



The CarbON [CII]line in post-rEionization and ReionizaTiOn epoch project (CONCERTO)

Alexandre Beelen

(on behalf of the CONCERTO Collaboration)



Fact Sheet

■ Focal plane

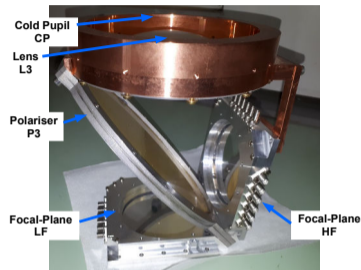
- **Kinetic Inductance Detectors (KIDs)**
- Based on the NIKA2 camera
- FOV $D = 20'$, $f\lambda$ samp. 2×2168
- Frequency range: 120 - 360 GHz
- $f_{\text{samp}} = 3.7$ kHz

■ Cryostat

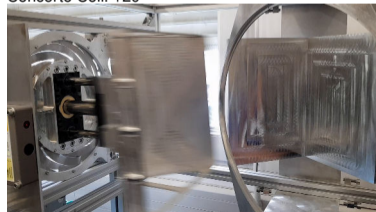
- $^3\text{He} - ^4\text{He}$ dilution 70mK
- 4K standard 2 stages pulse-tube

■ **Martin Puplett Interferometer FTS**

- Warm optic
- Cont. mirror sweep at a few Hz
- Constant $\delta\nu$, $R = 100$ to 300



Concerto Coll. +20





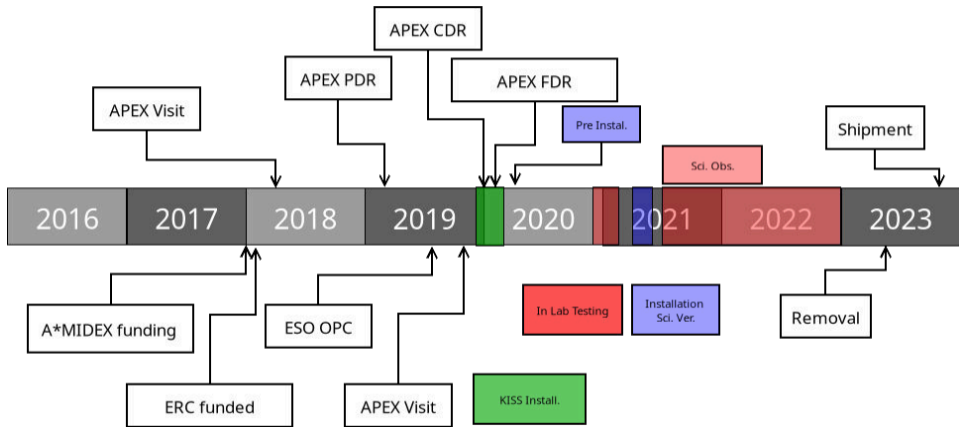
By Jgardiazabal — Personnel Work, CC BY-SA 3.0



Atacama Pathfinder EXperiment

- $D = 12 \text{ m}$
- 5105 m @ Chajnantor
- sub-mm Antenna
- surface upgraded in 2018
- MPIfR / ESO / OSO
(55 / 32 / 13)
- Extension Agreement until **end of 2022**

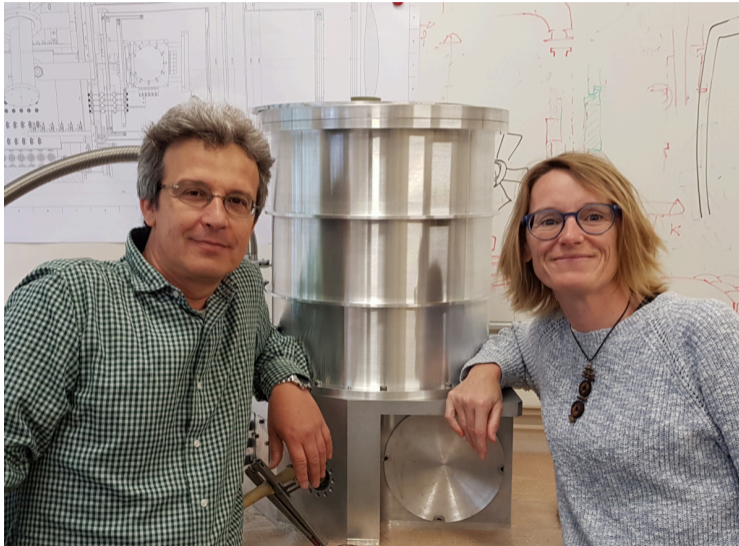
The CONCERTO Project



FOCUS yearly support
KIDs R&D / CONCERTO filters / ...

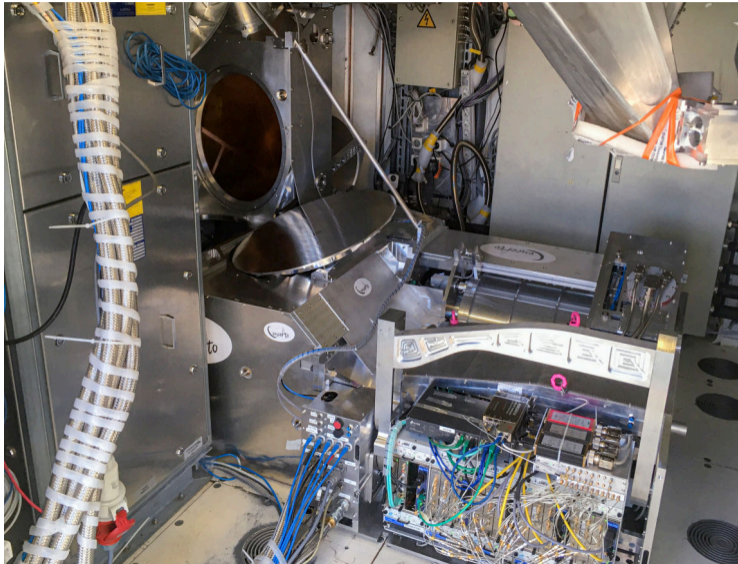
June 2019

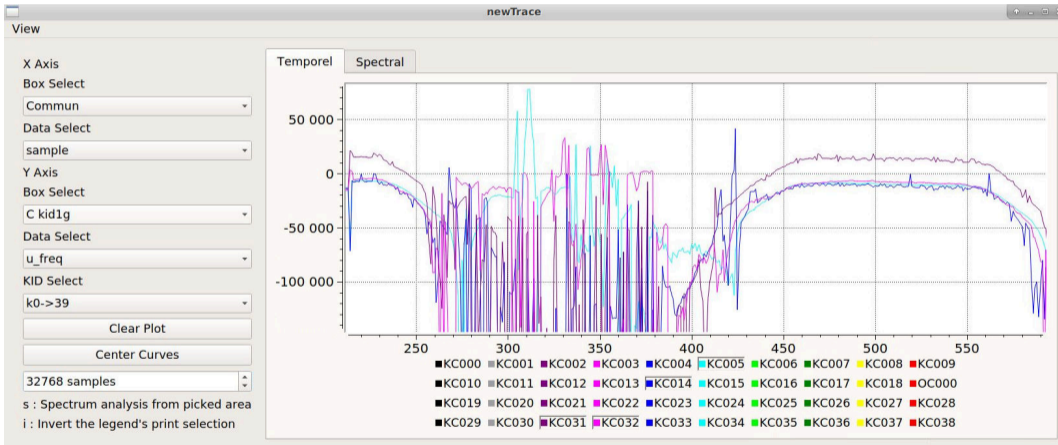
Leaking cryostat



April 14th, 2021

Installation Finished !







Credit: ESO/J. Emerson/VISTA

NGC 6334

Cat's Paw Nebula

- Telescope time: 16 min.
- 37'x25'
- Quickly demonstrating the mapping potential in imaging.
- All the fainter structures in this map are confirmed by existing Artemis, Herschel, SCUBA observations

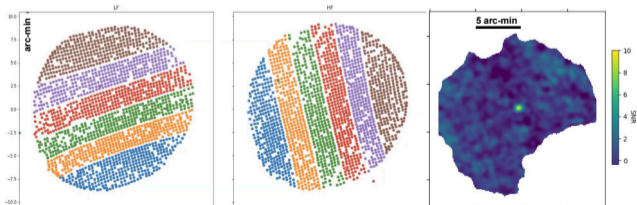
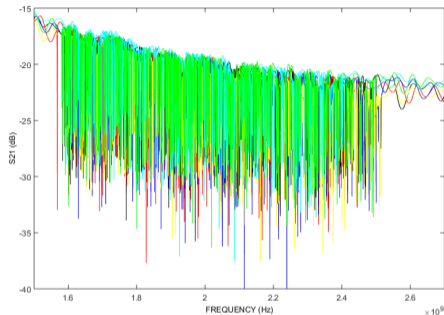
A New Low Res Spectral Imaging Instrument @ APEX

Monfardini+22

On Sky Performances

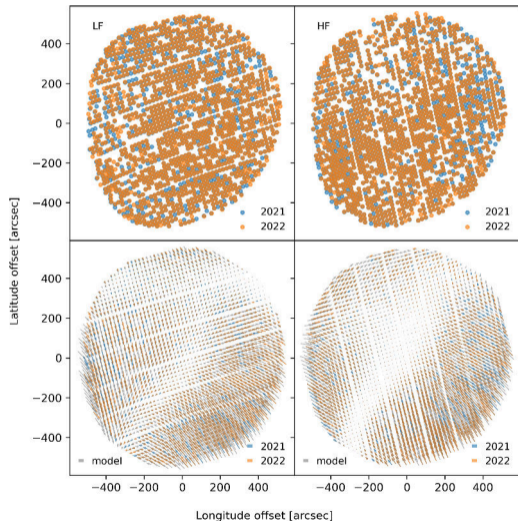
2021

- Fully funct. 90% of 4304 kids
- Sensitivity in agreement
- ~50 Hz optical noise
- Interferograms stability
- Optical aberrations



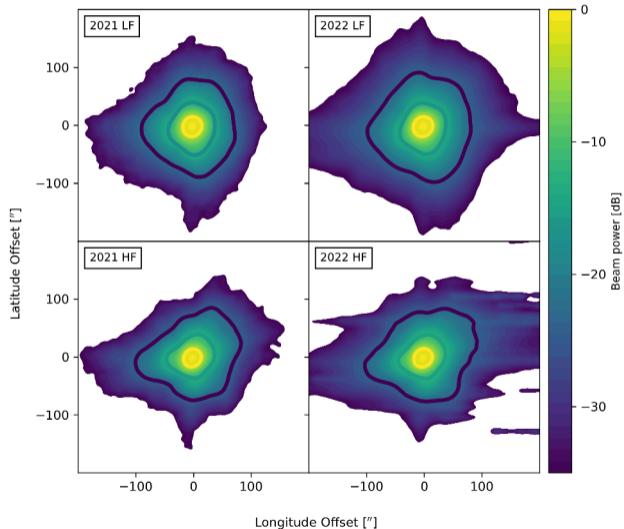
Focal Plane Reconstruction

- $\sim 71\%$ of valid kids
- Large FOV
- Stable between 2 years
- cross-talks ($\sim 15\%$)
- lack of stat. ($\sim 5\%$)
- FOV Deformation
- ellipticity



CONCERTO Performance Assessment in **Continuum**

Hu et al. to be subm.



Beams

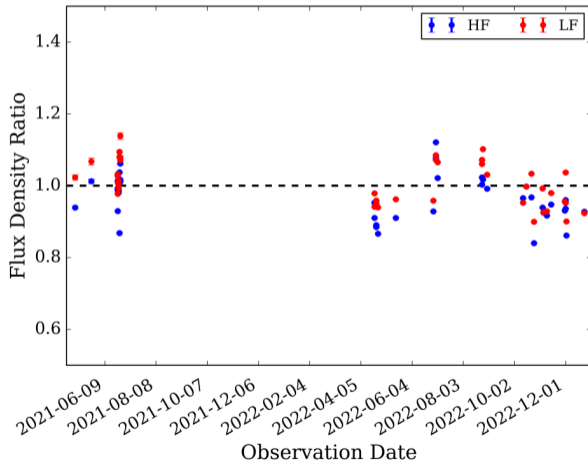
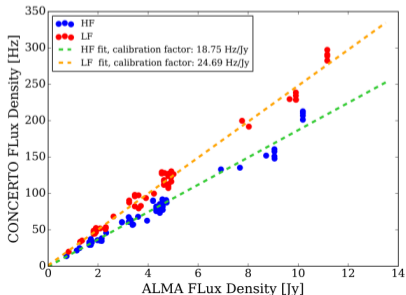
- Main beam
- 2 Error Beams
- down to -30dB !
- ellipticity
- Non Gaussian EB

CONCERTO Performance Assessment in **Continuum**

Hu et al. to be subm.

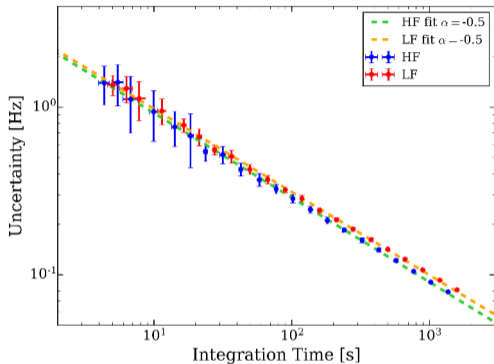
Photometric Calibration

- Derived on Uranus
 - LF 25.5 ± 0.9 Hz/Jy
 - HF 19.4 ± 0.6 Hz/Jy
- Checked on Mars
- Checked on QSO (ALMA)



CONCERTO Performance Assessment in Continuum

Hu et al. to be subm.



Sensitivities

- Noise PS
- Skydip
- Deep field : AS2UDS / COSMOS

NEFD

LF $118.8 \pm 0.3 \text{ mJy.s}^{1/2}$

HF $152.4 \pm 0.6 \text{ mJy.s}^{1/2}$

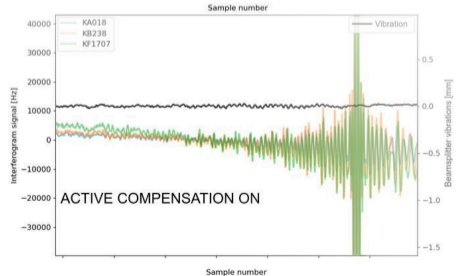
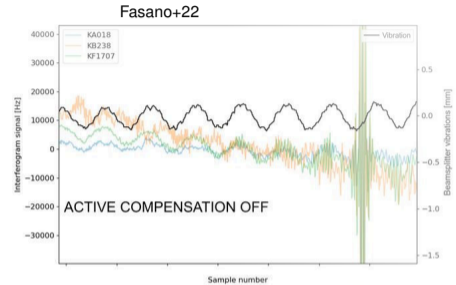
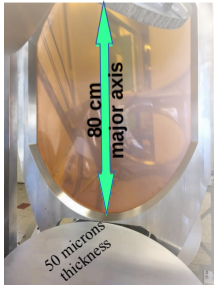
$$\text{rms}(t) \propto t^{-0.52 \pm 0.05}$$

$(112 \pm 48 \text{ mJy.s}^{1/2})$

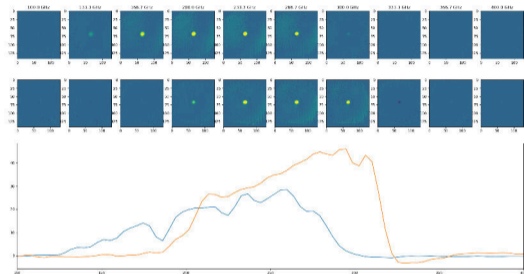
$(146 \pm 30 \text{ mJy.s}^{1/2})$

Systematic effect : Polarizer vibrations

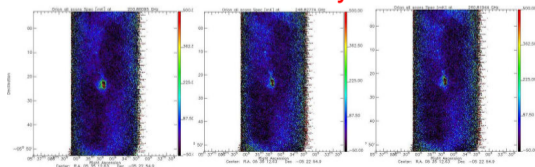
- Resonance frequencies (~ 47 Hz)
- OPD random noise
- Noise Cancelation down to ~ 10 Hz
- ... in open space since 02/2022



Mars – Preliminary



Orion – Preliminary



Remaining Challenges

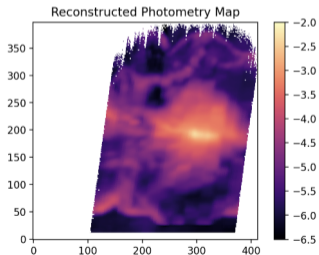
- Detector non linearities
- Precise Bandpasses
- Sailing effect
- Zero Path Difference
- Atmospheric emission
- ...

CONCERTO Simulation Mode

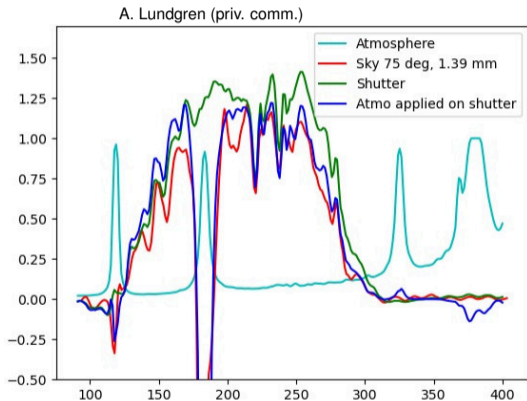
A. Fasano et al. in prep.

End-to-end Simulations

- Telescope scans / Laser course
- MPI reference
- Atmospheric emission
- Systematics



C. Dubois (priv. comm.)



CONCERTO LP

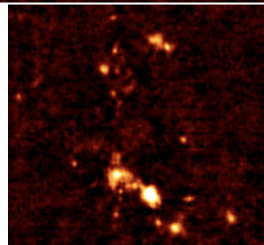
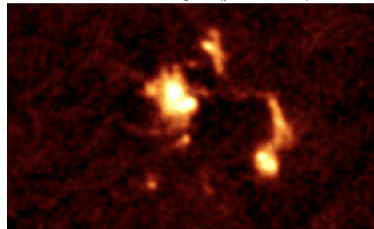
LIM [CII]

- COSMOS field
- 1.4 deg²
- 800 hrs ESO/OSO + 65 hrs CL

Open Time Programs

- 6 SZ Clusters
- 3 ISM studies
- 2 Evolved Stars
- ~ 465 hrs

RCW 122 – A. Lundgren (priv. comm.)



W33 – A. Lundgren (priv. comm.)

CONCERTO Removal

2023/05/21



2023/05/23

End of Observations

- Back to Europe (maybe?)
- 2 PhD thesis
- 2 PostDocs

Beginning of Data Analysis

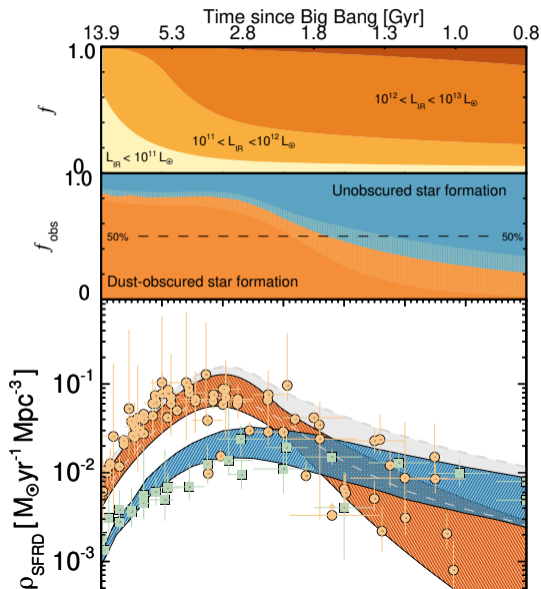
- Lab measurements (?)
- 2 PostDocs

The First Day of the Rest of the CONCERTO Project



Data Analysis is still on-going for the spectroscopic side
Stay tuned !

Why [CII] Intensity Mapping ?



SFRD vs $z < 2$

- Many observations
- Optical & IR

SFRD vs $z > 4$

- Fewer observations
- Model dependence
- **DSFGs contribution ?**

[CII]

158 μm 

- Brightest emission line in the

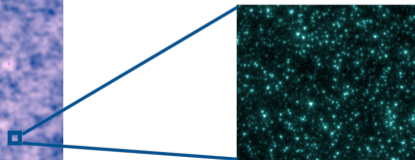
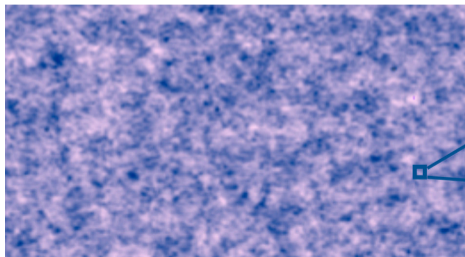
Why [CII] Intensity Mapping ?

Line Intensity Mapping

- Angular fluct. of Brighness
- Including faint sources
- Model dep.
- Foregrounds

Galaxy Surveys

- Individual sources
- Precise measurements
- very limited sample
- limited area



Galaxy surveys (HST,
Spitzer, JWST, ALMA)