# The HCAL barrel absorber structure

Design Status Report

**CALICE / EUDET HCAL**
**and**
**electronics / DAQ meeting**
@DESY 11.12.2008

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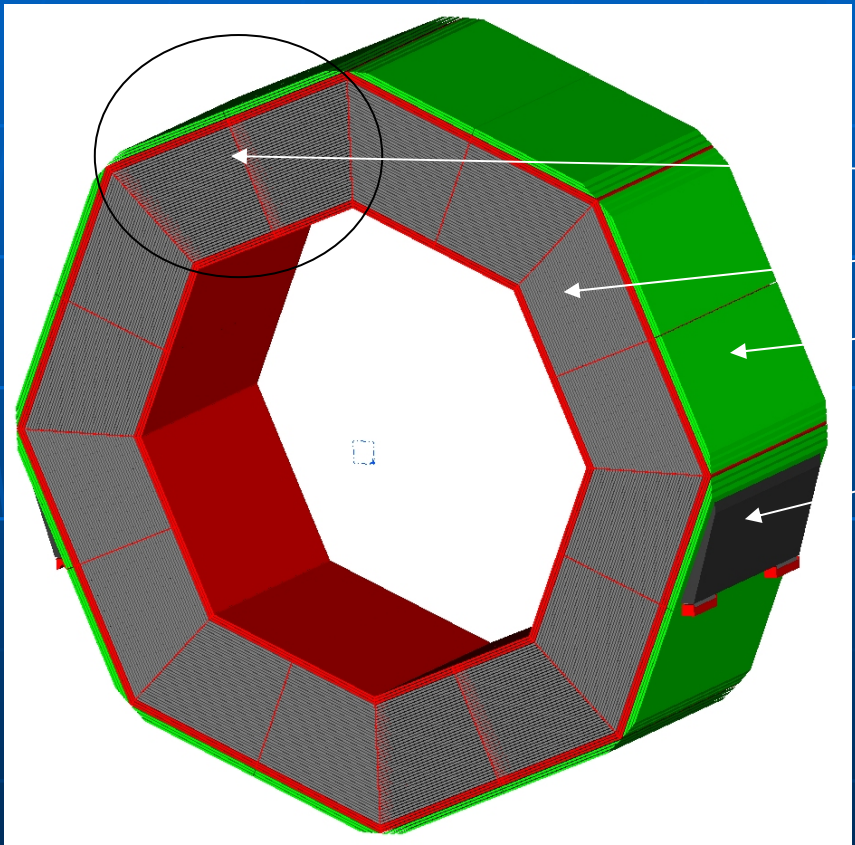
- HCAL barrel data set 1
- HCAL barrel mechanical design overview
- real size test setup
- first results
- first conclusions
- outlook

# HCAL 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 ( yes cracks, because there is maybe some material missing)
  - 4. HCAL sensitive layer
    - scintilator plates read out by SiPMs

# HCAL barrel absorber structure mechanical design overview (first loop)



- HCAL barrel absorber structure
  - module (stave)
  - sub-module (half stave)
  - backpack (top barrel)
    5,2 $\lambda$ slim version
  - support (new)

- **Attention!**

change of module orientation (22,5° rotation) to LDC01_05Sc
Impact to ECAL !!
Mokka?

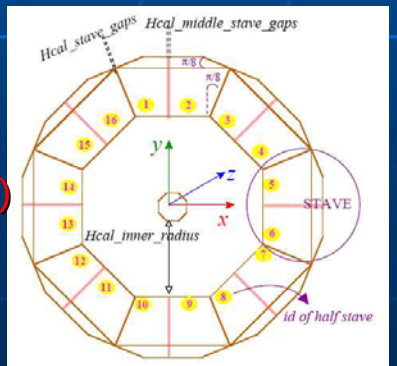


Figure 3: $x-y$ view of the HCAL barrel. The angle of symmetry is $\pi/8$.

# Time out!

Do I know the rules in the real world, outside of the simulation of Mokka, FEM and 3D CAD?

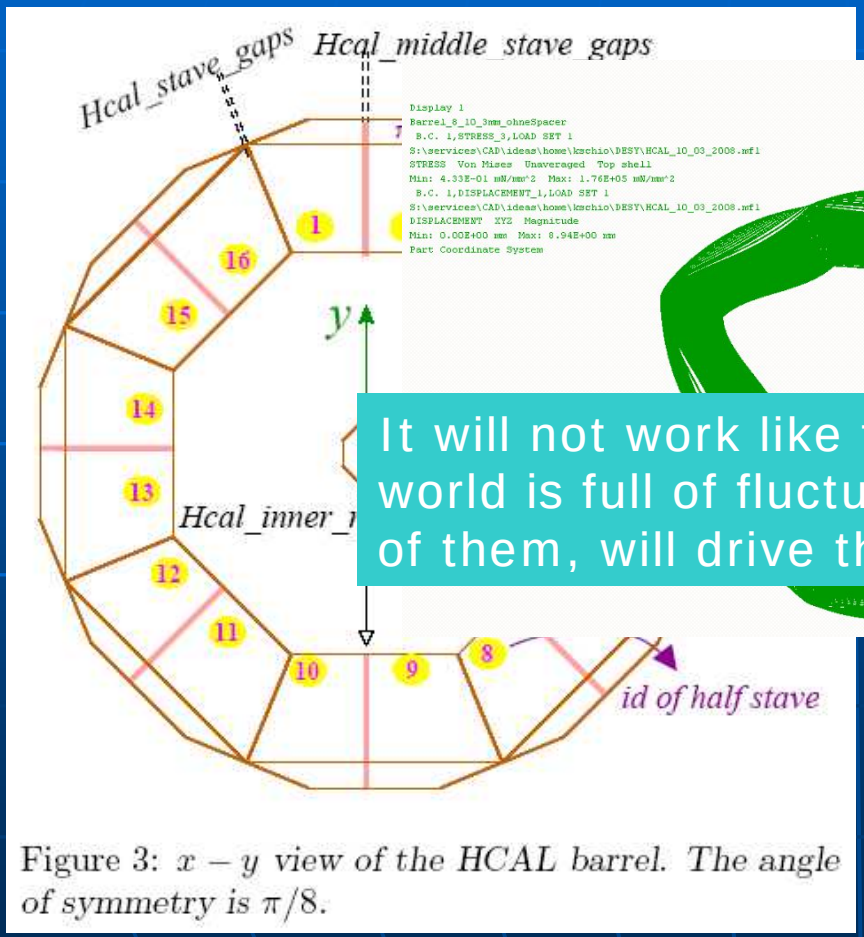
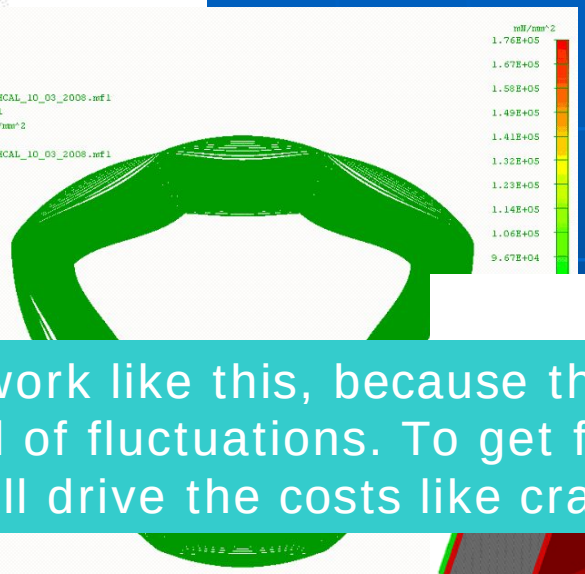
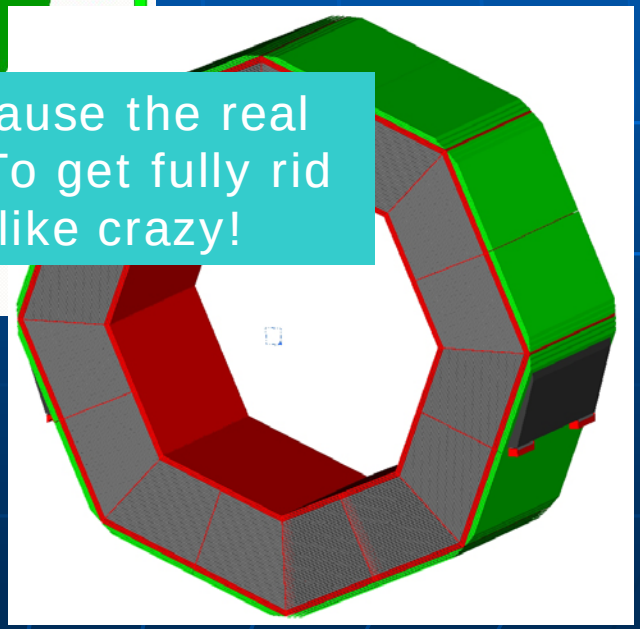


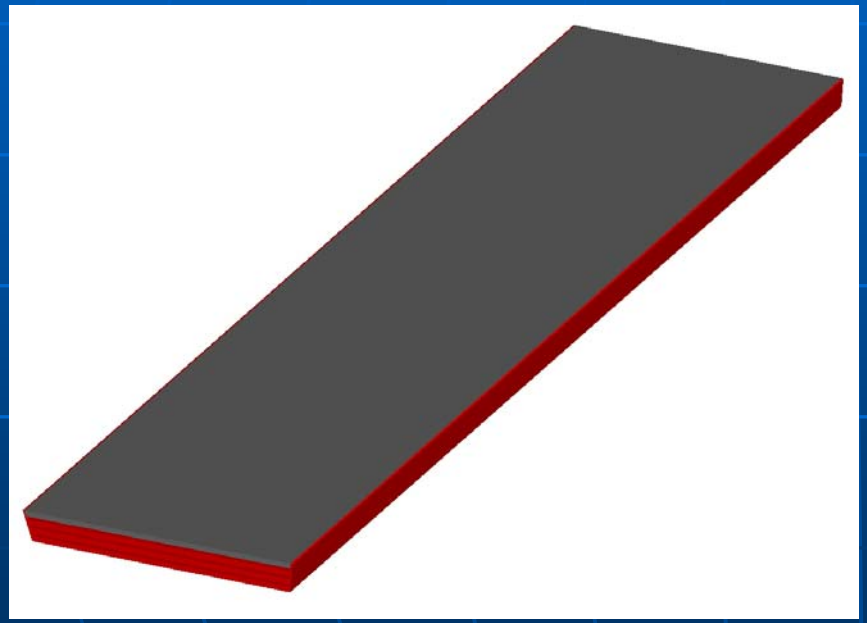

Figure 3: $x - y$ view of the HCAL barrel. The angle of symmetry is $\pi/8$.



It will not work like this, because the real world is full of fluctuations. To get fully rid of them, will drive the costs like crazy!

# real size test setup horizontal



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

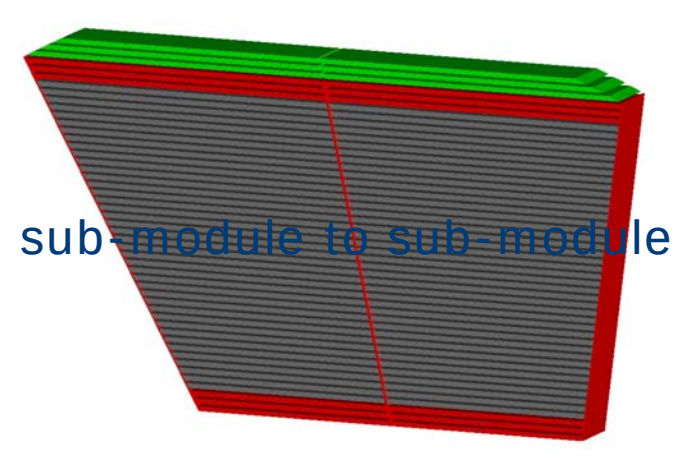
Order 1 (company 1): 4 plates (2 t)

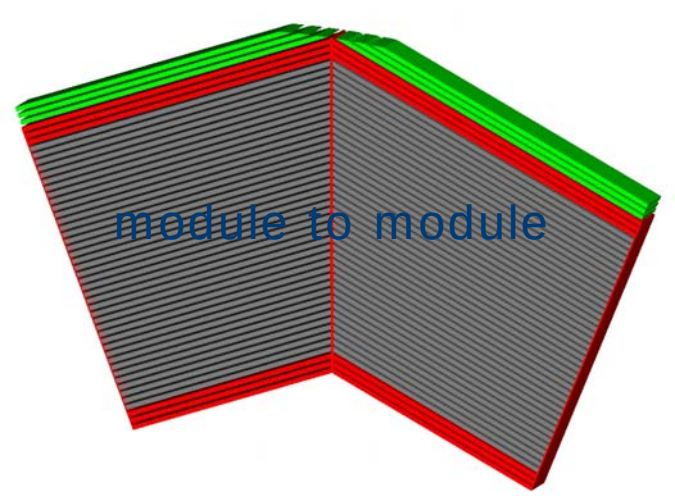
2500x1500x16 mm³, 1.4401

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:

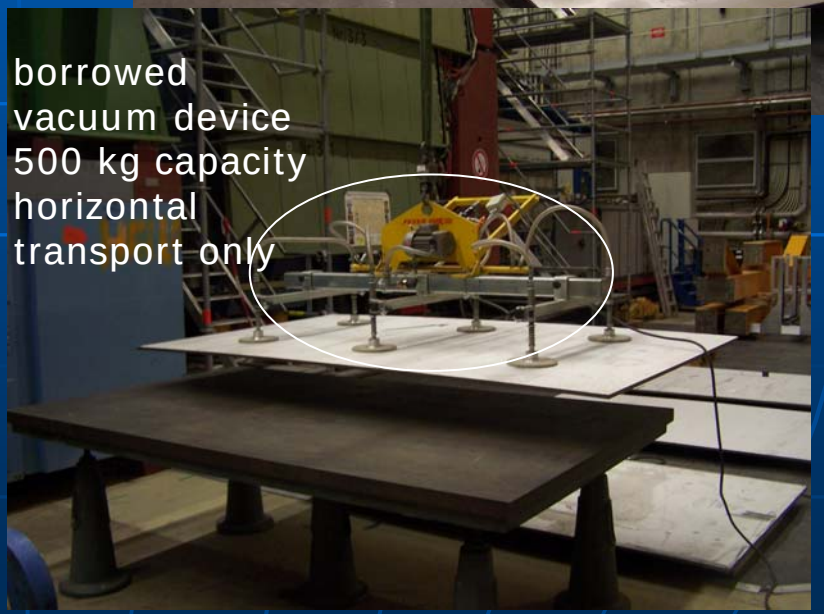
- material properties
  content, permeability, costs
- delivery tolerances
  flatness, thickness
- machining
  tendering, processing, handling, tolerances, costs
- sub-module mounting
  stacking and shape tolerances, module interconnection, stability
- sensitive layer installation
  handling, tolerances,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

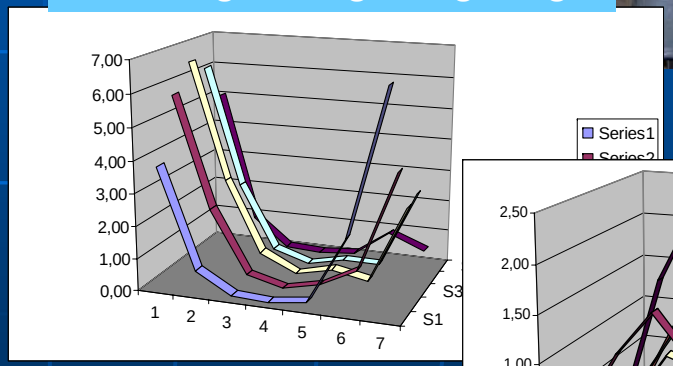
plates are according EN10029

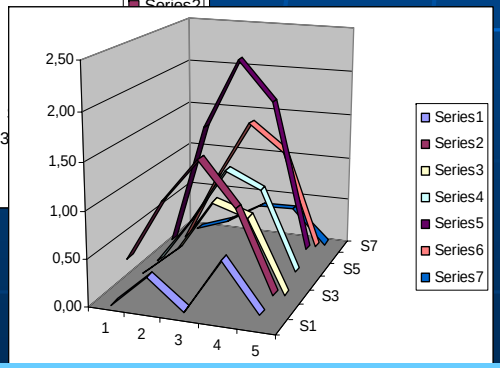
problem:

- 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

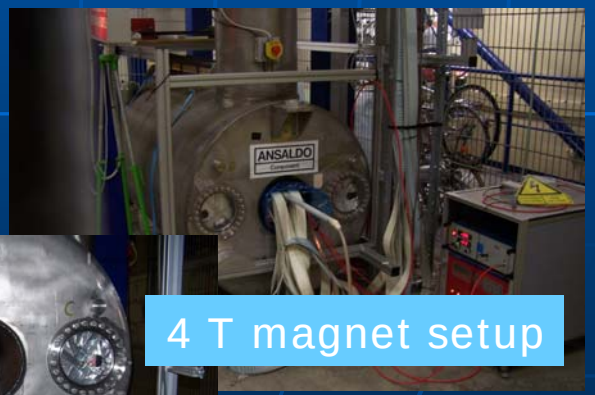
- 2 T magnet setup *easy to get time slots*
  - measured permeability, field
  - put a 2 Tesla magnetic field longitudinal to the samples
  - measured permeability and field again

  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

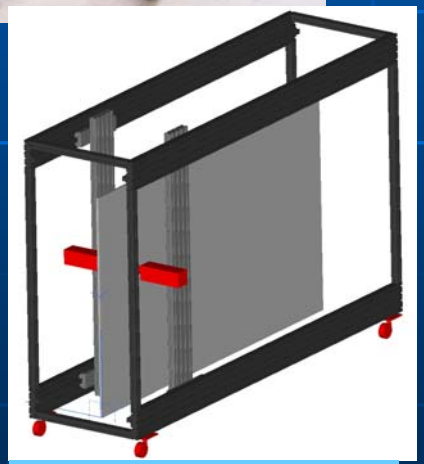
and

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