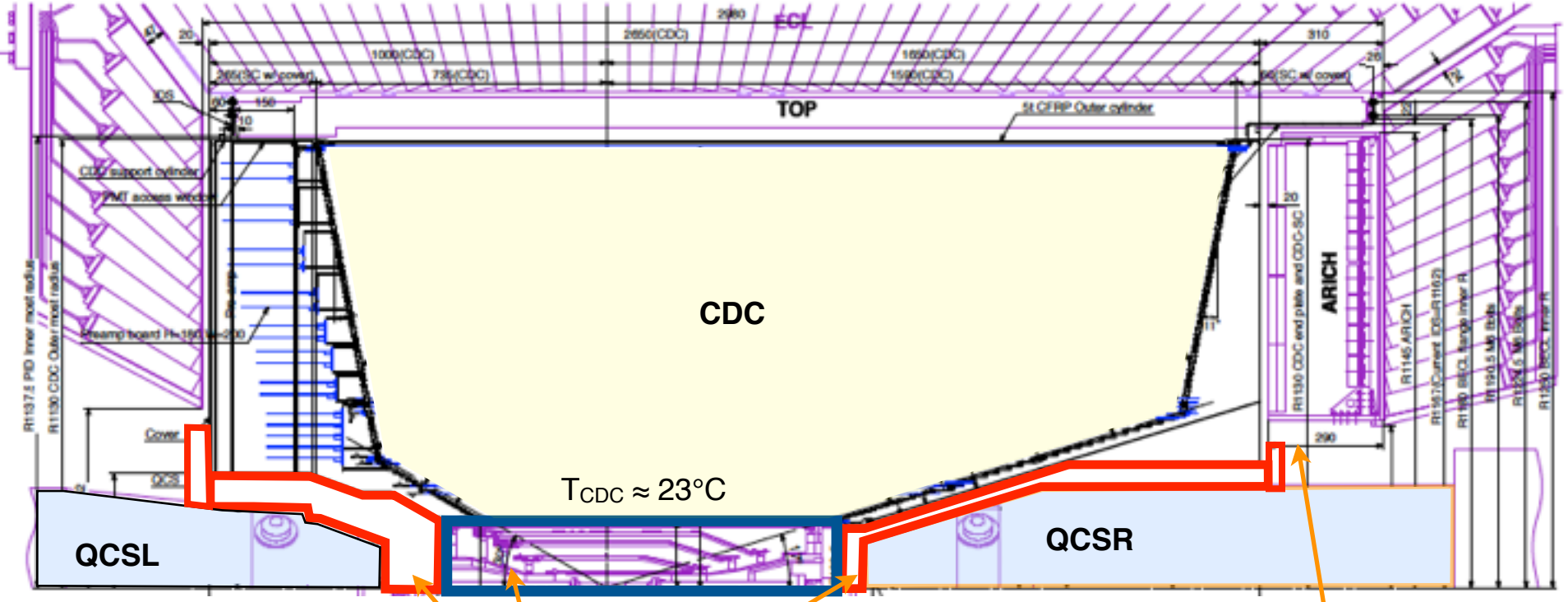
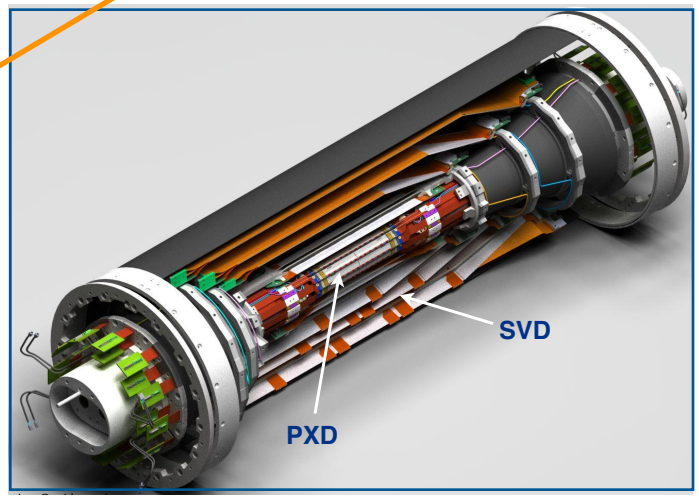
Thermal Mock-up Status

carsten.niebuhr@desy.de

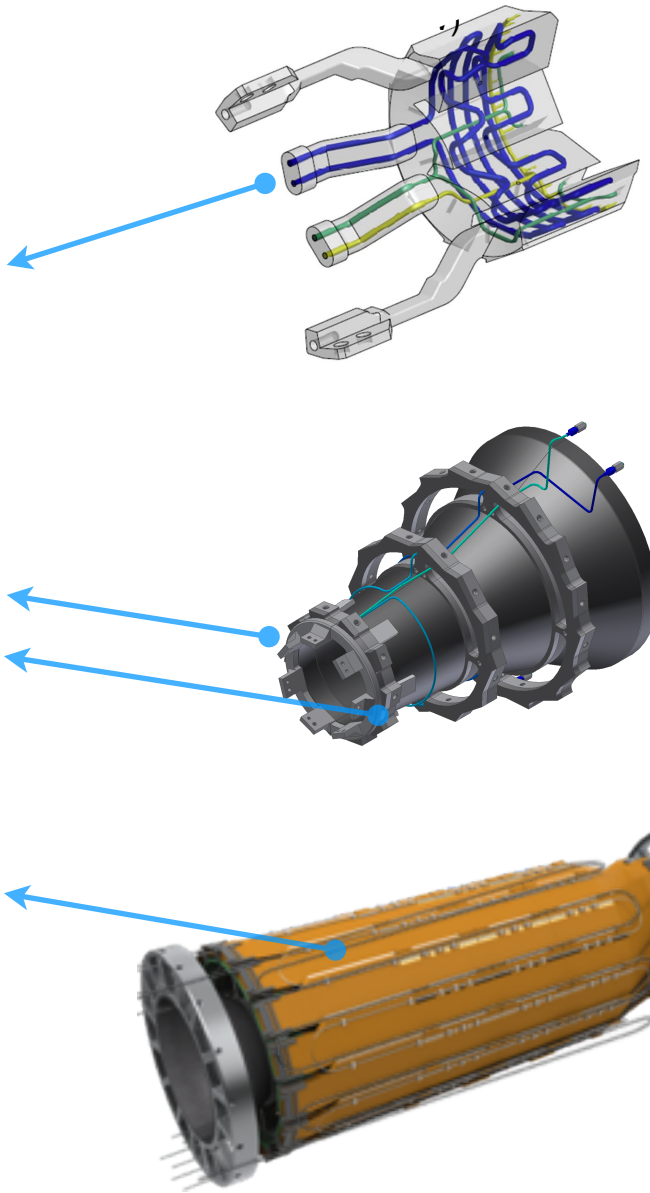
VXD Cooling Environment





VXD Heat Dissipation and CO_2 Cooling Circuits

CO_2 Circuit	Detector	Half	Layer	Type	Side	Power [W]
1	PXD	up	1&2	endring	bwd	90
2			1&2	endring	fwd	90
3		down	1&2	endring	bwd	90
4			1&2	endring	fwd	90
					sum PXD	360
5	SVD	left	3-6	endring	bwd	93
6		right	3-6	endring	bwd	93
7		left	3-6	endring	fwd	93
8		right	3-6	endring	fwd	93
9		left	4&5	origami	bwd	68
10		right	4&5	origami	bwd	68
11		left	6	origami	bwd	96
12		right	6	origami	bwd	96
					sum SVD	700
					sum VXD	1060



plus 4 circuits for N_2 supply

plus parasitic heat load from the environment

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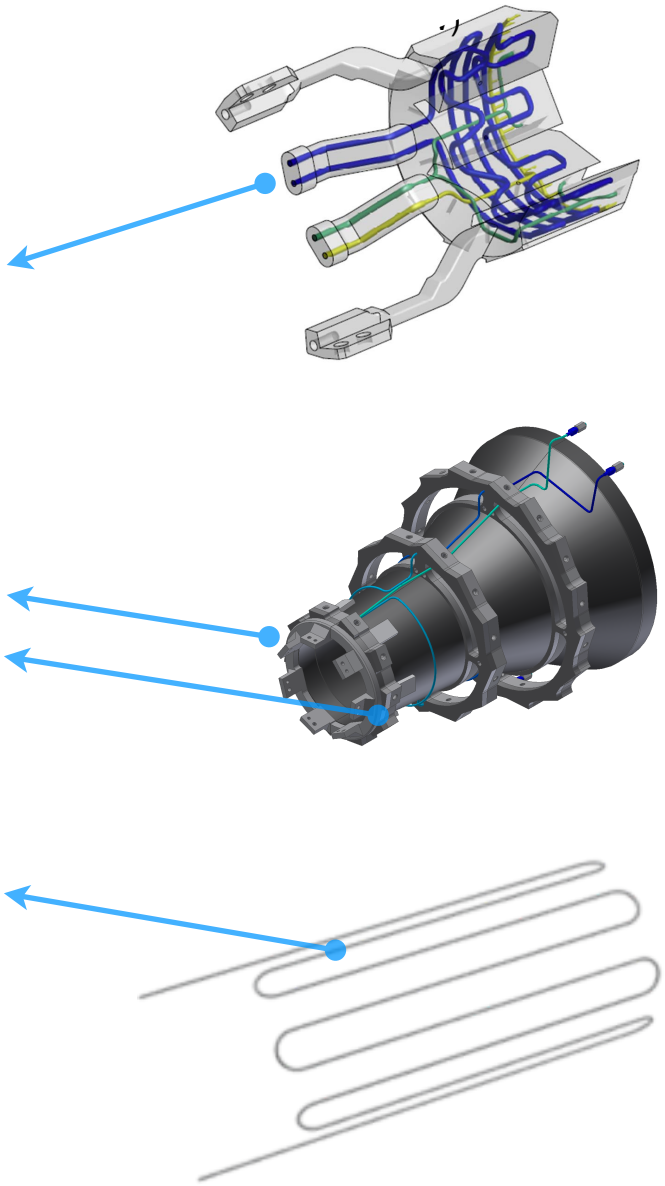

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ATLAS iTK Cooling Meeting on December 11

Bart Verlaat

IBL CO_2 cooling overview and experiences

Atlas ITK cooling kick-off
11 December 2014

Lessons for the future

- IBL cooling has learned us some very good lessons, not only for IBL but certainly for future systems.
- The thermodynamic behavior of the cooling loops had many surprises for us, which we did not see all in laboratory tests.
  - The 3D geometry is more important than believed.
  - For upgrade studies try to build full scale mock-ups, don't rely on simulations
- Boiling onset needs to have better trigger mechanisms
  - The magnitude of superheating seen in IBL was never observed in lab tests. Lab tests are all done in SS, IBL is Ti...
  - Perhaps special technics should be used at stave entrances to enhance boiling
    - Coatings? Orifices?....
- It was a big step to go from -30^0 (LHCb) to -40^0, everything becomes more critical, all aspects of the system must be well understood.
  - Always verify models with tests.
  - Full scale prototyping of distribution systems
- Vacuum shielding (fixed or flexible) is the choice for insulation inside the detector.
  - Flexible vacuum insulated transfer lines need more development, stationary lines are commercial.
  - 1 drawback observed: They insulate so well that liquid stays in for a long time.
    - Can be dangerous for the detector (Thermal shocks at stops)
    - Can be solved by having low parts exposed to a heat source

32

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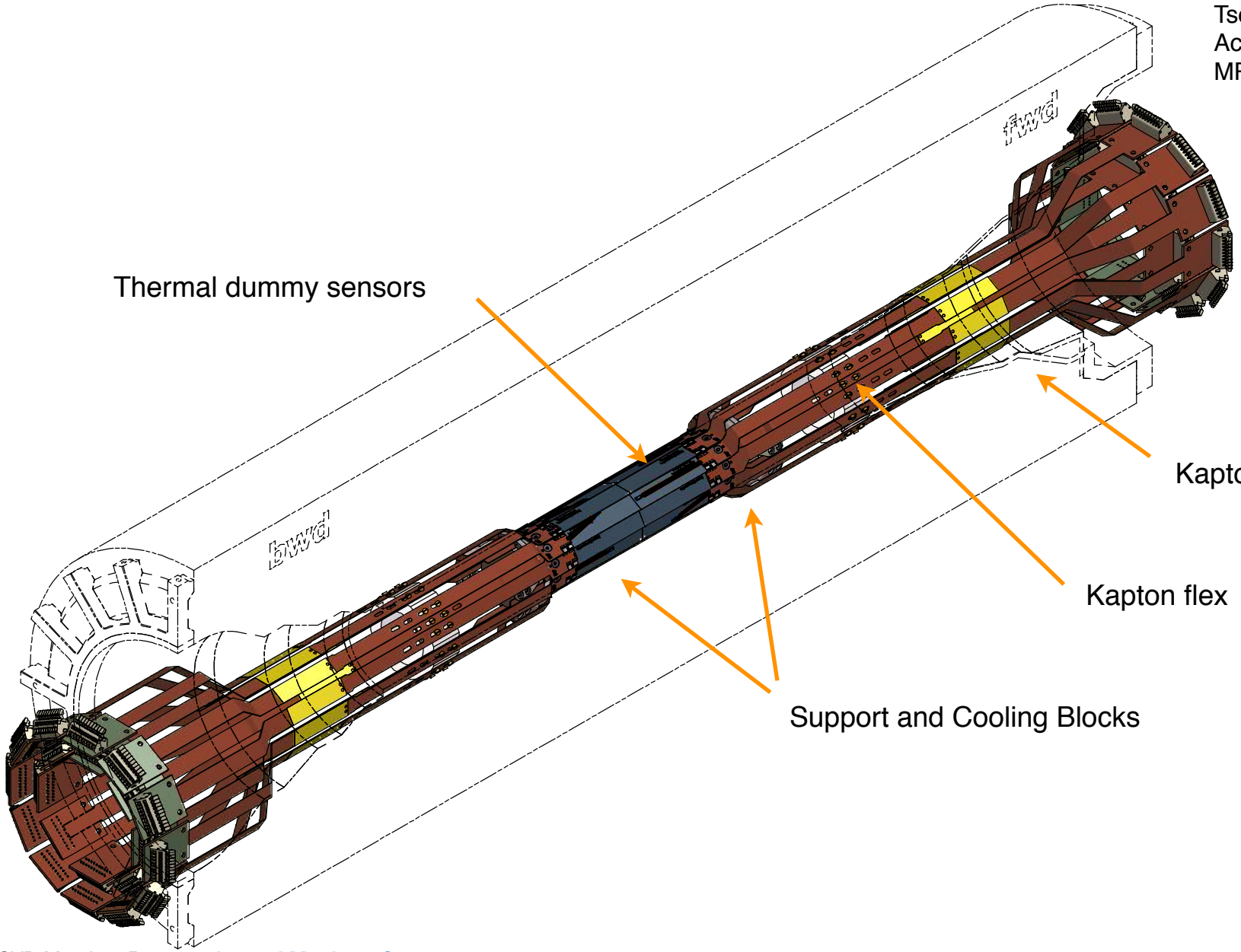
32

Realistic PXD Thermal Mock-up

Tscharlie Ackermann
MPI



Realistic PXD Thermal Mock-up

Tscharlie
Ackermann
MPI

Thermal dummy sensors

Kapton heating

Kapton flex

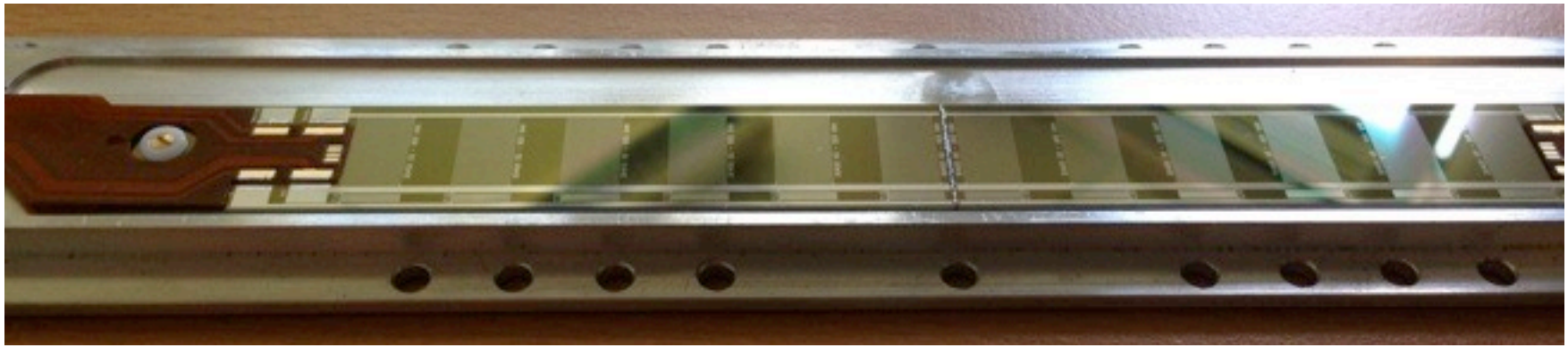
Support and Cooling Blocks

PXD Thermal Dummy Ladder

Produced at MPI / HLL

Si thickness 75µm

Kapton

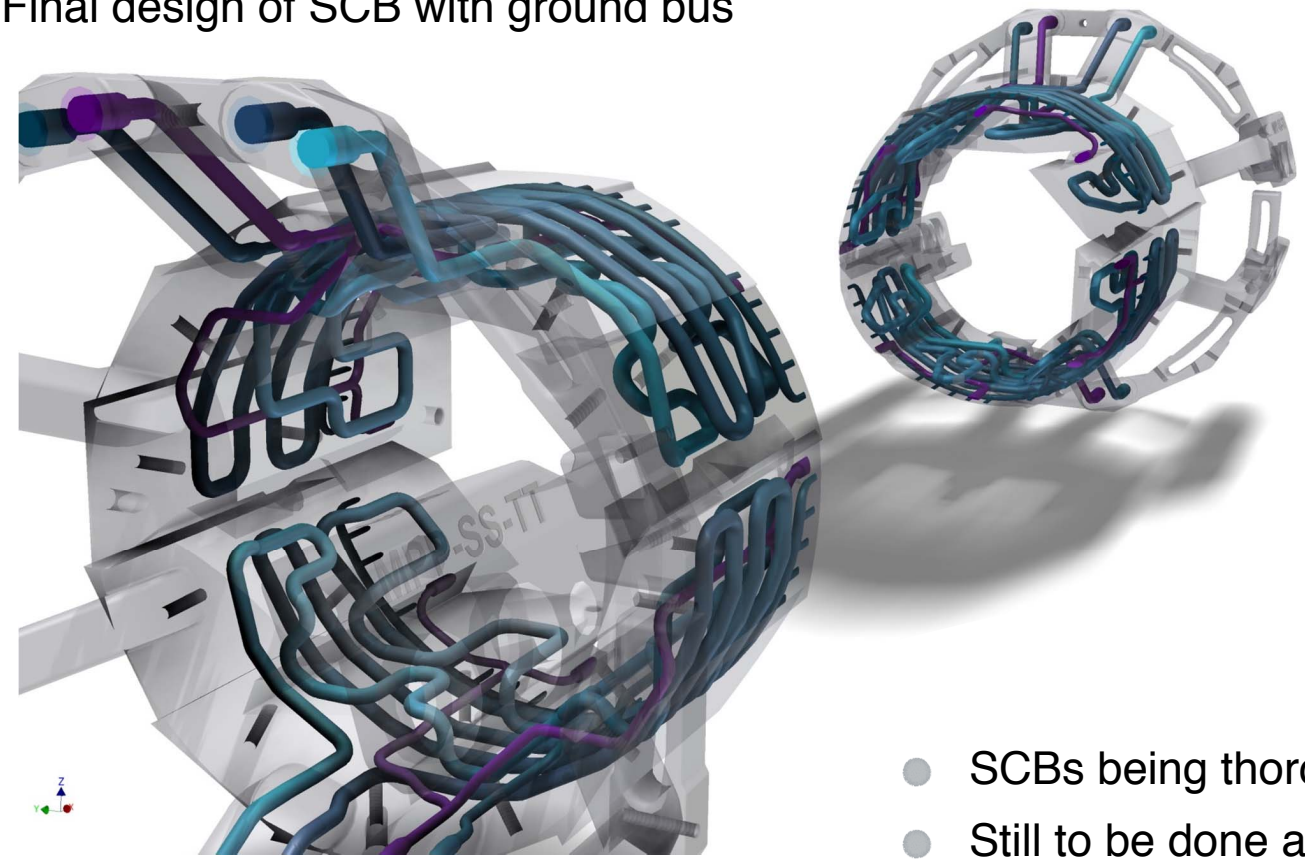


- Handling of dummy ladders (75µm) turns out to be quite delicate
  - lessons from mock-up expected to give very valuable input for real PXD assembly

Support and Cooling Blocks for PXD

Final design of SCB with ground bus

MPI

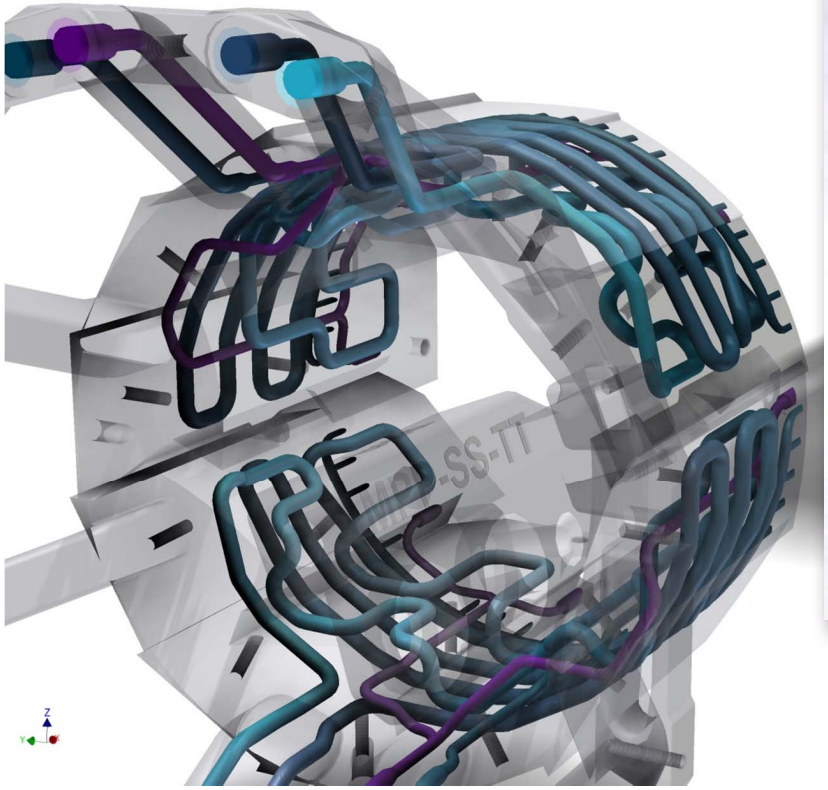


8 coated carbon tubes glued into SCB, painted with silver conductive film: R~2.5 Ω

- SCBs being thoroughly inspected at MPI
- Still to be done at MPI
  - pressure tests etc.
  - parylen coating
  - glueing of carbon tubes
- FOS integration at DESY with help of IFCA
- Humidity sensor integration: Trieste/INFN

Support and Cooling Blocks for PXD

Final design of SCB with ground bus



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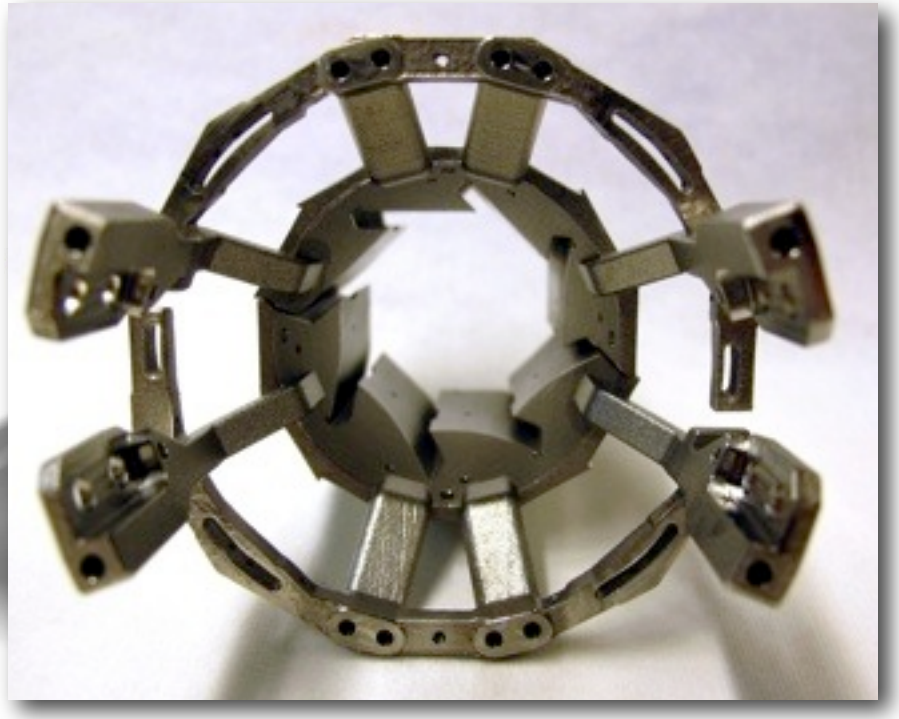

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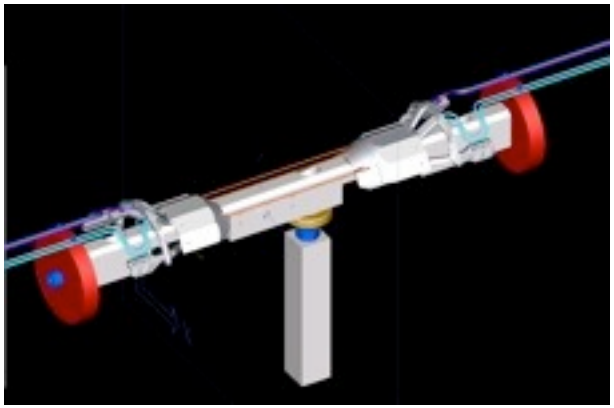
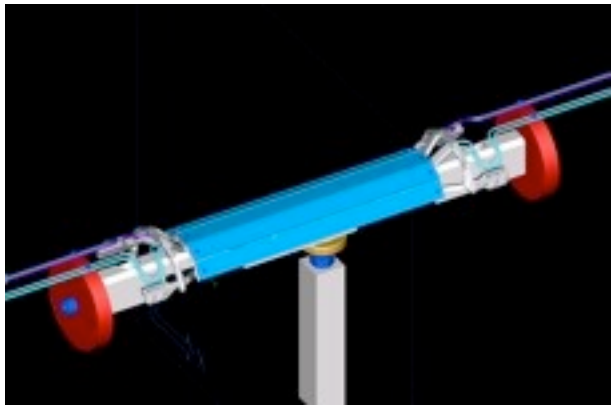
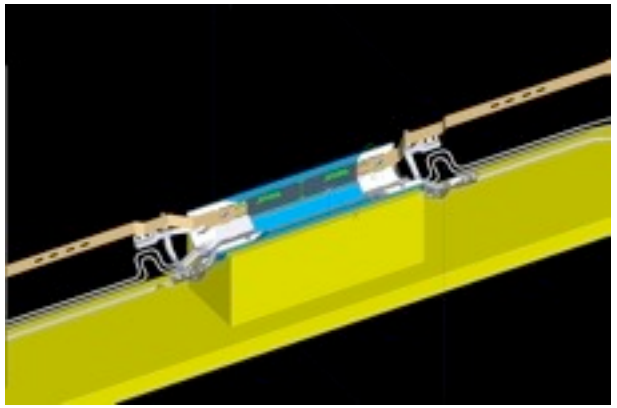
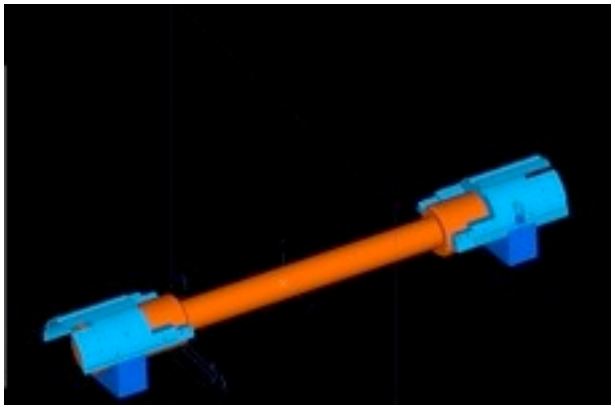
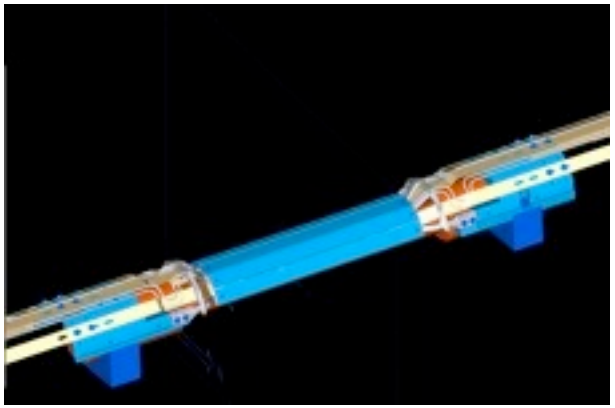
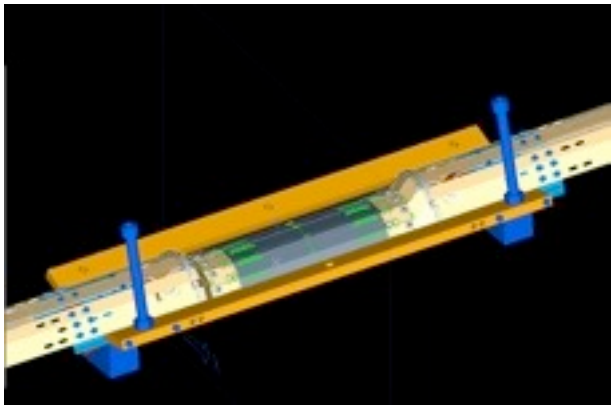
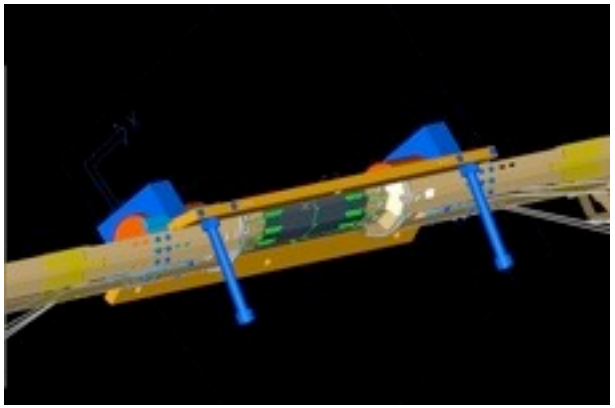
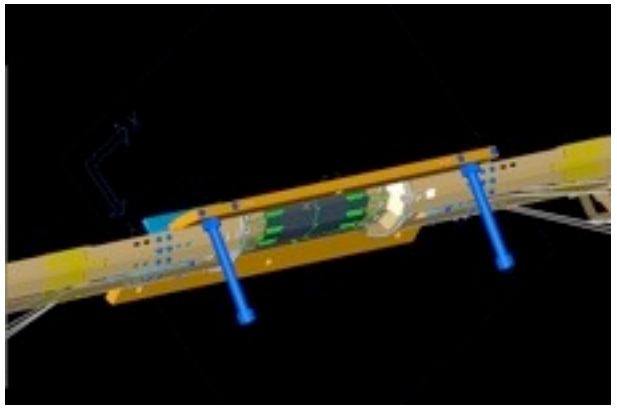
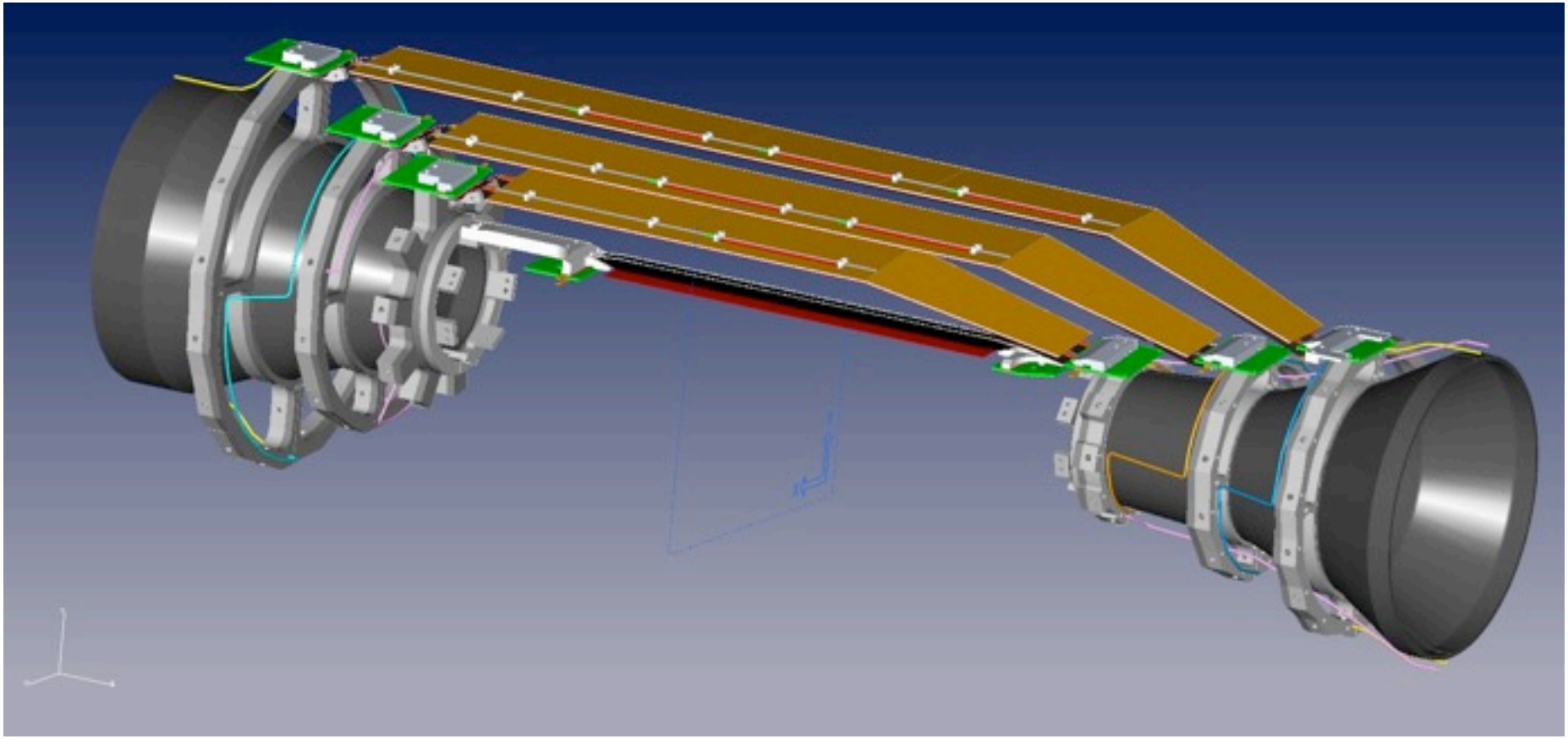
PXD Thermal Mockup Assembly Steps (R.Stever)

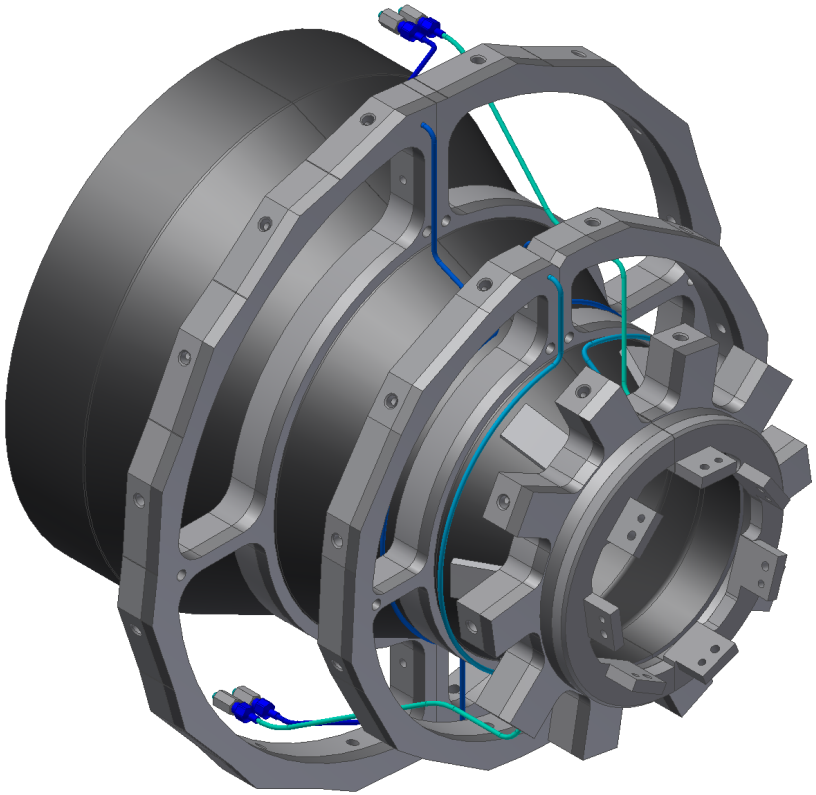




SVD Thermal Mockup Design

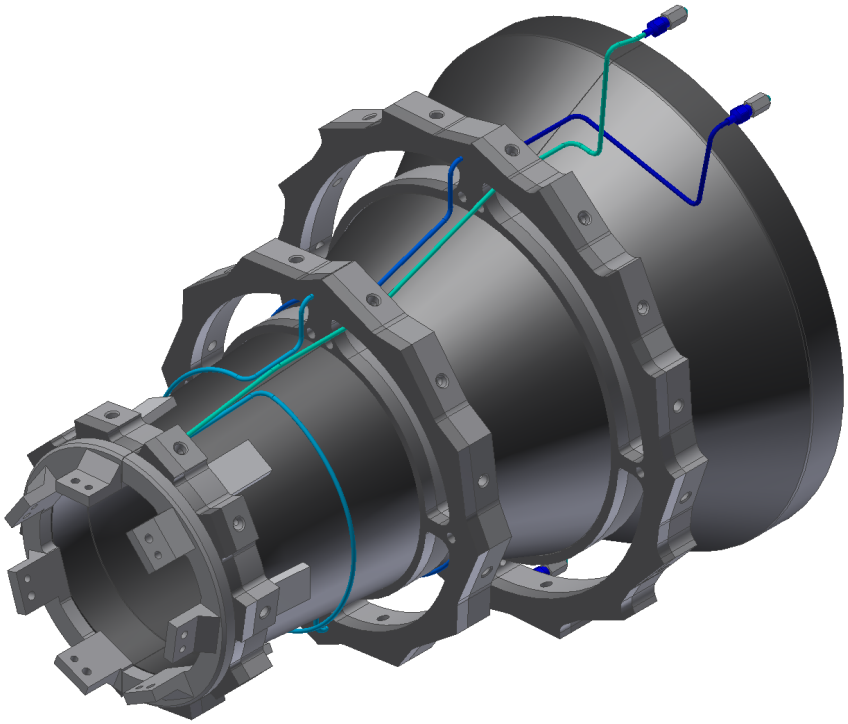


SVD Endrings

Backward (28 narrow bends)

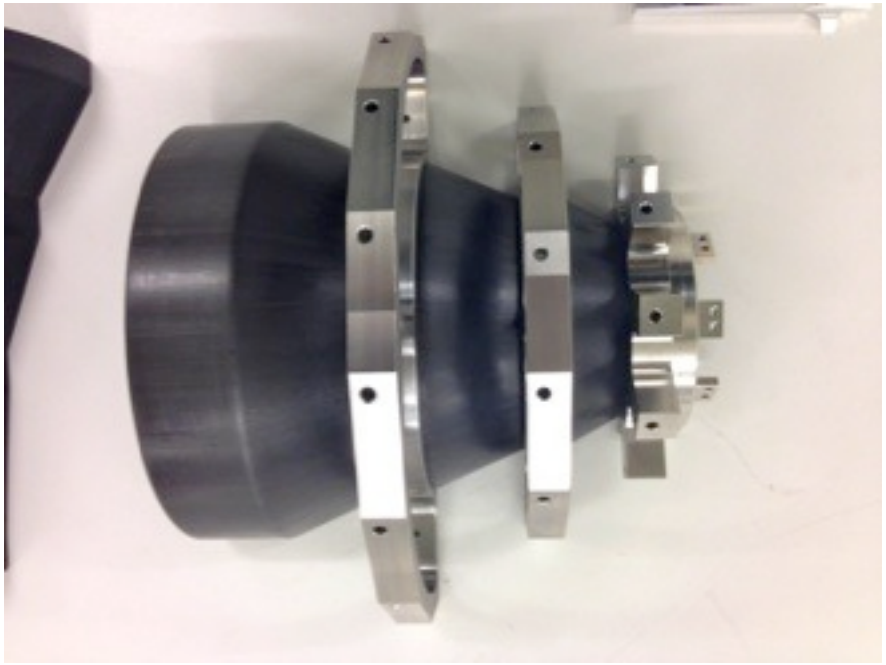


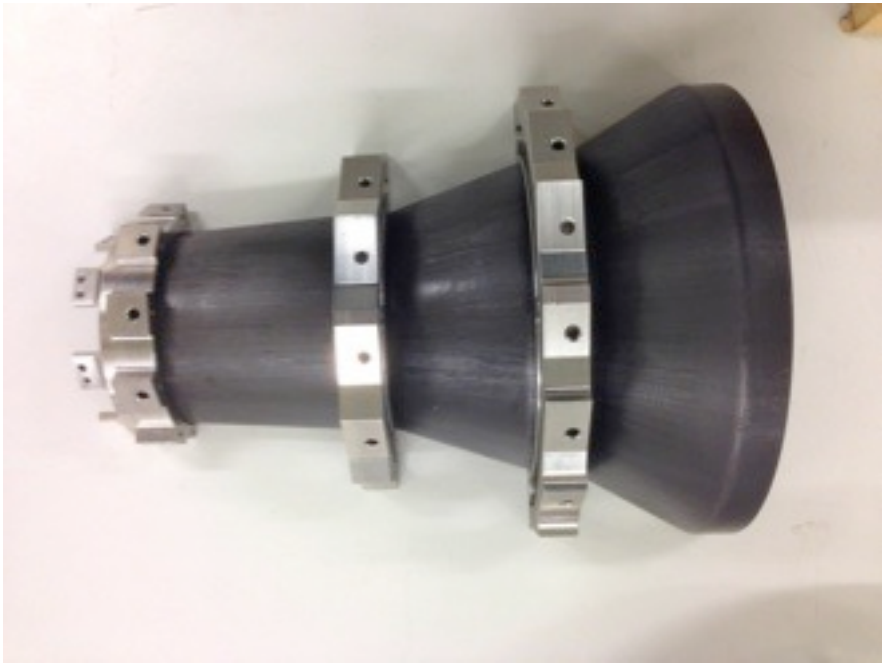
Forward (23 narrow bends)



- Rings and pipes to be connected by vacuum brazing at DESY

SVD Endrings and CFRP Support Cones

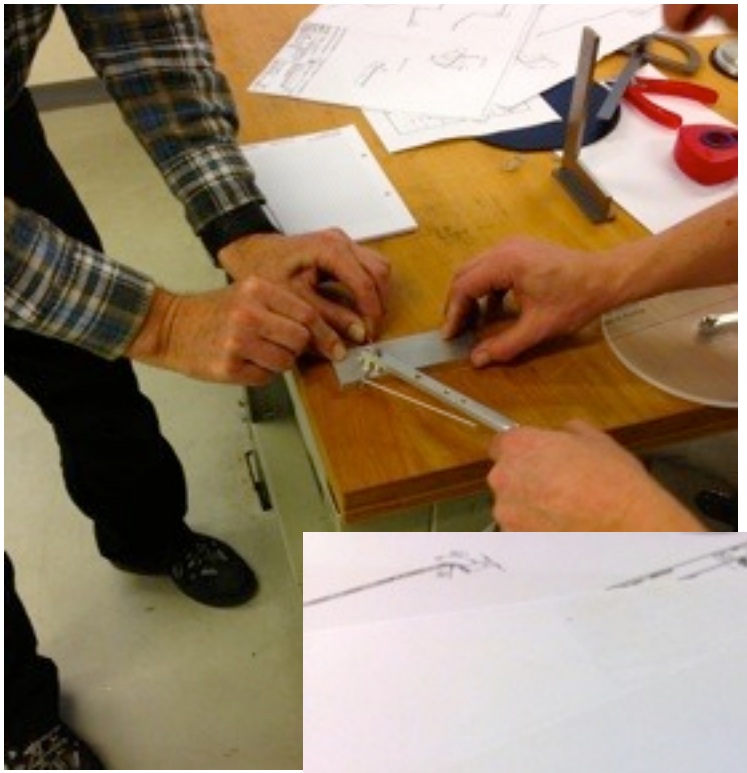


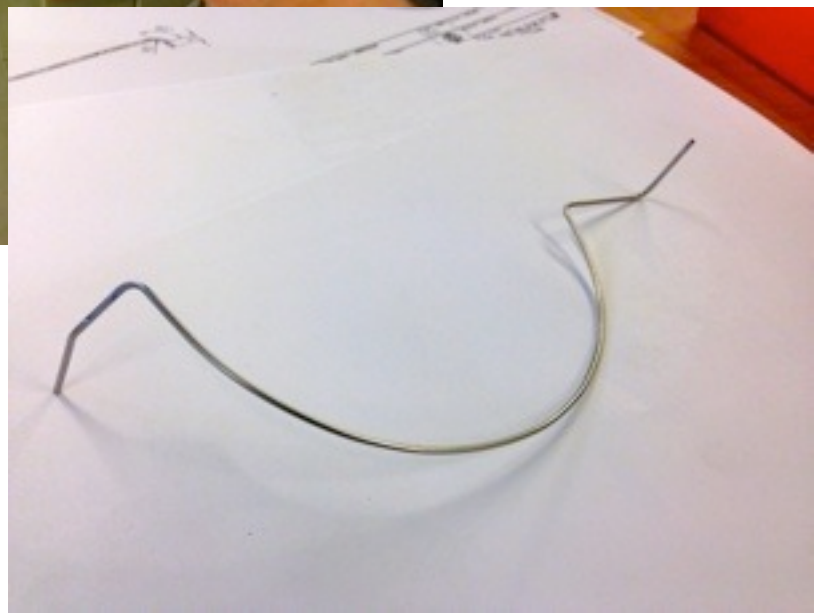


Pipe Bending

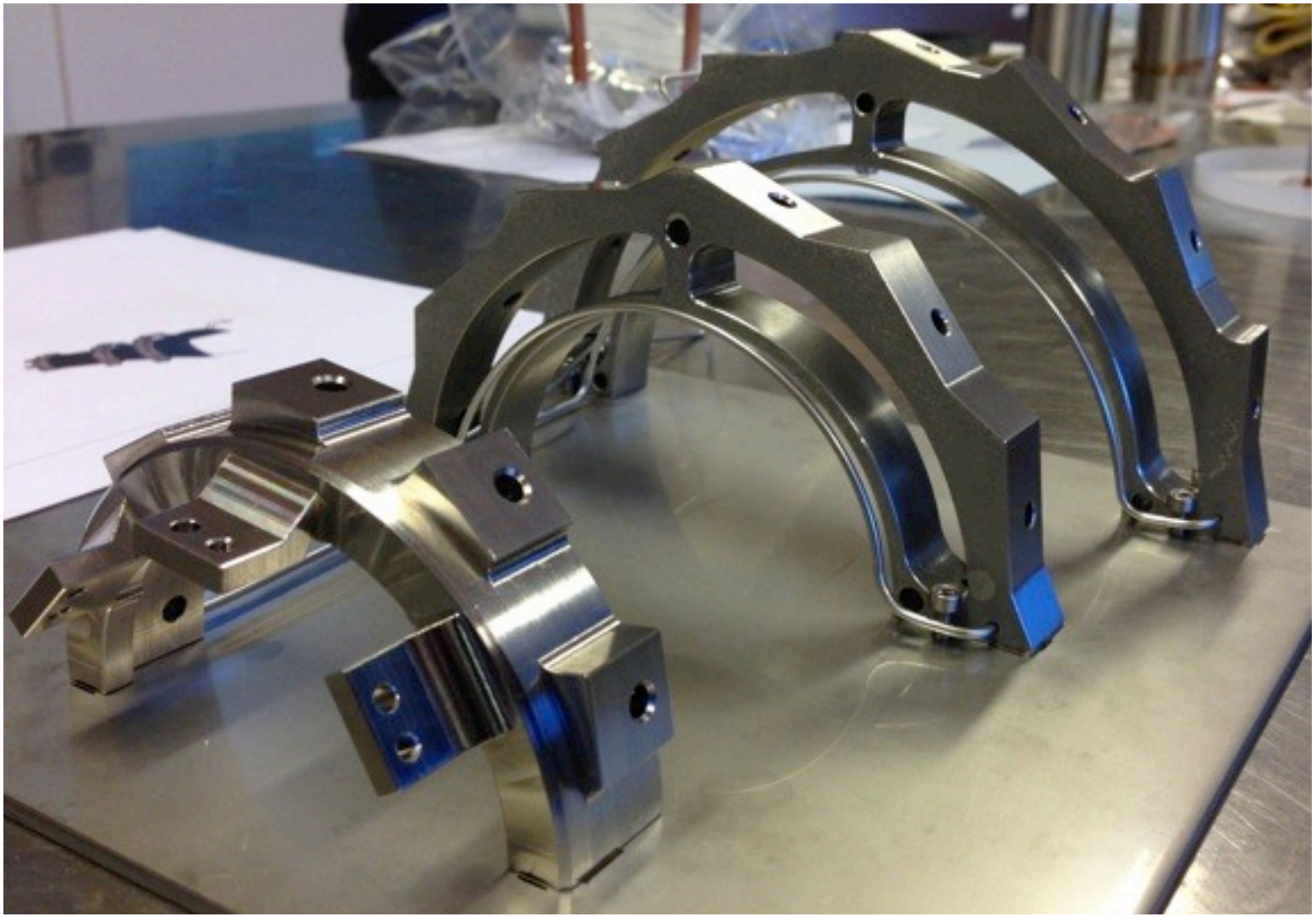
Filling pipe with sand

Bending





End Rings and Pipes before Vacuum Brazing

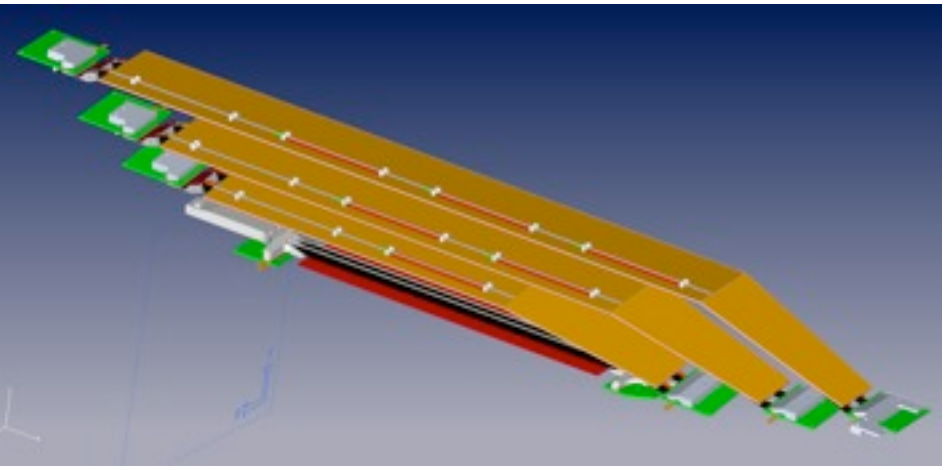


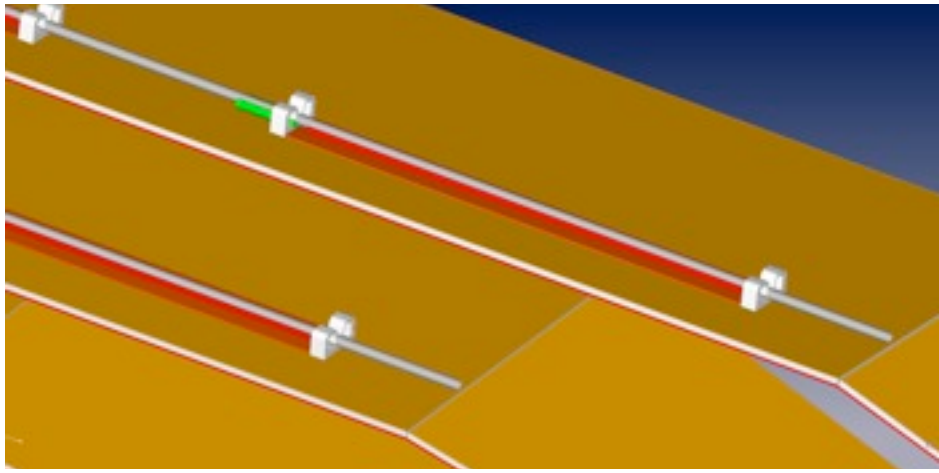
- First attempt to connect by vacuum brazing this week
  - further optimisation of process parameters in the next weeks

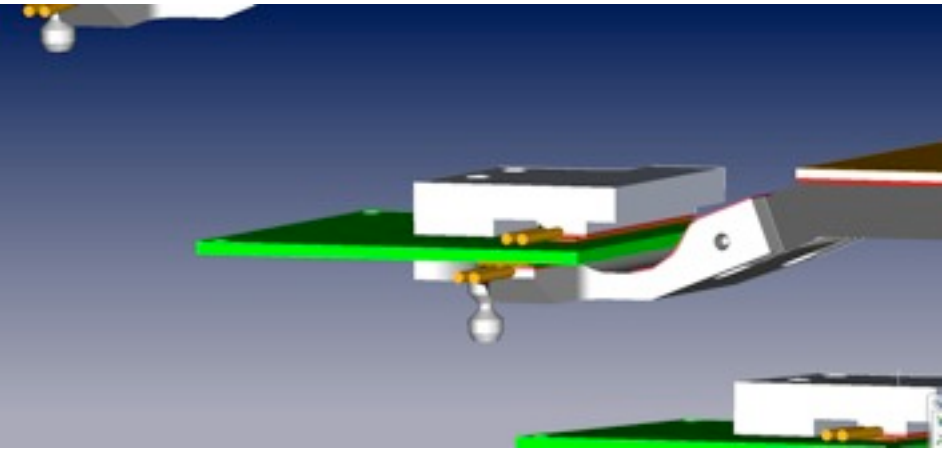
VXD Endflanges

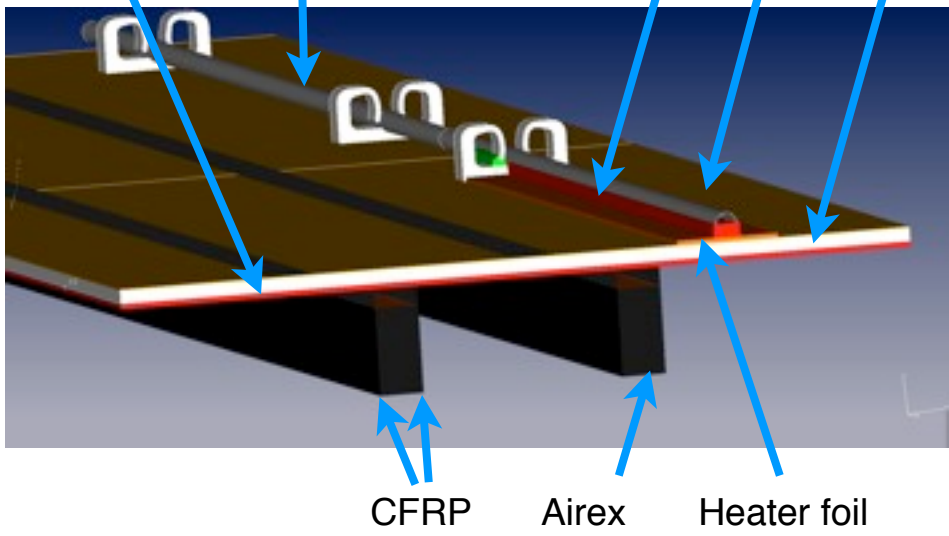
Hamburg University

SVD Thermal Dummy Ladder Design



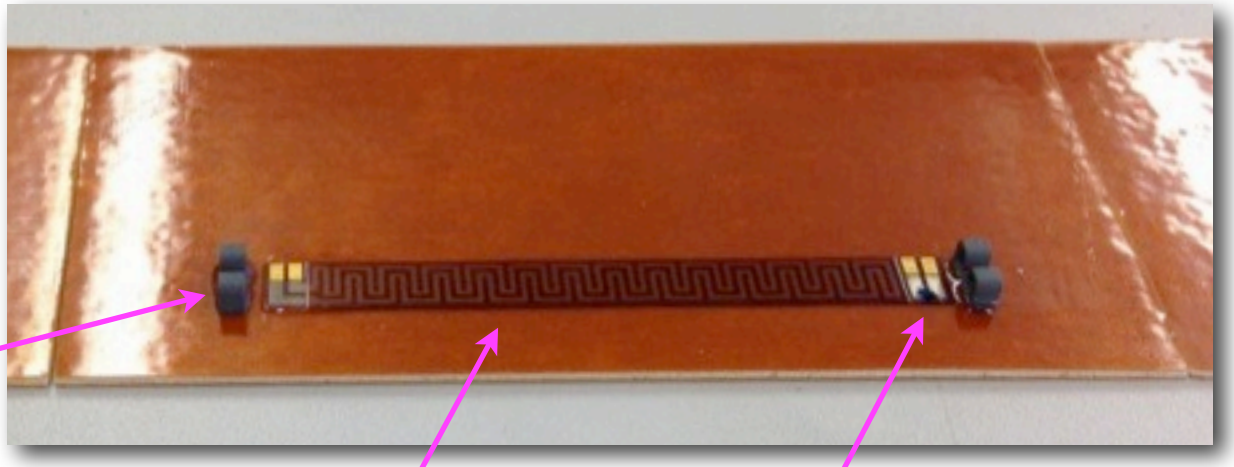






Heater Foils Glued to Dummy Sensors and PCBs

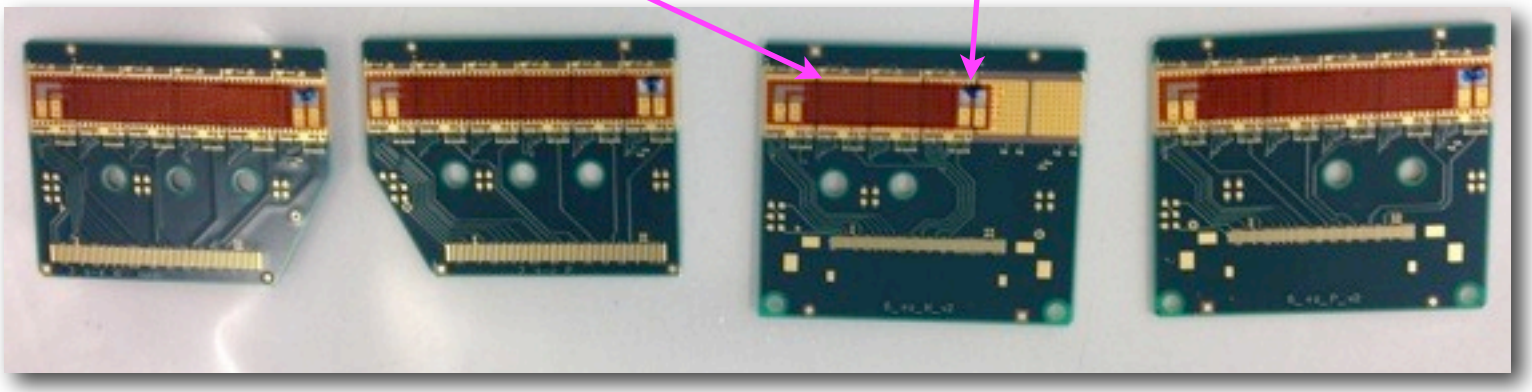
L6



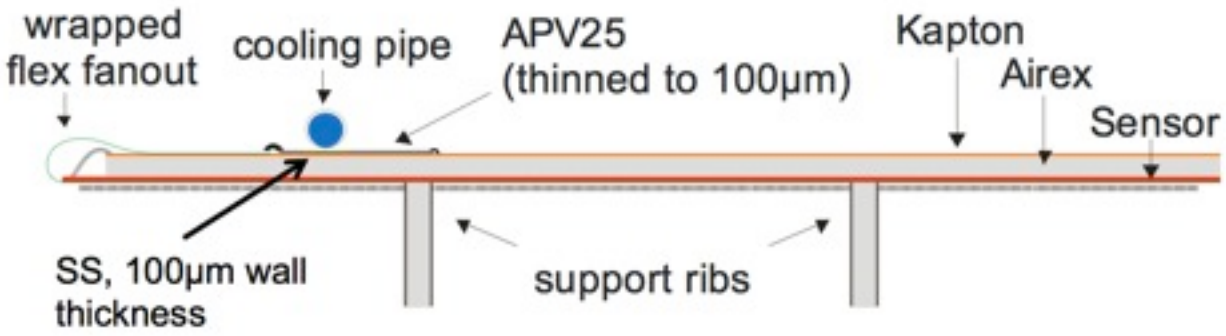
Clips
(HEPHY)

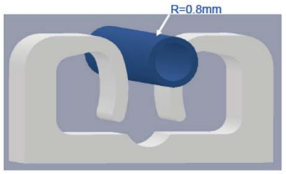
Heater foil with integrated CTN sensors

PCBs
(HEPHY)

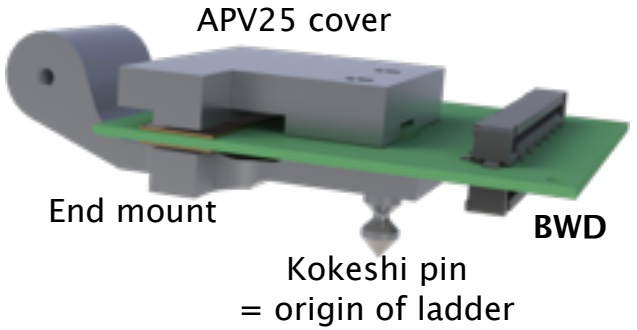


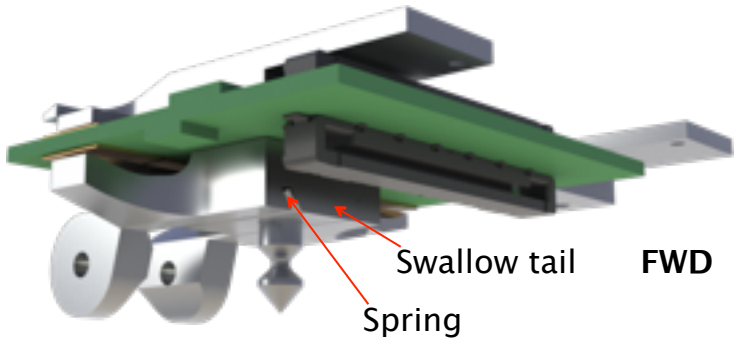
SVD Origami Cooling and End Mounts





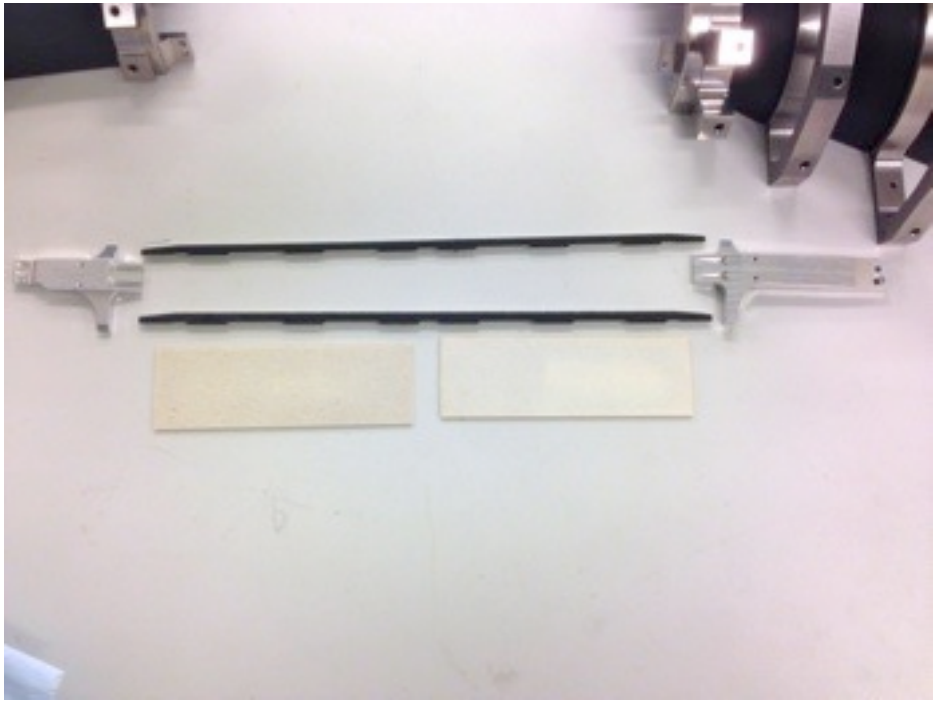
- For realistic mockup need to simulate heat transport through entire structure
  - 8 sets of L3 bridges, 5 sets of L4-5 end mounts, 5 sets of L6 end mounts received from KEK





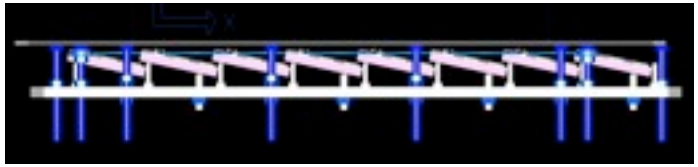
Optimized CFRP Rib Design

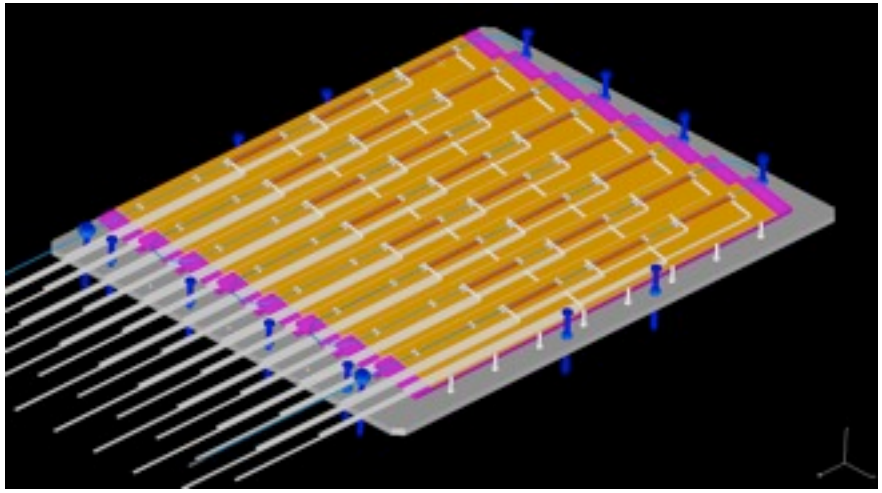
Ribs and endmounts L3

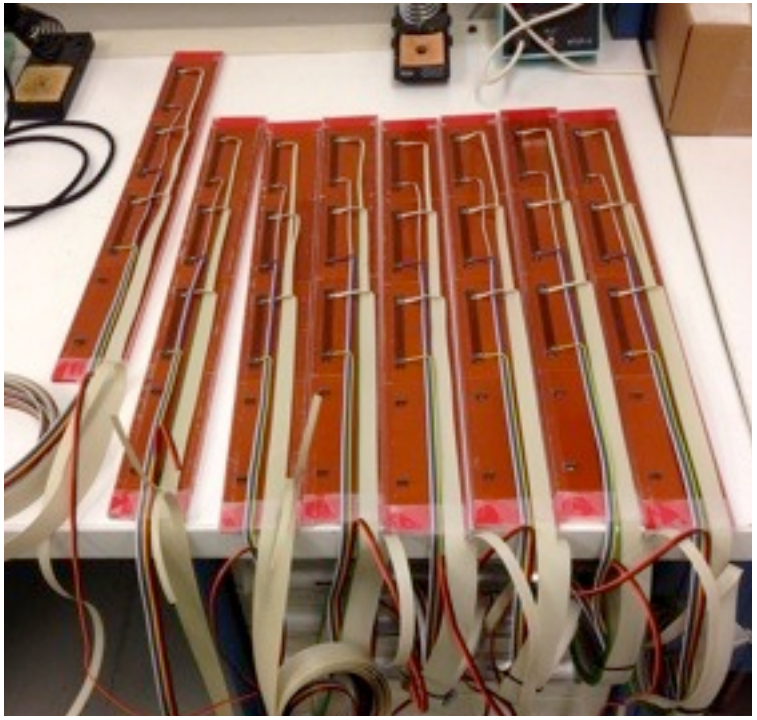


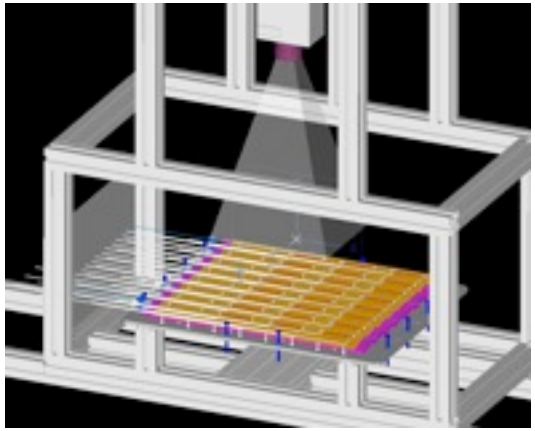
L4 ribs

Intermezzo: Flat SVD L6 Origami





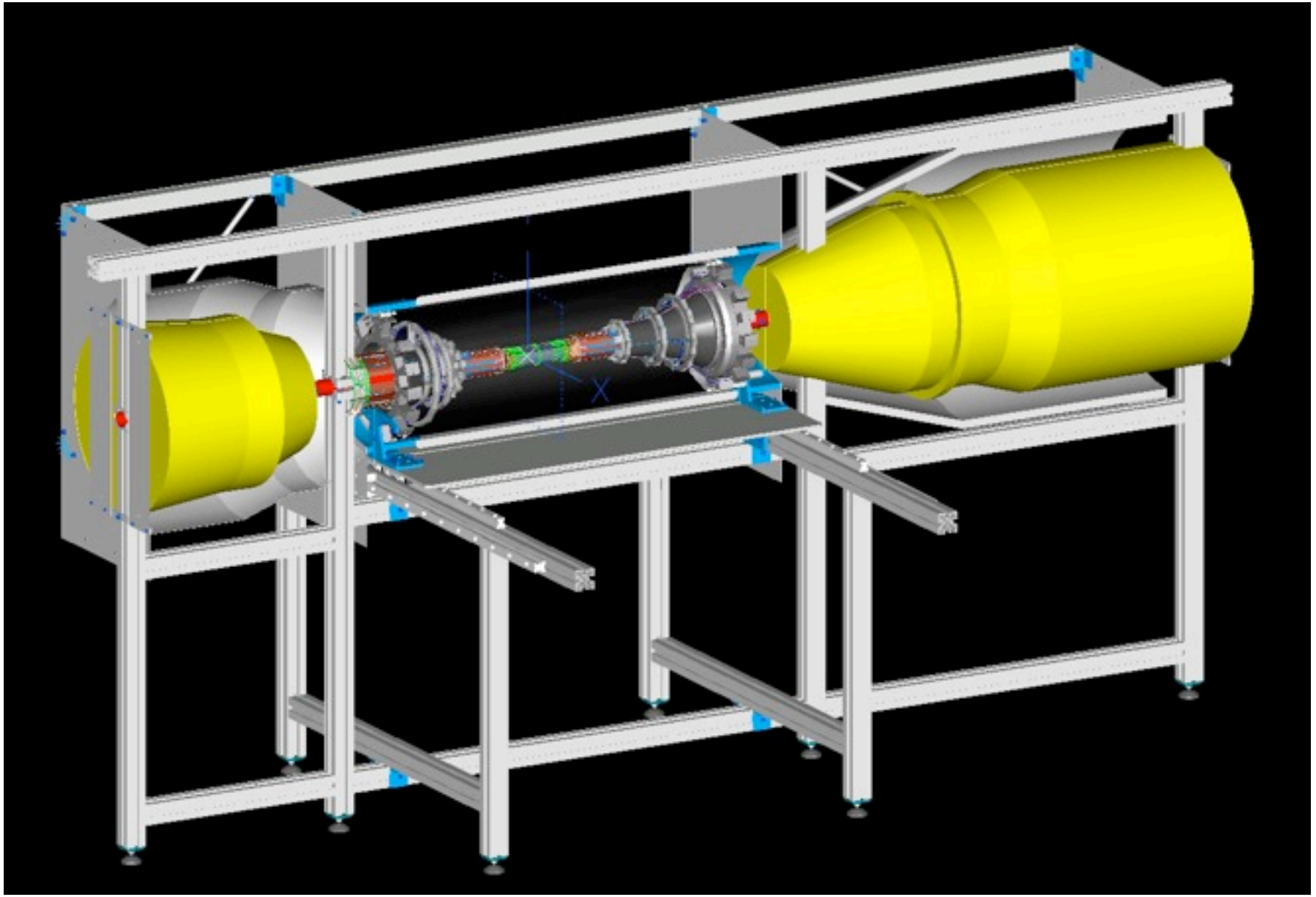




- Use time until PXD SCBs arrive from MPI
- Gain first experience with long Origami cooling pipe
  - „ ... BPAC suggests not to wait for the thermal mockup results but to try finding issues in cooling as early as possible (in areas where this is possible without a full scale mockup).“

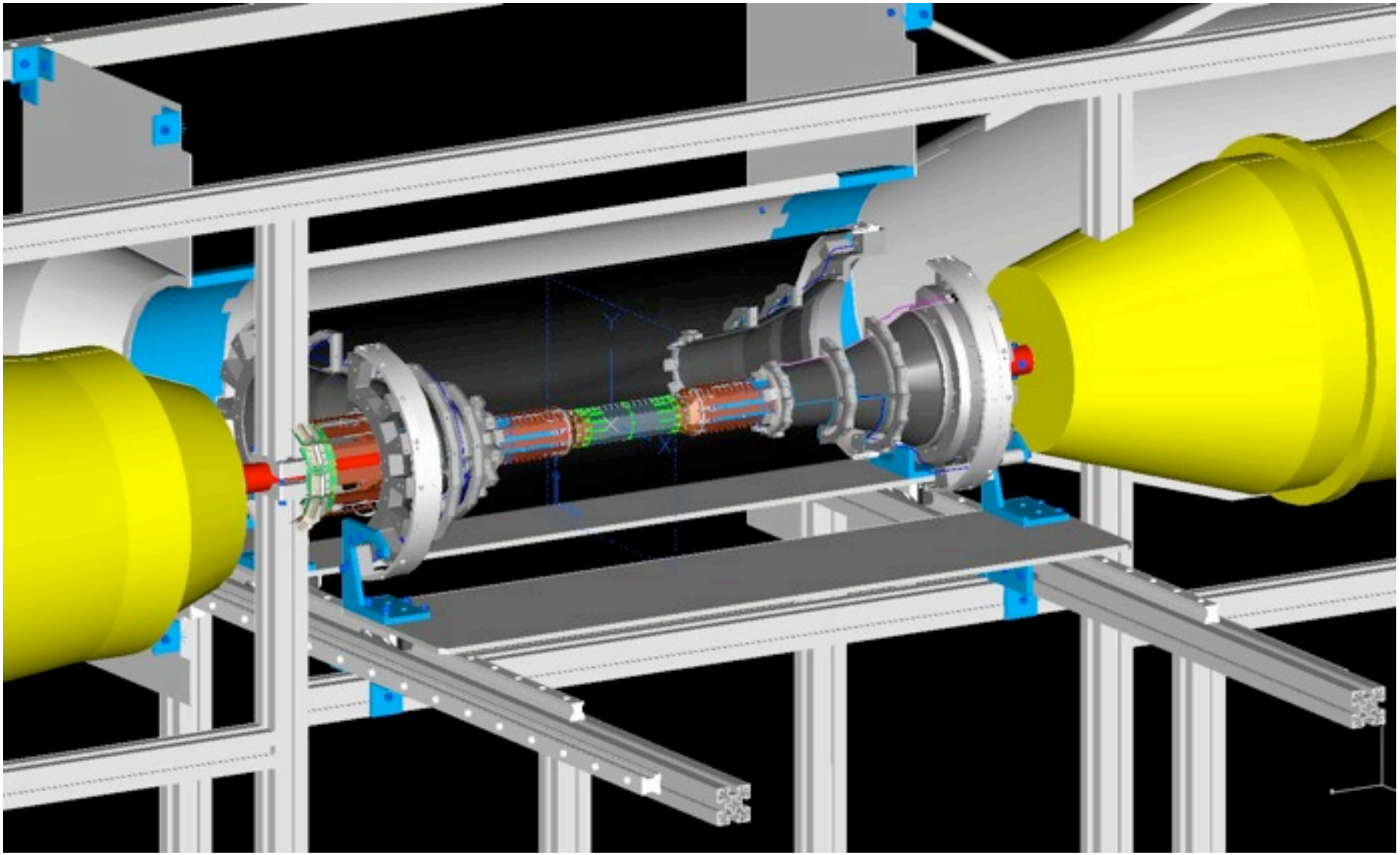
Thermal Mockup Support Structure

R. Stever



Thermal Mockup Support Structure

R. Stever



Schedule as shown at BPAC SVD Readiness Review

			2014		2015											
System	Task	Who	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
MARCO	Prepare and study transfer lines	DESY														
	Replacement of CO_2 pumps	DESY														
PXD	Final SCB production	MPI	(√)													
	Dummy ladder / kapton flex prod.	HLL/MPI	√													
	PXD thermal mock-up assembly	DESY														
	Integrate environmental sensors	IFCA/Trieste														
	PXD-only thermal studies	DESY														
SVD	SVD dummy sensor production	DESY	√													
	CFRP support cone/outer cover prod.	KEK	√													
	SVD end mount & Kokeshi pin prod.	KEK	(√)													
	SVD end ring production	DESY	√													
	Connect endrings w/ pipes&glue cones	DESY														
	VXD end flange production	Uni HH	√													
	Cooling pipe fixation clips & PCBs	HEPHY	√													
	SVD ladder assembly	DESY														
	Origami cooling pipe production	DESY														
	SVD mock-up assembly	DESY														
	Environmental sensor integration	IFCA/Trieste														
	VXD mock-up assembly	DESY														
	VXD thermal studies	DESY														

Updated Schedule

System	Task	Who	2014 Nov	2014 Dec	2015 Jan	2015 Feb	2015 Mar	2015 Apr	2015 May	2015 Jun	2015 Jul	2015 Aug	2015 Sep	2015 Oct	2015 Nov	2015 Dec
MARCO	Prepare and study transfer lines	DESY														
	Replacement of CO_2 pumps	DESY														
PXD	Final SCB production & tests	MPI	(√)													
	Dummy ladder / kapton flex prod.	HLL/MPI	√													
	PXD thermal mock-up assembly	DESY														
	Integrate environmental sensors	IFCA/Trieste														
	PXD-only thermal studies	DESY														
SVD	SVD dummy sensor production	DESY	√													
	CFRP support cone/outer cover prod.	KEK	√													
	SVD end mount & Kokeshi pin prod.	KEK	(√)													
	SVD end ring production	DESY	√													
	Connect endrings w/ pipes&glue cones	DESY														
	VXD end flange production	Uni HH	√													
	Cooling pipe fixation clips & PCBs	HEPHY	√													
	SVD ladder assembly	DESY														
	Origami cooling pipe production	DESY														
	SVD mock-up assembly	DESY														
	Environmental sensor integration	IFCA/Trieste														
	VXD mock-up assembly	DESY														
	VXD thermal studies	DESY														

Summary

- VXD thermal mock-up design has developed to quite a complex system
  - besides thermal studies expect to get valuable experience for handling and assembly of real system
  - decision to use final prototypes of critical components caused some delays
- Individual pieces are finally coming together
  - assembly of PXD mock-up will start soon
    - start of thermal tests of PXD delayed
    - use time to test Origami cooling pipe concept with „flat SVD L6“
      - respond to BPAC recommendation
      - provide data for Bachelor student
  - in parallel continue with assembly of SVD thermal mockup
    - full VXD thermal mock-up operational ~ in summer 2015
- New person power joined the project
  - Hua Ye (post doc from IHEP, Beijing)

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Additional Material

carsten.niebuhr@desy.de

VXD mechanics meeting

Date/Time: from Monday 26 January 2015 (08:00) to Tuesday 27 January 2015 (18:00) (Asia/Tokyo)

Location: DESY

Material: Slides

Monday 26 January 2015

09:30	**Cooling pipe bending (requirements and milestone)** (20')
09:50	**HEPHY staus (cooling pipe)** (20')
10:10	**KEK status** (20')
10:30	**DESY status** (20')
10:50	**Gemba discussion** (20')
11:10	**Further plan and milestone (discussion)** (20')
11:30	**VXD thermal mock status** (20')
11:50	**VXD thermal mock assembly procedure** (20')
12:10	**VXD mechanics for thermal test (Gemaba discussion)** (20')
12:30	**VXD remaining issues(discussion and further plan)** (20')

http://kds.kek.jp/event/17616

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ATLAS IBL Thermal Mock Up

Forum on Tracking Detector Mechanics June 2013

François-Xavier Nuiry, CERN

https://indico.cern.ch/event/233332/contribution/19/material/slides/1.pdf

Preliminary comments

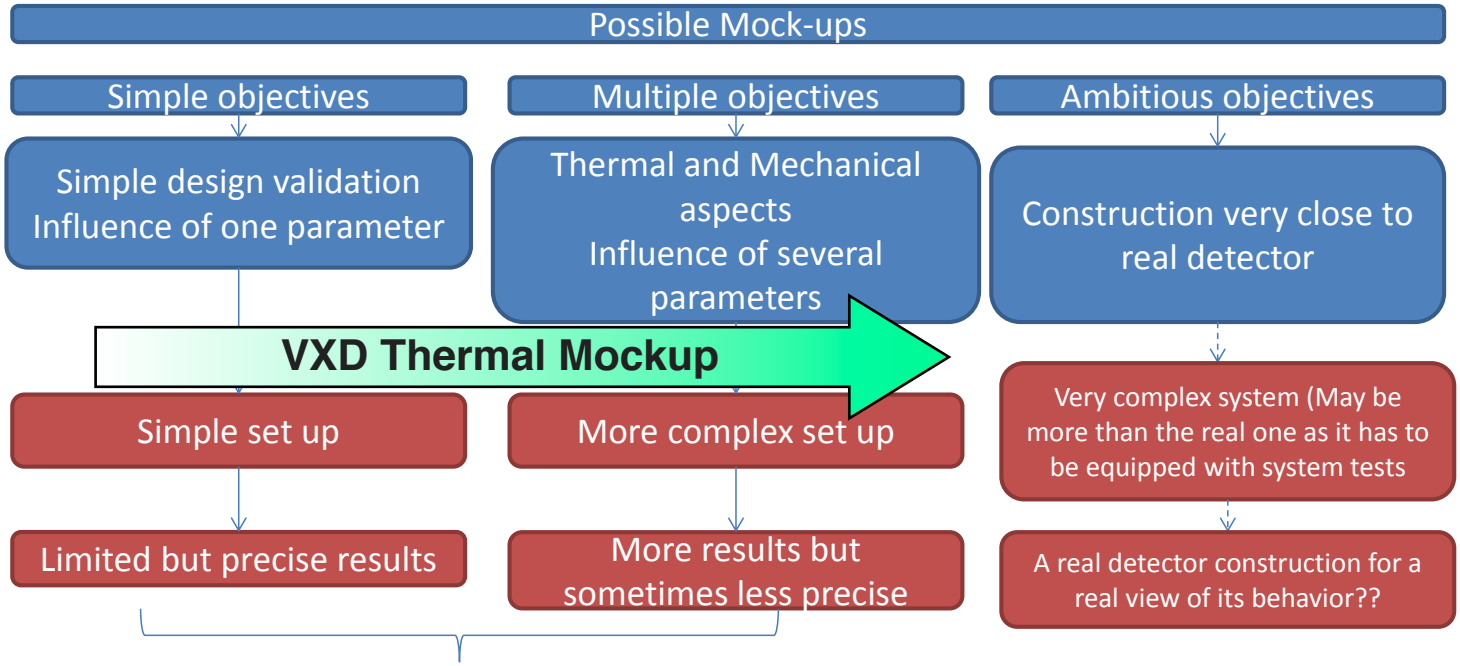
- It will be shown that building a detector mock up is often a result between several compromises:

→**Available design / materials**

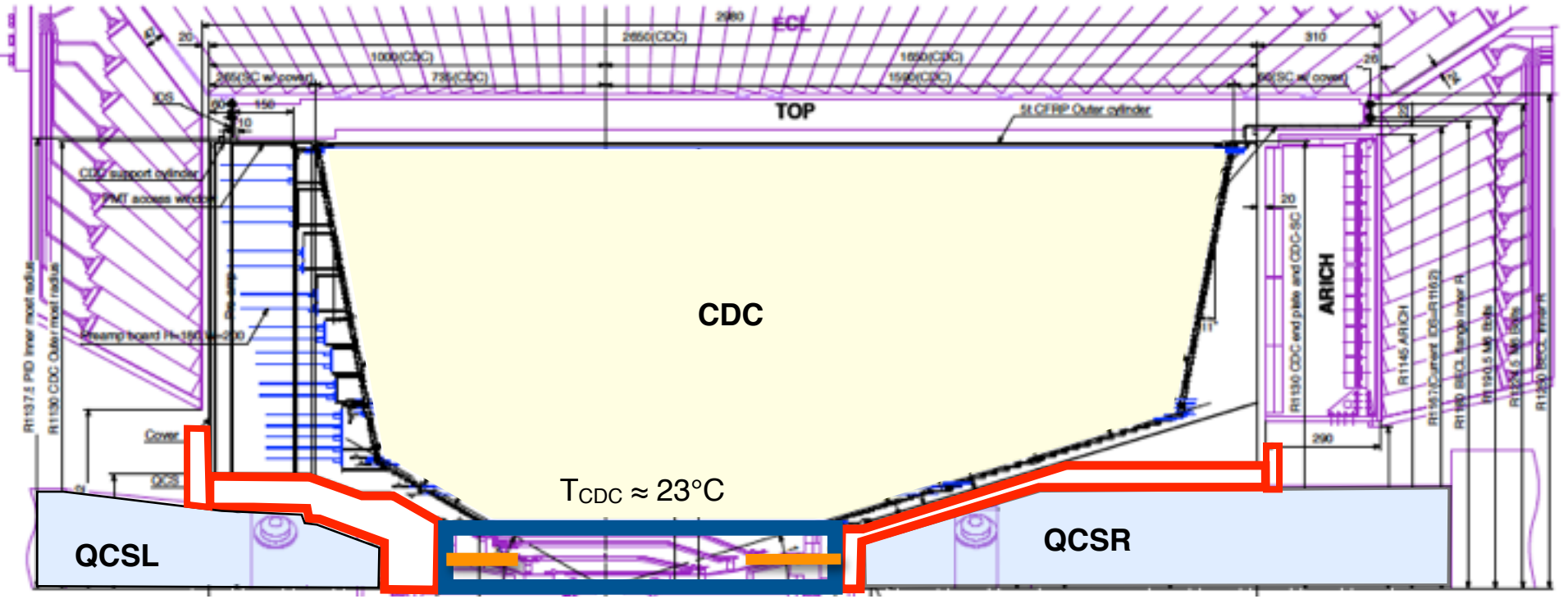
→**Objectives (Tests wanted / Outputs)**

→**Available time**

→**Available Money / Manpower**



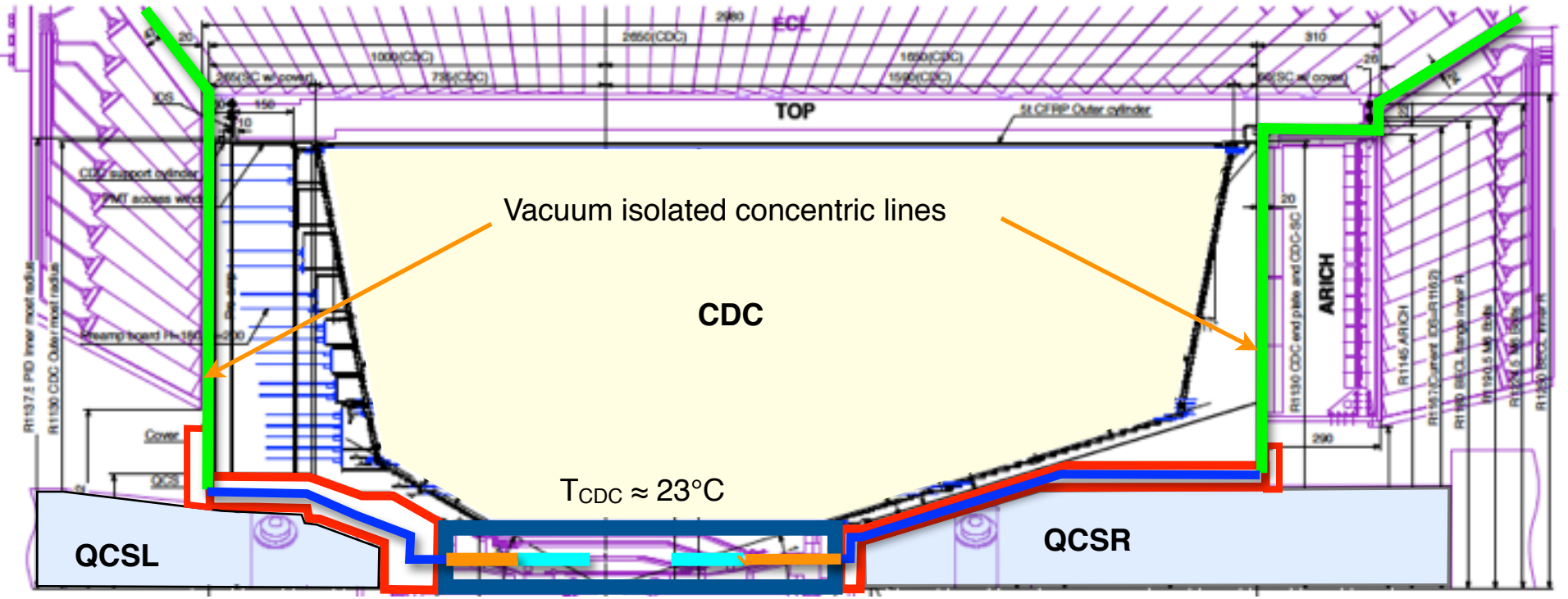
Cooling Environment



PXD		Endring		Origami L45		Origami L6	
L/mm	ø/mm	L/mm	ø/mm	L/mm	ø/mm	L/mm	ø/mm
7120	1	7120	1	7120	1	7120	1
660	1	660	1	660	1	660	1
575	1						
533	1,2	2078	1,5	2282	1,4	4909	1,4
				3013	1,4		
575	1,2						
660	2	660	2	660	2	660	2
7120	3	7120	3	7120	3	7120	3

PXD		Endring	
L/mm	ø/mm	L/mm	ø/mm
7390	1	7390	1
1180	1	1180	1
600	1		
580	1,2	1585	1,5
600	1,2		
1180	2	1180	2
7390	3	7390	3

Cooling Environment



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