Gantry crane for detector lowering

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@Infra/CFS mini-ws

Y. Sugimoto

INTRODUCTION

Discussion at SCJ committee

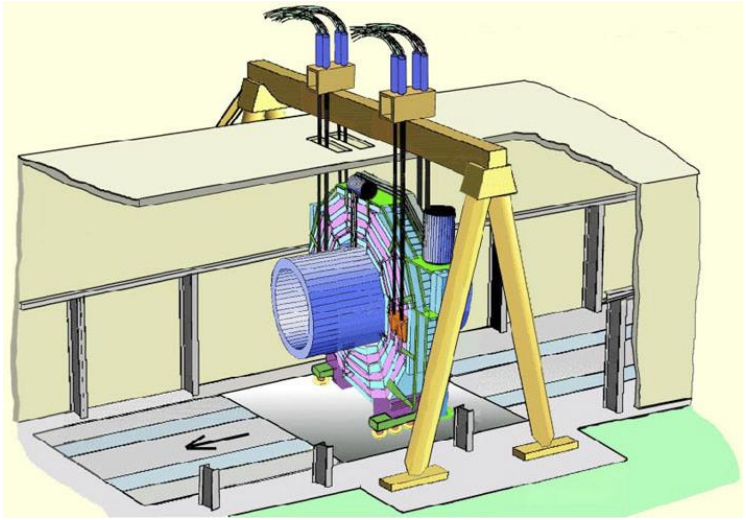
- We plan to lower ILC detectors using >4000t gantry crane (GC) by separating each detector into several parts
- Some of (sub-) committee members expressed doubt about feasibility of the >4000t GC
- I discussed with one of them when they visited KEK
  - I explained the structure of the GC (strand jacks), and showed some examples in Japan (3000t for Tokyo Sky Tree and 6000t for Kyocera Dome)
  - He understood the GC itself, but still has a doubt in the foundation (anti-seismic design)
- Actually, as far as I know, there is no study of the anti-seismic design of the GC in Japan
- Risks of 4000t GC should be estimated
- Also, risks of not using 4000t GC has to be studied
- There is no description on this issue in the report by the SCJ committee

Discussion at SCJ committee

- Gantry Crane in their mind ?

Discussion at SCJ committee

- Gantry Crane in our mind



Strand Jack

RISKS OF GANTRY CRANE

Possible risks

- Strand jacks
- Connection between strands and detectors
- Beam
- Column
- Foundation
- Operation
- Platform in Assembly Hall
- Cost

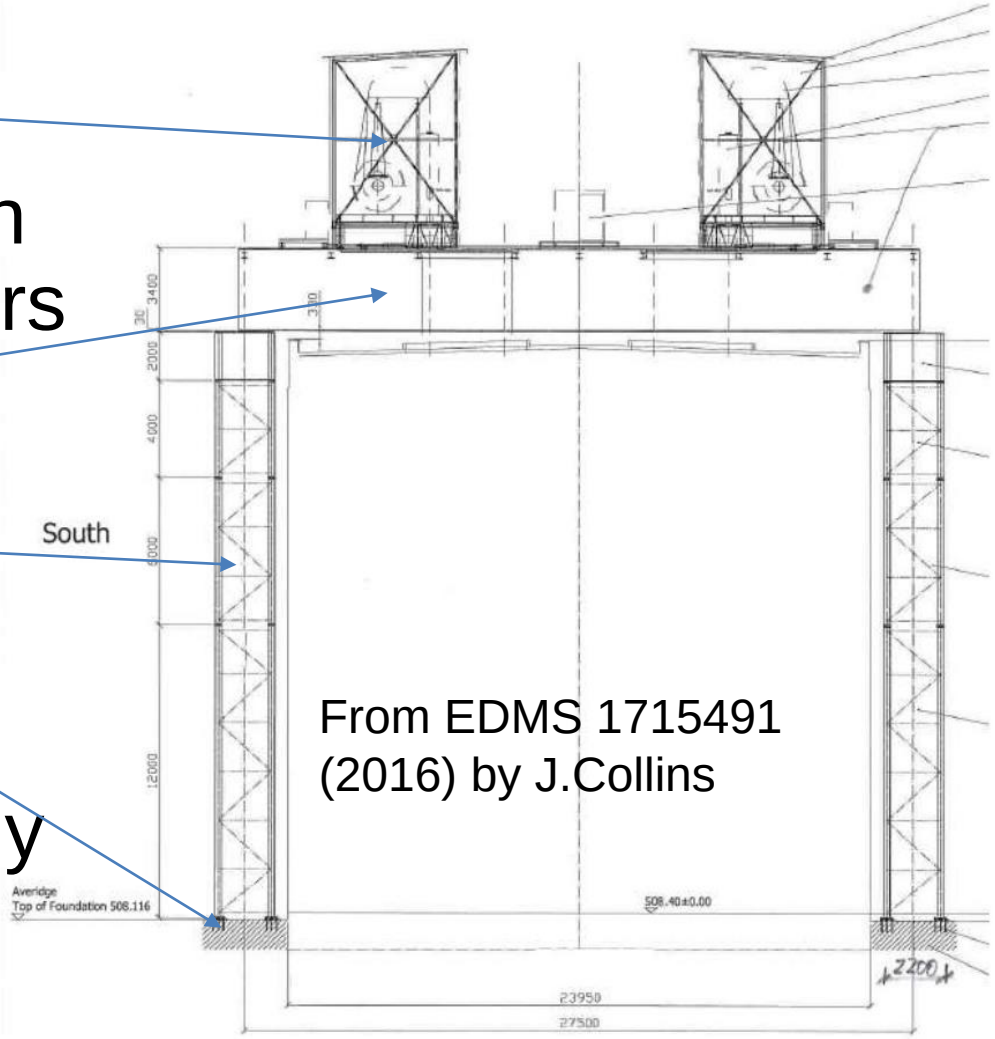


Figure 5: Front view (VSL, 2006)

Strand jacks

- CMS used 4x580t strand jacks
- Japanese company (Taihei Dengyou) can provide with 600t strand jacks with safety factor 3
- UK company (DLT) produces up to 1672t strand jacks
- US company (Enerpack), which has Japanese branch, can produces 1250t strand jacks
- Optimization of capacity/# of jacks should be done to minimize the cost

1022t jacks (From DLT web page)

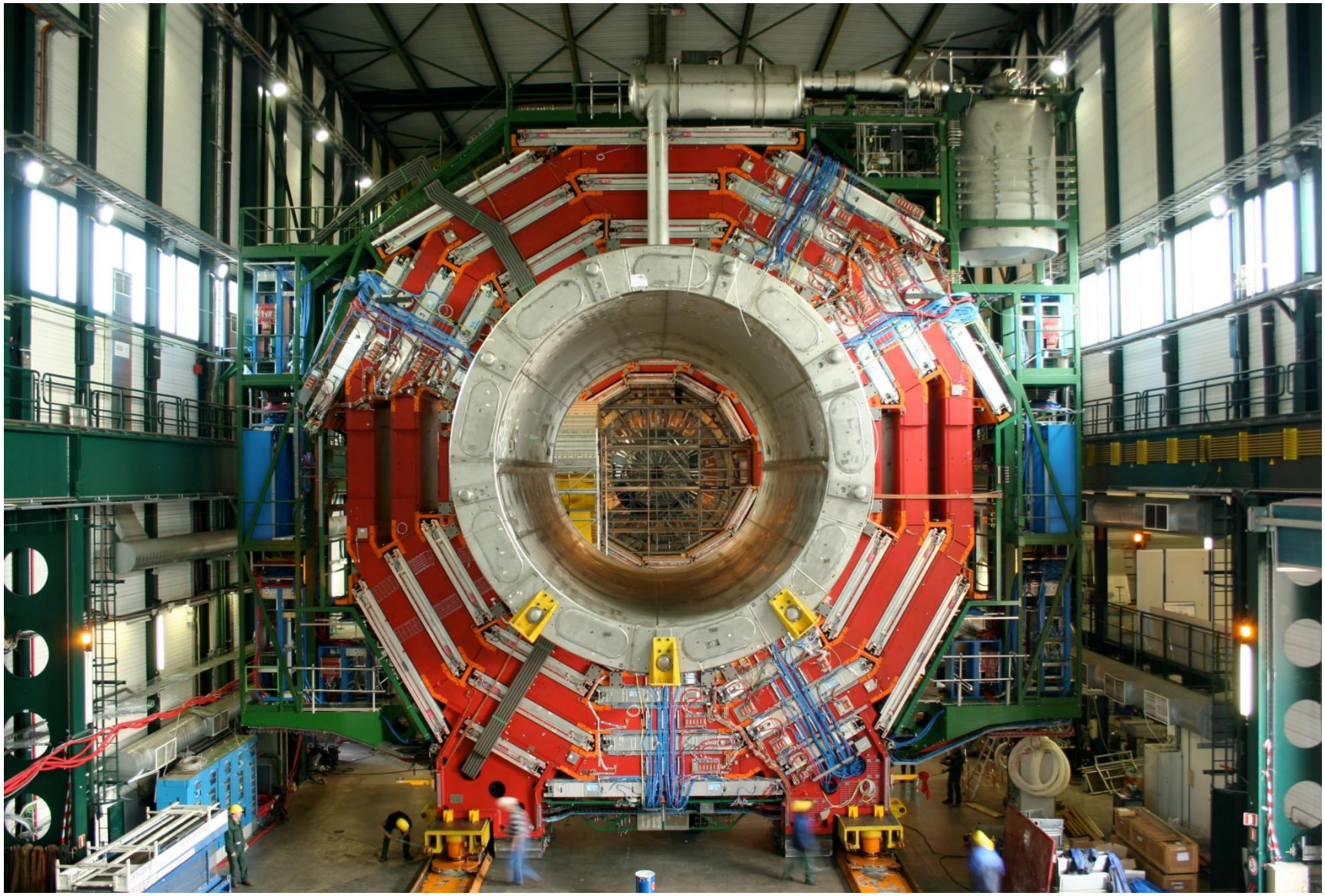
Connection between strands and detectors

- Detailed study on connection between strands and ILD has not been done yet
- We can learn from CMS

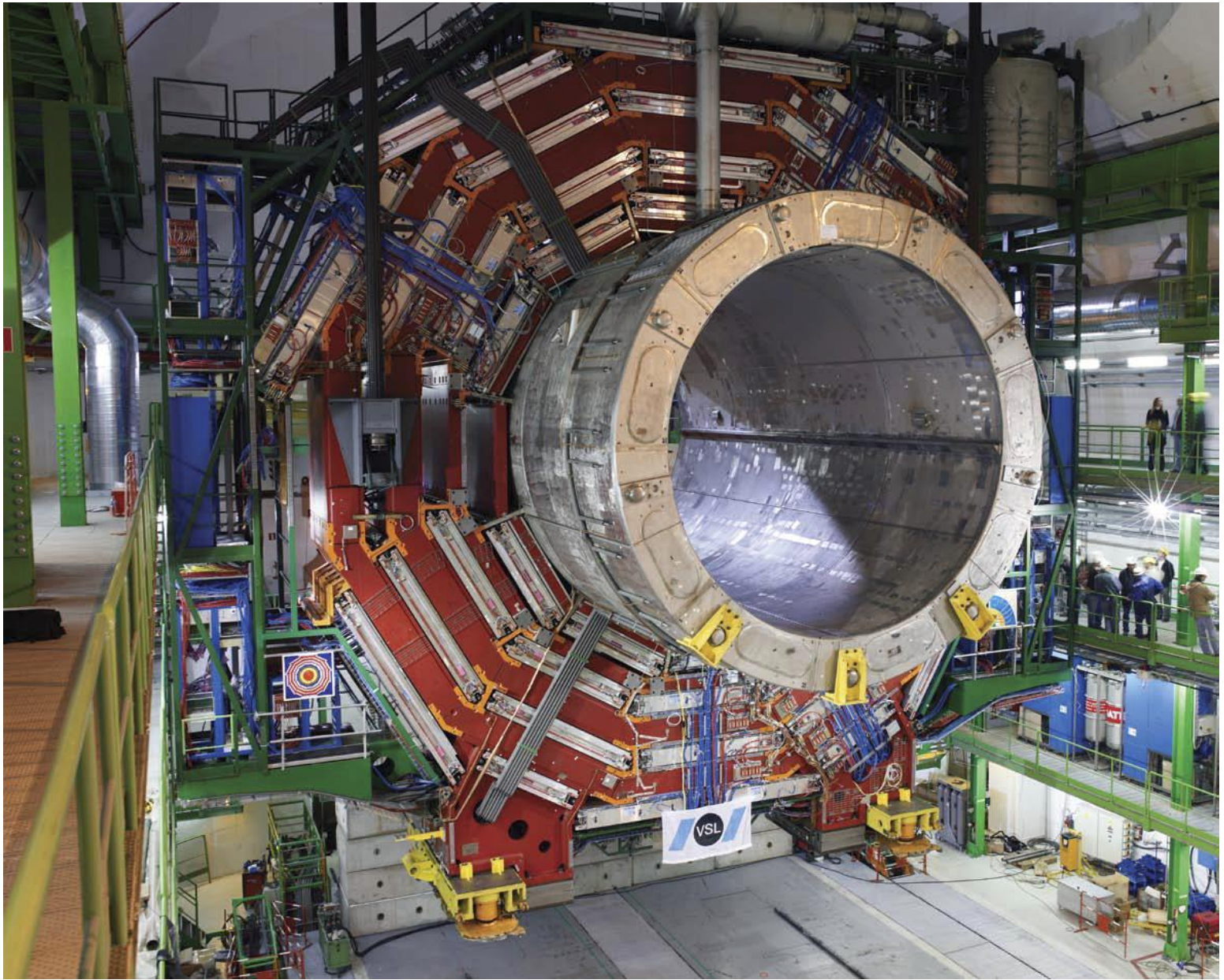
CMS at CERN

- Endcap is supported from the bottom
- YB0 is suspended from the yoke
  - Brackets fit in notches of the yoke
  - Brackets on both sides are connected by a thick rod
- CMS must have changed the position of strand jacks

CMS at CERN



CMS at CERN

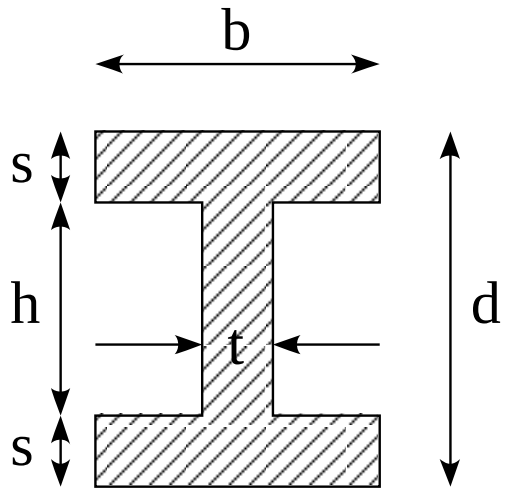


Beam

- Second moment of area of I-beam

$$I = \frac{bd^3 - h^3(b - t)}{12}$$

- X2 strength can be achieved by 20% increase of size



Column/Foundation

- GC for ILC detectors should be resistant against big earth quakes, particularly when a detector piece is suspended in Assembly Hall
- 3-column option with common platform in Assembly Hall could be an attractive option
- Anti-seismic design of columns and its foundation is mandatory
- Such design should be done by experts (civil engineering company) → We need some amount of budget

Operation – Load test

- Detector weight – ILD

Item	Mass (tons)
Barrel Yoke	2300
Solenoid	304
HCAL	640
ECAL	75
Barrel Total	**3319 (2300)**

Item	Mass (tons)
Endcap Yoke	3250
HCAL	290
ECAL	25
Endcap Total	**3565**

Operation – Load test

- Detector weight – SiD

Item	Mass (tons)		
	30° 11 layers	30° 10 layers	15° 11 layers
Yoke Iron	3863	3372	3569
Feet	80		
Solenoid	180		
HCAL	417		
Barrel Total	**4540**	**4049**	**4246**
Item	**Mass (tons)**		
	30° 11 layers	30° 10 layers	15° 11 layers
Yoke Iron	1655		
HCAL	55		
ECAL	12		
Packman	216		
Brackets	76		
Cart	277		
Endcap Total	**2291**		

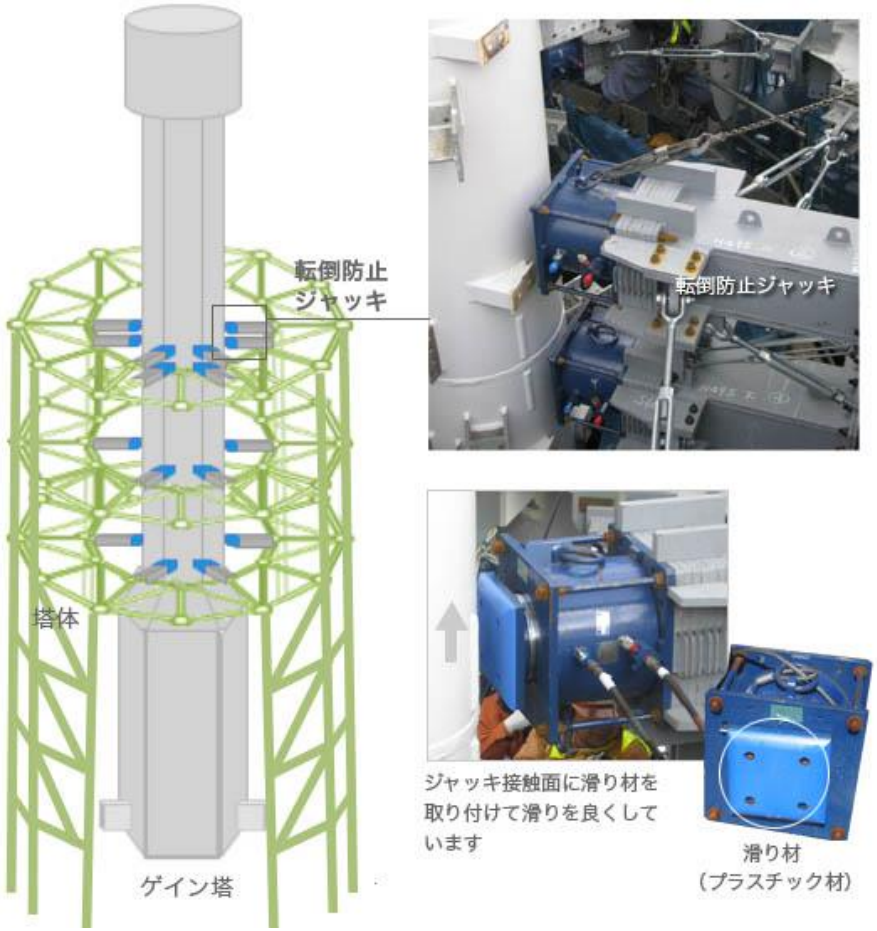
Operation – Load test

- Load test
  - If maximum load is 4000t, we have to do a load test with 4000tx1.25=5000t
  - We can do that with platform+ILD barrel ring (w/o detector)
    - Platform in Assembly Hall ~20mx20mx2.7mx2.5t/m^3=2700t
    - ILD barrel ring w/o detector ~ 2300t
    - Total 5000t

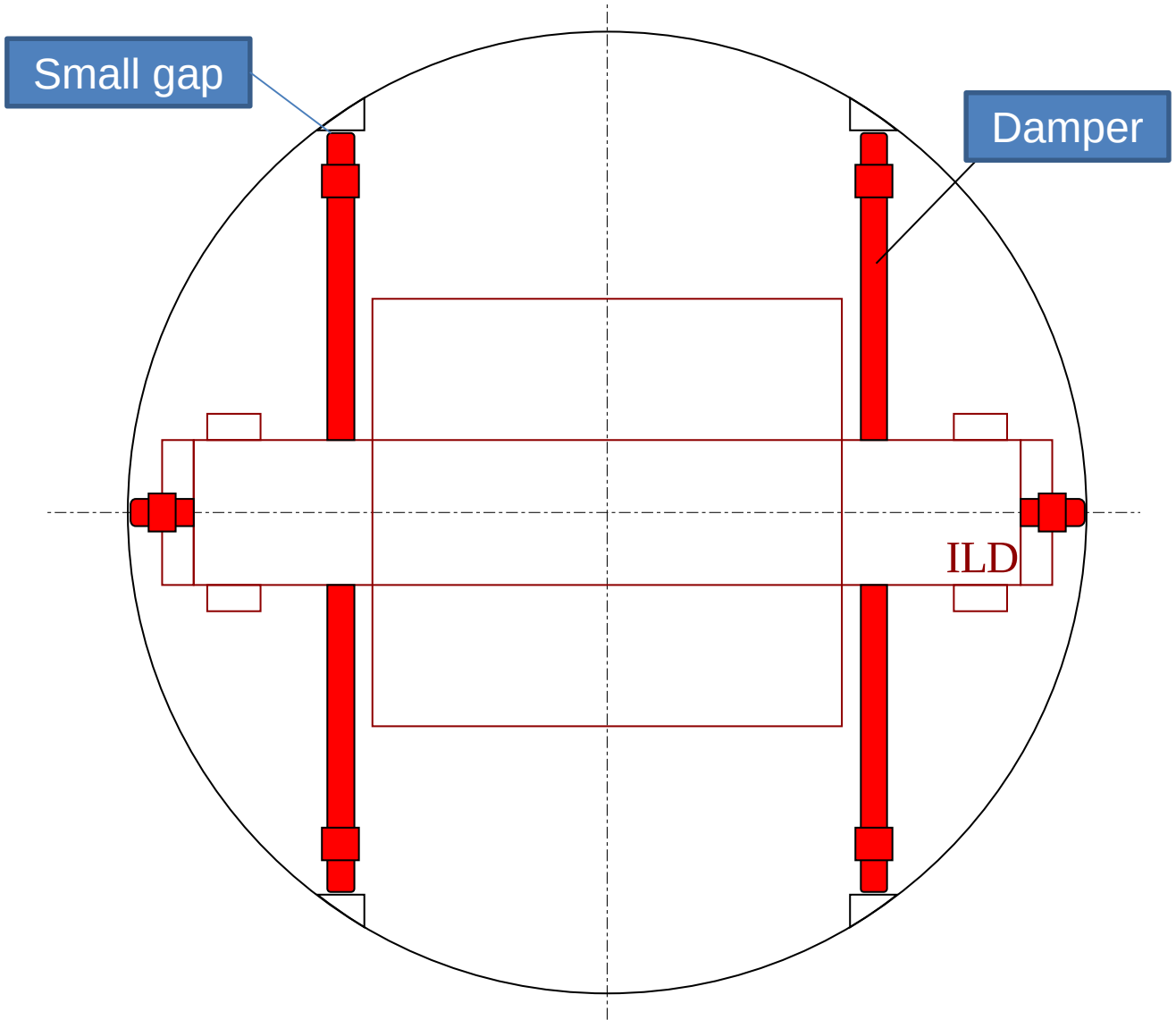
Load test of CMS gantry crane with >800t iron blocks + platform(1920t)

Operation – Lowering

- Protection against big earthquake during lowering
  - 3.11. earthquake happened during lifting up 3000t Gain Tower of Tokyo Sky Tree
  - There was no damage because it was supported from the side
  - We should adopt similar way during detector lowering



Operation – Lowering



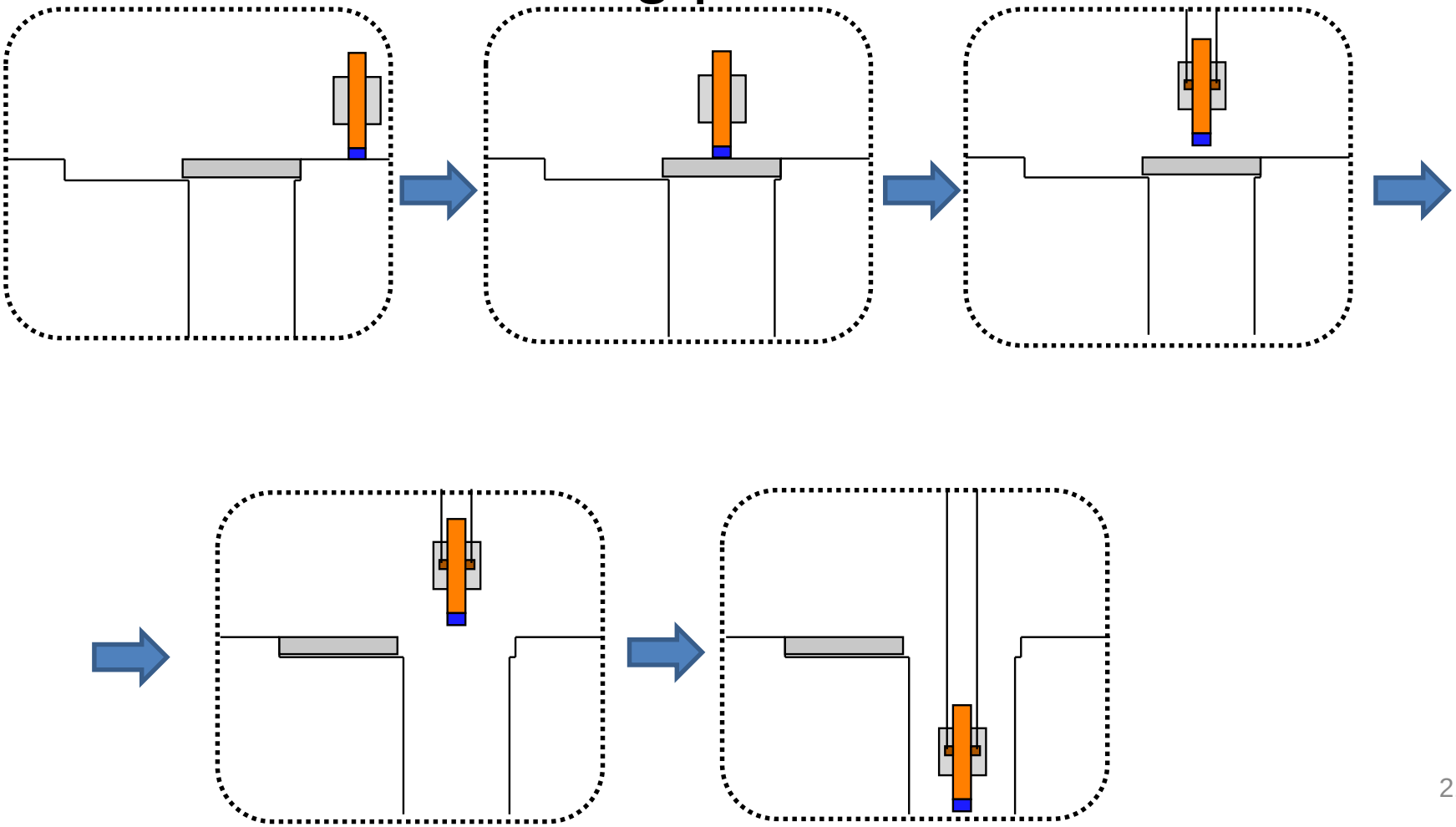
Platform in Assembly Hall

- Load on the platform is x2 larger than CMS case
- Can it move with such heavy load?
  - CMS platform slid without detector piece on it : ~ 1920t
  - SiD barrel + Platform ~ 6700t has to slide !!

➔ A new idea of “Common Platform”

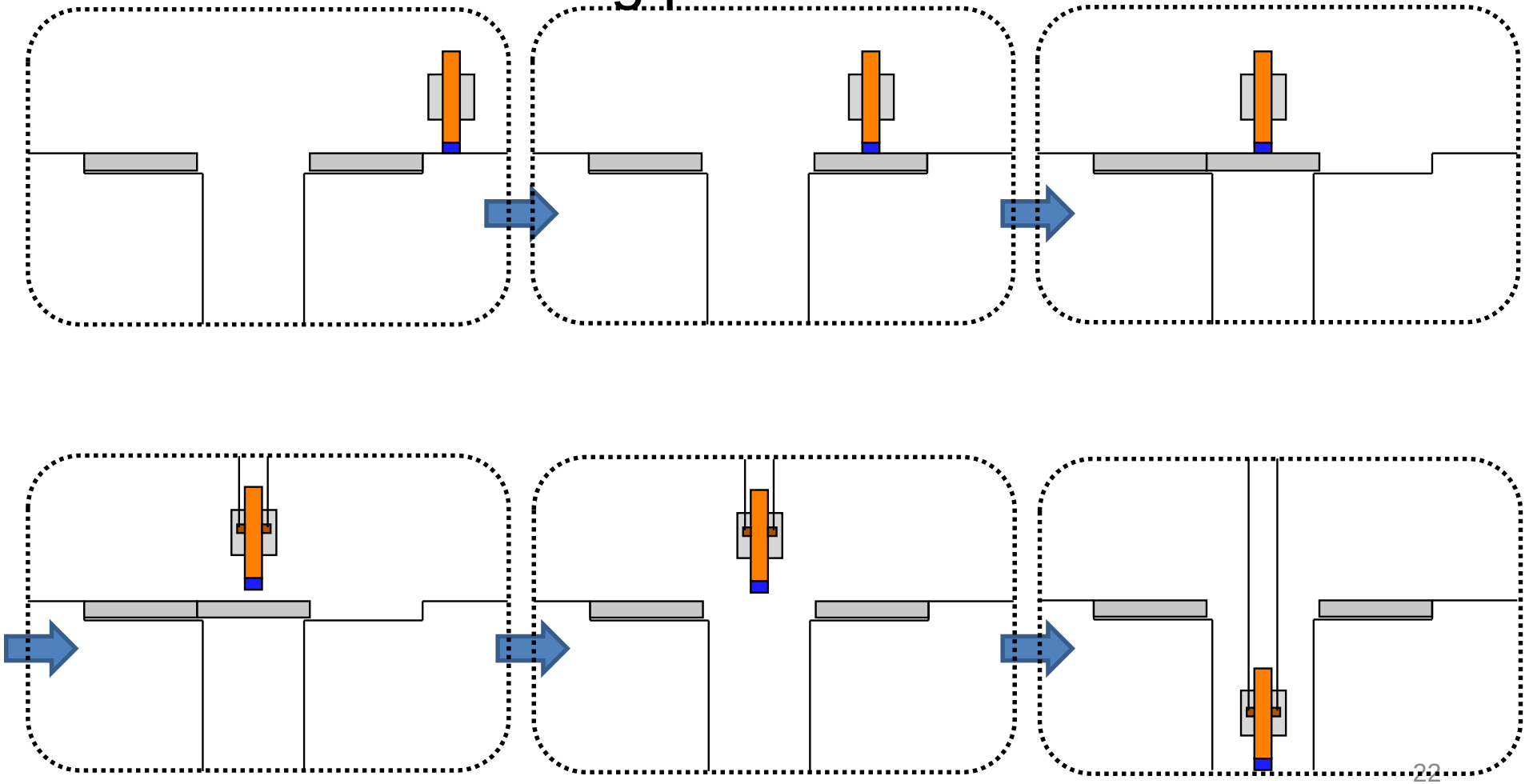
Platform in Assembly Hall

- Detector lowering procedure of CMS



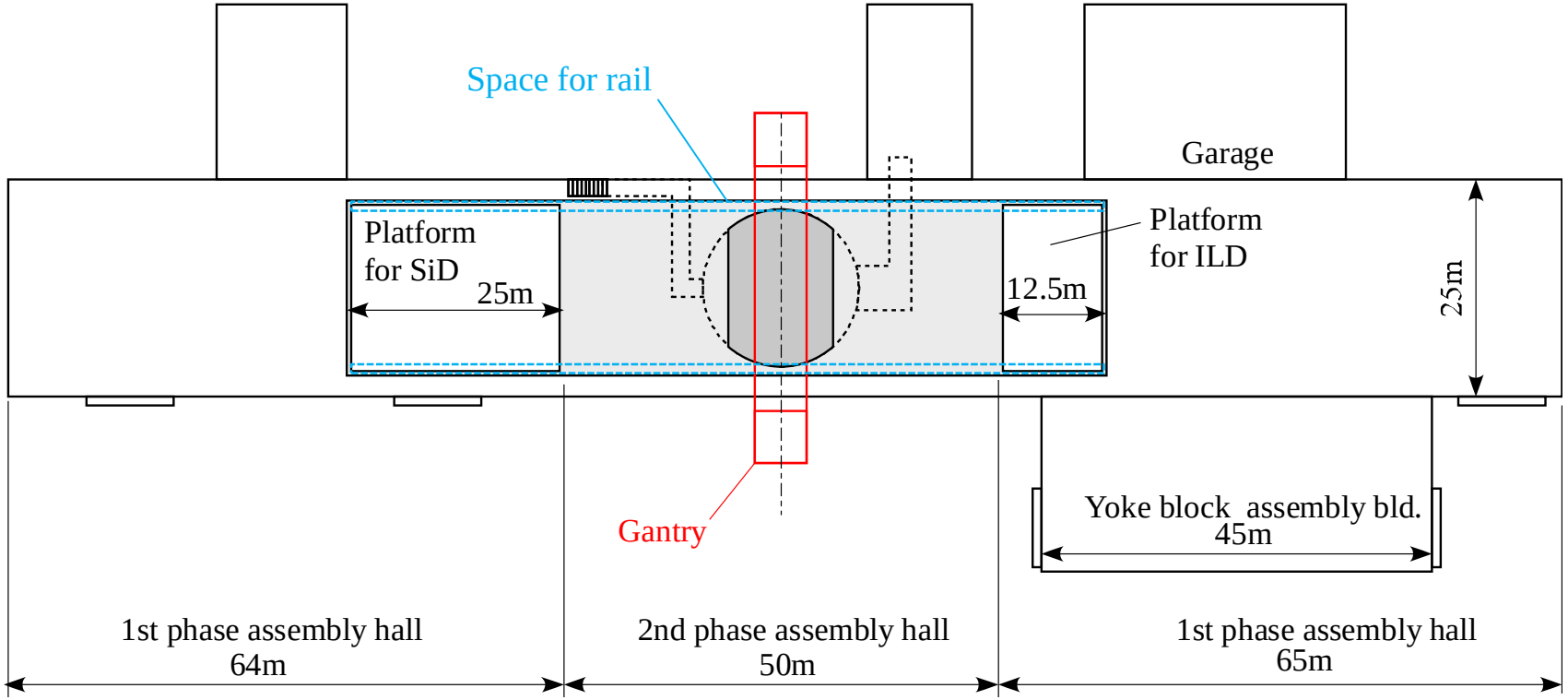
Platform in Assembly Hall

- Detector lowering procedure of ILD



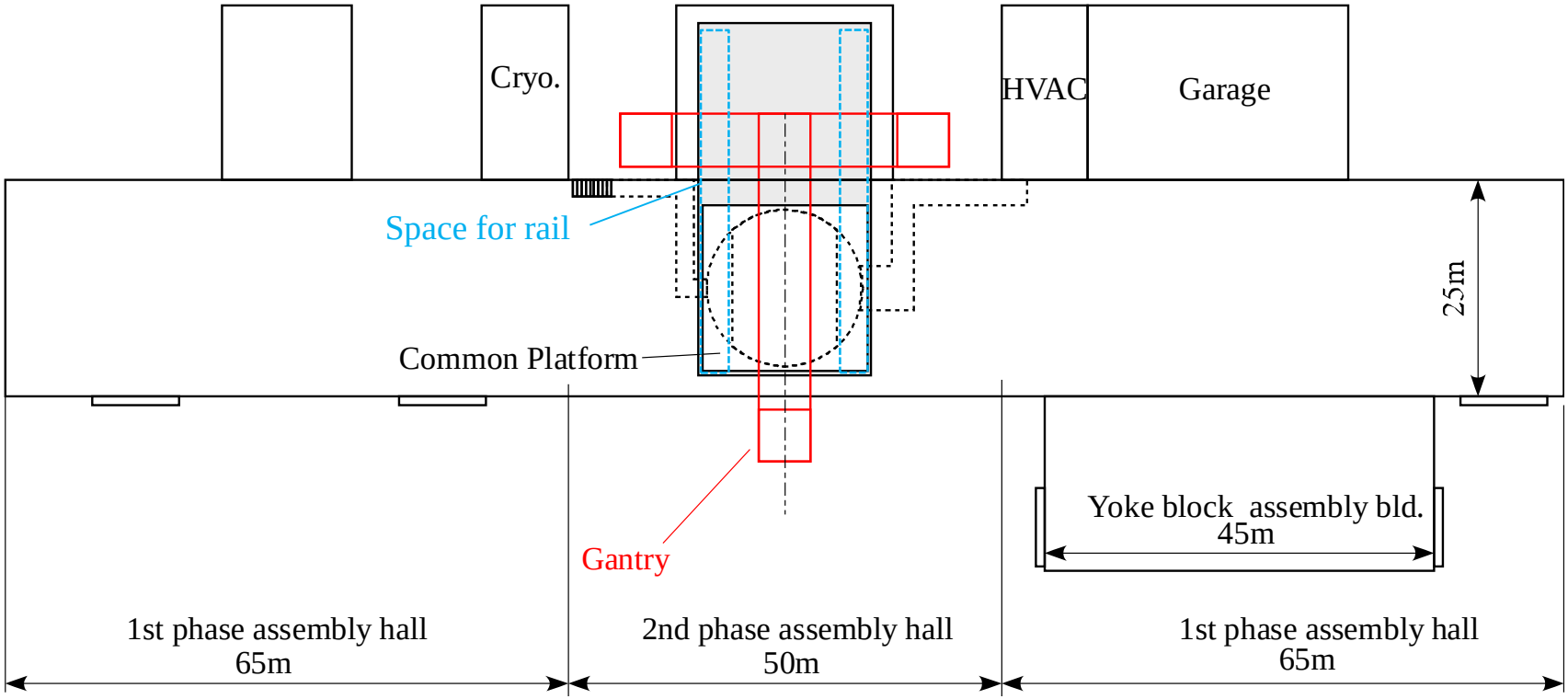
Platform in Assembly Hall

- Present design



Platform in Assembly Hall

- Common Platform option



Cost

- The cost of 4000t GC was estimated in Japan several years ago
  - VSL : ~X6 more expensive than CMS case
  - Taihei Dengyou : Slightly higher than VSL
- More serious estimation should be done
- Cost sharing should be discussed
  - CMS group paid the cost for GC from their common fund

Risks of not using 4000t GC

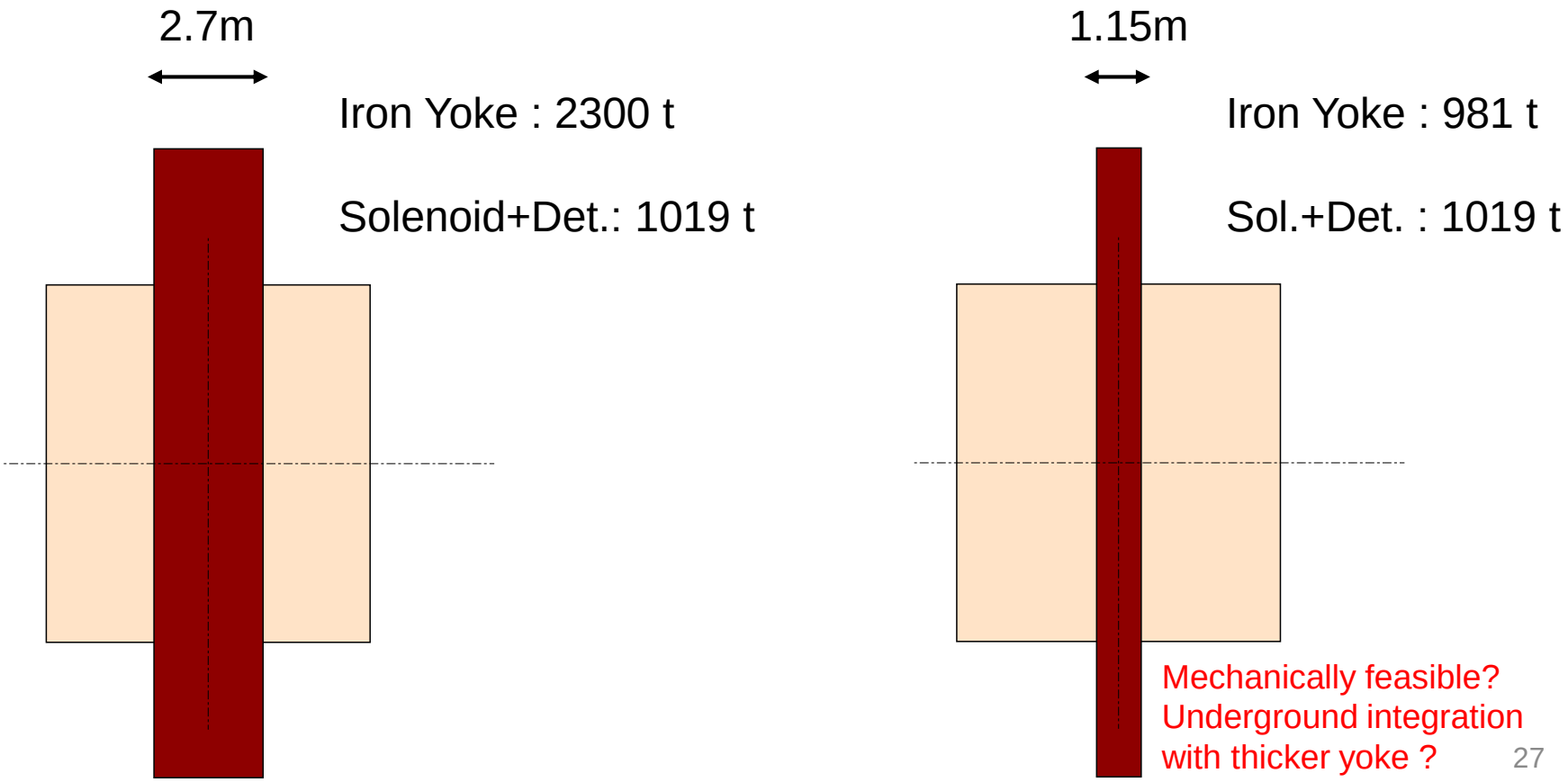
- What happens when capacity of GC is 2000t?
  - Detector has to be divided into more pieces
  - As a consequence, we need more assembly space, more integration/lowering time, and more cost
  - We might have to go back to underground assembly

		Weight		Division		
		Yoke	Detector	4000t	2500t	2000t
ILD	Barrel	6900	1019	3	3* or 5	5
	Endcap	3250x2	315x2	2	4	4
	Total			**5**	7 or 9	9
SiD	Barrel	3372	677	1	3	3
	Endcap	1655x2	636x2	2	2	4
	Total			**3**	5	7

* Detector installation in Detector Hall (underground)

In case of 2000t GC

- ILD YB0



SUMMARY

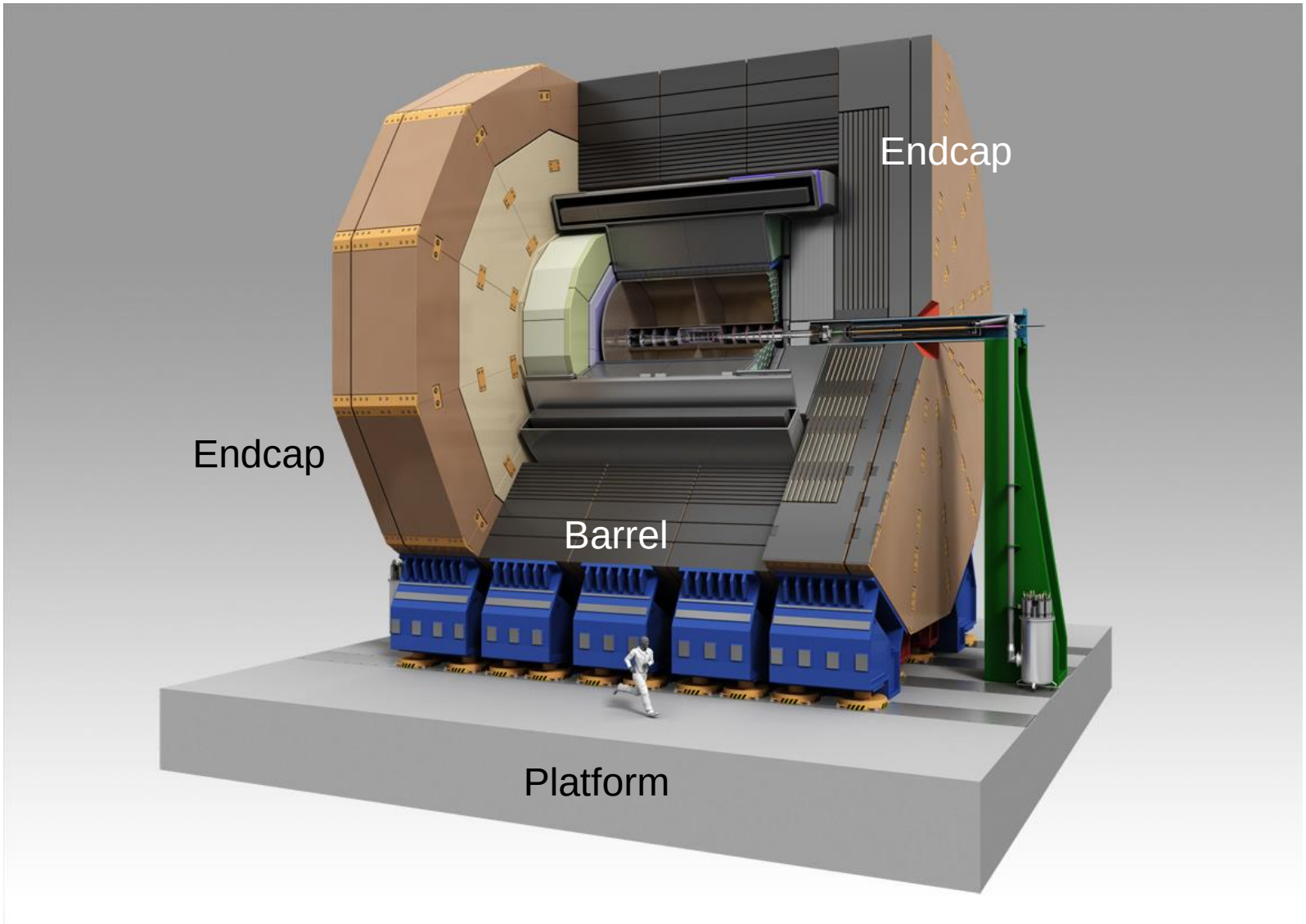
Action item

Item	Action	Who?
Strand jacks	• Optimization of capacity and number	Det., CFS, Company
Connection between strands and detector	• Detailed design of connection	Det
Beam/column/foundation	• Anti-seismic design of gantry	CFS, Company
Operation	• Decision of maximum weight • Detailed design of support arm	SiD Det., CFS
Platform in AH	• Agreement by ILD and SiD • Detailed design	Det., CFS Det., CFS, Company
Cost	• Detailed cost estimate	CFS, Company
In case of 2000t GC	• Study of necessary space and assembly timeline • Mechanical study of sub-divided detector	Det. Det.

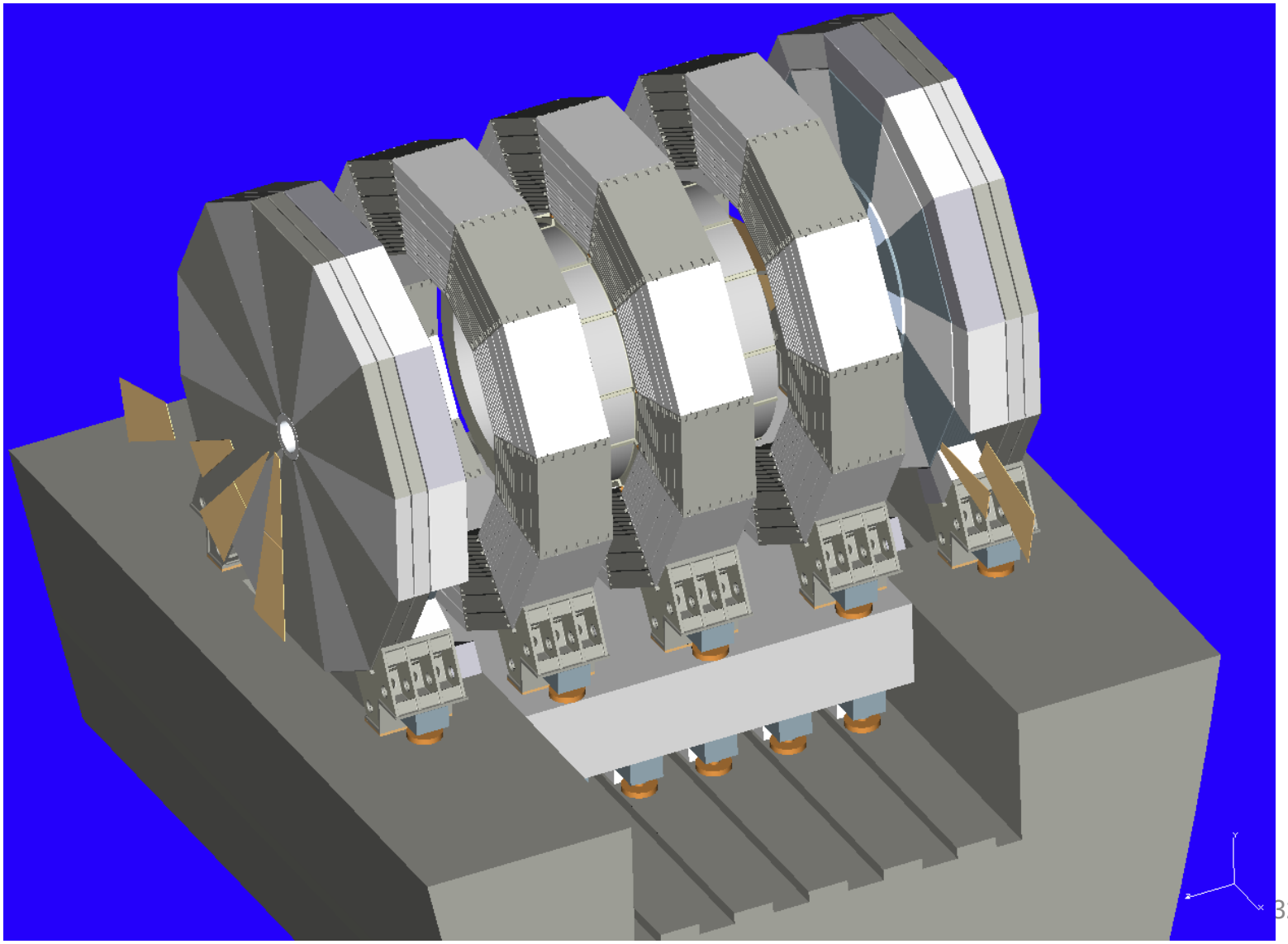
It seems there is no show-stopper for 4000t gantry crane

BACK-UP SLIDES

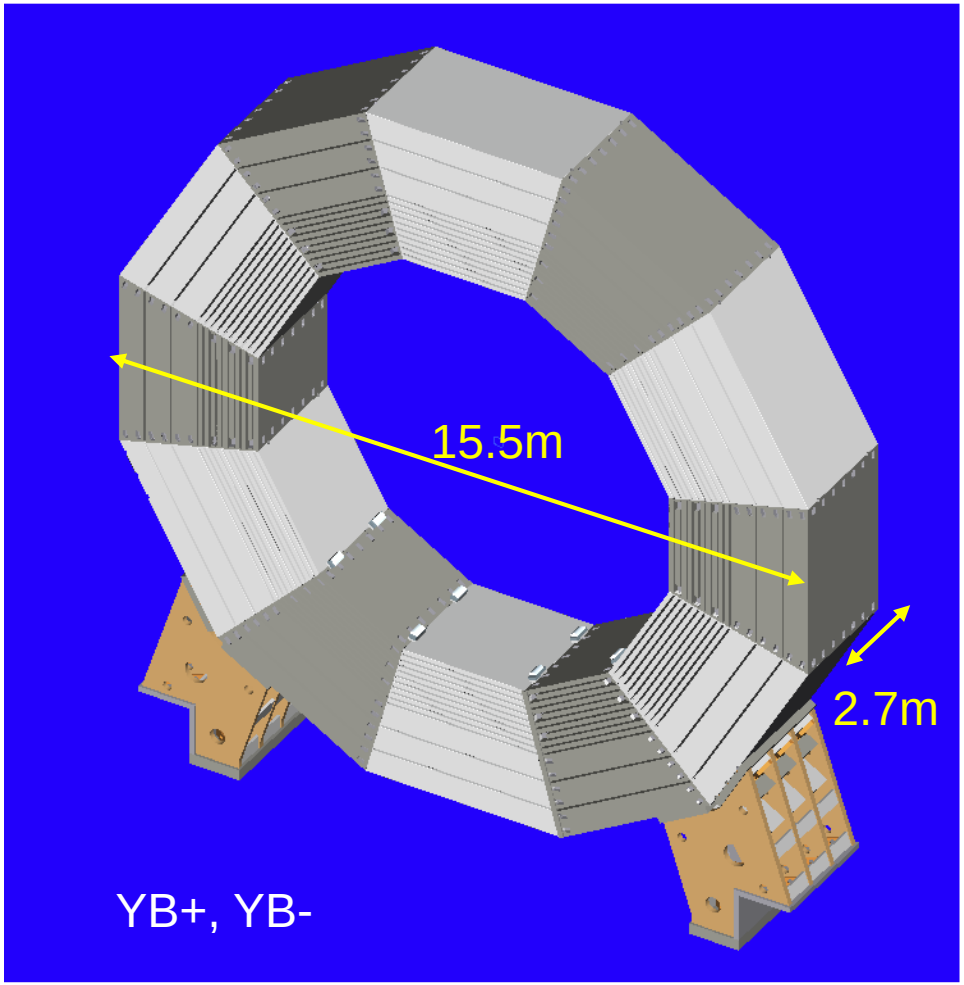
ILD

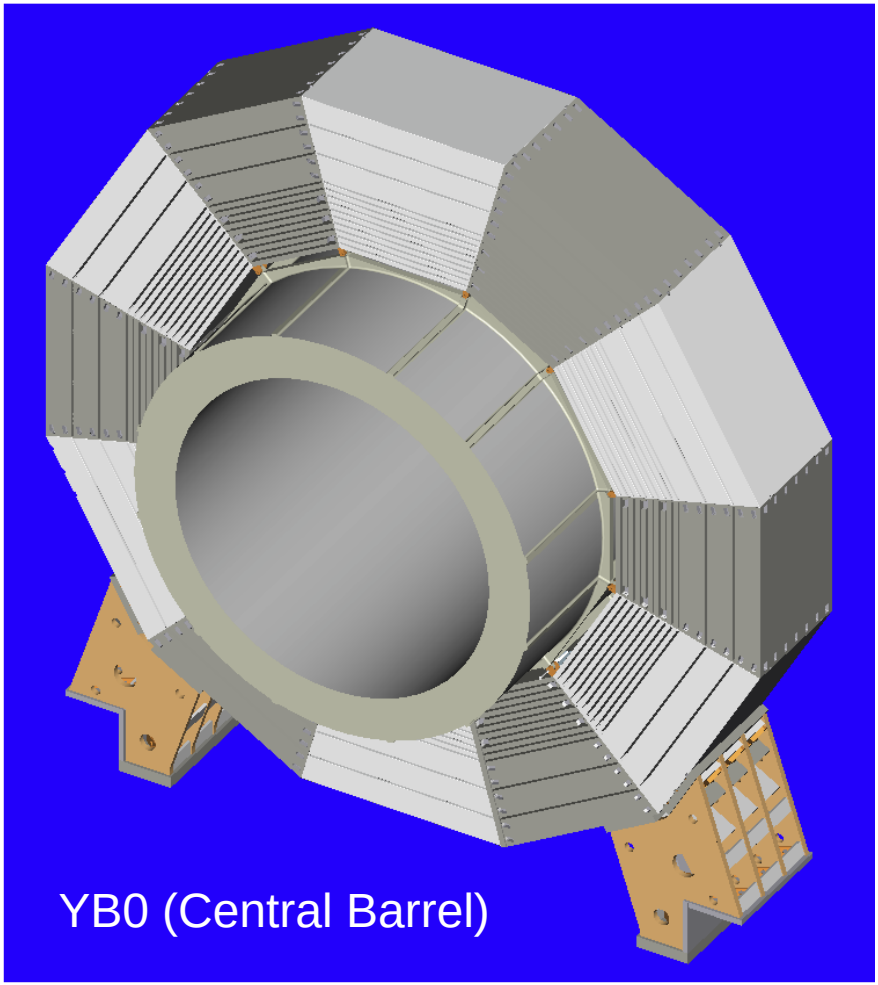


ILD



ILD Barrel





ILD Weight

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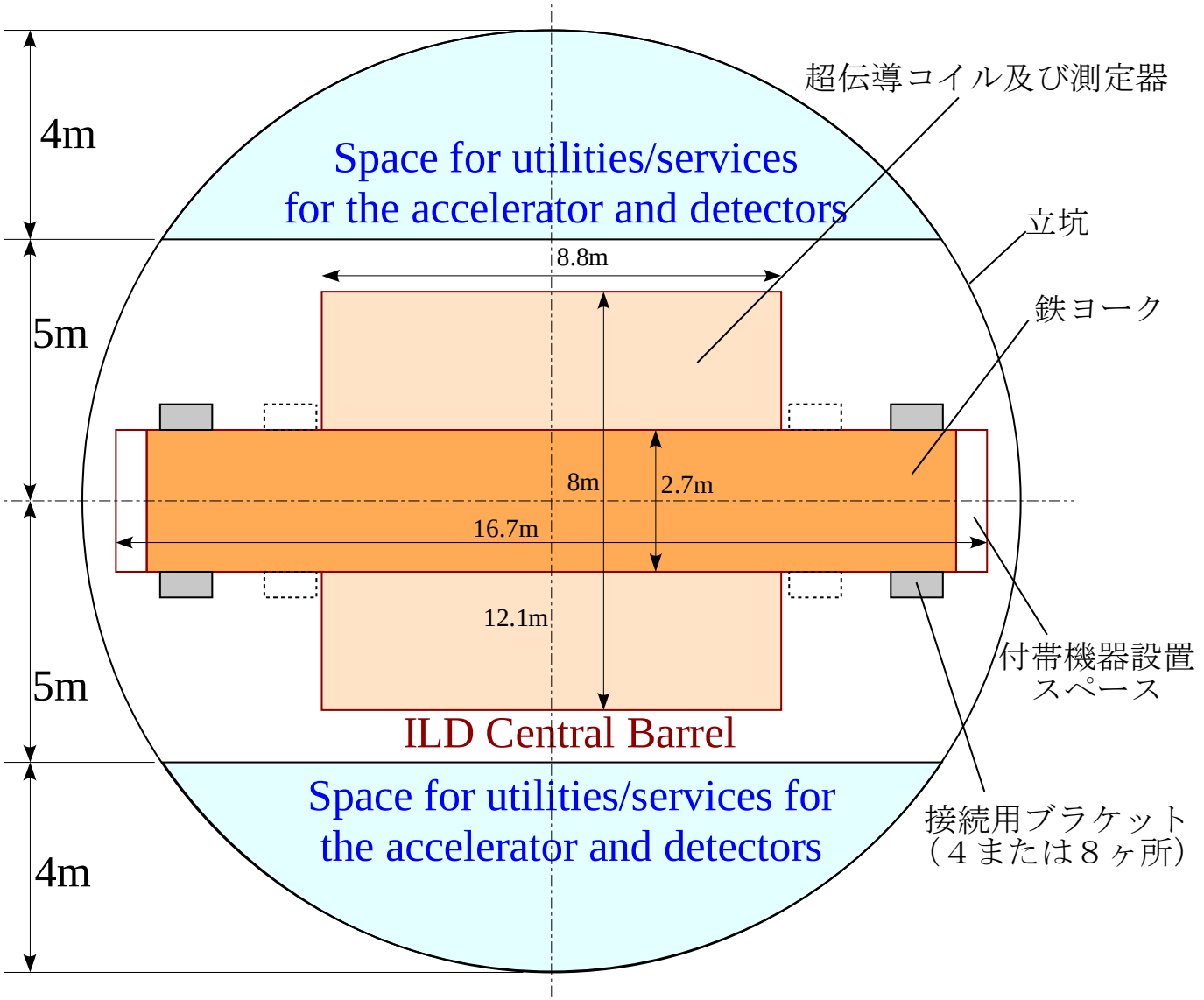
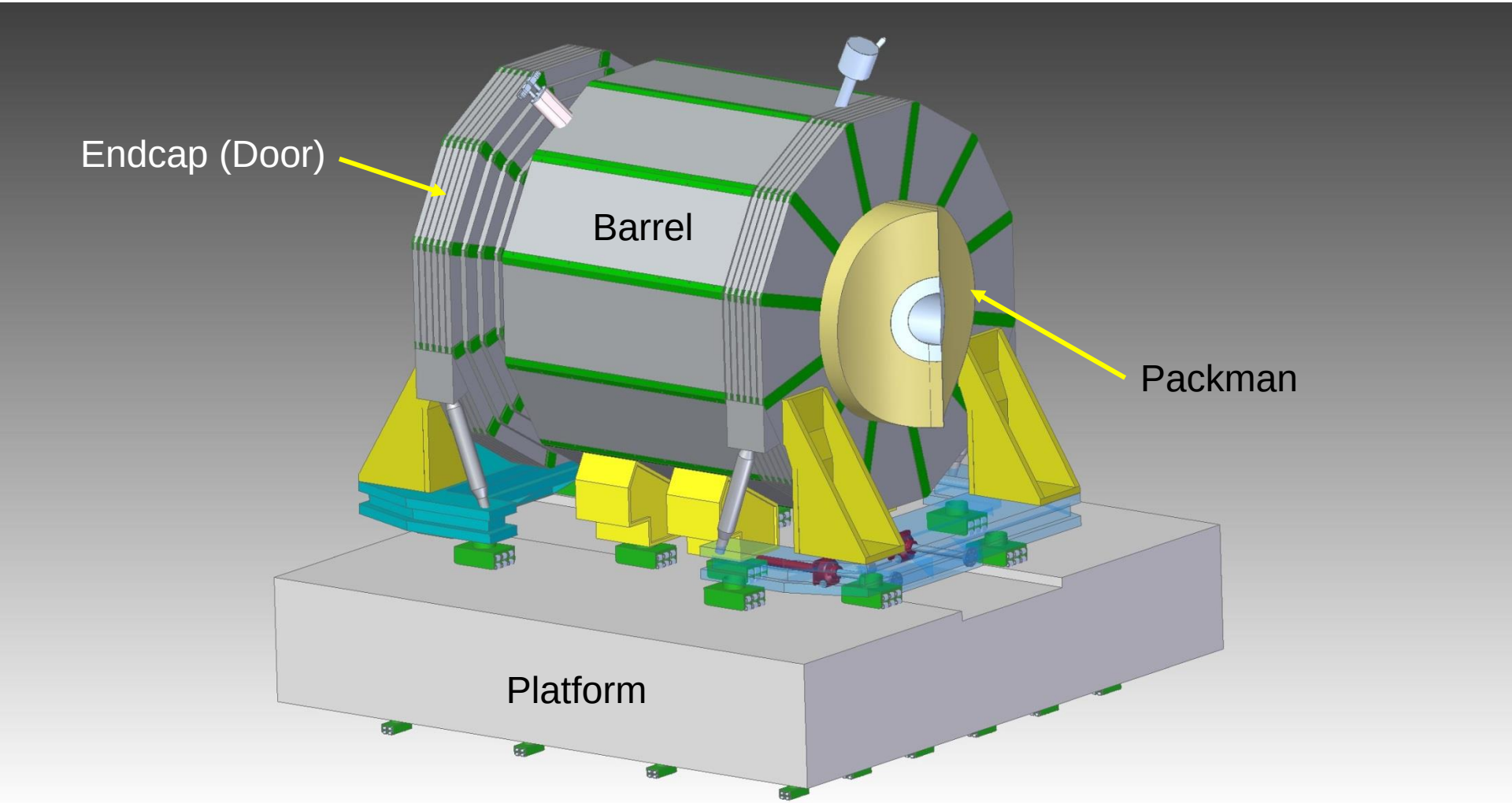
HCAL	290
ECAL	25
Endcap Total	**3565**

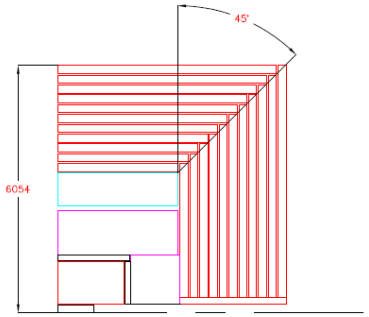
Vertical Shaft

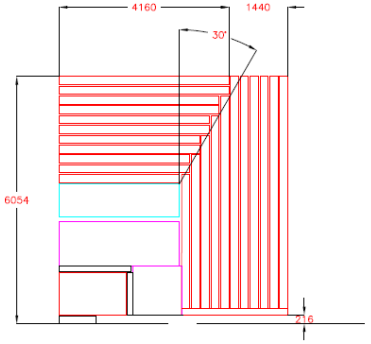


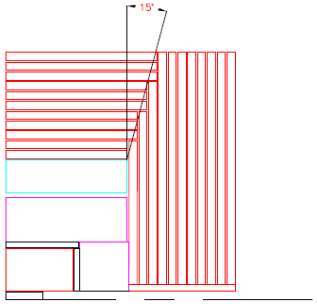
SiD

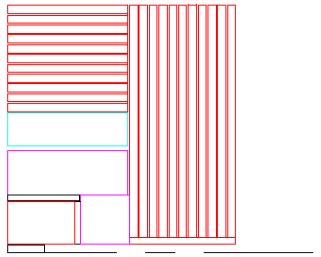


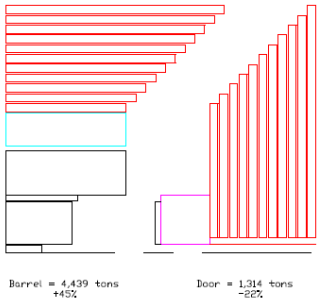
Barrel-Door partitions

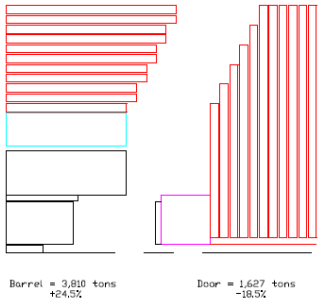


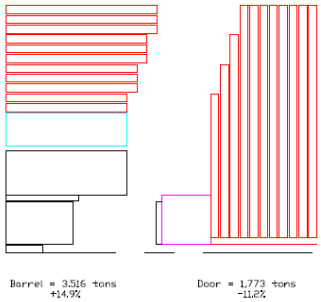


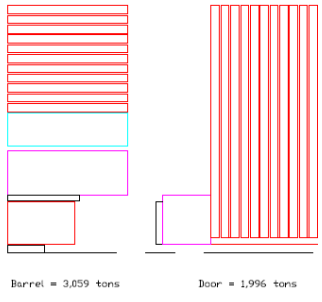












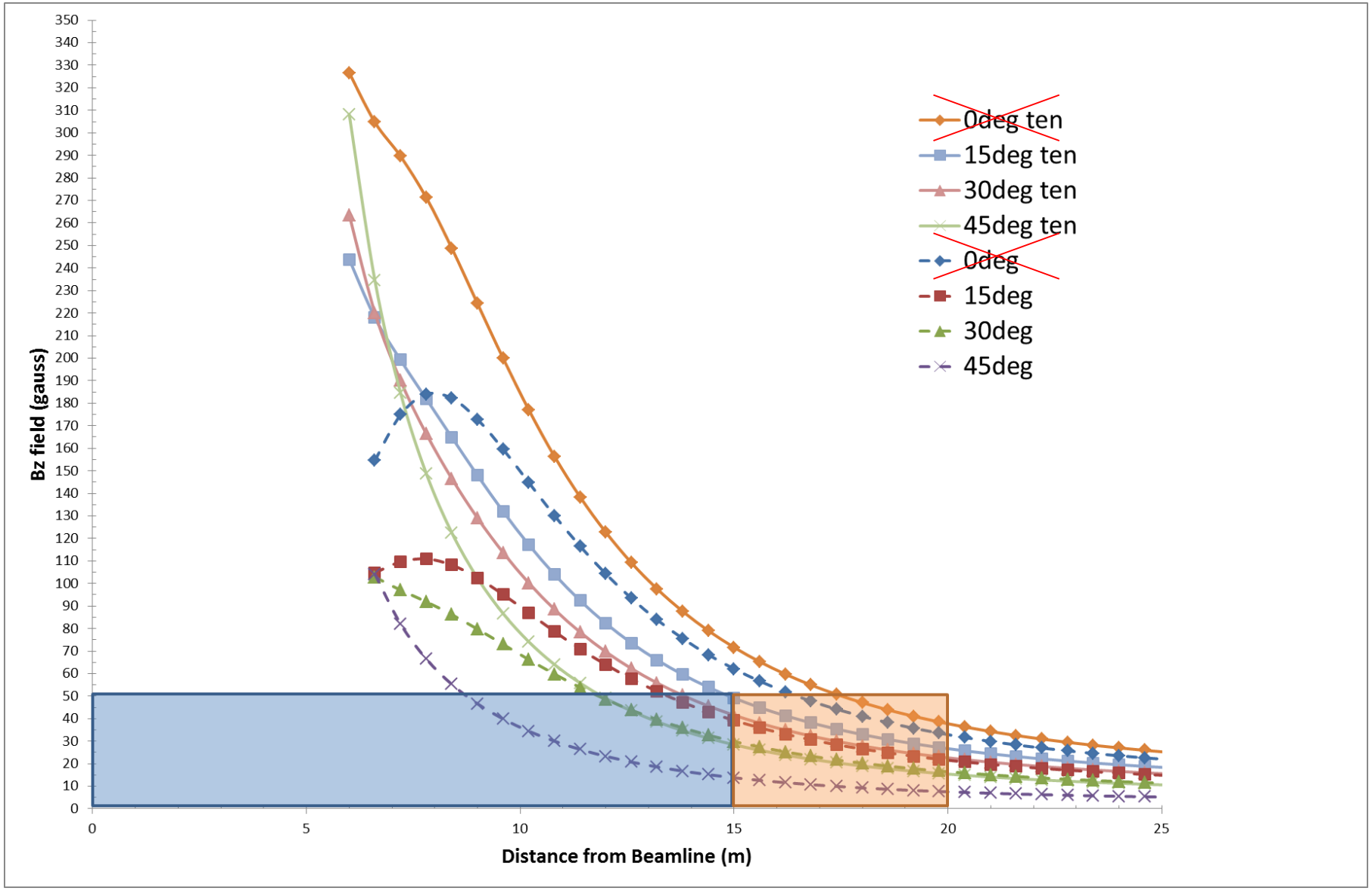
45 deg

30 deg

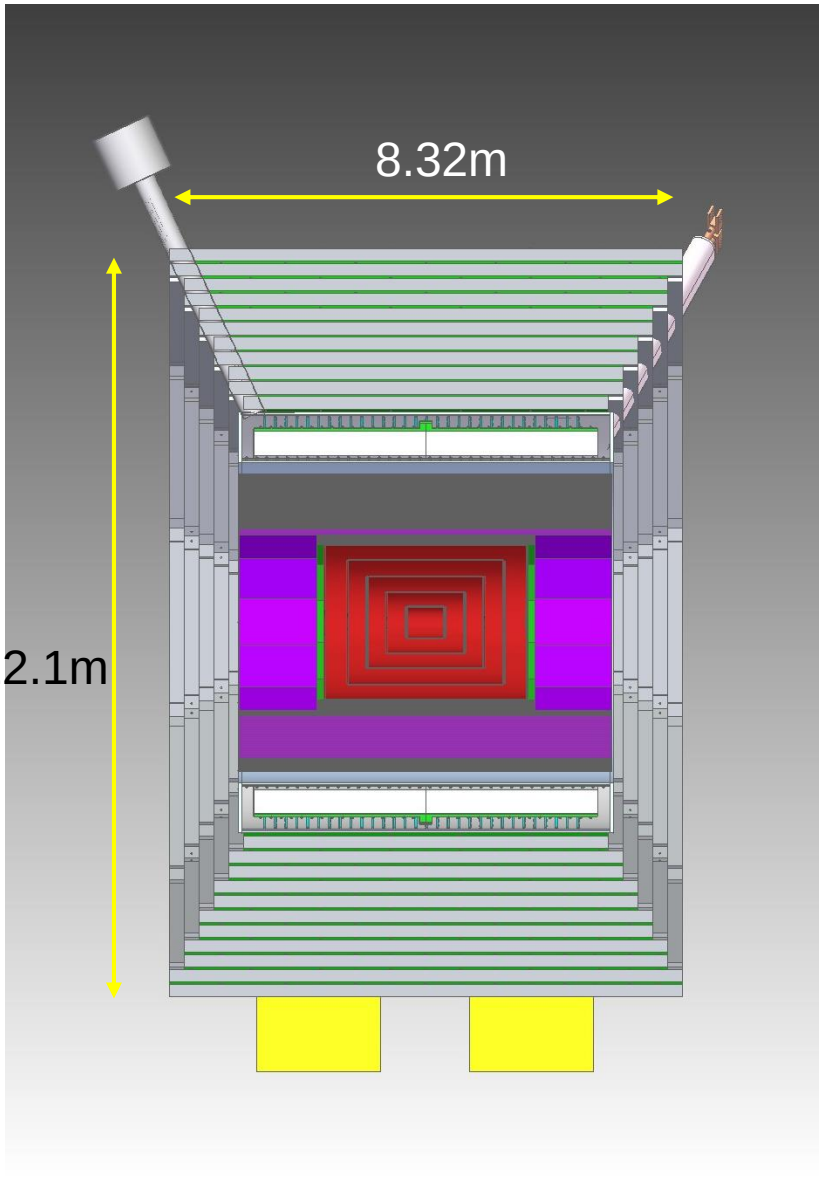
15 deg

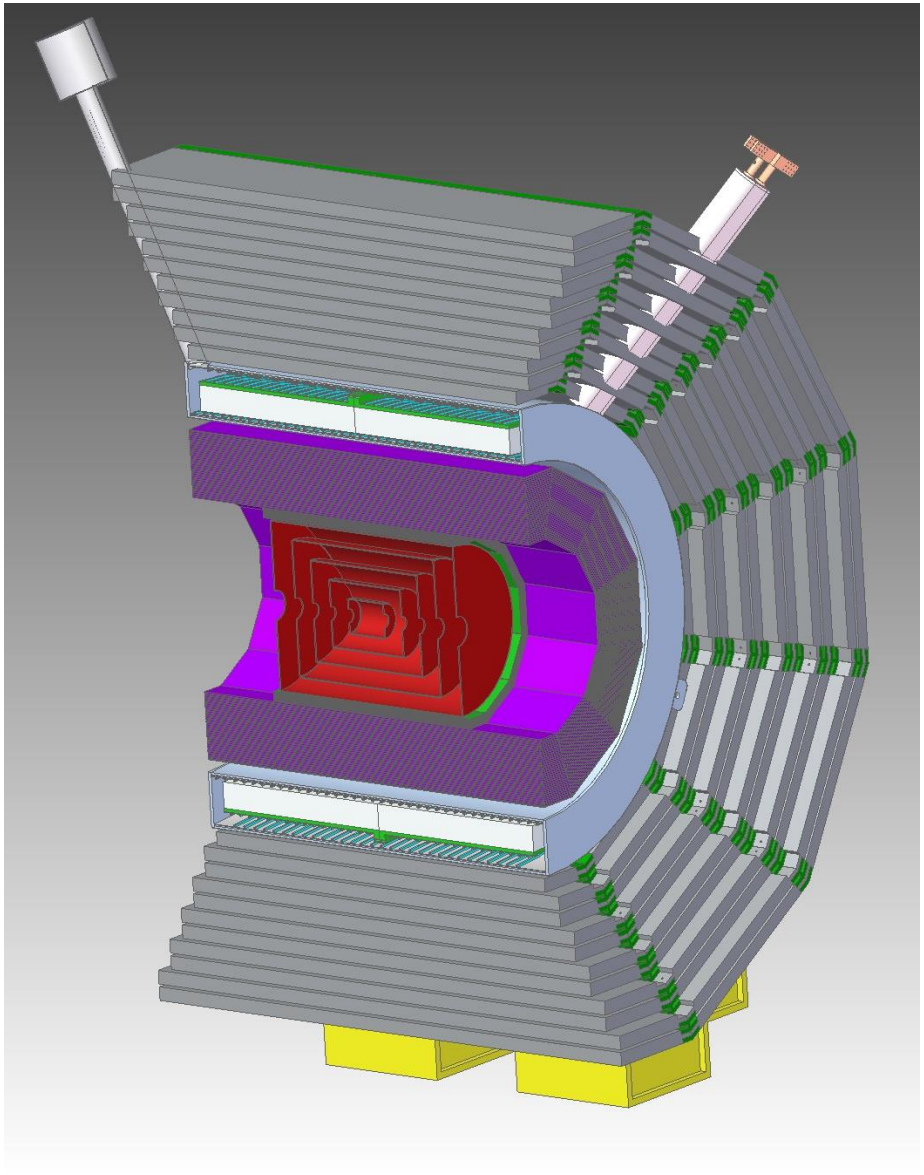
0 deg
Baseline

Bx field Far Region - All

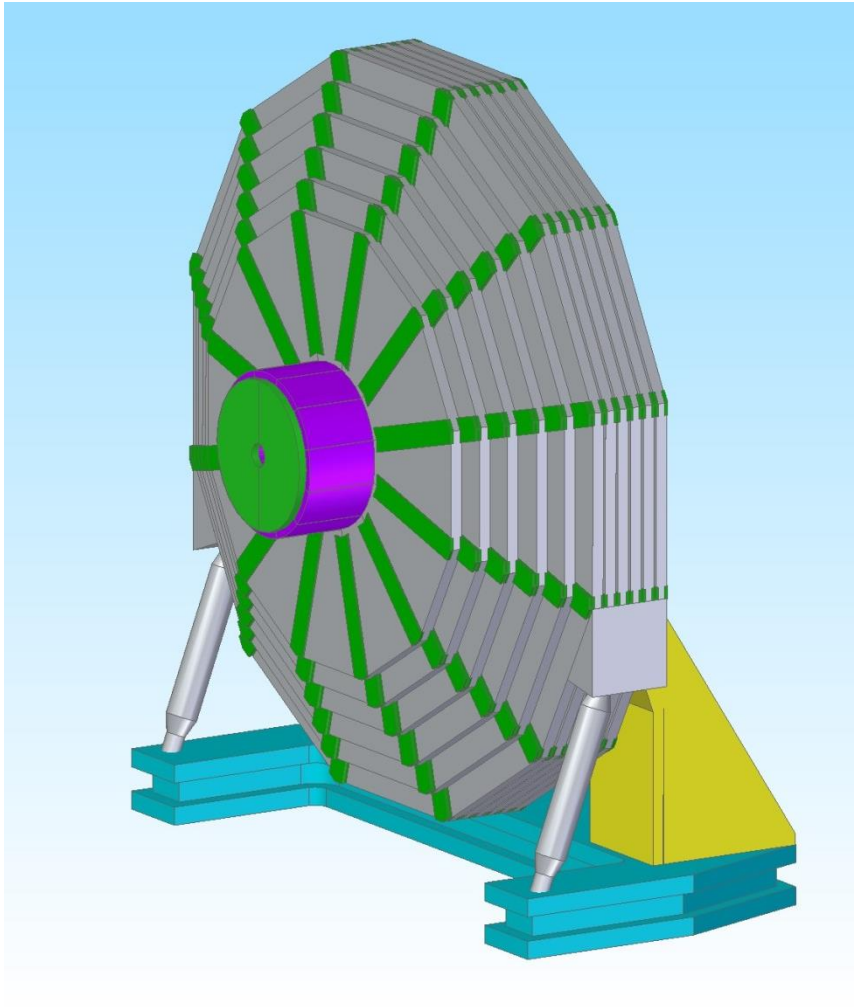


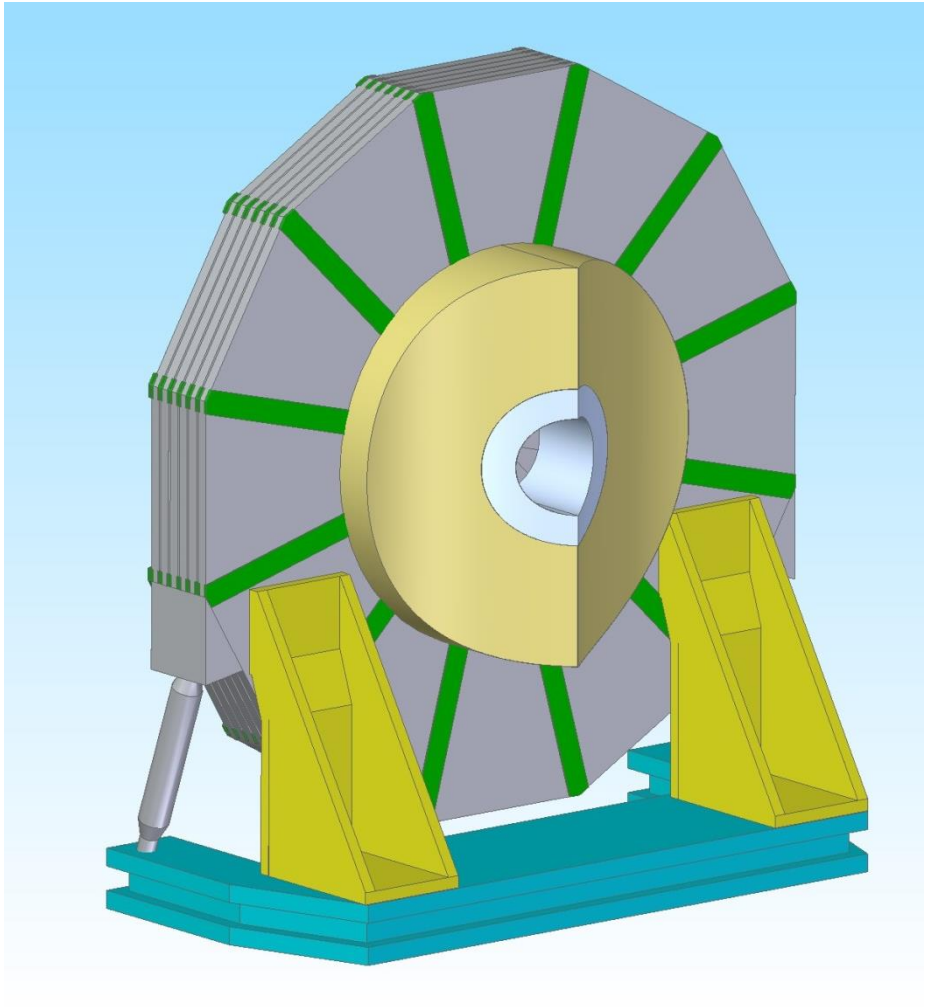
SiD Barrel





SiD Endcap





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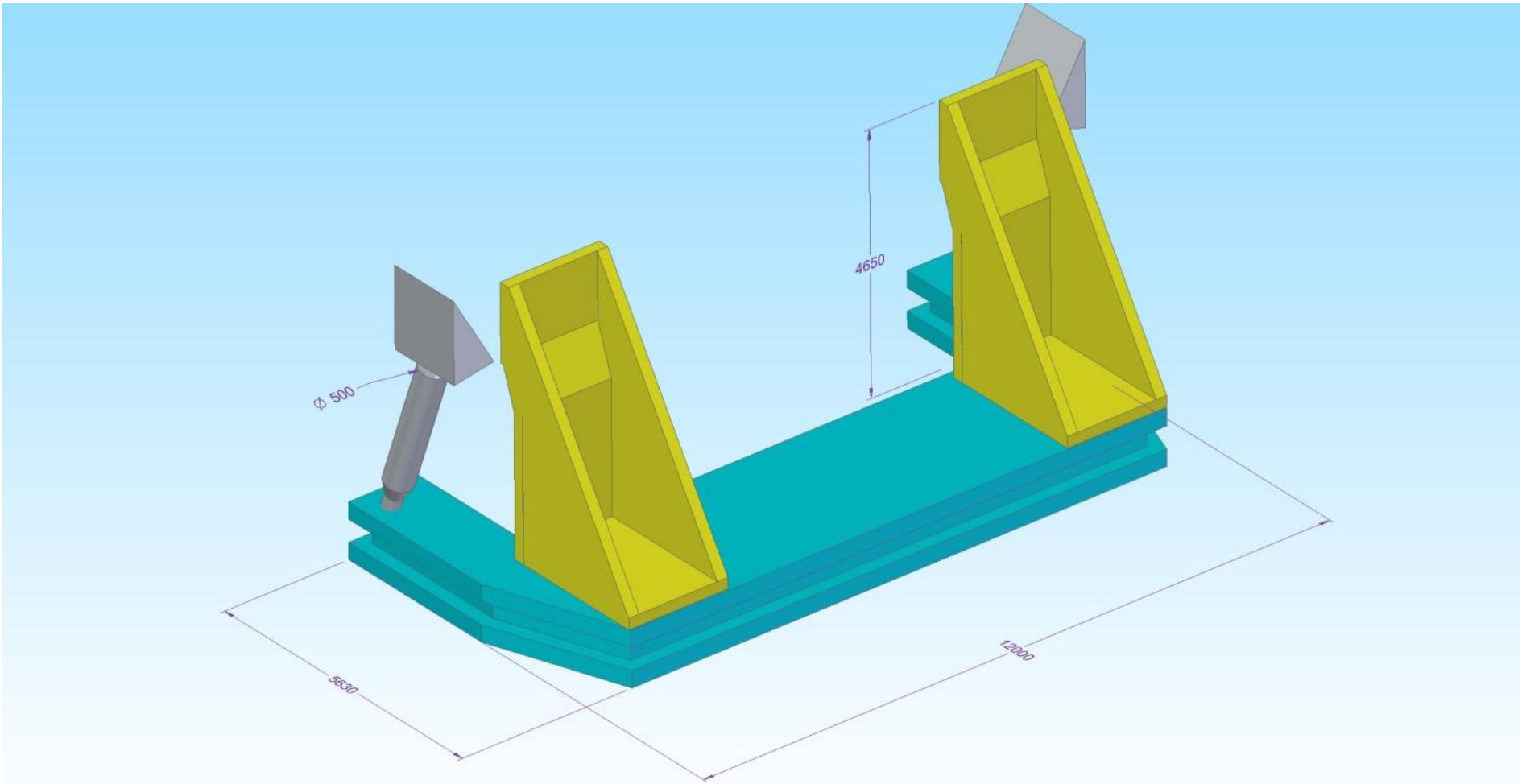

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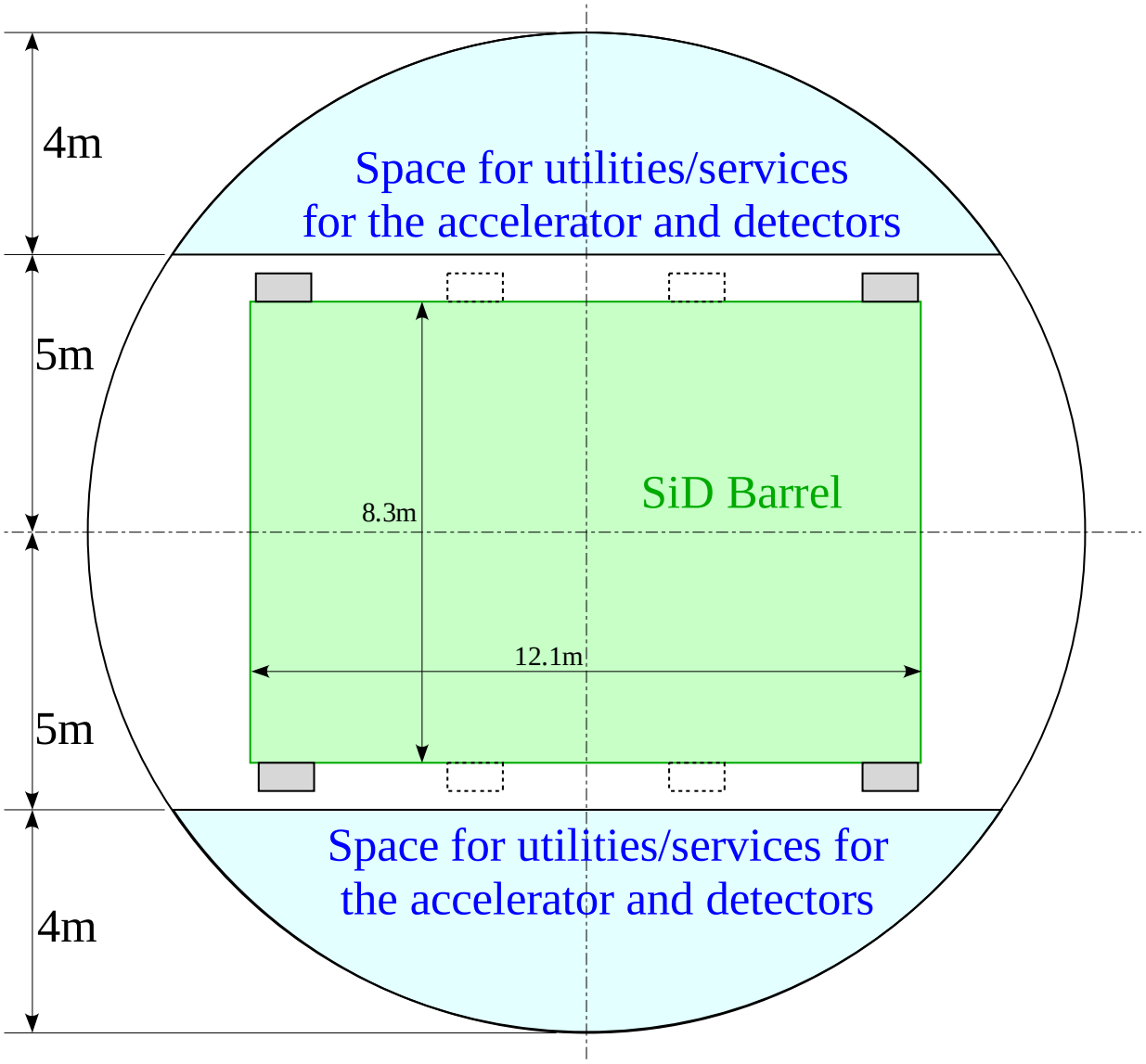
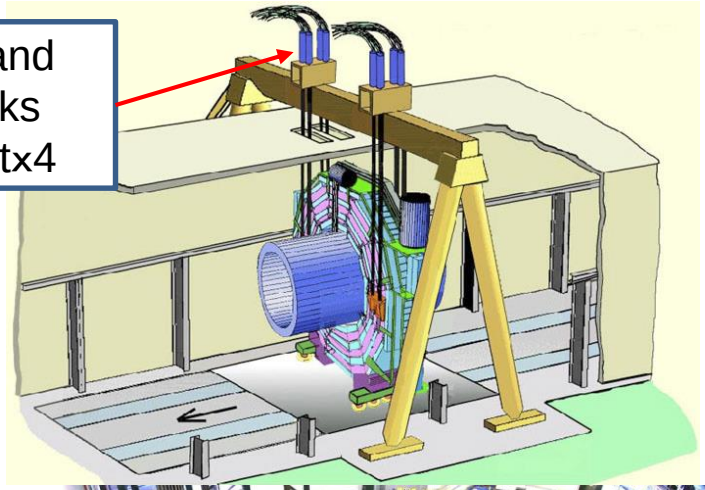
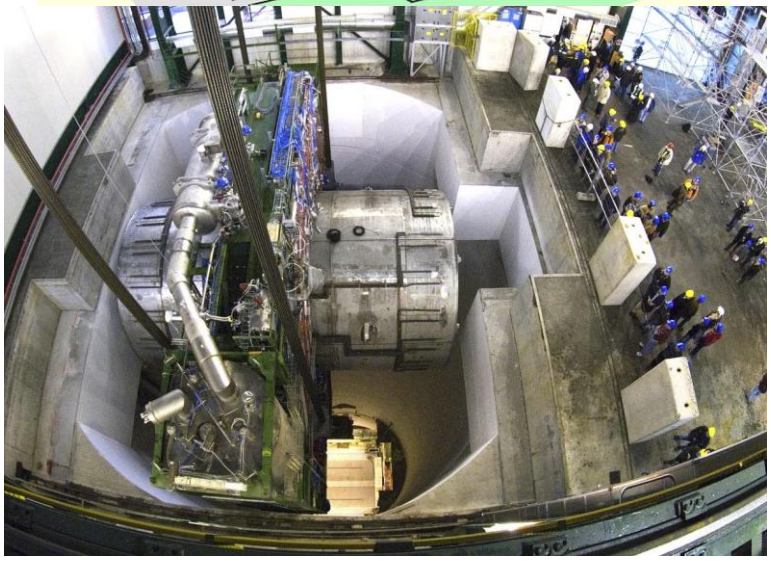
SiD in Vertical Shaft



CMS at CERN

- Detector modules (max 2000t) are lowered from Assembly Hall on surface to ~100m deep underground Detector Hall





Strand Jack