

ITER Liquid Helium Plants

Status and Test Protocol

ICEC June 29th, 2015 / Grenoble / France

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Summary

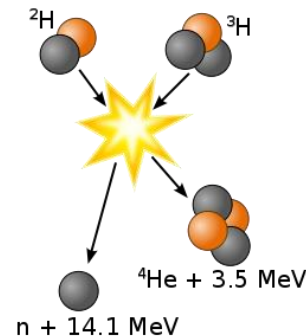
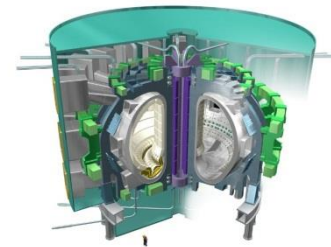
- The ITER Project
- Cryogenics at ITER – focus on the cryoplant (LHe plants & LN2 plants)
 - Global Process Overview
 - Focus on LHe Plants equipments
- LHe plants: End users description
- LHe plants : Test module description
- Conclusion

Introduction: ITER & Fusion

- ITER : the world's biggest experimental research project to demonstrate the scientific and technological feasibility of fusion power as an alternative source of energy
- An international project where each parties involved contributes in terms of kind (magnets, buildings, cryogenic parts, utilities, ...)

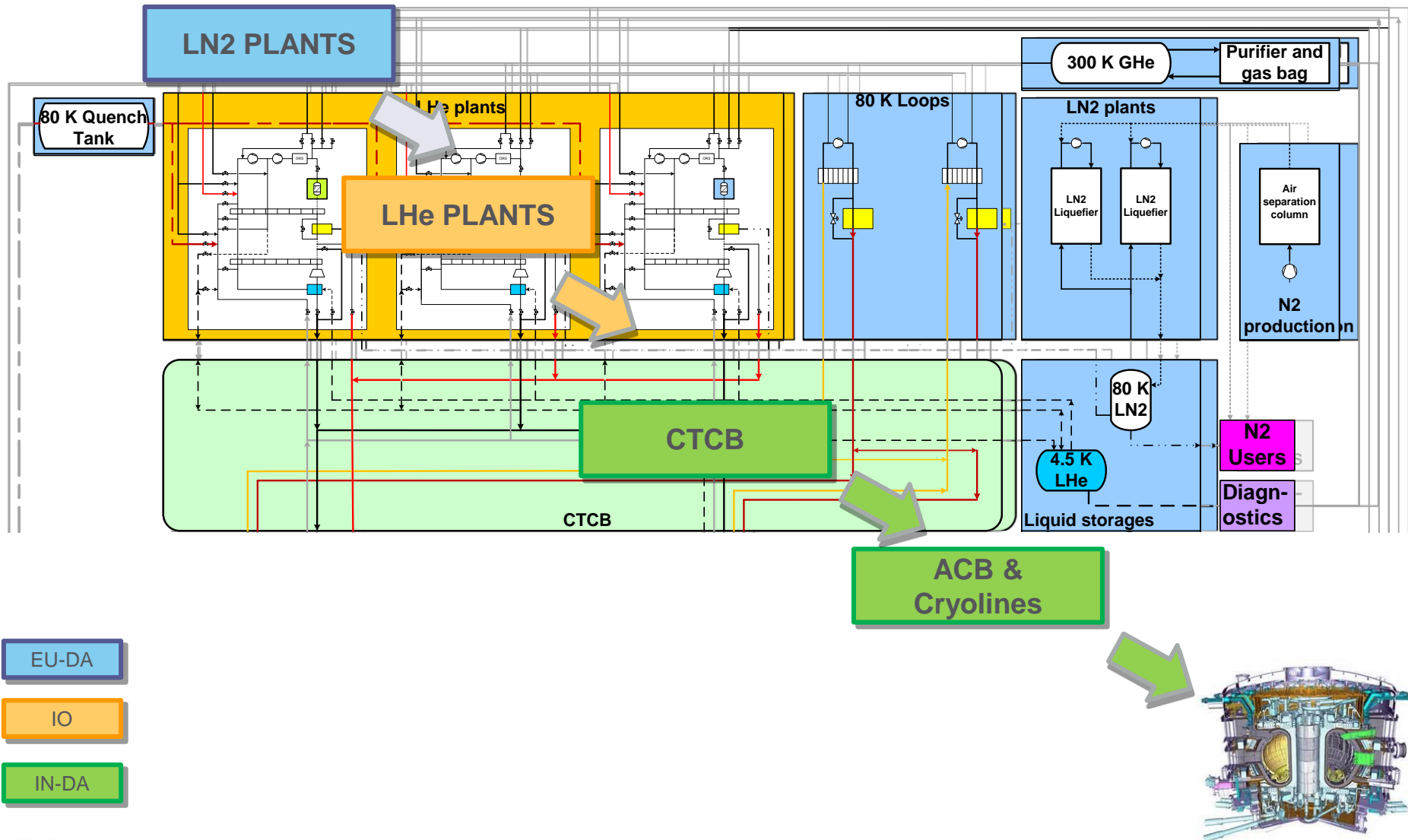
■ FUSION

- Fuel: abundant, world-wide distributed
 - Sufficient deuterium in seawater for millions of years
 - Tritium is produced from lithium
 - Conservative lithium ore recovery estimates indicate sufficient supplies for thousands of years
- Safety: no risk of major accidents
 - Reactor contains fuel for only a few seconds burn
- Waste: no long-term burden
 - Low radio-toxicity after < 100 years



ITER Cryogenics: process overview

PROCESS: Schematic Presentation

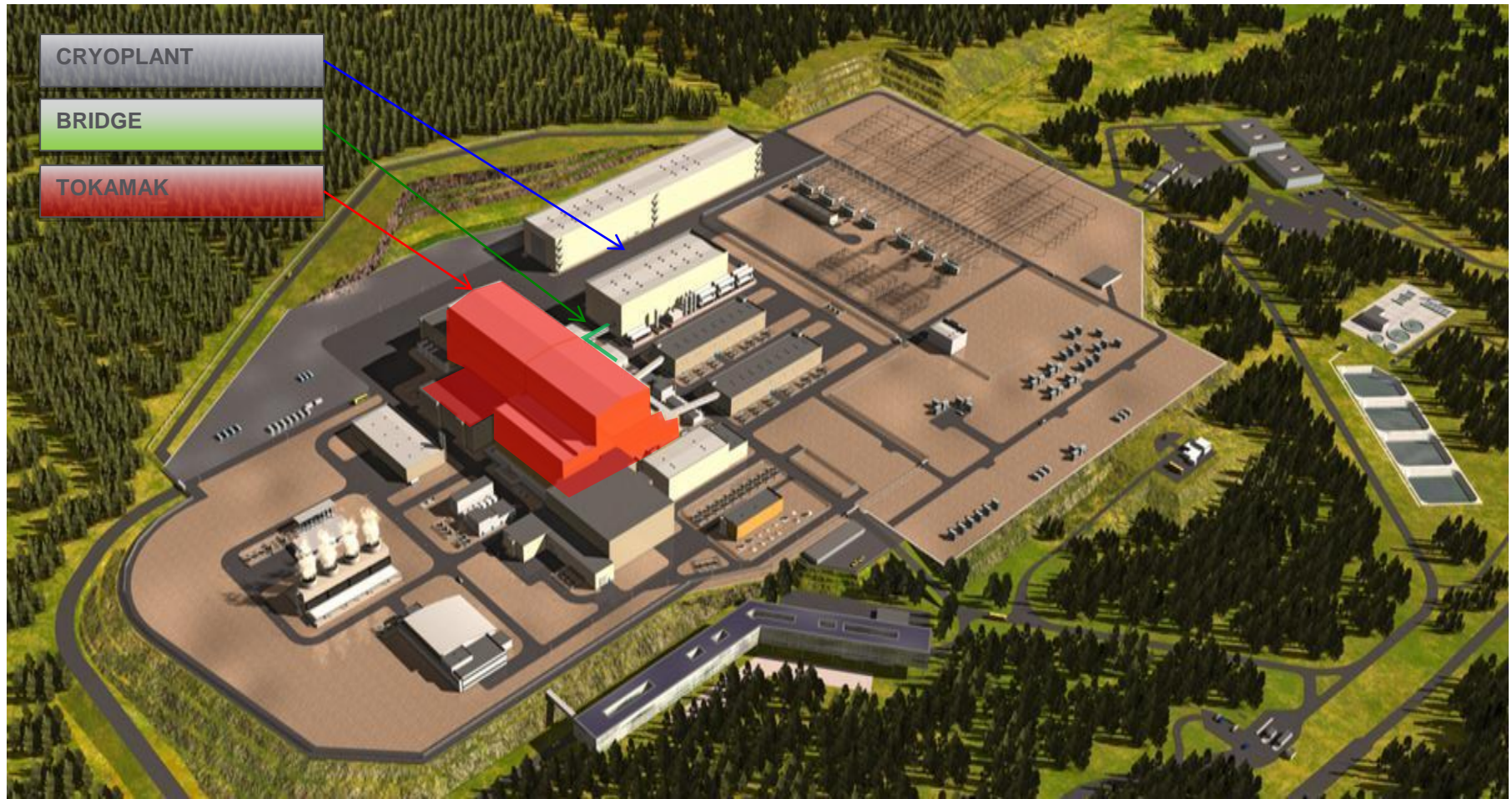


EU-DA

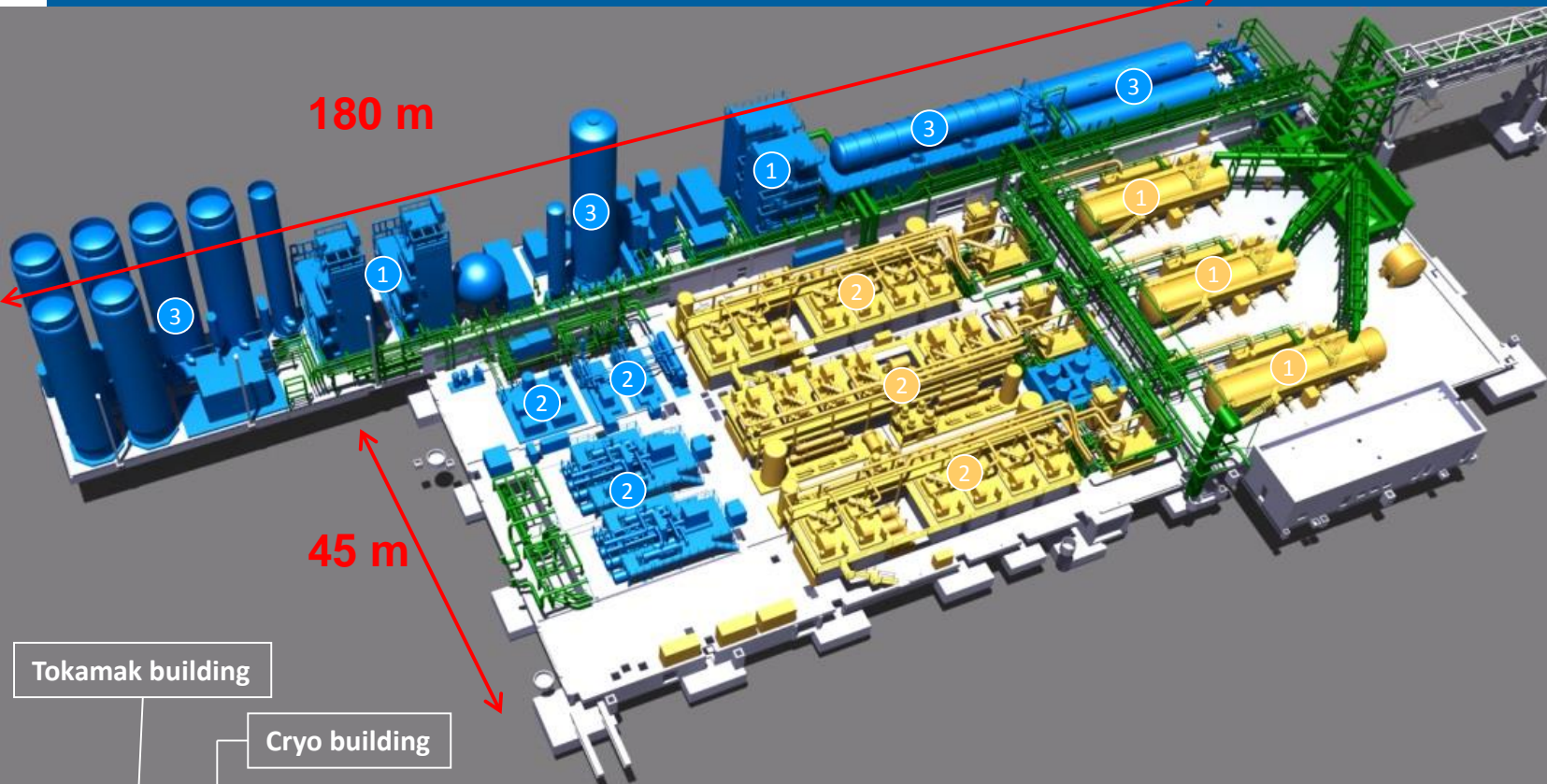
IO

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Cryoplant buildings overview

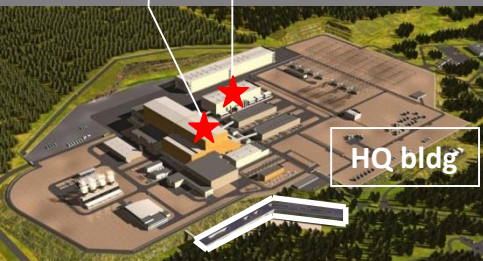


Cryoplant buildings overview – Buildings 51 & 52, Area 53



Liquid helium (LHe) Plants cold boxes

① and Compression station ②



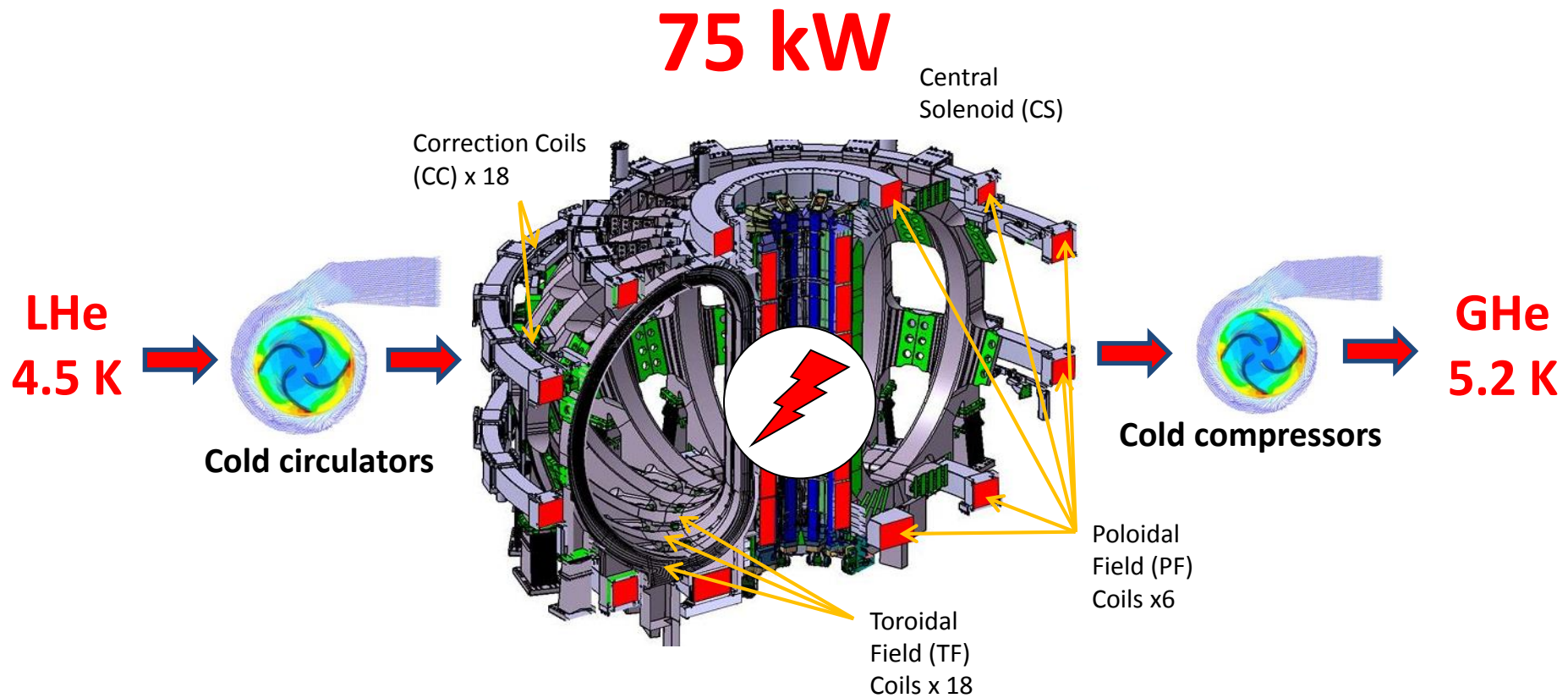
Cryolines & Cryoplant Termination Cold Box (CTCB)

Liquid nitrogen (LN2) plant and auxiliary system

Cold boxes ① Compressors ② Tanks ③

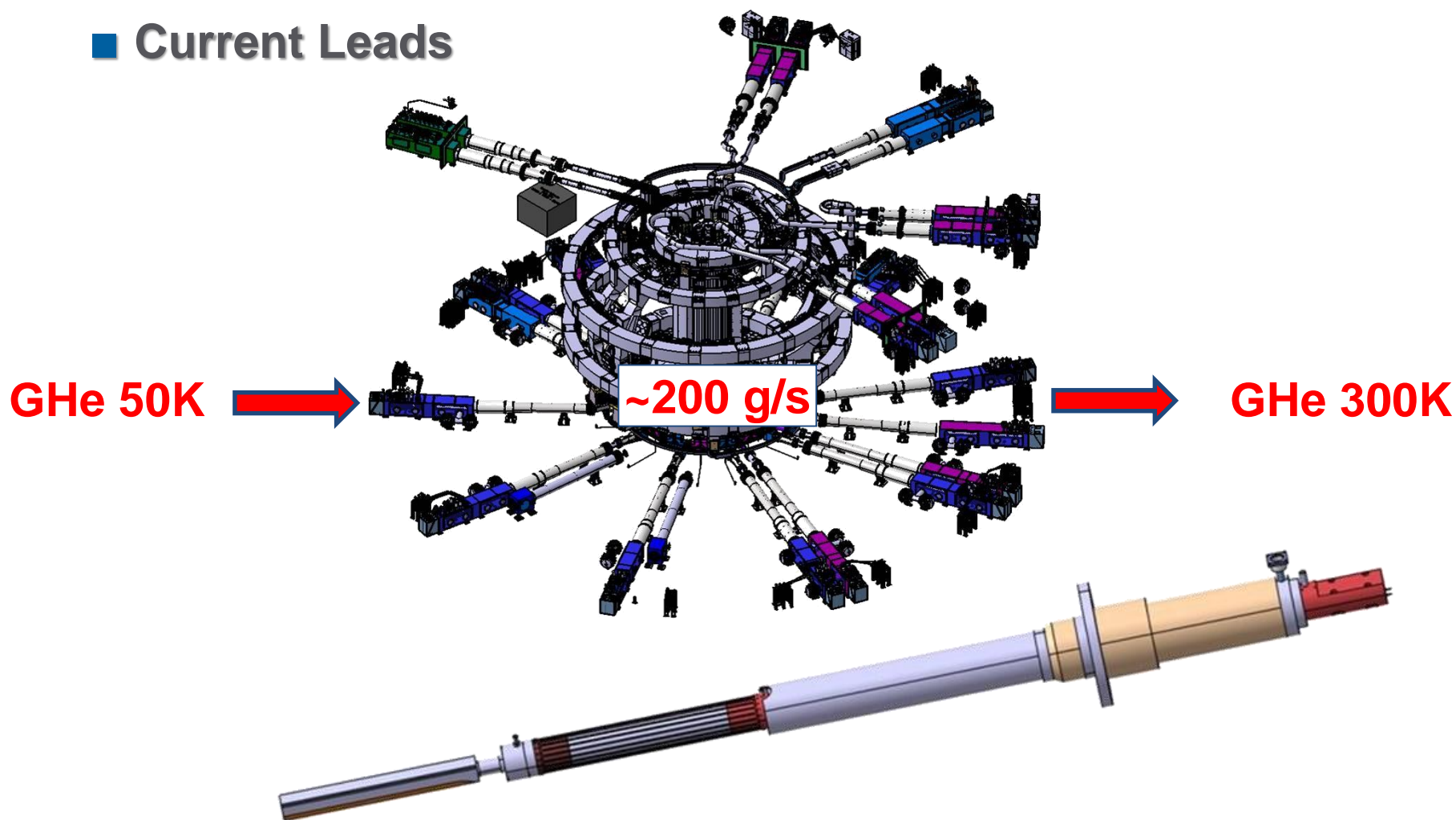
LHe Plants - End users

■ Magnets



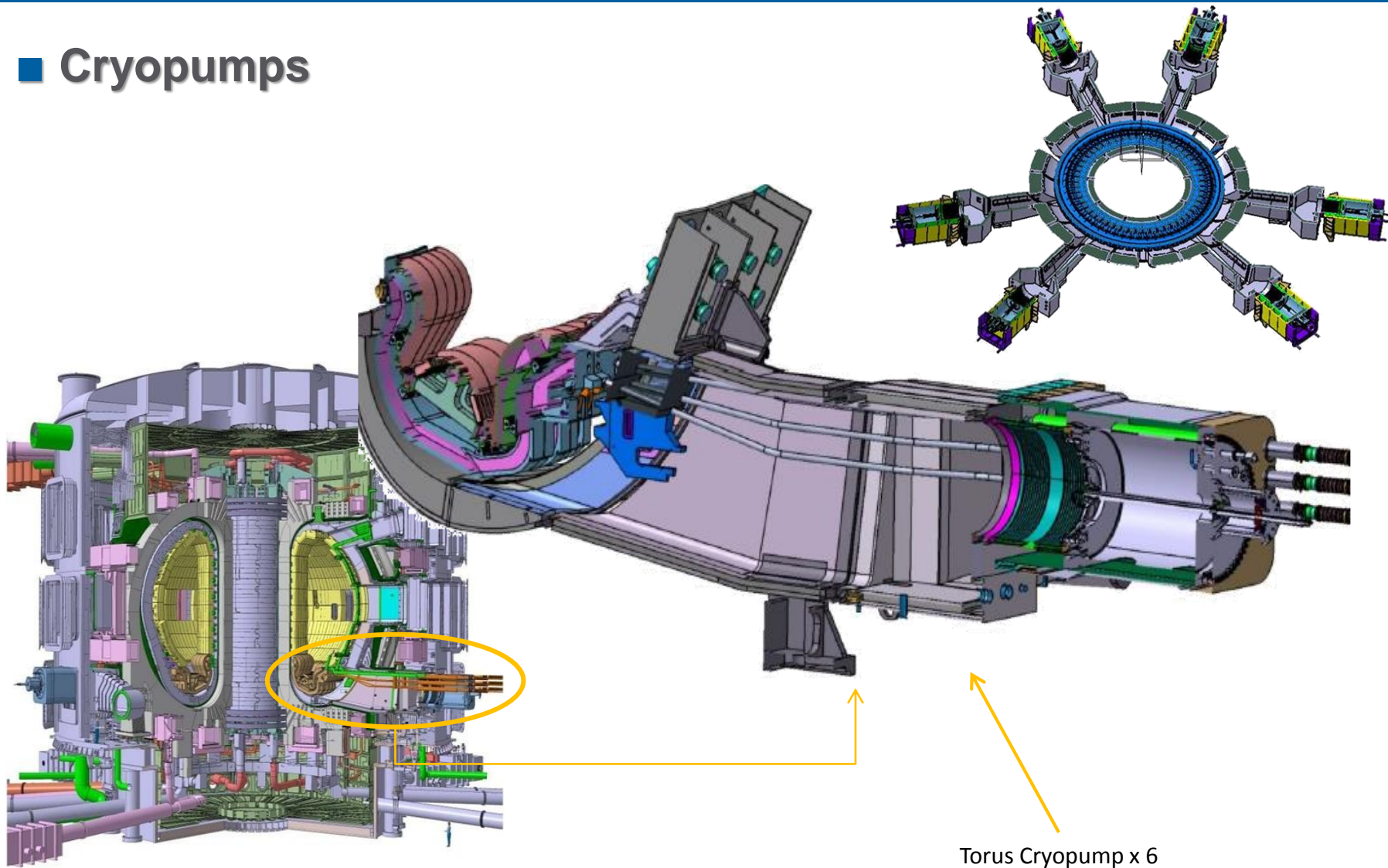
LHe Plants - End users

■ Current Leads



LHe Plants - End users

■ Cryopumps



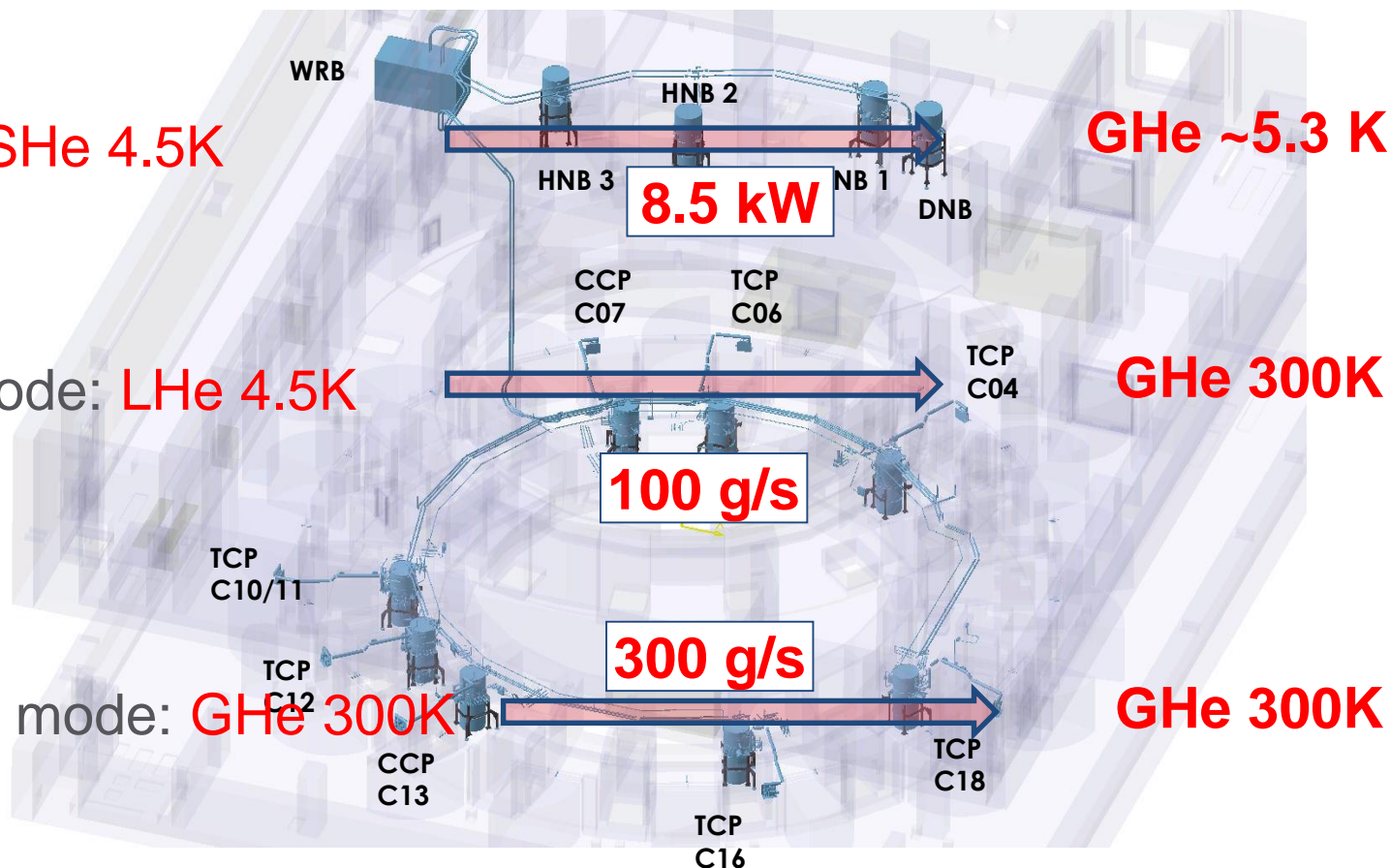
LHe Plants - End users

■ Cryopumps

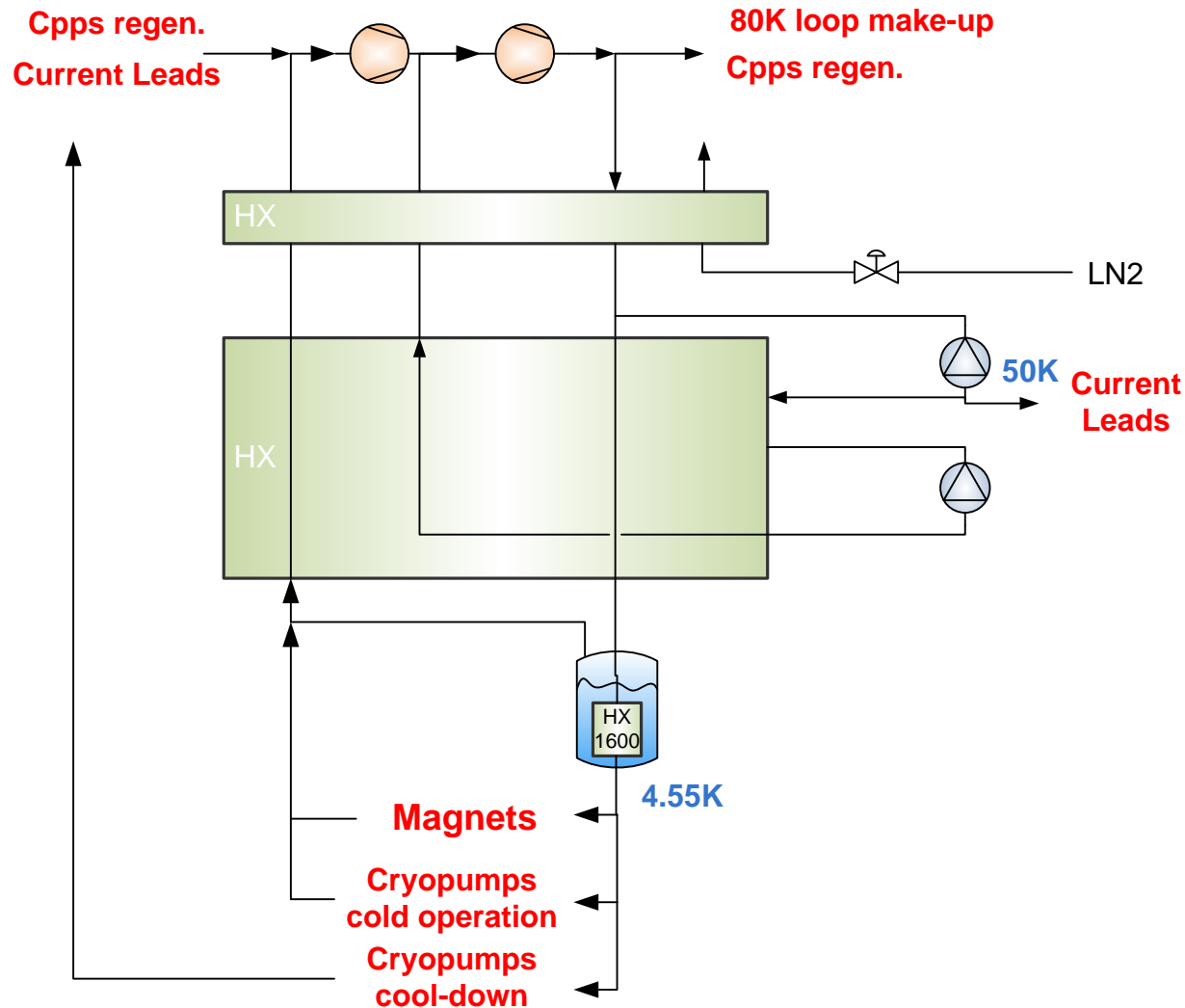
■ Cold mode : **SHe 4.5K**

■ Cool-down mode: **LHe 4.5K**

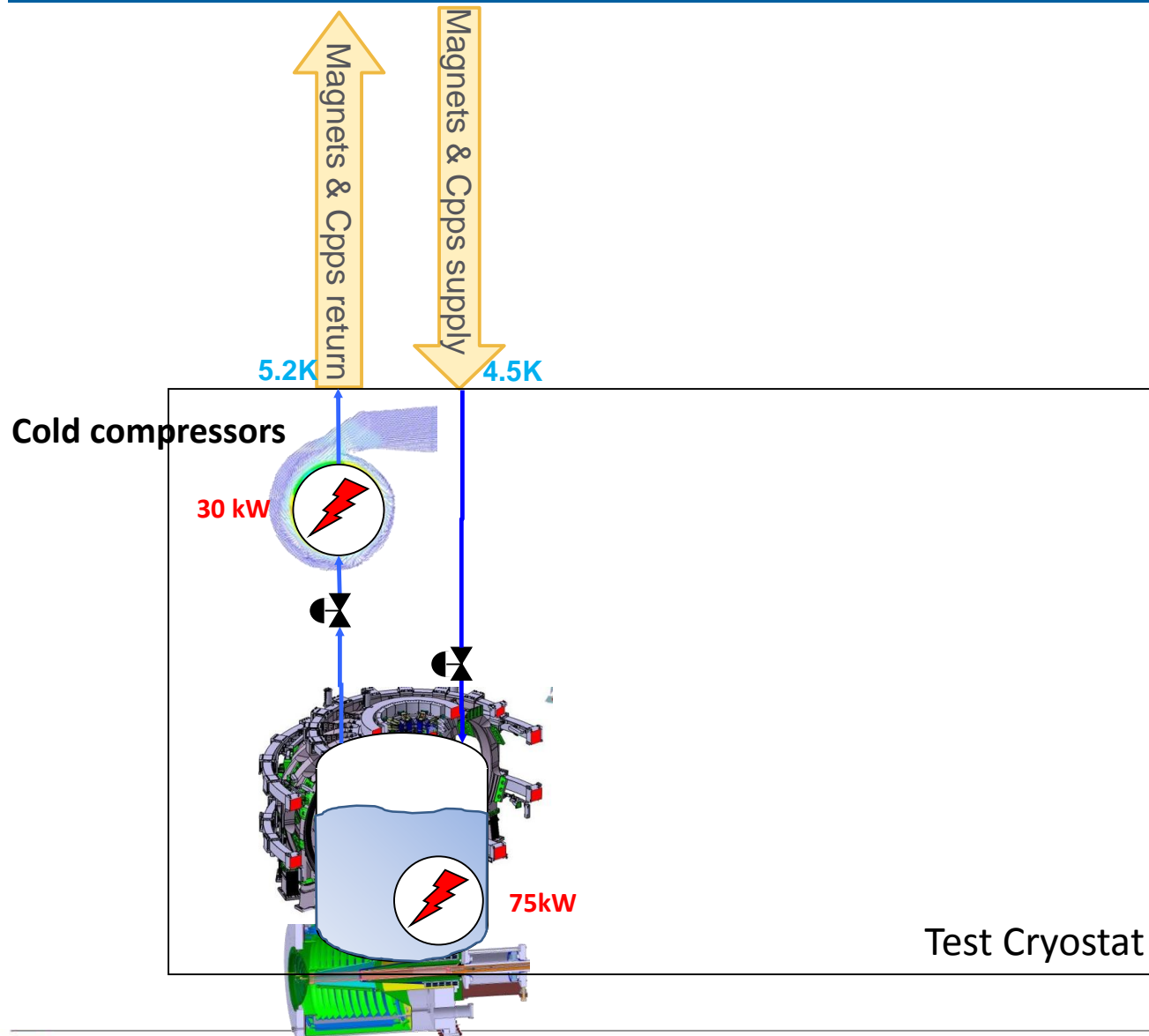
■ Regeneration mode: **GHe 300K**



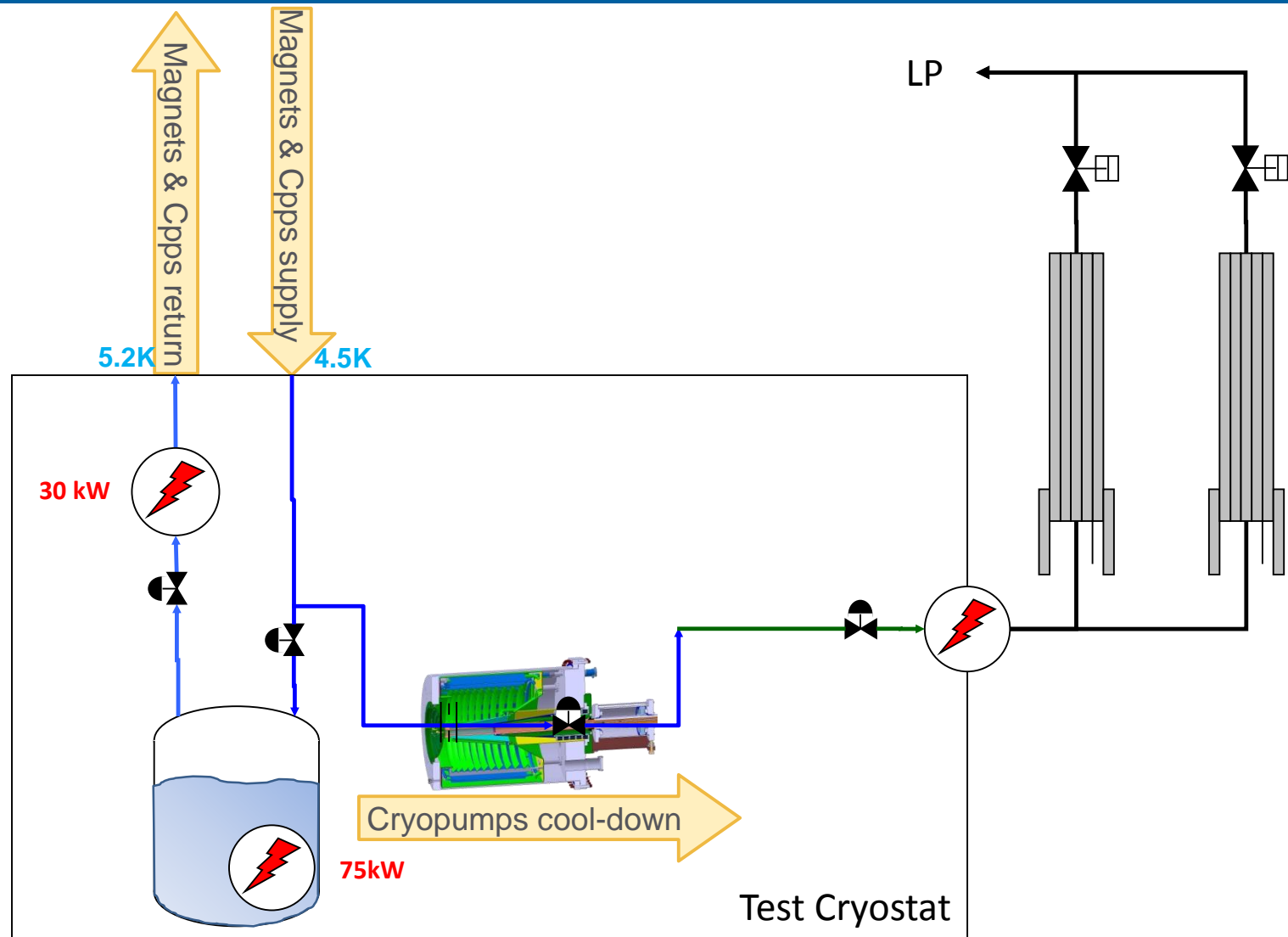
LHe Plant - simplified process



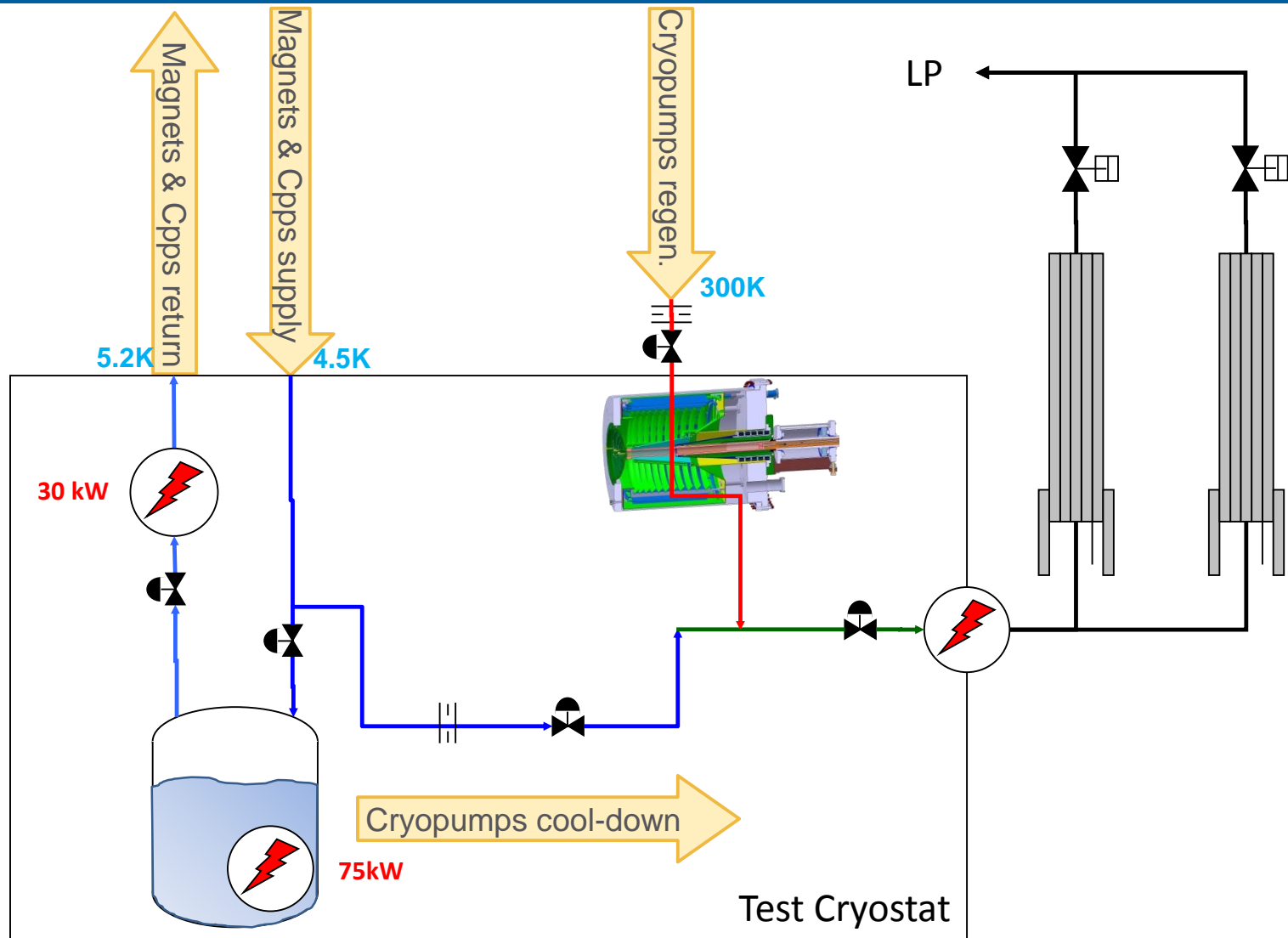
LHe Plants - Test module



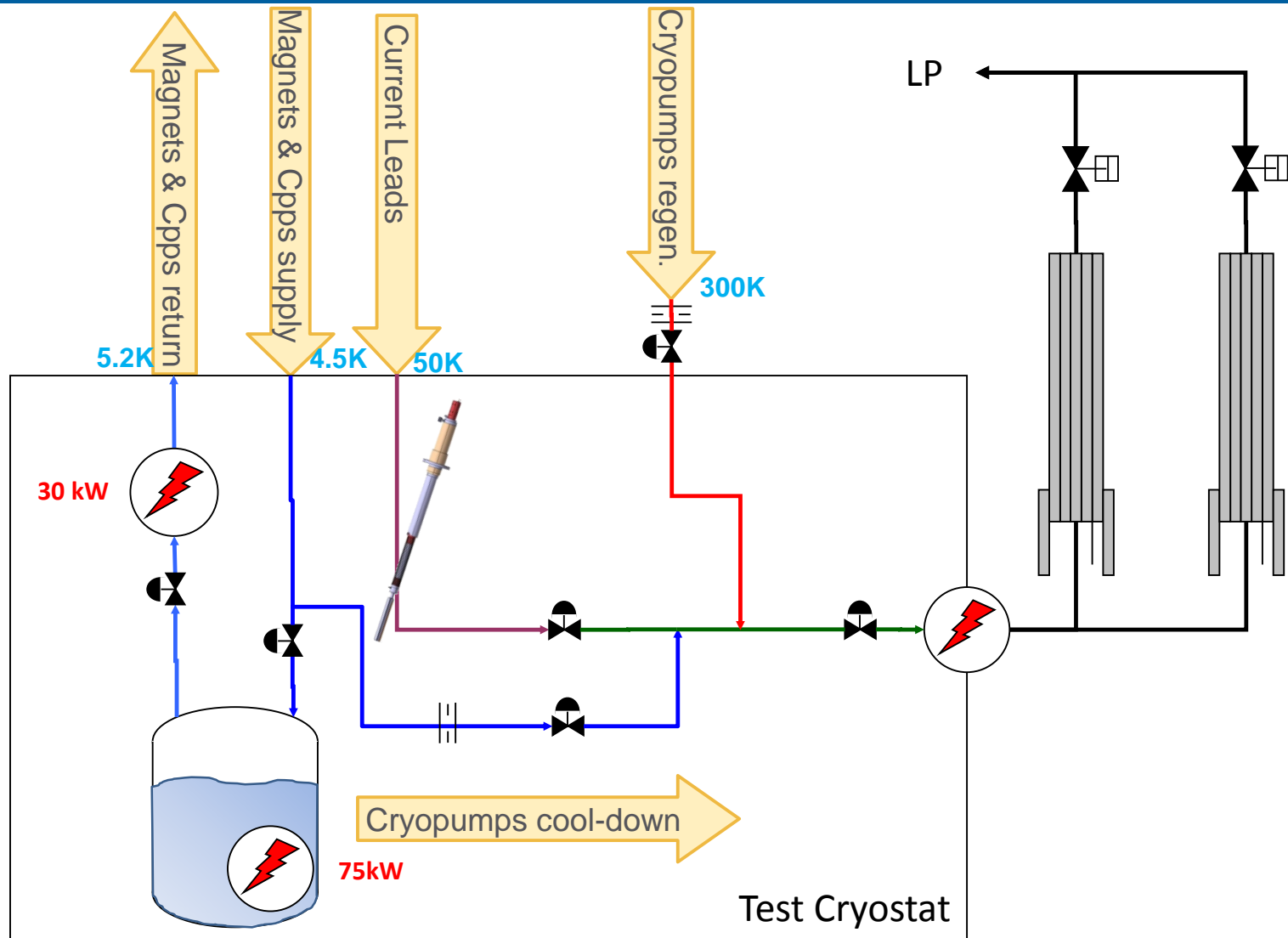
LHe Plants - Test module



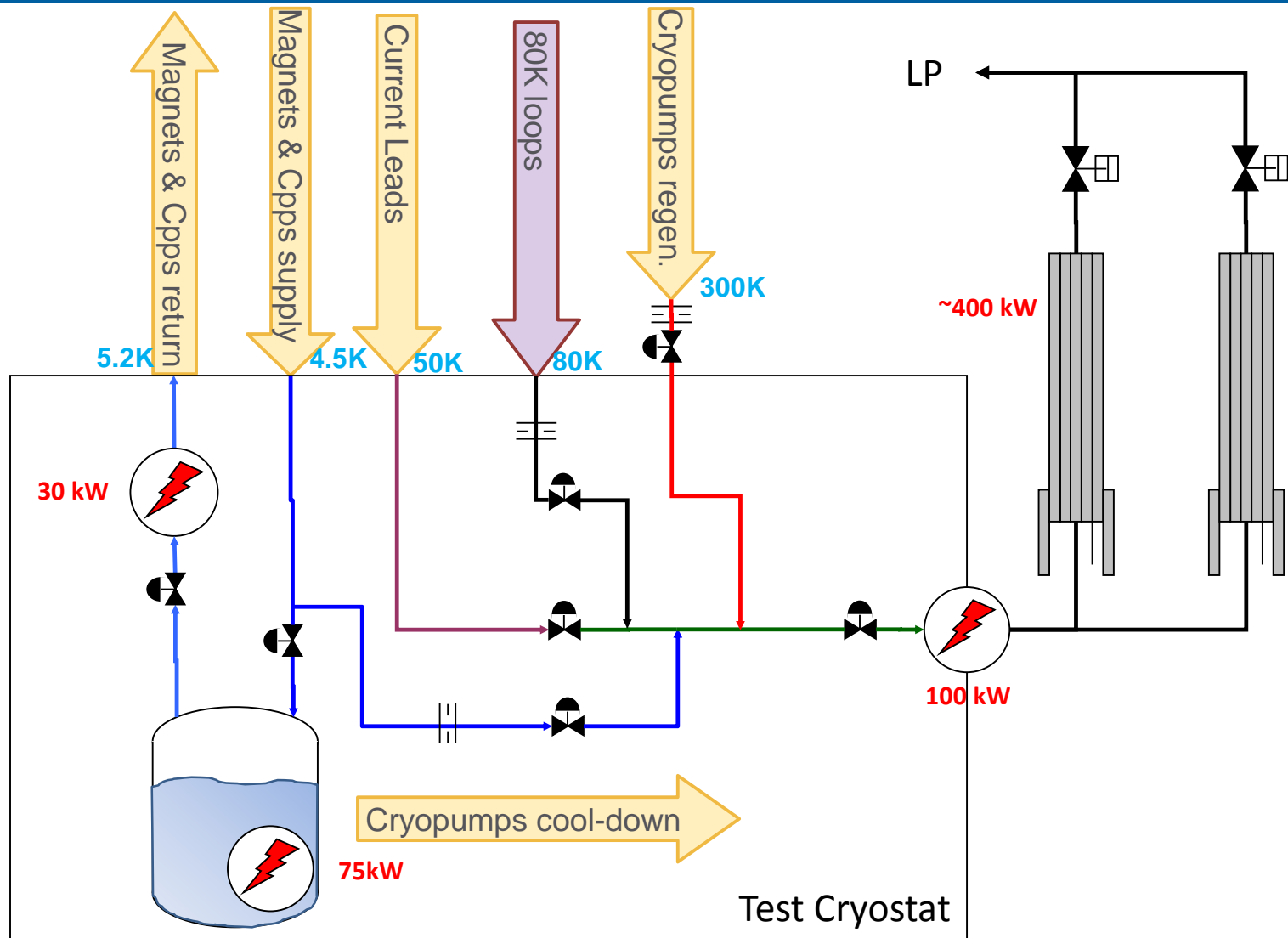
LHe Plants - Test module



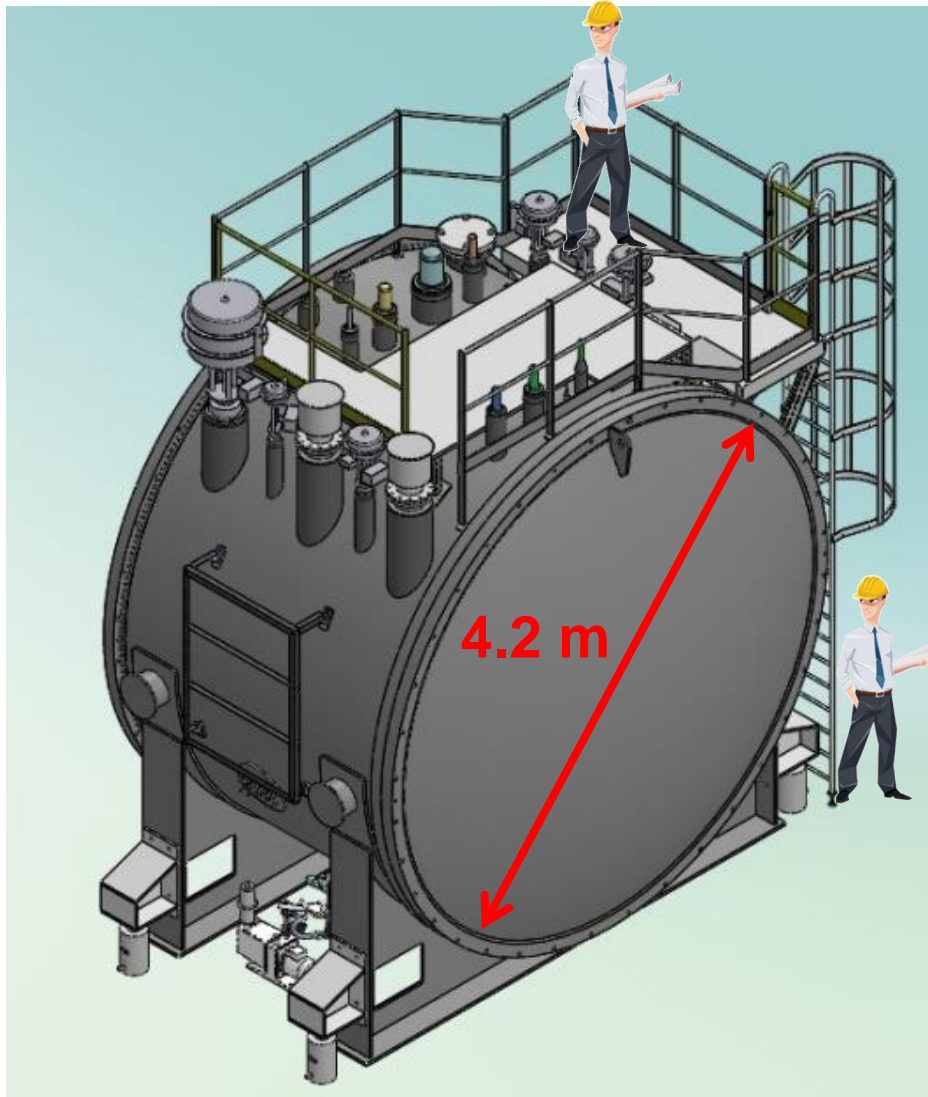
LHe Plants - Test module



LHe Plants - Test module

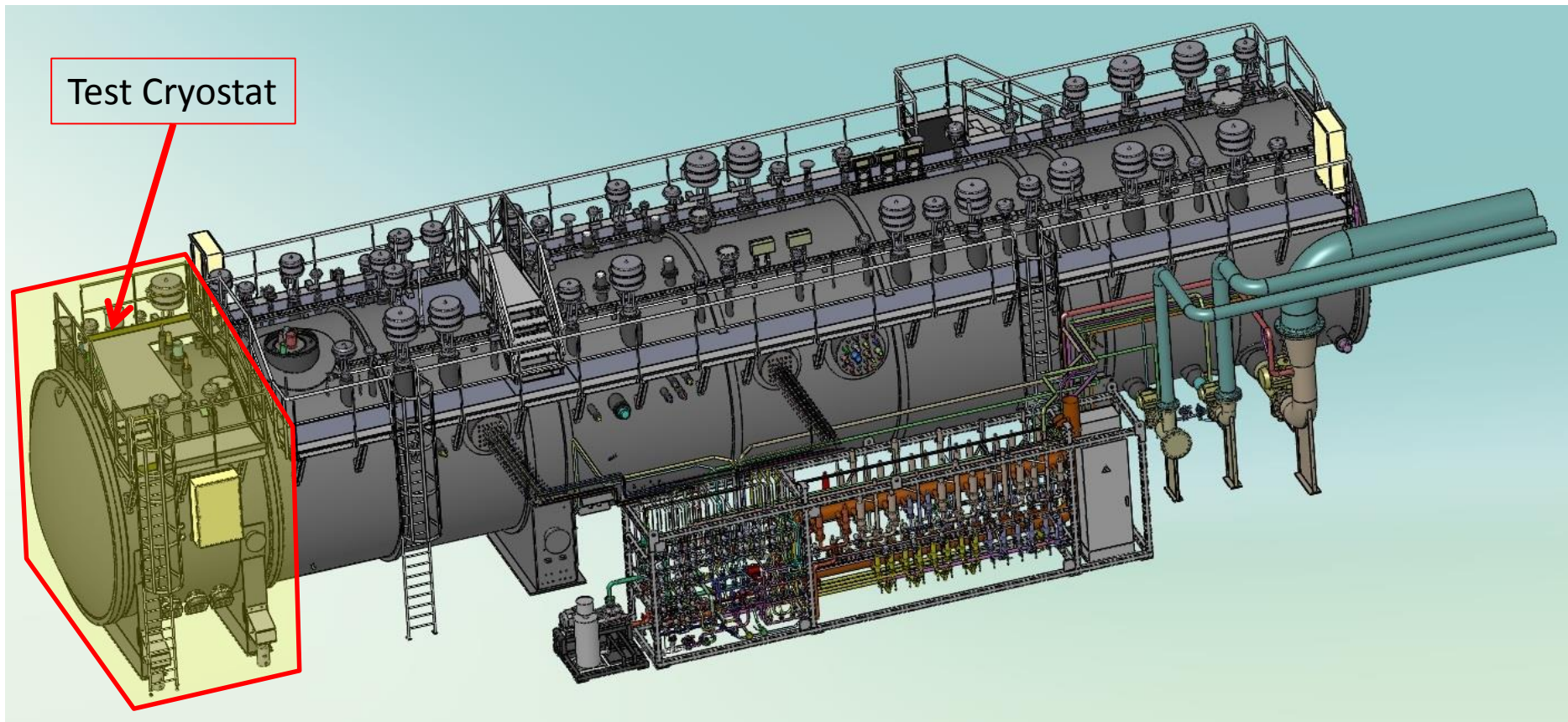


LHe Plants - Test module



- 20 tons
- 75 kW of isothermal heaters at 4.5K
- 130 kW of additional non isothermal heaters
- Liquid Helium phase separator can adapt with variations of 2.5 m^3 of liquid to cope with pulse modes

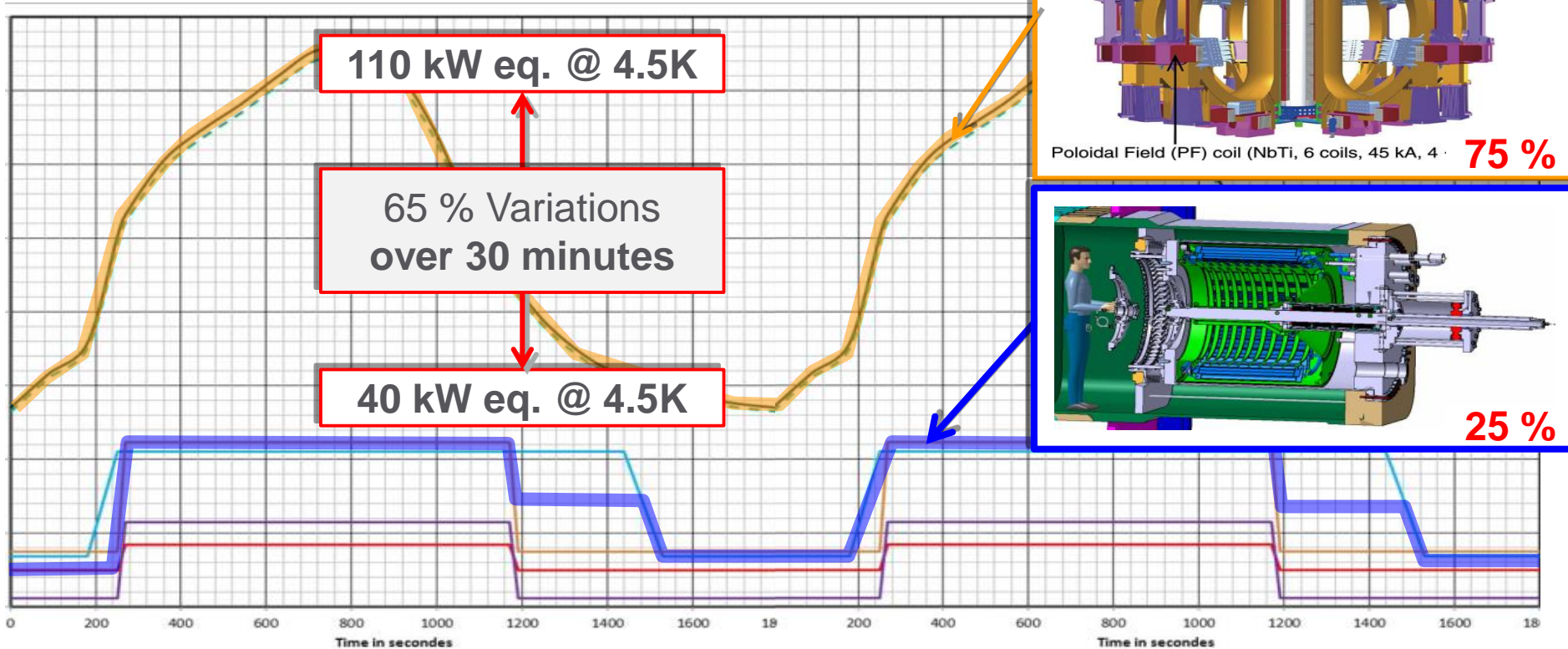
LHe Plants - Test module



LHe Plants - Technical challenges :

- Main challenges:

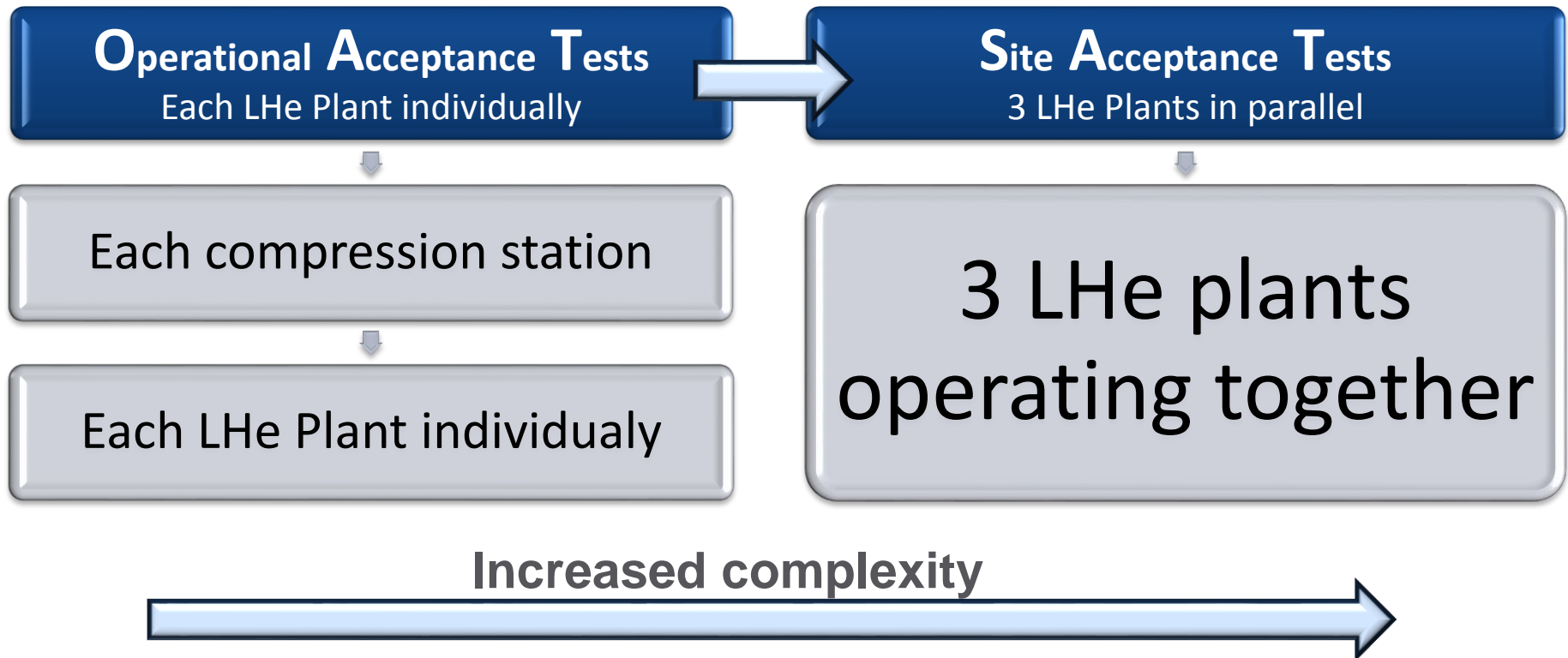
- Multiple Users
- Pulsed Loads
- 3 LHe Plants in Parallel



LHe Plants - Test program

- Tests in 2 stages:

Each plant individually → 3 Plants in parallel



Process - Test program

Operational Acceptance Tests

Compression station	Without Cold Box	Compressors characteristics at different operating points
		Slide valves test
		Full load
Single LHe Plant	Without the Distribution Box	Maximum Refrigeration Power
		1/3 of Plasma Operation State : <ul style="list-style-type: none"> • With static loads (averaged) • With Pulsed loads
	With the Distribution Box	Maximum Liquefaction capacity
		Maximum Refrigeration Power
		1/3 of Plasma Operation State : <ul style="list-style-type: none"> • With static loads (averaged) • With Pulsed loads

Process - Test program

Site Acceptance Tests

3 LHe Plants in parallel

With the Distribution Box

Magnets Cool-Down mode

Maintenance (backup) modes :

- 1 Plant in maintenance
- 2 Plants in maintenance

Plasma Operation States :

- with static loads
- with pulsed loads

Conclusion

- ITER cryoplant design progresses on schedule
 - LHe plants manufacturing on going (FDR passed)
 - LN2 & auxiliary systems design under completion (FDR planned July 2015)
 - Projects on schedule
- LHe Plants test module design to complete the functionalities of the end users
- Test program addresses ITER main technical challenges :
 - Operation with strong pulsed loads
 - Operation of 3 plants in parallel
- All interfaces and automatic sequences tested before connection to the magnets system

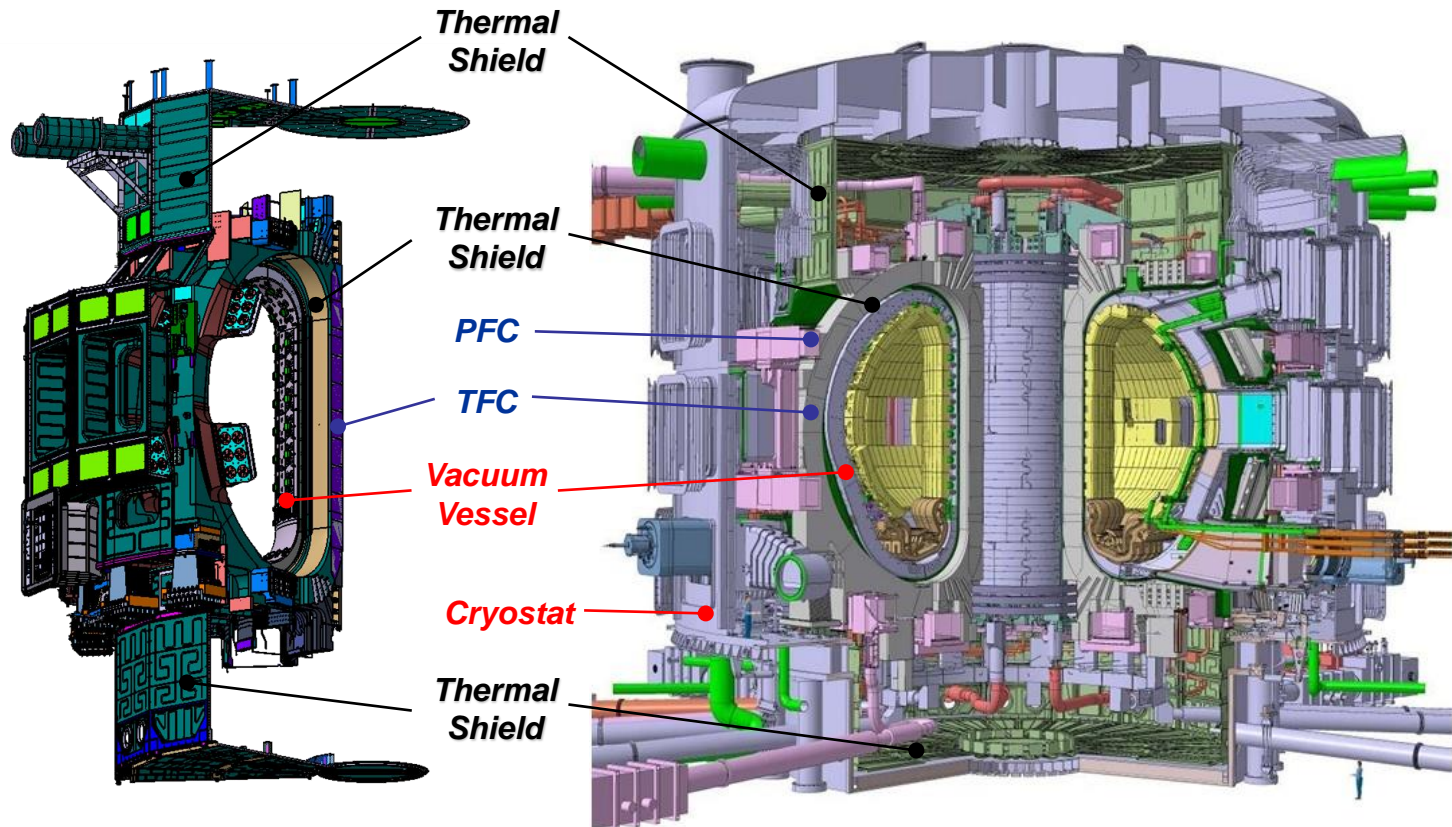
Air Liquide thanks Iter Organization for its fruitful cooperation

End of the presentation
Thank you for your attention



LHe Plants - End users

■ Thermal Shields



Thermal power supplied by 80K loops. Test is performed on 80K loops