

**Progress report for the period  
January 1st – October 1st 2006**

**AMSTAR\***

# AMSTAR mid-year Progress meeting and discussions on FP7

- The Amstar 2006 mid-year meeting was held on June 20th 2006 in Goetheborg. It followed the 3<sup>rd</sup> RadioNet Engineering Forum on “Cooled low-noise Microwave components” held the day before at Onsala Observatory. The presentation on the progress reports on the AMSTAR workpackages was followed by 20 engineers and scientists from AMSTAR and from the Forum.
- In the afternoon, a discussion took place on the common Expression of Interest for a JRA on mm/submm techniques that was sent to RadioNet this spring. The main drivers of the new proposals are large mm/submm Focal Plane Array Receivers and THz frequencies. This discussion will be resumed in the end-of-the-year AMSTAR meeting that will be held on December 7 & 8 in Paris.

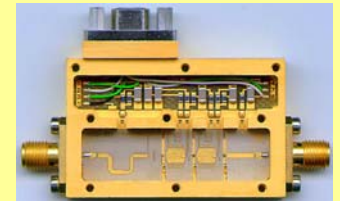
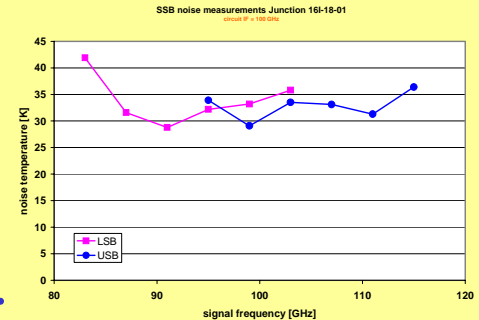
# Main AMSTAR Results (&Plans) -I

- A large amount of work has been made since the beginning of AMSTAR.
- Prototypes were built. Most workpackages are now in a phase of iteration aimed at getting the best performances.
- Two workpackages have come to an end and are at the stage of writing the final report.
- All, but one workpackage will be terminated in the summer 2007.

# Main AMSTAR Results (&Plans)- II

- **SIS mixers**

- First 3-mm SSB mixers with 4 GHz-wide IF band derived from prototype installed on IRAM interferometer. Noise lower than ALMA specs. **Development of 8-GHz wide band 2SB prototype mixer under way.**
- 0.5 mm prototype DSB mixer built according to OSO design and tested (200 K). **SSB mixer will be built in January 2007.**
- First 2SB prototype mixer operating at 0.4 mm built and being tested. **SSB Receiver noise 300 K.Rejection >7dB.**
- First tests on prototype 4-12 GHz cryogenic amplifier. **(Iterate to get lower noise)**



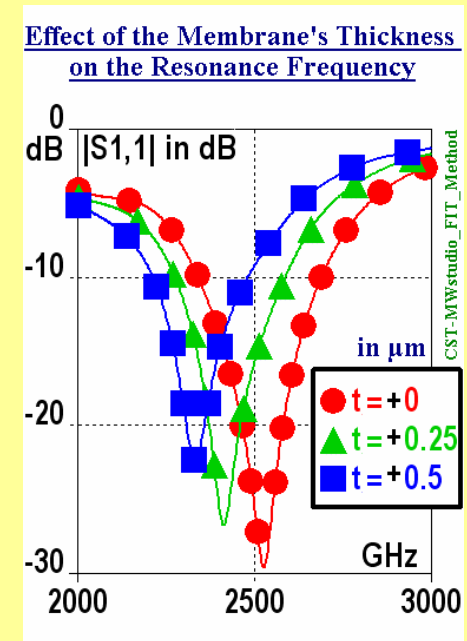
# Main AMSTAR Results (&Plans)- III

- **HEB mixers**

- First demonstration of a all solid-state HEB mixer receiver above 2 THz.
- Effect of membrane nature and thickness studied
- Structure of ultra-thin films investigated at ESRF

- **Focal Plane Arrays**

- LO signal from lasers phase-locked. First tests of SIS mixer with photonic LO. **4 element test array of SIS mixers built. Their performances tested with conventional LO are good.** First tests of complete system foreseen at the end of the year.



# AMSTAR workpackage Timeline

ID	Task Name	2004				2005				2006				2007			
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1	<b>Wide IF-band SIS mixers</b>	▼															▼
2	2.1.1 Wide IF-band 3mm mixer		▼														▼
13	2.1.2 wide IF-band 0.6mm mixer		▼														▼
21	2.1.3 wide IF-band 0.5mm mixer (SROII)	▼															▼
36	2.1.4 HEMT amplifier development		▼														▼
42	<b>2SB SIS mixers</b>	▼															▼
43	2.2.1 350 GHz 2SB mixer for FPA	▼															▼
54	2.2.2. 600-720 GHz 2SB mixer	▼															▼
64	<b>HEB THz mixers</b>	▼															▼
65	2.3.1. Phono-cooled HEBs	▼															▼
78	2.3.2. HEBs on Si <sub>3</sub> N <sub>4</sub> /SiO <sub>2</sub> membranes		▼														▼
83	2.3.3. Balanced 1.3 GHz HEB mixer		▼														▼
92	2.3.4. Ultra-thin film HEB mixers			▼													▼
102	<b>Focal Plane Array receivers</b>	▼															▼
103	2.4.1 Heterodyne Array	▼															▼
121	2.4.2. bolometer array detectors (SROII)	▼															▼

All AMSTAR workpackages are scheduled to end in summer 2007.

## Excerpts from results I: OSO 0.5 mm Wideband Mixer 2.1.2

The mixer chip with on-chip integrated local oscillator (LO) injection was fabricated in-house by in the Chalmers MC2 clean room facility. First DSB measurements yielded a  $T_{rec}(\text{DSB})=200\text{ K}$ .

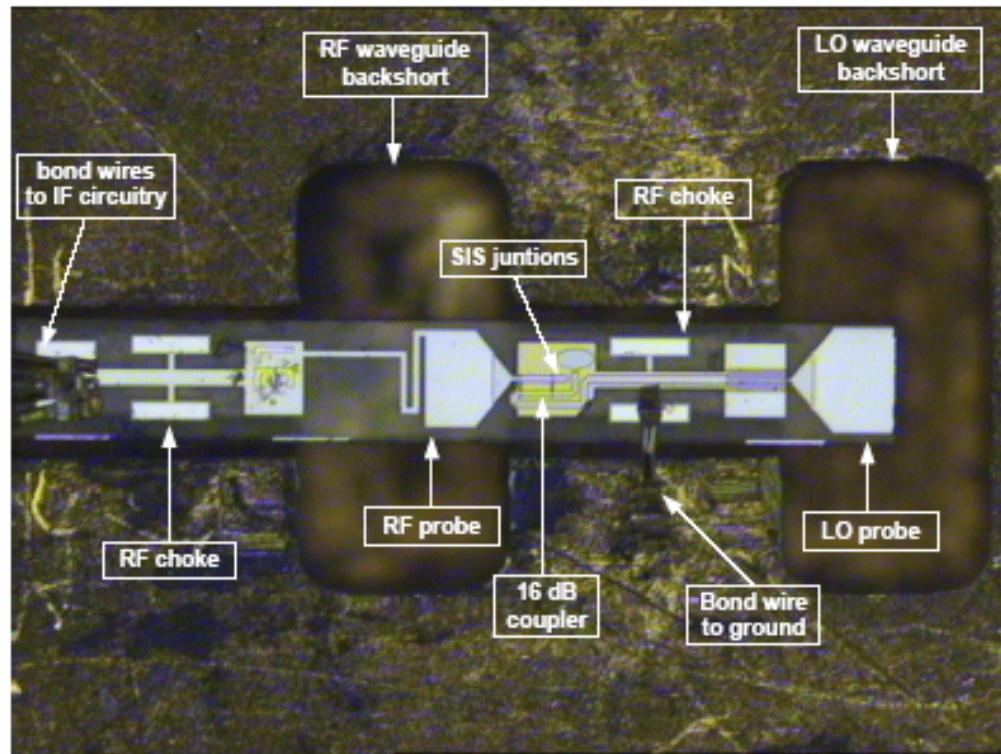


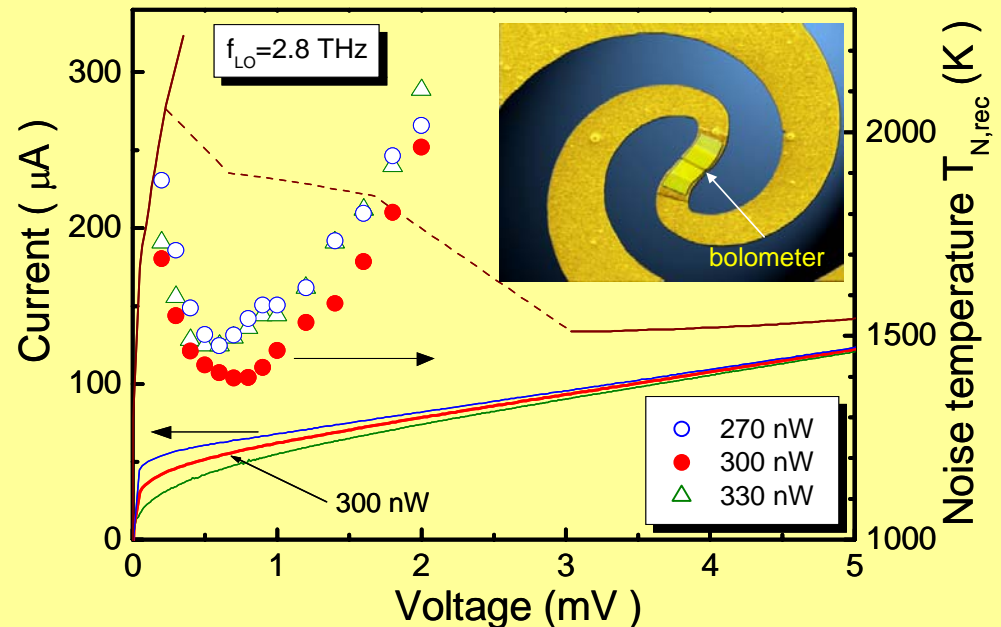
Fig. 1. Mixer chip layout.

A sideband separation (SSB) mixer, which consist of two mixers and an RF 90-degrees 3-dB hybrid and the LO power divider will be manufacture during January 2007.

# Excerpts from results (II): Phonon-cooled HEB mixer with a quantum cascade laser (QCL) LO

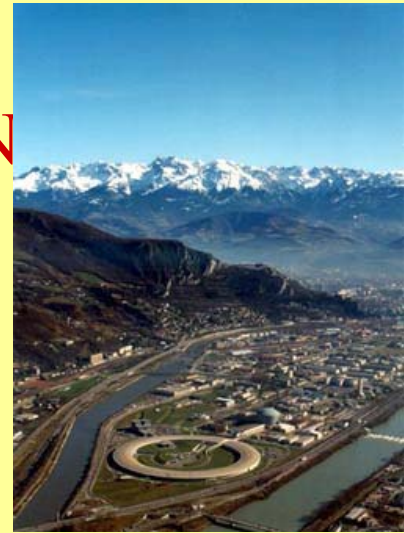
**First demonstration of an all solid-state heterodyne receiver** for spectroscopy above 2 THz. The receiver uses a NbN HEB as mixer and a QCL operating at 2.8 THz as LO. The Noise temperature is  $T_N=1400$  K @ 2.8 THz and a physical temperature of 4.2 K.

**Figure:** Measured receiver noise temperature  $T_{N,rec}$  versus the bias voltage for different LO power levels at the HEB mixer without and with radiation from the QCL at 2.814 THz

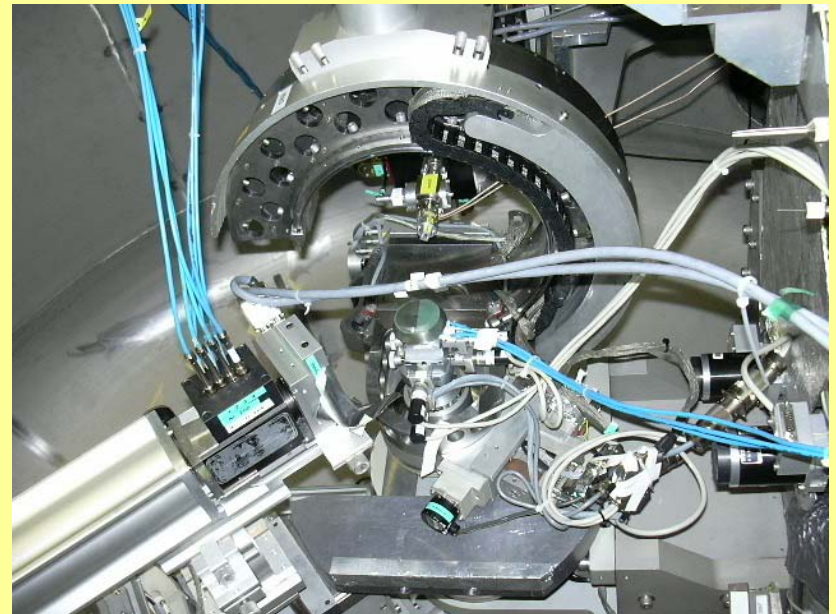
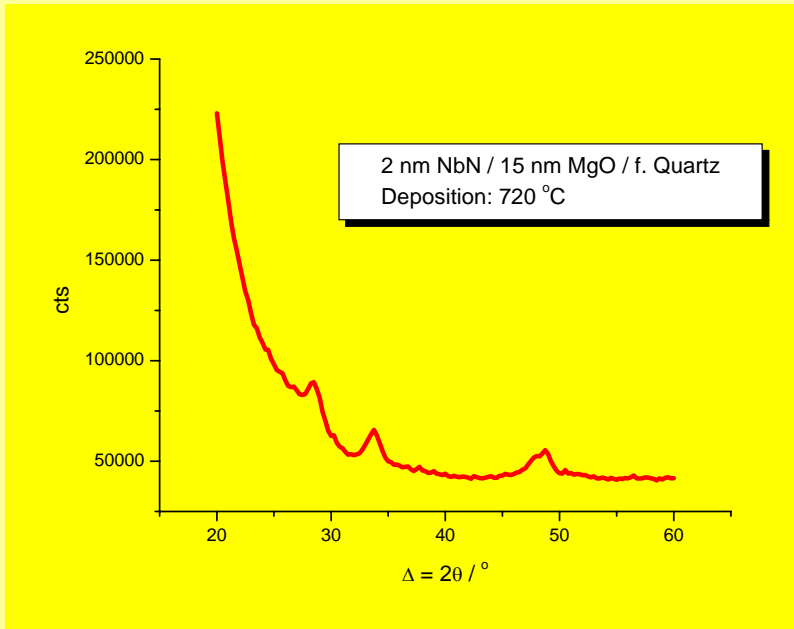


# Excerpts from results (III):

Small angle X-Ray scattering of ultra-thin NbN films using synchrotron radiation @ the European Synchrotron Radiation Facility



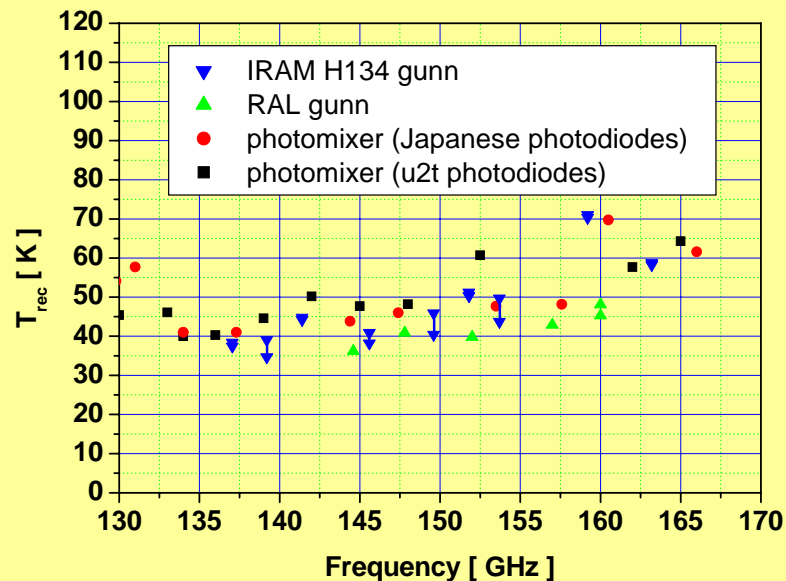
ESRF (Grenoble)



Left Figure: Small angle X-Ray scattering of ultra-thin NbN films using synchrotron radiation

# Excerpts from results (IV): FPA of SIS mixer receivers driven by photonic LOs

An SIS mixer and a photonic mixer designed in the frame of AMSTAR for 2-mm operation were tested together. The photonic LO brings almost no extra noise with respect to conventional a Gunn LO.



**Figure: Noise performance of SIS mixer pumped by photomixers (two types of photodiodes) or by a classical Gunn+doubler source (RAL/IRAM)**

The construction of the 4-pixel RF module is complete now. This module was integrated in the demonstration cryostat, and tested with a conventional Gunn LO, in order to decouple the possible problems coming from the receiver from those which can come from the optics design or construction.



Figure 1: left: Four pixel-RF module, comprising corrugated horns (front), LO coupler (middle), DSB mixer blocks (left rear) and photomixer (rear right). Right: 4-pixel module inserted in the demonstration cryostat

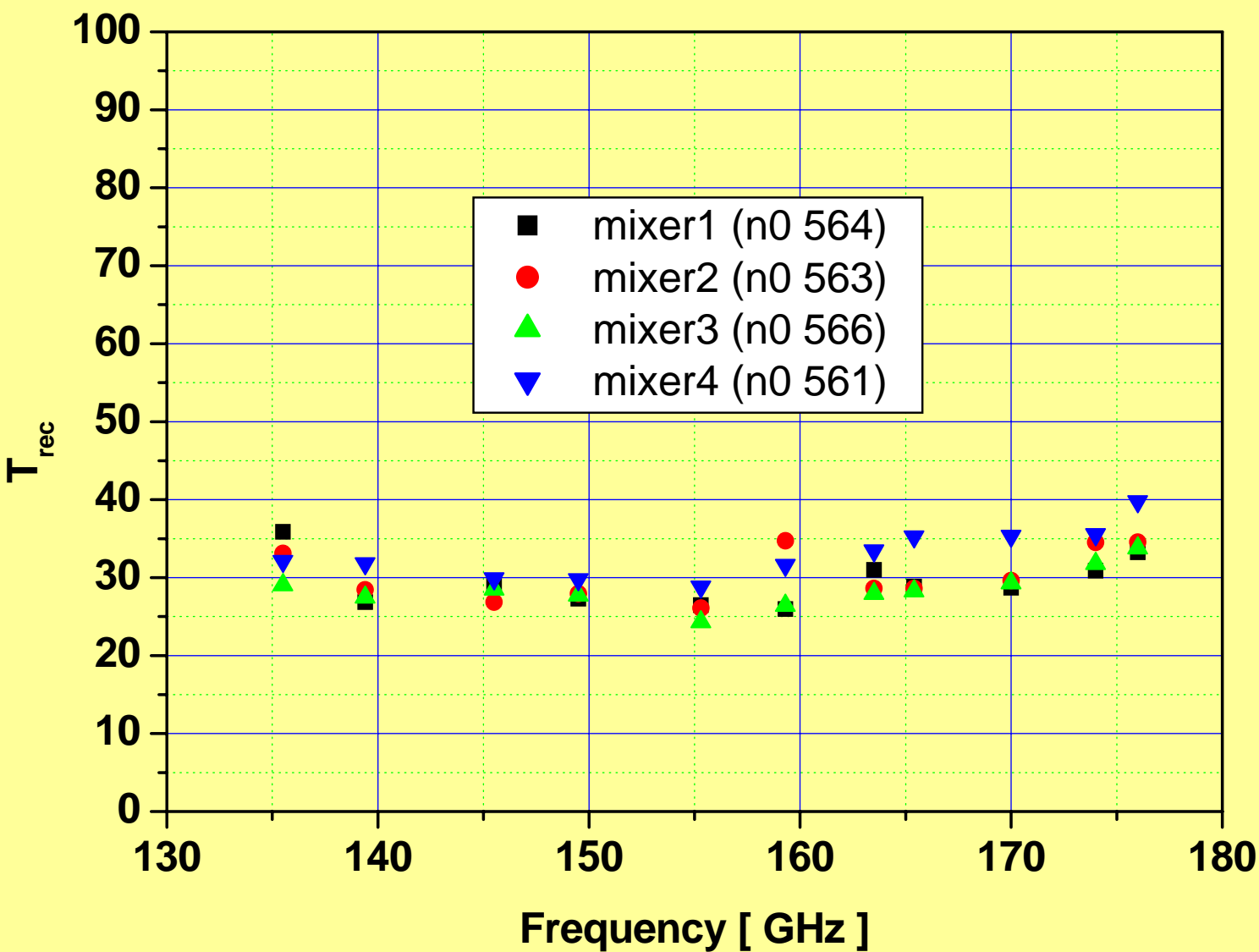


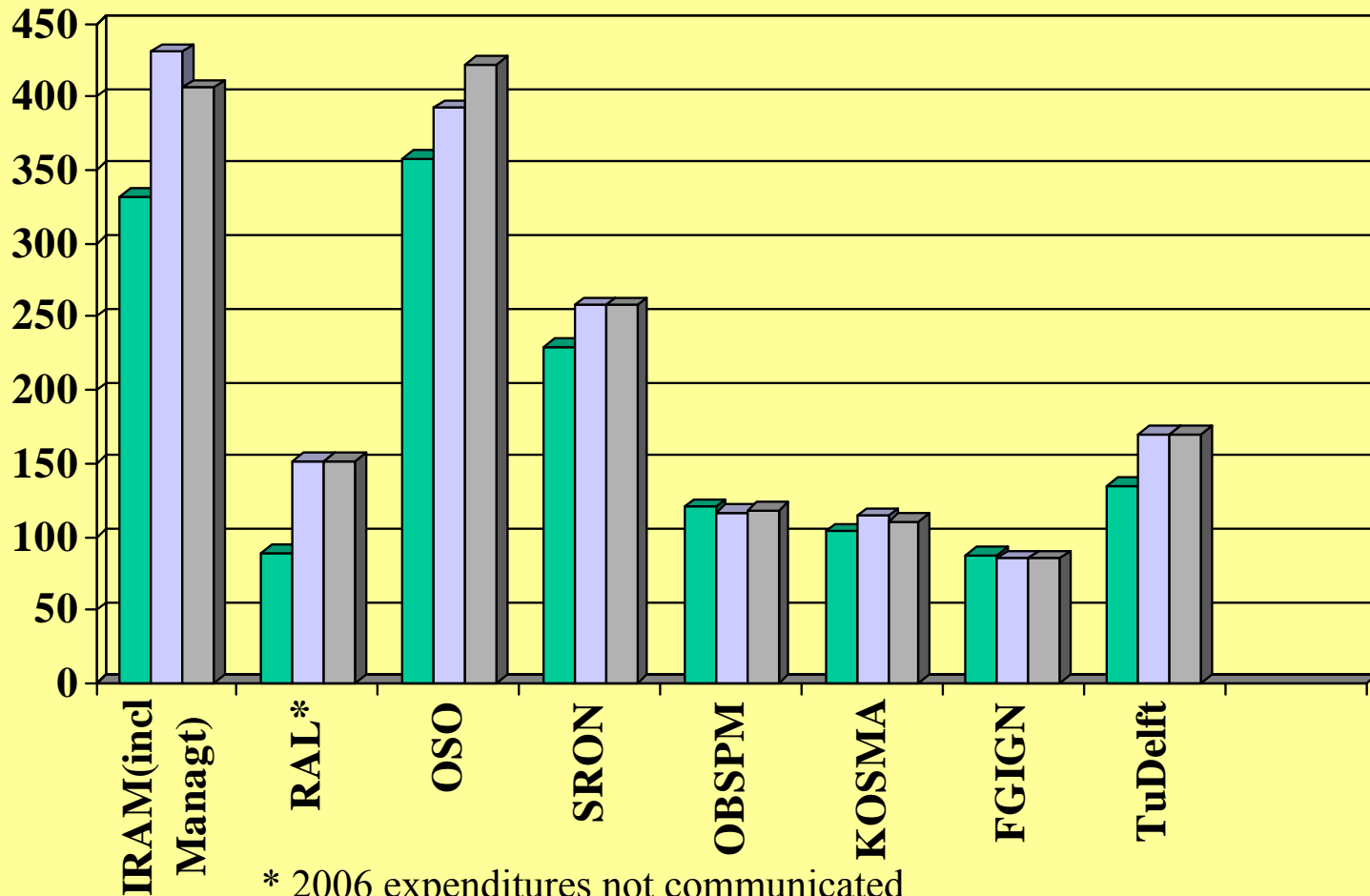
Figure 2: Noise temperature measured with a gunn doubled L.O. in the 4-pixel demonstration cryostat. Built by IRAM. A common test with RAL using a cooled photomixer is planned for the end of November.

# AMSTAR eligible expenditures (Jan-Sep 2006)

Institute	type	Eligible costs	To be claimed	Claim/plan
<b>IRAM</b>	FC	175209	87604	0.47
<b>RAL</b>		Not communicat		
<b>OSO</b>	AC	149328	149328	0.81
<b>SRON</b>	FC	153493	76746	0.73
<b>OBSPM</b>	FC	6801	6801	>1
<b>KOSMA</b>		26792	26792	0.71
<b>FG-IGN</b>	AC	14050	7025	>1
<b>TuD</b>	AC	23564	23564	0.40
<b>Total</b>		<b>549237</b>	<b>377860</b>	<b>0.69</b>

# AMSTAR Budget breakdown:

- - EC-contribution for 2004, 2005 and 2006 expenditures (9 months)
- - EC contribution 2004 and 2005 + 18 month plan projected costs
- - Original budget



# Budgetary considerations

- All groups will have spent (about) all their budget by Summer 2007, the planned end of the JRA. Some have already overspent.
- Some groups have extended their activities to reach upgraded goals and will overspend their original budget. It was hoped, originally, that it will be possible to answer to a second Call for Proposals in the frame of FP6, but we were discouraged to do so.
- The JRA management budget (PI salary and travel costs) was grossly under-evaluated. The actual costs will be  $\approx 80$  k€ at the end of the JRA, while the EC contribution to this task was budgeted for 20 k€. The overspendings are presently supported by a single institute: IRAM.

# Proposed Actions

- Allocate leftover AMSTAR funds (if any) to the “JRA Management” budget line,
- Ask to RadioNet for extra funds, if any available, to cover the remaining Management costs and, if possible, part of the extra costs due to the extension of 3 workpackages.
- The next AMSTAR Meeting will be held in December in Paris. The R&D items that will be proposed for a new JRA in the frame of FP7 (AMSTAR+) will be further discussed at this meeting.