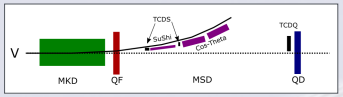
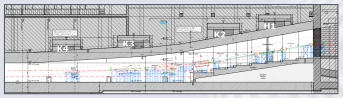
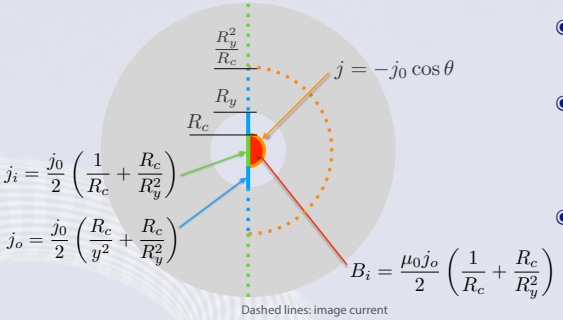
Needs

- shorter injection / extraction sector can be realized with a high field septum magnet
- for high energy or space-limited accelerators
  - Future Circular Collider (FCC) at CERN
  - SIS300 at FAIR, GSI
  - medical accelerators
- conventional septum magnets
  - iron dominated (C-shape yoke) magnet
  - magnetic field strength is limited about 2 T
- novel truncated cosine-theta design (TCT)
  - enables magnetic field above 2 T
  - right-left asymmetric coil structure
  - cylindrical iron yoke surrounding the coil



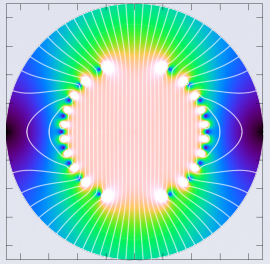




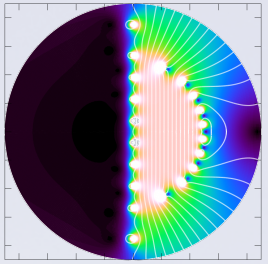
Theory

- right side
  - cosine-theta current
- left side
  - shielding current on y axis
  - current density proportional to the field strength
- Analytical calculation: five line currents per pole

full cosine-theta

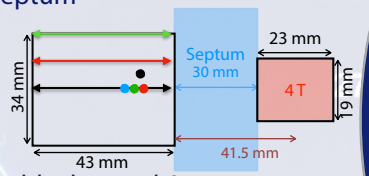


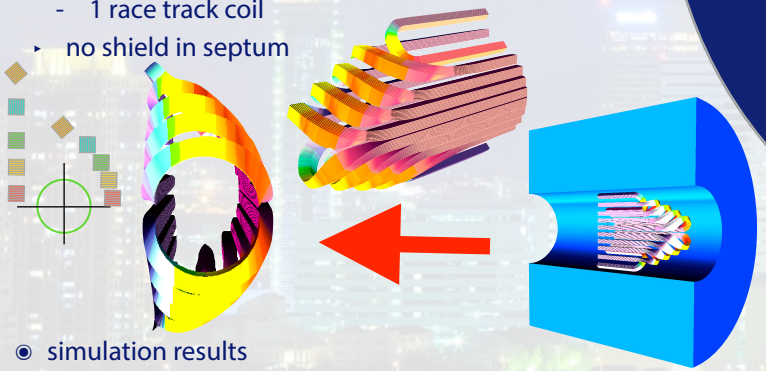
truncated cosine-theta



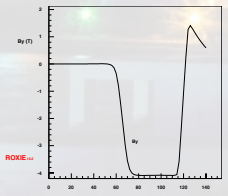
Model

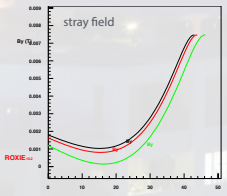
- target: FCC extraction septum
  - 4 T in the aperture
  - geometry contraints
- design
  - flat Rutherford cable
  - 9 conductors/block - 5 blocks - 5.5 kA
    - 4 right-left asymmetric saddle coils
    - 1 race track coil
  - no shield in septum

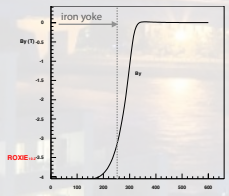


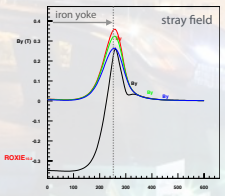


- simulation results
  - lateral field distribution
  - longitudinal field distribution









Truncated-Cosine-Theta Design for High Field Septum Magnets

Kei Sugita
GSI
Helmholtzzentrum für Schwerionenforschung GmbH

Abstract

Conventional design of a septum magnet is based on combination of a C-shape iron, which forms decent dipole magnetic field, and a coil. Due to saturation of magnetic induction of the iron yoke, the maximum magnetic field of such a kind of septum magnets is limited about 2 T. A higher magnetic field of septum magnets is required for next generation high energy accelerators. Truncated-cosine-theta (TCT) design enables to overcome the 2 T limitation and reach a higher magnetic field strength.

For Future Circular Collider (FCC) at CERN and a future heavy ion synchrotron at FAIR/GSI, design studies of superconducting septum magnets with TCT aimed at a field strength about 4 T is ongoing. Due to high rigidity of the beam of FCC, high field septum magnet is required to minimise the extraction beam line length. A future heavy ion synchrotron will be assembled above the other synchrotron SIS100 currently being constructed for FAIR. Due to limitation on space for the beam extraction, which is commonly used with SIS100, a high field septum magnet is considered.

In this presentation, the design principle of a TCT magnet will be described and status of the design studies will be presented.

Next steps

- coil end design optimization
  - asymmetric saddle coil
  - necessity of a shield
- realistic design
  - take existing cable design (e.g. LHC cables)
  - enough margin to quench
  - aperture size with a beam pipe
  - magnet length
- mechanical engineering design
  - support structure
  - winding: block-to-block cable transition
- cryogenic design
- quench protection

Summary

‣ TCT design is suitable for high field, space-saving septum magnets. ‣ Both FAIR at GSI and FCC at CERN requires about 4 T extraction septum magnets. ‣ Design studies will be continued in collaboration between CERN and GSI. ‣ Applications for medical accelerators will be investigated. ‣ The complex coil winding with a direct winding machine may be feasible. ‣ Furthermore, a conceptual design study for normal conducting magnets is an interesting topic. ‣ TCT would be an alternative of the conventional design, may have advantage under certain conditions.