



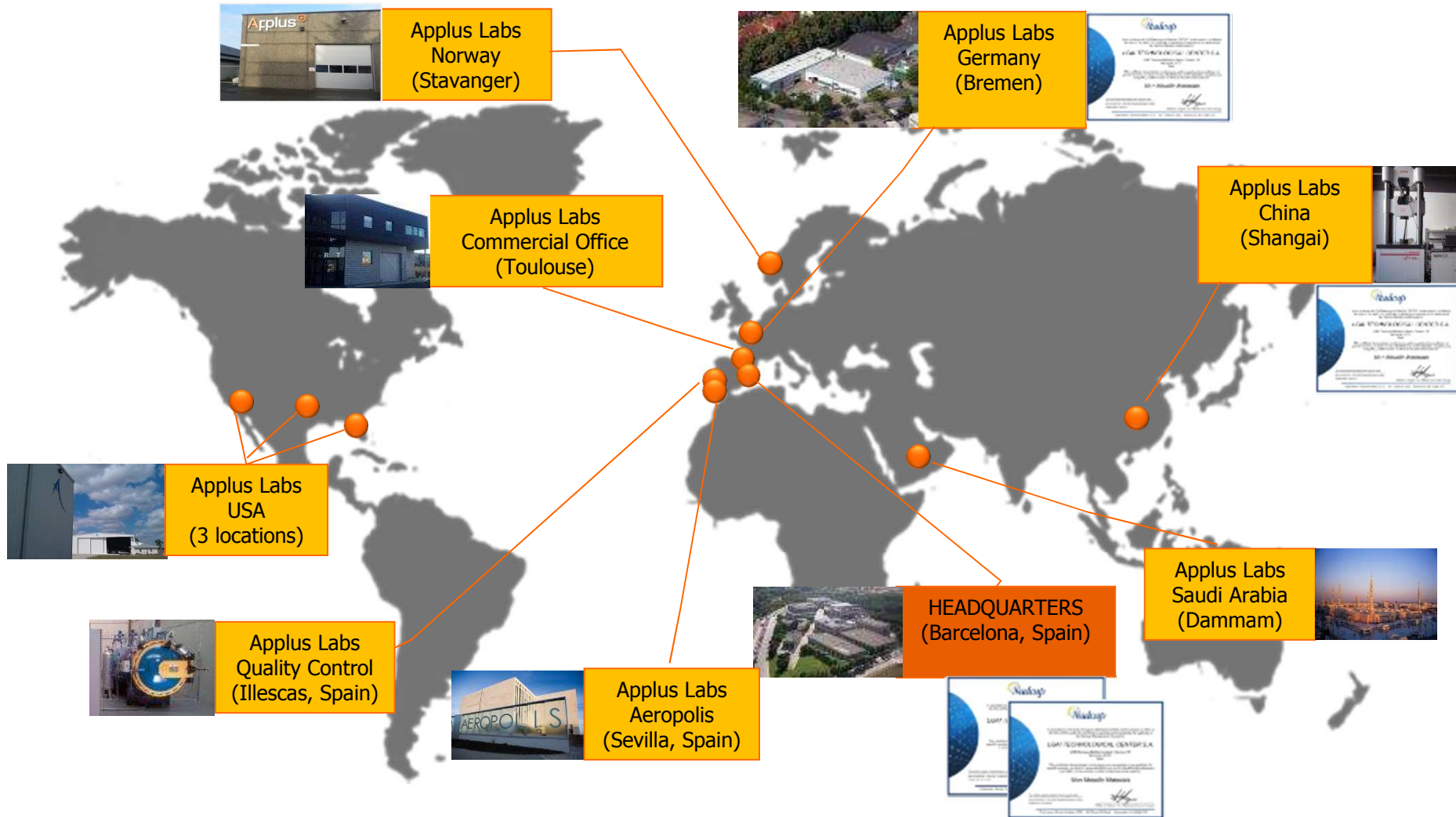
Your Competitive Asset

APPLUS PRESENTATION

Large Structures Mechanical and Electrical Test at Cryogenic Temperatures

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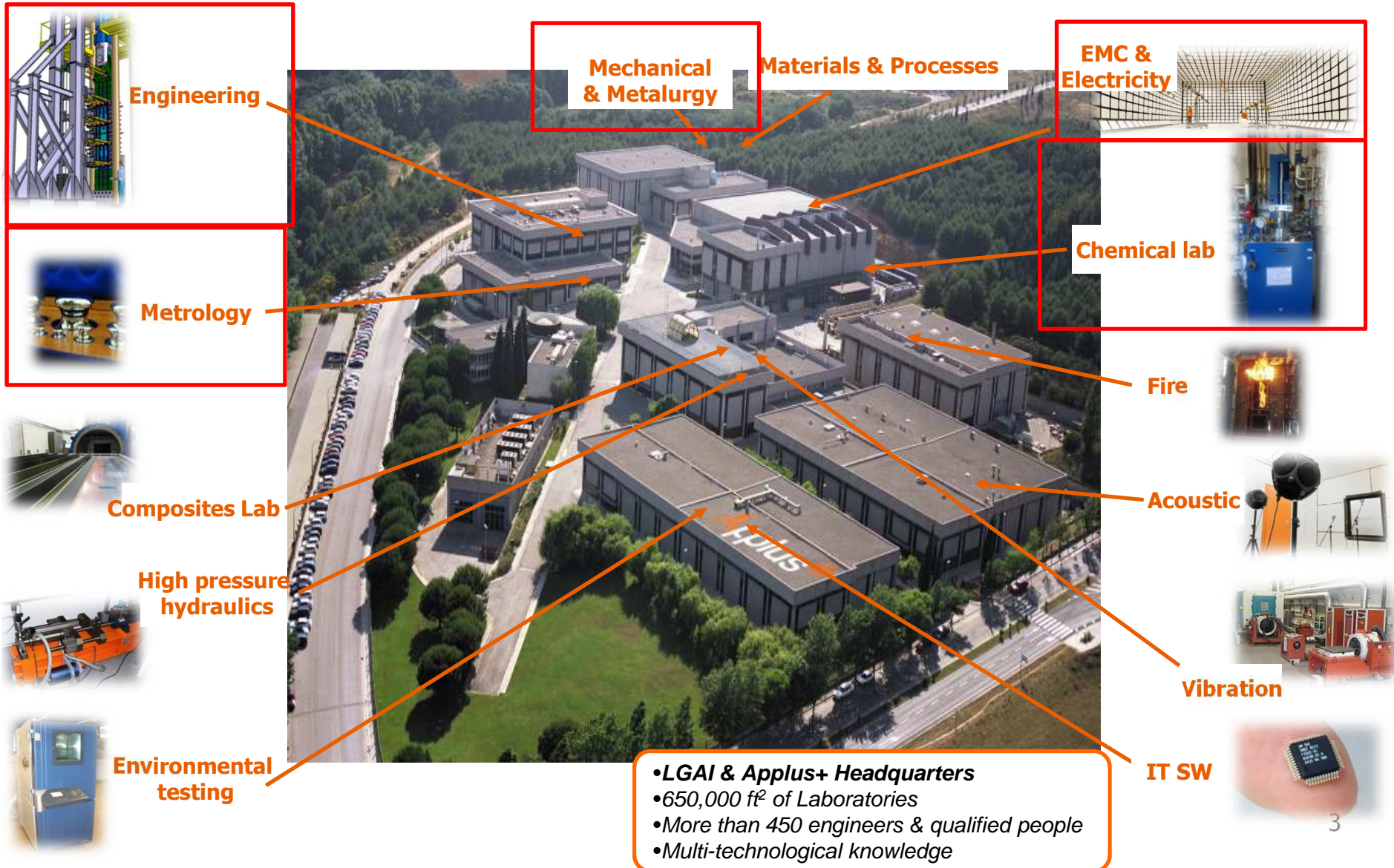
World wide laboratories Materials Laboratories



- Laboratories accredited according to **ISO 17025**.

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Applus Laboratories



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APPLUS LABORATORIES R&D Objectives

INNOVATION WITH INDUSTRIAL SENSE

- Be a solutions provider for the aeronautical sector in different technologies.
- Participate in complete projects, adding value from the early stage of the product development.
- Integrate the knowledge from different partners to create a complete and “able to implement” solution.
- Support our customers in their continuous improvements activities.

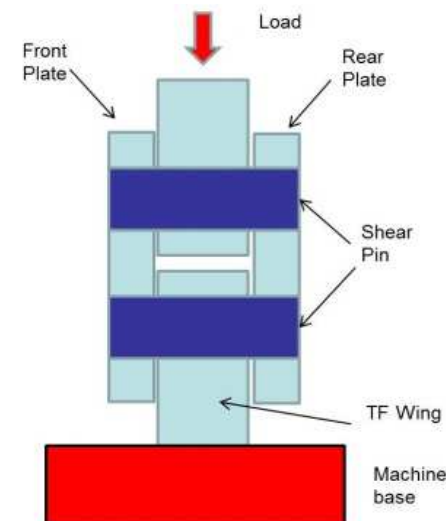
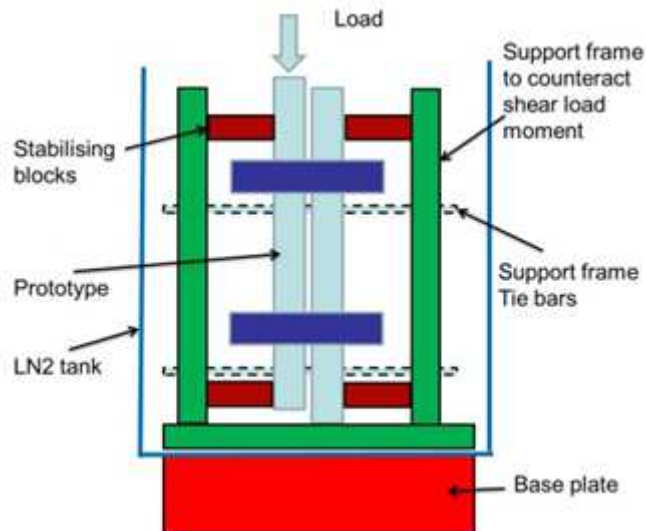


01 Applus⁺ CRYOGENIC TEST

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The requirements

- ⊕ Single shear and double pin Test
- ⊕ Cyclic shear loading tests at 77K
- ⊕ From ~2MN to ~9.7MN
- ⊕ Measurements
 - ⊕ displacements between the specimen, front plate and back plate.
 - ⊕ measurement of the electrical resistance of the low- voltage insulation during cyclic shear loading at 77K
 - ⊕ determine dimensional changes and assess possible damage at the interfaces



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The Specimen

- ⊕ Single and double shear pin assembly
- ⊕ Structural material is the stainless steel
- ⊕ Overall weight is about 3 Tn.
- ⊕ Low-voltage insulation on the pin hole

Confidential

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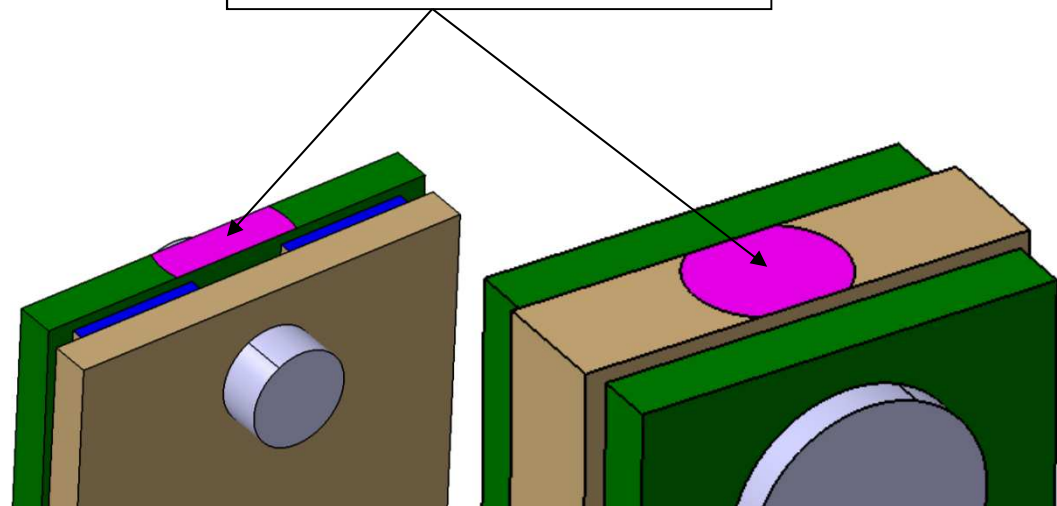
The facility – Load applied



MTS 15 MN

Actuator rating dynamic forces:	±15MN
Stroke:	400mm
Maximum test space:	8100mm
Width between columns – front:	2000mm
Strong Floor maximum side:	11500mm

Load Introduction AREA



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Cryogenic camera and tooling

- ⊕ N₂ boiling temperature -196°C
- ⊕ Boiling is an effective heat transfer mechanics
- ⊕ High temperature exchange
- ⊕ Film boiling
- ⊕ Not very effective heat exchange mechanism (from 100-1000 W/m²K)
- ⊕ When temperature of the part is -130°C Nucleated boiling
- ⊕ More effective (from 5.000-10.000 W/m²K)

- ⊕ Cool down type 5,5 hours
- ⊕ Room temperature after test 24 hours after the total emptying of the climate chamber

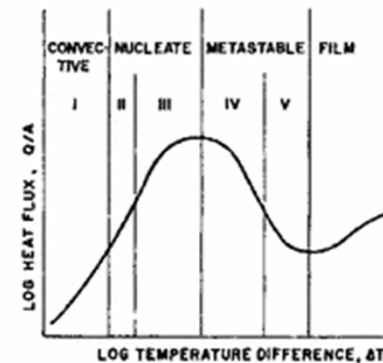


Fig. 1. Typical complete boiling heat-transfer curve.

- ⊕ Thermocouples will be screwed on the prototype.
- ⊕ Displacement sensors will be mounted to measure realtime displacements between the pins and the plates
- ⊕ One of the displacement sensor support is made of an electrical isolator in order to insulate the sensor from the prototype.
- ⊕ The wires are fixed on the tooling and guided to the outside by a tube attached to the side of lateral plate.

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The facility – Load applied

Risk Assessment

- ⊕ Skin burning in case of direct contact or projection
- ⊕ Asphyxia due to oxygen displacement
- ⊕ Liquid Nitrogen spill over
- ⊕ Explosion in case of pressure increase due to uncontrolled liquid evaporation

IPE



mandatory
face protection



mandatory
hand protection

Information



Attention
Danger



Attention
Danger of freezing



Attention
Hazardous



Attention
Oxygen deficiency

Active safety methods

- ✓ Security valves to assure a safe Nitrogen conduction
- ✓ Emergency shutdown button
- ✓ Oxygen detectors



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Success Keys



⊕ **Multi-Technology Test supported by different Applus Laboratories**

- ⊕ Mechanical Laboratory
- ⊕ Materials laboratory
- ⊕ Simulation and engineering office
- ⊕ Test Bench department
- ⊕ Chemistry department
- ⊕ Safety certification office

⊕ **Good partnership with our subcontractors**

- ⊕ Cryogenic gases provider
- ⊕ Tooling manufacturing provider
- ⊕ Machine manufactory provider

Applus⁺
laboratories

QUESTIONS?

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