Cryogenic System for Superconducting Final Focus Magnets* at ATF-2

N. KIMURA, T. TOMARU, Y. AJIMA, T. KUME,
A. YAMAMOTO, K. TSUCHIYA and T. TAUCHI

*SCFFM: Superconducting Final Focus Magnets

OUTLINE

- Proposed cooling scheme for SCFFM for 4K Connection Box
- ✓ Vibration control
- ✓ Heat load estimation
- Set up plan for the cryostat in the ATF-2
- Proposed schedule for construction plan
- Summary

Infrastructures at ATF2

- Infrastructures at ATF2

  LHe supply — Very limited

  (supplied only by dewar, from Cryogenics Science Center)

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

  Cryogenics facility — None

  Space for Liquefier around ATF — ??

  GHe recovery line — Yes

We would like to propose our plan which can be operated under limited infrastructures at ATF2!! and can be consistent with BNL's magnet cooling design.

Proposed the cryogenics system at KEK

- Cooling scheme @ ATF2
  - "A re-condensation cooling type" with low vibration Cryo-coolers
  - Vibration Control -> Mixture of LCGT scheme & SCGR scheme

A R&D work of low vibration cryogenics system have just started in Cryogenics Science Center as a basic.

Cooling scheme for 4K connection box at ATF2

Heat loads by Current leads into 4K level
300A x 4 leads (0.6 W, 0.15W/lead) by HTC conductor
20A x 10 leads (Total 0.56 W, 0.056W/lead) by Low RRR Cu

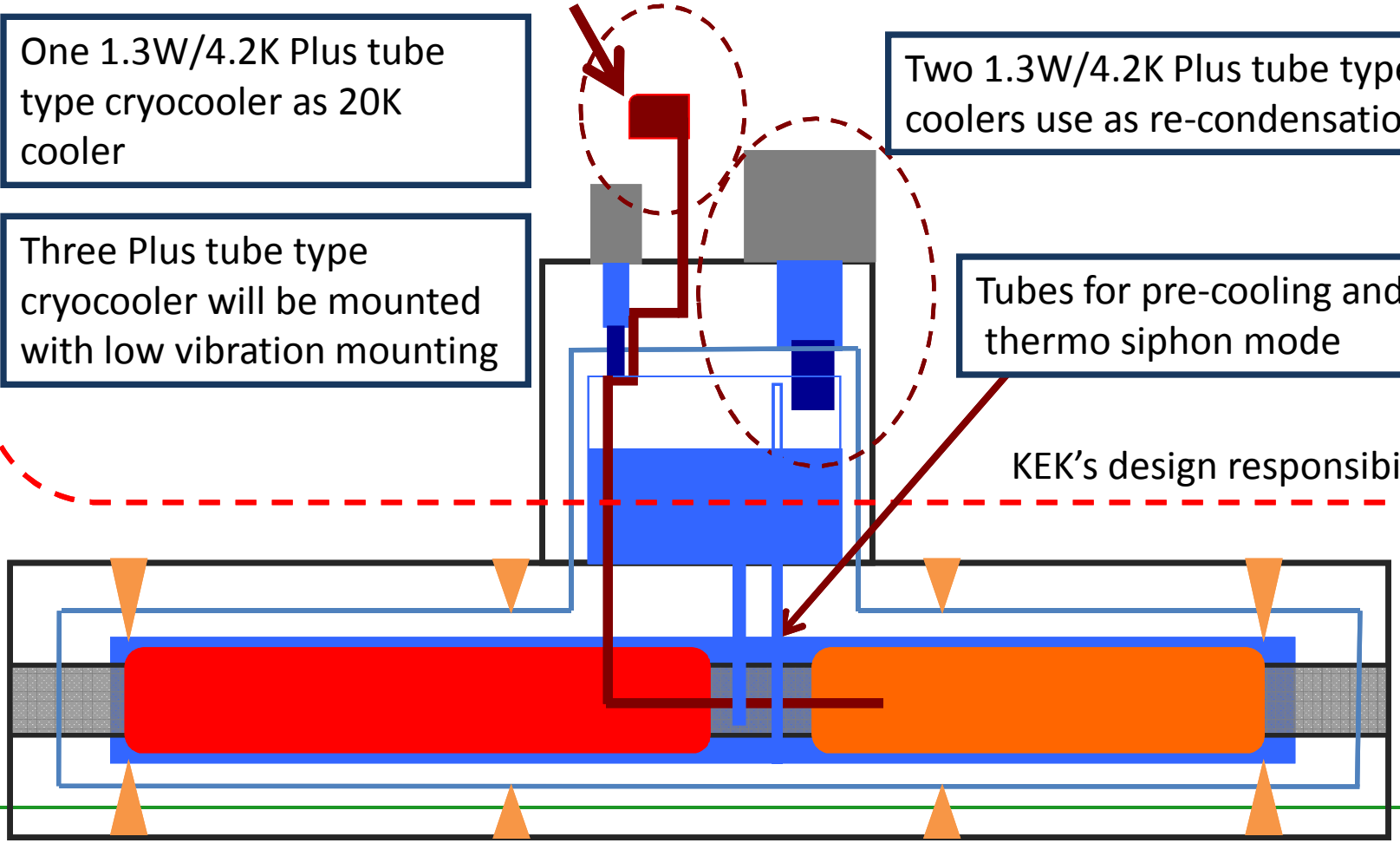
One 1.3W/4.2K Plus tube type cryocooler as 20K cooler

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

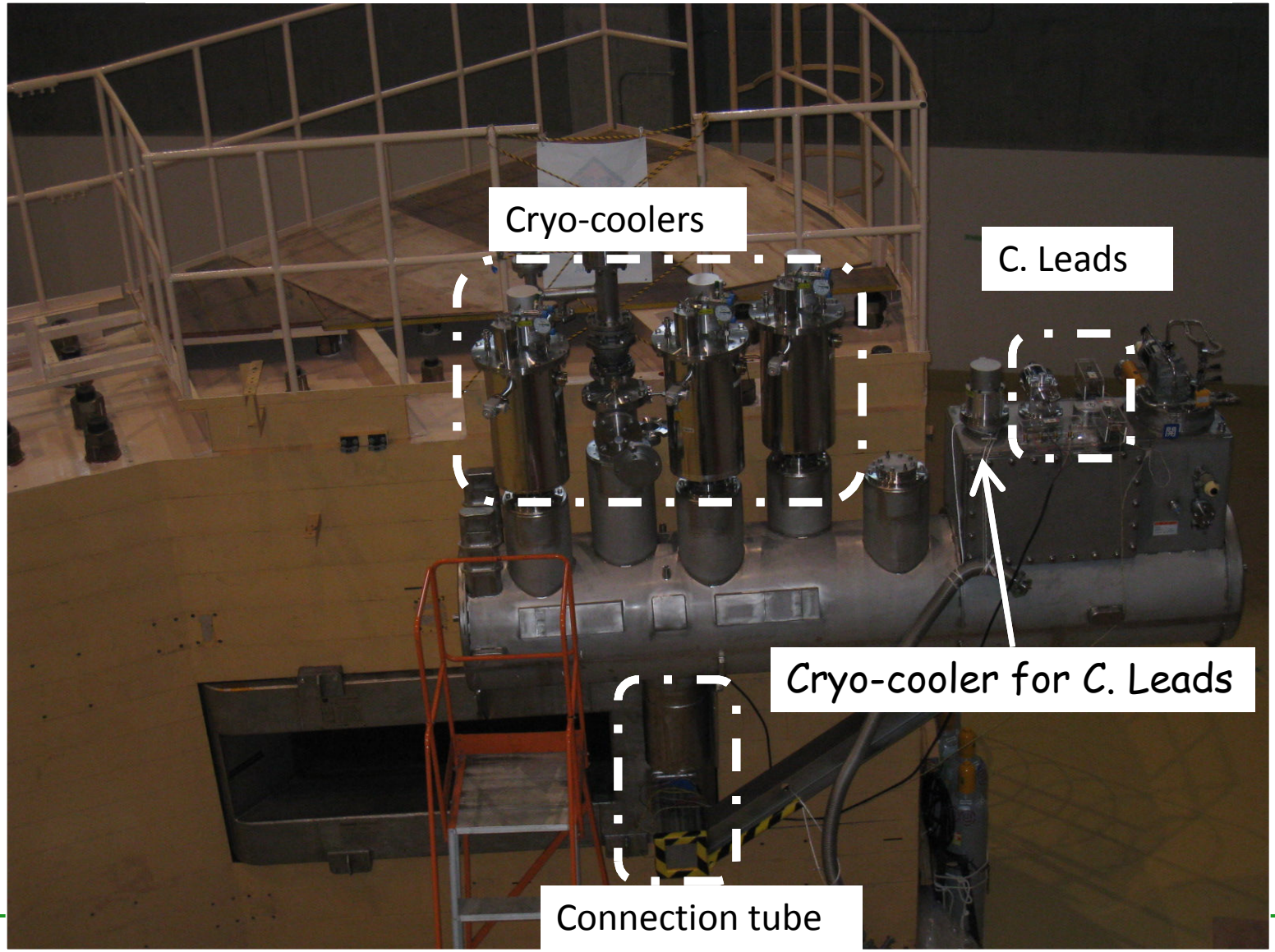
Two 1.3W/4.2K Plus tube type cryo-coolers use as re-condensation cooler

Tubes for pre-cooling and thermo siphon mode

KEK's design responsibility

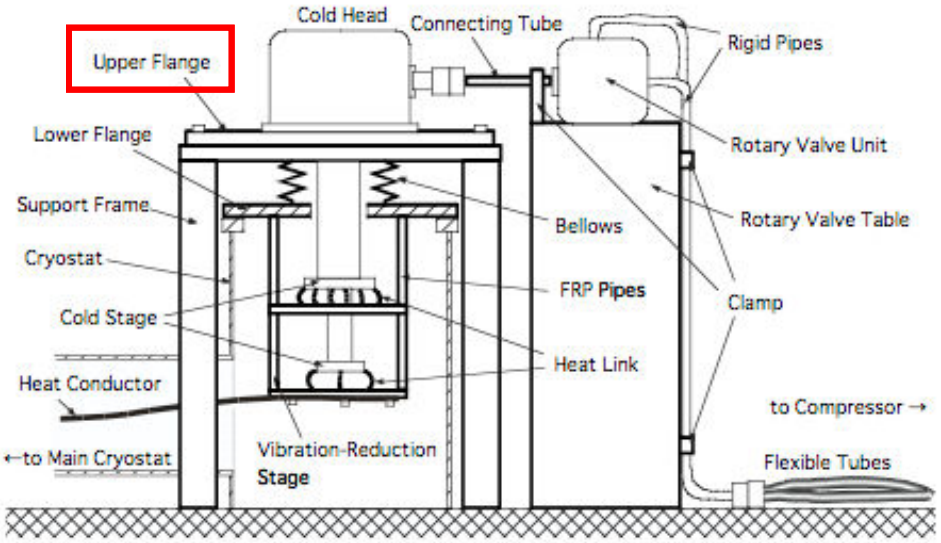


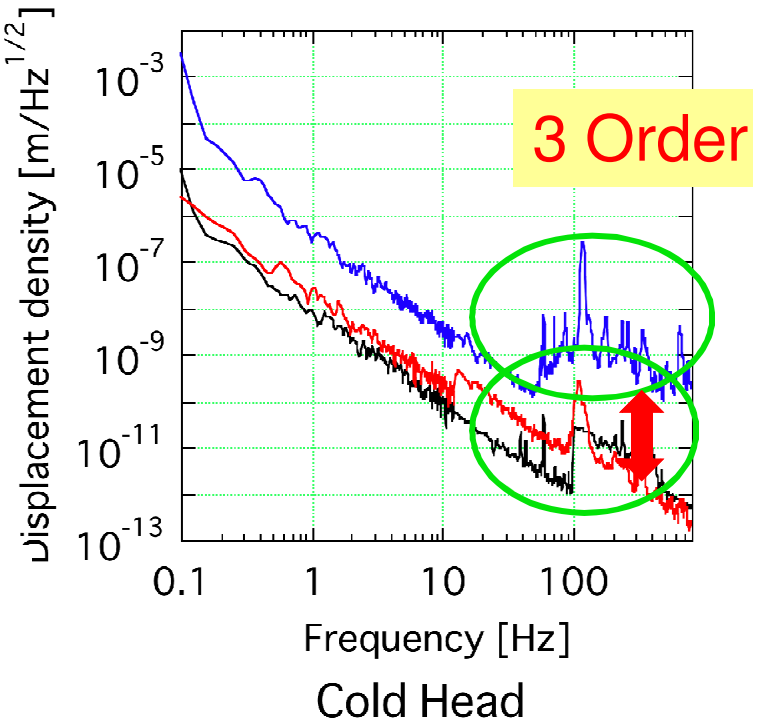
Example of Connection Box with Cryocooler and C. Leads at SKS



Example of Ultra-low Vibration Pulse tube cryo-cooler system for LCGT at KEK

This system was originally developed for gravitational wave detector.





Vibration level of the system was **almost the same as that in Kamiokamine.**

Vibration level is ~1nm@1Hz (Bin width~0.01)

When the cryo-cooler uses as a re-condensation cooler, do not need vibration reduction stage in above figure.

Point is separated Rotary valve from cold-head.

By courtesy of Dr. T. Tomaru (KEK)

This system was presented at ICC13.

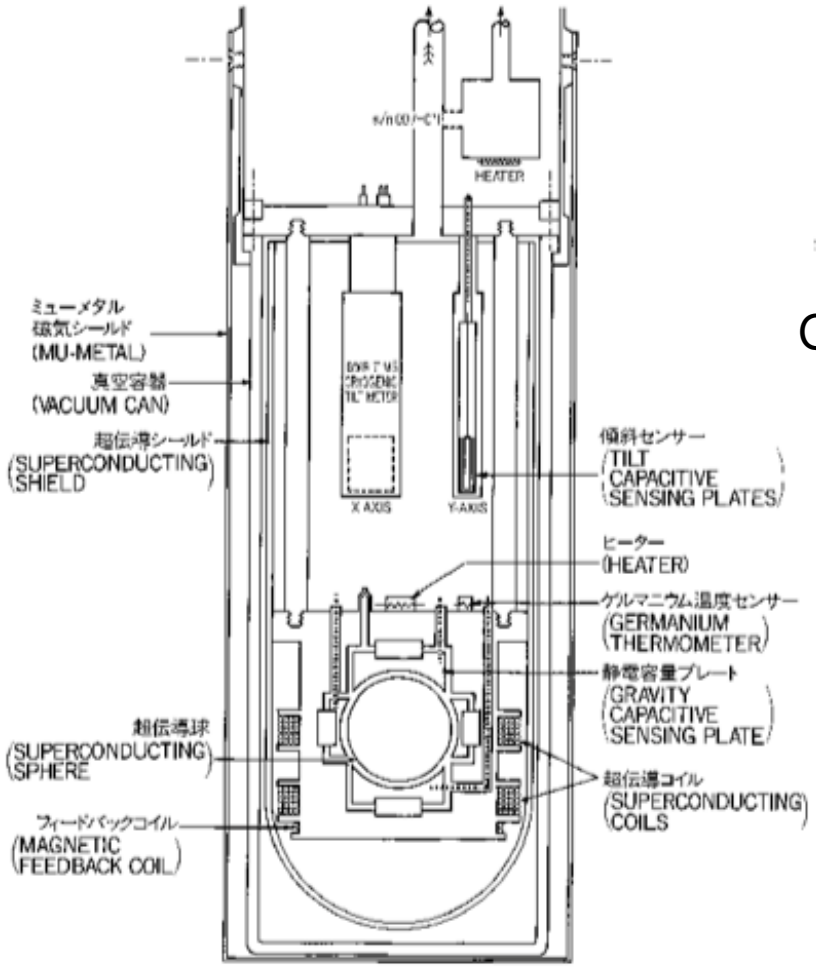
Example of Superconducting Gravimeter

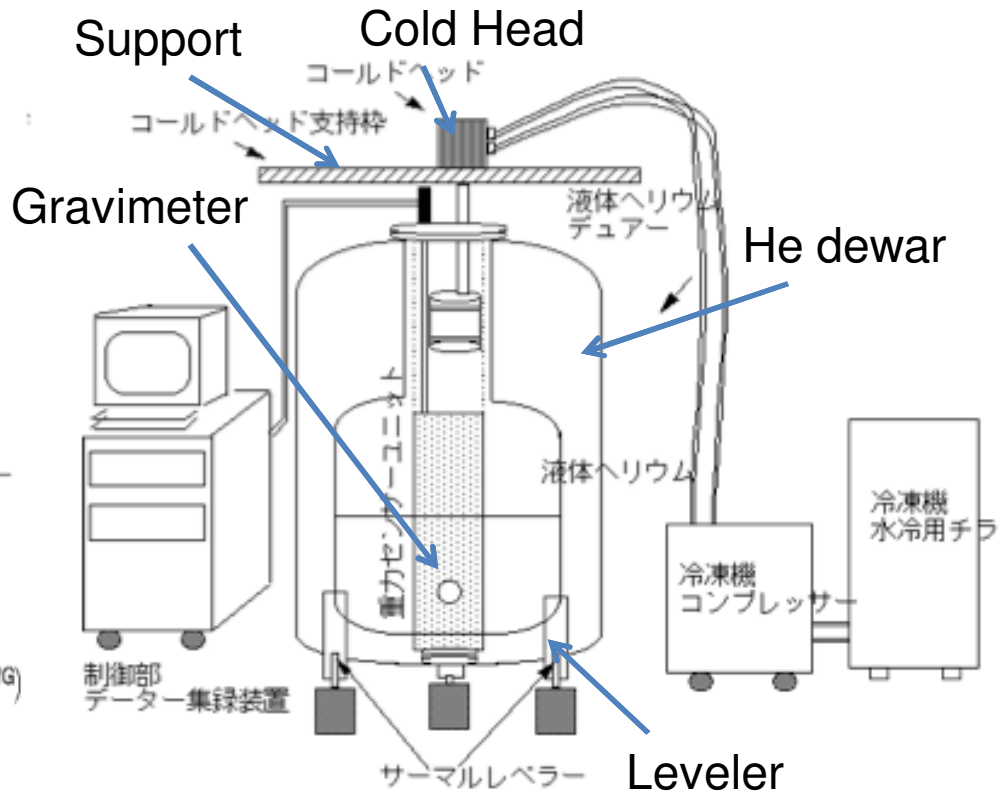
Restrain boiling type by using cooler

(Baby sitter, re-condensation, thermo siphon)

Sensitivity

$$\frac{\Delta g}{g} \approx 10^{-12}$$





Proposed the cryogenics system at KEK

- Cooling scheme @ ATF2
  - "A re-condensation cooling type" with low vibration Cryo-coolers
  - Vibration Control -> Mixture of LCGT scheme & SCGR scheme

A R&D work of low vibration cryogenics system have just started in Cryogenics Science Center as a basic reaserch.

Estimated heat loads at 4K connection box

	Element	Heat Loads (W) 300K->77K	77K->20K	20K(77K)->4.2K
Puls Tube No.1	Current Leads	50.0	4.70	1.04
Puls Tube No.2 &3	Radiation	3.2	0.00	0.11
	GFRP Support	5.0	0.00	0.10
	Electrical leads	5.0	0.00	0.10
		13.2	0.00	1.35
Puls Tube No.1		57.6	15.0	
Puls Tube No2+No.3		72.0		2.4
		58.8		1.1

One 1.3W/4.2K Plus tube type cryocooler as 20K cooler

Two 1.3W/4.2K Plus tube type cryo-coolers use for re-condensation coolers

~1.5 W From magnets

Enough cooling power for radiation shield

Cooling performance for magnet cryostat

OUTLINE

- Proposed cooling scheme for SCFFM for 4K Connection Box
- ✓ Vibration control
- ✓ Heat load estimation
- Set up plan for the cryostat in the ATF-2
- Proposed schedule for construction plan
- Summary

Proposed set up plan in the tunnel at ATF2

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

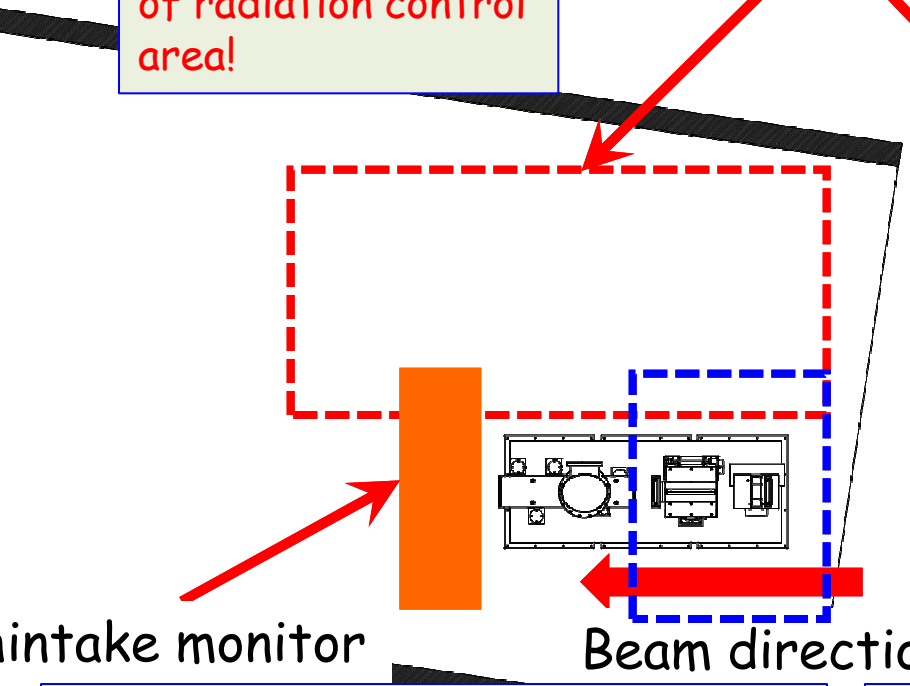
For working and walking space

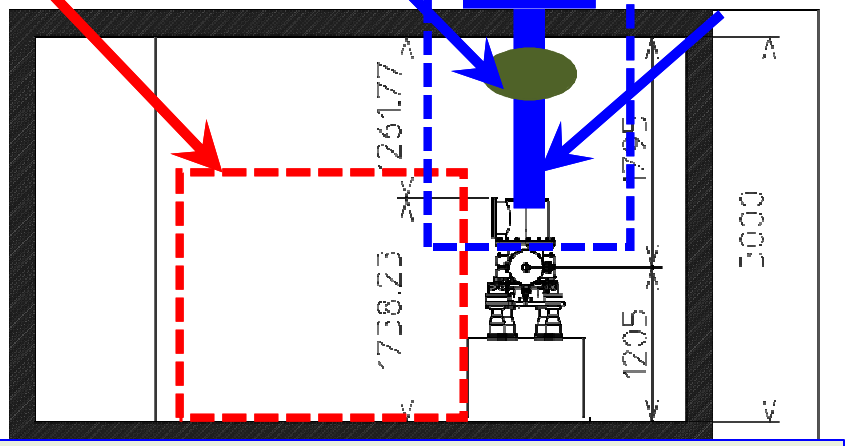
This is good solution at ATF2!

4K connection box

Bellows part

connecti





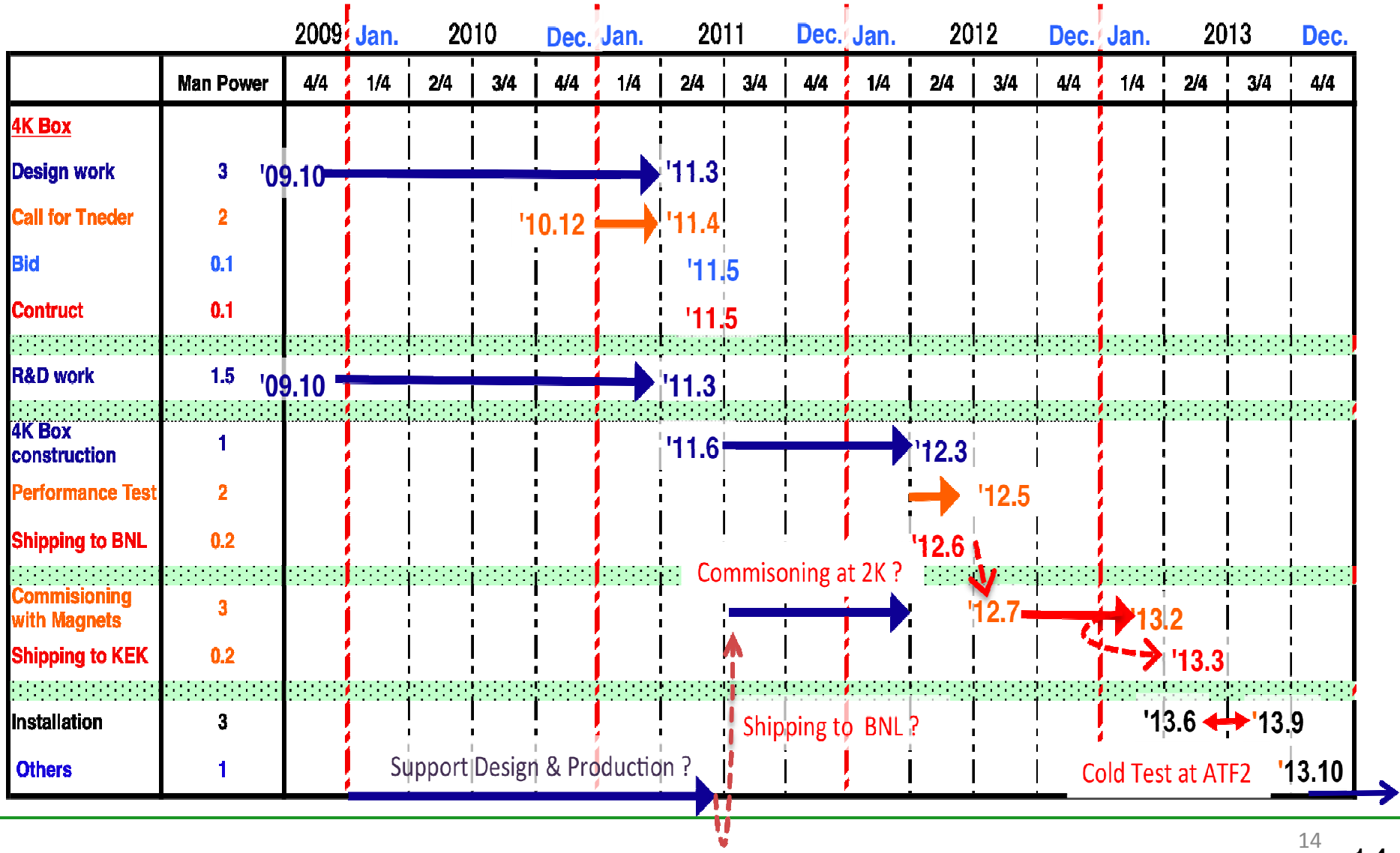
Advantage Two.
It easy to supply Lhe for pre-cooling and recovery after quench.

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

OUTLINE

- Proposed cooling scheme for SCFFM for 4K Connection Box
- ✓ Vibration control
- ✓ Heat load estimation
- Set up plan for the cryostat in the ATF-2
- Proposed schedule for construction plan
- Summary

Proposed Schedule (Construction & Installation)



OUTLINE

- Proposed cooling scheme for SCFFM for 4K Connection Box
- ✓ Vibration control
- ✓ Heat load estimation
- Set up plan for the cryostat in the ATF-2
- Proposed schedule for construction plan
- Summary

Summary

- Re-condensation cooling system @ ATF2 are proposed by KEK.
- For reducing vibration level lower than 50 nm, we may contribute to the low vibration cryocooler system design to be adaptable to the BNL magnet design in cooperation to the design.
- R&D work for low vibration cryogenics have been accepted in Cryogenics Science Center as a basic research.
- Final goal for the ready to operation in ATF-2 is the end of October 2013.

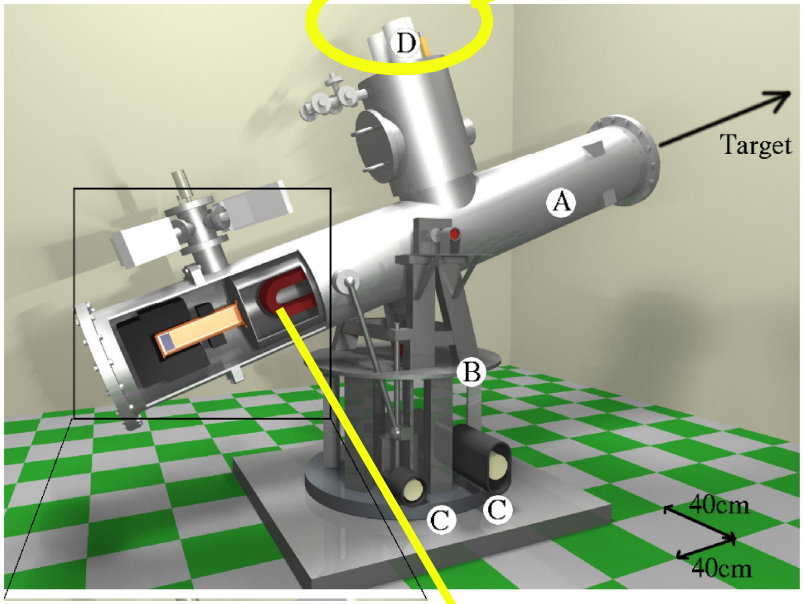
Open to Discussion

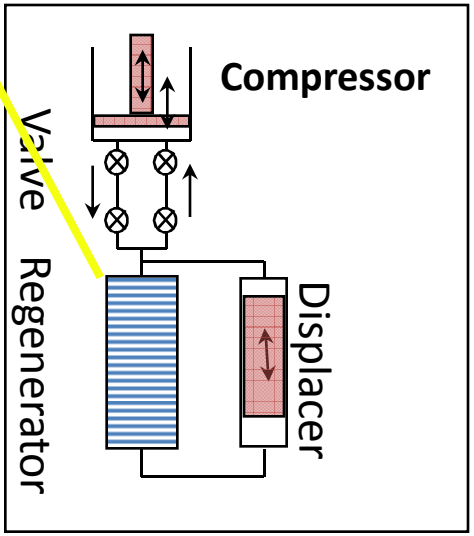
- R&D?
- Other part for Contributions?
- Support system?
- Vibration?
- Etc?

Appendix

Superconducting Magnet for Solar Axion Search @ ICEPP U-Tokyo

Cryo-cooler





Race Track Coils
(5 T x 2m)

- Dipole field of 10 T•m
- Cooled by using cryo-coolers (2 W at 4.2 K).