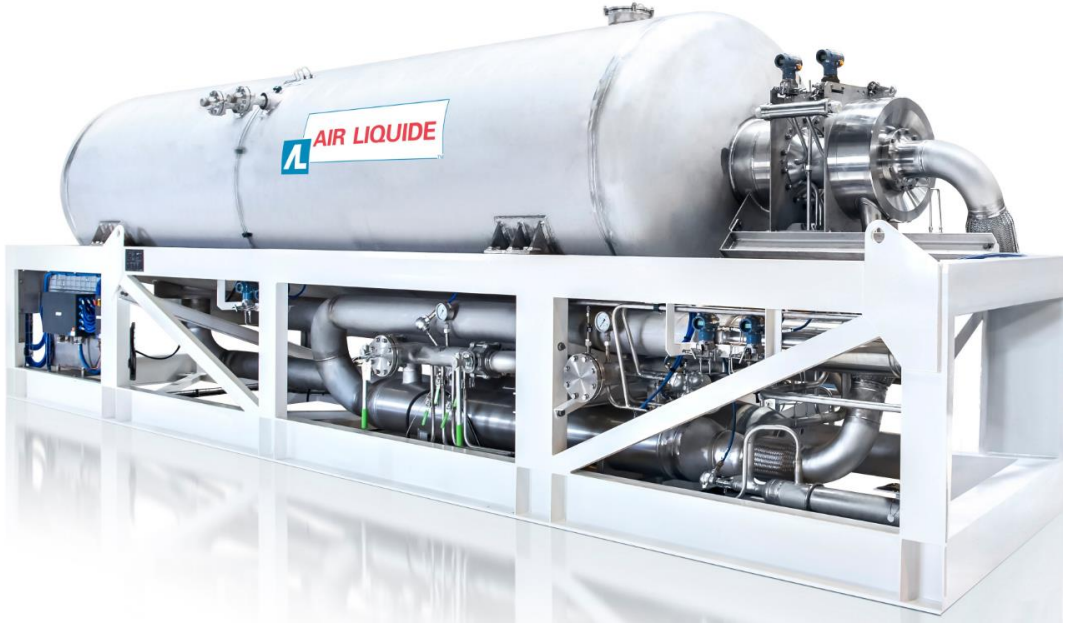
Turbo-Brayton cryogenic systems

An ideal solution for refrigeration

EASISchool2 – Oct 4th 2019 - Cécile Gondrand



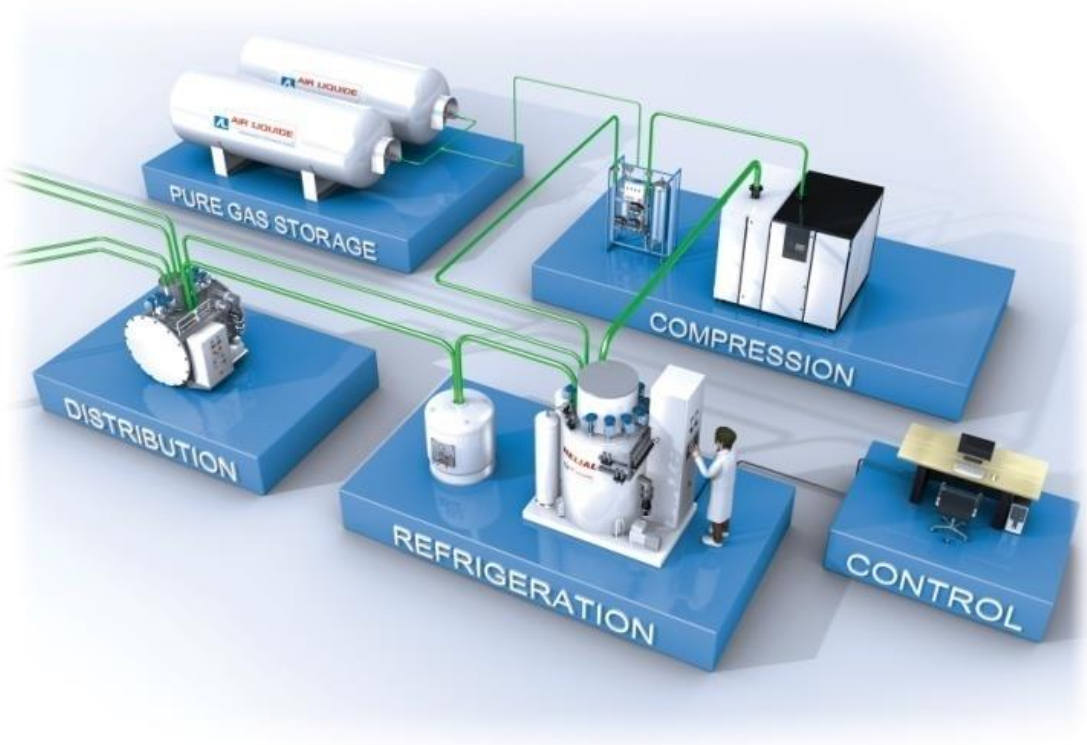
Outline

- Introduction
- From conventional Brayton to Turbo-Brayton
- Product line range
- Example of applications
- Conclusion

Introduction

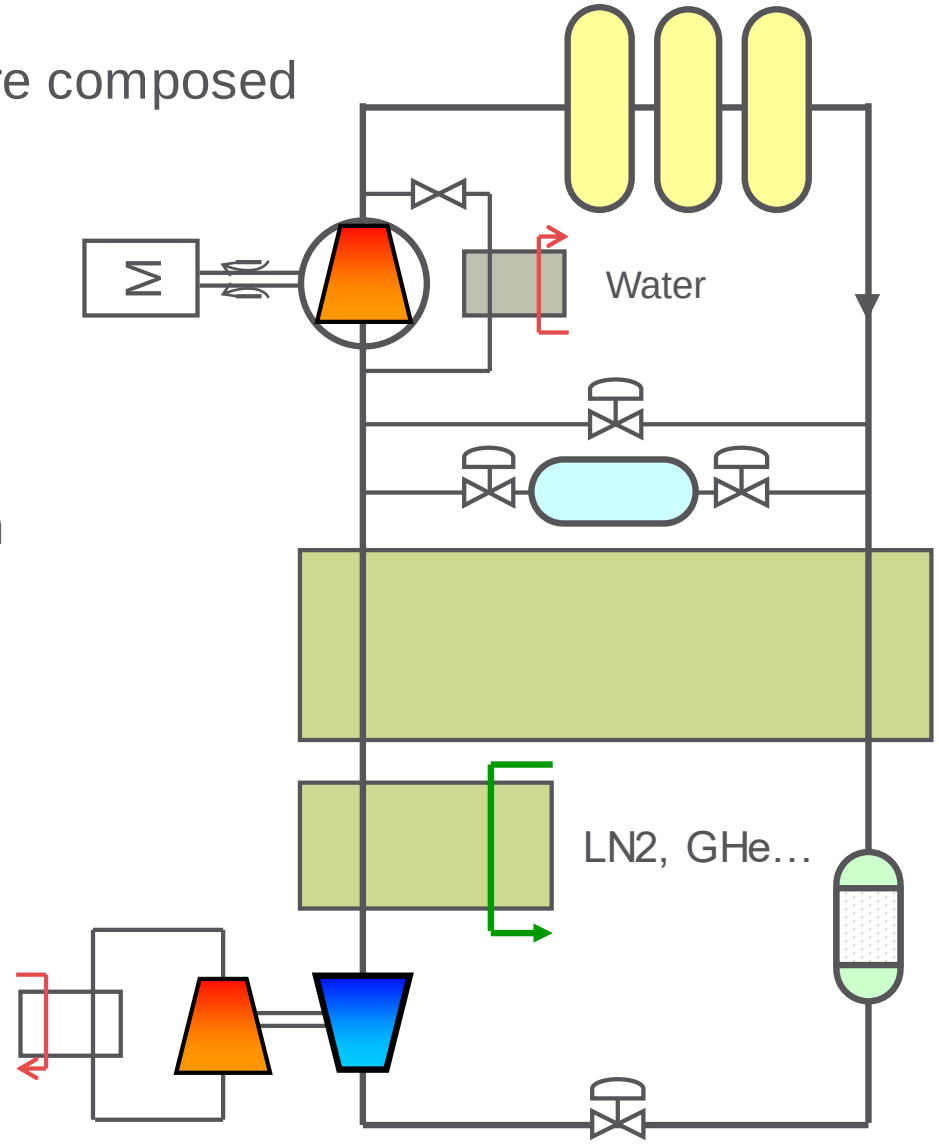
Turbo-Brayton - Introduction

- In order to produce cold
  - Compress gas
  - Expand gas
  - Heat exchanger to transfer the cold to an application

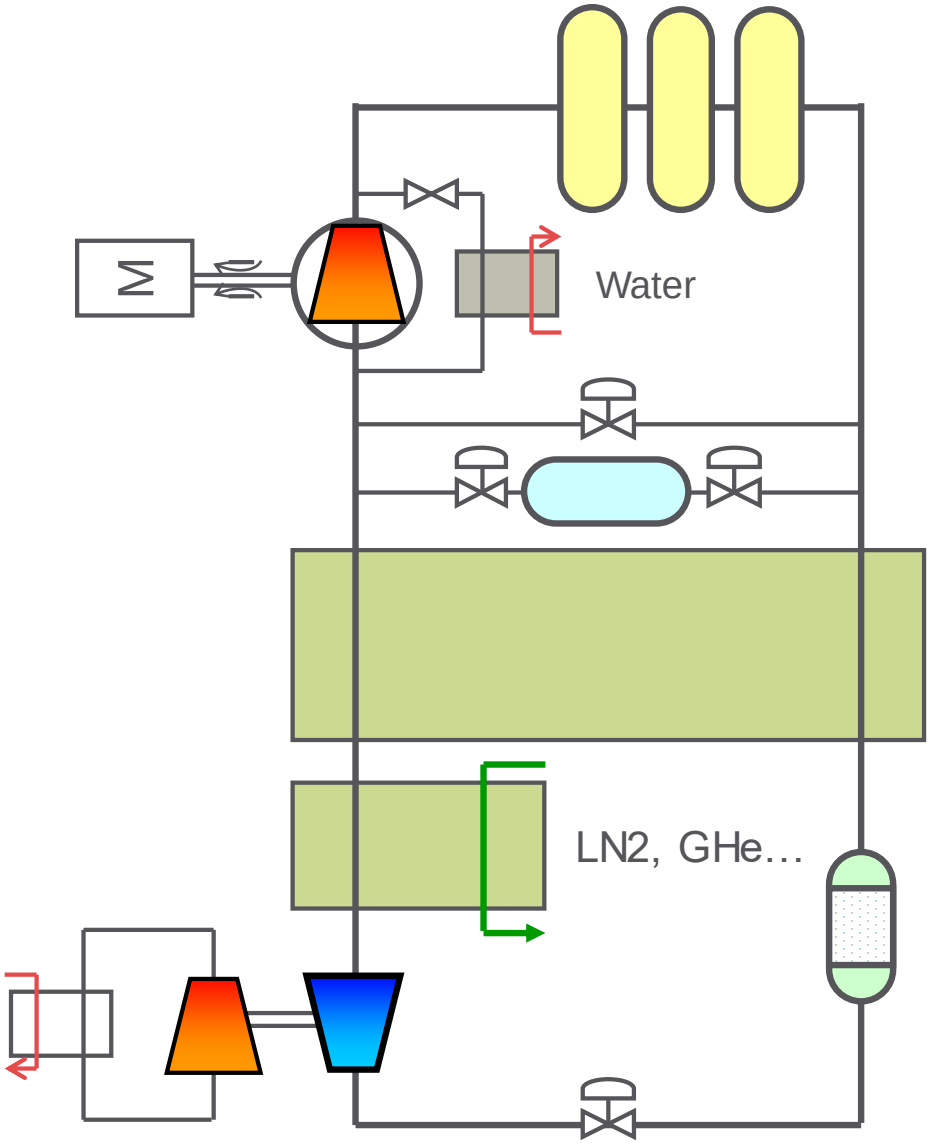


From conventional Brayton to Turbo-Brayton

- Classical Brayton refrigerators are composed of:
  - A lubricated screw compressor
  - An Oil Removal System (ORS)
  - A pressure management system
  - Cryogenic heat exchangers
  - A purification system (adsorber)
  - A cryogenic expander

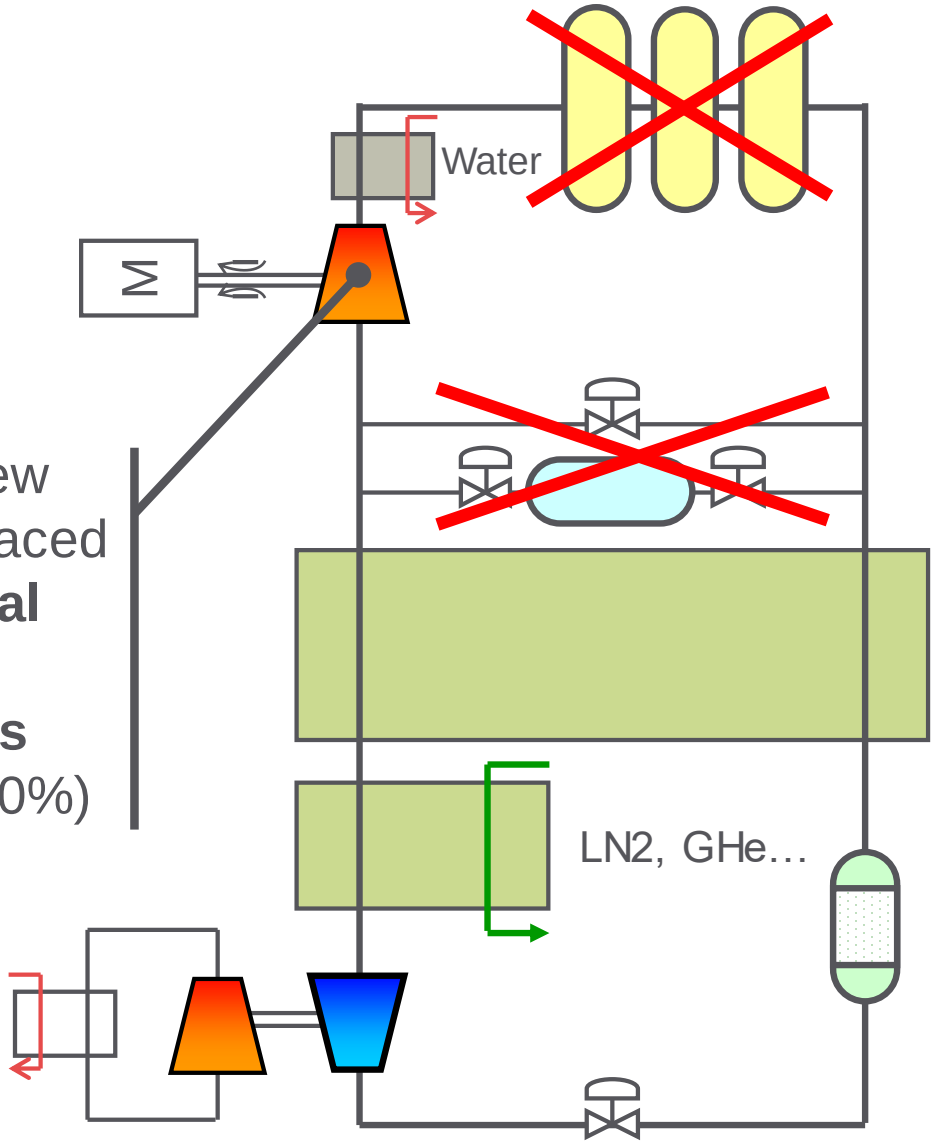


From conventional Brayton to Turbo-Brayton



From conventional Brayton to Turbo-Brayton

The lubricated screw compressor is replaced by a **dry centrifugal compressor on magnetic bearings** (Pelec : -12% to -20%)

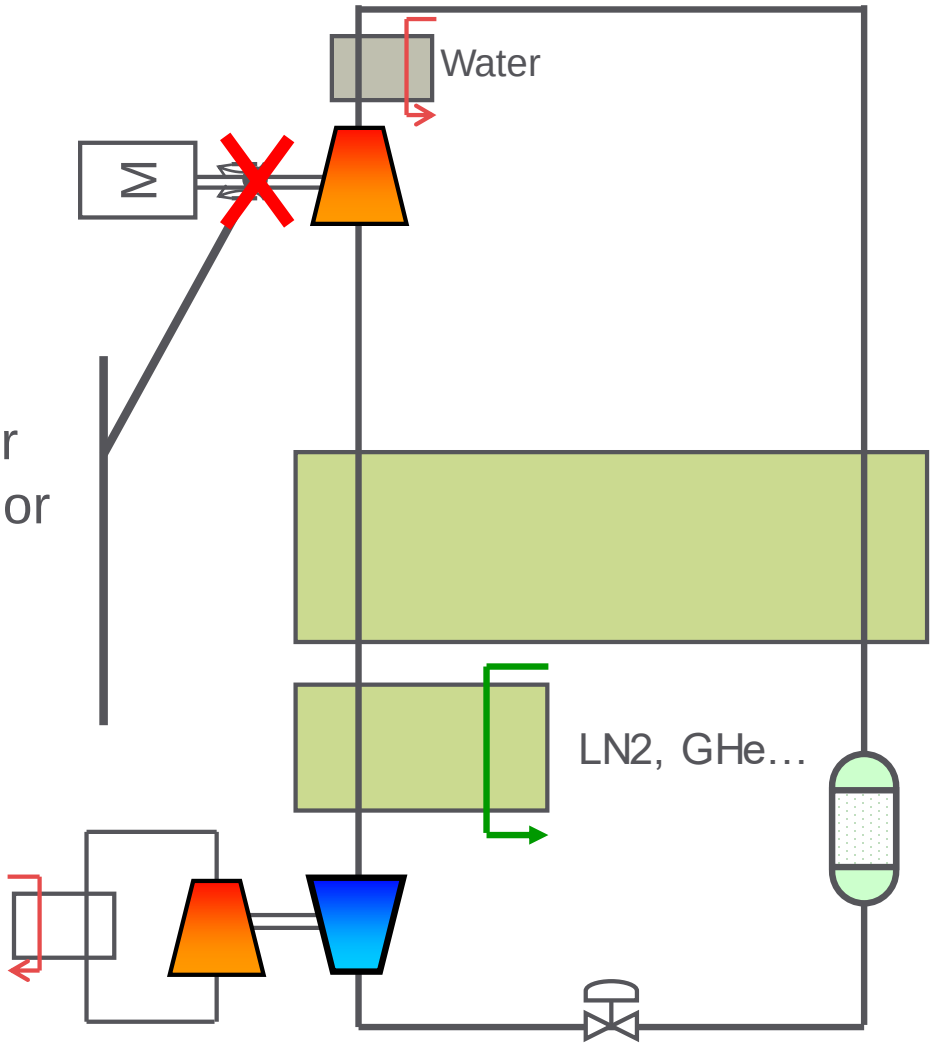


Removal of the ORS

Removal of the pressure management system

From conventional Brayton to Turbo-Brayton

The rotating seal between the motor and the compressor is replaced by a **hermetic moto-compressor**



From conventional Brayton to Turbo-Brayton

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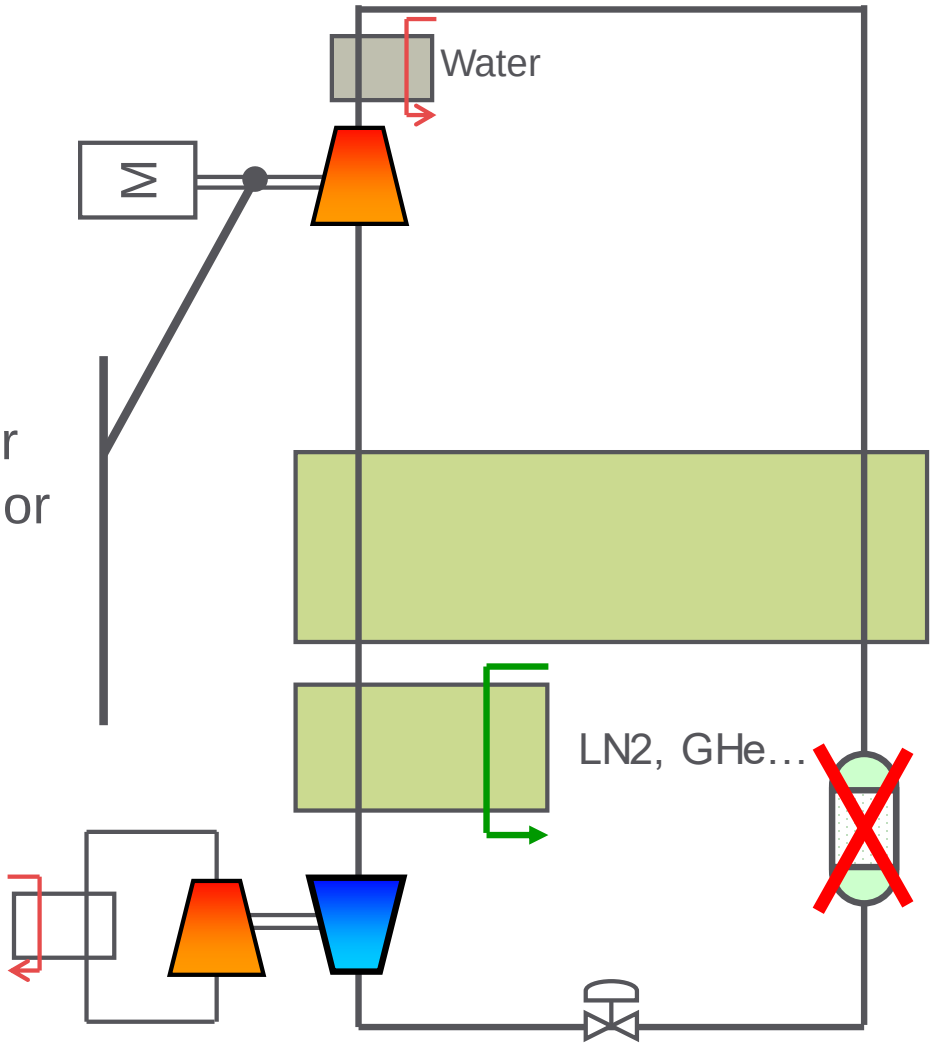
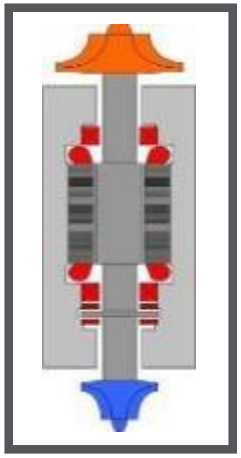


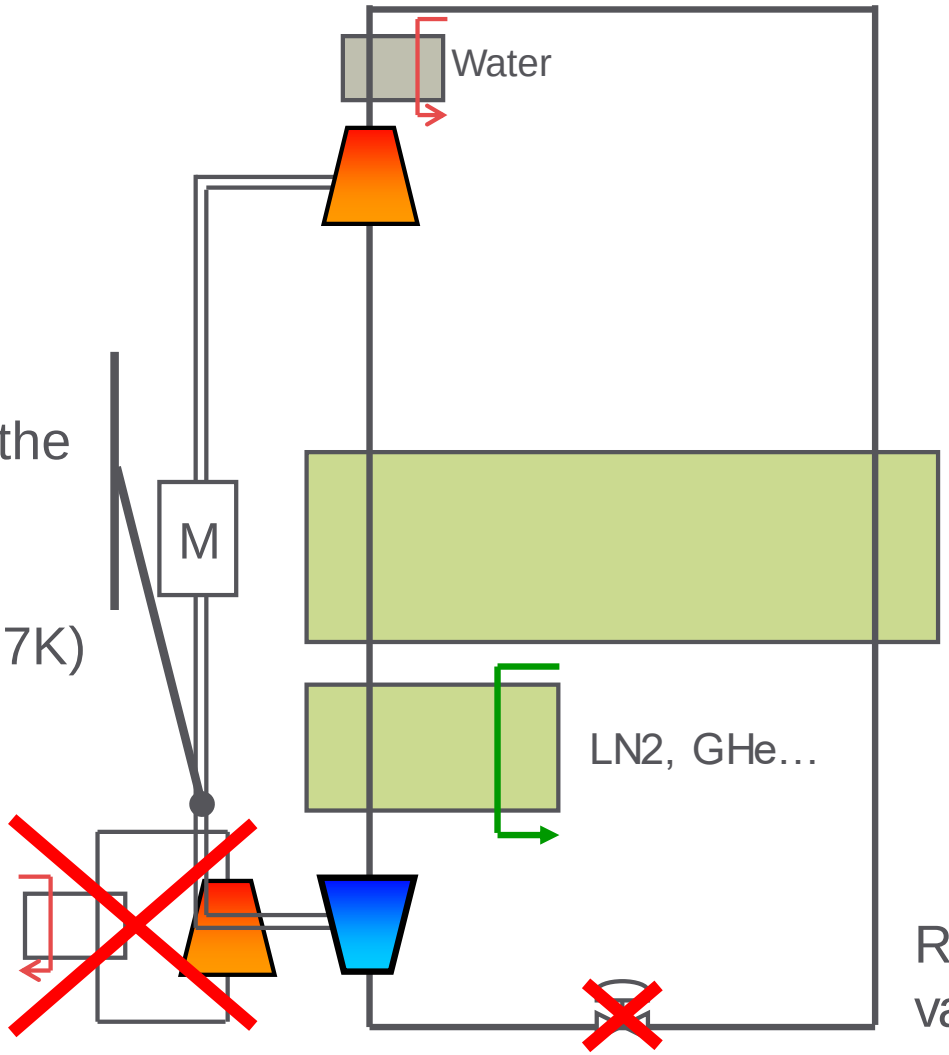
Removal of the adsorber

From conventional Brayton to Turbo-Brayton



The expander is directly linked to the motor: power recovery

(Pelec: -10%@77K)

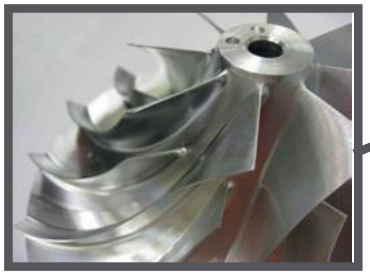


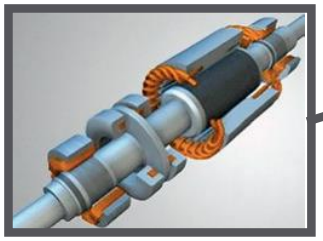
Removal of the brake

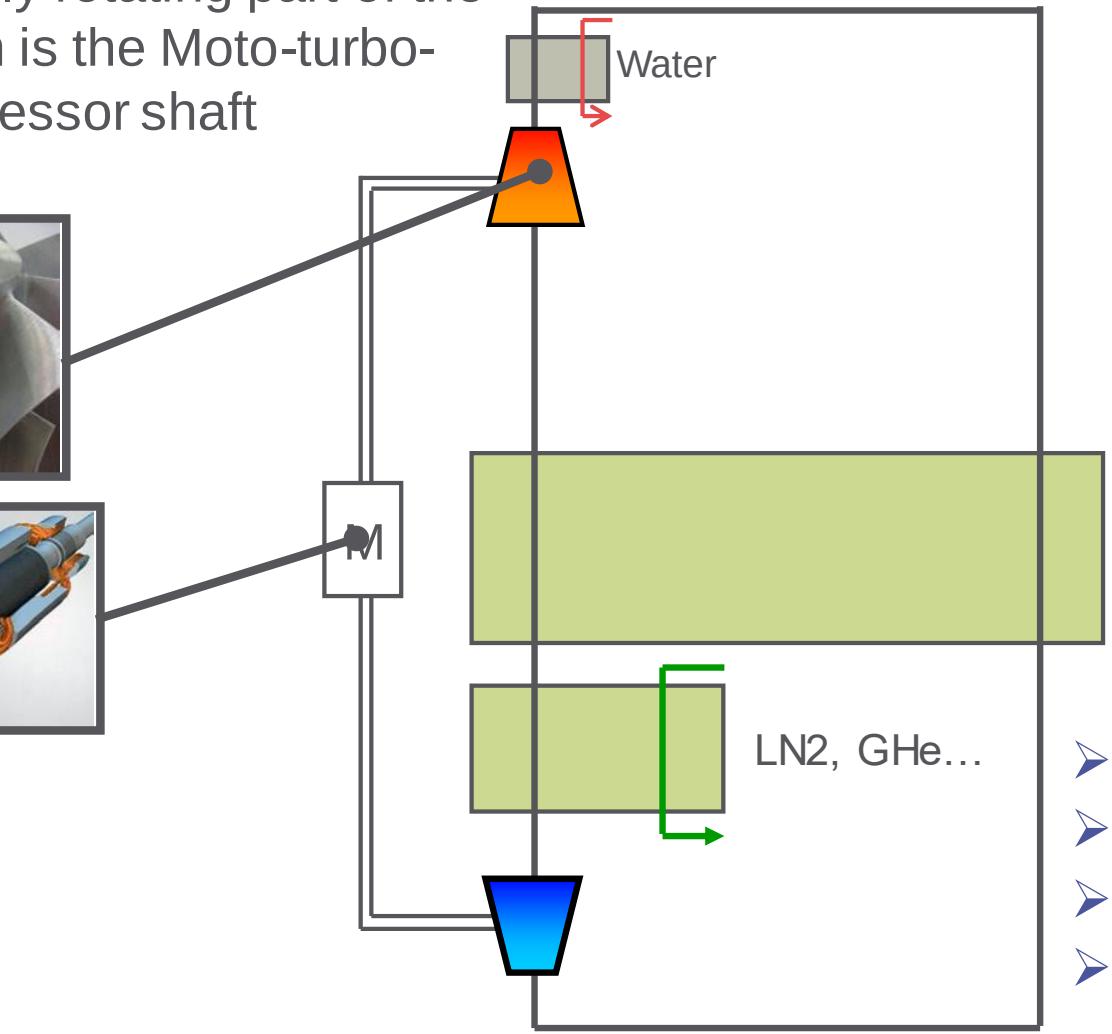
Removal of throttling valve

From conventional Brayton to Turbo-Brayton

- The only rotating part of the system is the Moto-turbo-Compressor shaft

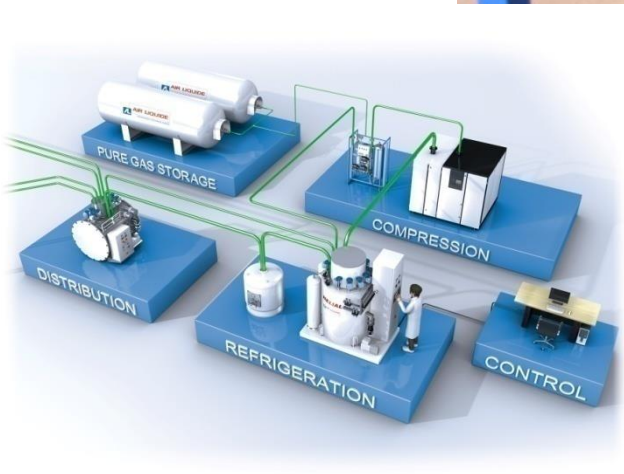






- High efficiency
- No maintenance
- High reliability
- High lifetime

From conventional Brayton to Turbo-Brayton



Range

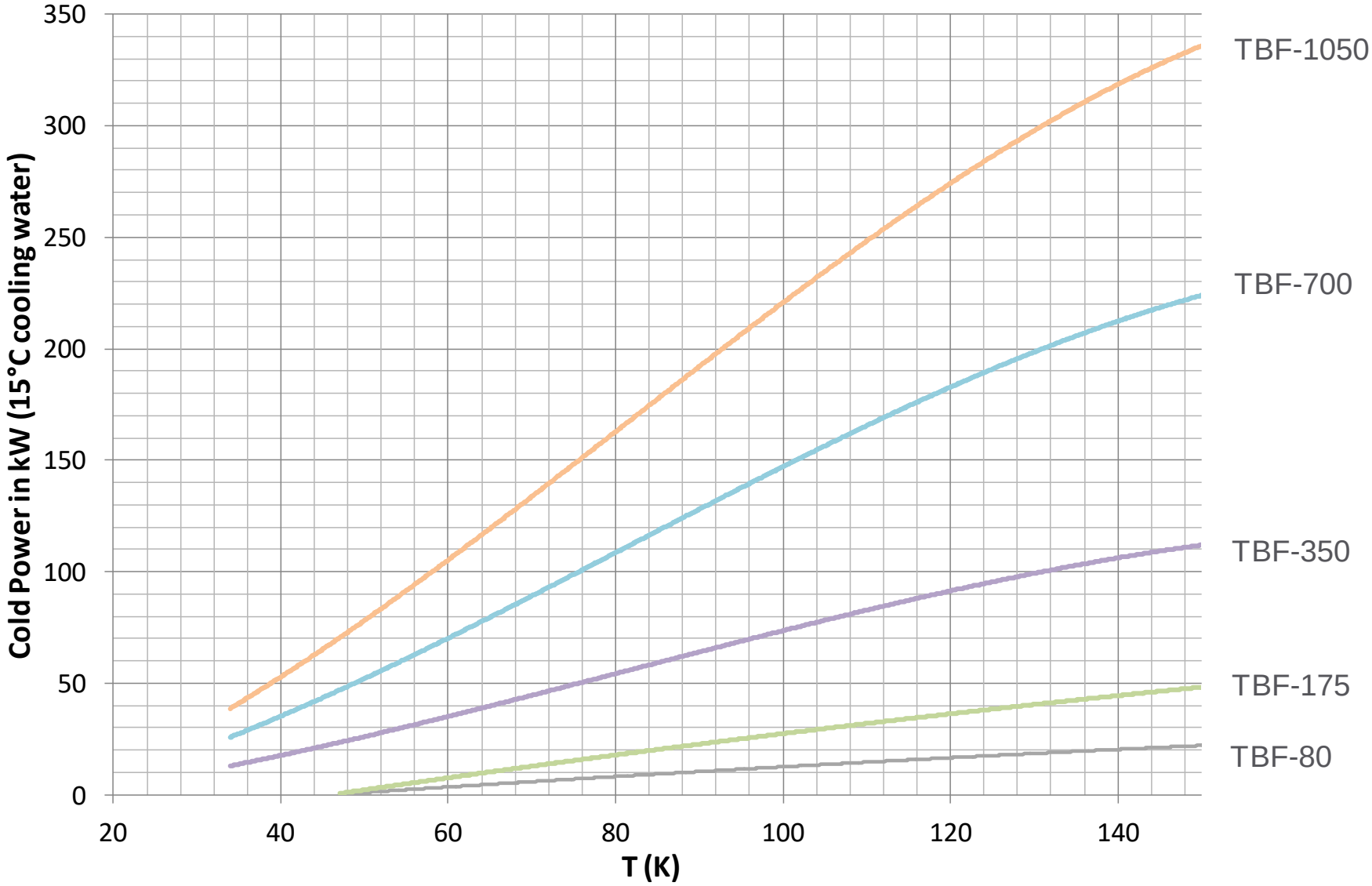
Turbo-Brayton – Range and applications

- This product line is composed of standard products for refrigeration

Product range	TBF-80	TBF-175	TBF-350	TBF-700	TBF-1050	TBF-1225

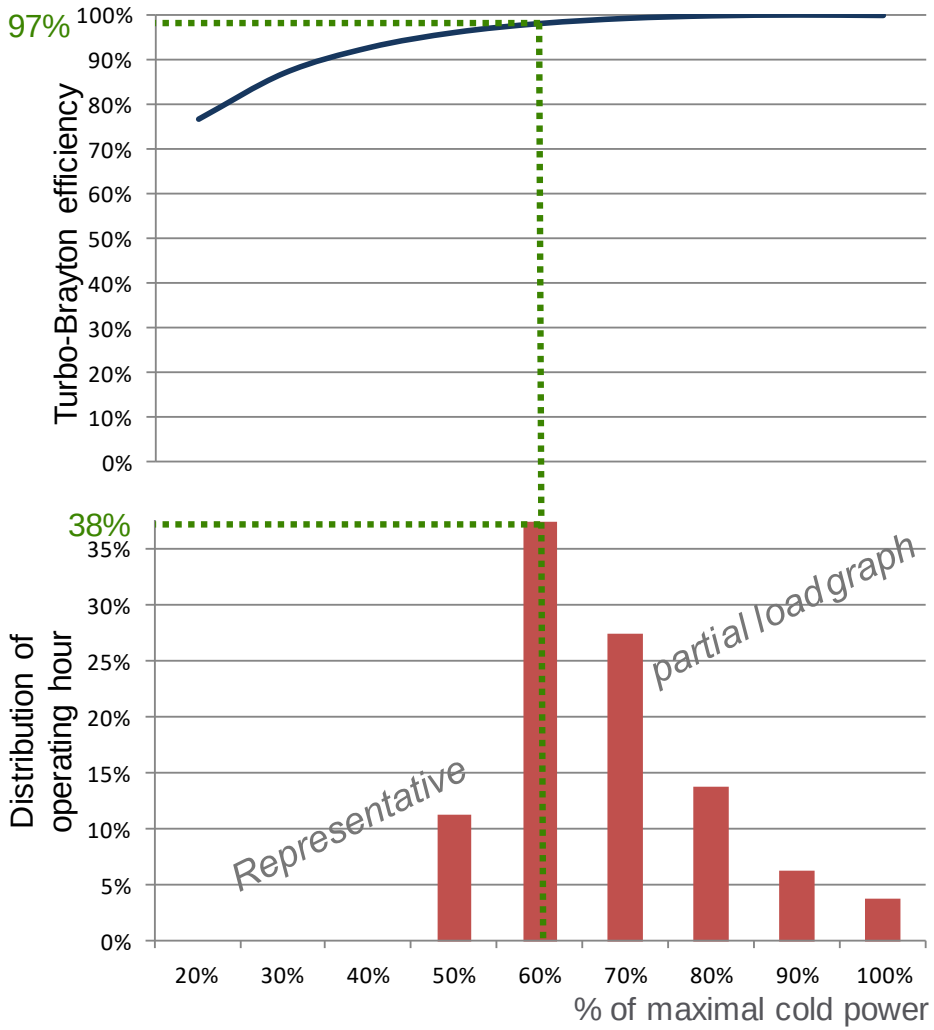
  - Range : 15 – 150 K
  - High efficiency > 40% Carnot

Turbo-Brayton – Cooling power vs temperature



Turbo-Brayton – Efficiency at partial load

- High efficiency is an advantage for full load, but even more at partial load. And that is exactly where most refrigerators operate.
  - **At 60 % partial load, the overall efficiency of the refrigerator is only decreased by 3 %**



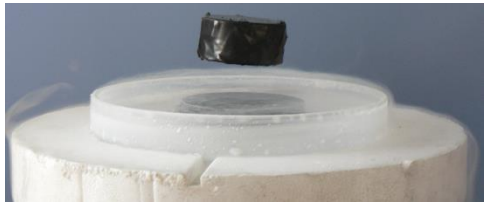
- The cold power is automatically adjusted from 0 to 100 % by varying the speed of the motor. No valves nor heater are needed.

Applications

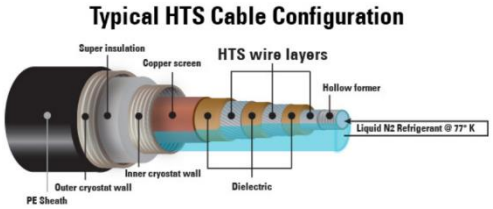
References – TBF-80

References - HTS cable cooling

- What is Superconductive material ?
  - Material with low electrical resistance and high magnetic field
  - Can be reached below a critical temperature



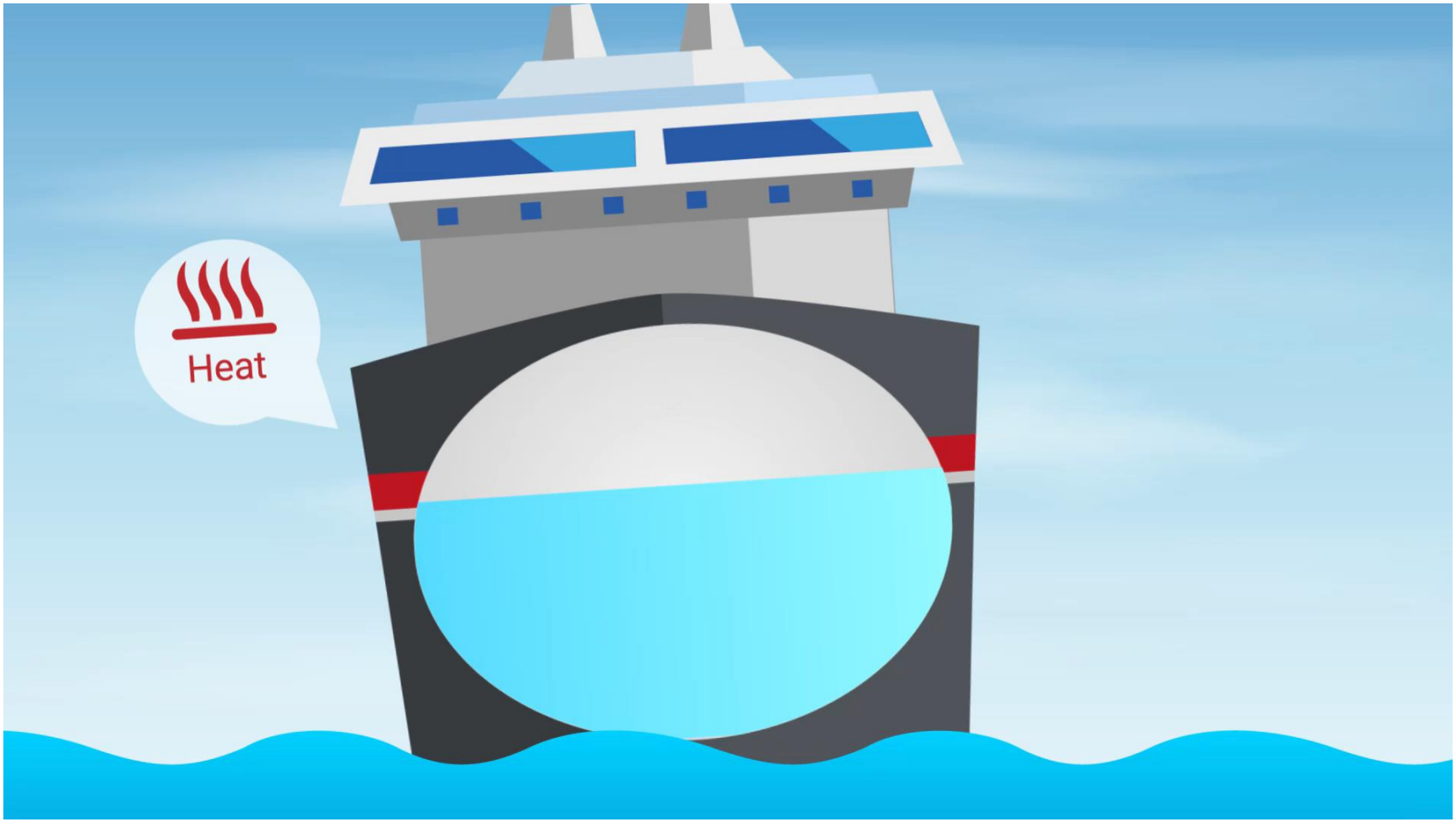
- High Temperature Superconductive cables can transit 5 to 10 times the electrical current of traditional copper or aluminum cables
  - Lower footprint
  - Higher currents can be transported
  - Ideal for long distance transportation or to increase current in saturated urban areas
  - Need of temperature below 77K



References - HTS cable cooling – TBF-175

References - HTS cable cooling – TBF-350

References – On-board reliquefaction of LNG BOG



References – Reliquefaction of LNG BOG – TBF-350

- Application
  - 6,500 m3 LNG bunker vessel

References – Reliquefaction of LNG BOG – TBF-1050

- Application
  - 174 000 m3 LNG carriers

References – Reliquefaction of LNG BOG – TBF-1225

Conclusions

Turbo-Brayton – Main features

- **The key benefits of the Turbo Brayton**
  - Efficient solution thanks to smart process
    - Carnot efficiency > 40%
    - Turndown between 0% and 100% and high efficiency on all operation range
  - Single skid solution
    - Easy installation
    - Plug and play design
    - Short start-up
    - Low foot-print
  - **High reliability**: with contact free, oil free technology - MTBF = 105 000 h
  - **Utility free**: no compress air, no oil, no nitrogen or any process gas make-up
  - **Drastically reduced maintenance** = few days each 5-years

- **A complete range of products**
  - Covering wide range of applications

Thank you for your attention