ILC / ILD TPC

status of the support mechanics

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ILD Workshop 2012 Kyushu University
21.05.2012

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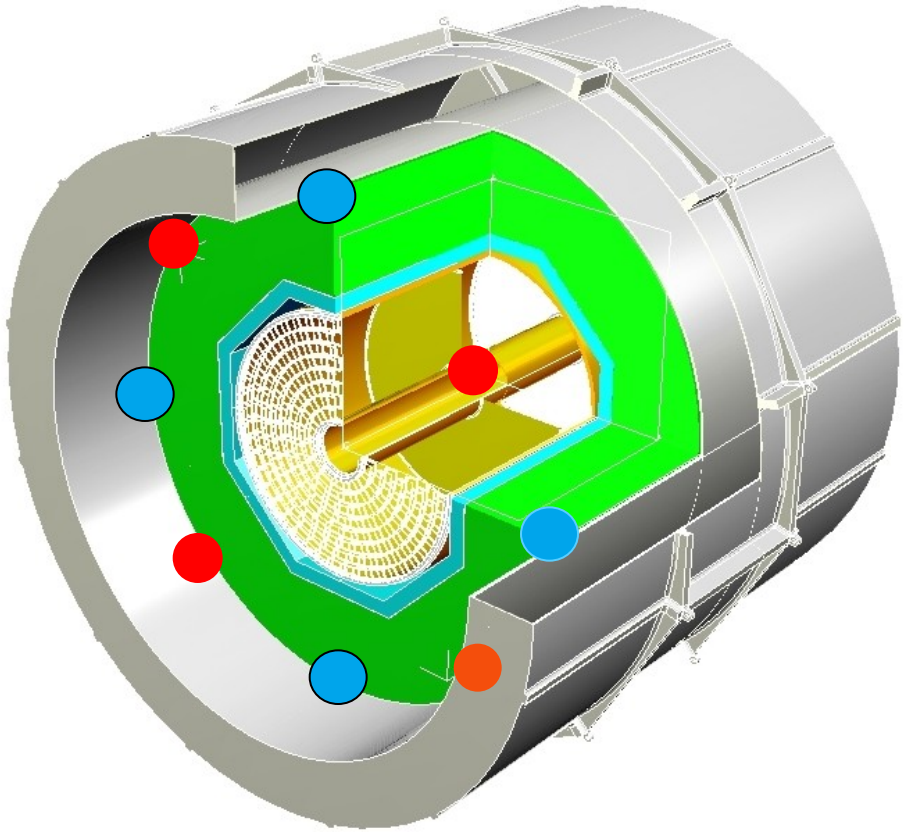
DESY

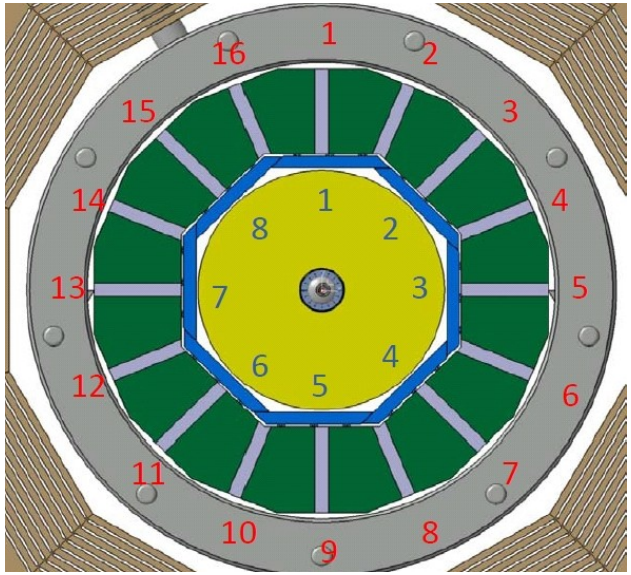
Overview

- Fixing points of the TPC support structure
- Requirements of the TPC support structure
- Estimated acceleration and forces
- Various designs of the support structure neu
- Dimensions of the support structure
- Flat ribbon support
- Design of the support structure (rectangular or T-bar)
- Numbers for an estimate CF calculation
- HV Cable and routing
- TPC installation
- Conclusion and outlook

Fixing points of the TPC support structure



Main dimensions of the TPC (outside)
Ø Od = 3616, r=1808
Ø Id = 658, r=329
Length = 4700 incl. endplate and cabling



Various possible fixing points

Only the cryostat is foreseen to support the TPC

Requirements of the TPC support structure

The support structure has to be fulfill the following tasks

- Non-magnetic material
- Low thermal expansion coefficient
- Robust system in x,y,z,

} Carbon fiber structure preferred

- Accuracy and stability has to be constant over the lifetime
- Earthquake-safe system
- Vibration absorption in Z direction
- Required accuracy 100 µm or better for Vertex, SIT, FTD !
- Min free space of 10 mm in all directions ! Gaps !

DESY

Estimated acceleration and forces

Values of basic peak acceleration a_0 [m/s^2]

North site
$A_0 < 1.5$ m/s²

South site
$A_0 < 1.0$ m/s²

For the proposed Japanese sides

Please have a look at the talk from **O. Ferreira, LLR Ecole Polytechnique**
http://ilcagenda.linearcollider.org/conferenceDisplay.py?confid=5524.

TPC weight for calculation: 2000 kg >20000 N (Incl. FTD, SIT, Vertex)

Seismic load force: 3000 N in x,y,z calculated with $A_0 < 1.5$ m/s²

The additional force load in longitudinal direction of the bar support should not be an issue.

Question: Which maximal amplitude can be accepted ?
An max. deflection of 1mm will be the aim

Various designs of the support structure

Two options would be followed

Flat ribbon and rectangular or double T-bar support

Skizze Dämpfung zum ECAL

Werte dimension UD-Core +/- 45° Gelege als facing, Carbon Werte für Auslegungen

Bar support

Stiffness and damping in Z direction

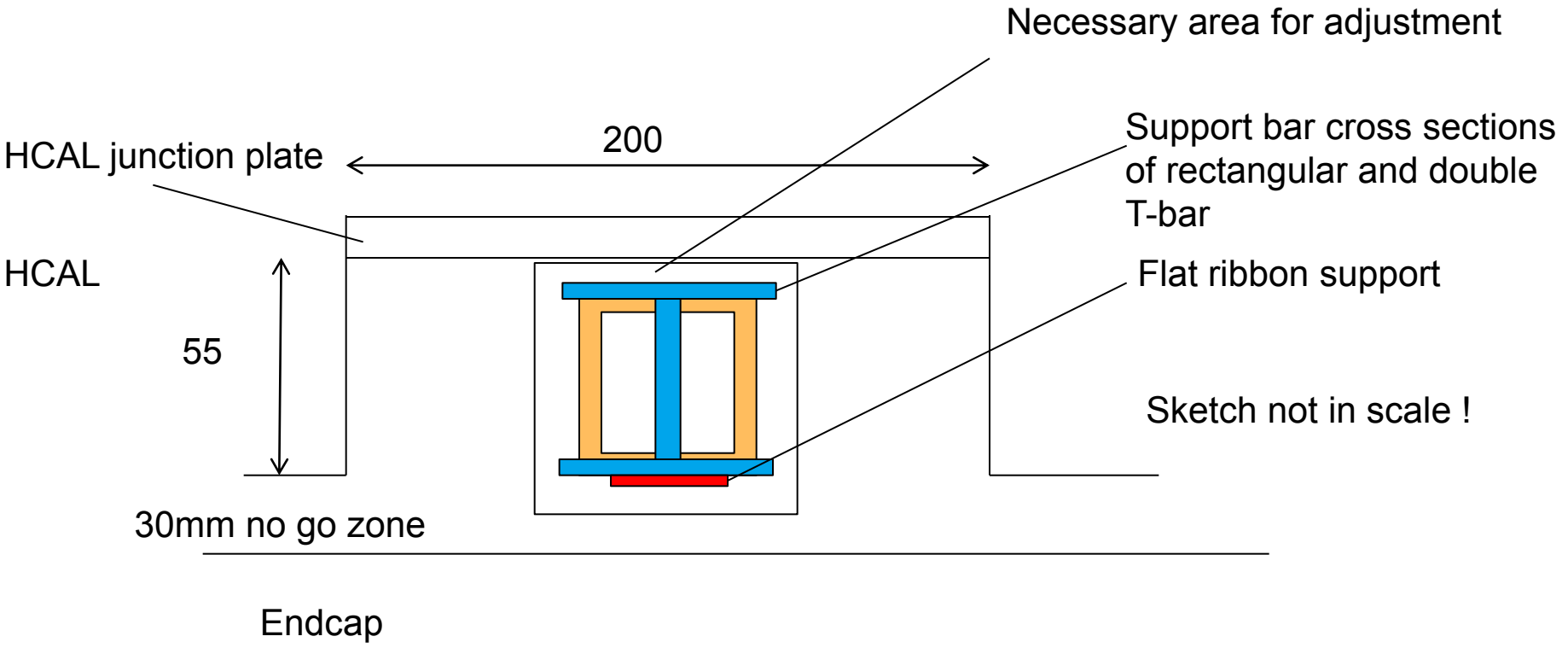
Pros and cons of the flat ribbon suspension

+ Thin and and small cross section design possible
- Support system ~ 1600mm long
- Damping support in Z necessary

Pros and cons of the rectangular or double T-bar system

+ Damping in Z possible
- Large cross section
- Support system ~ 1600mm long
- Now this space is not available!

Dimensions of support structure

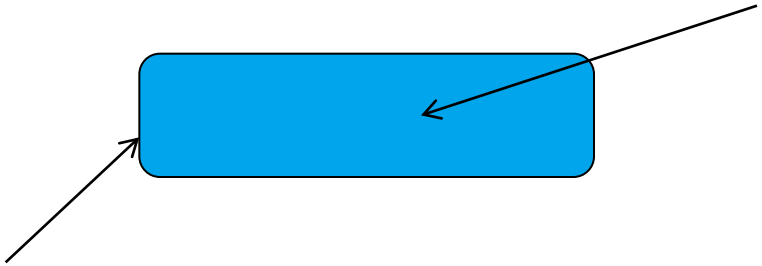


An cantilever design is only possible if minimum of 4 gaps can be used

Dimensions of support structure (Flat ribbon)

Minimum dimensin of the cross section of the flat ribbon support
a = 20 mm^2
Value incl. safety factor of 2, strain 10000N for one vertical ribbon,
tensile strength: 1000 N/mm^2

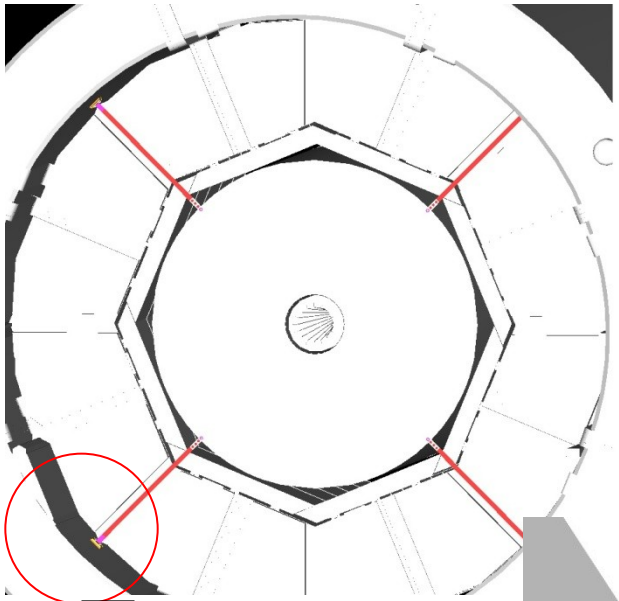
At the end of the ribbon the cross section comes to thicker (in the case of screw or rivet coupling
Value incl. safety factor of 2, strain 10000N for one vertical ribbon,
compression strength: 500 N/mm^2
a = 40 mm^2

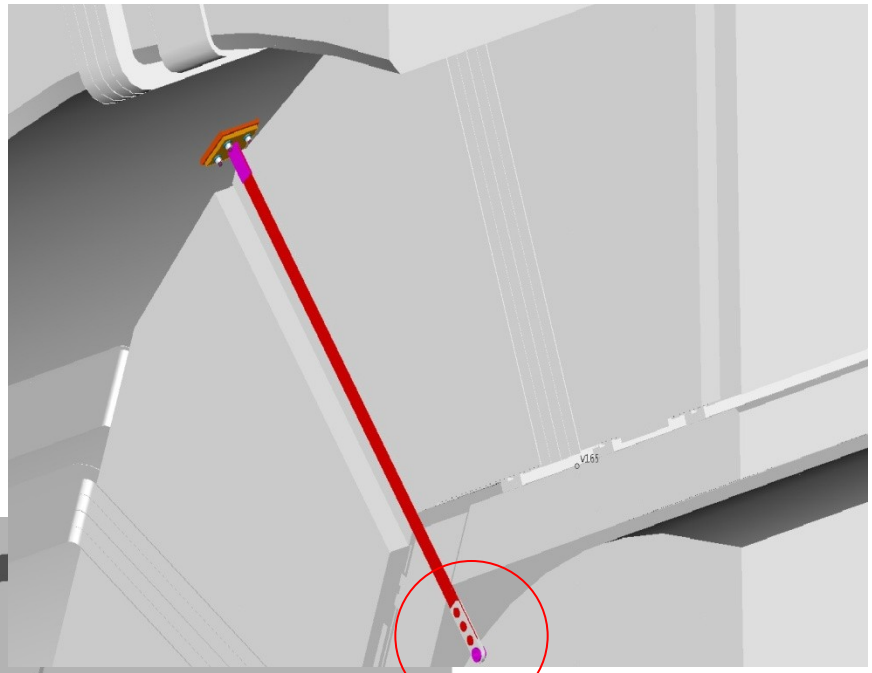


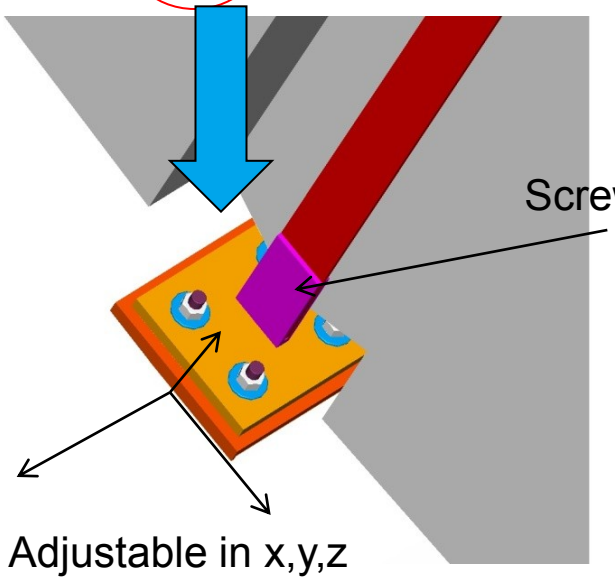
Facing: +/-45° thin layer

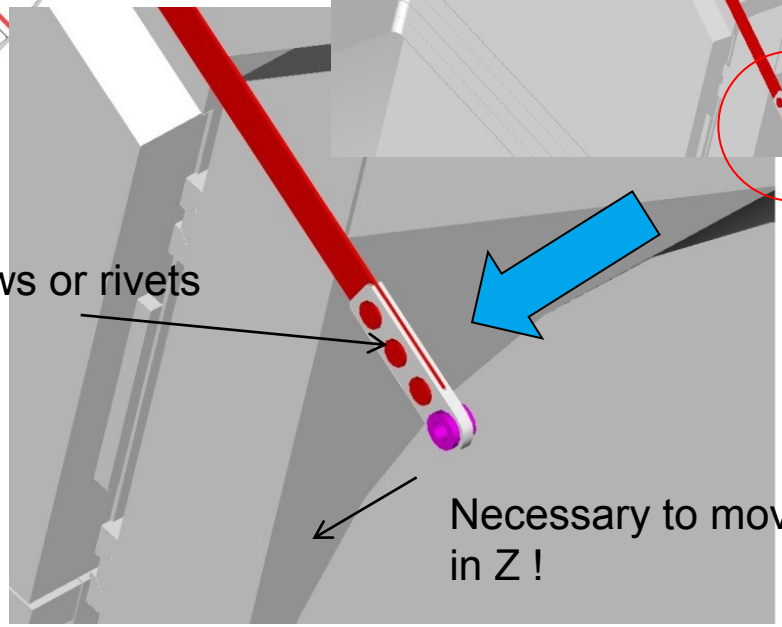
Realistic cross section dimensions has to be checked

Flat ribbon support









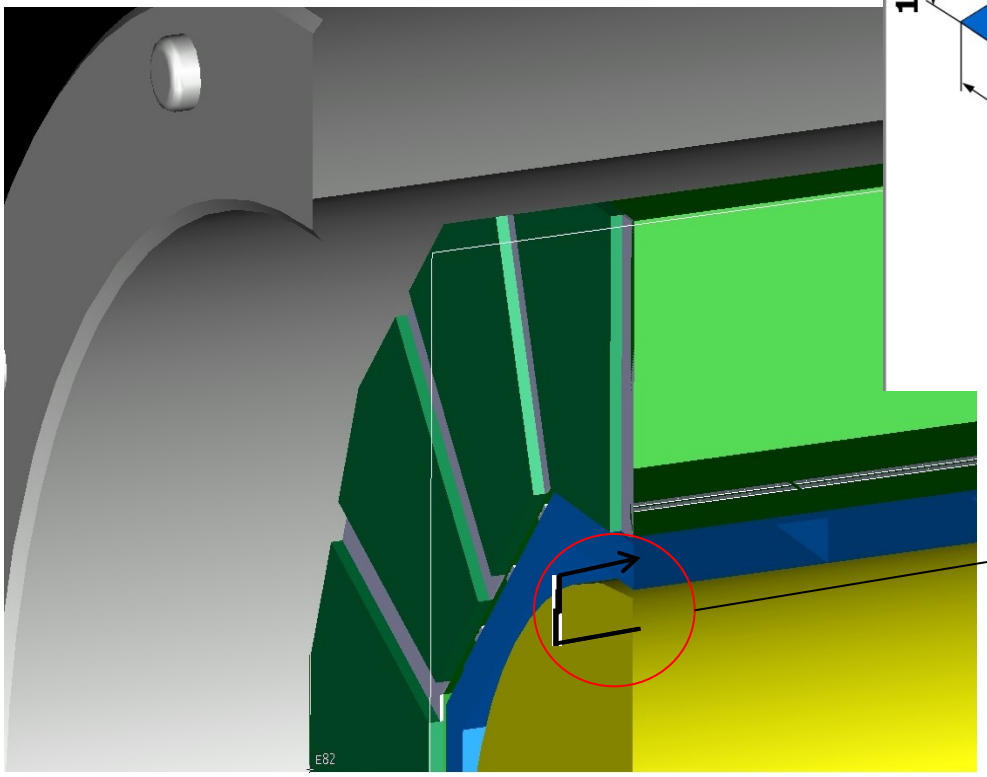
Screws or rivets

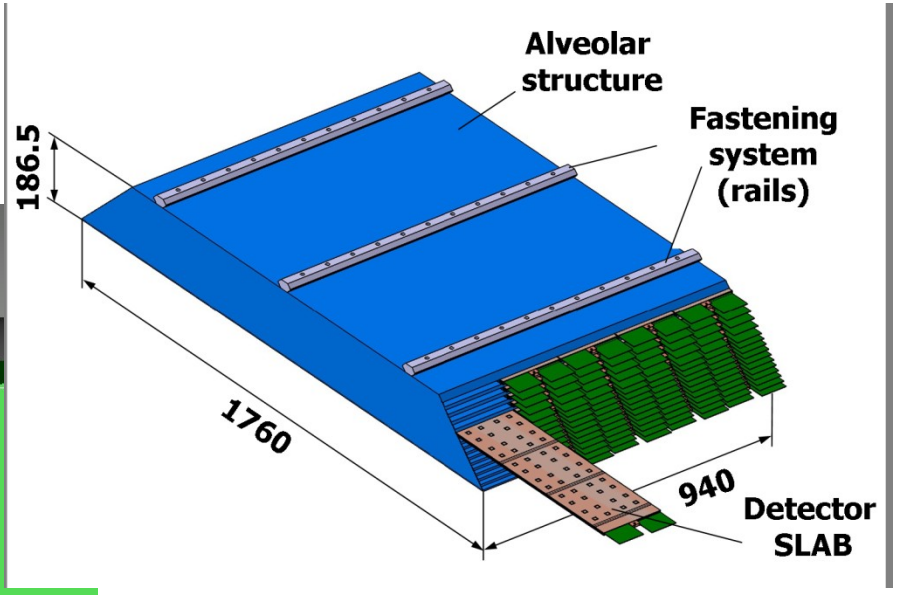
Adjustable in x,y,z

Necessary to move 55mm in Z !

Flat ribbon support

Support in Z- direction





- Stiff U-bracket mounted on the TPC-Endplate
- Incl. a spring to damping the TPC in Z
- Ballpoint connection will push on an plate mounted on the ECAL surface

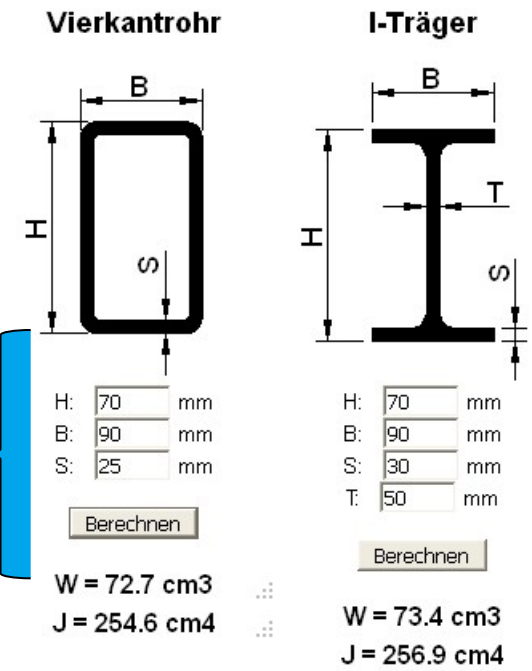
Design of the support structure (rectangular or T-bar)

Possible dimensions for an support beam with a deflection of 1mm during load force of 375N in Z-direction

Profile double T-beam

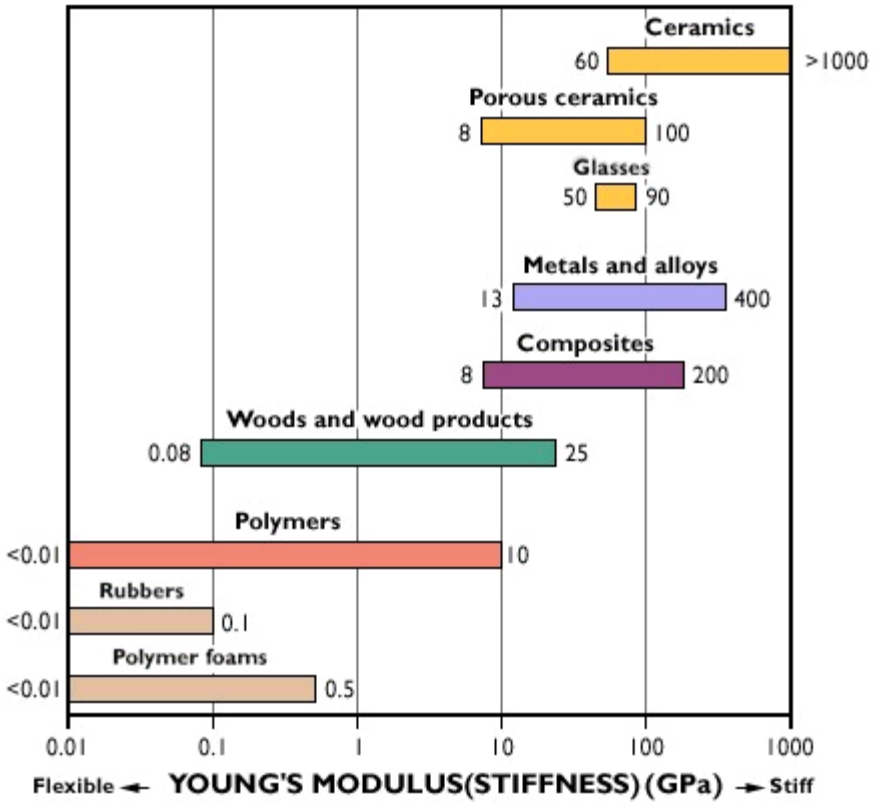
I=256cm^4

Material: St



Unrealistic values

http://www.mobile-soft.at/widerstandsmoment-berechnung.html



How this issue can be solved?

- Different material
- More than 4 bars
- Accept higher value of deflection
- Alternative support

Numbers for an estimate CF calculation

Values for an *laminate* with 43% volume of fiber

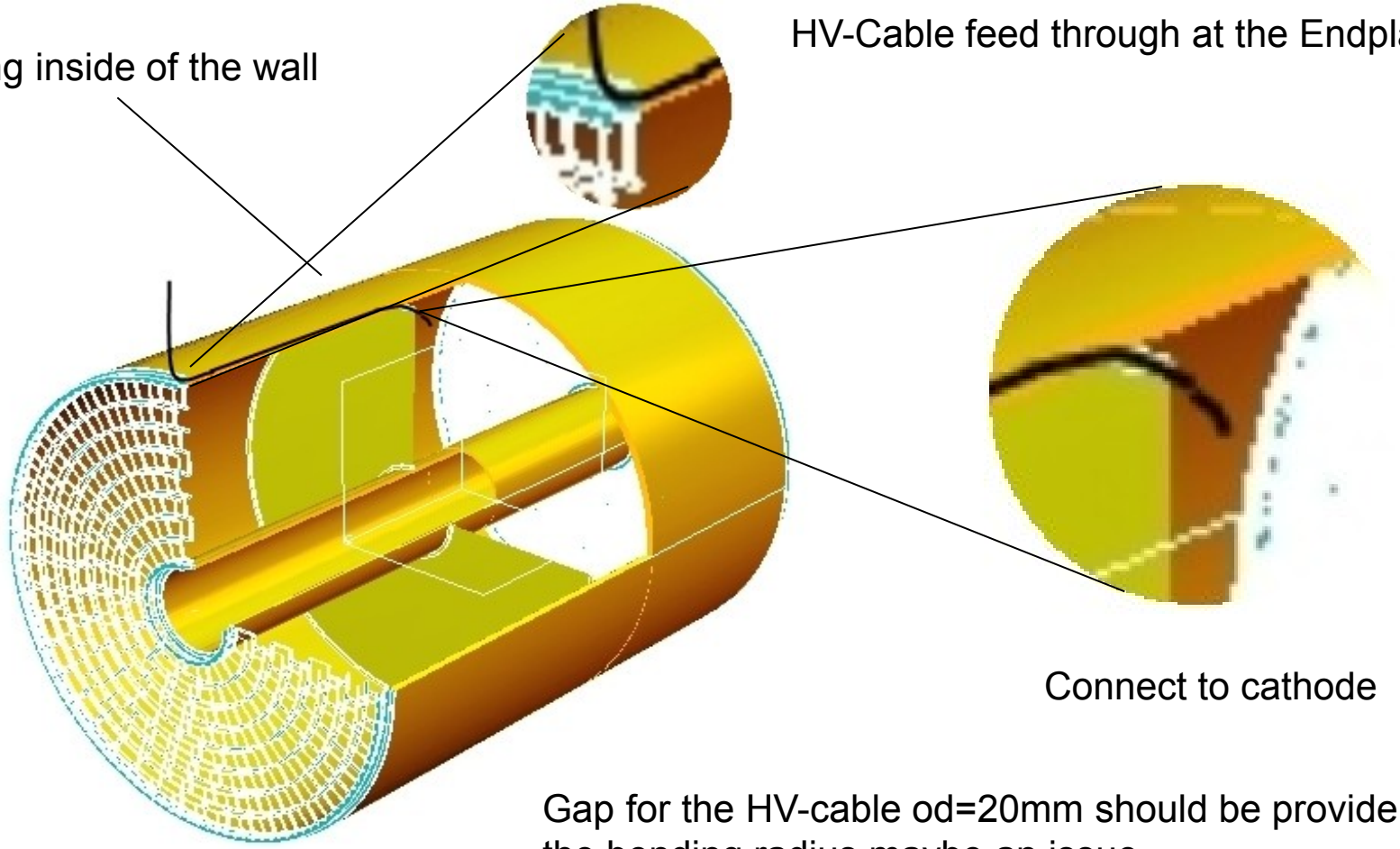
- Tensile strength: 1000N/mm^2 Ud, 450 for quasi isotrope assembly
- Compression strength: 500N/mm^2
- Modulus of elasticity: 100.000 N/mm^2

General values for CFK fiber

- Tensile strength: 2700N/mm^2
- Modulus of elasticity: 230.000 N/mm^2
- Breaking strain: 1,2 – 1,4 %
- Density of the fiber: ~ 1,7 g/cm^3
- Density of the matrix: ~ 1,1 g/cm^3
- Thermal expansion: -0,1 - -0,7*10$^{-6/k}$

HV Cable and routing

Overview of an first idea of the HV-cable routing



Gap for the HV-cable od=20mm should be provide, the bending radius maybe an issue

HV Cable and routing

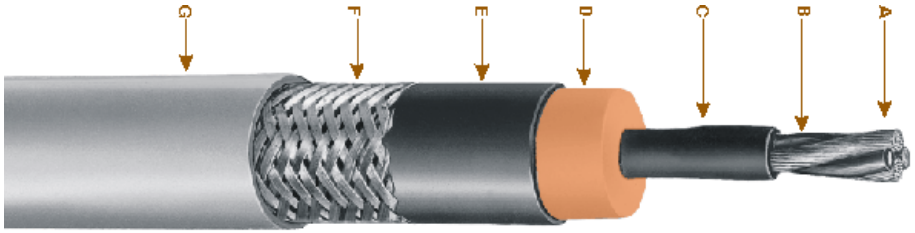
Samples of HV-cables

A Coated Stranded Copper Conductors
B Polyester Insulation
C Extruded Semiconducting Layer
D Primary Insulation – Okoguard
E Extruded Insulation Shield
F Coated Copper Braid
G Jacket – Okoseal

Okonite Hi-Voltage Cable: www.okonite.com

100kV, od= 16,76mm,

bending radius = 4*od > 70mm



Heinzinger HVC100 Best. No.:00.220.853.9 www.heinzinger.com

100kV, od= 14mm, bending radius min. 280mm!

FUG C 2124, Mat.- No.: 0502032124

Cross section of the HV-cable:
255-300mm^2 necessary

http://www.fug-elektronik.de/webdir/PDF/e/Access_data_sheet.pdf

100kV, od= 11,2mm, bending radius min. 152mm

TPC installation

Basic questions has to be solved

- Installation of the inner detector (carbon fiber support tube)
  - Independent assembly from the TPC necessary
- Installation steps of the TPC
  - Central Electrode has to be mounted and connected with the HV-cable
  - HV-Cable glued into the TPC
  - Patch panel necessary for the HV-cabel
  - Assembling steeps of the Endplate and the inner Vessel of the TPC
  - Cabling and Cooling
  - Alignment
  - Combined sliding tool should be discussed it can be used for:
    - Mounting of the central electrode
    - TPC assembling and moving
    - Installation of the central tube
    - Something else

Conclusion and outlook

Conclusion

- Support system with min. 4 bars necessary
- Required space is an issue with the infrastructure and gaps between and in the middle of the HCAL / ECAL octagons
- Various cross sections and materials of the support bars are calculated
- Two support systems available

Outlook

- Availability of space in the gaps has to be evaluated
- More FEA studies in progress
- Minimize the cross section of the support bars depends on the requirements
- Space for the HV-Cable necessary, the place holder model will be prepared soon
- HV-cable bending radius can be an issue
- Mounting tool, installation steps and schedule now in progress