Collaboration Meeting
MVD Subgroup
GSI, March 3, 2009

Thomas Würschig

Update on the MVD mechanics and presentation of a concept for the strip disks

MVD mechanics meeting

universitätbonn

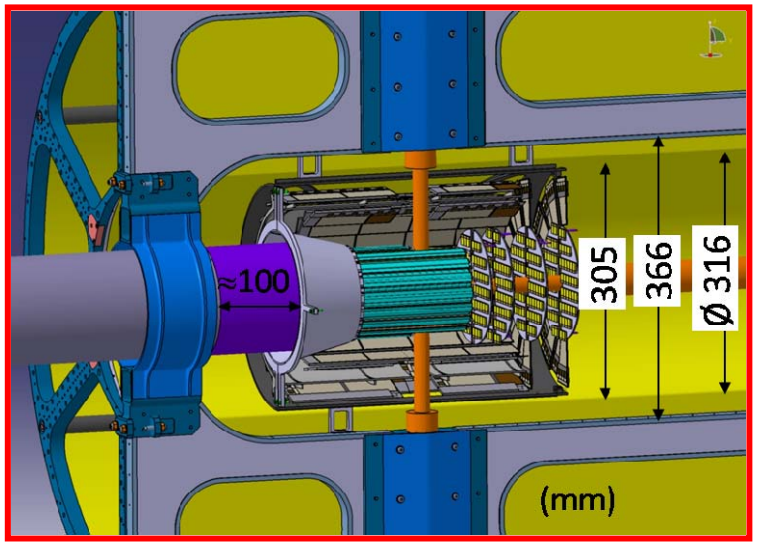
MVD Mechanics Meeting

- Jülich, February 9-10, 2009
  - Participants
    - ✓ T. Stockmanns, H. Jäger (IKP, FZ Jülich)
    - ✓ D. Grunwald (ZAT, FZ Jülich)
    - ✓ G. Giraudo (INFN Torino)
    - ✓ L. Lambrecht (IKV Aachen)
    - ✓ Th. Würschig (HISKP, Uni Bonn)
  - Program
    - ✓ Status in Bonn / Jülich / Torino; Presentation of IKV Aachen
    - ✓ Discussion:

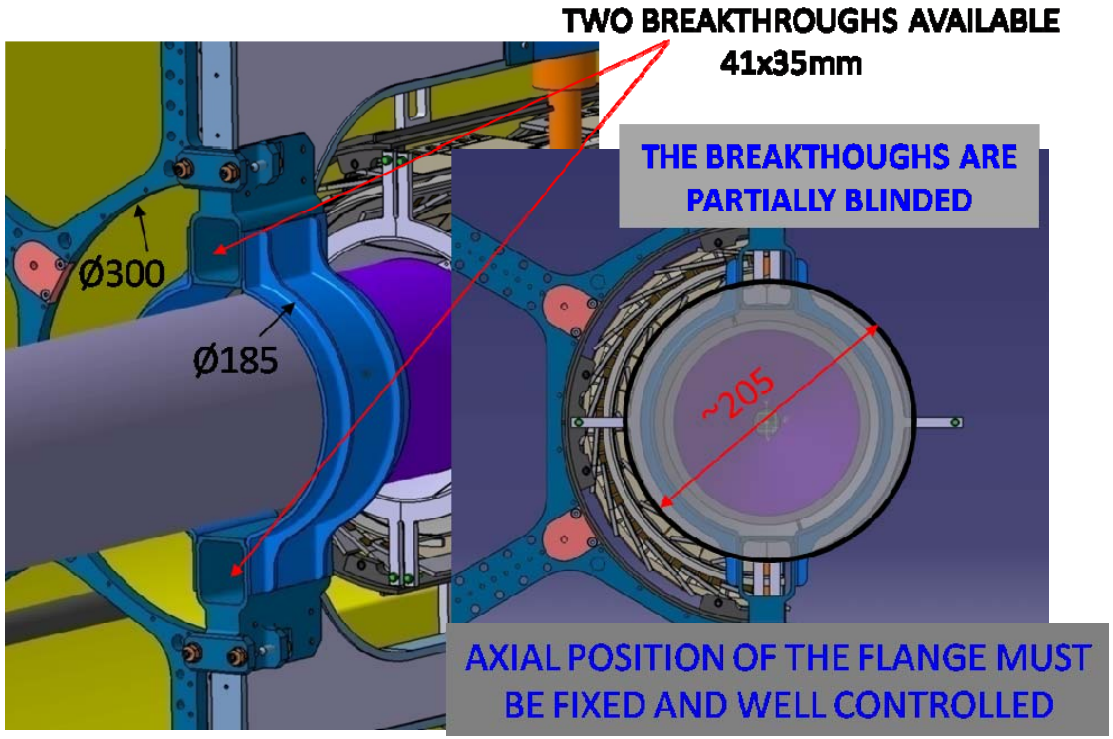
      Pixel design / Strip design / Cooling and integration / CAD conventions, CAD converter / Next steps and missing info

MVD Mechanics Meeting

- Communication with Frascati
  - Interface Central frame (CF) ↔ MVD ↔ (STT)



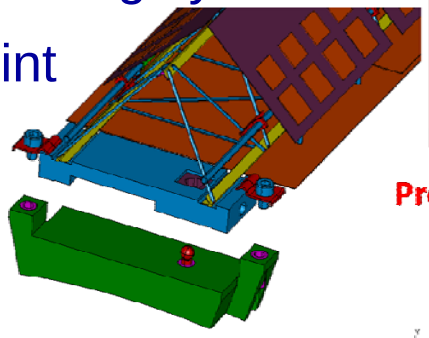
G. Giraudo, D. Orecchini

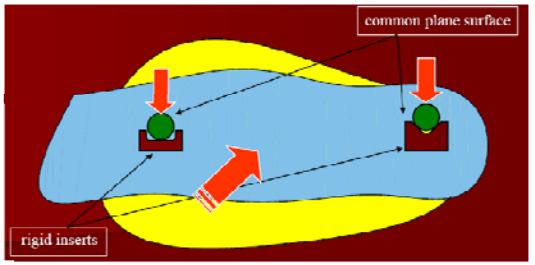


- ✓ Updated version of CF
- ✓ 41 x 35 mm^2 area at top and bottom over full length left for readout

MVD Mechanics Meeting

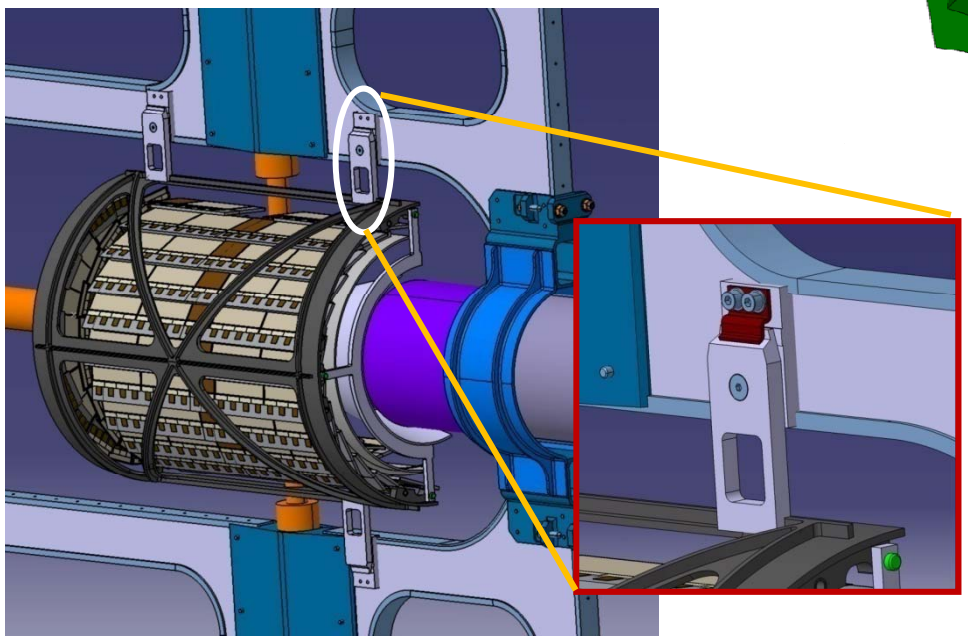
- Proposal for MVD coupling to CF
  - Based on ALICE ladder repositioning system
  - 2 fixed points @ top and 3rd point @ bottom define a plane

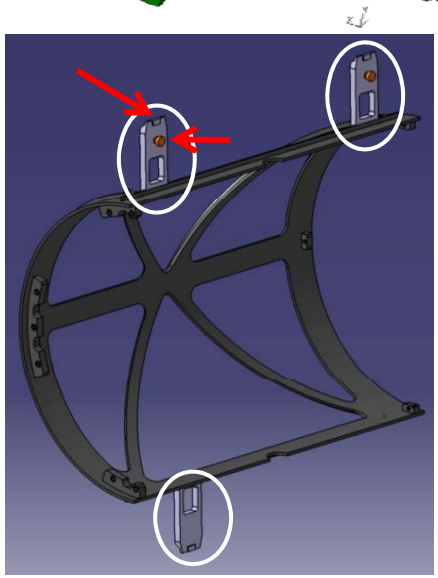


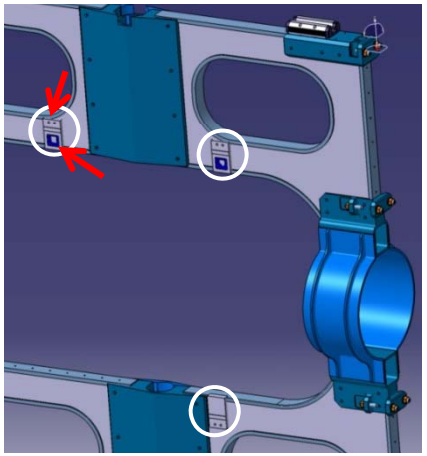


Precision < 6 µm

The SDD and SSD support structure for the ALICE Inner Tracking System.
G. Giraudo et all. 2009 JINST 4 P01003





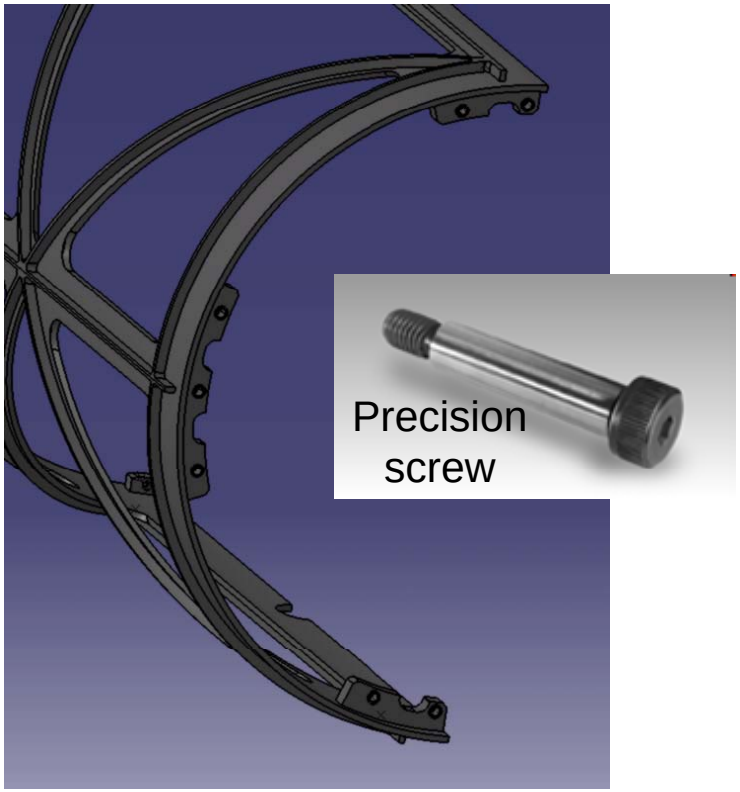


MVD Mechanics Meeting

- MVD global support ↔ barrel support

G. Giraudo

  - Common design for strip and pixel subsystem



- Three fixing points for pixels
  Screw:
  1 x M4 + 2 x precision M4

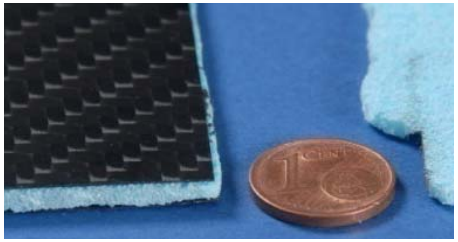
- Four fixing points for strips
  Screw:
  2 x M4 + 2 x precision M4

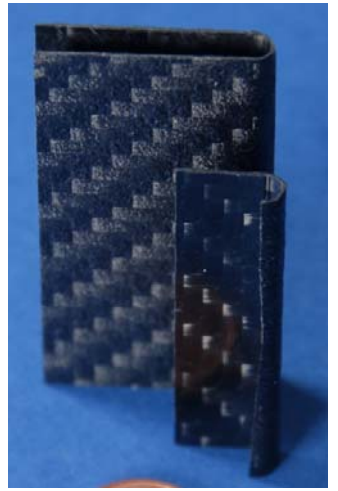
MVD Mechanics Meeting

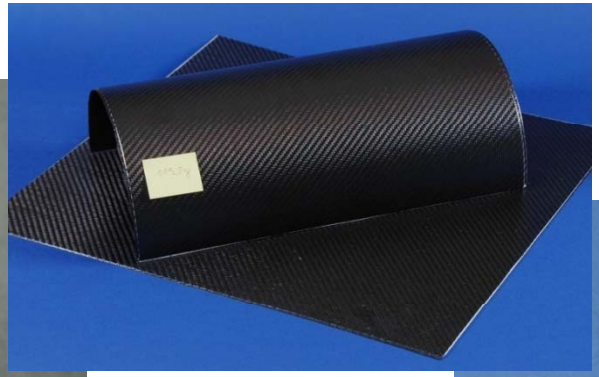
- Carbon structure processing
  - Stave support: Sandwich structure

    (Carbon – Foam – Carbon)
  - Barrel support: Half-shell and saw-tooth support

    → 1st water cutting





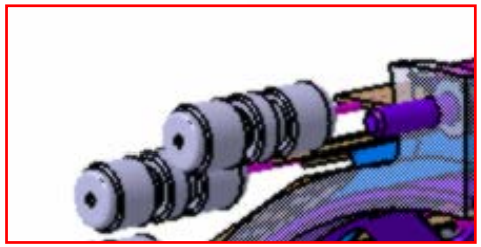


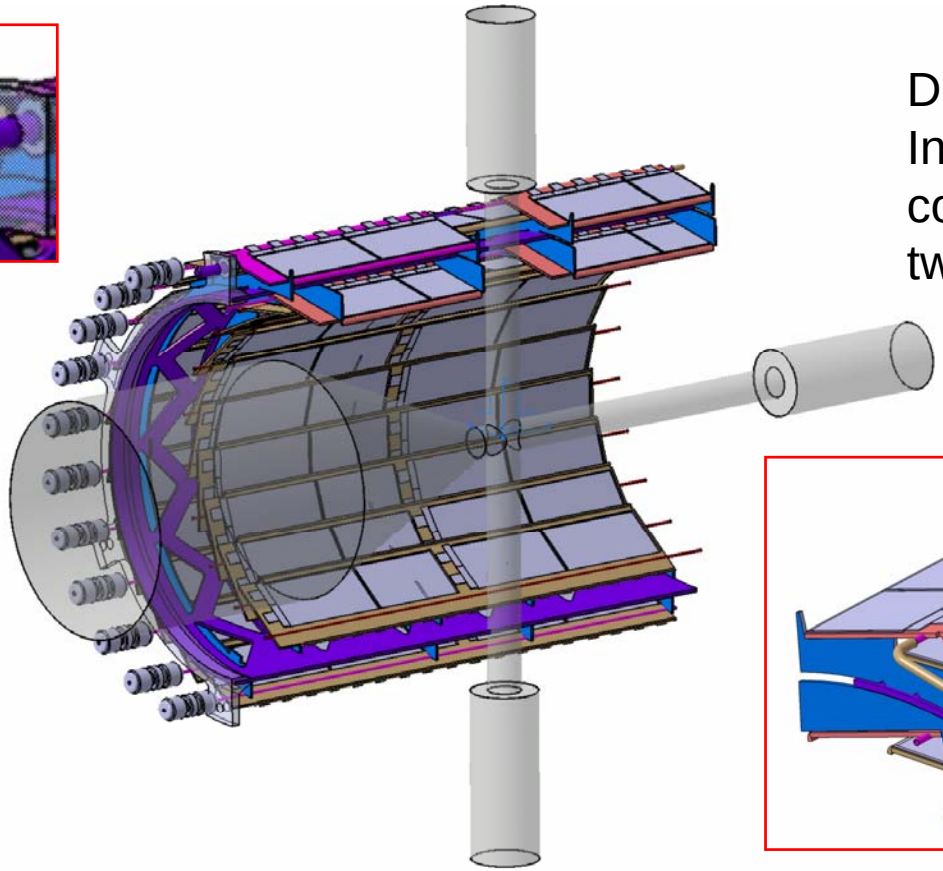
D. Grunwald,
L. Lambrecht

MVD Mechanics Meeting

- Strip barrel design

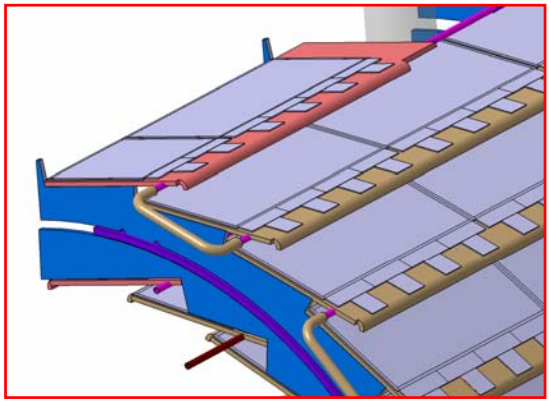
D. Grunwald





Downstream:
Interconnection of cooling pipes for two super-modules

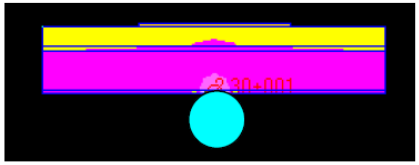
Upstream:
Lead trough connections for cooling pipes



MVD Mechanics Meeting

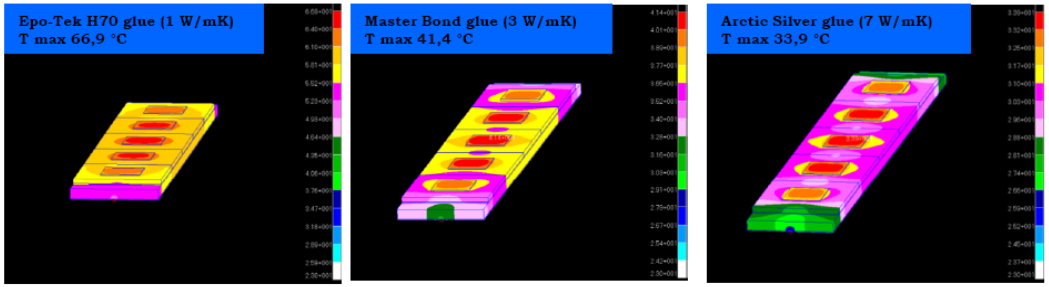
- Preliminary thermal simulations for pixel modules *S. Coli*

THERMAL SIMULATIONS:

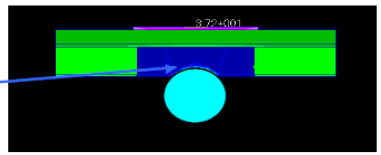


FIRST TEST MODEL:
Dummy FEE: 0,5 mm Alumina (20 W/mK) + 0,1 mm with Power: 5W
Glue layer: 0,1 mm (Epo-Tek H70, Master Bond EP30AN, Arctic Silver)
Carbon foam: 1 mm (40 W/mK)
Glue layer: 0,1 mm (Epo-Tek H70, Master Bond EP30AN, Arctic Silver)
Cooling water 18°C (about 23°C on the wall). Flow rate : 0,3 l/min
MODEL LENGHT: 50 mm

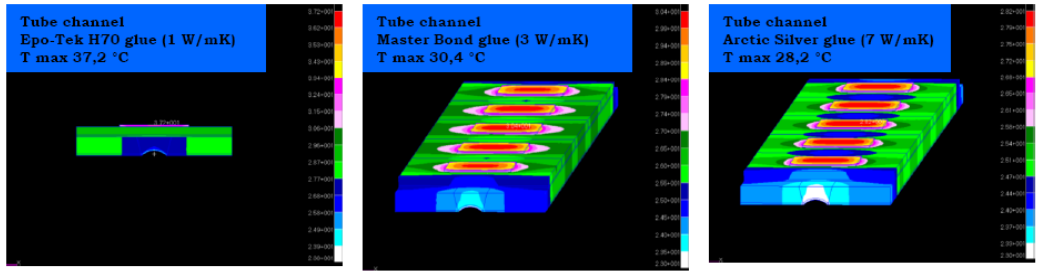
Different Thermal glues



Improving contacts



Better contact and different glues



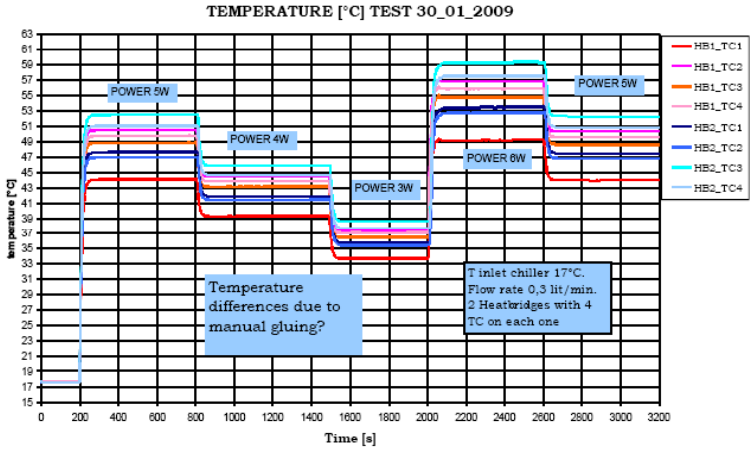
- Coolant: Water (18°C)
  - Improved contact with elliptical pipe
  - Best results for silver glue

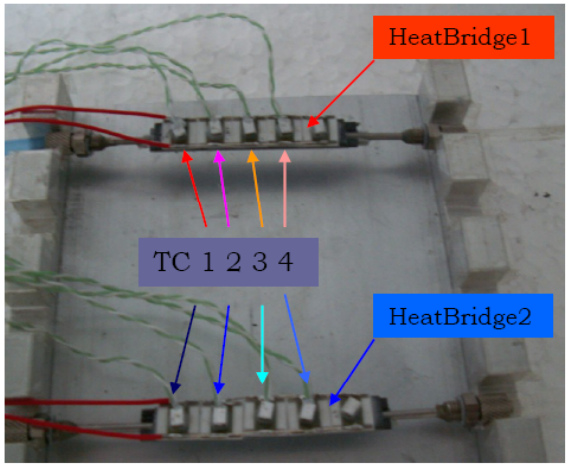
    BUT:
  - Comparable results for standard glue (*Epo-Tek*) with improved contact
  - Achieved temperatures:

    T_{max} = (28 ... 37) °C

MVD Mechanics Meeting

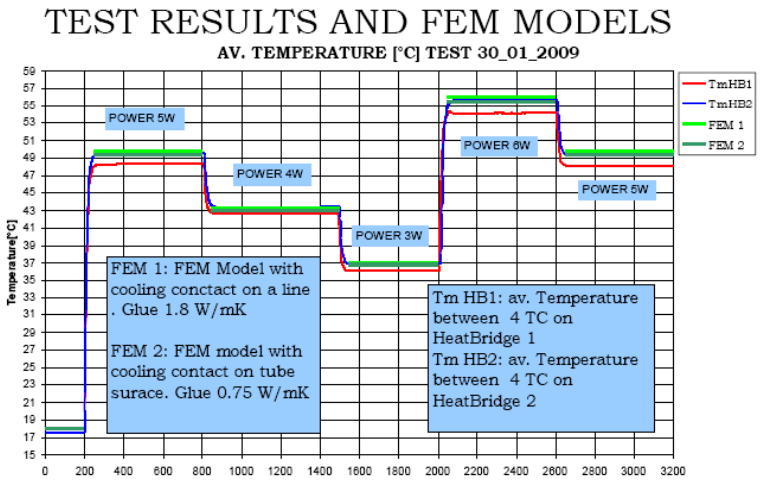
- Thermal measurements: built up and test of 1st prototype

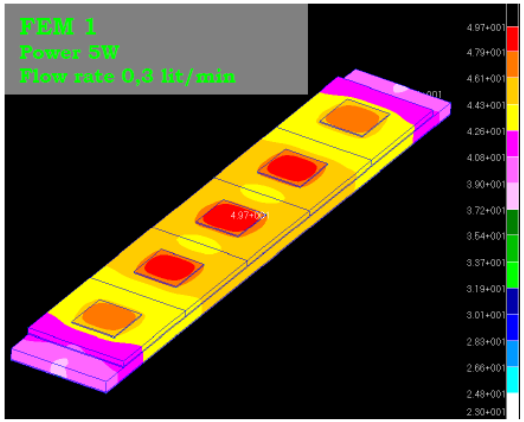




S. Coli

- Good agreement of mean value between FEM analysis and measurement



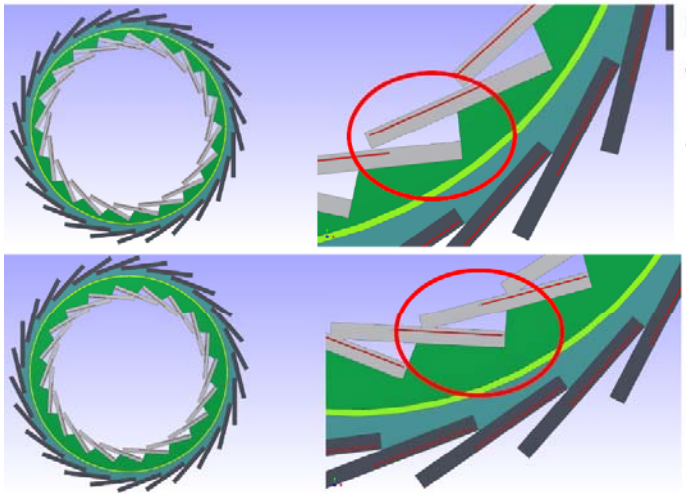


- Still bigger variations for single FEE dummies

→ improvement of glue contact

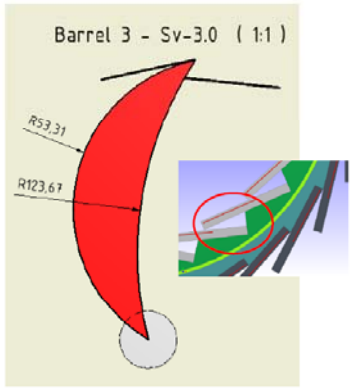
MVD Mechanics Meeting

- Dedicated concept for strip disks …more details later… *Th. Würschig*
- Design check for proposed modification in barrel 3

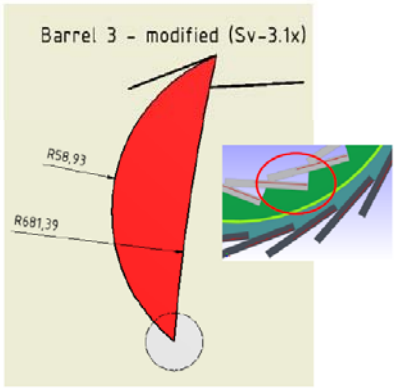


Default:
- Sensor at innermost radius
- Readout position at outer radius

Proposed modification:
- Readout at innermost radius
- Sensor position at outer radius



Default:
Maximum bending radius: 124 mm



Proposed modification:
Maximum bending radius 6 x higher!

PROS

- Better access to readout electronic

... But: is this really necessary and realistic?

- ✓ In operation there is NO access to the whole MVD at all
- ✓ In test phase: fully equipped MVD barrel layer must be taken apart even for the modified version to reach the regions of interest WITHOUT any danger of destroying the neighbouring modules

CONS

- More material load at inner radii
- Higher radial tilting angle for the super-modules
  - → Higher variation of radius of the sensor's active area
  - → Much bigger gap for bending radii
  - → Less space in between subsequent super-modules
- Referring momentum range of the gap in the bending radius reaches a highly populated region of the PANDA experiment!

MVD Mechanics Meeting

- **Discussions**
  - Pixel design:
    - ✓ Arrangement of pixels in the forward disks
    - ✓ Pixel module types
    - ✓ Cooling
  - Strip design:
    - ✓ Arrangement of super-modules in barrel part
    - ✓ Shape of the barrel stave support
    - ✓ Super-module positioning (barrel part)
    - ✓ Cooling
  - Integration:
    - ✓ Support for strip disks ↔ global MVD support
    - ✓ Support for strip barrel layers ↔ global MVD support

MVD Mechanics Meeting

- **Conclusions: Pixel part**
  - Implementation of different module sizes
    - ✓ Different lengths
    - ✓ Number of rows: one or two
    - ✓ Basic unit: 10 mm x 10 mm

  → Number of different module types should be minimized (4 … 6)

  - Work out of two designs

    Optimized coverage ↔ Minimized material *

    * Realistic considerations of technical limitations (e.g. cooling, spatial safety margins)

  → Input to simulations → Results basics for optimisation

MVD Mechanics Meeting

- **Conclusions: Pixel part**
  - Cooling
    - ✓ Coolant: water 18°C
    - ✓ Better contacts improve efficiency
    - ✓ Water flow does not have such big impact
    - ✓ Best cooling temperature for pixel modules roughly 30°C

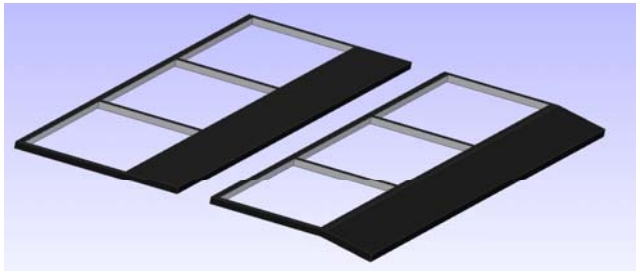
  → Study of effects for silicon sensors in this temperature region w.r.t. thermal runaway necessary! (also valid for strip part)

- **Conclusions: Strip part**
  - Forward part: New disk concept

  → Best solution for optimized coverage and minimized material budget

MVD Mechanics Meeting

- **Conclusions: Strip part**
  - Barrel layer: Implementation of modified stave support
    - ✓ Deflection of the plane supporting the FEE + cooling pipe
    - ✓ Deflection angle = tangential tilting of the super-modules



→ More radial space and prevention of collision between super-modules (FEE plane || next sensor plan)

→ Production feasible in carbon resulting in an even stiffer structure

  - Barrel stave positioning

→ Adaptation of “clip” technology used in ALICE as one option

- **Conclusions: Integration**
  - Forward part

  → Decoupling of pixel and strip part to MVD frame applying new concept

  → *Maybe additional support for pixel disks by strip disk part necessary*

  - Barrel part

  → Adaptation of the strip barrel support to the modified MVD frame

- **CAD hierarchy**

MVD pixel/ strip version	
MVD part:	**All barrel layer = Hshell** (half-shell) **All disk layer = Fwd** (forward part)
Layer:	All super-modules forming a half-layer → Functional level, (mechanically) not a "real" one
Super-module:	Module + support + cooling pipe → Smallest mechanically independent unit
Module:	Sensor, frontend, cable (maybe additional support) → smallest electronically independent unit (= readout channels) → mechanically (mostly) **not** independent
Sensor:	Active and passive volume

Concept for the forward silicon strip disks

Concept for strip disks

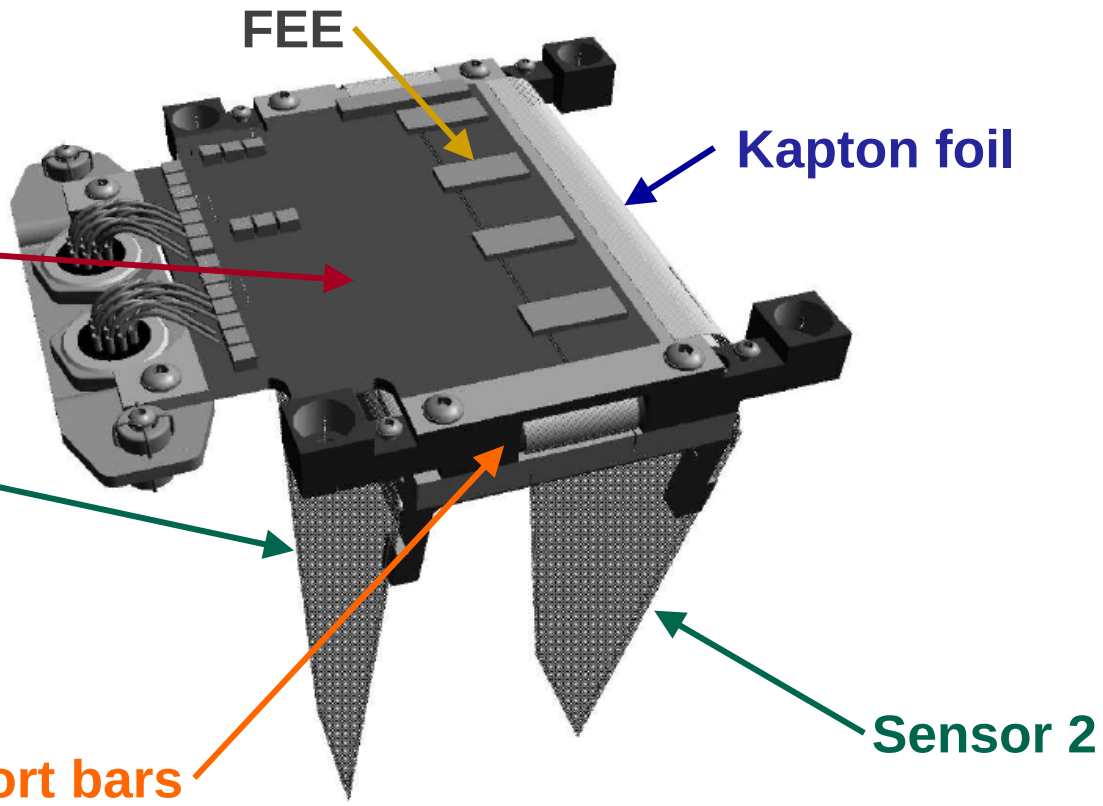
- Interesting solution for LAMBDA wheel at HERMES experiment
  - Setup:
    - ✓ Double sided trapezoidal strip sensor sensors (DSSD)
      (thickness: 300 μm; stereo angle: 30°; pitch: ≈160 μm)
    - ✓ 2 disk layers with a distance of 5 cm
    - ✓ Inner radius: 9 cm / Outer radius: 33 cm
    - ✓ Severe boundary conditions (R_{max} = 34 cm)
    - ✓ FEE: 0.4 W / 128 channel (HELIX chip)

Concept for strip disks

- Interesting solution for LAMBDA wheel at HERMES experiment
  - Concept:
    - ✓ Wire bonding (17 μm *Al*): sensor ↔ capton foil ↔ FEE
    - ✓ Carrier board (multi layer Kapton-Copper *OFHC*) for each sensor
    - ✓ Carrier boards connected to support (bars) to form a rigid structure
    - ✓ Connection of these (super-)modules to outer frame

Concept for strip disks

- Interesting solution for LAMBDA wheel at HERMES experiment
  - Illustration:



D.Heesbeen:
Quasi-real photo-production of hyperons on polarized $^{1,2}H$ targets,
Chapter 5: Lambda Wheels,
Dissertation, 2003;
Link:
***dissertations**.ub.rug.nl/FILES/faculties/science/2003/d.**heesbeen**/c5.pdf*

Figure 5.2: *Computer aided drawing of a* Lambda Wheels *silicon detector module.*

Concept for strip disks

- Interesting solution for LAMBDA wheel at HERMES experiment
  - Illustration:

D.Heesbeen:
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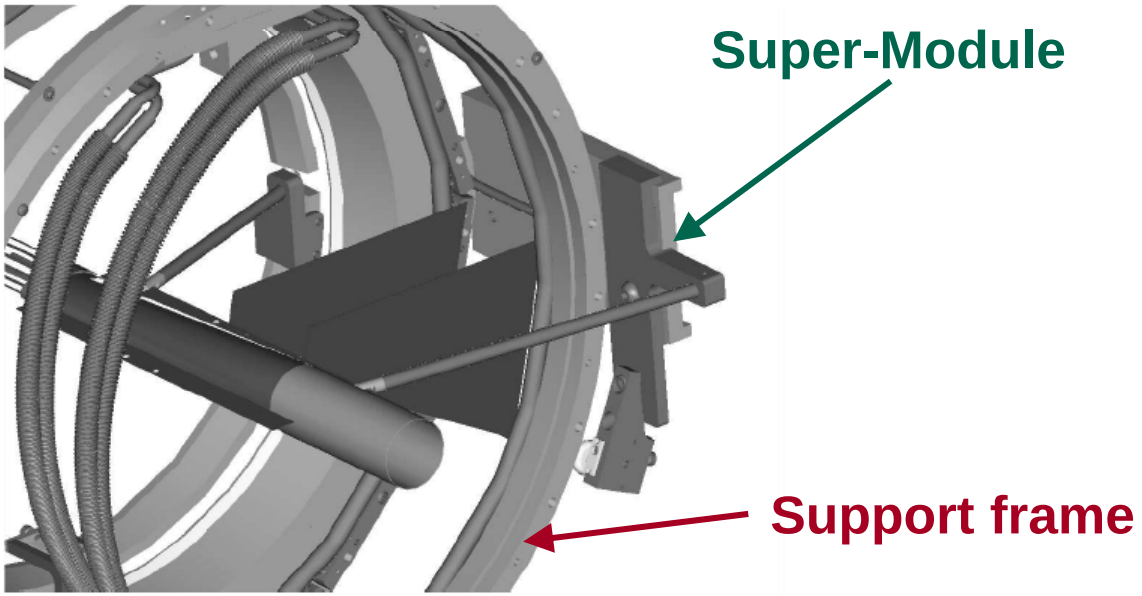


Figure 5.1: *Computer aided drawing of the frame of the* Lambda Wheels *with one module installed for ease of reference. The lepton beam enters the tapered wake field suppressor from the left.*

Concept for strip disks

- Adaptation of the HERMES concept for the strip disks of the MVD (incl. additional forward disks)

WHY?

- Similar conditions
  - ✓ R_{max} = 34 cm ↔ 28 cm (MVD)
  - ✓ Layer distance like for MVD
  - ✓ Sensor dimensions + pitch ~ ½ size for MVD
  - ✓ Same number of frontend chips
  - ✓ Comparable global support concept: frame
- Existing prototypes show feasibility of the concept!

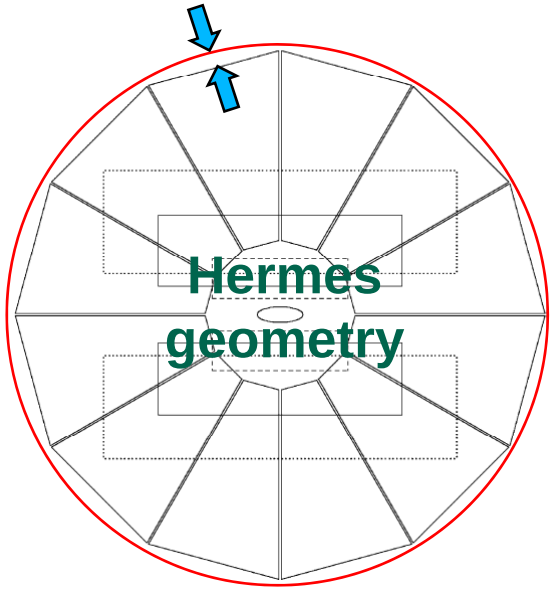
  Details:
  dissertations.ub.rug.nl/FILES/faculties/science/2003/d.heesbeen/c5.pdf

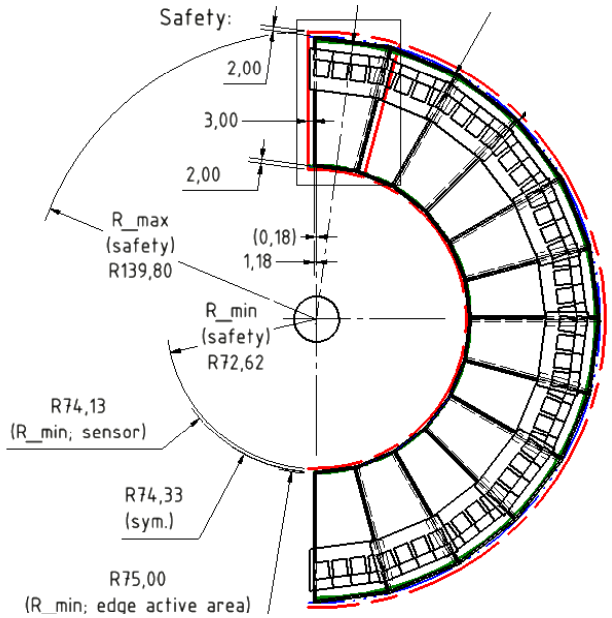
Concept for strip disks

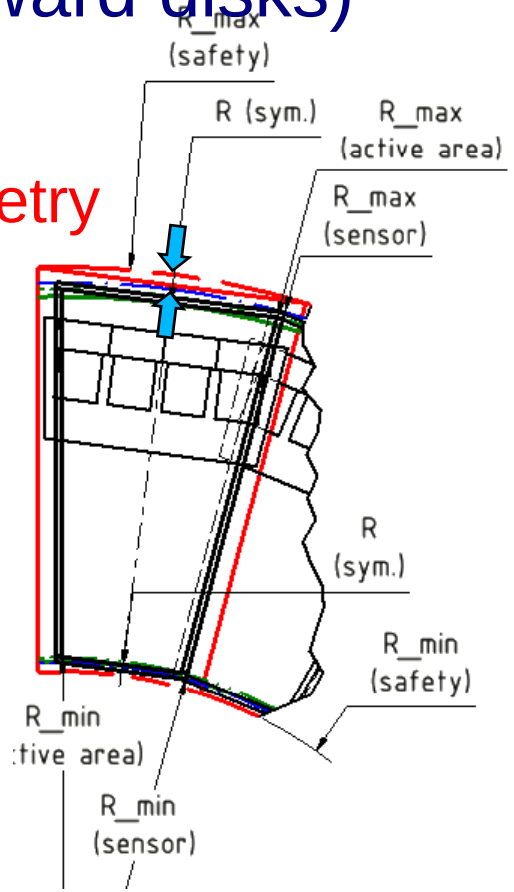
- Adaptation of the HERMES concept for the strip disks of the MVD (incl. additional forward disks)

What is different?

- Smaller margin to R_{max} → 24 fold geometry





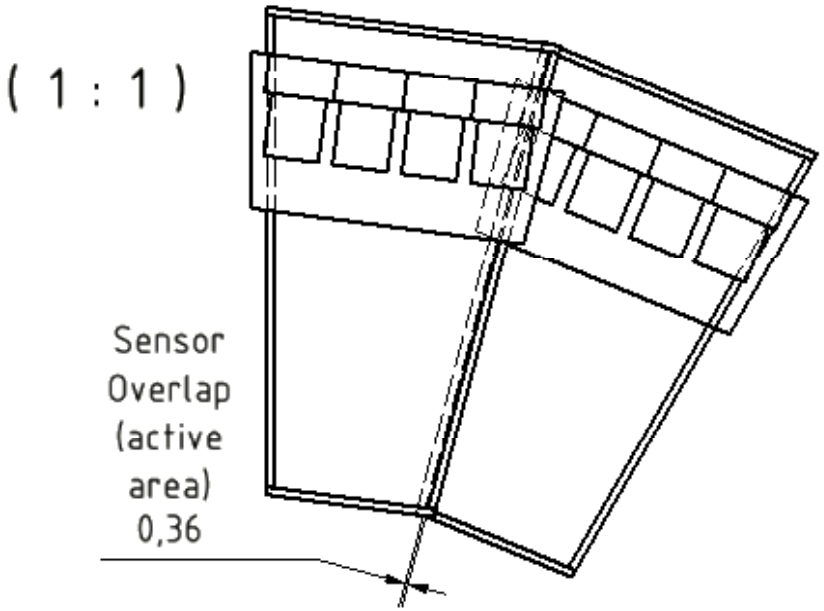


Concept for strip disks

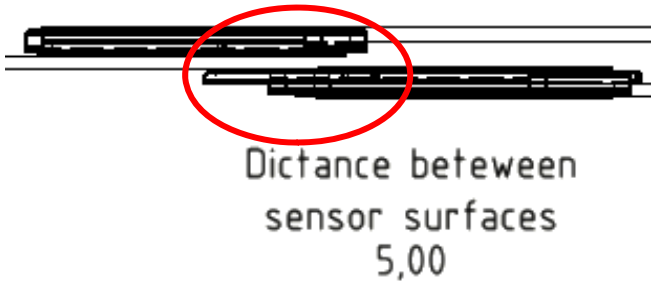
- Adaptation of the HERMES concept for the strip disks of the MVD (incl. additional forward disks)

What is different?

- Sensor overlap → Shift of subsequent sensor

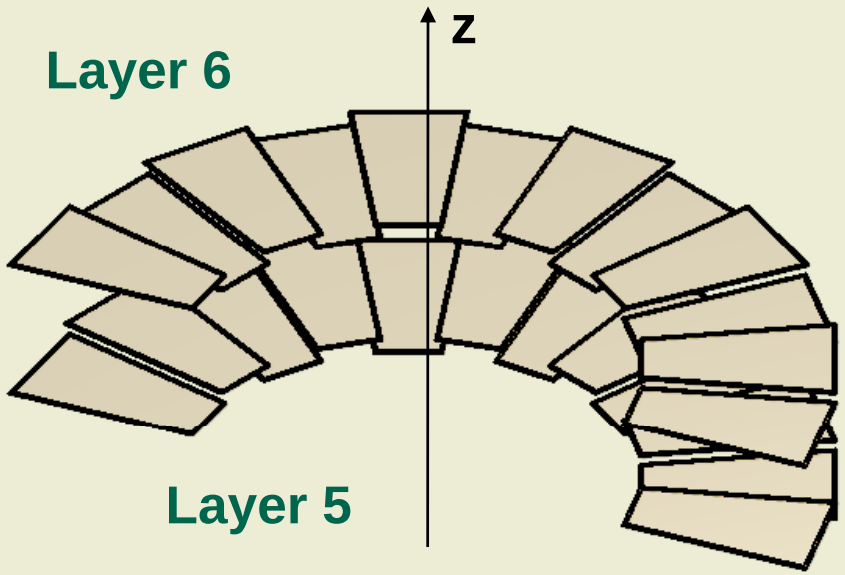


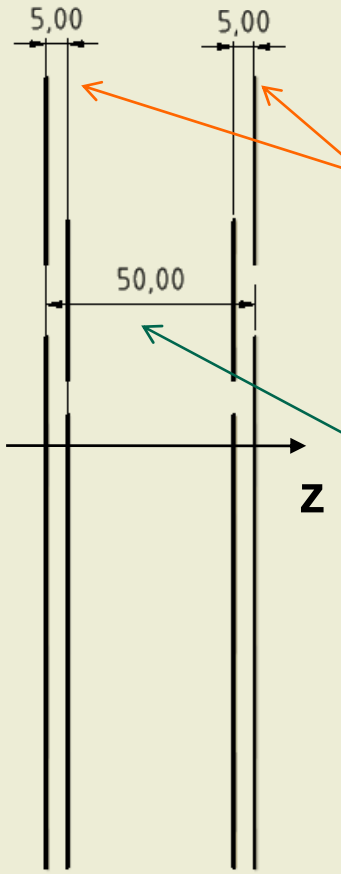
→ Two different z-position within one disk layer



Concept for strip disks

- Implementation of the new disk concept
  - General layout





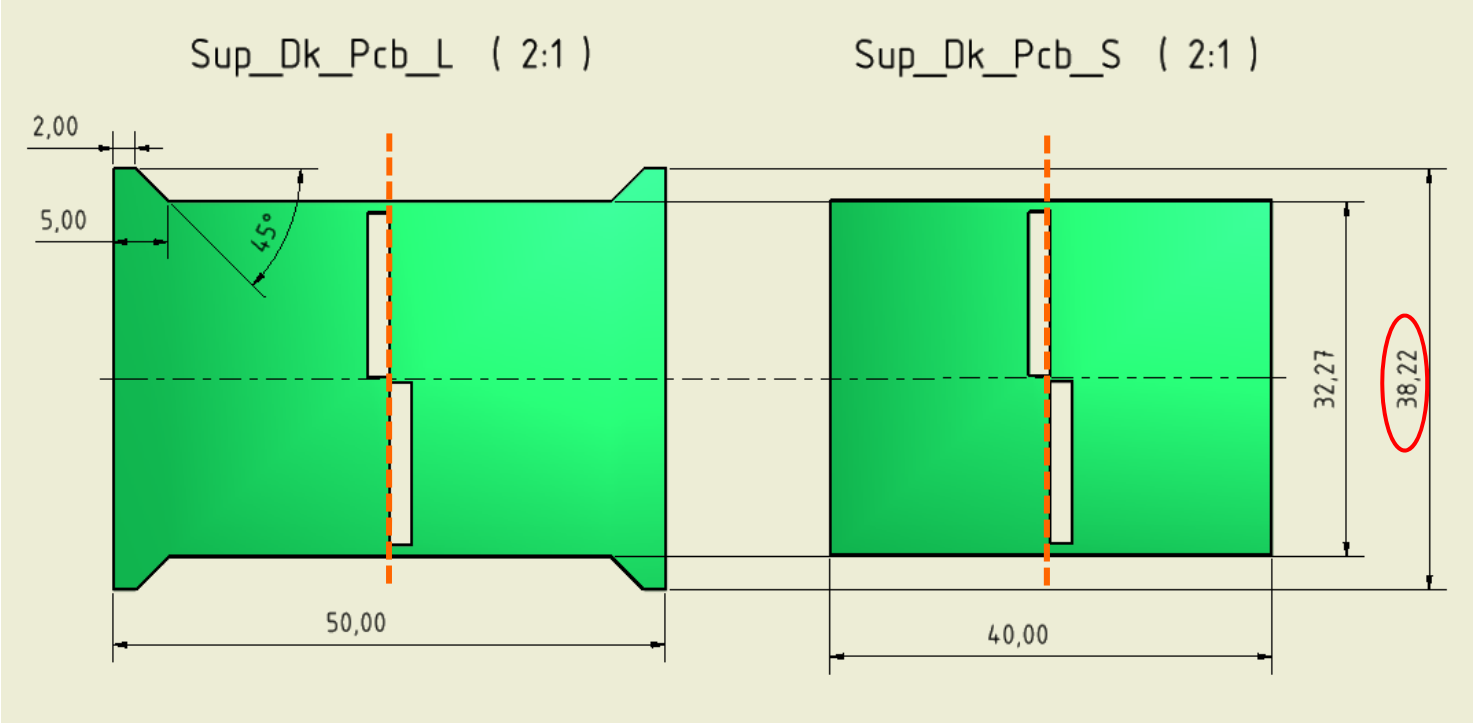
Distance: upstream sensor surface

Total width

Sensor stereo angle: 15 °

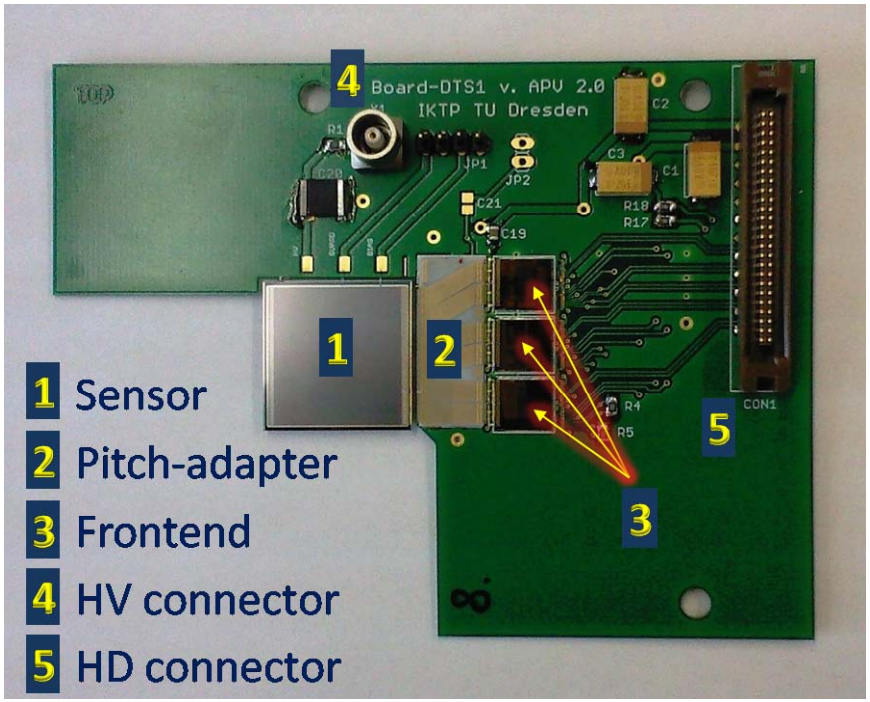
Concept for strip disks

- Implementation of the new disk concept
  - 2 carrier board with different shapes
    - ✓ Complete readout for both sensors
    - ✓ *Later: Modifications for 1 carrier board / sensor possible*



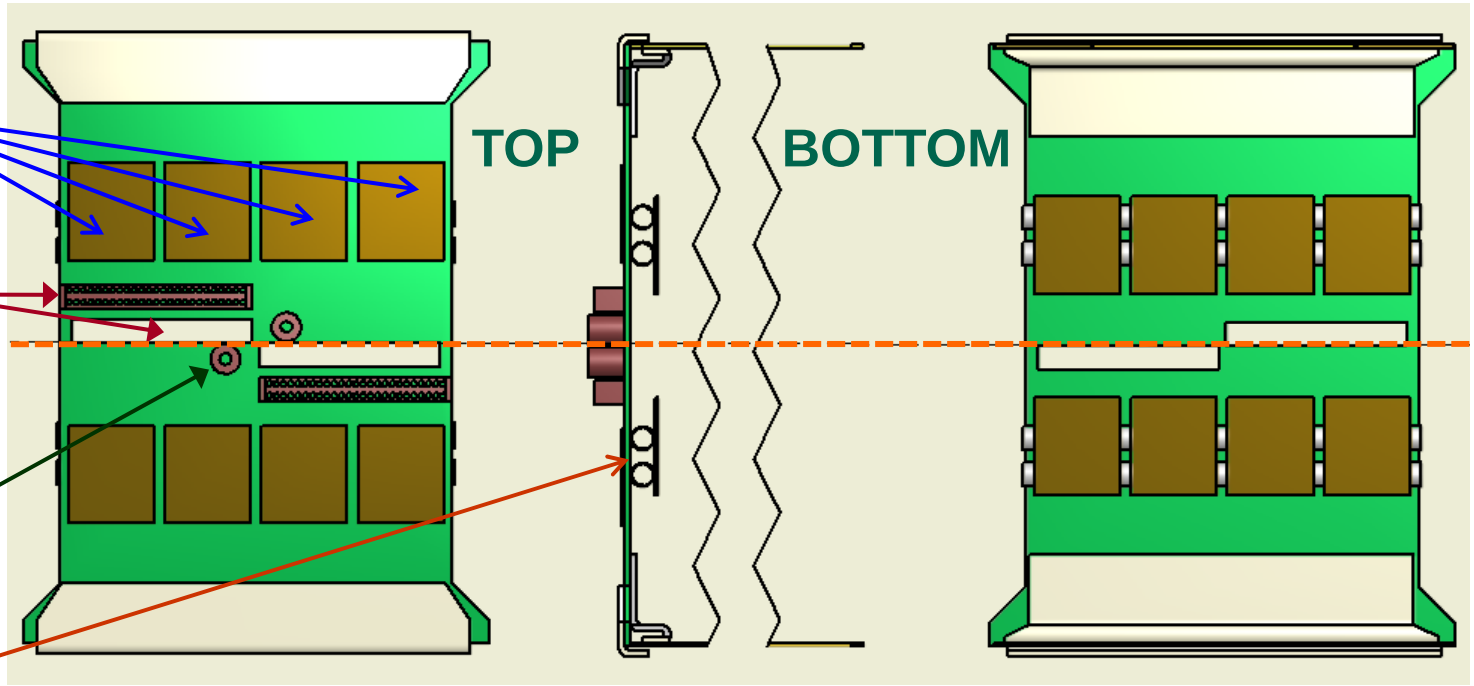
Concept for strip disks

- Implementation of the new disk concept
  - Equipped carrier boards
    - ✓ Master prototype: DTS L-board



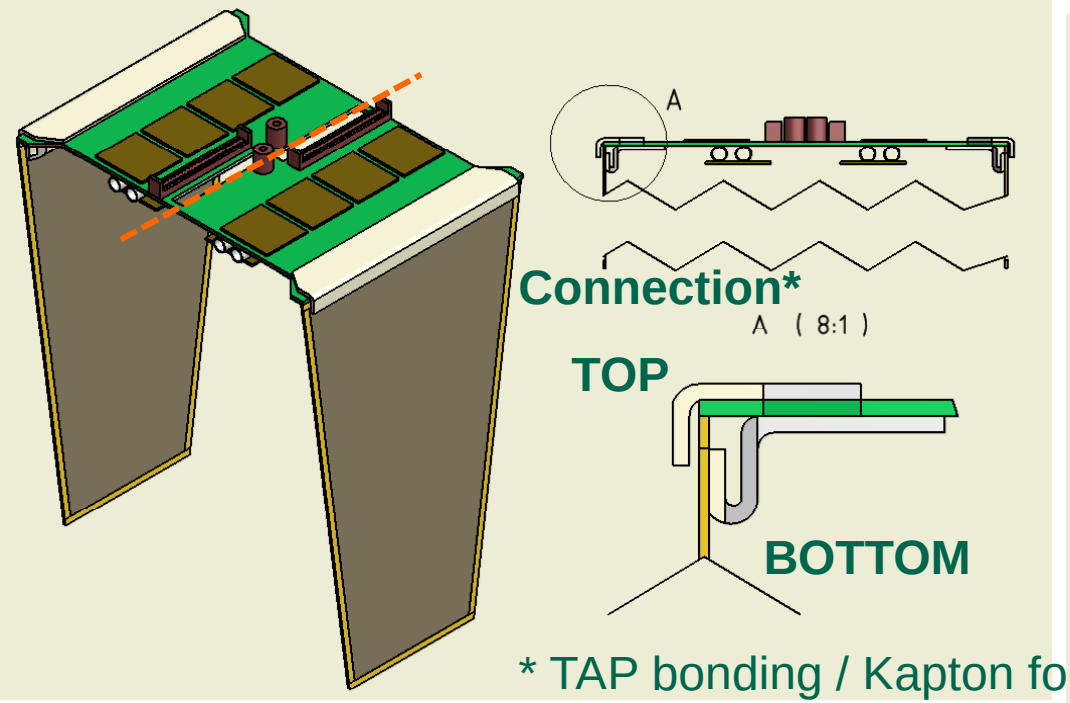
Concept for strip disks

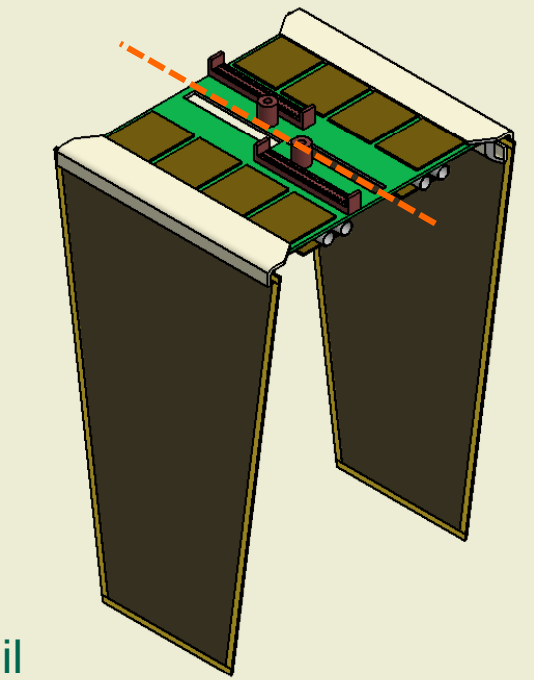
- Implementation of the new disk concept
  - Equipped carrier boards
    - ✓ Complete readout for both sensors
    - ✓ *Later: Modifications for 1 carrier board / sensor possible*



Concept for strip disks

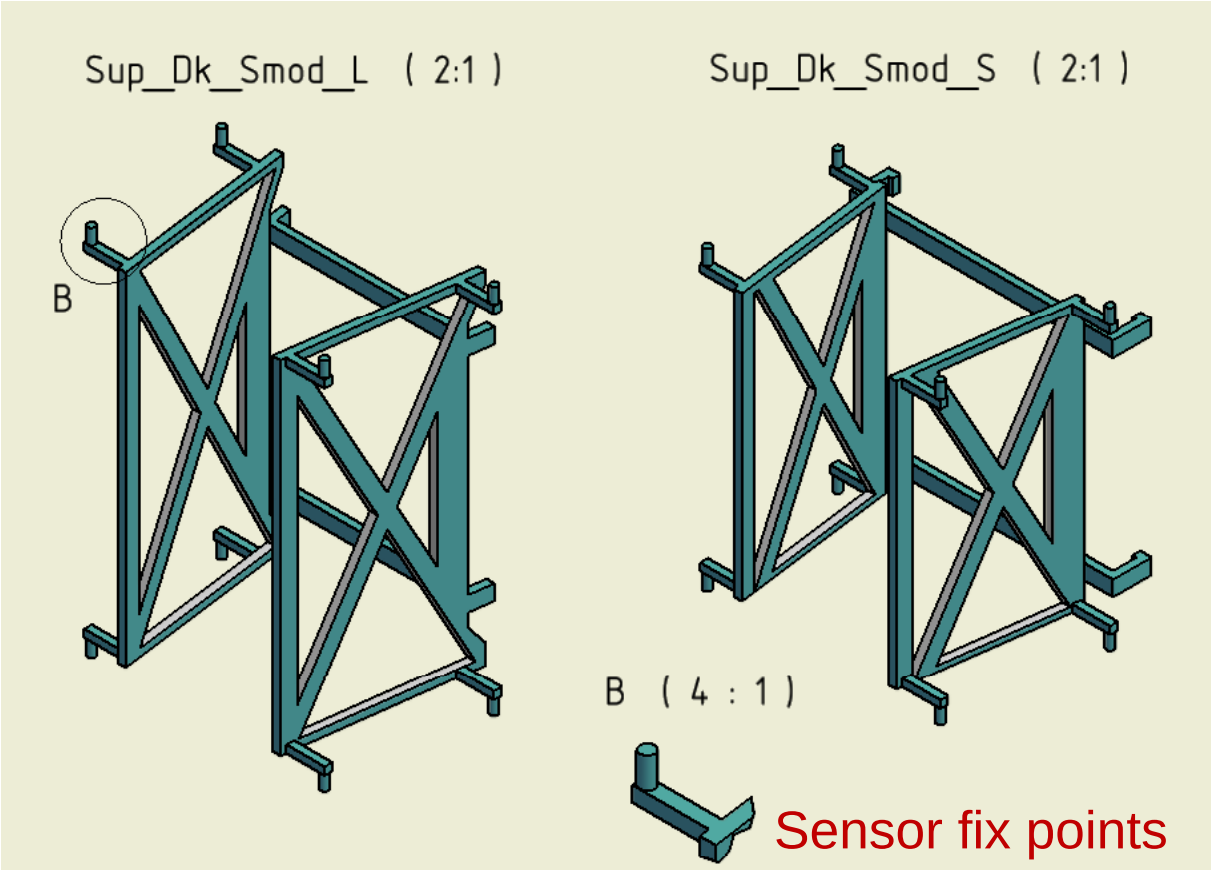
- Implementation of the new disk concept
  - Module: Equipped carrier boards + connected sensors
    - ✓ Complete readout for both sensors
    - ✓ *Later: Modifications for 1 carrier board / sensor possible*





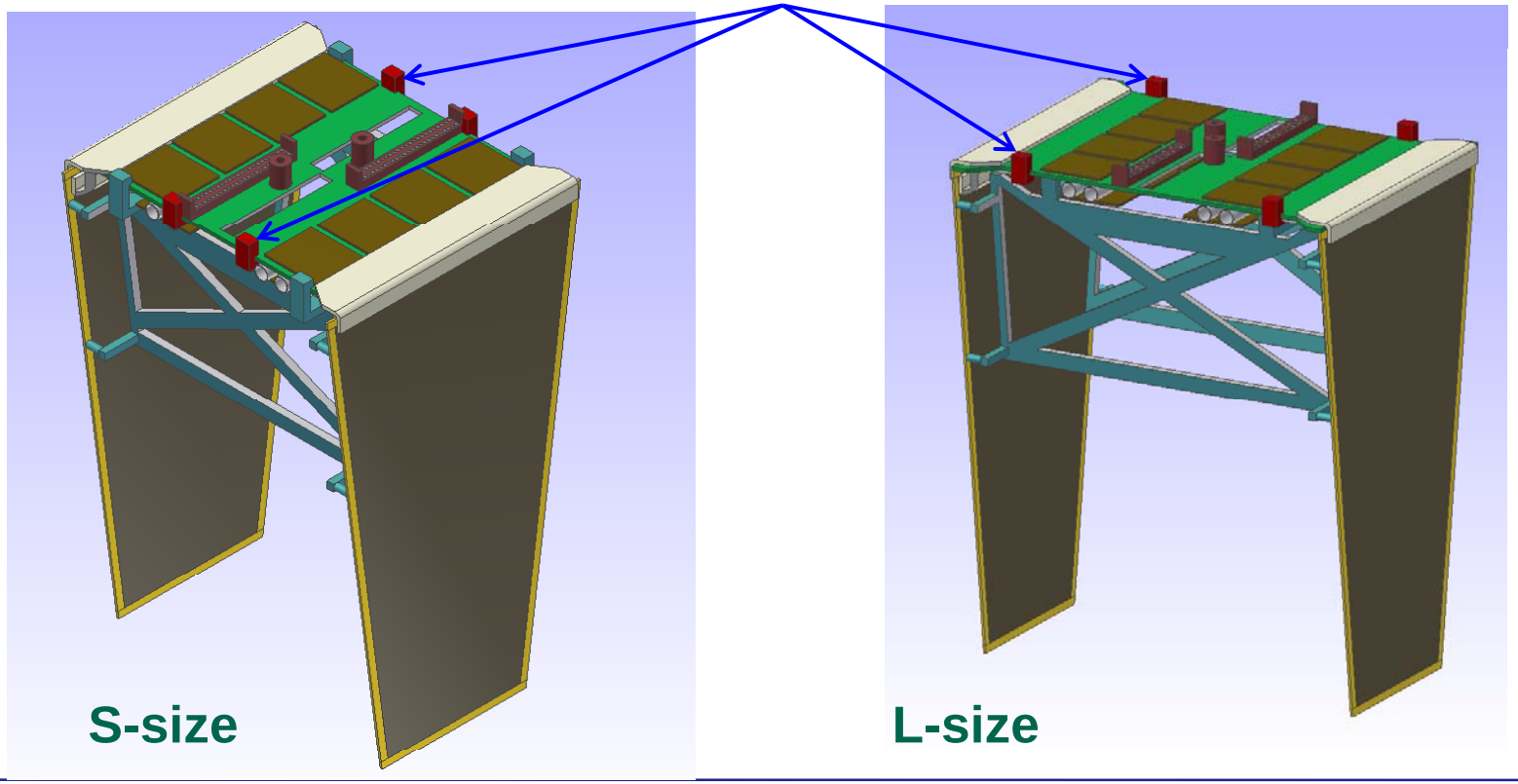
Concept for strip disks

- Implementation of the new disk concept
  - Support structure



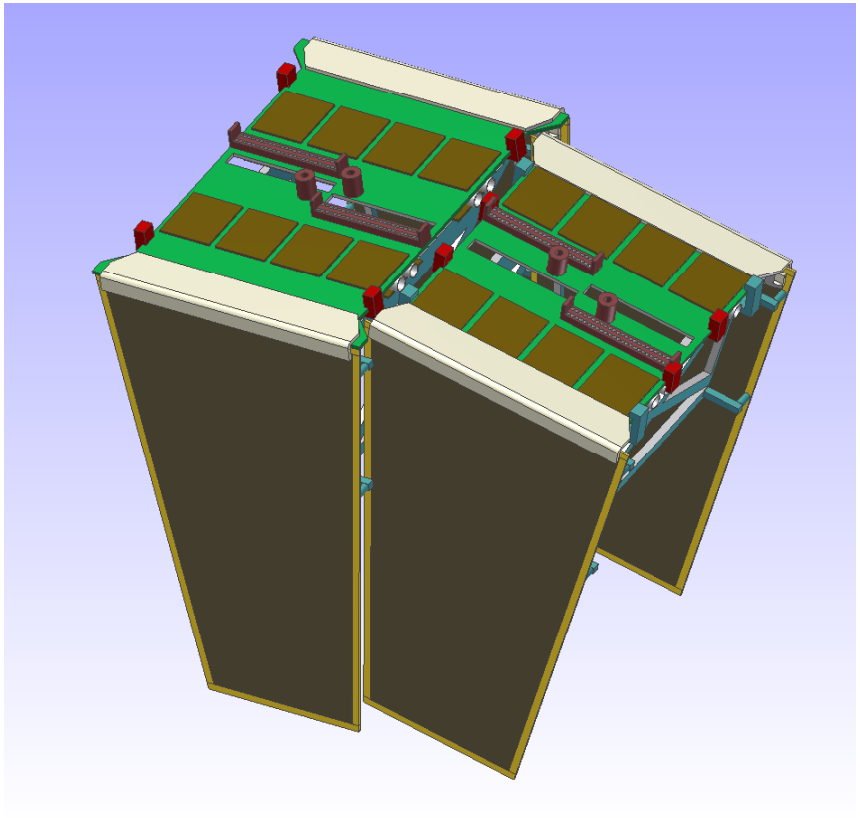
Concept for strip disks

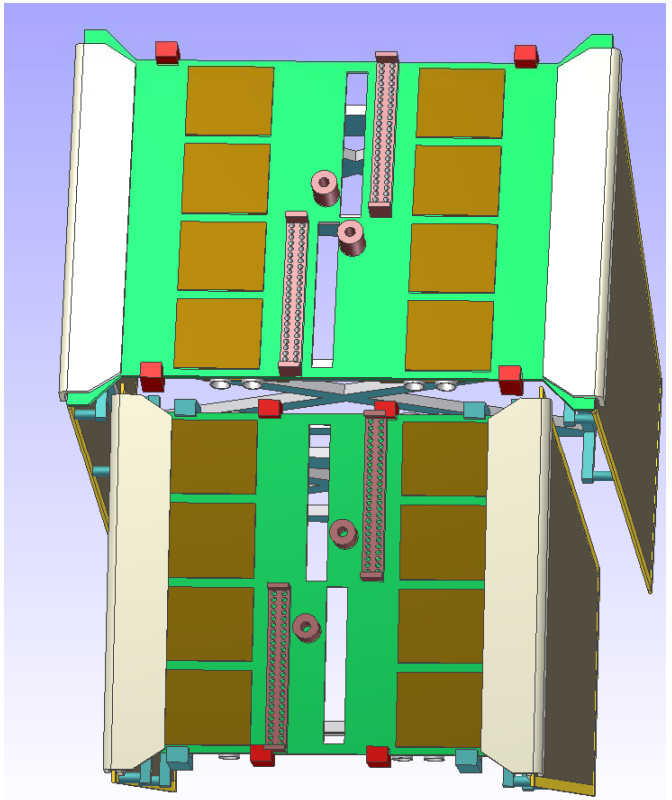
- Implementation of the new disk concept
  - Super-modules: Modules + support
    + connection to global support



Concept for strip disks

- Implementation of the new disk concept
  - Super-modules

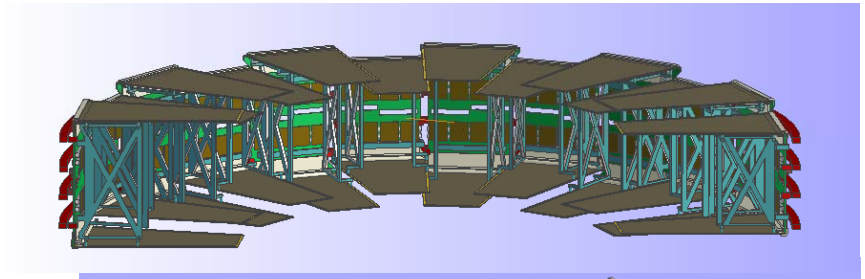


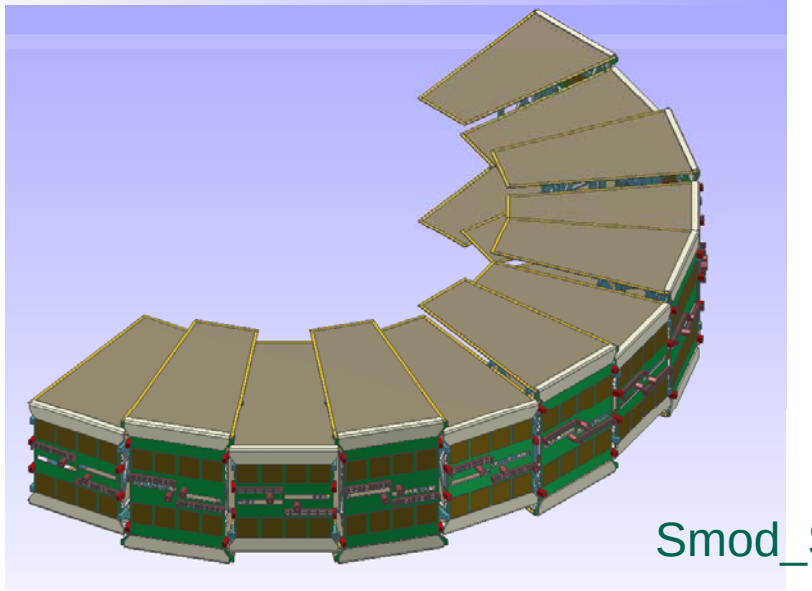


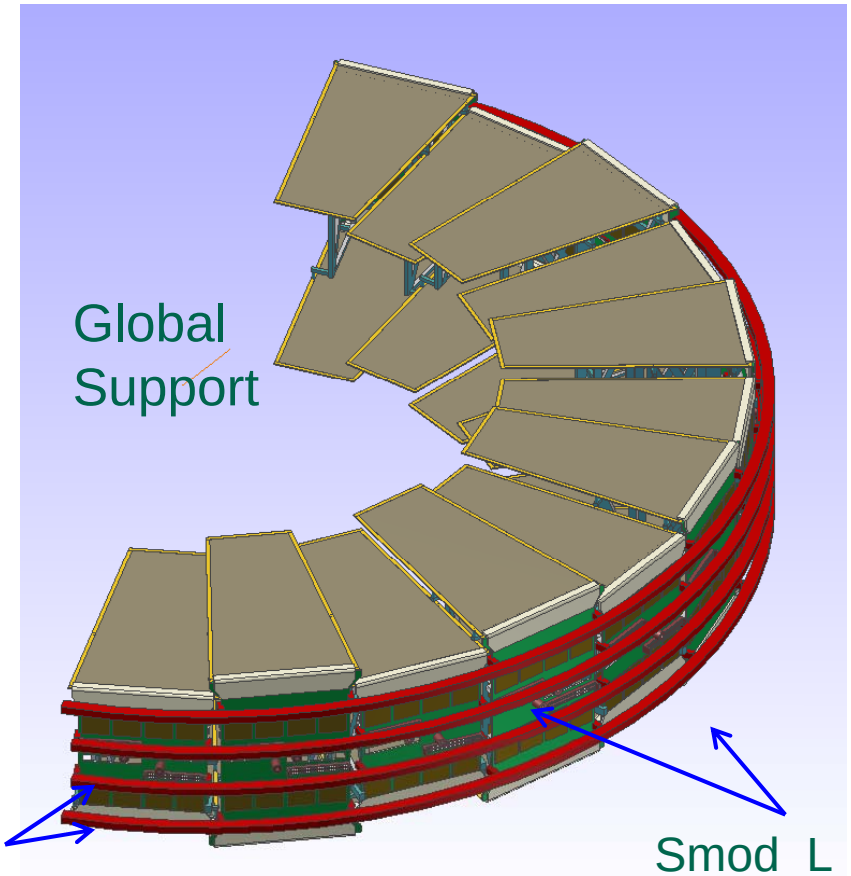
Concept for strip disks

- Implementation of the new disk concept

Disk layer / Forward part

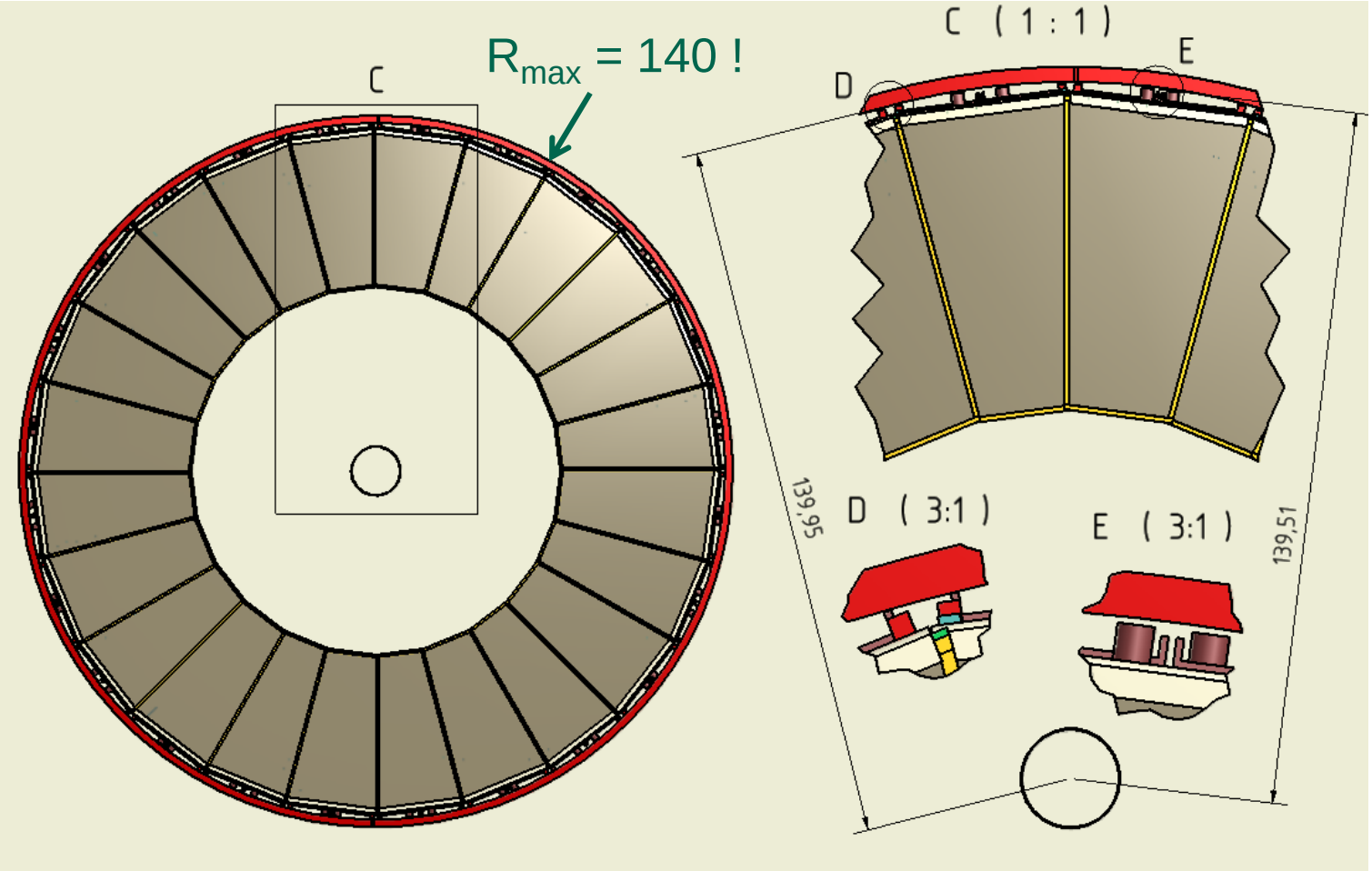






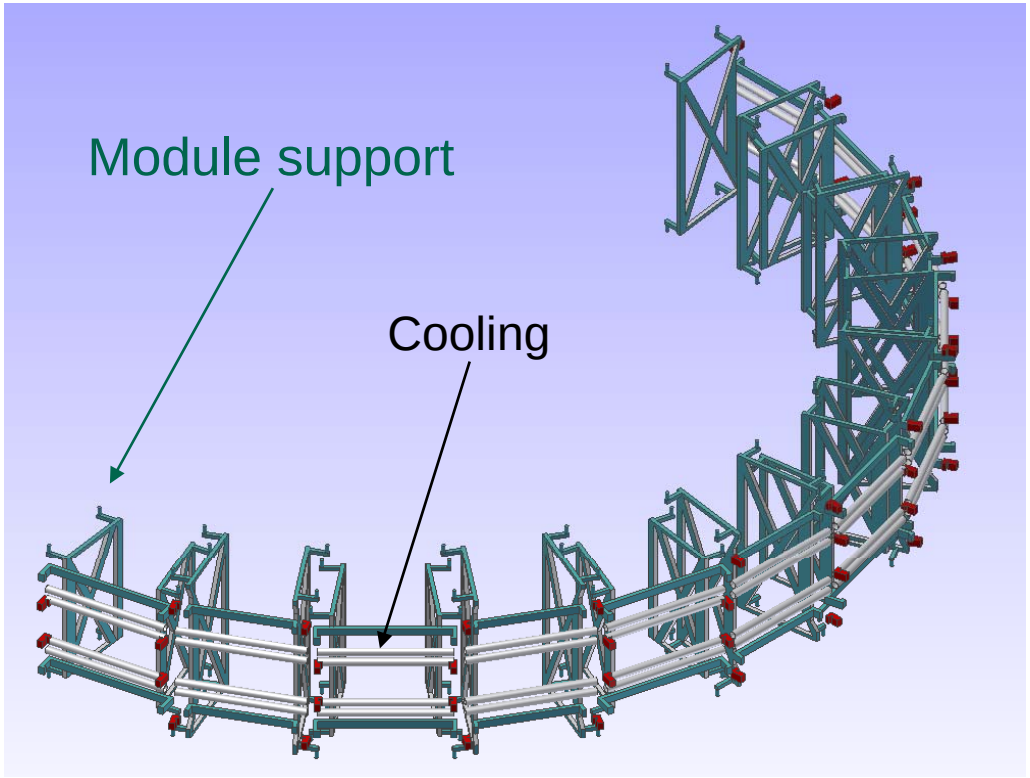
Concept for strip disks

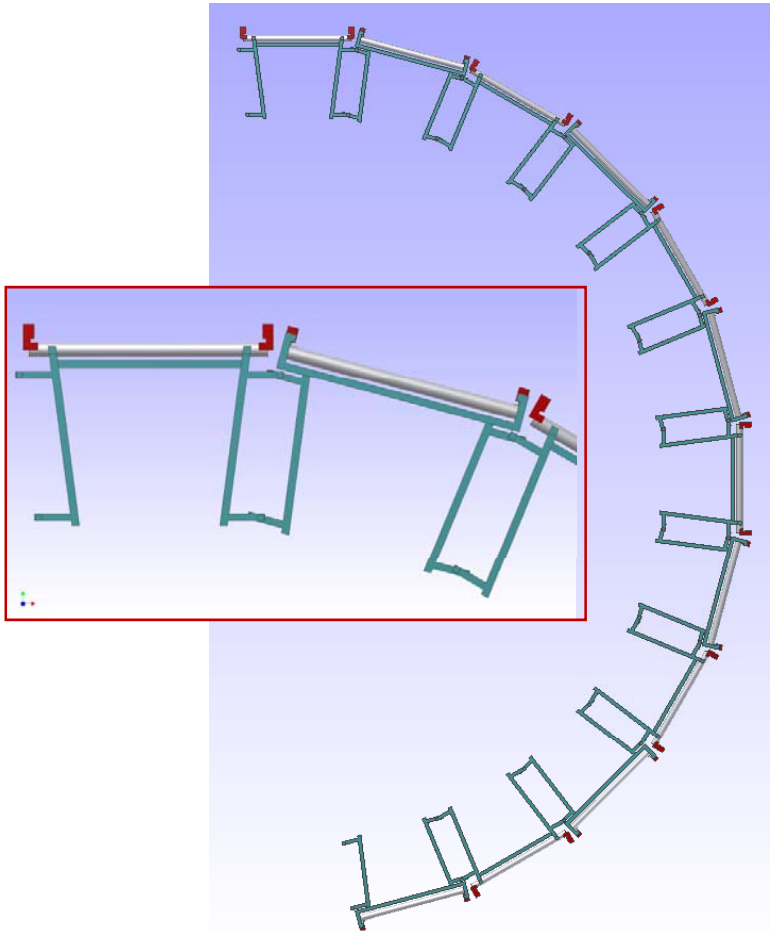
- New disk concept: Boundary conditions fulfilled



Concept for strip disks

- New disk concept: Cooling + support

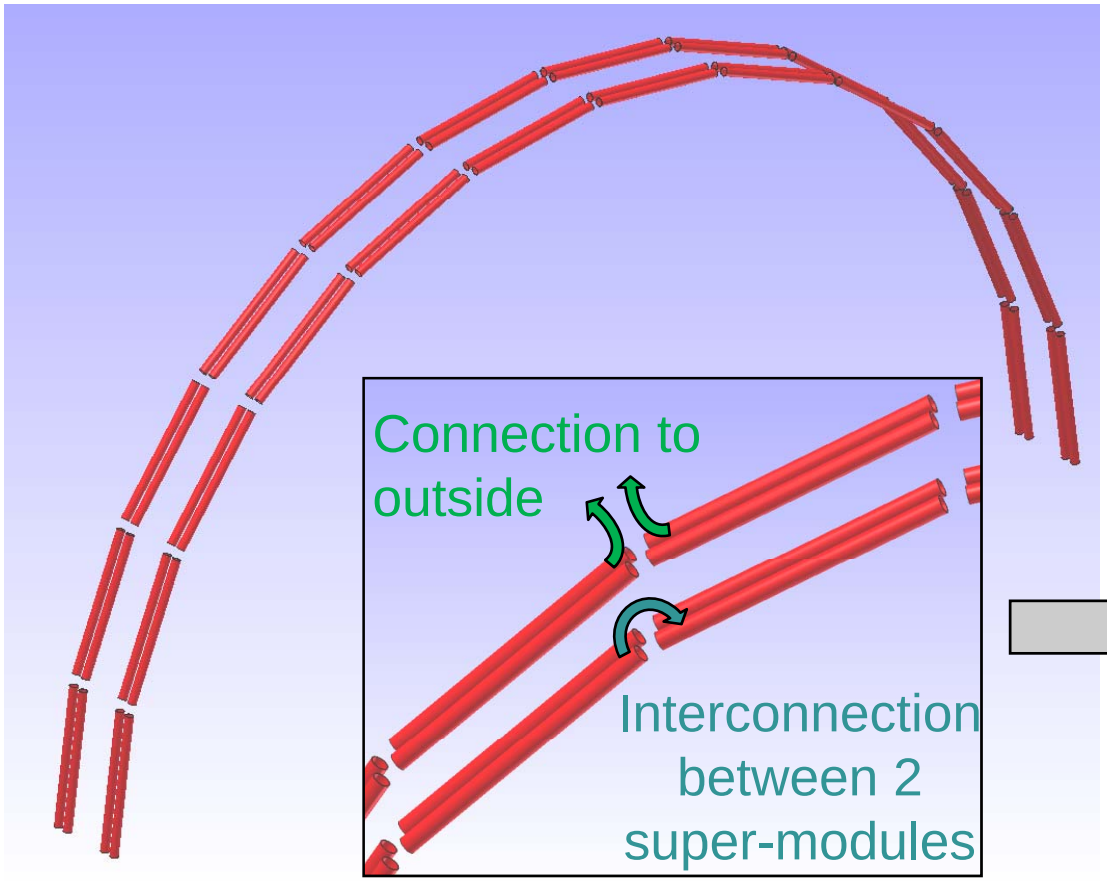




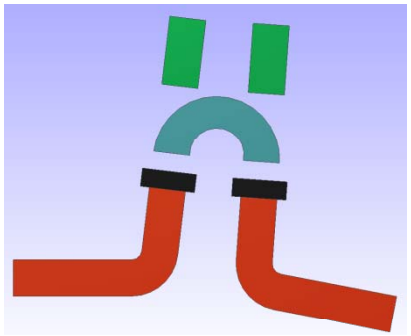
Connection to global support

Concept for strip disks

- New disk concept: Cooling



Concept:
Adapter at the end
enabling both configurations



Summary and open items

Summary

- **Introduction of regularly MVD mechanics meetings**
  - In-person meetings of at least 2 days
  - Very efficient and very important for coordination at the current stage of development
- **Main topics at last meeting**
  - Pixel disks occupancy
  - Strip barrel design details and new strip disk concept
  - Cooling and integration items
  - Coordination of next steps
  - Open questions and to whom to address
- **Next meeting foreseen in Torino, April 2009**

Open items

- **Beam target geometry** …more details in Mechanics session…
  - Axial position and aperture angle of cone (upstream)
    - Maximal angle < 21°
  - Target pipe diameter
    - Clear definition inner / outer radius
  - Changes of section in the target pipe
  - Upstream flange in front of CF
    - Axial position and size

... Meeting (at least 2 day workshop) with beam-target group and other groups involved **urgently needed** ...

Open items

- **Cabling**
  - ✓ More details on numbers and spatial occupancy
- **Cooling**
  - ✓ Water cooling sufficient everywhere, especially for pixel part?
    - → Best material for thin pipes is dependent on coolant!
  - ✓ What about sensor properties when working around 30°C?
  - ✓ Machining of thin pipes (∅ 2 mm):
    - – Transforming a round shape to an elliptical one
    - – Feasibility of bending → bending radius
- **Pixel super-modules**
  - ✓ Module sizes proposed in CAD models achievable?