R&D at IPAG

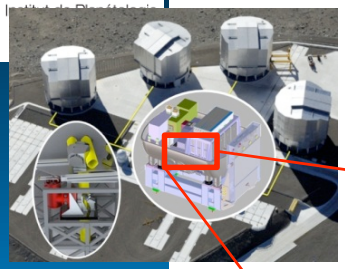
Cristal team

It is not an overview.

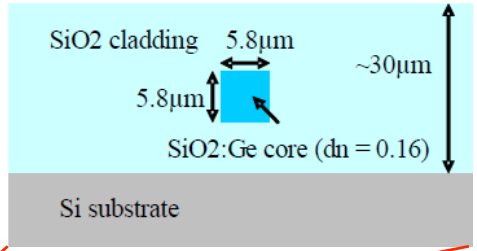
The talk is focused on

- integrated optics (combiner, spectrograph)
- detector developments

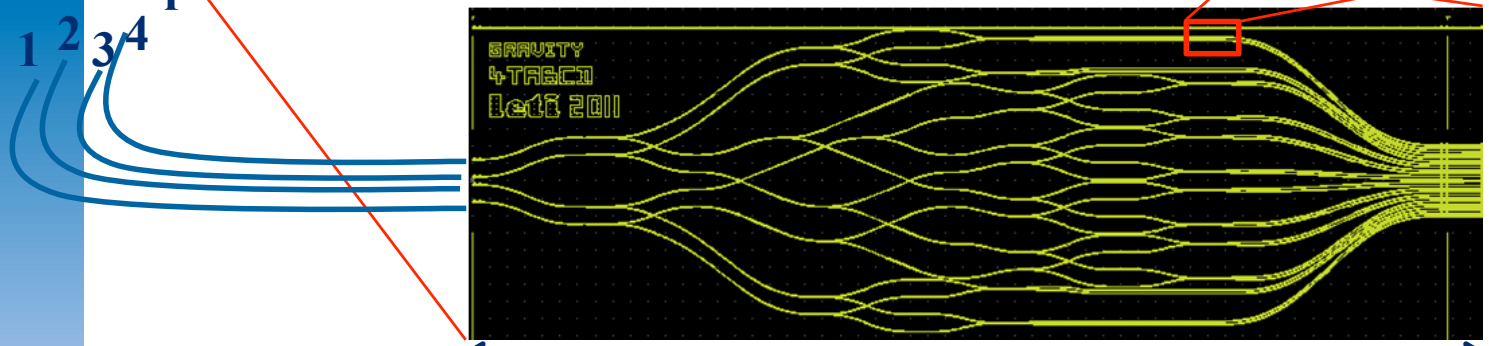
Integrated optics combiners at the heart of GRAVITY



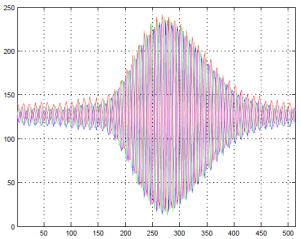
Single-mode waveguides
Silica-on-silicon etching technique
(Collaboration CEA-LETI/IPAG)



Telescopes
1 2 3 4

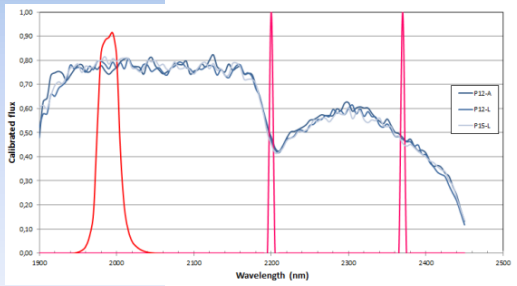


58 mm



(ii)

[Jocou et al. 2012]



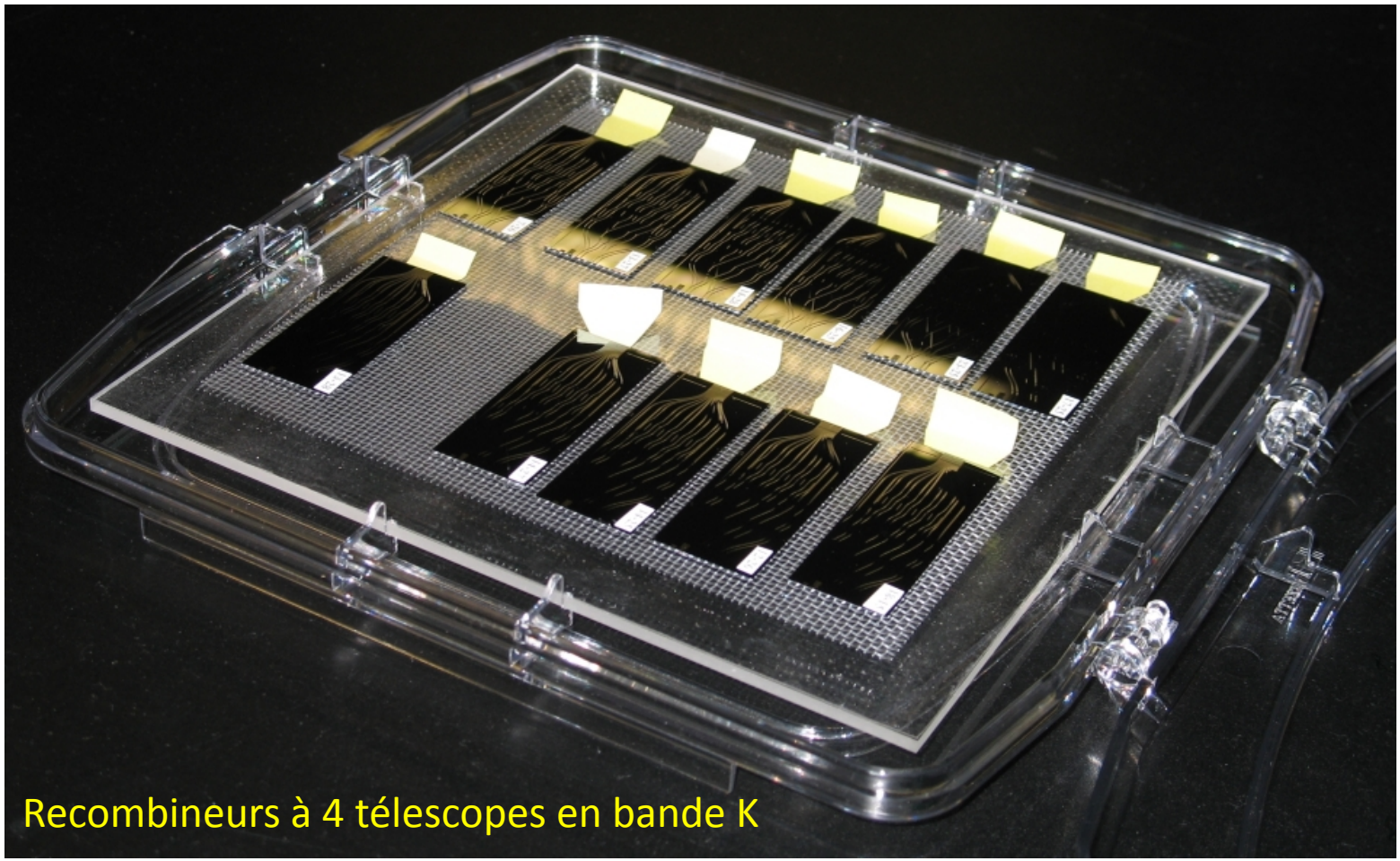
(i)

The beam combiners

- **Work in the K band (i)**
- **Ensure the fringe coding on 6 baselines (ii)**
- **Operate at 200 K in vacuum**
- **Allows the metrology laser to be injected**

Technological challenge: reach a throughput of 55% over the [2 µm ; 2.45 µm] spectral band

Final GRAVITY combiners

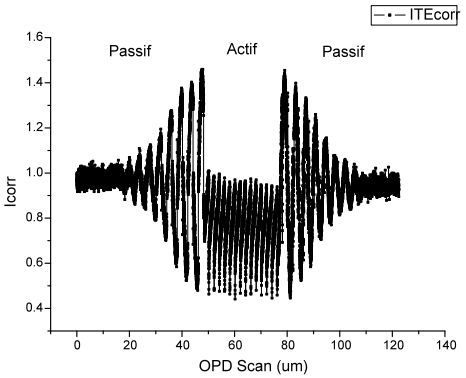


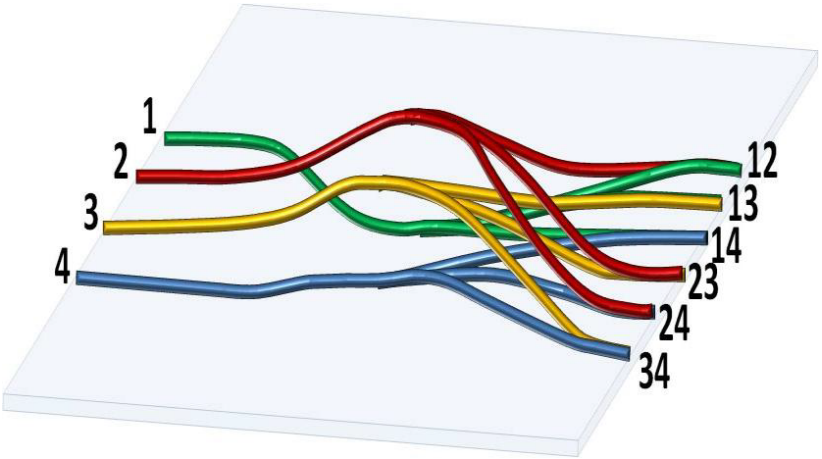
Recombineurs à 4 télescopes en bande K

Optique Intégrée Bande L

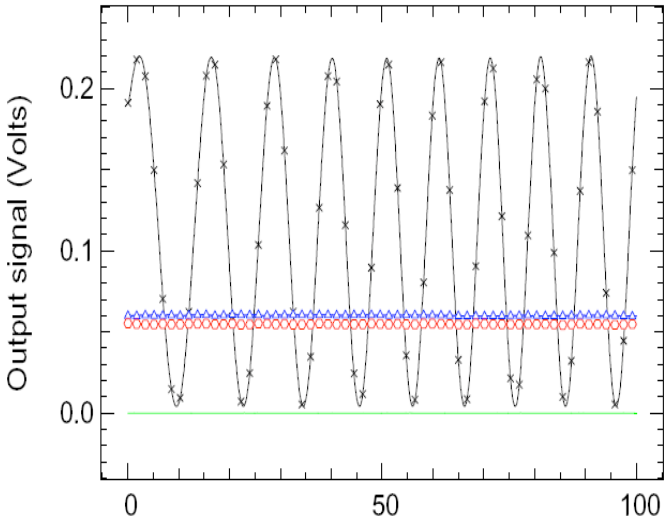
Préparer toutes les fonctions clé pour un futur instrument en bande L

- Guides Droits, Coupleurs, Y en Bande L
- Electro-optique (modulation interne de la phase)
    - Déplacement de 4 franges @ 3.39 µm avec 100 V
- Transmission (T(1cm)=93%)
- Différents matériaux utilisés :
    - Niobate (@ 3-5 µm)
    - Chalcos (@ 5-15 µm)
- Design 2D, 3D (pour raccourcir les composants)





Collaboration avec :
- PNNL (Washington)
- Université Heriot-Watt

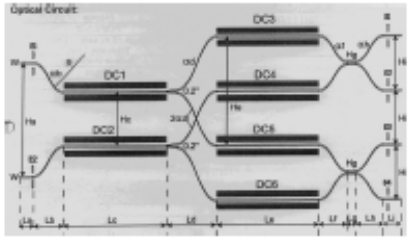


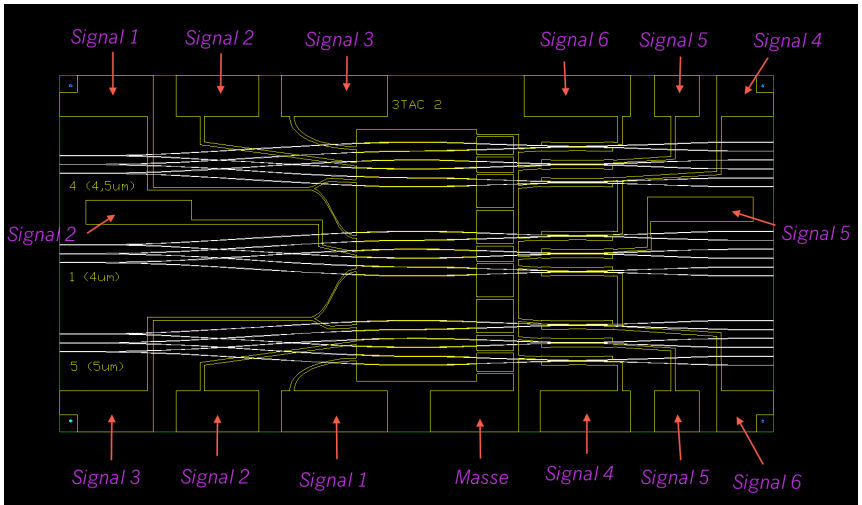
[Labadie et al. 2011]

Optique Intégrée Bande L

FEMTO-ST
PHOTLINE
Besançon

Waveguide building method :
Titanium diffusion
-20h diffusion @ 1050°C
-Both polarizations are guided
-Single mode behavior





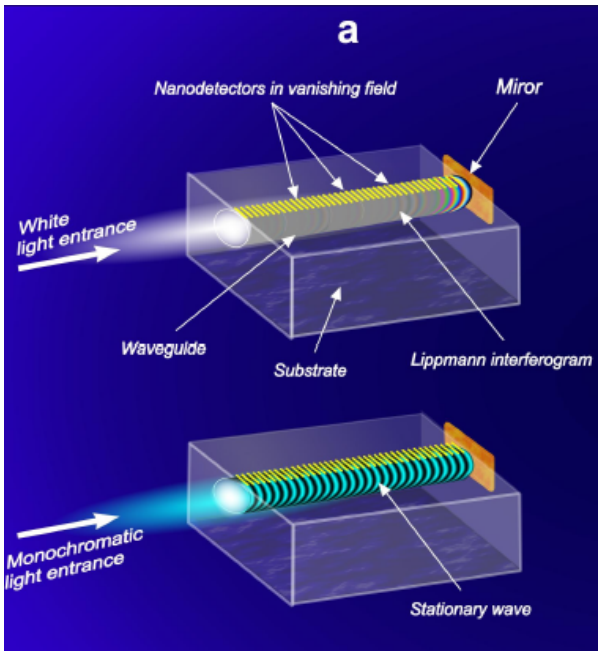
Recombineur à 3 télescopes en bande L

[Heidmann et al. 2012]

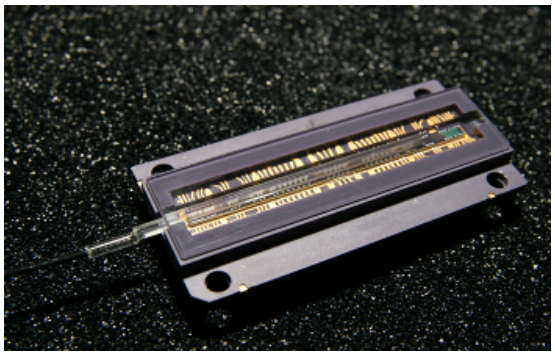
Spectrométrie intégrée

Idée :

Interférence dans un guide + détecteur in situ = spectromètre SWIFTS



[Le Coarer et al. 2007]



λ : [400 nm ; 1000 nm]
R ~ 50000

- Collaboration large : laboratoires académiques et partenaires industriels (FUI)
- Valorisation: start-up Resolution Spectra Systems
- IPAG: concepts, études système, calibration, traitement des données, tests

Detectors for astronomy

- **Connecting and stimulating various actors in « detector » world:**

  = Labex « FOCUS » started in 2012 (PI P. Kern)

- **Long wavelengths:** towards high survey efficiency (numerous and sensitive broadband pixels) based on KIDS.

- **Optical and NIR:** fast and sensitive sensors

  - ✓ **RAPID** *Sofradir – BiospaceLab – LAM – IPAG – CEA/LETI – ONERA*

    Based on avalanche photodiodes

  - ✓ **OCAM** *FP6/Opticon, E2V, OHP, LAM, IPAG, ESO*

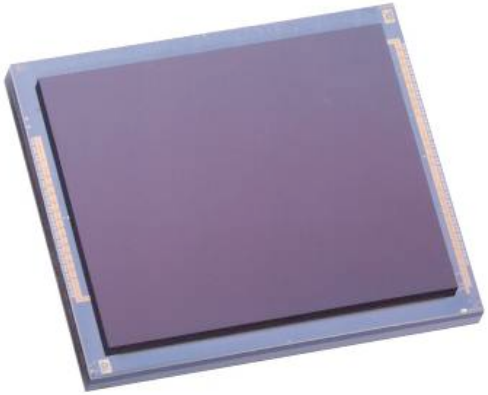
    Based on EMCCD

IPAG
Institut de Planétologie et d'Astrophysique de Grenoble

Rapid

Based on avalanche photodiodes

Funded by a FUI (2009-2012)



320x256 pixels (30 µm)
λ: 0.4-3 µm
1500 images/s
8 outputs
Noise: 3-4 e- (gain = 10) measured by CEA/LETI

Today:

4 chips available

2 are integrated in its cryostat (at IPAG)

Both cameras are equipped with a cold glued H-filter and operate at -200°C (without nitrogen)

The first camera will be soon delivered to ONERA for electronics characterization

First images by 2 months

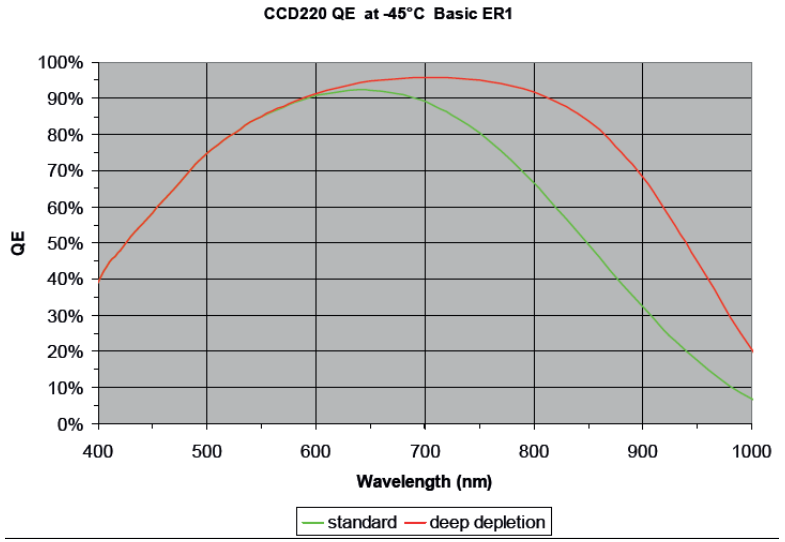
Future: go to the K band (new filter)

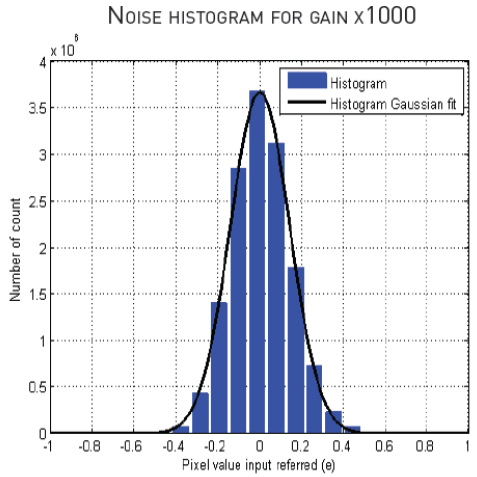
OCAM

Based on EMCCD (E2V detector)

Funded by OPTICON

Designed to match the SPHERE requirements





240x240 pixels (24 µm)

Noise: 0.5e- @ 1500Hz