The future of NIKA2
-
KIDs @Grenoble

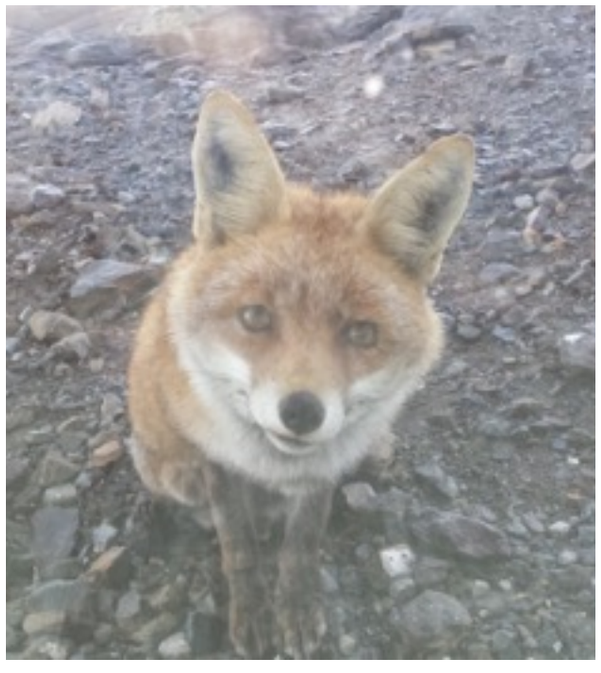
Nicolas Ponthieu,
on behalf of
Institut Néel, LPSC, IPAG, IRAM

NIKA2

A dual band KID camera at 150 and 260 GHz with polarization capability at 260GHz, operating at the IRAM 30m telescope, (Pico Veleta, Spain, alt. 2900m)

PI: A. Monfardini, I. Néel

NIKA2



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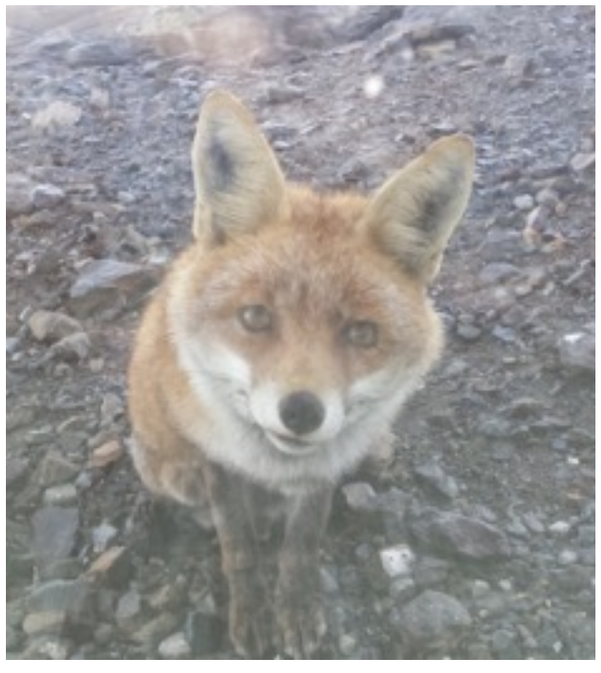

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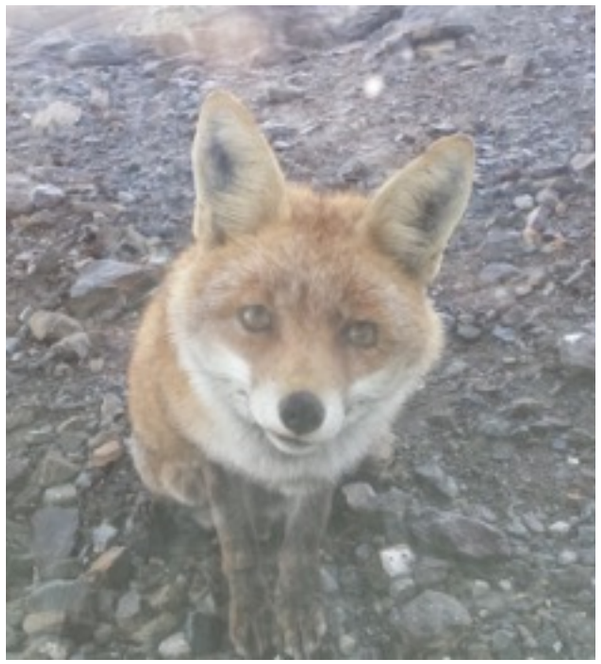

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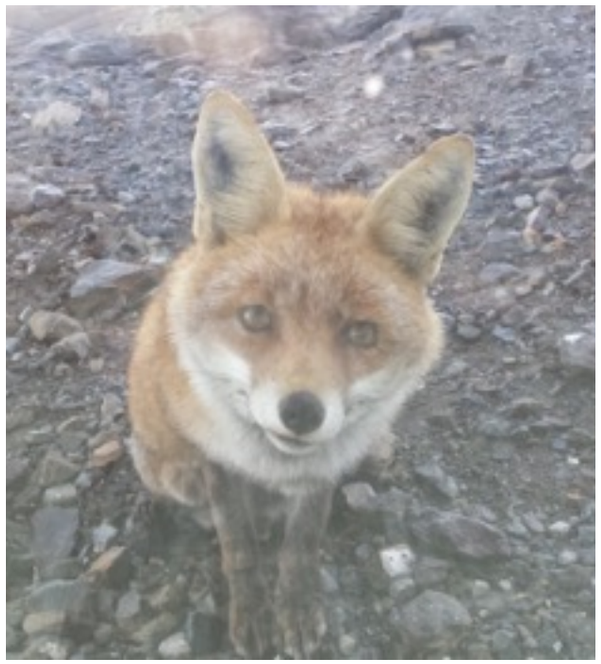

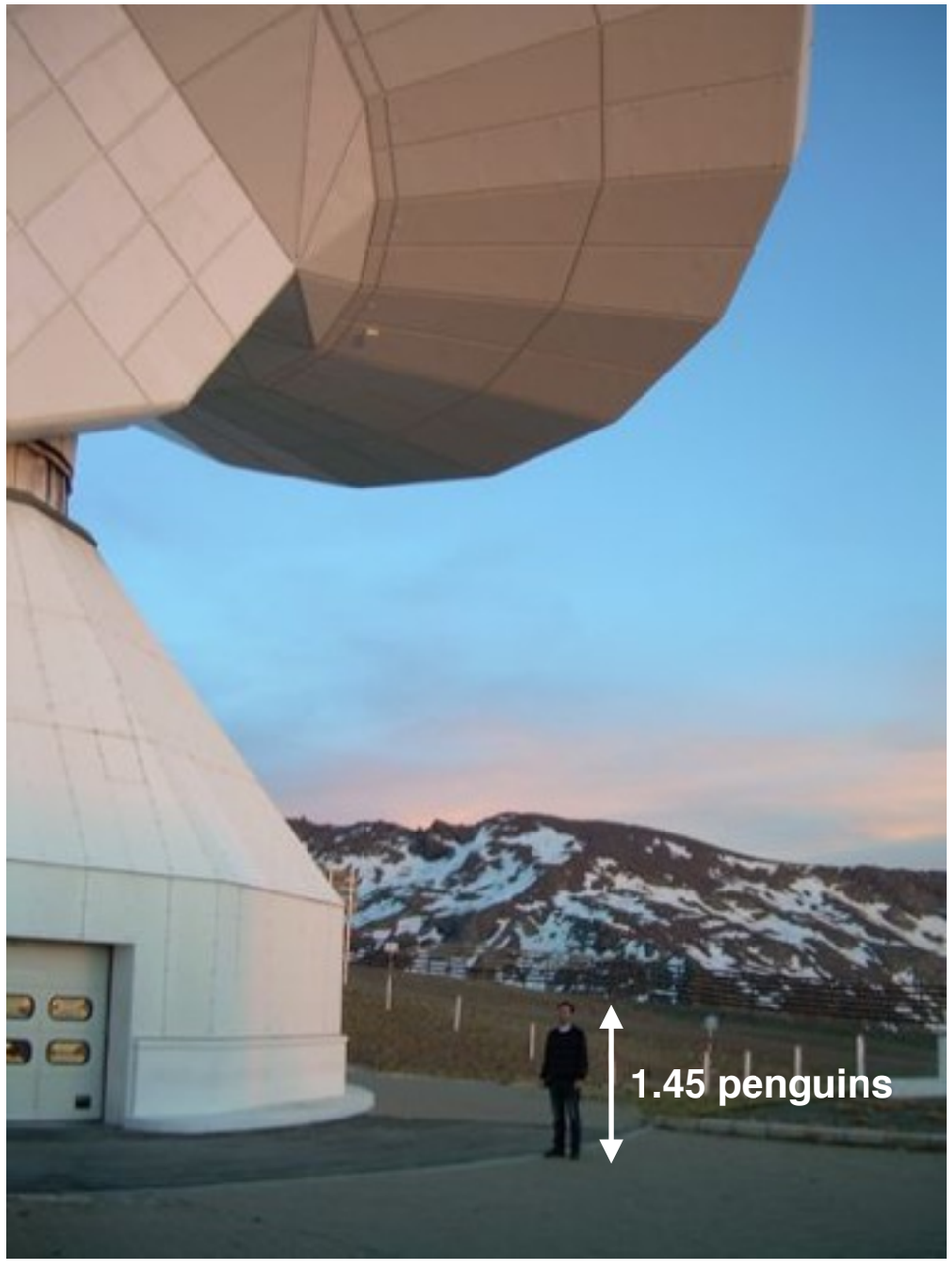

NIKA2 Consortium

@Grenoble Perm. staff FTC

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Ph. Camus IR
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http://ipag.osug.fr/nika2

NIKA and NIKA2

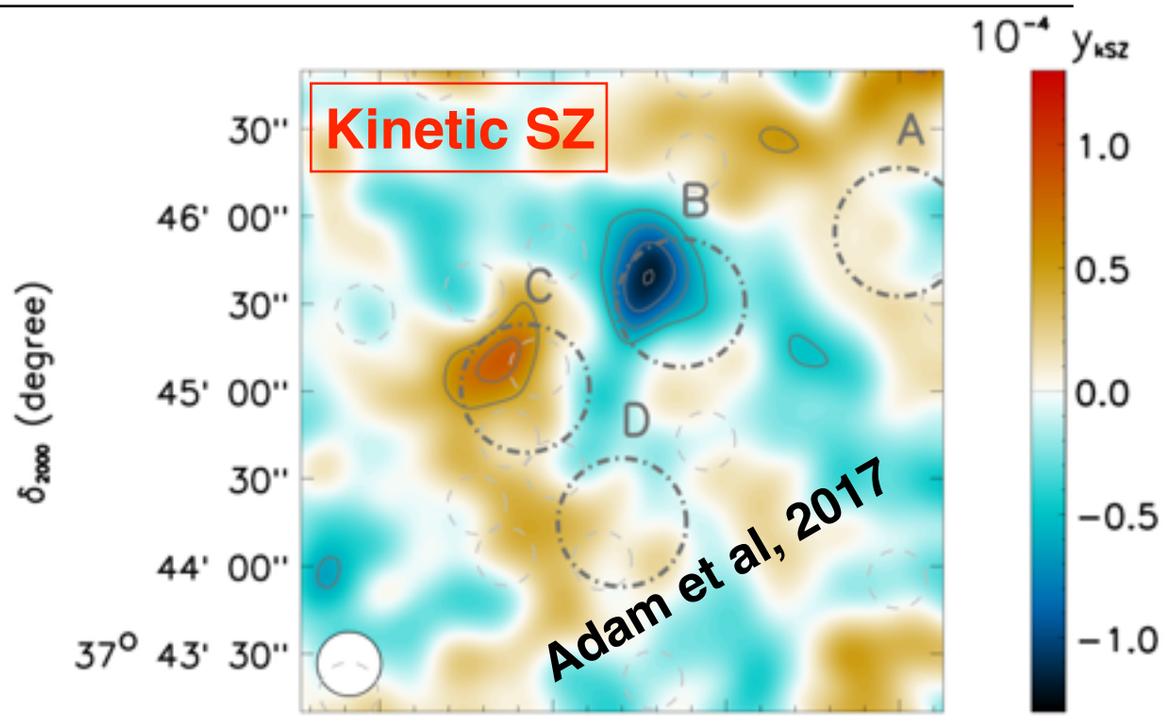
http://ipag.osug.fr/nika2

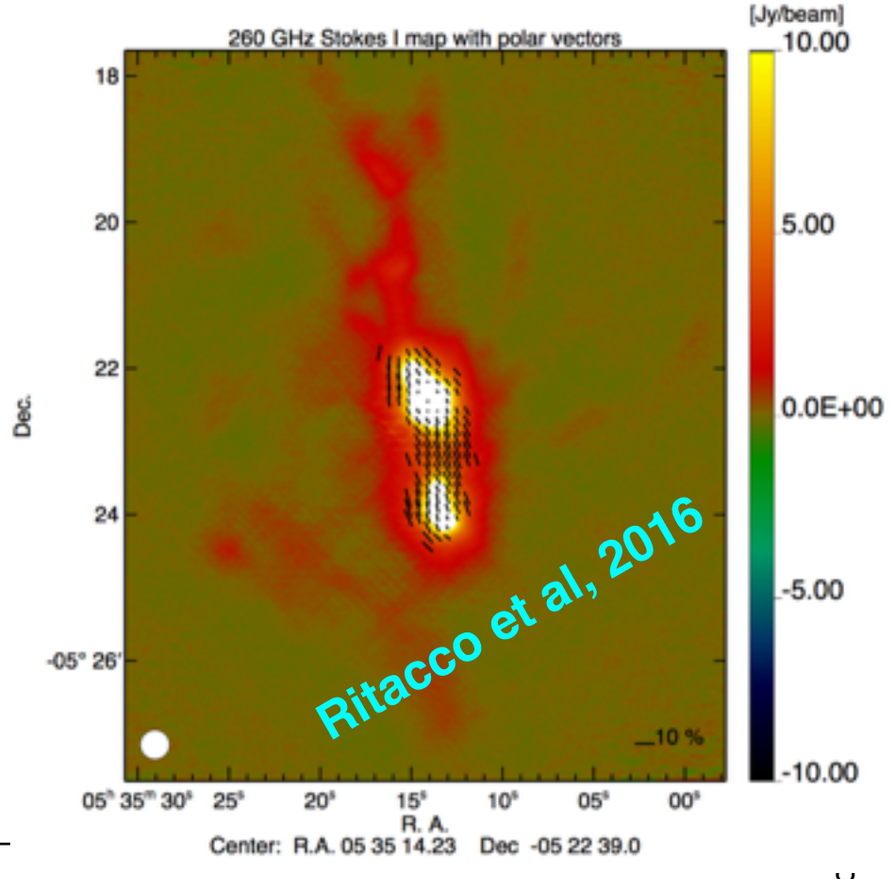
Welcome Instrument Science Schedule **Publications** PhD's Collaborators

NIKA2

Astronomical Publications
- Ritacco, A., Macias-Perez, J.-F., Ponthieu, N., et al, 2018, A&A, 616, A35 [arXiv:1804.09581]
- Ruppin, F., Mayet, F., Pratt, G. W., et al, 2018, A&A, 615, A112 [arXiv:1712.09587]
- Adam, R., Adane, A., Ade, P. A. R., et al, 2018, A&A, 609, A115 [arXiv:1707.00908]
- Rigby, A. J. N., Peretto, N., Adam, R. et al, A&A, 20018, 615, A18 A&A [arXiv:1801.09801]
- Adam, R., Hahn, O., Ruppin, F., et al, A&A, 2018, 614, A118 [arXiv:1712.01836]
- Romero, C., McWilliam, M., Macias-Perez, J.-F., et al, submitted A&A [arXiv:1707.06113]
- Adam, R., Arnaud, M., Bartalucci, I., et al, 2017, A&A, 606, A64 [arXiv:1706.10230]
- Bracco, A., Parlmeirim, P., Andre, Ph., et al, 2017, A&A, 604, A52, [here]
- Ritacco, A., Ponthieu, N, Catalano, A., et al, 2017, A&A, 599, A34 [astro-ph]
- Ruppin, F., Adam, R., Comis, B., et al, 2017, A&A, 597, A110 [astro-ph]
- Adam, R., Bartalucci, I., Pratt, G. W., et al, 2017, A&A, 598, A115 [astro-ph]
- Adam, R., Comis, B., Bartalucci, I., et al, 2016, A&A, 586, A122 [astro-ph]
- Adam, R., Comis, B., Macias-Perez, J.-F., et al, 2015, A&A, 576, A12, [ADS, DOI, pdf] [astro-ph]
- Adam, R., Comis, B., Macias-Perez, J.-F, et al, 2014, A&A, 569, A66 [ADS, DOI, pdf] [astro-ph]

Instrumental Publications
- Catalano, A., Adam, R., Ade, P., et al, 2016, SPIE, [astro-ph]
- Goupy, J., Adane, A., Benoit, B, et al, 2016, JLTP, in press, DOI 10.1007/s10909-016-1531-y [astro-ph]
- Calvo, M., Benoit, A., Catalano, A, et al, 2016, JLTP, DOI 10.1007/s10909-016-1582-0 [astro-ph]
- Ritacco, A., Adam, R., Adane, A., et al, 2016, JLTP, Vol. 184, Issue 3-4, pp, 724-732 [astro-ph]
- Bourrion, O., Benoit, A., Bouly, J.-L., et al, 2016, submitted to JINST [astro-ph]
- Catalano, A., Ponthieu, N., Calvo M., et al, 2014, A&A, 569, A9 [ADS, DOI, pdf] [astro-ph]
- Monfardini, A., Adam, R., Adane, A., et al, 2014, JLTP, Vol. 176, Issue 5-6, pp. 787-795, [ADS, DOI]
- Calvo, M., Roesh, M., Désert, F.-X., et al, 2013, A&A, 551, L12, [ADS, DOI, pdf]
- Bourrion, O., Vescovi, C., Catalano, A. et al, 2013, Journ. of Instr., Vol. 8, Issue 12, article id. C12006 [ADS, DOI]
- Bourrion, O., Vescovi, C., Bouly J.-L. et al, 2012, Journ. of Instr., Vol. 7, Issue 07, pp. 7014, [ADS, DOI, pdf]
- Bourrion, O., Bideaud, A., Benoit, A., et al, 2011, Journ. of Instr., Vol. 6, Issue 06, pp. 6012, [ADS, DOI, pdf]
- Monfardini, A., Benoit, A., Bideaud, A., et al, 2011, ApJs, 194, 24 [ADS, DOI, pdf]
- Monfardini, A., Swenson, L. J., Bideaud, A., et al, 2010, AAp, 521, A29 [ADS, DOI, pdf]

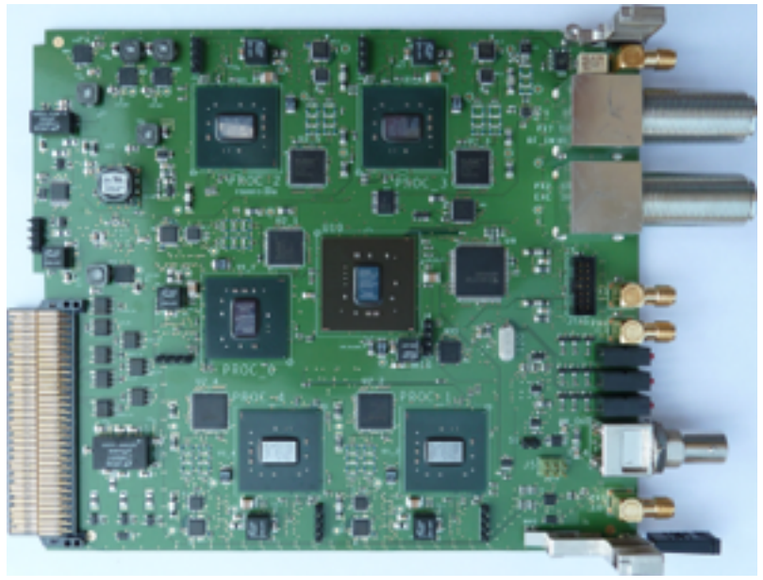




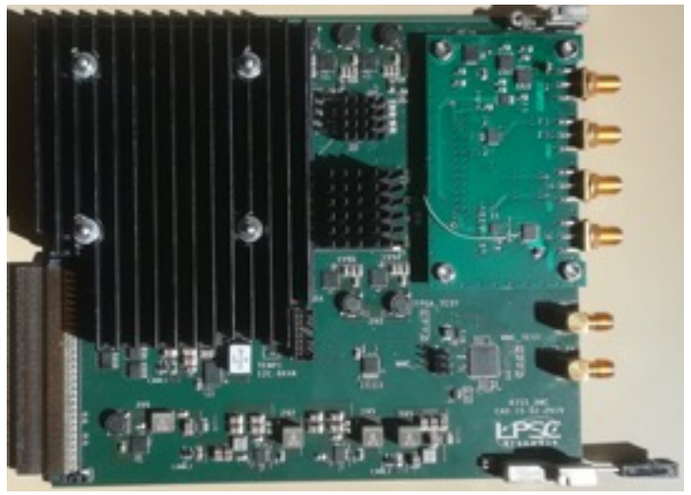
KIDs4CMB

KIDs4CMB: mux factor

NIKA2



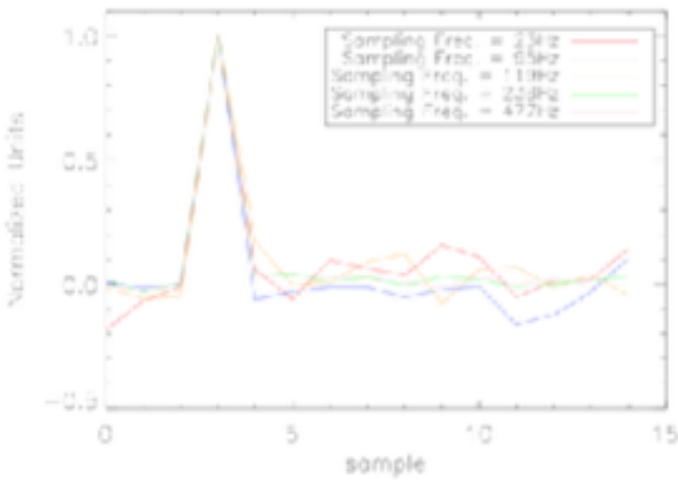
KISS/Concerto

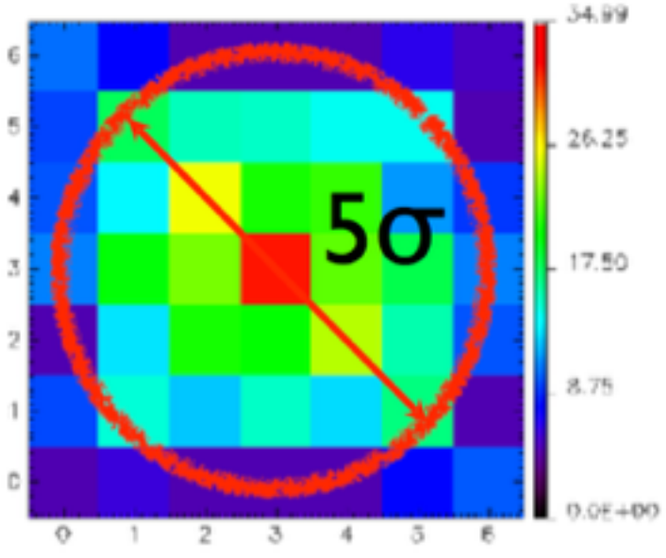


		NIKA2	KISS	Concerto
Elec. design	Matrix KID/Board	300	300	400
	Excitation range	1.3 - 2.8 GHz	400 - 900 MHz	1 - 3
	Max. analog badwidth	500 MHz	500 MHz	1GHz
	Readout max power	54 W	54 W	~30W
Matrix	Avg. resonance	2 - 3 MHz	1 - 2 MHz	1 - 3 MHz
	Number of KIDs/board	160 - 250	160 - 250	>300
	Optical freq.	120 - 300 GHz	80 - 270 GHz	120 - 360 GHz

KIDs4CMB: time constant

- ***An attenuation of the impact of the CRs***

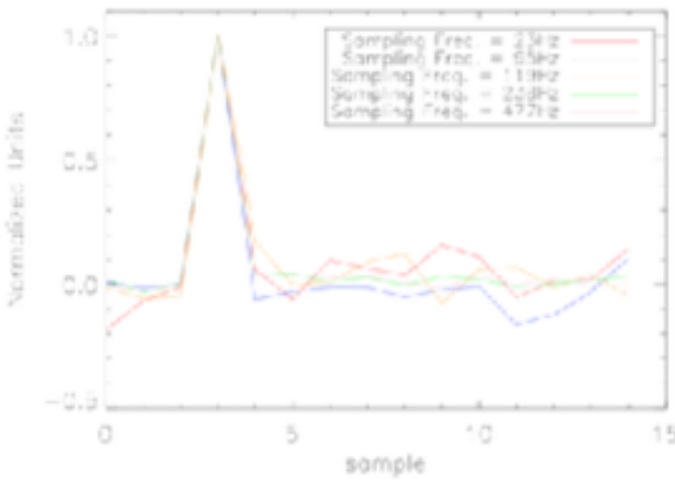


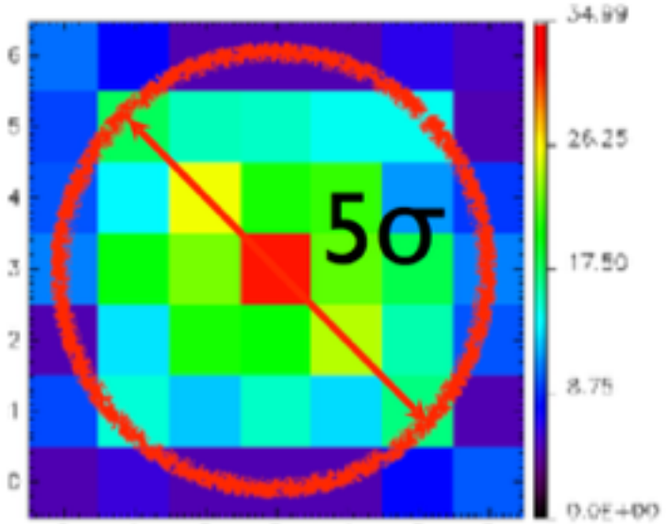


the surface of the silicon wafer impacted by a typical 200 MeV CR never exceeds a square of about 6x6 detectors (about 1.4 cm²).

KIDs4CMB: time constant

- ***An attenuation of the impact of the CRs***

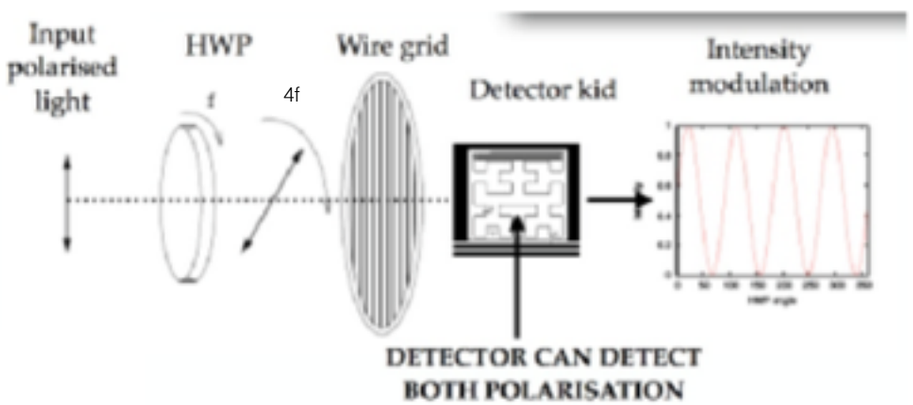


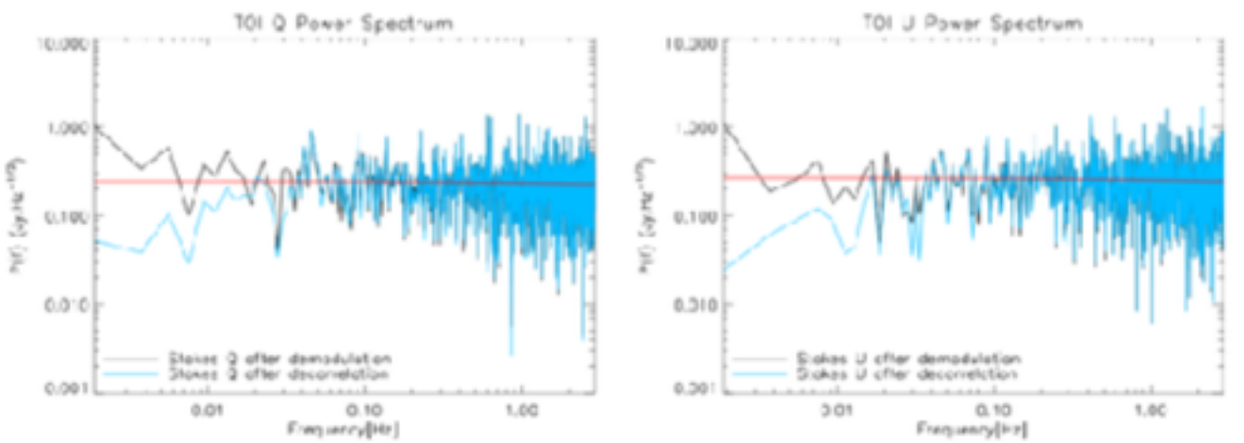


the surface of the silicon wafer impacted by a typical 200 MeV CR never exceeds a square of about 6x6 detectors (about 1.4 cm²).

- ***Use of a fast rotating optical element in front of the detector***

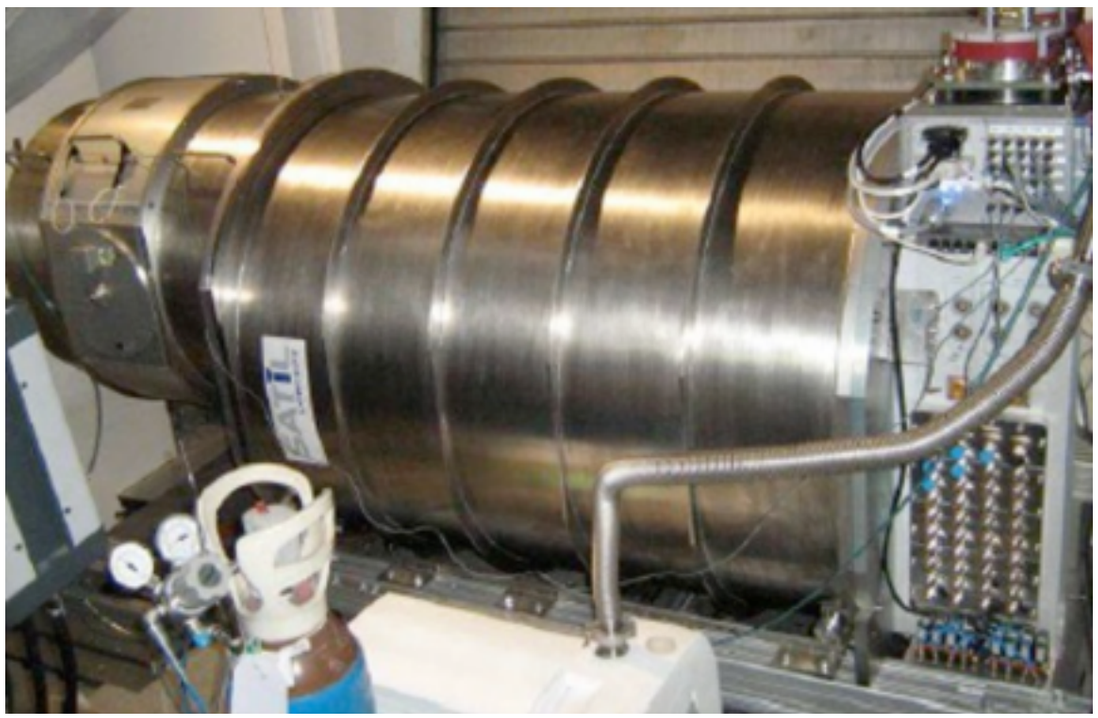
NIKA2 polarisation strategy

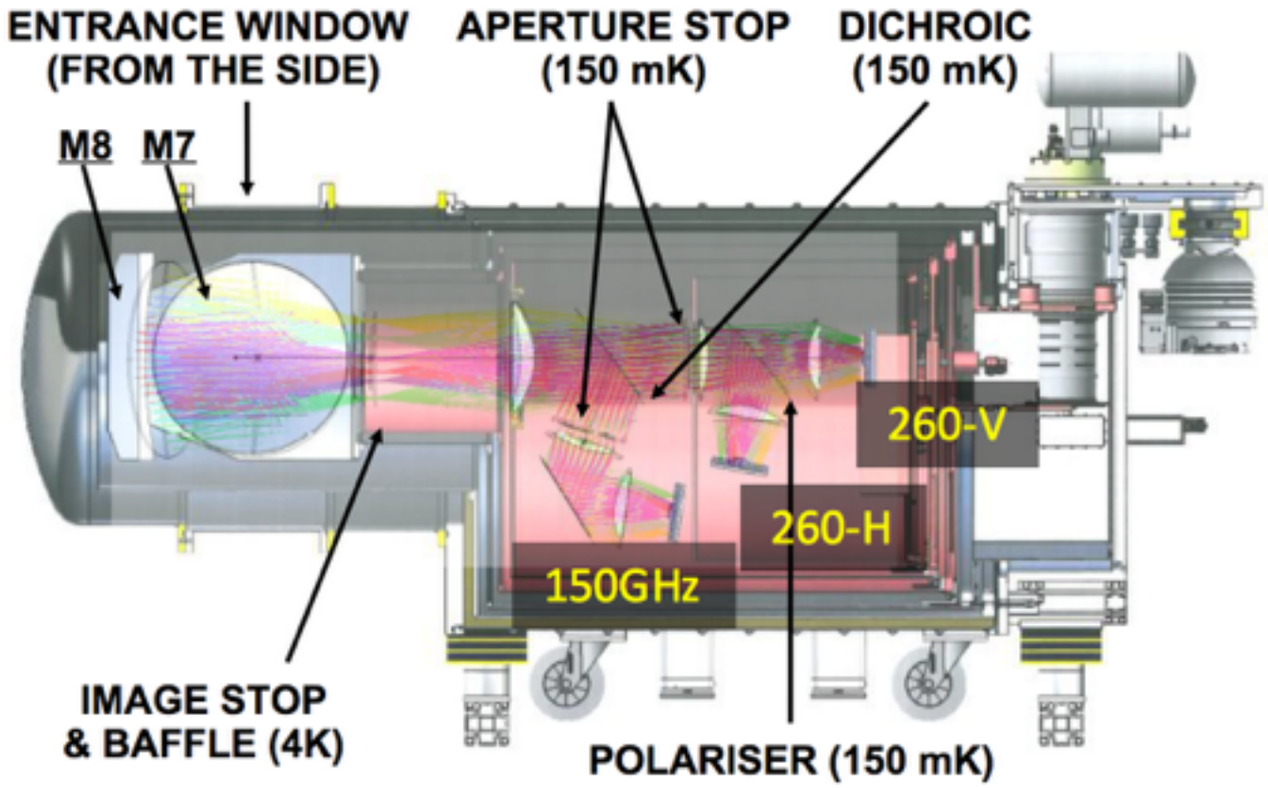




Flat noise spectrum thanks to the fast rotating half-plate (polarisation modulated at 12 Hz)

KIDs4CMB: sensitivity

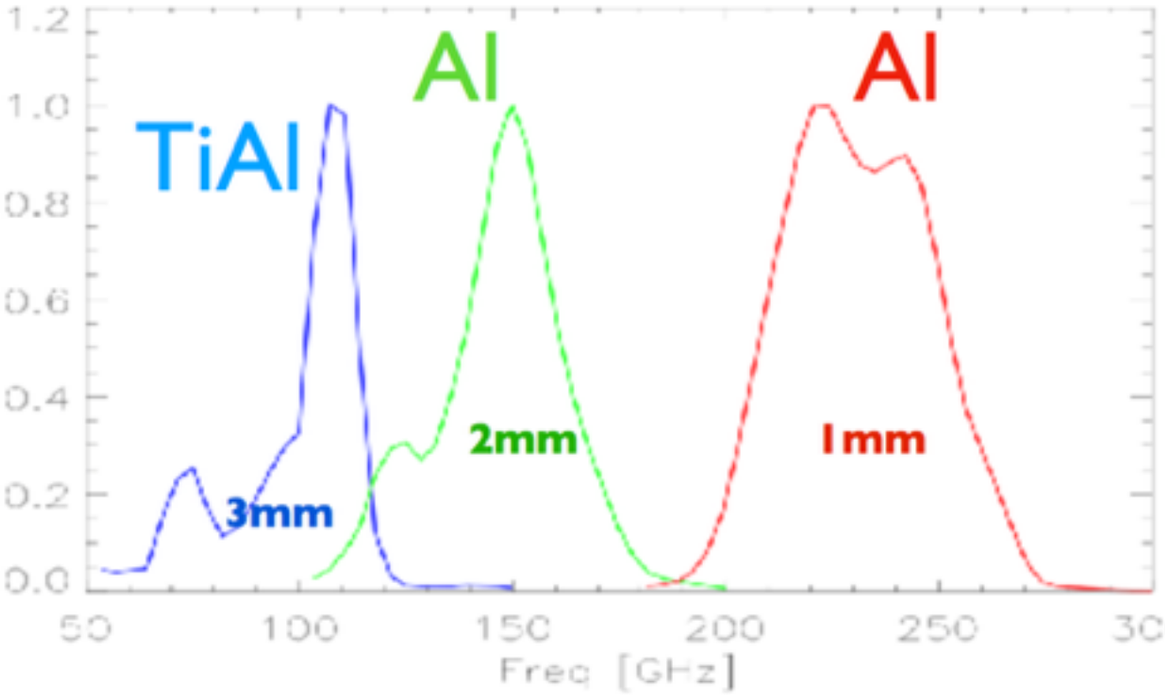


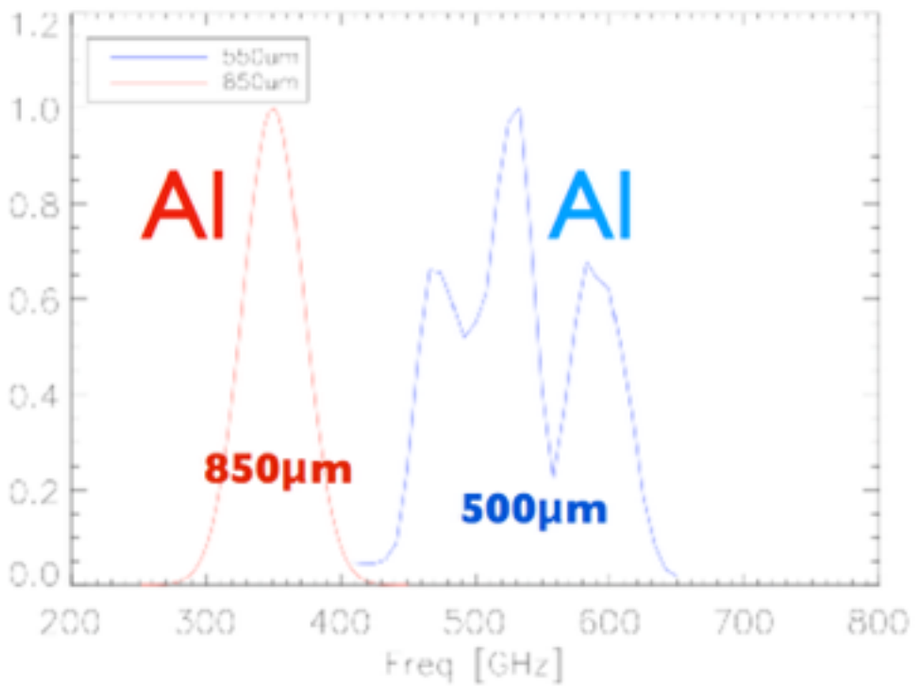


PER DETECTOR SENSITIVITY	150 GHz	260 GHz
@IRAM (mJy.s$^{1/2}$/beam)	8 +- 1	33 +- 2

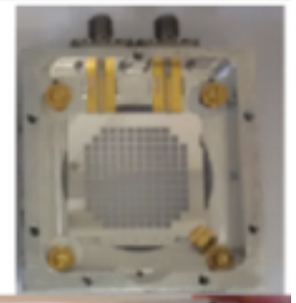
Assuming comparable SOmega as BICEP, while not accounting for atmospheric quality difference between IRAM and the South Pole, nor loss due to the 30m mirror, this leads to < 700 uK.s$^{1/2}$ at the pole (per KID at 150 GHz), i.e. a factor 2 compared to BICEP2 detectors.

KIDs4CMB: spectral response

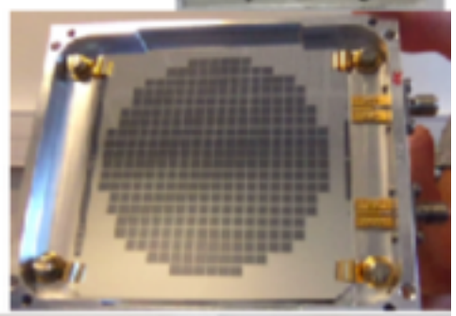




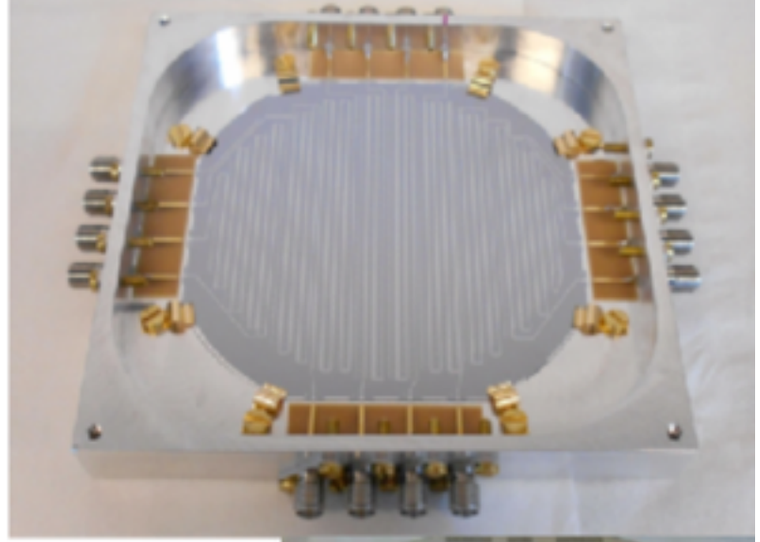
LEKID Demonstrators for space (132pix)
3mm - 2mm - 1mm - 850µm - 500µm



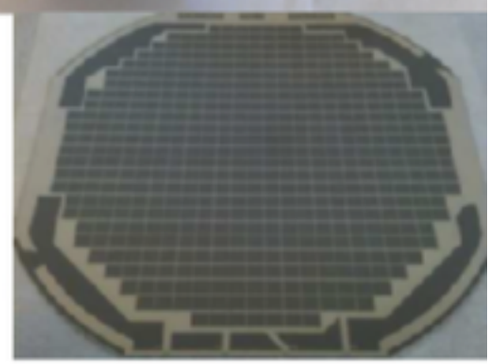
LEKID Array for KISS Interferometer (300pix) TiAl@3mm



LEKID Array for NIKA2 (2000pix) Al@3mm



LEKID Array for Ballon (500 pix) Al@500µm



KIDs: *rekap*

- Relatively simple to manufacture (1 lithographic step, more than 10 matrices of 100-2000 pixels built and tested in a single year)
- Relatively cheap
- Work at T<< material critical T, hence largely immune to bath temperature fluctuations and microphonics
- Tested from below 100 to above 500 GHz
- Mux factor larger than 300 achieved and put on sky
- Time constant below milli-second:
  - mitigates cosmic ray impact
  - allows for fast HWP polarization modulation and atmospheric noise rejection

Grenoble's timeline

2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025

NIKA1

NIKA2
build/install

NIKA2
commissioning

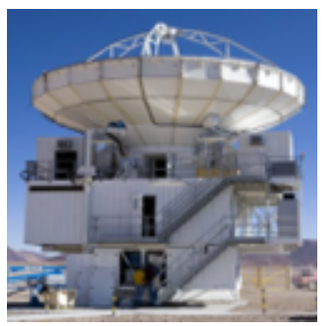
NIKA2
polarization and Large Programs

Imager 140 - 260GHz (pol)
3000 KIDs
@Pico Veleta IRAM spain

KISS
build and install

KISS
commiss/obs.

MP spectr. 70-260GHz
600 KIDs
@Quijote Tenerife



CONCERTO
build/install

CONCERTO
Commissioning & Observations

MP spectr. 120-350GHz
5000 KIDs
@APEX Chile

NEXT?
Concept study

NEXT?
Build and install

NEXT? in practice

- Experience driven cost estimate

	k€	
Test set-up (cryo,filters,optics)	800	
Room T electronics	432	36 /500KIDs
Room T electronics R&D	200	
Cold electronics	144	12 / 500 KIDs
Detector fabrication	300	
Detector R&D	250	250 / band
Optics R&D	200	
Opt. /mecha. module assembly	500	
Postdocs	960	
Running expenenses in lab	500	for 5 years
Integration and installation	280	
Contingency and environment		25% for CNRS
TOTAL	**5.7 M€**	**~ 7M€ for 2 modules**

- How does it fit in practice with current/forecast telescopes, current/forecast focal plane availabilities, timescales…?

- How to share tasks ?

Summary

- KIDs have demonstrated versatility and performance
- The combination of KIDs and a 3Hz rotating HWP are great at rejecting sky noise in polarization
- Building one tube (from scratch) at 150GHz with 6,000 pixels would coast 5.3M€, and extra one possibly at another frequency, probably 2M€ more
- Grenoble has gained experience on the full chain from design to observations on a 3,000 pixel CMB band camera
- In the context of on-going projects, timescales and current commitments, we are interested in providing KID detectors and electronics
- Discussions have started with colleagues from both SO and SPO, no firm plan of action at this stage
- We are putting together an administrative structure: ***G****roupement d'****I****nterêt* ***S****cientifique*, starting… now
    - Maintain key man power
    - Upgrade current facilities to allow larger production and higher TRL (Currently 4)