Present Status of ML and IR Cryogenics

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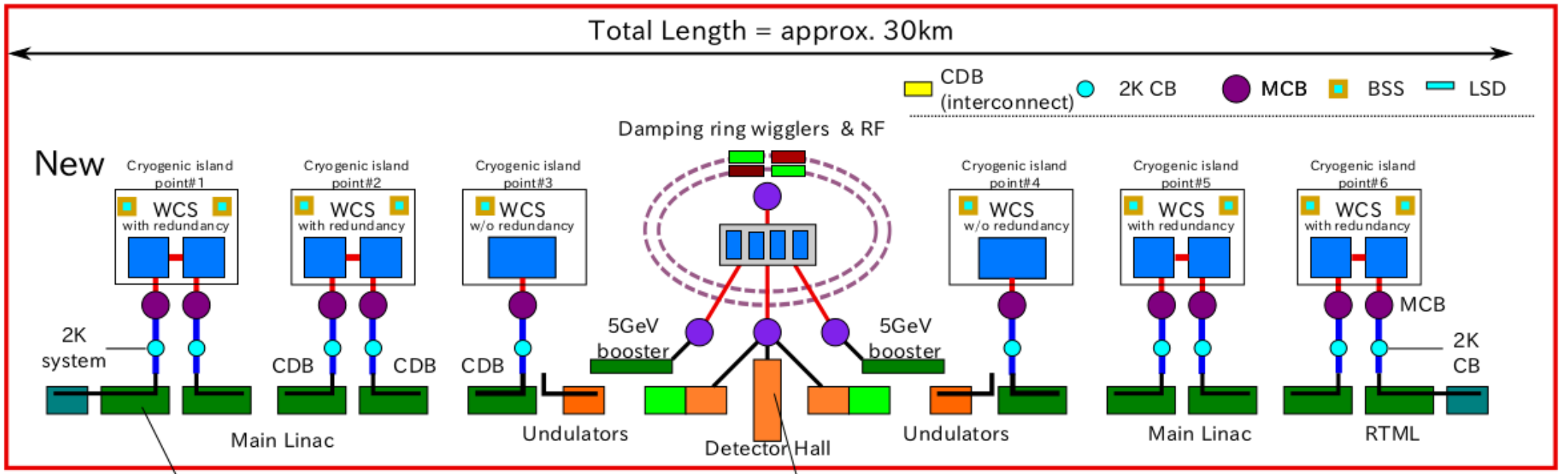
ML Cryogenic System

Overview of Cryogenics

- 4 sub-groups
  - ML Cryogenics　　now deeply discussed
  - IR Cryogenics　　no change scheme
  - BDS Cryogenics　　unconsidered so far
  - DR Cryogenics　　unconsidered so far



Cryo-unit これが10セット

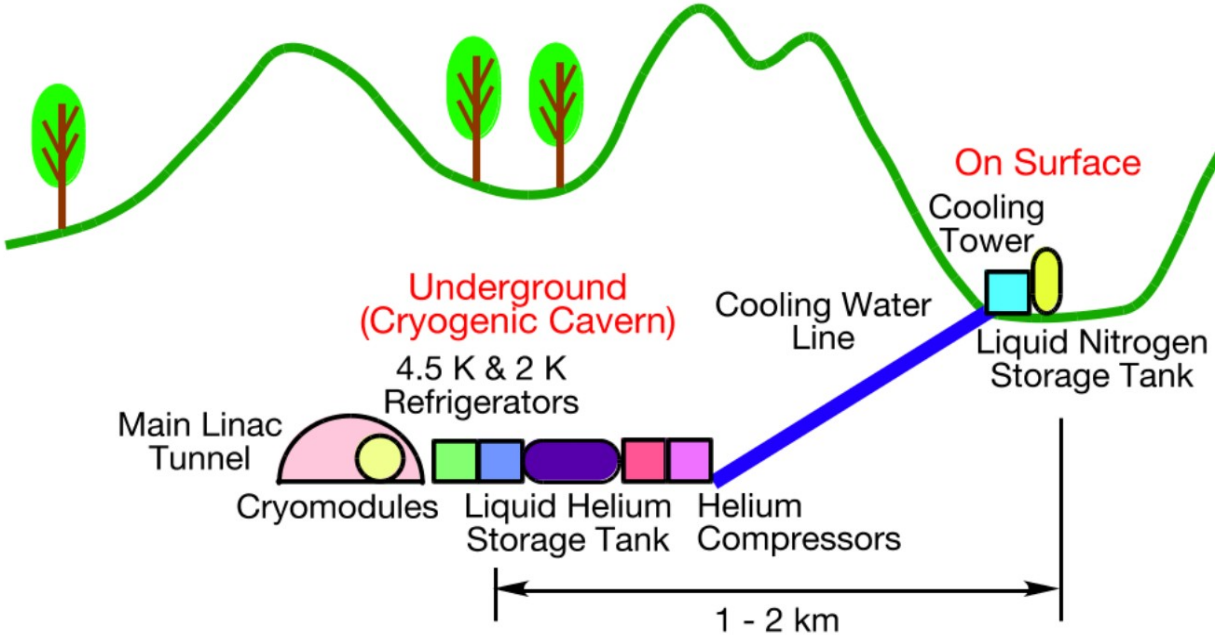
衝突点(検出器2台)

Cryogenic islands = 6 islands

Each cryogenic island have one or two refrigeration plants. (point#3,#4 have one cryo-plant.)

ML Cryogenics

- TDR scheme
  - All components are installed in underground.



- From the environmental view point,
  - Not good to storage all inventory with gas state of 2.0MPa
    - Required a lot of space for buffer tank on surface.
    - 11 buffer tanks with 250m3 are needed per 1cryo plant
  - TDR proposed that “All inventory should be stored in the state of Liquid”
    - LHE Storage dewar are needed.

Contents of the Change Request

- Location reconsideration
  - Main Compressor - surface (change)
  - LHE storage tank - surface (change)
  - 2K Cold Box - underground (keep)
  - 4K Main Cold Box - surface or underground (pending)
    - Which is better ?

- From the view point of “SAFETY in Underground”
  - LHE Storage Dewar should not be in cavern.
  - LHE Storage Dewar should be located on Surface.
    - This is high priority boundary condition!

Location issue of 4K-MCB

From the view point of “Steady State Operation”

- In case of surface
  - Easier to do daily check ?
  - Necessity of TRT with 5 inner pipe. (OD=700mm)
    - High cost
    - Low cryogenic efficiency
- In case of underground
    - Without TRT
    - High cryogenic efficiency
    - ➔ Cost reduction
    - ➔ 2K and 4K cold box can be combined.

Recent Progress

- Location of 4K-Main Cold box is almost determined.
  - Location is Underground.
    - To reduce manufacturing and running cost.
    - To obtain high efficiency
  - 2K and 4K cold box will be combined each other.
    - Main He compressor
      - ~ 5MW / 1 cyroplant
      - ~ 50MW in total
      - Minimum input power can be realized
        - 10MW reduction in total.

Some difficulties

- From the view point of “Steady State Operation”
  - Underground plan is very fine.

- From the view point of “Emergency etc.”
  - Underground plan has some difficulties.
    - Key Point is “LHE Storage dewar is located on surface.” (Change Request)
    - During power failure accident,
      - How to recover “Evaporated HE Gas generated from ML “ ?
        - In other words,
        - How to liquefy evaporated gas into LHE storage dewar?

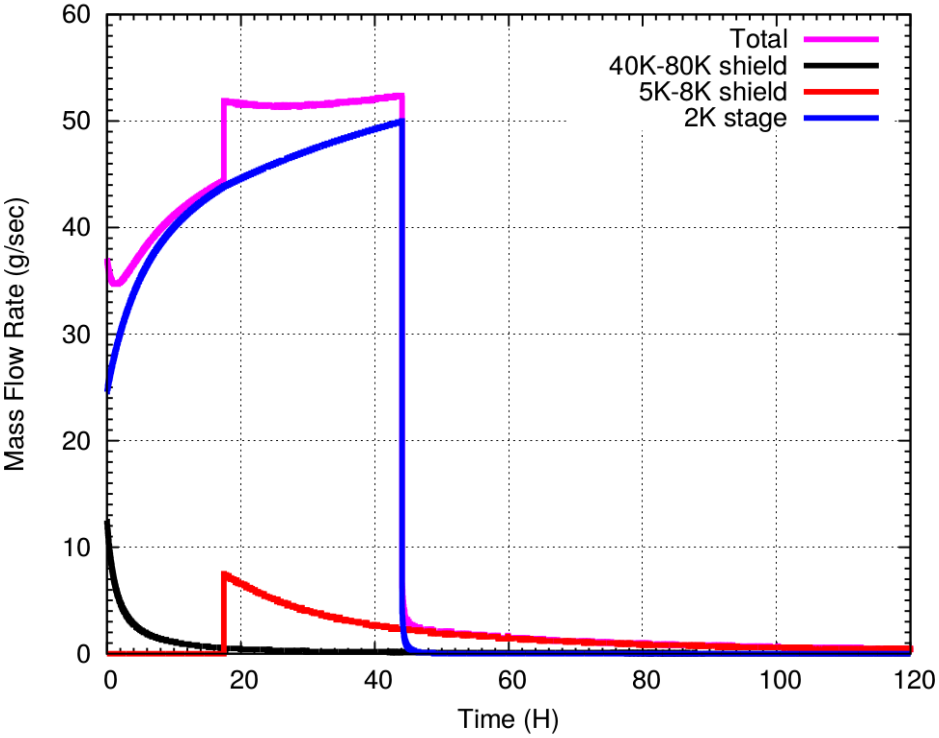
How to operate during power failure

- Evaporated He mass should be intentionally reduced as low as possible.
  - Desired value = within 30g/sec
  - Estimated value based on Heat Load = 50 g/sec
- A target time for recovery from starting the total power failure to resuming the ordinal/steady-state operation in our model study
  - Recovery time < 24 H is assumed.
- Quick action against main compressor stop
  - Preparation of simple and robust recovery compressor
    - Operation using secondary power line, immediately after power failure.
  - Preparation of several Buffer tank with 250m3

How to reduce evaporated He gas ?

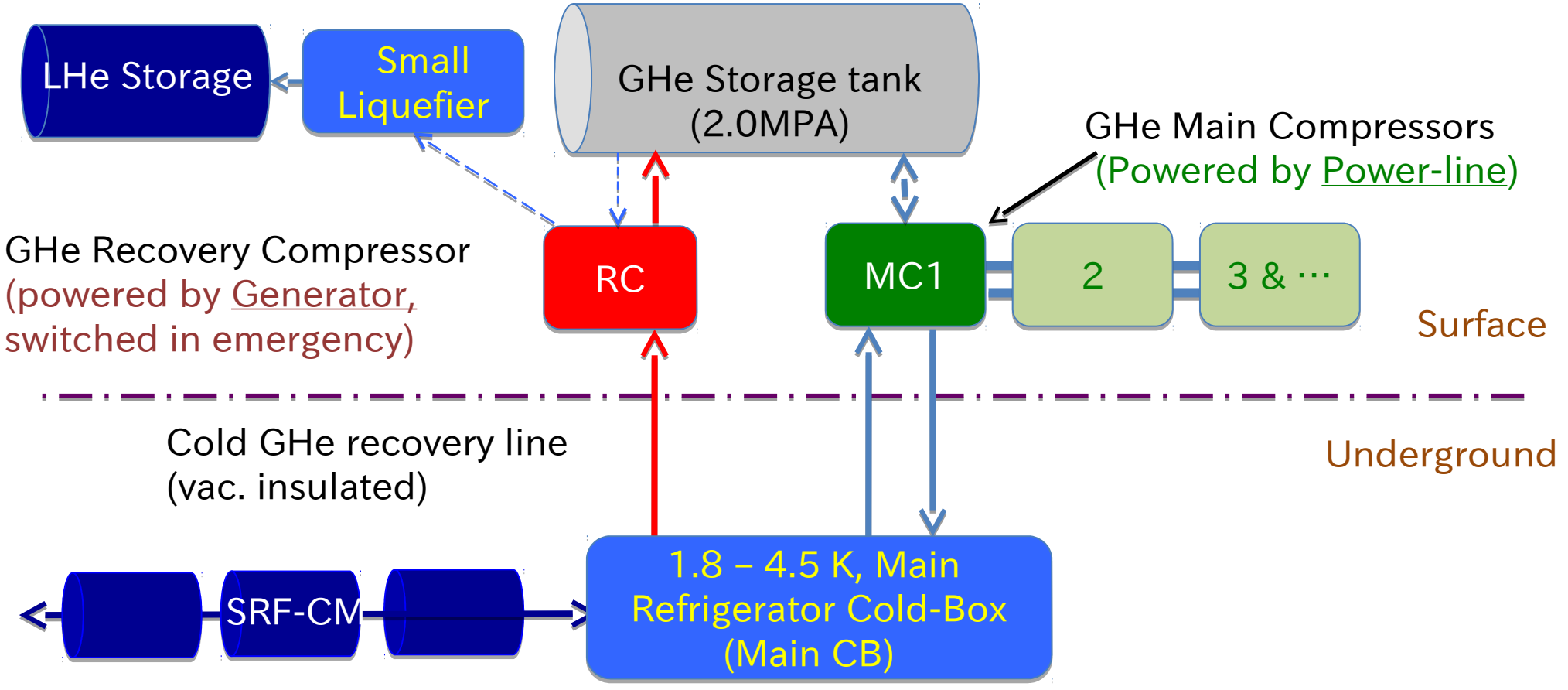
- Initial mass flow is 25-30 g/sec
- Maximum mass flow is 50 /gsec

The increment is caused by heat load increment due to temperature rise of radiation shield.



- Part of cold evaporated GHE should go through radiation shield.
  - to keep the static load to be < 25~30g/sec
  - efficient way to use the cold gas enthalpy and to keep the thermal load under control.

He Flow Lines in Emergency to Recovery
-- under investigation --



Operation Sequence (under investigation)

1. During power failure,
   - GHe recovery using Recovery Comp, RC (powered by Generator for < 24 hrs,
   - electric capacity per 1 Cryo Plant is 1MW.
   - Evaporated GHe is stored in the GHE storage tank.
2. LHE recovery during warm up,
   - Main comp, RC, Main CB and Small liquefier were operated simultaneously.
   - Total Recovery time ~ 1Week

IR Cryogenic System

Hybrid A' (All pipes for Helium and cooling water.)

cooling tower for IR compressors including DR.
volume flow rate = 1500L/min per 1 comp.
total volume flow rate = 6000 L/min (4 comps)

sub buffer tanks for comp

main buffer tank

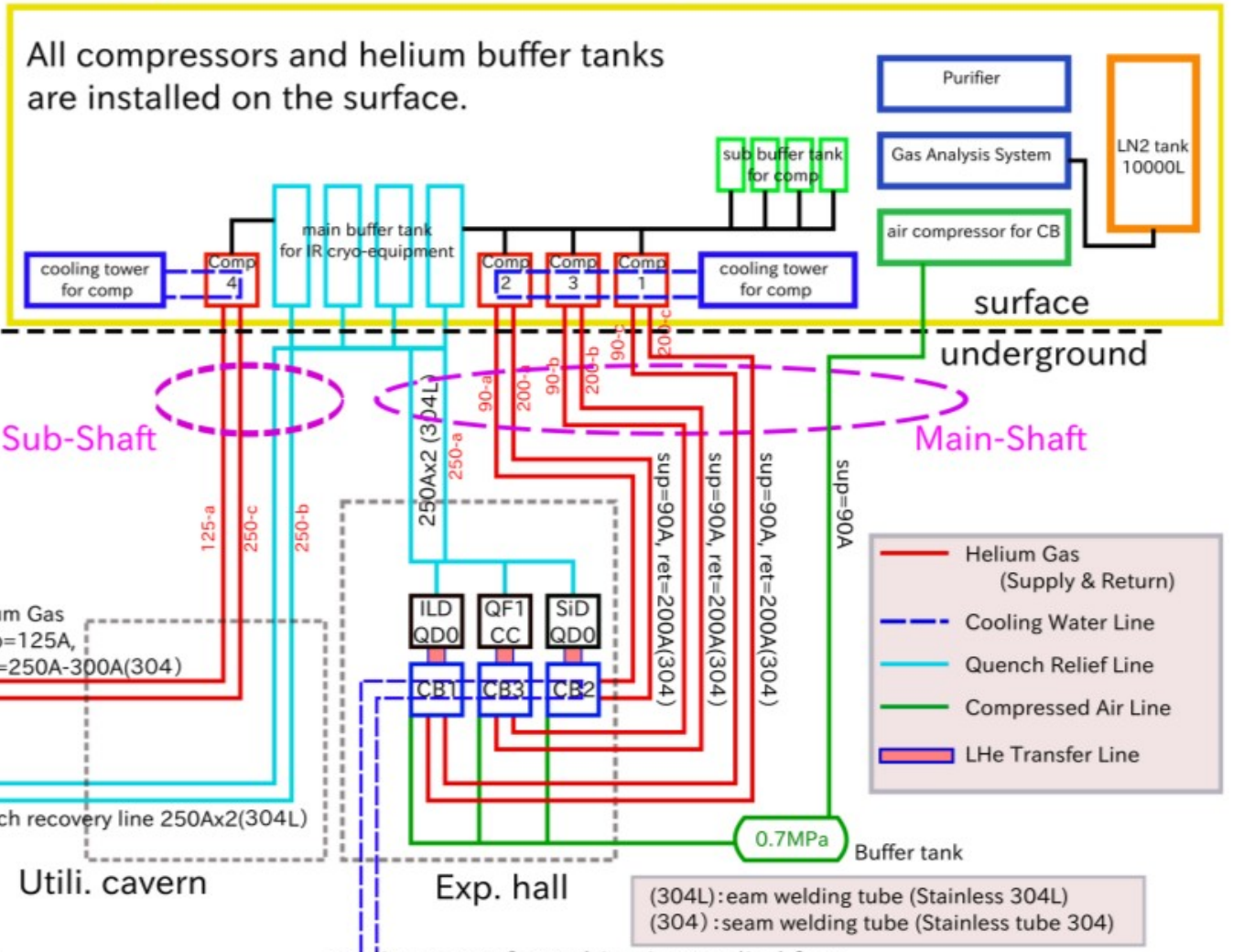
cooling towers

superconducting magnets (ILD, SiD, QD0)

CB

Comp

sub buffer for DR quench



cooling water for turbine is supplied from cooling water system located in the underground
100L/min per one CB.
Inlet temp = 31 deg.

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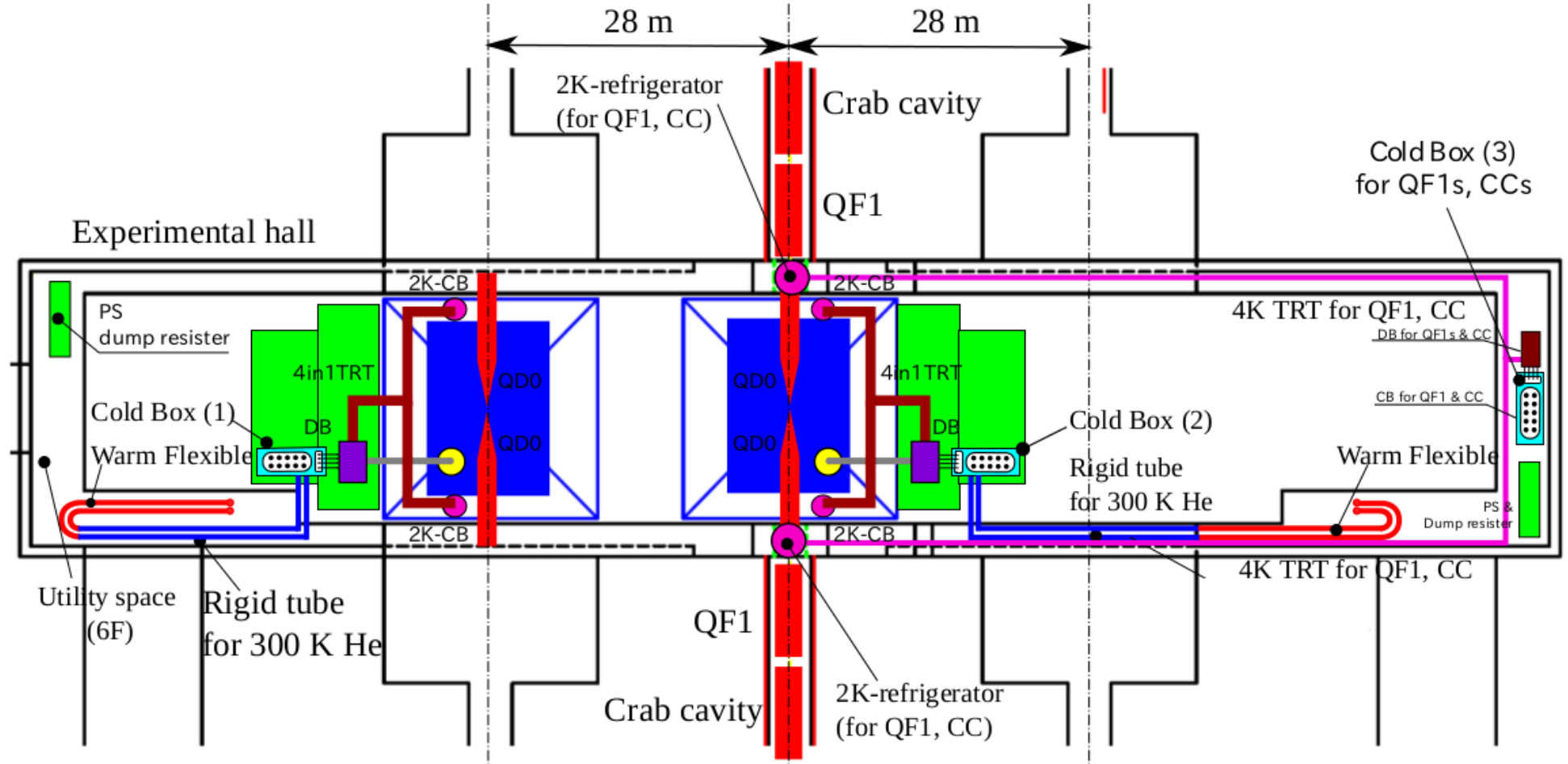
Configuration

- Four set of comp. and 4K cold boxes
  - ILD + QD0s
  - SiD + QD0s
  - Final focus QF1 and CC
  - DR (RF and Wiggler)

Superconducting system	compressor	4K cold box	2K refrigerators
ILD +QD0	500kW , surface	1kW, platform	platform
SiD + QD0	500kW , surface	platform	platform
Final Focus QF1 and CC	300kW , surface	Utility space	Utility space
Damping ring	600kW , surface	Cavern	



Cold box (2 kW)

2K refrigerator for QF1 and CC

4K distribution box

2K refrigerator for QD0

Chimney and current lead box for detector

Power supply for detector and QD0

4K LHe TRT for QF1 and CC (four in one TRT)

Fixed 300K Helium gas line (supply and return)

Fixed TRT for 4.2 K liquid helium (Four in one)

Fixed TRT for superfluid helium (2K, 4K 70K shield).

Flexible 300 K helium gas line (supply and return)----

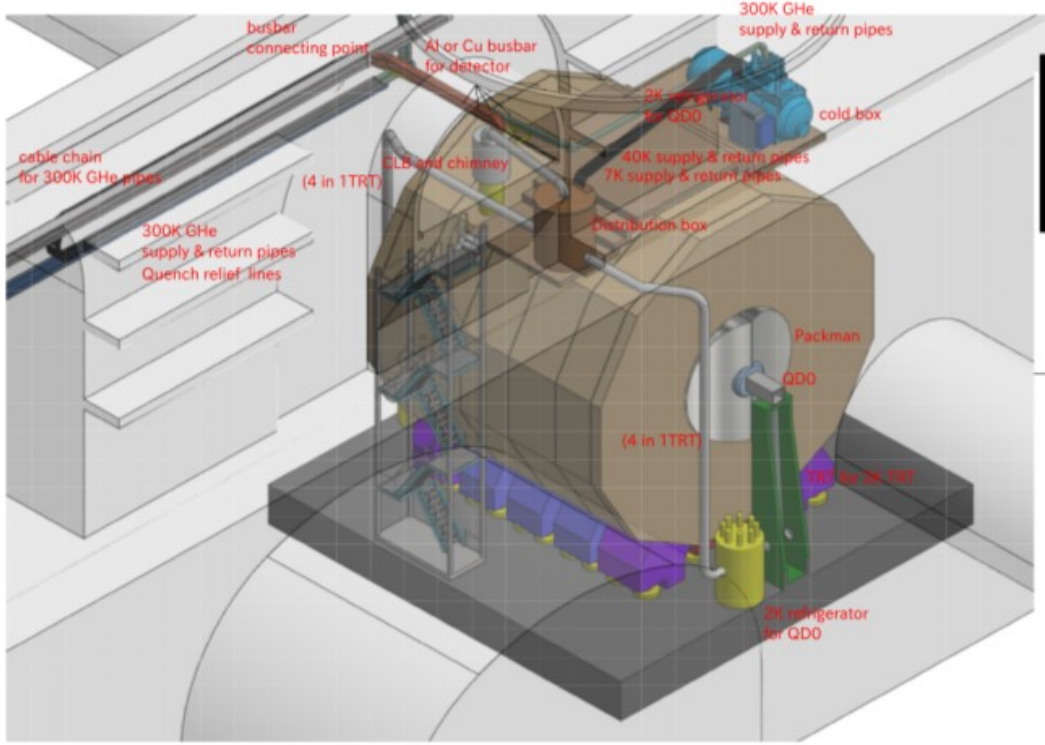
Bus bar for detector between PS and chimney.

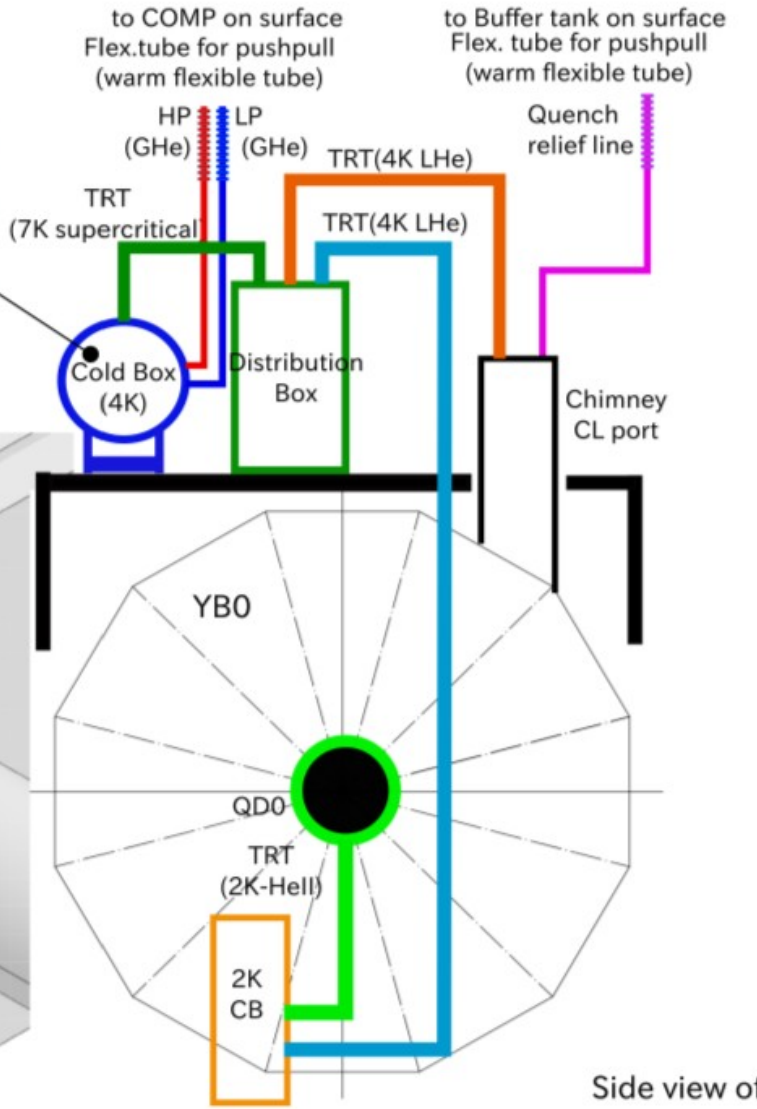
ILD cryogenic configuration

Cross section of TRT
4in1 TRT

2K refrigerator
(BNL)

4K cold box





Side view of ILD

During Pushpull

- Warm Flexible tubes for Ghe
  - High pressure line
  - Low pressure line
  - Quench recovery line
  - Other line such as compressed air line etc..
- Keep cryogenic condition
- No excitation
  - Busbar is not connected during pushpull

- Maintenance location
    - Cool down, excitation can be done.

Vibration

- Vibration from compressor can be isolated.

- 4K system does not have explicit vibration source.
  - Vacuum pump need not to be operated during cryogenic condition
  - Active use of cryo-sorption effect

- 2K system
  - Some kinds of vibration source
  - Necessity of vibration measurement using 2K system developed by BNL

- Power supply has vibration source.
  - Source is generated from cooling water. (we measured)
  - When operation of cooling water is stopped, vibration is drastically reduced.
  - But necessity of direct measurement using PS with same spec.