

AHCAL

Mechanics

status report

Karsten Gadow

CALICE AHCAL main meeting

DESY, 17.12.2014

Absorber structure validation (earth quake)

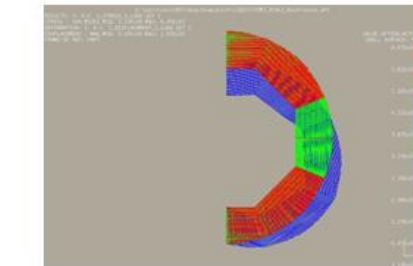
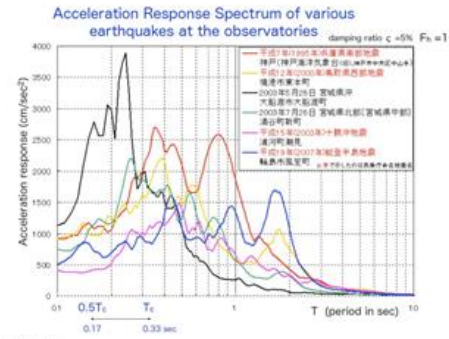
AHCAL Mechanics

Absorber structure validation (earth quake)

ILD workshop, Cracow, 24-26 September 2013

Summary on seismic issues

1. Earthquake protection will follow the ISO3010:
uses analysis with **acceleration response spectrum**
2. Earthquake model at Kitakami site :
150 gal (100 years) as earthquake representative
, where flat period between 0.17 to 0.34sec ($dT_e - T_e$)
the amplification factor(f_a) of less than 2.5
3. We would like to analyze ILD earthquake protection.
 - Rigidity of ILD detector
 - Isolation method with respect to the platform
and detailed layout needed



Simulation for
AHCAL barrel structure
will be done in summer 2014 by DESY-ZM1



AHCAL absorber structure validation

Internal order to DESY Group ZM1

(group engineers: M.Lemke, R.Platzer)

Order requirements:

- stress analysis for the design concept of the AHCAL and test the static integrity of the absorber structure including the detailed investigation of all screw joints **(65% done)**
- dynamic stress analysis for the design concept of the AHCAL to proof the static integrity for an possible ILD construction area in Japan **(20% done)**
- the dynamic stress analysis must fulfill the ISO 3010 and Eurocode 8 (earthquake) **(5% done)**
- the dynamic stress analysis must be done with real earthquake data from März 2011 (Ichinoseki / data: NIED K-NET IWT010 2011/03/11) **(5% done)**



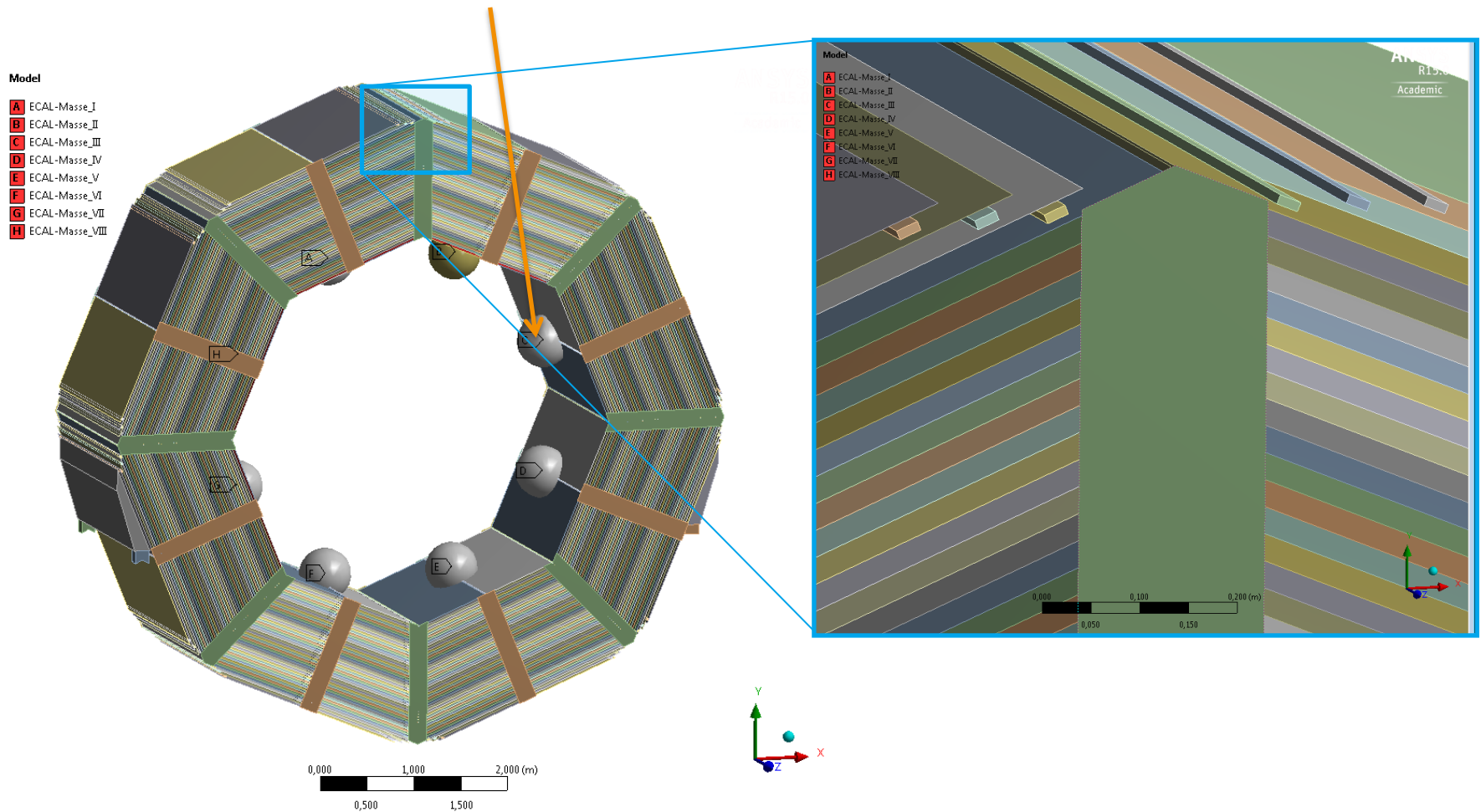
AHCAL geometry preparation

- analysis of conceptual setup of the ILD CAD model **(done)**
- check constrains from AHCAL to the other detector parts
ILD platform<>Iron Yoke<>Coil Cryostat<>AHCAL with rail system<>ECAL **(done)**
- get all relevant data for the finite element analyses FEM masses for
all detector components (ECAL, Coil, ...) **(done)**
- simplify the connection between AHCAL and cryostat **(done)**
- create full shell model for AHCAL **(done)**
- create 3D detail models incl. all single parts and screw joints
for detailed investigation **(done)**
- creating of the principle main model of the middle iron yoke, coil cryostat,
AHCAL and ECAL for the dynamic analyses **(50% done)**



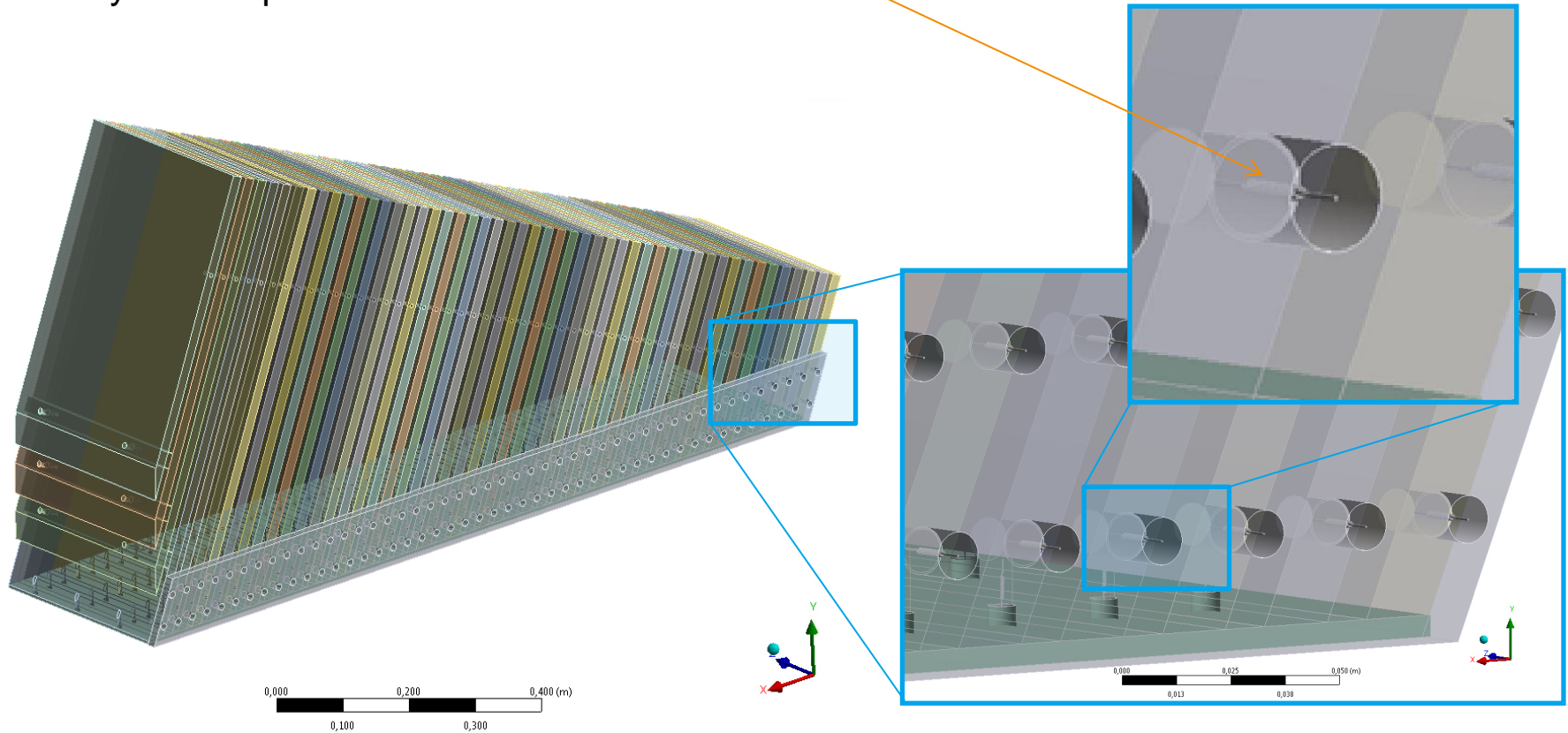
AHCAL shell model

AHCAL shell model with ECAL point masses



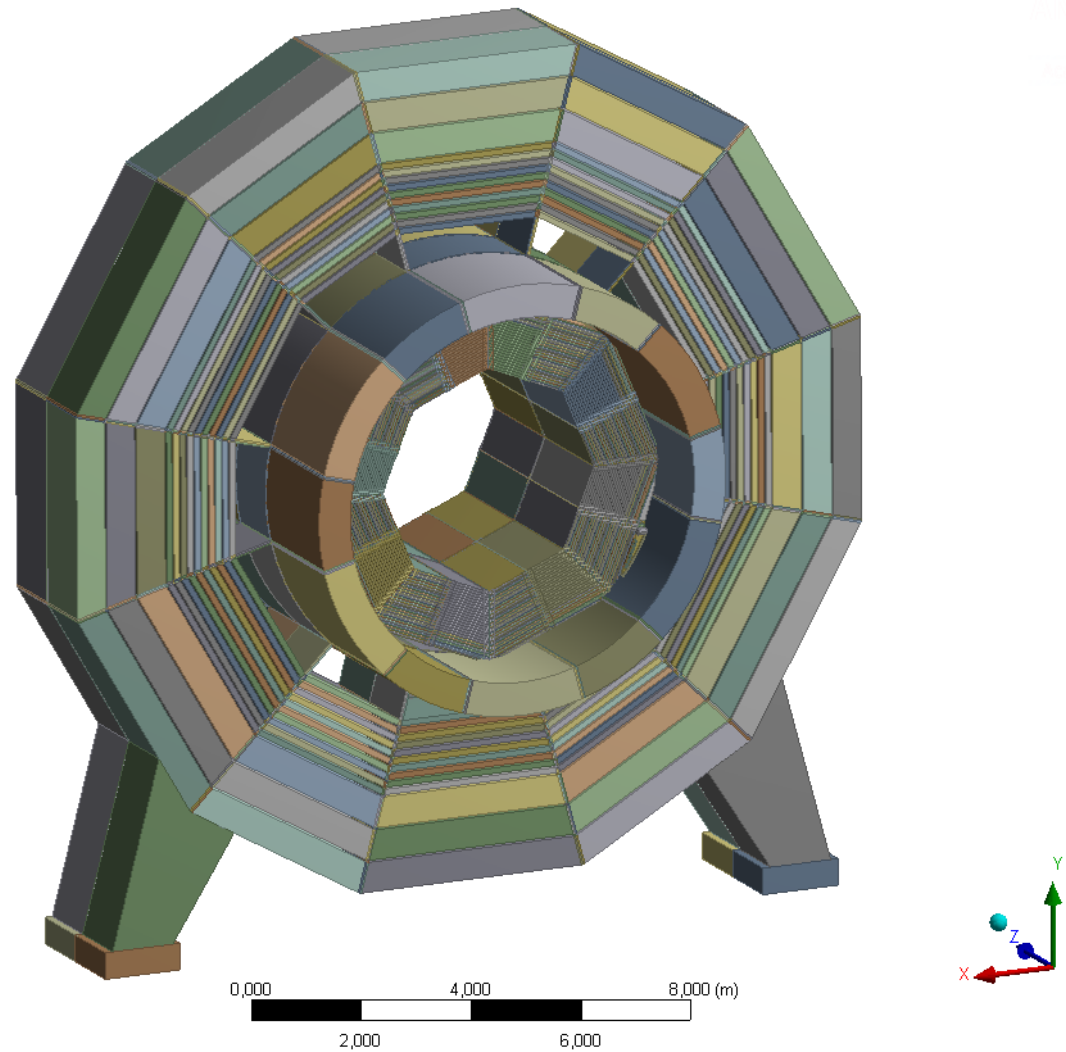
AHCAL screw joints

- detailed modeling with 3D structures
- screw joints are modeled as preloaded elastic spring parts therefore single screw joints analyses are possible



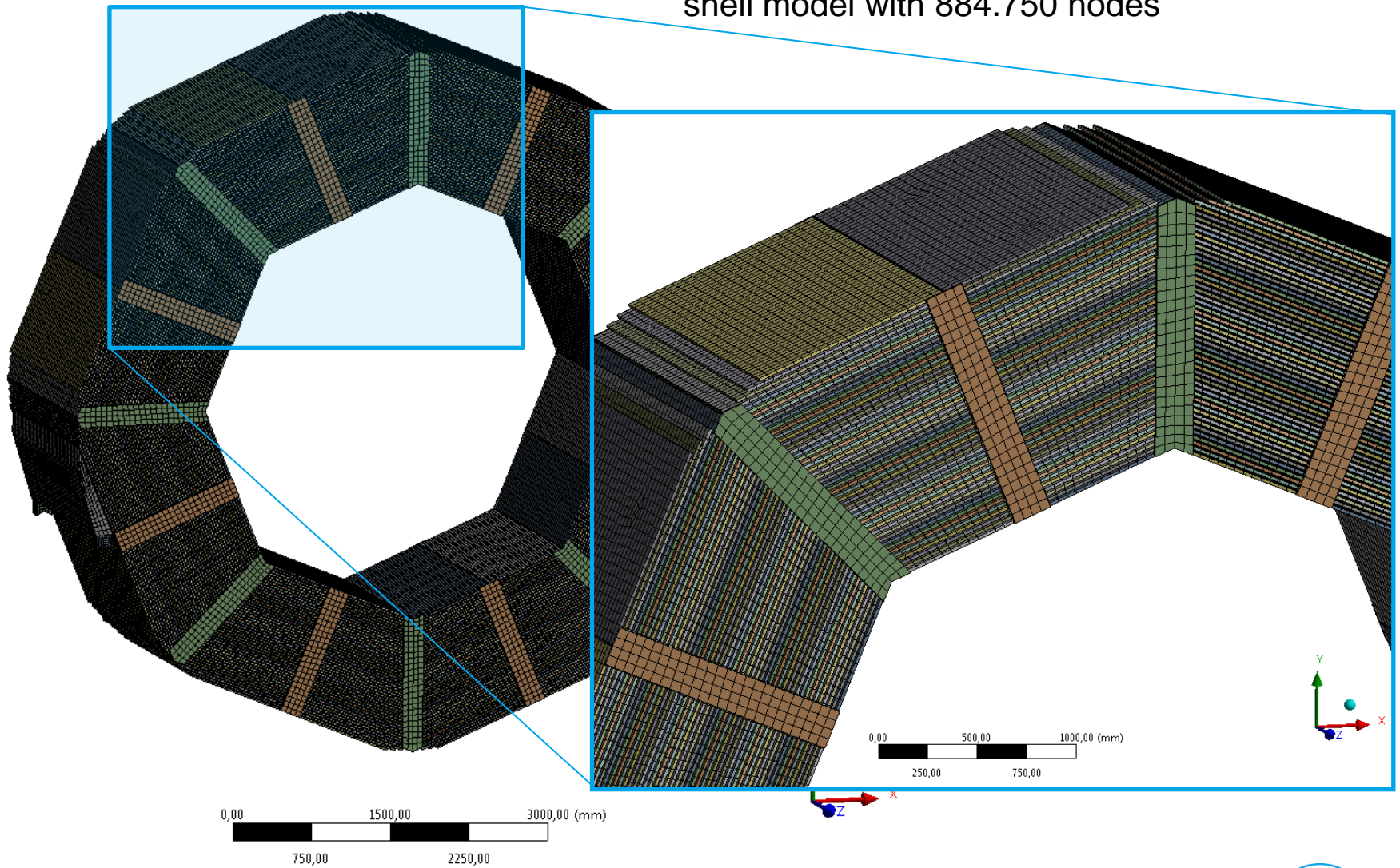
Main ILD shell model

shell model for dynamic analyses consisting from middle iron yoke, coil cryostat, AHCAL and ECAL



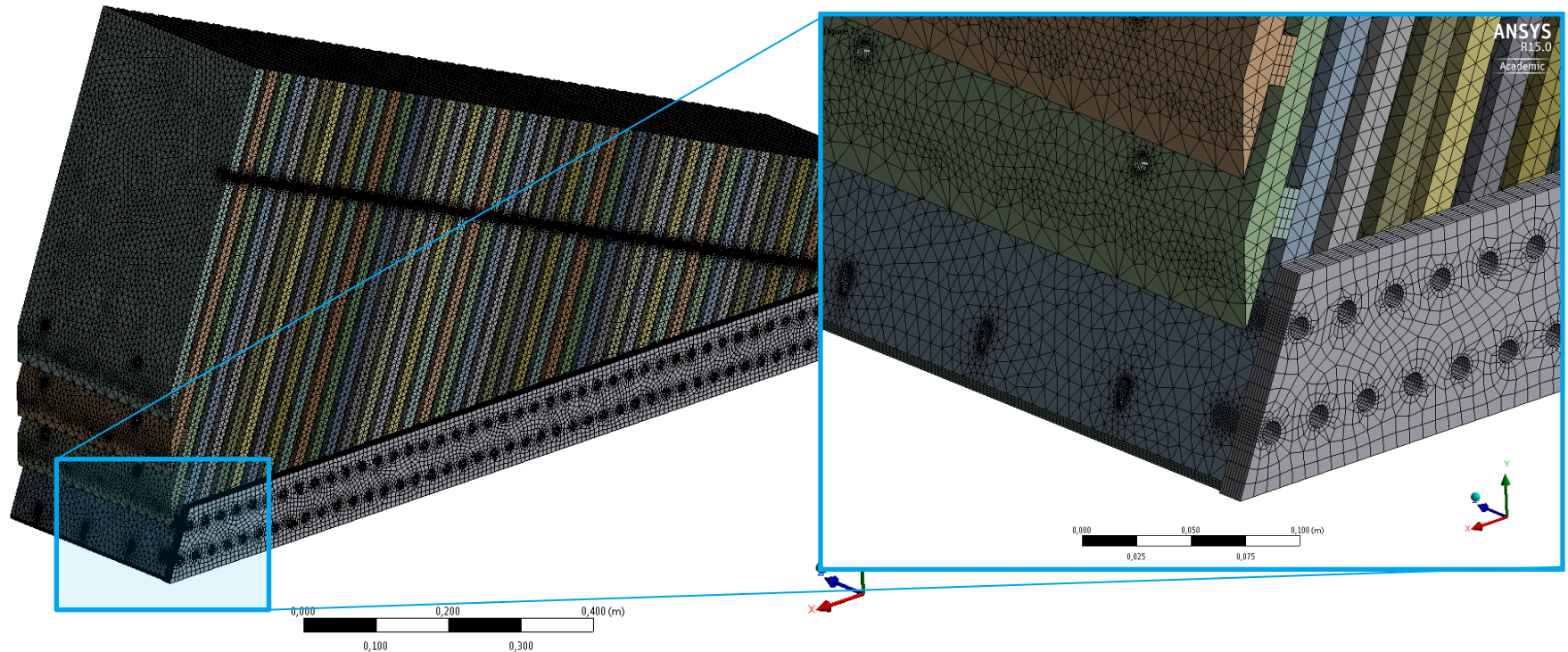
AHCAL shell model grid

shell model with 884.750 nodes



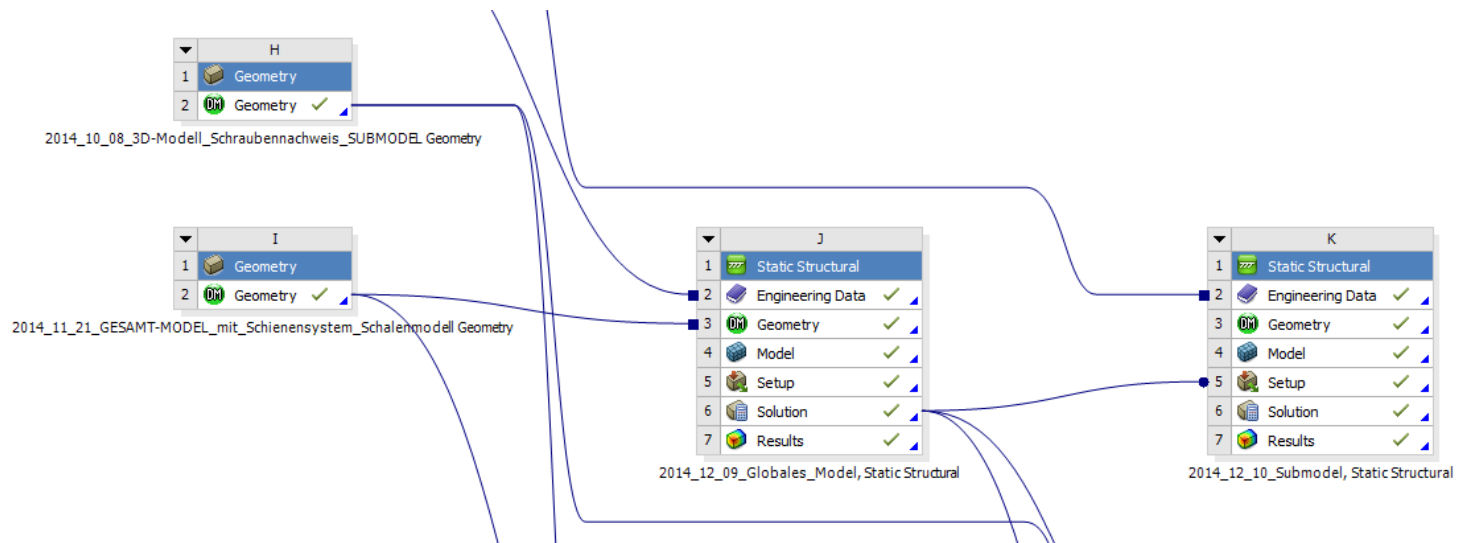
AHCAL detail shell model grid

tetrahedron and hexahedron elements with quadratic element functions are the basis of the 3D grid geometry (here 6,45 mi. nodes)



Workflow for all finite element analyses

- determining of the calculation diagram (very big model size) **(done)**
- calculation of the entire AHCAL model (shell model) **(done)**
- detailed calculation with complete 3D geometry's at relevant segments of the entire AHCAL model **(done)**
- calculation of the mechanical load to the structural components (displacement, tension) **(done)**
- working load of the screw joints and detailed verification **(started)**



Static finite element analyses

- static finite element analyses to investigate the entire AHCAL detector structure to characterize the stiffness and deformation behavior as a baseline for the dynamic analyses of earth quake incidents.
- static calculation of the AHCAL incl. sensor mass of 16,82 kg/m² and ECAL segments
 - AHCAL on rail system with dead load **(done)**
 - AHCAL on rail system with dead load and 9,81 m/sec² *vertical* acceleration **(done)**
 - AHCAL on rail system with dead load and 9,81 m/sec² *horizontal* acceleration **(done)**
 - AHCAL on rail system with dead load and 9,81 m/sec² *diagonal* acceleration **(done)**
- 3D detail model calculation with the four loads at all critical zones **(50 % done)**



AHCAL boundary conditions for static FEA

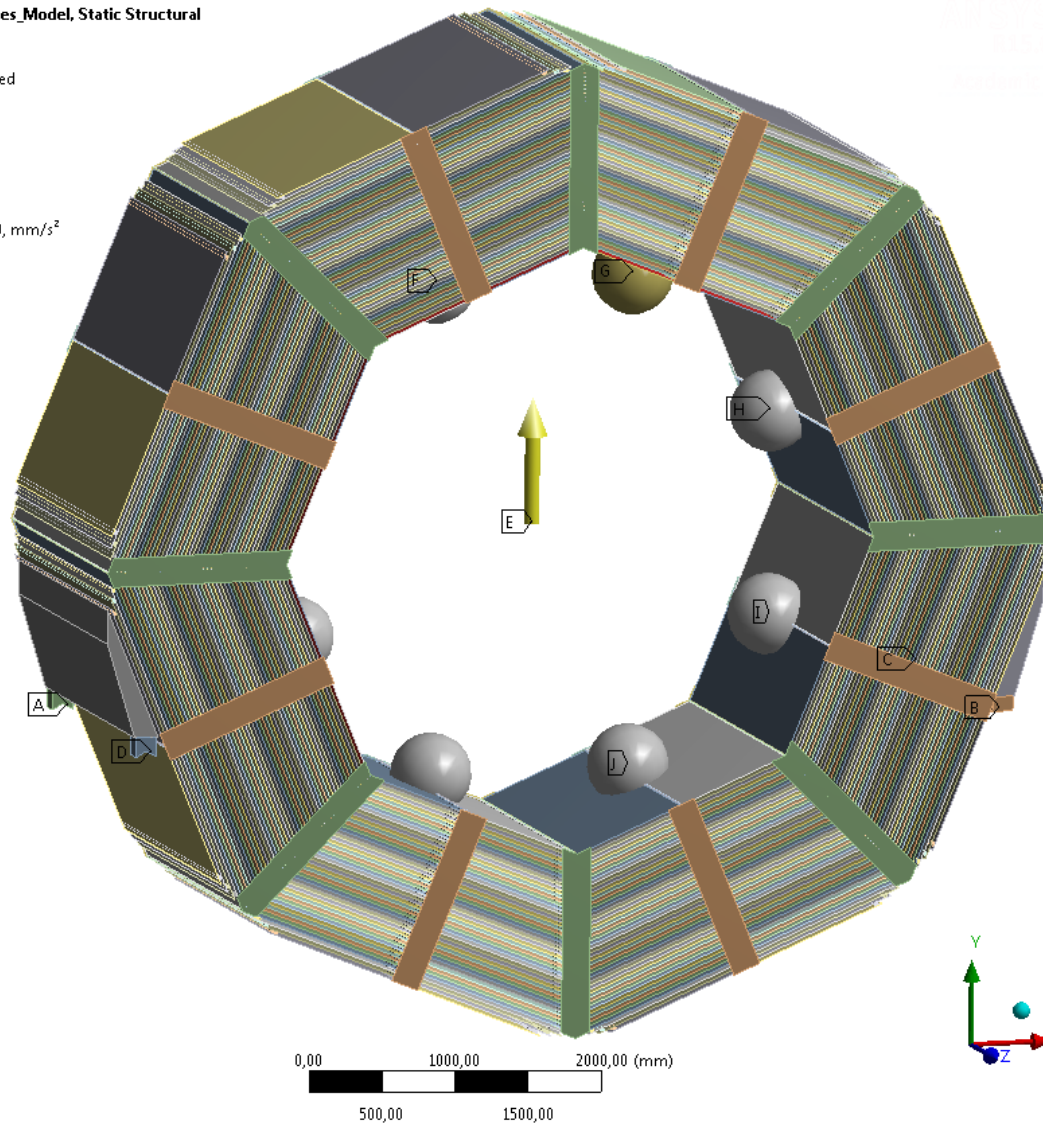
J: 2014_12_09_Globales_Model, Static Structural

Static Structural

Time: 1, s

Items: 10 of 13 indicated

- A** Fixed Support
- B** Displacement
- C** Displacement 2
- D** Displacement 3
- E** Acceleration: 9810, mm/s²
- F** ECAL-Masse_I
- G** ECAL-Masse_II
- H** ECAL-Masse_III
- I** ECAL-Masse_IV
- J** ECAL-Masse_V



- gravity
- realistic support and displacements
- installed ECAL masses



AHCAL deformation results for static FEA

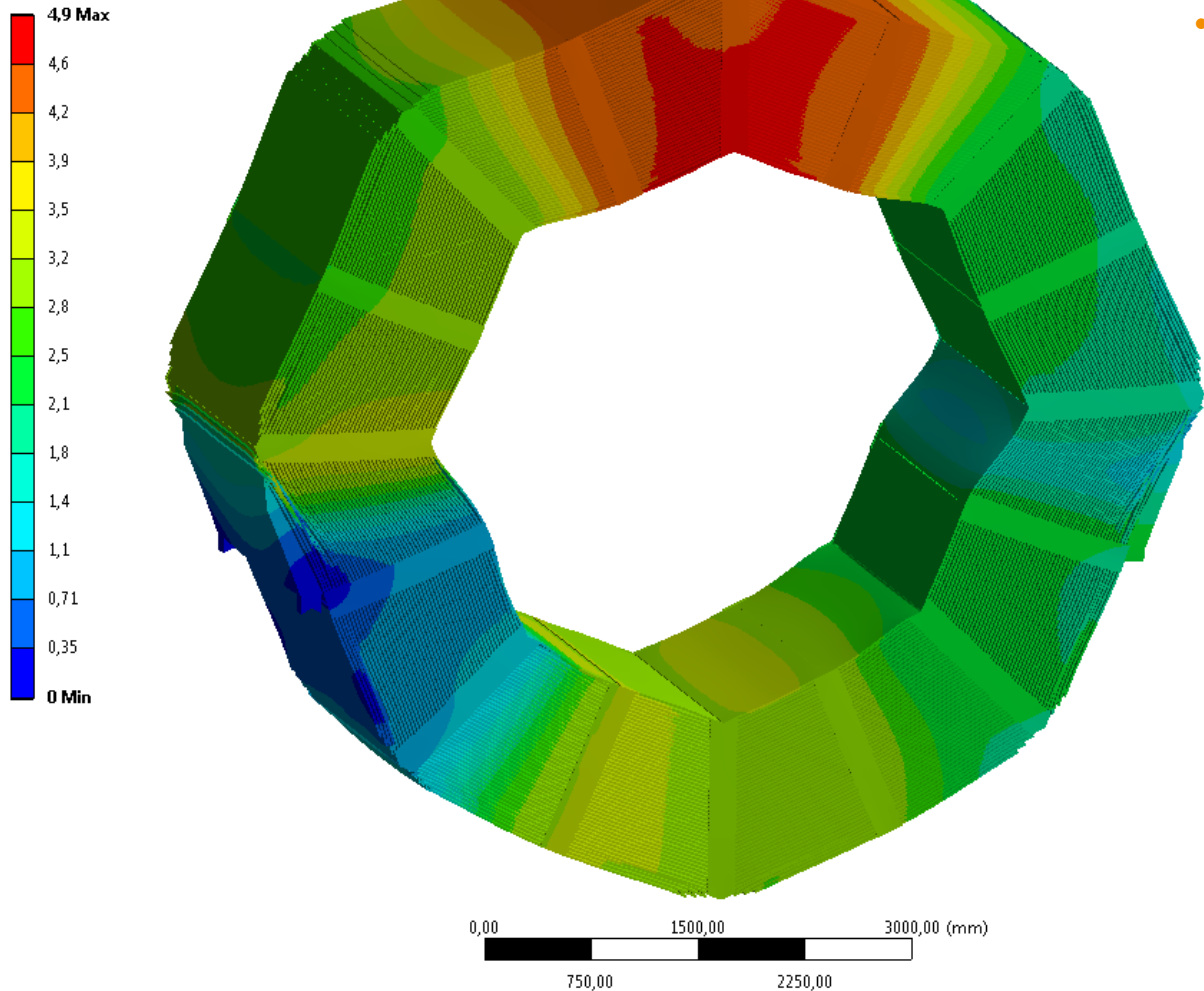
J: 2014_12_09_Globales_Model, Static Structural

Figure

Type: Total Deformation

Unit: mm

Time: 1

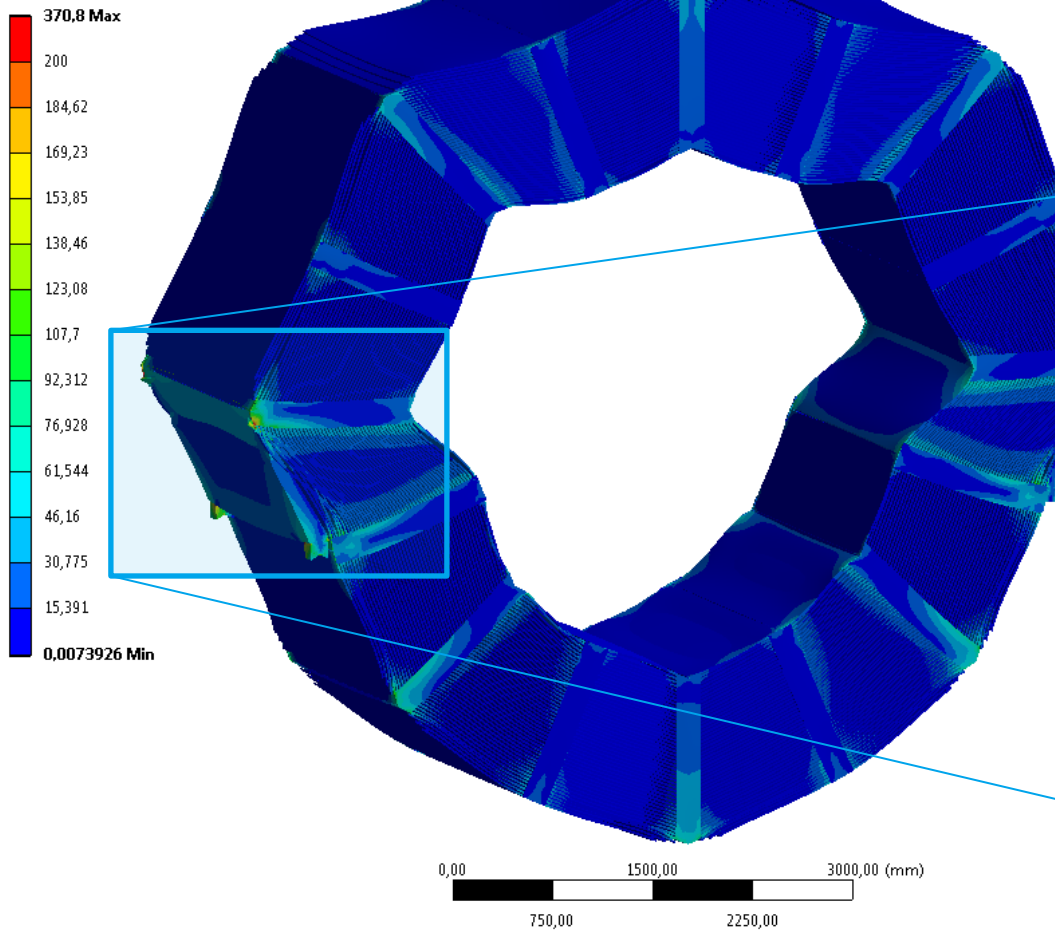


- 5,0 mm maximum deformation
- 50 times exaltation graphic

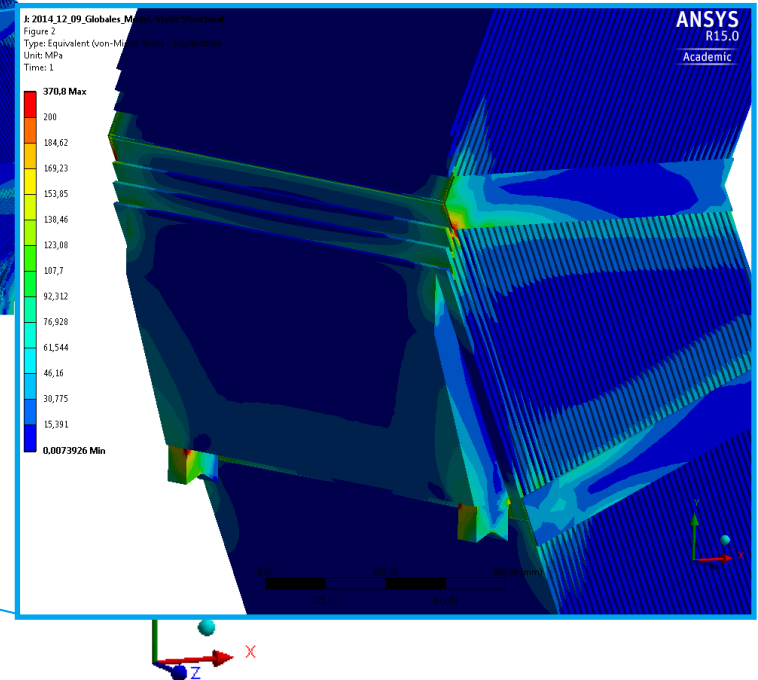


AHCAL tension results for static FEA

J: 2014_12_09_Globales_Model, Static Structural
Figure
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: MPa
Time: 1



- ~180 N/mm² maximum tension
- 50 times exaltation graphic



AHCAL boundary conditions for static FEA + 1g

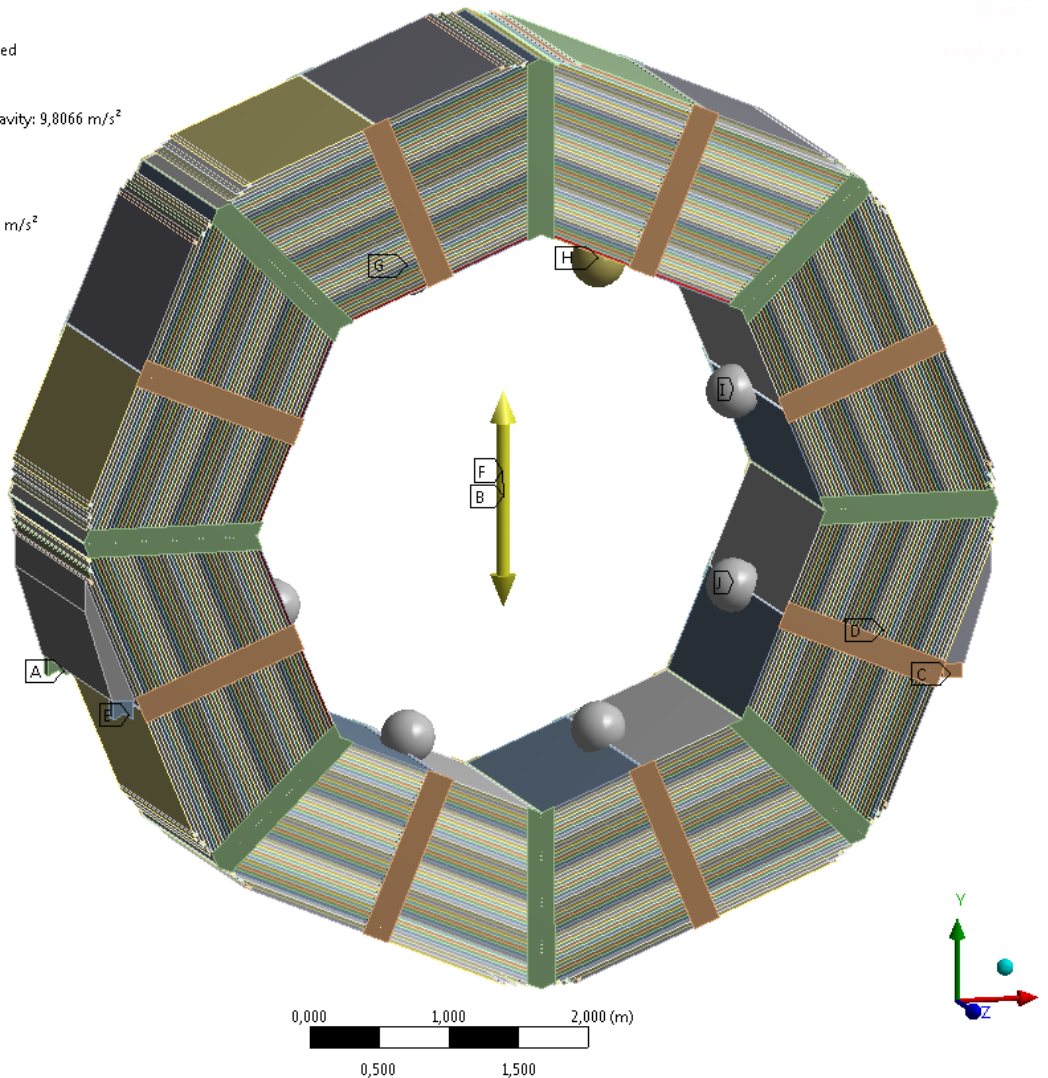
J: Model, Static Structural

Static Structural

Time: 1, s

Items: 10 of 14 indicated

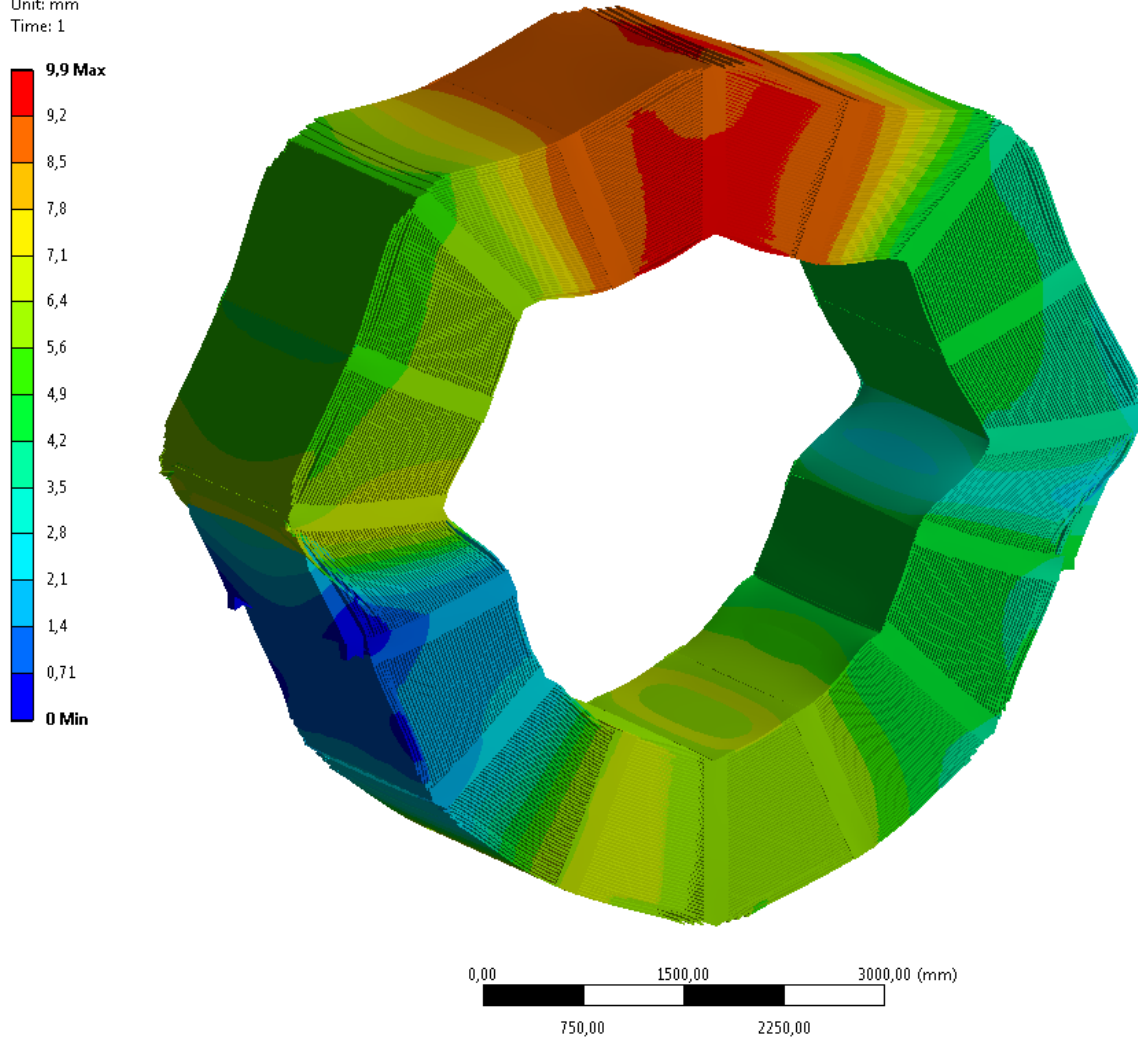
- A** Fixed Support
- B** Standard Earth Gravity: 9,8066 m/s²
- C** Displacement
- D** Displacement 2
- E** Displacement 3
- F** Acceleration: 9,81 m/s²
- G** ECAL-Masse_I
- H** ECAL-Masse_II
- I** ECAL-Masse_III
- J** ECAL-Masse_IV



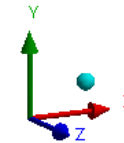
- gravity + 1g
- realistic support and displacements
- installed ECAL masses

AHCAL deformation results for static FEA +1g

J: Model, Static Structural
Figure
Type: Total Deformation
Unit: mm
Time: 1



- 10,0 mm maximum deformation
- 50 times exaltation graphic



AHCAL tension results for static FEA + 1g

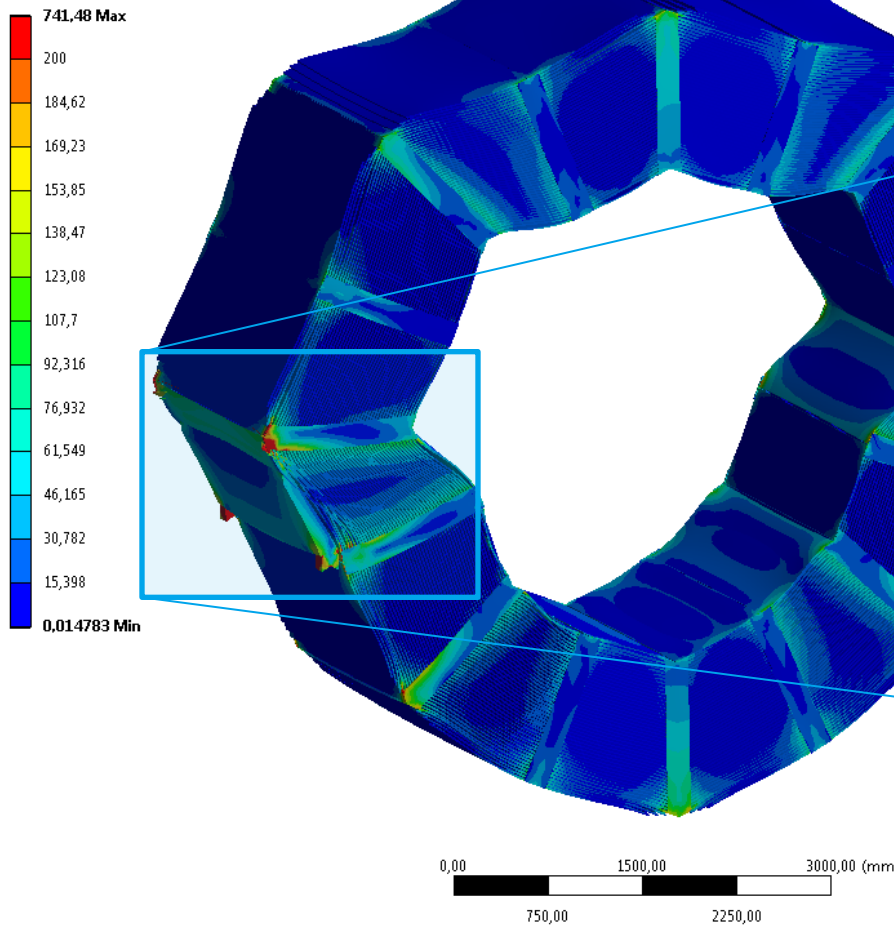
J: Model, Static Structural

Figure

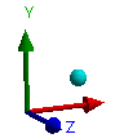
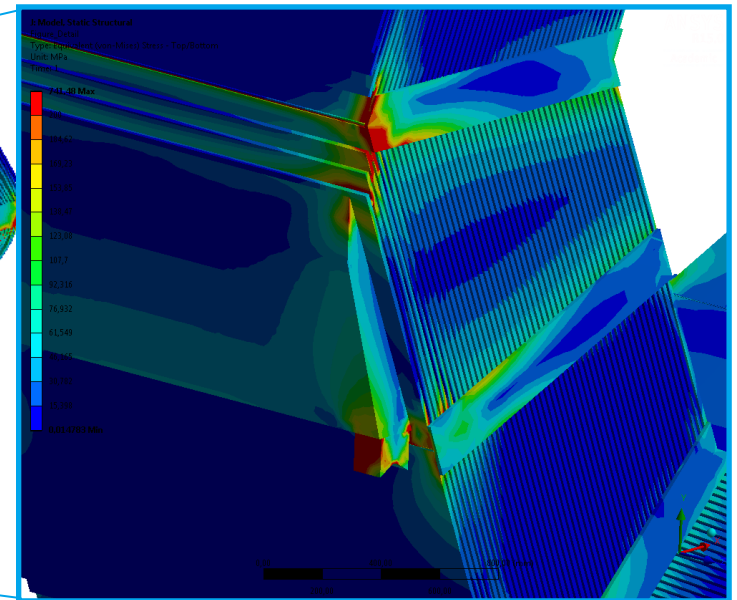
Type: Equivalent (von-Mises) Stress - Top/Bottom

Unit: MPa

Time: 1



- ~360 N/mm² maximum tension
- 50 times exaltation graphic



earthquake data from Japan (NIED-Network)

- earthquake data Ichinoseki (NIED K-NET IWT010 2011/03/11)
- maximum amplitudes
 - east-west 852,134 gal (8,52 m/sec²=>0,86 g)
 - north-south: 997,780 gal (9,98 m/sec²=>1,02 g)
 - vertical: 352,666 gal (3,53 m/sec²=>0,36 g)

[F:\Gemeinsame_Projekte\ILD\Daten_allgemein\Erdbebendaten_Japan_2011_03_11_ichinoseki_K.NET\IWT0101103111446.NS] - UltraEdit

File View Explorer Lists

Open Files IWT0101103111446.NS x

0	Origin Time	2011/03/11 14:46:00
1	Lat.	38.103
2	Long.	142.860
3	Depth. (km)	24
4	Mag.	9.0
5	Station Code	IWT010
6	Station Lat.	38.9334
7	Station Long.	141.1173
8	Station Height(m)	37
9	Record Time	2011/03/11 14:46:52
10	Sampling Freq(Hz)	100Hz
11	Duration Time(s)	300
12	Dir.	N-S
13	Scale Factor	3920 (gal) / 6182761
14	Max. Acc. (gal)	997.780
15	Last Correction	2011/03/11 14:46:37
16	Memo.	
17		-39088 -39090 -39093 -39094 -39173 -39140 -39087 -39094
18		-39064 -39086 -39145 -39161 -39151 -39129 -39073 -39039
19		-39118 -39212 -39147 -39005 -39056 -39206 -39153 -39038
20		-39081 -39124 -39119 -39142 -39079 -39047 -39122 -39129
21		-39103 -39087 -39091 -39183 -39190 -39043 -39035 -39163
22		-39164 -39169 -39164 -39021 -38986 -39067 -39196 -39317
23		-39088 -38818 -39073 -39342 -39149 -38980 -39097 -39189
24		

http://www.kyoshin.bosai.go.jp/

Deutschlands gr... Strong-motion s... Past Large Earthq... Select an eart...

NIED National Research Institute for Earth Science and Disaster Prevention

Strong-motion Seismograph Networks (K-NET, KiK-net)

Top Introduction Download Topics User info Manual Links

Data Download by Selecting an Earthquake

You can download strong-motion data by selecting an earthquake from monthly earthquake list.

>>Data Download after Search for Earthquakes

Earthquake List

Refresh List

Data Type K-NET & KiK-net Mar 2011

Origin time Latitude Longitude Depth Magnitude Number of sites

2011/03/11-14:46:00	38.103	142.860	024km	M9.0	122sites
2011/03/11-03:14:00	38.608	143.608	038km	M5.4	022sites
2011/03/10-20:21:00	38.528	143.313	023km	M5.2	048sites
2011/03/10-17:08:00	38.578	143.536	034km	M5.9	109sites
2011/03/10-09:34:00	38.398	143.416	038km	M5.2	086sites
2011/03/10-06:24:00	38.178	143.045	009km	M6.8	523sites
2011/03/10-03:45:00	38.488	143.436	036km	M6.9	172sites
2011/03/10-03:16:00	38.278	142.888	029km	M6.4	452sites
2011/03/09-20:27:00	38.558	143.158	008km	M5.3	071sites
2011/03/09-17:02:00	38.608	143.178	007km	M5.2	088sites
2011/03/09-13:45:00	38.448	142.948	022km	M5.3	094sites

K-NET ASCII Format (Details) K-NET Binary Format (Details)

Download All Data Max Acceleration List Animation

Data List

Network	Site code	Recording start time	Latitude	Longitude	Peak acceleration	Intensity	Epicentral distance	Site name
-KiK-	ISKH05	2011/03/11-14:47:47	37.22N	136.97E	0006.6gal	1.4	0529km	ANAMIZU
-KiK-	ISKH04	2011/03/11-14:48:47	37.05N	136.82E	0005.0gal	2.1	0546km	SHERA
-KiK-	ISKH07	2011/03/11-14:48:07	36.52N	136.64E	0004.4gal	1.9	0579km	KOHAZAKA
-KiK-	ISKH09	2011/03/11-14:48:08	36.27N	136.72E	0003.4gal	1.0	0582km	OGHII
K-NET	IWT001	2011/03/11-14:47:08	40.41N	141.72E	0272.7gal	4.9	0274km	TANEICHI
K-NET	IWT002	2011/03/11-14:47:07	40.18N	141.76E	0130.0gal	4.6	0249km	MUJI
K-NET	IWT003	2011/03/11-14:47:02	40.01N	141.89E	0163.0gal	4.9	0228km	FUDAI
K-NET	IWT005	2011/03/11-14:46:54	39.65N	141.98E	0280.0gal	4.8	0189km	MIYARO
K-NET	IWT007	2011/03/11-14:46:46	39.27N	141.86E	0741.6gal	5.7	0156km	KOHASHI
K-NET	IWT008	2011/03/11-14:46:47	39.08N	141.71E	0387.0gal	4.9	0148km	OHFNATO
K-NET	IWT009	2011/03/11-14:46:47	39.02N	141.40E	0570.0gal	5.4	0163km	DALTON
K-NET	IWT010	2011/03/11-14:46:52	39.15N	141.15E	0359.0gal	5.2	0188km	ICHINOSEKI
K-NET	IWT012	2011/03/11-14:46:52	39.32N	141.14E	0627.0gal	5.9	0202km	KITAGAMI
K-NET	IWT013	2011/03/11-14:46:51	39.34N	141.54E	0469.0gal	5.4	0178km	TORNO
K-NET	IWT014	2011/03/11-14:46:56	39.48N	141.15E	0249.0gal	5.1	0214km	SHIIBORIVA
K-NET	IWT015	2011/03/11-14:47:00	39.32N	140.78E	0100.0gal	4.3	0226km	KAWAJIRI
K-NET	IWT016	2011/03/11-14:46:54	39.60N	141.68E	0244.0gal	4.7	0195km	KAWAI
K-NET	IWT017	2011/03/11-14:46:56	39.63N	141.44E	0350.0gal	5.0	0210km	KADOMA
K-NET	IWT018	2011/03/11-14:46:58	39.70N	141.15E	0259.0gal	4.8	0231km	MORIOKA
K-NET	IWT019	2011/03/11-14:46:56	39.68N	141.80E	0335.0gal	5.4	0214km	KRAIZUMI
K-NET	IWT020	2011/03/11-14:46:58	39.78N	141.33E	0277.0gal	5.4	0229km	SABOYAMA
K-NET	IWT021	2011/03/11-14:47:03	39.32N	141.08E	0316.0gal	5.2	0254km	NISHINE
K-NET	IWT022	2011/03/11-14:47:07	40.10N	141.05E	0123.0gal	4.5	0271km	ASHIRO

Download All Channels Data

Acceleration Waveform

Velocity Response Spectrum



roadmap for dynamic AHCAL finite element analyses

- earthquake data
 - investigate ISO 3010 und Eurocode 8 (75 % done)
 - proof of practicability for the finite element model and test (open)
 - get, view and prepare data of NIED network at Japan for Ichinoseki (K-NET IWT010 2011/03/11) (done)
 - prepare all data for dynamic finite element analyses (open)
- dynamic calculation for complete AHCAL with ECAL mass segments
 - prepare dynamic test model (open)
 - earthquake calculation according ISO 3010/Eurocode 8 (open)
 - earthquake calculation with real data from Japan (open)



AHCAL finite element analyses

manpower and cost overview

- Manpower and costs 2014

- DESY ZM1 engineer cost per hour: 56 €/h
- already accumulated costs 2014: 132 h => 7.400 €
- July: 22,0 h / August: 18,5 h / September: 28,0 h / October: 18,0 h / November: 20,0 h / December: 25,0 h
- 14 % average work load per month with 1 engineer (165h/month)
- low priority due do many running DESY projects (XFEL, Petra III,.....)

- Manpower and costs 2015

- ZM1 engineer team will consist out of 2 engineers
- hope for 30% average work load per engineer => 100h/month
- work packages:
 - completion static finite element analyses 80 h => 4.500 €
 - preparation dynamic finite element analyses 40 h => 2.200 €
 - dynamic finite element analyses according ISO 3010 / Eurocode 8 80 h => 4.500 €
 - dynamic finite element analyses according real earth quake data 60 h => 3.350 €
- assumed costs 14.550 € for 260 hours in 3 month



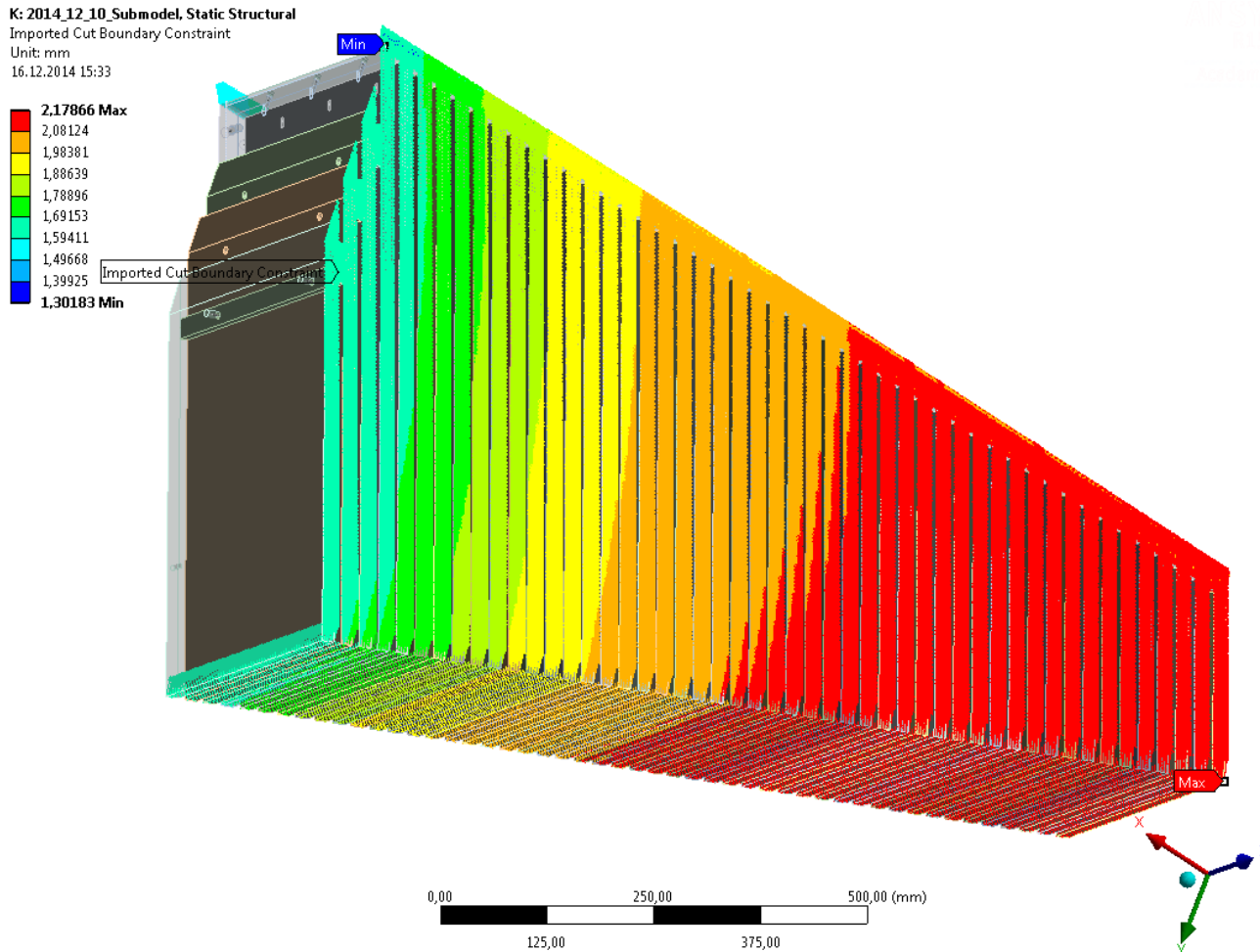
- Backup



AHCAL static finite element analysis I

3D detail model

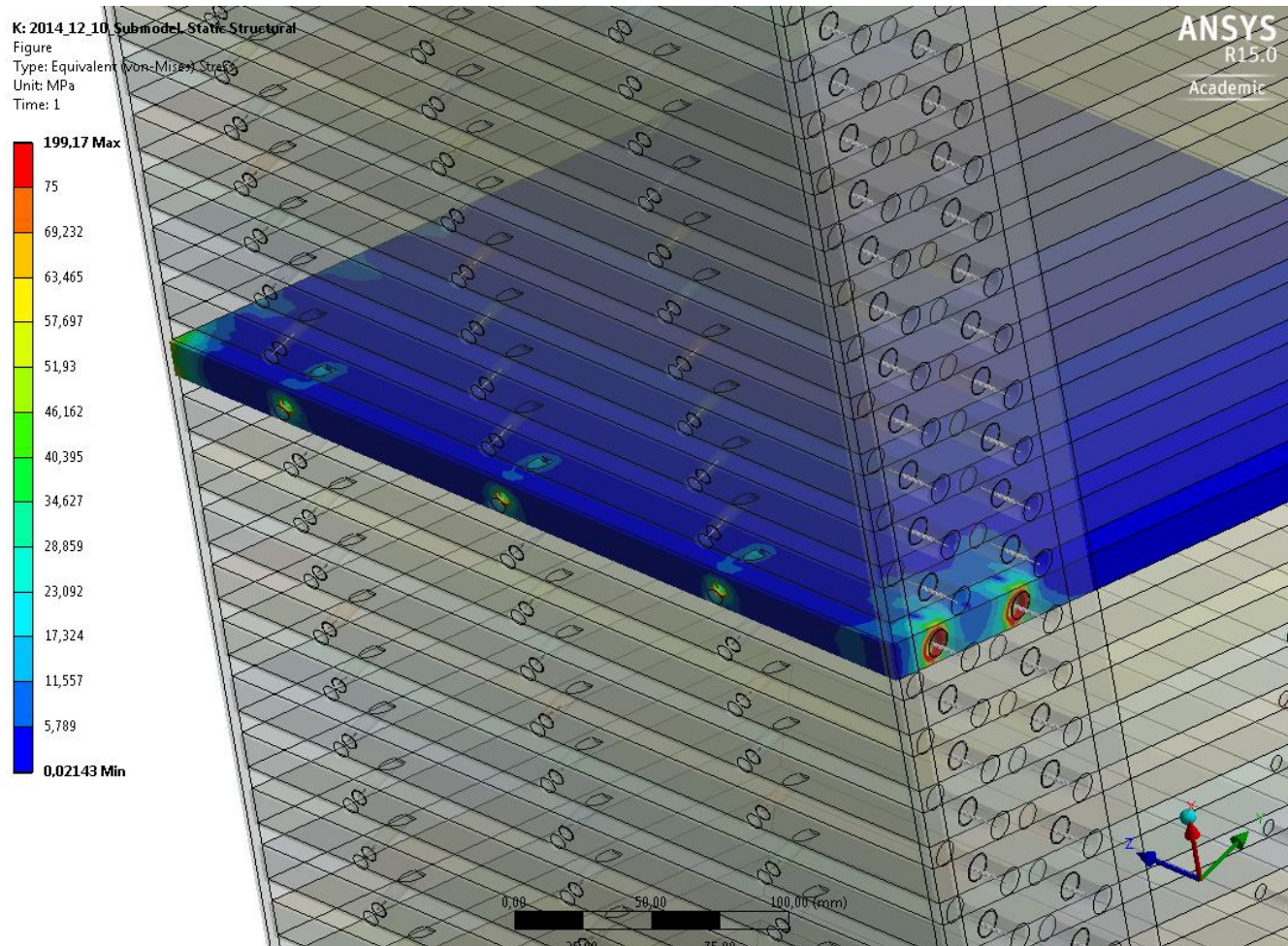
- displacements at boundary surfaces by interpolation of complete 3D detailed shell model



AHCAL static finite element analysis I

3D detail model

- evaluation of single structure parts possible



AHCAL static finite element analysis I

3D detail model

- evaluation of screw joints at arbitrary places possible

