

Studies of transverse instabilities in the CERN SPS

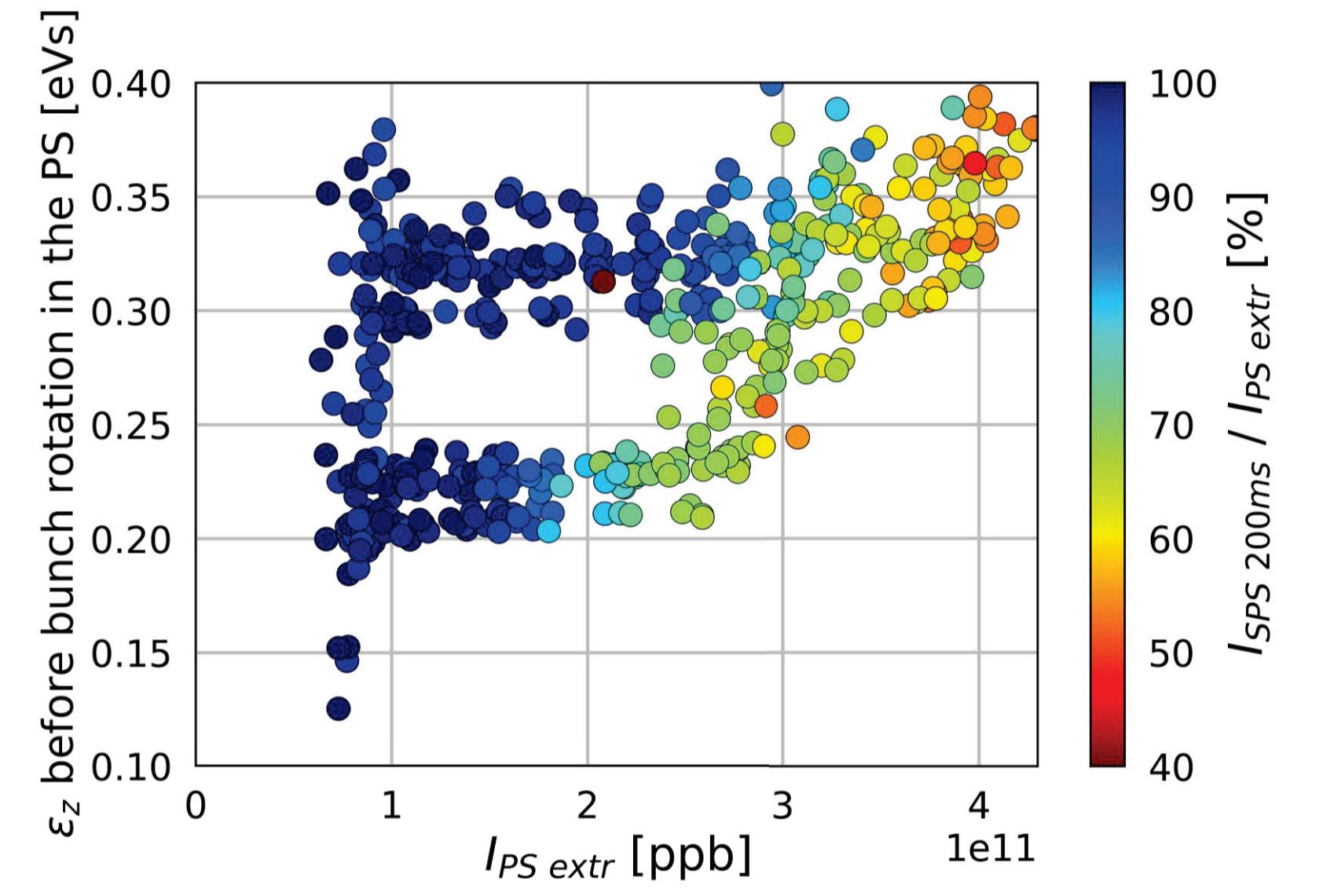
M. Beck*, H. Bartosik, M. Carla, K. Li, G. Rumolo, M. Schenk, CERN
U. van Rienen, University of Rostock

Motivation of the study

- For the LIU project the SPS is supposed to accelerate intensities, nearly twice as high as the current ones. **One of the major intensity limitations in the SPS is the vertical Transverse Mode Coupling Instability (TMCI).**
- To relax the demand on the RF power supplies the Q22 optics with intermediate transition energy has been proposed and has to be investigated.
- Octupoles introduce amplitude detuning which leads to a tune spread and creates Landau damping. They also contribute a second order chromaticity.
- To stabilize possible horizontal single bunch instabilities which occurred during recent high intensity (**2e11 ppb**) multi-bunch runs in the SPS the effect of the octupoles is investigated.

TMCI studies in the SPS

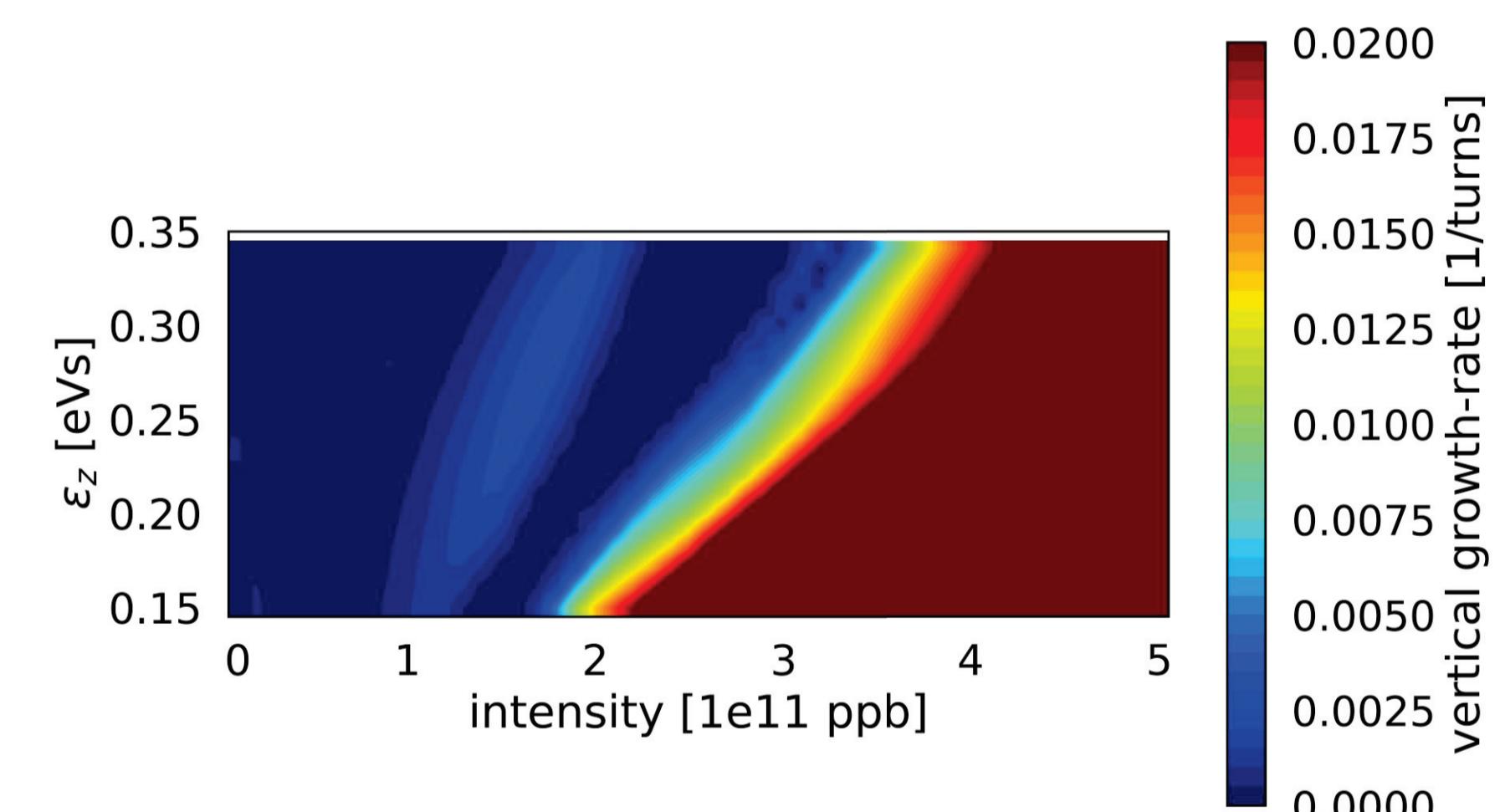
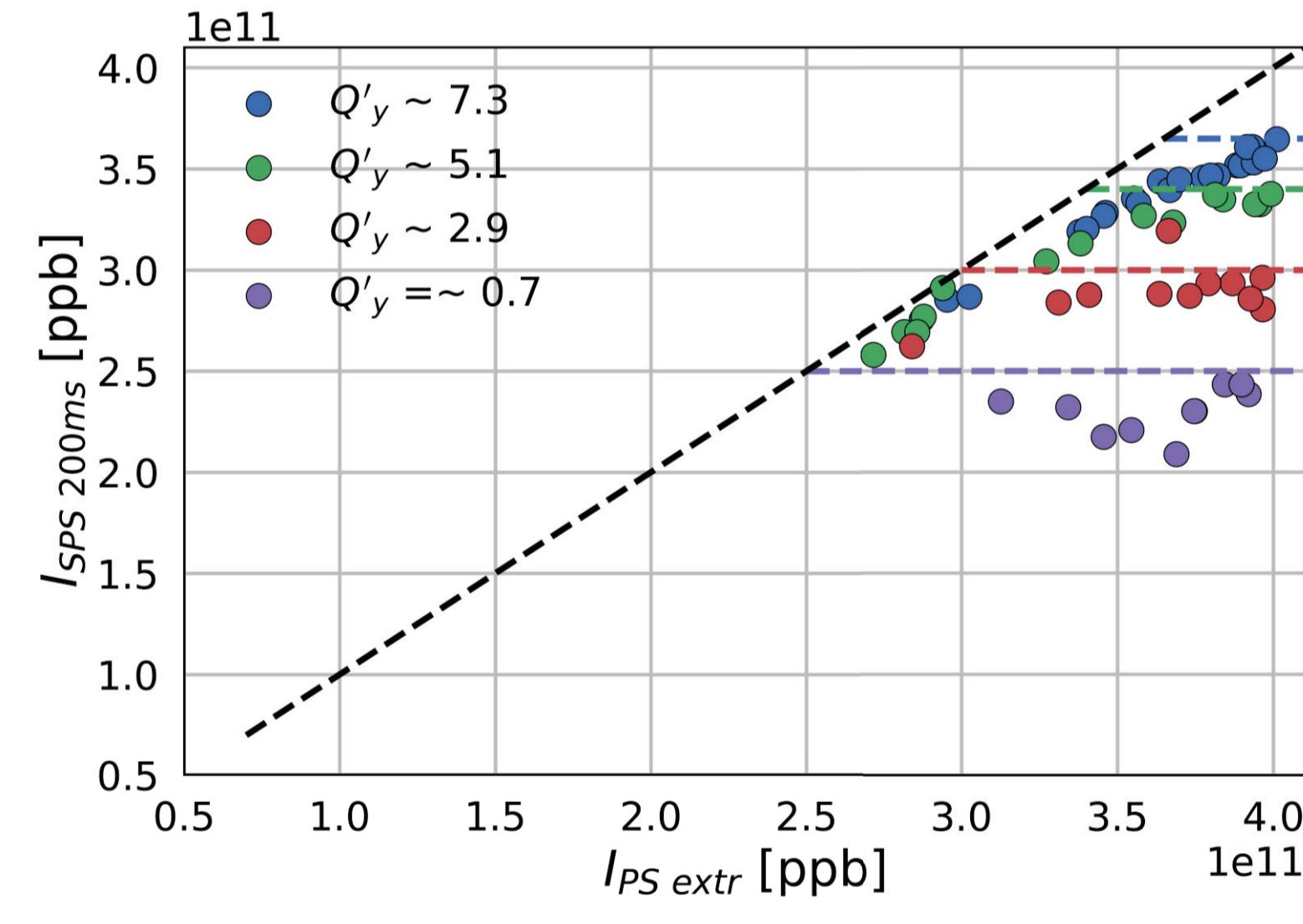
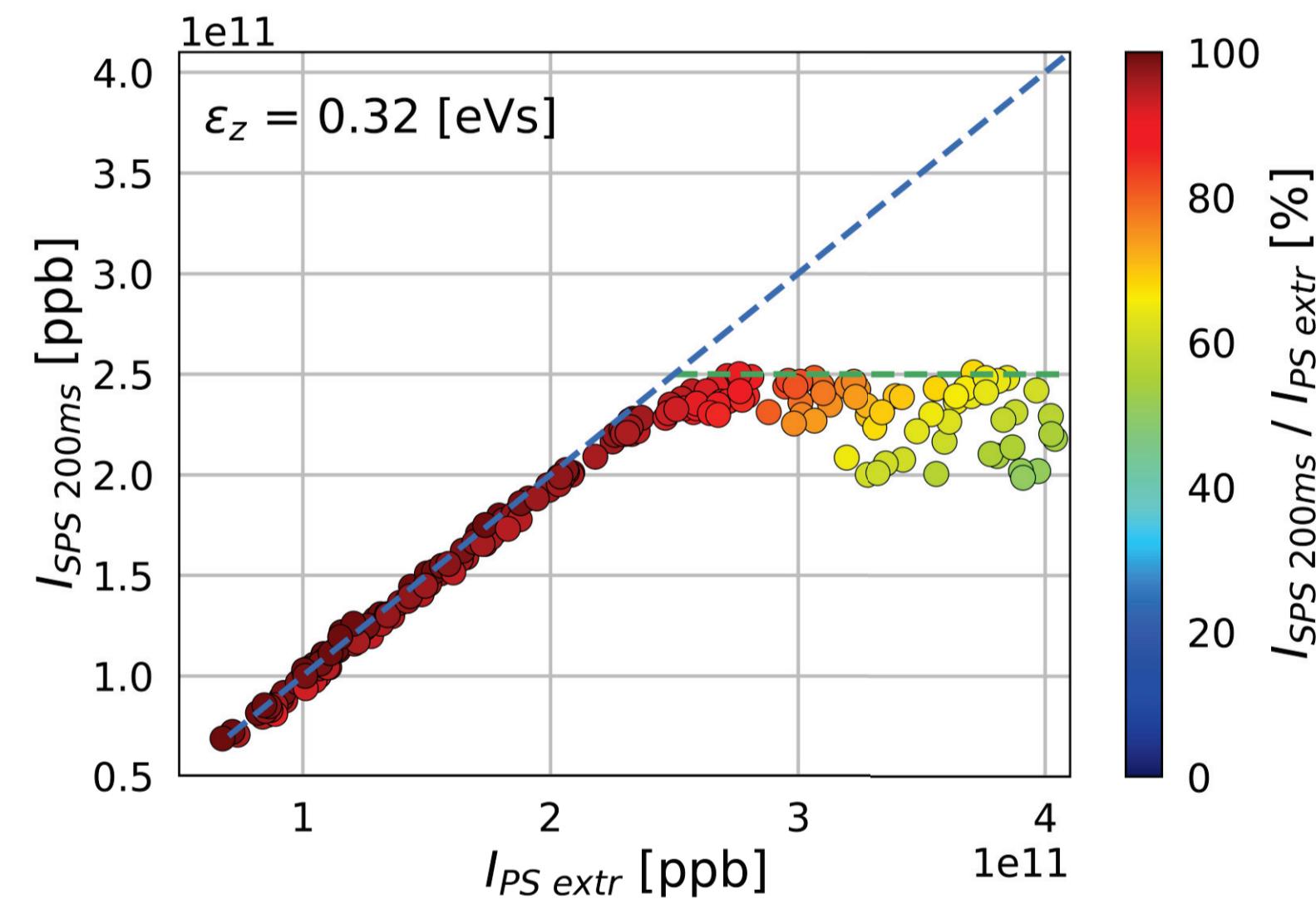
- Measurement in the vertical plane of the Q22 optics.**
- The chromaticity is set to 0.7, the intensity is ramped up to find the TMCI threshold
- The TMCI threshold in the Q22 optics is found at 2.5e11 ppb.**
- As expected from theory chromaticity can stabilize the beam.
- Simulations reproduce the observations in the machine well.** But the ‘island of slow instability’ predicted in simulations, was not observed during measurements.



$$N_{thr}^{TMC} = \frac{16\sqrt{2}}{3\pi} \frac{R|\eta|\varepsilon_z}{\beta_y e \beta^2 c} \frac{\omega_r}{|Z_y^{BB}|} \left(1 + \frac{Q'_y \omega_0}{\eta \omega_r} \right)$$

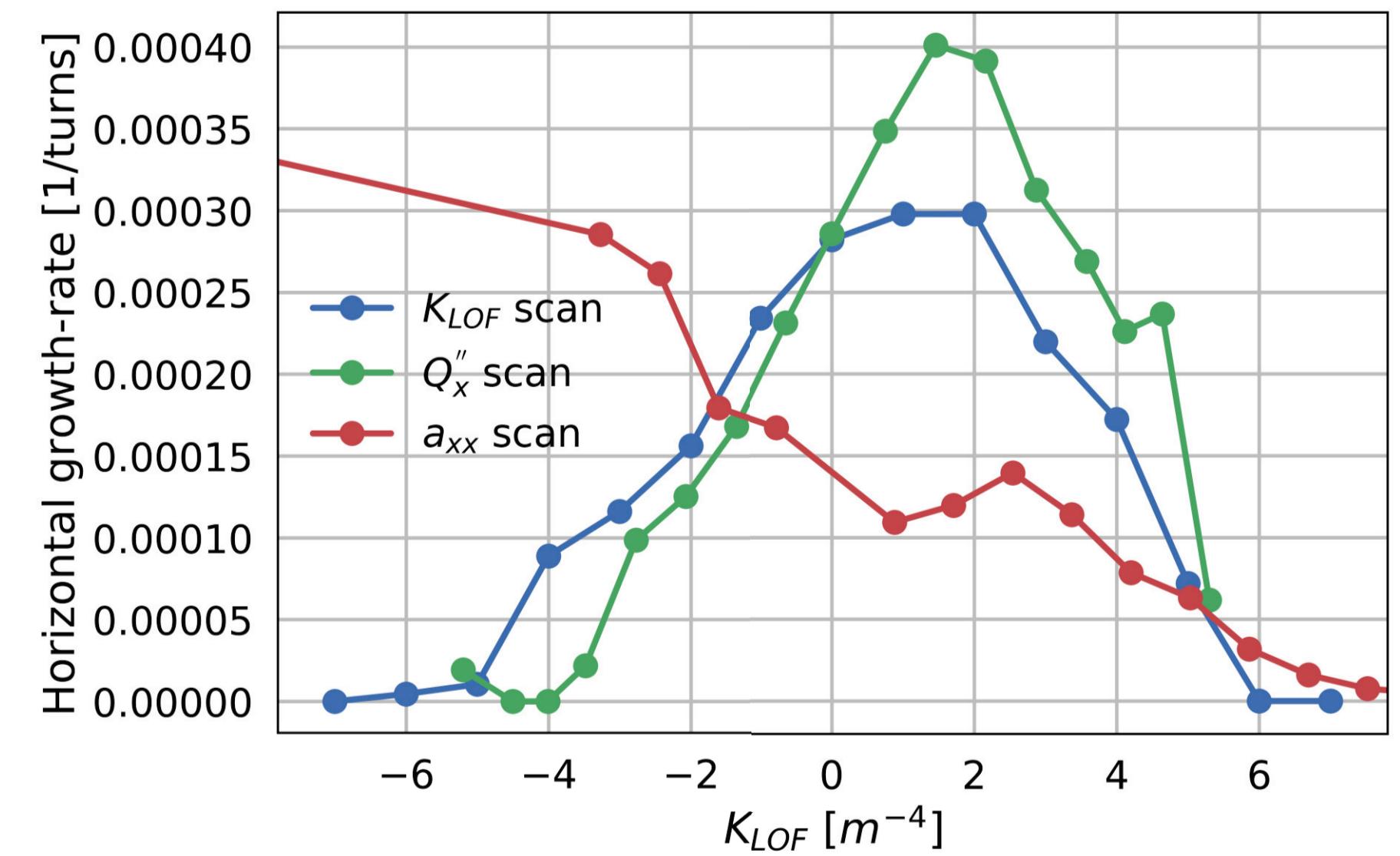
R : machine radius
 Q'_y : vertical chromaticity
 $|Z_y^{BB}|$: Impedance of broad band resonator model
 ω_0 : revolution frequency of the machine

ε_z : longitudinal emittance
 η : slippage factor
 ω_r : resonance frequency of broad band resonator model
 β_y : betatron function of the machine



Octupole contribution investigation

- Measurement in the horizontal plane of the Q20 optics with an intensity of 2e11 ppb.
- Chromaticity: -2 for K_{LOF} and Q''_x scan; -1 for a_{xx} scan to produce a horizontal mode 0.**
- Using three groups of Landau octupoles the LOF, LOD and LOE.
- For the K_{LOF} scan only the K values of the LOF are changed.
- MADX is used to calculate settings for all three octupole groups resulting in only Q''_x or only a_{xx} in the horizontal plane for the respective scans.**



Conclusion

- The TMCI threshold has been deeply investigated in the new Q22 optics for the first time and has been found at 2.5 ppb. Simulations reproduce this observation well.
- The influences of different parameters on the TMCI threshold have been studied during the measurements.
- The stabilizing mechanisms of the octupoles in the SPS have been measured. By compensating other contributions of the octupoles, the damping of pure a_{xx} and pure Q''_x was investigated. For positive octupole values Q''_x seems to dominate.