Experimental Hall in Mountain Regions

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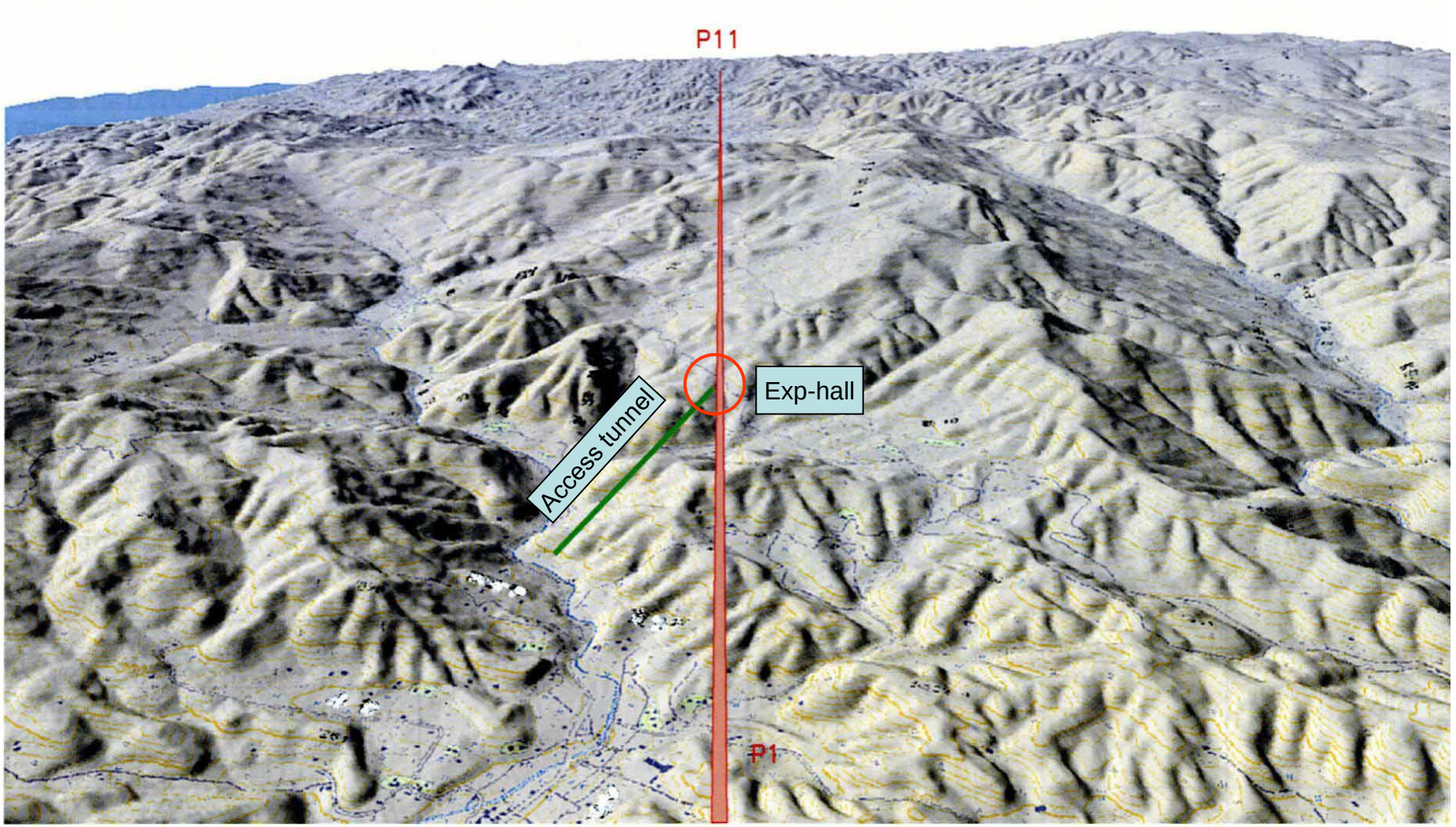
ILC CFS Workshop @SLAC

Study of CF in mountain regions

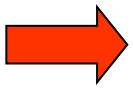
- Design study of conventional facilities (CF) in mountain regions is actively being done by KEK CFS group and AAA (Advanced Accelerator Associates Promoting Science and Technology) in Japan
- There was an International review on the Asian single tunnel design and the CF study in mountain regions (June 1-2) http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=4613
  - Review chair: Victor Kuchler (FNAL)
  - Positive review report
- Since CF design needs detector hall design, we are now involved in this activity (since Apr.2010)

An example of Asian mountain site



Exp-hall in mountain regions

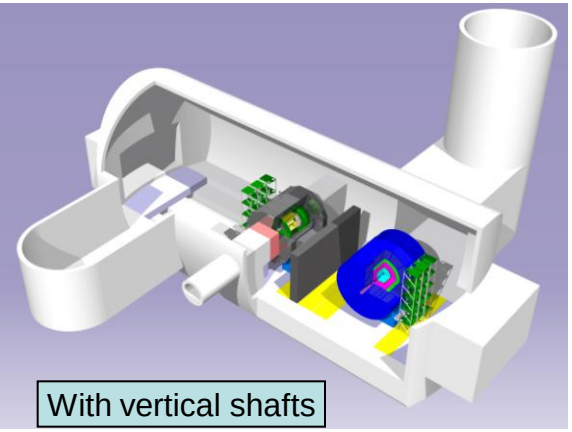
- For CMS-style assembly using big vertical shafts, depth of IP should be d≤100m
- This requirement restricts the location of IP in mountain regions
- By removing the constraint of d≤100m, more flexible choice of IP location and accelerator layout can be made
  - Selecting the location of the cavern with better geology would reduce the cost and the construction period

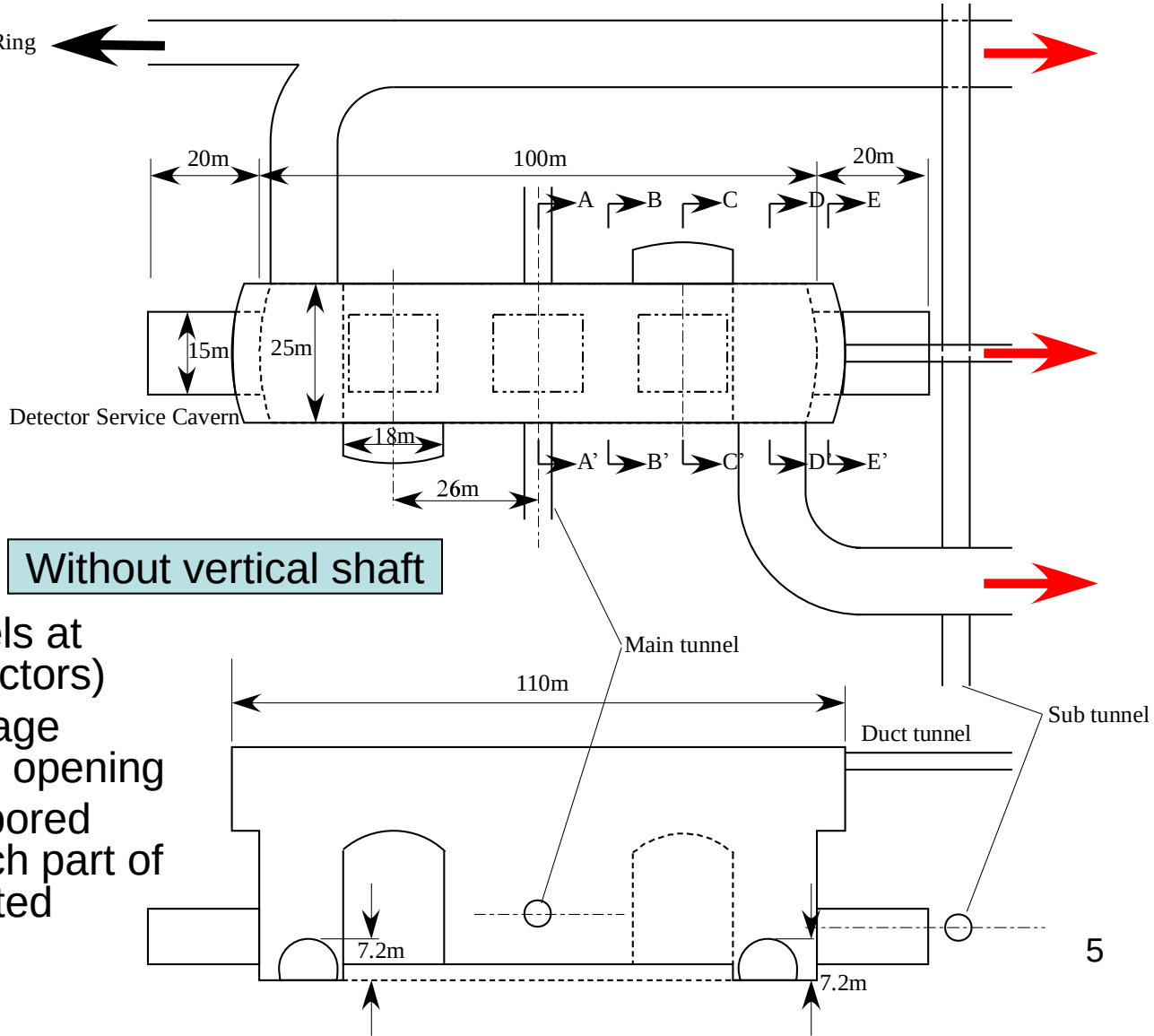


- **Exp-hall without vertical shafts** may be more suitable for some candidate sites in mountain region
- In that case, access tunnels are used to carry detector and accelerator components into detector cavern or accelerator tunnel
- We have just started to study on the exp-hall design and detector assembly method without vertical shafts as an option

(n.b. It does not mean that the CMS-style assembly using vertical shafts is excluded for all candidate sites in mountain regions)

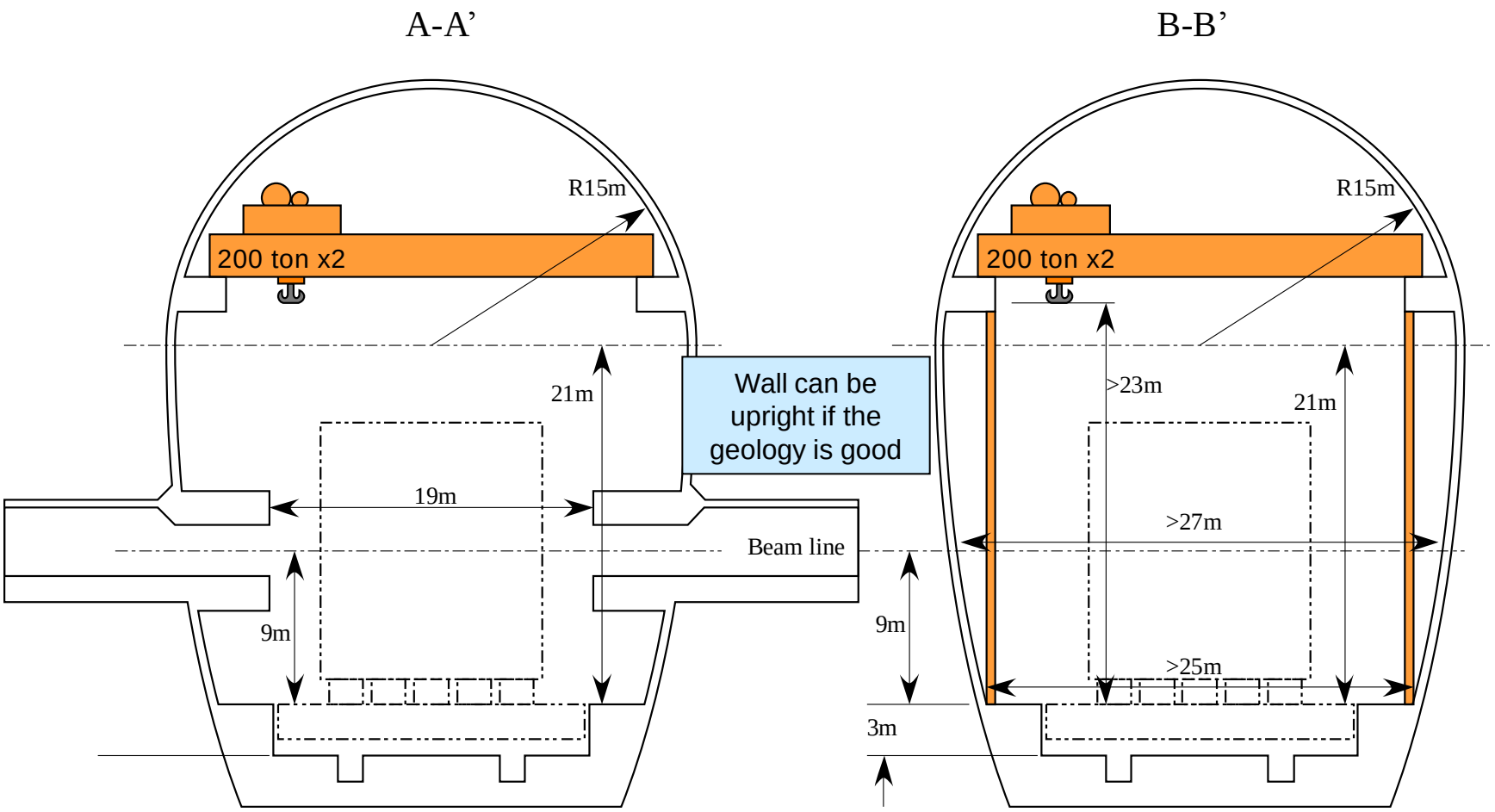
A possible design of exp-hall



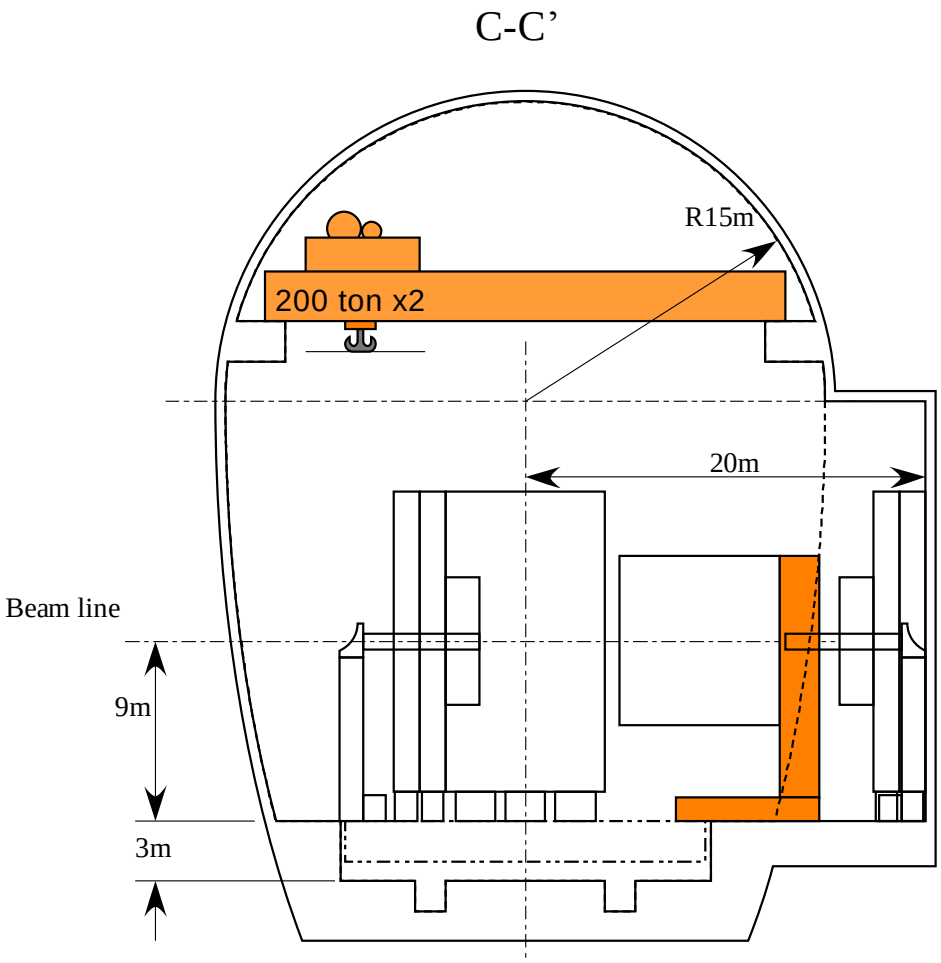


- Bottom access tunnels at both ends (for 2 detectors)
- Small alcoves at garage positions for detector opening
- Top (duct) tunnel is bored first, and then the arch part of the cavern is excavated

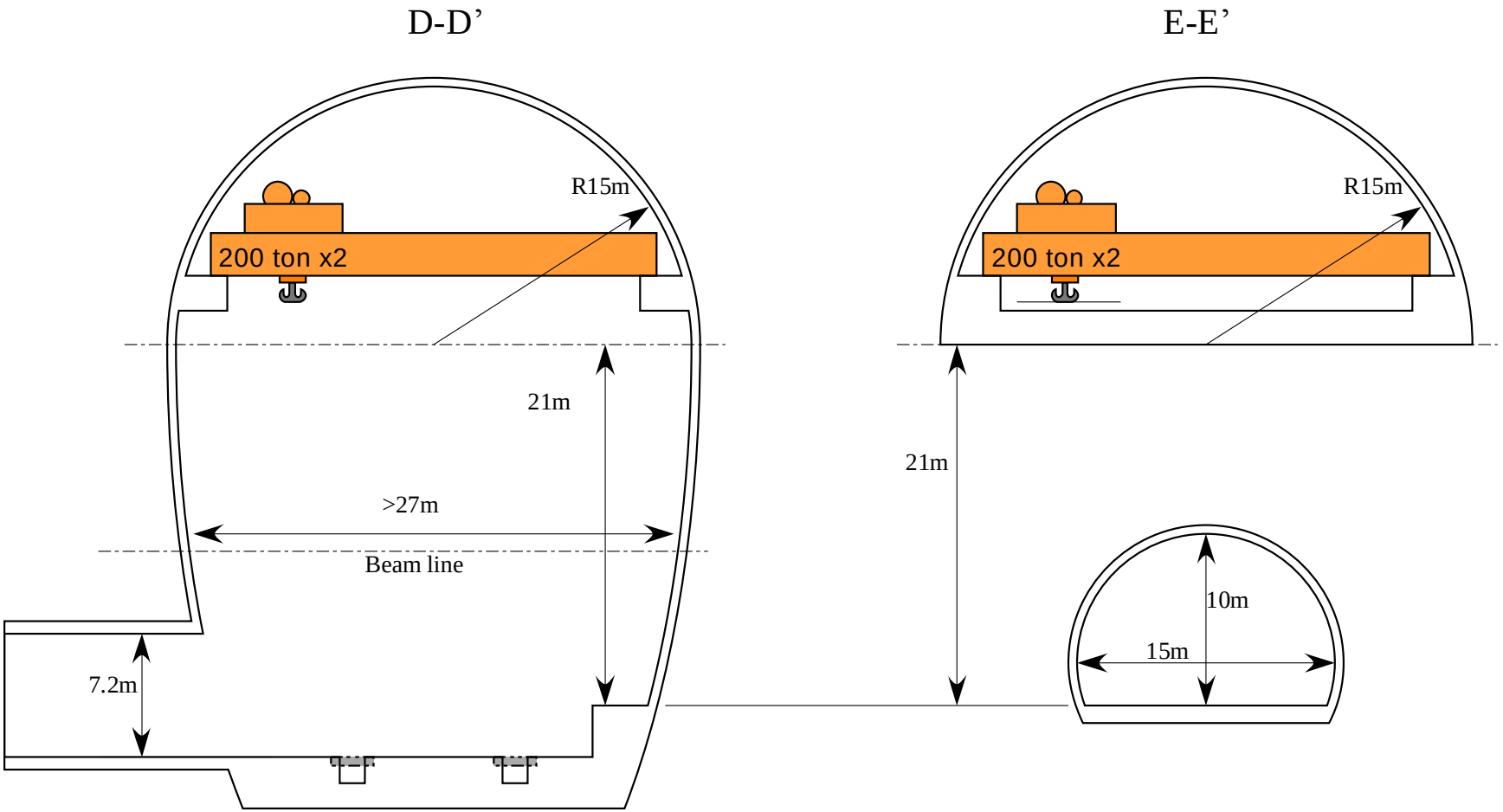
A possible design of exp-hall

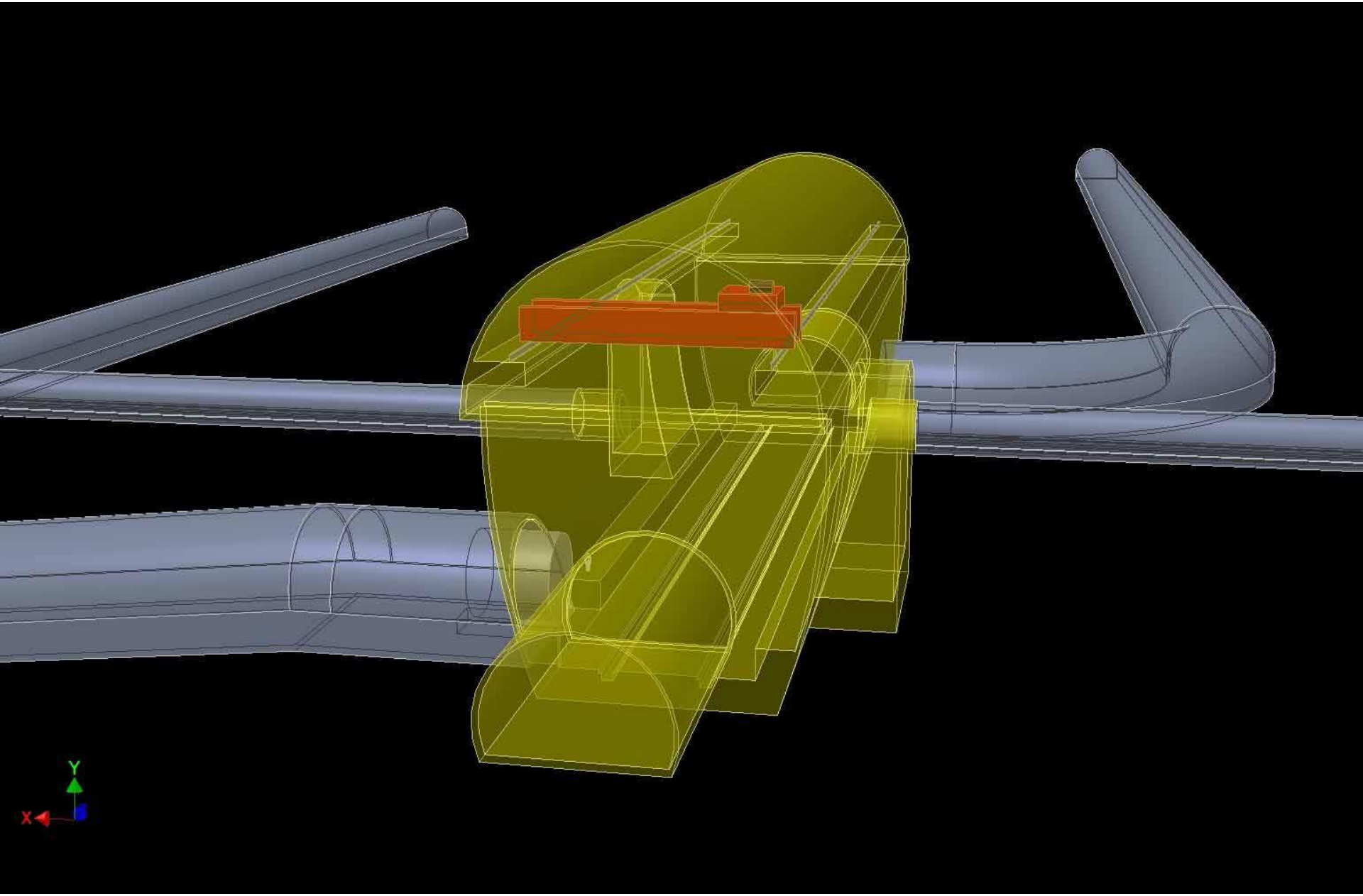


A possible design of exp-hall



A possible design of exp-hall




Y
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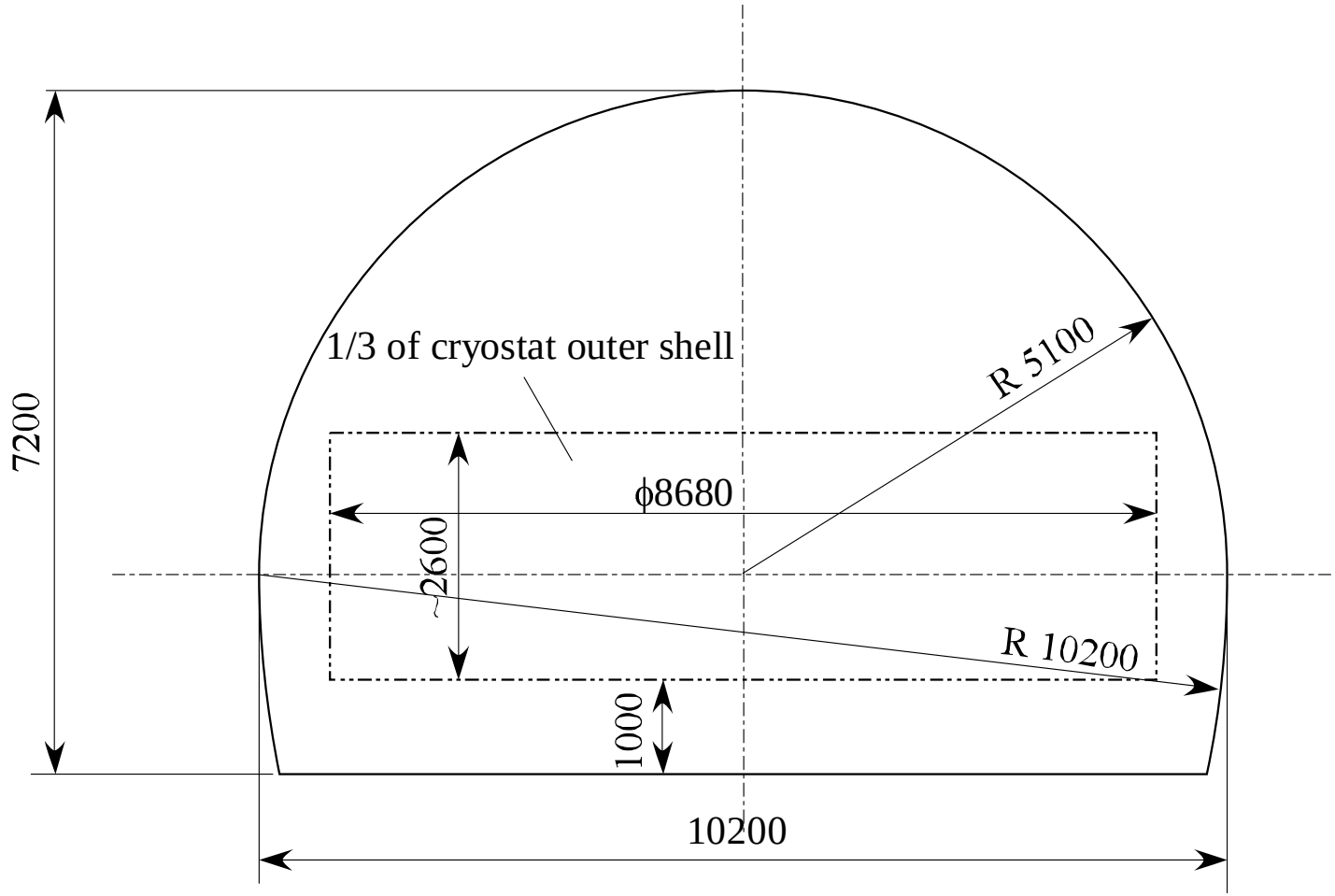
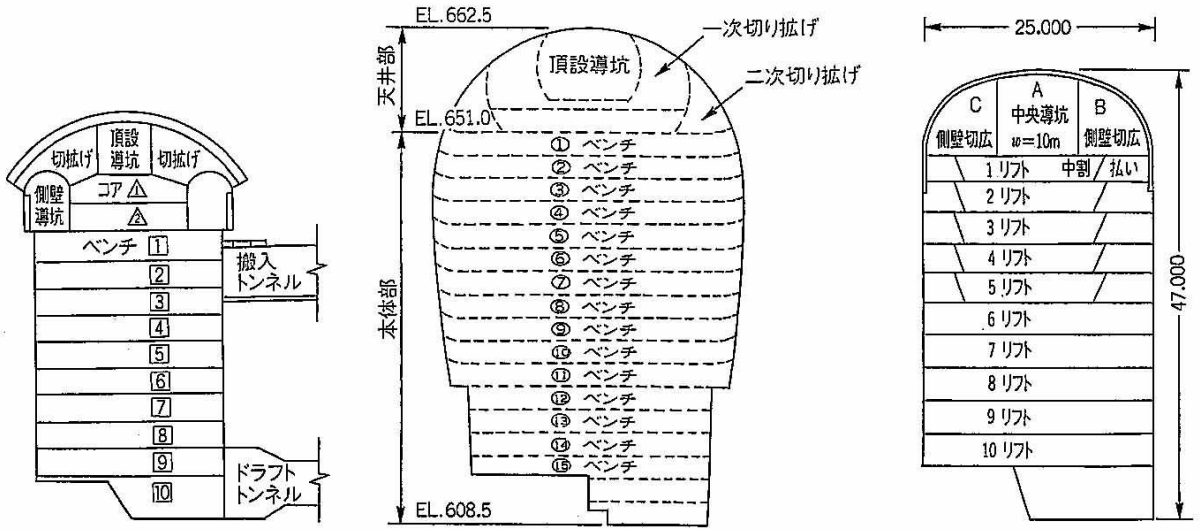
Access tunnel



Huge caverns in Japan

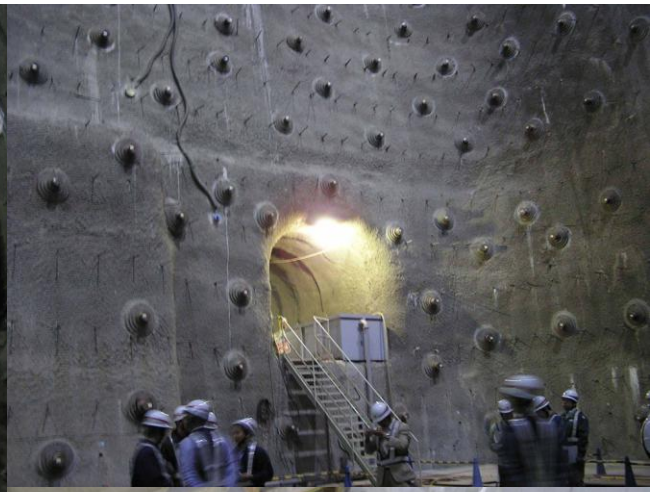
- More than 20 huge caverns with access tunnels have been constructed in Japan for hydroelectric power plants
- A 25m(W)x47m(H)x130m(L) (94,000m^3) cavern can be excavated only in 14 months, and a 34mx54mx210m (250,000m^3) was excavated in 21 months



(a) 奥美濃発電所 (きのこ形)　(b) 葛野川発電所 (卵 形)　(c) 奥多々良木発電所増設 (弾 頭 形)

Example of a cavern

- Underground hydroelectric power plant in Japan (Kannagawa power plant)
- Cavern size: 33m(W)x51.4m(H)x215.9m(L) in hard sedimentary rocks
- Construction (excavation) period: ~1y for arch, ~1y for bench
- Depth: d~600m → Heavy components of generators were carried into the cavern through access tunnels



Detector assembly

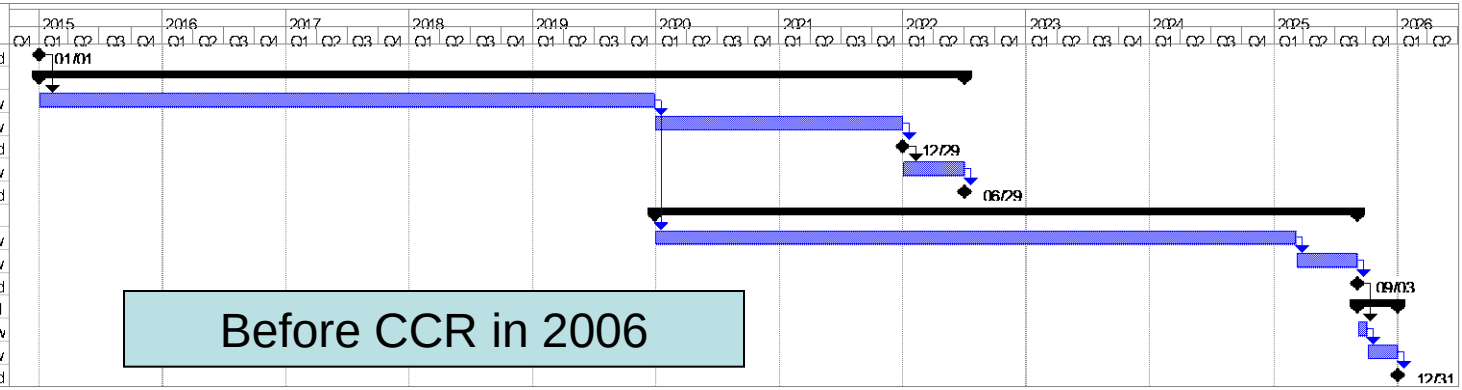
- Assembly hall locates at the entrance of access tunnel where wide flat surface and wide roads exist
- Detector would be assembled to relatively small pieces (<100~200 ton) at the assembly hall, carried to the cavern through the access tunnel, and integrated to the large detector inside the cavern (Similar to “modified CMS style assembly” which was proposed by GLD group in 2006)
- Barrel iron structure would be divided in ϕ (and R) direction, rather than Z direction
- Solenoid coil would be wound on surface for 5 modules, and these modules are connected into one solenoid in the cavern
- Detailed study on the assembly method is necessary

Construction period

- Construction period is one of the most controversial issues for the shaft-less exp-hall
- Construction period of an access tunnel (L~1km) would be similar to that of a vertical shaft (ϕ=18m, d~100m)
- Assembly of the iron yoke structure and the solenoid in the cavern would take ~1y, but it does not mean that non-CMS style assembly (new modified CMS-style assembly) takes 1y more than CMS style assembly

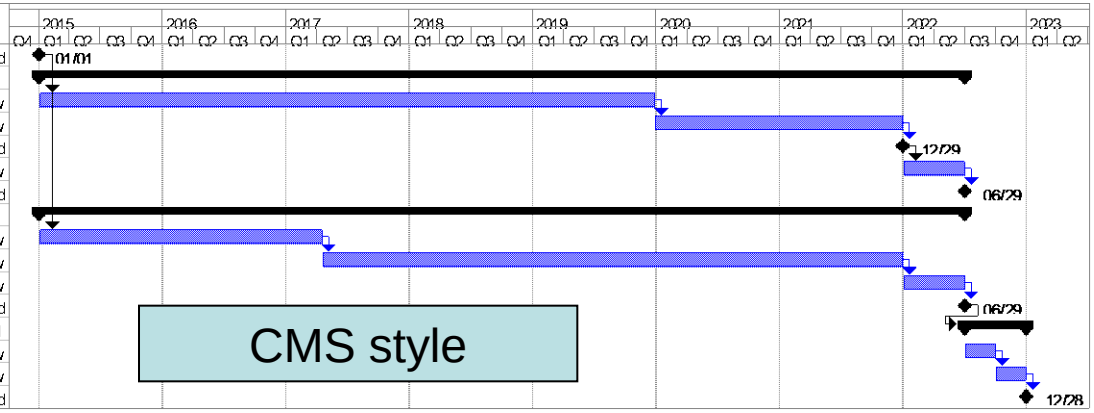
CMS Style

ID	Name	Duration
1	Project approval	0d
2	**Beam lines construction**	**1955d**
3	Cavern/Tunnel	260w
4	Beamline harware install	105w
5	Start of beam commissioning	0d
6	BDS pre-commissioning	28w
7	BDS ready for detectors	0d
8	**Detector construction**	**1485d**
9	Detector assembly	271w
10	Detector underground commissioning	28w
11	Detector ready for BDS	0d
12	**Final assembly & commissioning**	**85d**
13	Detector moved to IP	4w
14	Final beam commissioning	13w
15	Ready for physics run	0d



Before CCR in 2006

ID	Name	Duration
1	Project approval	0d
2	**Beam lines construction**	**1955d**
3	Cavern/Tunnel	260w
4	Beamline harware install	105w
5	Start of beam commissioning	0d
6	BDS pre-commissioning	28w
7	BDS ready for detectors	0d
8	**Detector construction**	**1955d**
9	Surface assembly hall	120w
10	Detector assembly	245w
11	Detector surface commissioning	28w
12	Detector ready for BDS	0d
13	**Final assembly & commissioning**	**130d**
14	Detector underground assembly	13w
15	Final beam commissioning	13w
16	Ready for physics run	0d

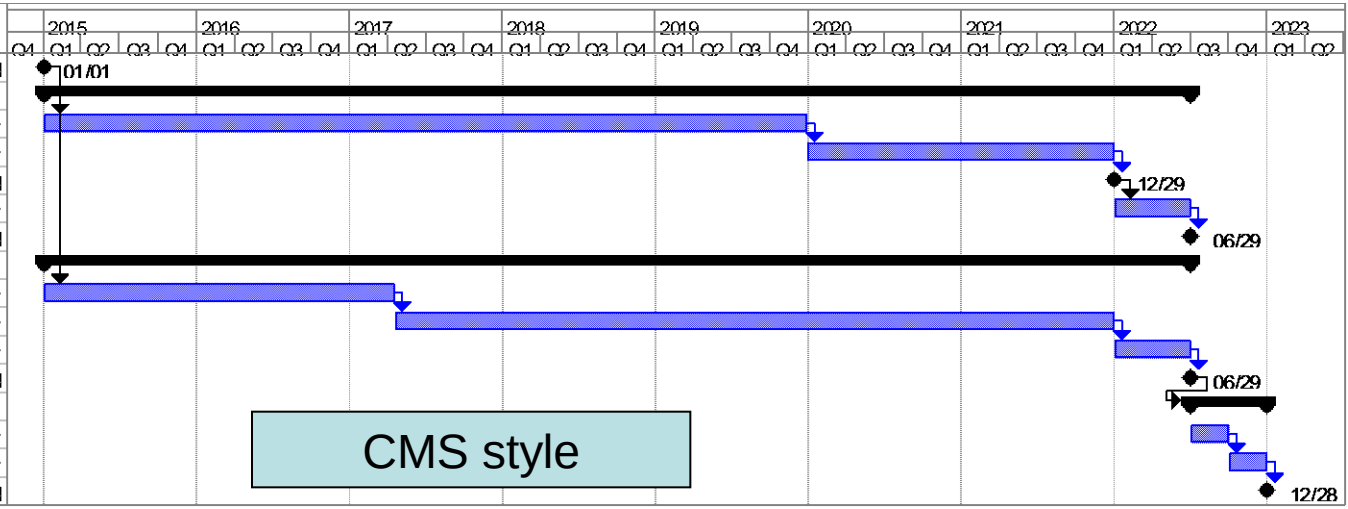


CMS style

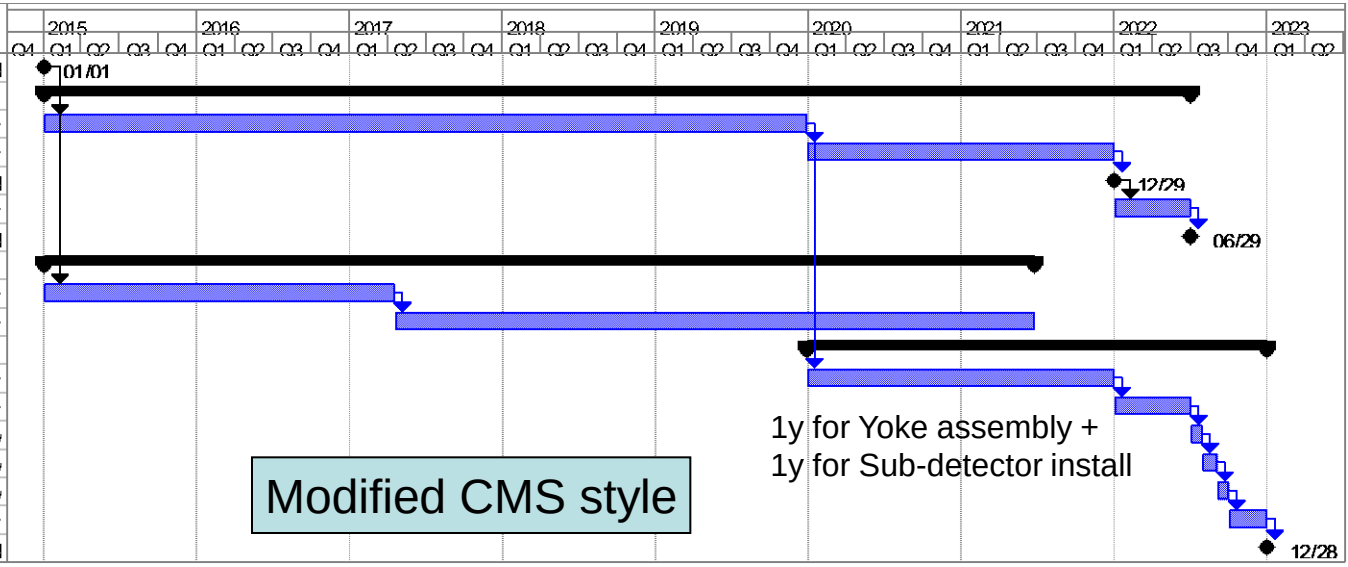
http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/CCR_surface/BDS_schedule.pdf

Modified CMS style

ID	Name	Duration
1	Project approval	0d
2	**Beam lines construction**	**1955d**
3	Cavern/Tunnel	260w
4	Beamline harware install	105w
5	Start of beam commissioning	0d
6	BDS pre-commissioning	26w
7	BDS ready for detectors	0d
8	**Detector construction**	**1955d**
9	Surface assembly hall	120w
10	Detector assembly	245w
11	Detector surface commissioning	26w
12	Detector ready for BDS	0d
13	**Final assembly & commissioning**	**130d**
14	Detector underground assembly	13w
15	Final beam commissioning	13w
16	Ready for physics run	0d



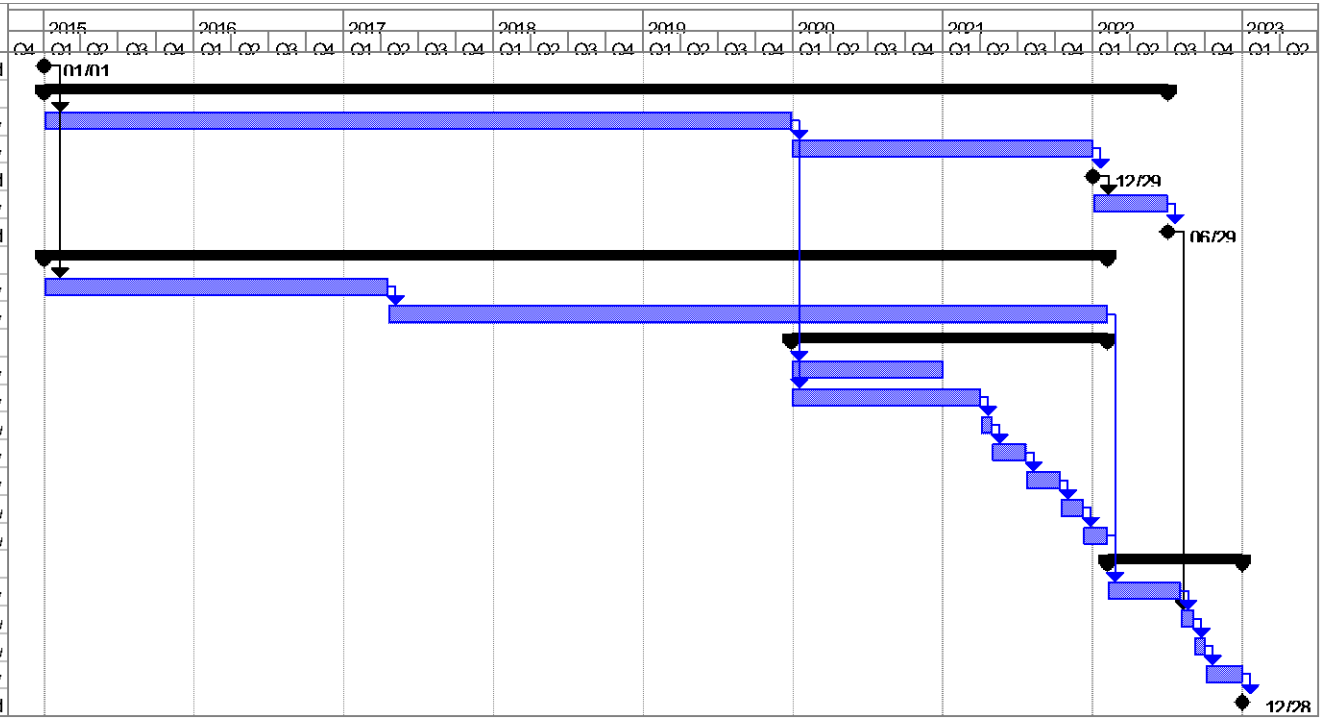
ID	Name	Duration
1	Project approval	0d
2	**Beam lines construction**	**1955d**
3	Cavern/Tunnel	260w
4	Beamline harware install	105w
5	Start of beam commissioning	0d
6	BDS pre-commissioning	26w
7	BDS ready for detectors	0d
8	**Detector construction**	**1690d**
9	Surface assembly hall	120w
10	Detector assembly on surface	218w
11	**Final assembly & commissioning**	**785d**
12	Detector underground assembly	105w
13	Detector pre-commissioning	26w
14	Detector roll-in	4w
15	Support tube, beam pipe, VTX install	5w
16	Detector check-out	4w
17	Final beam commissioning	13w
18	Ready for physics run	0d



http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/rdr/docs/CCR_surface/BDS_schedule.pdf

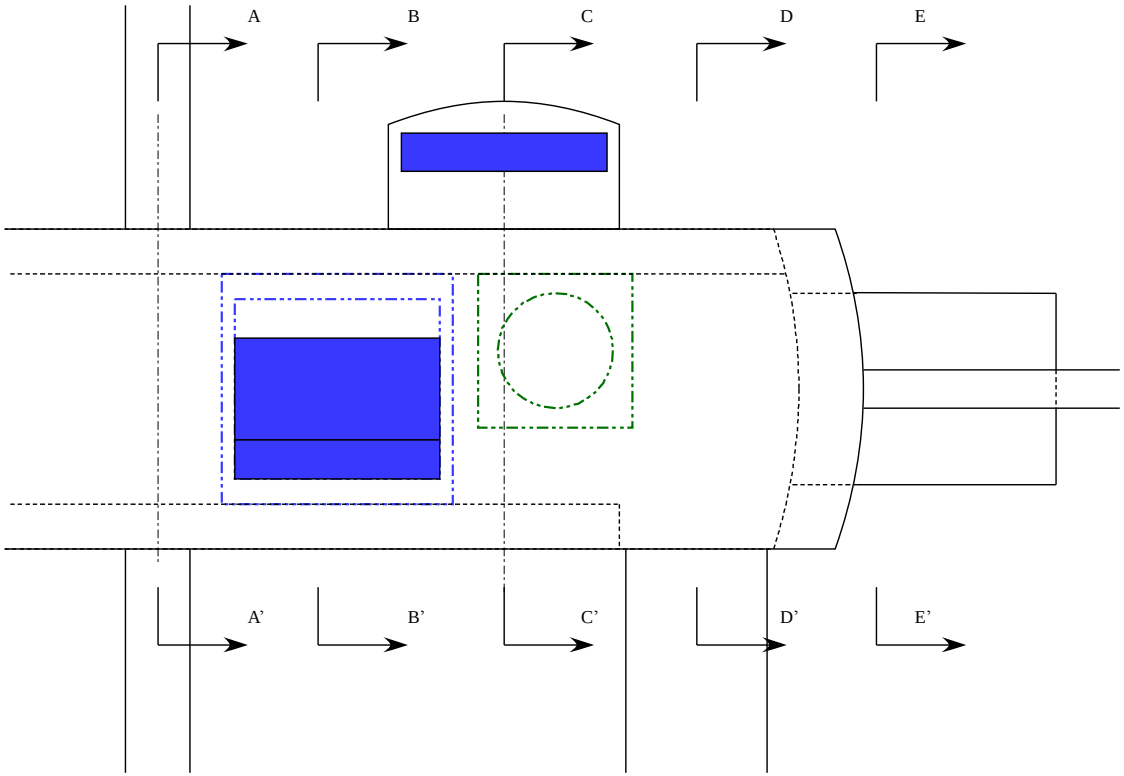
New modified CMS style

ID	Name	Duration
1	Project approval	0d
2	**Beam lines construction**	**1955d**
3	Cavern/Tunnel	260w
4	Beamline harware install	105w
5	Start of beam commissioning	0d
6	BDS pre-commissioning	26w
7	BDS ready for detectors	0d
8	**Detector construction on surface**	**1850d**
9	Surface assembly hall	120w
10	Detector assembly on surface	250w
11	**Detector assembly in cavern**	**550d**
12	Yoke assembly	53w
13	Solenoid assembly/install/test	66w
14	Field mapping	4w
15	HCAL install/cabling/test	12w
16	ECAL install/cabling/test	12w
17	TPC install/cabling/test	8w
18	SIT/FTD/VTX install/cabling/test	8w
19	**Commissioning**	**235d**
20	Detector pre-commissioning	26w
21	Detector roll-in	4w
22	Detector check-out	4w
23	Final beam commissioning	13w
24	Ready for physics run	0d



Space for assembly

- We need enough space to assemble the iron yoke and the solenoid in parallel
- Solenoid assembly procedure and installation method have to be studied
- Exp-hall should be equipped with two 200-ton cranes: usually one for each detector, and occasionally two cranes are used together to carry heavy (>200 ton) components



Summary

- Collaborating with KEK CFS group, we have just started design study of experimental hall and assembly method of ILD assuming a cavern without vertical shaft for mountain region sites
- In this scheme (exp-hall without vertical shaft), CMS style assembly cannot be adopted, and new detector assembly procedure has to be studied
- In addition, there are many issues to be studied for the optimization of the exp-hall design; some of them are common to the CMS style assembly:
  - Drainage of ground water (Cavern floor is lower than the proposed sub-tunnel)
  - Ventilation
  - Human safety
  - Cooling (Power consumption of the detector)
  - Cryogenic system (He compressor ~1km away from the solenoid?)
  - Vehicle for heavy (100~200 ton) components through the access tunnel
  - …….