



# 60° Optics - MD 6943

J. Keintzel

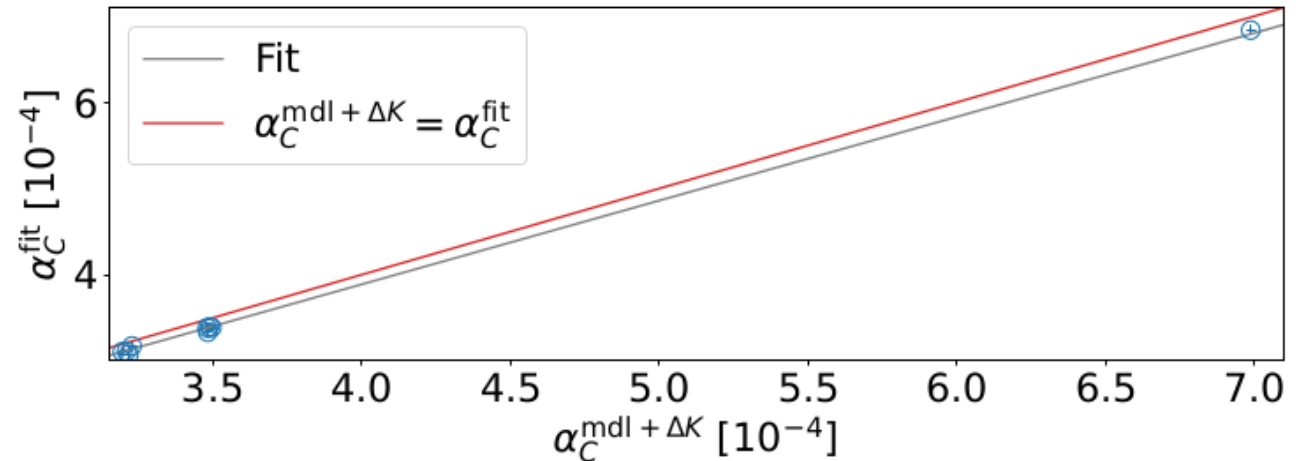
Acknowledgements:

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**OMC Meeting**  
CERN, Geneva, Switzerland  
26 November 2024

# Motivation of MD

- Origins of measured  $D_y$  and RDT jump in center of arc-56 for Beam 2 in 90° optics to be understood
  - Possible source could be rotated quadrupole (MQ.29.R5) of 15 mrad
- Beam 1 data of Run 2 and Run 3 (including 60°) show 3% larger momentum compaction
  - Strongly suggests average horizontal arc BPM calibration error of -3%, Beam 2 remaining
- With 60° optics errors are probed differently
  - Comparing measurements from both optics can help localizing lattice errors
  - Improved modelling and understanding
  - Possible improved corrections

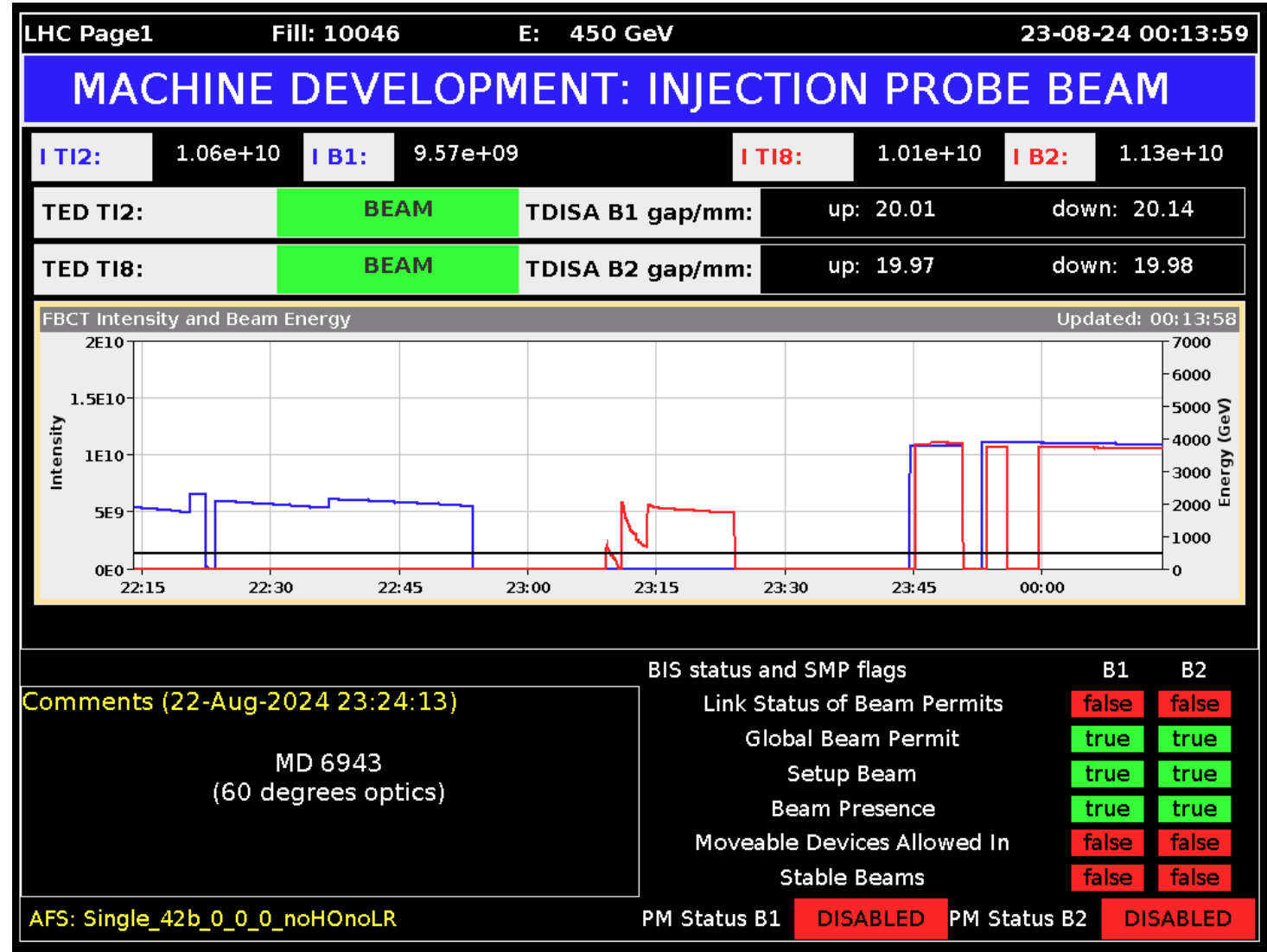


# MD Plan

- Perform beam threading for both beams
- Orbit corrections
- Linear on- and off-momentum optics measurements before global corrections
- Calculate and apply global optics corrections
- Linear on- and off-momentum optics measurements after global corrections
- Possibly perform non-linear measurements

# MD Start

- No precycle performed before
- Initial orbit correctors settings from 90° optics used
- OP performed beam threading for both beams
- Stable beams after ~3 h



# Orbit

- No precycle performed before
- Initial orbit correctors settings from 90° optics used
- OP performed beam threading for both beams
- Stable beams after ~3 h
- RMS orbit ~ 0.5 mm

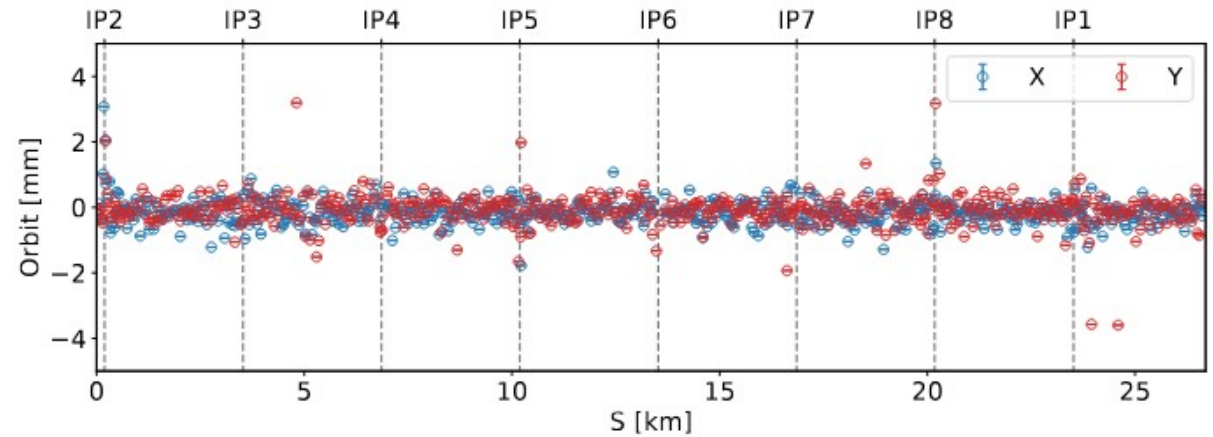


Figure 9: Beam 1 horizontal and vertical closed orbit measured from TbT data.

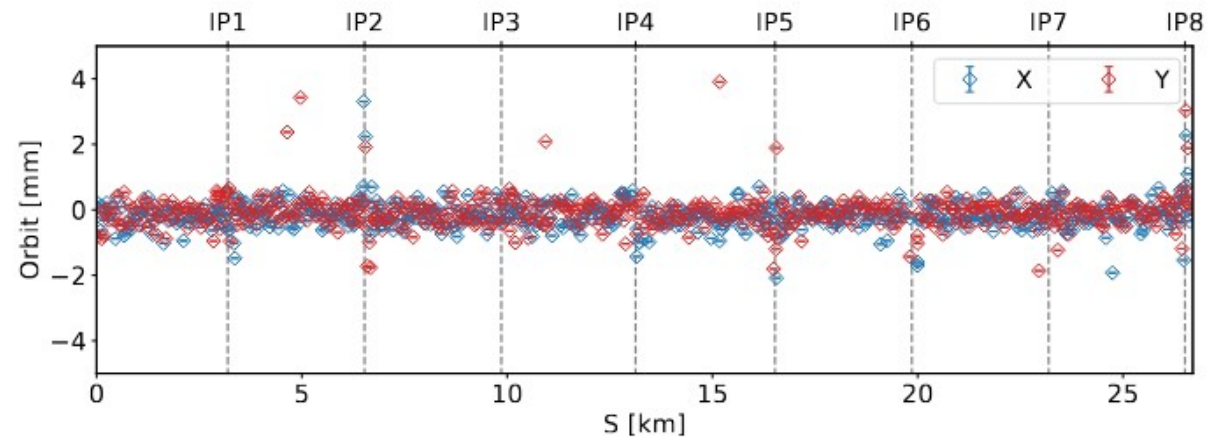


Figure 10: Beam 2 horizontal and vertical closed orbit measured from TbT data.

# Optics Measurements

Beam 1

- On- and off-momentum optics measured
- Global corrections calculated and applied
  - MQ\*4L8.B1: exceeding voltage error – to be understood
- Before: 50 % rms beta-beating
- After: Below ~10 % rms beta-beating

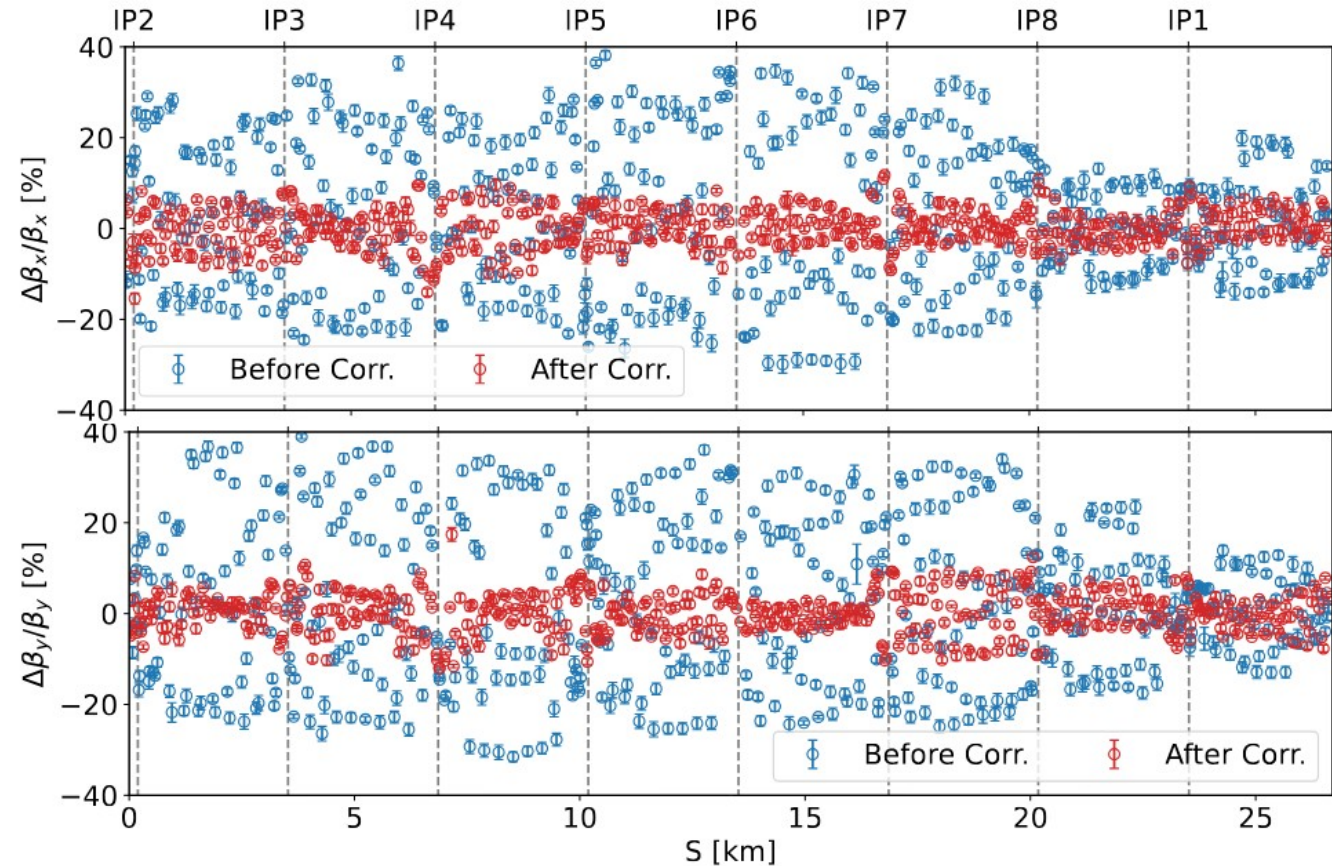
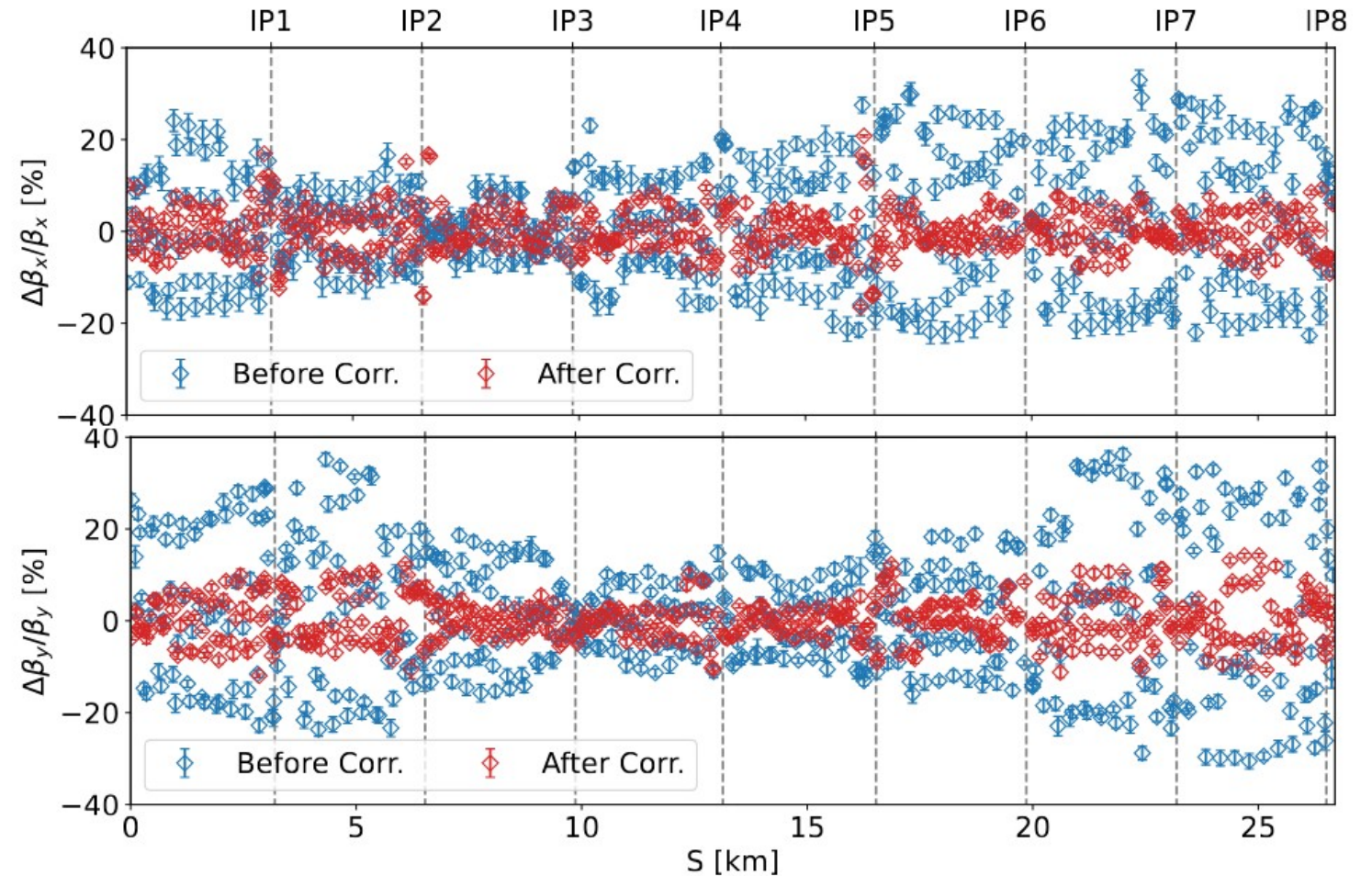


Figure 13: Beam 1  $\beta$ -beating before and after applying global corrections.

# Optics Measurements

Beam 2

- On- and off-momentum optics measured
- Global corrections calculated and applied
  - MQ\*4L8.B1: exceeding voltage error – to be understood
- Before: 50 % rms beta-beating
- After: Below ~10 % rms beta-beating



# Global Corrections

- Very large quadrupole strength change for beam 1 – one order of magnitude larger than for beam 2

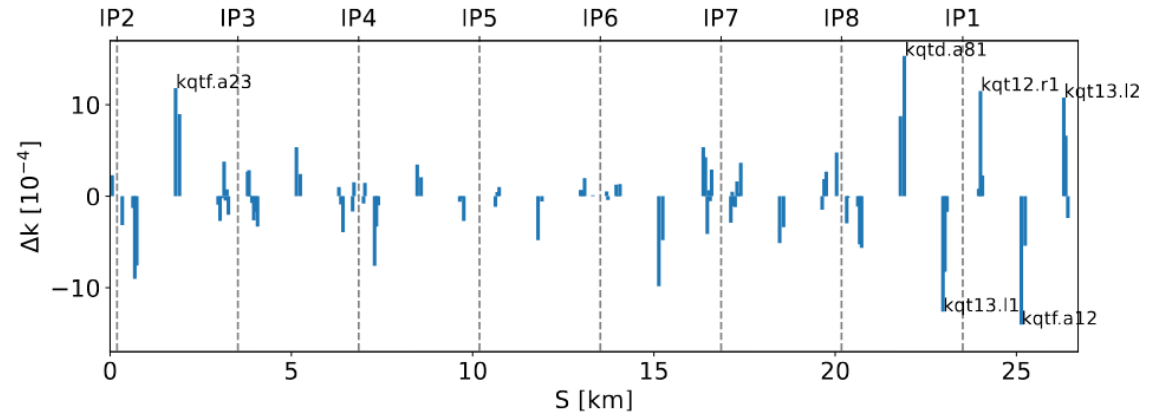


Figure 11: Beam 1 global corrections.

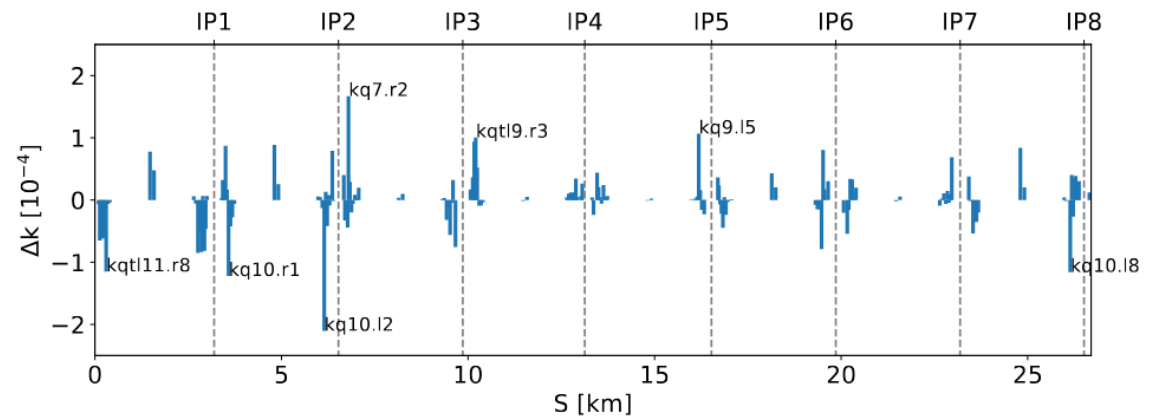
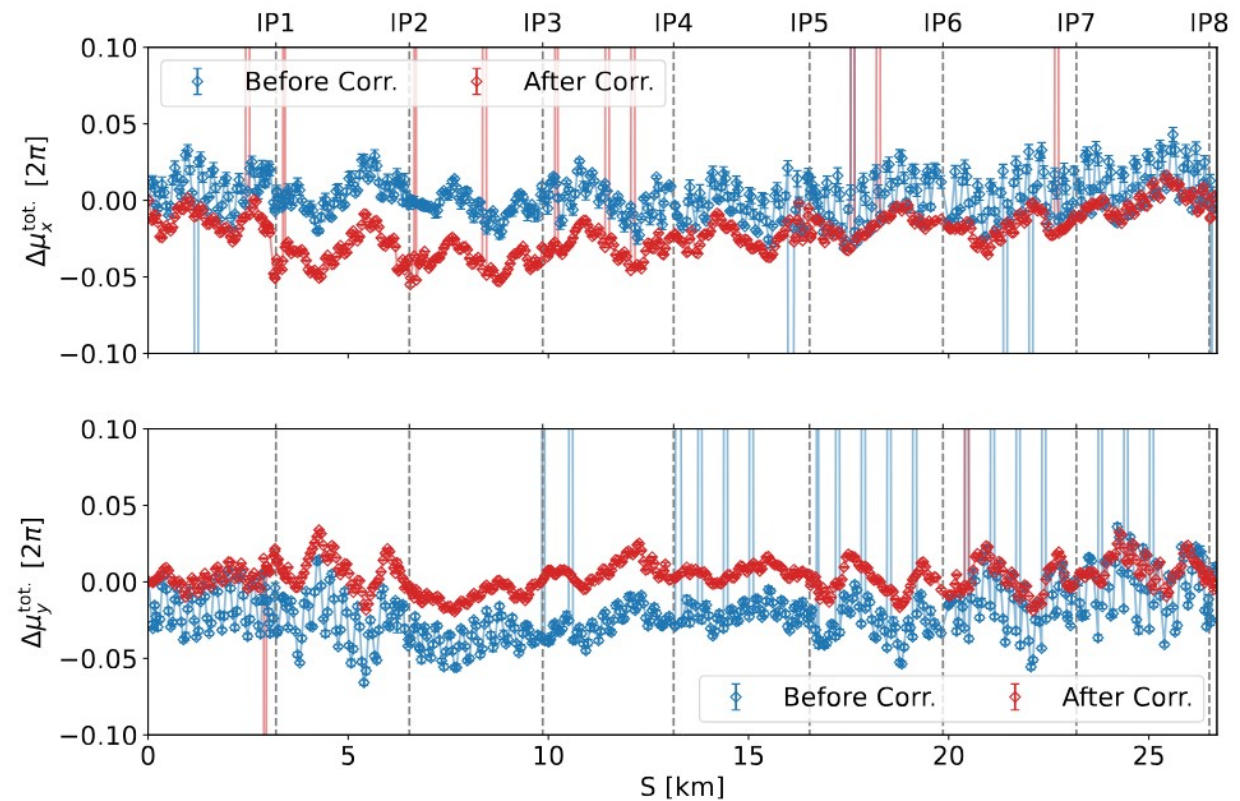
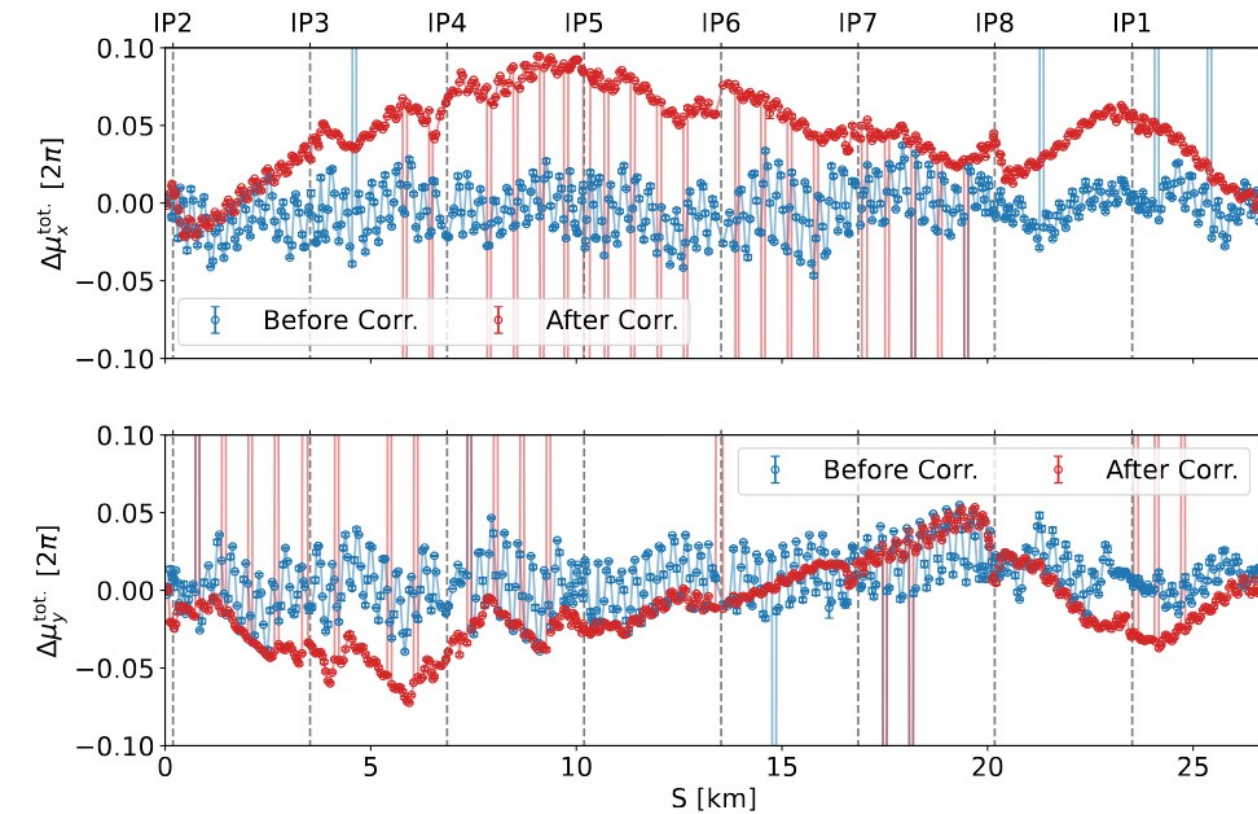


Figure 12: Beam 2 global corrections.

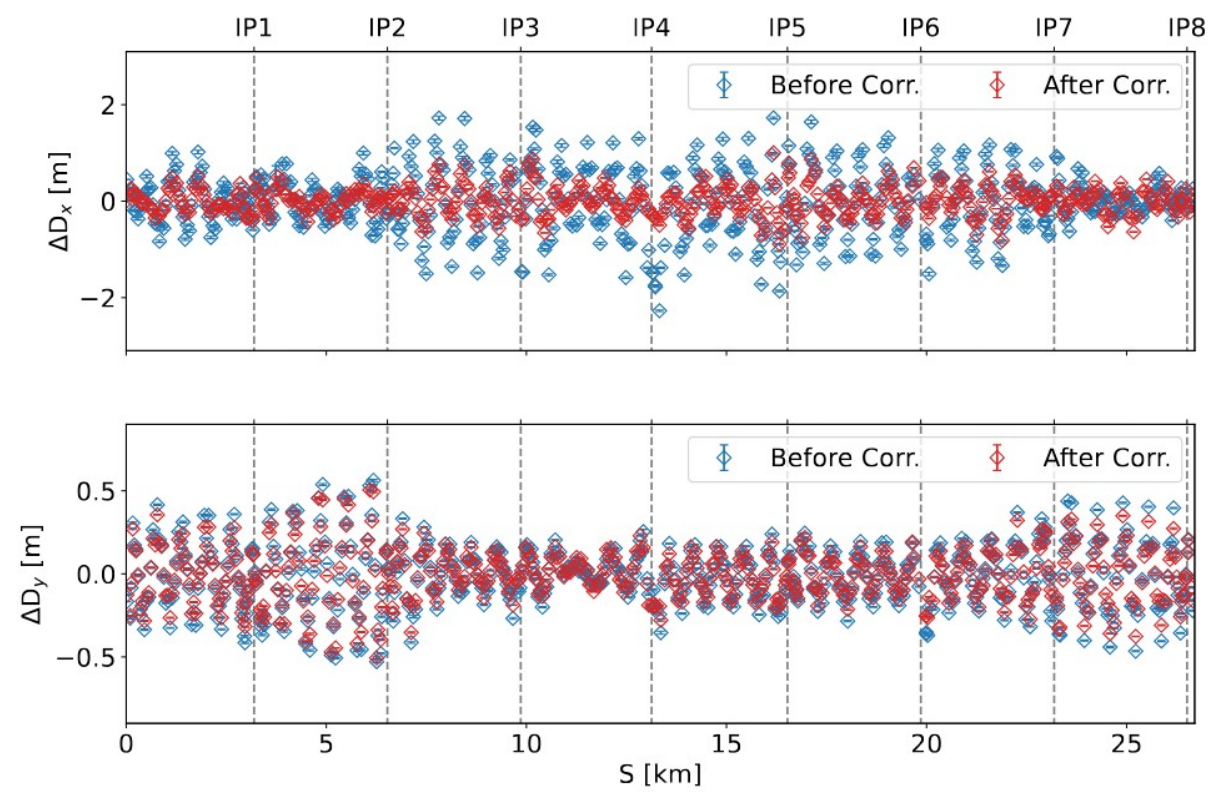
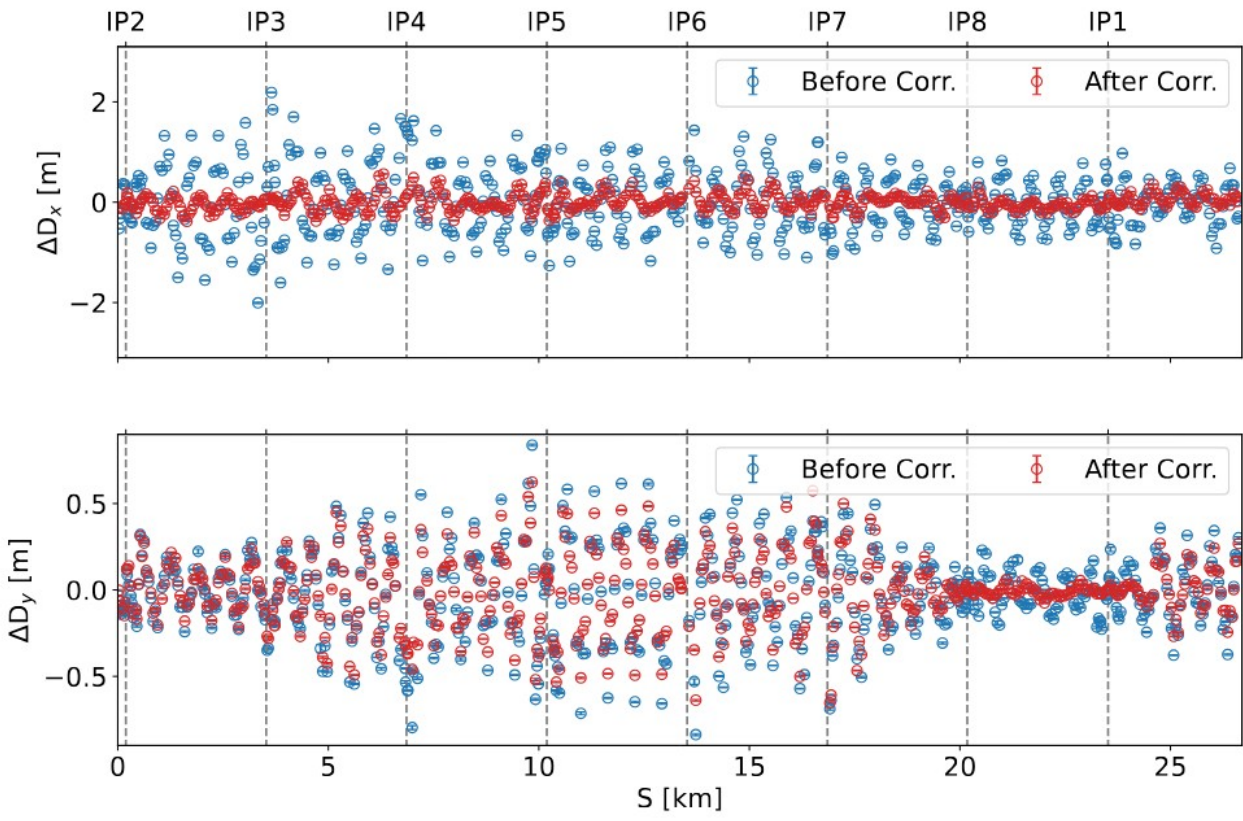


# Total Phase Advance

- Large phase advance error in beam 1

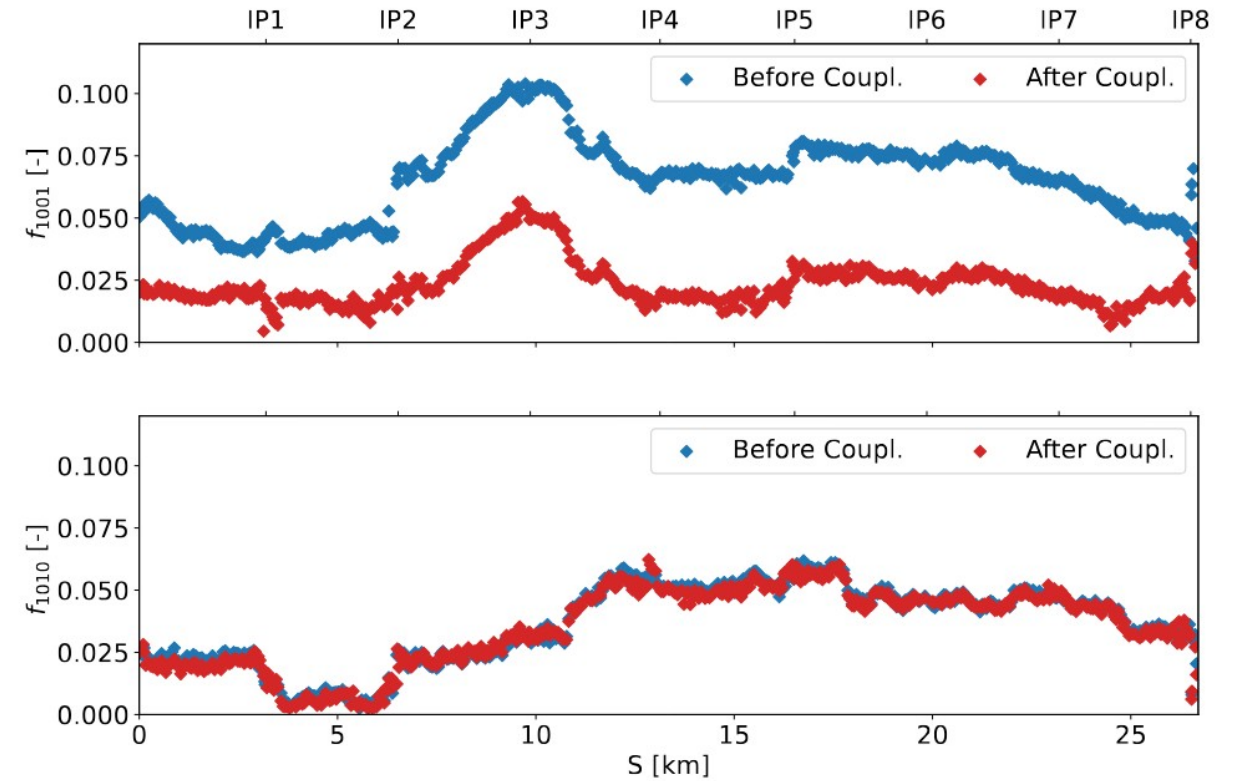
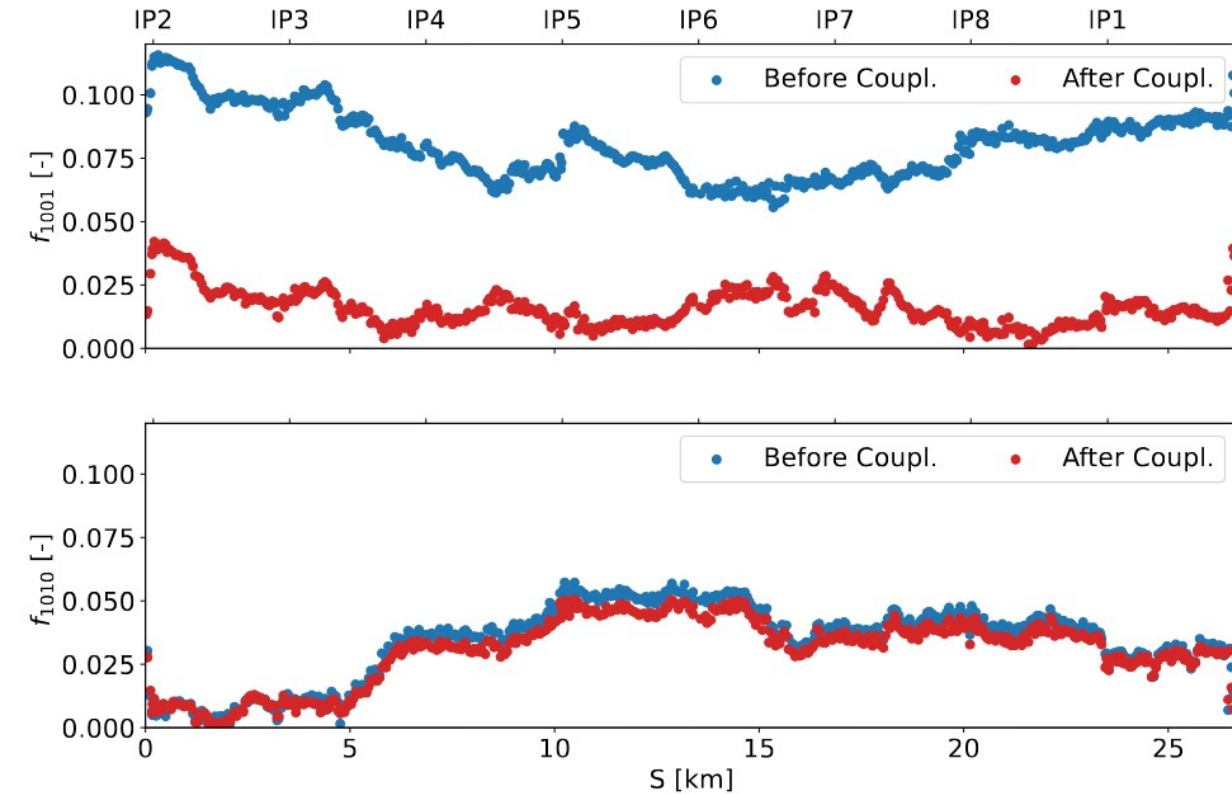


# Dispersion



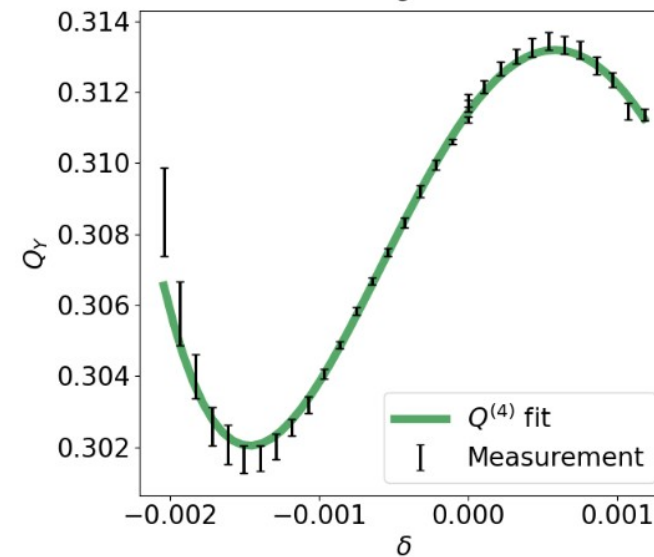
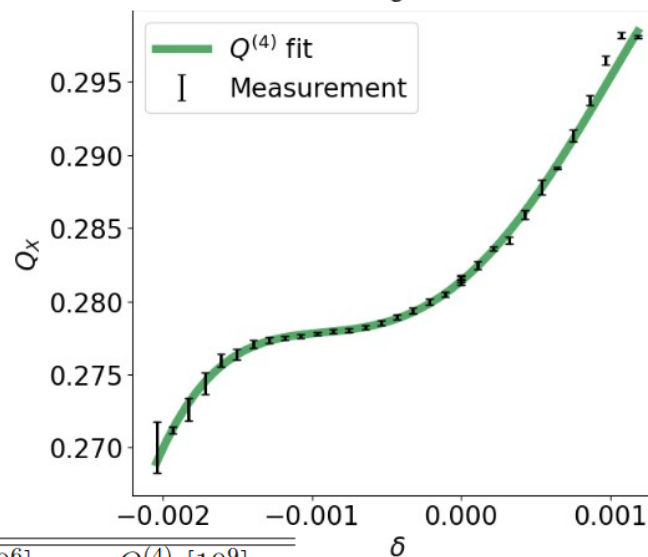
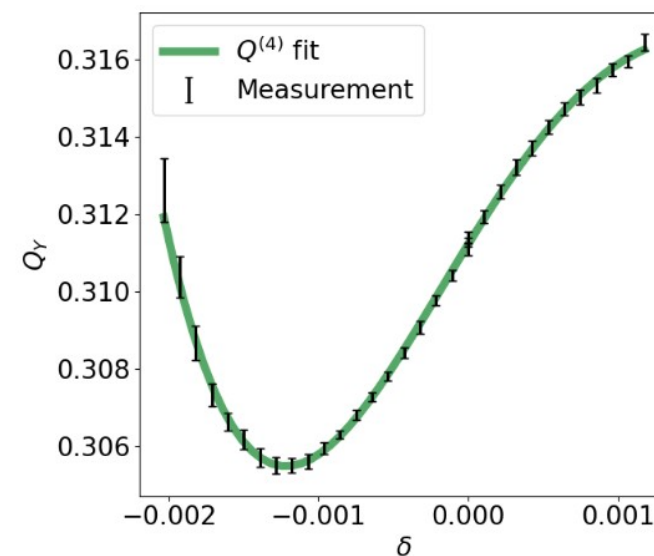
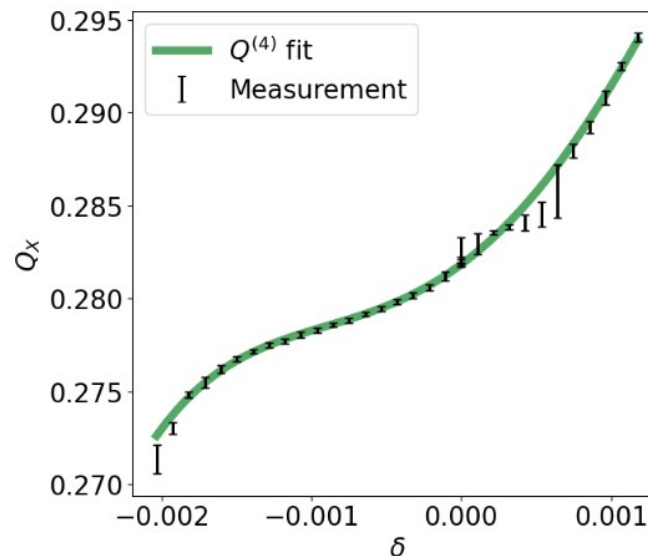
# Coupling Corrections

- Large coupling measured after global corrections – new coupling correction applied



# Chromaticity

- Chromaticity scans performed before and after global corrections, preliminary analysis for before correction

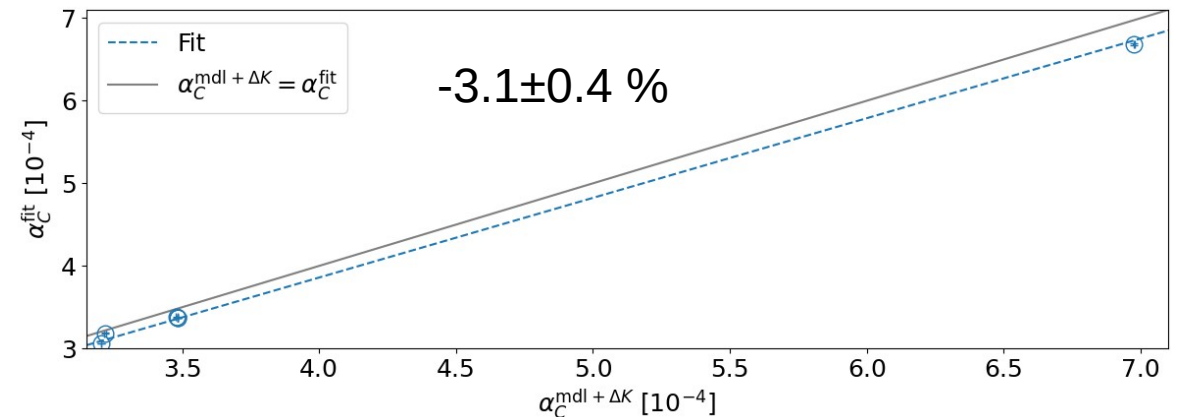
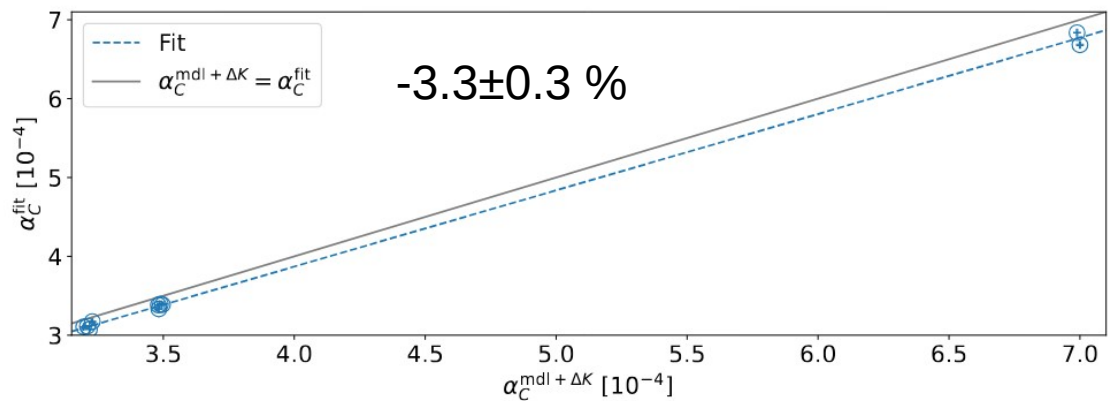
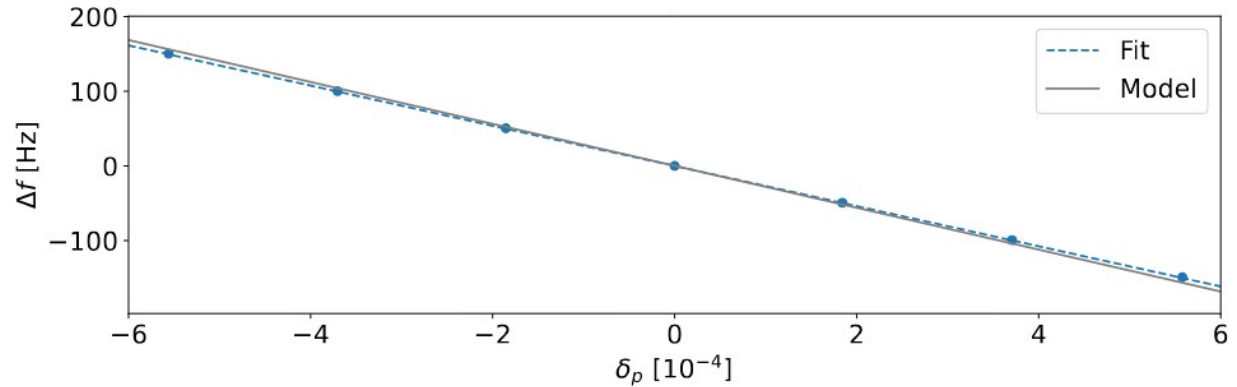
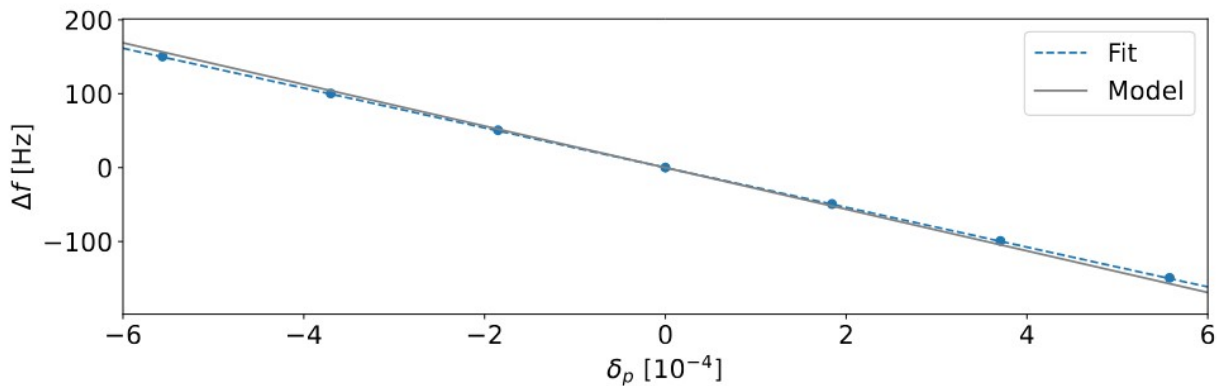


Axis	$Q$	$Q^{(1)}$	$Q^{(2)} [10^3]$	$Q^{(3)} [10^6]$	$Q^{(4)} [10^9]$
B1 Horizontal	$0.28 \pm 0.0$	$5.97 \pm 0.11$	$6.74 \pm 0.19$	$3.73 \pm 0.62$	$-8.12 \pm 1.42$
B1 Vertical	$0.31 \pm 0.0$	$6.28 \pm 0.05$	$-1.5 \pm 0.1$	$-7.4 \pm 0.28$	$8.74 \pm 0.74$
B2 Horizontal	$0.28 \pm 0.0$	$8.54 \pm 0.15$	$12.6 \pm 0.35$	$1.27 \pm 0.79$	$-26.85 \pm 2.15$
B2 Vertical	$0.31 \pm 0.0$	$5.77 \pm 0.1$	$-7.99 \pm 0.21$	$-9.37 \pm 0.58$	$14.24 \pm 1.65$

M. Le Garrec

# Momentum Compaction Factor

- Comparing 2 techniques for  $\delta p$ :  $\delta_p = \frac{\langle D_x^{\text{mdl}} x \rangle}{\langle (D_x^{\text{mdl}})^2 \rangle}$        $\delta_p^{\text{RF}} = - \left( \frac{1}{\gamma_{\text{rel}}^{-2} + \alpha_C} \right) \frac{\Delta f}{f}$





# Thank you!

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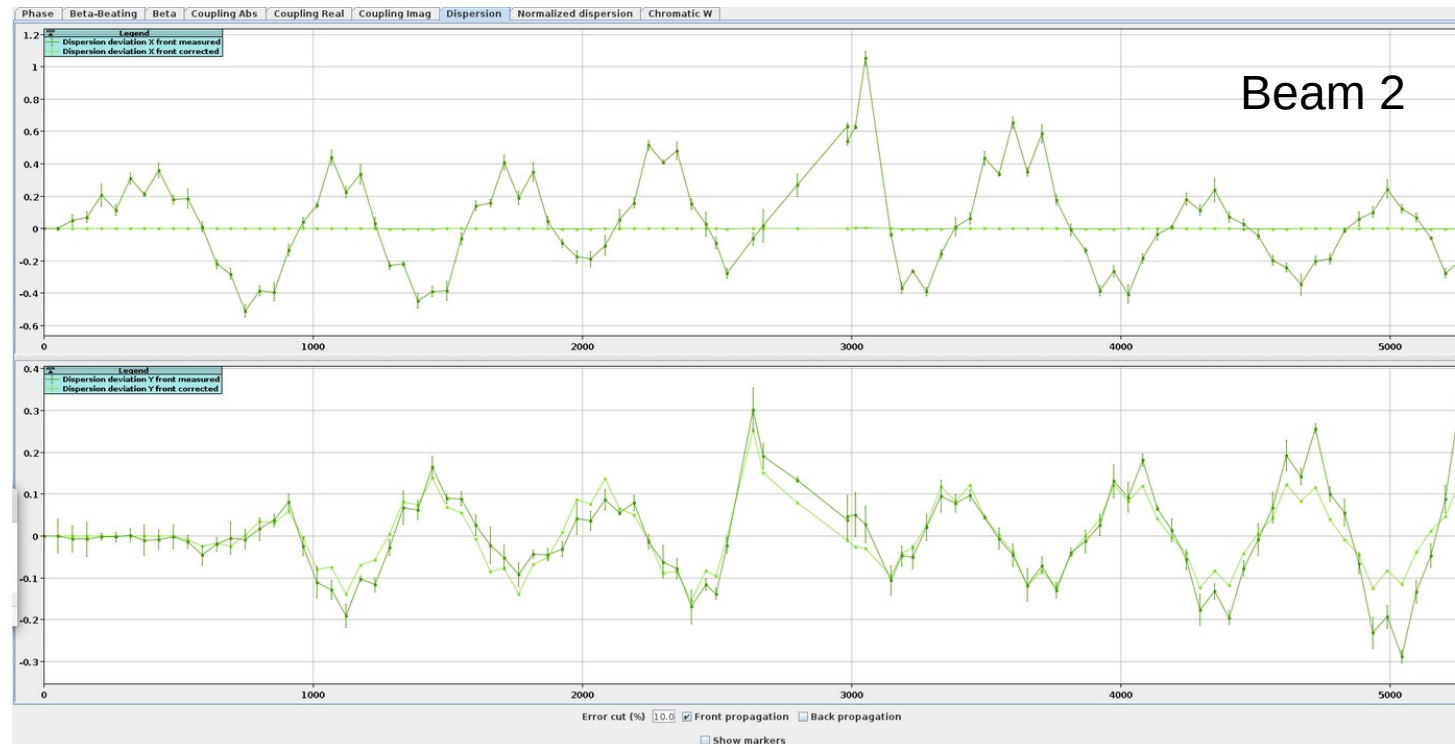
**LSWG**

CERN, Geneva, Switzerland

10 September 2024

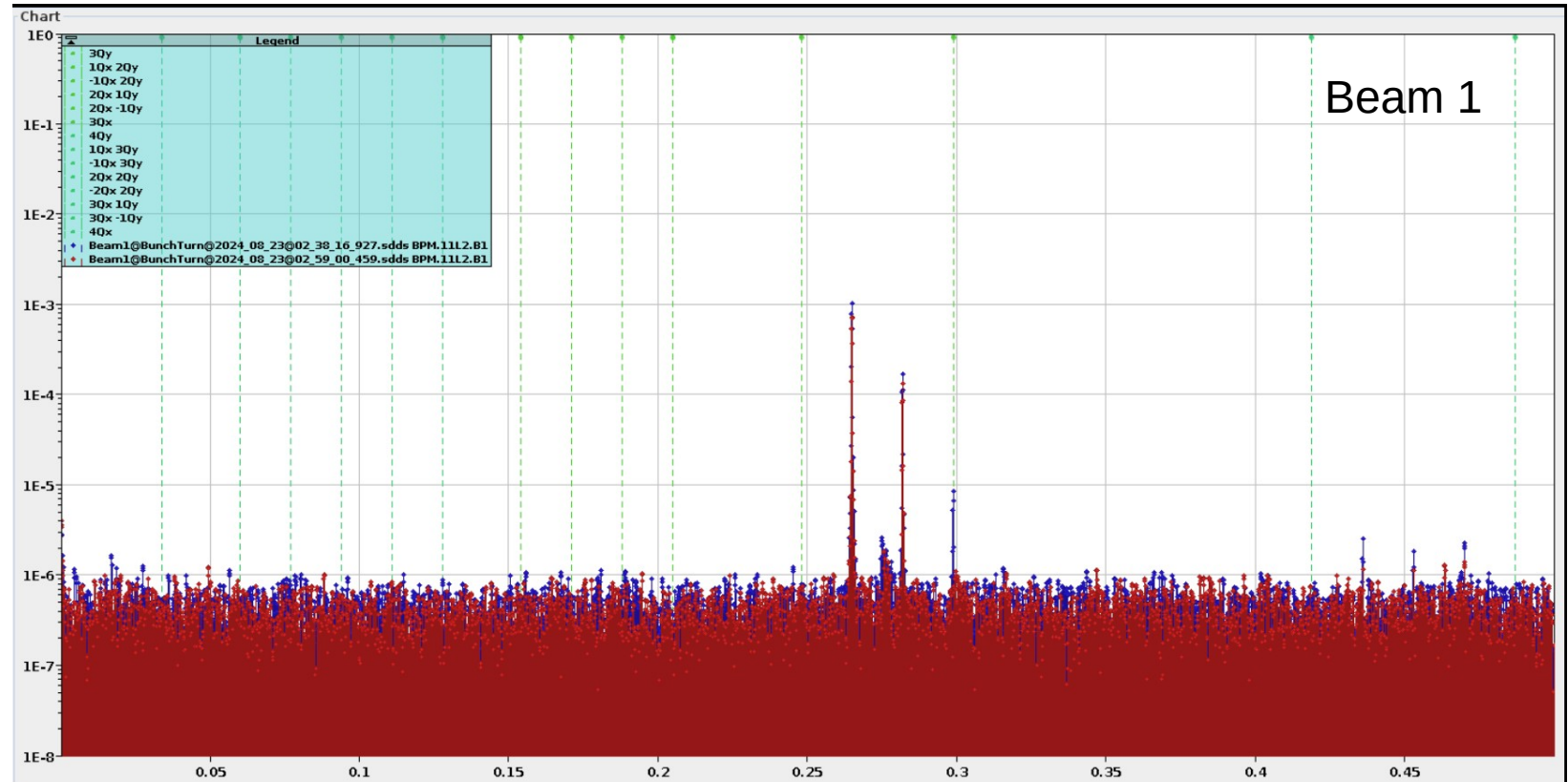
# Vertical Dispersion Jump

- In 90° optics MQ.29R5.B2 tilt of 15 mrad can reproduce observed jump
- In 60° optics MQ.29R5.B2 smaller tilt of only ~7 mrad
- Evaluating effect of orbit correctors ongoing before final conclusion can be drawn



# Octupolar Line

- Moved to e-cloud working point of 0.275, 0.293; AC-dipole deltas of -0.01, -0.011
- RDT f2002 and resonance lines (-1, 2) clearly visible
- Octupoles trimmed to + 5 m<sup>-4</sup>
  - Beam 1: line disappears
  - Beam 2: line enhances
  - To be understood





# Knobs and Initial Corrections

- Working point matched: 0.28, 0.31
- Coupling, large C- measured
  - Initially beam 1 / 2: 0.2 / 0.4
  - Corrected to below  $\sim 0.01$
- Chromaticity:
  - Chroma knobs did not change chroma linearly
  - Required correction of -40 units, could stem from conversion error
  - To be investigated

