MD4944: Local coupling measurement at the IPs

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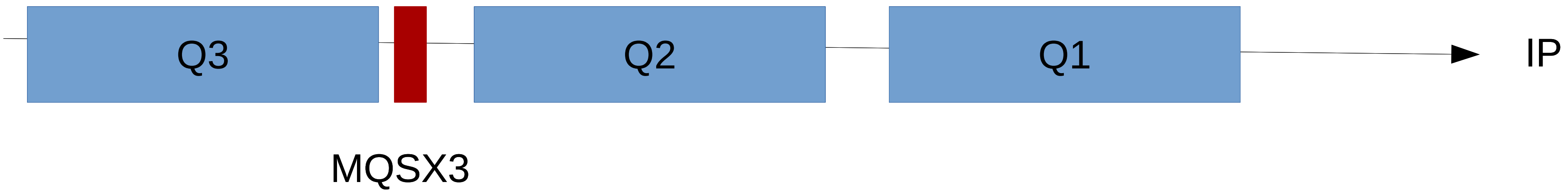
on behalf of the
Optics Measurement and Correction Team

Background

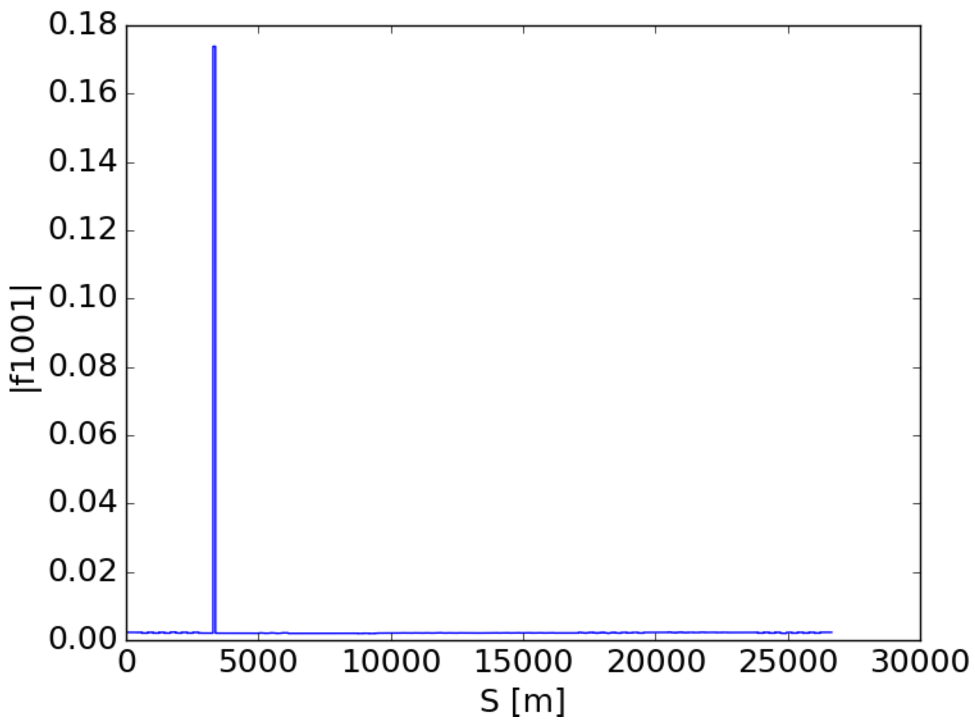
- The local coupling at IP2 increased the beam size significantly due to wrongly implemented correction of the local coupling
- Goals:
  - To test new methods to find the optimal correction without luminosity
  - Understand if there is an impact of the local coupling on the results from the K-modulation

Local coupling correctors



- We use the MQSX3 (left and right) to correct the coupling in the IRs
- Target:
  - To power the MQSX3s so that the coupling is zero at the IP for the two beams
- Challenge:
  - Increasing the left MQSX3 and decreasing the right MQSX3 gives almost no change outside the IR region
- The Colinearity knob (S. Fartoukh) :
  - Trimmed on top of the previous corrections
  - ΔMQXS.3L2 = +knobStrength* 10^{-4} m^{-2}
  - ΔMQXS.3R2 = -knobStrength* 10^{-4} m^{-2}
  - Optimal was found to be knobStrength=-12 (for this configuration)

Effect of the colinearity (-12) knob on f1001

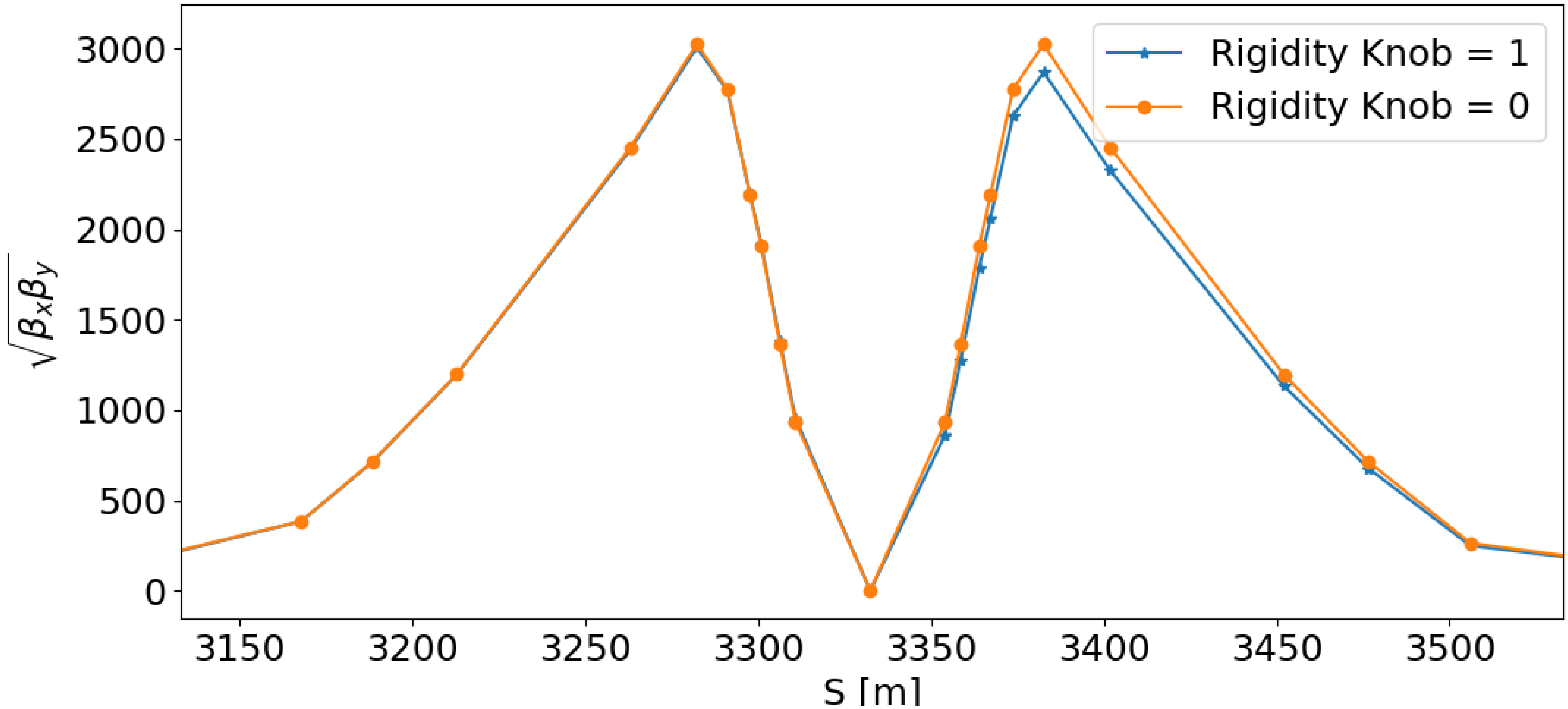


Expected change to the f_{1001}. Almost 0 impact on the global coupling.

1 unit of colinearity knob is ±1e-4 of MQSX

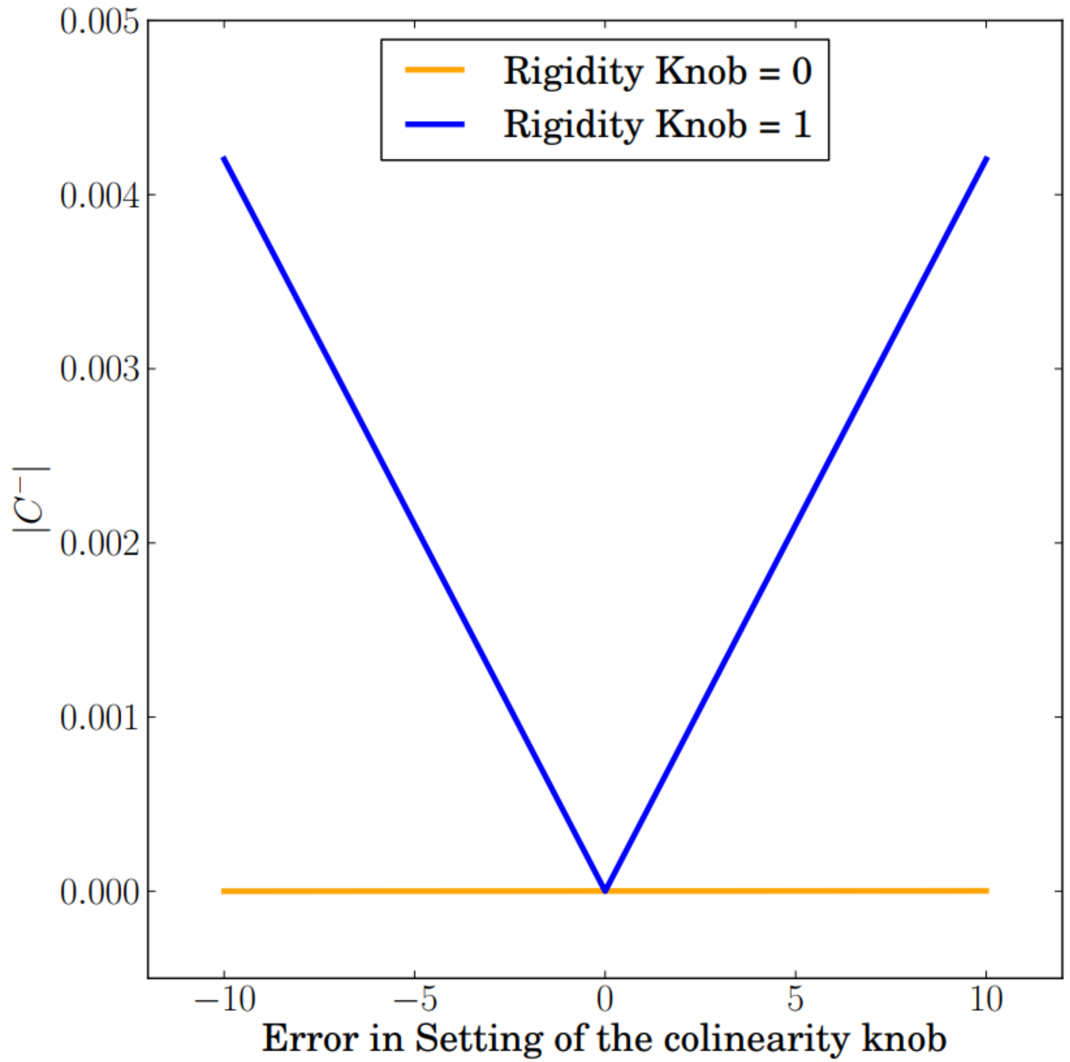
New method to measure the local coupling

- Principle of the rigid waist shift:
  - Unbalance the strength of the left and the right triplet
    - Breaks the left-right symmetry

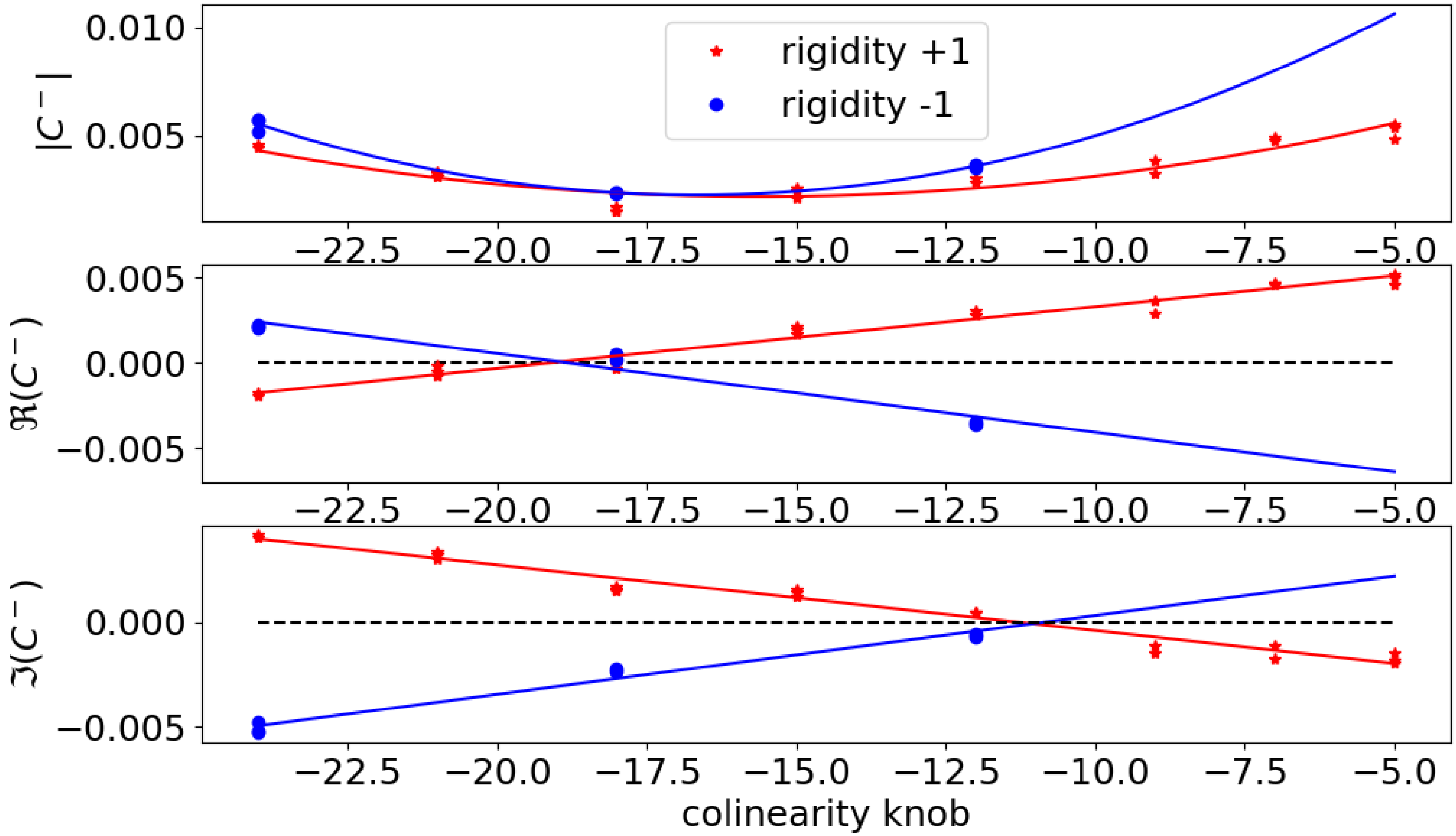


Rigidity waist shift knob

- The colinearity knob gives no contribution to the global observable |C-|
  - After applying the rigidity knob there is a dependency



Rigidity knob tested during the MD 2nd of December



During the MD we tested this strategy → optimal from this is between -15 and -16 → 3 - 4 units different from what was found with luminosity. Possibly different for the two beams.

Results from k-modulation taken during the MD (Beam 2)

	β* Horizontal [m]	β* Vertical [m]	Waist Shift Horizontal [m]	Waist Shift Vertical [m]
Colinearity -12 (operational setting of the machine for opposite polarity)	0.514	0.502	-0.08	-0.01
Colinearity -5	0.5084	0.5051	-0.049	0.025

Small change in the measured horizontal and vertical β* and waist shift as a function of the setting of the colinearity knob

The results are consistent with simulation → k-modulation is measuring β_x and β_y,

→ For a situation with strong coupling beam size is **not** equal to $\sqrt{\beta_x \epsilon_x}$

Pro:

- Measurement insensitive to local coupling errors
  - → Can be used for our normal quadrupolar corrections

Conclusion

- The MD was crucial to collect data to be ready for the commissioning after the Long shutdown
- The preliminary results indicates:
  - The settings of the MQSX can be found within a few 10-4 with the rigid waist shift→ luminosity reduction of a few percent.
  - The results shows that the K-modulation can be used to correct the normal quadrupolar error even in the presence of local coupling
- We were able to have good quality optics measurement with ions. In the past this was not possible due to the lower intensity
  - Not possible to use for studies where we need to excite to higher amplitudes due to the larger emittance.