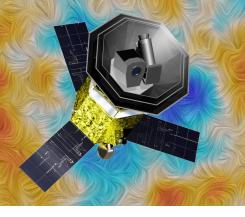
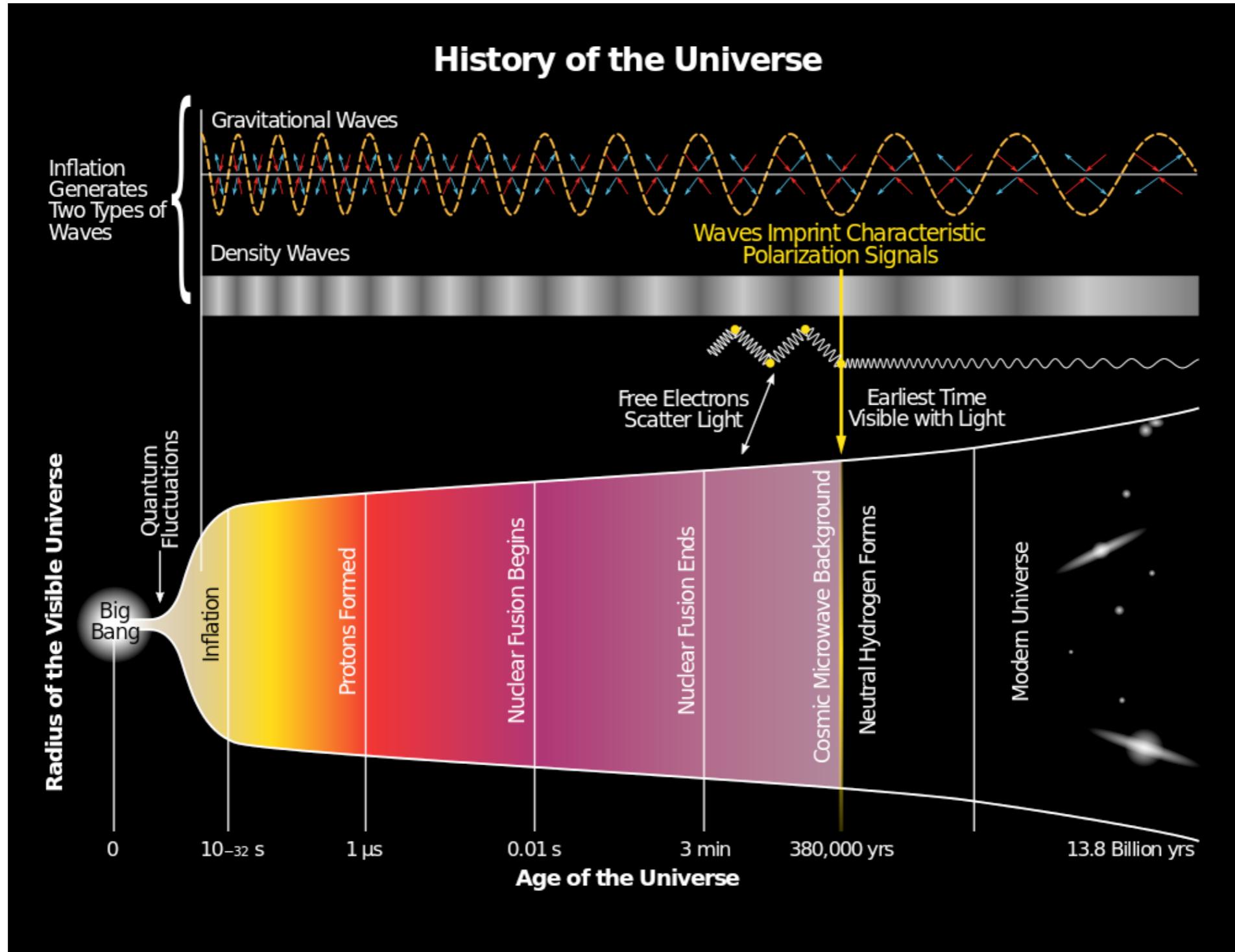


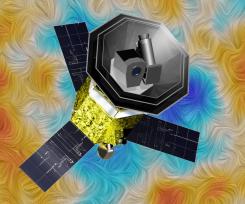
# LiteBIRD Overview

L. Montier  
on behalf of LiteBIRD-FRANCE



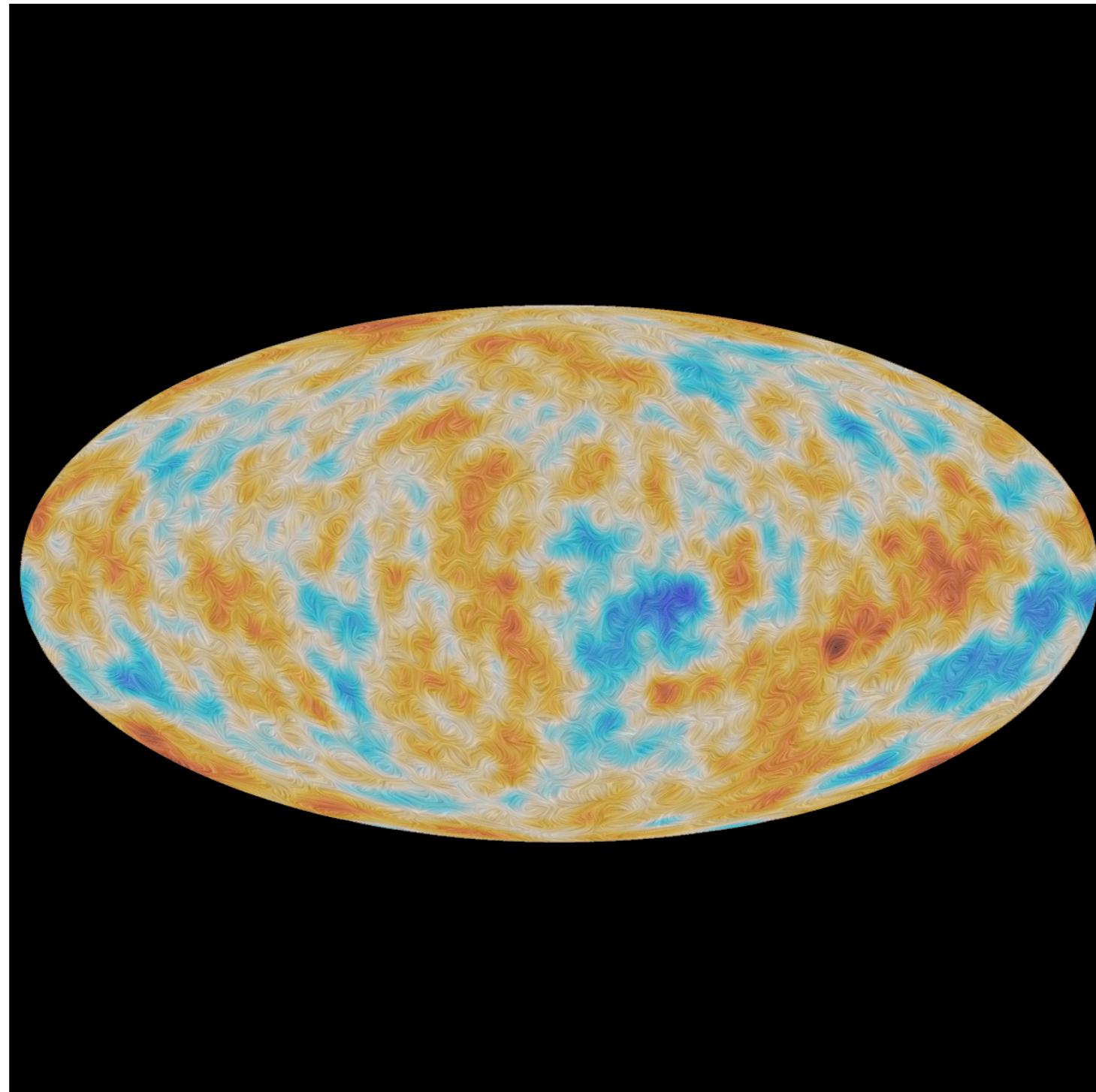
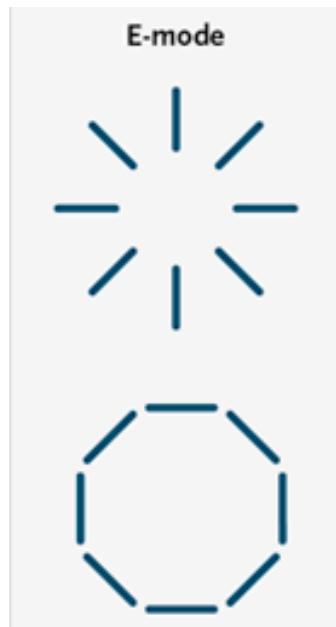
# Looking for Primordial Gravitational waves

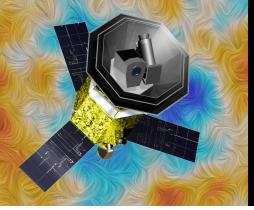




# Looking for Primordial Gravitational waves

*The imprints of gravitational waves on CMB*





# LiteBIRD Mission

## History

2015 Official Invitation from ISAS JAXA Director General S.Tsuneta to the European CMB Community

2016 Joint Study Group contributions as external members

2017 Building a European collaboration

2018 European collaboration takes lead of the MHFT design

May 2019 Selection by JAXA for L-Class 2027

July 2019 Kick-off Symposium JAXA

2019 Building a European contribution to LiteBIRD with ESA and National Space Agencies (in progress)



September 24, 2015.

Dear European Cosmic Microwave Background Colleagues,

Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency (ISAS, JAXA) considers its <strategic L-class missions> as the main pillar that sustains its space science activity. The strategic L-class missions

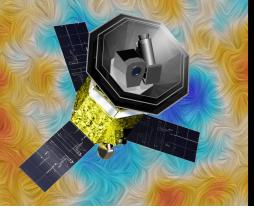
...

program, when materialized in a solid manner. I am looking forward to a nice Europe-Japan teaming-up for a reasonable size CMB mission that will fly timely.

Sincerely,

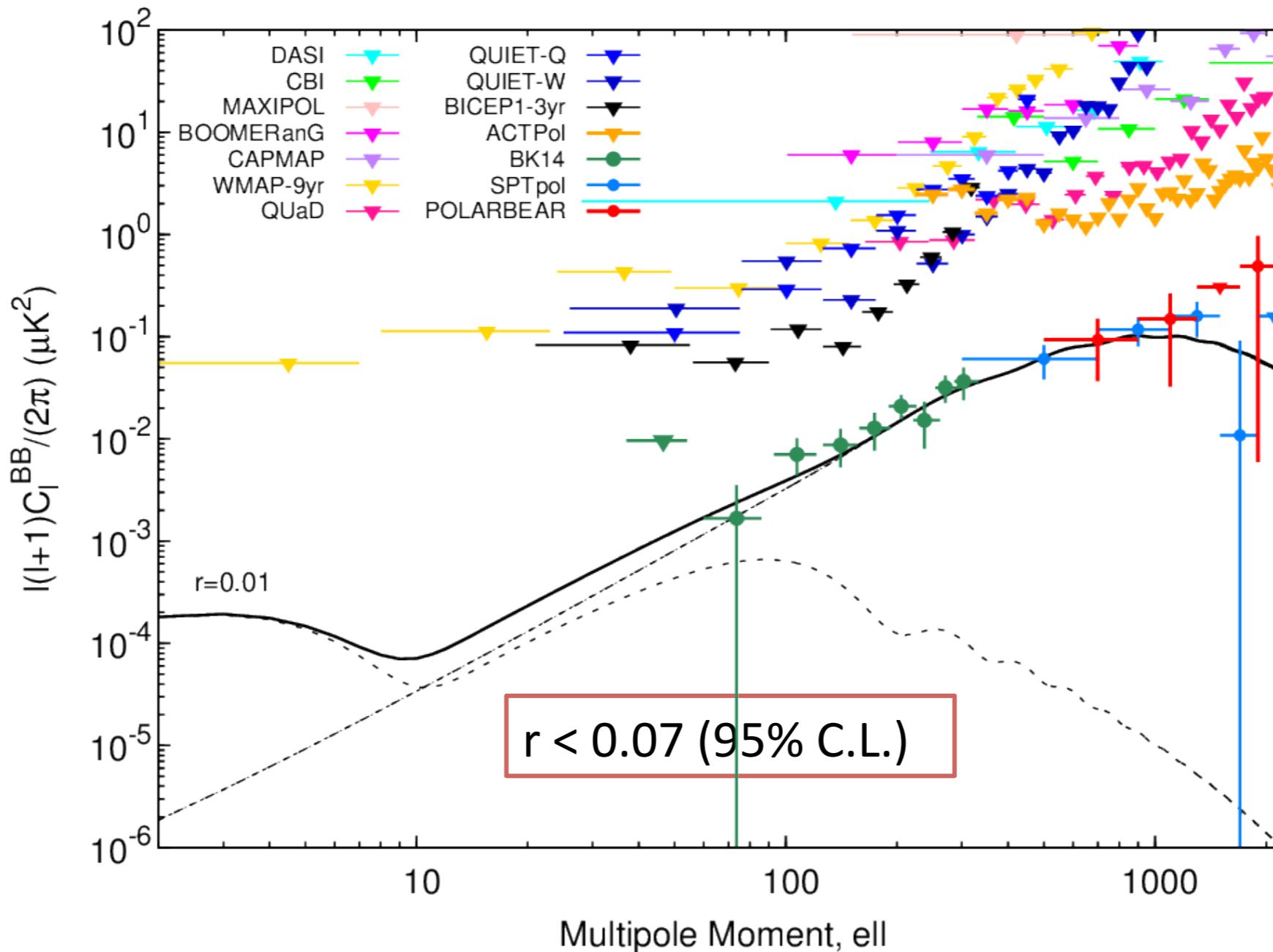
A handwritten signature in black ink that reads "Saku Tsuneta".

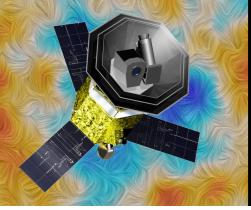
Saku Tsuneta  
Director General  
Institute of Space and Astronautical Science  
Japan Aerospace Exploration Agency



# LiteBIRD Mission

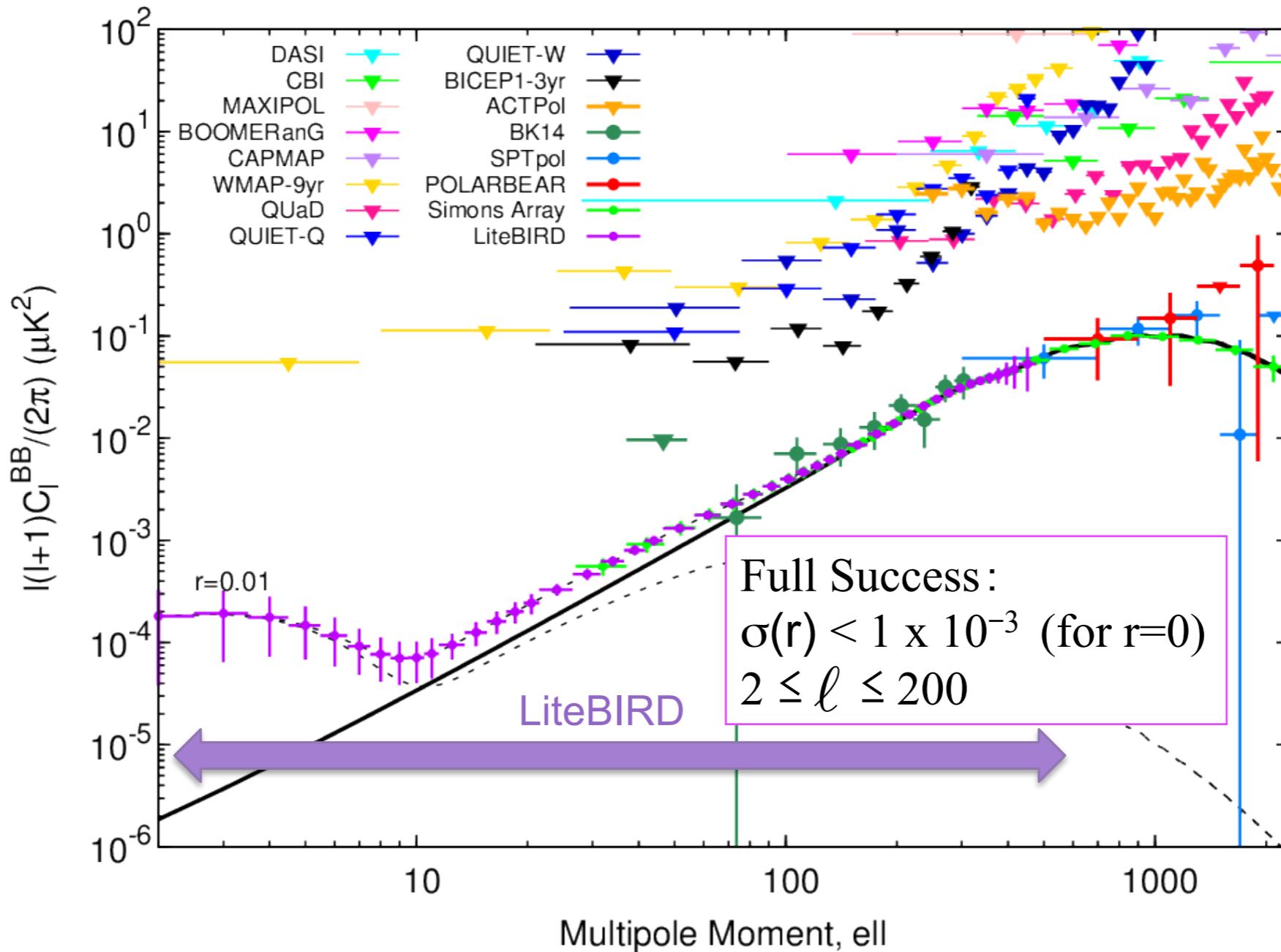
*Current status of the B-mode measurements*



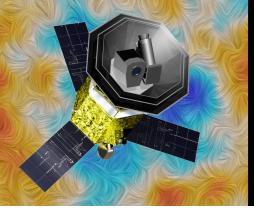


# LiteBIRD Mission

## LiteBIRD Expectation

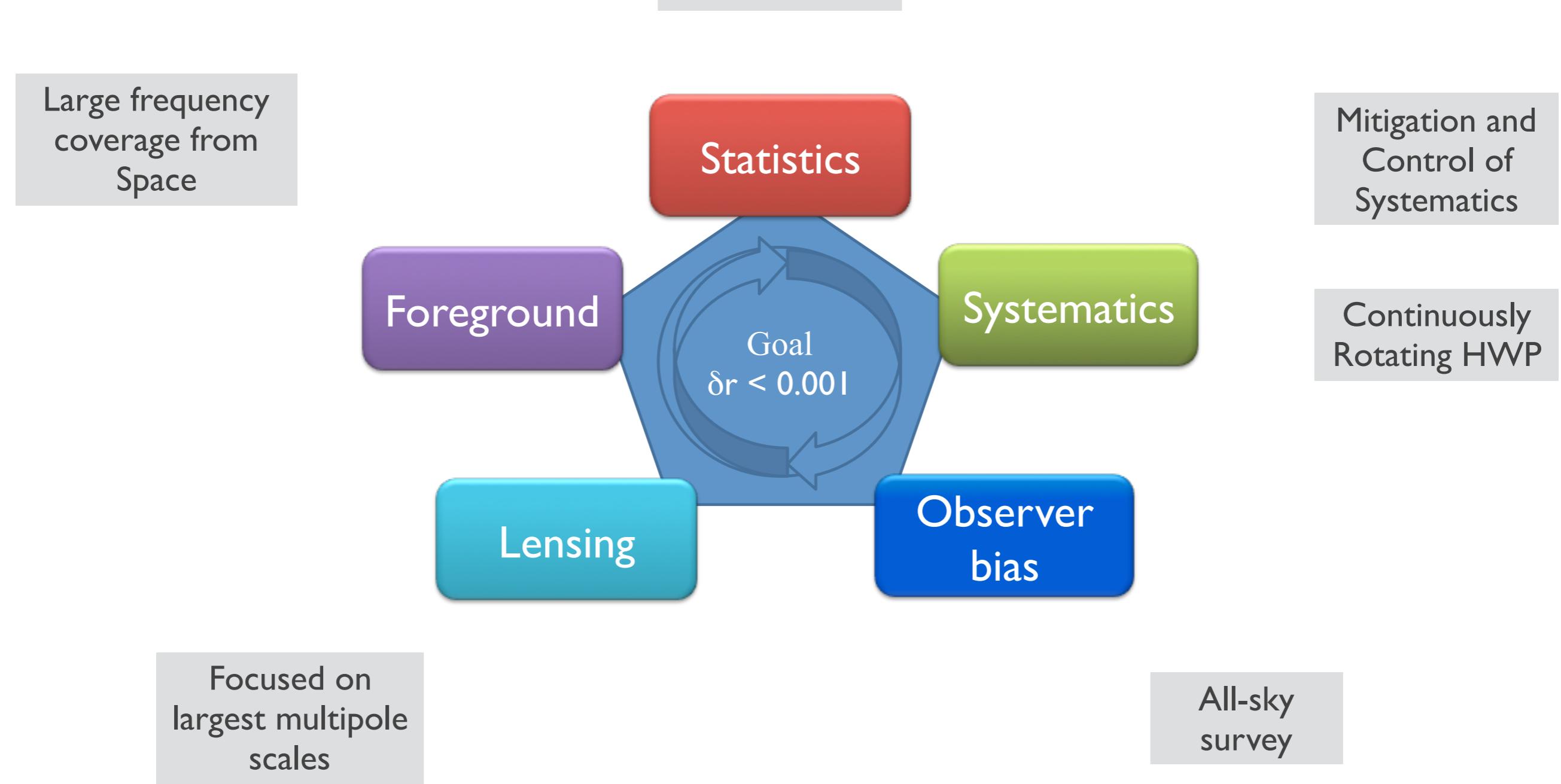


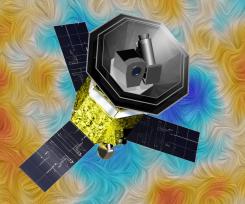
LiteBIRD  
only  
(without  
de-lensing)



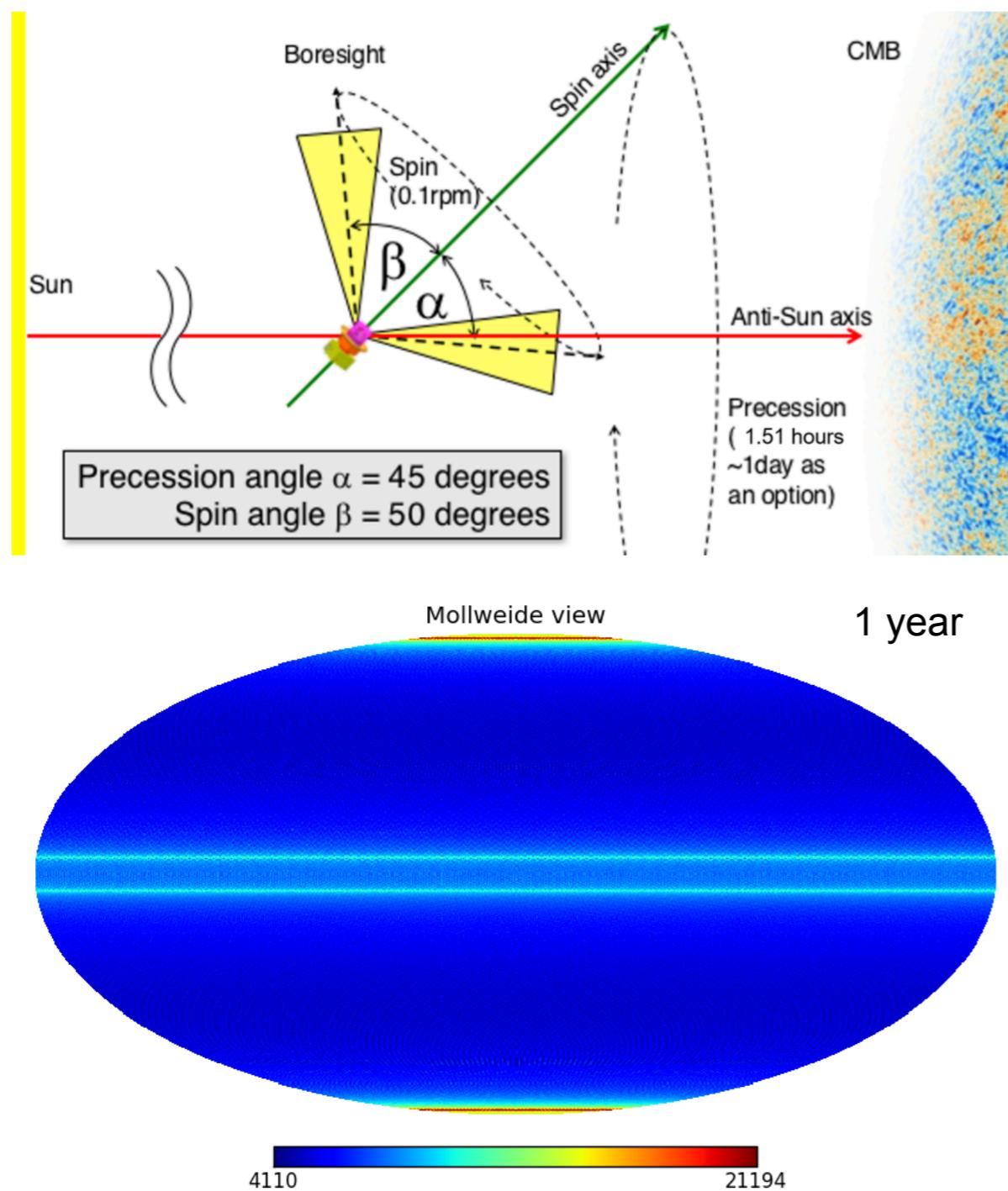
# LiteBIRD Mission

## Mission Challenges





# LiteBIRD Mission



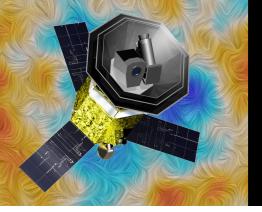
## LiteBIRD Mission

L-Class JAXA Mission  
Selected by JAXA May 2019  
Launch 2028

L2 orbit  
All-sky Survey during 3 years  
Large frequency coverage  
15 bands 34 - 448 GHz

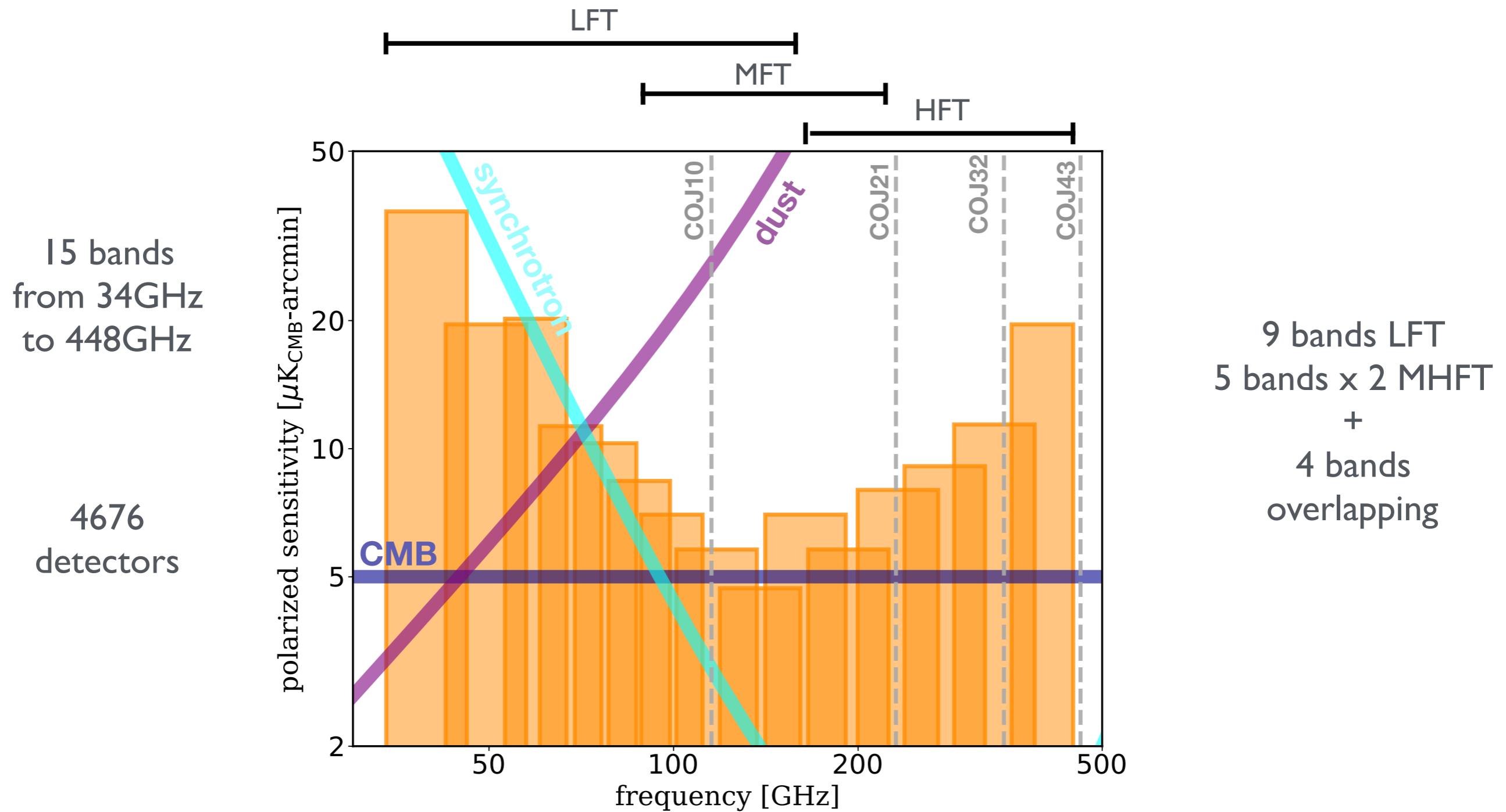
Resolution:  
LFT MHFT  
69' - 20.7' 27.6' - 9.7'

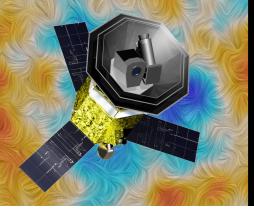
Sensitivity: 2.8 uK.arcmin  
after component separation  
more than 100 times better  
than Planck/HFI in P



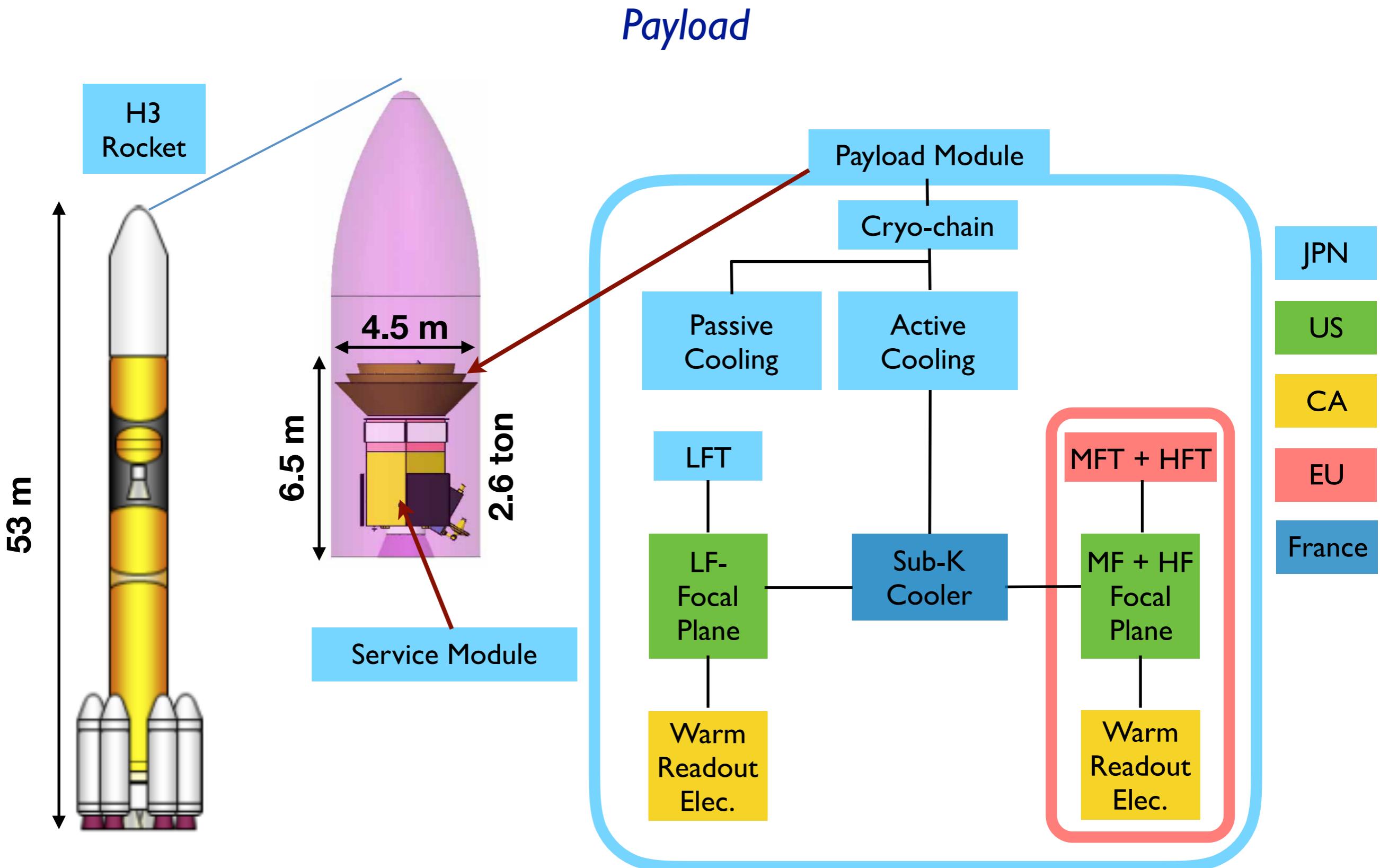
# LiteBIRD Mission

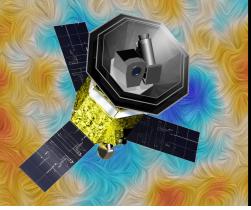
## Frequency coverage





# LiteBIRD Mission





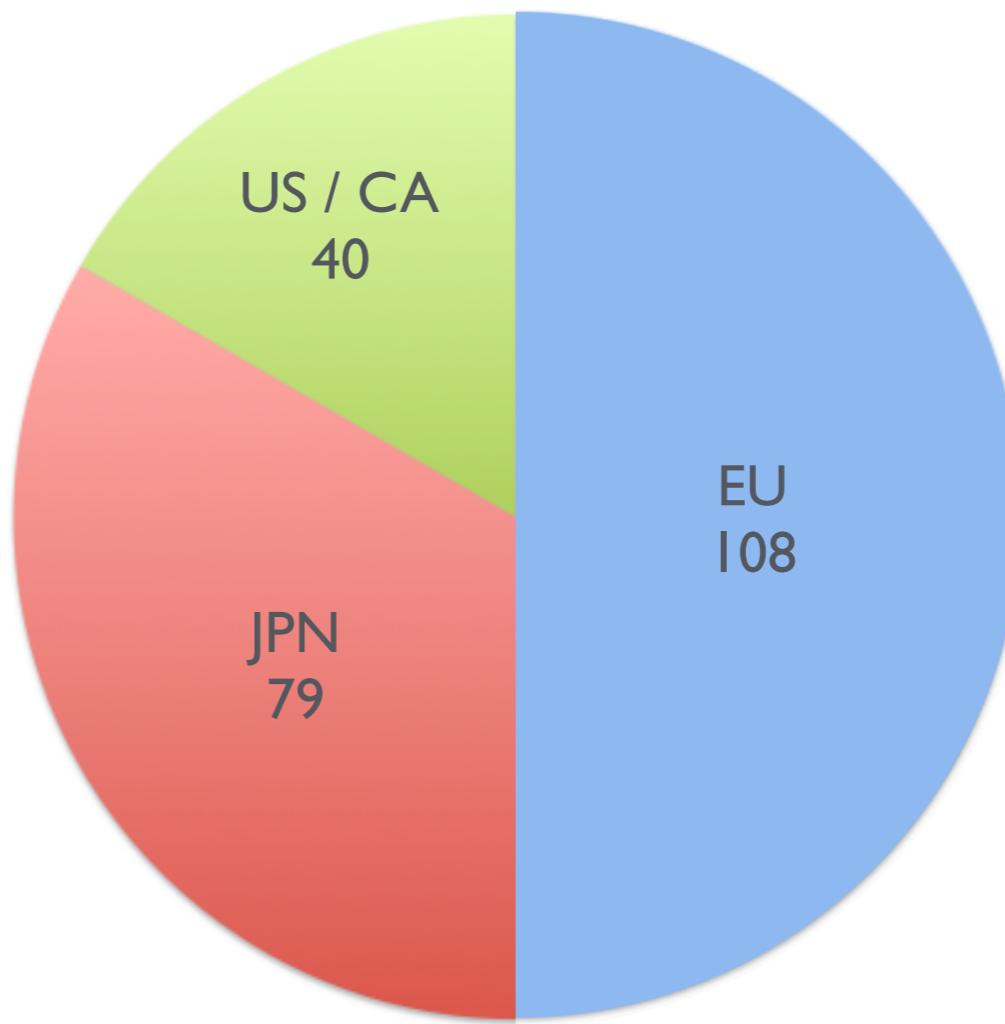
# LiteBIRD Collaboration

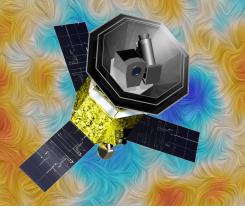
*An international collaboration*



More than 200 researchers from Japan, Europe & North America

Y. Sekimoto<sup>14,37</sup>, P. Ade<sup>2</sup>, K. Arnold<sup>49</sup>, J. Aumont<sup>12</sup>, J. Austermann<sup>29</sup>, C. Baccigalupi<sup>11</sup>,  
A. Banday<sup>12</sup>, R. Banerji<sup>56</sup>, S. Basak<sup>7,11</sup>, S. Beckman<sup>49</sup>, M. Bersanelli<sup>44</sup>, J. Borrill<sup>20</sup>,  
F. Boulanger<sup>4</sup> M T Brown<sup>53</sup> M Bucher<sup>1</sup> F Colombo<sup>2</sup> F I Coor<sup>10</sup> A C hallinor<sup>50,60,64</sup>,  
Y. Chinone<sup>16</sup>  
Petris<sup>46</sup>, M. I  
T. Ellefot<sup>41</sup>  
K. Ganga<sup>1</sup>, J.R.  
T. Hasebe<sup>1</sup>  
C. Hill<sup>21,47</sup>, Y.  
H. Ishino<sup>3</sup>  
T. Kawasaki<sup>17</sup>  
Y. Kobaya  
N. Krachi  
A.T. Lee<sup>21,47</sup>,  
S. Masi<sup>46</sup>, T  
L. Montier<sup>12</sup>,  
S. Nakamura  
H. Ochi<sup>59</sup>, H  
F. Piacentini<sup>46</sup>  
M. Remazeille  
M. Shiraishi  
A. Suzuki<sup>2</sup>  
Y. Terao<sup>38</sup>,  
M. Tristram<sup>19</sup>, M. Tsuji<sup>26</sup>, M. Tsujimoto<sup>14</sup>, S. Uozumi<sup>30</sup>, S. Utsunomiya<sup>16</sup>, N. Vittorio<sup>45</sup>,  
N. Watanabe<sup>17</sup>, I. Wehus<sup>56</sup>, B. Westbrook<sup>47</sup>, B. Winter<sup>62</sup>, R. Yamamoto<sup>14</sup>, N.Y. Yamasaki<sup>14</sup>,  
M. Yanagisawa<sup>30</sup>, T. Yoshida<sup>14</sup>, J. Yumoto<sup>38</sup>, M. Zannoni<sup>55</sup>, A. Zonca<sup>33</sup>,





# LiteBIRD Collaboration

## LiteBIRD-Europe

~100 external members, including scientists experts on instrument and data analysis:

### France

APC (Paris)  
CEA-DAp (Saclay)  
CEA-SBT (Grenoble)  
ENS-LERMA (Paris)  
IAP (Paris)  
IAS (Orsay)  
Institut Néel (Grenoble)  
IPAG (Grenoble)  
IRAP (Toulouse)  
LAL (Orsay)  
LPSC (Grenoble)

### Italy

Università di Roma "Tor Vergata"  
Università di Milano  
Sapienza Università di Roma  
INAF/IASF, Bologna  
INAF/OATS, Trieste  
Università di Milano-Bicocca  
Università di Genova  
INFN-Sezione di Pisa  
Università di Ferrara  
Università di Padova  
SISSA – Trieste

### UK

Cardiff University  
University of Cambridge  
Imperial College London  
University of Manchester  
University College London  
University of Oxford  
University of Portsmouth  
University of Sussex

### Germany

Max Planck Society (MPA, MPE,  
MPIfR)  
Ludwig-Maximilians-Universität  
München  
Universität Bonn  
RWTH Aachen Universität

### Spain

IFCA, IDR/UPM, DICOM/UC  
ICCUB, IAC  
Universidad de Oviedo  
Universidad de Salamanca  
Universidad de Granada  
CEFCA

### Holland

SRON  
RuG

### Norway

University of Oslo

### Sweden

Stockholm University

### Ireland

Maynooth

### European Meetings

06/19: Toulouse

04/19: Munich

11/18: Cardiff

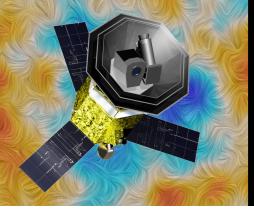
10/18: Toulouse

04/18: Munich

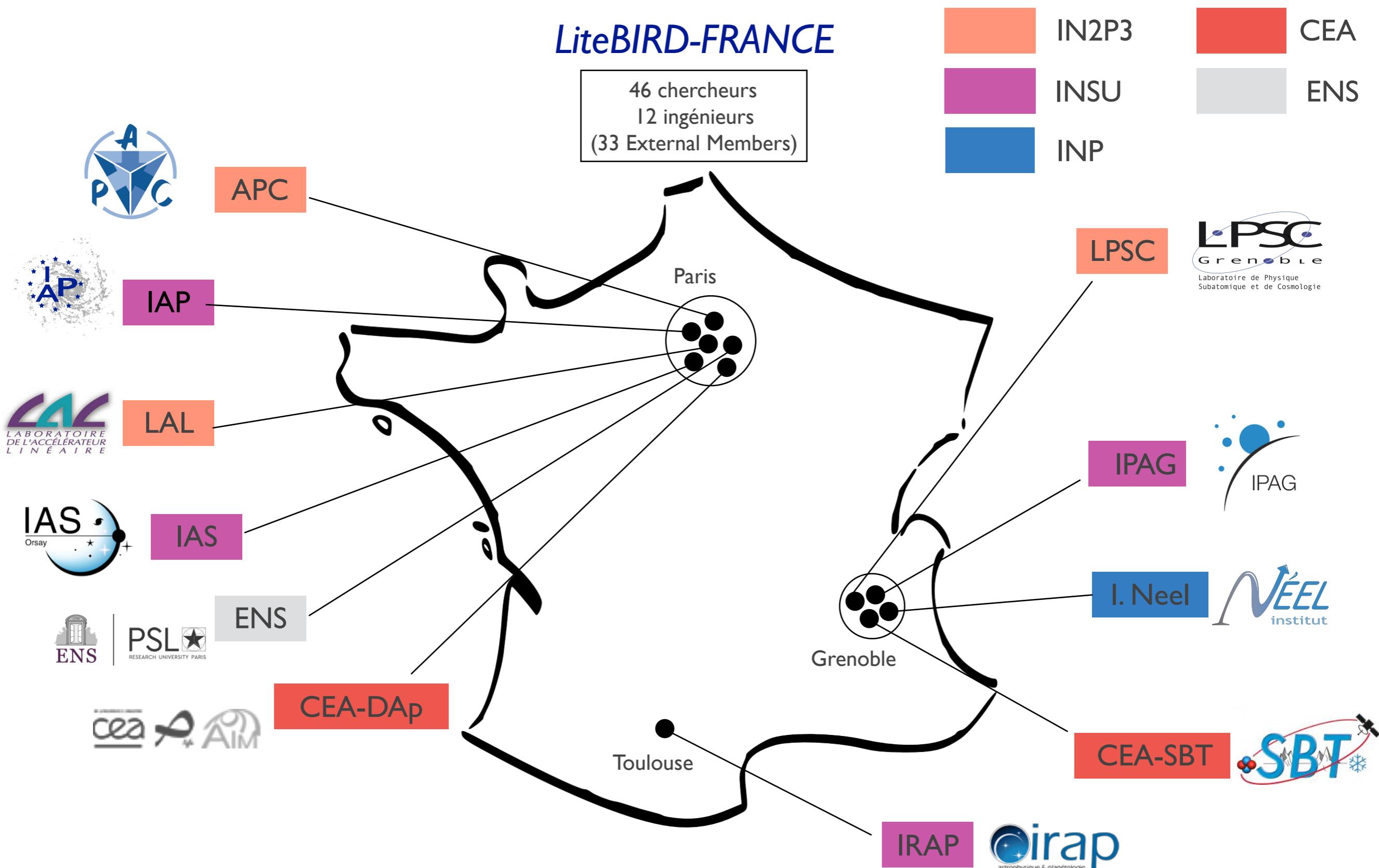
02/18: Turin

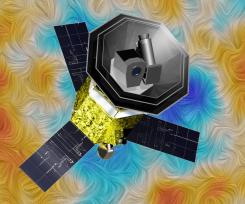
10/17: Paris

07/17: Cardiff

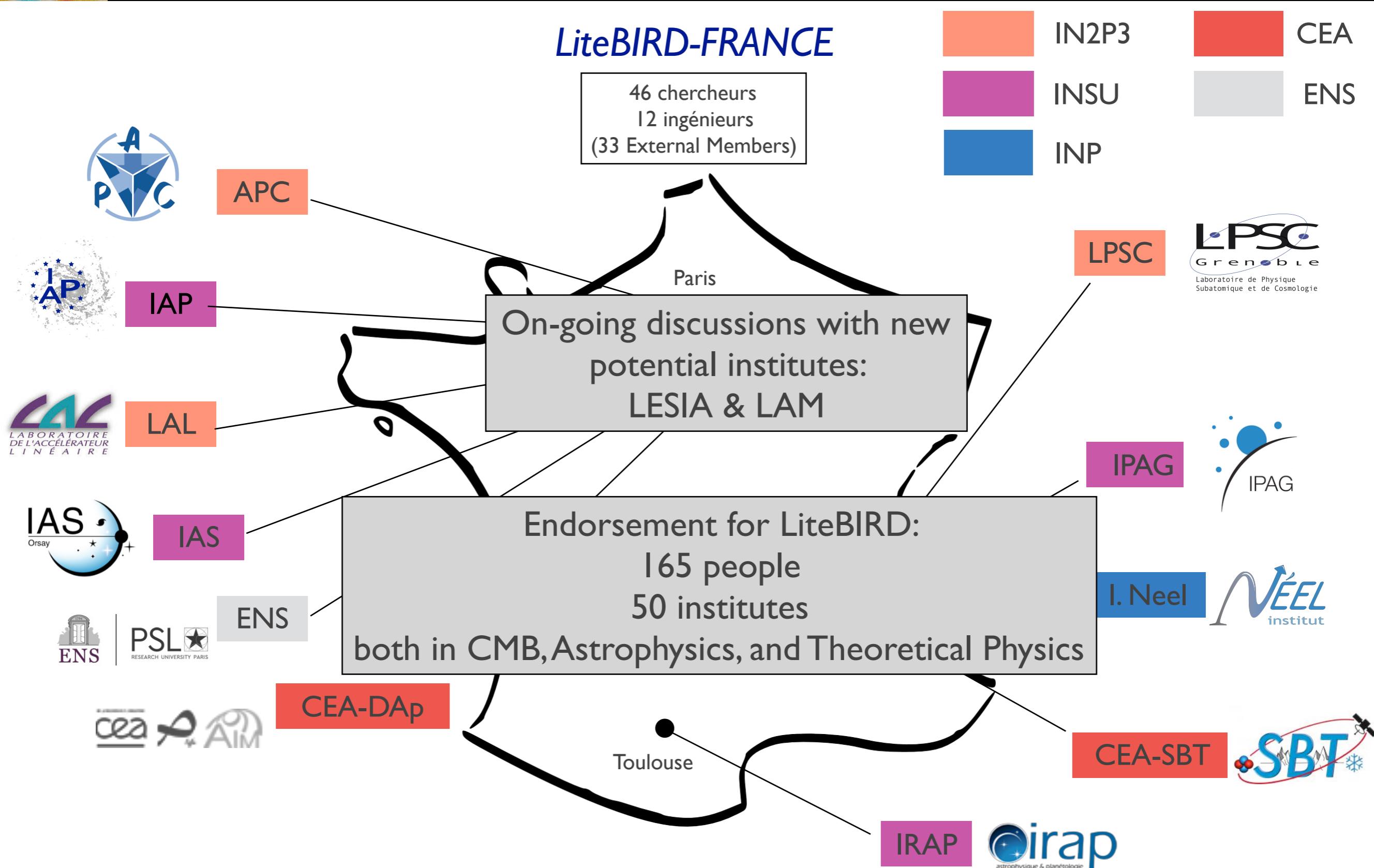


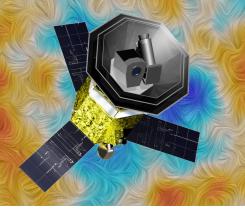
# Current French Involvement



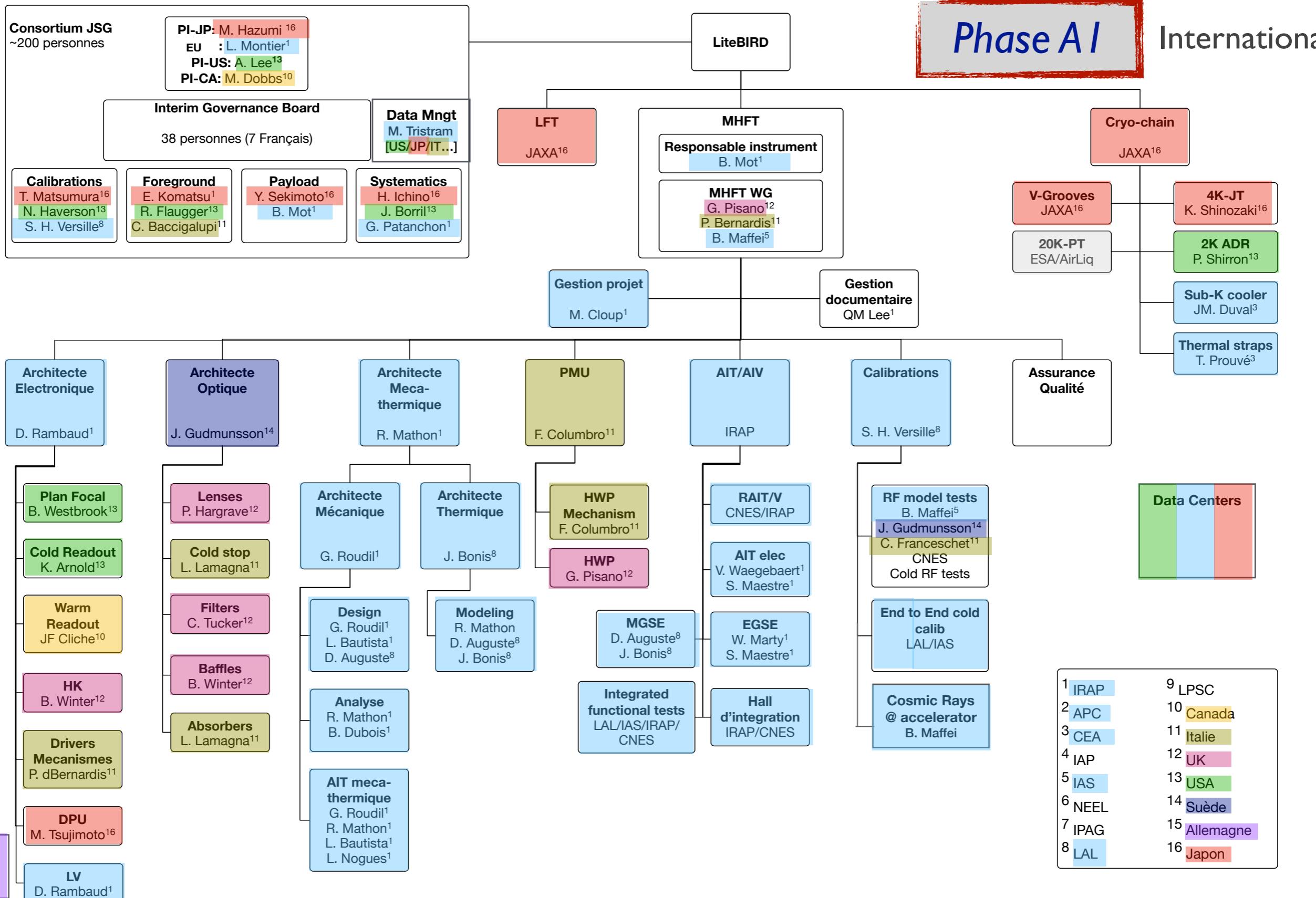


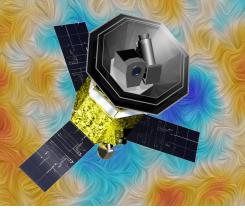
# Current French Involvement



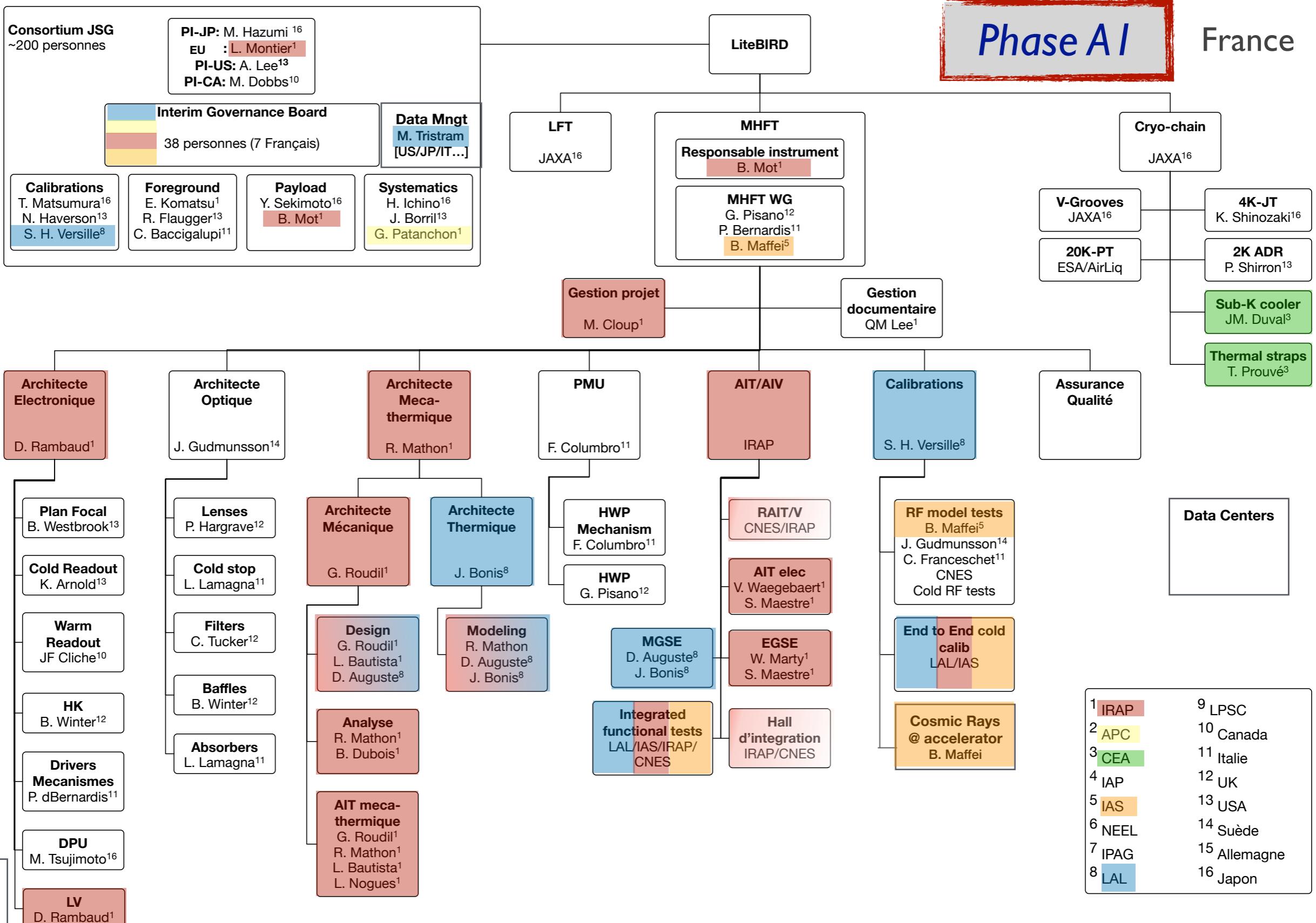


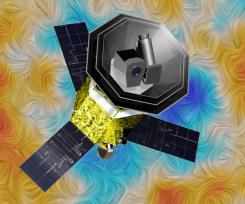
# LiteBIRD Collaboration





# LiteBIRD Collaboration





# Current French Involvement

CNES Phase-AI: 2018-2020

US

Focal Plane

Cold Readout  
Electronics

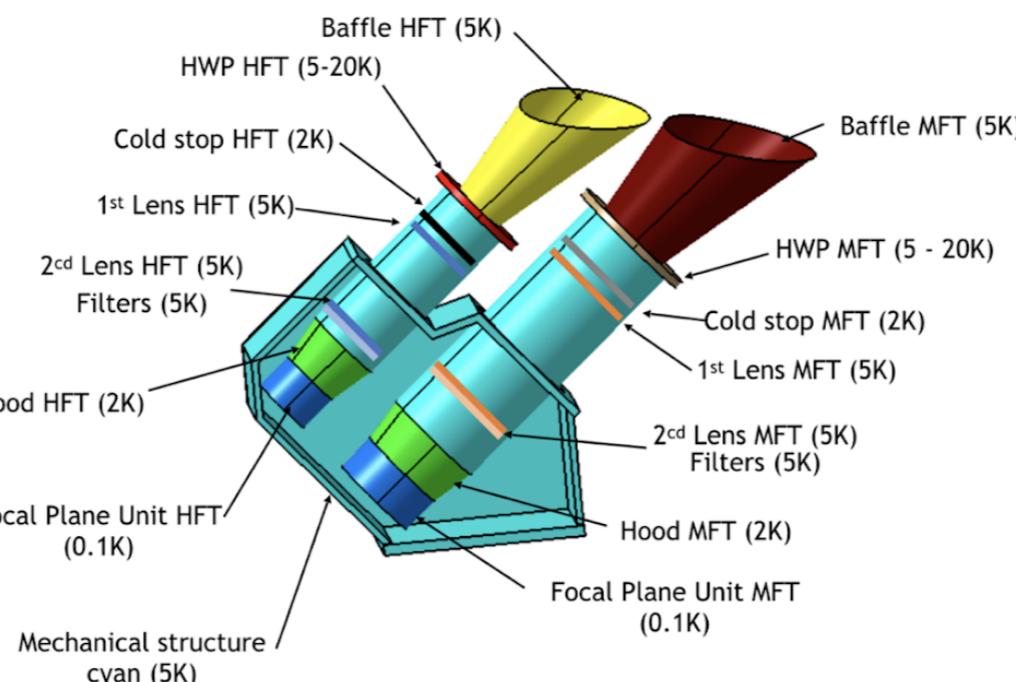
Canada

Warm Readout  
Electronics

Sub-K cooler  
HFT + LFT



WP 2



Instrument Design  
Management



WP 1

Rotating HWP  
mechanism



WP 3

Mechanical Structure



WP 4

Data Analysis

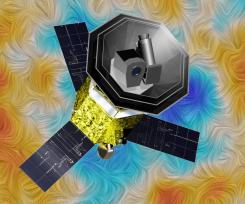


WP 6

AIIV  
Calibration



WP 5



# Building the European Contribution

## ESA Payload-CDF Study 2018

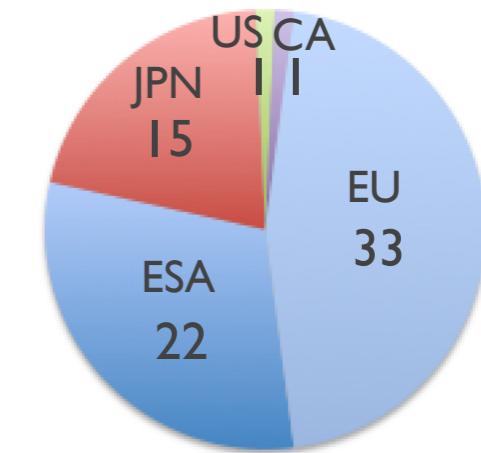
Aimed to be a first step towards an ESA Mission of Opportunity

ESA Mission of Opportunity (<50M€)

Contribution to well defined and high TRL sub-systems

8 one-day sessions from 15/03/18 to 21/06/18

CDF Team

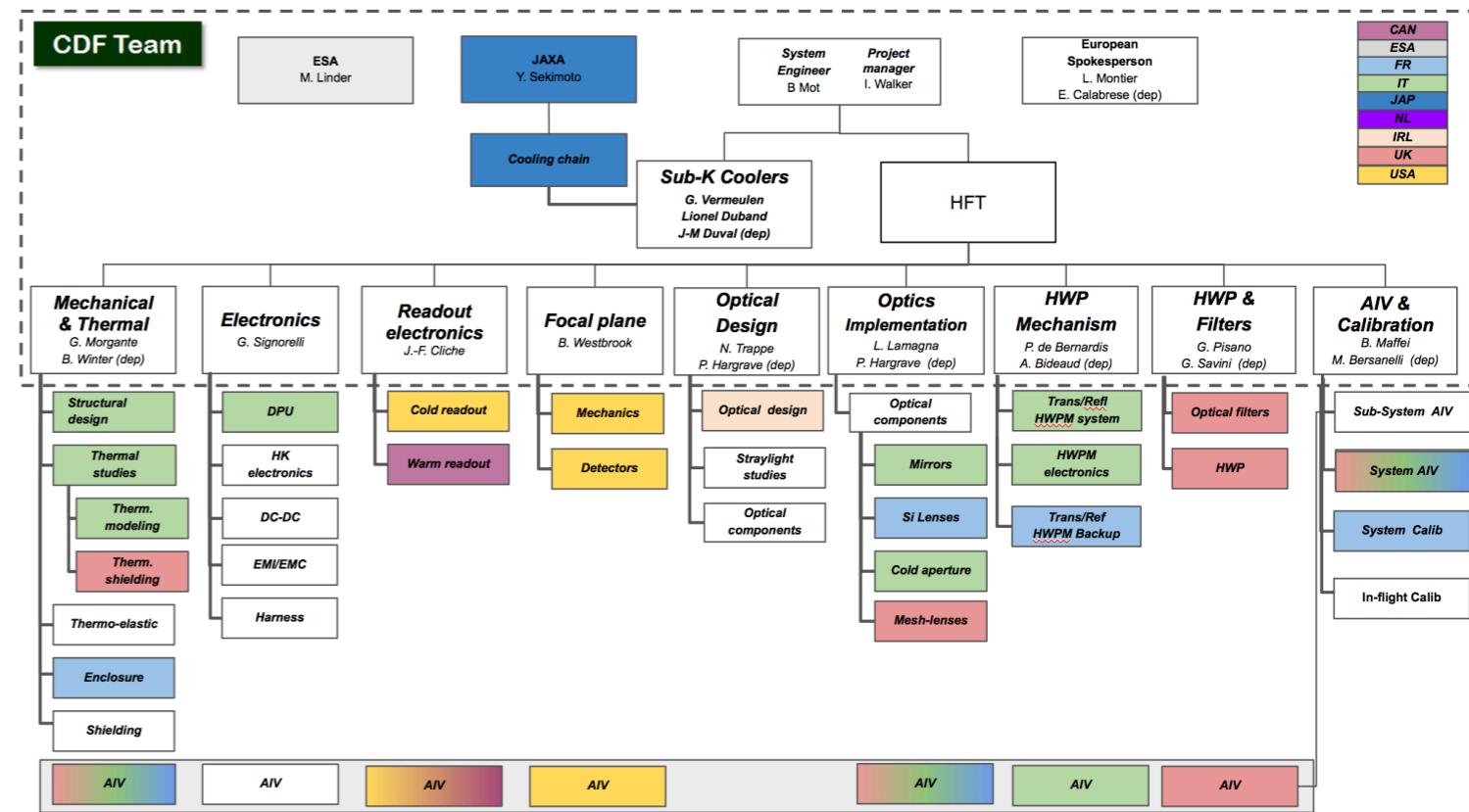


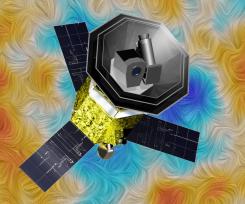
### Goals:

- Study the feasibility of HFT
- Optimisation of the cryo-chain
- Study ESA Mission of Opportunity
- Study ESA contribution

### Main Outcomes:

- Refinement of HFT requirements
- HFT Design Trade-off: 2 options
- Sub-K trade-off
- Procurement Philosophy
- Cost estimates





# Building the European Contribution

## Further steps

ESA

ESA's Science Programme Committee meeting on the 15/11/18

Under MoO

“The study showed that provision of the complete instrument is not feasible under the Mission of Opportunity scheme, for a number of reasons”

Full HFT: NO

“The Executive believes that components of the telescope (e.g., optics, structure, half-wave plate) could be provided under an MoO scheme.”

Sub-Systems: OK

“Whether a more comprehensive package could be assembled depends also on the readiness of interested Member States to contribute additional elements. The Executive would like to call a meeting of “Potential Participants” in the near future to discuss this.”

10/12/18

Invitation by ESA to LiteBIRD-Europe Collaboration for a CDF follow-up Meeting

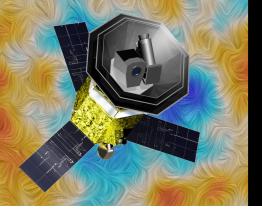
10/19

CNES

Phase-AI started since June 2018 up to end of 2019

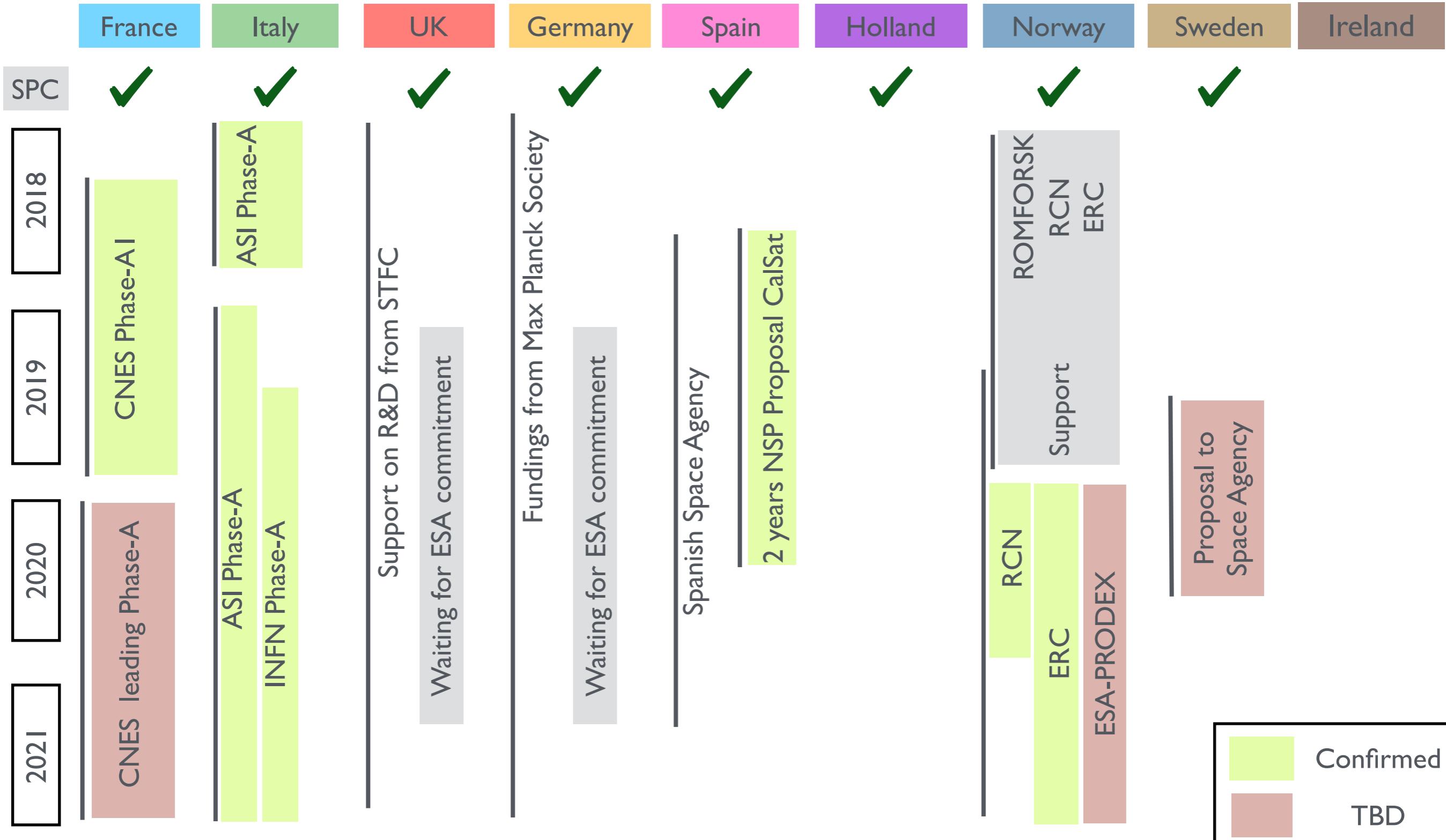
Study of the possibility to take the lead of the HFT, in coordination with European partners & ESA

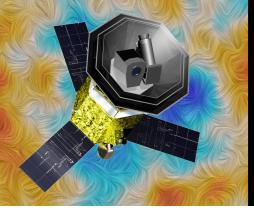
11/19



# Building the European Contribution

## European Partners





# Conclusion

Deep involvement of the French Community since 2 years

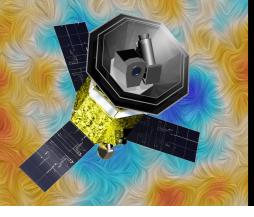
- Instrument Design Optimisation
- JSG activities
- Data analysis
- Support to JAXA Phase-AI exit review and down-selection process
- Support to US MO

Waiting for CNES decision for commitment into a MHFT Leading Phase-A by end of 2019

Further steps to build ESA MoO, including all other European partners

## Milestones

Phase-A	2020 - mid 2021
DM	2021
Livraison EQM	2023
Livraison FM	2025
Launch	2028



# Conclusion

Following talks:

Science Objectives

Matthieu Tristram

Instrumental Design

Baptiste Mot

Challenges I: Foreground Removal

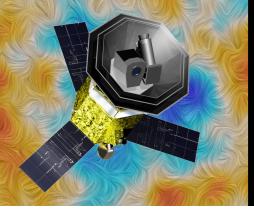
Josquin Errard

Challenges II: Systematics

Eric Hivon

Challenges III: Calibrations

Sophie Henrot-Versillé



# Orga Backup

