Summary of Lifetrac work

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HEBC meeting

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Overview (1)

What is done so far?

- Several transverse models are developed:
  - ideal HEBC
  - HEBC with angular harmonics
  - radial imperfections for HEBC
- Qualitive simulations:
  - good behaviour for ideal case
  - only quadrupole harmonic matters for pulse 1/5
  - removal rate is higher for radial case
- Aligment:
  - can handle thick element with exact translations and rotations
- Documentation:
  - documentation is available at the Wiki page
  - https:/cdcvs.fnal.gov/redmine/projects/elens/wiki/Modeling_and_simulations

Overview (2)

What is done so far? (cont.)

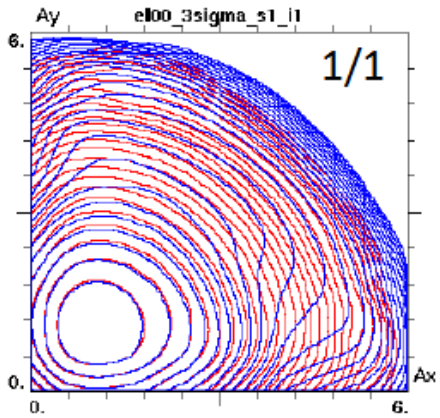
- Comparison with experiment
  - the order of loss rate is correct
  - simulations are very sensitive to parameters
  - optimal statistics/time

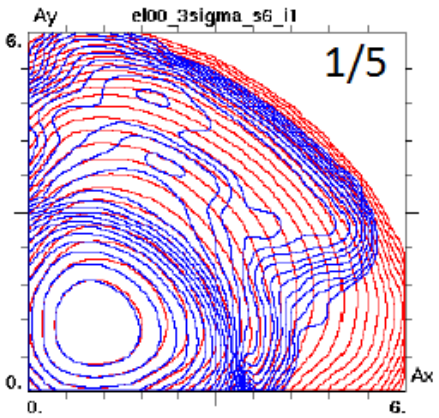
What else should be done?

- more simulations with errors in beam size
- comparison with shifted beam experiment
- alignment simulations
- complete documentation

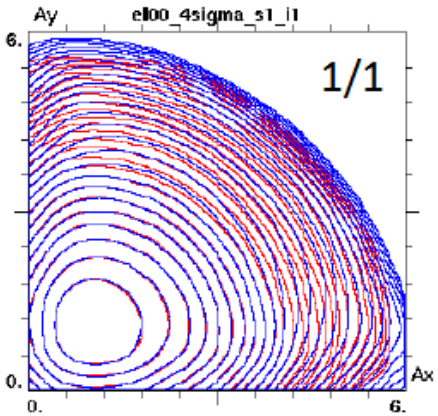
Ideal Model

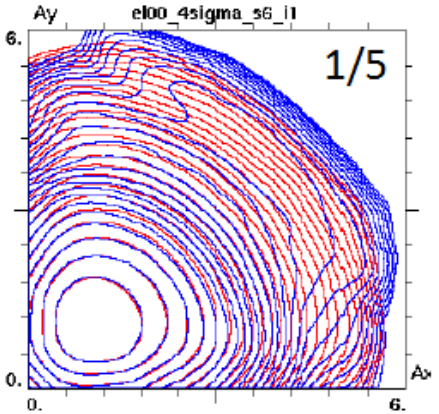
$r_1 = 3\sigma_y$



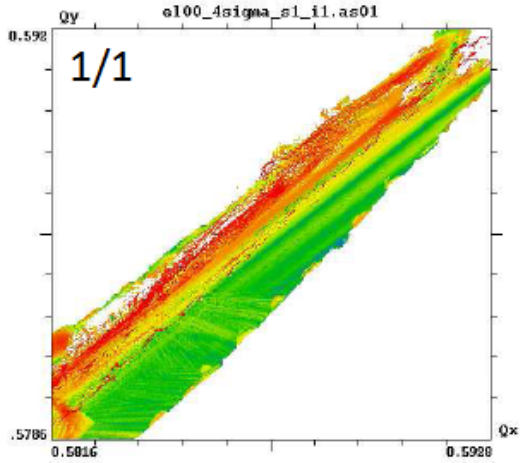


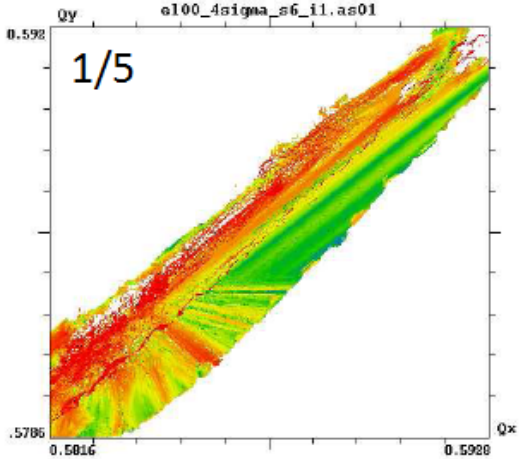
$r_1 = 4\sigma_y$





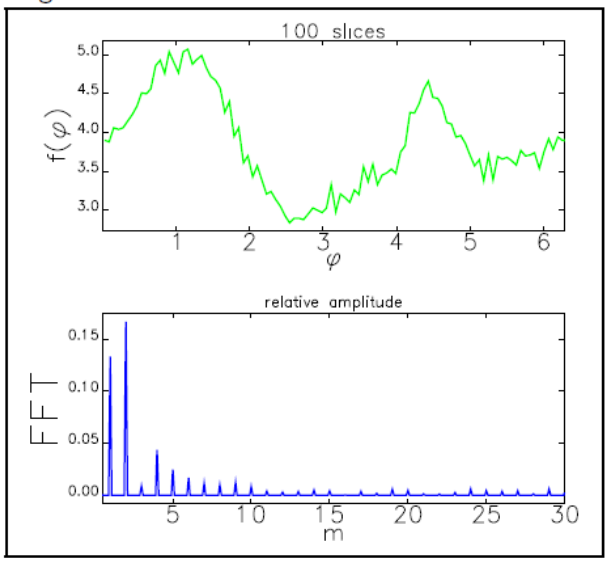
FMA: $r_1 = 4\sigma_y$



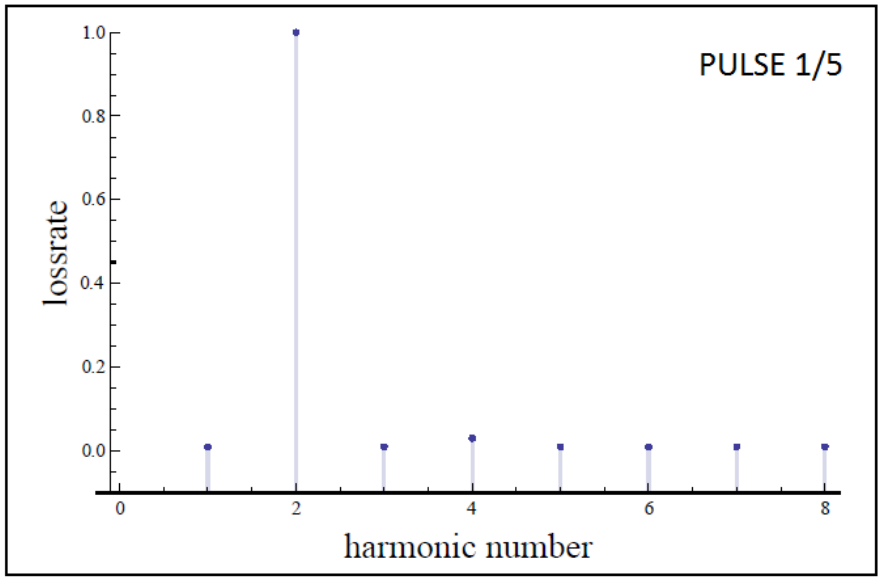


Harmonics

Angular distribution function and it's FFT



Harmonics contribution



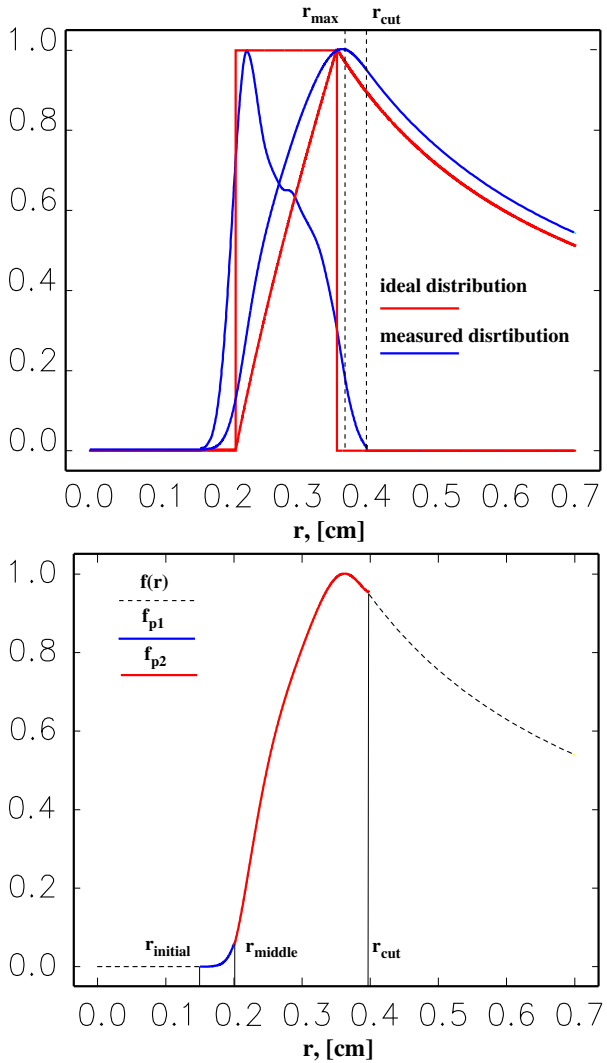
quad. harmonic is about 10-20%

$$\Delta p_x = -\Omega_e \Delta s \xi_m \frac{r^{m-1}}{r_e^m} \cos((m-1)\theta + \delta_m) \qquad (1)$$

$$\Delta p_y = \Omega_e \Delta s \xi_m \frac{r^{m-1}}{r_e^m} \sin((m-1)\theta + \delta_m) \qquad (2)$$

Radial model

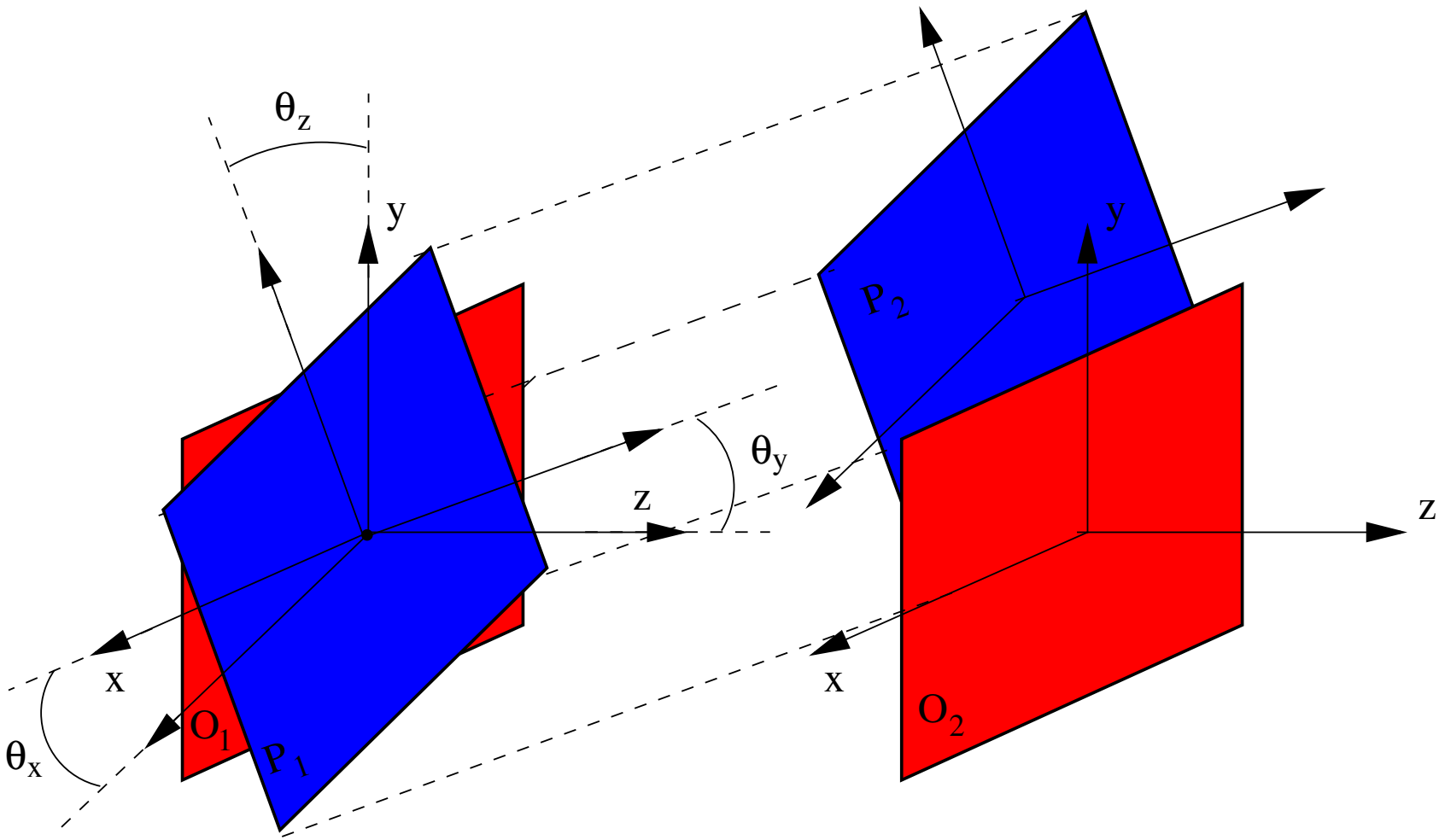
$$\Delta p_r = \frac{2\Omega_e \Delta s}{r_{max}} \frac{\kappa}{\eta} \begin{cases} 0 & 0 < r < r_{initial} \\ f_{p1} & r_{initial} < r < r_{middle} \\ f_{p2} & r_{middle} < r < r_{cut} \\ \frac{1}{r} & r > r_{cut} \end{cases}$$



- $\Omega_e = 0.3 \times 10^{-7} \frac{I_e(A)}{p_b(GeV/c)} \gamma_e \frac{1+\beta_e\beta_b}{\beta_e\beta_b}$
- f_{p1}, f_{p2} – polynoms 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 $\frac{\kappa}{\eta} = 0.95 \ldots 0.97$ and $\frac{r_{cut} - r_{max}}{r_{max}}$ strongly depend on the electron beam current

Alignment

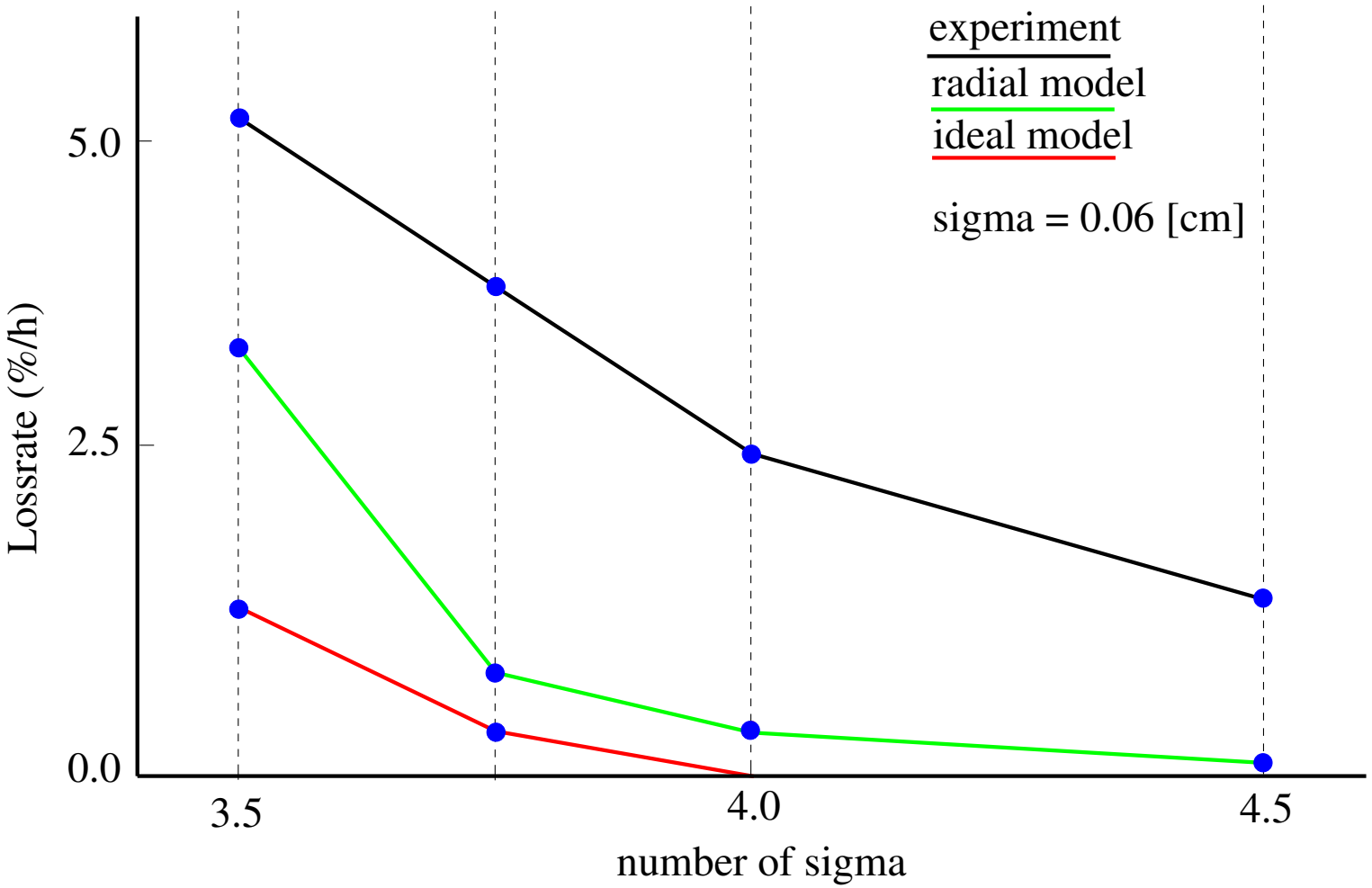


Simulation parameters

Parameters used in simulations:

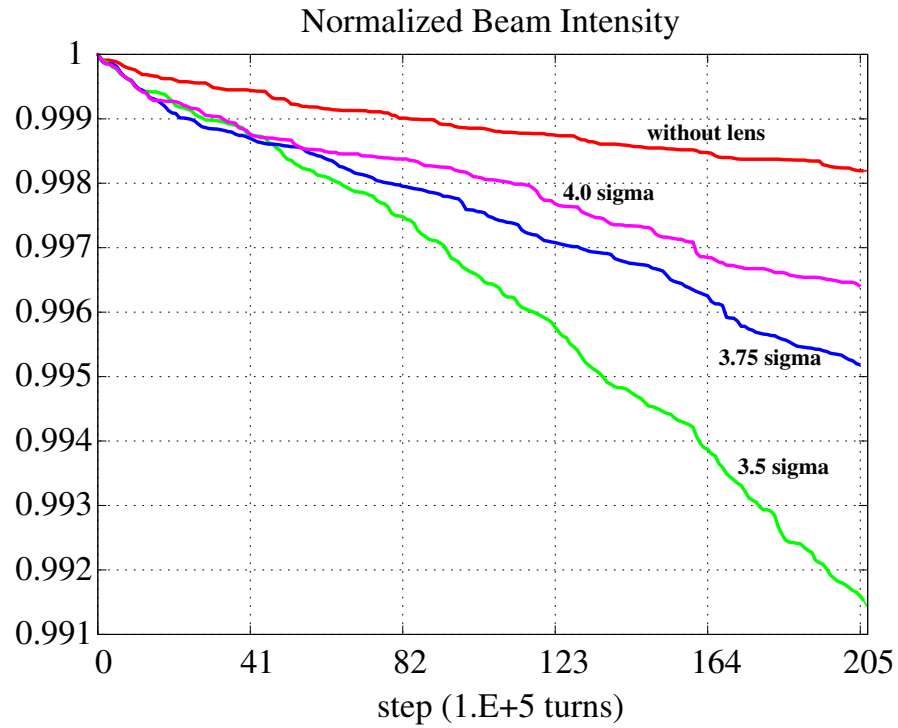
- 10000 and 20000 particles (weighted Gaussian)
- 600 steps with 10^5 in each (about 21 mins)
- $\sigma_y = 0.06$ and $\sigma_y = 0.057$ (5% error)[cm]
- electron beam radius $r_b = 3.5, 3.75, 4.0, 4.5\sigma_y$
- $L = 200$ [cm], $I = 0.4$ [A], $\beta = 0.135$, skip=1/1
- hollow weighted Gaussian beams do not help much
- different electron beam profile shows small lossrate because position of maximum field is lager

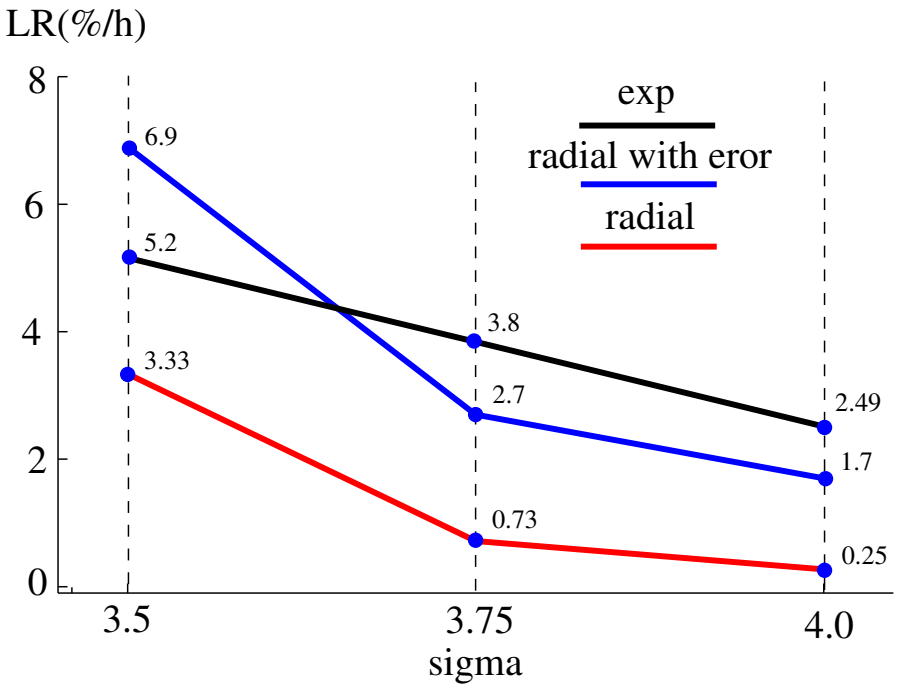
Loss Rate



for 20k particles loss rate is about the same

Radial model with error 5%





Conclusion

- simple analytical models were developed
- comparison with experiments is under way
- documentation is under development