DÉTECTEURS À INDUCTANCE CINÉTIQUE (KID)

Séminaire COMET

Le 11 octobre 2018

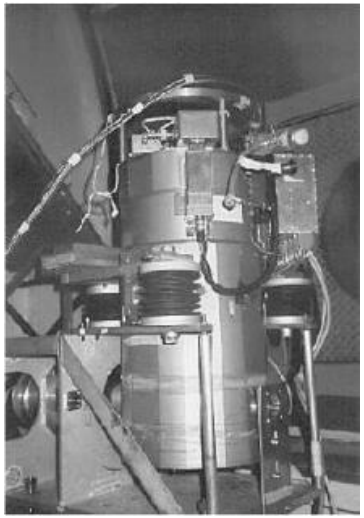
Toulouse (via WebEx)

Contenu

- Collaboration des laboratoires Grenoblois en astrophysique millémétrique
- Conception et production des détecteurs
- Vers une plateforme technologique ouverte…

Labs collaboration in Grenoble

- Millimeter Astrophysics (I.Néel, LPSC, IPAG, IRAM)



IRAM (Bure) – POM2
DIABOLO Instrument
(1994-1997)

Planck – L2
HFI Instrument
(2008-2010)

ARCHEOPS
(1999 - 2002)

IRAM 30M - Spain
NIKA&NIKA2 Instrument
(2010 -)

Teide Observatory
QUIJOTE Telescope/KISS Instrument
(2019 -)

APEX - Chile
CONCERTO Instrument
(2020 -)

Labs collaboration in Grenoble

- Instrumentation in Low Temperature
  - Low noise electronics for LTD
  - Cryogenics (Planck dilution refrigerator, customized DR for milimeter instruments and dark matter search)

- Detectors development
  - NbSi antenna-coupled arrays (Collaboration with CSNSM, Orsay)
  - KIDs arrays

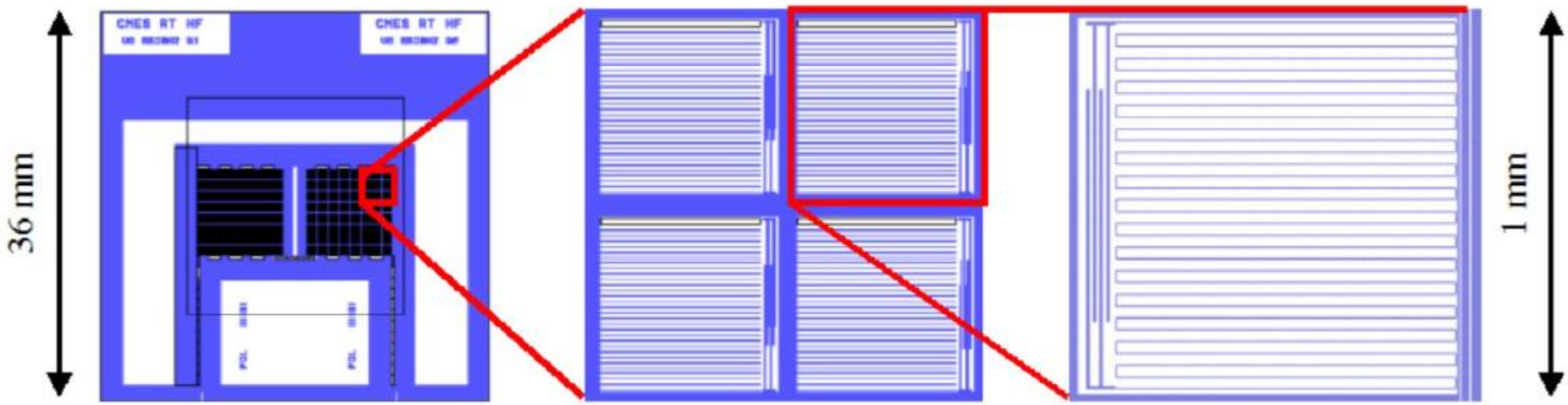
KIDs Arrays Design and Production

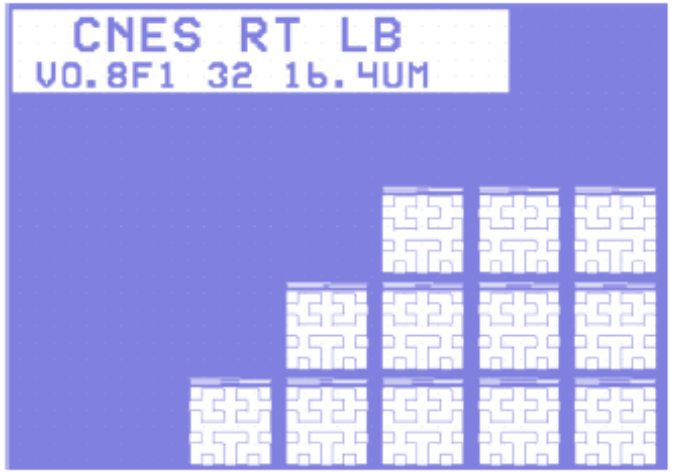
- Motivated by the instrumental needs in millimeter astrophysics
- Production of the NIKA & NIKA2 detection chain (detectors arrays, readout electronics, software) and current projects KISS and CONCERTO
- R&D activity for space applications:
  - Low background
  - Sensitivity to cosmic rays
  - Material optimization (energy gap vrs frequency)

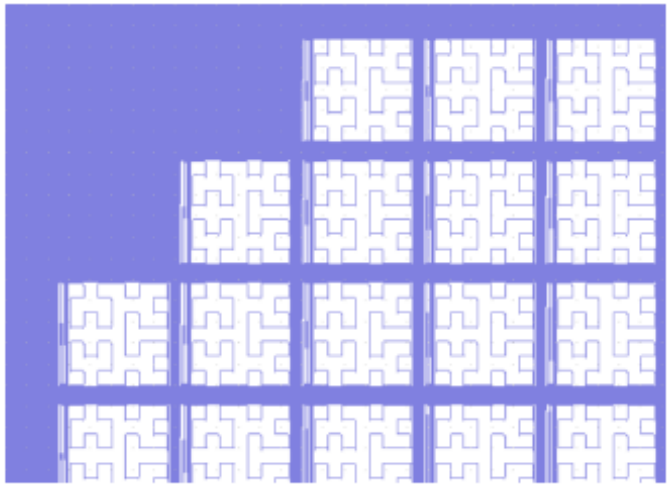
Design options for a LEKID array

- **Resonator geometry** (bandwidth, polarization, resonance frequency, frequency spacing)
- **Material** (Tc adaptation to the frequency)
- **Background adaptation** (coupling factor to the microstrip line)
- **Substrate** (HR Silicon, saphir)
- **Pixel design** (AR coating, backshort, front or back illumination)
- **Packaging** (magnetic shielding)
- **Temperature** (< Tc/10, ~100 mK for Aluminium)

KIDs Arrays Design and Production



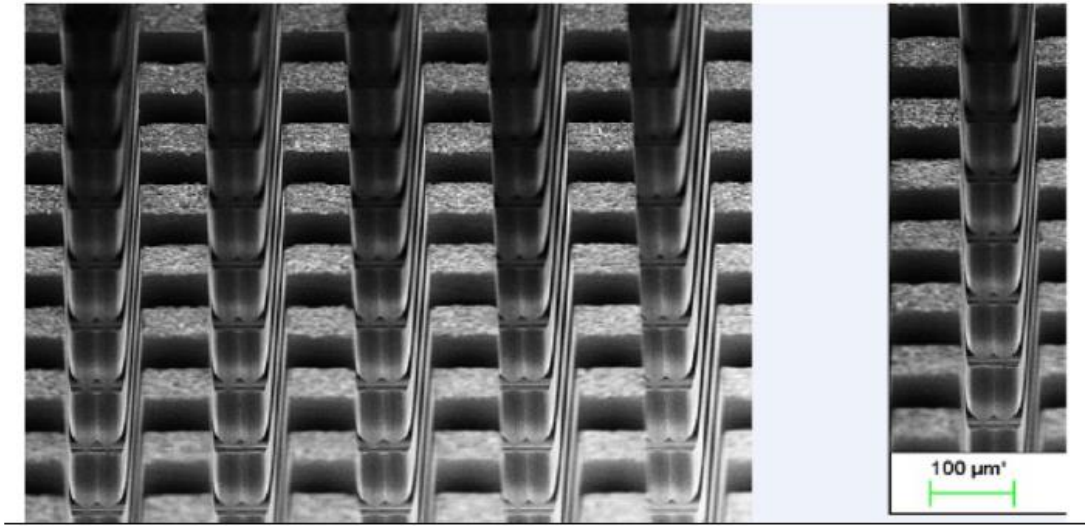


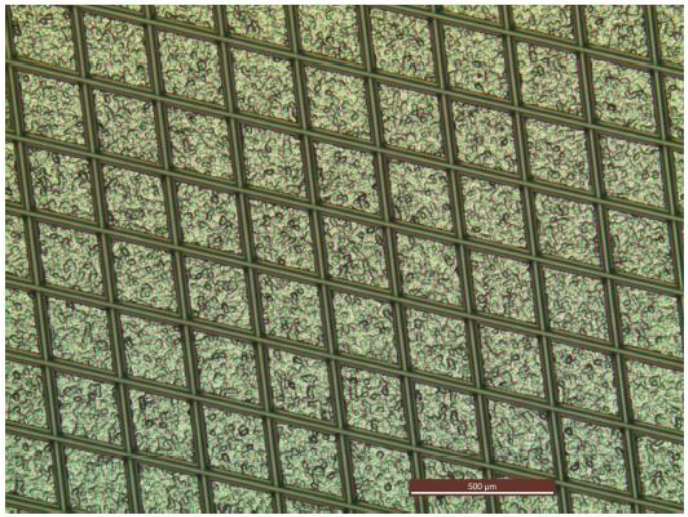


Développements NIKA2, financés par le Labex

FOCUS
Focal Plane Array for Universe Sensing

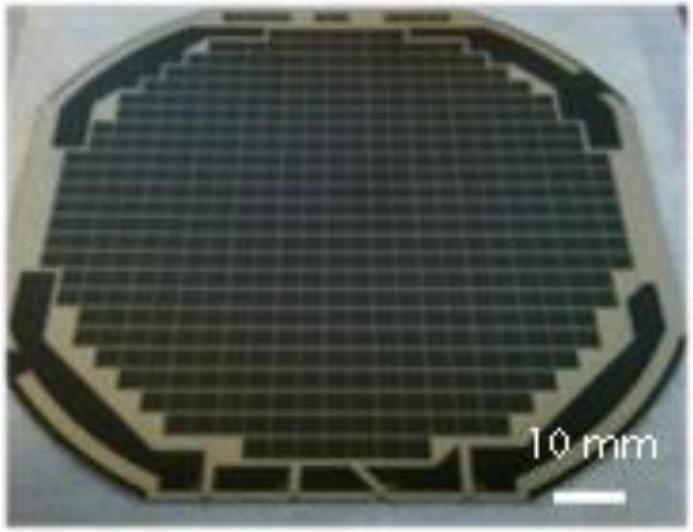
Réalisation de la couche Anti-réflexion

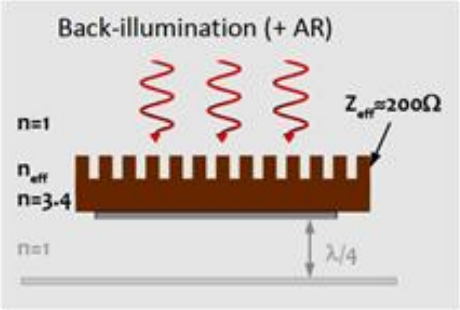


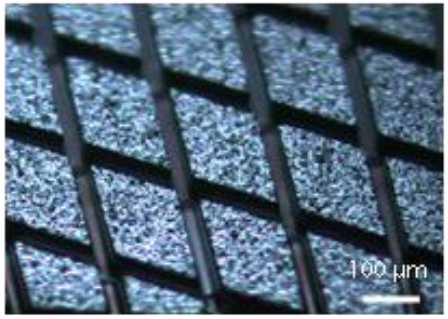


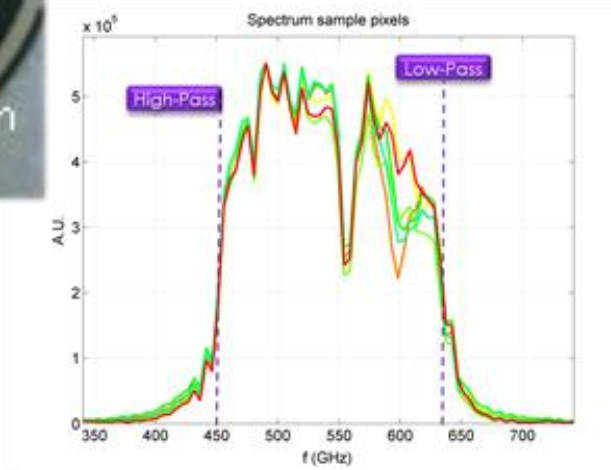
- Illumination au travers du substrat (Si)
- Epaisseur des gorges $\lambda/4$ (80 – 120 μm)
- Indice équivalent n~1,8
- Orientation par rapport aux axes du cristal

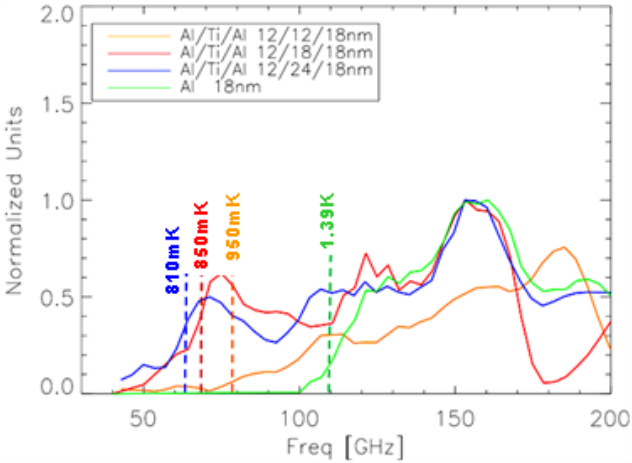
KIDs Arrays Design and Production







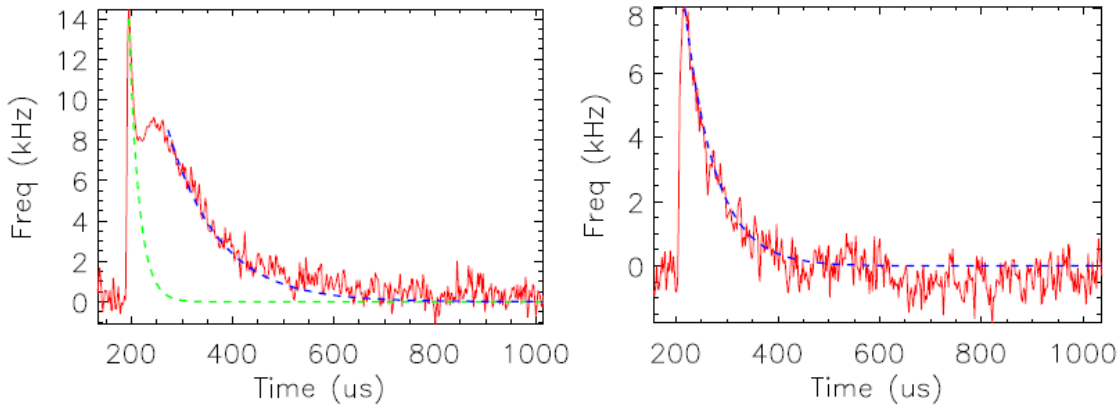


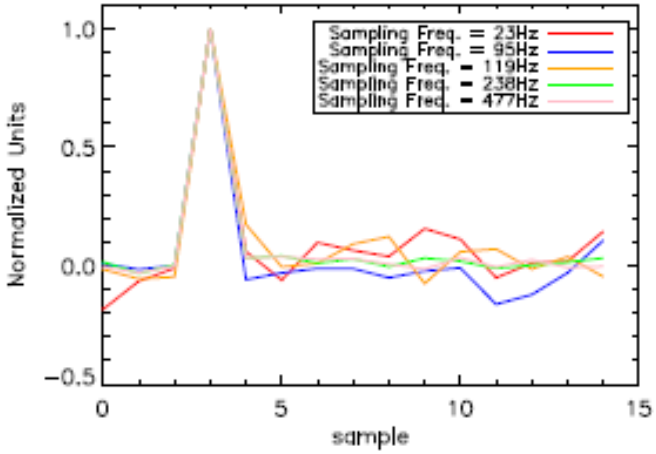


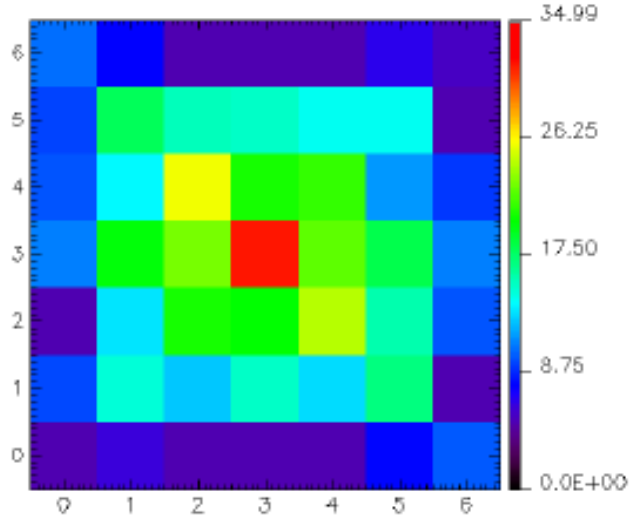
KIDs Arrays Design and Production

- Impact limité à 30 pixels pendant < 1 ms
- Impact sur les mesures (le temps mort est <1%) 10-12% sur Planck

A. Catalano et al.: Lumped elements kinetic inductance detectors maturity for space missions







KIDs Arrays Design and Production

Status

- Background limited detectors on NIKA2
- 4” wafer technology for 2000 pixels at λ = 1 mm
- Available design for the main CMB bands (1-2-3 mm); extension to higher frequency (450 - 600 GHz)

Motivations

- Keep the expertise acquired on KIDs arrays design by job creation

- Strenghten the capability to handle large-scale projects (space or ground instruments)

- Outreach the technical developments and skills to other fields than astrophysics

Towards an open facility

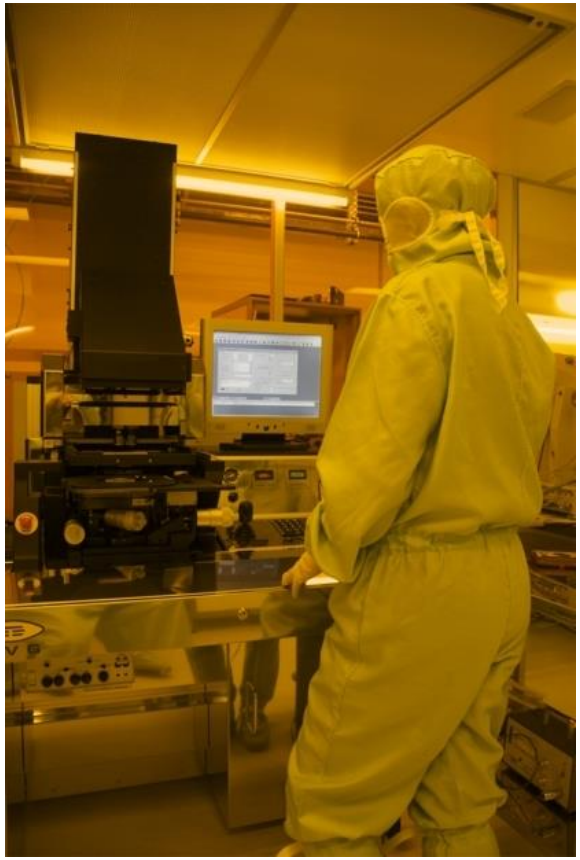
Labs partners (Grenoble)

Institut Néel, LPSC, IPAG, IRAM

Activities

- Design of the detection chain (arrays, readout, sotfware)
- Production
- Test
- Quality Plan

Infrastructure

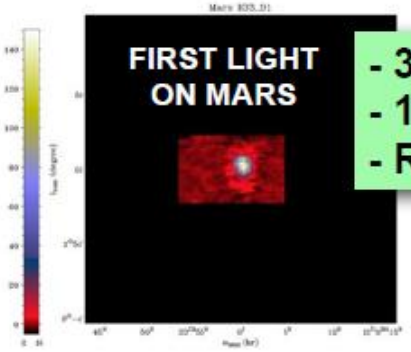


Dedicated microfab facility at IRAM

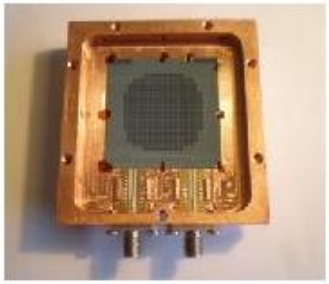
Integrated system optical test at I.Néel

Towards an open facility

2009

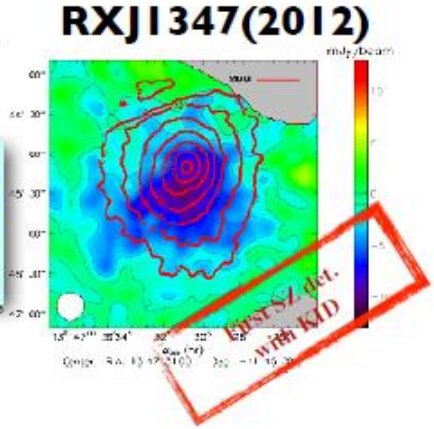


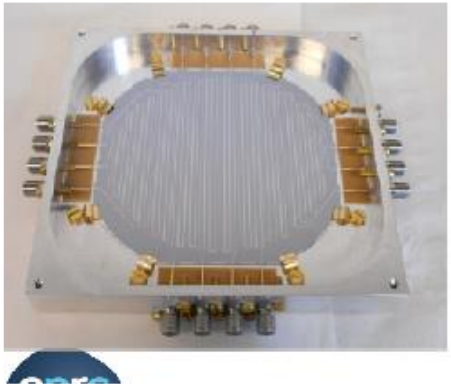
- 30 Pixels
- 120 mJy*s^0.5/beam
- Roach (Berkley) REU



2010-2013

- 190 valid pixel @ 1.25mm
- 125 valid pixel @ 2.14mm
- 35-15 mJy*s^0.5/beam
- NIKEL USB - REU





2014-today

- 1140X2 pixels @ 1.25mm
33 mJy*s^0.5/beam
- 652 pixels @ 2.14mm
8 mJy*s^0.5/beam
- NIKEL AMC

An Open Facility

- Local management group
- Dedicated ressources allocated by the partners (material and human)
- Open to new projects, even outside astrophysics applications
- The agreement between the laboratories should be signed by the end of 2018