Des détecteurs QCD haute bande passante au service de l'interférométrie infrarouge du futur.

Jean-Philippe Berger & Tituan Allain
Institut de Planétologie et d'Astrophysique de Grenoble
Université Grenoble Alpes, CNRS
Guillaume Bourdarot
Max Planck Institut for Extraterrestrial Physics
Hugues Guillet de Chatellus
Laboratoire Interdisciplinaire de Physique (LIPhy)
Carlo Sirtori
Laboratoire de Physique de l'ENS

Financement
INSU

Context: infrared imaging at very high angular resolutions

ALMA

Limitations in the infrared

Image complextiy

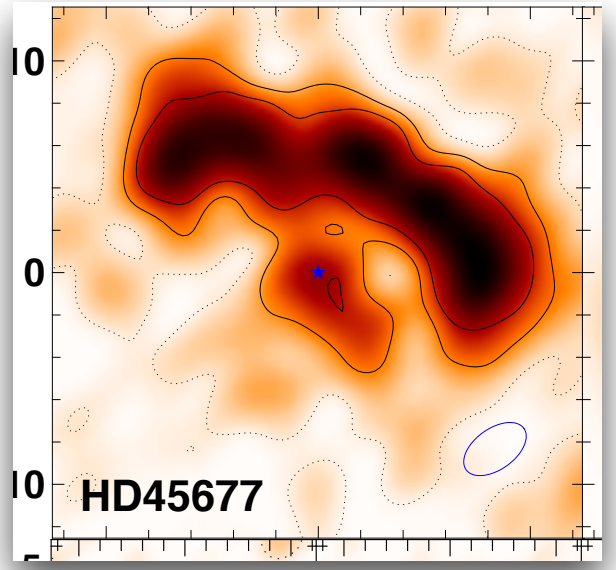
Dynamical range

Spectral resolution

Angular resolution

Need for new instrumental Concepts

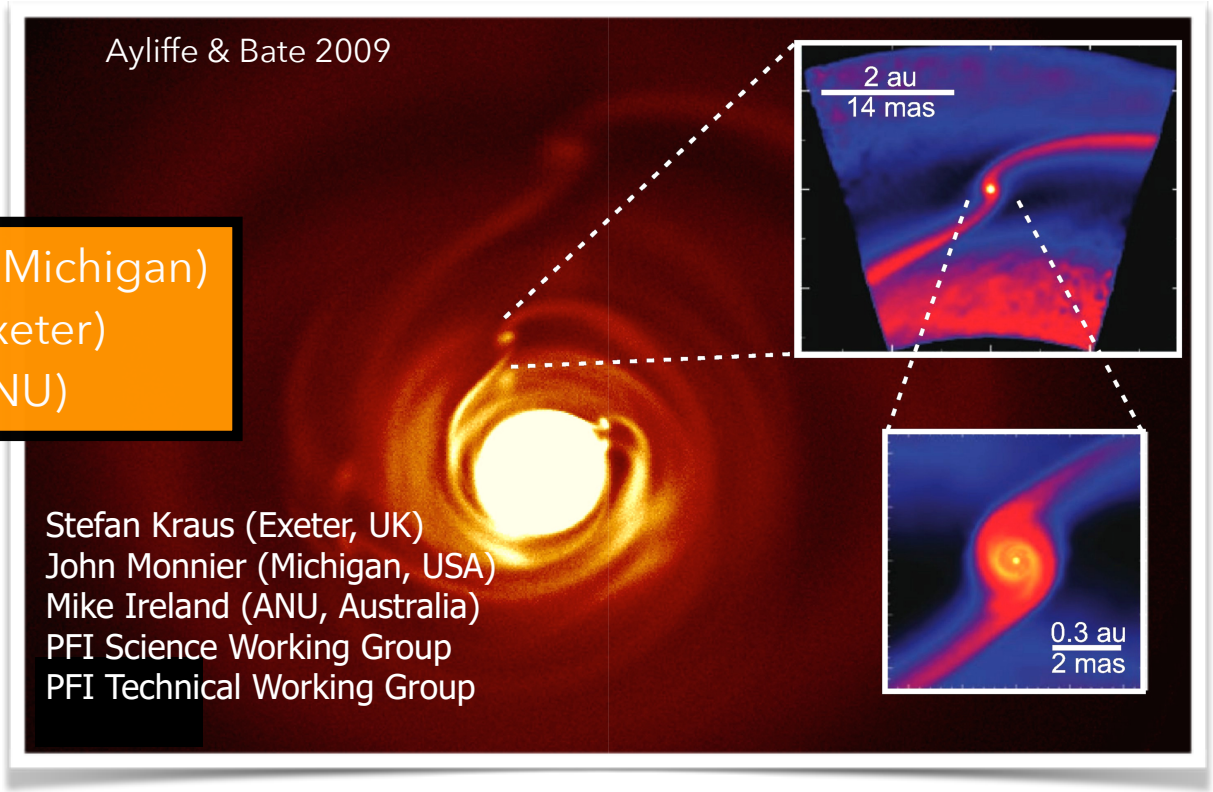
VLTI



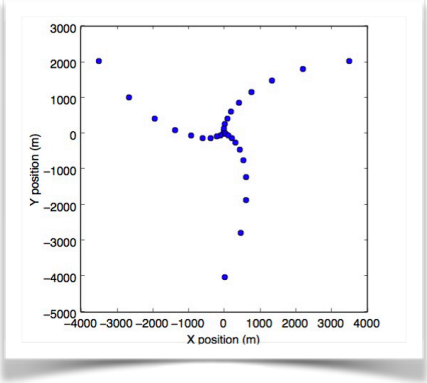
Kluska et al. 2020

Planet Formation Imager: a facility designed to image the key stages of planet formation

- PI: J. Monnier (U. Michigan)
- PS: S. Kraus (U. Exeter)
- PA: M. Ireland (ANU)



?



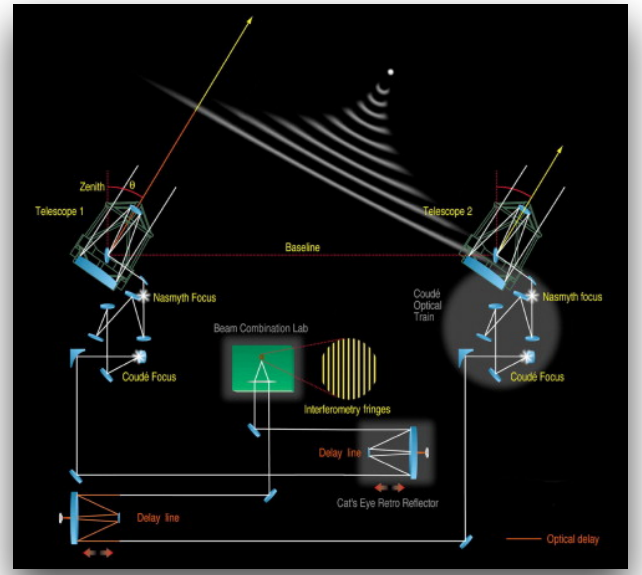
Top level science requirements

- Caracterising young exoplanets up to Taurus
- Resolving circumplanetary disks spatially and kinematically
- Mappping dust distribution and kinematics

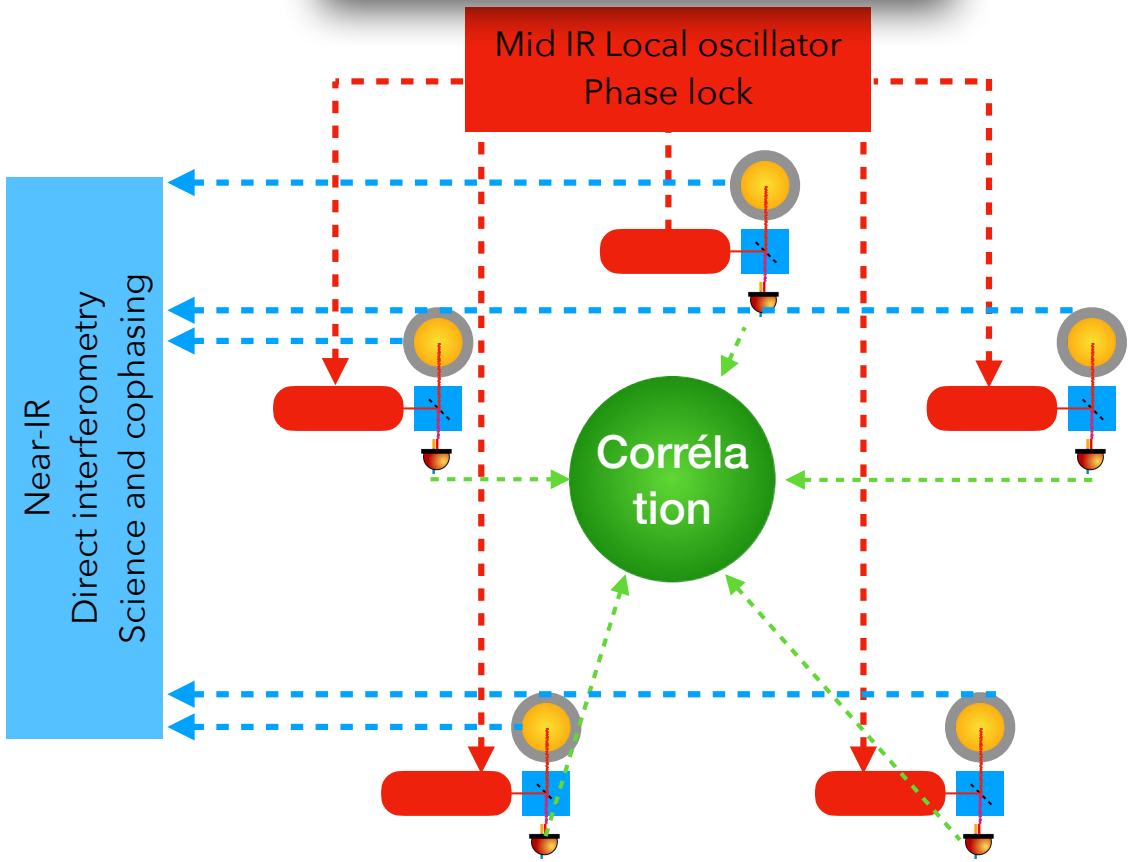
A vision for future interferometers

Fiber linked coherent infrared array

Direct interferometry

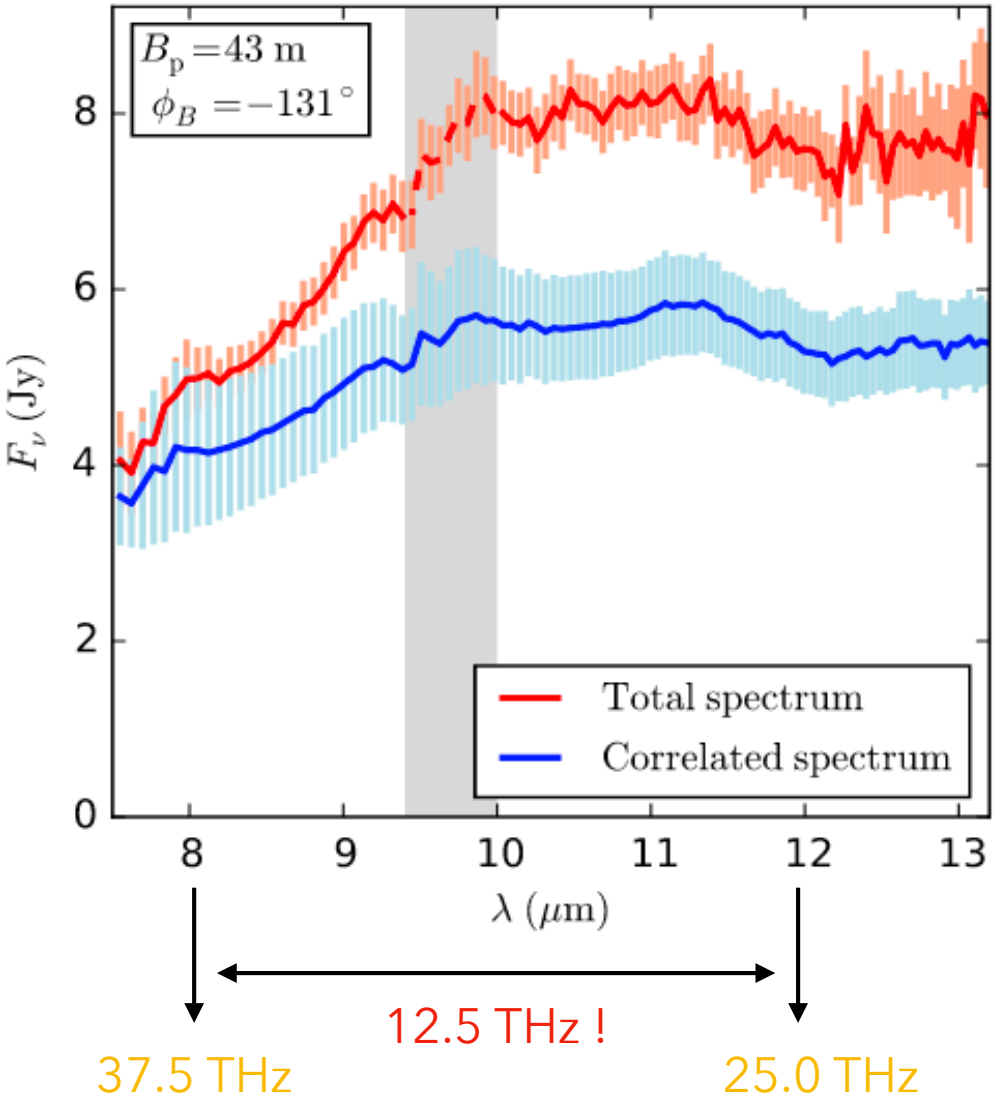


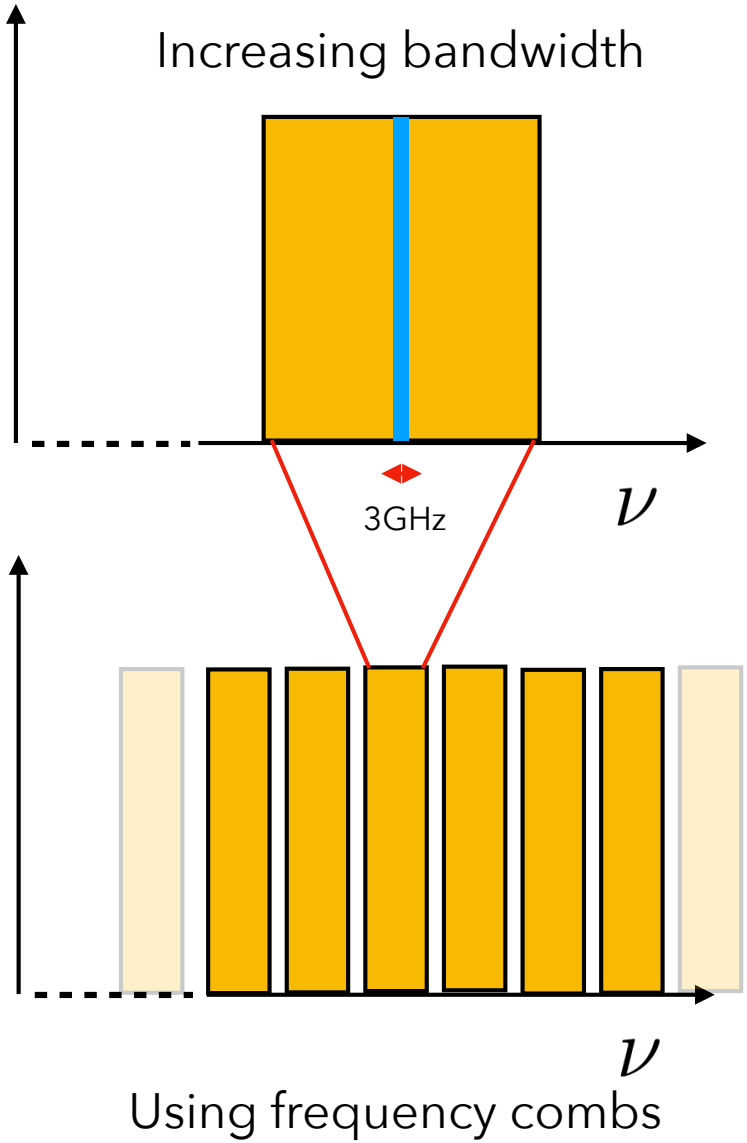
Heterodyne interferometry



The challenge of sensitivity

MIDI instrument at VLTI

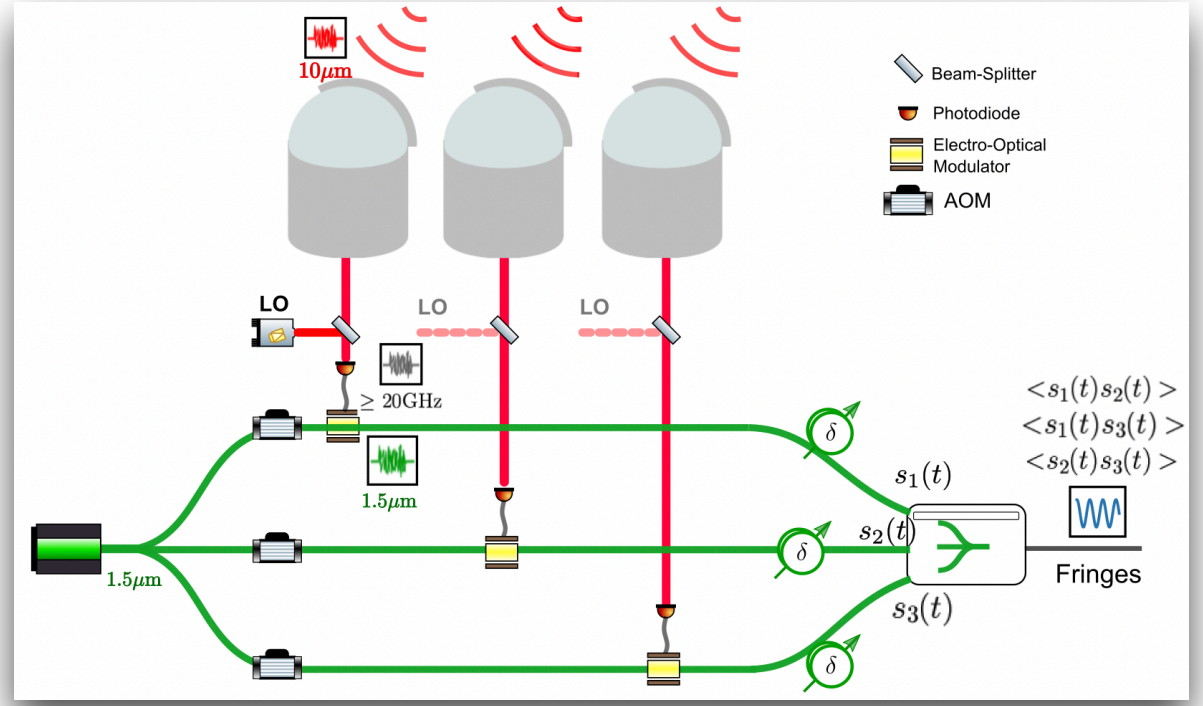




Using frequency combs

A vision for future interferometers

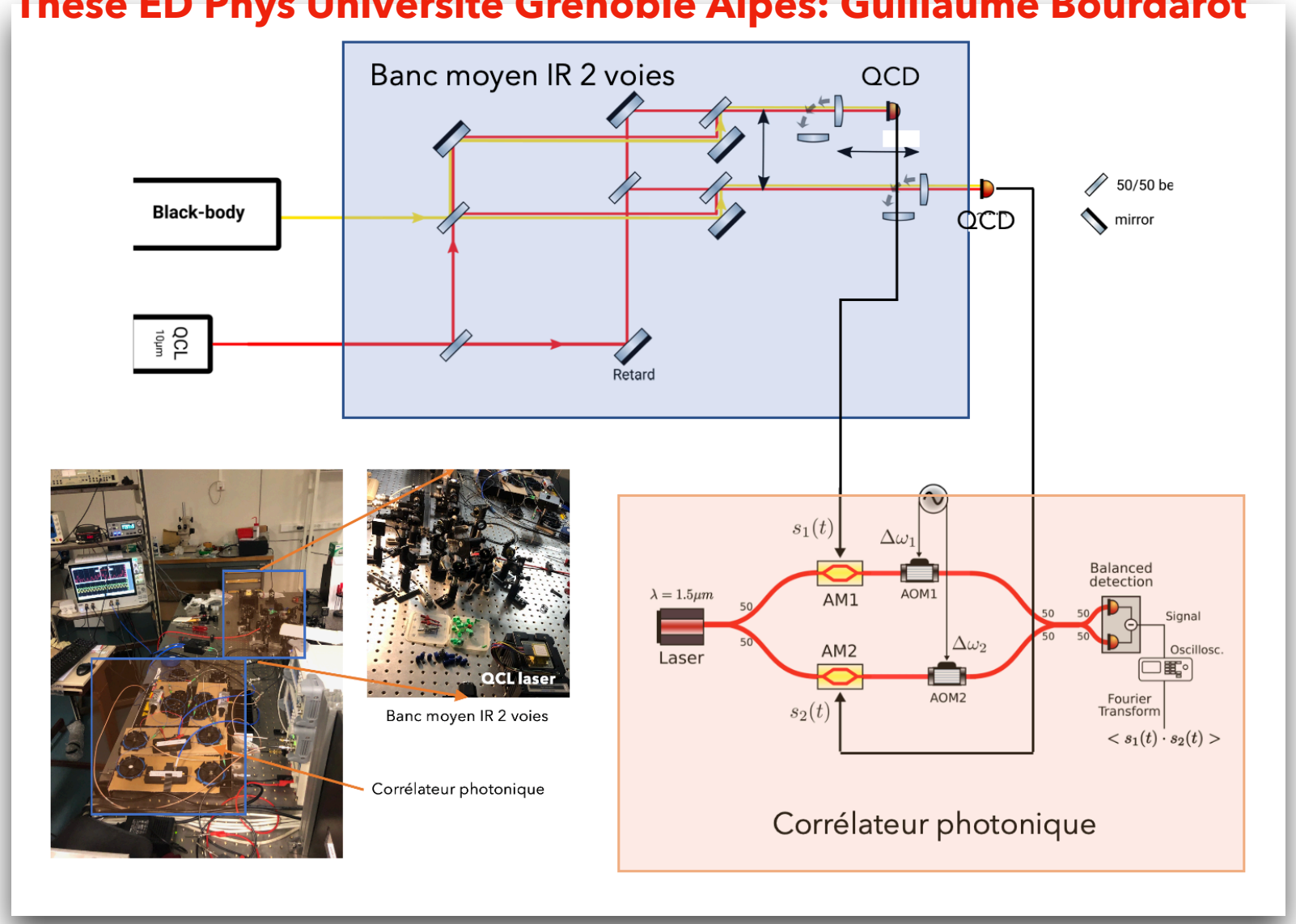
Fiber linked coherent infrared array



- Low-cost telescope technologies
- Sensitive high bandwidth detectors (~40 GHz)
- Mid-Infrared frequency combs
- Efficient "cheap" HR dispersers
- Phase lock over km baselines
- Correlators capable of handling > 10 Telescopes & 40 GHz signals

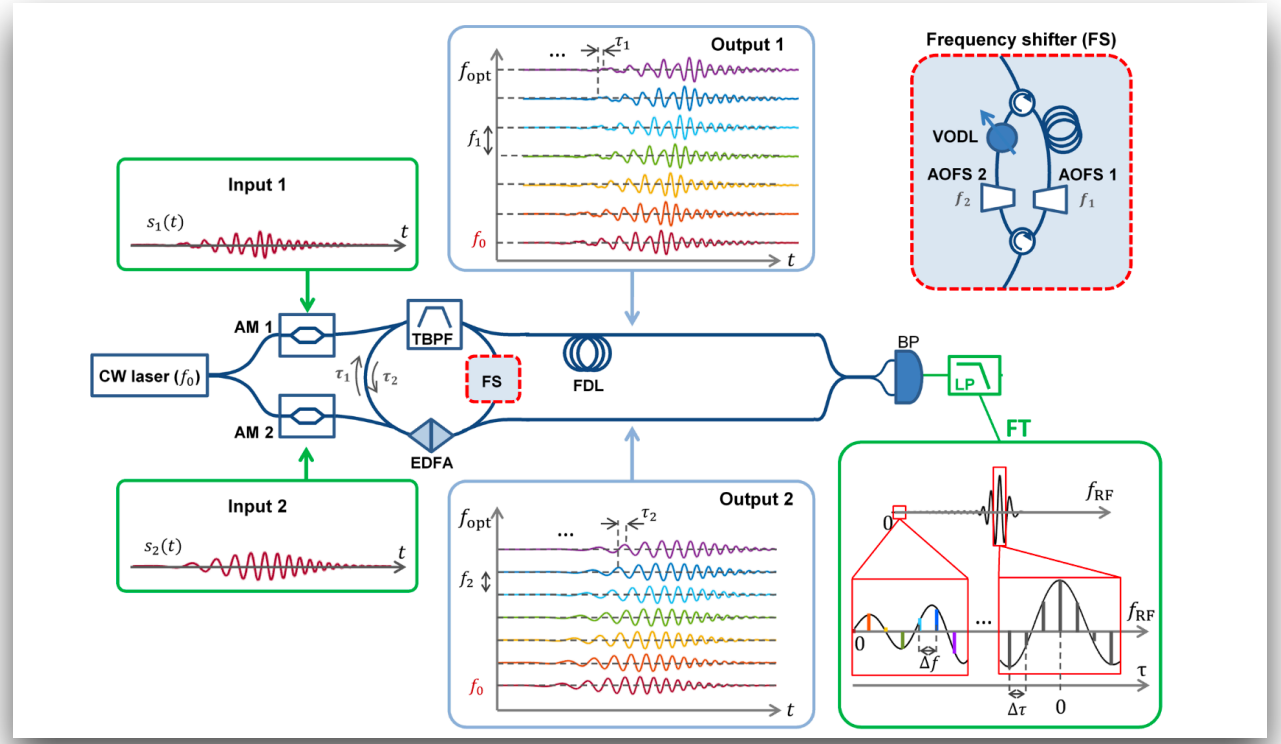
A complete heterodyne instrumental chain at IPAG

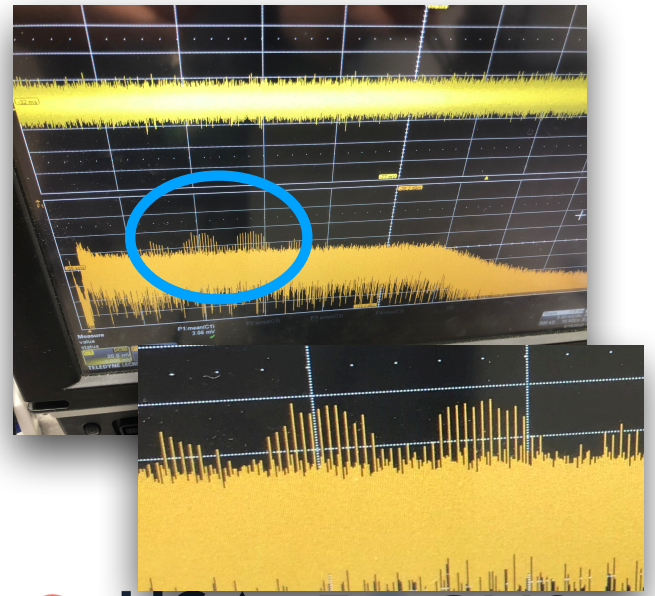
Thèse ED Phys Université Grenoble Alpes: Guillaume Bourdarot



IPAG Institut de Planétologie et d'Astrophysique de Grenoble
UGA Université Grenoble Alpes
FOCUS Focal Plane Array for Universe Sensing
INSU
cnrs

First demonstration of photonic correlation on sky





Corrélateur à double boucle à décalage de fréquence

IPAG Institut de Planétologie et d'Astrophysique de Grenoble

LIPhy Laboratoire Interdisciplinaire de Physique

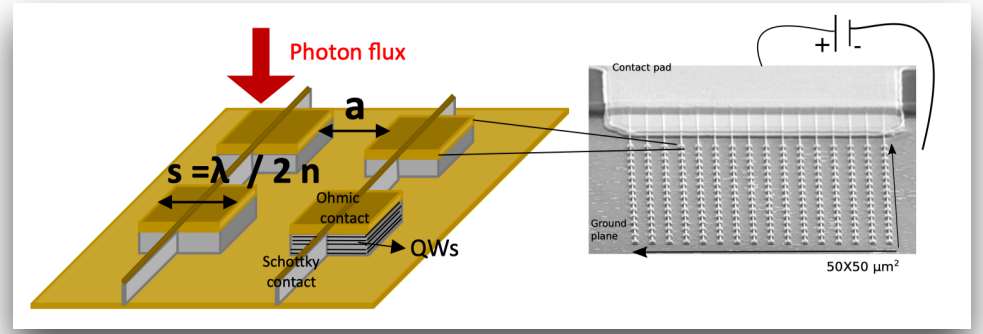
anr

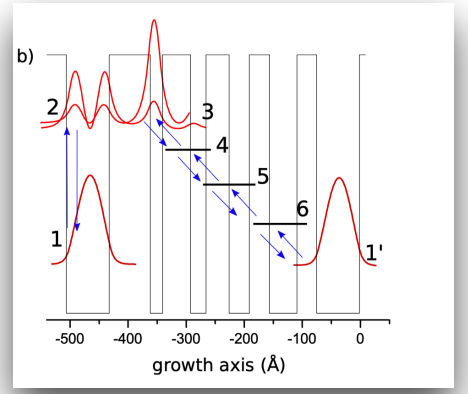
UGA Université Grenoble Alpes

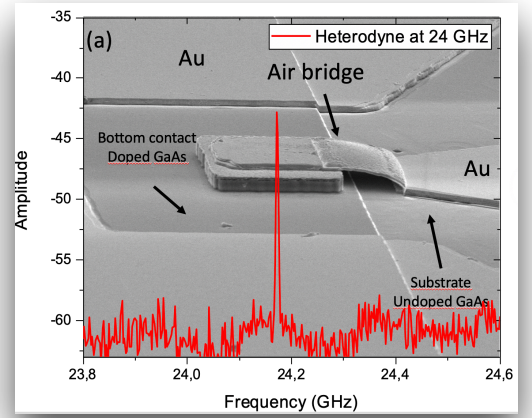
FOCUS Focal Plane Array for Universe Sensing

Développement de détecteurs unipolaires QCD à très grande bande passante

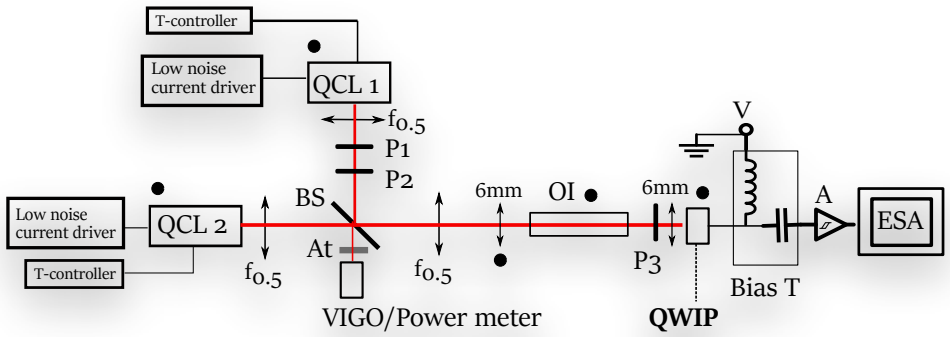
Thèse FOCUS-LPENS: Tituan Allain

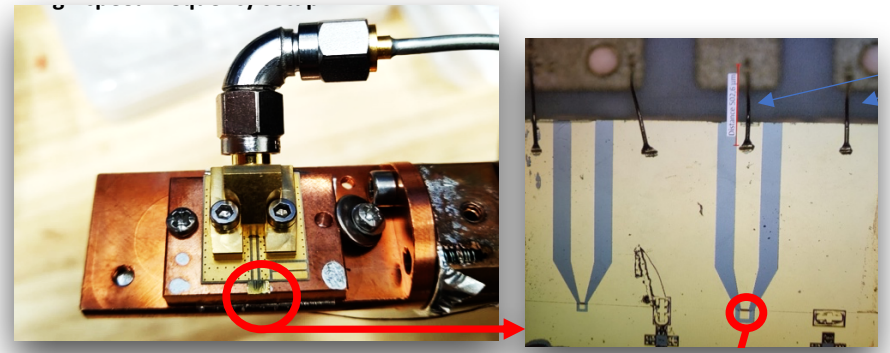






Obtenir des détecteurs à haute bande passante (>10GHz) et rendement quantique (>20%) validés sur corps noir.





Financement packaging détecteurs (Peltier, ampli, lentilles)

LPENS LABORATOIRE DE PHYSIQUE DE L'ÉCOLE NORMALE SUPÉRIEURE

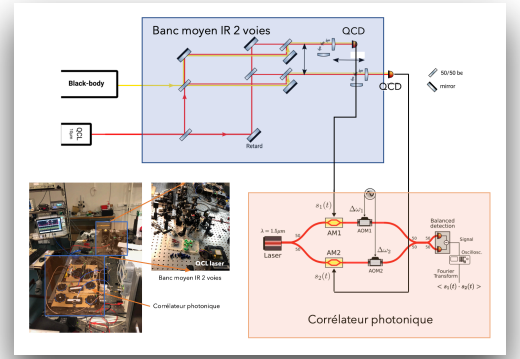
FOCUS Focal Plane Array for Universe Sensing

C. Sirtori (LPENS) group, Palaferri et al. 2018, Gacemi et al. 2018, Bigioli et al. 2020

Projection

Corrélation Photonique

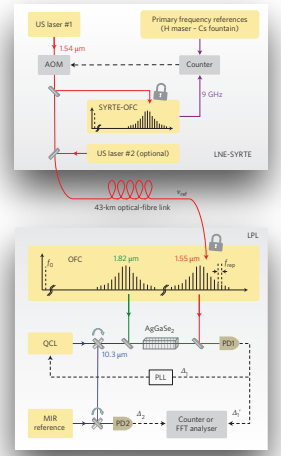
Détecteurs QCD



Banc IPAG

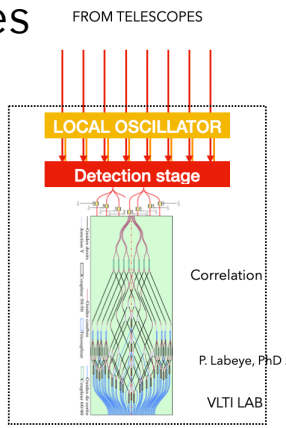
C2PU

Synchronisation d'oscillateur locaux (SYRTE, LPL)



V8

Correlating 8 VLTI telescopes



Next generation of scientific instrumentation, tools and methods and advanced digital solutions (INFRATECH)

Under Horizon Europe EN, the European Commission wants to enable new discoveries and keep Europe's research infrastructures at the highest level of excellence.

Opening the Q band to high spectral and high angular resolution at the VLTI

J.-P. Berger (IPAG)[1] , L. Labadie, E. Michael, N. Honingh (U-Cologne), J.-P. Rivet (OCA)

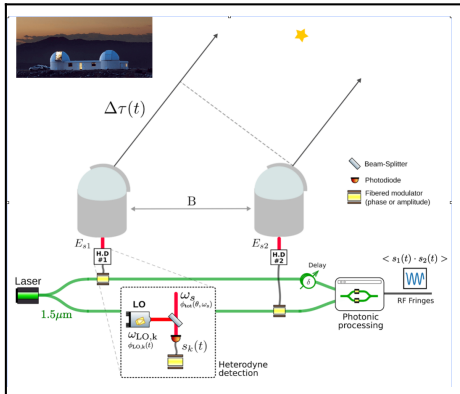
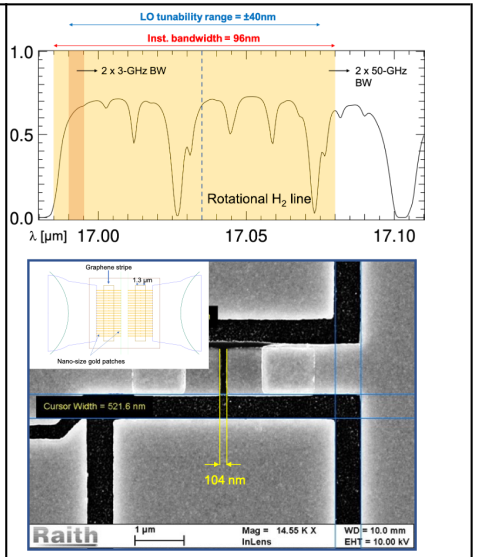


Figure: **Above:** schematics of the proposed C2PU interferometric implementation. ***Right-bottom:*** Inset showing a mask layout of a graphene-based double sideband mixer to be manufactured via E-beam lithography; Background image shows an example of nano-scale structure with typical sizes made at the Microstructure Lab in Cologne for a 10.7 THz (28 μm) mixer. These capabilities will be used to investigate the transition to graphene-based structures.



Above: typical Paranal sky transparency in the Q band showing the instantaneous bandwidth of a foreseen 50-GHz double side mixer and the tunability range of a commercial LO at 17.2μm.

Our goal is to demonstrate in the laboratory and on sky all the building blocks of a full two-way interferometric prototype heterodyne chain operating at high spectral resolution in the Q band thanks to prototype graphene detectors with the aim of opening a new astronomical window for the VLTI in the future.

Merci !