

SMOS PLM THERMAL BALANCE

A CHALLENGING TEST

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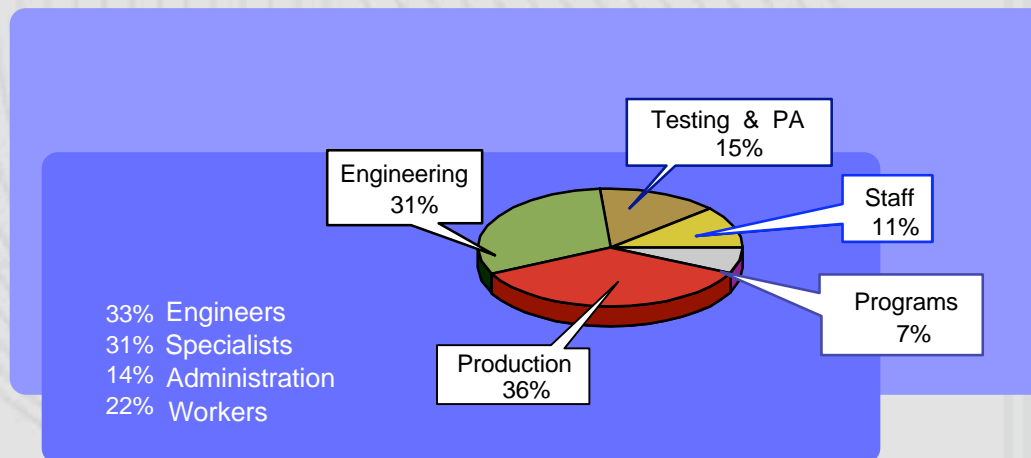
- 1.- ABOUT EADS CASA ESPACIO
- 2.- THE SMOS PROJECT
- 3.- THERMAL BALANCE TEST CONCEPTION
- 4.- SETTING UP THE TEST
- 5.- TEST PERFORMANCE

ABOUT EADS CASA ESPACIO

HISTORY:

- **1923:** CASA was founded in Madrid (SPAIN).
- **1966:** Space and Electronics Departments were created.
- **1984:** Merging of both departments into CASA SPACE DIVISION
- **2000:** Founded EADS from CASA, DASA and Aerospatiale Matra
- **2003:** Founded EADS CASA Espacio S. L.

HUMAN RESOURCES : About 362 people

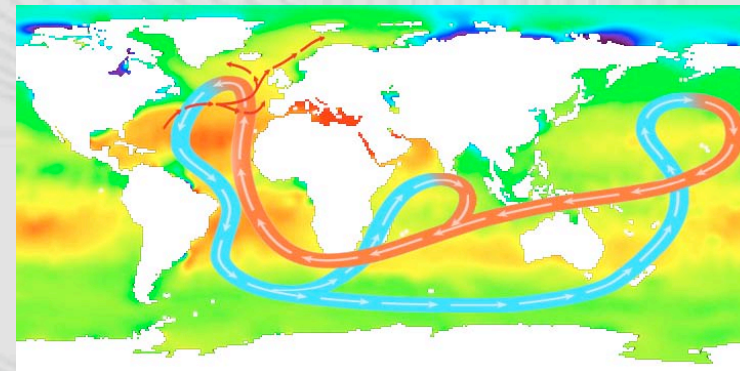
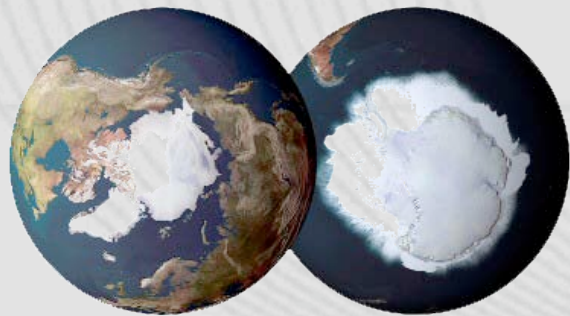
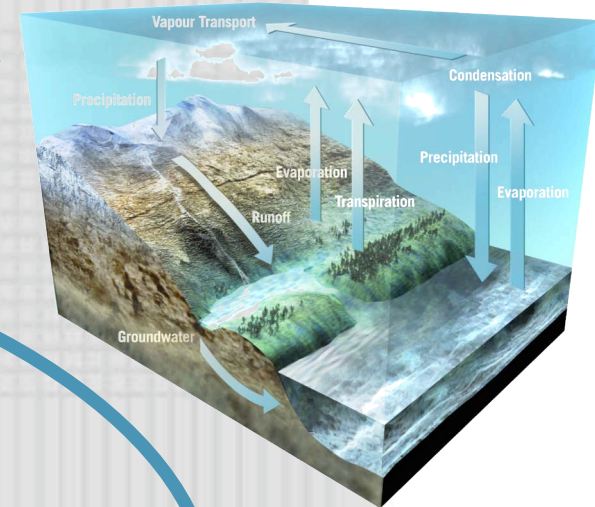


THE SMOS PROJECT

THE MISSION

ESA's Soil Moisture and Ocean Salinity (SMOS) mission has been designed to:

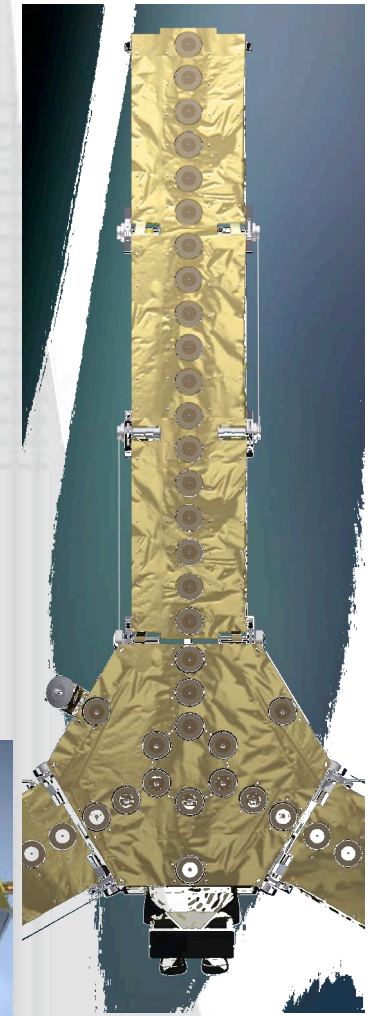
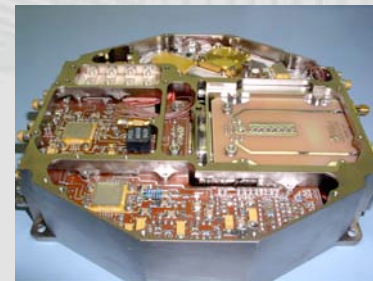
- Obtain soil moisture data urgently required for hydrological studies.
- Get data on ocean salinity, vital for improving our understanding of ocean circulation patterns.
- As a secondary objective, SMOS will also provide observations over regions of snow and ice, contributing to studies of the cryosphere.



THE SMOS PROJECT

THE INSTRUMENT

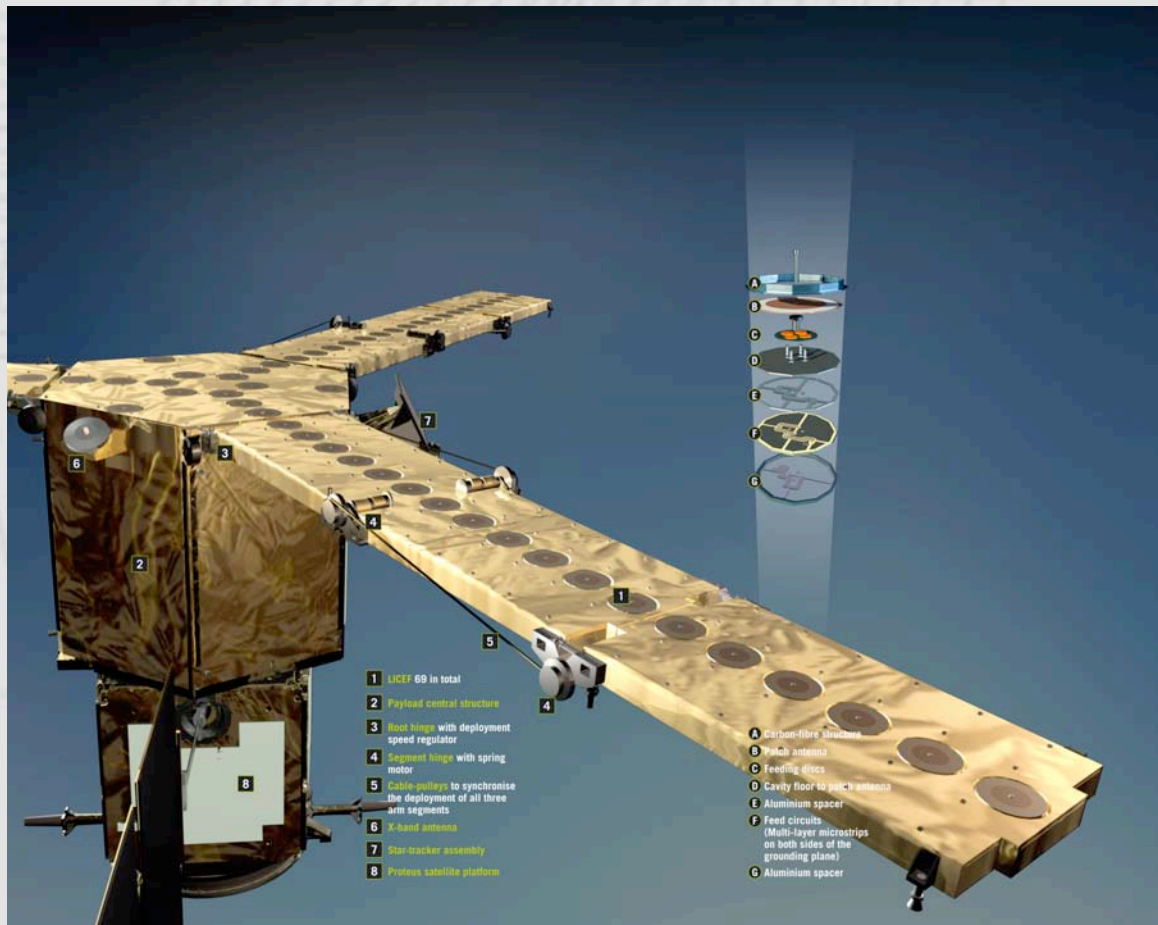
- A novel instrument has been developed that is capable of observing both soil moisture and ocean salinity by capturing images of emitted microwave radiation around the frequency of 1.4 GHz (L-band). SMOS will carry **the first-ever, polar-orbiting, space-borne, 2-D interferometric radiometer**.
- The innovative SMOS instrument, called **MIRAS** (Microwave Imaging Radiometer using Aperture Synthesis) has been realised after more than 10 years of research and development at EADS CASA Espacio for ESA.
- MIRAS consists of a central structure and three deployable arms, each of which has three segments. During launch, these arms are folded-up and, in orbit, they are deployed via a system of spring-operated motors and speed regulators.
- There are 69 antenna elements, the so-called **LICEF** receivers, which are distributed over the three arms and the central structure. Each LICEF is an antenna-received integrated unit that measures the radiation emitted from the Earth at L-band.
- The acquired signal is then transmitted to a central correlator unit, which performs interferometry cross-correlations of the signals. By pre-processing on-board, data that has to be transmitted to the ground is significantly reduced.



THE SMOS PROJECT

THE SATELLITE (I)

SMOS is fruit of the cooperation between CDTI (ESPAÑA), CNES(FRANCE) and ESA.



THE SMOS PROJECT

THE SATELLITE (II)



- Launcher:
ROCKOT
- Launch Date:
Early 2007
- Place:
Pletsek Cosmodrome
(Northern Russia)
- Ground Segment:
 - Satellite operation by
CNES (Toulouse-Kiruna)
 - Data reception & process
by ESA/CDTI (Villafranca)



THERMAL BALANCE TEST CONCEPTION

TEST DEFINITION

Test objectives:

- To demonstrate the ability of the thermal control system on the PLM to maintain temperatures inside the specified operational limits.
- To verify that the system performs correctly under vacuum and thermal conditions expected to be encountered during the mission.
- To validate the analytical thermal model of the PLM.

Test specimen:

Two PLM models must be tested:

- STM (Structural and Thermal Model) for the early assessment of the validity of the mathematical model hypothesis and for the tuning of the thermal control subsystem parameters. Only one arm deployed. This test must serve also to fine tuning the proposed set up for PFM.
- PFM (Proto-Flight Model) to qualify the thermal control subsystem and to verify the workmanship. Three arms deployed.

THERMAL BALANCE TEST CONCEPTION

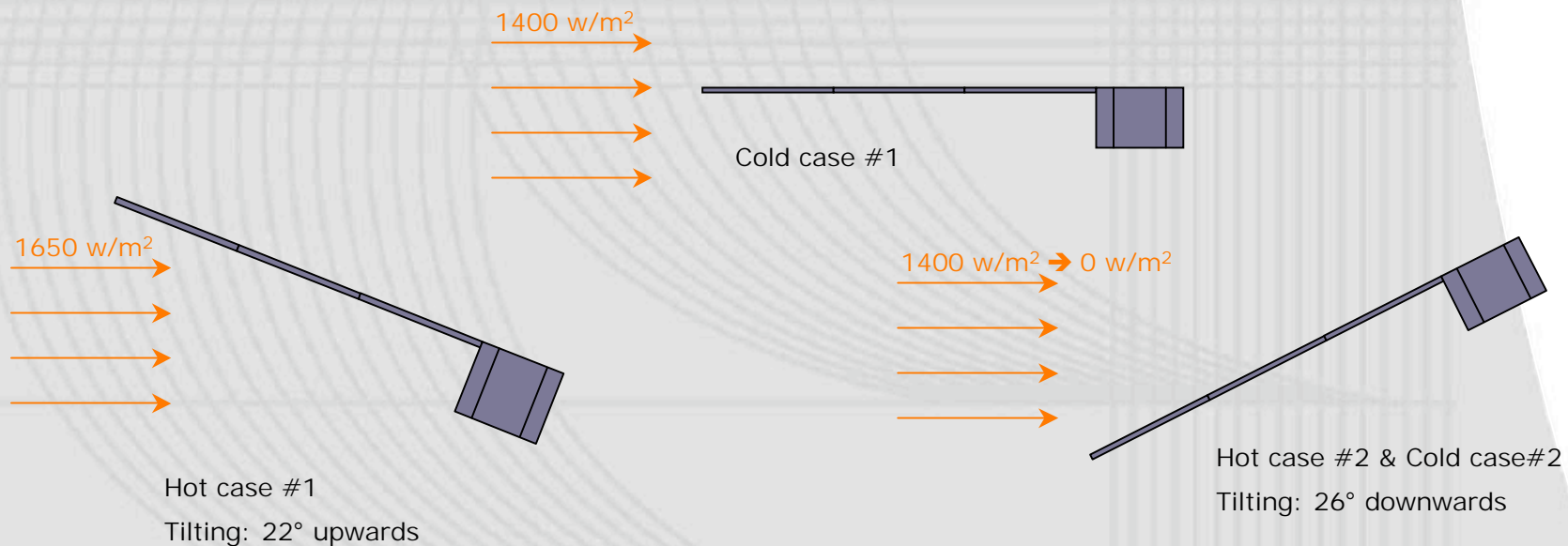
TEST DEFINITION

The test will be performed on a Solar Simulation Chamber capable of simulating the thermal environment expected during the operational phase.

The thermal state of the test article should be obtained by simulating the incident solar radiation and albedo in terms of spectra and intensities.

The thermal interface and conditions with PROTEUS Platform must be simulated during the test.

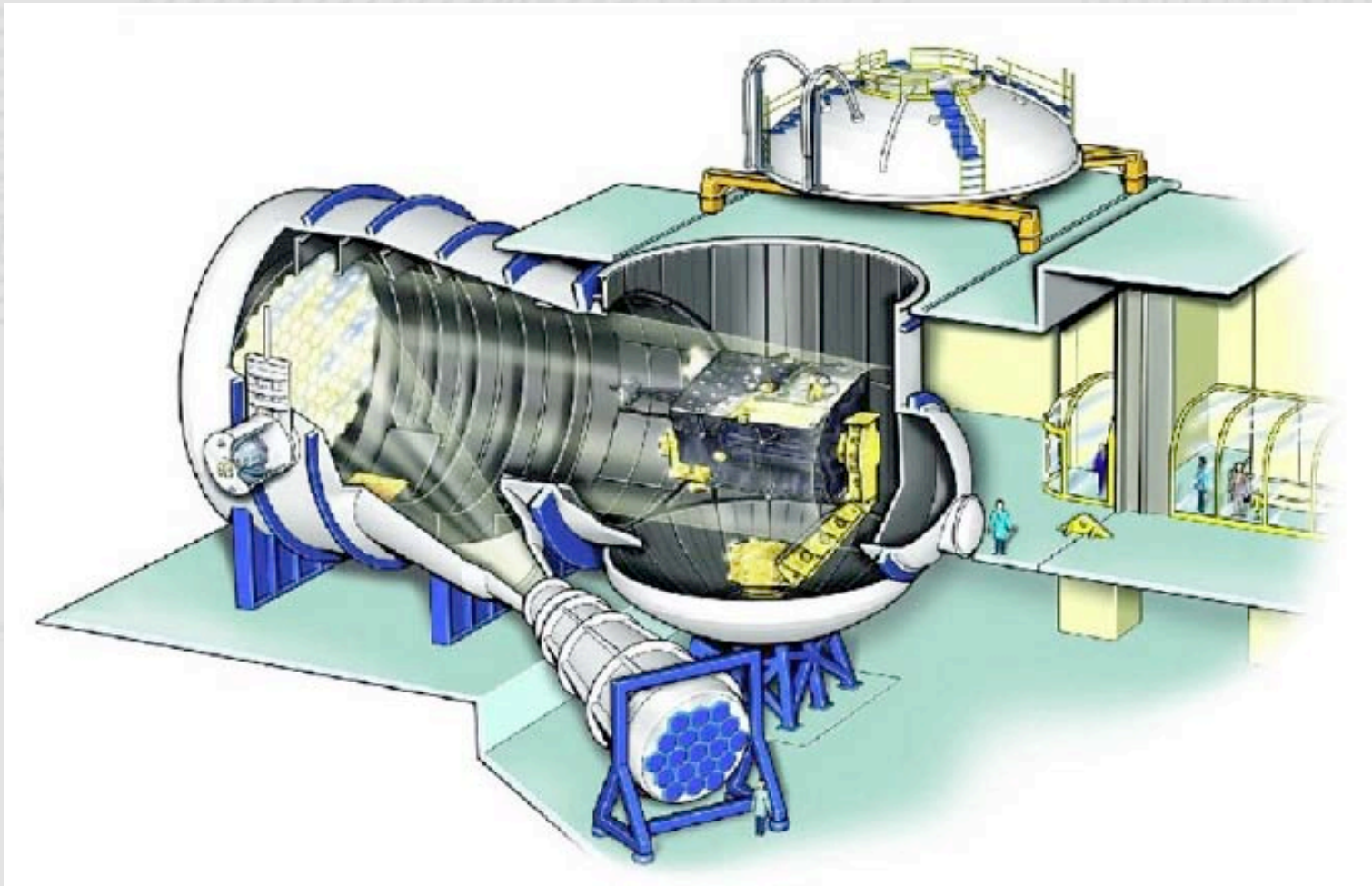
Three geometries w.r.t. the sun radiation will be tested:



SETTING UP THE TEST

TEST FACILITY

The **L**arge **S**pace **S**imulator (**LSS**) from ESTEC at Noordwijk (Nederland) was selected for the test.

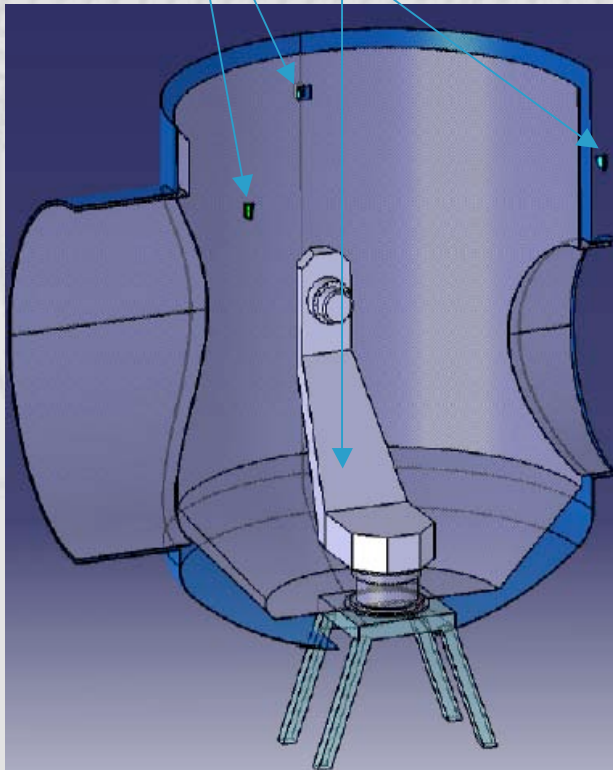


SETTING UP THE TEST

SET UP DEFINITION

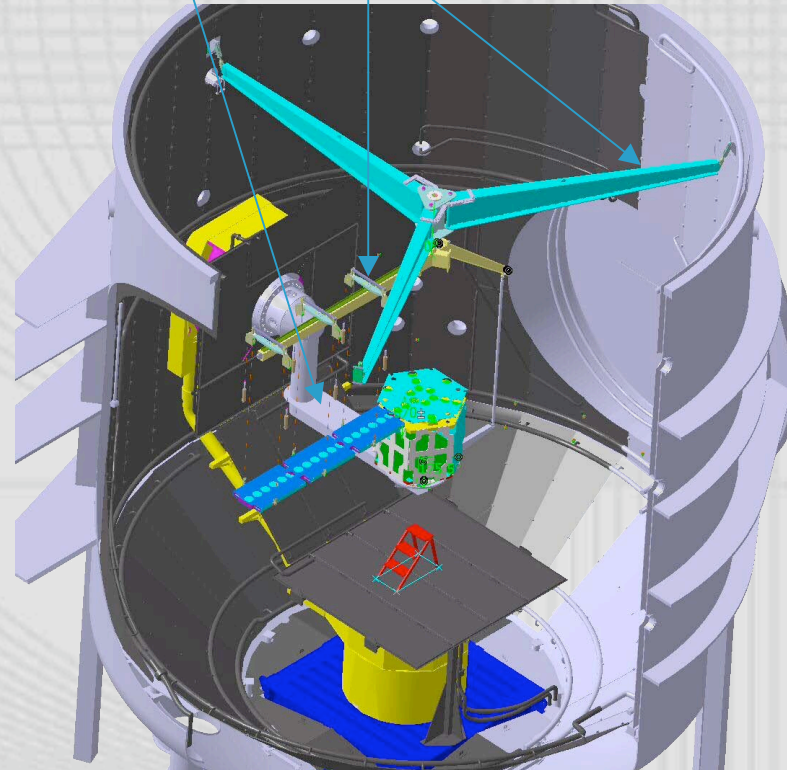
Chamber configuration:

- Gimbal Stand & Yoke
- 3 Support Points



Set up main components:

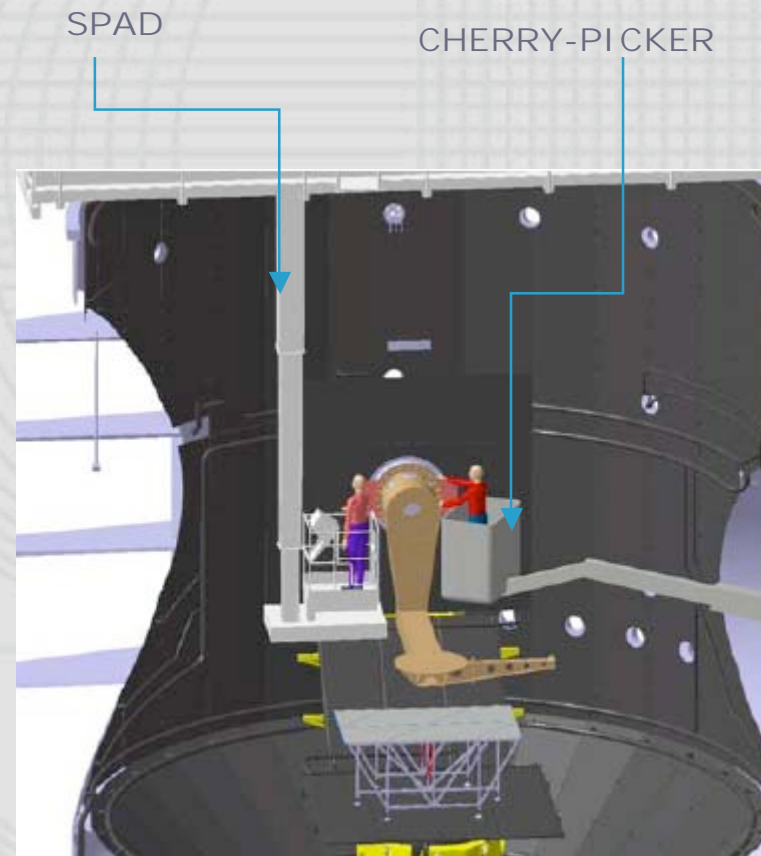
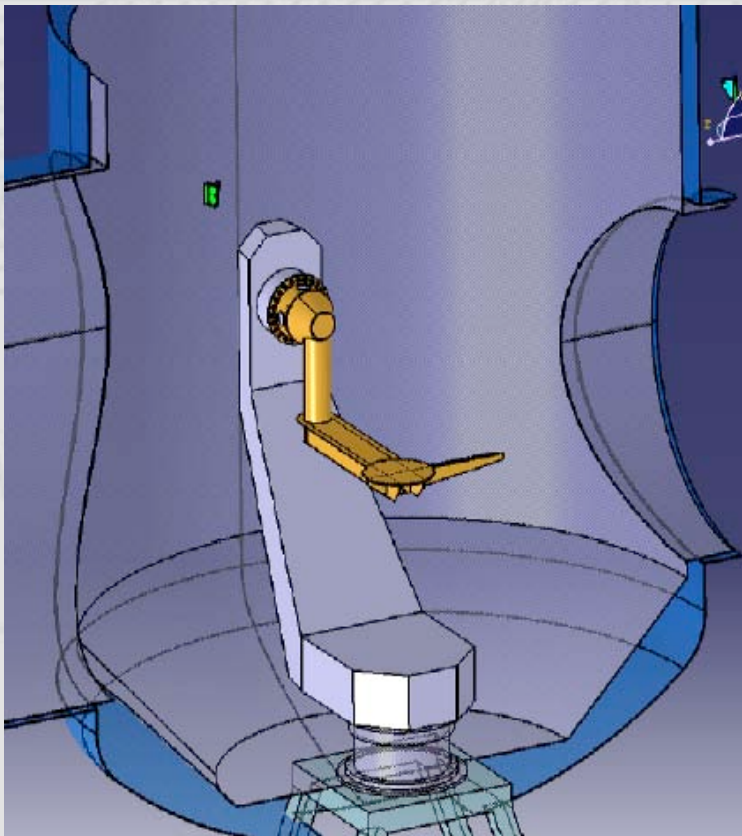
- Gantry
- Deployment System
- Support Arm



SETTING UP THE TEST

INSTALLATION SEQUENCE

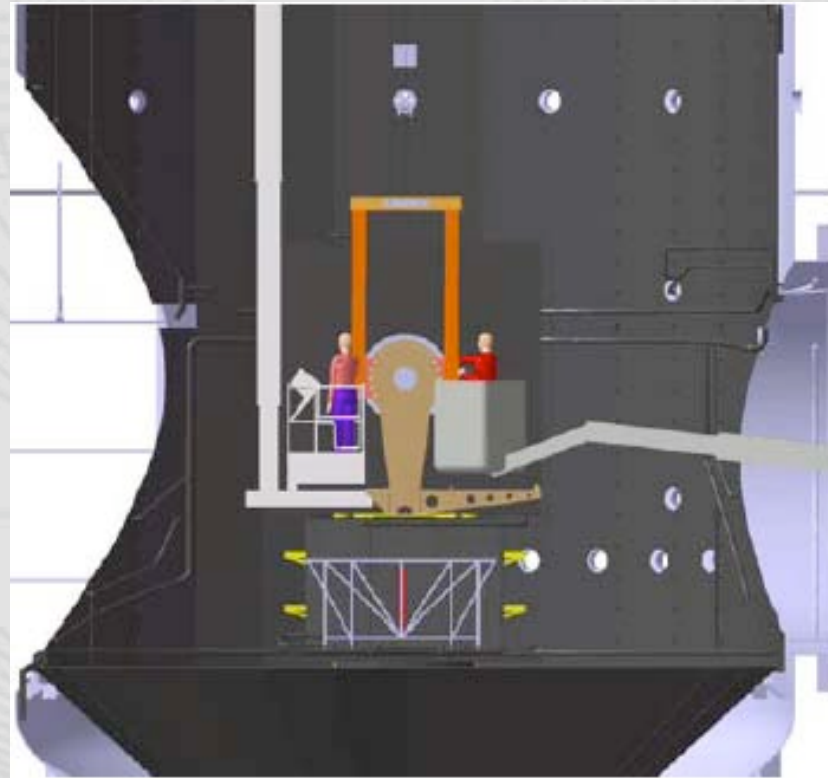
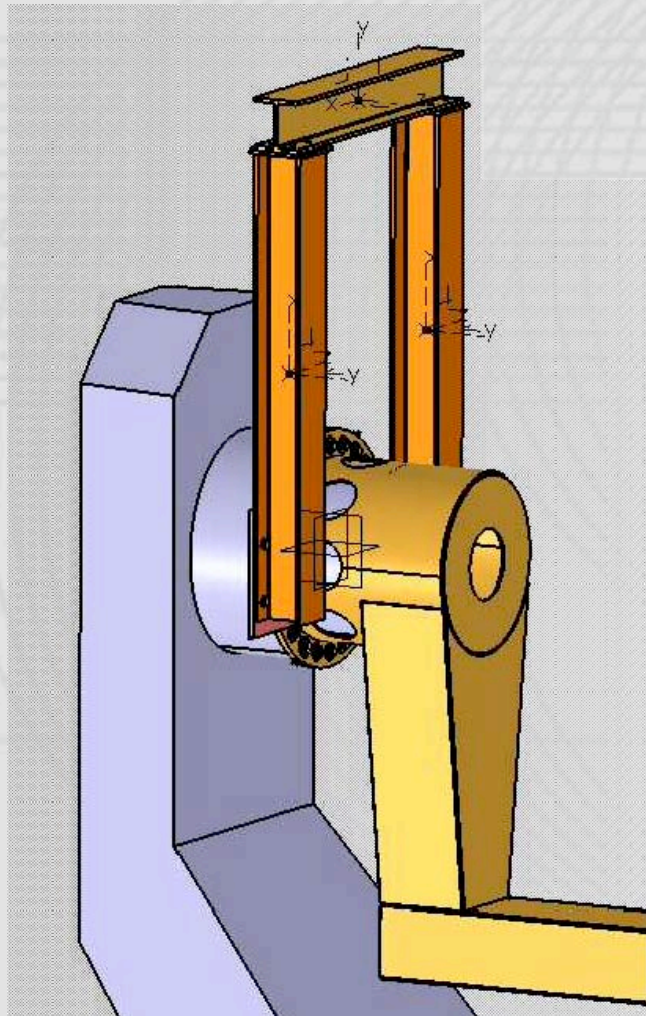
1.- SUPPORT ARM INSTALLATION



SETTING UP THE TEST

INSTALLATION SEQUENCE

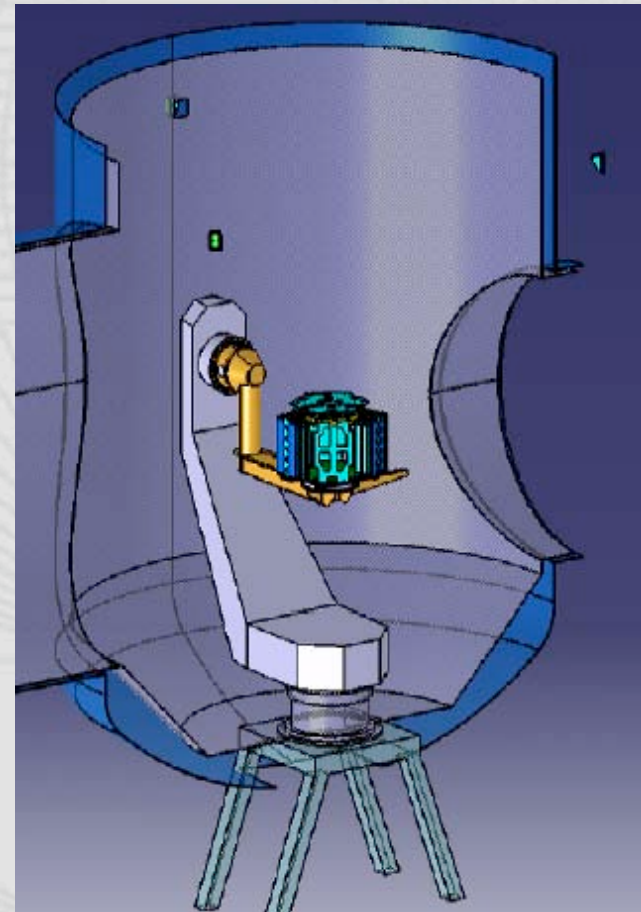
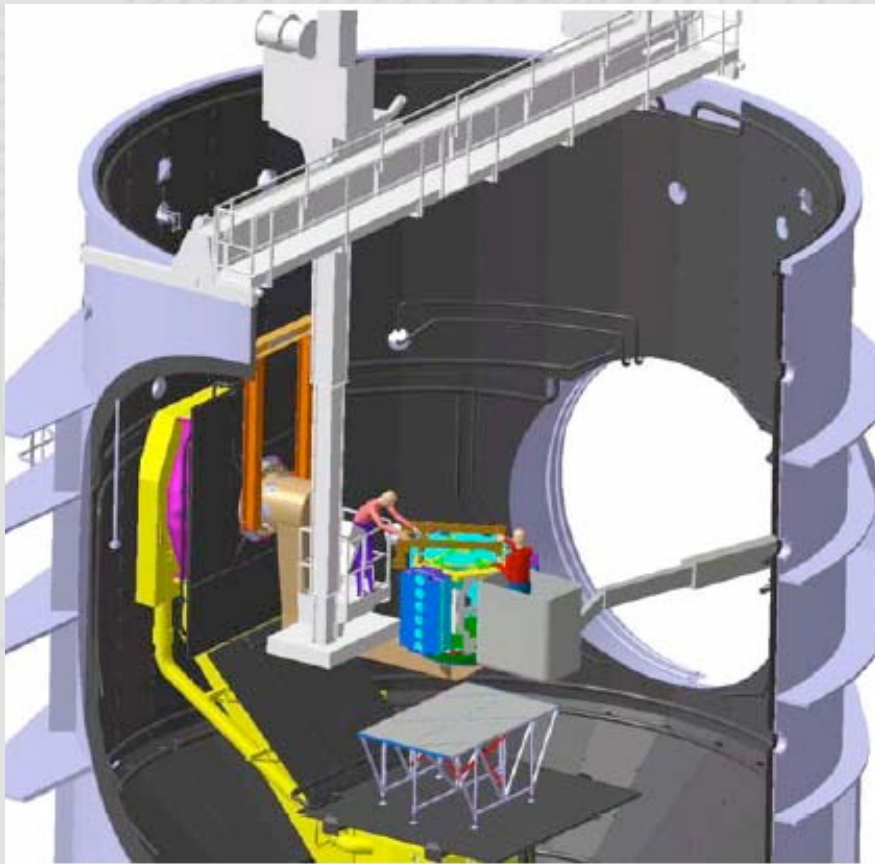
2.- COUNTERWEIGHT INSTALLATION



SETTING UP THE TEST

INSTALLATION SEQUENCE

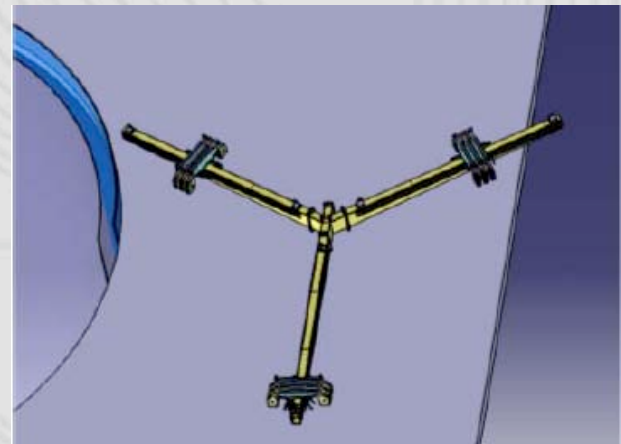
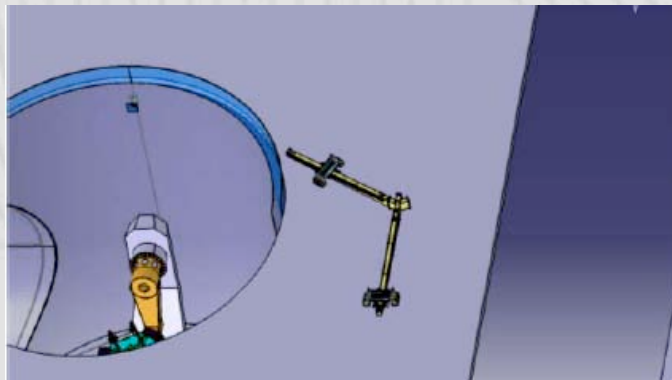
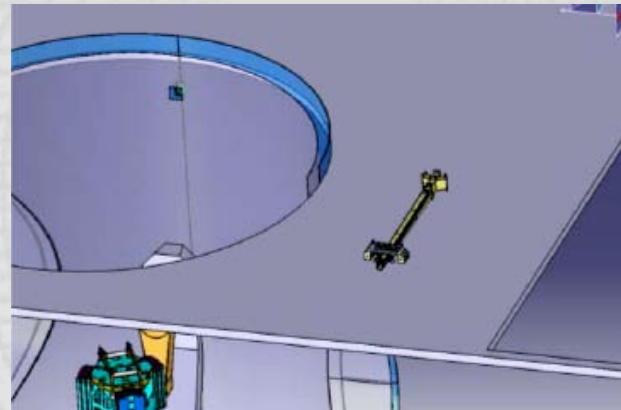
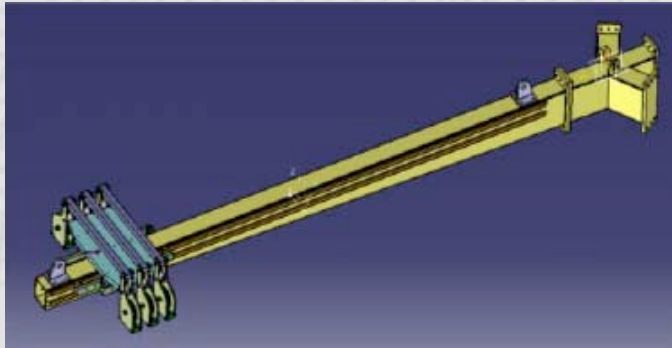
3.- SMOS INSTALLATION ON SUPPORT ARM



SETTING UP THE TEST

INSTALLATION SEQUENCE

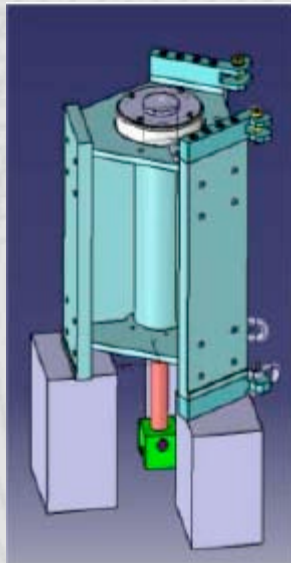
4.- DEPLOYMENT SYSTEM INTEGRATION ON THE TOP FLOOR



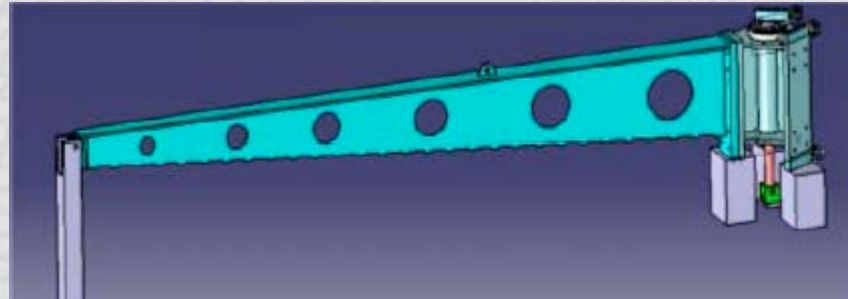
SETTING UP THE TEST

INSTALLATION SEQUENCE

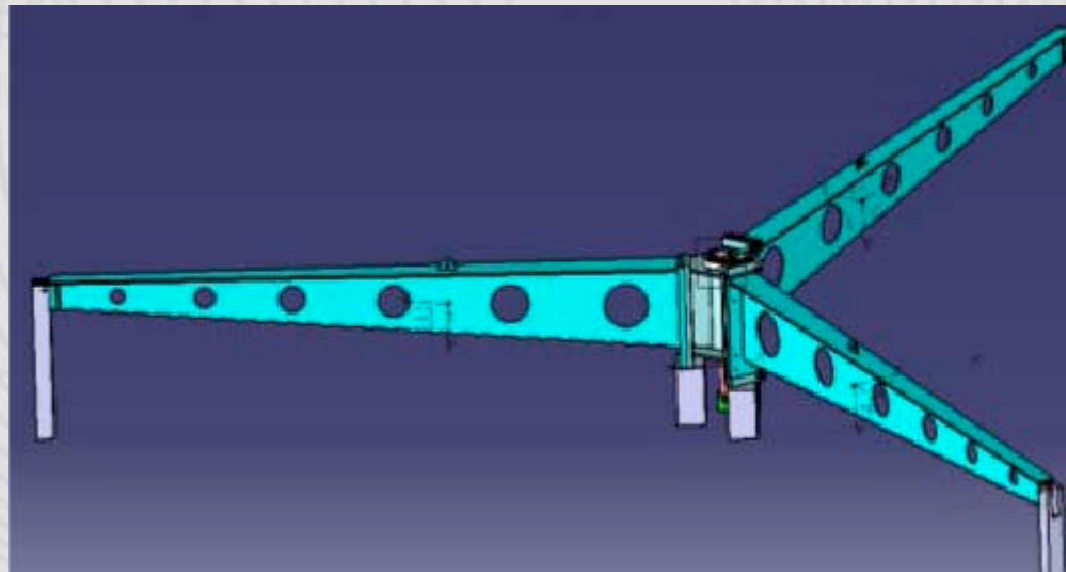
5.- GANTRY INTEGRATION ON THE LOWER FLOOR



GANTRY HUB



ONE ARM INTEGRATION



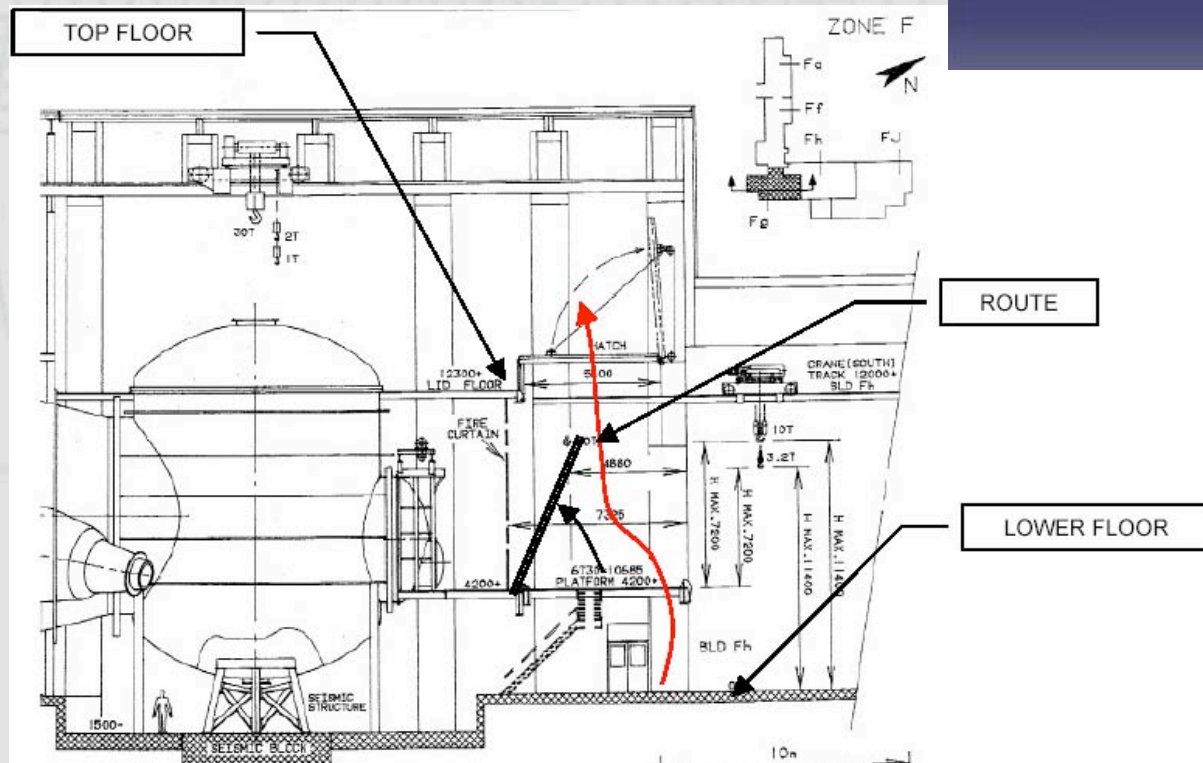
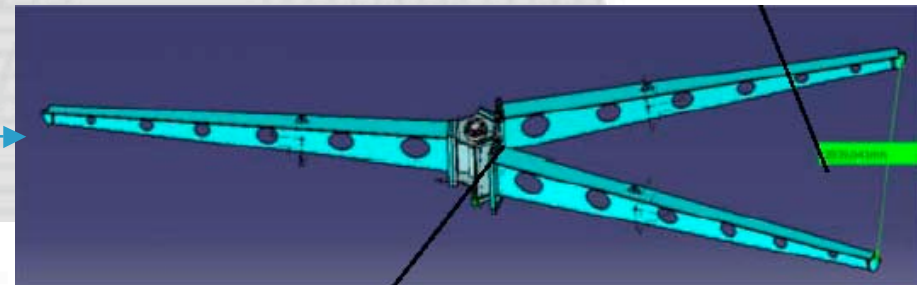
GANTRY

SETTING UP THE TEST

INSTALLATION SEQUENCE

6.- GANTRY LIFTING TO THE UPPER FLOOR

Partially folded for lifting

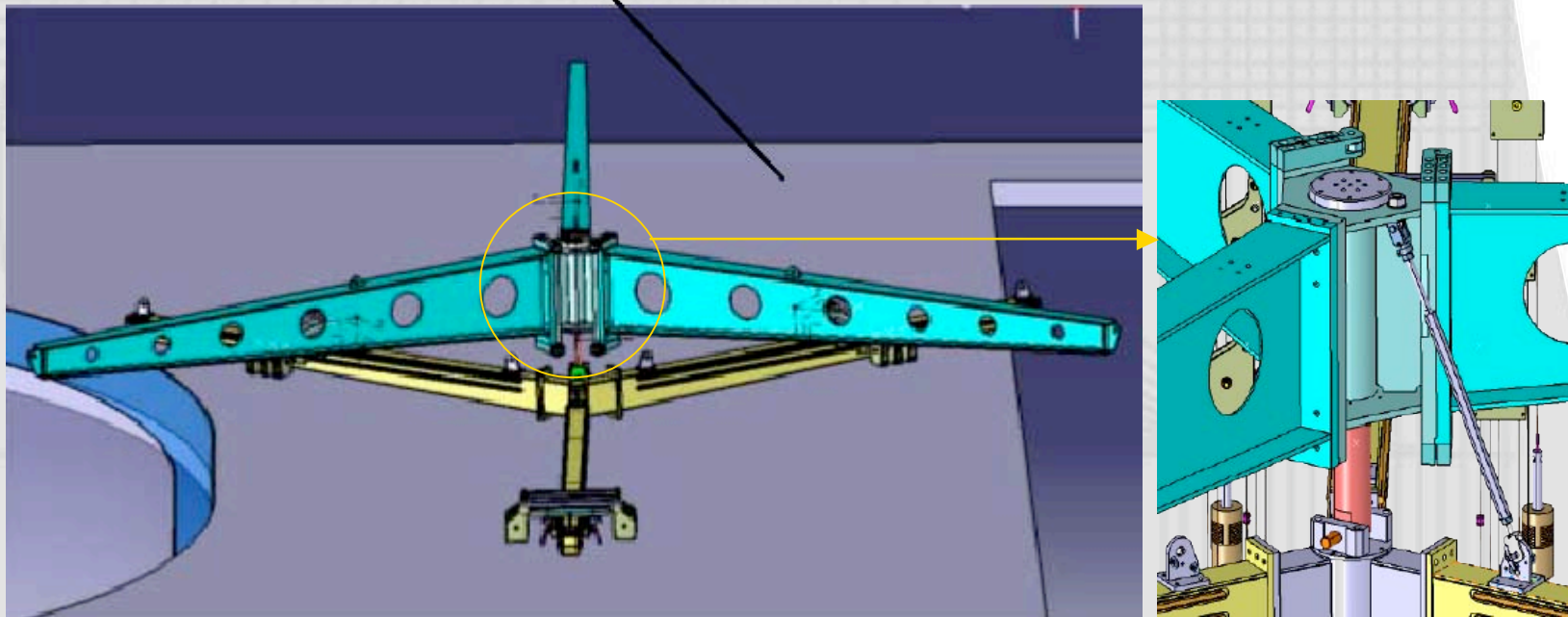


SETTING UP THE TEST

INSTALLATION SEQUENCE

7.- GANTRY & DEPLOYMENT SYSTEM INTEGRATION

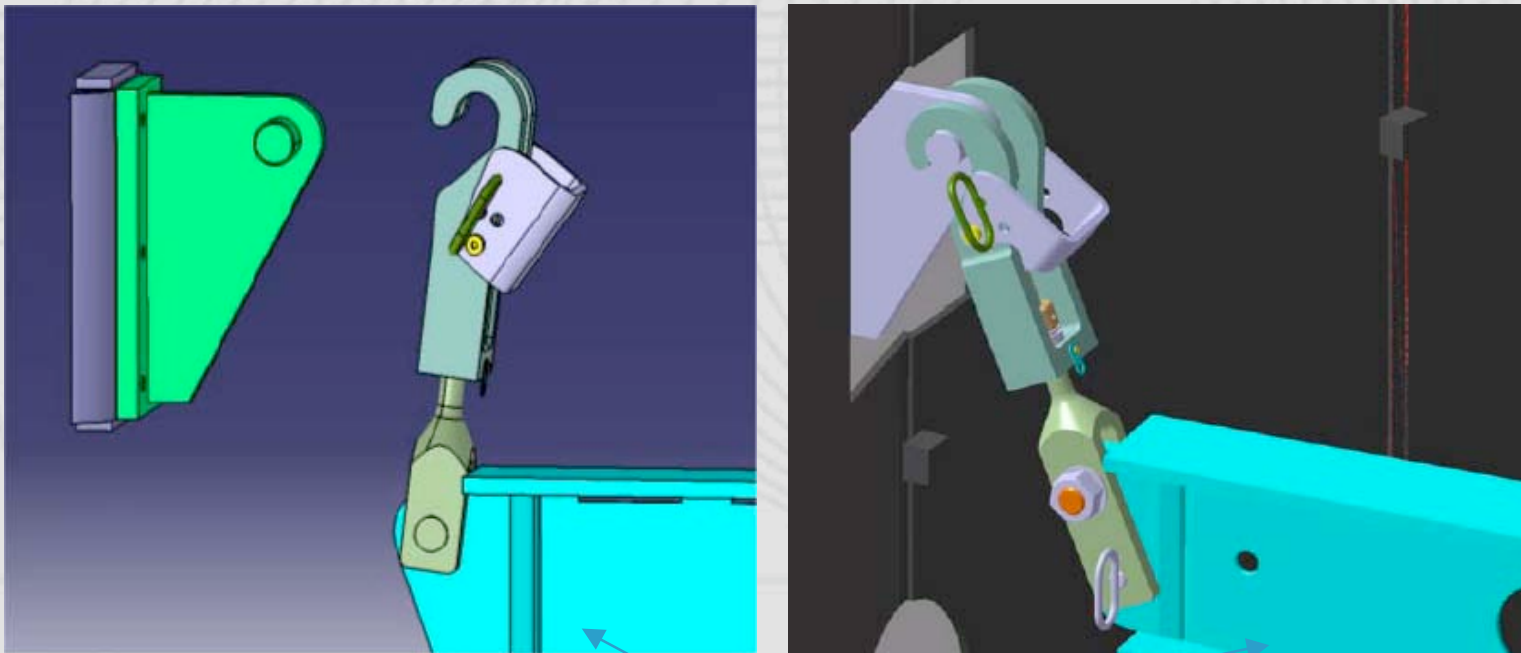
TOP FLOOR



SETTING UP THE TEST

INSTALLATION SEQUENCE

8.- GANTRY & DEPLOYMENT SYSTEM INSTALLATION ON THE LSS
BY MEANS OF THREE HOOKS

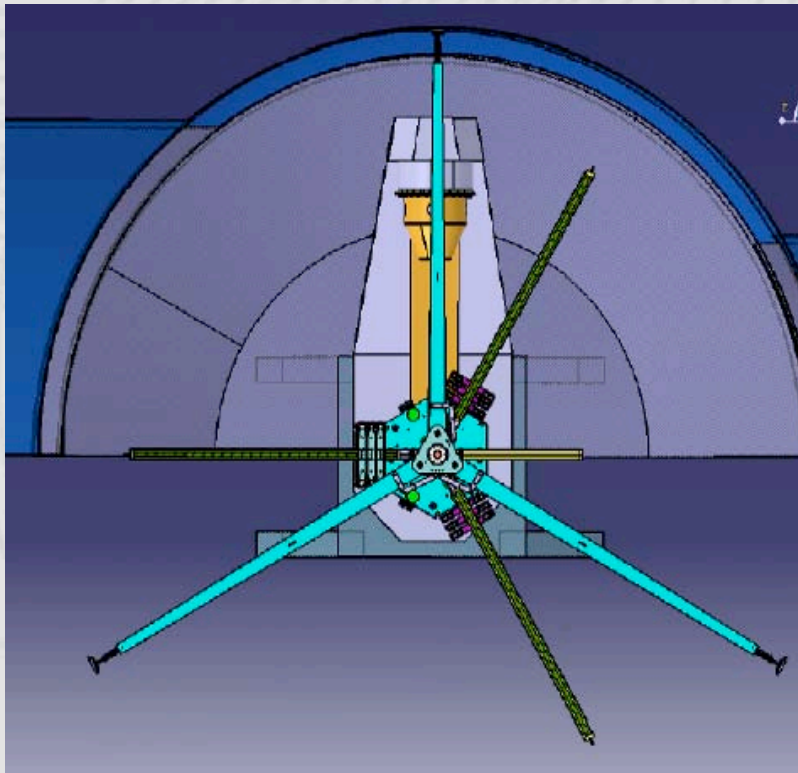


GANTRY

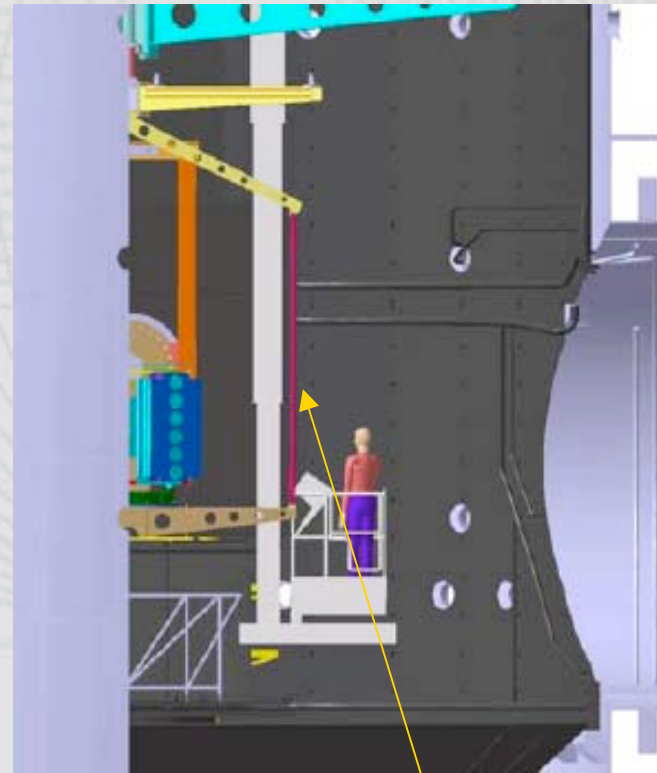
SETTING UP THE TEST

INSTALLATION SEQUENCE

9.- DRIVING BAR INSTALATION



Top view of the set up

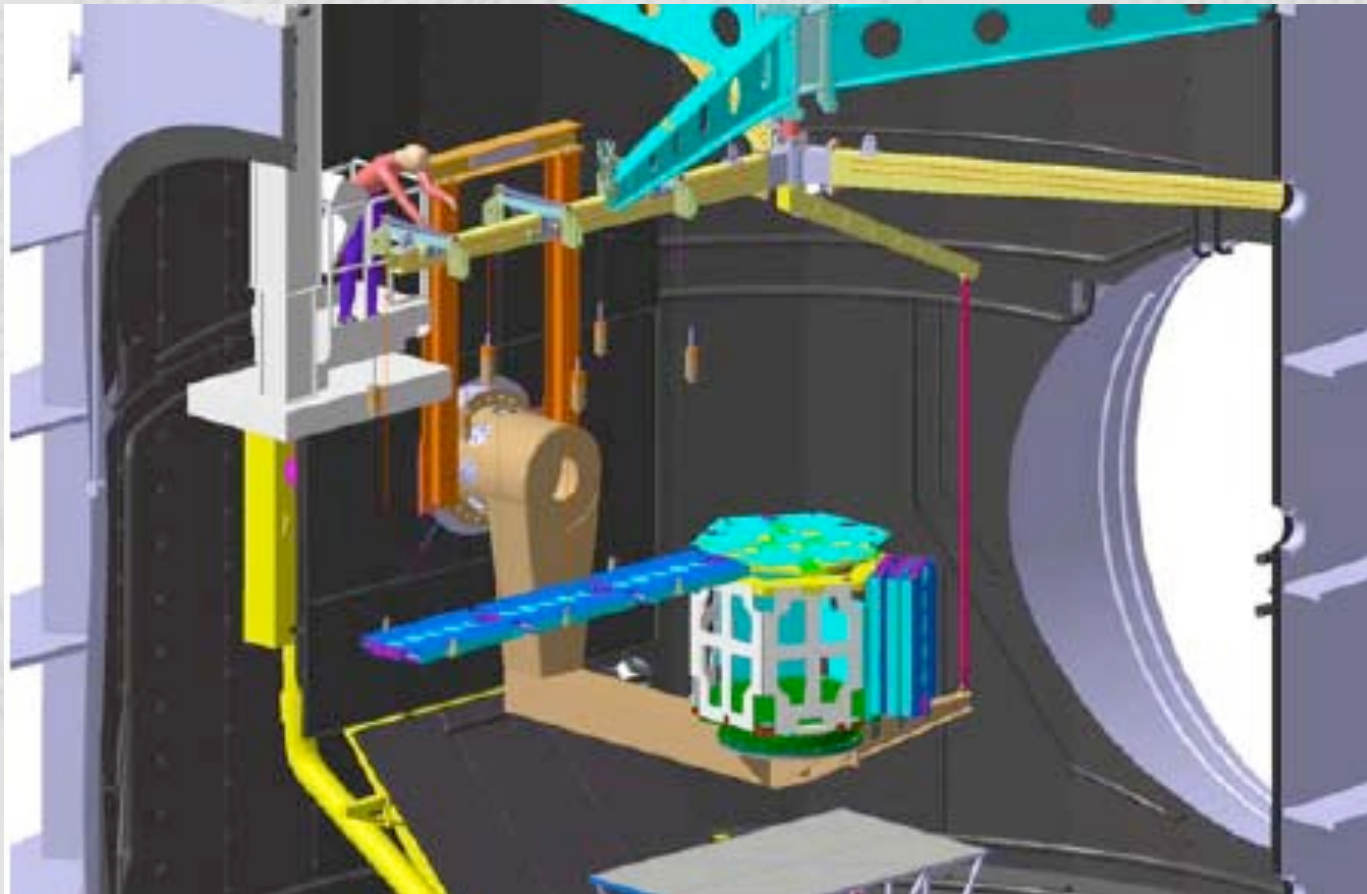


Driving Bar

SETTING UP THE TEST

INSTALLATION SEQUENCE

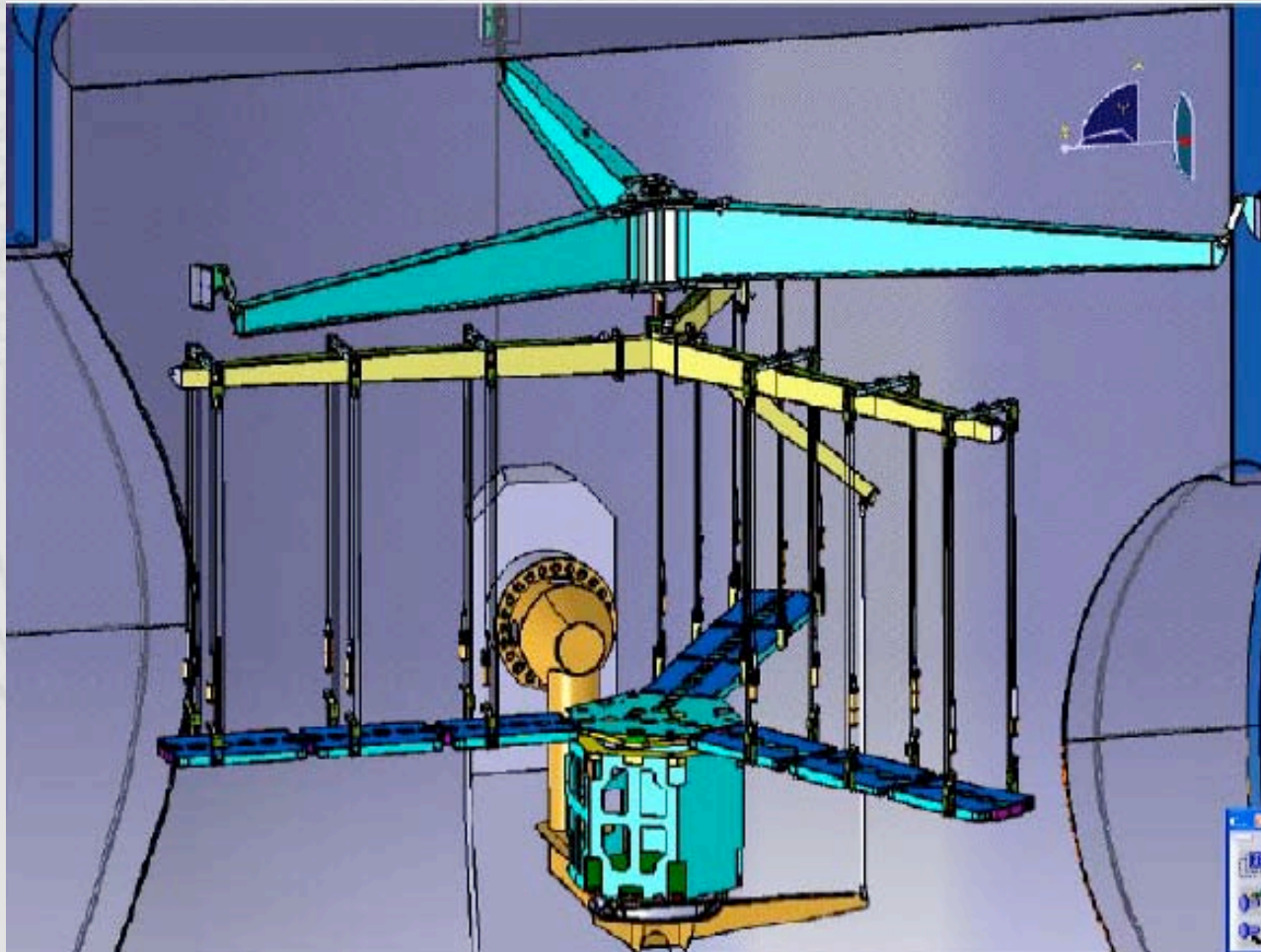
10.- ARM(S) MANUAL DEPLOYMENT



SETTING UP THE TEST

INSTALLATION SEQUENCE

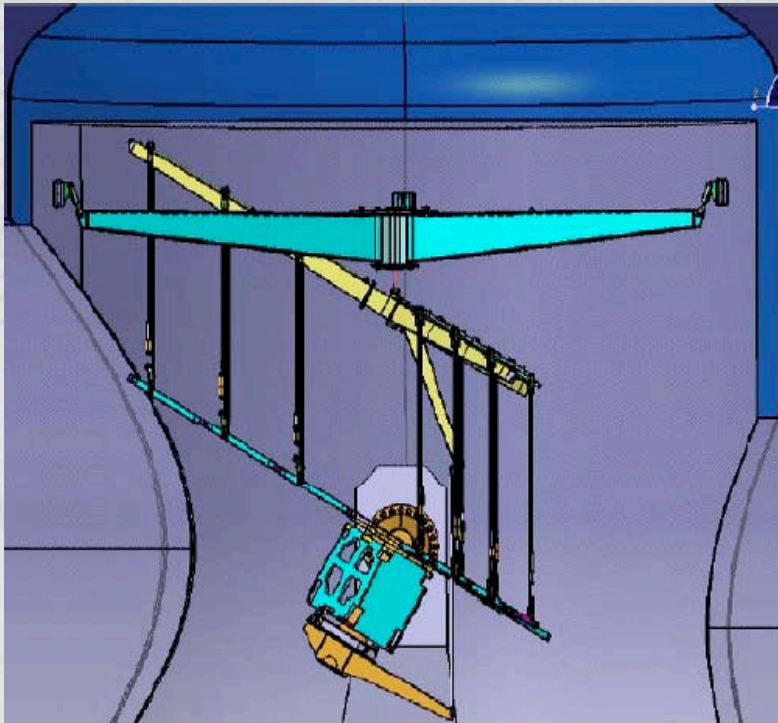
11.- ARMS DEPLOYED



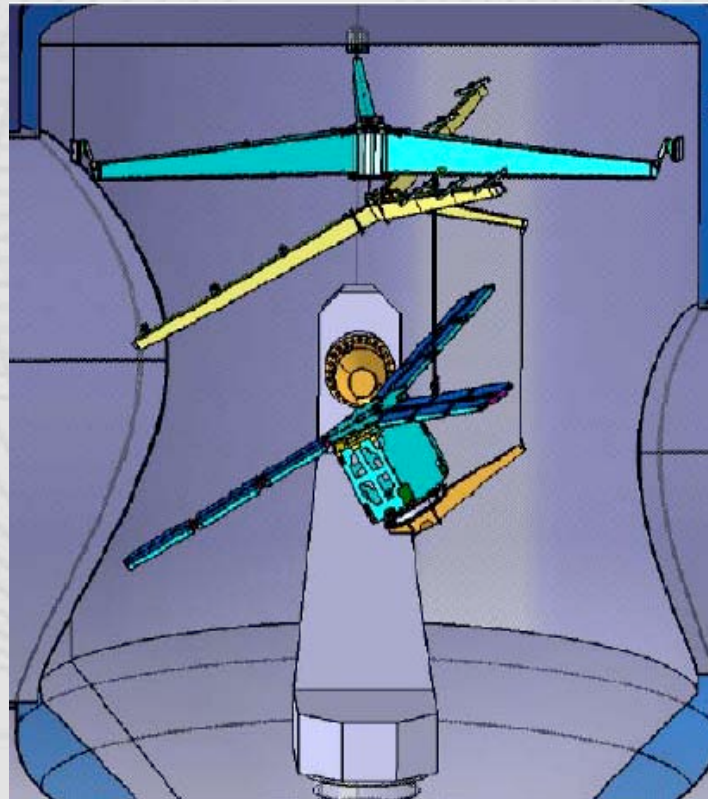
SETTING UP THE TEST

INSTALLATION SEQUENCE

12.- CHECK OUT OF TILTING CAPABILITY



TILTED UPWARDS 22°



TILTED DOWNWARDS 26°

SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



Support arm attached to the yoke

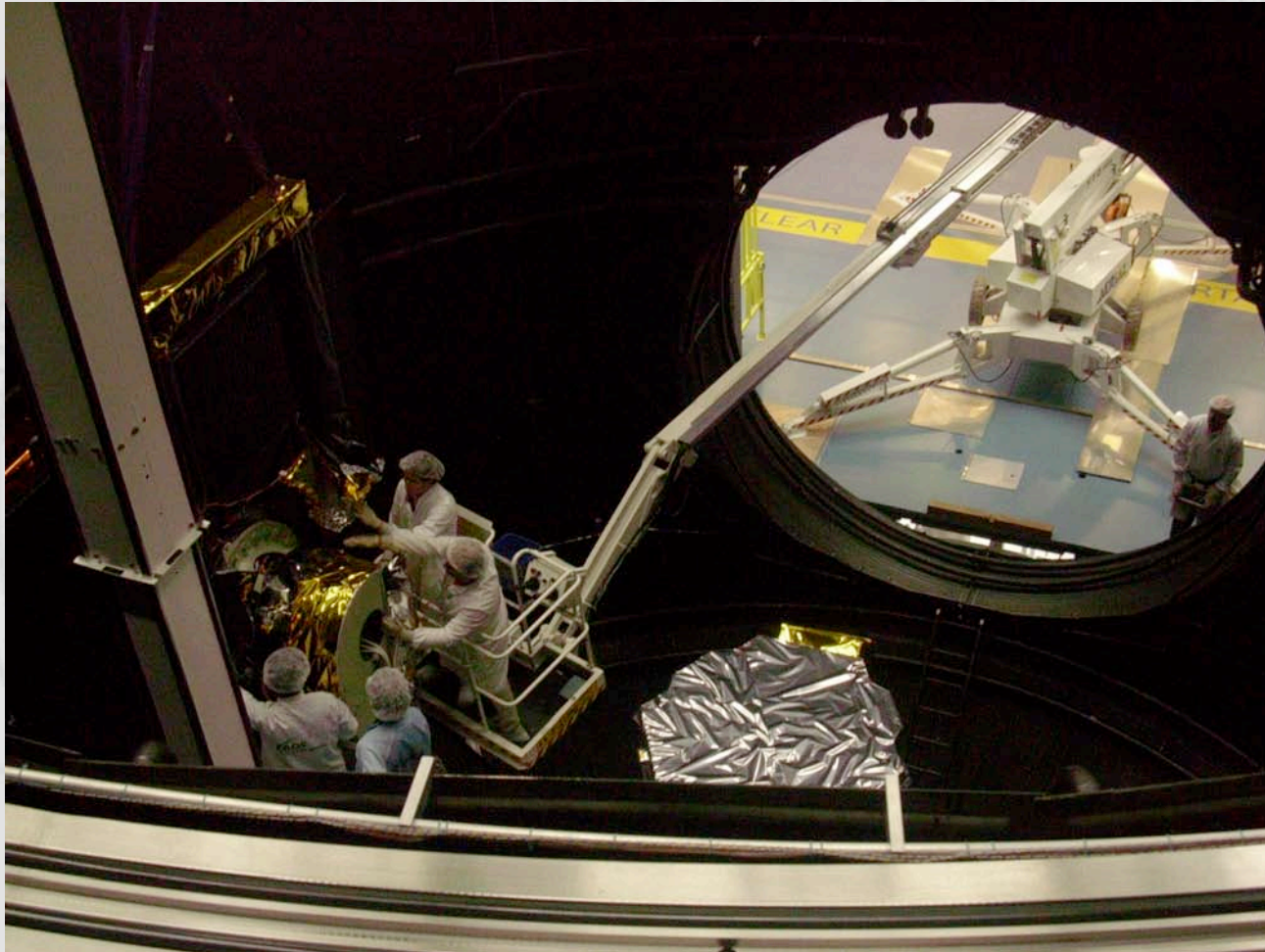
Installing the PLM on the support arm



SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



Closing MLI after counterweight installation

SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



Deployment device ready for gantry integration

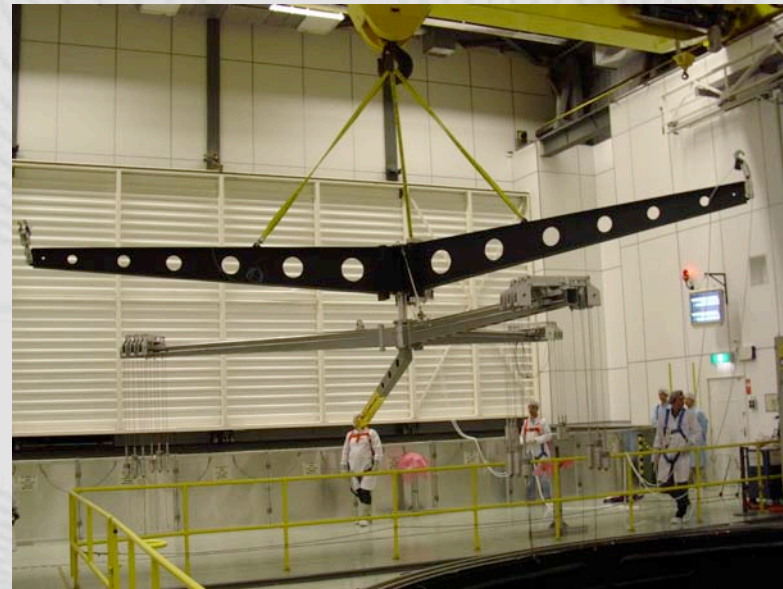
SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



Deployment device and gantry integration

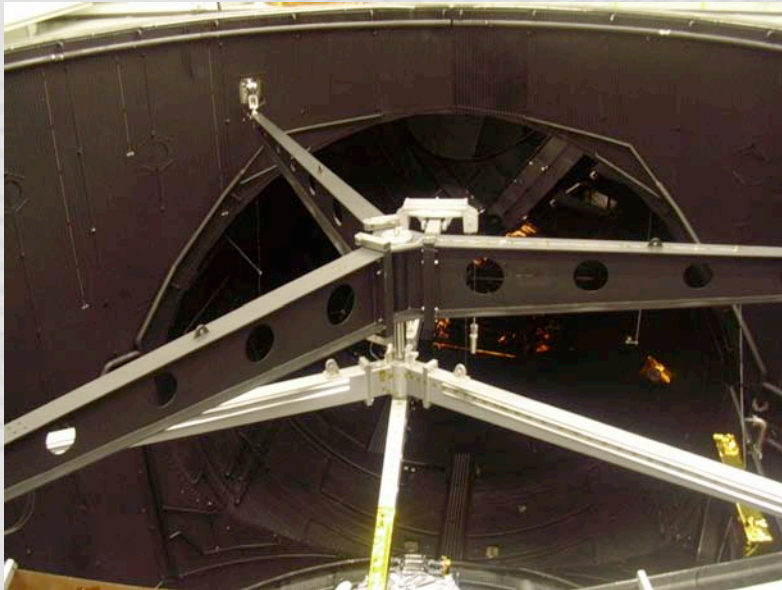


Moving gantry and deployment device to the chamber

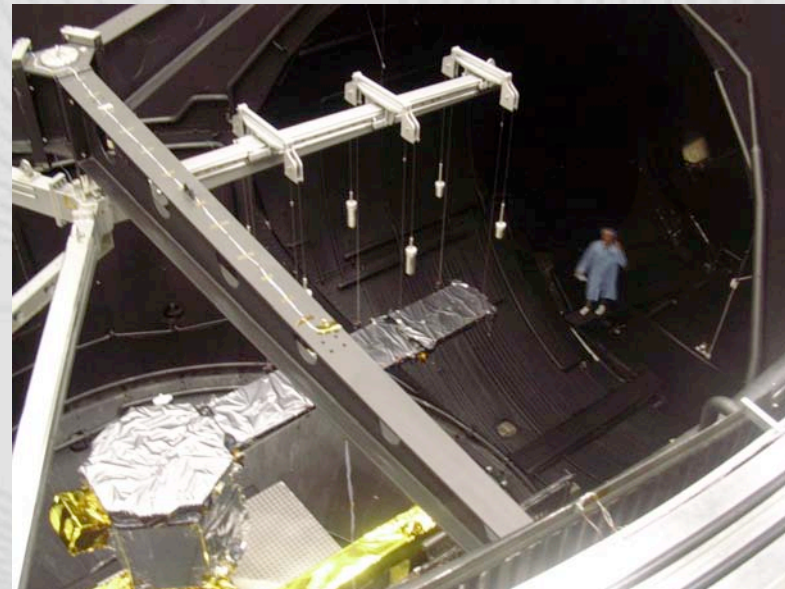
SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



Set up before deployment

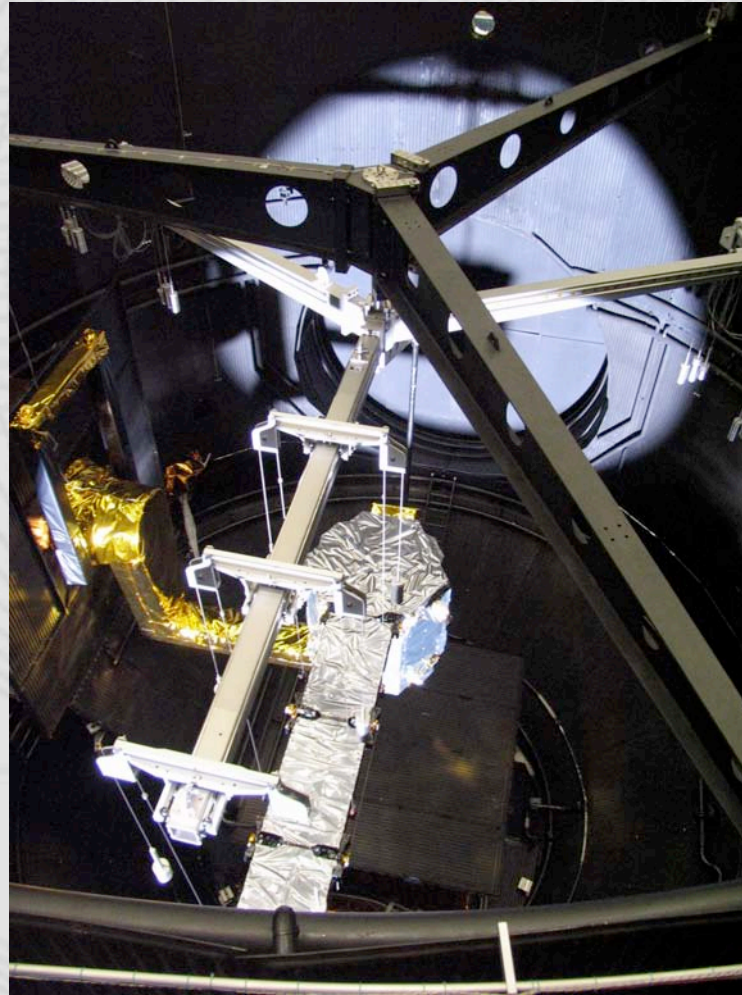
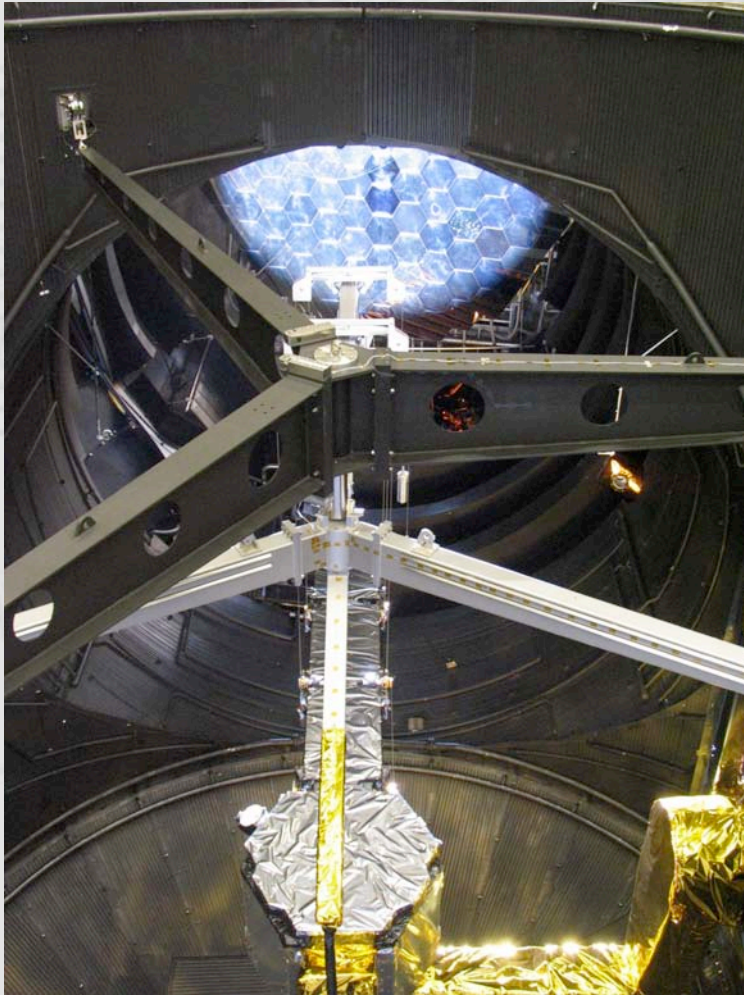


One arm deployed

SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



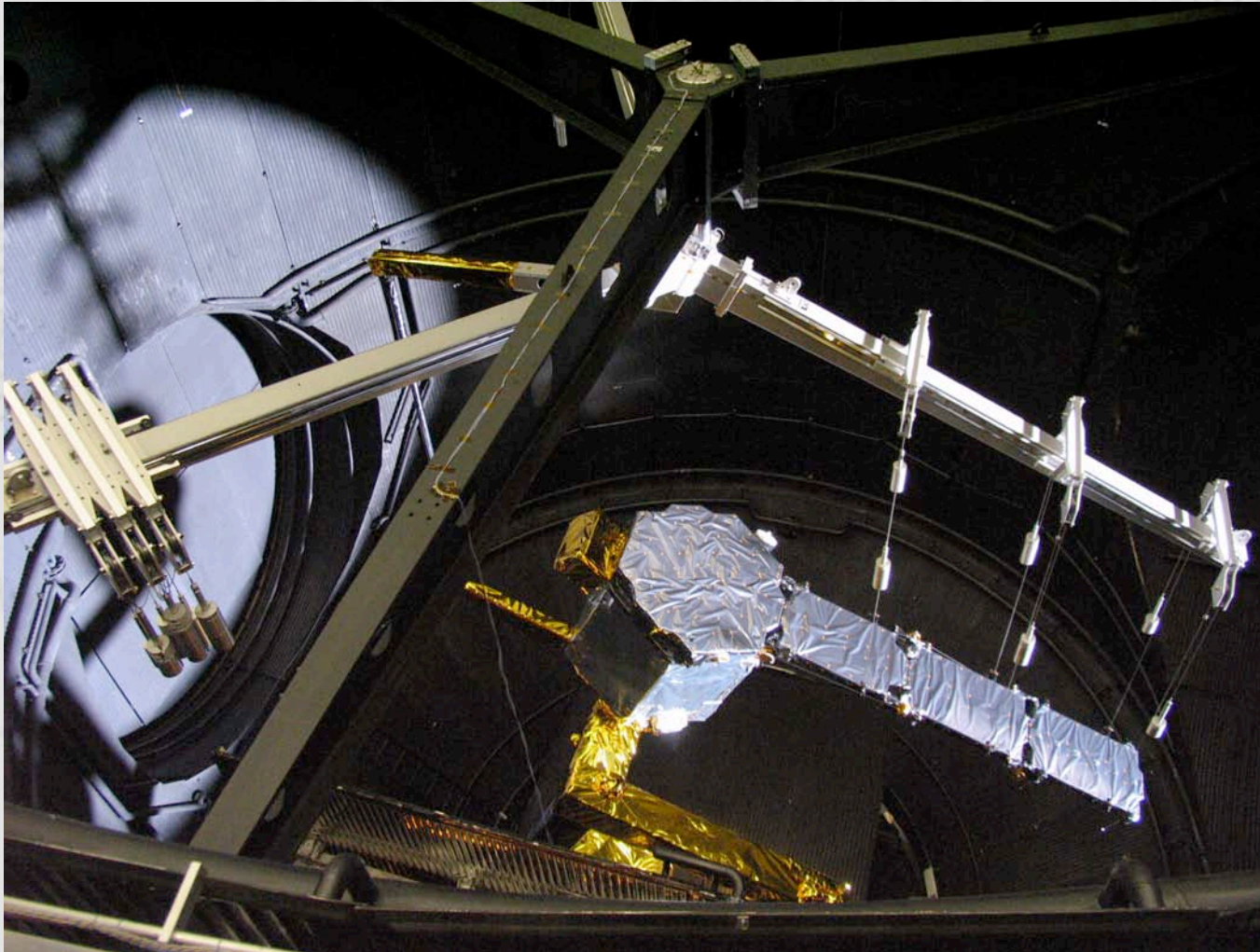
SMOS PLM STM lighted by one solar lamp

Aerospace Testing Expo 2005 North America – Long Beach – A. Gamonal / P. Martinez

SETTING UP THE TEST

INSTALLATION SEQUENCE

PICTURES



SMOS PLM STM tilted downwards and lighted by one solar lamp

Aerospace Testing Expo 2005 North America – Long Beach – A. Gamonal / P. Martinez

TEST PERFORMANCE

TEST INSTRUMENTATION

To perform this test three groups of heaters were used:

- Test Thermal Control Heaters: to simulate the active Thermal Control of PLM.
- Test Unit Heaters: to simulate power dissipation on the STM units.
- Test PLM Support Heaters: to control the mechanical test interfaces.

The following measurements were taken during the test:

- Chamber pressure ($<10^{-5}$ mbar).
- Chamber shroud temperatures (-170° K).
- Yoke temperature.
- Solar intensity (up to 1650 w/m^2)
- Solar attitude angle (-26° , 0° , $+22^{\circ}$).
- Test set up temperatures at all locations (350 thermocouples).
- Power supplies parameters (voltage and current at 37 lines).



All test objectives were reached and the data and experience obtained are being used for fine tuning of the Proto-Flight mode.

TEST PERFORMANCE

TEST SCHEDULE

The main milestones of the test were:

•Set up installation on LSS start	16.06.05	↑ 13 days ↓
•LSS closed and pumping down started	29.06.05	
•End of Hot Case #1	02.07.05	↑ 6 days ↓
•End of Cold Case #1	03.07.05	
•End of Hot Case #2	04.07.05	↓ 7 days ↑
•End of Cold Case #2	04.07.05	
•LSS opened	05.07.05	
•End of set up removal	12.07.05	

TEST PERFORMANCE

TEST TEAM

The test was performed by an integrated team from ESA, ETS (the company operating ESTEC test facilities), APCO and EADS CASA Espacio.



The Thermal Balance Test Team

Aerospace Testing Expo 2005 North America – Long Beach – A. Gamonal / P. Martinez

MORE INFORMATION



- <http://www.esa.int/esaLP/LPsmos.html>
- <http://www.eads.net>