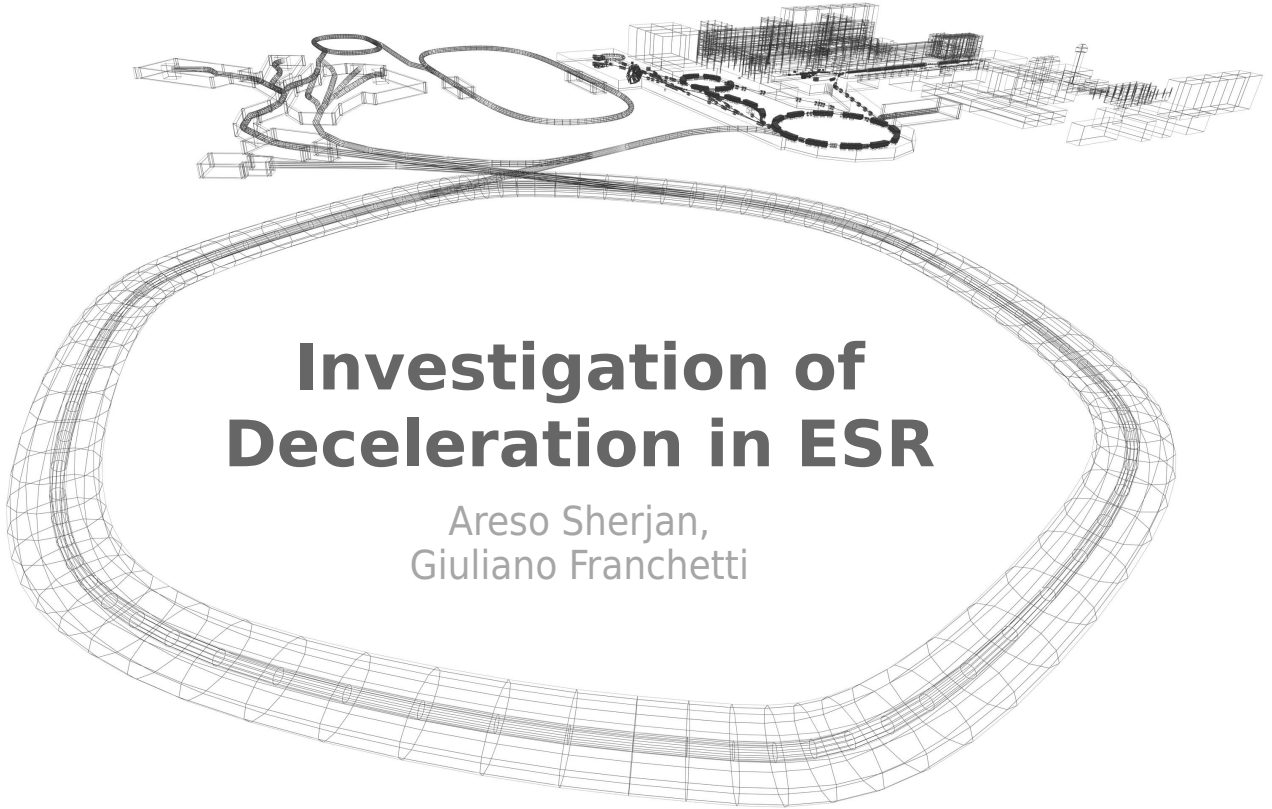


Investigation of Deceleration in ESR

Areso Sherjan,
Giuliano Franchetti

Outline

Goal of the MD:
Optics and Deceleration cycle

- MD Overview
- Motivation
- Aaron Heinz - Master Thesis
- Highlight of measurements
- Summary of the MD
- Next Steps...

Many Thanks to ...

...Bernd Lorentz to provide one week of MD and the ESR team for preparing the machine,

...Oleksandr Chorniy and Tino Giacomini for the support on beam diagnostics,

...Julian Rausch, Aaron Heinz and Giuliano Franchetti for participating to the measurements.

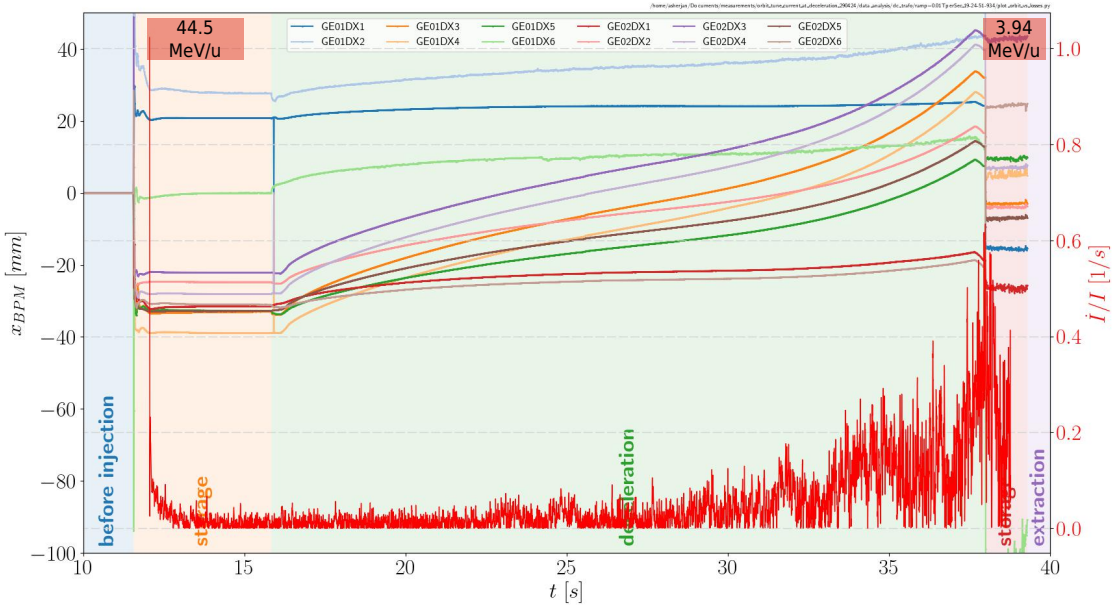
Overview MD 2025

Beam Parameters

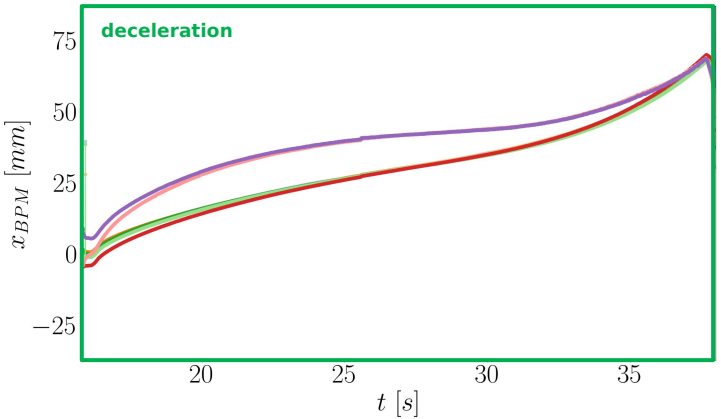
Naked Gold Beam :	$^{197}Au^{79+}$	
Beam Intensity N_0 :	~ 2 x 10^8 Particles	
Beam at Injection :	E = 400 MeV/u	(β = 0.71)
After 1st ramp :	E = 50 MeV/u	(β = 0.32)
After 2nd ramp :	E = 4 MeV/u	(β = 0.09)
Machine Qx / Qy :	2.35 / 2.35	(Injection)
Measured Qx / Qy :	2.2975 / 2.2265	(Injection)

- MD week from 28.4 - 4.5.
- Blocked due to tech. issues until Wednesday
- Setting up the deceleration completed by Friday

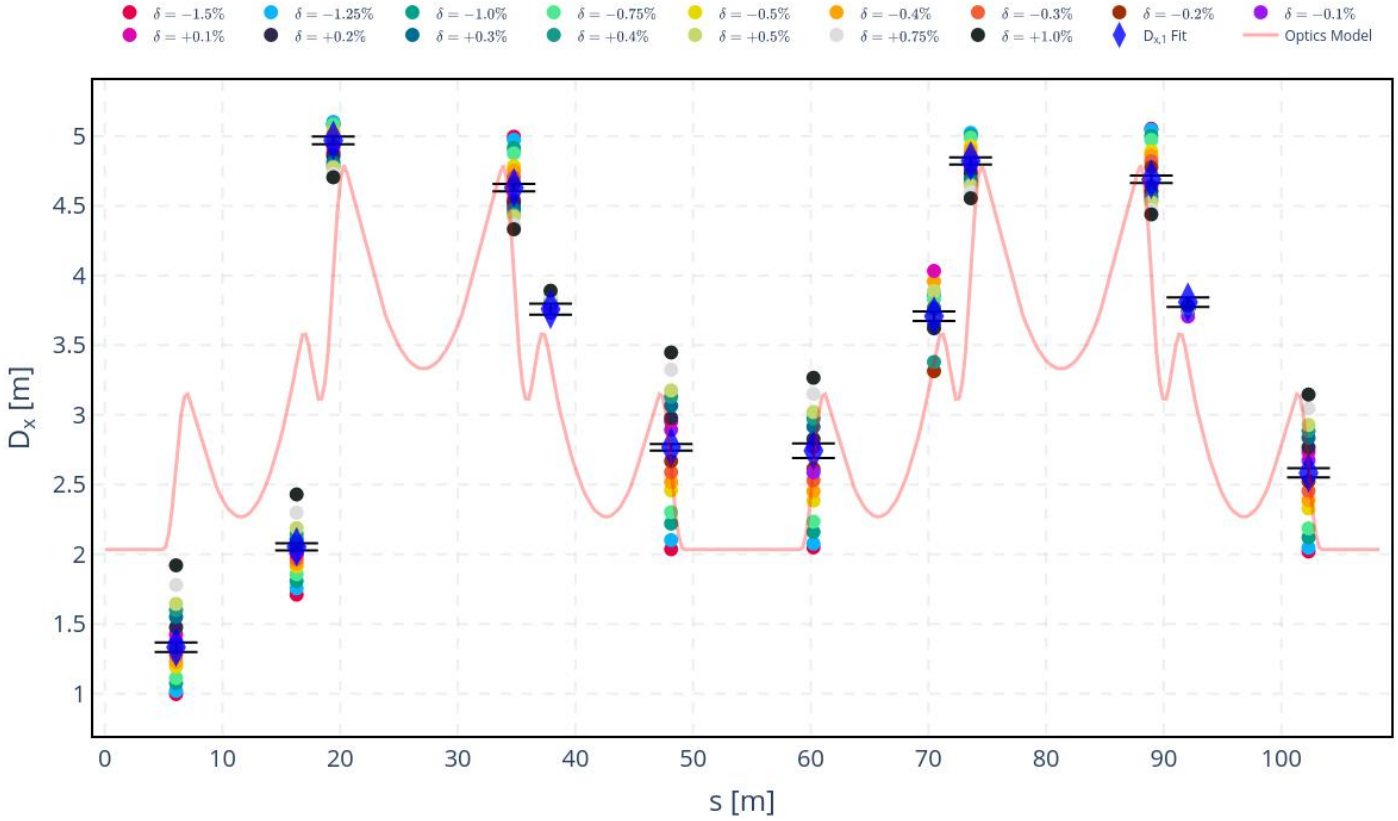
Motivation - MD 2024



Measurement data suggests inconsistency in the reconstruction of δp/p during deceleration



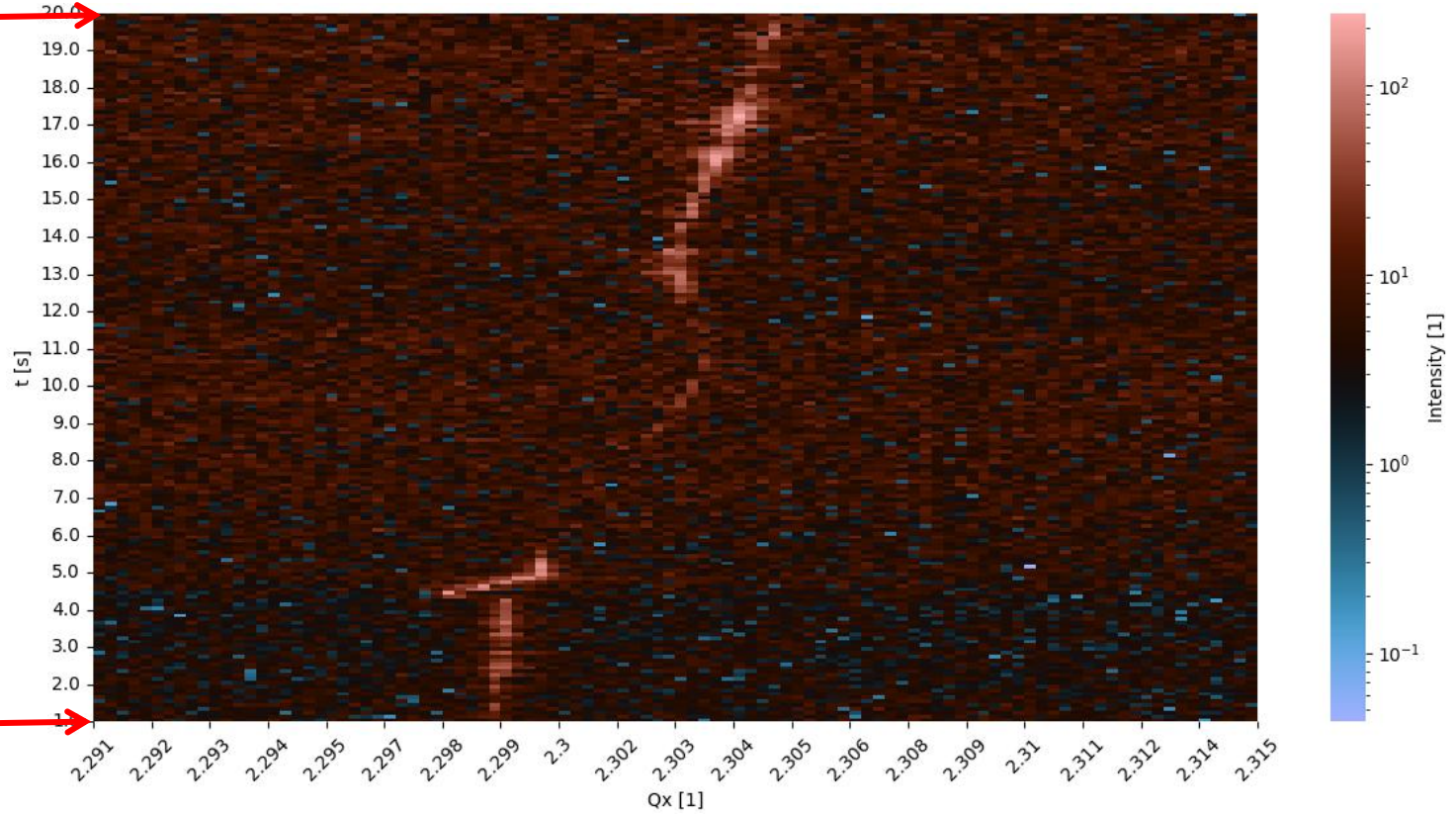
Nonlinear Dispersion - Meas. MD 2025

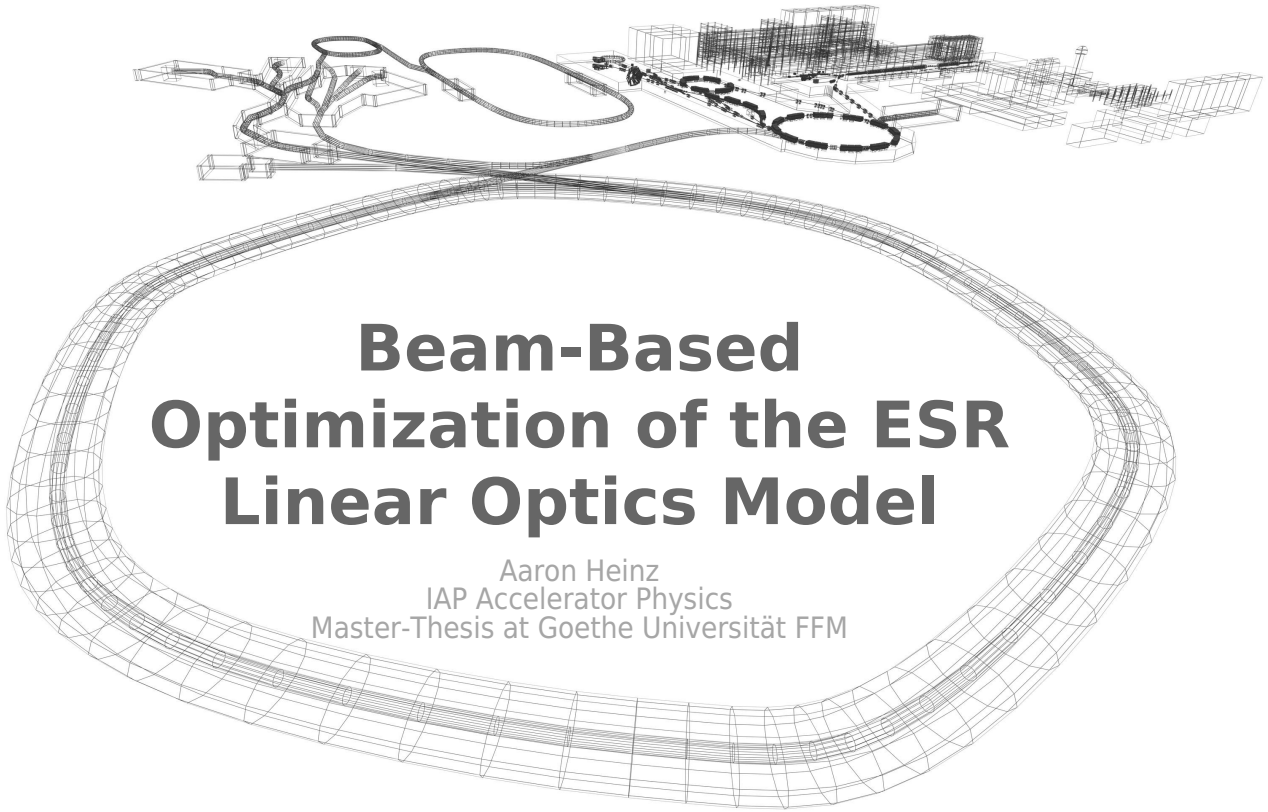


Motivation - MD 2024

$Q_x(t=20) = 2.400$
from machine settings

$Q_x(t=1) = 2.427$
from machine settings





Beam-Based Optimization of the ESR Linear Optics Model

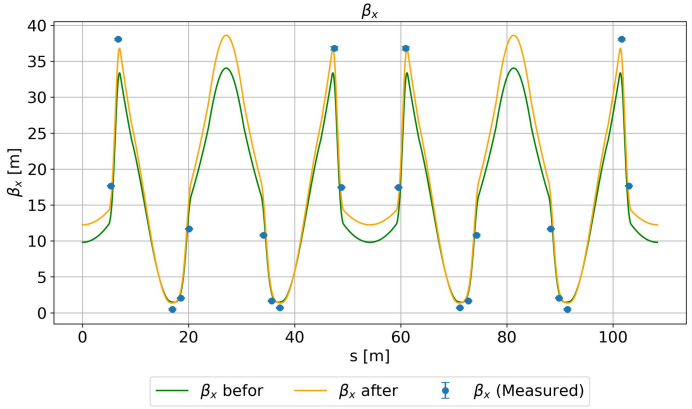
Aaron Heinz
IAP Accelerator Physics
Master-Thesis at Goethe Universität FFM

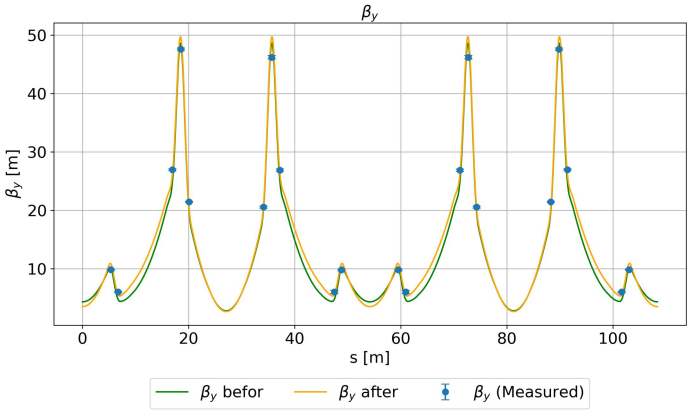
Overview

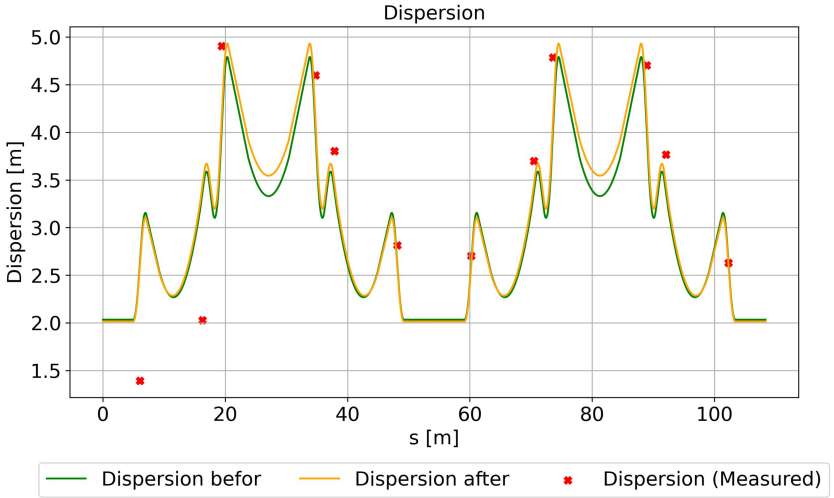
- Problem:
  - Measured vs. simulated tune is of by ~ 0.1 due to incomplete optics model

- Solution Approach:
  - ~300 Measurements to obtain tune / beta-function / dispersion
  - Lattice optimization through Differential Evolution Methode
    - Population-based optimization algorithm
    - Robust against local minima
    - Doesn’t need explicit functions

Results


β_x
β_x [m]
s [m]
β_x befor
β_x after
β_x (Measured)


β_y
β_y [m]
s [m]
β_y befor
β_y after
β_y (Measured)

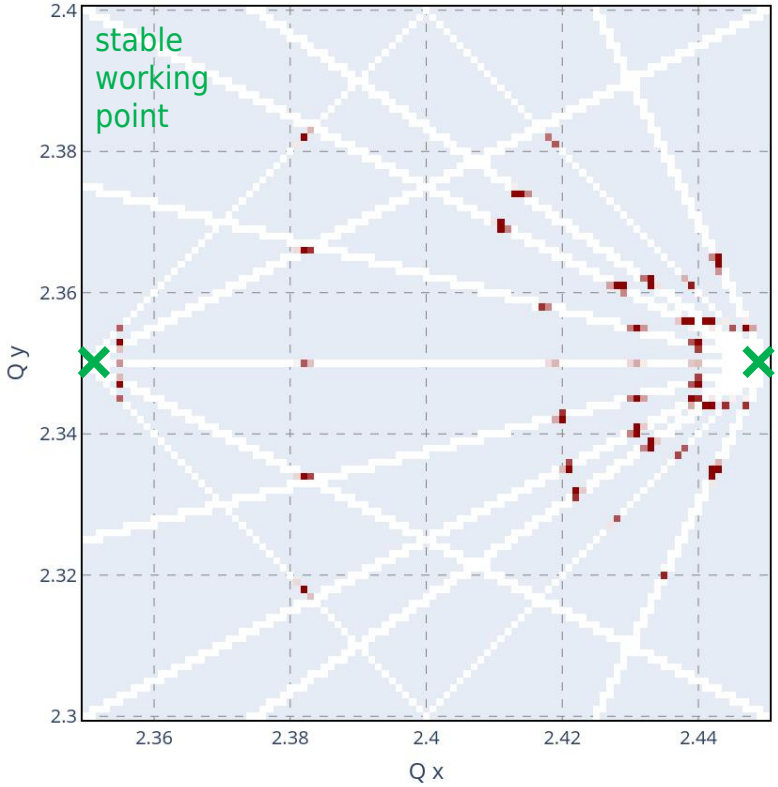

Dispersion
Dispersion [m]
s [m]
Dispersion befor
Dispersion after
Dispersion (Measured)

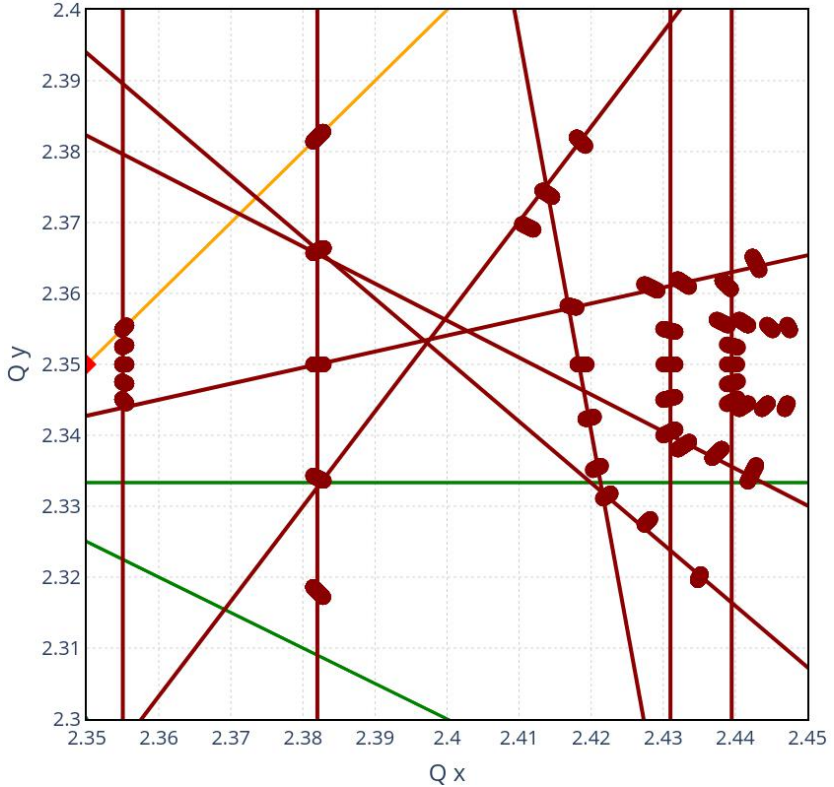
Result

	First Optics (for new model)		Second Optics (for testing)	
	$Q_x = 2.2972,\ Q_y = 2.2260$		$Q_x = 2.3366,\ Q_y = 2.2620$	
	Old Model	New Model	Old Model	New Model
$\lvert\Delta Q_x\rvert$	0.0542	0.0002	0.0651	0.0136
$\lvert\Delta Q_y\rvert$	0.0810	0.0003	0.0852	0.0020

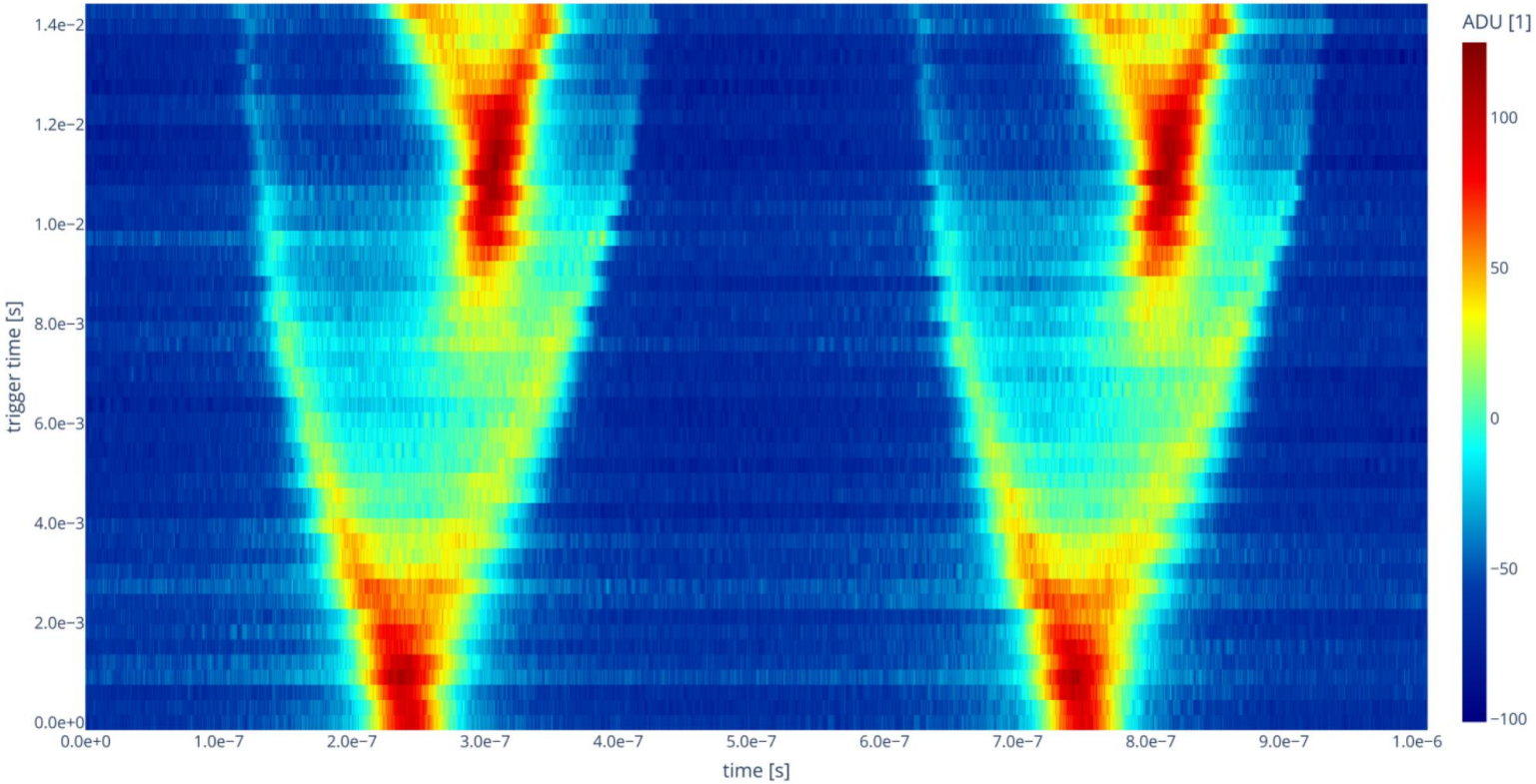
$$|\Delta Q| = |Q_{Measurement} - Q_{Simulation}|$$

Resonance Chart at Injection Energy

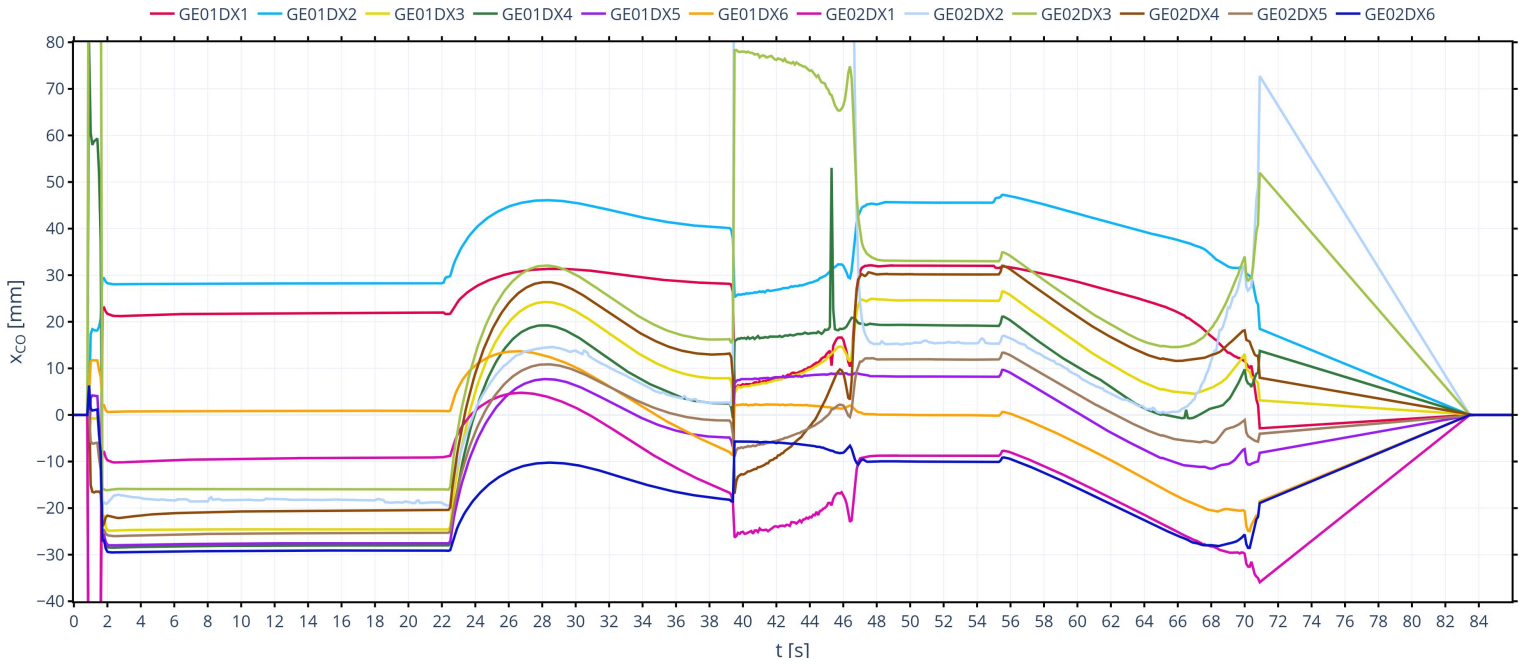




Longitudinal Beam Profile at Injection



Measurements of the Deceleration Cycle



Summary

- Tune response measurements suggest a new optimized linear optics model
- Dispersion measurements indicates high order components
- Measurements on the resonance chart for the ESR show presence of resonance lines, but are incomplete and require more studies on injection
- Different parameter of the whole deceleration cycle were measured for the simulation benchmarking
- ESR would benefit from adjustments of the beam diagnostic tools to the requirements of storage rings (very long cycles, low beam intensity)
- MCPs of the IPM and the current transformer before injecting into ESR need to be repaired

Next Steps...

- New machine optics model needs to be tested, also at different energies
- Measurement of the Dispersion at very low energy is missing
- Resonance chart needs to be improved with new optics model and with an optimised injection efficiency (and compared with resonance induced by ESR magnets)
- Measurement results will be included into simulation of the deceleration cycle to suggest optimisation tests for the next MD

Thank you!