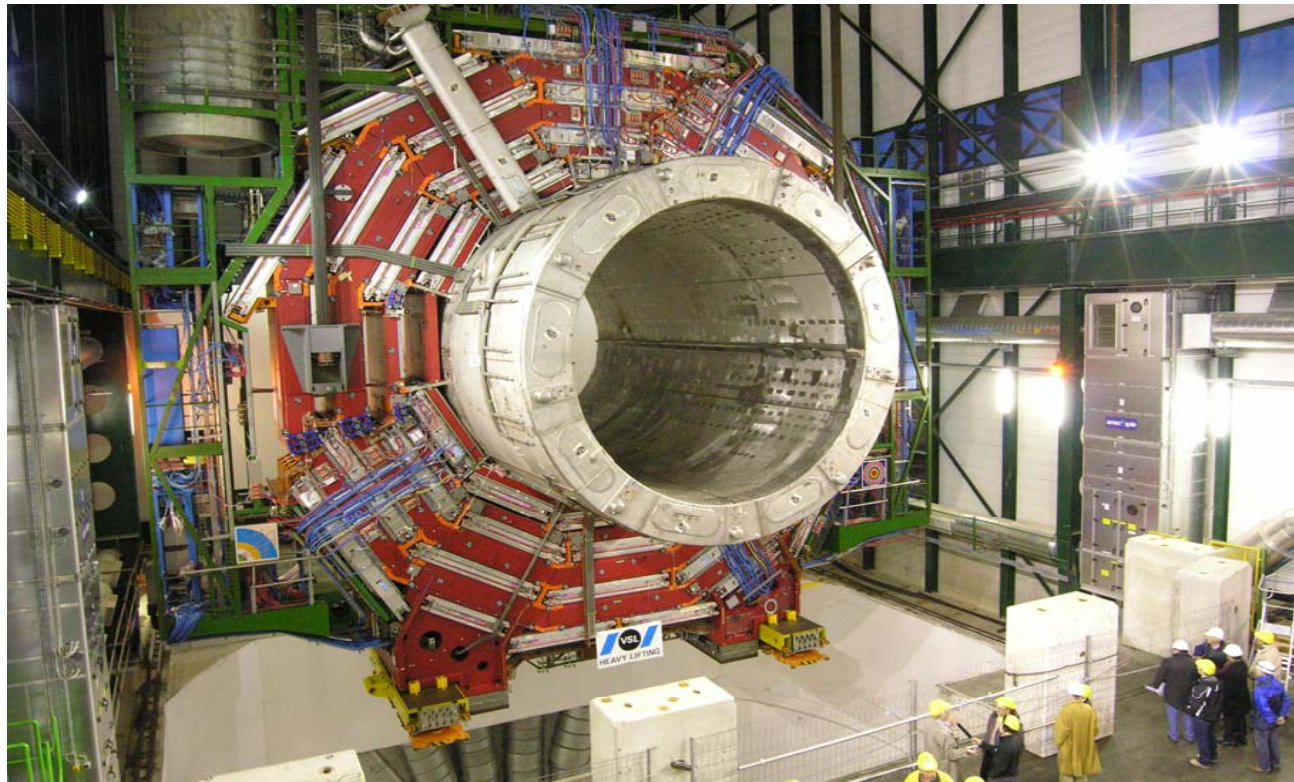


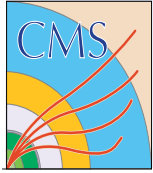


# Heavy Lifting

2000 tons traveling down 100 m



Hubert Gerwig  
CERN, Physics Department



# Heavy Lifting

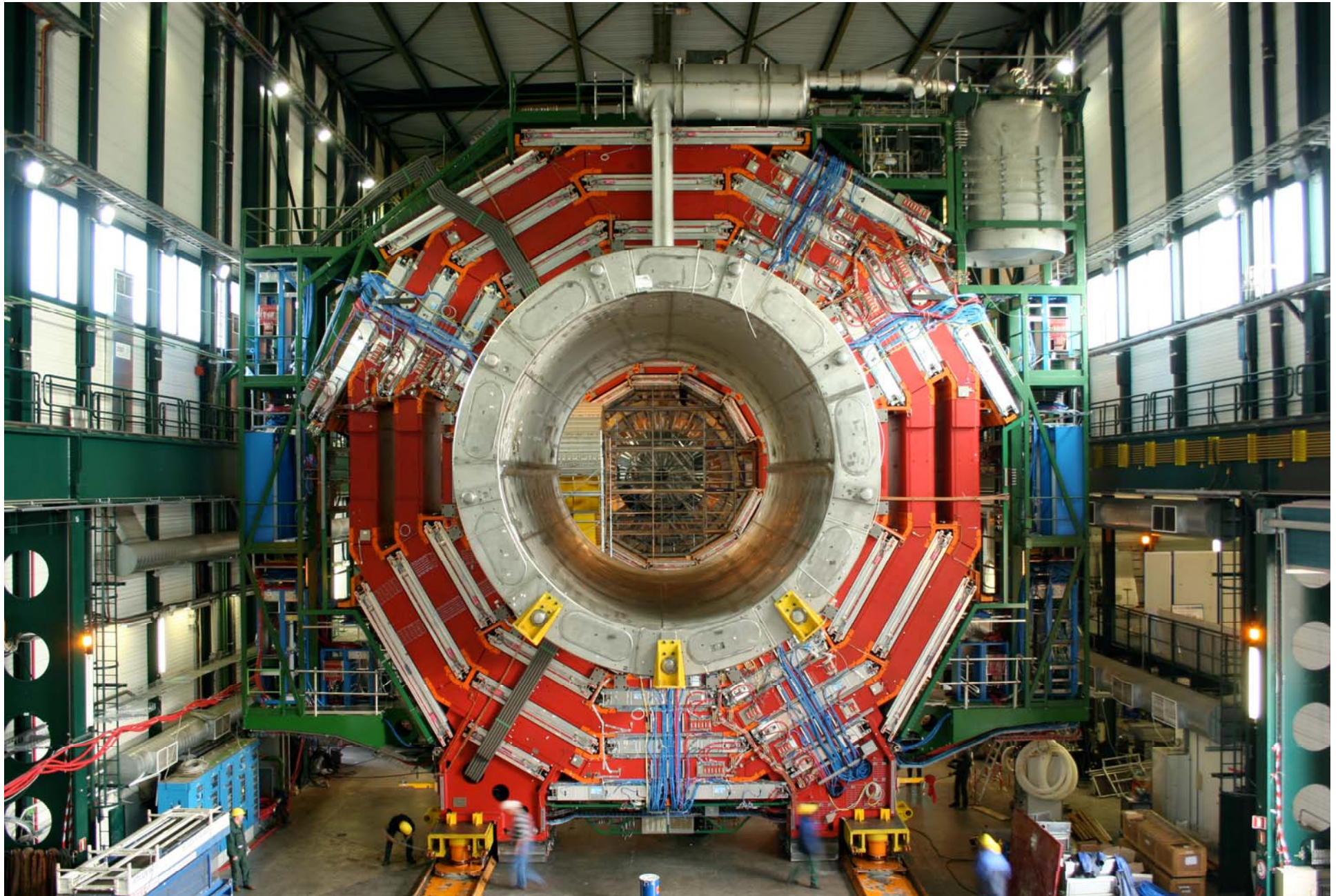


Lowering CMS by means of heavy lifting  
was a decision from the very beginning, 15 years ago

Then, experimental area, pits and surface hall have been designed  
around this goal, i.e. foundations for the gantry and a massive  
strong plug

And anchor points for lifting have been integrated in the yoke  
design and also in HCAL and HF platform and craddles





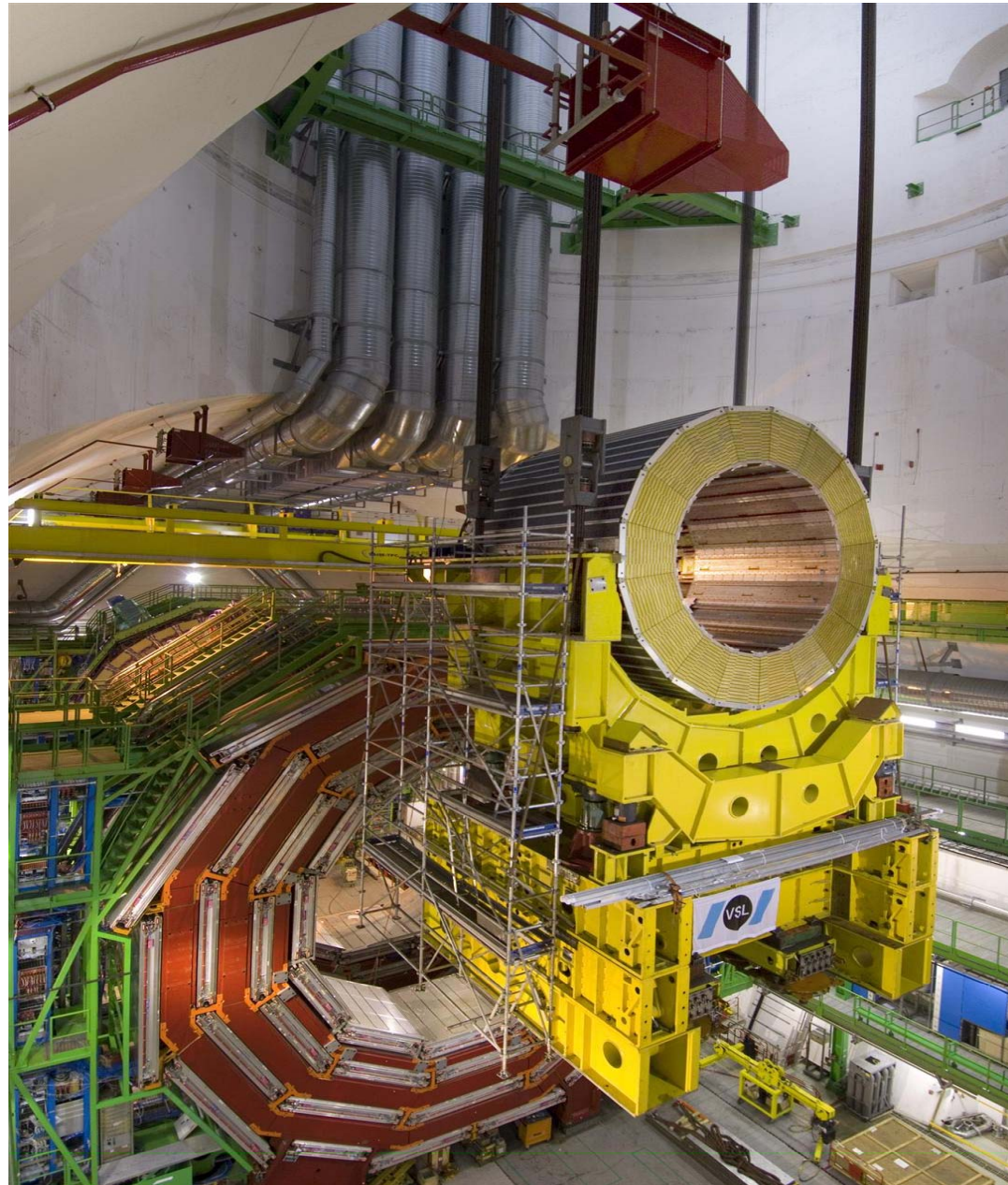
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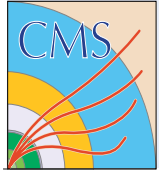
Hubert Gerwig, CERN PH



Hadronic Calorimeter  
going down with its cradle  
and some scaffolding

Some 700 tonnes



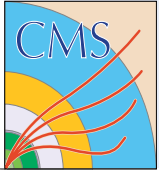


# Gantry Installation



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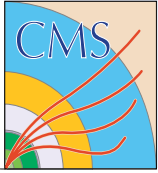


# Fact sheet Heavy Lifting strands



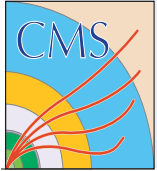
- 4 x 55 individual strands
- Diameter of 1 strand : 15.7 mm
- Steel section: 150 mm<sup>2</sup>
- Ultimate yield: 1860 N/mm<sup>2</sup>
- Ultimate capacity/strand: 28.4 tons
- Strand safety factor (for YB0) 3.26
- Gripping system = self-locking wedges





# 4 x 55 wedges to hold the load





# Fact sheet Heavy Lifting



- 4 hydraulic center hole jacks
- Gripping system = self-locking wedges
- Piston stroke: 550 mm
- Nominal load per piston: 625 tons
- Hydraulic pressure @ nom. Load: 344 bar
- Hydraulic pump flow speed: 65 liter/min
- Average lowering speed: 9 meter/hour
- Piston speed during stroke: 6 mm/ sec.

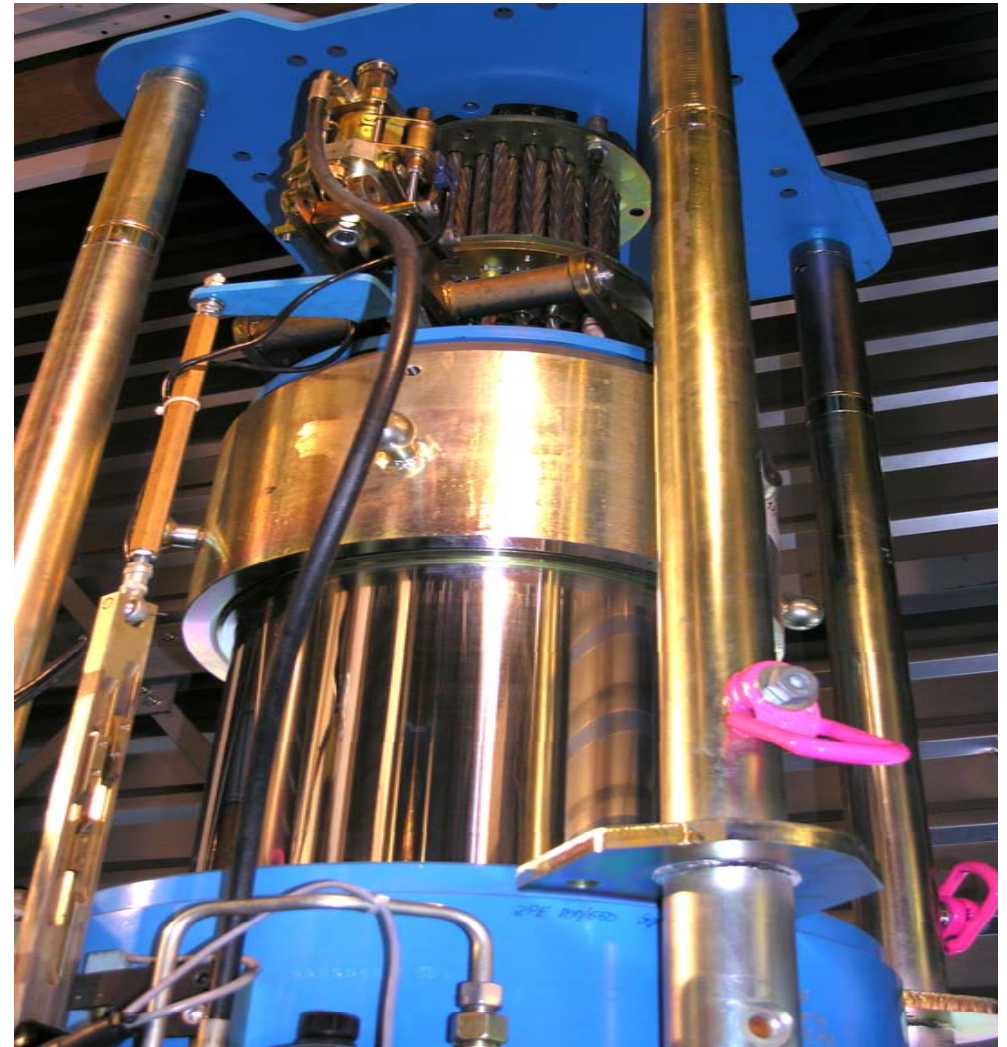




# Strand coils and hydraulic jack



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# Central Barrel arriving in cavern

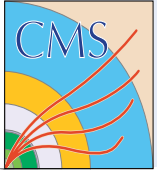


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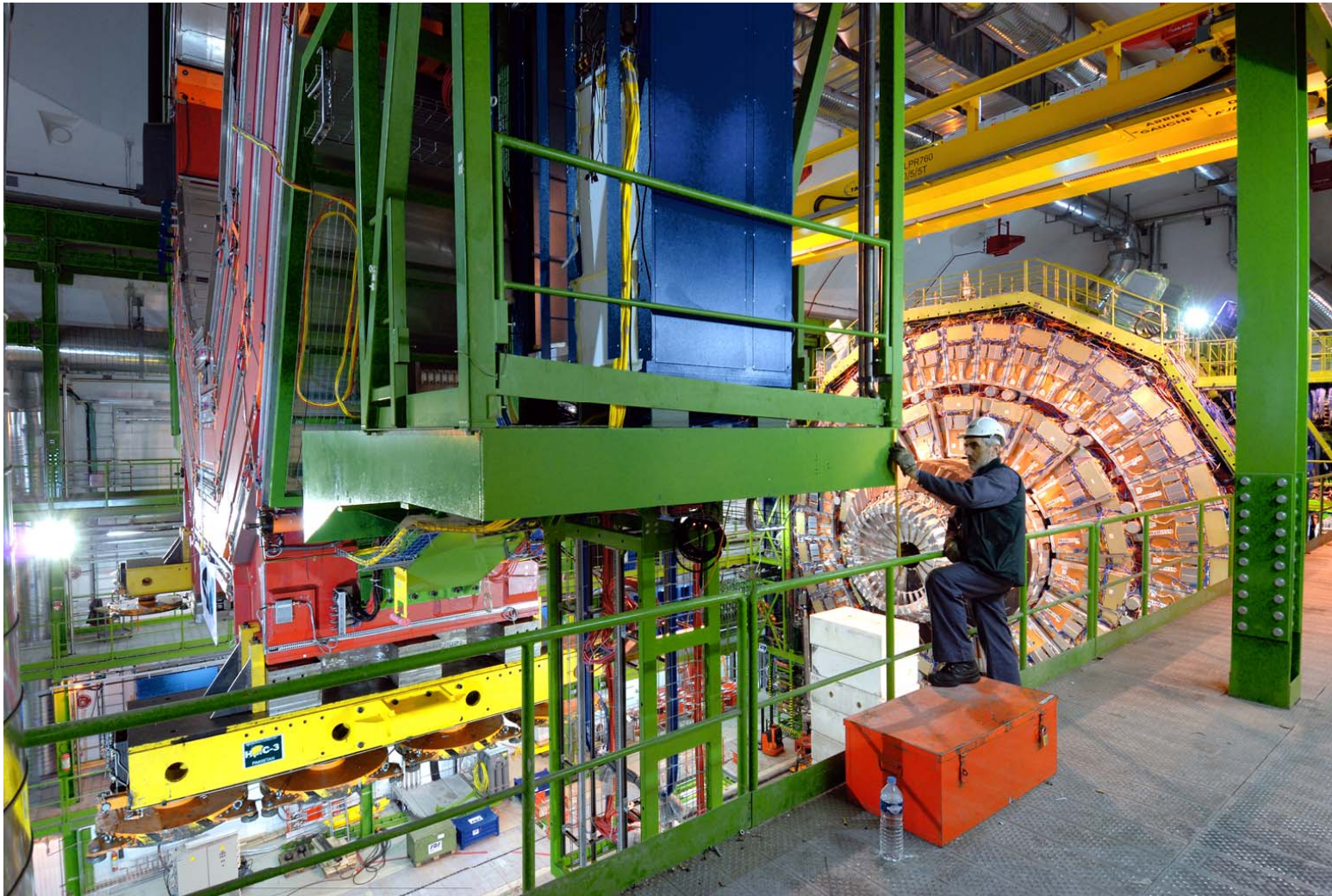
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10





# Central Barrel arriving in cavern

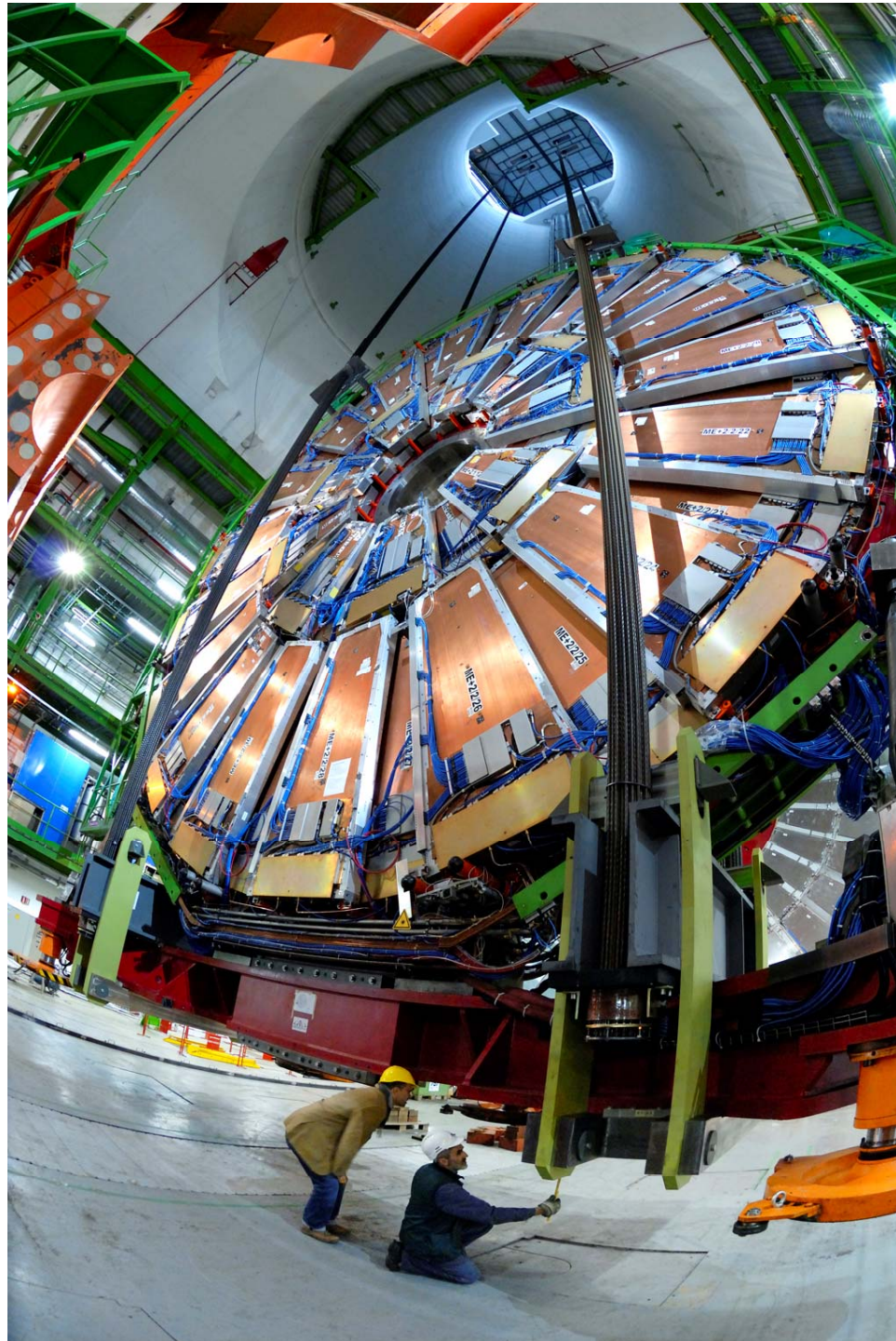




**End-cap YE+2**

**880 tons**

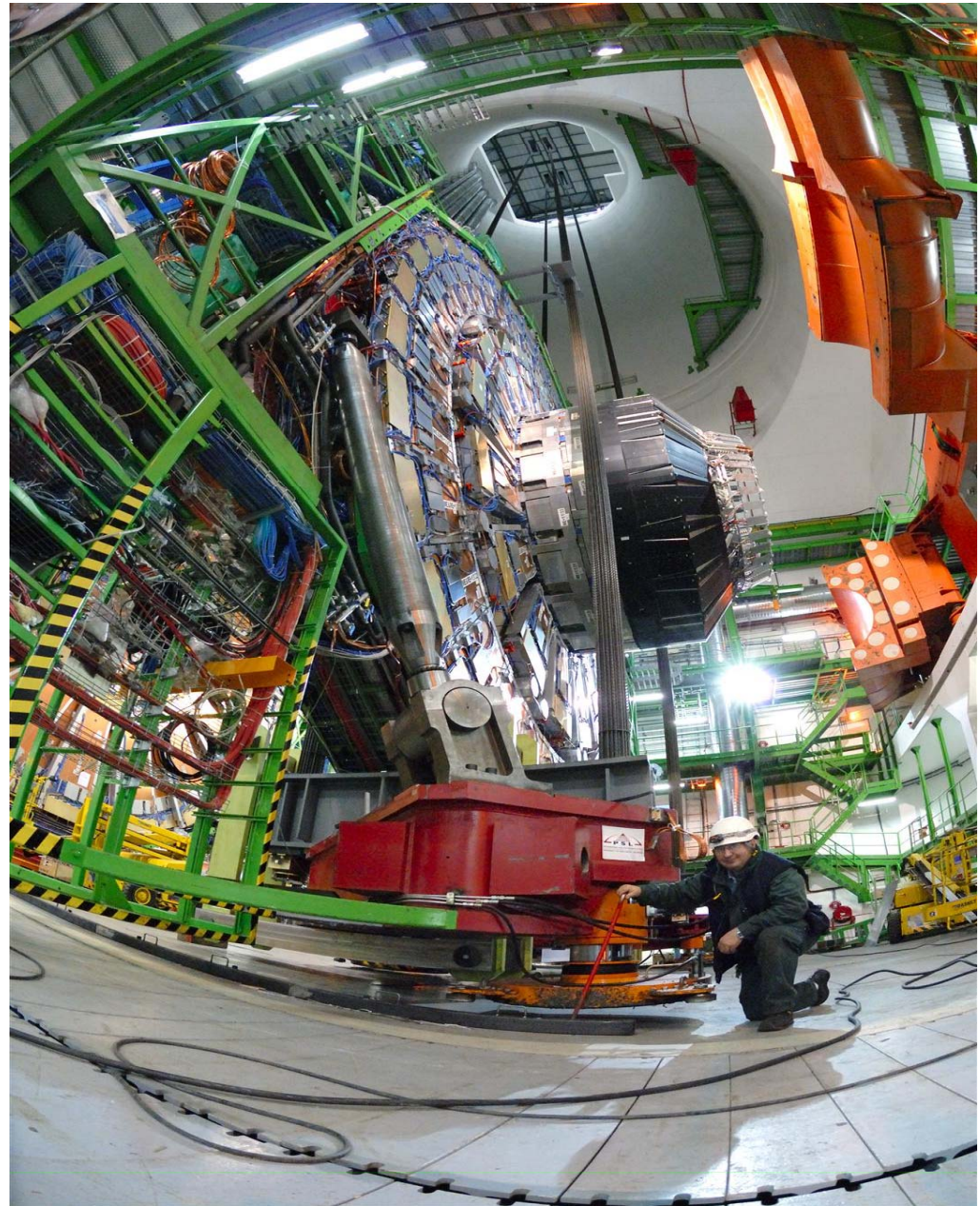
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**End-cap YE+1**

**1430 tonnes**



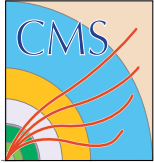


# Careful Testing - Dummy Load

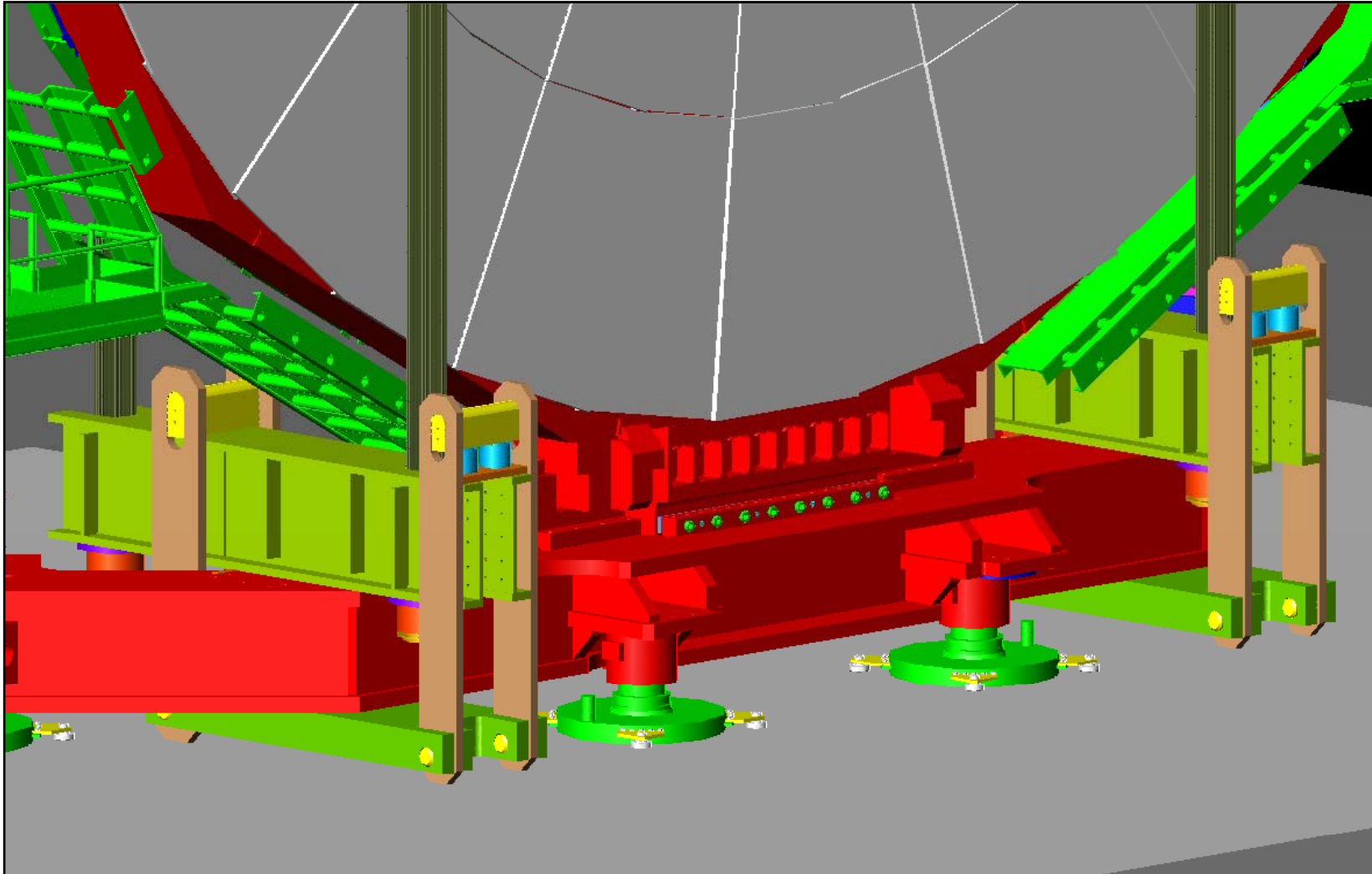




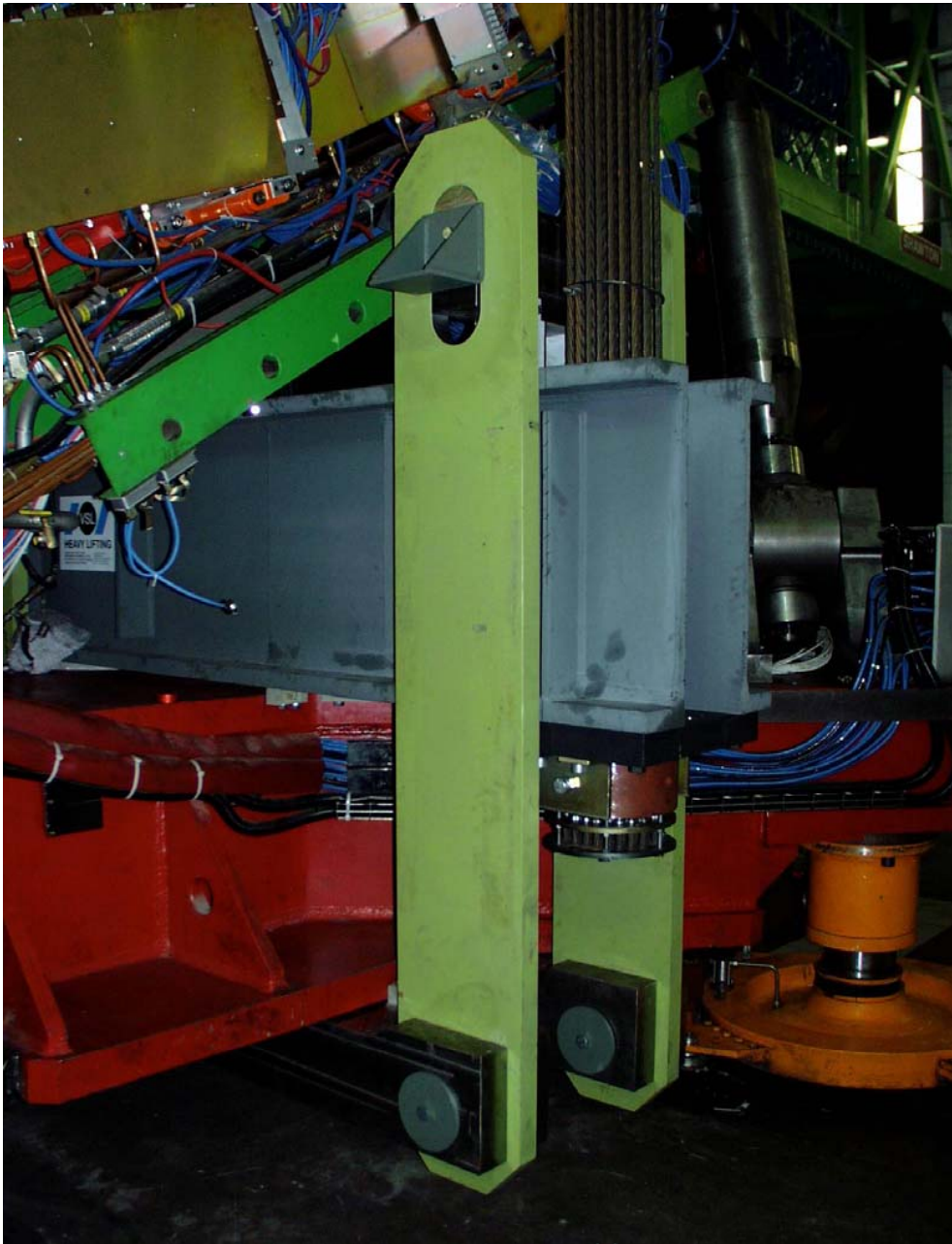




# And preparation





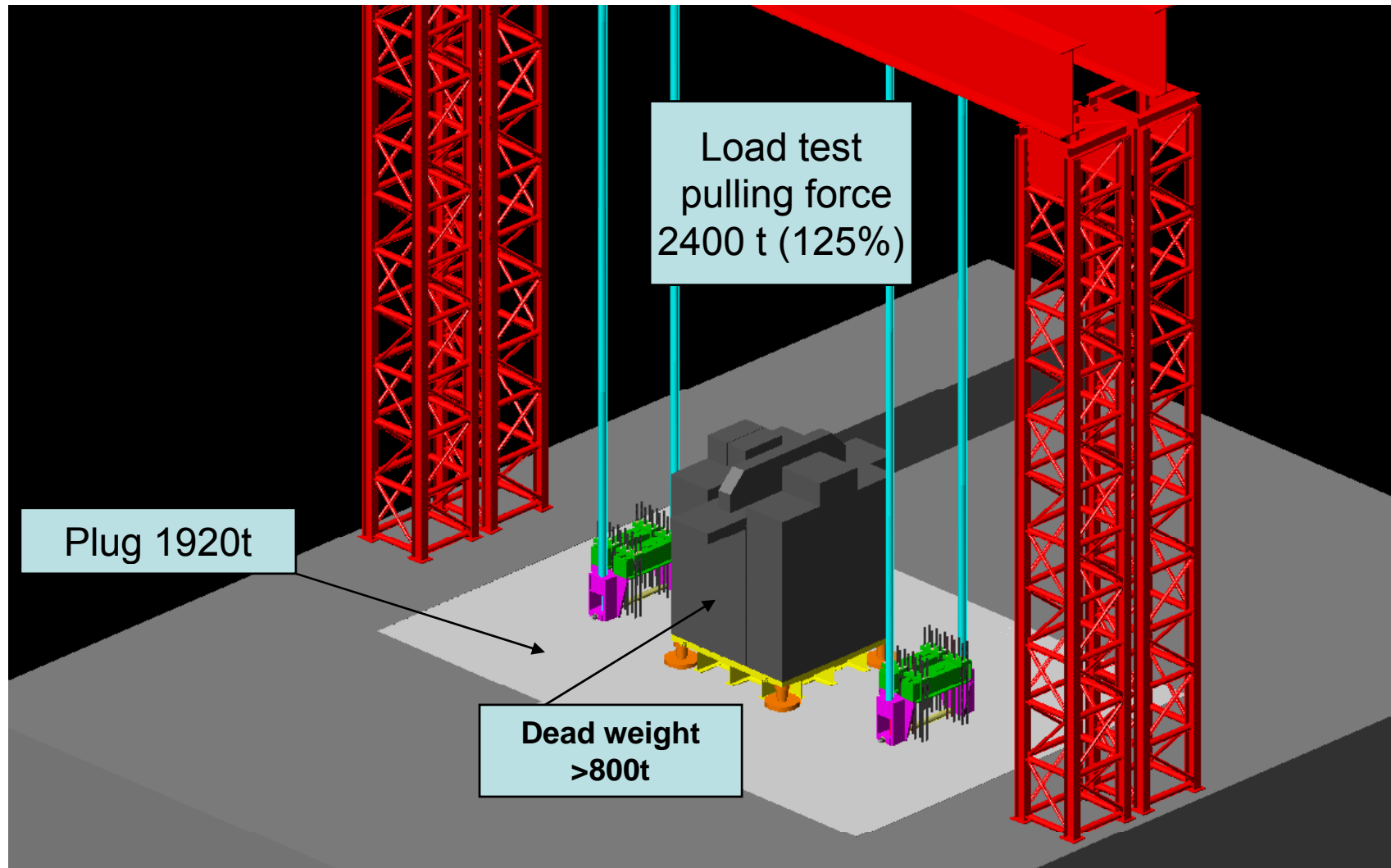


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# And still more preparation.....







# Comments on Heavy Lifting



- There are around 10 companies worldwide
- A 1.6 M\$ contract has been placed after international bidding
- Gantry is rented and made from existing towers and custom made horizontal beams



# Comments on Heavy Lifting



- This type of lifting equipment cannot follow lifting codes due to the impossibility of a 110% dynamic load test
- We at CMS did a 125% static load test and an additional 300 t dummy load test with a complete up and down maneuver
- Involvement of an official safety agency is very important to get final authorization (at least in Europe)





# Sub-lifting



Moving detectors with *high* precision  
and *low* friction

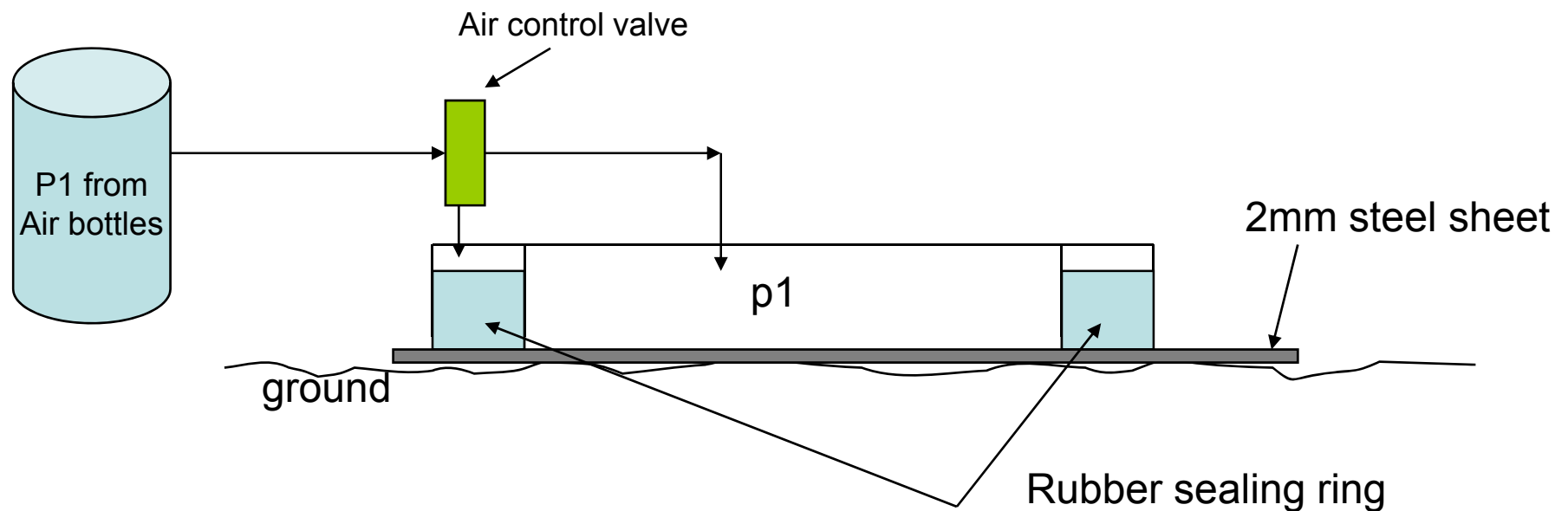


## About the airpads



CMS is built in a surface hall and moves on air pads

These air pads are not really comparable to classical air cushions as they have nearly no air losses due to a sealing ring





# Air pad photo





## Pro and con's of airpads



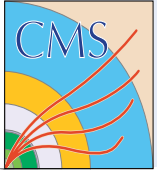
### Pro's

- Low air losses
- Low friction  $\mu = 0.01$
- Movements in x and z and rotation in plane
- Works from air bottles
- Very good for long and complicated movements

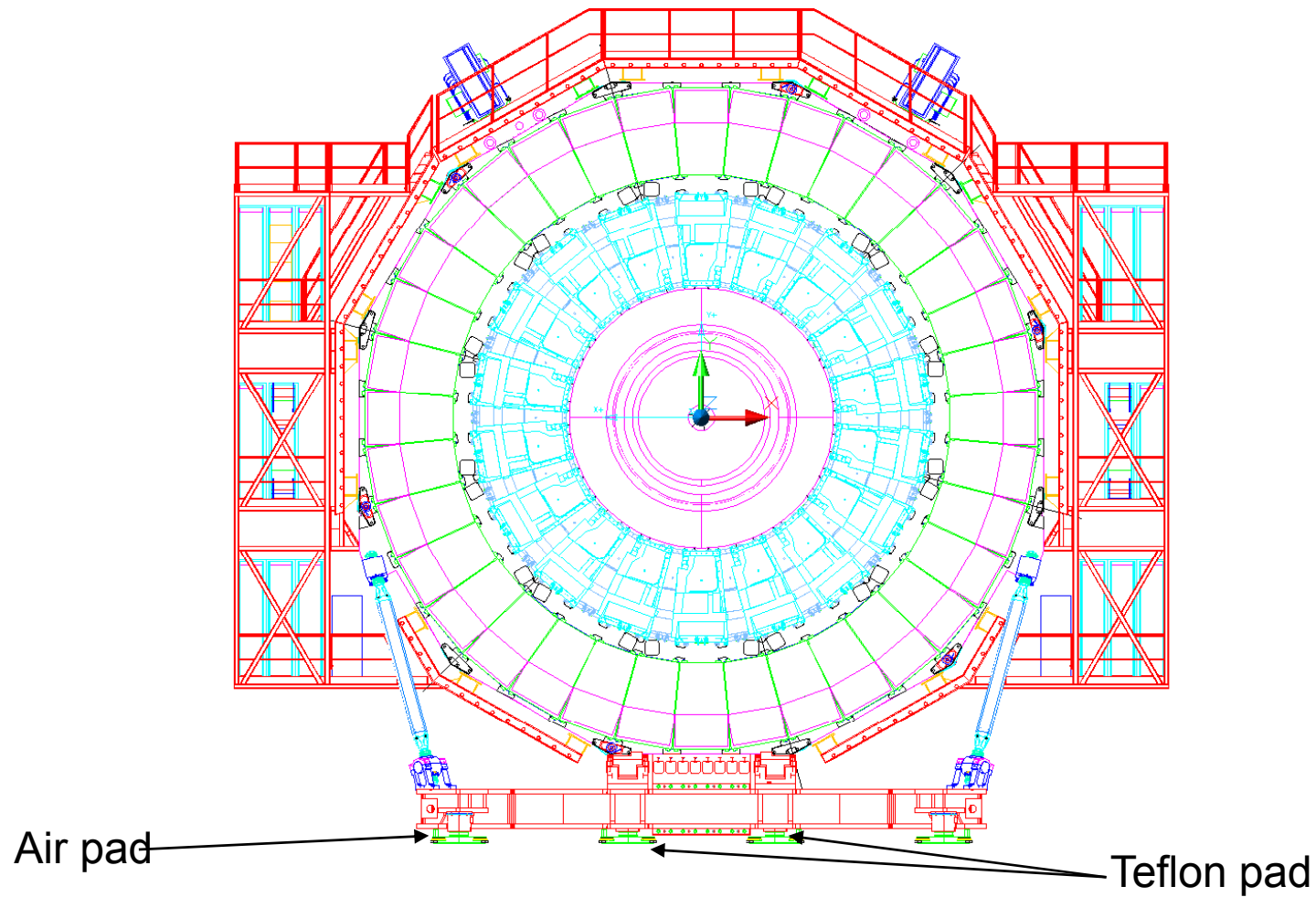
### Con's

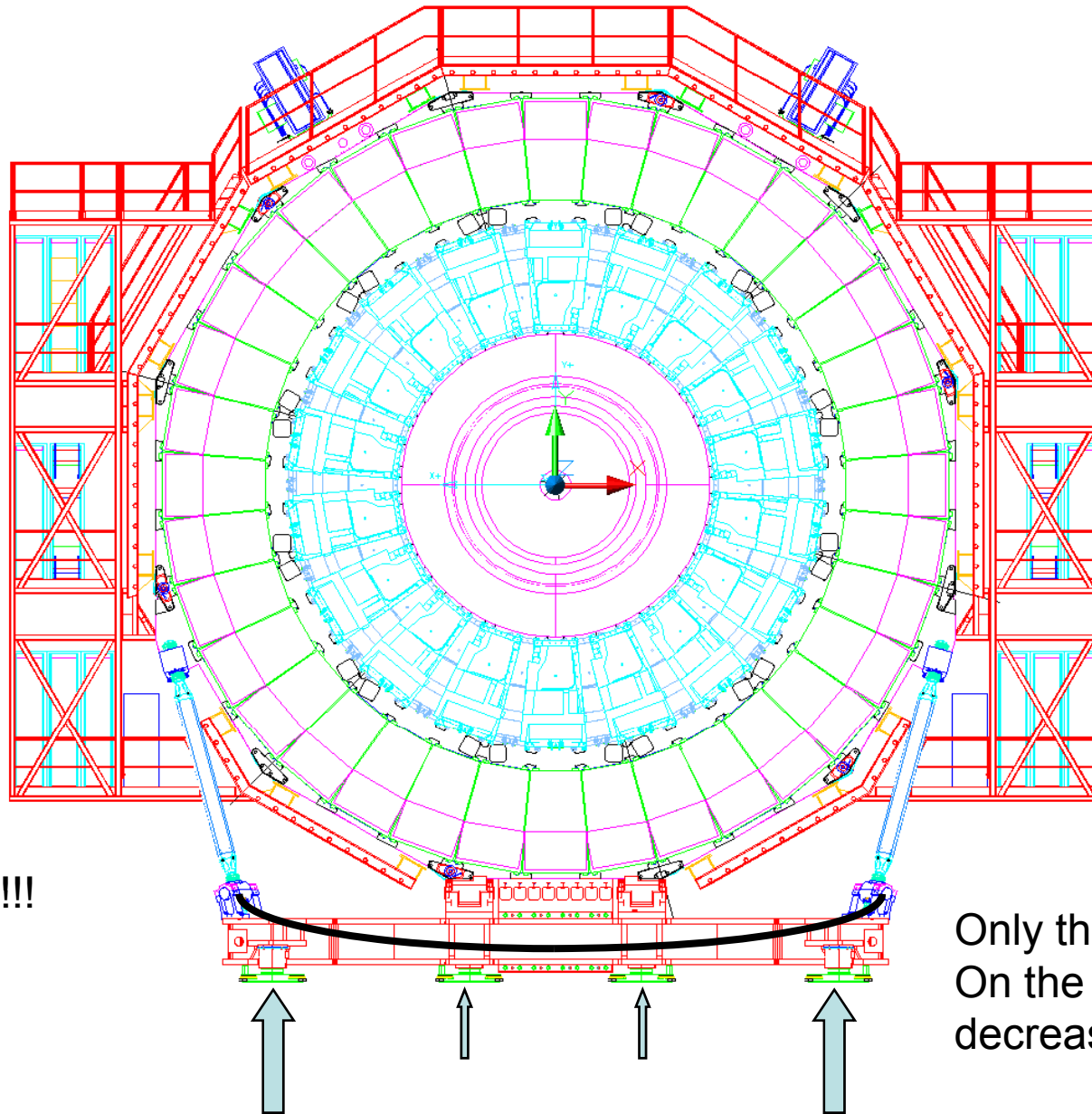
- Needs some lubrication
- Vertical movement at least 5 mm
- Due to this not suited for delicate final approach moves





# Sub-lifting solution combining air pads with teflon pads

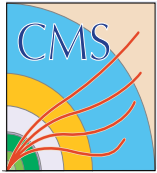




No lift-off !!!

Only the vertical load  
On the teflon pads  
decreases





## **Sub-lifting solution, combining air pads with teflonpads**



- Under the load of the air pads (f.ex. 90% ) the cart bends elastically upwards whereas the teflon pads remain in touch with the ground
- This is very important for the final approach between different elements and also beam pipe
- This mix of different lifting systems allows us to move 1400 ton elements with ca. 50 ton pushing
- To allow this some elasticity must exist or must be built inside an interface piece