TK-Settings

Operator Workshop
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Outline

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Motivation

- **Problems with low charge state operation**
  - Beam loss provokes sparkover in septum
  - Erosion of septum electrodes
  - Strong pressure increase in septum tank
    - Break down of dynamic vacuum
    - High losses during cycle

- **Solution: collimation in transfer channel (TK)**
  - Shift losses from SIS18 to transfer channel → Collimation
  - Reduce the beam emittance by cutting out hot core → High brilliance
Multi-Turn Injection (MTI) Principle

Basics for the injection:

- In the local region of a particle, the particle density in phase space is constant.
- In an occupied phase space volume cannot be injected a second time without losing particles.
- The injected beam should match as well to the phase space characteristics of SSI18.
- The phase space adjustment is done by using the Beam transport system before injection, it is essential for the transmission optimization.
- High packing density → higher losses.
- Lower packing density → lower intensity.
Multiturn injection losses

- injected beam
- Septum
- distorted orbit
- Bumper1
- Bumper2
- closed orbit
- Bumper3
- Bumper4

Injection start
Injection amplitude
Injection end
(80 µs)
Injection time

Bumperflanke [µs]

Bumperflanke linear

Acceptance
accumulated beam

Septum wires
injected beam

2πQ_x
MTI: Transversal Accumulation

- Accumulation with \( \frac{1}{3} \) Tune
  - Tune \( Q_h = 3 \frac{1}{3} \)

- Accumulation with \( \frac{1}{4} \) Tune
  - Tune \( Q_h = 3 \frac{1}{4} \)
MTI: Example with fractional Tune $Q_h=0.25$
TK Collimation

- Overlap of two beams by four turns
- To shift the particle losses from SIS18 to TK
- Protection of injection Septum
- Improvement of dynamic vacuum in SIS18
- Reduce the injected emittance and increase the beam brilliance
TK Collimation: TK-Settings

Prepare the beam for the collimation in TK:

- Calculate the beam envelope and emittance (MIRKO)
  - Green lines are the Profile Grids
  - Switch MIRKO for the Emittance fit
  - Try to find three combination of PGs that fit the envelope over all PG
  - The fitted envelope should be almost cover all profile grids
  - Calculate the beam emittance: MIRKO command akop

To check the phase advance between the collimators:

- Switch MIRKO to calculate the phase advance
- To check the phase advance between the collimators:
  - Load the makro schlitte.mak MIRKO command @schlitze
- Set the phase advance between two collimators to 90°
- Set the phase advance between the second collimator and the injection septum to 360°
- Increase the beam width at the collimators
TK Collimation: Envelope and Emittance Fit

- Emittance fit through three PG
  - Command to show the emittance value is `akop`
TK-Collimation: Phase Advance

- Switch MIRKO to calculate the phase advance
- Phase advance between Collimators and septum: MIRKO command @SCHLITZE
- Phase advance between PGs: MIRKO command @PROFILGITTER

\[
\phi: \text{TK6DS2H, TK7DS3H} \approx 90^\circ \\
\phi: \text{TK7DS3H, S12ME1I} \approx 360^\circ
\]
TK Collimation: TK Envelope
Collimation Results: Septum Protection

Without collimation:
- Sparkover and vacuum breakdown
- High losses during ramp

With collimation:
- Stable septum voltage (no sparkover)
- Stable beam current
Collimation Results: Injection Efficiency

Without collimation
- Injection efficiency only ~ 50 %
- High losses at injection septum

With collimation
- Injection efficiency ~ 95 %
- Few losses at injection septum
- Higher accumulated intensity
Collimation Results: Dynamic Vacuum

The graph illustrates the pressure over time with and without collimation in TK. The red line represents "Without collimation in TK", and the blue line represents "With collimation in TK". The x-axis represents time, ranging from 00:15 to 01:00, and the y-axis represents pressure in mbar, ranging from $10^{-11}$ to $10^{-8}$. The graph shows a decrease in pressure fluctuations with collimation compared to without collimation.
Collimation Results: SIS18 Intensity

- Without collimation in TK
- S01-collimator current without collimation in TK
- With collimation in TK
- S01-collimator current with collimation in TK
Summary

- Prepare an optic in TK for the collimation:
  - Read all profile grids with MIRKO
  - Emittance fit through three profile grids
  - Set the right phase advance between collimators and septum

- Collimation in TK:
  - Stable operation through protection of septum
  - Increased intensity and transmission
  - Better dynamic vacuum due to fewer losses in ring