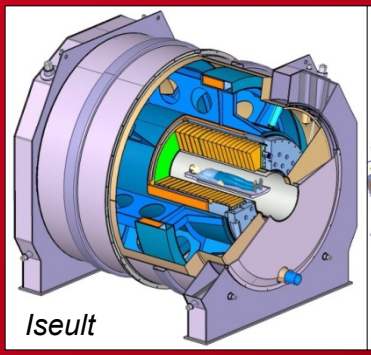
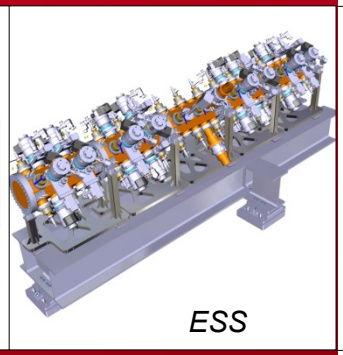
DE LA RECHERCHE À L'INDUSTRIE

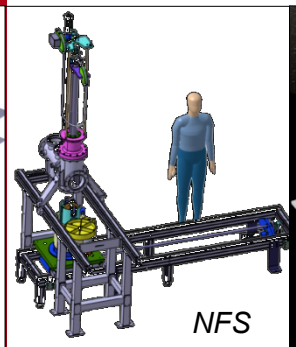
Projet LISA

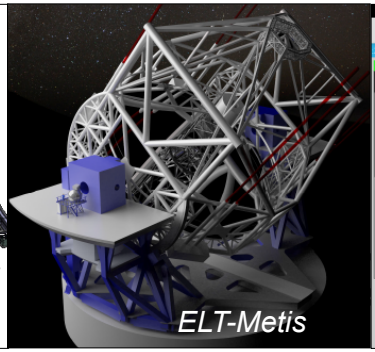
Département d'Ingénierie des Systèmes (DIS)

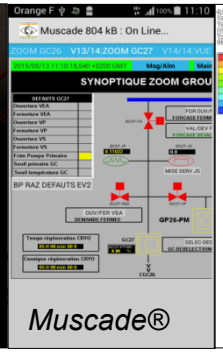
21/09/2017


Iseult

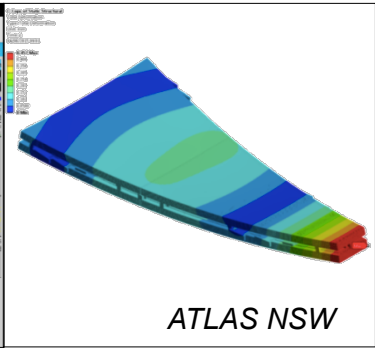

ESS


NFS


ELT-Metis



Muscade®


ATLAS NSW

Christian VEYSSIÈRE et Philippe DE ANTONI

www.cea.fr

Irfu

IRFU:OVERVIEW

- 17 ERC
- 975 publications
- 65 active patents

~ 1000 FTE

Institut de Recherche sur les lois Fondamentales de l'Univers

		GANIL	115 FTE
98 CDI 60 CDD 20 coll.	**DAp** Astrophysics	**DACM** Accelerators, Supra. Magnets	165 FTE
47 CDI 27 CDD	**DPhN** Nuclear Physics	**DEDIP** Detectors, Electronics, Computing	140 FTE
69 CDI 29 CDD	**DPhP** Particle Physics	**DIS** Engineering	130 FTE

MISSIONS

Design

Development

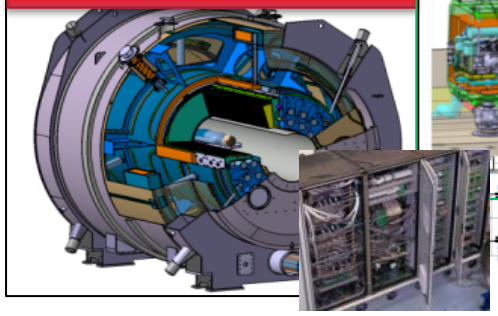
Deploy and maintain

Innovative & complex instruments for Physics applications

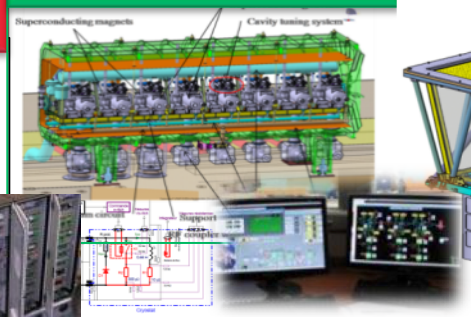
Mechanical Engineering

Instrumentation & Control

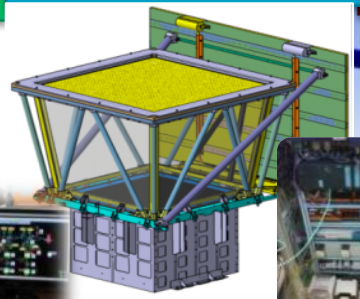
S.C. Magnets & tests facilities



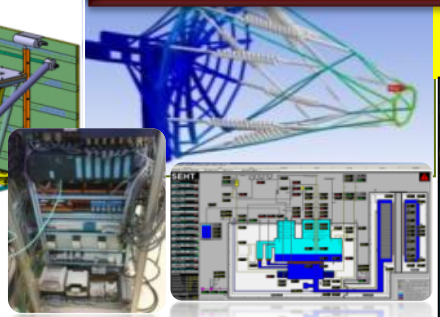
Accelerator components



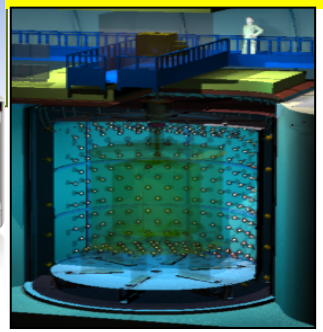
Space instruments



Telescopes



Detector & sources



LABORATORIES AT DIS

Design office (LCAP)

16 ing. ; 11 tech. ; 7 PNP

Industrial relations for manufacturing (LRI)

6 ing. ; 1 tech. ; 2 PNP

Studies and integration in electrotechnics (LEIGE)

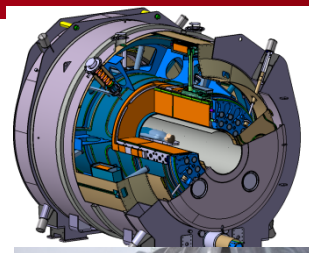
8 ing. ; 12 tech. ; 1 PNP

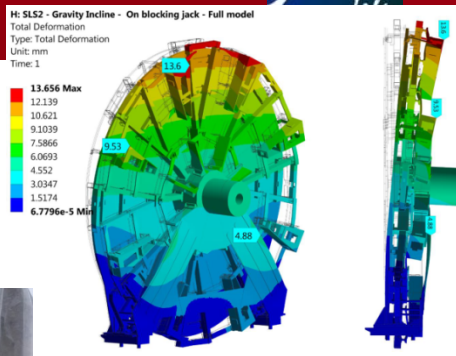
Electronics for instrumentation (LEI)

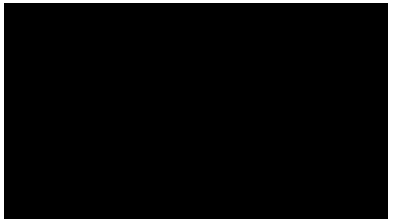
8 ing. ; 5 tech. ; 1 PNP

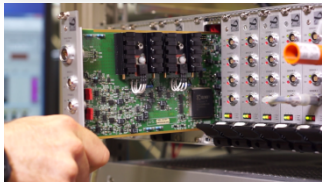
Control/command (LDISC)

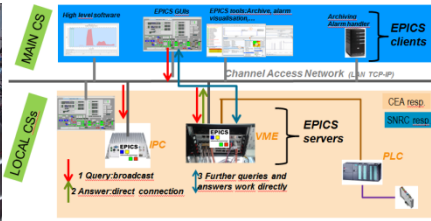
17 ing. ; 3 tech. ; 7 PNP





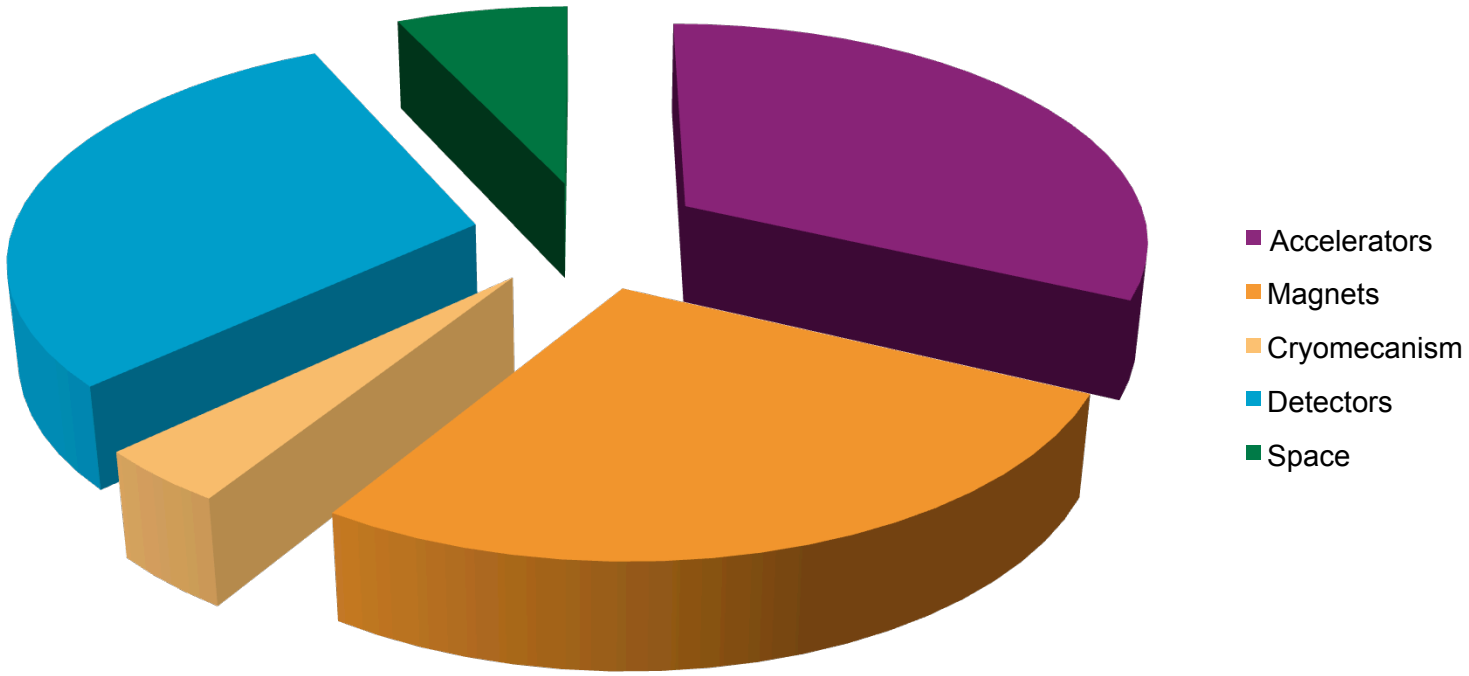






PROJECTS

2016 manpower breakdown per activity

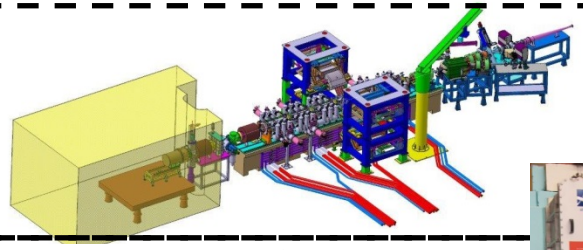


100 permanent (60% ing.)
30 non permanent
60 different projects

MAIN ACCELERATOR ACTIVITIES

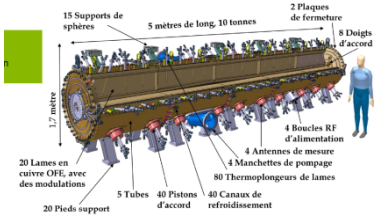
In operation

IPHI



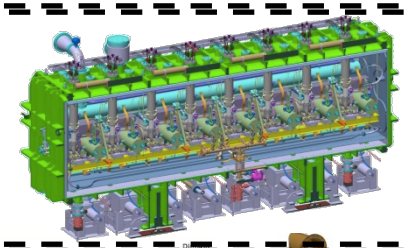
Under commissioning

SPIRAL 2



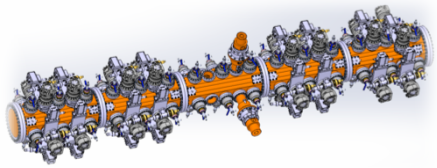
Installation

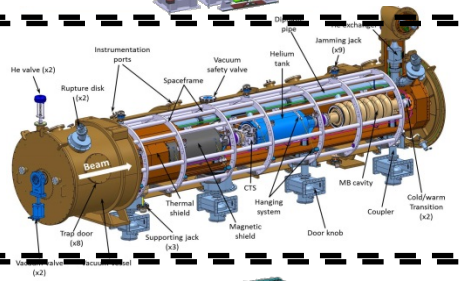
IFMIF - LIPAC



Construction phase

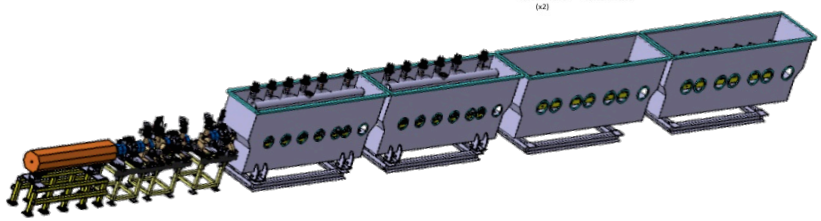
ESS-I





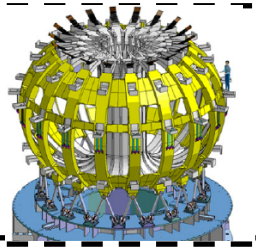
Construction phase

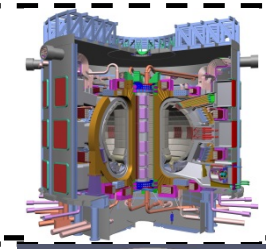
SARAF



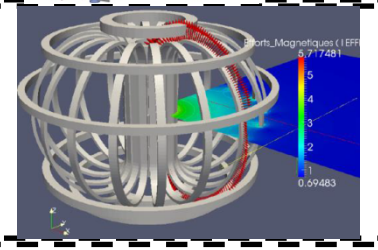
MAGNETS

Fusion: JT-60, ITER

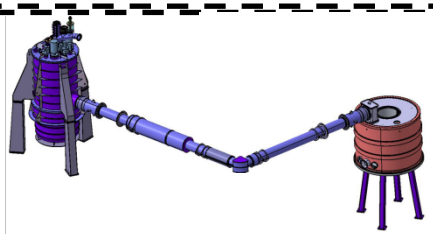




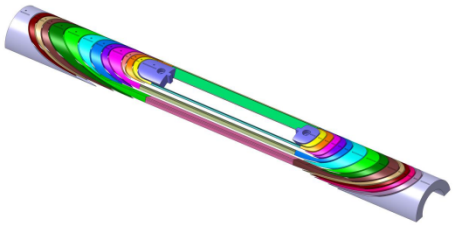
Future of fusion : DEMO

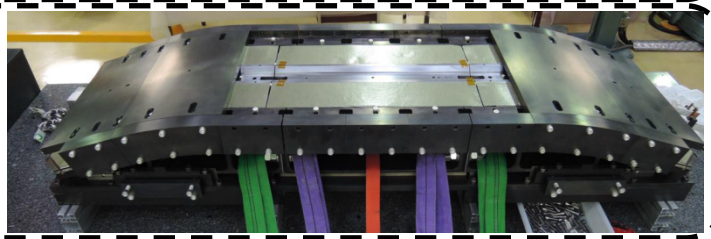


Hybrid magnet LNCMI

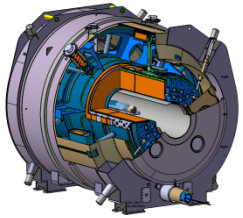


High field, HTc



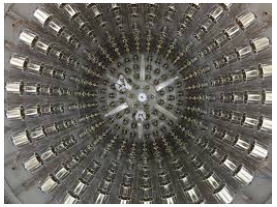


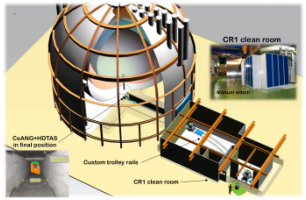
Health: ISEULT MRI

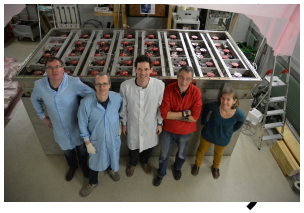


DETECTORS, SOURCES AND TARGETS

Neutrino: Double-Chooz, Nucifer, CeSOX, STEREO



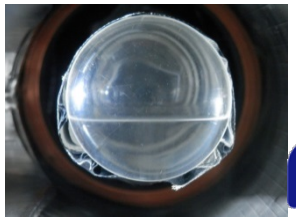




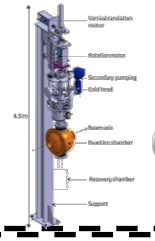
Neutron sources: NFS

GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3

H_2 target: MINOS, CHYMENE

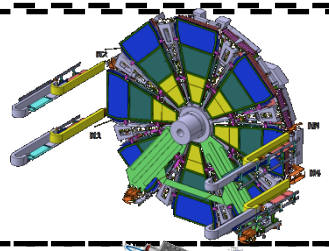


RIKEN



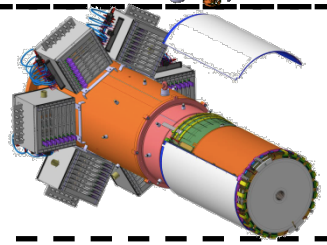
GANIL spiral2 laboratoire commun CEA/DSM CNRS/IN2P3

ATLAS NSW



CERN

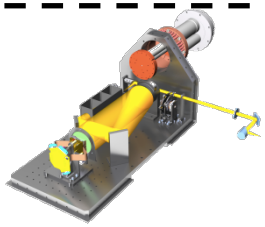
Physics of nucleon: CLAS12

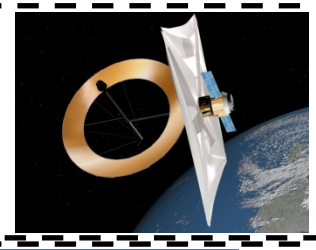


Jefferson Lab
EXPLORING THE NATURE OF MATTER

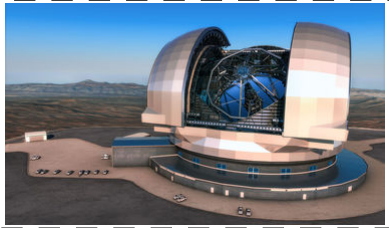
SPACE AND GROUND PROJECTS

Intrapix et TALC

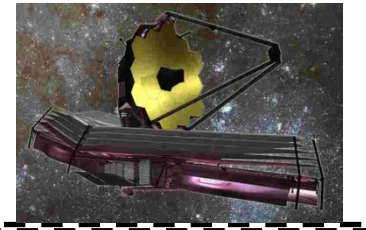


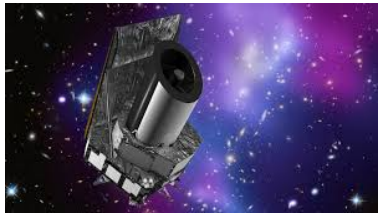


Spectro-imageur IR: ELT-METIS

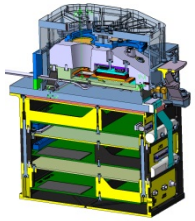


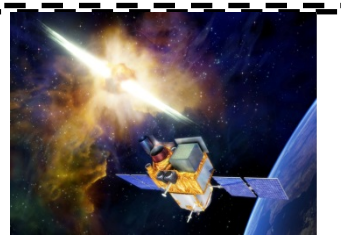
Redshift galaxie, lentille gravitationnelle: MIRI et Euclid



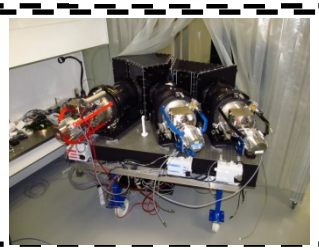


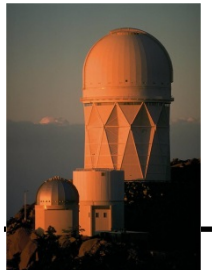
Gamma bursts: SVOM MXT





Dark energy: DESI





CRYOMECHANISM SYSTEM APPROACH

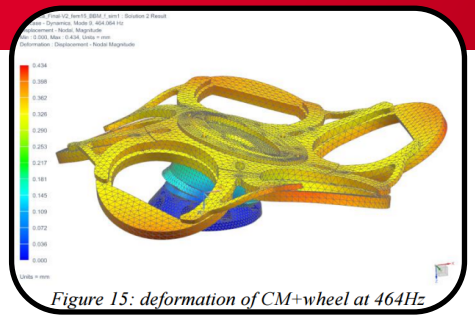
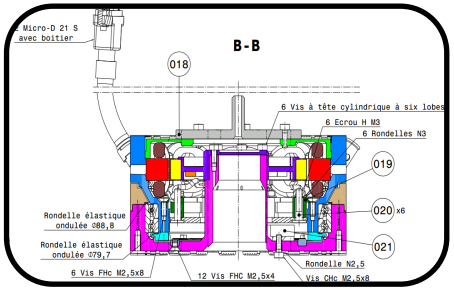


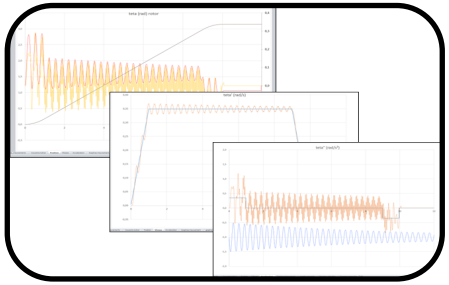
Figure 15: deformation of CM+wheel at 464Hz

Calculations, simulations

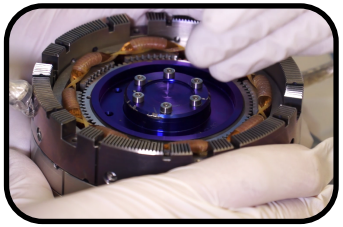


Mechanical design

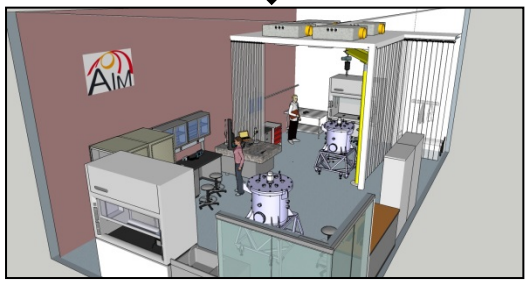
R&D



Control electronics under development



Clutch power supply



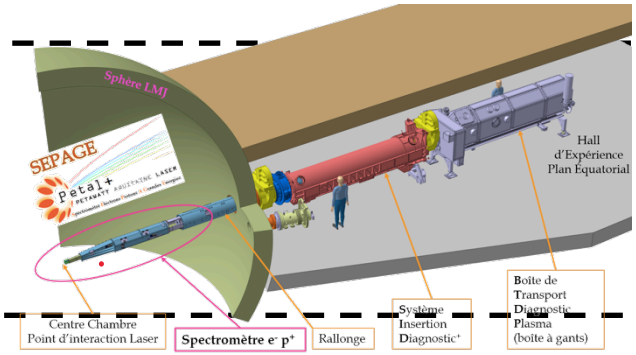
Test platform

TRANSVERSE PROJECTS

ICOS: CO2 measurement network

LSCE

SEPAGE: charged particle diagnostic



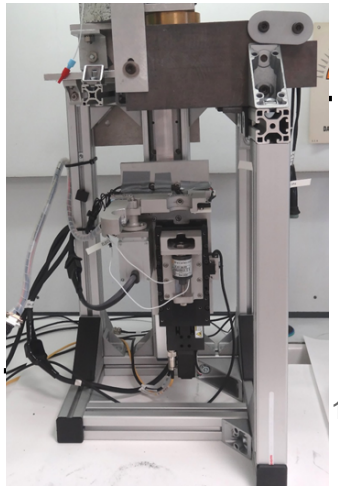
LOTUS: automatic syringe filling for radiopharmaceutical products

i2BM

PMB ALCEN

SIGMAPHI ACCELERATOR TECHNOLOGIES

FROM RESEARCH TO INDUSTRY cea tech



Laboratoire d'**E**lectronique **I**nstrumentale (**LEI**)

Philippe De Antoni

Equipe - moyens

Manager : Ph. De Antoni
Assistant : S. Sube

6 Engineers

- Ayoub Bounab
- Jean-Paul Charrier
- Olivier Dubois
- Philippe Galdemard
  - ✓ Chef de projet
- Yannick Mariette
- Yannick Queinec

4 Technicians

- Thierry Boussuge
- Dominique Gibier
- Thierry Moulin
- Guillaume Lys

MatLab, Scilab, IDL, Mathematica

Cadence (CAO) & Inventor (3D Mecatronic)

LTspice, VHDL, C & Embedded OS,

Equipements de mesures

National Instrument, LabView

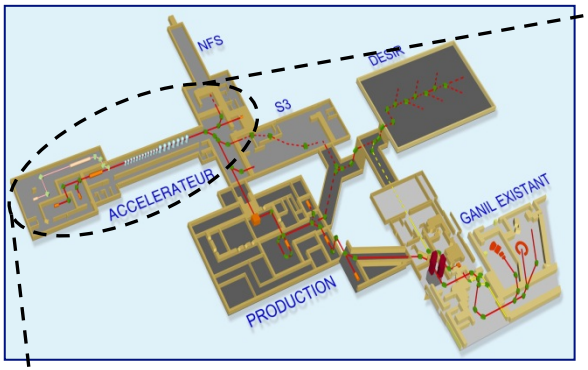
Office, Msproject …

savoir faire - Résumé

- Conception de l'instrumentation électronique spécifique destinée aux expériences de physique
  - Analyse des besoins
  - Spécifications and architectures
  - Développements, réalisations (sous-traitance) and installations sur site
- Domaines électroniques abordés
  - Electronique analogique et numérique
    - ✓ Mesure bas bruit, traitements analogiques, conversion A/N et N/A
    - ✓ Applications et traitements numériques utilisant des FPGA et/ou µP.
  - Intégration des équipements électronique (CAO Cadence & Inventor)
    - ✓ Circuits imprimés, châssis et baies
    - ✓ Installation sur site
  - Savoir faire particuliers:
    - ✓ Magnet Safety System (MSS) pour la protection des aimants supraconducteurs
      - Mesure bas niveau (jusqu'à 1 mV) isolées à plusieurs kV.
      - Fiabilité – besoin de redondance.
    - ✓ Electronique de mesure dans le domaine de la cryogénie.
      - Capteur de T° cernox
      - Mesure de niveau He

Spiral 2 LINAC – LLRF specifications - 1

Ganil facility (France – Caen)



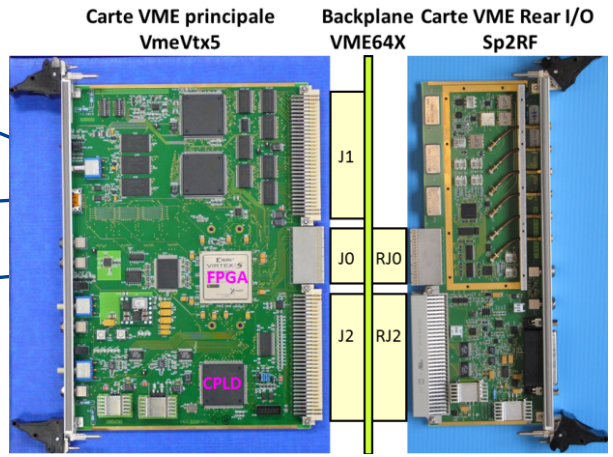
Rebunchers

Superconductive cavities A & B

Rebunchers

RFQ

- **Sources**
- **Low energy injectors**



The core of the LLRF are two VME64x boards

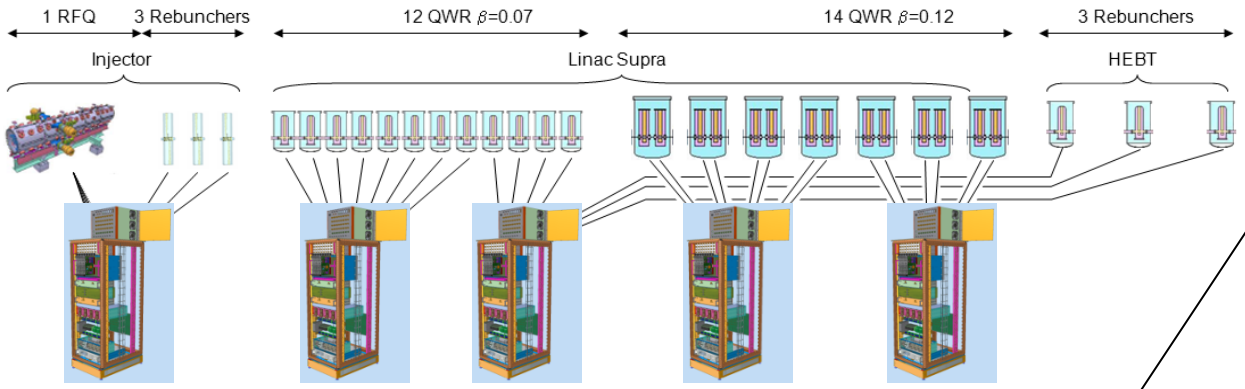
➢ **Linac**

- ❖ Frequency = 88,0525 MHz
- ❖ RFQ Output energy = 3 MeV
- ❖ RFQ max beam current = 5mA

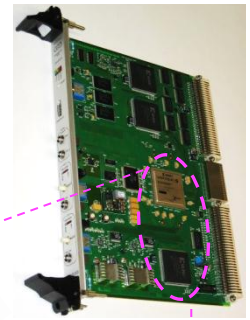
➢ **For each of the 33 accelerator cavities, the LLRF must:**

- ❖ Control the amplitude and the phase of the accelerating fields, with the precisions of ± 1% and ± 0.5°.
- ❖ Measure the detuning to feed the cavity frequency control system.
- ❖ Manage the protection of local RF equipment like the power couplers.

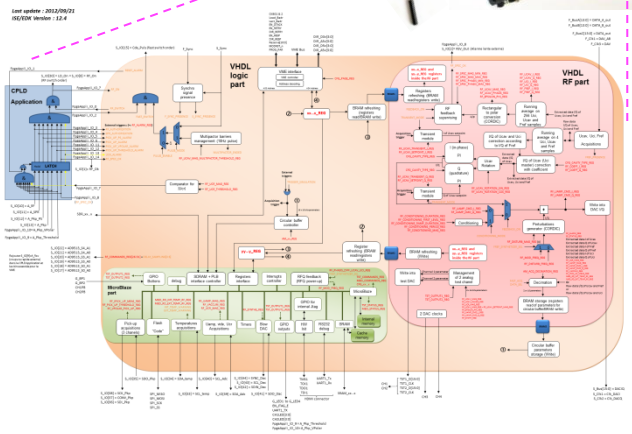
Spiral 2 LINAC – LLRF overview - 2

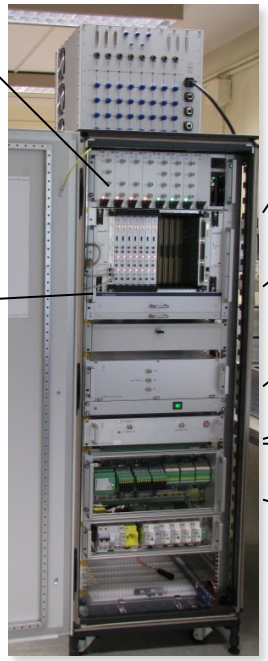


VmeVtx5 board
- 16 layers PCB
- FPGA Virtex 5



VHDL and C software





Sp2RF board
- Sampling of 3 RF channels @ 70 MHz
- I/Q modulator

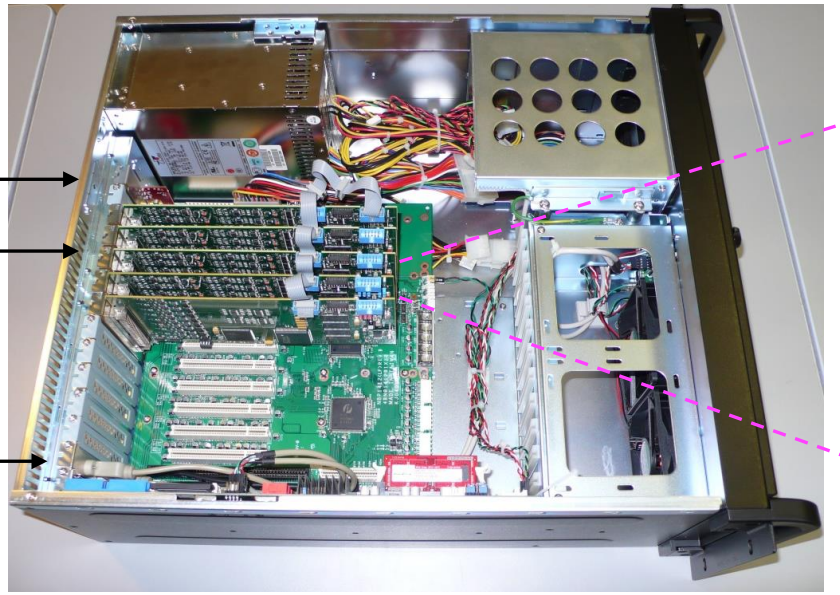
Pick-up ē board for the power coupler protection

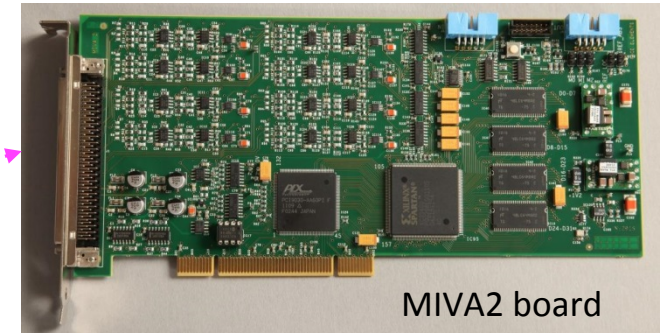
Signal interface board

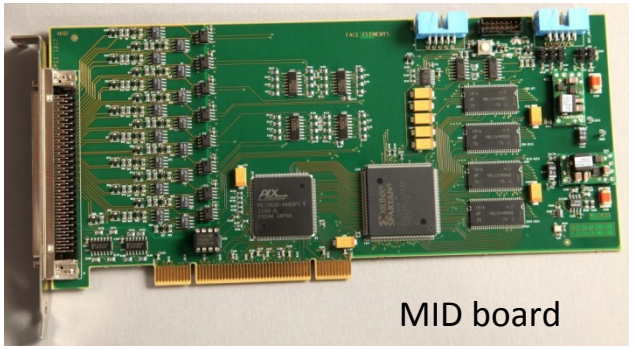
Deliverable: 5 LLRF cabinets

Acquisition ASnet

- The ASnet is a PCI crate with the 3 following functionalities:
  - Parallel acquisition of the analog and digital signals with the same clock (50 kHz max) and synchronization signals (Trigger, Reset).
  - Circular buffer with Pre-Trig and Post-Trig buffers when a Trigger is received.
  - Connection to a field bus (Fip, PROFIbus or PROFInet) as a slave to be read by the PLC.
- Main application: PCI crate acquisition for the MSS



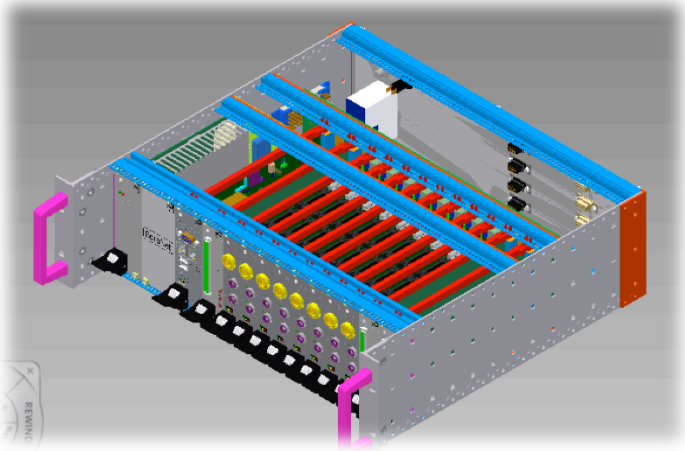




Centrale de conditionnement - BoraNet

CEA – Saclay

3D mechanical view (INVENTOR)



Modularity and compact system

- 8 conditioning modules for various sensors
- Ex : CERNOX® complex non-linear temperature sensors, Helium level probes for cryogenic applications
- Analog and digital outputs toward ASnet with 3 dedicated modules - 1 kHz data transfer

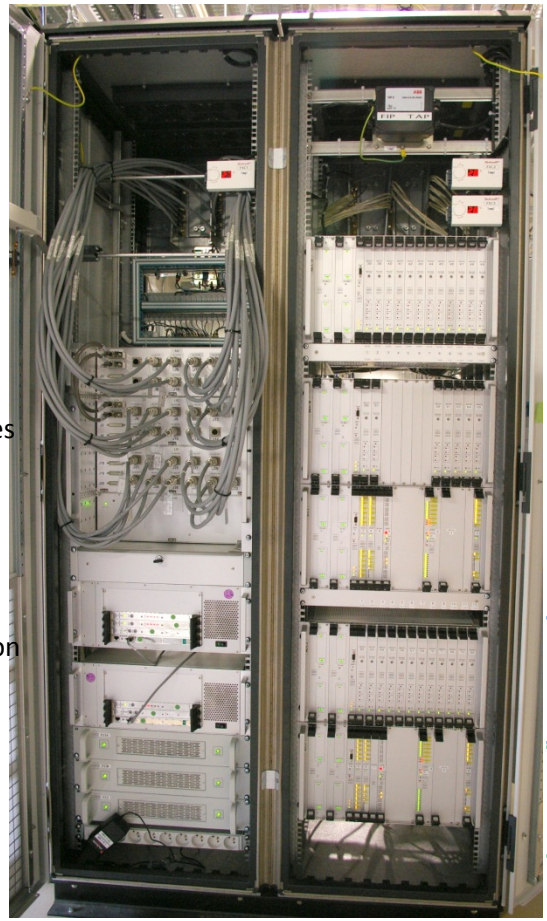
Cernox module (4 channels)

BoraNet Controller module

- Distant control functionalities using µS.C.A.D.A MUSCADE® for the monitoring (alarms) and the hardware configuration
- IOC-Server possibility for EPICS process control with the Linux 2.4
- Fieldbus connection profinet or profibus DP - 20 Hz data transfer

Magnet Safety System (MSS) – T2K (Japan)

The two cabinets of the MSS for T2K experiment

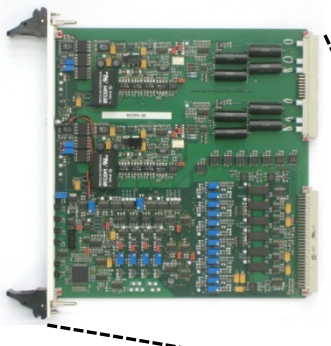


Interfaces

VME acquisition crates

Power Supplies

Low measurements (100 mV) with high CMM voltage (up to 2kV)



Measurement and detection

Safety Logic

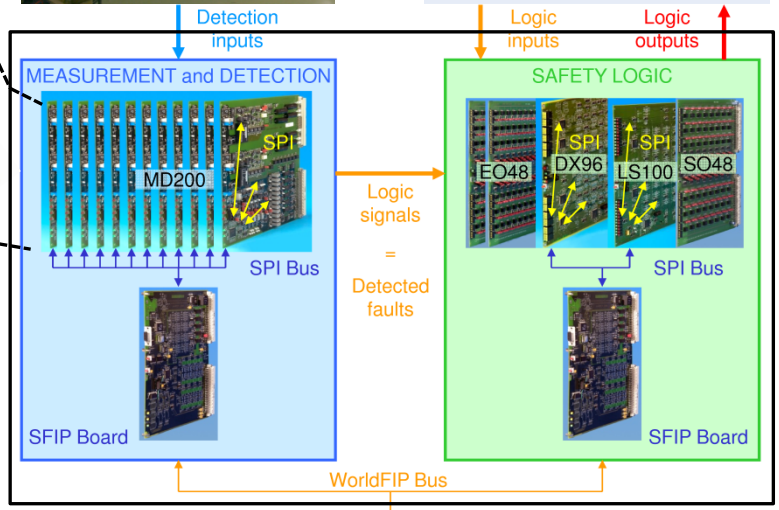
Redundancy

Measurement and detection

Safety Logic

Superconductive coils of T2K beam line

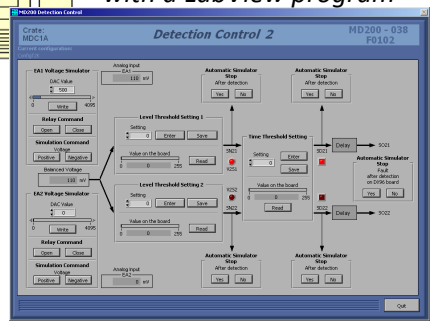
- Coils power supplies (several kA)
- Beam shutdown
- PLC (Cryogenic & vaccum)



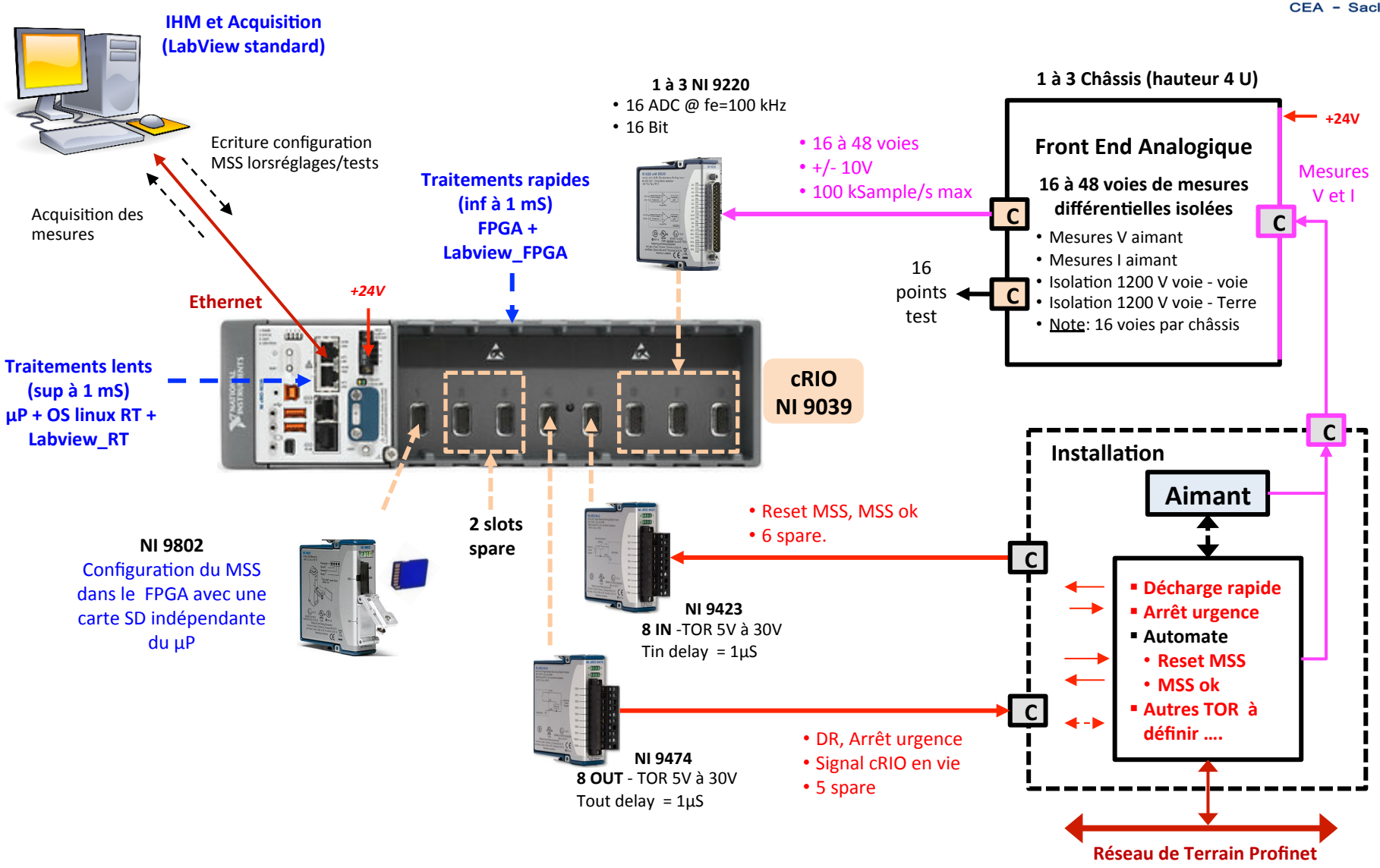
Local Monitoring PC

VME acquisition crates

Supervision of the MSS with a LabView program

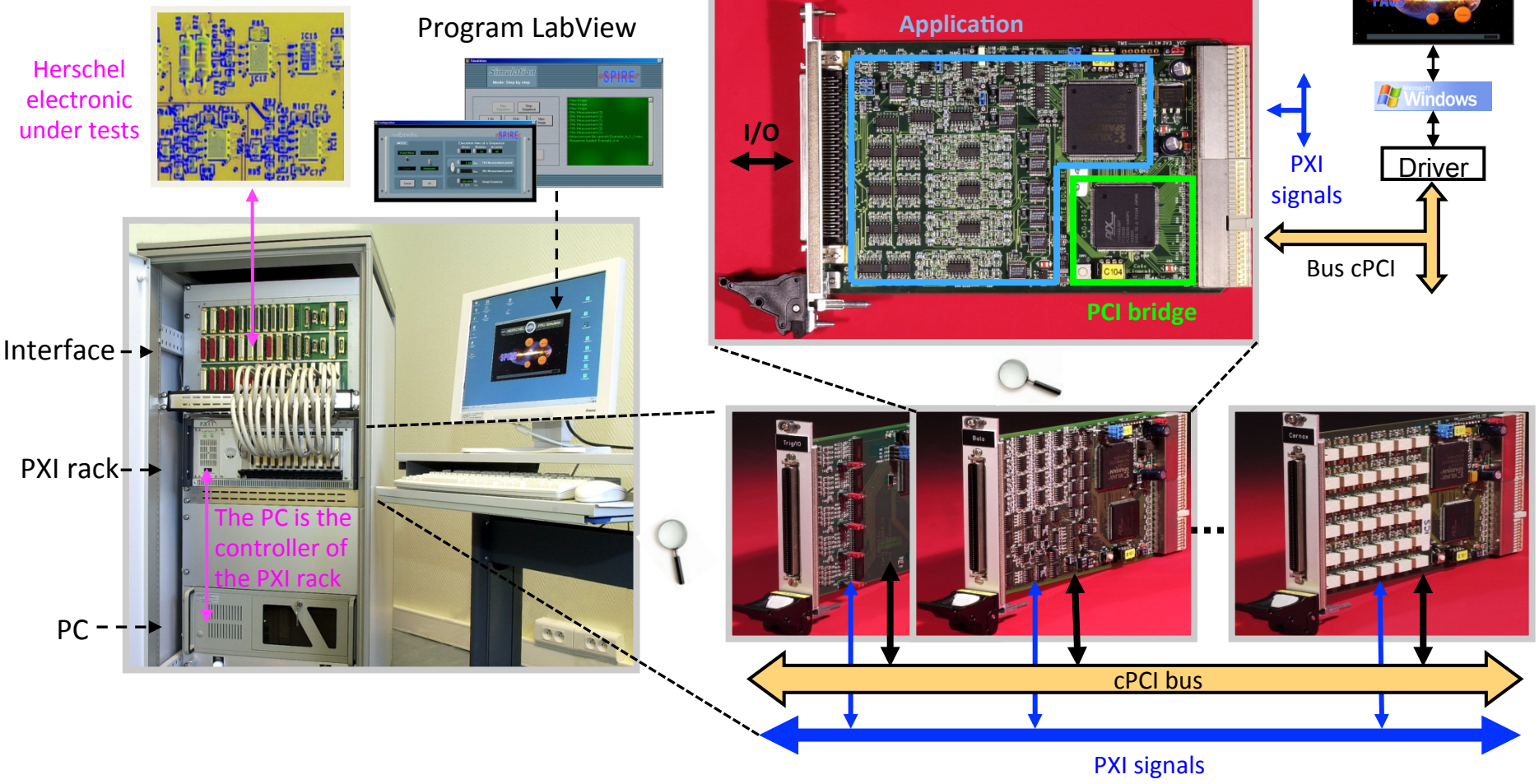


MSS et acquisition – Génération future



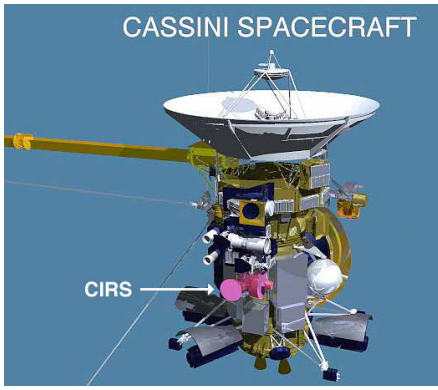
Herschel – A PXI instrumentation

The PXI device is used to simulate the Herschel infrared detectors (PACS and SPIRE) for the tests of the front end electronic.



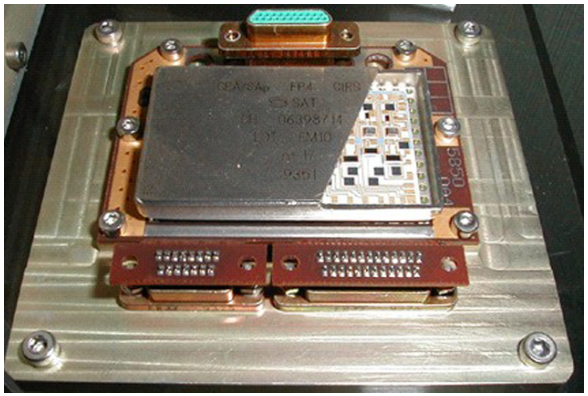
Cassini – CIRS (Composite Infrared Spectrometer)

- CIRS is a major science instrument aboard NASA's Cassini mission to Saturn. It measures the infrared energy from Saturn, its rings and its moons, especially Titan, in order to study their thermal structure and composition.
- Cassini launch date : 15 october 1997 (still working today …)
- **The SIS developed the electronic behind the detectors of the focal plan 4 (FP4)**



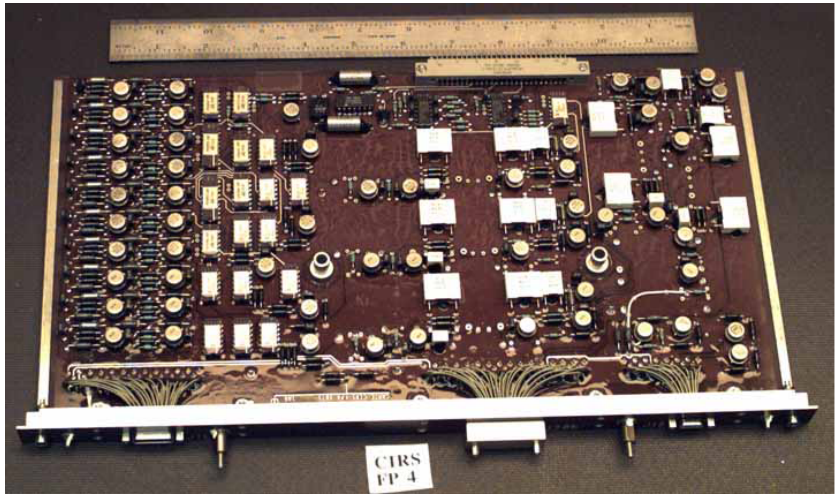
10 HgCdTe detector arrays of FP4

10 pre-amplifiers



- T° = 170K – 20 kRad max
- Low noise = 12nV/Hz$^{1/2}$
- 5mW per PA

Differential amplifiers / 5 band-pass filters / Multiplexer



- Band-pass filter : 46 Hz -58 Hz
- Low ripple gain and high phase linearity