Testing & calibration

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Rationale

- Scientific Challenges: extremely tiny signals much smaller than systematics
- Innovative Instrument Architectures, Devices and Observing Strategies to reduce and remove *systematics*
- System Level and Subsystem Level R&D
- Test and Calibration Facilities

New Scientific Challenges

Theoretician point of view

- CMB anomalies
- DE
- Inflation
- GW
- Spectral Distortions
- ….

Experimentalist point of view

- S_{xy} Parameters
- μK*pix
- Knee Frequency
- Instr. Pol. Rej.
- …

New Scientific Challenges

Theoretician point of view

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Sometimes is difficult to share the point of view…

Experimentalist point of view

- S_{xy} Parameters
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- …

From theoreticians' forecast to calibrated data: innovative architectures, devices and observing strategies

Ingredients:

- Imager, "dirty imager" (QUBIC like), interferometer, spectro-polarimeter: different systematics
- Sensitivity: Massive focal planes
- Radiometric, Bolometric
- Multi-wavelength: both radiometers and bolometers?, bolometers'low frequency extensions
- Detectors technology (TES, mKIDs, HEMTs)
- Readout Electronics

Whatever is the approach, R&D is fundamental

- R&D is an iterative process based on 3 steps
  - Design
    - Scientific goals translated into technical specifications
    - Schematic Ideas
    - Design
  - Realization
    - Foundry
    - Micromachining
    - Macromachining
  - Test
    - Measurable quantities
    - Test Set-up (systematics)
    - **Feedback**

Whatever is the approach, R&D is fundamental

Typical situation:

- Design, Fabrication and Test are so specialized that very often are performed in different sites

- Usually Design and Fabrication experts aren't CMB scientists and are time shared with many other "customers"

- Test is referred to "dirty" CMB scientists (experimentalists): they are needed to use standard lab instruments to characterize highly non standard devices. The only way to go from μV to μK.

Testing

- Few sites in Italy where HW and expertise are the heritage of a long term investment
- Synergic (marginal overlap: positive!)
- High Quality Facilities: attractive also for industry
- For the future
  - National activity coordination
  - Strategic evolution/development of the existing facilities

Test: 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)

Test: Knowledge Map

Italy is in a lucky position thanks to the experimental activity on the run

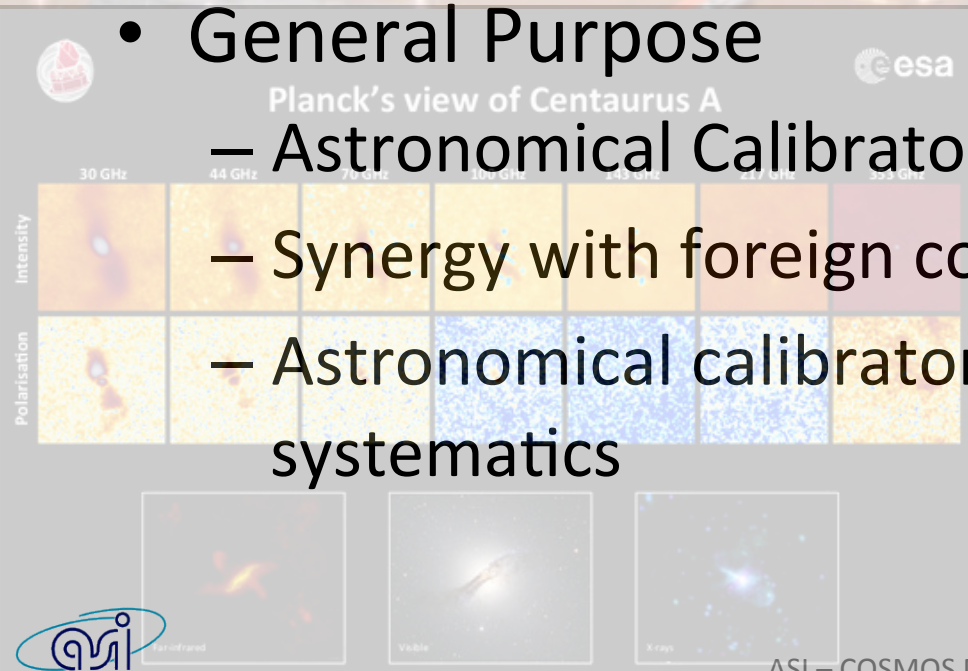
LSPE (STRIP/SWIPE): INAF-IASFBO, CNR-IEIIT, UniMi, UniMiB, La Sapienza

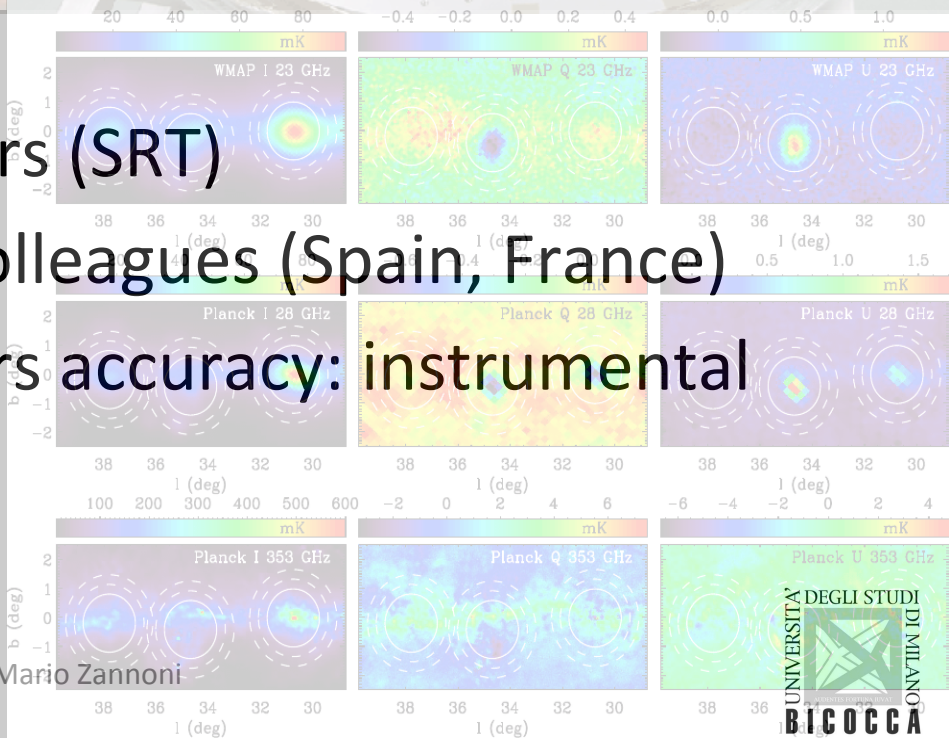
OLIMPO: La Sapienza, UniMiB

QUBIC: La Sapienza, UniMi, UniMiB

Calibration

- Hardware Specific
  - Subsystem Level Calibration (in lab)
  - System Level Calibration (in lab or on site)
- General Purpose
  - Astronomical Calibrators (SRT)
  - Synergy with foreign colleagues (Spain, France)
  - Astronomical calibrators accuracy: instrumental systematics





Conclusions

WP strategic for a future both from ground and space

Fundamental Recipe:

1. Human investment
2. HW investment (Strategic evolution/ development of the existing facilities)
3. Mobility (new ideas come from meltin-pot opportunities)
4. National activity coordination