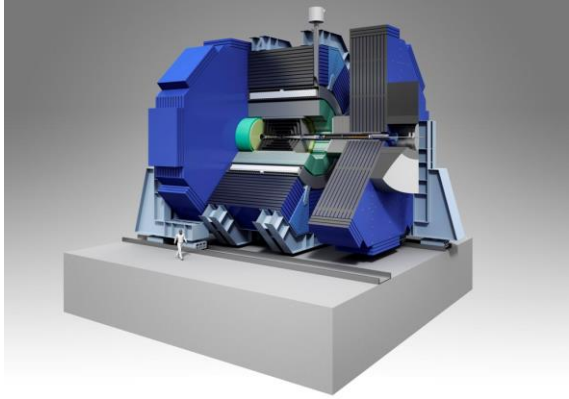


# SiD assembly

## Infrastructures & Timeline for Hybrid Access

Marco Oriunno (SLAC), May. 14, 2014

ALCW 2014, Fermilab

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

# SID key Features

Physics requirements :

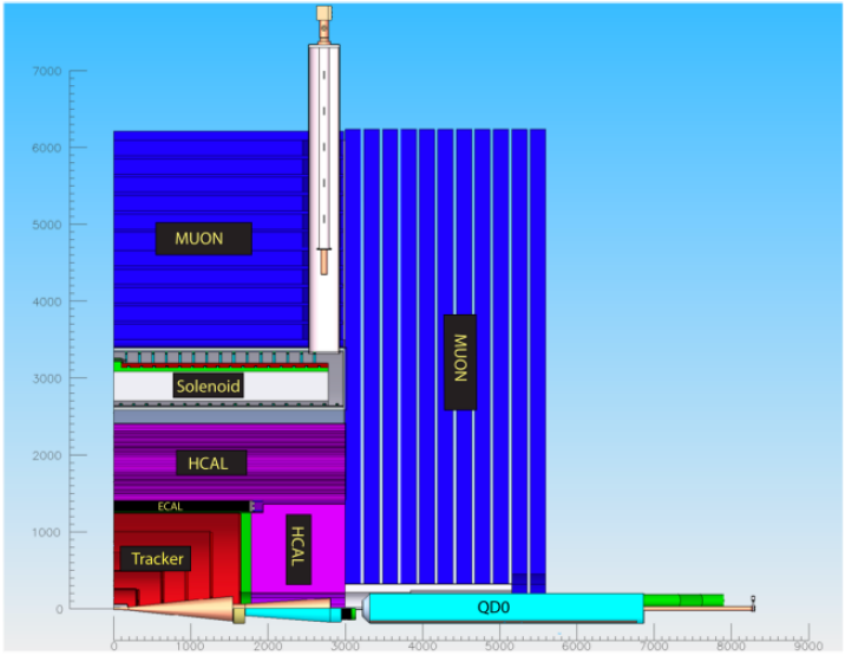
Strong central field of 5 Tesla + Full Silicon Tracker + High Granularity Calorimetry

-> Compact and Light Detector

Push Pull requirements

Self-shielded -> Monolithic Iron Barrel with, ~2.6 meter Iron thick

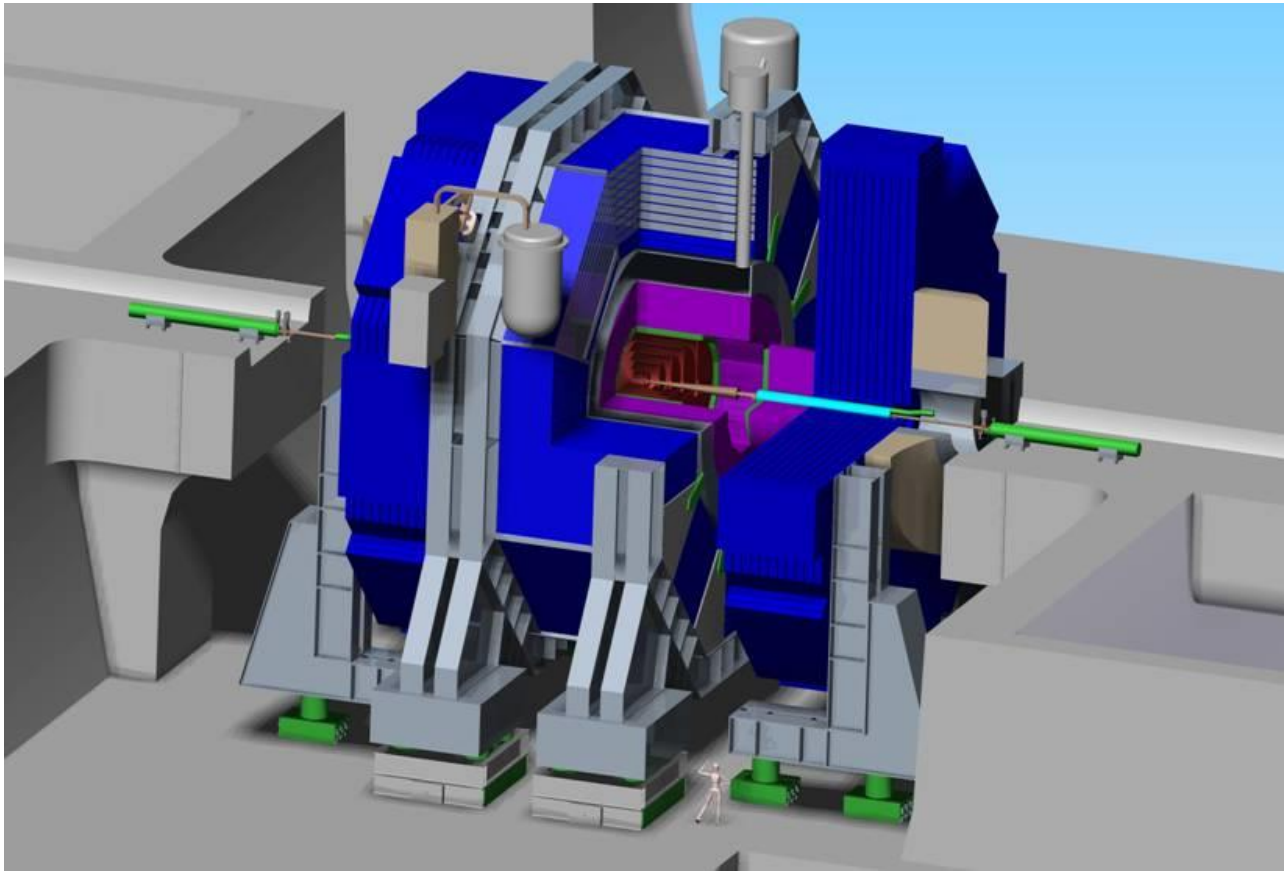
Short L* (3.5 m) -> FFS Captured in the door



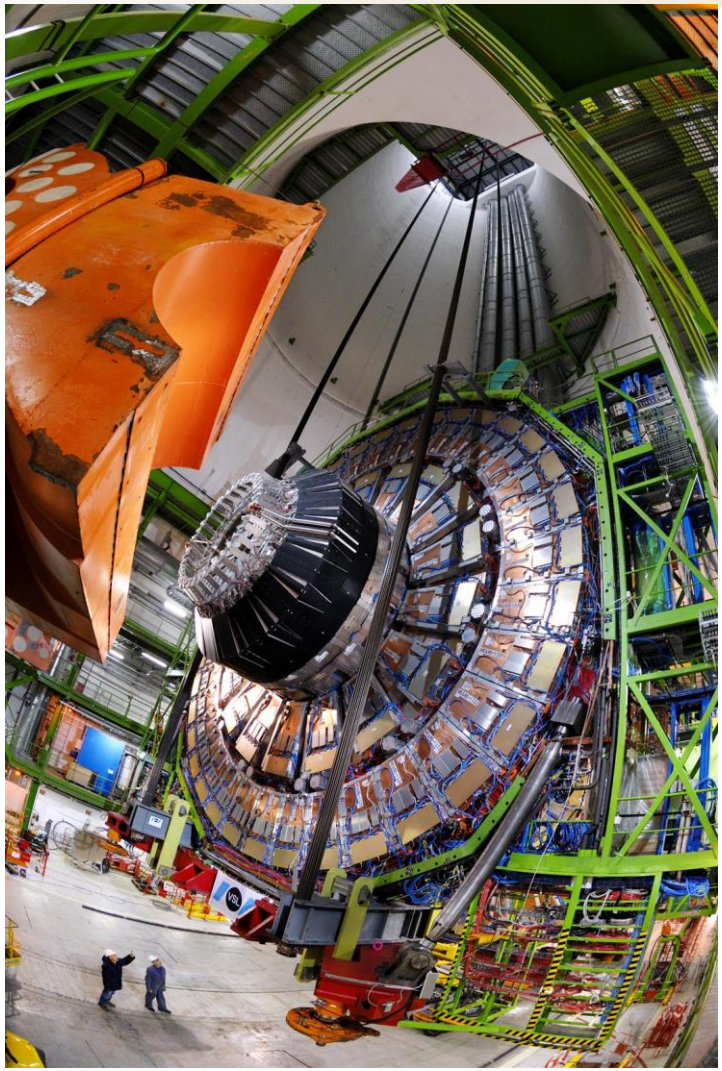

- SID Outer Diameter 3 meter < than ILD
- SID full length is half than CMS

# The Magnet drives the assembly procedure

The Solenoid and the sectors of the Iron Magnet are the heaviest and largest parts. They have an envelope diameter of 7 meters and 3 meters respectively. Both are under 200 Tons. They dominate the construction logistic and the infrastructures requirements.

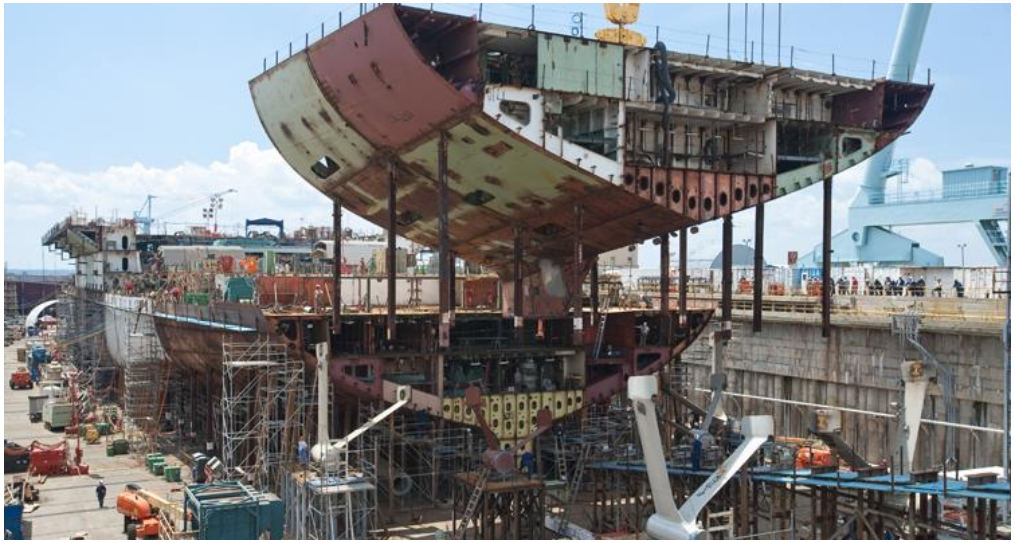


# Lean assembly – Some Examples



CMS Detector


Airbus



Shipbuilding

# Construction and Assembly Strategy:

1. Construction and Testing of large sub-assemblies in remote sites (Institutes/Factories).
2. Checking after transport and pre-commissioning on Surface.
3. Complete the construction underground.

- The iron of the magnet has a modular design with parts below 200 Tons, constructed at the factory and shipped to the site. The unit will be completed in situ with detectors (RPCs) and tested before they are moved in the Detector Hall

- Because of the compact design of SID, the full weight of the Solenoid is well under 200 Tons. The two coils will be made at the factory, where they will installed in the Cryostat and shipped to the site before a low current check test, which will be eventually repeated before to move it in the Detector Hall.

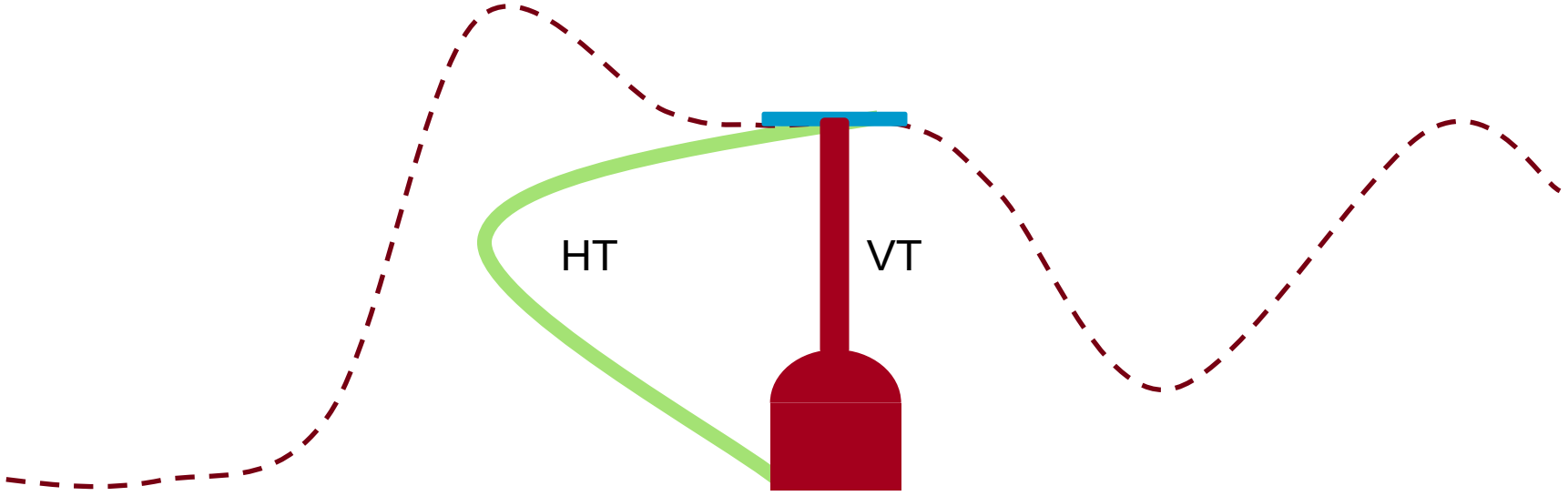
- All the detectors within the Solenoid diameter, Tracker, EMCAL and HCAL, will need appropriate infrastructures, therefore will be built and tested in remote Labs/Campus before being shipped to the site for the final installation.

# Assembly with the Hybrid Design

Option #1: Vertical shafts

Option #2: Horizontal Tunnel

Option #3: Both access



# Option #1: Vertical shafts

The barrel and the doors are fully assembled on Surface and lowered through the main shaft, with the solenoid inside the barrel

Calorimeters and Tracker through the Horizontal Tunnel with OD8m

Infrastructure required by SID alone :

20 x 20 $m^2$ Platform

one 200 T capacity crane on surface

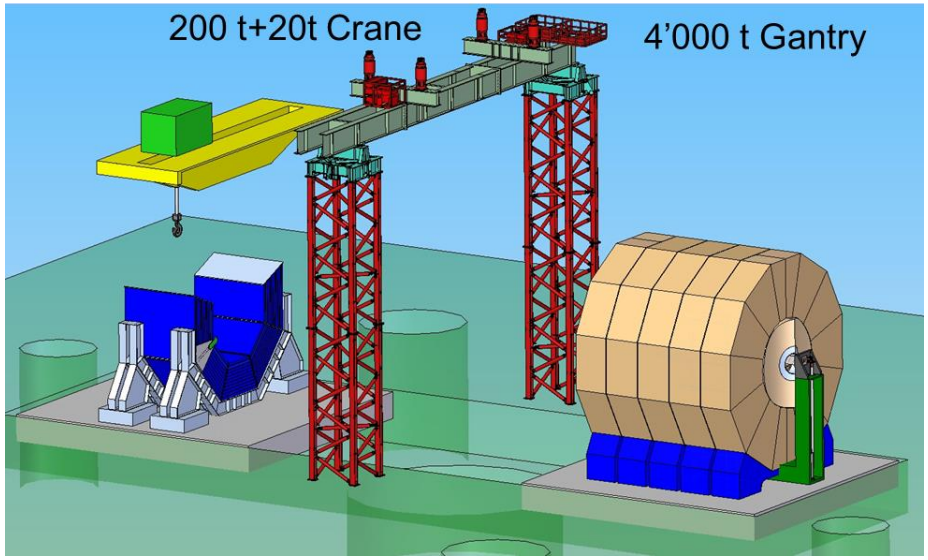
one 4,000 T Gantry on the main shaft (to be shared with ILD)

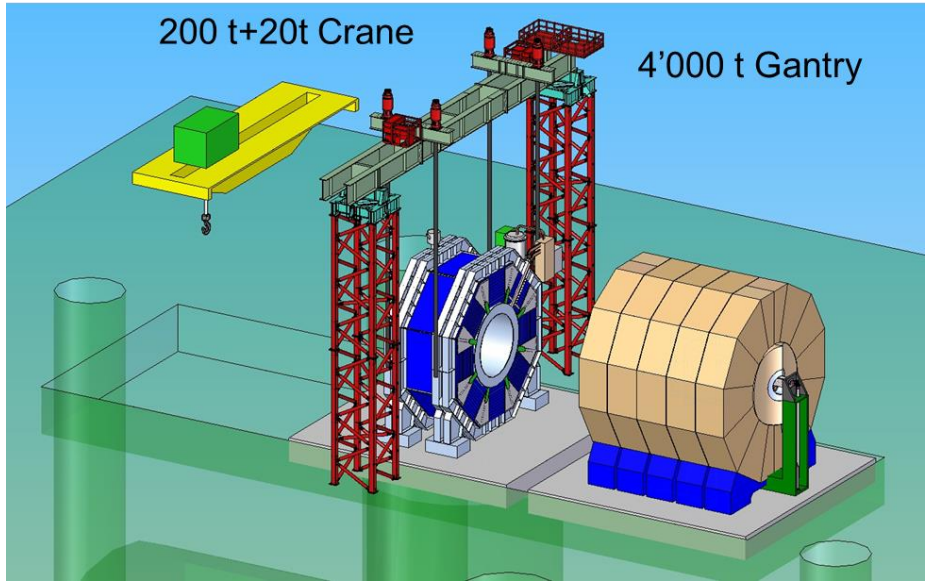
one 50 T crane underground

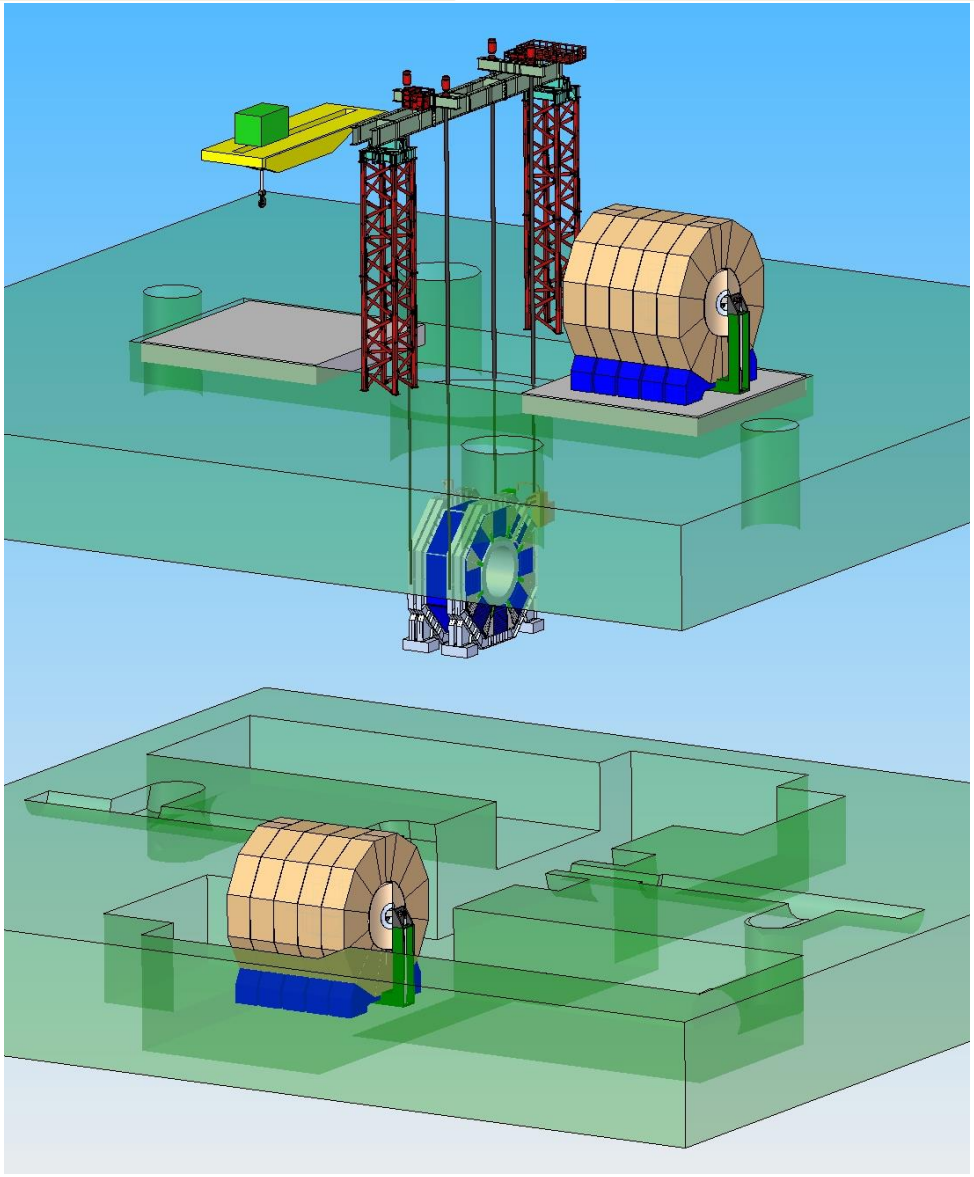
Heavy Load Truck with a capacity of 50 T on < 10% slope

- Cryogenics and Power Supplies required on surface if the Solenoid is commissioned to the full current.
- Two systems very likely required, one each detector.
- Not trivial if the Helium compressors are located underground (CMS has compressor and Helium storage on surface)

# Option #1: Vertical shafts

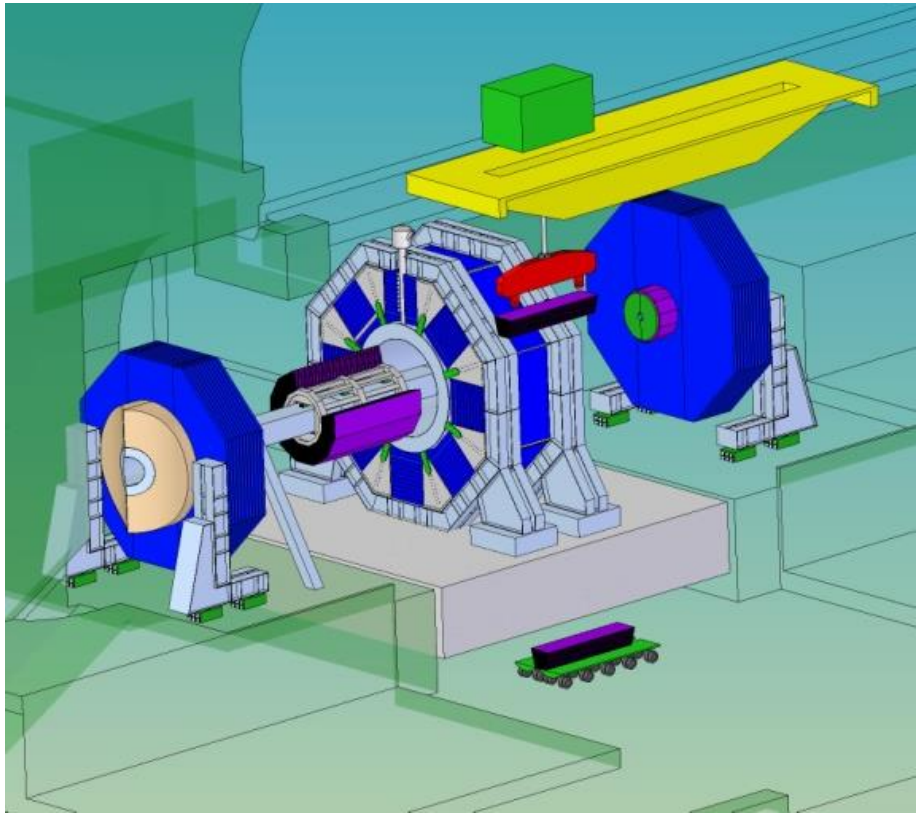


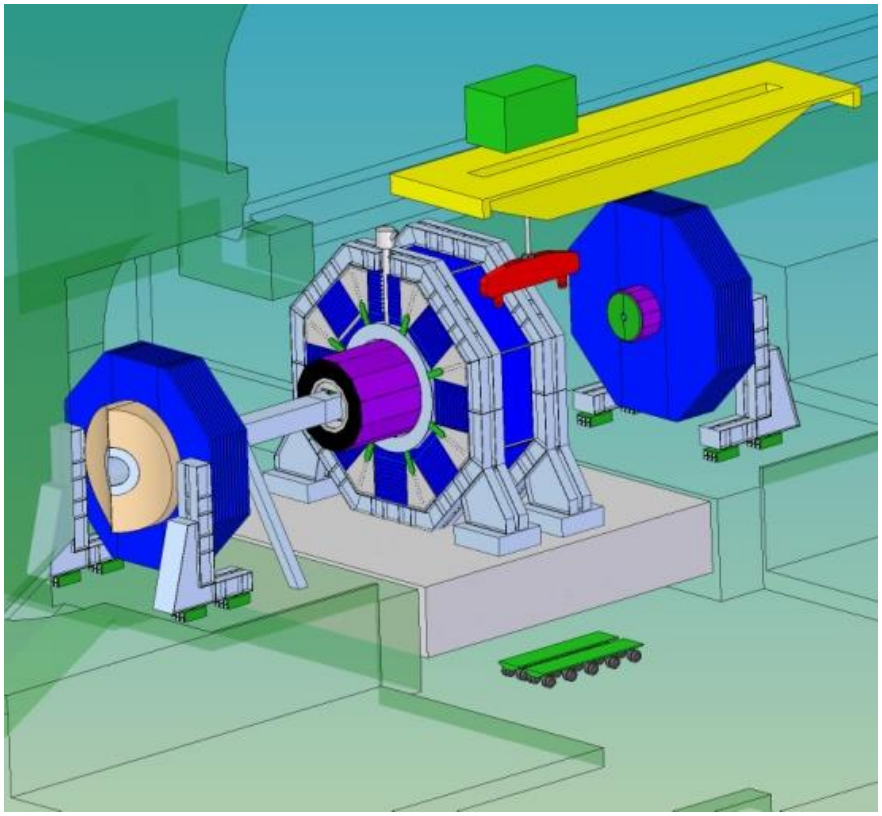



# Option #1: Vertical Shaft, HCAL Installation

Through the HT or a second shaft is required





# Option #1: Vertical shaft, comments

SLAC

1. Large infrastructures on Surface
2. Handling of components with large mass and dimensions
3. A single shaft shared by both detectors, requiring a not trivial logistic with high infrastructures density.
4. HT still required for Inner Detector (HAC, ECAL, Tracker)
5. Require Cryogenics on Surface for commissioning. Inconsistent with the idea of compressors underground.

Strategic advantage to full commission the Solenoid on surface and decouple the constructions of the Experimental Cavern and the Detector Assembly. But some of the benefits are lost because of a the point #3 and #4

# Option #2: Horizontal Tunnel with OD8m

Segments of the barrel and the doors with detectors are assembled on Surface and transferred through the horizontal tunnel.

Solenoid assembled at the factory, burned in on surface and transferred through the horizontal tunnel. Full current commissioning only happen underground.

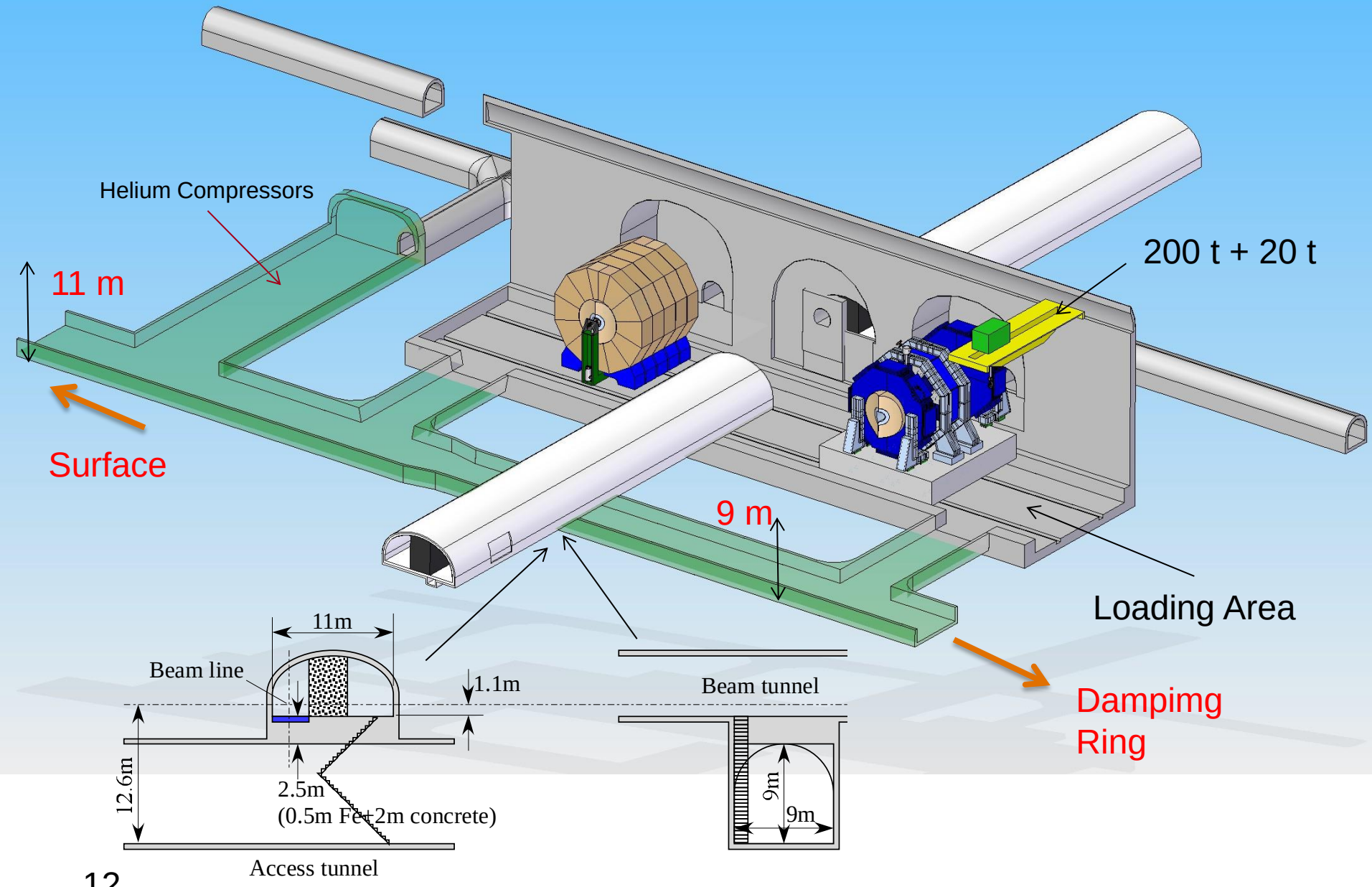
Calorimeters and Tracker through the Horizontal Tunnel with OD8m

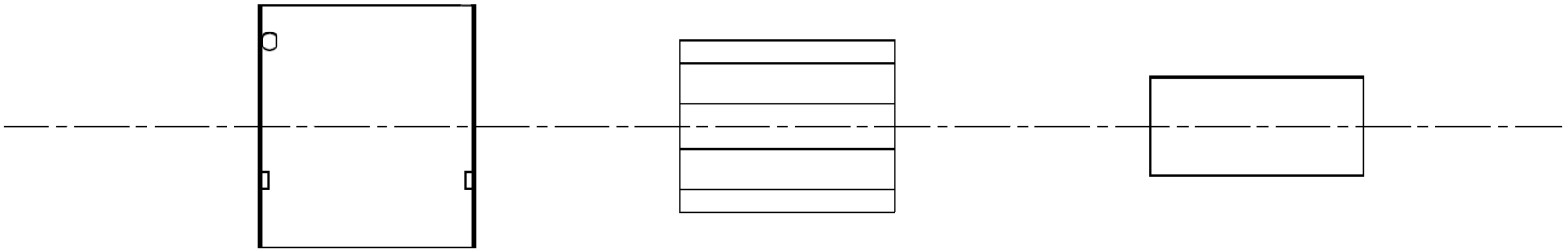
Infrastructure required :

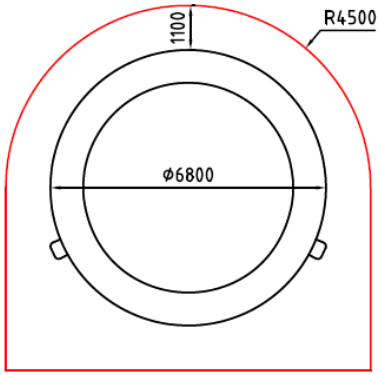
- one 200 T capacity crane on surface for SID
- One 50 Tons (my guess) capacity crane on surface for ILD
- one 2,000 T Gantry on the main shaft (only for ILD)
- one 200 T crane underground for SID and ILD
- Heavy Load Truck with a capacity of 200 T on < 10% slope

* No Cryogenics required on Surface for SID

# IR hall Specifications

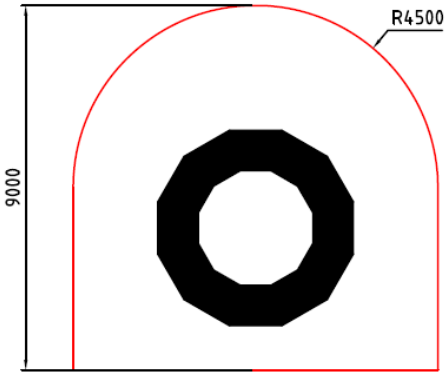






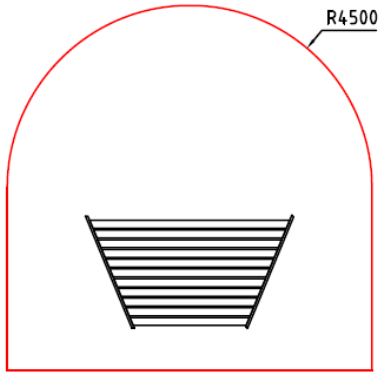

Solenoid
190 ton

Large Part



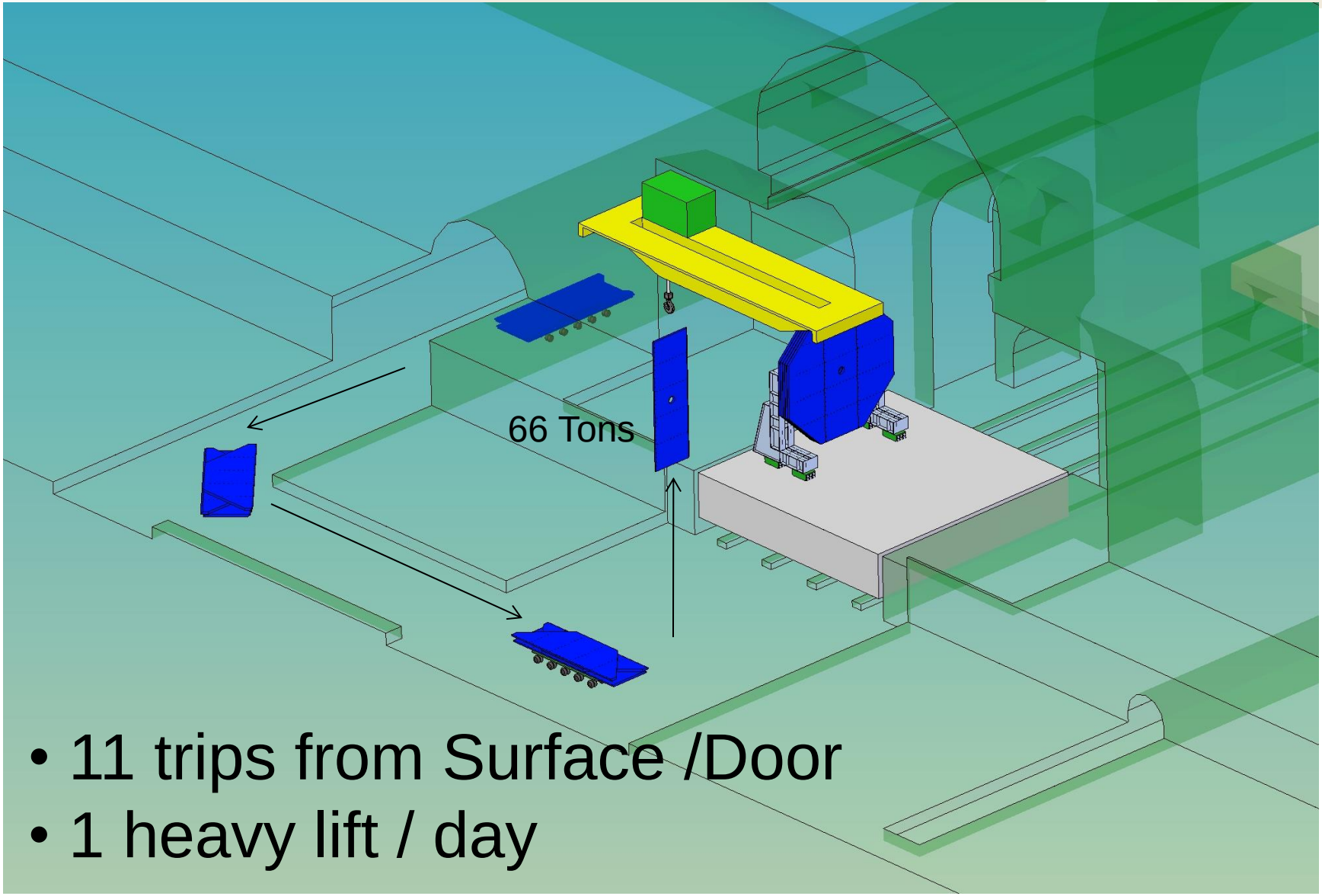

Hcal barrel
450 ton

Heavy Part



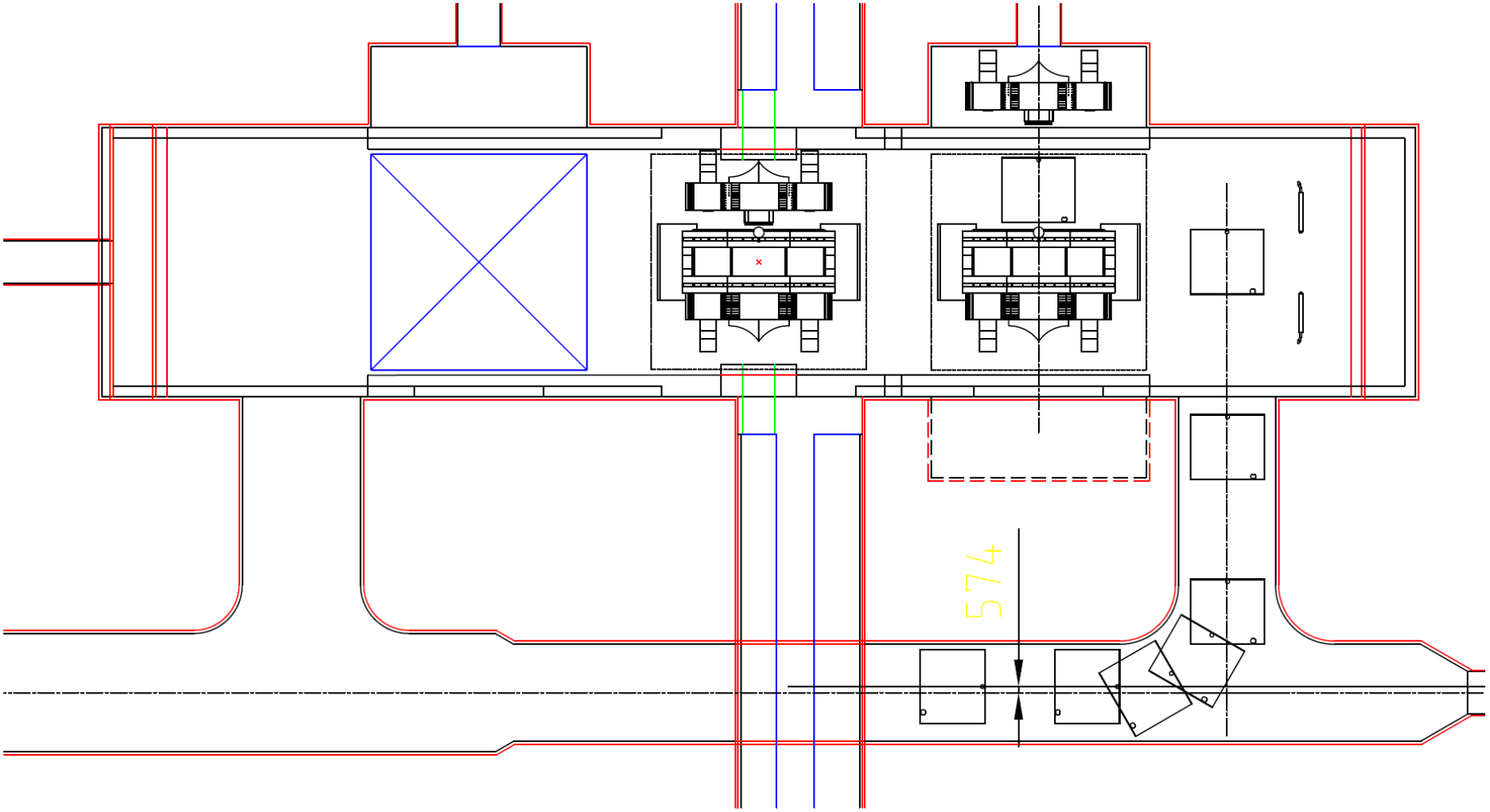

Iron barrel
Octant 410 ton

# Door Assembly on the platform

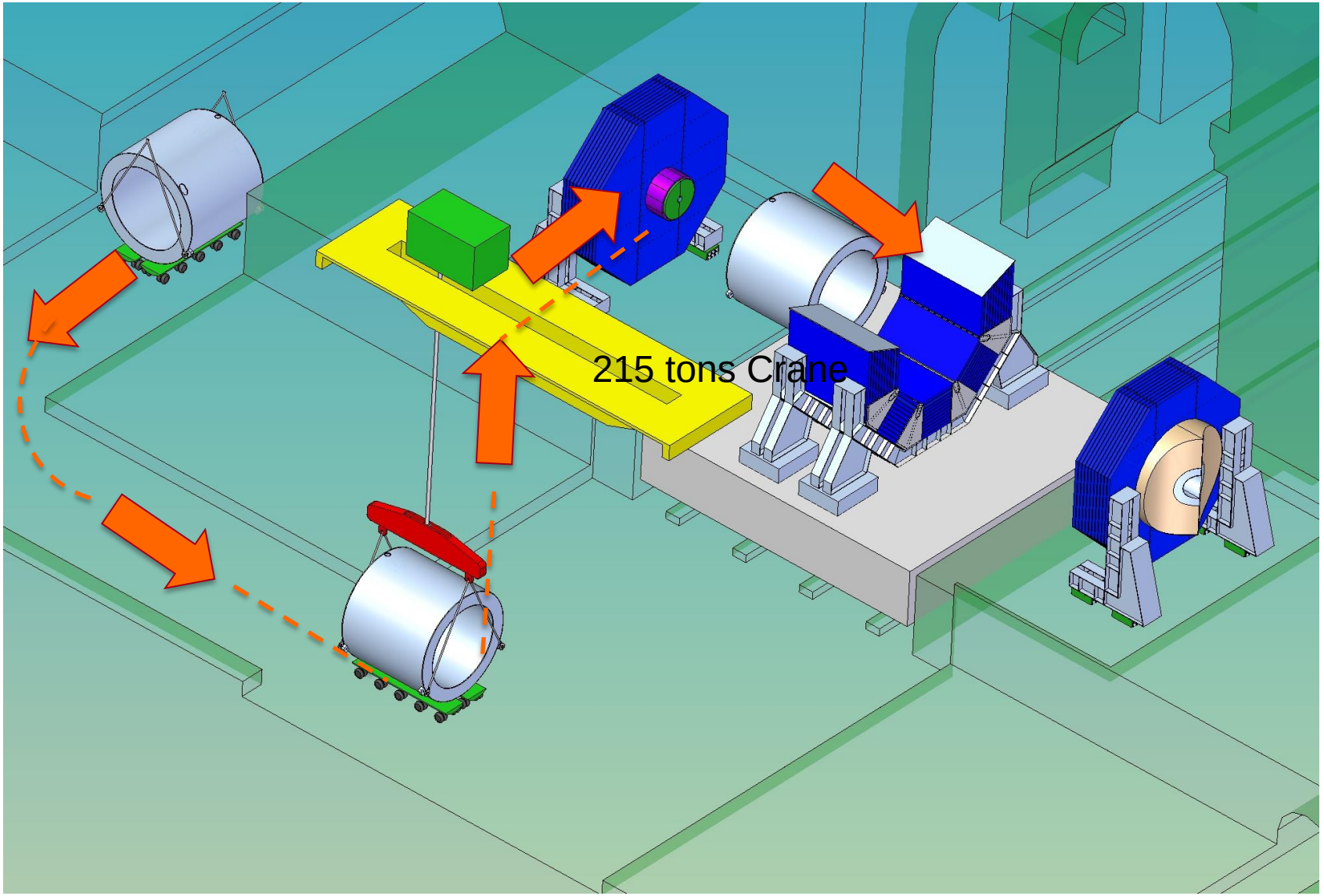



- 11 trips from Surface /Door
- 1 heavy lift / day

# Access Tunnel, Coil



# Solenoid Installation



# Option #2: comments

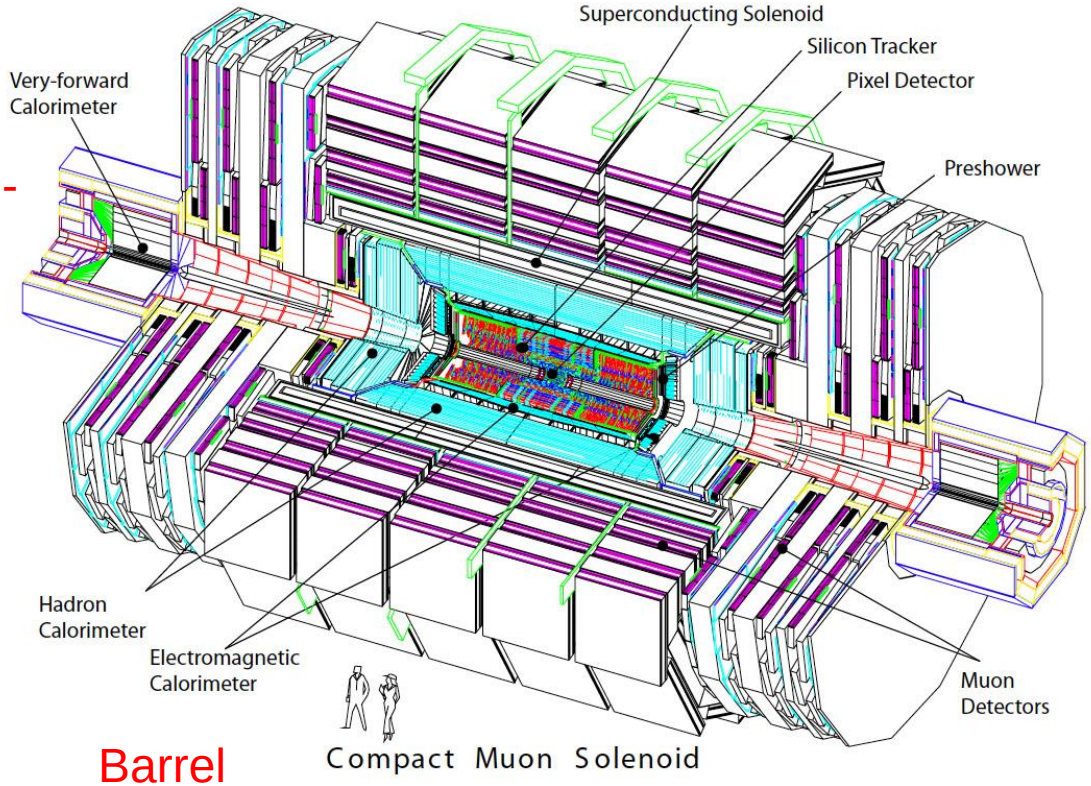
1. Medium-large infrastructures
2. Handling of components with large mass and dimensions but gantry limited to 2,000 Tons
3. Heavy handling schedule decoupled for the detectors
4. Larger crane undergrounds
5. Doe not Require Cryogenics on Surface (at least for SID)

# Handling of Large Weight

CMS Lowering Start-to-End = 12 months for 11 large components < 2,000 Tons

i.e. ~ 1 lowering/month

Endcap -
3 rings




Endcap +
3 rings

Barrel
5 rings

# SID Options

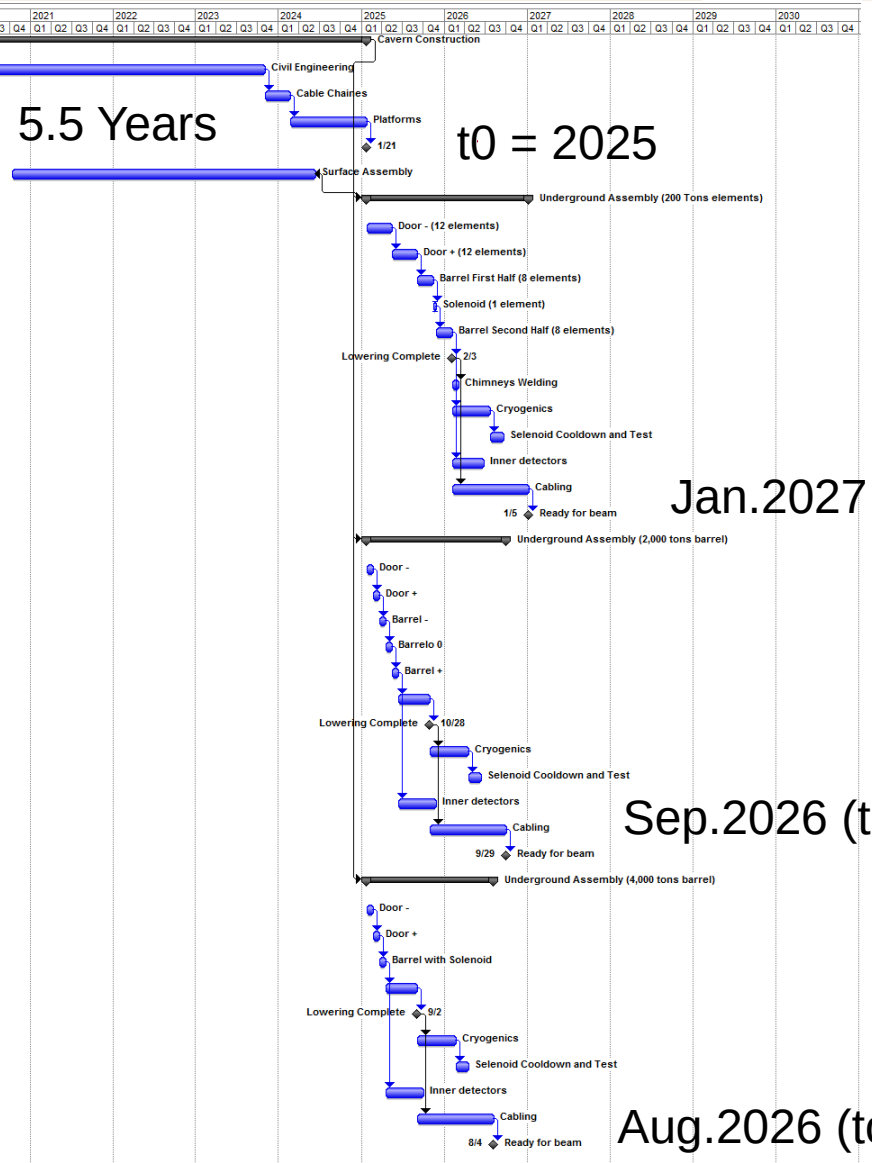
SID Option 1a = 3 components (2 x 2,500 T and 1 x 4,000 T)

SID Option 1b = 5 components (2 x 2,500 T and 3 x 1,300 T)

SID Option 2 = 40 components < 200 T

# Schedules, Gantt Chart

| ID | Task Name | Duration |
|---|---|---|
| 1 | **Cavern Construction** | **1320 days** |
| 2 | Civil Engineering | 50 mons |
| 3 | Cable Chaines | 4 mons |
| 4 | Platforms | 12 mons |
| 5 | Cavern ready | 0 days |
| 6 | Surface Assembly | 48 mons |
| 7 | **Underground Assembly (200 Tons elements)** | **510 days** |
| 8 | Door - (12 elements) | 4 mons |
| 9 | Door + (12 elements) | 4 mons |
| 10 | Barrel First Half (8 elements) | 2.5 mons |
| 11 | Solenoid (1 element) | 2 wks |
| 12 | Barrel Second Half (8 elements) | 2.5 mons |
| 13 | Lowering Complete | 0 days |
| 14 | Chimneys Welding | 1 mon |
| 15 | Cryogenics | 6 mons |
| 16 | Selenoid Cooldown and Test | 2 mons |
| 17 | Inner detectors | 5 mons |
| 18 | Cabling | 12 mons |
| 19 | Ready for beam | 0 mons |
| 20 | **Underground Assembly (2,000 tons barrel)** | **440 days** |
| 21 | Door - | 1 mon |
| 22 | Door + | 1 mon |
| 23 | Barrel - | 1 mon |
| 24 | Barrelo 0 | 1 mon |
| 25 | Barrel + | 1 mon |
| 26 | ILD (5 elements) | 5 mons |
| 27 | Lowering Complete | 0 days |
| 28 | Cryogenics | 6 mons |
| 29 | Selenoid Cooldown and Test | 2 mons |
| 30 | Inner detectors | 6 mons |
| 31 | Cabling | 12 mons |
| 32 | Ready for beam | 0 mons |
| 33 | **Underground Assembly (4,000 tons barrel)** | **400 days** |
| 34 | Door - | 1 mon |
| 35 | Door + | 1 mon |
| 36 | Barrel with Solenoid | 1 mon |
| 37 | ILD (Elements) | 5 mons |
| 38 | Lowering Complete | 0 days |
| 39 | Cryogenics | 6 mons |
| 40 | Selenoid Cooldown and Test | 2 mons |
| 41 | Inner detectors | 6 mons |
| 42 | Cabling | 12 mons |
| 43 | Ready for beam | 0 mons |




5.5 Years

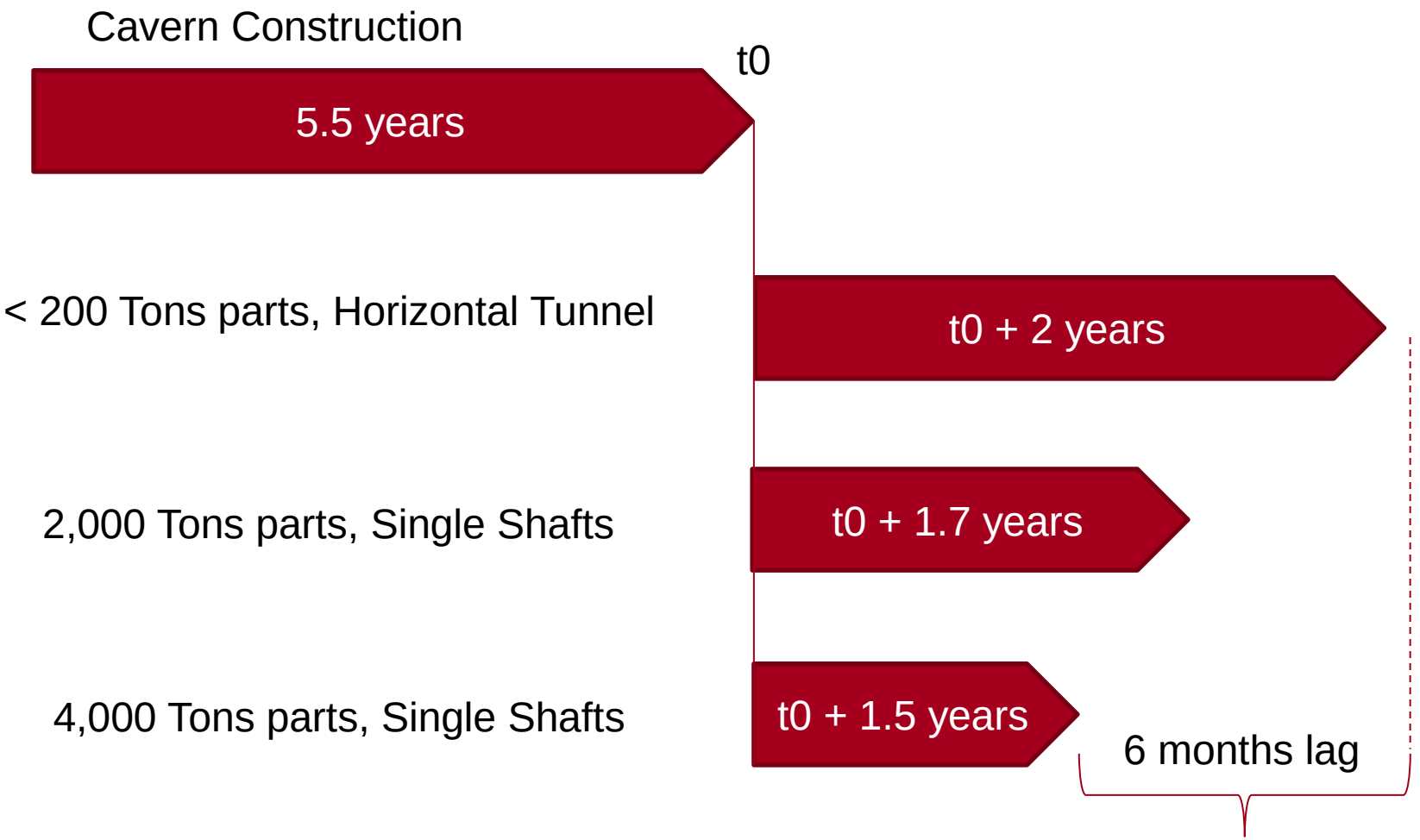
t0 = 2025

Jan.2027 (t0+2yr)

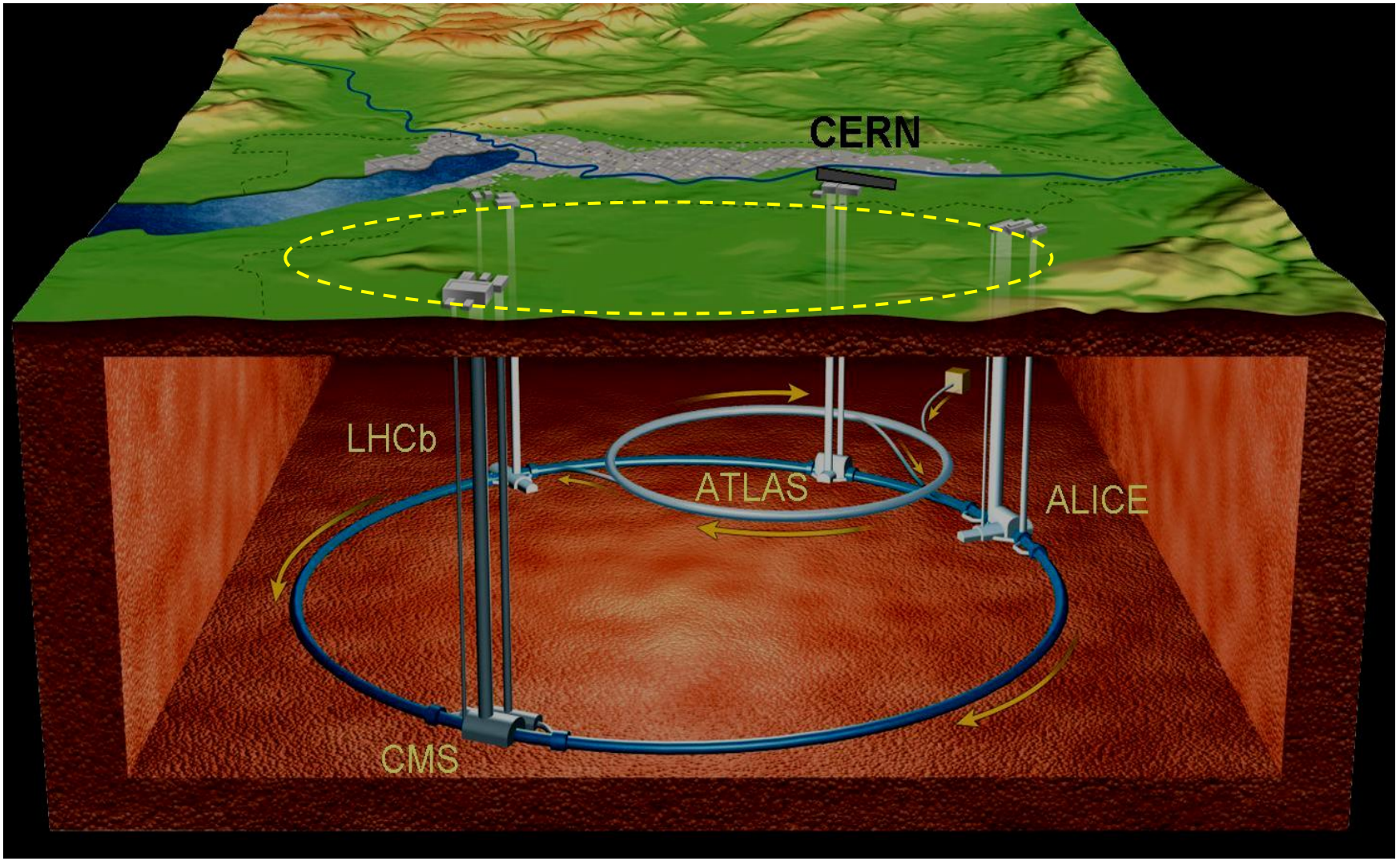
Sep.2026 (to+1.7yr)

Aug.2026 (to+1.5yr)

# Schedule, summary



# LHC = Vertical Shafts



# LHC Schedule drivers



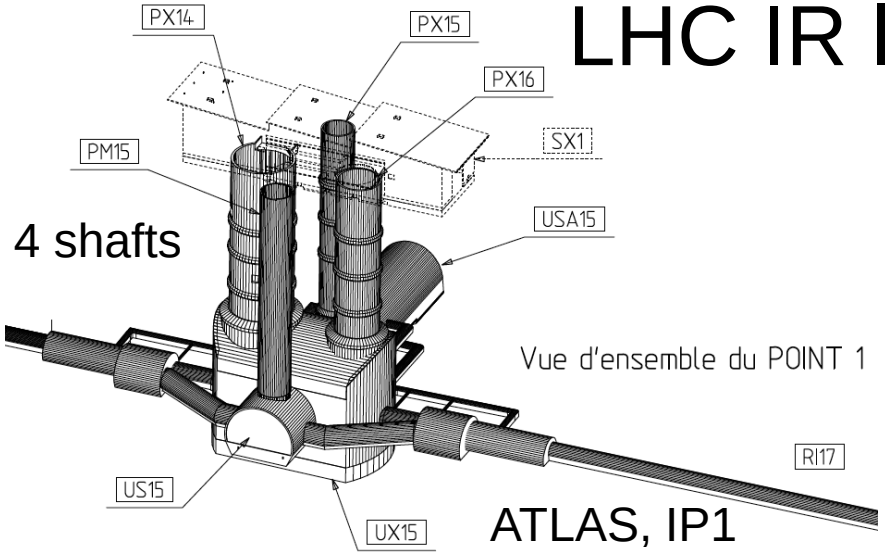
1. LHC was built inside the preexisting LEP tunnel.

2. The main schedule drivers were the removal of the LEP parts and the installation of the new magnets.

3. The CMS schedule challenges were because the cavern was built almost entirely, certainly true for the two new large shafts, versus an almost ready-to-go detector hall for ATLAS.

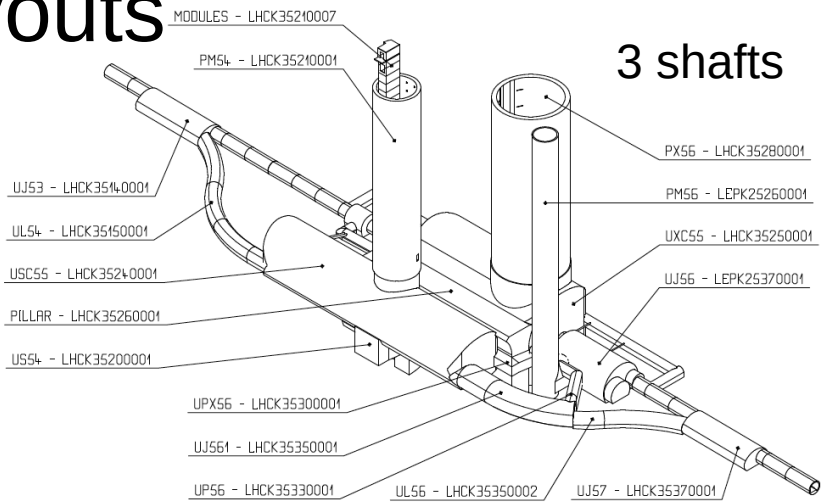
4. The ILC complex will be entirely built by scratch.

# LHC IR layouts



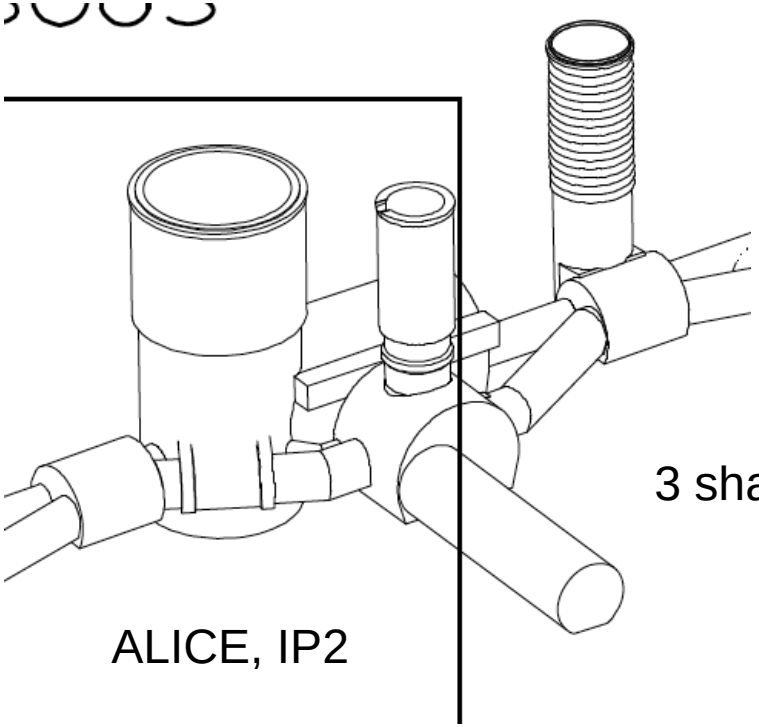

4 shafts

ATLAS, IP1



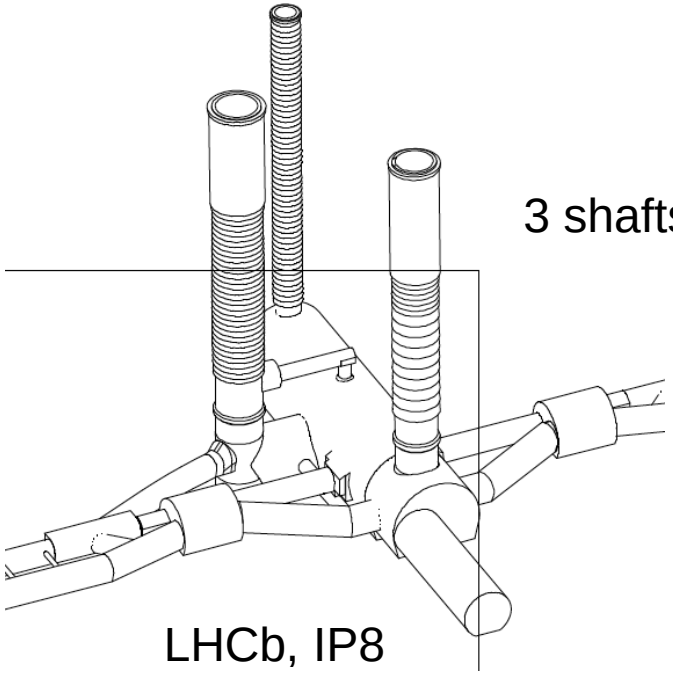

3 shafts

CMS, IP5



3 shafts

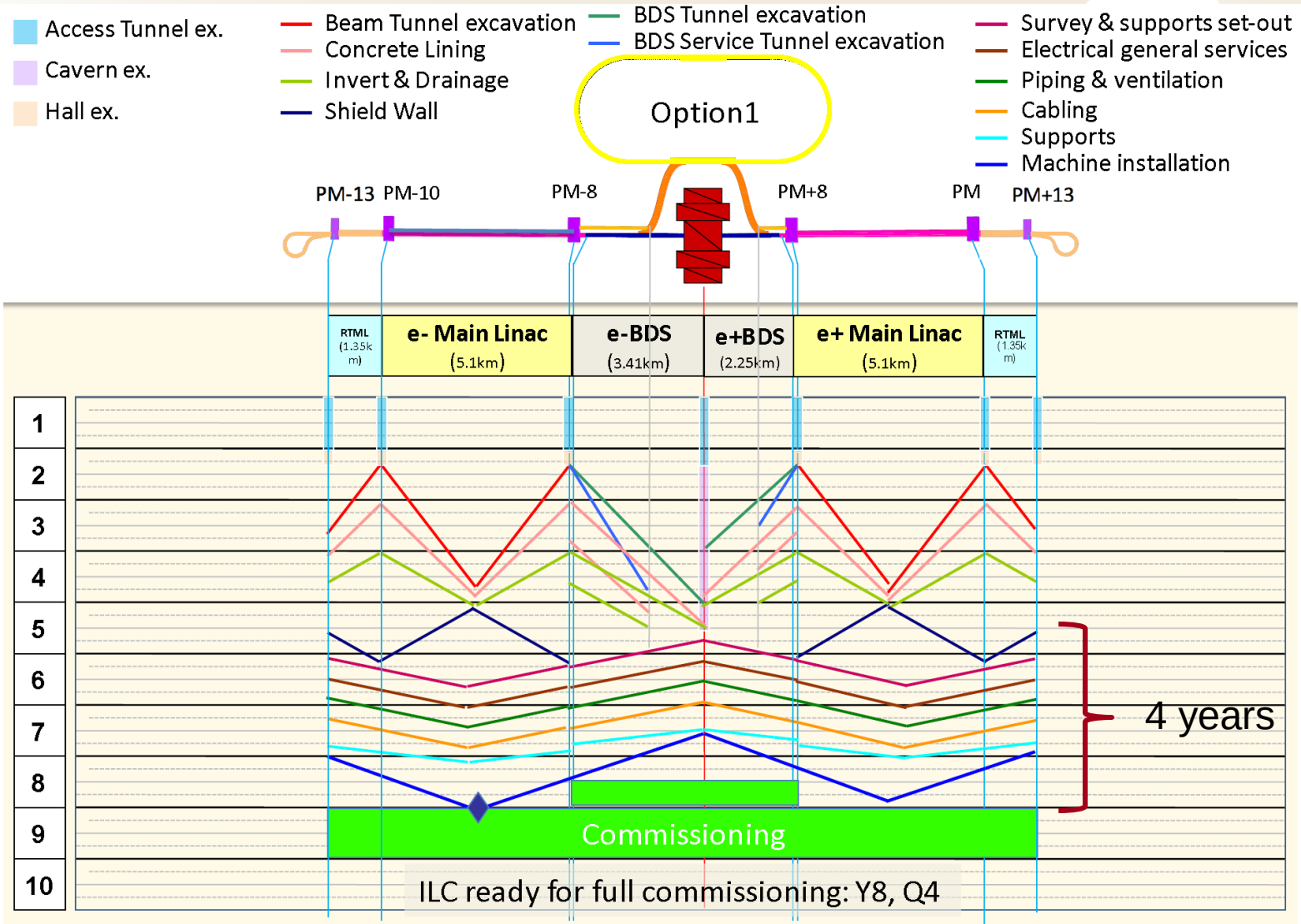
ALICE, IP2



3 shafts

LHCb, IP8

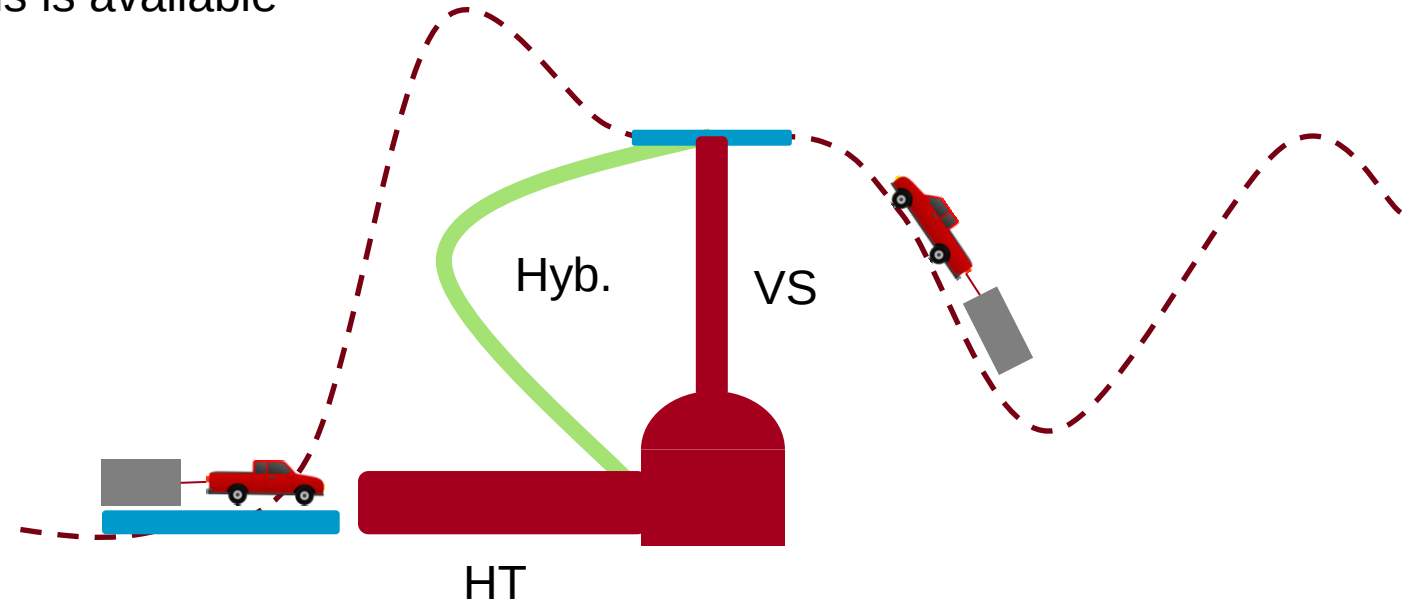
# ILC Schedule



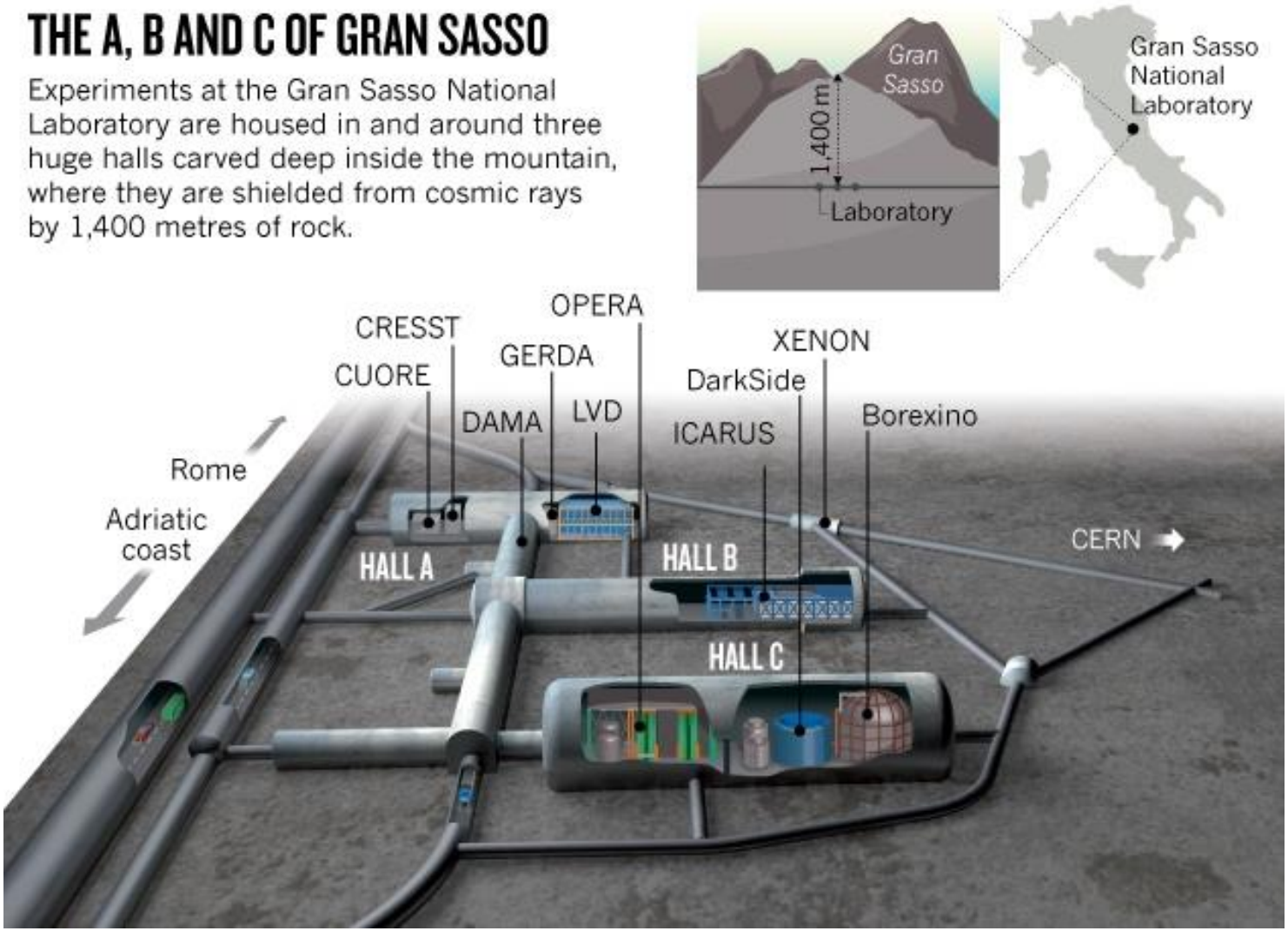
# Shafts versus Tunnel

1. Vertical shafts are an obvious solution for underground accelerator complex in flatlands (CERN)

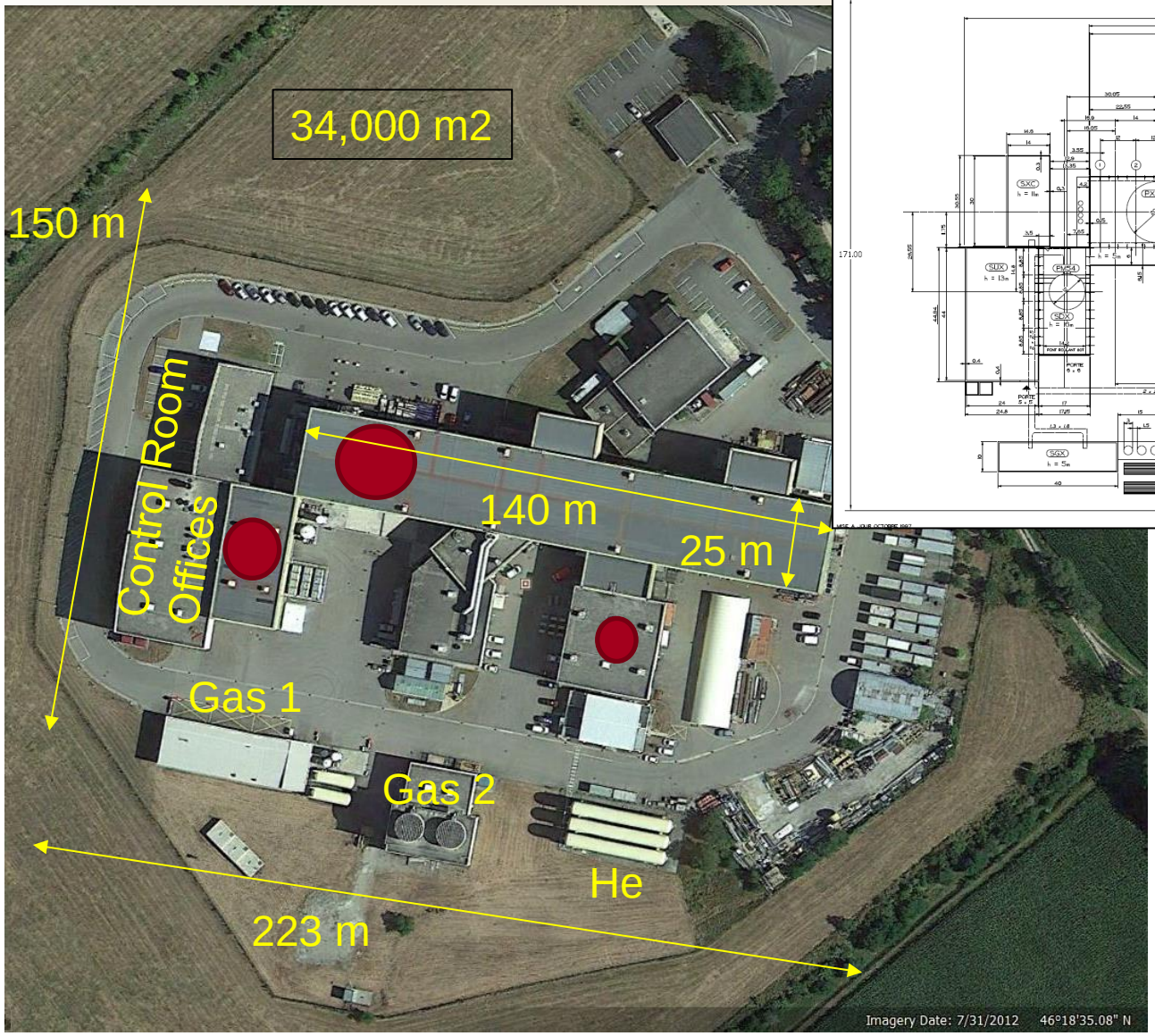
2. Are less obvious in mountainous sites if the choice of short and flat tunnels is available

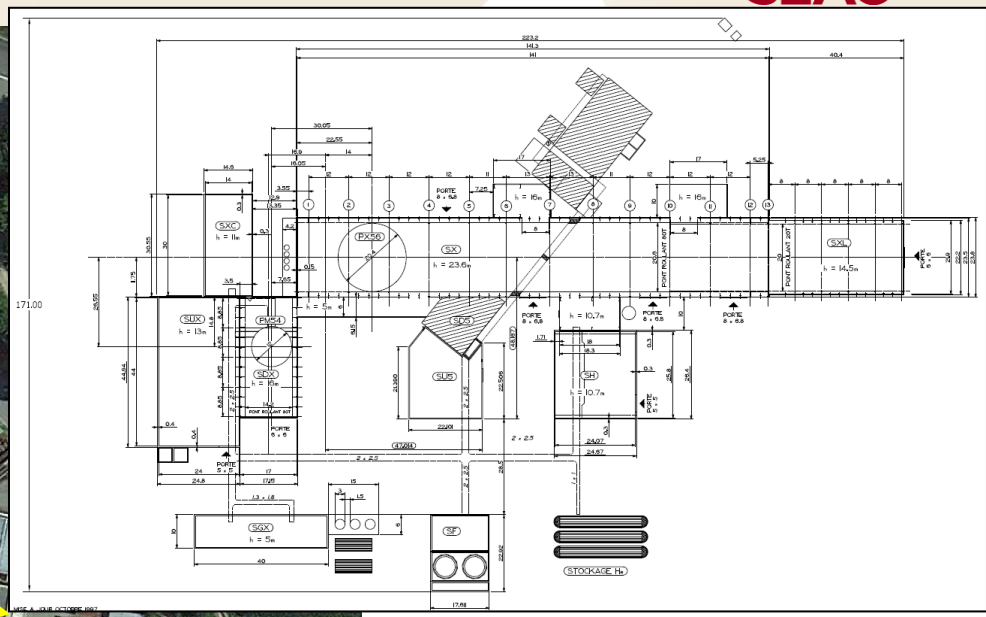


# Gran Sasso Lab = Horizontal Tunnel

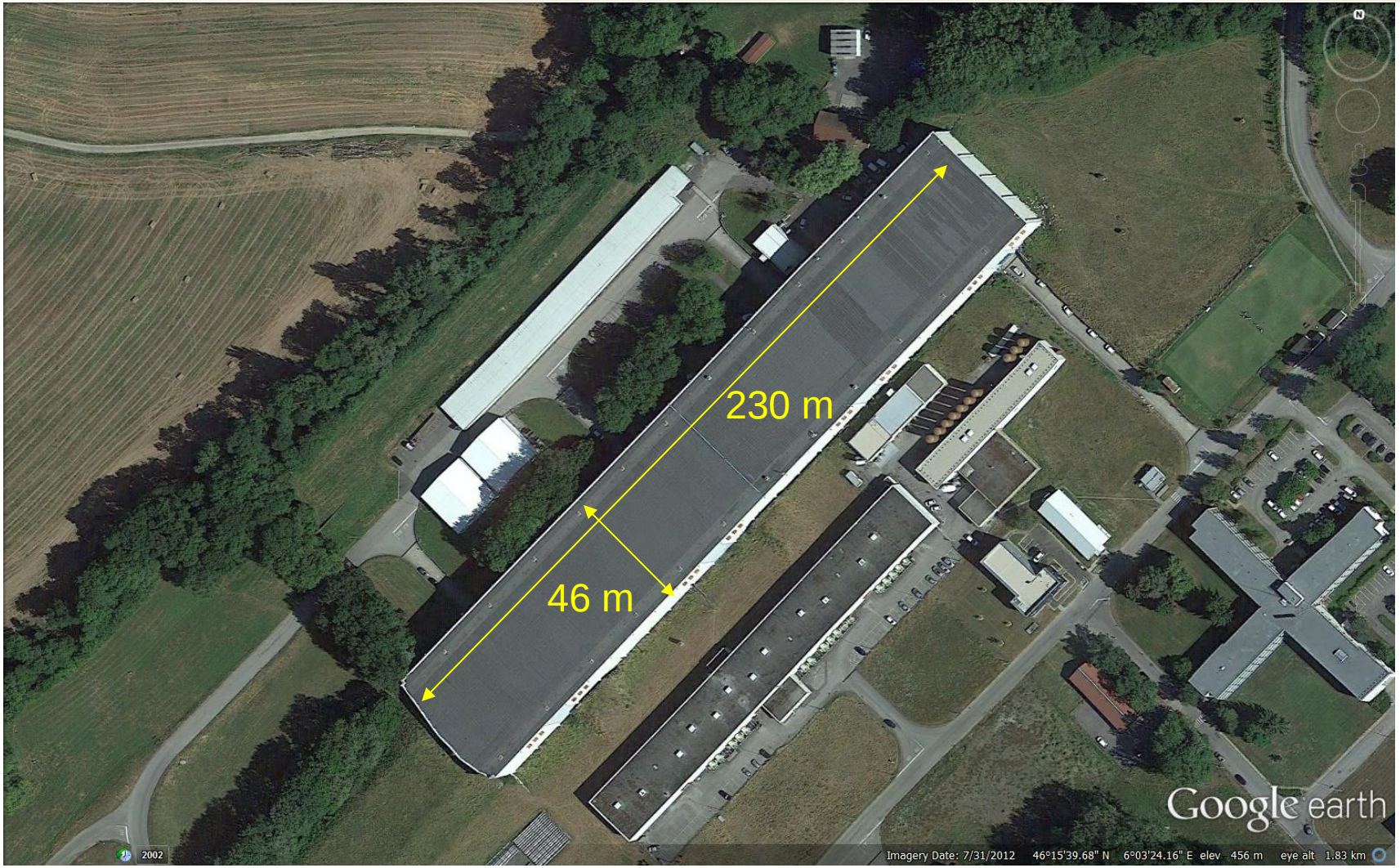


# Assembly Yard - CMS

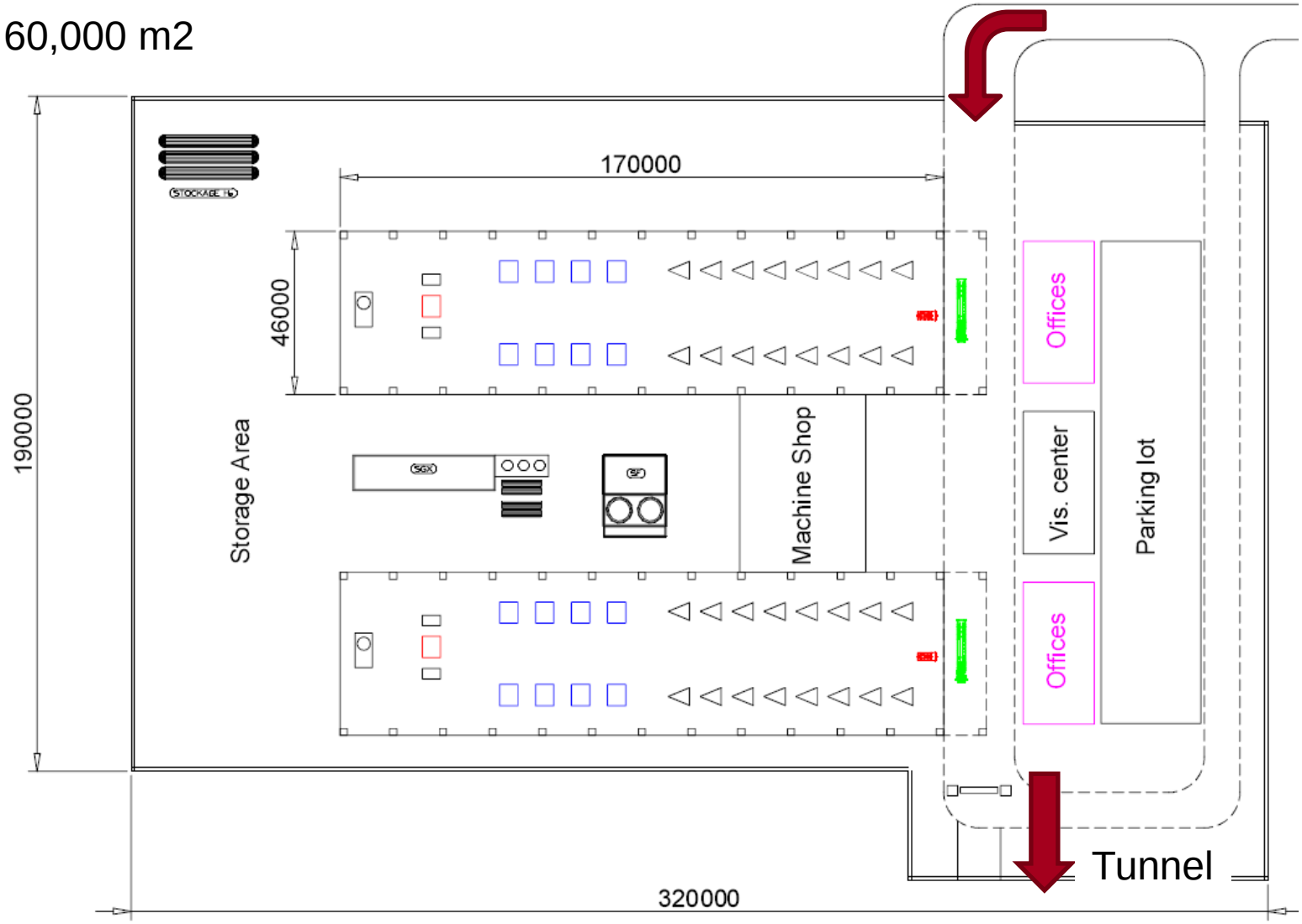


# SPS beam extraction - North area (CERN)

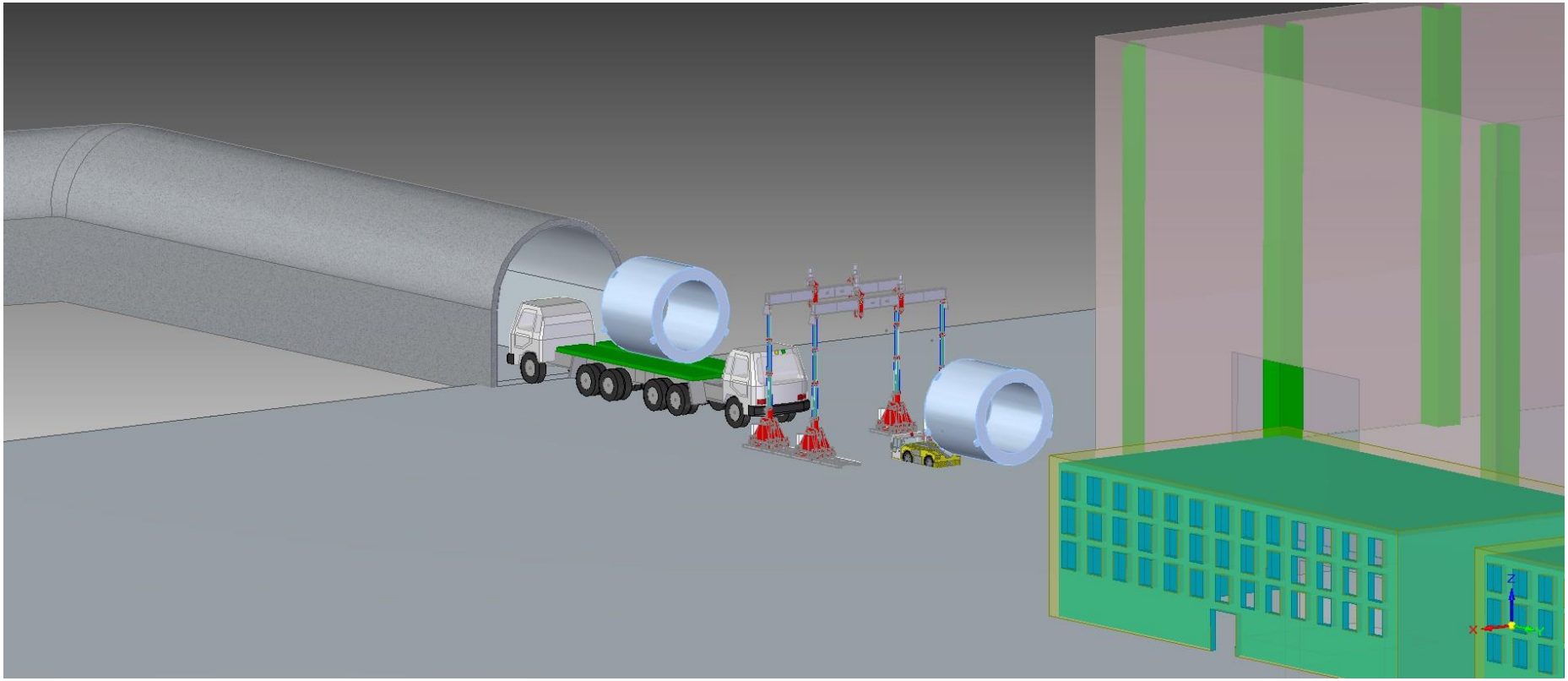


# Kitakami Access Yard = one 50T crane + one 200T gantry



# Detector Units on cart + Pushback track

# Transferring parts underground



# Conclusion

Large detector elements < 200Tons will be built remotely in Labs/Factories and shipped to the site.

SID has developed assembly procedures compatible with Vertical Shafts, Horizontal Tunnels or a combinations.

In the first case the schedule is only marginally shorter (few months) but with a non trivial heavy handling logistic on surface with a single shared main shaft.

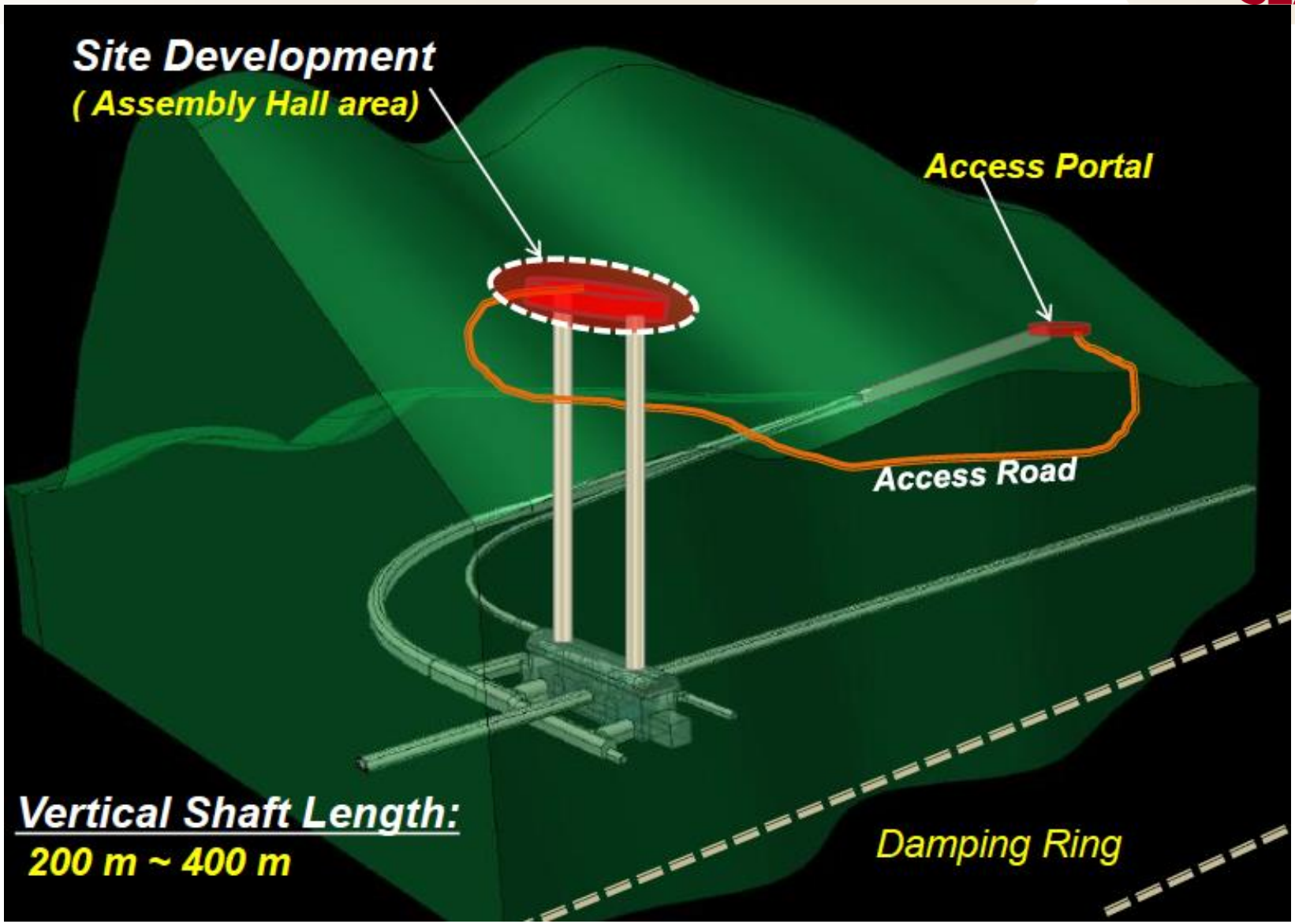
SID prefers the underground assembly through the horizontal tunnel of sufficient diameter OD8m and moderate slope.

If horizontal tunnels become not possible, a second large shaft, one each detector, would be needed, which would also decrease the schedule risk.

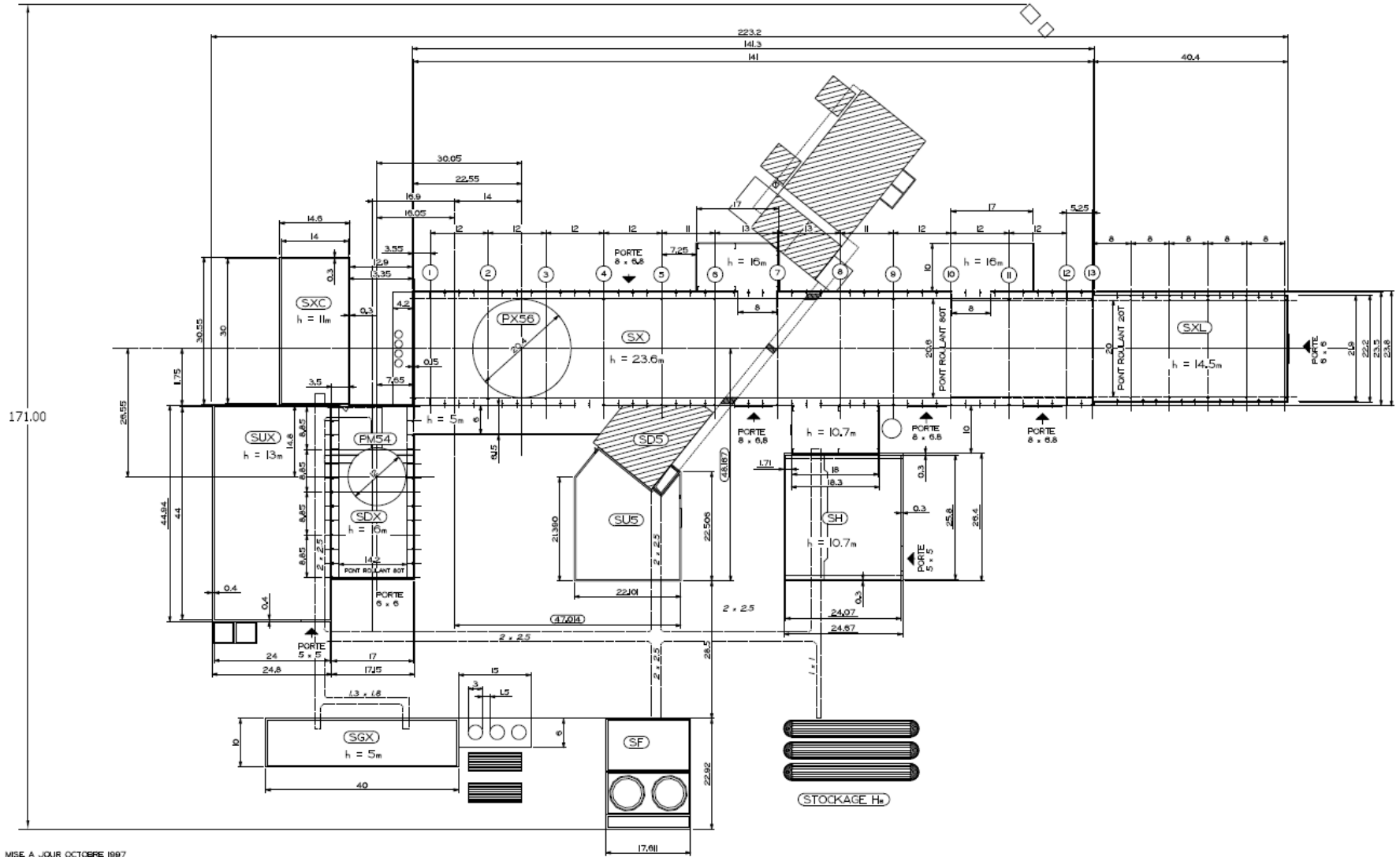
# EXTRA SLIDES

# ILC Site

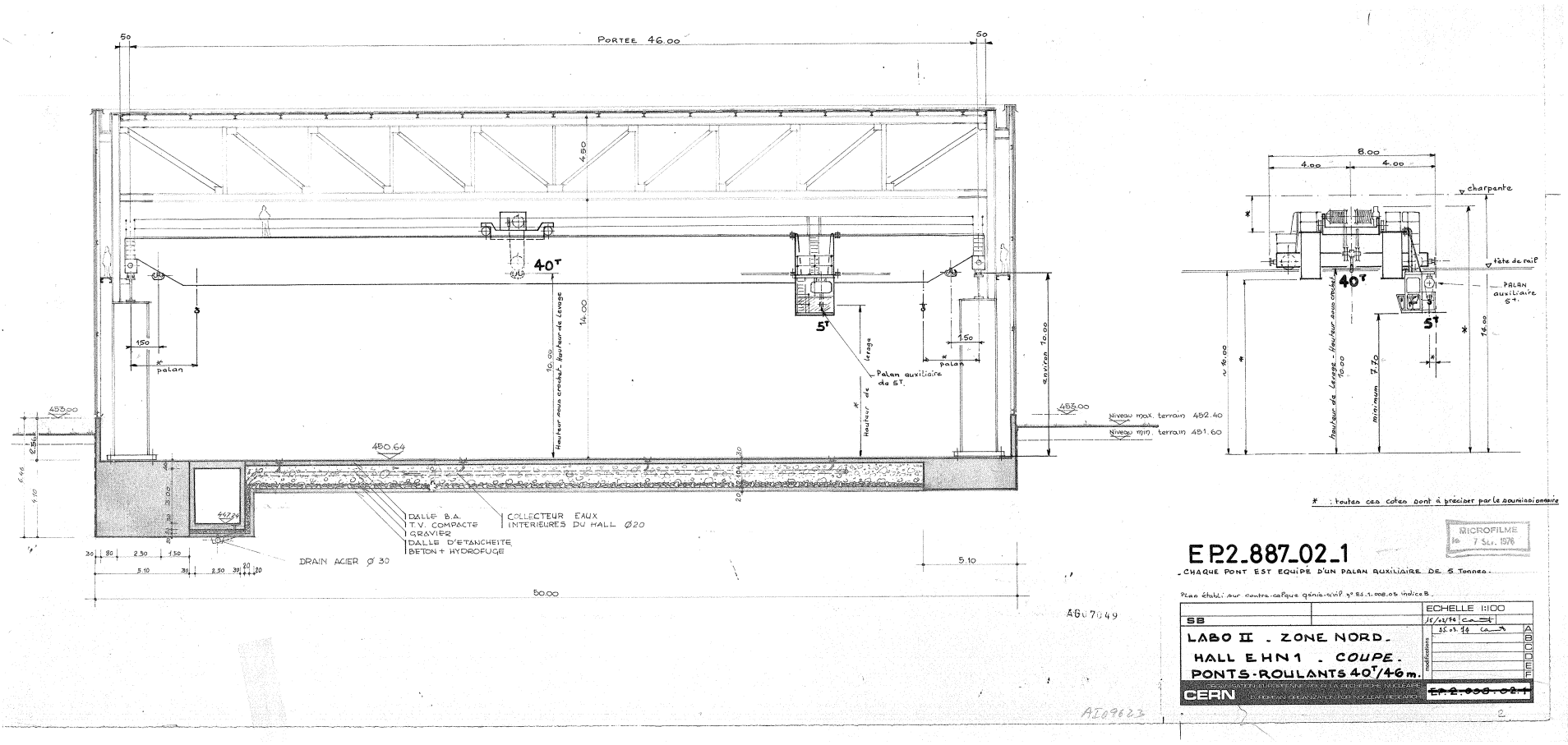



Site Development
( Assembly Hall area)
Access Portal
Access Road
Vertical Shaft Length:
200 m ~ 400 m
Damping Ring

# Assembly Yard - CMS

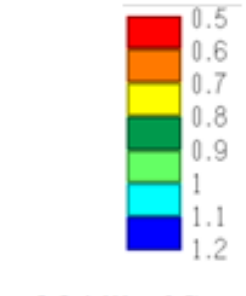


# SPS beam extraction - North area (CERN)

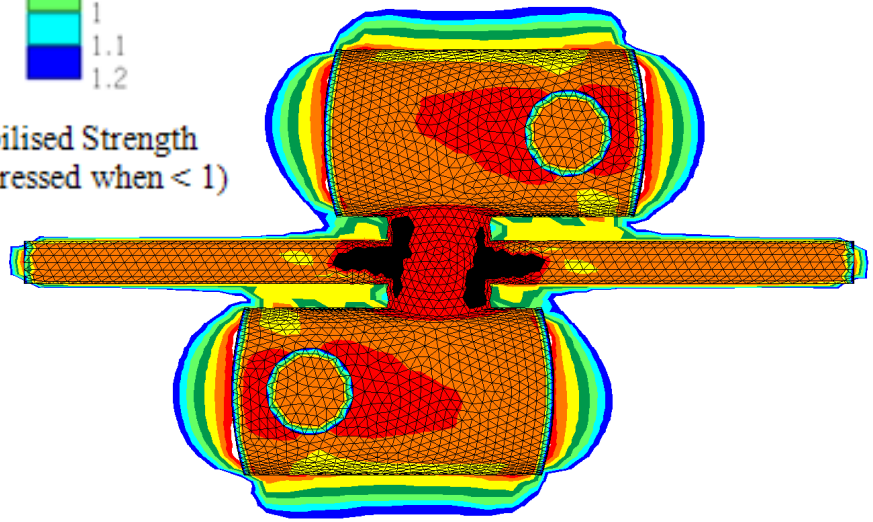


# Study (CLIC geometry)

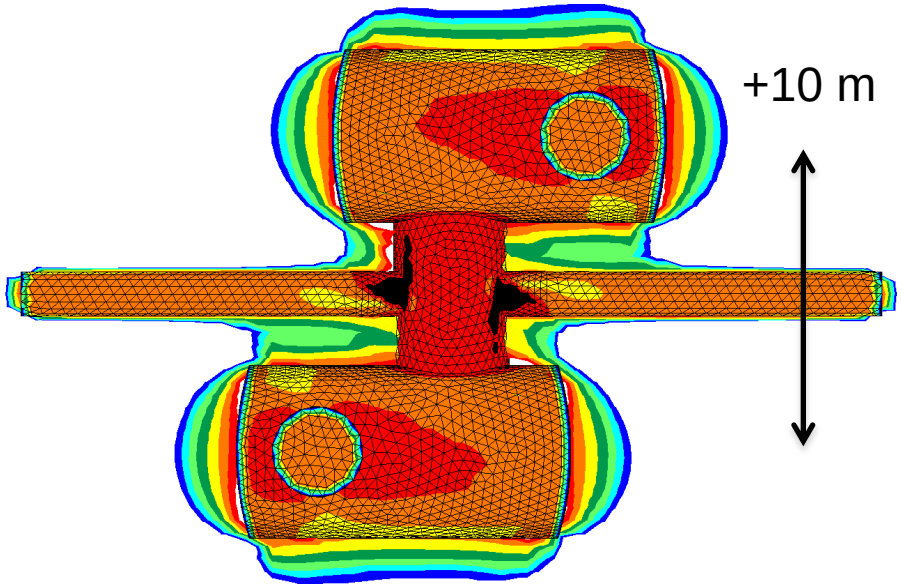
ARUP



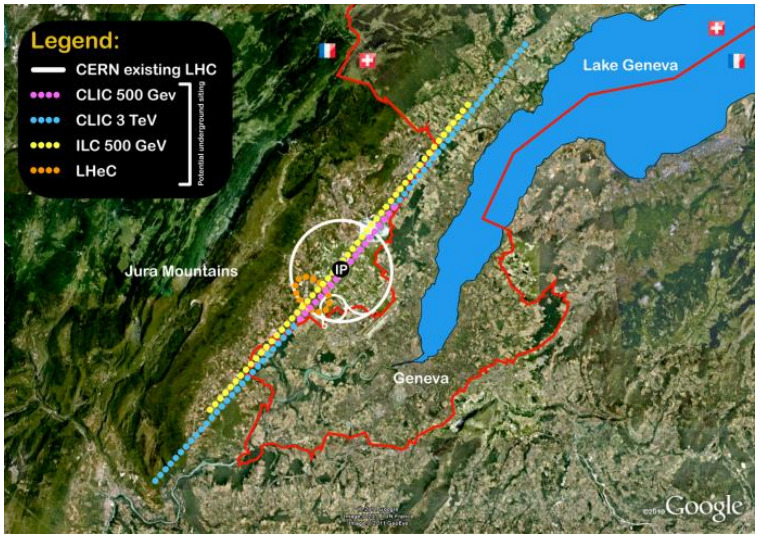

Mobilised Strength
(overstressed when < 1)

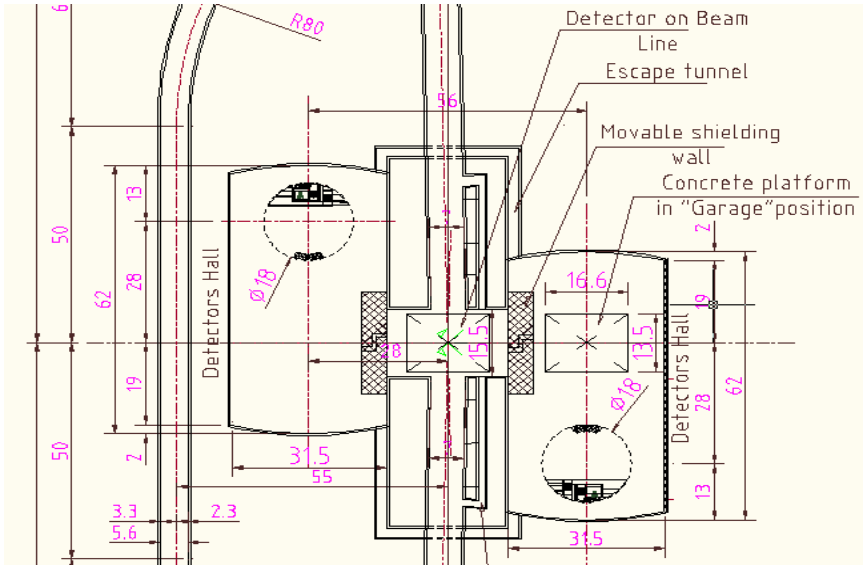


Baseline

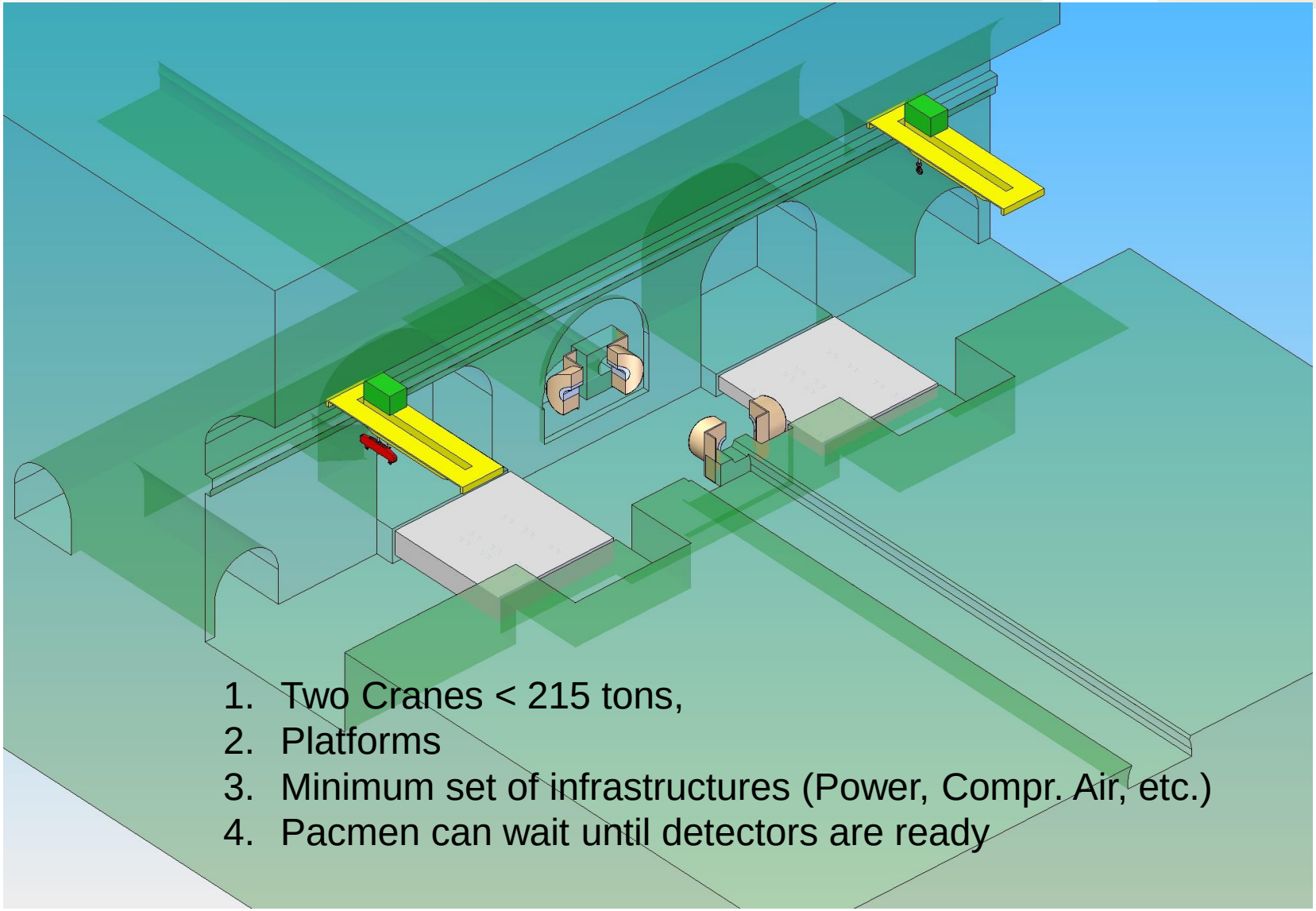



Baseline + 10m



# Detector Hall Delivery before Detector Assembly



1. Two Cranes < 215 tons,
2. Platforms
3. Minimum set of infrastructures (Power, Compr. Air, etc.)
4. Pacmen can wait until detectors are ready