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LEBT Alignment Studies

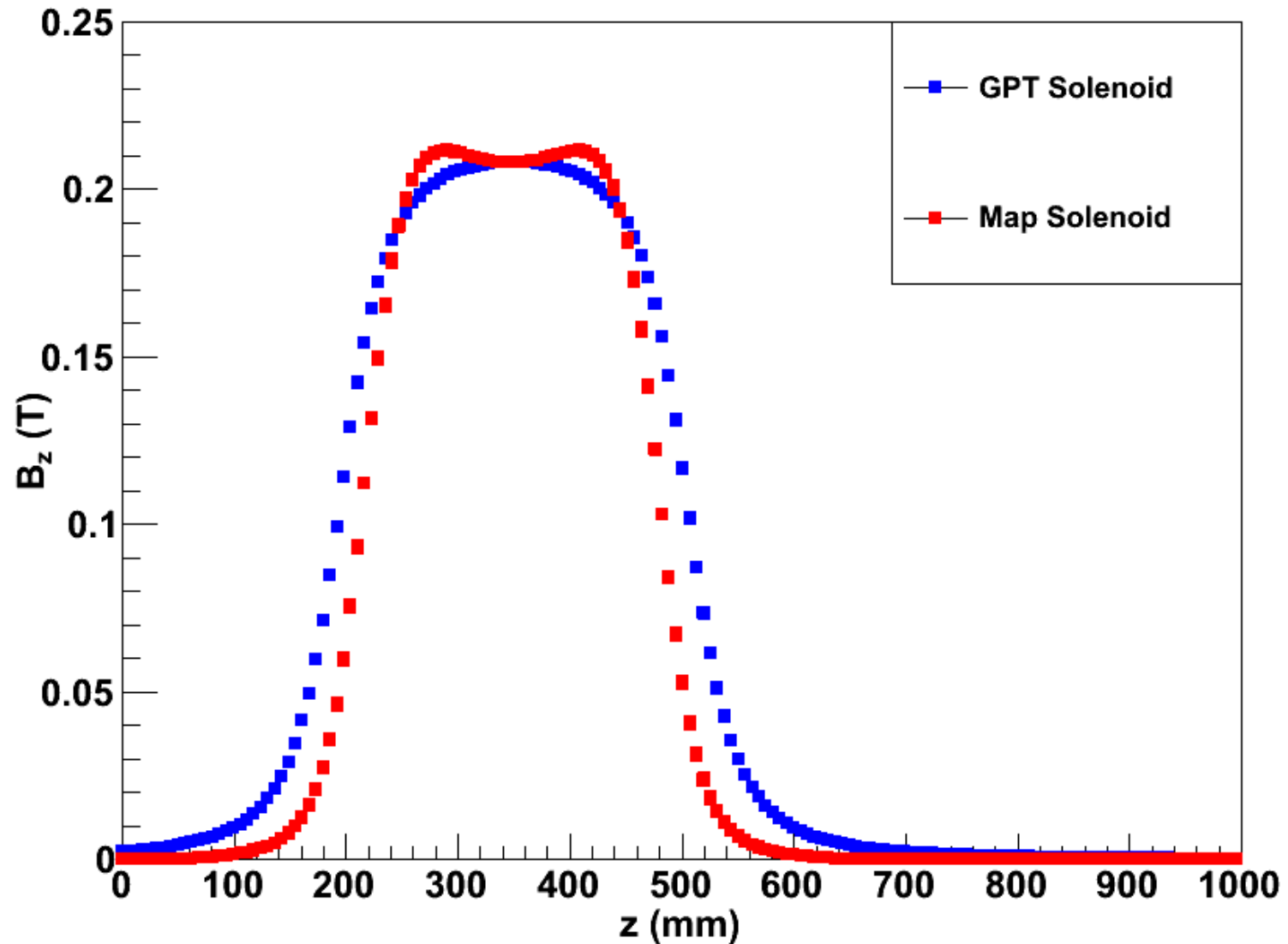
John Back
University of Warwick

FETS meeting 17th April 2013

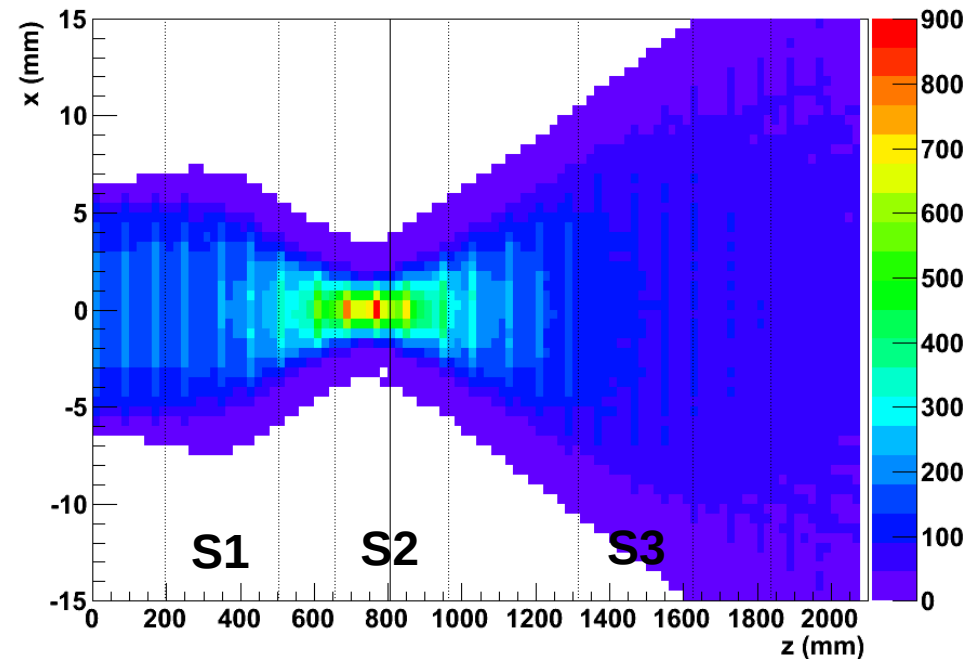
Introduction

- Using GPT to simulate LEBT beam dynamics to study C. Gabor profile measurements:
 - 50 keV beam, zero space charge assumed
 - Profiles measured at $\Delta z = +240$ 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 ($I_c = 150\text{A}$)



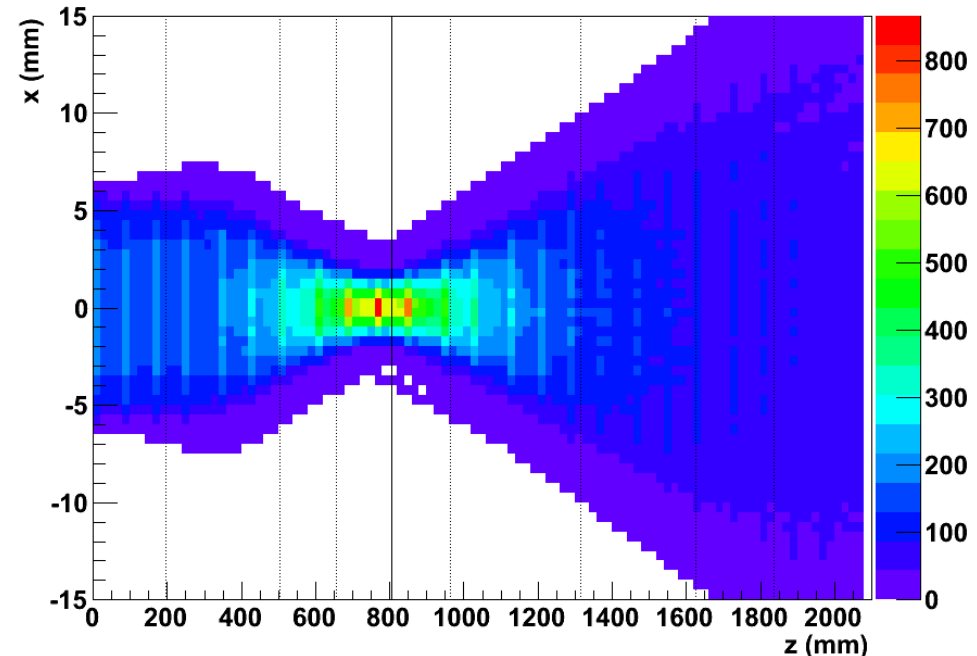
Comparison of GPT solenoid (top) and field map (bottom) for $I_c = 150$ A (using larger beam radius of 6 mm to clearly see focusing effect)



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

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

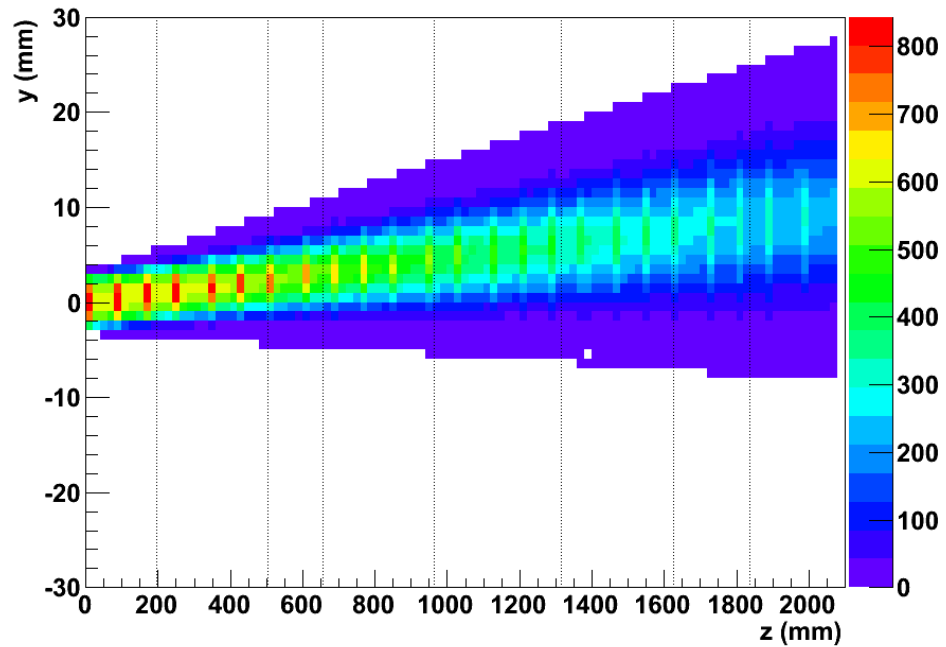
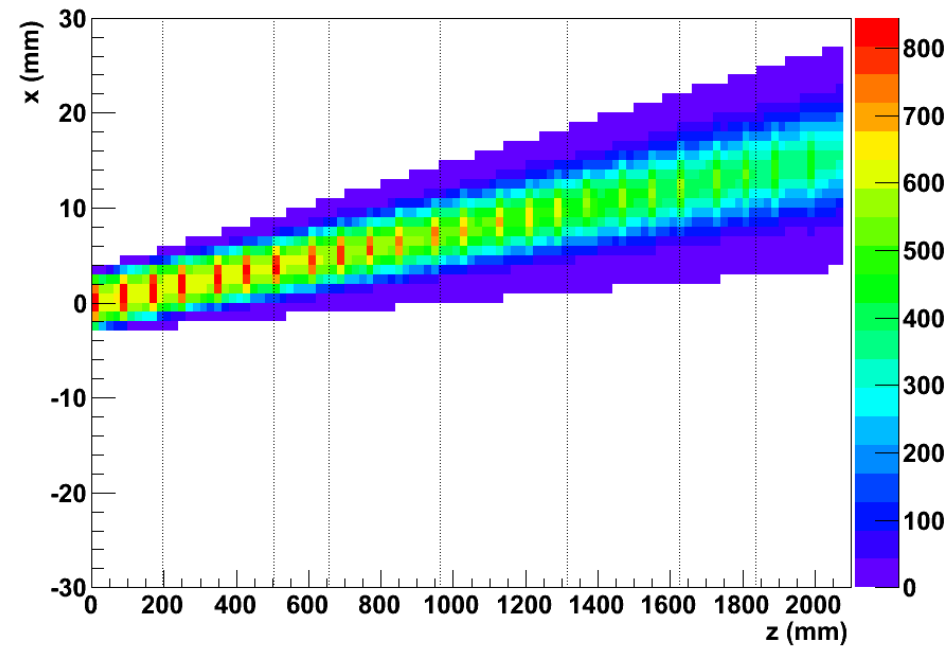
m = H ion mass, $U = 50$ keV,
 $q = 1$ e, L = sol. length (31 cm)
 $B_z = 0.211$ T for $I_c = 150$ A



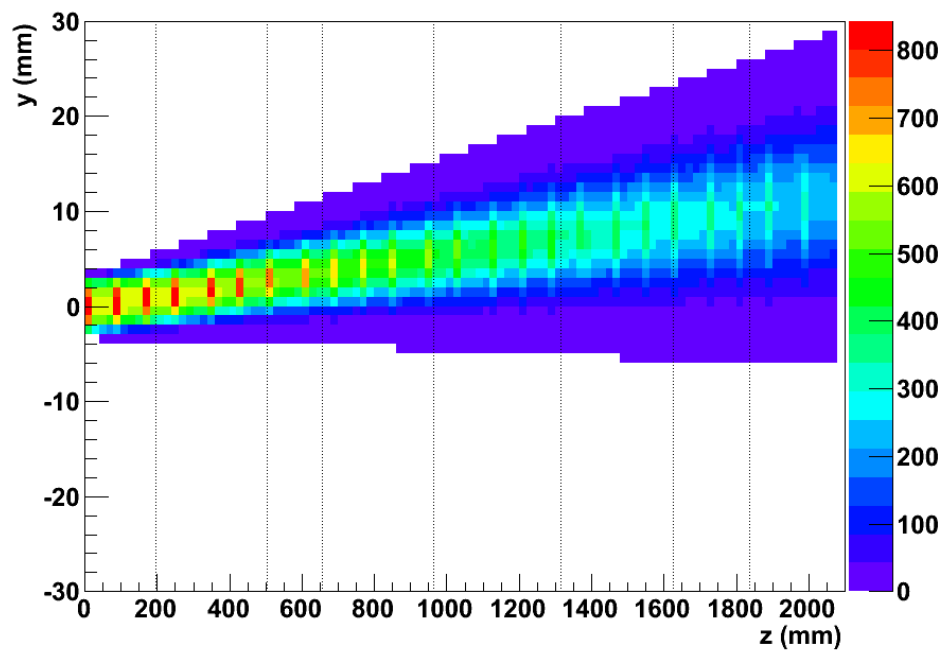
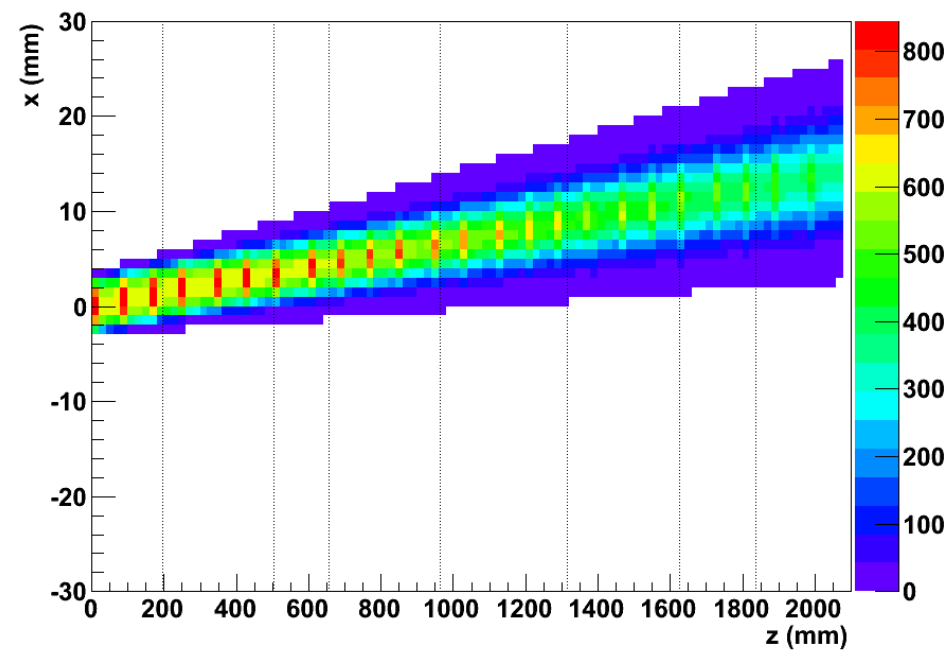
Data-GPT comparisons set-up

- 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, θ_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 $I_c = 1$ A data:
 $\theta_x = +7.5$ mr, $\theta_y = +4.5$ mr, $\sigma_x = 1.5$ mr, $\sigma_y = 2.5$ mr
- Keep initial parameters *the same* for all other I_c values
- Plot x-y distribution at $\Delta z_{\text{profile}} = +240$ mm position
 - Following pages use the **field map** for the solenoid

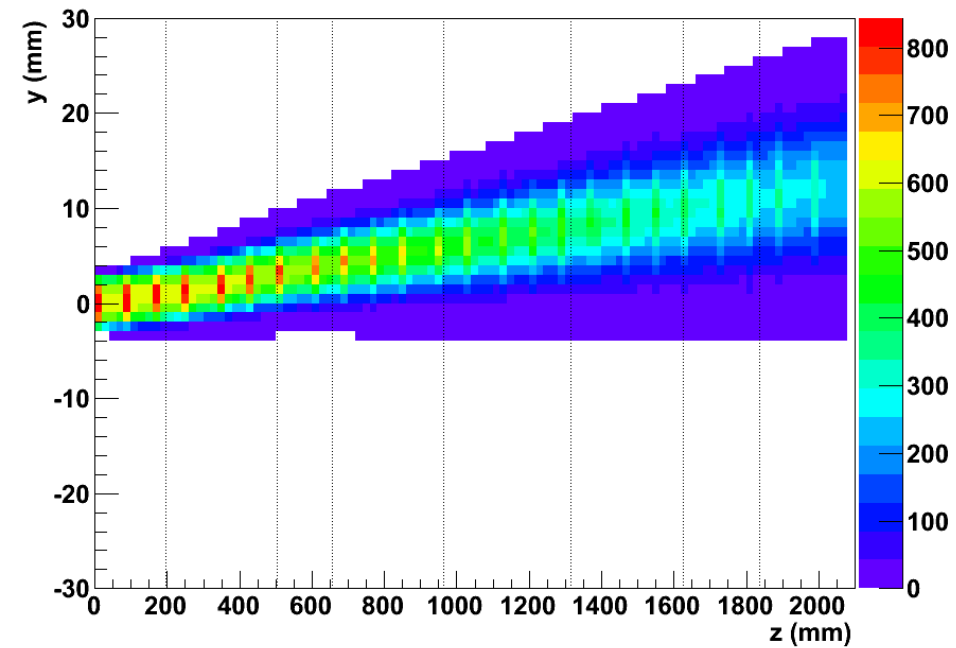
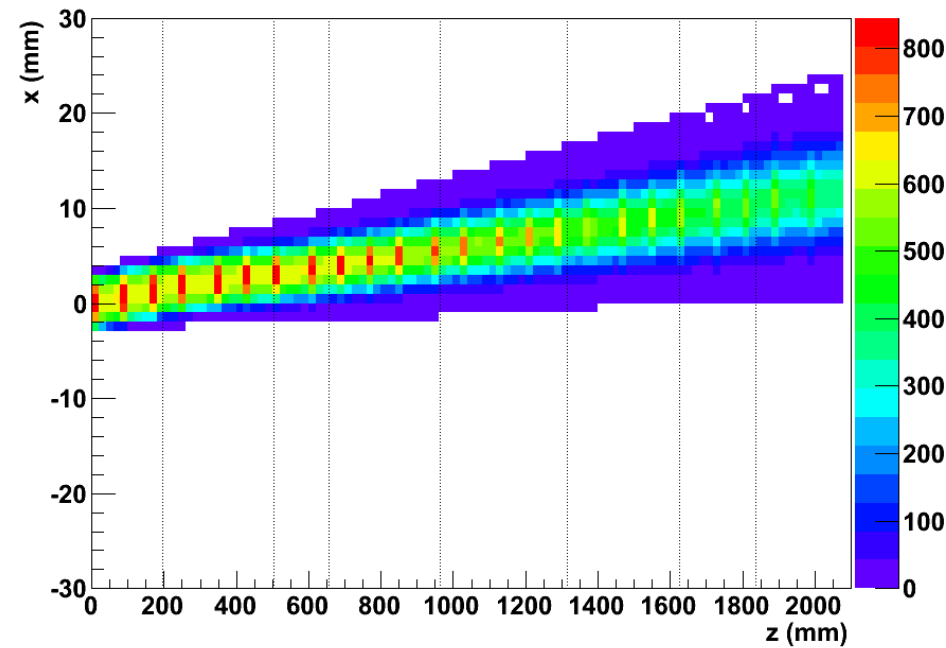
Beam envelope: $I_c = 1$ A



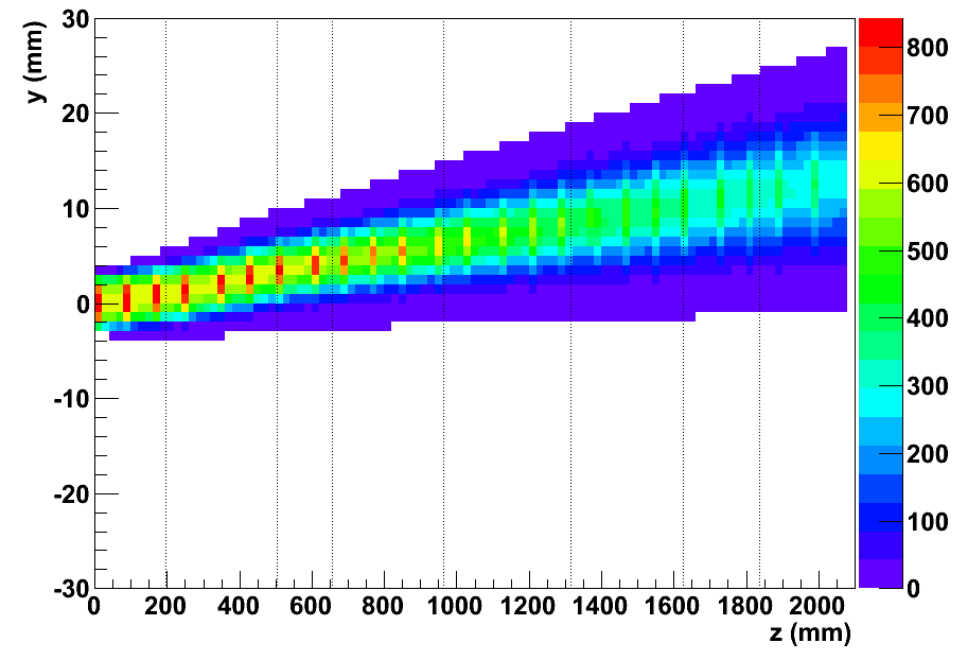
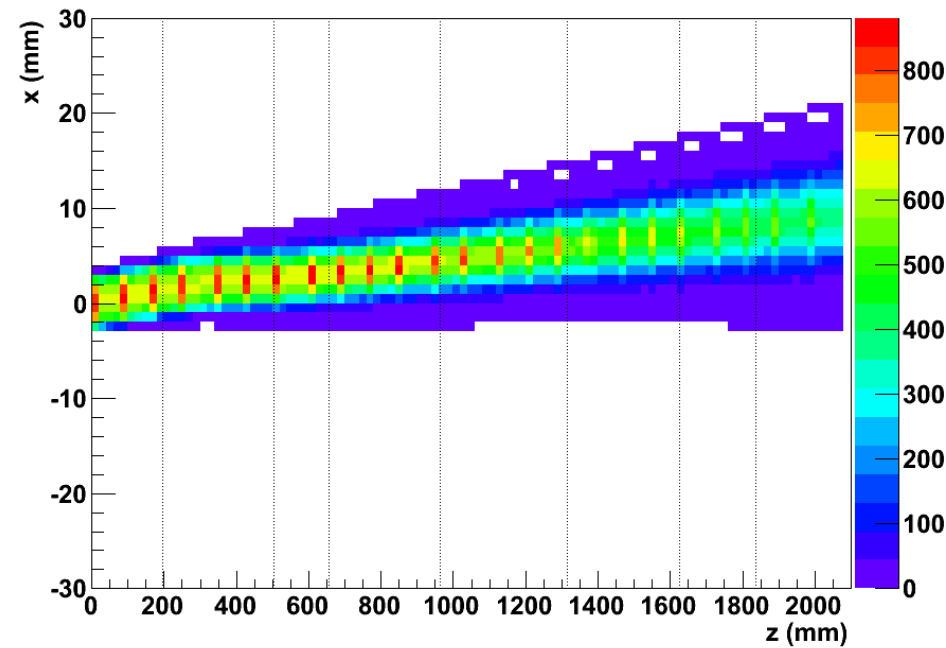
Beam envelope: $I_c = 20$ A



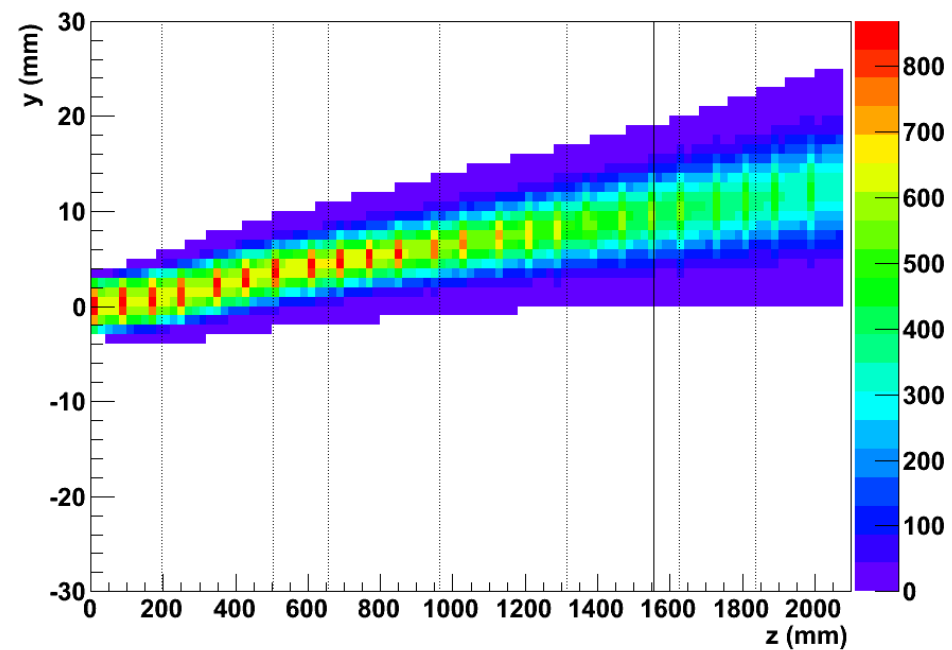
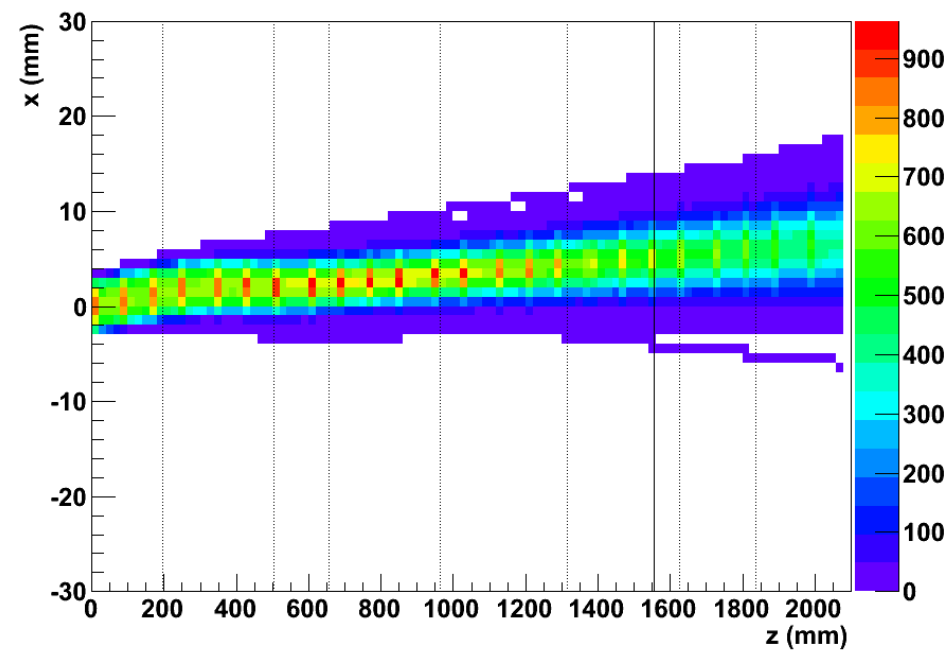
Beam envelope: $I_c = 40$ A



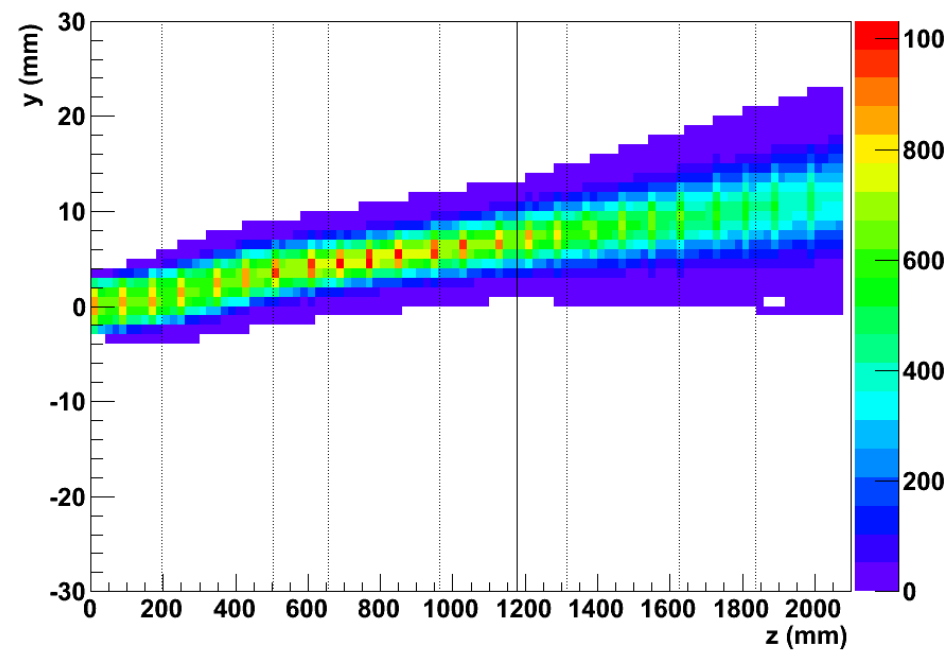
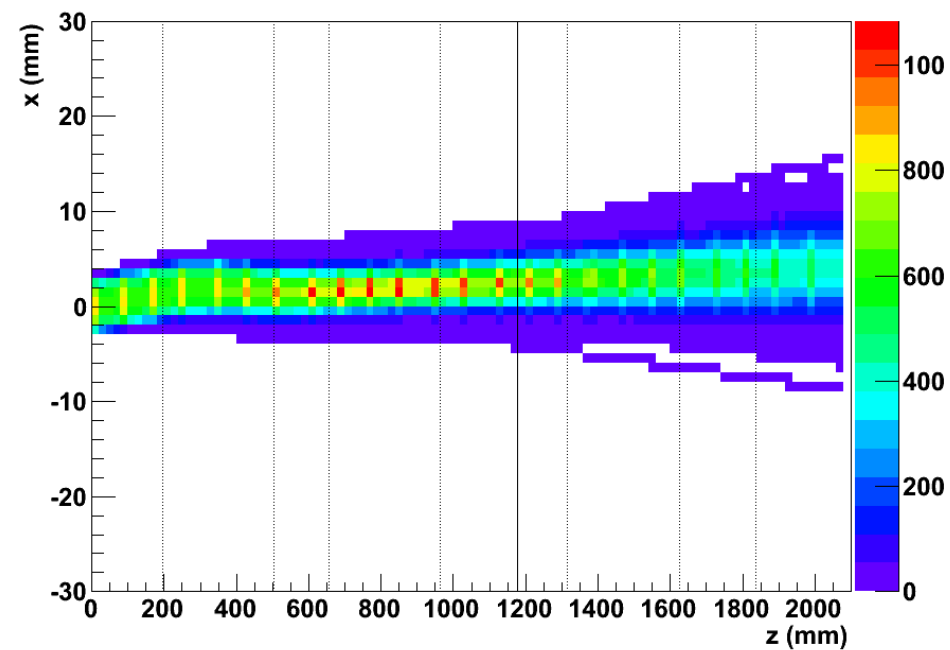
Beam envelope: $I_c = 60$ A



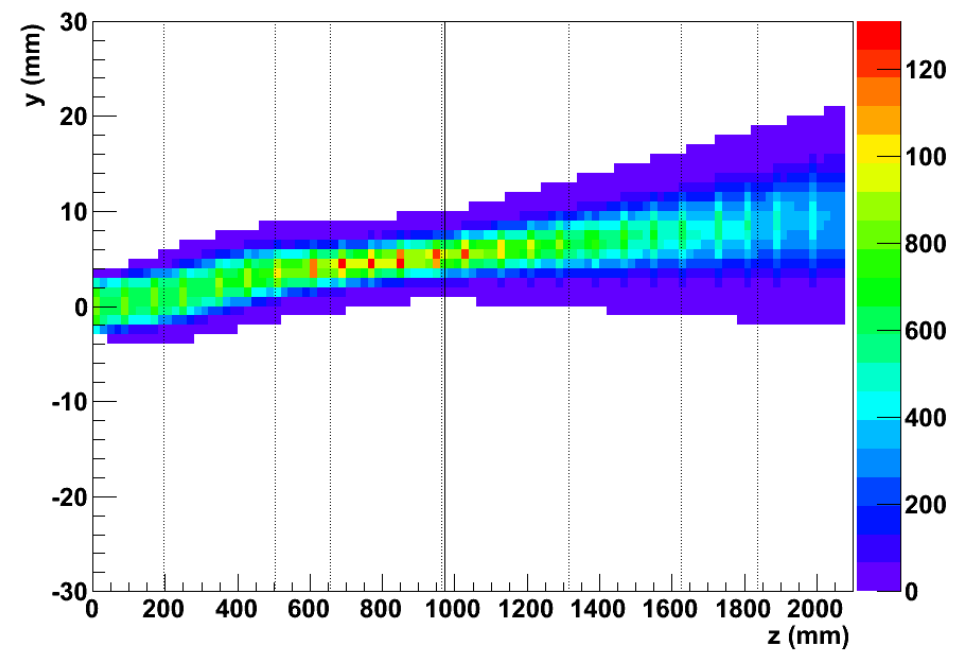
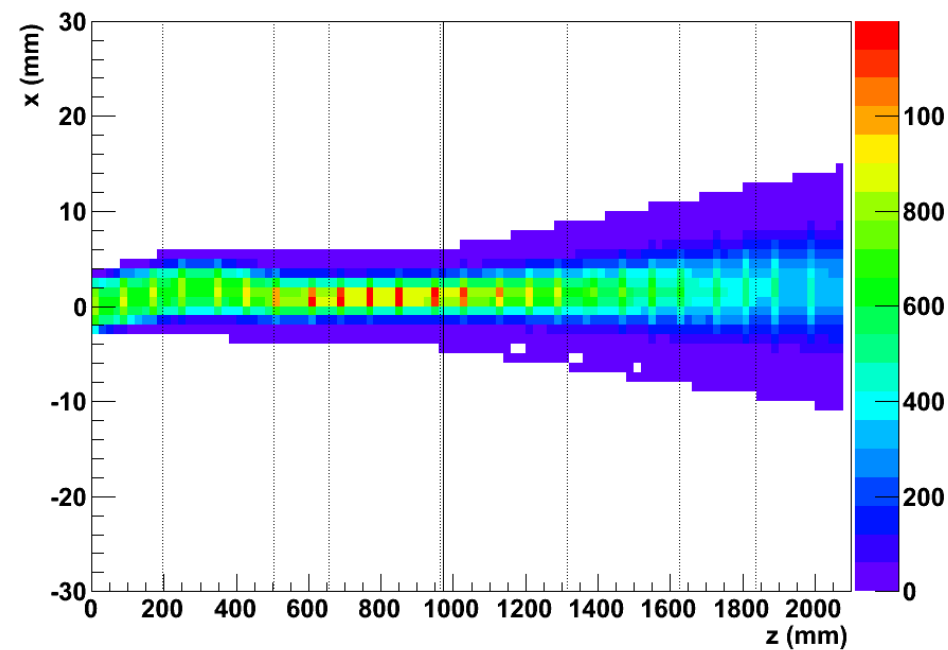
Beam envelope: $I_c = 80$ A



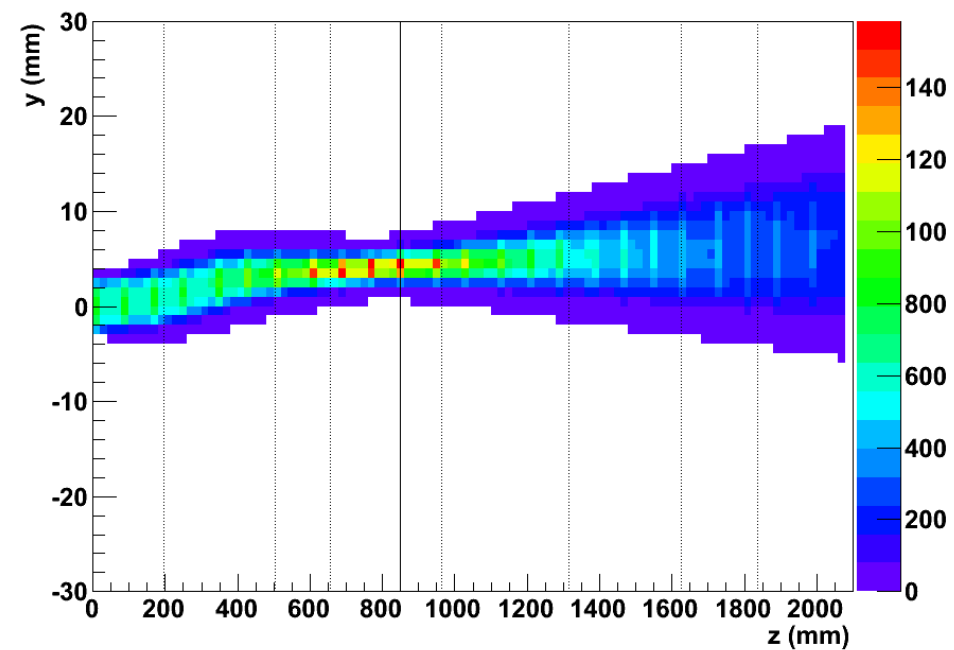
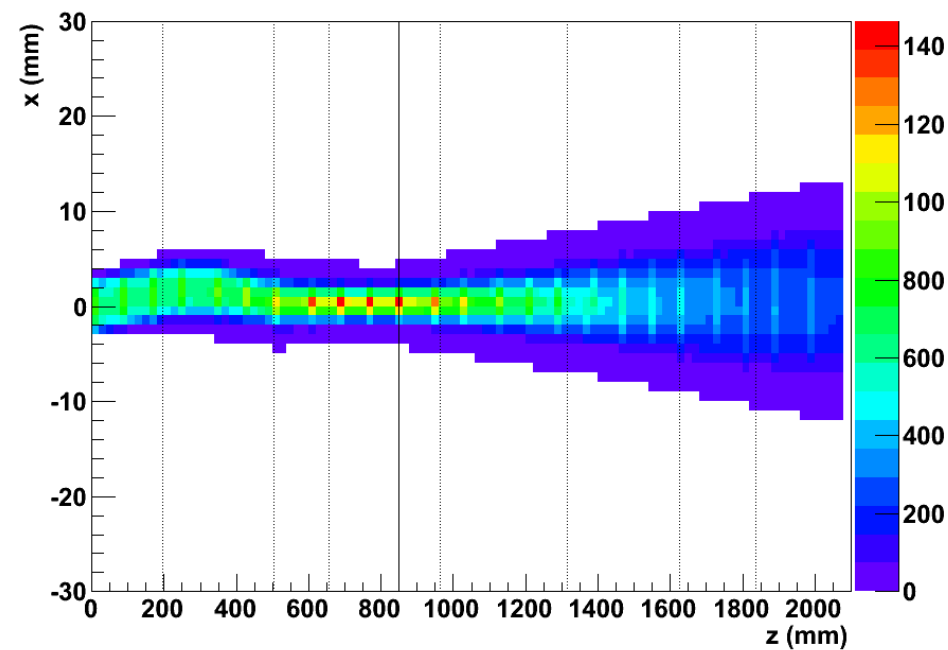
Beam envelope: $I_c = 100$ A



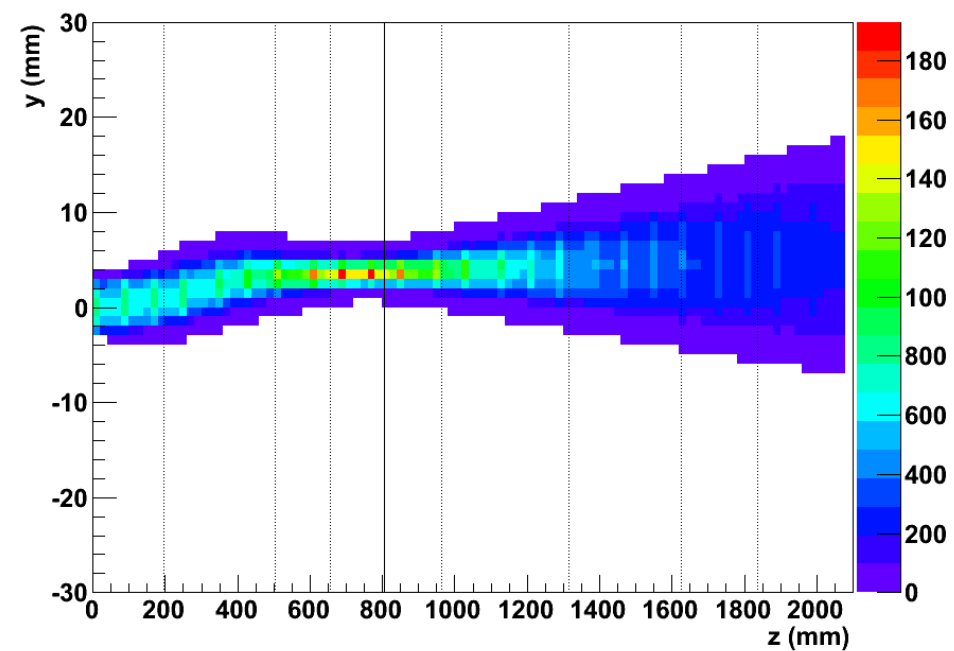
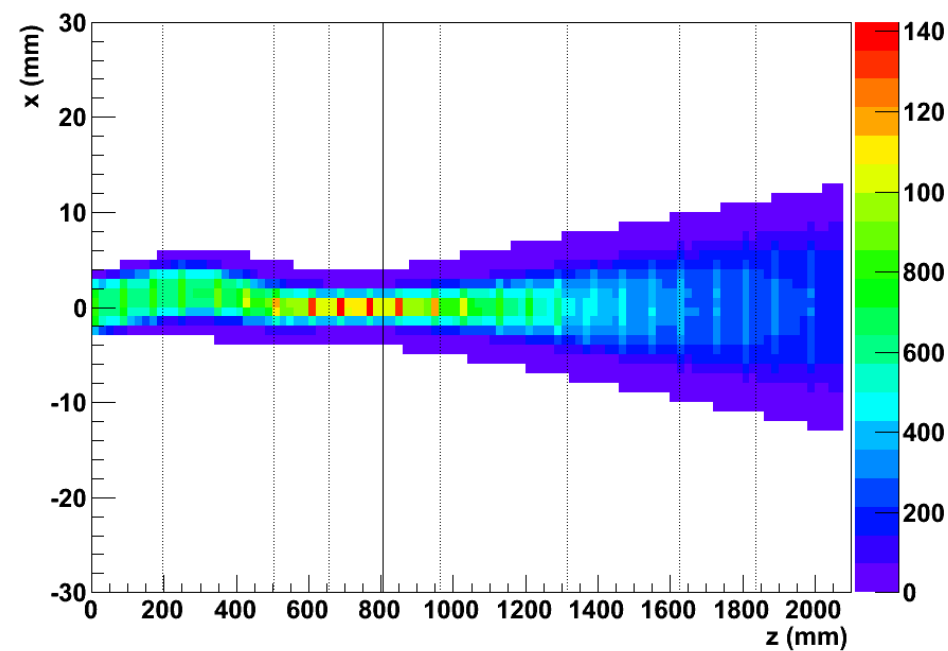
Beam envelope: $I_c = 120$ A



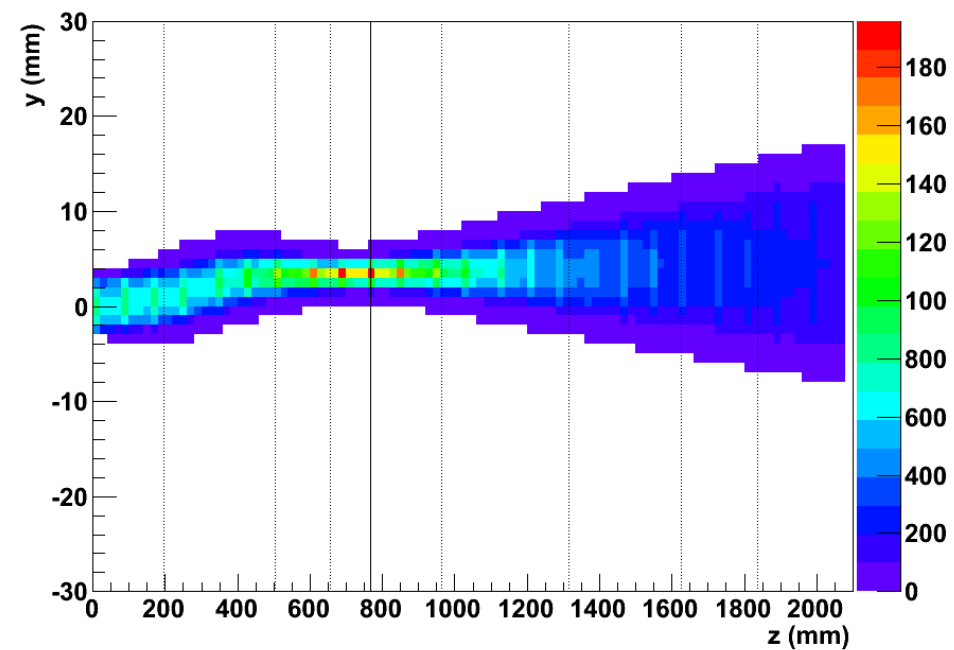
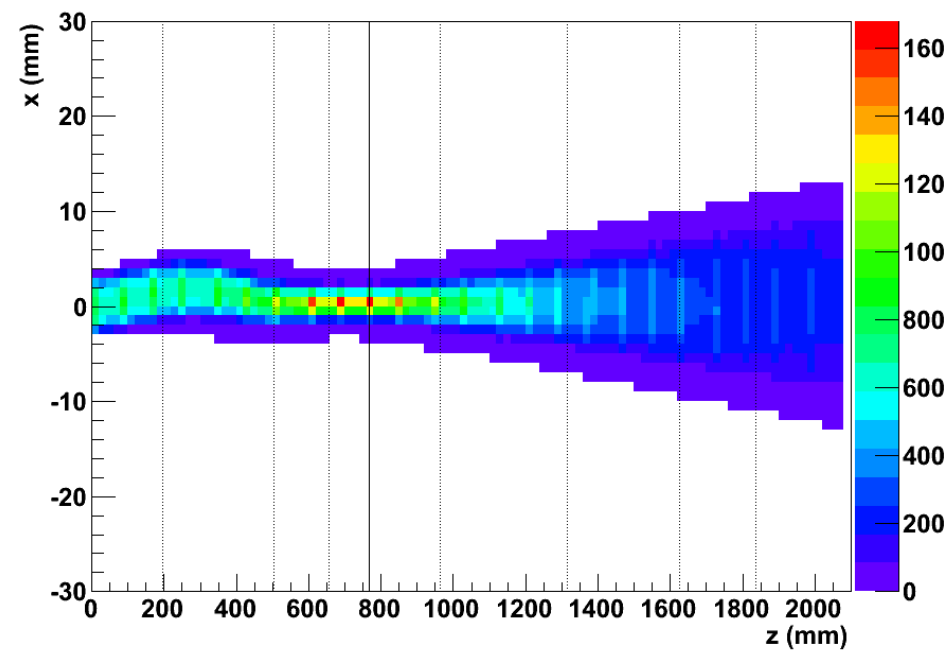
Beam envelope: $I_c = 140$ A



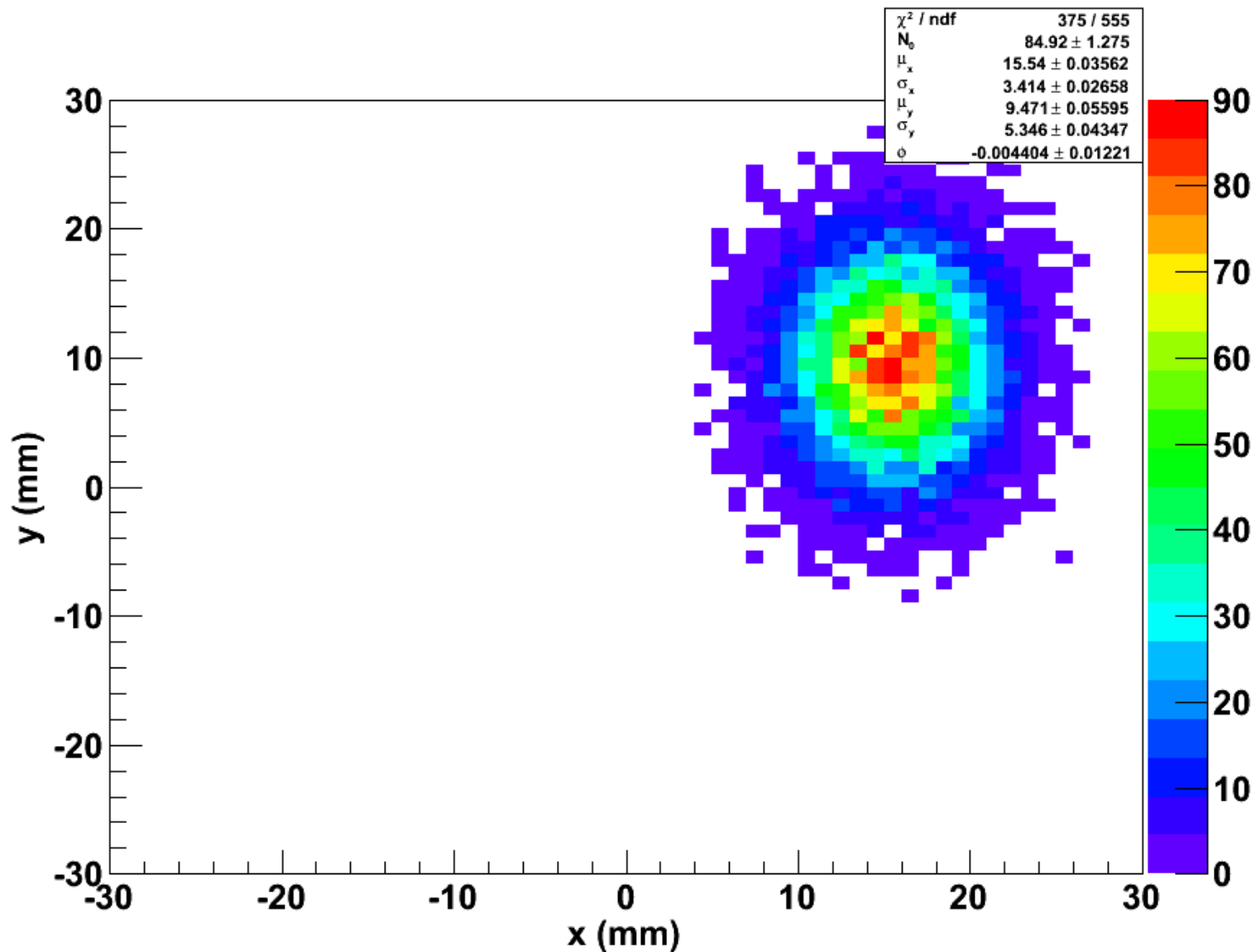
Beam envelope: $I_c = 150$ A



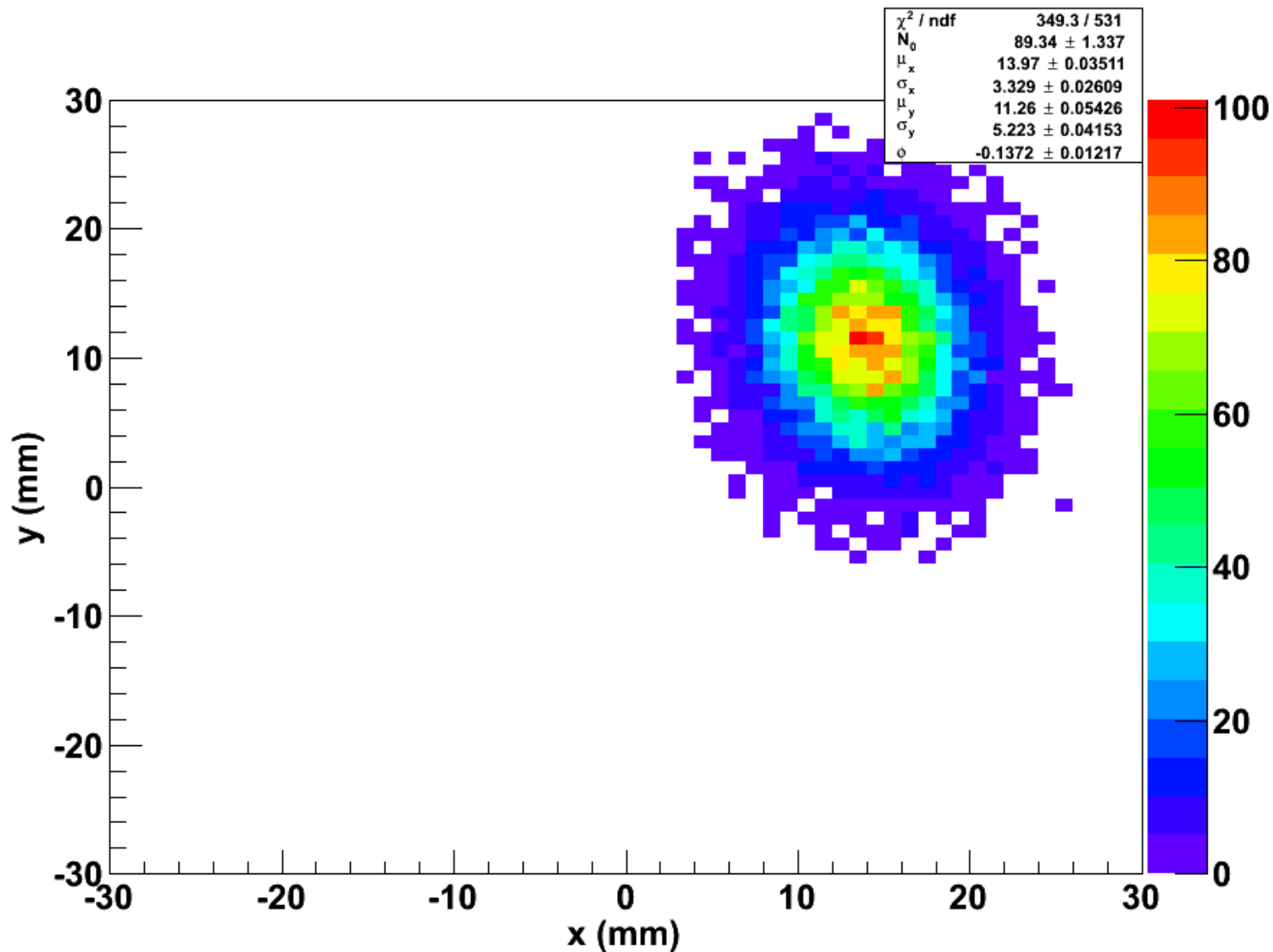
Beam envelope: $I_c = 160$ A



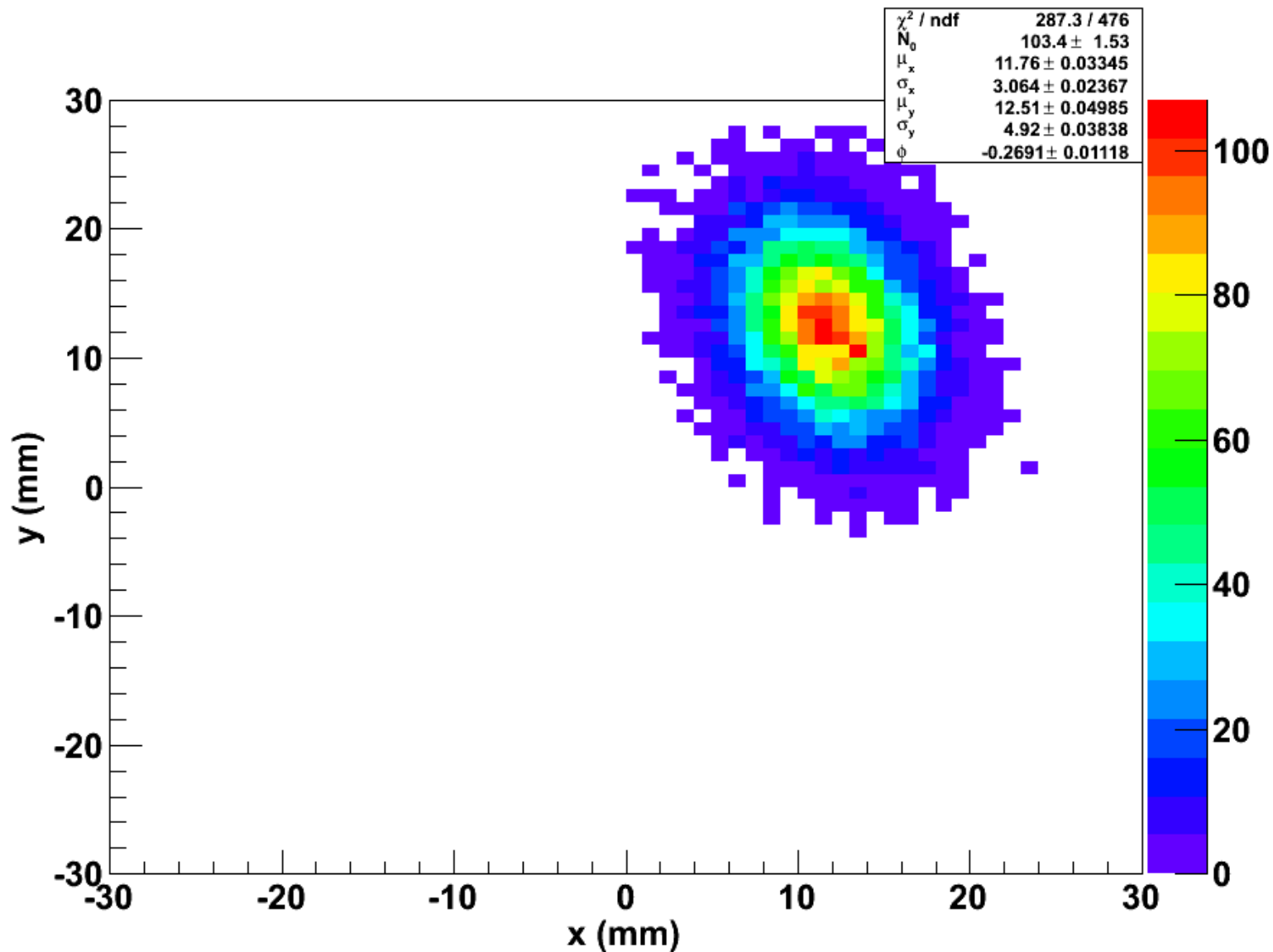
x-y profile: $I_c = 1A$



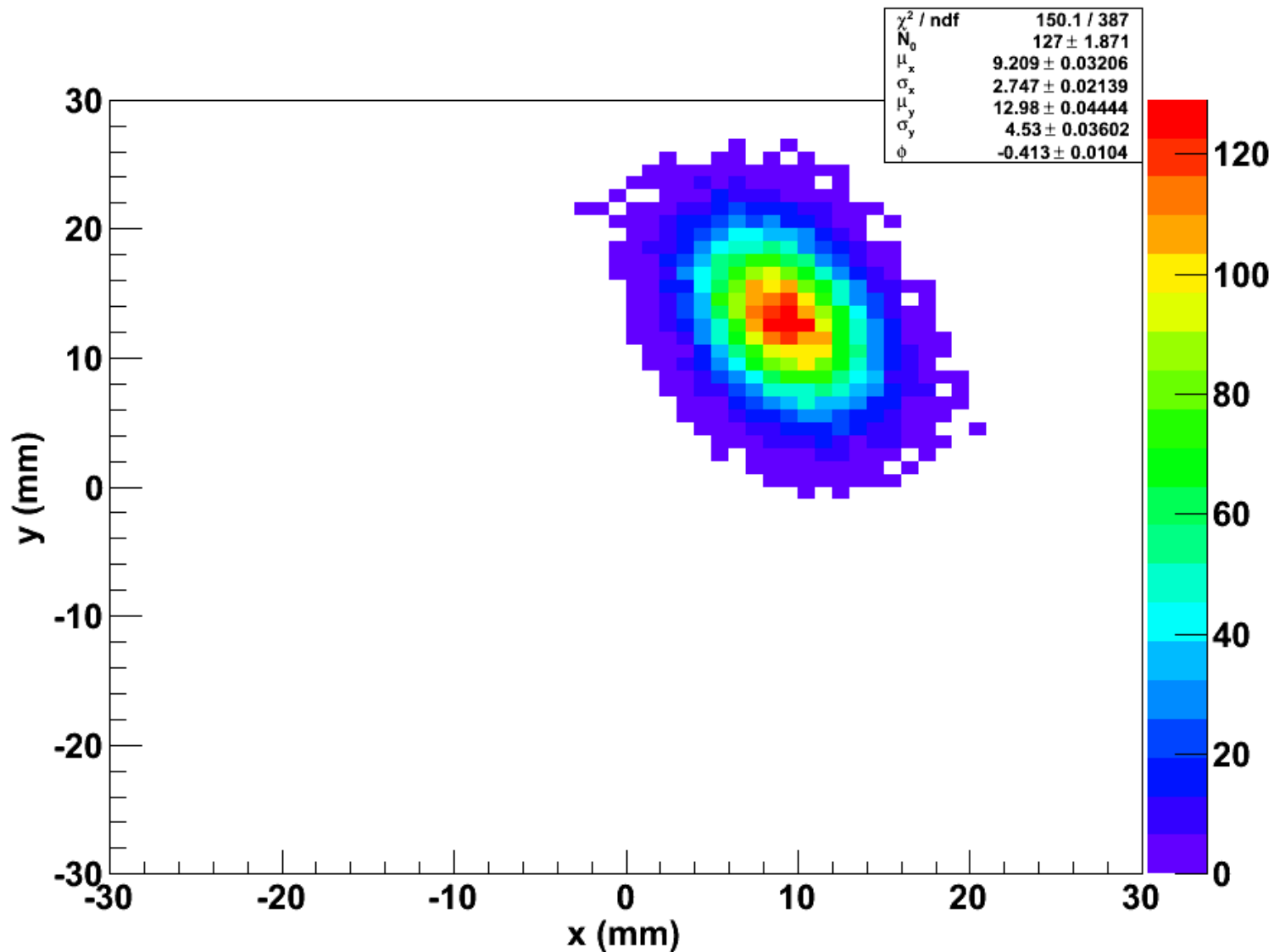
x-y profile: $I_c = 20A$



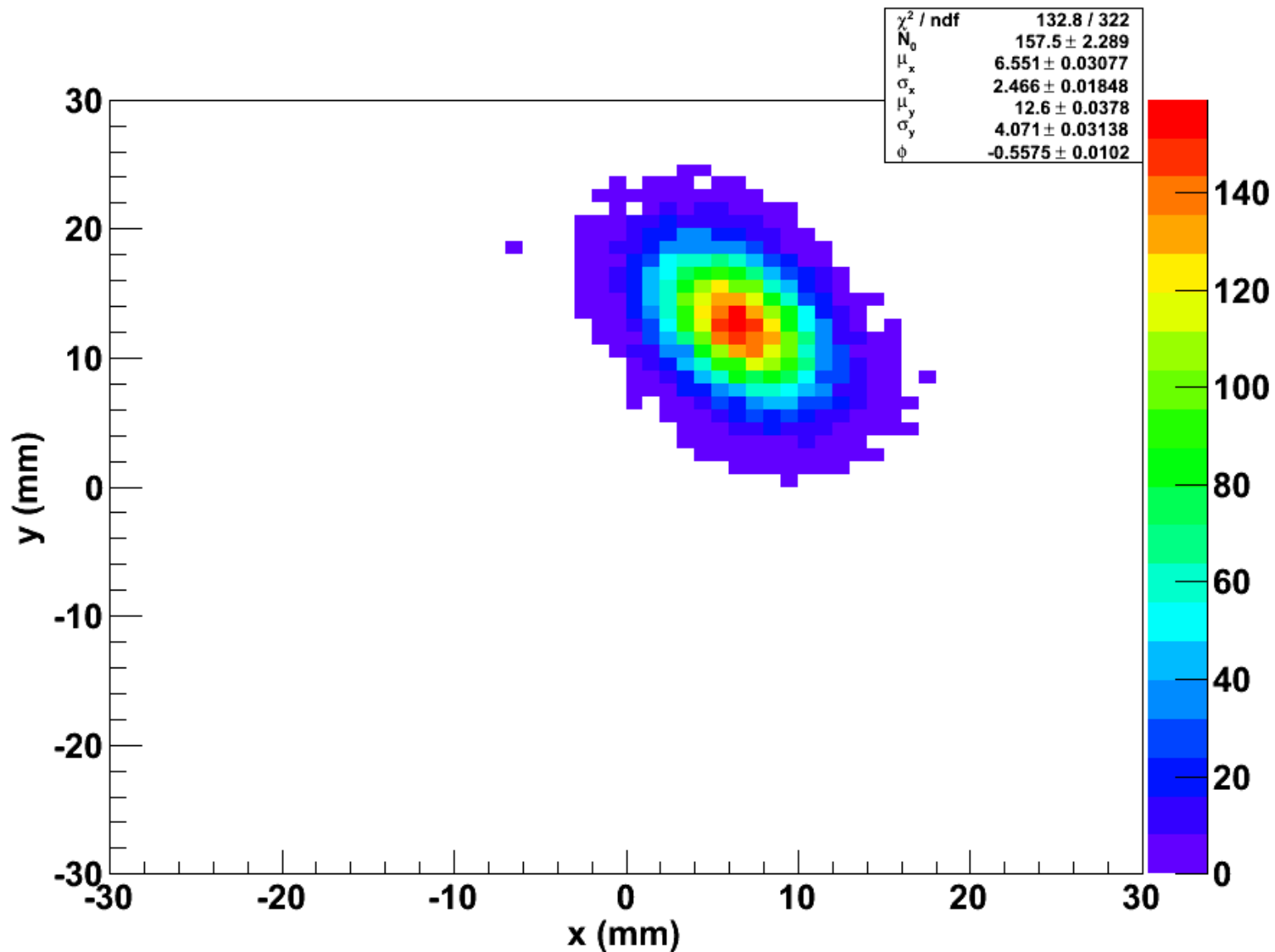
x-y profile: $I_c = 40A$



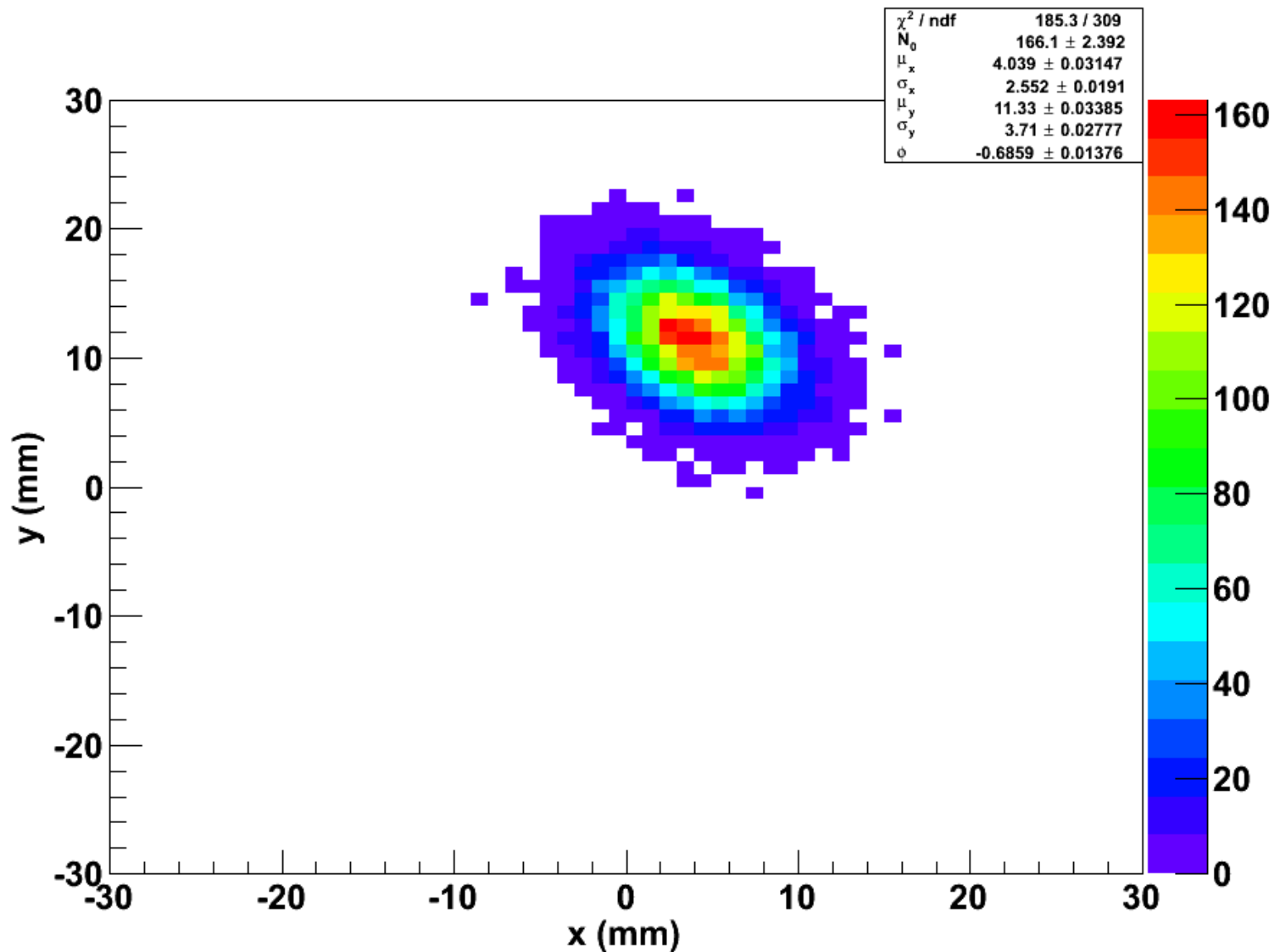
x-y profile: $I_c = 60A$



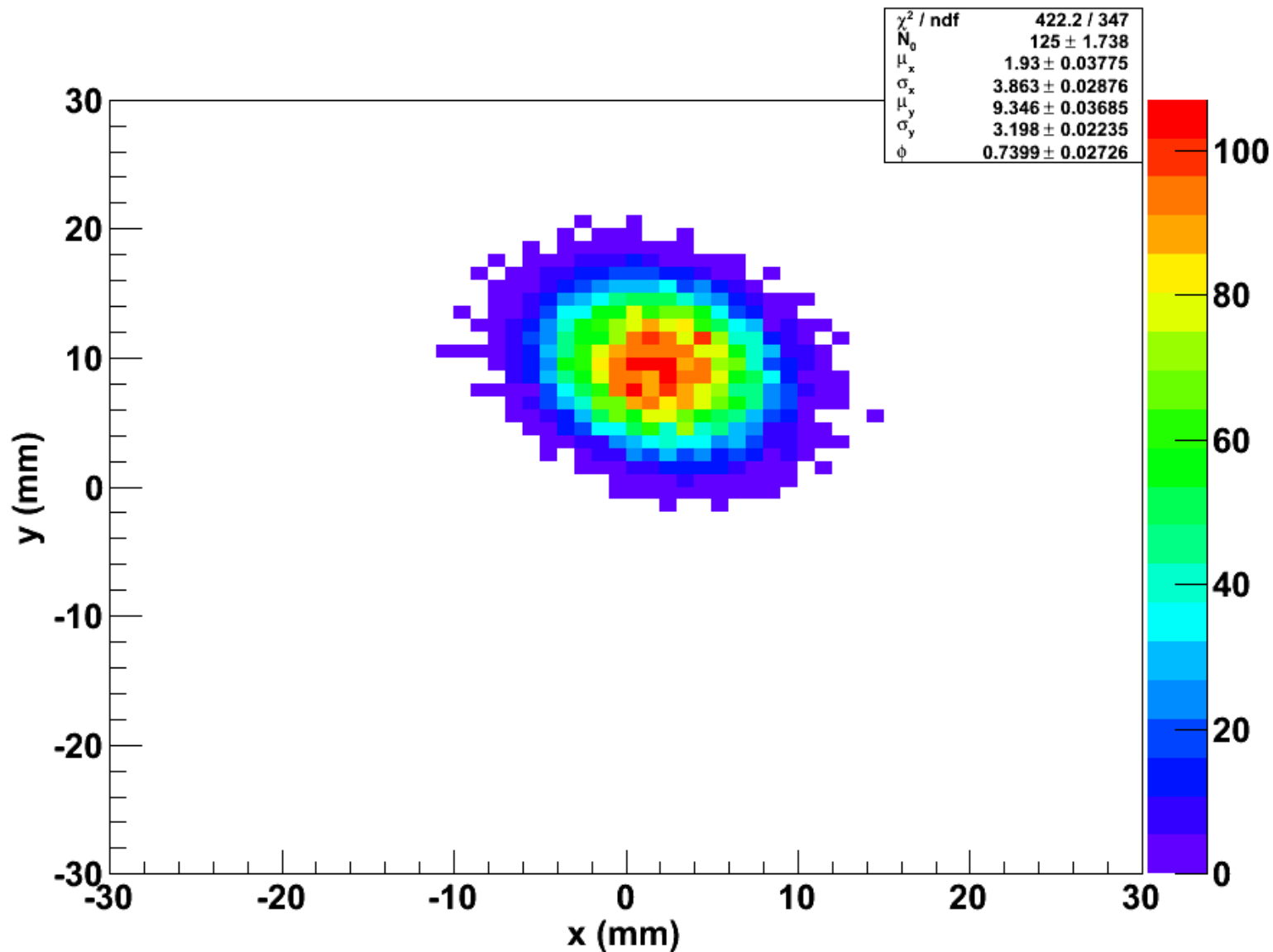
x-y profile: $I_c = 80A$



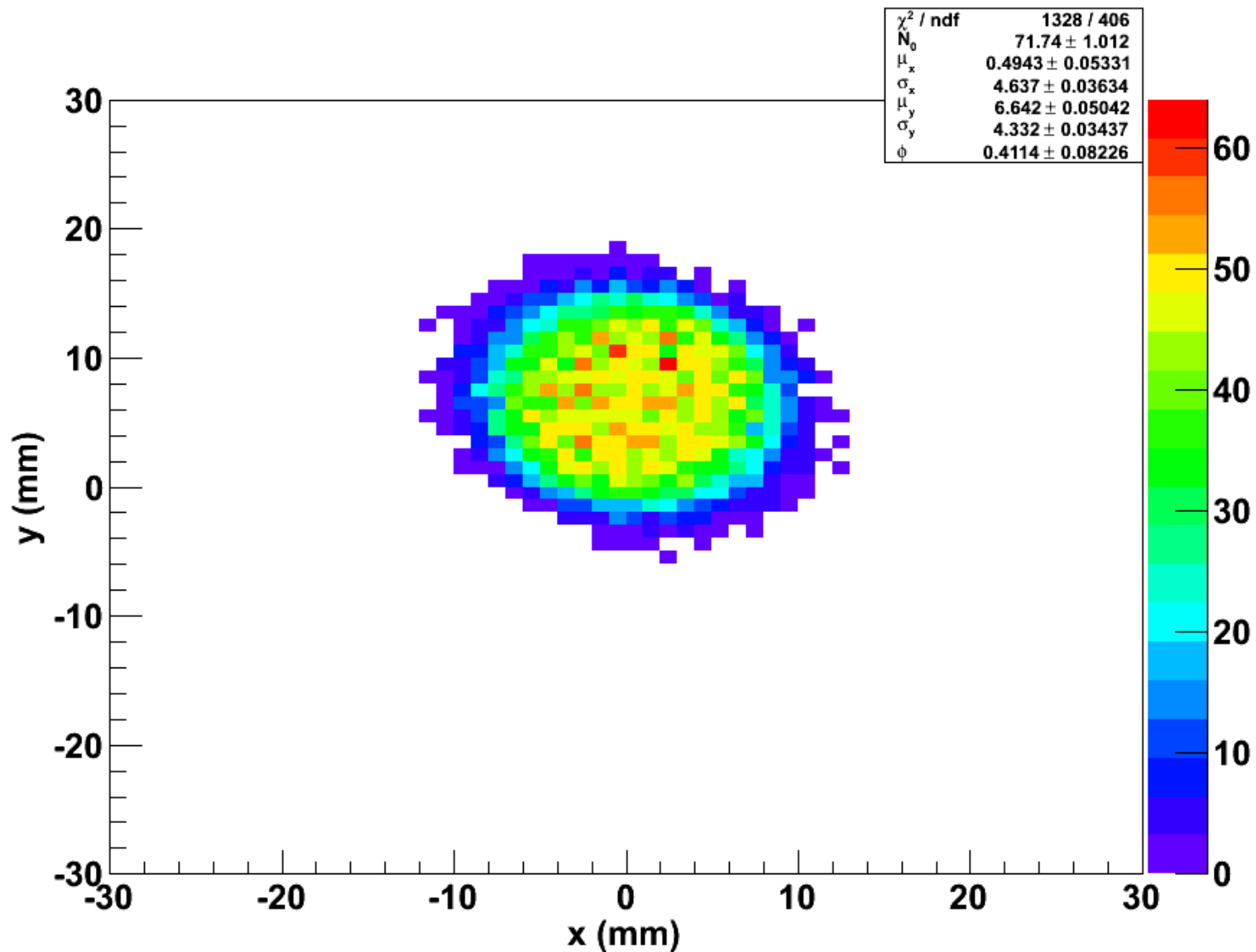
x-y profile: $I_c = 100\text{A}$



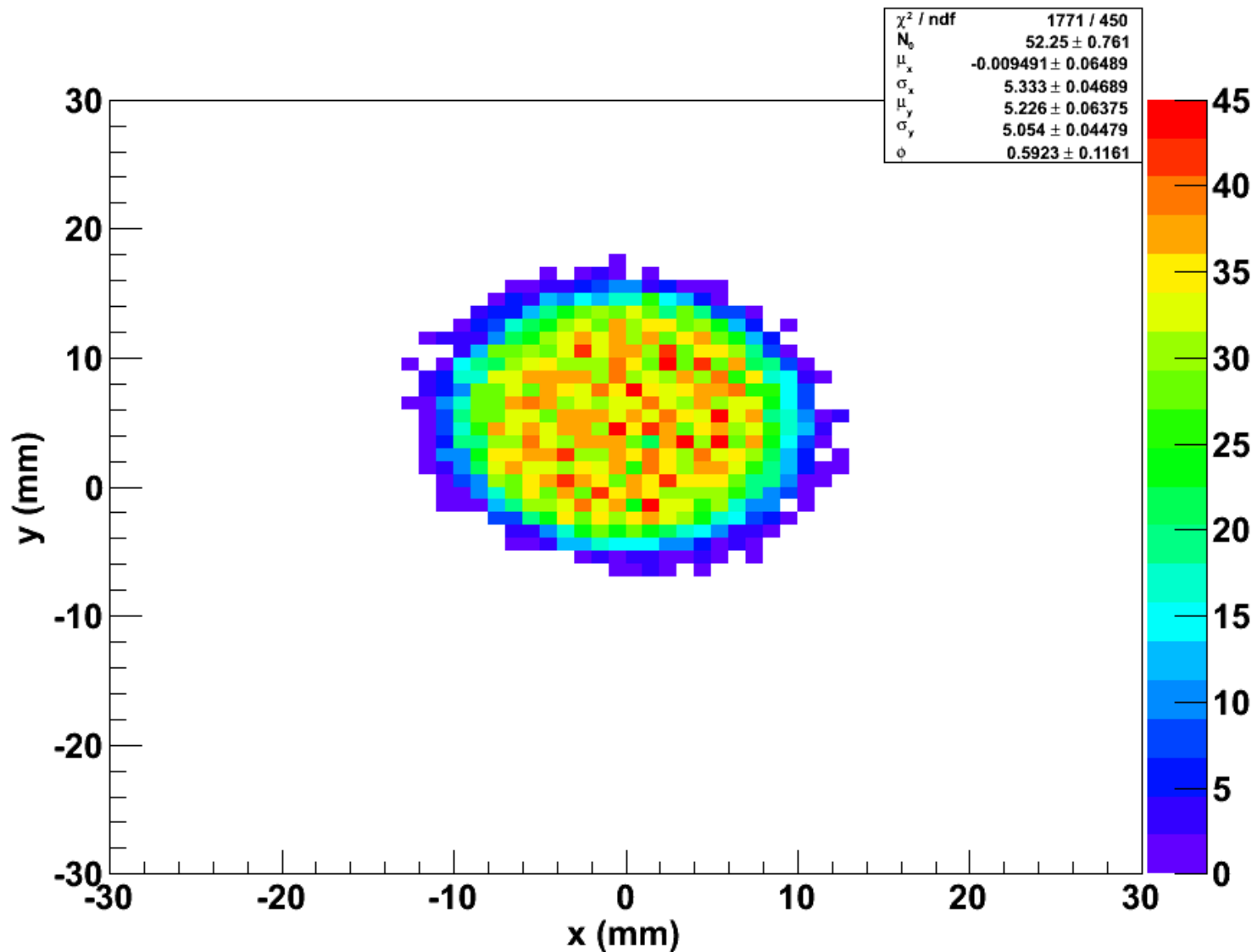
x-y profile: $I_c = 120\text{A}$



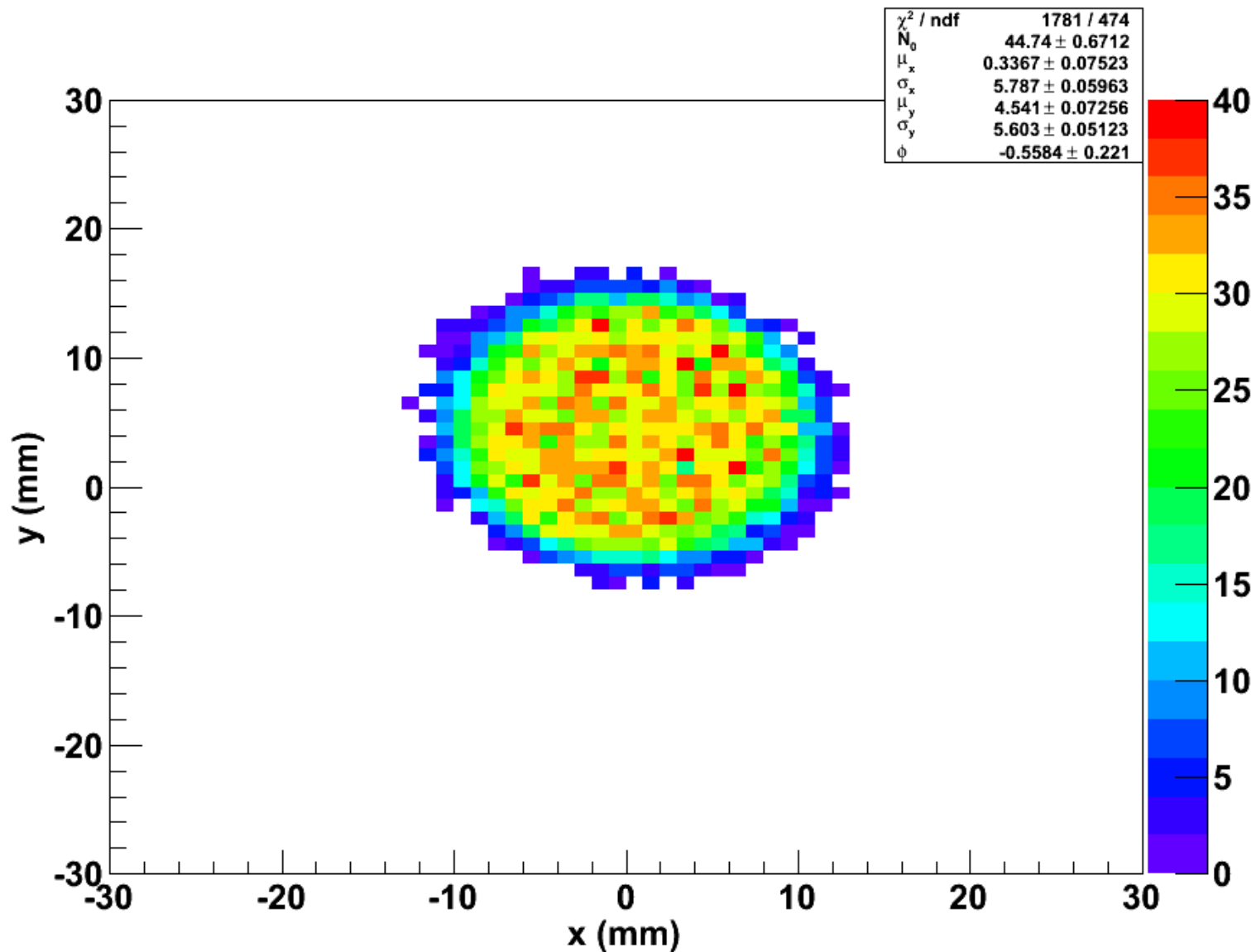
x-y profile: $I_c = 140\text{A}$



x-y profile: $I_c = 150\text{A}$



x-y profile: $I_c = 160\text{A}$



Comparison of mean x,y profile values

