LC定例打合せ技術報告会/20140623

A Mini-workshop on the ILC Cryogenics and He Inventory

LINEAR COLLIDER COLLABORATION

Designing the world's next great particle accelerator

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Rev. 0:

Overview (1)

- **Place and Dates:** CERN, 18 – 19 June, 2014
- **Participants:** M. Harrison, L. Tavian, D. Delikaris, H. Nakai, M. Miyahara, T. Sanuki, A. Yamamoto, A. Enomoto (remote), H. Hayano (remote)
- **Objectives**
  - Overview the ILC cryogenics design and further optimize it, to provide reliable inputs for CFS work during the ILC preparation phase.
  - Focusing on optimization of locations for major components such as main-compressors and He inventory
  - Establishing the safety guideline and design

Overview (2)

- **Agenda (June 18)**

09:00	Opening remark:	Mike Harrison
09:10	ILC preparation in Japan:	Akira Yamamoto
09:30	ILC Cryogenics design including updates:	Hirotaka Nakai
10:10	ILC Geological Conditions and Constraints:	Tomoyuki Sanuki
10:30	Coffee break	
10:50	CERN's experience for He inventory and advice:	Dimitri Delikaris
11:20	Discussion for the ILC He inventory safety and actions required	
12:00	Closing remark:	Laurent Tavian

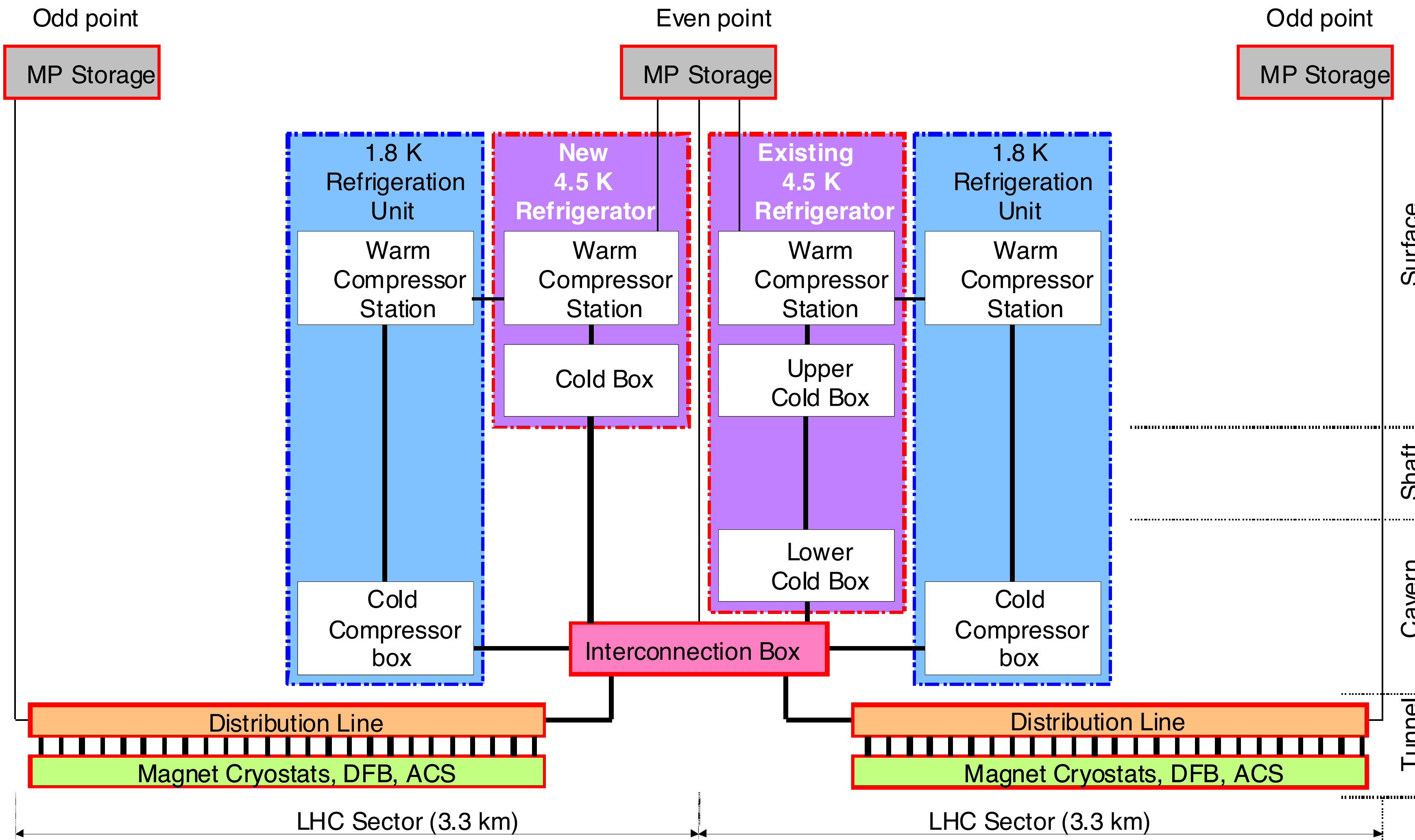
- **Agenda (June 19)**

08:15	SM18, Cold Test facility, and SM18, Cryogenics
10:30	CMS detector hall and Cryogenics

Main Subjects to Be Discussed

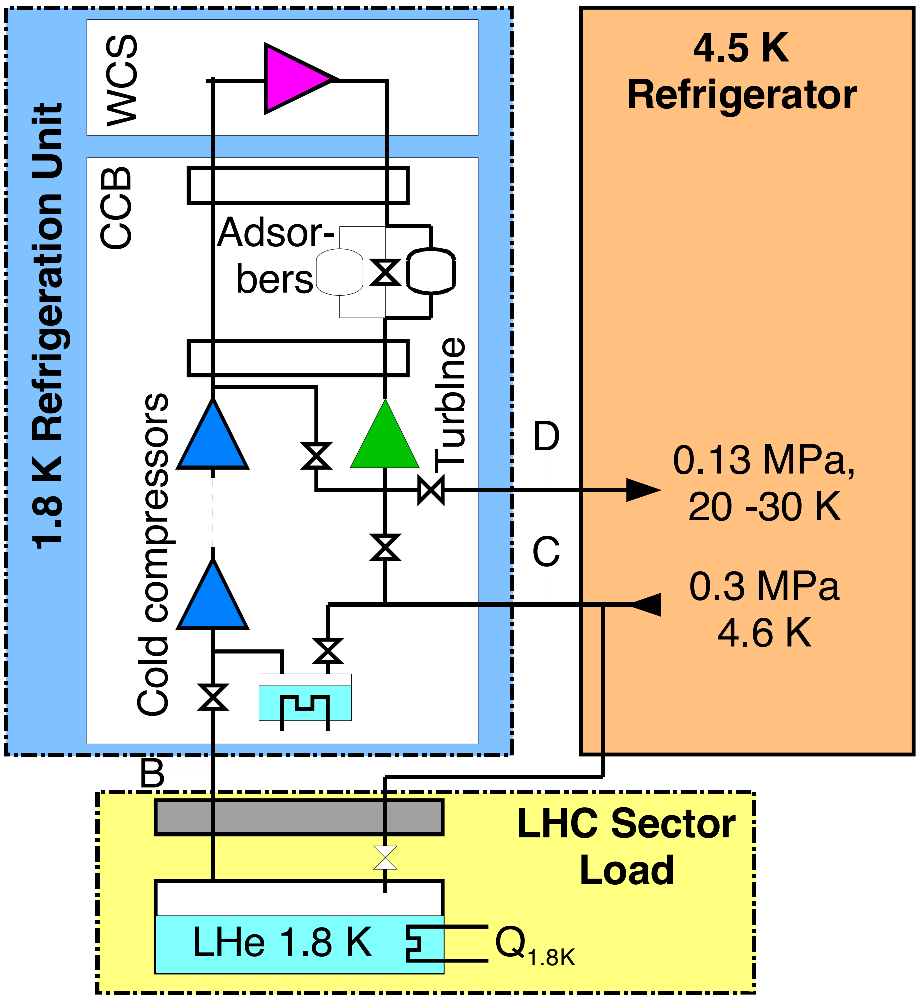
- **Optimum Cryogenics Layout**
  - Locations of Main compressors and He Inventory, and possible variations from view points of
    - Safety for liquid-gas handling (LHe and LN2 (if necessary))
    - Cost effective construction, operation, and maintenance
    - Environment
    - Vibration
- **Input to CFS design**
  - Within a period of ~ one year,
    - A goal to establish a basic consensus on the cryogenics layout, by LCWS-14, October, this year

Configuration of Cryogenics at CERN-LHC



Ph. Lebrun, Magnet Technology for Fusion Training School, 2009

Specification of CERN-LHC 1.8K Refrigerators

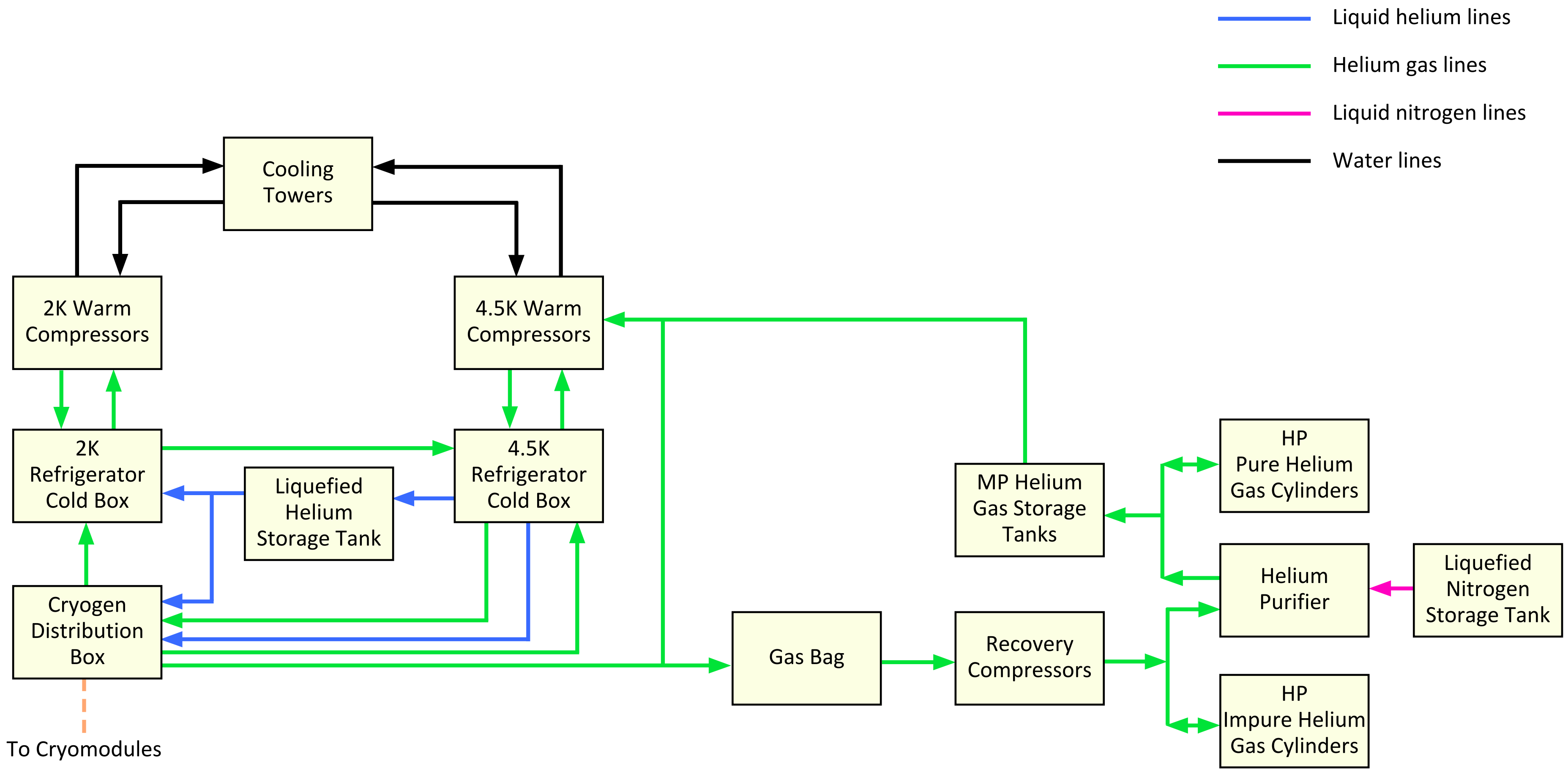


Steady state operation modes:

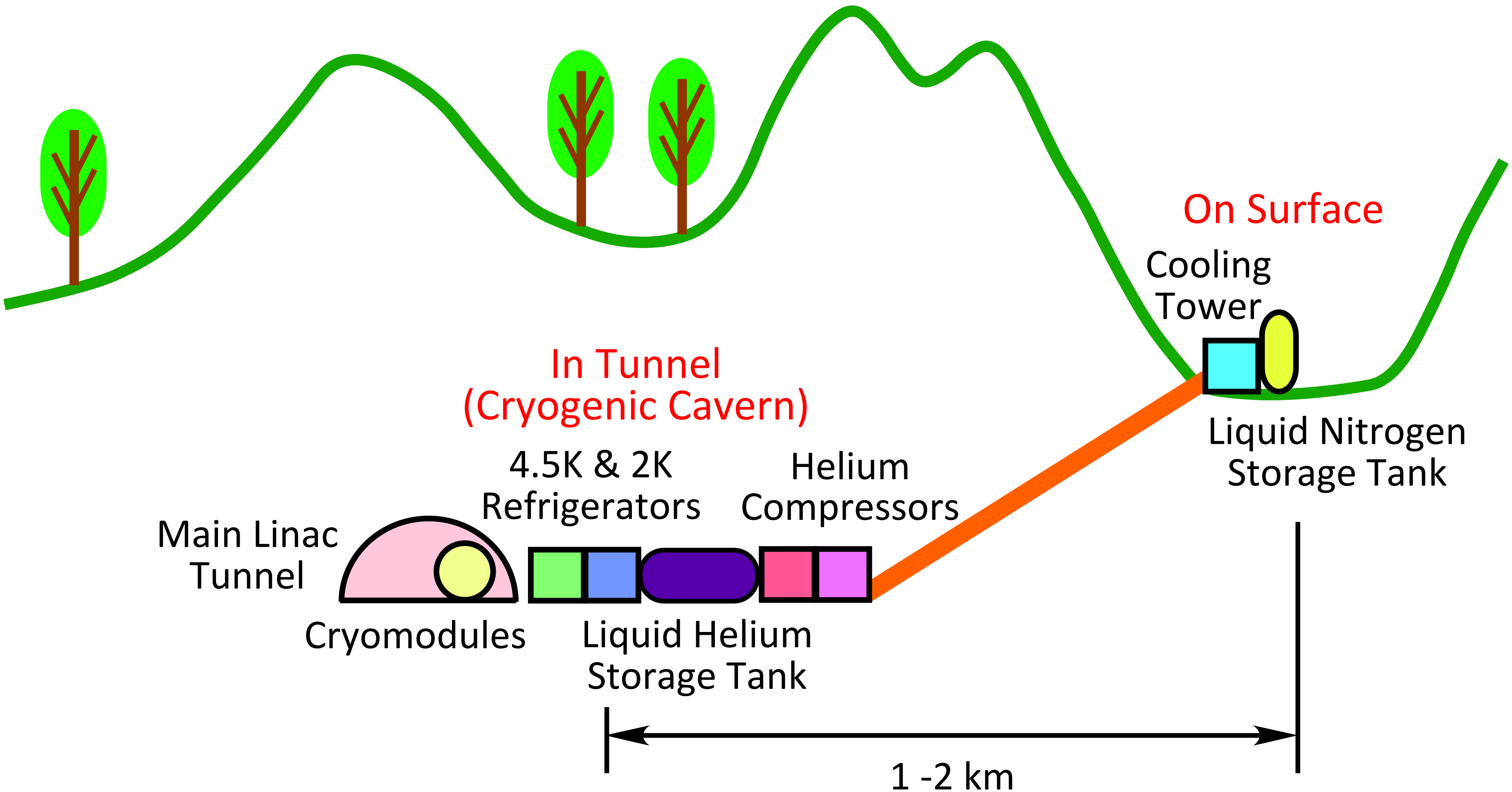
- Installed pumping capacity 125 g/s at 15 mbar (i.e. ~2.4 kW @ 1.8 K)
- Turndown capability: 1 to 3 without extra liquid burning
- Cold return temperature to the 4.5 K refrigerator below 30 K (reduced capacity) to 20 K (installed capacity).
- Capacity check in standalone mode (Interface B closed)

Ph. Lebrun, Magnet Technology for Fusion Training School, 2009

Tentative Cryogenic System Diagram



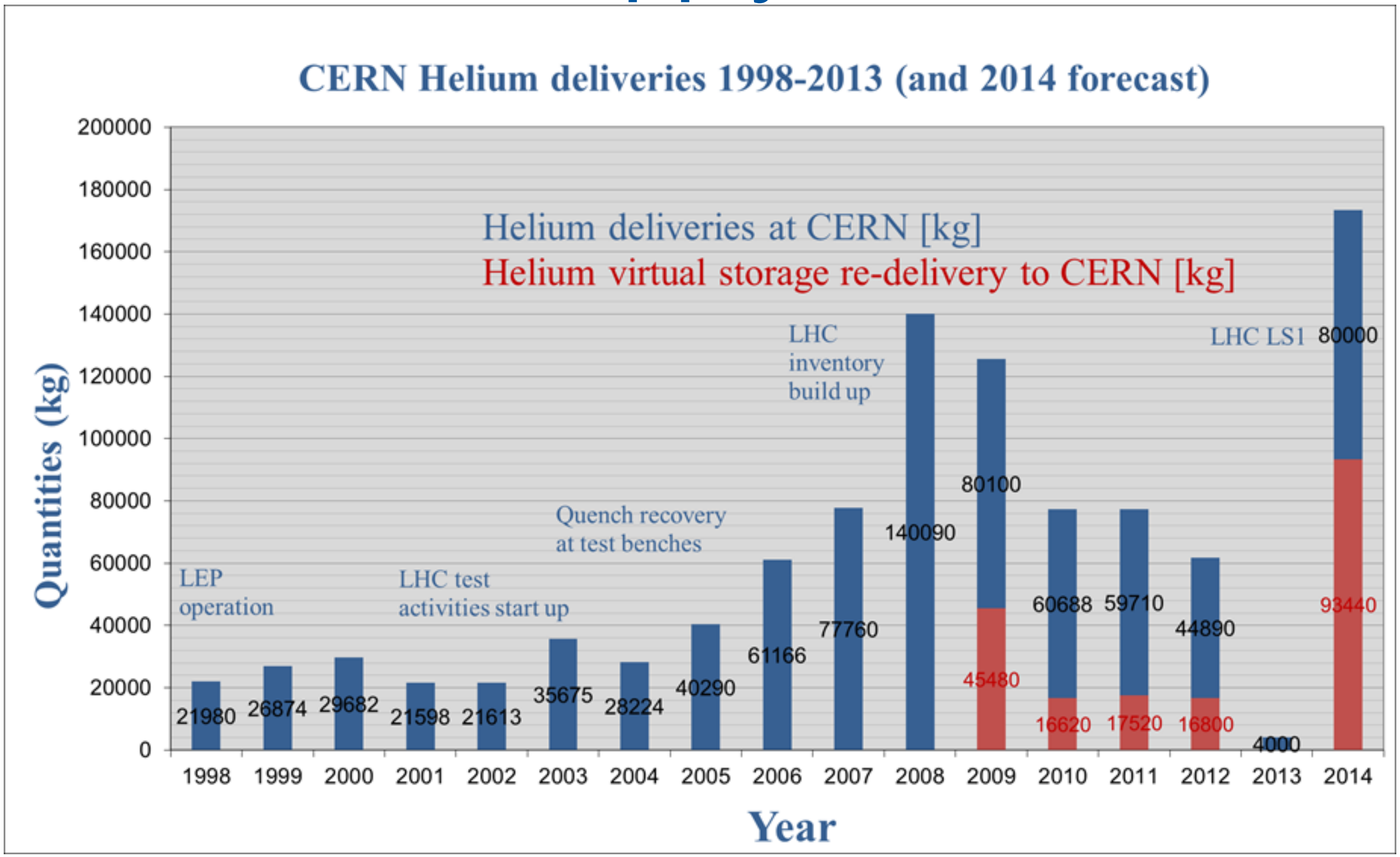
Conceptual Configuration



Outcome from the Workshop (1)

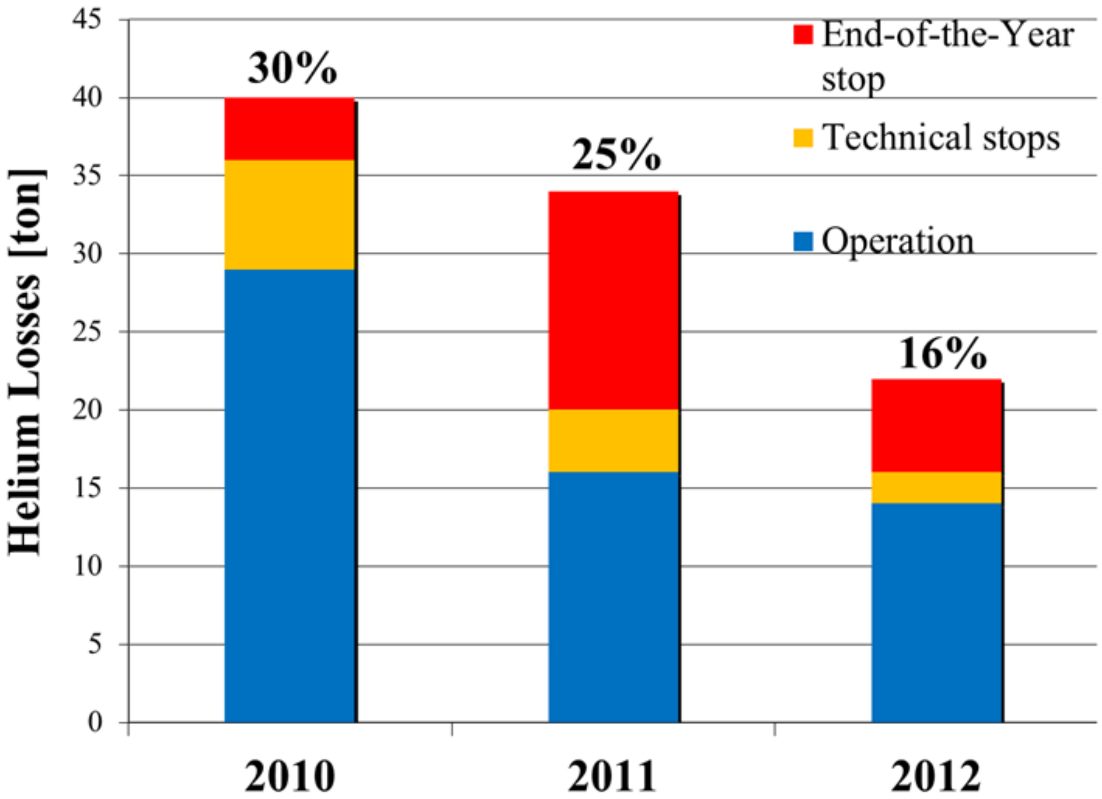
- **Component Location:**
  - Surface: Compressor, main LHe & GHe inventory storage tanks, and LN2 storage (CE),
  - Underground: Cold box, Distribution boxes, and small LHe dewars for buffering.
- **Compressor**
  - Full–flow Oil-remover and dryer may be integrated in the MC system, instead of external purification system. GN2 is required for charcoal activation (in the oil remover) and for dryer regeneration (in the water remover).
  - He gas evaporated from CM may be collected through safety/control valves, and the system may remain at medium pressure, during shutdown of the machine. It requires baby-sitter compressors.
  - It is advised not to use gas-bags and high-pressure recovery compressors.
- **He Storage**
  - LHe as primary storage and GHe storage for flexible operation. A compact He liquefier system is required to keep LHe and GHe balance for a long shut-down.
  - He inventory to be received with LHe containers (for efficient transportation and handling).
- **Cold Box (CB)**
  - CB (4.5 K and 1.8 K) may be compound as a cost effective design.
  - No LN2 usage is advised from a safety view point.

Helium Supply at CERN



LHC accelerator helium management

LHC Run 1

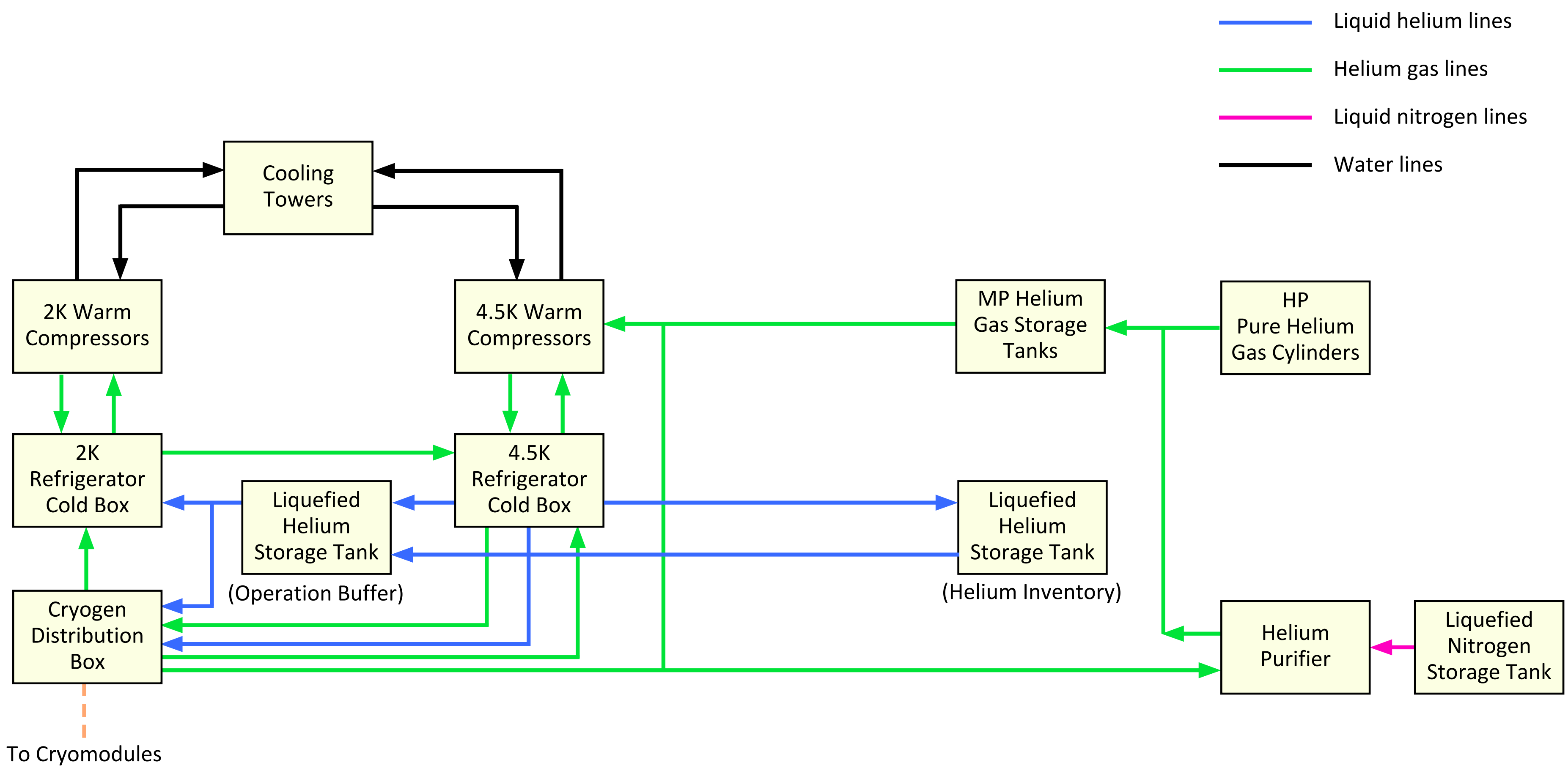


LINEAR COLLIDER COLLABORATION

CERN Liquid and Gas Helium Tanks on Surface

Mobile Liquid Helium Tank

ILC Cryogenics Configuration (Discussed)



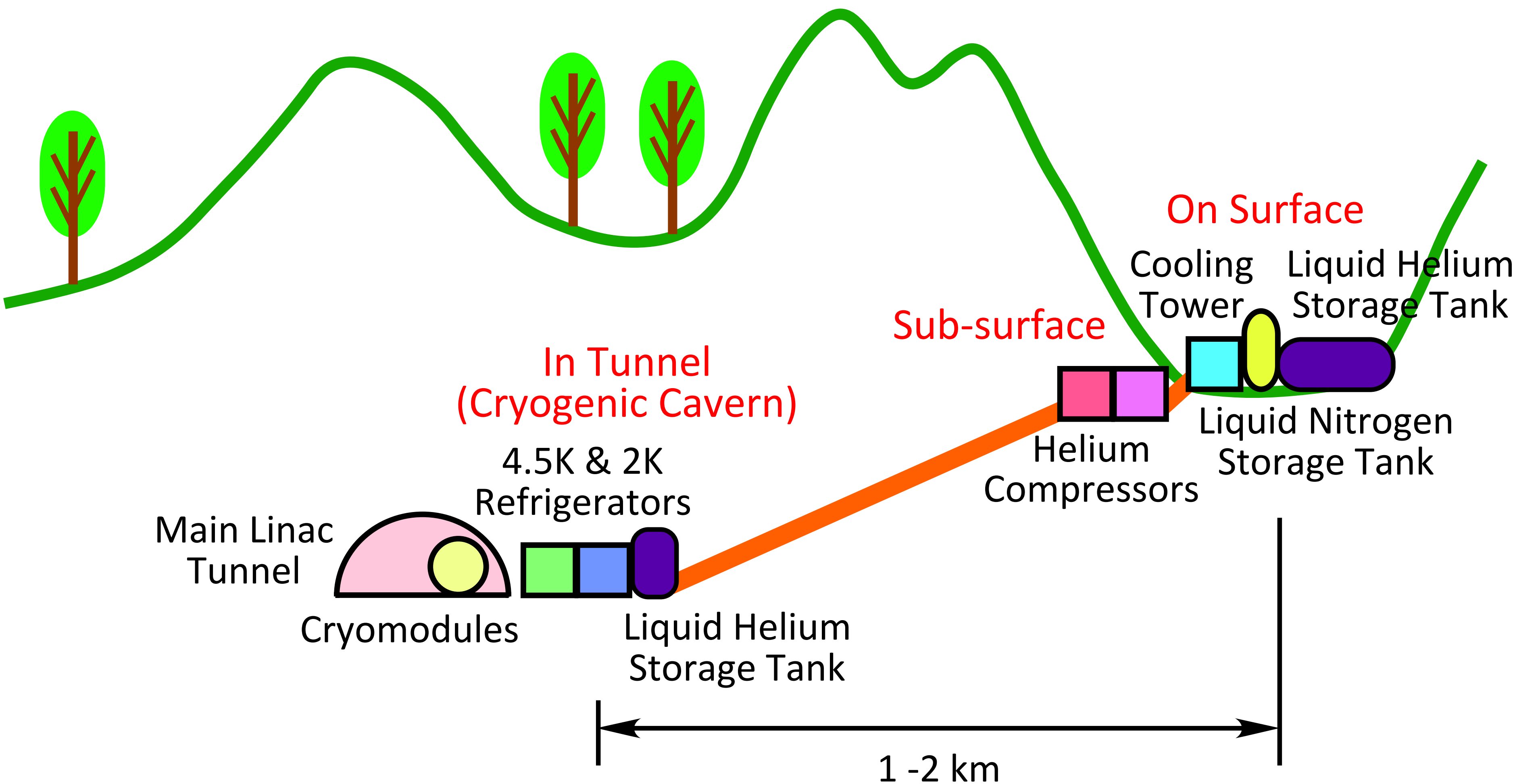
Cited from ILC-TDR

Regulation standard of the noise

example : a municipal regulation

	6 a.m. - 8 a.m.	8 a.m. - 6 p.m.	6 p.m. - 10 a.m.	10 p.m. - 6 a.m.
low-rise exclusive residential districts	45 db	50 db	45 db	40 db
medium-to-high-rise exclusive residential districts	50 db	55 db	50 db	45 db

ILC Cryogenics Component Layout (Discussed)



Outcome from the Workshop (2)

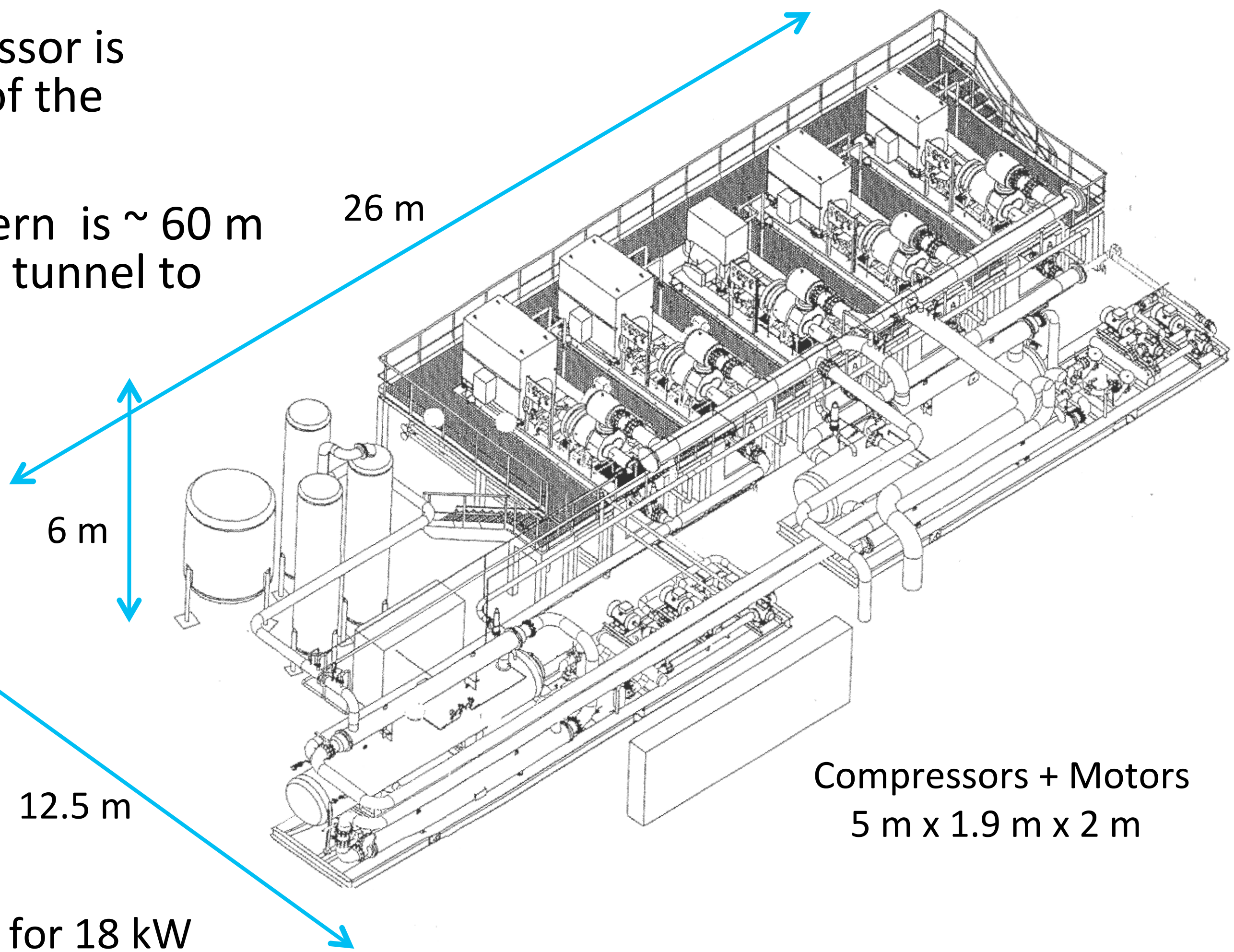
- **Accelerator and Detector Cryogenics at IP**
  - IP region cryogenics for detectors and accelerator, the compressor station may be unified, and the cold box locations may be optimized dedicated depending on the operational features and cold-mass inertia.
- **Energy Efficiency**
  - It may be important to innovate efficient ways of using thermal energy from compressors operation, according to "Green energy" concept.
- **Safety**
  - Safety condition at underground cavern may become much relaxed, based on the consideration above, although the safety condition remain unchanged in accelerator runnel

Outcome from the Workshop (3)

- **Civil Engineering**
  - Cryogenics can accommodate either with vertical or horizontal shaft. The driving force should be detector's installation scenarios.
  - The size of the tunnel or shaft cross section needs respect to the biggest object to be transported, and it will be probably the cold box (5~6 m high) for ordinal accelerator access tunnels.
  - What will be the second one in size? This may have an influence on the civil engineering and installation order including piping (plumbing) work along the access tunnel.
  - The access tunnel need to accommodate:
    - He medium pressure (go), low pressure (return), and bypass gas lines, and LHe transfer lines, although cooling water pipes and electric cable lines could be eliminated.

Main Linac Heat Loads & Cryogenic Plant Sizes

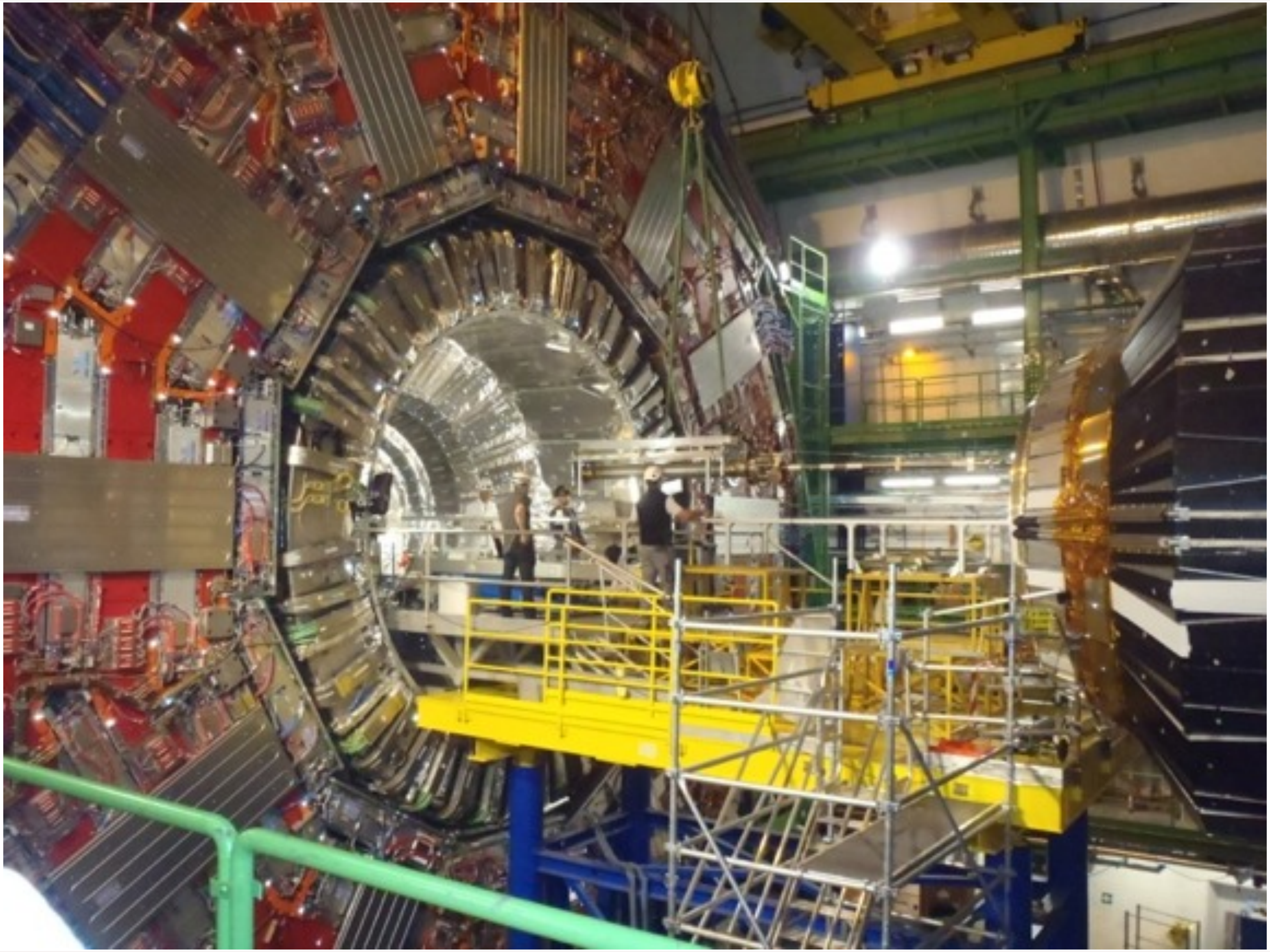
- The helium compressor is installed in far end of the cryogenic cavern
- Location of the cavern is ~ 60 m away from the main tunnel to avoid the vibration



Helium compressors for 18 kW
Helium Refrigerator / CERN LHC

K. Hosoyama, International Workshop on Linear Colliders 2010

Visit to CMS



Visit to ATLAS

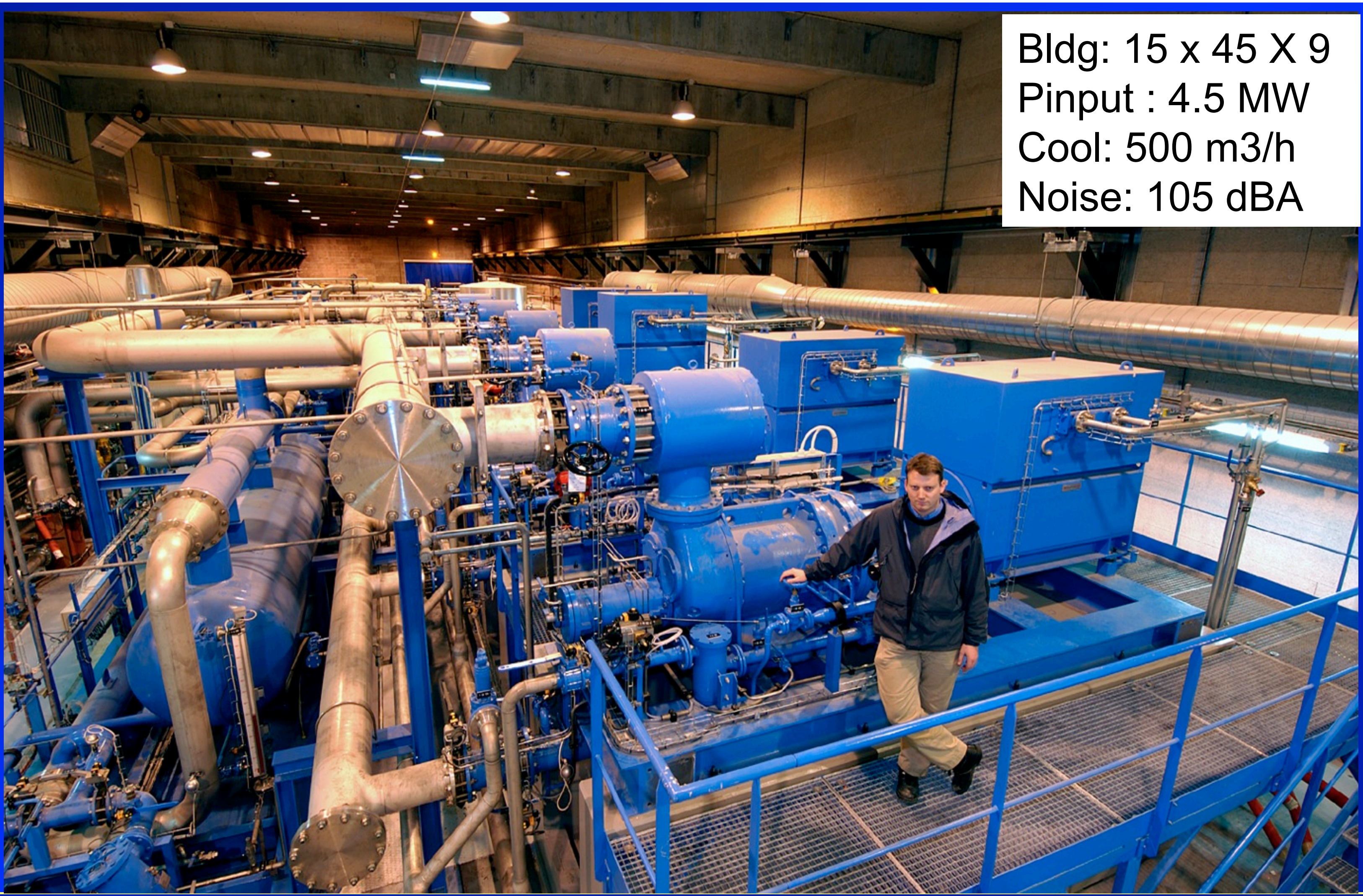
LHC 4.5K Refrigerator Cold box

Key components:

Expansion turbines on gas bearings, plate fin heat exchangers, cryogenic valves, vacuum shell

Bldg: 15 x 10 X 10
Pinput : 40 kW
Cool: 20 m3/h
Noise: 85 dBA

LHC Compressors



Bldg: 15 x 45 X 9
Pinput : 4.5 MW
Cool: 500 m3/h
Noise: 105 dBA