



TECHNISCHE
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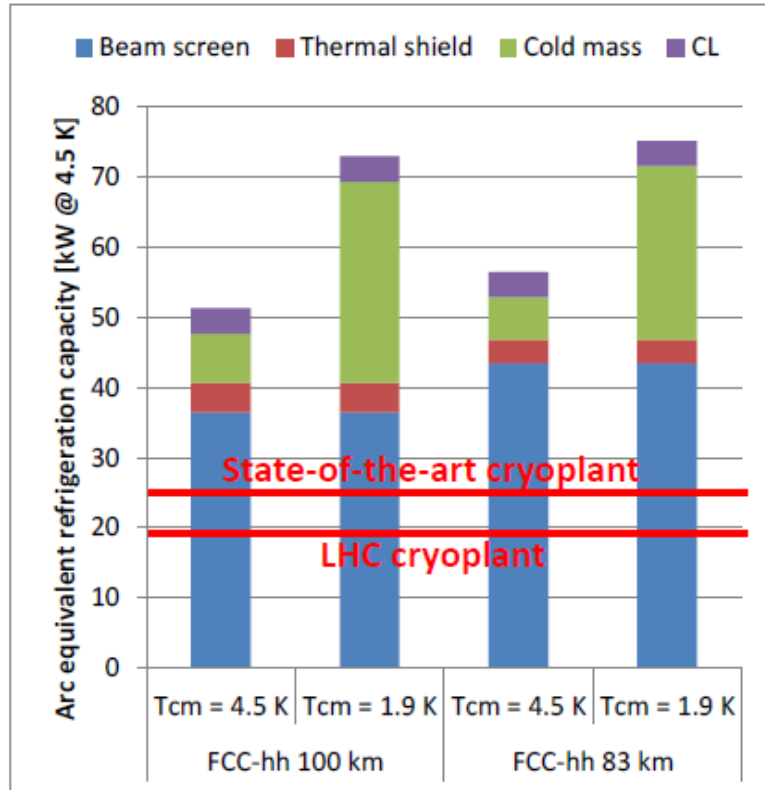


Neon as Refrigerant for the Beam Screen and Current Lead Cooling of the FCC

Hans Quack

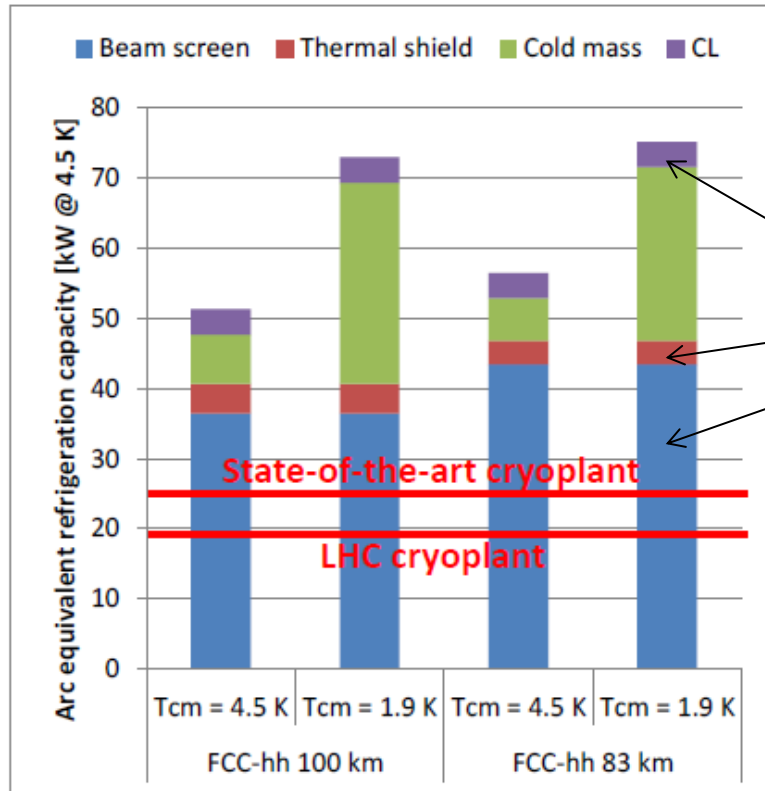
CERN, Sept 10nd, 2014

Per arc



Beam screen , thermal shield and current leads need refrigeration above 40 K.

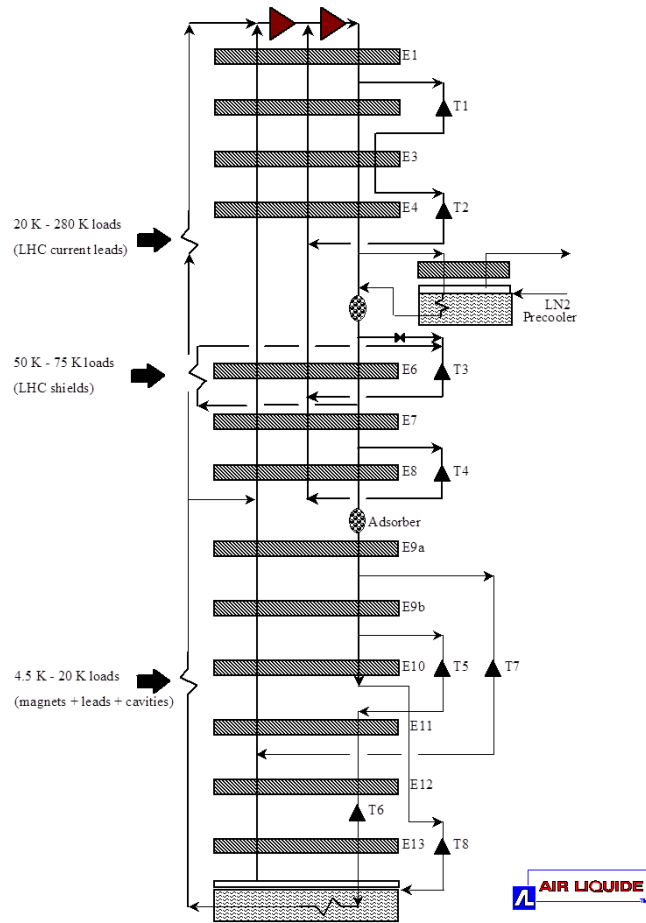
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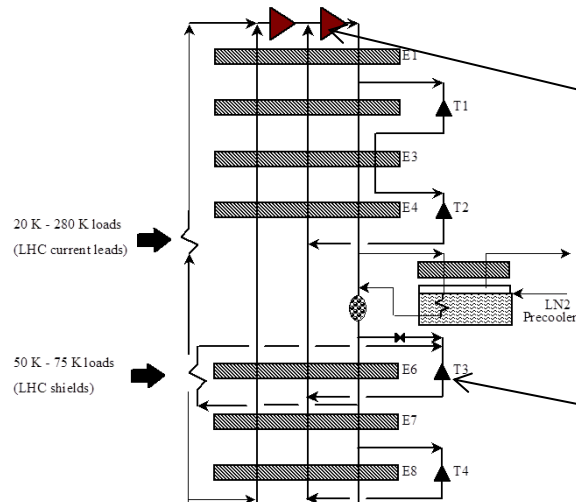
Beam screen , thermal shield and current leads need refrigeration above 40 K.

Together they need more than 50% of the equivalent refrigeration capacity.

There is potential for efficiency improvement and investment cost reduction.



We start with the LHC 4.5 K refrigerator.

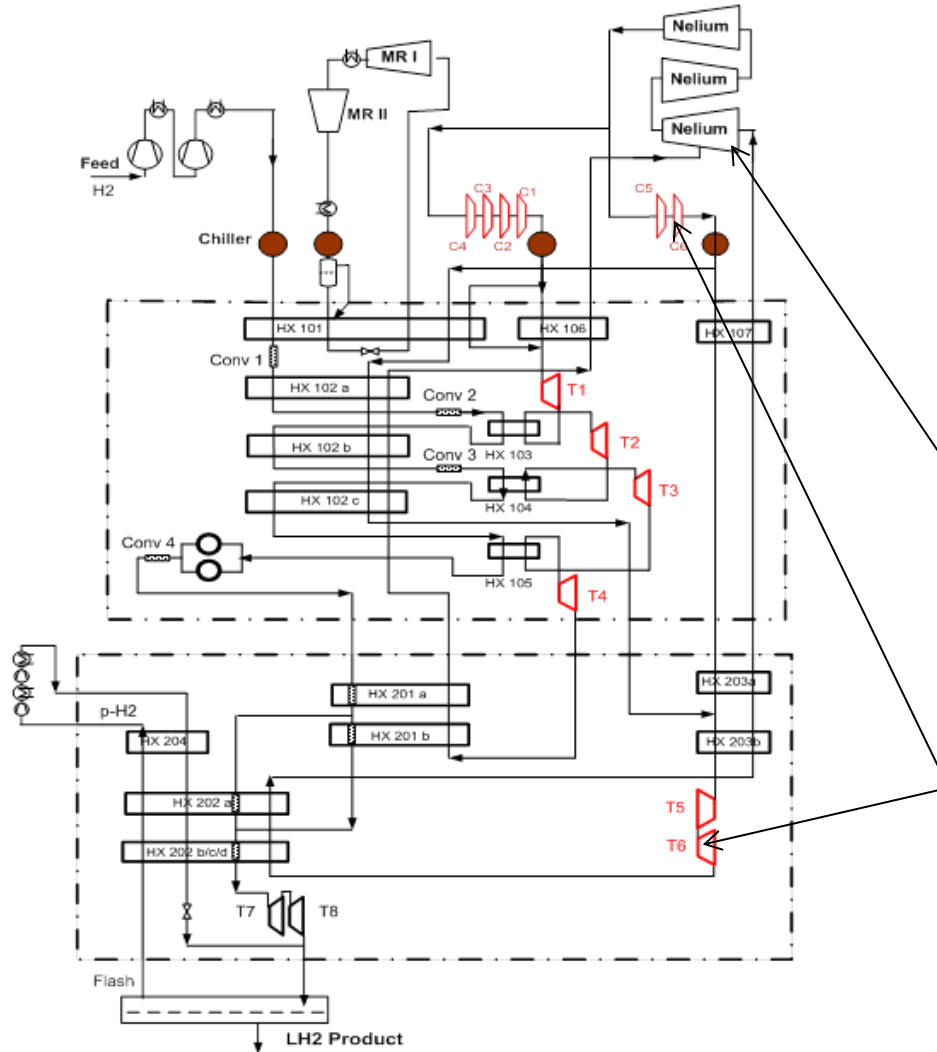


But concentrate on the section above 20 K

Presently used oil flooded screw compressors with 55 % efficiency should be replaced by turbo compressors with 70 % efficiency.

Presently used expansion turbines with power dissipation should be replaced by turbines with power recovery in directly coupled turbo compressors.

Both changes require a working gas with larger molecular weight than helium.



Recently we have studied methods to increase the efficiency of large scale hydrogen liquefiers.

The most effective steps were the choice of a mixture of helium and neon (called "Nelium") as refrigerant

and to recover the power of the cryogenic expansion turbines in directly coupled one-stage turbo compressors.

Replacement of 55 % screw compressors by 70 % turbo compressors brings a reduction of power consumption by 22 %.

Power recovery of turbines brings an additional reduction of power consumption of about 8 %.

An overall reduction of power consumption of 30 % brings a reduction of investment cost of about 15 %.

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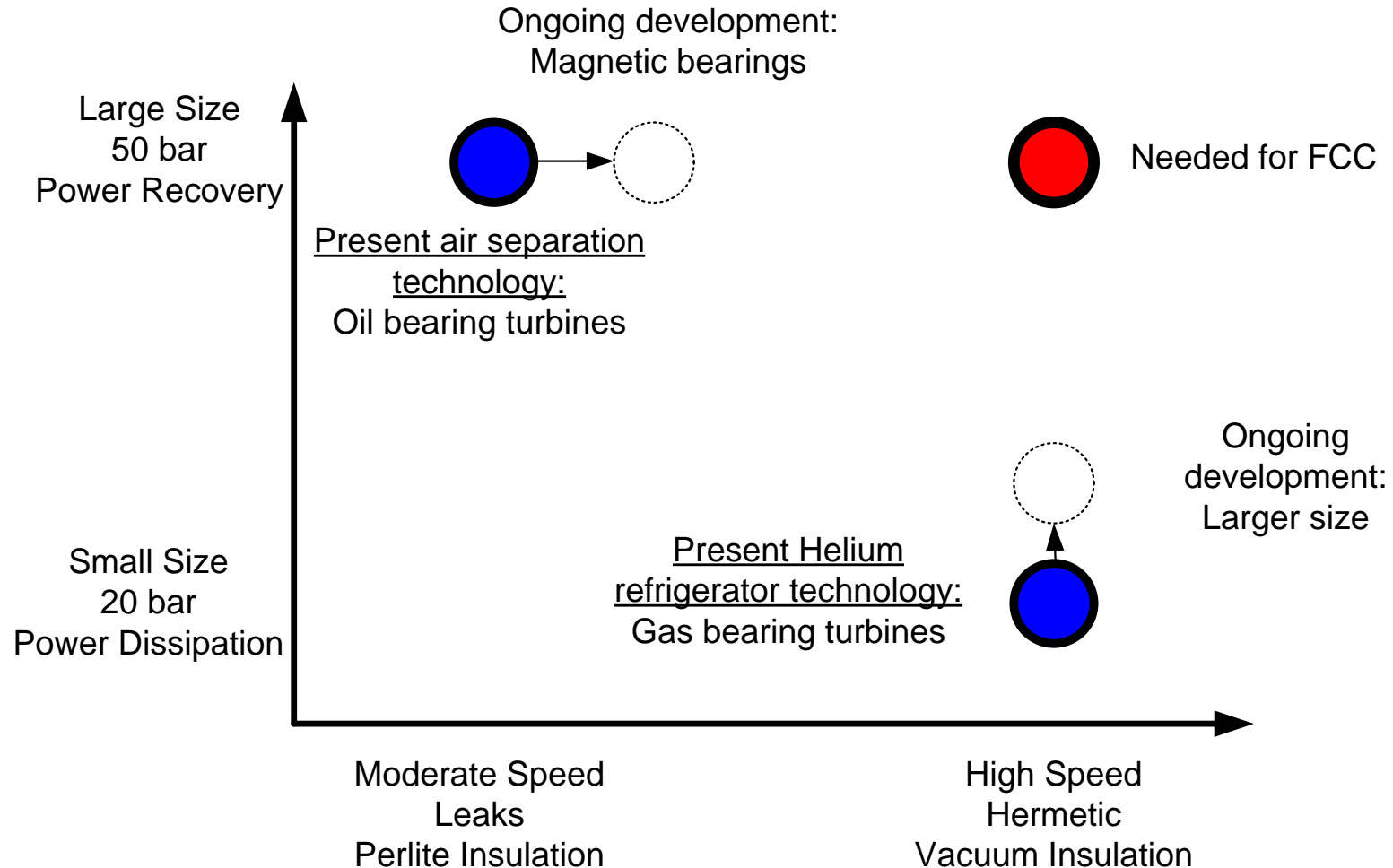
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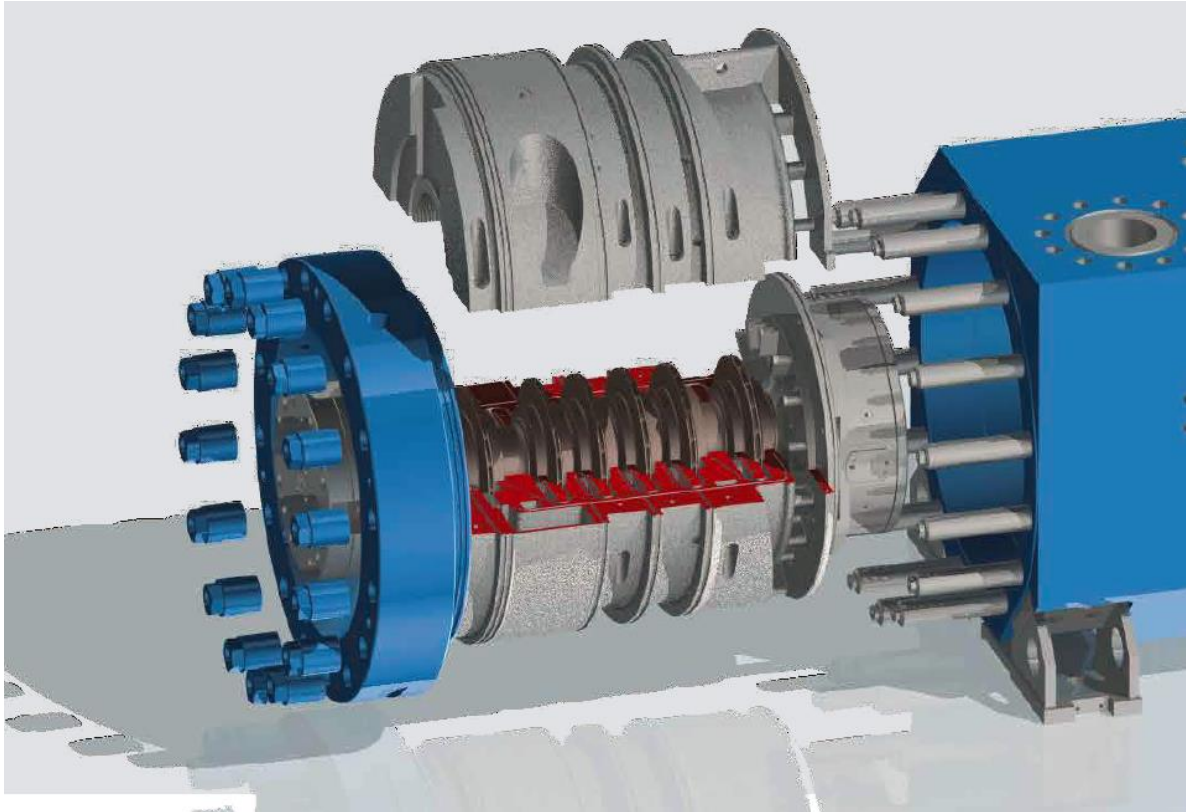
But:

Development work is needed:

Needed Expansion Turbine Development



Needed Turbo Compressor Development

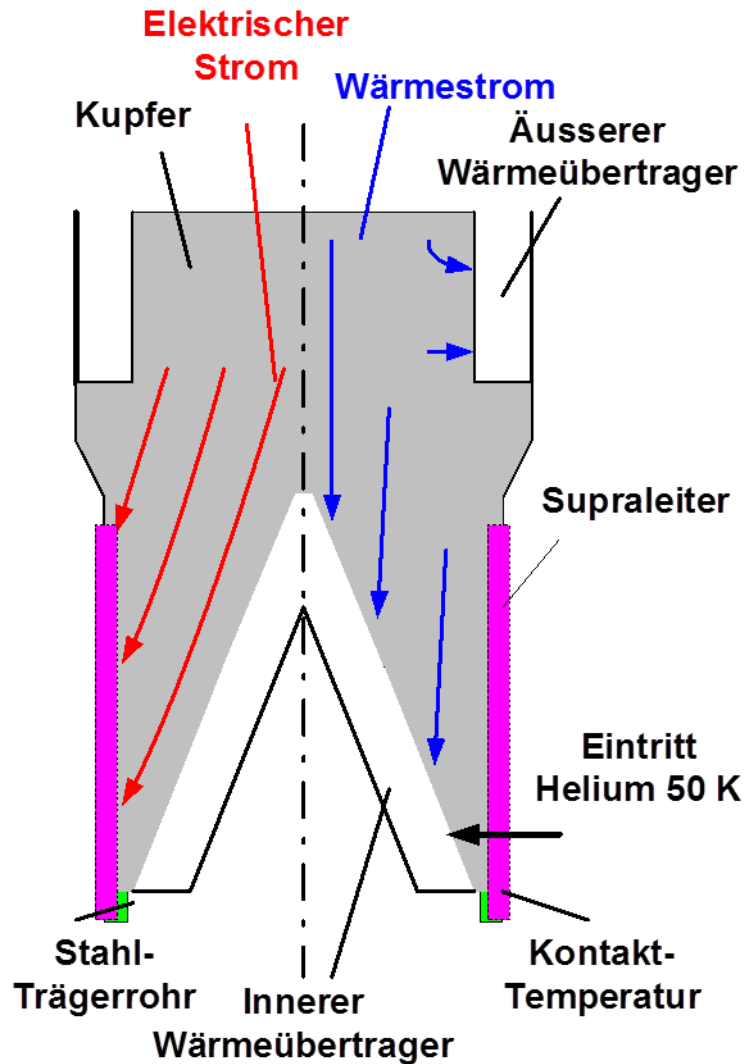


Oilfree turbo compressors with active magnetic bearings and integrated electric motor have been developed for natural gas subsea applications.

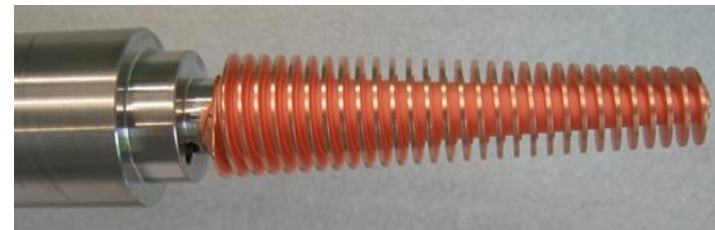
But for Helium one would need:

- New compressor wheel design
- New wheel material
- Higher circumferential speed
- More stages
- Better cooling of motor

Present CERN Current Leads Can be Improved



A reduction of the copper cross section in the transition region between the copper heat exchanger and the superconductor section will lead to a reduction of the needed amount of cooling gas by about 7 %.



Manufacturers of compressors and turbines are not very interested in development programs for uncertain applications. But in the end their cooperation is needed.

Our task as researchers are:

- Optimize process and heat exchangers: Clarify specification
- Identify aspects, which make machine development easier (e.g. chiller before entry into coldbox, which leads to lower suction temperature)
- Basic research e.g.
 - Thermophysical properties of Helium
 - Ideal shape and material for Helium compression wheels
- Identify applications with similar requirements (Hydrogen liquefaction, high temperature superconductivity applications)