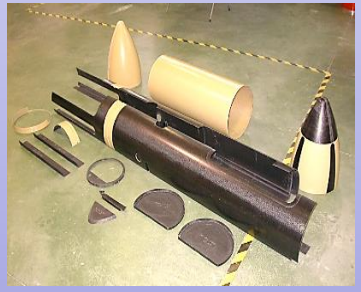
Capabilities and activities in cryogenic testing

INTA
Materials and Structures Department (DME)
Composite Materials Area (AMC)

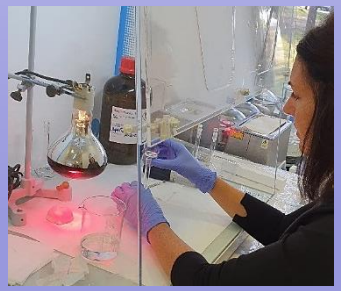
Composite Materials Area

GOBIERNO DE ESPAÑA · MINISTERIO DE DEFENSA · SECRETARIA DE ESTADO DE DEFENSA · INTA

Materials characterization



Development & Manufacturing of specimens and prototypes



Physical/ Chemical characterization of composite materials

Structural health monitoring of Composite Materials Structures

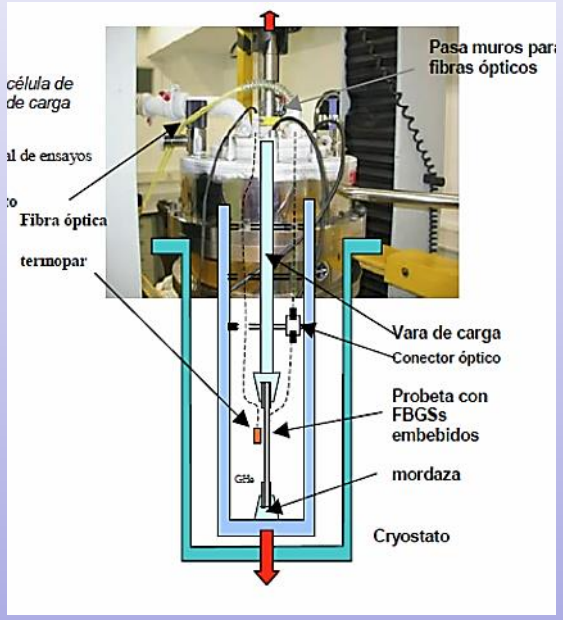
Cryogenic Equipment

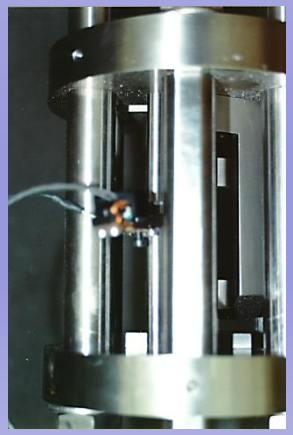
Tensile and compression tests with standard specimens

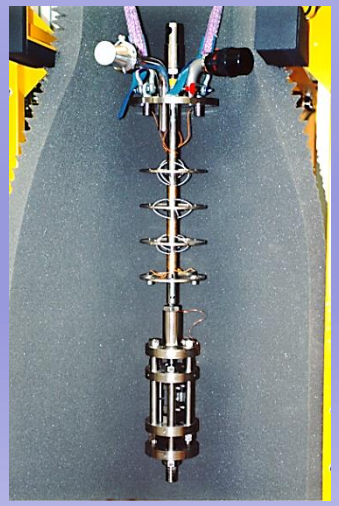
Cryogenic Mechanical Testing Device

Tmin= 4 K;

Max load = 100 kN





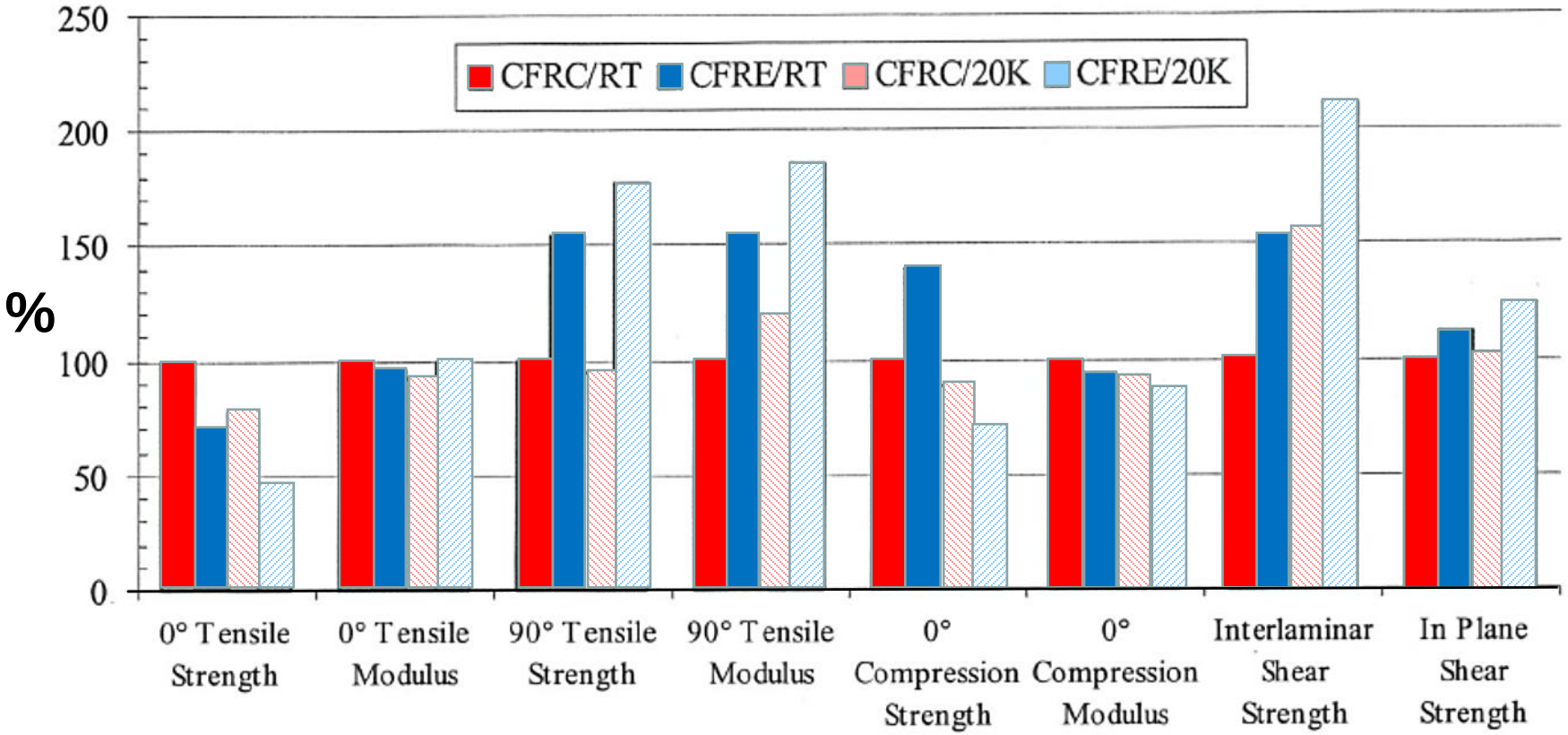


Earlier activities

ESA Project FESTIP 1 and 2: 1995…00

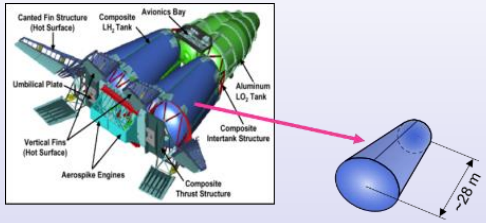
- Characterization of CFRC and CFRE composite material at 20K (temperature of LH2)
- Design and purchase of cryostat testing device
- Unique installation in Spain

ESA Project FESTIP 1 and 2: 1995-00: Results



CFRC: carbon fibre reinforced cyanate-ester (IM7/954-2A)
CFRE: carbon fibre reinforced epoxy (IM7/8552)

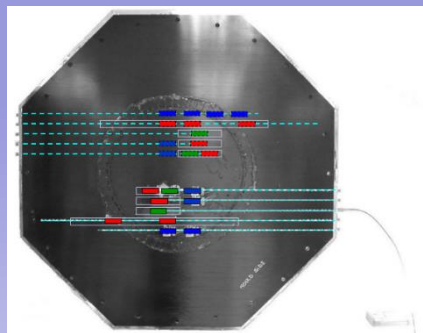
Proceedings of the European Conference on Spacecraft Structures, Materials and Mechanical Testing, Noordwijk, The Netherlands, 29 November-1 December 2000 (ESA SP-468, March 2001)



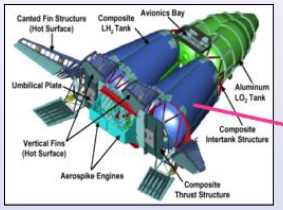
Earlier activities

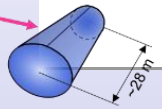
ESA Project CRYOFOS: 2002 … 05

- **MULTI-PURPOSE FIBER OPTIC SENSORS FOR REUSABLE CRYOGENIC TANKAGE APPLICATIONS**
- **Sensor development and cryogenic tests at 20K**
  - **H2-leakage, strain and T**
  - **Tesis**: Sensores de fibra óptica tipo redes de Bragg embebidos en material compuesto para medir deformaciones y temperaturas criogénicas



CryoFOS





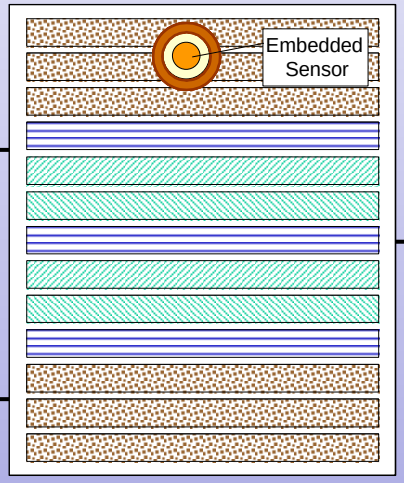
PHASE 1: "Triplet" Sensor Design

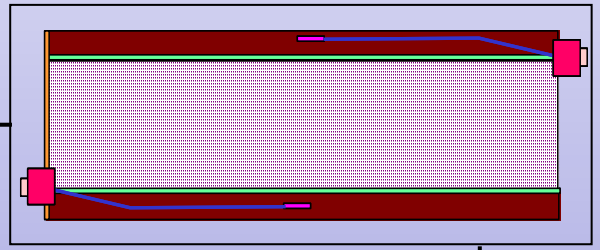
Review of Cryogenic Tank Structure Designs

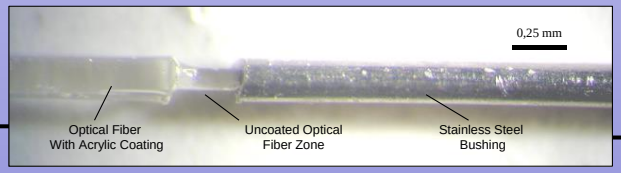
Review of Embedding Techniques

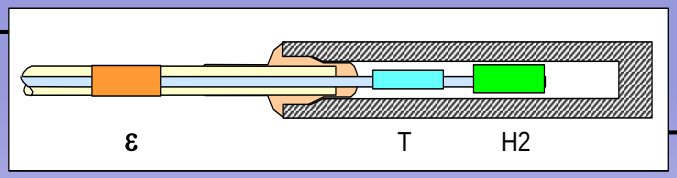
Review of Testing at Cryogenic Temperature

Review of ε, T & H_2 Sensors

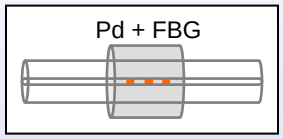




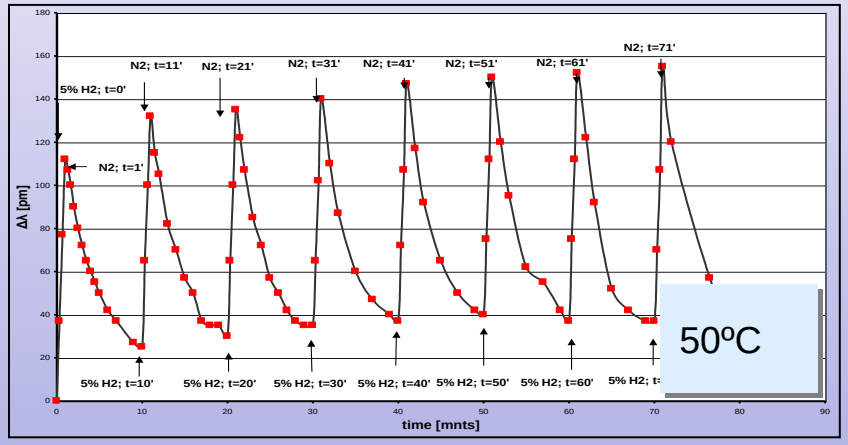


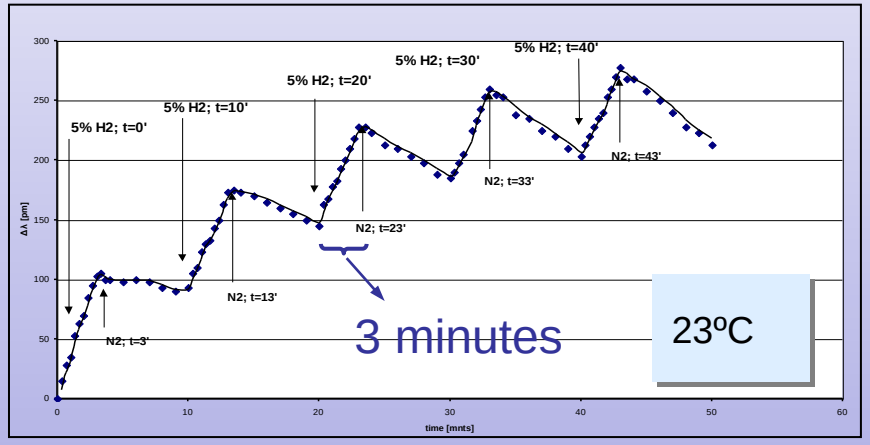


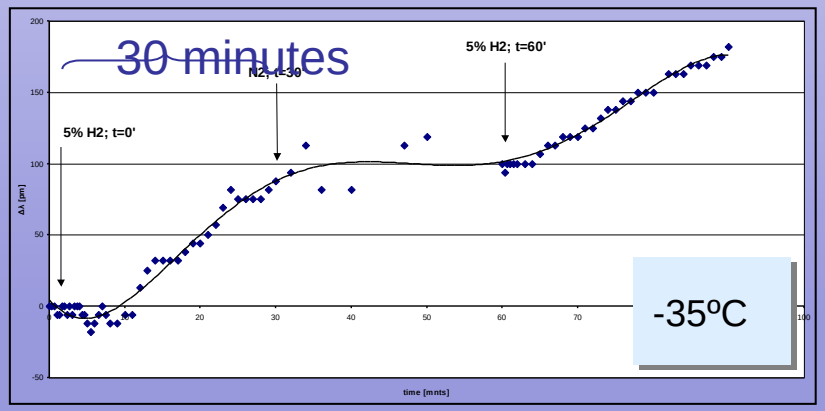
"Triplet" Sensor



Optical FBG Coated with a Thick (2-4 microns) Pd Layer

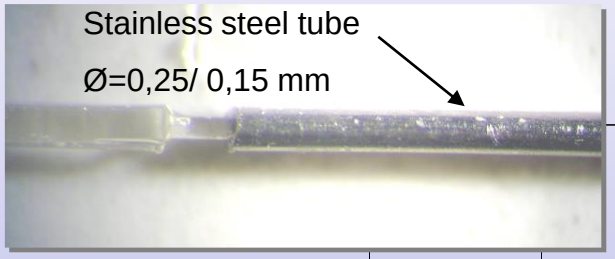






- Phenomena absorption /desorption are reversible, if enough time is given.
- The thick Pd layer did not attain saturation of H2 during Absorption → Qualitative Detector
- Desorption is slower (characteristic times 6 time larger)

CryoFOS: Temperature SENSORS



test in furnace

test in cryostat

free uncoated

Resolution at 20K: almost 0

with steel casquet

Resolution at 20K: ~1,5 pm/K

Δλ wavelength shift [pm]

1000
0
-1000
-2000
-3000
-4000

0
50
100
150
200
250
300
350
400

temperature [K]

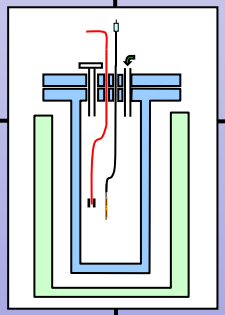
PHASE 2: Development on Simple Sample Free and Embedded Conditions

Characterization
Free H_2 Leak Sensors
[20K,RT]

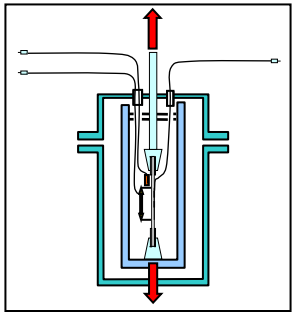
Characterization
Free T-Sensors
[20K,RT]

Characterization
Free ε-Sensors
[20K,RT]

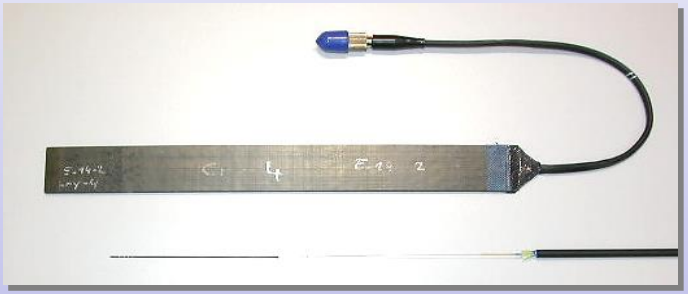
Development
Embedding/Integration
Techniques



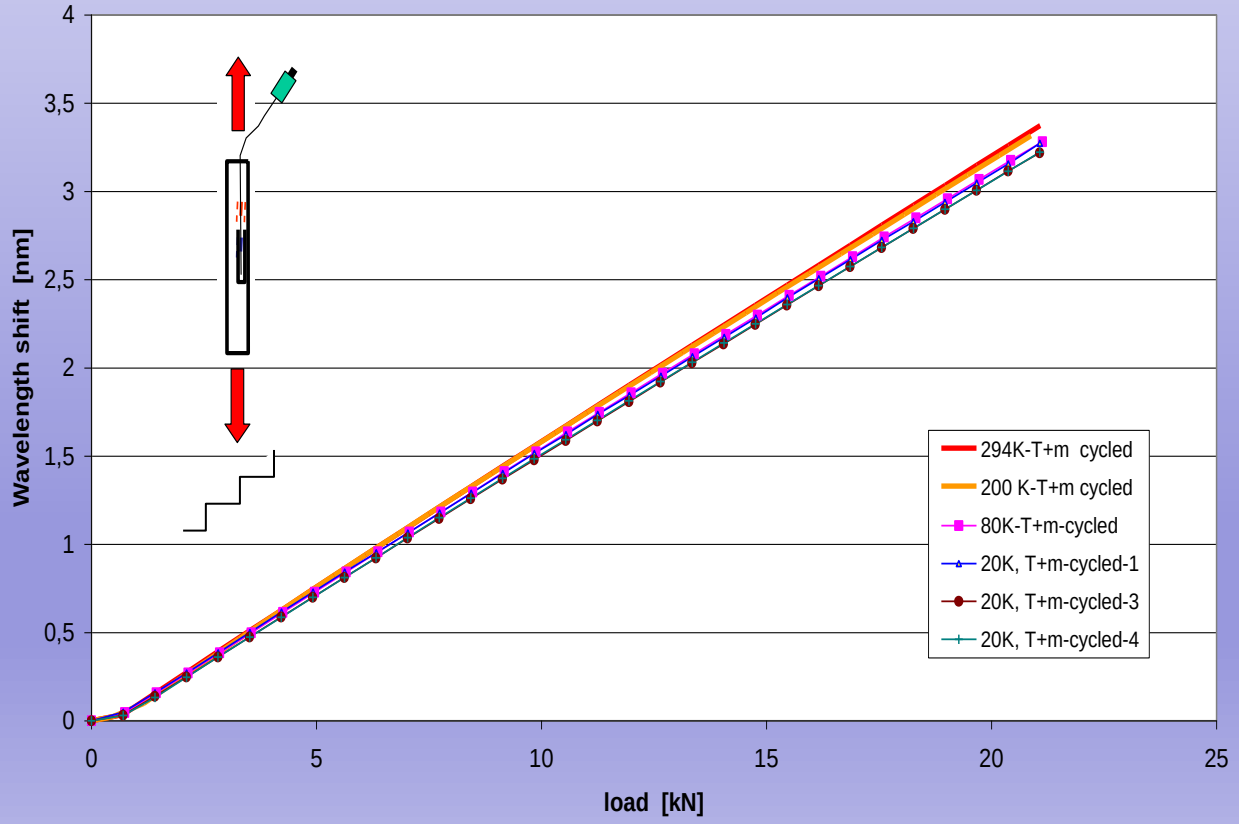
Characterization
Embedded ε, T & H_2 Sensors
[20K,RT]

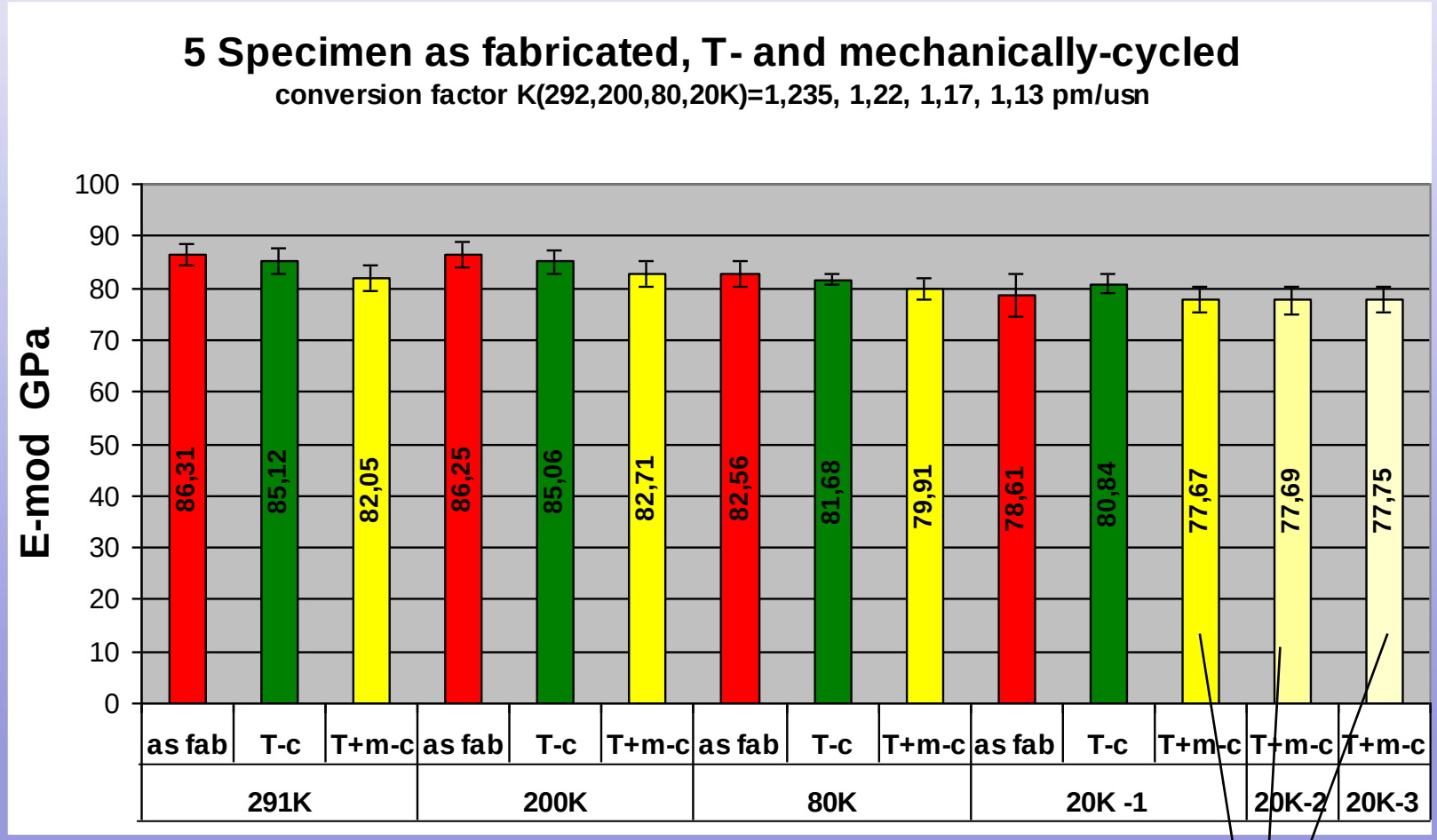


Tensile tests at RT, 200, 80, 20K



Universal testing machine with continuous flow cryostat



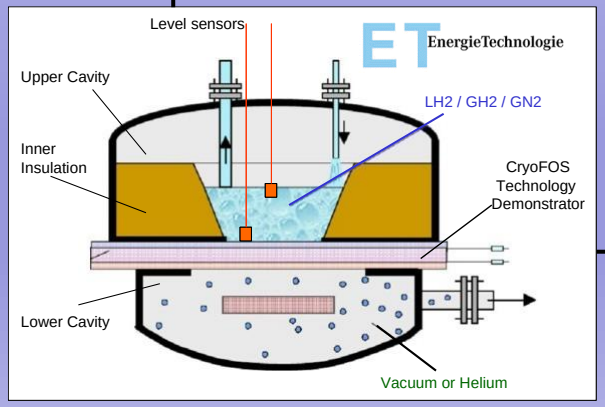


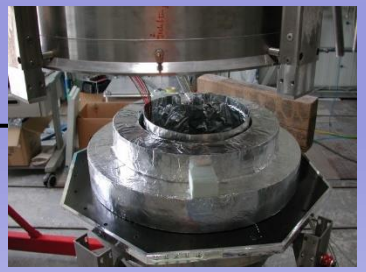
Thermal cycling (T-C): 50x 100K → 400K
Mechanical cycling (m): 400x 0 → 5000 με

Repeatability at 20K: ±0,5%

PHASE 3: Technology Demonstrator

Cryogenic Testing



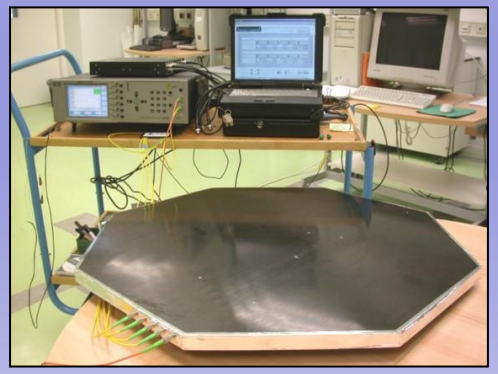


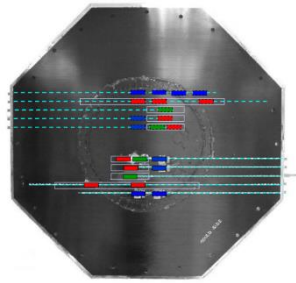
TEST SET-UP PREPARATION

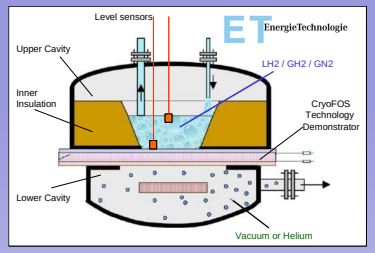
- Installation of Technology Demonstrator into Testing Chamber
- Application of Conventional Sensors on Both sides of the Piece
- Electrical and Optical Connections to Data Acquisition Equipments

TESTING CAMPAIGN

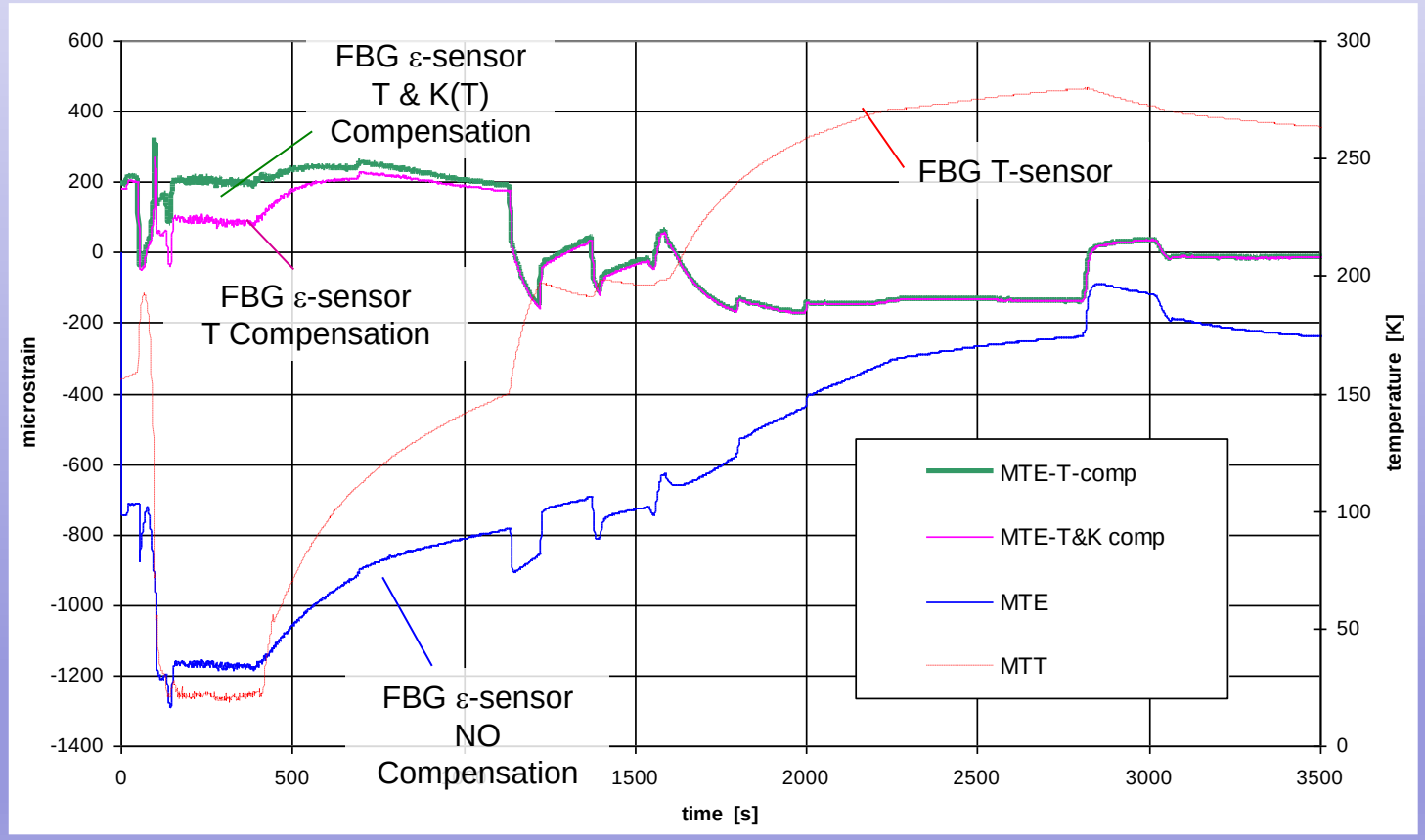
- Pre-tests with GN_2 at RT
- Tests with GH_2 at RT
- Tests with LH_2 at 20K







Embedded FBG ε-sensor: Temperature Compensation



LH2 on upper surface: 20 K

Actual activities and projects

Acronym	Name	Call
FASTER H2	Fuselage, Rear Fuselage and Empennage with Cabin and Cargo Architecture Solution validation and Technologies for H2 integration	**HORIZON-JU-Clean-Aviation-2022-01**
CRYFTO	TowaRds the design of saFe liquid hYdrogen tanks for effiCient and green Transport applicatiOns	**«PROYECTOS DE GENERACIÓN DE CONOCIMIENTO» Programa Estatal, 2021-2023. INTA - UdG**
Subcontracted, for different national and international activities		