



ILC Cryogenic System Shallow versus Deep Tunnel

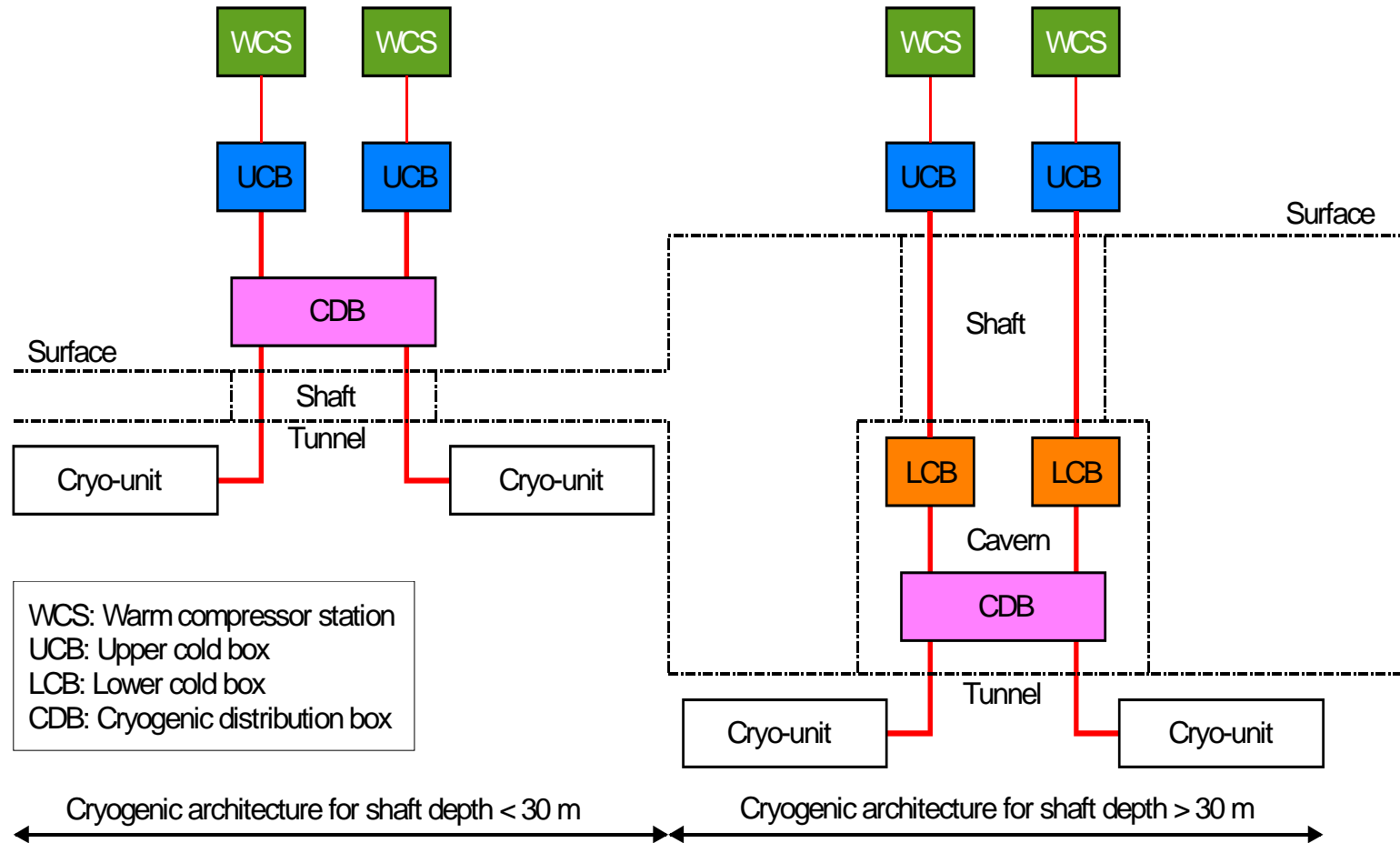
Tom Peterson
Dubna Meeting
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Illustration of shallow versus deep layout

(Slide from Laurent Taviani, CERN)





Lower coldbox installation at CERN



About 7 meters long and
7 meters tall, 2 m dia



Contents of lower cold box for deep site

- Heat exchangers
- Valves
- Cold compressors
- Turbo-expanders
- Assuming as much hardware on the surface as possible, minimal in the caverns, still means effectively the sub-20 Kelvin part of the cryogenic plant below ground

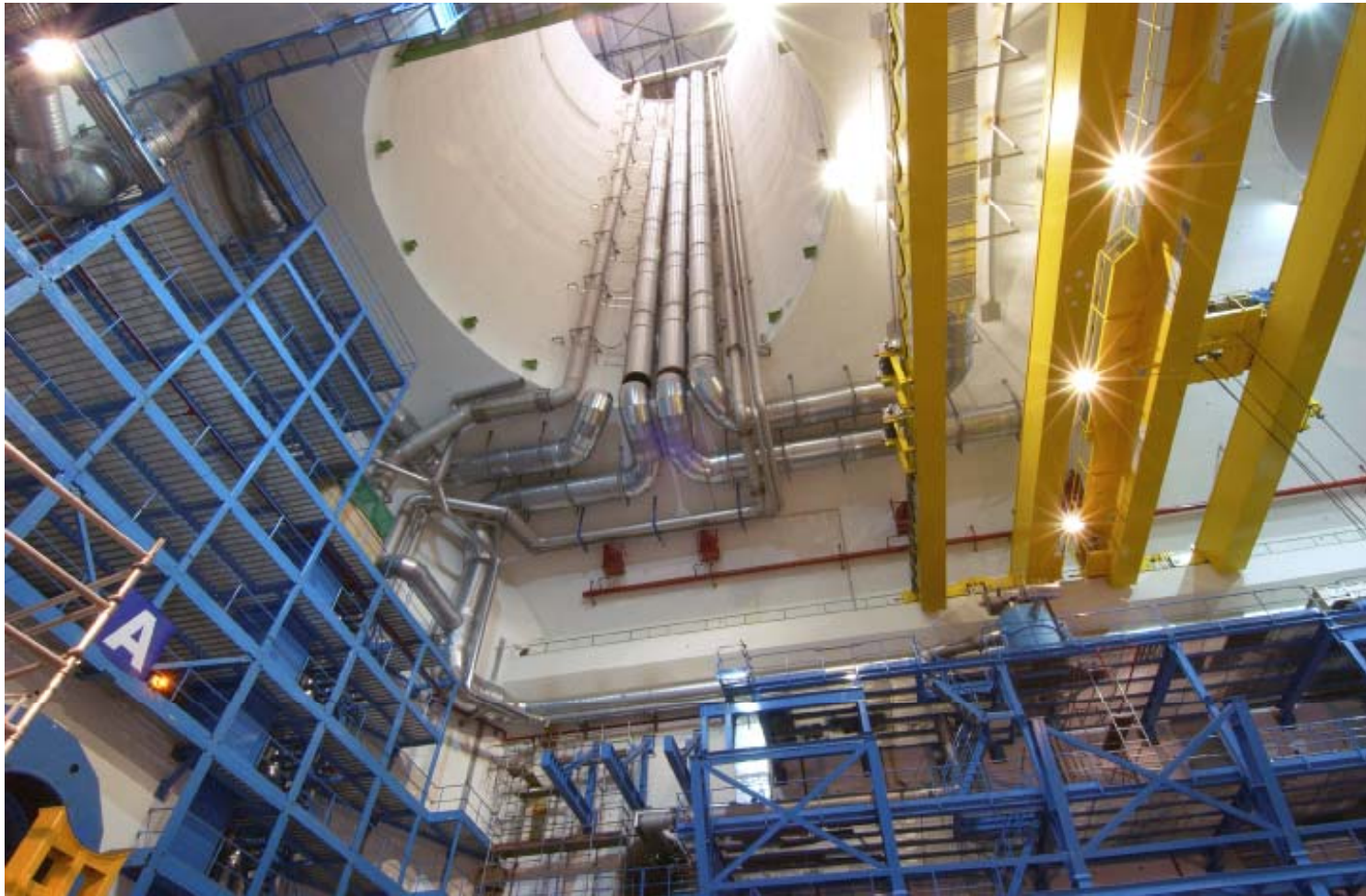


Vertical transfer line for the deep site

- About 300 - 600 mm OD vacuum jacket
- Inner lines include
 - ~20 K to and from lower cold box
 - 40 K supply and 80 K return thermal shield lines
 - Auxiliary piping for cool-down and off-design operation



Piping into ATLAS cavern



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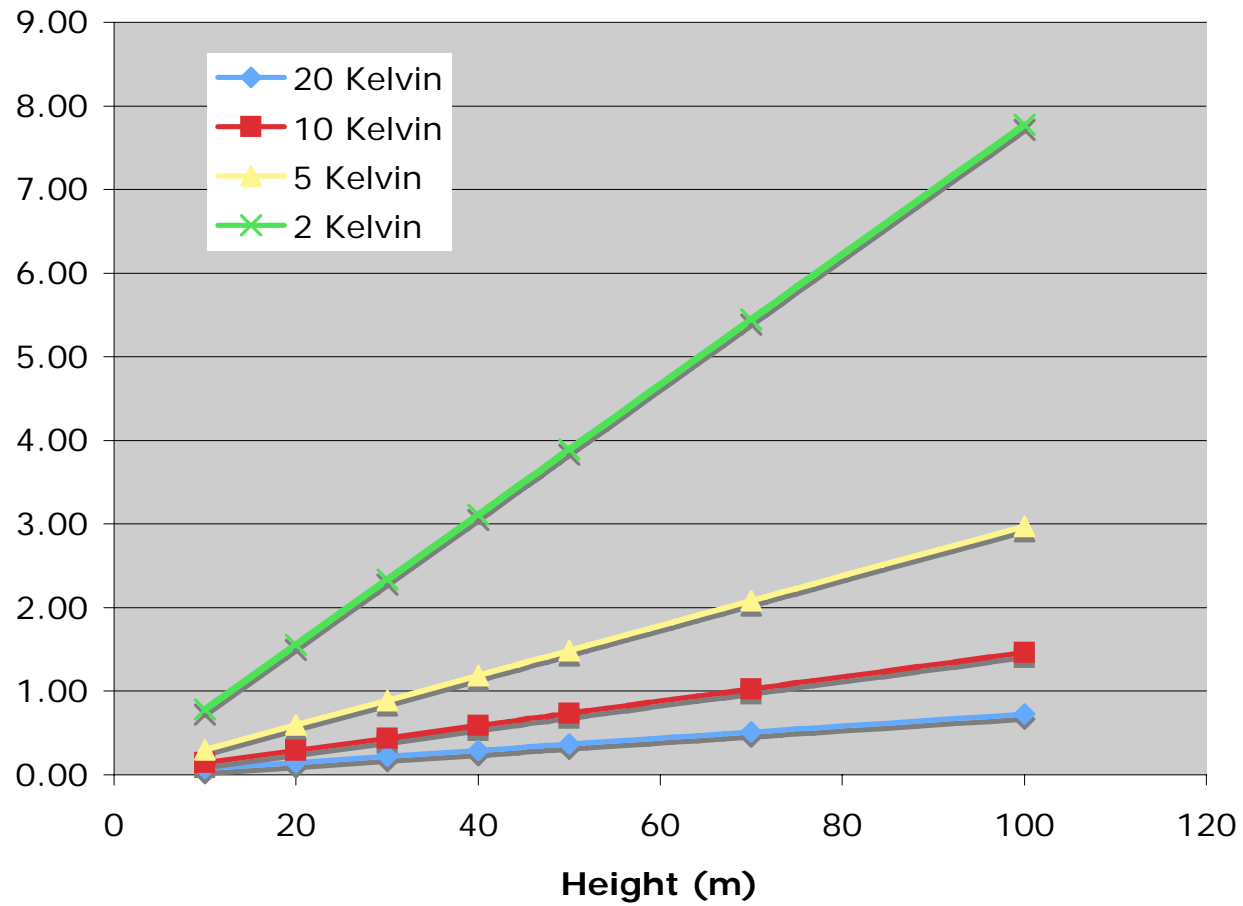


Why 20 K break and why 30 m?

- A 30 meter column of helium vapor at 2 Kelvin results in a pressure of about 2.3 mbar
 - This is about 10% of the cold compressor inlet pressure
 - So effectively have reduced cold compressor efficiency due to compression of column
 - For cold compressor elevated -- increases tunnel “2 K” temperature by about 1 mK per meter
 - Selected 30 m limit above which split the cold box
- 20 K provides low density for small pressure head up to 100 meters or more



Helium column head pressures (31 mbar helium)





Comments

- Shallow site (<30 meters deep) allows most cryogenic plant hardware to remain on the surface
 - **Just distribution in the tunnel**
- Reduces cavern occupancy
- Not a big cost difference in terms just of cryogenic hardware
- Additional installation costs for cold box in deep tunnel



Additional comment

- Access to the surface may be a more important factor than tunnel depth, but confounded with tunnel depth in our experience
- A shallow tunnel with no access to the surface except for the same very widely spaced locations as a deep tunnel “looks” much like a deep tunnel in terms of cryogenic system constraints except for the “lower cold box” requirement at refrigerators for the deep tunnel