Construction schedule for CFS

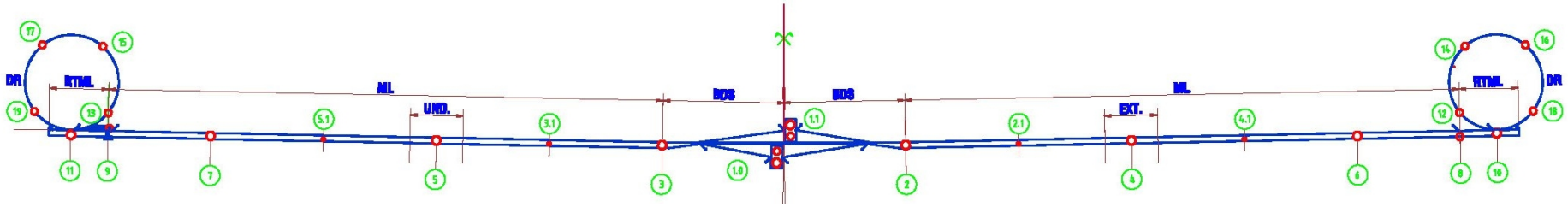
Agenda:

→Scope of CFS scheduling exercise

→Method to make time estimates

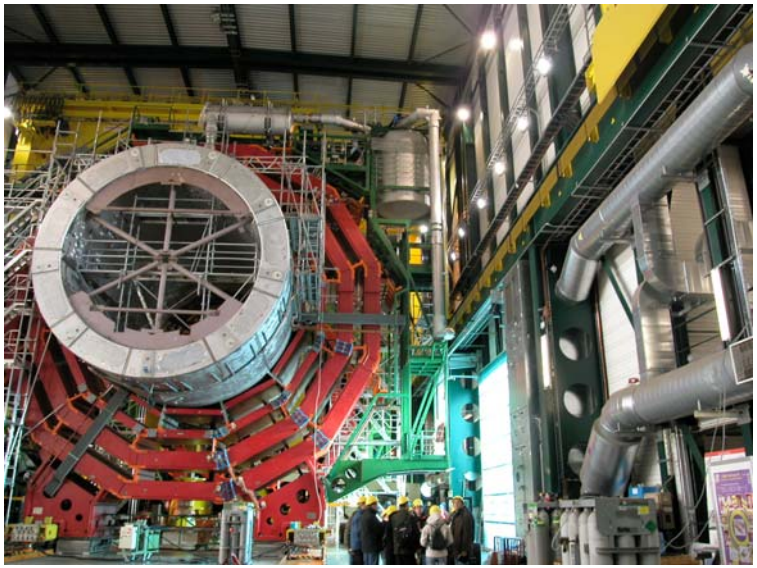
→Year by year schedule

→Conclusion



Scope of CFS scheduling exercise

- → Valid for Europe (both sample sites) and Americas
- → Based on input from:
  - → Amberg Engineering Ltd for Civil engineering work
  - → LHC project for tunnel construction & CFS services installation
  - → CMS project for surface buildings and detector hall construction and CFS services installation



Method to make time estimates

→ Use the completion examination of LHC and CMS work and scale it to ILC project

→ Based on a real life similar project

Civil Engineering

Cooling and Ventilation

Cranes

Electrics

Schedule of underground Civil Engineering work

- → RTML + Main Linac + BDS + DRs schedule for
  - → CERN and Americas
  - → DESY
- → Day 1 is the kick off date of the ILC project
  - → Detailed design and tender documents completed
- → Compatible with a 7-year project construction time
- → Shaft and caverns excavation includes the primary lining of the shaft base caverns and the final lining of the shaft. The finishing of the caverns only take place once no spoil is taken out from the shaft anymore.
- → DR schedule displayed independently

CERN and Americas: Year 1

→ Market surveys, call for tenders and contractor selection

→ Building permits, Environmental impact studies, Purchase of land

→ Based on experience with LHC - Implies having a frozen design!

CERN and Americas: Year 2

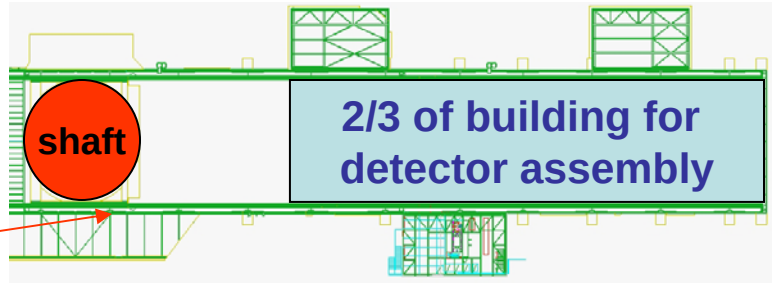
→Shafts excavation

11 shafts have to be started together

→Surface buildings

→Service buildings

→Part of surface detector building (CMS)



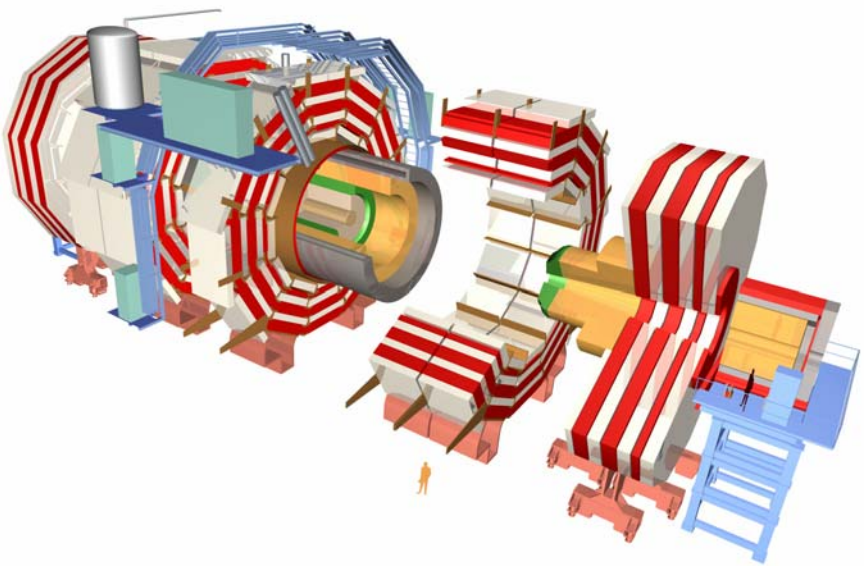
CMS concept

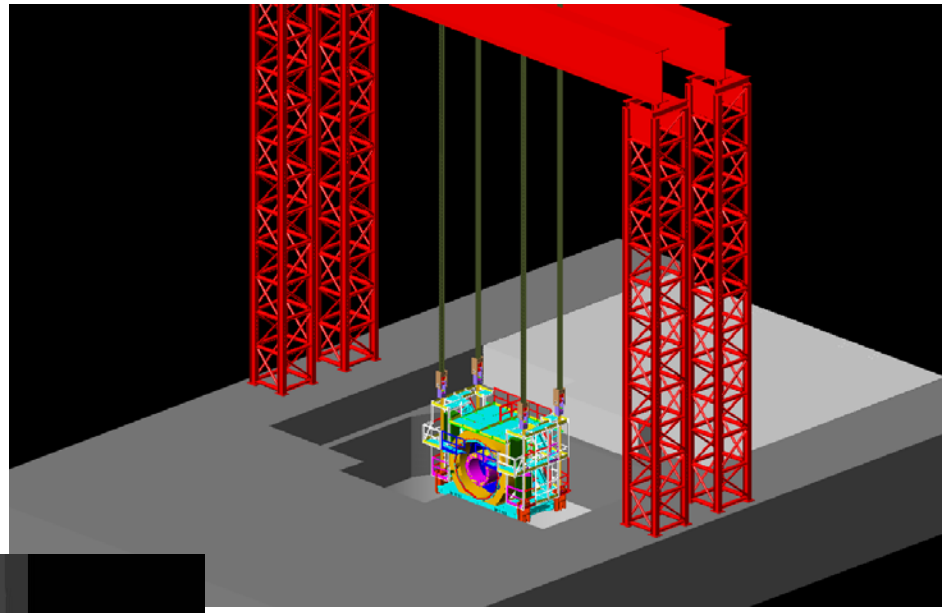
→ “When civil engineering work is so long that beneficial occupancy of the experimental cavern could be late, CMS has introduced from the onset the concept of constructing and testing the detector on the surface before transfer underground by heavy lifting means. This concept has proved quite successful”

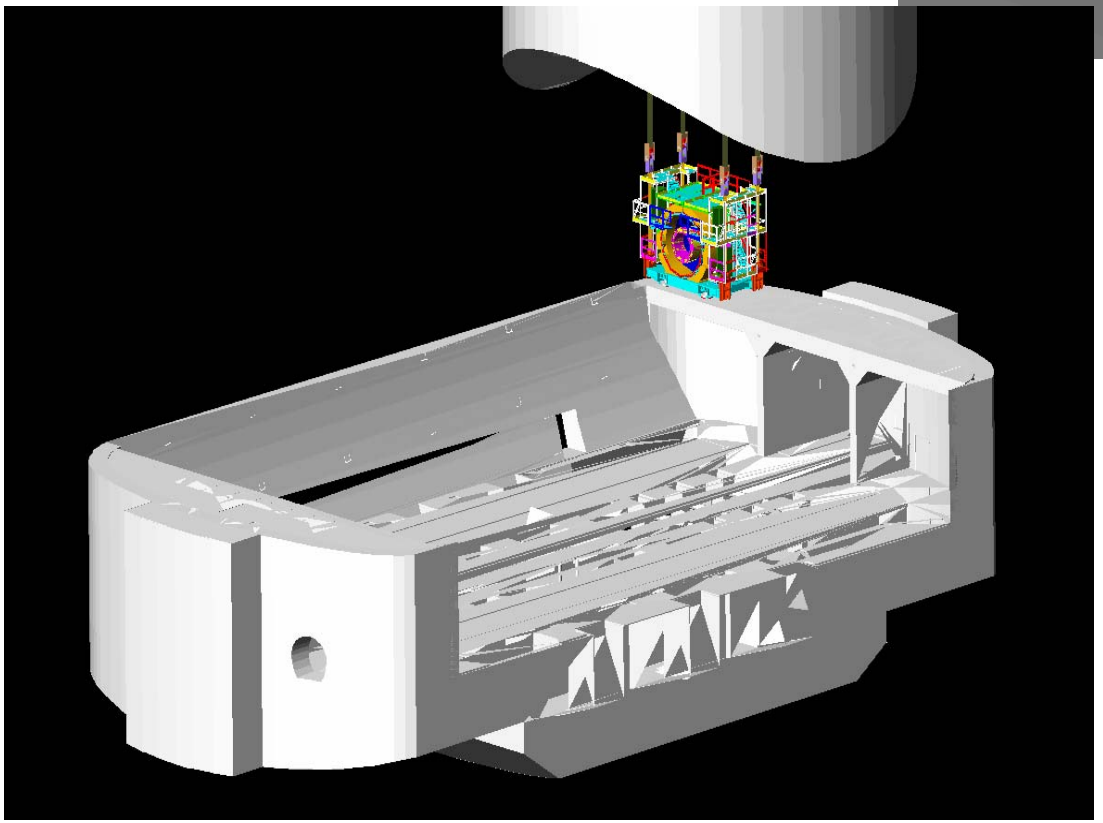
A Herve - CMS technical coordinator

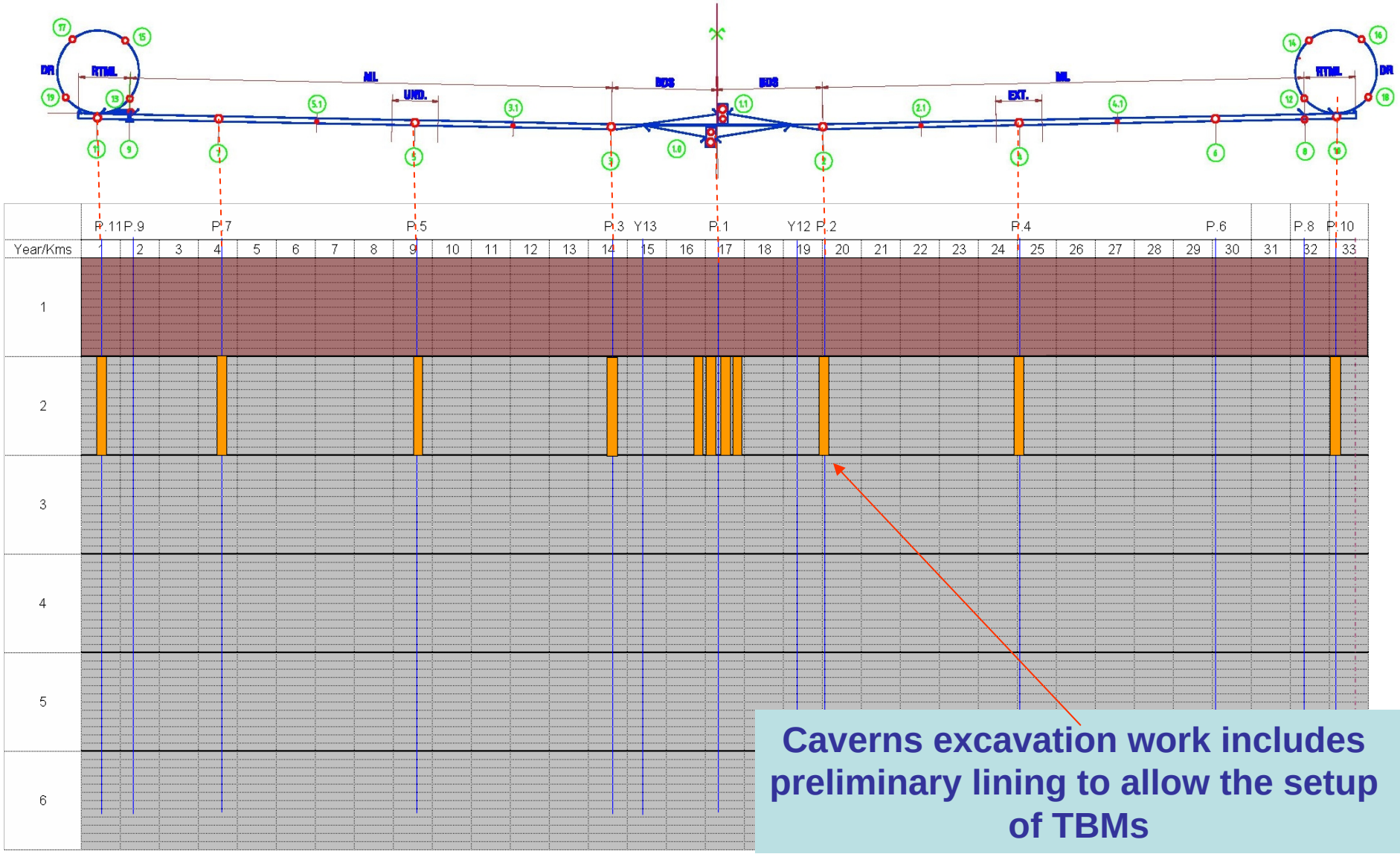
→ Key facts:

- → Work executed underground requires 50% more time than if performed on the surface and can be at least 30% more expensive
- → Extra costs attached to the CMS concept:
  - → Heavy lifting equipment (1.2MCHF for CMS)
  - → Large detector assembly building (3 MCHF for CMS)
  - → Both costs are already included in the CFS cost estimates for EU sites








RTML
ML
UMD.
BDS
BDS
EXT.
ML
RTML
P.11
P.9
P.7
P.5
P.3
Y13
P.1
Y12
P.2
P.4
P.6
P.8
P.10
Year/Kms
1
2
3
4
5
6
Caverns excavation work includes preliminary lining to allow the setup of TBMs
TBM ∅finished=5m
TBM ∅finished=4m
TBM ∅finished=6.5m option
MS TBM ∅=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

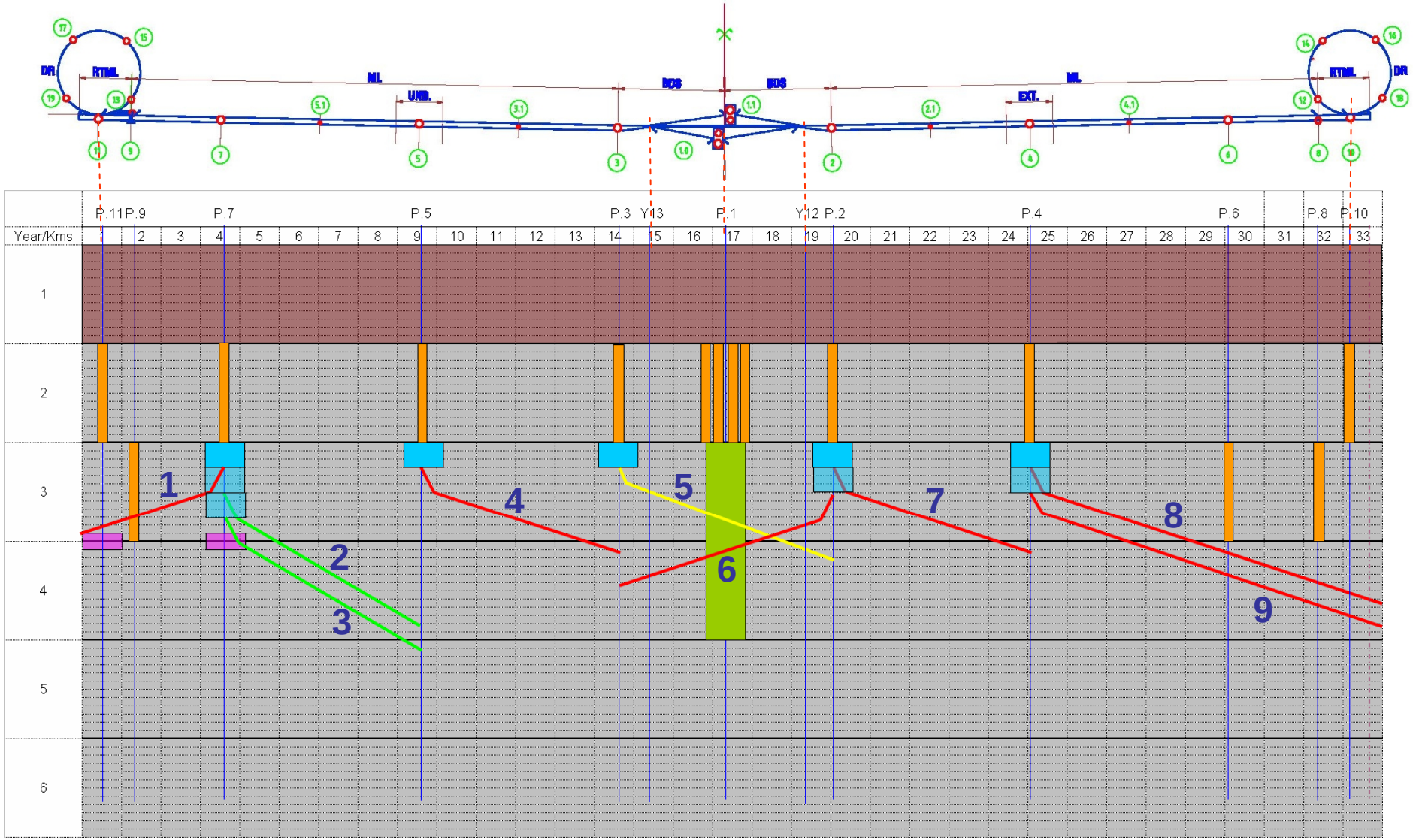
CERN and Americas: Year 3

→ Set-up and launch of TBMs both for RTML, ML, BDS and DRs

→ Completion of shafts excavation

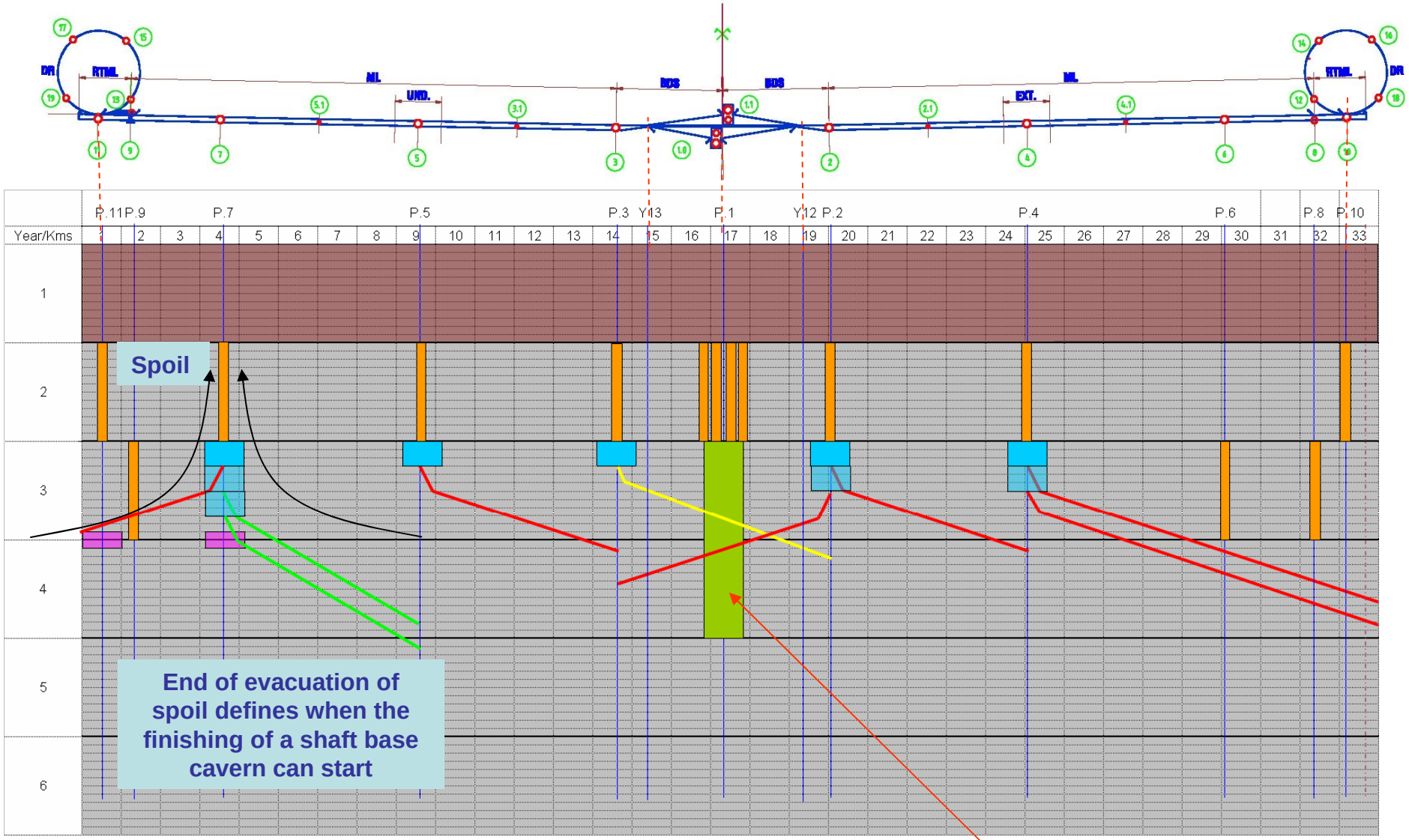
→ Detector halls construction

9 TBMs have to be started together +2 for DRs



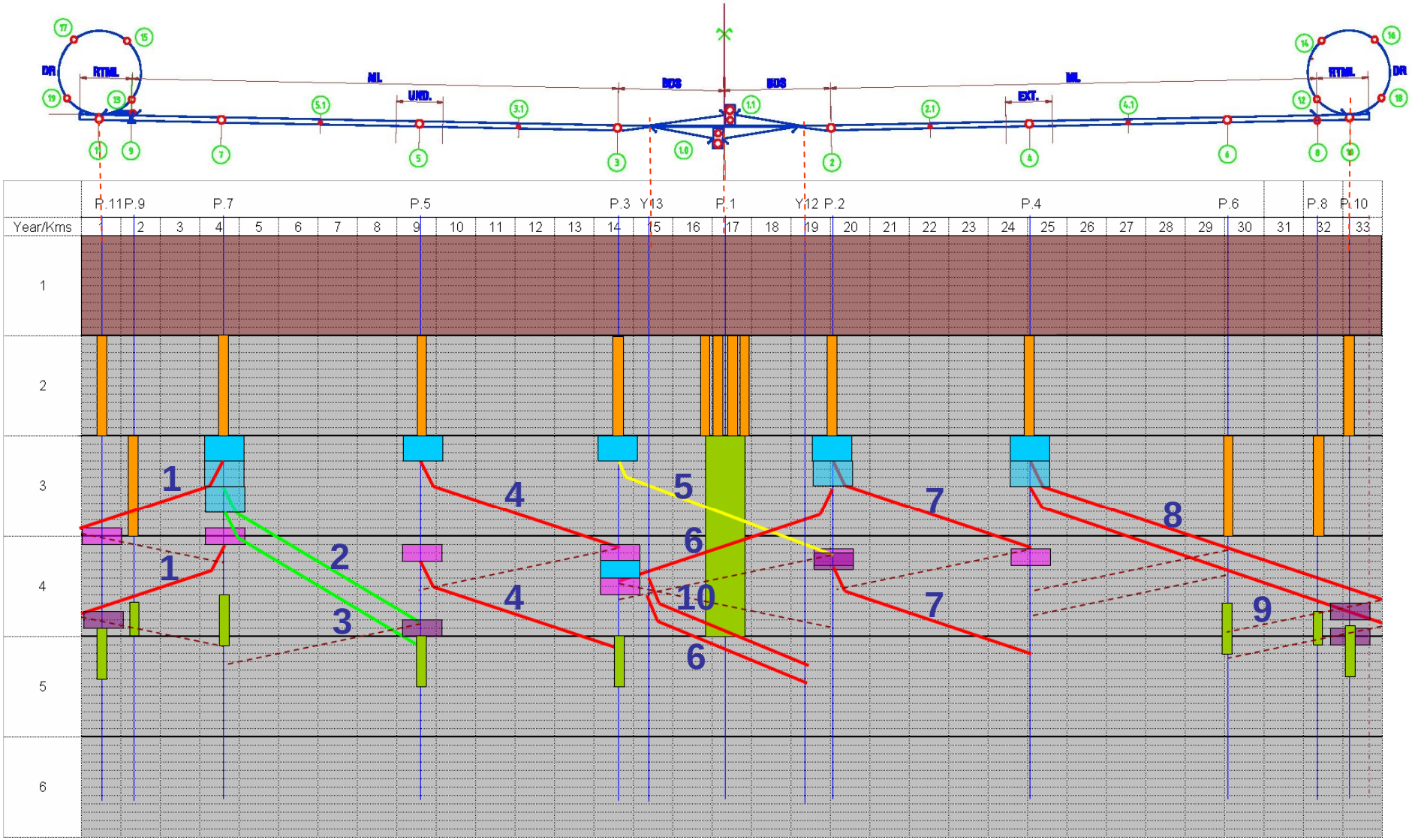
TBM $\varnothing_{finished}$=5m
TBM $\varnothing_{finished}$=4m
TBM $\varnothing_{finished}$=6.5m option
MS TBM $\varnothing$=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

9 TBMs
Different $\varnothing$ to
accommodate design


P.11 P.9
P.7
P.5
P.3
Y13
P.1
Y12 P.2
P.4
P.6
P.8
P.10
Year/Kms
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33
1
2
3
4
5
6
Spoil
End of evacuation of spoil defines when the finishing of a shaft base cavern can start
TBM ∅finished=5m
TBM ∅finished=4m
TBM ∅finished=6.5m option
MS TBM ∅=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work
Detector hall construction starts when shafts are complete

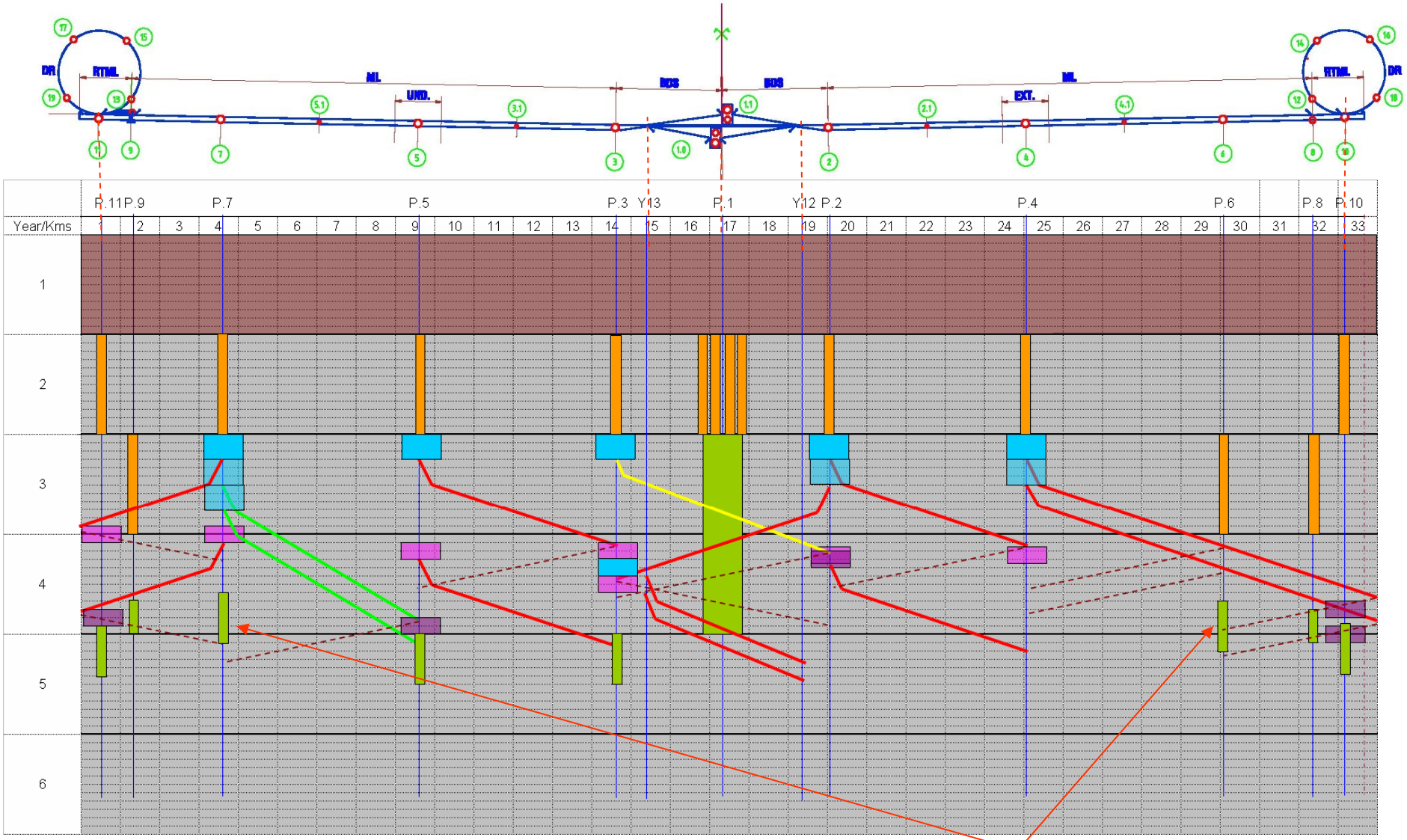
CERN and Americas: Year 4

→ Most resource intensive year:
- → 10 TBMs in action for RTML, ML, BDS + 2 for DRs
- → Completion of detector halls + on-going work for shaft base caverns
- → Finishing of tunnels + start of CFS services installation



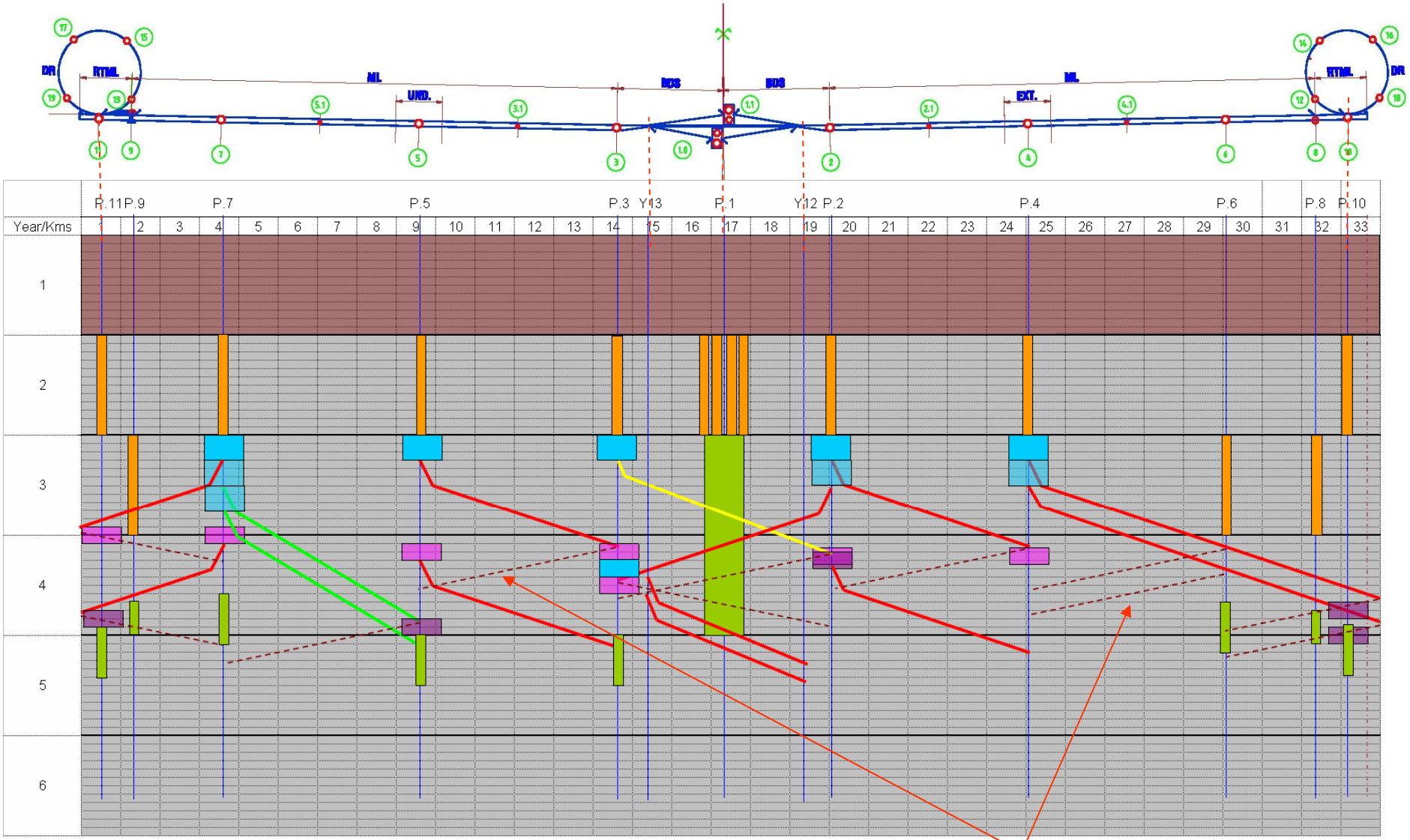
TBM $\varnothing_{finished}$=5m
TBM $\varnothing_{finished}$=4m
TBM $\varnothing_{finished}$=6.5m option
MS TBM $\varnothing$=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

10 TBMs for RTML, ML, BDS
But 3 are transported and reused



TBM $\varnothing_{finished}$=5m
TBM $\varnothing_{finished}$=4m
TBM $\varnothing_{finished}$=6.5m option
MS TBM $\varnothing$=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

Base shaft caverns finishing starts



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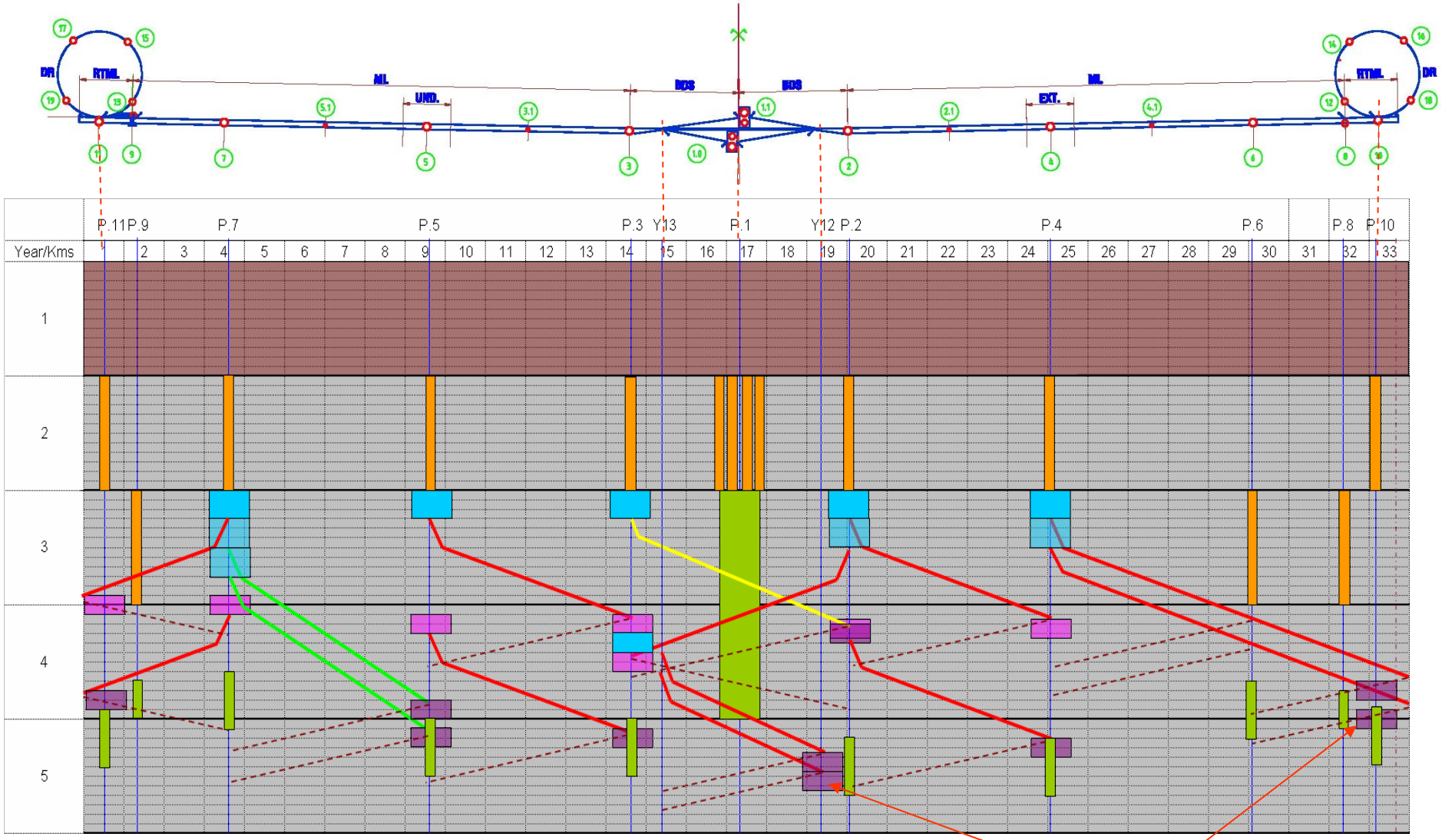
TBM $\varnothing_{finished}$=4m
TBM $\varnothing_{finished}$=6.5m option
MS TBM $\varnothing$=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

Finishing work for tunnel: Floor, drainage, painting…

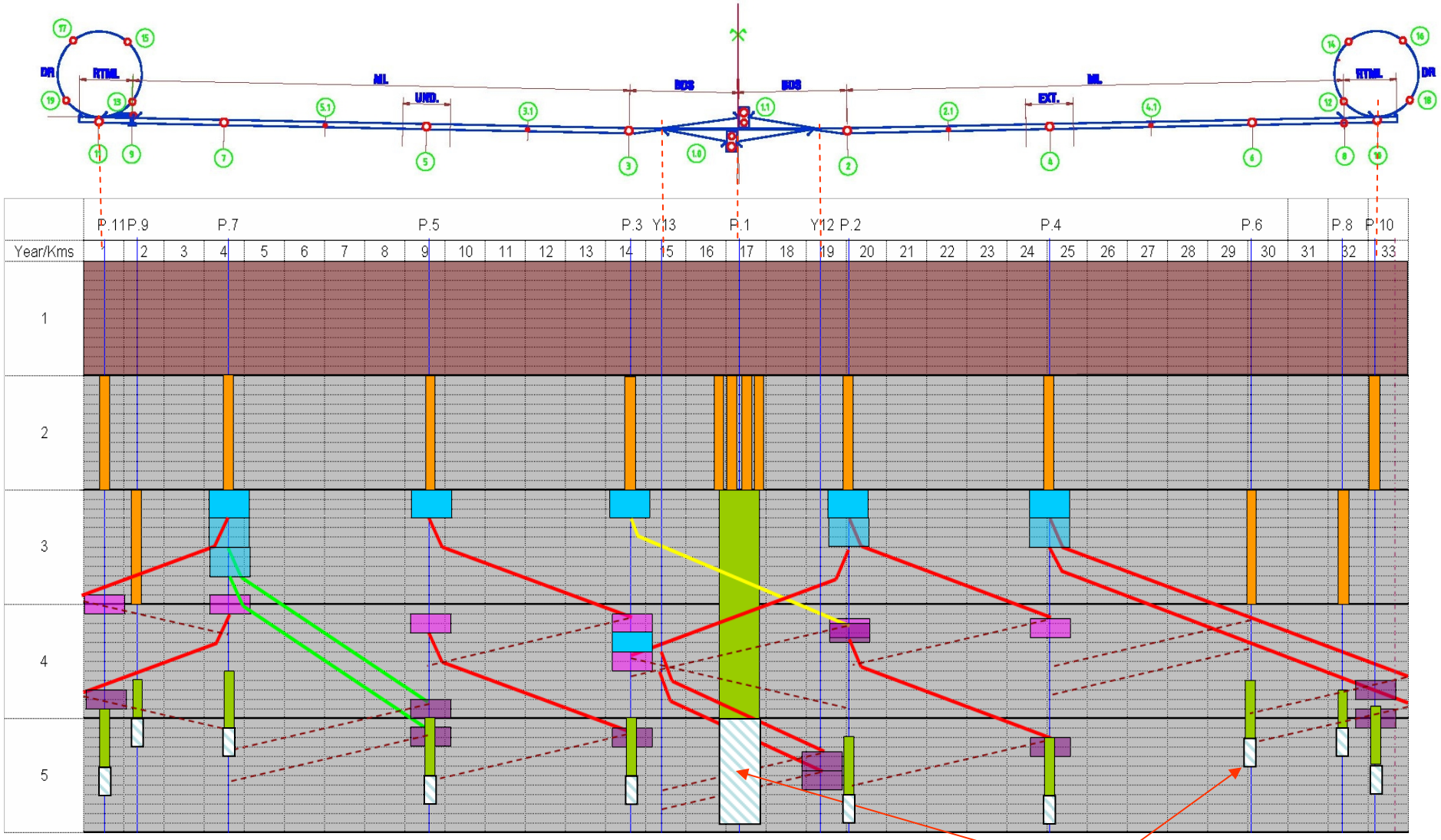
CERN and Americas: Year 5

→ Last year of underground CE work:
- → Extraction of TBMs
- → Start of installation for infrastructure in Detectors Halls
- → Completion of shaft base caverns
- → Finishing of tunnels + CFS services installation



TBM $\varnothing_{finished}$=5m
TBM $\varnothing_{finished}$=4m
TBM $\varnothing_{finished}$=6.5m option
MS TBM $\varnothing$=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

Extraction of TBMs



TBM $\varnothing_{finished}$=5m
TBM $\varnothing_{finished}$=4m
TBM $\varnothing_{finished}$=6.5m option
MS TBM $\varnothing$=5m
Cavern finishing
Shaft/cavern excavation
TBM setup
TBM transport
TBM removal
Finishing work

Install CFS services in Detector halls & Shaft base caverns

CFS services installation schedule for Detector Halls and Base Shaft Caverns

→ Based on experience with CMS

→ Time estimates for site work only

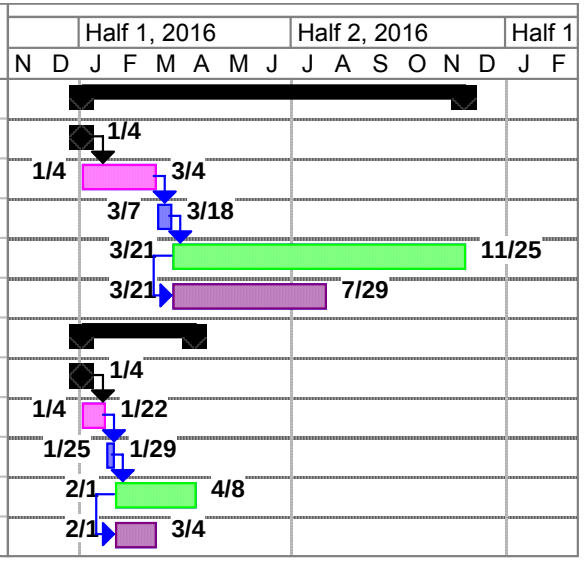
Cavern	Dimensions L x W x H	Metallic structures	Cooling and ventilation	Electrics General Services	Crane installation
CMS	53 x 26 x 25	5w	19w	10w	1w
ILC detector halls	72 x 32 x 35	9w	36w	19w	2w
ILC Shaft base caverns	50 x 14.5 x 18	3w	10w	5w	1w

Completion examination figures

Estimates

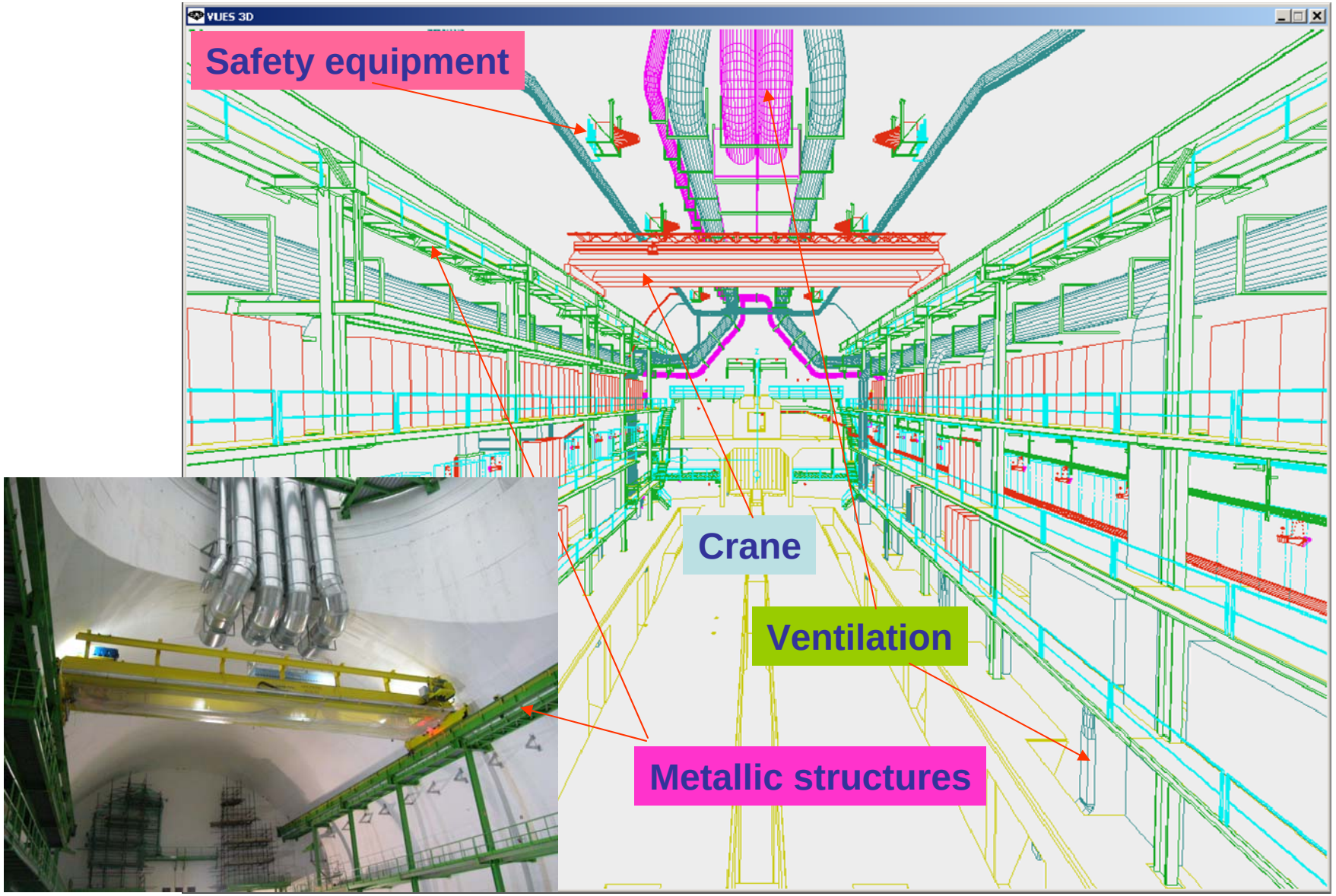
CFS services installation schedule for Detector Halls and Base Shaft Caverns

ID	Task Name	Duration	Owner
1	Underground Detectror Hall	**235 days**	
2	Detector Hall construction complete	0 days	TS-CE
3	Install metallic structures	9 wks	TS-IC
4	Install overhead crane	2 wks	TS-IC-HM
5	Install cooling and ventilation	36 wks	TS-CV
6	Install EL general services	19 wks	TS-EL
7	Shaft Base Caverns	**70 days**	
8	Cavern construction complete	0 days	TS-CE
9	Install metallic structures	3 wks	TS-IC
10	Install overhead crane	1 wk	TS-IC-HM
11	Install cooling and ventilation	10 wks	TS-CV
12	Install EL general services	5 wks	TS-EL



- → CFS services ready:
  - → Detector Halls: 11 months after hall construction complete
    - → Ready for detectors: end of year 5 (possible overlap with CV)
    - → Pre-commissioning done in surface building
  - → Shaft base caverns: 3 months after cavern completion

CFS services installation in detector hall

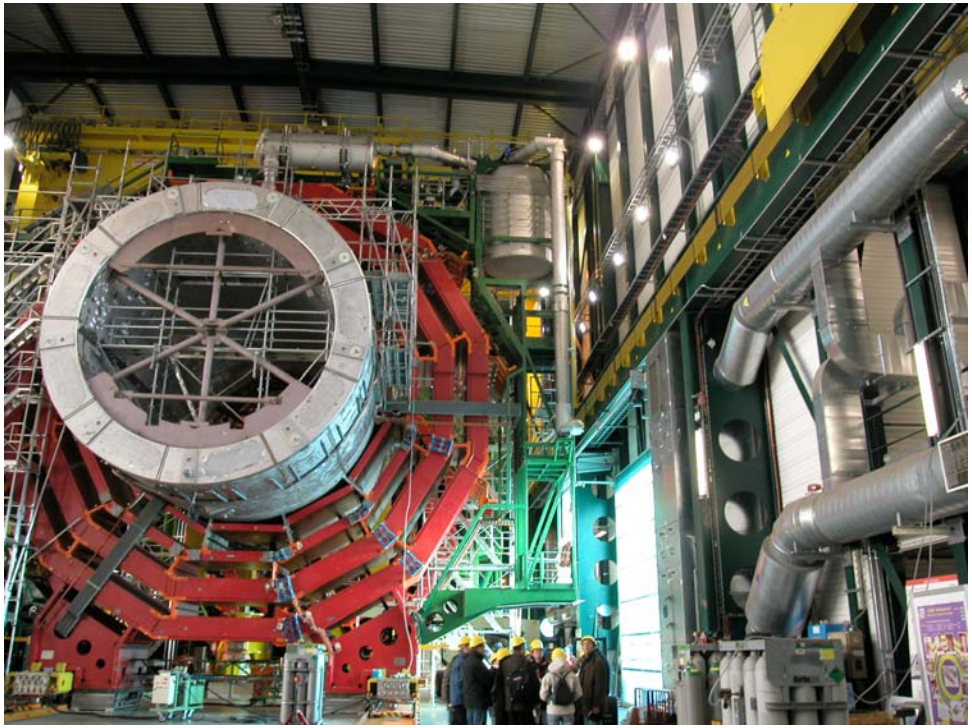


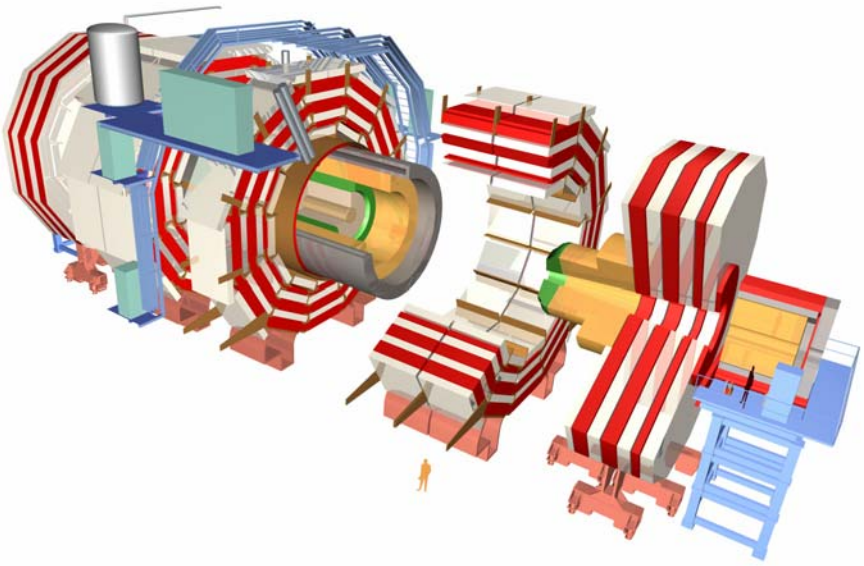
CERN and Americas: Year 6

→ Installation of infrastructure in all caverns
→ Installation of infrastructure in tunnels
→ Construction of Shaft access buildings
→ Construction of extension for detector building to cover shafts

CMS approach

- → Detectors are assembled on the surface
  - → Assembly runs in parallel with underground work
  - → Allows a pre-commissioning before lowering
  - → Lowering using dedicated heavy lifting equipment





CMS approach

Building and CFS services installation schedule for shaft access buildings

→ Based on experience with CMS

→ Time estimates for site work only

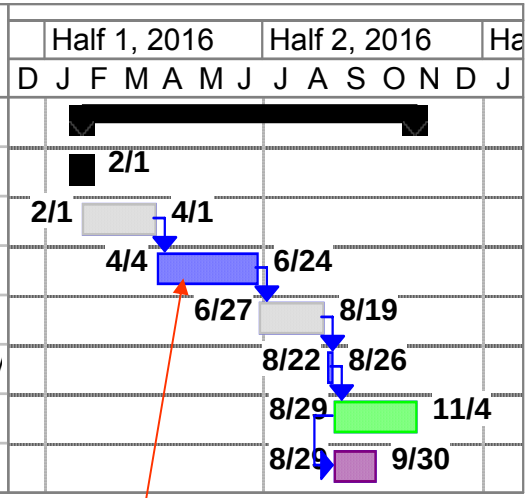
Building	Dimensions L x W x H	CE work Slab, shaft head	Metallic structures	Cooling and ventilation	Electrics General Services	Crane installation
CMS SDX5	36 x 17 x 15.5	15w	17w	18w	12w	1w
ILC Shaft access building	30 x 12 x 12	9w	8w	8w	5w	1w

Completion examination figures

Estimates

Installation schedule for shaft access buildings

ID	Task Name	Duration	Owner
13	Shaft access building	**200 days**	
14	Shaft Base Cavern construction complete	0 days	TS-CE
15	Concrete slab	9 wks	TS-CE
16	Install shaft with infrastructure	12 wks	
17	Build steelworks	8 wks	TS-CE
18	Install overhead crane	1 wk	TS-IC-HM
19	Install cooling and ventilation	10 wks	TS-CV
20	Install EL general services	5 wks	TS-EL



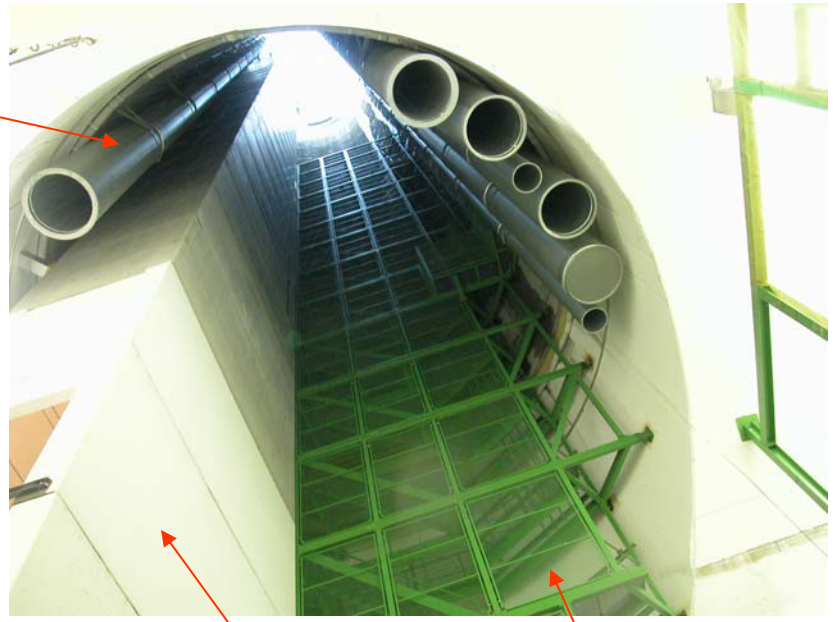
→ Bigger shaft access building complete in 10 months

→ A 12 week window is needed to install CFS infrastructure in shaft:

- → Concrete lift modules
- → Ventilation ducts
- → Cooling pipes
- → Cable trays
- → Metallic staircase

→ Last shaft access building complete by middle of Year 6

Ventilation ducts



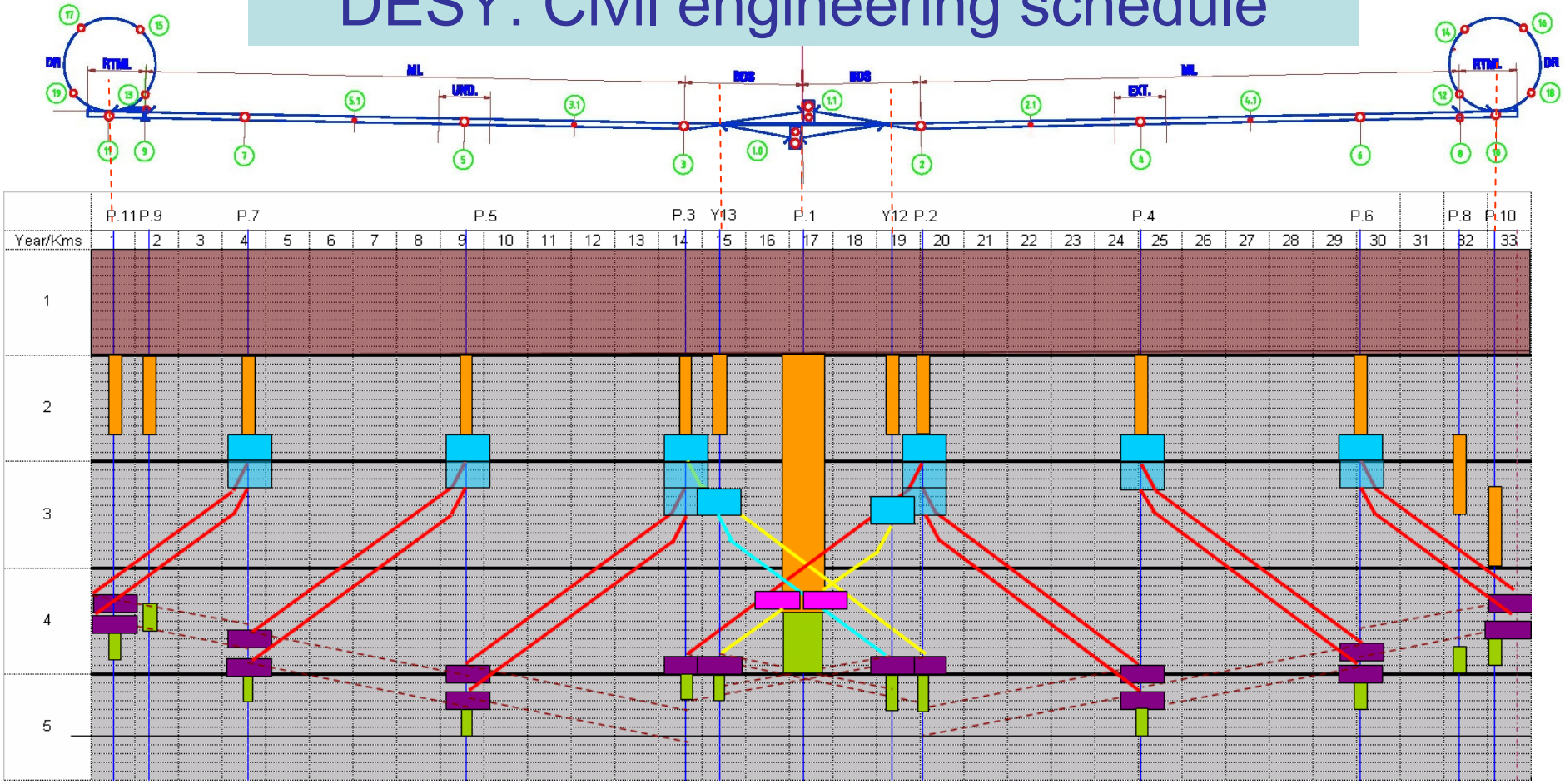
Crane

Concrete lift modules

Metallic staircase

Building complete

DESY: Civil engineering schedule



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- TBM $\varnothing_{finished}$=6.5m option
- MS TBM $\varnothing$=5m
- Cavern finishing
- Shaft/cavern excavation
- TBM setup
- TBM transport
- TBM removal
- Finishing work

16 TBMs needed for RTML, ML, BDS + 2 for DRs
Schedule compatible with CERN for surface buildings

Conclusions

→ Key milestones:

- → Detector Assembly Building ready for detector: t= t_0 + 3Y
- → First tunnel sections ready for services installation: t= t_0 + 4Y
- → DR ready for services: t= t_0 + 4Y (1 year procurement + 1 year shafts excavation + 1y10m TBM + 2m TBM extraction)
- → Detector Hall (cavern) ready for detector: t= t_0 + 4Y11m
- → All Base Shaft Caverns equipped with services: t= t_0 + 4Y11m

→ More efforts needed to reach reliable time estimates for the CFS services installation in the tunnels

→ CFS group is ready to take part in the consolidation of a general schedule including cryogenics, vacuum pipes and detectors installation which could be presented at the Valencia meeting…