Enabling technology developments (passive and coherent components, electronics)

Aniello Mennella
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on behalf of the Italian CMB community
Knowledge map

### Torino
- IEIIT – CNR (design development and testing of passive components)

### Milano
- UniMi (fabrication, bench and anechoic chamber testing, design)
- UniMib (bench testing, cryogenics, mechanic and electronic design and fabrication)
- IFP-CNR (anechoic chamber testing)

### Bologna
- IASF-INAF (passive components system development, cryogenics, horn and telescope design, calibrators, system engineering, AIV-AIT, RF design and tests, project control, thermo/mech design)
- IRA-INAF (coherent devices, RF testing)

### Roma
- La Sapienza (multimoded horns, optical simulations)

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Design and manufacturing of passive components
Relector telescope design

• LSPE-STRIP side-fed dragonian design (IASF-Bo)

• Optimized for low cross-polarization, key parameter for CMB measurements

• Dual reflector compact range for anechoic chamber in UniMi

• Currently being developed by COSPAL
LSPE 43 GHz feed-horn array (49 elements)

- Corrugated dual-profiled design (IASF-Bo)
- Optimal performance in CMB polarization measurements
- Manufactured using “platelet“ technique (UniMi)
- Guarantees high performance with low manufacturing costs
- Can be scaled to massive production of feed arrays
SRT 40 GHz feed-horn array (19 elements)

• Dual-profiled design (R. Nesti, Arcetri-INAF) with integrated marker injectors (IEIIT – CNR)

• To be placed in the secondary Gregorian focus of the Sardinia Radio Telescope

• Realized using “platelet technique” (stacking of machined rings) - UniMi
QUBIC 150-220 GHz feed-horn array (400+400 elements)

- Dual-profiled design (B. Maffei, U. Manchester)

- Realized using chemically etched platelets (UniMi – Lasertech)

- Several small modules manufactured to test different materials

- Two modules of 64 horns each realized for QUBIC technical demonstrator
QUBIC 150-220 GHz switch block

• Design by APC (Paris Diderot)

• Realized and tested in UNIMIB

• Operates and reads-out the positions of the QUBIC switches (64 for the prototype and 400 for the scientific module)
LSPE polarizers and OMTs

• Circular polarizers and OMTs designed for the LSPE-STRIP instrument (IEIIT – Torino)

• OMT designed for platelet production

• Full 49-elements array produced and tested

• High purity in polarization discrimination (spurious polarization < -30 dB)
LSPE polarizers and OMTs

- Same components designed also at 95 GHz (IEIIT – CNR)

- 7-elements array produced and tested: excellent polarization purity performance
Calibrators development and testing

- Calibrators for in-flight operations and ground tests developed for Planck-LFI (IASF-Bo)

- High performance calibrators designed and developed for LSPE-STRIP (IASF-Bo)

- Each horn calibrated independently in polarization, with optimal emissivity and polarization purity

- Tests on materials at cryo-T, performance verification and product assurance (IASF-Bo)

- RF testing up to 170 GHz (UniMib)
Testing of passive components
• Small anechoic chamber for testing of microwave components (up to 30 kg)

• Large anechoic chamber for testing small payloads (up to 9 ton, compact range under development)

• Scalar and vector RF equipment up to 70 GHz (W band in progress)

• Precision metrological measurements (1.8 μm)
Measurements on Q-band SRT horns

41.5 GHz, cross-polarization

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• Two oil-free vacuum facilities working in the range 4K – 300K

• Available volumes
  • 350x400x200mm$^3$
  • 500x500x400mm$^3$

• **Active** and **passive** components characterization (10 MHz - 170 GHz)
Cryowaves laboratory at IASF-Bo

- Develop, integrate, characterize, calibrate complex instrumentation from microwave to (sub)mm-wavelength
- Two cryo-facilities and four coolers for testing components and small payloads down to 4 K
- RF testing equipment (scalar up to W band, vector up to V-band [in progress]) and bias unit
- Crane for loads up to 1 ton
Coherent detectors and electronics
LSPE Q-band polarimeters

- Design and components by NASA-JPL

- Already deployed in QUIET experiment at Q and W-bands
Electronics development at UniMib

- LSPE-STRIP analogue and digital electronics (49 Q band Polarimeters: 294 LNAs, 196 ADCs, Data rate 4kHz)
- SKA SPF band 3-4-5 LNAs bias
- QUBIC switches driving and read-out electronics
- MKIDS readout electronics (ASI proposal and PRIN-2015)
Future trends

- Multi-beam HTS satellite communication systems
- VLBI receivers for very high resolution surveys
- Multi-Feed
- Multi-Band
- Multi-Mode
- Earth observation radiometers
- CMB receivers
Thanks to...

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