

Summary of hollow beam simulations in Lifetrac

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Simulation parameters

Parameters used in simulations:

- 10000 particles (weighted Gaussian)
- 600 steps with 10^5 in each (about 21 mins)
- $\sigma_y = 0.06$ [cm]
- electron beam radius $r_b = 3.5, 3.75, 4.0, 4.5\sigma_y$
- $L = 200$ [cm], $I = 0.4$ [A], $\beta = 0.13$, skip=1/1

and several new simulations:

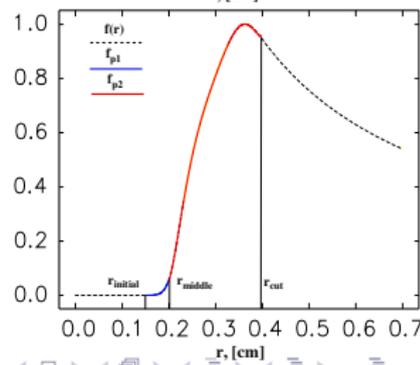
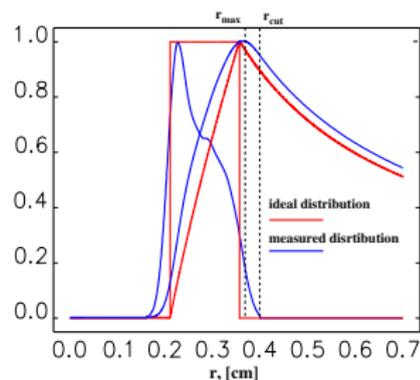
- 10000 particles (hollow weighted Gaussian)
- different electron beam profile ($I_e = 330$ [mA])
- error 5% in σ for ideal lens model ($\sigma_y = 0.057$ [cm])

More accurate radial model

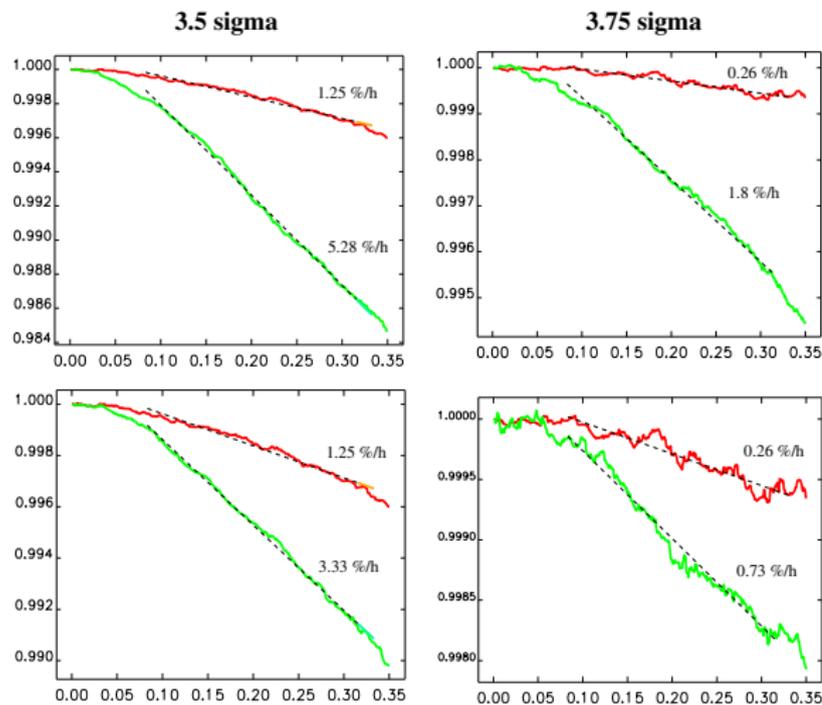
$$\Delta p_r = \frac{2\Omega_e \Delta s}{r_{max}} \frac{\kappa}{\eta} \begin{cases} 0 & 0 < r < r_{initial} \\ f_{p1} & r_{initial} < r < r_{middle} \\ f_{p2} & r_{middle} < r < r_{cut} \\ \frac{1}{r} & r > r_{cut} \end{cases}$$

- $\Omega_e = 0.3 \times 10^{-7} \frac{I_e(A)}{p_b(GeV/c)} \gamma_e \frac{1+\beta_e\beta_b}{\beta_e\beta_b}$
- f_{p1}, f_{p2} – polynomials in r
- r_{max} radius value where $f(r) = 1$
- $\kappa = \int_0^{r_{max}} g(r) r dr$
- $\eta = \int_0^{r_{cut}} g(r) r dr$, r_{cut} is the edge of distribution
- $g(r)$ – normalized radial density

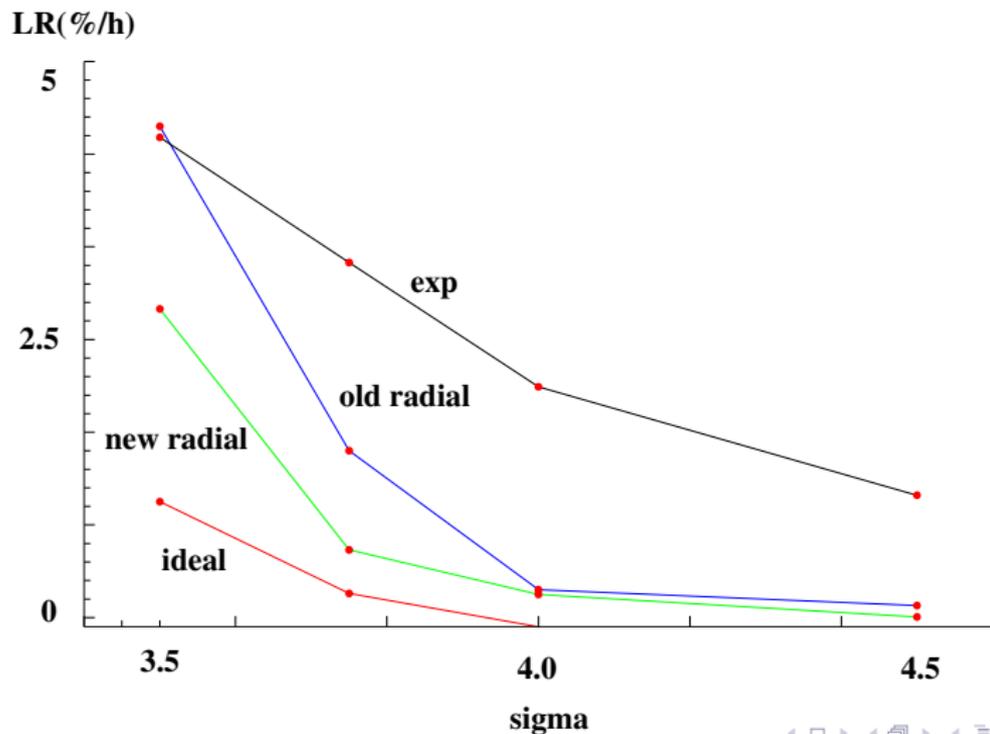
Typically $\frac{\kappa}{\eta} = 0.95 \dots 0.97$ and $\frac{r_{cut} - r_{max}}{r_{max}}$ strongly depend on the electron beam current



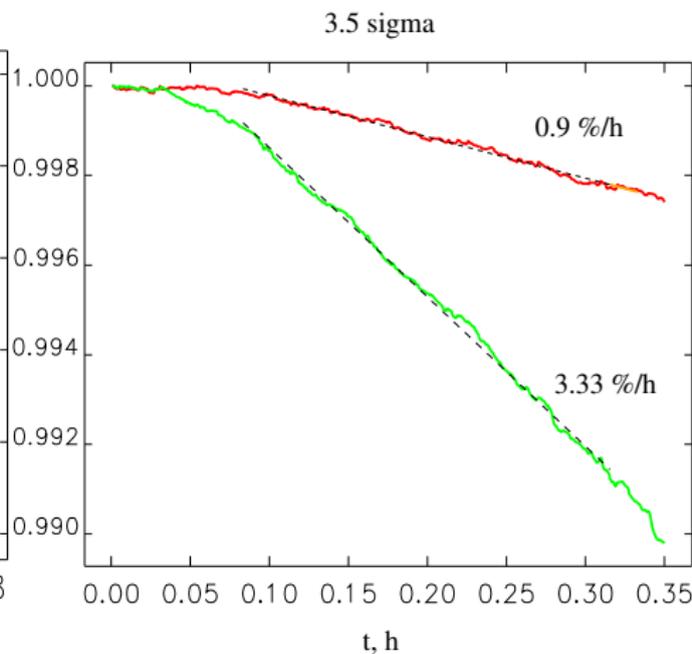
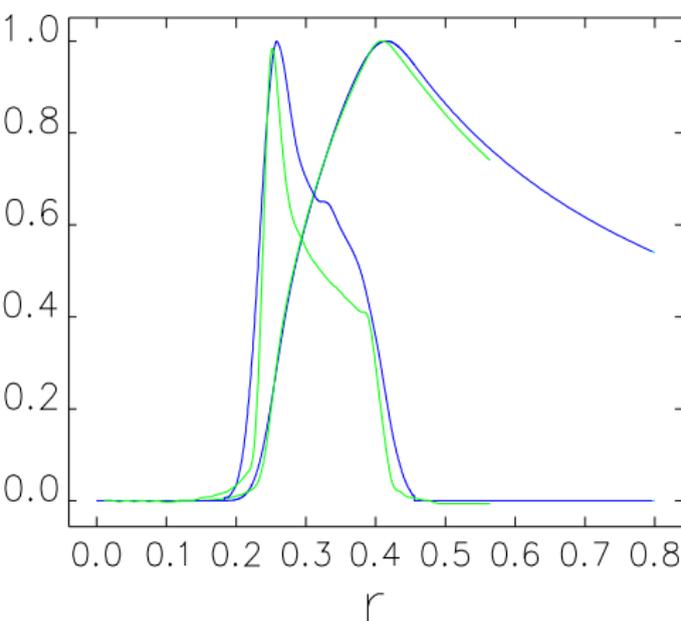
New radial model results(1)



New radial model results(2)



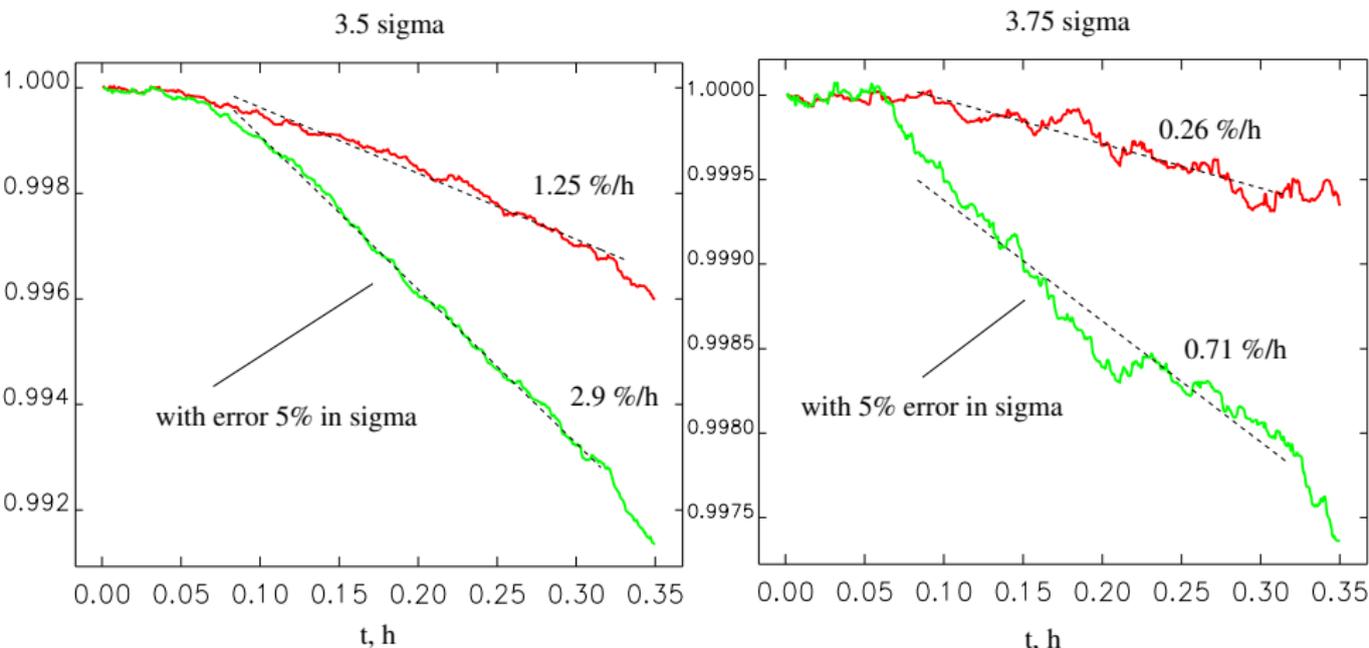
Different profile shape



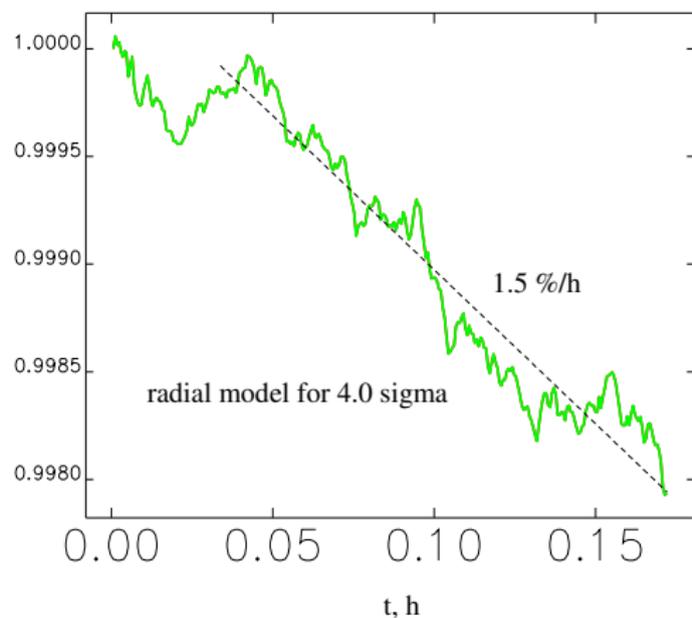
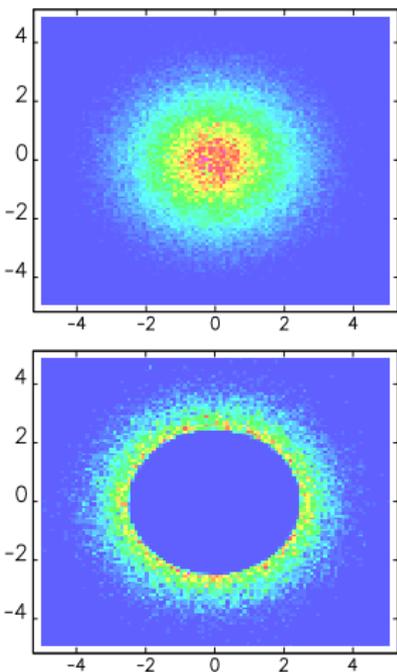
$$(r_{max} \frac{\eta}{\kappa})_1 = 0.3682 \text{ vs. } (r_{max} \frac{\eta}{\kappa})_2 = 0.3777$$



Error 5% in sigma for ideal case



Hollow Gaussian distribution



Summary

- simulations are very sensitive to input parameters
- the effect of profile shape depends mainly on it's maximum position
- errors in size and current are significant
- statistics is better with hollow initial beam

and more,

- documentation is almost finished
- upload files and other