



Linear Collider Workshop 2012, Arlington, USA

Structural studies for a realistic tungsten HCAL

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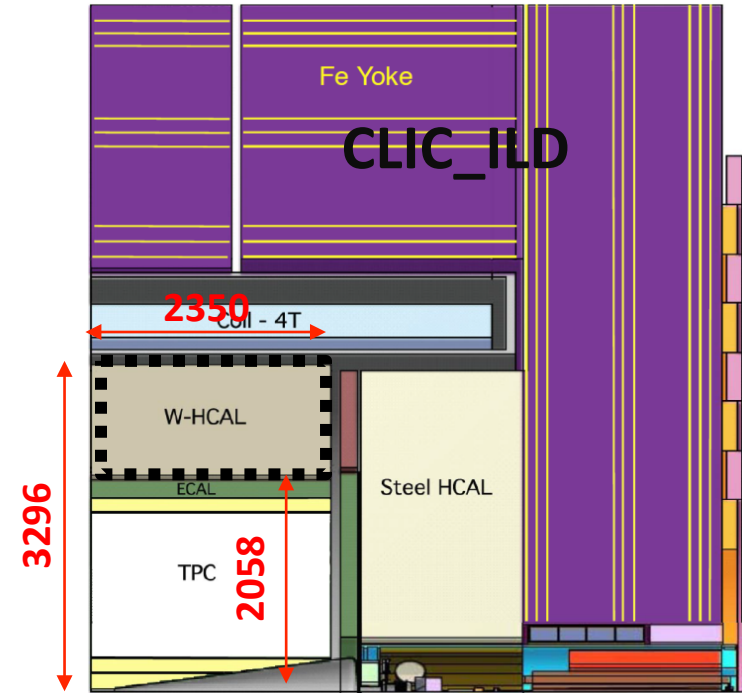
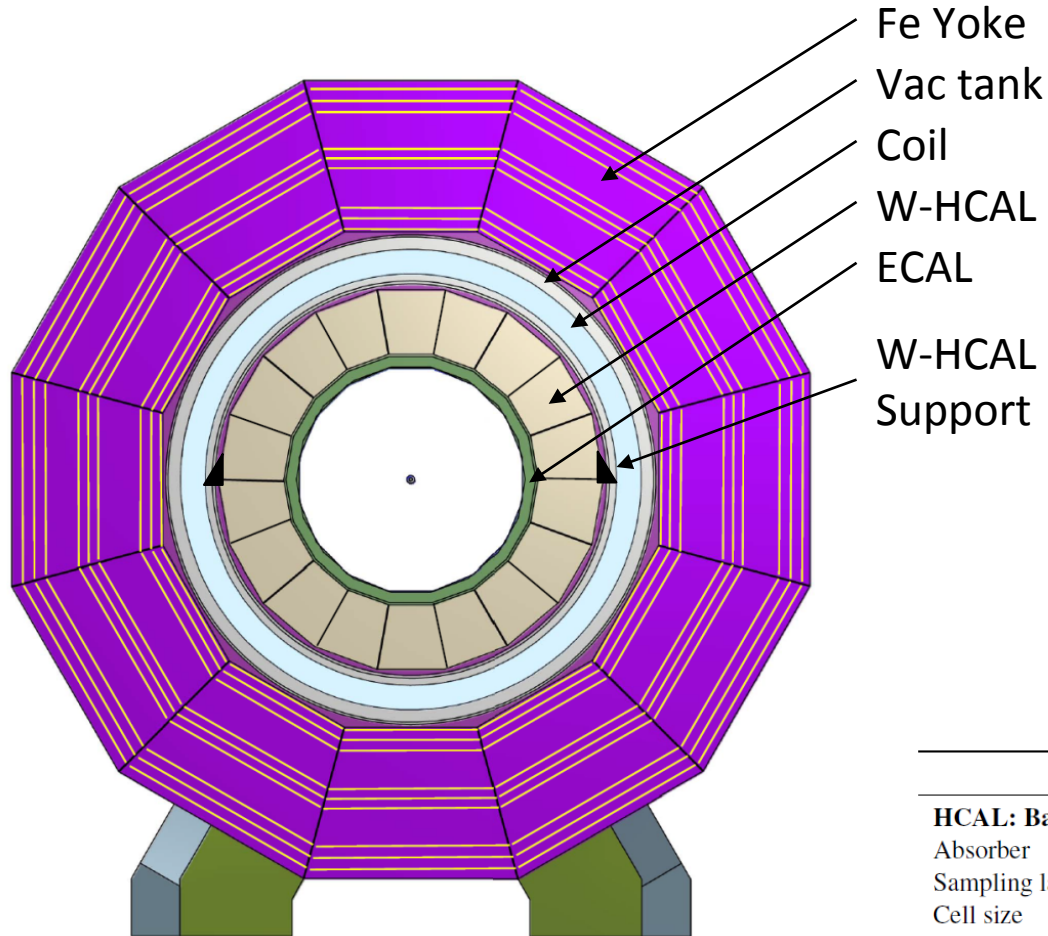
October 24th, 2012

Outline

- CLIC HCAL barrel layout;
- Tungsten design constraints;
- Design alternatives;
- Tangential scintillator insertion design proposal;
- Assembly sequence.



CLIC HCAL layout



	CLIC_ILD	CLIC_SiD
HCAL: Barrel		
Absorber	Tungsten	Tungsten
Sampling layers	75 × 10 mm	75 × 10 mm
Cell size	30 × 30	30 × 30
λ_1	7.5	7.5
Inner radius	2058	1447
Outer radius	3296	2624
Max. Z	2350	1765

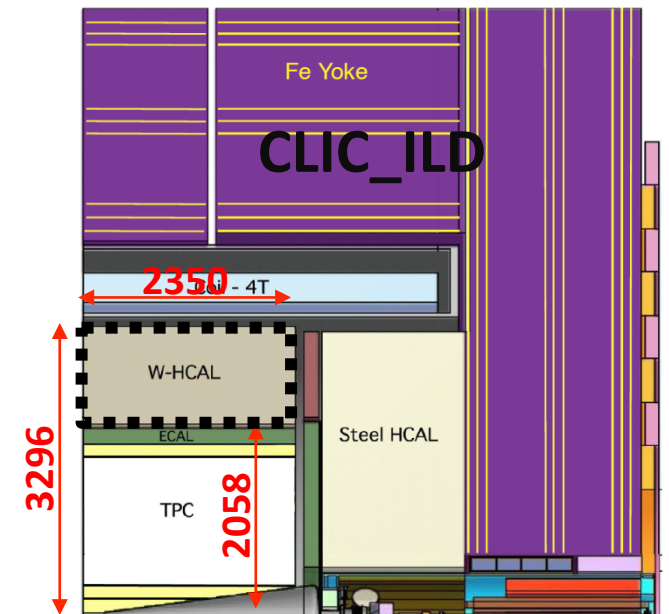
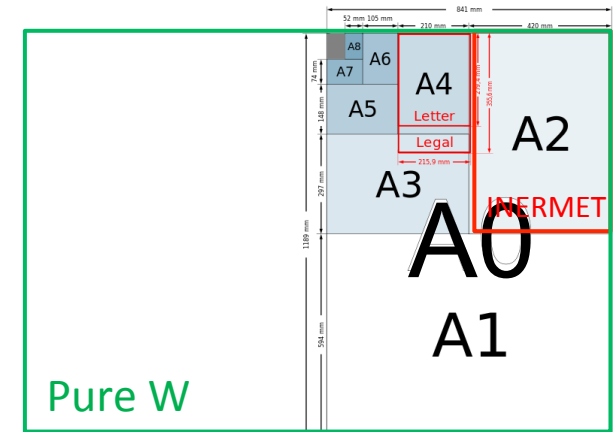


Design constraints

- Currently available plate sizes:

Pure Tungsten	Alloys (e.g. INERMET)
1200 x 1600 mm ²	400 x 600 mm ²

- Limited plate size → Pure tungsten;
- Poor W machinability;
- High W brittleness;



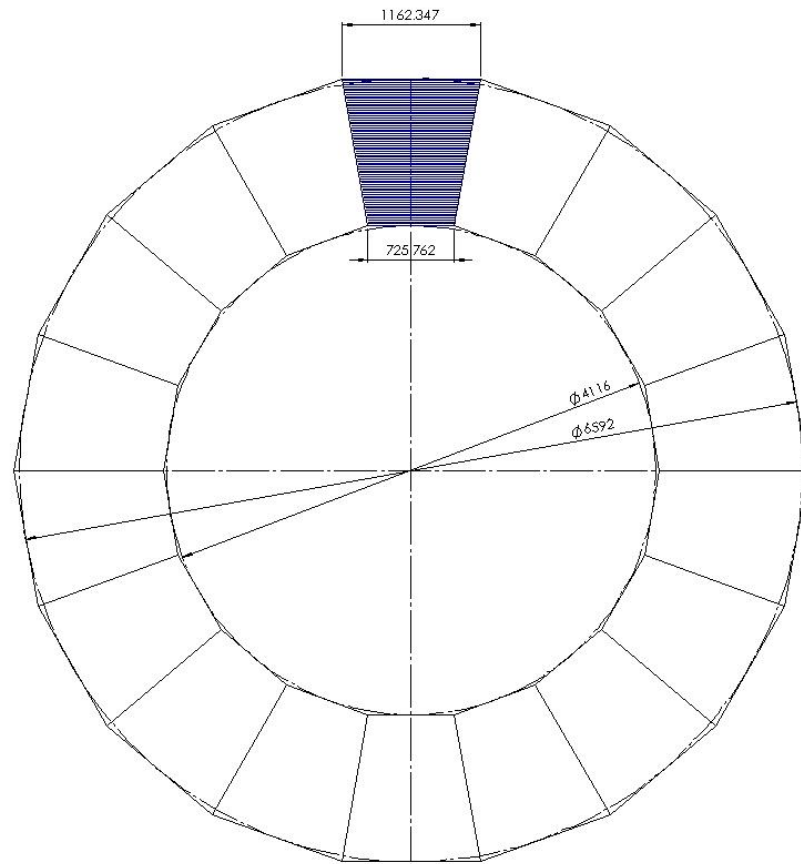
Design constraints

- Highly segmented HCAL (75 layers) → High # of (fragile / expensive) plates;
- 10 mm thick plates;
- Loose mechanical tolerances:
 - Flatness tolerance ca. 1.5 mm (< 1 mm possible);
 - Thickness tolerance ± 0.5 mm (with machining ± 0.1 mm – cost \uparrow);
- Need to minimize machining and handling risks.

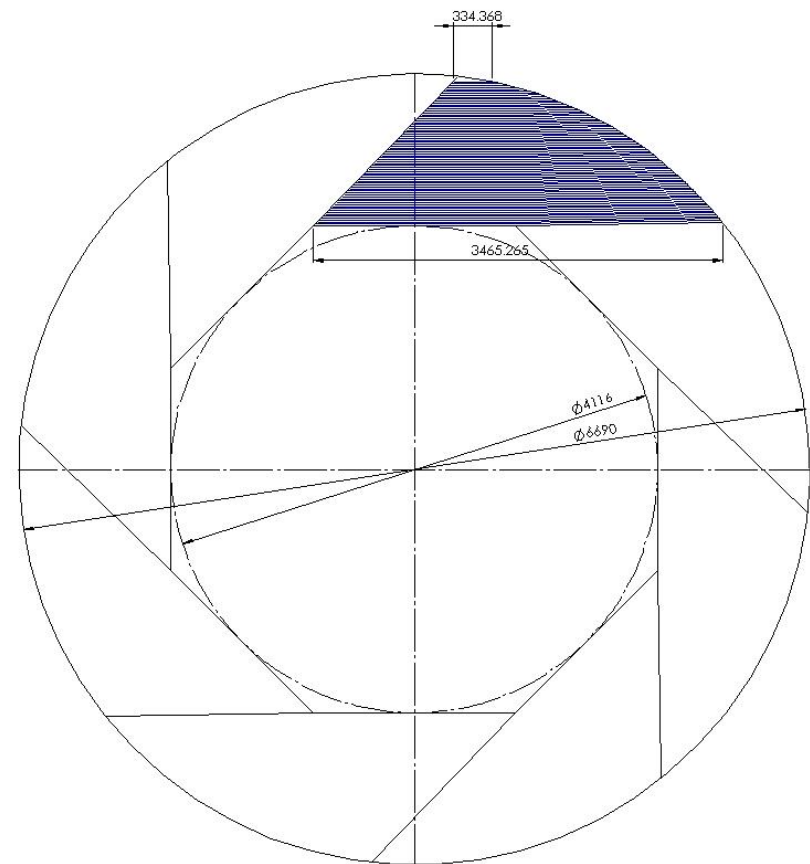


HCAL barrel design alternatives







Axial sensitive layer insertion

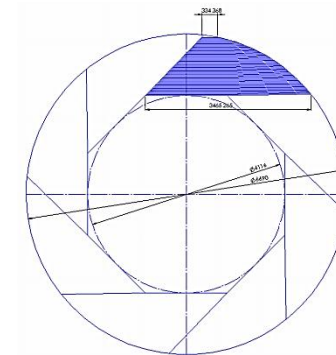
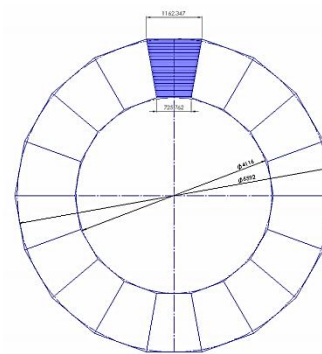


Tangential sensitive layer insertion



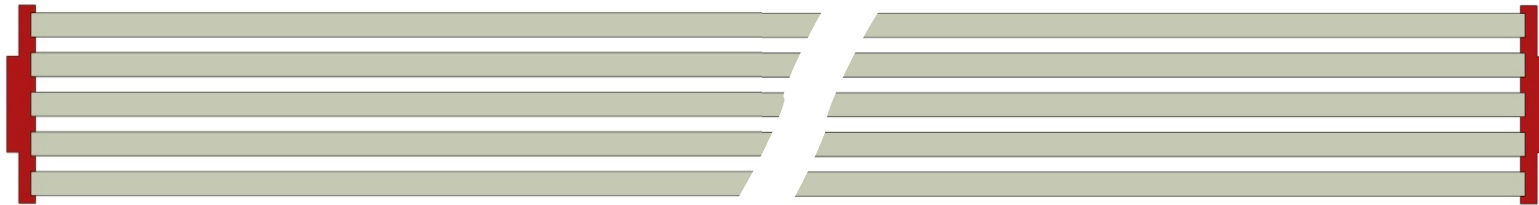
HCAL barrel design alternatives

	Axial sensitive layer insertion	Tangential sensitive layer insertion
Stiffness in transverse plane		
Load bearing tungsten plates		
Access to services		
(...)	(...)	(...)

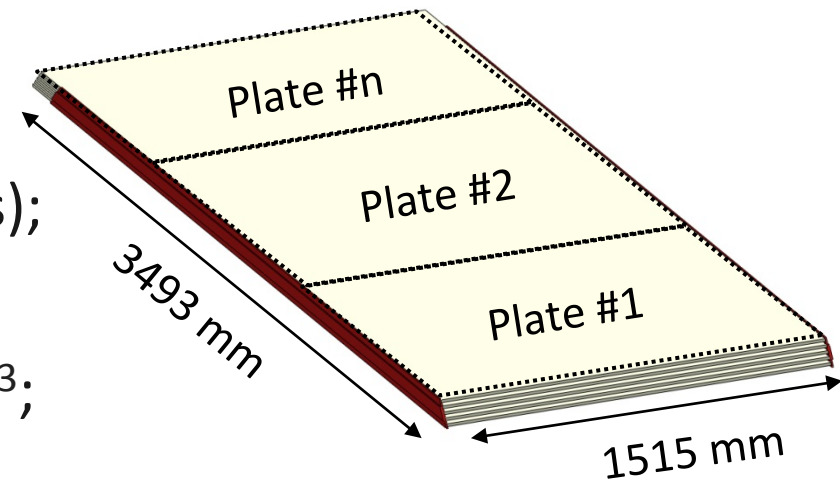


Tangential design

Functional unit – Drawer

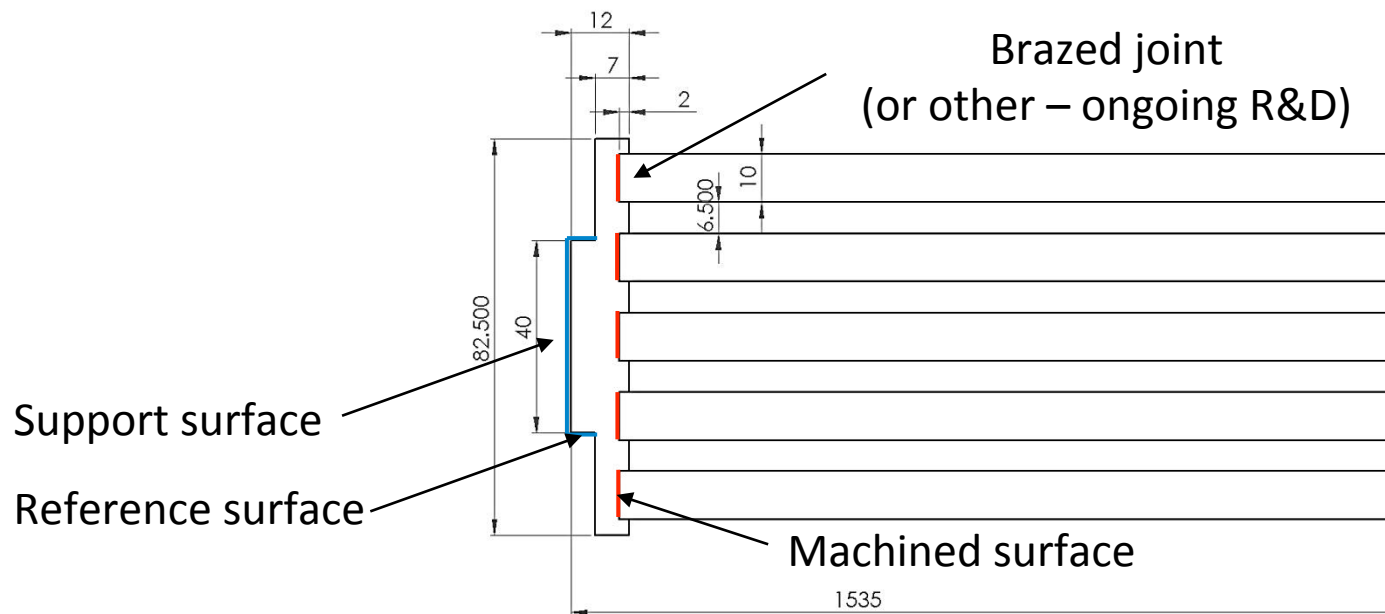


- 5 tungsten layers;
- 2 SST support rails;
- 15 drawers per sector (=75 layers);
- Flexibility in plate dimensions;
- Max. size 3493 x 1535 x 82.5 mm³;
- Maximum weight 5.04 tonne;



Functional unit – Drawer

- Minimal tolerance stacking;
- Only 2 machined surfaces per plate;
- End stoppers on the drawer prevent plate slide in case of joint failure;

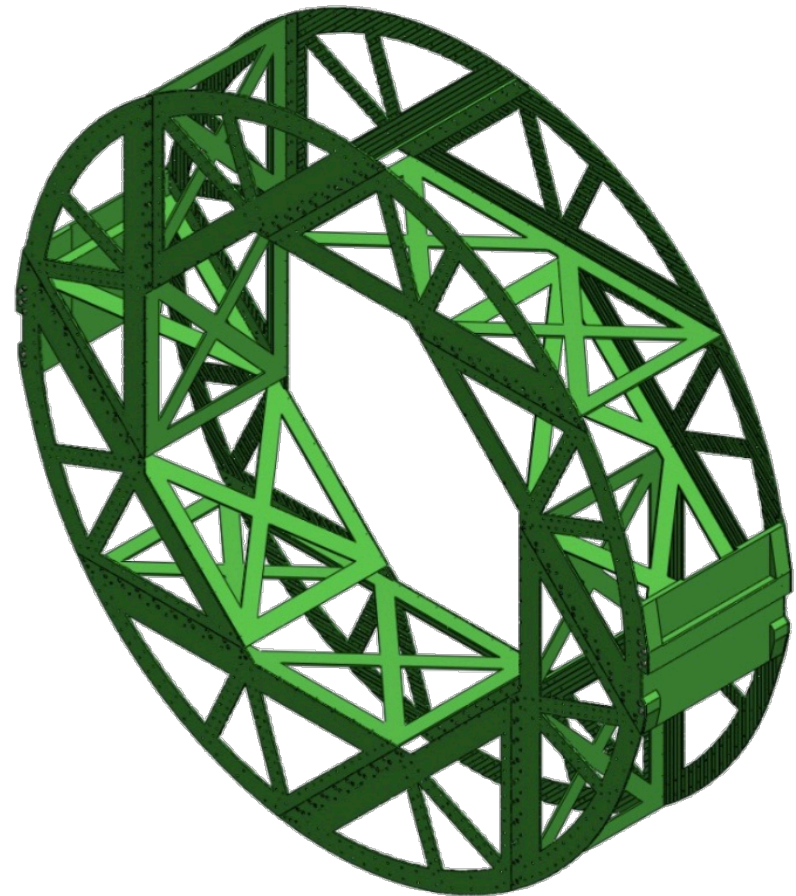


HCAL barrel frame

- 3 SST frames/rings (each 1565 mm wide);
- 8 sectors per frame;
- HCAL structural integrity provided by the frame;

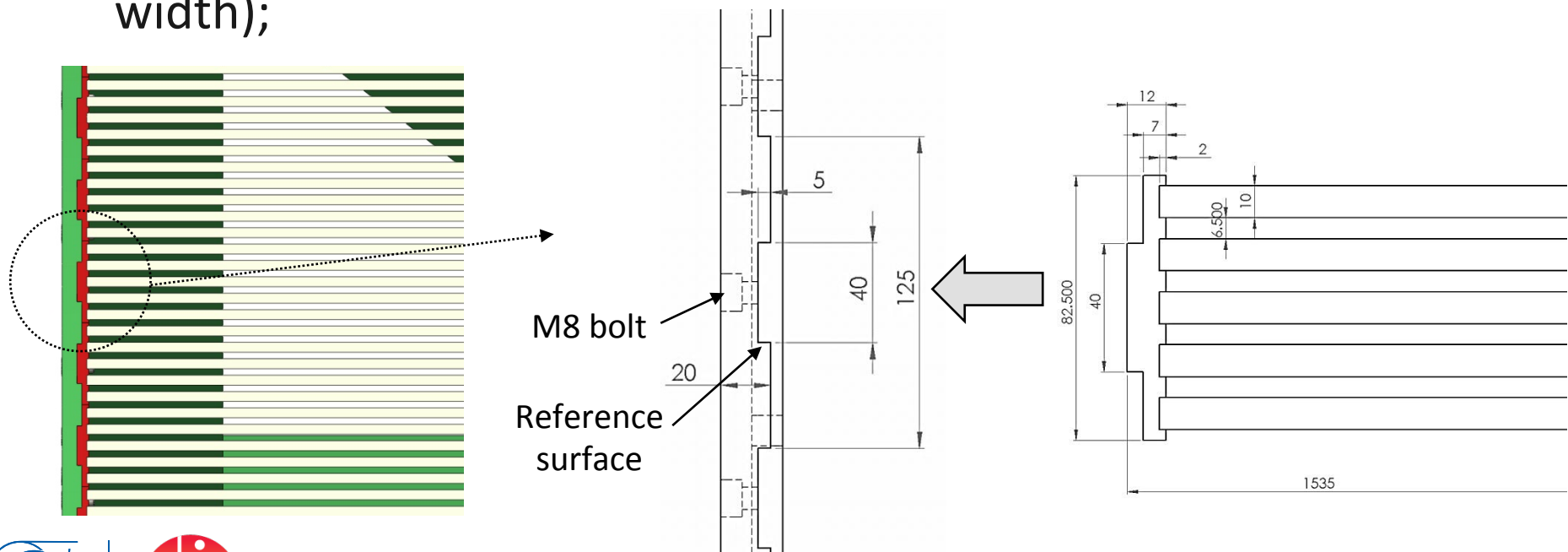
Purpose:

Maximize the HCAL stiffness with minimal material addition



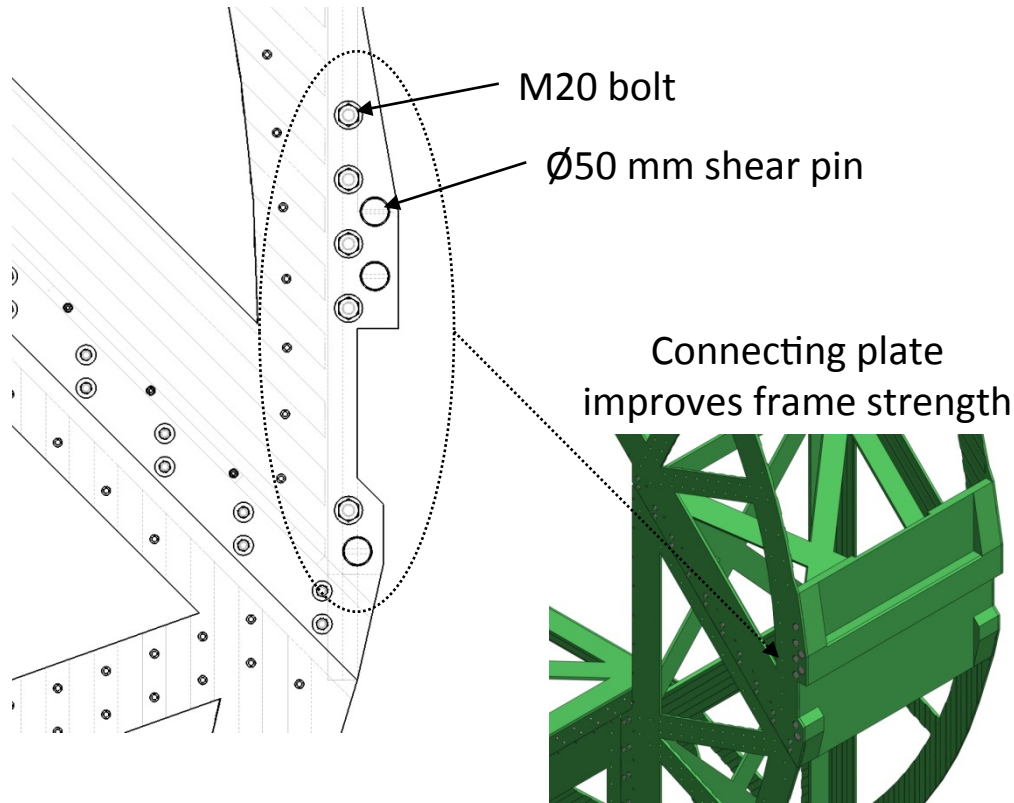
HCAL barrel frame

- Slots cut on the side plates to receive the drawers;
- Drawers secured in place with M8 bolts;
- Joint SST-Tungsten only holds the weight of the W plate;
- Width not instrumented – 54 mm per frame (3.5% of total width);

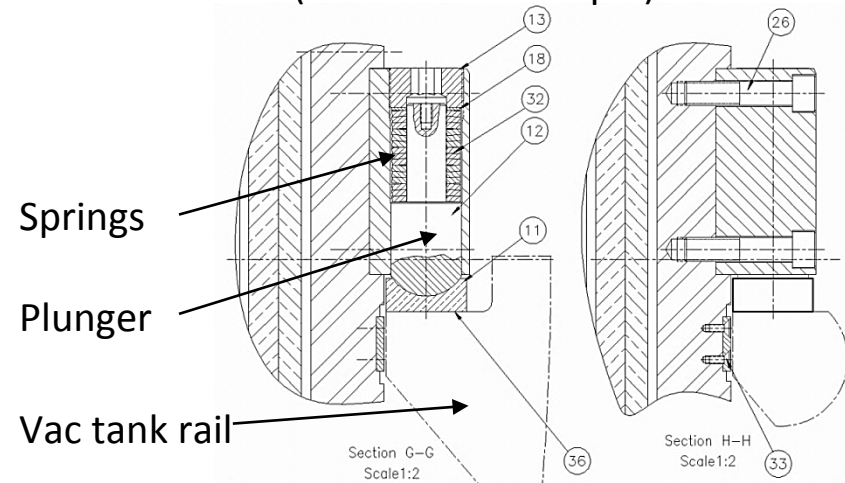


Barrel support rails

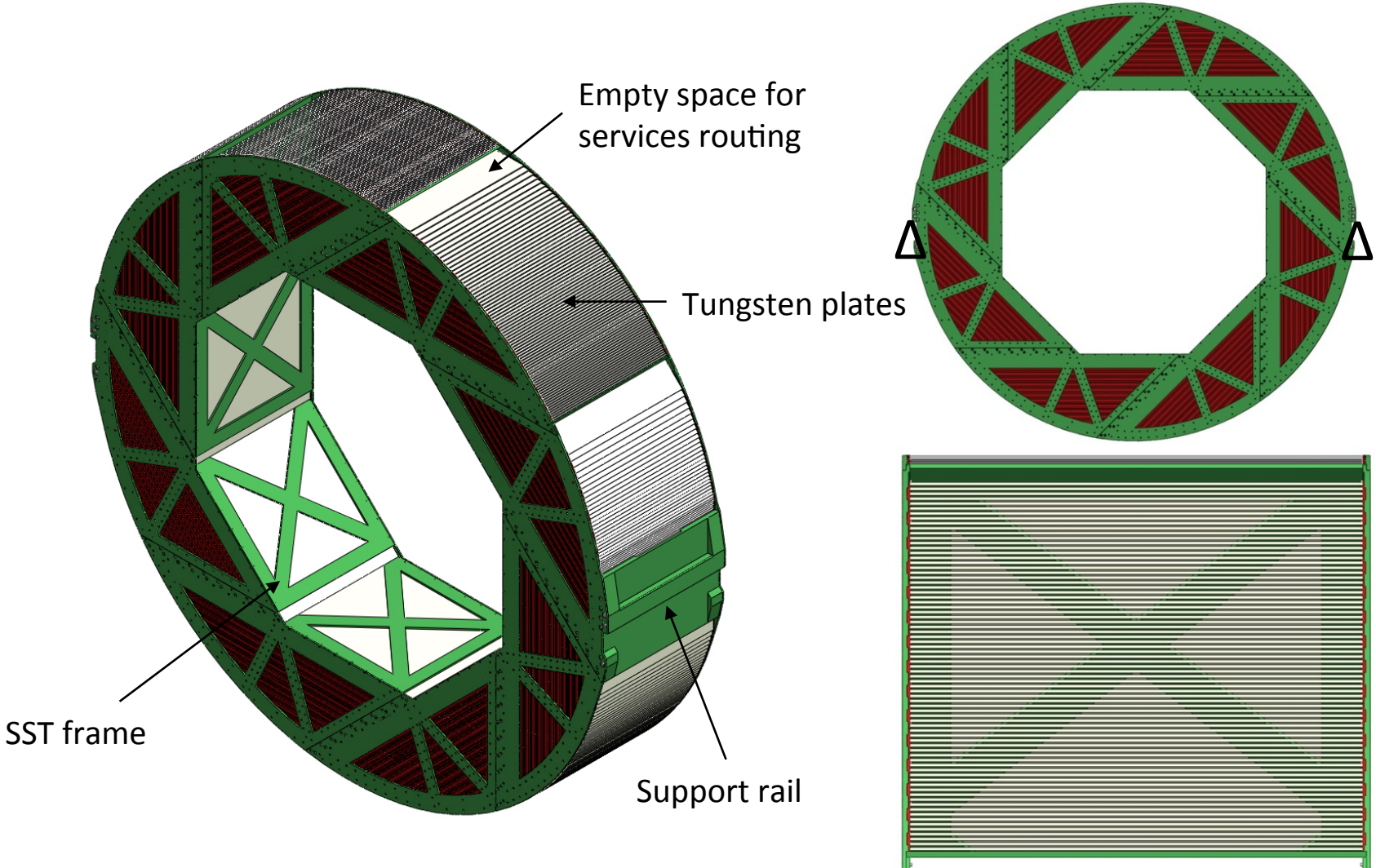
Problem:



Solution:
(CMS HCAL example)



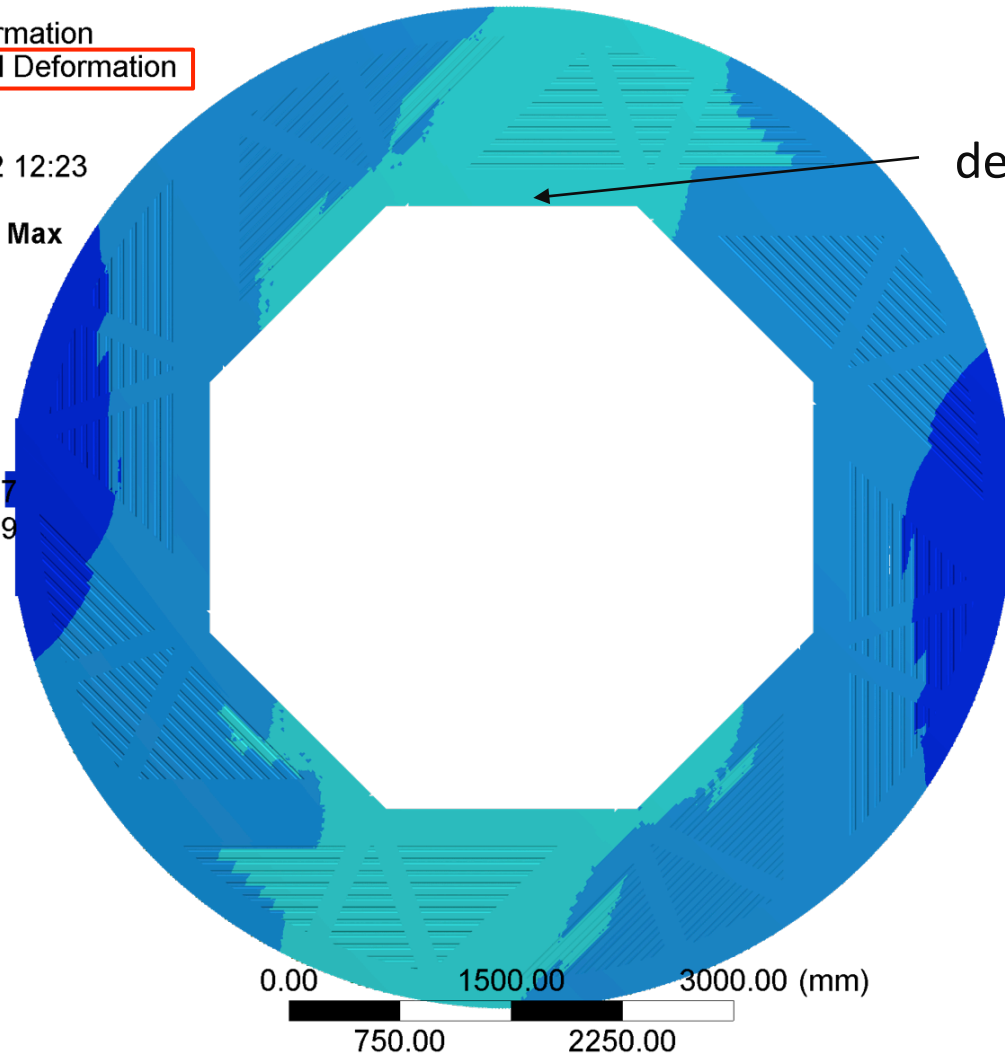
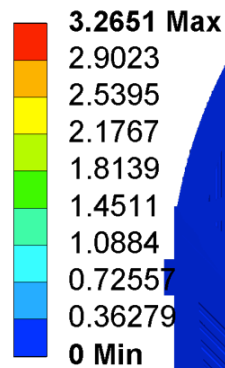
HCAL barrel wheel



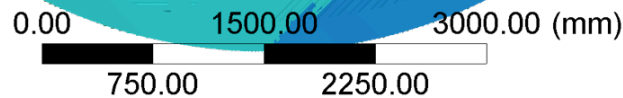
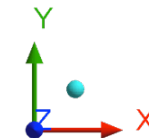
HCAL wheel deformation



B: Wheel
Total Deformation
Type: Total Deformation
Unit: mm
Time: 1
03/10/2012 12:23



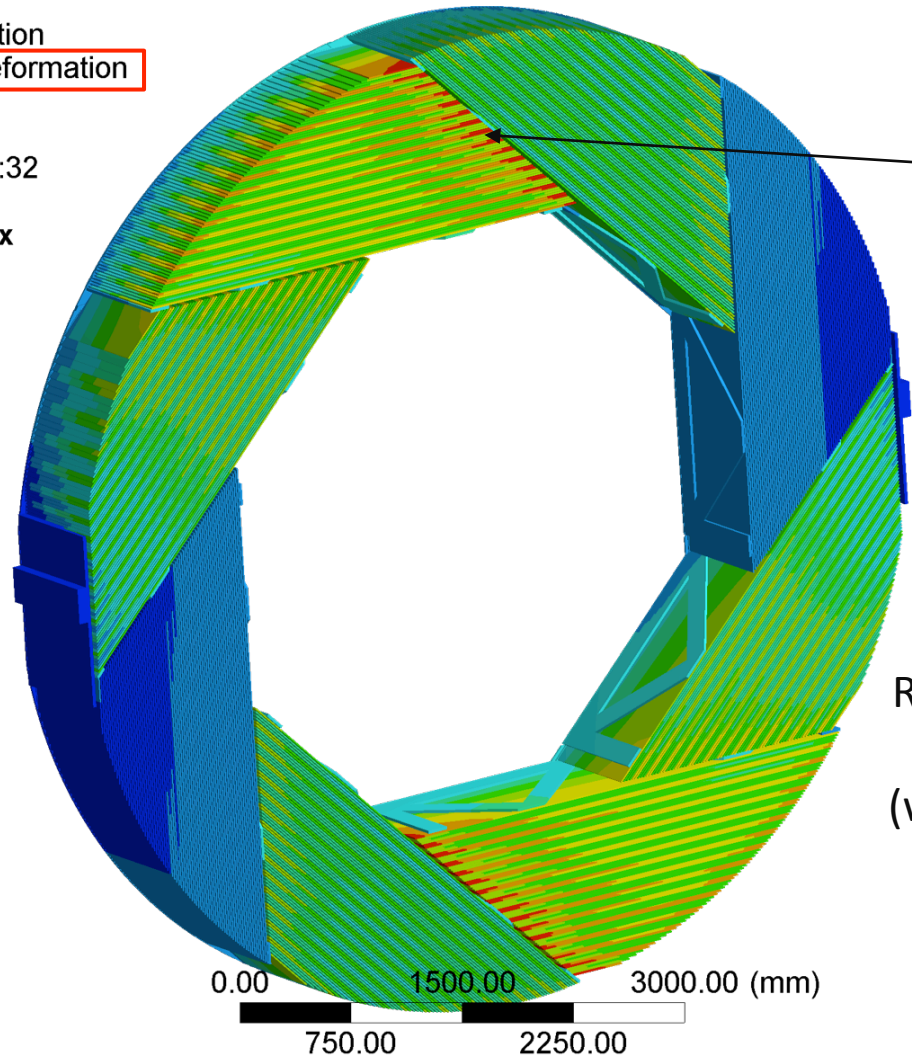
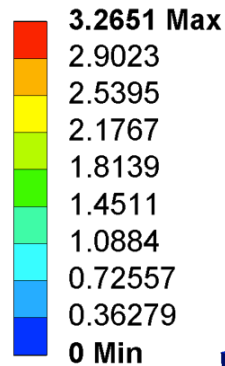
Maximum frame deformation: **1.2 mm**
(stiff design)



HCAL wheel deformation

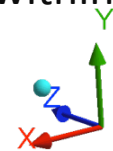


B: Wheel
Total Deformation
Type: **Total Deformation**
Unit: mm
Time: 1
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Maximum total deformation: **3.3 mm**

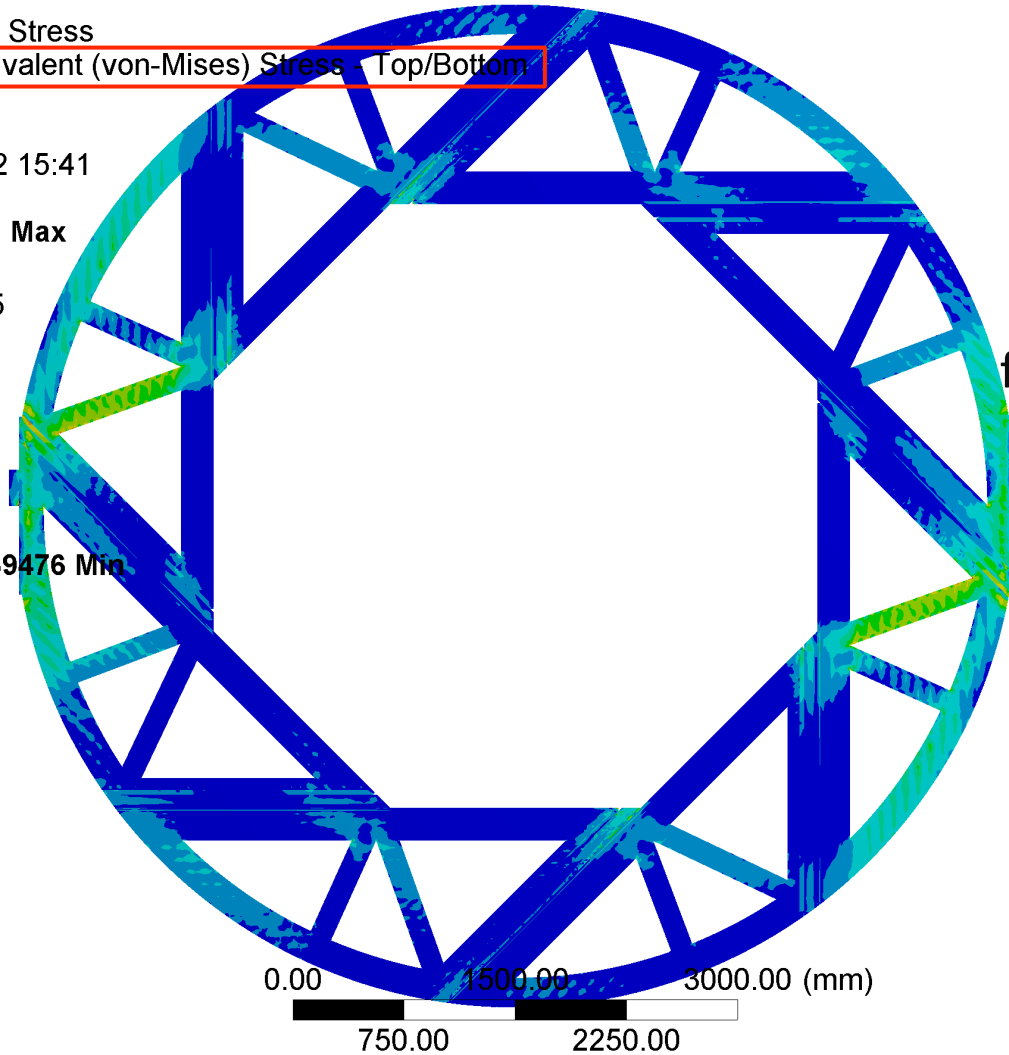
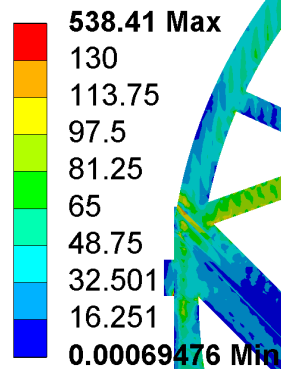
Relative plate deformation **below 1 mm**
(within flatness tolerances)



HCAL wheel stress



B: Wheel
Equivalent Stress
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: MPa
Time: 1
03/10/2012 15:41



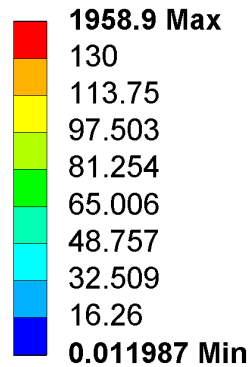
Stress levels in the frame within SST304 safety limits



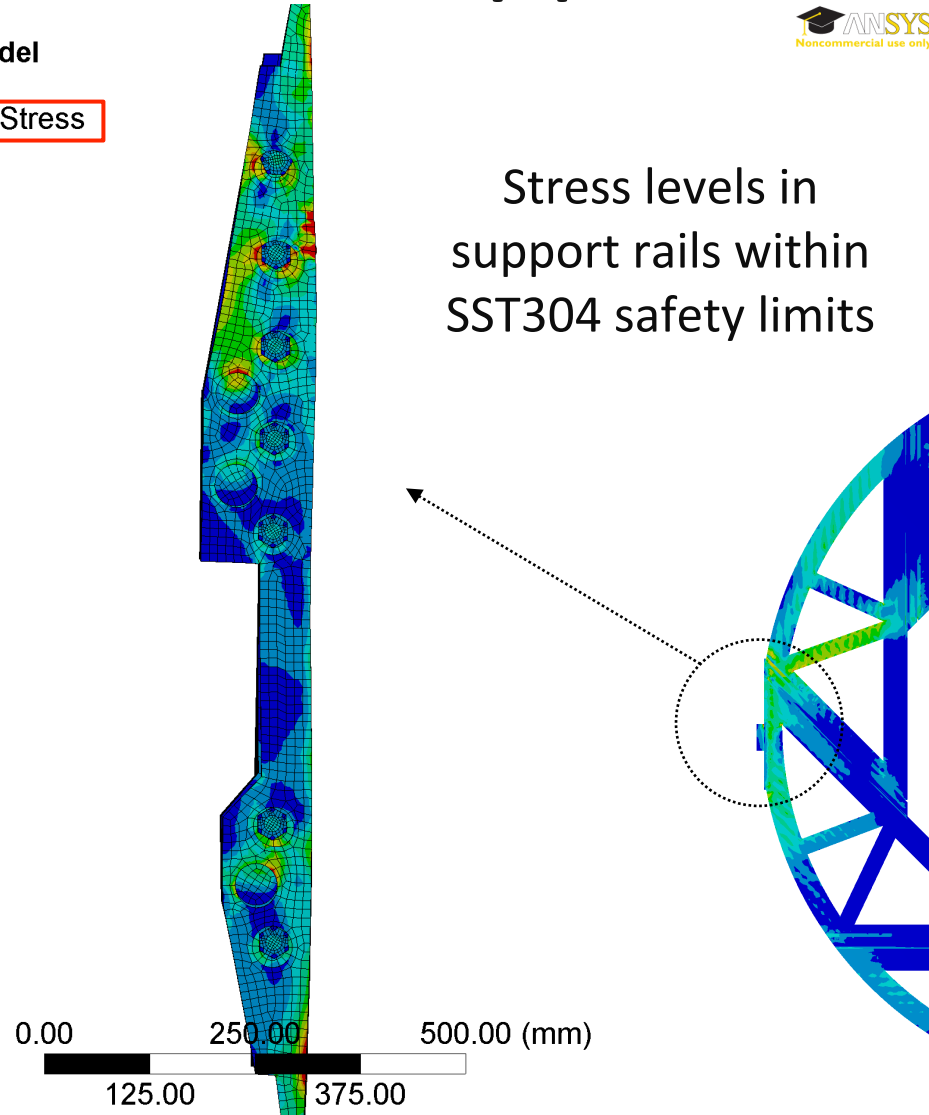
HCAL wheel support



F: Copy of Support - Sub-model
Equivalent Stress
Type: Equivalent (von-Mises) Stress
Unit: MPa
Time: 1
03/10/2012 15:45

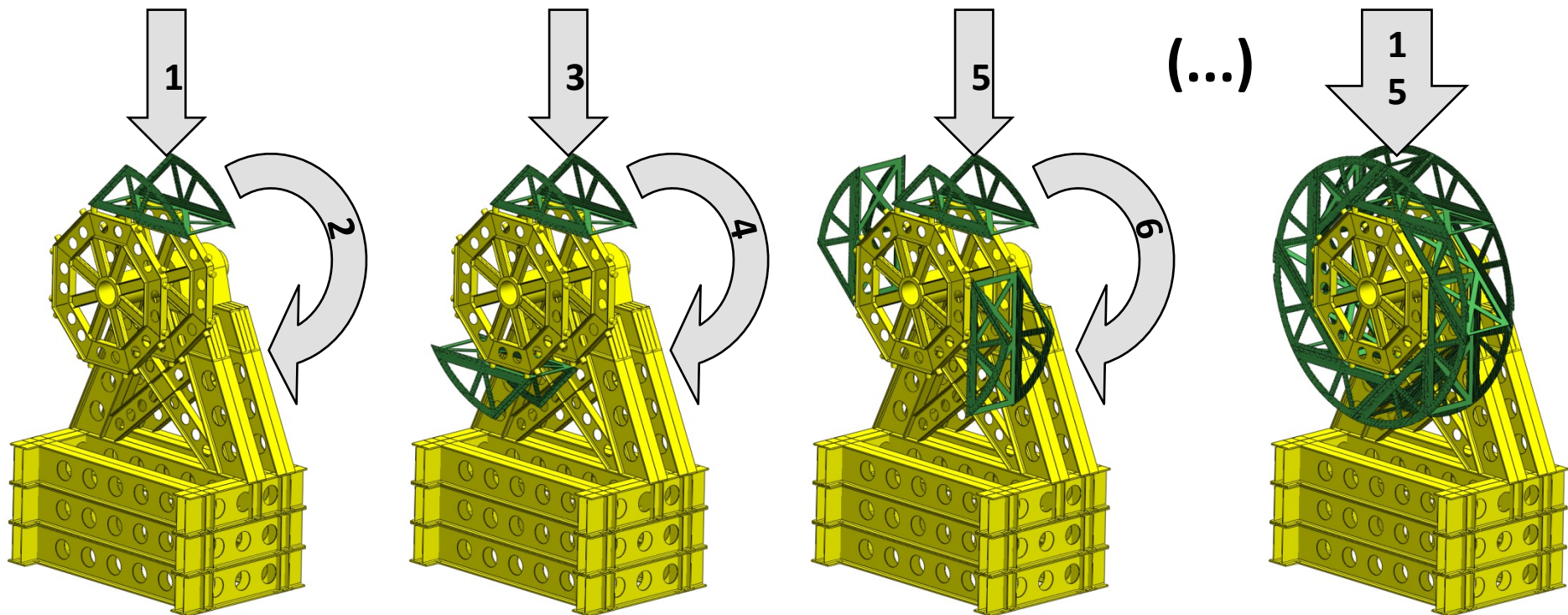


Stress levels in
support rails within
SST304 safety limits



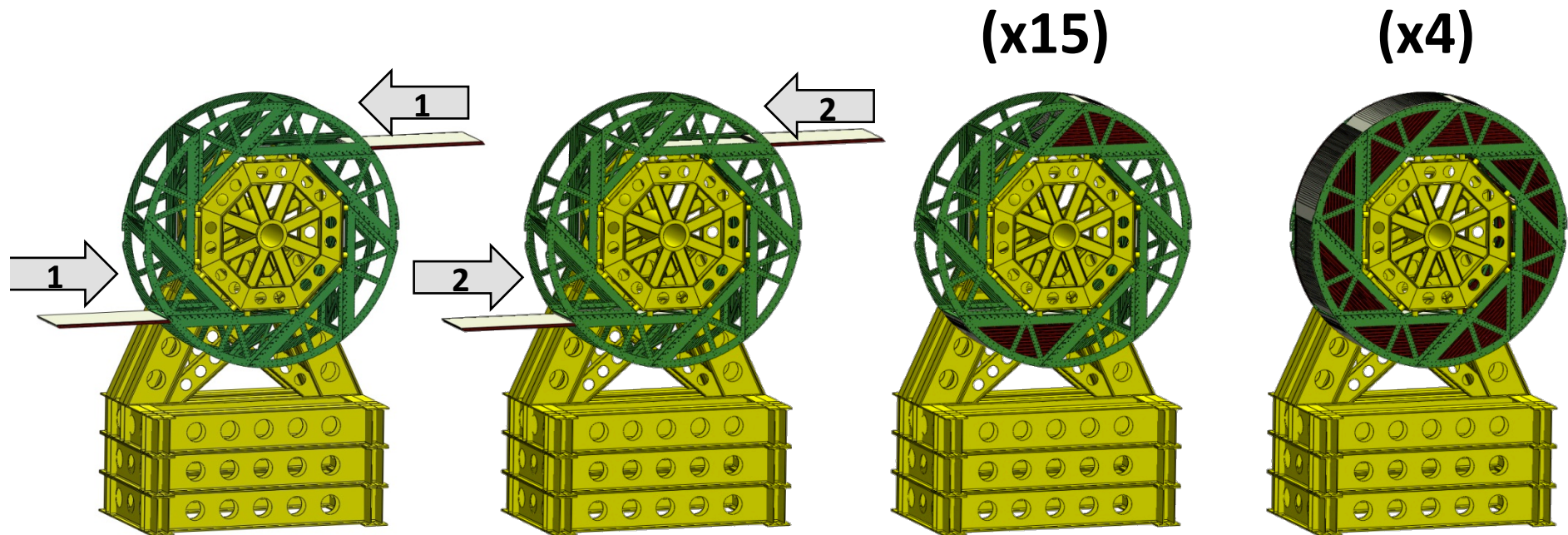
Assembly

- The first step will be to assemble the frame:



Assembly

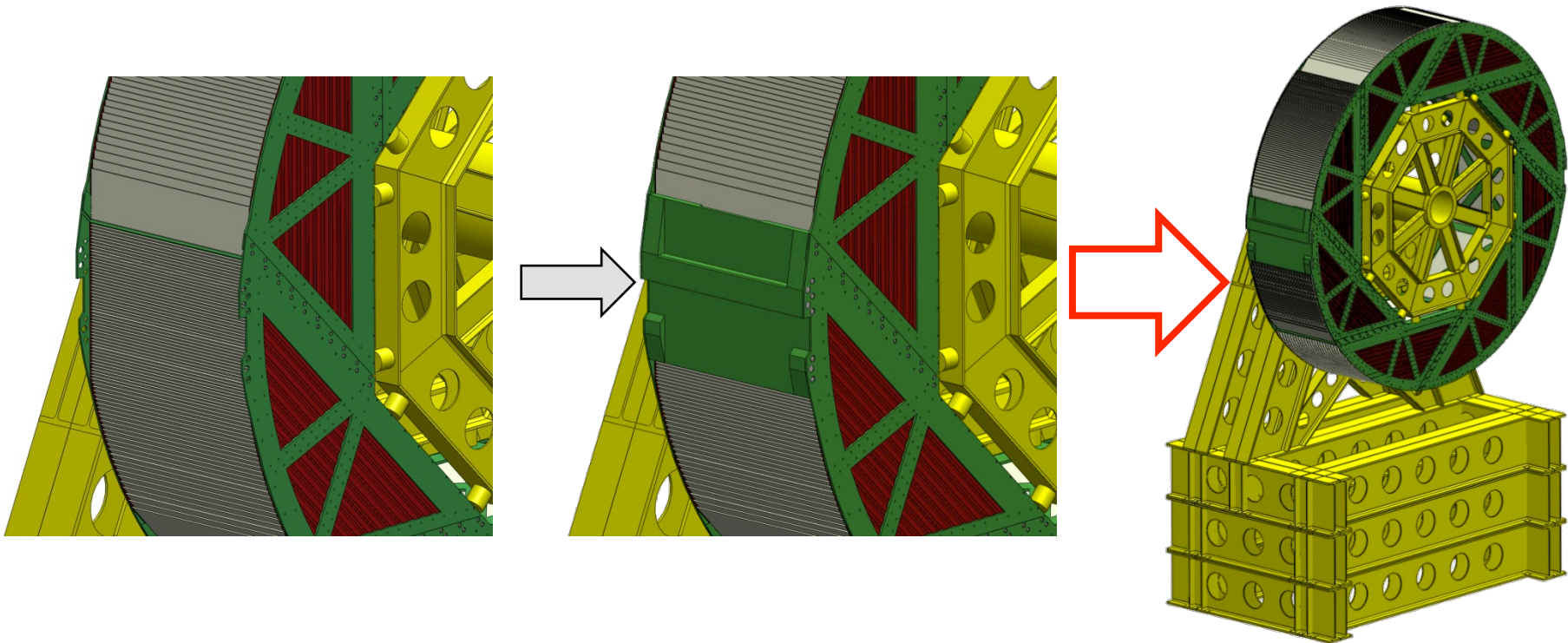
- In the next step, the drawers are inserted:



... followed by the insertion of the sensitive layers;

Assembly

- Finally, the support rails are attached after the sensitive layers are in place:



Summary

- Pure tungsten presents numerous challenges from the mechanical point of view;
- Two main HCAL design alternatives exist;
- Choice between the two will be governed mainly by the access/maintenance scenarios;
- A realistic HCAL barrel design has been proposed;
- Stiffness, manufacturing and assembly constraints are satisfied.



Thank You.