Air Liquide cryogenic solutions for HTS refrigeration

Focus on Turbo-Brayton

Cécile Gondrand – ICEC25 – July 9th 2014

Outline

- Turbo-Brayton for HTS: Why?
- Turbo-Brayton description
- Product line range
- Recent developments
- Conclusion

Turbo-Brayton – Why?

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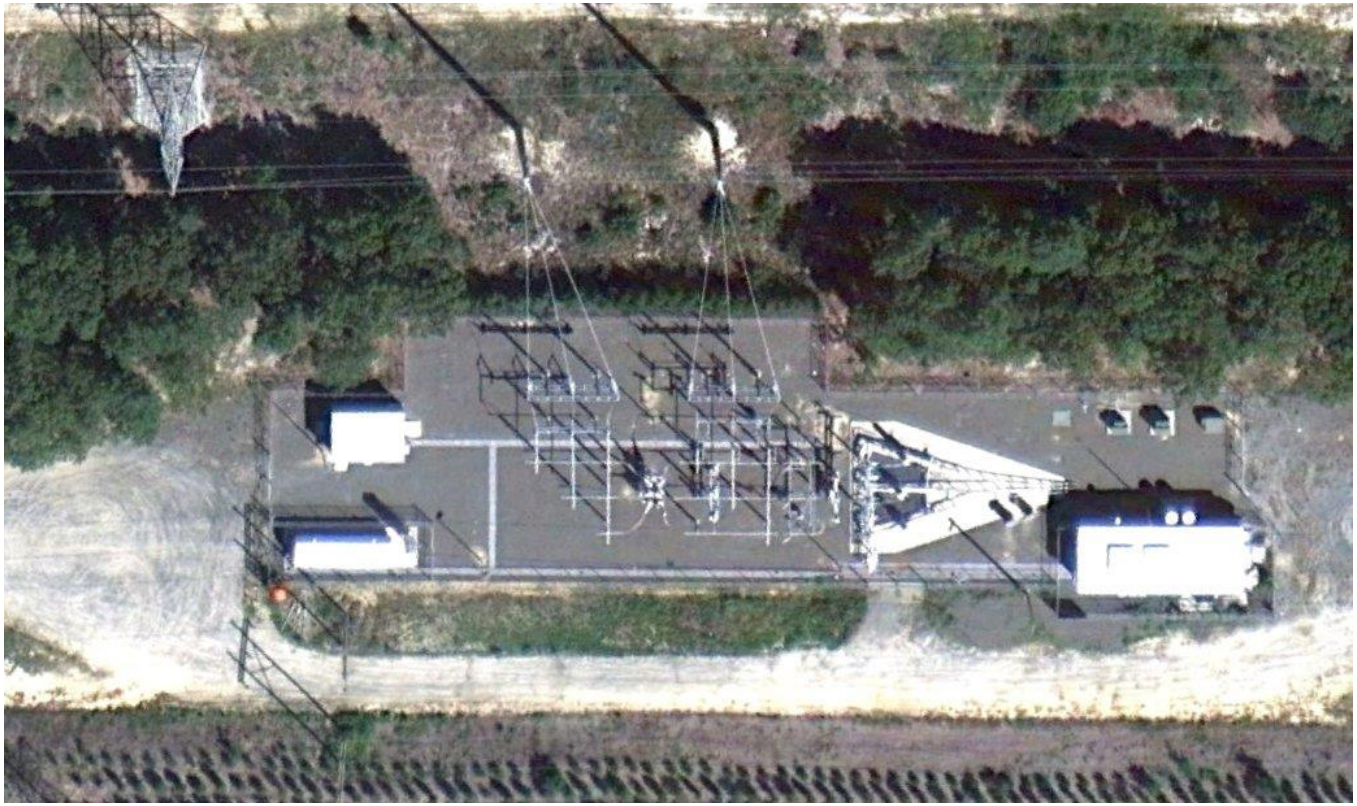

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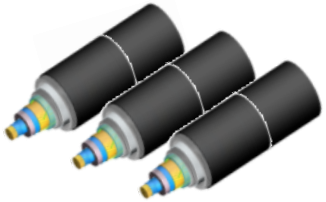
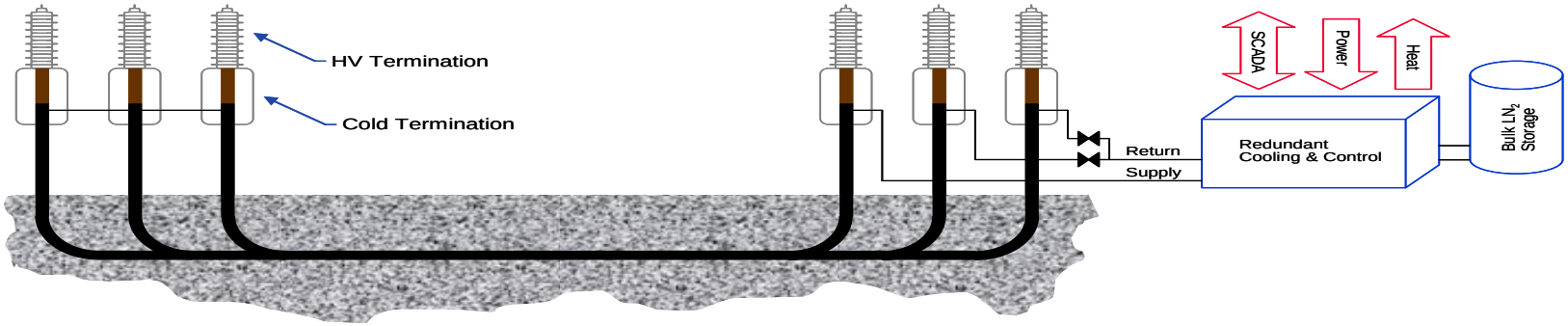
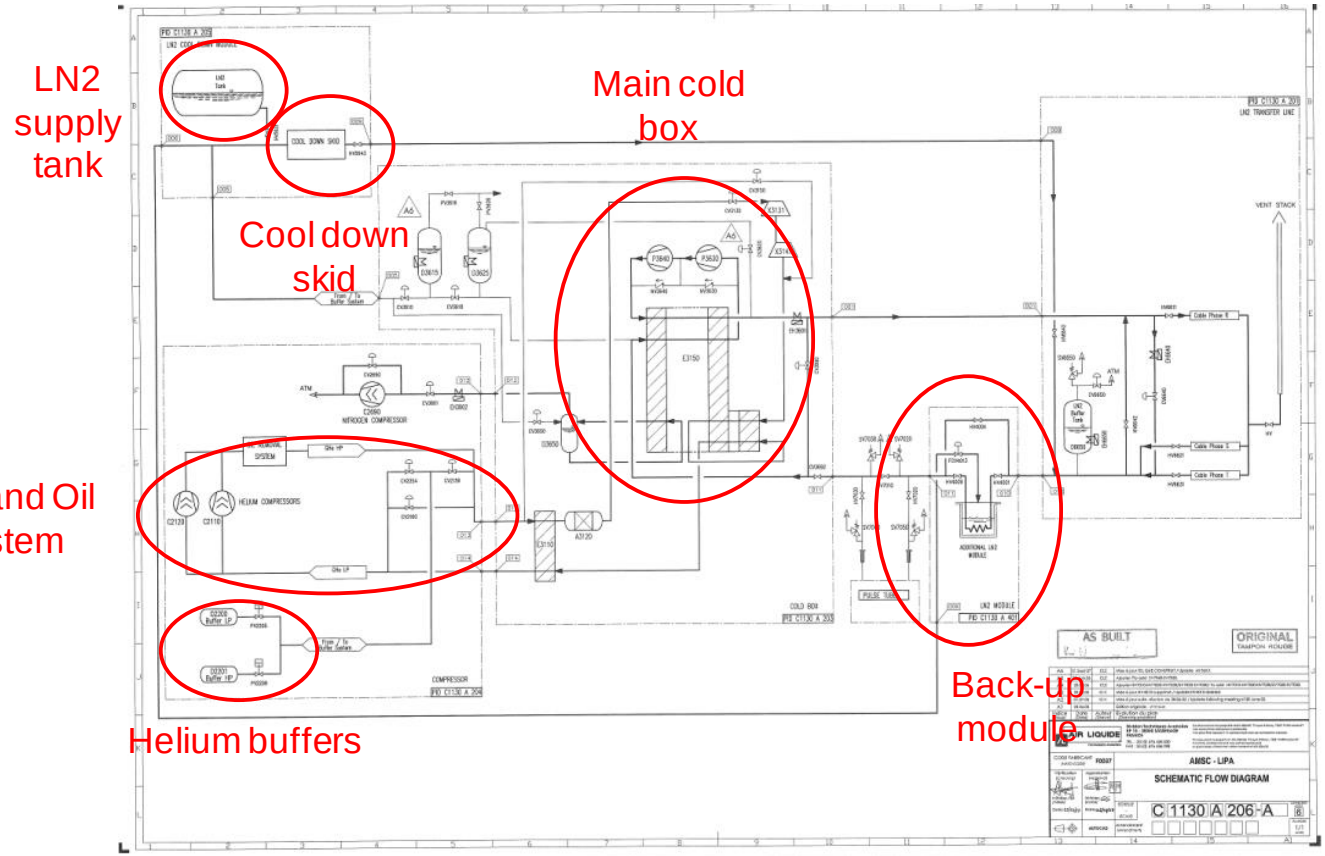




Turbo-Brayton – Why?

- LIPA experience
  - Classical Brayton refrigerator
  - Several modules for the overall operation



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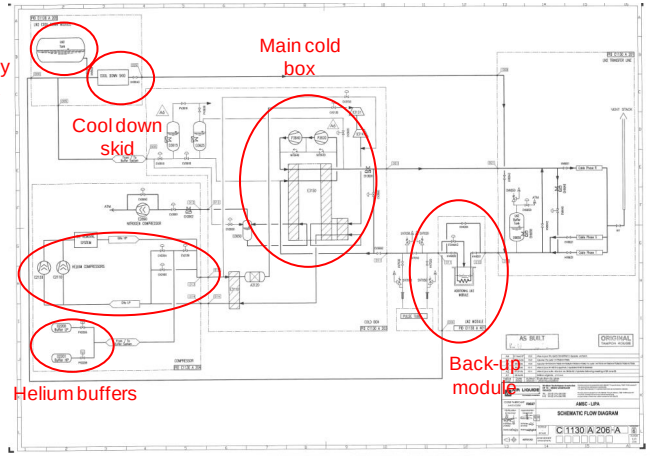
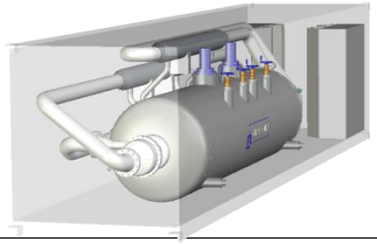


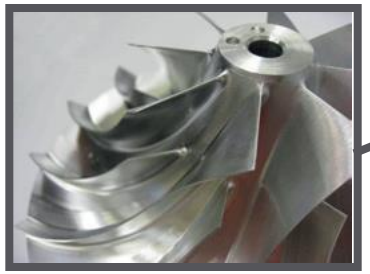
- Lessons learnt
  - Simplify the overall system
    - Only one skid => easy and quick installation and commissioning
    - Easier operation and control system
  - Improve the reliability of the refrigerator and its components
  - Improve the efficiency of the refrigerator, with an easy adjustable heat load

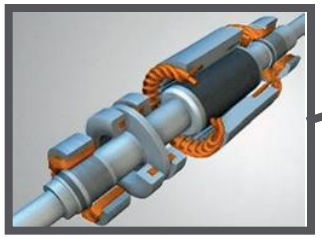
➔ **Turbo-Brayton**

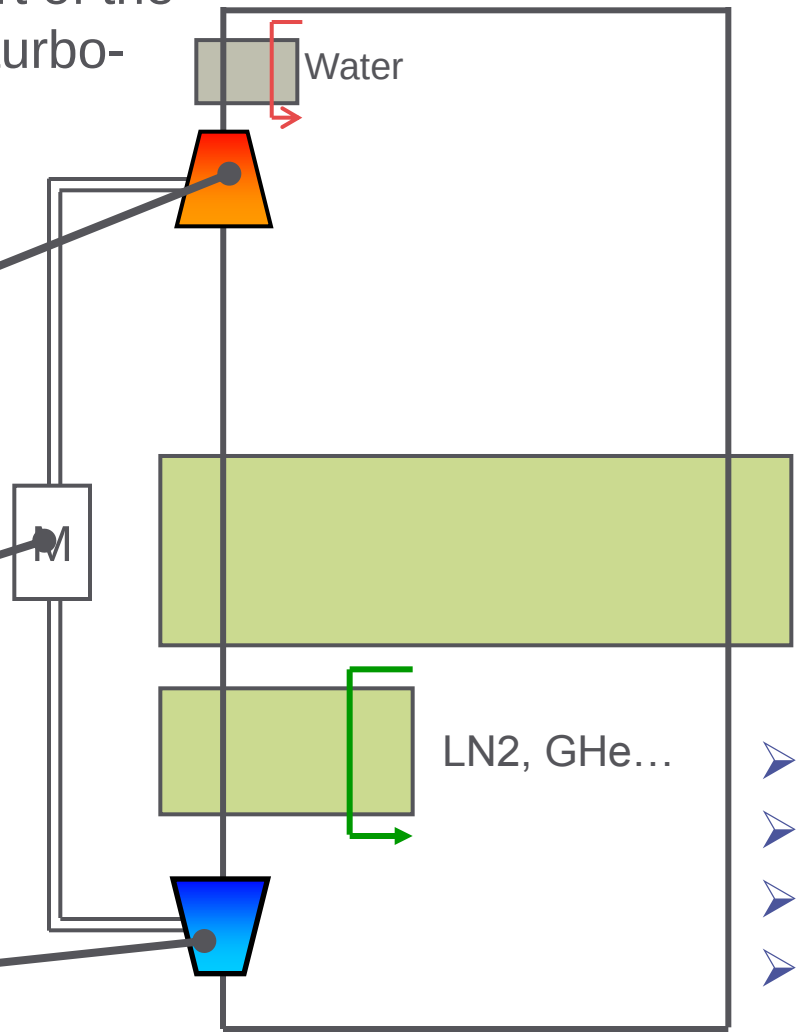


From conventional Brayton to Turbo-Brayton

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

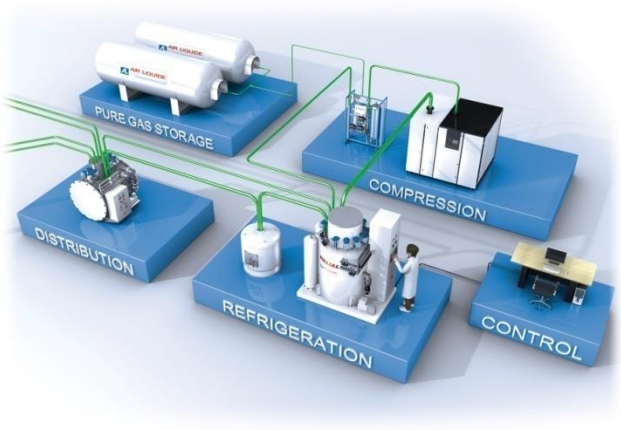






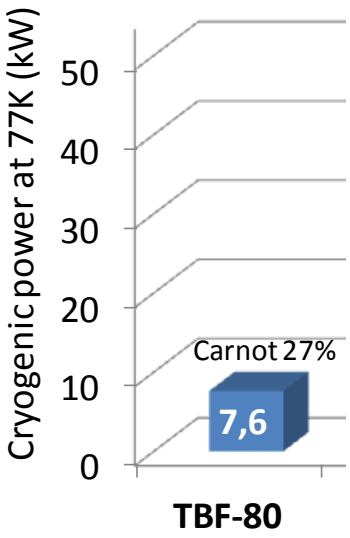
- High efficiency
- No maintenance
- High reliability
- High lifetime

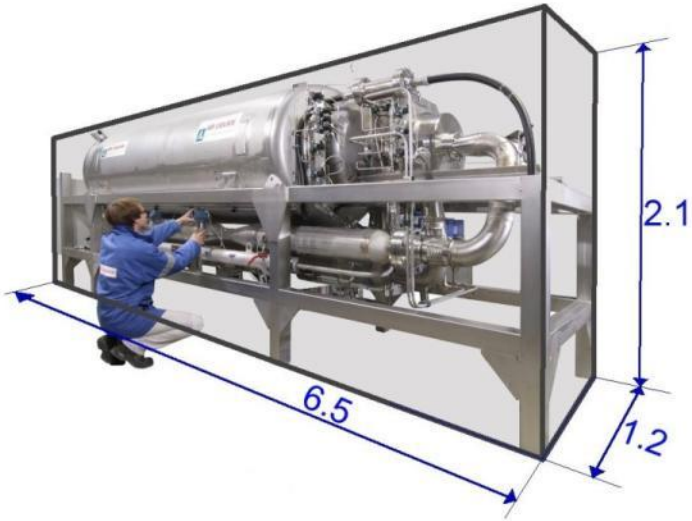
From conventional Brayton to Turbo-Brayton

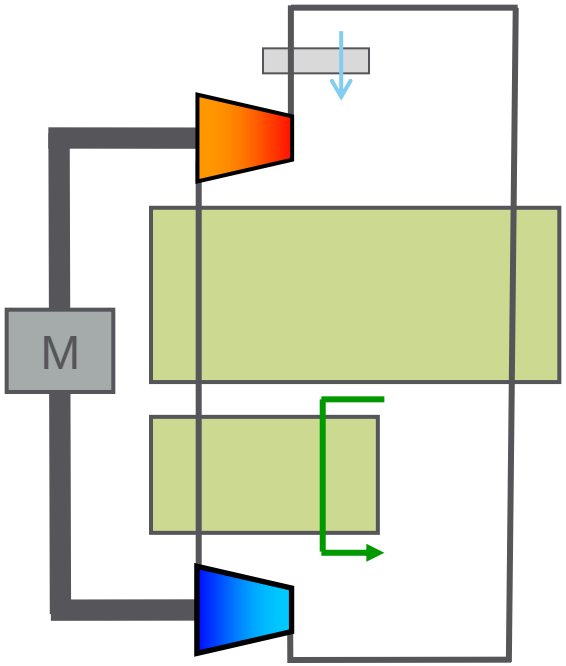


Turbo-Brayton product line range

Turbo-Brayton Product line – Range







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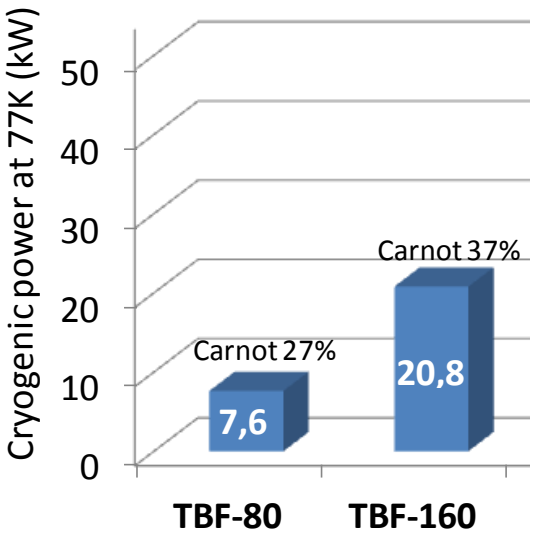

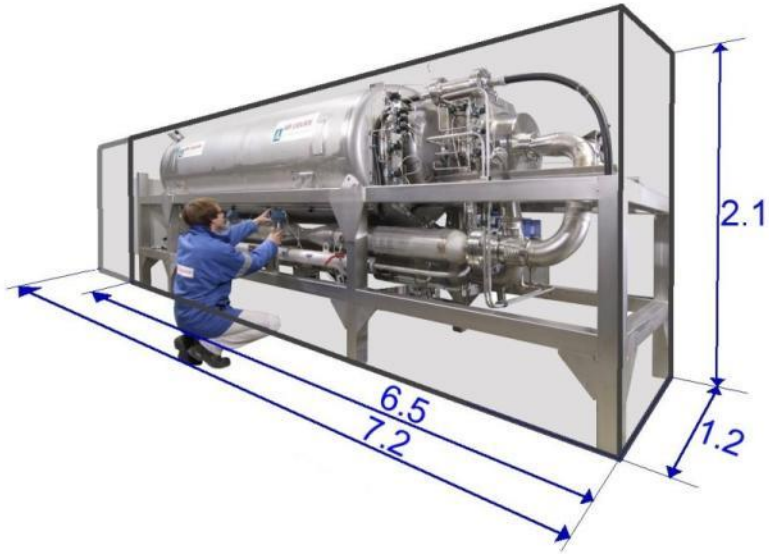

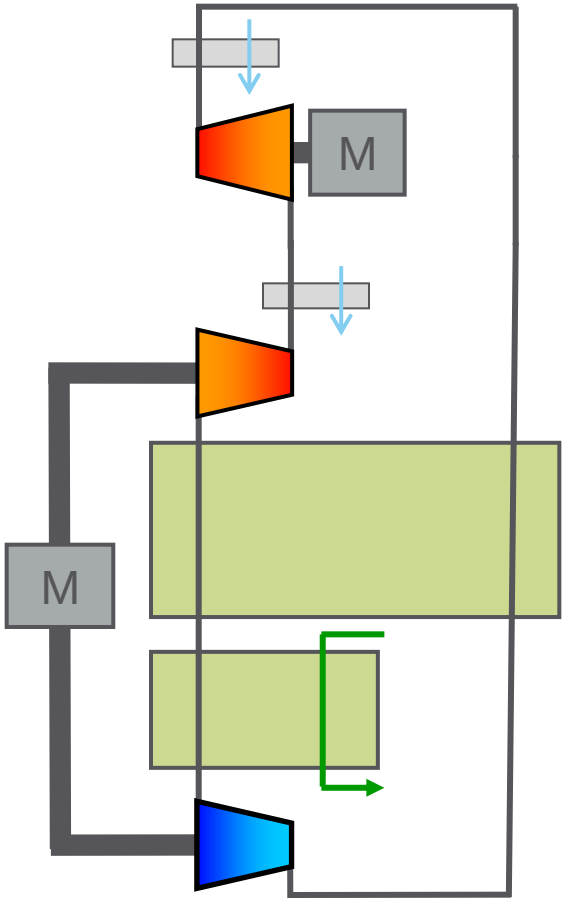

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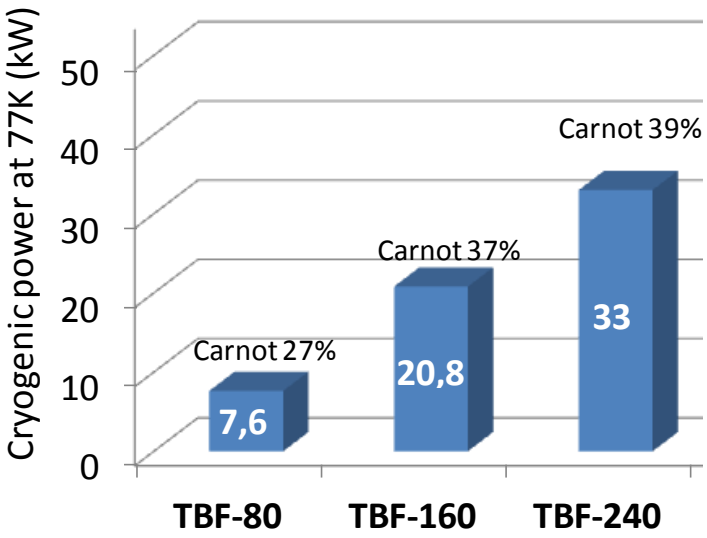

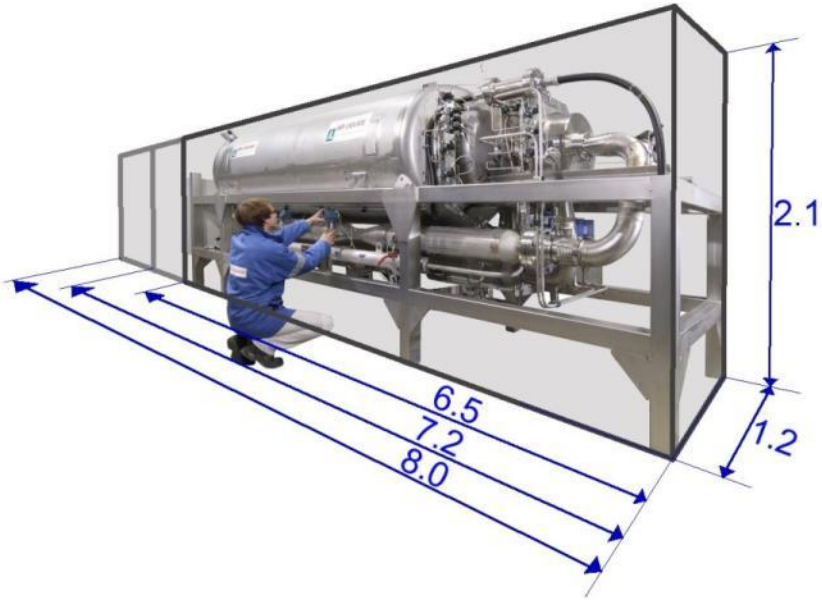

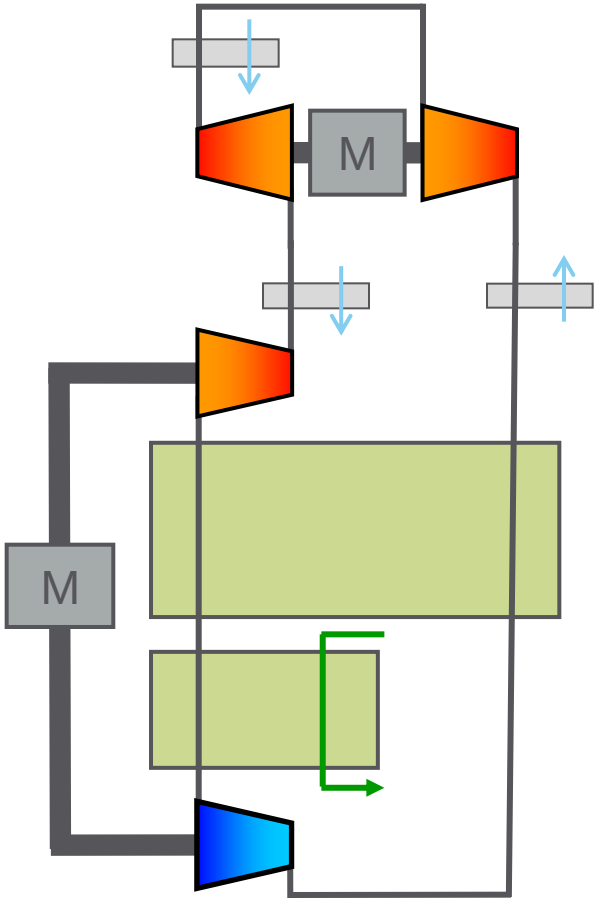

Turbo-Brayton recent developments

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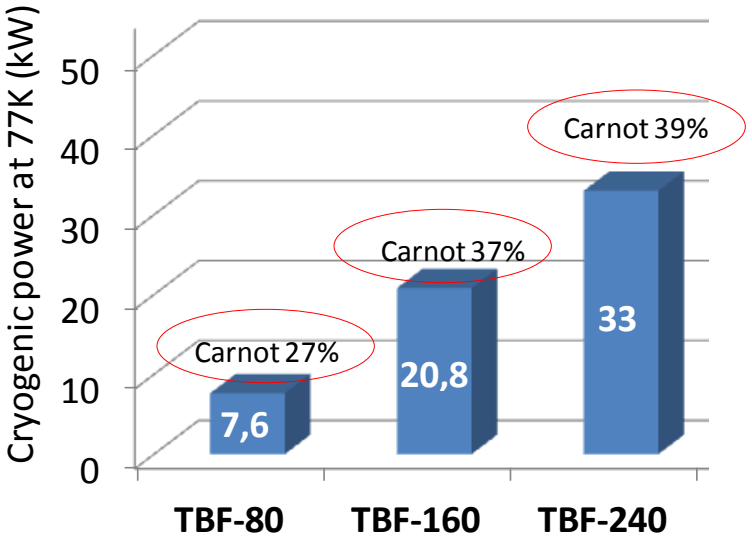
- Improvement of the existing range : -15% on electrical consumption
  - Increase of the turbine efficiency
  - Smarter motor control



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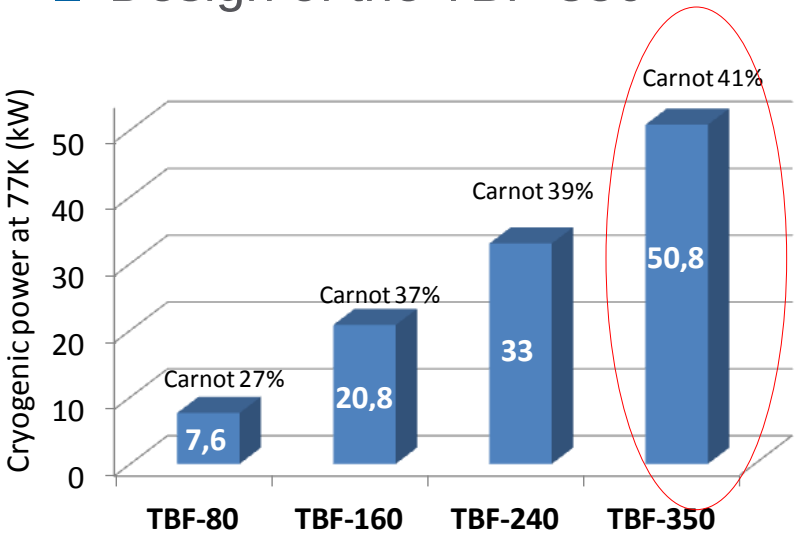
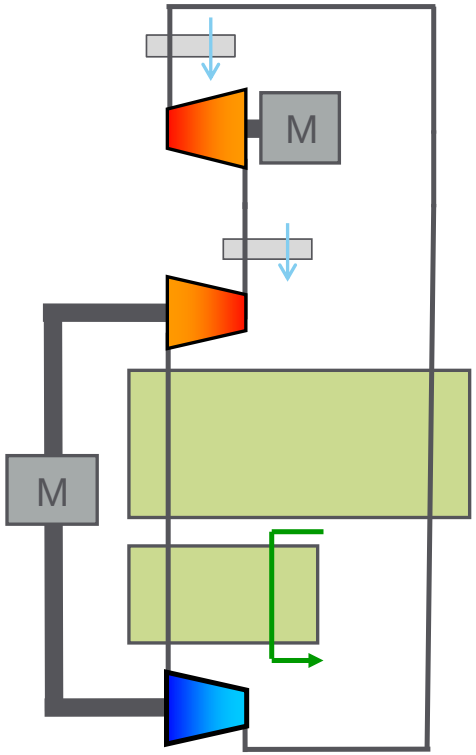
- Design of the TBF-350





➔ More than 40% Carnot efficiency

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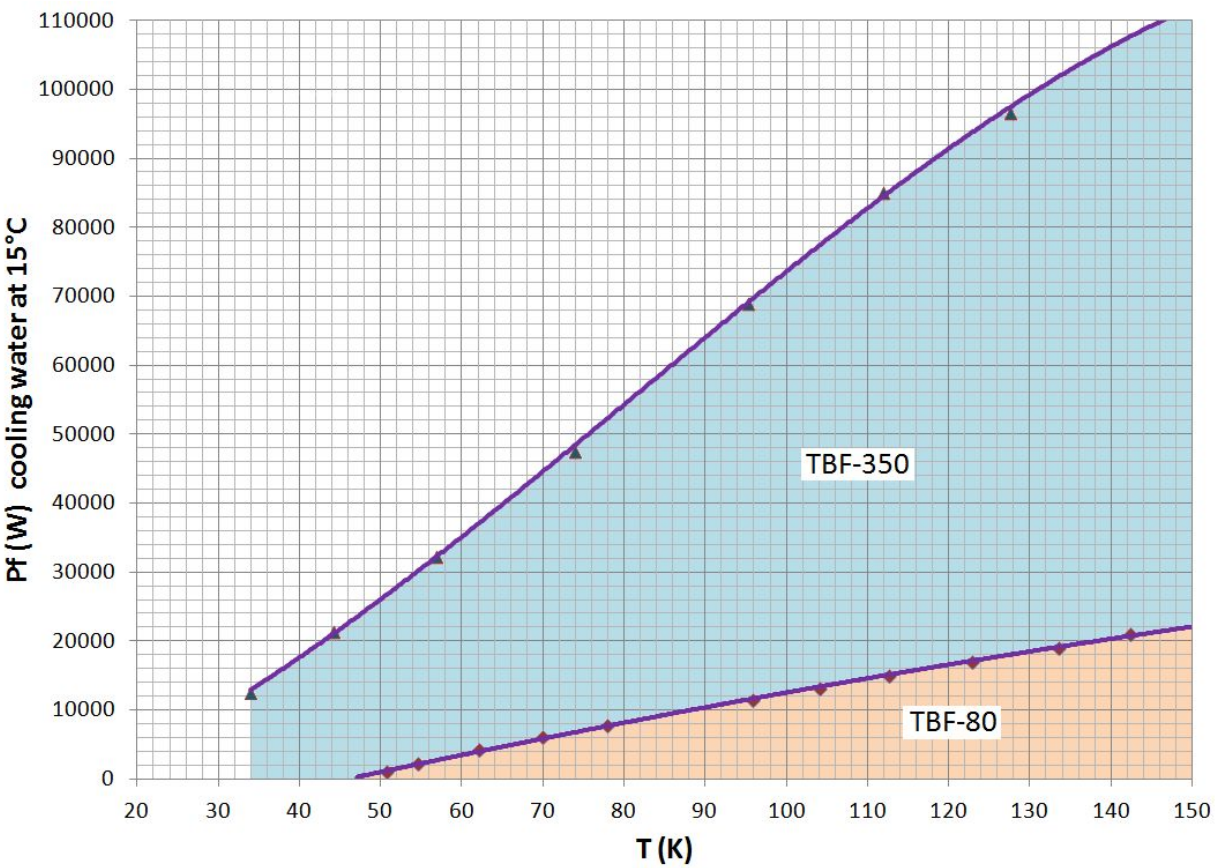


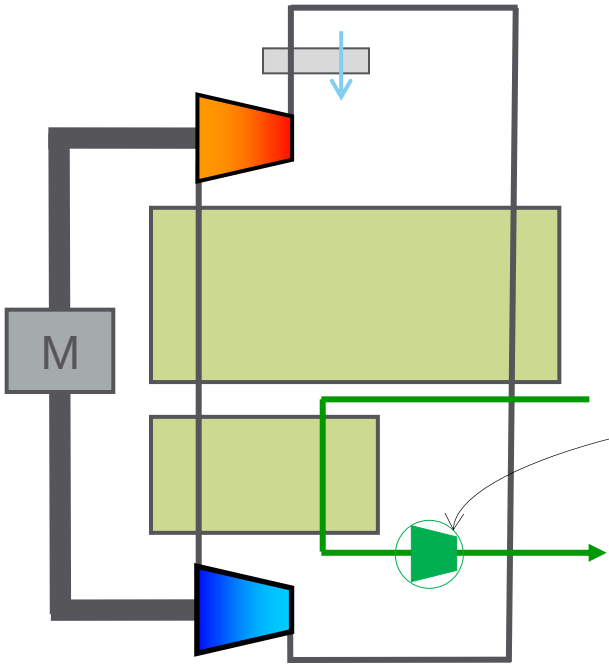
Refrigeration capacity vs Temperature of the Turbo-Brayton product line

- Higher refrigeration capacity available
  - Up to 51 kW at 77K
- Lower temperature
  - Down to 35K

Turbo-Brayton recent developments

- Goal : maintain a high reliability on global solution
  - Thermal link required to cool HTS devices : need of a pump for circulating fluid
  - Development of a pump on magnetic bearings

➔ Overall MTBF not reduced by the use of ball bearings



Conclusions

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- Thanks to ALAT long experience in HTS projects, a complete solution has been developed for efficient and maintenance free refrigeration
  - Complete oil-free technology for refrigerator+pump
  - From 35 to 150K
  - Up to 51kW at 77K
  - Carnot efficiency up to 41%
  - Global MTBF 105 000h

- Developments continue
  - Lower cryogenic temperature to address LTS applications
  - Increase efficiency

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