# Minutes of NIKA-2/MOKA Kick-Off meeting for ANR, September 24 2012

S. Leclercq

**Participants:**

| | |
|---|---|
| Néel: | Alain Benoit, Alessandro Monfardini, Christian Hoffmann, Martino Calvo |
| LPSC: | Olivier Bourrion, Andrea Catalano, Christophe Vescovi |
| IPAG: | François-Xavier Désert, Nicolas Ponthieu |
| CEA Saclay: | Philippe André, Vincent Reveret |
| AIG Cardiff: | Simon Doyle, Sam Row, Edgard Scordillis |
| SRON: | Andrey Baryshev, Stephen Yates |
| IRAM Grenoble: | Karl Schuster, Samuel Leclercq |

## Agenda

- Presentation of the optical design, instrument specifications and preliminary cryogenics (Alain Benoit)
- Current status of the NIKA prototype at Pico Veleta and results from last runs (Alessandro Monfardini, F. Xavier Désert)
- Collaboration organisation and working groups (see text for a proposed list of WG)
- IRAM point-of-view (Karl Schuster) and funding (Alain Benoit, Philippe André)
- Calibration and new sky simulator (open discussion involving IAS)

## Minutes

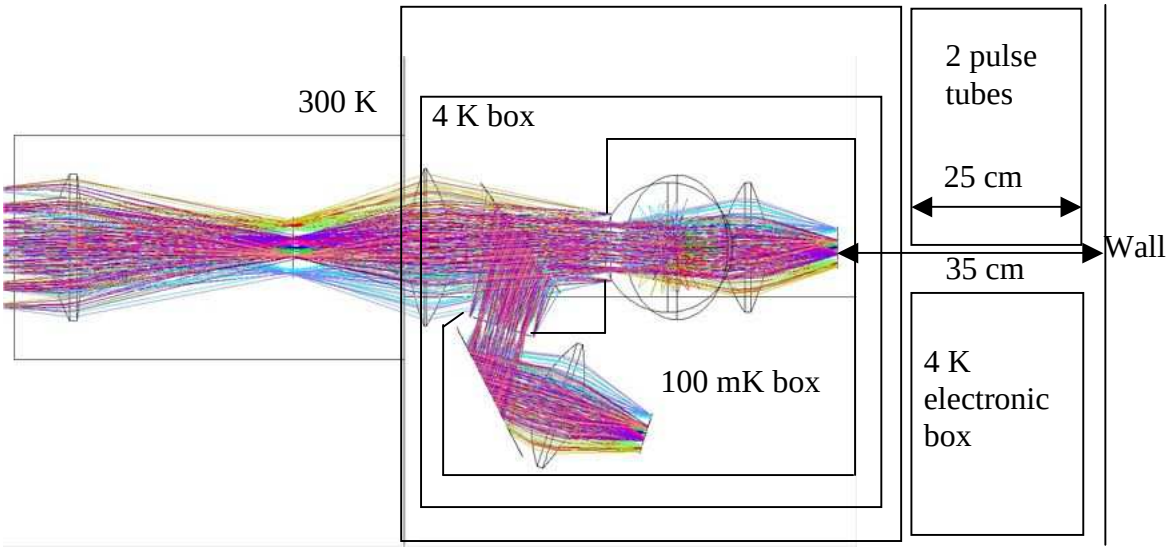
Meeting started at 9h30, ended ~ 16h30.
**Bold characters below: red = main items, black = key words for fast reading.**

### - Participants presented themselves

### - Optics, Cryostat, Instrument (A. Benoit) (on board presentation; no slides due to stolen computer)

- **Cryostat** already started: **optical design done, mechanical design done, mechanical studies started** (structures constraints, dilatations, etc.) → **~700 – 1000 kg.**
- 2 pulse tube to provide enough cooling power (~ 1W @ 4K)
- **Optical elements** (filters: Cardiff; lenses: IRAM) → SD: 35cm diameter OK for Cardiff; P.Ade makes very good **IR filters** now → 2 pulse tubes should be more than enough
- **SL will send the Zemax file to SD** so that he can see where to put the filters, what kind and what size.

- **Cryostat**: 4 boxes: 100 mK stage, 1 K stage (actually 0.7 K = dilution still), 4 K stage, 300 K; Shields: lead + mu-metal, and cylinder with back plate shape; somebody mentioned cup shape = very good shield geometry). Schematics:




- **Arrays characteristics**: Optics relative aperture (f-number) f/D = 1.4, arrays dimensions = 80 mm diameter (4 inches wafers)

| Wavelength | Resolution | Pixel Pitch | Number of pixels | Number of NIKEL boards |
|---|---|---|---|---|
| 2 mm | 0.7 Fλ | 2.3 mm | 1000 | 4 |
| 1 mm | 0.8 Fλ | 1.6 mm | 2000 | 8 |
| 1 mm | 0.8 Fλ | 1.6 mm | 2000 | 8 |

- **Optical tests on the big arrays**: SL and AB have designed 2 new lenses to be mounted **in** the NIKA **prototype 2010 cryostat** (used in run 2), in order to increase the size of the 2.8'FOV image from 40mm diameter to 80mm diameter and thus be able to illuminate all the pixels of the big arrays for optical tests.
- KS: OK but we should put the **highest priority** on **solving the crosstalk problem**, which is a potential killer; this can be done electrically in the dark.
- AM & AB: Actually we need to illuminate all the pixels to study correctly the crosstalk; indeed in the dark the pixels see many spurious resonances, but these strong couplings degrade with light → less crosstalk → we need light to investigate crosstalk in realist environment.
- We are currently still missing a bit of electronics to be able to test 4 lines in parallel.
- **Polarization**: AIG **Cardiff** knows how to **build rotating plates** (using hot press) that are lighter than a sapphire disk. → The rotating plate would be outside the cryostat, **on the "hot" pupil** close to the cryostat entrance.
- KS: Attention! Making a polarizer is easy, making a good one is NOT easy; see literature → many possible subtle effect can kill everything.
- **SL** will try to introduce **polarization in Zemax** simulations of the system, and also **send** these **files to VR** who works with a Zemax expert at the CEA who can look at this AB: the goal is to characterize and minimize the parasitic polarization from rotating plate and others optical elements.
- With polarization we **need very fast sampling** → go from the current 22Hz up to **60-80 Hz**; this should be no problem for the electronics since it actually sample at

1kHz, and then data pre-processing sum down to 22 Hz. We will need to decide on the pre-processing strategy for having manageable data file sizes.

- **NIKEL**: currently 5x100 = **500 MHz bandwidth** → Mux **400 pixels** on one line (that means 250 on the sky and 150 off-resonance KIDs); 1 measurement = 2 points (I, Q, dI, dQ).
- **Tuning**: **new method to recenter the resonances in 1 shot (few seconds) instead of sweeping**, using I, Q, dI, dQ to calculate the vector angle in the I-Q plane, and deduce directly the position of the resonance frequency → to be tested next run (Nov 2012).
- **Future absolute calibration**: we could drill a little **hole at the centre of M7** in front of the cryostat and put a **polarised artificial reference** behind it. The loss of illumination from the hole would be practically negligible since M7 is close to the hot pupil, and thus with practically no photons from the sky at the centre due to the blockage by the secondary mirror.

## - NIKA Prototype (F-X. Désert)

→ See slides at http://www.iram.fr/~leclercq/NIKA/NikaPage.html

**Discussion on systematics:**

- **On bright sources the whole array "moves"** (signal seen on all pixels = known also as the **"plateau"** by the data-processing participants). → Idea to solve this problem: **measure** not only the absolute height of the resonances, but the height with respect to the **baseline**, which is probably moving because of electronics response to fluctuating total loading of the mux line. → **To be tested in lab** in the coming weeks (several hypothesis exists: electronics, line coupling, …). **Otherwise** the plateau could be **removed at the processing level** by **using off-resonance** tones.
- **Spikes** have been seen at the telescope, but not so much in lab; origin still unknown.

**Total Power**: at some point in the future it will be possible to track all the frequency shifts starting from a calibrated reference; in this case we will have a total power instrument with instantaneous calculation of the atmosphere opacity → the **sky dips won't be necessary** anymore. But this is not ready yet.

**Run 5, Nov 2012:**

- **Test** some new things, in particular **NIKEL** that will be used for the 1st time. So far the noise performances using it (4 mK/Hz$^{1/2}$) looks comparable to the one obtains with the ROACH boards (in a 20% range …), but we still lack a real lab comparison: doing measurements, switching ROACH and NIKEL, while keeping everything else the same.
- Conduct **pre-commissioning** sequences deeper than last June (calibrate, tune the camera, powers, tone modulation, etc.). Investigate possible problems like "the plateau". Then do typical **science observations** to serve as a reference for external users.

**2013 – 2014 runs**: 2 main sorts of runs anticipated:

- Test **polarization**. For the 1st test no need for a system fully proven in lab before coming to the telescope; we could use a polarizing grid in front of the cryostat
- **Science** runs: Guaranteed Time and Open Time to the community in common campaigns.

**Sensitivity discussion**

- The NIKA team mention **18 mJy·s$^{1/2}$ @ 1mm and 12 mJy·s$^{1/2}$ @ 2mm**, but the call for tender specifications requested 8 and 5 respectively (NIKA's proposal mentioned 30 and 20 as the minimal requirement, and 15 and 10 as the goal).
- AM: if IRAM is not happy with these numbers, the NIKA team can concentrate its effort on pushing a pixel development giving the **best NEFD** possible, at the **detriment of the number of pixels**. Actually the best pixels on the small arrays give NEFDs comparable to GISMO's (which had ~10 mJy·s$^{1/2}$ on average during the April 2012 run).
- AB: we can 1) work on 100s pixel arrays to get the best NEFD ~ GISMO, or 2) work on 1000s pixel arrays problems.
- KS: **IRAM only ask for a clear development plan** saleable to the council and SAC (no need for a race with GISMO).

**Data Processing:** various possibilities (algorithms) exist, to be investigated in the future. **For now** FXD only uses **simple decorrelation and map-making method**. Discussion on **Noise structure**: The noise before decorrelation looks flatter than after decorrelation → it's a sign that it might be dominated by the amplifiers (or mixers ?) → either increase the responsivity or improve the cold amplifiers (the system must be background limited down to less than 0.1 Hz).

## - IRAM point of view, finances (K. Schuster)

➔ See slides at http://www.iram.fr/~leclercq/NIKA/NikaPage.html

**Discussions:**

- **Specifications priority** (has been reviewed after 2012 SAC and Council meetings): **1) Sensitivity, 2) Polarization, 3) FOV, 4) 0.8 mm band.**
- AB: all this already integrated in the current design of the instrument: some options are still in the air, but a number of important structures are already fixed, such as the 3 bands cryostat (2 bands for polarized 1 mm, 1 band for unpolarized 2mm). The amplifiers choice is also frozen now: 2-4 GHz bandwidth; Caltech said OK to provide 40 SiGe amplifiers. ➔ The instrument development is now more clear and simple than 6 months ago.
- **Organisation** clarification requested by SAC & Council → make it more clear, like in the proposal sent to the funding agencies (ANR, ERC), specifying structure tree, work packages, reporting, meetings minutes on dedicated Wiki, etc. *(all this already mentioned in MoU draft being written by SL, to be soon circulated among NIKA PI-ship group for common understanding and finalisation).*

**Money for 2013:**

→ **Cryostat,** some **electronics,** sky simulator (actually already funded), **filters.**

- KS: due to current **finance problems**, **IRAM** can only **provide** up to **~5k€** (for prototype). AB: most **urgent** now is a **leak detector → KS is OK**.
- **AB will provide a list of things to buy**, then we'll see if some things can't be on ANR.
- Cardiff had the idea that for **filters** ~50% would be on their own **funds**, and 50% on IRAM, now SD et al may need to **reconsider**, for example IRAM **might refund in GT** if cash problems persist ?
- → KS: GT distribution must be internal to the consortium; now if it is needed to **increase a bit the GT** (e.g. 30%) this could be **possible but need to be discussed** *(reminder the current proposed GT is ~1000 h)*. The final number for GT can be

decided later, for example in 2014, but we need to include these options in the MoU, i.e. the MoU must contain the structure about how we can manage the GT vs cash fund repartition.

- **CEA ERC grant: for polarization → λ/2 plate**, but also **lab tests**, etc. **225 k€** can be used in 2013. → AB, we can use it for the **cryostat** since it is necessary to make the polarization work! → PA: CEA budget plan was ~130 k€ for **detectors**, ~70 k€ for cryostat. AB: **1/3rd of the instrument is entirely dedicated to polarization** which represent ~200 k€, and **8 electronic boxes** also that cost ~100k€.
- In case there is not enough money: Is it an option to buy only 1 pulse tube at first and populate ~1/2 of detectors and electronics? → No, **we need the 2 pulse tubes**.
- Can we work without the new sky simulator? → Yes, it might be possible to use the current one with a new lens to be designed in order to illuminate the 6.5'FOV 80 mm diameter arrays.
- AB will have the **quotation for the cryostat in January**; he **expect ~ 500 k€** +/- 150 k€; this includes everything inside the cryostat up to the optics holders (filters, lenses…) and sample holders.
- **Electronics: 7 - 8 boxes needed for next year → 50 k€** (2 at the 30m, 1 at Cardiff, 5 at Néel). → this is the 1st generation of NIKEL, miniaturisation will be necessary to get 20 boxes at the telescope.
- Need also **money for calibration, detectors / clean room** (→ IRAM will take this in charge, + few mask will be taken on ANR), polarizer (rotating plate, chopper, electronics for synchronisation… 1st version of the polarizer would be for lab tests)

**Work Packages (PRELIMINARY):**

| *Name* | *Work Group Coordinator (WGC)* |
|---|---|
| **Cryogenics** | **Alain Benoit** |
| **Optics (includes also filters)** | **Samuel Leclercq** |
| **Electronics** | **Olivier Bourrion** |
| **Detectors (includes also amplifiers)** | **Alessandro Monfardini** |
| **Calibrator** | **François Pajot** |
| **On line software (instrument control)** | **Alain Benoit** |
| **Pipeline (includes calibration) Product and Software** | **François-Xavier Désert** |
| **Installation and Environment** | **Samuel Leclercq for now, somebody from the 30m later *(post meeting: Santiago Navaro volunteered)*** |
| **Polarisation** | **Vincent Reveret** |
| **Science (instrument fit to science goal)** | **François-Xavier Désert** |

- **See A.Monfardini slides for the lists of groups participants**. The participants of these groups must be committed persons, really working on the development of NIKA; these group lists must not be "political" lists.
- Discussion about who should be included in groups, in particular the detector group since different technologies are studied by different people (**LEKID, AMKID, Bolometers**) → create **sub-groups**. LEKID is currently the base line.
- The **WGC organize the WG,** including regular meetings (e.g. monthly), and write minutes and **reports** to the PI and to be posted on a dedicated Wiki.
- The **WGC and the PI** will gather regularly (e.g. every [few] month[s]) in order to produce a **status document** synthesising the work progresses of the groups.

- We have to make a **NIKA-2 Wiki page hosted at IRAM**, that will be the place where all the information about the development of the instrument is posted.

## - Miscellaneous discussions

**Calibrator:**

If it is polarised, we need to synchronise it with everything else and it would be slower than non polarized system; typically with a λ/2 plate we would rotate at ~1Hz (versus ~10Hz for non polarized system like a chopper).

**VR** will be responsible for **building the hardware**; he needs the size for the λ/2 plate prototype → SL will send him the Zemax files.

**Most urgent:** **cryogenics design / optics / electronics**.

We need money to start: ~40 k€ for **5 NIKEL boxes**. → We will see very soon how and when to get money from the CEA; in <1 month we will know if NIKEL is better than the ROACH boards, then it will be necessary to send the quoting to CEA for the hardware needed → **Early December** is the next soonest slot when **Néel and CEA** can **meet** again. It would be good to have the **5 boxes before March 2013**.

**Pre-Amplifiers**: use ANR. Caltech is OK to send one for free for testing.

➔ Everything should be ready in **December for doing lab measures of 1000 pixels**.