CFS Two Day Workshop at CERN/20150727

Cryo Change Control Drafting

LINEAR COLLIDER COLLABORATION

Designing the world's next great particle accelerator

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Rev. 0:

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Introduction

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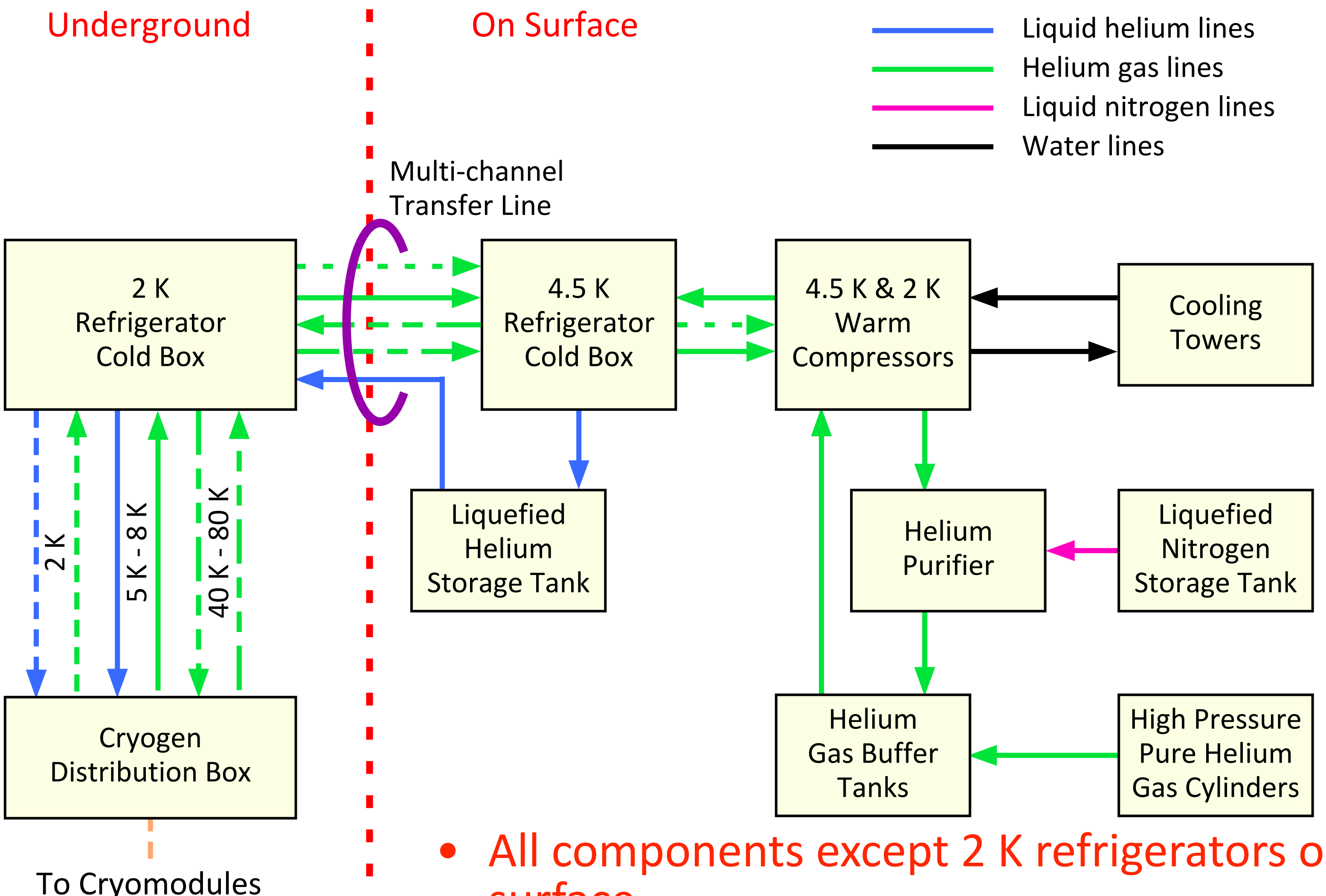
Introduction

The cryogenic system for the ILC consists of various components, such as cold boxes, compressors and transfer lines of cryogens. Baseline layout of the cryogenic system described in TDR was determined with the primary focus on the conservation of nature at the mountainous candidate site for ILC. Almost all cryogenic components will be installed in the cryogenic caverns next to the main linac tunnels about 100 meters below the ground level. Only the cooling towers for the cooling water of the helium compressors may be installed on the surface for easier heat removal.

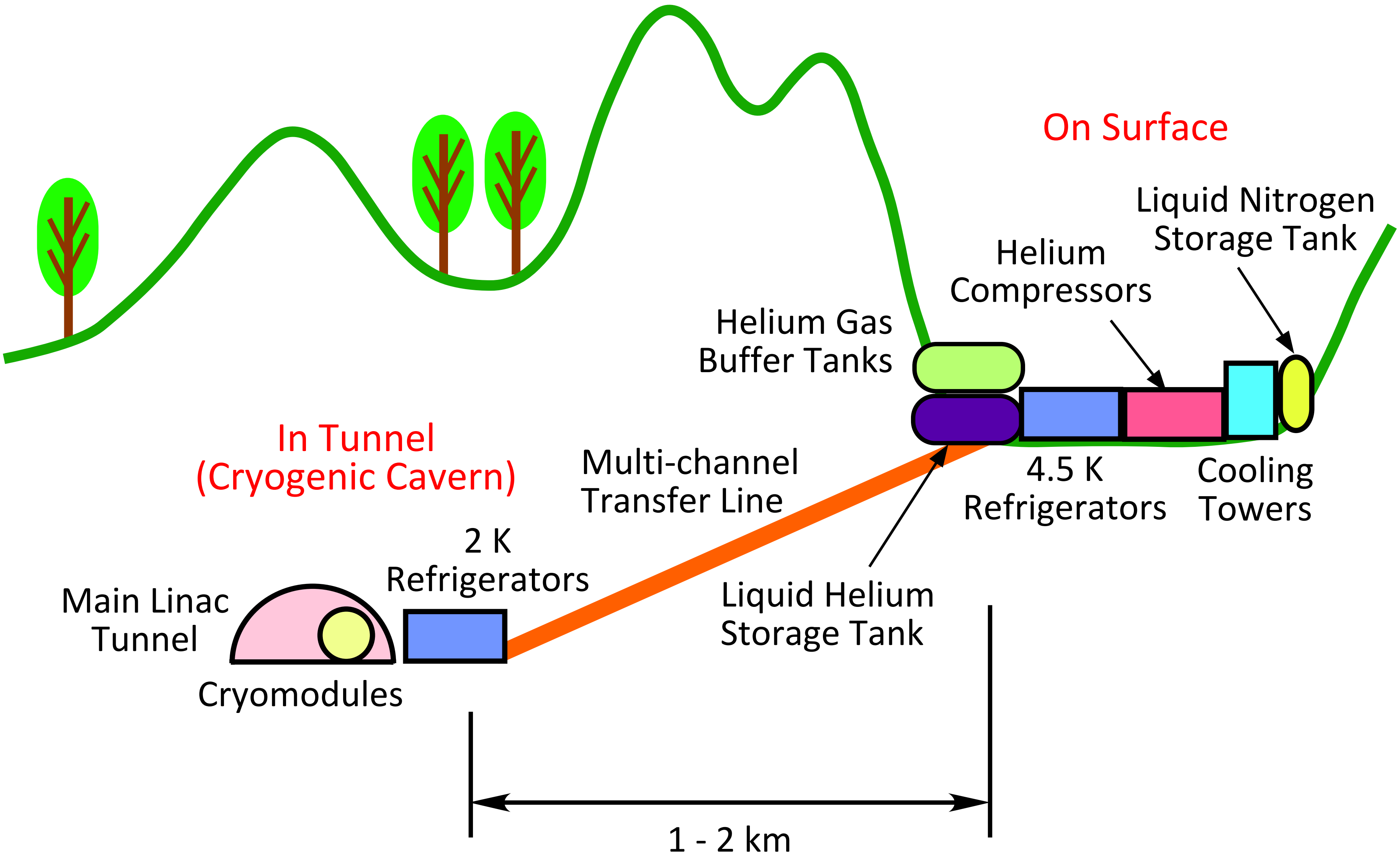
Succeeding discussions on the ILC cryogenic system after TDR, however, reveal some technological and safety issues for the prescribed cryogenic layout in TDR. One of major issues is that at some institutes the cryogen storage underground or in accelerator tunnels is strictly prohibited except the accelerator cryostats or cryomodules for the safety reason. The new cryogenic layout, shown in Figure 1, is proposed after several discussions on the cryogenic layout among the cryogenics experts. In the proposed cryogenic layout only 2 K refrigerator cold boxes will be installed at the cryogenic caverns and all other cryogenic components do on the surface. The multi-channel cryogenic transfer lines will connect the cryogenic components at the cryogenic caverns and on the surface (Figure 2).

Figure 1. Proposed Cryogenic Layout



- All components except 2 K refrigerators on surface

Figure 2. Schematic Cryogenic Layout



Advantages of Proposed Cryogenic Component Layout

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1. Operation Considerations (1)

Mechanical vibration and noise from compressors

It is pointed out that the mechanical vibration from the helium compressors may interfere in electron/positron beam operation. Hence from the point of view of the ILC operation it should be better not to install the helium compressors near ML tunnels, such as in a cryogenic cavern. Installation of the helium compressors on the surface can make the situation free from this issue.

1. Operation Considerations (2)

Large amount of cryogens underground prohibited at some accelerator institutes

The total liquid helium inventory for the ILC cryogenic system is estimated 632000 liters in TDR. For the case of mountainous region site, there will be 10 cryoplants, and hence the amount of 63200 liters of liquid helium should be managed at each cryoplant. Because of the safety reason, the cryogen storage underground or in accelerator tunnels is strictly prohibited at some accelerator institutes, even there is a large ventilation system equipped. There is no strong reason against such safety regulation in the ILC cryogenic system.

1. Operation Considerations (3)

Heat removal from helium compressors

The AC power consumption at each cryoplant is estimated at 3.2 MW in TDR. This consumption comes mainly from the helium compressors, and hence, the same amount of heat will be generated from the compressors in other words. If the compressors would be installed in the cryogenic caverns, such huge amount of heat should be removed from the cryogenic caverns underground to the surface of the site. If the compressors would be installed on the surface, conventional facilities and techniques can be employed.

1. Operation Considerations (4)

Accessibility to cryogen supply and daily check

Large amount of liquid helium should be introduced into the cryoplant at the initial stage. During the operation of the cryogenic system, the safety valves may activate some times by blackout or by improper operation and so on, and helium gas or liquid helium should be suppled into the cryogenics after the safety valve operation. If the cryogenic system would be installed at the cryogenic cavern, long supply lines for liquid helium and helium gas from the surface to the cryogenic cavern should be prepared. Or, wide roads for big trailers for liquid helium or helium gas cylinders would be required from the surface to the cavern. If the cryogenic system is installed on the surface such situation can be ignored.

1. Operation Considerations (5)

Much smaller underground areas necessary for cryogenic facilities

The major components of the cryogenic system are helium refrigerator cold boxes and the helium compressors. In the ILC cryoplants there are two helium refrigerator cold boxes; 2 K refrigerator cold boxes and 4.5 K refrigerator cold boxes. These components require wide areas to be installed. The cost of land development for the cryogenic components should be well considered for both cases of the cryogenic caverns underground and the surface facilities. If the surface land development is much easier than the cryogenic cavern construction, the new cryogenic layout has a big advantage.

1. Operation Considerations (6)

Radioactivation of helium

Radioactivation of helium is reported after some period of superconducting accelerator operation. However, the radiation level of helium is far below the generally accepted level. The issue of helium radio activation can be removed from the discussion on the cryogenic layout.

2. Schedule Considerations

The new cryogenic layout requires much smaller area of the cryogenic cavern next to the main linac tunnel only for the 2 K refrigerator cold box. The construction duration of the cryogenic caverns may become much shorter, if the area of the cavern is small. On the other hand, the surface area will become larger and the excavation duration may become longer. The resultant duration of shorter underground construction and longer excavation can be expected shorter in total. Detailed discussion on the schedule consideration will be made among CFS colleagues.

3. Cost Considerations

The same discussion on the schedule consideration can be made also for the cost consideration. The total cost for the cryogenic system seem to be reduced in total, if the new cryogenic layout is selected. Detailed discussion on the cost consideration will be made among CFS colleagues.

Disadvantages of Proposed Cryogenic Component Layout

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1. Natural Environment Conservation

Almost all cryogenic components except the 2 K refrigerator cold boxes will be installed on the surface, i.e. at the access points. This means many cryogenic components appear clearly in the natural mountainous areas. The helium compressors and the cooling towers may spread their mechanical noises and vibrations. Water vapor smokes from the cooling towers may be visible and may bring the emotional misunderstanding as radioactive smokes among the residents near the access points. It is important to assess how much noise and vibration can be accepted among the residents. It is also necessary to explain to the residents that the cryogenic facilities are radiation-free.

2. Cost Consideration

There are two cooling water lines between the cryogenic caverns and surface in the baseline layout. The lines may employ ordinary steel pipes because of water lines. If almost all cryogenic components would be installed on the surface and only the 2 K refrigerator cold boxes do in the cryogenic caverns, the multi-channel cryogenic transfer lines should be constructed. This transfer line, despite the well-known manufacturing technology, costs much higher than that for an ordinary water pipe.