Collaboration Meeting
MVD Subgroup
GSI, December 8, 2009

Thomas Würschig

Implementation of a dedicated routing concept for the updated MVD model

Updated MVD model

Updated MVD model

- Strip part: **Sv-3.3**
  - Uploaded on Wikipage together with documentation

Latest version:
Sv-3.3.stp
Sv-3.3_Sensitive.stp
Sv-3.3_FeeAndSensitive.stp
Sv-3.3_CoolingAndSupport.stp

MVD CAD file dump

MVD-2.0

Full versions

- Download file -	- Link to documentation -	- Comment -
: Mvd-2.0_Pv-3.0_Sv-3.2.stp :	ModelMvd2pt0	: MVD-2.0 step file including Sv-3.2 and Pv-3.0
: Mvd-2.0_Pv-3.0_Sv-3.2_ActiveSensor.stp :	ModelMvd2pt0	: same version, only active area :
: Mvd-2.0_Pv-3.0_Sv-3.2_ActiveSensor_FEE.stp :	ModelMvd2pt0	: same version, only active area and frontend chips:

Strip subversions

- Download file -	- Link to documentation -	- Comment -
Sv-3.0.stp	Docu Sv-3.0	: 1st strip subversion for MVD-2.0 (developed in Bonn):
Sv-3.0_Sensor-FE-PA.stp	Docu Sv-3.0	: Same as above but without local support (as template for FZJ):
Sv-3.1.stp	Docu Sv-3.1	: Strip subversion for MVD-2.0 (developed in Bonn) based on Sv-3.0:
Latest version:		
Sv-3.3.stp	Docu Sv-3.3	: Strip subversion for MVD-2.0 (developed in Bonn) based on Sv-3.2:
Sv-3.3_Sensitive.stp	Docu Sv-3.3	: same version, only active area:
Sv-3.3_FeeAndSensitive.stp	Docu Sv-3.3	: same version, only active area and frontend chips :
Sv-3.3_CoolingAndSupport.stp	Docu Sv-3.3	: same version, only (schematic) cooling and support structure:

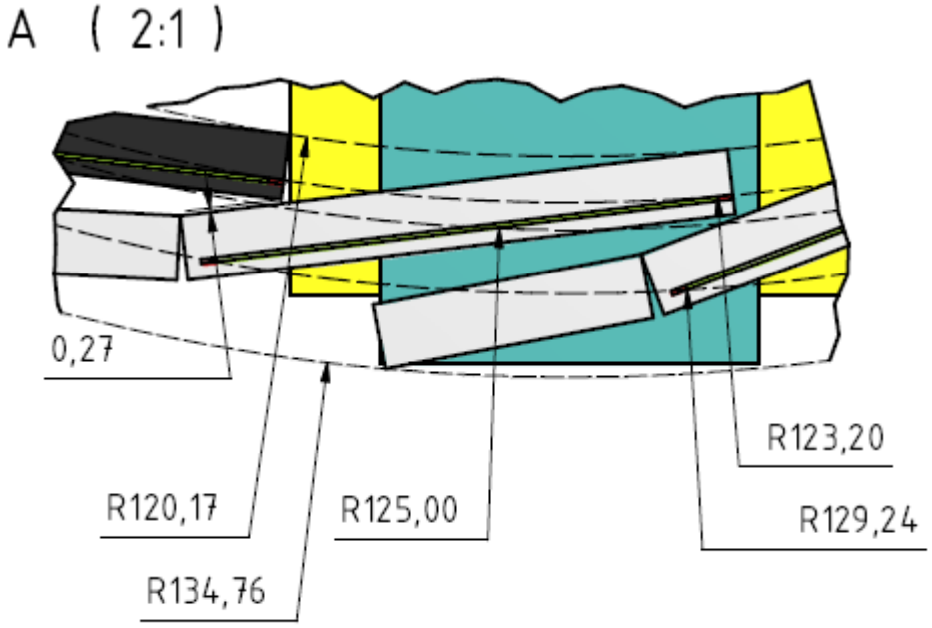
Sv-3.3

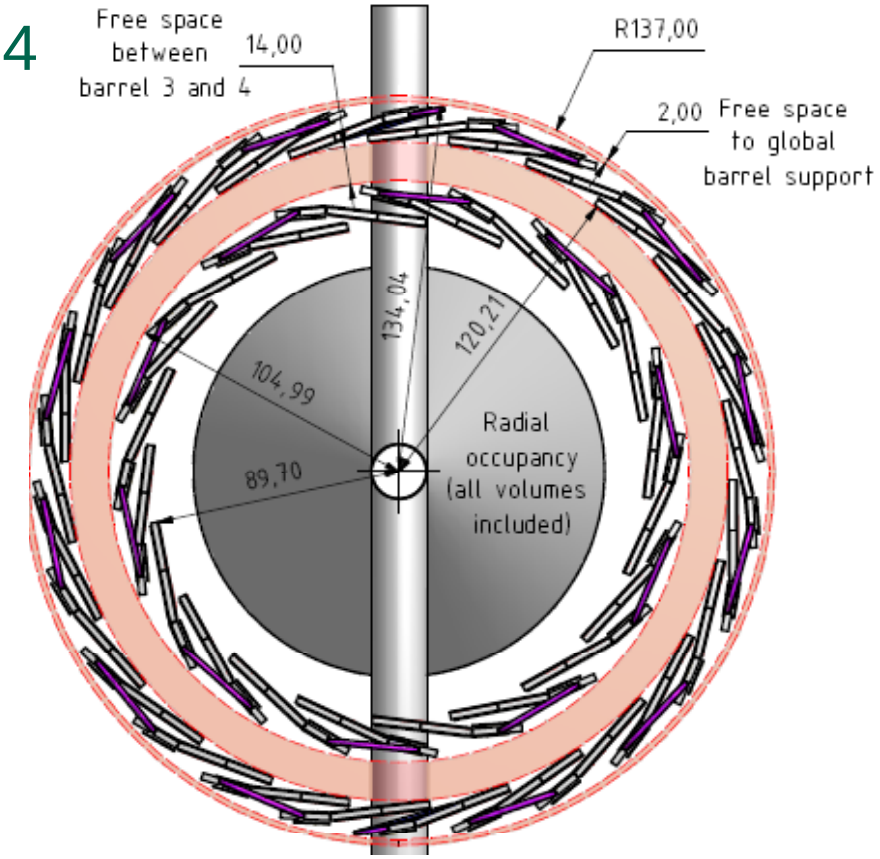
- **Modifications w.r.t.Sv-3.2**
  - Decreased outer radius (- 5mm) due to new MVD routing concept
    - Decreased radius barrel 4: from *r= 130 mm* to r= 125 mm (sensor middle)
    - Shortened trapazoidal sensor height: from *h= 62.67* to h= 57.67 (incl. 1mm passive edge at top and bottom)
  - Correction of slight displacement of target pipe staves (+1mm upstream shift in old version)
  - Correction of wrong hierarchy in forward part and of naming conventions (as discussed in MVD mechanics meeting in Bonn, see minutes >> Link
- Details (Technical drawings): Download PDF
  - PDF file is password-protected;

http://panda-wiki.gsi.de/pub/Mvd/ModelMvd2pt0/Sv-3_3-Docu_PWD.pdf

Updated MVD model

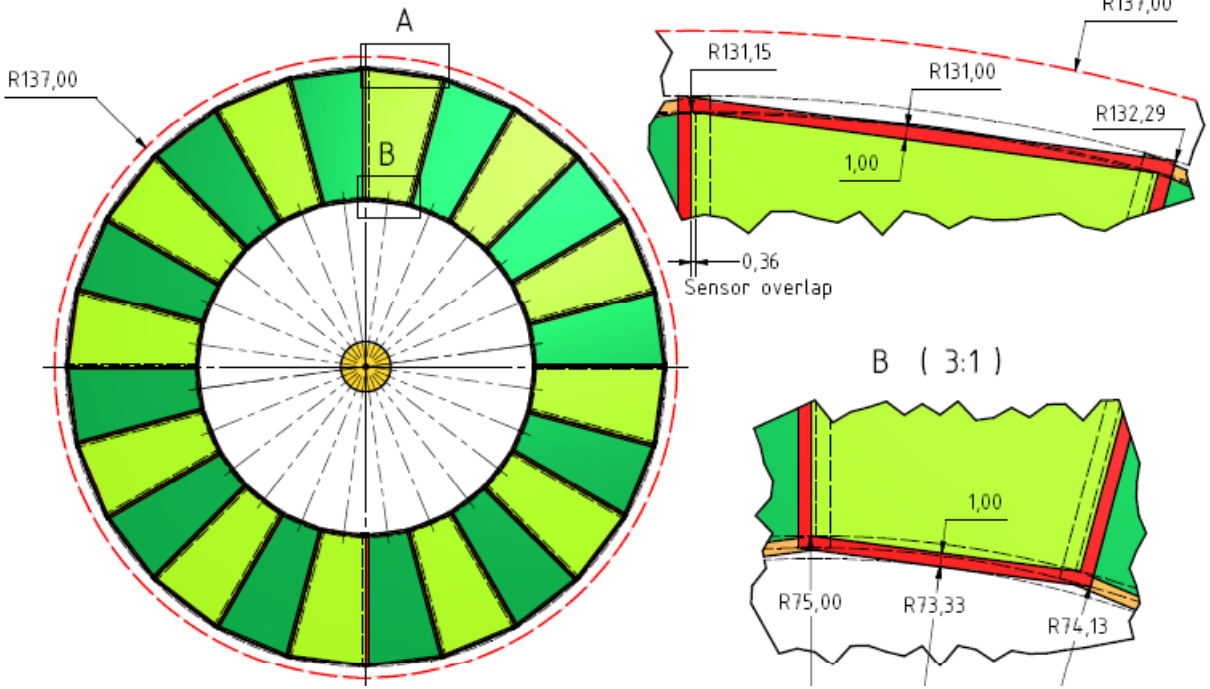
- Strip part: **Sv-3.3**
  - Decrease of outer radius to 135 mm
    - ✓ Smaller barrel radii layer 4
    - ✓ Smaller disk sensor

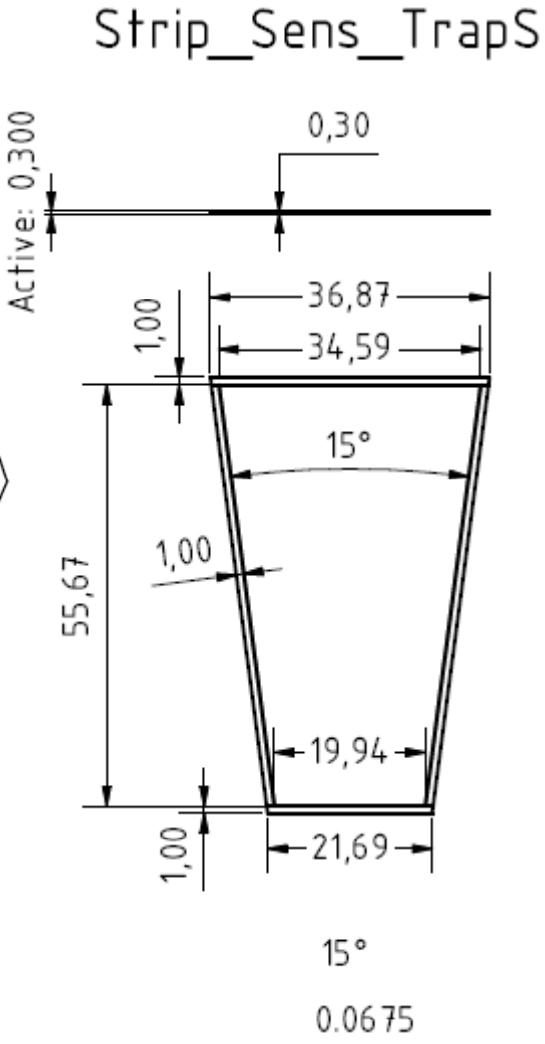




Updated MVD model

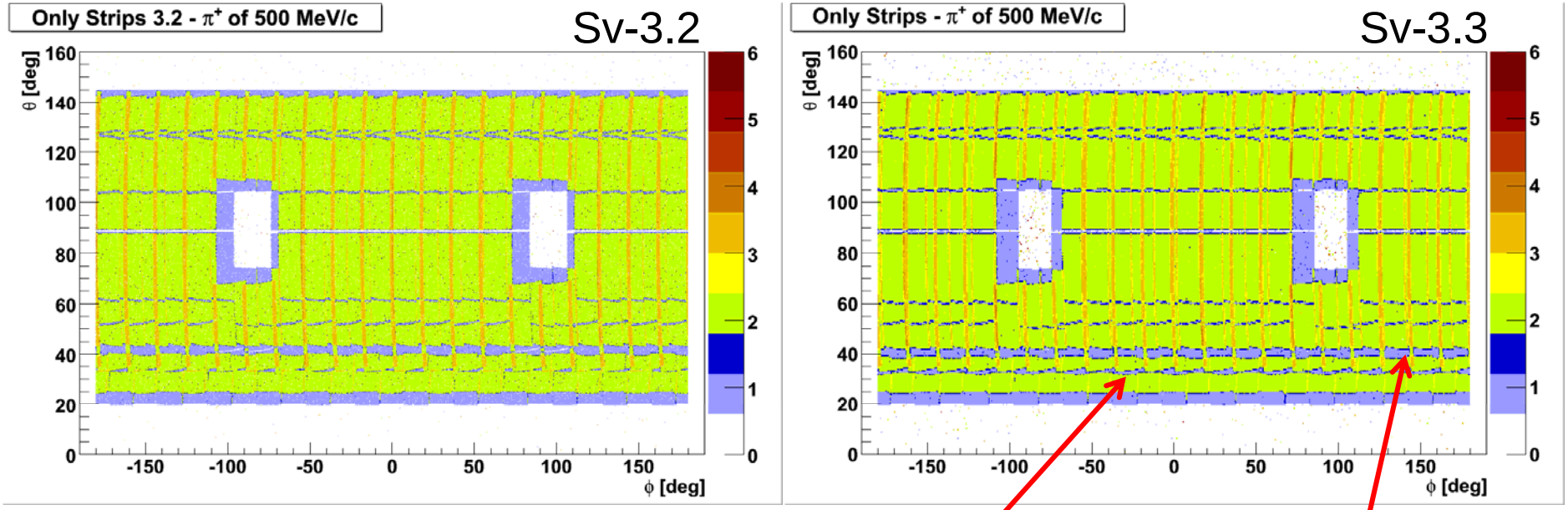
- Strip part: **Sv-3.3**
  - Decrease of outer radius to 135 mm
    - ✓ Smaller barrel radii layer 4
    - ✓ **Smaller disk sensor**





Updated MVD model

- Strip part: **Sv-3.3**
  - Coverage test



  - ✓ No big impact
  - ✓ Slight worsening: Between strip disks / barrel-disk section
    → Expected and acceptable in magnitude

Updated MVD model

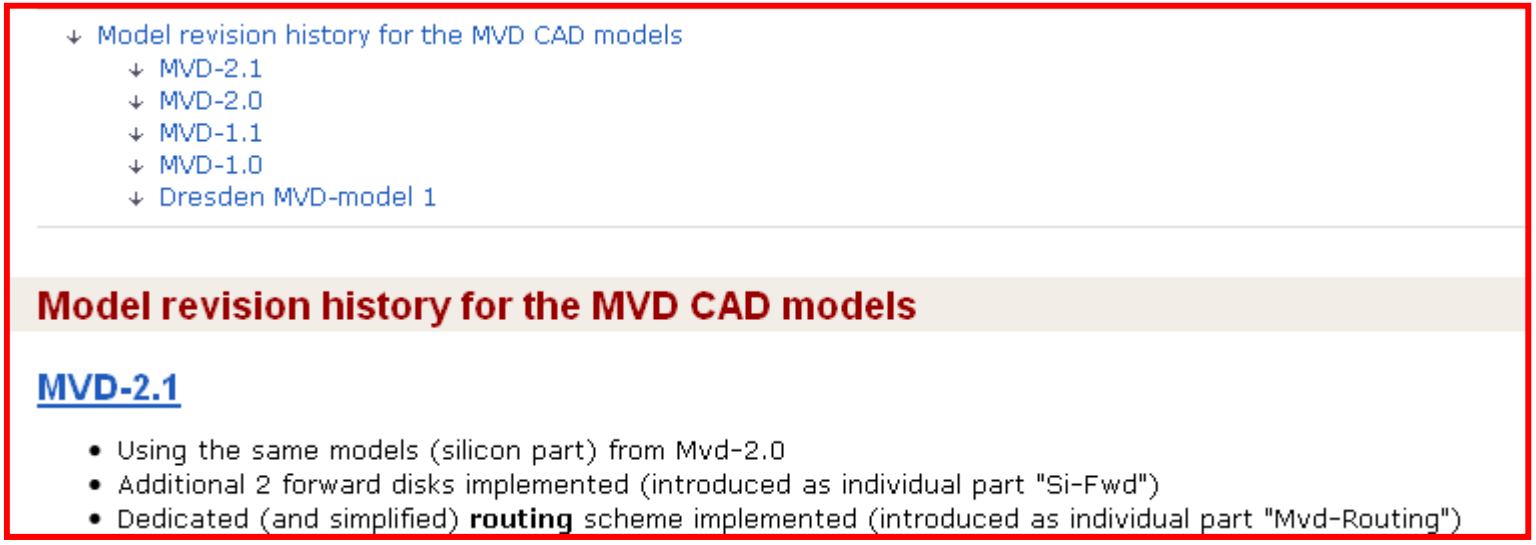
- Pixel part: **Pv-3.1**
  - Slight modifications in barrel part w.r.t. Pv-3.0
  - Redesign of last pixel disk due to beam pipe interaction
  - Introduced support concept for pixel disks
  - Slightly modified barrel support ...
  - More details presented in last updates @ FZJ, GSI CM

  ... Final upload to be done (last checks concerning CAD conventions) ...
- Updated global MVD support
  - See mechanics update (Beppe)

Dedicated routing concept for the MVD

Mvd-2.1: Routing concept

- General idea
  - Using only **silicon part** of MVD-2.0 versions
  - Adding 2 additional silicon forward disks (**Si-Fwd**)
  - Implementing dedicated routing concept for MVD



Mvd-2.1: Routing concept

- General idea
  - Using only **silicon part** of MVD-2.0 versions
  - Adding 2 additional silicon forward disks (**Si-Fwd**)
  - Implementing **dedicated routing concept for MVD**
    - ✓ Based on former assumptions and concepts presented at last collaboration meetings
    - ✓ Respecting latest MVD updates
    - ✓ Representing reasonable compromise between mechanics model (space), electronics development (starting at frontend level) and physics considerations
    - ✓ Balancing existing (still remarkable) uncertainties

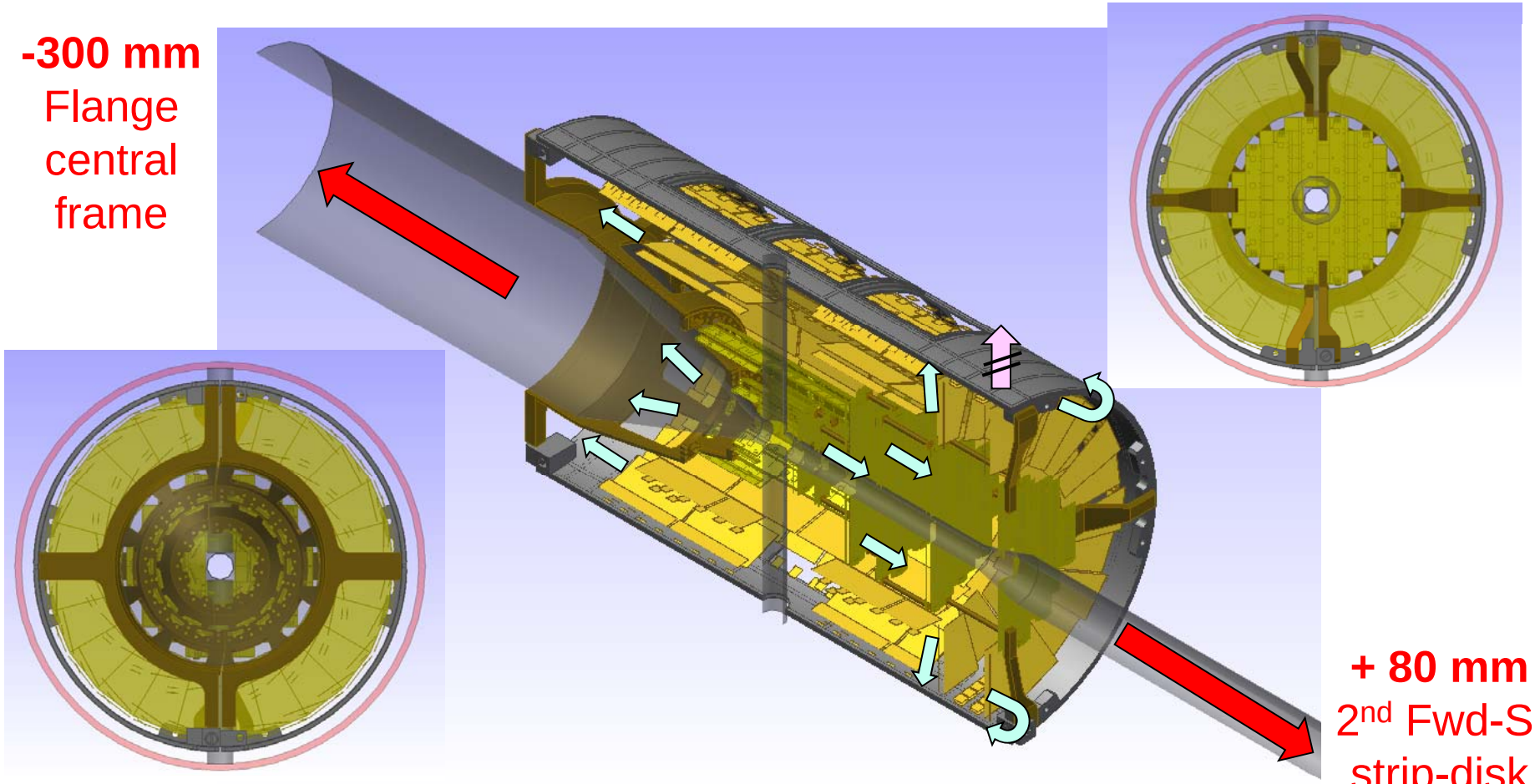
Mvd-2.1: Routing concept

- Purpose
  - Testing the feasibility of routing concept
    - ✓ Space requirements
    - ✓ Collision check
    - ✓ Ideas of installation sequence
  - Checking physics performance (simulations!)
    - ✓ Radiation length mapping
      - → Average values and fluctuations
      - → Identification of hot-spots
  - Extraction of simplified model for simulation software (→ reliable numbers ... also w.r.t. TDR)

Mvd-2.1: Routing concept

- Starting point: Silicon part + main support structure

-300 mm
Flange central frame



+ 80 mm
2nd Fwd-Si strip-disk

Mvd-2.1: Routing concept

- Starting point: Implementation
  (as discussed and presented in former meetings)
  - Bus cable (Signals)
    - ✓ Conducting core (10%) → *Al*
    - ✓ Insulation (90%) → PE
  - HV lines (Sensor depletion) → *Al*
  - Supply lines (Frontends) → *Cu*
  - Cooling
    - ✓ Coolant → Water
    - ✓ Pipe (2 mm diameter) / Insulation → Steel / PE
  - Support structure (local) → *C* or *C*-foam

Mvd-2.1: Routing concept

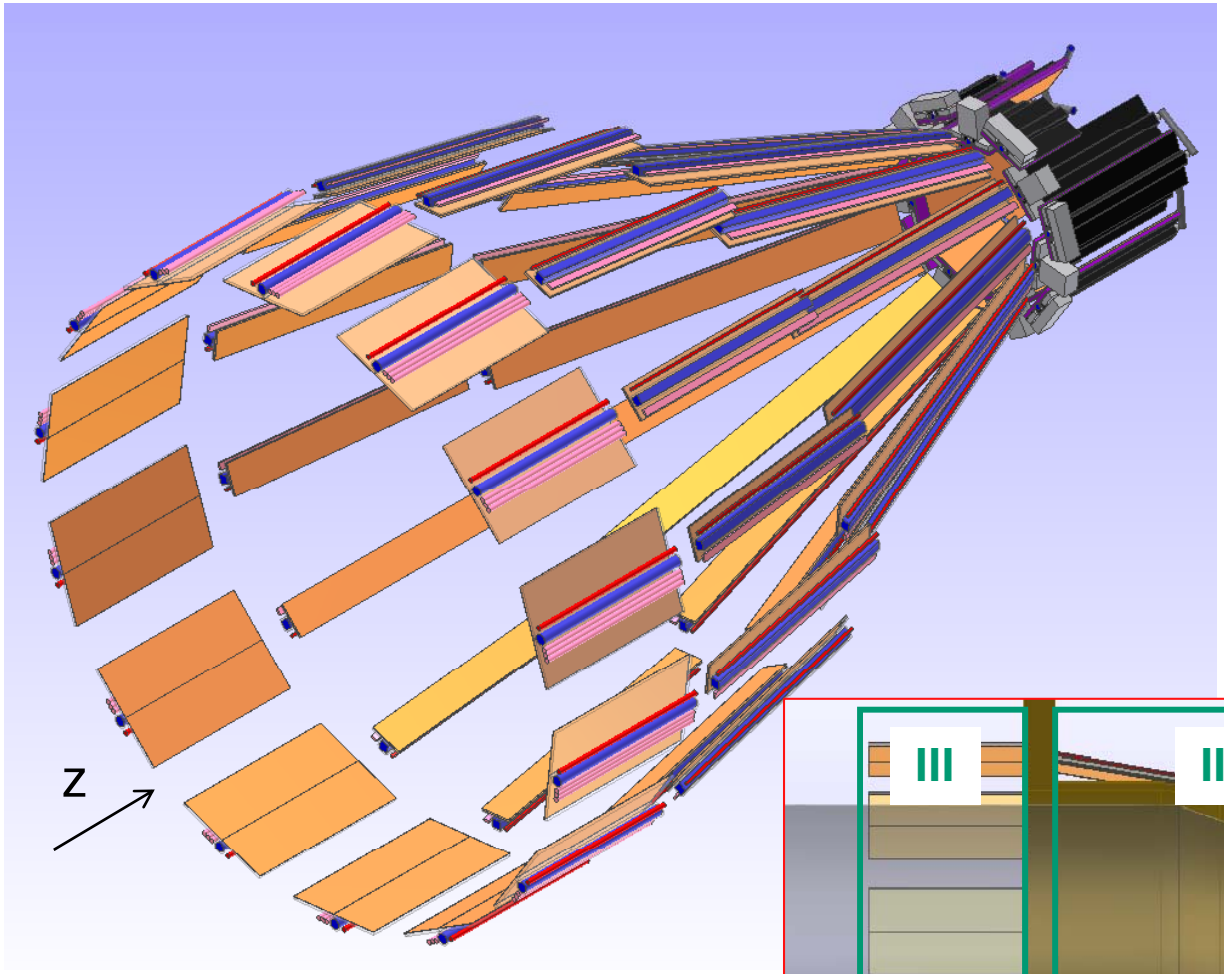
- Starting point: Scaling w.r.t. # of channels
  (as discussed and presented in former meetings)
  - Bus cable (Signals)
    - ✓ Pixel part: 1 cable / 2 frontend chips
    - ✓ Strip part: 1 cable / 4 frontend chips
  - HV lines (Sensor depletion): 1 line / sensor
  - Supply lines (Frontends): 1 line / frontend
  - Cooling
    - ✓ Barrel part: 1 pipe / stave
    - ✓ Disks, pixel part: 1 / 3 pipe(s) for small / large half-disk
    - ✓ Disks, strip part: 1 pipe / singular sensor segment

Mvd-2.1: Routing concept

- Not implemented
  - **Connectors (neither cooling nor signal or cable)**
  - Further electrical components (e.g. SMD)
  - Electrical conversion (Optoelectroinical-boards)
  - Cooling splitters

  - Routing at regions from z = -300 mm ... – 1000 m
    → Simplified model presented in previous meeting
    → Implementation in next step
  - Barrel support structures and global MVD support
    → Implemented with simplified modules in last step ...

MVD-2.1: Routing barrel 1



O: Sensor region

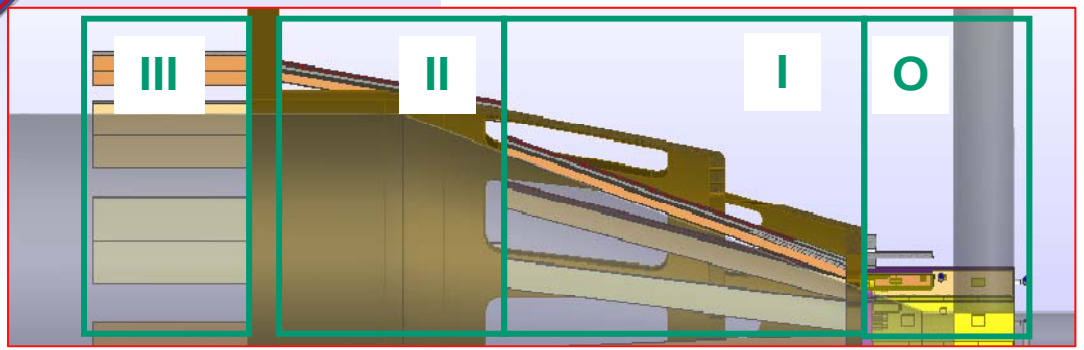
I: Inner routing

- Along beam pipe
- In between beam pipe and support cone

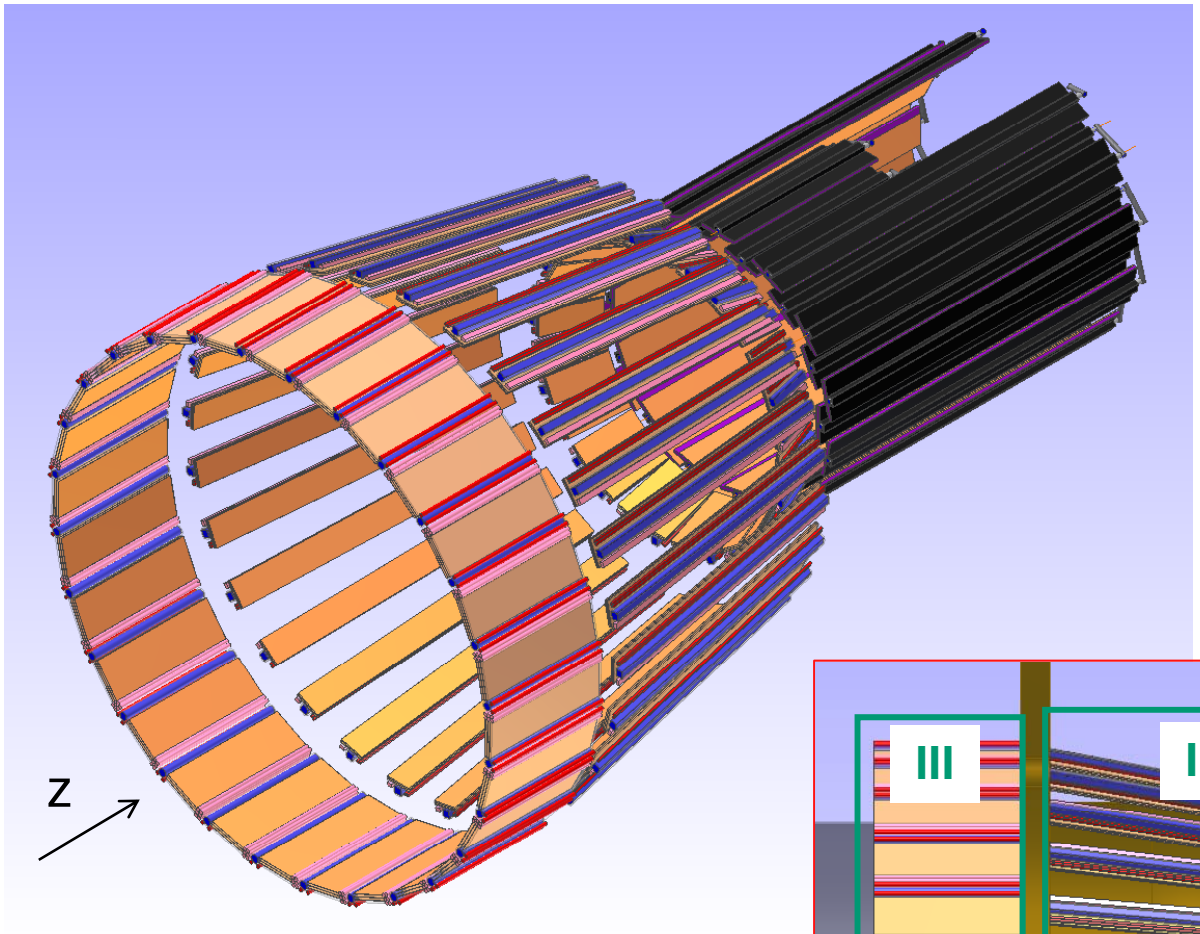
II: Outer routing

- Along support cone
- Until support cone flange

III: Until z = -300 mm



MVD-2.1: Routing barrel 2



O: Sensor region

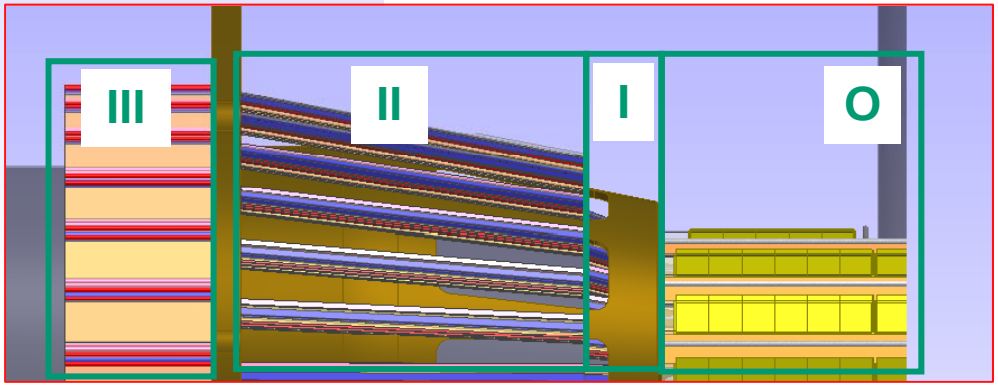
I: Inner routing

- Along beam pipe
- In between beam pipe and support cone

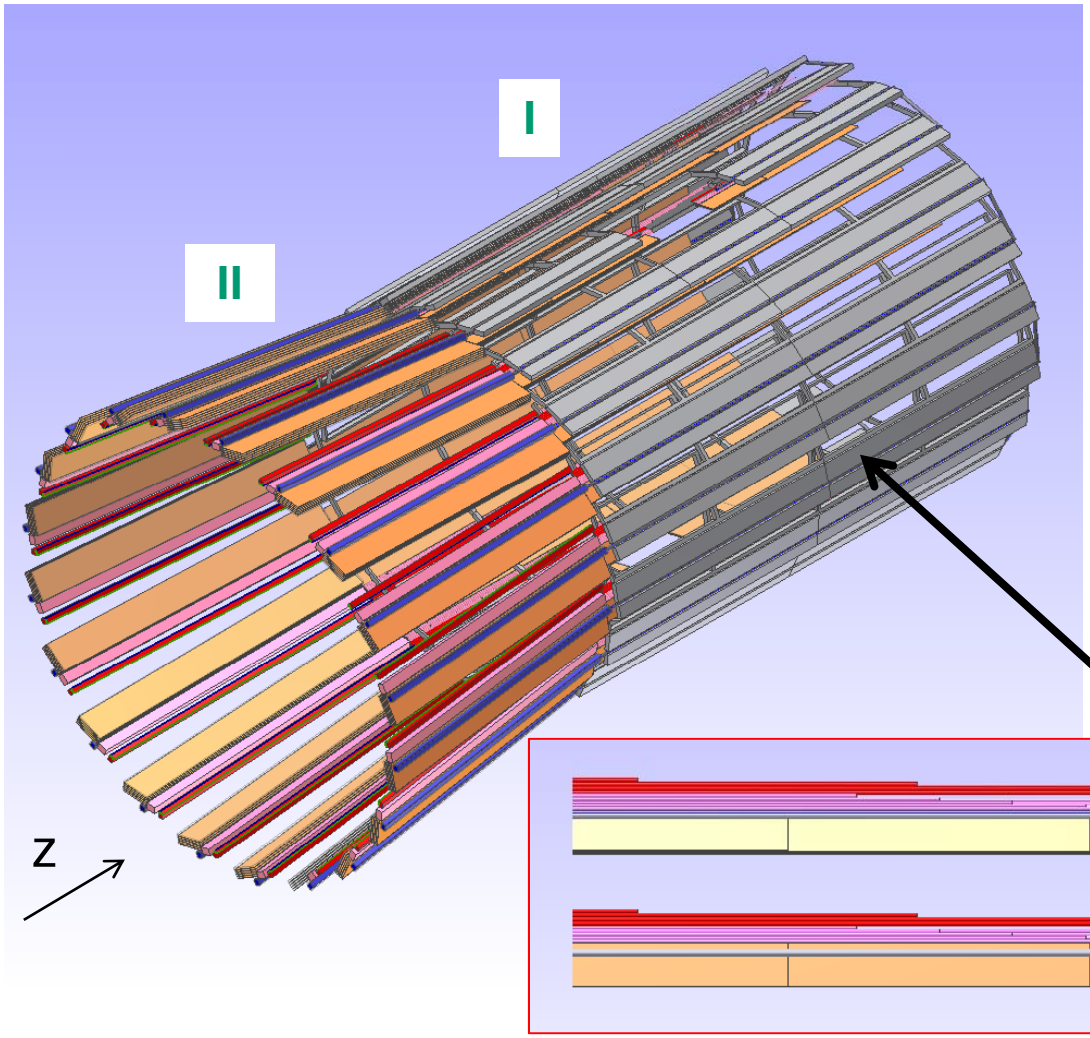
II: Outer routing

- Along support cone
- Until support cone flange

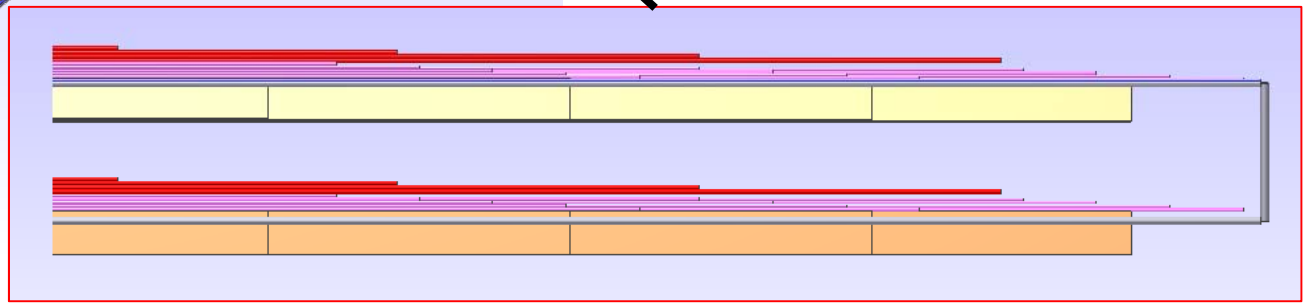
III: Until z = -300 mm



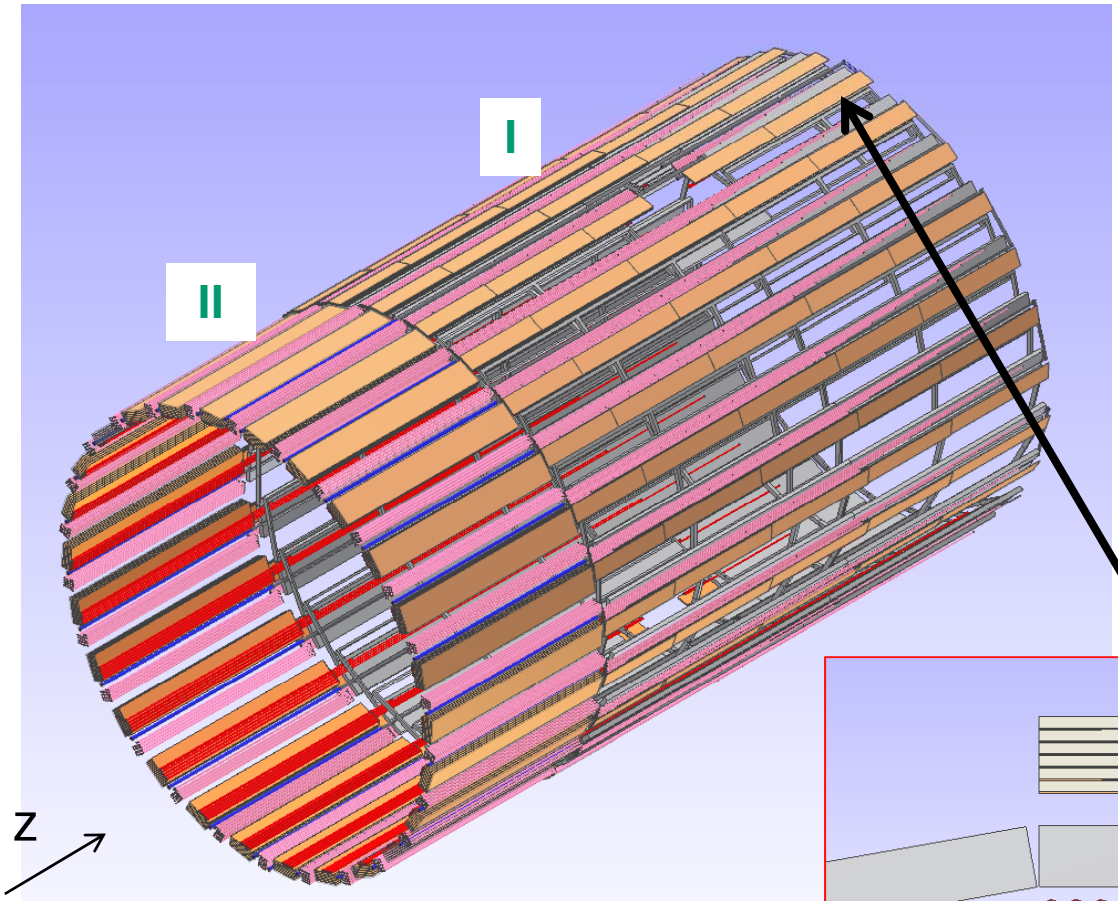
MVD-2.1: Routing barrel 3



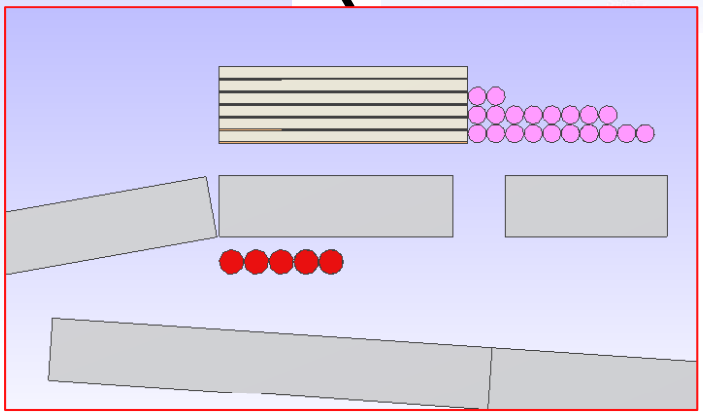
I: Along staves
II: Until z = -300 mm



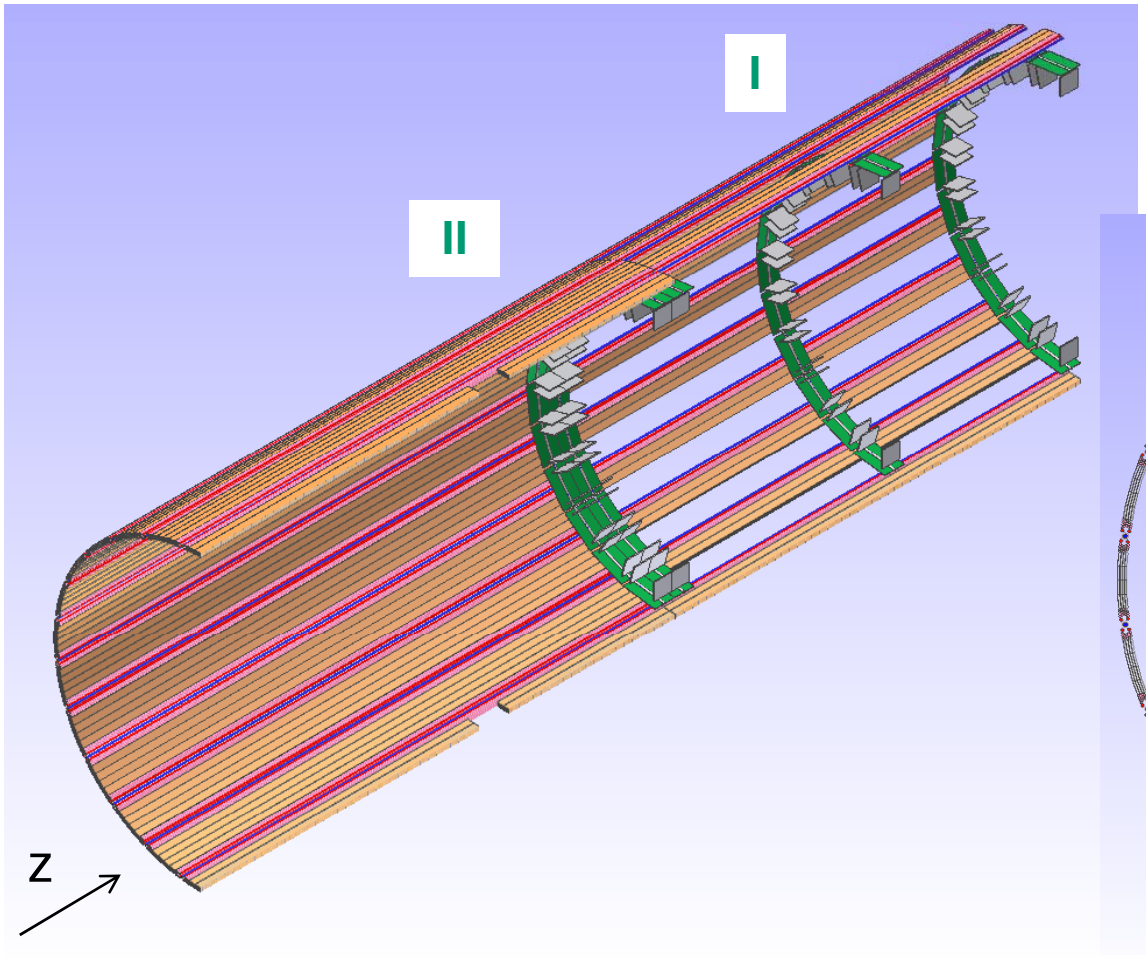
MVD-2.1: Routing barrel 4



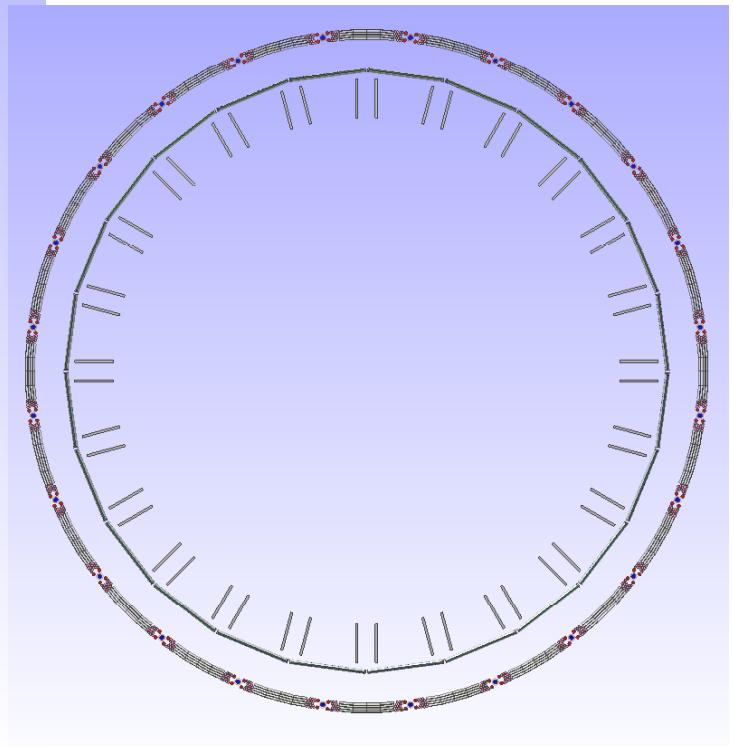
I: Along staves
II: Until z = -300 mm



MVD-2.1: Strip disks



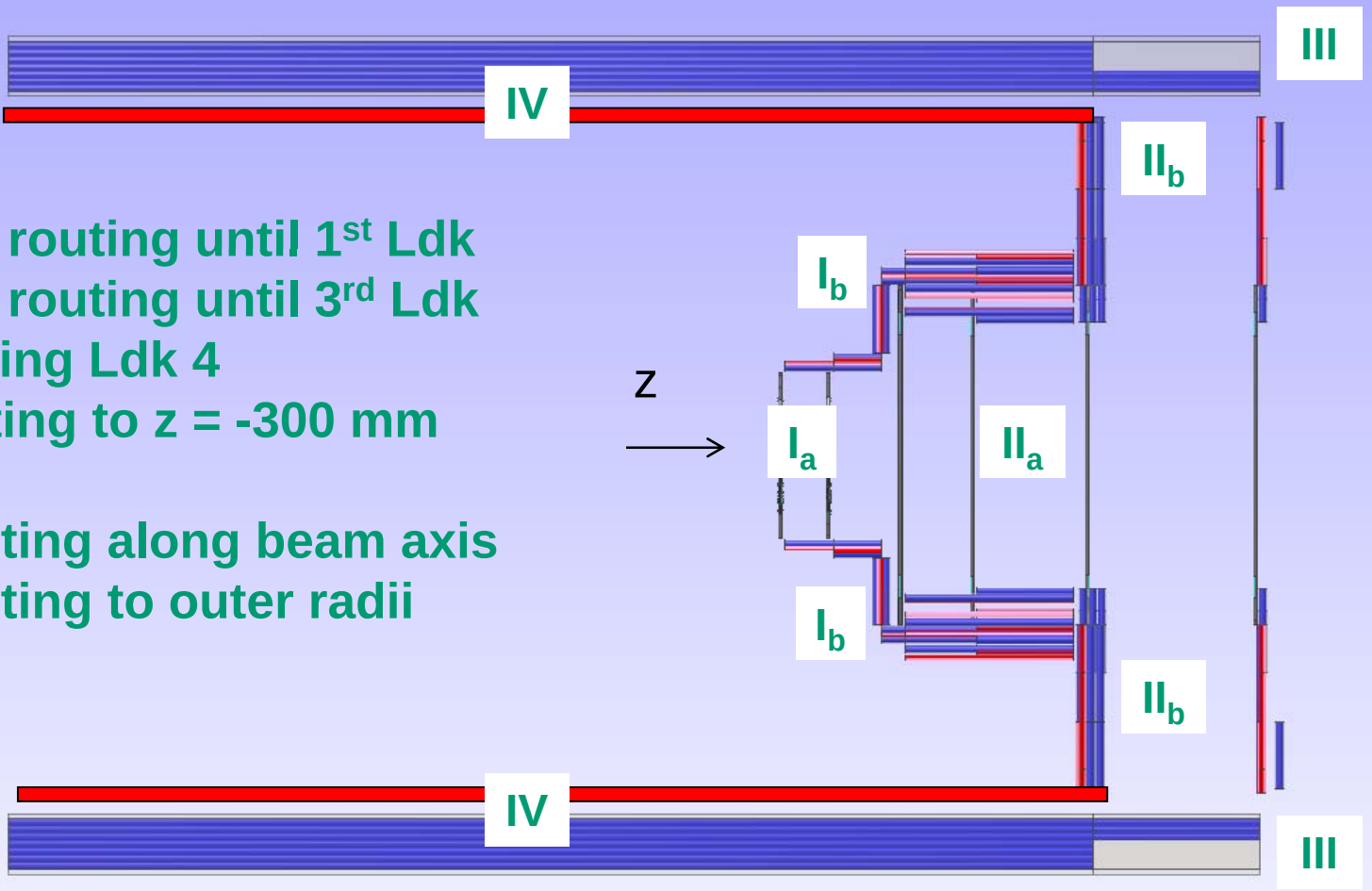
I: Additional disk routing
II: Until z = -300 mm



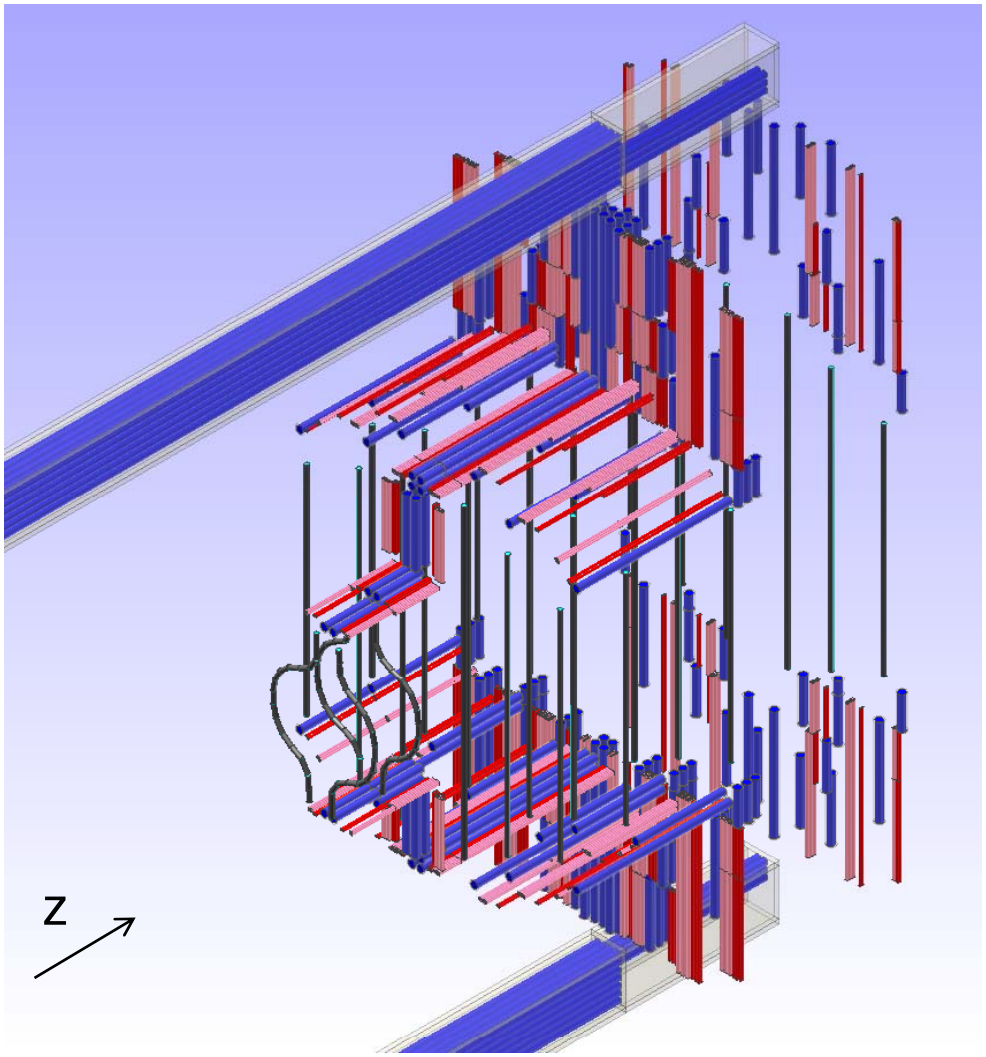
MVD-2.1: Pixel disks

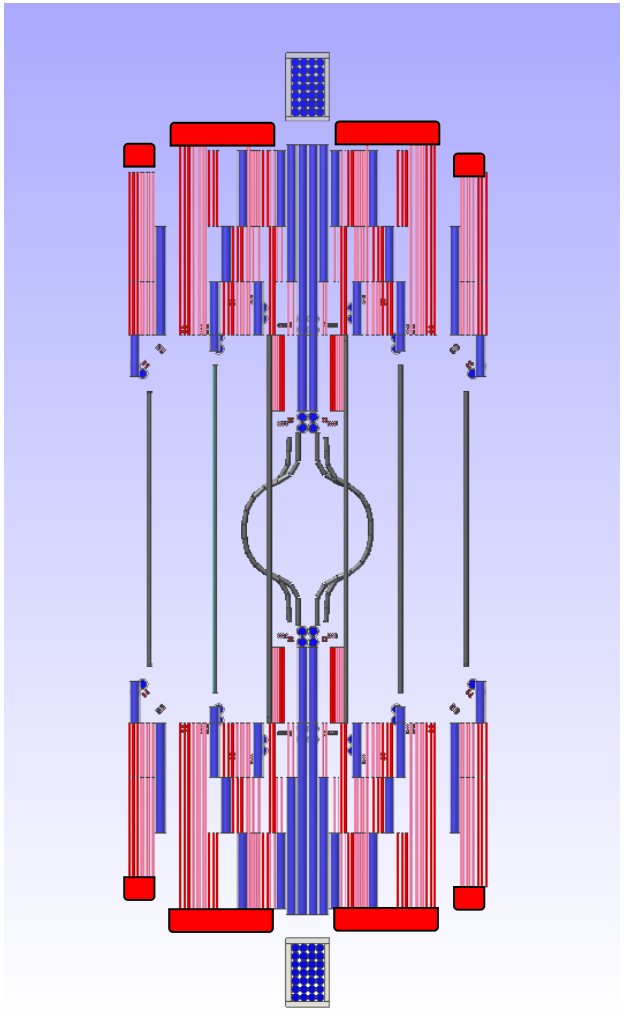
I: Inner routing until 1st Ldk
II: Inner routing until 3rd Ldk
III: Routing Ldk 4
IV: Routing to z = -300 mm

(a) Routing along beam axis
(b) Routing to outer radii



MVD-2.1: Pixel disks





Simulation results: Radiation length mapping

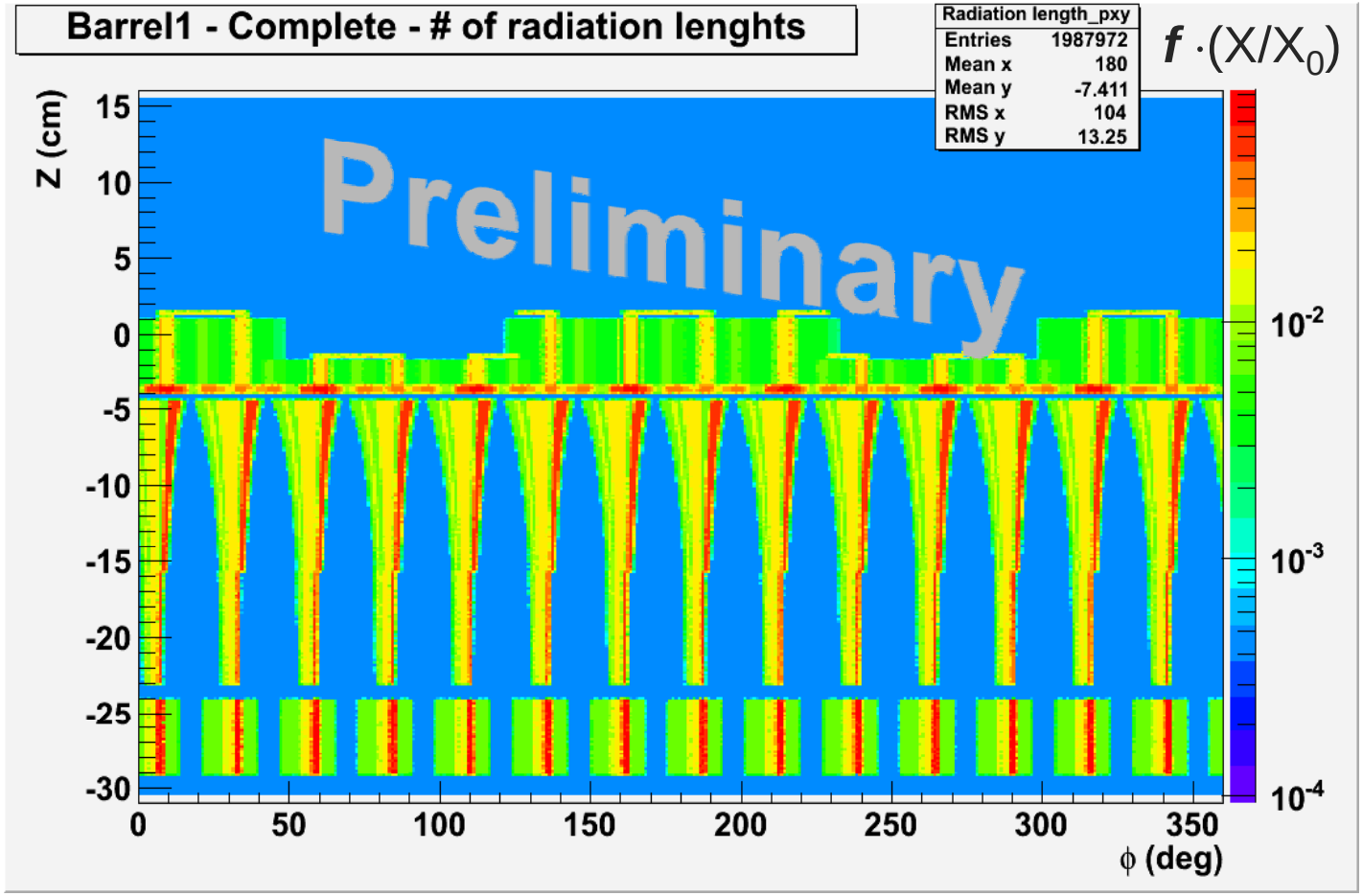
Radiation length studies

- Input parameters
  (as discussed and presented in former meetings)
  - Bus cable (Signals) → Width: 10 mm ... 15 mm
    - ✓ Conducting core, Thickness: 50 μm ... 100 μm
    - ✓ Insulation, Thickness: 450 μm ... 900 μm
  - HV lines → Diameter: 1.0 mm ... 1.5 mm
  - Supply lines → Diameter: 0.75 mm ... 1.0 mm
  - Cooling → Diameter: 2 mm ... 4 mm
    Wall thickness: 0.2 mm ... 0.5 mm
  - Carbon (foam) structures → Thickness: 0.2 mm ... 3.0 mm

... Higher numbers at regions far away from interaction point

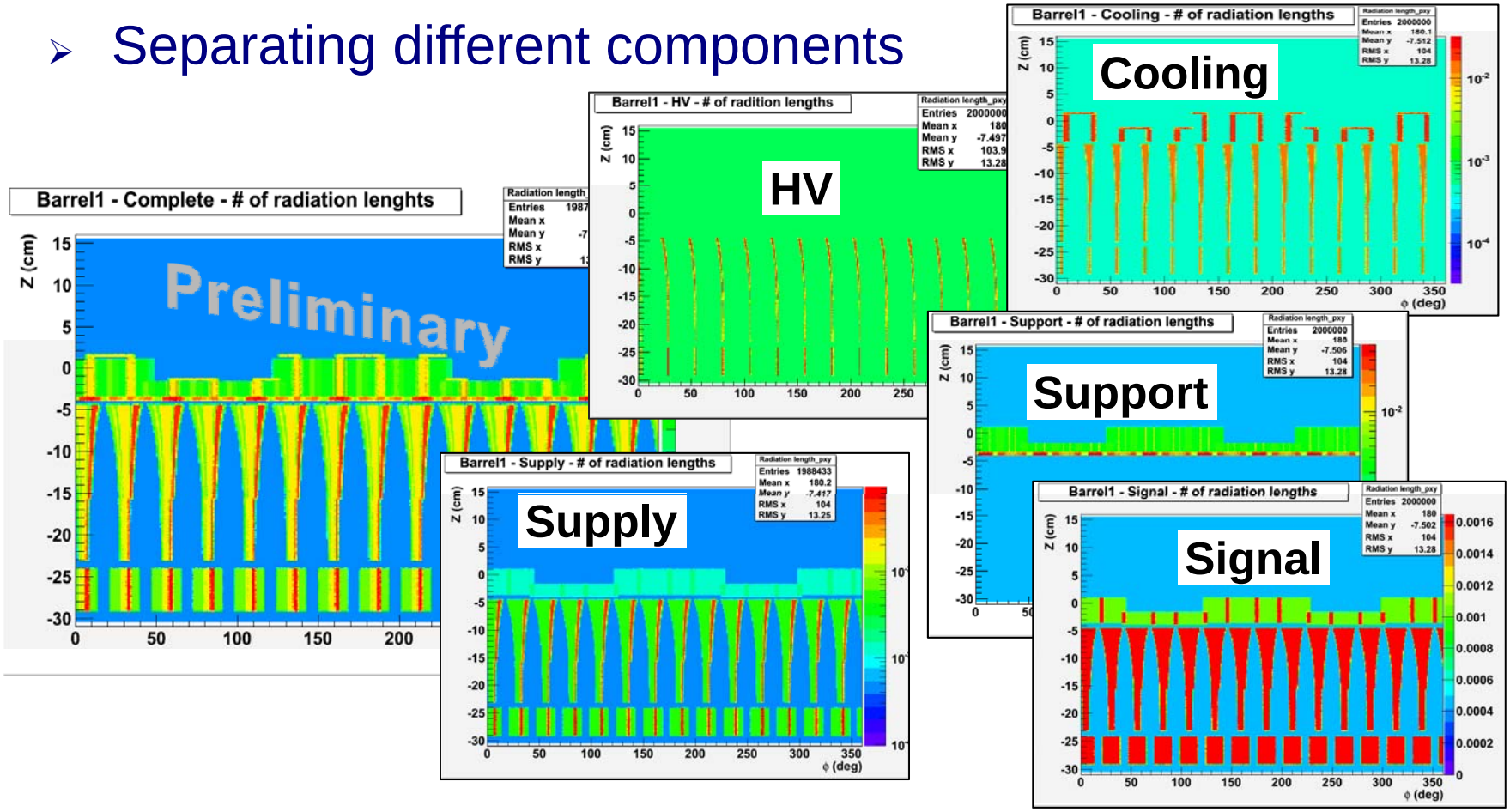
Radiation length studies

- Selected results: Scanning along beam axis



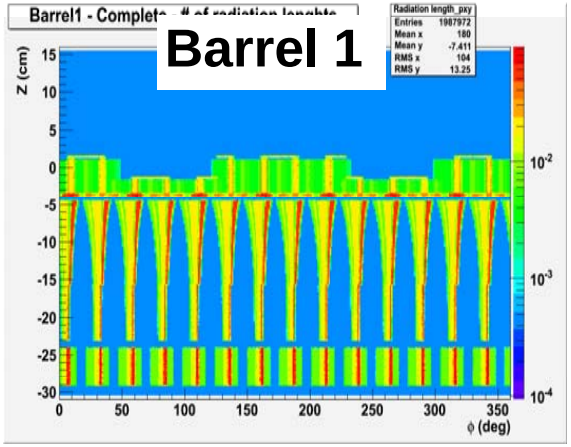
Radiation length studies

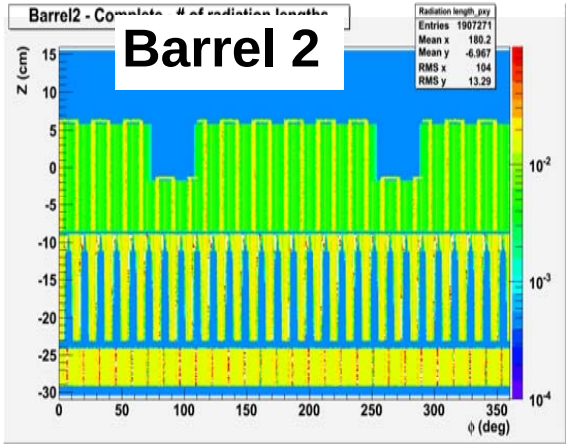
- Selected results: Scanning along beam axis
  - Separating different components

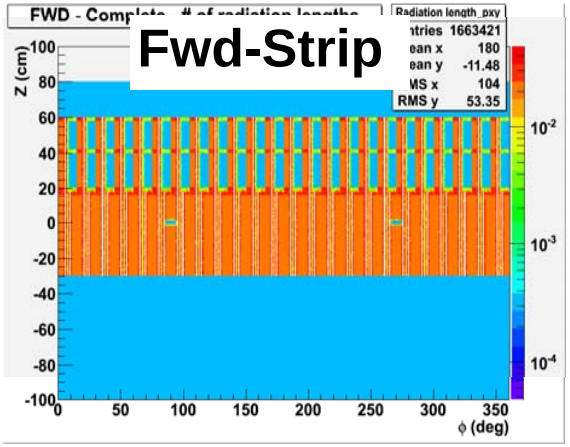


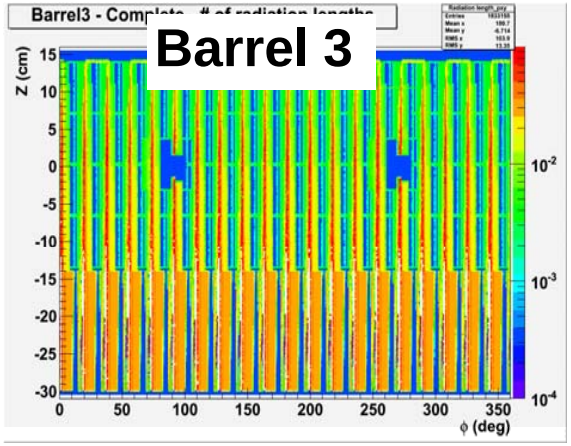
Radiation length studies

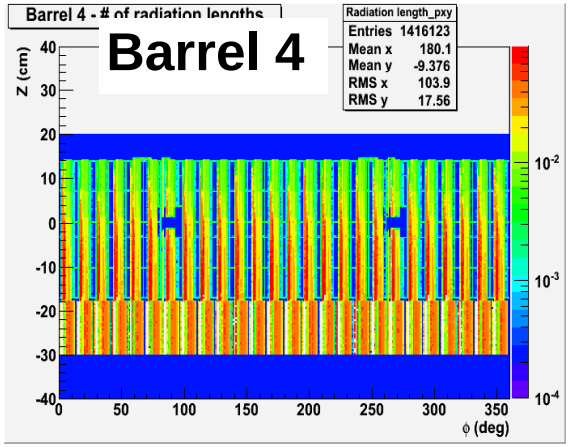
- Selected results: Scanning along beam axis

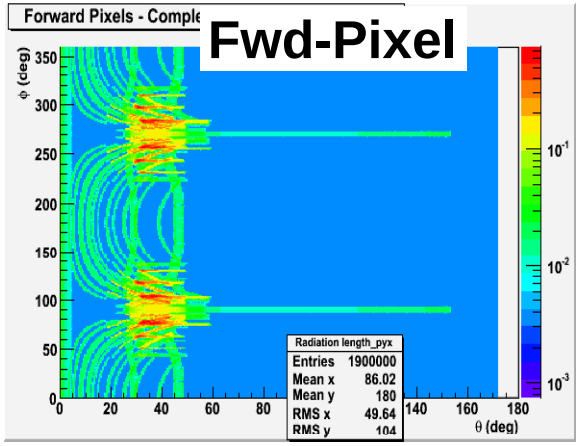






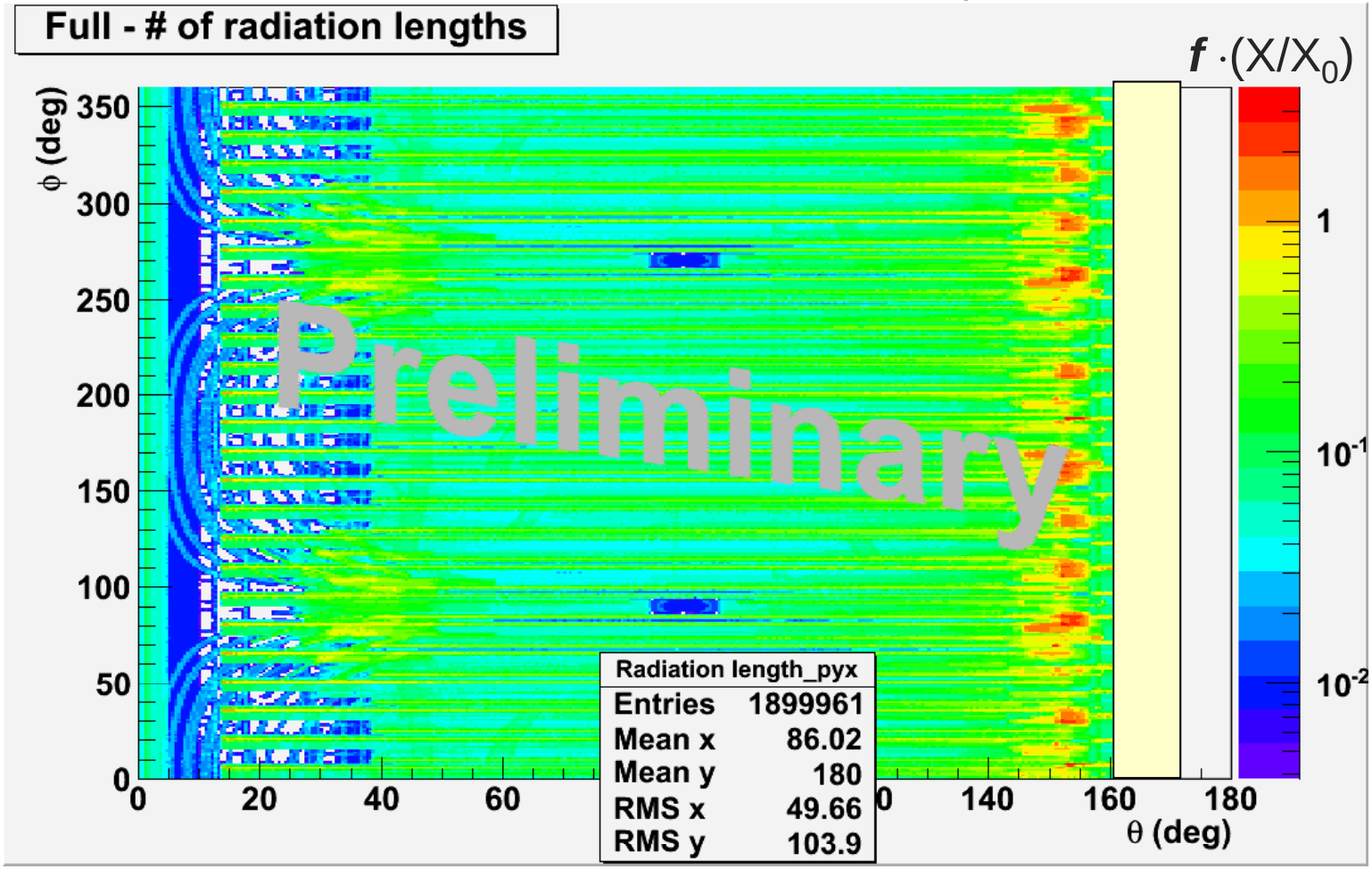






Radiation length studies

- Selected results: Polar mapping (θ-ϕ)



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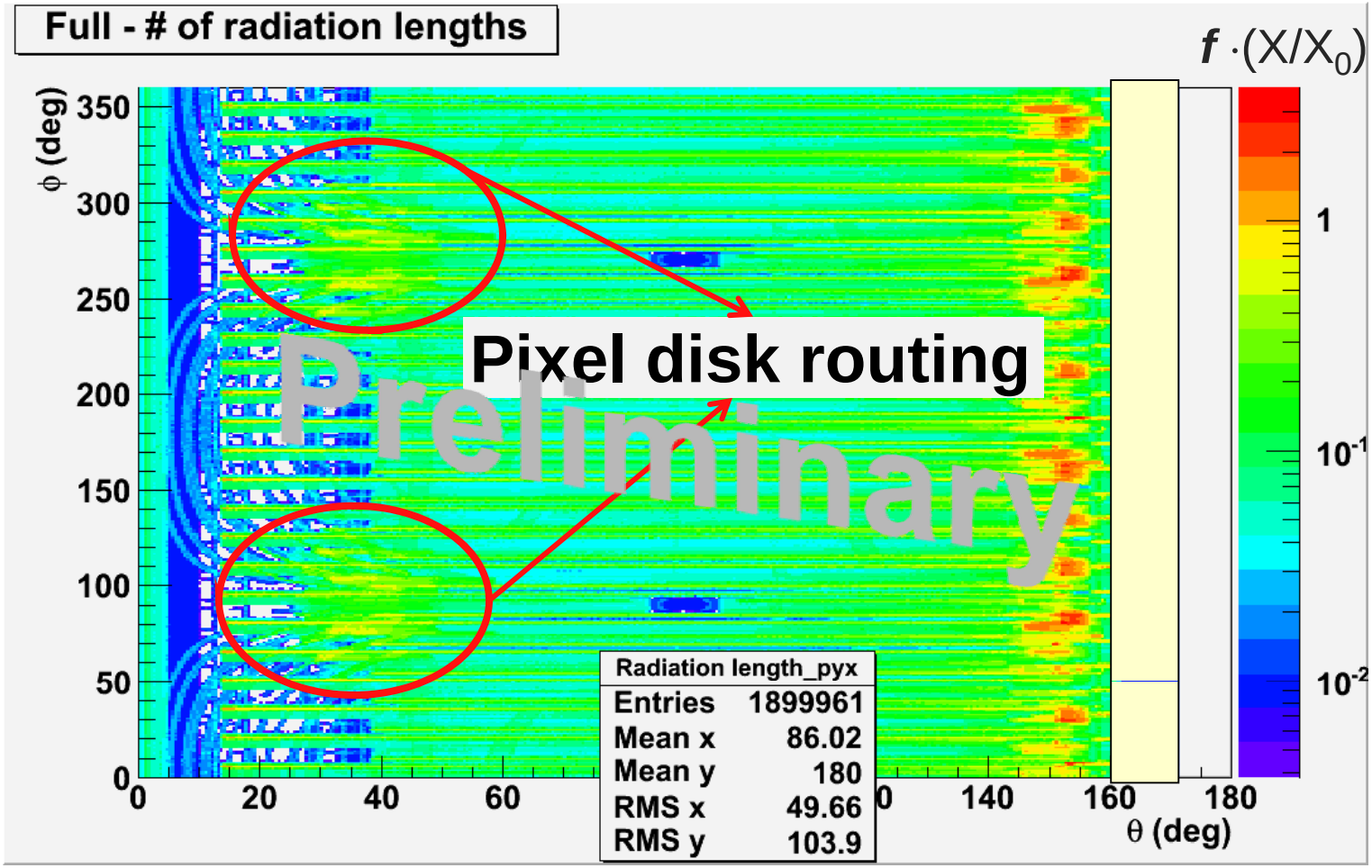
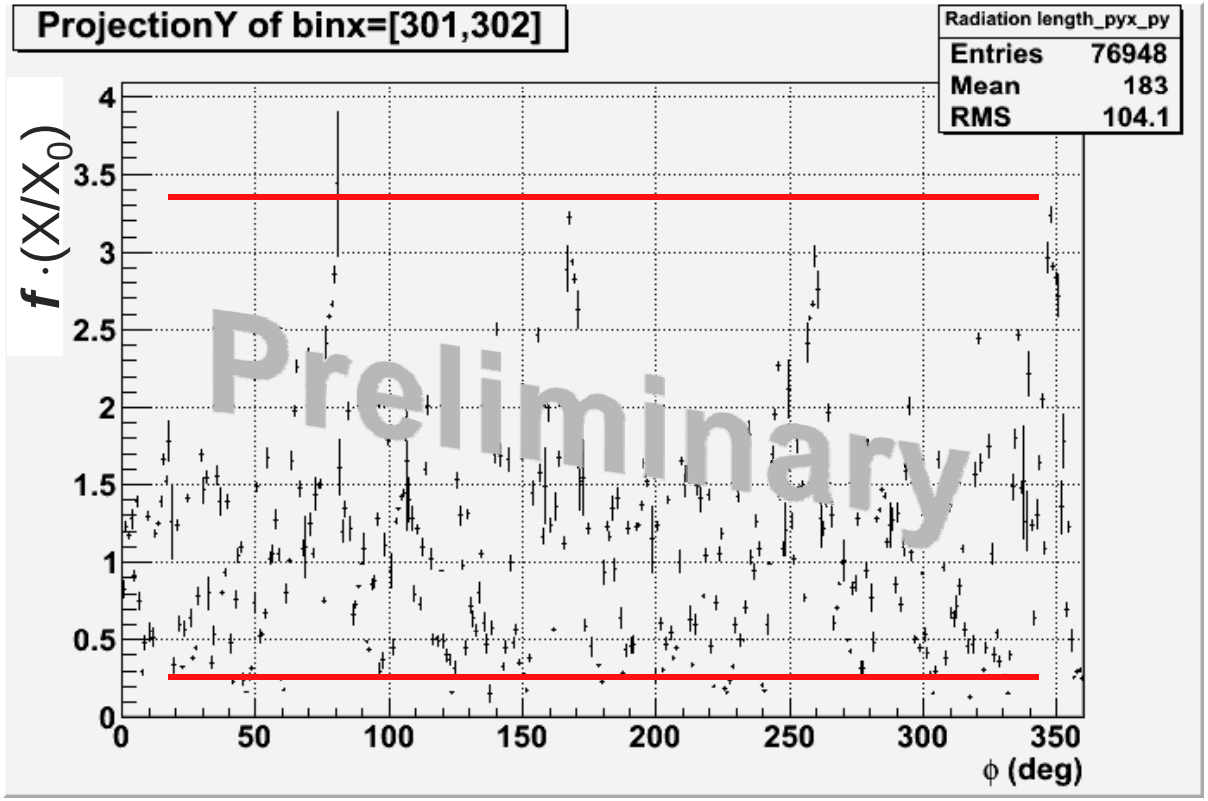


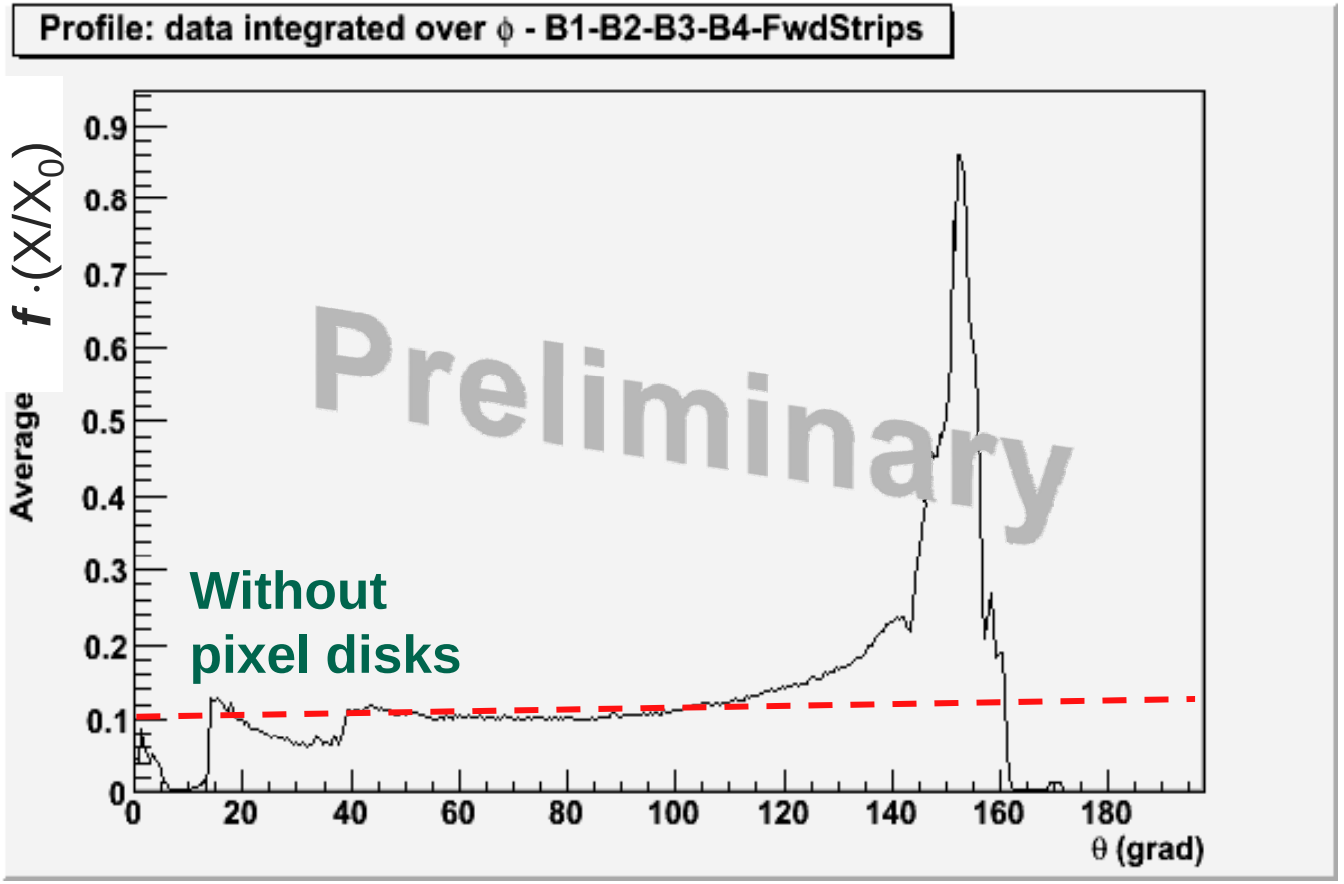
Radiation length studies

- Selected results: Scan for fixed polar angle (155 °)
  - Huge fluctuations ~ 1 order of magnitude



Radiation length studies

- Selected results: Polar angle projection (ϕ integrated)



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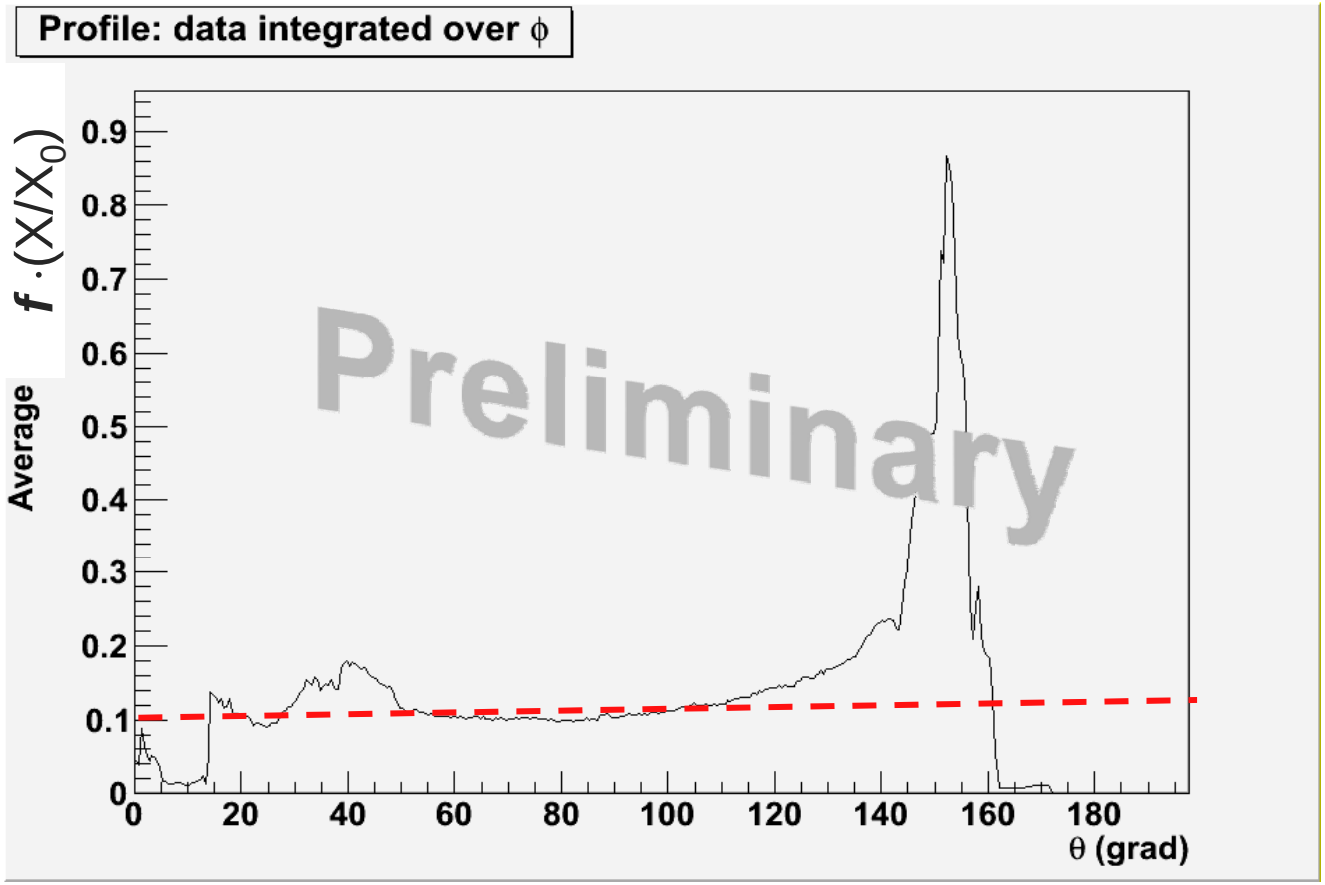
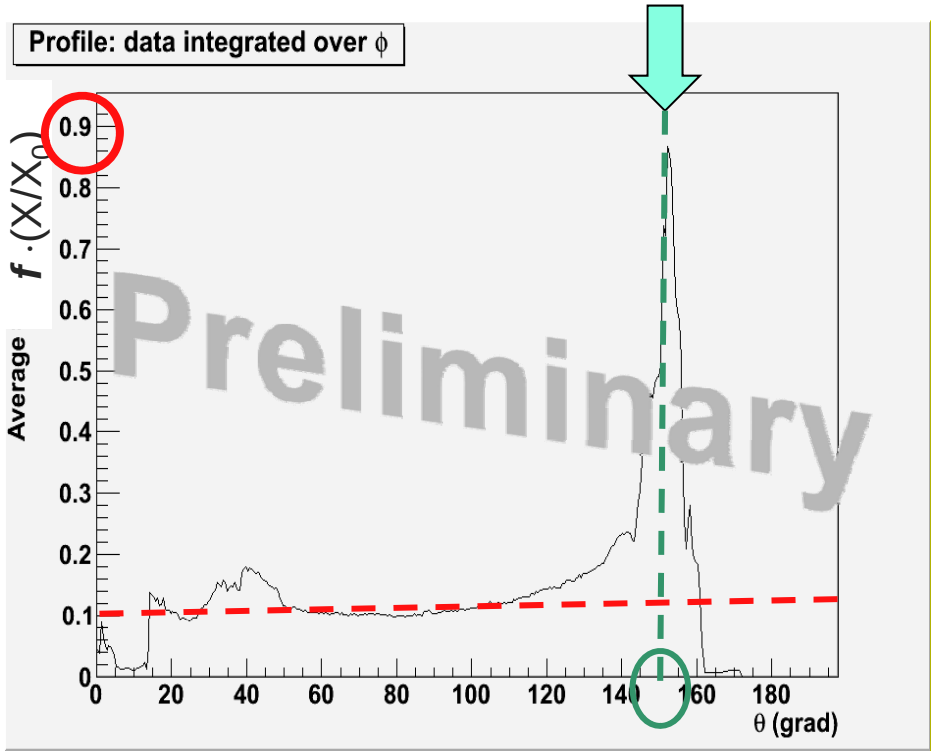
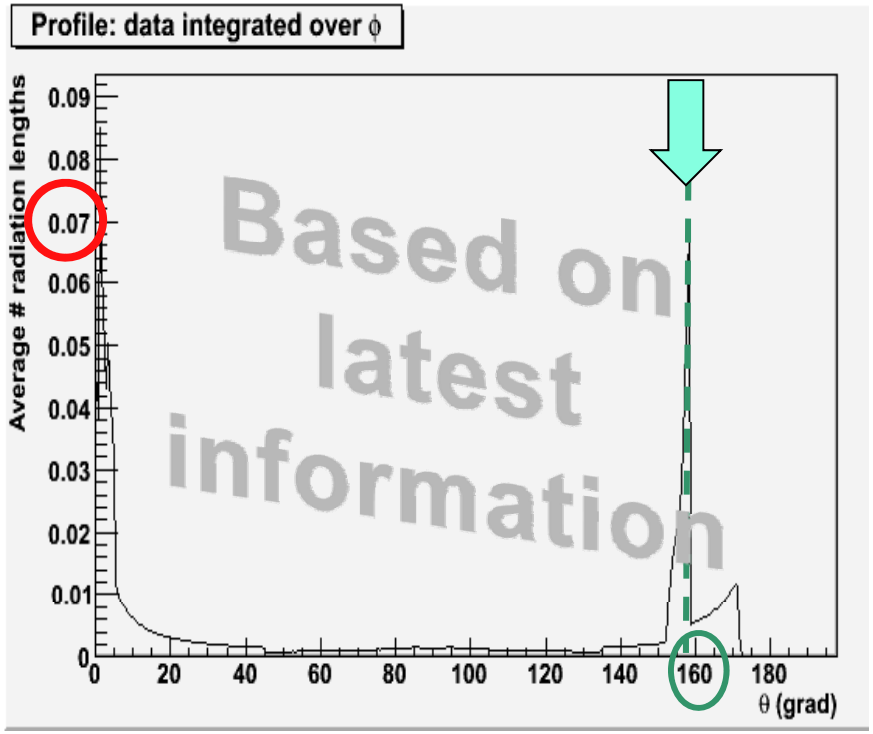


Radiation length studies

- Selected results: Polar angle projection (ϕ integrated)
  - Comparison with beam pipe





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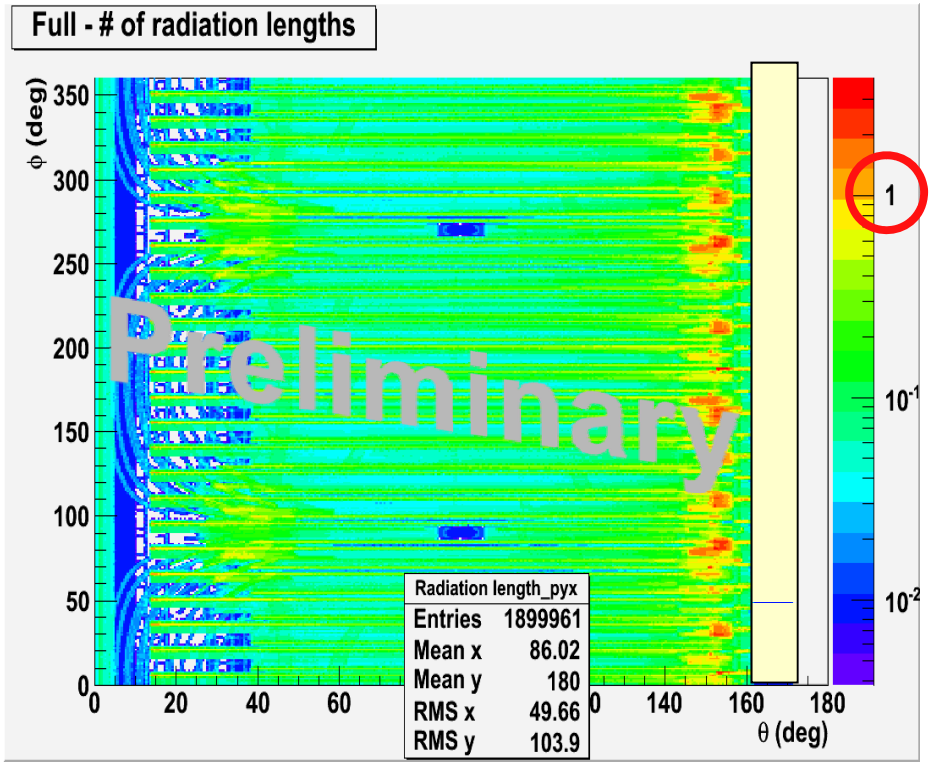
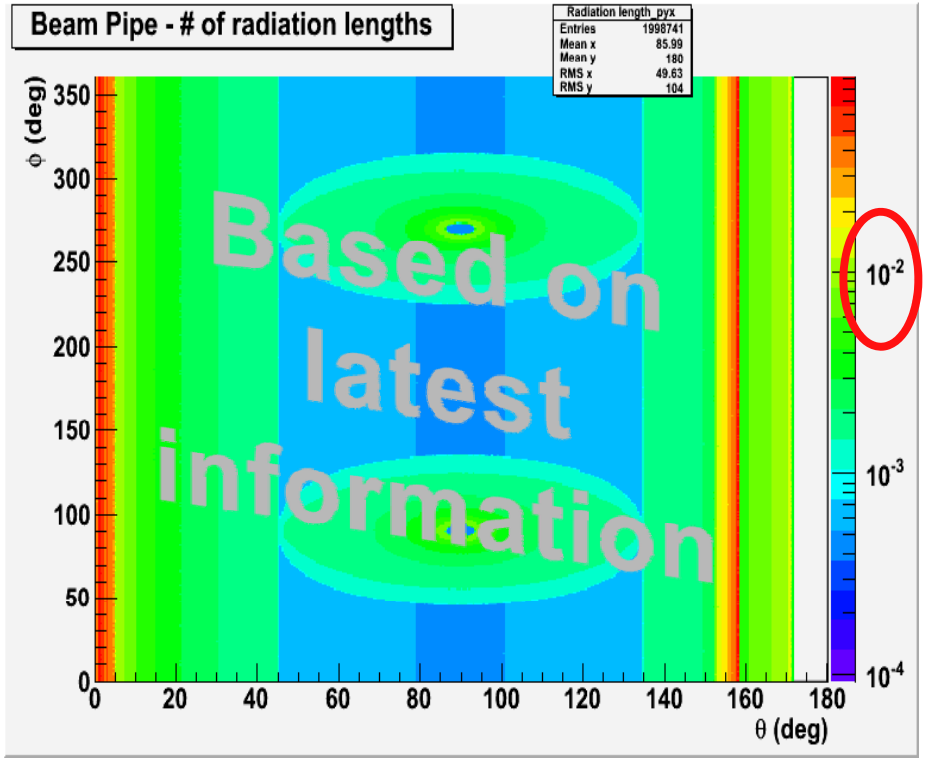
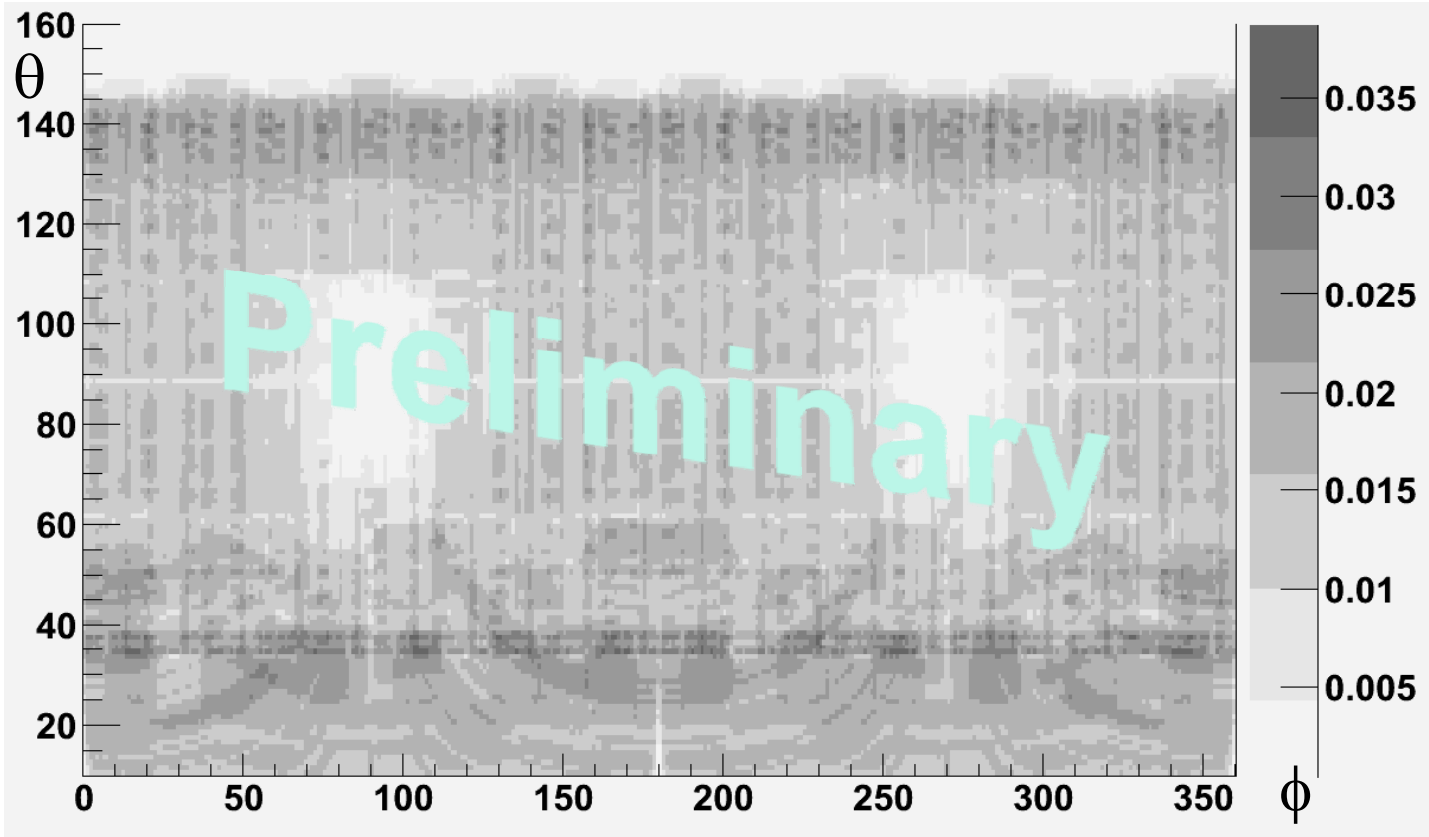




Radiation length studies

- Selected results: Silicon part (in addition to routing)
  - ~1% radiation length



Summary and conclusions

Summary

- Updated subversion Sv-3.3 passed coverage test
- **Implementation of an overall routing concept**
  - Proof of feasibility → No collisions with Mvd-2.0 parts! ☺
  - First complete radiation length studies
    → Obtained results allow already qualitative discussion
    → Input parameters to be checked carefully
    ... Dedicated meeting in beginning of next year (January)
    → Total numbers still inhibit scaling factor ***f*** (~1/n, n~2...5)
  - Extraction of a simplified model for detector simulation
    → Generalized layers (cylinder, cones) along beam axis
    → Averaged values according to material contributions (density, *Z*) / layer thickness defined by given rad length

Comments and questions

- Software implementation
  - Proper definition of middle point of volume crucial!
    → see talk of Simone

  ... Only due to CAD converter or general problem?
- Radiation length at higher polar angles (> 140°)
  - Rapid increase reaching (several) full radiation lenght(s)
  - Beam pipe contribution has (nearly) no impact
  - Any optical conversion (earliest after cone) has no impact or huge effect in reducing the number
    → Position corresponds to angles around 150°
    ... Reduction afterwards
    ... Increase (!) of material in sensitive region

Comments and questions

- Implementation of “smeared” layers accounting material budget of all non-silicon parts
  - High fluctuation over full ϕ

  ... In which way / how much to be taken into account?
- CF flange at z = -300 mm
  - Careful check of cross section left out for MVD routing
    ... Currently sufficient but at the limit!
- Robust model relatively insensitive w.r.t. modifications
  - Scaling factor ***f*** = f (thickness, crossing path, # channels)

  ... However, 1st results already reflect right order of magnitude

Roadmap

- Dedicated **MVD internal** meeting
  to fix input parameters ~ January 2010
- Implementation of updated MVD-2.1
  model into simulation software before March 2010
- Design description and extraction
  of reliable numbers for TDR ~ June 2010

... Updated model for detector simulation and some design fixations for TDR do not stop further mechanics and electronics development in parallel!