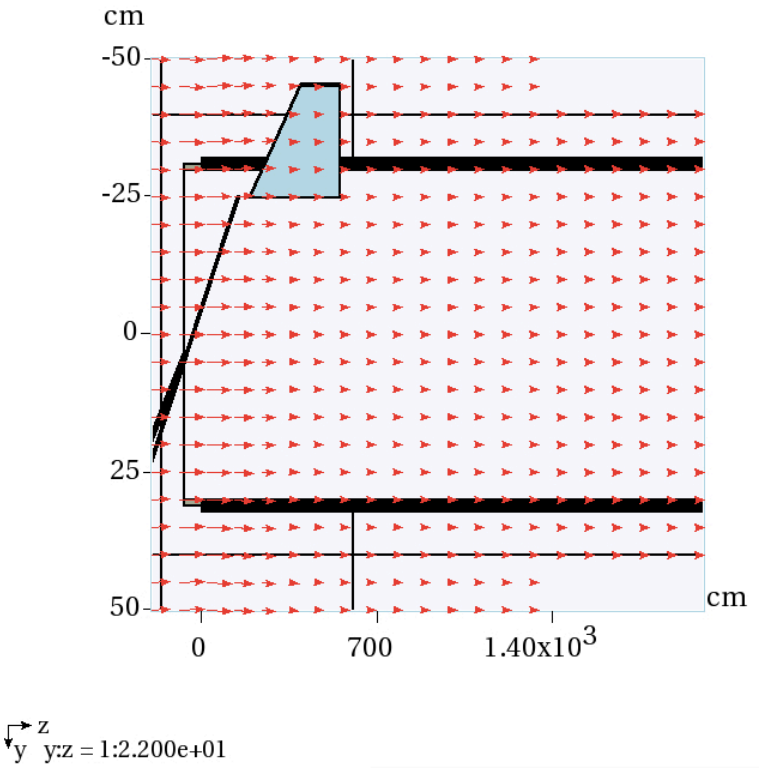


ICP1 MARS FIT2D Output Field Map



MARS RESULTS

- Beam Pipe with constant R = 30 cm
- Added subroutine to m1510.f (FIELD) to calculate the field using inverse cubic equations



Inverse Cubic Field(P=1)

B_z(end of taper) = 1.6667
T
Initial $N_P = 10^5$

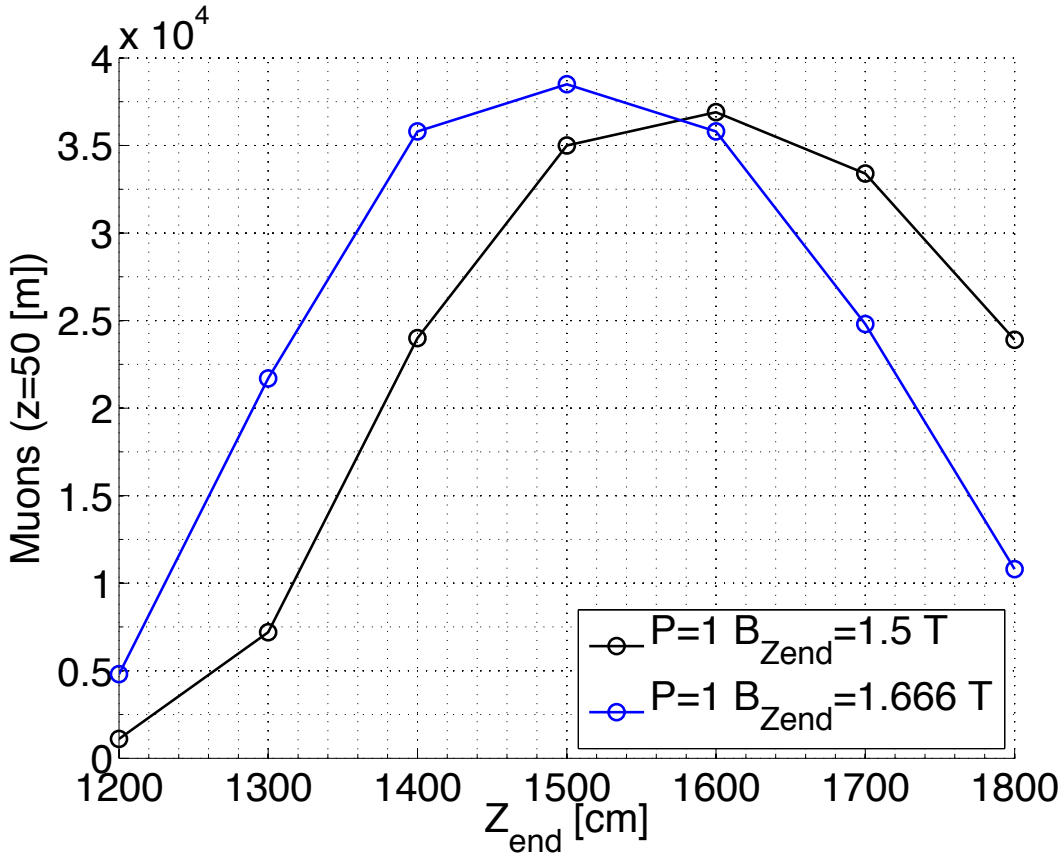
Z (end of Taper) [cm]	Muons (10^4)
1200	0.48
1300	2.17
1400	3.58
1500	3.85
1600	3.58
1700	2.48
1800	1.08

Inverse Cubic Field(P=1)

B_z(end of taper) = 1.5 T
Initial $N_P = 10^5$

Z (end of Taper) [cm]	Muons (10^4)
1200	0.11
1300	0.72
1400	2.4
1500	3.5
1600	3.69
1700	3.34
1800	2.39

MUON COUNT Z = 50 [m]



CONCLUSIONS

- Tapered field profile proved to have an impact on Muon production.
- Bz(R>0) & B R(R>0) how realistic & how can they effect the particle production.

[This study changed the field around the target, but did not insure that the beam overlapped well with the target
=> Apparent production falloff for long tapers.]