Summary from MDI meeting Friday 13 September, alignment & vibration stability

Review of Vibration and Stabilisation Studies at LAPP Laboratory

Interplay among all factors (mechanics, optics, beam dynamics…) to be studied in a global simulation (tracking simulation)

LAPP group would like to study the beam dynamics at the interaction point integrating:

- Mechanical design (with the concrete) and simulation of the final focus system and cryostat in cantilever mode to study resonance frequencies : LAPP group is interested to collaborate on mechanical studies (dynamics aspects)
- Realistic seismic motion and cultural noise (existing measurements like CMS or models)
- Integration of the various beam controls (collaboration with the CERN teams)

Important steps:

- **Determinate the needed specifications**
- Develop the active control system with sensors, actuators and controls (if needed).
- Develop prototypes to test the dynamics aspects and the dedicated active control
- Integration issues (ex: instrumentation)

Review of Vibration and Stabilisation Studies at LAPP Laboratory

- **Future prospects**
  - *Improvements of the developed sensor (Comparison of different technologies for the embedded sensitive part, radiations…)*
  - Continue monitoring of vibrations of superKEKB with correlation studies of luminosity and get more involved on beam dynamics and control (IP feedbacks)
  - Investigate possible activities in collaboration (ex: with Daϕne team?...)
  - Optics -> Specifications… -> mitigation strategy (concrete, mecanics, control, instrumentation…)
  - Start collaboration studies on mechanical design of final focus system for FCC-ee
  - Start studies on beam dynamics, vibration analysis and control (investigate tracking simulation code suitable for this kind of study)

Misalignment Tolerances

- Basic input parameters for the Survey team
- Misalignment Tolerances
  - Arc beamline elements, over ~100 m
    - ttbar, over ~100 m
    - dx = dy = 100 μm, 1 sigma
    - roll = 100 μrad, 1 sigma
  - Interaction Region
    - dx = dy = 100 μm, 1 sigma
    - roll = 100 μrad, 1 sigma

Misalignment Tolerances

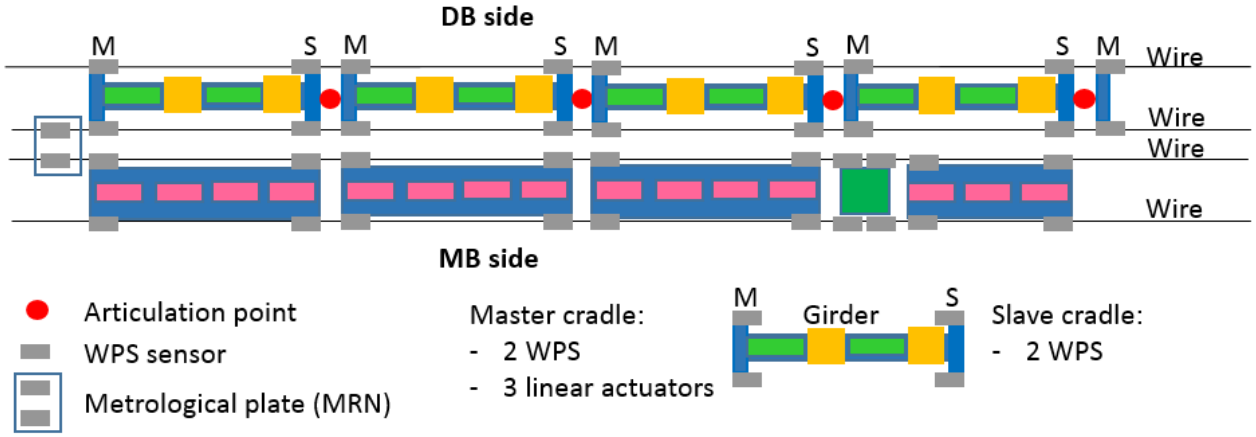
Questions to the MDI team

- Lower energy machines?
- Straight Section
  - Misalignment tolerance between beamlines?
- Relative misalignment tolerances?
  - One side of experiment to the other
  - Between QC1 and QC2
  - Metrology of split elements (e.g. QC1L1 – QC1L3)

FCC-ee Position Monitoring & Alignment

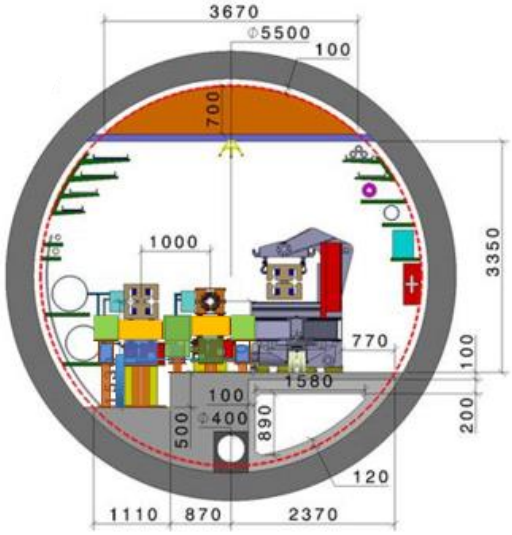
- Concept based on design for CLIC
  - Full Remote Position Monitoring and Alignment System
  - Wire Position sensors
  - Hydrostatic Levelling sensors
  - Motorised positioning system

Design for CLIC



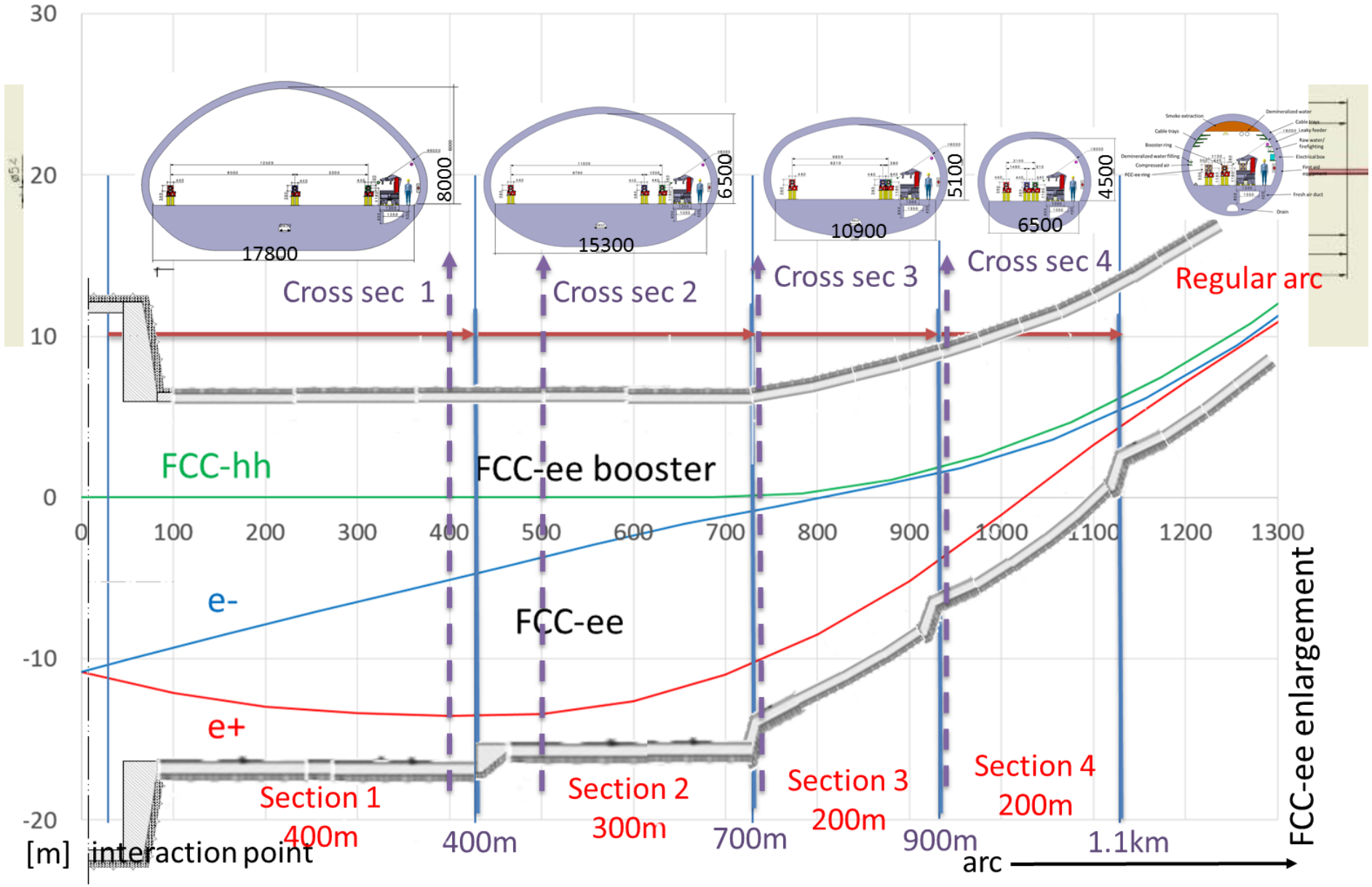
FCC-ee Position Monitoring & Alignment

- Precision specifications
- Smoothing Time Constraints
  - Continuous Monitoring
  - Automated remote re-alignment with continuous feedback
- Metrology precisions for ~6 m long elements
- Tunnel Reference Infrastructure
  - Space requirement in curved tunnels
  - Full remote maintenance (HL-LHC developments + … ??)



Possible solution for FCC

- Same strategy of fiducialisation based on PACMAN project results
- Internal monitoring of QC2, QC1, Anti-solenoid …
- Equip final components with permanent sensors (WPS)
- Monitoring of QC1, Lumical position
  - use absolute distance measurements.
- To link both sides of tunnel: very important to have dedicated galleries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-10
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8000
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17800
15300
10900
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Cross sec 1
Cross sec 2
Cross sec 3
Cross sec 4
Regular arc
FCC-hh
FCC-ee booster
FCC-ee
e-
e+
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
[m]
interaction point
Section 1
400m
400m
Section 2
300m
700m
Section 3
200m
900m
Section 4
200m
1.1km
arc
FCC-ee enlargement

Conclusions

- An alignment solution could be adapted from those applied and studied for HL-LHC and CLIC
  - It should meet the known misalignment tolerances

but

  - Can it be applied in this situation?
- Solution Requires
  - Additional space inside the experiment
    - Sensors, lines-of-sight, position adjustment system
  - Strong position and orientation links between accelerator elements in the cavern and those in the tunnels
  - Internal metrology for “encapsulated” elements
    - Inside cryostats, or detectors
- The application, adaptation, and integration of alignment and internal metrology components into a single system needs to be studied