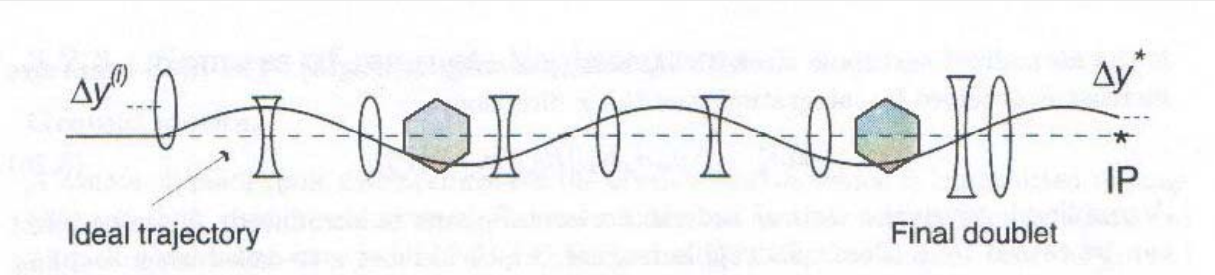
Definition of adaptative grid in Guinea-Pig for e+e- and e-e- collisions as function of offsets and beam parameters

Maria del Carmen Alabau, Philip Bambade, Guy Le Meur

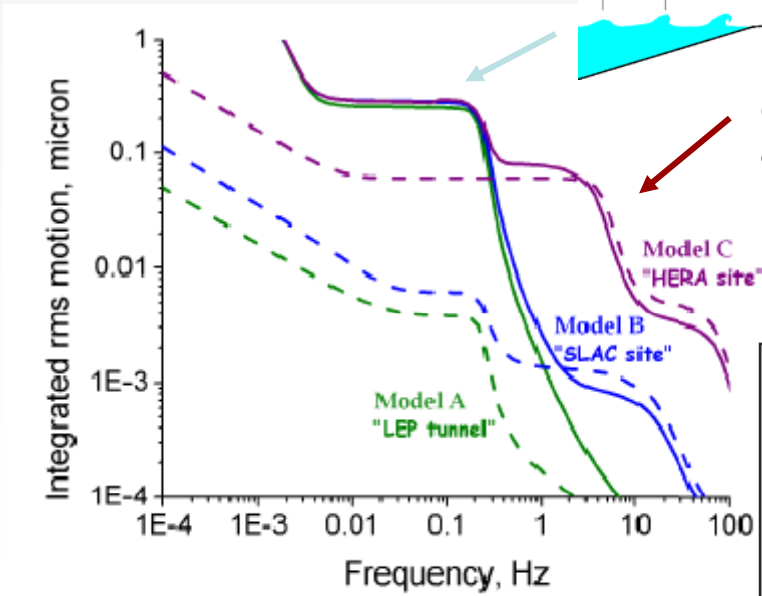
Sources of magnet displacements

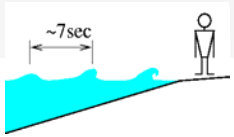
Magnet displacements introduce offsets at the IP

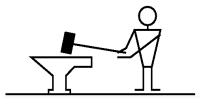


Source of magnet displacements: ground motion

Integrated ground motion spectra







Cultural noise & geology

Ground motion models:

-based in measurements taken in different sites

- include temporal and spatial correlations

Absolute motion

Differential motion for points separated by 50 m

* See e.g. A. Seryi, Ground Motion and Vibration Issues for Accelerators, Proceedings of the 2001 PAC, Chicago

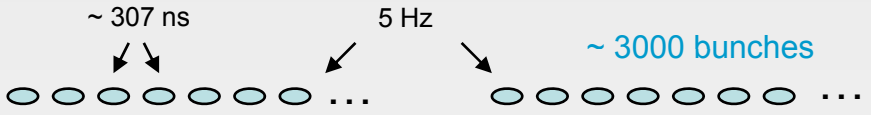
Beam-based IP position Feedback Simulation

Amplitudes of the IP y-offsets:

Train frequency:
~ hundreds of nm

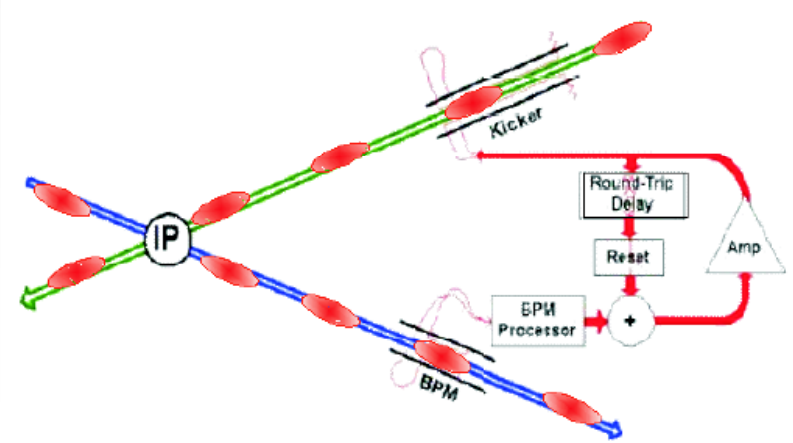
Bunch-to-bunch frequency:
~ fraction of σ_y

Structure of the beam:

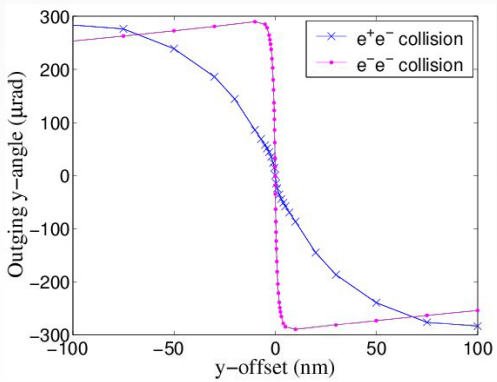


Beam-beam deflection IP position feedback system

1. Measure the out-going angle



2. Predict the offset between the beams



3. Correct the next bunch

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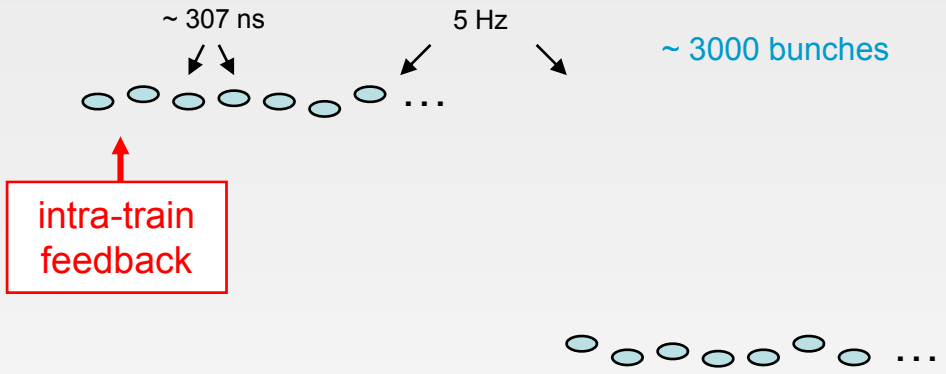

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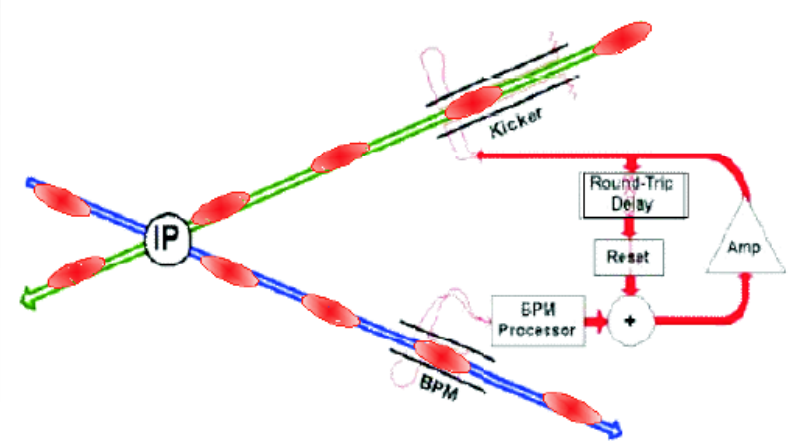

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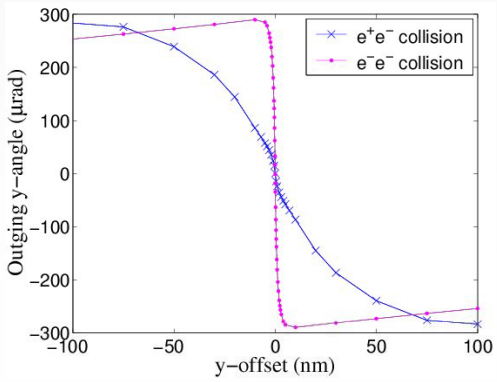


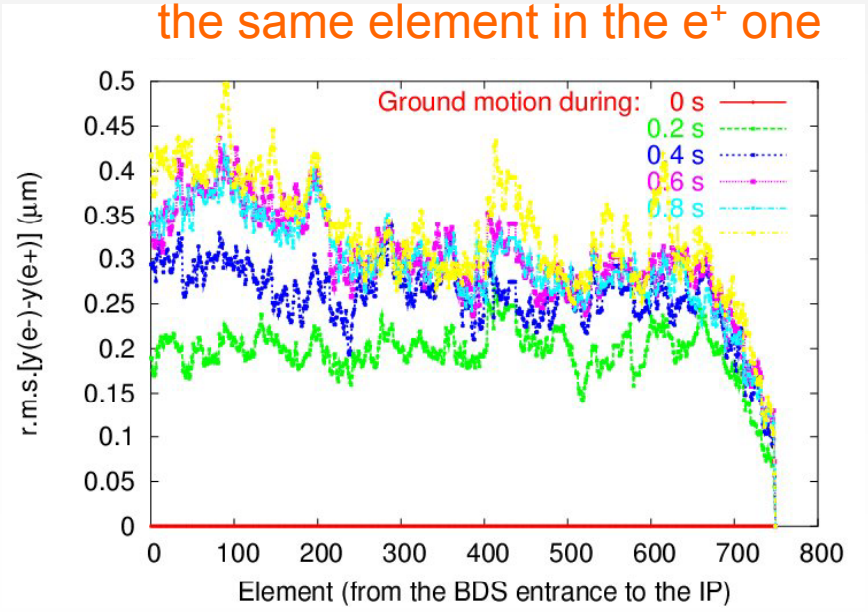
3. Correct the next bunch

Beam-Beam Feedback Simulation with Realistic Errors in the BDS (2)

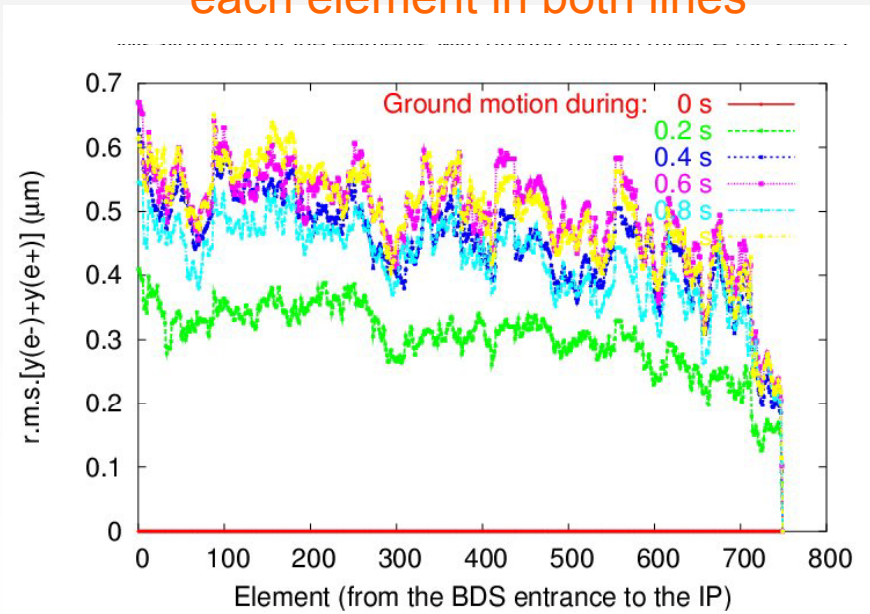
Effect of the ground motion in the lattice elements:

Misalignment of the elements with ground motion model B (50 seeds)
(ground motion applied at successive time intervals)

Misalignment difference of each element in the e^- line respect to the same element in the e^+ one



Addition of the misalignment of each element in both lines



Beam-Beam Feedback Simulation with Realistic Errors in the BDS (5)

Feedback simulation done for:

- e+e- and e-e-

- ~8 different successive time intervals of ground motion

- 50 seeds each lattice misalignment

Correction done bunch-to-bunch for 200 bunches:

200 collisions simulated with Guinea-Pig

Total: the order of 100000 collision simulations

Beam-Beam Feedback Simulation with Realistic Errors in the BDS (5)

Correction done bunch-to-bunch for 200 bunches:

200 collisions simulated with Guinea-Pig

if 1 min / collision ⇨ ~ 8 h

if 3 min / collision ⇨ ~ 24 h

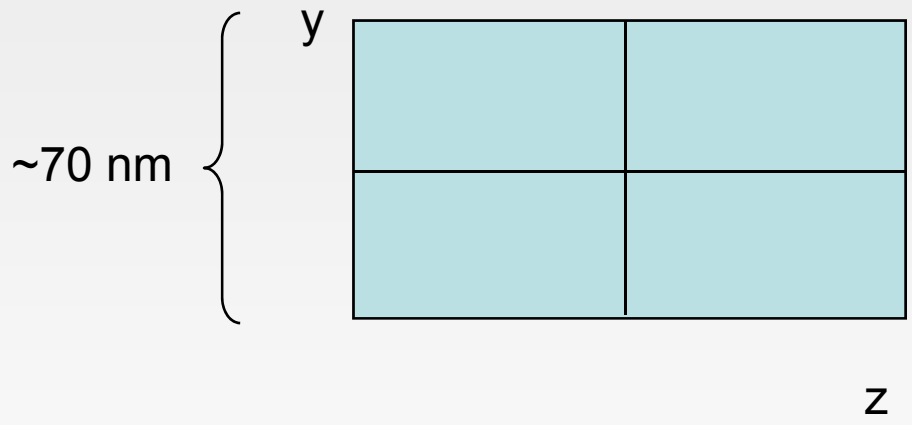
Time depends on size and precision grid:
Need to optimize the grid according to the offset between the beams

Guinea-Pig grid

Grid parameters for 0 nm offset (e+e-)

Size of the grid (half of the grid)

```
cut_x = 3 * sigma_x.1
cut_y = 6 * sigma_y.1
cut_z = 3 * sigma_z.1
```



Number of cells

```
n_x = 32
n_y = 128
n_z = 24
```

70 nm / 128 cells:

size_cell(y) ~ (1/10) σ_y

Guinea-Pig grid

Grid parameters for 0 nm offset (e+e-)

Size of the grid (half of the grid)

cut_x = 3 * sigma_x.1
cut_y = 6 * sigma_y.1
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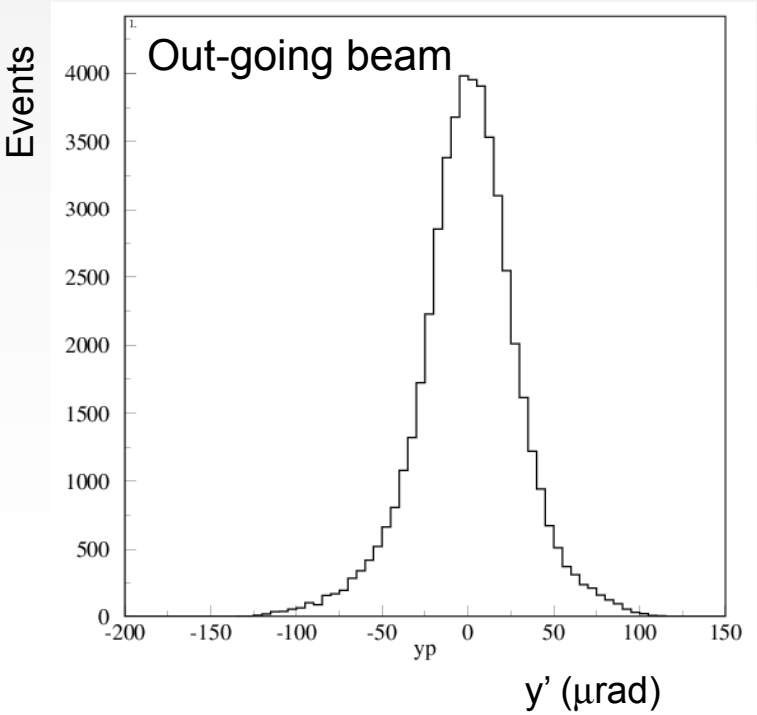
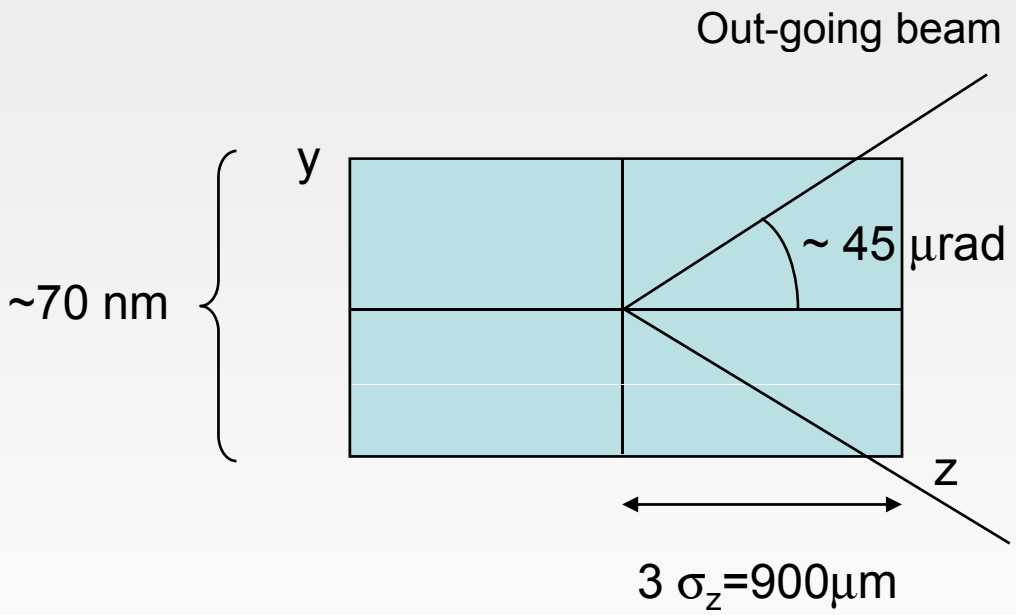
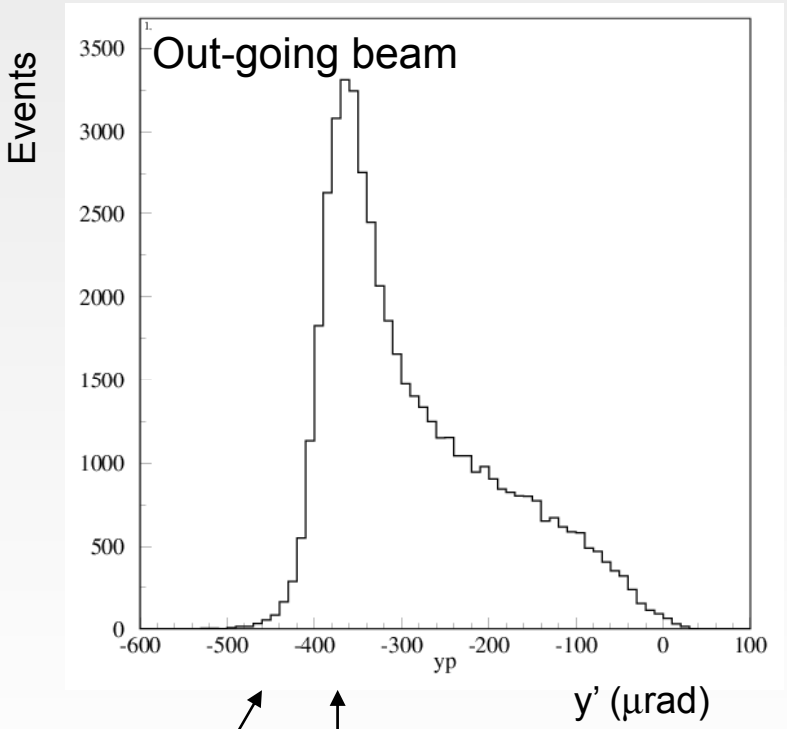


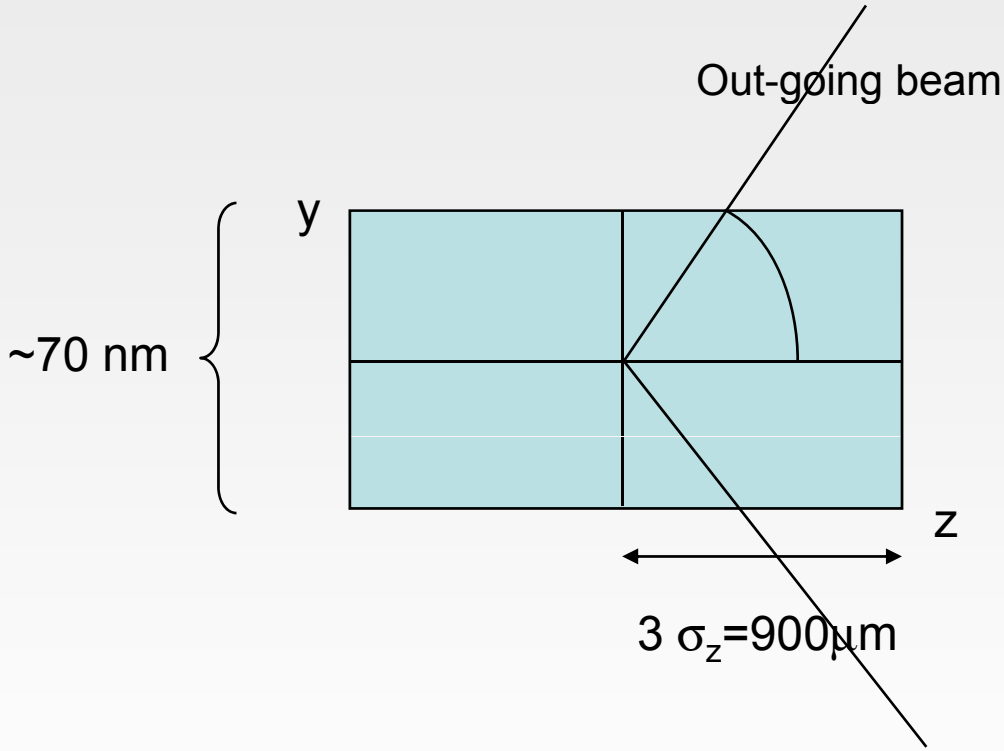


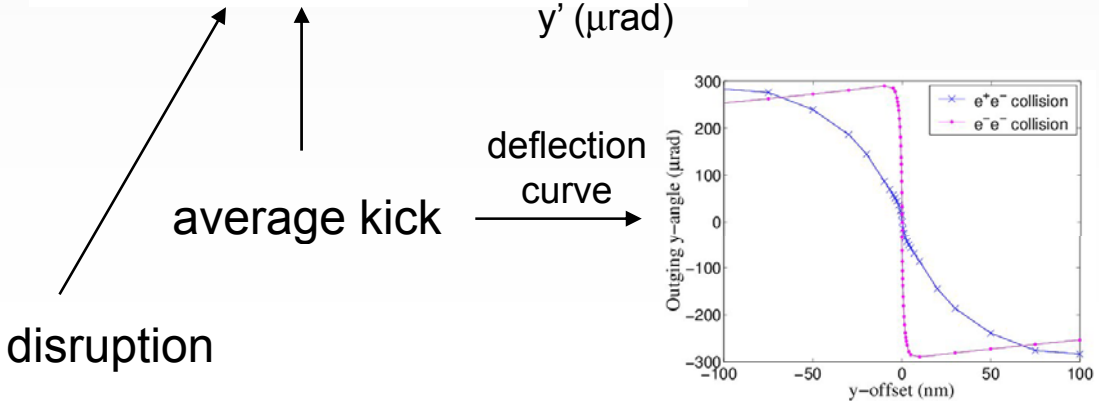
Guinea-Pig grid

Grid parameters for vertical offset between the beams:

200 nm vertical offset (e+e-)





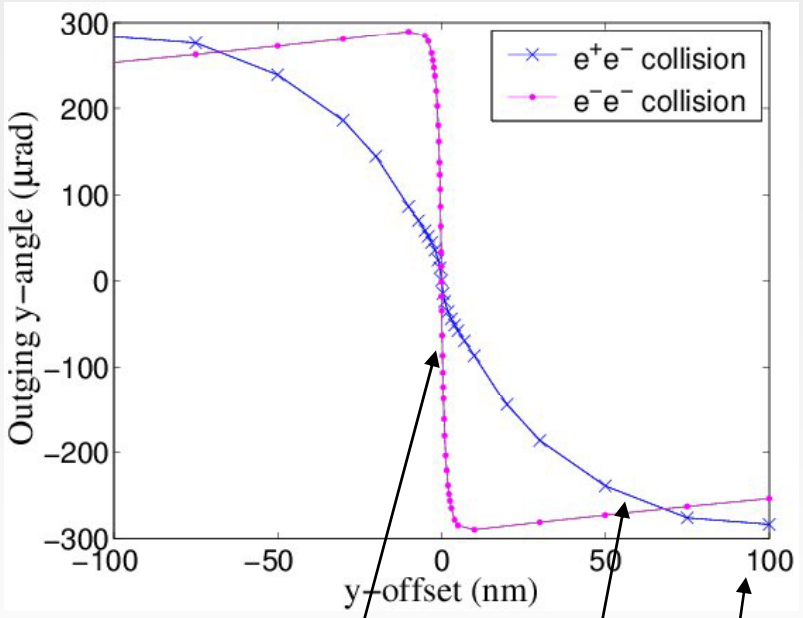


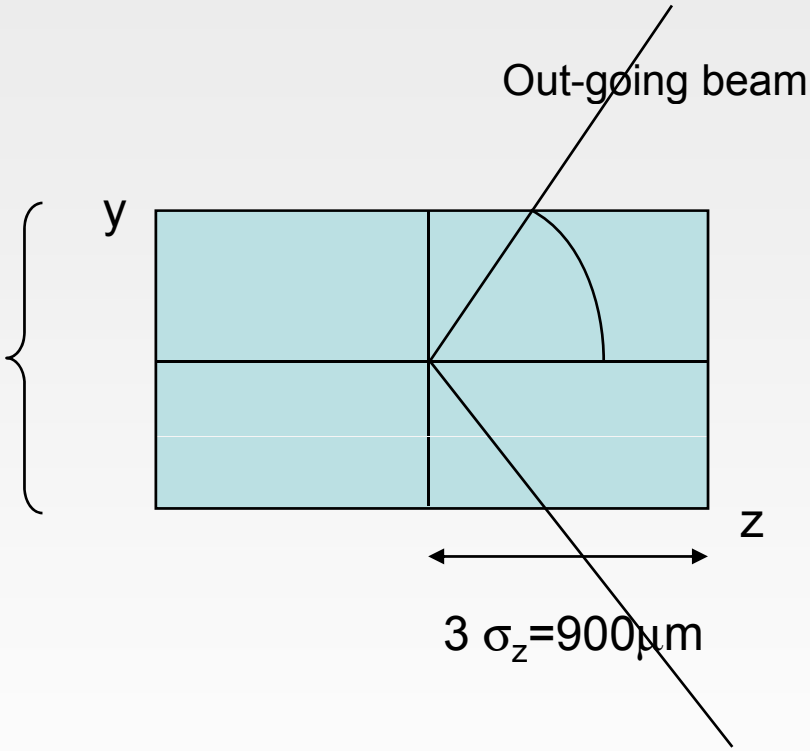
- Increase y grid size

- Increase the cell size

Guinea-Pig grid

Grid parameters for vertical offset between the beams:





(1/10)σ_y (1/10)σ_y (1/5) or 1σ_y

- Increase the cell size

- Increase y grid size: to loose maximum ~1% of the particles

Guinea-Pig grid (e^+e^- collisions)

Grid parameters for vertical offset between the beams:

semi-offset (nm):

$$y\_offset \le 0.1$$

$$cut\_y = cuty \times \sigma_y = 6 \times \sigma_y$$
$$n\_y = 128$$

$$0.1 \le y\_offset \le 100$$

$$cut\_y = 24 \times \sigma_y$$
$$n\_y = 512$$

$$100 \le y\_offset \le 200$$

$$cut\_y = \frac{y\_offset}{4} \times \sigma_y$$
$$n\_y = 2^{round[\log_2(10\,cuty)]}$$

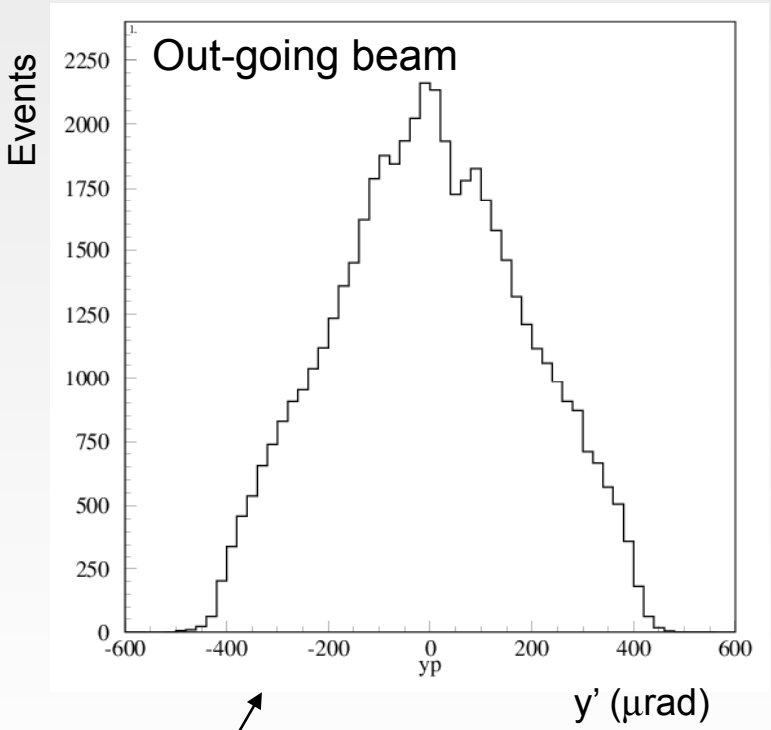
$$200 \le y\_offset$$

$$cut\_y = \frac{y\_offset}{4} \times \sigma_y$$
$$n\_y = 2^{round\left[\log_2\left(\frac{20\,cuty}{16}\right)\right]}$$

Guinea-Pig grid

Grid parameters for e-e- collisions: need more time

0 nm vertical offset (e-e-)



disruption

Disrupted angle 8 times the e+e- one:

Vertical grid size 8 times the e+e- one

```
cut_x = 3 * sigma_x.1
cut_y = 48 * sigma_y.1
cut_z = 3 * sigma_z.1
```

To maintain the same precision:

Number of cells x 8

```
n_x = 32
n_y = 1024
n_z = 24
```

Guinea-Pig grid (e^-e^- collisions)

semi-offset (nm):

$y\_offset \le 10$

$$cut\_y = cuty \times \sigma_y = 48 \times \sigma_y$$
$$n\_y = 1024$$

$10 \le y\_offset \le 50$

$$cut\_y = 48 \times \sigma_y$$
$$n\_y = 512$$

$50 \le y\_offset \le 70$

$$cut\_y = 48 \times \sigma_y$$
$$n\_y = 64$$

$70 \le y\_offset \le 500$

$$cut\_y = \left(\frac{y\_offset}{4} + 48 \right) \times \sigma_y$$
$$n\_y = 2^{round\left[\log_2 \left(\frac{20cuty}{16} \right) \right]}$$

$500 \le y\_offset$

$$cut\_y = \frac{y\_offset}{4} \times \sigma_y$$
$$n\_y = 2^{round\left[\log_2 \left(\frac{20cuty}{24} \right) \right]}$$