# Dynamic Alignment Simulations for ILC

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- Attempt to start full dynamic simulation of alignment

# Simulation Model

- First one-to-one steering is performed
- For each correction bin dispersion free steering is used

  $\Rightarrow$ minimise

$$\sum_i \left( w_{i,0} x_{i,0}^2 + \sum_j w_{i,j} (x_{i,j} - x_{i,0})^2 \right)$$

- Weight for trajectory of nominal beam and difference trajectories can be defined for each BPM independently

  - before a constant weight for all BPMs

- The beam energy is varied by varying the gradient
- The first six BPMs and quadrupoles are assumed to be perfectly aligned

  $\Rightarrow$ see Andreas talk for how to align them

- Finally tuning bumps are used (see Peder)

## Simulation Algorithm (One Test Beam)

- Apply static misalignments
- Perform one-to-one correction assuming static machine and no BPM resolution

  $\Rightarrow$ Effect of limited time for steering needs to be considered later
- Set gradient to the one for the test beam
- Apply dynamic misalignment
- Simulate one test beam and measure trajectory

  Apply correction to measurement as defined later
- Set gradient to nominal
- Apply dynamic misalignment

- Simulate nominal beam and measure trajectory

  Apply correction to measurement as defined later
- Determine optimum correction of for the bin
- Apply correction
- Calculate expected BPM readings from measurement and corrections applied
- Modify BPM target values accordingly
- Iterate on the bin, if required or move to next bin
- Iterate on machine, if required
- Perform one-to-one correction of machine assuming no dynamic effects

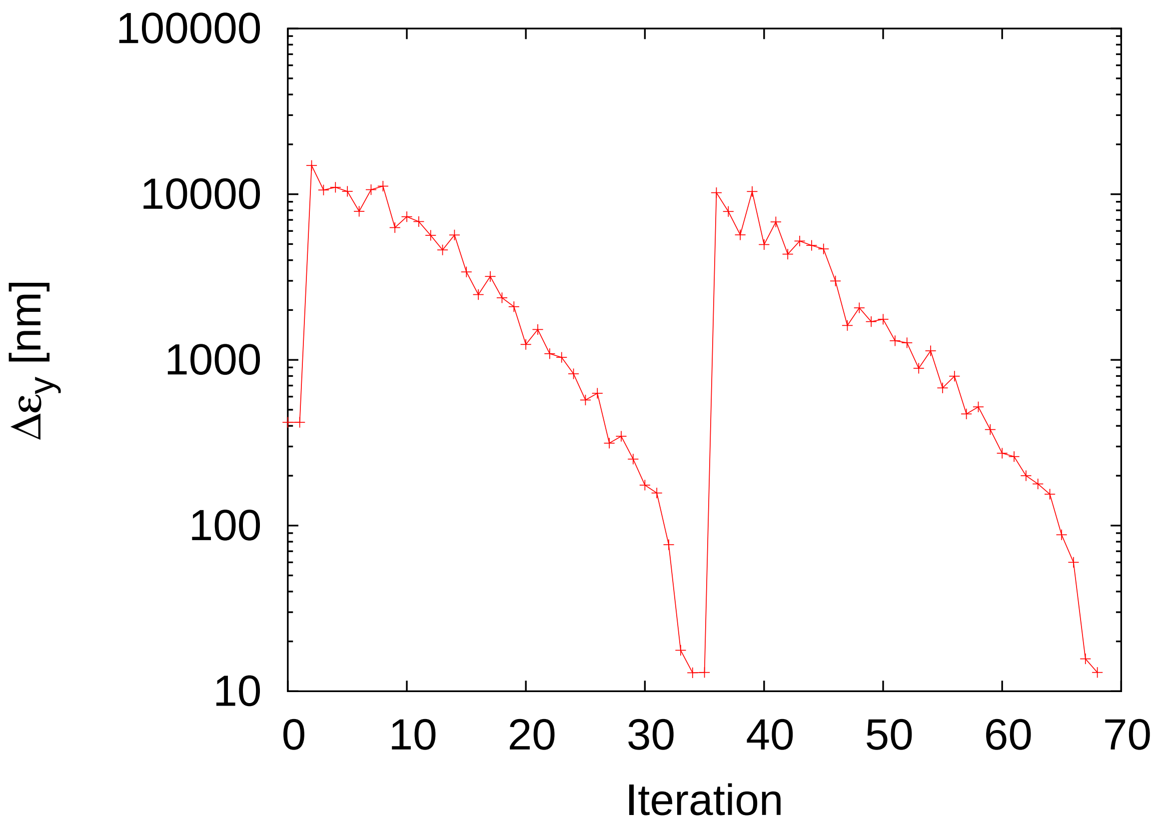
  $\Rightarrow$ Impact of dynmaics to be investigated later
- Apply tuning bumps (not yet included)

# Results

- 1 TeV centre-of-mass
- 24 cavities between quadrupoles
- Average over 25 machines
- No fit of incoming beam
- Two iterations on machine, one per bin

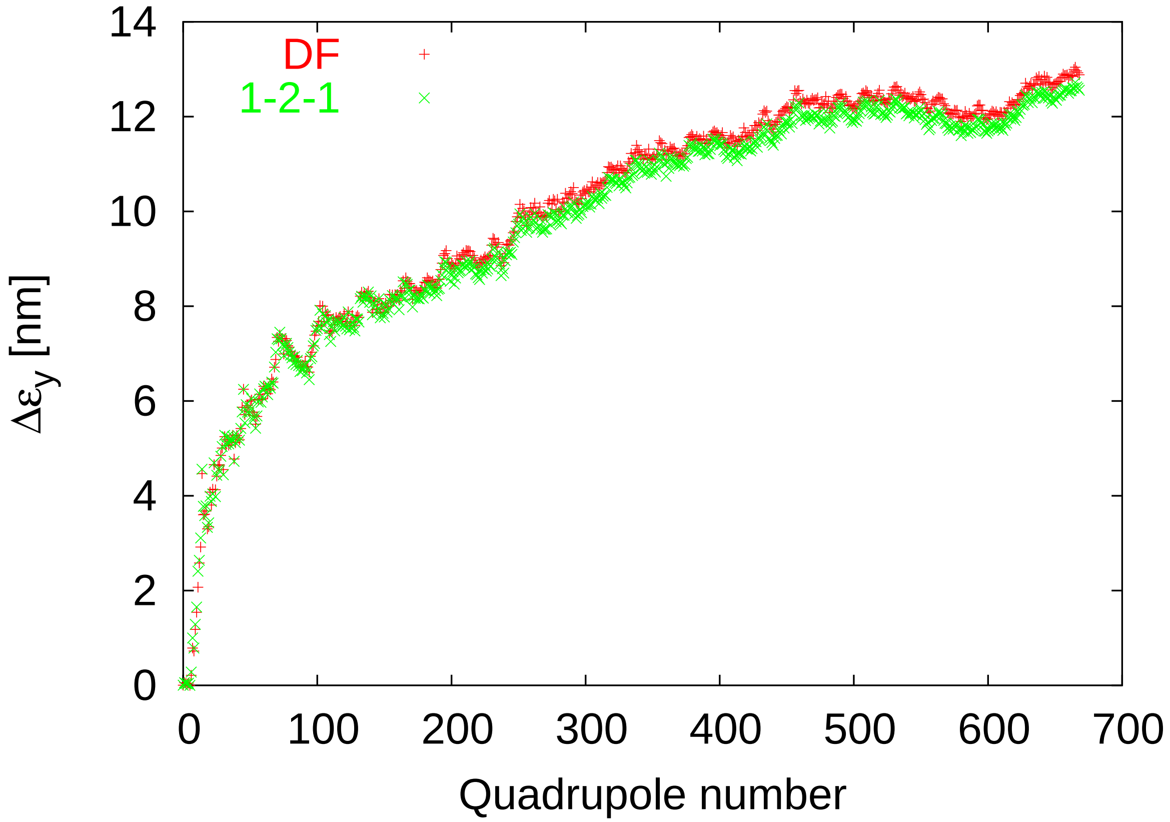
⇒ Results seem to recover previous values for CLIC

⇒ check for ILC to come soon



# Results (cont.)

- Effect of final one-to-one correction
- No dynamic effects during one-to-one



# Effect of Fitting the Incoming Beam

- One tries to remove beam jitter from the measurement
- Actual implementation is done as
  - three BPMs before the correction bin are used to measure incoming beam with respect to the target trajectory
  - the setting of two correctors is determined which should minimise the offsets in these BPMs
  - the effect of these corrector settings on the correction bin is calculated and subtracted from the measured offset
- This is repeated for all test beams, then the correction is calculated

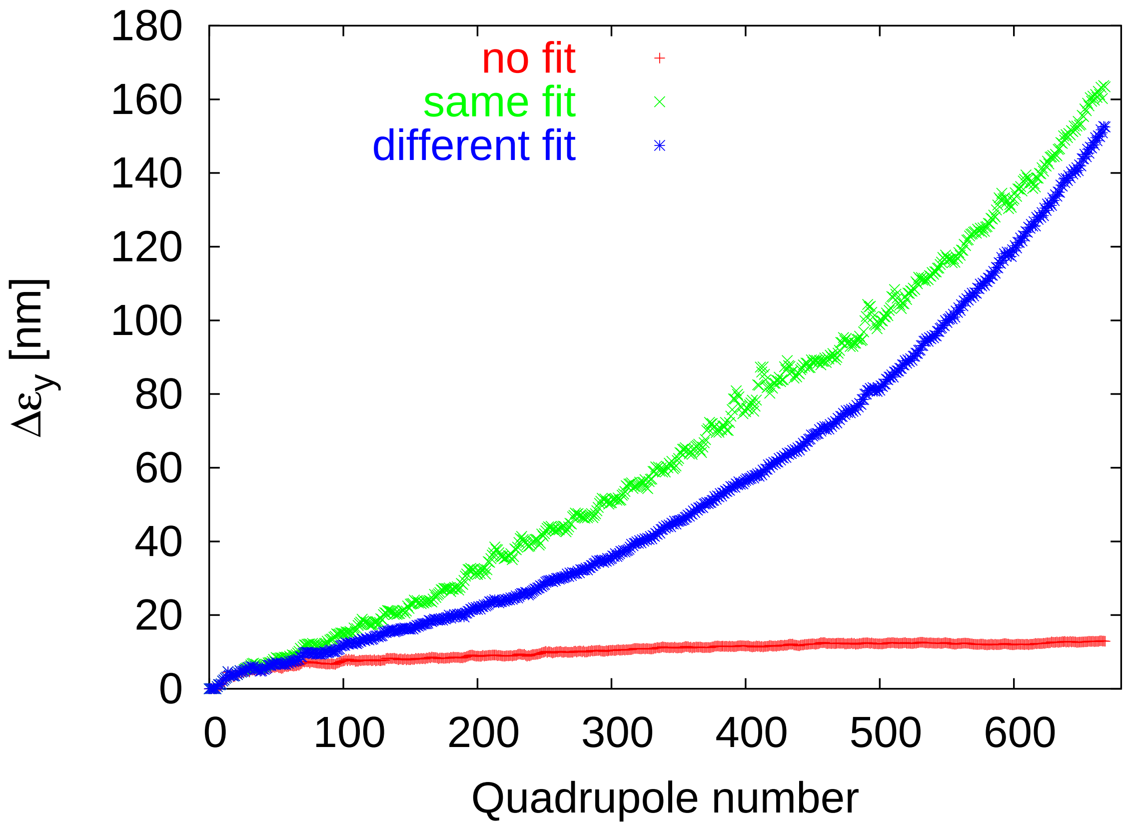
- The target offsets of the new fit BPMs is determined for each beam
  - the corrected measured value for the offset of the beam in the respective BPM is calculated
    - alternatively the measured trajectory of the nominal beam is used
  - the expected effect of the correction is added
  - the new target values are stored
- Errors are introduced twice
  - when determining where the nominal incoming trajectory is
  - when measuring the incoming beam

# Results

- No fit, fit to the nominal beam trajectory and fit the the trajectory of the same beam has been performed

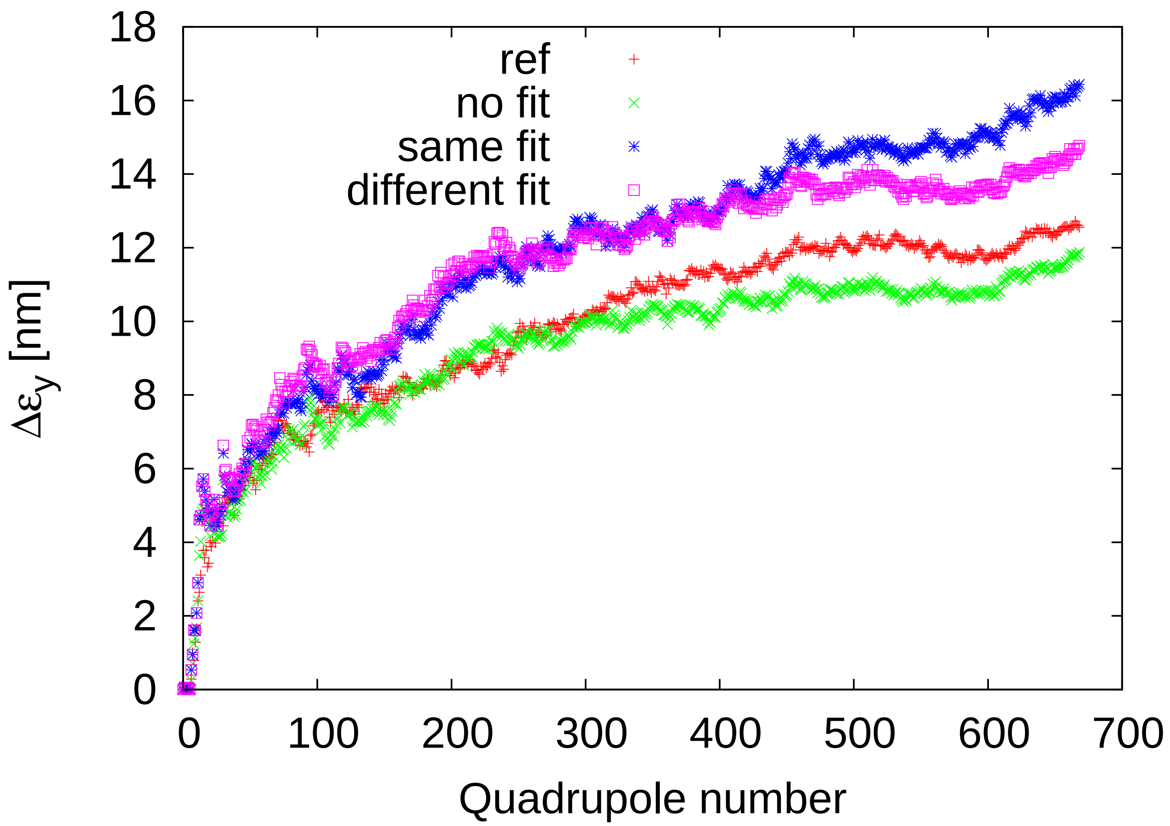
⇒ The fits make the situation worse

⇒ Fiting to the nominal beam trajectory is worst, but iterations help



# Results (cont.)

- Iterating the correction of each bin improves the results slightly
  - fit for same trajectory is improved significantly

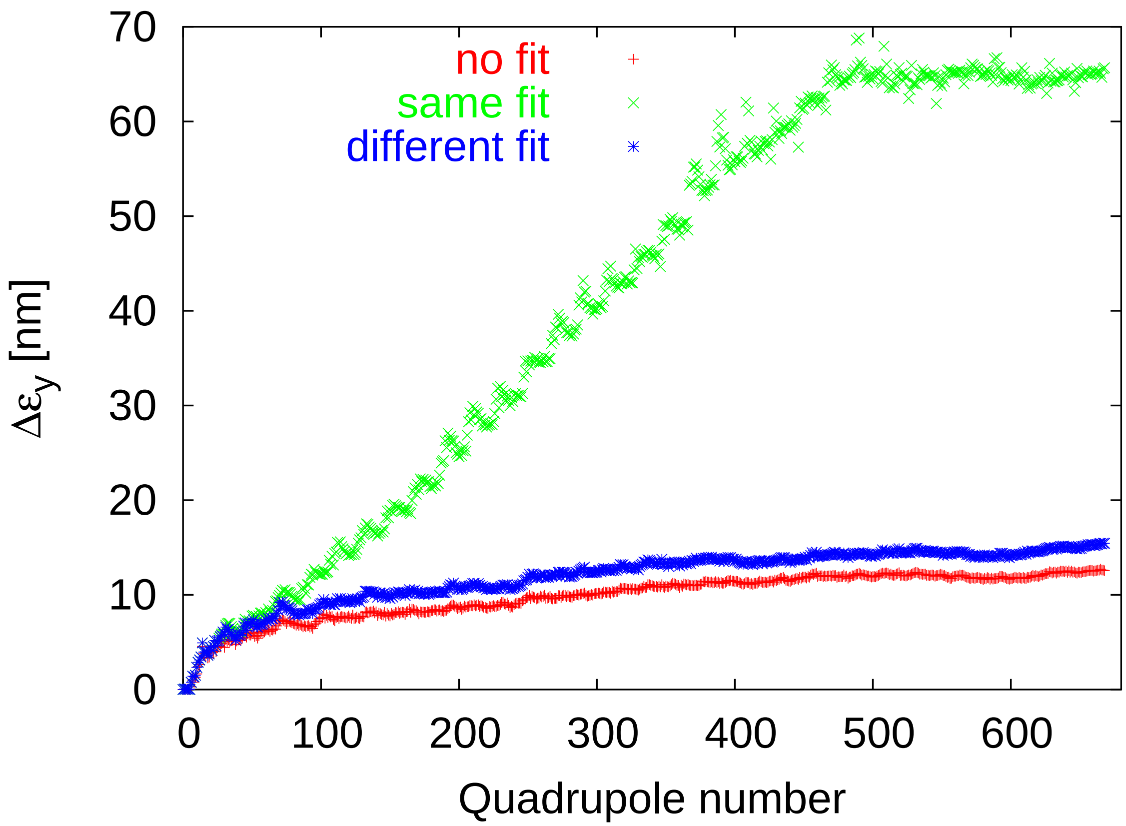


# Results (cont.)

- One-to-one correction applied

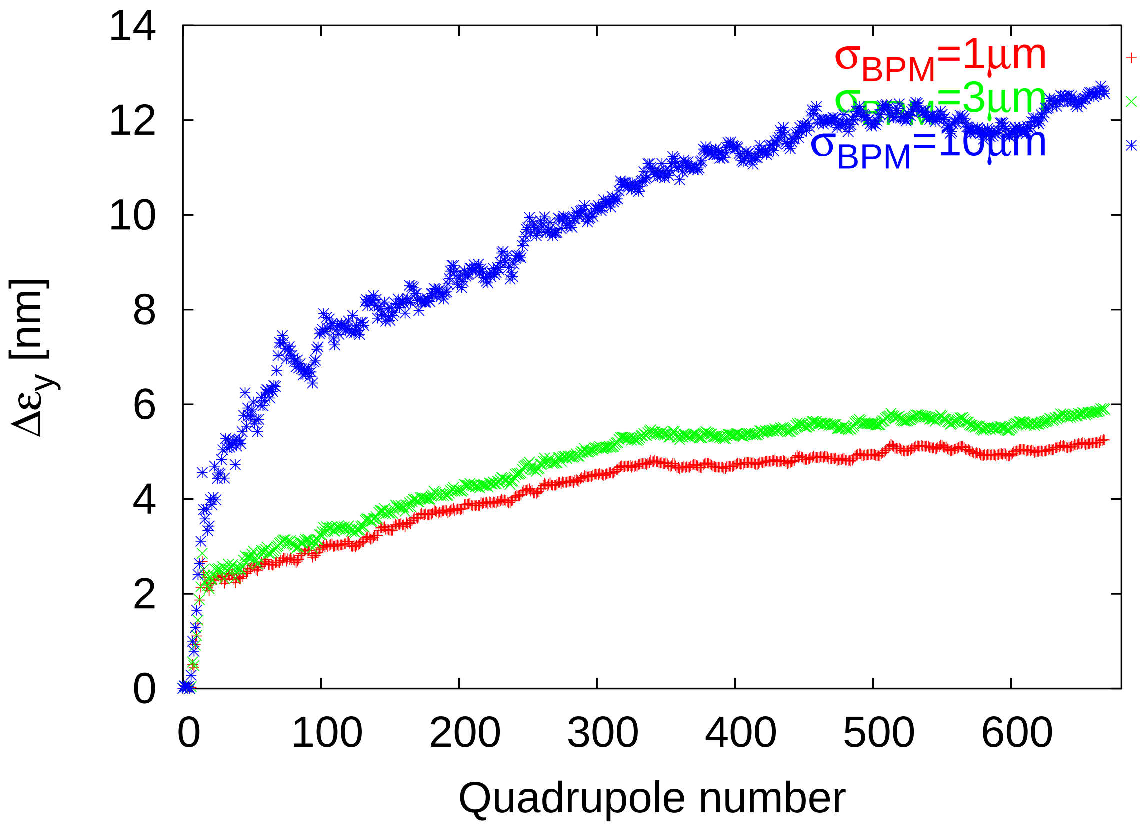
⇒ The result with seperate fits for each beam works much better

- But no fit is still best



# BPM Resolution

- No fit
- Weights not optimised for each resolution
- Bumps may change results



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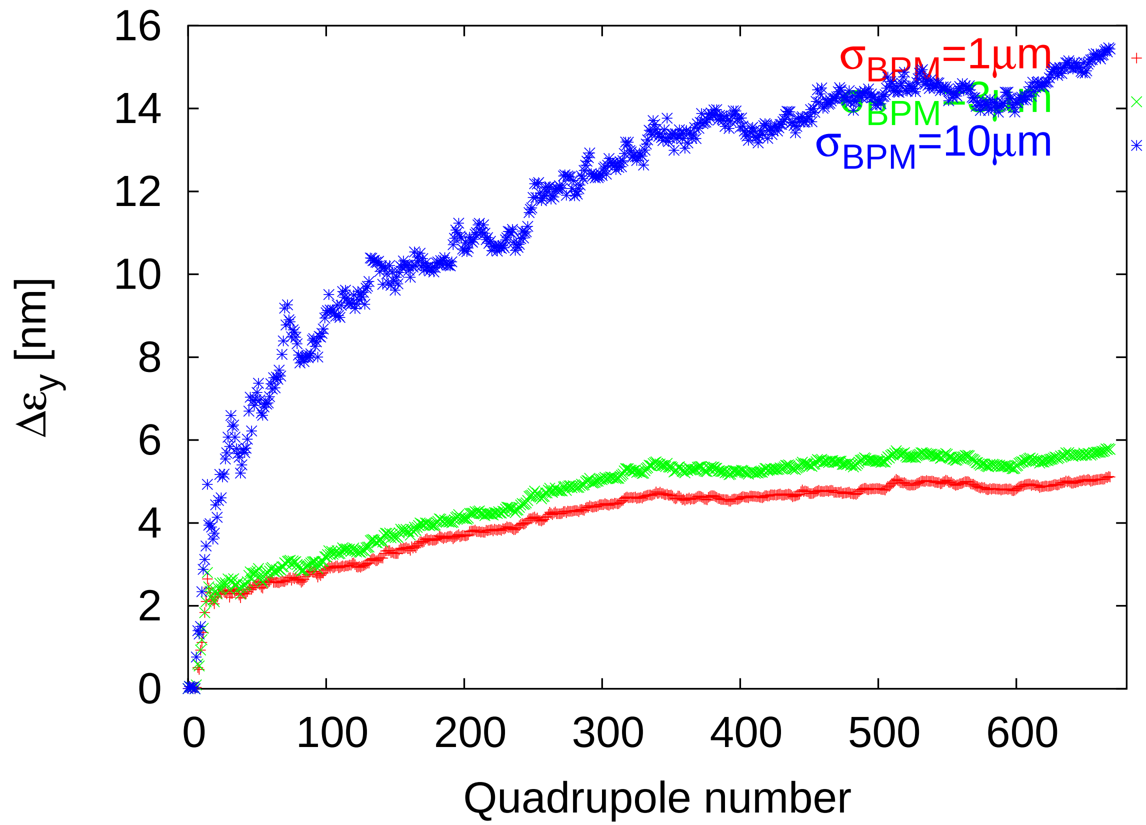
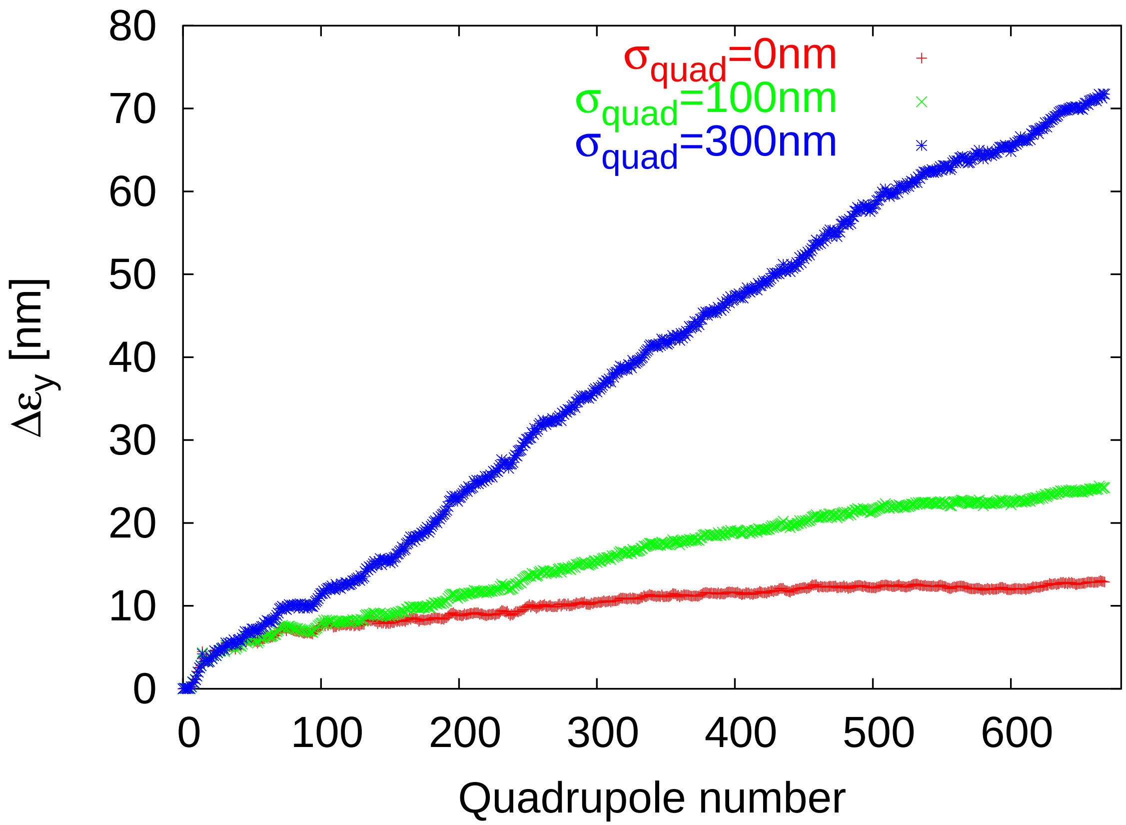


# Beam Jitter

- Beam jitter induced by random walk of quadrupoles
- Quadrupoles move between each pulse
- No fit of incoming beams
- No one-to-one correction

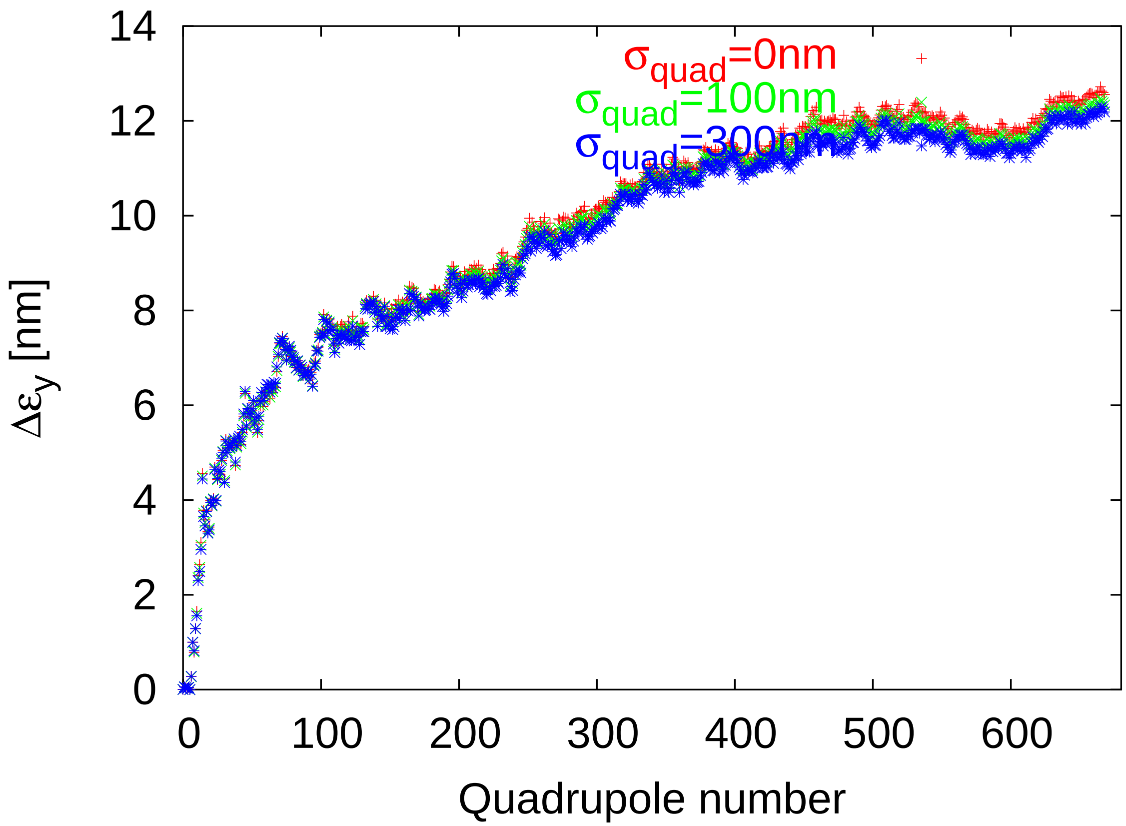


# Beam Jitter (cont.)

- One-to-one correction applied
- Assumed static machine during this final correction

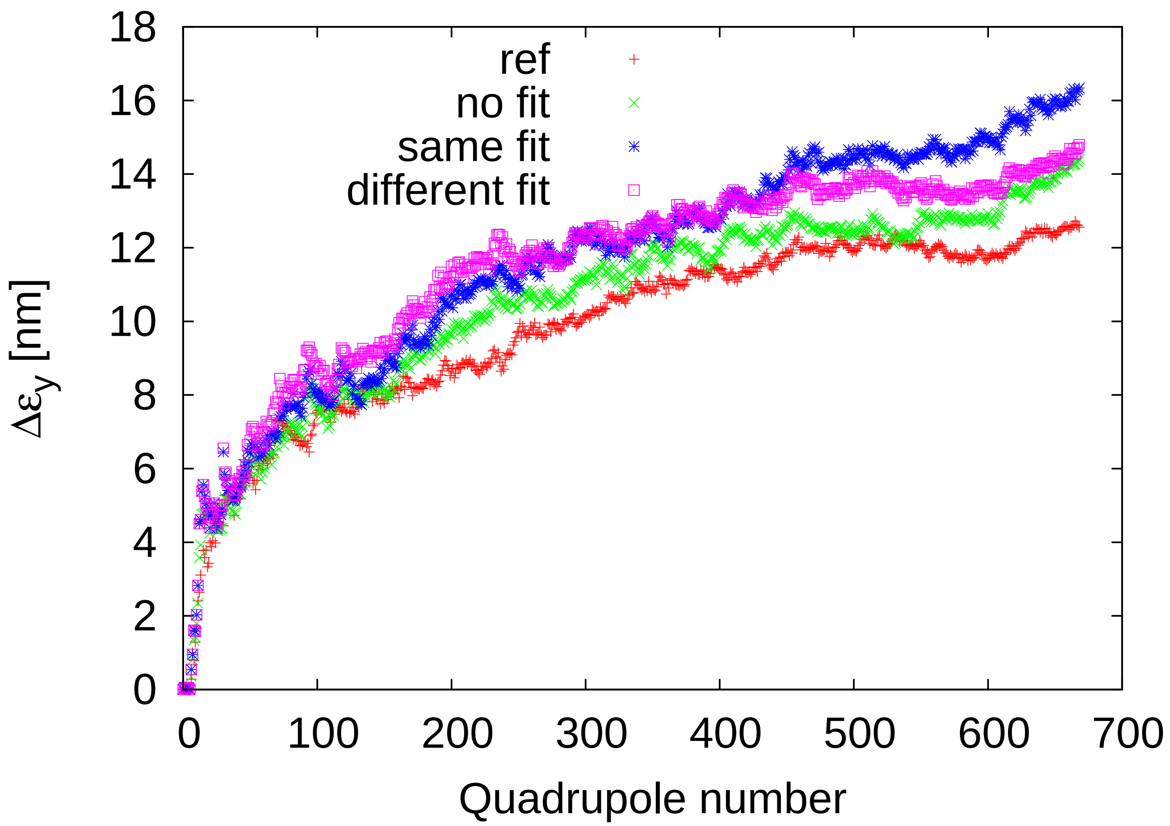
⇒ Beam jitter does not impact result very much

⇒ Direct luminosity reduction due to quadrupole jitter during one-to-one correction is the larger problem



# Beam Jitter (cont.)

- Incoming beams are fitted
- Three iterations per bin
- Large quadrupole jitter (300nm)



# Some Remarks

- Precise alignment procedure deserves consideration
  - could use different gradient in the same pulse

    $\Rightarrow$ quadrupoles would only move from one iteration to next
  - use of feedback to steer the beam within the pulse

# Conclusion

- Dynamic simulations allow to understand the alignment in detail

  $\Rightarrow$ make sure that there is no error in simplification of fast methods

- Effects during the correction can be included

$\Rightarrow$ Beam jitter during the correction seems to not pose a problem

$\Rightarrow$ Fiting the incoming beam seems often not to help

- Effect of tuning bumps needs to be included
- Simulations are much more time consuming