PRISM-FFAG magnet

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Overview of PRISM-FFAG magnet

- Radial sector type
- DFD Triplet
- Scaling type
- Field Distribution

\[ B(r) = B_0 \left( \frac{r}{r_0} \right)^k \]
Required parameters for magnet

- Central momentum for muon : 68 MeV/c
- Equilibrium radius : 6.5 m
- Number of cell : 10
- F/D ratio : 4~8
- k value : 4.1~5.1
- Momentum acceptance : ± 20 %
- Aperture : 100 cm in horizontal, 30 cm in vertical
- Yoke type : C type
Magnet form

- C type
- Aperture
  - 100 cm (horizontal)
  - 30 cm (vertical)
- Slant pole produce field gradient
- Trim coils are installed to correct magnetic field

Cross section of F magnet

Distance from machine center (6500)
3D calculation
Magnetic field distribution

Center of F magnet

Center of D magnet

tr931-fm

k+1 = 5.62

F/D = 6.02
Momentum acceptance

Gap height = ± 15 cm

4D-Acceptance (mm²·mrad²)

Momentum (MeV/c)

68 MeV ± 20 %
Phase space distribution

Horizontal phase space

Vertical phase space

Horizontal acceptance : 35,000 π mm mrad
Vertical acceptance : 5,000 π mm mrad

Gap height = ± 15 cm
4D acceptance with field error

4D acceptance was calculated when different random factors are applied to each triplets.

\[ B_i(r) = (1 + \delta B_i) B(r) \]

- \( i \) : cell ID number (1~10)
- \( \delta B_i \) : random error-factor within error tolerance

Error tolerance < 0.5~1.0 %
Change of magnetic field due to deviation from design value

Calculated result with TOSCA

Tilt of pole $\delta \theta = 0.11$ mrad

Height of pole: $\delta z = 0.5$ mm

Tilt angle < 0.11 mrad
Displacement of pole surface < 0.5 mm

These values are not difficult for manufacturing.
In case of magnet constructed from 100 mm iron plate

Yoke structure

Return yoke

not in scale

\[ \begin{array}{c}
  d_1 = 0.2 \text{ mm} ; \text{others} = 0 \text{ mm} \\
  d_2 = 0.2 \text{ mm} ; \text{others} = 0 \text{ mm} \\
  d_3 = 0.2 \text{ mm} ; \text{others} = 0 \text{ mm} \\
  d_4 = 0.2 \text{ mm} ; \text{others} = 0 \text{ mm} 
\end{array} \]

\begin{center}
\begin{tabular}{c|c|c|c|c|c|c}
  & 0 & 0.5 & 1.0 & 1.5 & 2.0 & Deviation \\
  \hline
  BL(F) & & & & & & \\
  BL(D) & & & & & & \\
\end{tabular}
\end{center}

To suppress deviation below 0.5 %, D3,D4 should be less than 0.2 mm.
At least, less than 0.05 mm.
Construction status

- Production of 40 set of D coils have been finished.
- Production of several F coils have been finished.
# Magnet parameters

<table>
<thead>
<tr>
<th></th>
<th>Fmagnet</th>
<th>Dmagnet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of magnet</td>
<td>17 t / 1 cell</td>
<td></td>
</tr>
<tr>
<td>Current (per 1 coil)</td>
<td>1750 A / 84000 A*T</td>
<td>1034 A / 30000 A*T</td>
</tr>
<tr>
<td>Power</td>
<td>100 kW / 1 cell</td>
<td></td>
</tr>
<tr>
<td>Flow rate of cooling water (per 1 path)</td>
<td>61.7 ℓ / min</td>
<td>38.3 ℓ / min</td>
</tr>
<tr>
<td>Pressure drop</td>
<td>4.8 kg / cm²</td>
<td>1.9 kg / cm²</td>
</tr>
</tbody>
</table>
Summary

- The design of the magnet have been almost completed.
  - The momentum acceptance is $68 \text{ MeV} / c \pm 20\%$
  - The error tolerance of the field factor should be less than $0.5 \sim 1\%$

- Production of D coils have been finished.
Next plan

- Fiscal 2005:
  - Production of F coils.
  - Production of 4~5 magnet bodies.
- Fiscal 2006:
  - Production of rest of magnet bodies.