The AHCAL Barrel integration in ILD

Design Status Report

ILD/CMS Engineering Meeting
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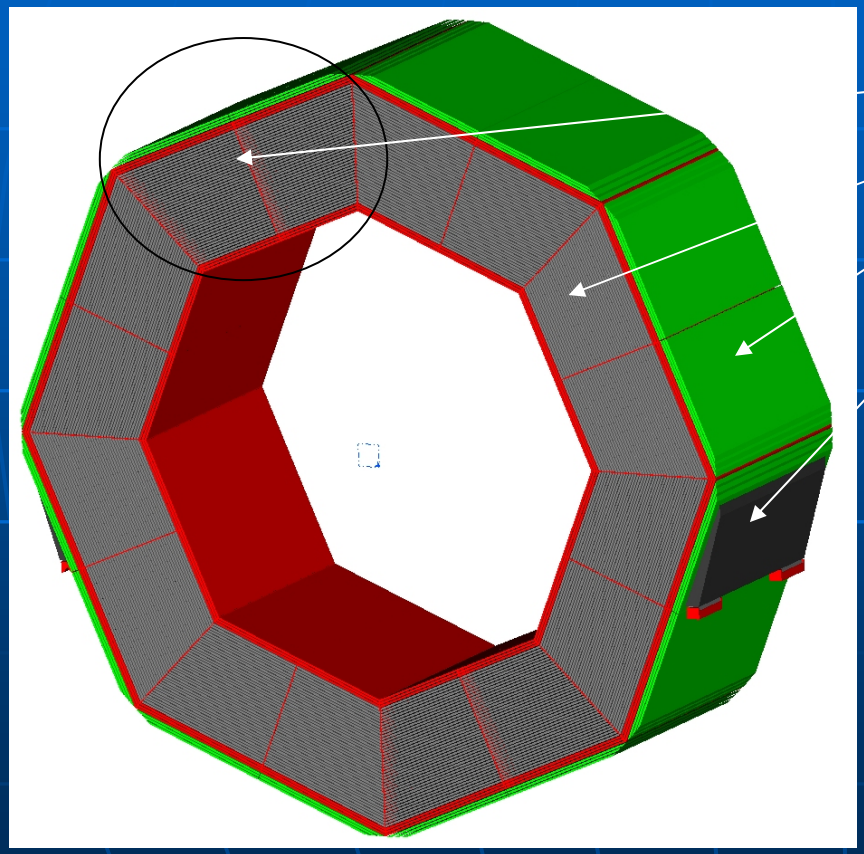
AHCAL barrel data set 1 (first loop) to start the mechanical design

- After the first loop through the "*Workflow to design a HCAL barrel absorber structure for the ILD*" based on LDC01_05Sc I got following HCAL barrel data set 1
  - 1. HCAL barrel material
    - stainless steel 1.4401 or 1.4435
  - 2. HCAL barrel dimensions
    - inner radius : 2000 mm
    - absorber thickness : 18 mm
      - absorber plate thickness : 16 mm
      - sensitive layer cover thickness : 2 mm
    - number of sensitive layers : 48 layers
    - sensitive layer gap thickness : 6,5 mm
    - number of absorber plates : 49 plates
    - outer radius : 3378 mm
    - Length of one absorber module: 2350 mm
  - 3. HCAL barrel shape
    - Octagonal inner shape , nearly circular outer shape
    - 2 sub-modules per octagon module
    - total : 2 barrel absorber structures x (8 modules x 2 sub-modules) = 32 sub-modules
    - pointing cracks 2 x (3 mm side plate + (7 mm spacer ?)) = 20 mm + air gap (5 mm)
  - 4. HCAL sensitive layer
    - scintilator plates read out by SiPMs

HCAL barrel absorber structure mechanical design overview (first loop)



- AHCAL barrel absorber structure
  - module
  - sub-module
  - backpack
    5,2 λ slim version
  - support
    4 feet per AHCAL half barrel
    load per foot 960 t / 8 = 120 t
    2 x 320 t (AHCAL half barrel) = 640 t
    5 x 8 x 8 t (ECAL modules) = 320 t

- Attention!

change of module orientation (22,5° rotation) to LDC01_05Sc
Impact to ECAL but not to Mokka!

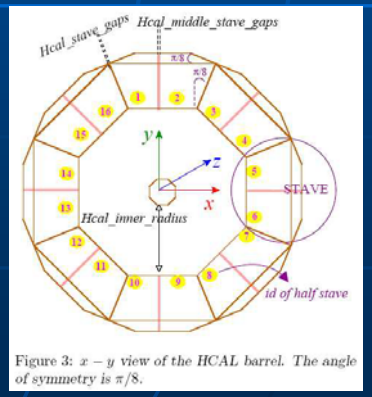


Figure 3: $x - y$ view of the HCAL barrel. The angle of symmetry is $\pi/8$.

Physics simulation in Mokka, 3D Design work, FEM studies, and real size prototyping are ongoing for the 1.Loop

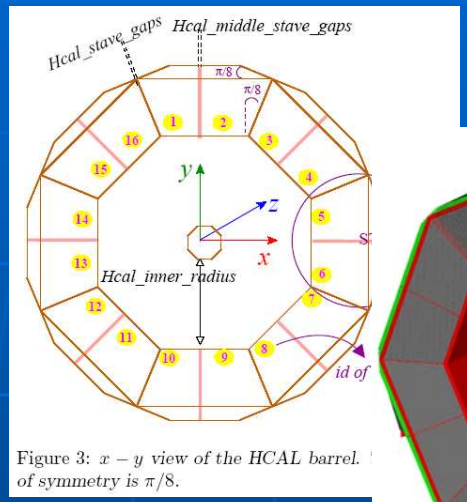
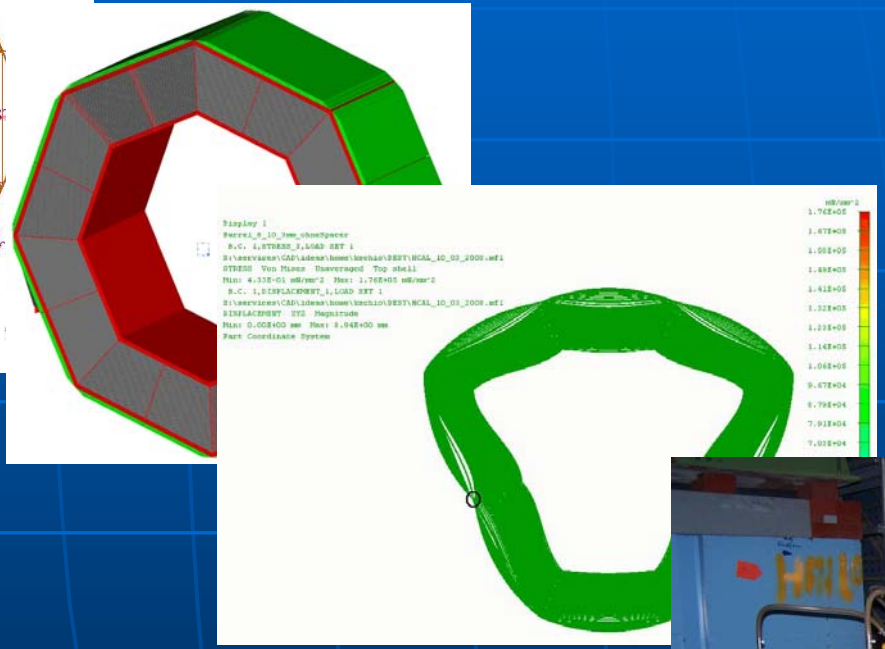
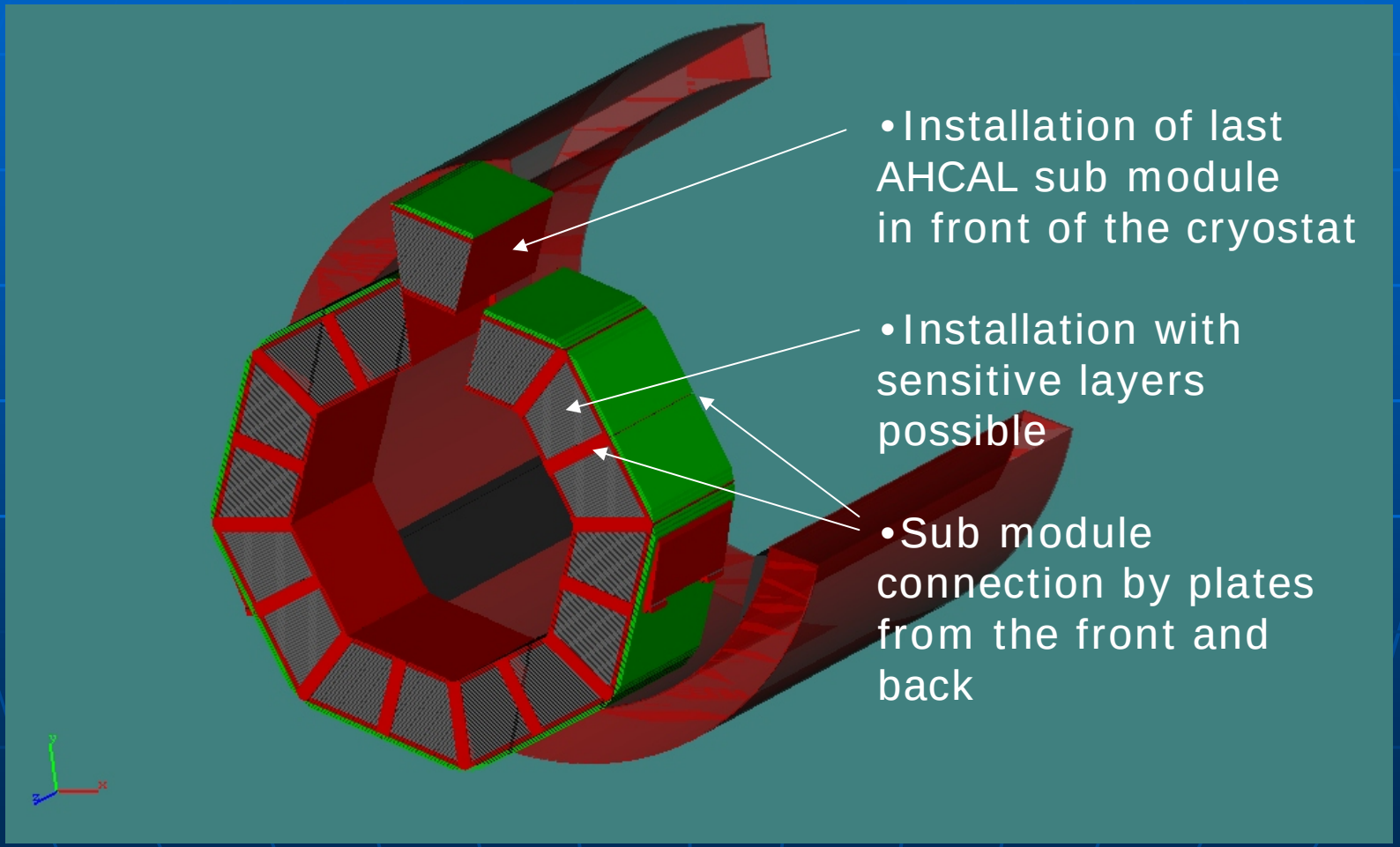


Figure 3: $x - y$ view of the HCAL barrel. of symmetry is $\pi/8$.



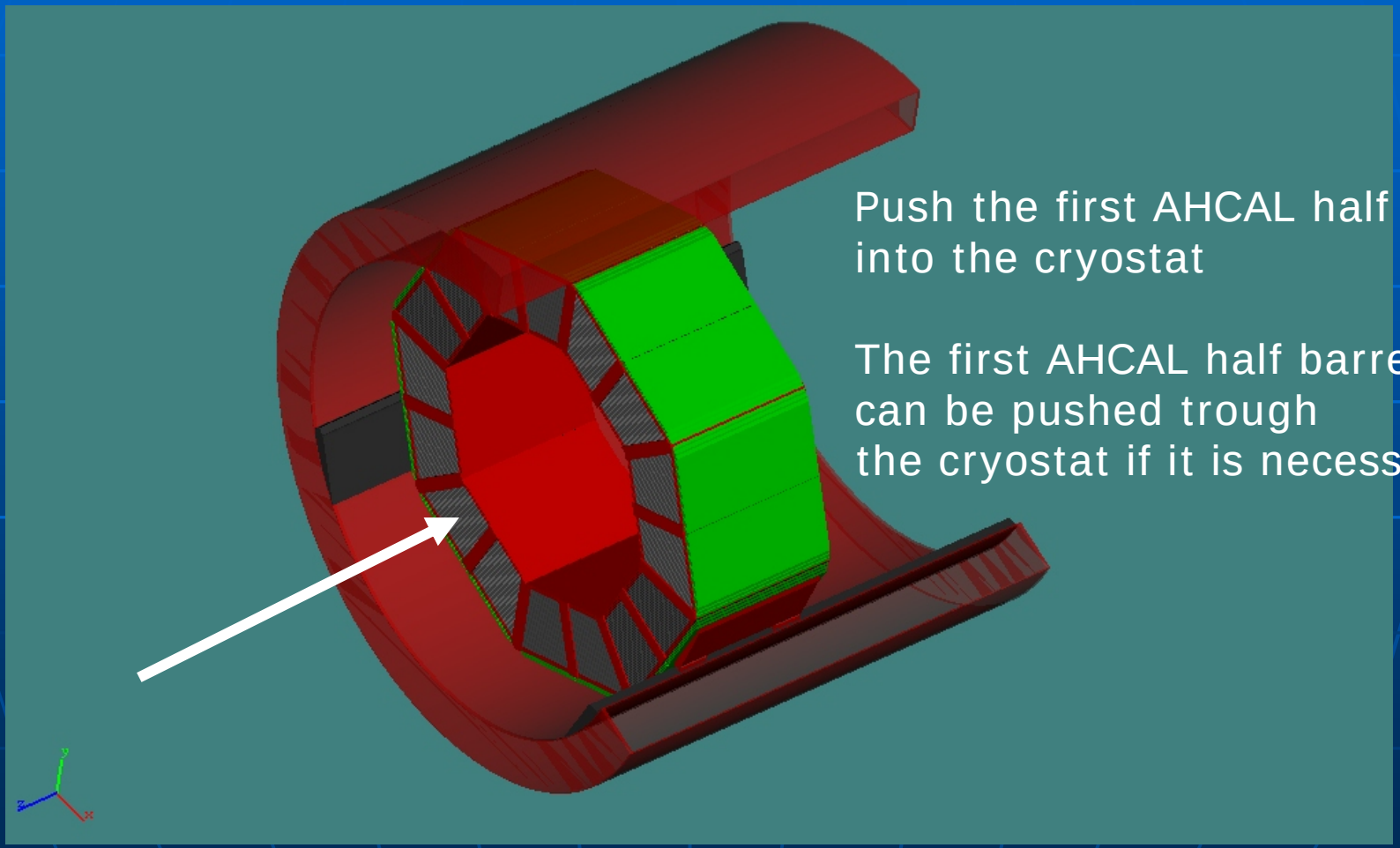
And we have a functional sensitive layer with a 1m³ physics prototype running!

AHCAL barrel integration in ILD step 1



- Installation of last AHCAL sub module in front of the cryostat
- Installation with sensitive layers possible
- Sub module connection by plates from the front and back

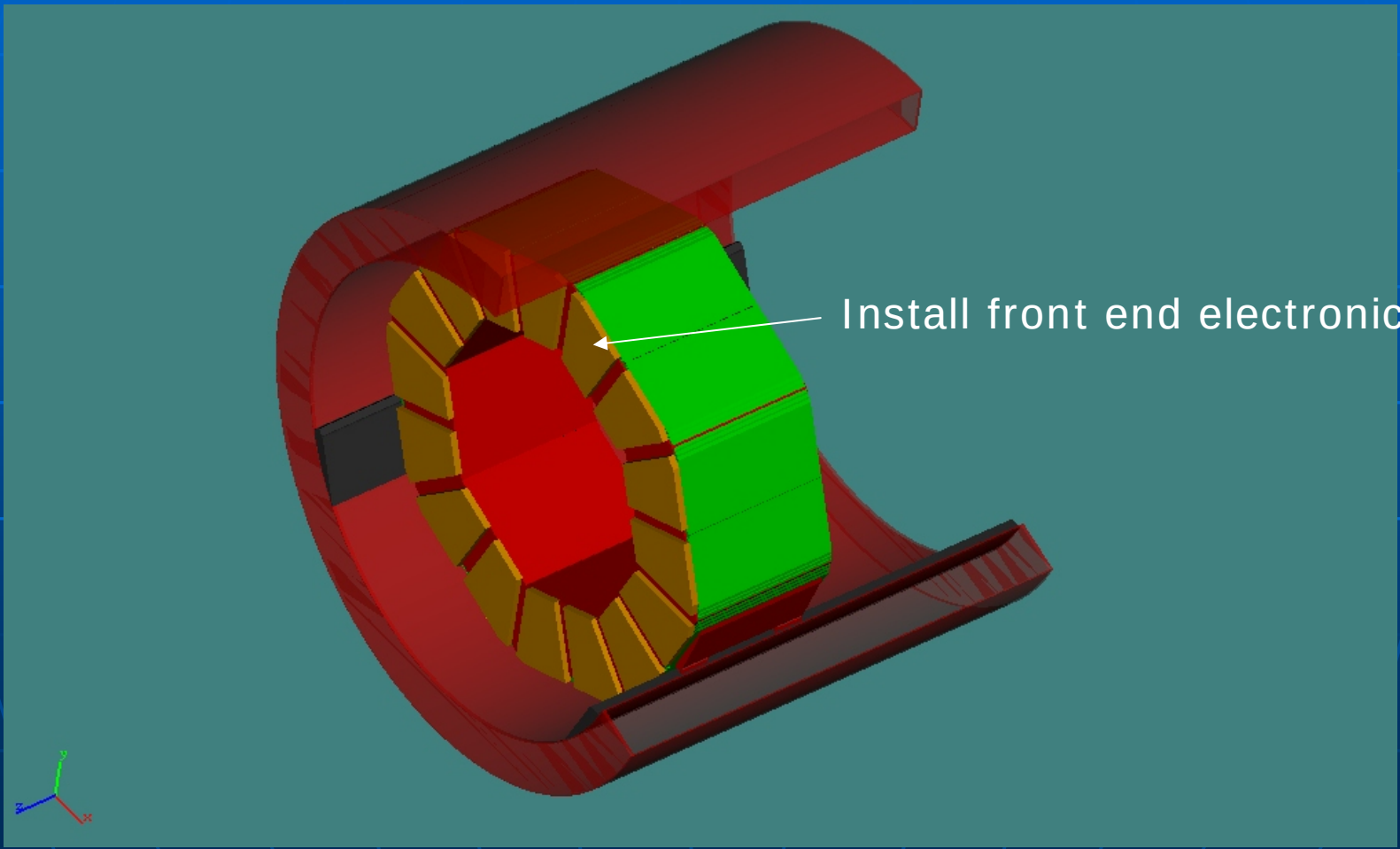
AHCAL barrel integration in ILD step 2



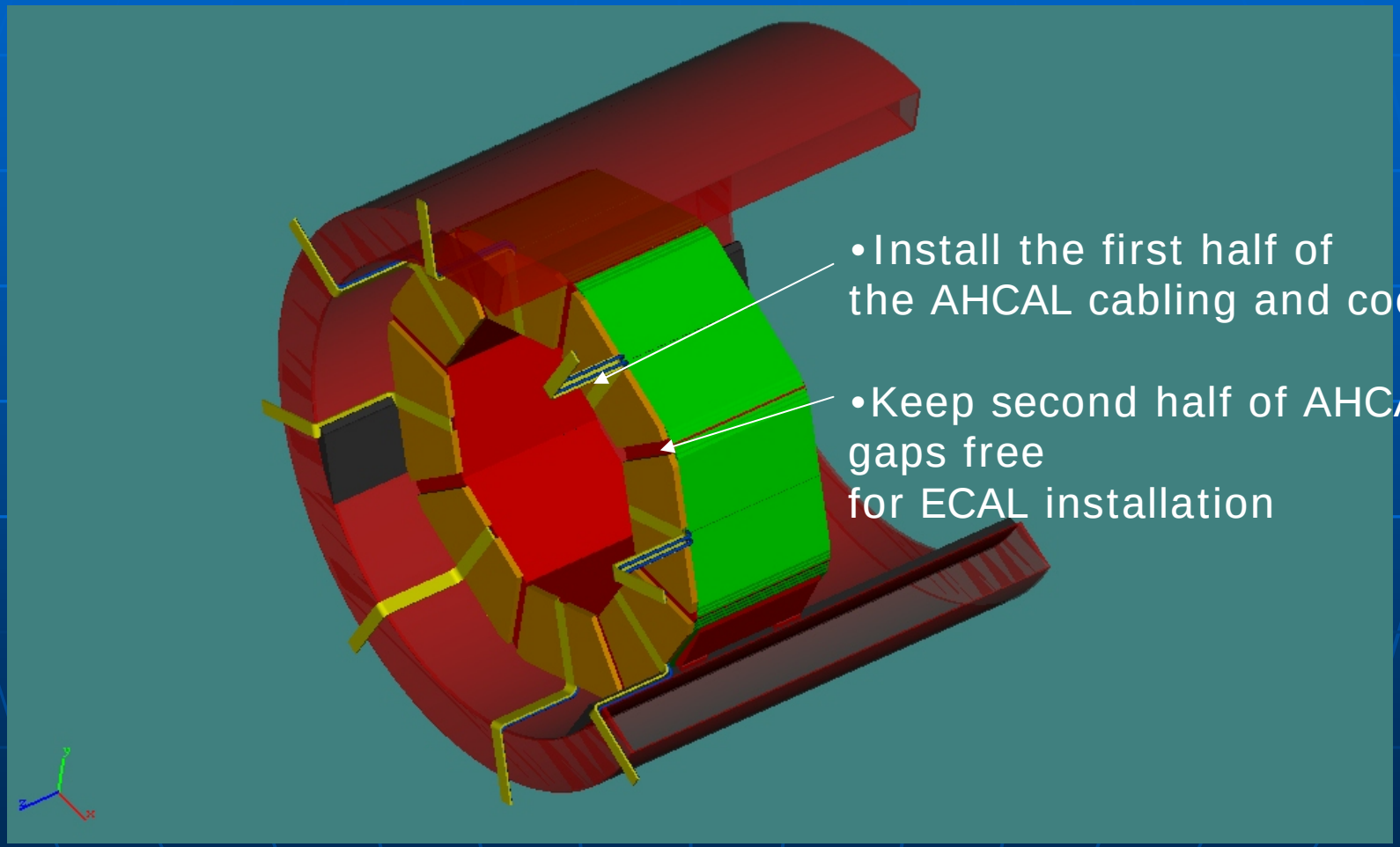
Push the first AHCAL half barrel into the cryostat

The first AHCAL half barrel can be pushed trough the cryostat if it is necessary

AHCAL barrel integration in ILD step 3

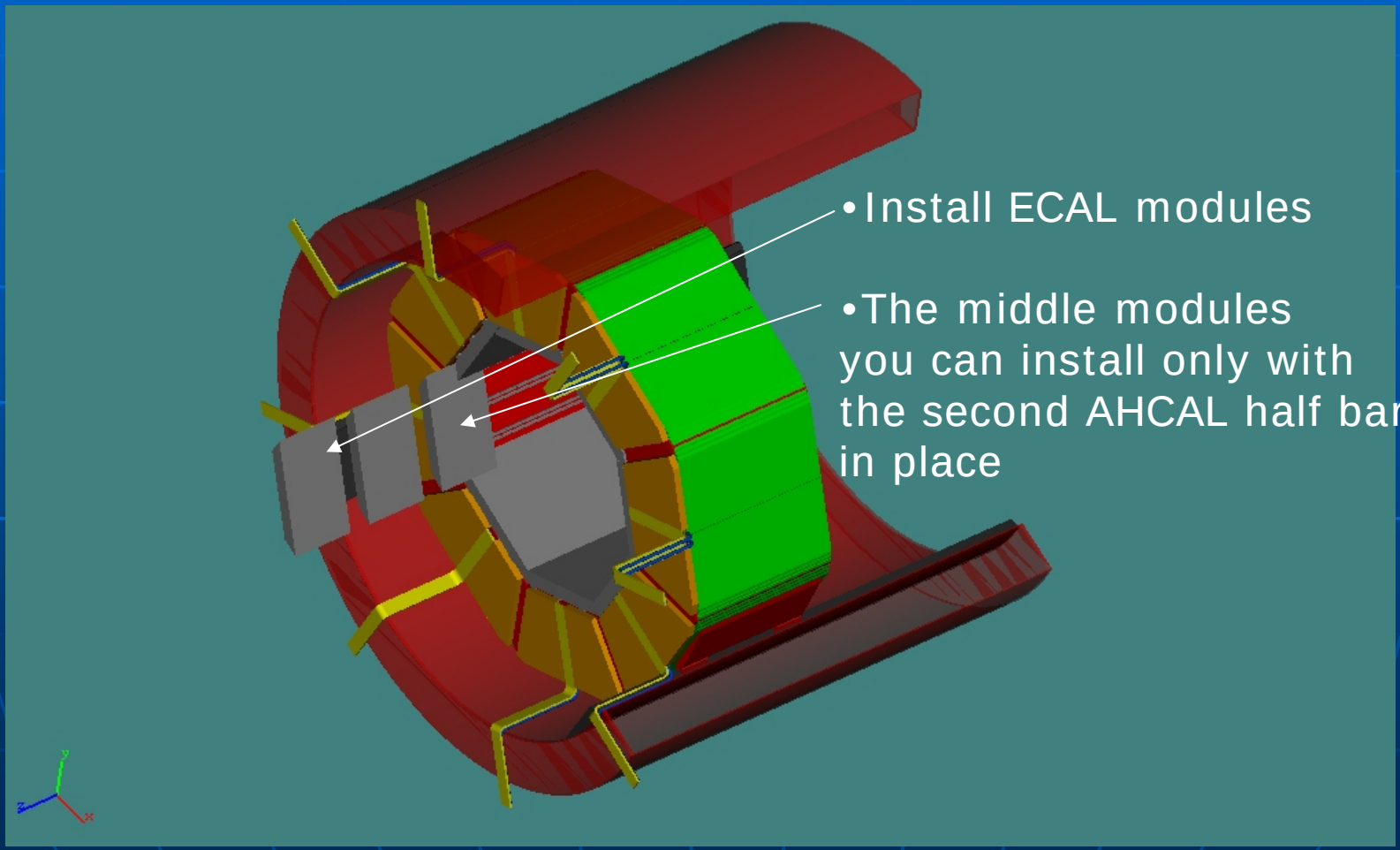


AHCAL barrel integration in ILD step 4

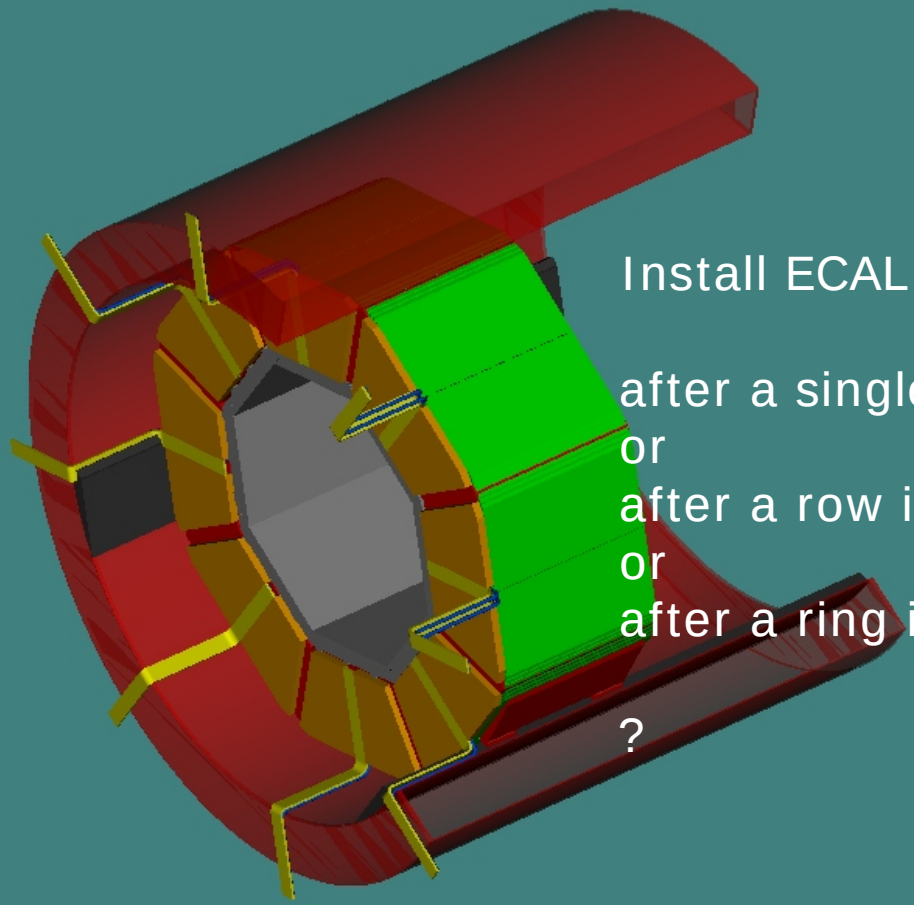


- Install the first half of the AHCAL cabling and cooling
- Keep second half of AHCAL gaps free for ECAL installation

ECAL barrel integration in ILD step 1



ECAL barrel integration in ILD step 2



Install ECAL cabling and cooling

after a single module installation
or
after a row installation
or
after a ring installation

?

conclusions

- We know what we have to do, to get a functional design for the AHCAL barrel detector, but there are problems with the total thickness of the absorber structure. Maybe we have to in crease the diameter of the coil, due to tolerance problems
- But we have to go much further into the details
- And we have to improve the interplay with the other detector components

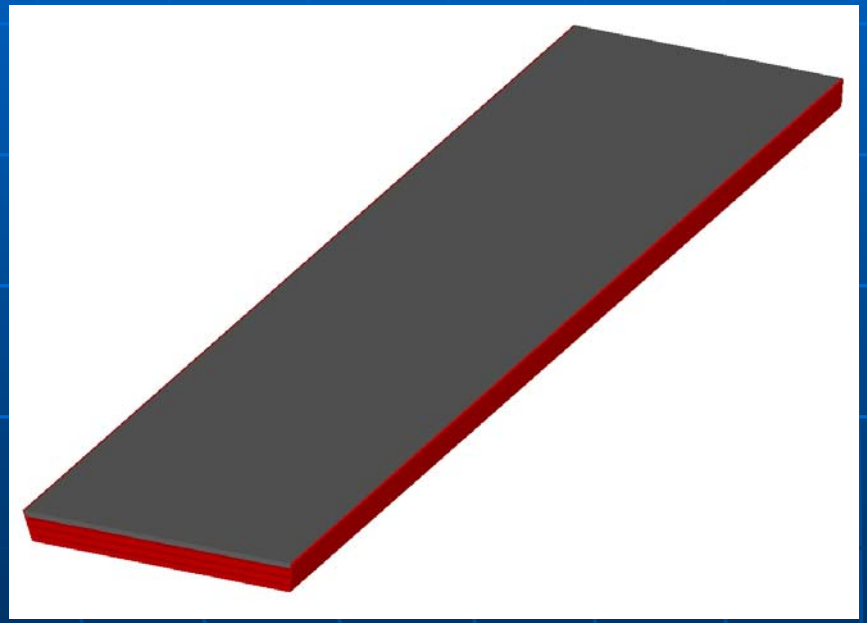
Outlook

- Implement the TPC model into the barrel structure starting in February
- Start the detailed mechanical design of the AHCAL end caps in summer 2009

backup slides prototyping

- real size test setup horizontal
- real size test setup vertical
- first results tendering, handling
- first results tolerances
- first results material properties 1
- first results material properties 2
- first conclusions
- outlook tolerances
- outlook material properties

real size test setup horizontal



- 4 full size absorber plates mounted to a fraction of a sub-module

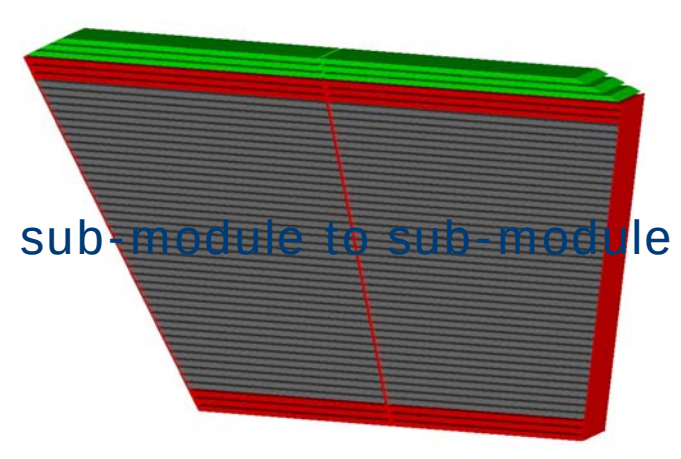
Order 1 (company 1): 4 plates (2 t)

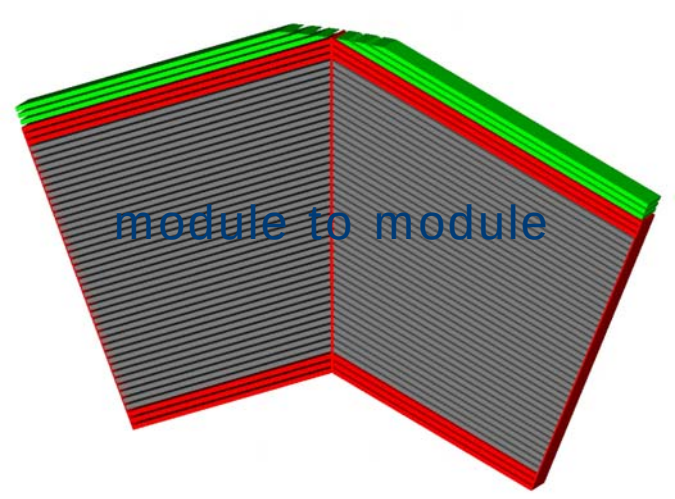
2500x1500x16 mm³, 1.4401

Results:

- material properties
  content, permeability, costs
- delivery tolerances
  flatness, thickness
- machining
  tendering, processing, handling, tolerances, costs
- sub-module mounting
  handling, gap tolerances, stability
- sensitive layer installation
  handling, tolerances, internal connection, cooling

real size test setup vertical





- 2 short length absorber sup-modules mounted to a short length module

Order 2 (company 2): 8 plates (4,6 t)

3000x1500x16 mm³, 1.4401

Results:

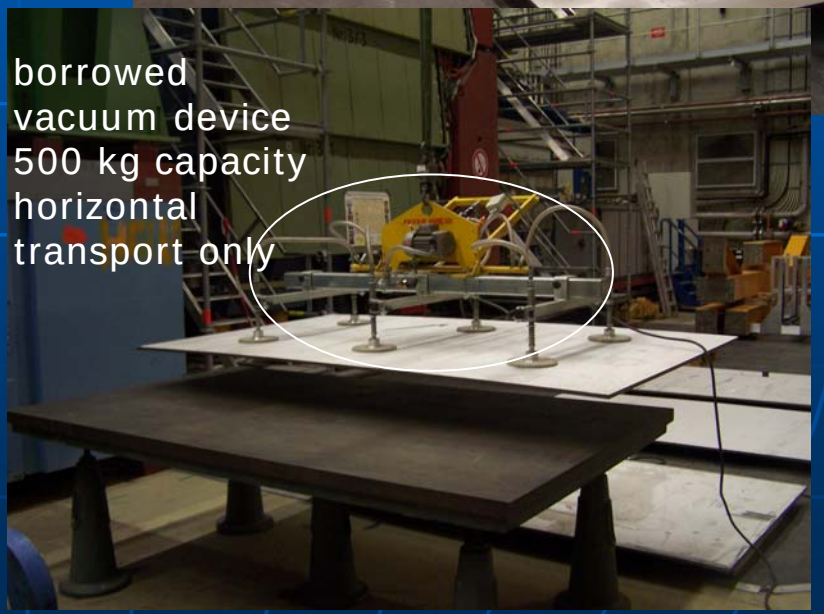
- material properties
  content, permeability, costs
- delivery tolerances
  flatness, thickness
- machining
  tendering, processing, handling, tolerances, costs
- sub-module mounting
  stacking and shape tolerances, module interconnection, stability
- sensitive layer installation
  handling, tolerances, vertical and horizontal layer connection, cabling and cooling routing

first results tendering, handling

Order 1: 4 plates for horizontal test setup
- 1.4404 (Type 316L) DIN EN 10088-2
- 2500 x 1500 x 16 mm³ EN 10029 class B N
- ~500kg each
- 6.200 Euro/t
- arrived 11.11.08 at DESY

Order 2: 8 plates for vertical test setup
- 1.4404 (Type 316L) DIN EN 10088-2
- 2500 x 1500 x 16 mm³ EN 10029 class B N
- ~600kg each
- 4.950 Euro/t
- 4 plates arrived 05.12.08 at DESY
- other 4 plates will arrive at DESY at 15.12.08

problem:
- tendering
  - not easy to get 16 mm material (1.4404,1.4435) in low quantity (less than 20t) on European market
- handling
  - vacuum lifting device needed for horizontal and vertical transport
  - device ordered with 750 kg capacity incl. 90° rotation around the long edge (~8.600 Euro)



first results tolerances

measurement of flatness and thickness deviation according EN10029 (steel plates t>3mm)

- t >=15<25 mm

- thickness
  - class B
  - min: -0,3 mm
  - max: +1,6 mm
- flatness
  - class N, steel group H
  - L(1000): 10mm
  - L(2000): 13mm

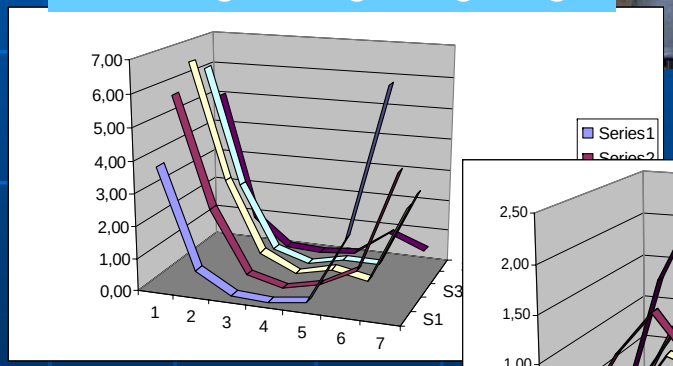
plates are according EN10029

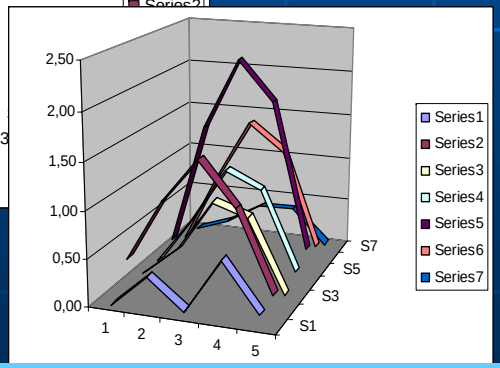
problem:

- measurement of the thickness at the plate edges (~50 mm) only
- difficult to connect the measurements to an real surface

measurement setup

bending along long edge





bending along short edge

first results material properties 1

measurement (spectroscopy) of material content according EN10088-2
(austenitic anticorrosive steel)
- 1.4404

plates are according EN10088-2

problem:
- cutting test samples out of the big plates is time consuming (~2h per sample)

4 test samples 100x100 mm²

	DIN EN 10088-2			Sample			
	1.4404			A1	A2	B1	B2
	min. mass %	max. mass %		mass %	mass %	mass%	mass %
C	0,000	0,030		0,024	0,025	0,024	0,024
Si	0,000	1,000		0,621	0,670	0,675	0,666
Mn	0,000	2,000		1,309	1,386	0,964	1,278
P	0,000	0,045		0,035	0,034	0,029	0,035
S	0,000	0,015		0,007	0,007	0,007	0,007
N	0,000	0,110		0,064	0,077	0,061	0,065
Cr	16,500	18,500		17,023	16,866	16,796	16,905
Cu				0,408	0,457	0,452	0,563
Mo	2,000	2,500		2,105	2,137	2,111	2,133
Nb				0,024	0,021	0,034	0,036
Ni	10,000	13,000		9,726	9,864	9,817	9,809
			V	0,096	0,082	0,084	0,100
			Al	0,006	0,006	0,008	0,008
			Ti	0,008	0,009	0,027	0,009
			Co	0,136	0,150	0,190	0,165
			W	0,000	0,000	0,000	0,000

cutting setup

first results material properties 2

magnetic measurements with the first 4 samples

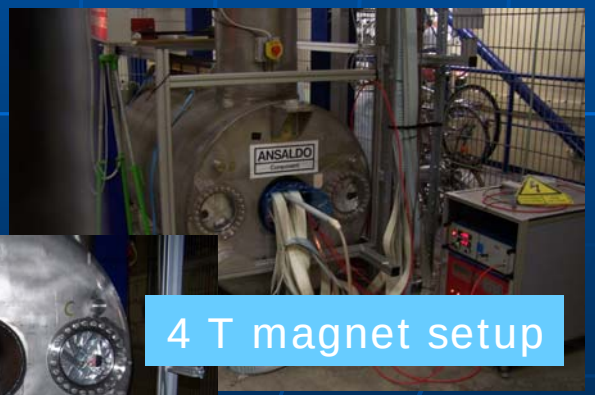
- 2 T magnet setup *easy to get time slots*
  - measured permeability, field
  - put a 2 Tesla magnetic field longitudinal to the samples
  - measured permeability and field again

  data available since 08.12.08

- 4 T magnet setup *difficult to get time slots*
  - repeated measurements after 4 Tesla magnet field

  data available since 10.12.08

2 T magnet setup



4 T magnet setup

first conclusions

- Tendering of non standard material (very good tolerances) is difficult with low quantity's
  (<20t=100.000 € ~ 1 sub-module)
- Standard tolerances are not useable for real production process, but with some tricks for the test setups
- Material properties are fine up to now
- I will get during building the test setups in the next 6 months enough information's that the detailed design process can speed up significantly

outlook tolerances

new measurement setup

for flatness and thickness deviation according EN10029 is under construction

the measurement setup can be modified easily between

vertical measurement for thickness

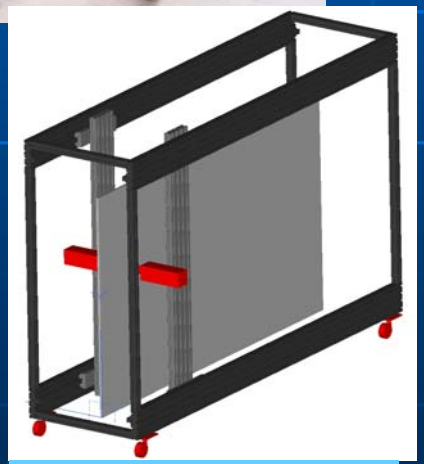
and

horizontal measurement for flatness

can be used also to measure a hole sub-module

New measurement setup

horizontal measurement



vertical measurement

outlook material properties

magnetic measurements with the first 4 samples and following 8 samples

- repeat measurements after milling of sample plate sides
- repeat measurements after cutting threads into sample plate sides
- repeat measurements after welding side wall samples to sample plate sides
- verify if we need 4 Tesla
  - 2T ramping 5 min
  - 4T ramping 60 min