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LEBT Alignment Studies

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FETS meeting 17th April 2013

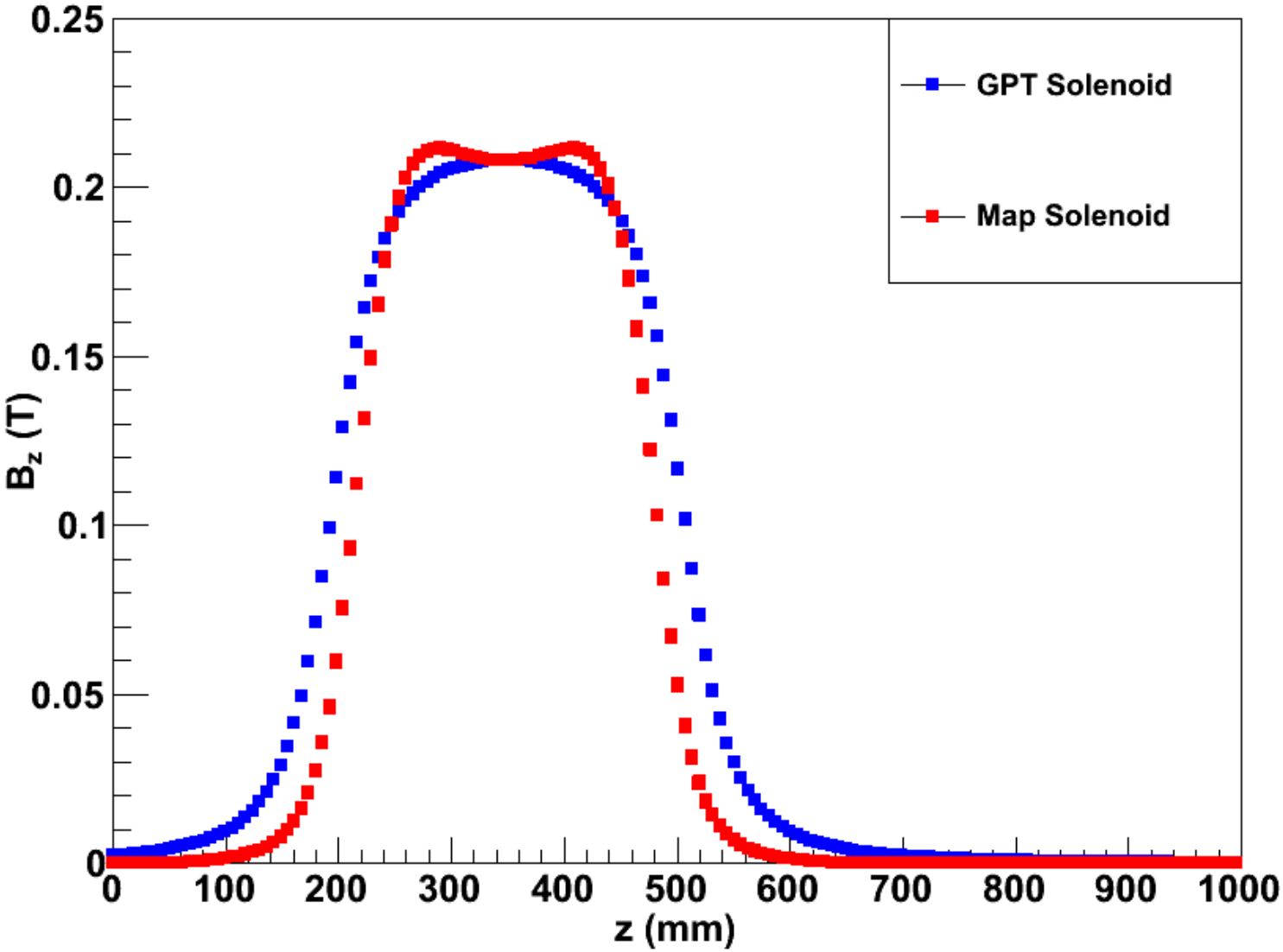
Introduction

- Using GPT to simulate beam dynamics to study

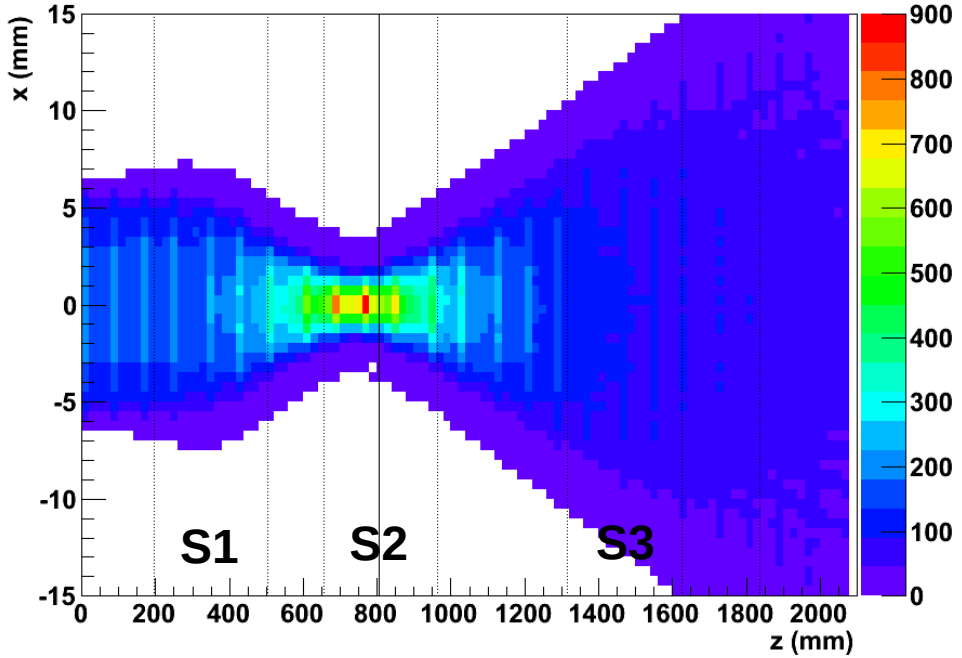
  C. Gabor profile measurements:
  - 50 keV beam, zero space charge assumed
  - Profiles measured at Δz = +240 mm from LEBT ‘end’ (default profile position)
  - Only solenoid 1 is used: $B_z = 1.4085\ I_c$ (A) mT
  - Initial collimation: 3 mm radius aperture hole
  - Assume initial beam centre = (0,0), i.e. no offset
  - Vary initial (mean) divergence angles

- Comparison between (Comsol) field map and GPT solenoid element

Solenoid Field B_z (I_c = 150A)



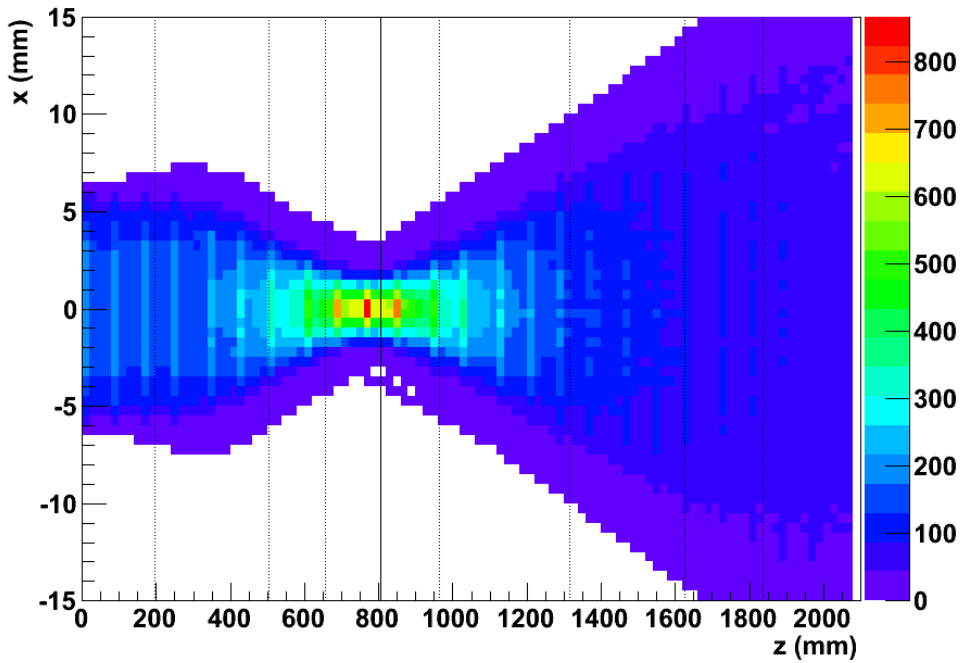
Comparison of GPT solenoid (top) and field map (bottom) for I_c = 150 A (using larger beam radius of 6 mm to clearly see focusing effect)



Solid line near z = 800 mm is theoretical focal position from end of solenoid 1 (S1)

$$f \approx \frac{8mU}{q^2 B_z^2 L}$$

m = H ion mass, U = 50 keV,
q = 1 e, L = sol. length (31 cm)
B_z = 0.211 T for I_c = 150 A



Data-GPT comparisons set-up

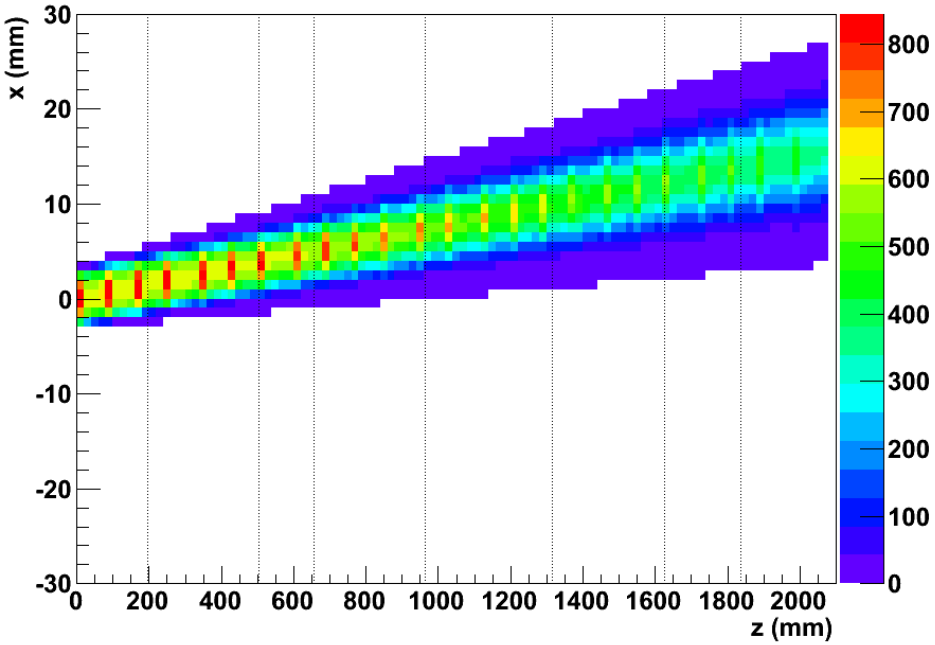
- KE = 50 keV, zero space charge
- Initial beam parameters:
  - Uniform in radius, ϕ (r = 3 mm)
  - Gaussian transverse velocity distribution:
    - Non-zero mean divergence angles θ_x, $\theta_{y:}$

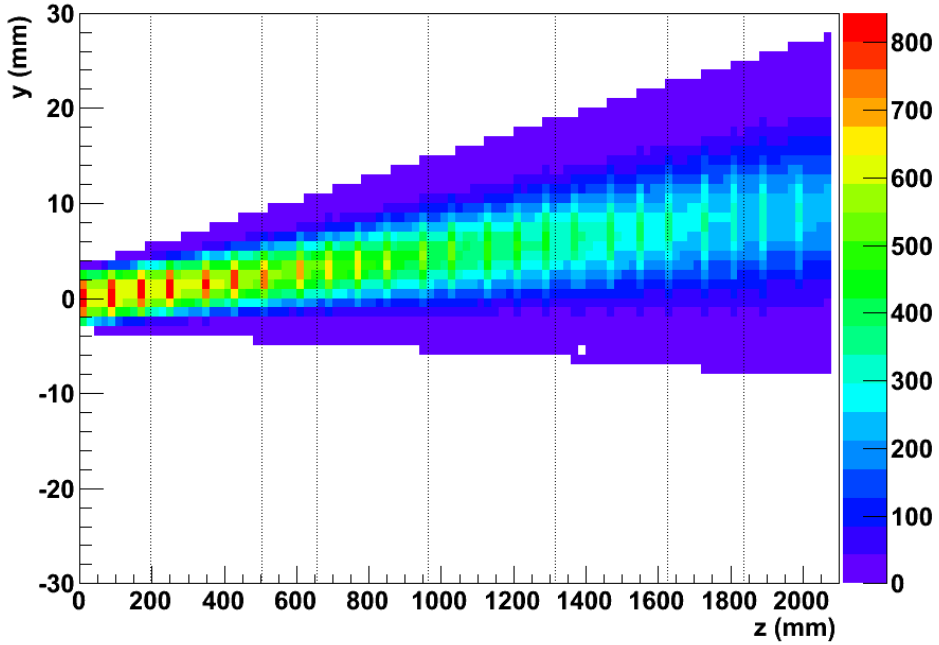
      $\Rightarrow$ $\beta_x = \beta\gamma\theta_x$ and $\beta_y = \beta\gamma\theta_y$
    - Divergence spread σ_x , σ_y (3 sigma cut-off)

- Find θ_x, θ_y that gives best match to I_c =1A data
- Keep initial parameters *the same* for all other I_c values

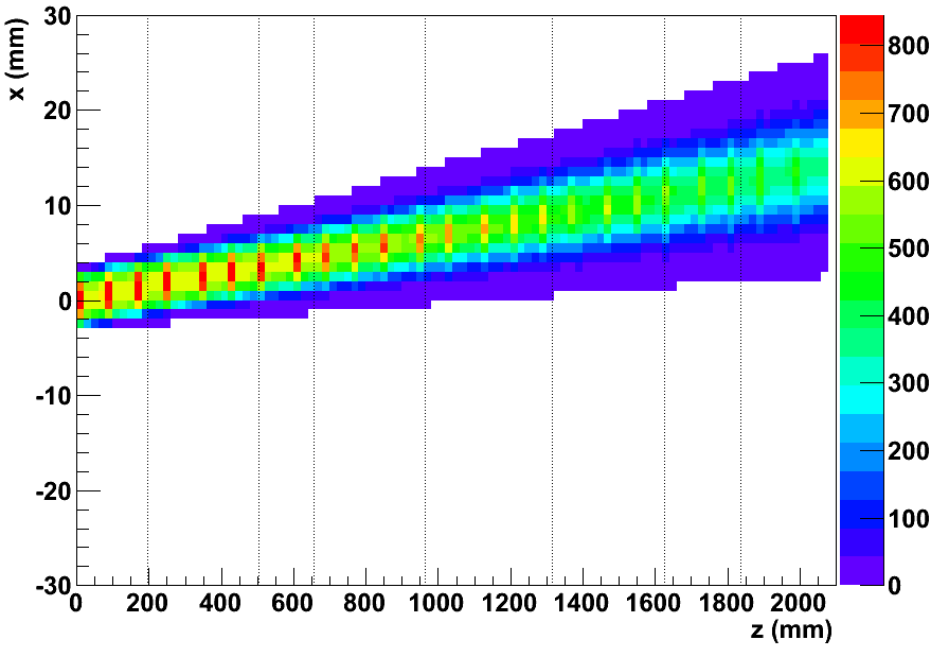
- Plot x-y distribution at $\Delta z_{profile}$ = +240 mm position
  - Following pages use the field map for the solenoid

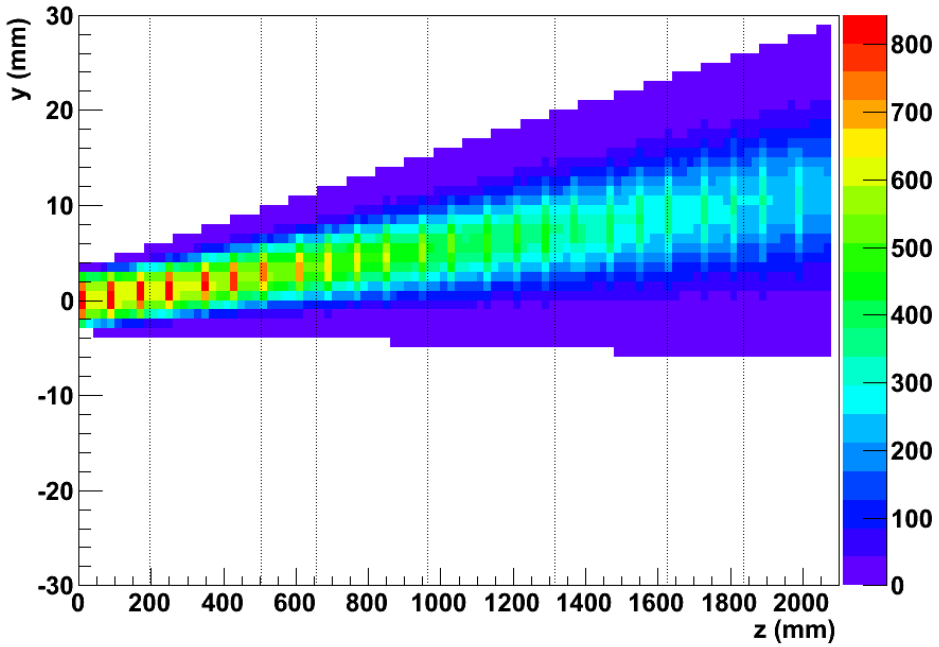
Beam envelope: I_c = 1 A



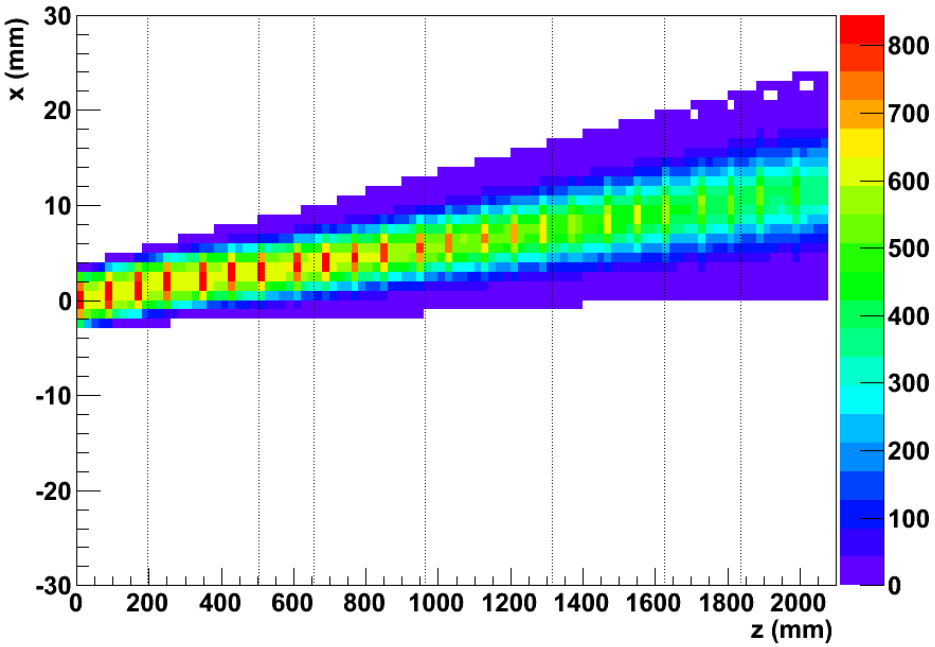


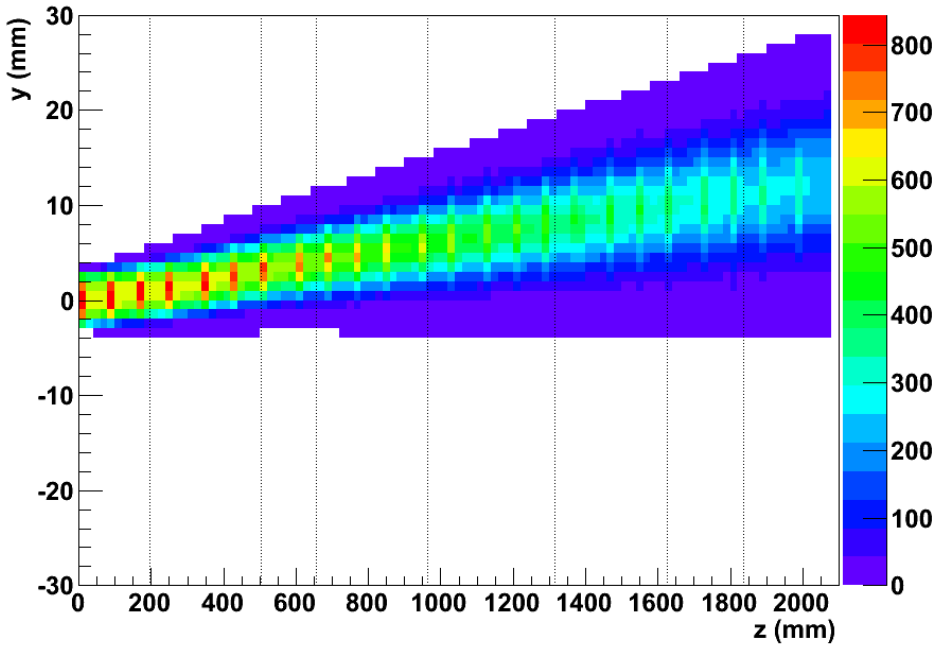
Beam envelope: I_c = 20 A



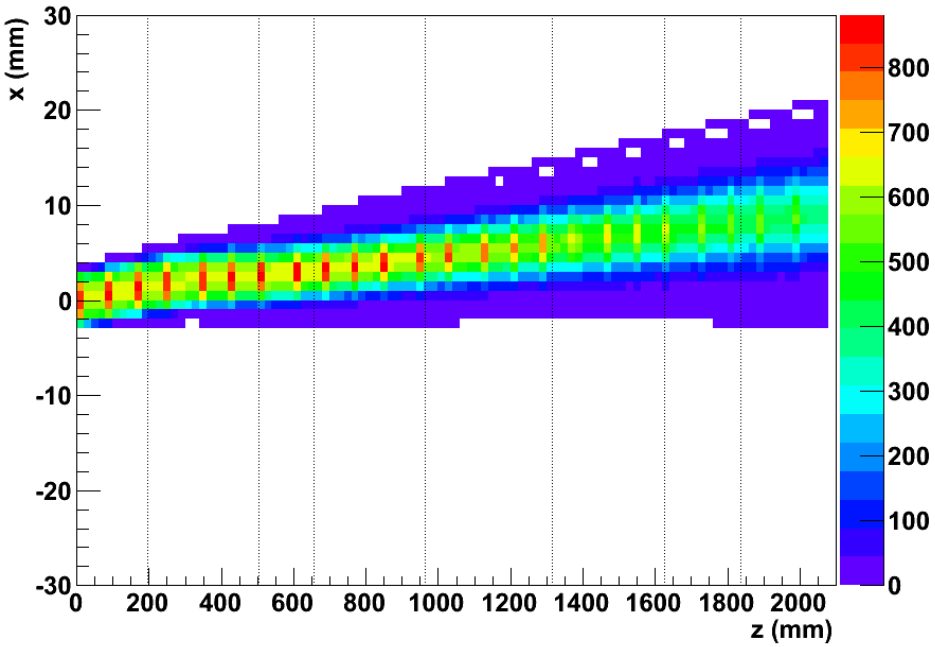


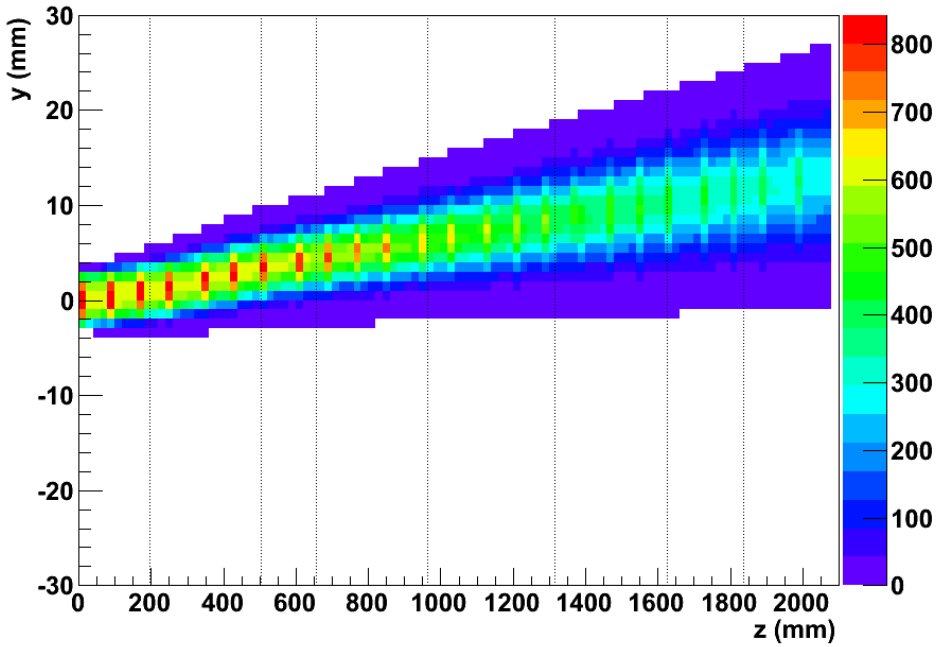
Beam envelope: I_c = 40 A



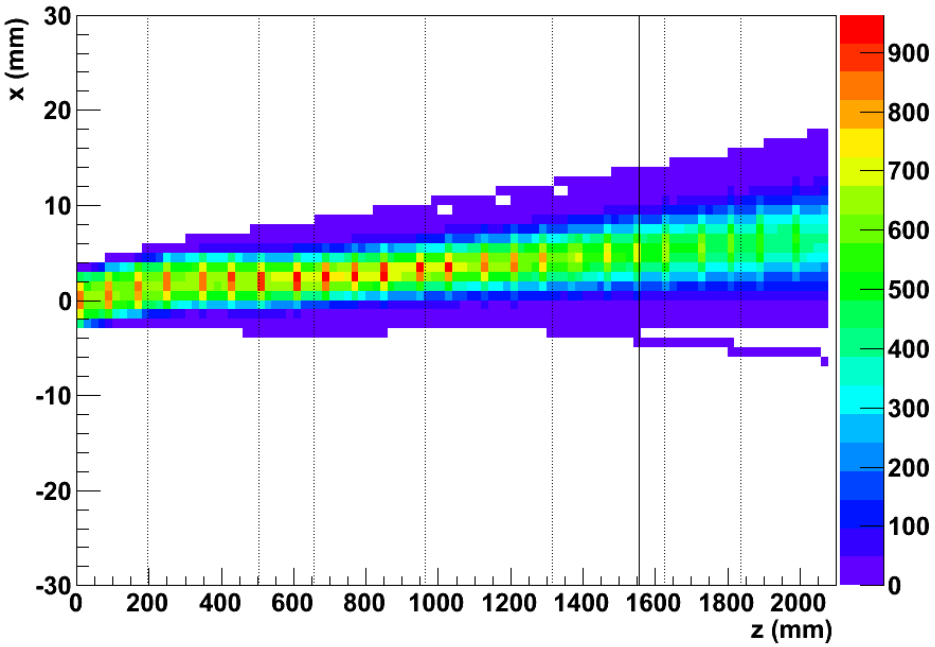


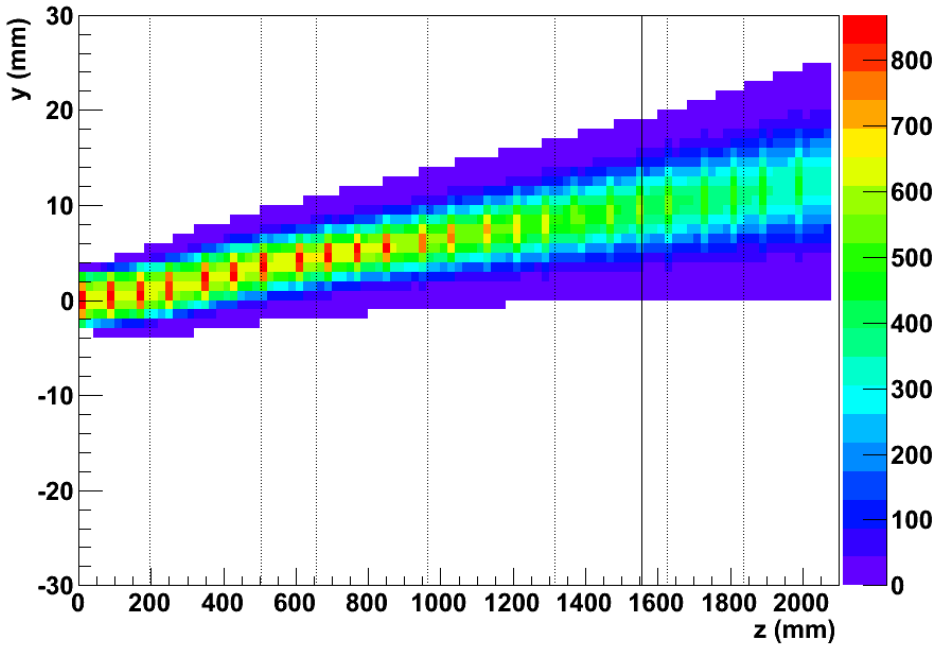
Beam envelope: I_c = 60 A



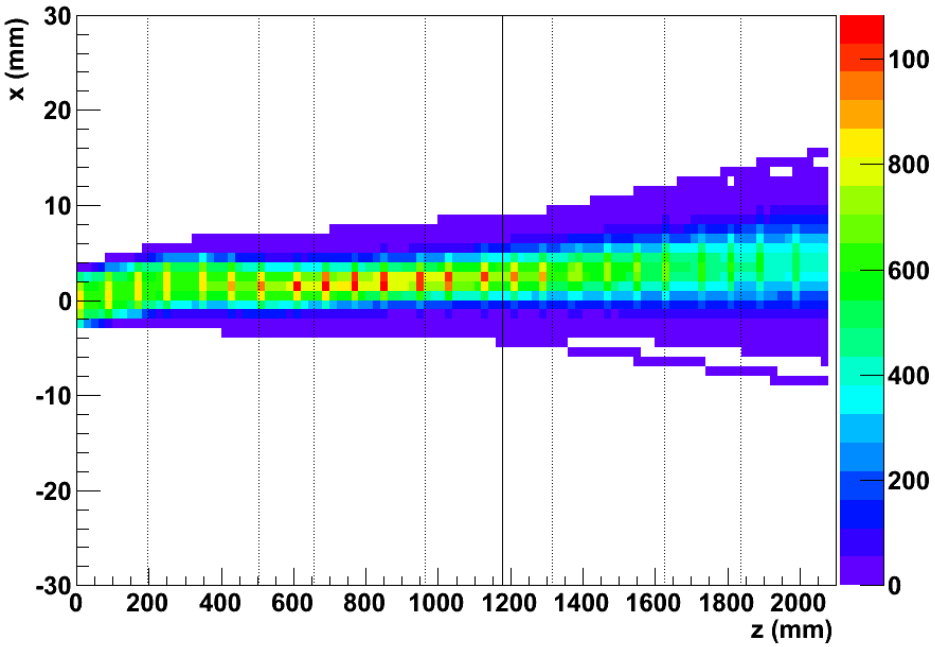


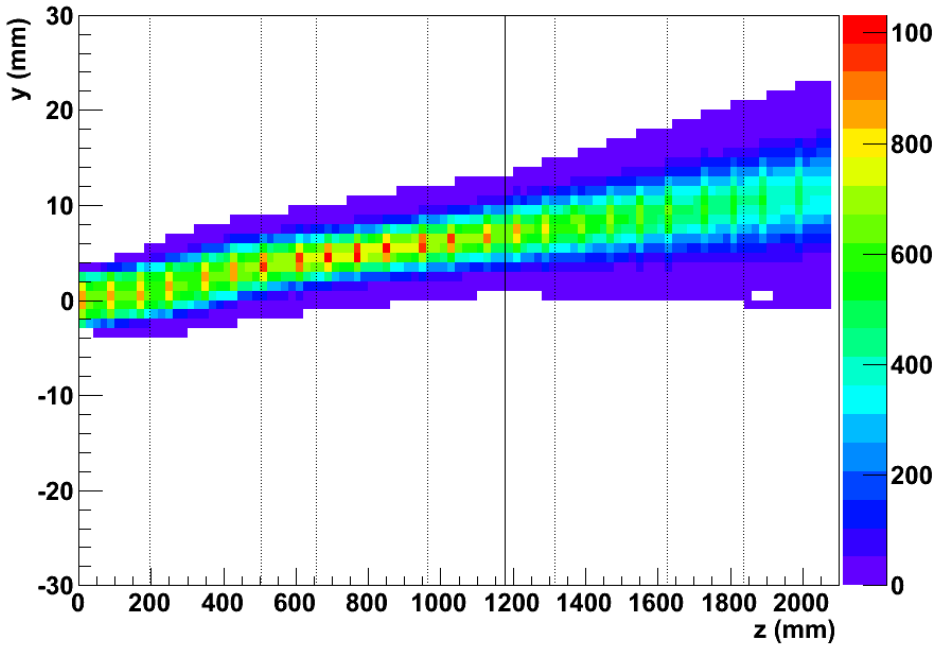
Beam envelope: I_c = 80 A



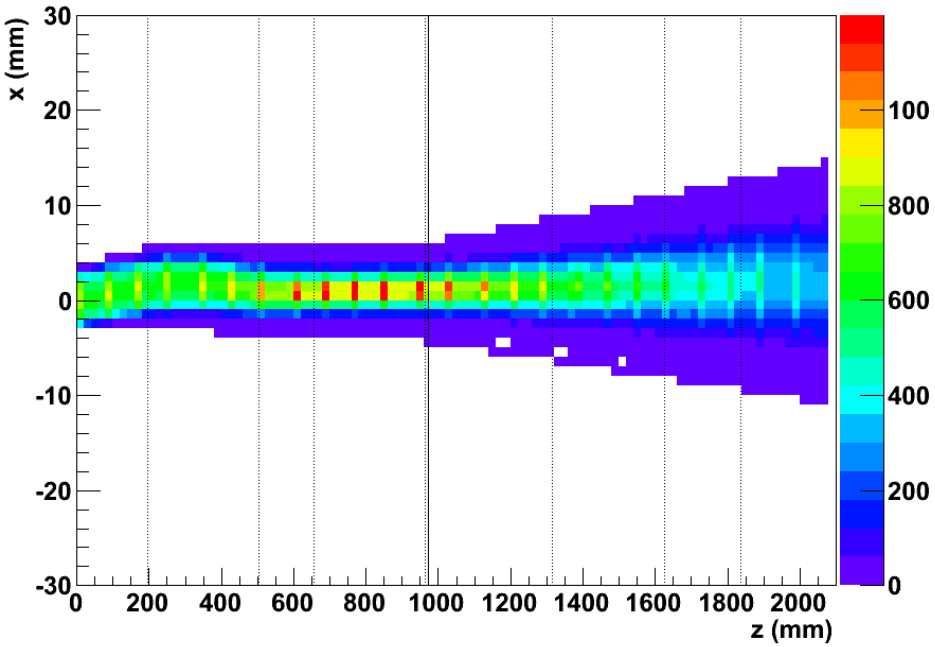


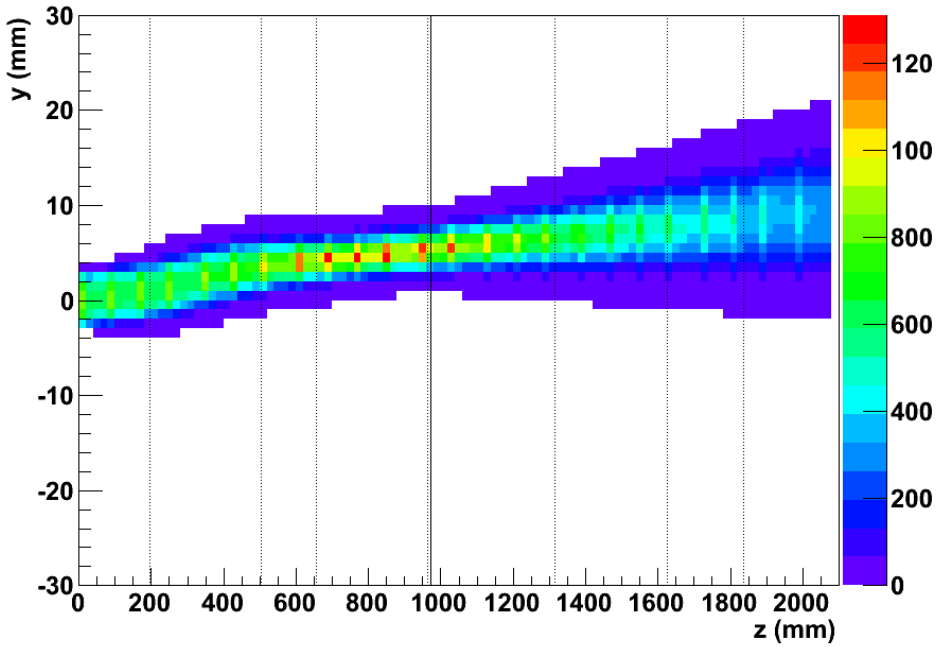
Beam envelope: I_c = 100 A



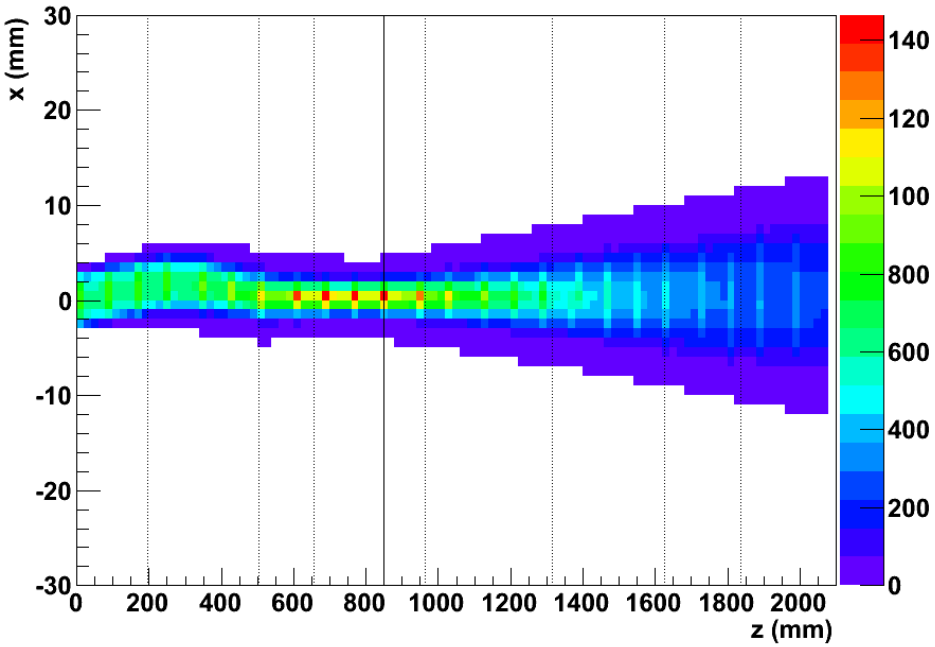


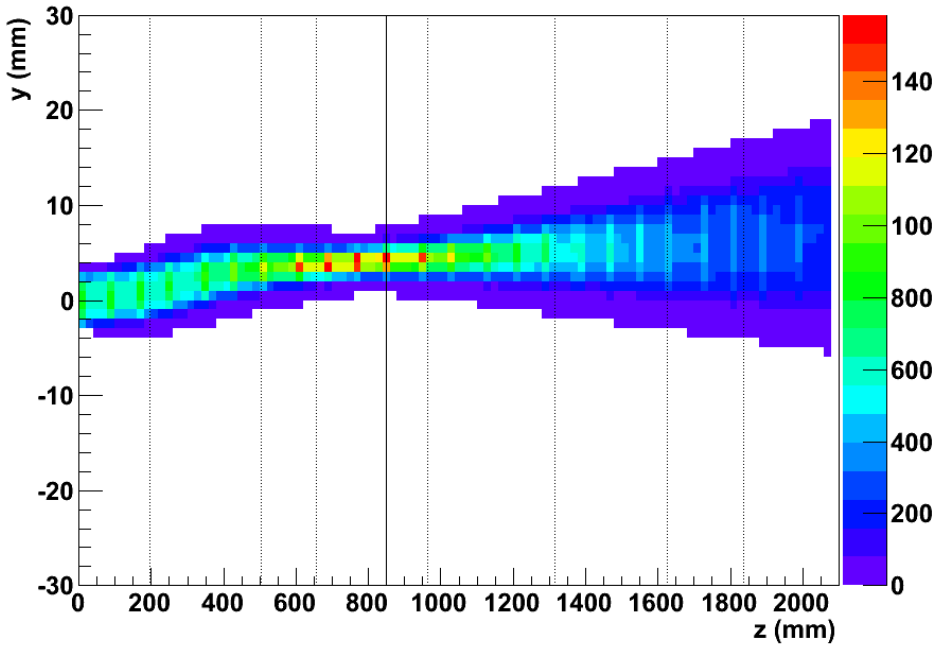
Beam envelope: I_c = 120 A



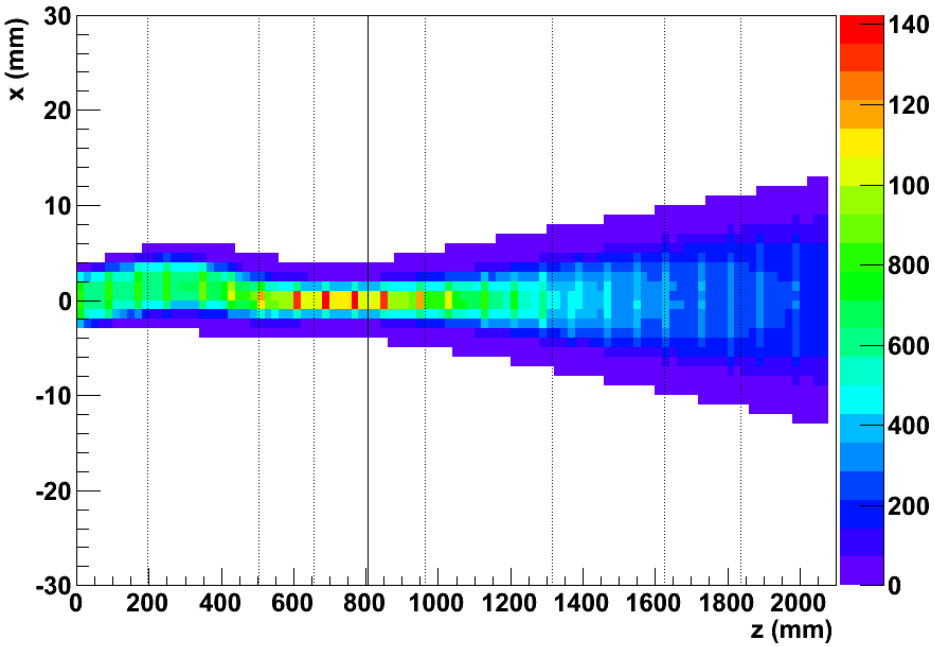


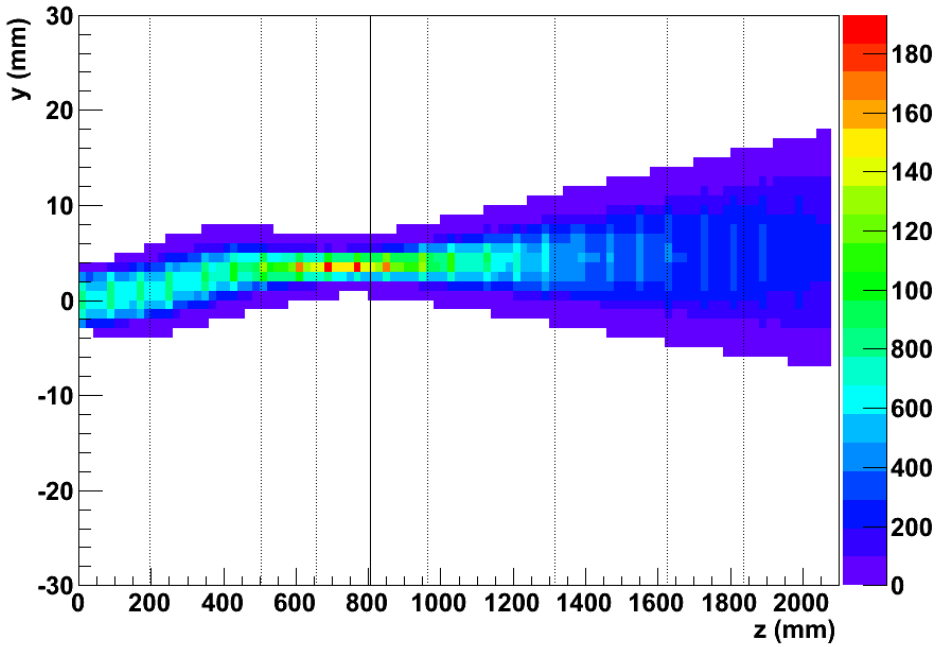
Beam envelope: I_c = 140 A



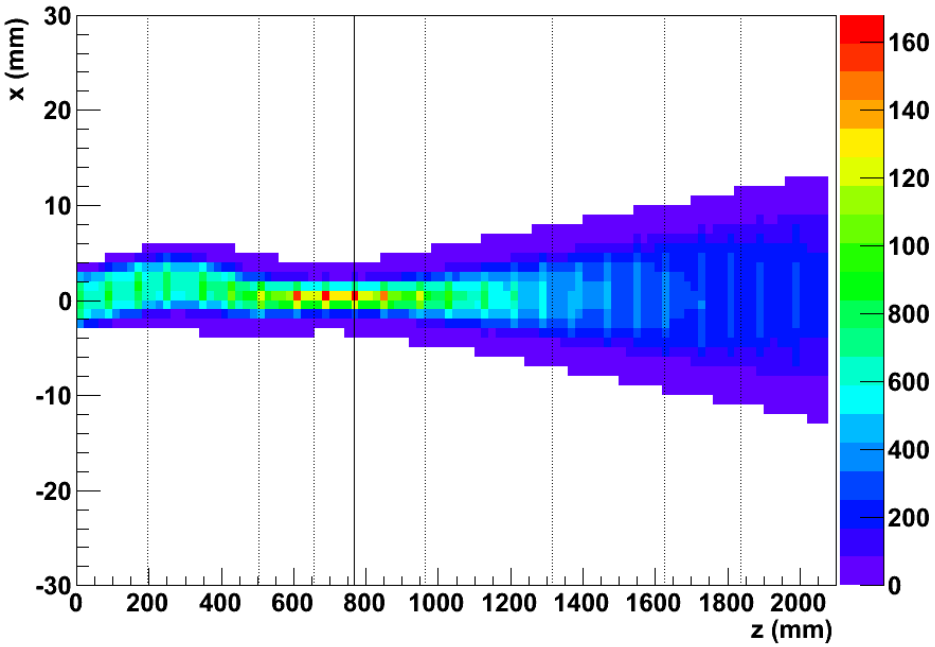


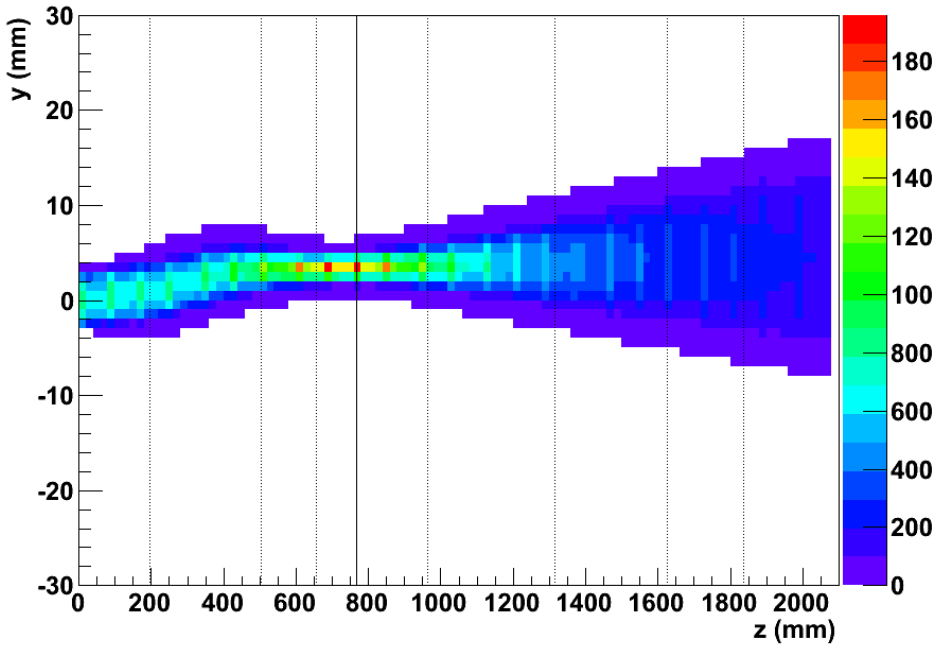
Beam envelope: I_c = 150 A



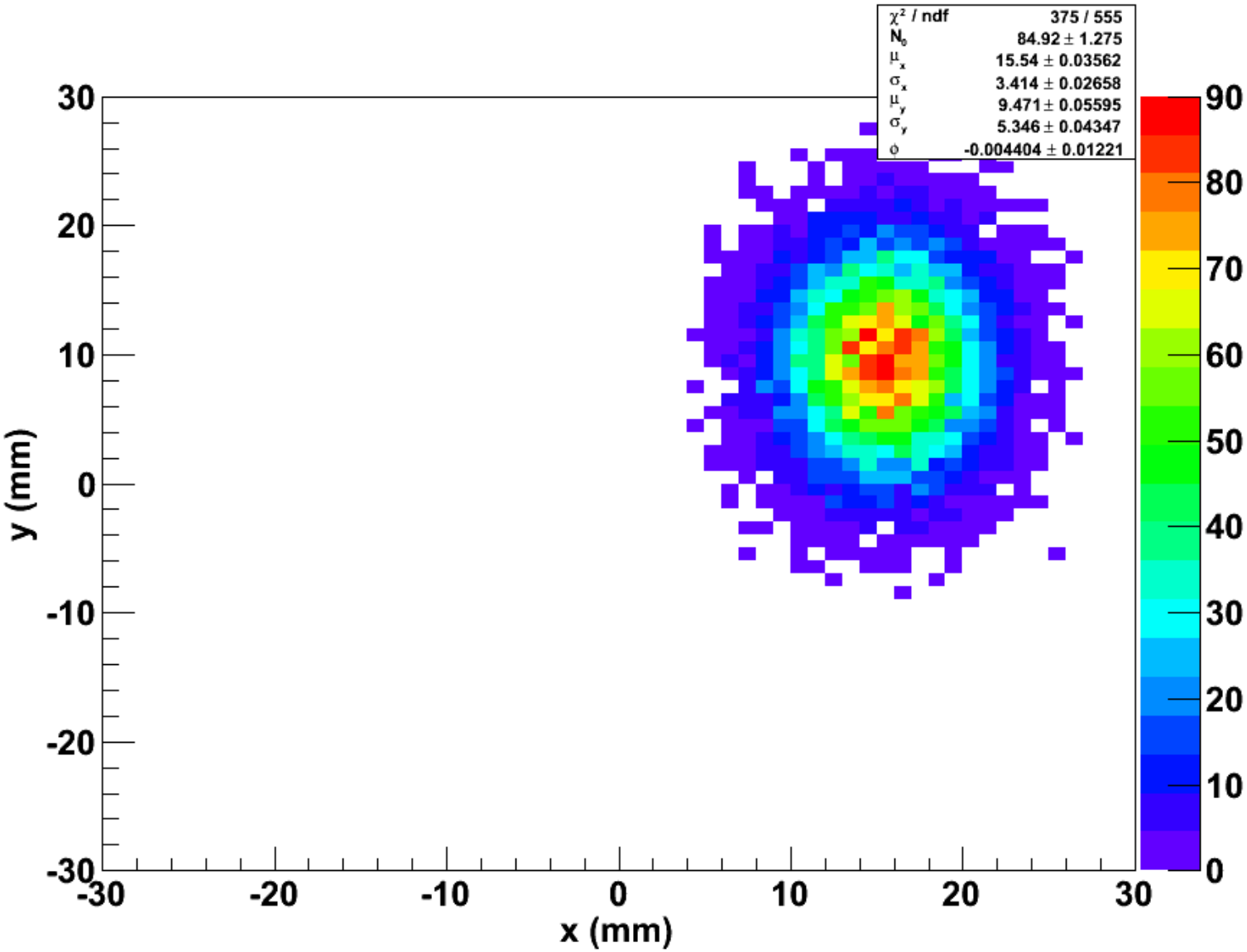


Beam envelope: I_c = 160 A

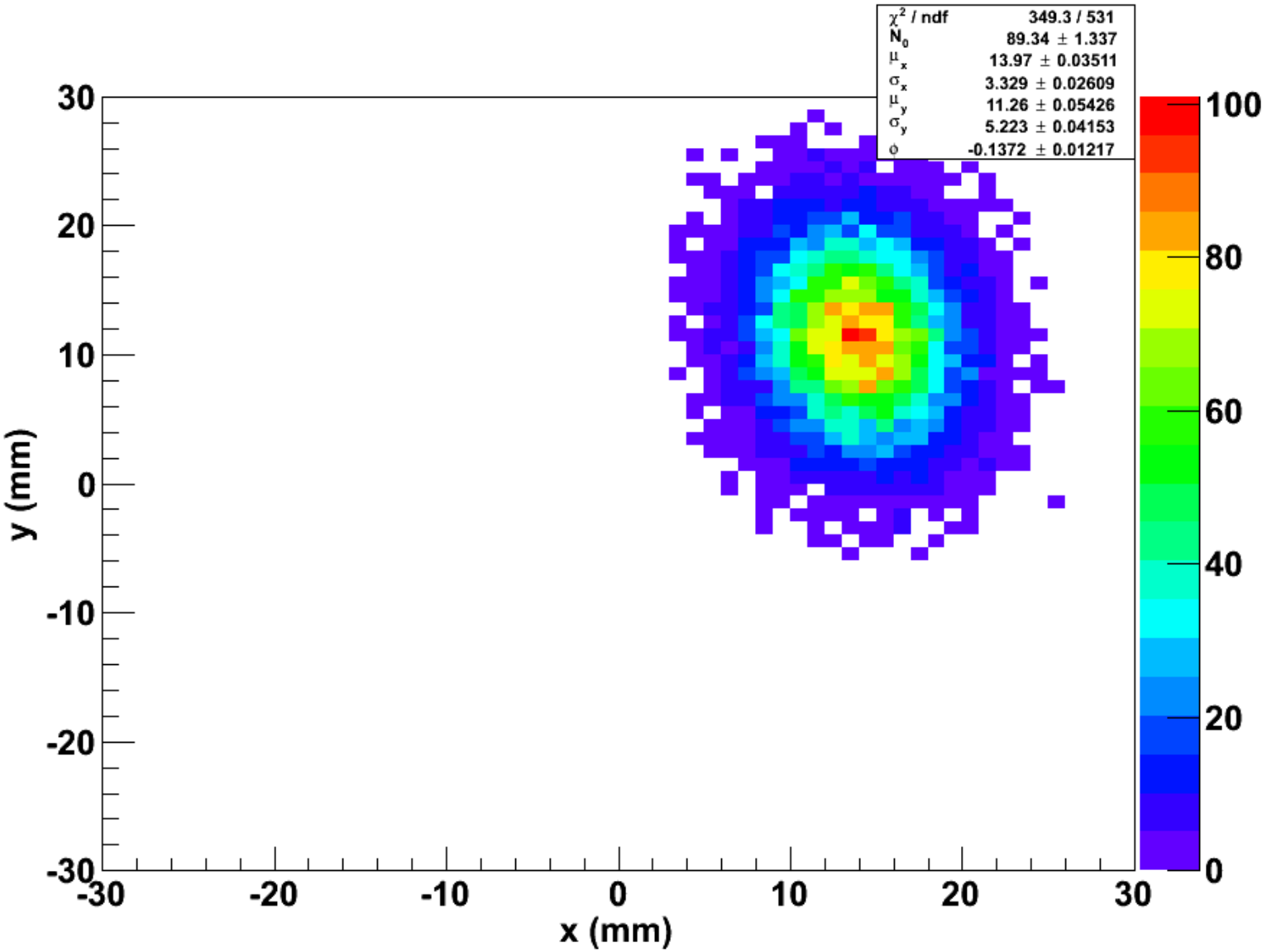




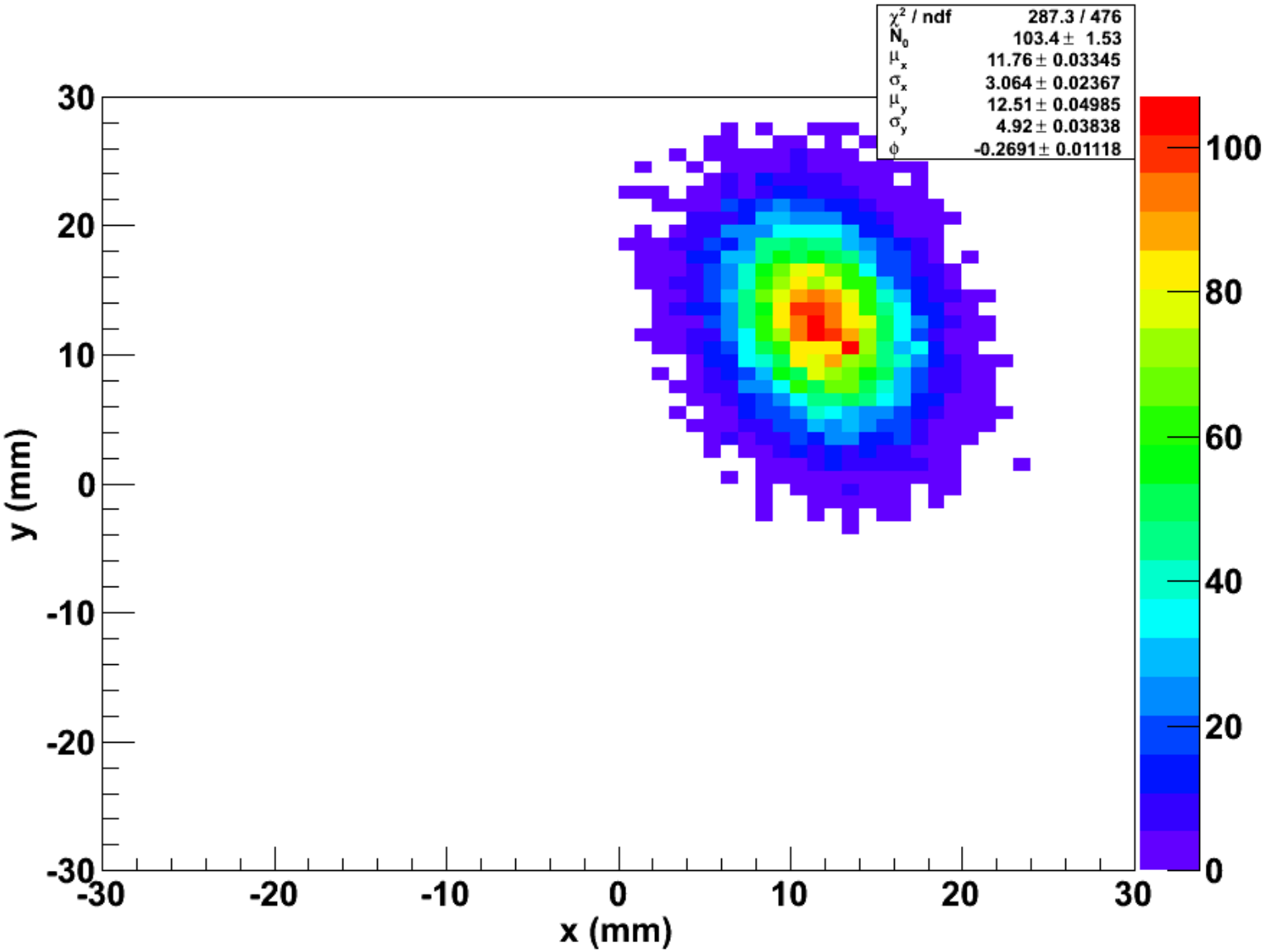
x-y profile: I_c = 1A



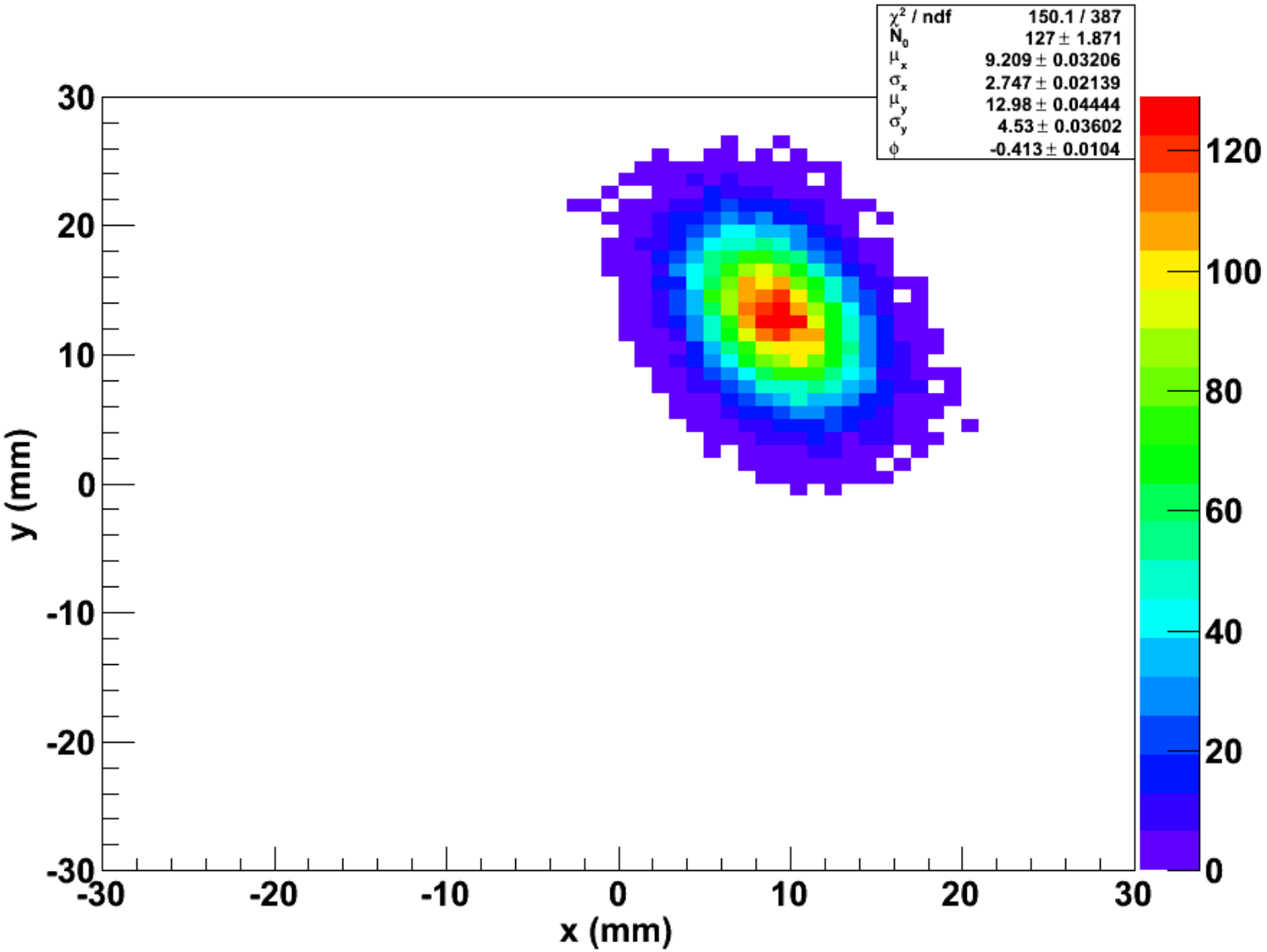
x-y profile: I_c = 20A



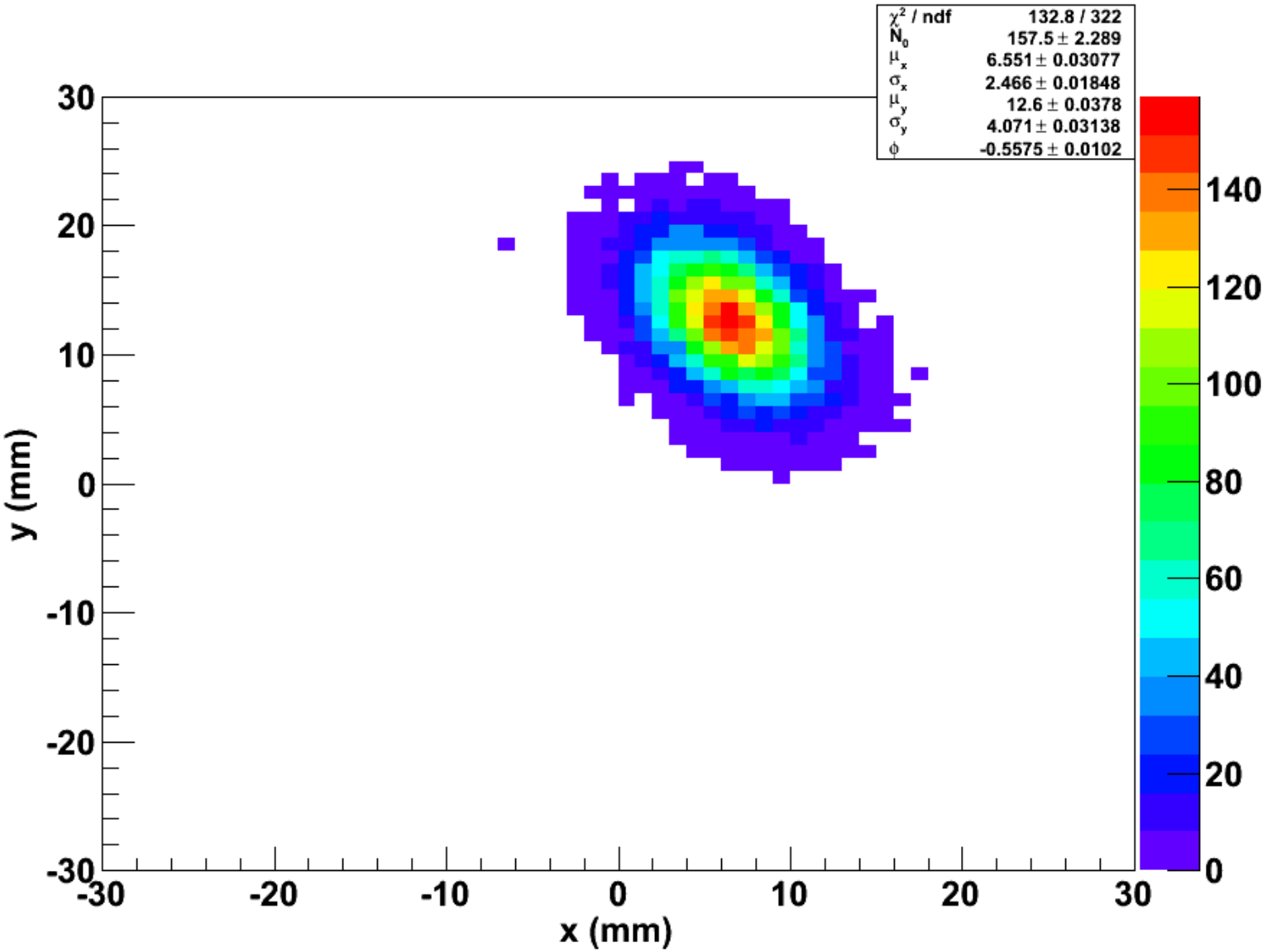
x-y profile: I_c = 40A



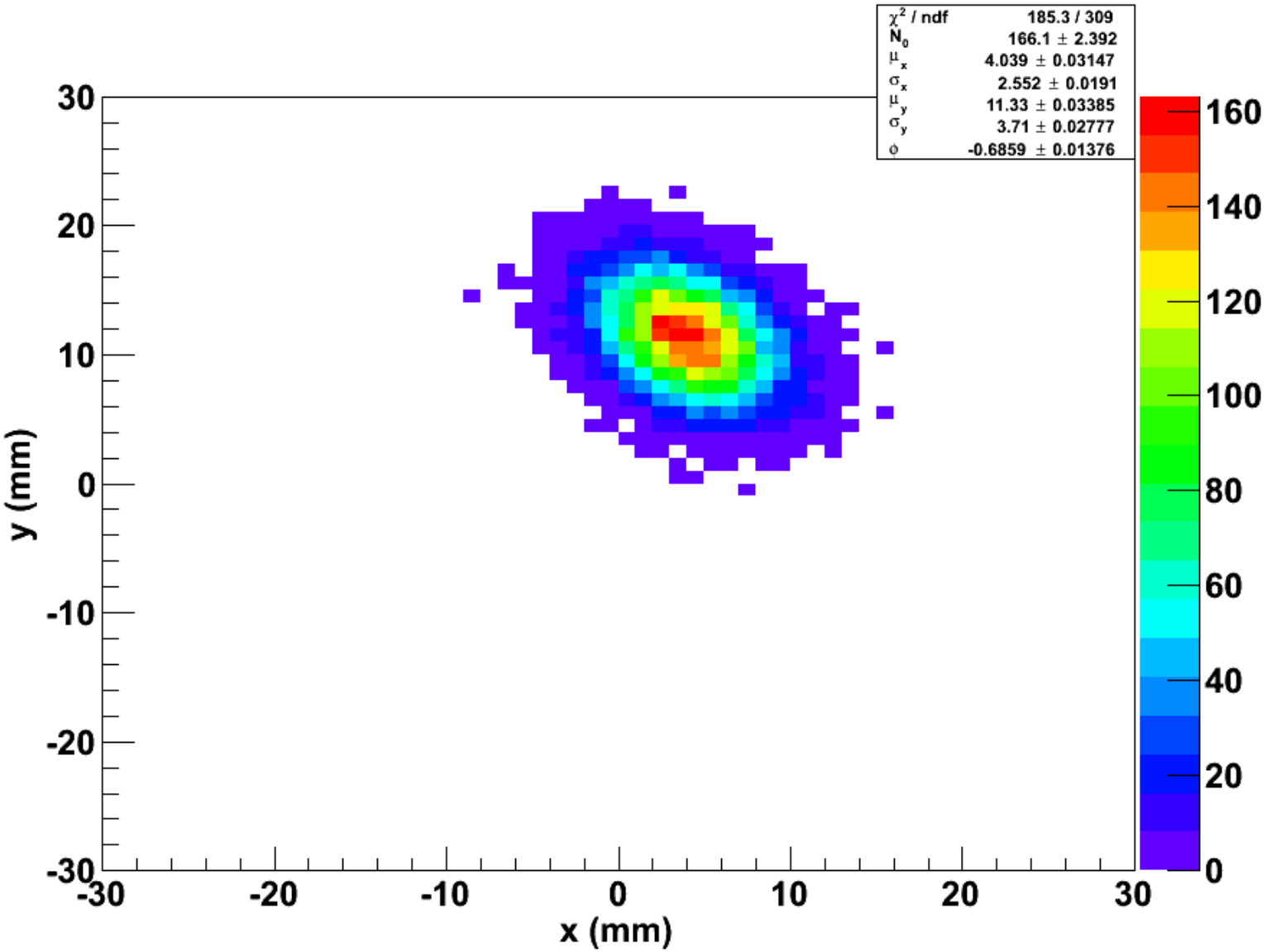
x-y profile: I_c = 60A



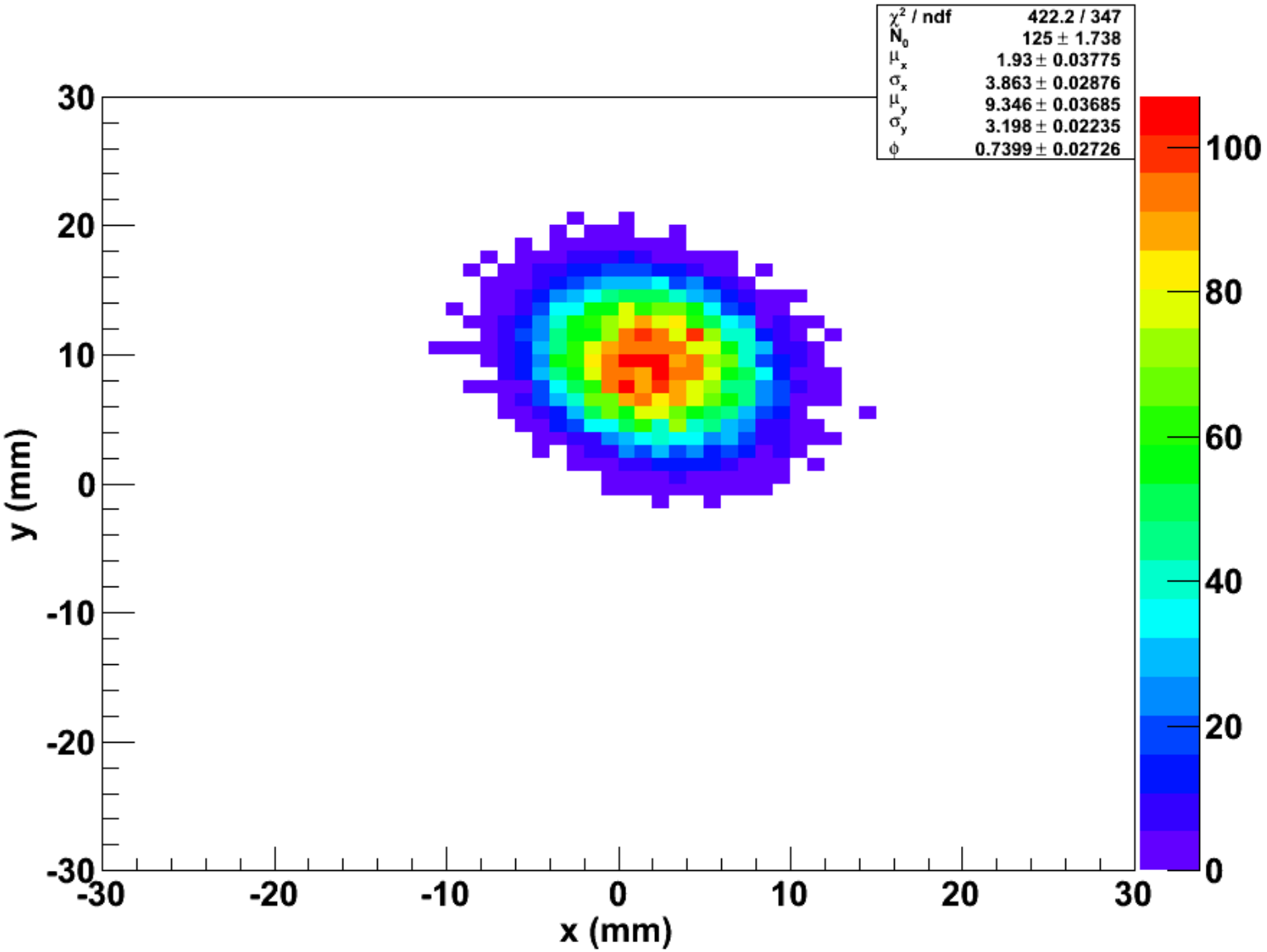
x-y profile: I_c = 80A



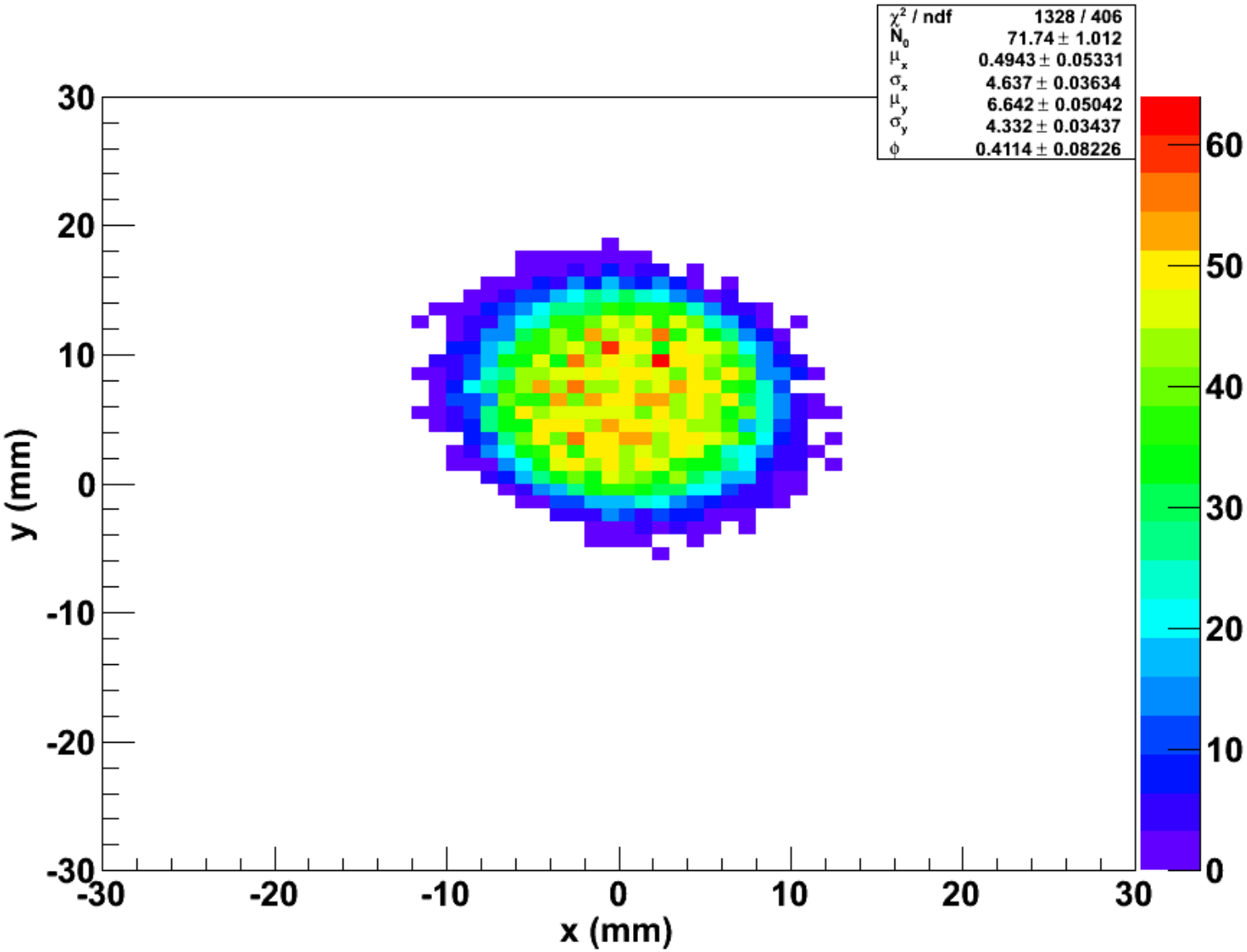
x-y profile: I_c = 100A



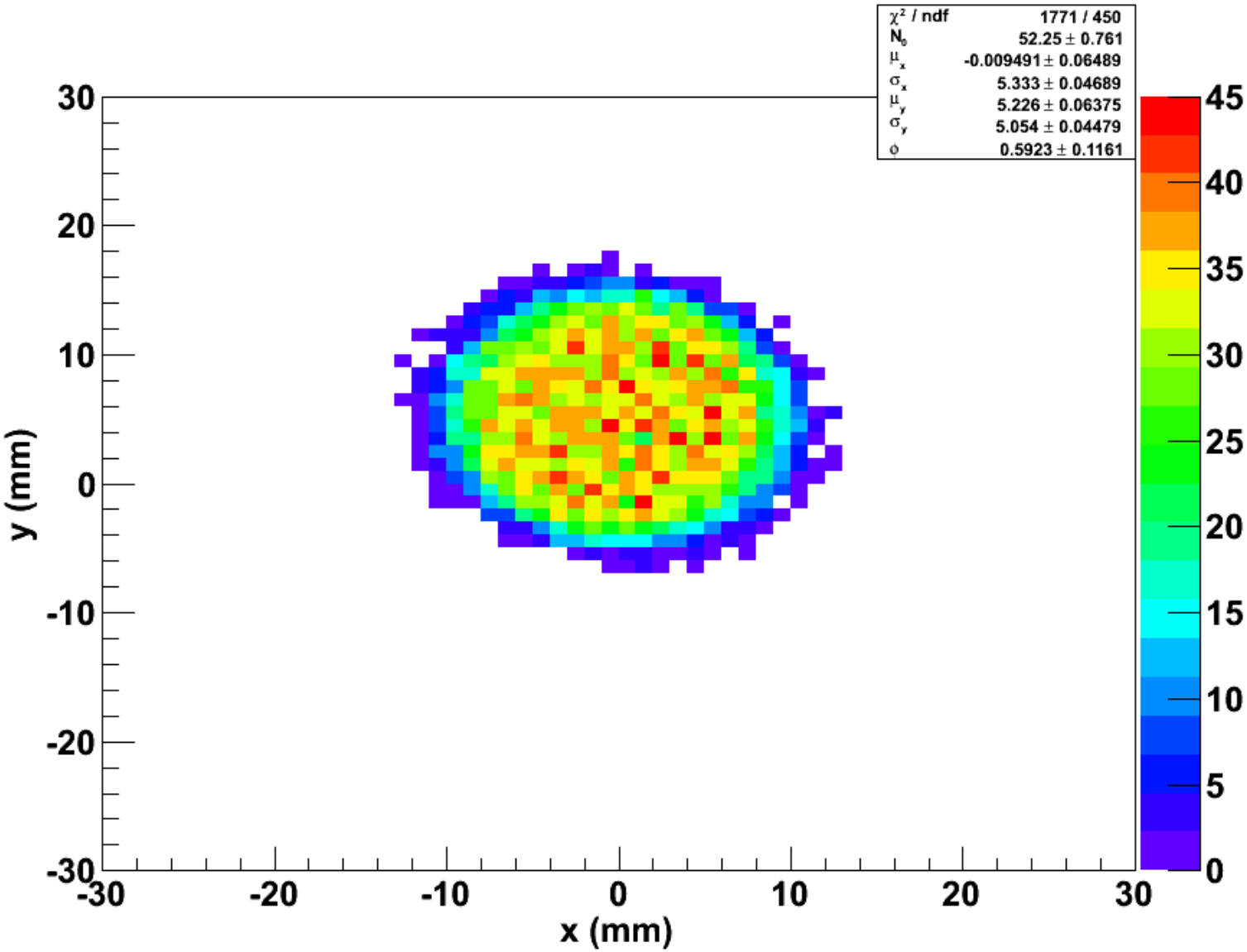
x-y profile: I_c = 120A



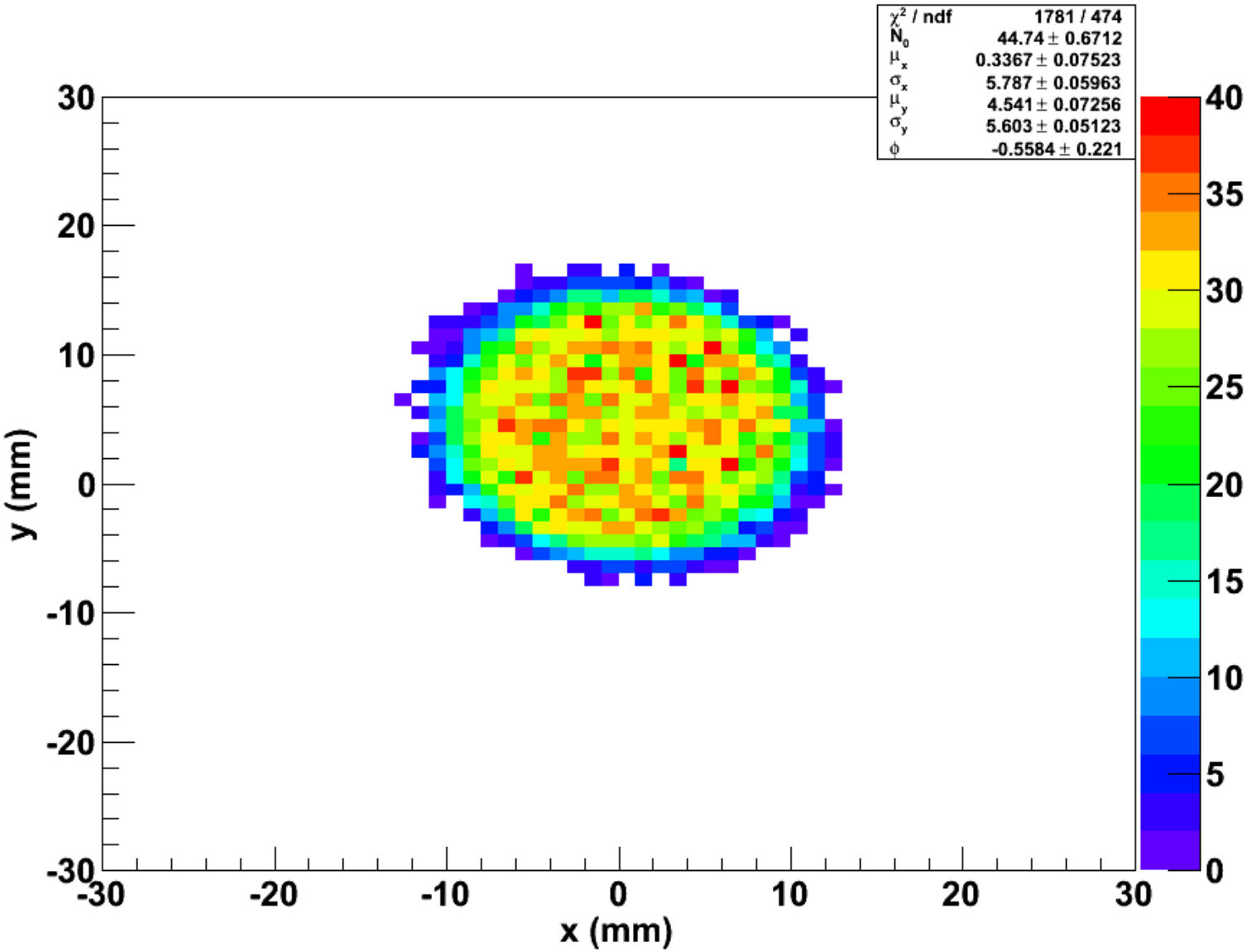
x-y profile: I_c = 140A



x-y profile: I_c = 150A



x-y profile: I_c = 160A



Comparison of mean x,y profile values