Groupe Détecteurs Supraconducteurs et Instrumentation

Christine Chaumont

09/09/2024

(On the behalf of the GDSI group)

- **The group consists of :**

2 IR including 1 with HDR (PhD supervision), 2 IE, 1 T, 1 PhD student and 1 postdoc

- **We 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 such as :**

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

- **3 key detector technologies :**

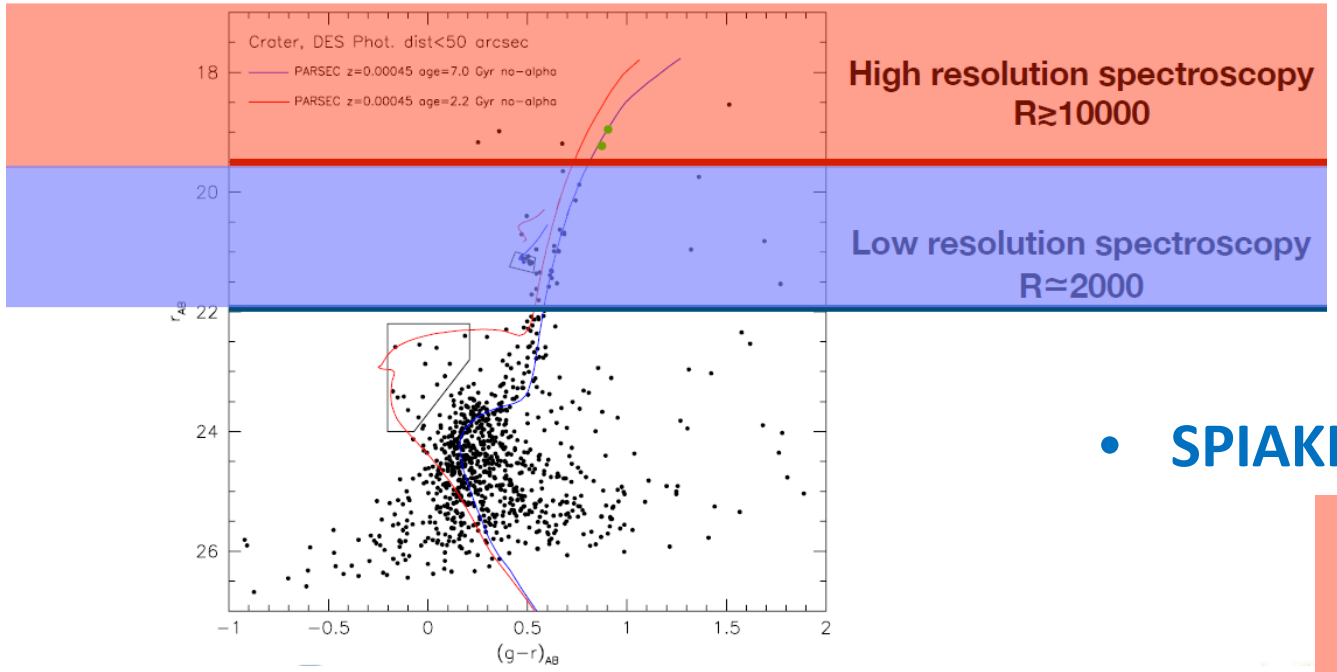
- Superconductor-Isolator-Superconductor (SIS) junction (ISM)
- Hot Electron Bolometers (ISM)
- Microwave Kinetic Inductance Detectors (Faint stars and galaxies, CMB, ISM…)

Project 1

SPIAKID (with MKIDs)

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

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

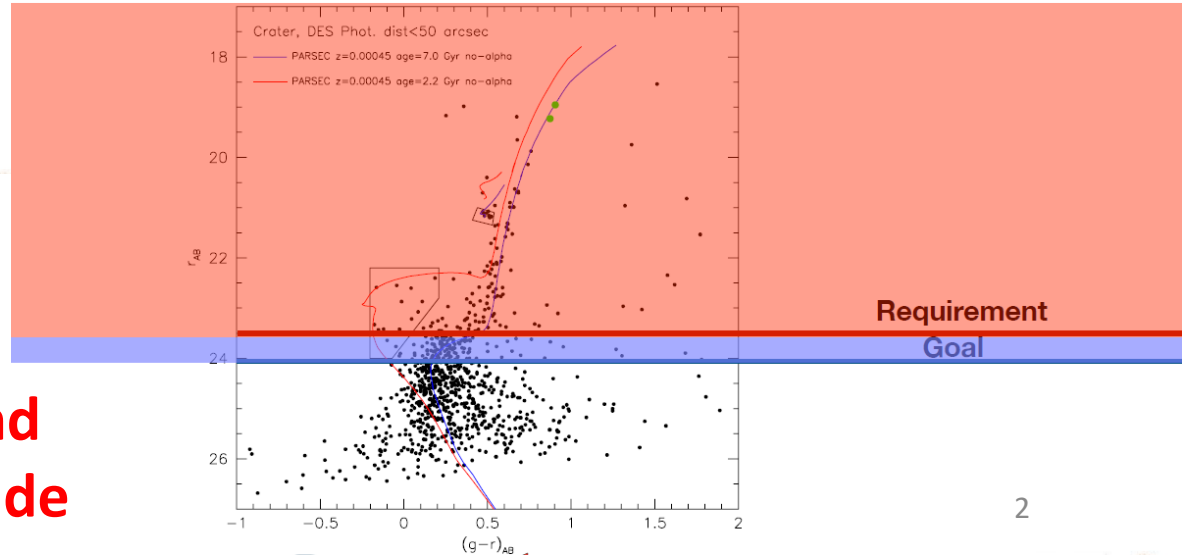


UFD Grus II after 1h of observation with ESO's 8m telescope

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**



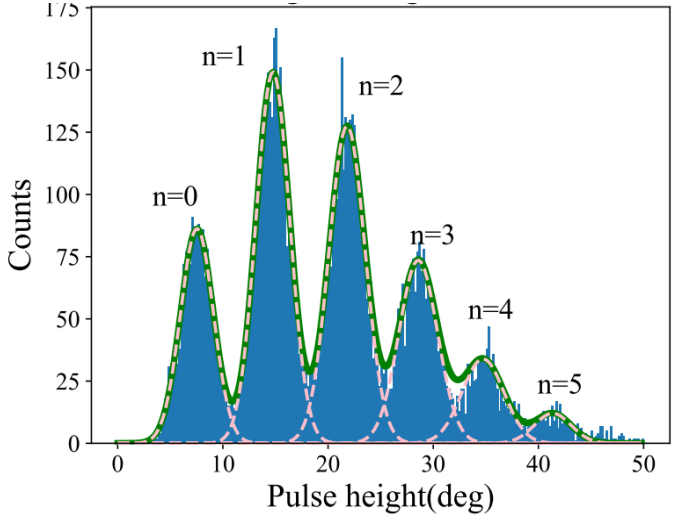
Challenge : obtain multi-colour photometry and spectroscopy from stars up to the 24th magnitude

Project 1

Microwave Kinetic Inductance Detectors

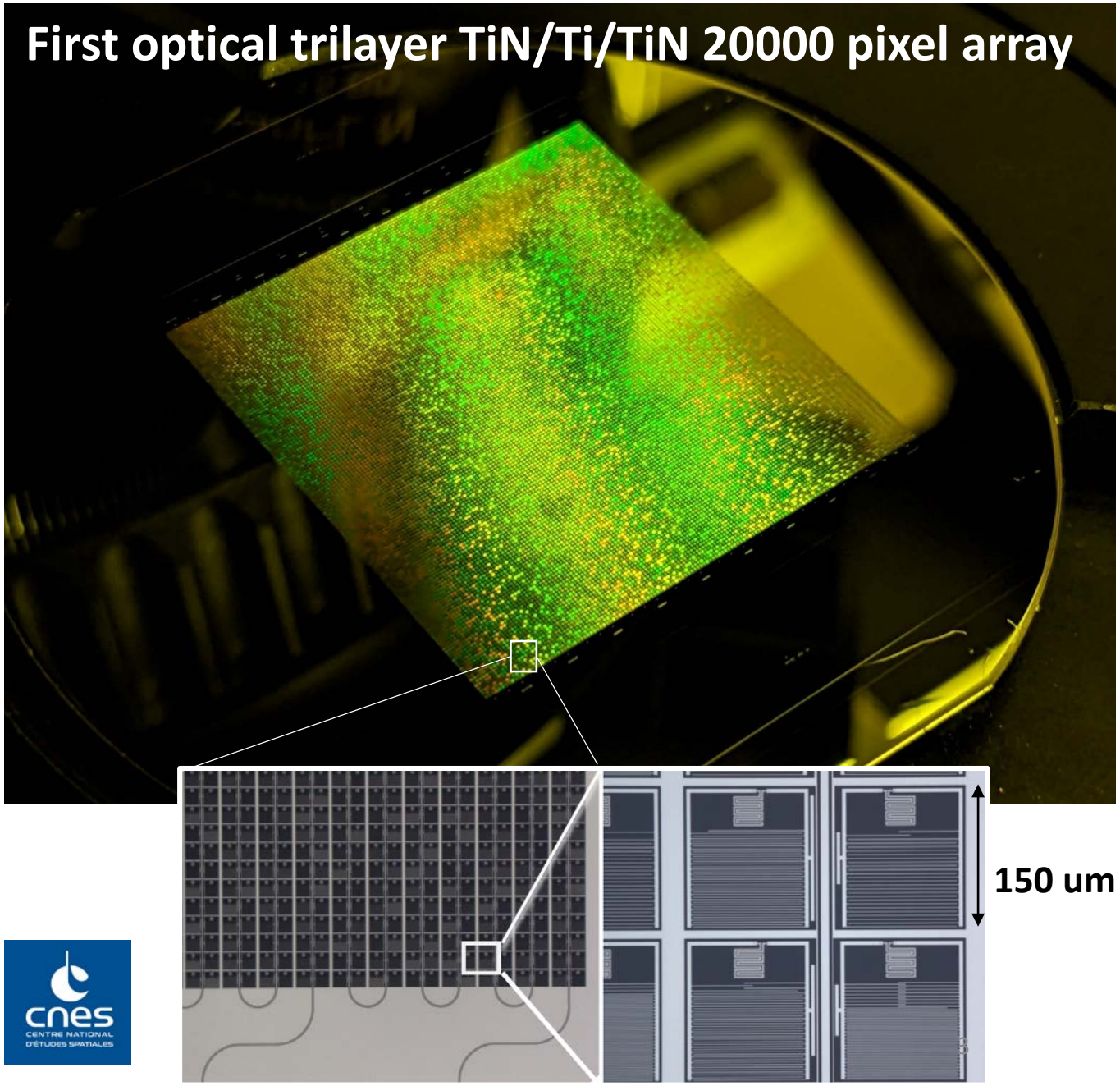
After 6 years of development, involving 2 PhD students and 2 postdocs, our detectors are now capable of counting photons:

- **B. Samir et al., 2019, 2022**
- **J. Hu et al., 2022, 2024**
- **P. Nicaise et al., 2022, 2024**
- **M. Appavou et al, 2024**



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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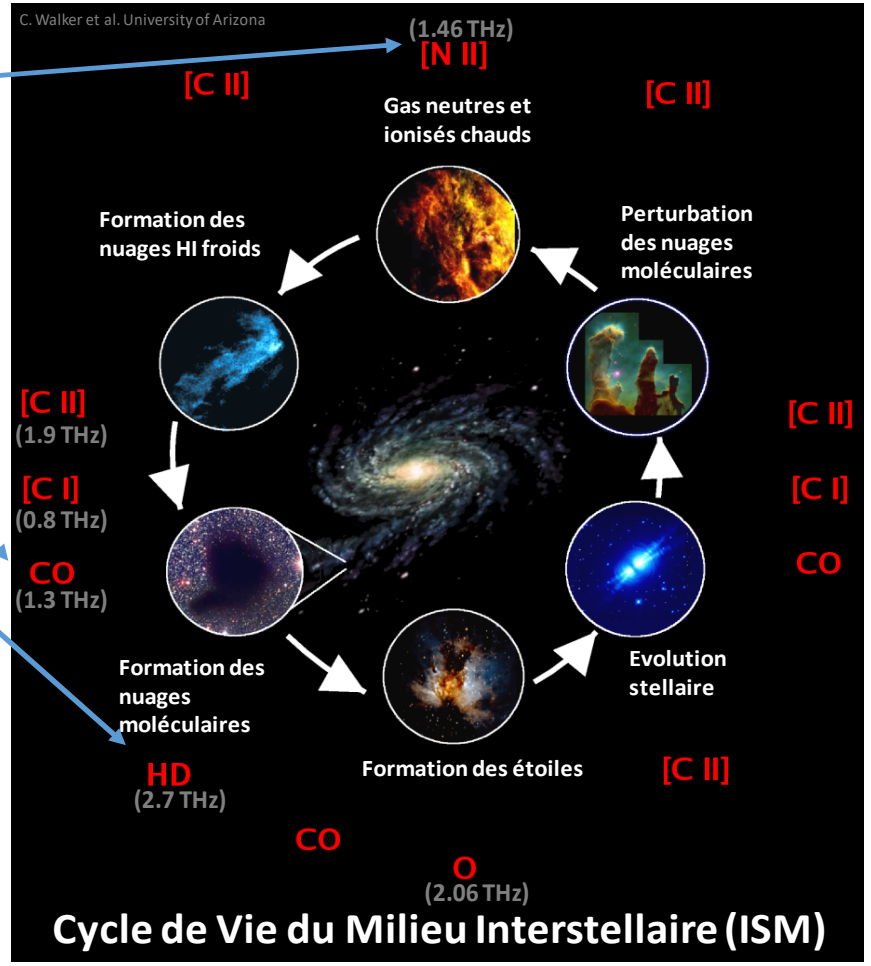
Project 2

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.

R&D

Development of millimeter and submillimeter SIS-based heterodyne receivers

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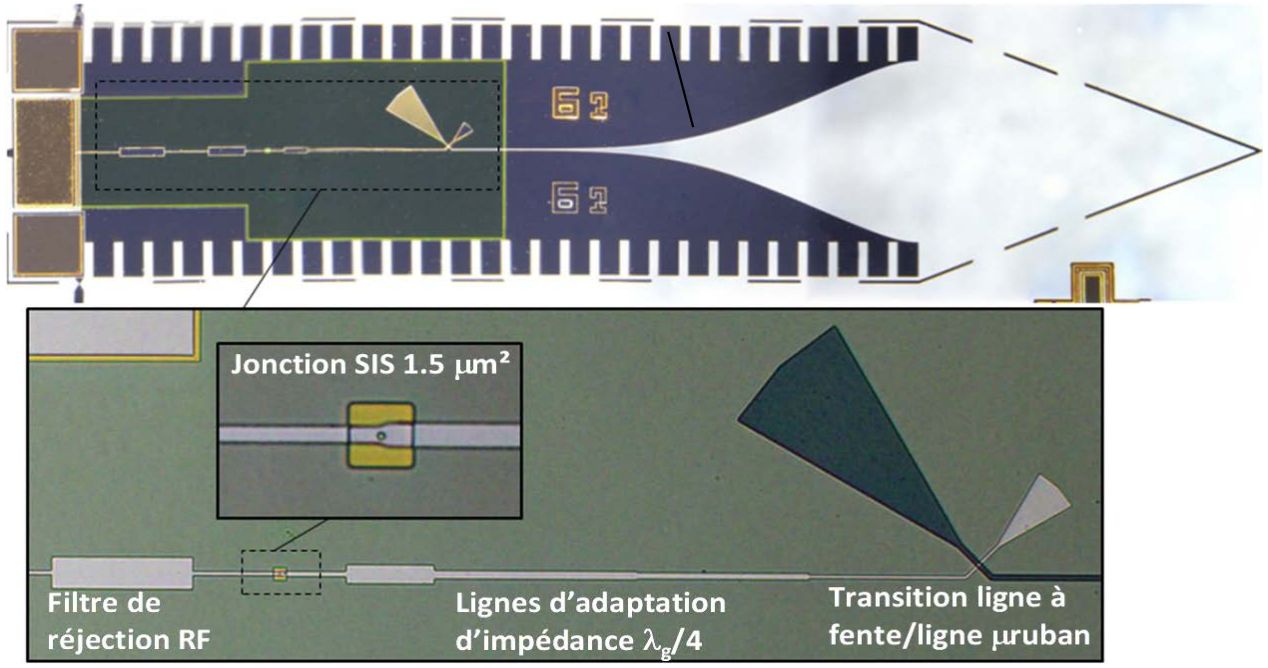
UNIVERSITY OF OXFORD

We collaporate with the University of Oxford (Astrophysics department) to develop ultrasensitive SIS based heterodyne receivers.

- **One of the application is the study of the cosmic microwave background (CMB), and in particular the Sunyaev Zeldovich (S-Z) effect at 220 GHz.**

- **Initially developed as part of the SIS-based receiver for HERSCHEL project (2009-2013)**



- J. Garett et al., 2019, 2022
- J. Wienneger et al., 2023

Summary

- **We develop the key detector technologies needed to study :**

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