SUMMARY AND LOOK AHEAD FOR FCC CIVIL ENGINEERING

Timothy WATSON

Host States and Civil Engineering Pillar Coordinator

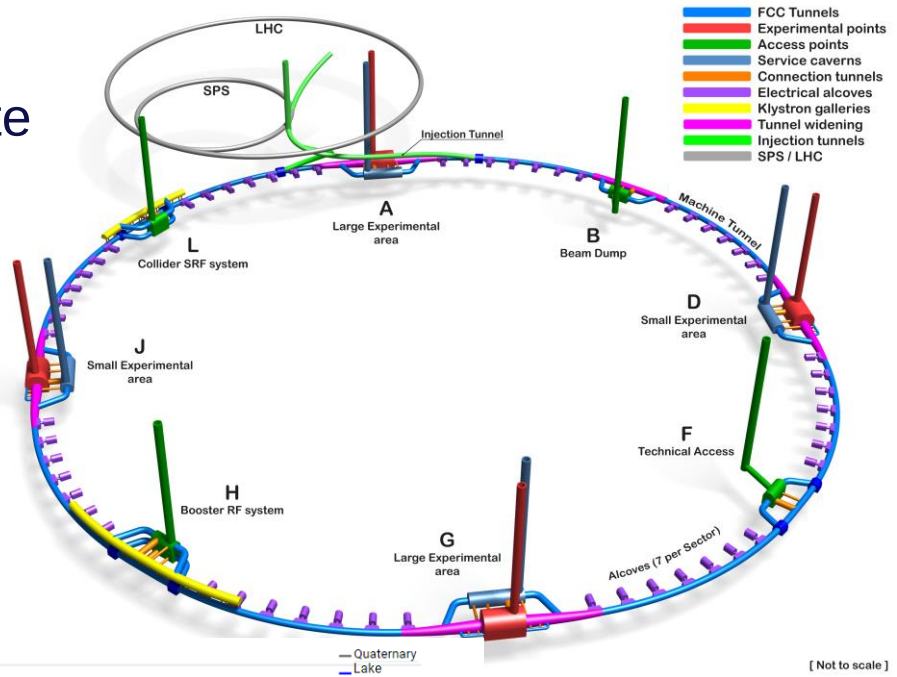
1. Summary of the session on civil engineering
2. Look ahead of activities up to the completion of feasibility study ….. and beyond?

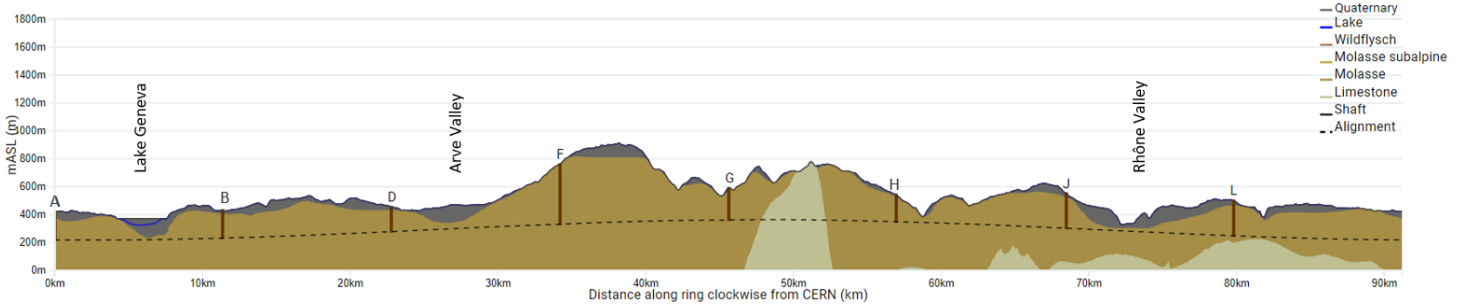
Acknowledging the contributions and presentations made by the CERN FCC team as well as our external collaborators from Fermilab, ILF and Quantum.

Presentation 1

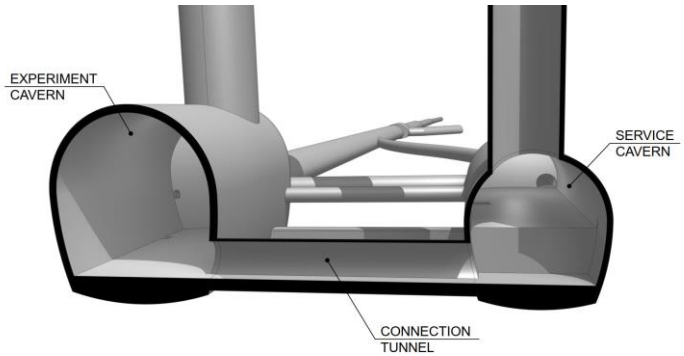
FCC underground civil engineering update

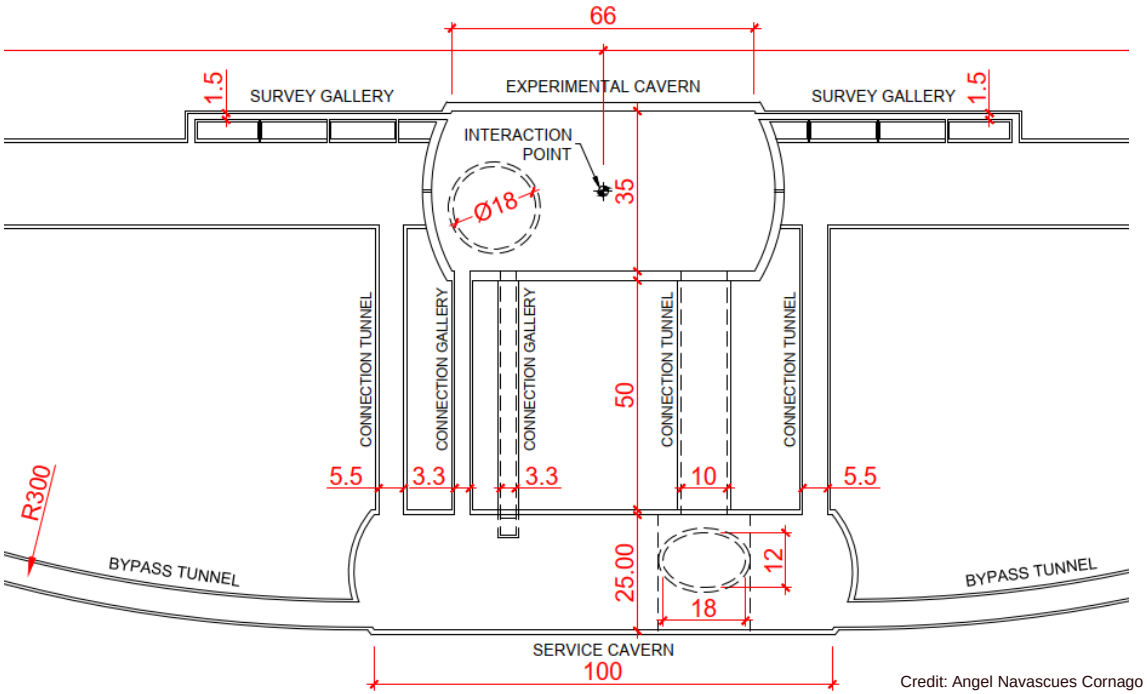
- Liam Bromiley (CERN)
- Liliana Florez (ILF)





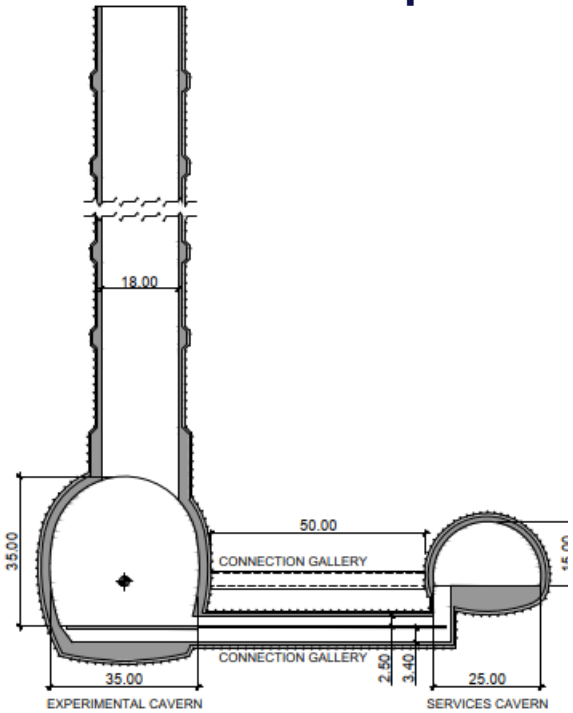
Experimental Area



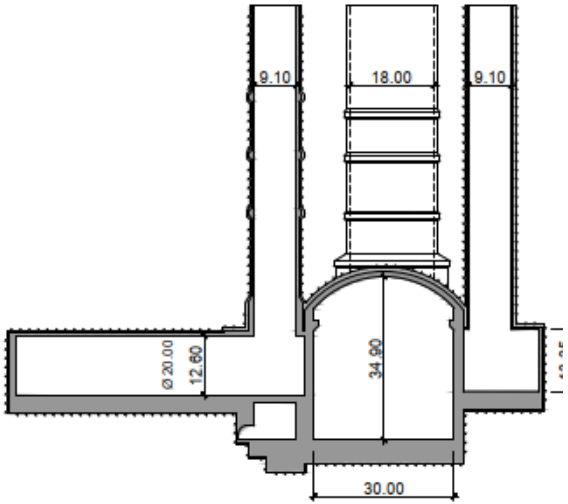


Credit: Angel Navascues Cornago

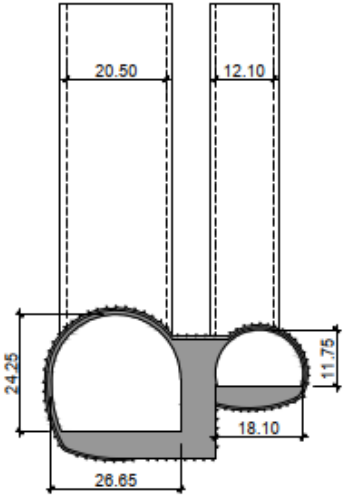
Comparison FCC to ATLAS and CMS Cavern Complexes



FCC



ATLAS

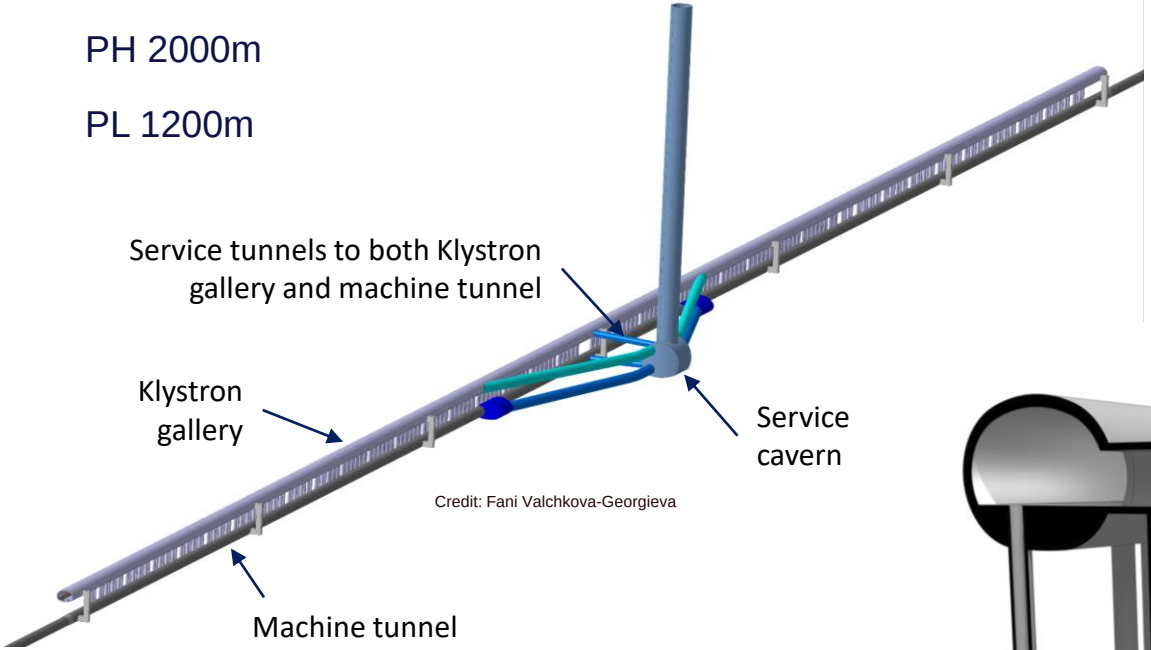


CMS

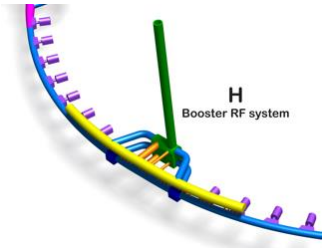
Klystron Galleries

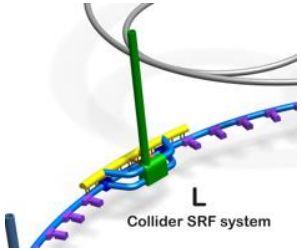
PH 2000m

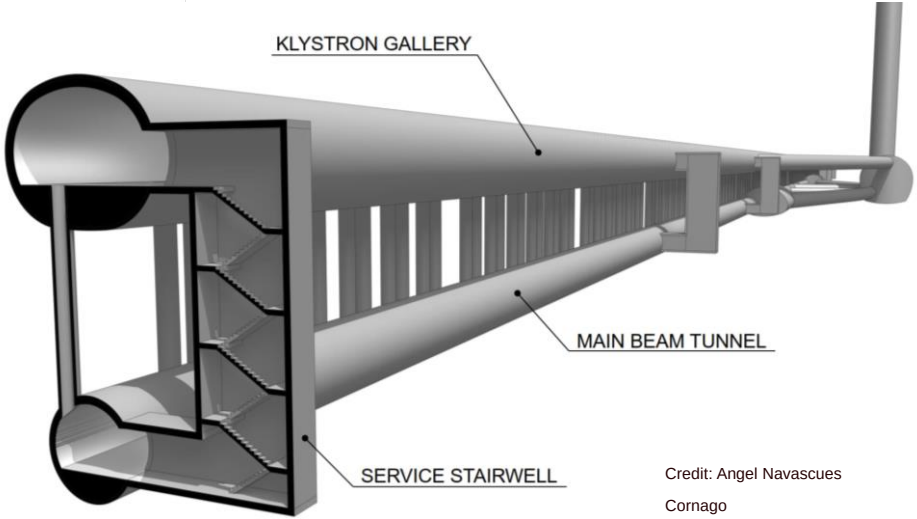
PL 1200m



Credit: Fani Valchkova-Georgieva







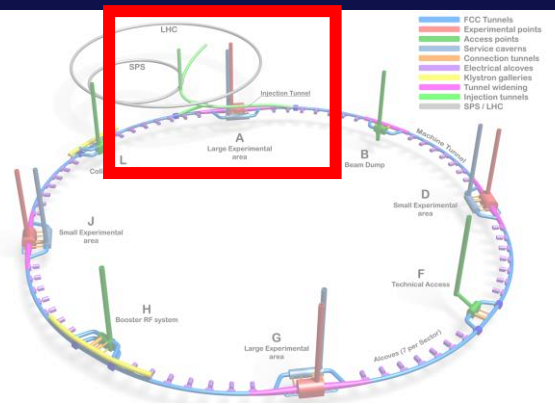
Credit: Angel Navascues Cornago

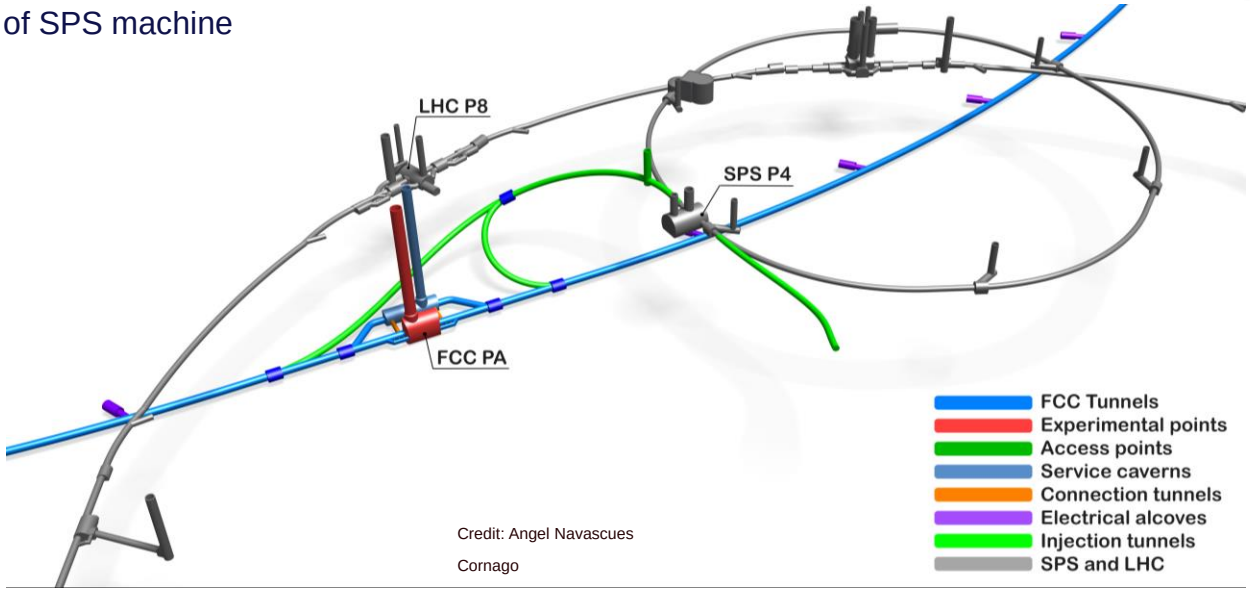
SPS Injection Lines

CERN Prevessin LINAC to SPS Point 4

SPS Point 4 to FCC

Reuse of SPS machine

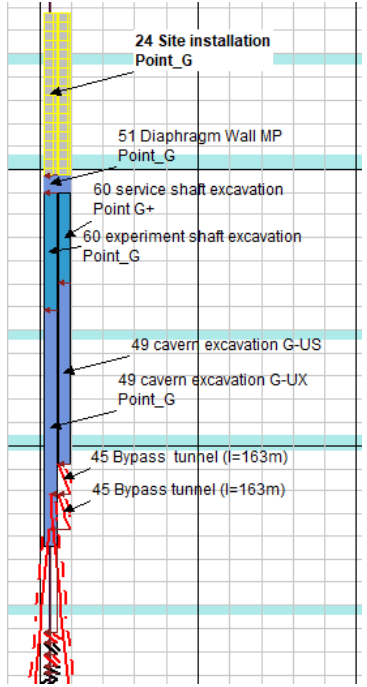




Credit: Angel Navascues Cornago

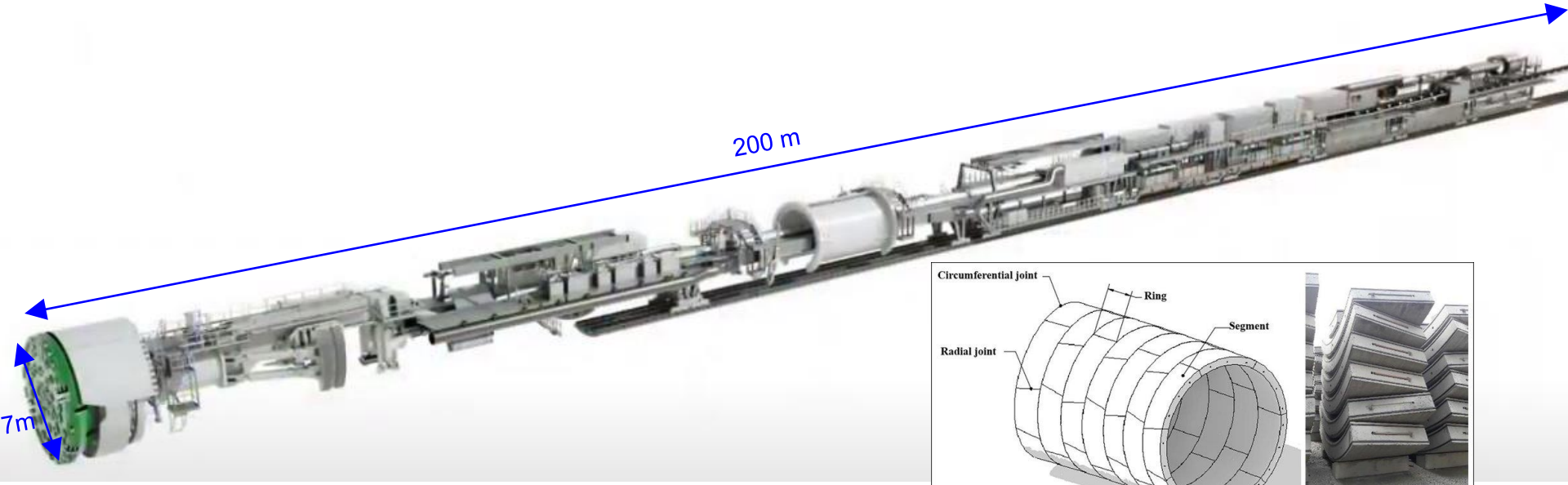
Sequence of the construction schedule

Roadheader



Schedule at Point G

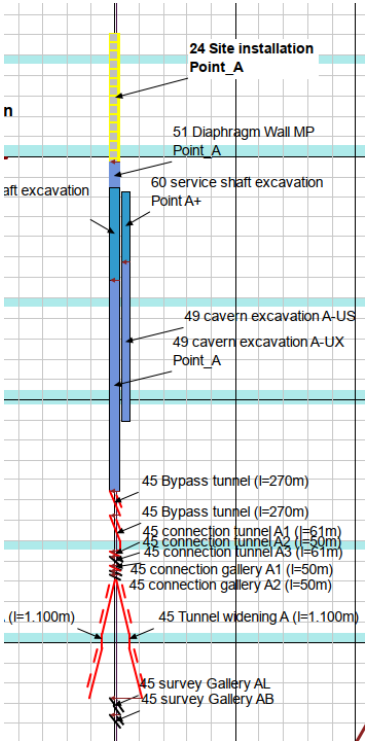
Tunnel Boring Machine (TBM)

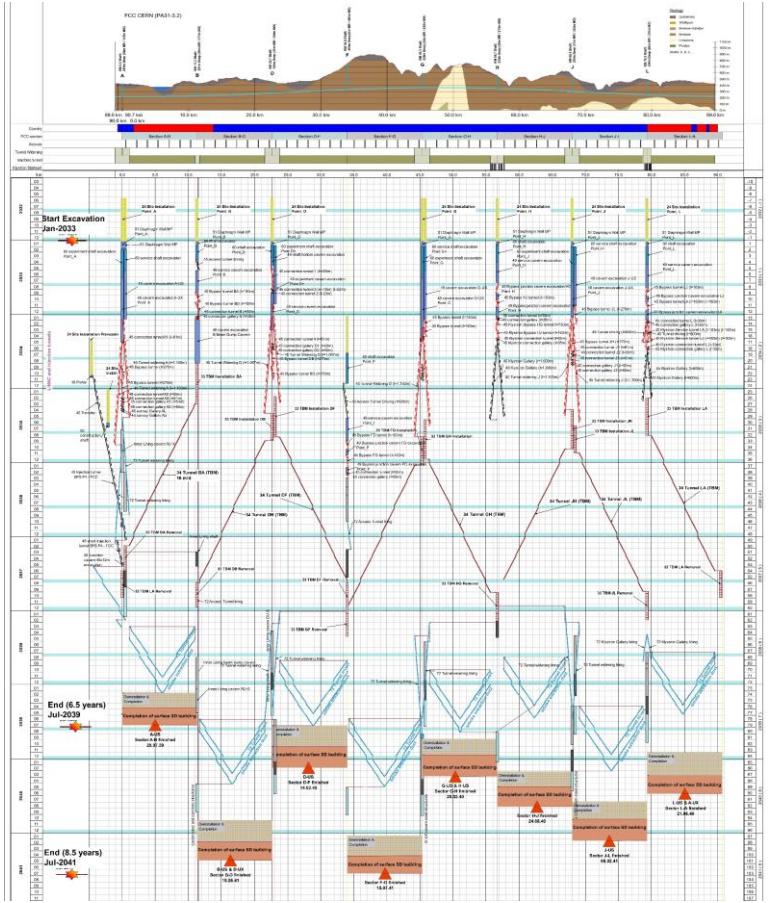


Precast segments

Construction Schedule Study

Tilos





Credit: ILF

Presentation 2

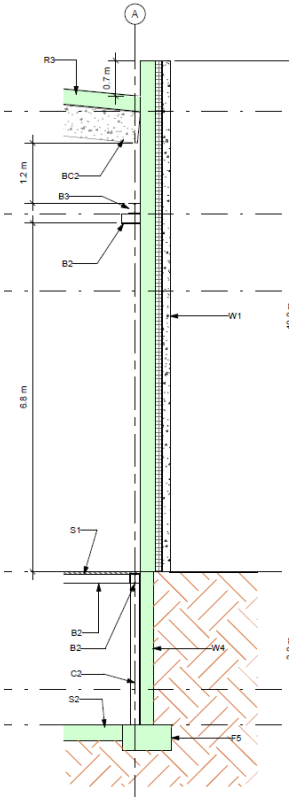
Preliminary layouts and designs for two of the FCC surface sites

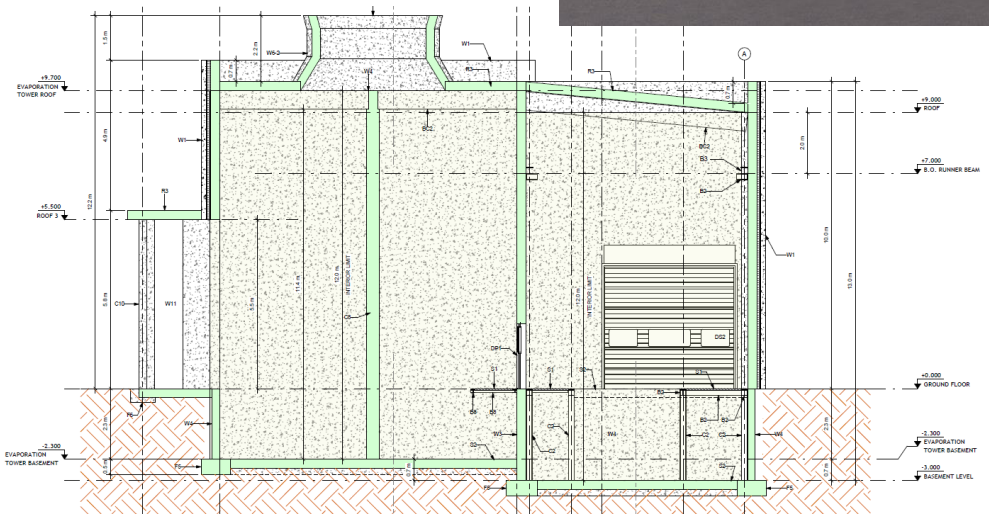
- Damian DOCKERY (Fermilab)
- Andrew FEDEROWICZ (Fermilab)
- Brian RUBIK (Fermilab)

Aerial view of proposed Site PA

View overlooking Site PB entrance

Site PB / SF Cooling Plant





Presentation 3

FCC sub-surface investigations into areas of geological uncertainty

- Roddy Cunningham (CERN)
- Lucy Rew (QUANTUM)

Areas of Geological Uncertainty

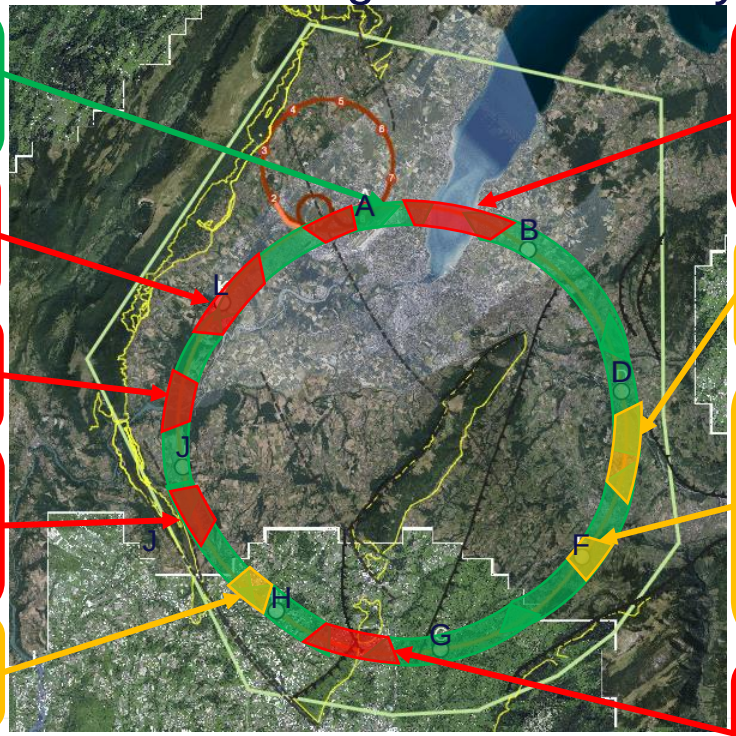
- Good knowledge of the ground (e.g. information near to CERN from LEP/LHC projects)
- Good confidence that the tunnel alignment is in molasse

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

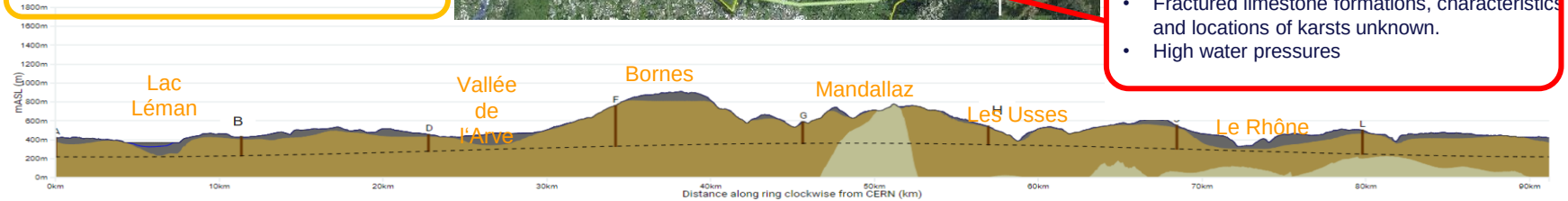


Lac Léman
- Moraine/molasse interface uncertain
- Soils and rock properties uncertain
- High uncertainty in the hydrogeological conditions and water pressure

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.

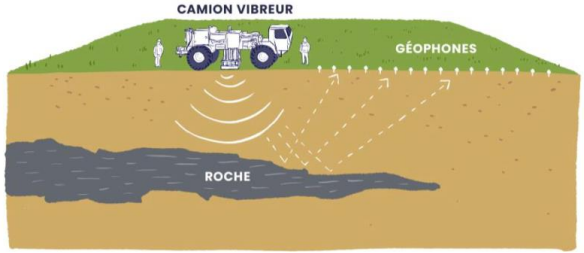
Mandallaz
- Fractured limestone formations, characteristics and locations of karsts unknown.
- High water pressures

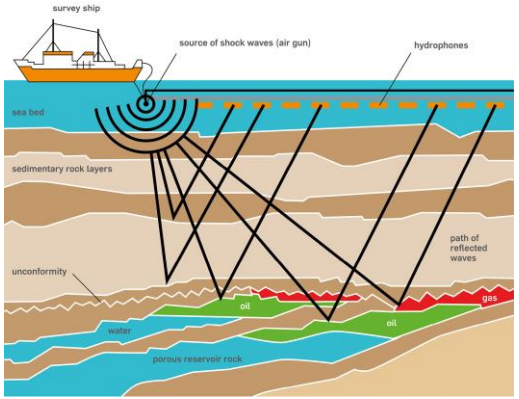


Types of Site Investigation: Geophysics

Use of different techniques depending on site constraints and the geological aim of the investigation:

- Seismic reflection
  - High resolution using vibratory truck (most common)
  - Very high resolution using a barrow
  - Offshore airgun for Lake Geneva
- Seismic refraction
  - Explosives or weight drop, depending on the sensitivity of the area (Usses and Rhône valleys only)
- Total of over 80km of seismic investigation



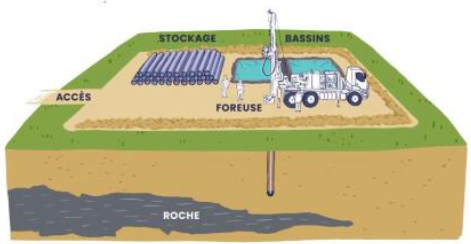


Types of Site Investigation: Boreholes

Geotechnical borehole drillings

- 48 boreholes (including 4 on Lake Geneva)
- Certain boreholes to be equipped with piezometers

Sector	Quantity	Depths (m)
Jura 1	13	230-275
Jura 2	3	240-250
Lake	4	130-185
Arve	5	185-210
Mandallaz	3	360-510
Usses	2	70-75
Vuache	5	210-295
Rhône	7	75-190




Drilling at Prevessin, CERN 2020


Drilling on Lake Geneva

Credit: www.swissdrilling.ch

Look Ahead

For civil engineering, the mid-term review is a snapshot of the technical aspects, cost and schedule as of early 2023.

Even today the project continues to evolve beyond the technical solutions that have been incorporated in the mid-term review.

Therefore, an important task after the mid-term review will be to re-assess the technical aspects of the civil engineering and take on board any new approved project requirements and their associated civil engineering solutions.

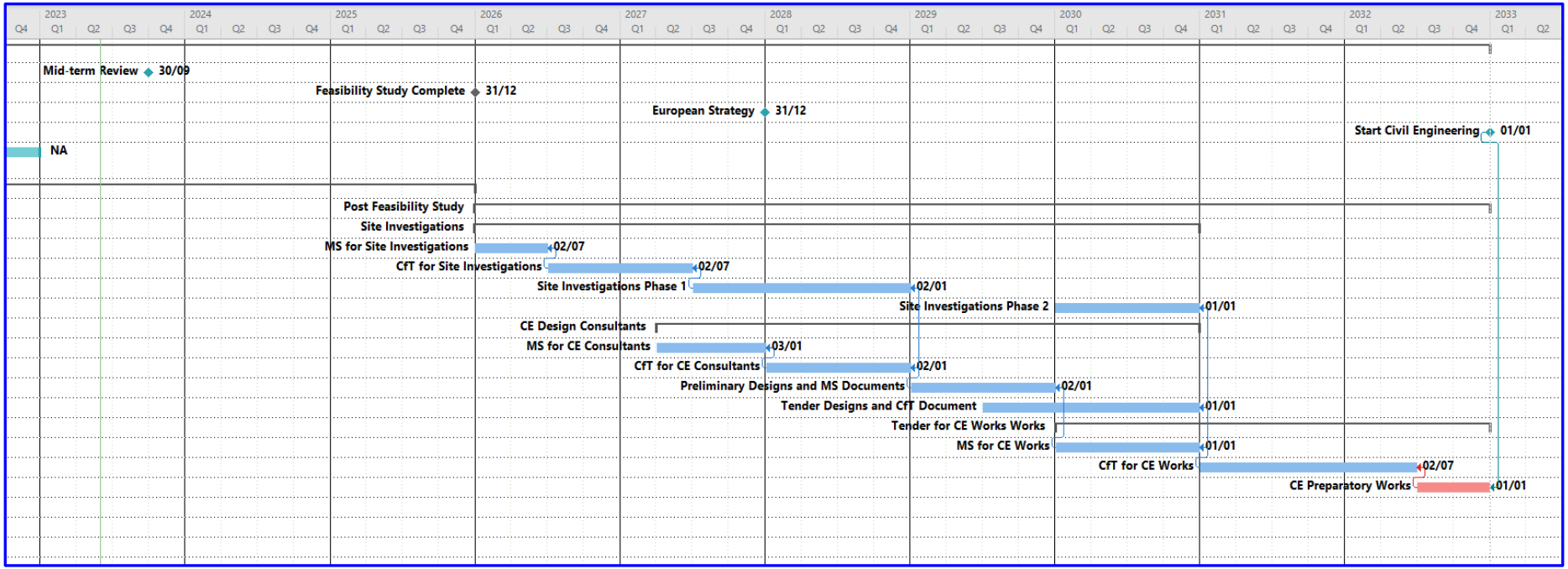
In addition, the areas of the study that have not yet been looked at in sufficient detail will need to be progressed further.

Further evaluation of some of the requirements will be made to assess whether alternative, more efficient solutions can be found and incorporated into the final conclusions of the study (value engineering).

Look Ahead

1. Undertake the site investigations and analyse results/update depth and/or tunnel inclination
2. Complete layouts and designs for the surface buildings at all 8 points taking into account any new requirements (internal or external).
3. Refine the current designs for underground by optimizing cavern sizes, tunnel widenings and shaft diameters using more refined requirements from users.
4. Update (where necessary) the schedule and cost estimates for the final report
5. Prepare more detailed cost estimates for the surface works
6. Identify work that may need to be carried out prior to project go/no-go decision.

Post Feasibility Study Best-Case Schedule



The schedule above is not an official CERN document. It is intended only to demonstrate that some preparatory works may need to undertaken prior to December 2027

Conclusions

1. Civil engineering for the FCC Feasibility Study is well advanced and fairly mature designs and associated cost estimates and schedule (underground works) will be included in the mid-term review.
2. The Call for Tender for the site investigation works is about to be issued with works planned in 2024 and 2025.
3. Additional work that is required prior to the completion of the Feasibility Study has been identified.
4. Work needed after the Feasibility Study but prior to a go/no-go decision is being identified.

FCC

Thank you
for your attention.