Cryogenic System of Hybrid A' for ILC-IR

Takahiro Okamura

KEK/IPNS/Cryo

2014/7/30

Overview of cryogenic system for IR

IR cryogenics

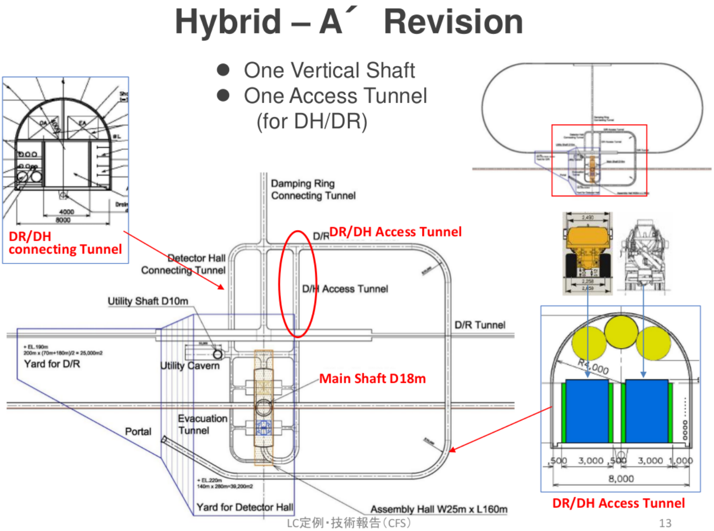
Following superconducting magnet should be cooled down by IR cryo equipment (CB. comp. cooling tower).

- ILD, SiD, QD0s, CCs and QF1s are installed in or near the exp. hall.
- Superconducting magnets for DR are also cooled by IR cryogenic equipment.

Brief strategy

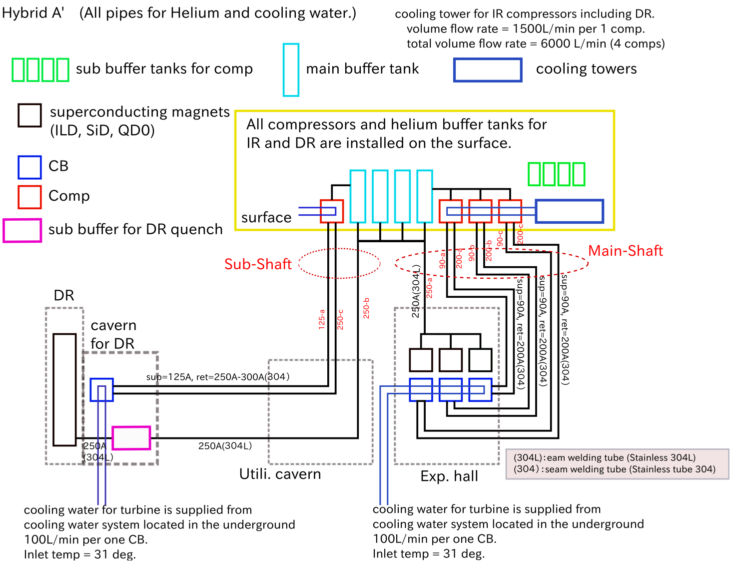
- All compressors are installed on the surface.
- Cooling towers for comps are also installed on the surface.
- All CBs are installed in the underground.
- Helium tubes for ILD, SiD, QD0s, QF1s and CCs are laid through main shaft.
- Helium tubes for DR are laid through sub-shaft.
- Strategy of helium buffer tank for IR ?? (gas storage or liquid storage??)

Layout of Hybrid A’



Schematic diagram for IR cryogenics (1)

Layout of IR crygenics including DR is shown below.

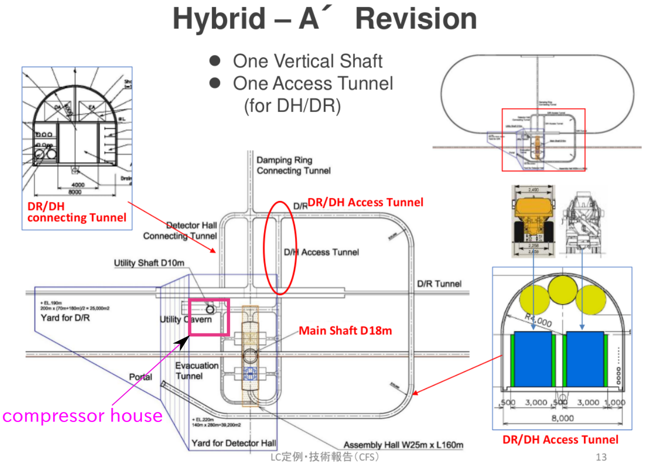


Schematic diagram for IR cryogenics (2)

- 4 compressors are installed on the surface (in a compressor house).
- Cooling tower system for compressor is also located adjacent to the comp. house.
- Helium tubes for all cryogenic system installed in or near the exp. hall should be laid through the vertical shaft.
- Helium tubes for DR cryogenic system should be laid through the utility sub-shaft.
- 3 CBs for ILD, SiD, QD0, QF1, CCs are installed in the exp. hall.
- 1 CB for DR is installed near the DR superconducting magnet section.
- Sub buffer tank for DR magnet quench had better be prepared near the DR to reduce the pressure shock during magnet quench.
- Sub buffer tank for detectors quench need not be prepared in the underground because the length of vertical shaft is at most $100 \sim 200$ m. Helium buffer tank for detector quench should be prepared on the surface.
- Cooling water for expansion turbines installed in the CBs and for other utilities installed in the underground are supplied from cooling water system for the underground.

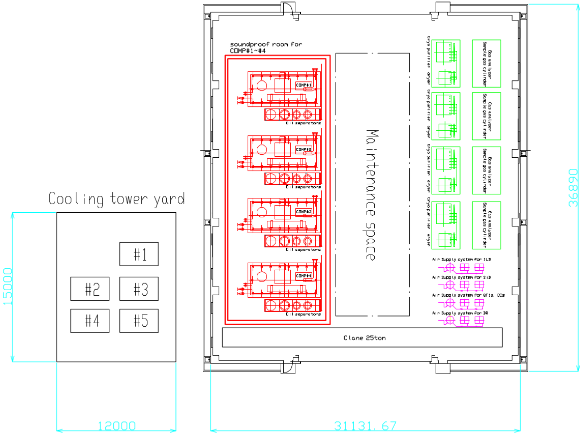
Brief layout on the surface

Layout of IR crygenics including DR is shown below.



Compressor house should be located near the utility cavern (sub-shaft).

Yard size example on the surface



Compressor: main specification

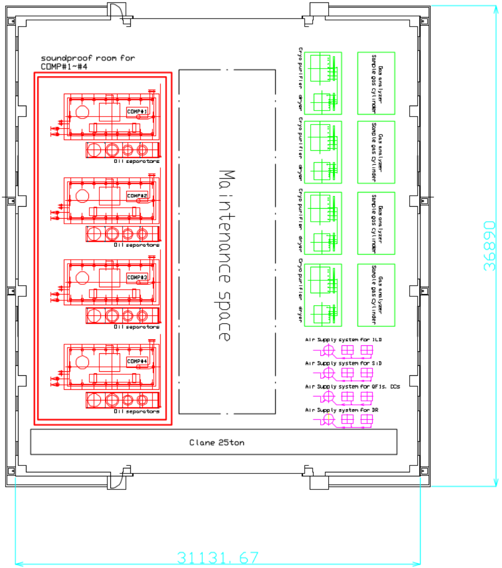
COMP #1 : for ILD+QDOs (500 kW)
COMP #2 : for SiD+QDOs (500 kW)
COMP #3 : for QF1s, CCs (300 kW)
COMP #4 : for DR (600 kW?)

Total Cooling water for each compressor

COMP #1 : 1700 L/min (cooling tower #1
COMP #2 : 1700 L/min (cooling tower #2
COMP #3 : 1000 L/min (cooling tower #3
COMP #4 : 2000 L/min (cooling tower #4
Cooling tower #5 is for other equipmen

- Cooling tower yard had better be located near the compressor house.
- Liquid nitrogen tank of around ∼ 5000 L had better be employed for cryogenic purifier and compressor maintenance.

Compressor house (layout example)



Compressor house

- House size is L=37m, W=32m, H=10m $\sim$ 15m.
- House has 25 ton crane for installation and maintenance.
- In order to reduce noise of compressor ~ 100 dB, soundproof room should be employed in the house.
  - Noise sound can be reduced from ~ 100 dB to ~ 70 dB. (according to Maekawa co. Ltd.)
- 4 comps are installed in the house.
- Air supply systems are also installed in the house.
- Gas analyzer and cryo purifiers are also installed in the house. $\rightarrow$ Liquid nitrogen tank with the size of $\sim$ 5000 L had better be employed near the comp. house.
- liquid nitrogen tank should be employed near the compressor house. Charcoal for oil separator should be reproduced by warmed nitrogen gas for around one week during maintenance season. Therefore we had better prepare liquid nitrogen tank and evaporator (heat exchanger).

Discussion Item-(1)

- Installation location of CBs for detectors
  - on the platform ?
  - on the utility space in the exp. hall ?
  - on the surface ?
- Treatment of 2K refrigerator for QD0 cooling.
  - Option A) Should 2K refrigerator be installed in the 4K CB ?
  - Option B) Should 2K refrigerators be prepared near the both side of QD0 independently ?.
- Helium gas storage strategy ?
  - Gas and liquid storage method seems to be fine.
    - Gas storage tank is mainly for magnet quench and for compressor buffer[a]
    - Almost all helium inventory is stored in the liquid storage tank.
  - Liquid storage scheme is fine from the view point of size and space. In this case co-generator has to be employed.

[a] Two kinds of gas storage tank should be prepared. One for quench recovery, the other for compressor buffer tank.

Discussion Item-(2)

- Safety system
  - Safety scheme during magnet quench.
  - Safety scheme during loss of vacuum accident (LOVA).
  - etc.
- Necessity of hermetic structure for IR
  - In order to prevent radioactive gas exhaustion into the surrounding environment.
  - whether the dual structure of all building is required or not ?