5th Slow Extraction Workshop, Wiener Neustadt

11-14 February, 2024

TECHNISCHE UNIVERSITÄT DARMSTADT

Beam loss optimization for SIS18 slow extraction

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OUTLINE

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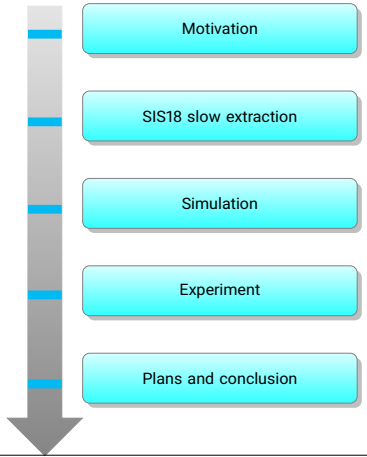

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MOTIVATION

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- Reduce the undesirable activation of accelerator components
- Prevent electrostatic septum damage
- Goal: automated minimization of uncontrolled particle loss during slow extraction

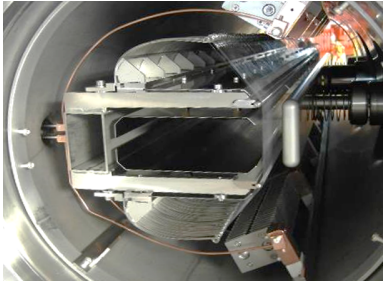

Figure 1: Electrostatic septum for SIS18 slow extraction

SIS18 SLOW EXTRACTION

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Operation mode

- Resonance tune $Q_x = \frac{13}{3}$
- Chromaticity $Q'_x = -6$
- Excitation by six sextupoles
- 2 orbit bumps at electrostatic septum and magnetic septum
- Standard technique: quadrupole driven extraction

Quadrupole driven extraction

- tune ramp by 2 quadrupoles
- chromaticity is uncorrected
- all separatrix sizes go to spill
- different momentum are extracted

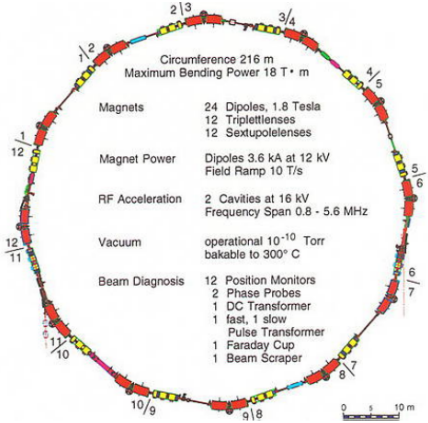

Figure 2: SIS18 sectors

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What parameters were varied?

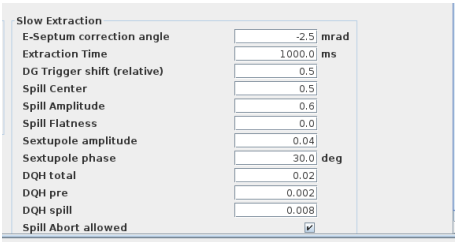

Figure 3: ParamModi screenshot for slow extraction

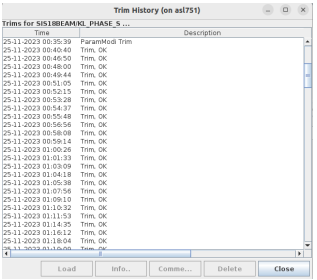

Figure 4: Trim history in LSA

- $(k_2L)_n = (k_2L)_a * sin(2\pi * (n-1)/n + \phi)$ strength of the resonances sextupoles
- n - number of a sextupole

- sextupole amplitude $(k_2L)_a$
- sextupole phase ϕ

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SIMULATION RESULTS

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- Loss reduction for the Nelder-Mead algorithm is 40%, Powell and COBYLA algorithms - almost 100%

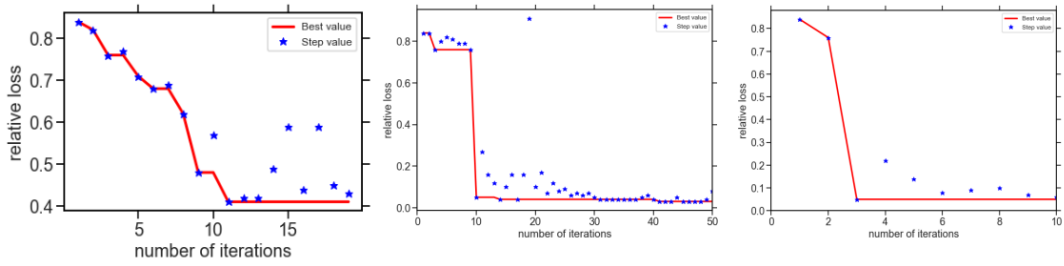

Figure 5: Optimization algorithms (from the left to the right - Nelder-Mead, Powell, COBYLA)

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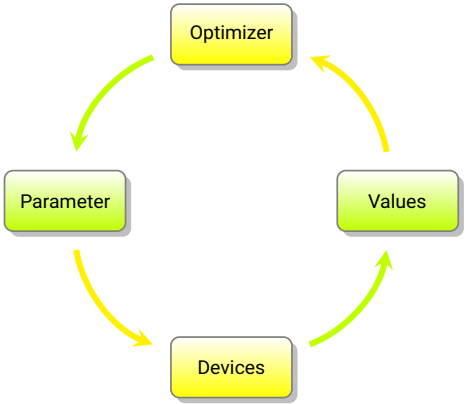
EXPERIMENT

FESA/LSA Python bridge*



- minimization of particle loss by maximizing extraction efficiency N_{ext}/N_{tot}
- N_{ext} - number of extracted particles from the ionization chamber
- N_{tot} - number of particles from the current transformer in the ring
- initial settings are not optimal

**many thanks to S.Appel, N.Madysa, GSI*

EXPERIMENT RESULTS

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• Each step takes less that 1 min • 10-15 min for optimization
• increase in the efficiency from 60% to 80%

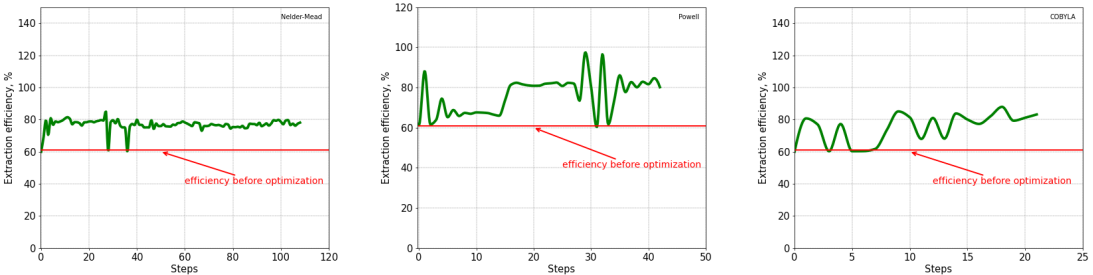

Figure 6: Optimization algorithms (from the left to the right following chronological order - Nelder-Mead, Powell, COBYLA)

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SUMMARY

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- First attempt of automated loss minimization for SIS18
- Loss reduction by 20% with 3 different algorithms varying 2 parameters
- Algorithms show different convergence
- Simulation performed before shows higher extraction efficiency. Possible reason is incompleteness of the simulation model

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Further studies required

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PLANS AND CONCLUSION

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- Extension of the simulation model
- Identification of further parameters to vary
- Implementation of Bayesian optimization/BOBYQA/...
- New measurements

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