FCC-ee civil engineering and infrastructure studies

FCC Feasibility Study

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FCC Civil Engineering

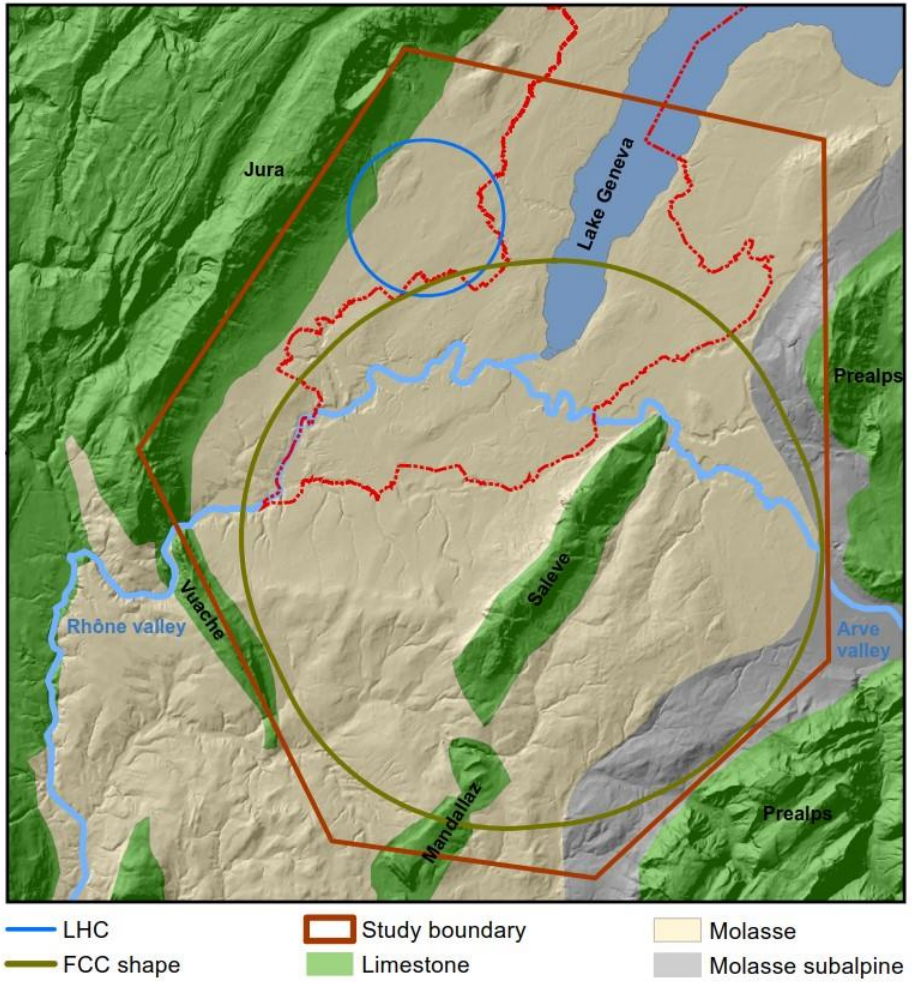
91.2 km tunnel

5.5 m internal diameter

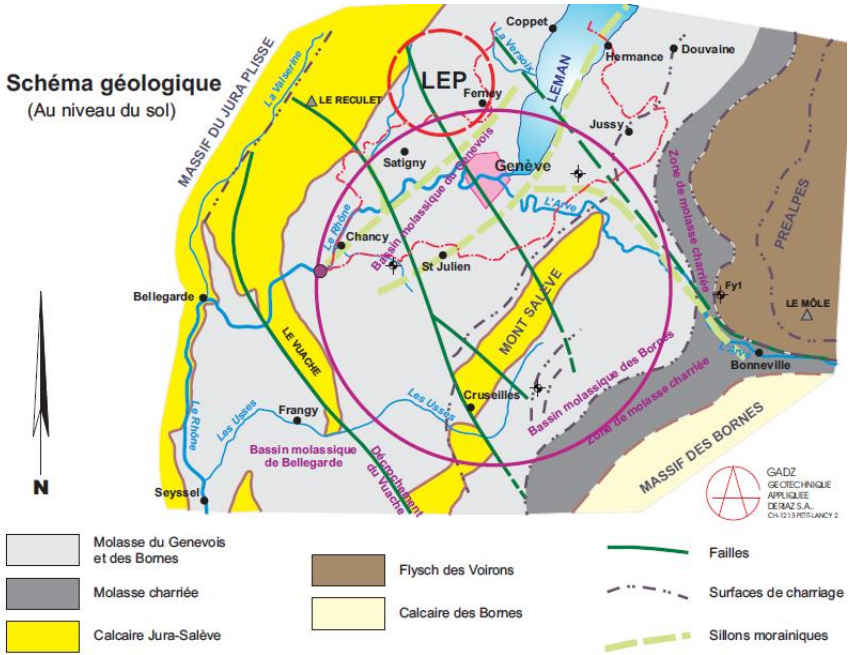
Complex geology

Lake crossing

150 - 400 m deep



Geology in the FCC region



Main geological units

Molasse

- Mixture of sandstones, marls and formations of intermediate composition
- Relatively weak rock (Average compressive strength: 5.5-48 Mpa)
- Considered good excavation rock
- Relatively dry and stable
- Faulting due to the redistribution of ground stresses
- Structural instability (swelling, creep, squeezing)

Moraines (Quaternary Deposits)

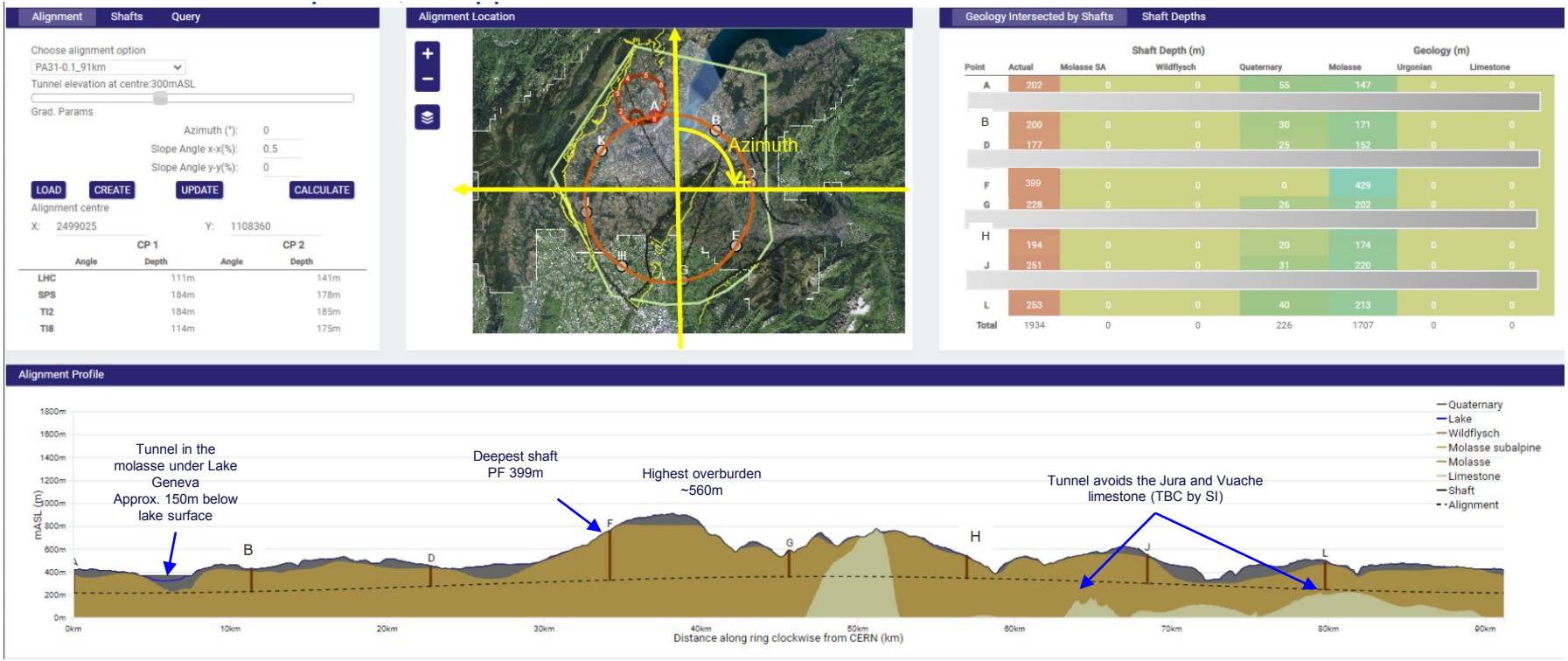
- Glacial deposits - gravel, sands silt and clay
- Water bearing

Limestone

- Hard rock
- Normally considered as sound tunneling rock
- Fractures and karsts likely
- High inflow rates measured during LEP construction (600L/sec)
- Clay-silt sediments in water
- Rockmass instabilities

Conclusions from the Placement Review Workshop

Selected scenario to be studied: **91km PA31-1.0 (8 points)**



Credit: ARUP

Areas of Geological Uncertainty

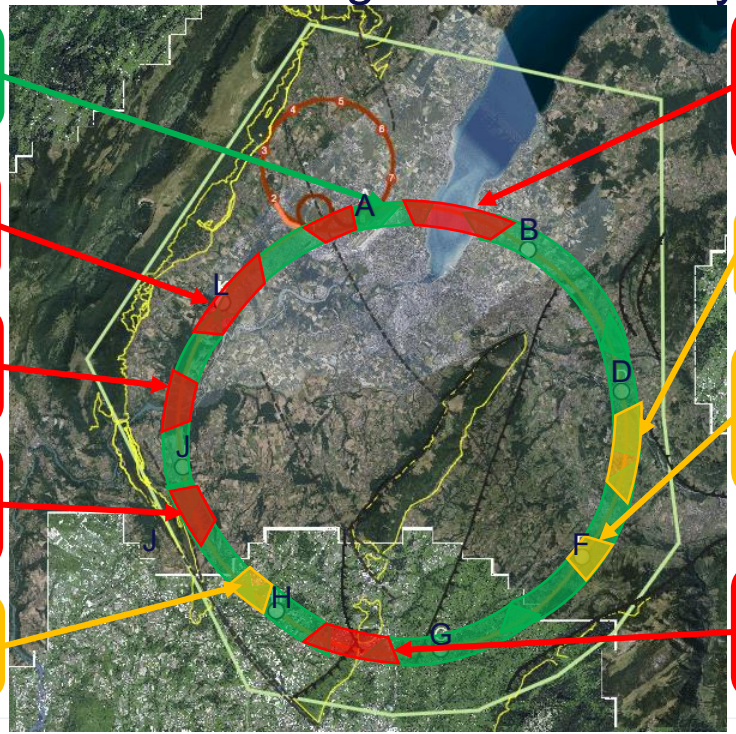
- Good knowledge of the ground (e.g. information from LEP/LHC projects)
- Good confidence - alignment in molasse

Jura
- Limestone/molasse interface uncertain.
- Risk of karts and high water pressures

Le Rhône
- Moraine/molasse interface not certain.
- Proximity to protected area

Vuache
- Limestone/molasse interface not certain.
- Risk of karts and high water pressures
- Proximity to main active fault

Les Usses
- Moraine/molasse interface not certain.
- Low tunnel rock cover

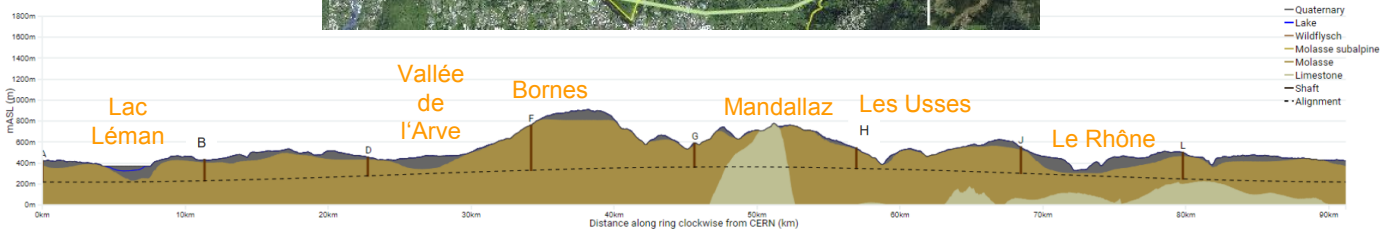


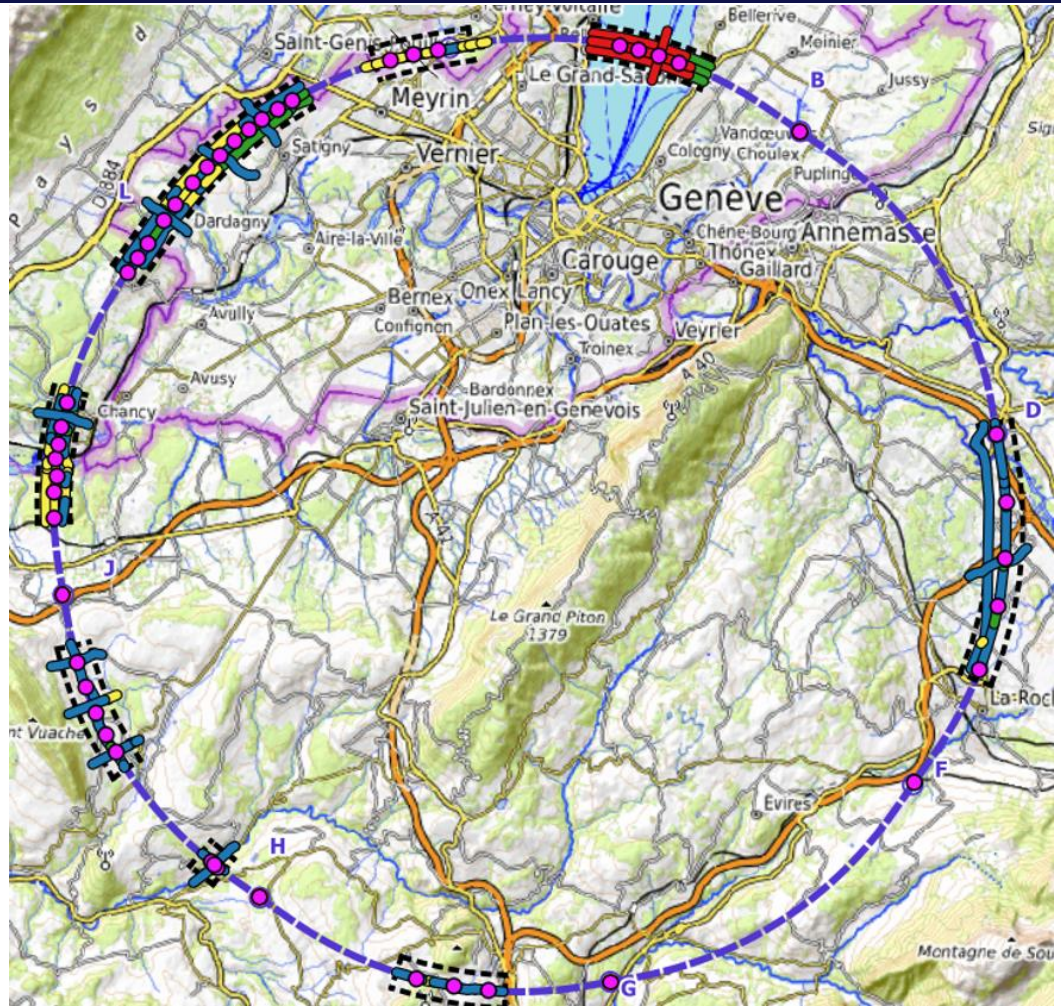
Lac Léman
- Moraine/molasse interface uncertain
- Soils and rock properties uncertain
- High uncertainty in the hydrogeological conditions and water pressure

Vallée de l'Arve
- Moraine/molasse interface uncertain.
- Lack of reliable boreholes

Bornes
- Insufficient deep borehole information
- Complex faulted region, thrust zone.
- Quality of molasse is uncertain. High overburden.

Mandallaz
- Fractured limestone formations, karst properties unknown.
- High water pressures

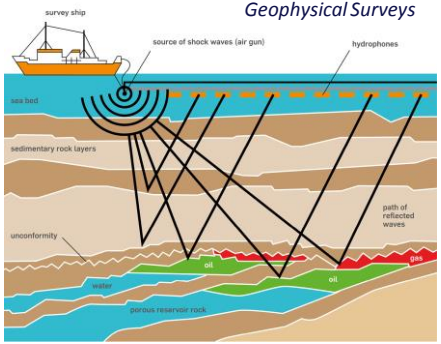


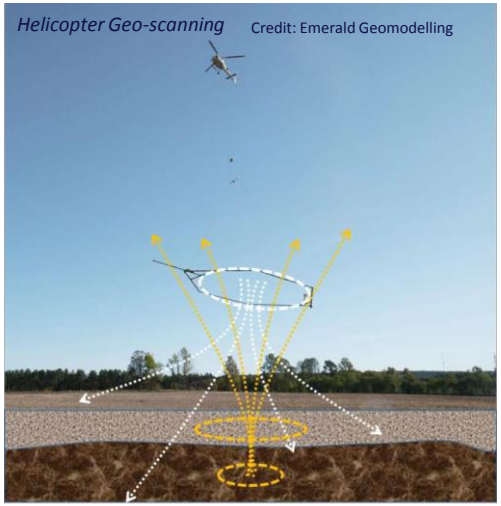


Planned site investigations

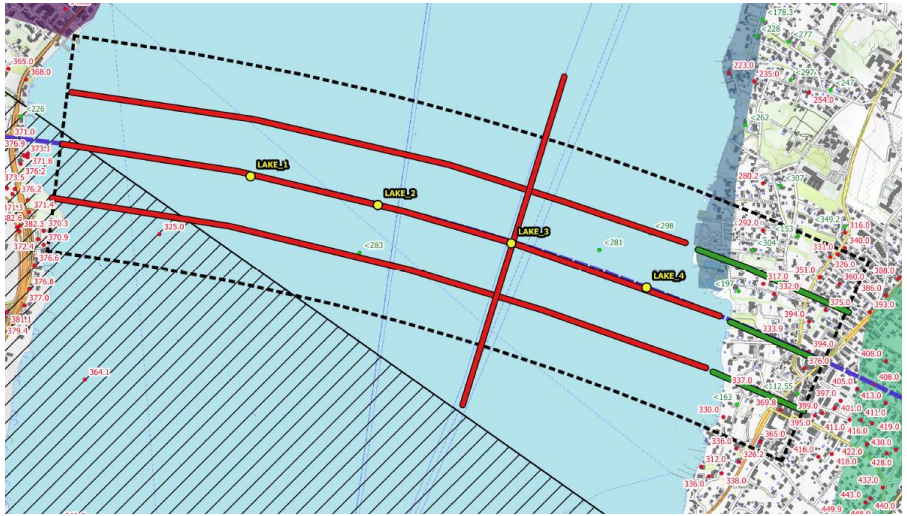
Types of Site Investigations

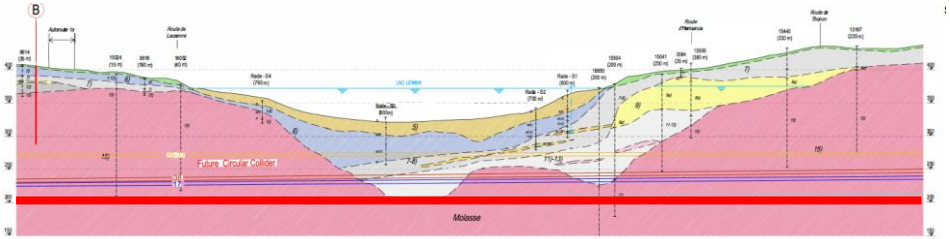
Lake Geneva
Geophysical Surveys





SI DEFINITION – LAKE GENEVA





3 seismic reflection lines parallel to the alignment

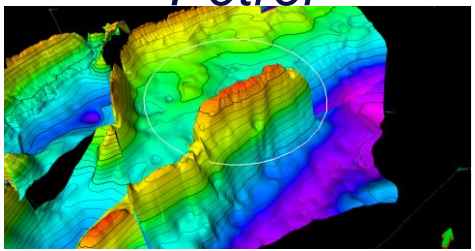
1 seismic reflection line perpendicular to the alignment

4 fully cored boreholes

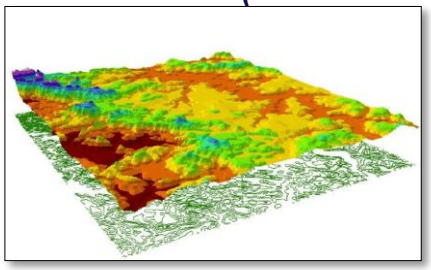
UNIGE geological model

Collaboration with University of Geneva to develop a 3D geological model (October 2020 - Ongoing)

Petrel



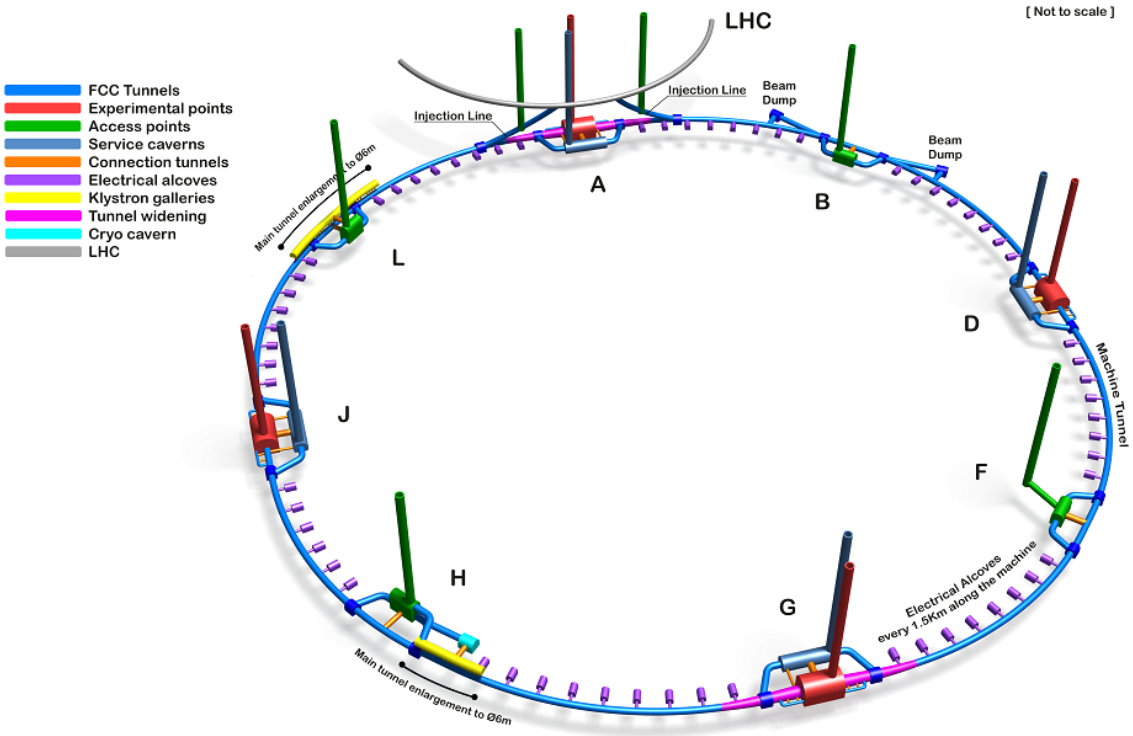
SOLSTISS (GESDEC)



- Received an updated molasse and limestone rockhead map
- Updated fault lines layers
- Ongoing analysis of new boreholes and data integration in the model
- New acquisition of BRGM seismic lines and reprocessing

8 Point FCC

Schematic

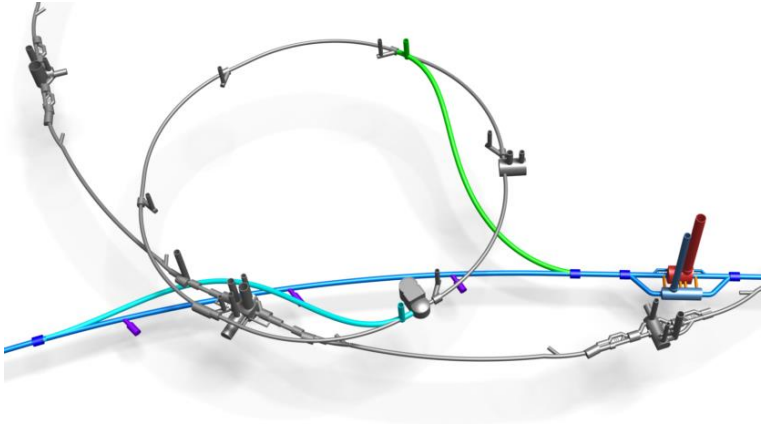


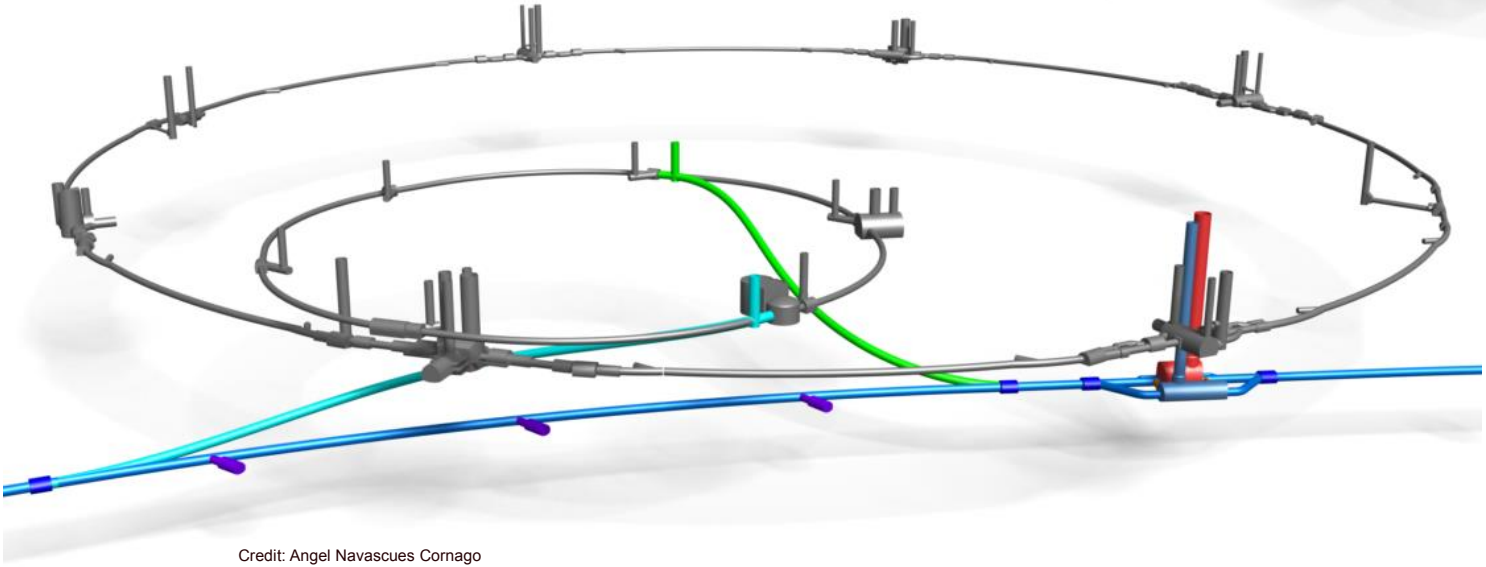
Credit: Angel Navascues Cornago

- 8 surface sites
- Sectors of 11 km
- 14 shafts
- Klystron Galleries at Point H and L
- Point H & L tunnel widening to 6.3 m diameter
- 4 Experimental sites
- 4 Technical sites
- Tunnel widening at experiment sites

SPS to FCC Transfer

Schematic

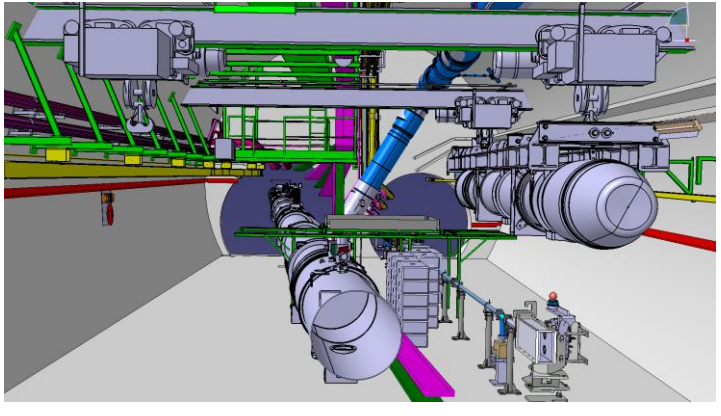




Credit: Angel Navascues Cornago

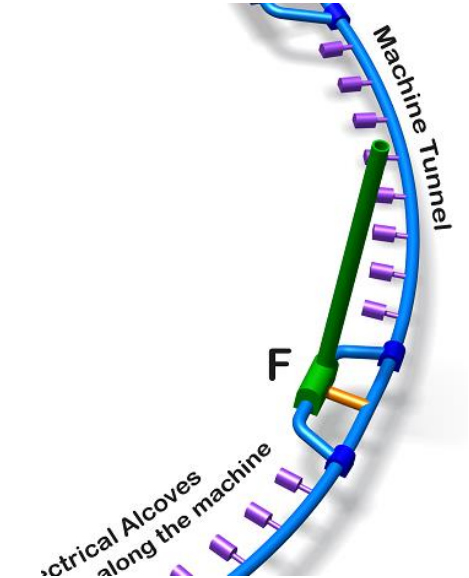
Existing Transfer Tunnels

Beam junction



Offset Shaft - Point F

Schematic

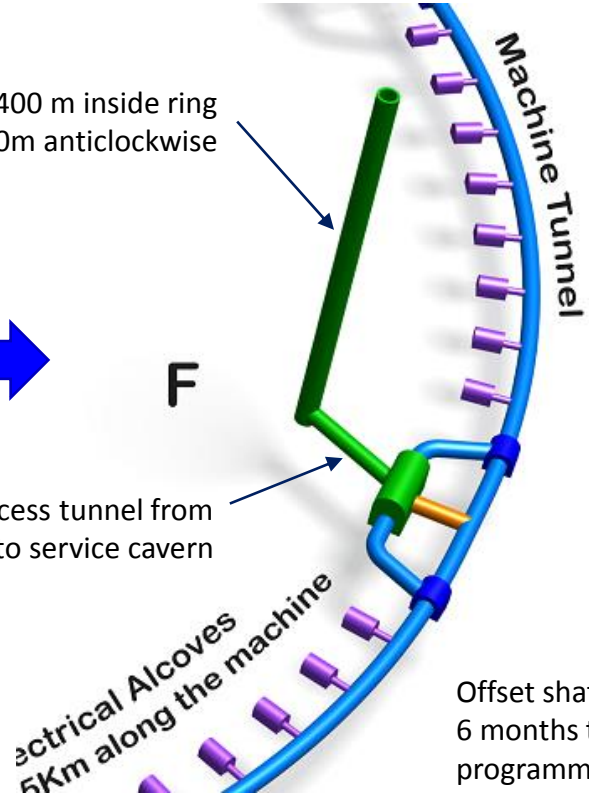


Credit: Angel Navascues Cornago

Surface constraints - residential

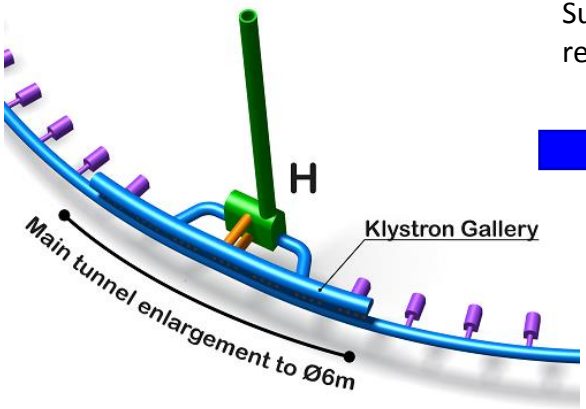
Shaft offset 400 m inside ring and 430m anticlockwise

Access tunnel from shaft to service cavern



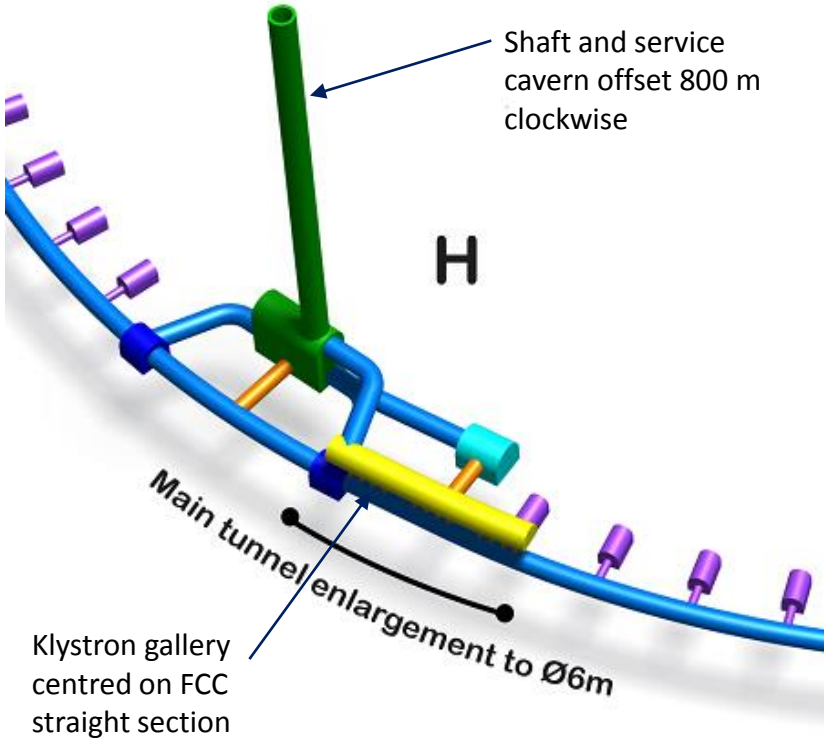
Offset shaft adds approx. 6 months to construction programme

Offset Shaft - Point H



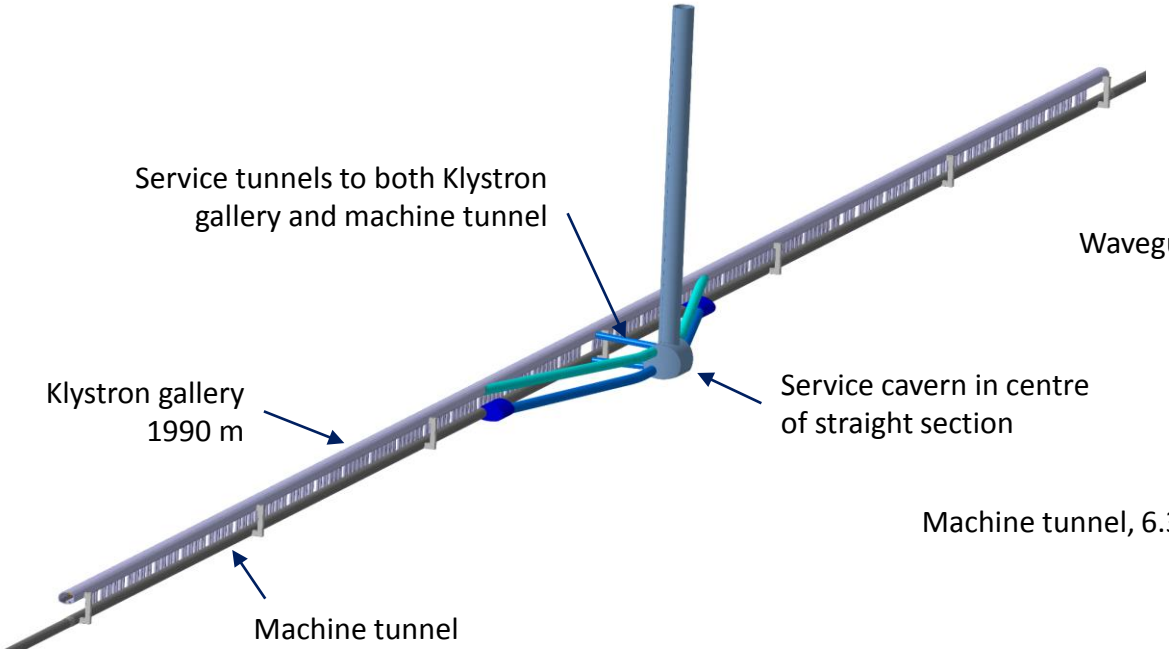
Credit: Angel Navascues Cornago

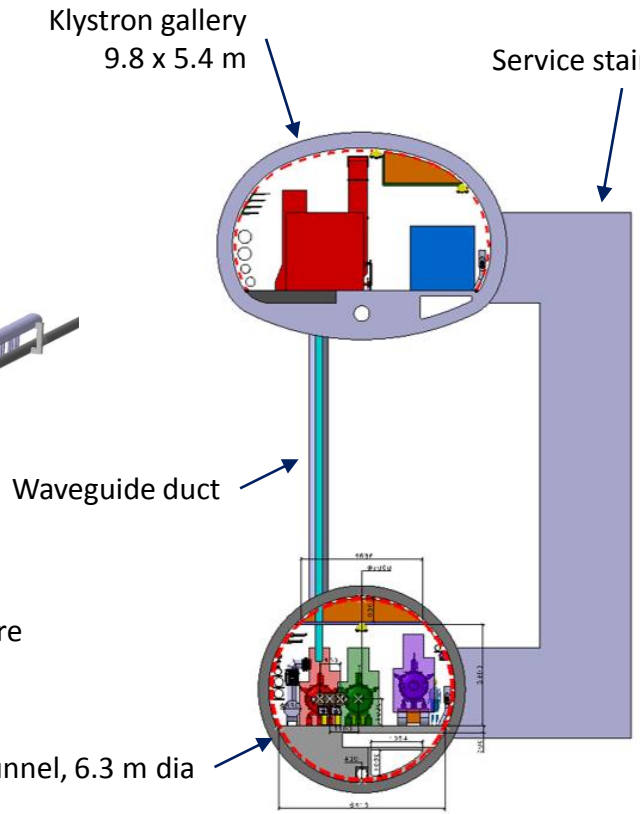
Surface constraints - residential and site access



Klystron Gallery - Point L

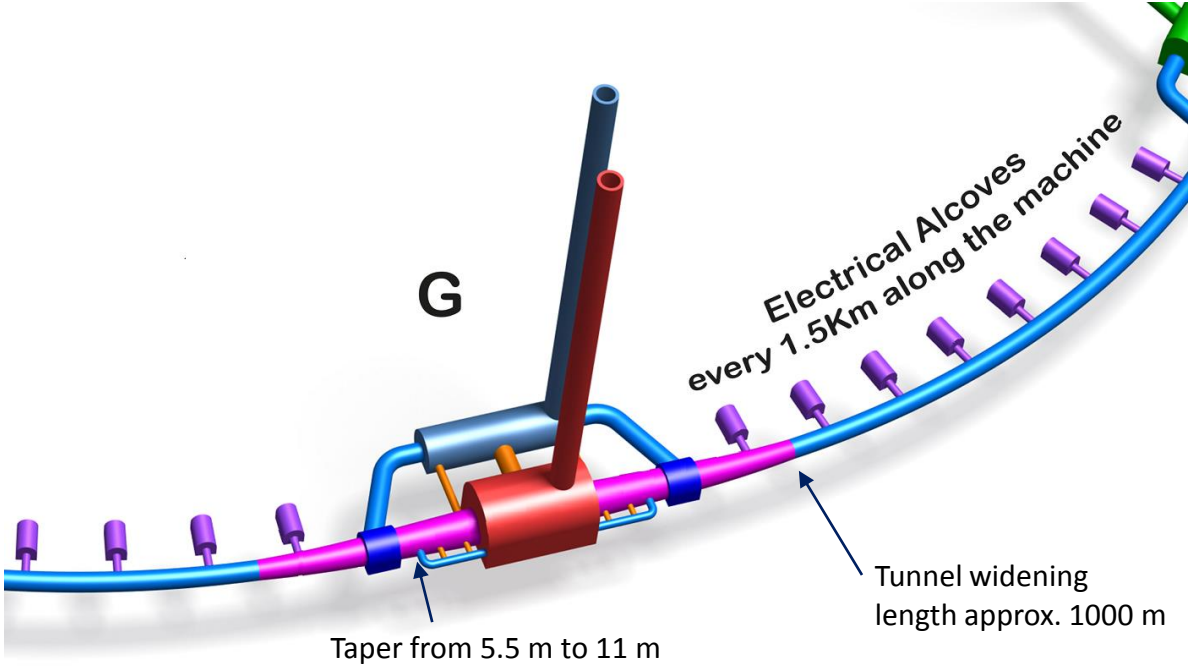
1990 m length Klystron gallery





Credit: Fani Valchkova-Georgieva

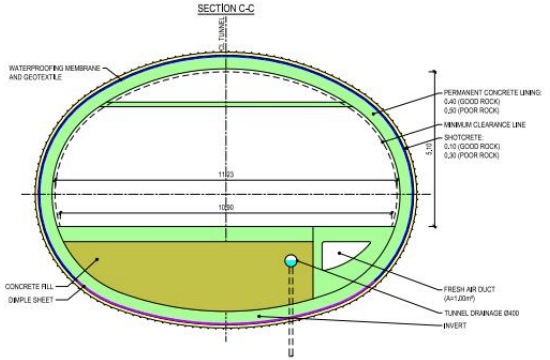
Tunnel Widening – Experiment Points

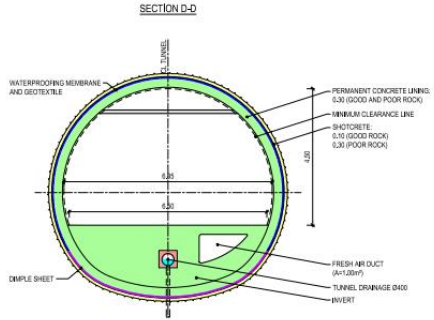


Taper from 5.5 m to 11 m internal diameter. TBC

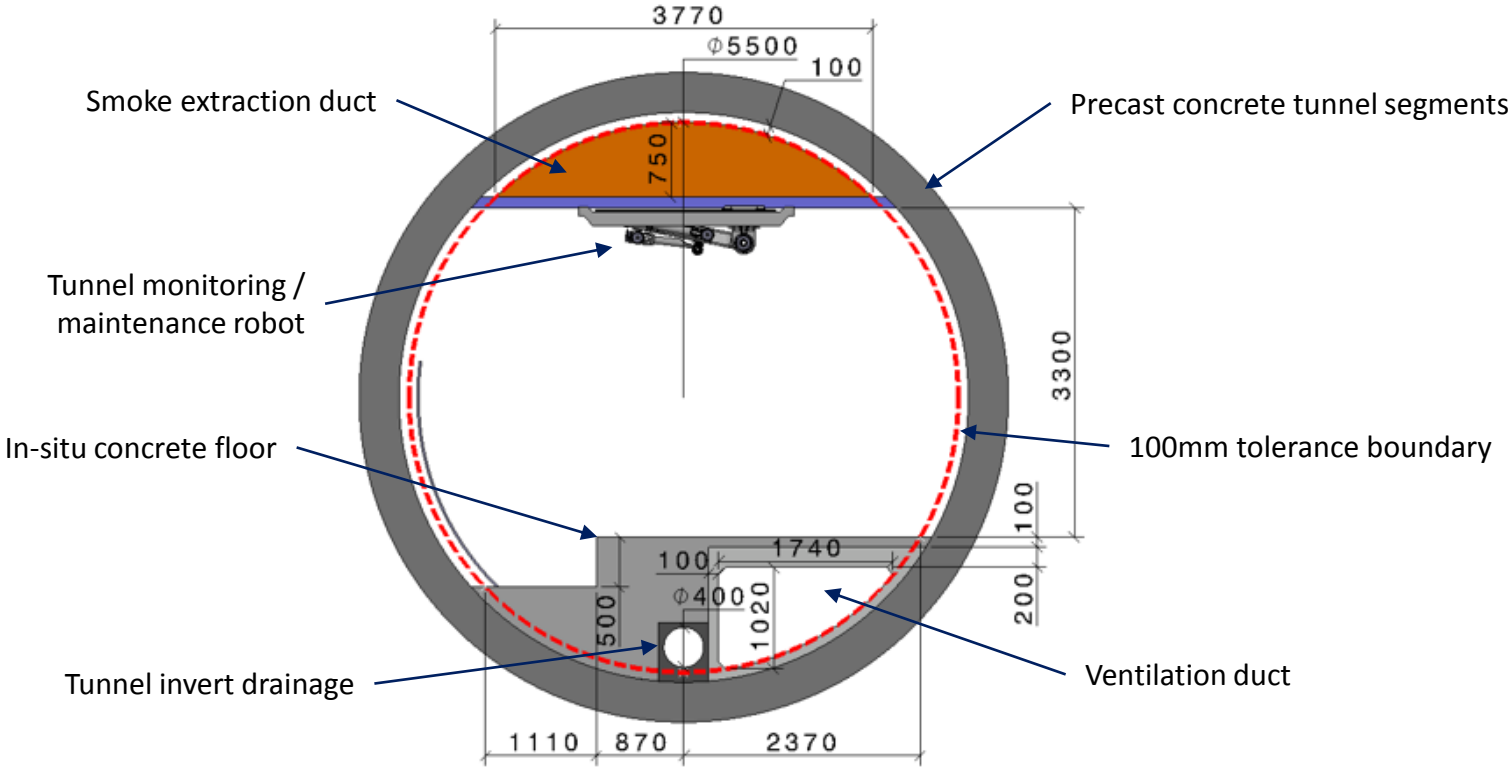
Tunnel widening length approx. 1000 m

Credit: Angel Navascues Cornago





Main Tunnel Cross Section

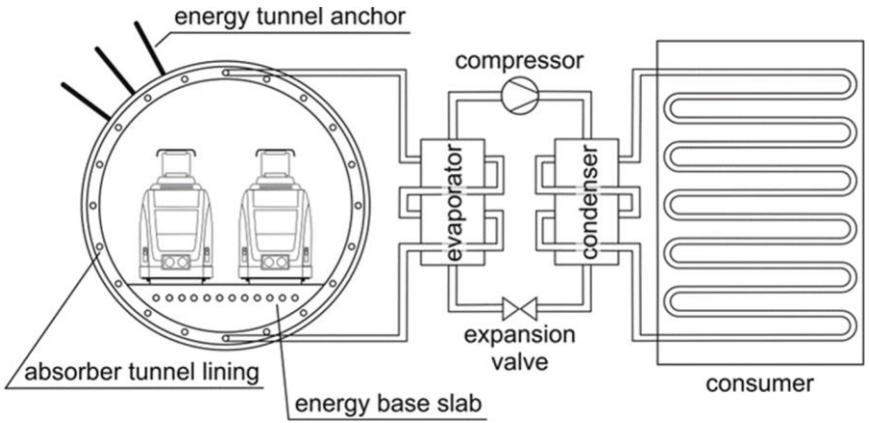


Credit: Fani Valchkova-Georgieva

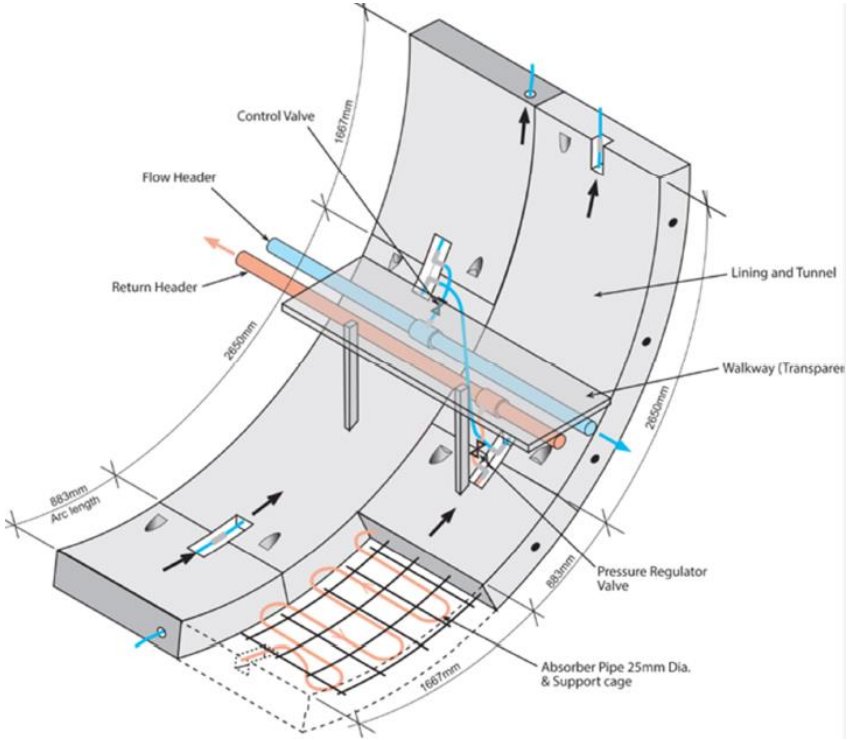
Tunnel Heat Recovery

600 m of tunnel equivalent to 35no. 100 m geothermal boreholes

Half the cost

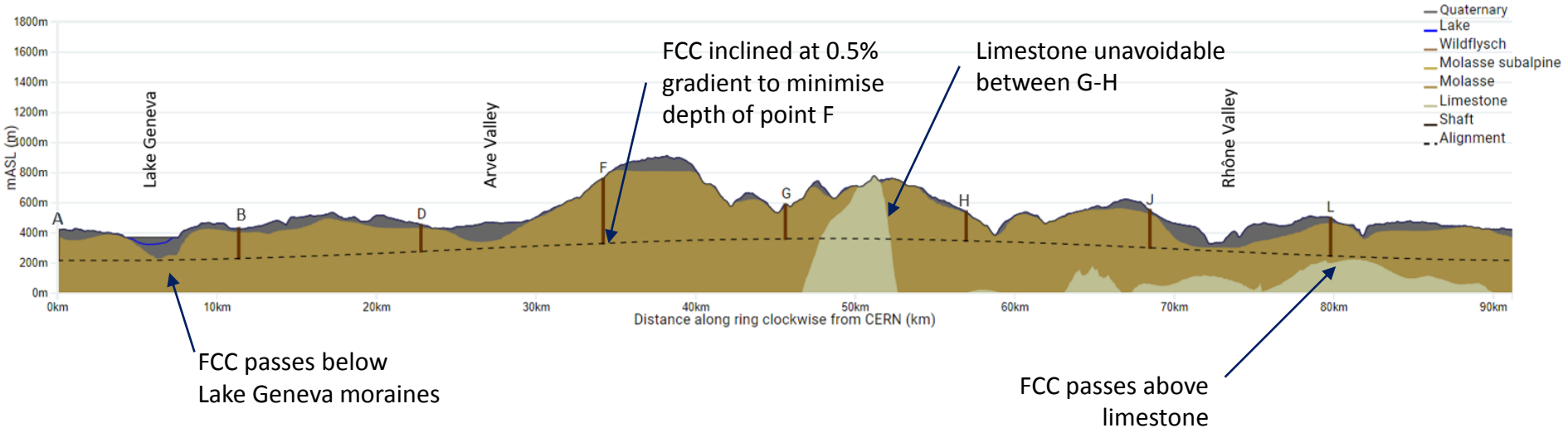


Credit: Stemmle, et al. 2022



Credit: ARUP

FCC Long Section – PA31-1.0

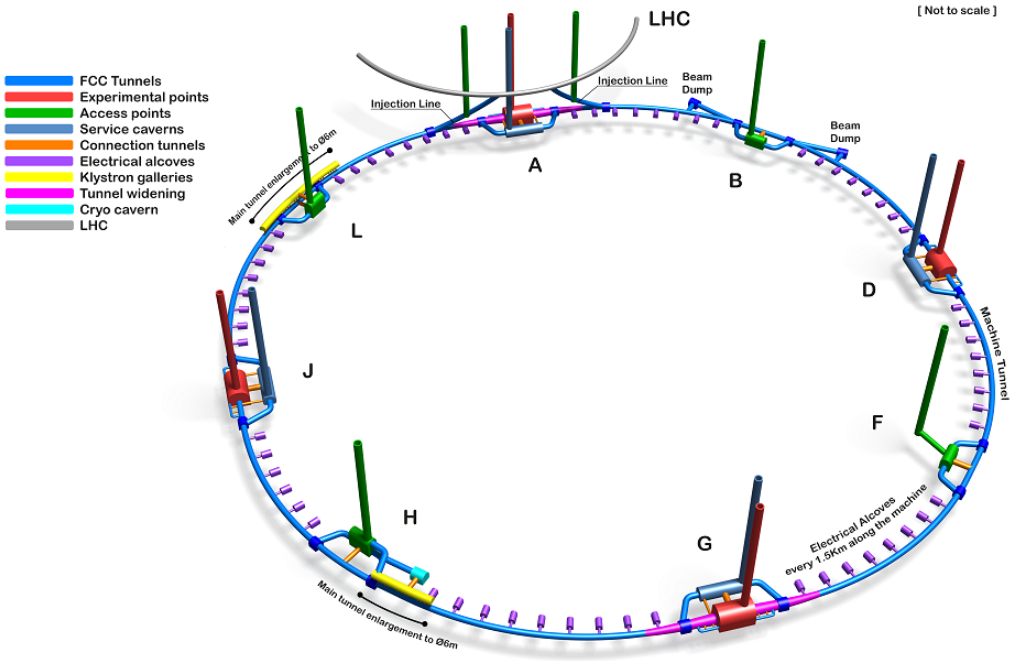


Shaft depths:

A: 202 m B: 200 m D: 177 m F: 399 m G: 228 m H: 139 m J: 251 m L: 253 m

Total shaft depth = 1849 m

Future



Credit: Angel Navascues Cornago

- Baseline FCC underground structures to be frozen by end of 2022.
- Updated cost / schedule to be provided ahead of mid term review (2023).
- Site investigations commence 2024.

Thank you
for your attention.