



KEK Cryogenics System for ATF2-FF SC magnet

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OUTLINE

- Progress of the cryostat design work
- Status of R&D for Low Vibration Cooling System
- Summary



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Infrastructures @ ATF-2 (reminder)

- Issues

LHe supply Very limited
(supplied only by dewar, from Cryogenics Science Center)

- It can be supplied for pre-cooling and re-cover for quench.

Cryogenics facility None

Space for Liquefier around ATF ??

GHe recovery line Yes

Human resource for cryogenics operation None

Power supplies for SC magnets None

KEK proposed cryogen free cooling scheme which can be operated under limited infrastructures at ATF2!!

It may help the magnet operation in fully automatic mode with "operational shift-free".



Cooling scheme for 4K connection box at ATF2

Heat loads by Current leads into 4K level

300 A x 2 leads (0.36W, 0.18W/lead) by HTC conductor

150 A x 2 leads (0.024 W, 0.012W/lead) by HTC conductor

20A x 10 leads (Total 0.12 W, 0.012W/lead) by by HTC conductor

Responsibility part of KEK

One 1.0 W/4.5K Plus tube type cryocooler

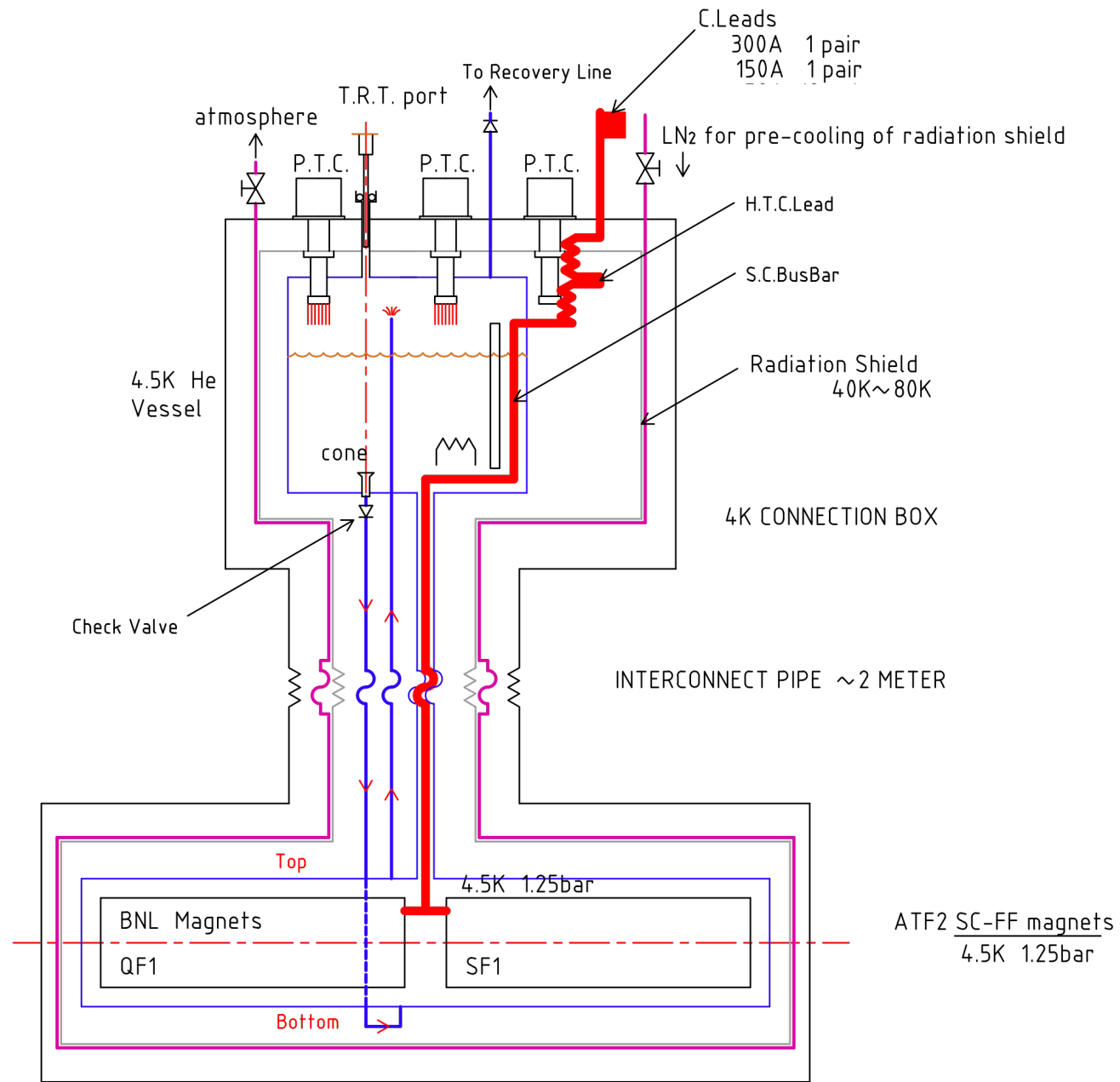
Two (Three) 1.5W/4.5 K Plus tube type cryo-coolers use as re-condensation cooler

Three Plus tube type cryocooler will be mounted with low vibration mounting

Tubes for pre-cooling and thermo siphon mode

Co-operative design part !

Responsibility part of BNL



Magnet is cooled in LHe at ~4.5 K, 1.25 bar
with Thermo Siphon Loop

A flow diagram translated from the proposed cooling scheme

Proposed set up plan in the tunnel at ATF2

Advantage one.
Easy maintenance
of cryogenics part
due to the outside
of radiation control
area!

For working and
walking space

This is good solution at ATF2!

4K connection box

Bellows part

Connection
Tube ~2m

Shintake
monitor

Beam direction

1261.77

1738.23

1795

1205

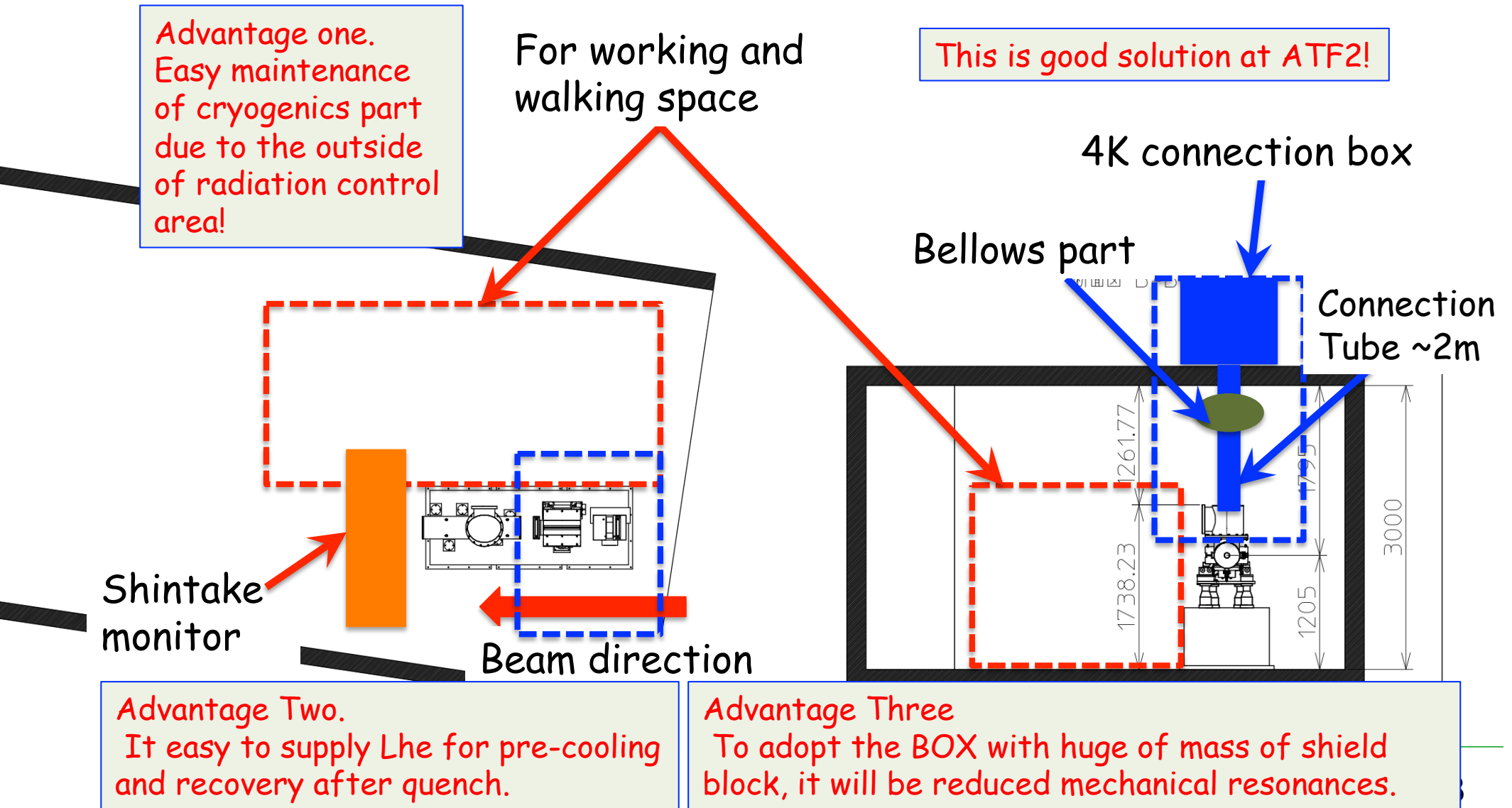
3000

Advantage Two.

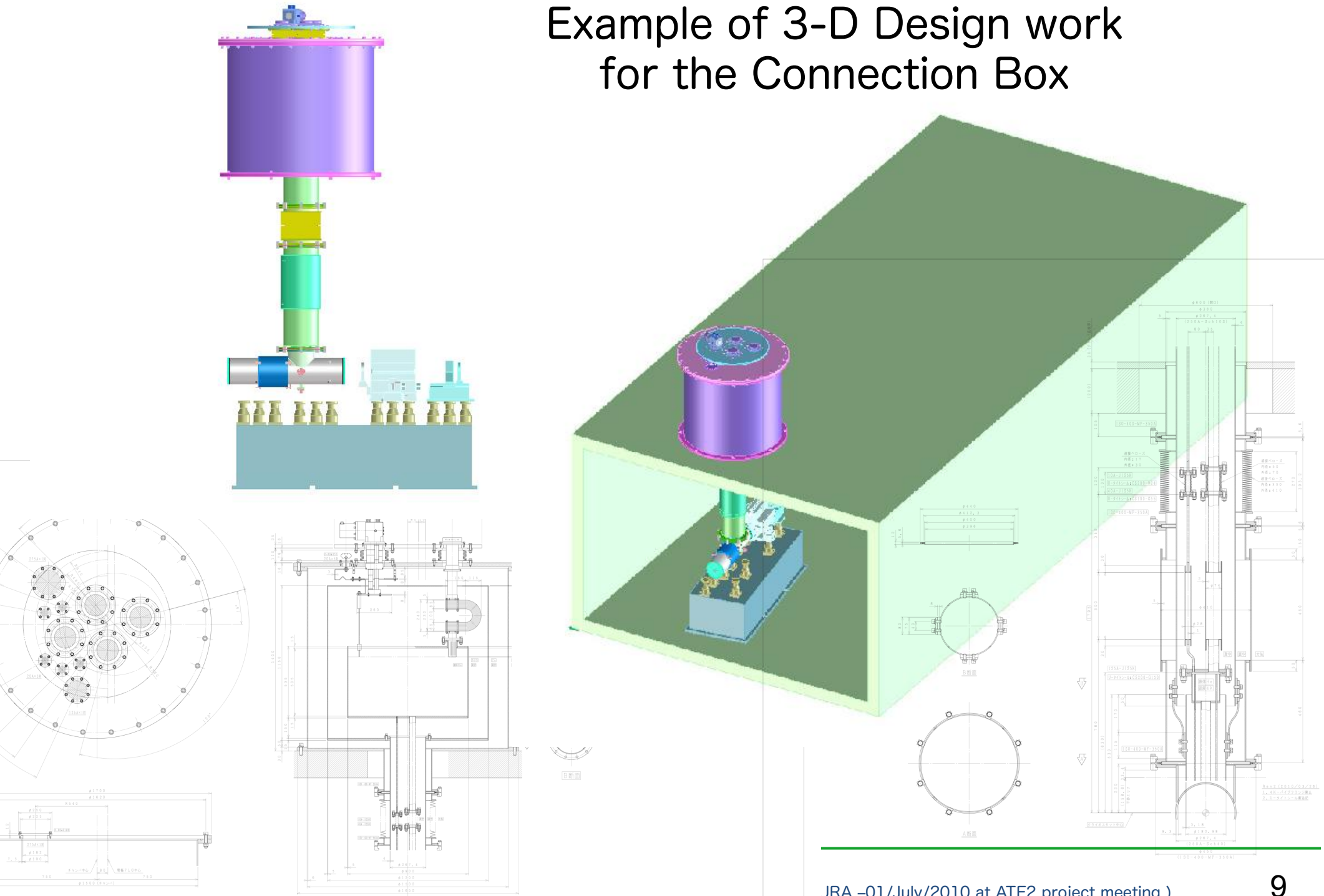
It easy to supply Lhe for pre-cooling
and recovery after quench.

Advantage Three

To adopt the BOX with huge of mass of shield
block, it will be reduced mechanical resonances.

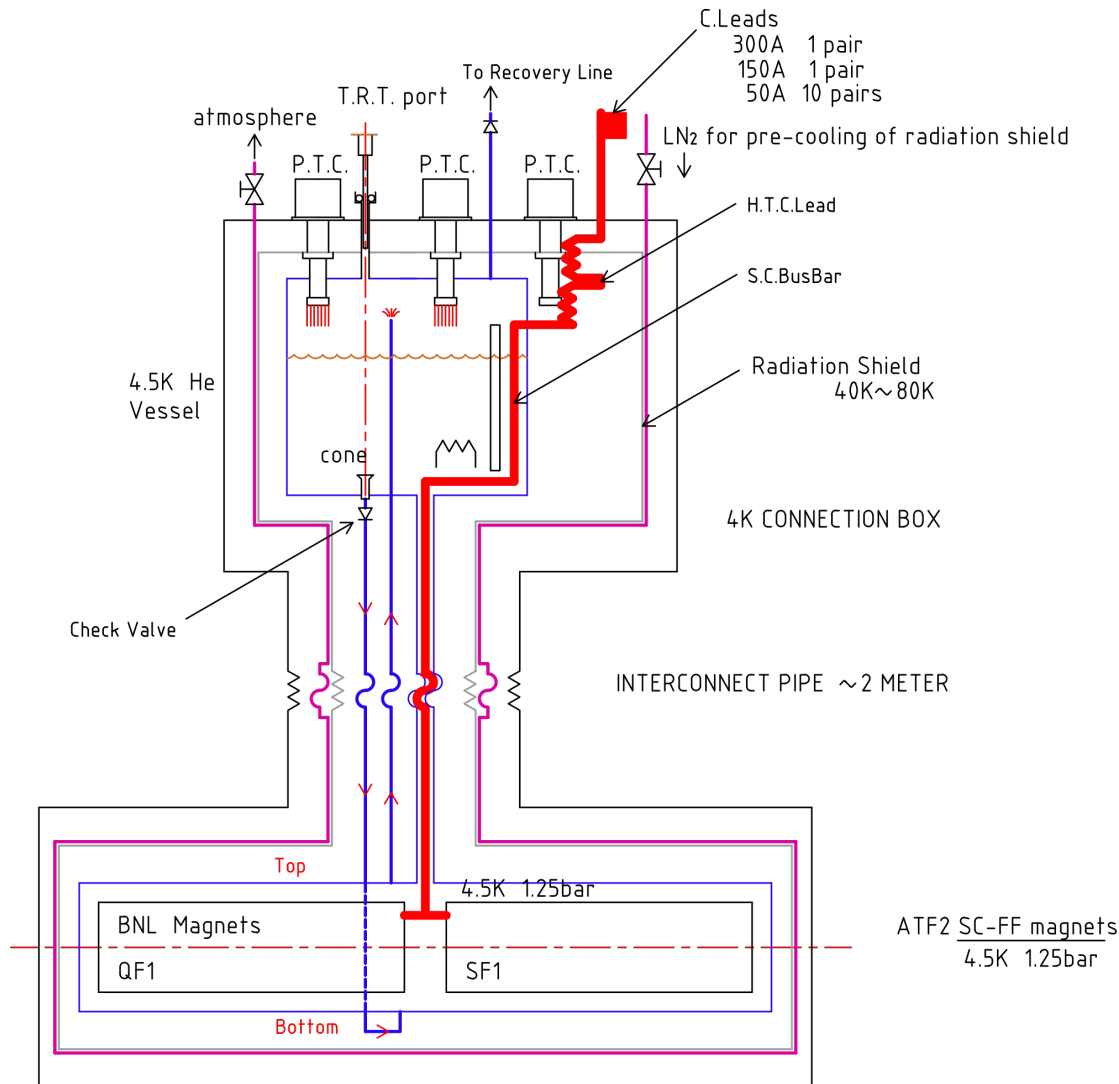


Example of 3-D Design work for the Connection Box





Criteria of Design Parameters Part-1



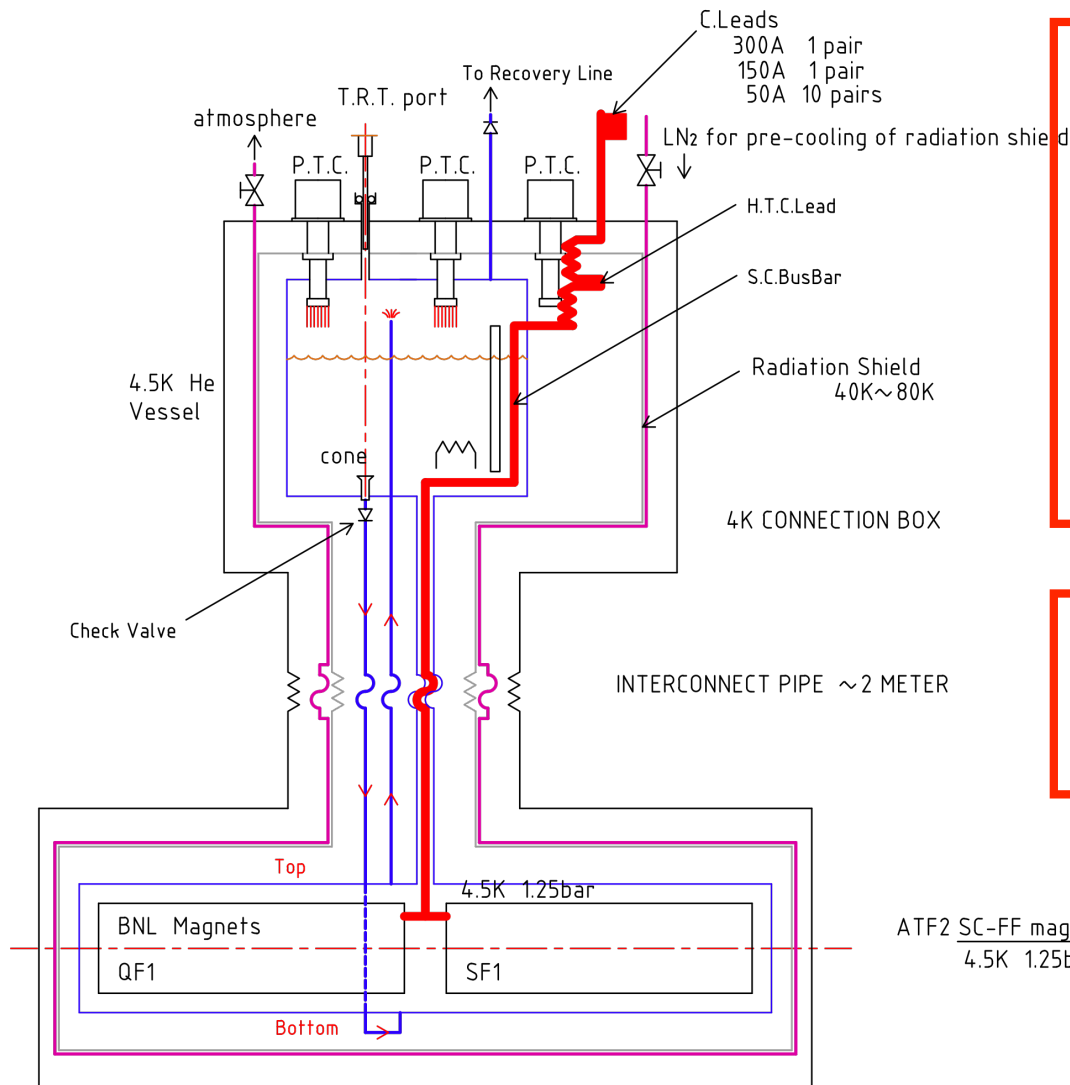
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At our design parameters

- Heat Load
 < 2.5 W (magnet part)
 < 2 W (re-condensation part including heat load by C.L.)
- Re-condensation
 : Re-condensation with P. T. Coolers
- Operation Pressure
 : $P_O = 1.25 \sim 1.3$ Bar
- Operation Temperature
 : $T = 4.5$ K
- Design Pressure
 : $P_D = 1.5$ Bar
- Test Pressure
 : $P_T = 1.625$ Bar
 $= P_O \times 1.25$



Criteria of Design Parameters Part-2



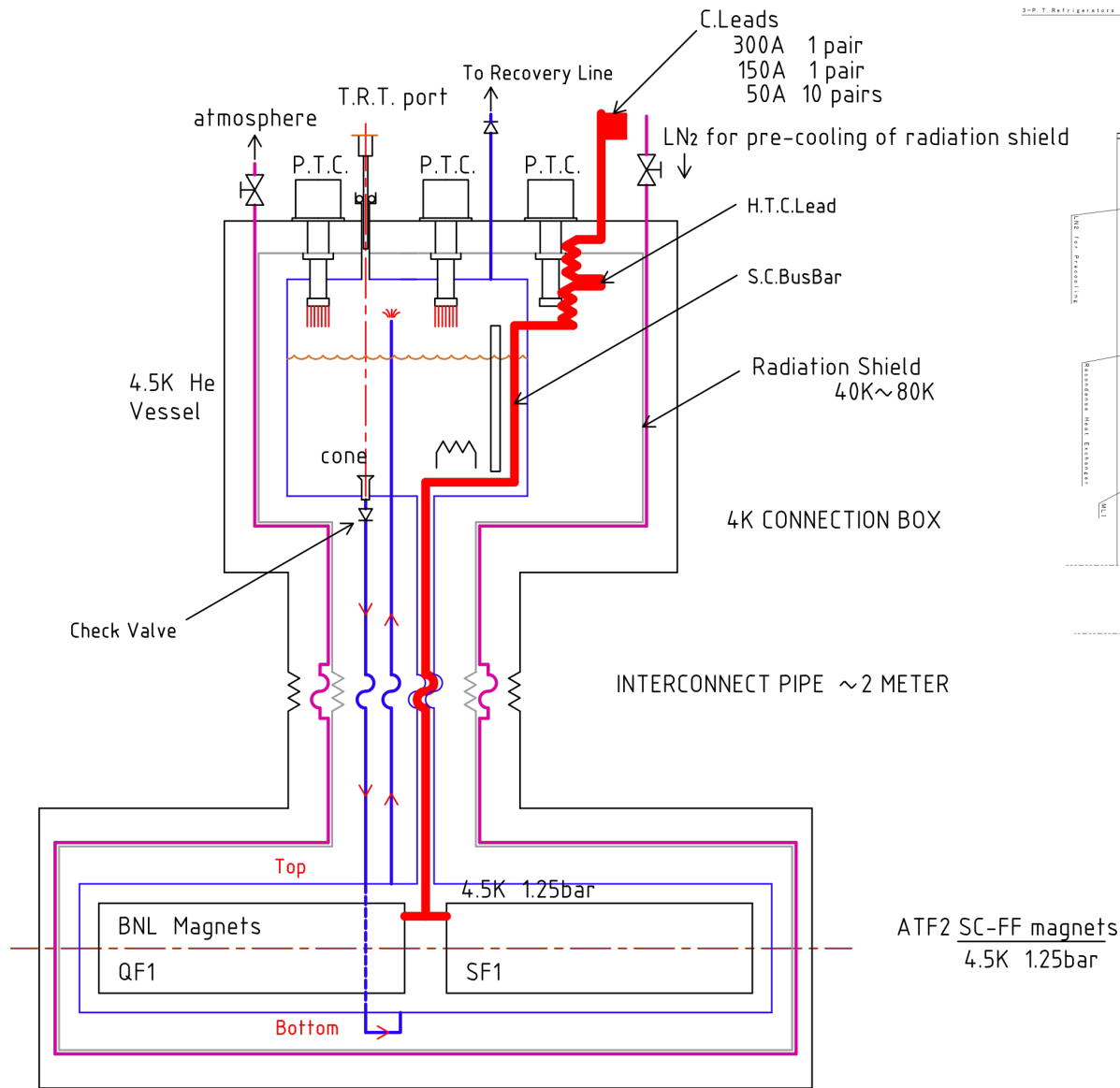
Magnet is cooled in LHe at ~ 4.5 K, 1.25 bar
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At our design parameters

• Piping

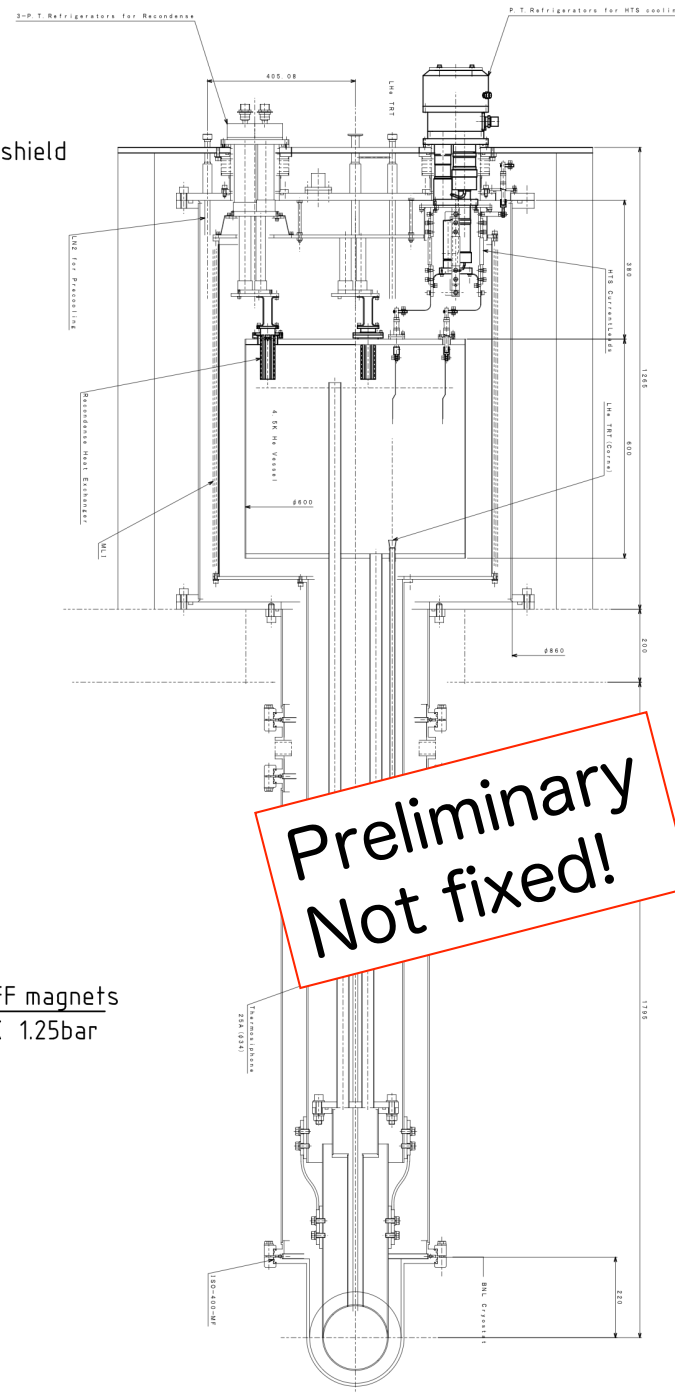
- ✓ one pair of pre-cooling tube for radiation shield
- ✓ one pair of thermo siphon loop
- ✓ one pre-cooling tube for 4.5 K

Need to confirm parameters compatibility between BNL and KEK!



Magnet is cooled in LHe at ~4.5 K, 1.25 bar with Thermo Siphon Loop

Comparison of flow diagram and cryostat design!



**Preliminary
Not fixed!**

ATF2 SC-FF magnets
4.5K 1.25bar

Cross cut view of the cryostat



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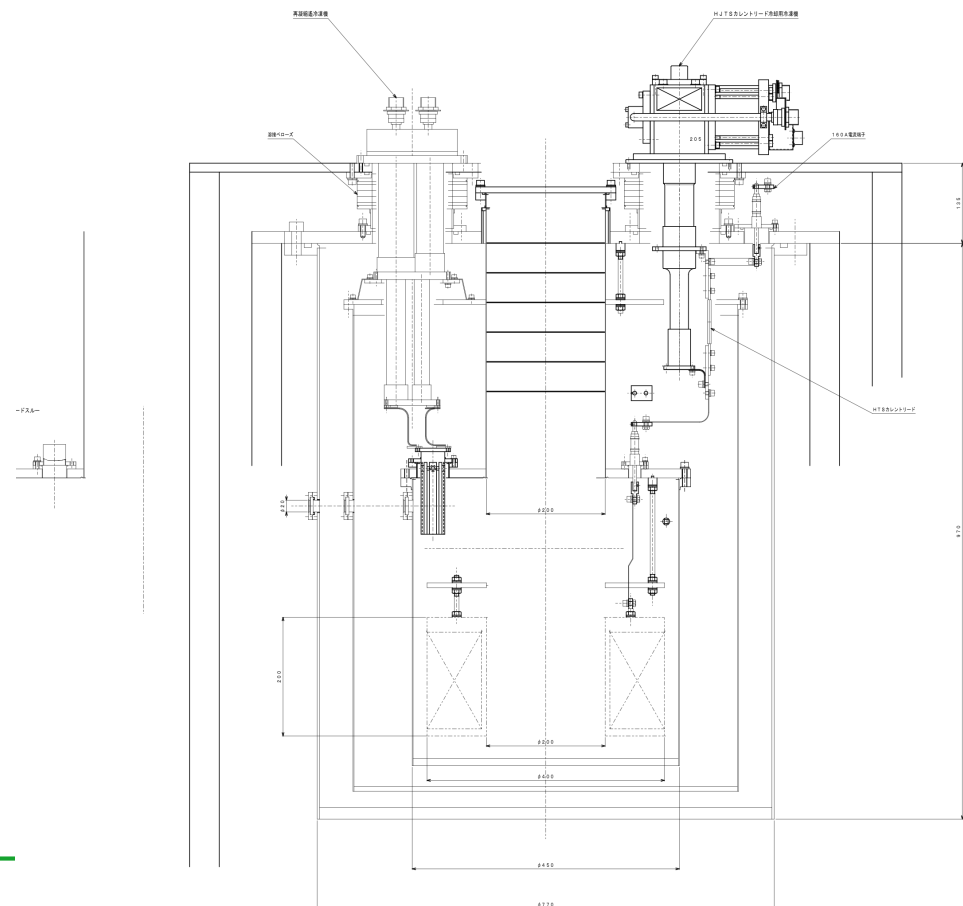


R&D of Low vibration cooling system

- We are jointed g-2/EDM solenoid group, and co-operated R&D to develop low vibration cooling system.
- A few money are founded from Cryogenics Science Center for R&D.

In one year:

- build prototype of cooling system
- study how to reduce vibration in *thermo siphon cooling system*
- Yamaoka-san join R&D group, and will design a suspension frame for cold head for R&D.





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Summary

- Re-condensation cooling system @ ATF2 are proposed by KEK for reducing vibration level lower than 50 nm. It may be adaptable to the BNL magnet.
- Rough design work for cryogenics at ATF-2 are finished. We can step into engineering design work, but it need to discuss with BNL some issues.
It needs to take half year for discussion.
- + It needs to take one and half year for design and construction from now technical point of view.
- R&D work for low vibration cryogenics have just started in Cryogenics Science Center.
It will take one year for above R&D work.



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Responsibility part of KEK

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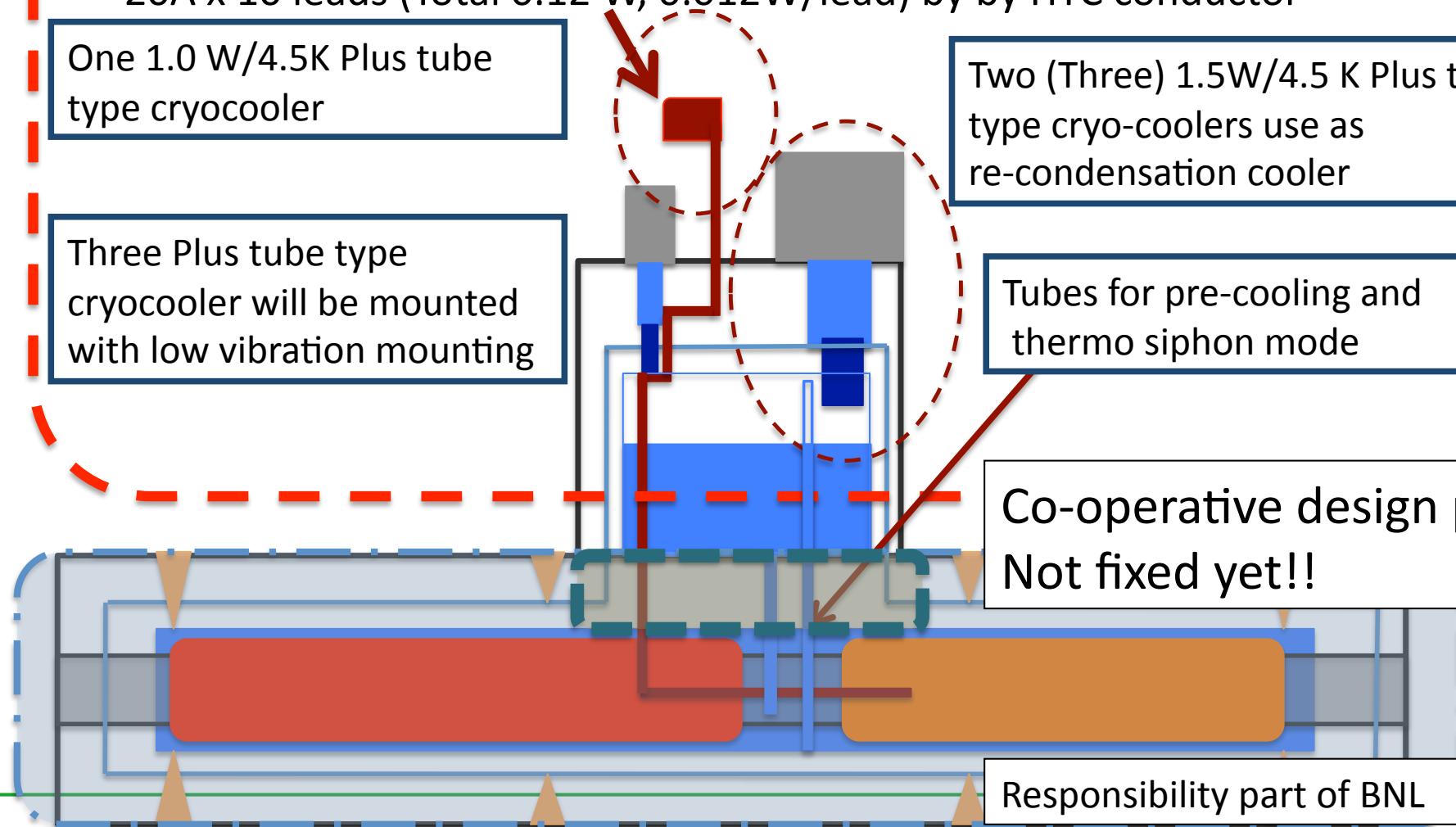
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Three Plus tube type cryocooler will be mounted with low vibration mounting

Tubes for pre-cooling and thermo siphon mode

Co-operative design part
Not fixed yet!!

Responsibility part of BNL





Have to Discussion with BNL

- We would like to confirm compatibility of design parameters.
 - Design Pressure
 - Operation Pressure
 - Piping design
 - Number of C. Lead
- We would like to discuss the interface part between the magnet cryostat and the connection box with BNL for the detailed design work.
- Who does take care of S. C. wires for bus-bar?
- Who does design S. C bus-bar in the cryostat?
- It needs to design pipe size of thermo siphon loop. When does bus bar design fix in the magnet cryostat?
KEK want to know BNL's bus bar design to fix ours.
- When can we discuss interface part to fix final design?



Appendix



Questions for BNL

- We would like to know following items;
 - Value of heat load of radiation shield in magnet cryostat in case of 40 K and 77 K.
 - Who dose make support material for magnet cryostat at ATF2?
 - When the operation current of the magnets are fixed?



SC solenoid for g-2/EDM experiment

- Solenoid with very high uniformity



Employ MRI technology

- 1 ppm MRI at 3T is commercially available
- could reach 0.1 ppm by modifying MRI technology

- Items to be studied
 - Precision field monitoring system
 - Source of error field
 - Seismic ground vibration
 - > Low vibration cryogenic system

