Vacuum system of SuperKEKB interaction region

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(on behalf of SuperKEK Vacuum Group)

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LCWS24 MDI&CFS Sessions

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2. IP pipe IP: interaction point
3. QCS pipes QCS : final focusing superconducting magnets system
4. RVC RVC : remote vacuum connection
5. Summary

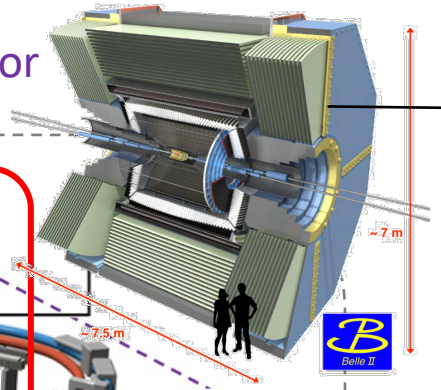
Almost all presentation materials were provided by

K. Kanazawa(SuperKEKB), S. Tanaka(Belle) and K. Gadow(DESY).

1. Overview

SuperKEKB interaction region

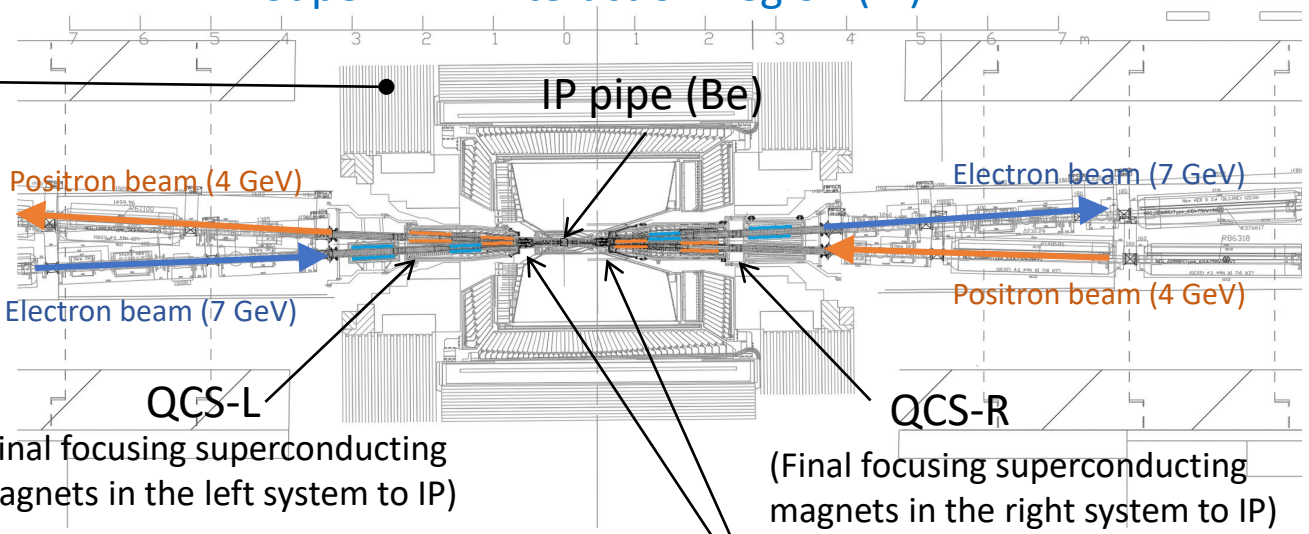
Belle II detector



SuperKEKB

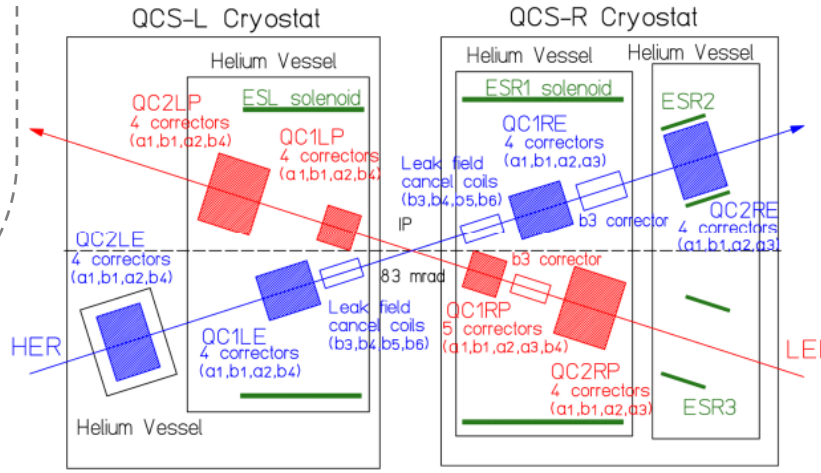
IP pipe

SuperKEKB Interaction Region (IR)



(Final focusing superconducting magnets in the left system to IP)

(Final focusing superconducting magnets in the right system to IP)



QCS

Final focusing superconducting magnet system

RVC

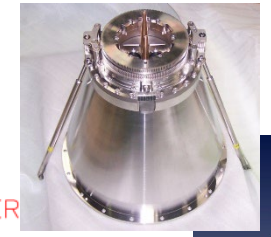
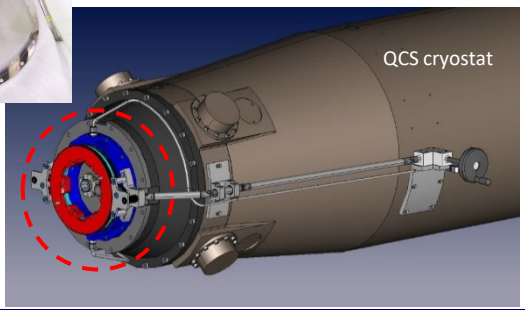


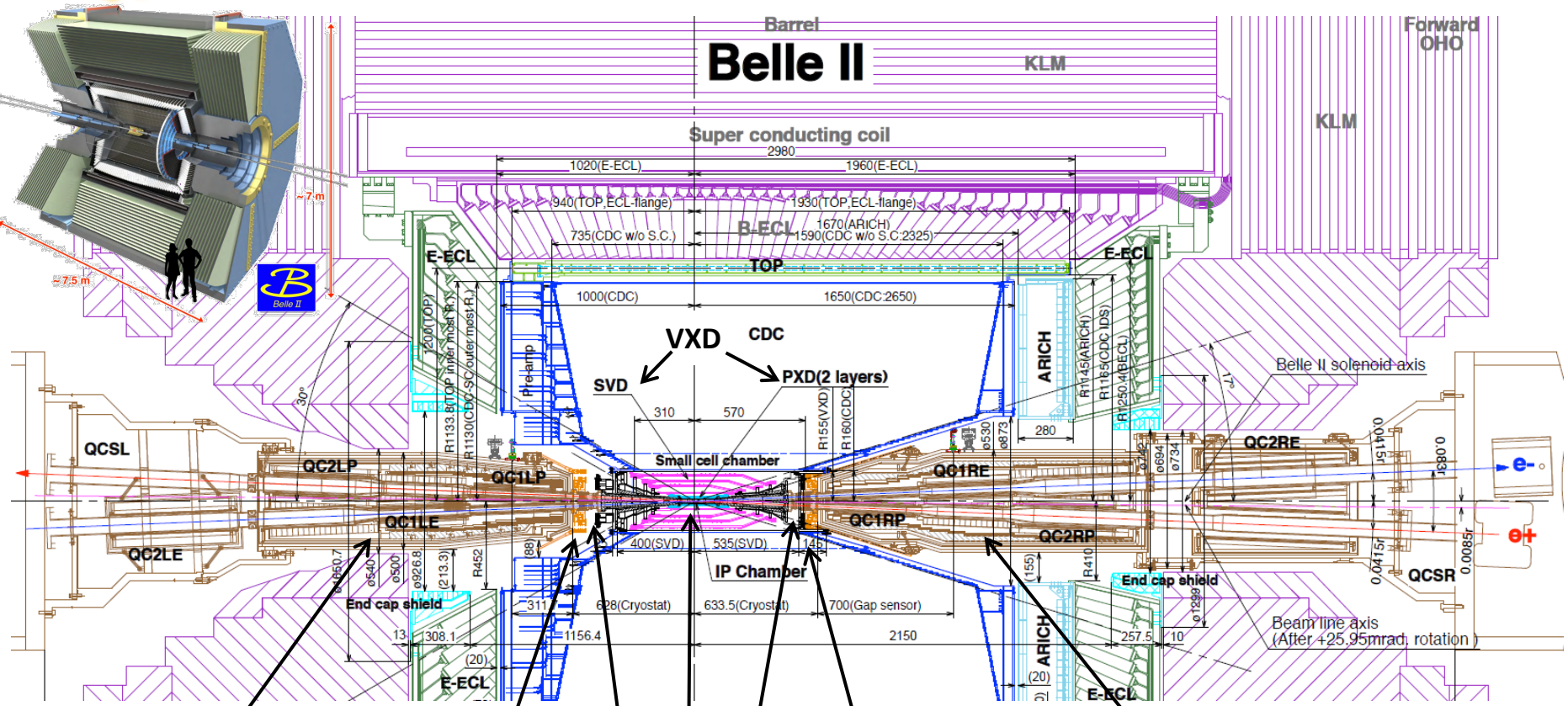
Photo by DESY

RVC

Remote vacuum connection



Configuration inside Belle II detector



QCS-L cryostat

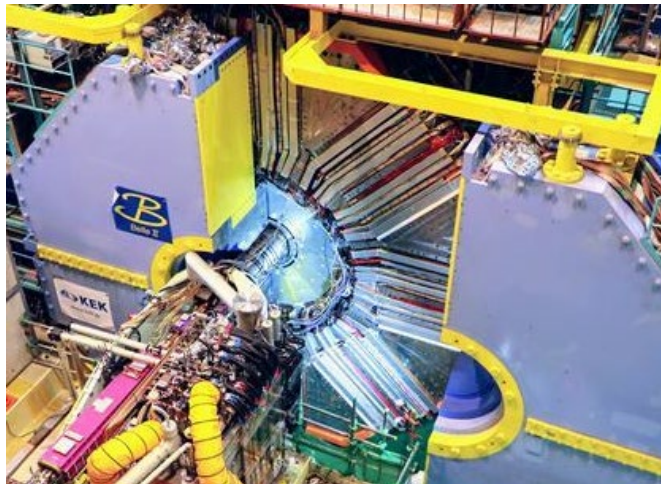
RVC

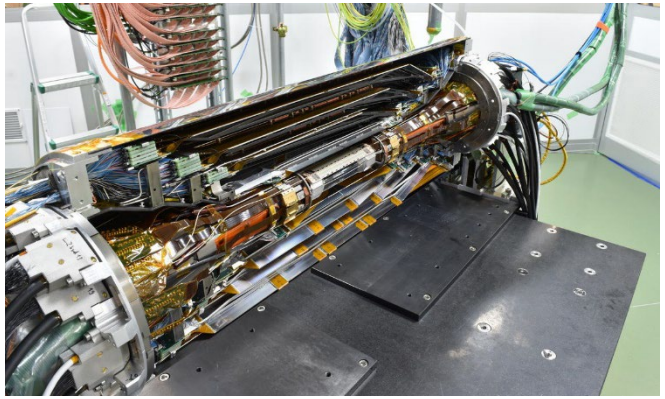
IP pipe

RVC

QCS-R cryostat

BPM-bellows chamber





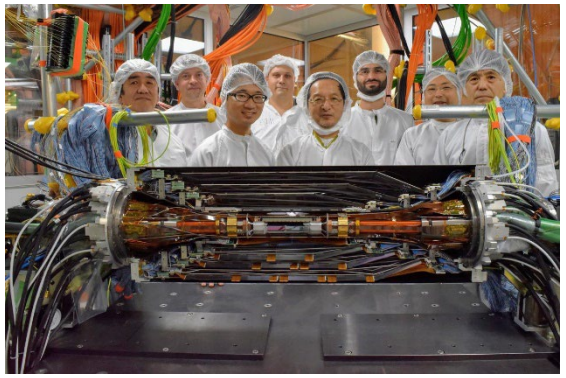
IP pipe assembled with VerteX Detector (VXD)

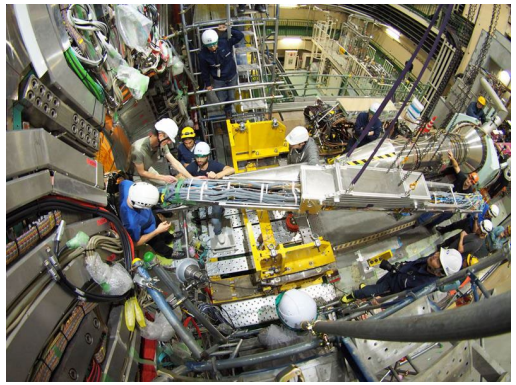
Installation procedure of IR beam pipes

1.1 Assembling IP pipe and VXD

1.2 Installing BPM-bellows chambers into both sides of IP pipe

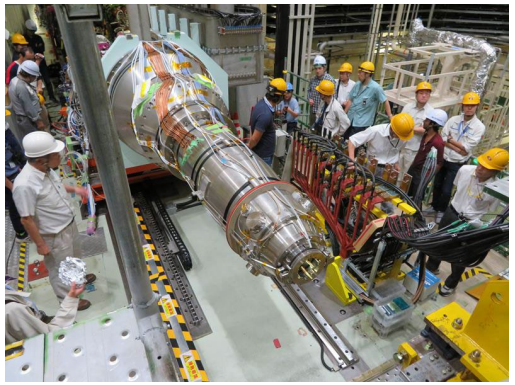
1.3 Installing IP pipe assembled with VXD into Belle II





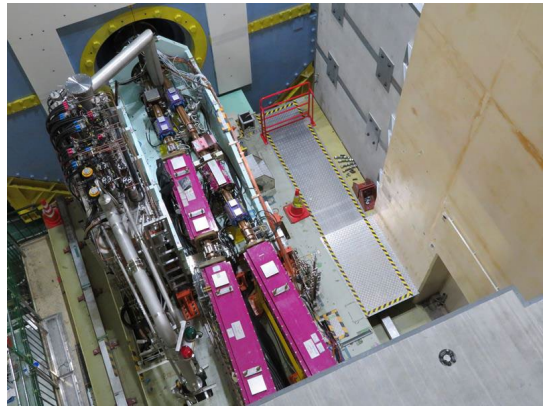
2.1 Installing QCS beam pipes into QCS cryostat

2.2 Inserting QCS on movable platform into Belle II



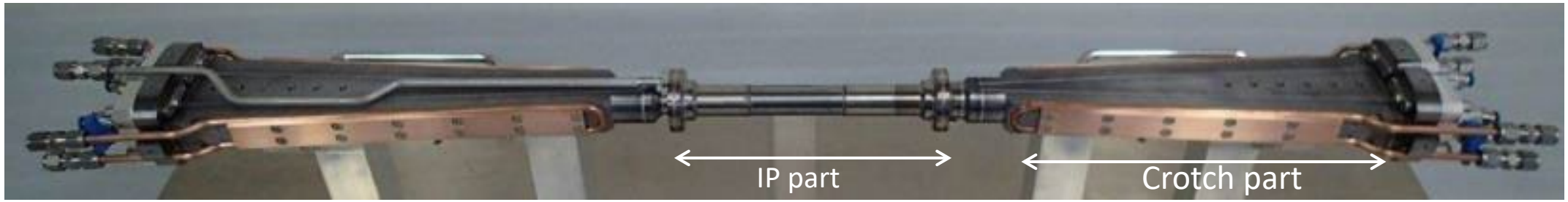
3.1 Connecting IP pipe and QCS pipes by RVC

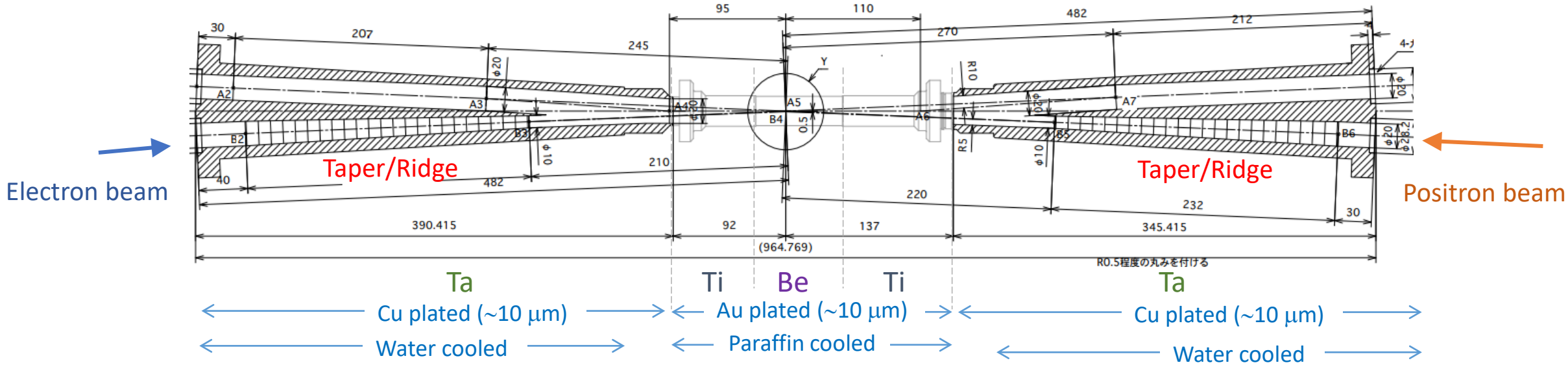
3.2 Installing magnets and beam pipes outside movable platform



2. IP pipe

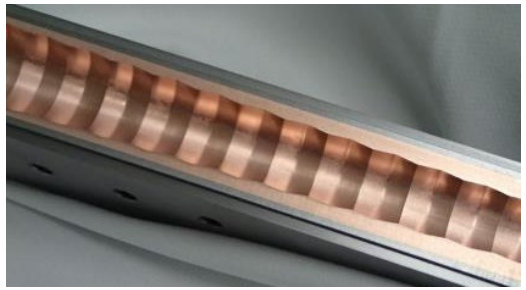
IP pipe

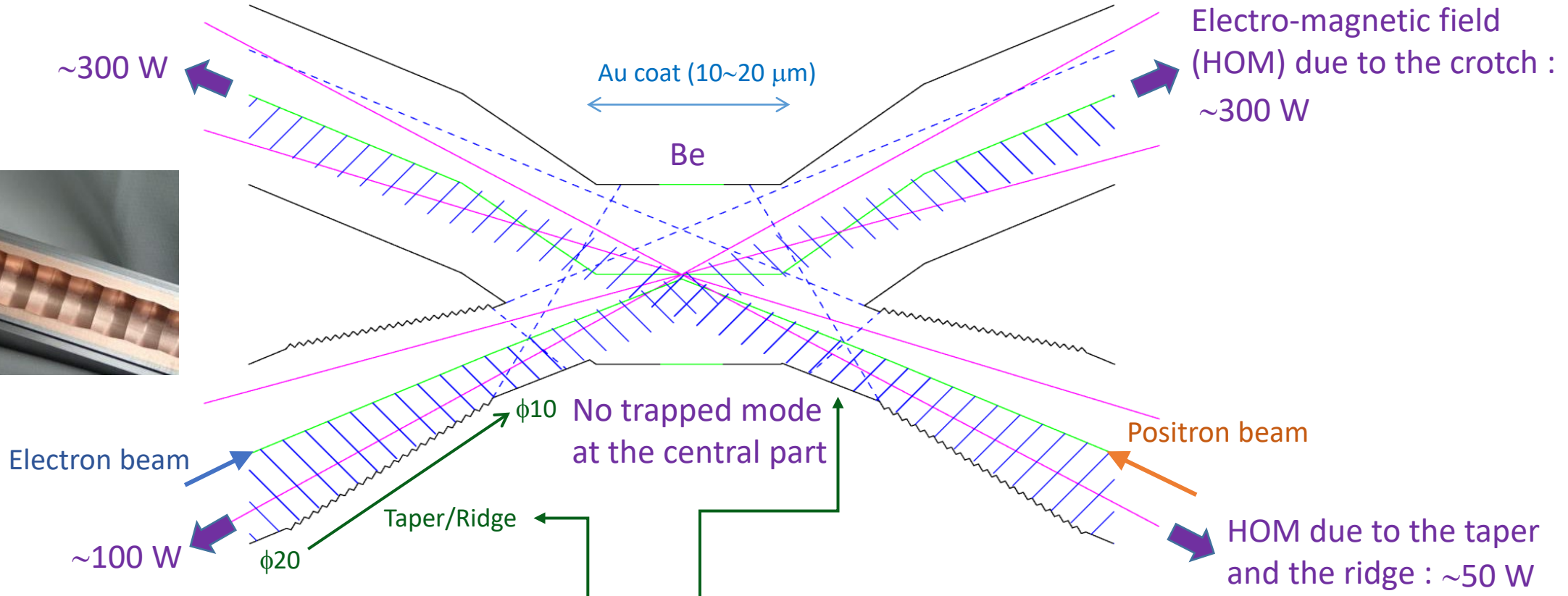




- Central IP part is made of Be and crotch parts are made of Ta.
- Ti is used to connect Be and Ta.
- Only taper parts are exposed to direct SR from last bend.

Synchrotron radiation and Trapped mode



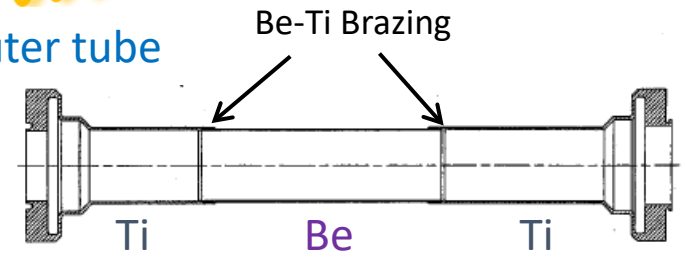


- Taper : to reduce the number of photons entering into the central part
- Ridges : to keep the direction of scattered photons away from Be pipe

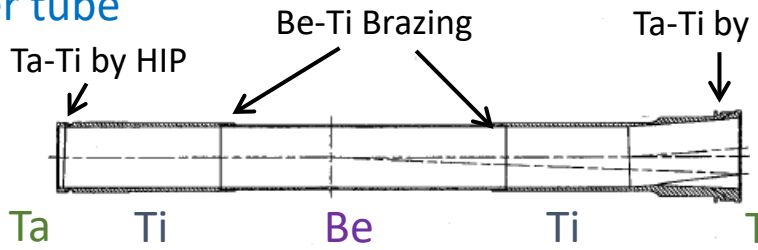
- Ridges are omitted to avoid complex machining.
- This part is slightly bent downward (in this drawing) to avoid direct SR hit on Be pipe.

Central part of IP pipe

Outer tube



Inner tube

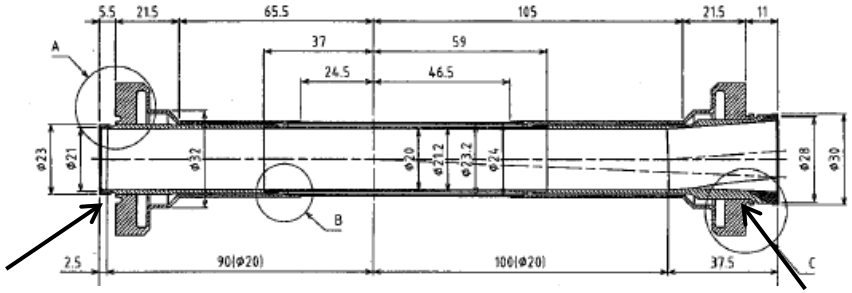


(HIP : Hot Isostatic Pressing)

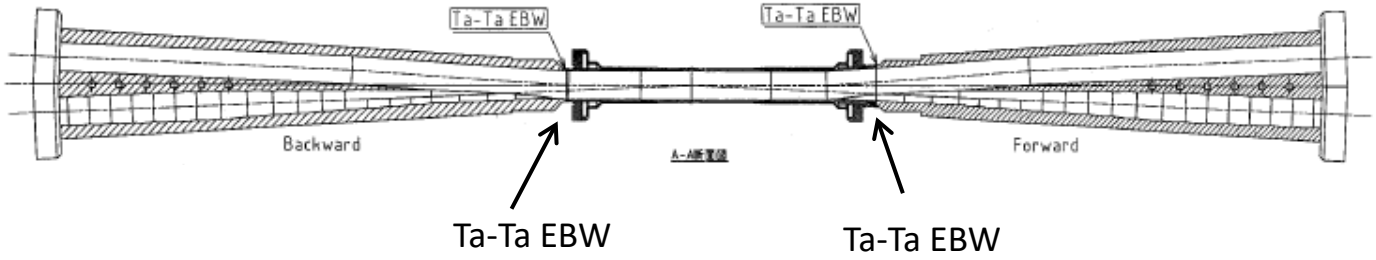
EBW(Ti-Ti)
・回転方向の位置決め

- Outer Be : 0.4 mm thick
- Inner Be : 0.6 mm thick
- Gap : 1 mm

・IP chamber



- The central straight part consists of inner and outer tubes.
- Paraffin runs between tubes for cooling.
- Connection between tubes is done by Ti-Ti EBW.
- Connection between IP part and crotch part is done by Ta-Ta EBW.

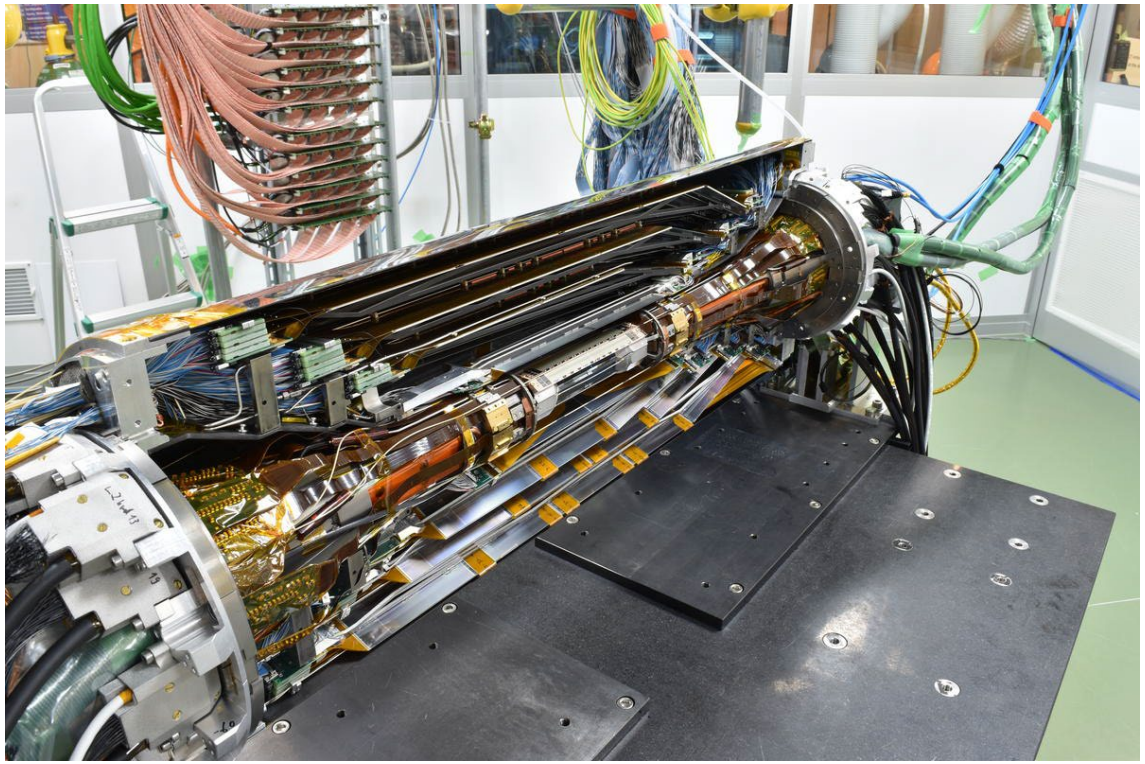


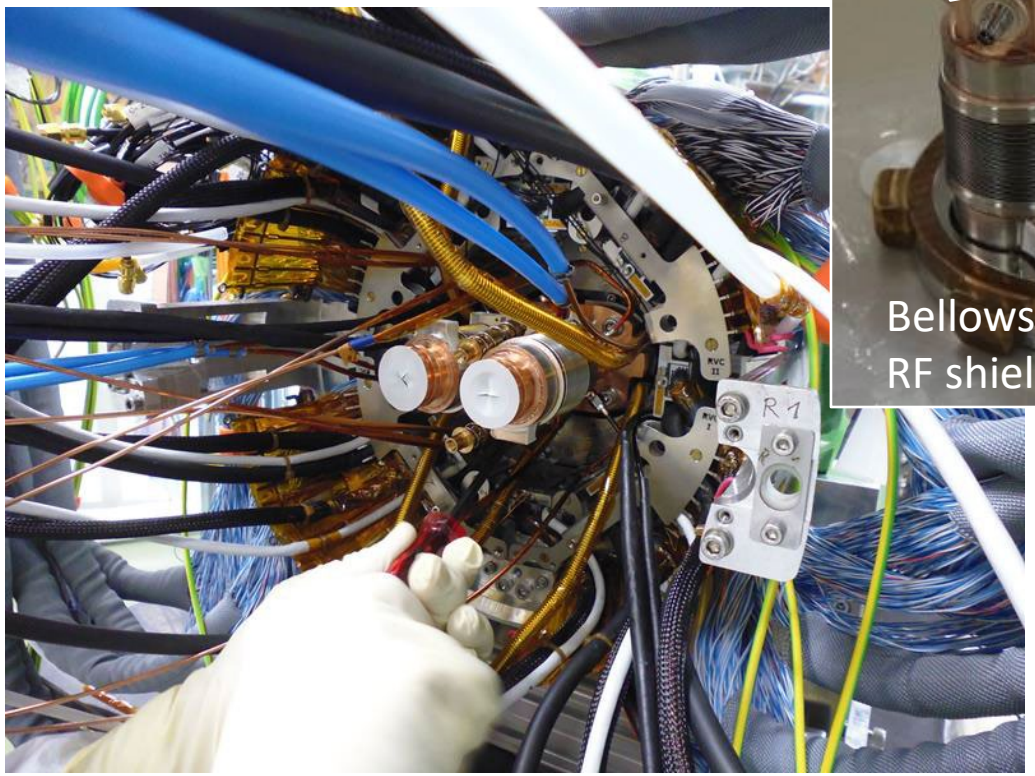
Installation of IP pipe into Belle II

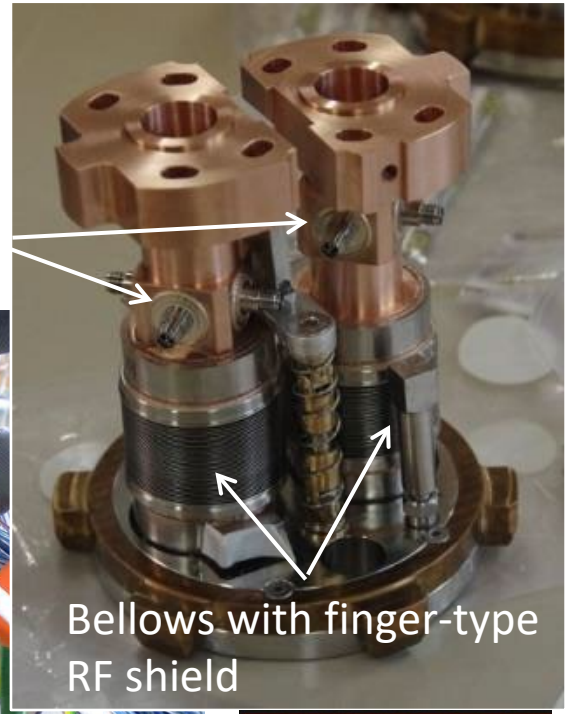
1.1 Assembling IP pipe and VXD

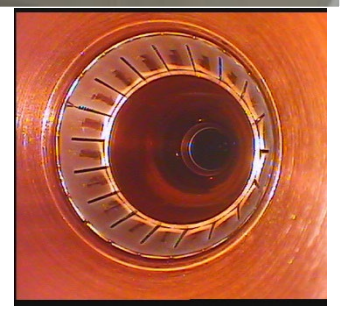
1.2 Installing BPM-bellows chambers into both sides of IP pipe

1.3 Installing IP pipe into Belle II







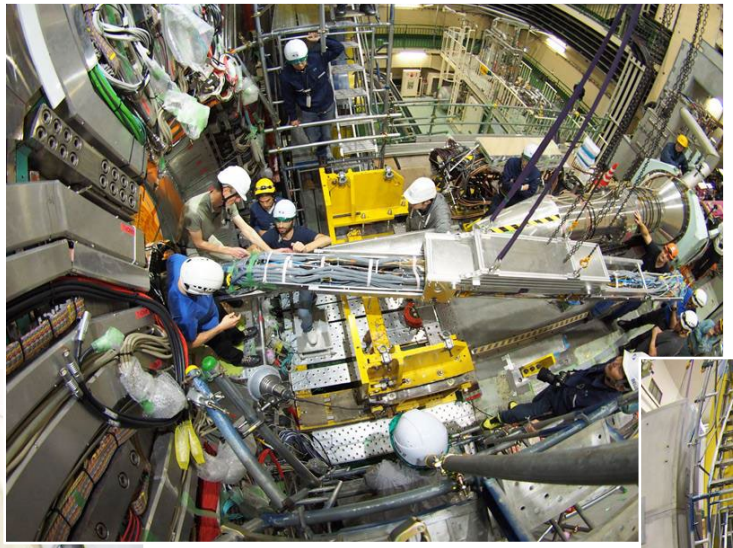


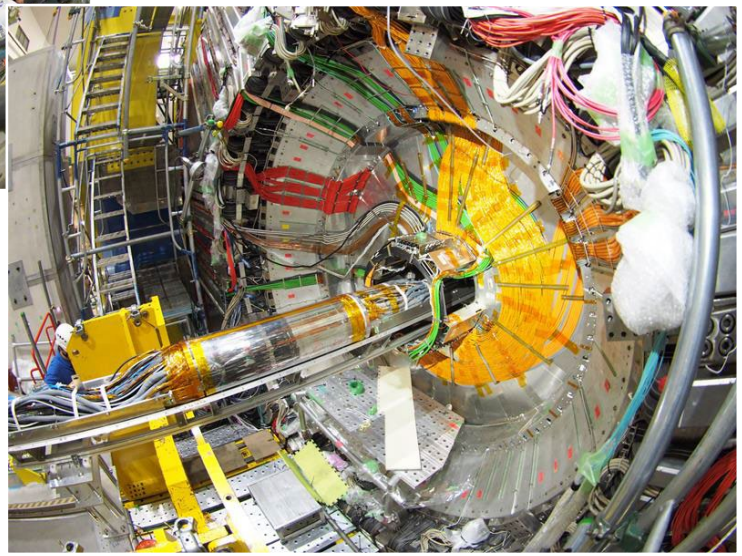
Installation of IP pipe into Belle II

1.1 Assembling IP pipe and VXD

1.2 Installing BPM-bellows chambers into both sides of IP pipe

1.3 Installing IP pipe into Belle II





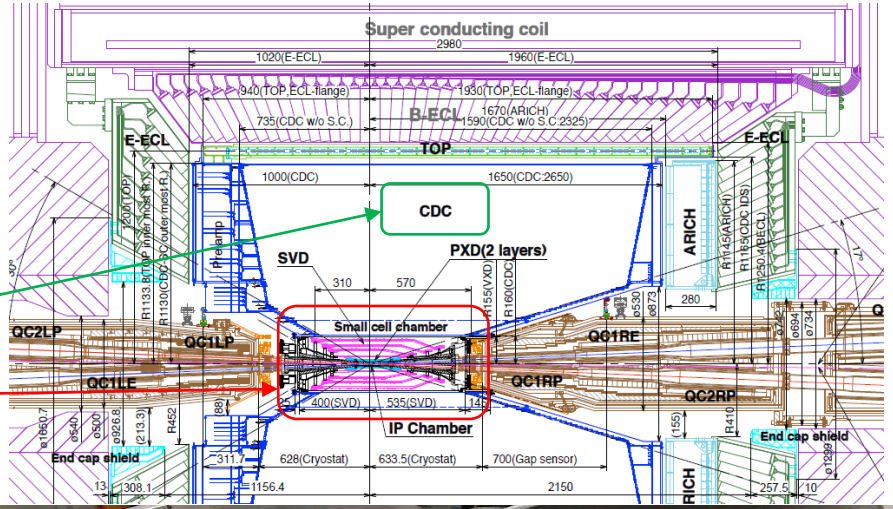
Installation of IP pipe into Belle II

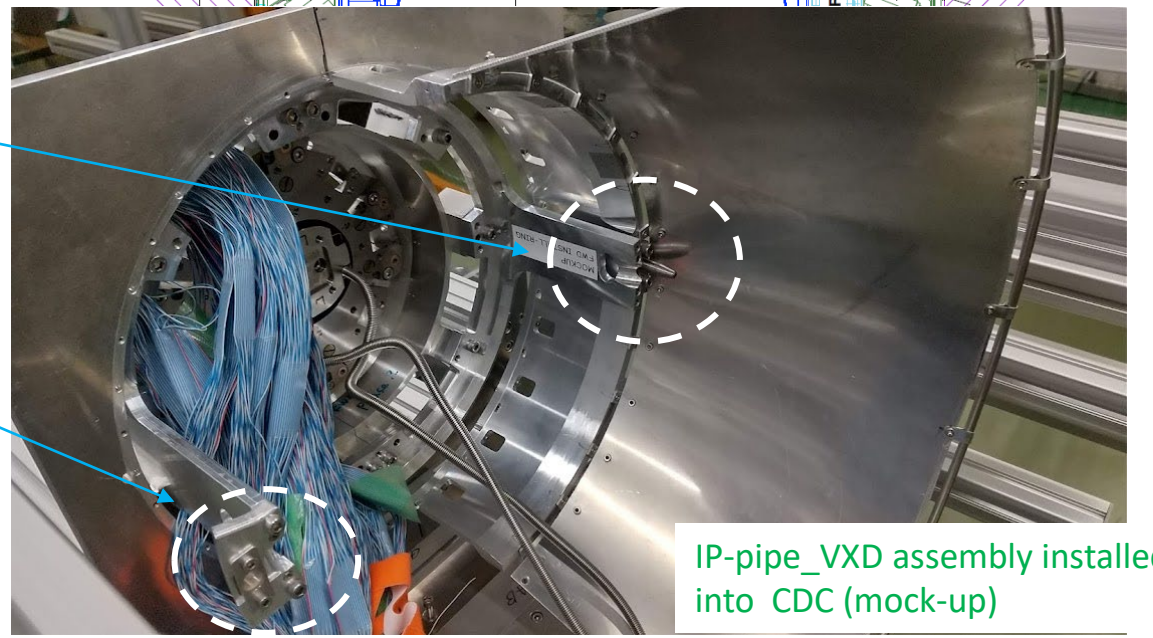
1.1 Assembling IP pipe and VXD

1.2 Installing BPM-bellows chambers into both sides of IP pipe

1.3 Installing IP pipe into Belle II

- IP pipe alignment
  - IP-pipe_VXD assembly is mounted on CDC.
  - Location of IP-pipe_VXD assembly is determined by CDC positioning pins.
  - Position of CDC positioning pips are measured by laser tracker before installation of IP-pipe_VXD assembly.
  - Pin holes of IP-pipe_VXD assembly are positioned so that the IP pipe can be installed in the proper position for the accelerator.
  - Position of VXD is estimated from particle track data.





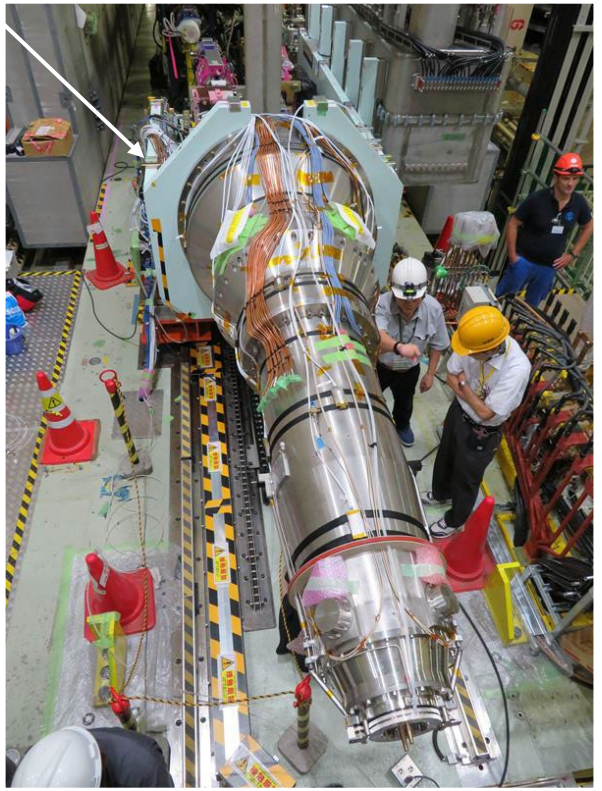
IP-pipe_VXD assembly installed into CDC (mock-up)

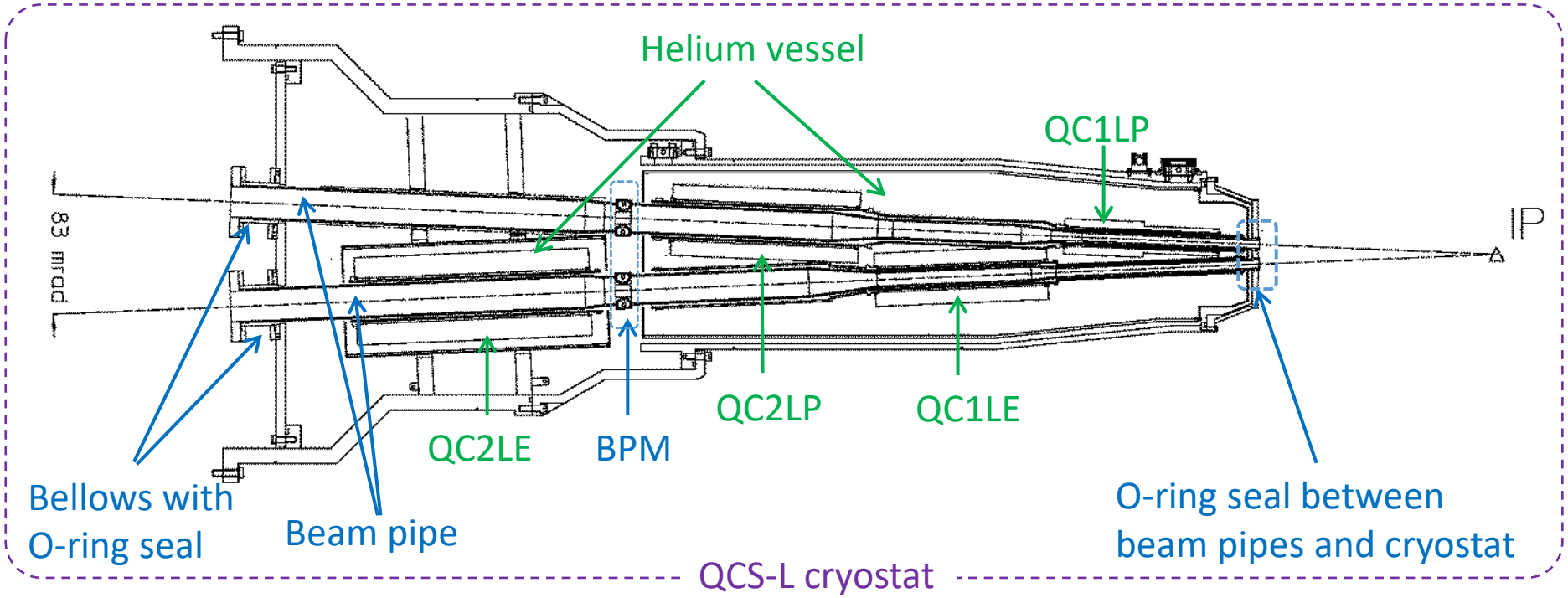
3. QCS pipes

Beam pipes for QCS

- Beam pipes are fixed to QCS cryostat.
- They are made of stainless steel with a 4 mm thick wall.
- They have water cooling channels on both sides.
- Inner surface is coated with Cu (+ TiN only for positron ring).

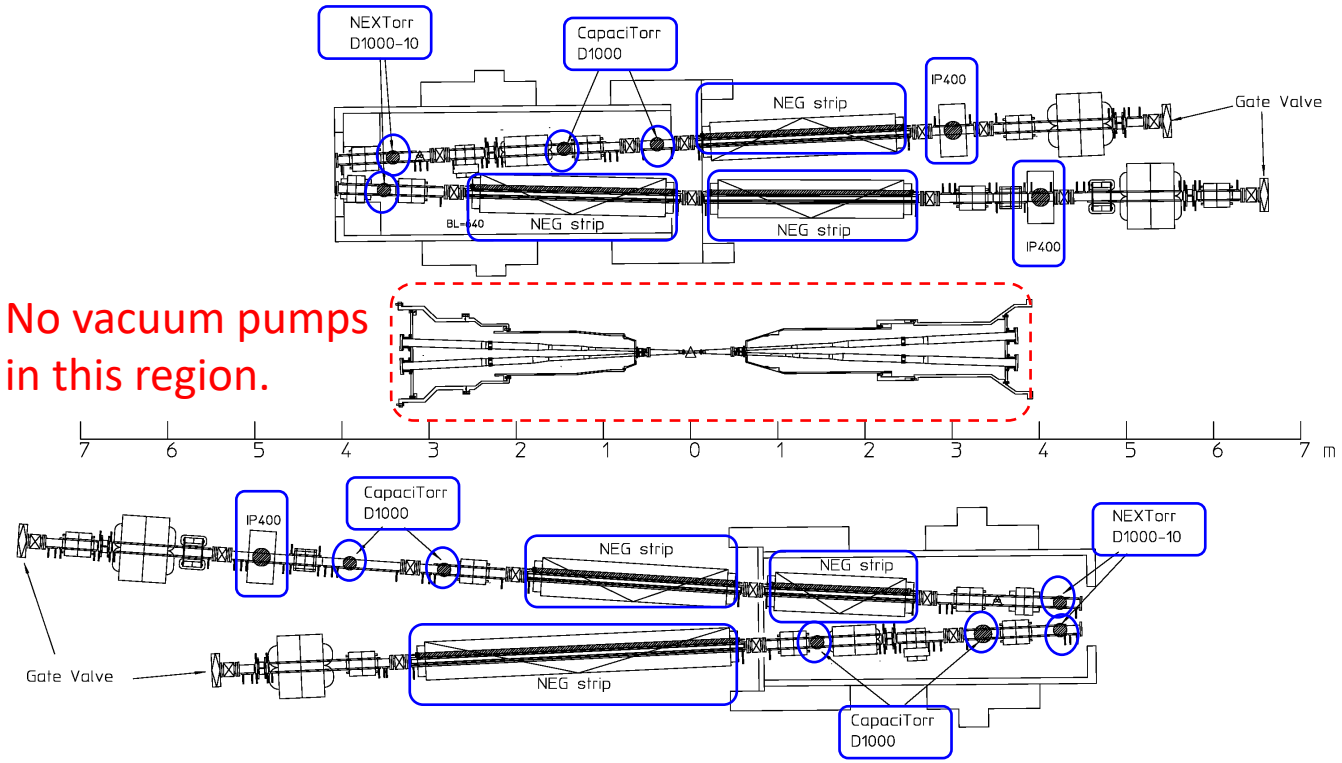
Movable platform



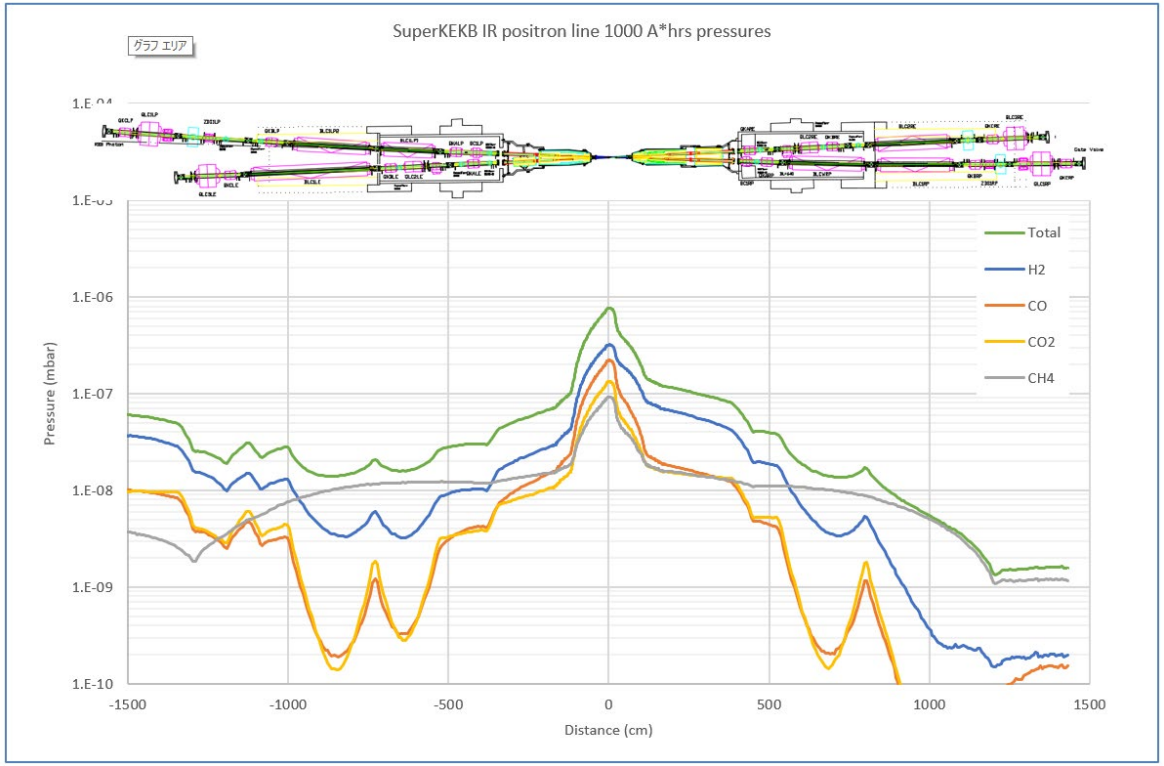


IR pressure distribution

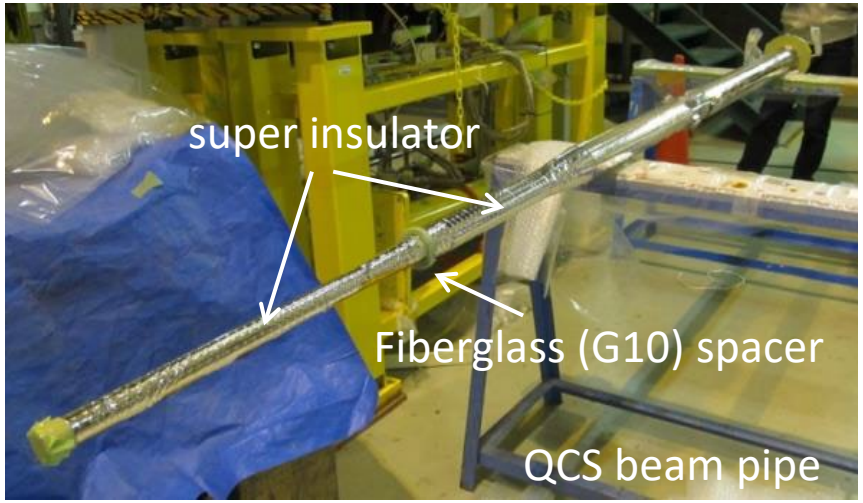
- IP pipe and QCS beam pipes have no pump.
- Pressure at IP is estimated to be about one order higher than that at the end of the cryostat.



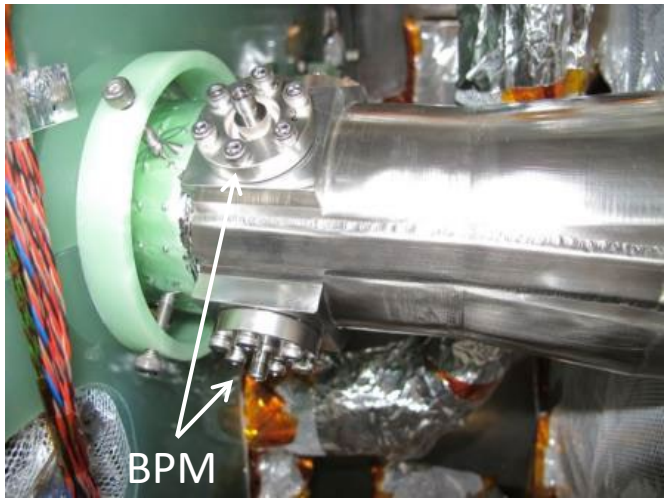
Thanks to J. Carter (ANL), M. Ady, R. Kersevan, and P. Chiggiato (CERN)



QCSR beam pipe installation



- Installation procedure :
  1. Set beam pipe
  2. Attach BPM and leak check
  3. Connect BPM cable
  4. Leak check of the cryostat



- Beam pipe is inserted using a special tool.
- Service window on QCSR cryostat is used to manually guide the beam pipe and to attach BPM.

Photo by Y. Arimoto

QCSL beam pipe installation

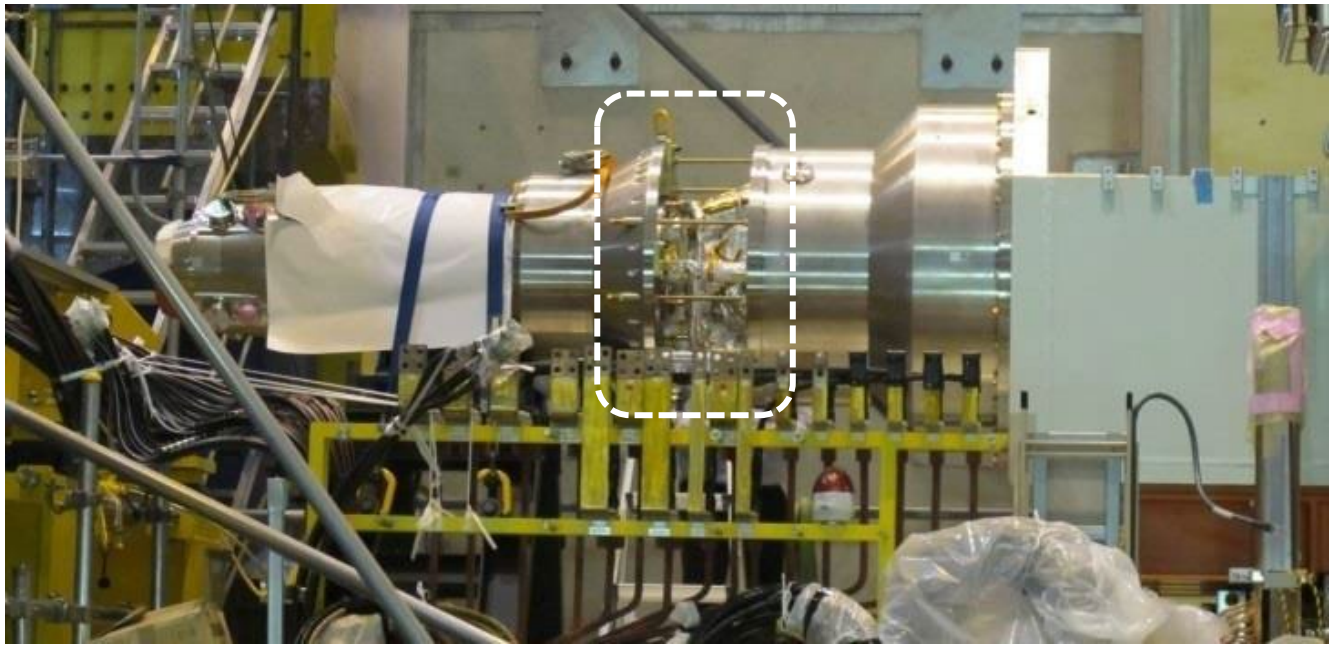


Photo by Y. Arimoto

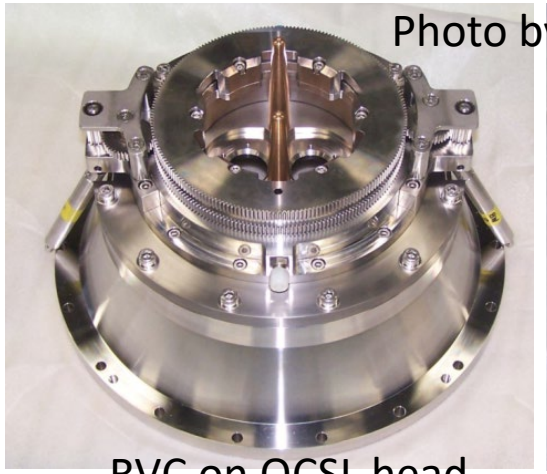
- Since QCSL cryostat has no service windows, the cryostat is disassembled for beam pipe installation.

4. RVC

Remote vacuum connection (RVC)

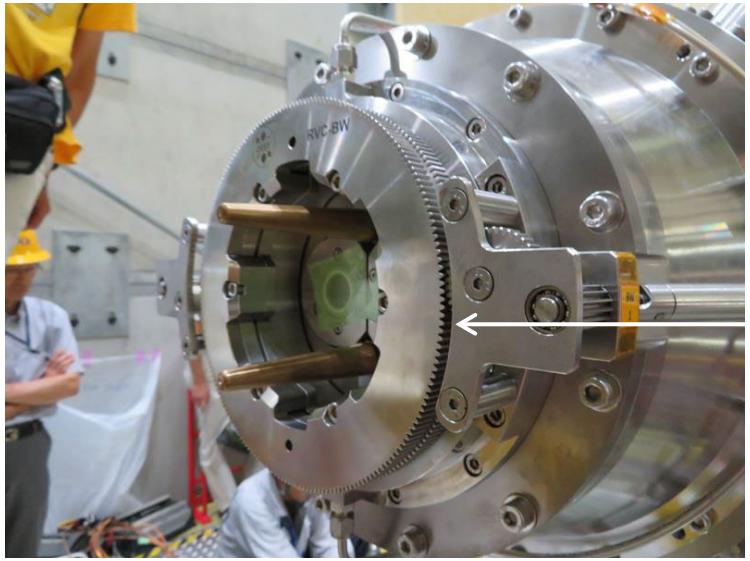
- QCS is inserted into Belle II by movable platform and connected to IP pipe.
- There is no space for vacuum sealing work by hands.
- RVC is a mechanism introduced by Belle group to connect QCS beam pipes to IP pipe (BPM-bellows chambers) by a remote manipulation.
- RVC was designed and produced by DESY.

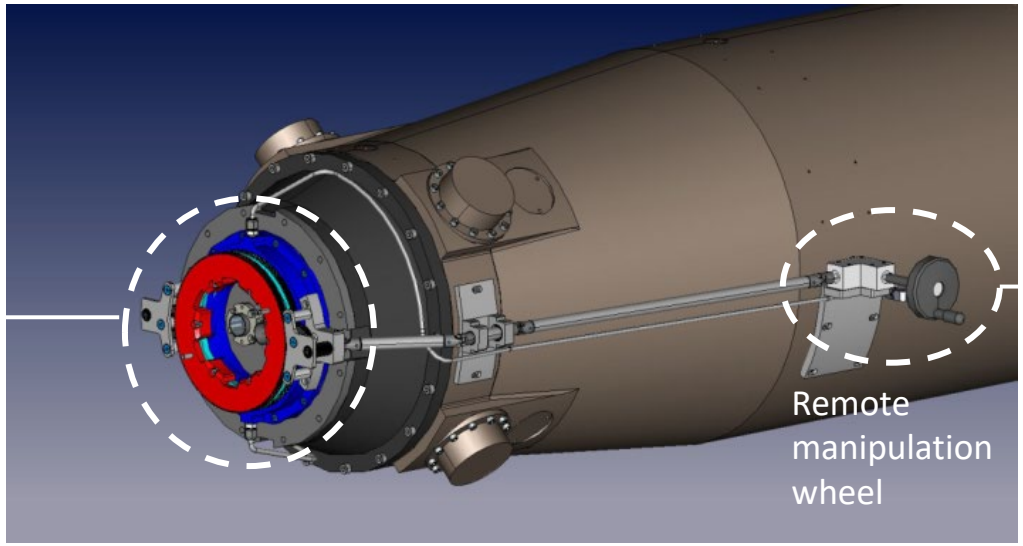
Photo by DESY

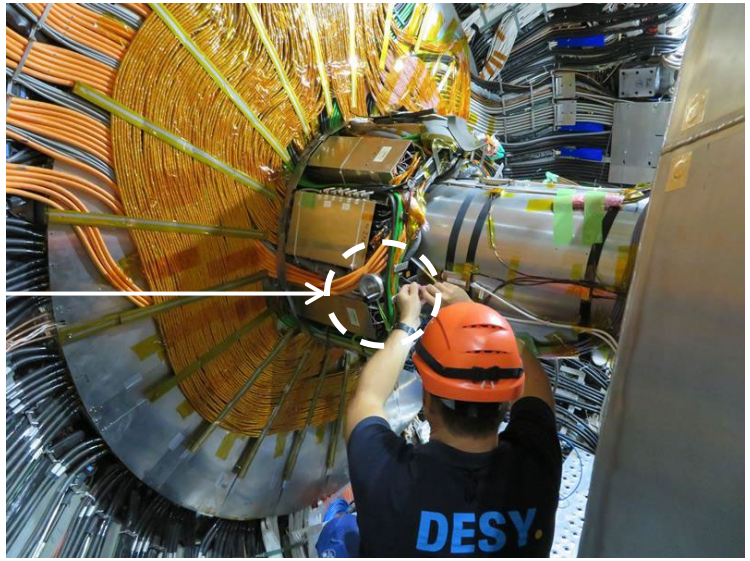


RVC on QCSL head

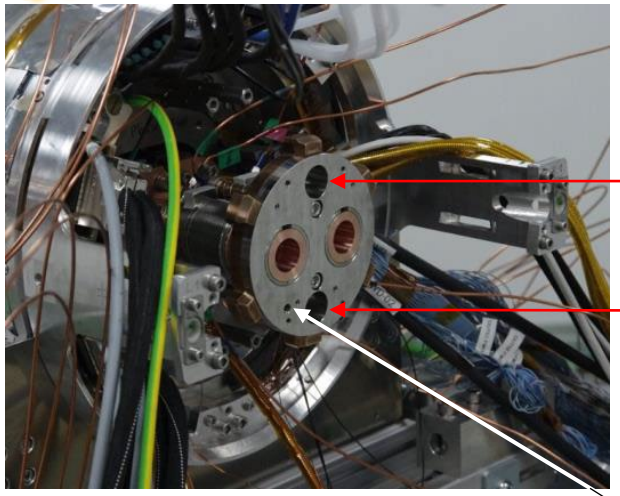
RVC on QCSR head

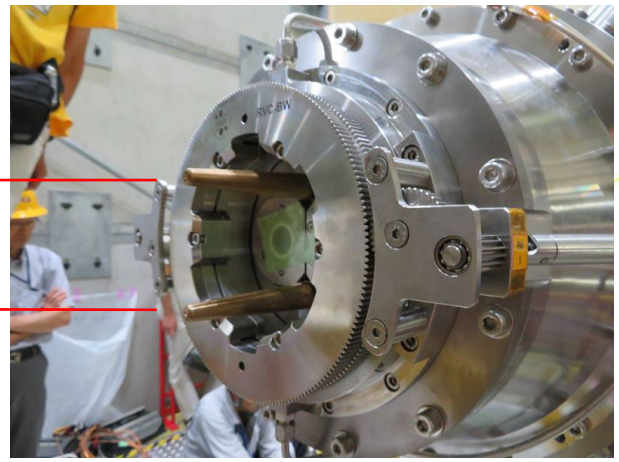




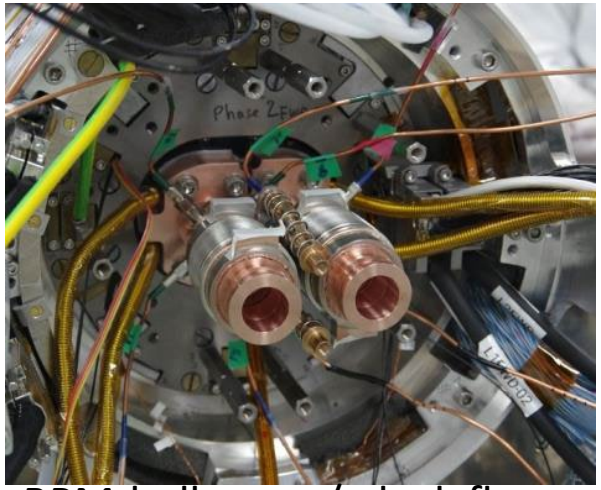


How RVC works



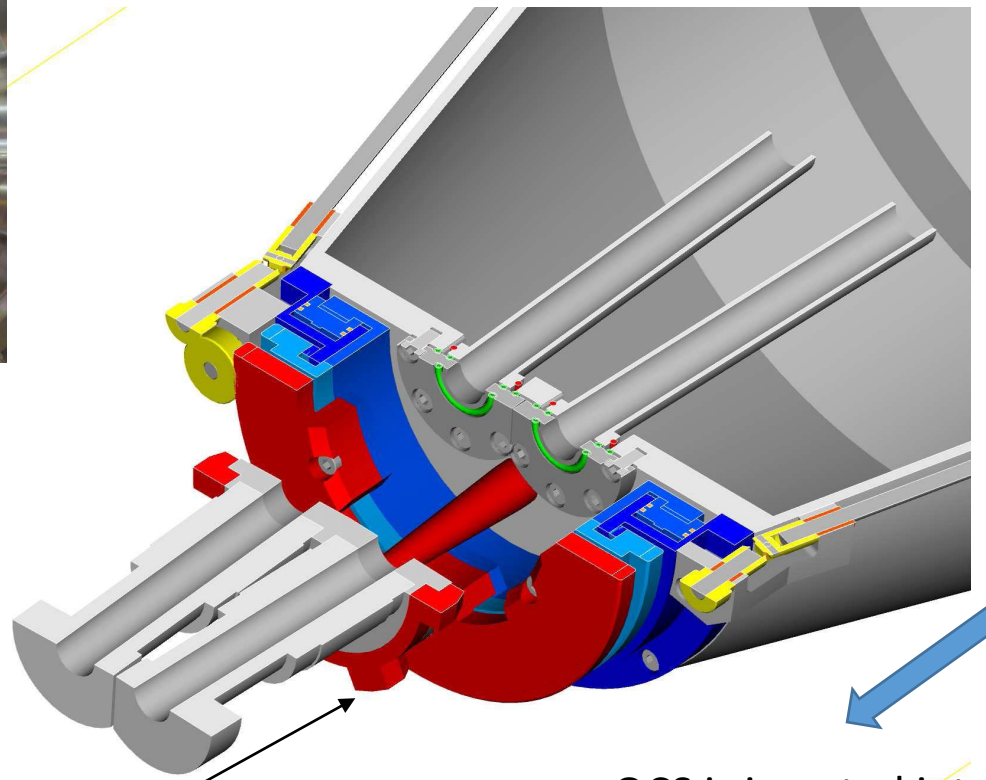


BPM-bellows w/ lock flange



BPM-bellows w/o lock flange

Drawing by K. Gadow

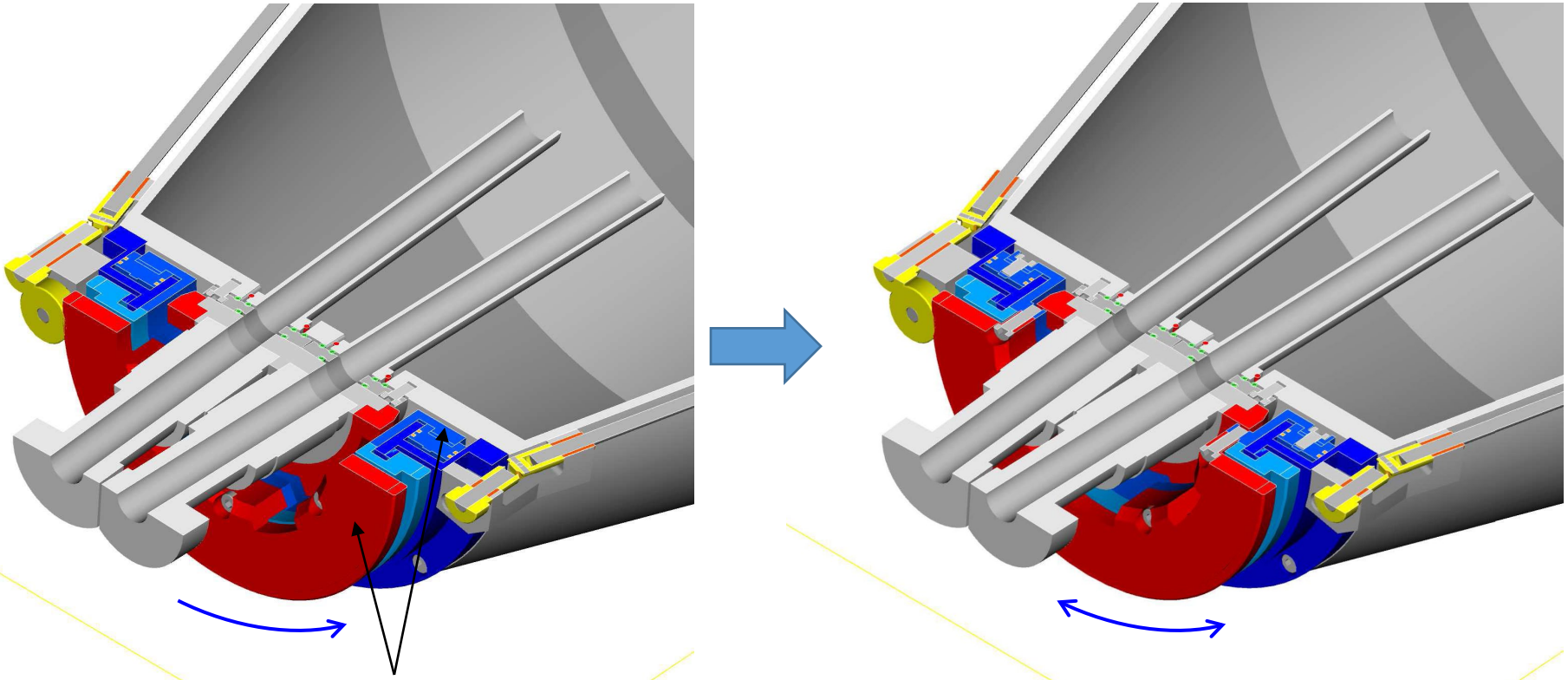


QCS is inserted into Belle II.

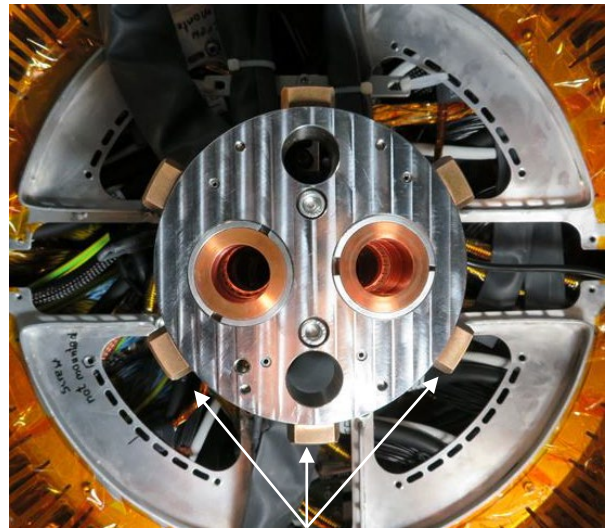
Single lock flange with a retainer is attached to two bellows units.

How RVC works

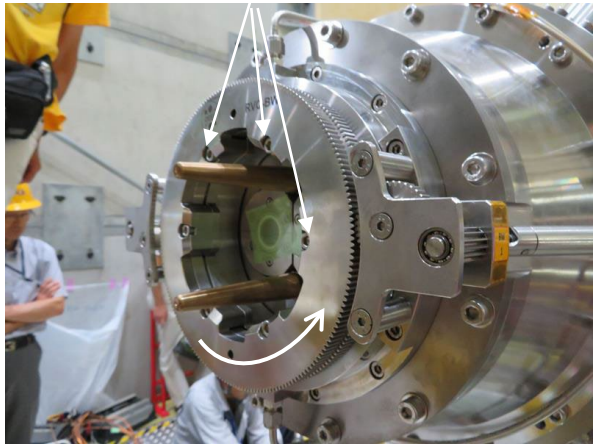
Drawing by K. Gadow



These components (red+blue) rotate to catch the lock flange.



Protruding claws of the lock flange are caught by RVC.

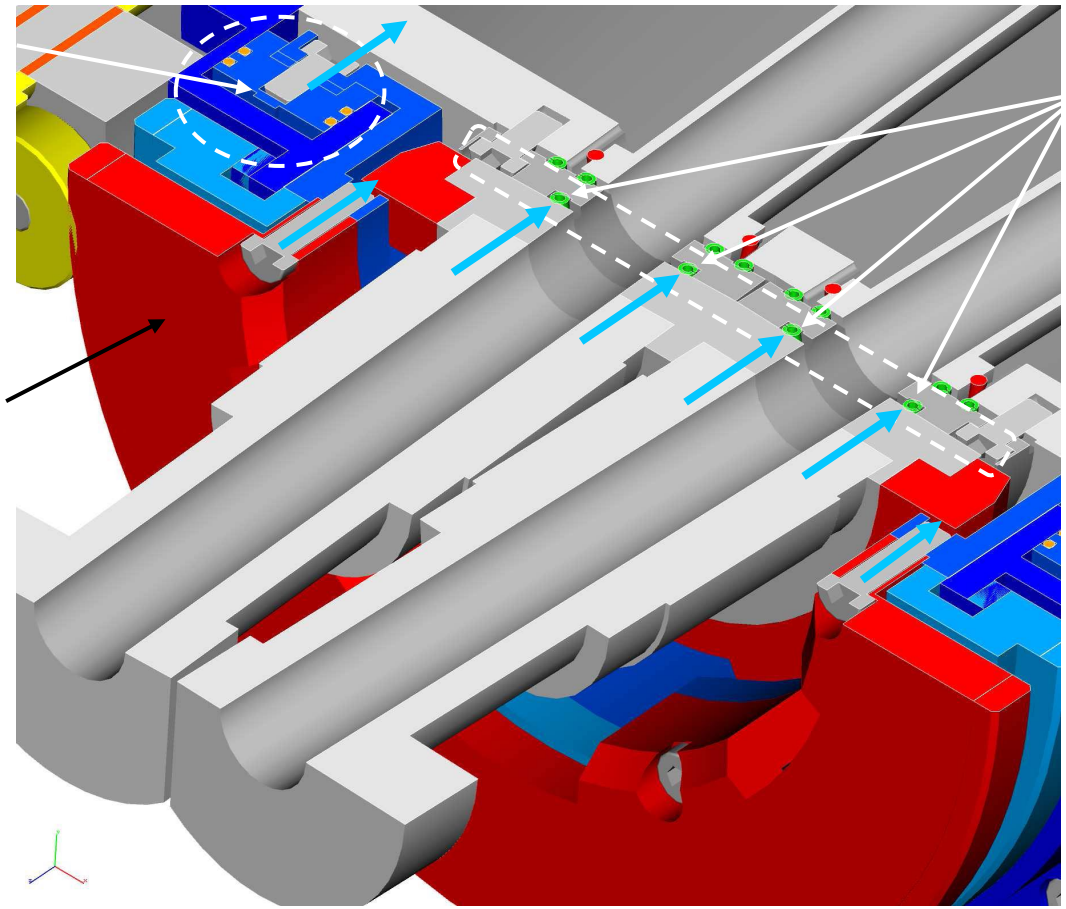


How RVC works

Drawing by K. Gadow

Cylinder for dry N_2 (about 50 bar)

High pressure N_2 gas is introduced into this volume.

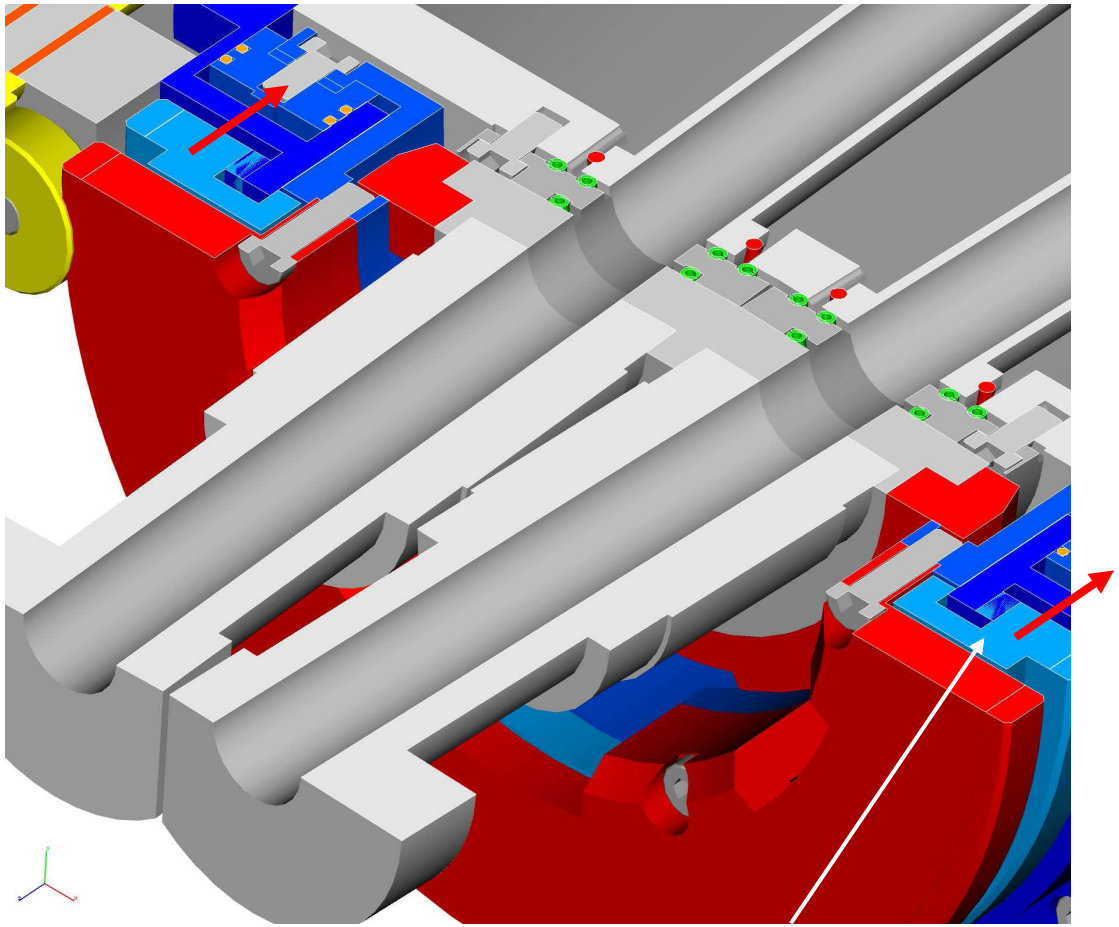


These parts are connected to the piston in the cylinder, and shift to press the bellows flange to the cryostat.

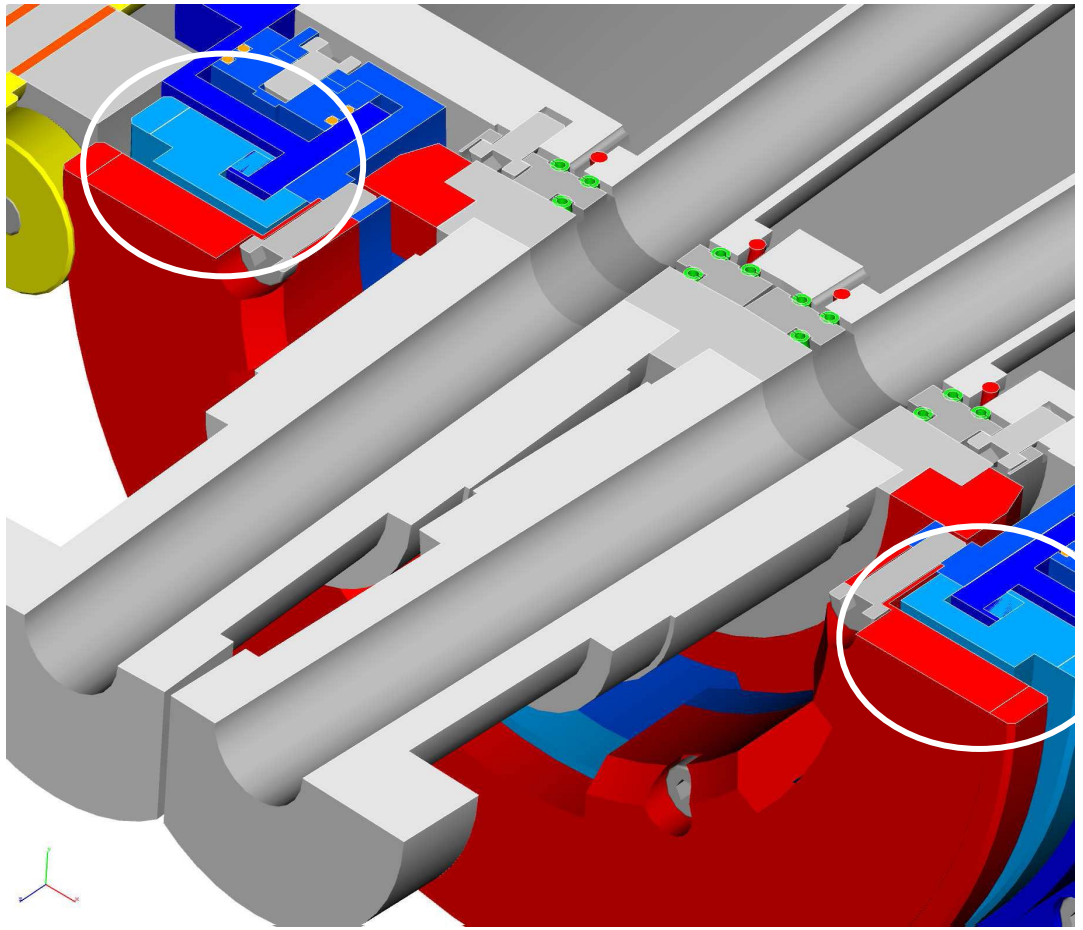
As a result, vacuum sealing between IP pipe (BPM bellows chamber) and QCS pipe is completed.

How RVC works

Drawing by K. Gadow



This large light blue screw nut turns to lock the mechanism.

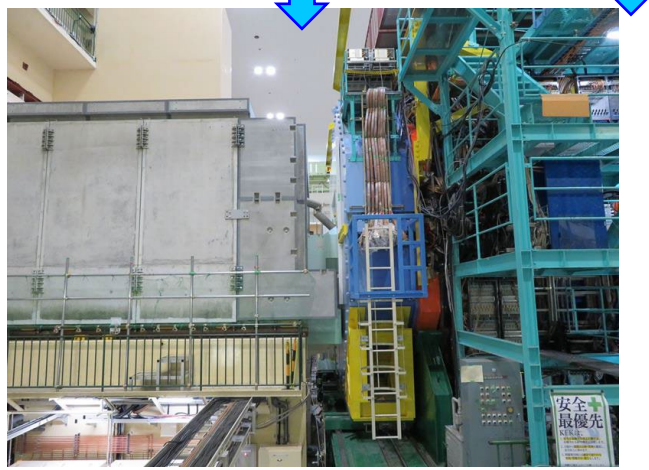


Completed!!

IR exterior appearance

- Finally concreate radiation shields cover accelerator components.




5. Summary

Summary

- IP pipe;
  - IP pipe consists of Be (center), Ti and Ta (crotch) parts.
  - Central Be pipe is not exposed to direct SR.
  - Crotch part has taper and ridge structures to reduce the number of photons entering into the central part.
  - IP pipe is assembled with VXD and installed into Belle II.
- QCS pipes;
  - SUS pipes are fixed to QCS cryostat and inserted into Belle II by QCS movable platform.
  - QCS pipes have no pump
  - Pressure at IP is estimated to be about one order higher than that at the end of the cryostat.
- RVC;
  - RVC is a mechanism introduced by Belle group to connect QCS pipes to IP pipe by a remote manipulation.
  - RVC was designed and produced by DESY.

Fin.

Thank you for your attention.

Backup