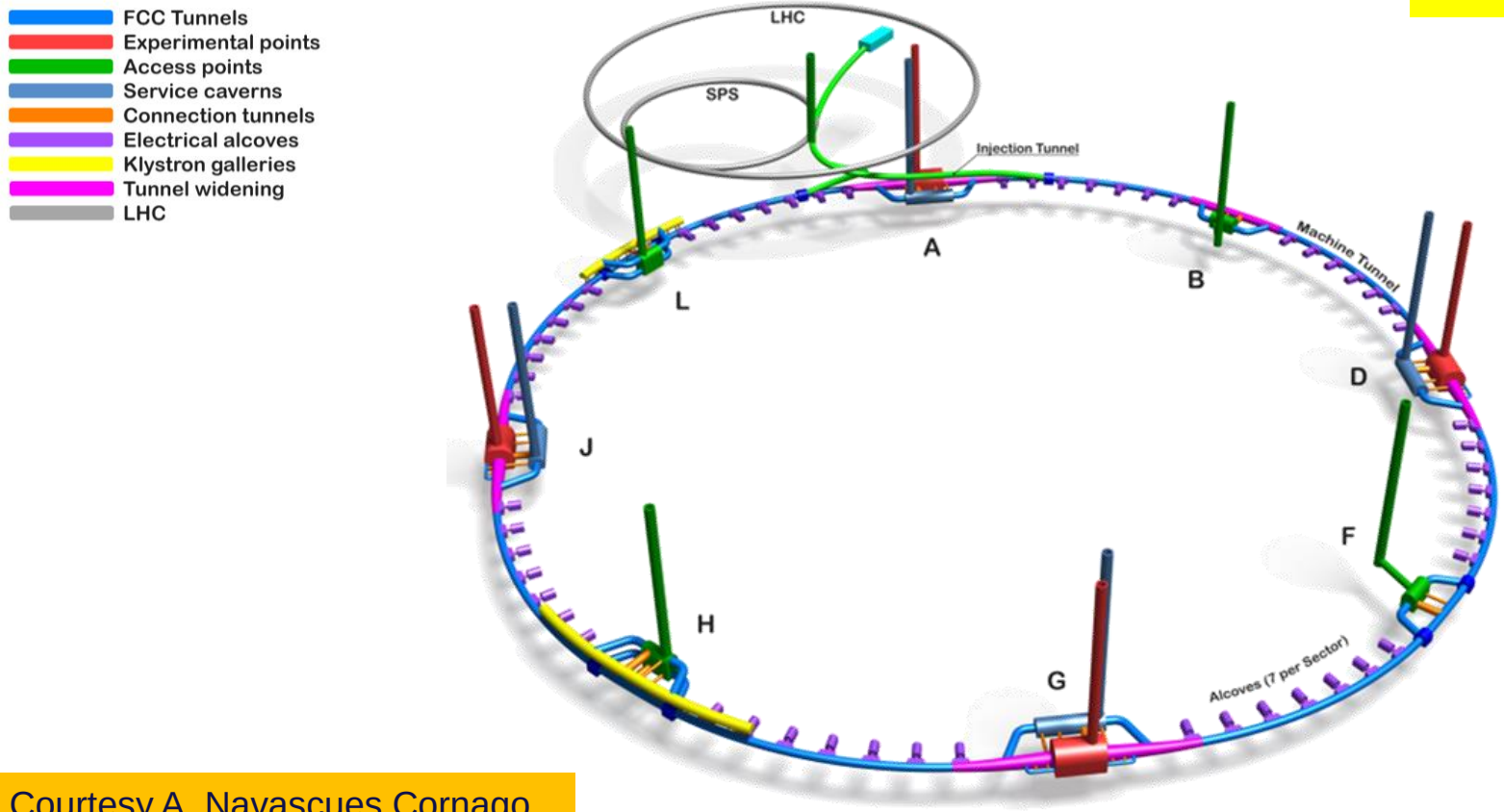
# INTEGRATION UPDATE TUNNEL AND ARCS, CAVERNS, SERVICE CAVERNS, ETC

F. Valchkova-Georgieva and Dieudonne Adrien Ngo'O

- FCC-ee Underground Structure Overview
- Integration of FCC-ee Arc Cell
- FCC-ee Underground Structure point A and G
- Integration of FCC-ee Beamstrahlung dump
- Integration of FCC-ee Alcoves and transport areas
- Integration of FCC-hh Arc Cell

# FCC-ee Underground Structure Overview

Only schematic, and not to scale.

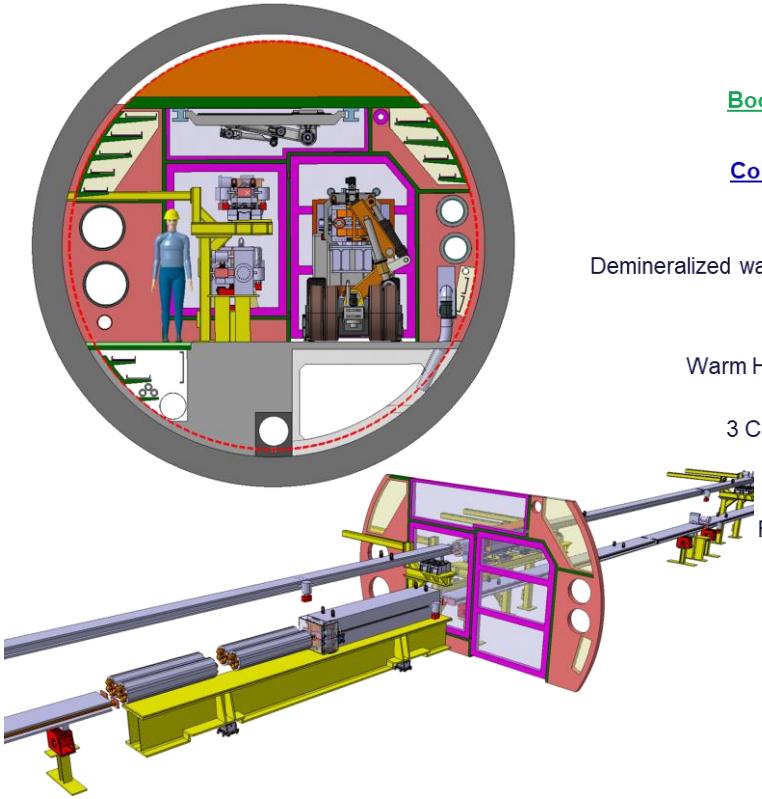



Courtesy A. Navascues Cornago

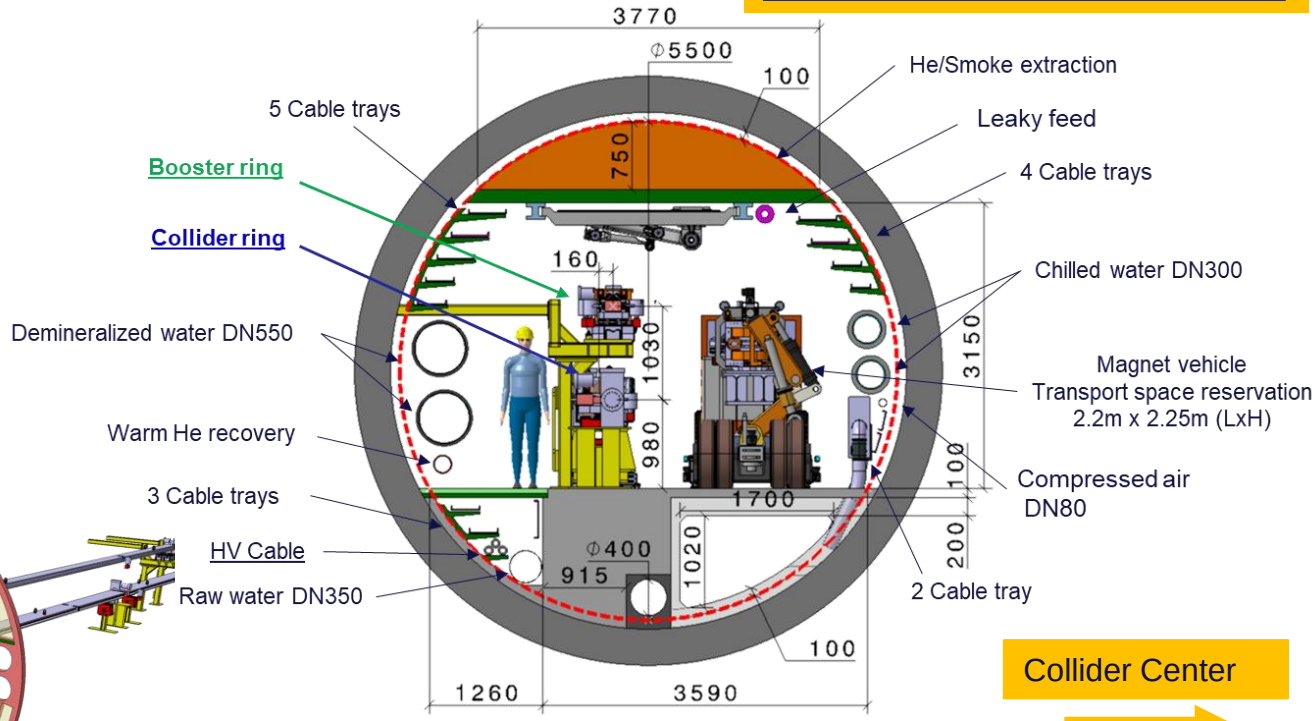
# Integration study of FCC-ee Arc Cell

# Integration study of FCC-ee machine elements (regular arc)

Machine tunnel cross section with compartment door



Machine tunnel 5.5m in diameter

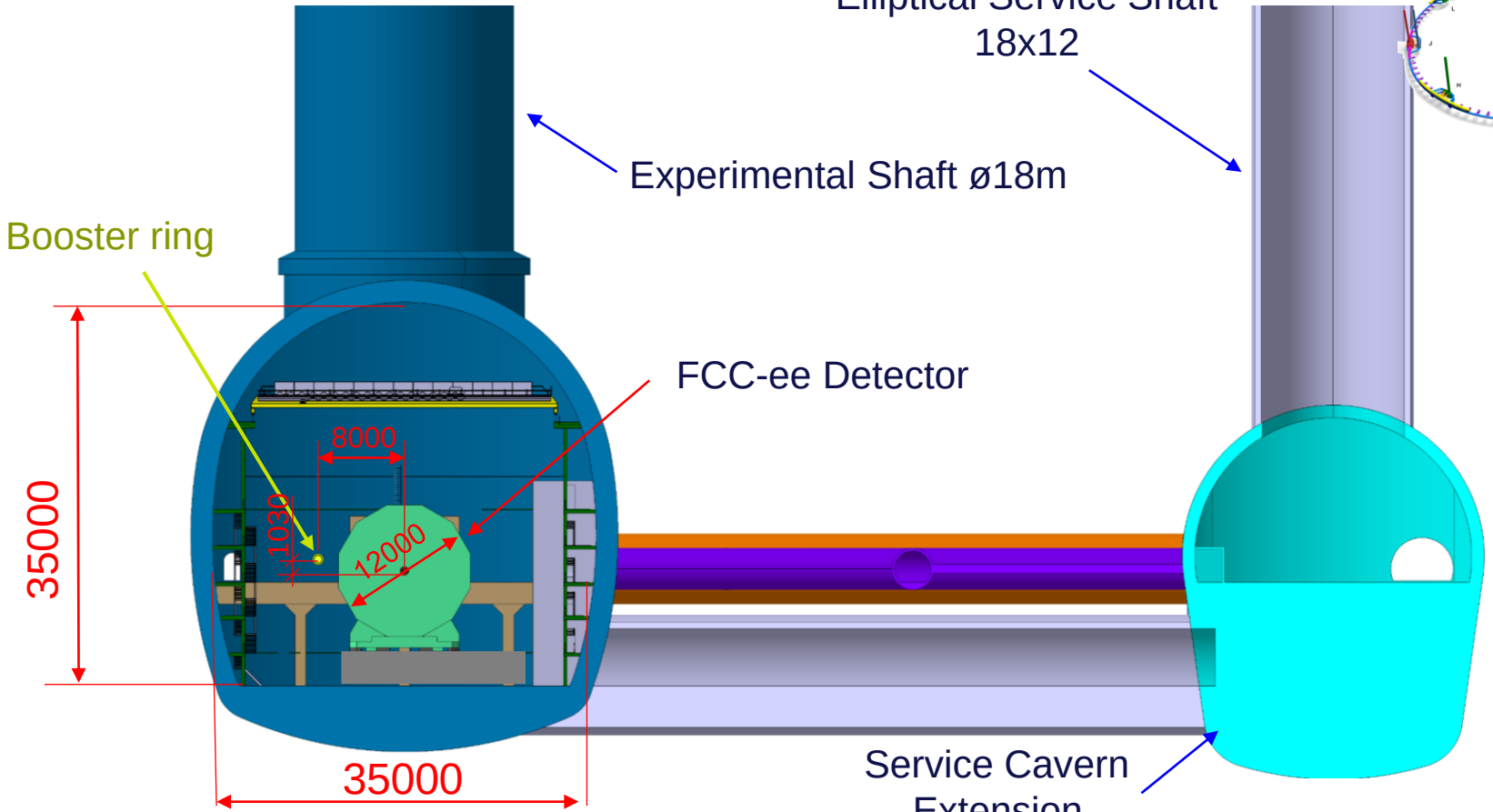



Collider Center

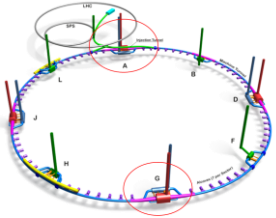
Main cross section as for FCC-hh
Main ring below of booster ring
Main ring and booster ring 1.03 m distant

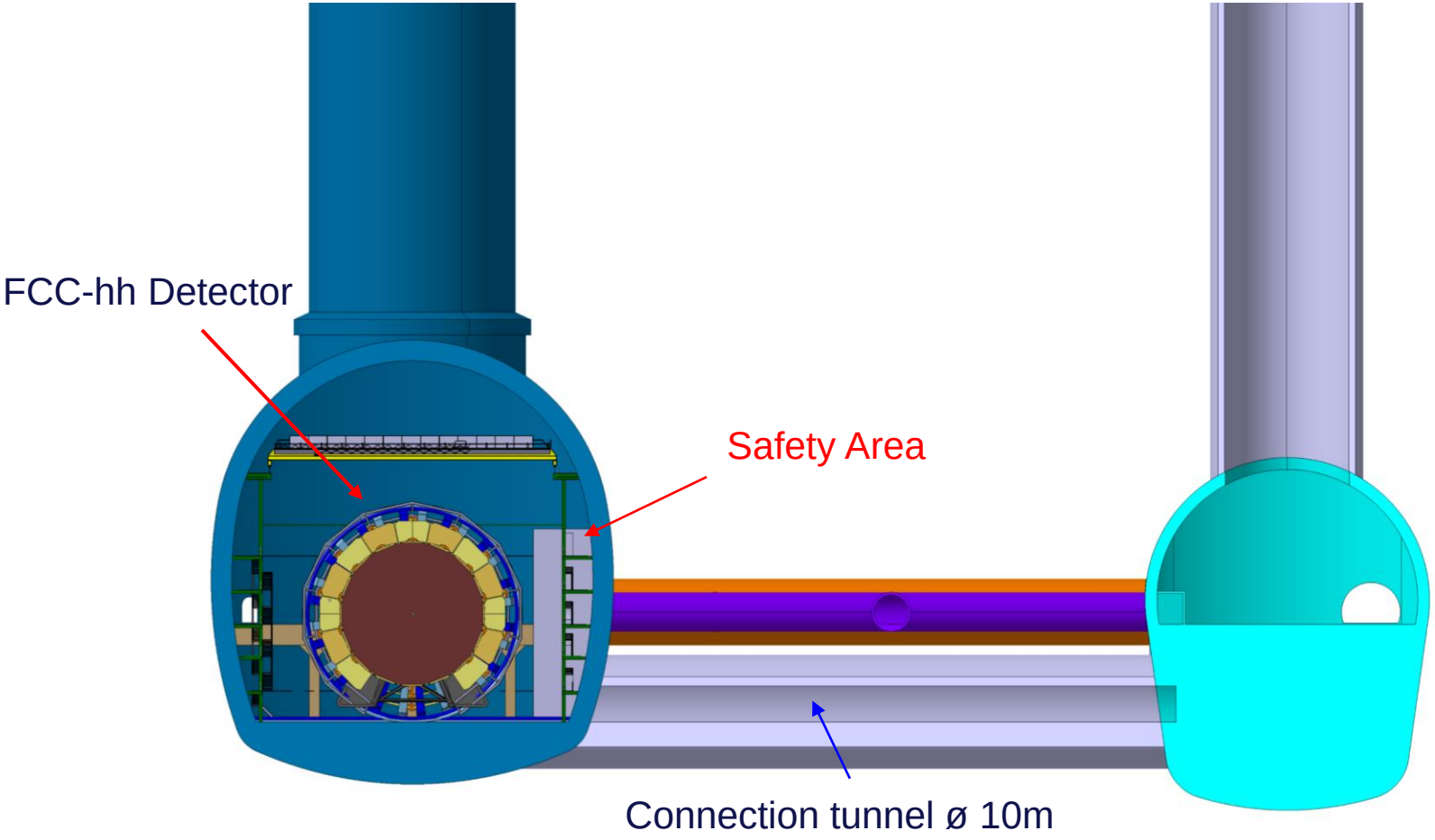
# FCC-ee Underground Structure point A and G

# FCC Experiment Underground Structure

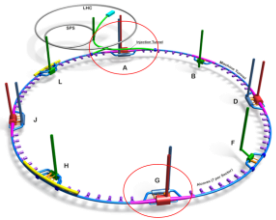


# FCC Experiment Underground Structure

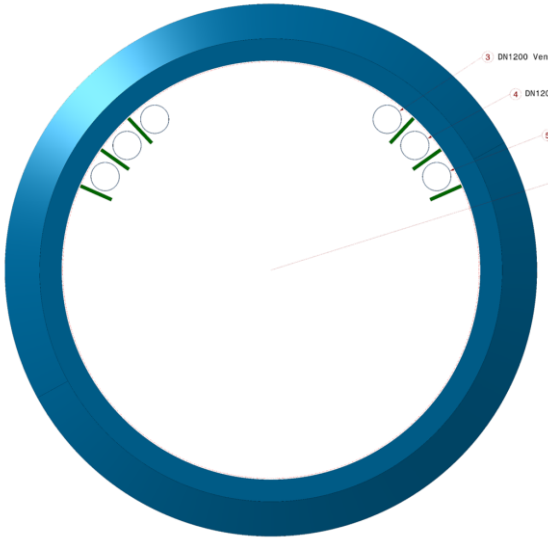


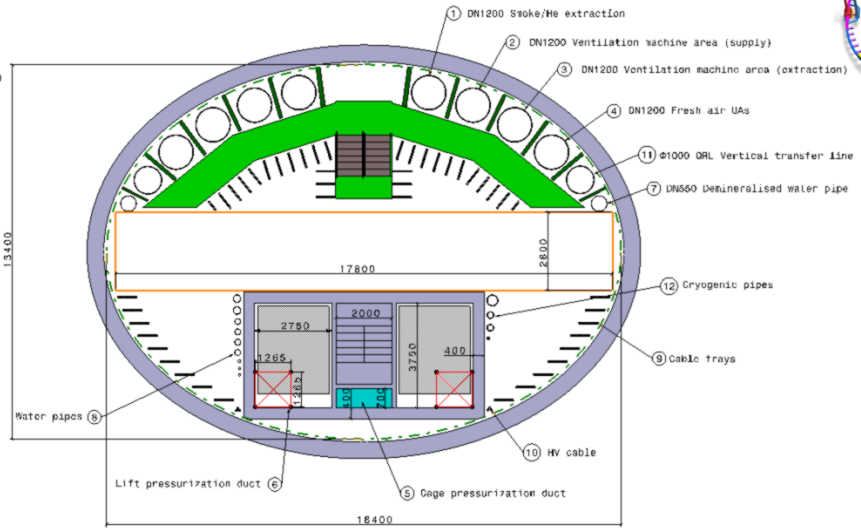


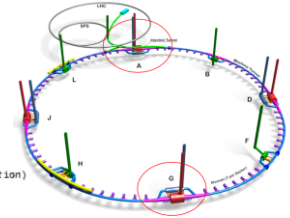
# FCC-ee Underground Structure at point A



# FCC-ee Underground Structure at point A

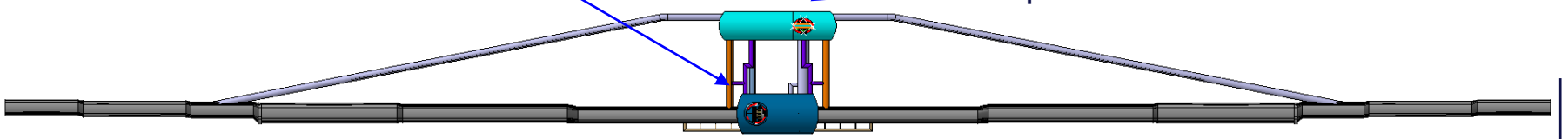


Experiment Shaft ø 18m

Elliptical Service Shaft

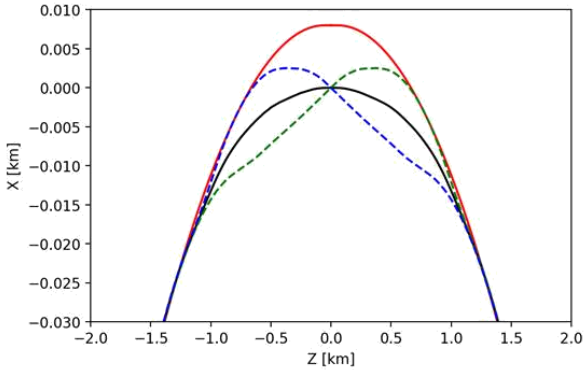


1.7 km

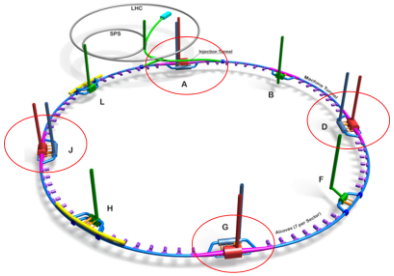
# Integration study of FCC-ee Beamstrahlung dump

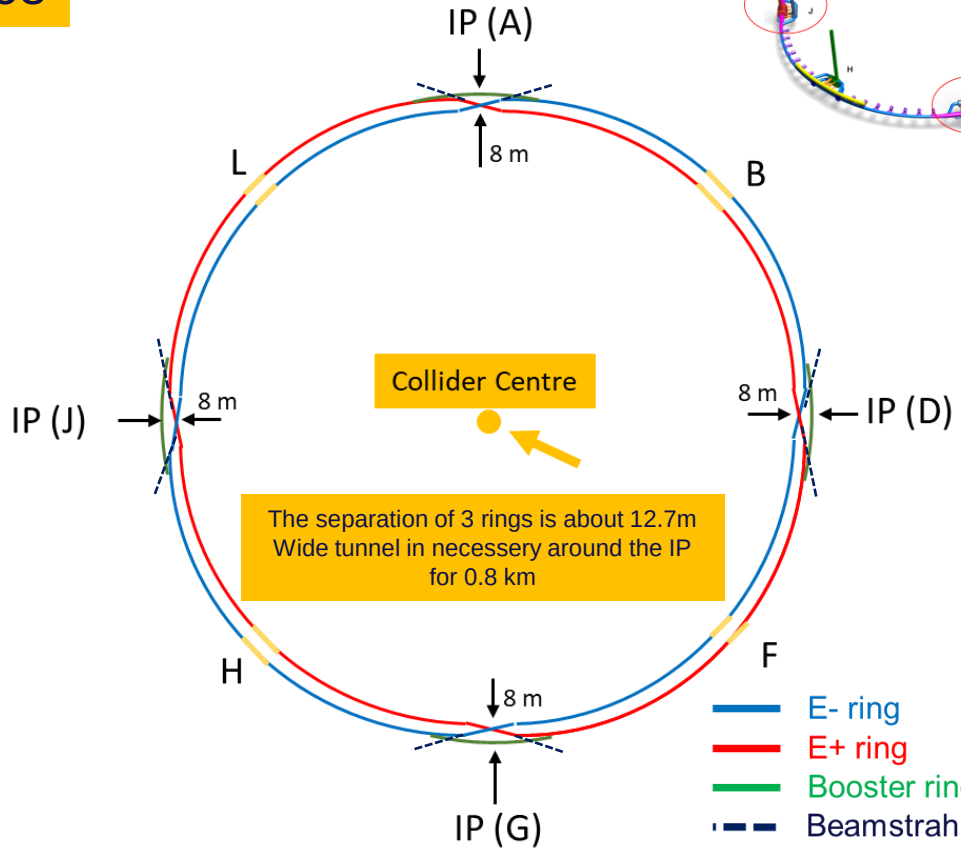
# FCC-ee main and booster rings Layout

Courtesy K. Oide/ A. Chance



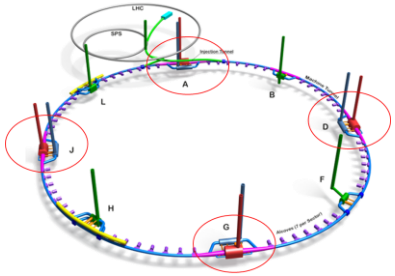

E- ring
E+ ring
Booster ring

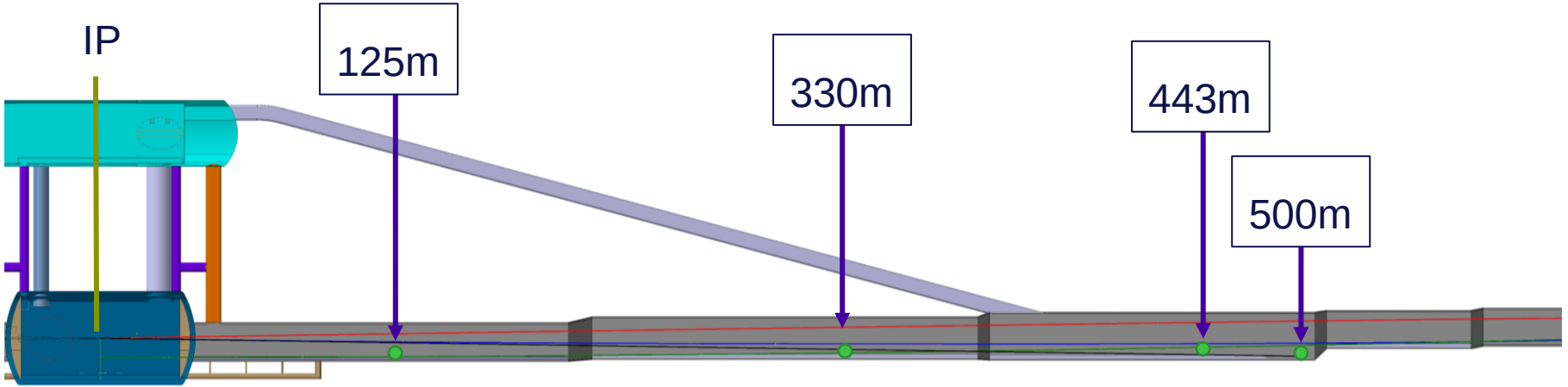




# FCC-ee beamstrahlung dump integration study at point A

- E- ring
- E+ ring
- Booster ring
- Beamstrahlung Dump



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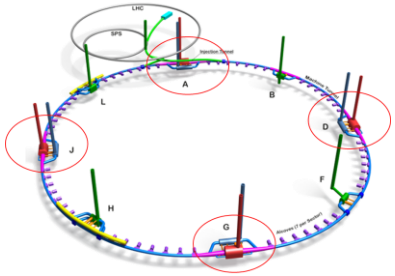
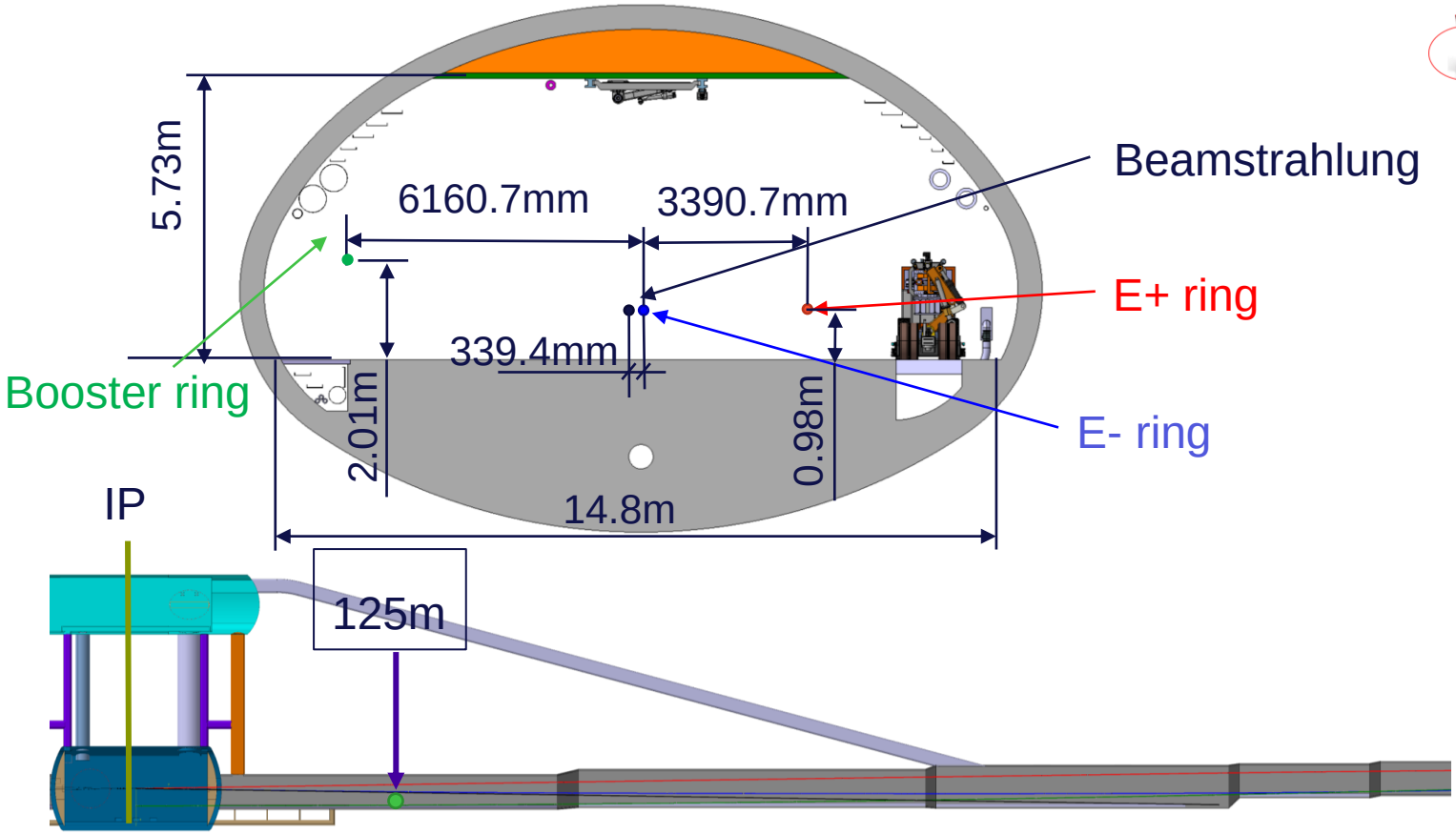
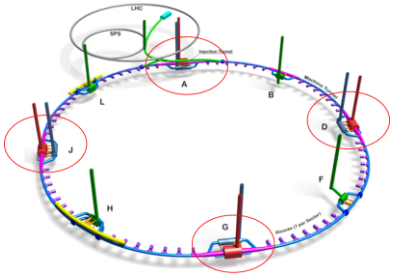
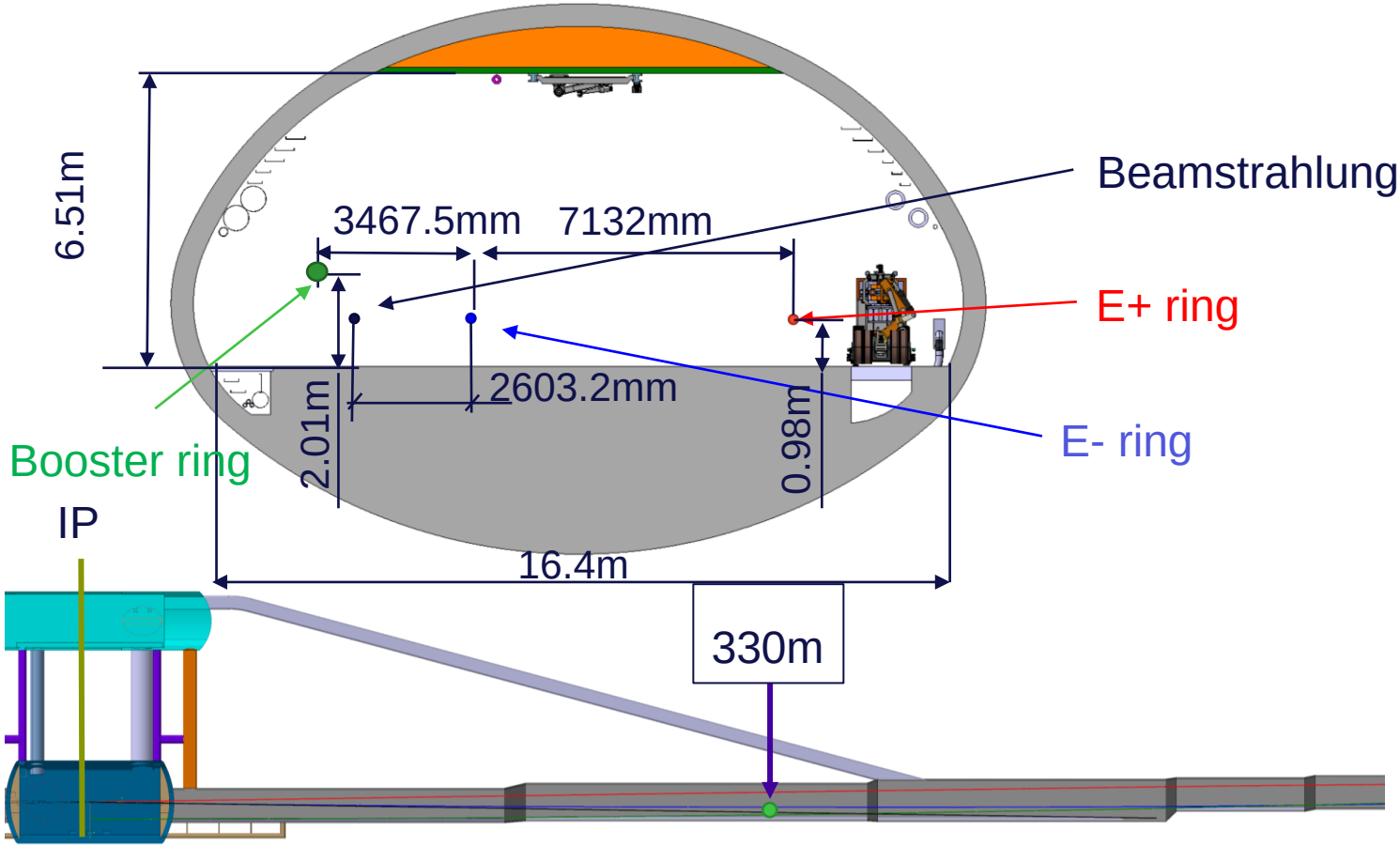


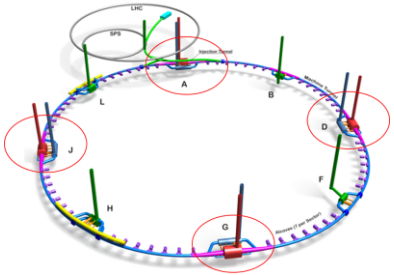


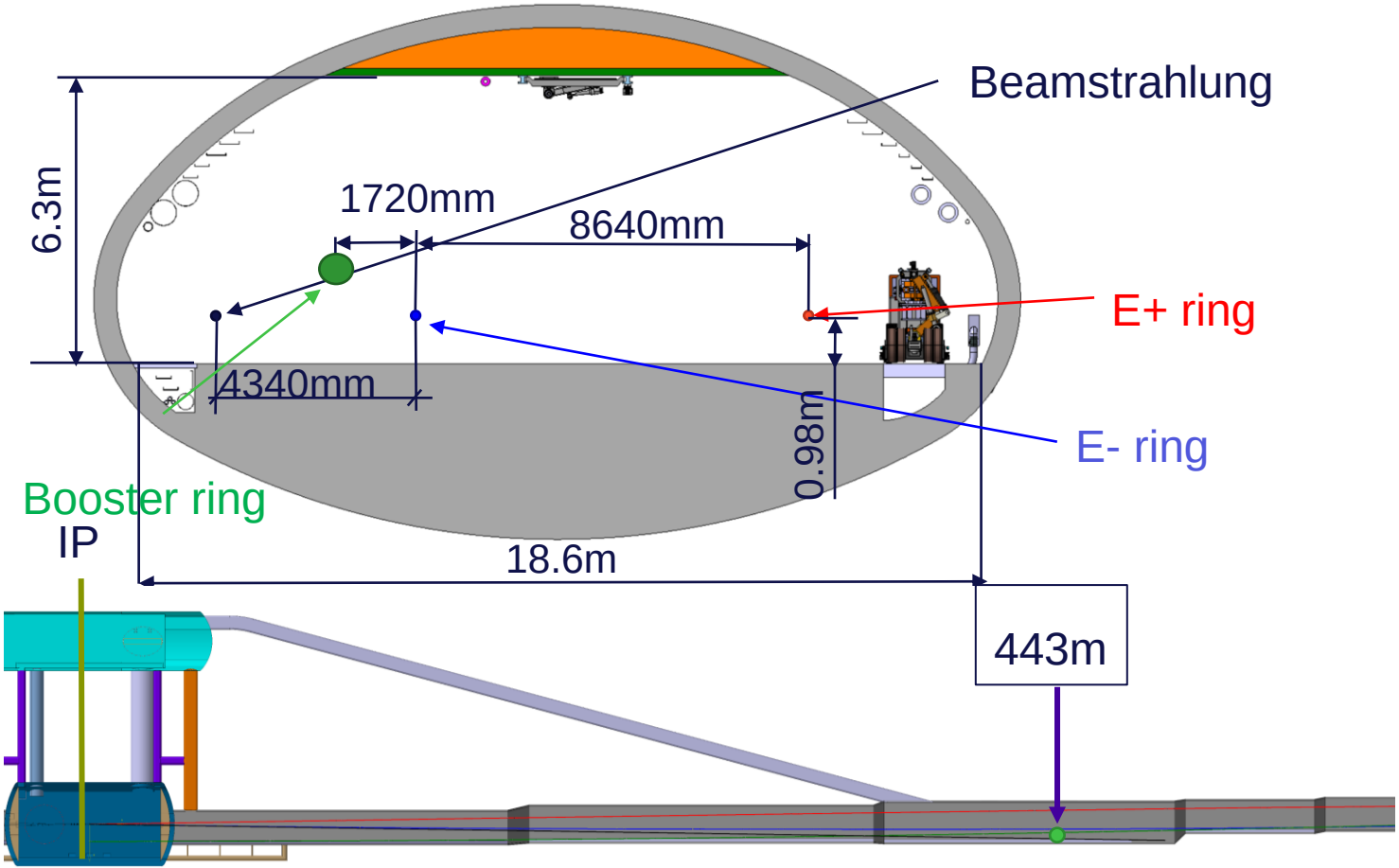
# FCC-ee beamstrahlung dump integration study at point A



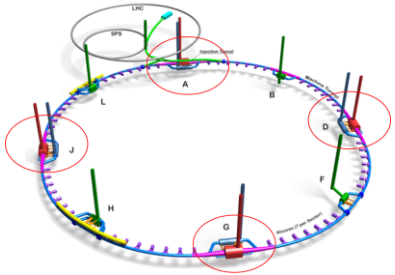


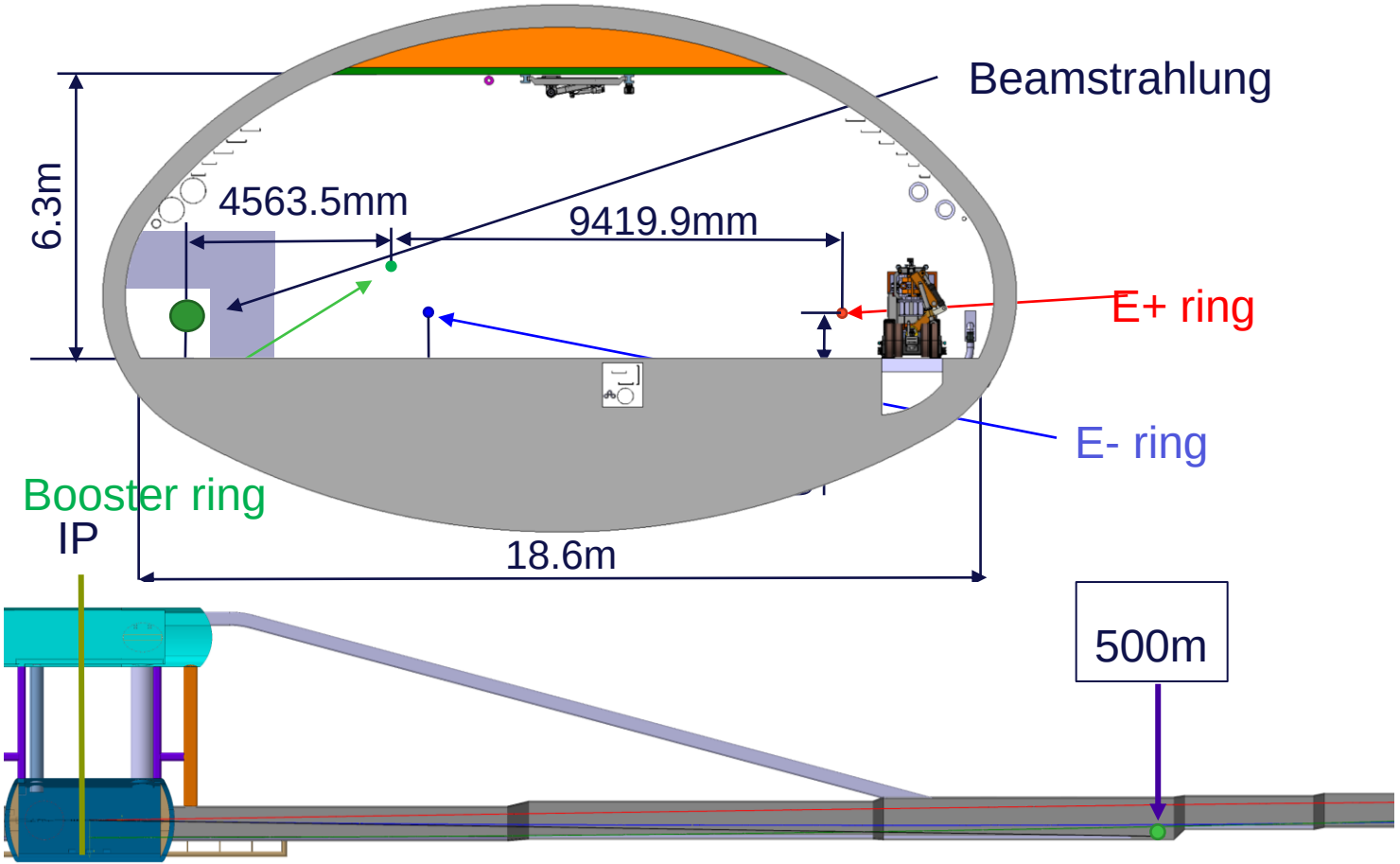
# FCC-ee beamstrahlung dump integration study at point A





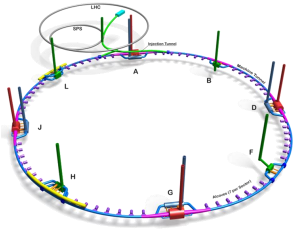
# FCC-ee beamstrahlung dump integration study at point A



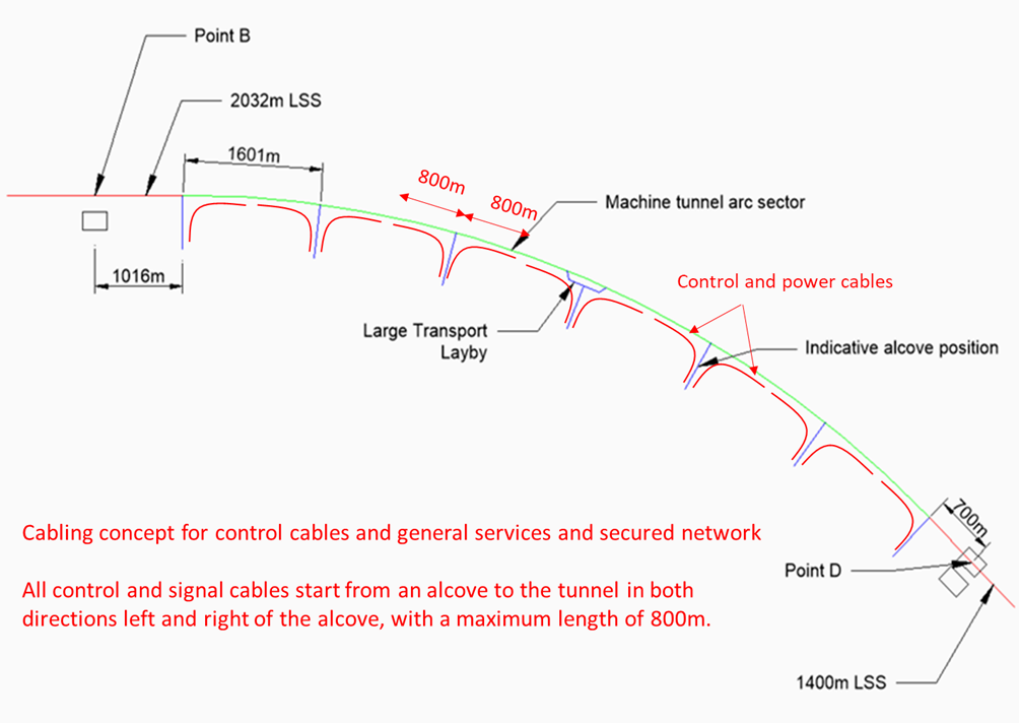


# Integration study of FCC alcove and transport Layby

# FCC Alcove and transport Layby integration



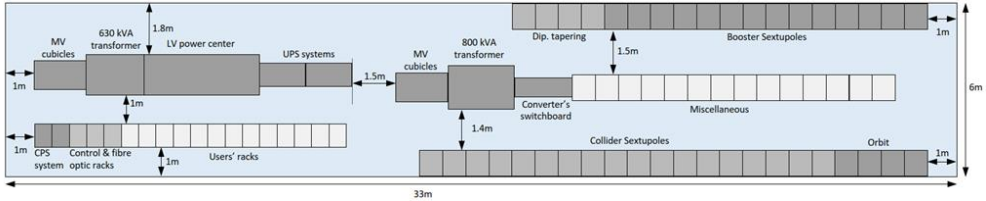
## Courtesy Jean-Paul Burnet




Schematic of the principle of cabling from the alcoves

# FCC Alcove and transport Layby integration

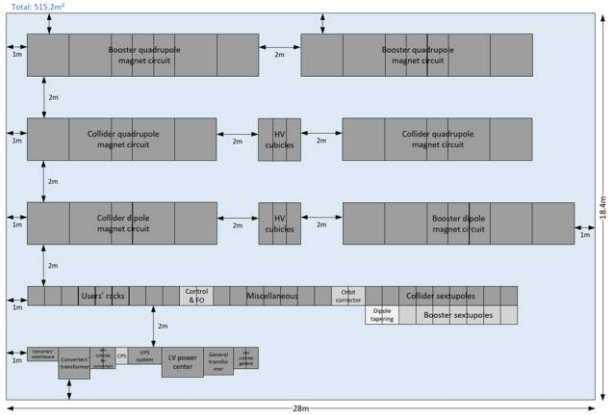
## Electrical requirements for Small Alcoves:




| Converter \ Number of alcoves | Alcove / 1500 m |
|---|---|
| Collider Sextupoles (73 converters per sector) | 18 racks in total (based on SIRIUS S converter) |
| Booster Sextupoles (37 converters per sector) | 14 racks in total (based on SIRIUS 2S converter) |
| Dipole tapering (*) (60 converters per sector) | 4 racks in total |
| Orbit corrector | 4 racks in total |
| Miscellaneous | 14 racks in total |

| Equipment | Number | Total footprint (width x depth cm) |
|---|---|---|
| **MV cubicles general** | 3 | 180x100 *(60x100 each)* |
| **630 kVA transformer general** | 1 | 200x140 |
| **LV power center** | 1 | 400x140 |
| **UPS systems** | 2 | 320x80 *(160x80 each)* |
| **CPS system** | 2 | 120x80 *(60x80 each)* |
| **Control & fibre optic racks** | 3 | 180x80 *(60x80 each)* |
| **MV cubicles EPC** | 3 | 180x100 *(60x100 each)* |
| **800 kVA transformer EPC** | 1 | 230x150 |
| **EPC's switchboard** | 1 | 300x65 |
| **Miscellaneous** | 14 | 1120x90 *(80x90 each)* |
| **Orbit corrector** | 4 | 320x90 *(80x90 each)* |
| **Dipole tapering** | 4 | 320x90 *(80x90 each)* |
| **Booster sextupoles** | 14 | 1120x90 *(80x90 each)* |
| **Collider sextupoles** | 18 | 1440x90 *(80x90 each)* |

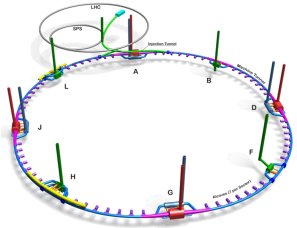
## Electrical requirements for Big Alcoves:



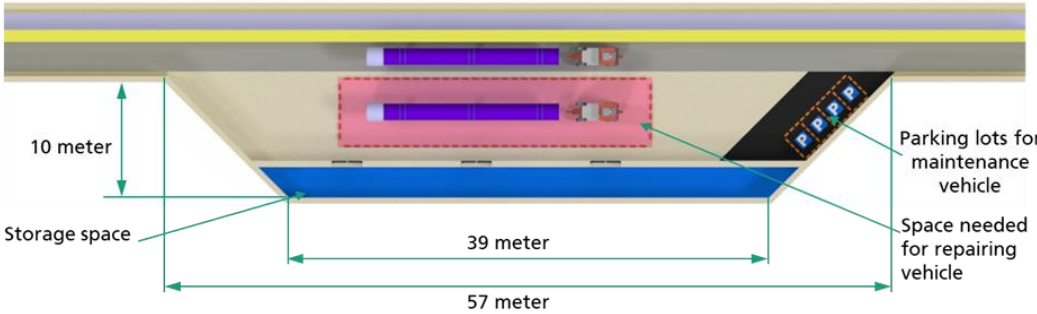

| Blocks | Equipment | Number | Size | Required access at back and front? |
|---|---|---|---|---|
| **Collider dipole magnet circuit** | | **1** | | |
| | Power transformer | 2 | 2m x 2m each | Yes |
| | Power converter | 2 | 2m x 2m each | Yes |
| | Output + DCCT | 1 | 1m x 2m | Yes |
| **Collider quadrupole magnet circuit** | | **2** | | |
| | Power transformer | 2 | 2m x 2m each | Yes |
| | Power converter | 2 | 2m x 2m each | Yes |
| | Output + DCCT | 1 | 1m x 2m | Yes |
| **Booster dipole magnet circuit** | | **1** | | |
| | Power transformer | 2 | 2m x 2m each | Yes |
| | Power converter | 2 | 2m x 2m each | Yes |
| | ESS | 2 | 1m x 2m each | Yes |
| | Output + DCCT | 1 | 1m x 2m | Yes |
| **Booster quadrupole magnet circuit** | | **2** | | |
| | Power transformer | 2 | 2m x 2m each | Yes |
| | Power converter | 2 | 2m x 2m each | Yes |
| | ESS | 2 | 1m x 2m each | Yes |
| | Output + DCCT | 1 | 1m x 2m | Yes |
| **HV cubicles** | 3 cubicles each | **2** | 2m x 2m each | Yes |

| | | | | |
|---|---|---|---|---|
| **EL distribution** | | | | |
| | MV cubicles general | 2 | 0.6m x 1m each | Yes |
| | 300 kVA transformer general | 1 | 1.3m x 1.4m | Yes |
| | LV power center | 1 | 2m x 1.4m | Yes |
| | UPS system | 1 | 1.6m x 0.8m | Yes |
| | CPS system | 1 | 0.6m x 0.8m | Yes |
| | Control & optical fiber racks | 2 | 0.6m x 0.8m each | Yes |
| | Users' racks | 7 | 0.6m x 0.8m each | Yes |
| **Other converters** | | | | |
| | MV cubicles for Power Converters | 2 | 0.6m x 1m each | Yes |
| | 400 kVA transformer for Power Converters | 1 | 1.5m x 1.5m | Yes |
| | Power Converters' switchboard | 1 | 1.5m x 0.65m | No |
| | Miscellaneous | 7 | 0.8m x 0.9m each | Yes |
| | Orbit corrector | 2 | 0.8m x 0.9m each | No |
| | Dipole tapering | 2 | 0.8m x 0.9m each | No |
| | Booster sextupoles | 7 | 0.8m x 0.9m each | No |
| | Collider sextupoles | 9 | 0.8m x 0.9m each | No |

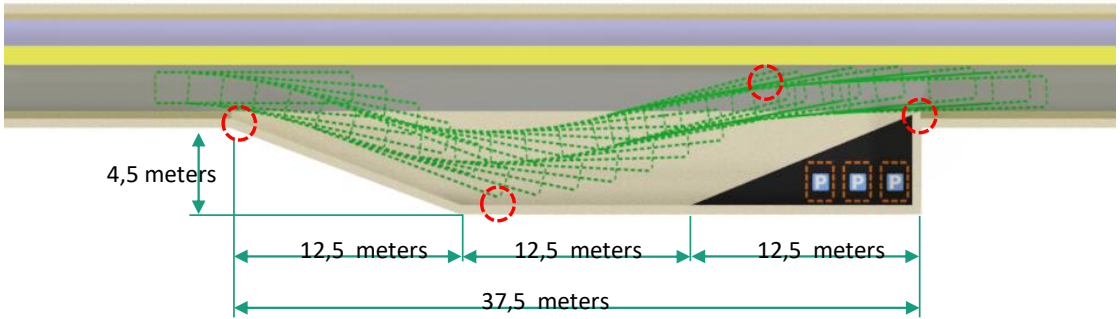
# FCC Alcove and transport Layby integration



## Transport requirements:

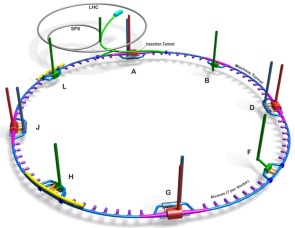


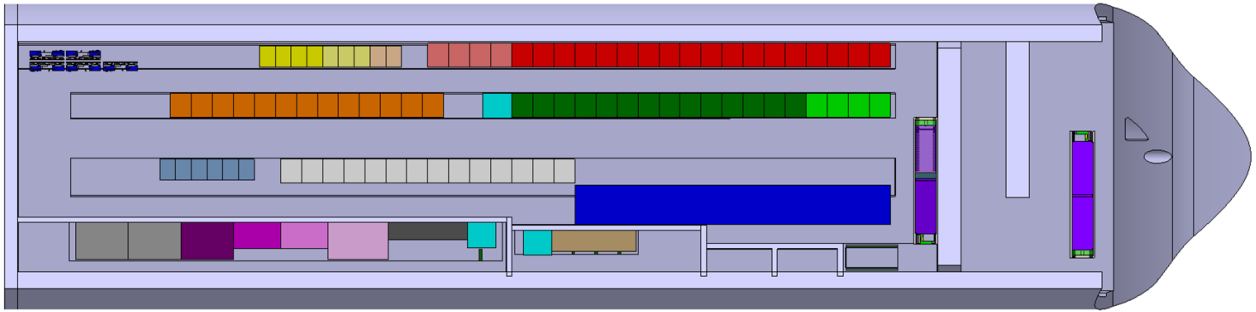

Big layby zone



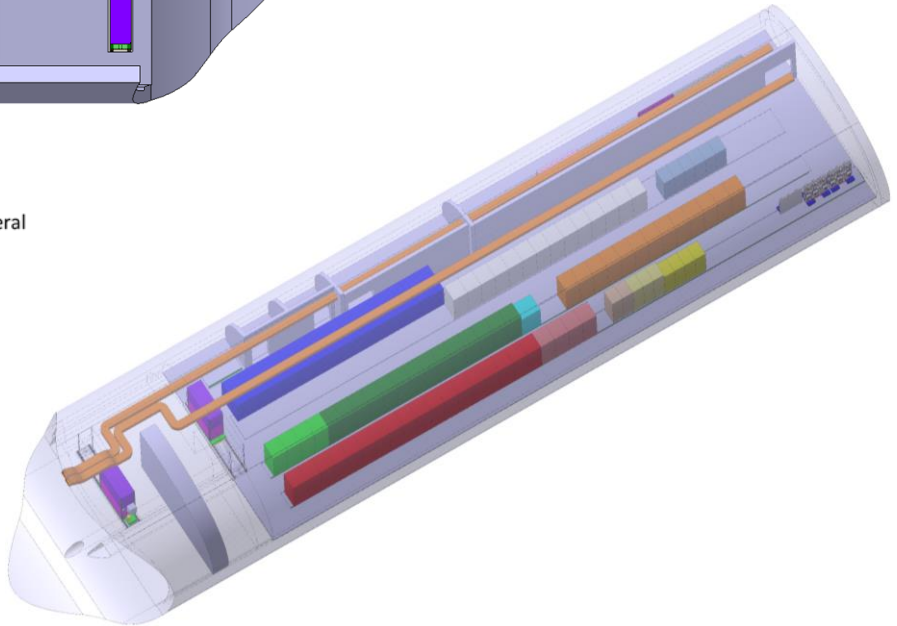

Small layby zone

# FCC Small alcove integration study

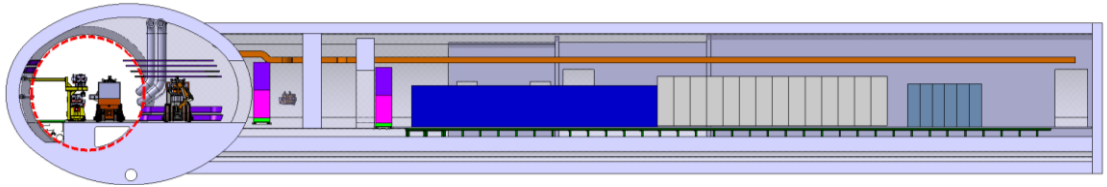


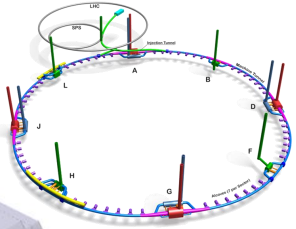


- User Racks
- Booster Racks
- Alarm , Light and Spare Racks
- Control and Fibre Optic Racks
- CPS System
- Orbit Racks
- Collider Racks
- Miscellaneous Racks
- Control Cubicle
- Air Handling Unit
- Booster Racks
- Cryo Racks
- Dipole tapering Racks
- UPS systems
- LV power centre
- 630 kVA transformer general
- MV cubicles general
- MV cubicles EPC
- 800 kVA transformer
- EPC switchboard



# FCC Small alcove and Small transport Layby integration study



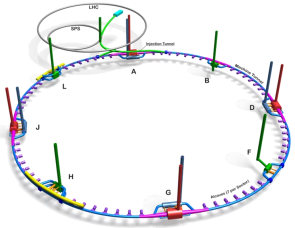


Section view



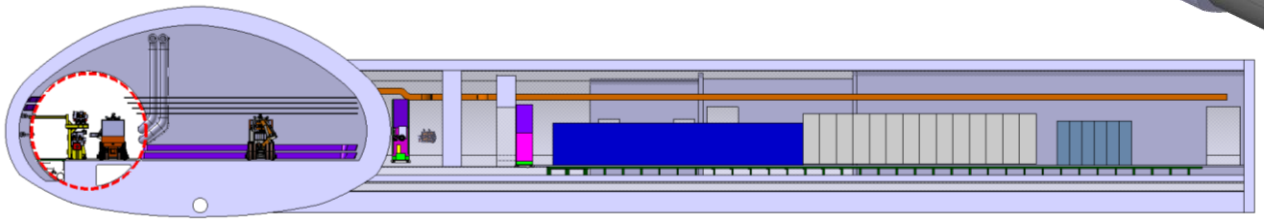
Isometric view

# FCC Small alcove and Big transport layby integration study



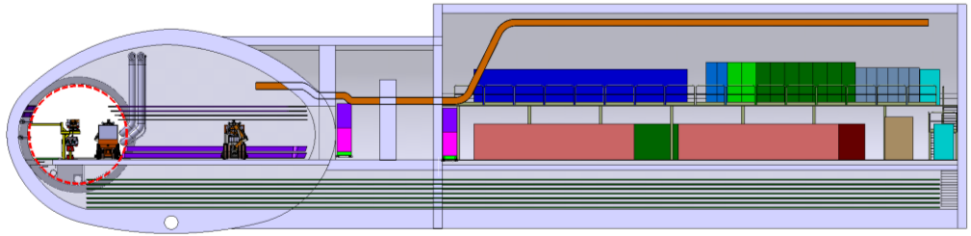
## Isometric view

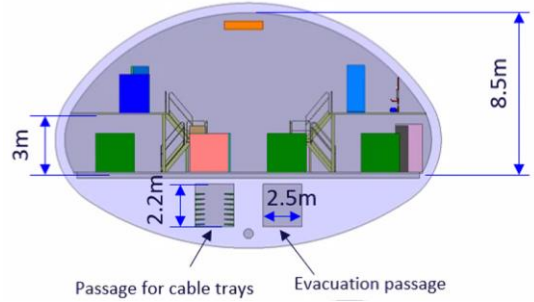
## Section view

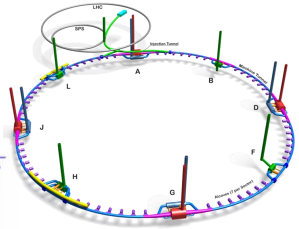


# FCC Big alcove and Big transport layby integration study

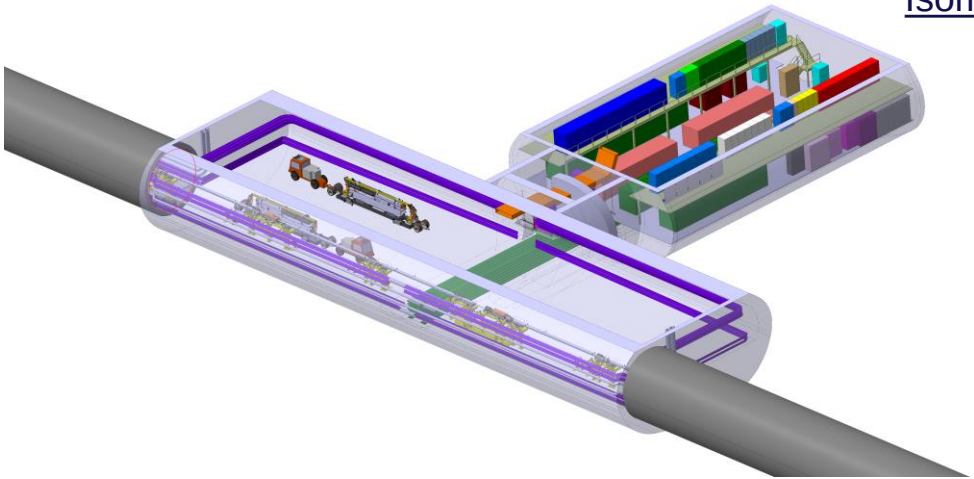
## Section View

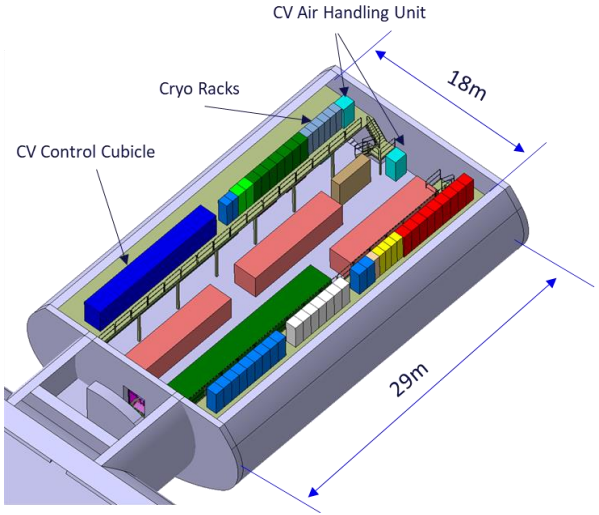




## Isometric View





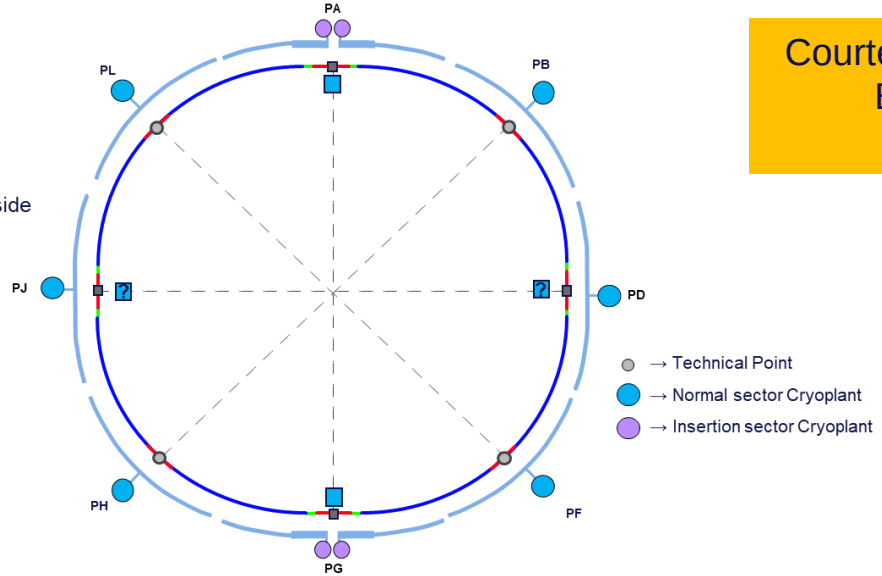
# Integration study of FCC-hh Arc Cell

# FCC-hh cryogenic system updated layout

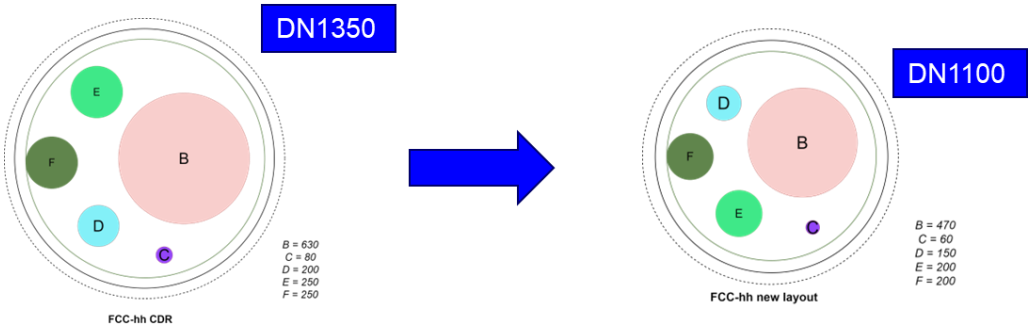
**Circumference**: 91 km
**Sectors**: 8
**Sector length**: 11.4 km
**Cryo cooling length**: 5 km per side
**Cryoplants**: 10
- 6 sector cryoplants
- 4 insertion cryoplants

**Heat loads**:
- 1.4 W/m @ 1.9 K
- 70 W/m @ 40-60 K

**QRL diameter**: 1100 mm

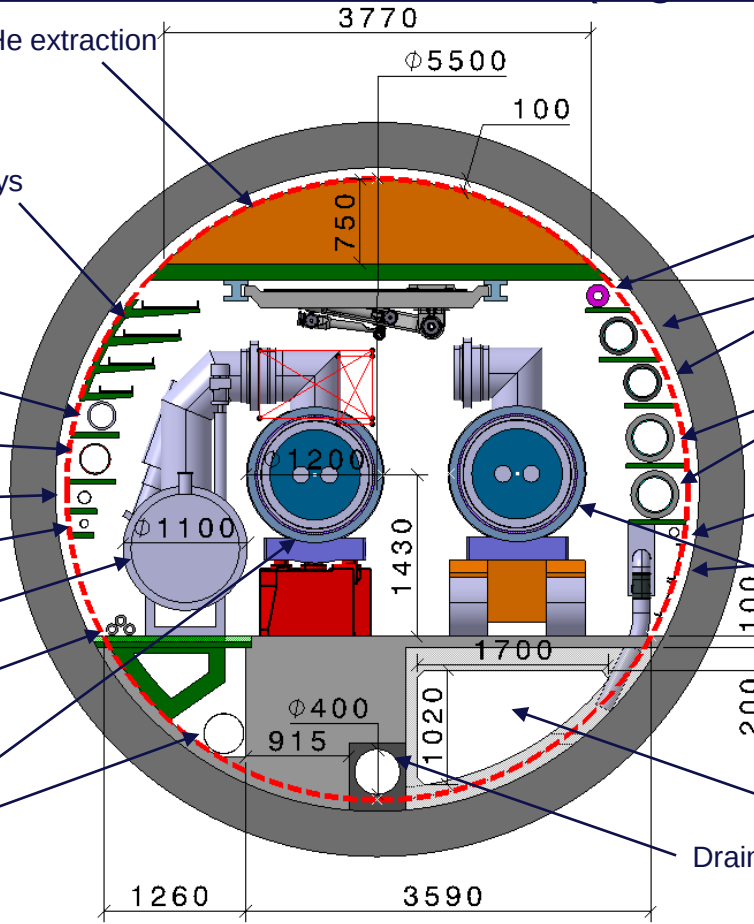



Courtesy B. Naydenov, L. Delprat, B. Bradu, K. Brodzinski



# Integration study of FCC-hh machine elements (regular arc)

Machine tunnel 5.5m in diameter




Smoke/He extraction

4 Cable trays

Superconducting link DN250

Warm He recovery DN250

He DN100

Demineralized water felling DN65

QRL ø 1350

Electrical HV power transmission

Machine cryostat ø 1200

Raw water DN350

Leaky feed

Demineralized water DN250

Chilled water DN300

Compressed air DN80

2 Cable trays

Magnet vehicle
Transport space reservation
2m x 2.6m (LxH)

Fresh air duct

Drain

Main cross section as for FCC-ee

Collider Center

# Conclusion

- The layout of the machine tunnel Arc Cell is still under study.
  - The study for the support structure of the booster magnets and girder design of the collider quadrupole magnets is in progress
  - The study of Cooling & Ventilation services and Electrical services are in progress
  - The study for synchrotron radiation protection is in progress

- The integration studies on Experimental caverns and technical/service areas (RF klystrons, injection/extraction, dump, etc.) are still progressing.

The objective of integration studies is to provide realistic 3D models for the overall FCC, including underground facilities for the detectors, services, accelerators, transfer lines, and access by September 2024 to the Civil Engineering team.

I would like to acknowledge the FCC Technical Infrastructure Coordination team and the FCC Accelerator Technology team for their input and support in the integration studies.

# Thank you for your attention.