

11/April/2019

Alessandro Fasano

An overview of KISS

A spectrum-imager dedicated to the study of the secondary anisotropies of the CMB







Outlines *The path*

Ph.D. in instrumental technology for mm-astronomy

- . Science context and requirements
 - Sunyaev Zel'dovich Effect
- II. Observation strategy and instrument design
 - Fourier Transformation Spectrometry
 - Fast detectors: Kinetic Inductance Detectors
- III. Laboratory tests and characterization
 - Detectors performances
 - Geometrical characterization
- IV. Installation and observations
 - My role in this phase
 - The Moon observations
 - Focus on the pointing model
- V. Conclusions and perspectives

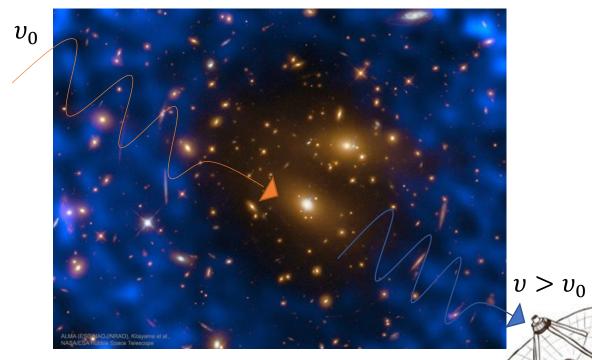
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I. Science context and requirements

Sunyaev Zel'dovic Effect

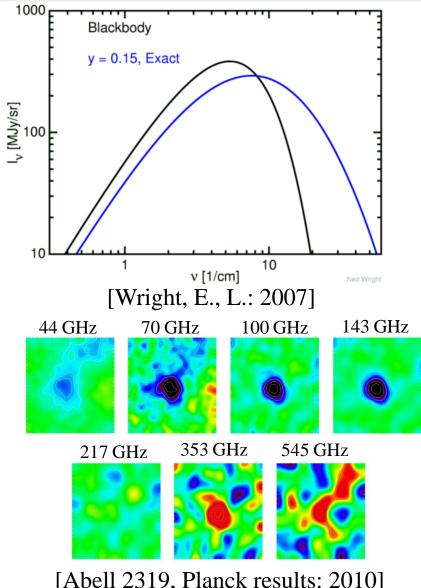
Inverse Compton scattering CMB-IntraClusterMedium

RXJ1347.5



[Kitayama, T. et al.: 2016]

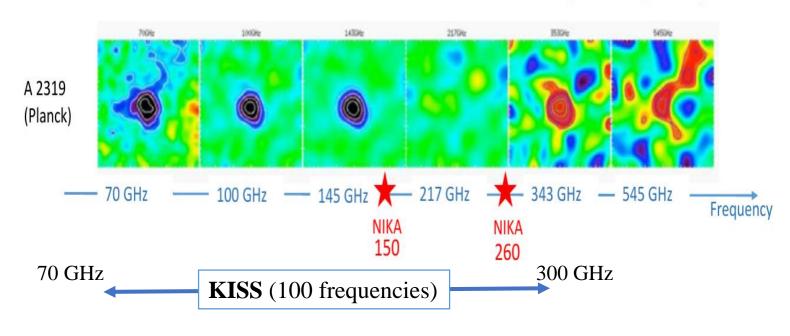
$$\frac{\Delta T_{SZE}}{T_{CMR}} \approx \frac{\Delta v}{v} \cdot \tau \approx 10^{-4}$$



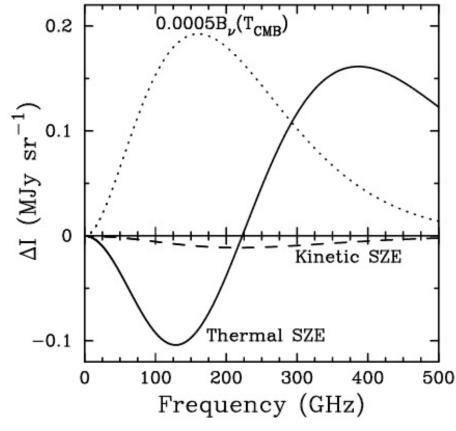
[Abell 2319, Planck results: 2010]

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I. Science context and requirements SZE - state of art



Experiment	# frequencies	angular resolution @ 150 GHz	# pixels
Planck	6	5 arcmin	52
NIKA2	2	20 arcsec	5'000
KISS	100 ←	4 arcmin	632



Observing several frequencies to separate the SZ components

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I. Science context and requirements State of art and necessities

GOAL

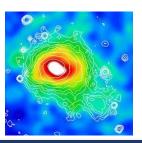
Low resolution spectroscopy observations of known low redshift galaxies at mm wavelenghts to map cluster physical properties from spectral distortions.

STRATEGY

Compensate relative expected low sensitivity with respect to Planck or photometric ground-based instrument by integrating longer (tens of hours per cluster).

Use spectroscopy to fully separate different components and extract physical information from spectral distortions: pressure, temperature, density, mass, LOS velocity

Possible target COMA cluster



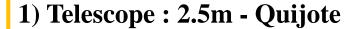
From scientific requirements to instrumental characteristics

1) Low angular Resolution

(low redshift clusters)

- 2) Large FOV and band 100-300GHz
- (~1 Degree)
- 3) Low Spectral resolution
- (~1.5-10GHz at least 20 bins to separate properly different contributions)
- 4) Maximum Sensitivity

(photon noise detectors)



(~ few degrees corrected FP angular resolution from about 2 to 5 arcmin)

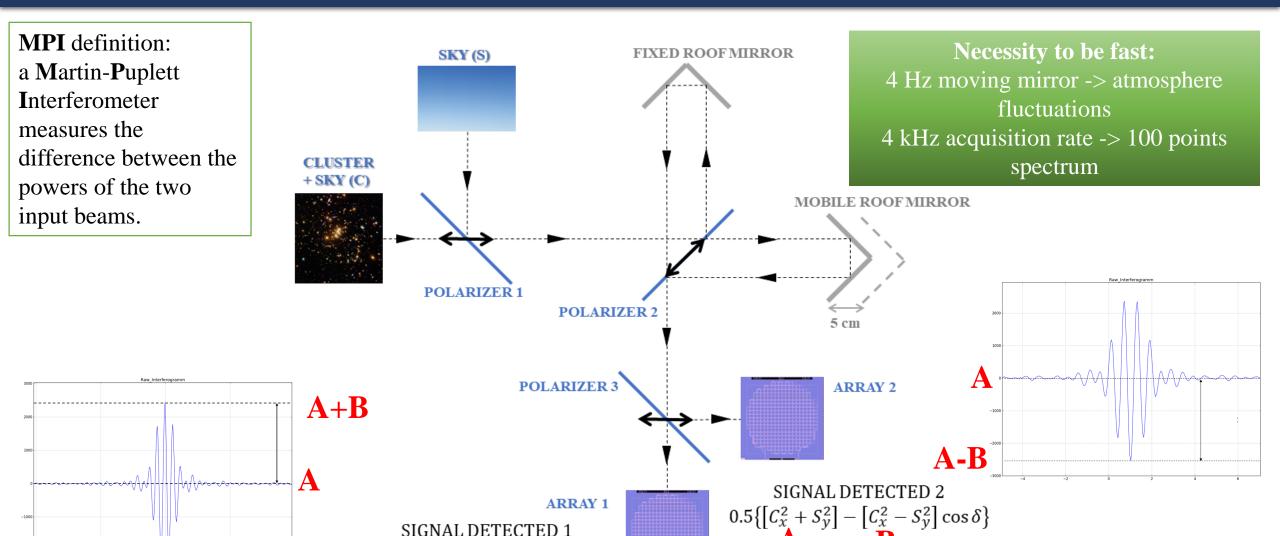
2) FTS Technique - Fast MPI

(10 cm excursion, fast acquisition, avoid 1/f noise from the atmosphere.)

3) 2 Arrays of 300 pixels



Fourier Transformation Spectrometry

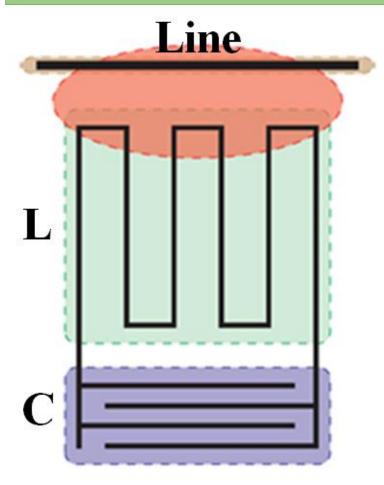


 $0.5\{ \left[C_x^2 + S_y^2 \right] + \left[C_x^2 - S_y^2 \right] \cos \delta \}$

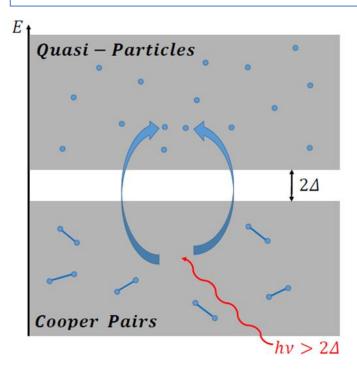
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Fast Detectors: Kinetic Inductance Detectors

High-Q LC series circuit, feedline coupled, working at superconducting regime

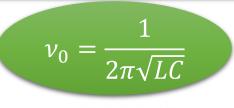


A KID measures the variation of the population of the quasi-particles in a superconducting resonator

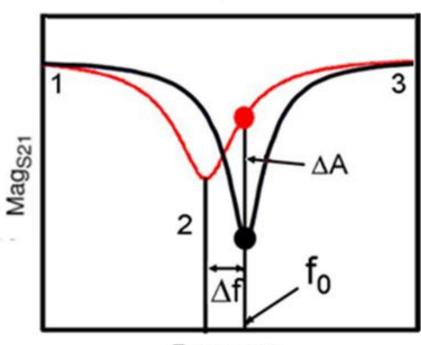


Binding Energy

 $2\Delta = 3.5k_BT_c$



Amplitude

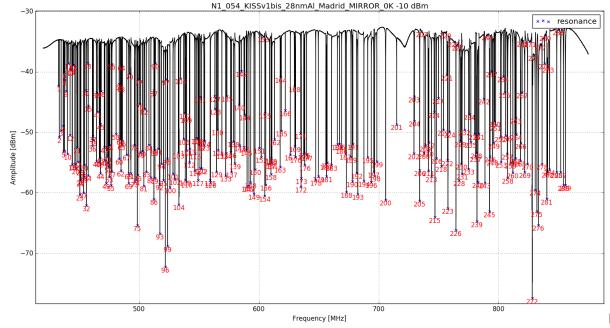


Frequency

Very low temperatures required order of 100 mK

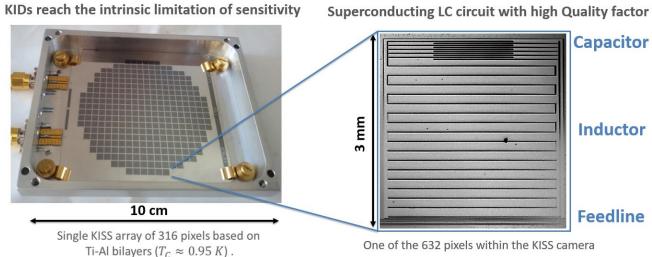
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Fast Detectors: Kinetic Inductance Detectors



Multiplexed array 300 pixels

The realization of an array with a zoom over a pixel

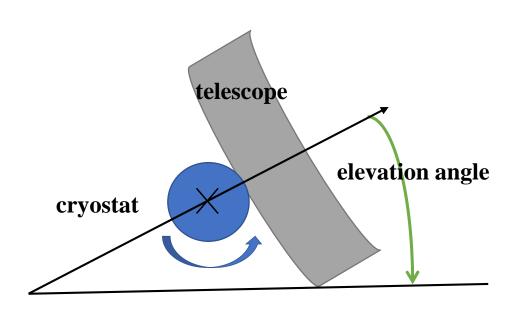


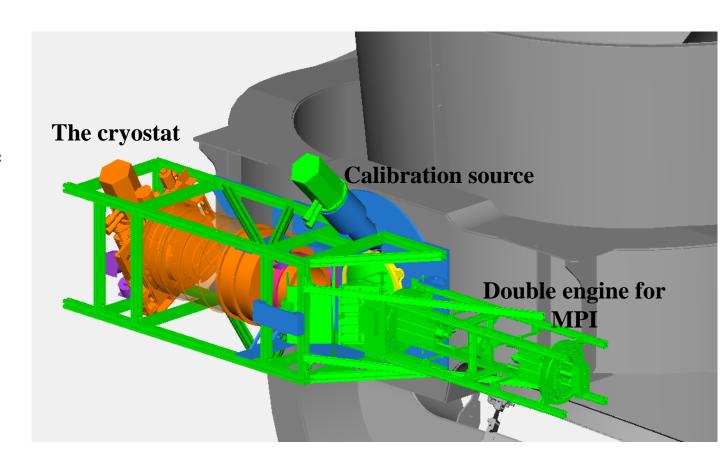
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II. Observation strategy and instrument design Fast Detectors: Kinetic Inductance Detectors

Technological constraints:

- calibration source for the MPI
- double MPI engine to delete the vibrations
- stable temperature cryostat for the focal plane





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III. Laboratory tests and characterization

First year of thesis

October 2017 – October 2018

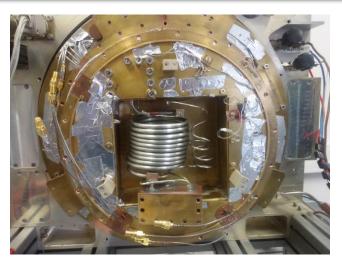
III. Laboratory tests and characterization Fast Detectors: Kinetic Inductance Detectors

Implementation:

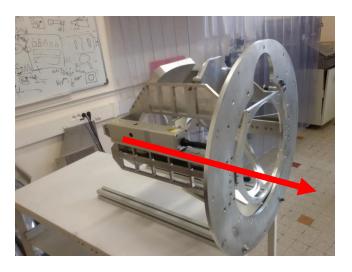
- Focus interface
- Subsystem integration
- Daily laboratory life (problem solving for day-by-day issues)

Measurements and characterization:

- Simulations of the single pixel with quality requirements
- MPI simulation
- Data analysis for electric proprieties of the detectors
- Sensitivity measurement
- Geometrical characterization of the matrix



Inner part of the cryostat



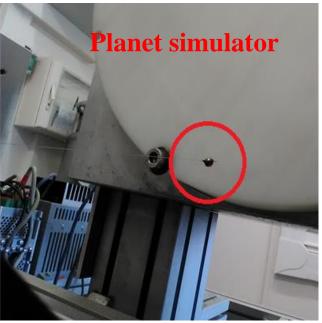
Engine to control the focus

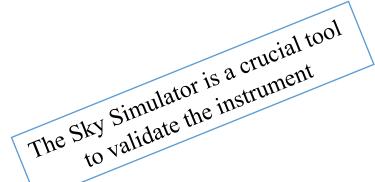
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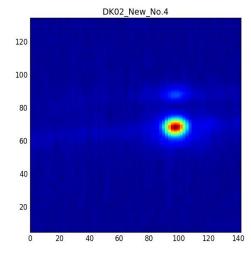
III. Laboratory tests and characterization

Geometrical characterization

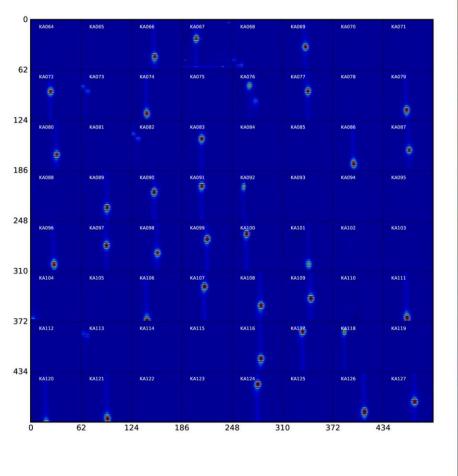






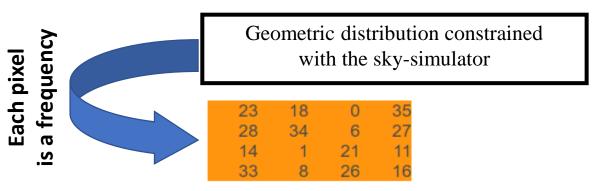


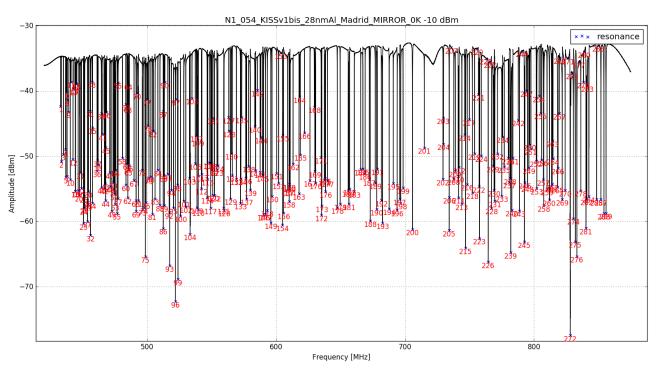
Example of map making with Sky-Simulator for KISS



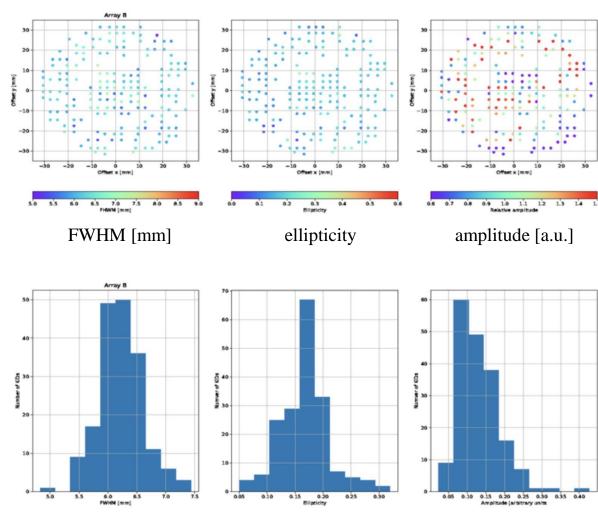
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III. Laboratory tests and characterization Geometry of the array





Geometrical characterization of the array



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Second year of thesis

November 2018 – NOW

IV. Installation and observations Chronological path

Installation [November 2018- January 2019]:

- transportation of the instrument (4-days journey)
- direct interface with local team
- mechanical, electrical and network installation
- interface with the telescope

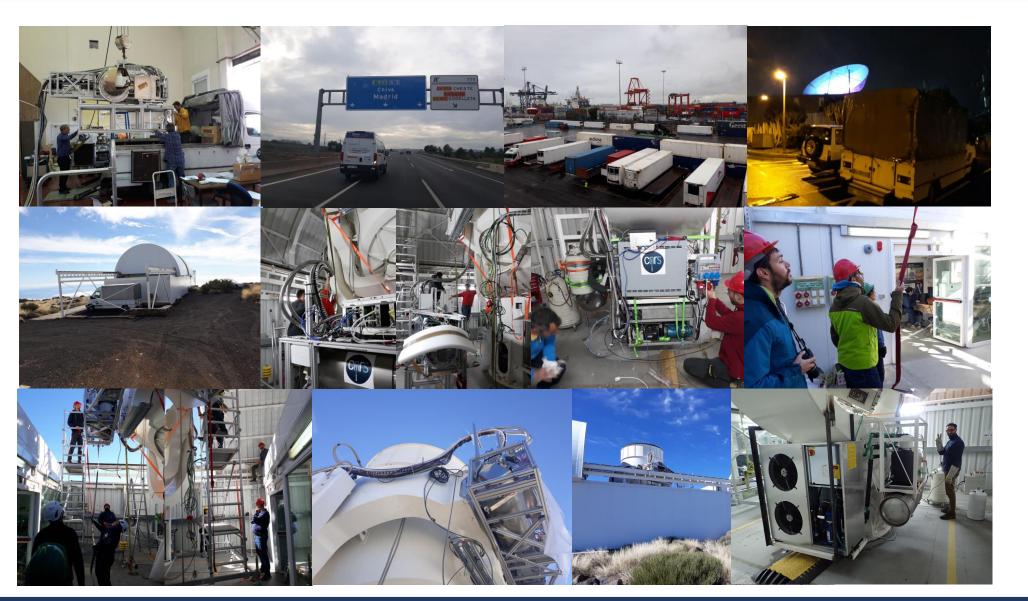
Operation [February 2019 - NOW]:

- maintenance in situ
- active partecipation with local research group
- commissioning phase [in progress]



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A long way to Tenerife



INSTALLATION TEAM























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Moon observations

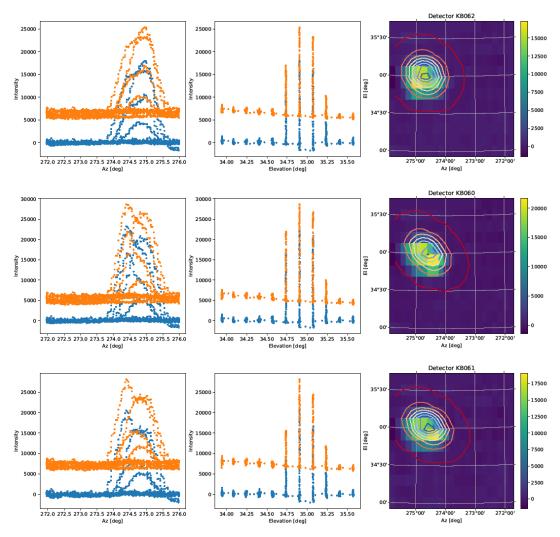
13/60 whole days of observation (and almost everyday to solve the issues)

name source	OP	MD / A on fac	no.			focus				14 March 2019								
	[mm]	MP/Acq frequer	ncy time second source	details		focus [mm] scan number	size maj	p pointing mod	d analysis	Variation (7707.)								
00		5/4Khz	04h28 cold	sciencemap - H2O=11% - we stop before	the end	23 255 \$	size 240x150 ', step=10'	AzEl? (shift Az=1deg	eg,			[Hz] time second sou			focus [mm] scan number	Size map step=10' v=5'/s		
on		3/ 41012	041120 C010	sciencemap 1120-1170 We stop before t	ure erru	V	/=5'/s	El=0)		moon 23 moon 23	5/4Khz 5/4Khz	18h39 cold 18h55 cold	sciencemap - source covered sciencemap - source covered			, step=10' v=5'/s , step=10' v=5'/s		
n		5/4Khz	05h28 cold	sciencemap - H2O=10% - we stop before t	the end	23 256 s	size 120x120 ', step=5' /=5'/s	AzEl? (shift Az=1deg El=0.5)	·g,		S/ HOLE	20103 COID	scarcemap source coverer	a by clouds 1120-3	37.0 10 320 2100100 ;	, step-10 1-5/2		
		5/4Khz	05h28 cold	asianaaman - 1/20-100/ - we aten hefere l	the end		size 200x120 ', step=5'	AzEl? (shift Az=1deg	eg,	13 March 2019								
"		3/4KHZ	031126 C010	sciencemap - H2O=10% - we stop before t	ule ello	V	/=5'/s	El=0.5)		name source OP	[mm] MP/Acq frequenc	[Hz] time second sou	irce		details	focus	is [mm] scan nui	mber Size m
n		5/4Khz	05h44 cold	sciencemap - H2O=10% - we stop before t	the end	23 258 5	size 200x120 ', step=5' v=5'/s	AzEl? (shift Az=1deg El=0.5)	eg,	moon 23	5/4Khz	20h15 cold			sci	iencemap - H2O=25% 40	158	size 180x180 ', step=10' v=5
							v=5/s size 200x120 ', step=5'	AzEl? (shift Az=1dea	10	moon 23	5/4Khz	20h28 cold	sciencemap - we saw the mo			40	159	size 240x180 ', step=10' v=5
1		5/4Khz	04h54 cold	sciencemap - H2O=11% - we stop before t	the end	50 259 v	r=5'/s	El=0.5)	·91	moon 23	5/4Khz	20h45 cold 21h07 cold	sciencemap - we saw the mo			40	160	size 240x180 ', step=10' v=5
n		5/4Khz	05h00 cold	sciencemap - H2O=11% - we stop before t	the end	23 260 s	size 200x120 ', step=5'	AzEl? (shift Az=1deg	eg,	moon 23 moon 23	5/4Khz 5/4Khz	21h07 cold 21h30 cold	sciencemap - we saw the mo sciencemap - we saw the mo			40	161 162	size 240x180 ', step=10' v=5 size 240x180 ', step=10' v=5
		3) HG12	OSHOO COIG	Science in particular in the stop before t	are end	V	/=5'/s	El=0.5)		moon 23	5/4Khz	21h48 cold			it seems that is there the problem H2O=25% - pl	hoto analyzed by A.J. 40	162	size 240x240 ', step=10' v=5
1		5/4Khz	05h33 cold	sciencemap - H2O=11% - we stop before t	the end	50 261 S	size 200x120 ', step=5'	AzEl? (shift Az=1deg El=0.5)	eg,	moon 23	5/4Khz	22h09 cold	sciencemap - we saw the mo			40	163	size 240x240 ', step=10' v=5
				sciencemap - H2O=11% - too slow, Jupiter	r in advance wrt the		size 200x120 ', step=5'	AzEl? (shift Az=1deg	ia.	moon 23	5/4Khz	22h36 cold	sciencemap - we saw the mo	on, really low in elev	evation - photo analyzed by A.J.	40	164	size 240x240 ', step=10' v=5
er		5/4Khz	06h00 cold	map. Not observed		50 262 s	/=5'/s	El=0.5)	-97	12 March 2019								
er		5/4Khz	06h15 cold	sciencemap - H2O=10% - well in the middle	e. Maybe Jupiter		size 200x180 ', step=8'	AzEl? (shift Az=2deg	ig,									
				observed sciencemap - H2O=12% - well in the middle	a Mauha Junitar		/=5'/s size 200x90 ', step=4'	El=-0.5) AzEl? (shift Az=2deg	10	name source OP		[Hz] time second sou		focus [mm] scan r				
er		5/4Khz	06h25 cold	observed	e. Maybe Jupiter	50 266 v	/=5'/s	El=0)	191	moon -	S/4Khz	14h18 sky	sciencemap - no modulation		size 290x120 ', step=10' v=5'/s			
	E (Alche	z 05h41	sciencemap - H2O=12% - well in the middle. Maybe	50		267 size 200x120 ', step=4' A	AzEl? (shift Az=Odeg,			moon -	5/4Khz 5/4Khz	14h43 sky 14h57 sky	sciencemap - no modulation sciencemap - no modulation		size 290x120 ', step=10' v=5'/s size 400x120 ', step=10' v=5'/s			
	5/4KHZ	2 05041	cold sciencemap - H2O=12% - well in the middle. Maybe Jupiter observed	50		v=5'/s E	El=0)				3/ 11/12	a-mar any	sciencemap - no modulation	40 130	size 400X120 , step=10 4=3/s			
h 2019										11 March 2019								
. 2019										name course On	[mm] MD/Aca frac	[Uz] time second	arce details focus [mm] sc	an number	Size map			
sour	ce OP [r	mm] MP/Acq frequ	ency [Hz] time second source	details focus	s [mm] scan numbe	er size map	pointing mod	analy	ysis	moon -	5/4Khz	13h54 cold	sciencemap 40 14		Size map 30x120 ', step=6' v=5'/s			
	23	5/4Khz	06h50 cold sciencemap - H2O=4% - we	didn't see jupiter 20	226	size 120x120 ', step=5' v=5'/s AzEl? p.		-						Jac 100				
	23	5/4Khz	6h59 cold sciencemap - H2O=4% - we		227	size 120x120 ', step=5' v=5'/s RaDec?		-		2 March 2019								
	23	5/4Khz	7h09 cold sciencemap - H2O=4% - we		228	size 180x120 ', step=5' v=5'/s AzEl? p.		-		name source OP	[mm] MP/Acq frequenc	[Hz] time second sour	rce details focus [mm] sca	n number	Size map			
	23	5/4Khz		didn't see jupiter (in telekiss: no source) 20	231	size 180x120 ', step=5' v=5'/s AzEl? p.	.model offset=(-2,0)			jupiter 23	5/4Khz	7h37 cold	sciencemap 20 138		0x100 arcmin, step=6' v=3'/s			
	23	5/4Khz 5/4Khz	7h41 cold sciencemap - H2O=4% - it s 7h59 cold sciencemap - H2O=4% - nol		232	size 180x120 ', step=5' v=5'/s RaDec?		todo		jupiter 23	5/4Khz	7h49 cold	sciencemap 20 139		0x100 arcmin, step=6' v=3'/s			
	23	5/4KNZ 5/4Khz			233	size 180x120 ', step=5' v=5'/s RaDec?		-		jupiter 23	5/4Khz	8h02 cold	sciencemap 40 140		0x100 arcmin, step=6' v=3'/s			
	23	5/4Khz	8h11 cold 8h24 cold	sciencemap - H2O=4% 50 sciencemap - H2O=4% 50	234 235	size 210x120 ', step=7' v=5'/s RaDec? size 180x120 ', step=5' v=5'/s RaDec?				jupiter 23	5/4Khz	8h14 cold	sciencemap 40 141	size 80x8	x80 arcmin, step=6' v=1.5'/s			
	23	5/4Khz	cold sciencemap - H2O=4% - no		240	size 180x120 ', step=5' v=5'/s AzEl? p.	.model offset=/-0.5 -n s	5) -		jupiter 23	5/4Khz	8h29 cold	sciencemap 40 142	size 120x	0x120 arcmin, step=6' v=1.5'/s			
	23	5/4Khz	9h27 cold sciencemap - H2O=4%	50	241	size 180x120 ', step=5' v=5'/s AzEI? p.				1 March 2019								
	23	5/4Khz	9h25 cold	sciencemap - H2O=4% - nothing seen 25	242	size 180x120 ', step=5' v=5'/s AzEl? p.					formal sendence for	feral blace acces *	225			faces formal a		etas as
	23	5/4Khz	9h34 cold sciencemap - H2O=4%	25	243	size 180x120 ', step=5' v=5'/s AzEl? p.	.model offset=(-2,-1) -	-		moon 23	[mm] MP/Acq frequenc 5/4Khz	[Hz] time second sou 8h36 cold	sciencemap - we didn't see t		letails	focus [mm] scan nu		Size map 80 arcmin, step=7' v=6'/s
	23	5/4Khz		SEEMS THERE: just one point 25	244	size 180x120 ', step=5' v=5'/s AzEl? p.		todo		moon 23	5/4Khz	8h54 cold	sciencemap - we didn't see t sciencemap - we didn't see t			40 129		40 arcmin, step=/ v=6/s
3	23	5/4Khz		SEEMS THERE: just one point 25	245	size 180x120 ', step=5' v=5'/s AzEl? p.		-		moon 23	5/4Khz	9h15 cold	sciencemap - it seems visible	1		40 131		90 arcmin, step=10' v=10'/s
	23	5/4Khz	cold sciencemap - H2O=4%	25	247	size 180x120 ', step=5' v=5'/s AzEl? p.	.model offset=(+2,-1) -	not seen -		moon 23	5/4Kh2	9h31 cold	sciencemap - moon in subsci	an 15,17 /30totale		40 132	size 290x2	90 arcmin, step=10' v=10'/s
										moon 23	5/4Khz	10h02 cold	sciencemap - moon in subsci	an 7/15total in pixel I	KB065 & KB180 (kiss tuning wasn't working prop	erly) 40 134		80 arcmin, step=10' v=8'/s
th 2019										moon 23 moon 23	5/4Khz 5/4Khz	10h22 cold 10h33 cold	sciencemap - we saw someth sciencemap - we saw the mo			40 135 40 136		20 arcmin, step=5' v=6'/s 00 arcmin, step=6' v=3'/s
me	OP	MP/Acq frequency	time second details	focus	scan	eter -	map pointing mod	analysis		moon 23	5/4Khz	10h45 cold	sciencemap - we saw the mo			20 137		00 arcmin, step=6' v=3'/s
irce	[mm]	[HZ]	source	[mm]	number			analysis			14,	10000				177. 1571	1000	
	23	5/4Khz 5/4Khz	19h40 cold sciencemap - H2O=7% - we didn't see the mod			120 ', step=10' v=5'/s 120 ', step=10' v=5'/s	RaDec?		25 February 2019									
						120 ', step=10' v=5'/s 120 ', step=10' v=5'/s	AzEl? p.model		name source OP	[mm] MP/Aca freque	ncy [Hz] time secon	source details focus	[mm] scan number					
	23	5/4Khz	19h55 cold sciencemap - H2O=8% - we didn't see the mod 20h12 cold sciencemap - H2O=7% - we didn't see the mod			240 ', step=10' v=5'/s	AzEl? p.model	-	Electrical Test -	[mm] Fir/ried medac	12h27 cold	40		D RESONANCES - v	we disconnected the old instrument that was	s connected to the ground	nd analyzed()	
	23		20h12 cold sciencemap - H2O=7% - we didn't see the mod 20h33 cold sciencemap - H2O=7% -	20	215 size 340x							40			pumping bench pipes connected to the earth			1=0.02 ohm, R [compressor-ear
	23	5/4Khz	20h12 cold sciencemap - H2O=7% - we didn't see the mod 20h33 cold sciencemap - H2O=7% - sciencemap - H2O=6% - we saw the moon, th	20					Electrical Test -		12h53 cold					(floor ground) - R [pump		
	23	5/4Khz 5/4Khz	20h12 cold sciencemap - H2O=7% - we didn't see the mod 20h33 cold sciencemap - H2O=7% -	20	219 size 90x1	20 ', step=10' v=5'/s	AzEl? p.model			-	12h53 cold 13h08 cold	40			as 12h53 + small pipes of dilution connected			
	23	5/4Khz 5/4Khz	20h12 cold sciencemap - H2O=7% - we didn't see the mod 20h33 cold sciencemap - H2O=7% - sciencemap - H2O=6% - we saw the moon, th	e problem seemed to be that we lost 20	219 size 90x1		AzEl? p.model		Electrical Test - Electrical Test -	-	12h53 cold 13h08 cold 13h51 cold	40 40 40	- NO GOO	D RESONANCES - a	as 12h53 + small pipes of dilution connected PulseTube? in the ground floor			
	23 23	5/4Khz 5/4Khz 5/4Khz 5/4Khz	20h12 cold sciencemap - H2O=7% - we didn't see the mor 20h33 cold sciencemap - H2O=7% - cold sciencemap - H2O=6% - we saw the moon, the the Moon because it flew away	20 20 20 20 sciencemap - H2O=6% - 20	219 size 90x1	20 ', step=10' v=5'/s 0 ', step=10' v=5'/s, on the moon we see 10 a, 80 kHz KB	AzEI? p.model AzEI? p.model		Electrical Test -	-	13h08 cold	40	- NO GOO	D RESONANCES - B		to compressor ones + bot	ottom of pumping	that is connected to the fork o
	23 23 23	5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz	20h12 cold sciencemap - 100-7% - we didn't see the mor 20h3 cold sciencemap - 100-7% - we didn't see the mor cold sciencemap - 100-6% - we saw the moon, the cold the Moon because it flew away 21h54 cold sciencemap - 100-7% - we tried to anticipate	20 20 20 20 20 20 20 20 20	219 size 90x1 220 size 60x6 kHz on KA	20 ', step=10' v=5'/s 0 ', step=10' v=5'/s, on the moon we see 10 A, 80 kHz KB size 120x60 ', step=5' v=	AzEl? p.model AzEl? p.model 3/9 AzEl? p.model		Electrical Test - Electrical Test - Electrical Test -	-	13h08 cold 13h51 cold	40 40	- NO GOO	D RESONANCES - B	PulseTube? in the ground floor	to compressor ones + bot	ottom of pumping	that is connected to the fork of
	23 23 23 23 23 23	5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz	20h12 cold sciencemap - 120-7% - we didn't see the mod 20h33 cold sciencemap - 120-7% - we saw the moon, th cold sciencemap - 120-6% - we saw the moon, the the Moon because it flew away 21h34 cold 2h05 cold sciencemap - 120-7% - we tried to anticipate disconfirmity appears	sproblem seemed to be that we lost 20 20 20 20 20 20 20 20 20 20 20 20 20	219 size 90x1 220 size 60x6 kHz on Ks 221 222	20 ', step=10' v=5'/s 0 ', step=10' v=5'/s, on the moon we see 10 a, 80 kHz KB size 120x60 ', step=5' v= size 120x60 ', step=5' v=	AzEI? p.model AzEI? p.model a'/s AzEI? p.model a'/s AzEI? p.model a'/s (-1,-1)		Electrical Test - Electrical Test -	-	13h08 cold 13h51 cold	40 40	- NO GOO	D RESONANCES - B	PulseTube? in the ground floor	to compressor ones + bot	ottom of pumping	that is connected to the fork of
	23 23 23 23	5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz	20h12 cold sciencemap - 100-7% - we didn't see the mor 20h3 cold sciencemap - 100-7% - we didn't see the mor cold sciencemap - 100-6% - we saw the moon, the cold the Moon because it flew away 21h54 cold sciencemap - 100-7% - we tried to anticipate	sproblem seemed to be that we lost 20 20 20 20 20 20 20 20 20 20 20 20 20	219 size 90x1 220 size 60x6 kHz on Kd	20 ', step=10' v=5'/s 0 ', step=10' v=5'/s, on the moon we see 10 a, 80 kHz KB size 120x60 ', step=5' v= size 120x60 ', step=5' v=	AzEI? p.model AzEI? p.model a'/s AzEI? p.model a'/s AzEI? p.model a'/s (-1,-1)		Electrical Test - Electrical Test - Electrical Test - 23 February 2019		13h08 cold 13h51 cold 15h48 cold	40 40 40	- NO GOO - NO GOO	D RESONANCES - a D RESONANCES - B D RESONANCES - a	PulseTube? in the ground floor	to compressor ones + bot	ottom of pumping	
	23 23 23 23 23 23 23 23 23	S/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz	20112 cold sciencemap - 1202-7% - we didn't see the mod cold 20133 cold sciencemap - 1202-7% - we saw the moon, the Moon because it flew away cold the Moon because it flew away 21564 cold sciencemap - 1202-7% - we tried to anticipate discontinuity appears 22h05 cold sciencemap - 1202-7% - we tried to anticipate discontinuity appears 22h13 cold sciencemap - 1202-7% - we tried to anticipate discontinuity appears	problem seemed to be that we lost 20 20 20 Sciencemap - H20=6% 20 50 50 50 50 50 50 50 50 50 50 50 50 50	219 size 90x1 220 size 60x6 kHz on K/ 221 222 223 224	20 ', step=10' v=5'/s, on the moon we see 10 0', step=10' v=5'/s, on the moon we see 10 size 120x50', step=5' v= size 120x50', step=5' v= size 120x120', step=10' v= size 120x120', step=10' v=	AzEI? p.model AzEI? p.model =3'/s AzEI? p.model =3'/s AzEI? p.model offset (-1,-1) =5'/s AzEI? p.model offset (-1,5,-1.5) RaDec?		Electrical Test - Electrical Test - Electrical Test - 23 February 2019		13h08 cold 13h51 cold	40 40 40 40	- NO GOO - NO GOO - NO GOO	D RESONANCES - a D RESONANCES - a D RESONANCES - a	PulseTube? in the ground floor all the pipes together, not anymore at the flo	to compressor ones + bot	ottom of pumping	
	23 23 23 23 23 23 23	5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz	20h12 cold sciencemap - 1020-7% - we didn't see the mod sciencemap - 1020-7% - we didn't see the mod cold cold sciencemap - 1020-6% - we saw the moon, the Mod because it flew away cold sciencemap - 1020-7% - we tried to anticipate discontinuity appears - we tried to anticipate discontinuity appears - we tried to anticipate discontinuity appears - 1020-7% - we tried to anticipate sciencemap - 1020-7% - we tried to anticipate discontinuity appears - 1020-7% - we tried to anticipate sciencemap - 1020-7% - we tried to	problem seemed to be that we lost 20 20 20 Sciencemap - H20=6% 20 50 50 50 50 50 50 50 50 50 50 50 50 50	219 size 90x1 220 size 60x6 kHz on KJ 221 222 223	20 ', step=10' v=5'/s 0 ', step=10' v=5'/s, on the moon we see 10 a, 80 kHz KB size 120x60 ', step=5' v= size 120x60 ', step=5' v= size 120x120 ', step=10' v=	AzEI? p.model AzEI? p.model =3'/s AzEI? p.model =3'/s AzEI? p.model offset (-1,-1) =5'/s AzEI? p.model offset (-1,5,-1.5) RaDec?		Electrical Test - Electrical Test - Electrical Test - 23 February 2019 name source OP		13h08 cold 13h51 cold 15h48 cold	40 40 40	- NO GOO - NO GOO - NO GOO	D RESONANCES - a D RESONANCES - p D RESONANCES - a 1] scan number 104 s	PulseTube? in the ground floor	to compressor ones + bot	ottom of pumping	that is connected to the fork of
	23 23 23 23 23 23 23 23 23	S/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz 5/4Khz	20112 cold sciencemap - 1202-7% - we didn't see the mod cold 20133 cold sciencemap - 1202-7% - we saw the moon, the Moon because it flew away cold the Moon because it flew away 21564 cold sciencemap - 1202-7% - we tried to anticipate discontinuity appears 22h05 cold sciencemap - 1202-7% - we tried to anticipate discontinuity appears 22h13 cold sciencemap - 1202-7% - we tried to anticipate discontinuity appears	problem seemed to be that we lost 20 20 20 Sciencemap - H20=6% 20 50 50 50 50 50 50 50 50 50 50 50 50 50	219 size 90x1 220 size 60x6 kHz on K/ 221 222 223 224	20 ', step=10' v=5'/s, on the moon we see 10 0', step=10' v=5'/s, on the moon we see 10 size 120x50', step=5' v= size 120x50', step=5' v= size 120x120', step=10' v= size 120x120', step=10' v=	AzEI? p.model AzEI? p.model =3'/s AzEI? p.model =3'/s AzEI? p.model offset (-1,-1) =5'/s AzEI? p.model offset (-1,5,-1.5) RaDec?		Electrical Test - Electrical Test - Electrical Test - 23 February 2019 name source OP 0745+241 -	4 kHz	13h08 cold 13h51 cold 15h48 cold ncy [Hz] time secon 00h15 cold	40 40 40 40 I source de sciencemap - p	- NO GOO - N	D RESONANCES - a D RESONANCES - P D RESONANCES - a B] scan number 104 s 105 s	PulseTube? in the ground floor all the pipes together, not anymore at the flo size 30x30 arcmin, step=5' v=5'/s	to compressor ones + bot	ottom of pumping	
1 2019	23 23 23 23 23 23 23 23 23 23 23 23	5/440hz 5/440hz 5/440hz 5/440hz 5/440hz 5/440hz 5/440hz 5/440hz	20h12 cold sciencemap - 1020-7% - we didn't see the moderate of the cold 20h33 cold sciencemap - 1020-7% - we saw the moon, the cold cold sciencemap - 1020-6% - we saw the moon, the cold 21h54 cold sciencemap - 1020-7% - we tried to anticipate discontinuity appears 22h33 cold sciencemap - 1020-7% - we tried to anticipate discontinuity appears 22h30 cold sciencemap - 1020-7% - we tried to anticipate discontinuity appears 22h26 cold sciencemap - 1020-7% - we saw the moon	problem seemed to be that we lost 20 20 Sciencemap - H2O=6% 20 20 Sciencemap - H2O=6% 20 20 20 20 20 20 20 20 20 20 20 20 20	219 size 90x1 220 size 60x6 kHz on Ki 221 222 223 224 225	20 ', step=10' v=5'/s 0 ', step=10' v=5'/s, on the moon we see 10 0 ', step=10' v=5'/s, on the moon we see 10 size 120x60 ', step=5' v= size 120x60 ', step=10' v= size 120x120 ', step=10' v= size 120x120 ', step=10' v=	AZET p.model AZET p.model =31/s AZET p.model =31/s AZET p.model =31/s AZET p.model offset (-1,-1) =51/s AZET p.model offset (-1,5-1.5) 851/s RaDec?		Electrical Test - Electrical Test - Electrical Test - 23 February 2019 name source OP 0745+241 - moon 23	4 kHz 4 kHz	13h08 cold 13h51 cold 15h48 cold ncy [Hz] time secon 00h15 cold 01h30 cold	40 40 40 40 sciencemap - p	- NO GOO - NO GOO - NO GOO letails focus [mm] photometry	D RESONANCES - a D RESONANCES - P D RESONANCES - a S Can number 104	PulseTube? in the ground floor all the pipes together, not anymore at the flo size 30x30 arcmin, step=5' v=5'/s size 90x90 arcmin, step=7' v=4'/s	to compressor ones + bot	ottom of pumping	
2019	23 23 23 23 23 23 23 23 23 23 23 23	5/440z 5/440z 5/440z 5/440z 5/440z 5/440z 5/440z 5/440z	20112 cold	20 20 20 20 20 20 20 20	219 size 90x1 220 size 60x6 221 222 223 224 225 focus [n	20 , step=10' v=5'/s 0', step=10' v=5'/s, on the moon we see 10 size 120:60', step=5' v= size 120:60', step=5' v= size 120:60', step=10' v= size 120:120', step=10' v= size 120:120', step=10' v= size 120:120', step=10' v= size 120:120', step=10' v=	AZEIP p.model AZEIP p.model AZEIP p.model AZEIP p.model AZEIP p.model AZEIP p.model AZEIP p.model offset (-1,-2) AZEIP p.model offset (-1,5-1.5) AZEIP p.model offset (-1,5-1.5) AZEIP p.model offset (-1,5-1.5)		Electrical Test - Electrical Test - Electrical Test - Electrical Test - 23 February 2019 name source 0745+241	4 kHz 4 kHz 4 kHz	13h08 cold 13h51 cold 15h48 cold ncy [Hz] time secon 00h15 cold 01h30 cold 01h35 cold 02h45 cold	source de sciencemap sciencemap	- NO GOO - NO GOO - NO GOO letails focus [mm photometry 10 10 40	D RESONANCES - a D RESONANCES - P D RESONANCES - a 1] scan number 104 s 105 s 106 s 107 s 115 s	Pulsartuber in the ground floor all the pipes together, not anymore at the fic size 30x30 arcmin, step=5' v=5'/s size 90x00 arcmin, step=7' v=4'/s size 180x100 arcmin, step=7' v=6'/s	to compressor ones + bot	ottom of pumping	
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2019 Source	23 23 23 23 23 23 23 23 23 23 23 23 23 2	5/40/2 5/40/2	20112 cold	problem seemed to be that we lost sciencemap - H2O+6/h - 20 sciencemap - H2O+6/h - 20 the moon and we saw it 2 details details details si si si si si si si si si	219 size 90:1 220 size 60:6 221 vic on K 222 223 234 225 60:00 40 40 40 40 40 40 40 31 31 3292ed by A.J. 45 20 20 20 40 40 40 40 512e map 40 40 40 40 40 40 40 40 40 40 40 40 40	20 , step=10' v=5/s 0 , step=10' v=5/s 0 , step=10' v=5/s size 120x50' , step=5' v= size 120x50' , step=5' v= size 120x50' , step=10' v= size 120x10' , step=10' v= size 120x120' , step=10' v= size 120x120' , step=10' v= size 20x120' , step=10' v= 171	Actify p.model Actify p.model		Electrical Test - Electrical T	4 1542 4 1542	13/h06 cold 13/h11 cold 13/h12 cold 15/h48 cold 15/h48 cold 15/h48 cold 05/h15 cold 01/h15 cold 07/h17 cold 07/h17 cold 07/h17 cold 07/h17 cold 07/h17 cold 08/h12 cold 08/h17 cold 08/h17 cold 08/h17 cold 08/h17 cold 08/h17 cold	source di seincemap - 1 sencemap - 1 seincemap - 1 seincemap - 2 seincemap - 3 seincemap sciencemap	No Good No G	0 RESONANCES - 2 OF RESONANCES	PulsarUbaP in the ground floor all the pipes together, not anymore at the fic size 30x30 arcmin, step=5' v=5'/s size 90x30 arcmin, step=2' v=6'/s size 180x180 arcmin, step=2' v=6'/s size 180x180 arcmin, step=10' v=10'/s size 240x230 arcmin, step=10' v=10'/s size 240x230 arcmin, step=10' v=10'/s size 250x230 arcmin, step=10' v=10'/s size 250x230 arcmin, step=10' v=10'/s size 250x230 arcmin, step=5' v=2'/s, deplacems size 60x00 arcmin, step=5' v=2'/s size 30x30 arcmin, step=5' v=2'/s size map	to compressor ones + bot boor, but to the bottom of t boor, but to the bottom of t ent +3 deg in elevation ent +3 deg in elevation ent +2 deg in elevation ent +2 deg elevation ent +2 deg elevation and elevation ele	ottom of pumping the compressor! nd +1 deg in azim nd +1 deg in azim nd -1 deg in azim	Sib nutth nutth nutth uuth
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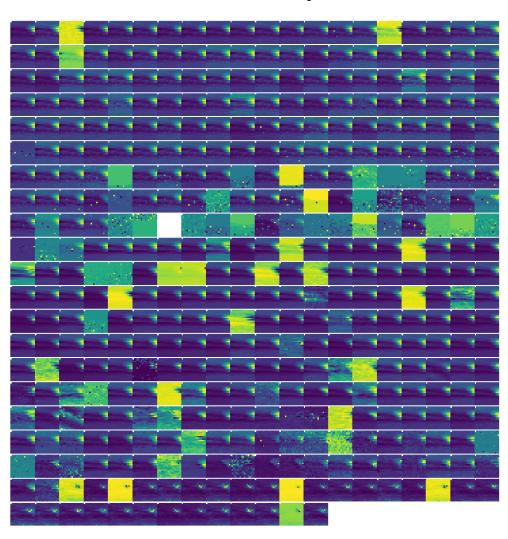
Alessandro Fasano 17/24

Observations of the Moon





Whole array



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IV. Installation and observations *Facts about the observation*

FACTS

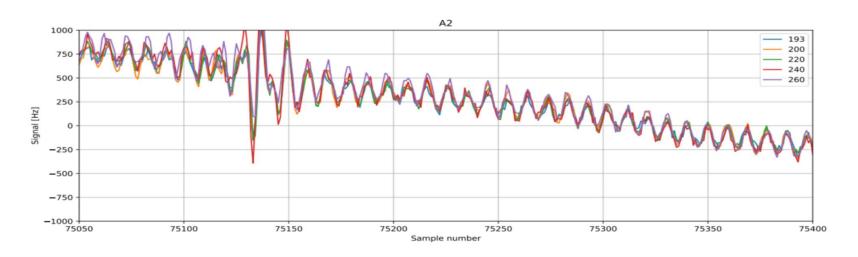
Commissioning phase in progress and we are handling two major issues

1) Noise:

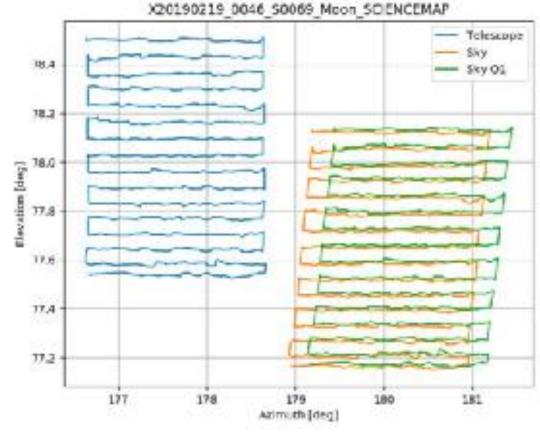
source of noise at 400 Hz.

2) Pointing Model:

pointing correction are of the order of degree especially at higher elevation angles. They are due to the different distribution of weight to respect to the previous instrument installed at the same telescope.



Status of the pointing model

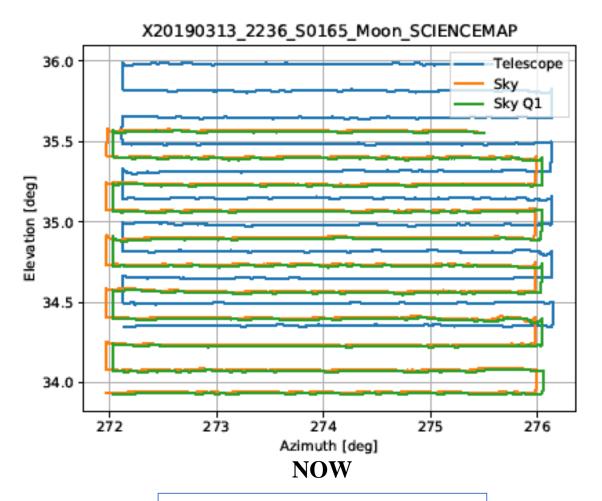


BEFORE

Telescope: telescope position

Sky : mean values for all pixels

Sky Q1 : position on central pixel

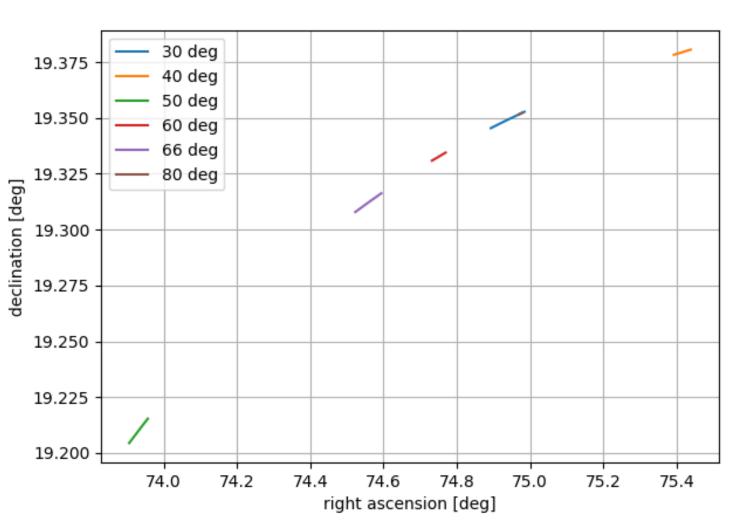


We still need better constraints

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IV. Installation and observations Status of the pointing model

Observation of the Moon at different elevations

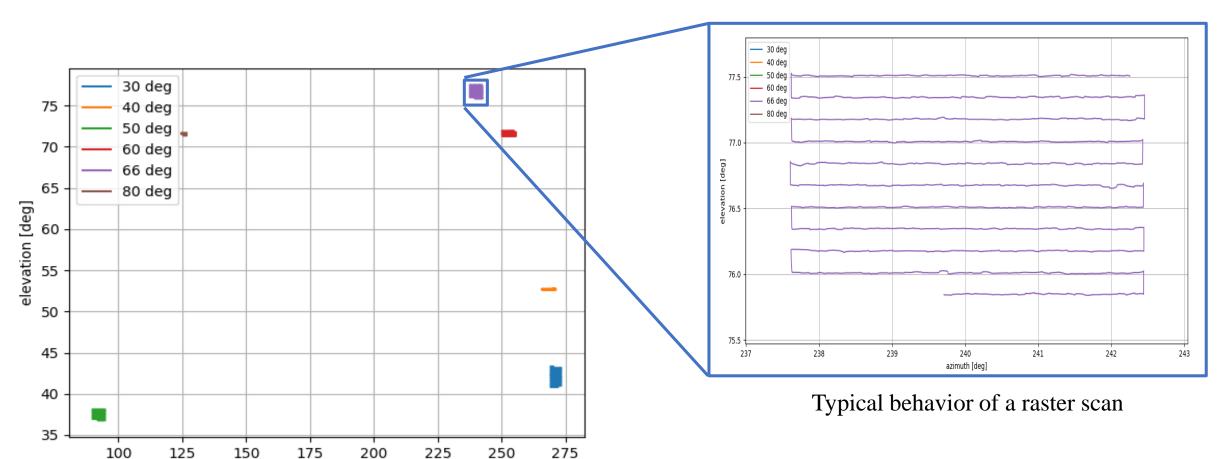


Different positions on the parameters

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IV. Installation and observations Status of the pointing model

Observations of the Moon at different elevations Raster Scans

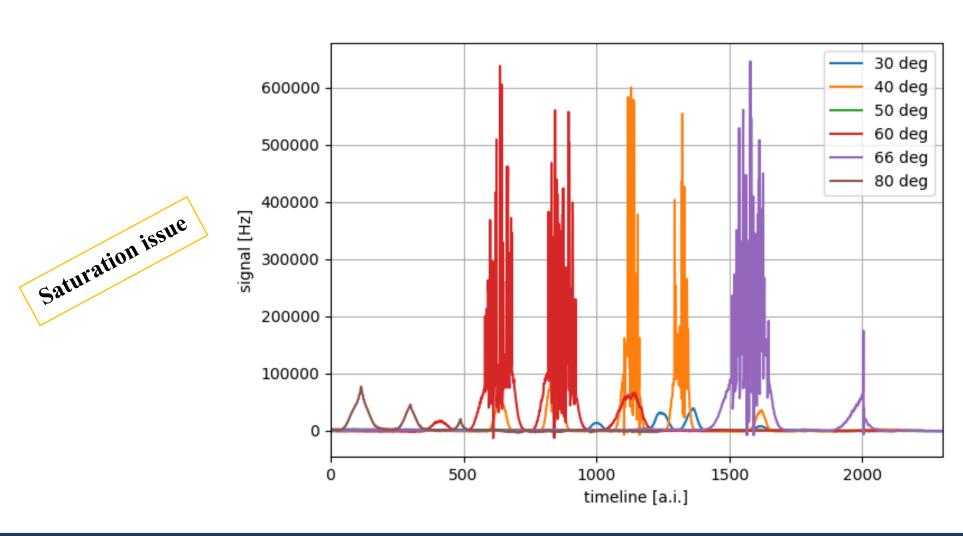


azimuth [deg]

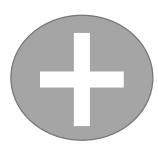
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IV. Installation and observations Status of the pointing model

Observation of the Moon at different elevation



Solutions: diaphragm



We reduce the signal because the Moon is a bright source

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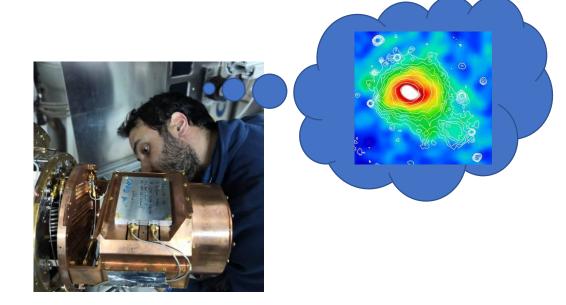
V. Conclusions and persepectives Past, present and future of the observations

Multidisciplinary aspects of the Ph.D.:

- Science
- Instrumentation
- Astronomical observations
- Data analysis

Perspectives for the second half of the Ph.D.:

- Accomplishment of the commissioning phase
- Cluster observation
- Manuscript



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EXTRA

EXTRA *Timeline*

Duality Ph.D./experiment

I. [past]

R&D, characterization and validation

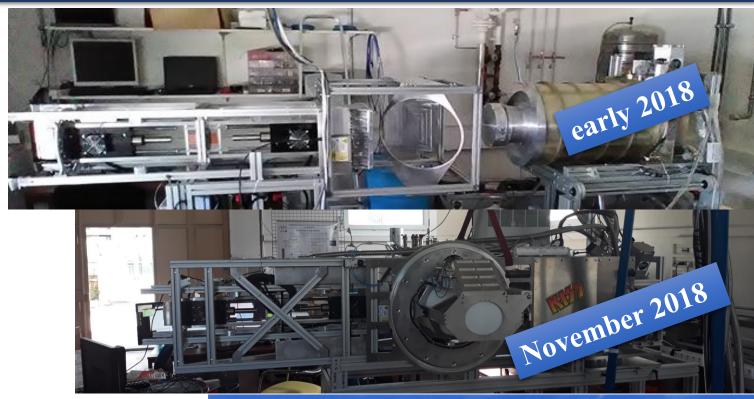
II. [present]

Installation and observations

III. [future]

Data analysis and implementation on Concerto experiment



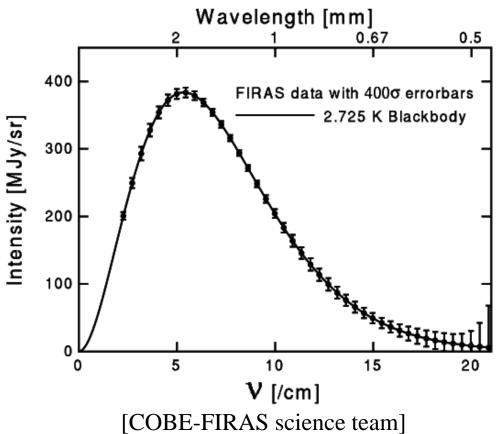




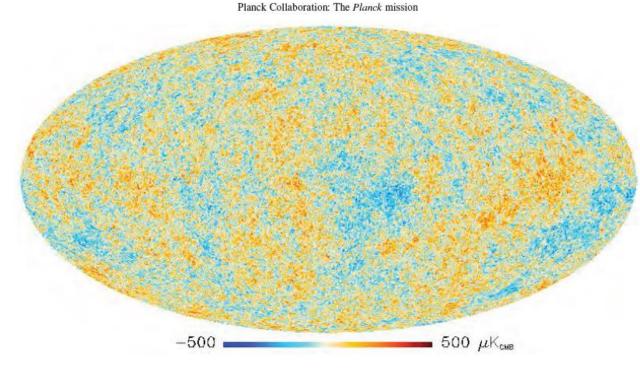
EXTRA

Cosmic Microwave Background

- Formed after the Big-Bang, during the baryogenesis.
- Represents a faithful footprint of the 300'000 years old universe.
- The most perfect Black-Body in the universe.



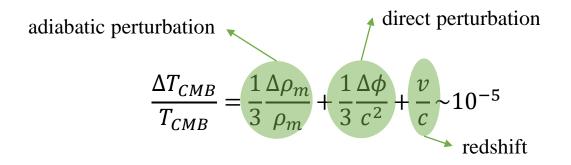
 $T_{CMB} = 2.725 \pm 0.002 K$



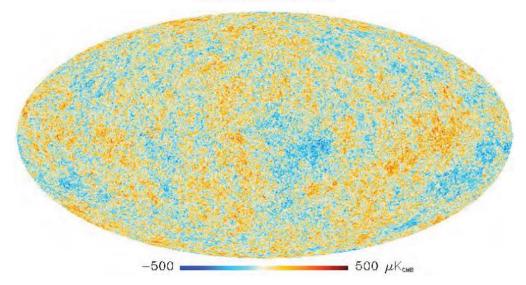
[Planck Collaboration et al.: 2015]

 $\Delta T_{CMB} \sim 10^{-5}$ T_{CMB}

Extra CMBR anisotropies



Planck Collaboration: The Planck mission



[Planck Collaboration et al.: 2015]

Thermal Effect

$$\frac{\Delta T_{SZE}}{T_{CMB}} \approx \frac{\Delta v}{v} \cdot \tau \approx 10^{-4}$$

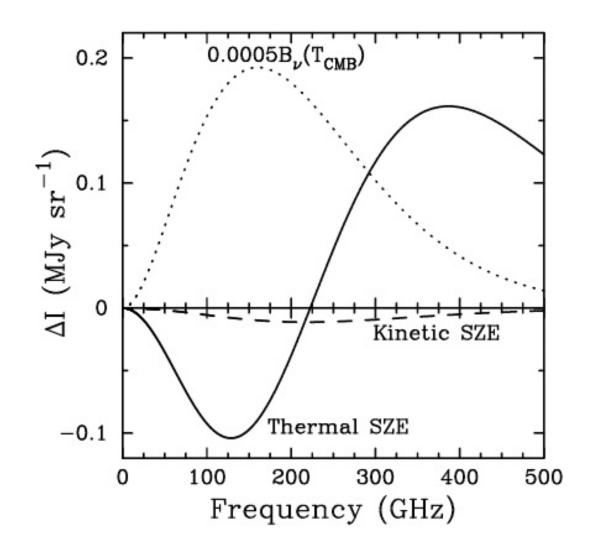
$$t = \sigma_T \cdot n_e \cdot l \approx 10^{-2}$$

$$\sigma_T \approx 10^{-25} cm^2$$

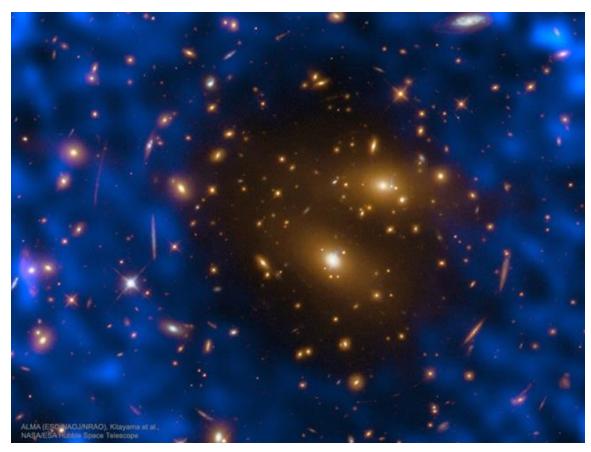
$$n_e \approx 10^{-3} cm^{-3}$$

$$\frac{\Delta v}{v} = \frac{k_B T_e}{m_e c^2} \cong \frac{0.005 \ MeV}{0.511 \ MeV} \approx 10^{-2}$$

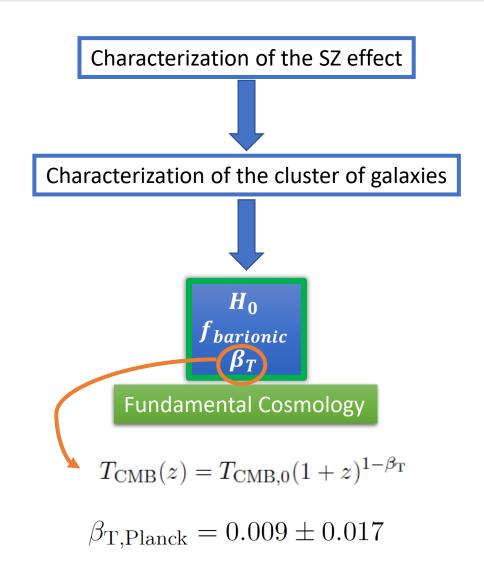
component	$\Delta T [\mu K]$
primary anisotropy	10
E modes	1
B modes	0.1
tSZE	100
kSZE	1
rSZE	1-10 (up to 100)



Extra SZ Effect

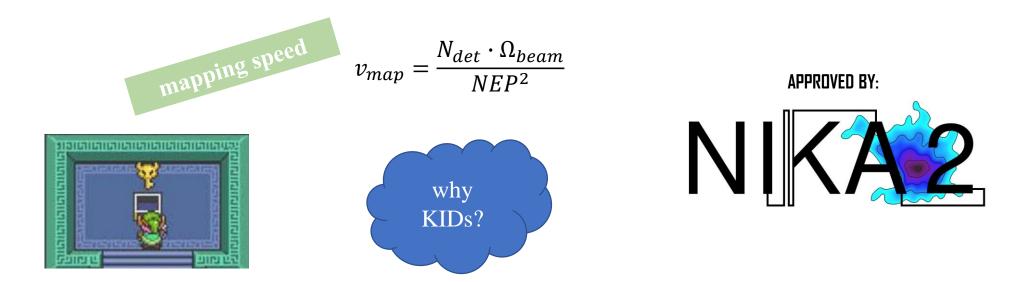


RXJ1347.5 [HST NASA]



EXTRA

Kinetic Inductance Detectors



The main features that make KID competitive with the other microwave detectors for astronomy (e.g. TES and bolometers) can be summarized in three points:

- <u>fabrication</u>: it consists in just two steps of deposition, a step forward the easiness and the pragmatic approach to the large matrices production;
- <u>multiplexability</u>: KIDs are intrinsically multiplexable, with a factor 300-400, they do not require complex readout electronics;
- **recovery speed**: it is defined by the recombination time of the Cooper-pairs,100 μs, gaining a factor 10 with respect to the competitors.

EXTRA

Quality factors & Responsivity

Quality factors

$$Q = 2\pi N = \omega_0 \frac{E_{stored}}{W_{lost}} = \frac{Q_i Q_c}{Q_i + Q_c}$$

$$Q_c \qquad \text{compromise: resonance depth vs high Q}$$

$$\text{optimised for background}$$

$$Q_i \qquad \text{depends on the number of quasi particles}$$

Responsivity

$$\mathcal{R} = \frac{d\varphi}{dN_{qp}} \propto \frac{\alpha Q}{V}$$

$$\alpha \equiv \frac{L_{kin}}{L_{tot}}$$

Minimising V Maximising α and Q

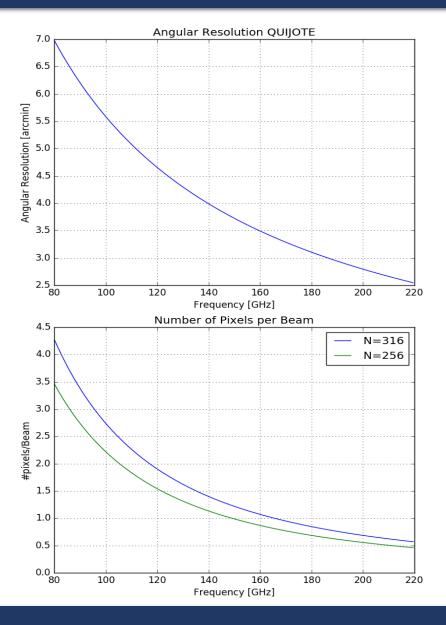
EXTRAOutlines

Quijote telescope in Tenerife





Quijote telescope diameter	³ He- ⁴ He diluition cryostat temperature	FoV [diameter]
2.5 m	150 +- 10 mK 170 mK stable	1°



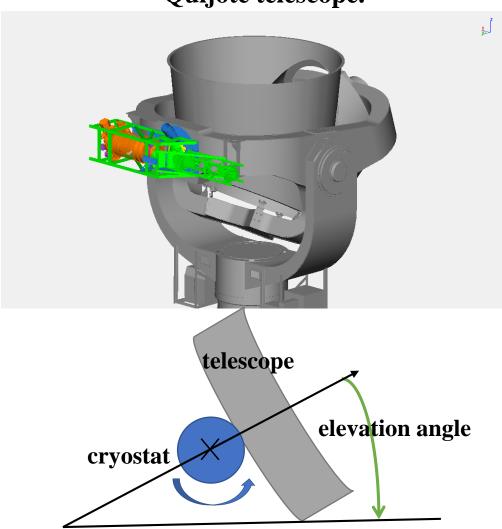
EXTRA

Crossed Dragone

- Primary Mirror = 2.5 m
- Secondary Mirror = 1.85 m
- Surface accuracy $< 150 \mu m$
- rms roughness pattern $< 1.6 \mu m$
- Telescope aperture = $2-3^{\circ}$

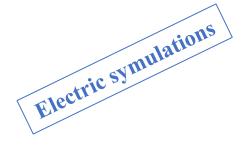


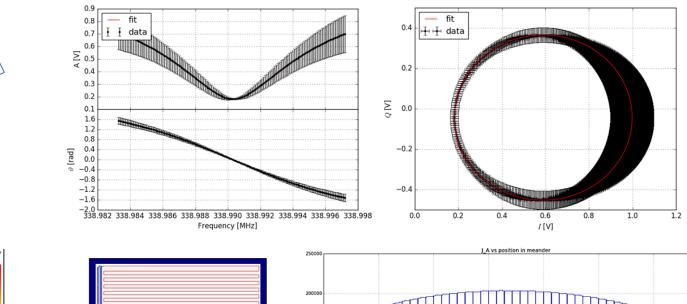
Schematic of KISS coupled to the Quijote telescope.

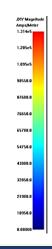


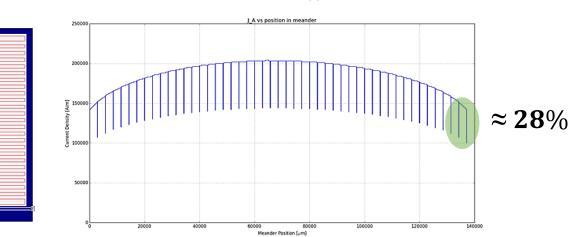
EXTRA *R&D, I part*

Matrix Name	Material	Optical condition	Backshort		
KISS_PB_01	10/25 nm	Back-Illuminated	PIZZA		

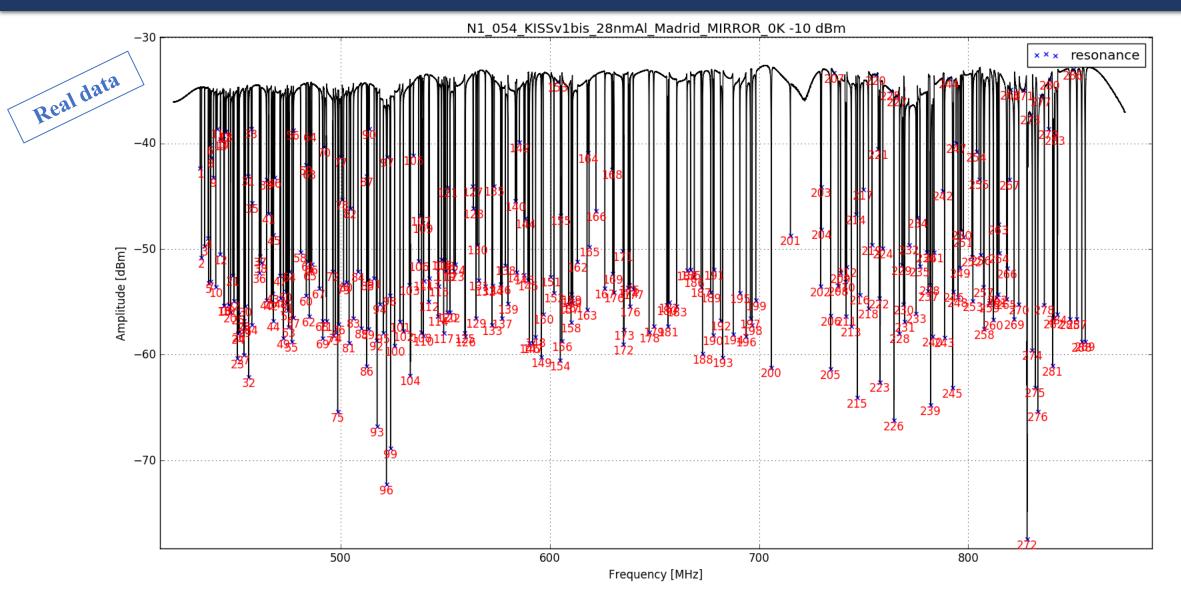








KISS VNA scan



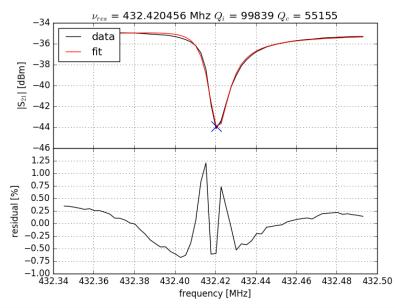
Amplitude scan

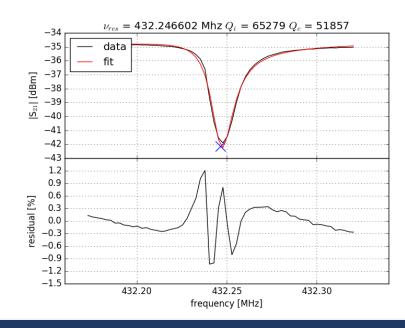
$$S_{21}(\nu; \nu_0, Q_{tot}, A, B, C, D) = A + B \cdot (\nu - \nu_0) + \frac{C + D \cdot (\nu - \nu_0)}{1 + 4Q_{tot}^2 \cdot (\nu - \nu_0)^2 / \nu_0^2}$$

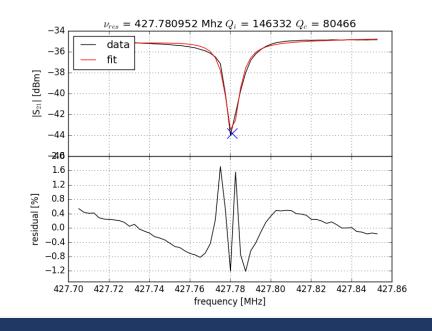


$$Q_i = \frac{Q_{tot}}{|S_{21}^{min}|}$$

$$Q_i = \frac{Q_{tot}}{|S_{21}^{min}|}$$
 $Q_c = \left(\frac{1}{Q_{tot}} - \frac{1}{Q_i}\right)^{-1}$



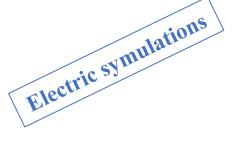


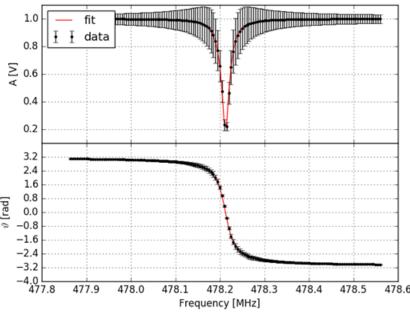


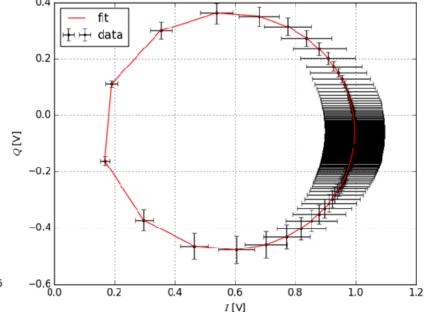
Detectors performances

$$S_{21} = ae^{-2\pi jv\tau} \left[1 - \frac{\frac{Q_{tot}}{Q_c}e^{j\phi_0}}{1 + 2jQ_{tot}\left(\frac{v - v_0}{v_0}\right)} \right]$$

$$Q_{tot} Q_c \nu_0 \longrightarrow \frac{1}{Q_{tot}} = \frac{1}{Q_c} + \frac{1}{Q_i}$$





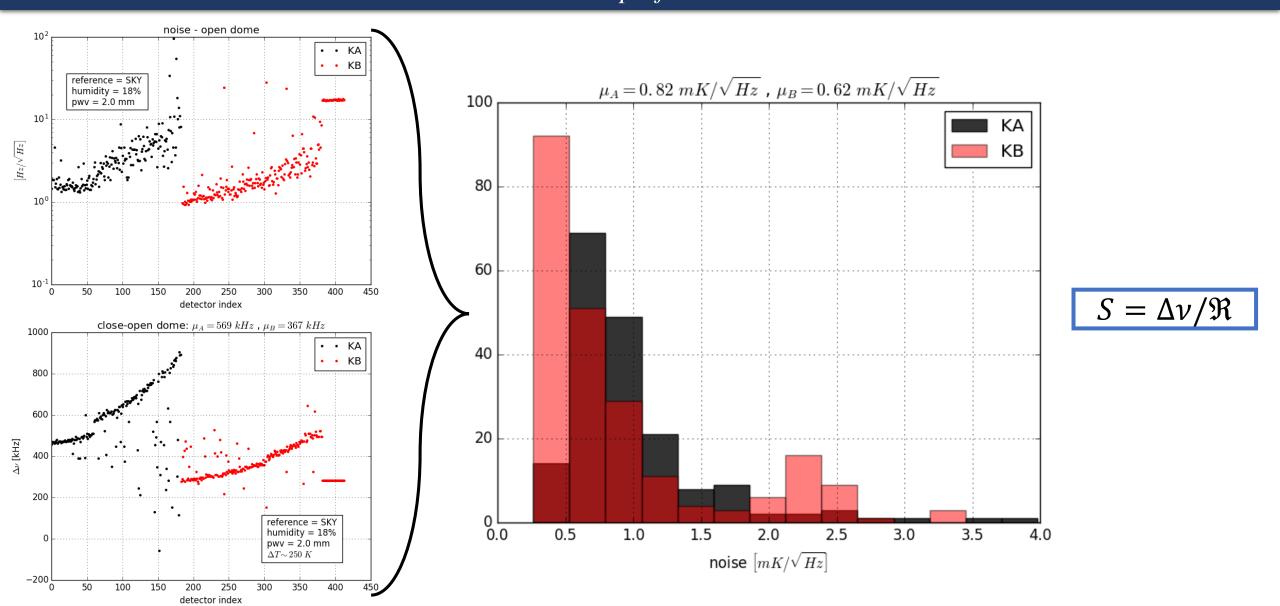


$$\begin{cases} I = A \cos(\varphi) \\ Q = A \sin(\varphi) \end{cases}$$

$$S_{21} = I + jQ = Ae^{j\varphi}$$

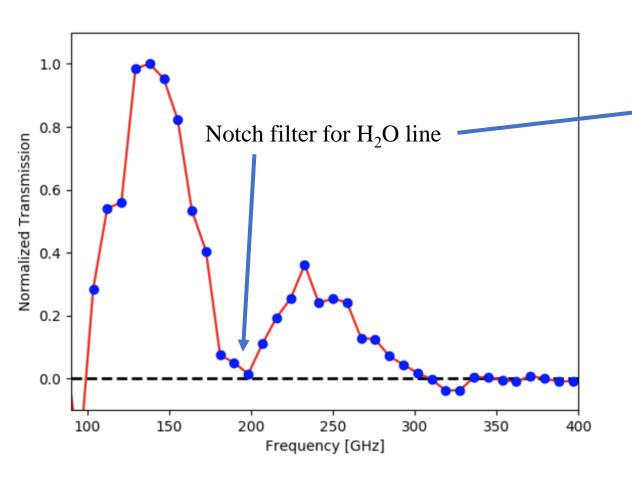
$$\begin{cases} I = A\cos(\varphi) \\ Q = A\sin(\varphi) \end{cases} S_{21} = I + jQ = Ae^{j\varphi} \begin{cases} A = \sqrt{I^2 + Q^2} \\ \varphi = arctan2\left(\frac{Q}{I}\right) \end{cases}$$

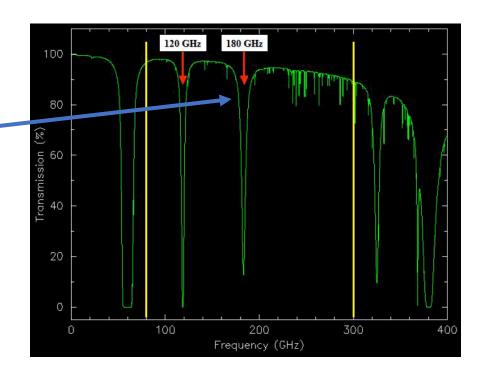
EXTRADetectors performances



EXTRADetectors performances

Absorption spectrum of the matrix



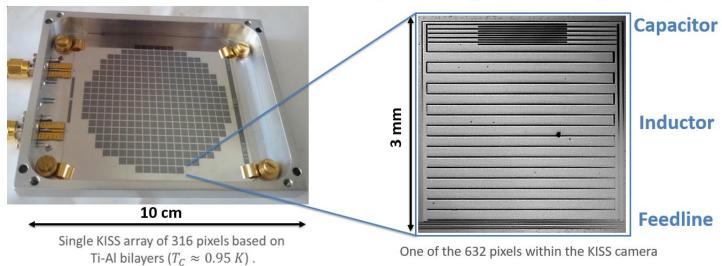


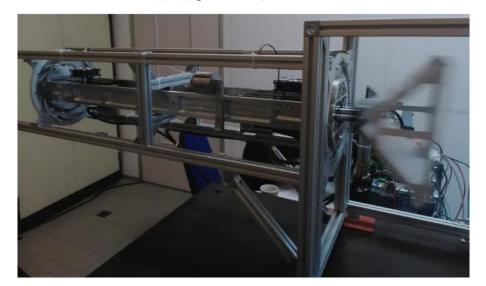
Predicted Atmospheric Transmission O_2 , H_2O [Monfardini, A. et al: 2016]

Instrumentation

KIDs reach the intrinsic limitation of sensitivity

Superconducting LC circuit with high Quality factor





Closed KISS cryostat: Pulse-Tube/³He-⁴He dilution.



Martin Puplett Interferometer: fast integration for wide band 5 Hz oscillating mirror on 10 cm total OPD

EXTRAState of art and necessities

Quijote telescope in Tenerife





Integration of KISS

GOAL

Low resolution spectroscopy observations of known low redshift galaxies at mm wavelenghts to map cluster physical properties from spectral distortions.

STRATEGY

Compensate relative expected low sensitivity with respect to Planck or photometric ground-based instrument by integrating longer (tens of hours per cluster).

Use spectroscopy to fully separate different components and extract physical information from spectral distortions: pressure, temperature, density, mass, LOS velocity

EXTRA *MPI advantages*

Multiplex (Felgett) advantage

$$M \doteq (v_{max} - v_{min})/\delta v$$

$$\begin{cases} S_{N_{disp}} = S(v)\delta v \sqrt{T/M} / NEP \\ S_{N_{FTS}} = S(v)\delta v \sqrt{T/NEP} \end{cases}$$

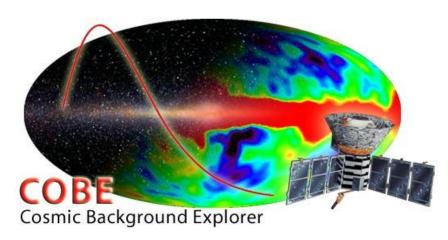
$$\left(\frac{S}{N_{FTS}} \right) / \left(\frac{S}{N_{disp}} \right) = \sqrt{M}$$

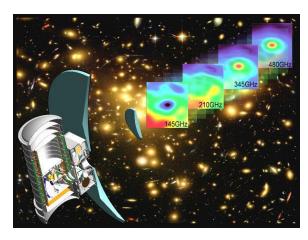
Throughput (Jaquinot) advantage

 $throughput \doteq A\Omega$

The throughput represents the conservation of energy.

In the case of dispersion spectrometers the necessity of slits in entrance and at the end, limits the diameter of the collimated beam: i.e., the area of the focal plane (A) is limited and it results in a smaller signal.



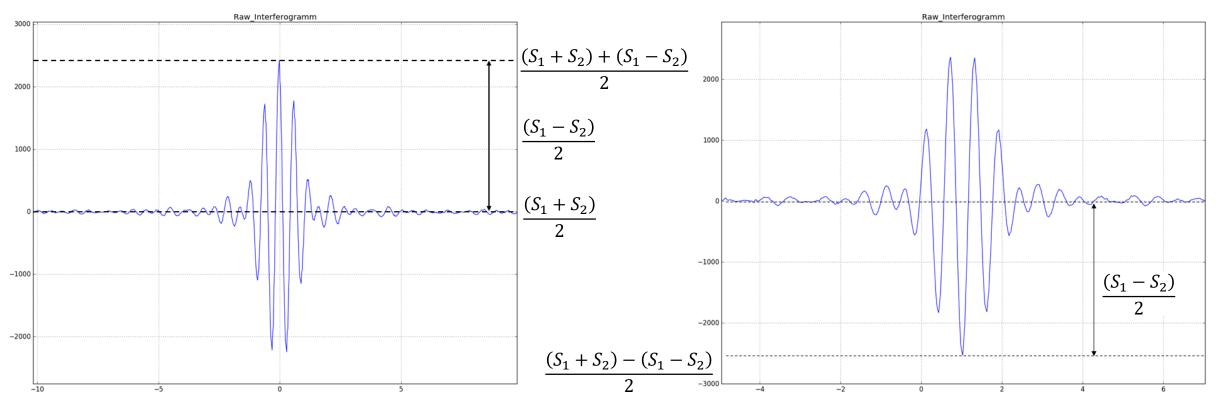


OLIMPO

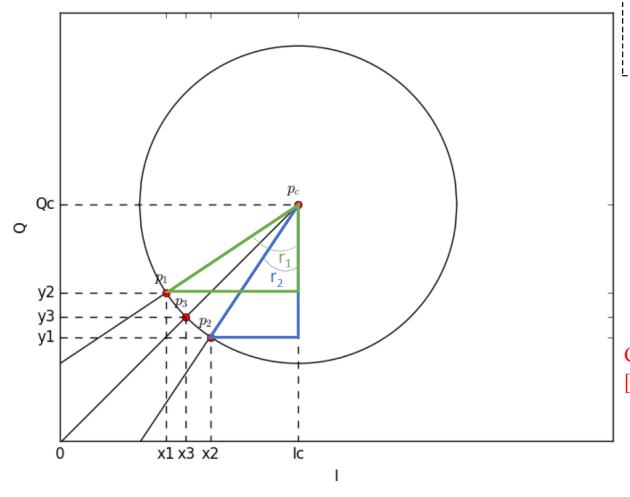
Extra MPI output

I output

put II output



Tuning and modulation



Ic,Qc: from circular fit

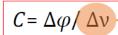
x1,y1 : from modulation

x2,y2 : from modulation

$$r_1 = \arctan\left(\frac{I_c - x_1}{Q_c - y_1}\right)$$
$$r_2 = \arctan\left(\frac{I_c - x_2}{Q_c - y_2}\right)$$

$$r_2 = \arctan\left(\frac{I_c - x_2}{Q_c - y_2}\right)$$

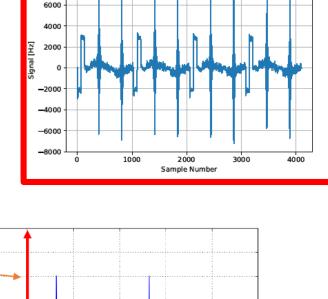
$$\Delta \varphi = r_2 - r_1$$



C: calibration factor [rad/Hz]

> -2000 -3000

> > 200



1000

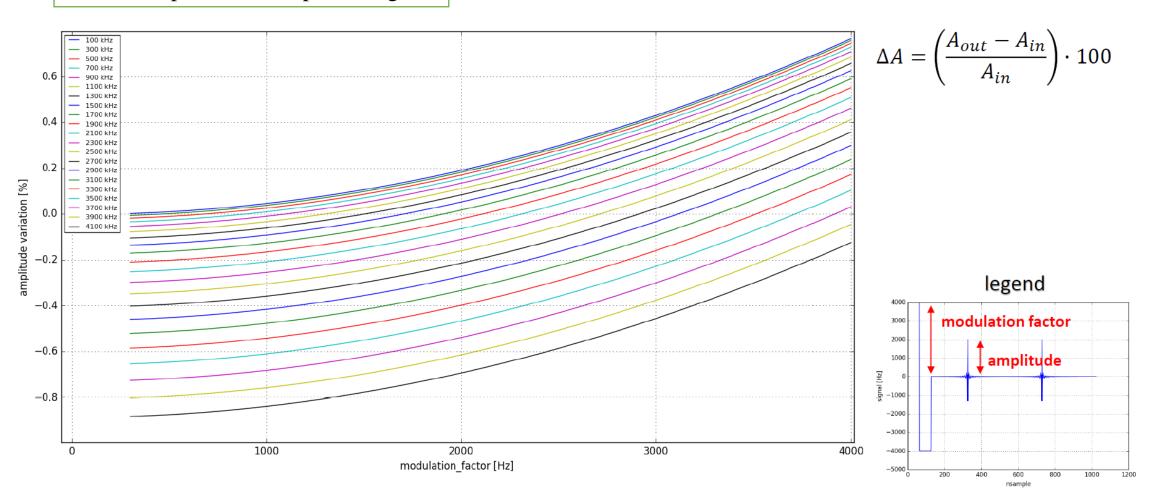
1200

Real data

Amplitude criteria for modulation

as close as possible to expected signal

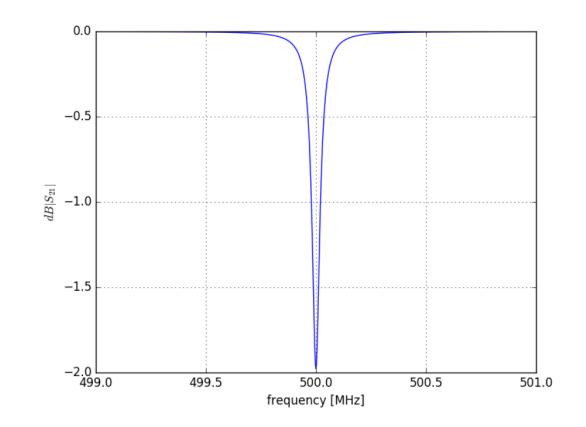
fixed background



Single pixel simulation

Modulation signal
$$S_{21} = ae^{-2\pi jv\tau} \left[1 - \frac{\frac{Q_{tot}}{Q_c}e^{j\varphi_0}}{1 + 2jQ_{tot}\left(\frac{v - v_0}{v_0}\right)} \right]$$

$$\begin{array}{ll} \tau & = 1 \\ \phi_0 & = 0 \\ Q_i & = 15'000 \text{ with } 50 \text{ K of background} \\ Q_c & = 26'000 \\ v_0 & = 500 \text{ MHz} \\ \Re & = 1.5 \text{ kHz/K} \\ \end{array}$$



$$S_{21} = I + jQ = Ae^{j\varphi}$$

$$\begin{cases} I = A\cos(\varphi) \\ Q = A\sin(\varphi) \end{cases}$$

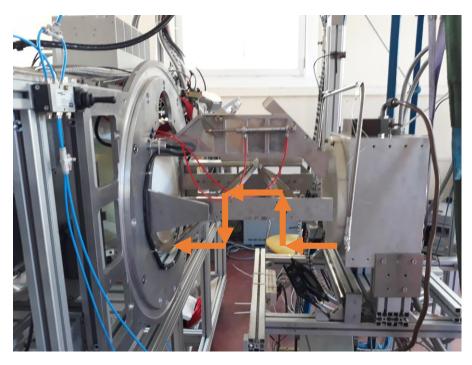
$$\begin{cases} A = \sqrt{I^2 + Q^2} \\ \varphi = \arctan(2\frac{Q}{I}) \end{cases}$$

Second source for KISS

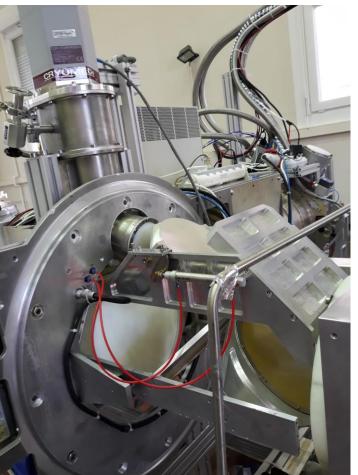
I. Defocused FoV (~30-50 K) Best for point sources II. Mirror looking inside cryostat (~100 K)

Best for extended sources









EXTRA *Noise*

$$NEP^{2} = NEP_{Johnson}^{2} + NEP_{phonon}^{2} + NEP_{gr}^{2}$$

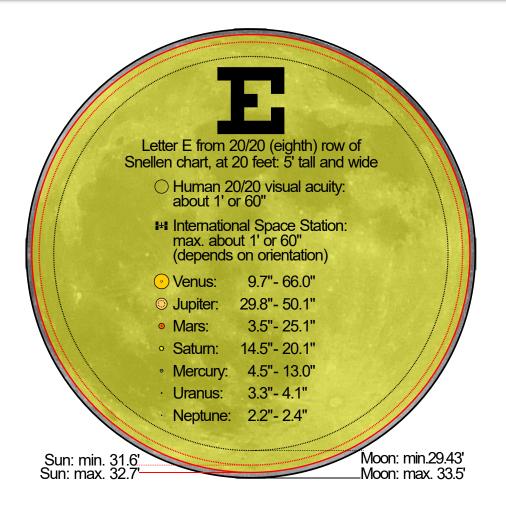
$$= \frac{4k_{B}RT}{\mathcal{R}} + 4k_{B}GT^{2} + \left(\frac{2\Delta}{\eta_{opt}\eta_{pb}}\right)^{2} \cdot \frac{\langle N_{qp}\rangle}{\tau_{qp}}$$

$$NEP_{gr} \propto e^{-\Delta_{0}/k_{B}T}$$

$$NEP_{photon}^{2} = \frac{2}{\eta} \int_{\Delta\nu} P_{\nu}h\nu d\nu + \frac{1}{\eta^{2}} \int_{\Delta\nu} \frac{P_{\nu}^{2}c^{2}}{A\Omega\nu^{2}} d\nu$$

$$P_{\nu} = \epsilon t \eta A\Omega BB(\nu, T)$$

EXTRASolar System



Planet	Freq. [GHz]	THERMODYNAMIC TEMPERATURE [K]					
		Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Mean
Mars	100	198.4 ± 0.7	186.7 ± 0.7			197.7 ± 0.7	$194.3 \pm 0.5 \text{ (stat.)} \pm 0.8 \text{ (syst.)}$
Mars	143	203.3 ± 0.6	188.9 ± 0.5			203.0 ± 0.5	$198.4 \pm 0.4 \pm 1.1$
Mars	217	207.3 ± 0.3	192.1 ± 0.3			206.2 ± 0.3	$201.9 \pm 0.2 \pm 1.3$
Mars	353	215.1 ± 0.5	200.1 ± 0.5			214.5 ± 0.5	$209.9 \pm 0.4 \pm 1.6$
Mars	545	215.0 ± 1.7	199.1 ± 1.5			213.5 ± 1.5	$209.2 \pm 1.1 \pm 4.0$
Mars	857	218.1 ± 1.7	202.6 ± 1.9			219.9 ± 1.8	$213.5 \pm 1.3 \pm 6.6$
Jupiter	100	172.8 ± 0.4	172.1 ± 0.4	173.1 ± 0.4	171.0 ± 0.4		$172.3 \pm 0.4 \pm 0.7$
Jupiter	143	174.0 ± 0.2	172.5 ± 0.3	174.4 ± 0.2	172.3 ± 0.2	174.7 ± 0.2	$173.6 \pm 0.2 \pm 0.9$
Jupiter	217	175.4 ± 0.1	174.7 ± 0.1	174.6 ± 0.1	175.2 ± 0.1	173.8 ± 0.1	$174.7 \pm 0.1 \pm 1.1$
Jupiter	353	166.1 ± 0.4	166.0 ± 0.4	166.5 ± 0.4	165.9 ± 0.4	167.1 ± 0.4	$166.3 \pm 0.4 \pm 1.3$
Jupiter	545	137.0 ± 0.9	138.2 ± 0.9	136.5 ± 0.9	135.1 ± 1.0	135.7 ± 1.0	$136.5 \pm 0.9 \pm 2.6$
Jupiter	857	156.7 ± 1.2	163.8 ± 1.3	160.1 ± 1.3	158.3 ± 1.4	162.3 ± 1.4	$160.3 \pm 1.3 \pm 4.9$
Saturn	100	145.2 ± 0.3	148.3 ± 0.3	143.5 ± 0.3	145.9 ± 0.3		$145.7 \pm 0.3 \pm 0.6$
Saturn	143	146.4 ± 0.2	148.6 ± 0.2	145.4 ± 0.2	147.7 ± 0.2		$147.0 \pm 0.2 \pm 0.8$
Saturn	217	143.8 ± 0.1	145.4 ± 0.1	144.3 ± 0.1	146.0 ± 0.1		$144.9 \pm 0.1 \pm 0.9$
Saturn	353	139.9 ± 0.3	140.4 ± 0.3	142.4 ± 0.3	143.1 ± 0.3		$141.5 \pm 0.3 \pm 1.1$
Saturn	545	100.1 ± 0.6	99.9 ± 0.7	105.0 ± 0.7	104.3 ± 0.7		$102.4 \pm 0.6 \pm 2.0$
Saturn	857	112.1 ± 0.9	111.0 ± 0.8	120.0 ± 1.1	118.7 ± 1.0		$115.5 \pm 1.0 \pm 3.6$
Uranus	100	121.1 ± 0.8	118.1 ± 0.8	120.9 ± 0.8	121.6 ± 0.8	120.6 ± 1.0	$120.5 \pm 0.4 \pm 0.5$
Uranus	143	107.6 ± 0.2	109.1 ± 0.2	108.5 ± 0.2	108.6 ± 0.2	108.4 ± 0.2	$108.4 \pm 0.1 \pm 0.6$
Uranus	217	98.3 ± 0.1	98.5 ± 0.1	98.6 ± 0.1	98.7 ± 0.1	98.5 ± 0.1	$98.5 \pm 0.1 \pm 0.6$
Uranus	353	86.5 ± 0.2	86.3 ± 0.2	86.1 ± 0.2	85.9 ± 0.2	86.2 ± 0.2	$86.2 \pm 0.1 \pm 0.7$
Uranus	545	74.0 ± 0.5	73.5 ± 0.5	73.2 ± 0.4	73.5 ± 0.5	75.1 ± 0.6	$73.9 \pm 0.2 \pm 1.4$
Uranus	857	66.0 ± 0.5	66.2 ± 0.5	66.3 ± 0.5	66.2 ± 0.5		$66.2 \pm 0.2 \pm 2.0$
Neptune	100	118.2 ± 2.2	117.6 ± 1.9	117.3 ± 1.9	116.6 ± 1.9		$117.4 \pm 1.0 \pm 0.5$
Neptune	143	105.8 ± 0.5	106.3 ± 0.4	107.0 ± 0.5	106.5 ± 0.4		$106.4 \pm 0.2 \pm 0.6$
Neptune	217	97.1 ± 0.3	97.7 ± 0.2	97.8 ± 0.3	97.0 ± 0.2		$97.4 \pm 0.1 \pm 0.6$
Neptune	353	82.2 ± 0.3	82.8 ± 0.3	82.7 ± 0.3	82.6 ± 0.2		$82.6 \pm 0.1 \pm 0.6$
Neptune	545	72.4 ± 0.5	71.9 ± 0.4	72.4 ± 0.5	72.2 ± 0.4		$72.3 \pm 0.2 \pm 1.4$
Neptune	857	65.2 ± 0.5	65.5 ± 0.5	65.3 ± 0.4	65.1 ± 0.5		$65.3 \pm 0.2 \pm 2.0$

[Planck intermediate results. LII. Planet flux densities, 2016]

Cosmology with the SZ Effect

Hubble Constant

 β_{T}

$$D_A \propto \frac{\Delta T_{tSZE}}{S_X}$$
 $D_A(z, H_0, \Omega_k) = \frac{l}{\theta}$

$$f_b = \frac{\Omega_b}{\Omega_m}$$

$$f_{gas,SZE} \propto D_A$$

$$f_{gas} \sim 80\% f_b$$

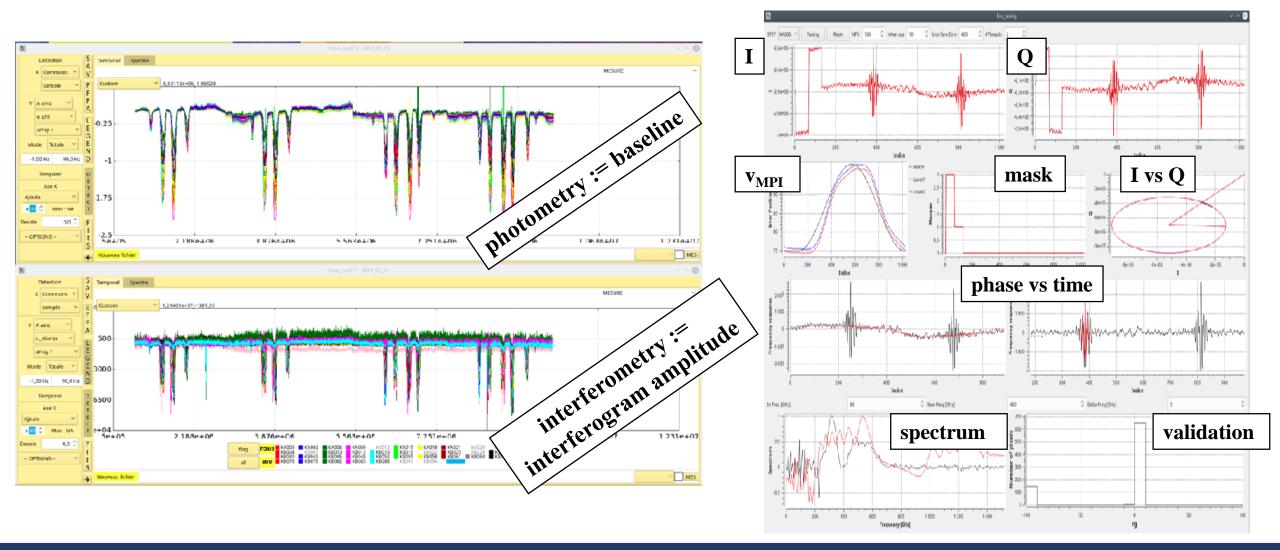
$$T_{CMB} = T_{CMB,0} (1+z)^{1-\beta_T}$$

Study the cluster of galaxy properties

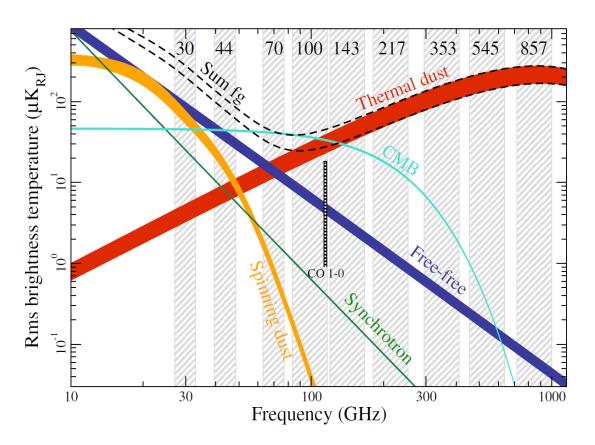
On the fly / real time data

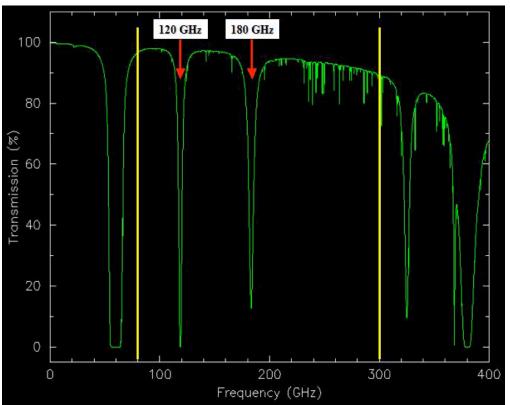
Photometry & Interferometry

and more details...



EXTRA *CMBR foregrounds*





Predicted Atmospheric Transmission O_2, H_2O

[Monfardini, A. et al: 2016]

Quality factors & Responsivity

Quality factors

$$Q = 2\pi N = \omega_0 \frac{E_{stored}}{W_{lost}} = \frac{Q_i Q_c}{Q_i + Q_c} \qquad \qquad Q_c$$

$$Q_c$$

compromise: resonance depth vs high Q optimised for background depends on the number of quasi particles

Responsivity

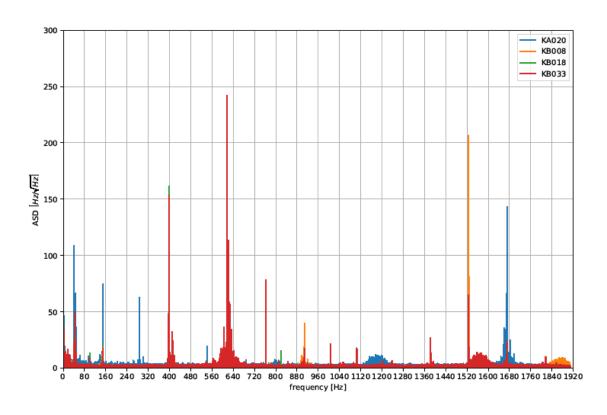
$$\mathcal{R} = \frac{d\varphi}{dN_{qp}} \propto \frac{\alpha Q}{V}$$

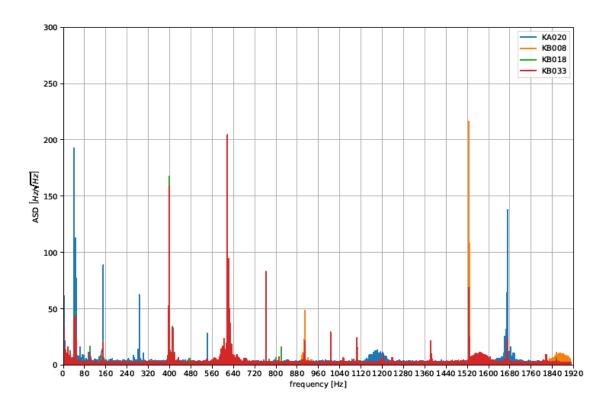
$$\alpha \equiv \frac{L_{kin}}{L_{tot}}$$

Minimising V Maximising α and Q

EXTRA400 Hz noise

Normal alimentation



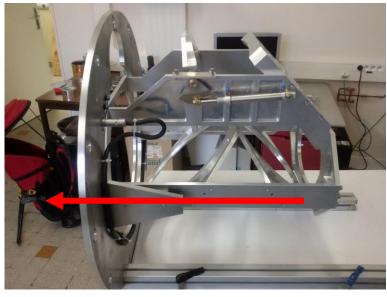


Focus engine



Engine to control KISS' focus









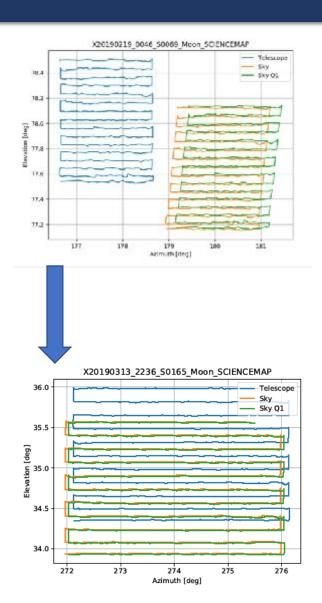
Controlled by RaspberryPi. Double connection:

- Tcp server
- Touchscreen interface

Status and perspectives

FACTS

- KISS installation lasted from November 2018 to January 2019.
- KISS started observations on February 2019.
- 1) Noise: the 400 Hz noise is still there and it is not still clear where it comes from. Further analysis are required. It is possible that the problem is inside the cryostat: something could be unplugged during the transportation.
- 2) **Pointing Model:** Pointing correction are of the order of degree especially at higher altituted. Nowadays we are able to observe with more accuracy but still we have to implement the model with the rights parameters.
- 3) Calibration sources: We are acquiring maps of the Moon to set a pointing model accurate enough to allow point source observations. Jupiter and Venus are still under observation. The problem with the Moon is that its flux saturates the pixel. We are studying a solution to reduce the flux.



Status of the pointing model

QUIJOTE1 model parameters

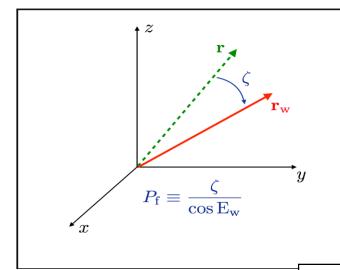
- 1) vertical flexure **Pf**
- 2) tilt on azimuth axis Px, Py
- 3) non-perpendicularities Pc, Pn
- 4) encoders errors Pa, Pb

Precision up to visible band

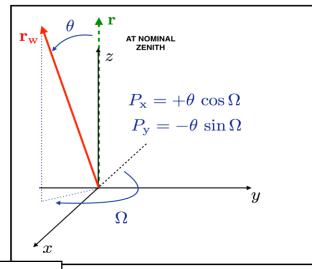
Required data:

[JDate, Azimuth, Elevation, Right Ascension, Declination, signal]

Vertical flexure



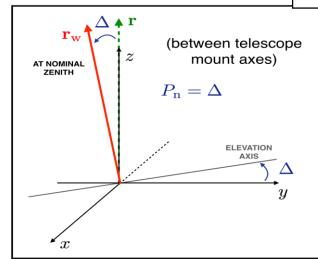
Roll axis misalignments

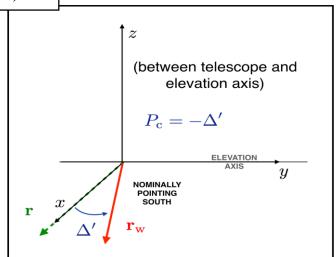


Non-perpendicularity I

Tramonte, D.

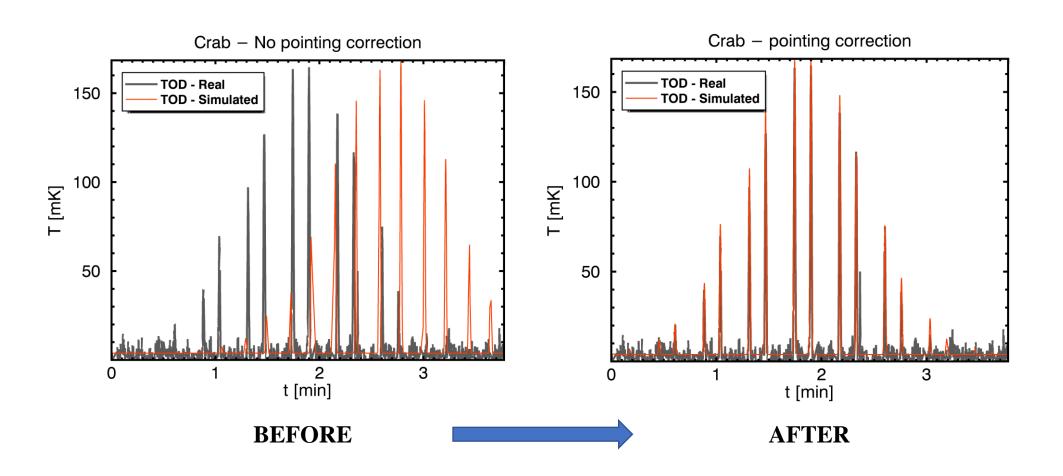
Non-perpendicularity II





EXTRAStatus of the pointing model

MODEL FOR QUIJOTE2



EXTRATesting signal level reduction for Moon observation

