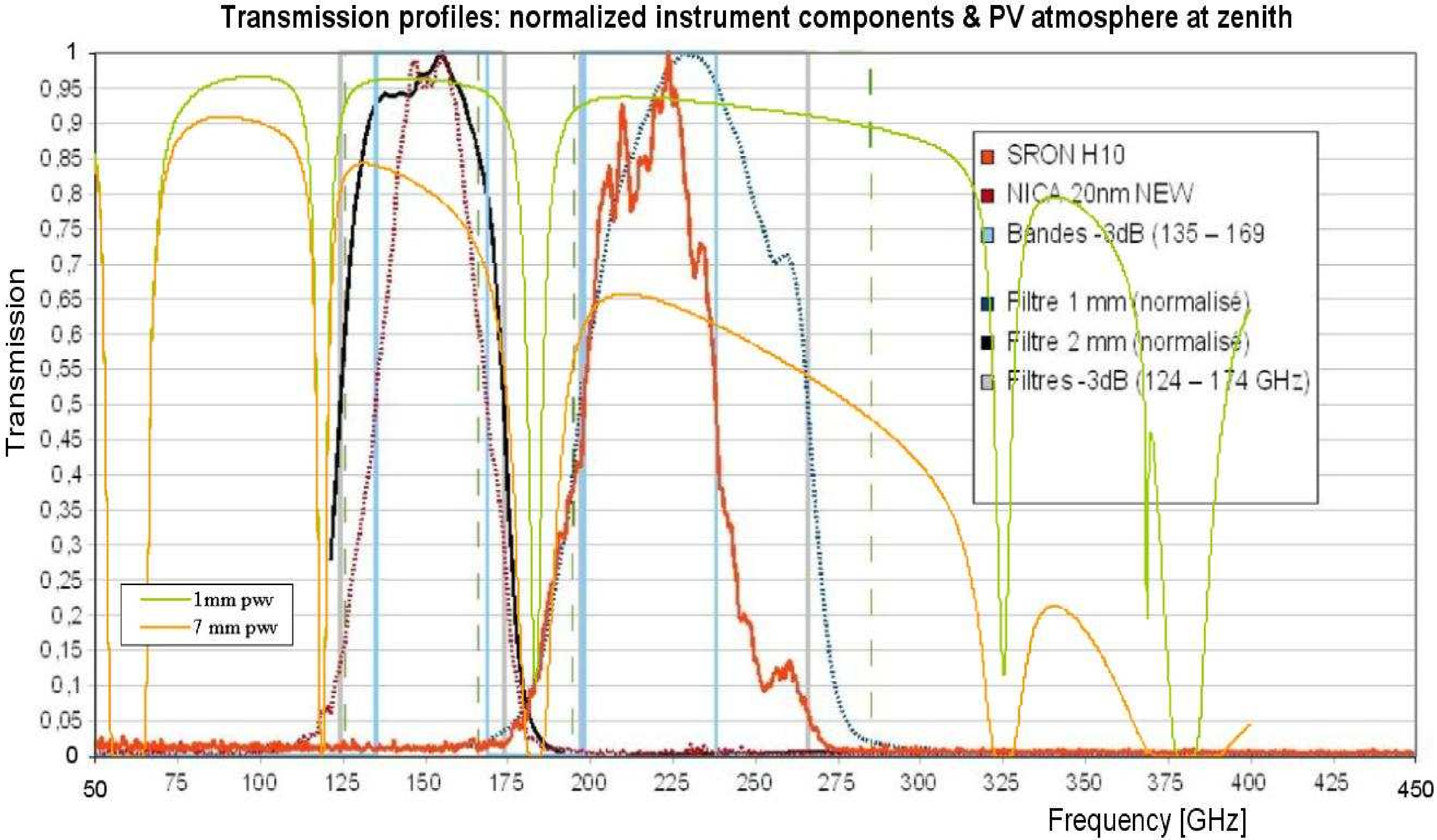
Extra slides

New NIKA spectral responses



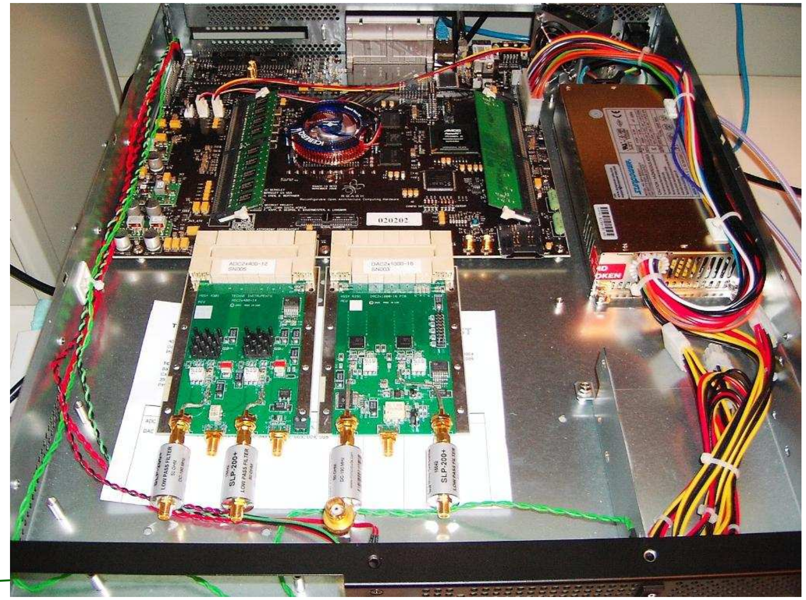
Bands spectral response obtained with a Martin-Puplett interferometer

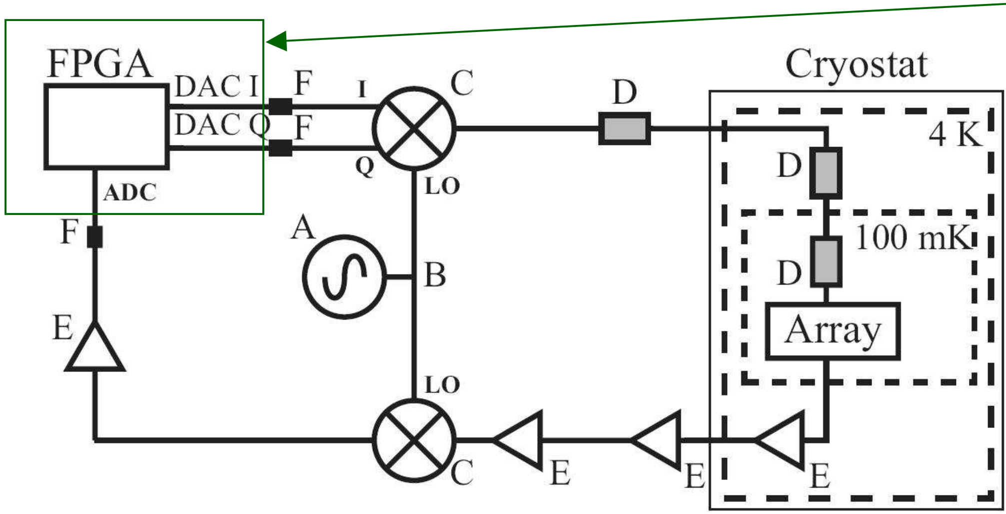
New NIKA backend

Electronics

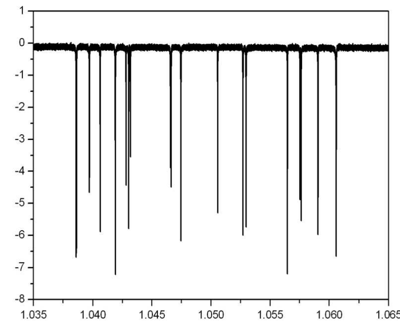
Based on 2 **CASPER ROACH Boards** from the **Open Source project** (development of 128 channels modules for KIDs readout).

- Rubidium clock reference
- 466 MSPS
- 233 MHz readout
- 72 (1mm band) & 112 (2mm band) "lock-in like" tone generator
- each pixel response broadcasted at 22Hz





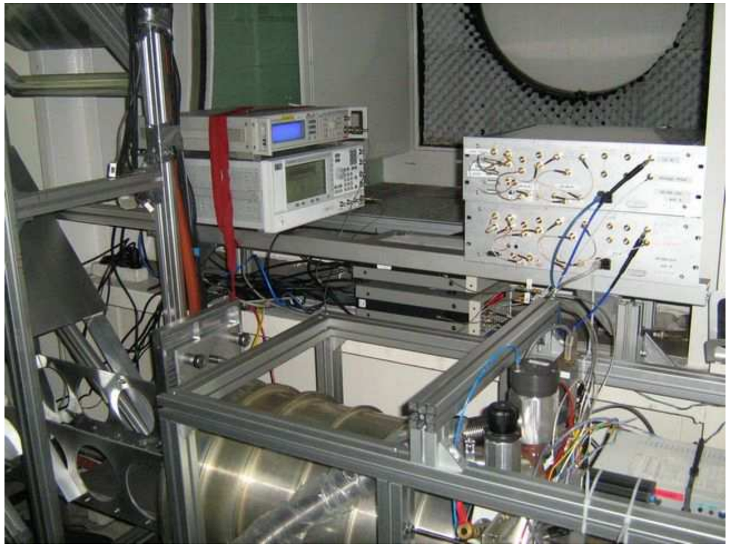
A) High frequency synthesizer
B) Splitter
C) Mixer
D) Attenuator
E) Amplifier
F) Low pass filter



Frequency multiplexing
1 tone / pixel on a feed line

Individual pixel response = pair of in-phase (I) and quadrature (Q) values.

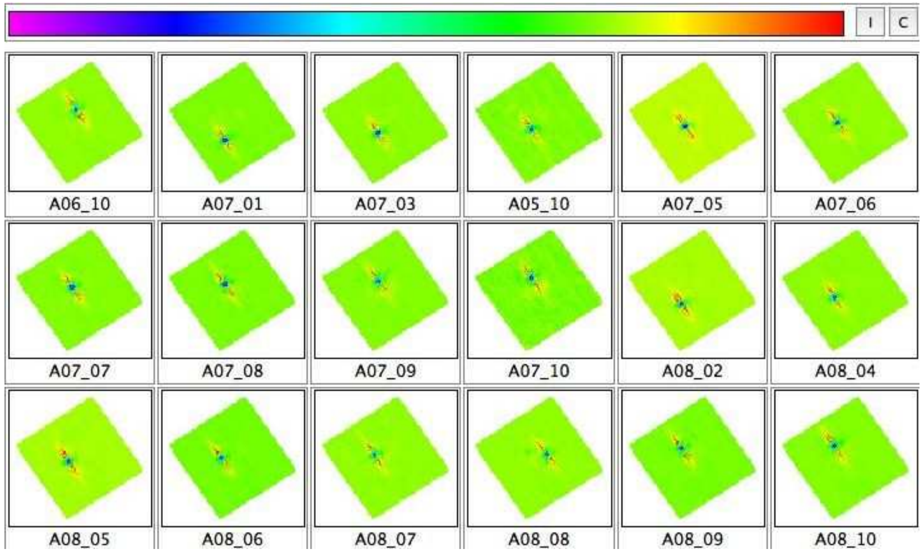
NIKA 2nd run: Installation in the cabin



NIKA 2nd run: Preparation phase

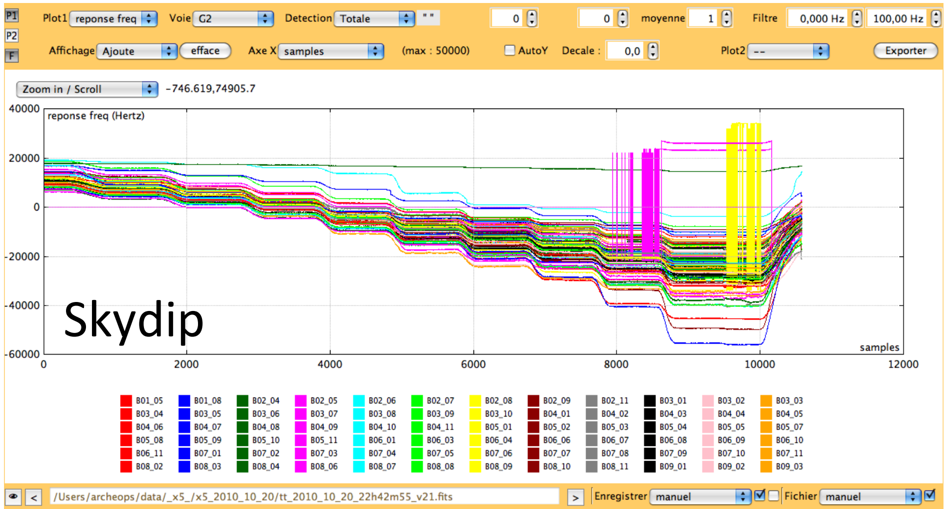
(acquisition soft, merging with telescope data, detector tuning, …)

Control room

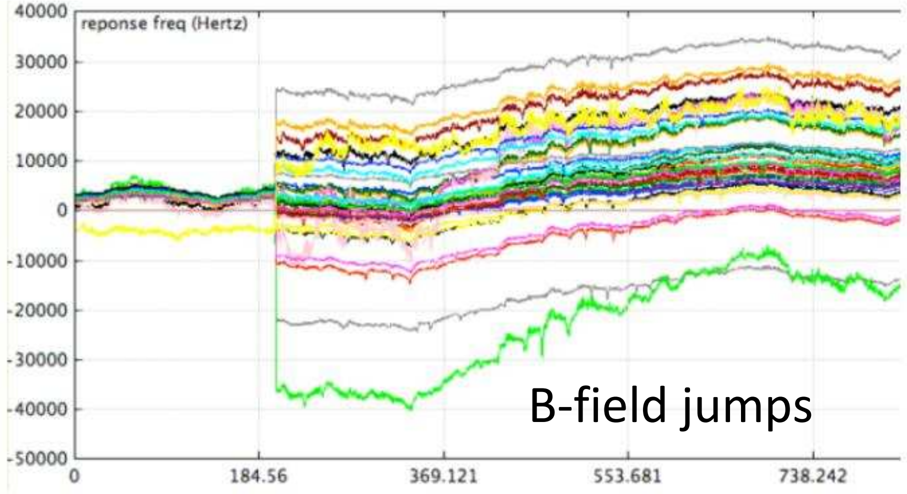


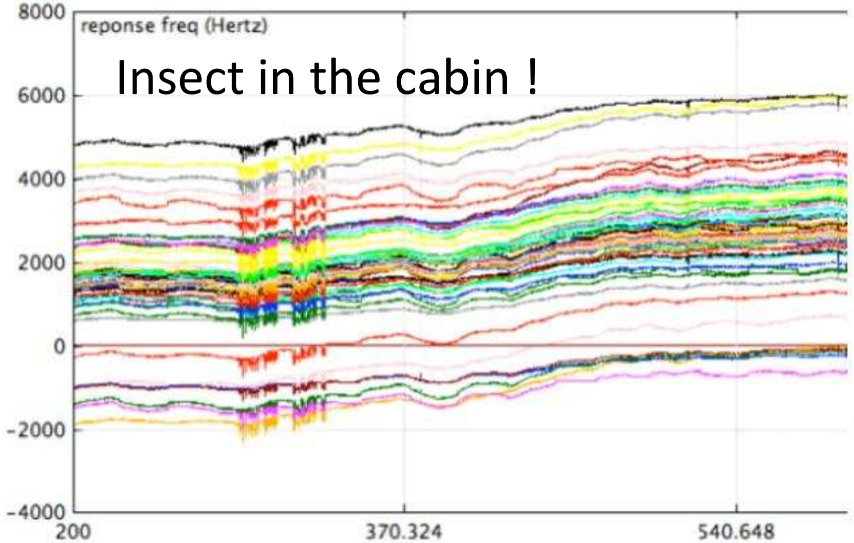
Mars maps (pointing, focus, calibration…)

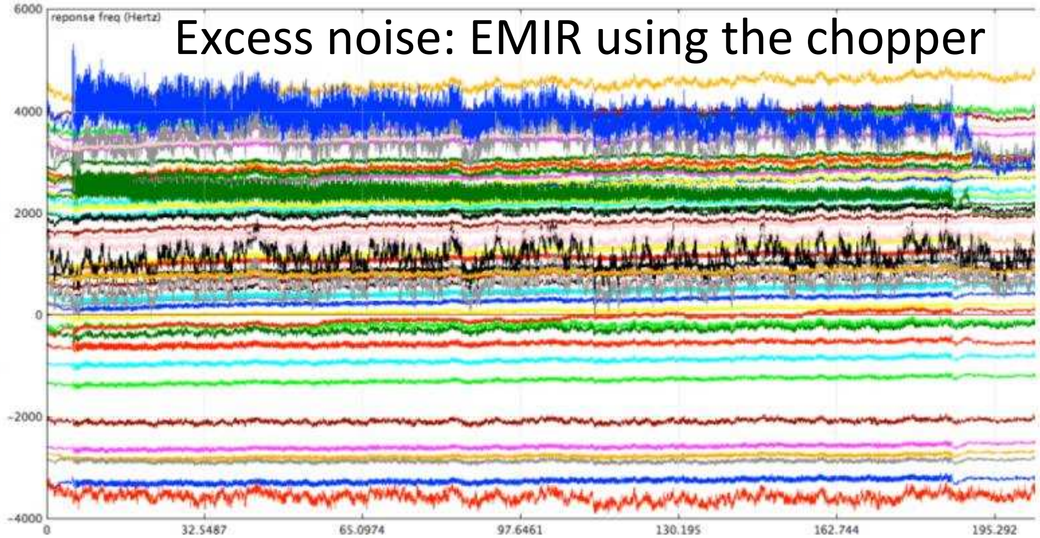
Tuning the resonances



NIKA 2nd run: Example of problems







NIKA 2nd run: Data analysis and results

Calibration

- Only using Response in Frequency signal (better than run1)
- Assumed to be linear with power
- From I and Q, get complex phase on calibration circle, then translate to equivalent frequency shift, as measured during KID tuning

Traditional transmission amplitude:

$A^2 = I^2 + Q^2$

and phase:

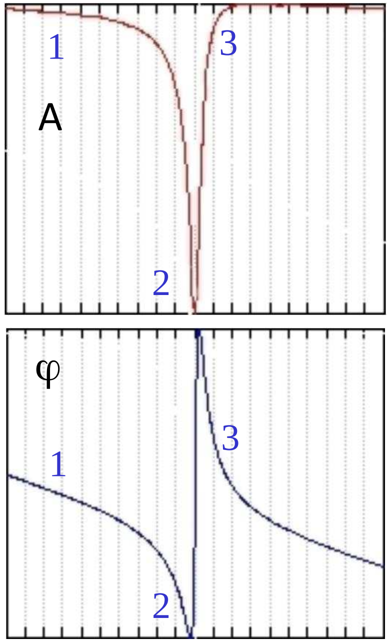
$\varphi = \mathrm{atan}(Q/I)$

Equivalent frequency shift:

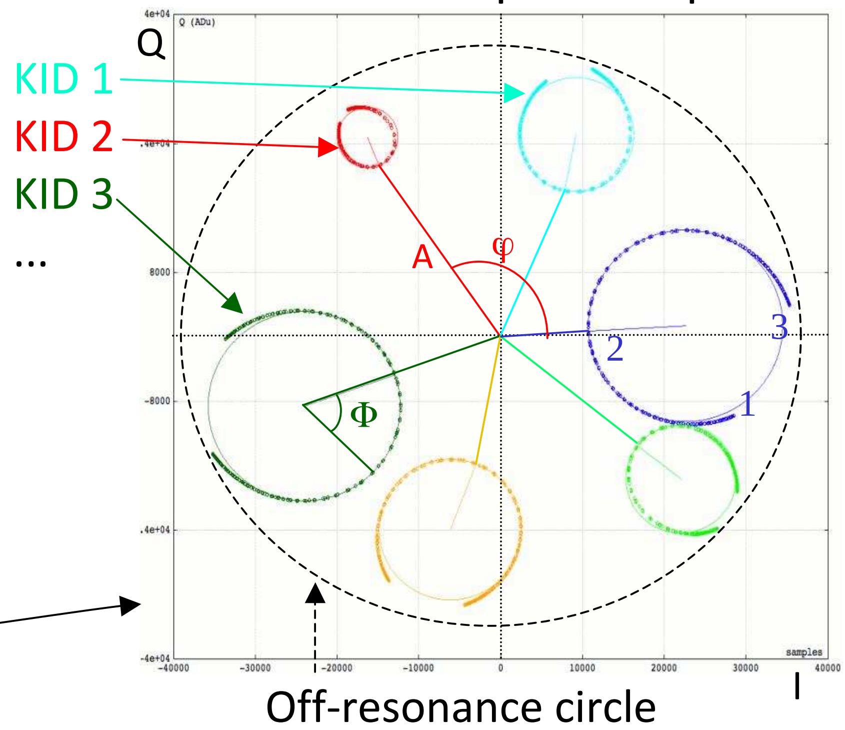
$\Phi = \mathrm{atan}(Q\text{-}Q_c/I\text{-}I_c) - \Phi_0$

$\sim \delta f_0 \sim (f_0^3/n_s)\delta P_i$

f_0 = resonance frequency,
n_s = Cooper pair density,
P_i = incident power

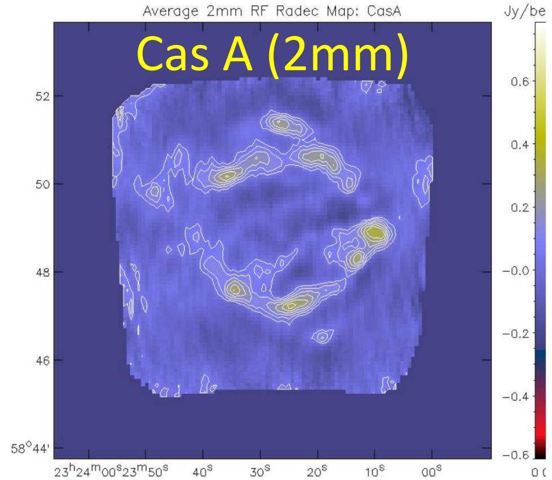


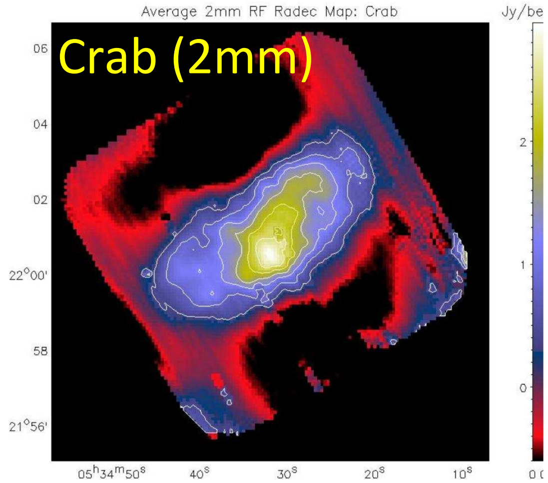
Resonance loops in I-Q plane



NIKA 2nd run: Data analysis and results

Source	Integration time [s]	Flux measured (1mm , 2mm) [mJy]	NEFD measured (1mm , 2mm) [mJy·s $^{1/2}$]
Strong sources (no sky decorrelation)			
Neptune	1087	17000 , 7000	2400, 4200
SgrB2(FIR1)	900	76000 , 17700	
MWC 349	495	1700 , 1000	1100 , 1100
IRC 10420	2410	94 , 21	530 , 120
Weak sources (sky decorrelation)			
IRC 10420	2410	94 ± 12 , 21 ± 1	371 , 45
Cyg A	2200	269 ± 34 , 87 ± 22	
NGC 1068	1260	142 ± 25 , 66 ± 3	
PSS 2322	1950	2 ± 12 , 1.1 ± 0.6	330 , 29





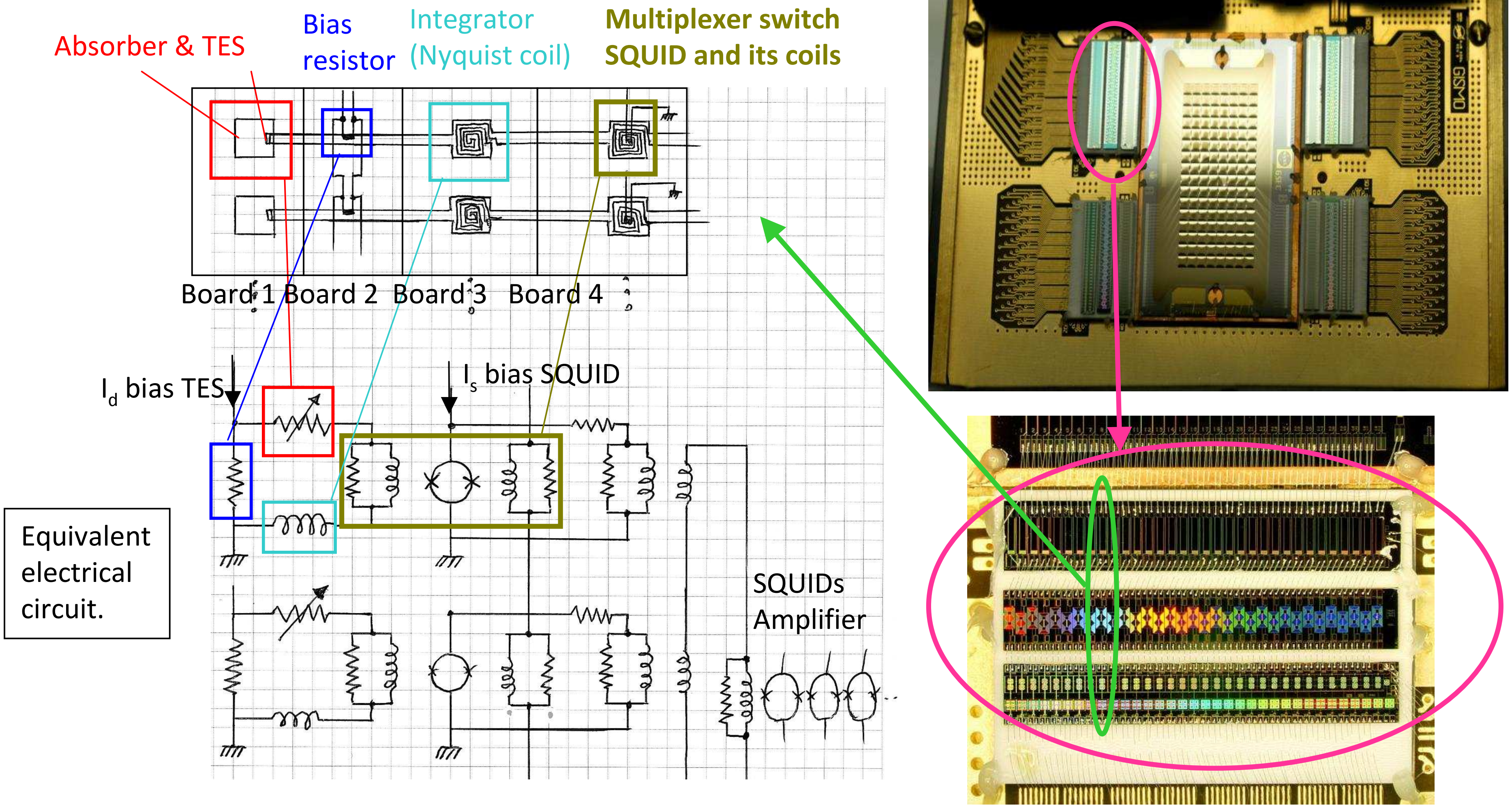
⇒ Strong sources: NEFD dominated by source noise (photometric reproducibility)

⇒ Weak sources: conservative NEFDs (mJy·s $^{1/2}$): 400 @ 1mm, 40 @ 2mm

⇒ NET ≈ 4 mK·s $^{1/2}$

GISMO backend

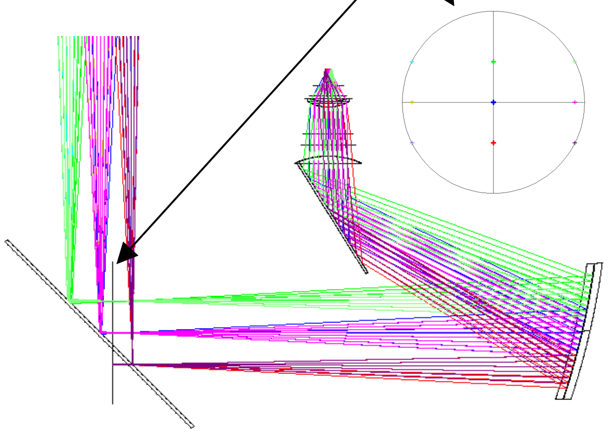
Physical aspect of 2 pixels cold backend on a multiplexed line.

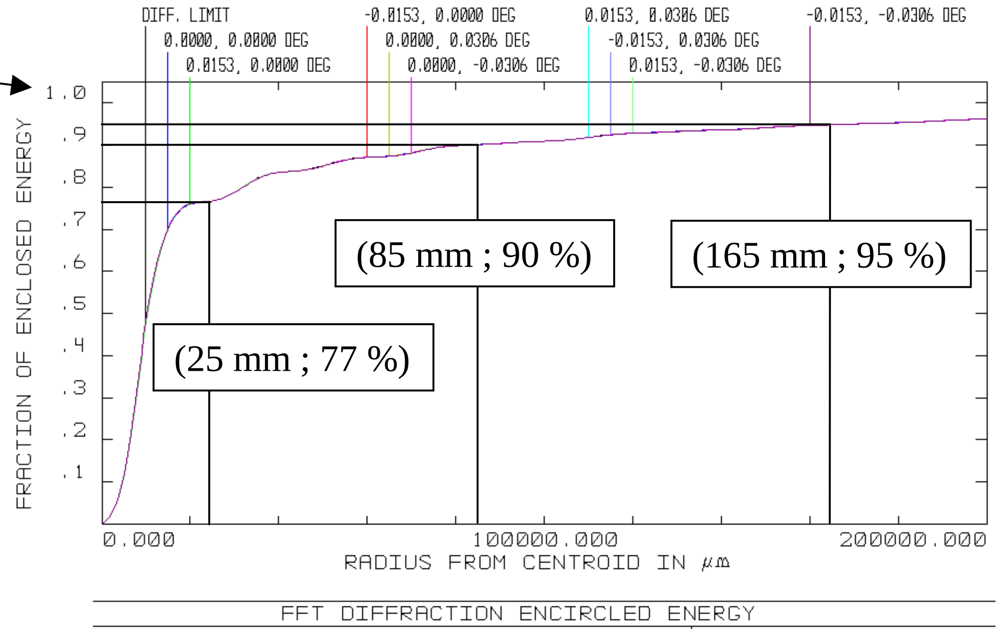


GISMO 4th run: Installation in the cabin

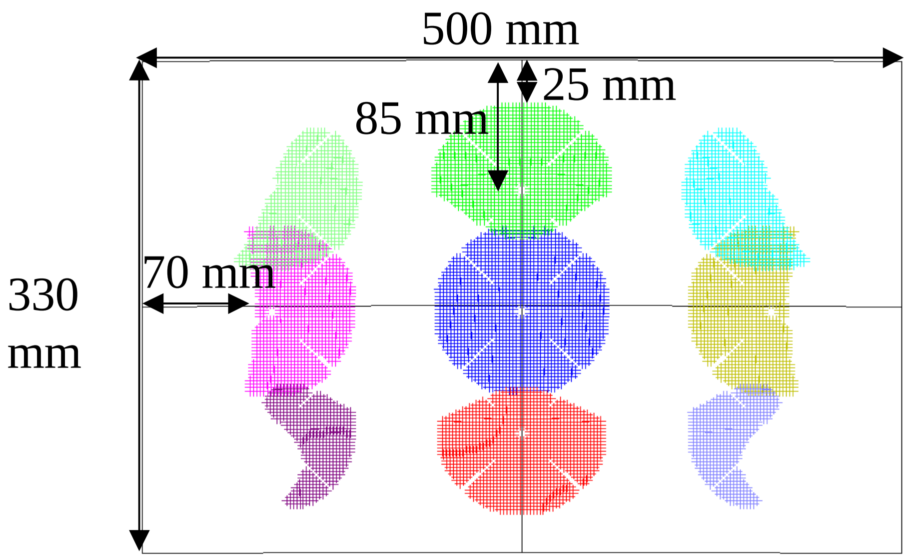
GSIMO 4th run main problem: spill-over on M7

Integrated energy of the diffraction beams at the telescope focal plane





Approximation: each ray PSF has the same shape and FWHM along the optical path as long its doesn't encounter a powered surface.
=> rays have the same encircled energy diagram anywhere in the cabin, they spill over all the mirrors, M7 being the "worse".
50% of the rays are in the 100 mm radius disc centered on the middle of M7 (~5% spill-over for rays at this position).
=> **global spill-over on M7 ~ 6%.**



Call: FOV, number of pixels and mapping speed

Number of 0.5 Fλ pixels filling a given FOV for each atmospheric window available at the 30m telescope:

FOV (diameter)→ Band **center** ↓	4	6	**6.5**	7
92 GHz **3.25 mm**	340	750	880	1020
146 GHz **2.05 mm**	840	1890	**2210**	2560
250 GHz **1.2 mm**	2250	5060	**5940**	6890
345 GHz **0.87 mm**	4650	10450	12260	14220

MAMBO-2: 117 pixels, 11" for each pixel HPBW.

Mapping time $t \sim NEFD^2 \cdot (\Omega_{map}/\Omega e_{array}) \Rightarrow$ mapping speed ratio:

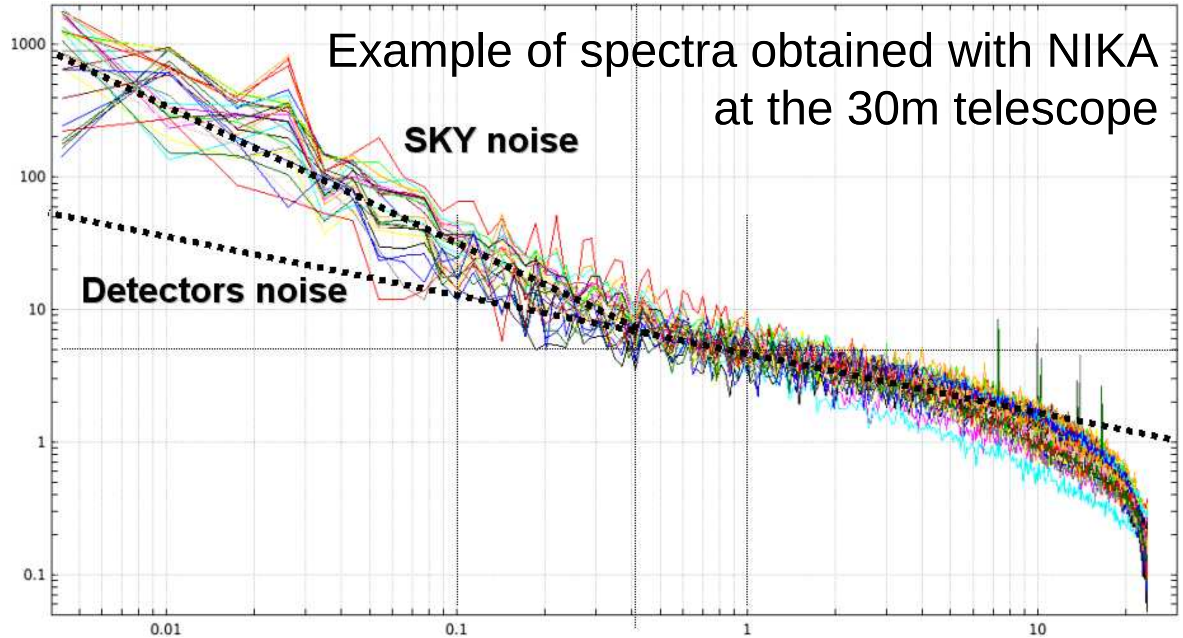
$t_{MAMBO\text{-}2} / t_{6.5'FOV,0.5F\lambda filled} = (35^2/(117 \cdot (11/60)^2)) / (8.6^2/6.5^2) \approx 180$

Call: Dynamic and frequency range requirements

The background temperature can fluctuate from 20 to 200 K depending on the weather conditions and the elevation. Dynamic range required of an instrument background-limited at any weather condition: $\Delta T/(NET/2) = 10^6\ s^{-1/2}$.

Typical on-the-fly mapping speed ~10"/s, typical subscan period ~10s.

Fluctuations of the atmosphere, and other possible sources (e.g. electronics) create 1/f noise, mostly correlated.



$\Rightarrow$ the NEP requirements applies for the 0.1 - 100 Hz frequency domain

Remark: the pixel to pixel stability should last much longer (several minutes) than the stability of the array

Call: Calibration, software, operation, budget

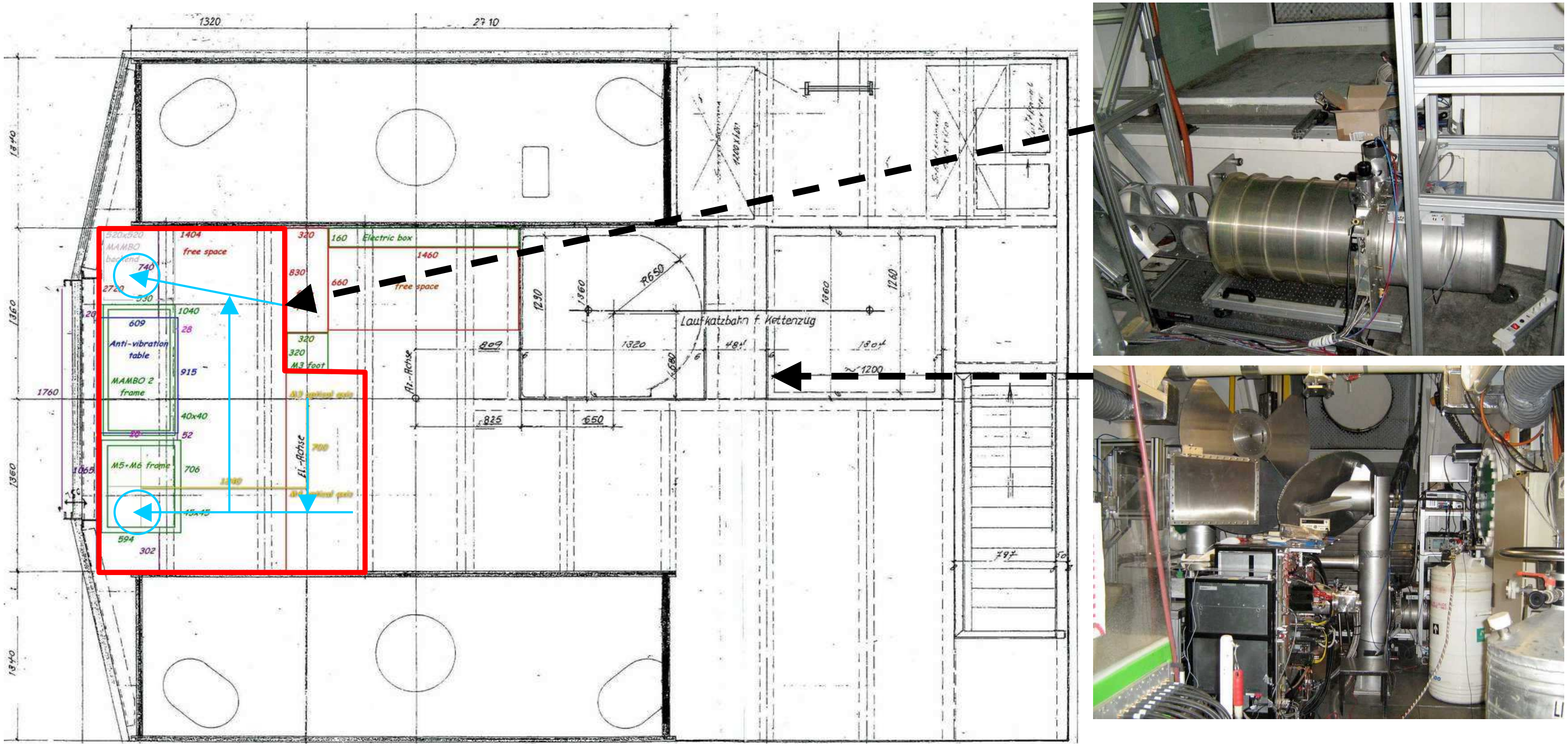
Calibration
The instrument will have to include elements for the calibration of the pixels electrical and optical responses. The specifications for laboratory measurements (e.g. sky simulator) are:
- 5% minimum on the absolute photometry, goal 3%
- 2% minimum on the relative (inter epoch, inter band) photometry, goal 1%.

Software
A software allowing to control the instrument, do the interface between the instrument and the telescope control system, and provide calibrated data in a defined format should be delivered together with the instrument. As part of the package, the source code of this acquisition software must be available to IRAM and be documented .

Operation
Cooling of the instrument shall be obtained with a closed cycled cryogenic system with automatic procedures. Maintenance and science operation should be feasible by trained IRAM staff.
The anticipated instrument lifetime is 10 years.

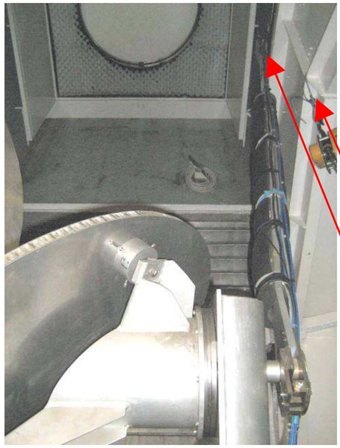
Budget
The total budget envelop of the instrument is 2 M€. The proposing consortium will contribute with a budget of 1 M€. This effort will be compensated by guaranteed time for programs using the instrument at the 30m telescope *(~1000 €/h evenly distributed over 4 years, ~125 hours/ semester).*

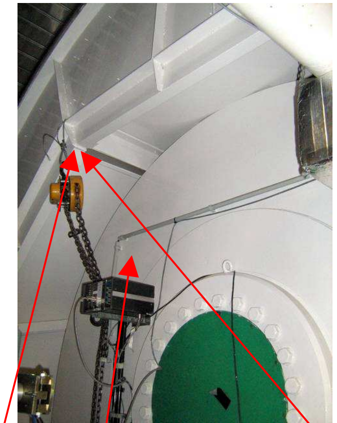
Call: Room available in the receiver cabin

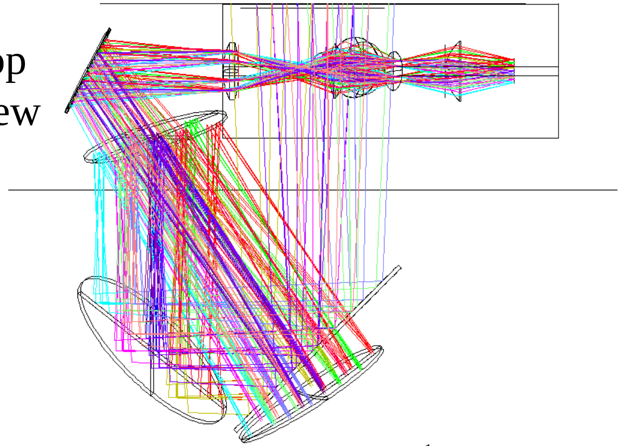


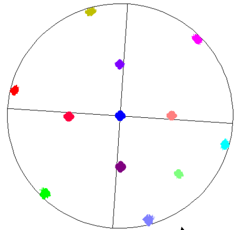
Space available for the components of the future continuum instrument (red contour), optics and support frame of MAMBO-2 (green), current light path between M3 and M5 (yellow), possible light paths and entries for the future cryostat using a new set of mirrors (light blue arrows and circles). Zemax simulations of the telescope $\Rightarrow$ FOV limited to 4.5' with current M3, 7' with new M3 (+40% tricking with M2 shift).

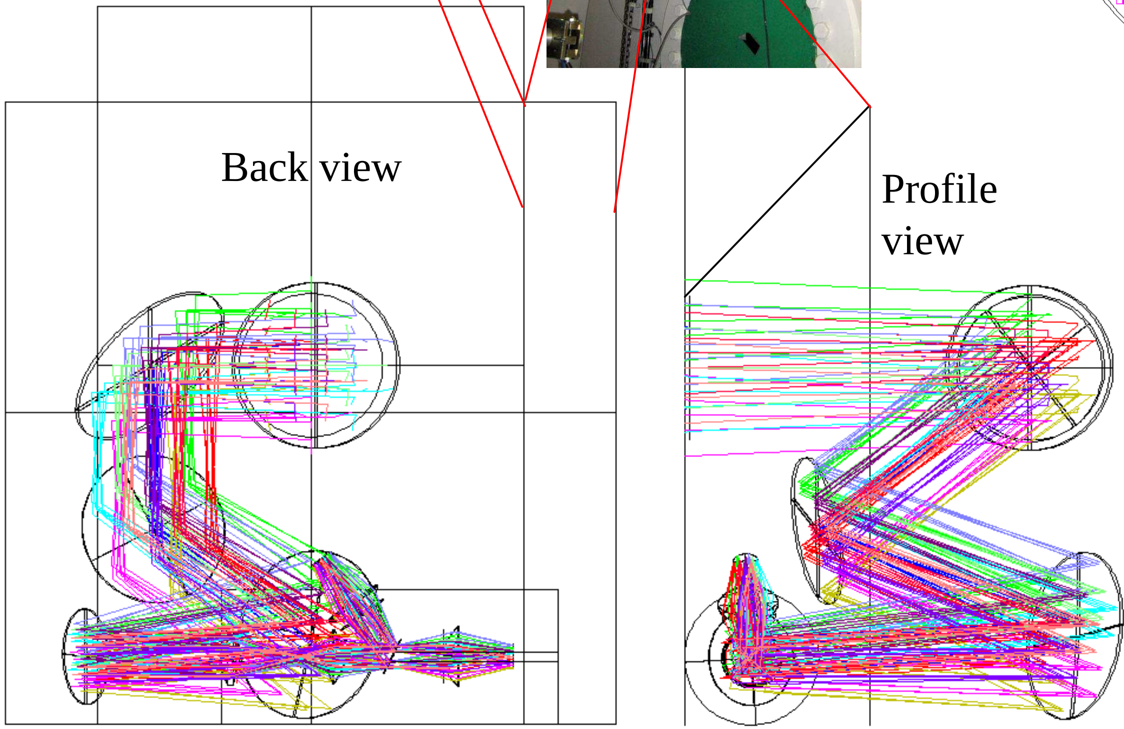
Call: Possible optical design for the future instrument

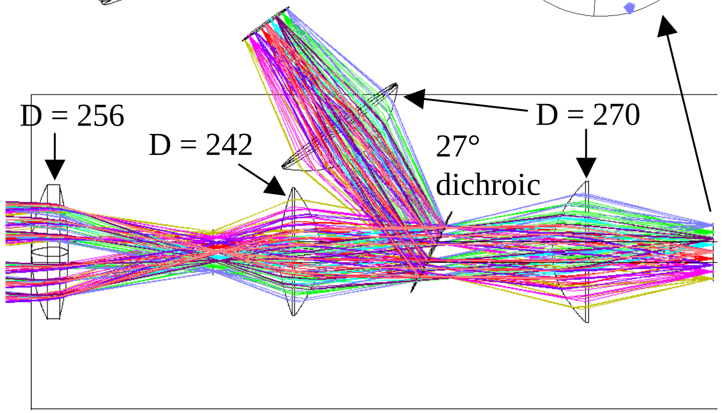






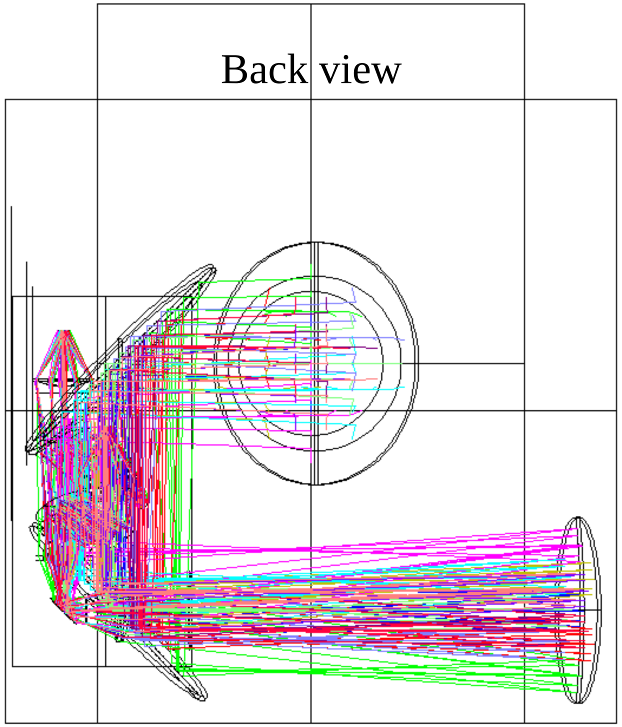


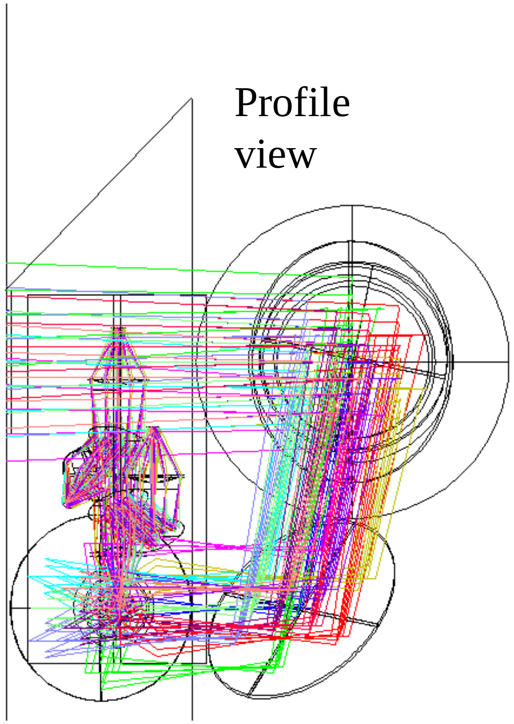


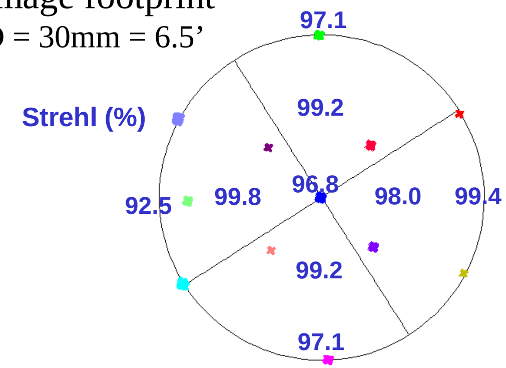


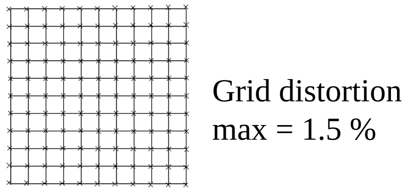
⇒ The cryostat should not exceed 0.6×0.6×1.6 m^3, and the field of view cannot exceed 6.5’

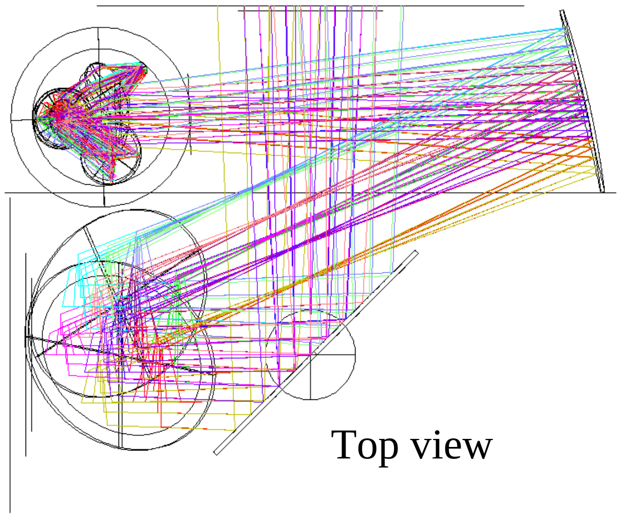
Call: Possible optical design for the future

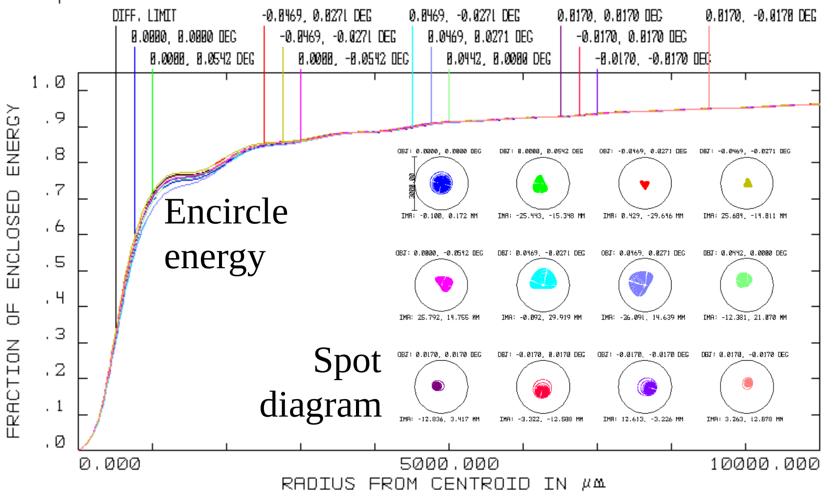












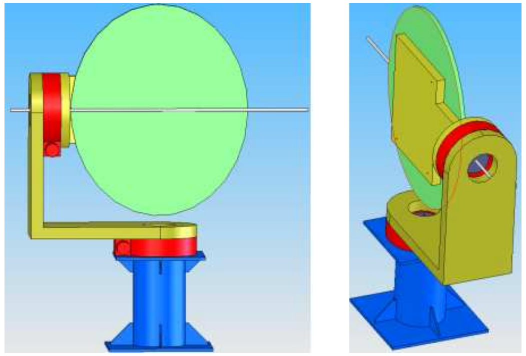
Call: Increase 30m FOV

Reorganization of the 30m optics refurbishment project:

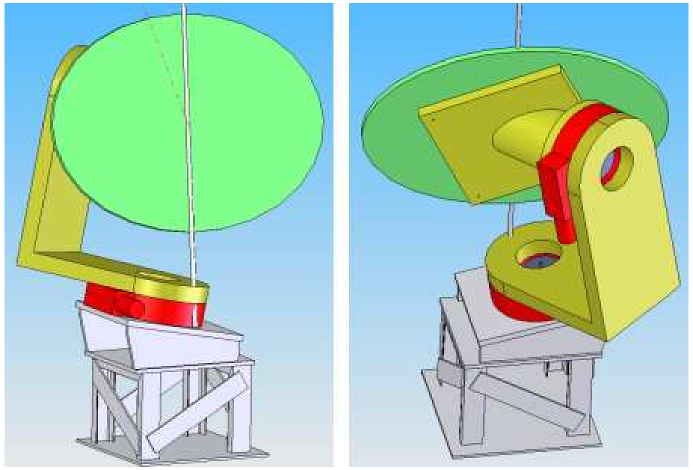
- New M3 leg and possibility for motorization
- New M3 and motorized M4 (Nasmyth ~7' FOV, 2012 ?)

⇒ move everything in the cabin + new mirrors after M4.

S1: "one-armed alt-azimuthal"



S2: "tilted pseudo-Nasmyth"



S3: "horizontal az-alt"