Collaboration Meeting
Mechanics session
GSI, March 8, 2010

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Implementation of a dedicated geometry for the inner tracker (MVD)

HISKP universitätbonn

General comments

- New versions implemented in simulation framework
  - Rapid progress of mechanics development *
    → Geometry based on all recent updates
    → Overall support concept: Input of 1st prototypes
  - Dedicated routing concept (z = 0.4 m ... – 1m) included
    → Scaling with number of channels
    → Based on specifications of actual electronics and detector development **
  - Implementation of additional components */**
  - Additional Silicon forward disks included in full version:
    → Geometry optimized for the MVD part
    → Additional disks represent conceptual design only

General comments

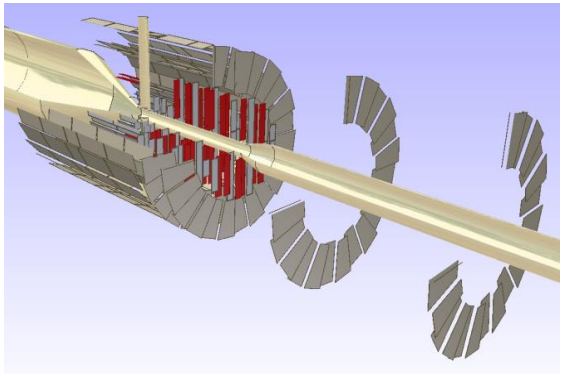
- Implementation
  - Complete, detailed CAD model
  - CAD converter: STEP file → ROOT geometry
  - Material definition of all components
- Extensive collision checks
  - CAD / PANDA root
- Simulation
  - Mapping of overall material budget
  - Study of influence of different components and layers

Main versions available

- **Mvd-2.1_AddDisks_FullVersion**
  - Full version of extended inner tracker: MVD + Additional disks
- **Mvd-2.1_FullVersion**
  - Full version of MVD

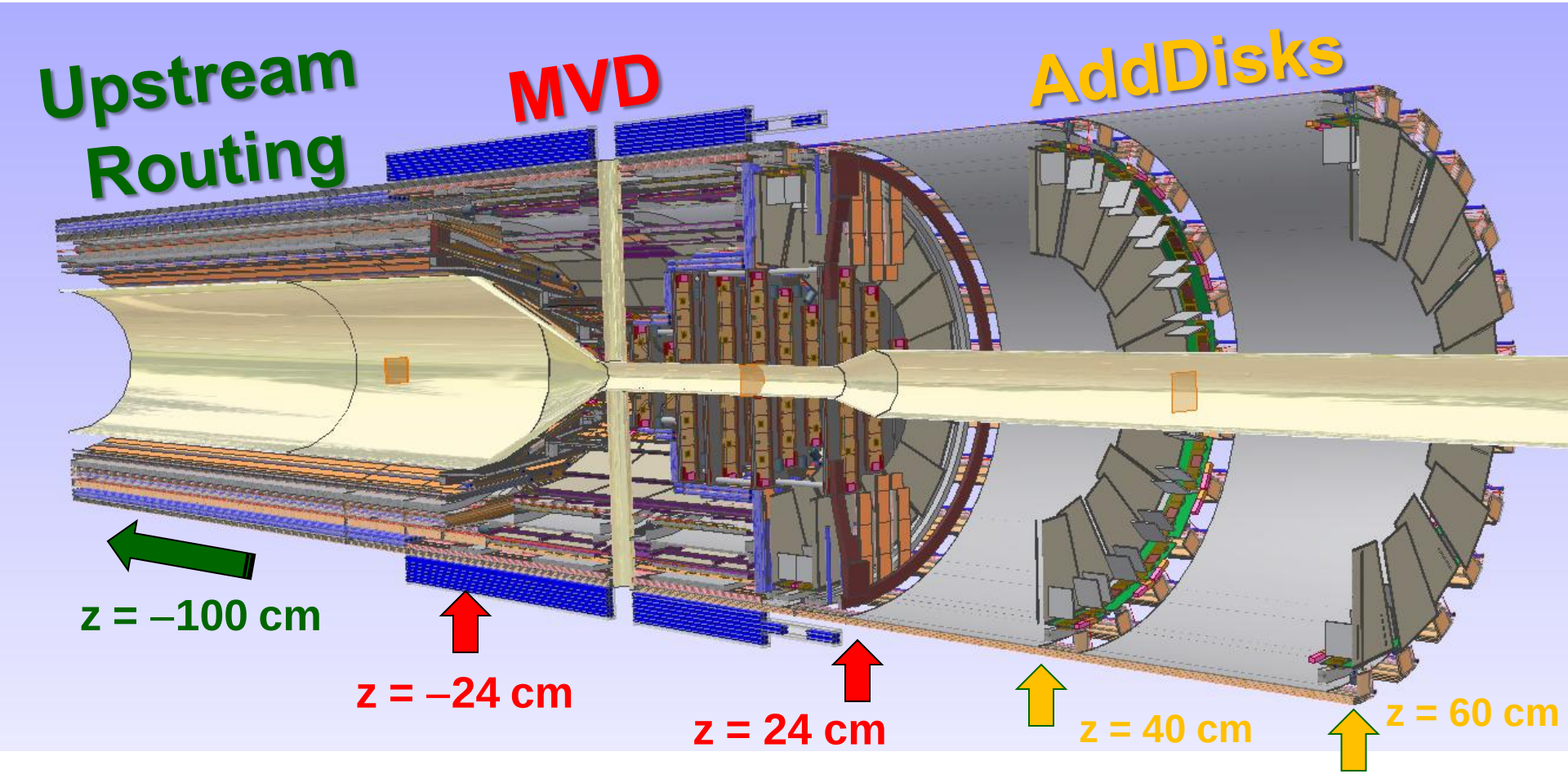
# of volumes: 70.458
# of different volume types: 597

- **Mvd-2.1_AddDisks_Sensitive**
  - MVD + Additional disks: Active detector volumes only
- **Mvd-2.1_Sensitive**
  - Active MVD detector volumes only



Main versions available

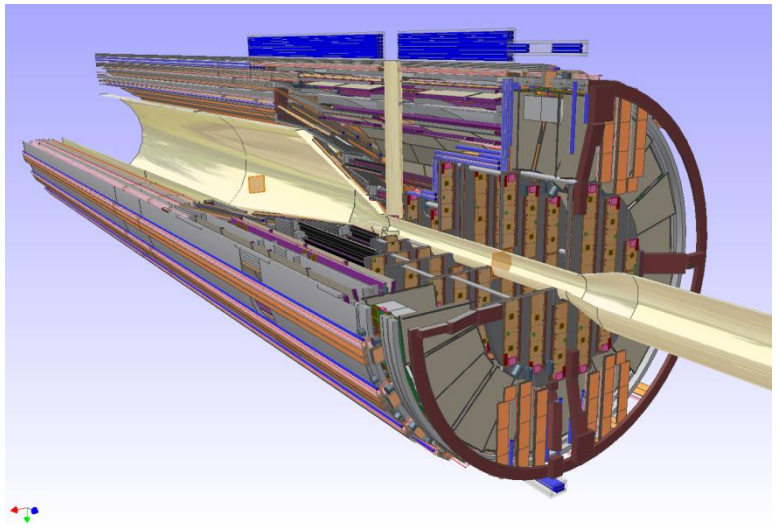
- Illustration of MVD and additional forward disks



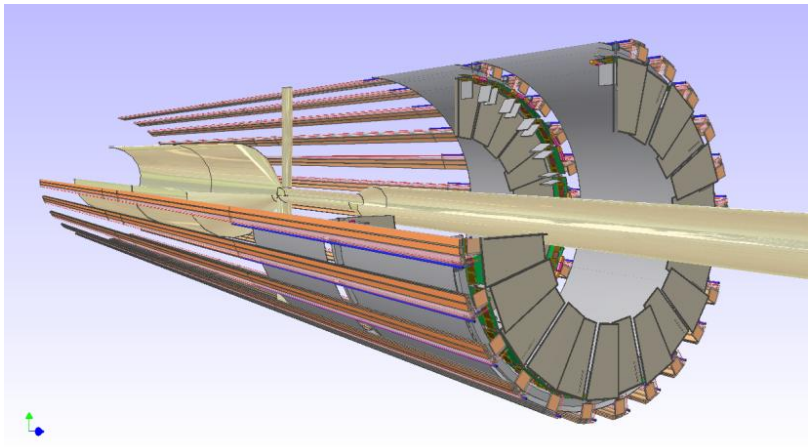
Main structure

Mvd-2.1_AddDisks_FullVersion

Mvd-2.1 (*Full version*)



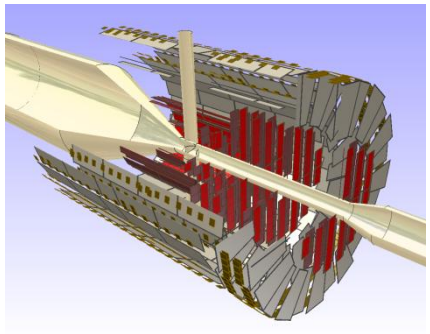
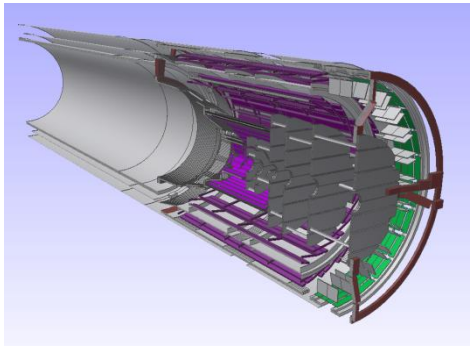
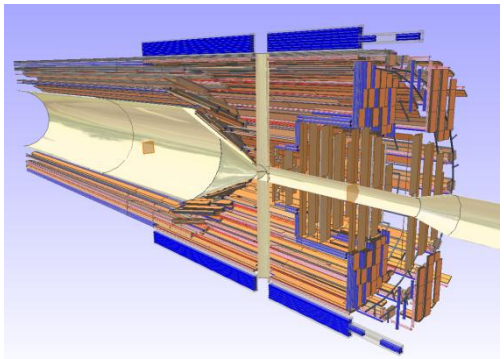
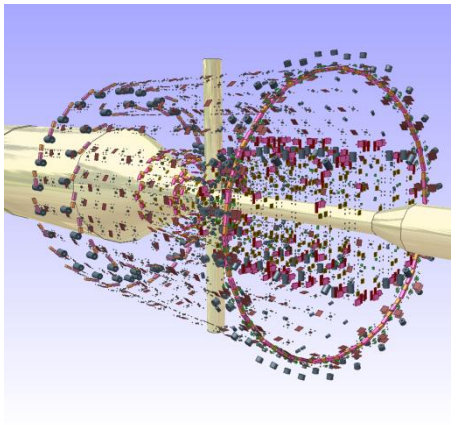
AddDisks (*Full version*)



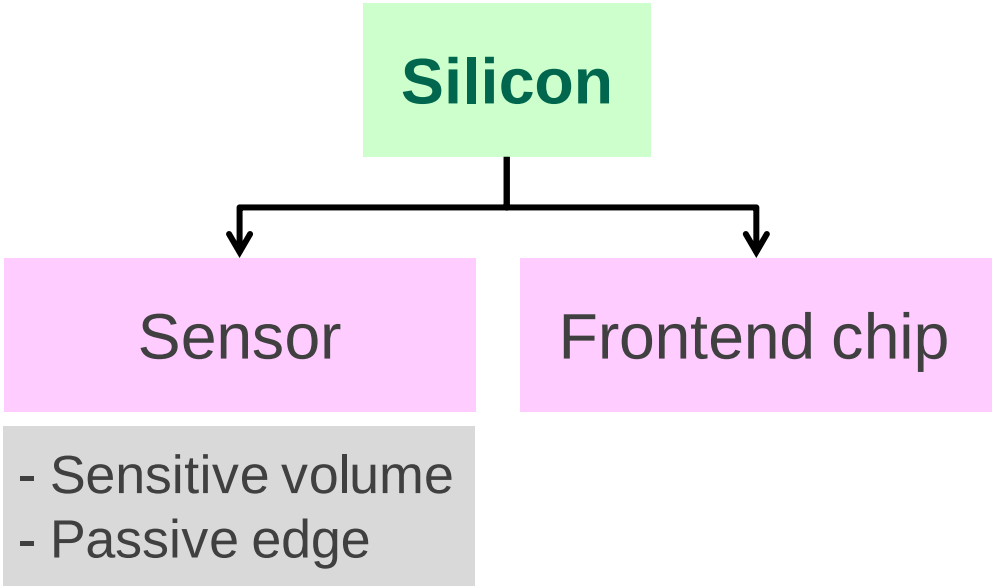
Main structure

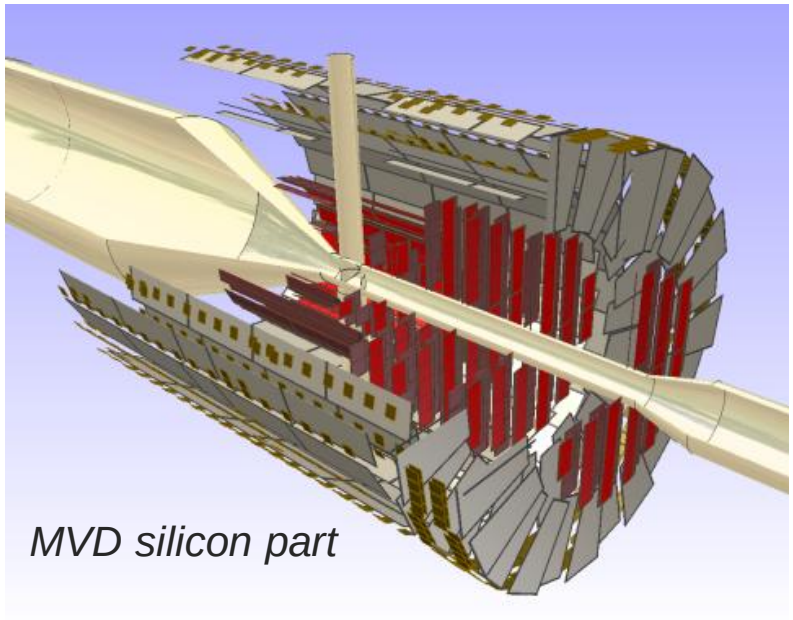
Mvd-2.1 / AddDisks (*Full version*)

- **Silicon**
- **Support**
- **Routing**
- **Components**

Structure of main parts





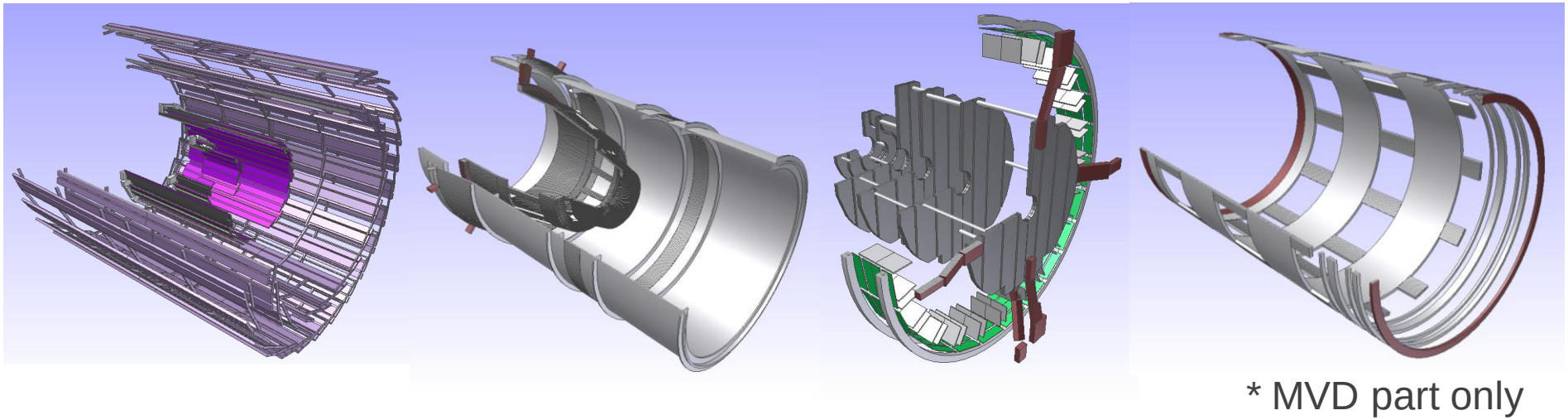
MVD silicon part

- Defined material: Silicon
- Substructure (MVD): Half-shells including barrel layer,
  Forward part including half-disks
- Design optimized for MVD part
  → Number of frontends defined by pixel cell size + strip pitch

Structure of main parts

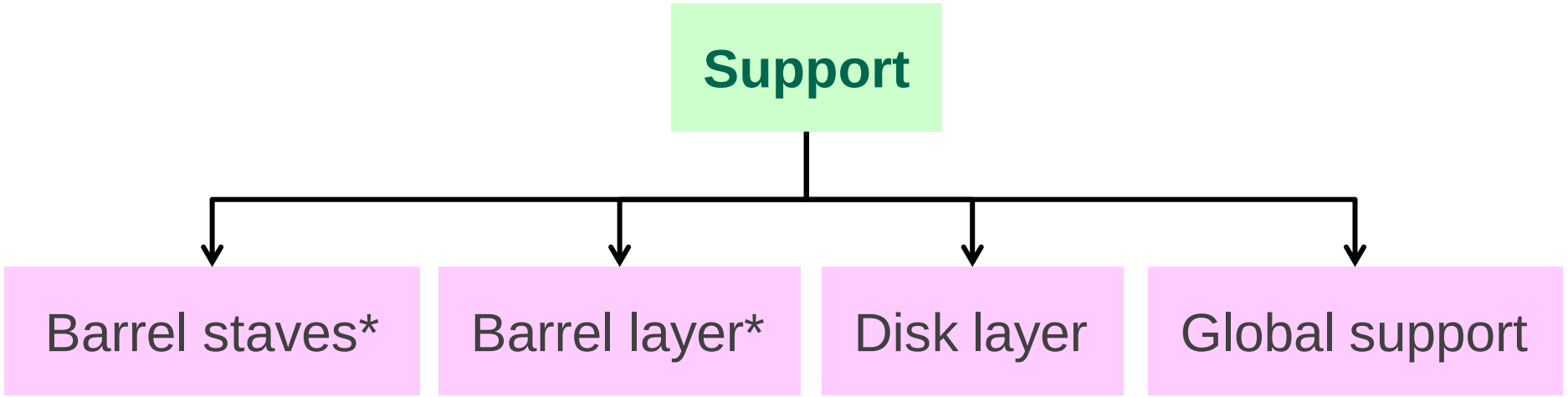
Support

- Barrel staves*
- Barrel layer*
- Disk layer
- Global support



* MVD part only

Structure of main parts

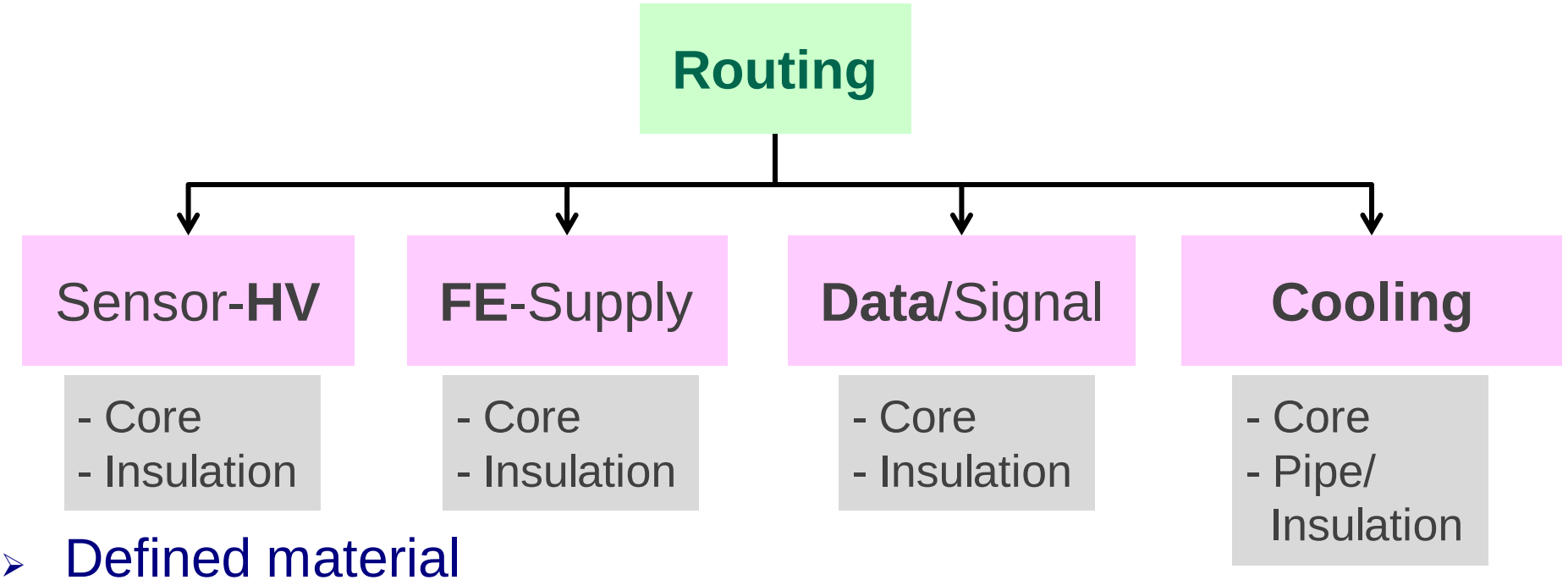


- MVD frame
- Routing AddDisks*
- Upstream routing*

**schematic*

- Defined material: Carbon foam, Carbon, Different “light carbon” materials
- Implementation of detailed mechanical model
  - ✓ Cones: Segmented
  - ✓ Complex structures: Simplified

Structure of main parts



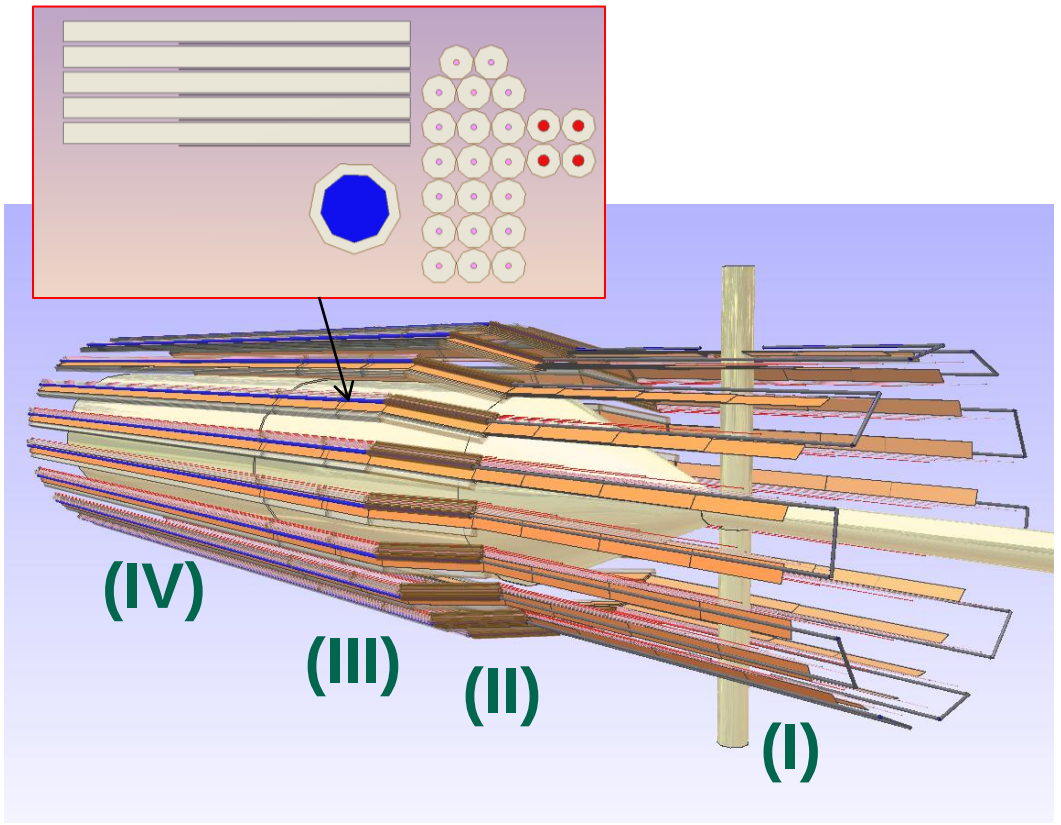
- Defined material
  - ✓ Core: Aluminium (HV, Data) / Copper (FE) / Water (Cooling)
  - ✓ Insulation: PVC / Pipe (Cooling): Steel
- Substructure (MVD): Single barrel layer, Pixel disks, Strip disks

Structure of main parts

- Implementation:
  "Packets" for individual super-modules
- Routing regions:
  (I) Within active region (super-module)
  (II) Within MVD volume (MVD global frame)
  (III) Until z = –30 cm (End of central frame)
  (IV) Until z = –100 cm (End of EMC BW EC)

Routing

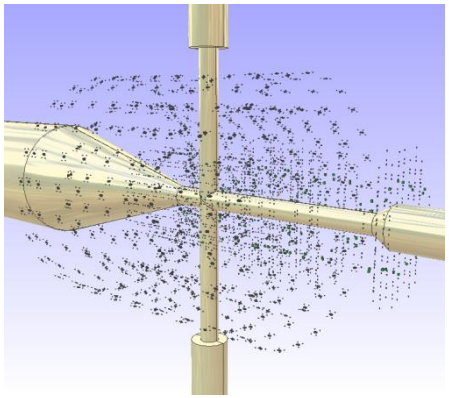
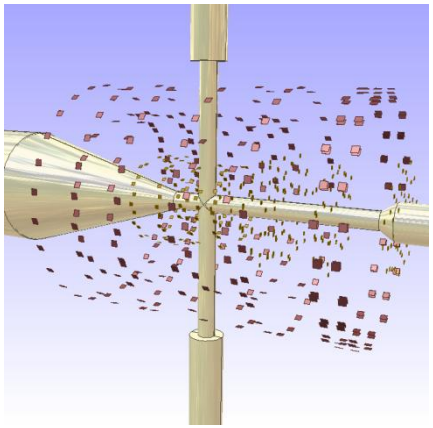
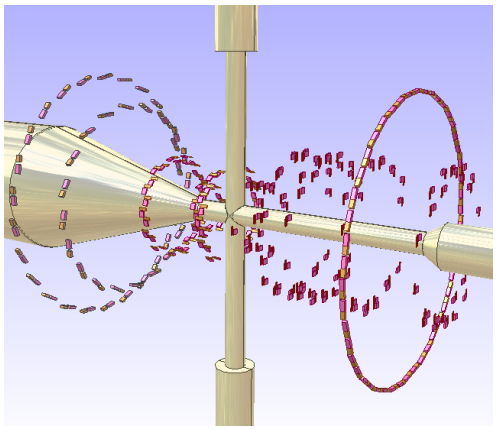
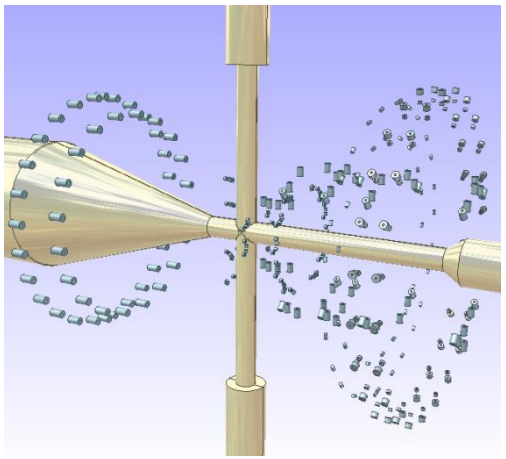
Example: Barrel 3



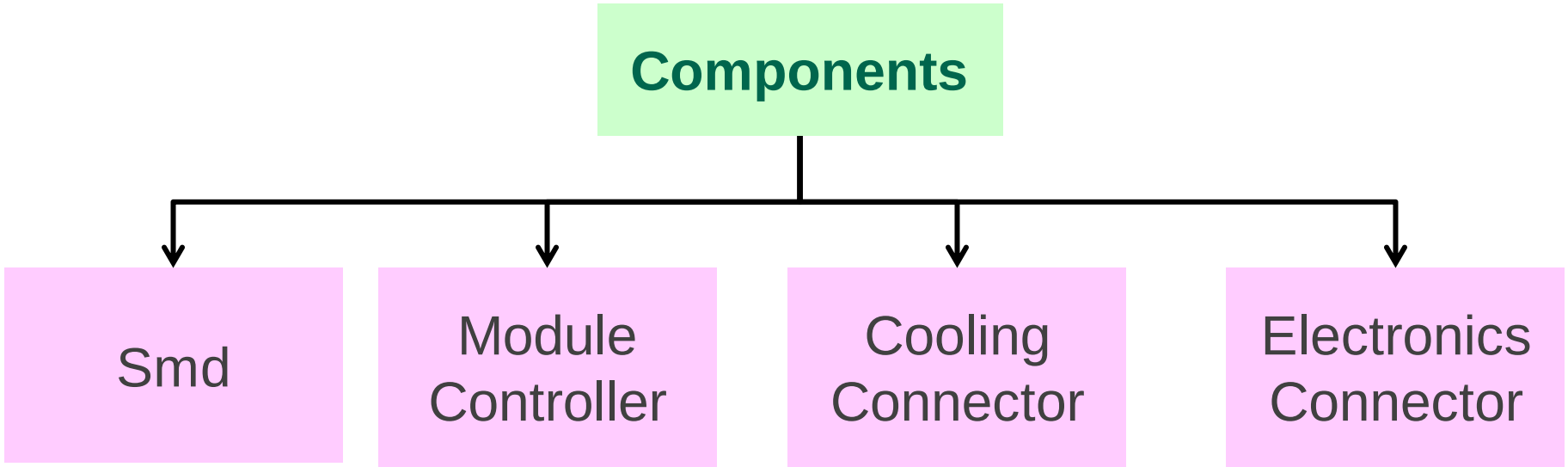
Structure of main parts

Components

- Smd
- Module Controller
- Cooling Connector
- Electronics Connector

Structure of main parts



- Defined material

  Cooling connector: PVC / Module controller: Silicon

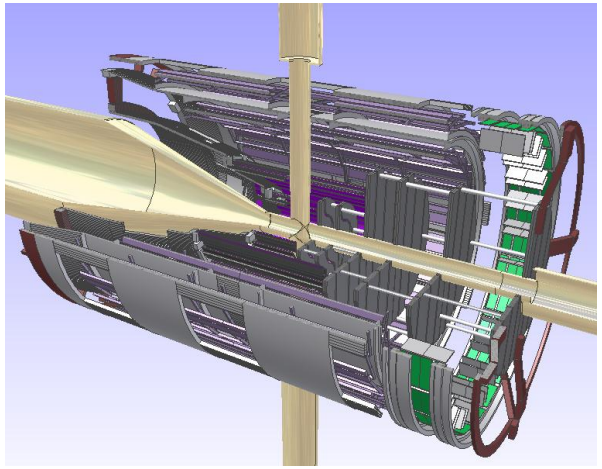
  Smd: “Light” aluminium (reduced density) /

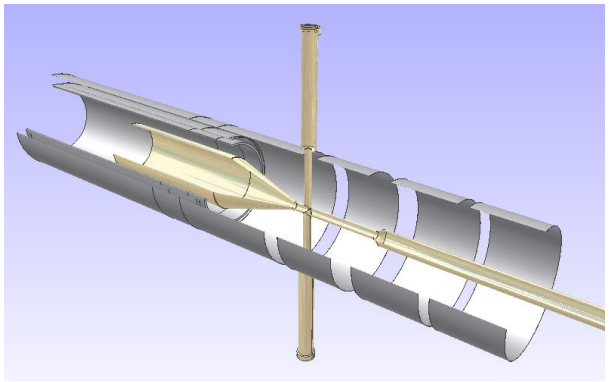
  Electronics connectors: “Heavy” PVC (increased density)
- Simplified, more schematic implementation

Mechanics aspects

Support concept

- Detailed implementation for MVD
  - ✓ Global MVD (half-)frame(s) attached to central frame
  - ✓ Different MVD parts attached to global MVD frame
- Schematic support layers (no detailed solution so far):
  - ✓ Upstream routing
  - ✓ Additional forward disks

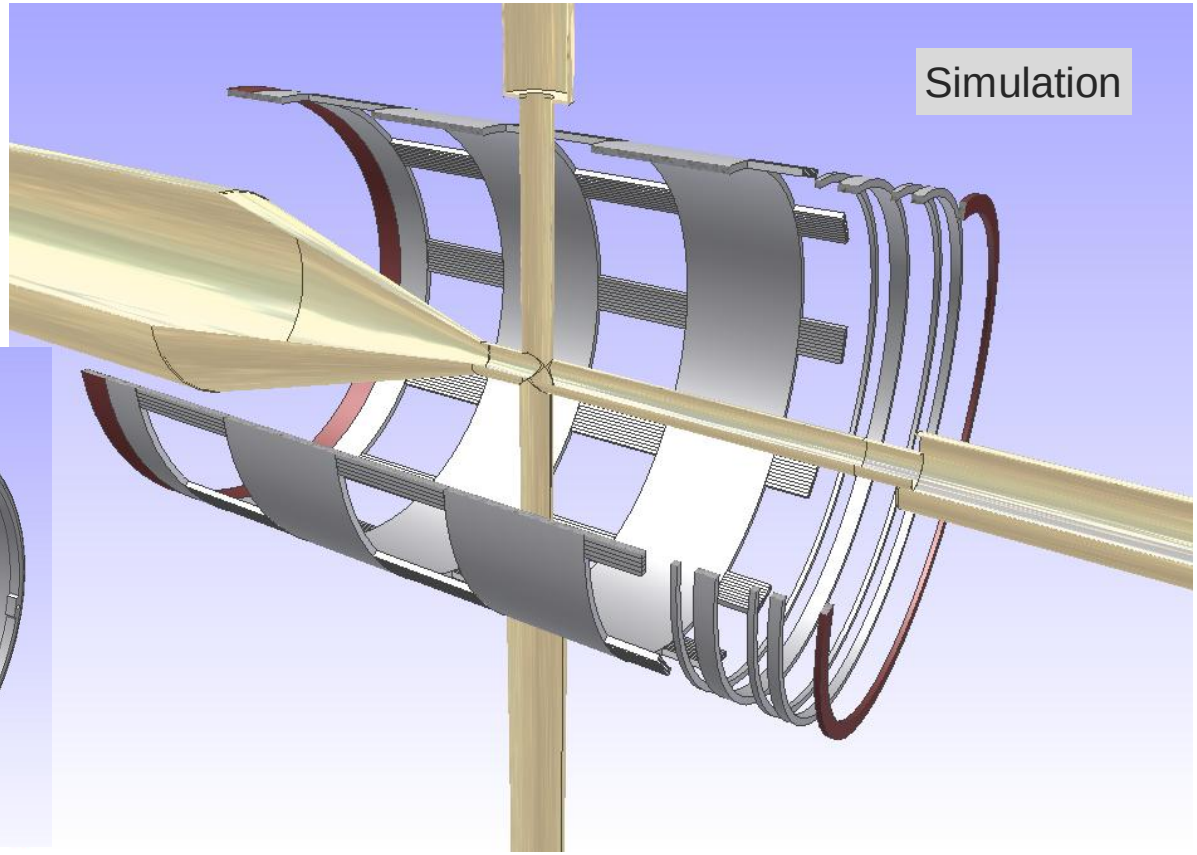


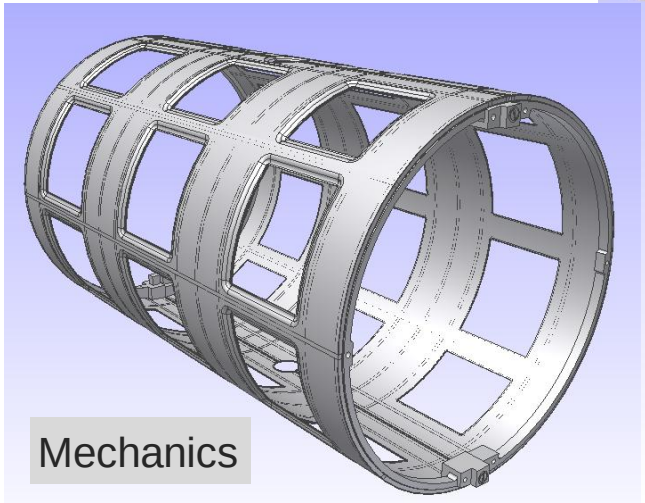


Mechanics aspects

Support concept: MVD, sequence (1)

- Global MVD frame

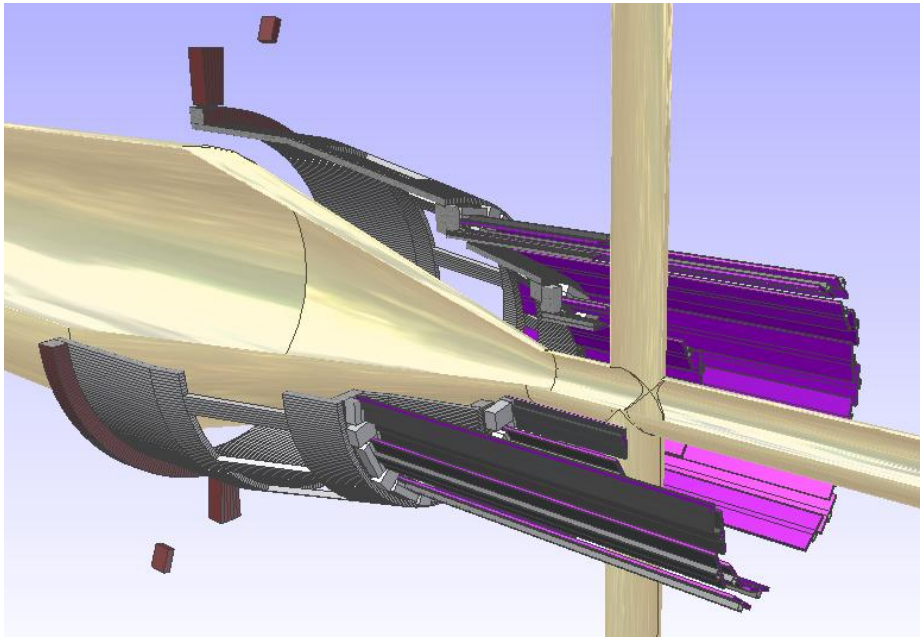


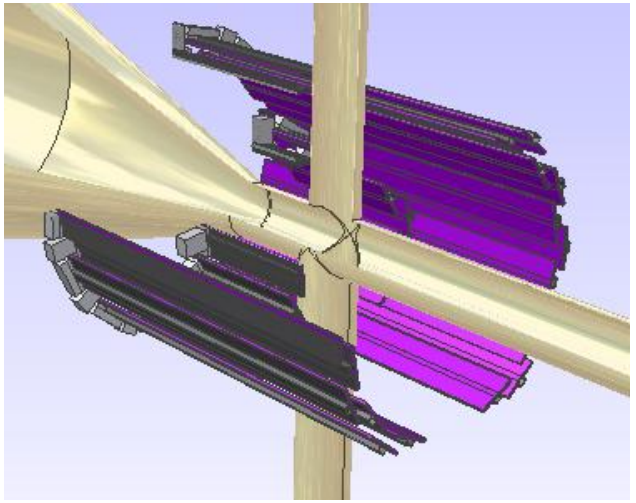


Mechanics aspects

Support concept: MVD, sequence (2)

- Pixel barrel support
  - ✓ Staves for module support



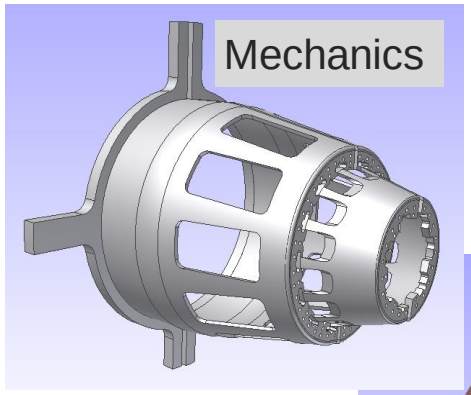


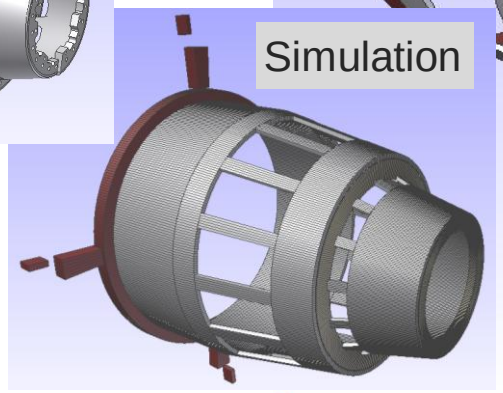
  - ✓ Staves attached to upstream cone

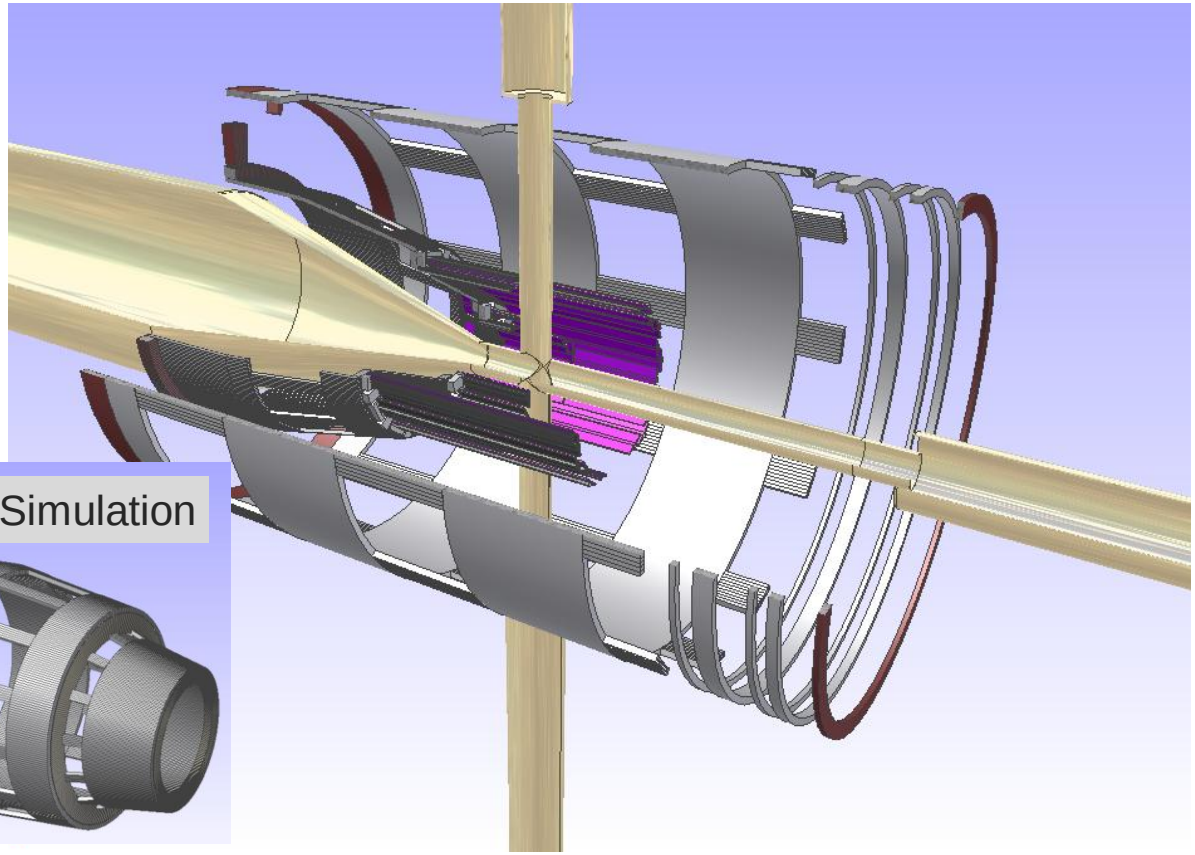
Mechanics aspects

Support concept: MVD, sequence (2)

- Pixel barrel support



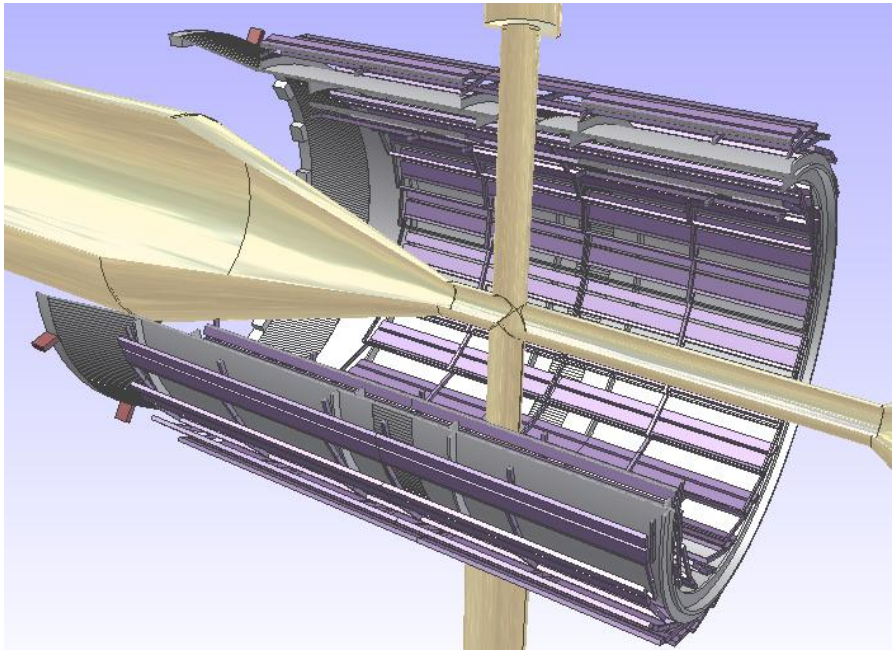


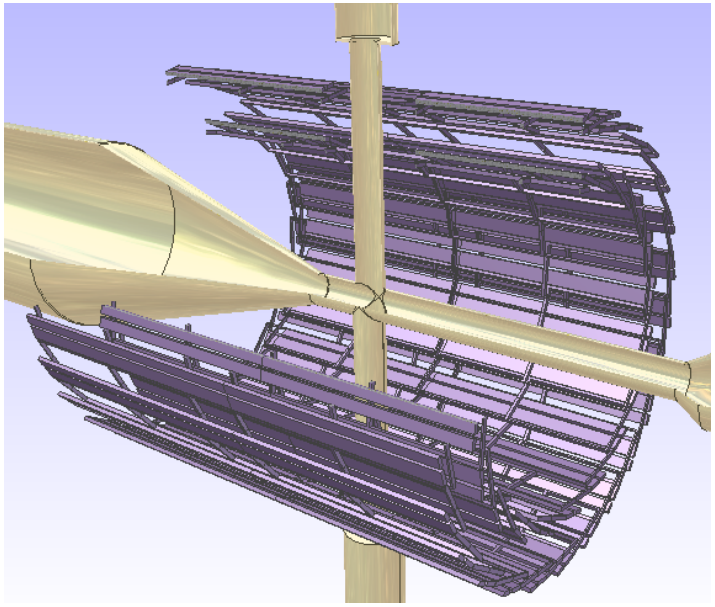


Mechanics aspects

Support concept: MVD, sequence (3)

- Strip barrel support
  - ✓ Staves for module support



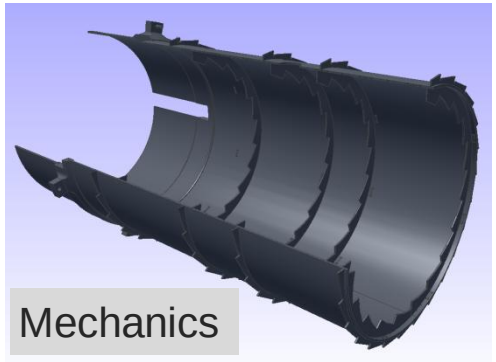


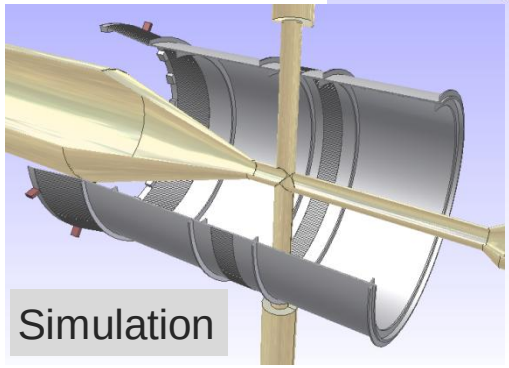
  - ✓ Cylinder between barrel layer
  - ✓ Saw-tooth for staves

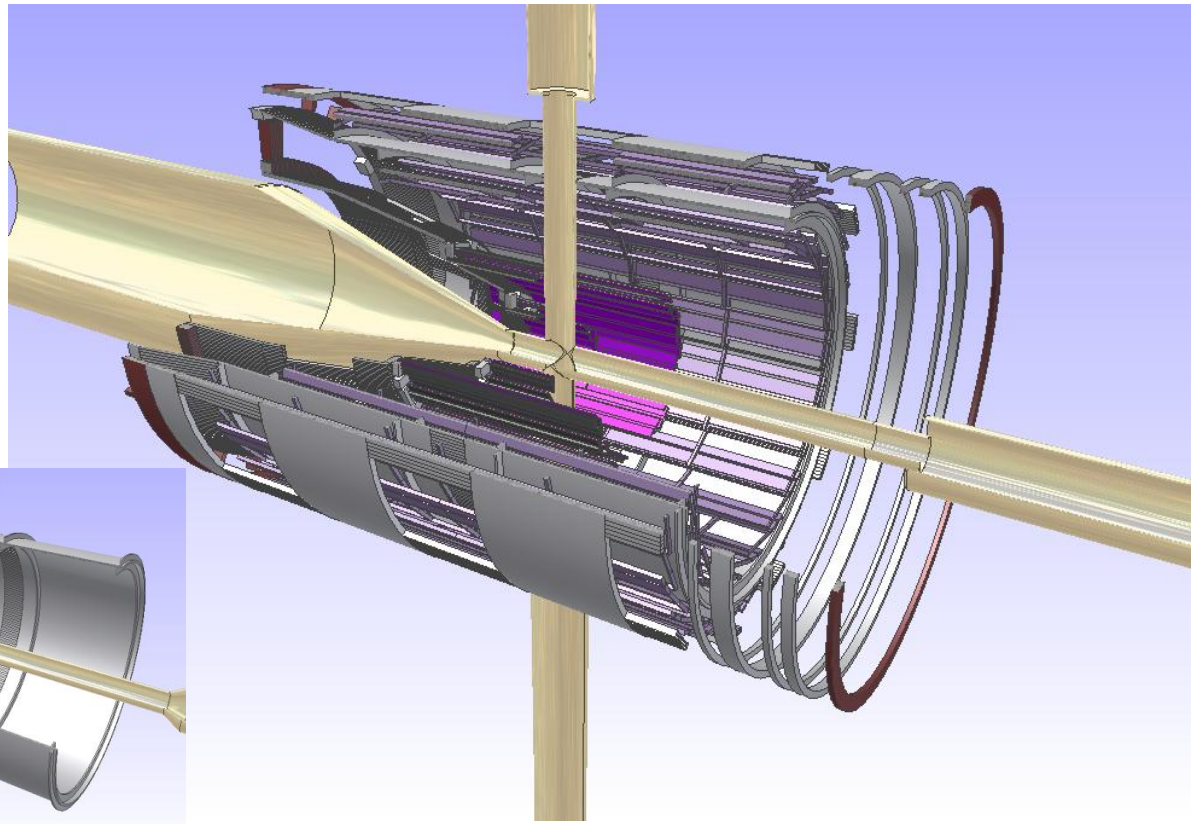
Mechanics aspects

Support concept: MVD, sequence (3)

- Strip barrel support



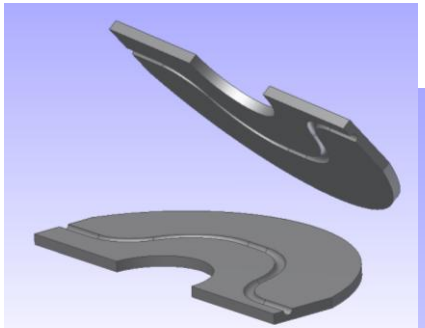




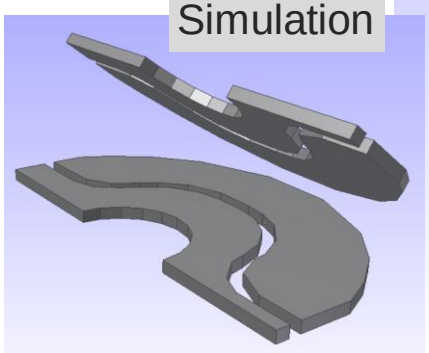
Mechanics aspects

Support concept: MVD, sequence (4)

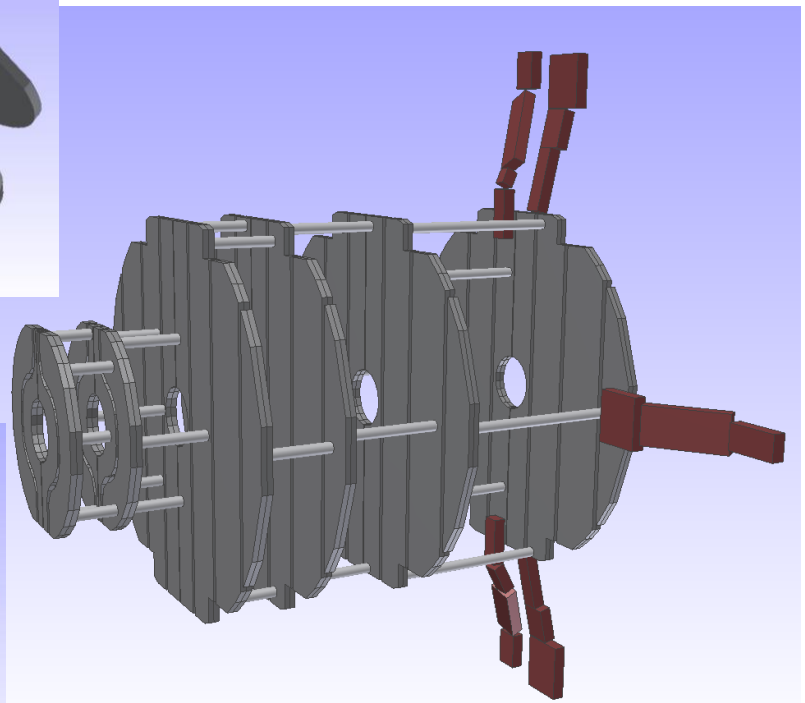
- Pixel disk support
  - ✓ Half-disks hosting detector modules
  - ✓ Spacers between disks
  - ✓ Suspensors to attach to global MVD frame



Mechanics



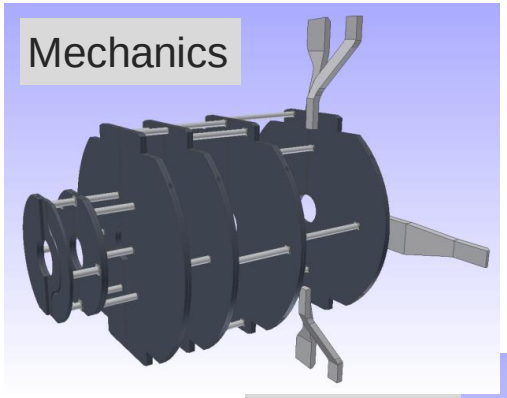
Simulation

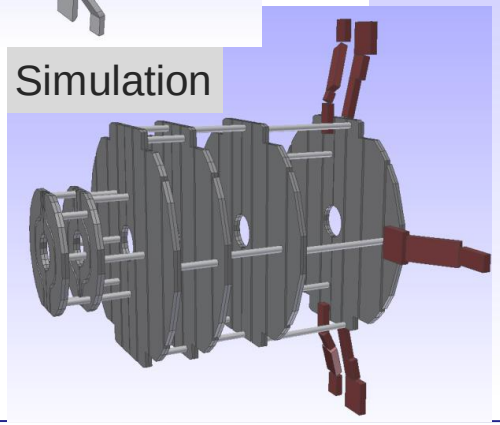


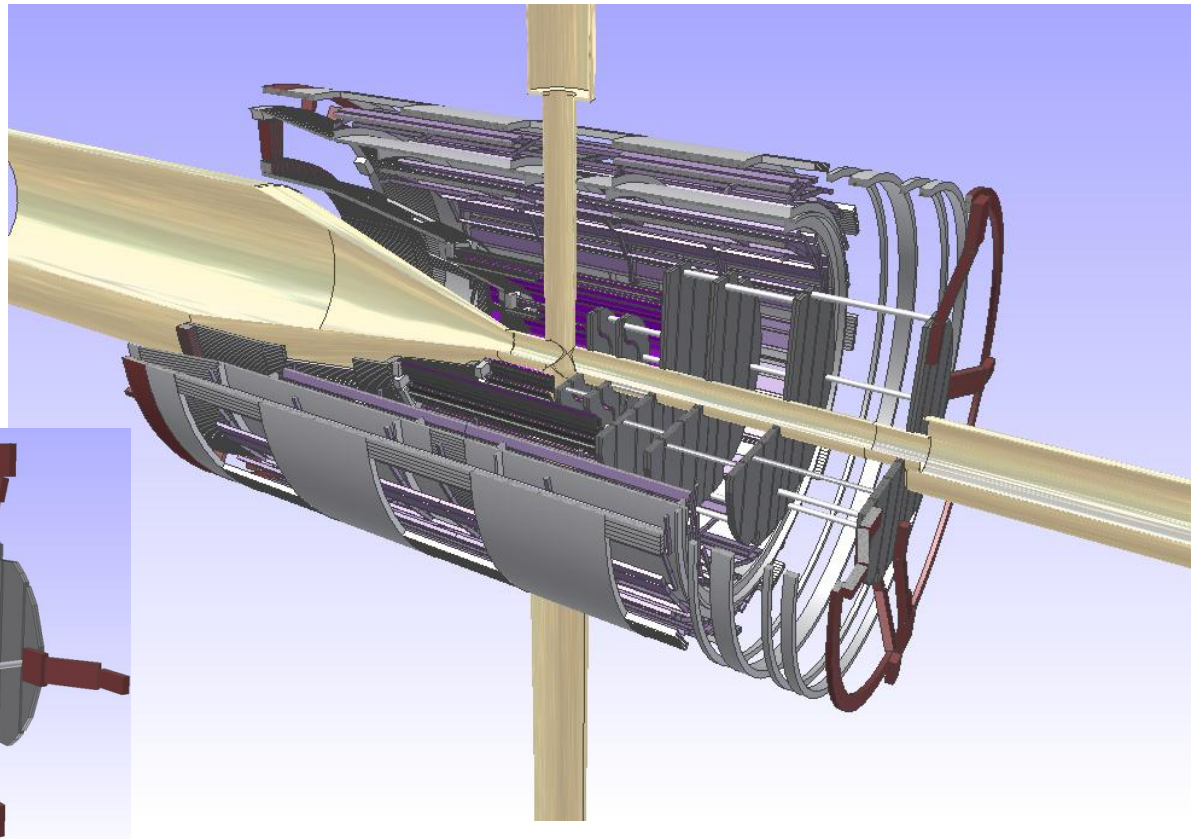
Mechanics aspects

Support concept: MVD, sequence (4)

- Pixel disk support



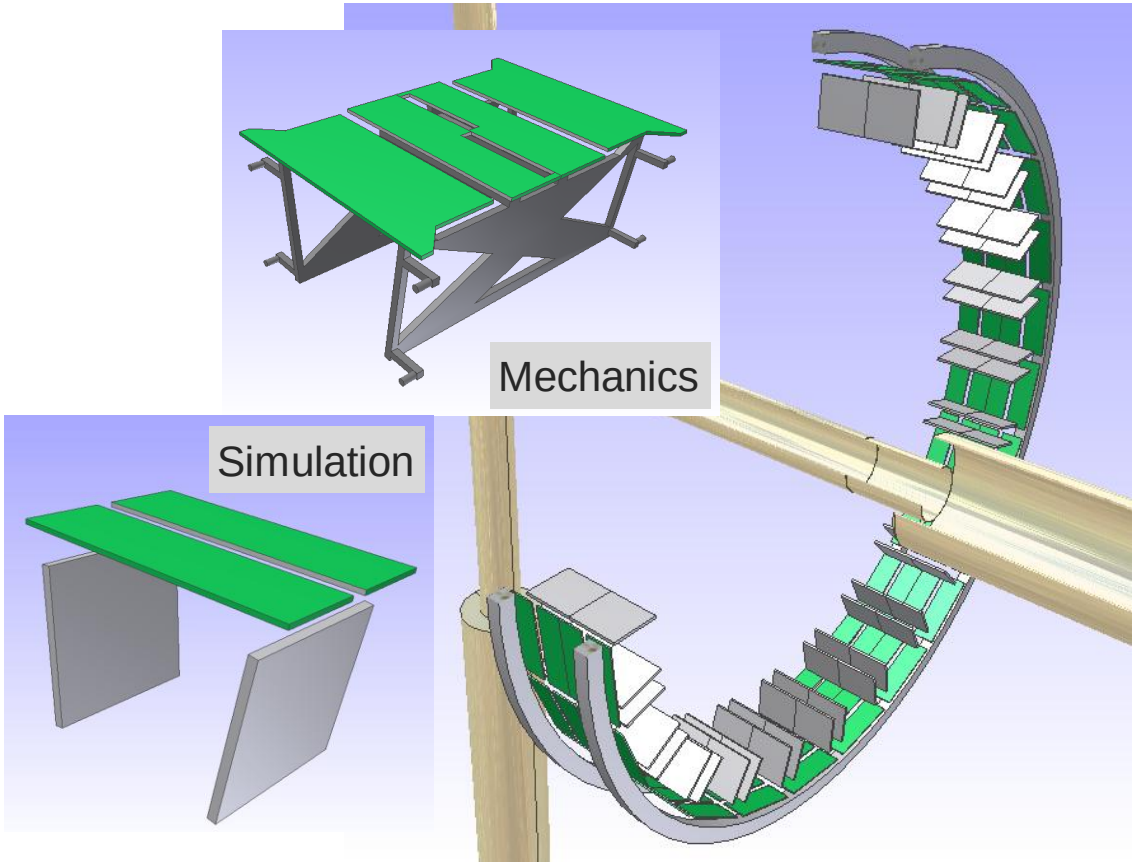




Mechanics aspects

Support concept: MVD, sequence (5)

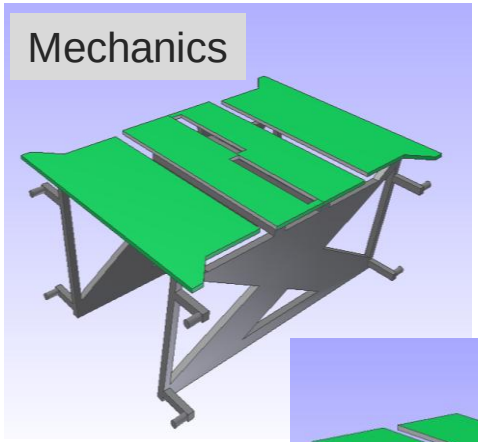
- Strip disk support
  - ✓ PCB between layers
  - ✓ Dedicated sensor support
  - ✓ Support structure for attachment to global MVD frame

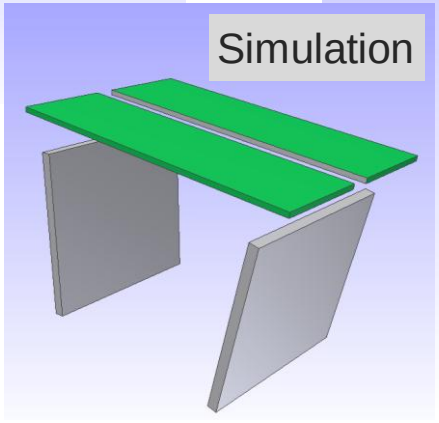


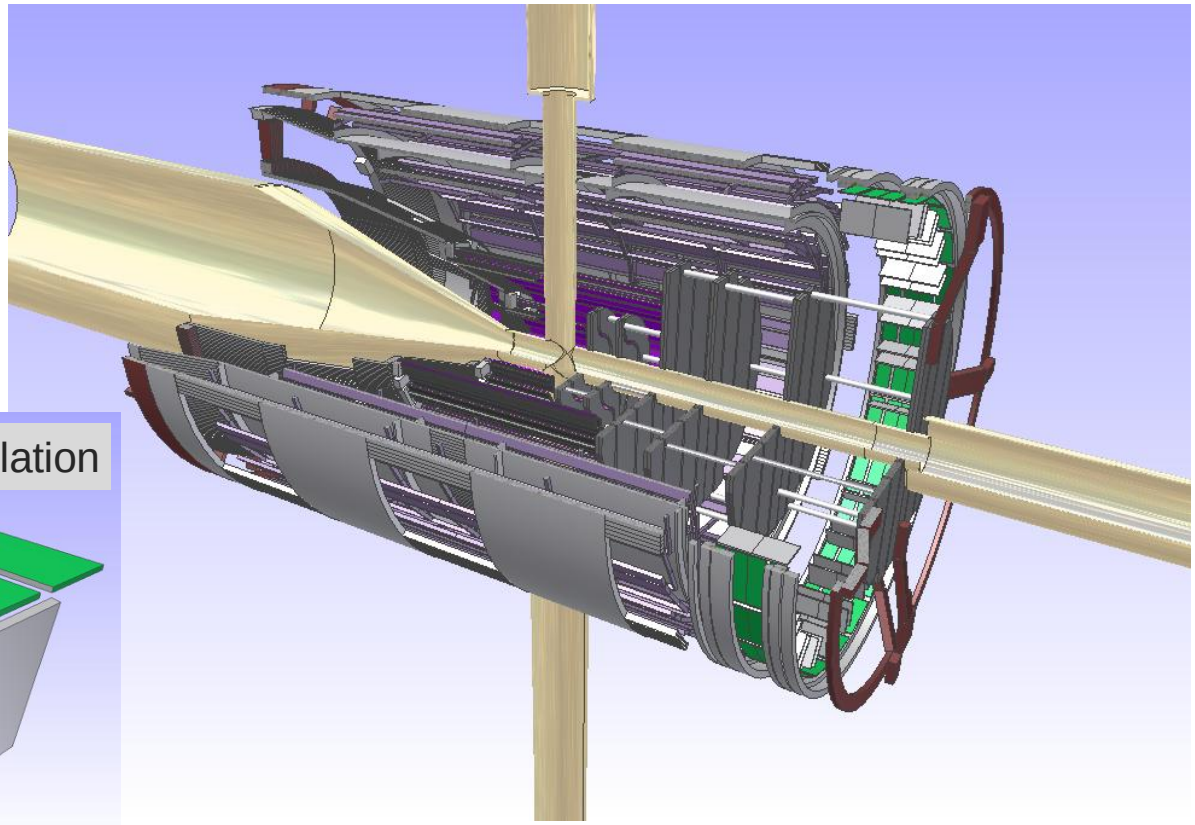
Mechanics aspects

Support concept: MVD, sequence (5)

- Strip disk support



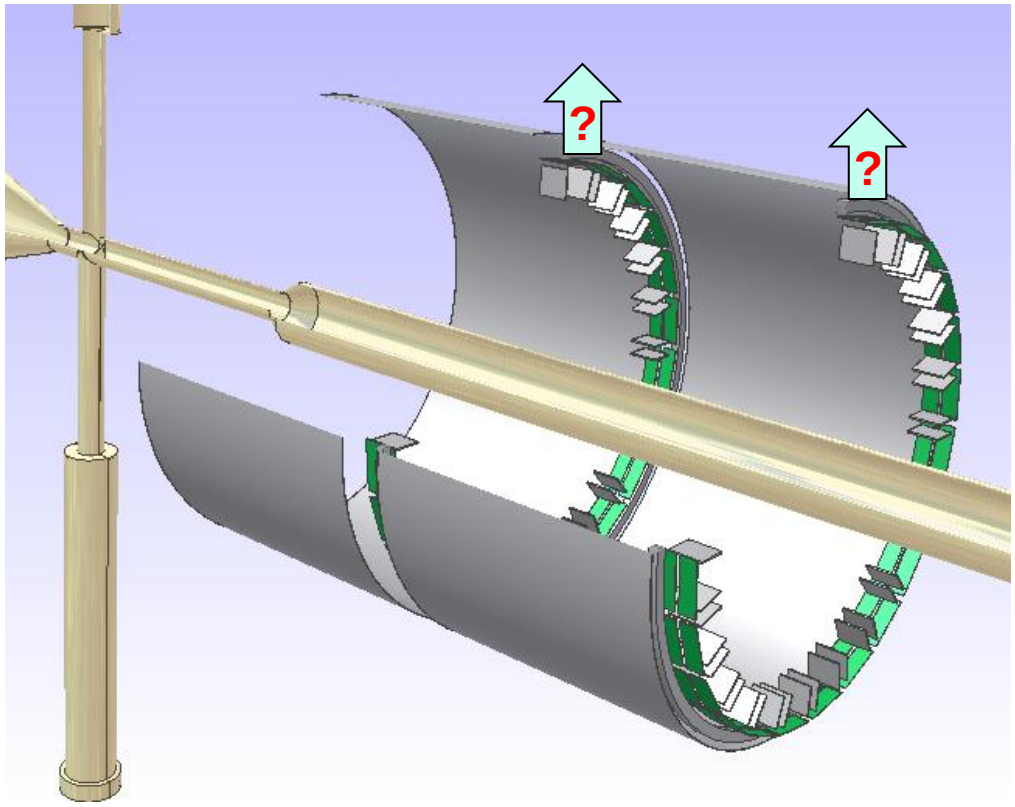




Mechanics aspects

Support: Additional disks

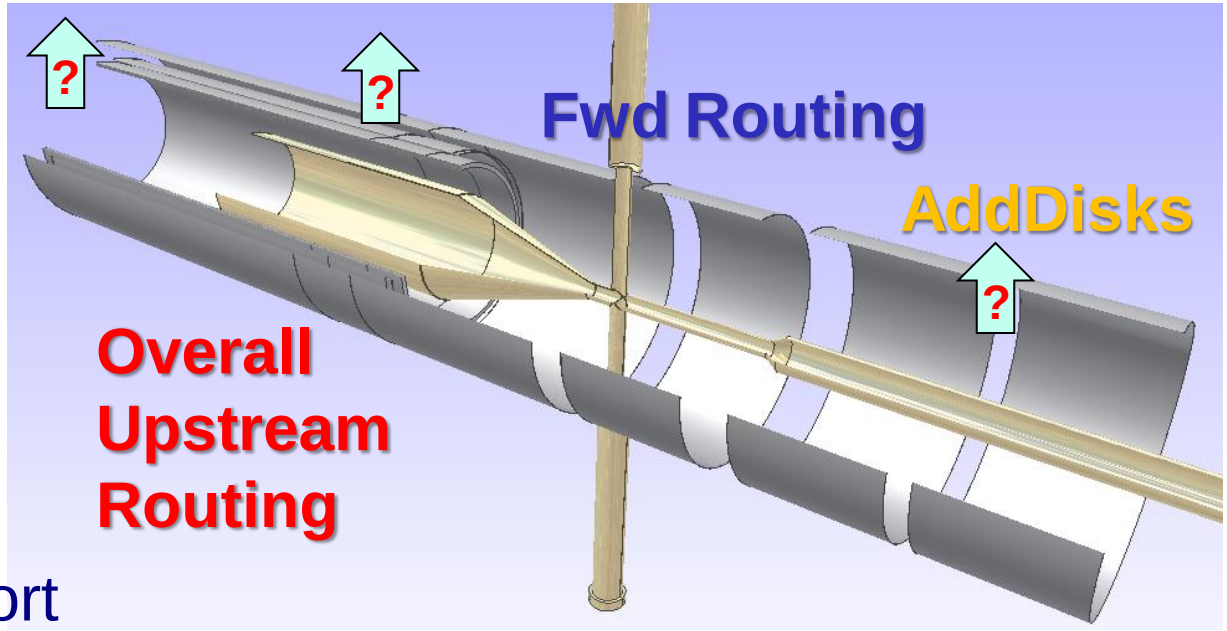
- Local support for detector modules: Same concept as for MVD strip disks
- Attachment to central frame not defined
- Backward routing support:
  - Schematic (cylinder)
  - Until start of MVD support



Mechanics aspects

Schematic routing support

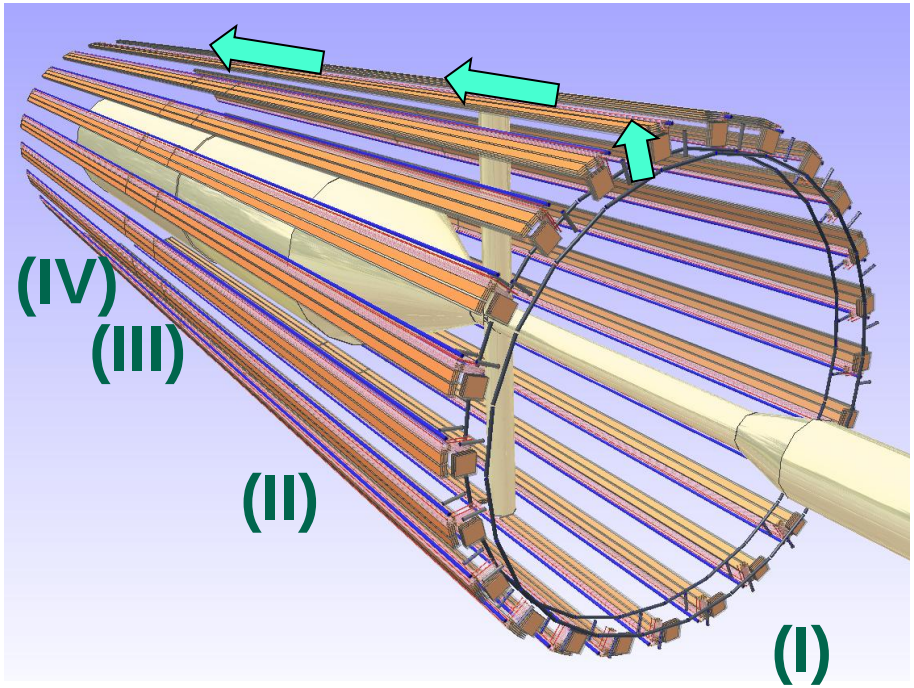
- Backward routing
  (A) Additional disk
  → No details for integration
  (B) MVD Fwd part
  → Integration with global frame or connected to upstream support

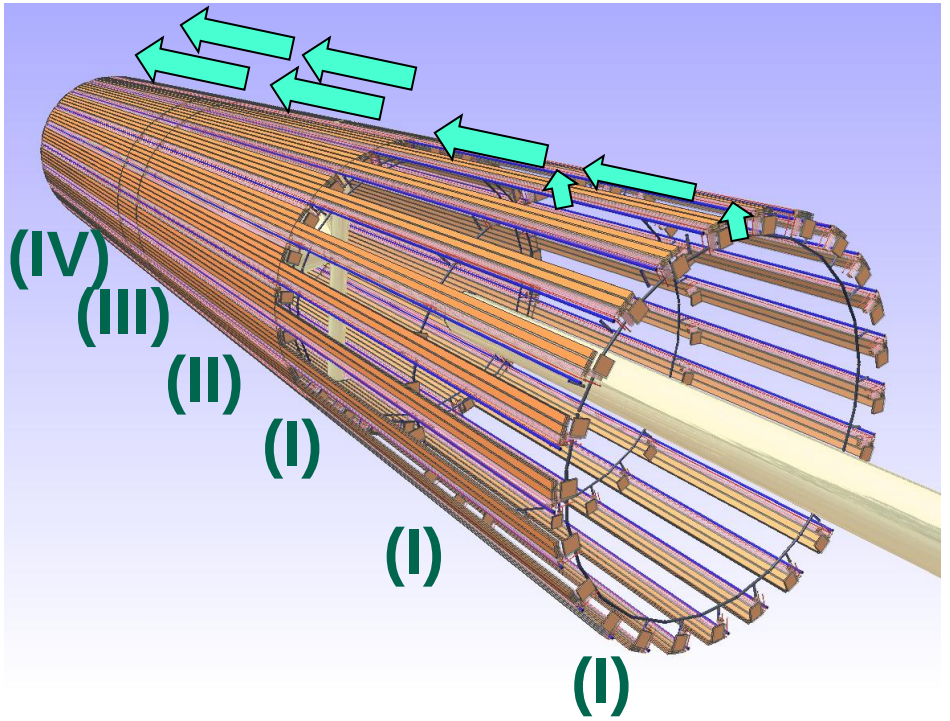


- Upstream support
  → Integration not clear ... See later

Mechanics aspects

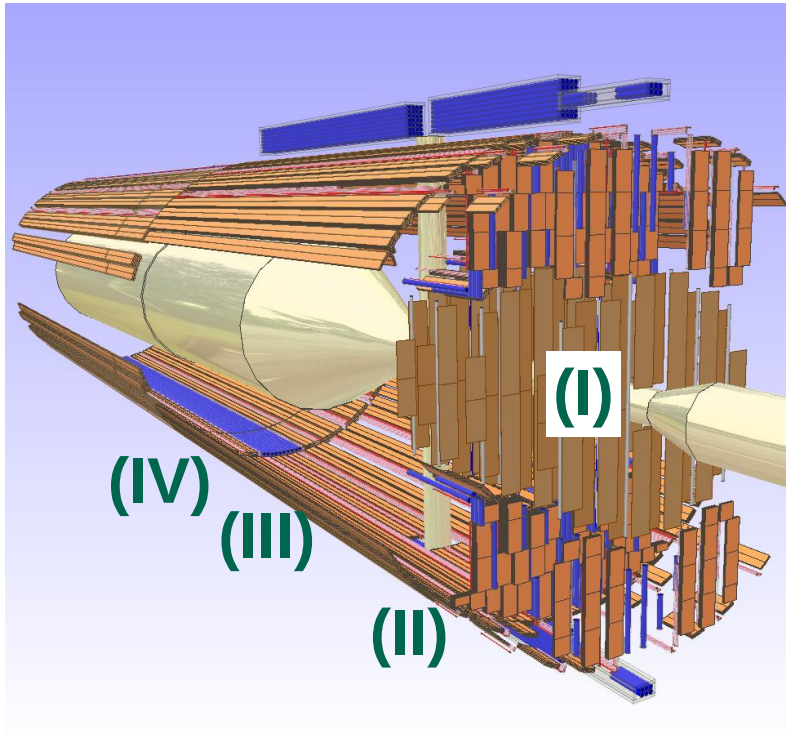
Routing: MVD strip disks + AddDisks

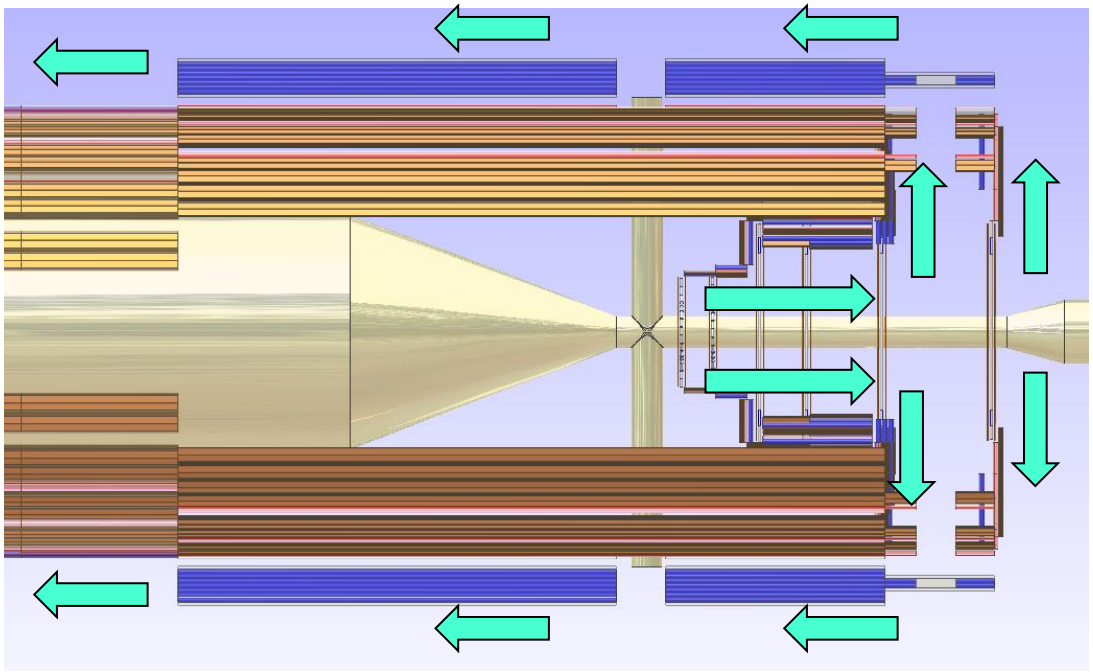




Mechanics aspects

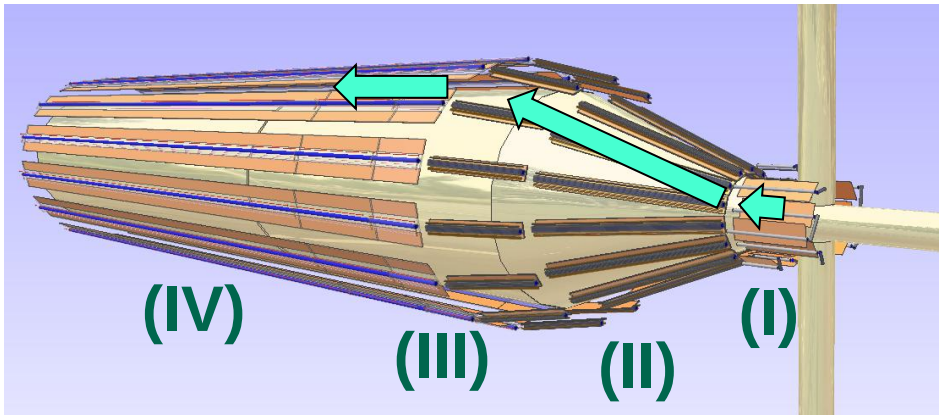
Routing: MVD pixel disks

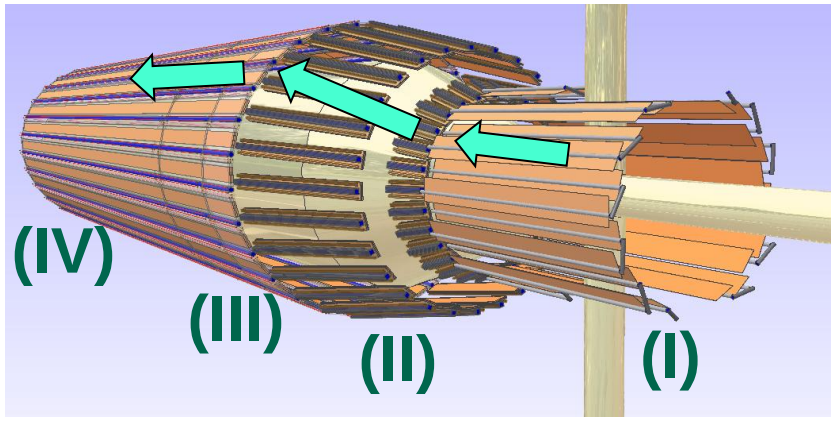


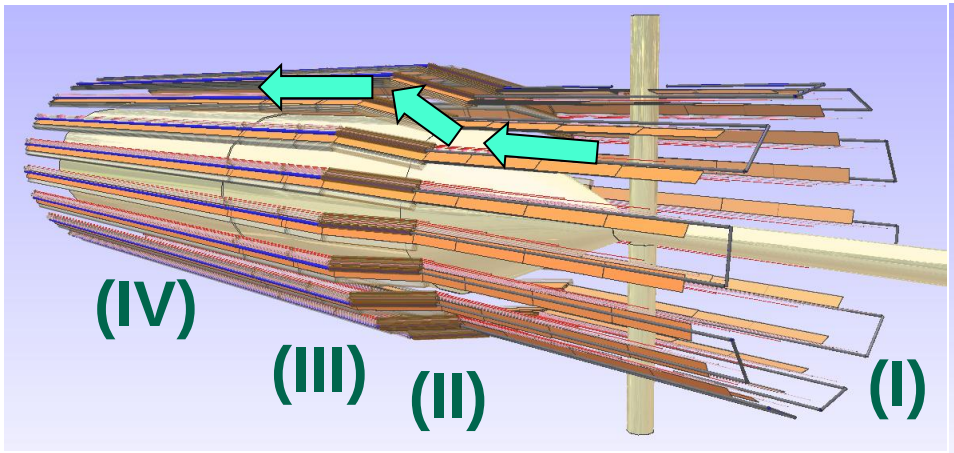


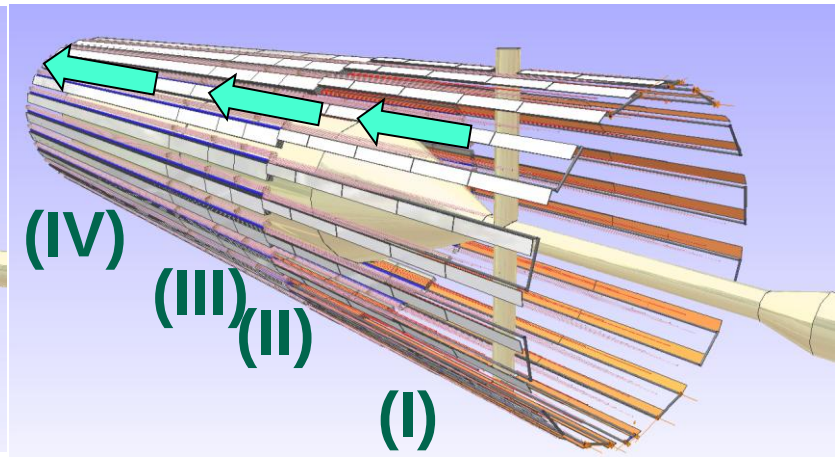
Mechanics aspects

Routing: MVD pixel barrel layer



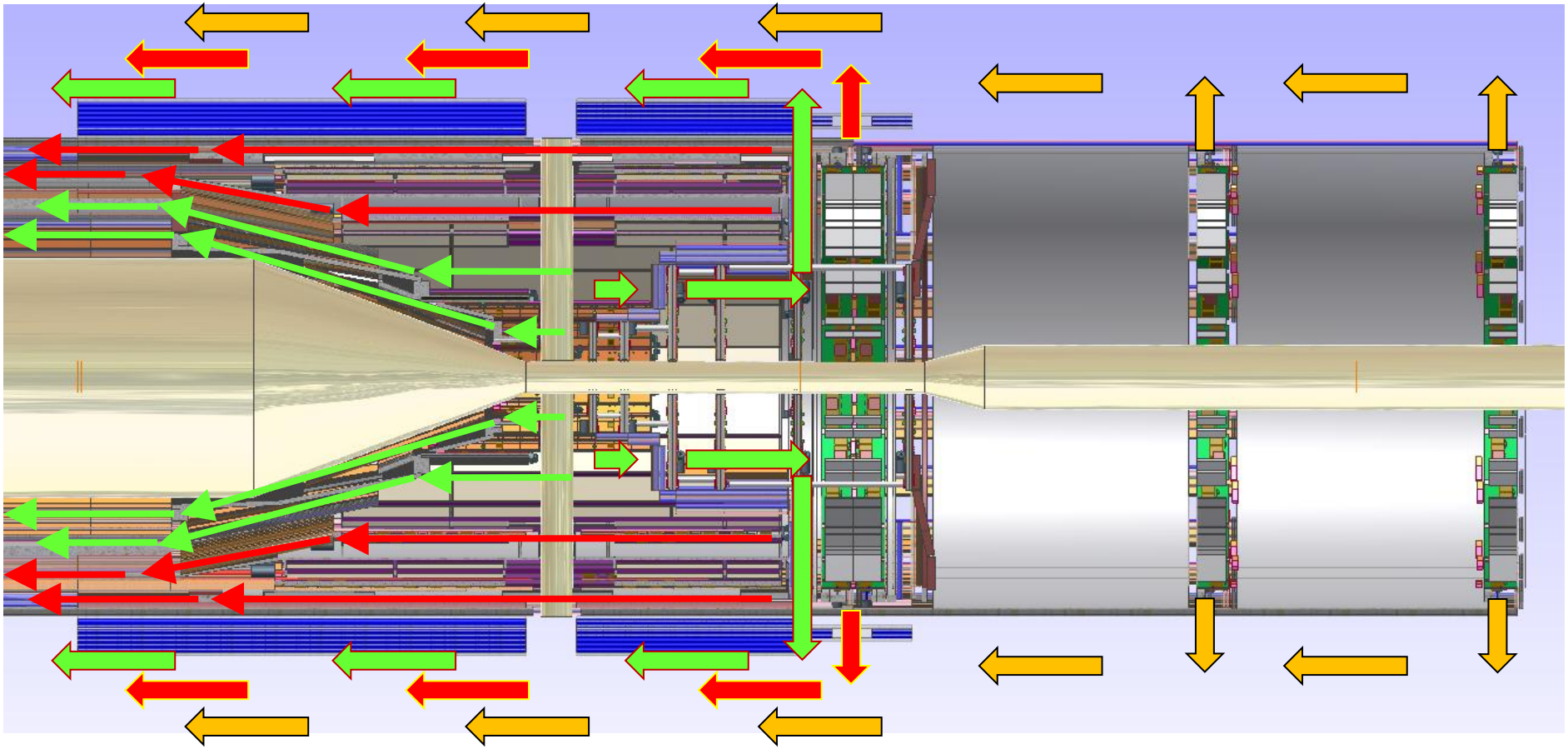




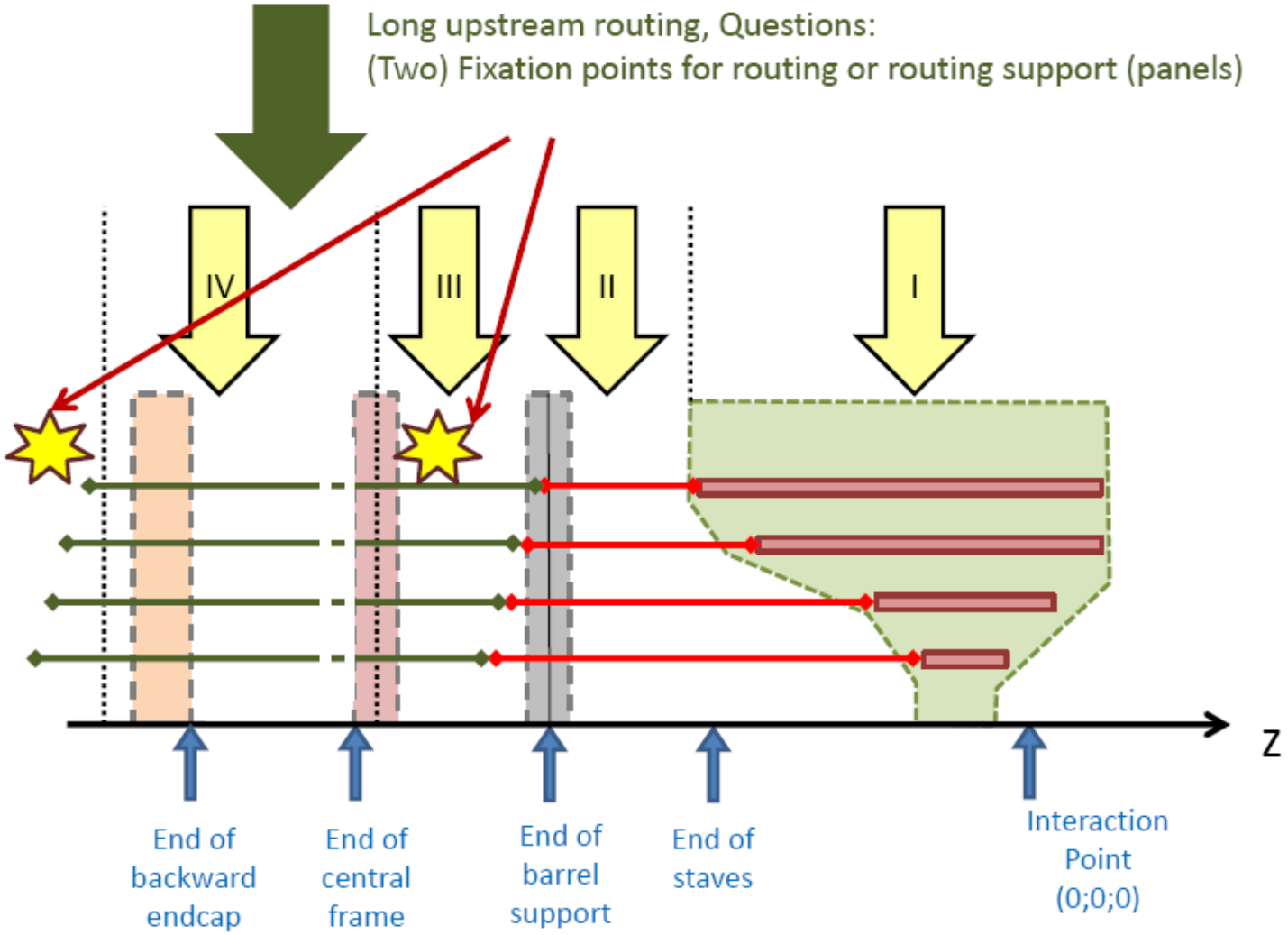


Mechanics aspects

Routing: Schematics



Mechanics aspects



Mechanics aspects

Long upstream routing, Questions:

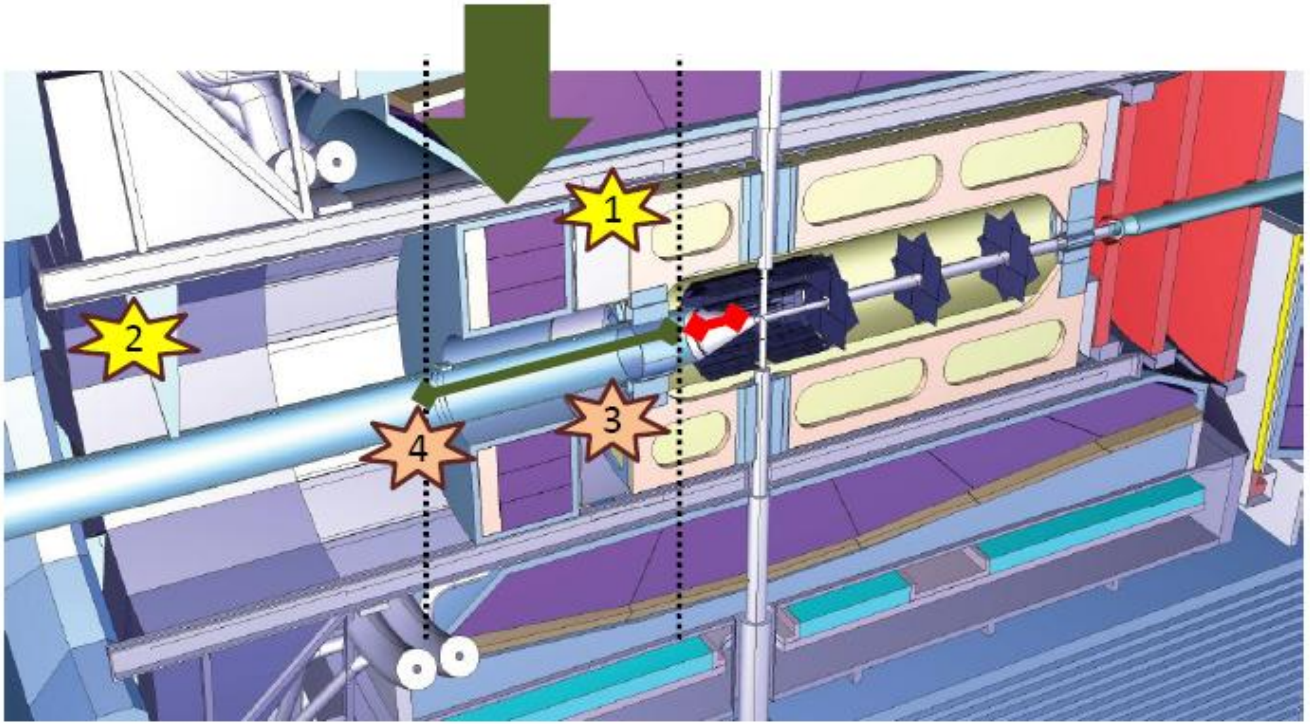
(Two) Fixation points for routing or routing support (panels)

1: Using upstream support for outer tracker

2: Using upstream beam pipe support

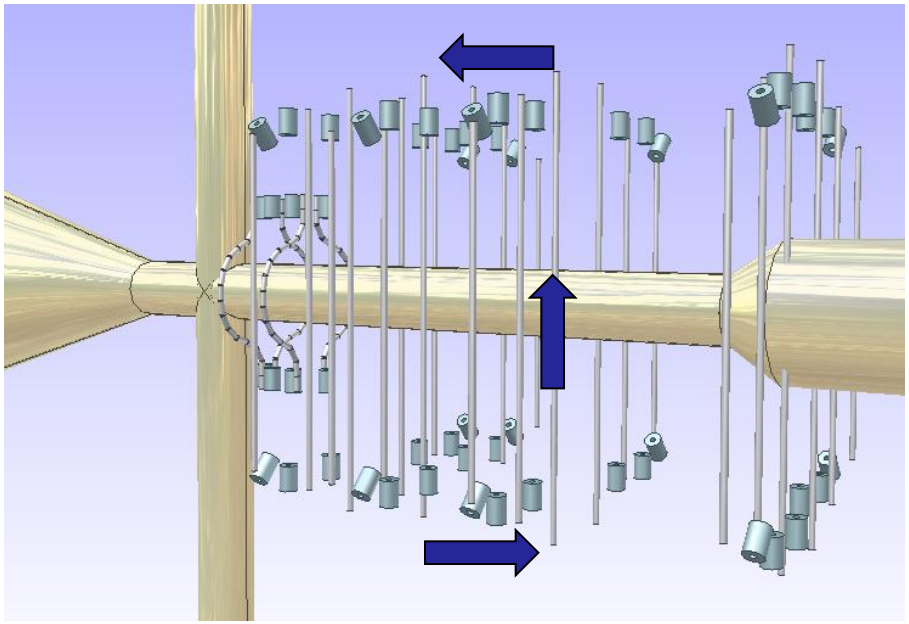
3: *alt.* Holding structure for beam pipe at end of central frame

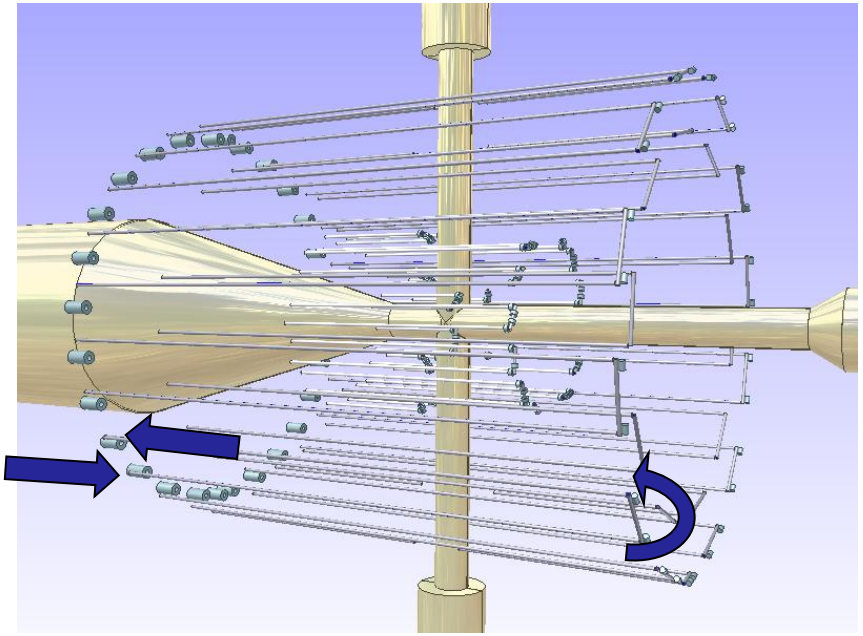
4: *alt.* Beam pipe flange



Mechanics aspects

Cooling

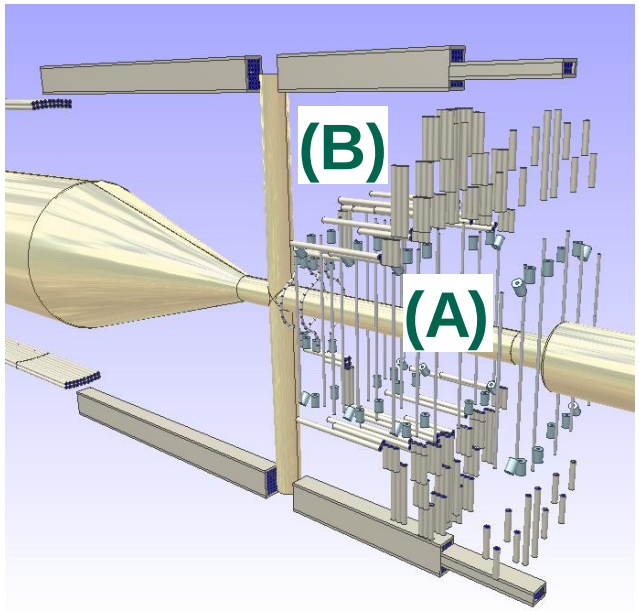


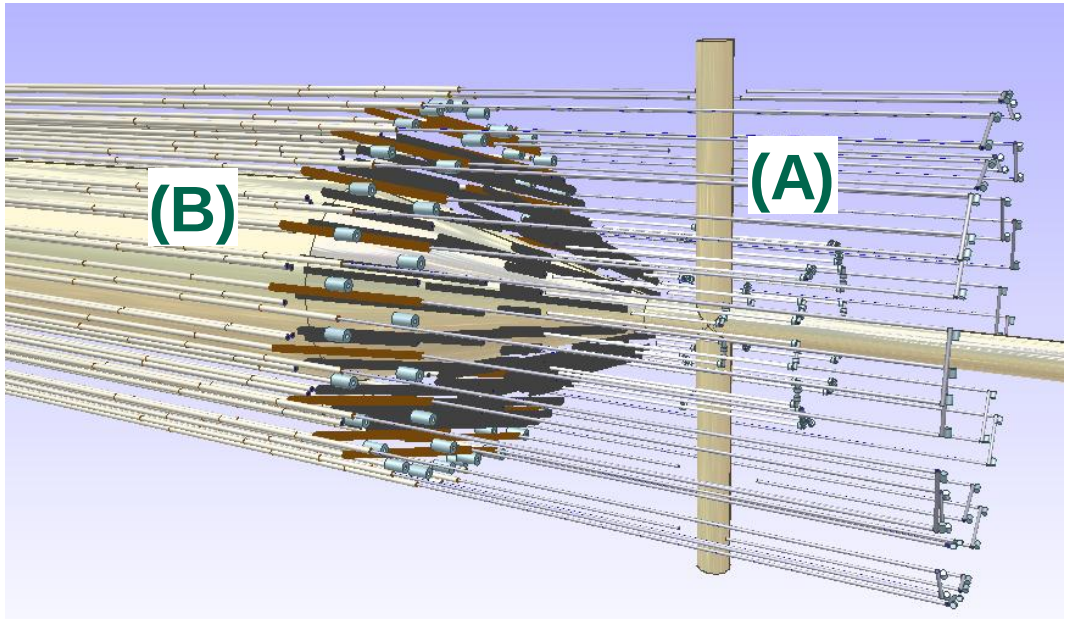


- ∅ 2 mm pipes within detector modules (active cooling)
- Barrel: 1 pipe / stave ; Downstream connection
- Pixel disk: 1 pipe / module row

Mechanics aspects

Cooling



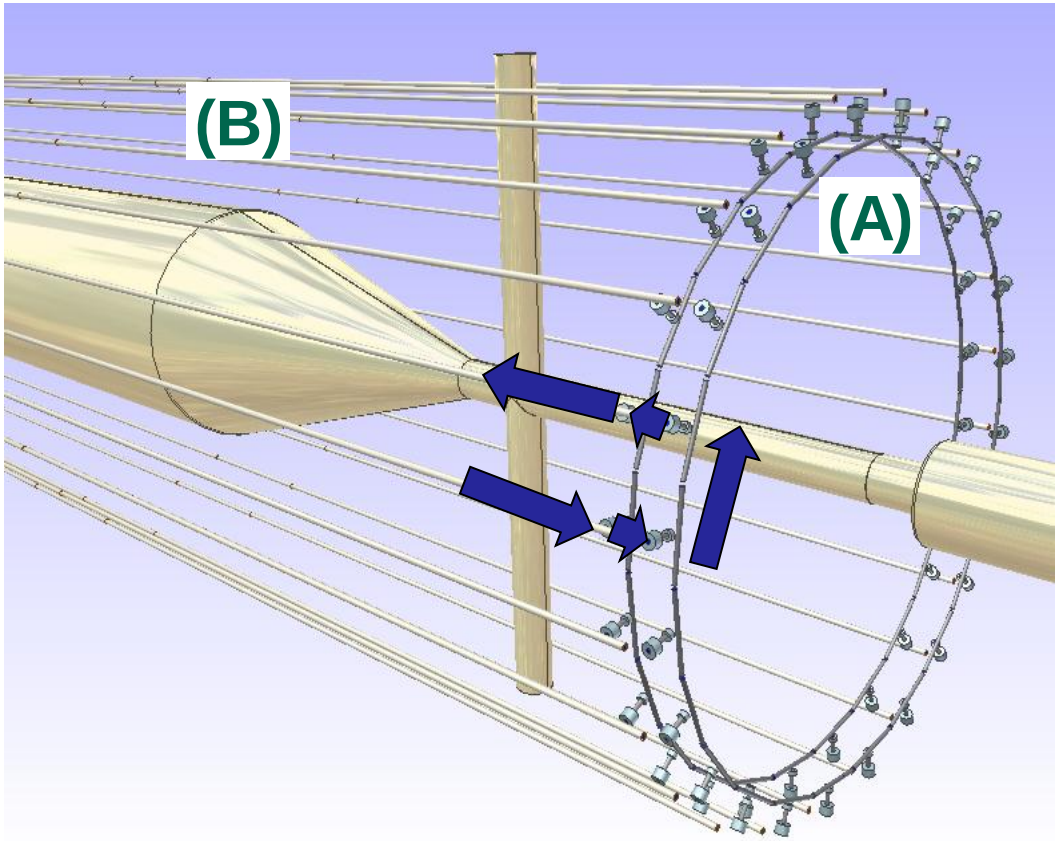


- Connector:
  (A) ∅ 2 mm pipes (steel) → (B) ∅ 4 mm flexible (plastic)

Mechanics aspects

Cooling

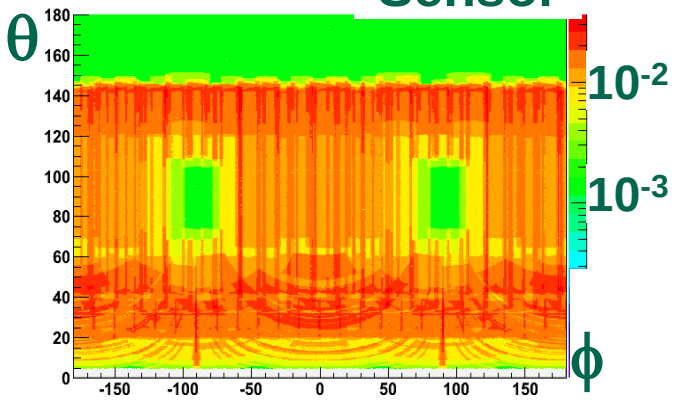
- Connector:
  (A) ∅ 2 mm pipes (steel)
  → (B) ∅ 4 mm flexible (plastic)
- Strip disks:
  Schematic implementation
  → 1 IN/OUT per super-module
  → 1 interconnection



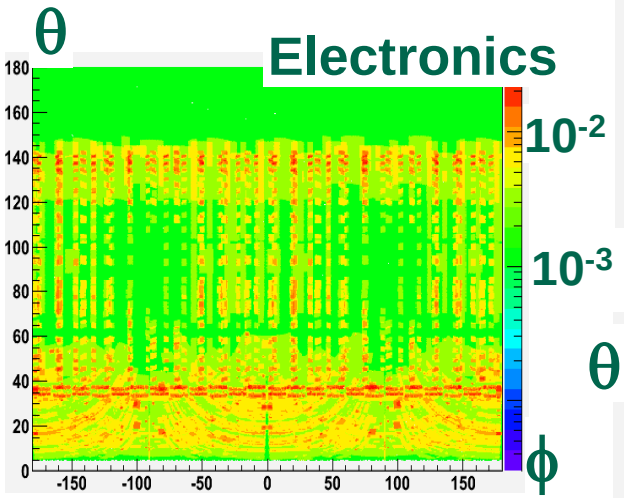
Simulation

- Selected results of radiation length study
  - 2D mapping of main parts (MVD)

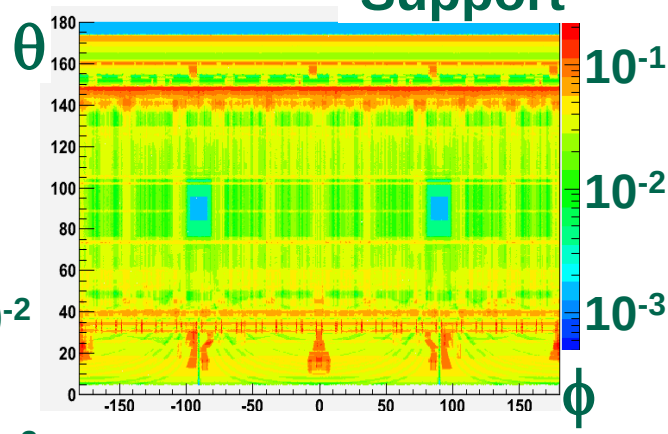
Sensor



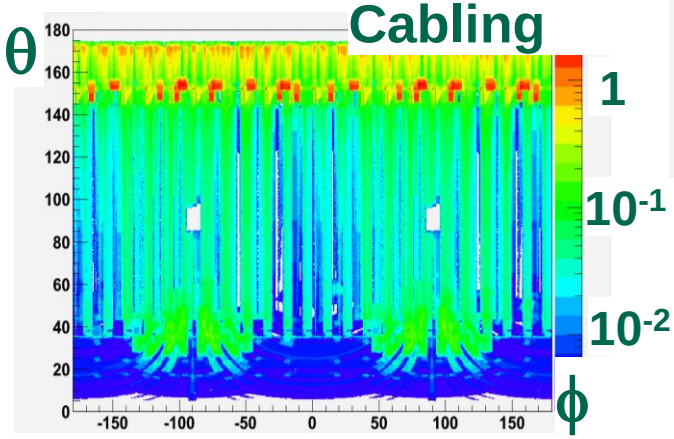
Electronics



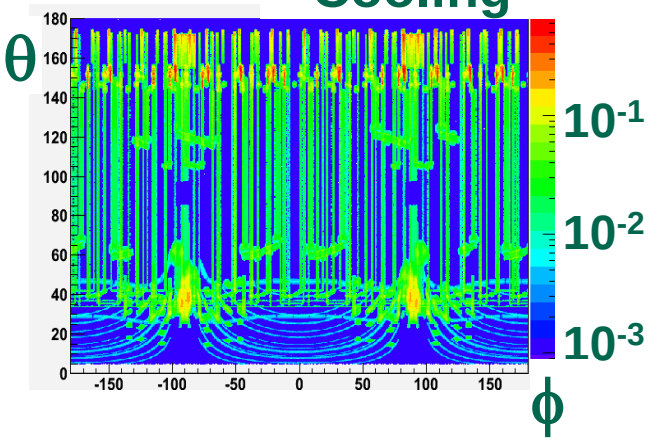
Support



Cabling

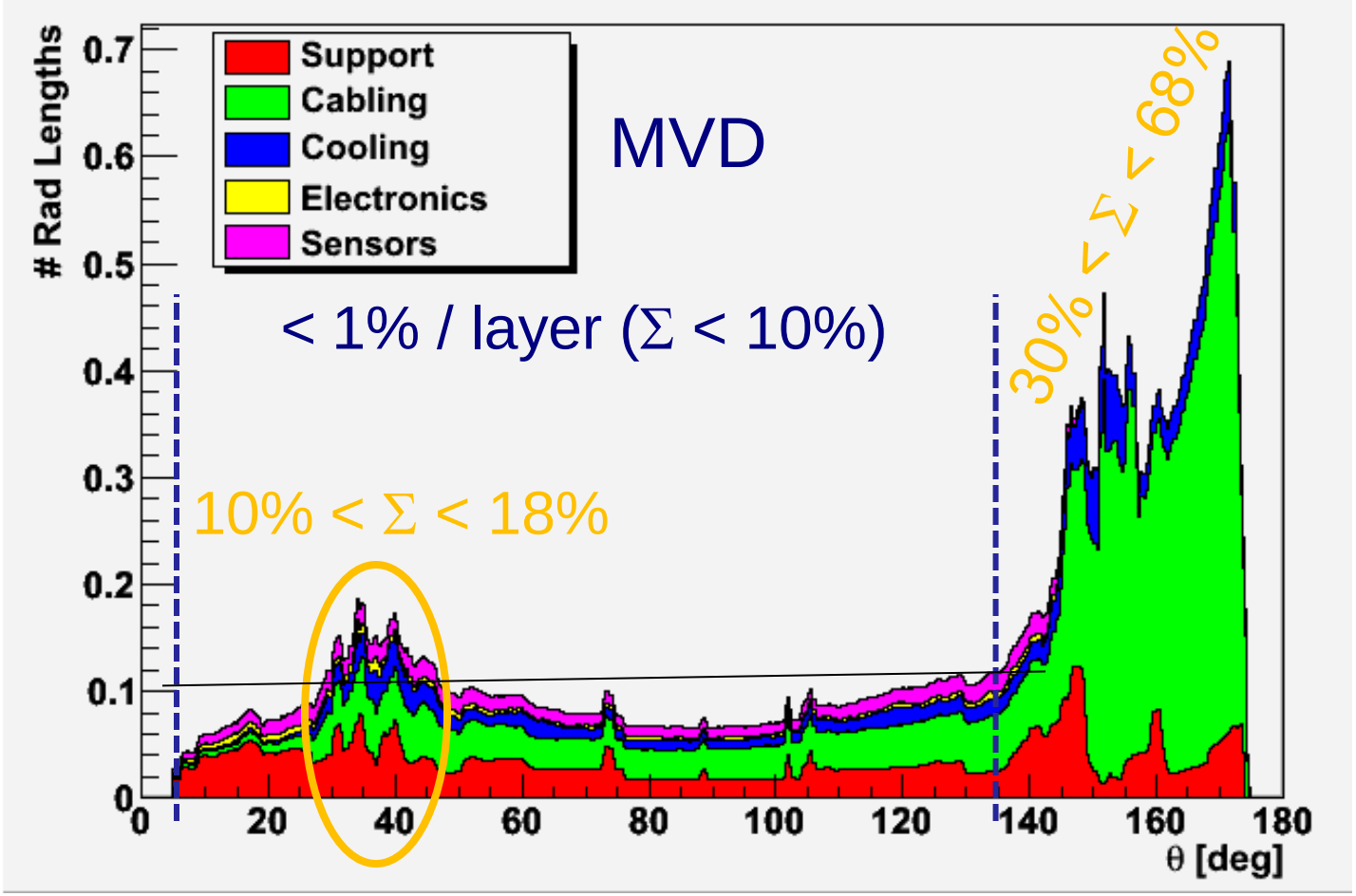


Cooling



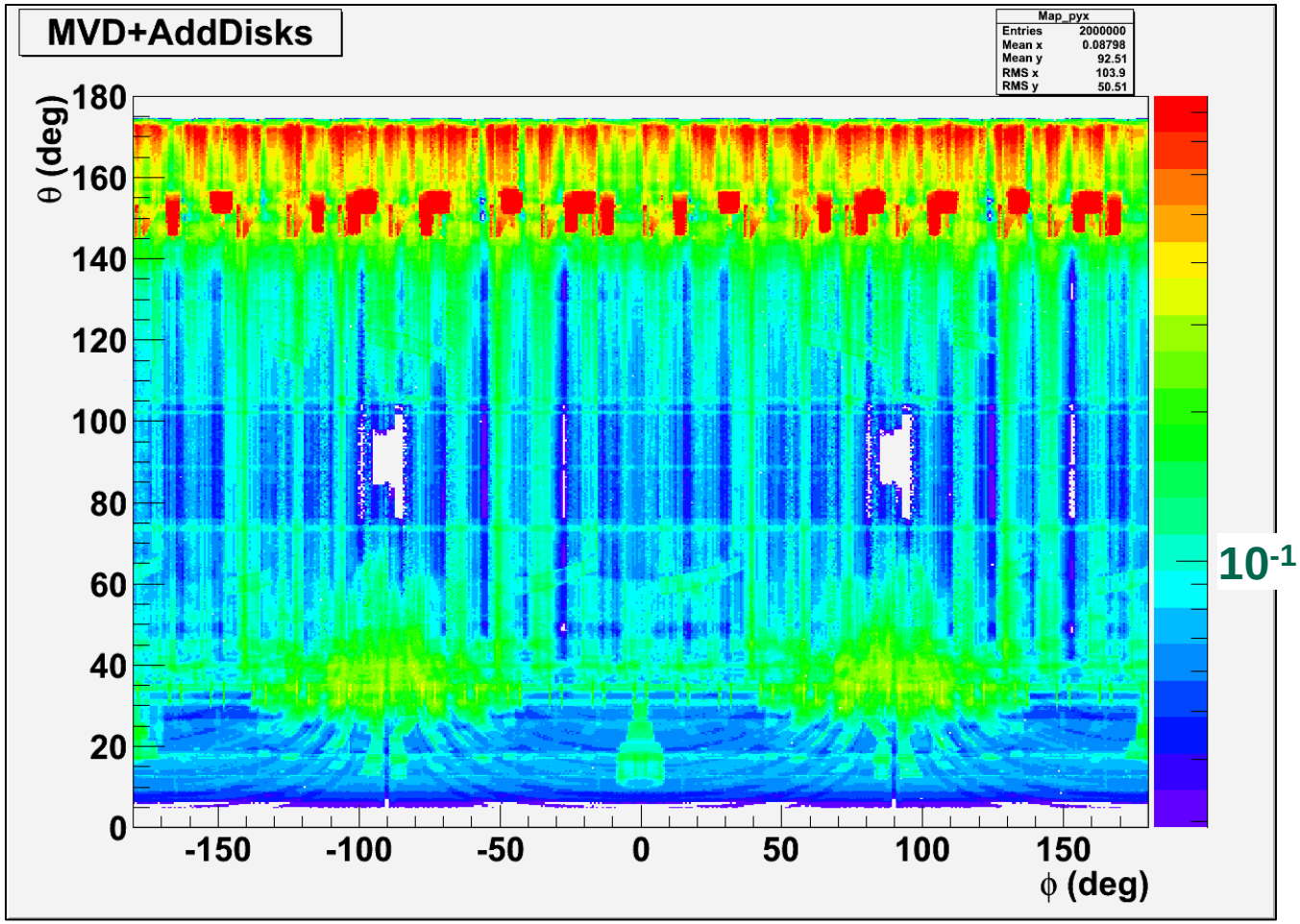
Simulation

- Selected results of radiation length study



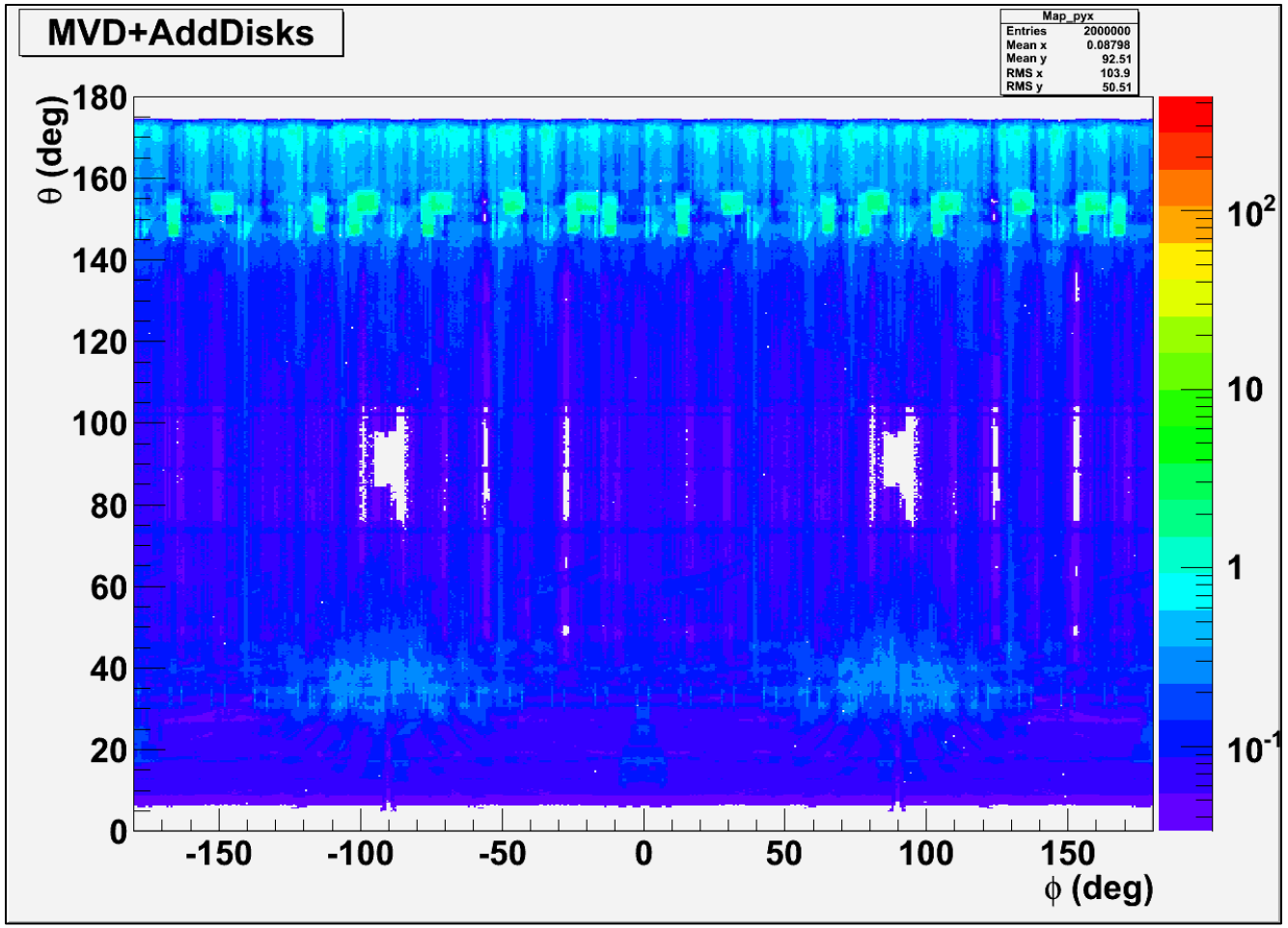
Simulation

- Selected results of radiation length study



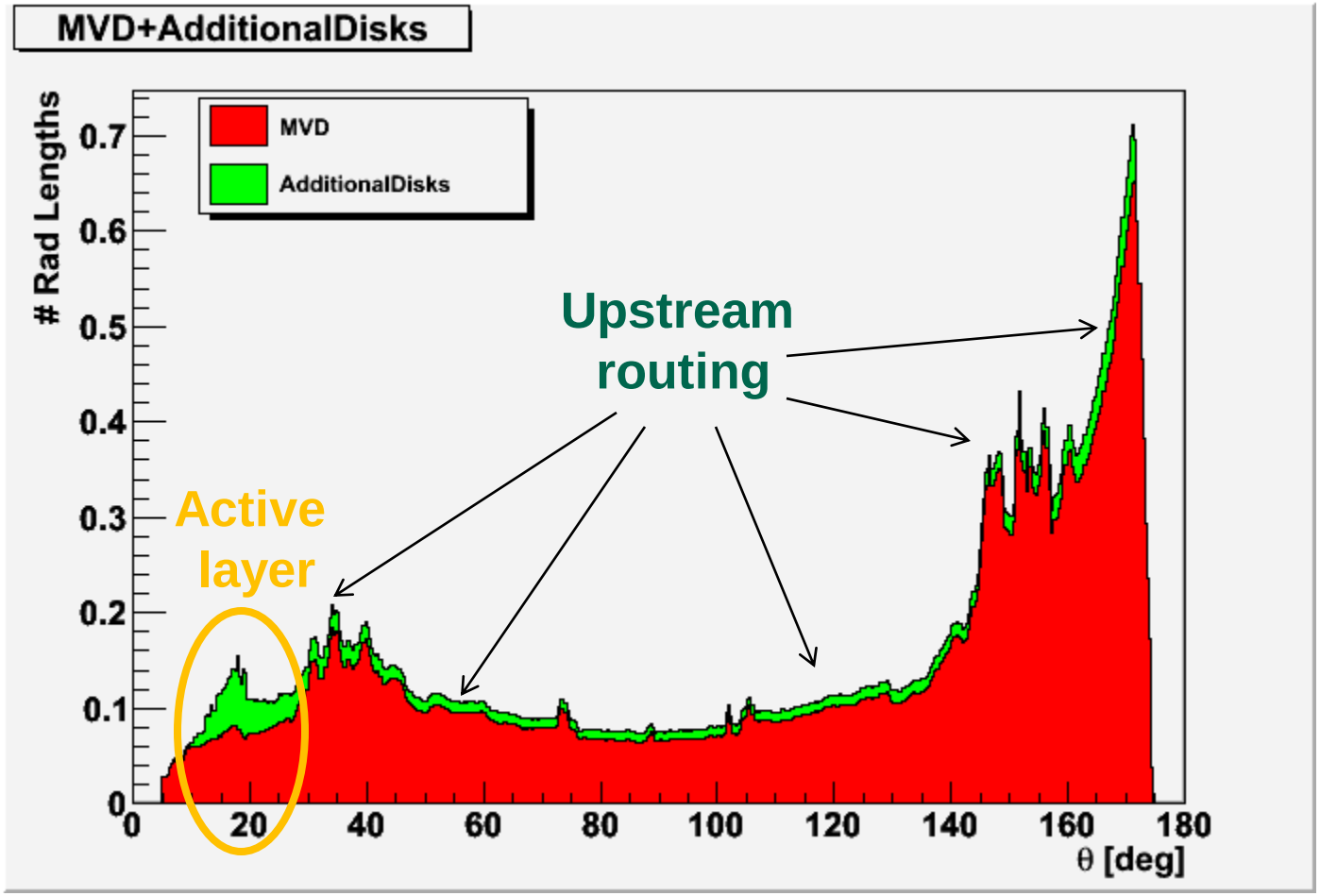
Simulation

- Selected results of radiation length study



Simulation

- Selected results of radiation length study (*Geantinos*)



Summary

- Detailed model for MVD
  - Advanced description containing all information of current hardware development
  - Realistic input concerning overall material budget: Studies on material effects
  - Comfortable handling due fixed conventions (see e.g. MVD-note 1)
- Additional disks
  - Doubling of radiation lengths (>10%) between 10° and 20°
  - Detailed conceptual design derived from MVD
  - No dedicated concept of overall integration yet

Summary

- Question: Upstream support
- Parts not implemented
  - Voltage regulator boards
  - Optical conversion
  - Upstream patch panels and cooling splitters
- Remark...
  - Any optical conversion (earliest after cone) has no impact in terms of reduction of radiation length but, of course, is essential for signal quality
    → Position corresponds to angles around 150°
    ... Reduction afterwards
    ... Increase (!) of material in sensitive region