

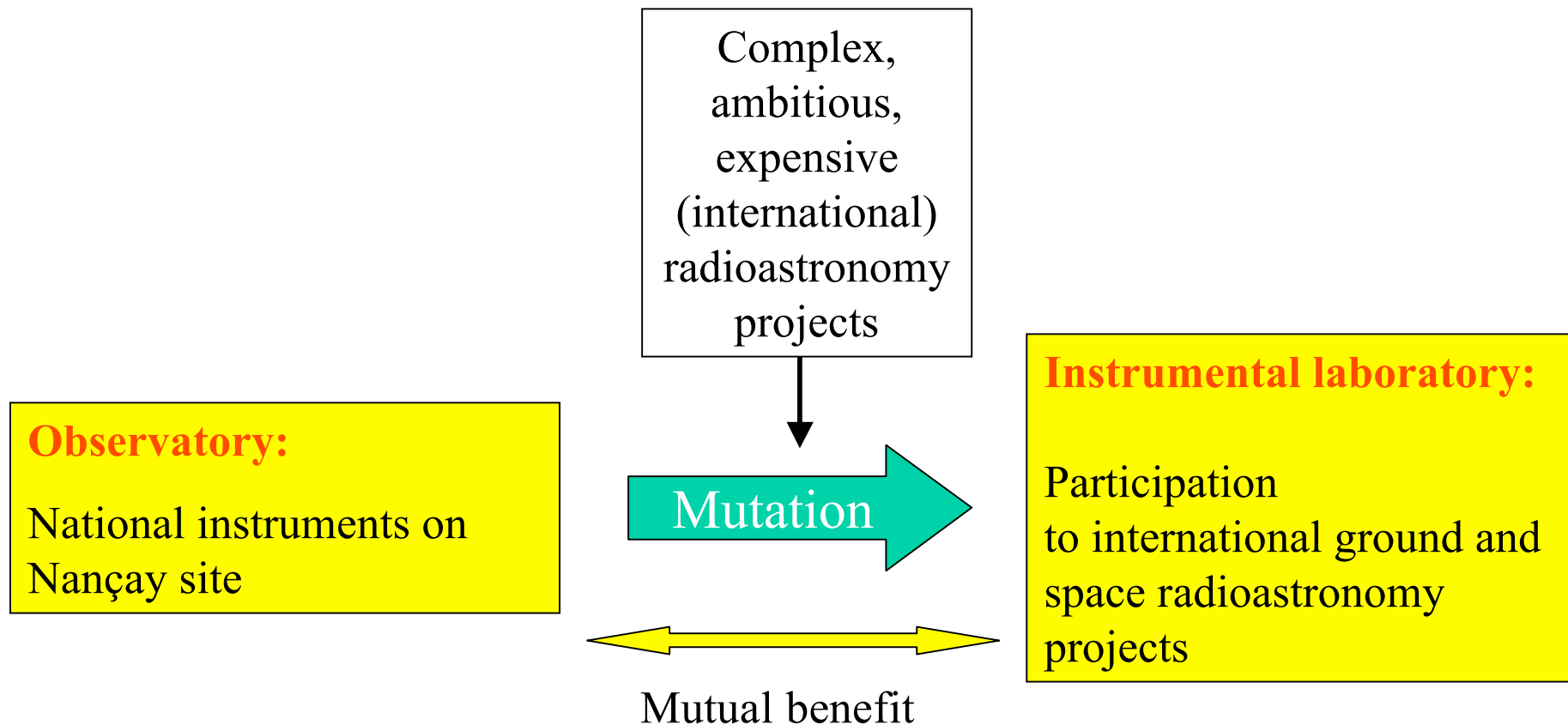
## Unité Scientifique de l'Observatoire de Paris

### Unité de Service et de Recherche associée au CNRS n° B704

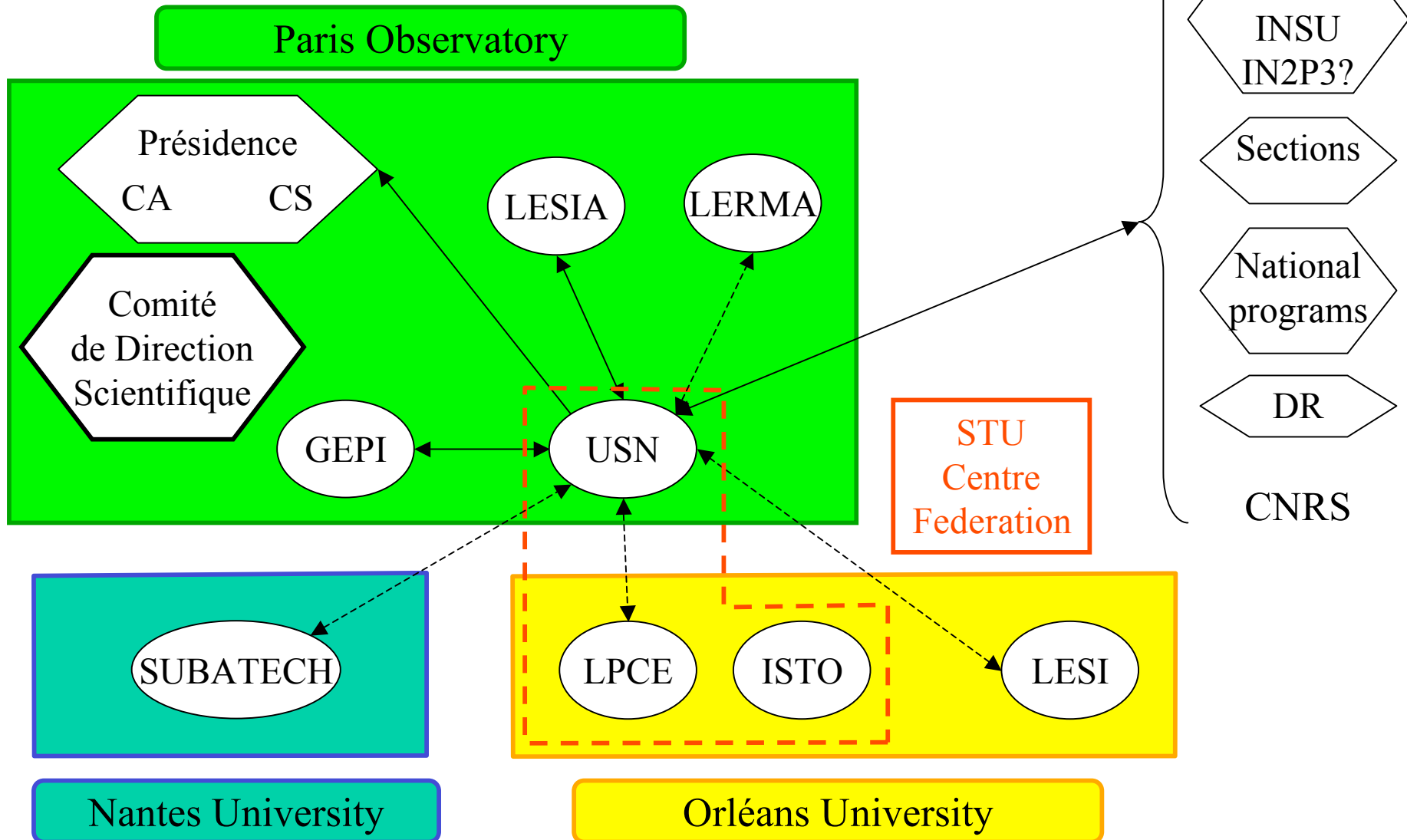
About 45 engineers and technicians (MEN and CNRS)

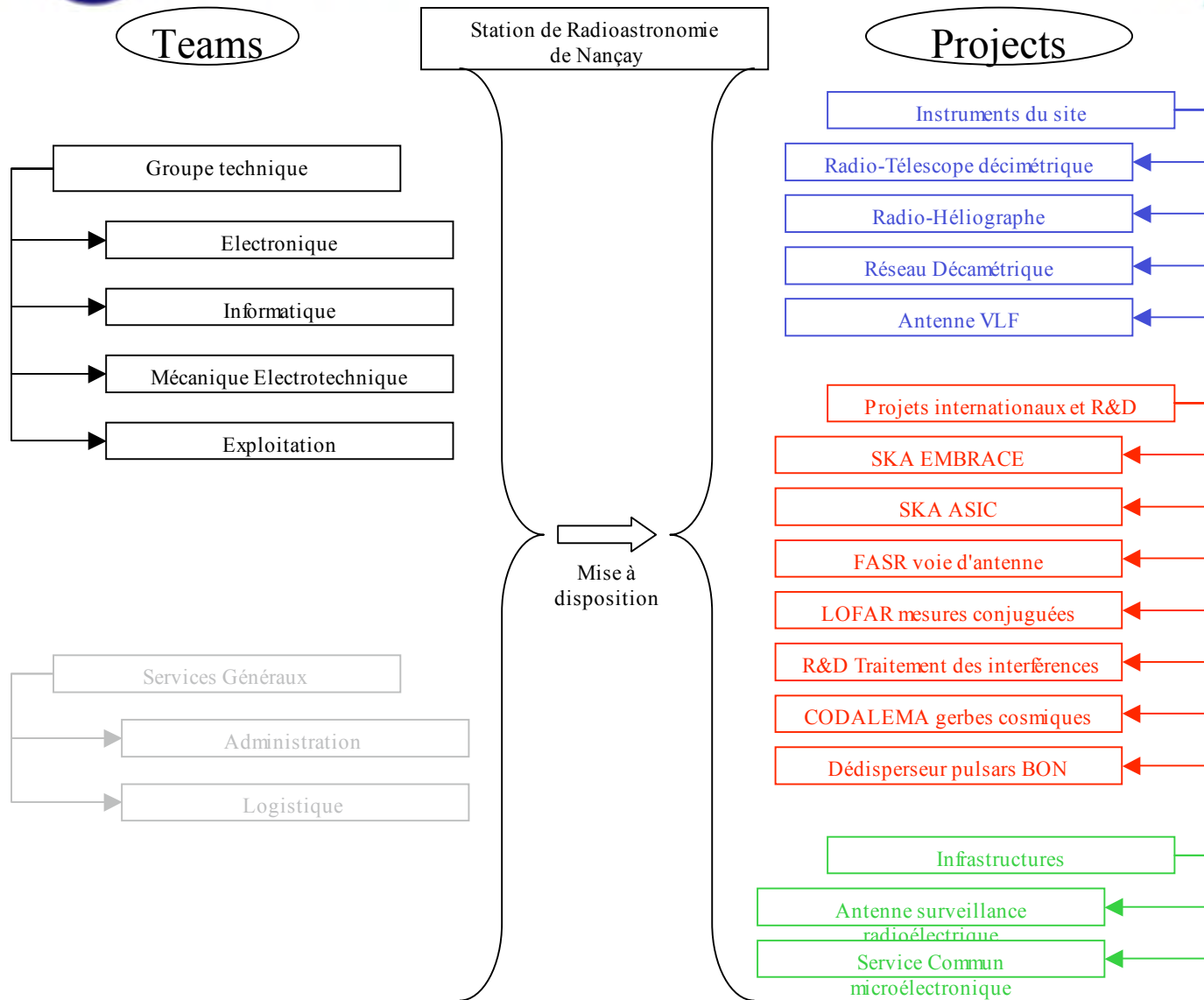
Cooperation with scientific teams from Paris Observatory (Meudon)  
and University of Orléans  
(about 30 scientists)

## Scientific context



## Relations with authorities and partners





# Teams and projects

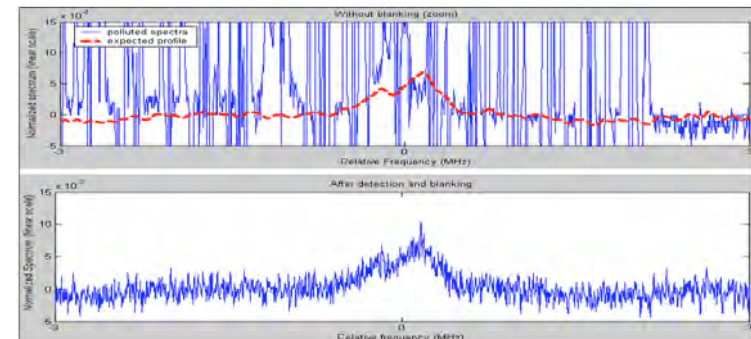
# Priority 1

Instrumental laboratory

R&D and international projects

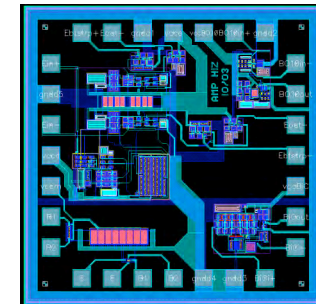
## R&D RFI mitigation

- RFI robust receivers:
  - High dynamic range
  - Algorithms for RFI detection and elimination
- 2001: «Reconquête» receiver, INSU support since 2003
- Applications:
  - International radioastronomy projects (FASR, LOFAR, SKA)
  - Nançay instruments (test bench)
- Cooperation:
  - LESI (Orléans): 2 PhD
  - GEPI, LESIA, LPCE
  - European partners (SKADS)



## R&D « front end » ASICs

- **Functions:** amplification, filtering, beamforming
- Interest for future projects (large numbers of antennas):  
**reliability, cost**
- Start in 2003 (CNRS/INSU support), main steps:
  - Comparison between technologies
  - Function optimization on frequency band
  - Function integration (PhD)
- Equipments shared between Nançay and LPCE (space applications)
- Cooperation:
  - **IRCOM** (STIC, Limoges): PhDs, student training
  - **Industry** (Philips semiconductors, Ommic)
  - European partners (**SKADS**, JRA RadioNet FP7?)





# SKA (Square Kilometer Array)

1<sup>st</sup> priority project

Generalist instrument, area 1 km<sup>2</sup>

0.15 – 20 GHz

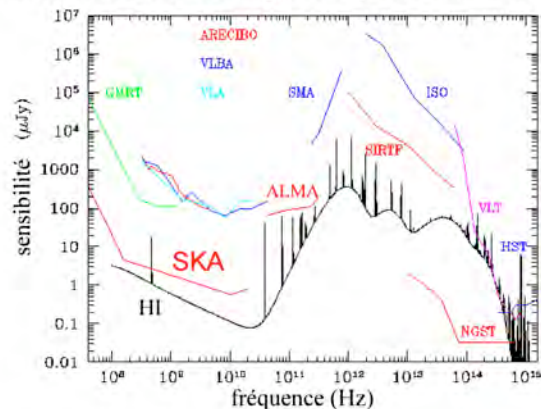
Major project of international radioastronomy for 2015-2020

Complementary with ALMA, LOFAR, ...

HI up to  $z = 5$



détection de raies d'une galaxie spirale 'normale' à  $z=2$



Several concepts in competition

Europe : multi-beam observations

Budget  $\approx$  1 G€



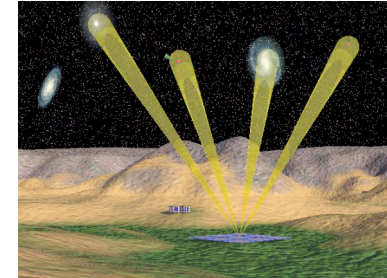
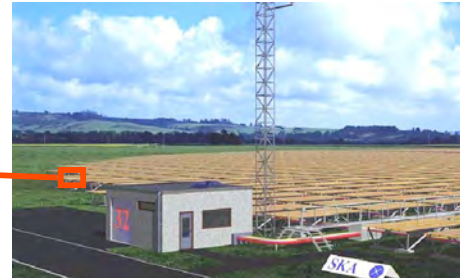
# SKA Design Study



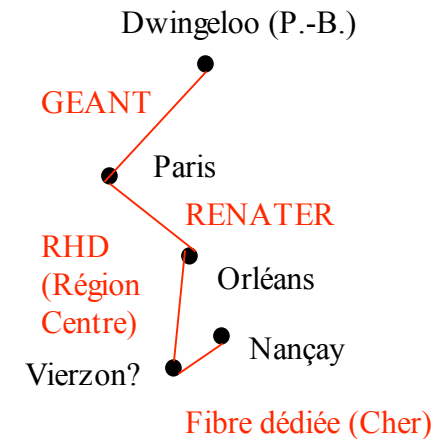
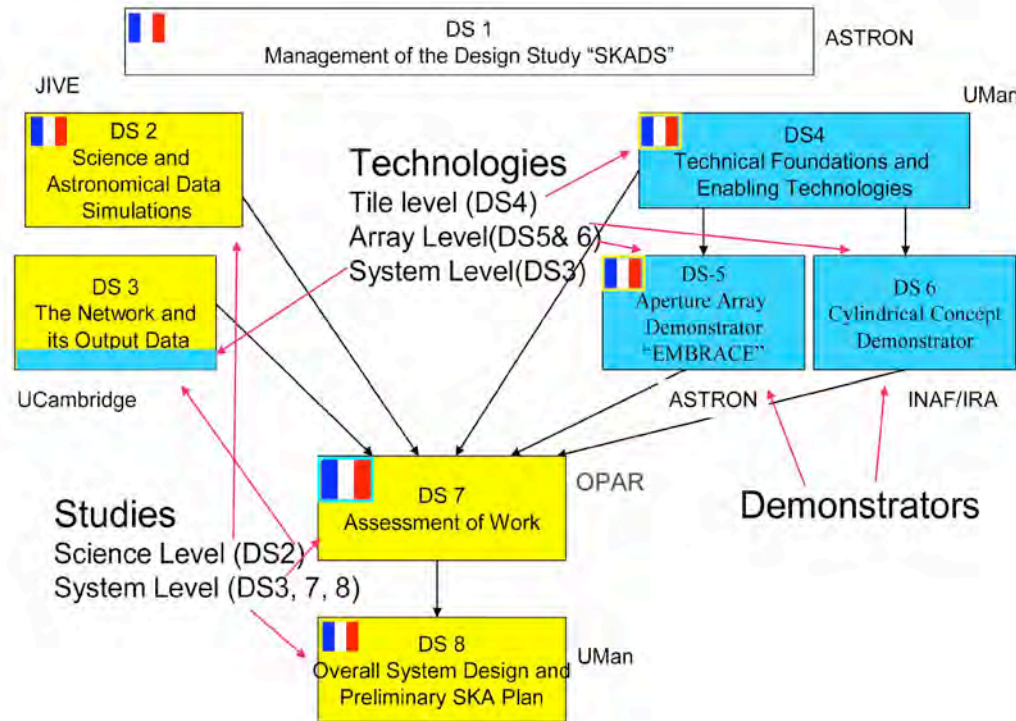
- **FP6 project** : 38 M€ incl. 10.4 M€ EC (incl. 1.8 M€ for France)
- Main objectives:
  - Construction of **EMBRACE**, **demonstrator** of the European aperture array concept for SKA (located in Westerbork and Nançay in 2008)
  - R&D for further progress towards SKA
- EU partners : 32 institutes from 13 countries (NL, UK, **F**, I, ...)

France: Paris Obs., Univ. Orléans, CNRS, OMMIC (Philips)

Activities: scientific simulations (cosmology), **EMBRACE** (**conception, construction, operations**), **R&D** (**ASIC, RFI mitigation**), assessment



# Impact of SKADS in France and Nançay



- Strengthening of Nançay technical pool (international cooperation)
- Scientific preparation of SKA in France
- Manpower  $\approx$  40 % of Nançay engineer resources (5 à 6 FTE/year)
- EU funding, but also MEN (PPF), CNRS/INSU demands ...
- Optical fiber link ( $>$  1 Gbit/s) to Nançay (co-funding by local governments + ...)

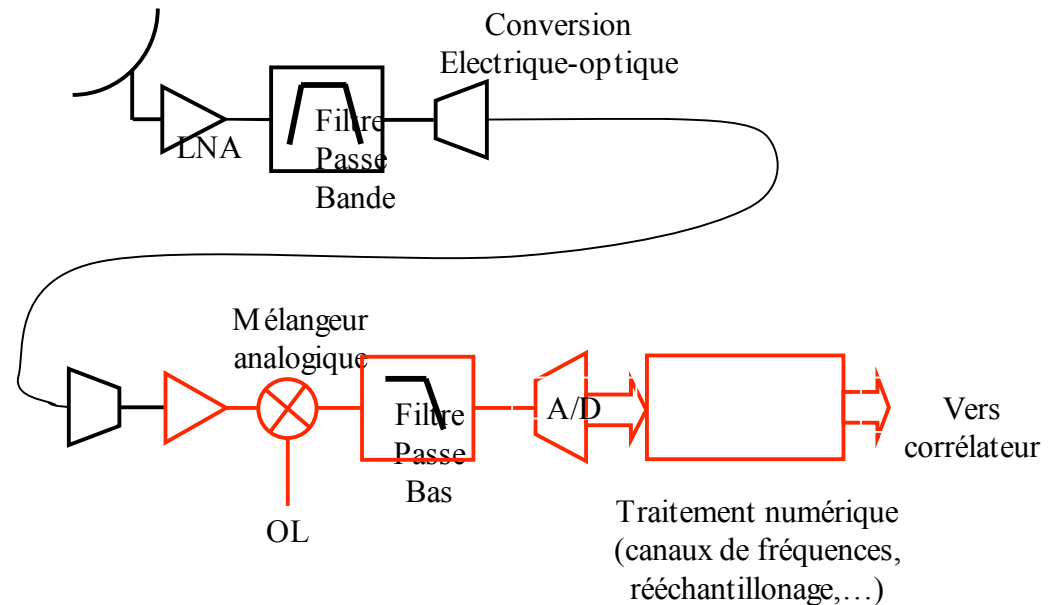
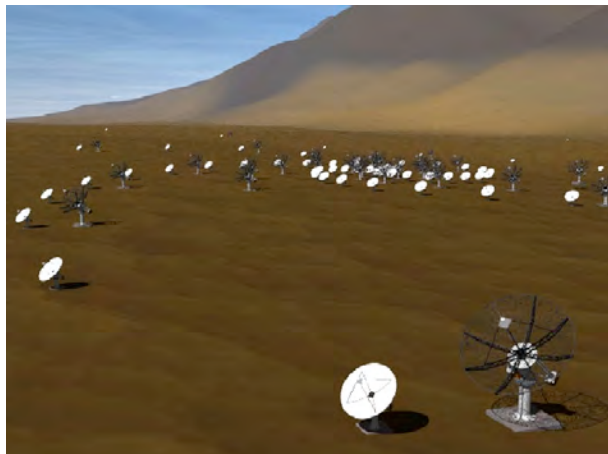
# FASR (Frequency Agile Solar Radiotelescope)

U.S. project

French participation crucial for LF (numerical receiver, support from CNRS/INSU), possible further steps = prototype, RFI mitigation, participation to construction ?

Dedicated to the observation of the solar corona (Sun-Earth relations)

Operational in 2010 ?



## LOFAR (LOW Frequency ARray)

Dutch project (+Sweden, Germany)

10–200 MHz, area 0.1-1 km<sup>2</sup>

Discovery of the « decameter Universe »:

- cosmology/re-ionization
- solar physics
- astroparticles

+ generic concept of captor network:

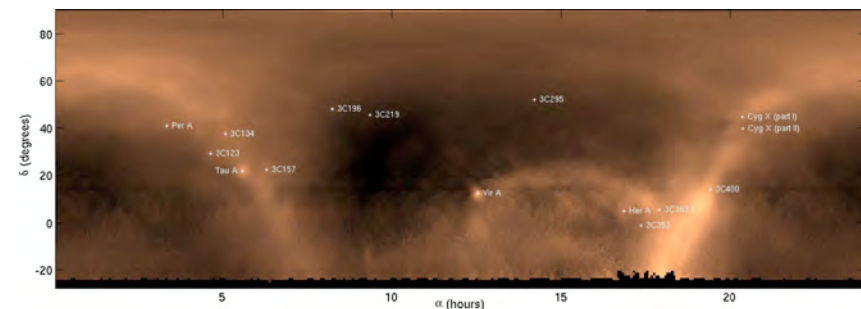
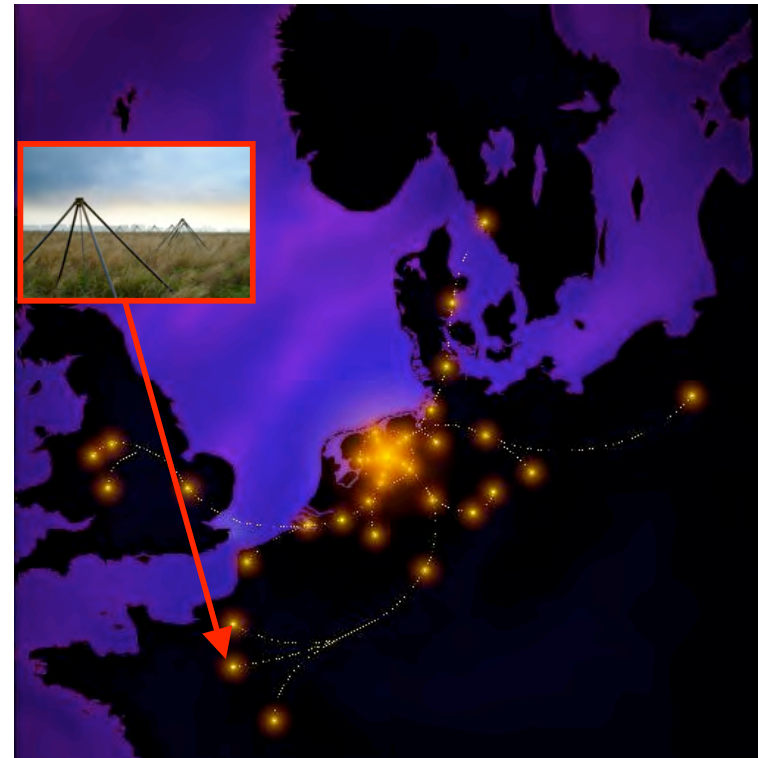
- geophysics (ISTO)

1<sup>st</sup> station ITS since end 2003, « core »

100% operational in 2007-2008

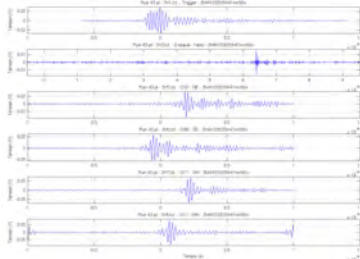
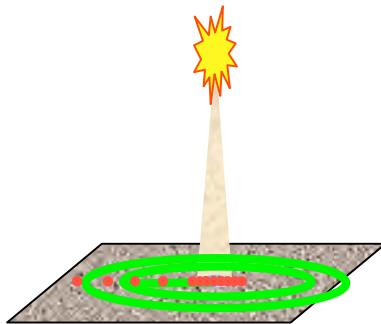
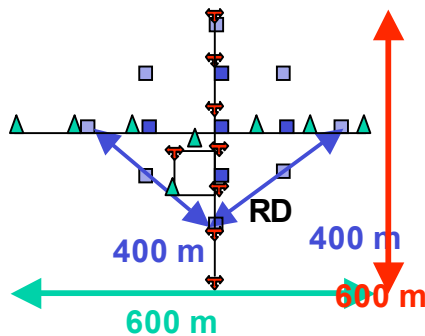
European extension : **role of France?**  
(stations, data treatments, responsibility  
of key programs, ...)

Precursor of SKA European concept





## CODALEMA (radio-detection of air showers)



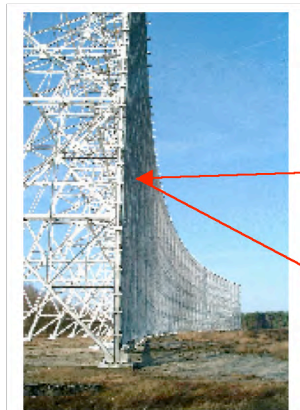
- Idea: high temporal resolution receivers (1 ns), connected to the Nançay Decameter Array
- Start in 2003, CNRS/INSU support in 2004, extension of the instrument (ANR project 500 k€)
- Applications : **astroparticles** (radio-detection of air showers), solar physics, ...
- **Interest of the method** : large volume sampled, access to key parameters of the primary (energy, direction of arrival), low cost
- Cooperation: IN2P3 (Subatech, Nantes)
- **Method validated** (correlation with scintillators), next steps:
  - systematical measurements
  - toward a large instrument (**AUGER, LOFAR**)?

# Priority 2

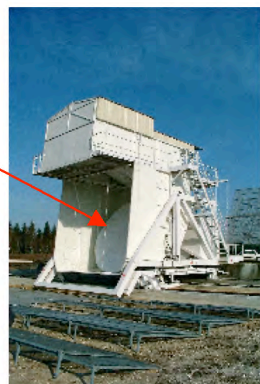
## Observatory

Scientific et technical valorization  
of Nançay instruments

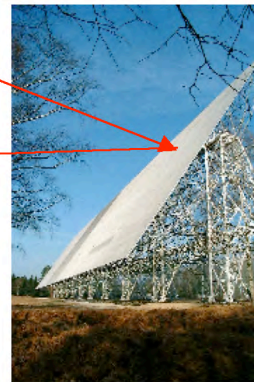
## Decimeter Radiotelescope : presentation of the instrument



miroir fixe



chriot focal



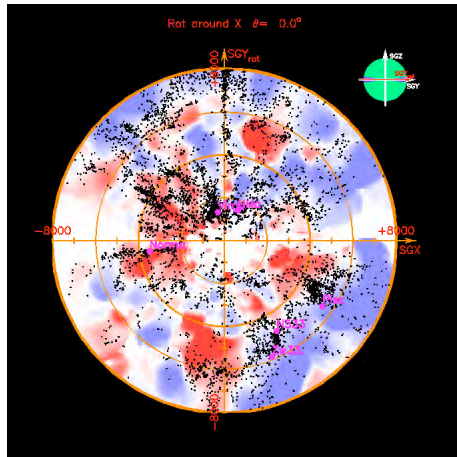
miroir mobile

P C H E ,  
PCMI, PNC,  
PNG, PNP,  
PNPS, PNST

- 1500-3500 MHz (18 et 21 cm lines)
- $\approx$  50% of time demands from **foreign radioastronomers**
- Excellent compromise between **sensitivity** and **sky coverage**
- ideal for **systematic** and **long term** measurements
- « **White paper** » in preparation

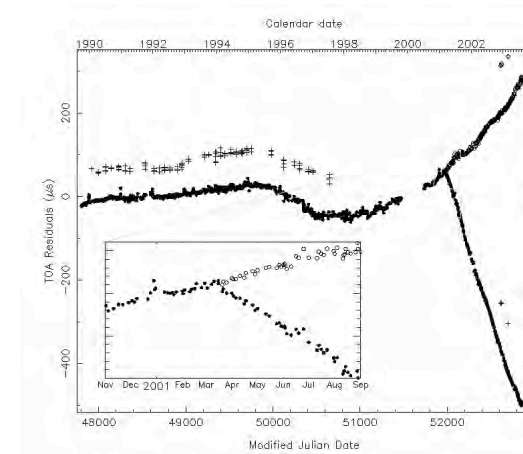
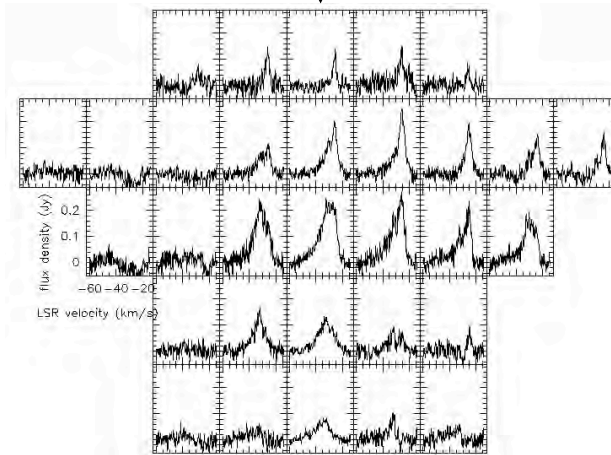


# RT science programs



Dynamics of the Local Universe and large structures

HI envelopes of the AGB giant stars



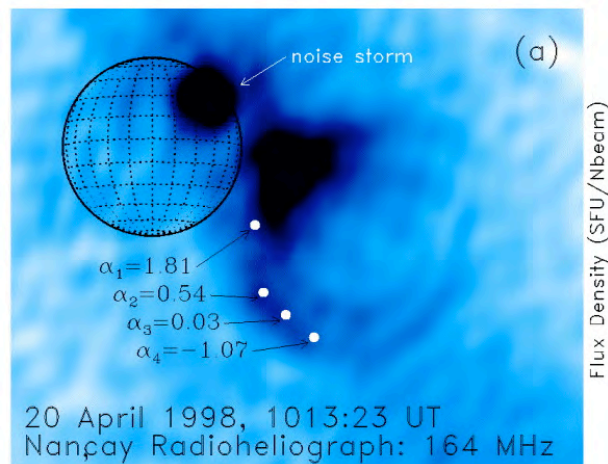
Long term timing of pulsars: « glitches »

ETC ...

# Radio-heliograph

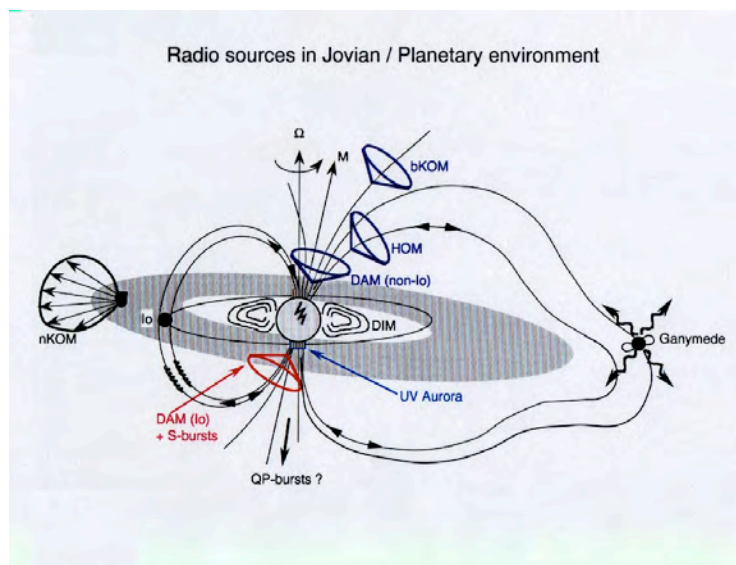


- unique instrument, **interferometer** observing the solar corona between 150 et 450 MHz
- 3 branches (19, 25 et 4 antennas)
- **fast imagery** < 1 s



- **solar physics** et **Sun-Earth** relations
- open data base BASS 2000
- **spatial collaborations** (SOHO, Stereo, ...)

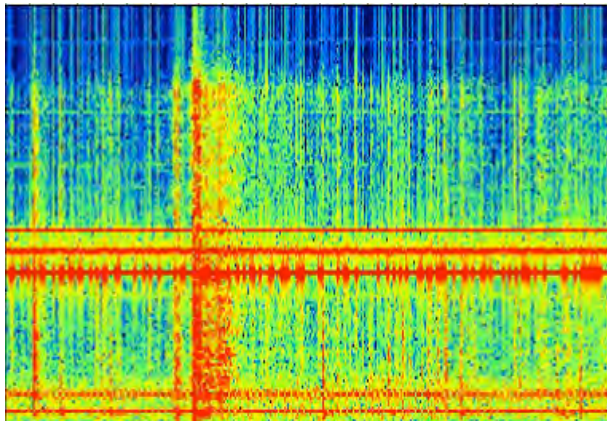
# Decameter array



- phased array, 144 antennas
- total array 10000 m<sup>2</sup>
- high frequency and time (< 1 ms) resolution between 10 and 100 MHz
- **Jupiter** : systematic measurements, polarimetry, fast pulses, **spatial collaborations (Wind, Galileo)**
- **Sun** : upper corona, **spatial collaborations**

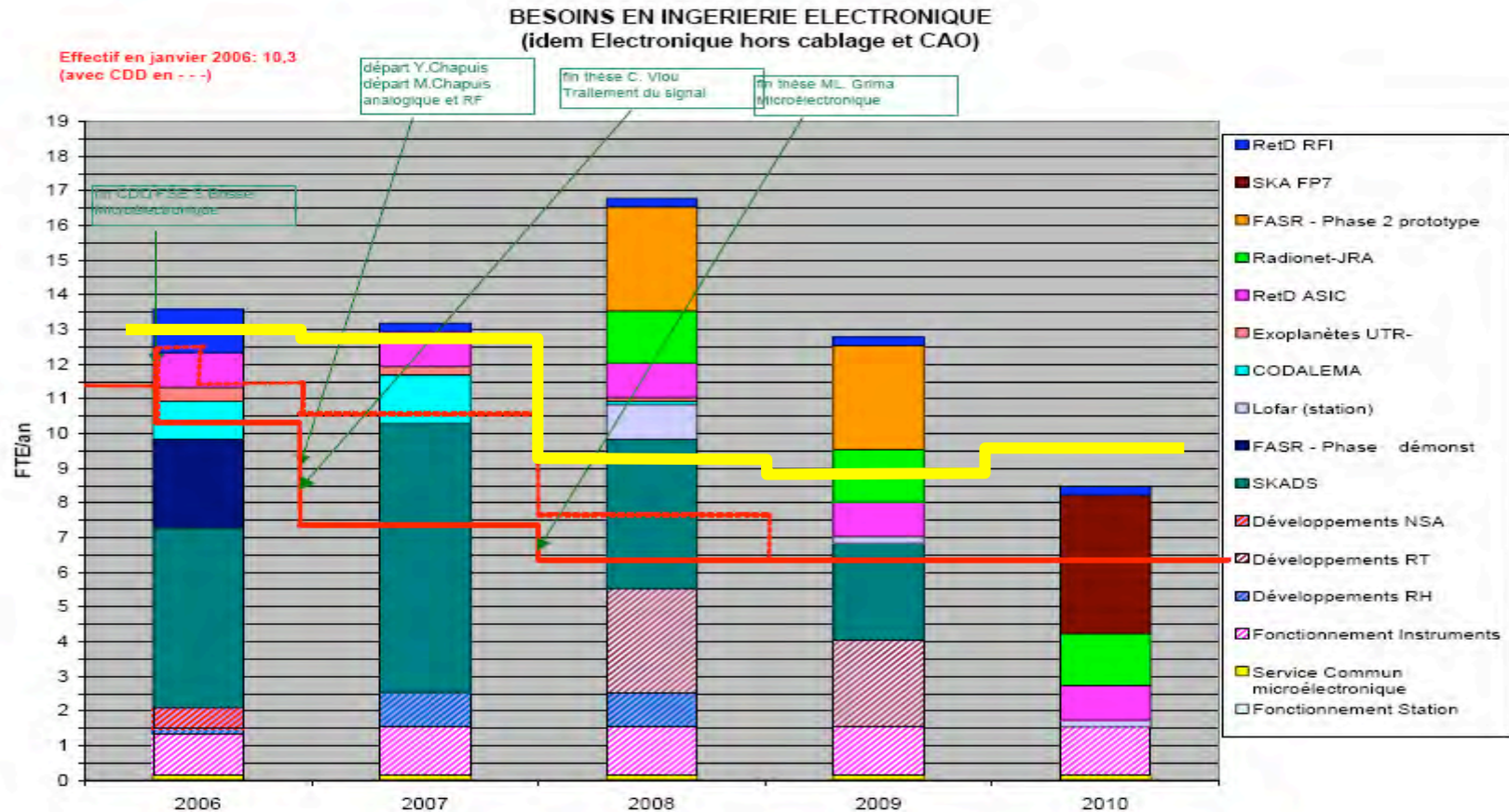


## VLF antenna



- LPCE Orléans instrument located in Nançay
- Systematic measurements of VLF waves (0-50 kHz) of atmospheric and ionospheric origin (**international network**)
- Since 2003: campaigns for « **sprites** » associated emission detection
- **Advantages of Nançay site** : clean radio-electric environment, infrastructures, operational capabilities

Man-power issues



- Difficult situation until 2008: SKA = priority 1
- Priorities and/or choices to be decided this year for 2008 and +
- New positions needed!

# Conclusions

- Major evolution: participation to **international radioastronomy projects**
  - Objective: increase scientific benefit for France
  - Role of Nançay instruments (RT) as test benches
- Need to develop **international cooperations**:
  - FP7 RadioNet
  - LOFAR / astroparticles
  - SKADS follow-on
- Need to develop **regional cooperations**:
  - Science (pulsars) and technical (ASIC and RFI mitigation R&D) collaborations
  - Possible support from local governments
- **New radioastronomer positions** needed (GEPI, LESIA, LPCE, ...)