Improvement of the tomographic reconstruction procedure at PITZ.

- > Introduction: motivation & implementation
- > Simulation results
- > Summary and outlook

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Motivation & Implementation

> Aim: Refine the calculation of the beam transport along the tomography lattice by including:



- > Gain: Better estimation of the phase space rotation → more accurate reconstruction
- Use V-Code to simulate the phase advance mismatch (difference from the target value of 45° between consecutive screens) for:
 - Current approach: Approximated magnetic profile of the quadrupoles, <u>no space charge</u>
 - New approach: Measured magnetic profile of the quadrupoles, linear space charge
- The simulated beam enters the FODO lattice perfectly matched, with zero momentum spread. Non-linear space charge is excluded



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Simulation observations

> No space charge case (same for both emittance values / charge densities)

- Matching of the effective quadrupoles → proof of principle. Possible reason for mismatch < 0.3° : numerical artifacts (?)
- The current quadrupole representation induces a 6.4° maximum phase advance mismatch in comparison to the measured gradient profile

> Linear space charge case:

- The inclusion of linear space charge can shift the phase advance of the effective quadrupoles at a maximum of 12.9° for 3mm·mrad or 34.5° for 1mm·mrad
- The defocusing effect varies slightly for the different gradient profiles

Combined case:

- Both features together give a maximum phase advance mismatch of 19.1° for 3mm·mrad or at 40° for 1mm·mrad
- The result will introduce a bigger effect on the reconstruction than an equivalent projection angle mismatch, due to the beam shearing



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Thanks to Barbara Marchetti and Dmitriy Malyutin.

THE END.





Backup Slides



Normalized gradient profile calculation:

> Gtomo:

 Profile directly calculated as in the code: and then divided by the strength

$$G(z) = \frac{k}{1 + e^{\frac{2 \cdot (2 \cdot ||\Delta z|| - L_{eff})}{Q_{bore}}}}$$

Effective length (integrated normalized flux) : 43.11 mm

> Real:

- [grad->I] convert the gradient required for matched solution (g = 4.1455 T/m) to current (average of all tomography quads)
- [I->B] for that current calculate the curve of the longitudinal magnetic profile (interpolate between the measured values)
- [B->B/m] get the gradient by dividing with the radius
- Normalize by dividing with the gradient for matched solution (g)
- Exclude 10mm from the beginning and 10mm from the end, so that the length equals exactly half FODO cell (negligible)
- Effective length (integrated normalized flux) : 43.35 mm



V-Code screenshot

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V-Code screenshot – no space charge

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V-Code screenshot – linear space charge

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Data analysis for Effective quads with no space charge @ 1mm*mrad (same as for 3mm*mrad)











Data analysis for Gtomo quads with no space charge @ 1mm*mrad (same as for 3mm*mrad)











Data analysis for Real quads with no space charge @ 1mm*mrad (same as for 3mm*mrad)







