Cryogenic System of ILC IR

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KEK/IPNS/Cryo

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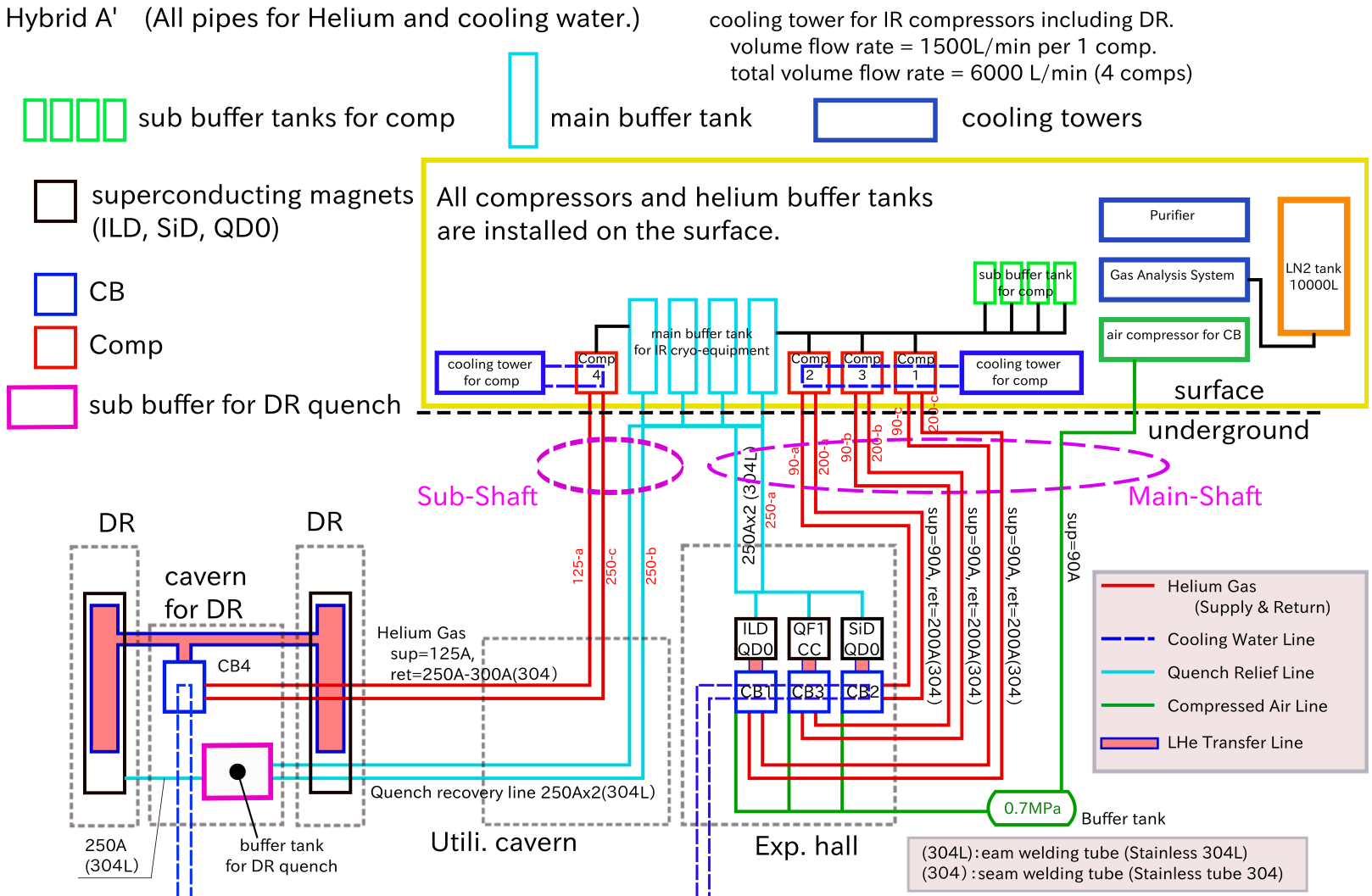
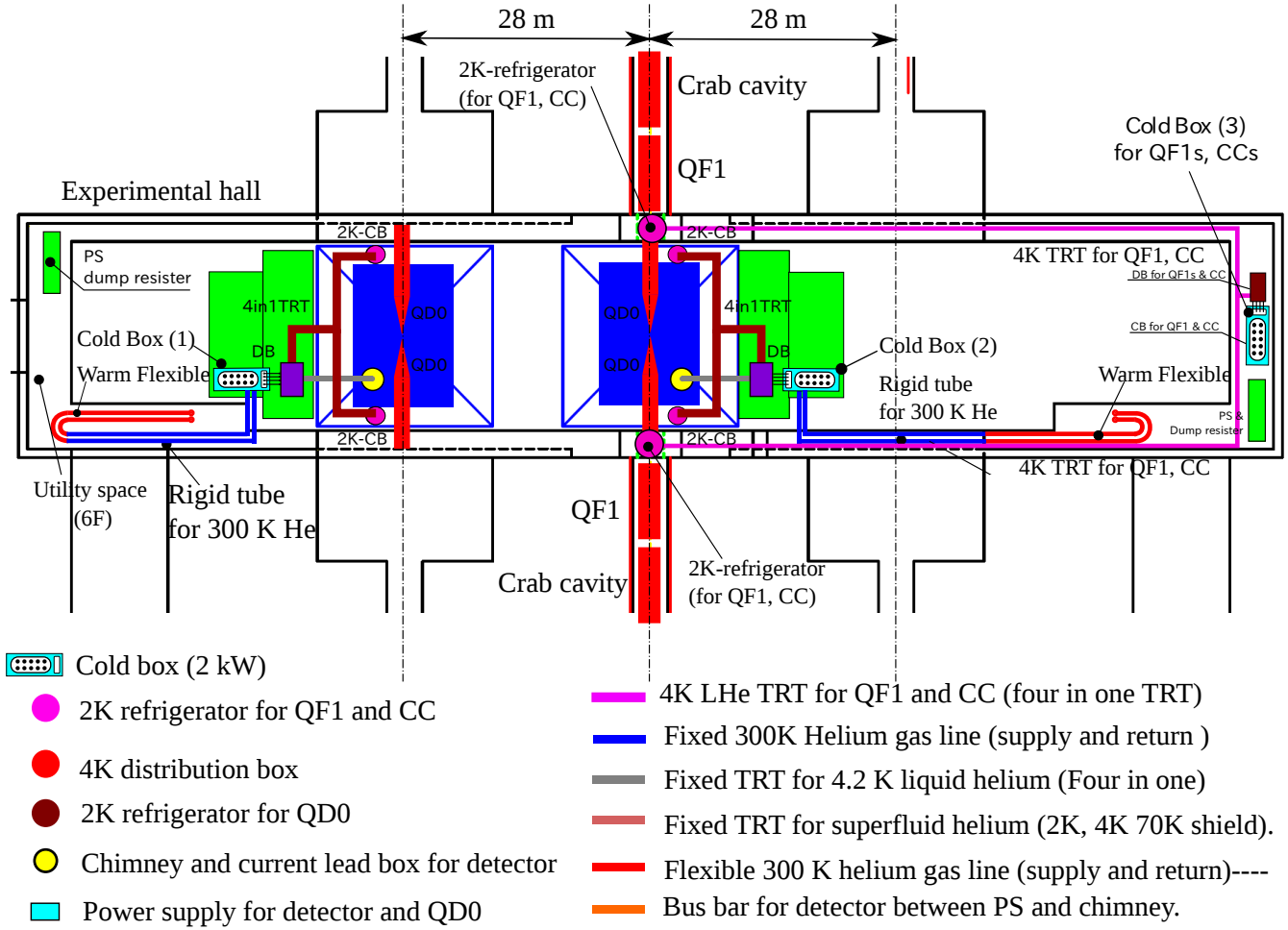
Cryo Configuration (ILD,SID,QD0,QF1,CC,DR)

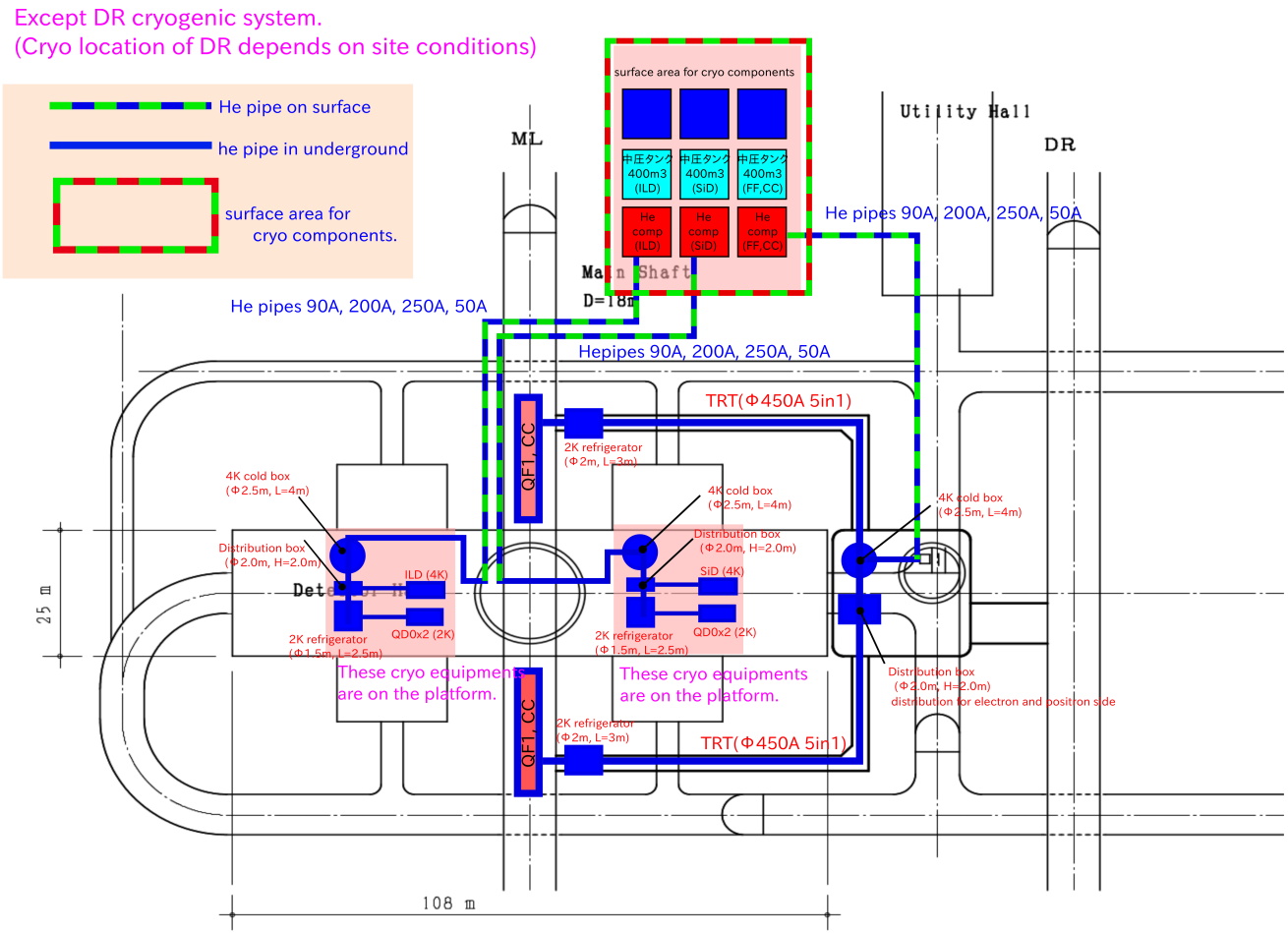


Layout example in DH (ILD,SiD,QD0,QF1,CC)



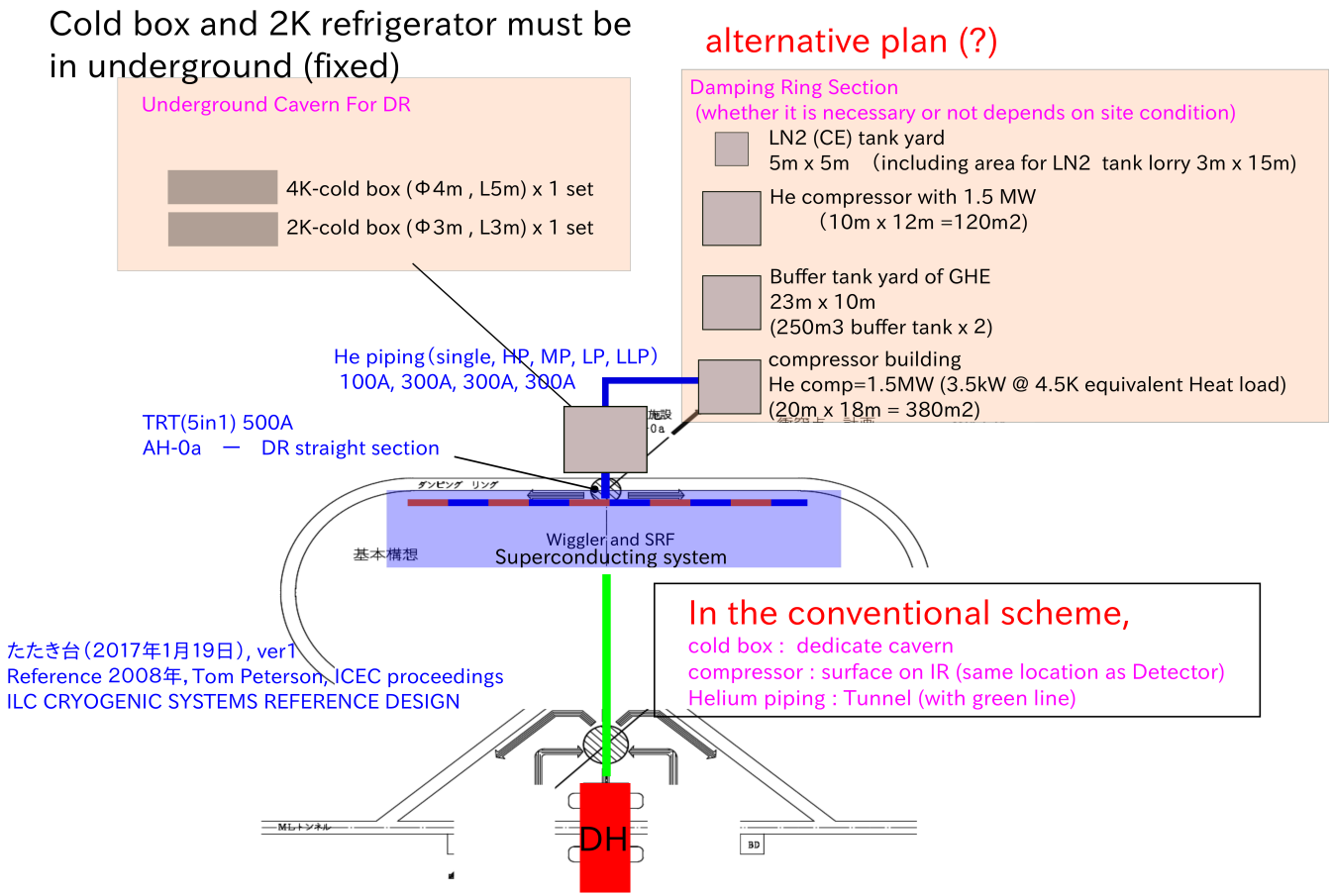
- 2K refrigerator for CC and QF1 should be located close to them.
- CC and QF1 are cooled by coolants with different thermo physical state. (saturated-HeII, QF1 and Pressurized-HeII).

Cryo config. topview (except DR)



- To prevent the complexity around packman, 2K refrigerator had better be installed at the dedicated cavern in the each accelerator side which is very close to CC and QF1 as shown in above figure.

Cryo config. topview (DR Cryogenics)



- Cold box is located in the underground. (same as ML cryo)
- There is a open to be argument about the location of compressor.
  - Case 1: compressor is located at the same location as IR cryo system.
  - Case 2: compressor is located at the dedicated DR surface area.

Helium Compressor

Helium compressor

- 4 compressors are installed on the surface (in a compressor house).
- Mechanical noise have to be reduced.
  - Bare intensity of mechanical noise is around 100 dB in the case of MYCOM.
  - Noise intensity can be reduced to 70 dB by employing soundproof house (example of J-PARC neutrino cryo-system).
- Required amount of cooling water (after cooler and oil cooler) for 4 compressors are described below.

COMP. No.	Cryo equipment	Shaft Power	Cooling Water
Comp1	ILD+QD0s	~ 500 kW	~ 1500 L/min
Comp2	SiD+QD0s	~ 500 kW	~ 1500 L/min
Comp3	QF1s & CCs	~ 300 kW	~ 860 L/min
Comp4	DR(RFs & Wigglers)	~ 1.5 MW	~ 4500 L/min

Necessity of liquid nitrogen tank

♠ **In the underground**

- Liquid nitrogen should not be employed from the view point of safety.

♠ **On the surface**

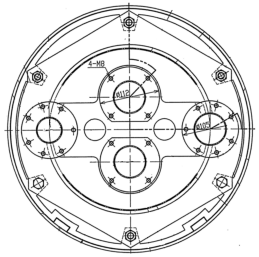
- Liquid nitrogen should be employed following two operation.
  1. cryo-purifier
     ⇒ Gas analyzer and cryo-purifier are also installed in the compressor house.
  2. charcoal and MS baking process [a] during maintenance season.
     ⇒ LN2 Evaporator also should be prepared in this case.

[a] Charcoal and MS (each vessel volume is $\sim$ OD=1.5m, height=3.5m) should be employed for oil separator.

Liquid nitrogen tank with the size of $\sim$ 10000 L had better be employed close to the comp. house.

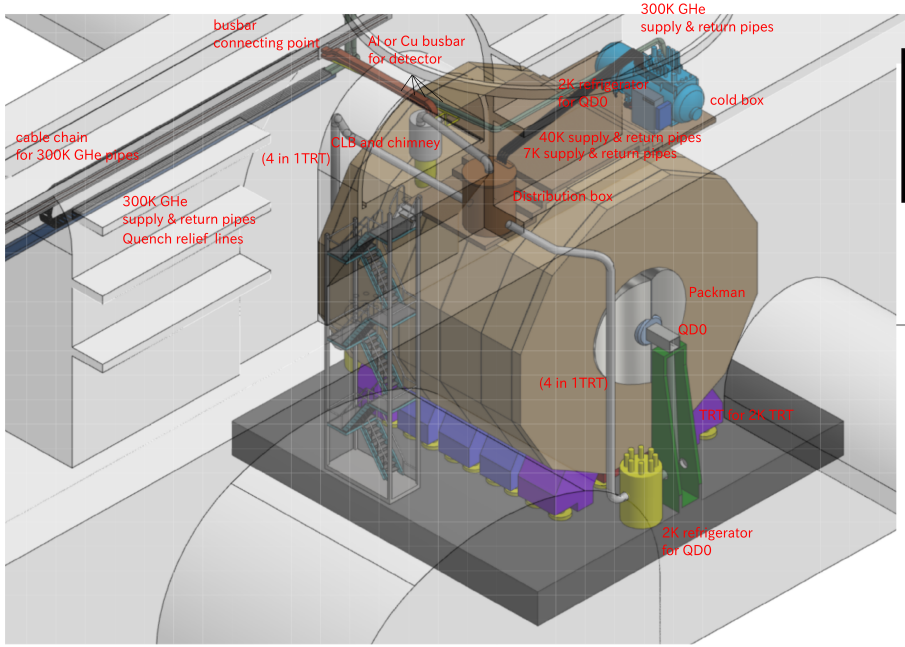
Layout example for ILD

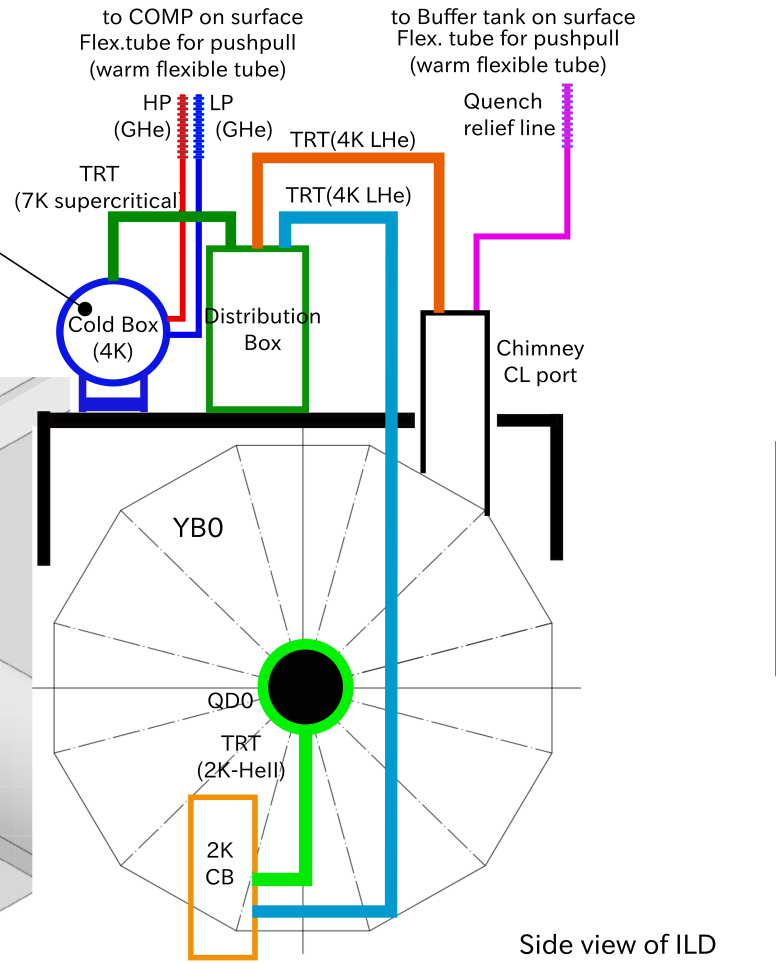
Cross section of TRT
4in1 TRT



2K refrigerator
(BNL)

4K cold box

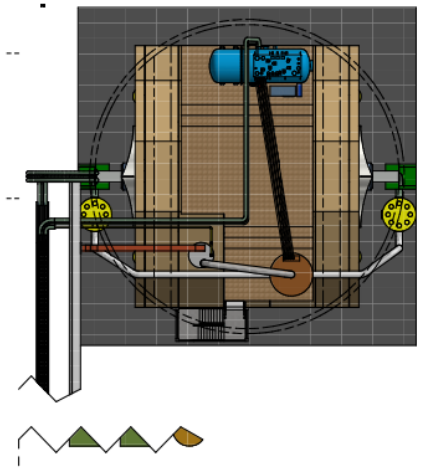


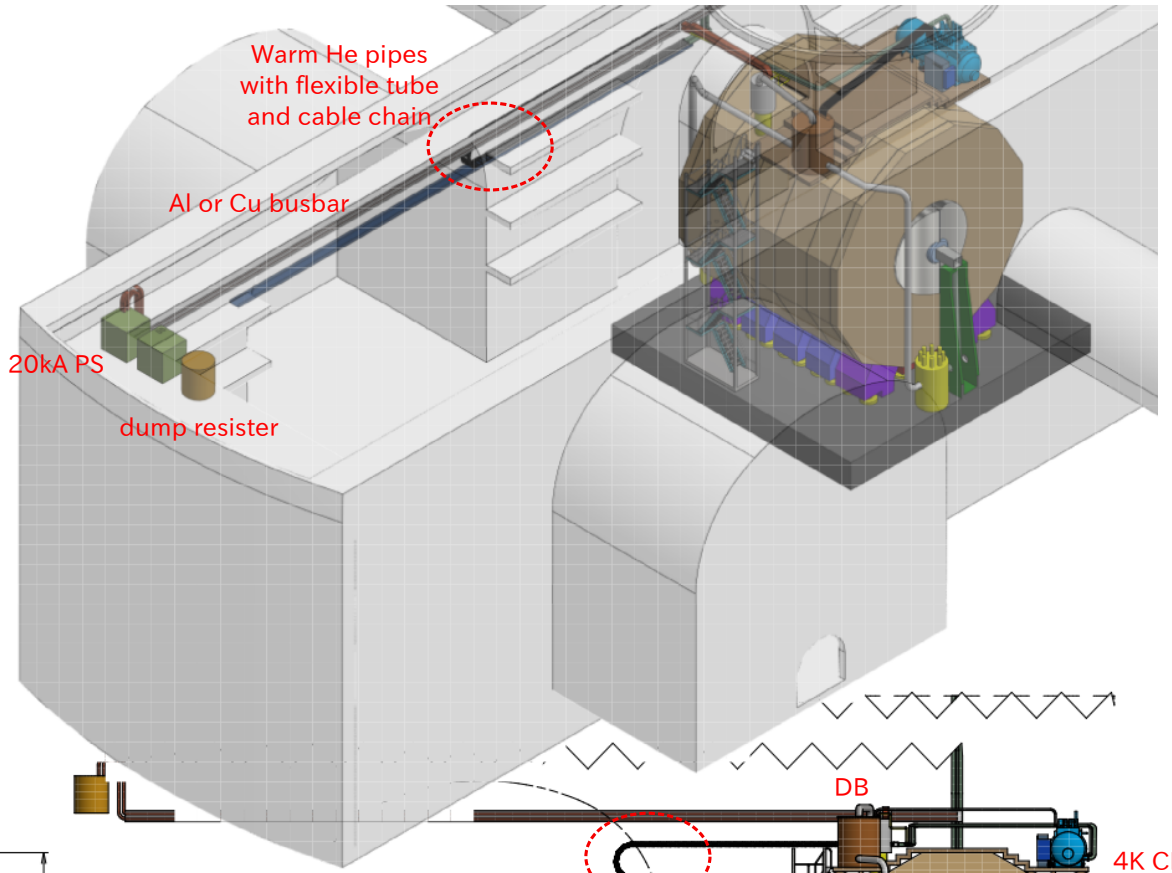


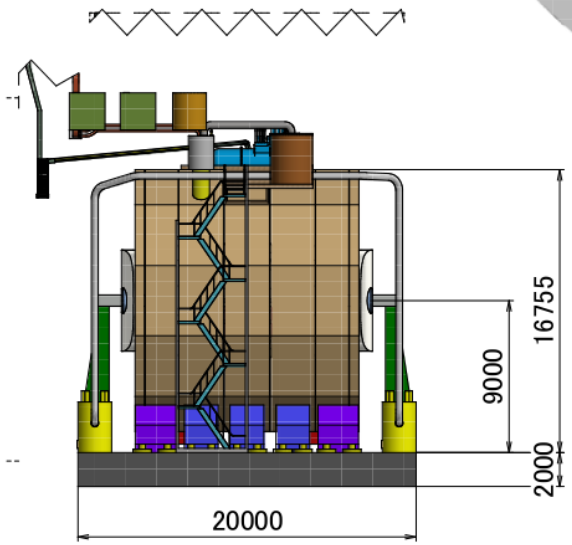
Side view of ILD

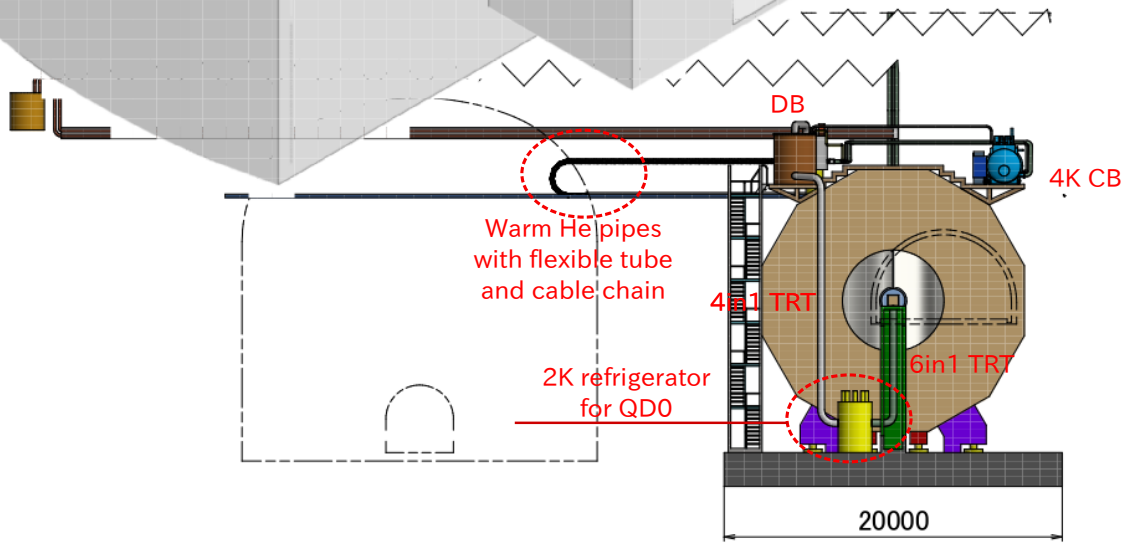
Most of the cryo-equipment should be located on the YB0 platform in order that ILD detector should be divided into 5 sectors as easy as possible.

layout example for ILD(2)





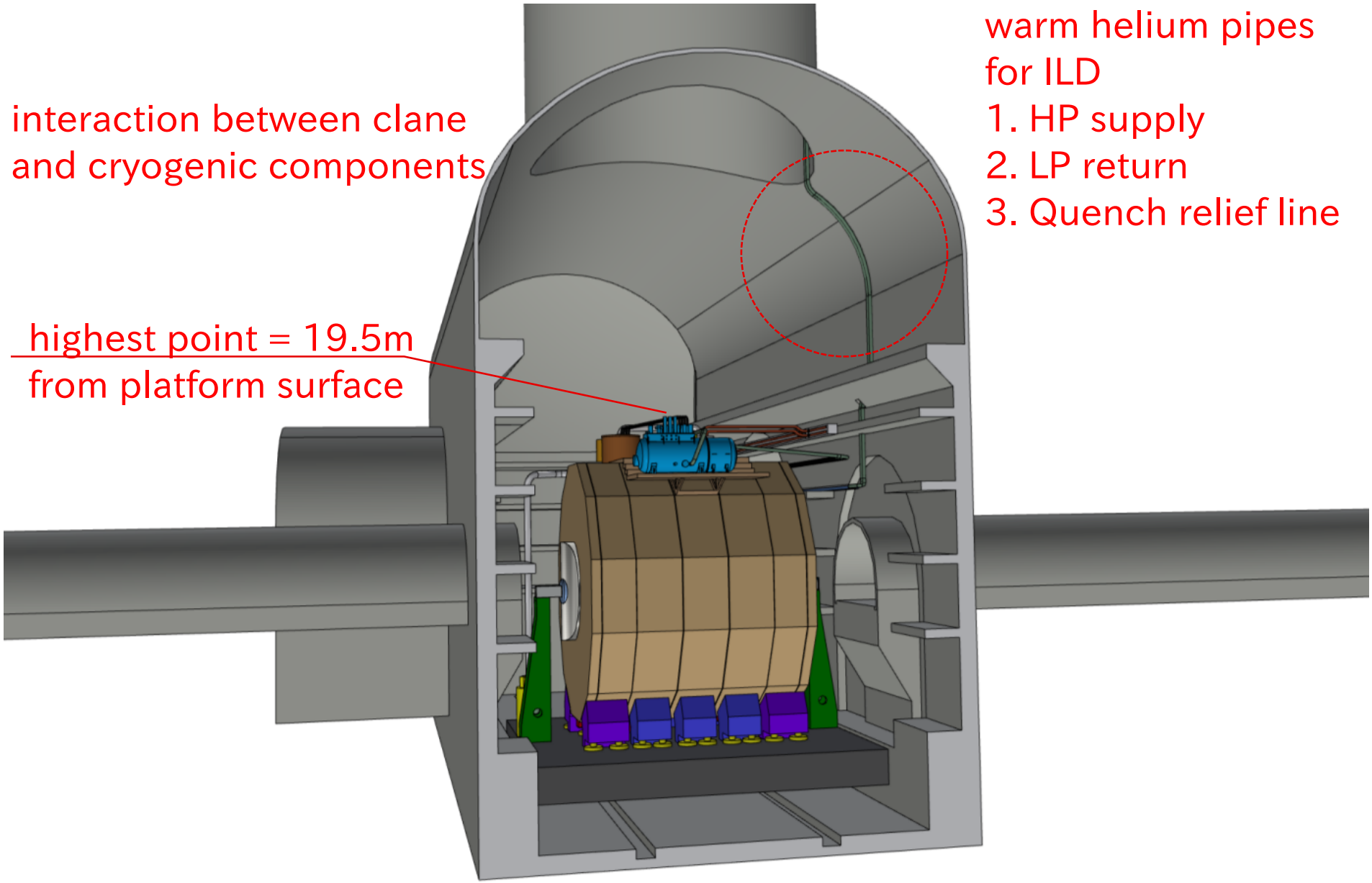




layout example for ILD(2)

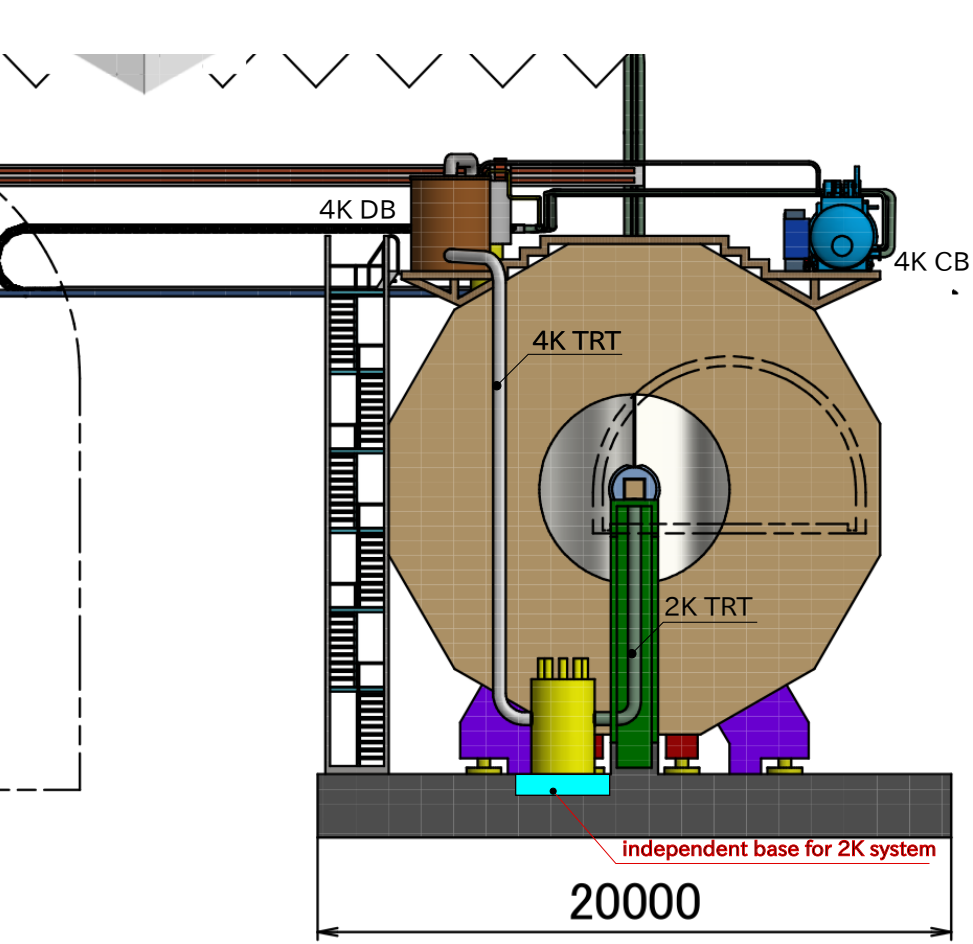
interaction between clane
and cryogenic components

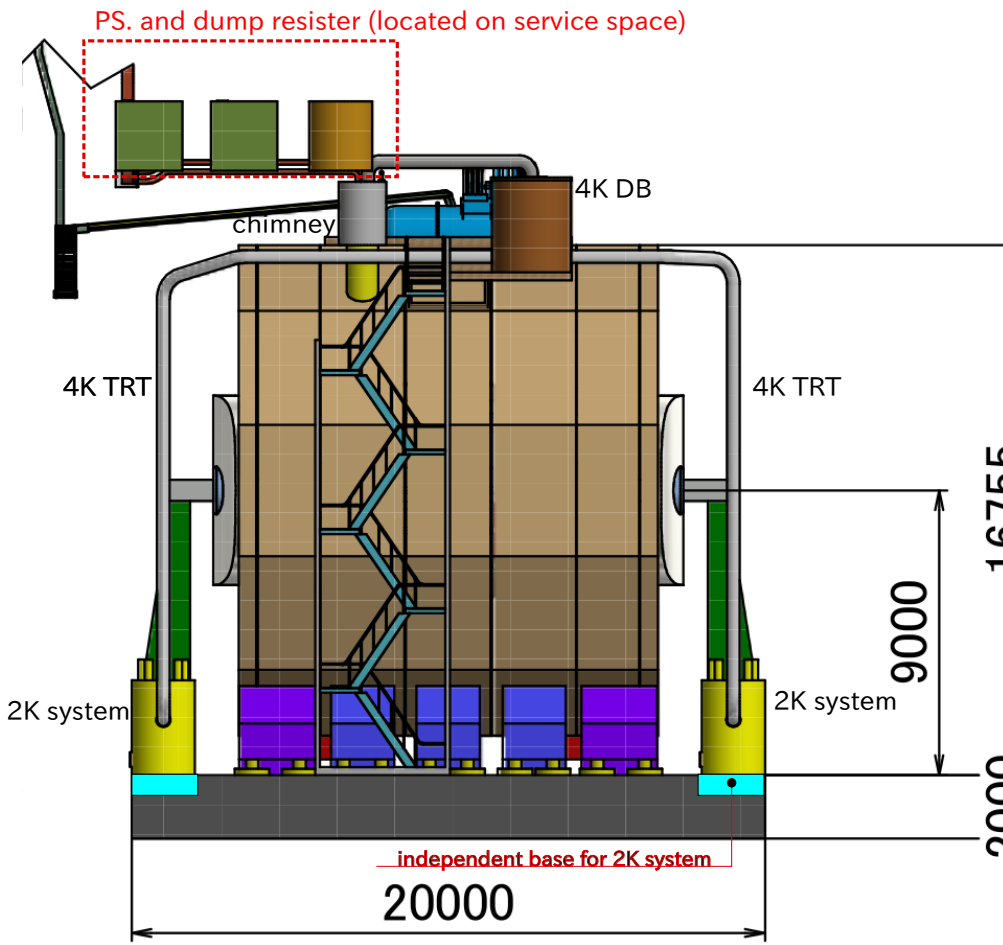
highest point = 19.5m
from platform surface



warm helium pipes
for ILD
1. HP supply
2. LP return
3. Quench relief line

Location of 2K Refrigeration System





- Vibration of vacuum pump can be propagated through 6in1 TRT.
- In order to reduce this effect, location of vacuum pump and interfacial structure between 2K-system and 6in1 TRT should be deeply considered.

During push-pull and maintenance

During pushpull

- without breaking up all kinds of tubes.
- Bus-bar (wired type) had better be disconnected.
  $\Rightarrow$ No excitation during push-pull

During ILD maintenance

- End cap (YE+,YE-) can be moved between end cap and support post.
  - CB, 2K-refrigerator and all kinds of tubes don't have to be decomposed and removed.
- All iron yokes are divided into 5 sectors.
  - TRT,CB, 2K refrigerator have to be decomposed.

Simulation on Helium spill into DH

motivation and purpose

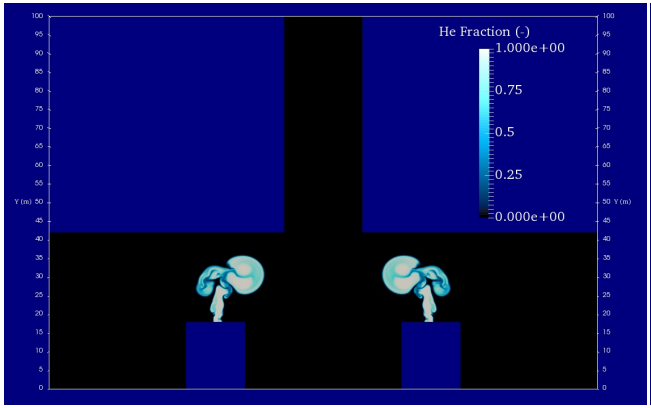
- Detector cryogenics has LHe storage dewar.
- CMS has 5000L storage dewar to supply LHe during power failure for several hours.
- Ramp down should be done for several hours therefore to supply LHe into magnet, LHe storage dewar with such volume is needed.
- There are 10000L=5000L+5000L for ILD and SiD.
- We had better clarify helium gas behaviour during helium gas spill due to some kind of incident.

method

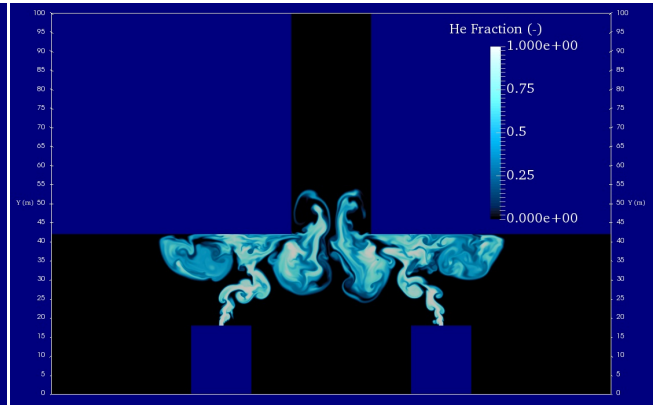
- LES (Large Eddy Simulation) for two fluid mixture.
- spill time : 15 sec
- Discharge volume : LHe with 10000L

Simulation Results

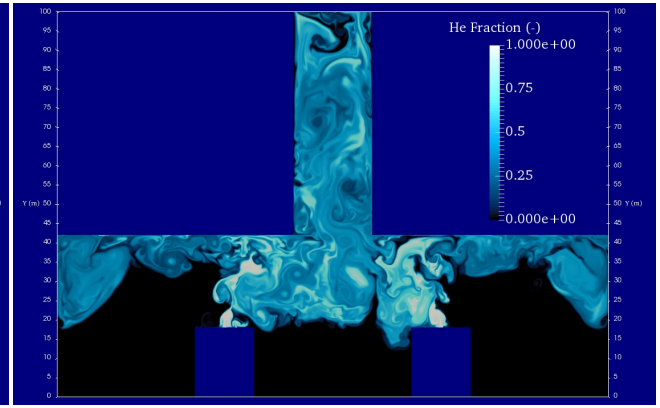
- simulation results (safety factor, $S = 3$)



2 sec



6 sec



15 sec

- According to the simulation with $S = 3$, Most of the helium gas are going to the upper part of DH due to buoyancy (He-Air density difference). So Floor level will not be oxygen deficiency.
- But service area (such as 3rd, 4th floor), we had better evacuate immediately down to the lower side or floor level.

Summary

- Cryogenic configuration for IR has not widely changed so far.
- But cryo system for CC and QF1 and DR has to be reconsidered by considering utility cavern specification.
- There is a open to be argument about the configuration of DR cryo. To determine it, we have to discuss with cryo, civil, DR magnet group for the convenience of dedicated surface area of DR.
- Near future, we will measure the compressor vibration characteristics. After getting the information of vibration characteristics, we will reconsider and rearrange the cryo-system according to the need.
- Helium spill into DH are roughly estimated by performing LES with some additional model.
- Concerning other area such as MT, helium convective diffusive behaviour are also simulated with same scheme.
- To confirm the validity of these kinds simulation, we will compare simulation with a few experimental results with same conditions. (DESY and CERN).