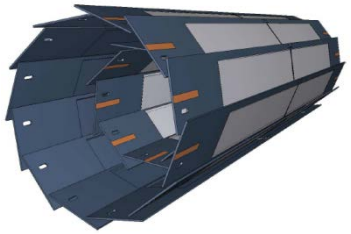
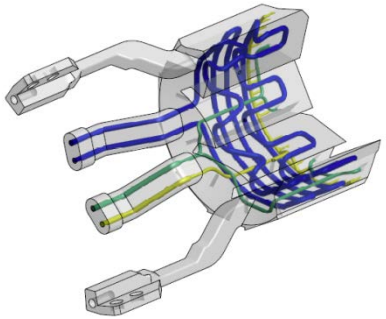
Mockup-Meeting: Introduction and Issues

- The Belle II Experiment for Newcomers
- The Vertex Detectors PXD and SVD
- Workpackages of the PXD (and SVD)
  - Mechanics
  - CO2 Cooling
  - Installation
- Types of Mockups and their Purposes
- Agenda of the Meeting





New Collaborators in the PXD Project

- DESY Hamburg

  Group leader: Carsten Niebuhr

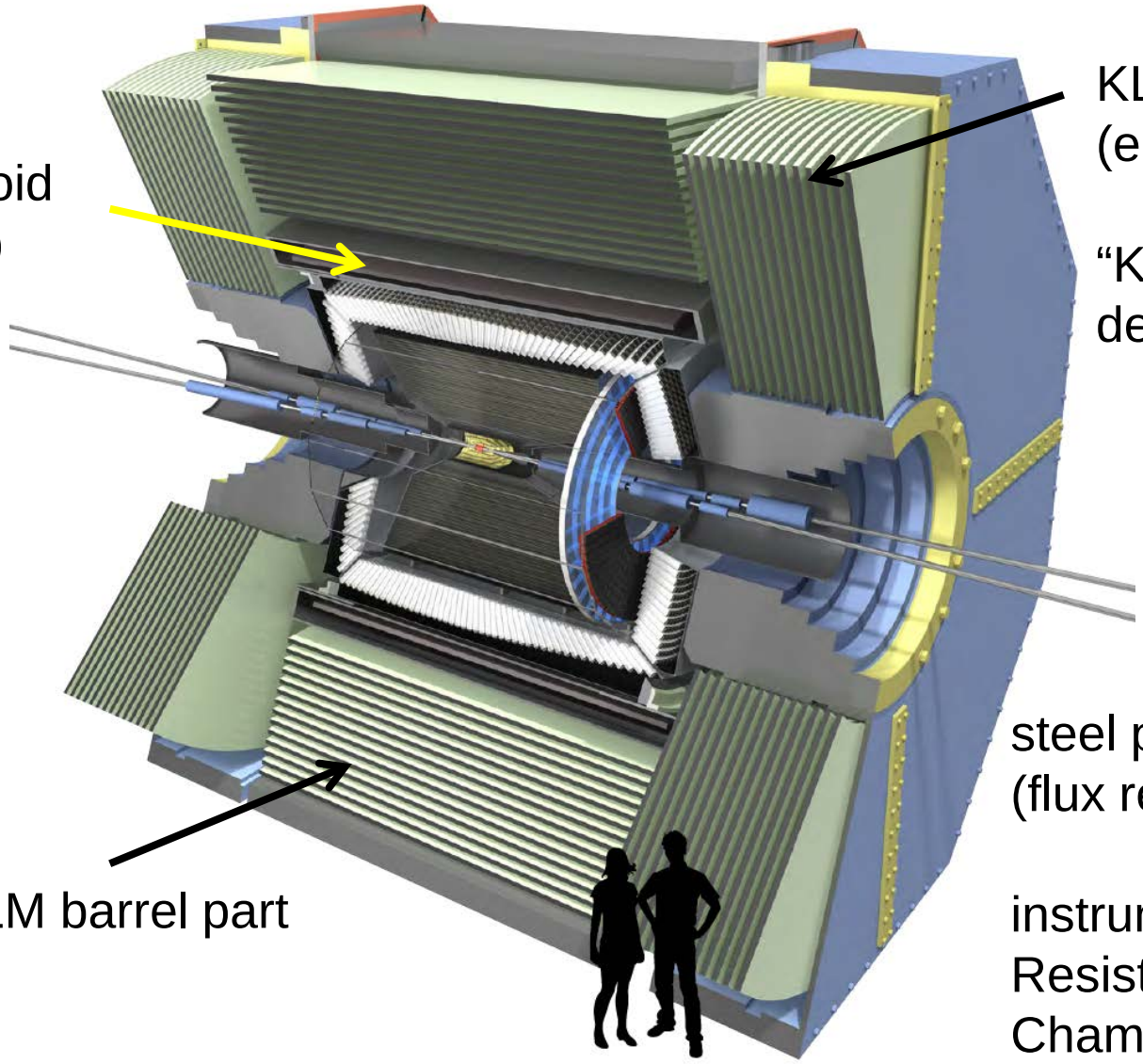
  Members: Karsten Gadow (engineer, 50 %)
  NN (engineer, 100 %)
  NN (PostDoc) ?
  NN (Phd students)

  WP's: mechnical and thermal mockup
  → beampipe, PXD, SVD

  \+ ?

- New manpower at the electrical engineering level:
  Fernando Arteche et al. (ITA Zaragoza, Spain):
  grounding scheme for the PXD + ….

The Belle II Detector



Solenoid
(1.5 T)

KLM
(end cap)

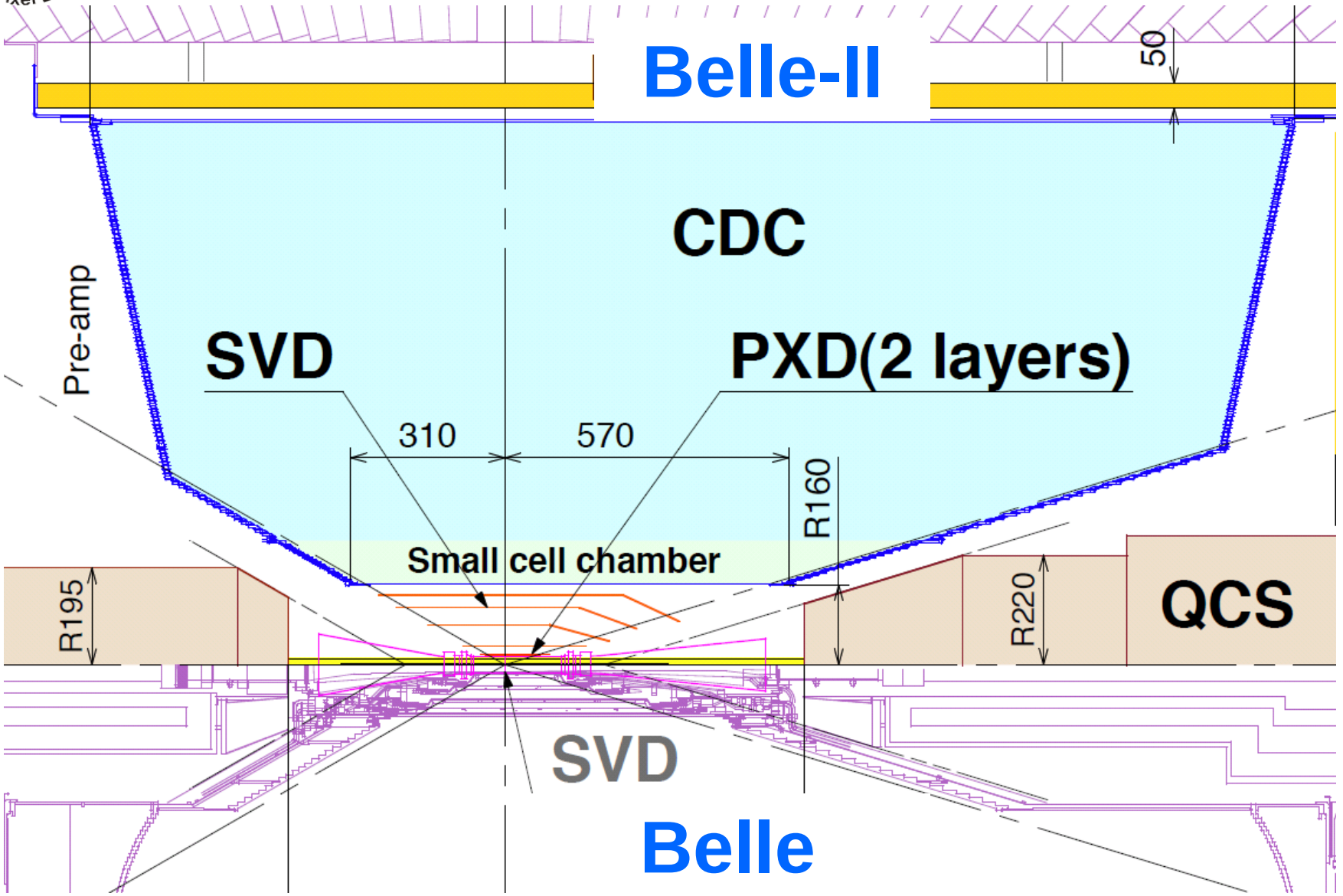
"K_L and muon"
detector

steel plates
(flux return yoke)

KLM barrel part

instrumented with
Resistive Plate
Chambers (RPCs)

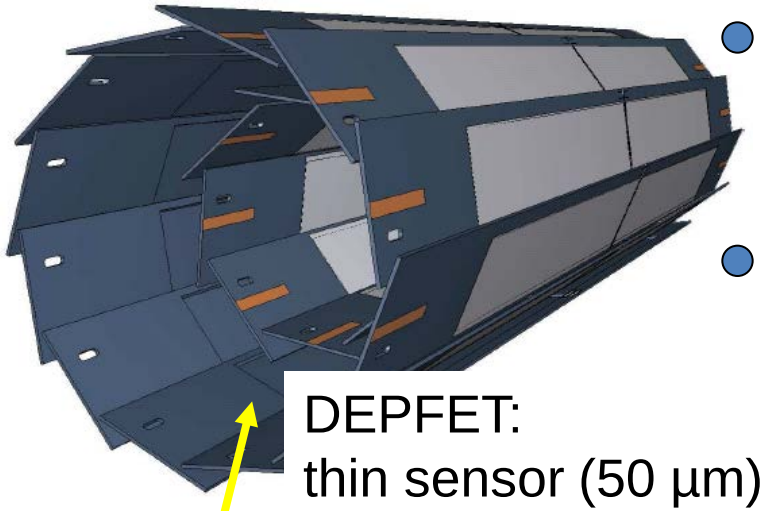
New Tracking System for Belle-II



Silicon Tracking System for Belle II

SuperKEKB: Nano beam option, 1 cm radius of beam pipe

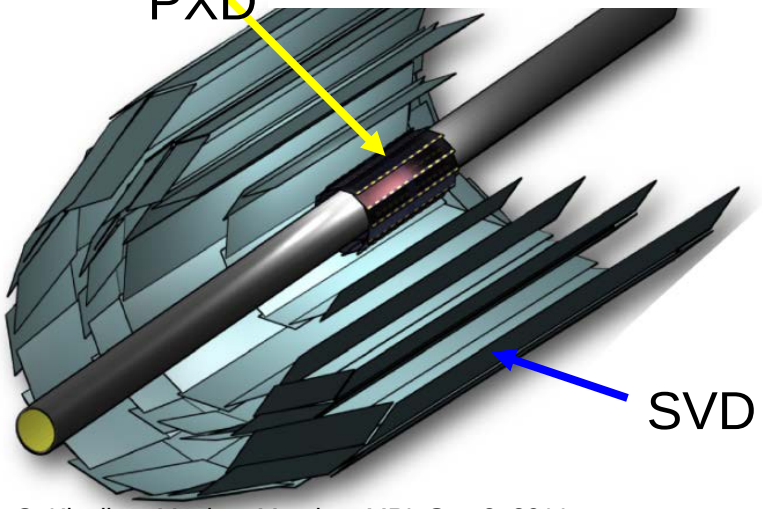
„PXD“



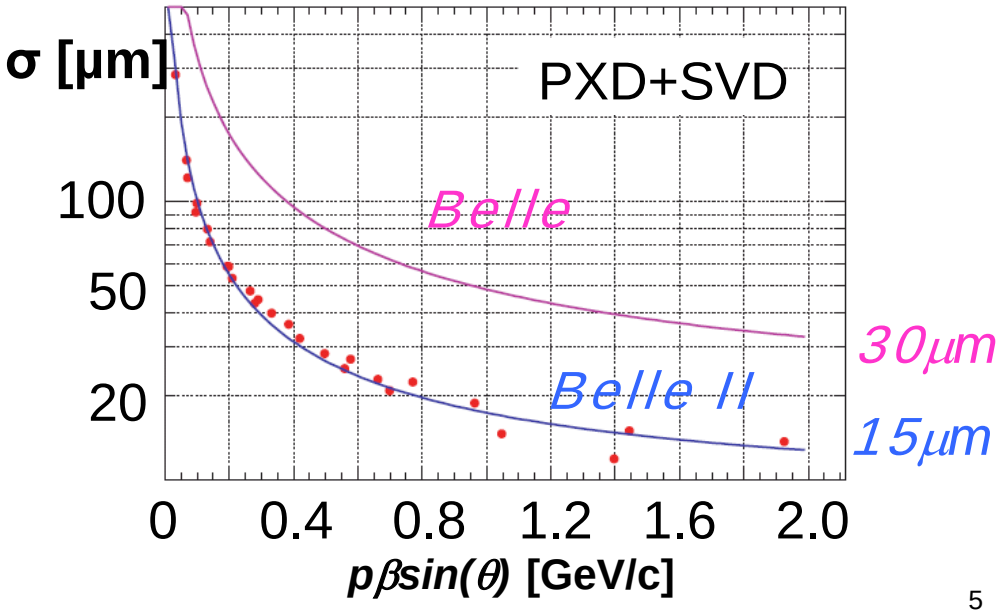
- 2 layer Si pixel detector (DEPFET technology)
  (R = 1.4, 2.2 cm) monolithic sensor
  thickness 75 µm (!), pixel size ~50 x 50 µm²
- 4 layer Si strip detector (DSSD) ← „SVD“
  (R = 3.8, 8.0, 11.5, 14.0 cm)

DEPFET:
thin sensor (50 µm)
unique worldwide

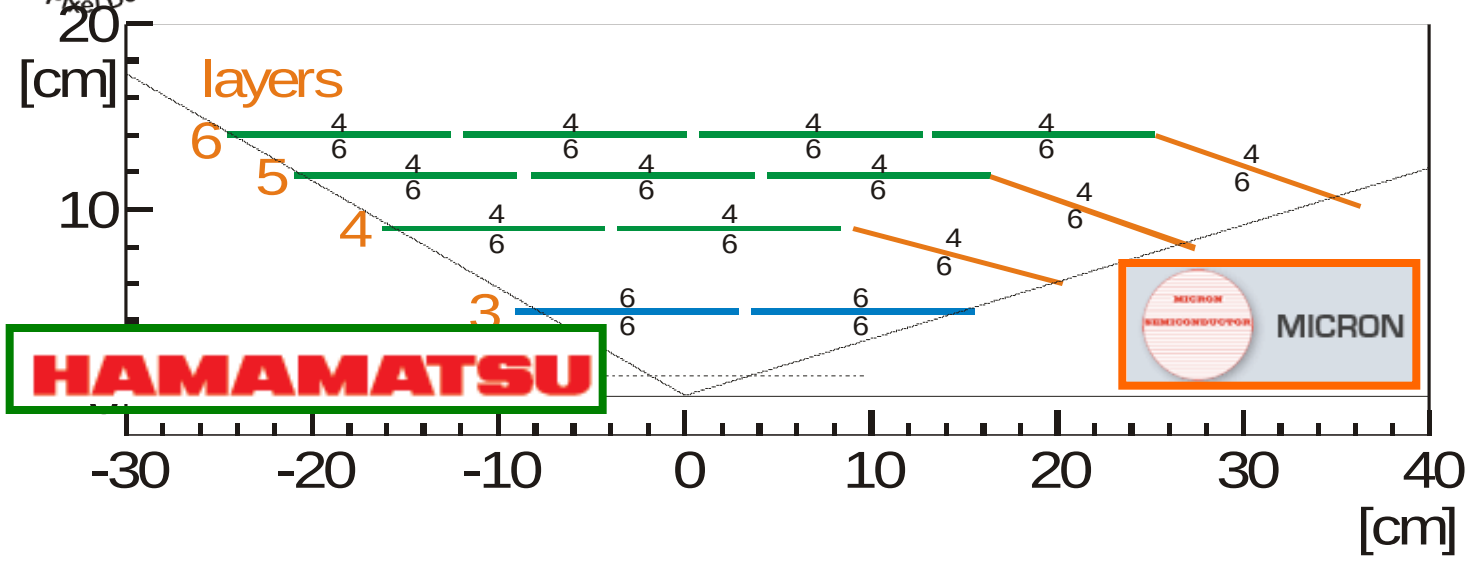
PXD



Significant improvement in z-vertex resolution



New Strip detector : SuperSVD



300 µm DSSD

Pitch:
50/160 µm (rect.)
50-75/160 µm (wedge)

Special requirements for SVD (due to increased background):

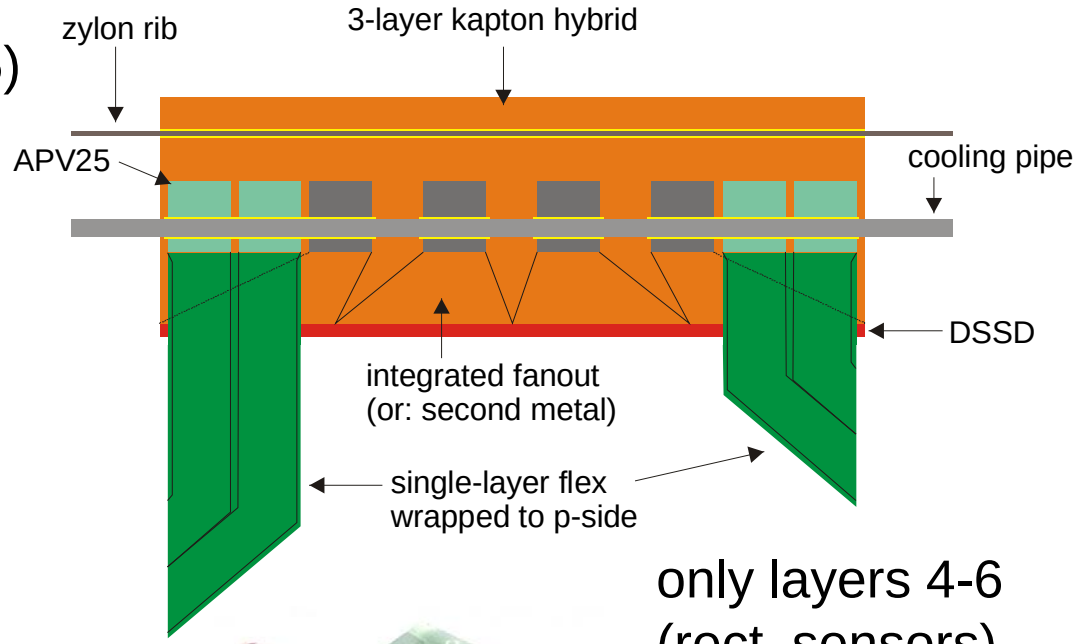
Signal integration time has to be shortened drastically !

Belle: 2 µs,
Belle II: 20-50 ns shaping time for premplifier

New sensors, new electronics (CMS-type APV 25)

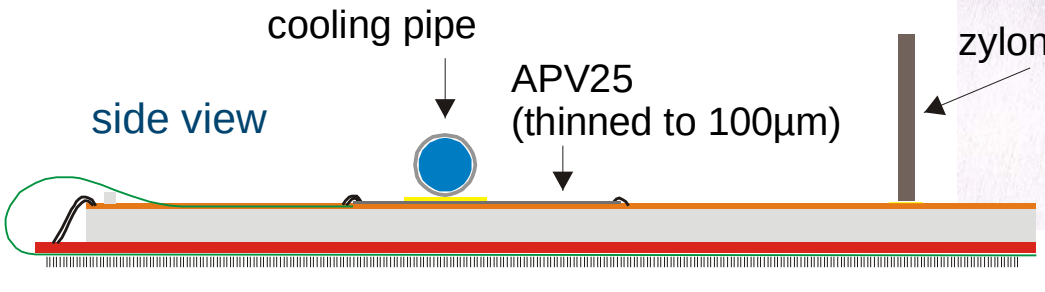
Chip on Sensor: The Origami Concept (SVD)

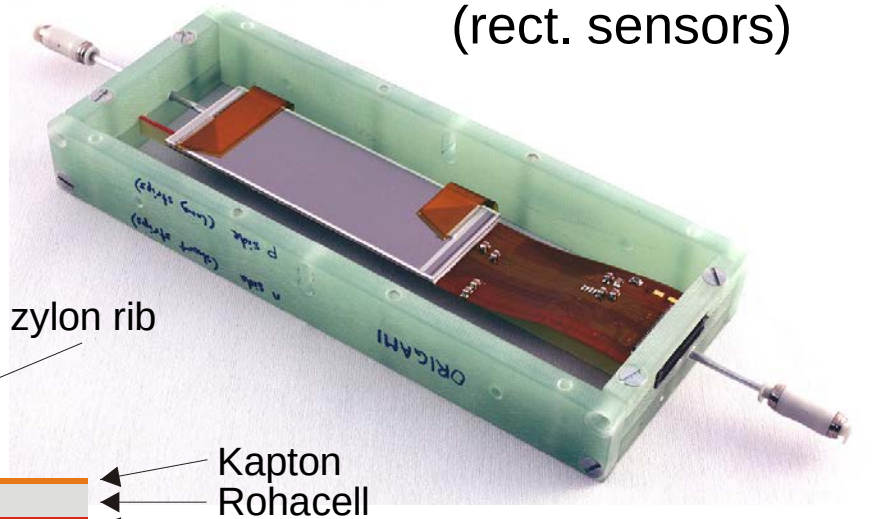
- Thinned readout chips (APV25) on sensor
- Strips of bottom side are connected by flex fanouts wrapped around the edge
- All readout chips are aligned → single cooling pipe
- Shortest possible connections → high signal-to-noise ratio



only layers 4-6
(rect. sensors)

Total material budget: 0.6% X_0
(cf. 0.48% for conventional readout)





DEPFET Pixel Detector (PXD) - Layout

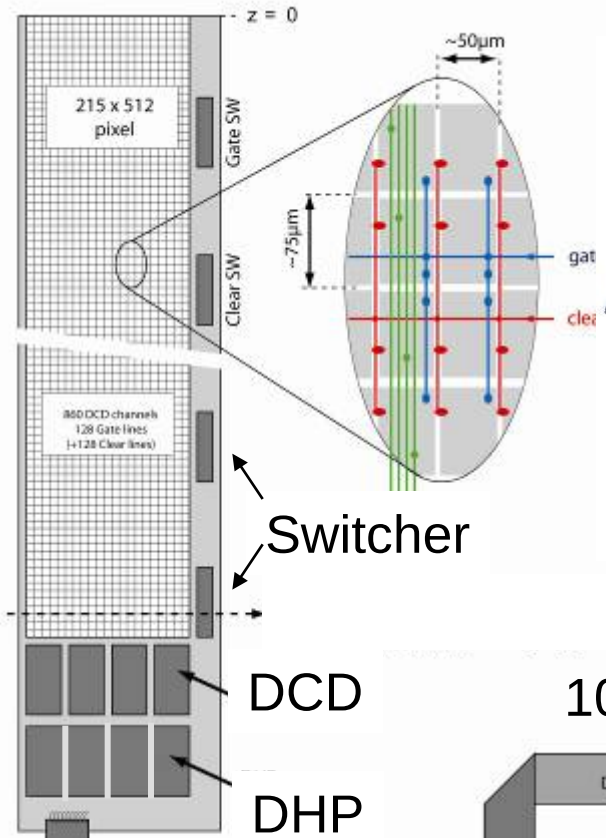
2 layers: @1.4(2.2) cm

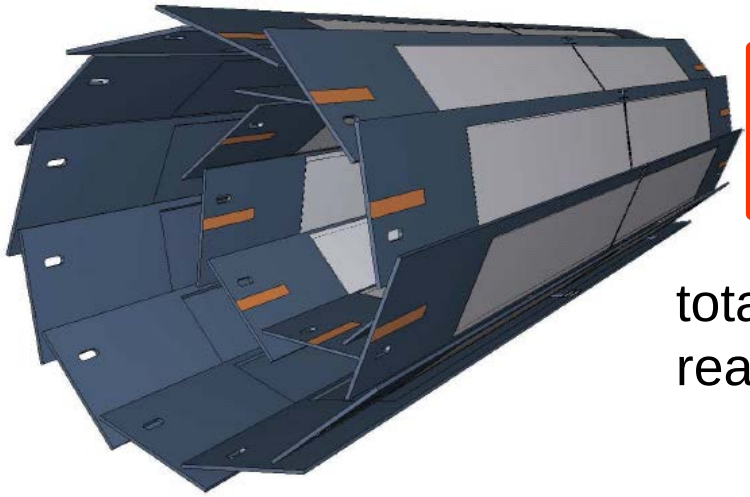
Pixels: 50 x 50(75) µm

half ladder: 768 rows

250 cols

15 x 70 (85) mm





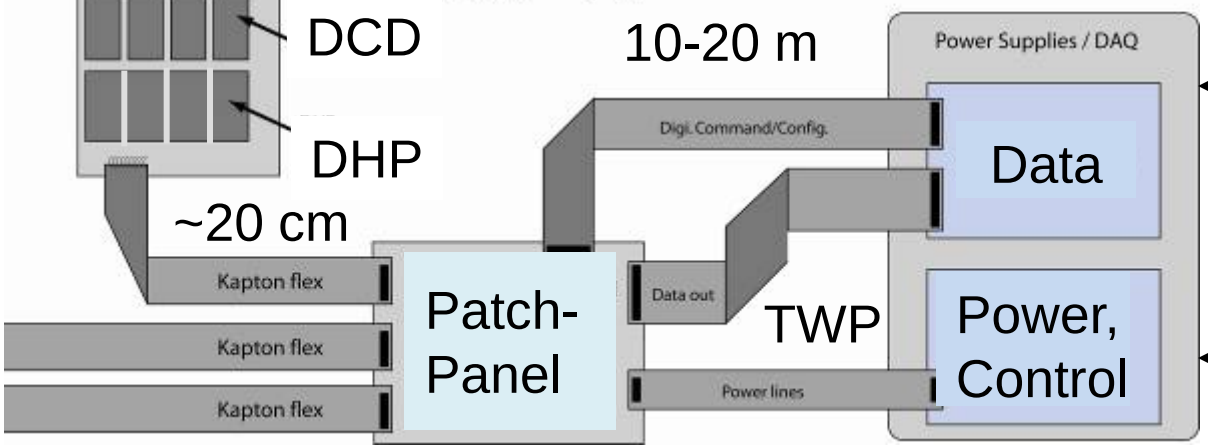
Thickness: 75 µm

total of 8 Mpx
readout: 20 µs

DHH

10-20 m

~20 cm



Opt.

DAQ, Trigger, Timimg

Cu

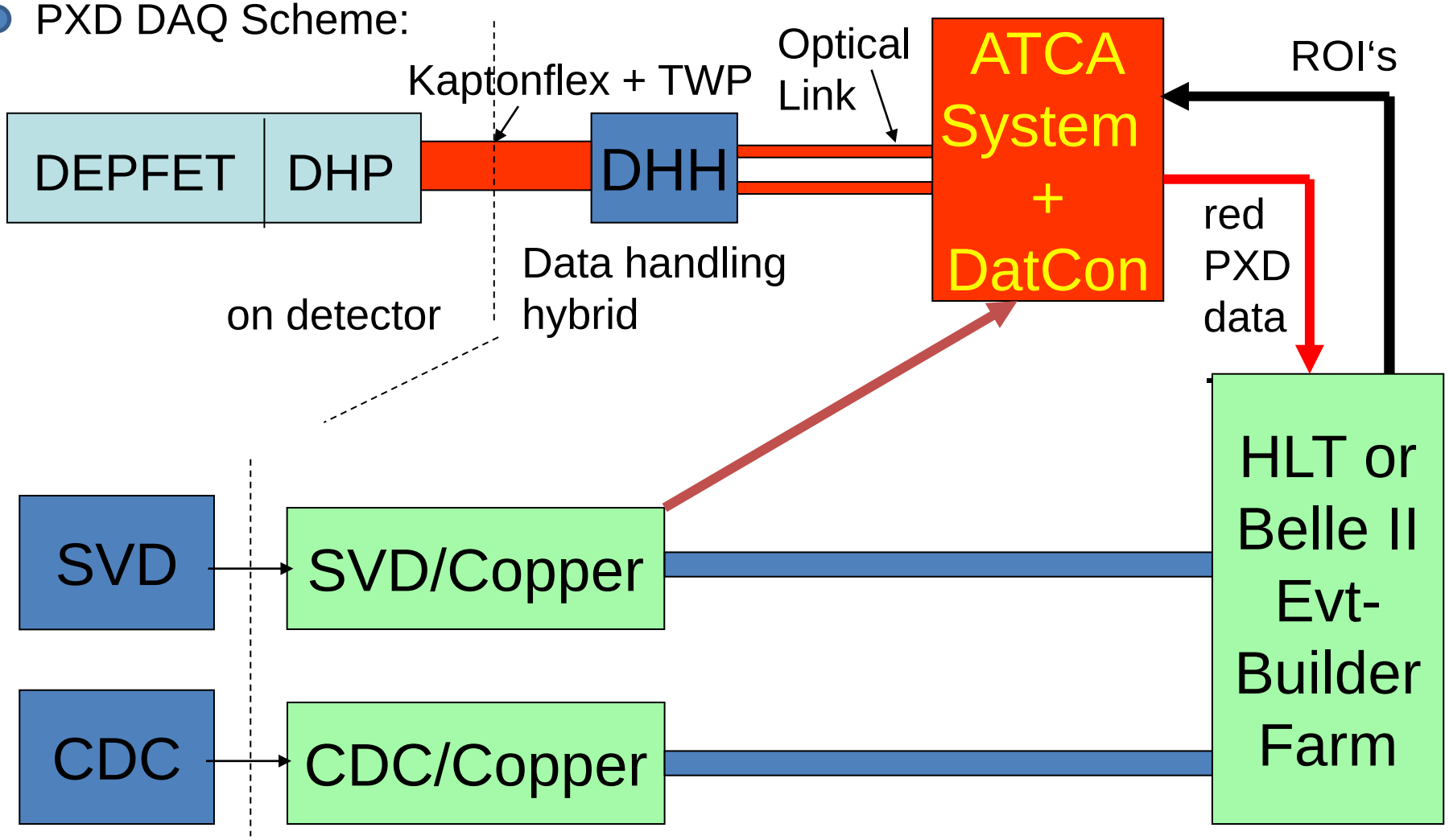
Opt.

PS, Slow control

total of 240 Gb/s !

PXD Data Acquisition System

- PXD DAQ Scheme:



Decision for the ATCA system taken in Münzenberg Workshop (9.6.11)

Work Packages (mainly PXD)

Nr.	Work Package	Lead Institution	Collab. Institutions
1.0	**DEPFET Modules**		
1.1	Parameter definitions	MPI	PRA
1.2	**Sensor Development**	MPI	
1.3	**ASIC Development**		
1.3.1	Switcher	HEI	
1.3.2	Current Digitizer (DCD)		
1.3.3	Data Handling Processor (DHP)	BON	MPI, UBA
1.3.4	Interconnection technology	BON	CNM, HEI, IFB, MPI
1.3.5	Electronic Multi-Chip Module (EMCM)	MPI	BON, CNM, HEI, IFB
1.4	**Module Design**		
1.4.1	Sensor Ladder	MPI	BON, CNM, HEI, IFV, IFB
1.4.2	Kapton Flex + Patch Panel	BON	LMU
1.4.3	Data Handling Hybrid (DHH)	TUM	BON, GOE

Work Package Distribution (cont.)

Nr.	Work Package	Lead Institution	Collab. Institutions
1.5	**Mechanical Design**		
1.5.1	ladder support and cooling block	MPI	IFV, KAR, KEK, VIE
1.5.2	support on beampipe	MPI	KEK
1.5.3	real time position monitor	IFC	MPI, VIE
1.6	**Thermal Issues**	KAR	MPI, VIE, KRA, IFV
1.7	**System**		
1.7.1	Data Acqusition	GIE	BON, TUM, MPI, KRA
	(pre-event builder)		GOE, KEK, VIE
1.7.2	Services (Power, cables)	LMU	KRA, KEK, TUM
1.7.3	Cooling plant	MPI	VIE, KAR, KEK, IFV
	(CO2 refigerator)		
1.7.4	Slow Control	TUM	LMU, MPI
1.7.5	Grounding	ITA	MPI, LMU

Work Package Distribution (cont.)

Nr.	Work Package	Lead Institution	Collab. Institutions
2.0	**Test Facilities**		
2.1.1	Test beam setup	IFV	KAR, BON, VIE, IFV, IFC
2.1.2	Test beam analysis	PRA	GOE, HEI, IFB, MPI
2.1.3	Lab test procedures	MPI	(all)
2.2	Setups for thermal tests	KAR	IFV, MPI, VIE
2.3	Mechanical / thermal mockups		DES, FV, KRA, MPI, VIE
2.4	Irradiation Tests	MPI	BON; KAR

DES = DESY

lead institution of WP 2.3 to be defined in September meeting

Work Package Distribution (cont.)

Nr.	Work Package	Lead Institution	Collab. Institutions
3.0	**Integration and running-in scenario**		
3.1	Radiation monitor during machine commissioning (“ BEAST II”)	MPI (?)	?

Nr.	Work Package	Lead Institution	Collab. Institutions
4.0	**Operation Issues**		
4.1	Belle II Slow Control	TUM (?)	

WP associations subject to change

Mechanics and Cooling: PXD

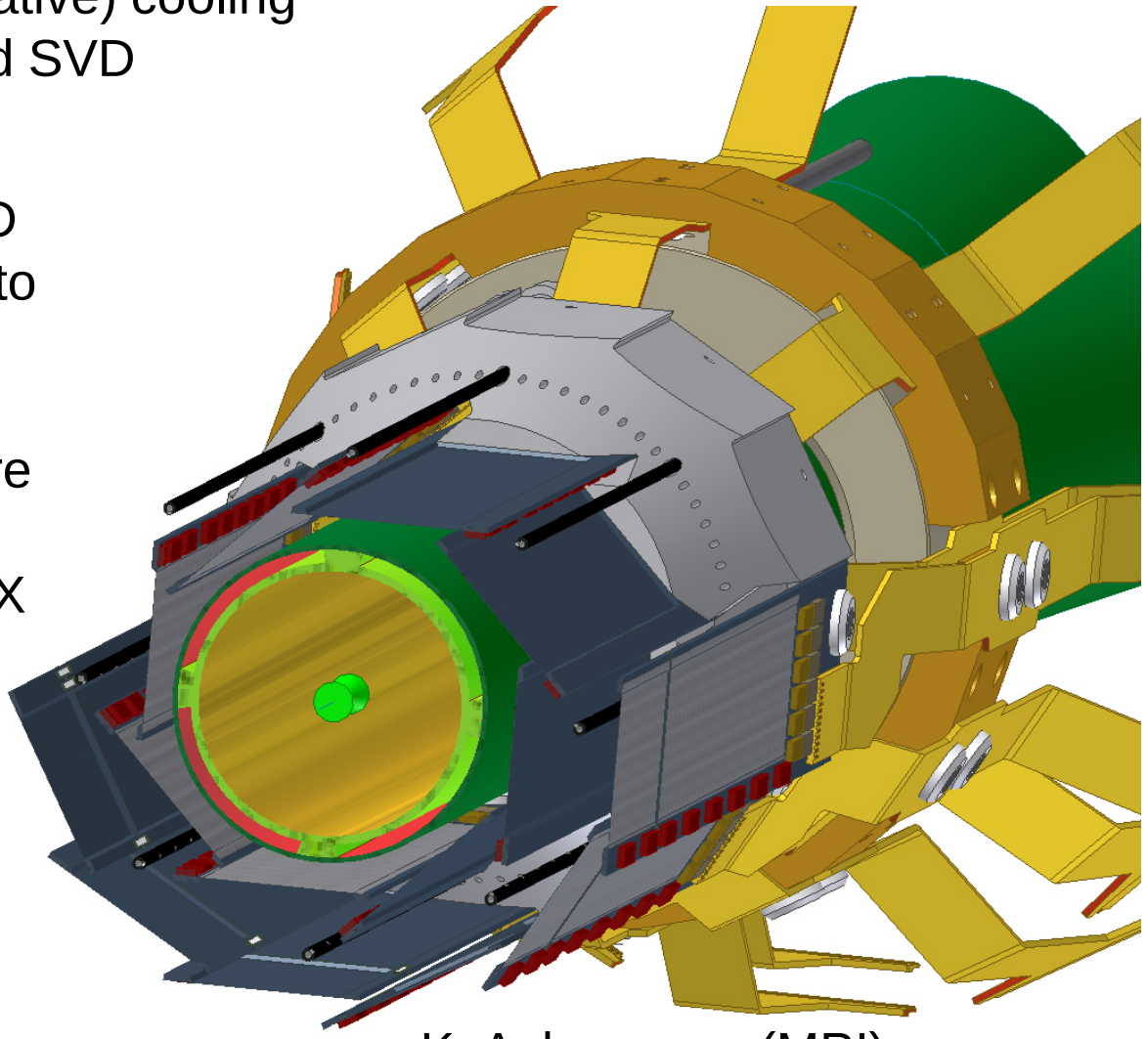
CO2 (2-phase evaporative) cooling for PXD (~ -20 °C) and SVD

CO2 pipes within the PXD support structure (needs to stand 120 Bar)

➔ design of support structure based on novel 3D manufacturing using INOX („rapid prototyping“)

New idea for air flow:

additional carbon pipes for direct air cooling of the switcher chips



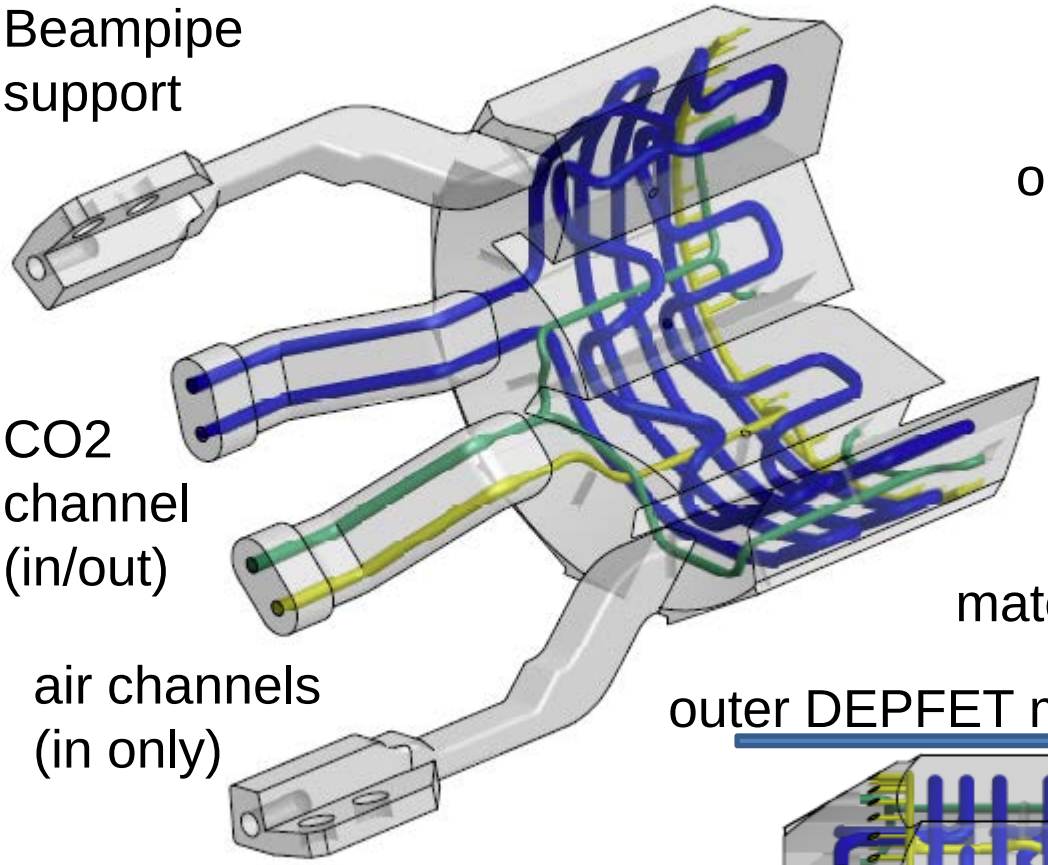
K. Ackermann (MPI)

Mechanics and Cooling (cont.)

Beampipe support

CO2 channel (in/out)

air channels (in only)

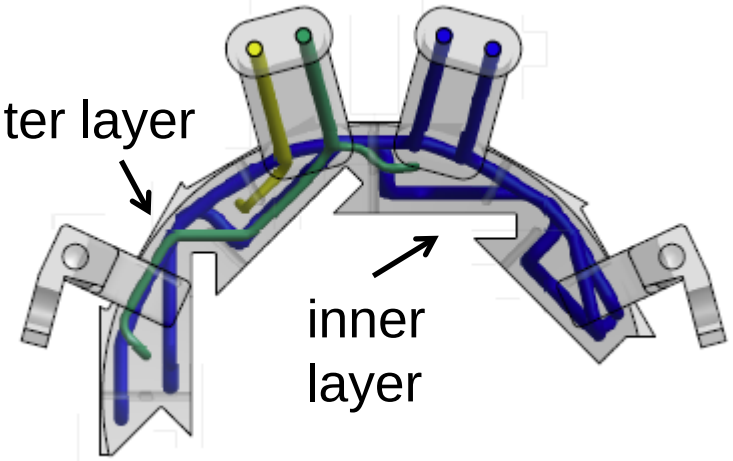


air

CO2

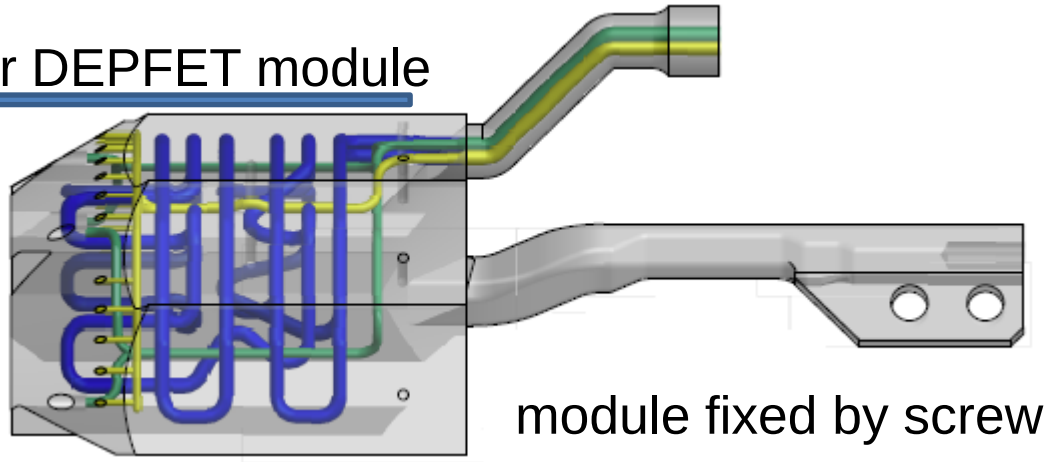
outer layer

inner layer



material INOX

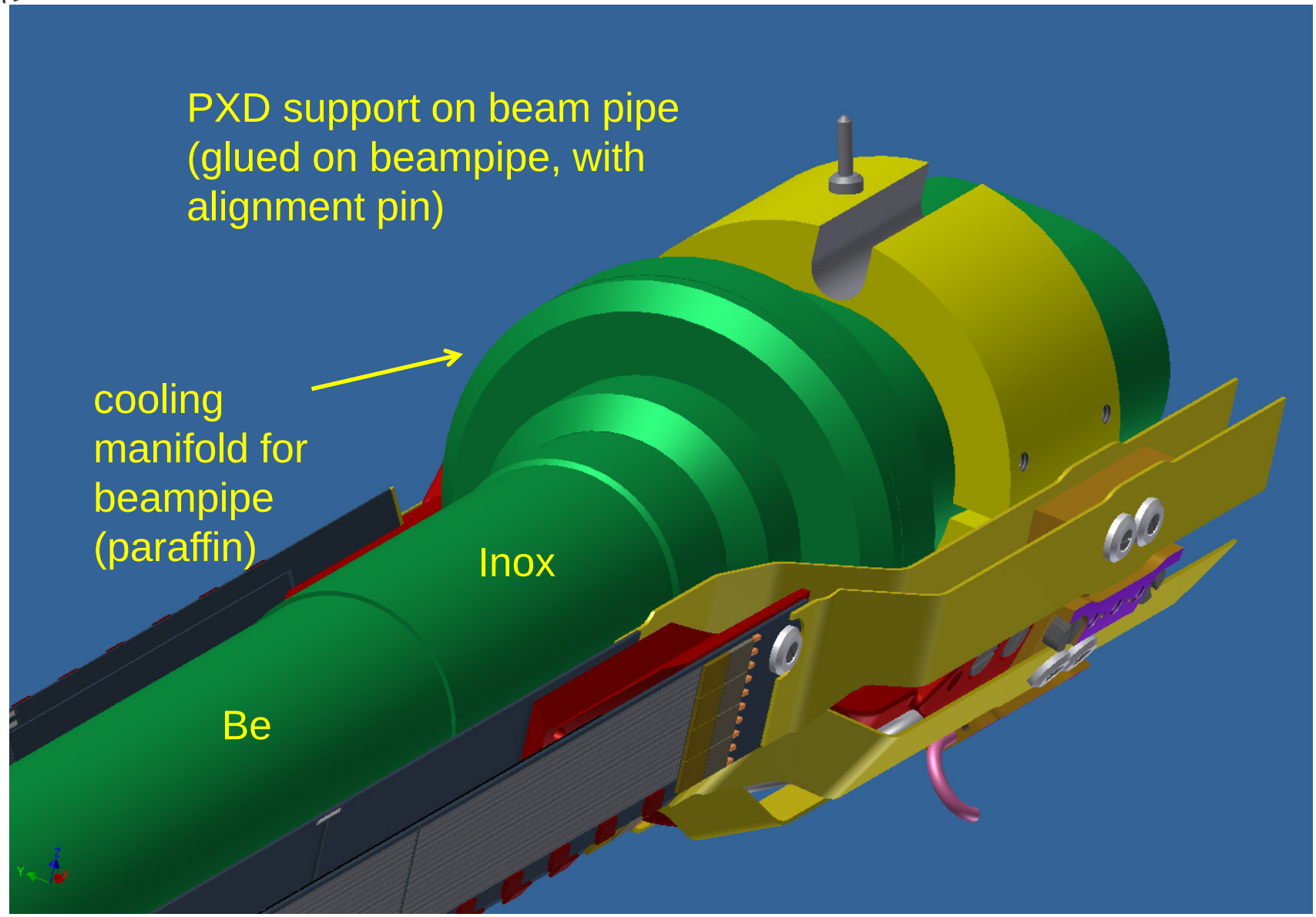
outer DEPFET module



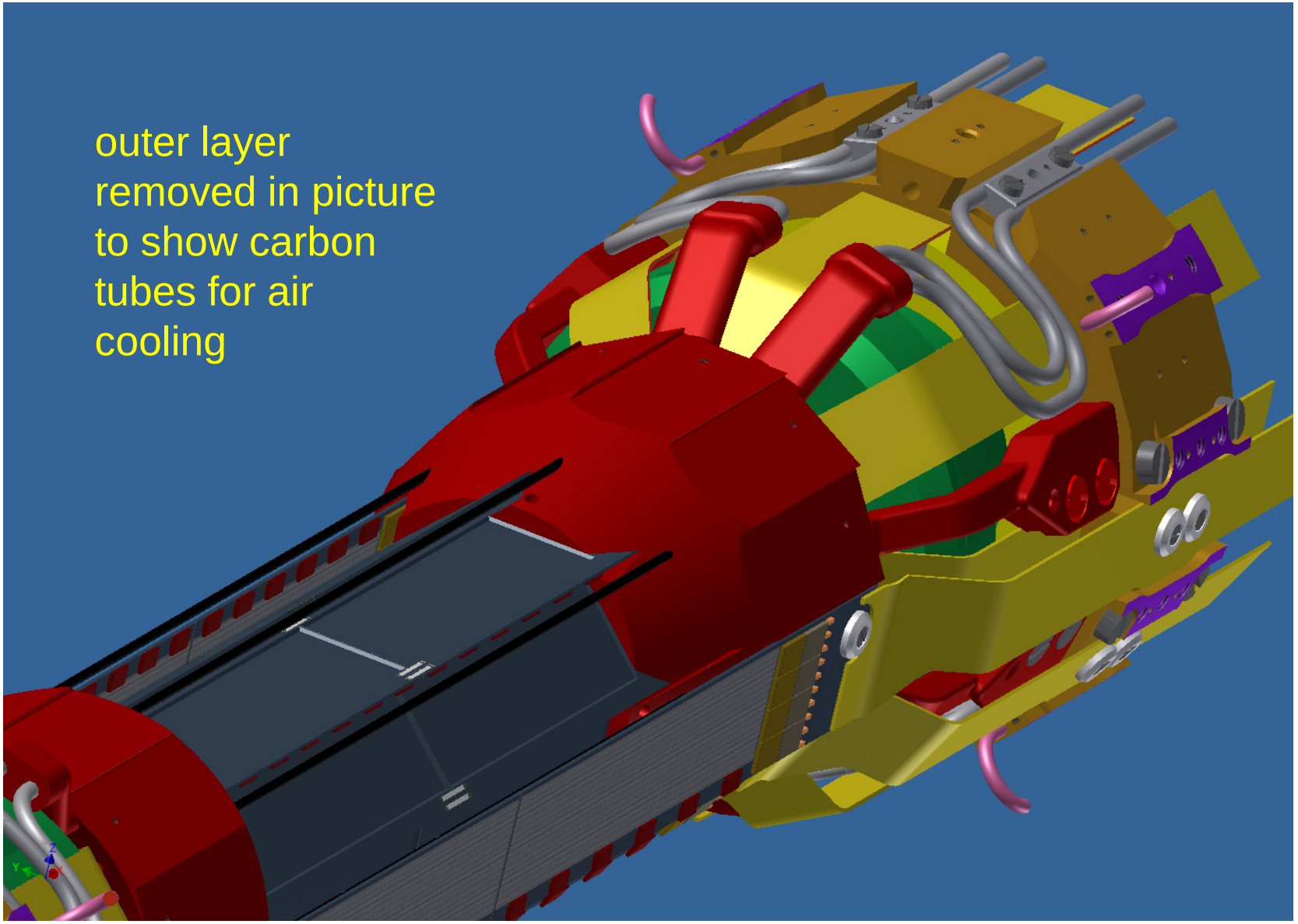
module fixed by screw

design: K.A. (MPI)
manufactured by Fruth Innovative Technology (FIT)

PXD Fixture on Beampipe



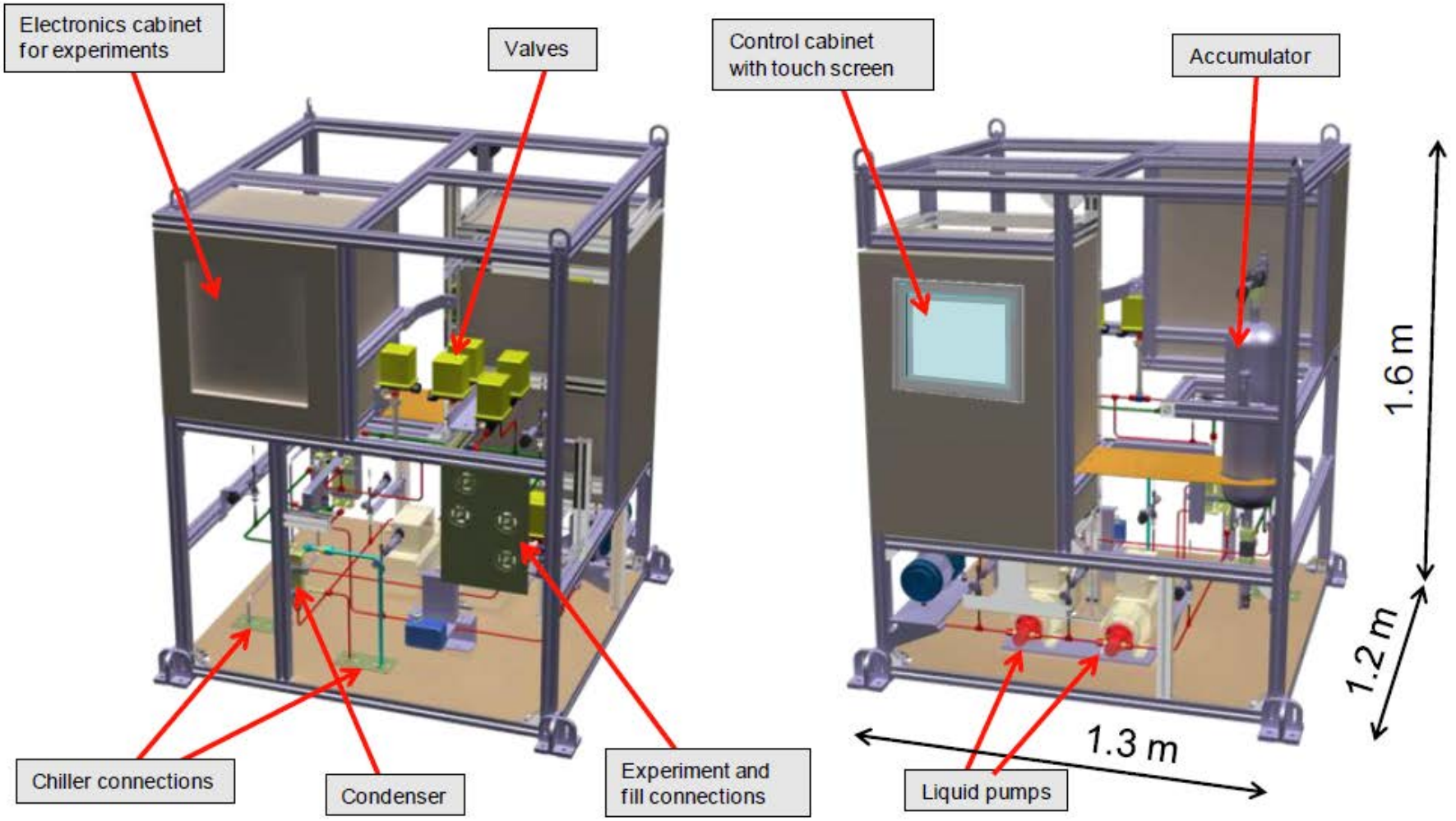
PXD Mounted on Beam pipe



Workpackage: CO2 Cooling Unit

- Cooling of PXD with CO2 established (open and closed systems)
- Concrete plans to build a closed CO2 System for PXD and SVD at MPI with the help of Nikhef/CERN, Vienna and Karlsruhe
- MARCO (Multipurpose Apparatus for Research on CO2)
  - close collaboration with CERN and Vienna
  - prototype for common project “IBBelle” (ATLAS IBL and Belle II)
  - learning phase started June 6 (- end July)
  - ordering of parts for MARCO done
  - frame being done at CERN by MPI technician (by mid September)

Workpackage: CO2 Cooling (cont.)

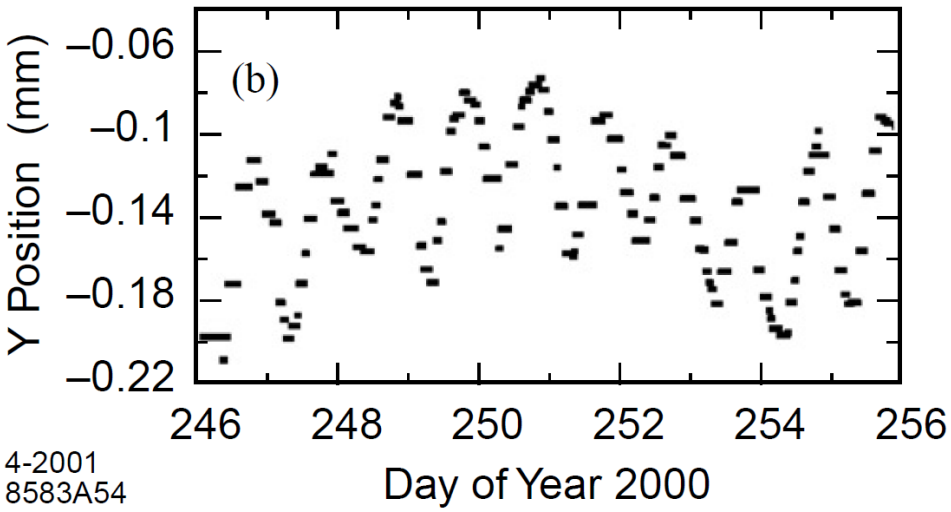


Frame with accumulator will come to MPI by mid Sept. for the piping job orbital welding done at MPI, then back to CERN for commissioning

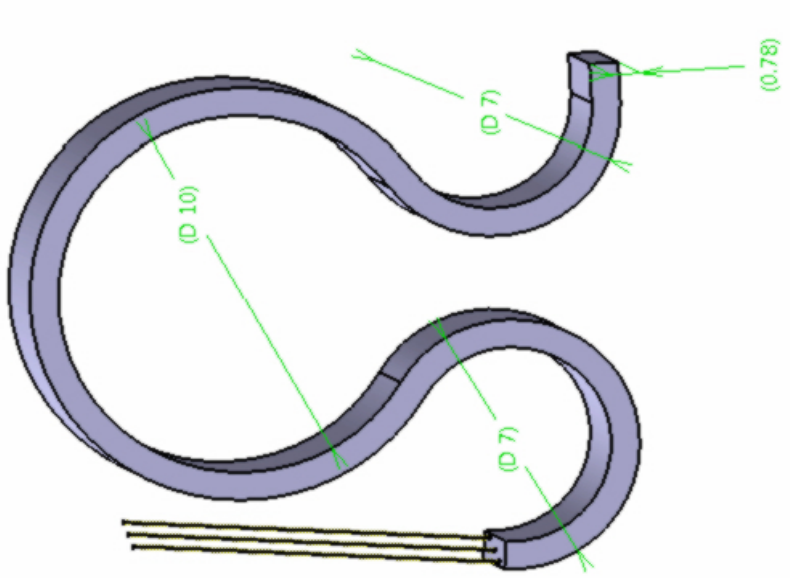
Workpackage: RT Position Monitor

Possible scenario: PXD (on beampipe) moves relative to SVD (supported on CDC), possibly by O(100 µm) over a few hours, and possibly periodically (temperature).

This is what BaBar saw:

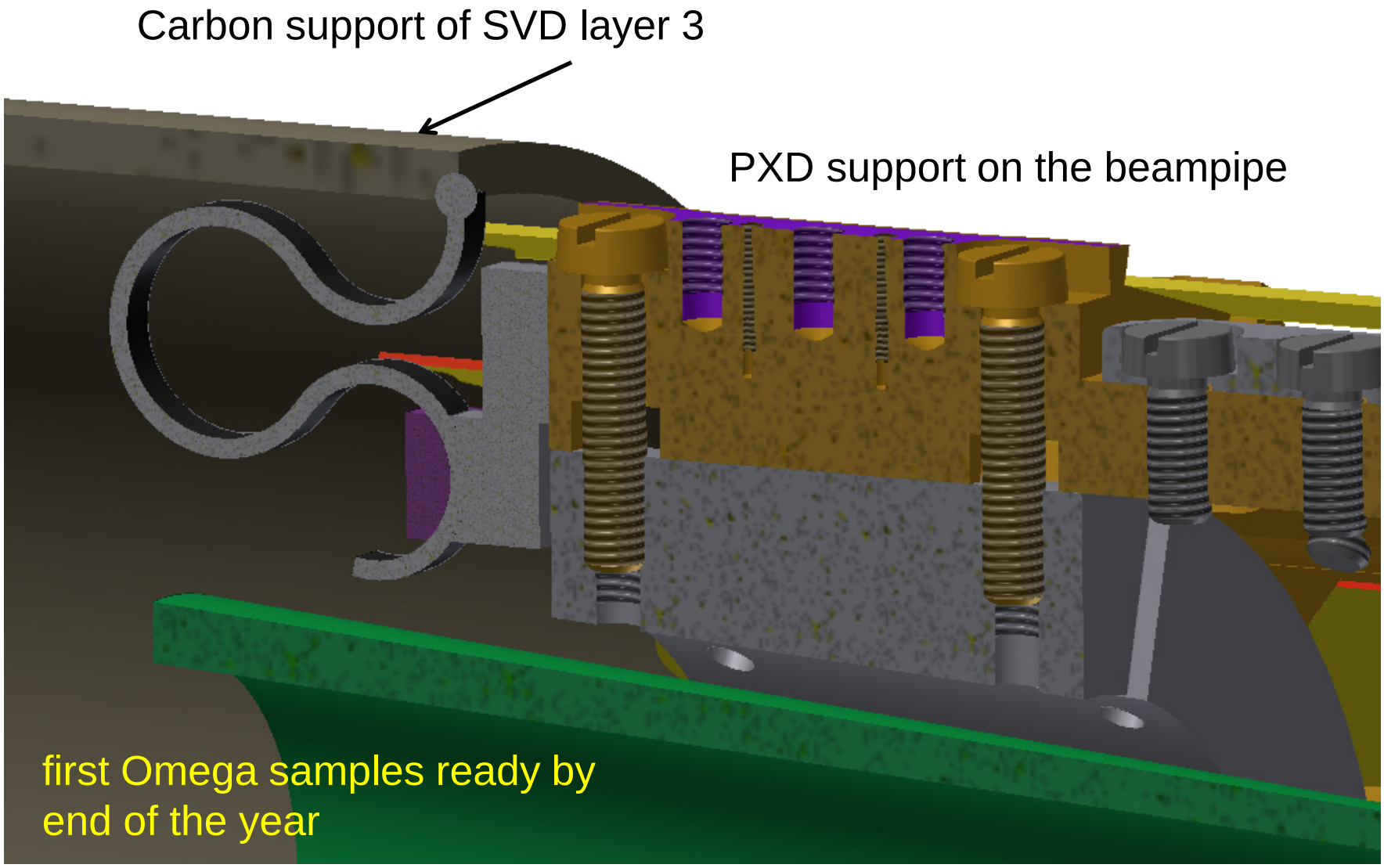


Solution by our Spanish colleagues (Ivan Vila et al., Univ. Santander): Fiber Optical Sensors (FOS)

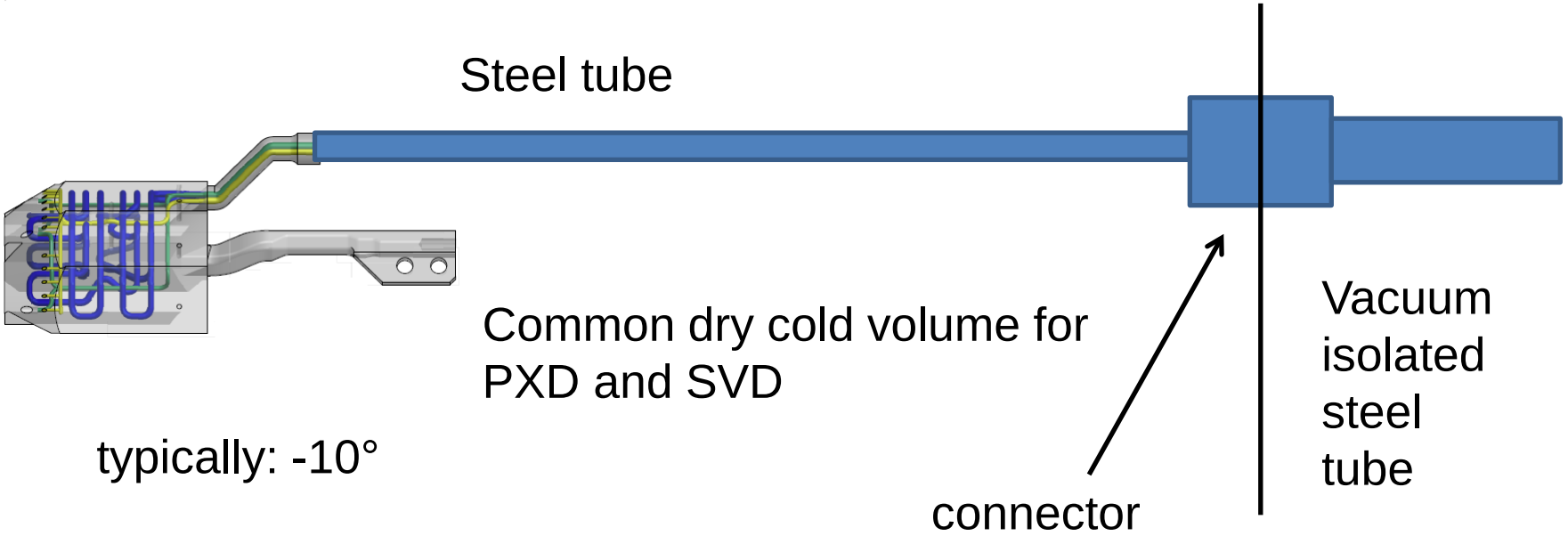


Idea: monitor relative position in real time

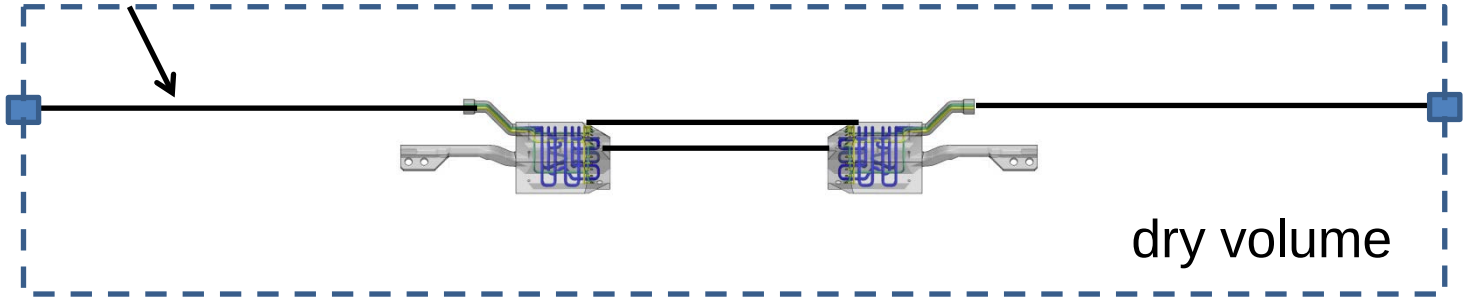
PXD-Workpackage: RT Position Monitor (cont.)



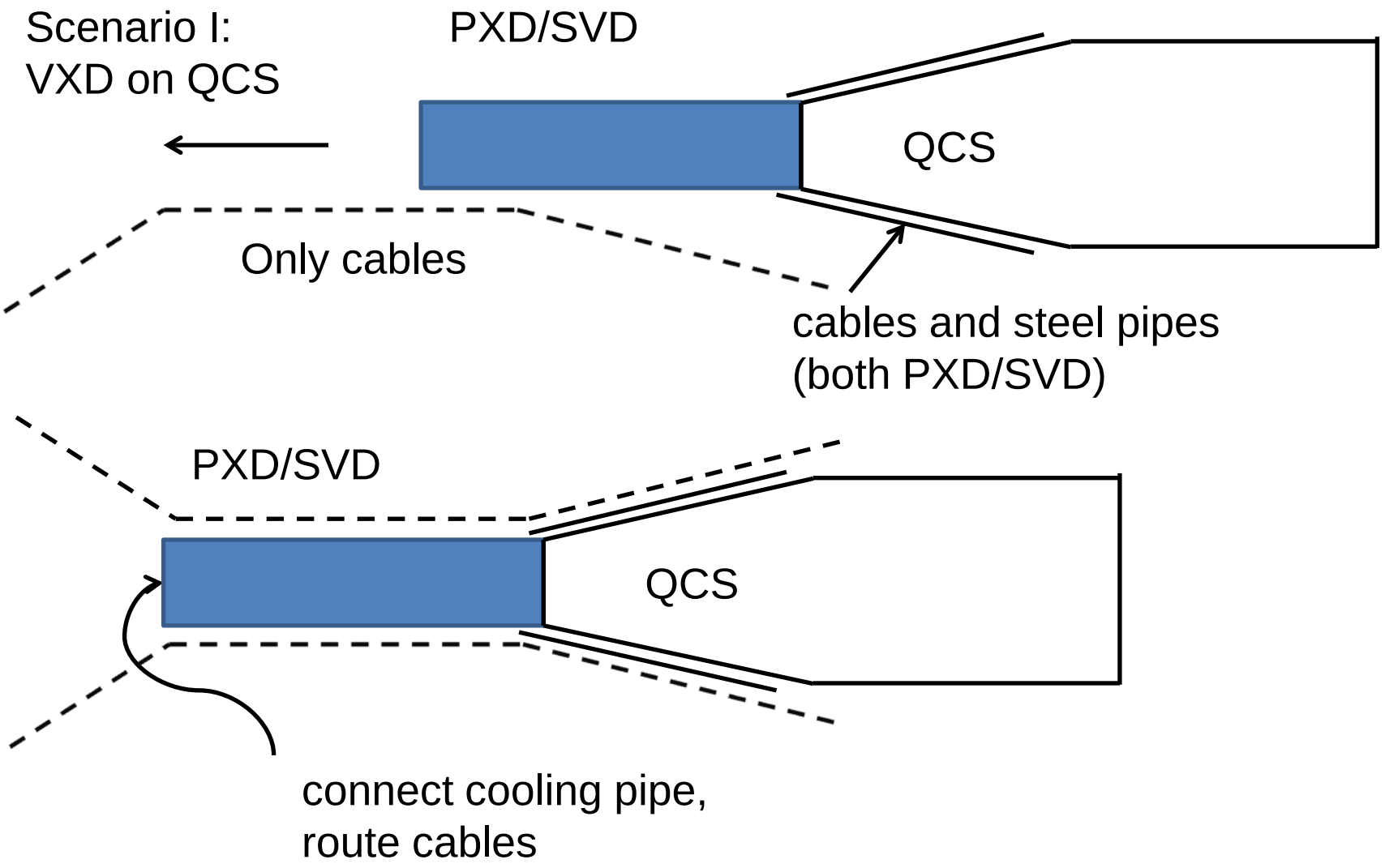
Common Cold/Dry Volume



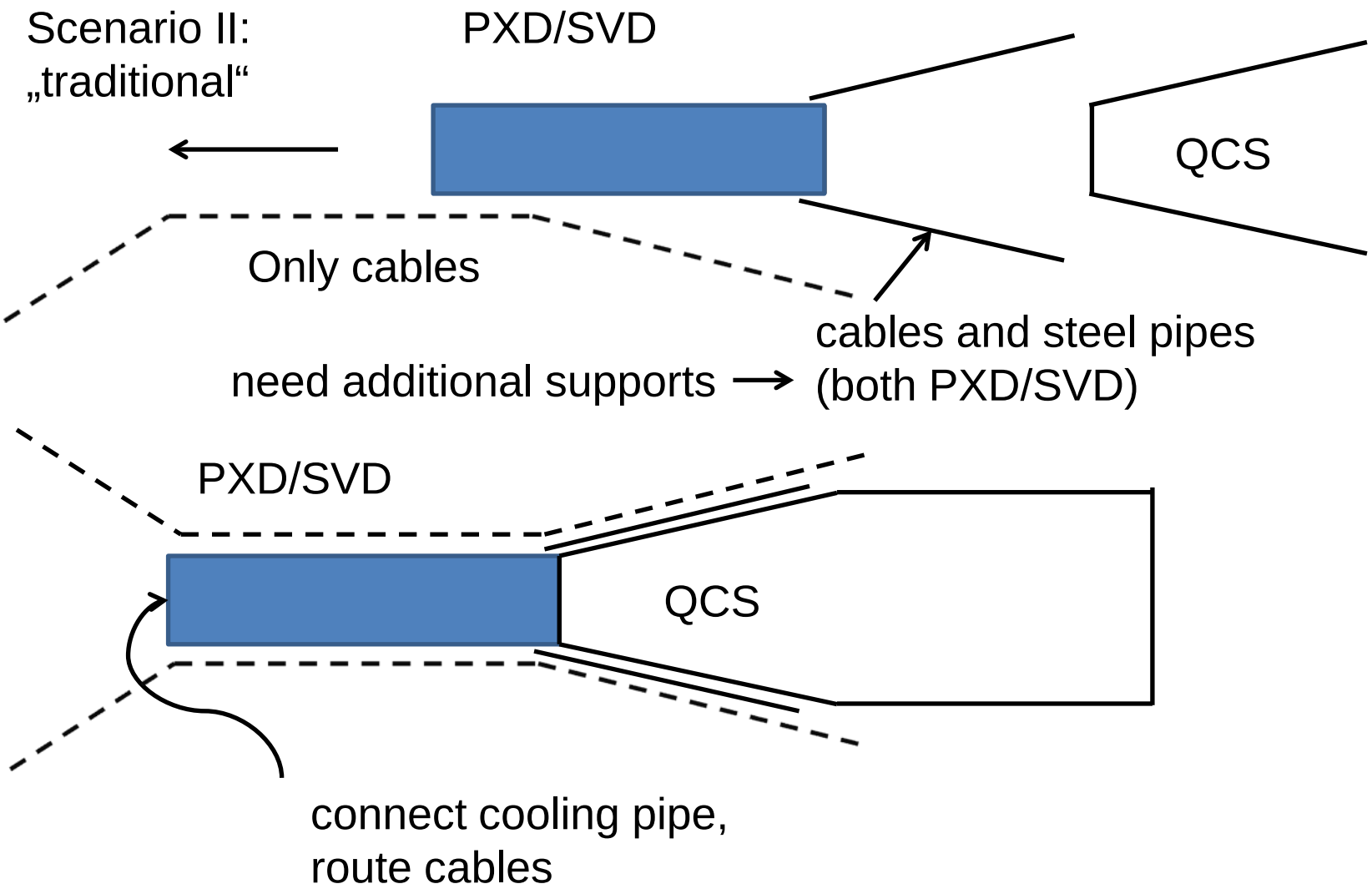
Mounting jig needs to provide stress relief also for these tubes



Installation in Belle II



Installation in Belle II



Installation Procedure

Beampipe / PXD / SVD installation managed by KEK

However: presently it is foreseen to mount the BP/PXD/SVD onto the forward QCS, then move the whole assembly through the CDC

Nb: the inner bore of the QCS is the beampipe, i.e. scew the QCS onto the beampipe.

Are there other possible scenarios (e.g. similar to SVD2 in Belle) ?

-> remote-control locking system (space issues) needed for the backward anyway

Workpackage: Mockups

Three main purposes of the mockups:

1. Mechanics

   Support and services (space!)
   PXD: need to model beampipe + masks
   SVD: need to model support from CDC

2. Thermal Properties

   common cold volume for PXD and SVD
   does the air cooling for the switchers / sensors work?
   how to isolate against the CDC ?

3. Installation

   can we install independently (SVD first, PXD later) ?
   can we install without QCS ?

Mockup for Installation

- Installation procedure sufficiently involved !
- Need dummies, tools (jigs) + training / ideas
- Mockup of all the components:

  Beam pipe
  PXD
  SVD
  Inner tube CDC
  HM masks, QCS

  } including cables and piping, weights should be realistic !

- Schedule to be planned soon (some guess: by time of B2GM)
- Involved parties: DEPFET Coll. + Vienna + KEK

Schedule for Installation

2014			2015								
10	11	12	1	2	3	4	5	6	7	8	9
						BEAST phase 1	Summer Shutdown				
machine ready w/o QCS										PXD ready	QCS ready
Detector Installation (except for PXD/SVD)									Roll-In	GCR Contract over	COMP ready by Oct. 1

2015			2016								
10	11	12	1	2	3	4	5	6	7	8	9
phase2			Winter Shutdown		Physics Run				Summer Shutdown		
			VXD inst.	GCR							

Meeting Agenda

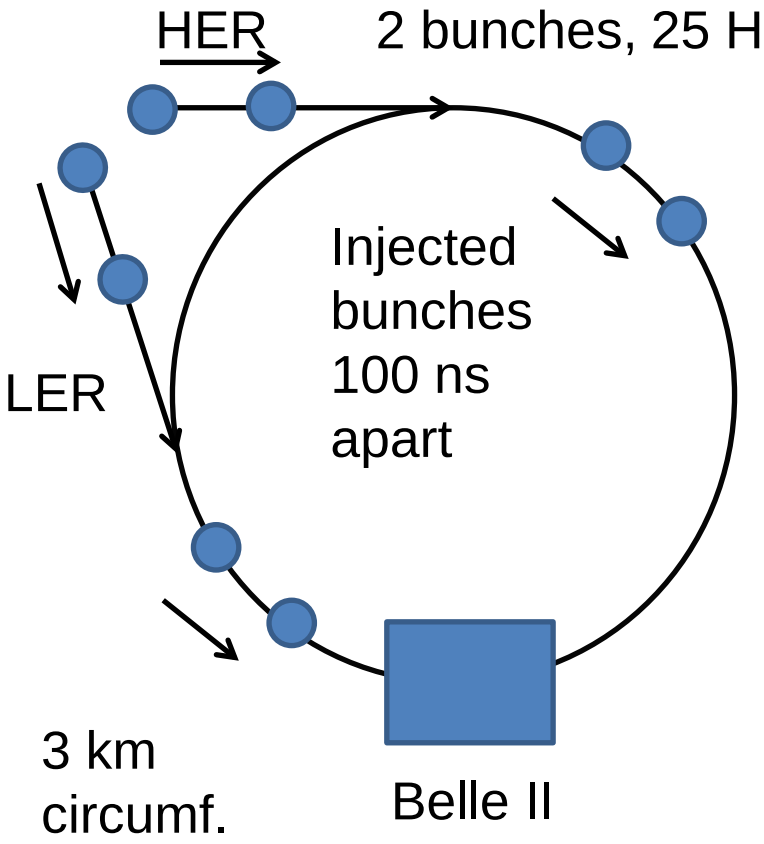
Thursday 08 September 2011

top

09:30	Introduction, Purpose of the Meeting (20')	Christian Kiesling
09:50	Status of PXD Mockup at MPI (25')	Martin Ritter
10:15	Plans for SVD Mockup at Krakow (15')	Andrzej Bozek
10:30	Discussion on SVD Mockup at Krakow (30')	Jerzy Kotula
11:00	Coffee break (30')	
11:30	Thermal Mockup at Valencia (30')	Carlos Lacasta
12:00	Installation Procedures for PXD/SVD (30')	Immanuel Gfall
12:30	Lunch break (1h00')	
13:30	Installation procedures in the H1 Experiment (30')	Karsten Gadow
14:00	Discussion and Planning of Mockups (1h00')	
15:00	Coffee break (30')	
15:30	Discussion and Planning of Installation Scenarios (1h30')	
17:00	End of Meeting (15')	

Backup

Machine: Injection Noise



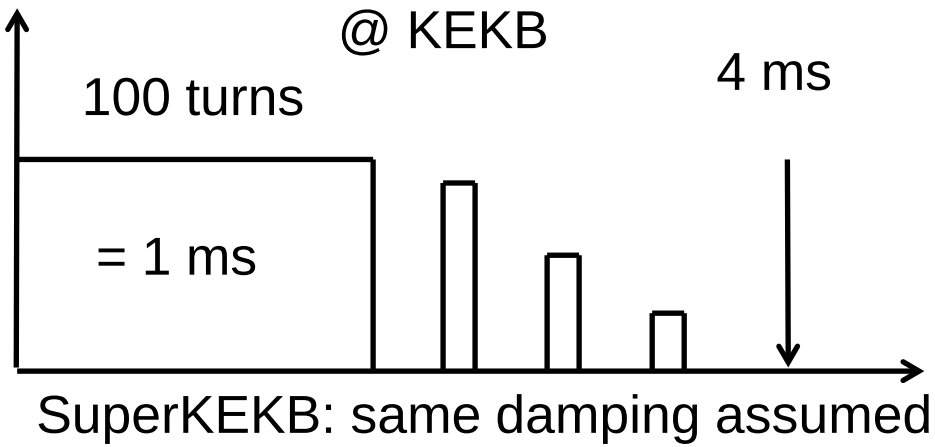
revolution time
= 10 µs

Total rate: 50 Hz

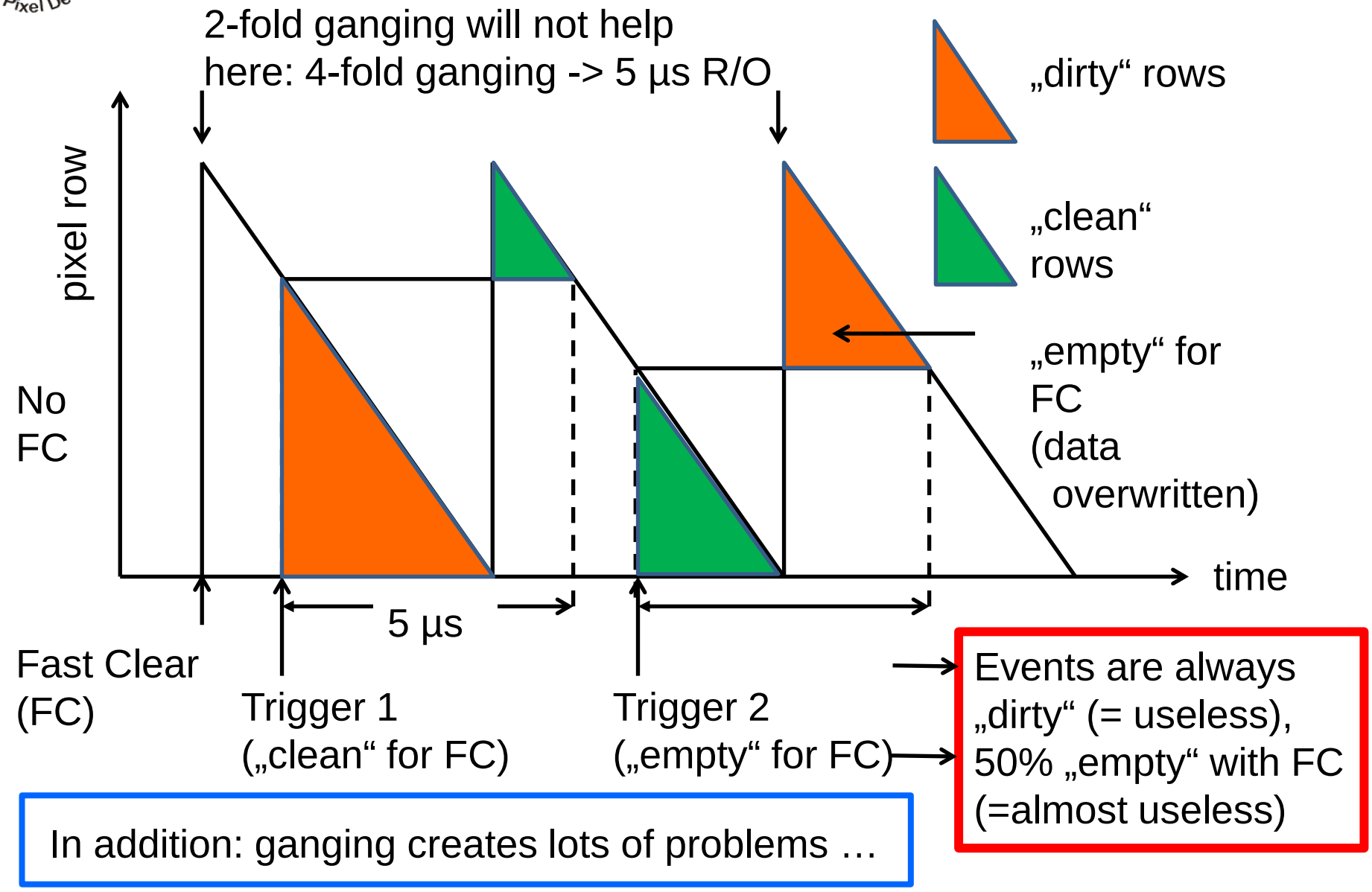
Principle:

continuous injection, developed by KEKB machine physicists

Liouville theorem:
bunches cannot be injected into same phase space volume
-> „cooling“ by synchroton radiation
-> particle loss -> „noisy bunches“



Does a Faster DEPFET Readout Help?

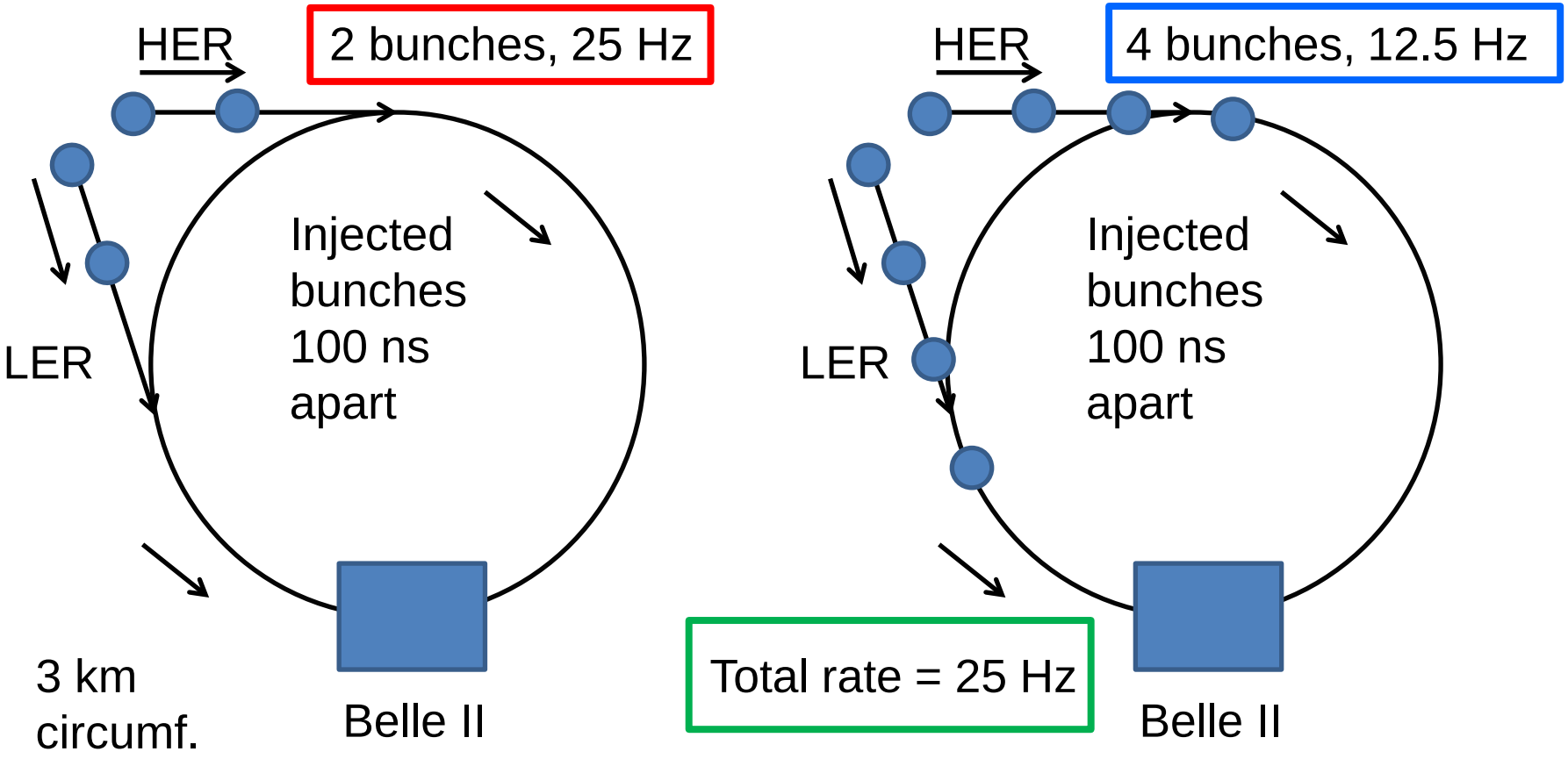


In addition: ganging creates lots of problems …

Machine: Injection Noise (cont.)

Three (different) proposals how the machine could help:

1. Inject 4 bunches instead of 2

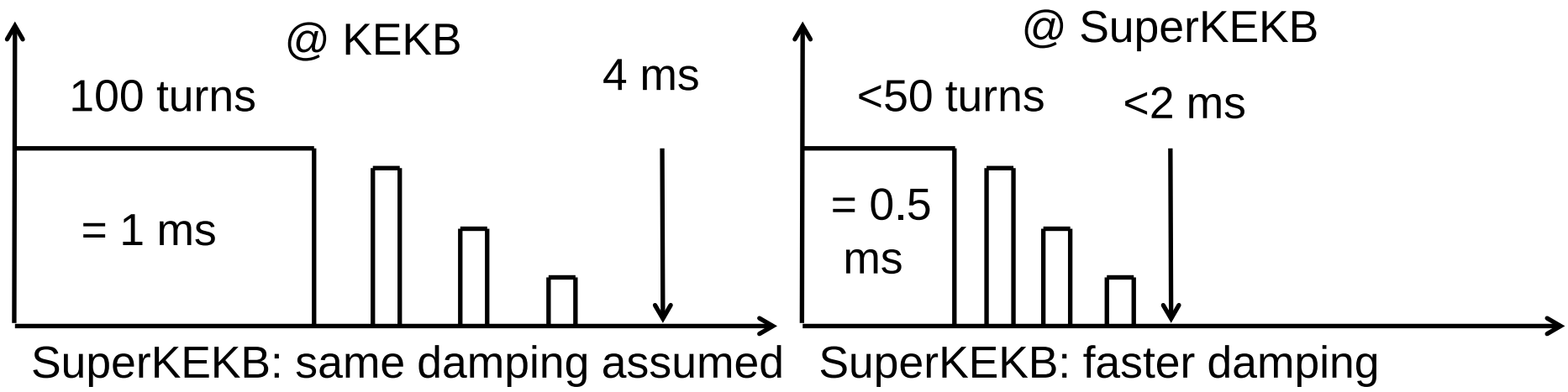


2. Reduce damping time

KEKB: faster damping times were observed, reasons unknown
T ~ O(few 100 µs)

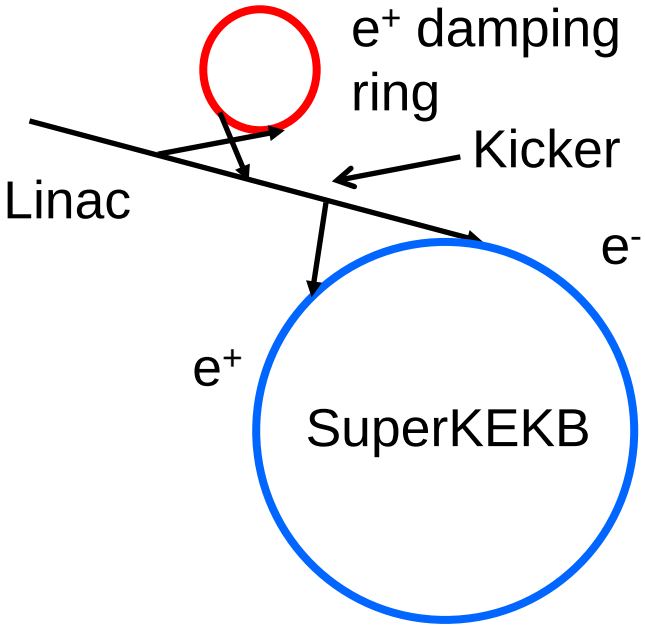
(reason not clear)

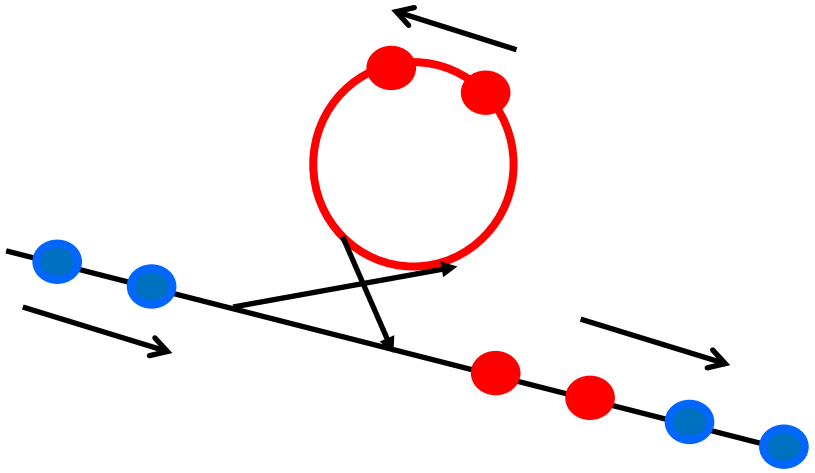
SuperKEKB:
new damping scheme foreseen, using additional synchroton phase oscillation damping



Machine: Injection Noise (cont.)

3. Synchronize injections



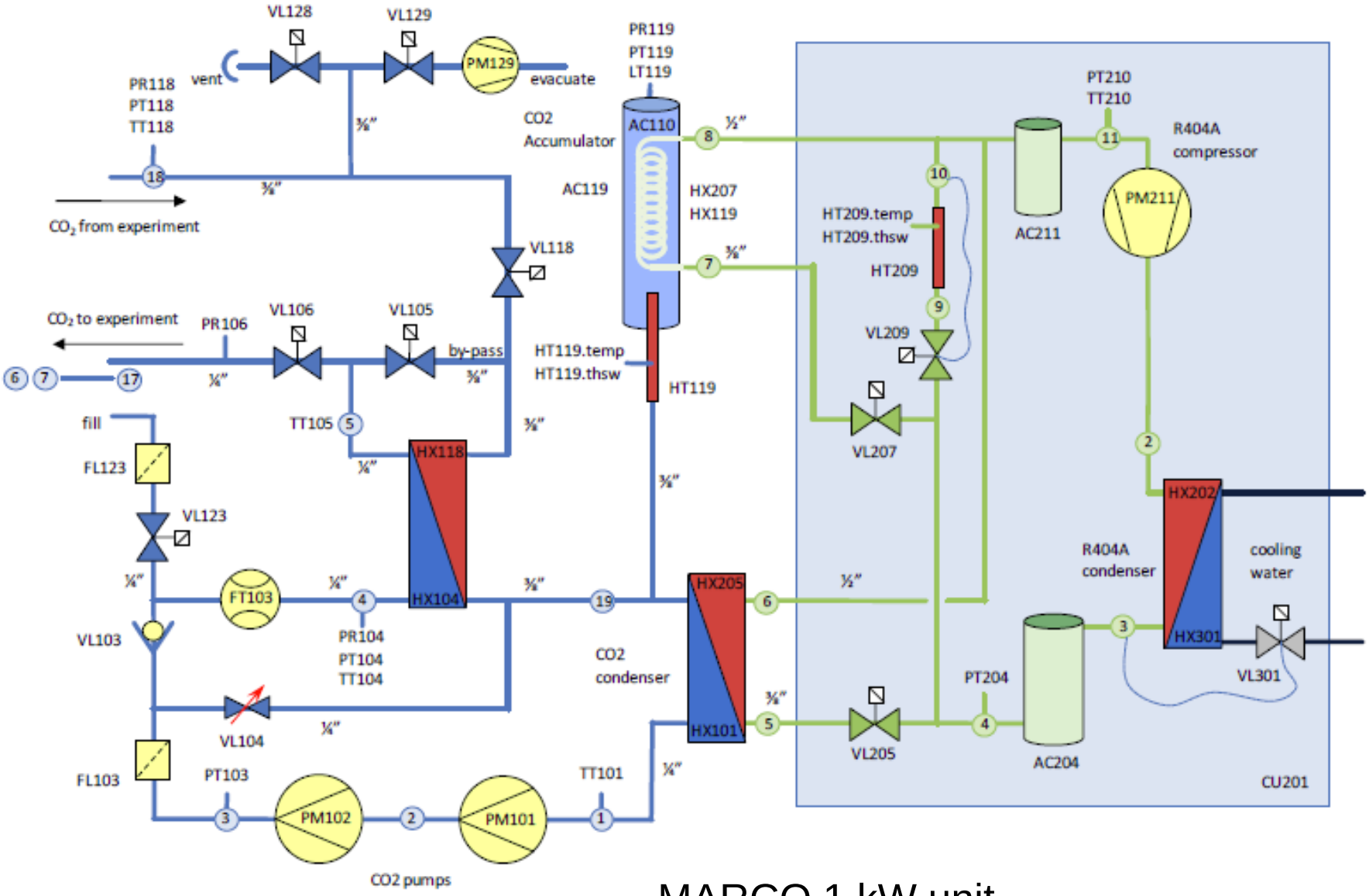


Inject alternatively (50 Hz), but extract from damping ring in phase (same Linac pulse)

Not synchronized -> 50 Hz noise

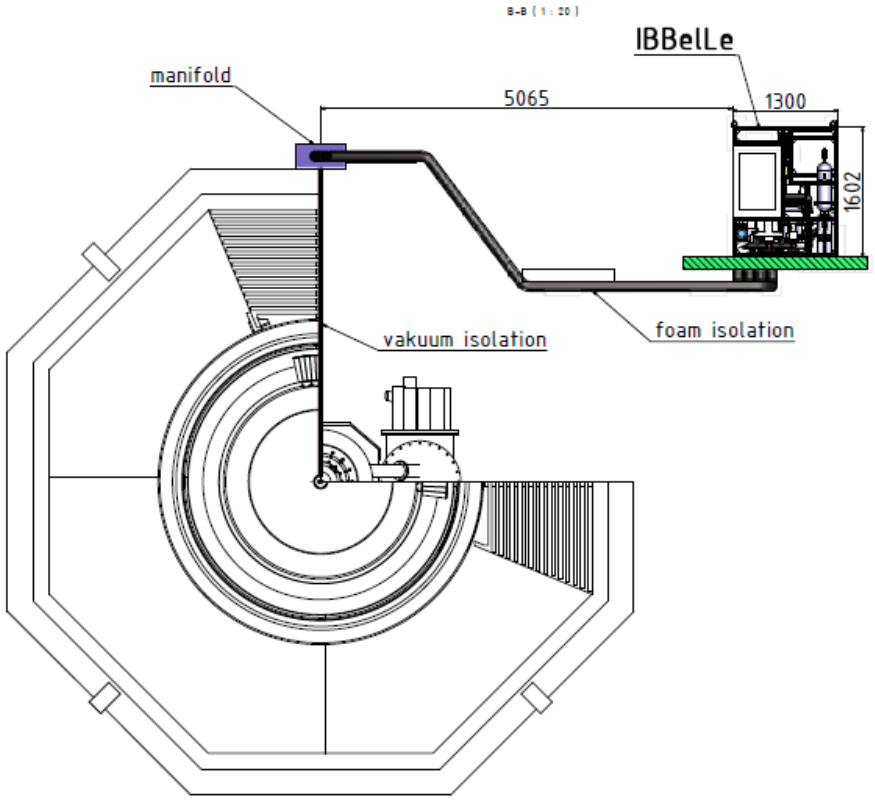
synchronized -> 25 Hz noise

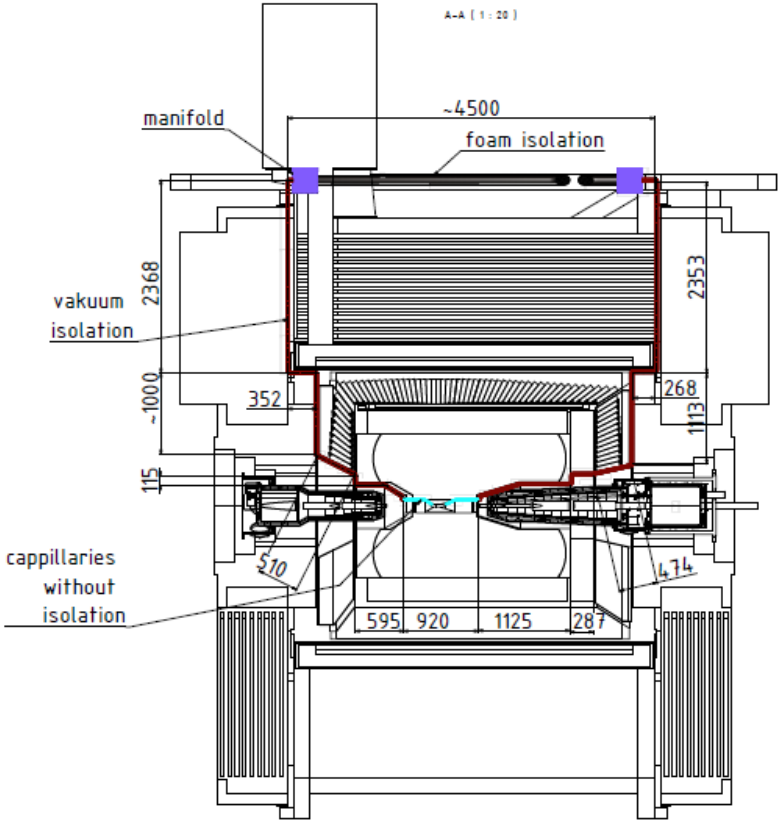
Workpackage: CO2 Cooling (cont.)



MARCO 1 kW unit

Workpackage: CO2 Cooling (cont.)

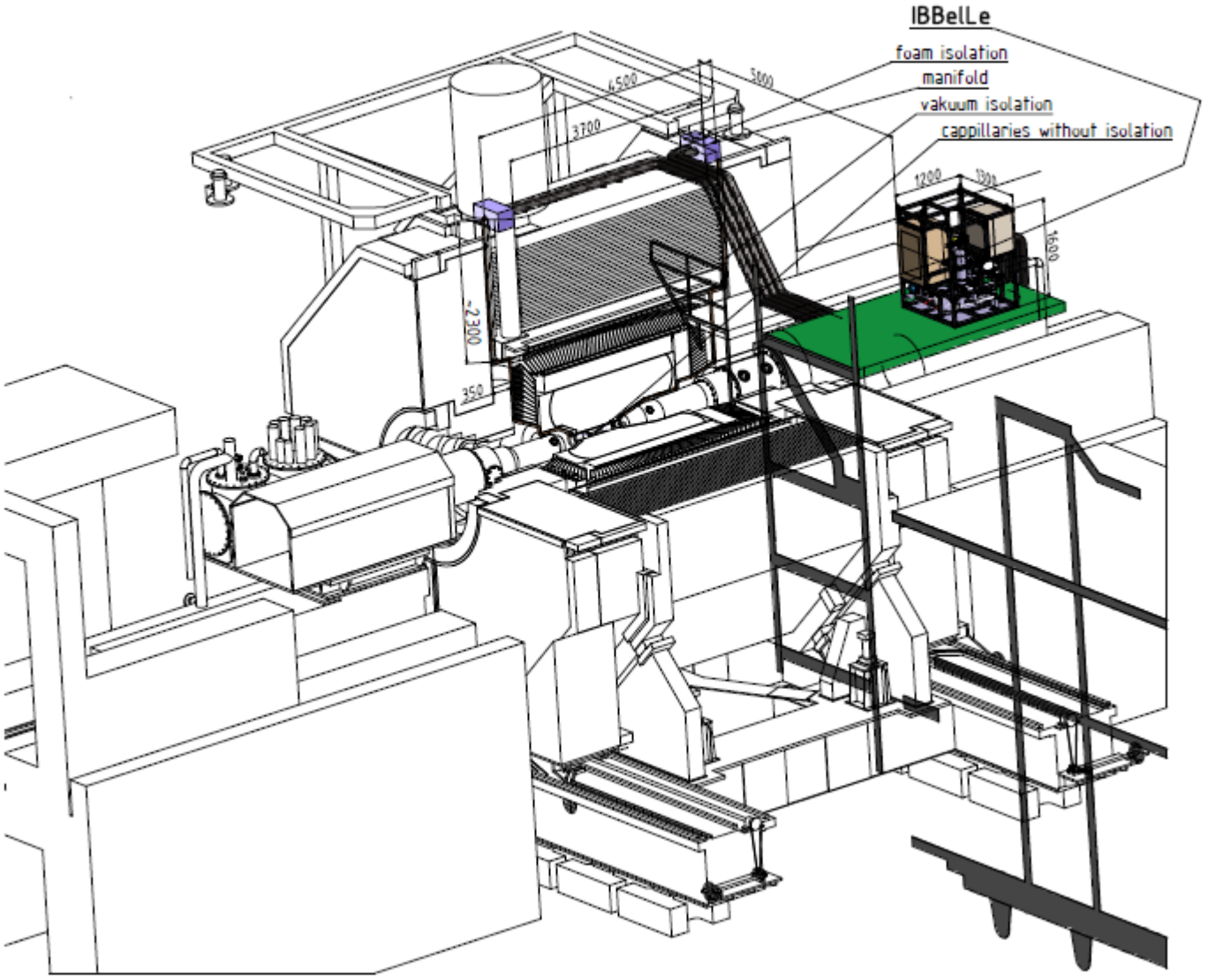




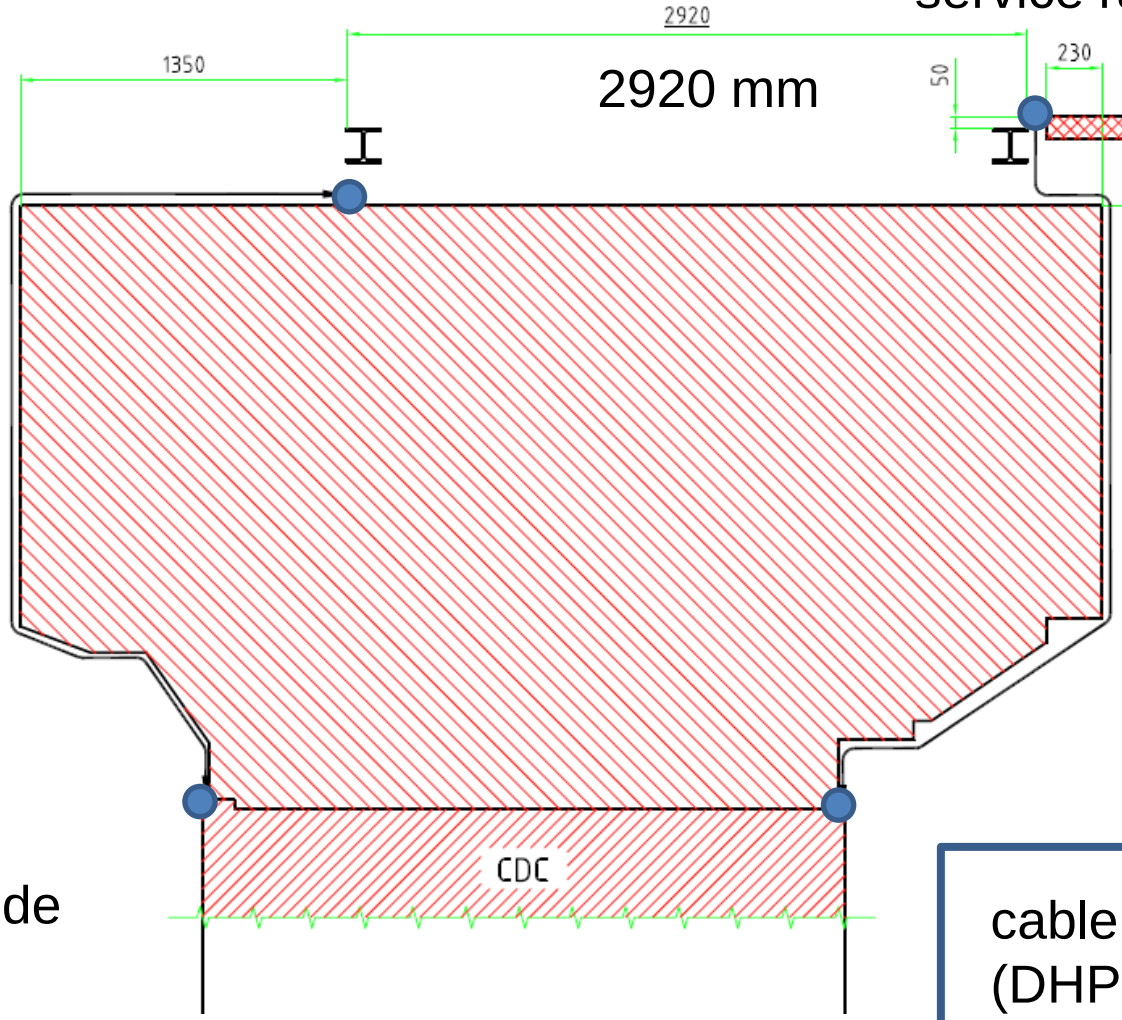
foam insulation from IBBelle to the manifold on top of Belle II

Vacuum insulation (double tube) from manifold to the dry volume of the SVD/PXD

Workpackage: CO2 Cooling (cont.)



Measurement of Cable Lengths



5910 mm

4450 mm

backward side

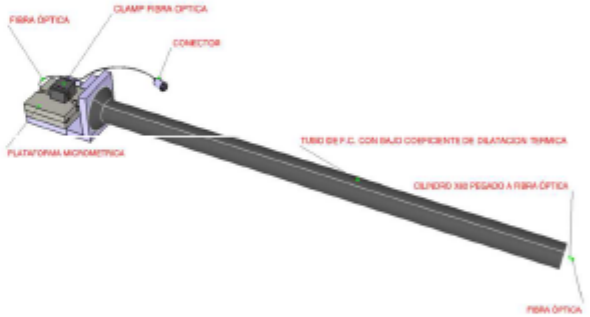
cable length
(DHP -> DHH)
< 15 m

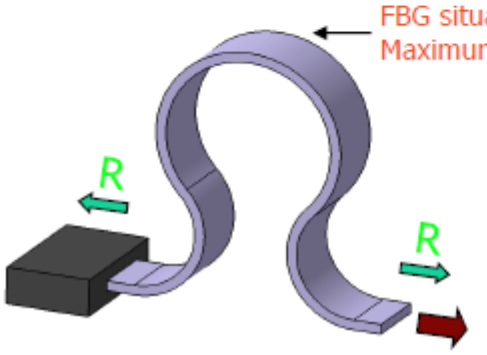
Realtime Position Monitor of PXD

- Univ. Santander (I. Vila et al.) : Fibre Optical Sensors

The optical fibers have been calibrated before their irradiation in the Spanish National Accelerator Centre with 15.5MeV protons (results after irradiation will be presented soon)

Optical fiber is fixed in one end to a carbon fiber bar and the other end is clamped to micrometric stage

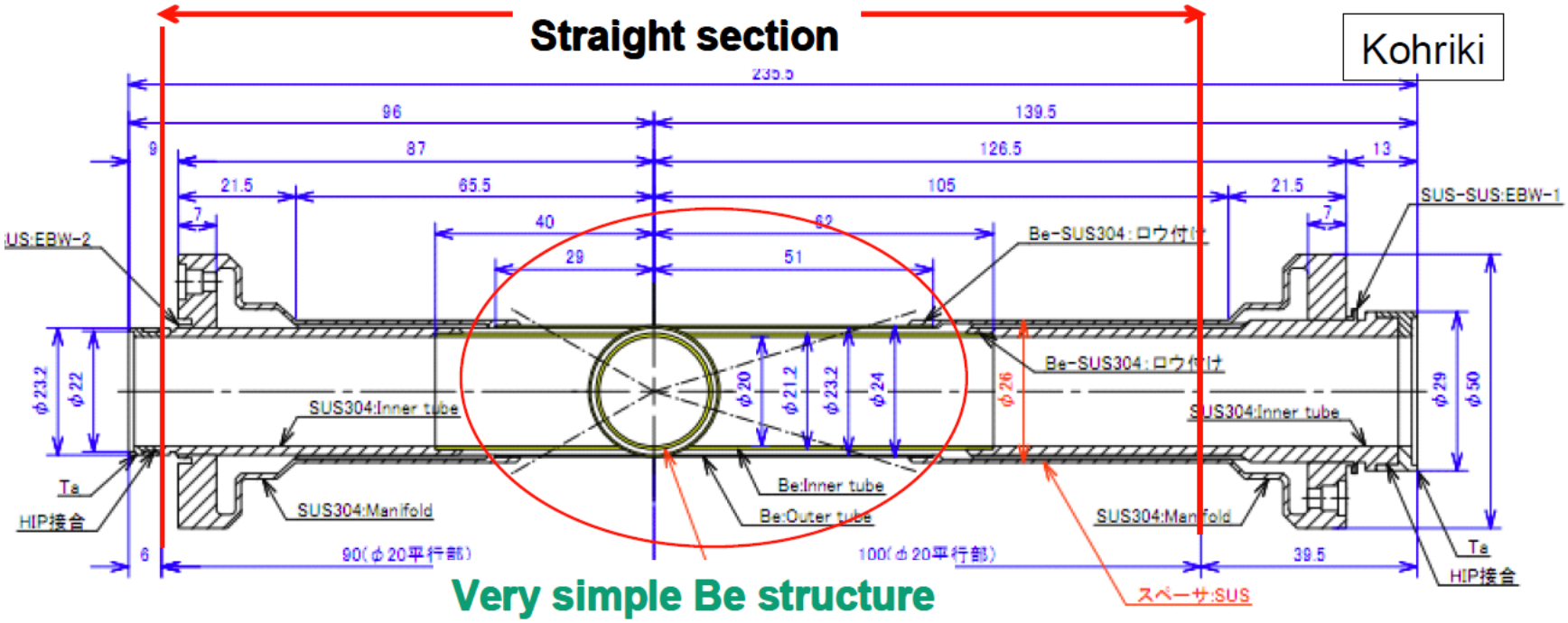




The displacement-strain conversors are designed and the production is expected by the end of november:

→ Relative displacements between PXD and SVD

New Beam Pipe Design



Short Be part, additional SS part -> outer radius increased!!
new radius: 12.7 mm +0 -0.1 (was 12.0 mm !!)

Consequence: clearance between SS and PXD ladder reconsidered.
attention: ASIC + caps + wire bonds …
PXD ladder @14 mm

New Mockup of PXD in Munich

Purpose: realistic construction of supports

including

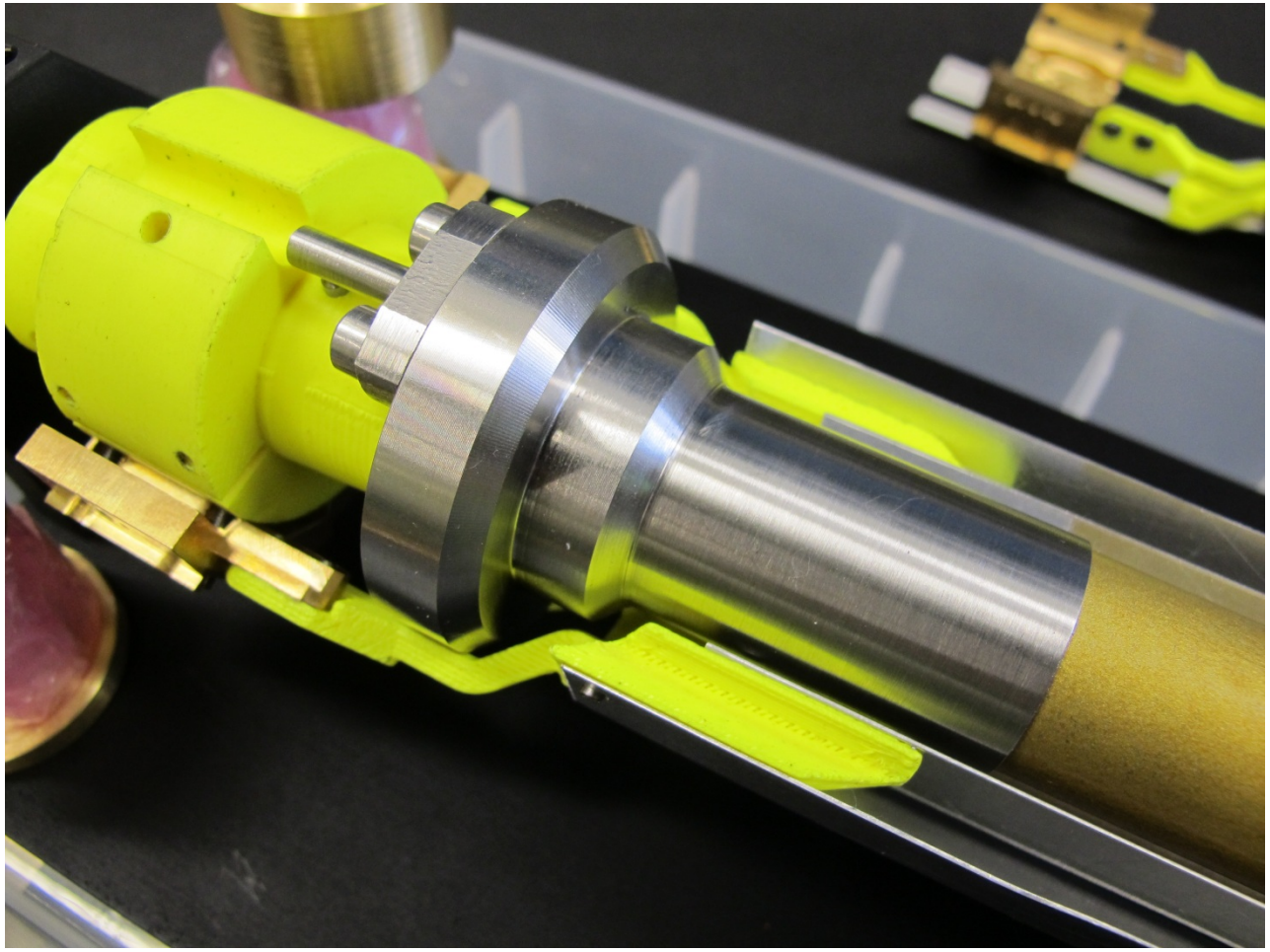
beampipe cooling,

PXD on beampipe,

stress relief for Kapton cables

cable routing

etc.



New Mockup of PXD in Munich (cont.)