

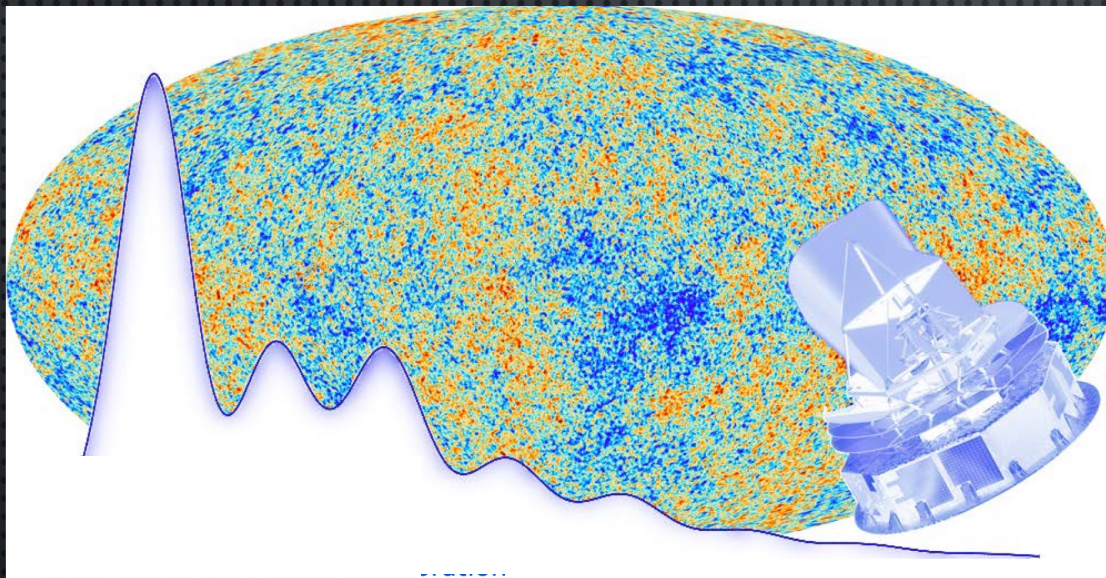
# **THE ITALIAN CONTRIBUTION TO LITEBIRD**

*Nicola Vittorio  
22 Maggio 2023*



# ITALIAN CMB-DAY

• ASI- MARCH 30, 2016



## New challenges in Cosmic Microwave Background studies

### Italian CMB-day workshop

Agenzia Spaziale Italiana - Roma - March 30, 2016

start	duration	what	who
09:00:00	00:30:00	Registration	
<b>CMB: PAST, PRESENT, AND FUTURE</b>			chair <b>DE ZOTTI</b>
09:30:00	00:10:00	Introduction	ASI - Battiston
09:40:00	00:20:00	The CMB in Italy	Bersanelli
10:00:00	00:30:00	Planck and its legacy	Mandolesi
10:30:00	01:20:00	Science Targets after Planck	Liguori
		primordial CMB	Mazzotta (+ Baccigalupi, Lapina)
		SZ & Xcorr	Melchiorri
		Astroparticles	Burigana (+ De Zotti)
		Foregrounds	
11:50:00	00:20:00	coffee break	
<b>CURRENT ACTIVITIES</b>			chair <b>VITTORIO</b>
12:10:00	00:30:00	Italian contributions to current CMB experiments	Masi
12:40:00	01:00:00	Enabling Technology Developments	
		passive and coherent components	Mennella
		KIDs	Castellano
		TESs	Gatti
		space cryogenics	Morgante
13:40:00	01:00:00	lunch break	
14:40:00	00:45:00	data analysis and exploitation	
		Italian involvement in Data Exploitation, Analysis, Archiving, Supercomputing Resources, Formation (3 talks)	Baccigalupi, Natoli, Polenta
<b>FORTHCOMING SPACE MISSIONS</b>			chair <b>DANESE</b>
15:25:00	00:25:00	the international scenario (balloons, LITEBIRD, PIXIE, Millimetron, ...)	Piacentini
15:50:00	00:35:00	CORe++	de Bernardis
16:25:00	00:20:00	coffee break	
<b>DISCUSSION</b>			chair <b>MANDOLESI</b>
16:45:00	01:00:00	<b>DISCUSSION: PERSPECTIVES OF THE ITALIAN SCIENTIFIC COMMUNITY AND OF ASI IN THE CMB</b>	
		Short contributions from	Scientists INAF - INFN - CNR Industries ASI
		General Discussion	
17:45:00	00:10:00	living document	Baccigalupi
17:55:00	00:20:00	concluding remarks	Battiston
18:15:00		EOM	



# ITALIAN CMB-DAY: CONCLUSIONS

- **PLANCK HAS DEFINITELY SET A MILESTONE IN THE HISTORY OF THE CMB:**
  - *THE ULTIMATE TEMPERATURE ANISOTROPY DATASET AND OPENED A NEW ERA FOR POLARIZATION*
- **FRONTIERS OF COSMOLOGY AND FUNDAMENTAL PHYSICS**
  - *STILL FAR TO BE REACHED*
- **PLANCK HAS CERTAINLY BEEN THE DRIVING FORCE**
  - *FOR GROWTH OF THE ITALIAN CMB COMMUNITY*
  - *FOR ITS INTERNATIONAL LEADING ROLE IN THE FIELD*
- **TO MAINTAIN AND INCREASE THIS LEADING ROLE**
  - *SYNERGIES WITH OTHER COMMUNITIES ARE CRUCIAL*
- **TECHNOLOGICAL PLANCK'S LEGACY**
  - *OPTICS, MICROWAVES, MM-WAVES, CRYOGENICS*
  - *NEED TO BE TRANSFERRED TO THE ITALIAN INDUSTRY*
- **THE LEGACY OF PLANCK CANNOT BE DISPERSED**



# COSMOS

## Cosmic Orbital and Suborbital Microwave ObservationS



Attività di studio per la comunità scientifica di Cosmologia

Partner

Pagina di esempio

# THE ASI/COSMOS PROJECT

KO MEETING DECEMBER 21, 2016



# COSMOS GOALS

COSMOS

Cosmic Orbital and Suborbital Microwave ObservationS



- **DEFINITION OF A ROADMAP**

- *FOR CARRYING OUT EXPERIMENTS FROM GROUND, FROM BALLOONS AND FROM SPACE TO MAKE THE ITALIAN COSMOLOGICAL COMMUNITY INCREASINGLY COMPETITIVE AT A EUROPEAN AND GLOBAL LEVEL;*

- **PREPARATION FOR THE DATA ANALYSIS**

- *OF THE LSPE EXPERIMENT, ALREADY FUNDED BY ASI, AND OF FUTURE OBSERVATIONAL CAMPAIGNS IN WHICH THE ITALIAN COMMUNITY IS ALREADY INVOLVED;*

- **TRAINING, INTEGRATED AT NATIONAL LEVEL, OF A NEW GENERATION OF COSMOLOGISTS**

- *CAPABLE OF ENTERING FRONTIER RESEARCH IN THE THEORETICAL, EXPERIMENTAL AND DATA ANALYSIS FIELDS.*

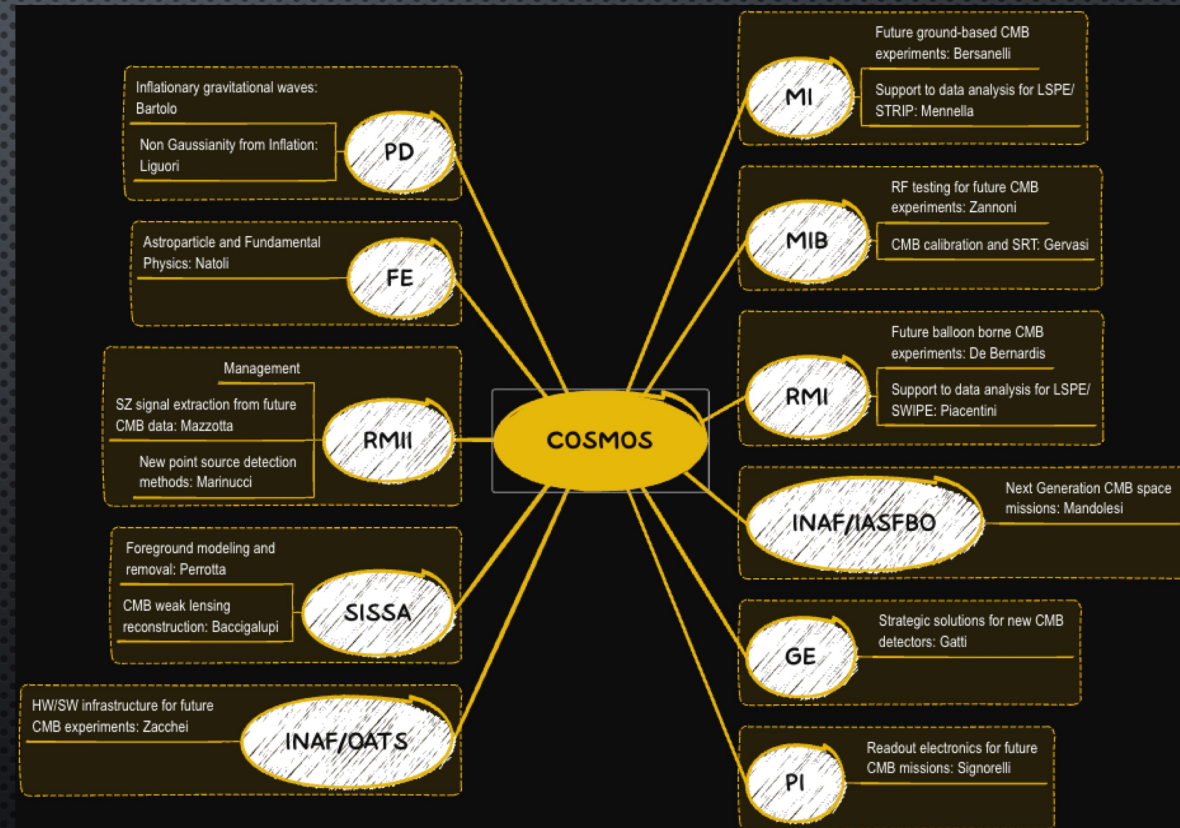


# COSMOS GOALS

- **THE TRAINING, INTEGRATED AT NATIONAL LEVEL, OF A NEW GENERATION OF COSMOLOGISTS CAPABLE OF ENTERING FRONTIER RESEARCH IN THE THEORETICAL, EXPERIMENTAL AND DATA ANALYSIS FIELDS.**
- **COSMOS WANTED TO**
  - *WORK AS A RESEARCH INFRASTRUCTURE*
  - *BE REPRESENTATIVE OF THE CMB COMMUNITY*
- **PROVIDED FINANCIAL SUPPORT FOR 11 RTD/A POSITIONS**
  - *2/3 OF THE COSMOS BUDGET*
  - *NO 'WATERING-CAN' PRINCIPLE*
    - *HAVING BACK IN ITALY EXPERIENCED PEOPLE*
    - *AWARDING THE MOST PROMISING ONES*

COSMOS

Cosmic Orbital and Suborbital Microwave ObservationS





# SPACE MISSIONS

- **THE ESA/CORE MISSION PROPOSAL**

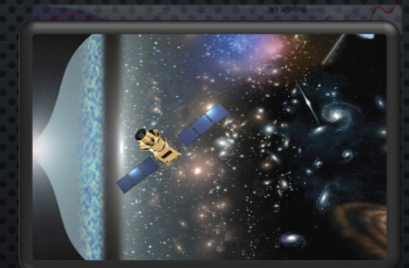
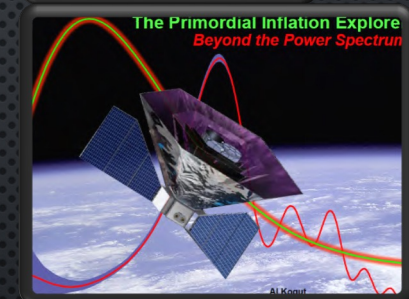
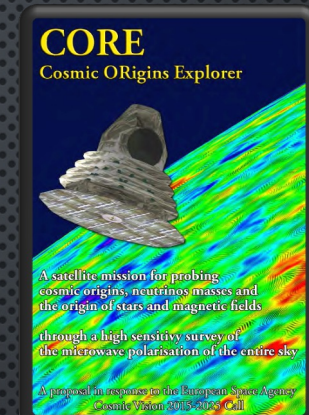
- *'INCOMPATIBLE WITH THE BOUNDARY CONDITIONS FOR THE M5 CALL'*

- **THE NASA/PIXIE PROPOSAL**

- *NOT SELECTED...*
- *NO OTHER SPACE MISSION TO MEASURE CMB SPECTRAL DISTORTIONS*

- **THE JAXA/LITEBIRD SATELLITE**

- *21/05/2019: ISAS SELECTED AXA/LITEBIRD AS THE STRATEGIC LARGE MISSION*

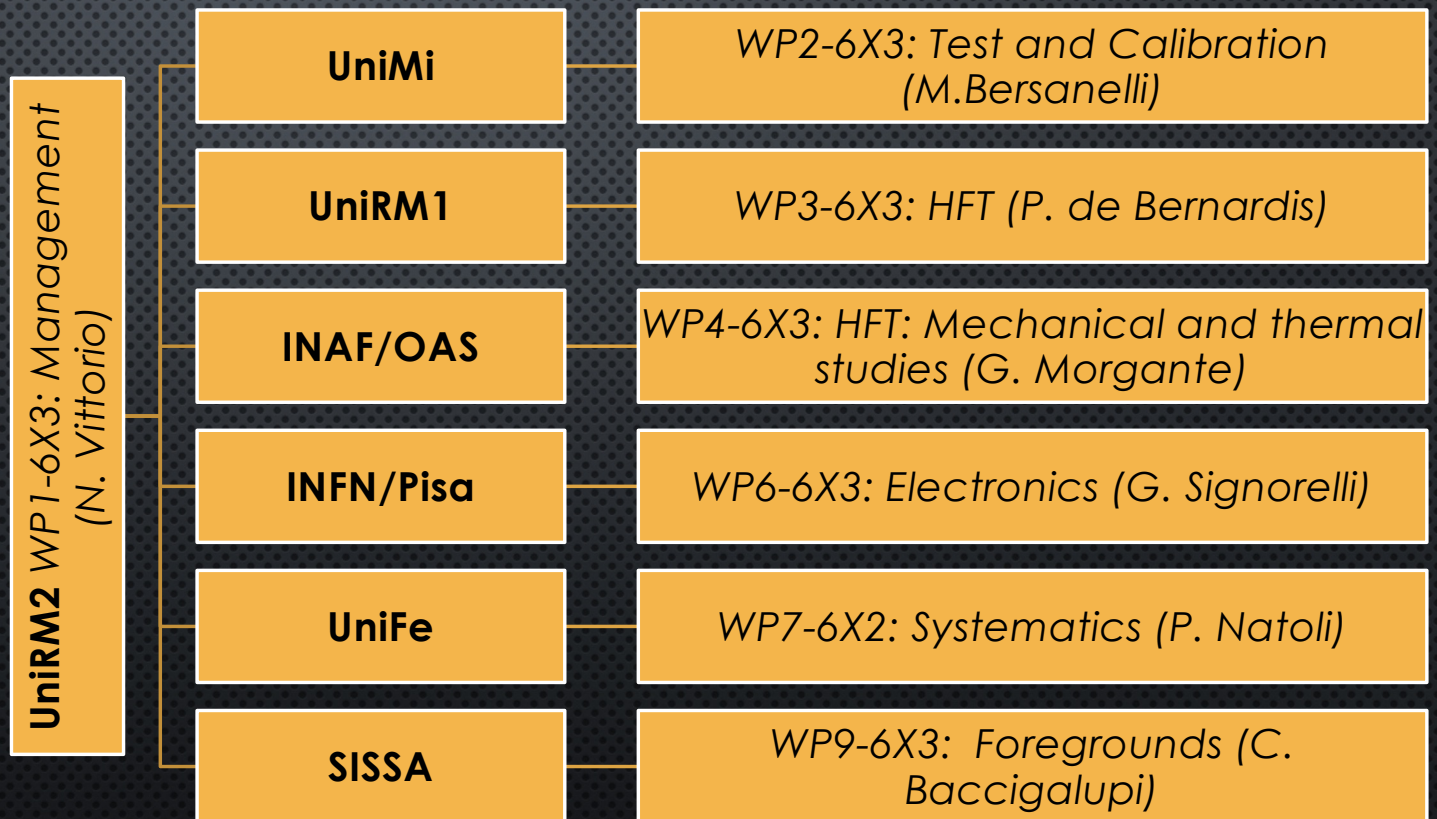




# ADDENDUM LITEBIRD TO COSMOS

• **05/06/2018**

- *THE STARTING OF THE ITALIAN LITEBIRD ACTIVITIES*





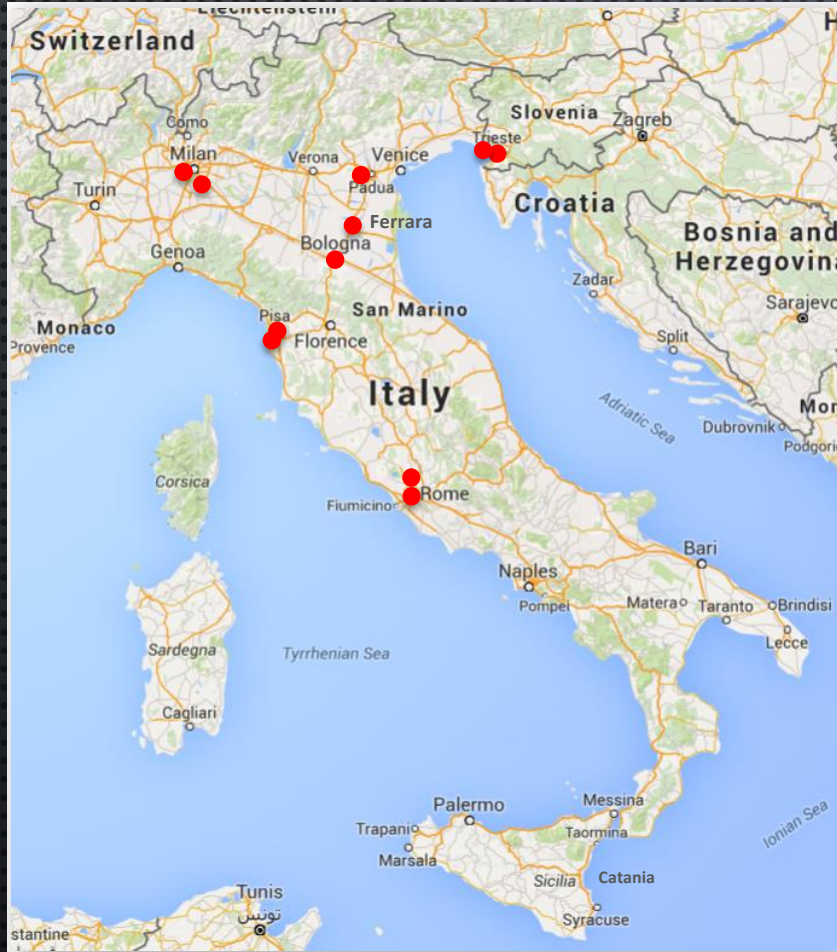
# ASI/LITEBIRD

- **ASI/ TOR VERGATA AGREEMENT TO SUPPORT THE PARTICIPATION OF THE ITALIAN COMMUNITY IN THE LITEBIRD PHASE A**
  - *LETTER OF BATISTON TO OKUMURA (01/06/2017)*
  - *LETTER OF OKUMURA TO BATISTON (13/06/2017)*
  - *LETTER OF INVITATION A DOTANI E HAZUMI BY NV ON BEHALF OF BATISTON (07/06/2017)*
  - *LETTER OF NEGRI TO TOKAKU TO DECLARE THE COMMITMENT FO ASI FOR THE LITEBIRD PHASE A1 (01/03/2018)*
- **KO MEETING 20/05/2020**
- **LITEBIRD AS A UNIQUE OPPORTUNITY FOR CMB**

**See Paolo de Bernardis talk**



# AGREEMENT ASI-TOV FOR LITEBIRD PHASE A



*UniTOV: Vittorio*

*UniMI: Bersanelli*

*UniRM1: de Bernardis*

*INAF-OAS: Morgante*

*INAF-OATS: Zacchei*

*UniMIB: Zannoni*

*INFN/PI: Signorelli*

*UniPI: Nicolò*

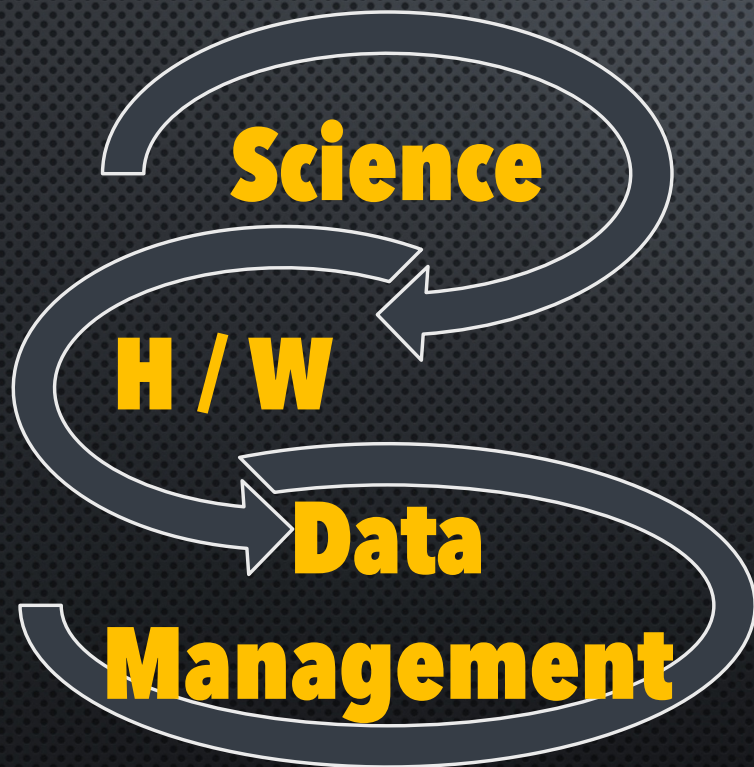
*UniFE: Natoli*

*UniPD: Matarrese*

*SISSA: Baccigalupi*



# AGREEMENT ASI/TOV: LITEBIRD-ITALY





Science S. Matarrese	CMB Statistics C. Baccigalupi	WP3-6X11 - CMB XC - C. Baccigalupi, SISSA WP3-6X12 - Large-scale galaxy distribution - M. Migliaccio, RM2 WP3-6X13 - Non-Gaussian statistics - D. Bertacca, PD
	Fundamental physics M. Lattanzi,	WP3-6X21 - Astroparticle - M. Lattanzi, FE WP3-6X22 - Non-standard signatures from CMB polarization - A. Gruppuso, INAF-OAS
	Inflation and Gravitational Waves N. Bartolo, PD	WP3-6X31 - Modelling the primordial GW background and primordial spectral distortions - N. Bartolo, PD WP3-6X32 - Forecasts for new space missions - F. Finelli, INAF-OAS
	Science Ground Segment A. Zacchei,	WP4-6X11 - Science Ground Segment - D. Tavagnacco, INAF-OATS
	E2E Simulations P. Natoli,	WP4-6X21 - Level S - D. Maino, MI WP4-6X22 - Systematics from electronics - F. Nati, MIB WP4-6X23 - Systematics from HWP modulator - F. Columbro, RMI WP4-6X24 - Map-making - D. Molinari, FE WP4-6X25 - Electronics calibrations - A. Tartari, INFN
Data Management P. Natoli	In Flight Calibration M. Tomasi,	WP4-6X31 - In flight calibration - M. Tomasi, MI WP4-6X32 - Noise properties reconstruction - L. Lamagna, RMI
	Foregrounds N. Krachmalnicoff, SISSA	WP4-6X41 - Modelling the Galaxy in the microwave - N. Krachmalnicoff, SISSA WP4-6X42 - Cleaning techniques for foreground removal - D. Poletti, SISSA WP4-6X51 - De-lensing - C. Baccigalupi, SISSA
	From data to Science L. Pagano, FE	WP4-6X52 - Power Spectrum & Likelihood - L. Pagano, FE WP4-6X53 - Parameter estimations - D. Paoletti, INAF-OAS WP4-6X54 - Reionization - M. Migliaccio, RM2
H/W F. Piacentini,	Polarization modulator P. de Bernardis	WP5-6X11 - HWP Rotator - P. de Bernardis, RMI WP5-6X12 - Optical components - L. Lamagna, RMI
	Calibration & Testing M. Bersanelli	WP5-6X21 - Sub-system calibration - C. Franceschet, MI WP5-6X22 - Cryogenics testing - G. Morgante, INAF-OAS
	Readout Electronics G. Signorelli	WP5-6X31 - SQUID Controller Enclosure - G. Signorelli, INFN WP5-6X32 - SQUID Controller Electronic Boards - M. Zannoni, MIB WP5-6X33 - SQUID Controller Unit tests - D. Nicciò, PI



# THE EUROPEAN CONSORTIUM

Cardiff, 2-3 August 2017

Paris, 23-24 October 2017

**Turin, 8-9 February 2018**

Munich, 24-27 April 2018

Toulouse, 8-10 October 2018

Cardiff, 21-23 November 2018

**F2F@ASI Jan 23-25, 2019**

Munich, 21-22 March 2019

Toulouse, 12-14 June 2019

Santander, 30 September – 2 October 2019

F2F Monaco, 11-13 Dicembre 2019

Workshop LiteBIRD-Italia 2023 @ INFN-LNF

S2S, 23-24 Aprile 2020



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**LiteBIRD** (Lite satellite for the studies of **B**-mode polarization and **I**nflation from cosmic background **R**adiation **D**etection) is a JAXA's strategic large mission candidate in Phase-A1 (concept development).

**LiteBIRD** has the goal of being a very focused mission to test inflation with all-sky surveys of CMB polarization. Primordial gravitational waves, emitted during the cosmic inflation era (around 10–38 sec after the beginning of the Universe), are expected to be imprinted in the CMB polarization map as special patterns, called the "B-mode". From the viewpoint of high-energy physics or elementary particle physics, the observation of the CMB B-mode is very important because it will allow us to search for physics in ultra high-energy scales, which are not accessible with man-made accelerators. Measurements of CMB polarization will open a new era of testing theoretical predictions of quantum gravity, including those by the superstring theory.

Nicola Vittorio - 22  
Maggio 2023



# LITEBIRD CNES/PHASE A2

- **CNES TOGETHER WITH JAXA ORGANIZED AN INTERMEDIATE KEY POINT ON THE MHFT INSTRUMENT ONGOING PHASE A2 STUDY.**
  - *THE OBJECTIVE IS TO GET AN ASSESSMENT BY AN INDEPENDENT GROUP OF EXPERTS OF THE CURRENT ACHIEVEMENTS AND OF THE REMAINING ISSUES TOWARDS THE COMPLETION OF THE PHASE A2.*
- **THE PRESENTATION BY THE MHFT PROJECT TO THE REVIEW GROUP IS PLANNED MARCH 23RD.**
  - *A QUESTIONS / ANSWERS SESSION WILL BE PLANNED BEG. APRIL, AND THEN A DECISION BOARD. ALL THESE MEETINGS WILL BE HYBRID (TOULOUSE + ZOOM + A CONNECTED ROOM AT CNES HQ PARIS).*

**See Francesco Piacentini talk**



# LiteBIRD MHFT KP Objective and Agenda



The main goal of this KP is to get an MHFT progress status, to determine when the MHFT PO could be ready to have the MHFT phase A2 final review and to propose recommendations.

In particular, it is expected to have presented and discussed the work plan and organization implemented towards reaching end-of-phase A maturity level. This PK will then propose recommendations to the board with the aim to consolidate the remaining of phase A2 work.

The main objective of the phase A2 is to demonstrate the MHFT technical and programmatic feasibility.

## KP agenda:

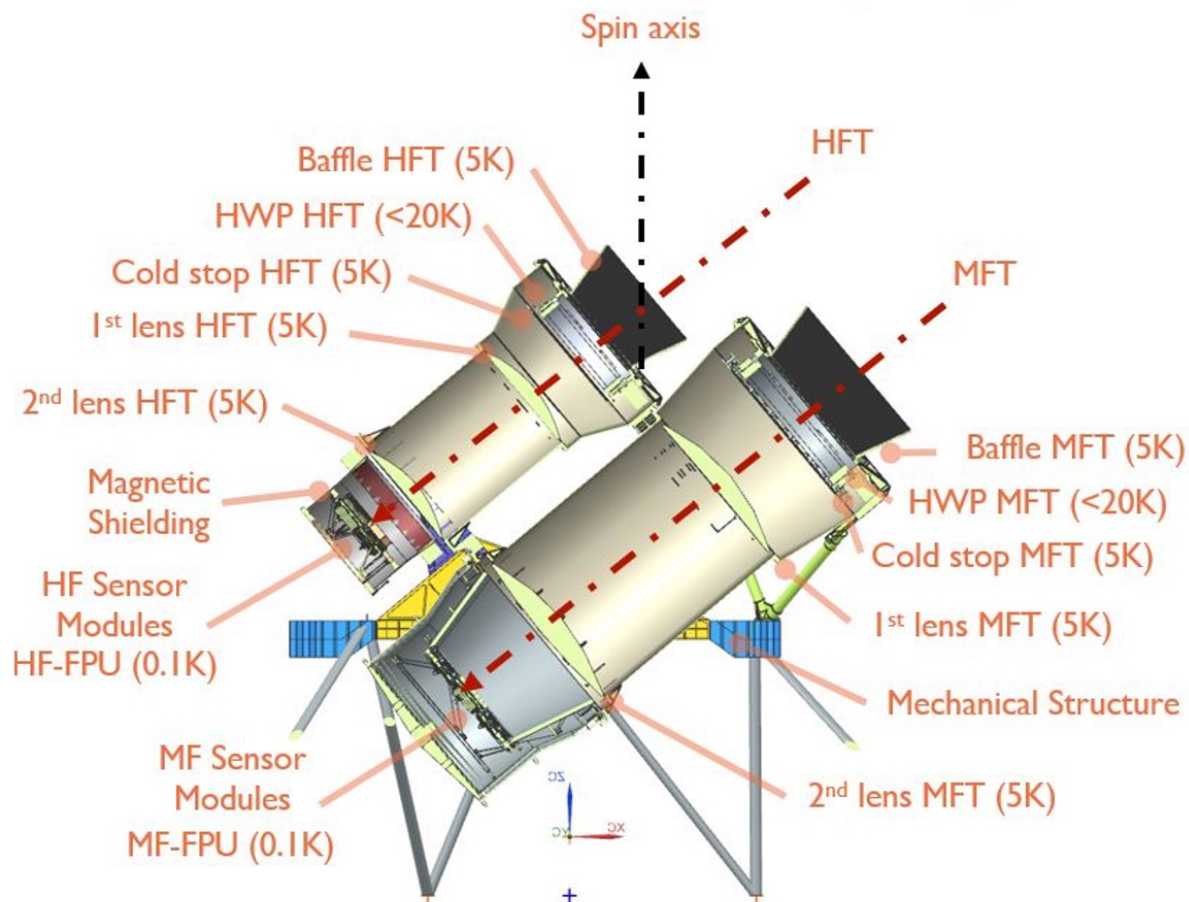
Documentation (best effort)	2023/03/15 (one week before the KP)
<b>MHFT PO presentation</b>	2023/03/23; one full day 9h00 – 19h00 (CET) Location : Toulouse (IRAP) + Paris (CNES) + ZOOM
Review group meeting	2023/03/24; half day 9h00-12h00 Location : Paris (CNES) + Toulouse (CNES) + ZOOM
RID's batch	2023/03/30; One week after the KP presentation
RID's answer by MHFT PO	2023/03/30
RID's discussion	2023/04/06 Location : Toulouse (IRAP) + ZOOM
Review Group Report	2023/05/05
Decision Board Meeting	Date TBD; Location : Paris (CNES) + Toulouse (CNES) + ZOOM



# MHFT Design Overview



## Mid-High Frequency Telescopes (MFT / HFT)



- HWP Mechanism
- Cold Aperture Stop
- FPGA Warm Readout Electronics
- HWP
- Front Baffles
- Lenses / Filters
- Sensor Modules
- Delivered by QUP Japanese
- Collaboration with US teams
- Magnetic Shielding
- Thermometers readout electronics
- Warm Readout Electronics
- System Responsibility
- Mechanical Structure 5K
- Focal-Plane Structure + FPU Integration
- DPU
- AIV + Calibration
- Calibration



# THE MHFT KP DECISION BOARD

- WILL BE HELD ON MAY 23RD 11:00-13:00
- WITH THE PARTICIPATION OF ALL THE NATIONAL SPACE AGENECIES INVOLVED IN THE PROJECT.



# LITEBIRD - ITALY @ INFN/LNF

- **POST PTEP-PAPERS**
- **SIMULATION ACTIVITY**
- **SYSTEMATICS**
- **H/W**

- 
- **LITEBIRD-S4 WG**

See Carlo Baccigalupi talk



*Thank you for your attention*