

2009 KIDs Arrays ON-Sky Test Plan at the IRAM 30m telescope

S. Leclercq from A. Benoit, F.X Désert, A. Monfardini, W. Brunswig, C. Kramer, C. Thum, and others emails. Updated Oct 14 2009.

This document gathers all information useful for the test of the KIDs prototypes at the 30m telescope in October. It compiles various emails exchanges describing the organization of the run and the proposed approach to integrate the KIDs Arrays prototypes (NIKA, NICA or NISCA?) on the telescope and to characterize their performances by means of astronomical observations.

Planning of the test run

| Dates | Main Task | Details | Lead | Support |
|-----------------|---|---|-------------------------|----------------------------|
| 15.10. | | 1 st visitors: Granada | | |
| 16.10. | Store, computer/network | Arrival of truck | Clemens, Alain | Walter |
| 17.10. Saturday | Installation (mount rack and cryostat), Start cool down. | Limited access to Rx-Cabin: <3 hours ^(*) | Clemens, Alain | Dave, Walter |
| 18.10. Sunday | Cool-down, detectors & electronics test. | Limited access to Rx-Cabin: <1 hour ^(*) | Clemens, Alain | Albrecht + Dave on standby |
| 19.10. Monday | Detectors & electronics test, 1 st optical alignment | Limited access to Rx-Cabin: <1 hour ^(*) | Clemens, Alain | Santiago + Dave |
| 20.10. Tuesday | Full alignment (incl. removal of M3). | | Samuel, Alain | Santiago + Dave |
| 21.10. Wed. | Daytime observations | | Operators, Alain | Christof (AoD) |
| 22.10. Thursday | Daytime observations | | Operator & Juan, Alain | Christof (AoD) |
| 23.10. | No observations | | | |
| 24.10 - 27.10. | Daytime observations | | Operator & Juan, Alain | Albrecht (AoD) + Markus |
| 28.10. Wed. | Dismounting | Departure of truck | Operators, Alain, Mark. | |

^(*) The total time from the 16th to the 19th during which the telescope can't do observation because of NIKA installation should not exceed 4 hours.

More details and updates on the IRAM Spain NeelBolometer Wiki page:

<http://www.iram.es/IRAMES/mainWiki/NeelBolometer>

Hardware and people

Detectors to be tested

All of them work at 2mm (the window is 125-170GHz). The pixels spacing is 1.6-2.4mm (depending on which array we decide to mount). The de-magnifying factor with respect to the IRAM f/# on the focal plane is about 6. It means we are f/1.6 on the detectors. So, the arrays are 0.5-0.75 F λ , oversampling the diffraction spot at 2mm.

The arrays considered for the run according to the lab tests are:

- 6x7 pixels antenna-coupled distributed KIDs (pixels pitch 1.6mm).
- 14x14 pixels lumped elements KIDs (pixels pitch 2.2mm). That's the best, but probably we'll not use it this time ... we are waiting a few upgrades on the electronics for that. In any case in Alessandro's opinion this will be the starting block for the 1000s pixels array (in 2010 ?).
- 4x8 pixels lumped elements KIDs (pitch 2.4mm).
- 5x6 pixels lumped elements KIDs (pitch 2.4mm).

List of material that will be send at the 30m:

Cryostat, pumping system, LN2 trap, RF electronics rack (small) and computers to run the instruments, laptop to run the cryostat, various other (but small) things

Fluids supplies

- 6 bottles of 25 liters each of liquid Nitrogen for the cryostat cold trap.
- Compress air line in the receiver cabin.
- A bottle of compressed helium, including a pressure regulator allowing to set the output can in the 0-5 bar range.
- 9 dewars of 100 liters each of liquid Helium for 1 week of sky observation, considering 2 cool-downs (2 dewars per cool down, 40 l/day once cold for 6 days, 2 dewars for contingency = 4 + 3 + 2). Two cool-downs have been planed in order to get 1 day warm-up for possible array exchange or other work on the detectors or cryostat.

List of list of the NIKA visitors and their presence schedule at the telescope

| | |
|---------|--|
| Truck | = Travel by truck (and spend one night at hotel Kenia in Pradollano on arrival) |
| Plane | = Travel by plane and spend the night to the place scheduled for the next day (arrival) or come from the place scheduled for the preceding day (departure) |
| Granada | = Spend the night in the rooms at IRAM Granada or hotel Condor in Granada (with possibly a travel by air or road to get there on the same day) |

| | | Th | F | Sa | Su | M | Tu | W | Th | F | Sa | Su | M | Tu | W | | |
|-----------------------|------|---------|-------------------------|---------------------------|----------|---------------------------|-------------------------|--------|---------|--------------------------|---------------------------|--------|--------|--------|----------|-----------|----------|
| | | 15-Oct | 16-Oct | 17-Oct | 18-Oct | 19-Oct | 20-Oct | 21-Oct | 22-Oct | 23-Oct | 24-Oct | 25-Oct | 26-Oct | 27-Oct | 28-Oct | 29-Oct | |
| A. Bideau | NEEL | Truck | Pico Veleta (30m rooms) | | | | | | | | | | | | | own hotel | Vacation |
| A. Monfardini | NEEL | Truck | Pico Veleta (30m rooms) | | | | | | | | | | | | | Granada | Truck |
| P. Camus | NEEL | Truck | Pico Veleta (30m rooms) | | | | | | | | | | | | | Granada | Truck |
| L. Swenson | NEEL | Granada | Pico Veleta (30m rooms) | | | | | | | | | | | | | Granada | Truck |
| A. Benoit | NEEL | Granada | Pico Veleta (30m rooms) | | | | | | | | | | | | | Granada | Plane |
| F-X. Desert | LAOG | | | | | Granada | Pico Veleta (30m rooms) | | | | | | | | | Granada | Plane |
| S. Yates | SRON | | | | Plane | hotel Kenia in Pradollano | | | | Book own hotel (Granada) | | | Plane | | | | |
| J. Baselmans | SRON | | Plane | hotel Kenia in Pradollano | | | | | Plane | | | | | | | | |
| A. Baryshev | SRON | | | | | | | | | Plane | hotel Kenia in Pradollano | | | | Plane | | |
| S. Doyle | AIG | | Plane | hotel Kenia in Pradollano | | | | | | Plane | | | | | | | |
| S. Leclercq | IRAM | Granada | Pico Veleta (30m rooms) | | | | | | | | Plane | | | | | | |
| M. Roesch | IRAM | | | | | | | | Granada | Pico Veleta (30m rooms) | | | | | | Granada | Plane |
| # visitors at the 30m | | 0 | 6 | 8 | 8 | 9 | 10 | 10 | 9 | 8 | 8 | 8 | 8 | 8 | 7 | 0 | |
| Planing | | | Network | Mount | Cooldown | Tests | Observations SRON KID? | | | Break | Observations LEKID? | | | | Dismount | | |

Contact and phone list:

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| | |
|---------------------------------------|----------------------|
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| Carsten Kramer | +34 958 805 454 |
| Javier Lobato (organization in Spain) | +34 958 805 464 |

Alignment procedure of the cryostat in the 30m receiver cabin

There are two alignments to do:

- 1) Center the image on the secondary pupil (entrance to the cryostat)
- 2) Center the center of the focal plane at the center of the detector arrays.

This corresponds to 2 displacements and 2 orientation angles of the cryostat.

The most important is centering on the pupil since this will optimize illumination and reduce parasite fluxes.

Alignment with a LAZER

Given that mirrors M6, M7 and M8 are connected to the cryostat, moving the cryostat on the table in 2 horizontal directions will do the alignment of the pupil (the height of the cryostat on the table will play only on the focus that will be tuned with the secondary mirror M2). So the IRAM laser will be used to visualize the beam path on the cabin mirrors and the cryostat will be moved so that the laser illuminates the center of the entrance window.

Adjusting the centering of the focal plane will be done by tilting the whole cryostat / mirrors around the X and Y axes thanks to the adjustable foot support. A small mirror on the entrance window of the cryostat will reflect the laser and the tilt will be adjusted to ensure the incoming and reflected laser rays coincide.

Note that the rotation of the whole cryostat around the vertical axis Z does not change the alignment but turns the matrix in the beam. The exact rotation will be measured on the sky with a strong source.

Once the cryostat positioned, it will be possible to refine the alignment of the pupil playing on the micrometer screws steering the mirror M7. But the alignment of the image on the detectors won't be adjusted anymore.

Verification with observations on the sky

When the detectors are ready, measures on the sky can begin.

The alignment of the pupil will be checked by actions on the micrometer screws of M6 and the telescope pointing at zenith: we can verify that the total power reaches a minimum and increases symmetrically in a misalignment in all directions.

The position of the central beam on the matrix will be measured with the observation of a bright source. This position will allow to calculate the pointing of each detector from the pointing on the sky and the angle of elevation, which gives the image rotation around the central beam. Possibly, more precise measurements will allow determining an offset to this rotation to account for geometric imperfections of assembling the matrix and positioning the cryostat.

The adjustment of the focus with M2 will be done simultaneously on this bright source.

List of possible astronomical observations

The observing modes planned to be used for the run are the traditional source tracking, raster scans and tests with the wobbler switching technique.

The list of sources to be observed for the NIKA 1st run is given in the order of priority.

Planets and radio-sources are prime targets. The others are just in case the sensitivity allows them. The date of reference is 23 Oct 2009 during day time.

2 Planets can be observed: Mars and Saturn (Strong signal and Calibration)

MARS

RA 08:23:52.1570 Dec 20:39:28.979 Az 102.72276 El 17.93162

Sun.D. 86.9 Vel. -13.194

DE=1.25 DS=1.55 Maj= 7.49 Min= 7.45 PA=352.71 TB=204.98 S(100.0)= 63.83

Frequency 100.0: Beam 24.0 Tmb 13.11 Flux 61.73 Size 24.8

SATURN

RA 12:00:41.9020 Dec 02:07:56.608 Az 43.61467 El 46.33722

Sun.D. 31.0 Vel. -14.742

DE=10.29 DS=9.45 Maj=16.07 Min=14.34 PA=357.38 TB=150.00 S(100.0)= 191.69

Frequency 100.0: Beam 24.0 Tmb 35.55 Flux 167.36 Size 27.1

The Sun is at RA=14h Dec=-10deg. Say day time starts at 7UT and ends at 17UT.
Look for sources with RA from 9h to 19h, Dec above -15 deg. Coordinates in J2000

Radio sources from IRAM catalog

OJ287 08h54m48.9s +20d06m31s
! Highly Variable. S(3.3) = 2.9 - 8.3 Jy.

0923+392 = 4C+39.25 09h27m03.0s +39d02m21s
! S(3.3) = 1.3 - 3.2 Jy.

3C273 12h29m06.6997s +02d03m08.598s
! Variable. S(3.3) = 10 - 20 Jy.

3C279 12h56m11.1s -05d47m22s
! Variable. S(3.3) = 6.4 - 8.2 Jy.

3C345 16h42m58.8s +39d48m37s
! Variable. S(3.3) = 5.6 - 7.7 Jy.

NRAO530 17h33m02.7s -13d04m50s
! Variable. S(3.3) = 5 - 7 Jy.

3C380 18h29m31.8s +48d44m46s
! S(3.3) = 1.0 - 2.8 Jy.

Galactic sources

Oph (18h+10d)
strong source, complex map. Test of mapping procedures.

W49: 19h08m11.4s +09d03'32" 2200Jy at 100micron

G34.262: 18h50m47.0s +01d10'49"

G35.191: 18h59m14.5s +01d08'46"

Nearby Galaxies (Test of mapping)

M82 = NGC3034 at 09h51m42.4 +69d54'59" Expected 2mm flux 2Jy
mapping 1x1 arcmin

M51 = NGC 5194 13h29m52.37s +47d11'40.8"

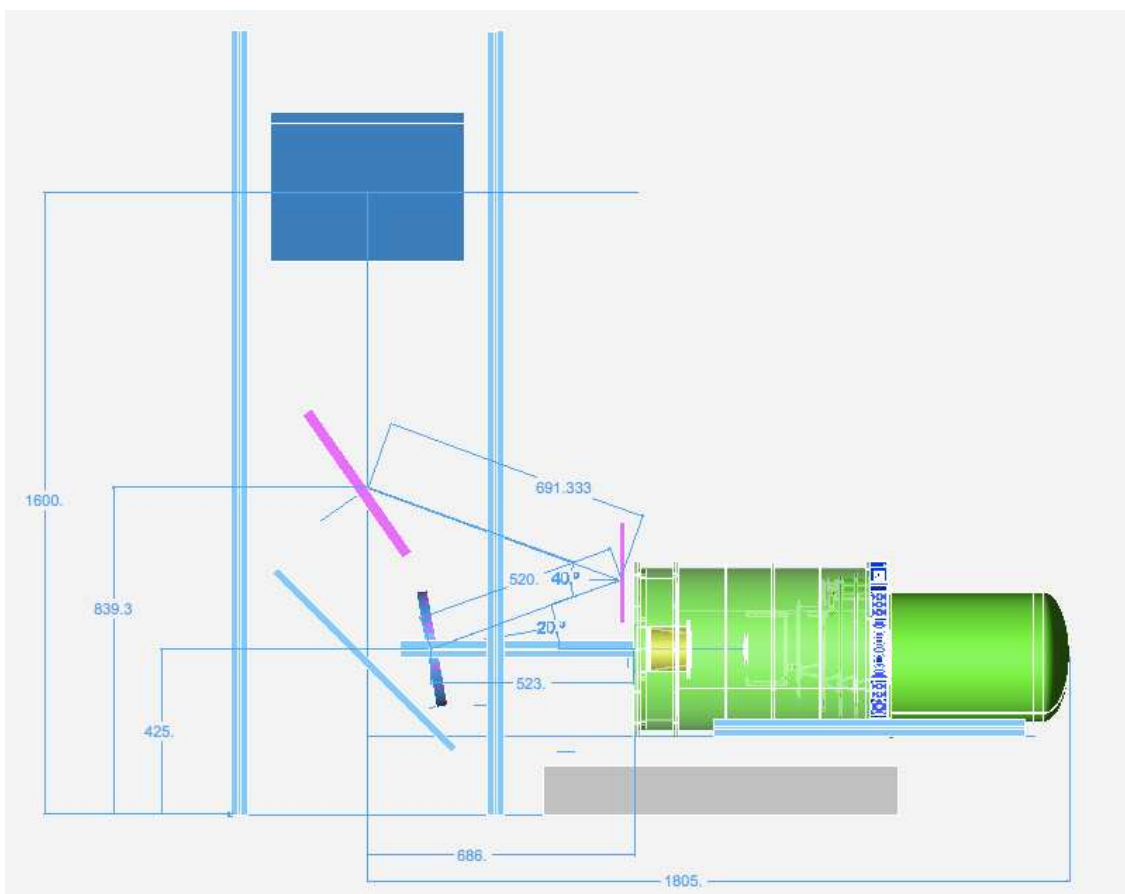
Distant Galaxy (Test of very faint point source flux noise)

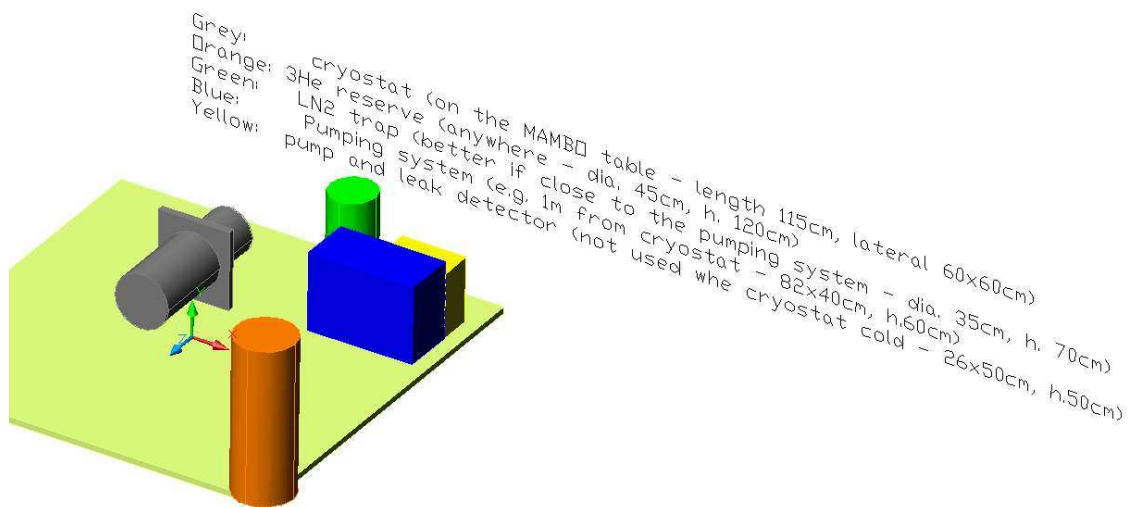
F10214+4724 10h24m34.50s +47d09'11.0"

Clusters of galaxies (mapping noise test)

A2163: 16h15m45.91s -06d08'53.5"

Annex 1: Dimensions of NIKA.





Annex 2: Interfacing the instrument with the telescope.

Emails exchanges between A.Benoit and W.Brunswig in preparation of the interfacing:

WB:

We have a 1Gbit Ethernet link to the receiver cabin, which could be shared. We might also be able to provide a separate twisted pair cable that can run at 100Mb/s. You can of course use a private 192.168... domain with up to 16^2 nodes. Nevertheless, I guess we also would have to share some part of the network, which might mean to have devices that can bridge between different network areas.

Note that Ethernet is NOT a real-time network. Communication might take more than a second and the network might be blocked sometime. We do not guarantee anything else. Our software is therefore prepared to handle those cases and the control software also has to take this into account.

AB:

Our data acquisition system is based on Ethernet network. The hardware communicates by Ethernet with the acquisitions computers. We have 3 boards for bolometers readout, 1 for cryogenic control and 2 for temperature control, each with a given IP. Connected to these, we will have 1 or 2 computers in the cabin and at least 5 in the control room.

For preparing and testing the system, we use a private network in 192.168... domain. This network is connected to our labs network with a small NAT router that can be connected on the public IRAM network. However, all the acquisitions computer have 2 Ethernet ports and are connected on the private network and on the public IRAM network (with a IRAM IP number).

The data flow will be typically 200 or 400 pixel, 32 bit each at 100 Hz so it is only a few Mega bit/sec. A twisted pair at 100 Mb/sec would be perfect for our local network between cabin and control room.

I prefer to not share the line with the IRAM network because we use UDP protocol and we will lose some packet if there are too much collisions.

For the NCS data, we have two requests:

- 1) For data reduction during the observations, we would like to get the telescope position in "real time" by Ethernet. As you told us, Ethernet is not a real time network but the transfer time is of order of msec and we can use that for on time reduction. So a convenient way would be to send a UDP broadcast on the network at a rate between 1Hz and 10Hz with the corrected pointing position and the elevation of the telescope. With this information, we can reconstruct the pointing of each individual pixel of our array and make a map in real time during the observations. Such broadcast is a small data flow on the network and, as it is only for real time reconstruction, if some packet are delayed or missing, that do not cause too much trouble.
- 2) However, the complete data reduction after the observations will be done using a pointing file with time stamp to get a perfect synchronization with the acquisition. I think that such files are available through the network a few second after each observation.

We need also to have a good time synchronization with the telescope and I think that this can be done also using the Ethernet network.

WB:

We distribute every second positional information of the antenna. A process can request this information via a server program (Elvin) and we have code for this written in Python under Linux.

We also produce every minute a FITS file with more detailed position and information. These files can be accessed via NFS (or sftp).

AB:

- 1) For real time acquisition, there is a client that requests the information of the antenna in each acquisition computer. We use 3 acquisition computers (Macintosh) in parallel for redundancy.
- 2) For the secondary mirror, if we use it for chopping, we need a good synchronization. Does the TTL signal from the telescope still exist, which level or do you have another way to achieve a good synchronization with the secondary?
- 3) When using the FITS file for reconstructing the pointing after the observations, we need good time synchronization. How can we synchronize the acquisition computer with the time stamps that are used in the FITS file? Do you have a time server?

WB, internet addresses for the NIKA computers at the telescope:

```
; NIKA bolometer
mrt-nika1    IN    A    150.214.224.22
mrt-nika2    IN    A    150.214.224.23
```

In order to access these computers when installed at the MRT, one should use the tandard ssh entrance via gra-lx1.iram.es, account “hello”, pw “ar1adne8”.

The use VNC may be considered to connect to these systems, also via gra-lx1.iram.es (with - -via option on vncviewer).

The telescope default router is on address 150.214.224.223 and the name-server has the address 150.214.224.100 .

We have a 1 Gbit optical link between the computer/backend room and the receiver cabin. The older 100 Mb twisted pair cable is also still available. However, the distance is pretty large and I won't assure that the twisted pair cable is in good shape.

Anyhow, for communication from the receiver cabin we only use switches that should be collision free.

I have a program now that generated a udp broadcast message for a specific NCS message, ex:

```
('150.214.224.59', 55735) <Info TimeStamp='2009-10-08T08:13:26.750'
LogId='antMD:trace' ><Data
Name='MJD,LST,xOffset,yOffset,basisLong,basisLat,inSegment,actualAz,actualEl,track
Az,trackEl,slowRate,fastRate,SigTrAz,MaxTrAz,MinTrAz,SigTrEl,MaxTrEl,MinTrEl,Fl
agA,FlagE'
> >55112.342674,32895.260441,0.000000,0.000000,1.549464,0.352124,-
1,260.999247,45.231991,-0.078947,-0.921053,8,16,0.120135,-0.070175,-
0.166667,0.982799,-0.921053,-1.017544,0,0</Data></Info>
```