Recycler flying wire profile analysis

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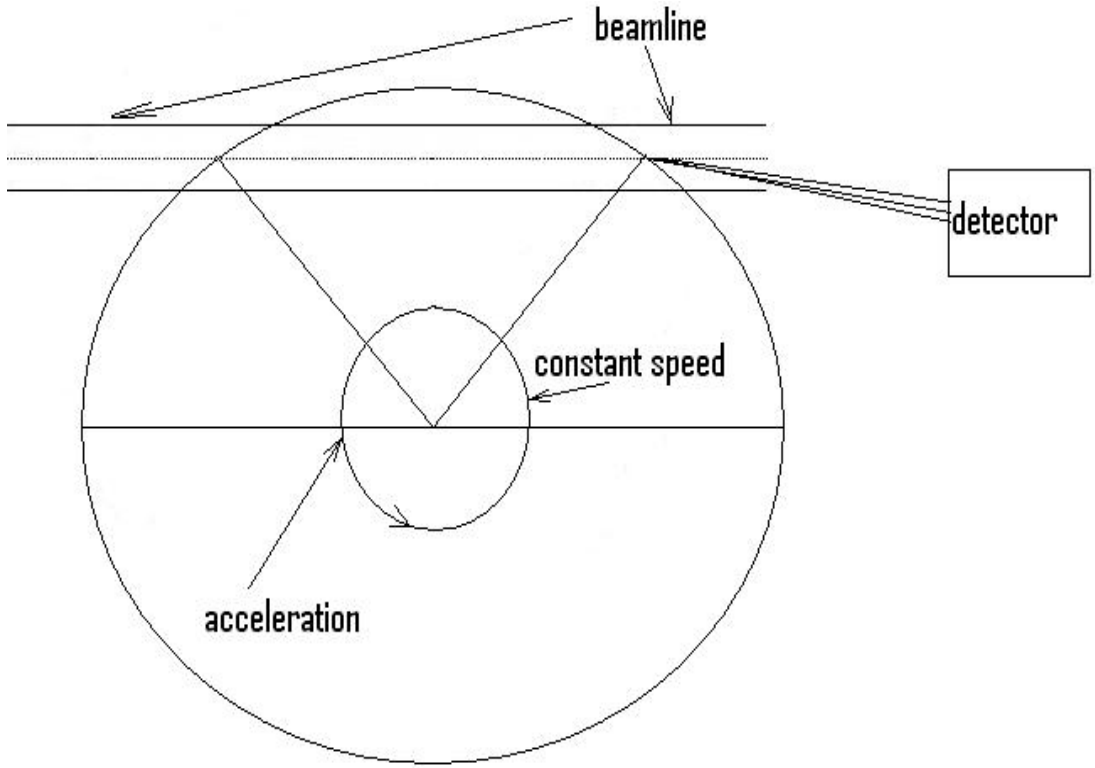
Purpose of work

- To develop a new method of beam profile measurement, based on flying wire data
- To apply this method for beam profile measurement, during electron cooling

Flying wire profile measurement

- Fork length 133 mm
- 5 μm carbon wire
- Nominal speed 6 m/s
- 16384 steps per 360 degrees, 50 μm per step
- Goes 3/2 turn:
  - ½ acceleration
  - ½ constant speed (goes 2 times through the beam)
  - ½ deceleration



Formulas, used in analysis

Initial fitting formula

$$f_1(x) = a \cdot \exp(-{(x-b)^2}/{2 \cdot \sigma^2})$$

Formula, used for fitting in my work

$$f_2(x) = a_1 \cdot \exp(-{(x-b)^2}/{2 \cdot (\sigma_1)^2}) + a_2 \cdot \exp(-{(x-b)^2}/{2 \cdot (\sigma_2)^2})$$

Criterion of fitting

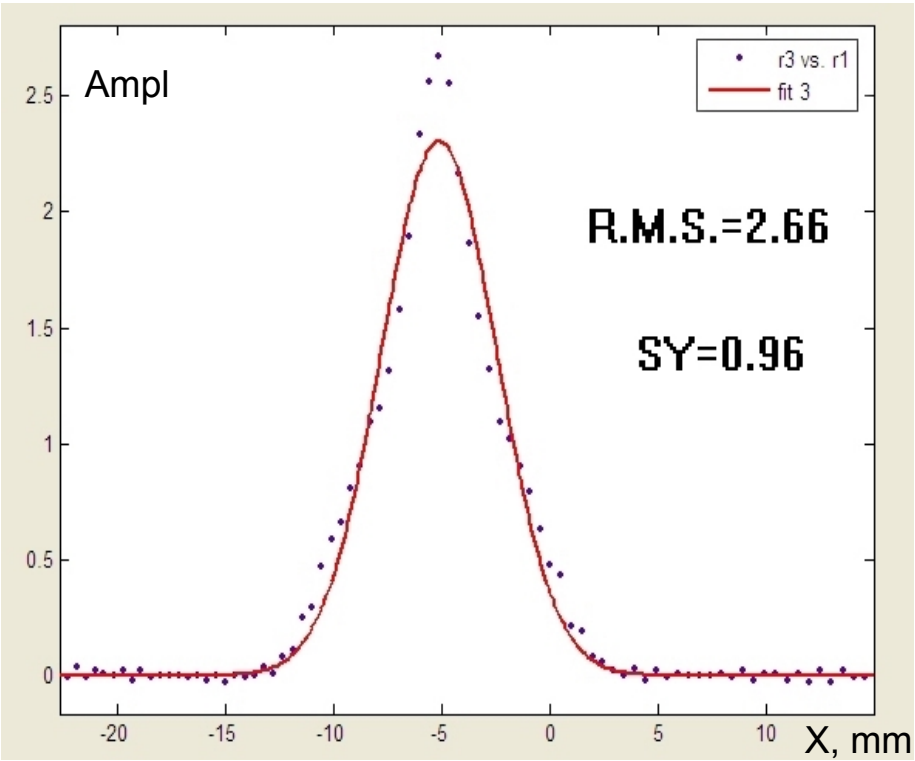
$SY = \sum_i (f(x_i) - y_i)^2$, we need to minimize SY for best fit

Useful coefficients

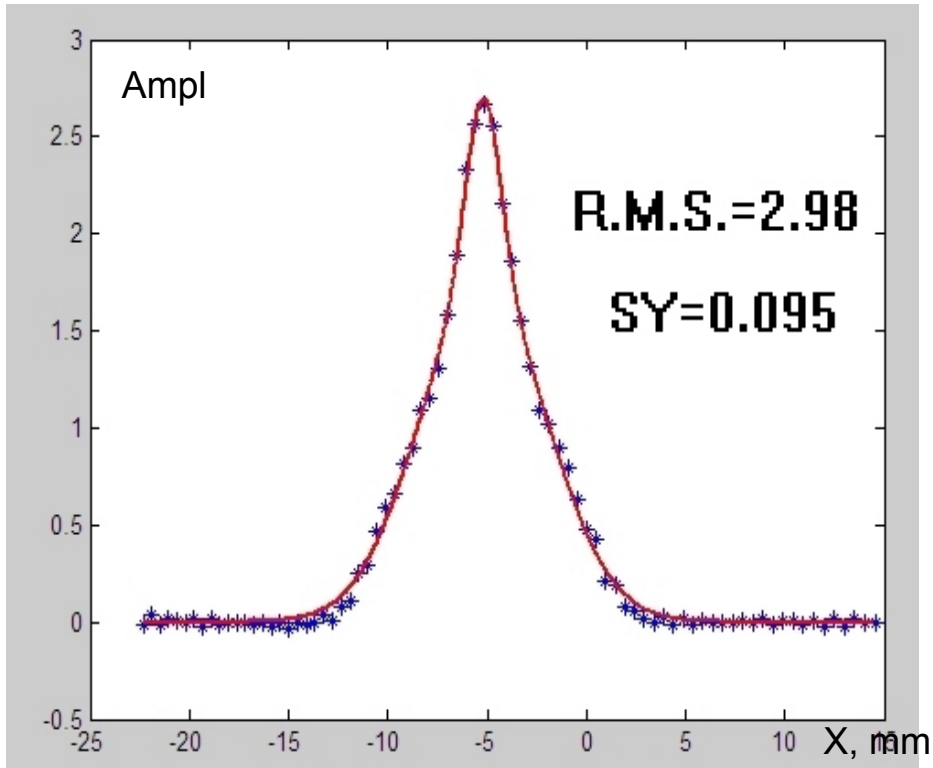
$$k = a_1 / a_2 \qquad k_1 = \sigma_1 / \sigma_2$$

Fitting of profile by one and two Gaussians

Fitting of profile by one Gaussian



Fitting of profile by two Gaussians

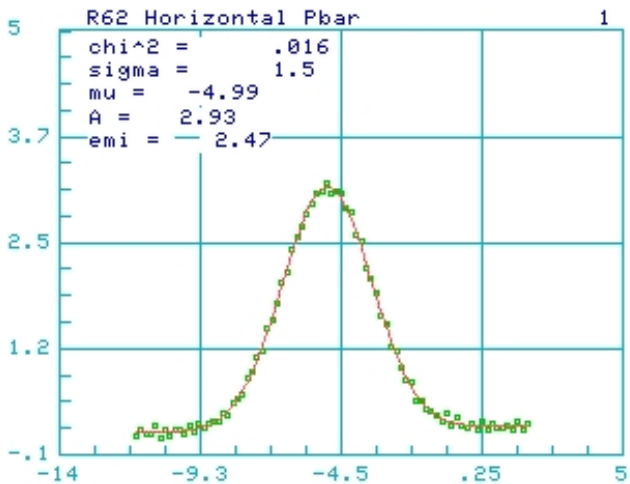


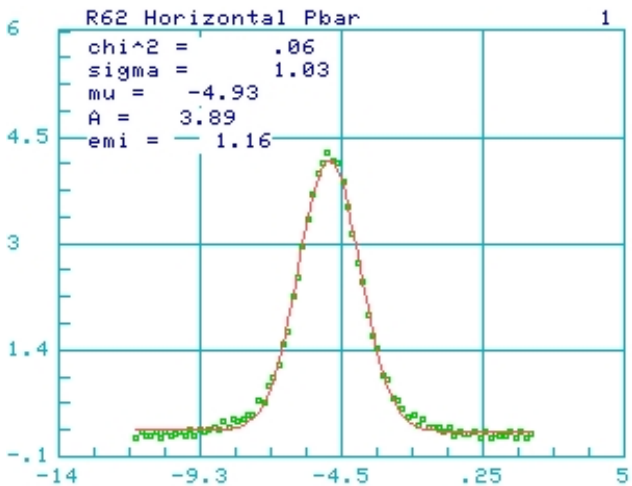
Stochastic and electron cooling was on for this measurement

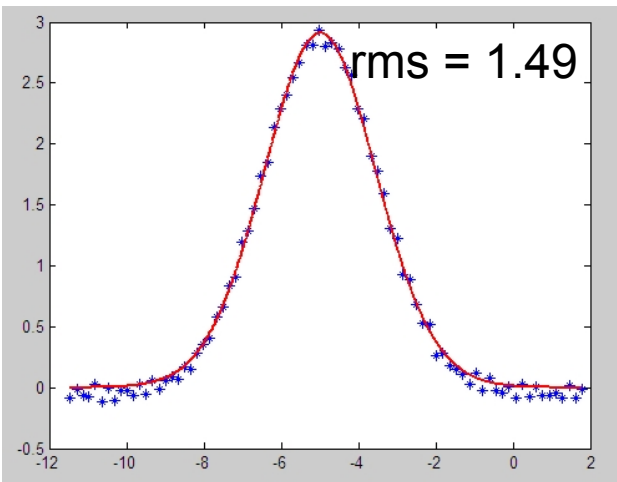
Conditions of study

- 134 E10 pbars, 6.5 μsec bunch
- Electron beam 100 mA
- Electron beam on-axis with pbars
- Good pbars lifetime
- Stochastic cooling is off

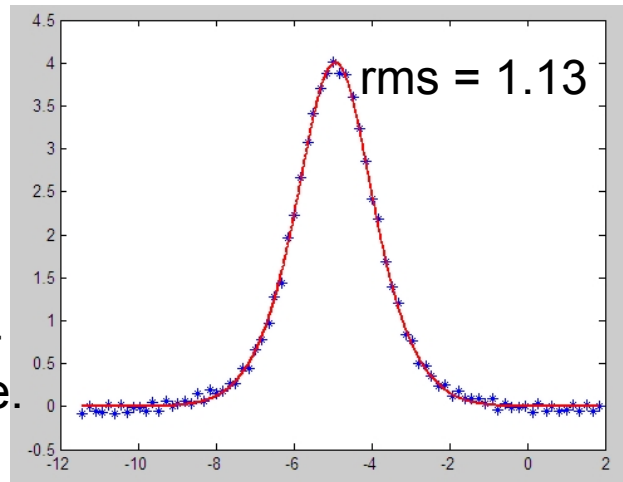
First and last profiles of the study



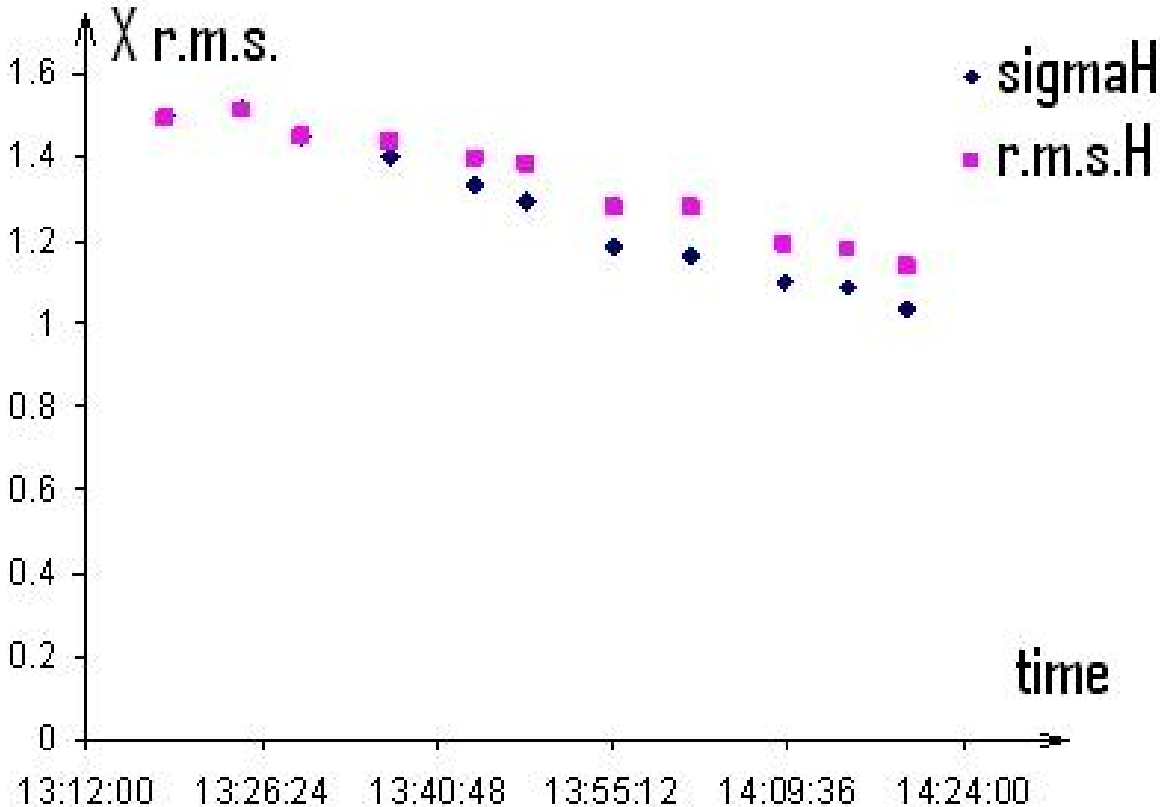




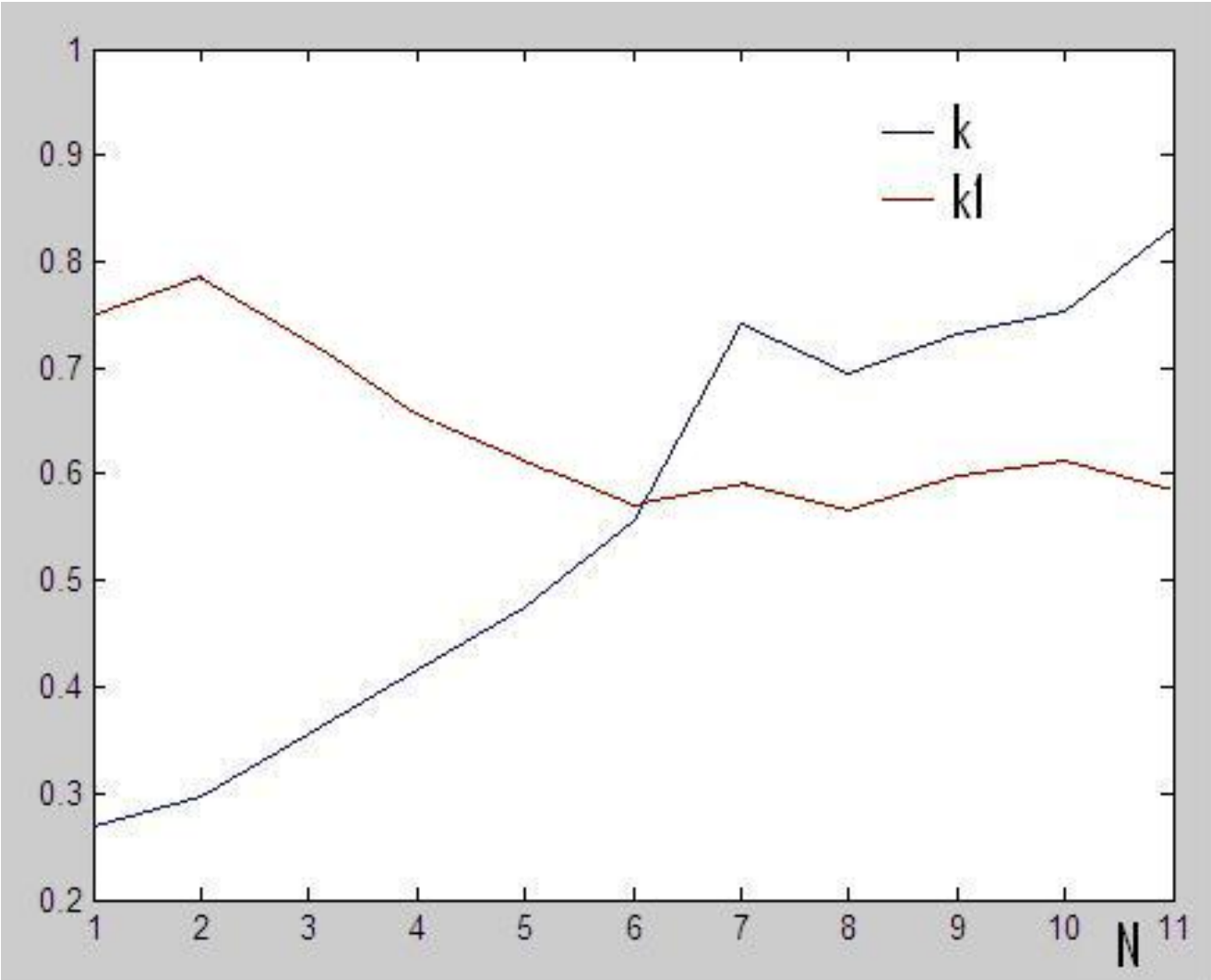
Fitting curve is the sum of two gaussians; the r.m.s. is calculated from the background-subtracted curve.



Reduction in transverse beam size, σ vs. r.m.s. based on two-Gaussian fit



Ratio between amplitudes and r.m.s. of first and second Gaussians, during electron cooling



$$k = a_1 / a_2$$

$$k_1 = \sigma_1 / \sigma_2$$

Conclusion

- The new method of beam profile measurement was developed. As a result of using this method, fitting errors decreased. This allows to calculate beam profile more precisely.
- New method was applied during electron cooling measurements