

This document and its content is the property of Astrium [SAS/GmbH], Airbus Defence and Space [Ltd/GmbH] and is strictly confidential. It shall not be communicated to any third party without the written consent of Astrium [SAS/GmbH], Airbus Defence and Space [Ltd/GmbH].



Experience on SEE testing of EEE parts

SEE Tests capabilities at ADS

Christian Binois (ADS_Elancourt) Mirko Rostewitz (TESAT_Backnang)
TSOEF1 - EEE Parts Engineering & Radiation
31/03/2016



OUTLINE

- The Team
 - **R**adiation **T**est **L**ab at ADS Elancourt
 - RF devices at TESAT Backnang
- SEE Test activity overview in ADS and TESAT
- Overview of existing Test benches
 - Generic test boards
 - One shot test benches for complex devices
 - RF test bench (TESAT)
- Test Problematic
 - SETUP design
 - Facilities
 - Devices preparation
- CONCLUSION

SEE TEST ACTIVITY OVERVIEW In AIRBUS DS

- More than 600 tests since 2003
- Mainly dedicated to provide SEE behaviour of EEE devices used by any ADS project
- Fully integrated within the procurement process at early level, traceability (man lot, factory etc...) avoid a huge number of tests
- Some internal R&D activities as well as some funded by ESA, CNES and DLR
- Support on request to external customers (mainly on ADS related projects)

Overview of some existing Test benches

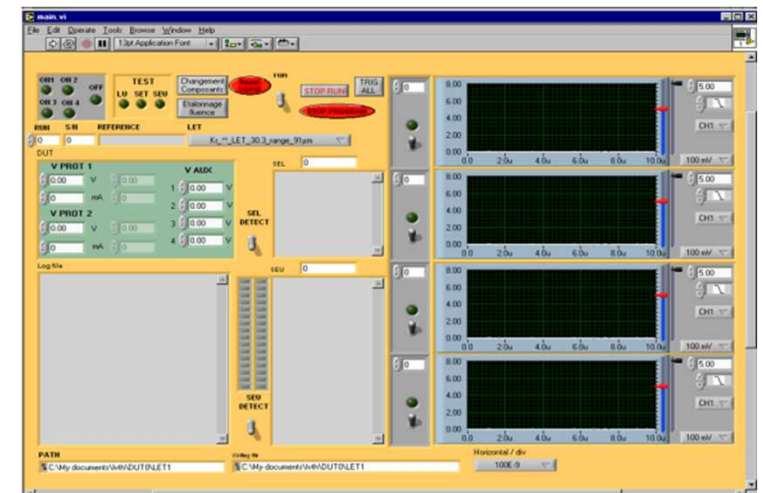
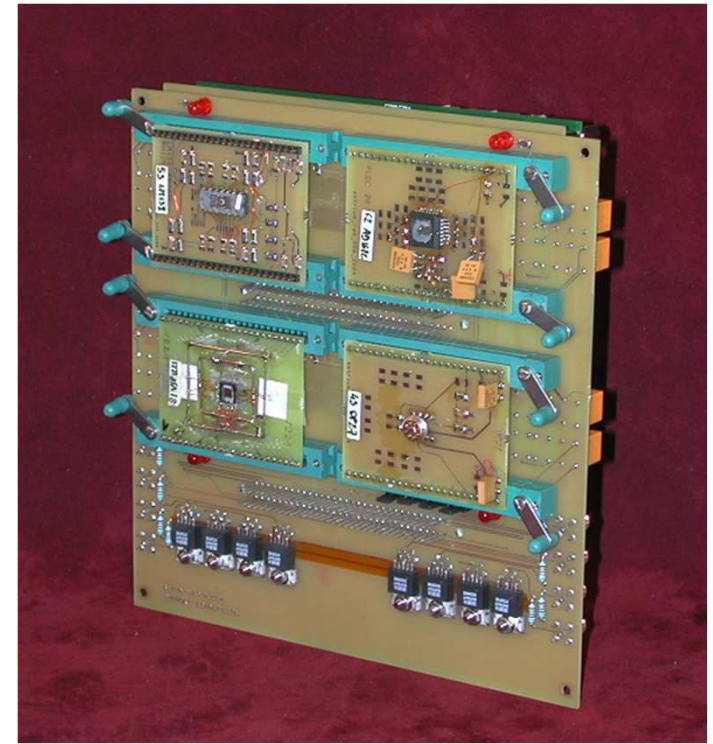
- Generic test benches used for more than 90% of devices
 - Multi devices board
 - MOSFET
 - HV diodes
 - Memories (Flash)

- One shot test benches
 - High Frequency devices
 - Optical sensors
 - Complex ASIC like SOCs

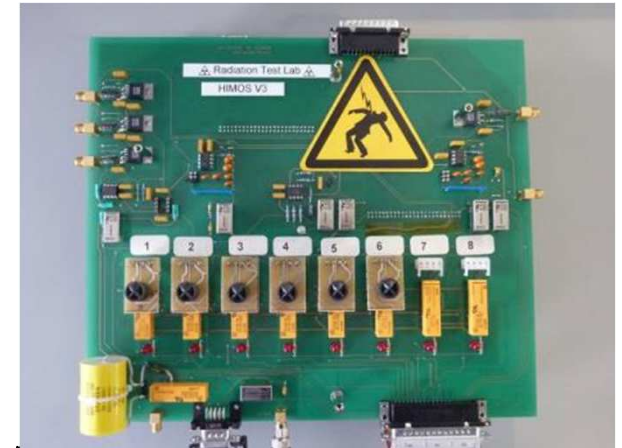
- RF test bench

XMULTI TEST BOARD

- 4 test slots
- Board compliant with all facilities.
- Many remotely programmed analog and digital I/O
- High speed digitizers for SET
- Ability to test SEU, SET and SEL separately or at the same time depending on the device
- Ability to test Opamps, comparators, voltage ref and regulator, DAC, ADC and the most current digital circuits (line buffer, latches etc...)
- Ease of daughter board design (a few days)
- Capability to change quickly test conditions during test
- Autotest to check device and tester good health



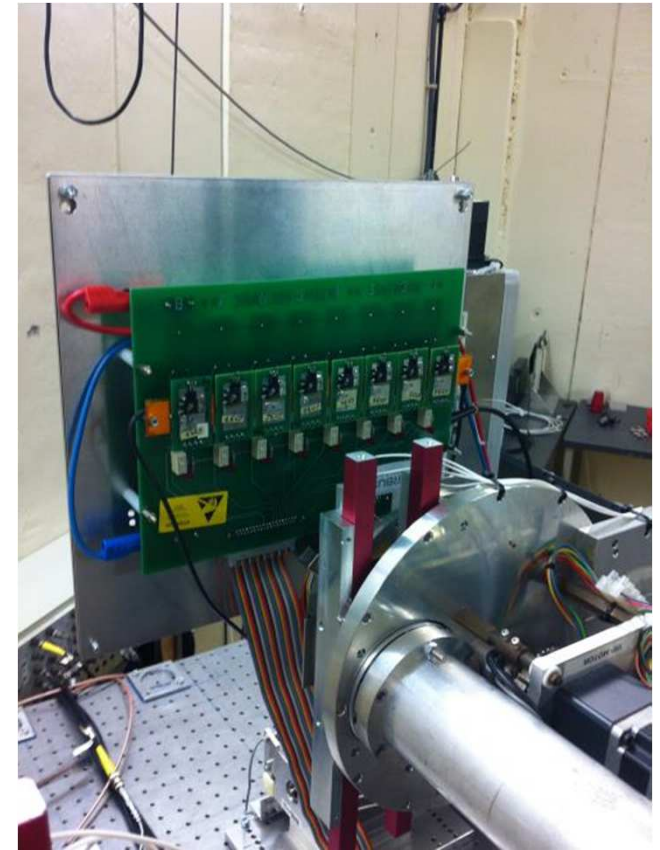
MOSFET TEST Board



- 8 test slots
- Can hold P or N channel up to 600V Vds and +/-100V Vgs
- On line measurement of Igss (10pA to 100mA) and Idss
- **SEB detection** and **Drain charge collection** integrated acquisitions
- Integrated VGSth measurement for N channel (P to be added)
- Integrated PIGST capability
- Fully Remote controlled operation
- Integrated autotest to check device connection and tester integrity before irradiation (**a not connected device is seen insensitive**)

HV Diodes TESTBENCH

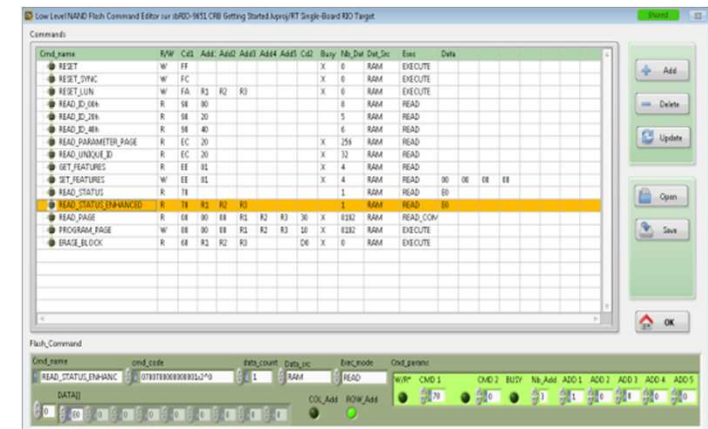
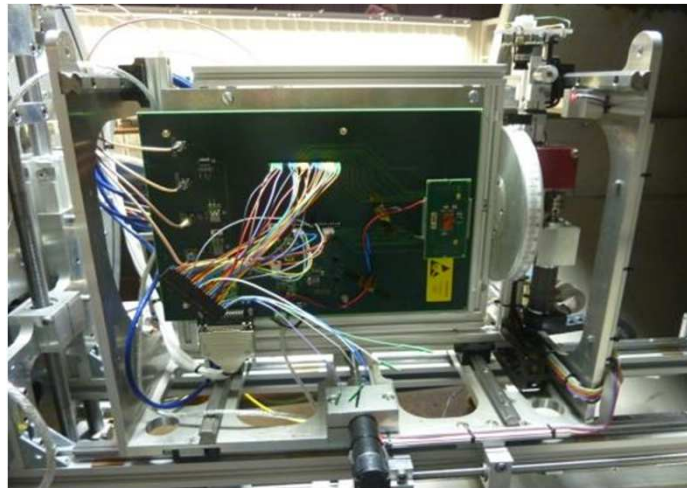
- 8 test slots
- up to 1100V VR (design limit 7.5kV)
- Temperature monitoring with heating option
- On line measurement of I_r (10pA to 20mA)
- Remote controlled operation
- Integrated autotest to check device and tester integrity before irradiation (a not connected device is seen unresponsive)



Generic Test bench (4/4)

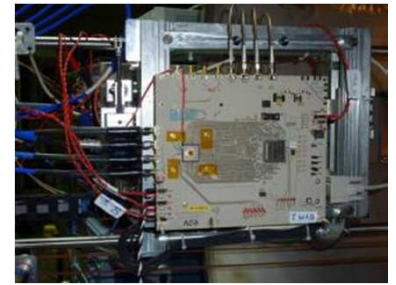
FLASH MEMORY TESTER

- 40 MHz asynchronous mode & 20 MHz synchronous DDR mode
- 2 adjustable protected supplies (SEL) with on line voltage and current monitoring
- Embedded Processor under Linux RT and FPGA
- Remote controlled operation through single ethernet link
- Integrated hard drive for high speed data recording (many Gbytes of data during test)
- User defined test sequence up to 2000 cmd/s



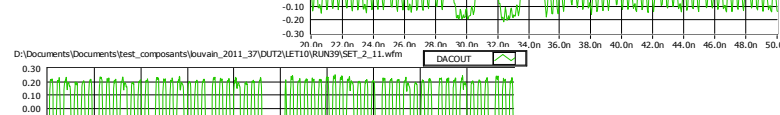
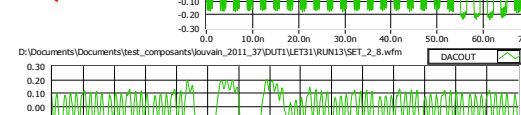
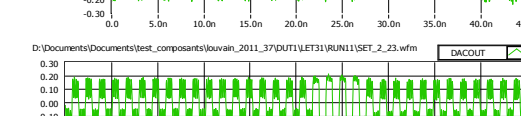
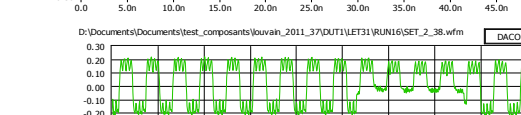
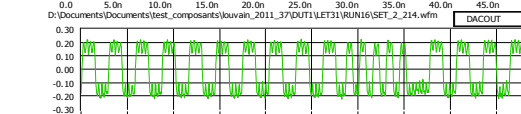
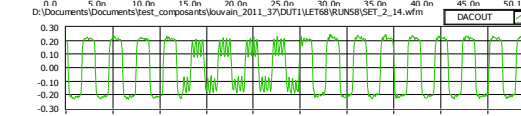
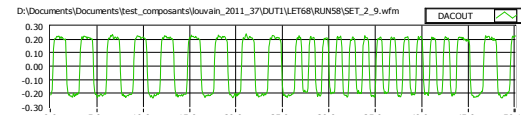
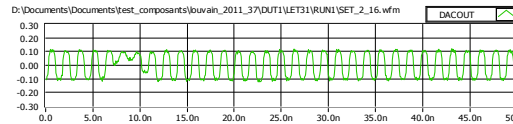
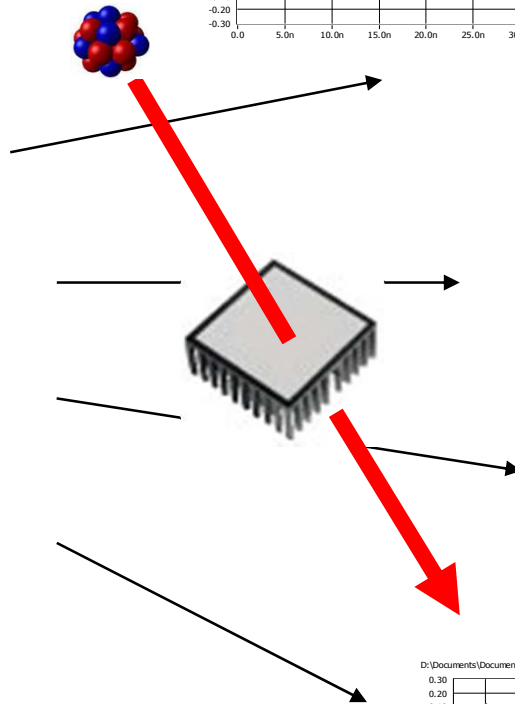
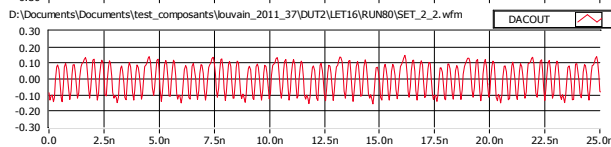
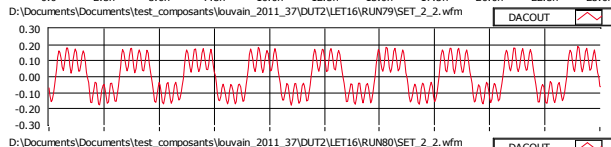
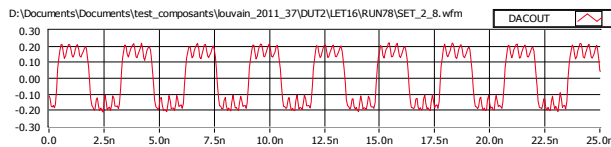
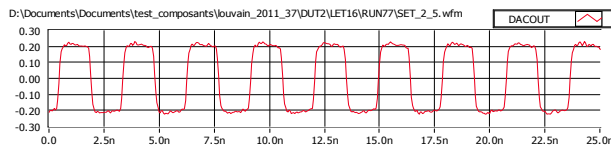
One shot test bench(1/3) : 12bits 3Gps 4:1 MUXDAC

- **SET detection with High Frequency dynamic signals**, (400MHz with 3GHz carrier) no Scope trigger usable → dedicated analog trigger designed
- 4 output modes



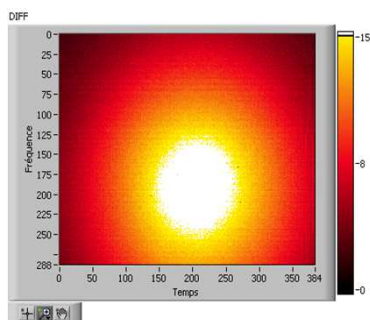
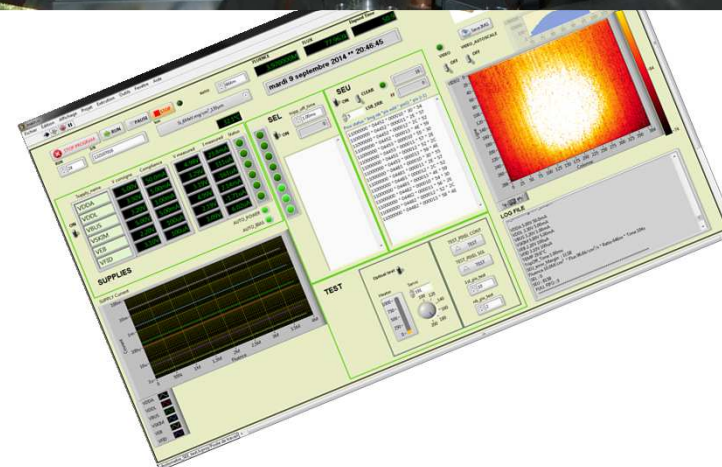
Events induced by energetic particles

Normal output



One shot test bench(2/3) : Optical sensor

- Uncooled IR 110 kpixels Image sensor
 - SEL assesment for Delatcher design
 - **Full speed operation at 6.6Mpix/s**
 - **Image to image comparison** for SET detection on pixel ($>14mV$)
 - **Removable optical stimuli** to check device fonctionnality (vacuum mandatory)

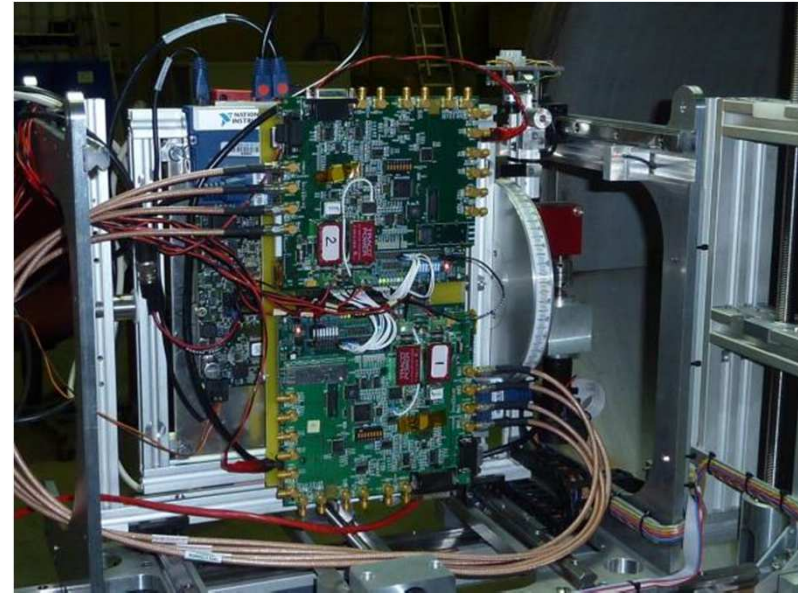


Stimuli viewed by sensor

One shot test bench(3/3)

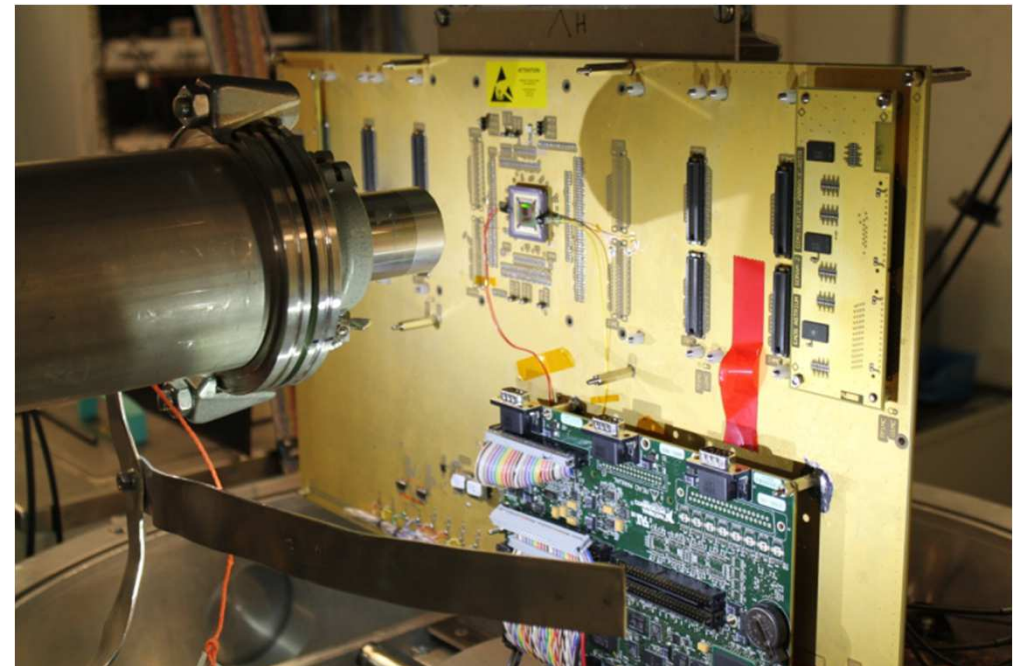
- **1.5GBPS SERDES**

- **300 MO/s to be checked** on line
- Difficult to manage gigabit connexions and PCB
- **Rx/TX synchronisation** (many bits stored in the Tx line)

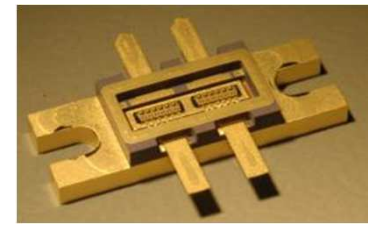


- **SCOC3 ASIC**

- **Many elementary tests** to cover all fonctionnal units
- **High workload for test development** and data analysis after test



RF SEE Testing (TESAT 1/2)



Single Event Effect testing under RF conditions:

- E.g. “Qualification of GaN Power Bars for BIOMASS” with the ESA contract No. 4000110760/14/NL/CT
- 15 and 80 W RF GaN power devices from UMS

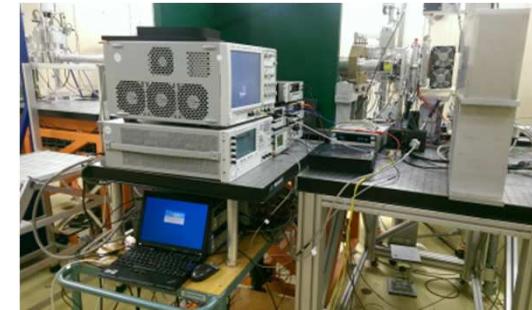
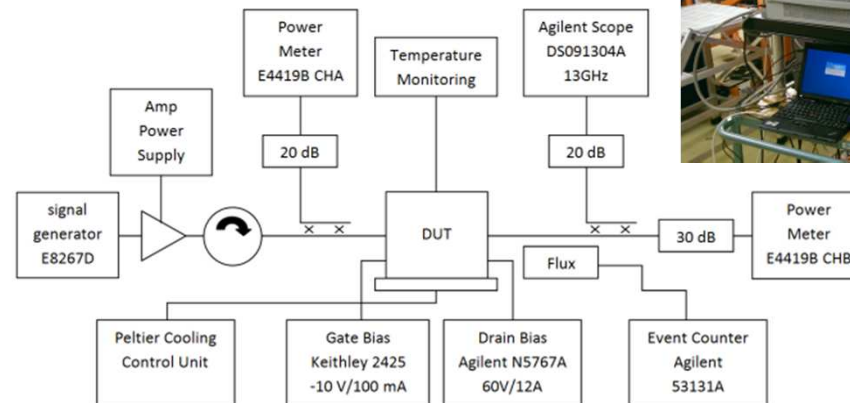


Test Facility:

- In-air facility is needed due to the high heat dissipation
 - KVI – center of advanced radiation technology at the University of Groningen (The Netherlands)
 - In air beam line with 29 MeV/amu

Test Setup:

- Complex RF Test Setup
- High RF Power handling capability
- Peltier Cooling Unit
- Remote control capability



Challenges:

- Preparation phase
 - Beam simulation wrt. worst case condition (LET, range)
 - Setup adaption to test facility (e.g. remote control by Ethernet connection)
 - Procurement of RF equipment for target frequency (Isolator, RF-amplifier, ...)
- Test Campaign
 - KVI not fully established by ESA → Space related beam parameter implementation (field homogeneity, flux, fluence, ...)
 - Beam validation by using reference devices
 - Fast test plan adaption in the case of unexpected device failures
 - The more complex the test system the more extra time for setup problems has to be taken into account
- Test Report
 - Analysis of a high amount of test data

Test Problematic : Setup design

❑ The best setup is able to :

- ✓ Operate the device in real condition
- ✓ Detect and record any abnormal behaviour induced by Irradiation (trigger ?? when faced to high frequency and complex signals)
- ✓ Monitor on line all DC parameters → give additionnal information on behaviour
- ✓ Allow fast and easy reconfiguration of test conditions
- ✓ Be remotely operated from 10 to 80 meters far of the irradiation stand
- ✓ Withstand vacuum conditions
- ✓ Etc.... Etc....
- ✓ Fits reasonably in a small suitcase ! Not too heavy

Test Problematic : Test Facilities

❑ ESA sponsored FACILITIES

- UCL Louvain la neuve BELGIUM HI and low E Protons (60MeV)
- RADEF Jyvaskyla FINLAND HI and low E Protons (60MeV)
- PSI Villigen SWITZERLAND High E Protons (200MeV)

❑ OTHER FACILITIES

- GANIL Caen FRANCE mainly Xe for MOSFETS
- TAMU College Station USA TEXAS HI High E HI (up to 40MeV/A)
- KVI Groningen NETHERLAND High E Protons (200MeV) and High E HI

Test Problematic : Devices preparation

Topside decapsulation systems

- ✓ LASER Pre-opening
- ✓ Manual Chemical Opening
- ✓ Automatic Chemical Opening



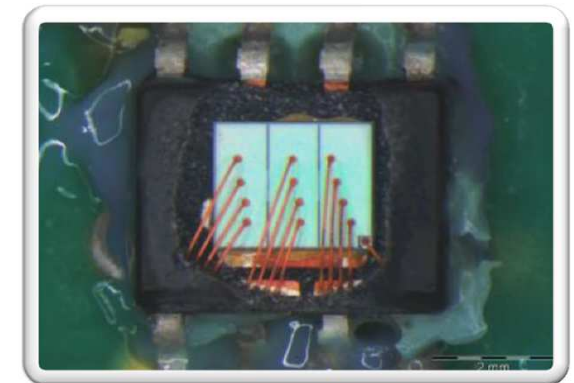
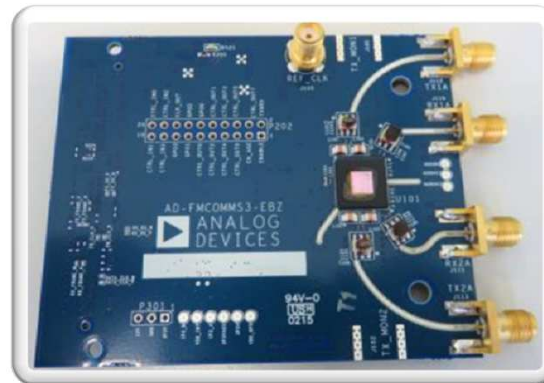
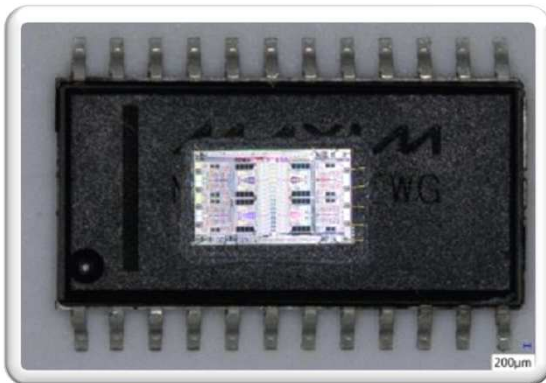
=> A full range of equipment compatible with Au, Cu and Ag Bondings !

Decapsulation capability:

✓ Component alone

✓ Component reported on board

✓ Copper bondings protection



CONCLUSION

- ✓ **Many basic testers availables** which offer the capability to carry out a test in a rather short delay (a few weeks) at a relatively low cost
- ✓ **Capability to develop on demand test setup for complex devices** (μ P High frequency devices, RF fixtures etc...) higher cost driven by the test preparation effort
- ✓ **Access to many facilities**, selection is based on more than 15 years of experience
- ✓ **In house device opening capability especially for plastic packages** more and more difficult
- ✓ **Good electronics skills are mandatory** for test setup development as well as a good knowledge of the tested device.