FCC - Large Scale Metrology

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ENGINEERING
DEPARTMENT

Outline

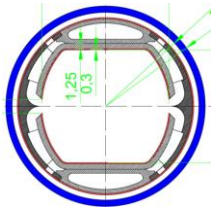
- Large Scale Metrology Activites
- Alignment Specifications \ Restrictions
- Current activities
- Next steps
- Conclusions

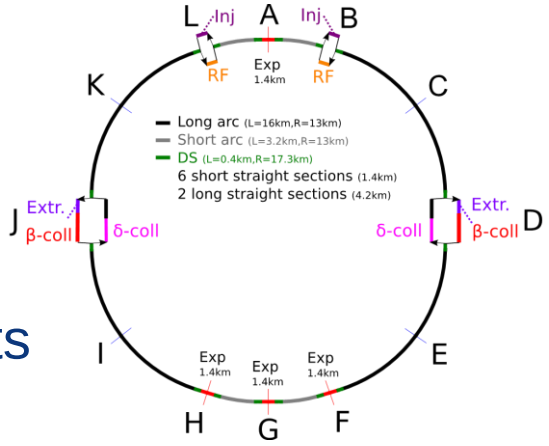
Large Scale Metrology Activities

- Geodesy
- Data Management and Data Processing
- Accelerator Alignment
  - Including injector chain and secondary beamlines
- Micro Technology and Instrumentation
  - Sensors and systems for permanent monitoring of critical components
- Metrology for Detectors
  - Including fixed target and other experiment facilities
- As-Built Surveys
  - Laser scanning

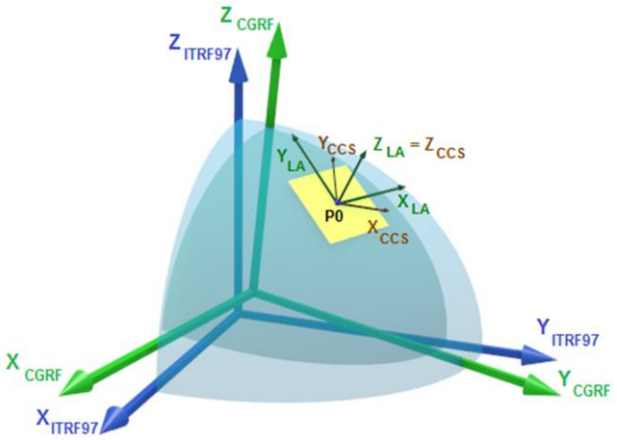
Alignment Specifications \ Restrictions

- Alignment precisions
  - Relative precision over a given distance
  - Fundamental input for all Large Scale Metrology concepts
- Alignment precisions need to be broken down
  - Manufacturing
  - Dimensional control
  - Fiducialisation
  - Component assembly
  - Final alignment control
- General Layout
  - For all modified or new installations
- Access restrictions
  - Radiation hazard, magnetic fields, space limits



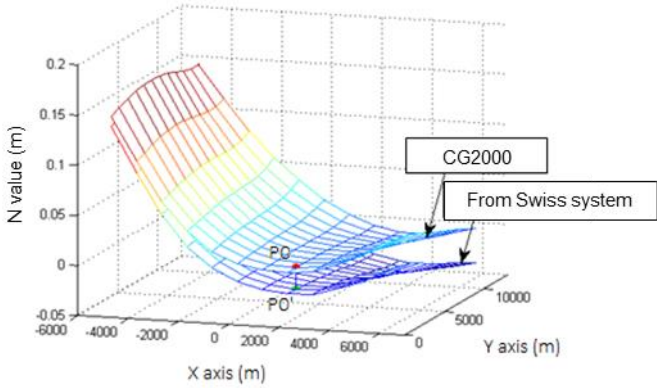


CERN Reference Systems

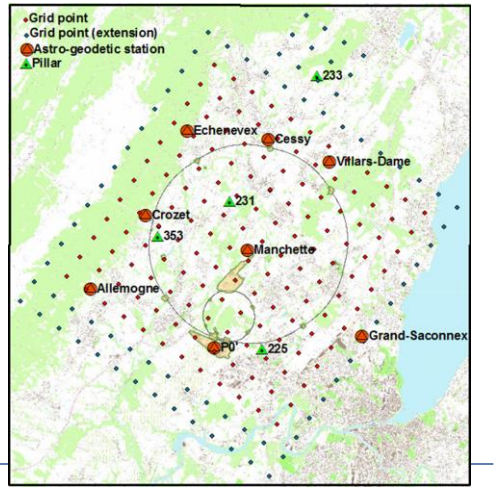


- CERN Coordinate System
  - Used to defined the position of all CERN installations
- CERN Geodetic Reference Frame
  - Provides connection to the global, Swiss and French reference systems
- Analysed anomalies in the parameters defining the two reference frames
  - Propose to change some of the parameters
  - More details in the poster by Nerea Ibarrola [168]

Geoid Model



- Vertical Reference Surface
  - Height above mean sea level
- Several evolutions since the start of CERN
- Some inconsistences to be explained
- Another new model will be needed for the FCC
  - Need to combine both French and Swiss data
  - Started work, with support from Swisstopo, to analyse data and measurements available and required
  - Looking for input from IGN and from some universities



Alignment Precision

- Initial analyses to see if we could match LHC alignment precision
  - 0.15 mm at 1 sigma
  - relative alignment of 3 quadrupoles

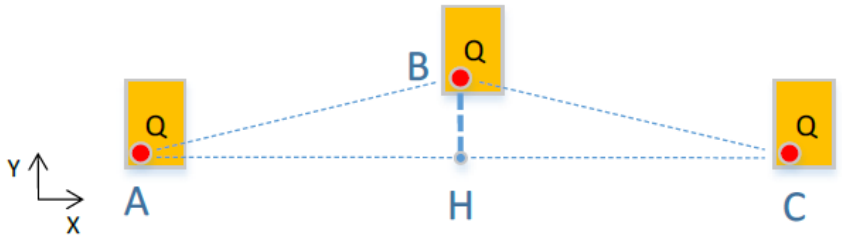


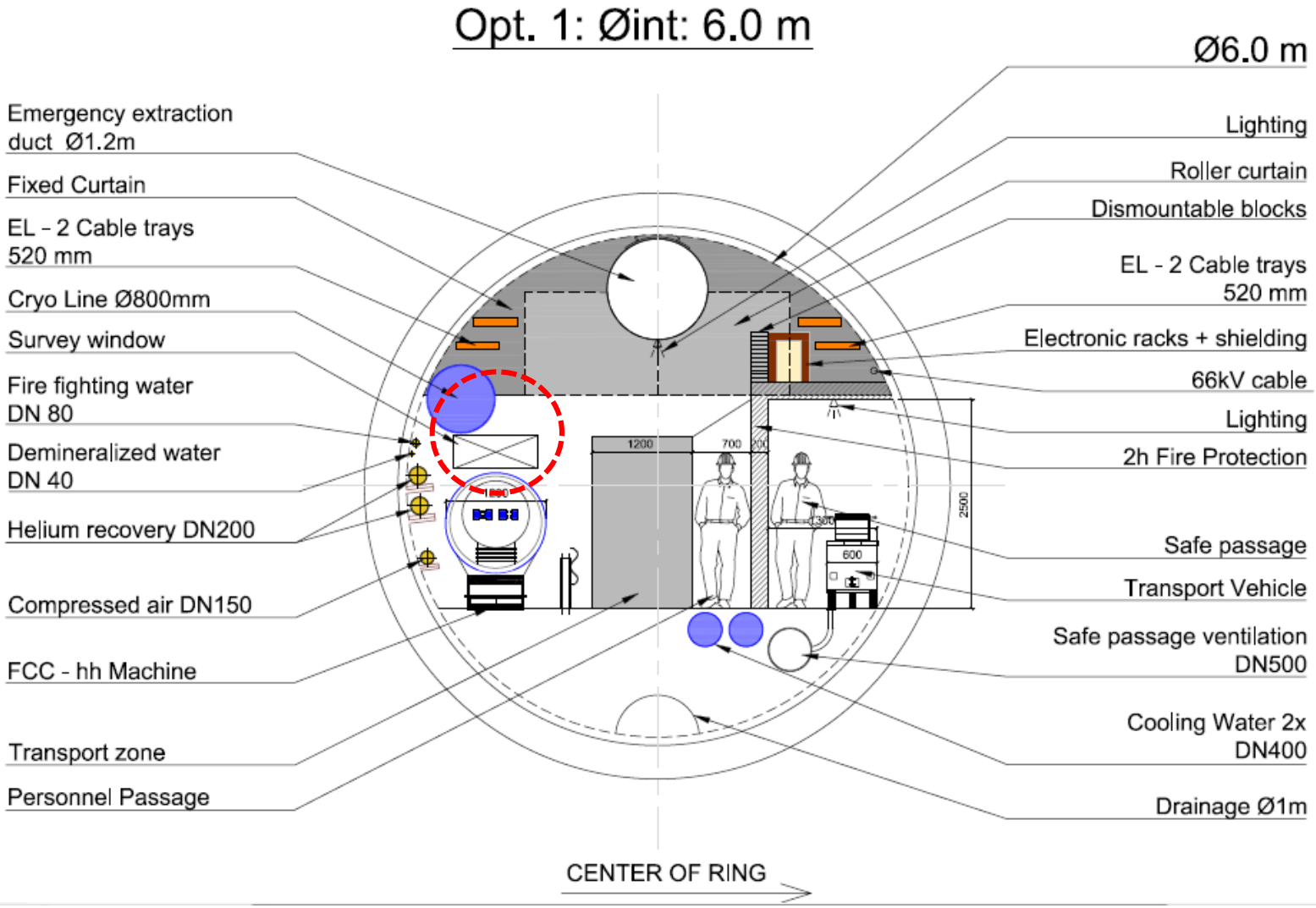
Figure 4. Triangle formed by three consecutive quadrupoles.

- Vertical possible with some improvement in measurement precision
- Horizontal possible if we can reliably model a 225 m stretched wire

Survey access \ reserved space

- Space for access
  - Positioning system
  - Instruments and Targets
- Space for instrumentation
  - Dependent upon the system

Survey access \ reserved space



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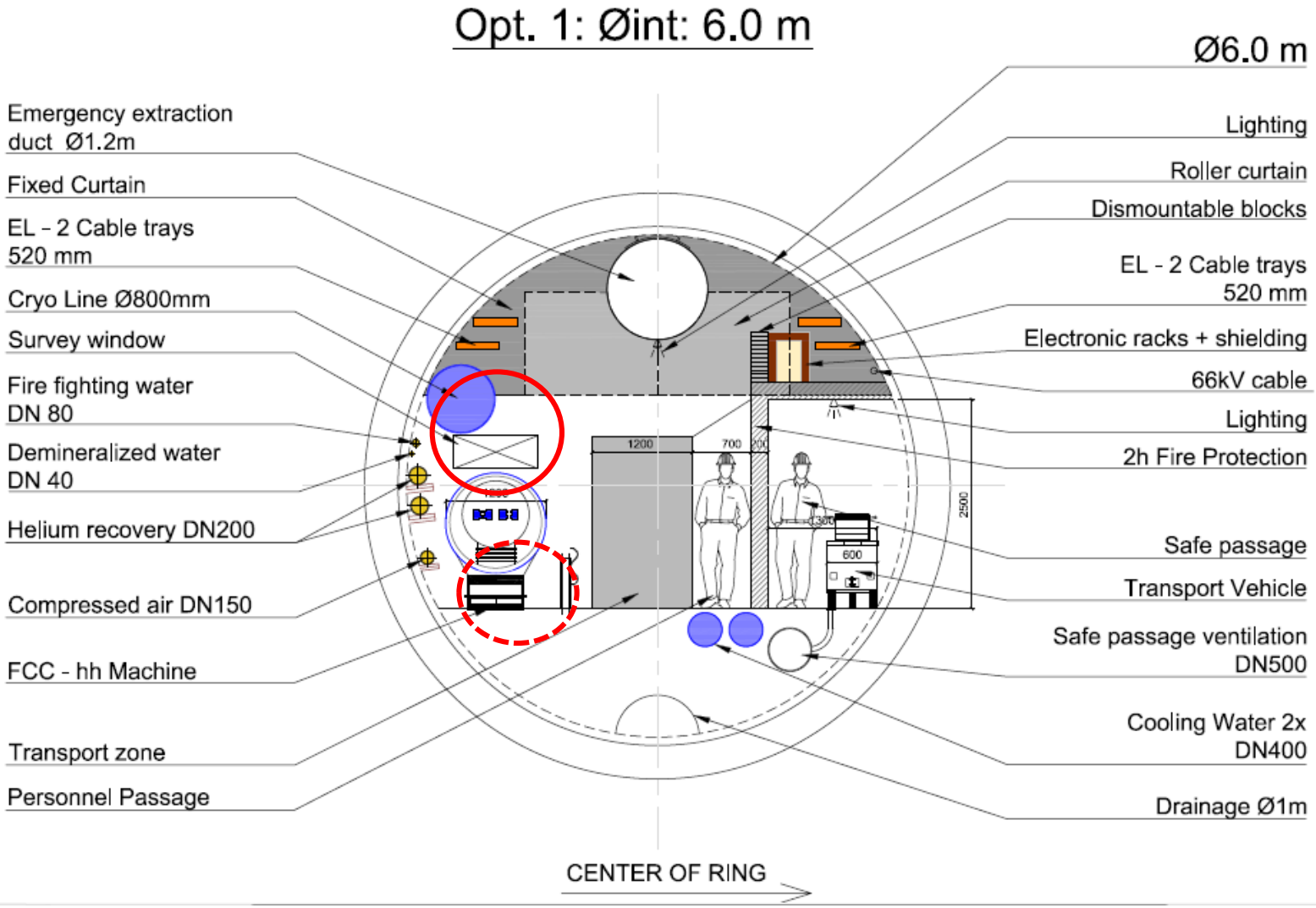

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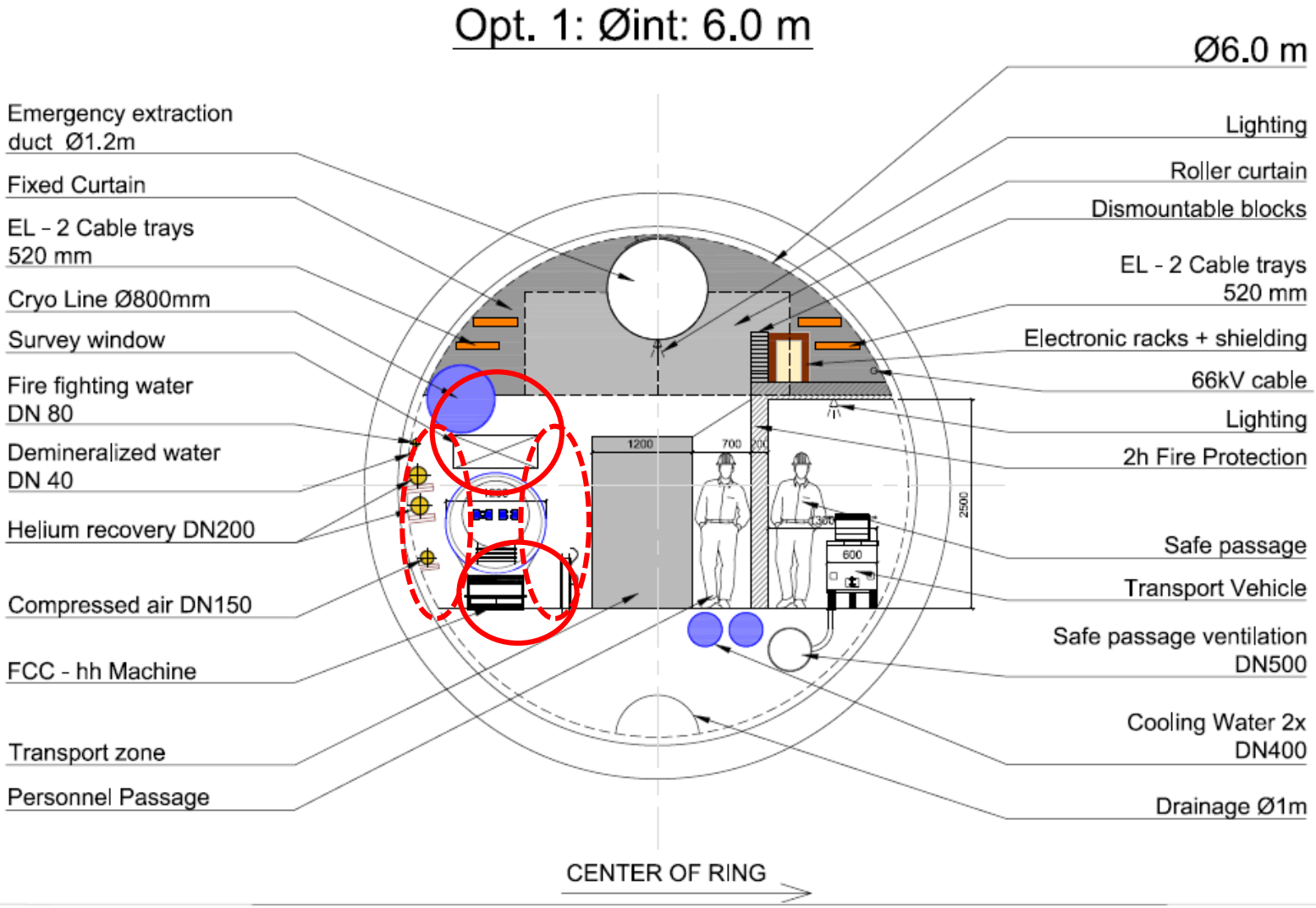

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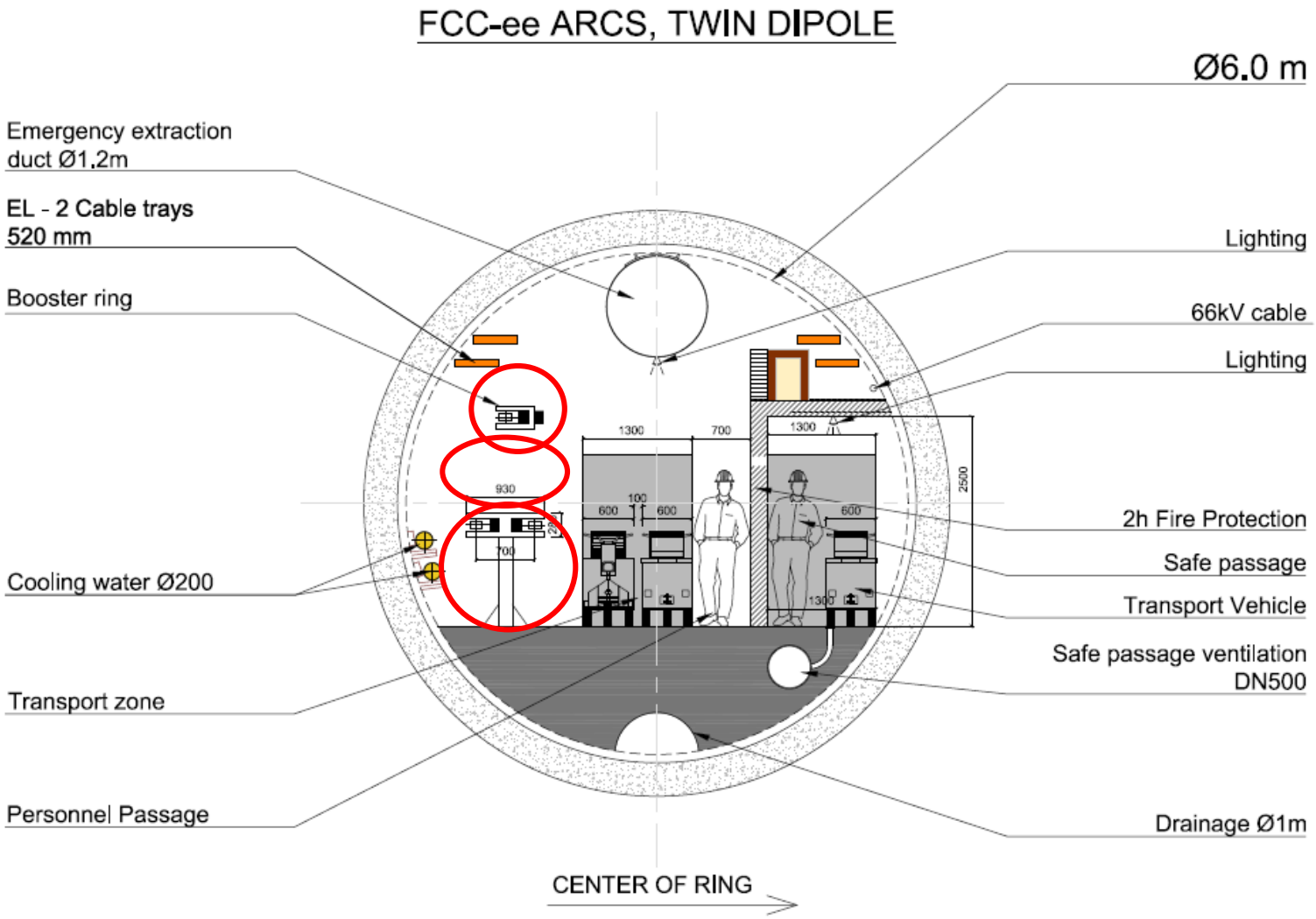
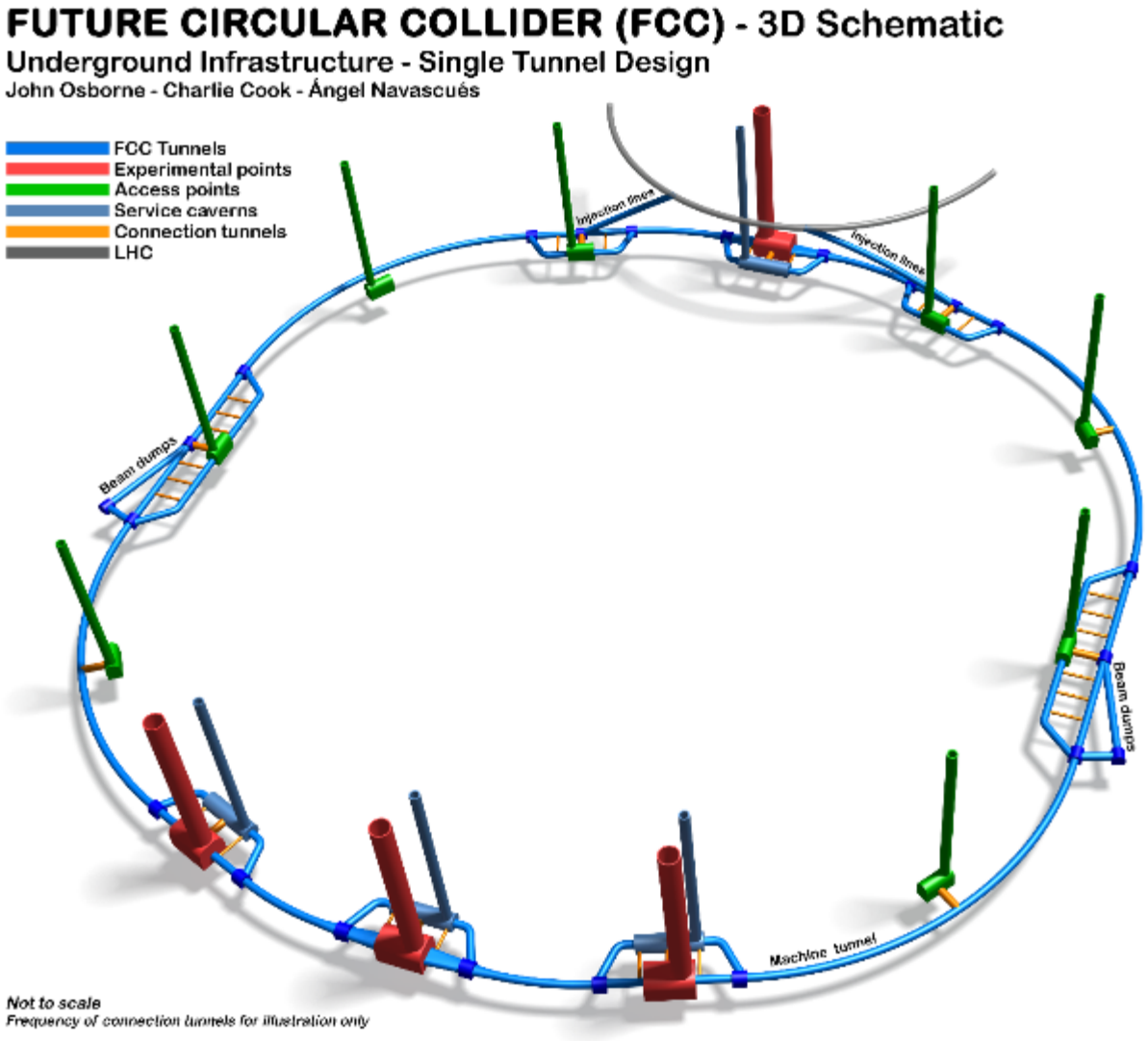


Survey access \ reserved space

Transfer Shafts



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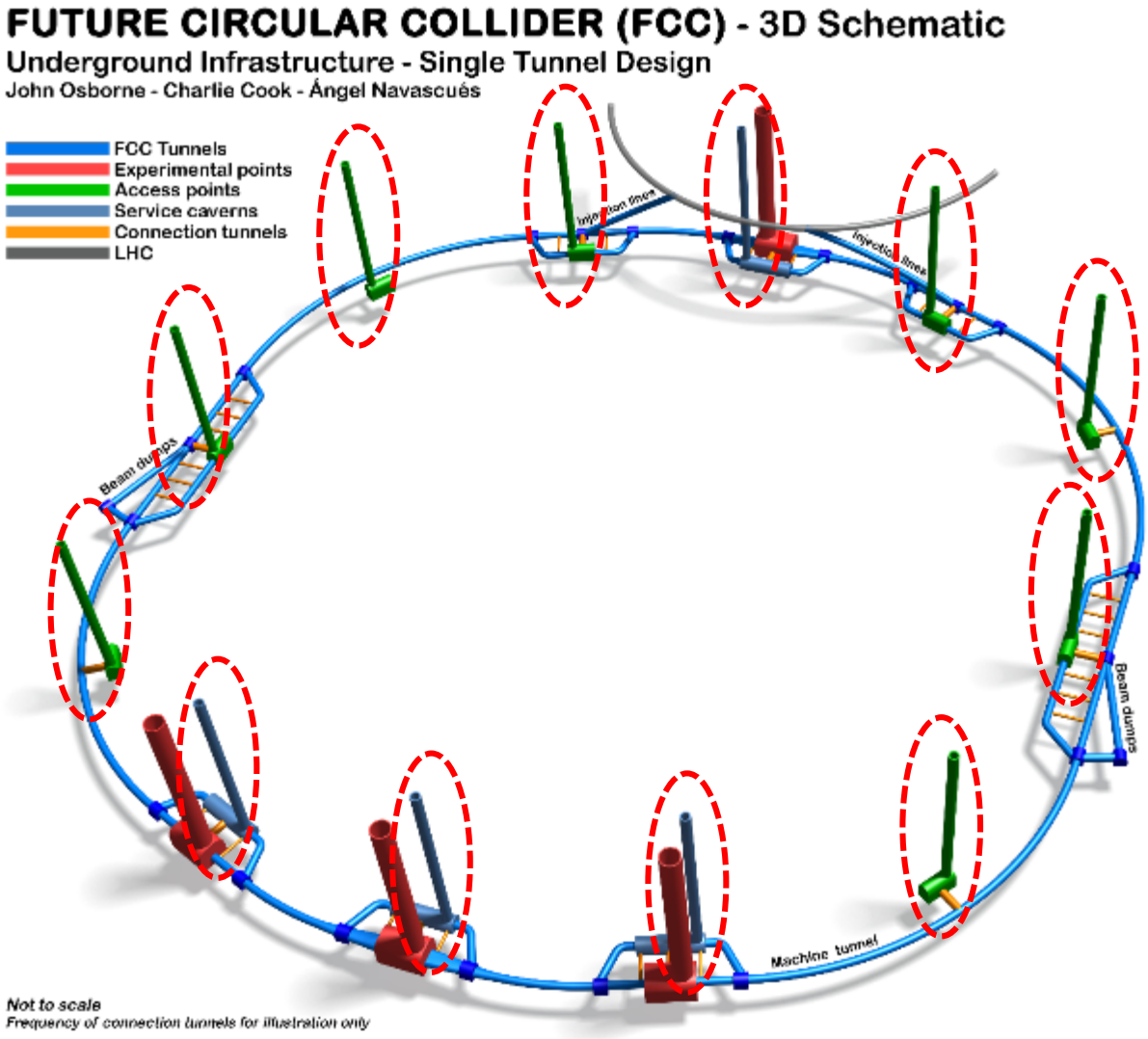

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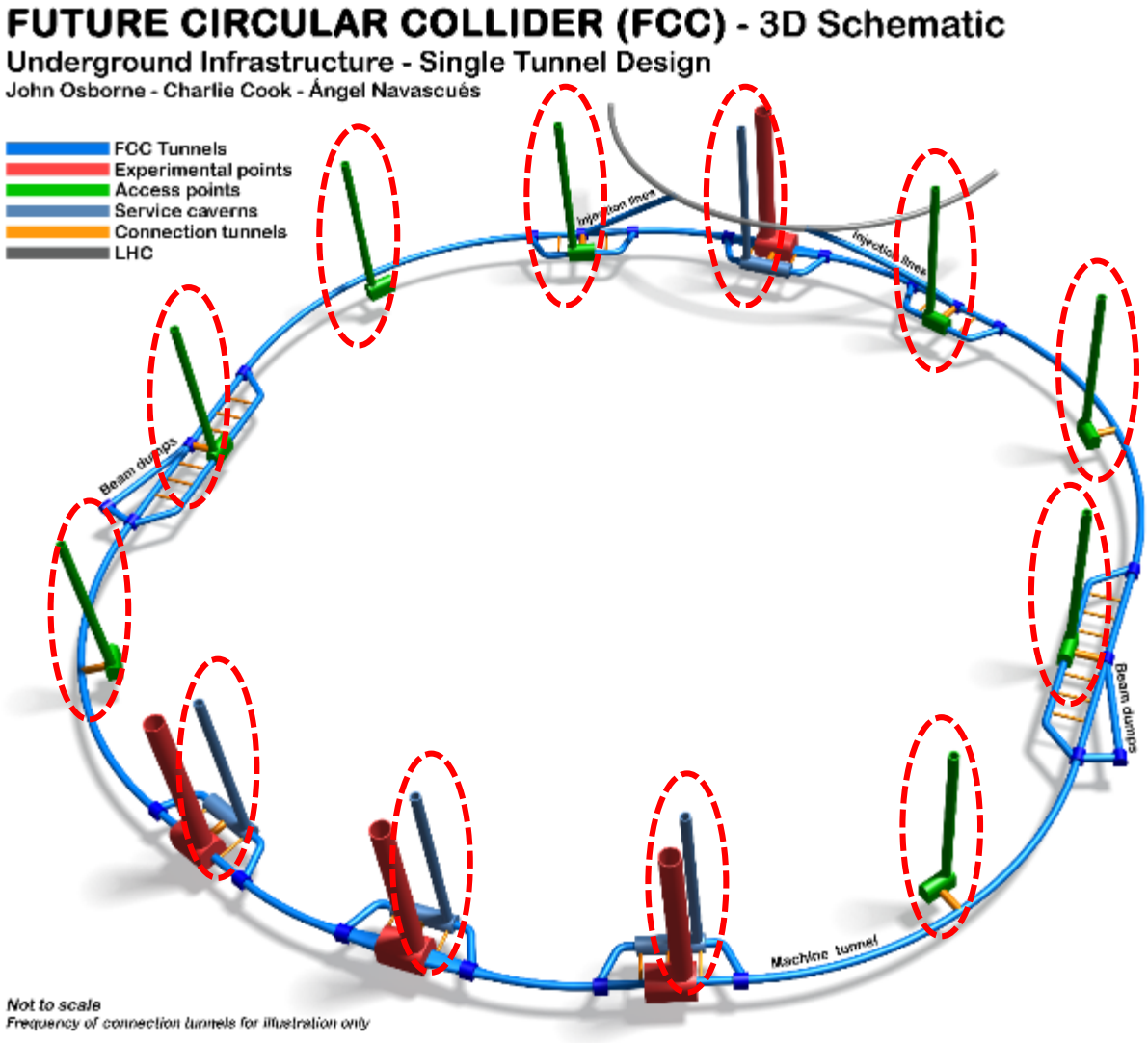
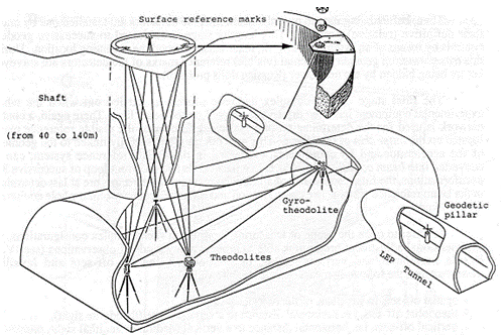
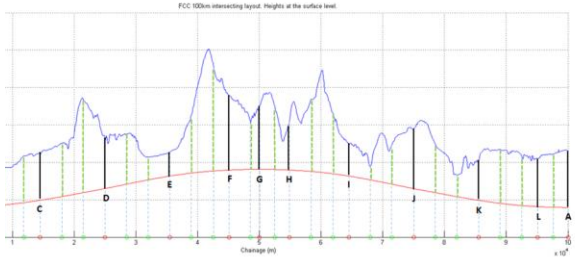
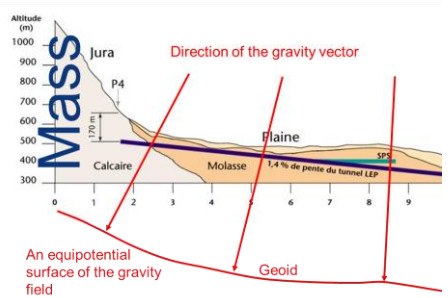


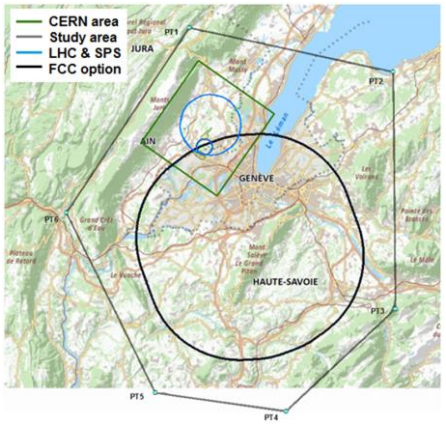




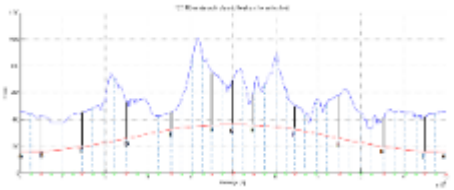
Next Steps

- Geoid Model
  - Continue work to understand measurements required

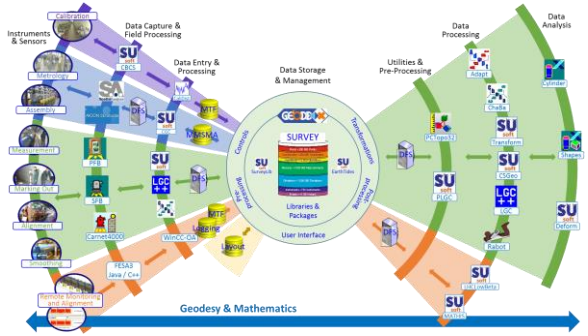




- Geodetic Reference Network Simulations
  - Surface
  - Surface to underground transfer
  - Tunnel and experiment halls



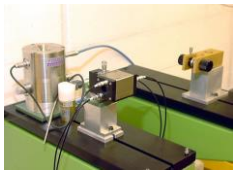
- Instruments and Mathematical Observation Models
  - Longer distances – airflow, refraction, …
  - Validation of instruments
  - Refined instrument error models

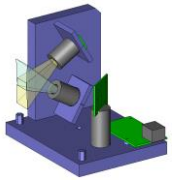


Next Steps

- Analysis of alignment precisions
  - Need numbers to analyse!!
  - FCChh, FCCee, Transfer Lines, Experiments
  - MDI, Injection, Extraction

- Design control, alignment & monitoring systems
  - Selected as a function of final alignment precision
    - ≥ 0.15 mm, 1 sigma
      - standard instruments
    - < 0.15 mm, 1 sigma
      - options to be studied



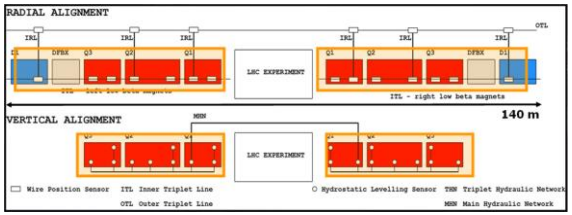


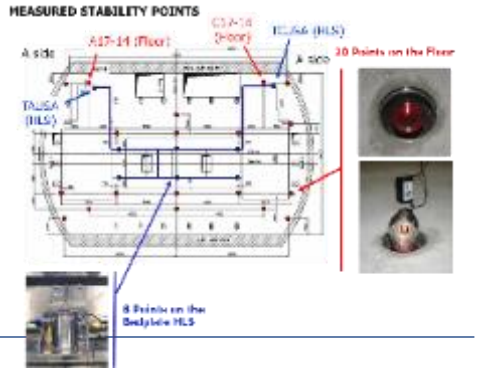
Next Steps

- Space and Access
  - Define for the tunnels, shafts and experiment halls
- Surface Tunnel Shafts
  - Define if additional shafts are required.

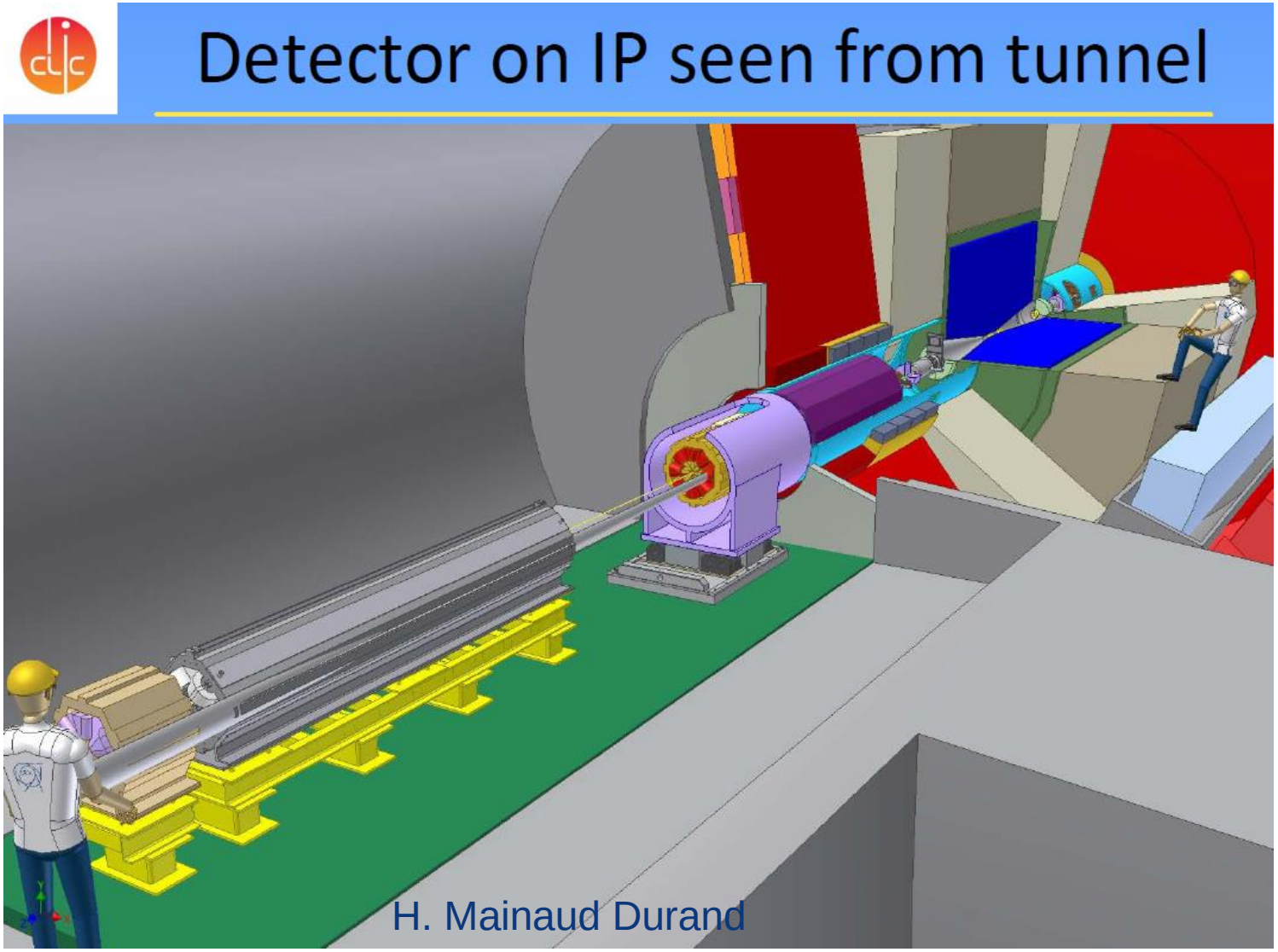
Next Steps

- Permanent monitoring, alignment and control system
  - When?
    - High alignment precision
    - Short/long term access restrictions
  - What?
    - Motorised positioning system(s)
    - Remote system control & maintenance
    - Different space requirements
  - Where?
    - MDI, Collimators (large installation)
    - Experiments, Injection & Extraction ?
    - FCCee (complete machine) ?
  - Remote control & maintenance ?





FCCee MDI



Conclusions

- Still ongoing work on the reference systems for the FCC site
- What monitoring, alignment and control system technology is required?
- Further progress is limited without input on alignment specifications!
  - Could imply R&D!

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