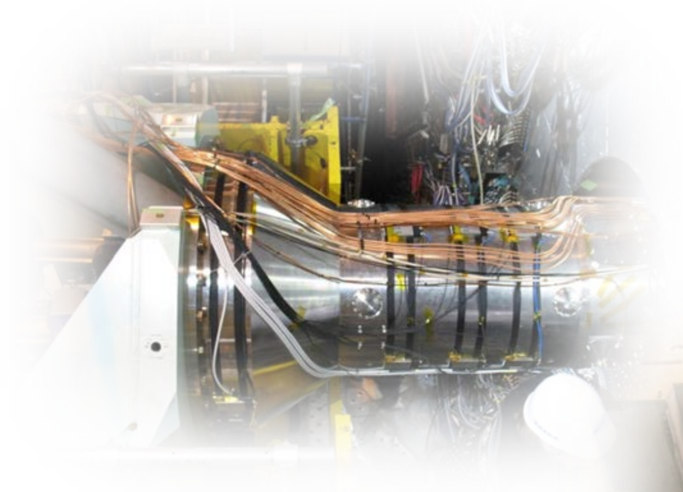
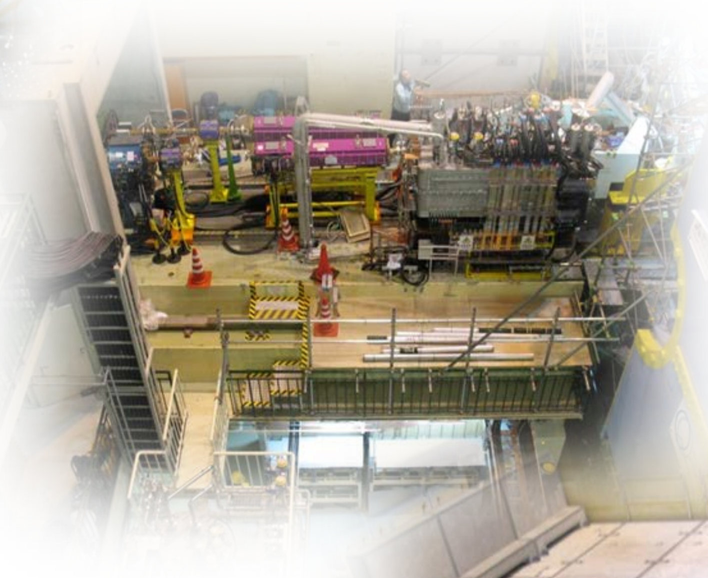
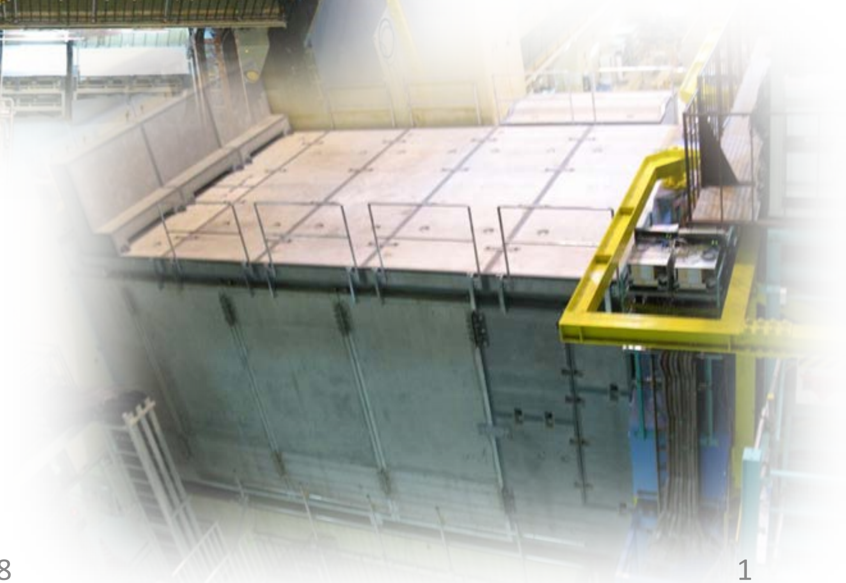
IR Assembly







22nd KEKB Accelerator Review Committee
KEK, 14-16 March 2018
Accelerator Laboratory
Ken-ichi Kanazawa
For
All persons working at IR

Contents

- Assembly for Phase 2
- BEAST II installation
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  - RVC
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- Water cooling troubles
- Concrete radiation shield for Phase 2
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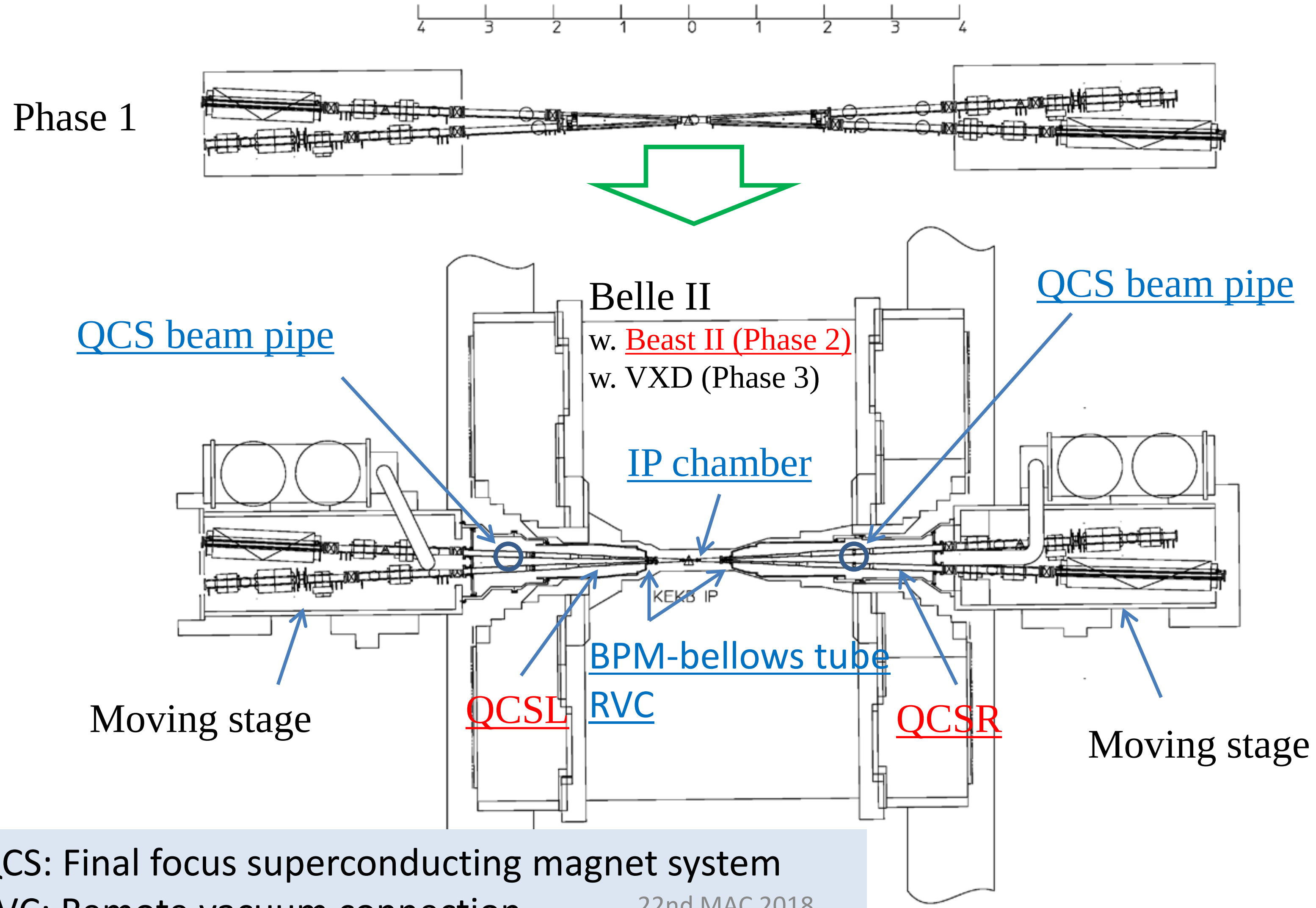
Assembly for Phase 2

Schematic drawing

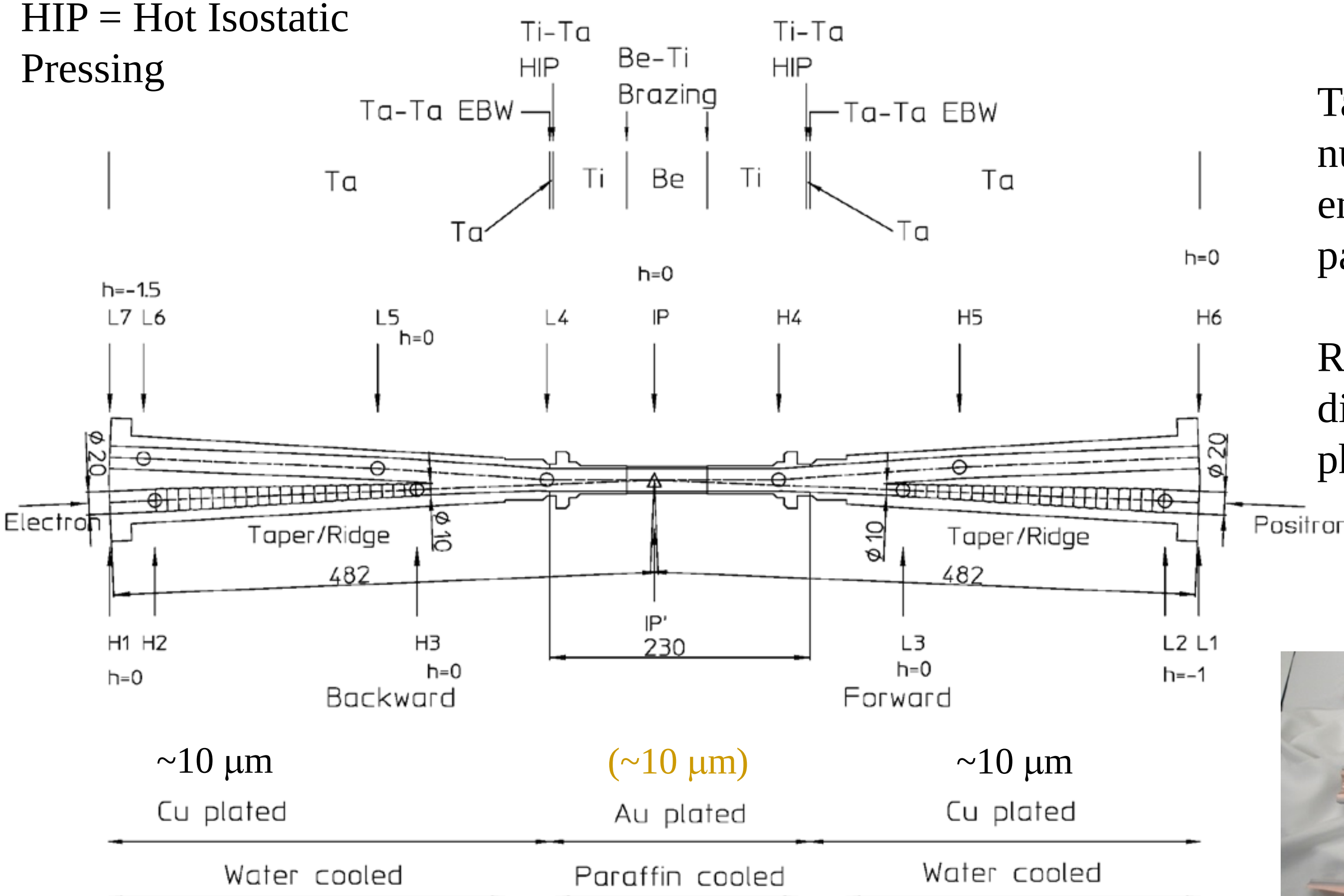


QCS: Final focus superconducting magnet system
RVC: Remote vacuum connection

BEAST II installation

IP chamber: Design feature

HIP = Hot Isostatic Pressing



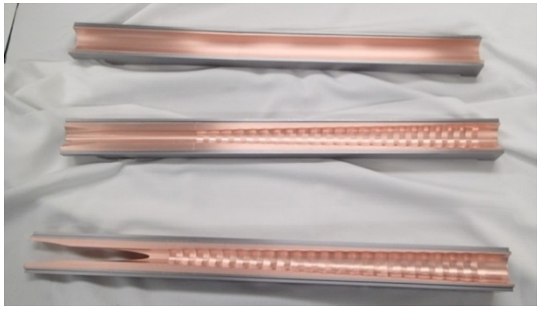
Beam space design with minimum trap of HOM at the central part.

Only taper parts are exposed to direct synchrotron radiation from the last bend.

Taper: to reduce the number of photons entering into the central part

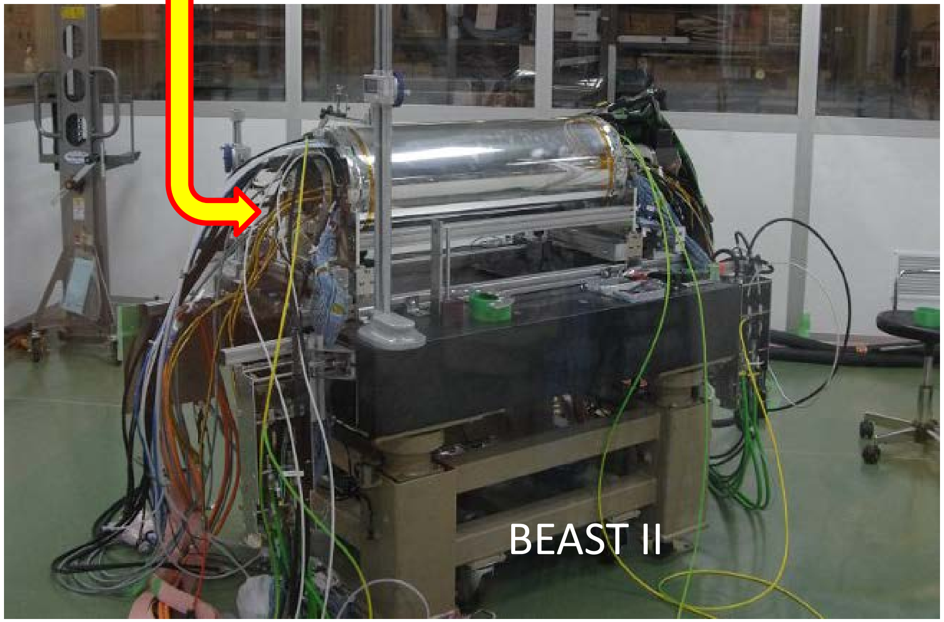
+

Ridges: to keep the direction of scattered photons away from Be



BEAST II installation

IP chamber



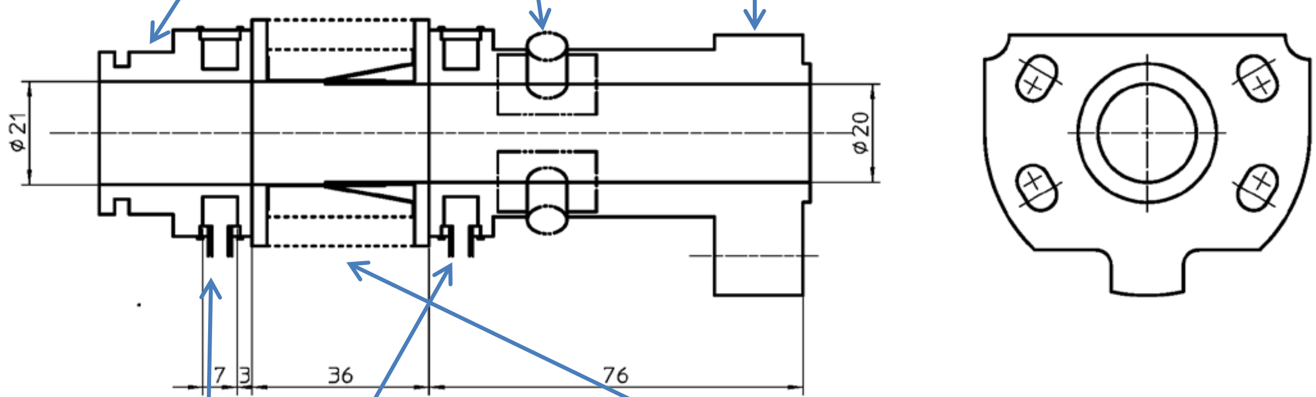
- The central straight part consists of double tube. Paraffin runs between them.
  - Outer Be: 0.4 mm thick
  - Inner Be: 0.6 mm thick
  - Gap: 1 mm

Without feedback from Phase 2 experiences, the next chamber for Phase 3 must be fabricated.

Photo by M. Tobiyama

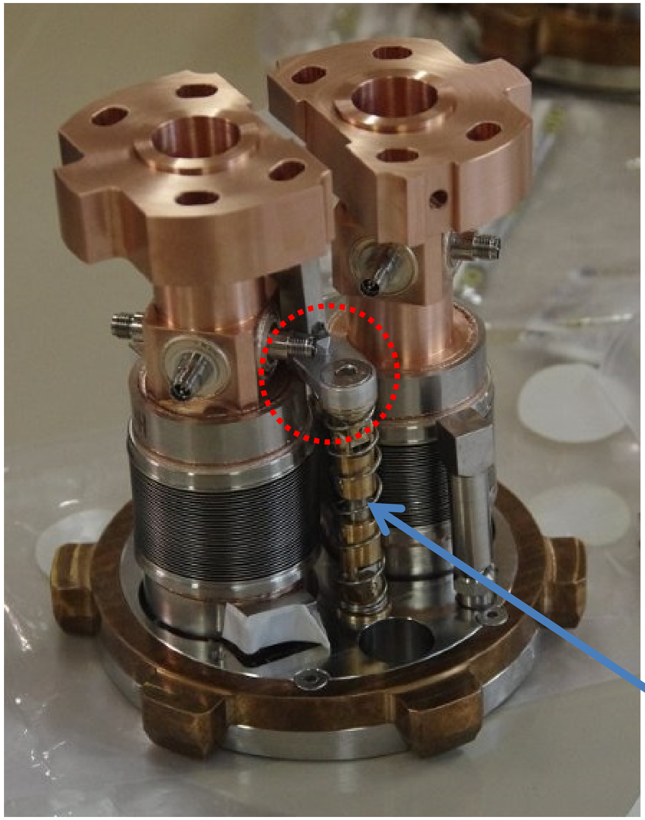
BEAST II installation

BPM-bellows tube between IP chamber and QCS



Bellows unit with a conventional RF-bridge.
A comb-type structure cannot give a sufficient flexibility for a small diameter.

Connecting BPM-bellows tube



BPM-bellows tubes (about 14 cm long) set on a flange for RVC

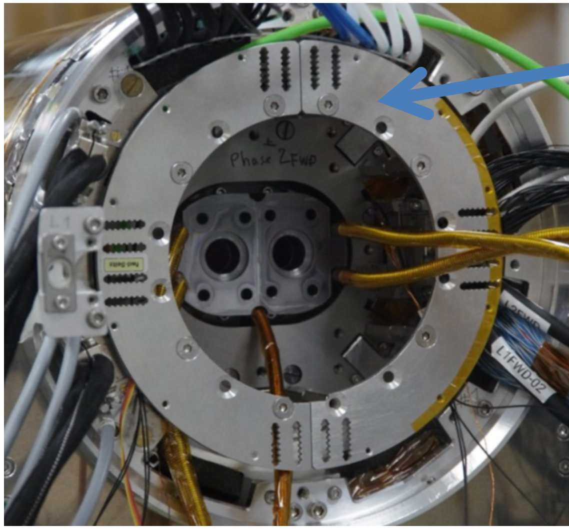
Beast II assembling group strongly suggested that it is practically impossible to connect BPM-bellows tubes to the IP chamber after BEAST II is installed into Belle (especially in FWD).
Therefore, The tubes were connected to the IP chamber before BEAST II installation.

Travel limiter to limit the longitudinal displacement of the bellows.
It was found a cable for the nearby BPM feedthrough must be connected before this limiter is set.

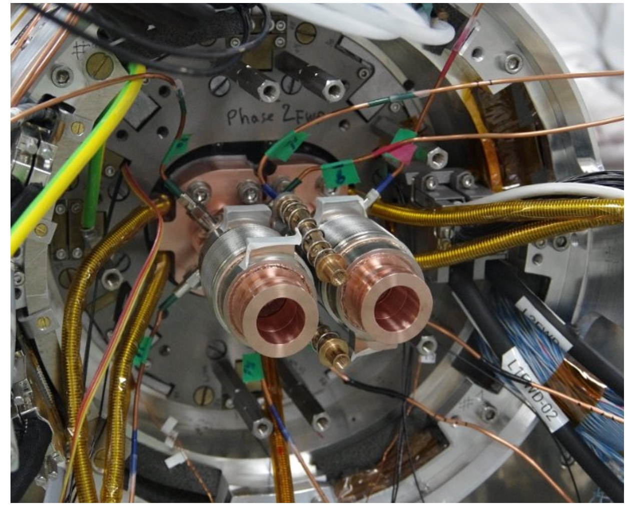
Photo by M. Tobiyama

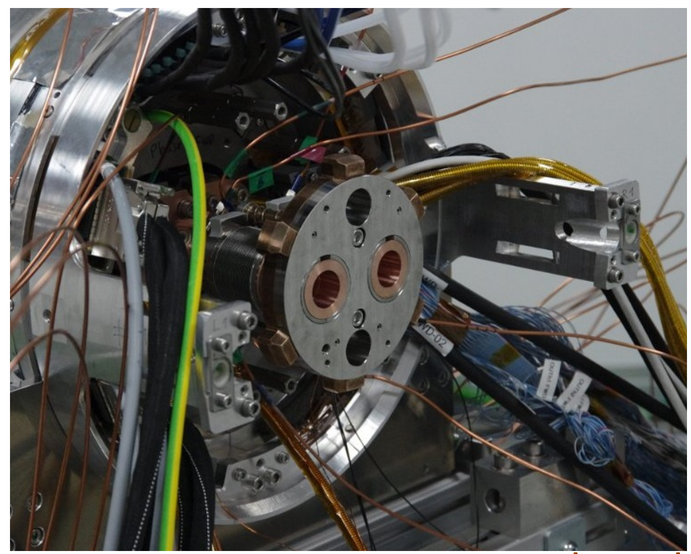
Beast II installation

Connecting BPM-bellows tube



Cable cage





FWD

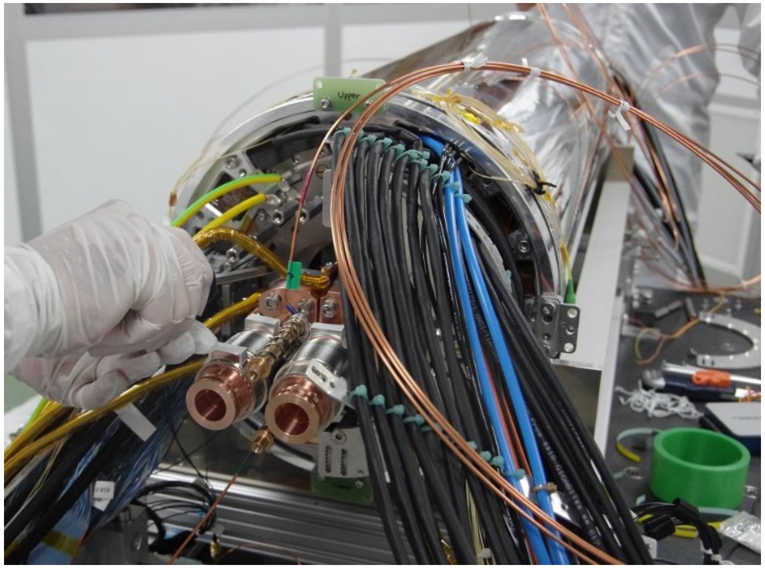
The vacuum flanges of IP chamber is about 8 cm behind the cable cage.

The cable cage interfered with connecting work. It is temporally removed.

Photo by M. Tobiyama

Beast II installation

Connecting BPM-bellows tube



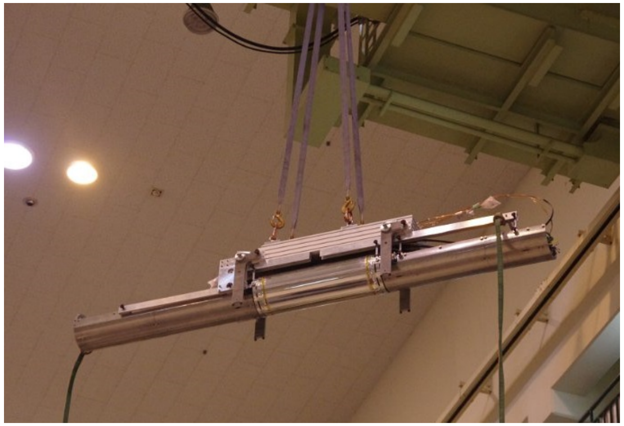
BWD
The vacuum flanges of IP chamber is in front of the cable cage.

Vacuum leak check

Work summary
Not a few issues didn't follow an original scenario. Serious discussion based on this experience is necessary for Phase 3.

Photo by M. Tobiyama

Beast II installation (Nov. 18, 2017)



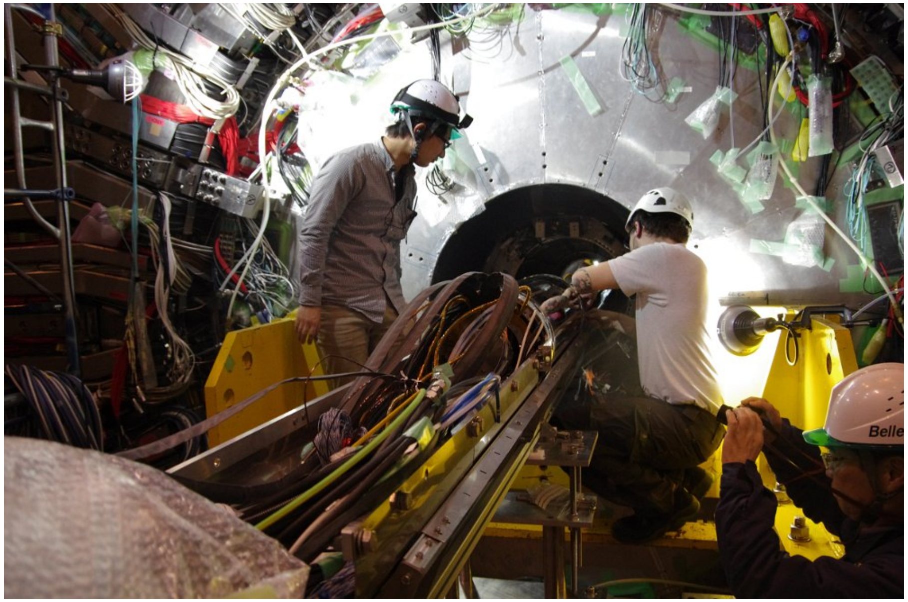
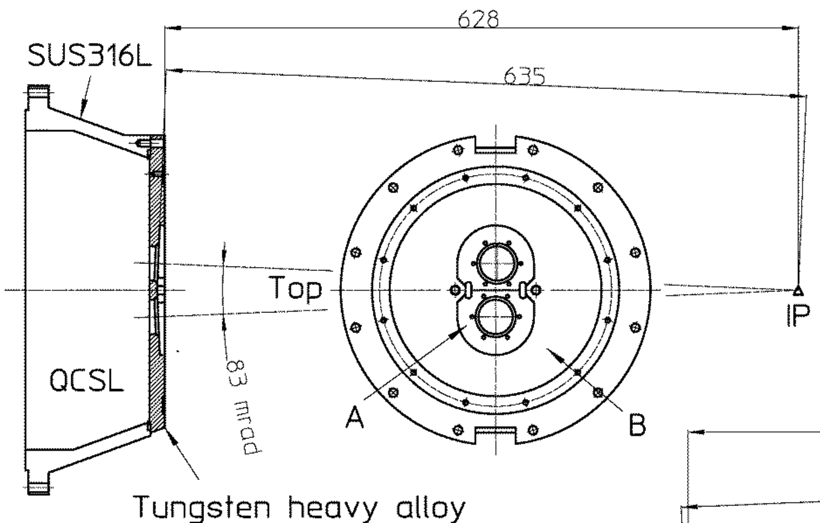


Photo by M. Tobiyama

New cryostat head



QCSL cap

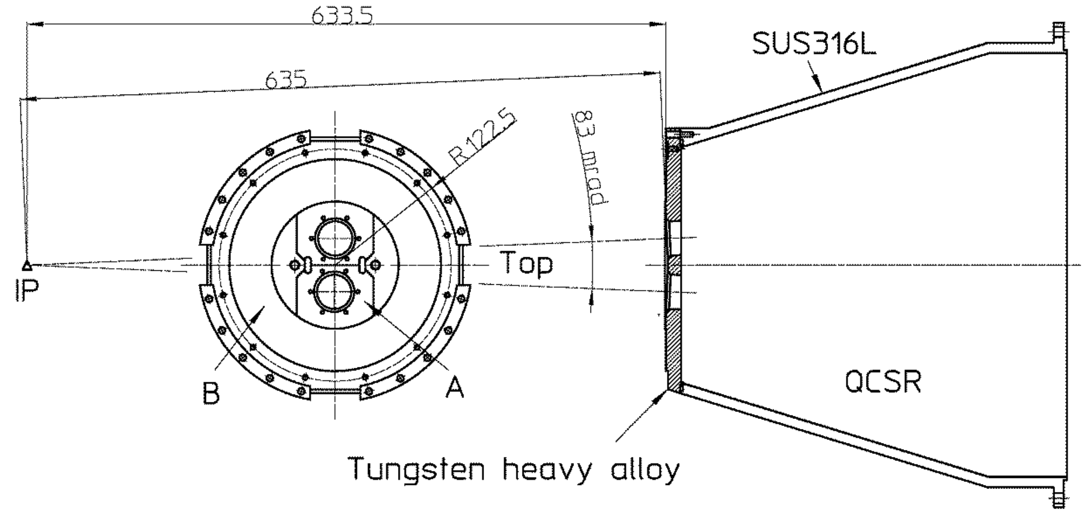
Replace the head of the cryostat with a new one which has a W-alloy face. The face is machined to install RVC on it.

RVC: Remote Vacuum Connection (picture later)

Exchange the cryostat head

⬇

Leak check of the cryostat



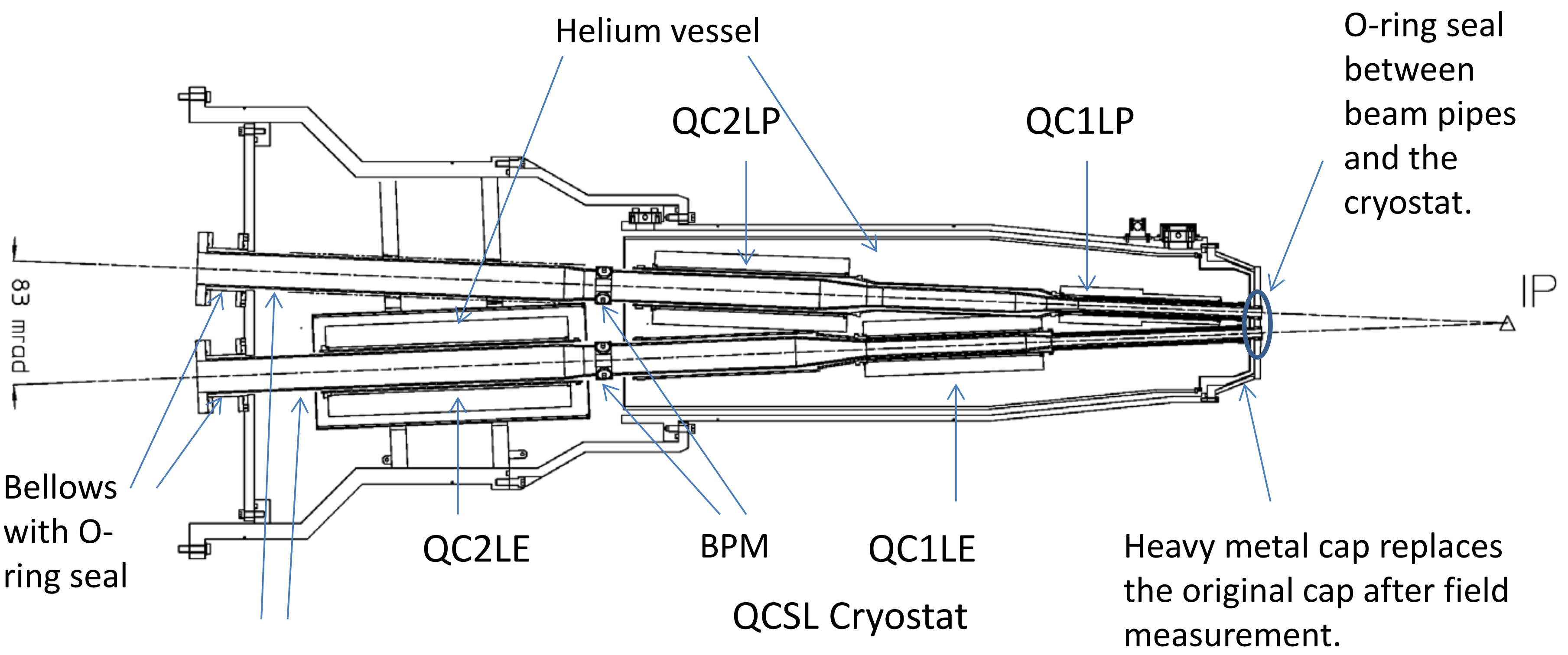
QCSR cap

Fig2

QCS cryostat parts exchange

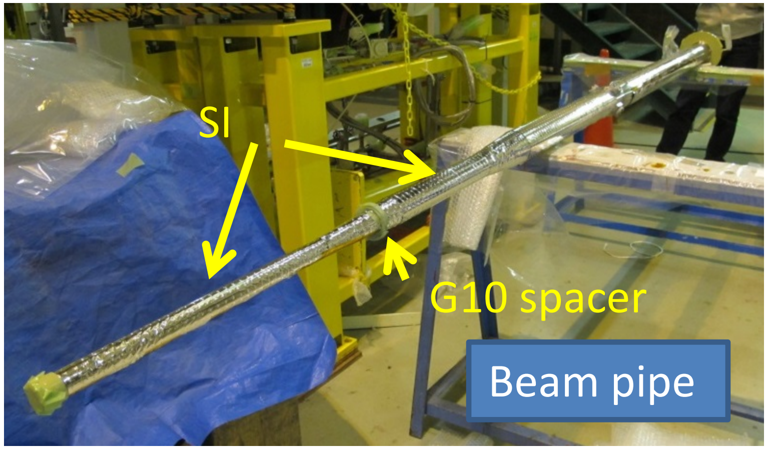
Beam pipes for QCS

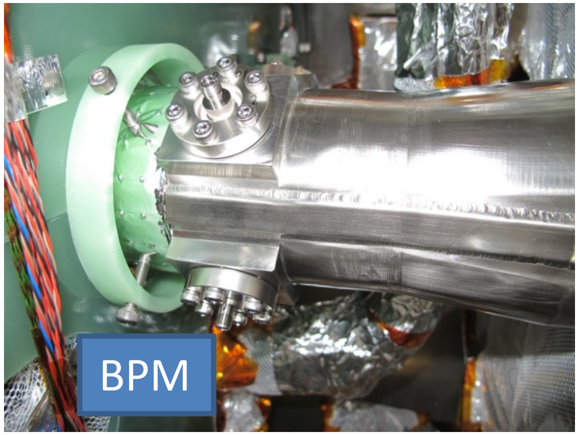
Beam pipe is made of stainless steel, with a 4 mm thick wall, and with water cooling channels therein. Inside is Cu (+TiN) coated. It is fixed to the QCS cryostat.



QCS cryostat parts exchange

QCS beam pipe installation





Set beam pipe

↓

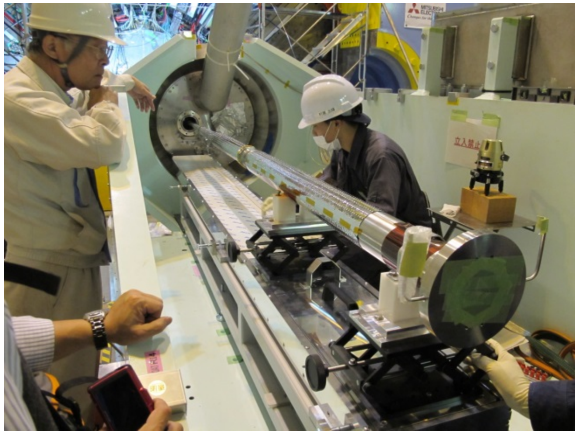
Attach BPM and leak check

↓

Connect BPM cable

↓

Leak check of the cryostat

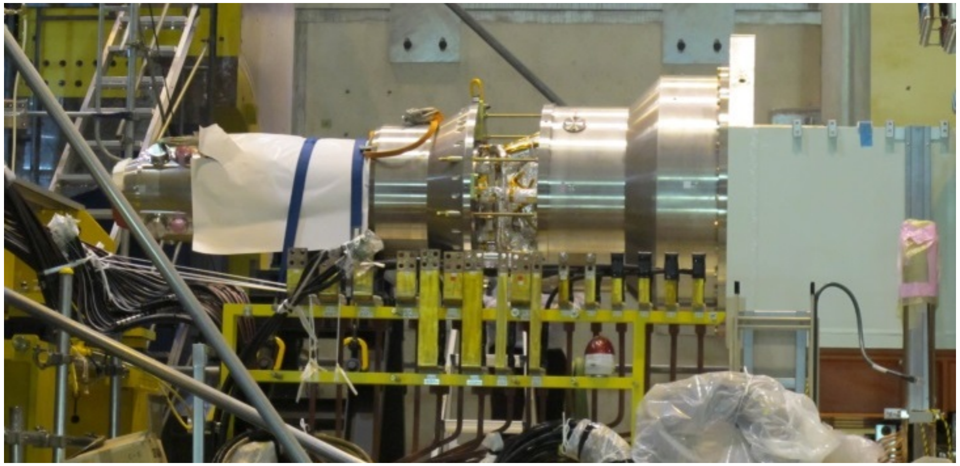


Beam pipe is inserted using a special tool

Service window on the QCSR cryostat used to manually guide the beam pipe and to attach BPM

Photo by Y. Arimoto

QCS beam pipe installation



Since QCSL has no service windows, the cryostat was disassembled for this work. Magnet group checked marker positions on the cryostat after re-assembling. Roughly speaking, the front body is rotated anti-clockwise by 0.7 mrad seen from IP. The consistency of the measurement with the mechanical tolerance of the cryostat design is not yet given.

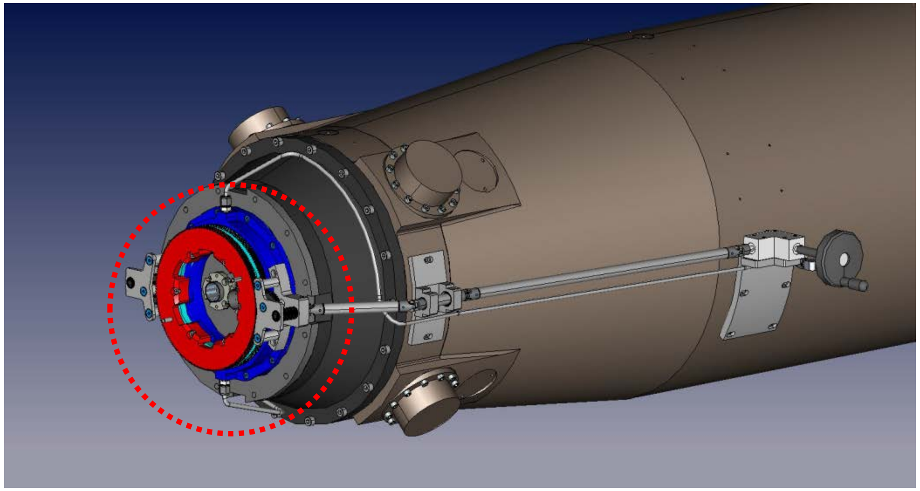
Work summary

1. The front nitrogen-shield of QCSR were not in the correct position, and interfered with beam pipes. The interference was removed by re-machining the shield.
2. The outside space of G10 spacers was different from available drawings. The spacers were re-machined.

Photo by Y. Arimoto

QCS cryostat parts exchange

RVC

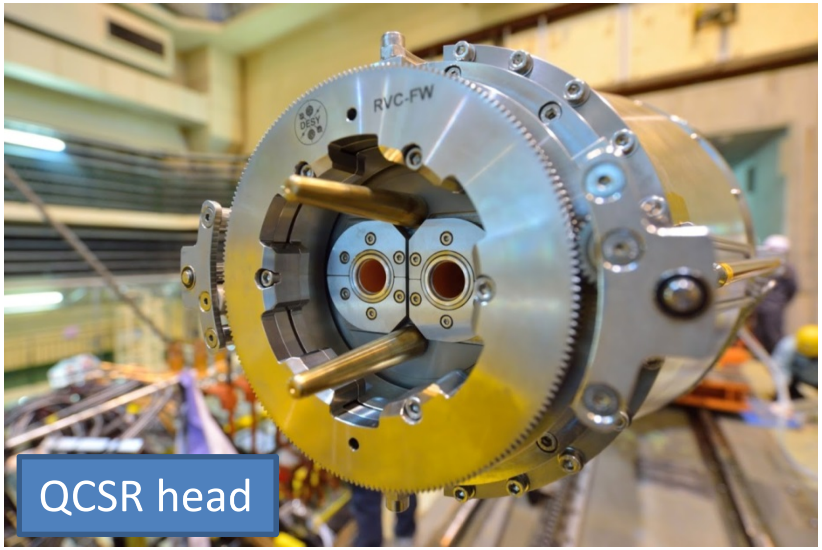


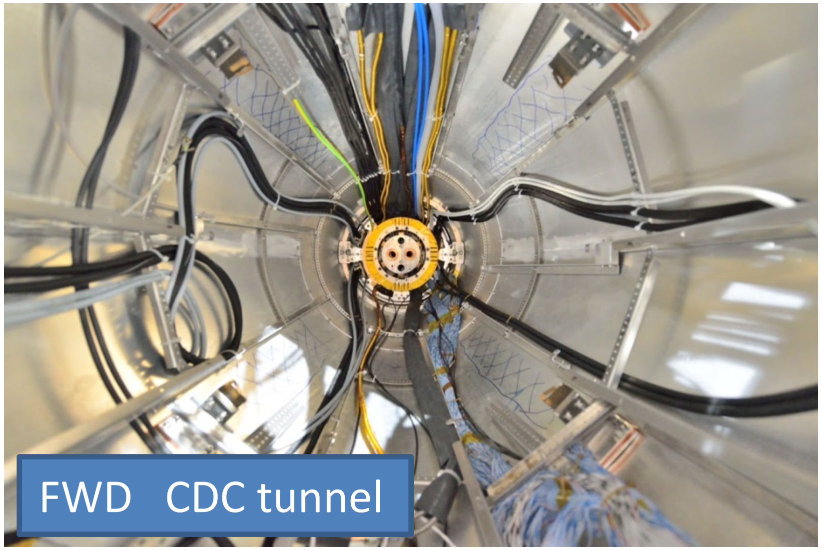
RVC is a mechanism introduced by Belle group to disconnect QCS from VXD by a remote manipulation.
RVC was designed and produced by DESY.

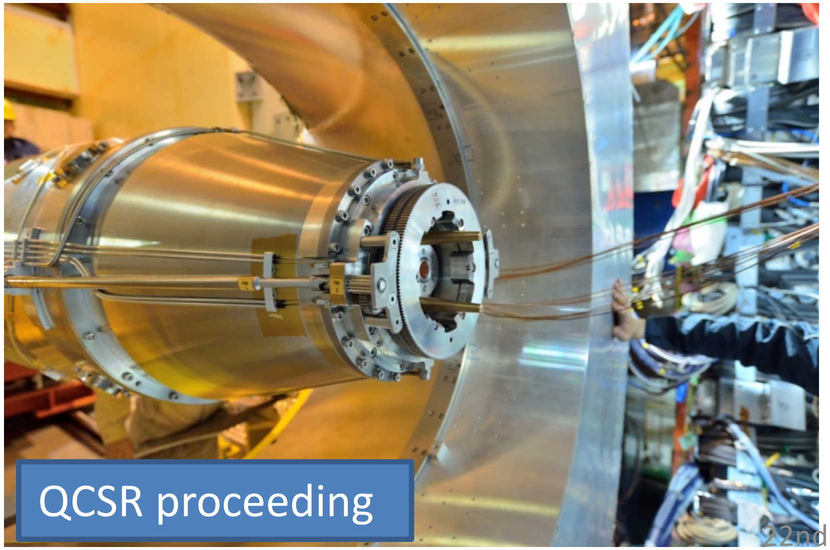
RVC on the new QCS head

Photo by DESY

QCSR-Beast II connection (Jan. 9, 2018)







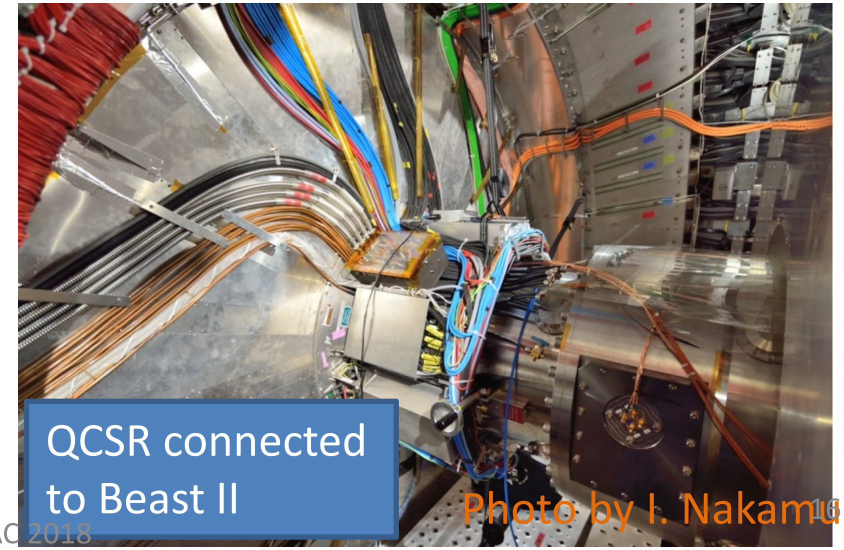
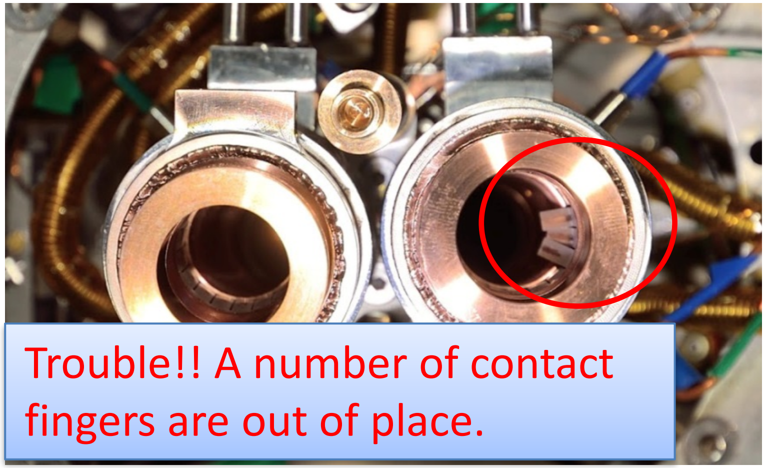
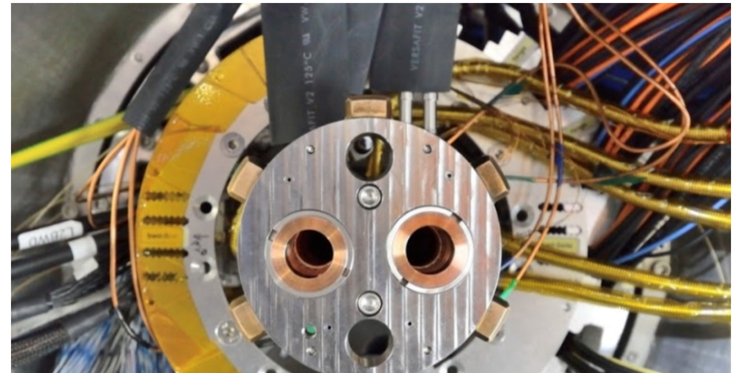


Photo by I. Nakamura

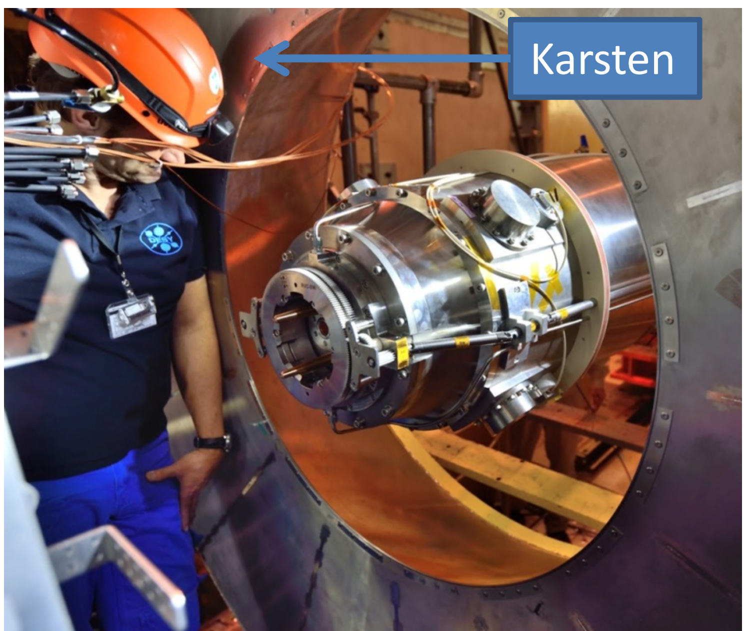
QCSL-Beast II connection (Jan. 15, 2018)



Trouble!! A number of contact fingers are out of place.



Contact fingers were miraculously put in order by Karsten (DESY)



Leak checking scene

Photo by I. Nakamura

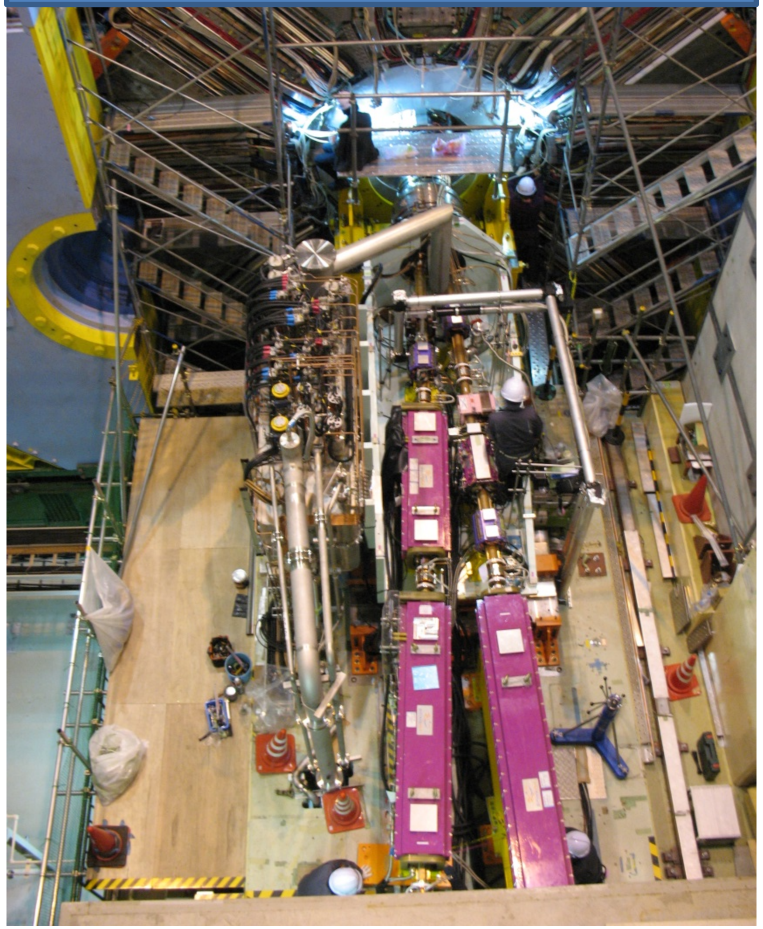
QCS-Beast II connection

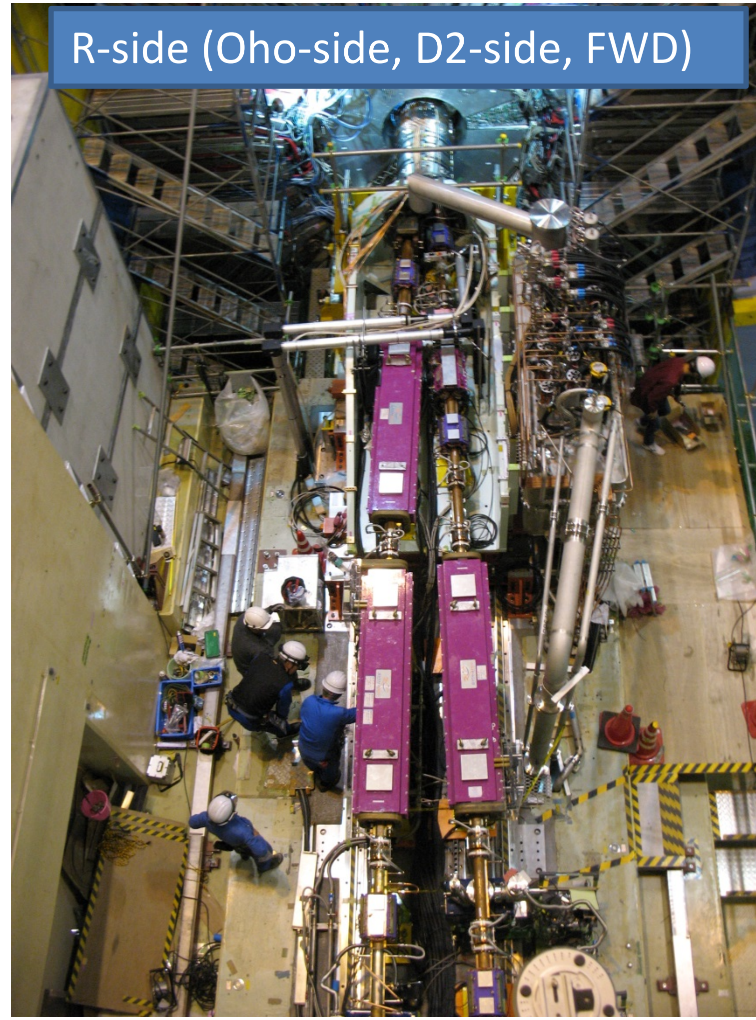
Work summary

- Just before QCSL-Beast II connection, it was found that contact fingers of one BPM-bellows tube were out of place. This seems to be caused by an accidental large turning of the RVC flange. Happily enough, this was repaired by Karsten. We should be careful not to cause the same trouble for Phase 3.
- At the first trial of QCSL move-in, cooling pipes for the BPM-bellows tube designed by KEK interfered with RVC, and RVC was not able to catch the flange of BPM-bellows tubes. This is caused by miss-estimation of the RVC volume in designing the cooling tubes. The interference was not serious to cause any mechanical damage. The cooling tubes were replaced with those prepared by DESY.
- RVC worked completely well.

IR after QCS-BEAST II connection

L-side（Nikko-side, D1-side, BWD）





All magnets are re-installed, all beam pipes are connected. Cabling and other works are going on.

Water cooling troubles

- On Feb. 16, cooling water was flowed, with a pressure less than 4.5 bar. After about one our, a water sensor of CDC (backward) got alarmed. After searching work, it was found the cooling line of the HER bellows outer at BWD, most probably its flex part, shows a leak of 2 Pa m^3 sec^{-1}, using a pressurized nitrogen of 5 bar.
  - We decided to use (cooled) nitrogen gas for the leaked line (Suggested by T. Kageyama).
- On Feb. 16, cooling water was flowed to QCSL beam pipe, but water froze. This is caused insufficient pre-warm-up of the pipe. By this accident, it was necessary to warm up QCSL temporally.
  - Before flowing water to QCS beam pipe, flow room-temperature nitrogen at least 10 hours.
  - In case the water stops, nitrogen will be purged.
- On Mar. 5, after cooling water was flowed, HV trip happened at some layers of CDC without any alarm by a water sensor. After checking work, it was found the cooling line of the LER bellows outer at FWD shows a leak of 3×10^{-2} Pa m^3 sec^{-1}.
  - We decided to use room-temperature nitrogen gas for this line for safety.

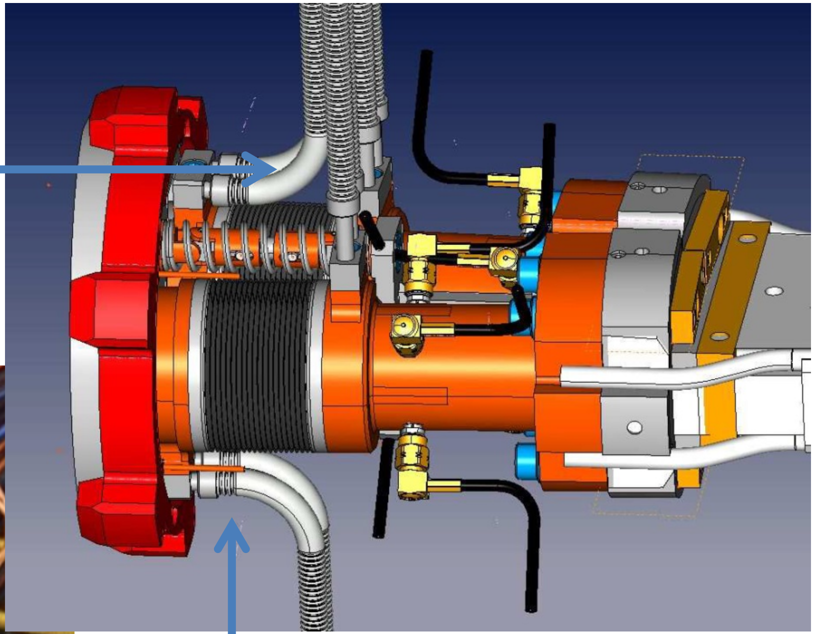
- Nitrogen is supplied from the Belle cryogenic system.
- Snoop criterion: If the leak rate measured by gas is less than $10^{-3} \sim 10^{-2}$ Pa m^3 sec^{-1} , water does not leak.

Back-up for gas cooling
- Apply a water circulation driven below atmospheric pressure.
  - A chiller by this method is commercially available. We started a study to construct a realistic system.
- Apply a liquid seal.
  - Mock-up test is successful. A present concern is about the material property of the seal.

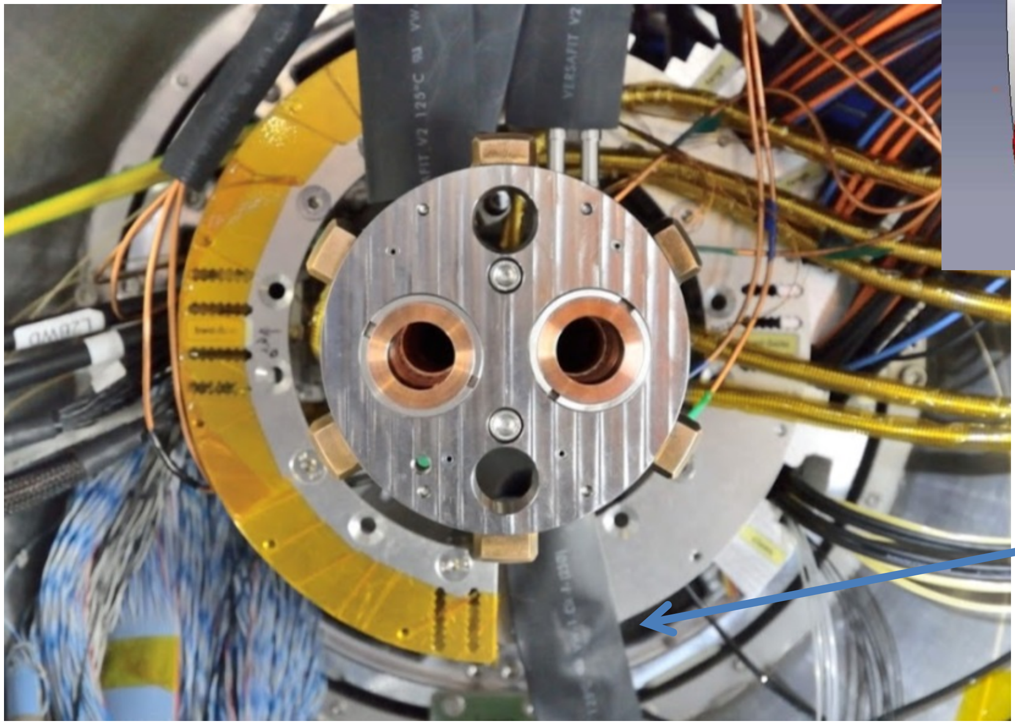
Water cooling troubles

Cooling lines

Almost leaked at FWD



Drawing by K. Gadow



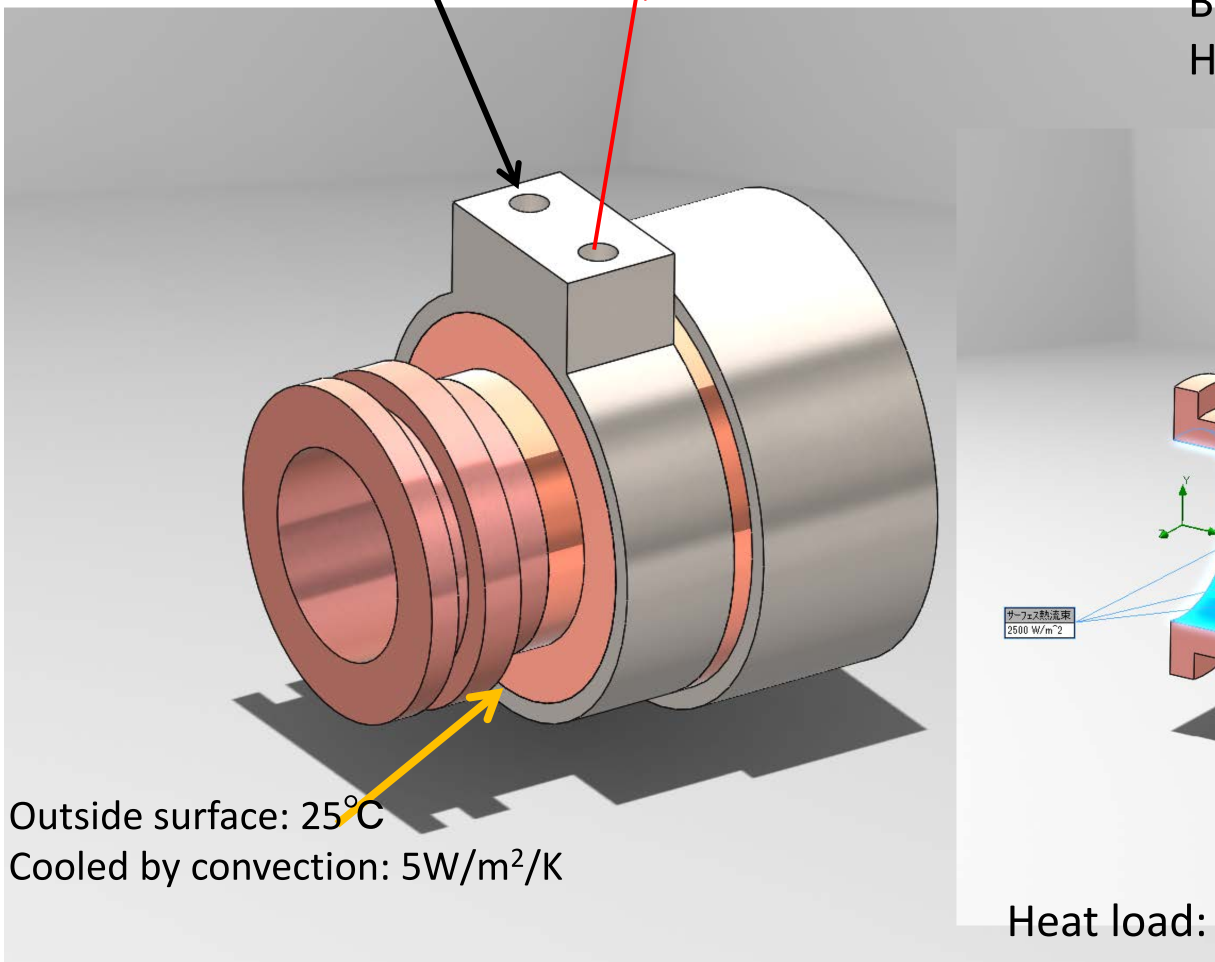
Leaked at BWD

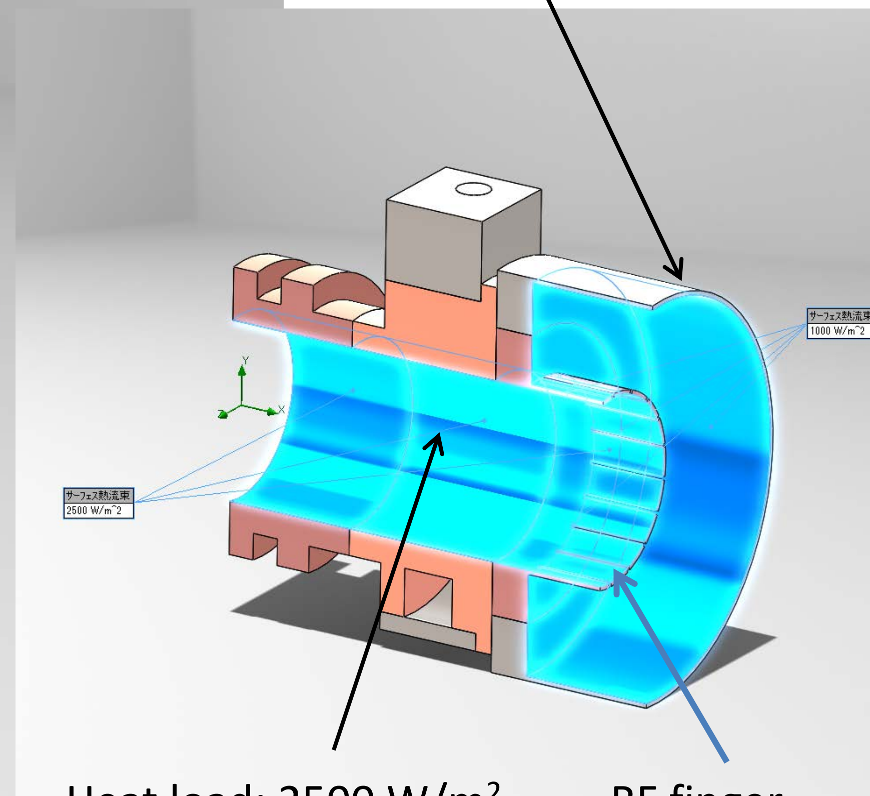
We cannot access these cooling tubes without separating QCS from BEAST II.

Photo by I. Nakamura

Water cooling troubles

Why gas cooling: simulation conditions





Water cooling troubles

Why gas cooling

Simulation by
K. Watanabe

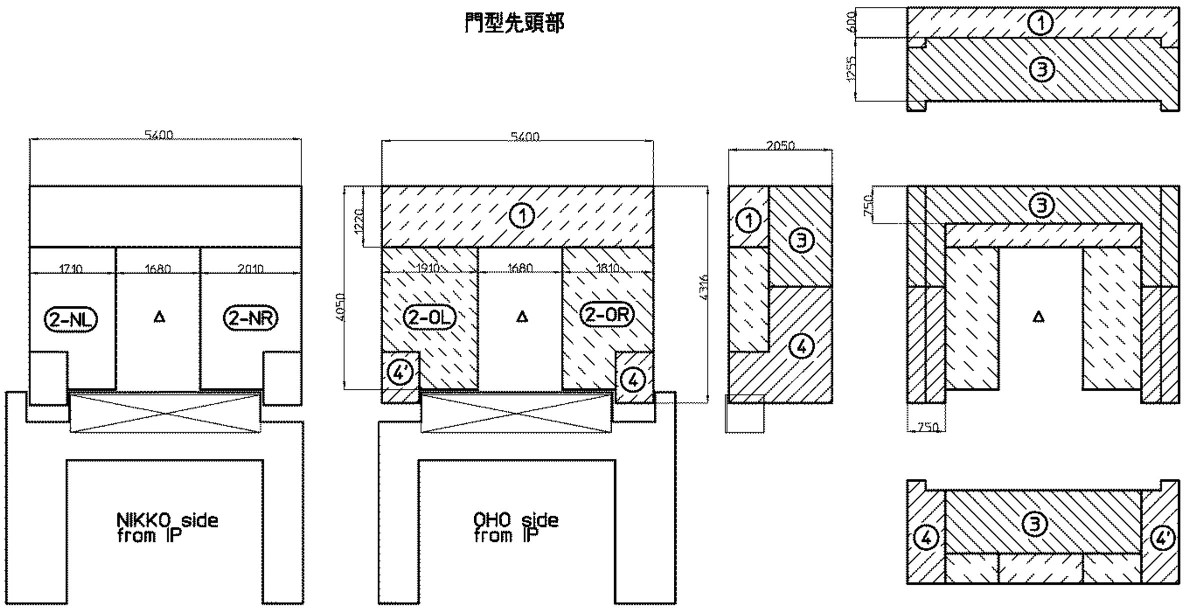
	Flow rate	RF finger	Bellows	Pressure（MPa） Outlet Temp
Water	1.7 l/min (30 C)	39.9 C	69.2 C	In: 0.3062, Out: 0.3013 30.11 C
Gas -1	0.25 l/s (30 C)	87.3 C	107.2 C	In: 0.1019, Out: 0.1013 53.9-60.6 C
Gas-2	0.40 l/s (30 C)	66.6 C	90.6 C	In: 0.2036, Out: 0.2013 37.6-42.8 C
Gas-3	0.52 l/s (30 C)	57.6 C	83.4 C	In: 0.3068, Out: 0.3013 34.0-37.0 C
No cooling	0.01 l/s (30 C)	177.6 C	179.5 C	
Gas-4	0.52 l/s (20 C)	48.1 C	75.6 C	In: 0.3071, Out: 0.3013 23.4-27.3 C

Possible flow rate

The value of temperatures is not important, since we don’t know the actual heat load.
The important point is that gas cooling is not so bad compared with water cooling.

Concrete radiation shield for Phase 2

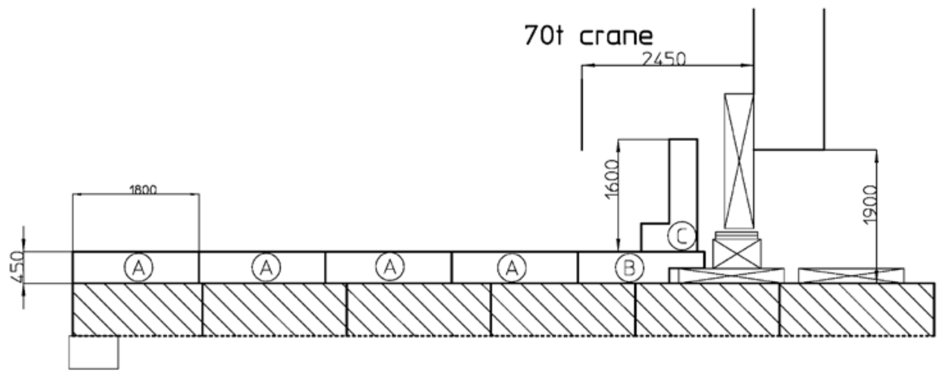
(1) The front end of the existing gate shield was newly designed to have a narrow opening.

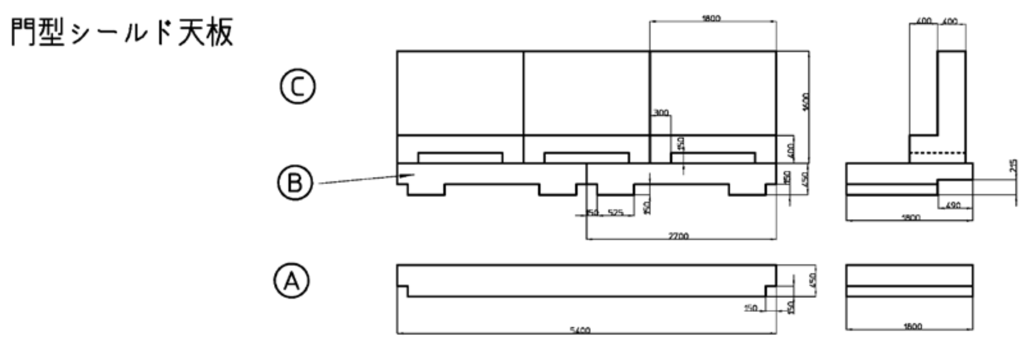


(2) Polyethylene layer between the shield and the end yoke of the detector.

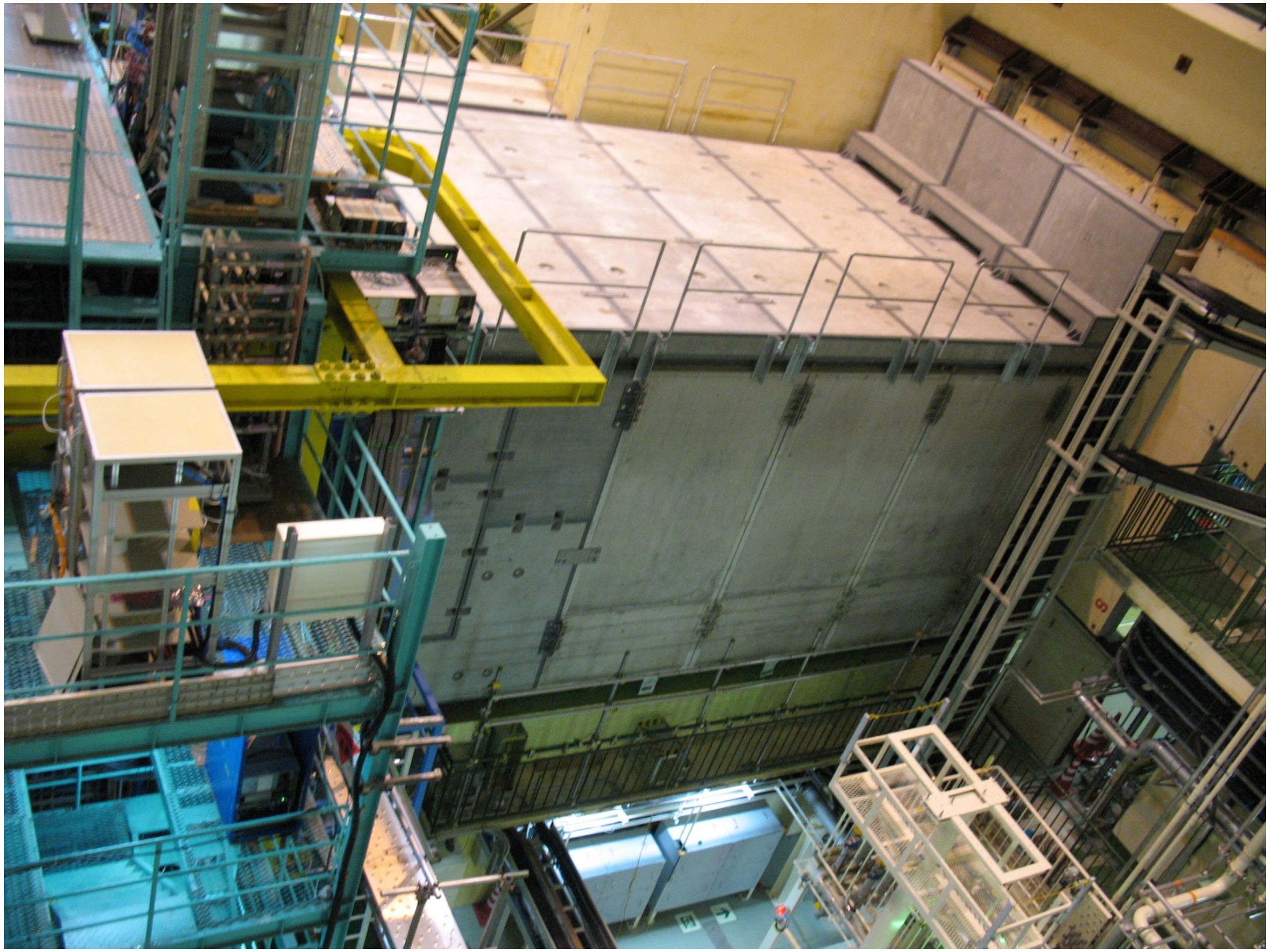
Concrete radiation shield for Phase 2

（3）Additional shields on top of the existing shield, and at the boundary between the experimental hall and the accelerator tunnel.





Concrete radiation shield for Phase 2



New shields at L-side.

Conclusion

- Now IR is ready for Phase 2.
  - Beams will judge our ambitious designs.
  - Experiences during construction should be reviewed carefully and be reflected for Phase 3 preparation.
- As to water leak trouble, we chose a merit of ensuring beam-tuning time than a risk of bellows heat-up.