Partial Return Yoke

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Outline

• Introduction and Concept

• Performance

• Engineering

• Extension to Step VI
Concept

- Partial Return Yoke (a.k.a. “shield”, “yoke”)
- Concept presented at MICE CM 2012
- Initial Geometry
  - Tube of radius 1.2 m
  - wall thickness 10 cm
  - azimuthally -50..50°
  - weight: 30t

H Witte. Step IV & VI: Local Flux Return. MICE CM 34, October 2012.

(Note: not to scale)
Geometric Variations

Initial Design

Vertical Extensions + New Virostek Plates

Present Design

Engineering driven
Simulation Details

• How certain are we of the results?
  – Simple concept
  – Key simulations done with two FEA codes

• Opera from VectorFields/Cobham
  – Solves for scalar potential
  \[ \nabla \mu \nabla \phi - \nabla \mu \left( \int_{\Omega_j} \frac{J \times R}{|R|^3} \, d\Omega_j \right) = 0 \]

• Comsol Multiphysics
  – Solves for vector potential
  \[ \nabla \times (\mu^{-1} \nabla \times A) = J \]

Iron: AISI 1010 steel

H Witte. Software Model Verification, 14 November 2012, Magnetic shielding meeting.
Partial Return Yoke

Support Structure

3m
8m

Courtesy of Jason Tarrant
Performance
Iso-Surface 0.5 mT

No Shield

12 cm Shield

Step IV
200 MeV Flip
Frontal View – 240 MeV Solenoid

No Shield

10 m

All 5 Gauss

12 cm Shield

1.3 m

0 m
240 MeV Solenoid/Flip mode

- Blue line: t=10cm
- Green line: t=12cm
- Red line: No iron, Sol
- Cyan line: No iron, Flip

Field at r=1.5m
MICE Step IV 240 MeV

28 March 2013
Engineering
BNL Engineering
- Steve Plate
- Mike Anerella
- (lots of help from others: Jason Tarrant, Craig MacWaters, Tim Hayler, Geoff Barber)

Preliminary Design Phase
- (almost finished)
- General concept (forces, tolerances, joining of pieces, …)
- Costing
- Time line
- Assembly procedure

Detailed Design Phase
- Complete design
- Fabrication drawings
- Interferences
Interferences

ACCESS TO HYDROGEN SYSTEM MAY BE AFFECTED

FRONT BEAMS AND DIAGONAL STRUTS TO BE CUT OFF WHERE ALIGNED WITH YOKE

COMPRESSOR HOSE & CABLE (& MAGNET CABLE - NOT SHOWN) SUPPORTS TO BE MOUNTED OFF THE YOKE

VACUUM SYSTEM TO BE RECONFIGURED TO ENABLE VACUUM SERVICES TO BE ROUTED AROUND THE YOKE

HYDROGEN FILL STATION TO BE MOVED ELSE LIMITED ACCESS TO CHANGE BOTTLES

HINGED PLATFORMS TO BE RAISED BY 200 mm (REQUIRES STEPS ON/OFF) ALSO SECTIONS OUTSIDE OF LENGTH OF YOKE REQUIRE RAISING TO THIS LEVEL

X-BAR BRACKETS TO BE RECONFIGURED TO ACT AS SUPPORT FOR HINGED PLATFORM

MOVE BEAMS OUT BY 100 mm TO ALLOW VERTICAL CABLE TRAY BEHIND

SIGNIFICANT MODIFICATIONS TO TRENCH ROOF

SERVICES IN TRENCH ROOF (INCL. WATER) TO BE RECONFIGURED

SECTION A-A

Courtesy of Jason Tarrant, STFC
Engineering - Mezzanine

Courtesy of Jason Tarrant, STFC
Step VI
Step VI

3.3 m wide  6.4m X 4m X 0.3 m
COMSOL Model

Based on Steve Plate’s shield design

Same shape as Step IV
5 Gauss Surface

Step VI, 240 MeV Solenoid

No Shield

Shield
5 Gauss Surface

Step VI, 240 MeV Solenoid

No Shield

Shield

30 m

8 m
Conclusion

- Demonstrated shielding concept
  - Reduces stray field to 5—10 Gauss (10/12 cm)
    (No shield: 300—600 Gauss = factor 50+)
  - Also for Step VI
- Feasibility
  - Penetrations – tracker waveguides, vacuum, …
  - Connections for vertical gaps
- Effect on beam: no issue
- Engineering
  - ongoing