Italian Workshop on SPICA

INAF Headquarters, Monte Mario, 7-8 February 2013

The Low Noise Amplifiers of SAFARI

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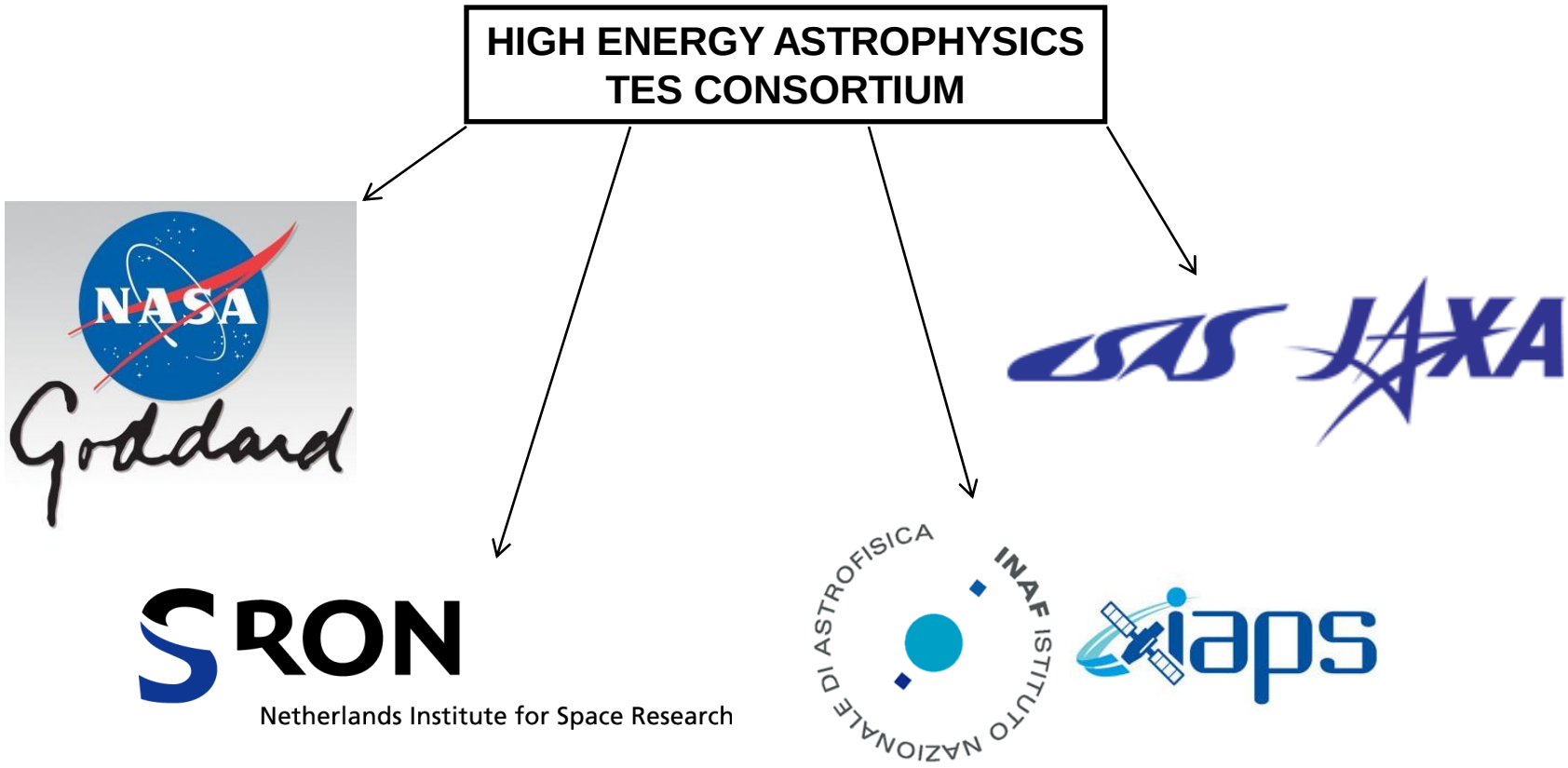
Outline

- The TES Consortia for High Energy Astrophysics
- Involvement in the SAFARI/SPICA activities: The Cryogenic DC-LNA
- Design and preliminary test (by TAS-I, Milano)
- Test at IAPS Roma
- Conclusion



The Italian TES Consortium for HEA (IXO/ATHENA missions)

Management
TES Design and test
TES readout: test
Particle BKG: GEANT4

INFN Istituto Nazionale di Fisica Nucleare
UNIVERSITÀ DEGLI STUDI DI GENOVA

TES Design, development and test

IFN Institute for Photonics and Nanotechnologies

TES Readout electronics: design and test

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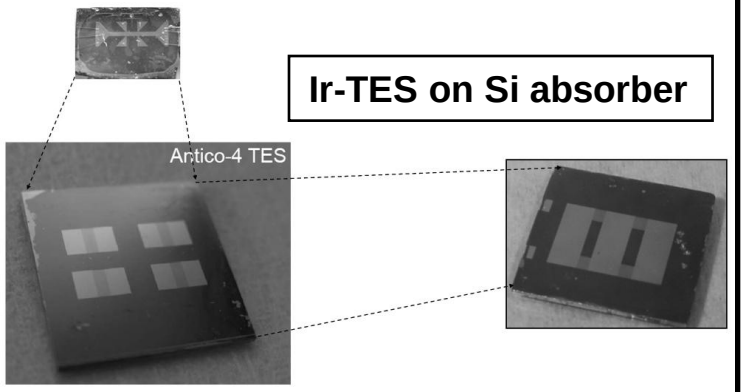
TES Readout electronics: design and test

IASFPa

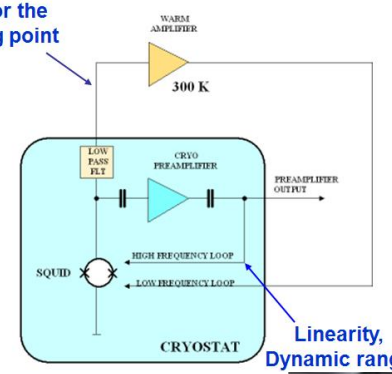
X-Ray filters, Particle BKG

TES Detectors, TES Cryogenic Readout electronics, particle-BKG → Skill
TESes are "interdisciplinary" and work from "mm to gamma-ray",
the space agencies CAN capitalise their investments

Ir-TES on Si absorber

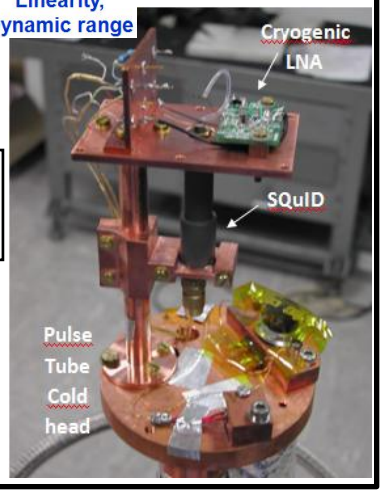


Bias for the working point



Linearity, Dynamic range

DL-FLL
TES array readout



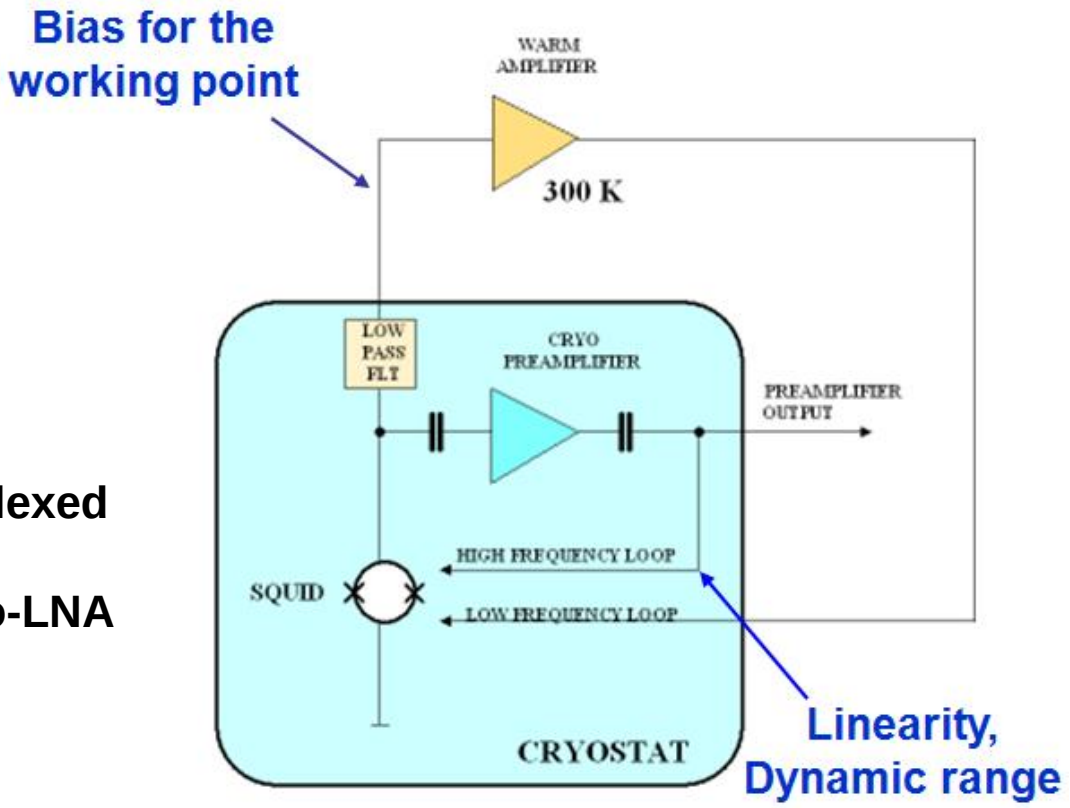
The SAFARI cryo DC-LNA is a DL-FLL technique spin-off

Multiplex tens of AC-biased X-ray pixels in the MHz range by applying the FDM tecnique

To guarantee linearity and stability of the readout system
→ high gain-loop at high frequency → limited delay (**short cable lenght**)
from the SQUID to the pre-amp stage

↓

Cryogenic electronics: DL-FLL to simplify



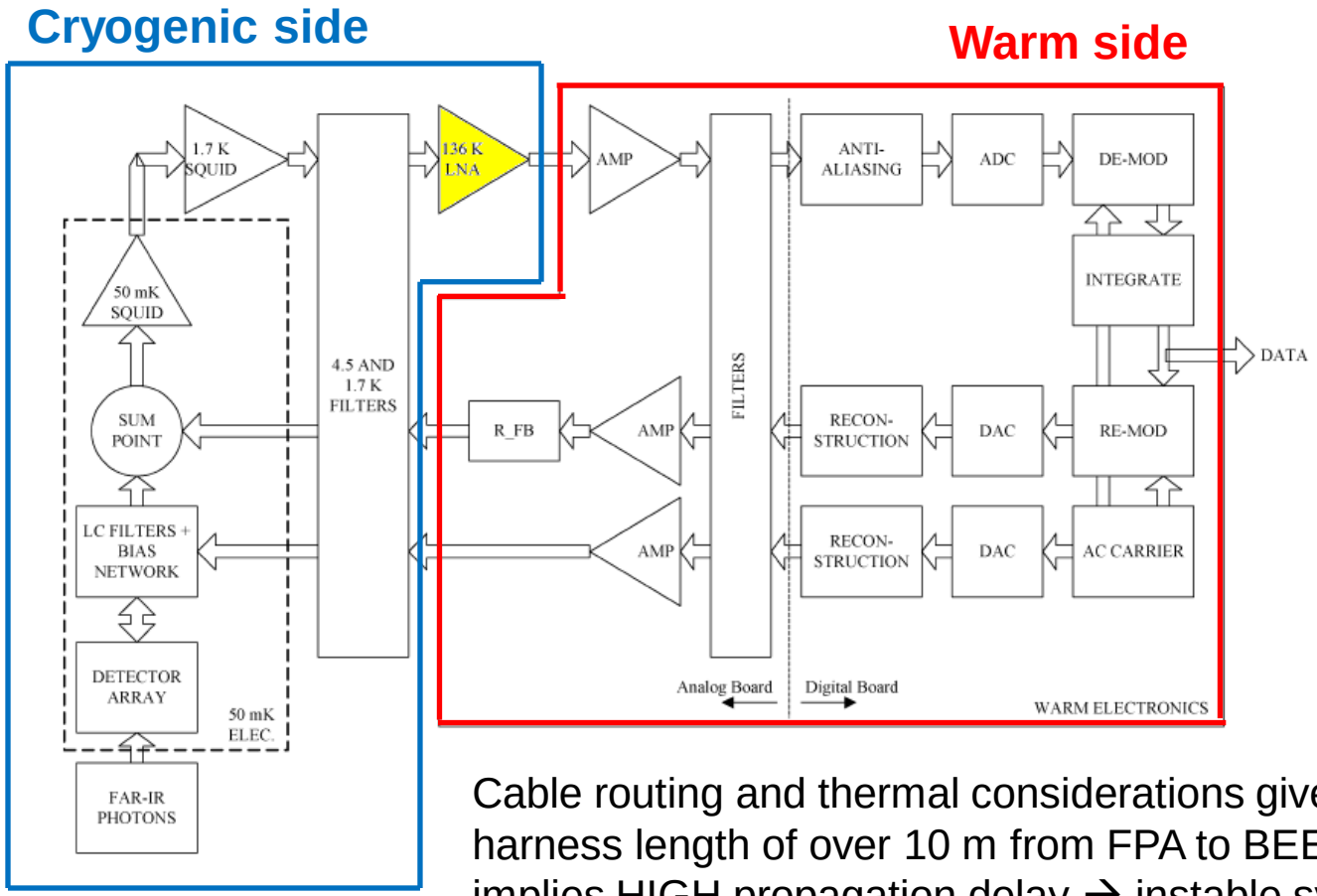
On the paper up to ~ 100 kPxl multiplexed

The core of this technique is the cryo-LNA

This is the reason why we are here!

Involvement in the SAFARI/SPICA activities: The Cryogenic DC-LNA

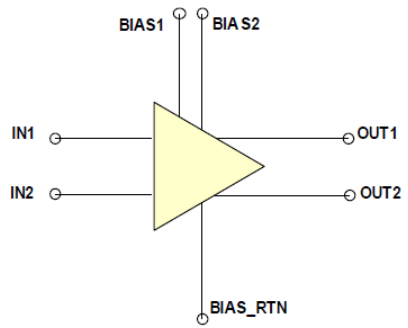
SAFARI DETECTOR SYSTEM



Cable routing and thermal considerations give rise to a considerable harness length of over 10 m from FPA to BEE → for SQuID readout it implies HIGH propagation delay → instable system → usual FLL scheme not for the SPICA case → BBFB (SRON) scheme BUT it is necessary to boost the signal due to the long harness → Cryo DC LNA!

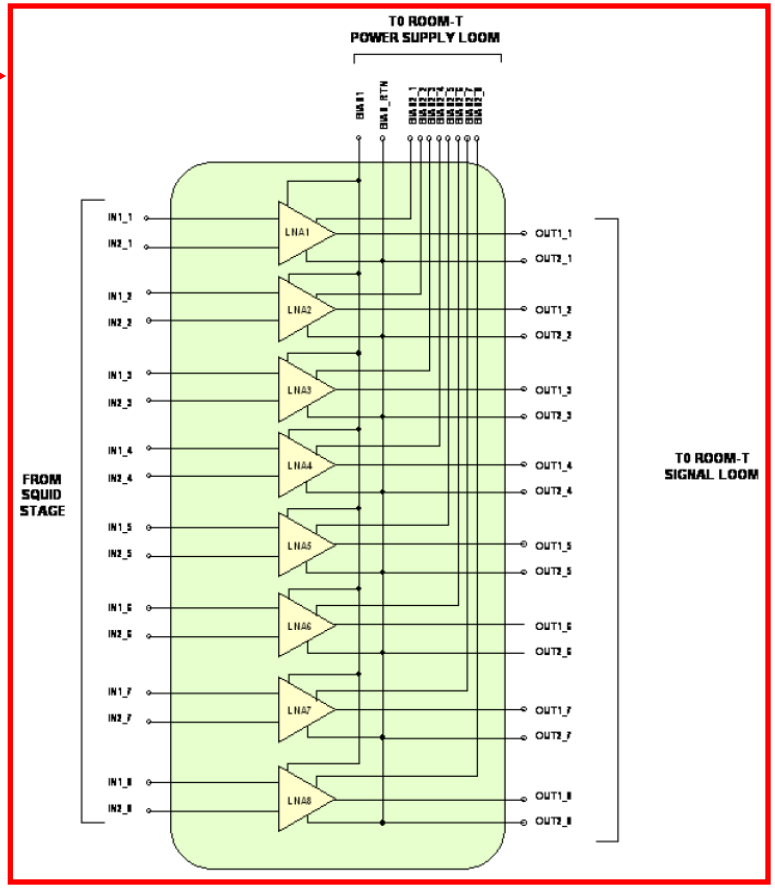
Design and preliminary test (by TAS-I, Milano)

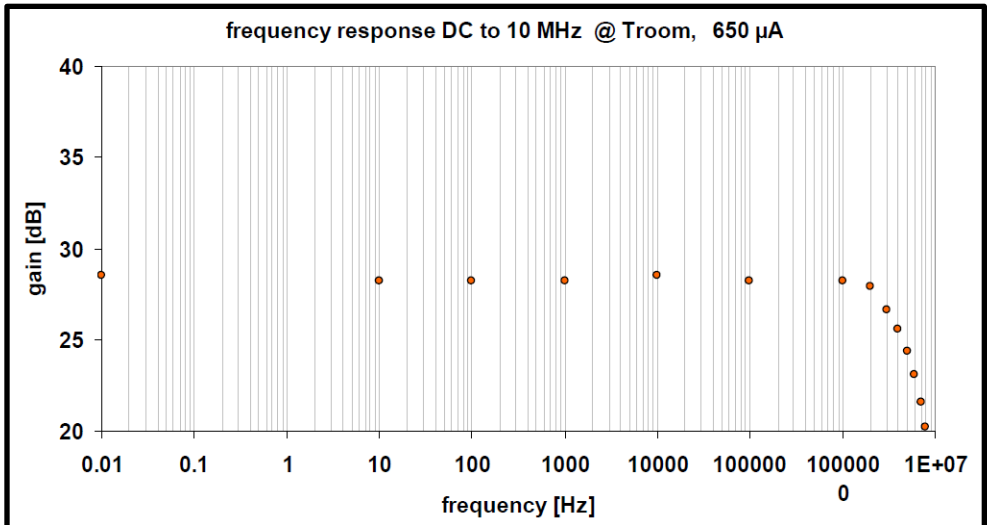
From the single channel LNA interfaces, whose core is the INFINEON BFP650 HeteroJunction Si:Ge...



Main requirements to be satisfied at 135 K are:
BW: DC to 3 MHz
GAIN: 20 V/V
NOISE: < 3nV/sqrt(Hz) (< 1nV/sqrt(Hz) as goal)
POWER: < 2 mW/channel (goal), 5 mW/channel MAX

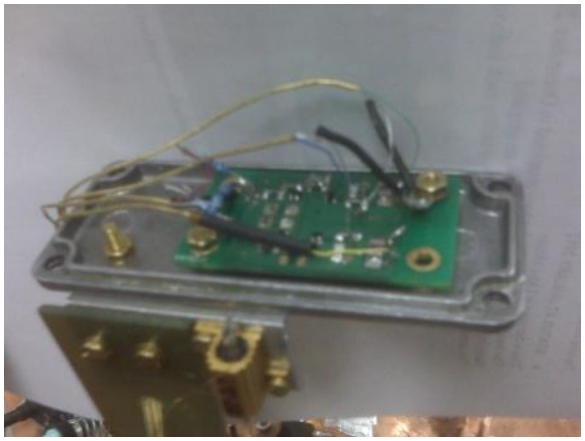
...to octal unit as possible grouping scheme to manage the amplification of each SW-MW-LW array

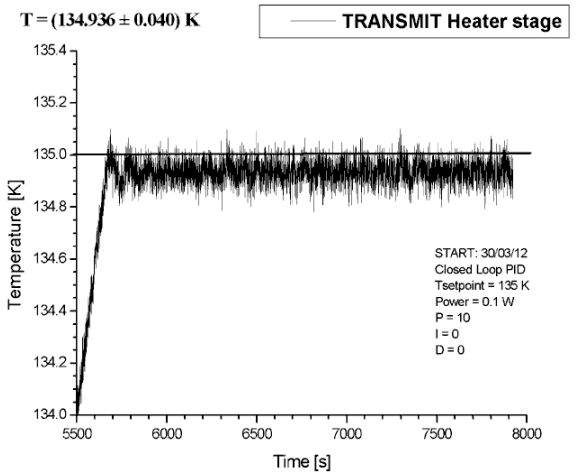


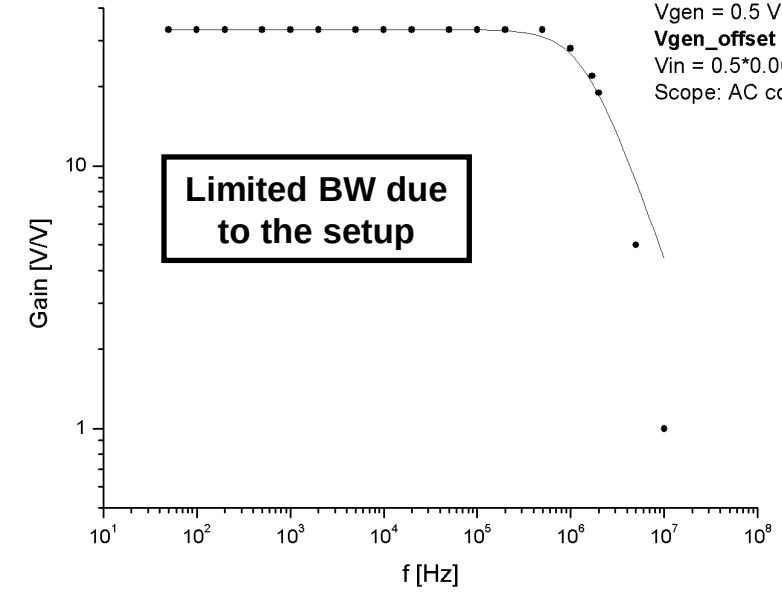


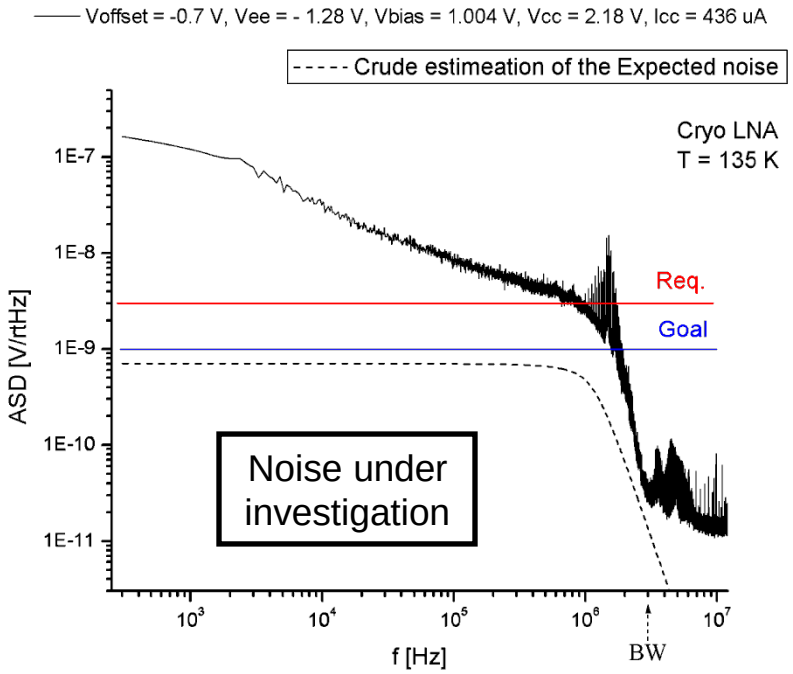
Troom frequency response from DC to 10 MHz at Troom and at low power (~1mW). The -3 dB point in this condition is around 4 MHz. G ~ 25 V/V

Cryo-test at IAPS Roma: results









Conclusion

• The prototype of the DC LNA for the SAFARI SPICA programme, has been tested at TAS-I and INAF/IAPS Roma both at warm and cold environment.

• At 135 K Gain up to 30 V/V and Pmax = 1.5 mW: well inside the requirements (20 V/V, 2 mW). The noise is to be further investigated.

• A second version of the LNA board will be produced, a sort of test bench to verify the simulated model and to see the limit of the present LNA

So, the designed LNA is a promising architecture for the DC cryogenic low noise amplifier for the SAFARI/SPICA programme. Further work (already ongoing) is needed to understand some detail about the noise at cold (135 K).