Civil Engineering for FCC-eh IR

John Osborne, Jo Stanyard & Matthew Stuart (SMB - Site Engineering - FAS Section)

Acknowledgements to all FCC study groups.

FCC-eh Introduction

- Scope of FCC-eh Civil Engineering
- A recap of the previous options presented in Rome.
- Changes to the FCC layout and the impact on FCC-eh position
- Preferred FCC-eh position
- Future Challenges

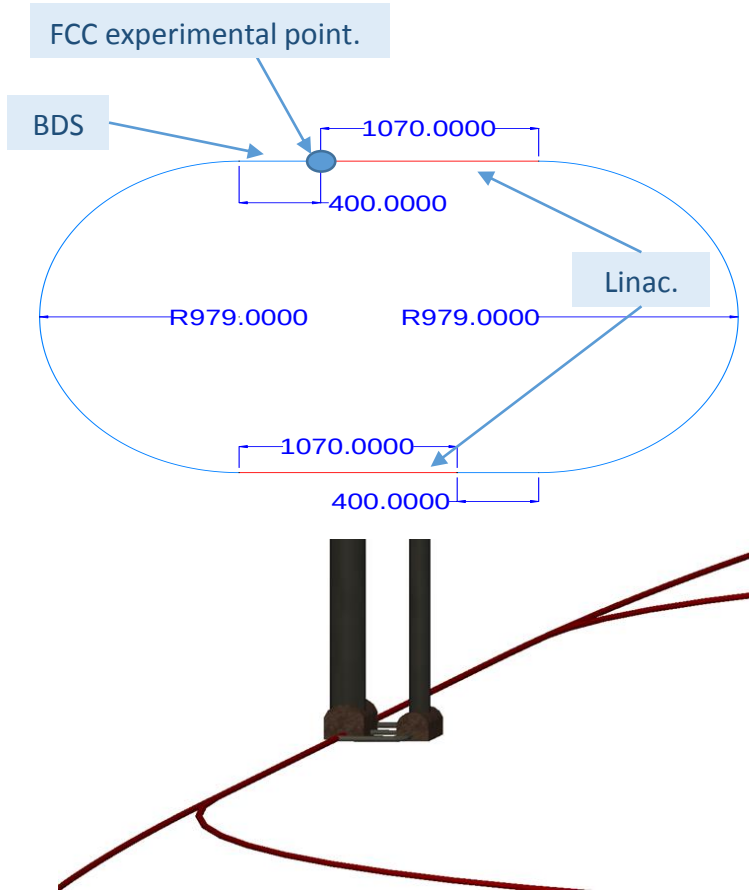
Scope of FCC-eh Civil Engineering

Tunnel Dimensions:

- 400m Beam Delivery System (BDS)
- 1070m Linac
- 979m radius arcs (x2)
- 400m drift section.
- **Total Length of 9091m of tunnel.**

Cavern and shaft requirements:

- Experimental shaft and cavern
- Access shaft and cavern



FCC-eh Rome 2016 CE Proposals

Point L

- Geological risk – Karstic Limestone.
- Further probing to check geology required.

Point B

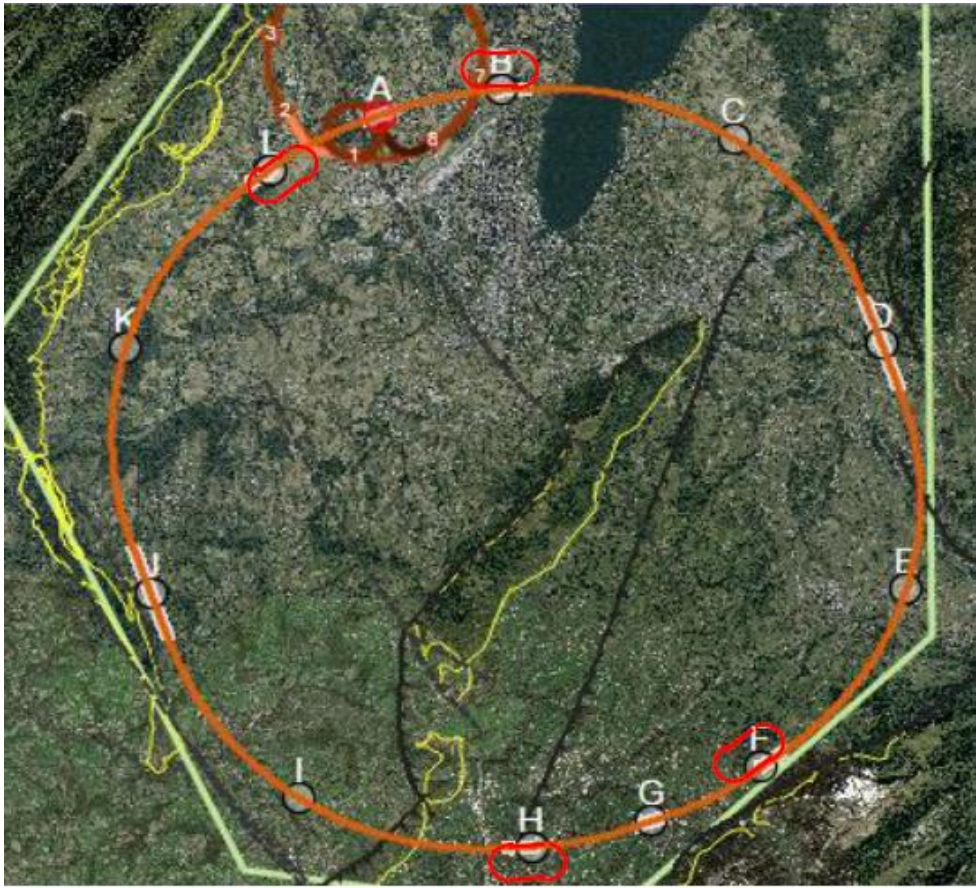
- Low geological risk (molasse) anticipated but could encounter Jura limestone.

Point F

- High geological uncertainty in this region
- Very far from existing CERN sites.

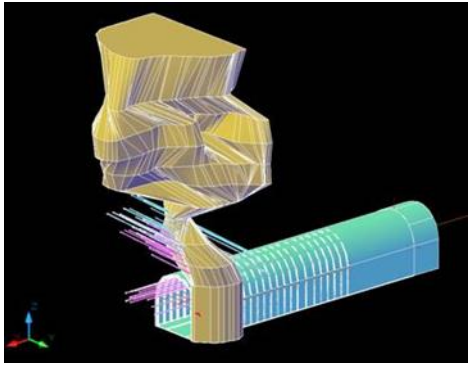
Point H

- Very far from existing CERN sites
- Low geological risk (molasse).

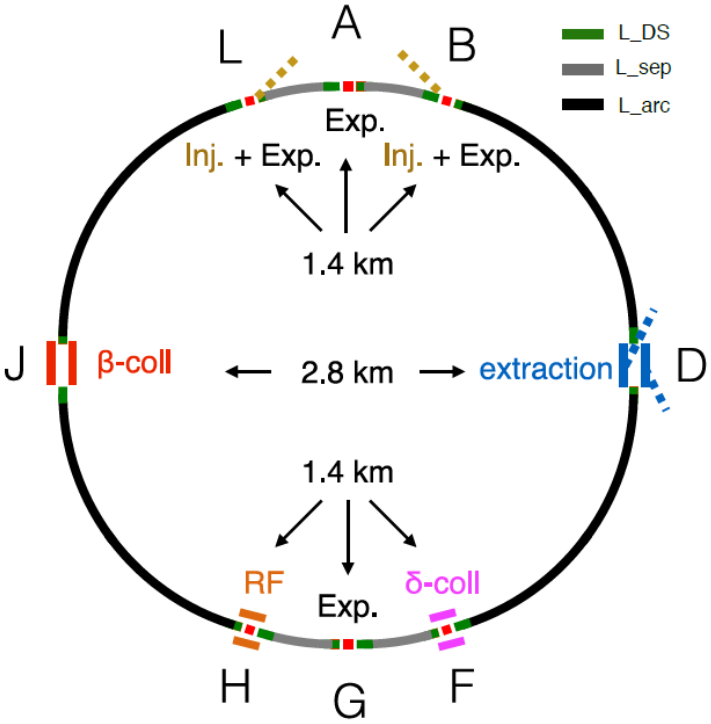


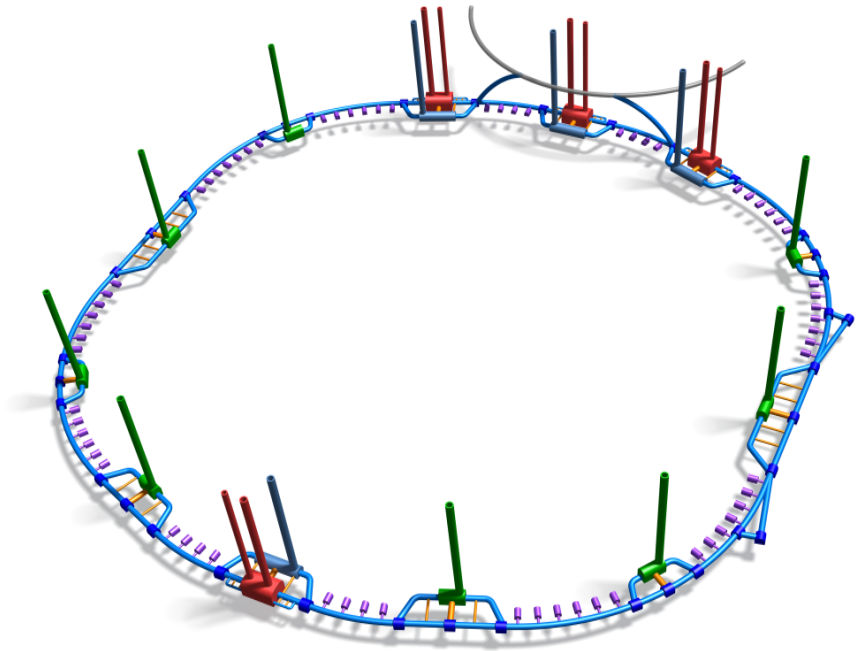
Limestone Properties:

- Hard rock
- Normally considered as sound tunneling rock
- In this region fractures and karsts encountered
  - Risk of tunnel collapse
  - High inflow rates measured during LEP construction (600L/sec)
  - Clay-silt sediments in water
  - Rockmass instabilities

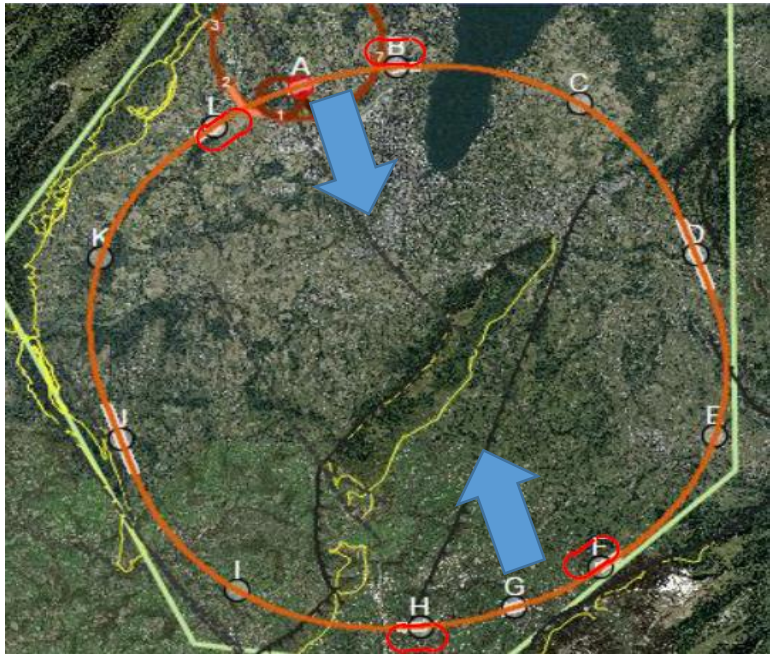


FCC Layout Changes





Rome 2016 Layout



Updates since Rome 2016 layout:

- Reduced depth below surface level.
- Reduced length of straight sections at J and D.
- Increased tunnel length from A-L, A-B and G-F, G-H.
- Avoids Jura Limestone and Pre-Alps region.
- Reduced Total Tunnel Length.

FCC Layout Changes

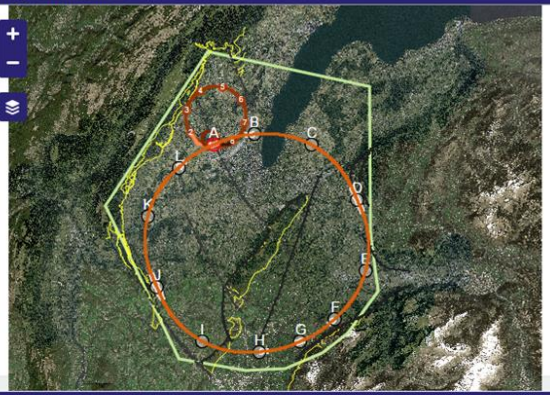
ARUP

Alignment | Shafts | Query

Highlights:

- Avoids Jura and Pre-Alps limestone.
- Only one sector containing limestone.
- Significantly reduced total shaft length.
- Experimental Site at Point A on existing CERN land.
- Avoids extremely large overburden.

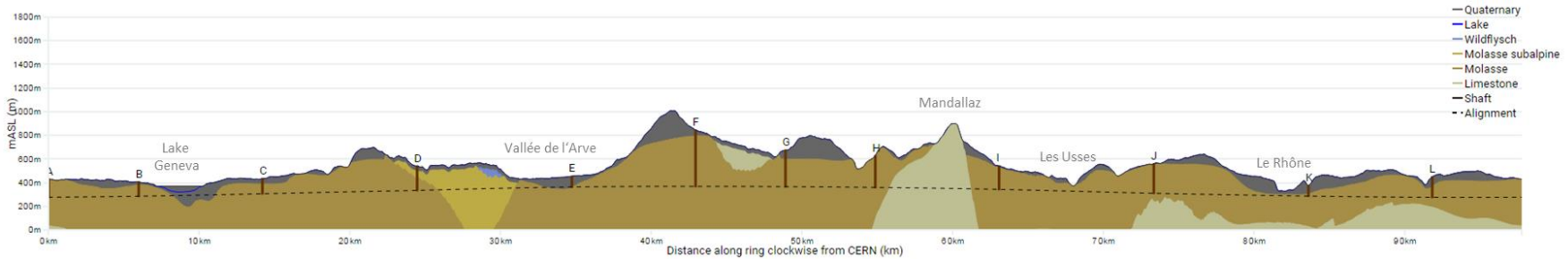
Alignment Location



Geology Intersected by Shafts | Shaft Depths

	Shaft Depth (m)				Geology (m)		
Point	Actual	Molasse SA	Wildflysch	Quaternary	Molasse	Urgonian	Limestone
A	152	0	0	0	152	0	0
B	121	0	0	26	95	0	0
C	127	0	0	44	83	0	0
D	205	66	0	40	100	0	0
E	89	0	0	89	0	0	0
F	476	0	0	49	427	0	0
G	307	0	0	73	234	0	0
H	266	0	0	0	266	0	0
I	198	0	0	11	187	0	0
J	248	0	0	1	247	0	0
K	88	0	0	70	18	0	0
L	172	0	0	89	83	0	0
Total	2449	66	0	492	1892	0	0

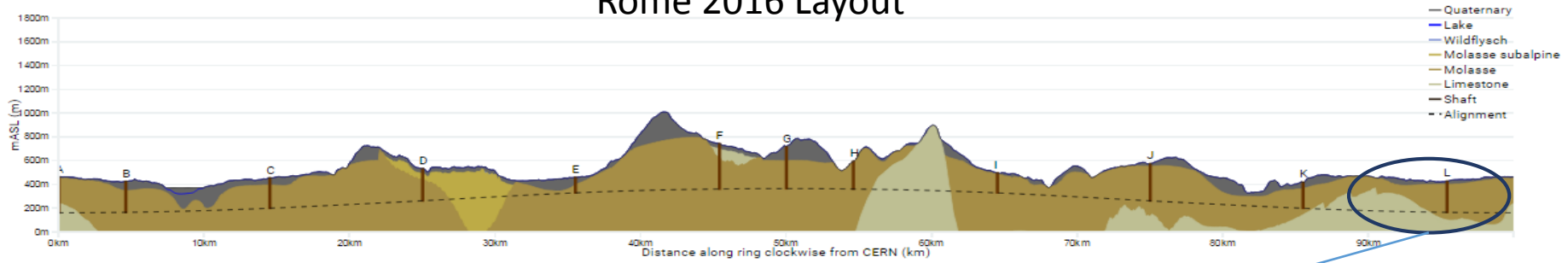
Alignment Profile



Geology Intersected by Tunnel | Geology Intersected by Section

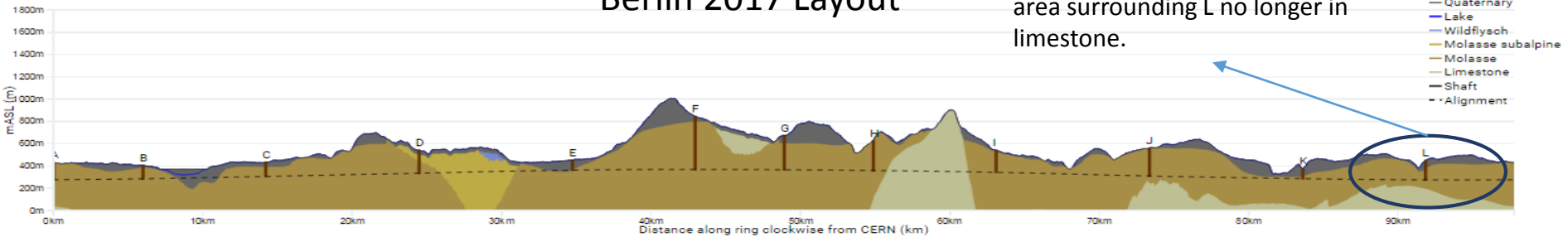
FCC Layout Changes (profile)

Rome 2016 Layout



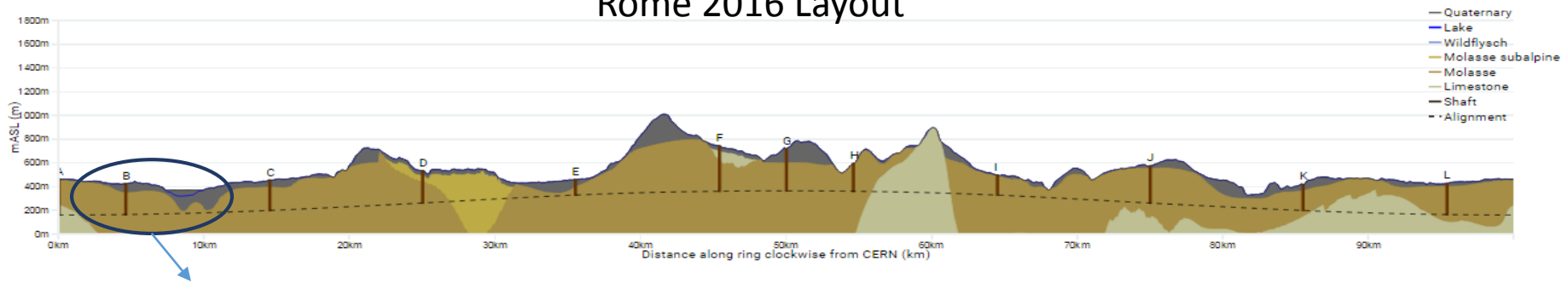
Reduced Depth & alignment change; area surrounding L no longer in limestone.

Berlin 2017 Layout



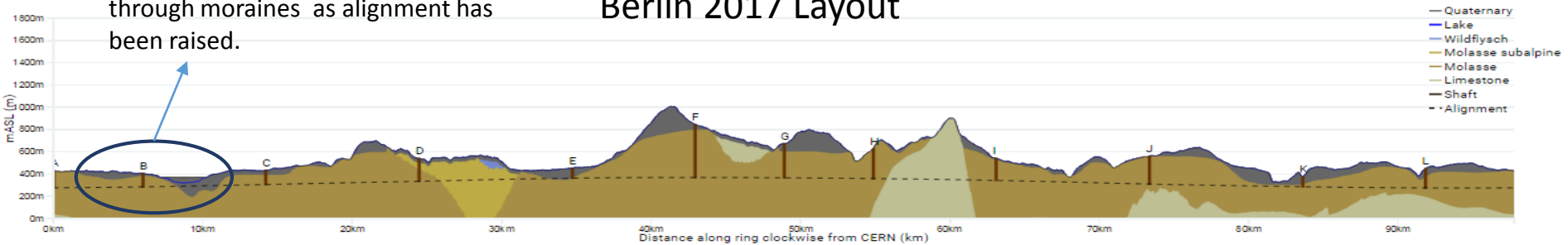
FCC Layout Changes (profile)

Rome 2016 Layout



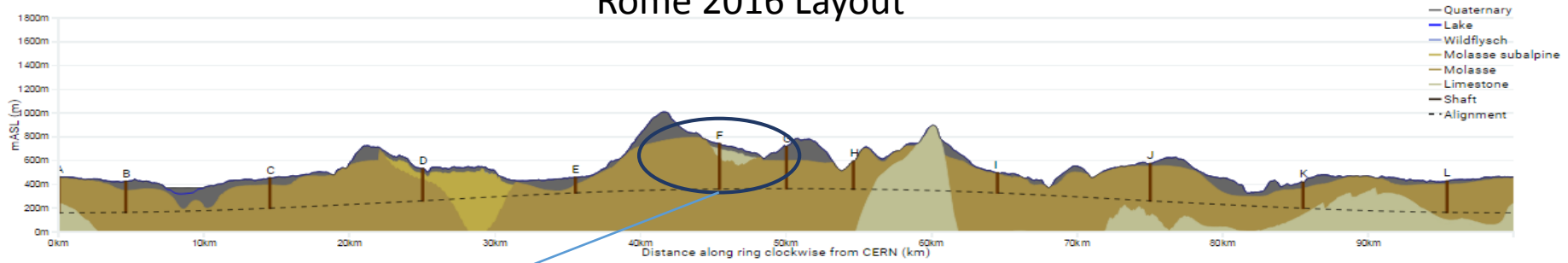
Introduced a high risk of tunnelling through moraines as alignment has been raised.

Berlin 2017 Layout



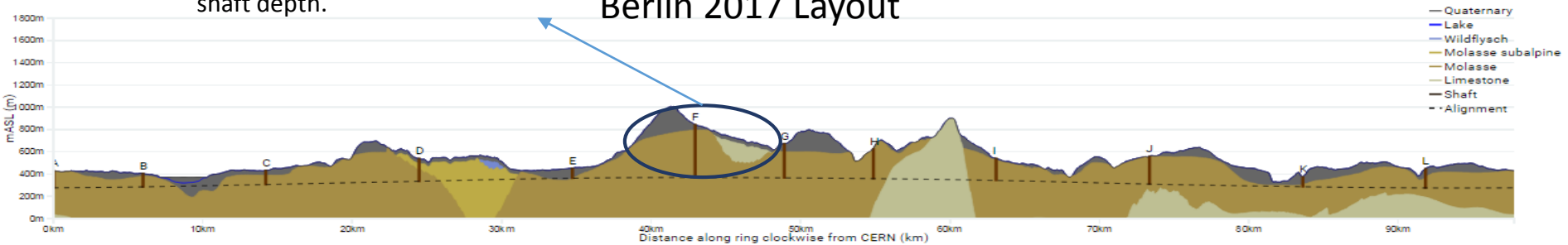
FCC Layout Changes (profile)

Rome 2016 Layout



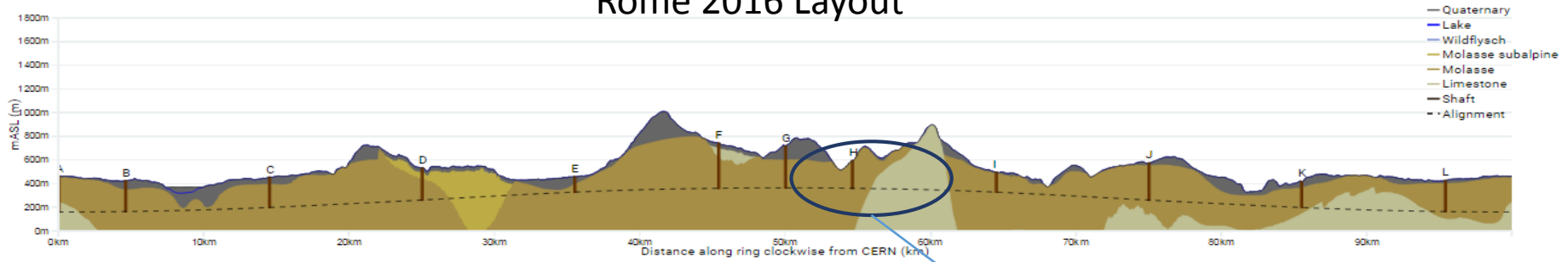
Access more difficult and increased shaft depth.

Berlin 2017 Layout



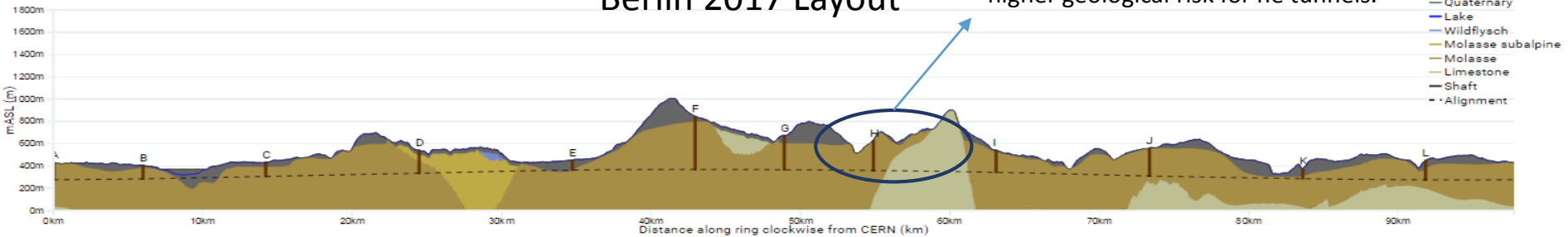
FCC Layout Changes (profile)

Rome 2016 Layout



Closer proximity to limestone – higher geological risk for he tunnels.

Berlin 2017 Layout



FCC-eh Preferred Location

Why is experimental point L preferred?

Positives:

- Low geological risk compared to other locations, anticipated tunnelling in molasse only.
- Close to current CERN site.
- FCC ring relatively shallow at this point, therefore shallower shafts.

Remaining problems:

- Potential clash with injection lines needs to be studied.
- Located inside the FCC ring so integration with other structures to be studied.
- Depth below Rhone to be evaluated.

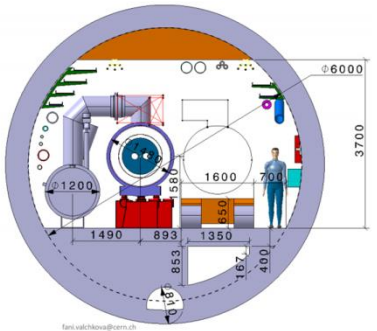
Summary

Conclusions:

- Due to the new layout of FCC position L is the preferred location:
  - Good geological data and suitable geology.
  - Close to CERN but not interfering with current infrastructure.
- Still compatibility challenges to overcome:
  - Connection to FCC tunnel.
  - Layout to avoid other structures.

Future Steps:

- Continue the civil engineering feasibility study in more detail for location L:
  - Geological Profiles of tunnel
  - Cost & schedule study
- Design a layout for the FCC-eh tunnels that is compatible with FCC infrastructure.



www.cern.ch