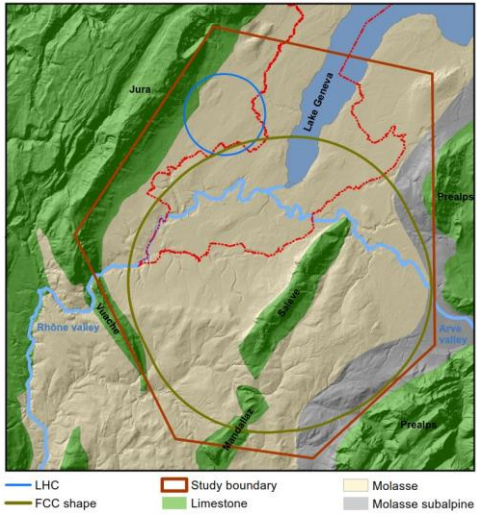
Updates of the Underground Civil Engineering Layouts Since the CDR

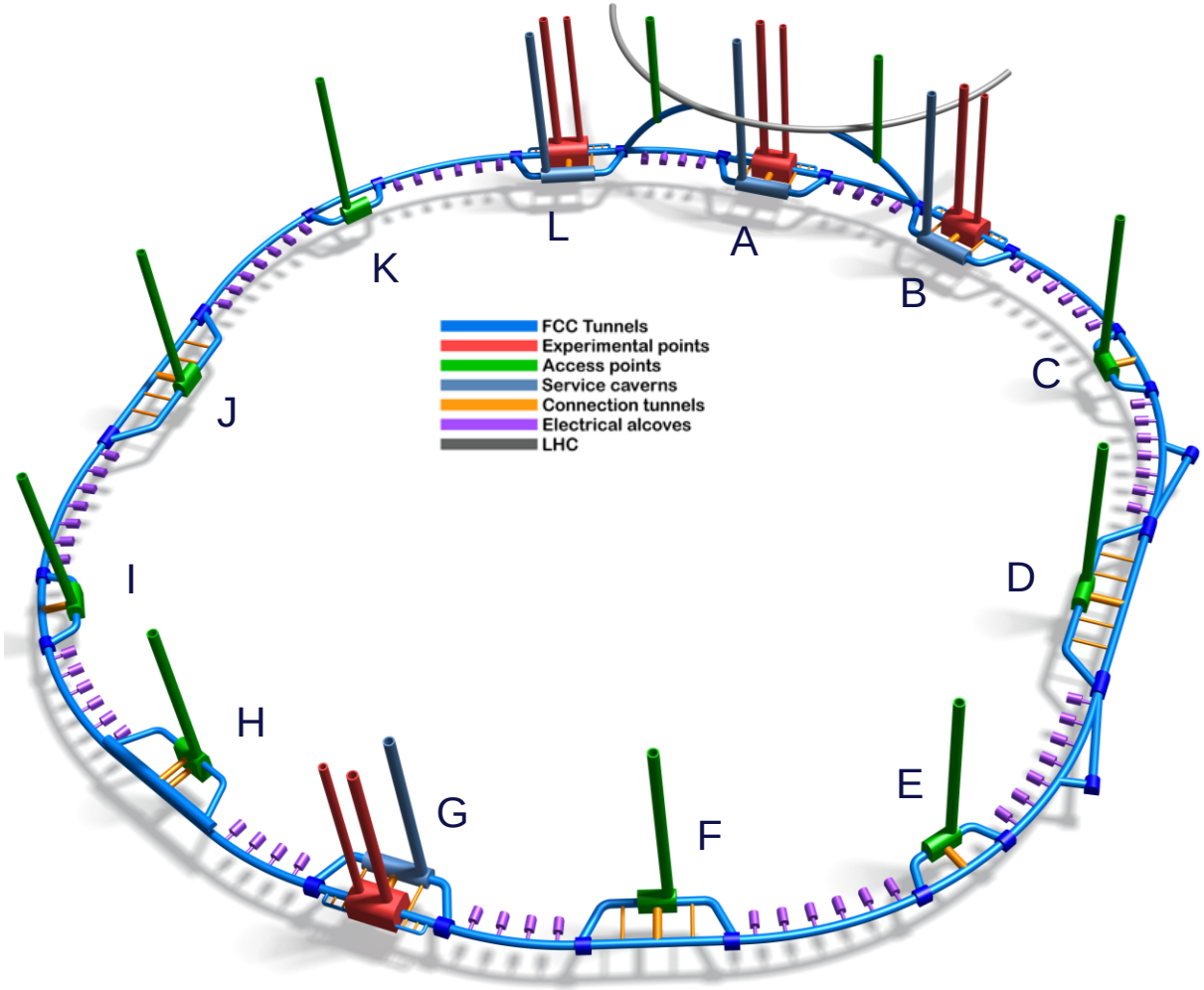
FCC Feasibility Study

Liam Bromiley SCE-DOD-FS
John Osborne SCE-DOD-FS
Roddy Cunningham SCE-DOD-FS

CDR 2018

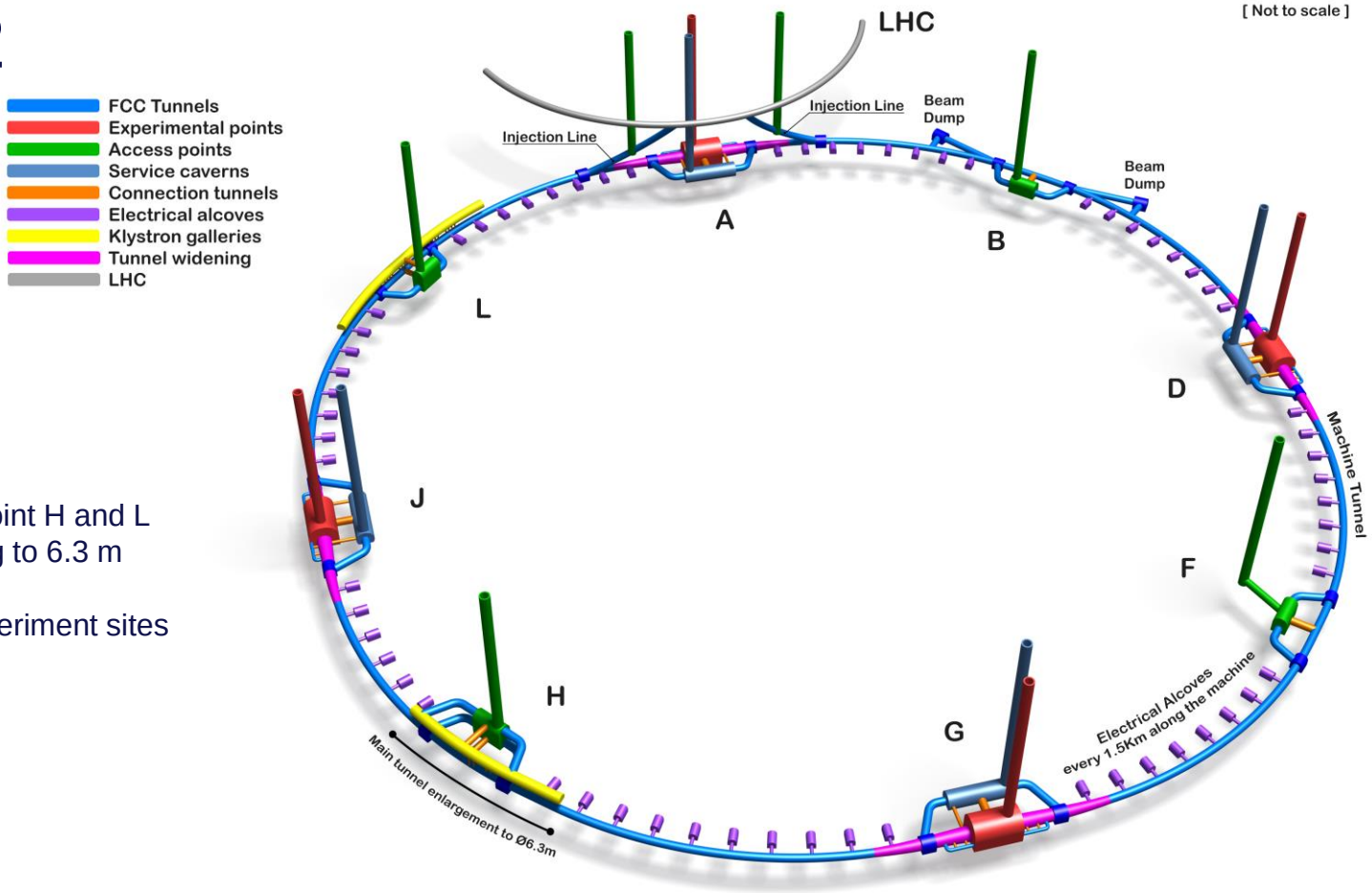
- 97.75 km
- 12 Surface sites
- 4 Experimental Areas
- 8 Technical Areas
- 22 Shafts
- 5.5 m internal diameter main tunnel



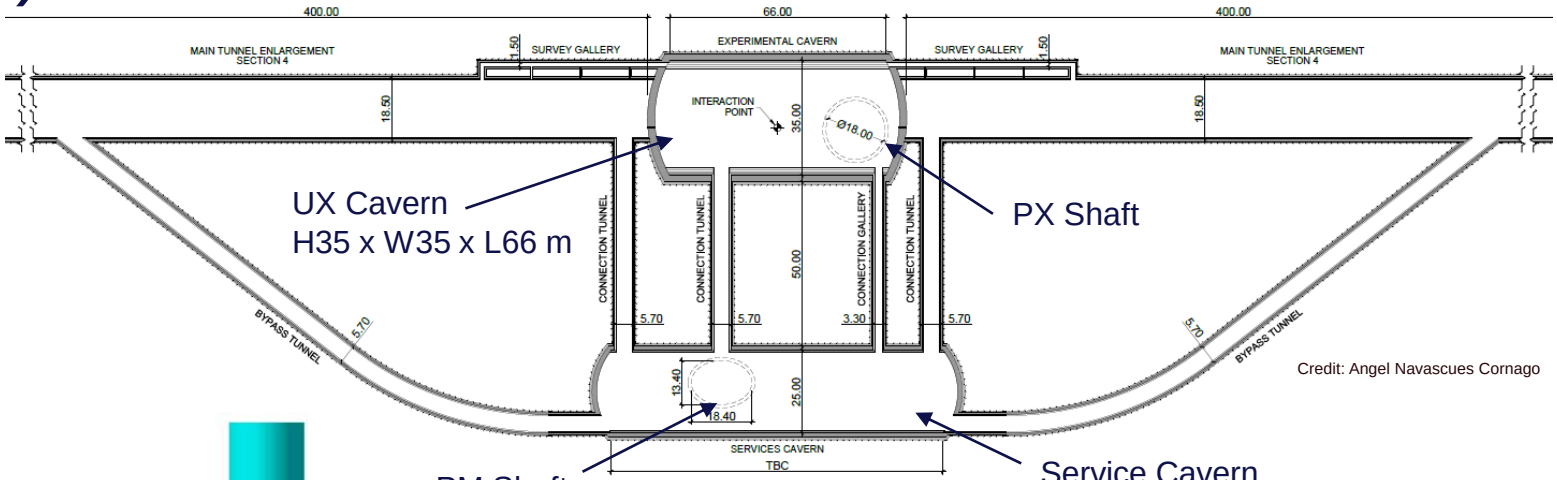


FCC 2022

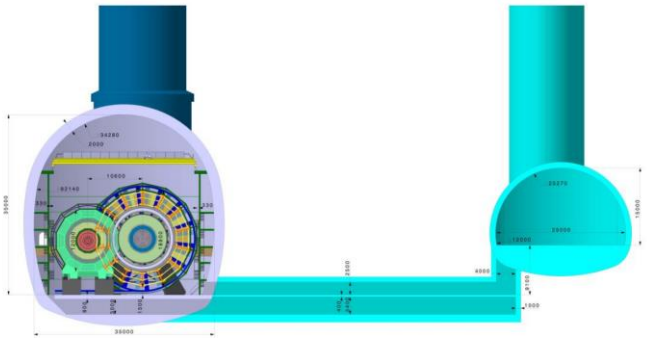
- 91.2 km
- 8 Surface Sites
- 4 Experimental Areas
- 4 Technical Areas
- 14 shafts
- Klystron Galleries at Point H and L
- Point H tunnel widening to 6.3 m diameter
- Tunnel widening at experiment sites
- Beam dump at point B



Typical Layout of Large Experimental Area (A & G)

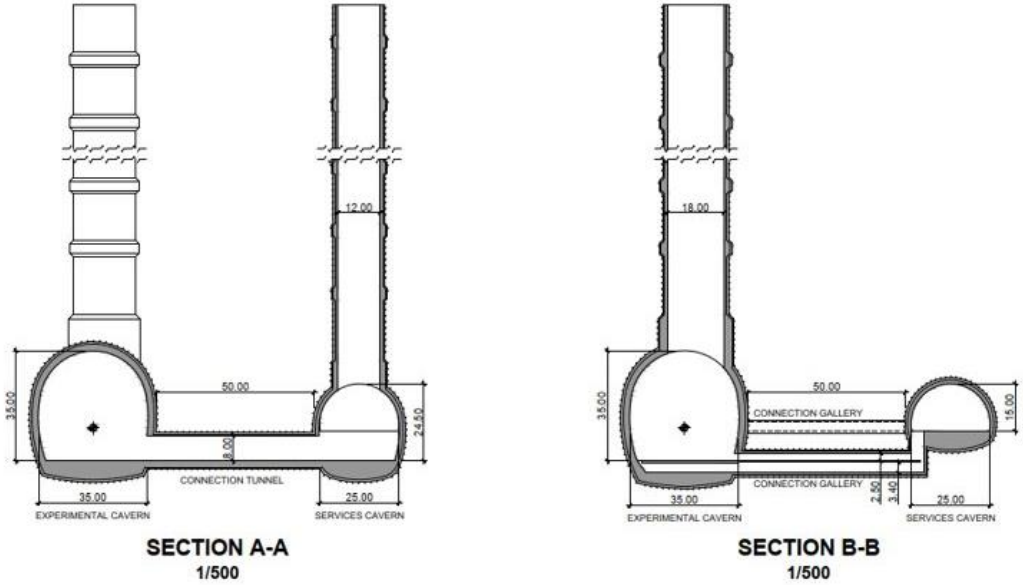


Credit: Angel Navascues Cornago



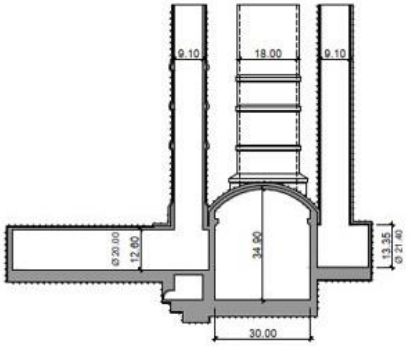
Credit: Fani Valchkova-Georgieva

Large Experimental Area (A & G)

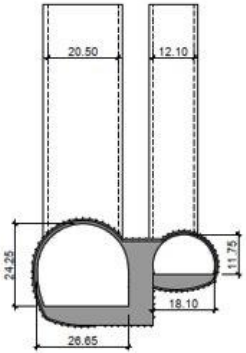


Credit: Angel Navascues Cornago

FCC

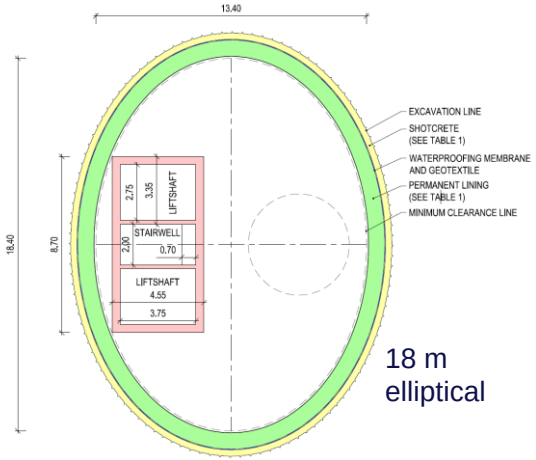


ATLAS

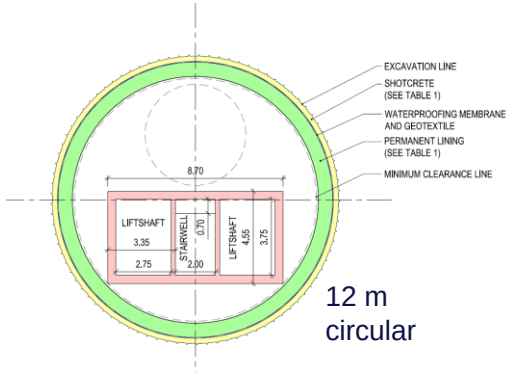


CMS

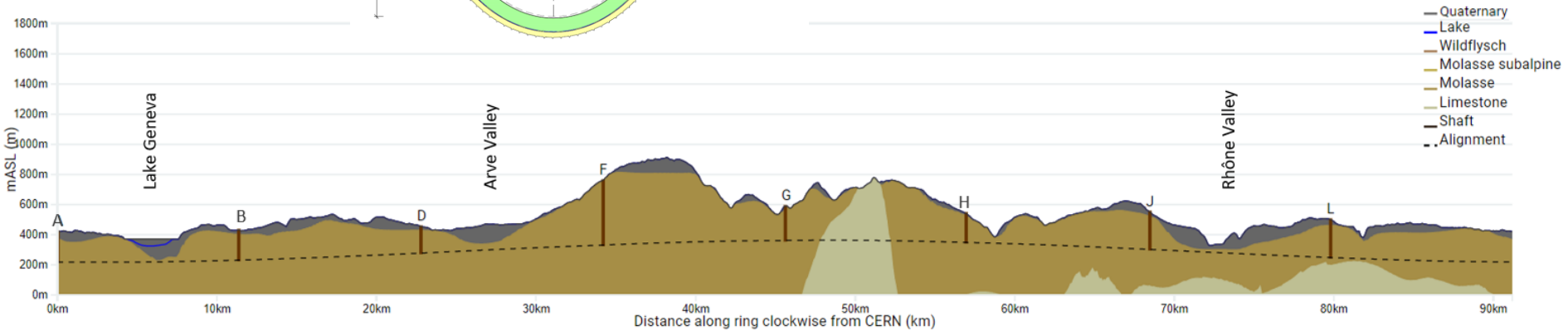
Shafts



18 m elliptical



12 m circular

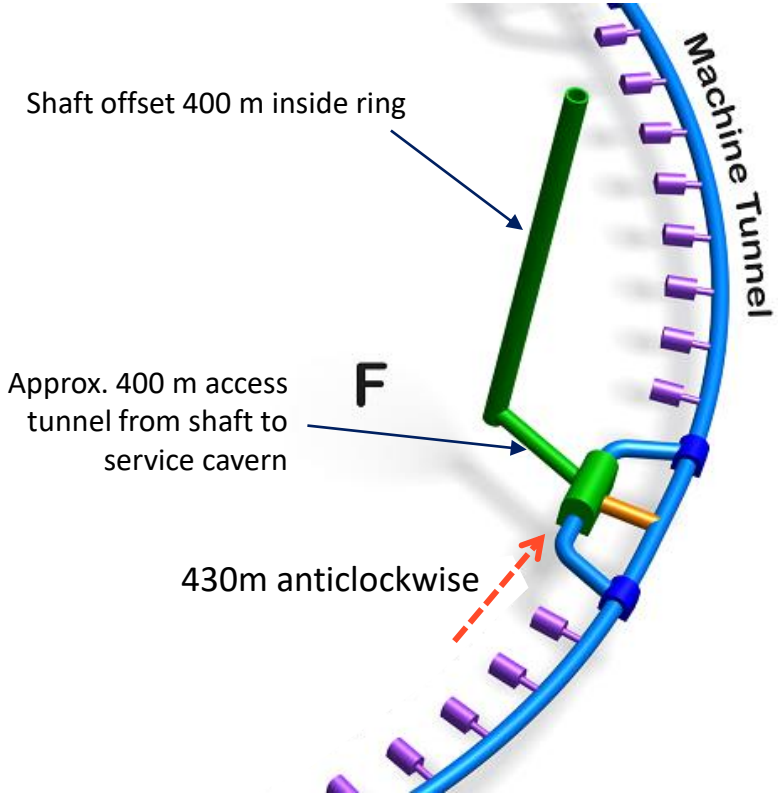


Shaft depths:

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

Offset Shaft - Point F

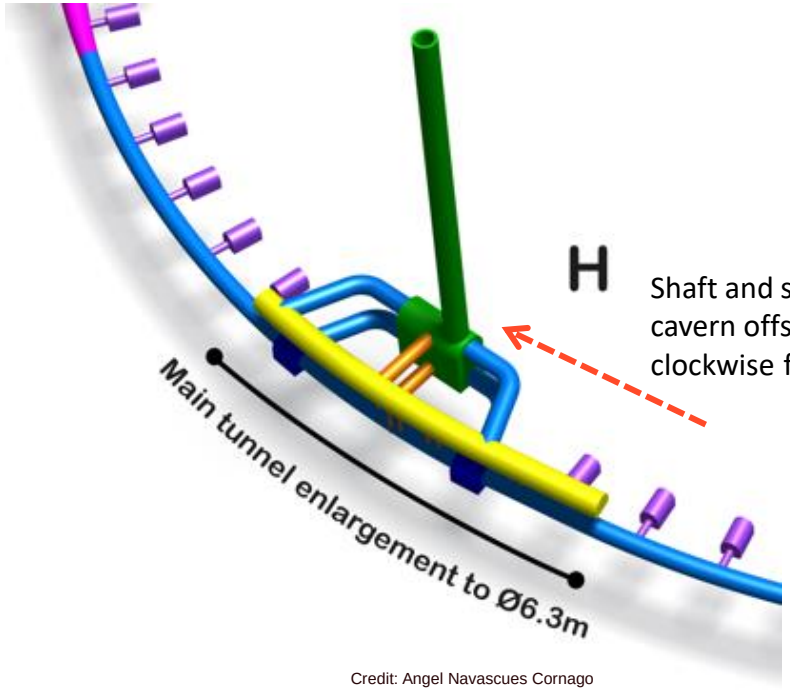
Offset will probably be required due to surface access constraints.



Credit: Angel Navascues Cornago

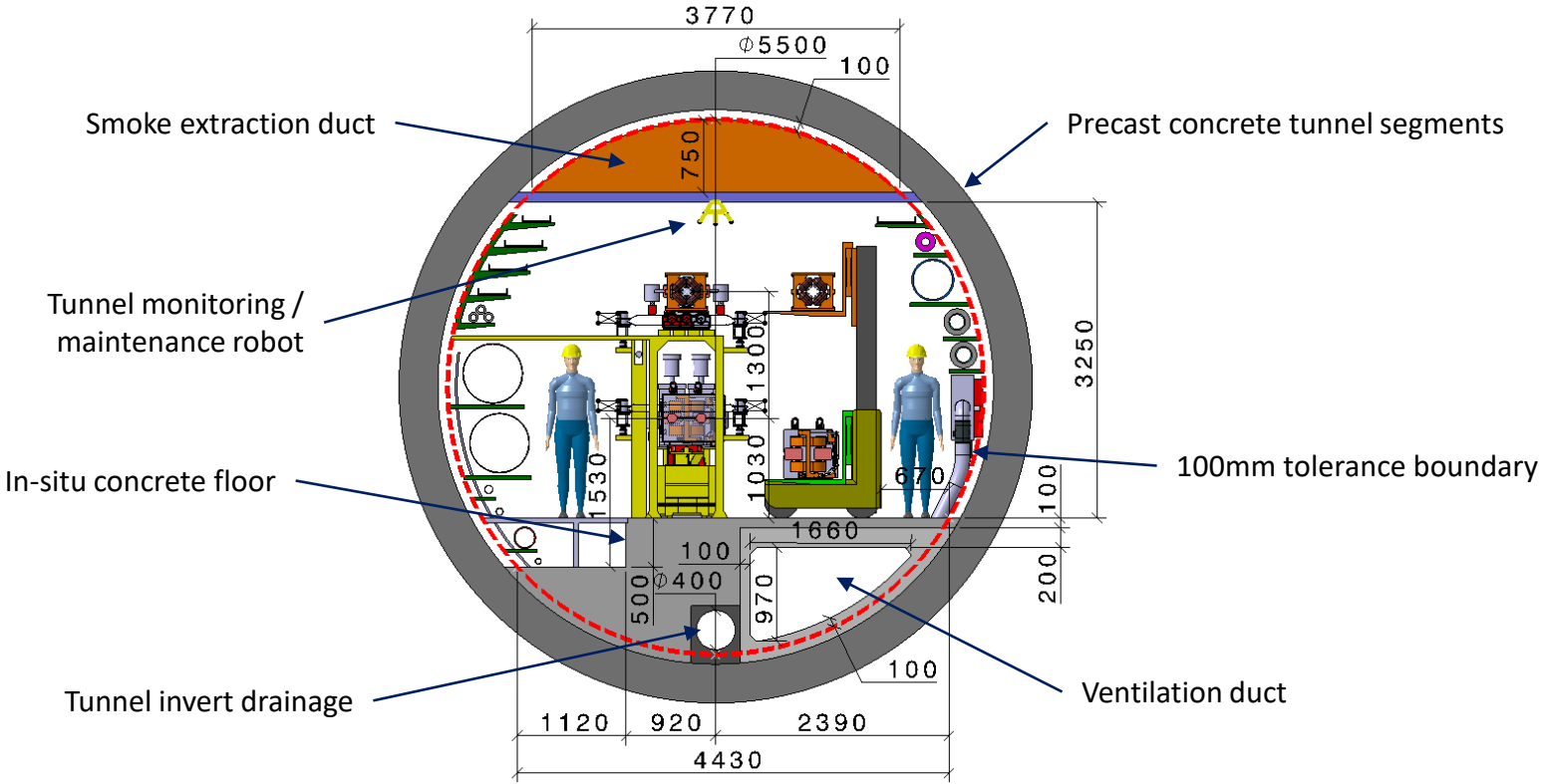
Offset Shaft - Point H

800m offset helps to avoid forested surface site. Though technical preference remains at the centre of the LSS



Credit: Angel Navascues Cornago

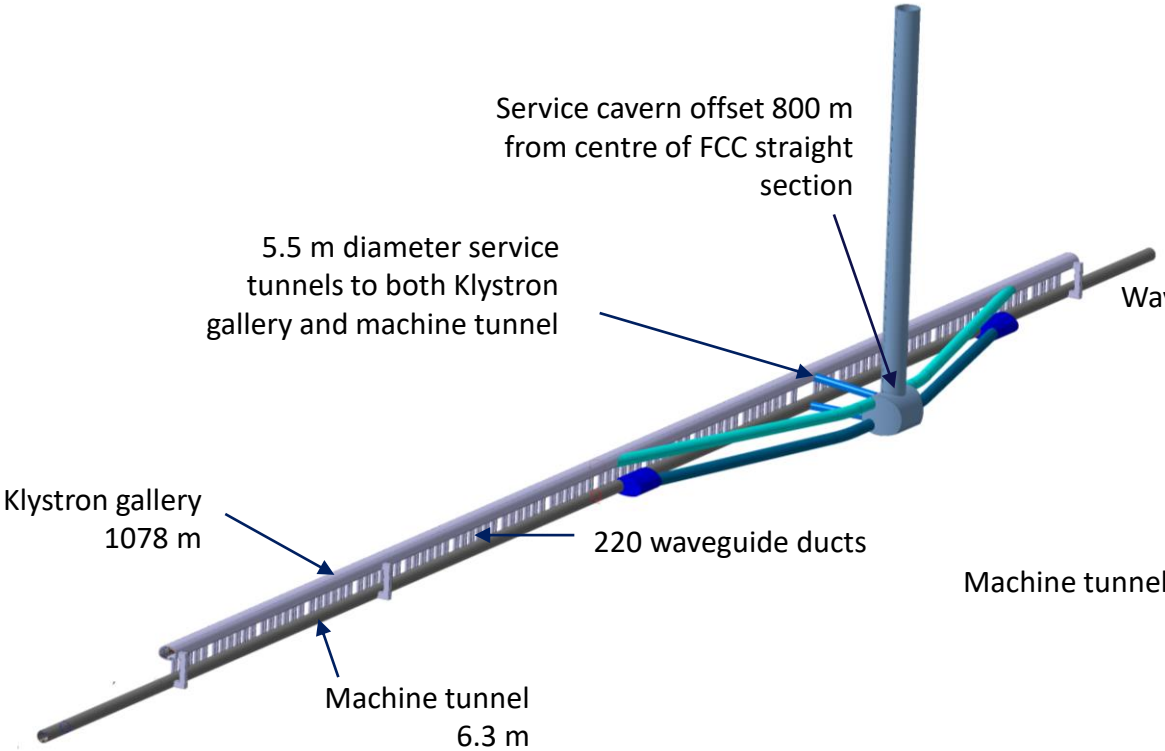
Main Tunnel Cross Section

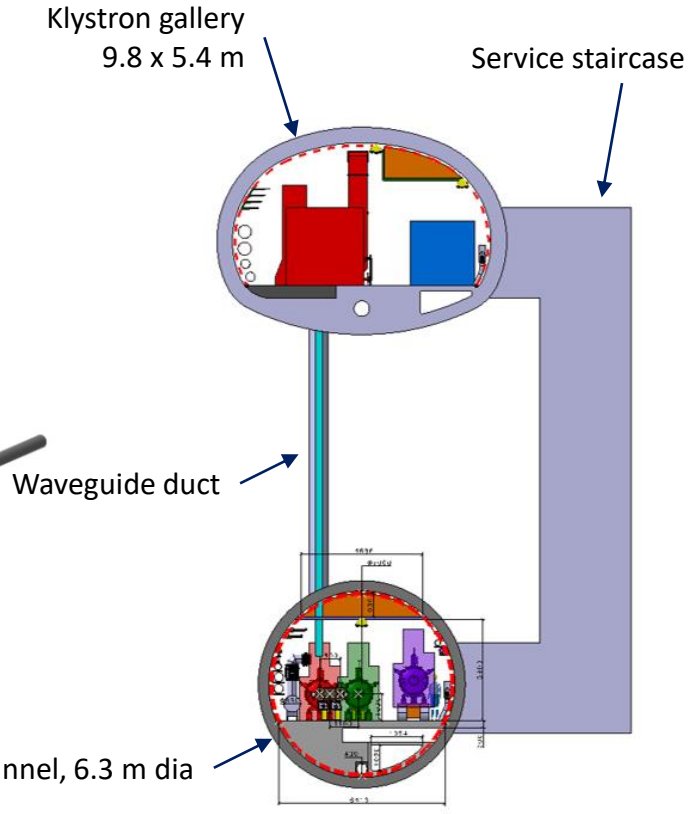


Credit: Fani Valchkova-Georgieva

Klystron Gallery - Point H

1078 m length Klystron gallery

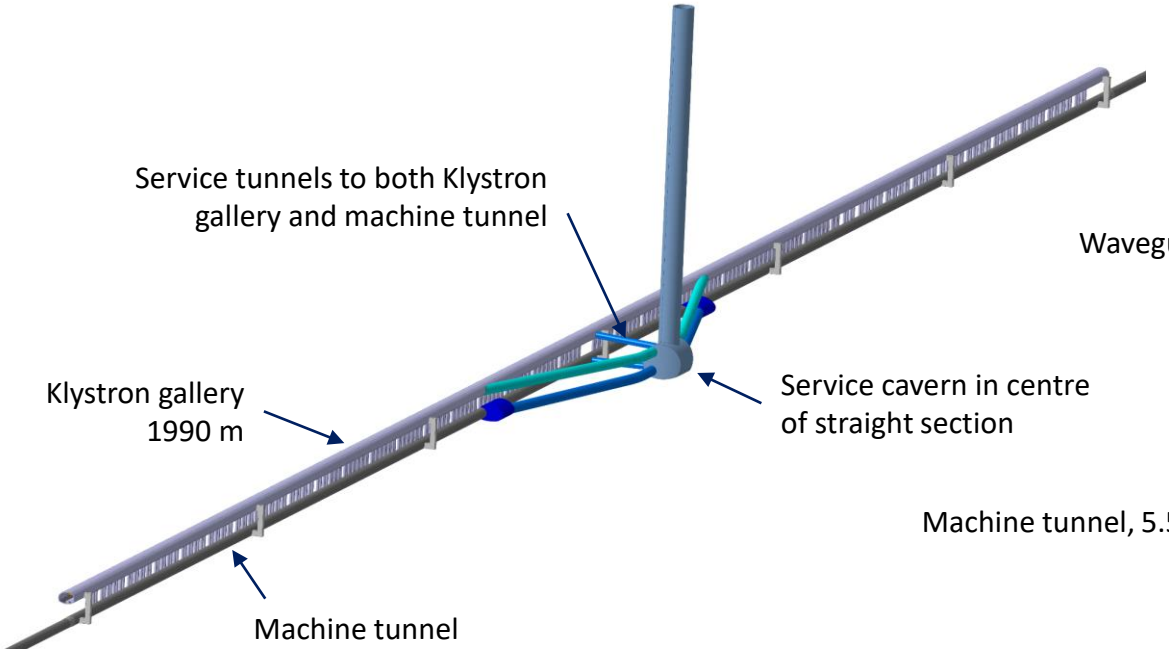


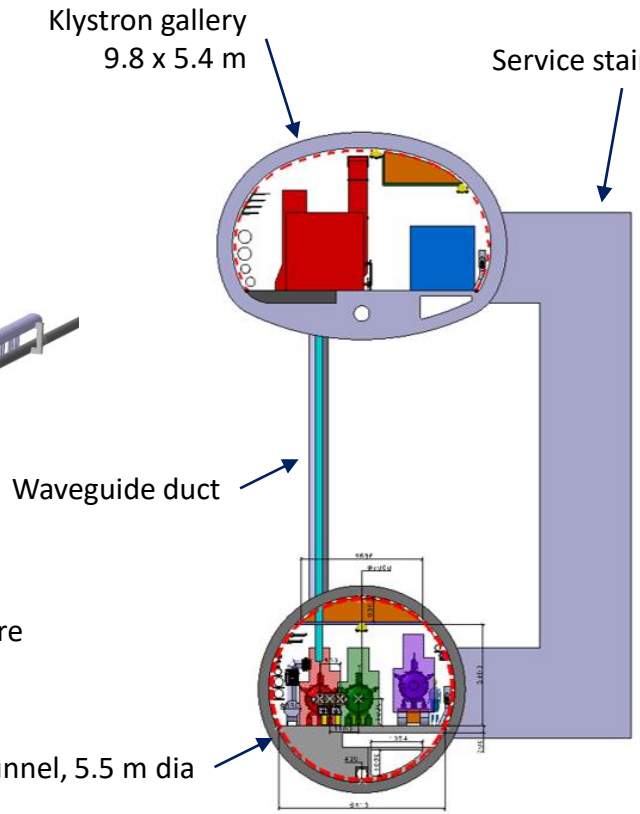


Credit: Fani Valchkova-Georgieva

Klystron Gallery - Point L

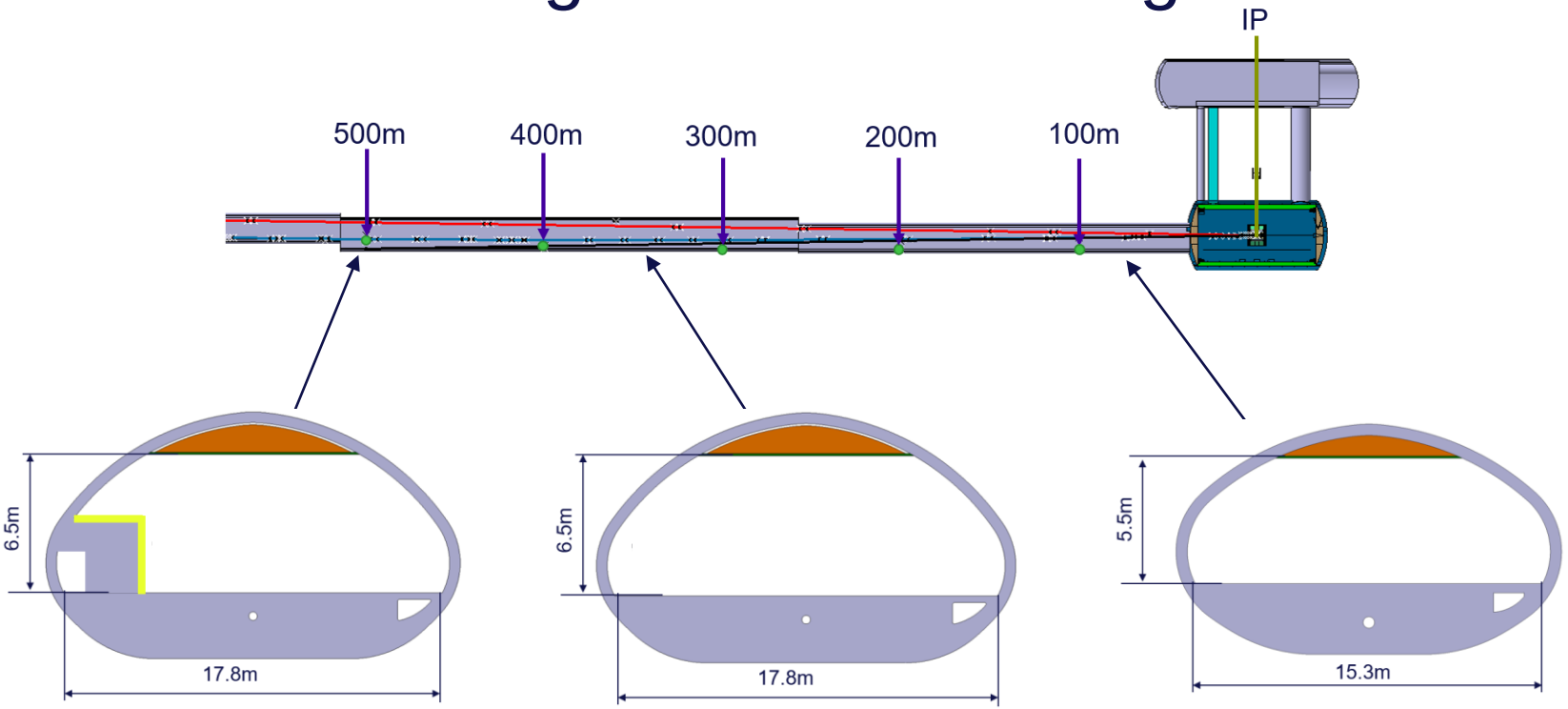
1990 m length Klystron gallery





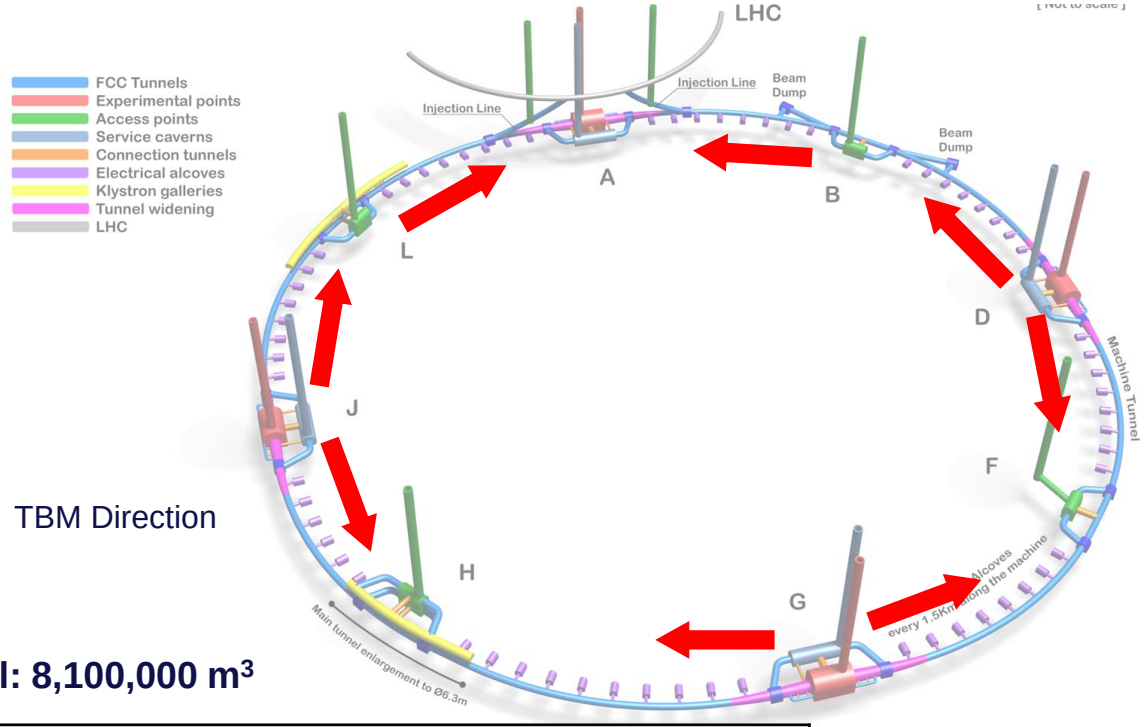
Credit: Fani Valchkova-Georgieva

Tunnel Widening – Beamstrahlung



Excavated Spoil

Possible TBM arrangement



Total Spoil: 8,100,000 m³

Excavation Quantities	Extraction Point							
	A	B	D	F	G	H	J	L
TBM	-	585,199	1,170,399	-	657,743	-	1,267,957	617,719
Drill & Blast	-	-	-	-	228,076	-	-	-
Road Header/Rock Breaker	263,109	319,347	193,980	158,064	635,152	227,573	218,820	726,300
Mined Shaft	93,739	231,227	82,137	114,426	105,804	25,865	116,477	47,078
Totals	356,847	1,135,773	1,446,516	272,491	1,626,775	253,438	1,603,254	1,391,098

Areas with highest geological uncertainty

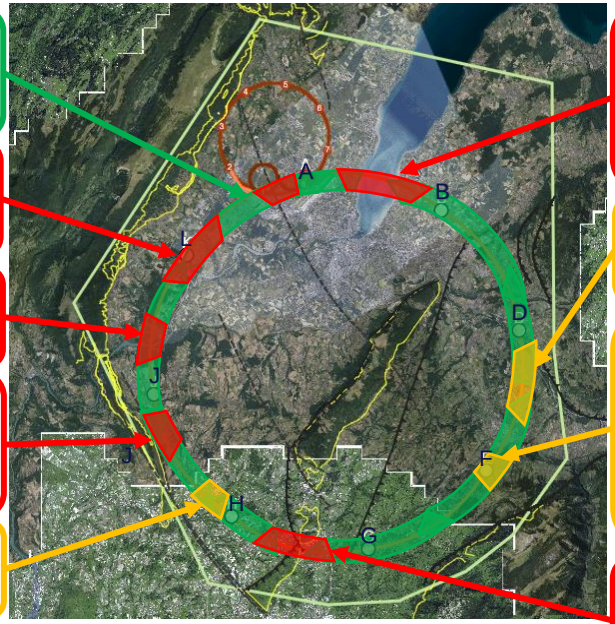
- Good knowledge of the ground (e.g information near to CERN from LEP/LHC projects)
- Good confidence that the tunnel alignment is in molasse

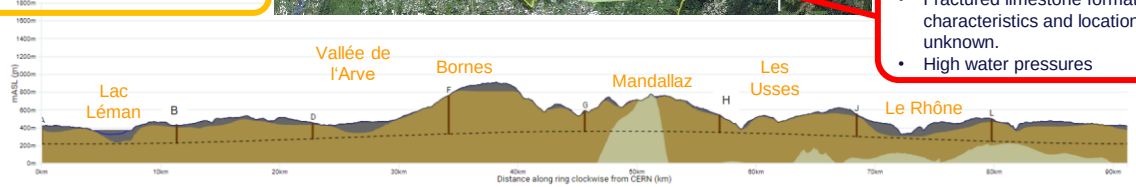
Jura
- Limestone/molasse interface uncertain.
- Risk of karts and high water pressures

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

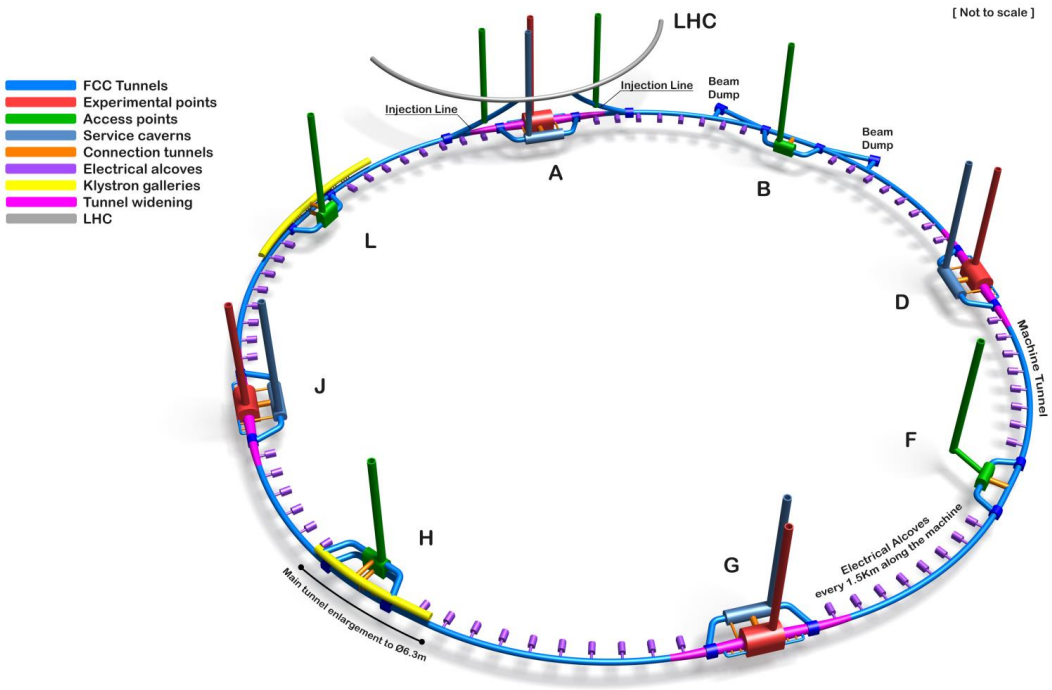
Vallée de l'Arve
- Moraine/molasse interface uncertain.
- Lack of reliable boreholes

Bornes
- Insufficient deep boreholes information
- Complex faulted region, thrust zone.
- Quality of molasse is uncertain. High overburden. Large span experimental caverns should be constructed in good molasse.

Mandallaz
- Fractured limestone formations, characteristics and locations of karsts unknown.
- High water pressures

On-site investigation works 2024-25

Tasks Ahead

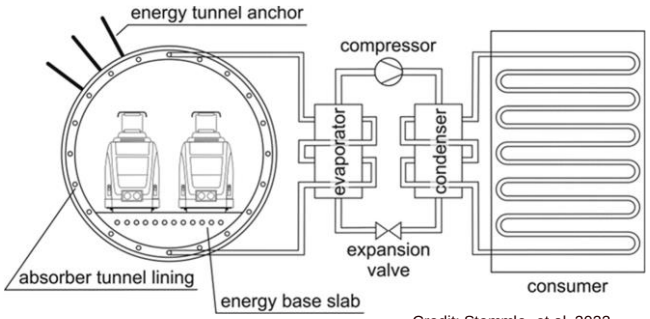


Credit: Angel Navascues Cornago

- Baseline FCC underground structures to be frozen by early 2023.
  - TBM drive directions
  - Injection lines from LHC/SPS
  - Tunnel widening/Beamstrahlung
  - Alcove design
  - Beam dump
- Updated cost / schedule to be provided for the FCC mid-term review, October 2023.
- Lifecycle assessment study for underground civil engineering.
- On site investigations for areas of geological uncertainty.

Thank you
for your attention.

Additional Studies



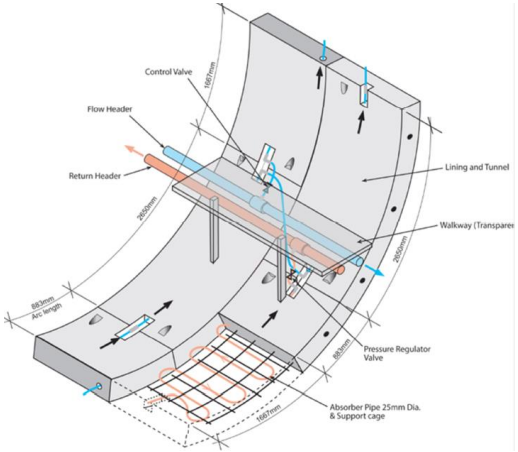
Credit: Stemmle, et al. 2022

Thermal Heat Recovery

600 m length of tunnel

Equivalent of 35no. 100 m geothermal boreholes

Half the capital cost

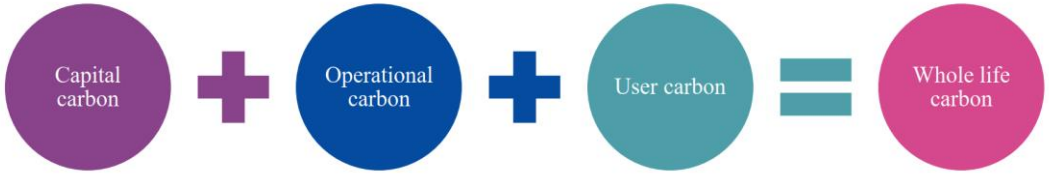


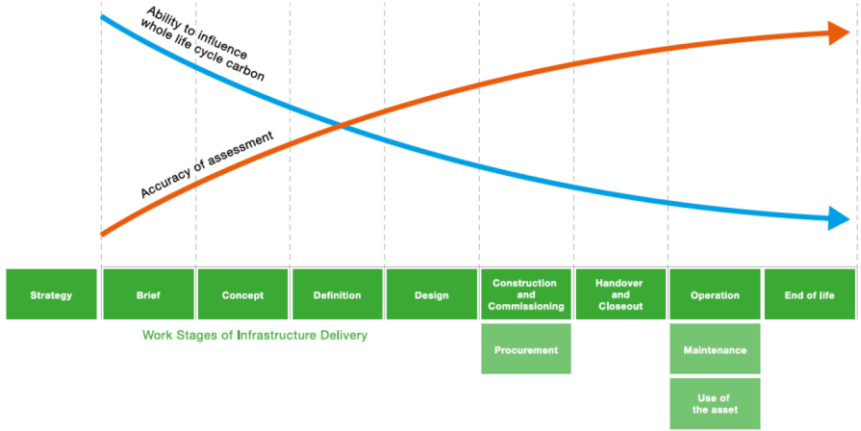
Credit: ARUP

Life Cycle Assessment

PAS 2080

Carbon Management in Infrastructure





Credit: PAS2080