LUX Observatoire de Paris | PSL

Groupe Détecteurs Supraconducteurs et Instrumentation

- **6 permanent IT, 1 PhD student and 1 postdoc :**

- Christine Chaumont
- Josiane Firminy
- Florent Reix
- Patrice Barroso
- Frédérique Sayède
- Faouzi Boussaha

- Maria Appavou (PhD student)
- Zhaohang Peng (postdoc)

- The group develop superconducting detectors. Thanks to their unrivalled performance, particularly in terms of sensitivity which can approach the quantum limit given by the photon noise, they are required over a wide range of applications :

- Interstellar medium (ISM)
- Faint stars and galaxies
- Cosmic Microwave Background (CMB), etc

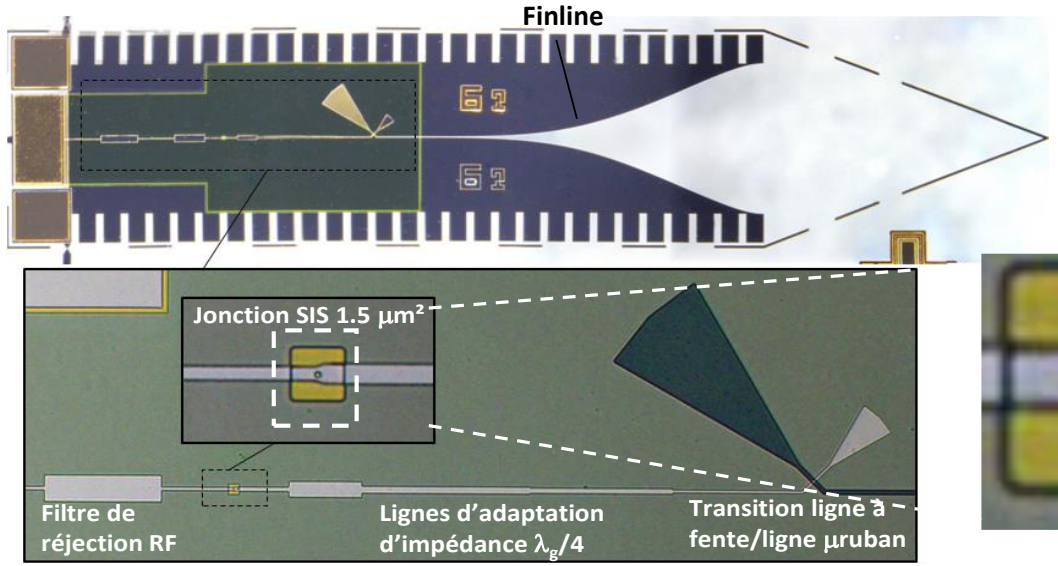
- **3 key detector technologies** :

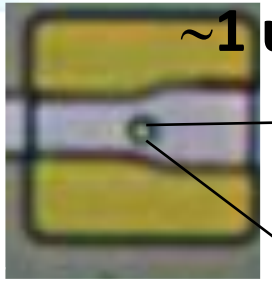
- Superconductor-Isolator-Superconductor SIS detector (ISM)
- Hot Electron Bolometer HEB detector (ISM)
- Microwave Kinetic Inductance Detector MKID (Faint stars and galaxies, CMB, ISM…)

SIS

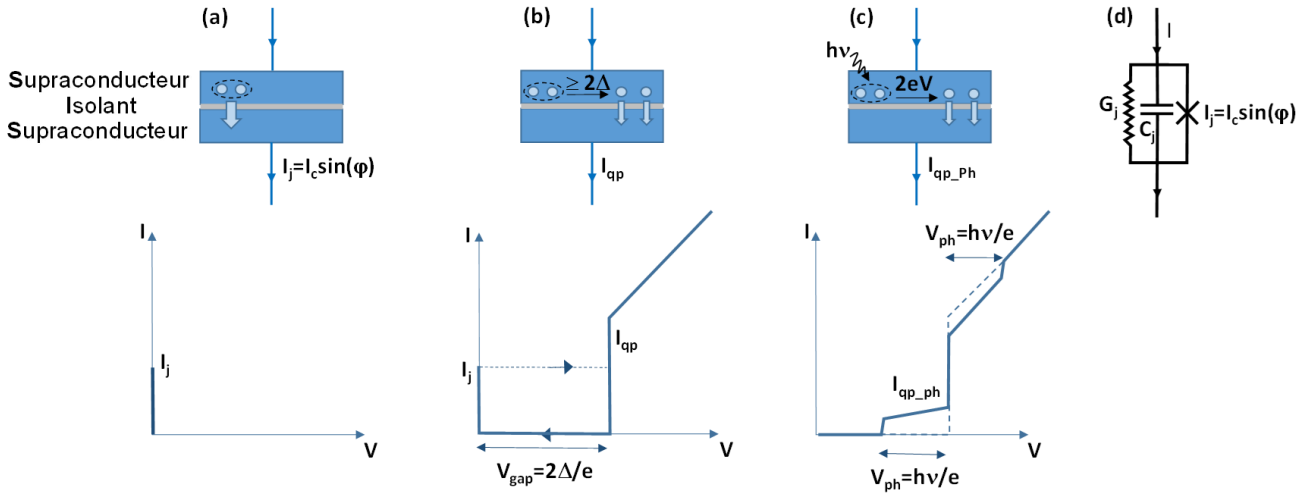
Development of millimeter and submillimeter SIS-based heterodyne receivers

For example, NOEMA and ALMA use SIS mixers





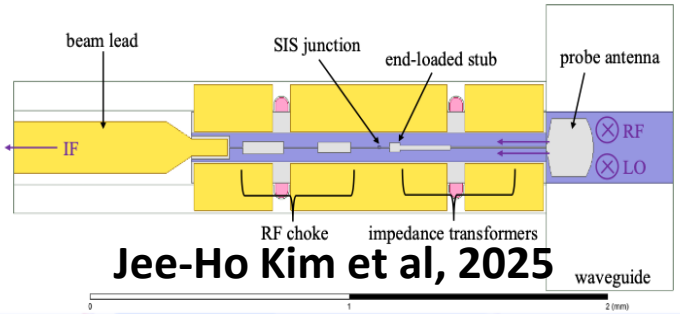
220 GHz mixer developed with Oxford University



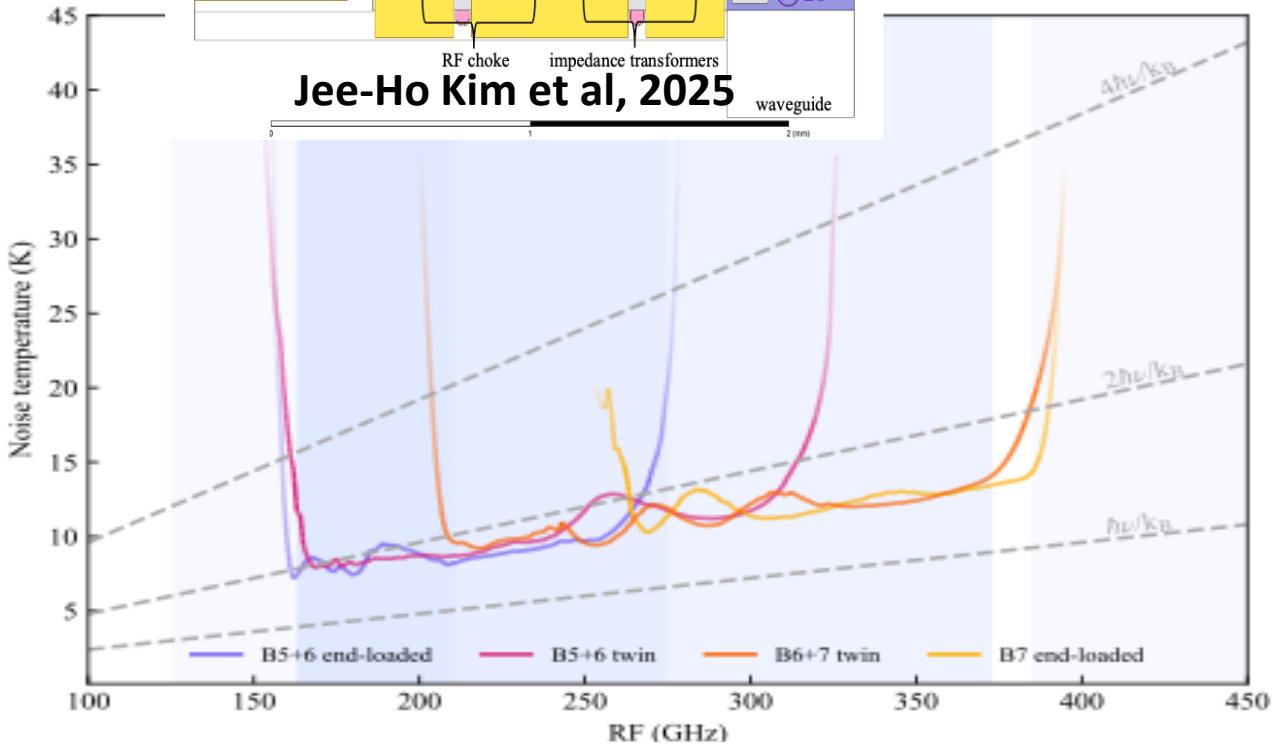
SIS

Development of millimeter and submillimeter SIS-based heterodyne receivers

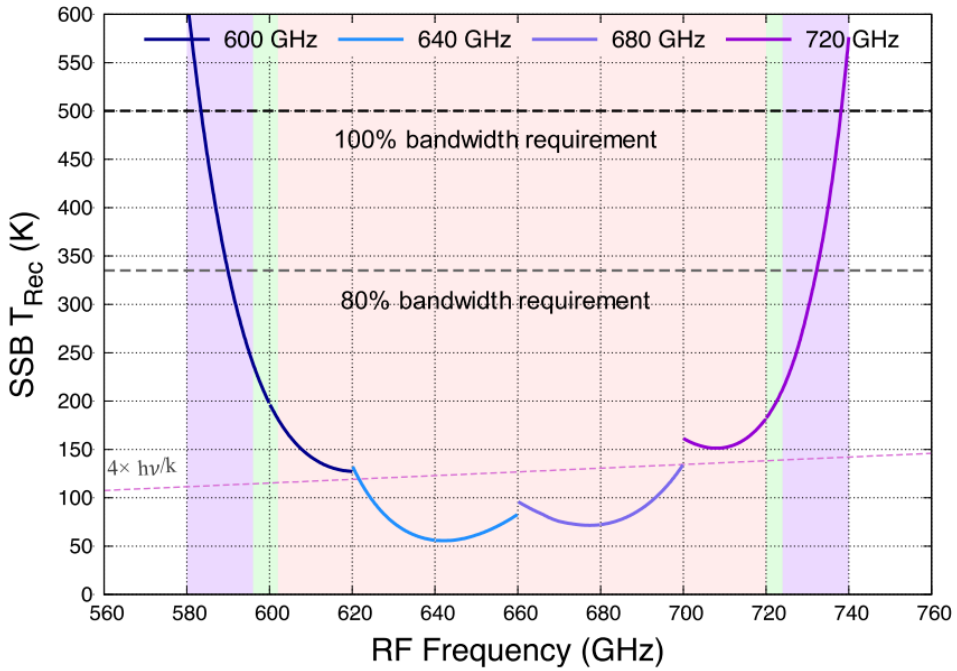
- We first developed the SIS detectors as part of the HERSCHEL project (2009-2013). LERMA was responsible for channel 1 (480-640 GHz).
- Now, we collaborate with the University of Oxford (Astrophysics department) to develop ultrasensitive SIS based heterodyne receivers.



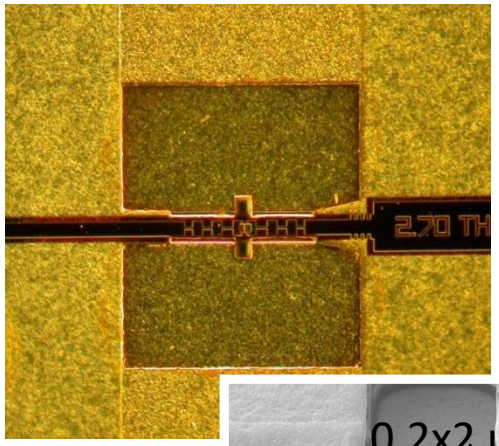
Jee-Ho Kim et al, 2025

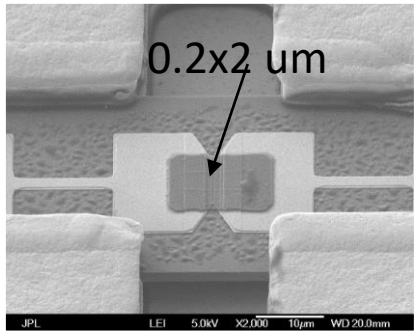


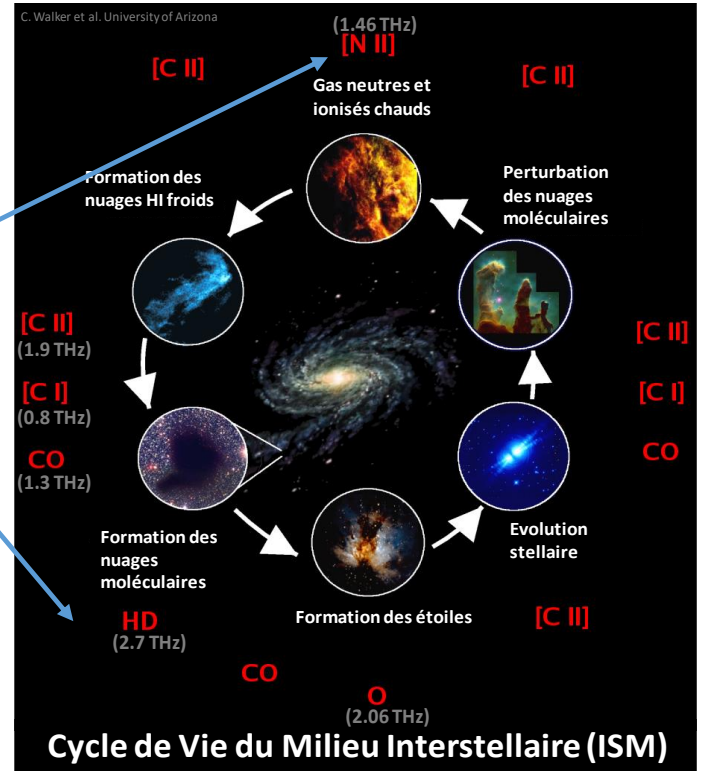
Boon Kok Tan et al, 2025



ASTHROS (with HEBs)
(Astrophysics Stratospheric Telescope for High Spectral Resolution Observations at Submillimeter-wavelengths)







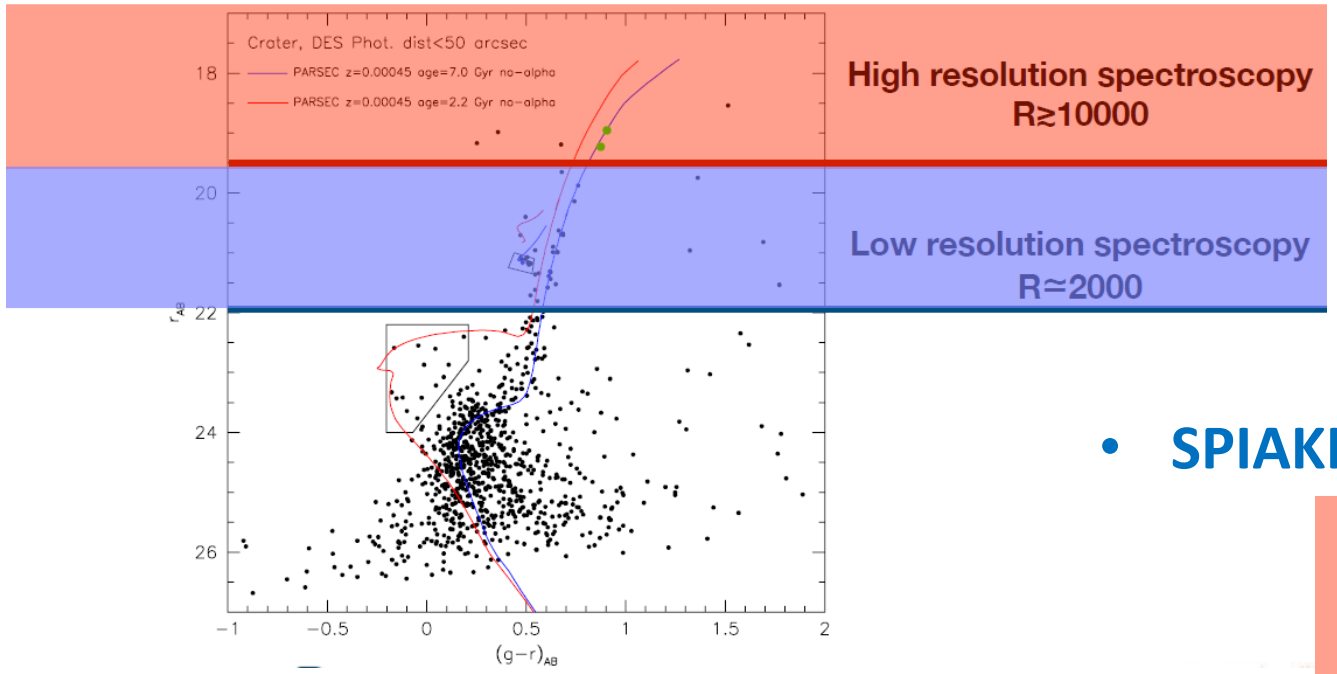
- One of ASTHROS' main science goals is to provide new information about stellar feedback in the Milky Way and other galaxies, a process in which stars either accelerate or decelerate the formation of new stars in their galaxy. Stellar feedback has played a critical role in the evolution of galaxies throughout the universe's history.
- Our group contributes its expertise to the superconducting detectors (HEB hot-electron bolometers) that form the heart of the instrument.

MKID

SPIAKID

(Spectro-Photometric Imaging in Astronomy with Kinetic Inductance Detectors)

- **Classical view of what can be done observationally**

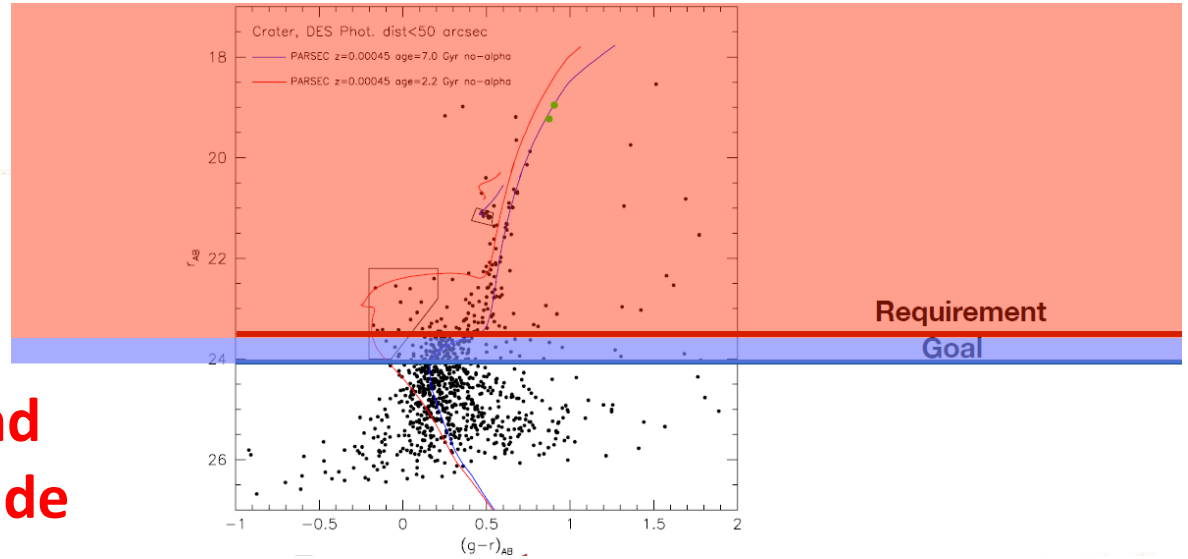


UFD Grus II after 1h of observation with ESO's 8m telescope

Study of the stellar populations of at least one Ultra Faint Dwarf galaxy in the Local Group

PI : Piercarlo Bonifacio

- **SPIAKID view of what can be done observationally**



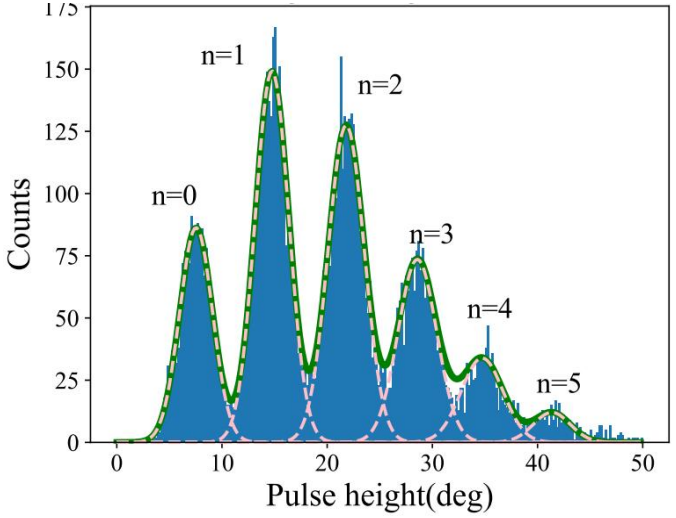
Challenge : obtain multi-colour photometry and spectroscopy from stars up to the 24th magnitude

MKID

Microwave Kinetic Inductance Detectors

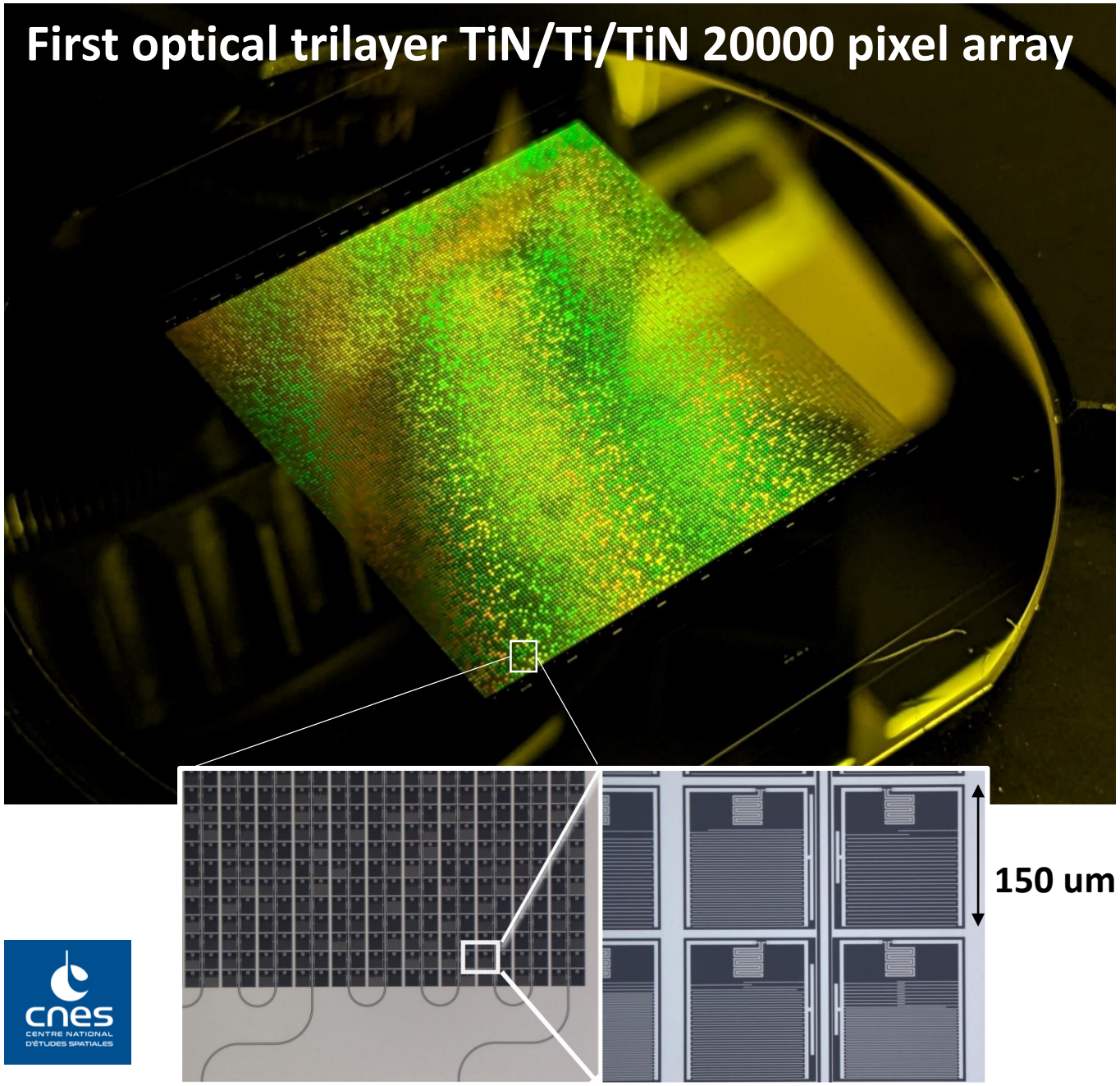
Our detectors are now capable of counting photons.

- B. Samir et al., PhD, 2016 - 2019
- P. Nicaise, PhD, 2019 - 2022
- M. Appavou, PhD, 2023 - 2026
- J. Hu, postdoc, 2022- 2024
- Z. Peng, postdoc, 2024-2026



Energy Resolution $R/\Delta R$	
n=0	2.0
N=1	3.9
N=2	5.4
N=3	6.6
N=4	7.4
N=5	10.0

$$\Delta R = 2\sqrt{2ln2}\sigma$$



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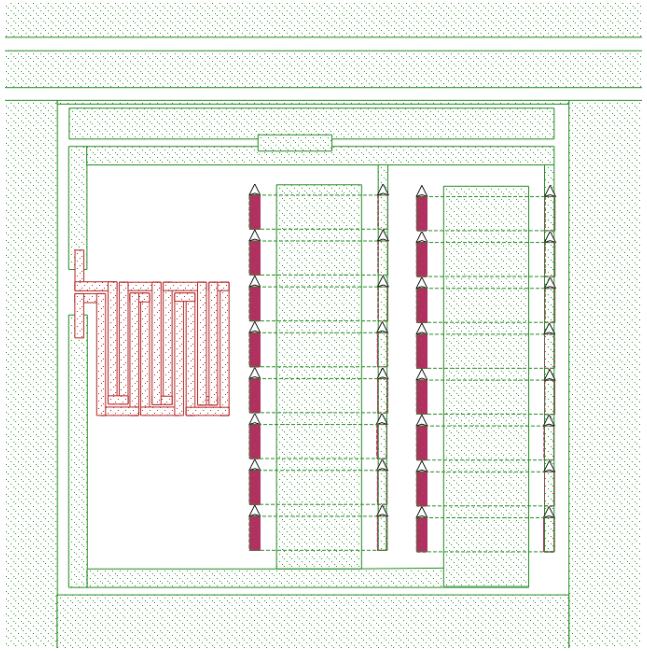
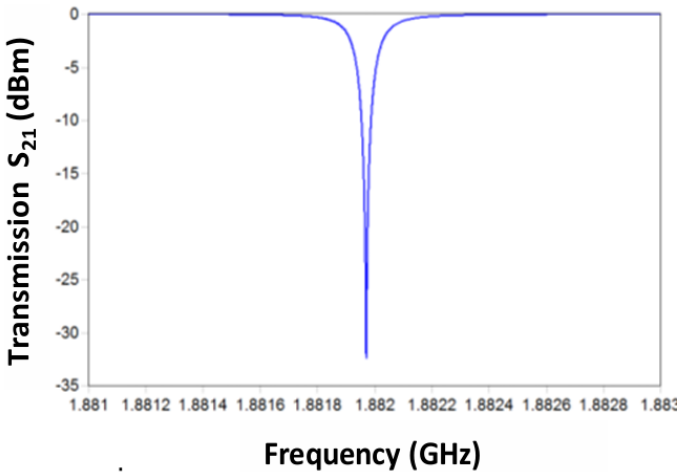
CENTRE NATIONAL D'ÉTUDES SPATIALES

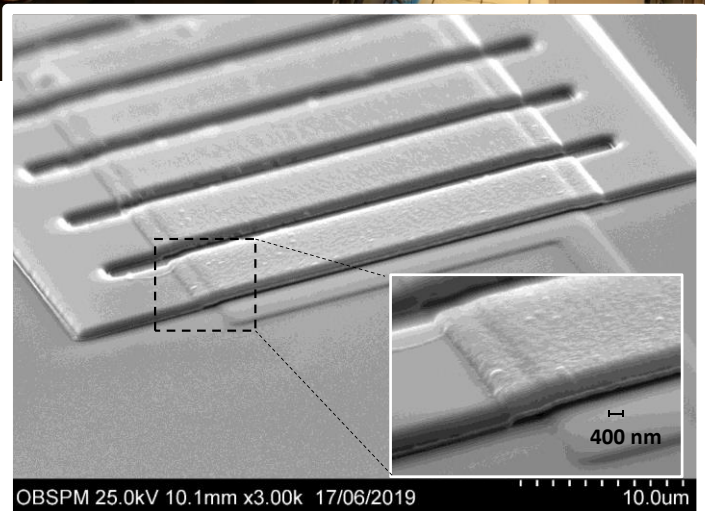
- **Simulations**
- **Micro-Fabrication**
- **Measurement & characterizations**

Commercial and “home-made” software

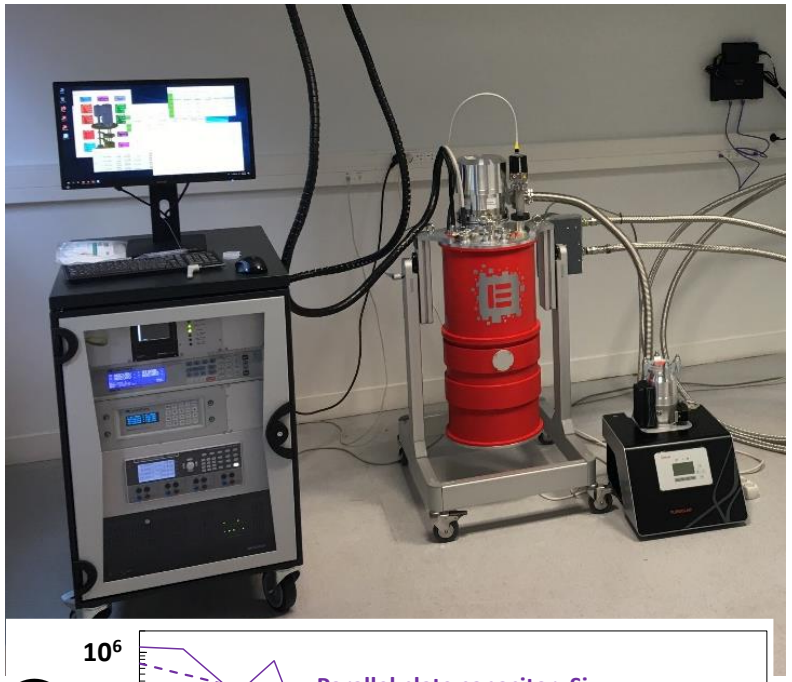


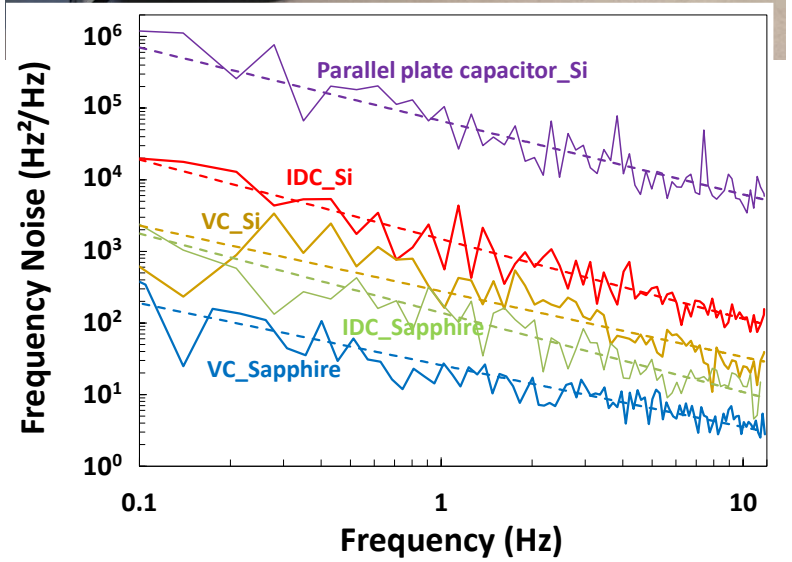


ISO7 class clean room facility



Cryogenic lab





2 patents on MKIDs and 1 patent on SIS detector

https://observatoiredeparis.psl.eu/-plateformes-.html?lang=fr

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EN

Centrale Technologique de Recherche et Développement (CTRD)

La CTRD contribue aux développements de nouveaux capteurs, particulièrement supraconducteurs, et micro-dispositifs pour les applications en astronomie. Elle regroupe les moyens de nano et microfabrication, notamment une salle blanche de norme ISO 7, ainsi que de moyens de tests cryogéniques. La CTRD est une structure mutualisée au sein de l'Observatoire de Paris et fait partie du réseau parisien des salles blanches de proximité de Paris et du réseau national RENATECH+. La CTRD est placée sous la responsabilité du groupe de Recherche Instrumentale du LUX, la gestion financière de sa salle blanche est co-portée par l'UNIDIA (cf. ci-dessous).

Our most relevant contributions :

- Coronographs for SHARK and MICADO projects for LESIA/LIRA
- Microwave circuits for submm heterodyne receivers for LERMA/LIRA
- Atom chips as inertial sensors for SYRTE/LTE

We develop the key detector technologies needed to study :

- Interstellar medium (ISM)
- Faint stars and galaxies
- Cosmic microwave background (CMB)…

We are available and will be delighted to collaborate with the scientific teams.