ASCEND

The first step towards cryogenic electric propulsion

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IEEE CSC & ESAS SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue 52, January, 2023.
This presentation was given at EFATS 2022, August 30-31, 2022.

PURPOSE

Boost Airbus by **accelerating future technologies**

VISION

Fly the future of aerospace, Incubate talent, Inspire Airbus transformation

AMBITION 2025

Be THE reference for Technology Value Assessment
Be recognized as an inspiring place to work
Act as entrepreneurs

VALUES Keep it Simple, Be Audacious, Exploring Together
Mindset

DNA Speed Of Execution, Caring for Each Other, Open to the World
Unique value proposition

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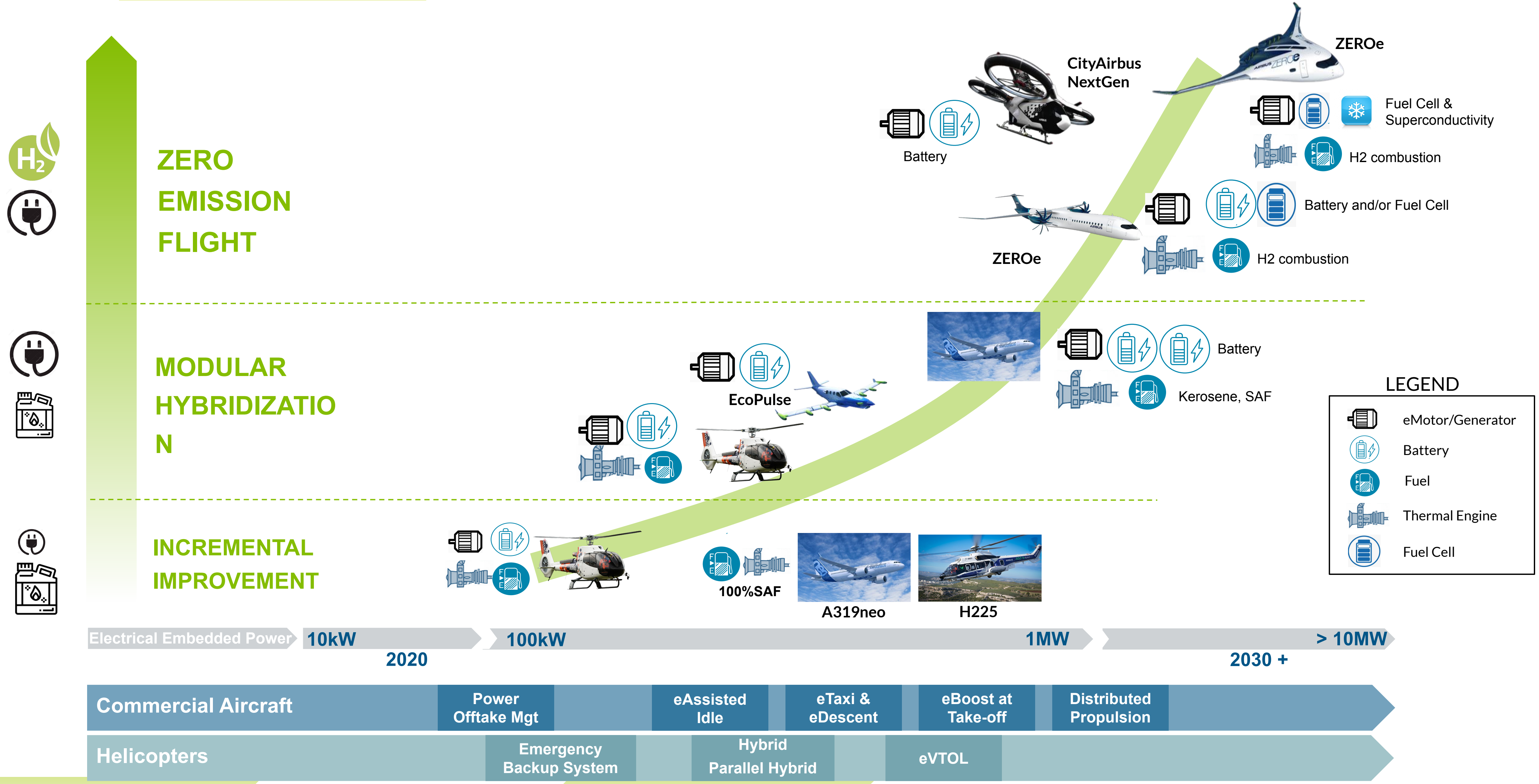
Energy-related technologies to reduce aviation's carbon footprint



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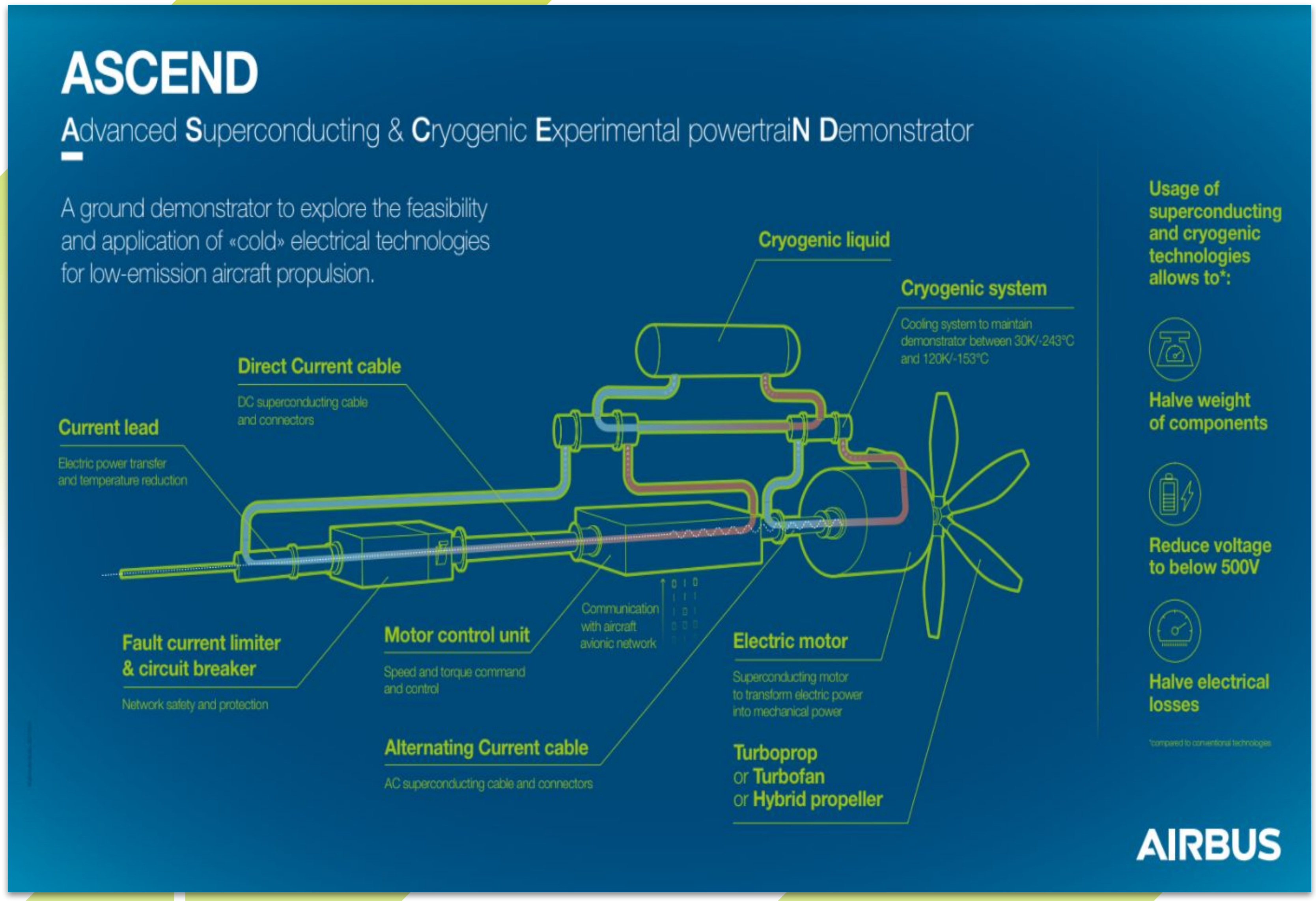
A Superconducting Powertrain 300V/ 500kW



3 years to Breakthrough high power electric systems

- Low voltage (< 500V)
- Reduce weight and volume
- Increase efficiency (+ 5-10%)
- Enable high torque motors, fault current limiters

For Propulsive & Non-propulsive systems

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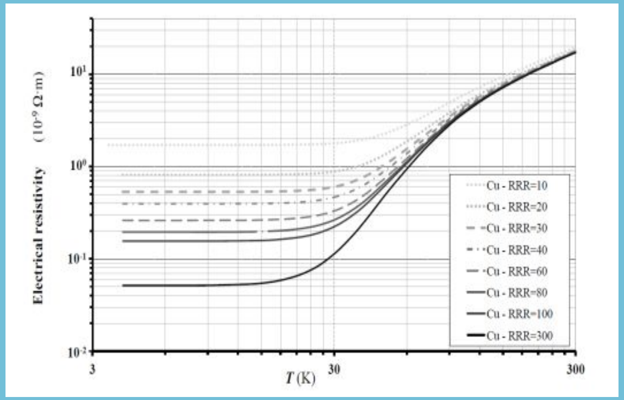
Cryogenic technologies?

Cryogenic

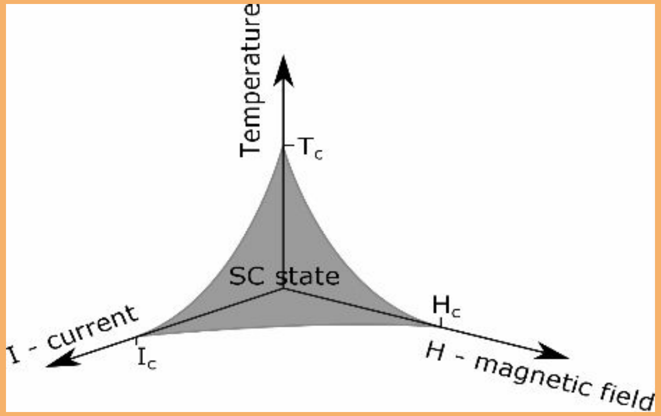
Conventional techno at low temperatures



→ **losses divided by 3 to 5**
→ increase thermal properties

Superconductivity

Specific materials below 3 parameters



→**no DC losses**
→ Carry >100 times more current than copper
→ Perfect diamagnetism

A 500kW propulsion system using cryogenic temperature as an opportunity to

→Improve figure of merit
→Explore new degree of freedom

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3 years and main steps

2021

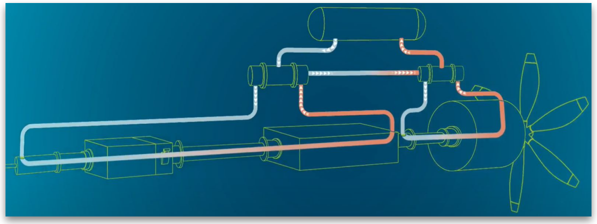
- **Project launching**
- Team building
- technology selection
    - demonstrator
    - sub-demonstrator
- Partnerships
- Specifications

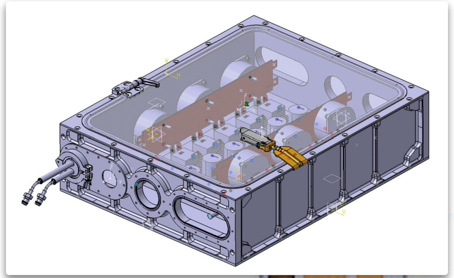
2022

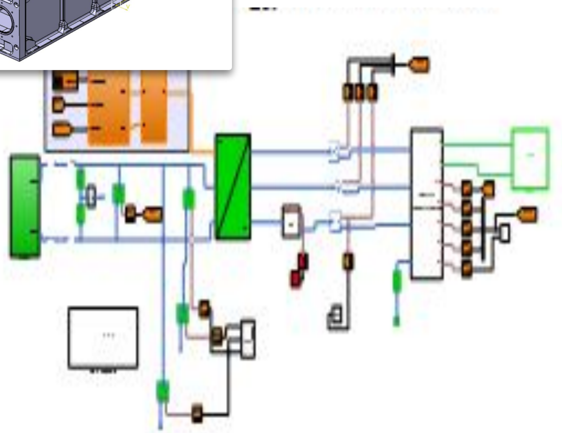
- Preliminary and detailed design
- Manufacturing
- Partial tests
- Test bench design
- Assessment at aircraft level

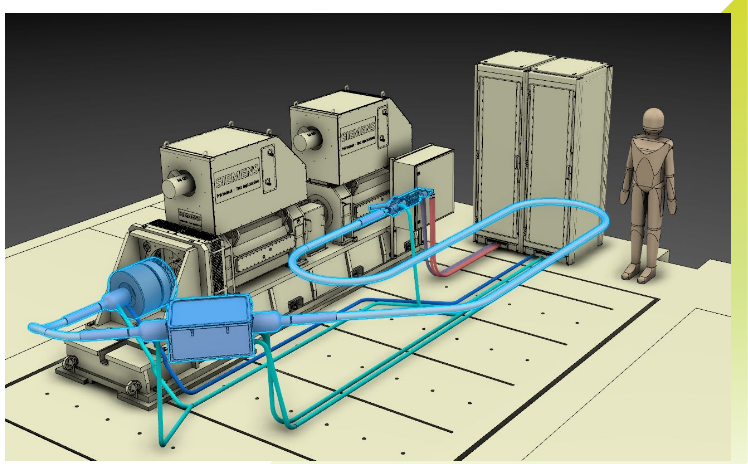
2023

- Delivery of test bench
- Demonstrator integration
- Ground tests
- Sub-demonstrators tests
- feasibility and potential for aircraft report









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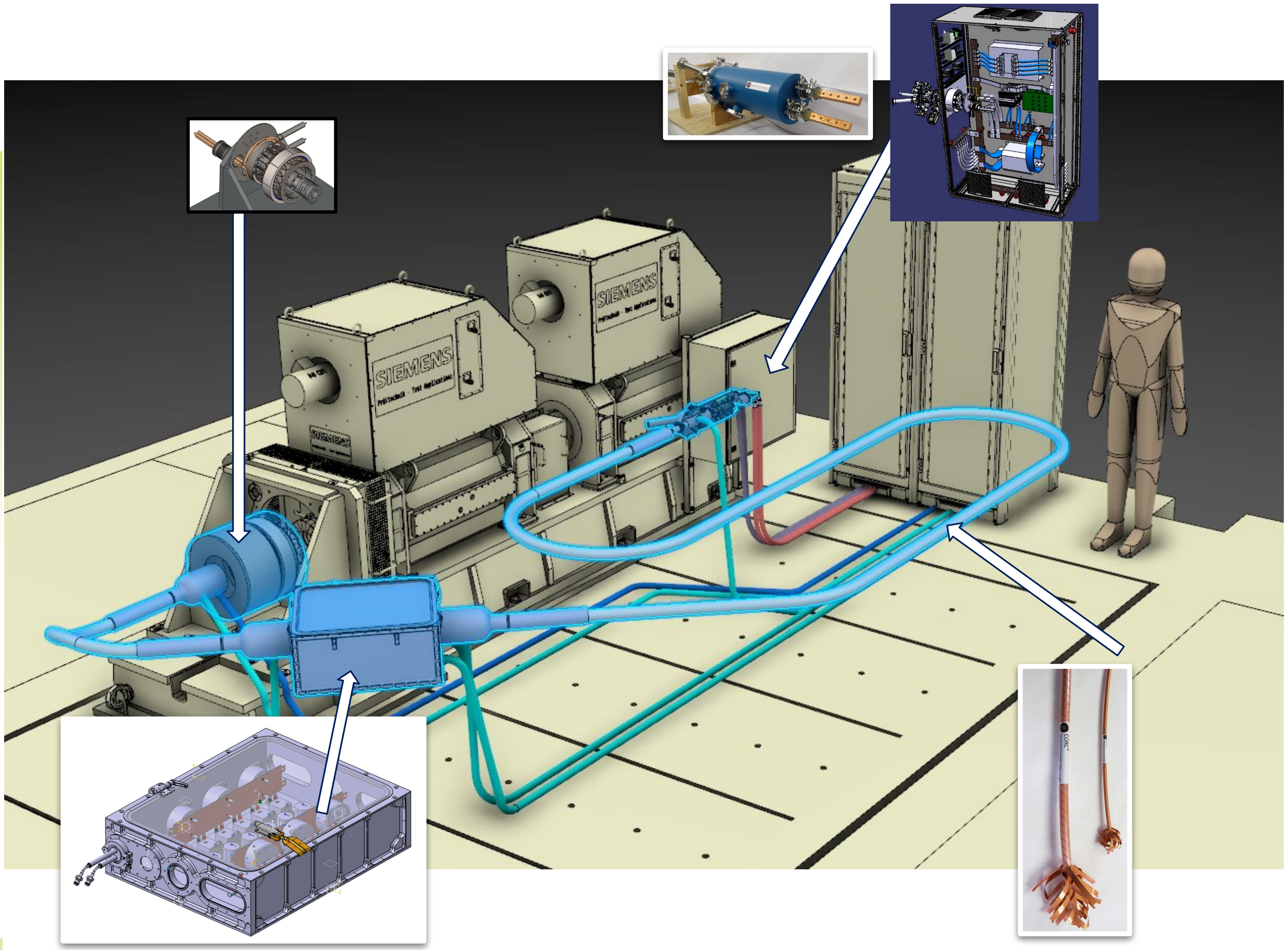
preliminary results at component level



→**No showstoppers**

→**Promising performances with available technologies**

- efficiency: +5-6%
- new degree of freedom
  - high current
  - motor torque
  - Fault CL
- power over weight increase with power

→**a large room for future optimisation**

→**but challenges on**

- cryogenic component weight
- reliability
- operation

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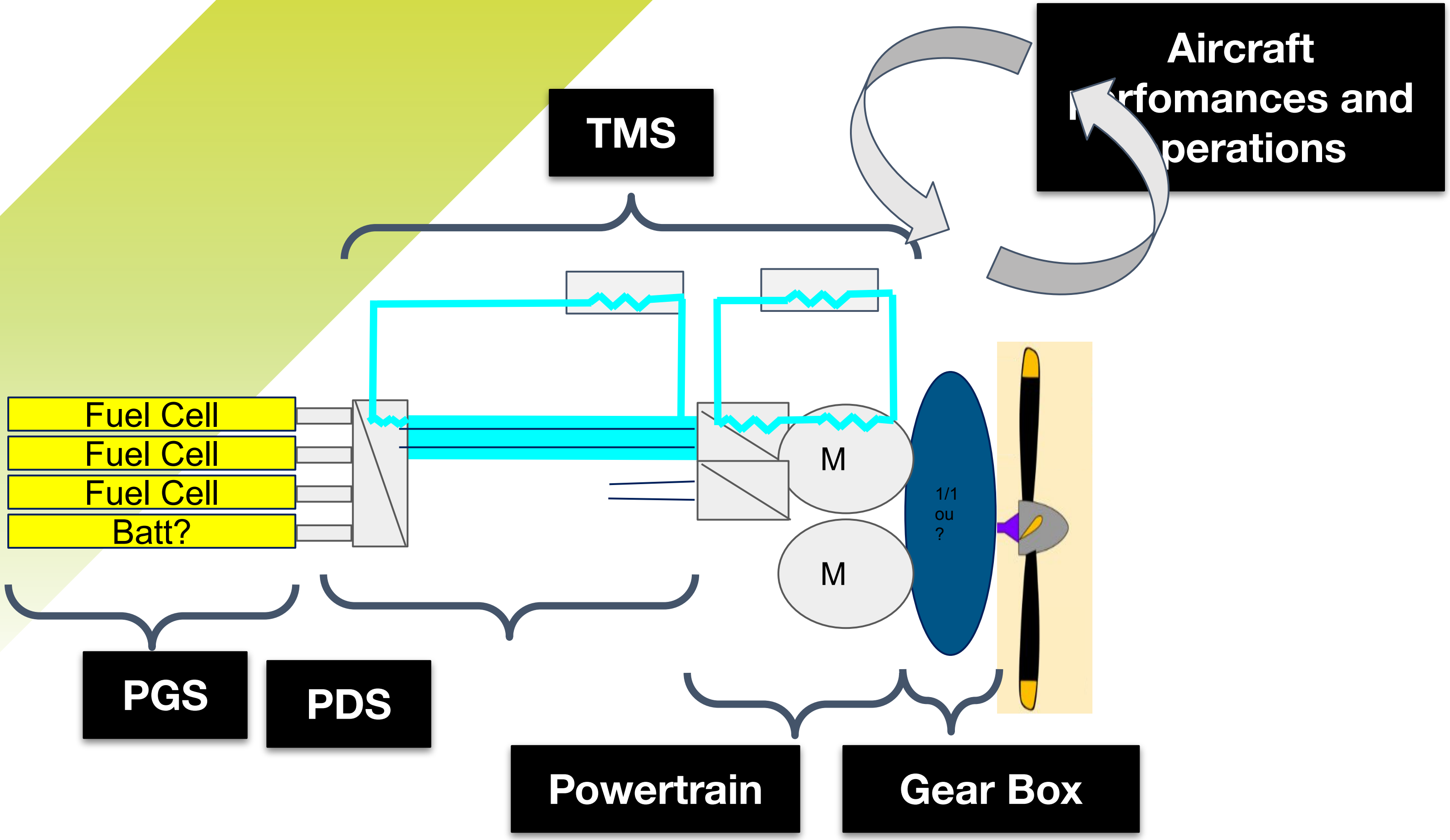
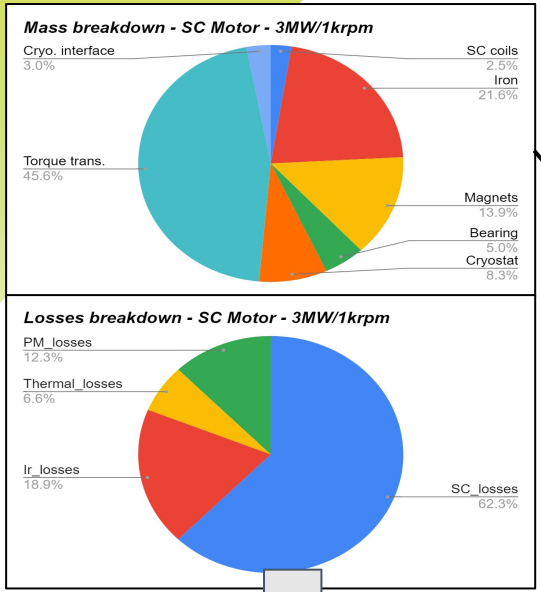
At aircraft level: 5 main interdependent systems

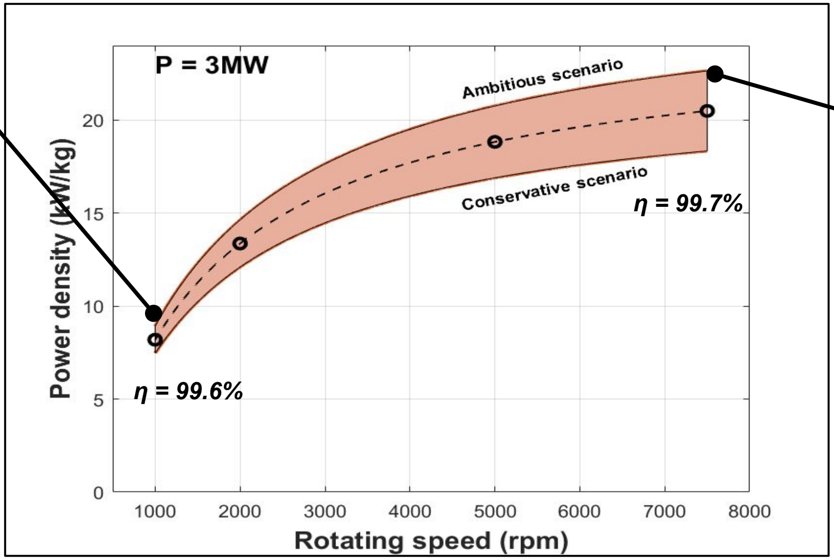


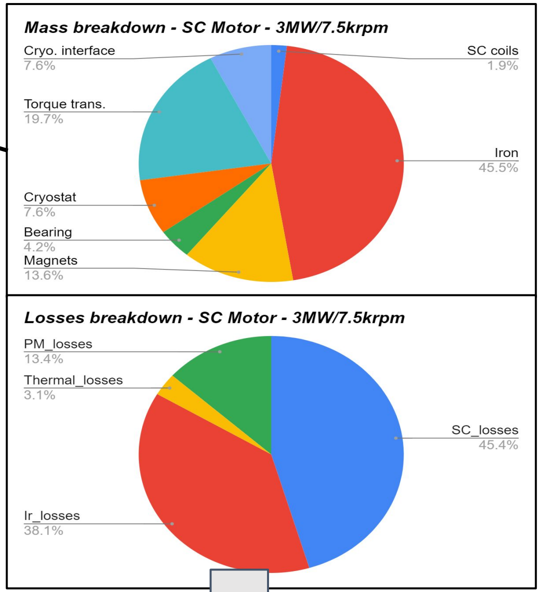
- **PGS: Power Generation**
  Fuel cell and connections
- **PDS: Power distribution**
  Distribution + connections + DC/DC + Cables
- **Powertrain**
  Power electronics integrated with superconducting motor
- **Gear box**
  Adapt the speed to the propeller
- **Thermal Management**
  Control temperature and extract losses

Main drivers to "enable" cryogenic propulsion system:
-Weight & efficiency Vs conventional systems
-complexity, operability and reliability at aircraft level

Partial superconducting motor with PM: short term acheavable weight/efficiency and perspectives







higher weight but direct drive

-non active part weight: 62% ->low margin
-SC losses 62% ->an opportunity for … cooling

light weight but need of Gear box "system"

-active part weight : 60% → margin with topology
-losses: need to reduce SC losses and Iron losses

Need better tapes and new topology for optimisation

Need new topology and better tapes

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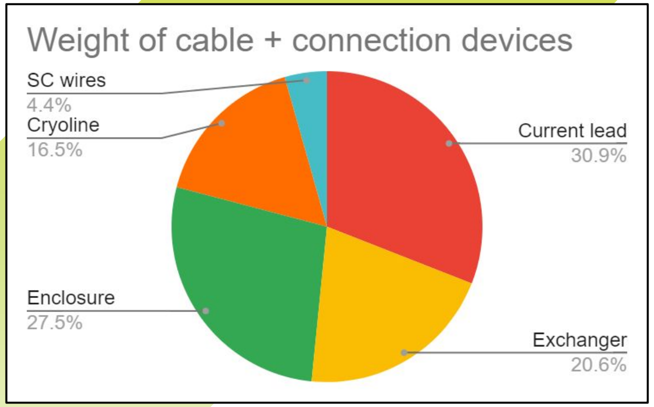
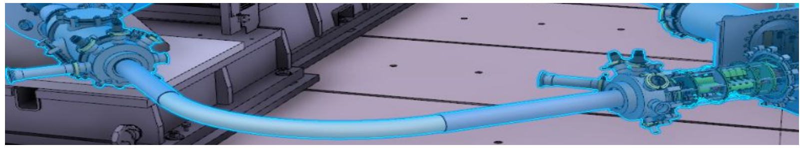
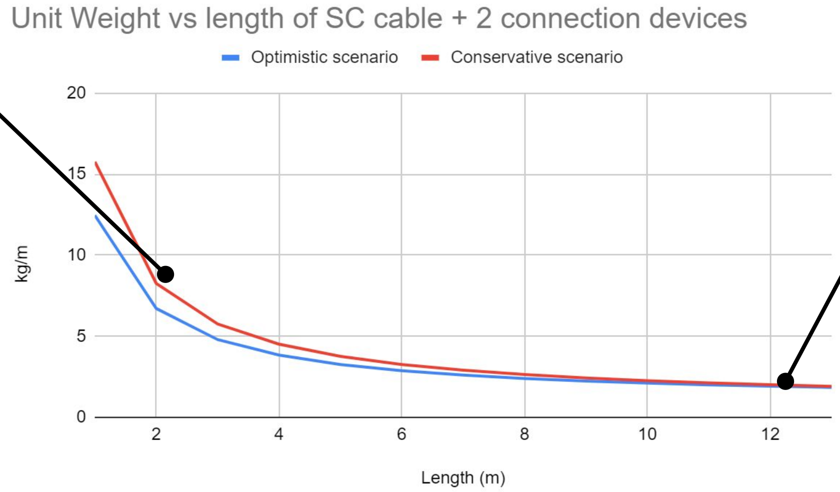
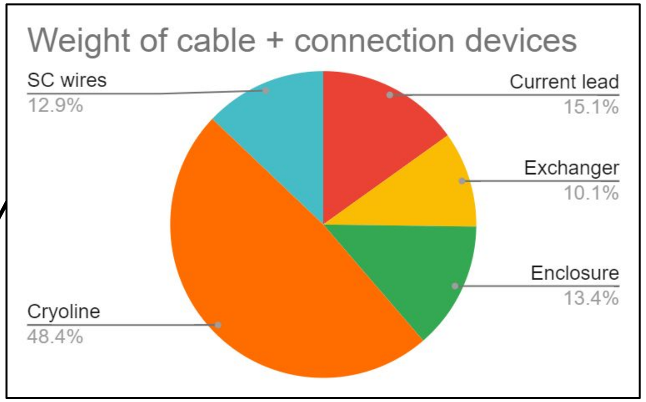
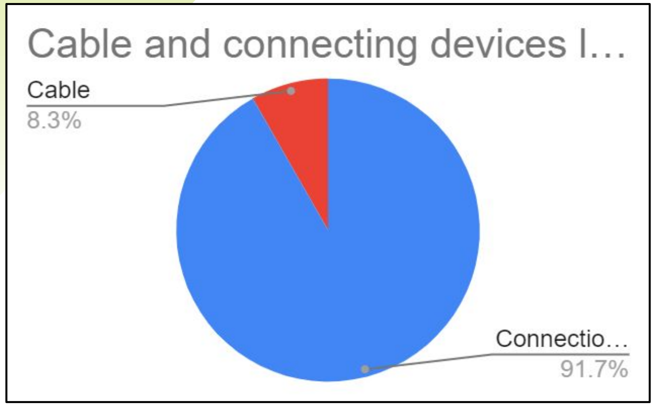
3kA Superconducting DC cable + connection devices

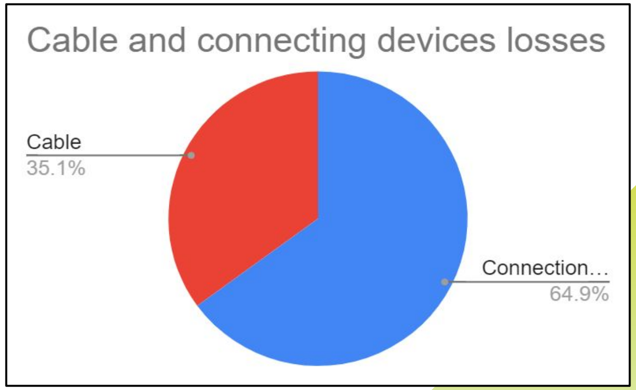








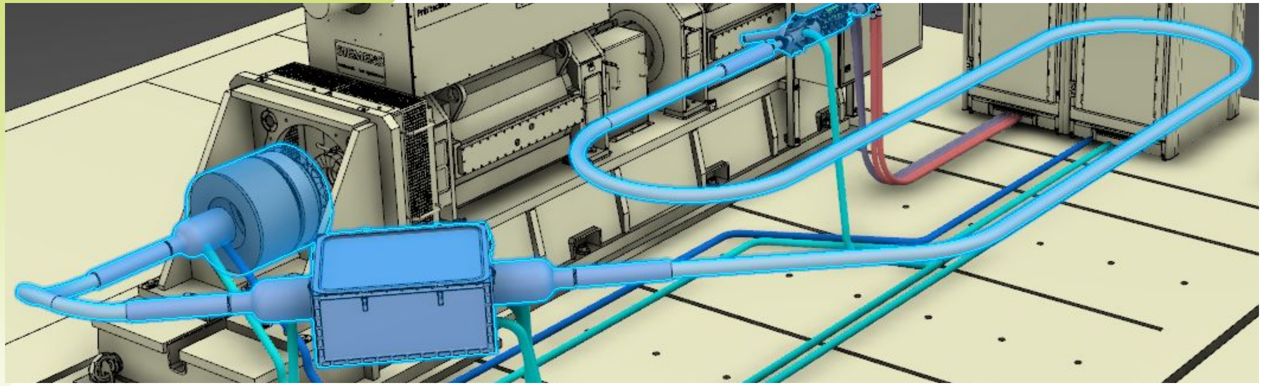


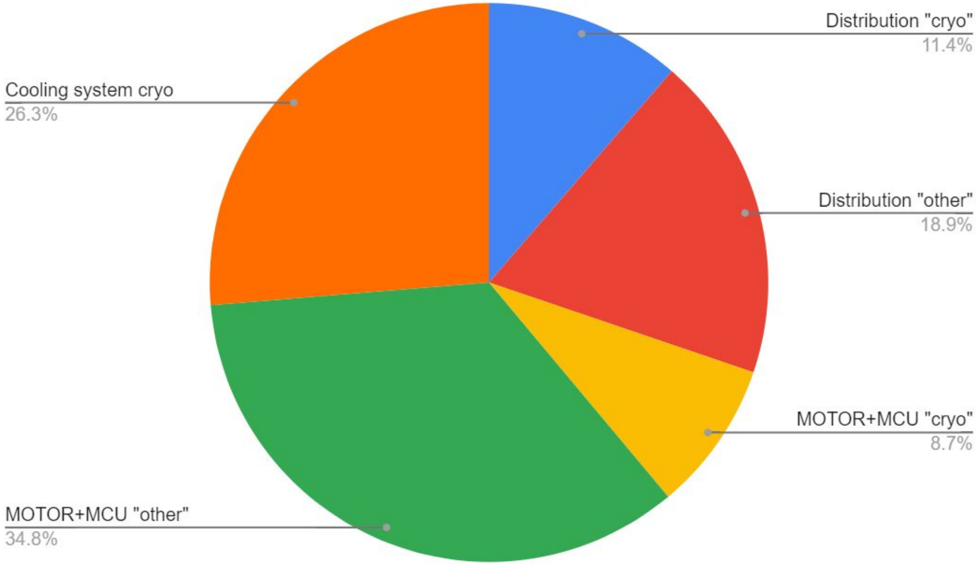


-the more the cable is long, the more superconducting cable is interesting.

-Weight and losses of Superconducting cables mainly depends on Cryogenic components

Powertrain + cables + thermal system based on optimised ASCEND technologies





-48.3% of the propulsion system weight are from cryo-components or cooling system!

-reduce cryo-losses vs weight of components to reduce the constraints on Cryo-cooling
-reduce weight of cryo-components (vacuum chamber, cryostats...) and better integration

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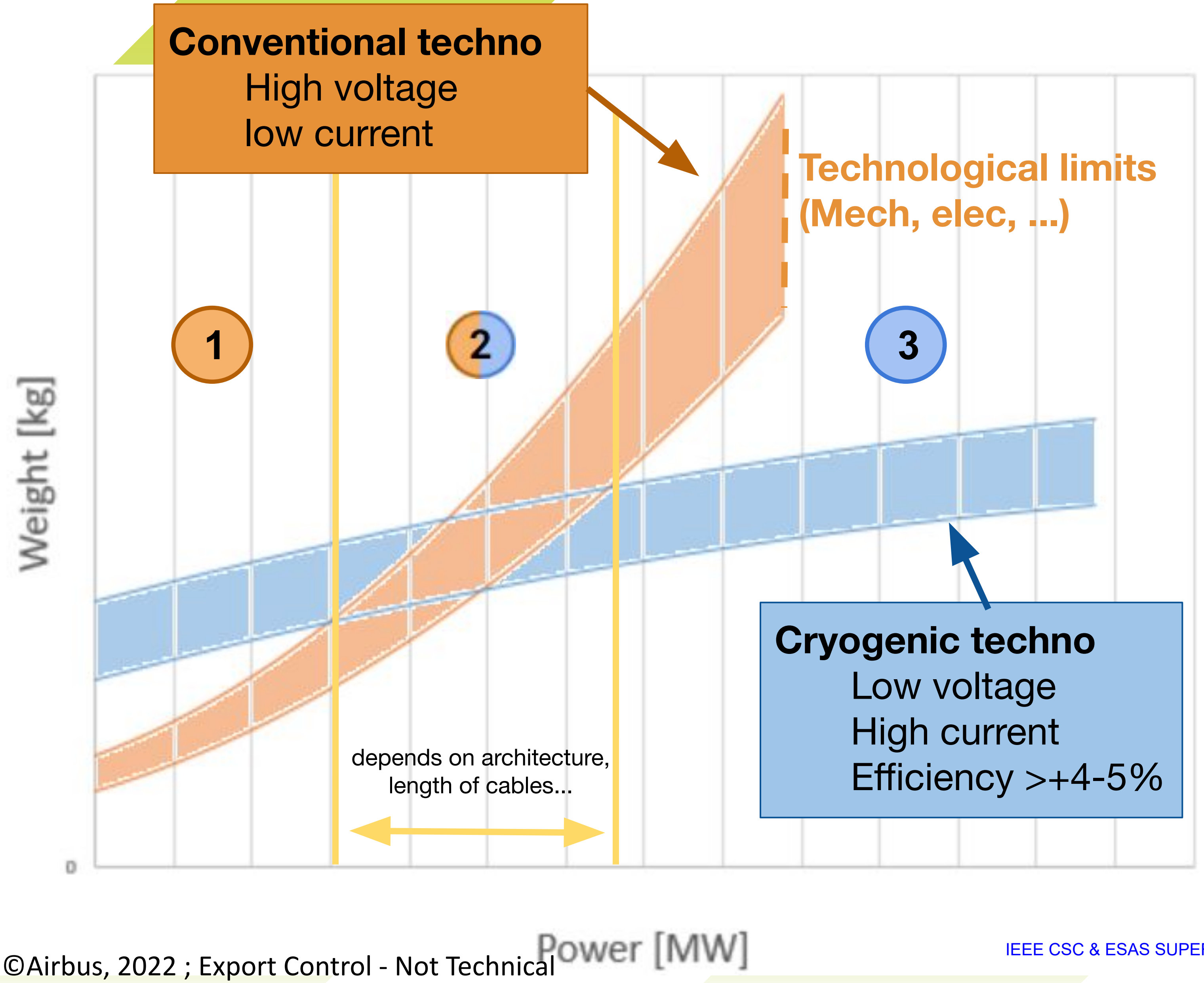
Cryogenic powertrain with LH2



A new paradigm:

Performances increase with power
Enable high Current/low voltage
Enable high torque e-motor
High efficiency

1 **Conventional techno is the best**

2 **Game changer depends on architectures**

3 **Enabler for high power**

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thank you & keep moving

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