Dispersion Measurements at VUV-FEL

FEL R&D Program – Weeks 47 & 48

W. Decking, T. Limberg, E. Prat
DESY, 6 December 2005
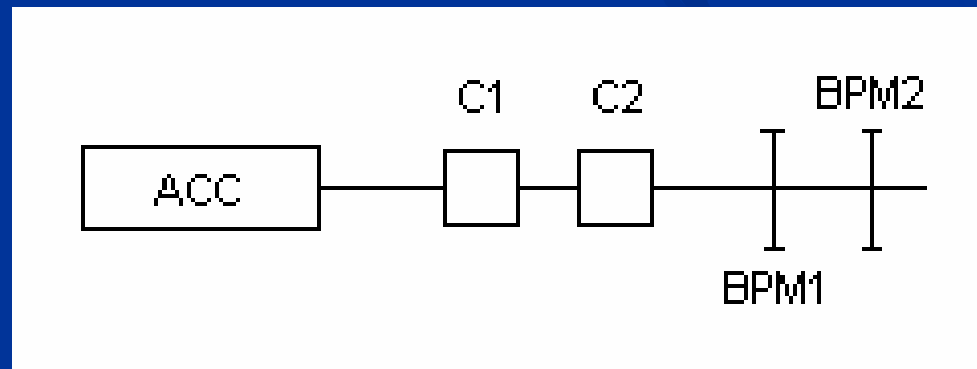
Index

Overview 1/2

PROCEDURE

- Change RF gradient of the module

- Apply orbit correction to restore launch conditions after the module

- Read BPM positions downstream BPM2

Overview 2/2

INTERMEDIATE GOAL
Obtain a dispersion in the undulator smaller than 1 cm in both planes

GOAL of WEEKS 47-48
Perform 1st dispersion measurements

ACHIEVEMENTS
-Successful test of tools for measure dispersion everywhere at VUV-FEL
-Measured dispersion:
  dispersion downstream BC2-undulator
  dispersion downstream ACC2/3 – dogleg
  dispersion contribution of the dogleg
  dispersion contribution of the undulator

Index

-Overview

-Previous steps: Energy calibration
                 Orbit correction

-Dispersion measurements and simulations
    -deltap/p profile
    -Example for a single BPM
    -Downstream BC2 ÷ undulator
    -Downstream ACC2-3
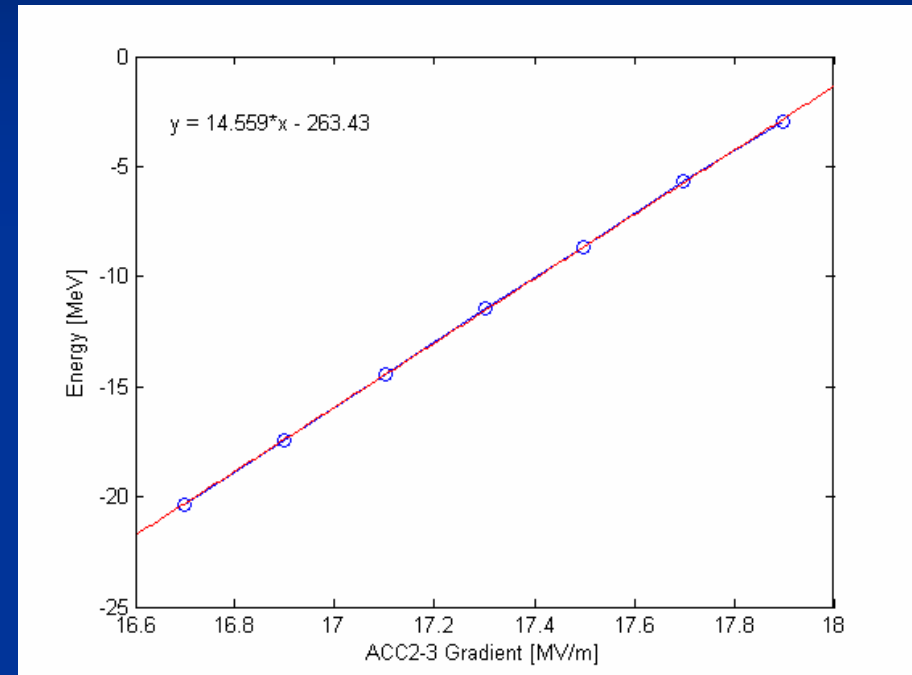   -Downstream ACC4-5

-Summary / Conclusions

-Next steps

Previous steps: Energy calibration

-We calibrated the change of energy as a function of a gradient change in ACC2-3

-We will do it also for ACC1 and ACC4-5

-For this measurements we have assumed:

$$\Delta E[\mathrm{MeV}] = L_{cav} * \Delta V[\mathrm{MV/m}]$$

Previous steps: Orbit Correction

- Based on Vladimir and Nina Optic Server and code from HERA

- Easily adaptable to Accelerator Toolbox

- Orbit bump

  Creates arbitrary n-corrector bumps with n-2 constraints (position or angle at any position in the lattice).

- Orbit correction:

  Performs orbit correction with arbitrary number of correctors and BPMs

Orbit Correction examples
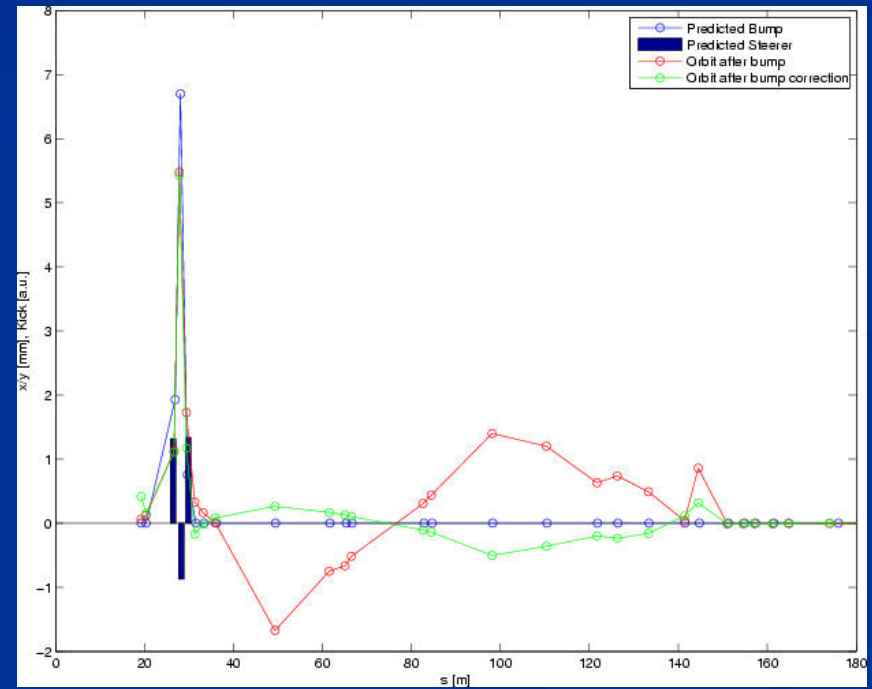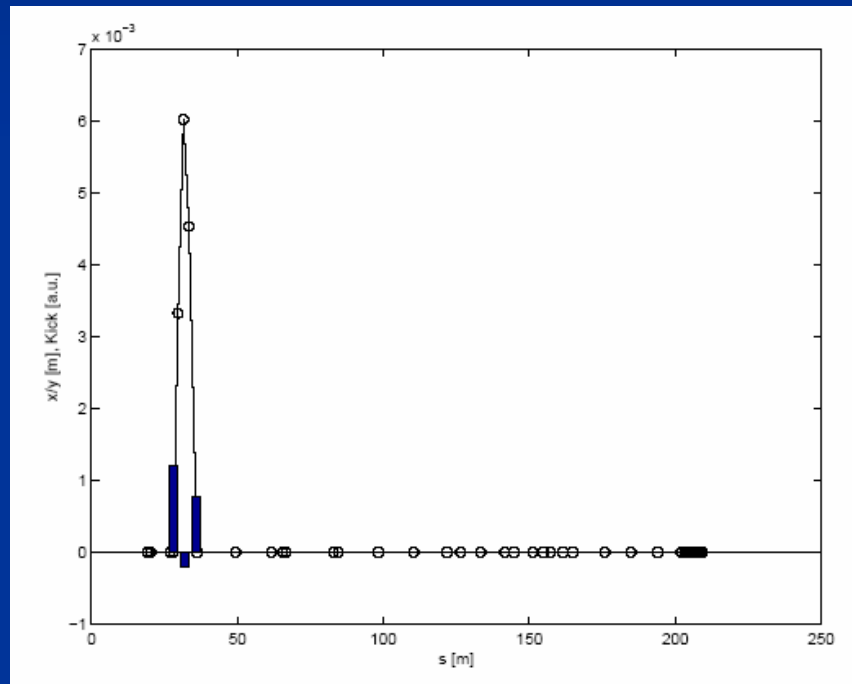
Orbit Correction examples
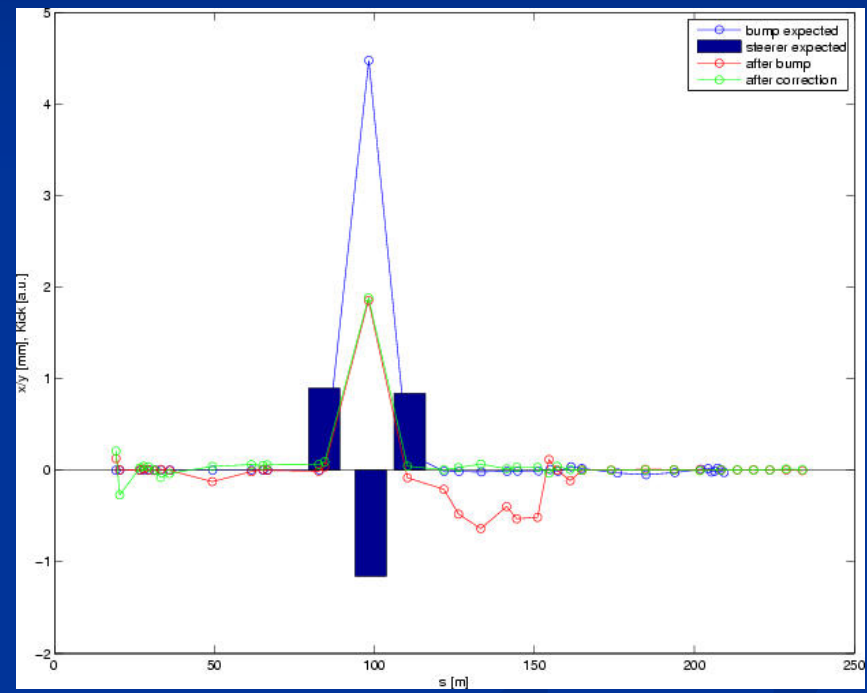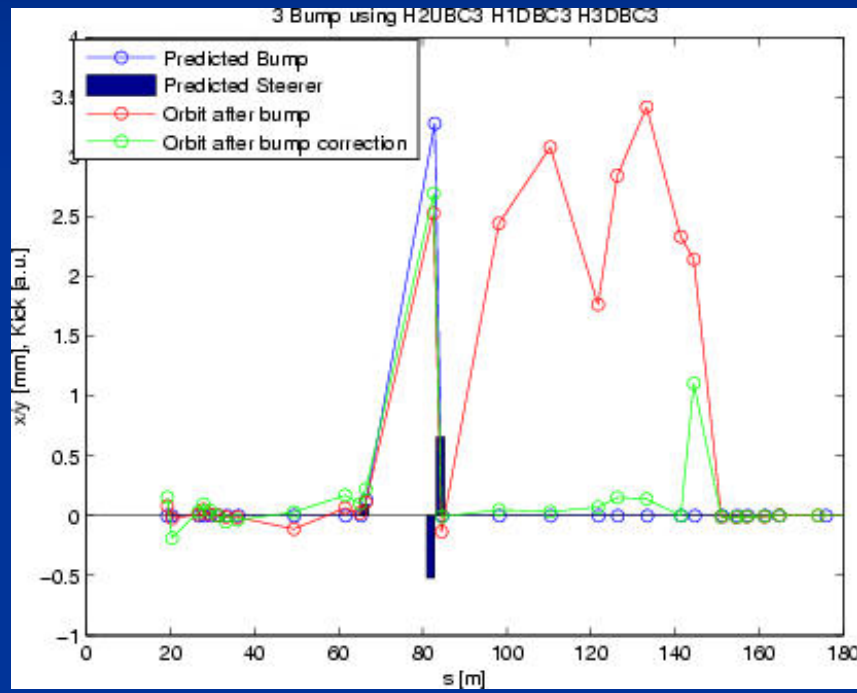
Index

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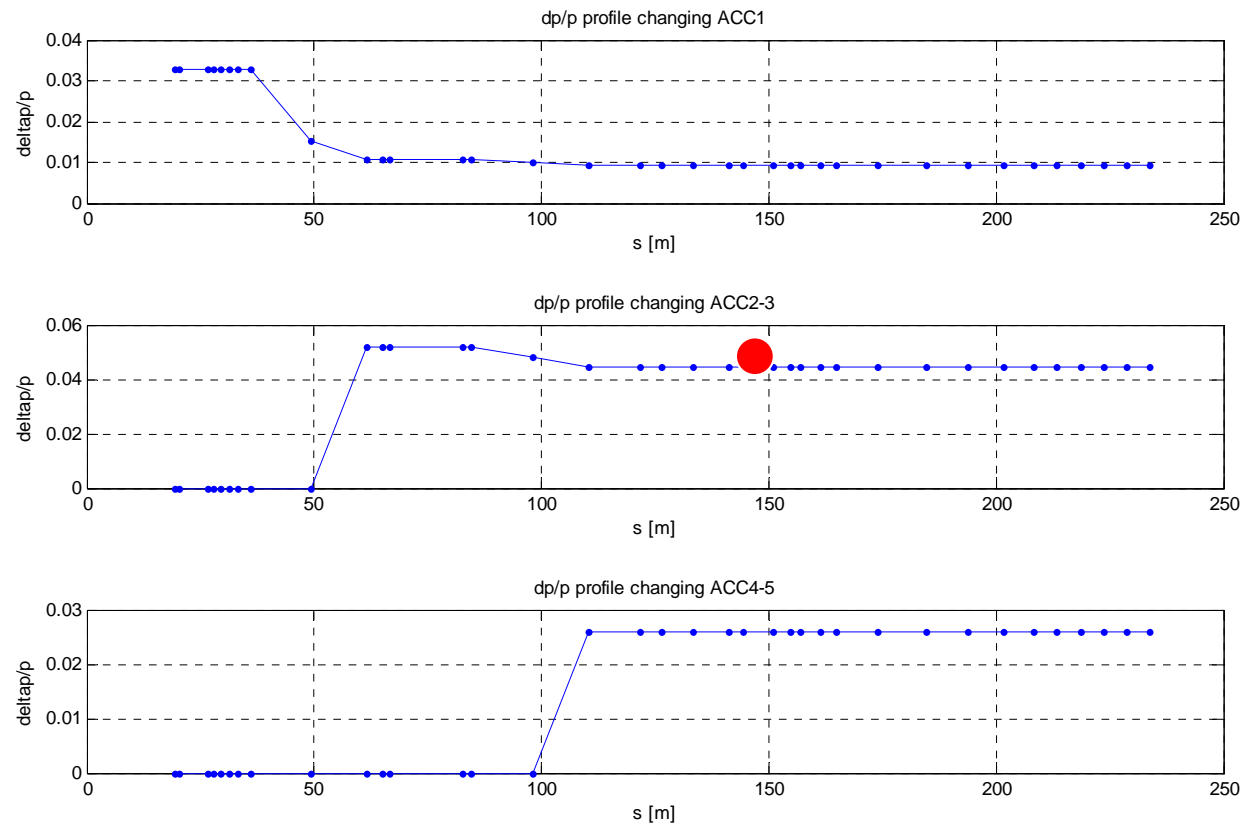   -Example for a single BPM
    -Downstream BC2 ÷ undulator
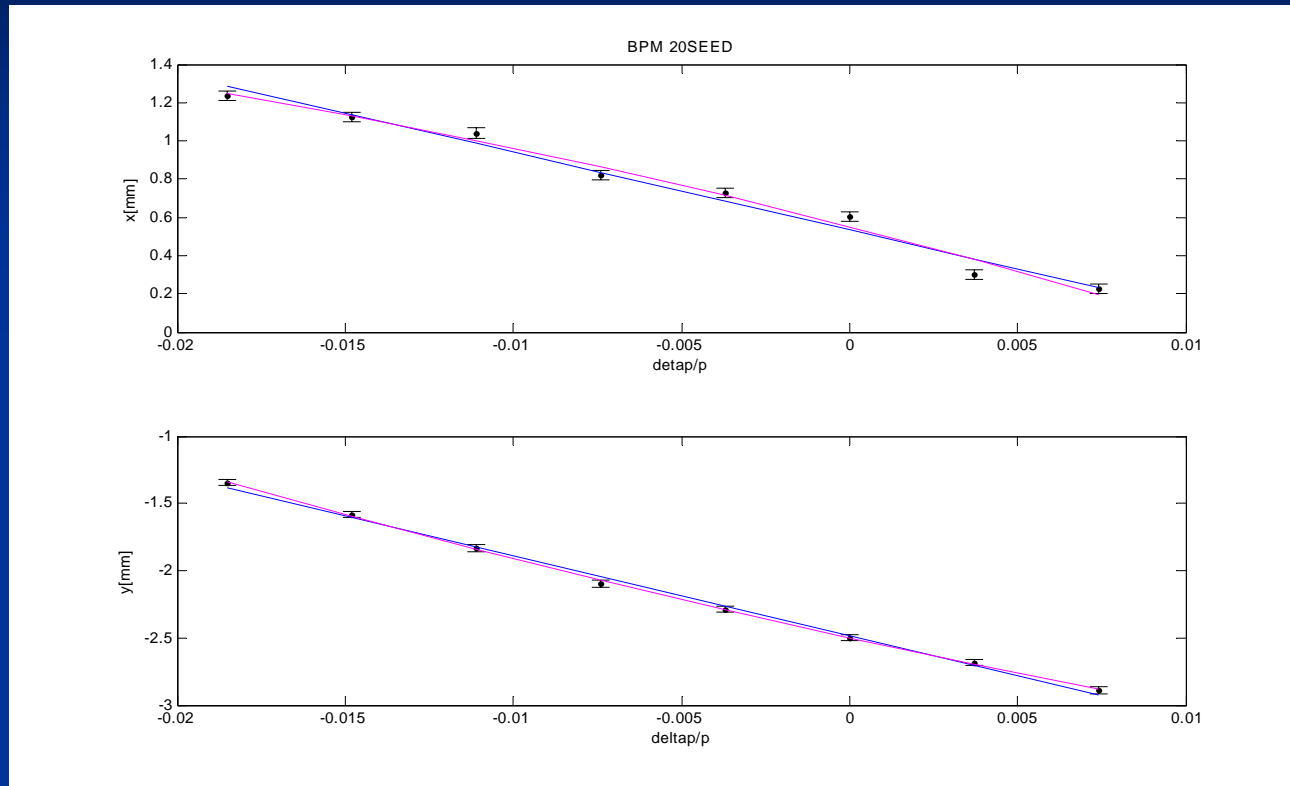   -Downstream ACC2-3
    -Downstream ACC4-5
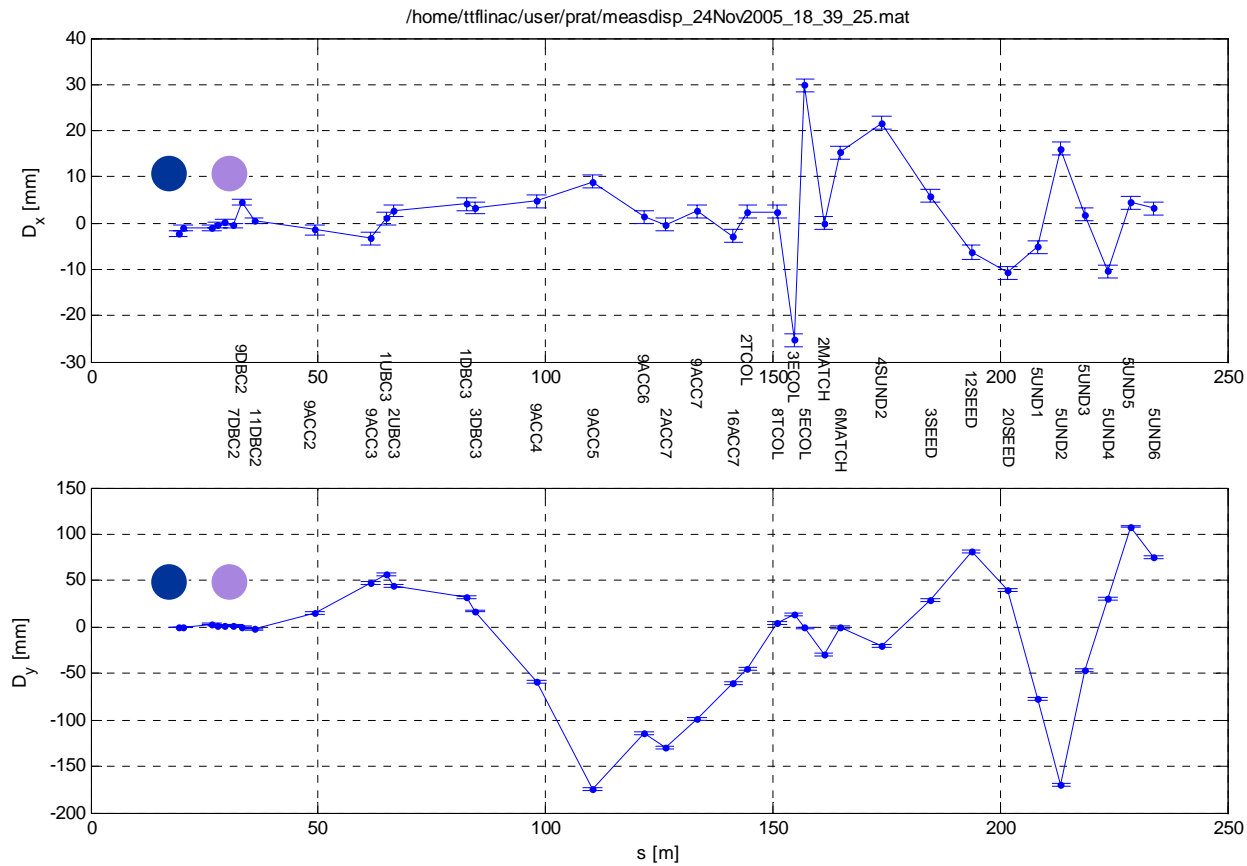
-Summary / Conclusions

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deltap/p profile

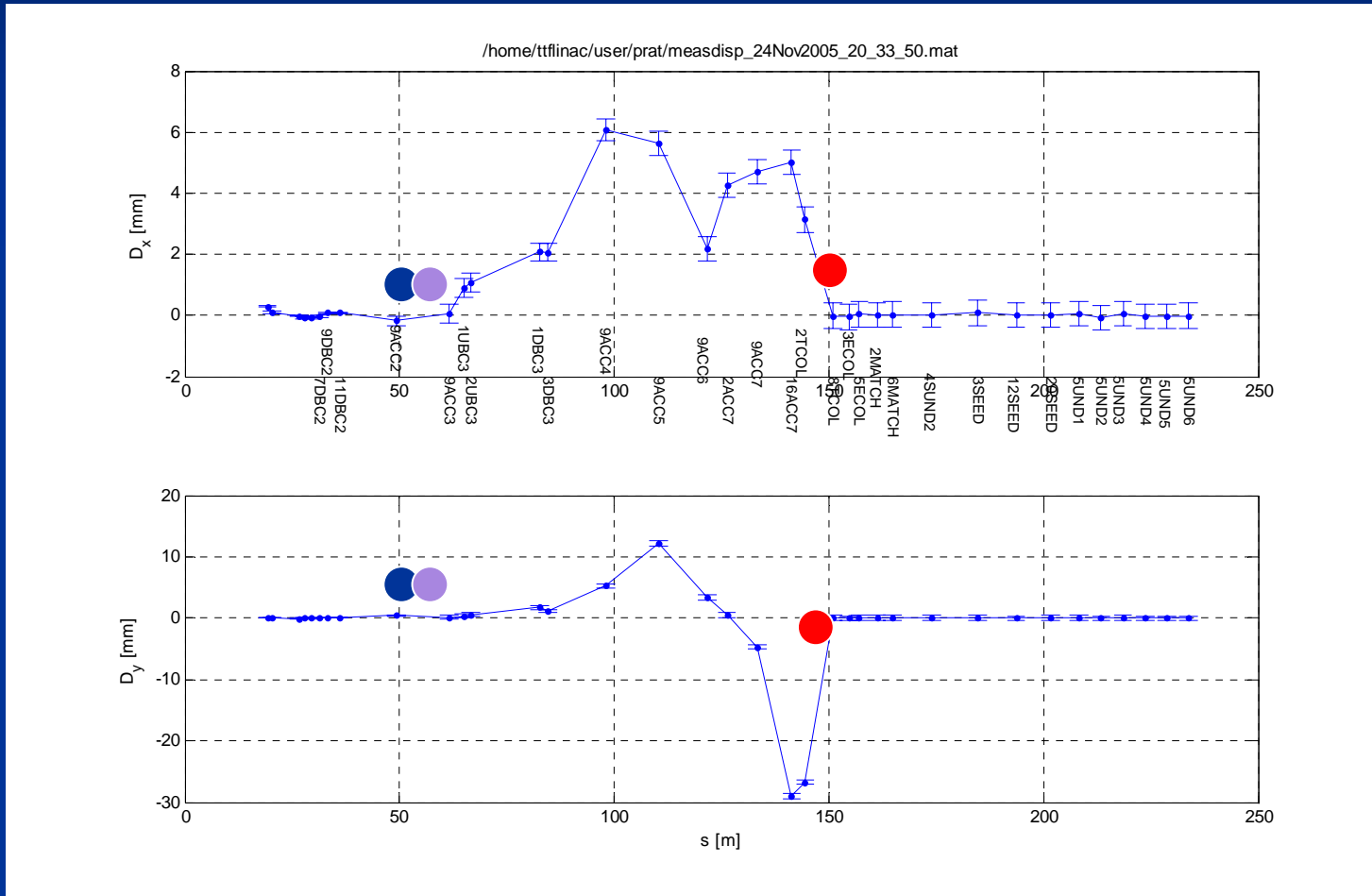# Example of dispersion measurement

$$x = x_0 + D_0 \frac{\Delta p}{p} + D_1\left(\frac{\Delta p}{p}\right)^2 + ...$$
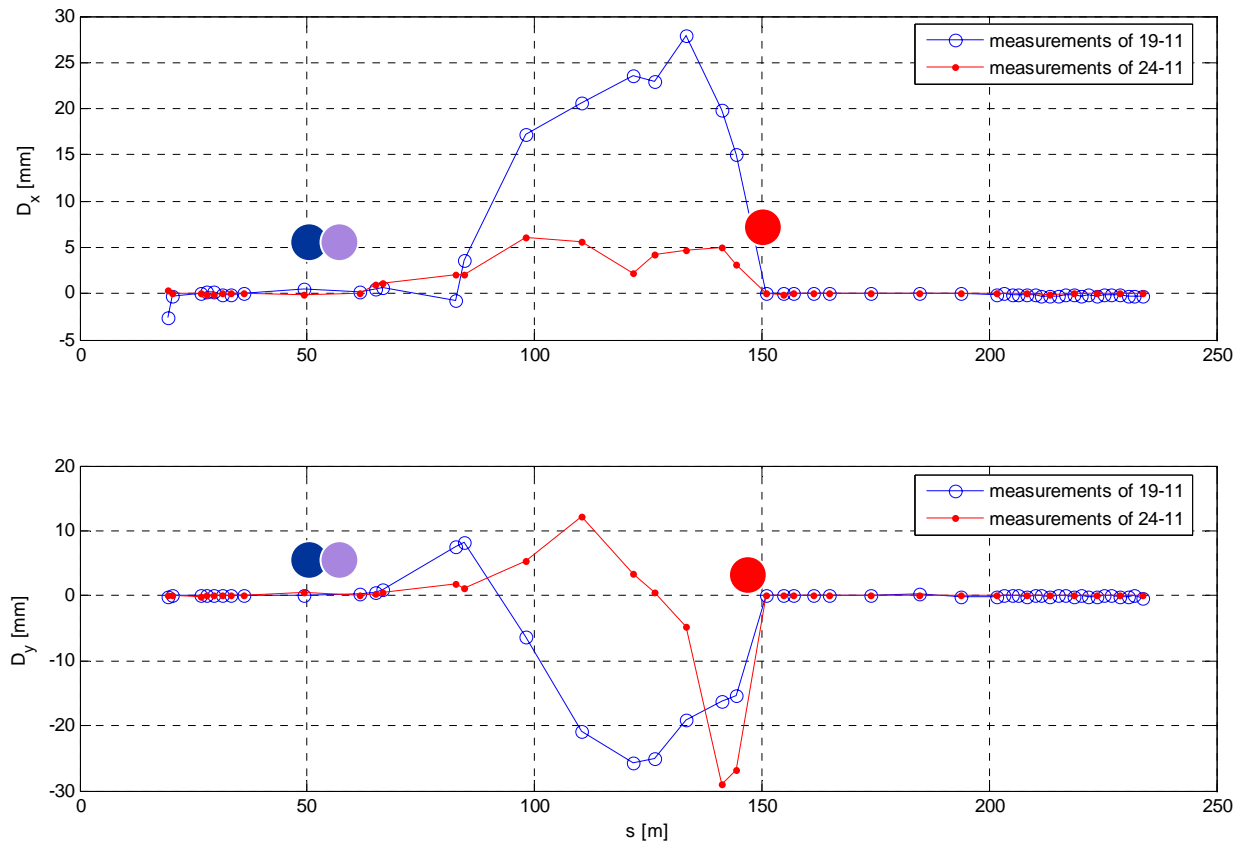
Dispersion

Dispersion DBC2÷undulator
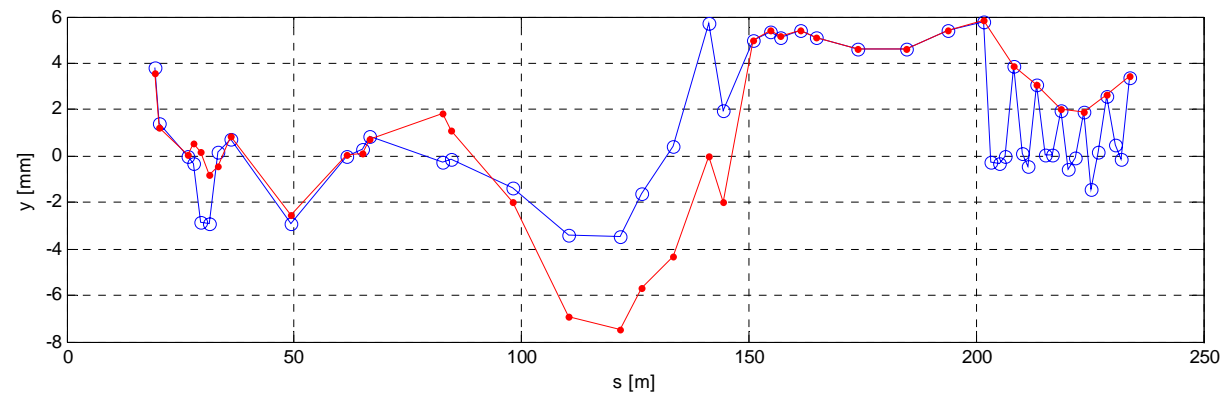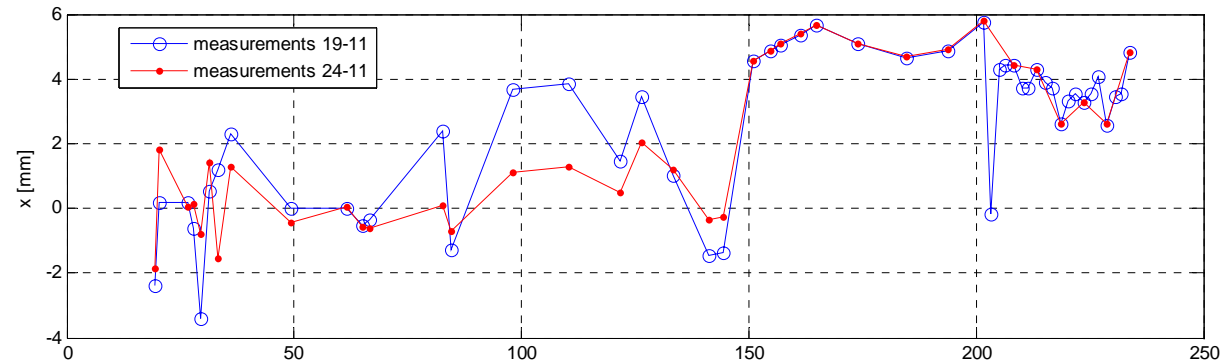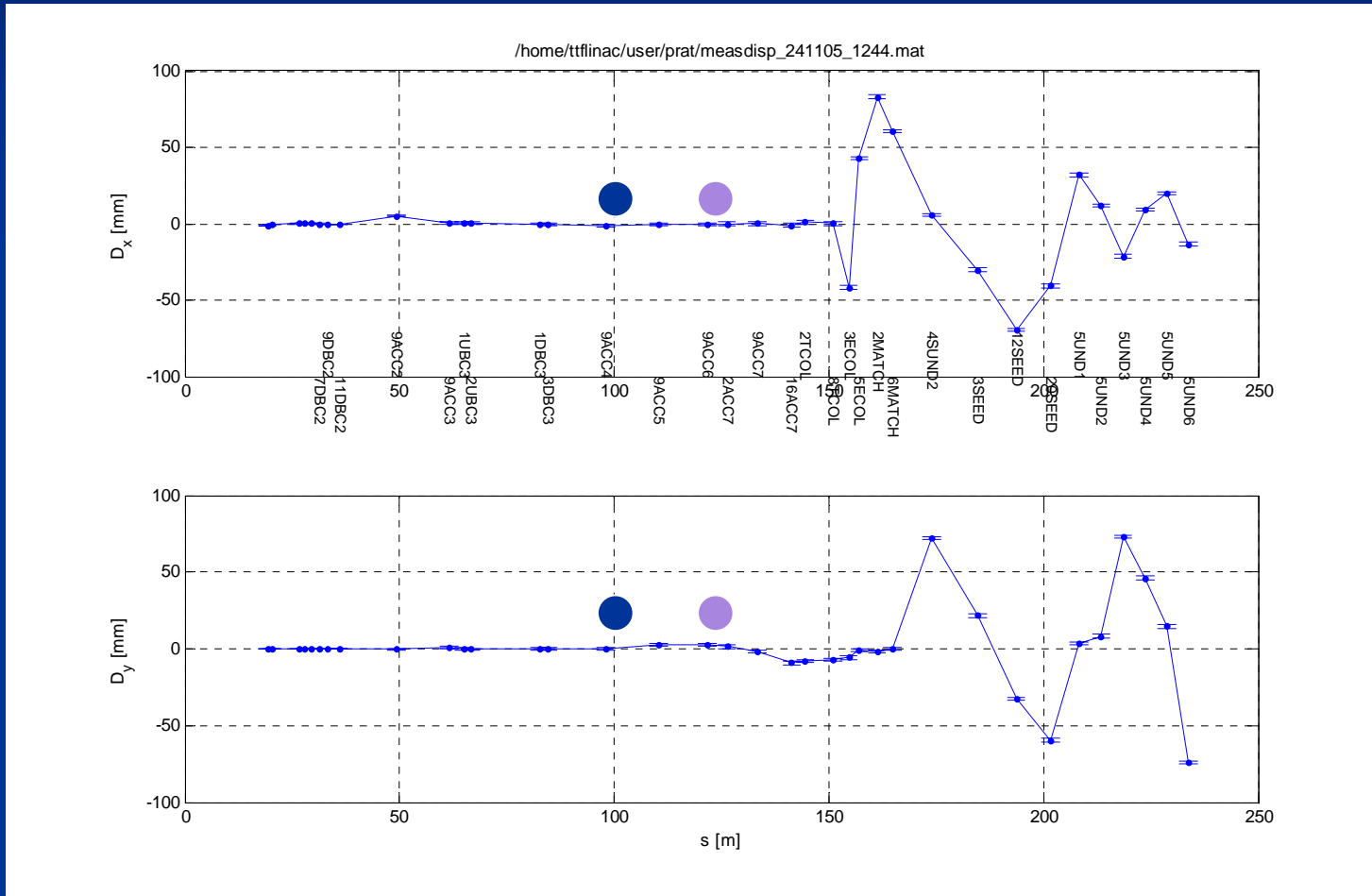
Dispersion downstream ACC2-3

Dispersion downstream ACC2-3
Differences between measurements
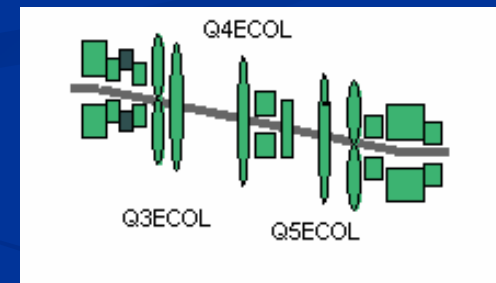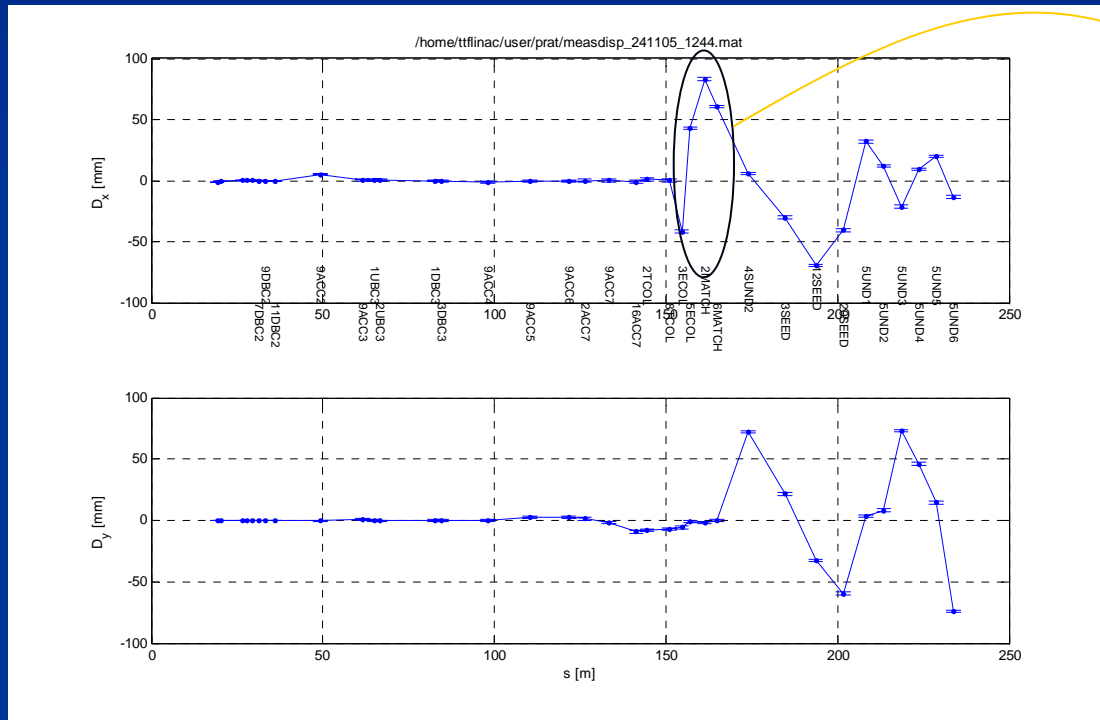
Dispersion downstream ACC2-3
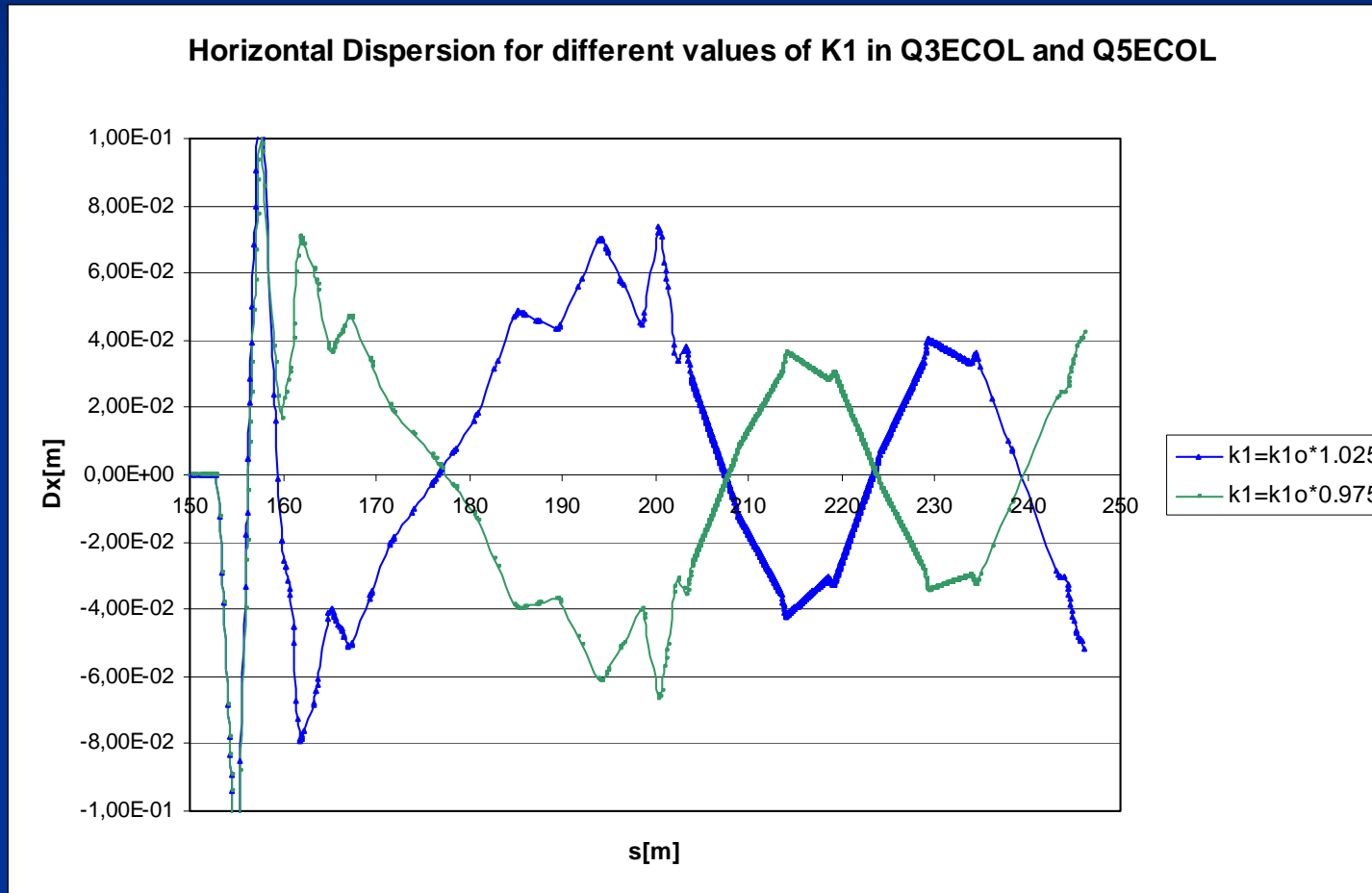## Differences between measurements

Dispersion downstream ACC4-5

Dispersion downstream ACC4-5 - Dogleg

Dispersion downstream ACC4/5 - Dogleg
Change Q3/Q5ECOL - Simulations

Horizontal Dispersion for different values of K1 in Q3ECOL and Q5ECOL

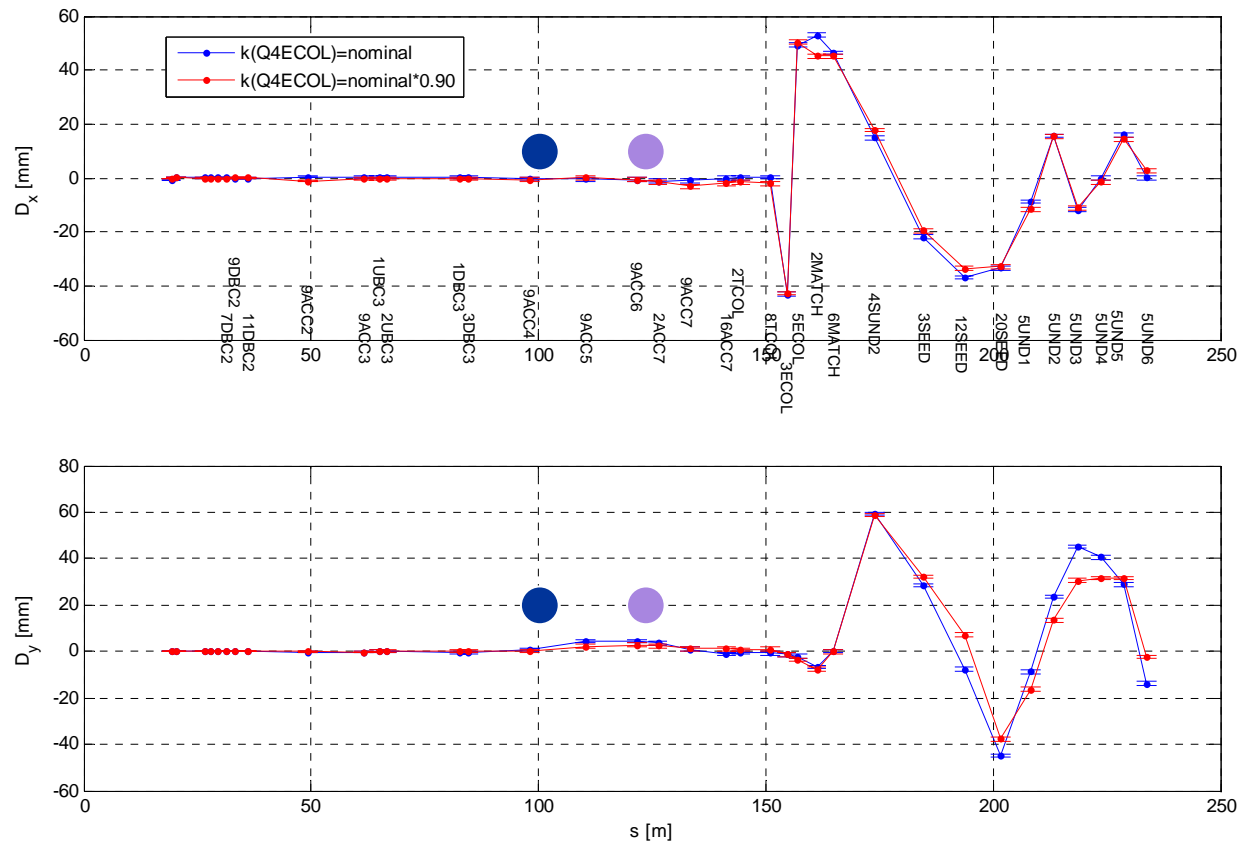# Dispersion downstream ACC4/5 - Dogleg
Change Q3/Q5ECOL - Measurements
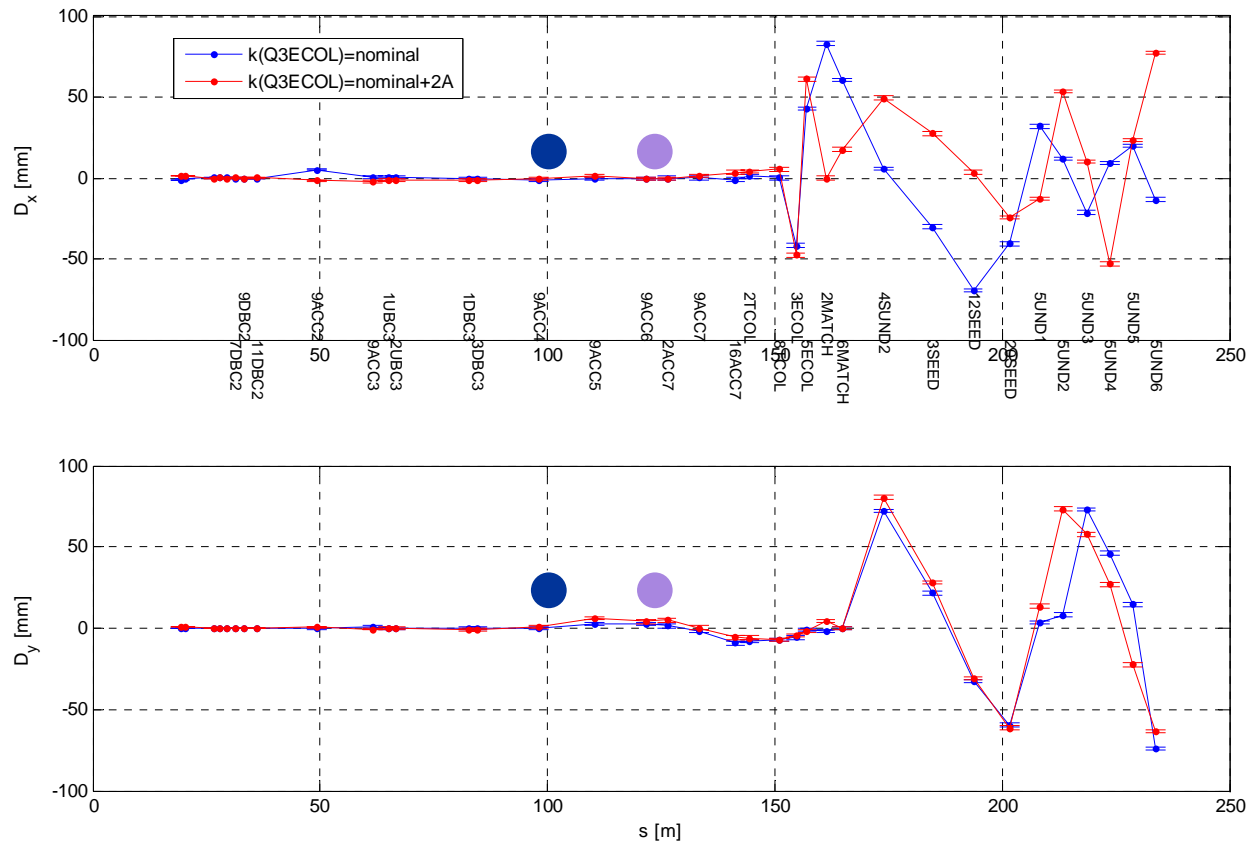
Dispersion downstream ACC4/5 - Dogleg
Change Q4ECOL

Dispersion downstream ACC4/5
Vertical bump (V3MATCH-V6MATCH-V5SUND2) – Simulations

centroid output--input: orbit_bump.ele   lattice: bump.lte
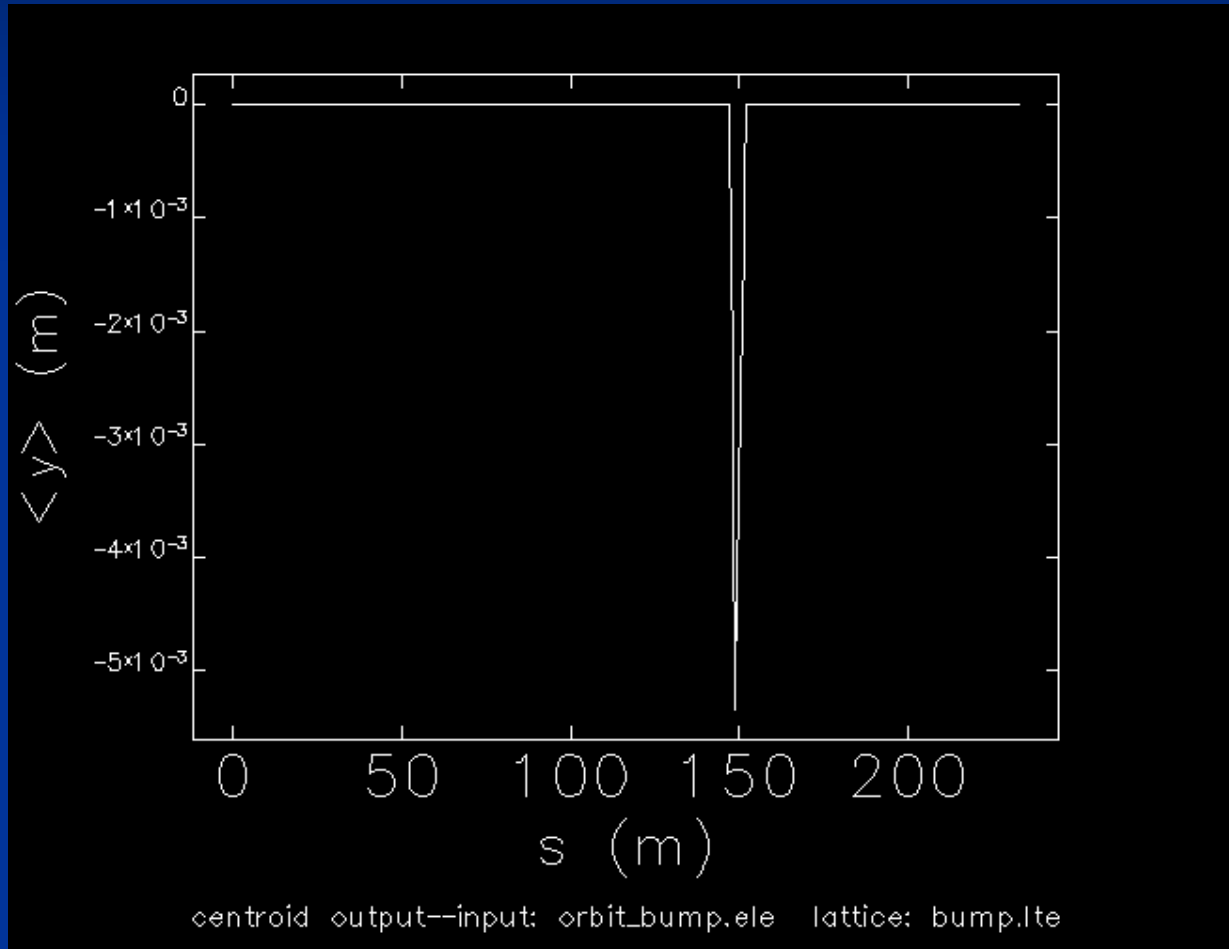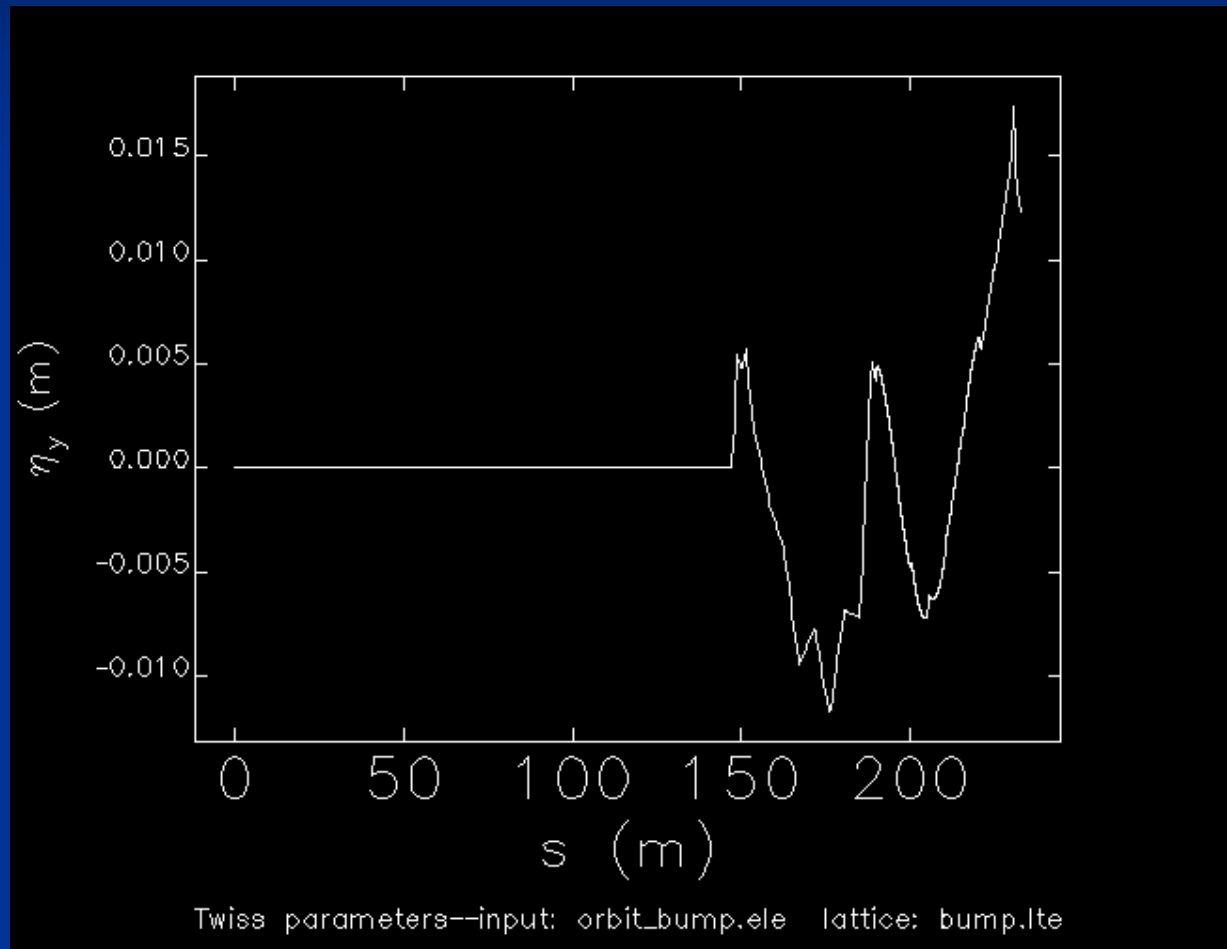
Dispersion downstream ACC4/5
Vertical bump (V3MATCH-V6MATCH-V5SUND2) – Simulations

Dispersion downstream ACC4/5
Vertical bump – Measurements
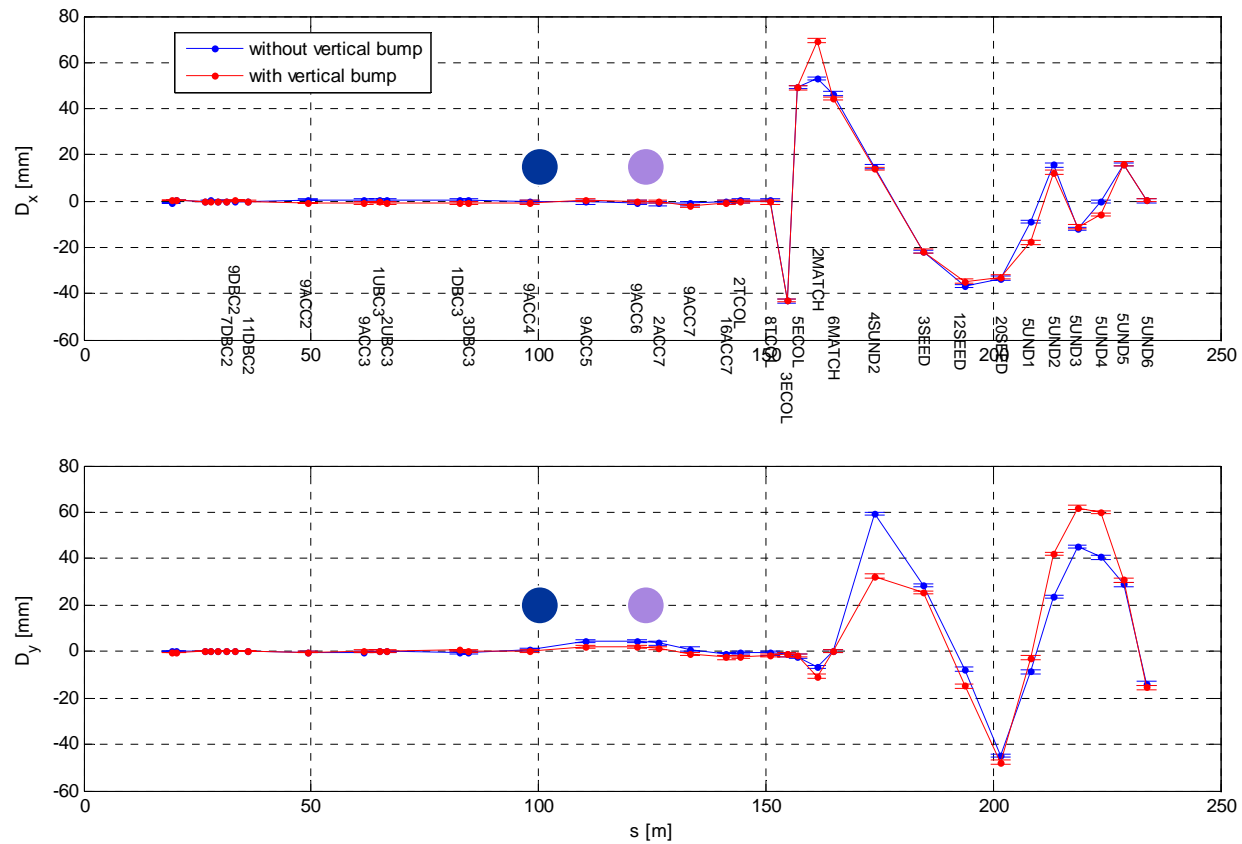
Dispersion downstream ACC4-5
Undulator
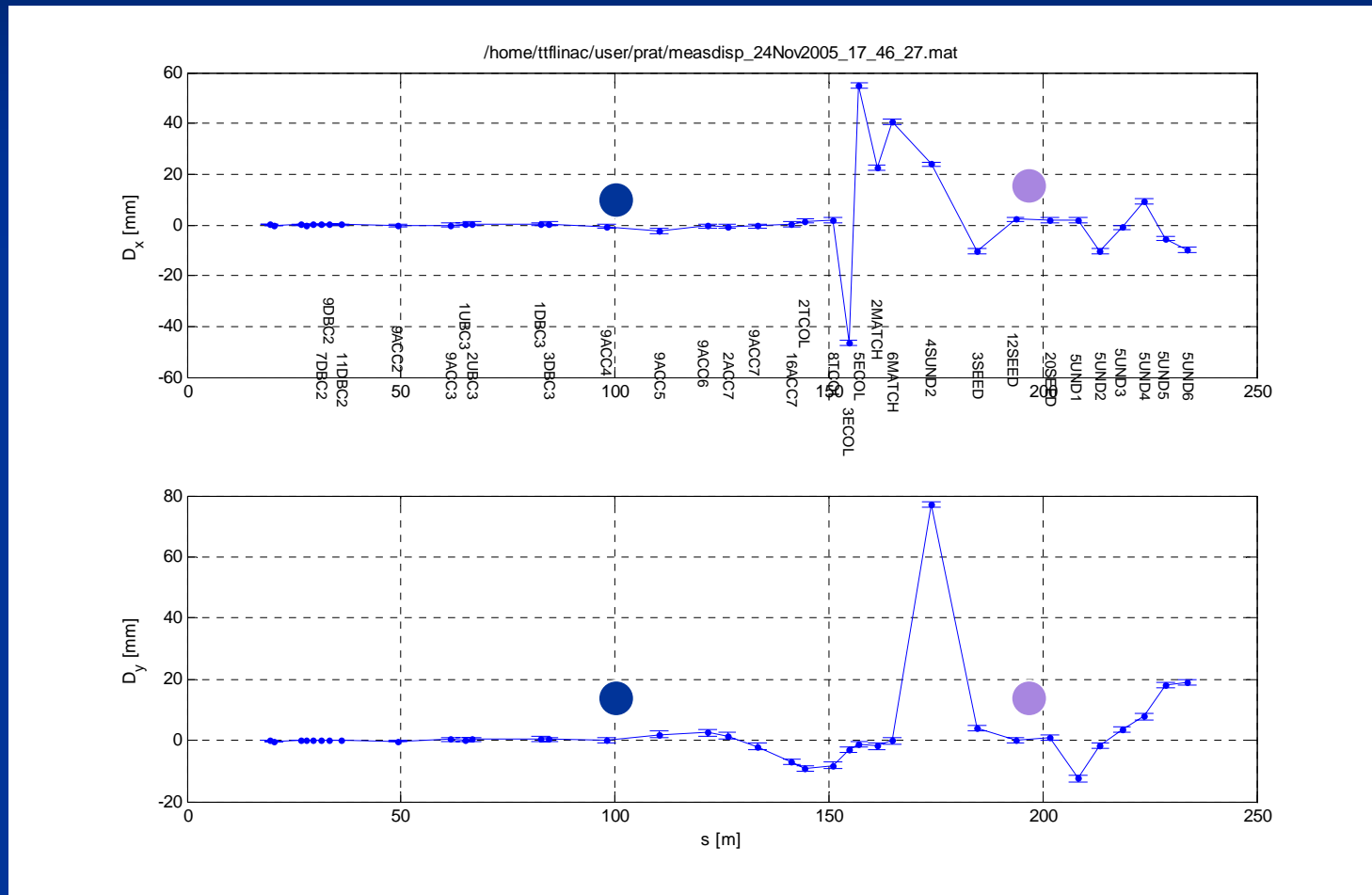
/home/ttflinac/user/prat/measdisp_24Nov2005_17_46_27.mat

Index

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-Summary / Conclusions

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Summary/conclusions

- Measurement DBC2-undulator dispersion shows 20mm horizontal dispersion in the undulator but 100mm vertical one

-Dispersion contribution of BC3 is about 5mm in the horizontal plane (contrary to previous measurements) and 20-30mm in the vertical plane

-Dog-leg seems to be a source for horizontal and vertical dispersion of about 60/70mm

-Dispersion generated in the undulator is about 10mm in the horizontal plane and 20 mm in the vertical one

-In general, vertical dispersion seems to be worse than horizontal one

-Changing Q3/Q5ECOL influences horizontal dispersion downstream the dog-leg

- Arbitrary orbit bump applied after the dog-leg improved vertical dispersion at 4SUND2 by 2cm but it got worse in the undulator

Next steps

-Further simulate dispersion measurements

-Develop dispersion correction methods

- Re-measure dispersion and correct it

Thank you!