Progress of mechanics system

Haijing Wang
Workshop on the Circular Electron-Positron Collider
April 16, 2019, Oxford, UK
- Regular supports and transport vehicles
- Mockup plan
- Installation scenario of MDI
- Movable collimator
- Summary
- CEPC is composed by the double ring Collider, the Booster, the Linac and Transport lines.

- Over 80% of the length is covered by magnets of about 138 types, each magnet needs to be supported.

- Accelerating tubes, vacuum tubes, instruments…, all need supports.

- Aims
  - Simple & flexible structure: plates or standard elements
  - Small deformation & good stability: multi-point support, optimization
  - Low cost: concrete or steel frames, adjusted manually

<table>
<thead>
<tr>
<th>Magnet</th>
<th>DEC</th>
<th>R02</th>
<th>R12</th>
<th>R13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-axis injection</td>
<td>Booster</td>
<td>Electron Ring</td>
<td>RF Station</td>
<td>Linac</td>
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<tr>
<td>Position Ring</td>
<td>RF Station</td>
<td>Off-axis injection</td>
<td>On-axis injection</td>
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</tbody>
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Regular supports and transport vehicles

- **Adjusting methods**
  - Bolts & push-pull bolts
    - simple and low cost

<table>
<thead>
<tr>
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<th>Range of adjustment</th>
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<tbody>
<tr>
<td>X</td>
<td>≥ ±20 mm</td>
</tr>
<tr>
<td>Y</td>
<td>≥ ±30 mm</td>
</tr>
<tr>
<td>Z</td>
<td>≥ ±20 mm</td>
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- **Support method**
  - Magnets in Collider, Linac, Damping Ring: supported to the ground by concrete.
  - Magnets in Booster: hanged on the wall of the tunnel by steel frame
  - Magnets in Transport Line: due to the location of the magnet
Supports for dipoles

- Location of four supporting points: minimum deformation.

Supports in Booster

- Topology optimization is used: best static stability
Quadrupole in Collider and its support:
2 support points, 2000mm

Dipole in Collider and its support:
4 support points, 5670mm

Sextupole in Collider and its support:
2 support points, 1400mm

Dipole in Booster and its support:
4 support points, 5445mm

Quadrupole in Booster and its support:
2 support points, 940 mm
Regular supports and transport vehicles

Accelerating tube in Linac and its support:
2 support points, 3000 mm

Typical magnets and their support

Different accelerating tubes, wave guides, bunchers...
Two types of vehicles

- One for “long” magnets and the other for “short” magnets.
- Transport, adjustment (horizontal and vertical)
- Uneven ground is considered.

* Cooperate with Beijing North Vehicle Group Corporation.
- Primary design of tunnel mockup
  - Interface checking of the equipment locations, installation, alignment and transportation.
  - Including part of arc section and part of RF section.
  - The mockup for each ring includes two dipole cores (or two dipoles), one quadrupole, one sextupole, one BPM and one cryomodule.
  - The total length is 30~50 m. The detailed design is ongoing.
  - A CEPC model of 100m is also under design for exhibition.
Installation scenario of MDI

- Yoke
- Solenoid
- Detector
- IP
- SC magnets
- Support system
- Vertex detector
- Silicon inner tracker
- Forward tracking detector
- Time projection chamber
- IP
- Be-Cu IP chamber
- Remote vacuum connector
- HOM absorber
- Lumical
Basic conditions

- Both sides of IP chamber are fixed to VTX transversally and are free longitudinally.
- The IP chamber, VTX, SIT and FTD can be considered as one assembly.
- The assembly above can be supported by TPC and be aligned transversally.
- Remote vacuum connector can be used.
- The high precision part of Lumical is with the detector and the main body is with the accelerator.

Little transversally space & long longitudinally distance. It is impossible to connect flanges by hands.
Installation scenario of MDI

- Difficulties:
  - Support and fixing.
  - Alignment.
  - The detailed design is ongoing.
- Assembly of detector side and accelerator side.
  - Suppose the IP chamber assembly has been fixed to TPC.

- Pre-alignment of SC magnet: cryomodule in working condition.

- Installation of Lumical, BPM, HOM absorber, RVC and relative support mechanism.
• Move the SC magnet to working location. Connect the flanges using RVC, do the alignment.

• Requirements: accuracy: ≤(30 μm), leak rate ≤2e-10 Torr.L/s

• Alternative design for remote vacuum connection is also under consideration.

* Cooperate with Shenyang Huiyu vacuum technics co., Ltd on the remote vacuum connection.
• Finish the connection and alignment for both sides, install the yoke walls.
• We need holes through the yoke walls for alignment, or to open them.
• We are trying our best to reach the accuracy requirement, but no solution yet.
Methods to improve the accuracy in consideration

- Adjustment mechanism: wedge jacks in three directions.
- Movement mechanism: high precision tracks & rack, in Z direction.
- Optimization will be done to increase the rigidity in limited space.
- Sensors will be used for deformation monitoring.
- Special structure and alignment method will be used for high accuracy requirement, but it’s not clear now.

* Cooperate with Beijing Institute of Space Mechatronics on the SC magnet support system
An alternative scenario.

From K. Kanazawa of KEKB, the 18th KEKB Accelerator Review Committee, 2013
- Two types of collimators.
  - Movable and fixed. TDR stage mainly focus on movable collimators.

Collimator of SuperKEKB

Collimator of LEP

Collimator of PEPII

Sketch of movable collimator of CEPC
Located in straight section between two dipoles, the length is 800 mm.

Primary impedance estimation has been done.

The synchrotron radiation is the main thermal load, the cooling method is under consideration.

Evolution of inner profile owing to impedance
Primary design of supports for typical magnets and transport vehicles have been done, and is on-going for other devices and under refining.

A tunnel mockup with part of arc section and part of RF section will be built for adjustment, alignment and transportation tests.

The rough layout of MDI has been done, based on which the primary installation scenario has been designed.

The primary estimation of impedance and synchrotron radiation at movable collimators has been done, the cooling method is on-going.
Thanks for your attention!