

# Spanish community update

- I. E-CMB meeting in Santander
- II. Existing infrastructures
- III. Spanish roadmap for CMB experiments: ongoing and near-future projects
- IV. Ideas for an European roadmap

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# Spanish E-CMB meeting in Santander

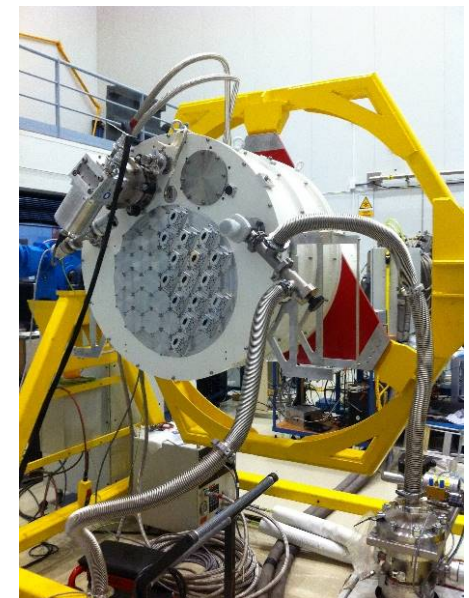
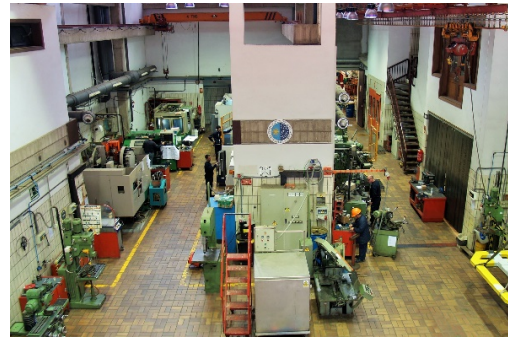
## 15 June 2017

- Most of the Spanish CMB groups were represented covering science and technology: about 20 people from Barcelona, Madrid, Oviedo, Salamanca, Santander, Tenerife, Teruel.
- Short presentations of the expertise and future plans were presented, specially in relation to the E4 proposal.
- Possible interest in future CMB ground-based and satellite projects was discussed, in particular a mission like CORE and ground-based experiments covering the low frequency domain (QUIJOTE and post-QUIJOTE like) and the medium one (KIDs development).



# IAC Facilities

Mechanical Workshop  
Dimensional Metrology Lab.  
Microwave Laboratory 1-50GHz  
Electronics Workshop  
Technical Drawing  
Mechanical Design  
Cryogenic Design  
AIV class 100,000 cleanroom  
Software  
3D printing



# The Izaña Site

Observatorio del Teide

( <http://www.iac.es> )



Altitude: 2400 m

Longitude: 16° 30' W

Latitude: 28° 17' N

Typical PWV: 3 mm, and below 2mm during 20% of time.

Good weather: 90%

Easy access: 40 km road journey from IAC

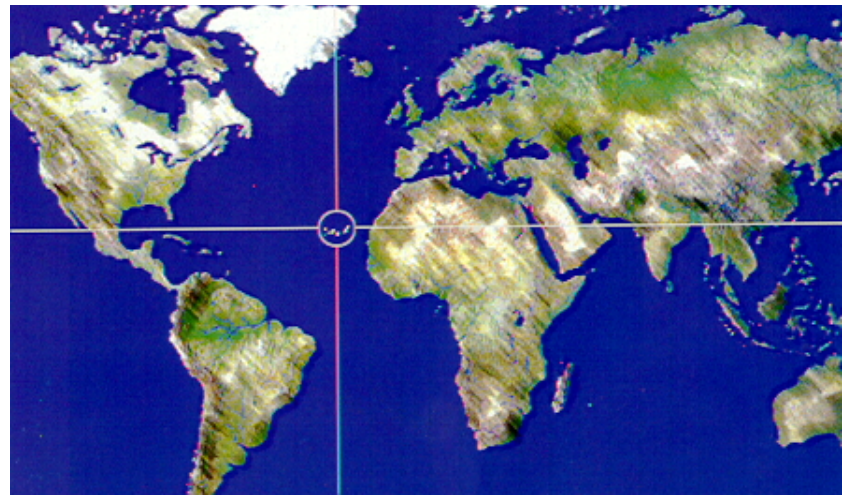
**Tenerife experiment**  
10, 15, 33 GHz



**COSMOSOMAS**  
11, 13, 15, 17 GHz



**The Very Small Array**  
30GHz



## *UC-DICOM capabilities*

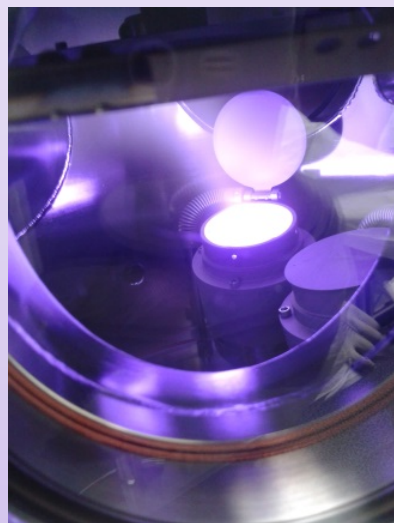
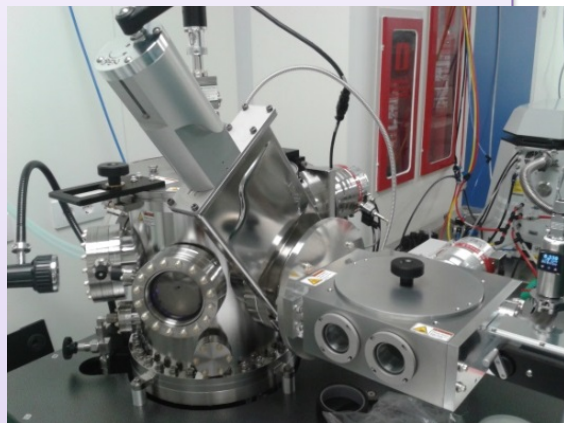
Design, testing and manufacturing of:

Radiofrequency and microwave systems for radio astronomy.

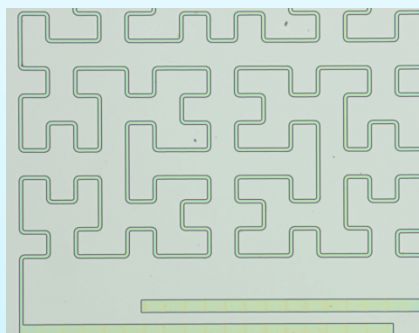
- Cryogenic LNA Monolithic Microwave Integrated Circuits (MMIC):
  - IAF-Fraunhofer 100 nm and 50 nm mHEMT technologies (two collaboration projects since 2008 with Observatorio de Yebes), cryo-LNA in several bands from 2 to 110 GHz
  - OMMIC (France) mHEMT 70 nm, Ka and Q-band LNA
- Horn antennas, Orthomode Transducers (OMT), Polarizers, Couplers:
  - Several frequency bands, from 10 to 110 GHz
  - Broadband performance (10-14 GHz, 14-20 GHz, 26-36 GHz, 35-47 GHz, 81-99 GHz)
- Radiometers and polarimeters:
  - Planck-LFI: 30 and 44 GHz Back End Modules
  - QUIJOTE TGI and FGI (30 and 40 GHz): horns, OMT, polarizers, receivers (Front End and Back End Modules) (31 pixels)
  - Polarimeter demonstrator at 90 GHz: horns, OMT, polarizers, receivers (Front End and Back End Modules) (2 pixels)
- Broadband subsystems:
  - Cryogenic and ambient LNA
  - Phase-switches, microwave correlators, filters, Schottky diode detectors, ...

# KIDs: Fabrication

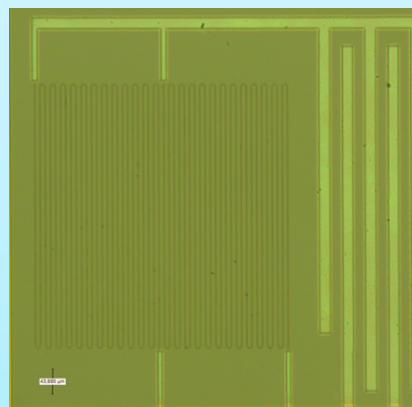
**Sputtering:**  
*Deposition of  
superconducting films*



**Nano and micro  
lithography**

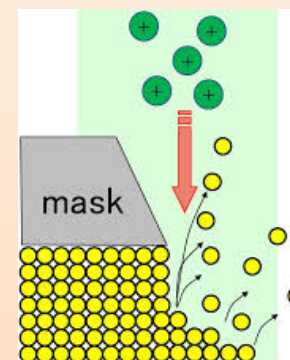


*Laser writer*



*e-beam lithography*

**Etching:**  
*Wet etching,  
ion milling and RIE*



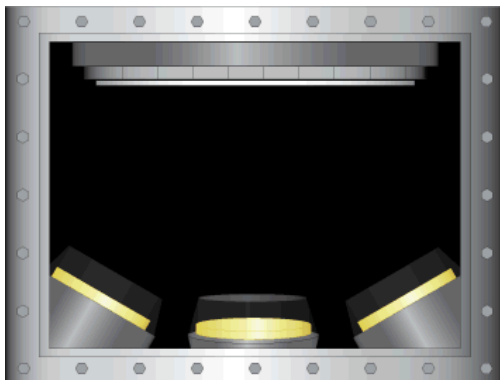
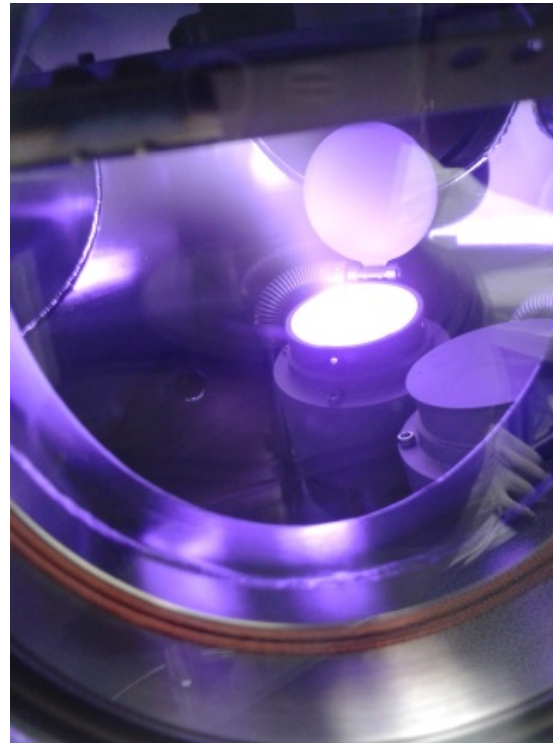
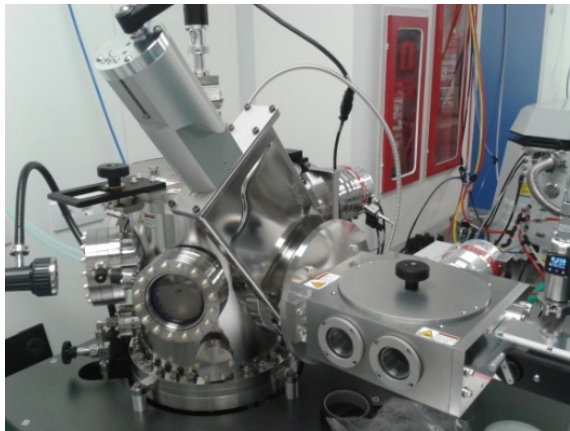


# KIDs: Fabrication

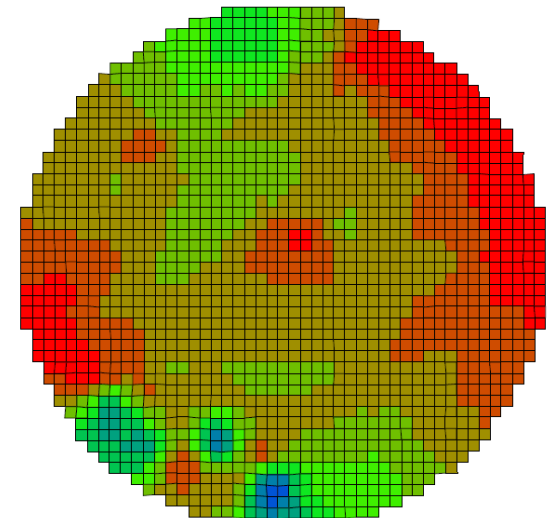
4 inch wafers → Scaling number of pixels...

Very high homogeneity is necessary for scaling the number of pixels (cross-coupling ,...)

Installation of Confocal Sputtering (Al, Nb, Ti)

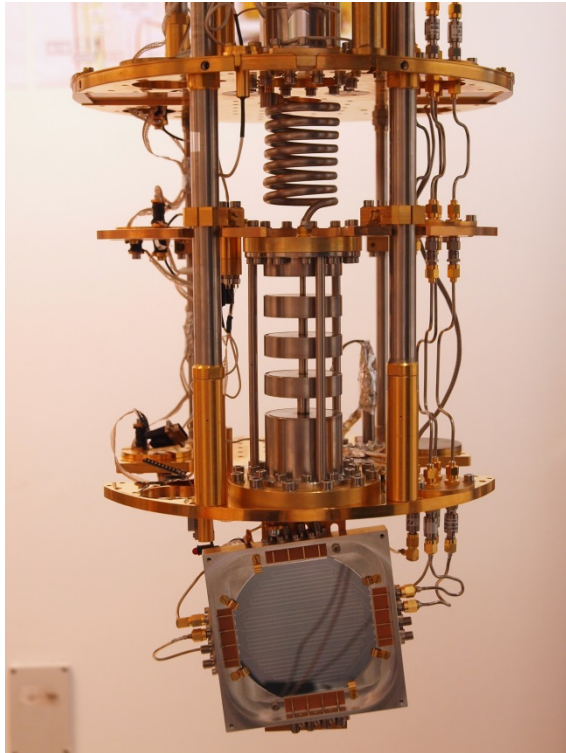


Homogeneity  $\approx 1.5\%$



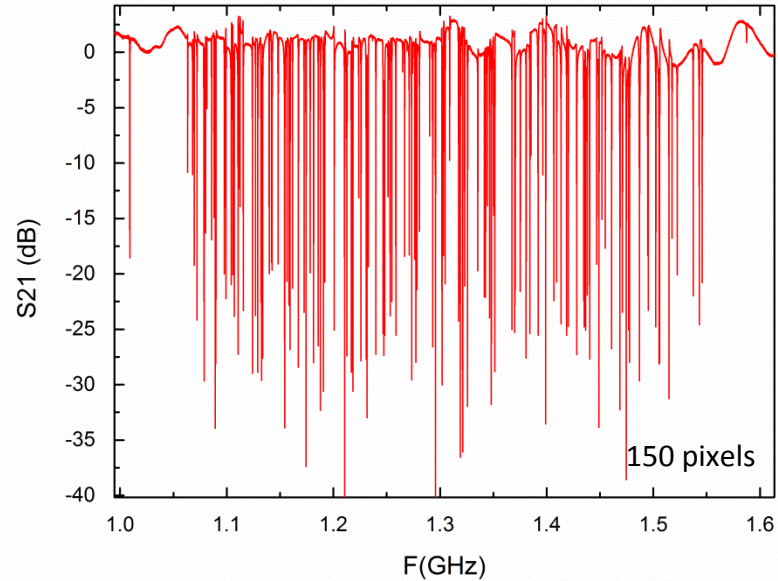


# KIDs: Characterization

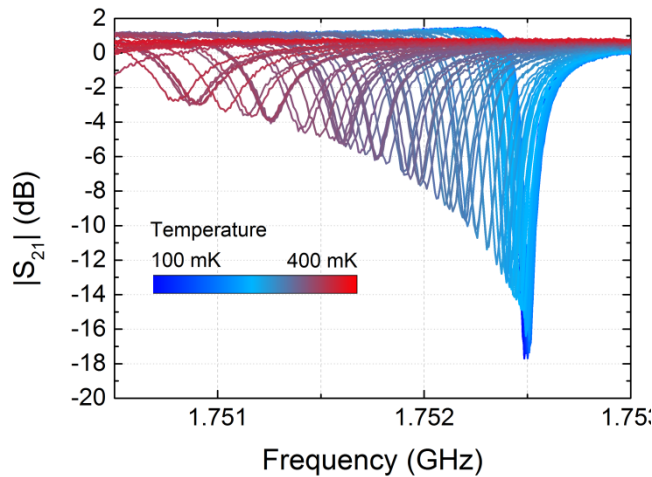


Dilution cryostat  
for testing (10mK)

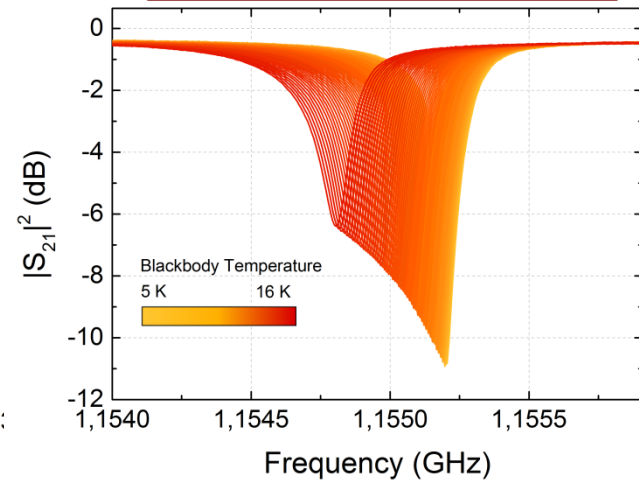
VNA scan



Dark response



Optical response





# Spanish roadmap for CMB experiments.

The ongoing projects are:

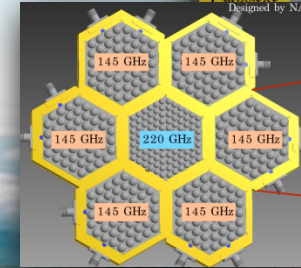
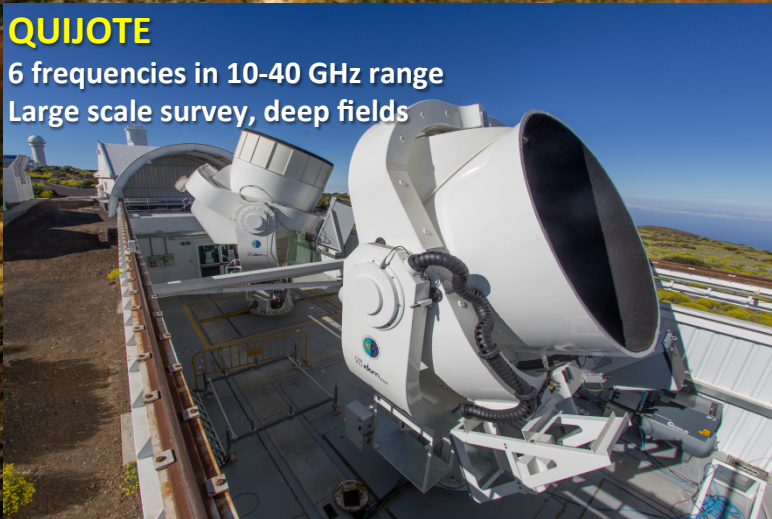
- **Ground-based low frequency polarization observations.**
  - QUIJOTE. Extension of QUIJOTE to southern hemisphere?
  - LSPE-STRIP.
  - Interferometer with optical correlator at low frequencies (10-50GHz).
- **Ground-based high frequencies polarization observations.**
  - GROUND BIRD.
- **CMB spectral distortions.**
  - KISS (80-300 GHz).
  - Microwave spectrometer 10-20GHz.
- **Design and fabrication of KID prototypes for CMB polarization**
- **Short duration balloon flights for calibration.**

# Teide Observatory (Tenerife)

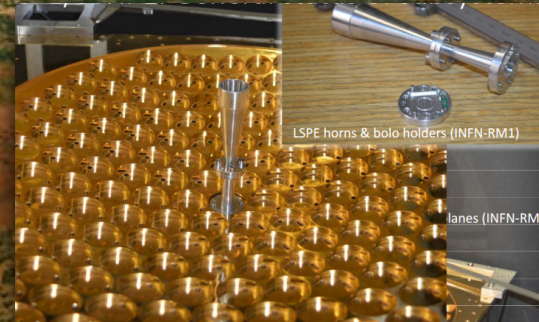
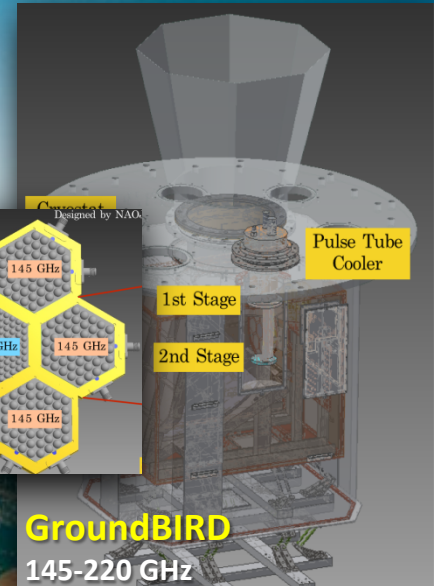
Same sky area (>20% sky, North Hemisphere)  
10 frequencies from 10 to 240 GHz  
Redundancy, cross-correlation

## QUIJOTE

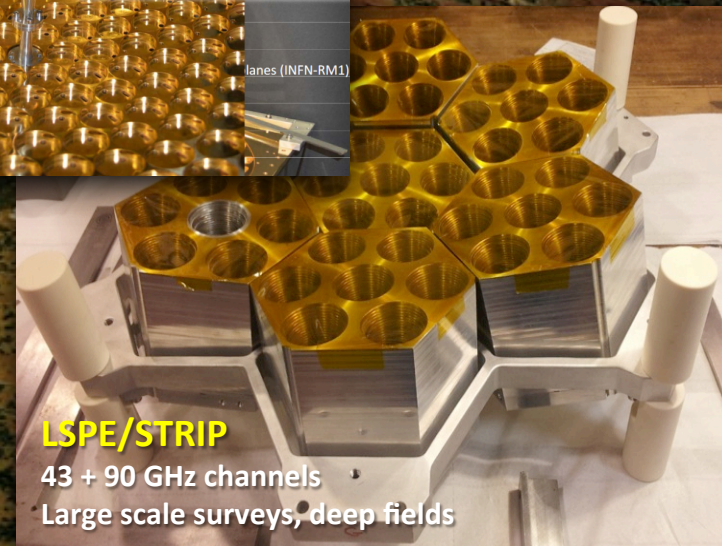
6 frequencies in 10-40 GHz range  
Large scale survey, deep fields



**GroundBIRD**  
145-220 GHz



**LSPE/SWIPE**  
140-220-240GHz



**LSPE/STRIP**  
43 + 90 GHz channels  
Large scale surveys, deep fields

# Ideas for an European roadmap

- **Our strengths:**
  - Low frequencies. Spectrometers (SZ, absolute).
  - Sites: Teide Observatory in Tenerife.
  - Technologies: HEMTs and KIDs.
- **Frequencies below 50 GHz are needed to control the synchrotron emission to the required precision**, and have to be observed from the ground with experiments like QUIJOTE.
- Natural synergy with existing efforts in Europe (e.g. STRIP/LSPE, QUBIC).
- **Present and future needs to complement any satellite mission and S4 at low frequencies:**
  - To construct sensitive experiments in the range 10-50 GHz with thousands of detectors and cover both hemispheres → super-QUIJOTES (6-8m class)? Interferometers?
  - To contribute to the development of 10 kpixels instruments based on KIDs
  - The cost and operation of the future experiments will require most probably an international consortium with contributions from several countries.
- **Spectral distortions measurements** from the ground, balloons and space. Multiple efforts in Europe (e.g. OLIMPO, COSMO, KISS, IAC-Spectrometer), and also the old PRISM proposal.