



The modification of CMS electromagnetic calorimeter Supermodule insertion tool

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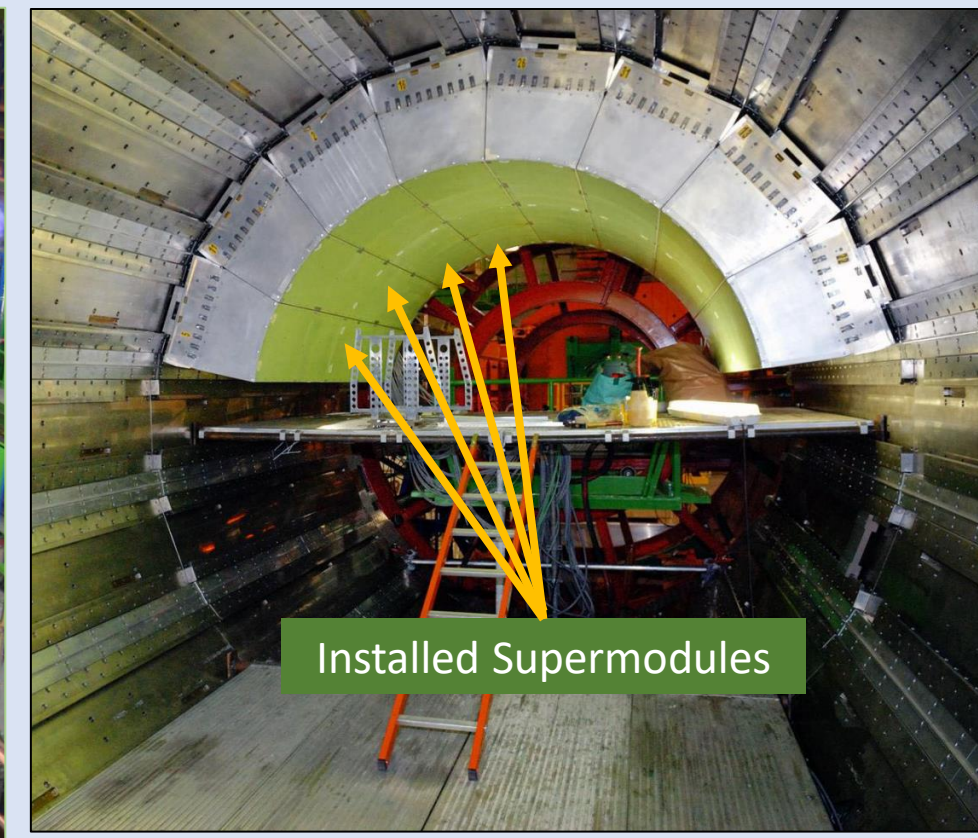
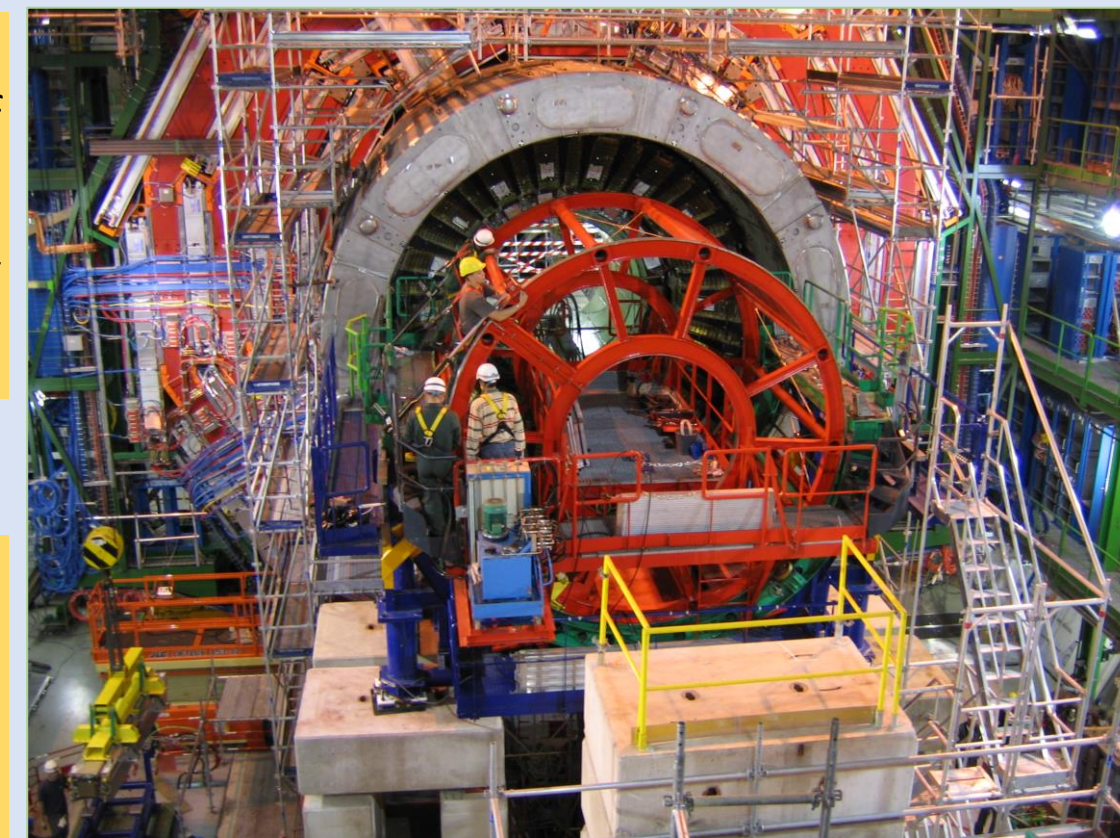
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Introduction

- The Electromagnetic Calorimeter (ECAL) barrel of CMS experiment at CERN is made of 36 Supermodules (SM), each consisting of 1700 lead tungstate scintillating crystals
- Each SM weights 2.7 tons, with dimensions 3,0 m x 0.6 m x 0.6 m, and is a highly sensitive and fragile object

The Enfourneur

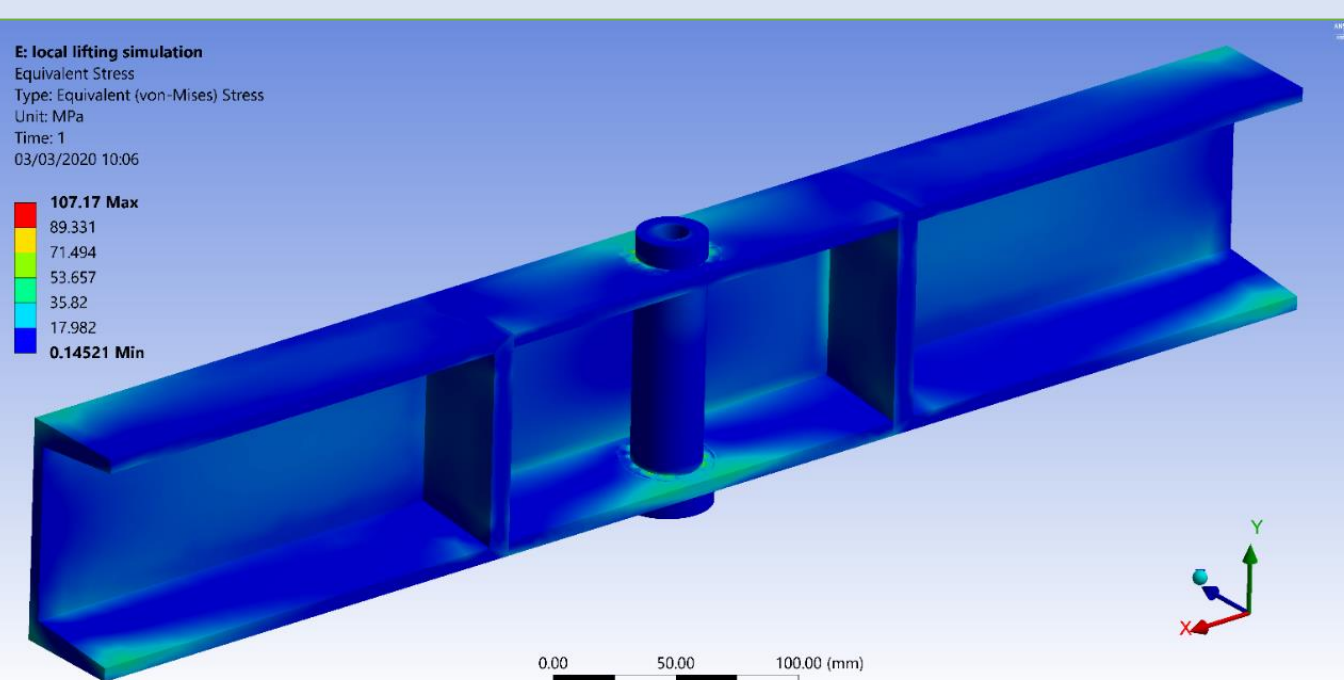
- The Enfourneur (E) is a large and heavy tool (20 tons) developed to install and remove the SMs of CMS ECAL
- E is hydraulically actuated with a fine adjustment system installed on the SM last interface, named the Yellow Beam
- E main steel structures have been modified for functionality improvement



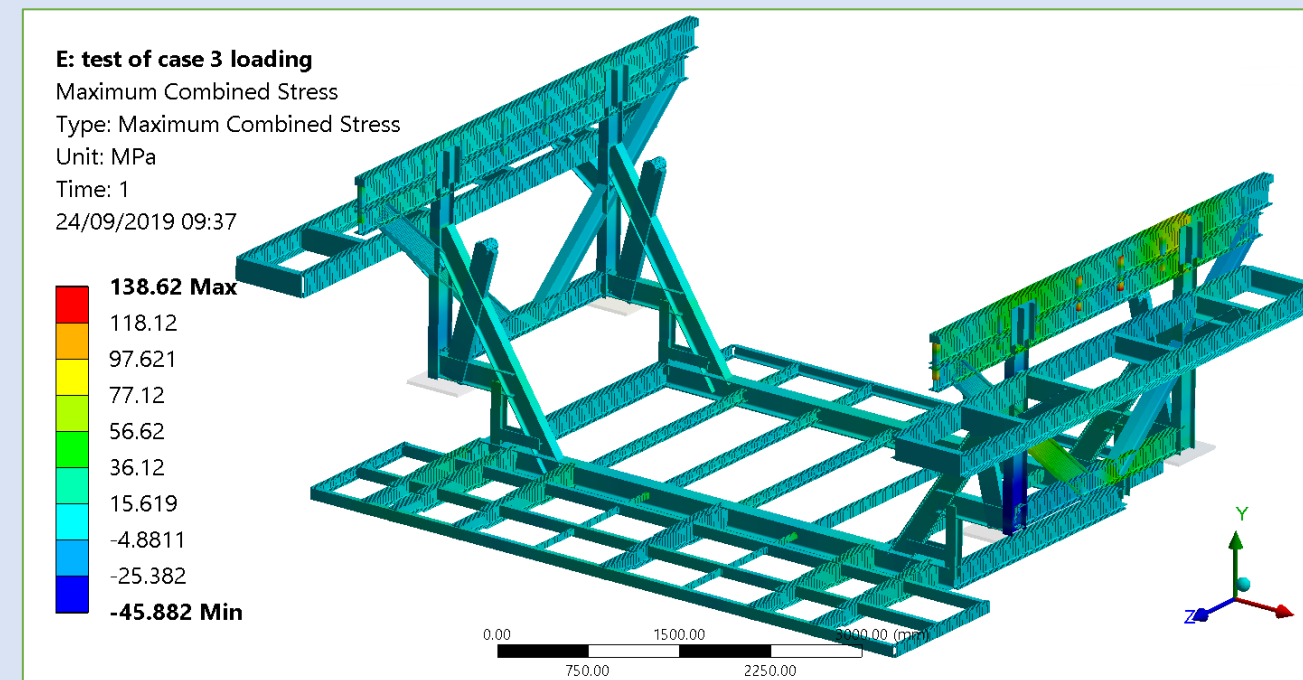
Installed Supermodules

The Modifications of the Enfourneur

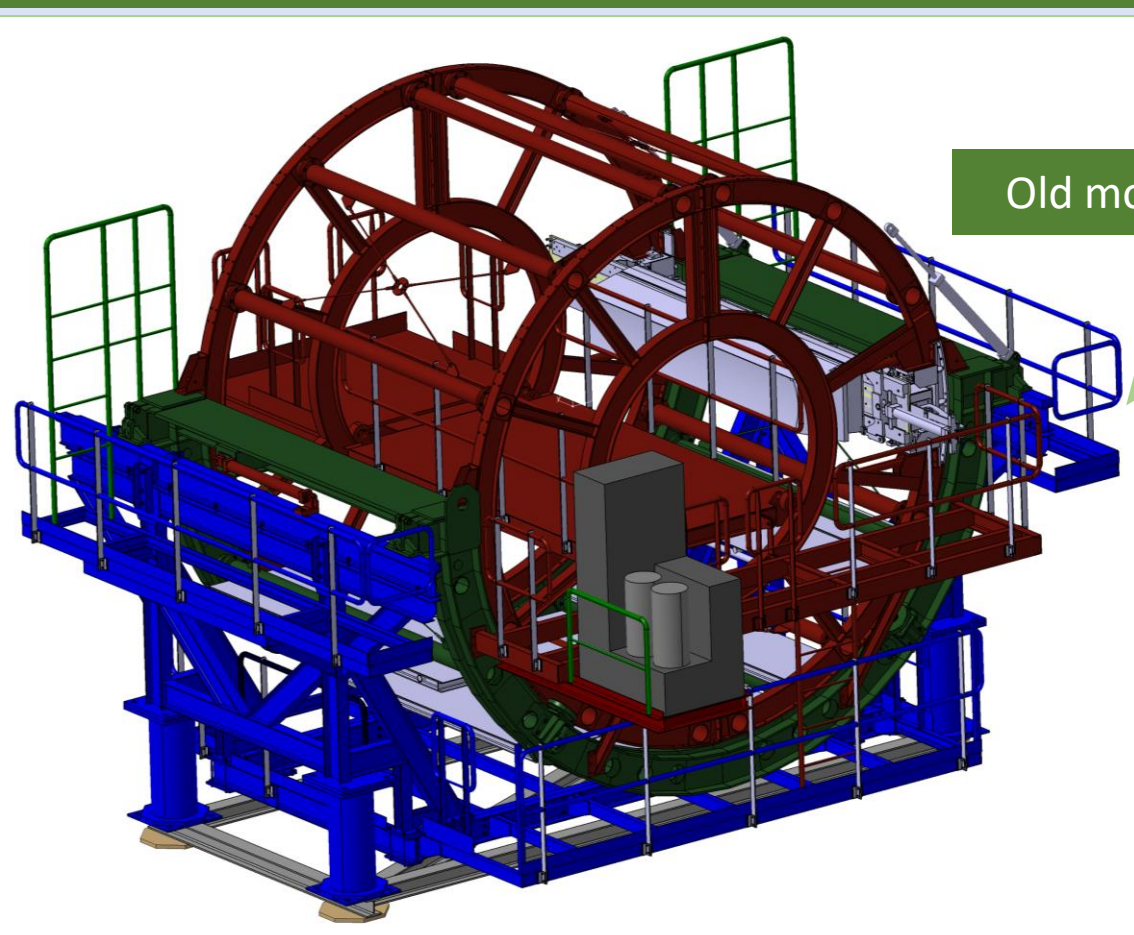
- Balconies and walkways enlarged and mobile stairs integrated to ease operators mobility on board
 - Hydraulic plant: main distribution composed by rigid tubes and flexible hoses with cable chains to drive movements in the last segments close to pistons
 - Upgrade of Red Cage safety mechanical blocks and operators anchoring points (safety harnesses)
 - Optimization of SM piston supports of the Yellow Beam
- New design compliant with Eurocode 3 and 9.



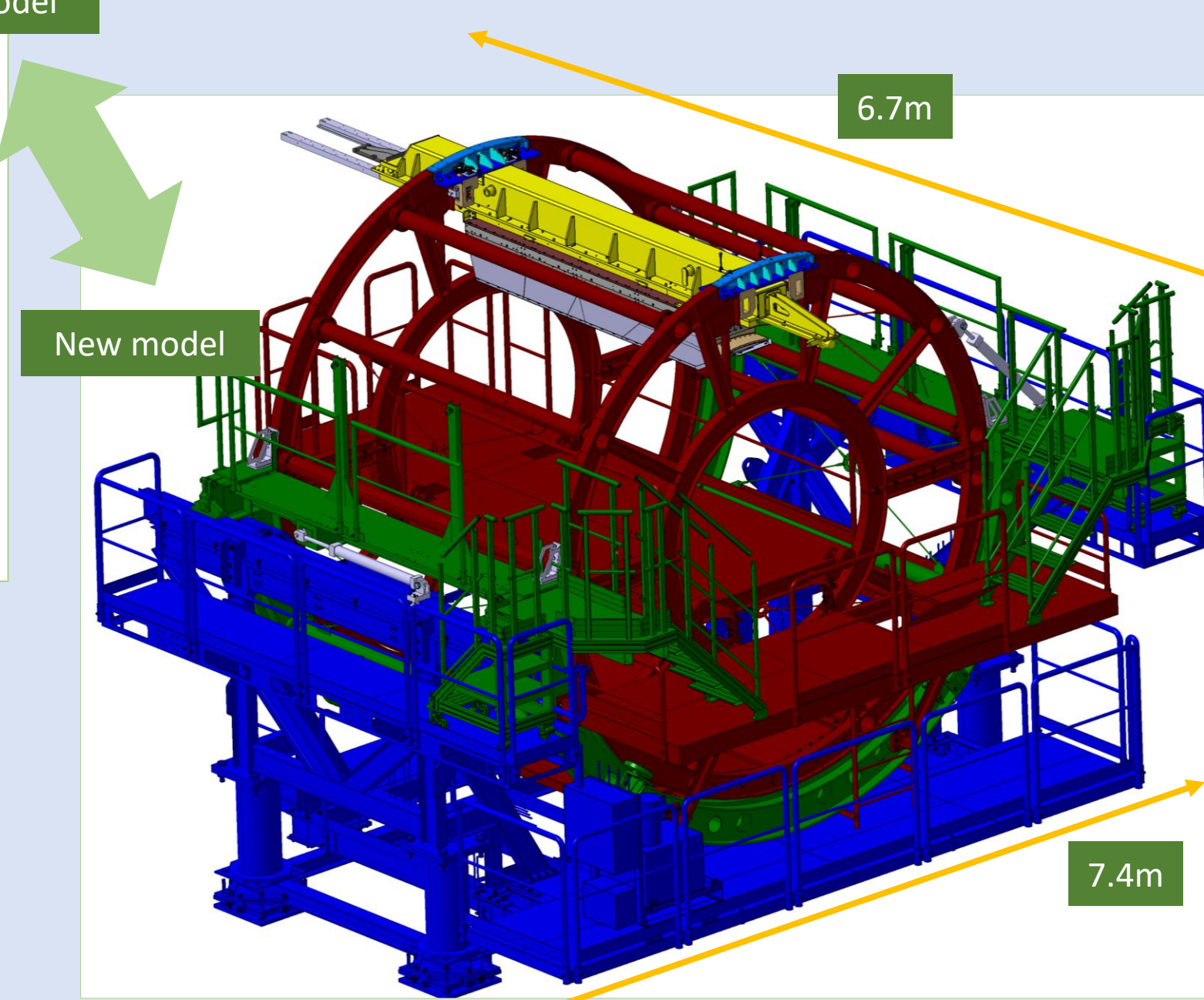
The Stress of the welded connection of the lifting point of the Blue Balcony



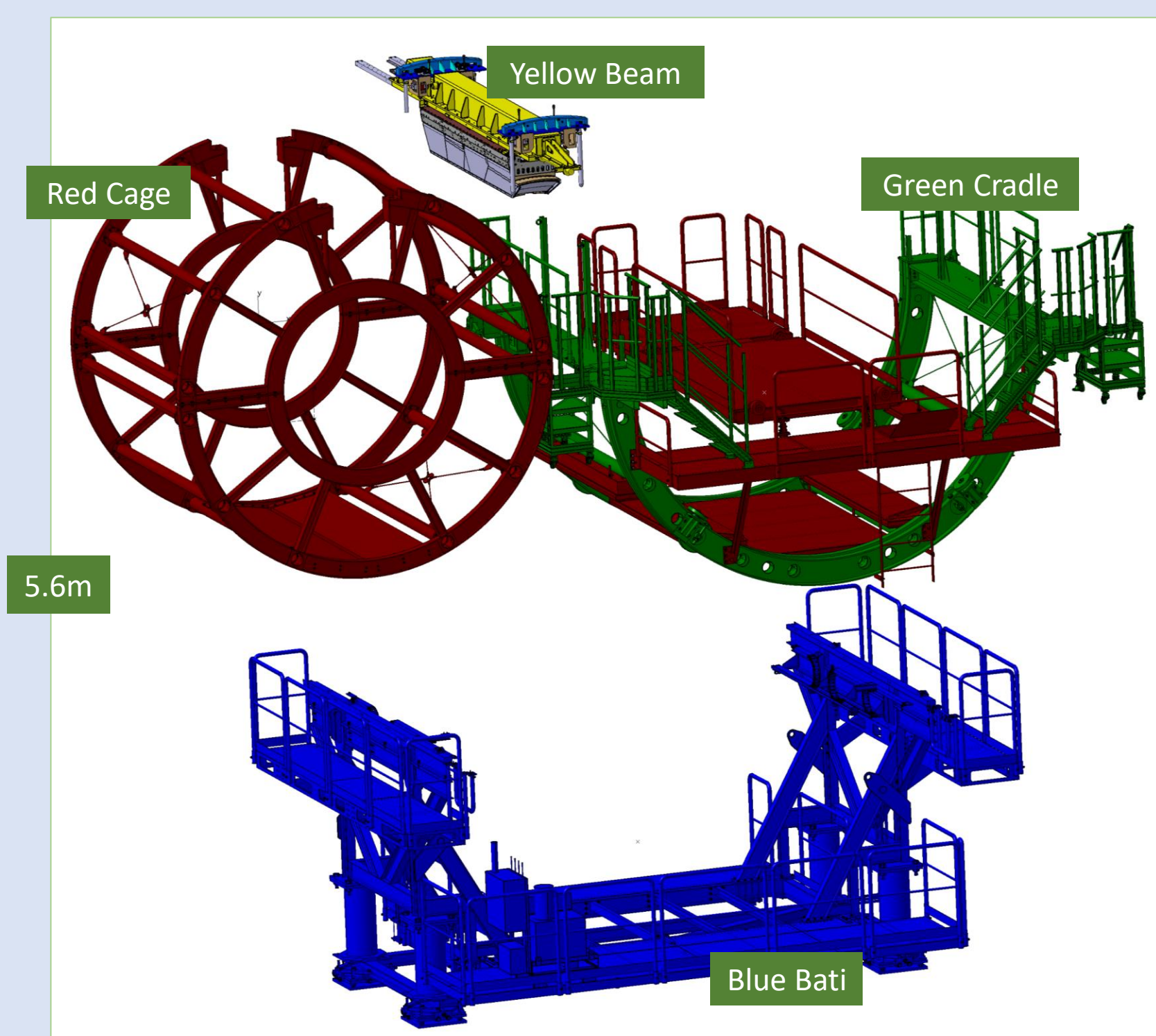
The Stress distribution in the beam element model of the Bati



Old model



New model

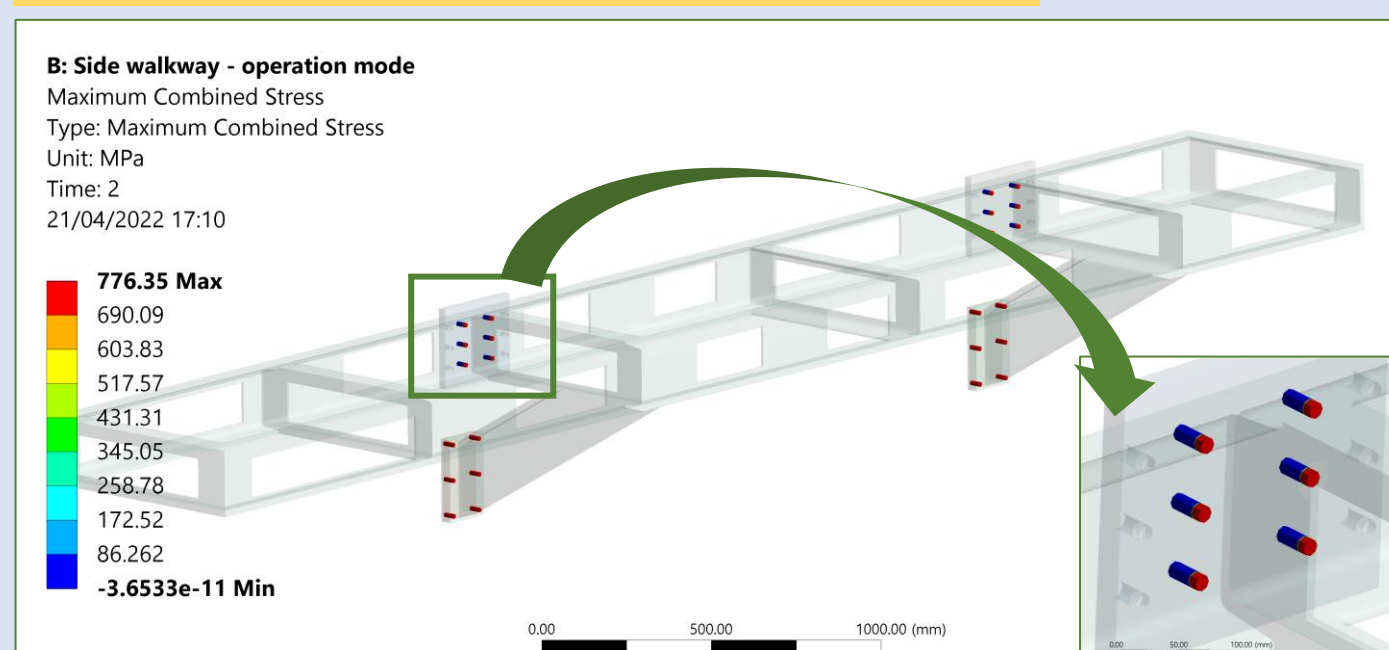


Design constraints and tests

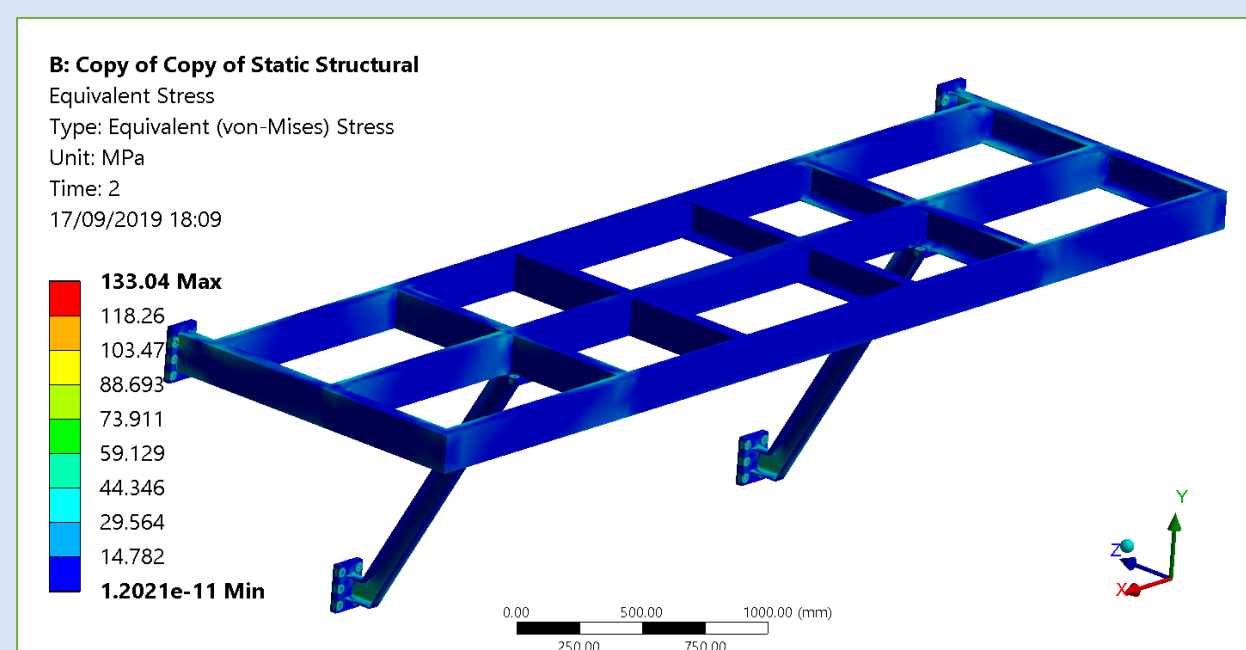
Constraints:

- Cavern crane capacity (20 tons)
- Safety norms (CERN HSE review)
- Integration inside CMS cavern

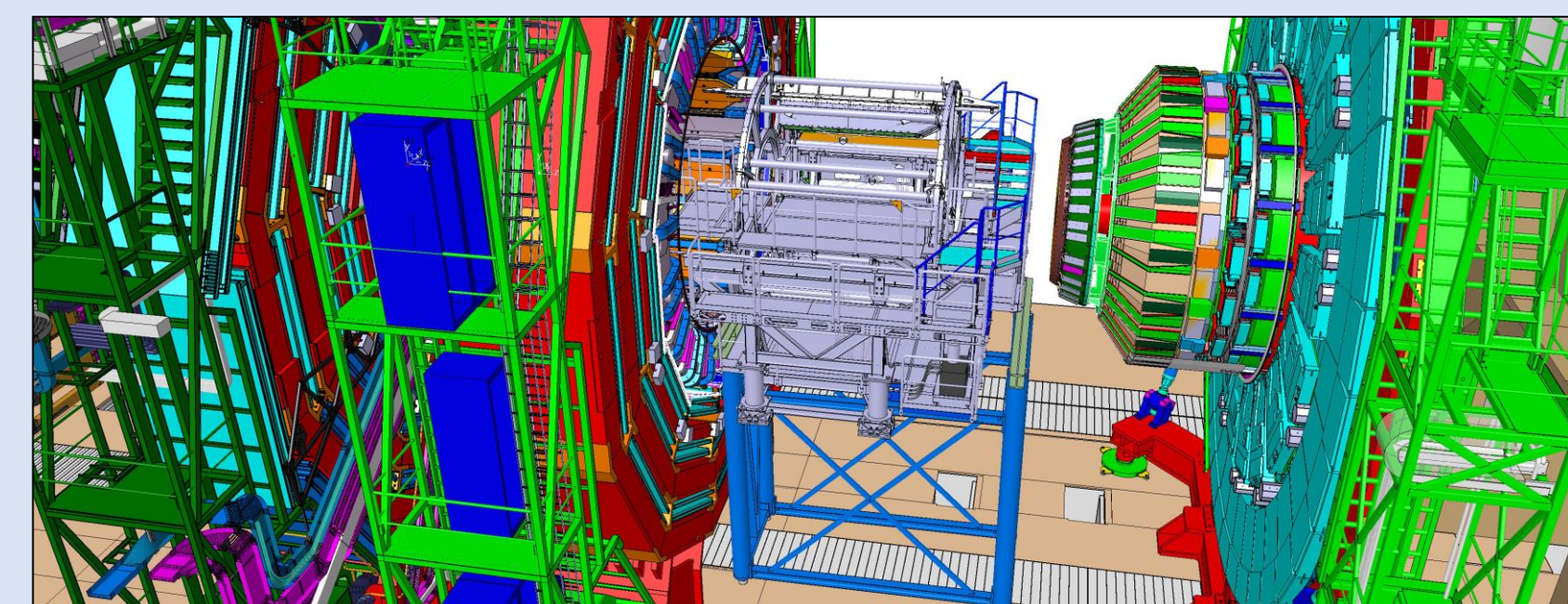
Modified Enfourneur successfully tested at CMS P5 facility



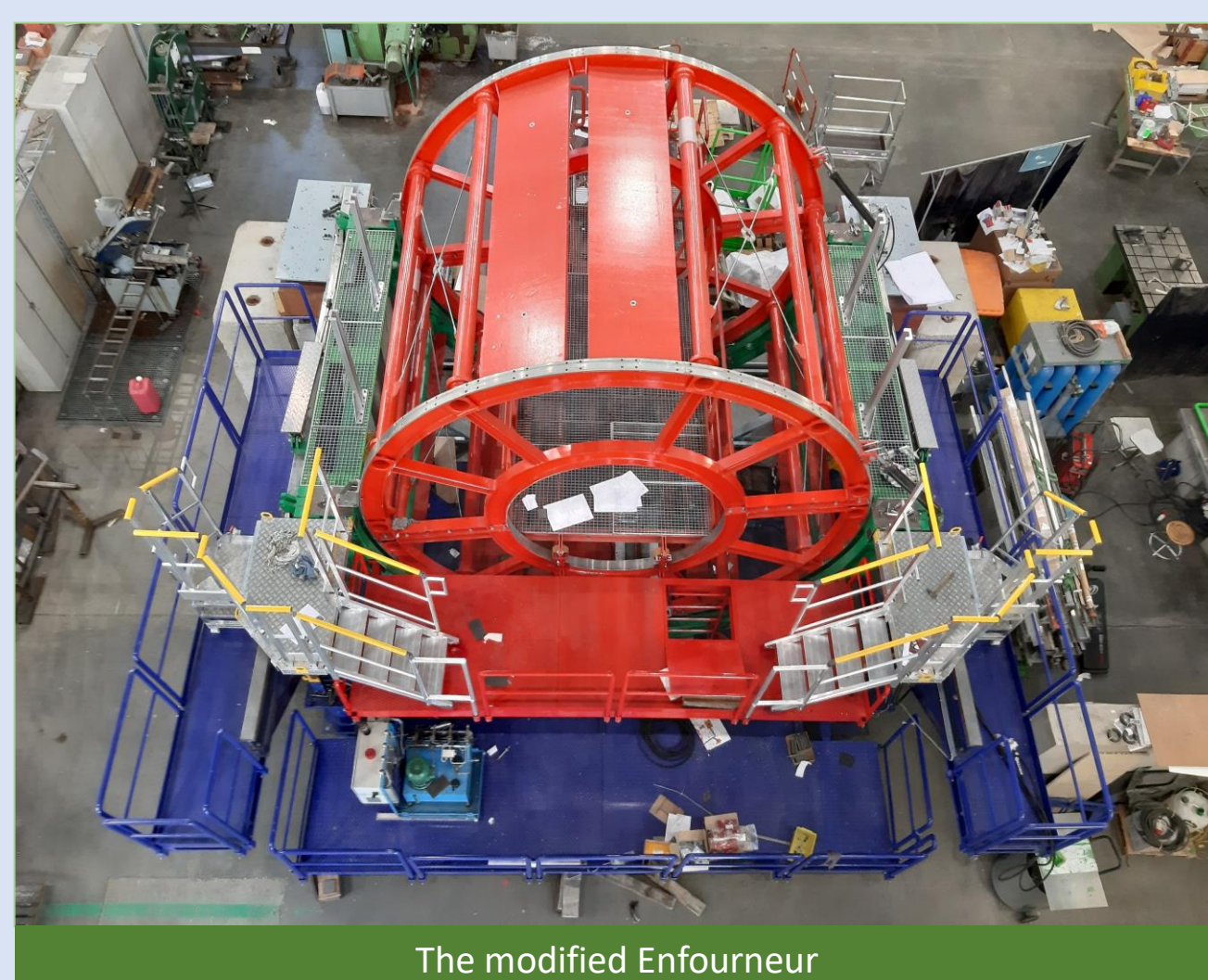
The maximum combined stress in the preloaded bolts of the Side Walkways



The equivalent stress distribution in the Red Balcony



The integration check of the Enfourneur in the CMS Cavern



The modified Enfourneur



The validation test of the Enfourneur using dummy SM (3 tons)

Conclusion

- All the intended modifications have been designed in compliance with the applicable standard and norms
- All the structural changes have been appropriately implemented on the machine and tested
- The overall performance of the Enfourneur improved after its modification in terms of operational simplification and efficiency, ergonomics and safety

References

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- [5] M.Ezzeldine, "The Lifting Study of the Modified Balconies and Walkways of," EDMS 2104898, 2021.