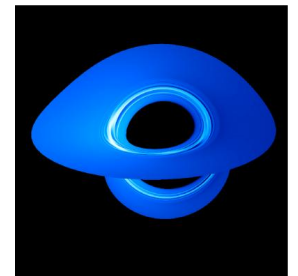
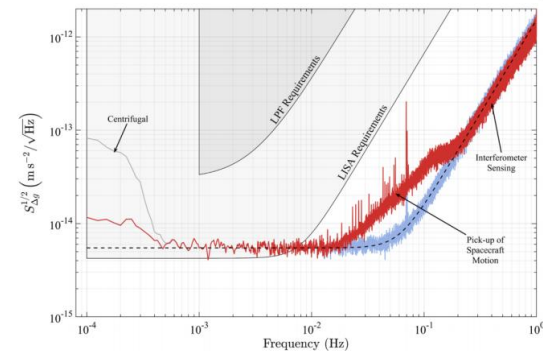
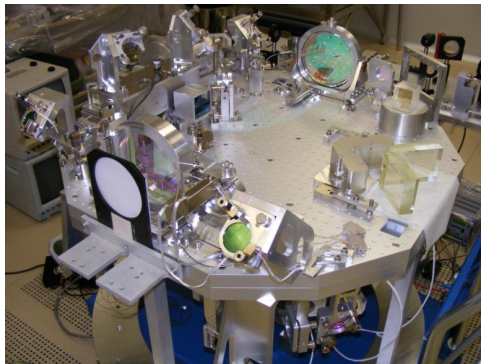
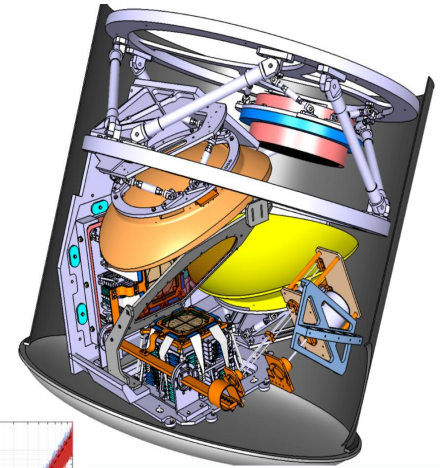
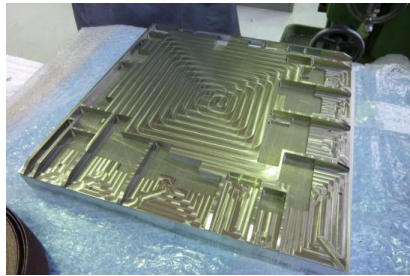


# 2012-2016 APC Laboratory Technical Activities T. Zerguerras on behalf of the Technical Departments





# Technical Departments

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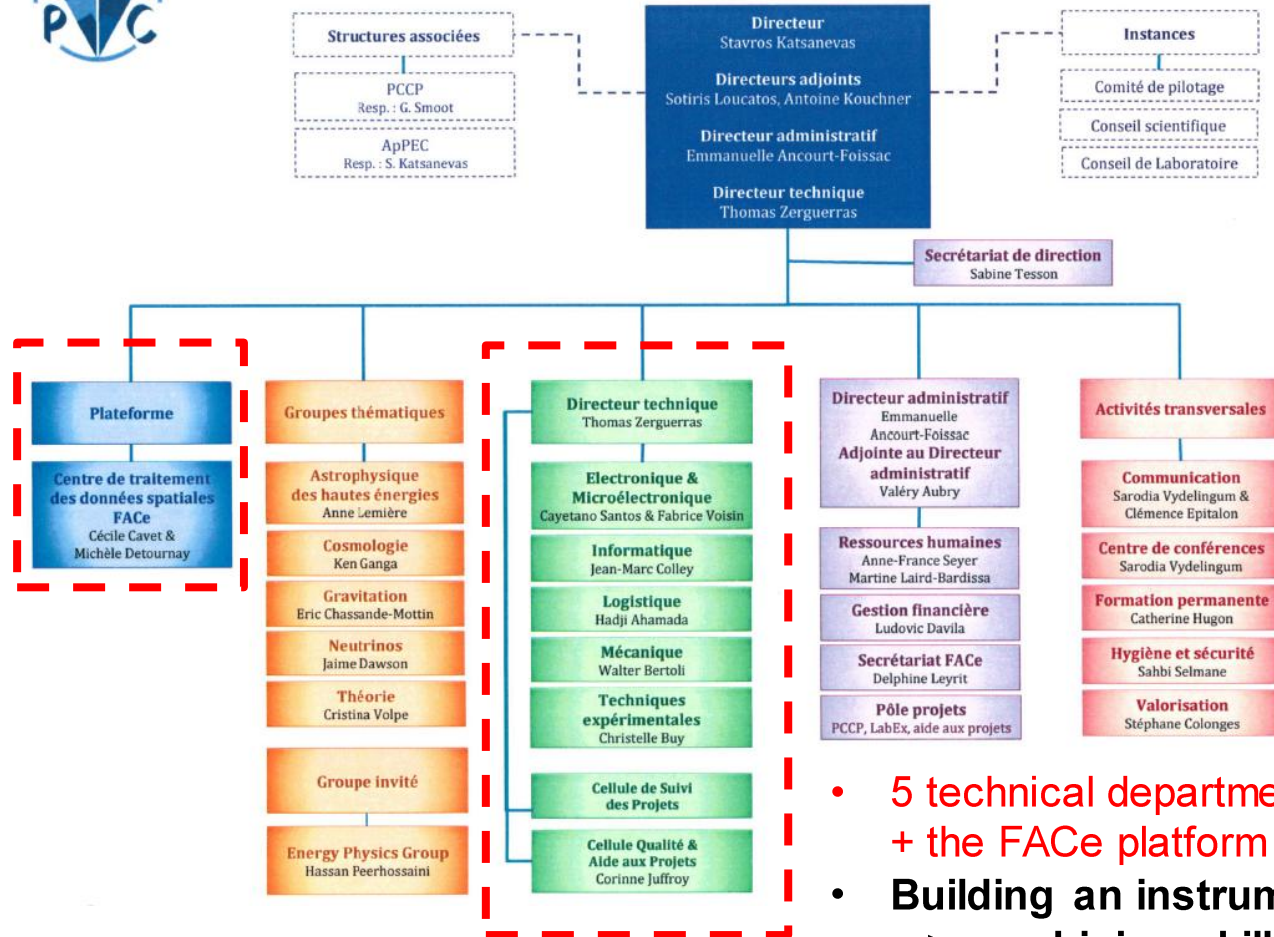
- ☐ **Organisation**
- ☐ **Equipment, facilities and platform**
- ☐ **Instrumentation Department (Techniques Expérimentales)**
- ☐ **Electronics and Microelectronics Department**
- ☐ **Mechanics Department**
- ☐ **IT Department**
- ☐ **Quality Unit**
- ☐ **Analysis & Prospects**



# General organisation



## AstroParticule et Cosmologie - UMR 7164




- 5 technical departments + Quality Unit + the FAcE platform
- Building an instrument => combining skills



## Organisation: structure

---

- ✓ **Matrix organisation structure:** Project/Department (Assignment to a department, participation to projects)
- ✓ One specific skill (Mechanics, Electronics/ $\mu$ electronics, Instrumentation, IT, QA/PA)
- ✓ Transverse activities of the Quality Unit
- ✓ Supervision : Head of department
- ✓ Project coordination: Project manager
- ✓ Indicator Boards for activities and assignments monitoring
- ✓ Project Monitoring Committee (Comité de Suivi de Projets CSP)



This organisation aims to create a bond of trust with funding and tutelage agencies



# Organisation: Role of the technical director

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Missions officially defined by a CNRS/IN2P3 model of letter of mission (ATRIUM -136477) since November 2016

@ APC:

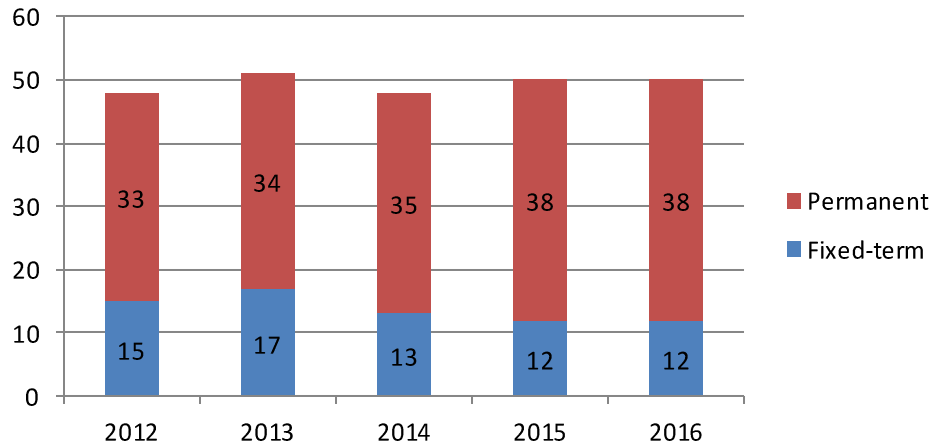
- ✓ Member of the direction board
- ✓ **Hierarchical:** Supervision of the technical departments, management tasks (annual evaluation interviews and career files of Technical Dpts heads ...)
- ✓ **Organizationnal:** operation following laboratory matrix structure ; needs of quality in project and organisation of CSP project reviews (support of the Quality Unit) ; survey of project management procedures and tools (ex: CNRS/IN2P3 NSIP database, APC Indicator Boards ...)
- ✓ **Strategic:** analyzis and survey of technical implications in projects (skills, workforce, infrastructures, consequences on other on-going projects) to give recommandations and alerts to the laboratory director (final decision maker); definition of the technical recruitment policy
- ✓ Main contact with the CNRS/IN2P3 technical director, participation to meetings and reviews organized by tutelage and funding agencies



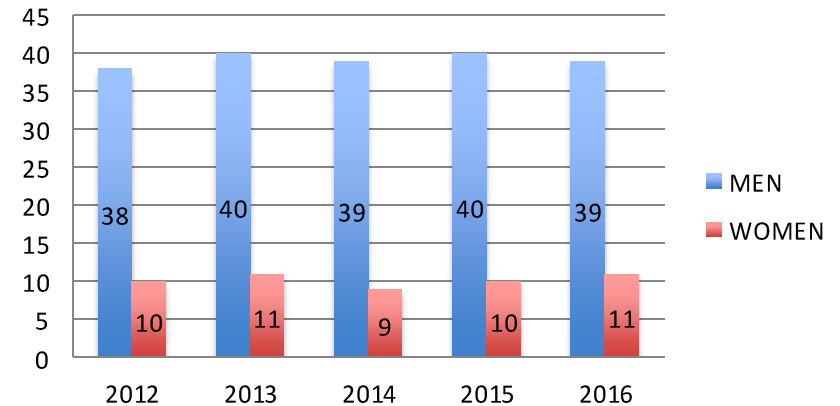
# Organisation: Technical staff evolution

**On 31/12**

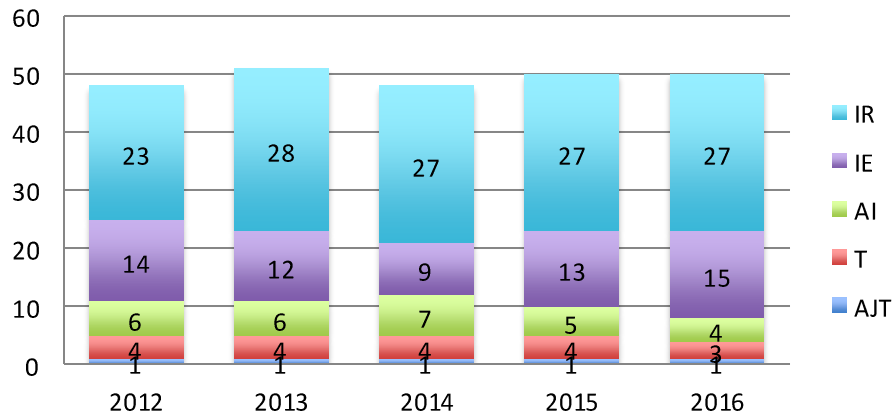
## Technical departments staff evolution



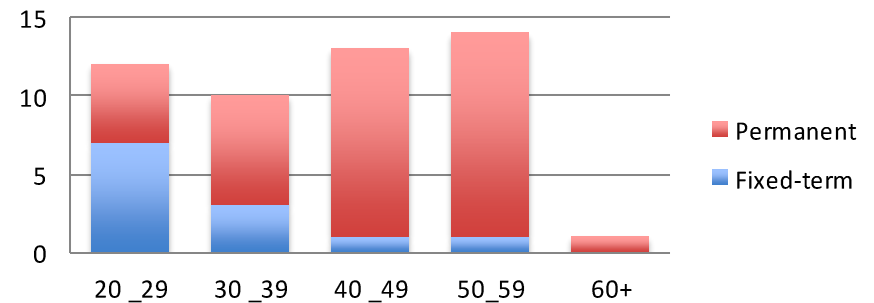
## Technical departments staff - Gender



## Technical departments staff - Skill level



## Age distribution - 31/12/2016







# Equipment and facilities



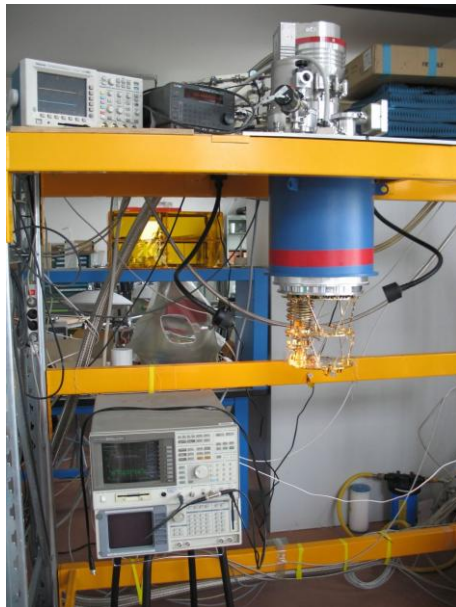
## ISO8 Cleanroom (128m<sup>2</sup>):

- Integration room
- LISA room
- VIRGO room



## Frequency comb generator

(Laser emission in a spectral band from 1 to 2 $\mu$ m with a frequency step of 250MHz)



## Millimetric Laboratory: 100mK dilution-free cryostat (Oxford Instrument)

(Cooling power:  
160 $\mu$ W @100mK,  
No cryogenic fluid)

## Millimetric Laboratory: Vector network analyzer

(characterization of  
antenna and filters in  
the frequency range  
70-220GHz)





# Equipment and facilities

**Low electromagnetic noise test room**  
(37,5m<sup>2</sup>) including a Faraday cage for components tests from 0.1mHz to 10Hz



**Mechanics Workshop**



**3D Printing Stratasys Fortus FDM250mc**  
(ABS plastic)



**Mouting hall**



**Photodetection Laboratory**







# Platform: FAcE

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**Started in 2010, support of IPGP in the framework of the Paris-Diderot University Space Campus – Application to the CNRS/IN2P3 Platform Label**

- **Scientific Manager:** Cécile Cavet (IT Department)
- **Technical Manager :** Michèle Detournay (IT Department)

## **Missions:**

- ✓ **Building and infrastructures management** (electrical facilities, CDF, HVAC, maintenance, subcontracting management)
- ✓ **Computing infrastructures management**
- ✓ **Services to projects** (data bases, web applications, development platform, training and user support)

## **Equipment:**

- ✓ **Computing parallel cluster:** 652 cores et 42Tb storage
- ✓ **80 virtual servers** for astroparticle and space projects (**storage: 180Tb**)
- ✓ **Concurrent Design Facility (CDF):** design and operations (LISAPathfinder, LISA ...)

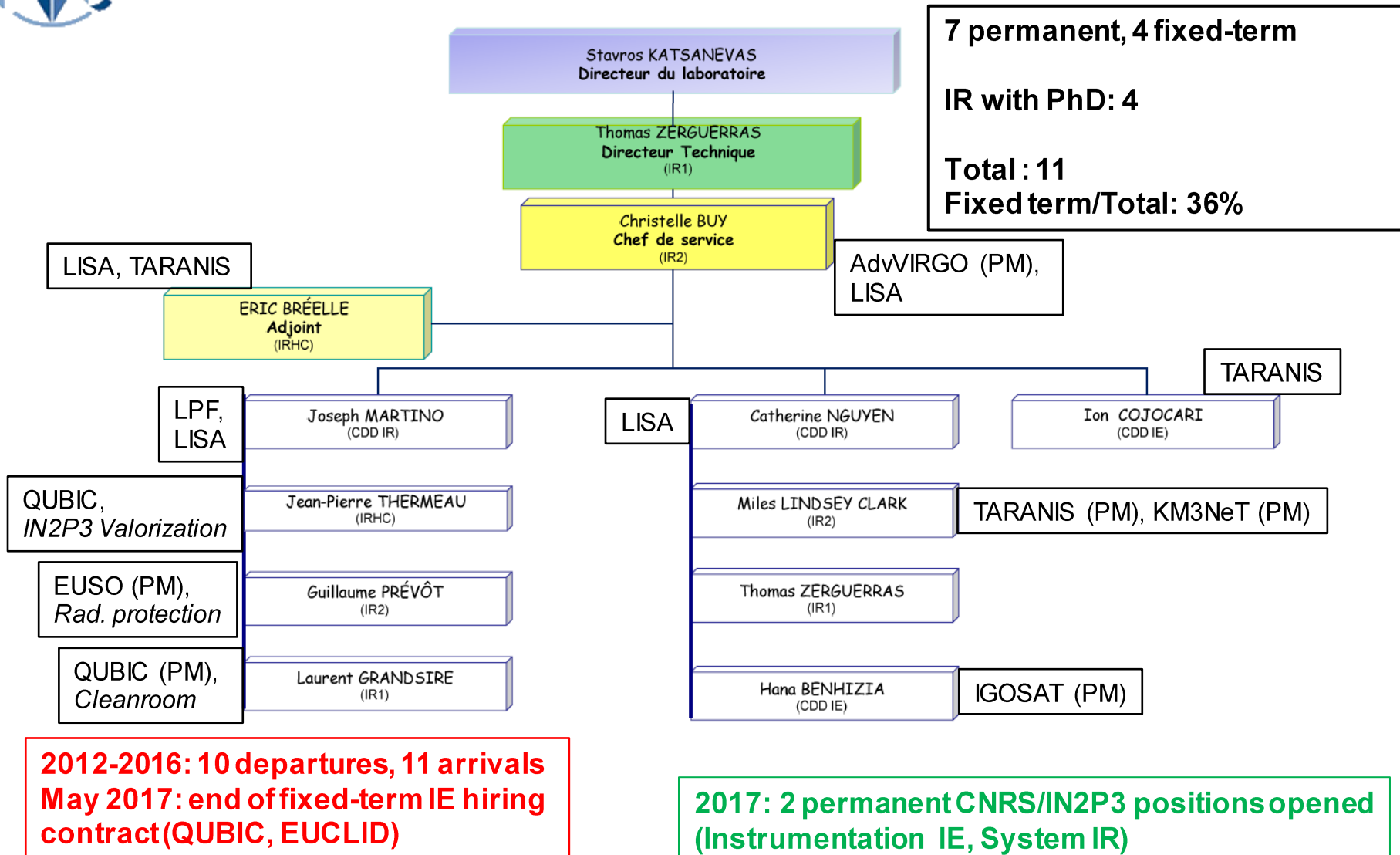
**Projects: PLANCK, INTEGRAL, CODEEN (EUCLID) ...**

## **Next:**

- ☐ **FAcE relocation in 2018**
- ☐ **Contribution : LISA DPC, SVOM pipeline**



# Instrumentation Department : Organisation





# Instrumentation Department: Skills

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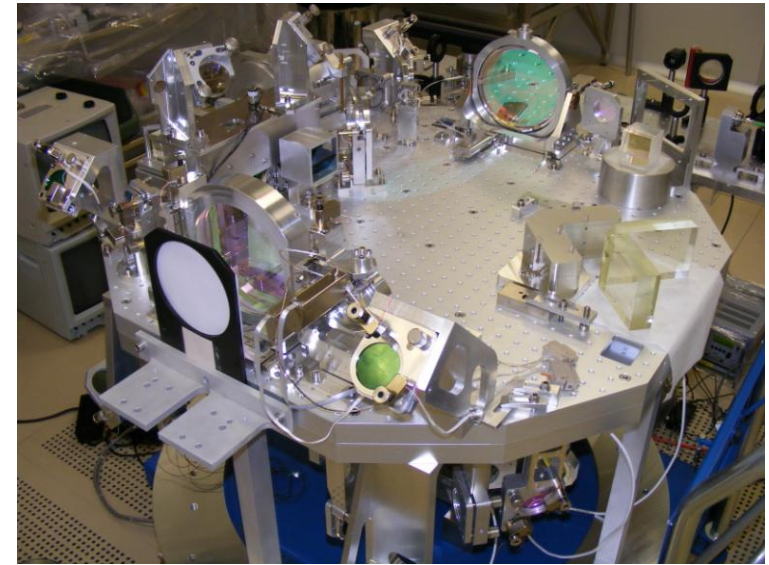
- ✓ **Optics and interferometry**
- ✓ **System engineering**
- ✓ **AIT/AIV**
- ✓ **Vacuum and cryogeny**
- ✓ **Bolometer**
- ✓ **Photodetection and spectroscopy**
- ✓ **Simulations (Zemax, Fred, Matlab ...)**
- ✓ **Test benches design for detector characterization**
- ✓ **Data acquisition (ex: Labview)**
- ✓ **Data analysis (ex: Matlab)**
- ✓ **Spatial and QA background (environment qualifications ...)**
- ✓ **Cleanroom**
- ✓ **Project management**



# Instrumentation Department: AdvVIRGO and post-AdvVIRGO R&D

## ✓ Telescopes for Advanced Virgo (2011-2015):

- ✓ Adapting beam size from a few mm (laser bench) to 5 cm in cavities (and vice-versa)
- ✓ Workpackages:
  - Optical simulations and design
  - Validation tests in the APC cleanroom
  - Definition of alignment procedures
  - Installation of 5 telescopes on site.



## GW detection in coincidence with LIGO (August 2017)

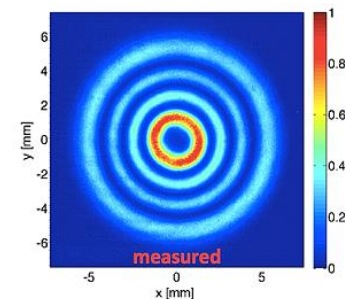
## ✓ Laguerre-Gauss modes

### ✓ MAJOR EVENTS:

- ✓ Production of higher-order LG modes : PRL 2010
- ✓ Interferometry : first lock (2014)
- ✓ Thermal compensation of aberrations: PRD 2015

## ✓ Prospects:

- ✓ **Einstein Telescope:** Third generation GW detector (underground, cryogenic, ...) : LG modes integration



PHYSICAL REVIEW D 90, 122011 (2014)

**Fabry-Pérot-Michelson interferometer using higher-order Laguerre-Gauss modes**

A. Gatto, M. Tacca, F. Kéfélian, C. Buy, and M. Barsuglia  
*Laboratoire AstroParticule et Cosmologie (APC), Université Paris Diderot, CNRS/IN2P3, CEA/Irfu,  
Observatoire de Paris, Sorbonne Paris Cité, 10, rue Alice Domon et Léonie Duquet, 75013 Paris, France  
(Received 9 October 2014; published 31 December 2014)*

**Contribution: Mechanics Dpt**





# Instrumentation Department: LISAPathfinder

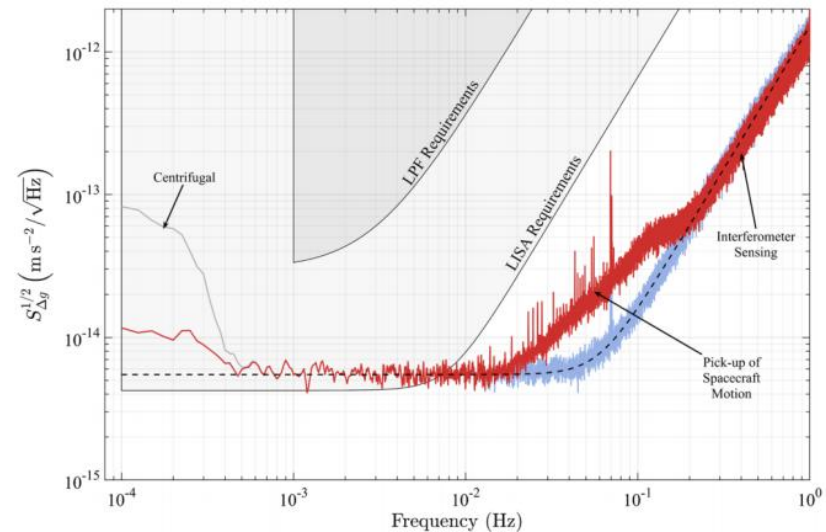
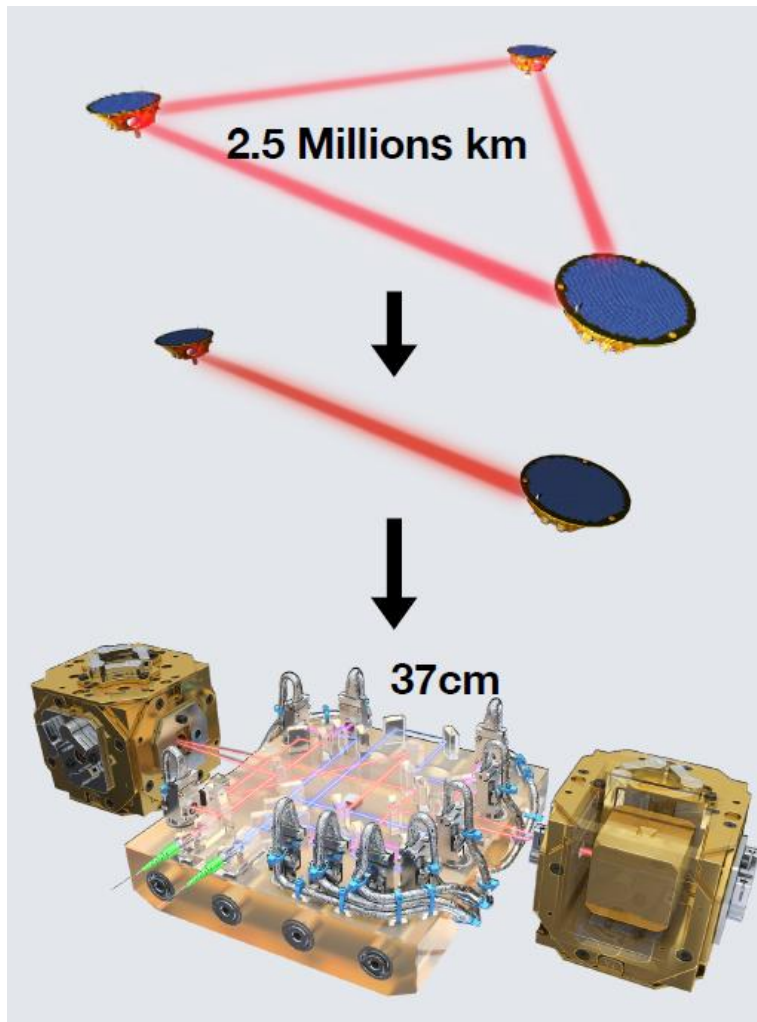
Successfully launched on 03/12/2015(end : July 2017)

## Validation of the technology for LISA:

measurement of the distance between two free-falling test masses by laser heterodyne interferometry

Major contribution of the APC to data analysis and interpretation ( $\mu$ -thrusters, deglitch ...)

Interferometer noise performances one order of magnitude better than LPF requirements



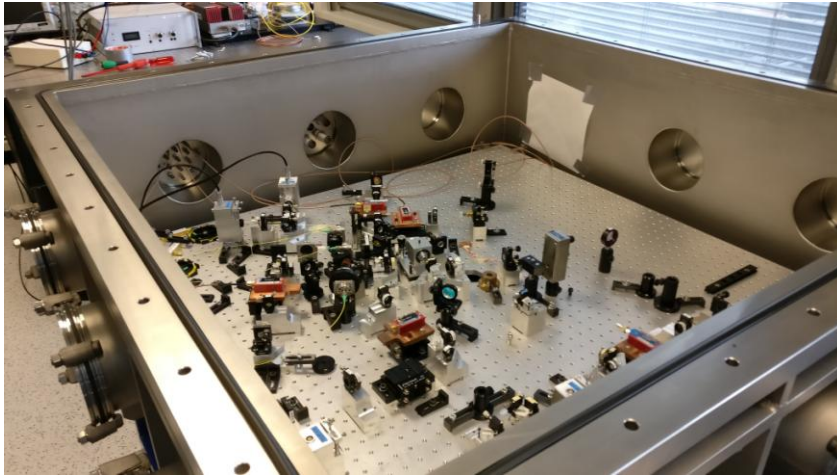
LISA selected as ESA L3 mission (launch: 2034)



# Instrumentation Department: LISA

**AIT/AIV Phase 0 CNES and ESA**

## LISA On Table (LOT)



**Hardware simulator of LISA to test in a representative acquisition chain:**

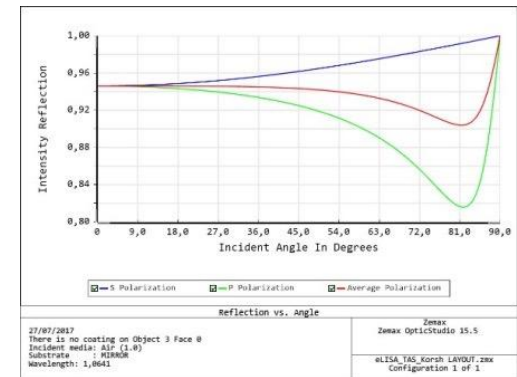
- ✓ Noise reduction techniques
- ✓ Instruments (photometers, phasemeter)
- ✓ 1st TDI (tested)
- ✓ Preparation for vacuum operations ( $10^{-1}$  mbar)
- ✓ Funding: R&T CNES

## Straylight studies

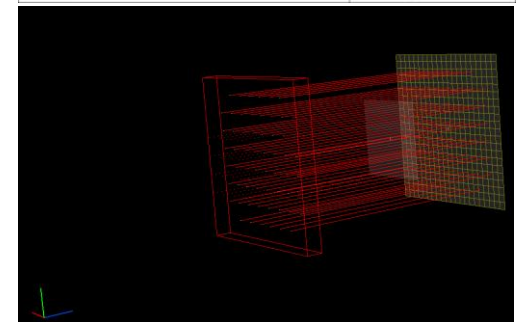
**Simulations to estimate the scattered light from LISA telescopes:**

- ✓ Specifications on surface properties with micro-roughness models ; cleanliness
- ✓ Polarization of scattered lights
- ✓ Funding: ESA ITT (collab: Thalès Alenia, APC, ARTEMIS, LMA)

Zemax

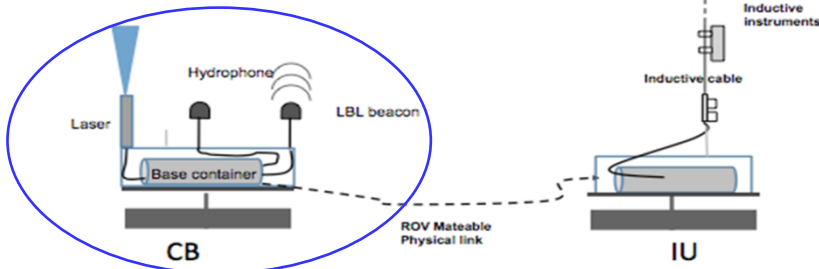
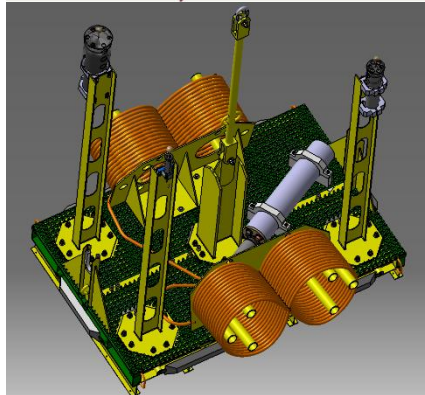
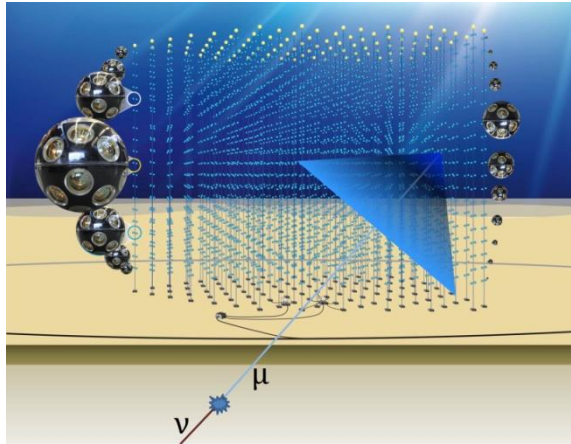


**FRED**  
Optimum





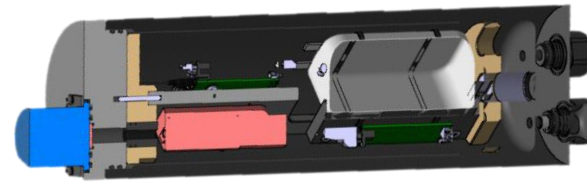
# Instrumentation Department: KM3NeT



**Project started @ APC in 2014**

**APC in charge of (CB+IU) project management**

- ✓ Design, integration, characterization and qualification of a new generation Laser Beacon for time calibration



- ✓ Design, integration and deployment of a calibration unit for the KM3NeT ORCA detector
- ✓ Collaboration with the CPPM (Marseille, France) in charge of the instrumentation line
- ✓ Funding FEDER + CNRS/IN2P3: 400 k€ (CB + IU)
- ✓ Starting operation : mid-2019

**Calibration test bench for DOM  
@ APC Memphyno tank**

**Contributions:**

- Mechanics Dpt
- Electronics Dpt
- QA/PA

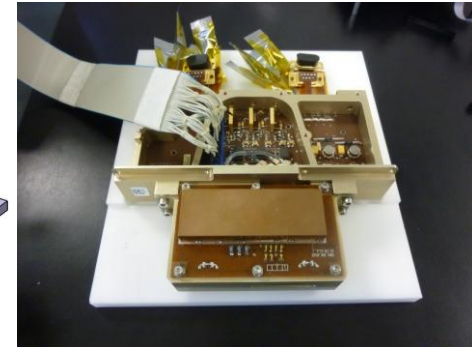
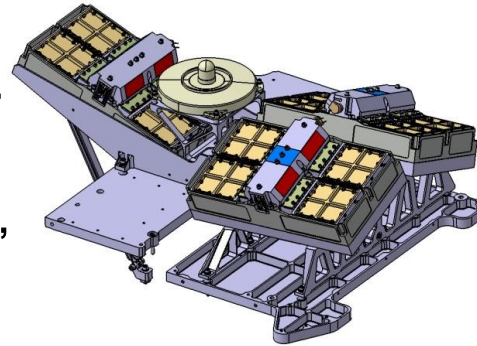


# Instrumentation Department: TARANIS

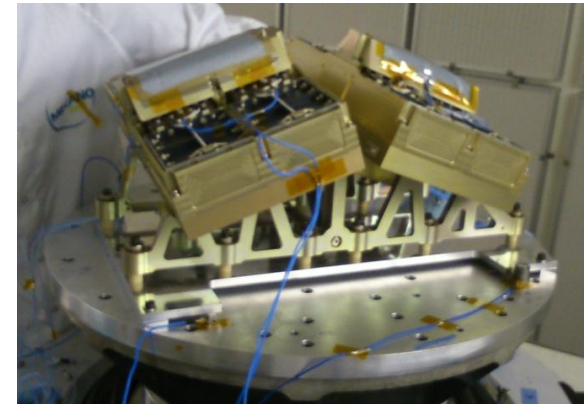
## CNES Microsatellite to study TLEs occurring during large storms

Design, production and validation of the XGRE sensor (3 x 4 DU: LaBr<sub>3</sub>, plastic scintillators, PMT).

Instrumentation AIT/AIV (EGSE and MGSE development, design and production of QM and FM, environment tests implementation).



- ✓ **Production and validation of the XGRE QM sensors (vibration and thermal vacuum tests) completed (August 2015)**
- ✓ **Production and validation of the XGRE FM sensors**
  - ✓ **SM2 qualifications @ CNES (February 2016)**
  - ✓ **AIT FM sensors & vibration qualif. tests (March 2016)**
  - ✓ **Shock qualif. tests (April 2016)**
    - ✓ **Anomaly detected on LaBr<sub>3</sub> (loss of performances)**  
→ Production process upgrade by St Gobain
- **June 2017: delivery of new LaBr<sub>3</sub> (12 FM DUs + 4 QM DUs)**
- **July 2018: delivery of FM DUs**
- **End 2018- mid 2019: AIT on satellite and calibration**



**Contributions:**

- Mechanics Dpt
- QA/PA
- Electronics Dpt
- NEXEYA (QA/PA and AIT/AIV)





# Instrumentation Department: EUSO

## Towards UHECR detection from space using UV light

- **Major facts / key milestones achieved**
  - ✓ **2012-2014: successful flight of the EUSO-Balloon mission**  
(12 countries, funding CNES+ Collaboration = 1,7 M€)  
Project management + integration & calibration focal surf @ APC
    - **Congratulations from CNES for the scientific return + funding for a second flight**
  - ✓ **Test campaigns in collaboration with the Telescope Array collaboration (USA+Japan) and in Turlab (Torino)**
    - **First UHECR detection using JEM-EUSO prototype**
  - ✓ **Funding from Europe (EuHIT), Campus Spatial (Paris Diderot) and CNES for second flight (Total for APC and LAL: 225 k€)**
  - ✓ **April 2017: EUSO-SPB (long duration balloon flight) by NASA :**  
Design, integration and calibration of the detector @ APC
- **Upcoming milestones**
  - ✓ **Dec. 2018: launch of the mini-EUSO mission towards ISS**  
Design, integration and calibration of PDM and HV system @ APC
  - ✓ **April 2020 : Second SPB flight, POEMMA prototype, selected as NASA Probe studies program in 2017**



### Contributions:

- **Mechanics Dpt**
- **Electronics Dpt**
- **QA/PA**



# Electronics and Microelectronics Department : Organisation

Stavros KATSANEVAS  
Directeur du laboratoire

Thomas ZERGUERRAS  
IR1  
Directeur Technique

Cédric CHAMPION  
IE2  
Adjoint

Cayetano SANTOS  
IE2  
Chef de service

Fabrice VOISIN  
IR1  
Chef de service

## Electronique

CTA, KM3NeT

Claude BOUTONNET  
IEHC

CTA (PM), KM3NeT

Cédric CHAMPION  
IE 2

ATHENA, TARANIS

Kuo Kuan CHAN  
CDD IR 2

Multi projects TARANIS, JUNO, WA105 CTA, R&T Compton

Guy MONIER  
TCN

Alexis NOURY  
CDD IE

Ronan OGER  
AI

Pierre PRAT  
IR1

Cayetano SANTOS  
IE 2

Sahbi SELMANE  
IE 1

LISA, LPF

JUNO (PM), LISA,  
WA105 (PM)

EUSO, HSD

## Microélectronique

Cyril BEILLIMAZ  
CDD IE

ATHENA

Damien PRÊLE  
IR2

ATHENA (PM),  
GAMMACUBE  
QUBIC

Fabrice Voisin  
IR1

ATHENA,  
QUBIC

**Electronics:**

**7 permanent**  
**2 fixed term**

**Total: 9**  
**Fixed term/Total: 22 %**

**Microelectronics**  
**(creation in 2016)**

**2 permanent**  
**1 fixed term**

**IR with PhD: 2**

**Total: 3**  
**Fixed term/Total: 33%**

## Electronics Dpt:

- 2 retirements in the next 5 years
- End of the 2 fixed-term hiring contracts (31/12/2017 and 04/09/2018)

## Microelectronics Dpt:

- End of the fixed-term IE hiring contract in 2018
- Need of a 3rd permanent IR



# **Electronics and Microelectronics Department :**

## **Skills**

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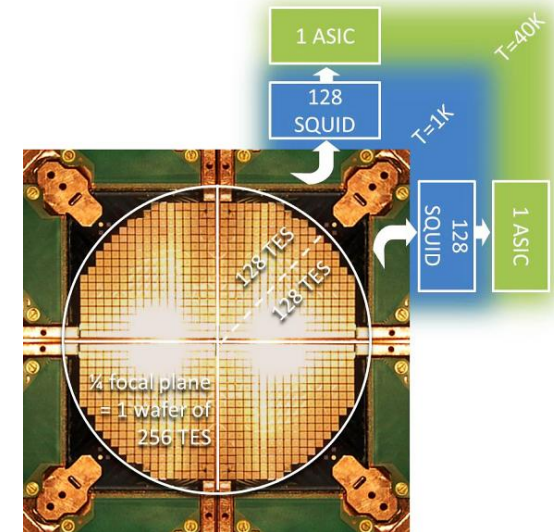
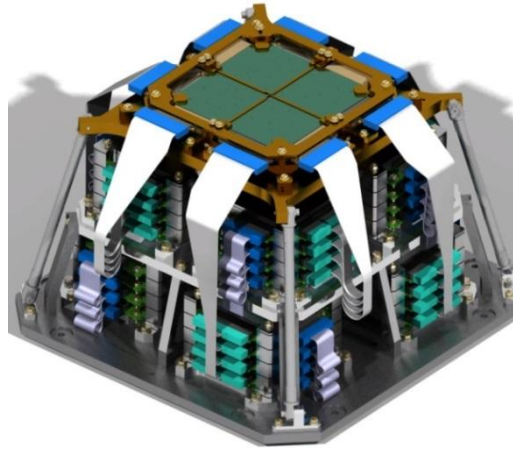
- ✓ **Analog/Digital electronics**
- ✓ **Cryogenic microelectronics**
- ✓ **ASICs definition, design, characterization and integration**
- ✓ **FPGA programming (ALTERA, XILINX ...)**
- ✓ **PCB design & integration (CADENCE)**
- ✓ **Timing and clock distribution systems (White Rabbit)**
- ✓ **Simulations: ASICs (VIRTUOSO), VHDL, PCB (ALLEGRO)**
- ✓ **Tests and characterization (ex: OMEGA ROC ASICs)**
- ✓ **Spatial and QA backgrounds (RadHard qualifications ...)**
- ✓ **Project management**



# Microelectronics Department: QUBIC

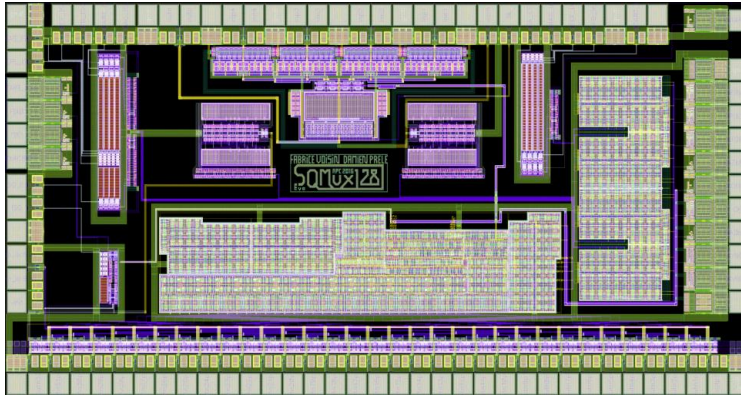
## Focal plane:

- 4 wafers made of 256 TES @300mK each
- 128 SQUID @ 1K + 1 ASIC @ 40 K for 1/4 focal plane
- Readout: time multiplexing



## SQMUX128 v2:

ASIC Cryo. AMS BiCMOS SiGe 0,35μm standard



**Includes:** LNA with multiplexed inputs (1:4)  
 Multiplexed current supply (1:32) for SQUIDs bias  
 Digital circuit for addressing and serial link

**Summer 2015:** Integration and validation of 1/4 focal plane @ APC

**15/06/2016:** ASIC v2 delivered - Successfull test in the dilution-free cryostat

**September 2016:** Starting QUBIC demonstrator integration (2x 1/4 focal planes, 512 channels)

## Contributions:

- Mechanics Dpt
- Instrumentation Dpt

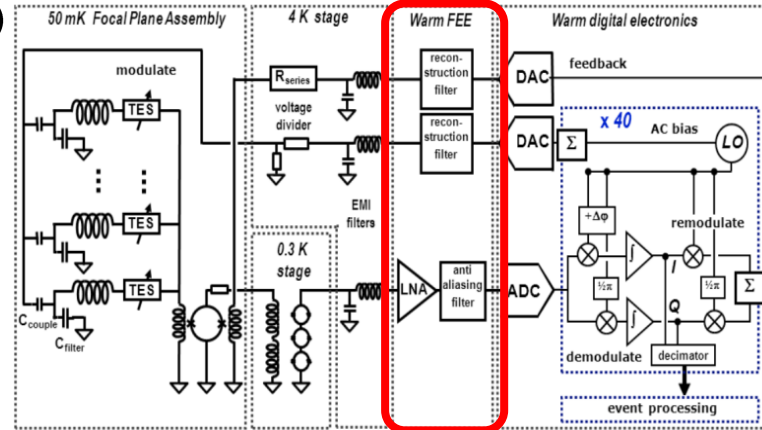
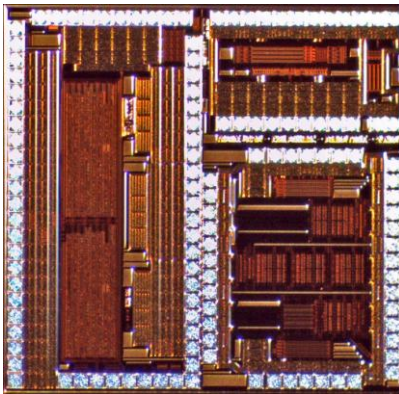




# Microelectronics Department: ATHENA

## Warm Front-End Electronic (FEE) for the X-IFU instrument

- ✓ 96 LNA (100V/V, 1-6MHz, 1nV/ $\sqrt{\text{Hz}}$ )
- ✓ SQUIDs biasing
- ✓ Bias regulation, HK, SQUID deflux
- ✓ Box for cryostat + EMI filters



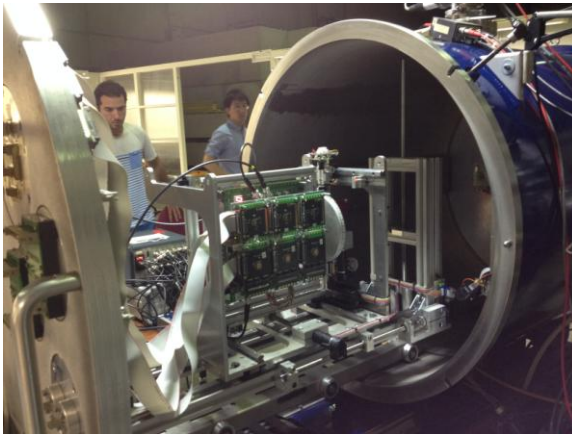
### Phase A:

2015-2019

- ASIC production + RadHard qualif.
- EGSE test benches
- Mechanics integration

**awaXe\_v1:**

ASIC AMS BiCMOS SiGe 0,35μm



### Goals:

- ✓ Test and characterization of several architectures
- ✓ Validation of Rad Hard digital libraries
- ✓ awaXe\_v1 delivered on 01/08/2016.
- ✓ Successful RadHard test campaign @ Cocase (high-intensity 60Co source) and latch-up tests @ Louvain-la-Neuve (heavy ions)
- ✓ ASIC v2 in preparation



# Electronics Department: TiCkS board for CTA

## TiCkS board (Time and Clock Stamping) based on the White Rabbit (WR) SPEC node:

- ✓ Providing ns-precision Time Stamps (TS) of input signals
- ✓ Transmission of these TSs to a central collection point for use in any CTA camera

## Modification in the Spartan-6 FPGA :

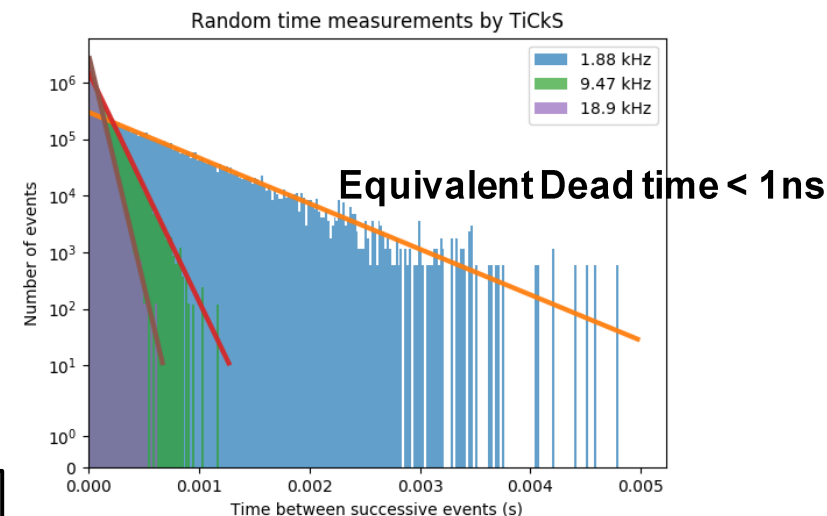
- ✓ Addition of a 1ns precision TDC for the TSs (collab. CEA/IRFU)
- ✓ UDP stack :
  - send TSs on WR fiber (No loss up to 320kHz @ fixed frequency )
  - Receive config & slow control commands on the same fiber
  - Send PPS and event counter
- ✓ 2 versions :
  - TiCkS –UCTS (FMC) soon available in the WR Open Hardware repository
  - TiCkS-CTA (2xRJ45)

C. Champion et al., Proc. ICALEPCS2017, Barcelona, Spain October 8-13 2017 (accepted)

## Next:

- ✓ TiCkS on NectarCAM test bench: end of 2017
- ✓ Network of 8 TiCkS: end Q1 2018

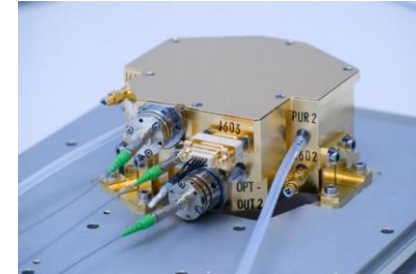
Contribution: QA/PA





# Electronics Department: LISAPathfinder and LISA

**LISAPathfinder:** LASER MODULATOR: beam splitter + 2 AOM + actuators  
Validation of test procedures with the manufacturer  
Monitoring during the mission



**LISA R&T:** Electronics development for the LISA On Table simulator

- ✓ Servo electronics for laser amplitude and optical paths stabilization
- ✓ Implementation and modification of a phasemeter developed at the AEI Hannover
  - building hardware for RF electronics and DDS kits
  - external clock synchro + jitter correction
  - Upgrade to 14 bits @200MHz sampling
- ✓ Low frequency noise measurements on RF components and voltage references



**REFIMEVE:** Ultra-low phase noise sinusoidal signals synthesizer synchronized on the REFIMEVE signals under development (Goals: LOT upgrade, LISA phasemeter characterization)



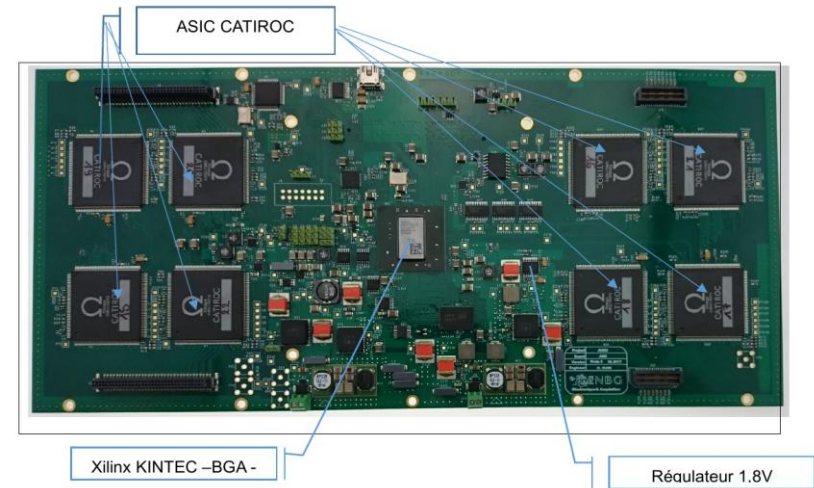
# Electronics Department: Electronics readout for large PMTs assemblies

## Card design, firmware and data acquisition

### JUNO @ APC

Joint effort with CENBG and OMEGA  
– 1st version Mezzanine

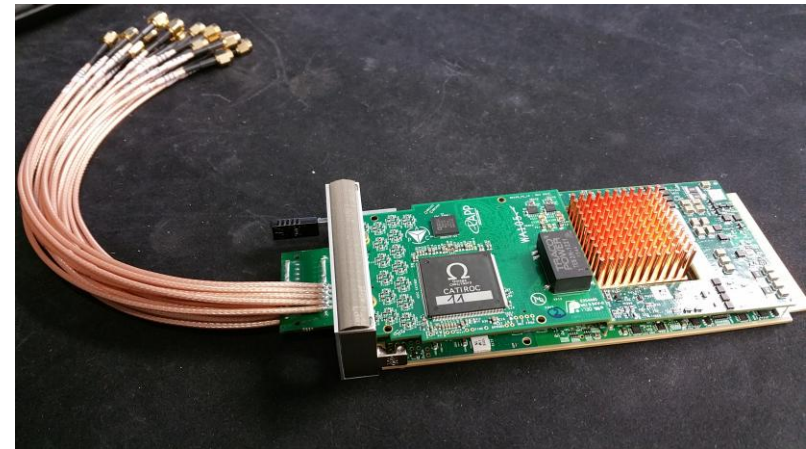
- 128 channels
- 8x CATIROC ASICs
- Kindex 7 FPGA
- FMC connector



### WA105 @ APC

Collaboration with IPNL, LAPP  
and OMEGA

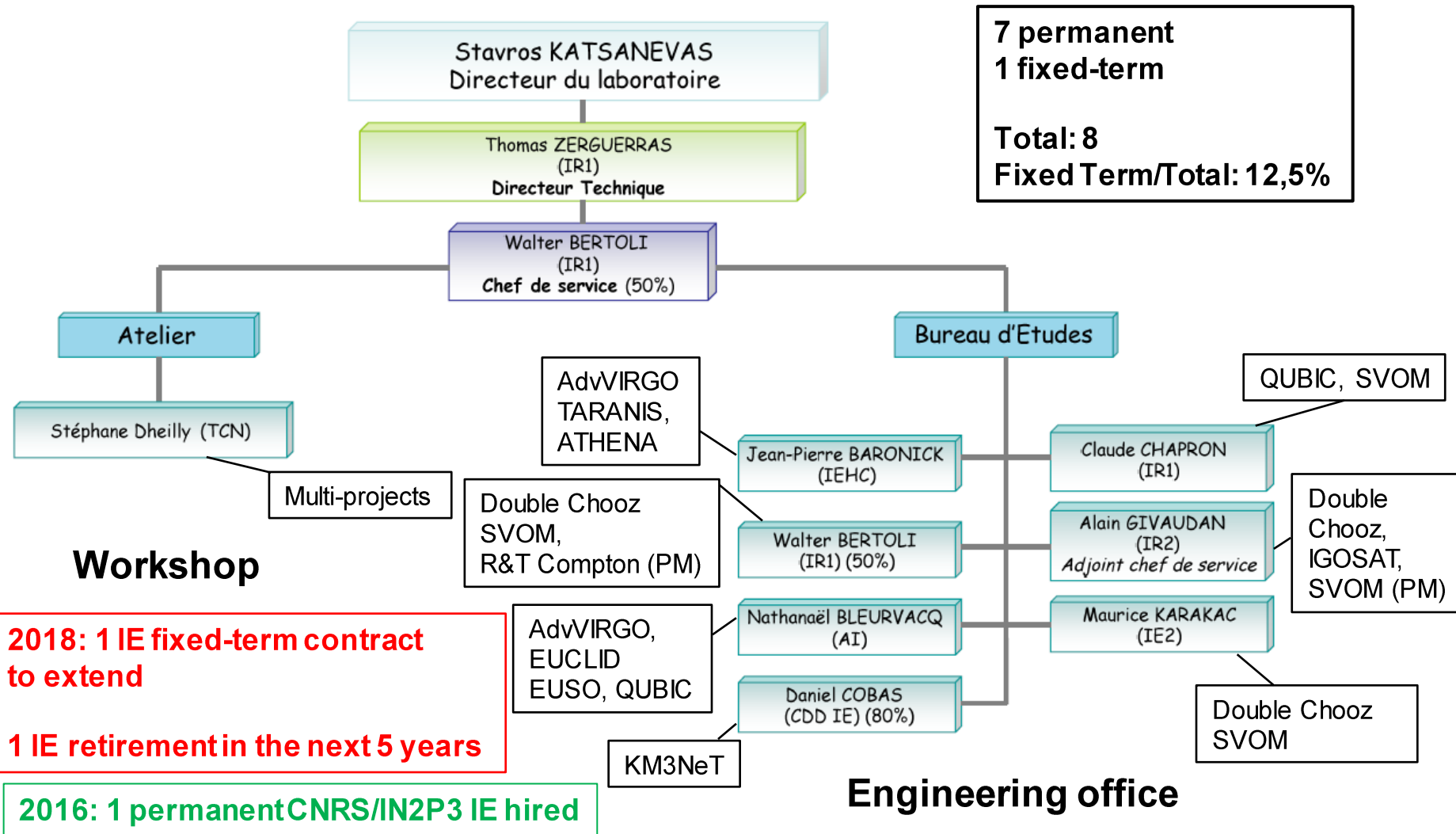
- 16 channels
- 1x CATIROC ASICs
- 65 Msps ADC
- $\mu$ TCA AMC
- FMC connector







# Mechanics Department: Organisation





## Mechanics Department: Skills

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- ✓ **Mechanical design in specific environment (space, undersea, vacuum, cryogeny, high-level cleanliness)**
- ✓ **CAD (CATIA)**
- ✓ **Finite-element analysis (transition from Samcef to ANSYS): isotrope materials, mechanics, thermal management**
- ✓ **Dimensionnall metrology (mechanics) + programmation**
- ✓ **Spatial and QA background (environment qualifications ...)**
- ✓ **Project management, call of tenders for public contracts**
- ✓ **Subcontracting monitoring**
- ✓ **Workshop: CNC machine 2,5 axes (drilling)/assembly, numerically controlled machining center.**

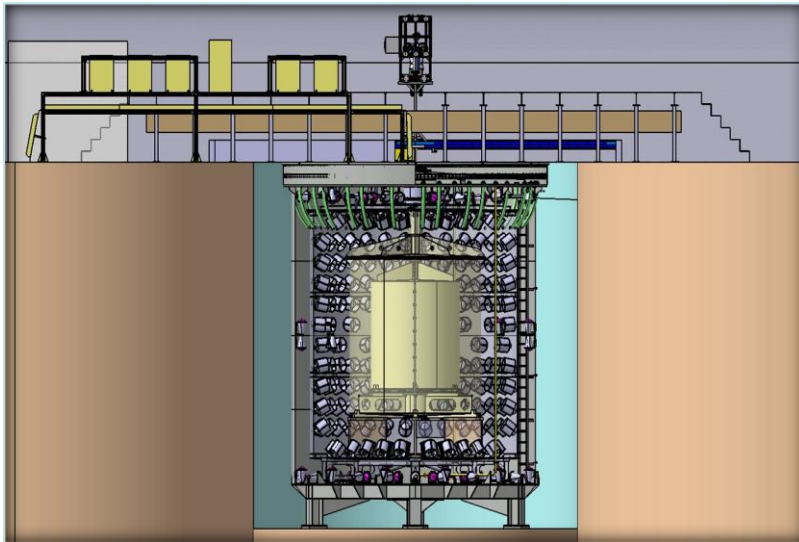
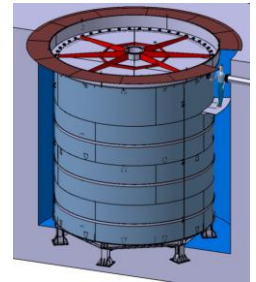


# Mechanics Department: Double Chooz

## Far Detector: Design, production and installation (2011)

### Near Detector: Design, production and installation (2012-2014)

- ✓ Shielding: 1m water (except steel on top)
- ✓ Stainless steel tank on steel supports (outer vessel)
- ✓ Support stiffness strengthened to prevent any deflection  $> 1\text{mm}$  of the bottom (45 tons thrust load)
- ✓ Upper shielding (steel), platform and electronic hut





# Mechanics Department: SVOM

**French-Chinese Space Mission for detection of X and gamma bursts with a 4 keV threshold**

**APC workpackage: Design, production, test and validation of the coded mask for the ECLAIRs instrument:**

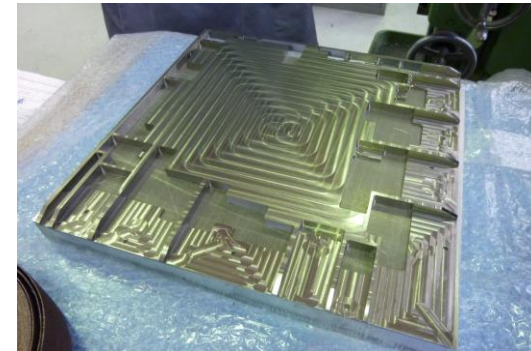
- ✓ Pattern area  $540 \times 540 \text{ mm}^2$ , 40% transparency, self-supporting mask

Initial design : pre-tensed foil made of allied Tantalum 0.6mm thick (4000 random holes)

**CNES review (B phase) : September 2016**

**Currently: Phase C**

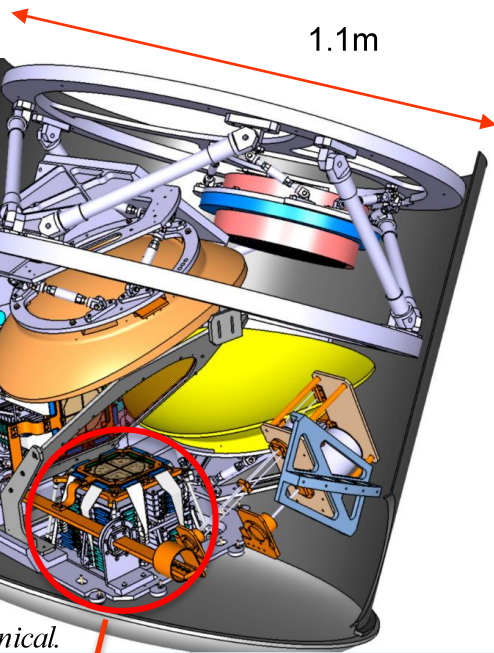
Current design: new pattern with enlarged holes  
→ sandwich Ti/Ta/Ti 33.6mm thick



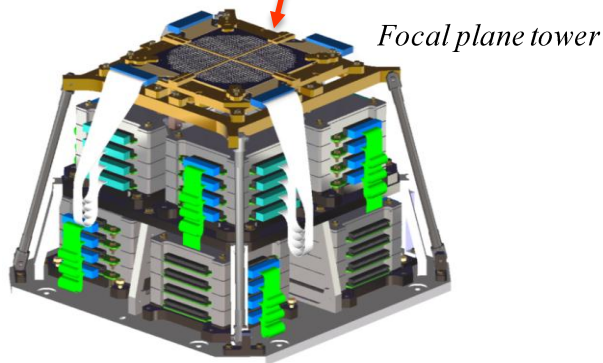
- ✓ Production of SM for further vibration test: End 2017
- ✓ Structural Thermo Model delivery : May 2018
- ✓ FM Mask: 2019
- ✓ Launch : 2021



# Mechanics Department: QUBIC



*Instrument mechanical architecture*



*Focal plane tower*

## APC mechanics workpackages :

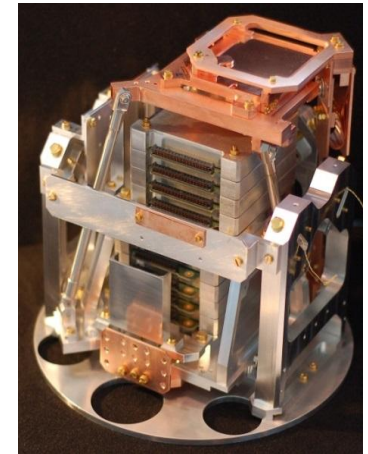
- ✓ Thermal & mech. design of focal plane towers
- ✓ Therm. & mech. design of the instrument architecture inside vessel
- ✓ Mech. design of the switches / R&D on horns manufacturing
- ✓ Integration process of instrument inside vessel and tests

## Technical challenges

- ✓ Mass optimization
- ✓ Keeping optics alignment when instrument is cooled
- ✓ EMC optimization
- ✓ Many interfaces
- ✓ Integration

## Milestones:

- ✓ Technical Demonstrator design finalized
- ✓ Production plan finalized
- ✓ Production: laboratories for small components (GEPI, LAL, APC), subcontracting for the biggest



*1/4 Focal plane prototype*

## **Contributions:**

- **Microelectronics**
- **Instrumentation**





# IT Department : Organisation

## Networks & systems

### administration:

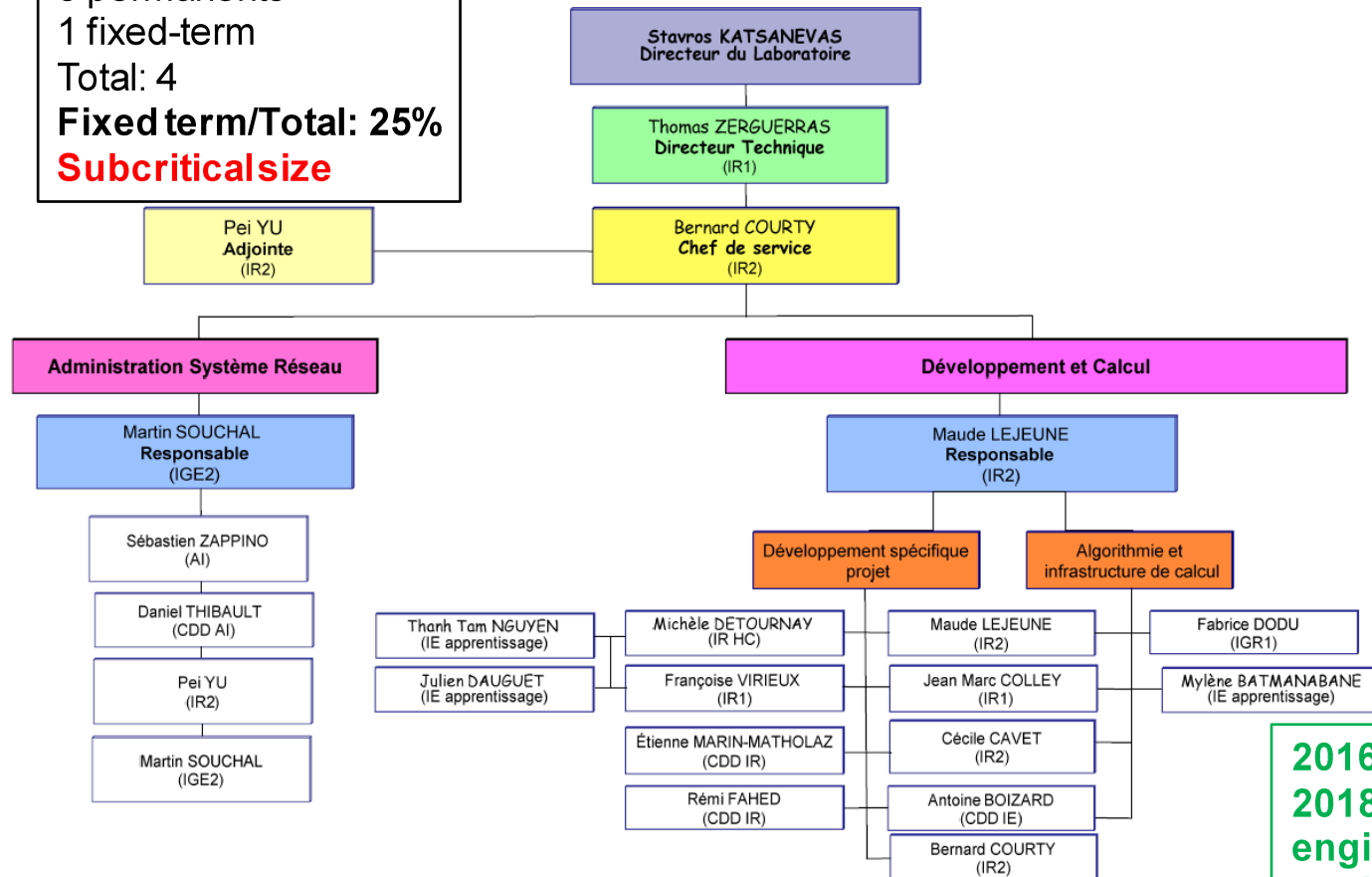
3 permanents

1 fixed-term

Total: 4

**Fixed term/Total: 25%**

**Subcriticalsize**



## 2 subdepartments:

- ✓ Networks and systems administration
- ✓ Development and calculation

## Development & calculation:

7 permanent

3 fixed-term +

3 apprentice

**IR with PhD: 3**

**Total: 13**

**(FT+Appr.)/Total: 46%**

**High ratio of non-permanent members of staff**

**2016: 1 permanent IR hired**  
**2018: Opening of a software engineering IR permanent position (LSST, LISA)**



# IT Department: Skills

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- ✓ **Network & System Administration** : network, storage, Unix account, databases, identification system
- ✓ **Support: material (hard & soft) and users**
- ✓ **APC Website management** (Drupal)
  
- ✓ **Infrastructures for calculation and projects:** parallel calculation cluster (~ 800 CPU), APC cluster (~ 600 CPU), **collaborative platforms**, EGEE grid, **cloud computing (OpenStack) and Big-Data (Hadoop cluster)**
  
- ✓ **Control & command, real-time:** architecture of distributed applications, control and monitoring of mechanical components (motor, presence detector, lock ...), data acquisition (PXI and USB bus), multi-threading and multi-processing architecture
  
- ✓ **Data analysis:** data analysis chain development (ex: CMB cards), parallel and distributed programming in shared distributed memory
  
- ✓ **Simulations:** processes in astrophysics (plasma jets from black holes, accretion disk), HPC, instrumental data (ex: EUCLID telescope)



# IT Department: CTA PHP

**Generalities** : a web interface to manage proposals for scientific observations

Preparation

Submission

Evaluation

Follow-up

Admin

## Planning

2015- Mid-2016: demonstrator dev. phase

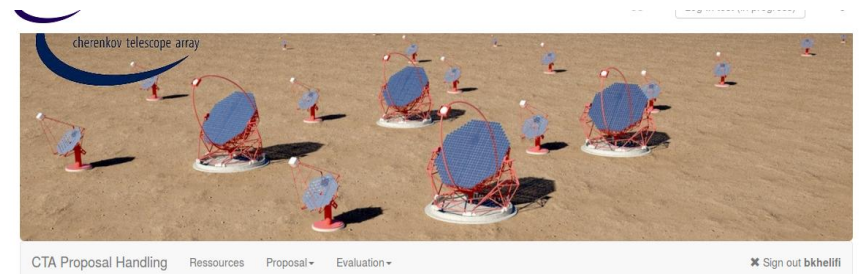
Mid-2016- Mid-2018: Implementation

Mid- 2018: operationnal demonstrator version for the consortium

Mid-2020: First release to the observatory

## Technical Team

- Developper engineer: TT. Nguyen, J J. Dauguet
- Project manager: M. Detournay



### The Cherenkov Telescope Array (CTA)



[www.cta-observatory.org](http://www.cta-observatory.org)

The CTA project is an initiative to build the next generation ground-based very high energy gamma-ray instrument. It will serve as an open observatory to a wide astrophysics community and will provide a deep insight into the non-thermal high-energy universe.

### CTA VO Access

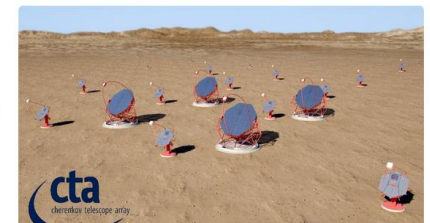
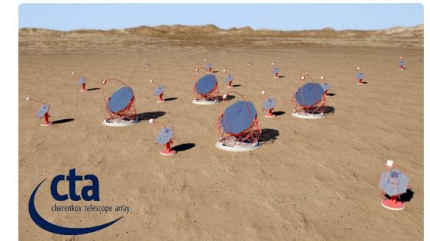


The work necessary to the provision of data via the Virtual Observatory (VO), a requirement for CTA, is coordinated by the LUTH/Observatoire de Paris. In this context, we developed a prototype that allows a user to access CTA data using VO tools, standards and protocols, and provides the ability to analyze the data online.

### CTA Proposal Handling Platform

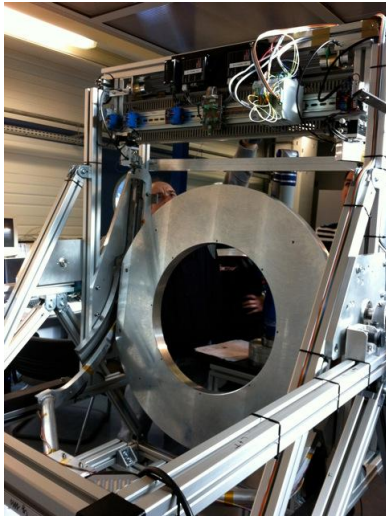
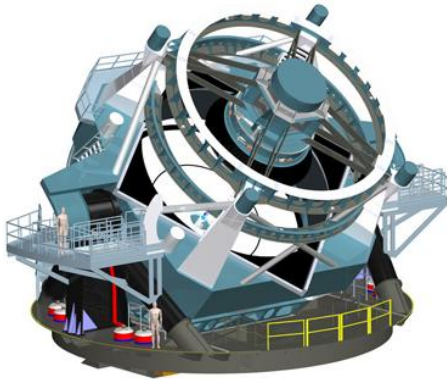


The work necessary to the management of the GO proposals, a requirement for CTA, is coordinated by the APC/CNRS-Universite Paris Diderot. We are developing a demonstrator to develop and test the main technical aspects of the Proposal Handling Platform.





# IT Department: LSST



- ✓ **JAVA development framework for the CCS camera:**  
Monitoring and managing communications between subsystems (filters change, shutter, cooling, power supply management) and information flux between databases.  
**Concept proposed by the APC laboratory and selected by the collaboration**
- ✓ **FCS subsystem (filter changer) Control/Command: 6 filters**  
(motion control, exchange, positioning).  
**Critical (1 filter = 700k€)**
- **Successful reviews: Director NSF-DOE JSR (2016), RSP IN2P3 (2017), FCS MRR (2017)**
- **Scale 1 prototype under construction @ LPSC, CPPM and LPNHE**

F. Virieux (PM), E. Marin-Matholaz



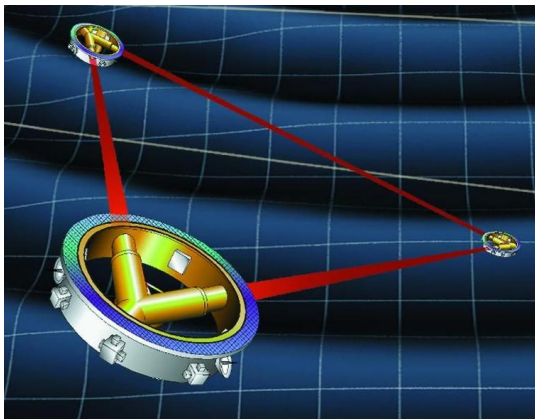
# IT Department: DPC LISA

## France in charge of the Data Processing Centre (DPC) :

- ✓ CNES phase 0 : load peaks management  
=> hybrid cluster (continuous load) / cloud (peak) system.
- ✓ R&T CNES/ATOS : Docker containerization of applications

**Objective:** provide hardware and software tools to the consortium to host and process LISA data analysis.

**Context:** APC + CNES leadership, relatively small data volume (1Tb/year) but some processing tasks are CPU demanding



- > use distributed/on-demand CPU (~ 5000 cores/center, ~ 3 centers, including the main French center)
- > develop luggable tools and services (virtualization, containers)

**Ongoing activities:** 1) APC provides the proto-DPC (continuous Integration) + (due to end 2017) proto-database expected for the next data challenge.

2) CNES, APC and the LISA consortium write the definition document and specify workpackages.

M. Le Jeune, C. Cavet, E. Marin-Matholaz, M. Batmanabane

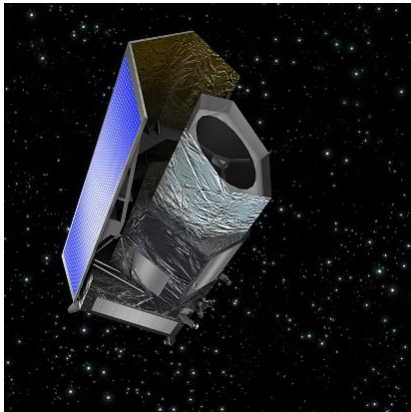




# IT Department: EUCLID

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- **Ground Segment : phase C2**
  - CODEEN :
    - Continuous integration platform for software development
    - Administration and user support, migration on the OpenStack@CC-IN2P3 cloud in 2017
  - EXT/SIM :
    - Ground observatories data integration
    - Development of simulator and data analysis pipeline (démarrage EXT-generic starts in 2017, EXT-LSST in 2018 if Euclid/LSST agreement)
  - SDC France scientific coordination (CC-IN2P3) :
    - Interface between the IN2P3 et the EUCLID project
    - Production infrastructure sizing and ressources allocation



C. Cavet (PM), A. Boizard, J.M. Colley, M. Detournay, R. Fahed, M. Le Jeune, M. Souchal
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## Map-making for CMB data analysis

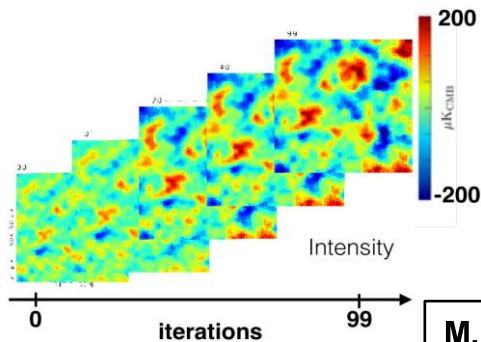
How to keep refined data analysis when data volume is exploding ?

Number of detectors :

Polarbear I: 1200 -> Polarbear II: 7500  
-> SIMONS array (2018): 22000

Size =  $n_t (10^9) \times n_{pix} (10^7)$

**Unbiased mapmaking (iterative)** to get full map recovery at optimized CPU cost

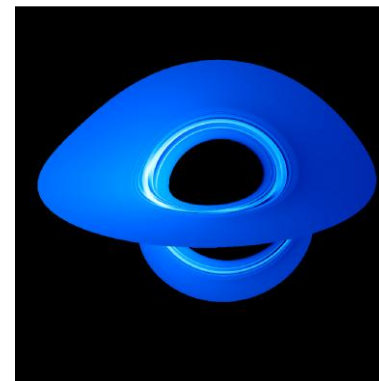


M. Le Jeune

## High Performance Computing

Studies of disk instabilities around black hole accretion disk

- Support : FAcE (7 nodes bought by the HPC project team), CINES
- Scientific library compilation, optimization, installation
- Visualization for very big data : a new challenge



F. Dodu



# Quality Unit: Organization

3 permanent  
1 apprentice

IR with PhD: 1

Total: 4 +  
1 ext. consultant

**CQAP**  
**Corinne JUFFROY (IR1)**  
**Quality Manager**

Management  
Quality Project  
*CNRS Quality in Research Network Steering  
Committee*  
*IN2P3 and INSU Quality Networks*

**Stéphane COLONGES (IR2)**  
**Product Assurance**

**Electronics  
Product  
Assurance**

*Valorisation Deputy  
GTR FIDES  
CNRSElectronics Network*

**Catherine HUGON (IE2)**  
**Information Systems**

**Information  
Systems**

*Training Deputy  
Démocratie Network*

**Sébastien GAUCHERY**  
**Apprentice Engineer**

**KM3Net**

**Ghania MEDJDOUB**  
**Nexeya Consulting**  
**Product Assurance**

**TARANIS**

**2012: 1 no-replaced IR departure**

**Multi-projects and transverse activities for the laboratory**



# Quality Unit:Skills

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## **Quality Assurance Support:**

- ✓ Setting up quality and management procedures to continuously improve scientist instruments produced by the laboratory
- ✓ Includes:
  - ✓ Documentation management
  - ✓ Non-conformities management
  - ✓ Traceability process implementation
  - ✓ Control of assembly operations

## **Electronics Product Assurance:**

- ✓ Components qualification for commercial products or specific ASICs : Radhard qualification process, studies of reliability and ITAR process for space electronics components

## **Information and indicators management:**

- ✓ Electronics documentation management
- ✓ Scientific bibliography
- ✓ Database studies and development for laboratory management



# Quality Unit: Involvement in projects

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## **TARANIS**

Quality Project + Electronic Product Assurance (the whole project)  
Quality AIT/AIV

## **CTA / NectarCam**

Reliability analysis of the MUTIN circuit Board and clock distribution.  
RAMS activities for NectarCam : (RAMS = Reliability Availability  
Maintenability Safety)

## **KM3NeT**

Reliability analysis of DOM (Digital Optic Module) and other subsystems

## **EUCLID**

NISP sensor RadHard test campaigns for EUCLID focal plan

## **SVOM**

Quality Project Documentation

## **ATHENA**

Quality Project + RADHARD Qualification





# Quality Unit: Achievements

## Indicators Database Human Resources:

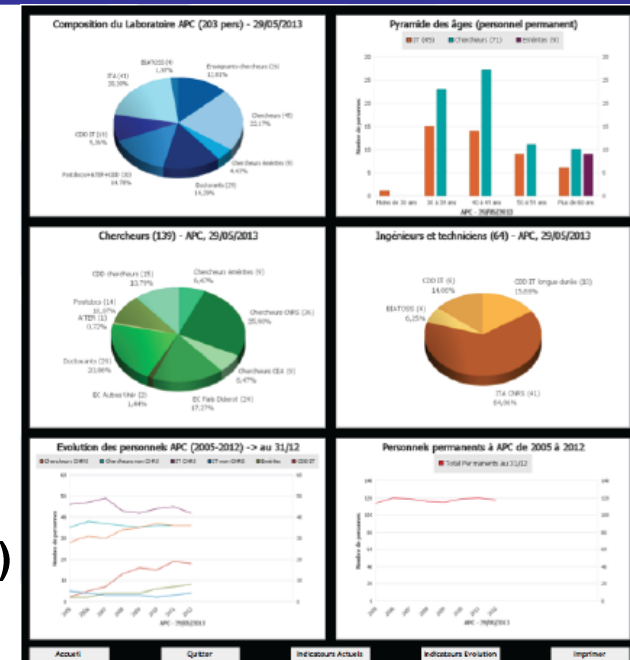
- ✓ Information on Human Resources of the laboratory for tutelage agencies, scientific and evaluation committees

## Project resources database:

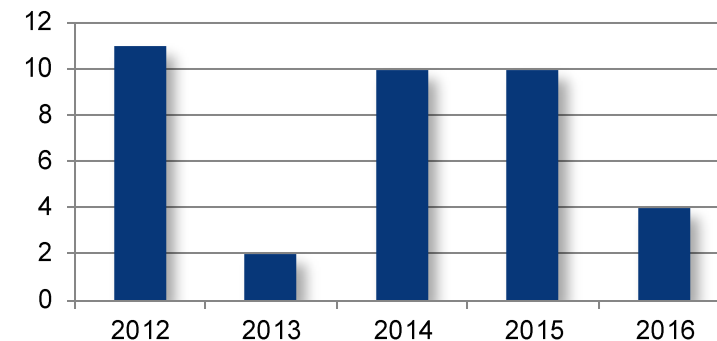
- ✓ Overview on human resources assigned to each project for a better visibility
- ✓ Production of indicators (statistics, charts, graphics)

## Documentation:

- ✓ Provision of documentation templates for projects
- ✓ Provision of an on-line documentation system (ATRIUM) for centralisation and storage
- ✓ Assistance to project reviews (CSP) organisation and reports management



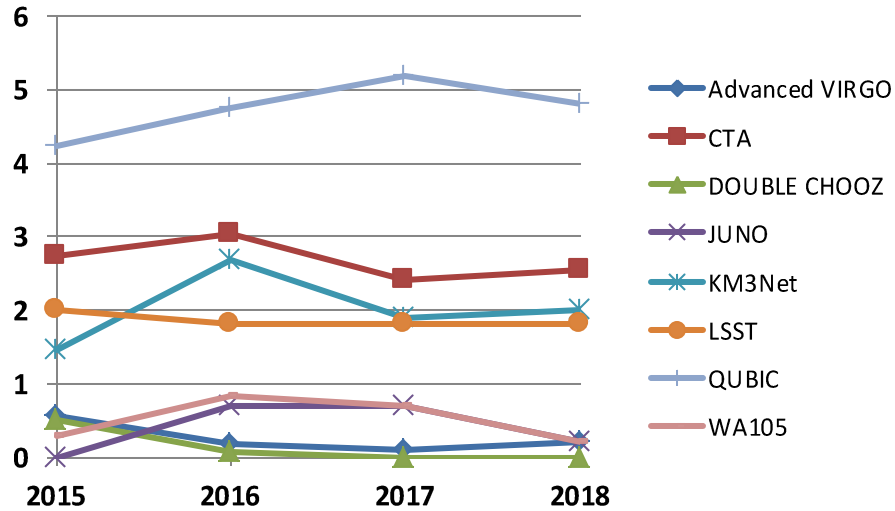
## 2012-2016: 37 internal reviews



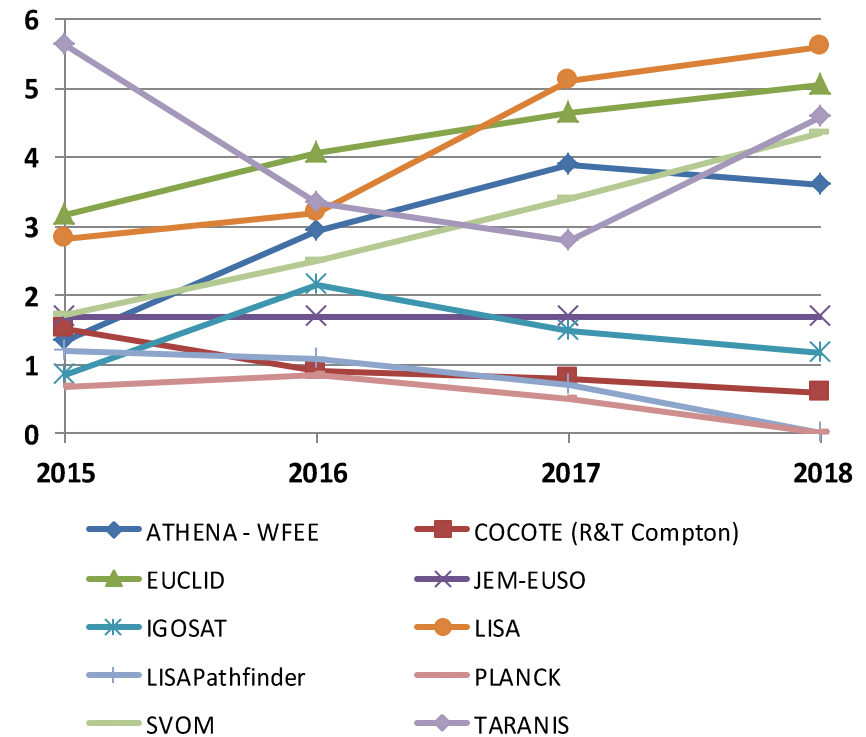


# Analysis & Prospects: Technical FTE

## On-ground and under-sea projects



## Space projects





# Analysis and prospects: Projects roadmap

	Preparation
	Construction
	Exploitation
	End

Projects	2016	2017	2018	2019	2020	2021
Advanced VIRGO - Telescopes						
ATHENA - WFEE						
CTA - TiCKS						
CTA - NECTARCAM- RAMS						
CTA -GATE						
CTA-PHP						
COCOTE (R&T Compton)						
DOUBLE CHOOZ						
EUCLID-CODEEN						
EUCLID-EXT						
EUCLID-NISP Rad Hard						
EUCLID-SIMULATIONS						
mini-EUSO (ISS)						
EUSO-SPB						
EUSO-SPB 2						
IGOSAT						
JUNO - Electronics						
KM3Net - Calibration Unit						
LISA AIT/AIV						
LISA-DPC						
LISAPathfinder						
LSST - CCS et FCS software						
PLANCK						
QUBIC- Demonstrator						
QUBIC-FI						
SVOM- ECLAIR coded mask						
SVOM- Pipeline						
TARANIS - XGRE						
WA105 – Electronics						

R&D Gammacube stopped in 2016



# Analysis & Prospects: SWOT Analysis

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• <b>Specific skills:</b> optics, photodetection, cryogenic <math>\mu</math>electronic, space AIT/AIV (mechanics &amp; instrumentation), QA/PA, virtualization and cloud</li> <li>• <b>Skills in space and balloons projects management</b></li> <li>• <b>Recognition as a key actor in space projects by the CNES</b></li> <li>• <b>National and international visibility</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Imbalance between projects needs and available technical HR</b></li> <li>• <b>High turn-over</b></li> <li>• <b>Risk of losing strategic skills</b> (fixed-term contract, mobility, retirement ...)</li> <li>• <b>Some permanent members of staff are the only ones with their skills</b> (ex: optics, AIT/AIV, electronics PA, mechanics workshop technician)</li> <li>• <b>Strong commitment in projects limits involvement in generic R&amp;D and general technologic surveys</b></li> <li>• <b>Logistics support reduced</b></li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• <b>Space and funding agencies, tutelage organisations, national and international collaborations calls of tender</b></li> <li>• <b>Long-term projects:</b> EUCLID, CTA, KM3NeT, LSST, QUBIC, LISA, ATHENA ...</li> <li>• <b>Multi-messenger astronomy rising</b></li> </ul>	<ul style="list-style-type: none"> <li>• <b>Financial cut from funding agencies and partners</b></li> <li>• <b>Time-consuming non-technical tasks increasing</b> (ex: management, institutionnal consultancy, funding applications ...)</li> <li>• <b>Specific skills difficult to find on the labor market</b></li> <li>• <b>Unfavorable change in tutelage agencies hiring policy</b></li> <li>• <b>More and more restrictive administrative regulating</b> (ex: Sauvadet, GBCP)</li> </ul>





# A view for the future ...

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## **Technologies and skills:**

- ASICs for CMB instruments
- Optics for on-ground and space GW detectors
- Mechanical design and calculations in various environments (space, cryogeny, vacuum ...)
- AIT/AIV (on-ground, balloon and space projects)
- Timing and clock distribution system (White Rabbit and beyond ...)
- Electronics readout for photodetection (partnership with the Omega Pole)
- QA/PA (in particular Electronics PA)
- Cloud and Big Data
- Collaborative platforms for space projects
- HPC and simulations (instruments, astrophysics ...)

## **Long-term challenging technical projects in the frame of the Multi-Messenger Astronomy:**

- Cosmo: EUCLID, LSST, QUBIC (demonstrator, FI ?), S4 (?), Litebird (?)
- AHE: ATHENA, CTA, EUSO (?), SVOM
- Neutrinos: KM3NeT, JUNO (?), WA105/DUNE (?)
- Gravitation: AdvVIRGO and +, LISA

**Lead a continuous effort to reach a balance between the technical workforce and the scientific roadmap**

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Thank you for your attention !