

LiteBIRD(-LNF):

**the measurement of the B-mode polarization of the
CMB**

(Luca Porcelli for the Local Participants)



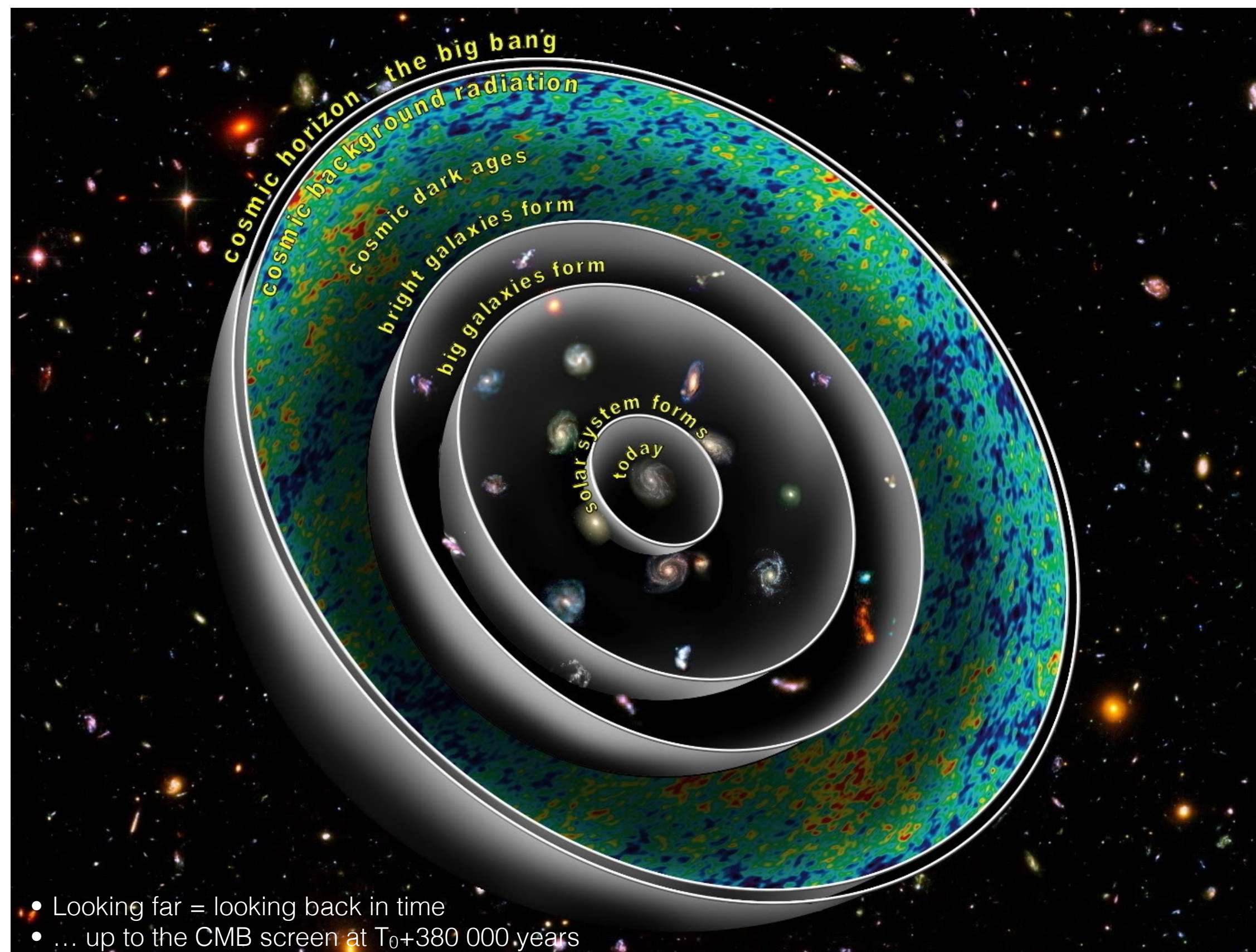
The measurement of the B-mode polarization of the CMB: the path towards the next space experiment

Giovanni Signorelli
INFN Sezione di Pisa

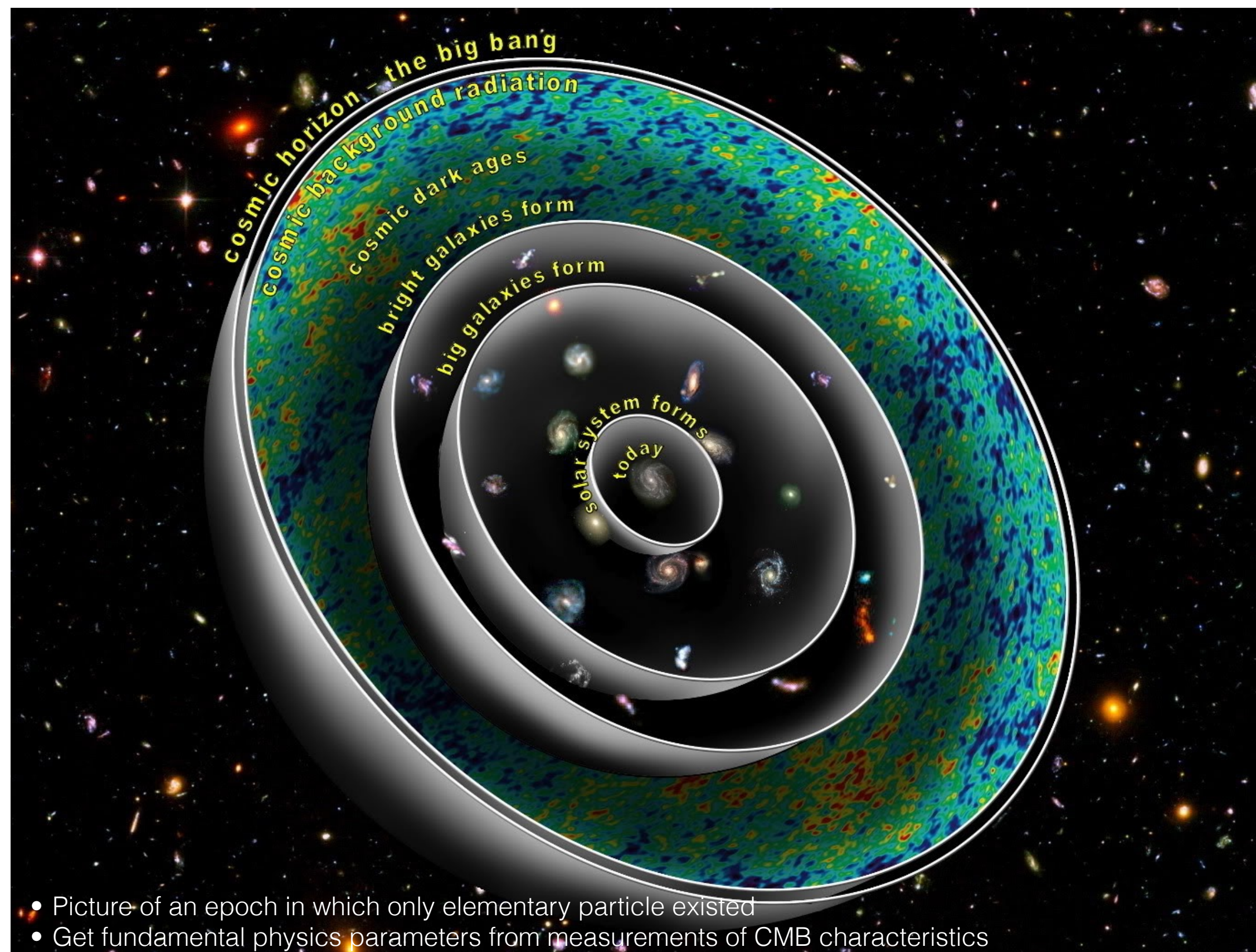


INFN Laboratori Nazionali di Frascati - 8 June 2022

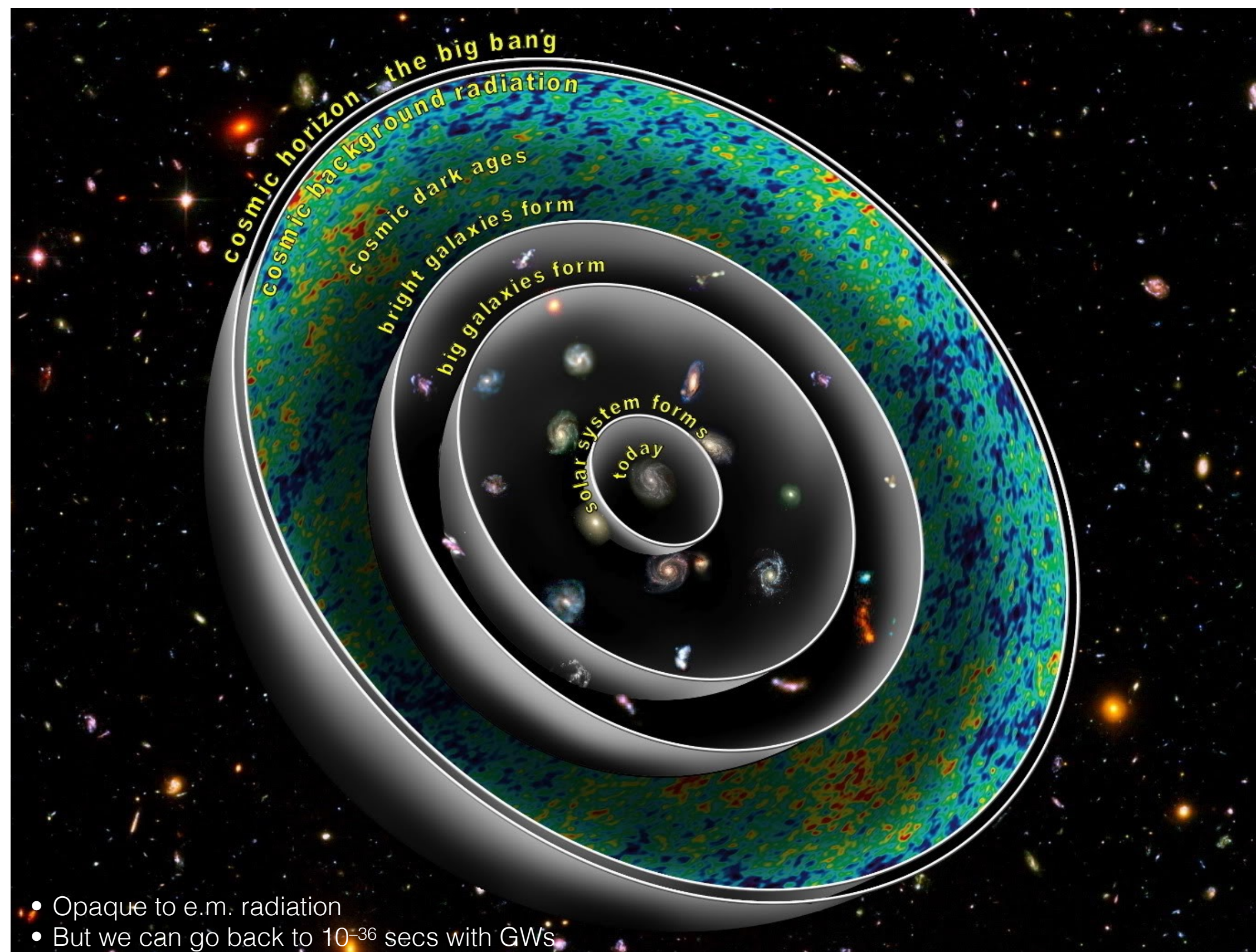
giovanni.signorelli@pi.infn.it



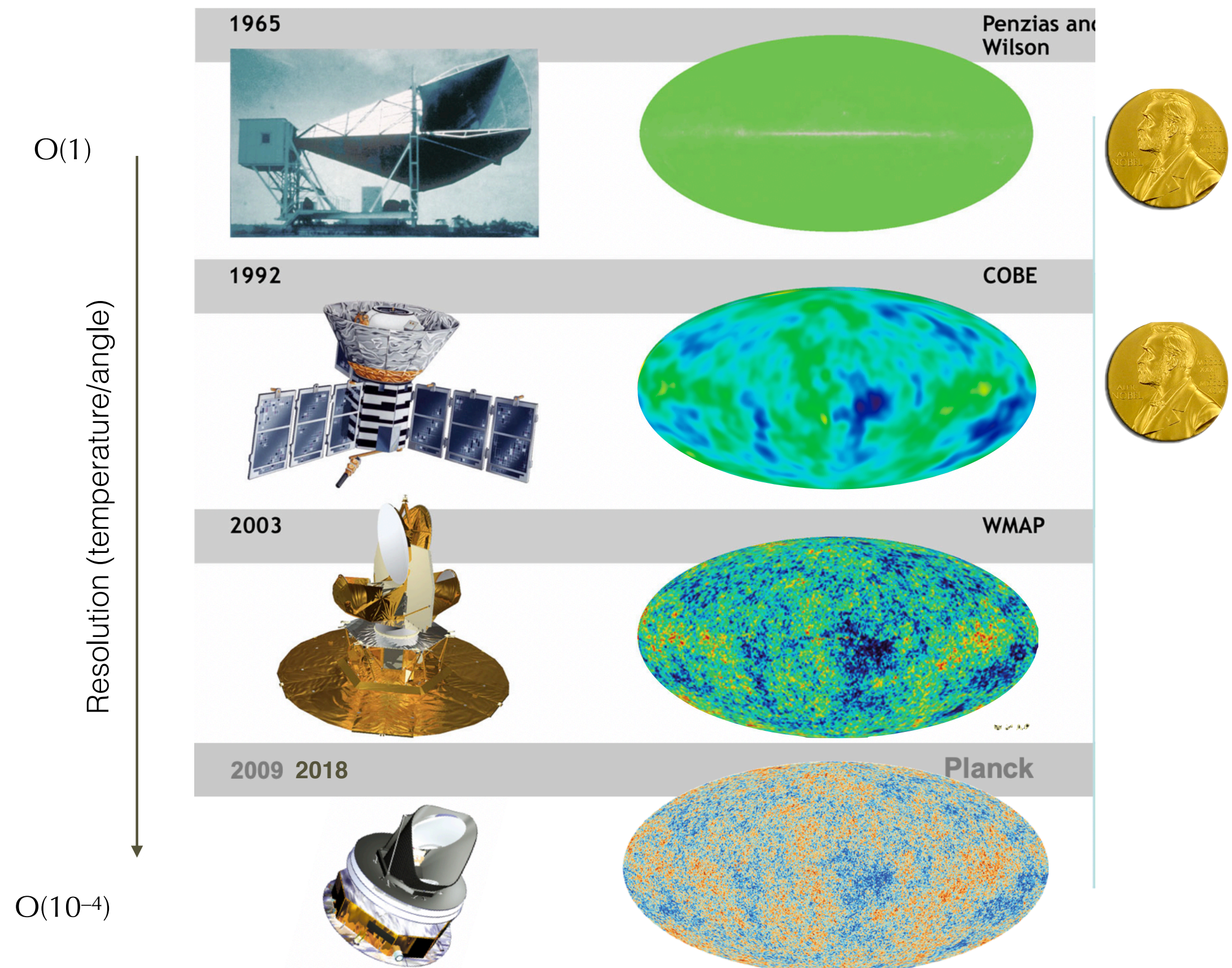
Slide courtesy: G. Signorelli.



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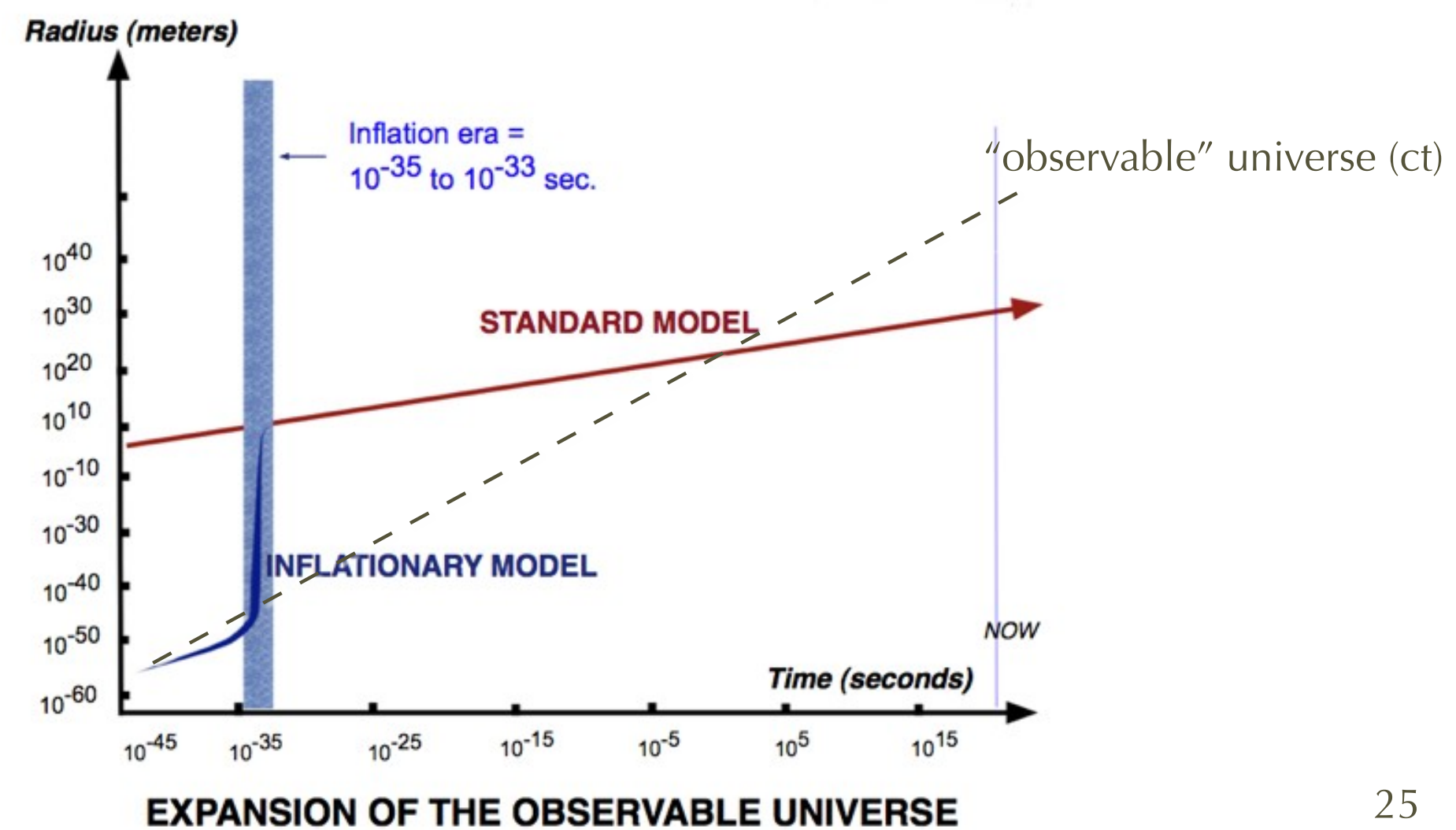
Slide courtesy: G. Signorelli.



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Isotropy... too much!

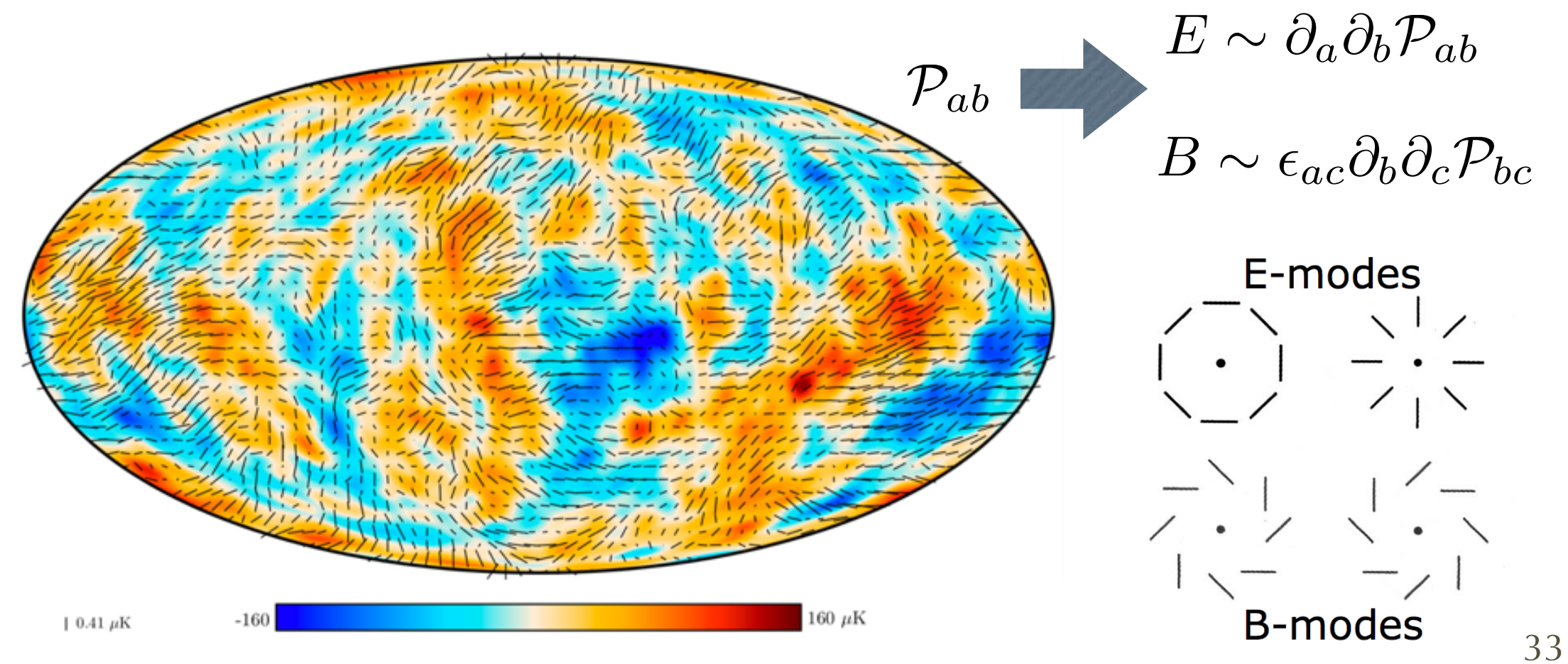
- Same temperature (to 10^{-3}) in regions of the Universe that have never been in causal contact
- One of the reasons to develop the cosmological inflation paradigm
 - superluminal expansion of metrics happened between 10^{-36} and 10^{-33} sec. after the Big Bang at $E \sim 10^{16}$ GeV



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How do we measure polarization?

- **Monopole** term: 2.725 K blackbody O(1)
- **Dipole** term: 3.355 mK O(10⁻³)
- **Anisotropy**: 100 μK rms O(10⁻⁴)
- **Tensor perturbations** produce a background of **primordial gravitational waves** O(10^{-6÷7})
 - **E-mode polarization**: 3 μK rms
 - **B-mode polarization**: <500 nK rms

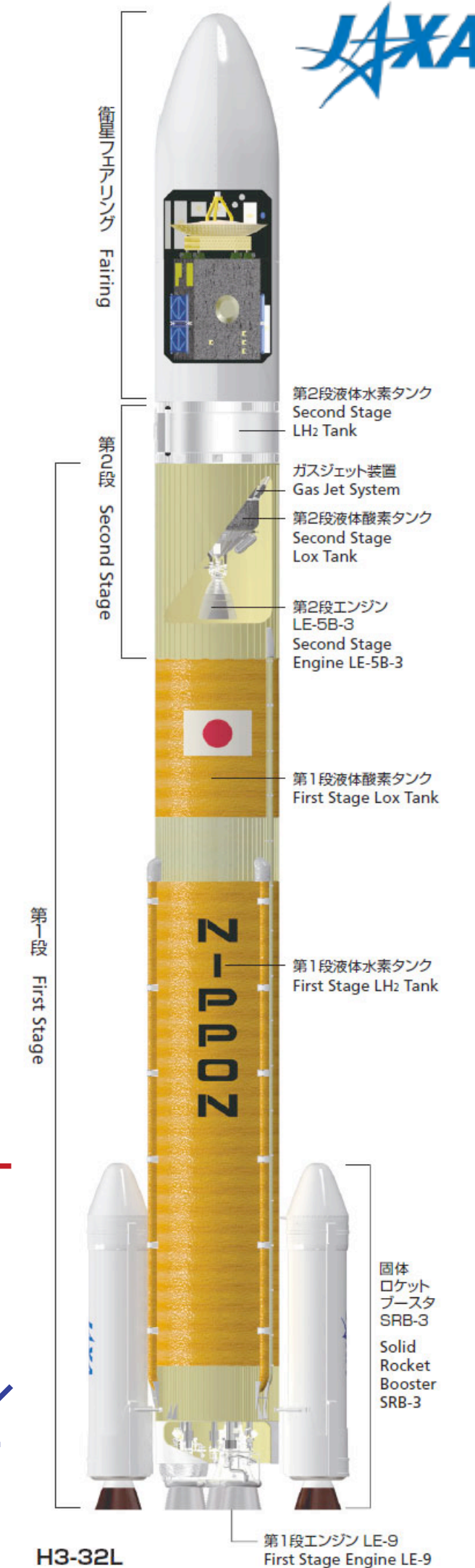
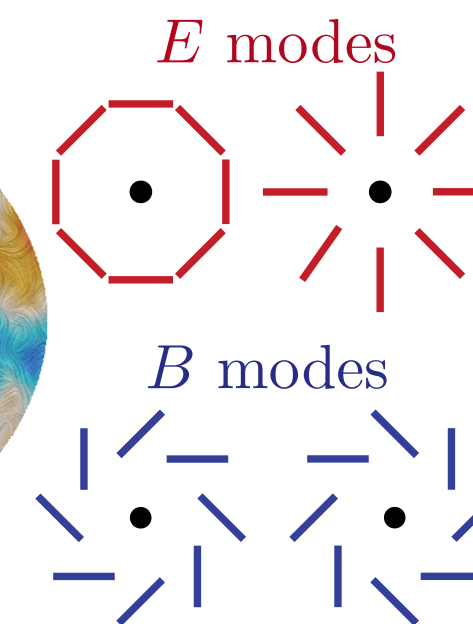
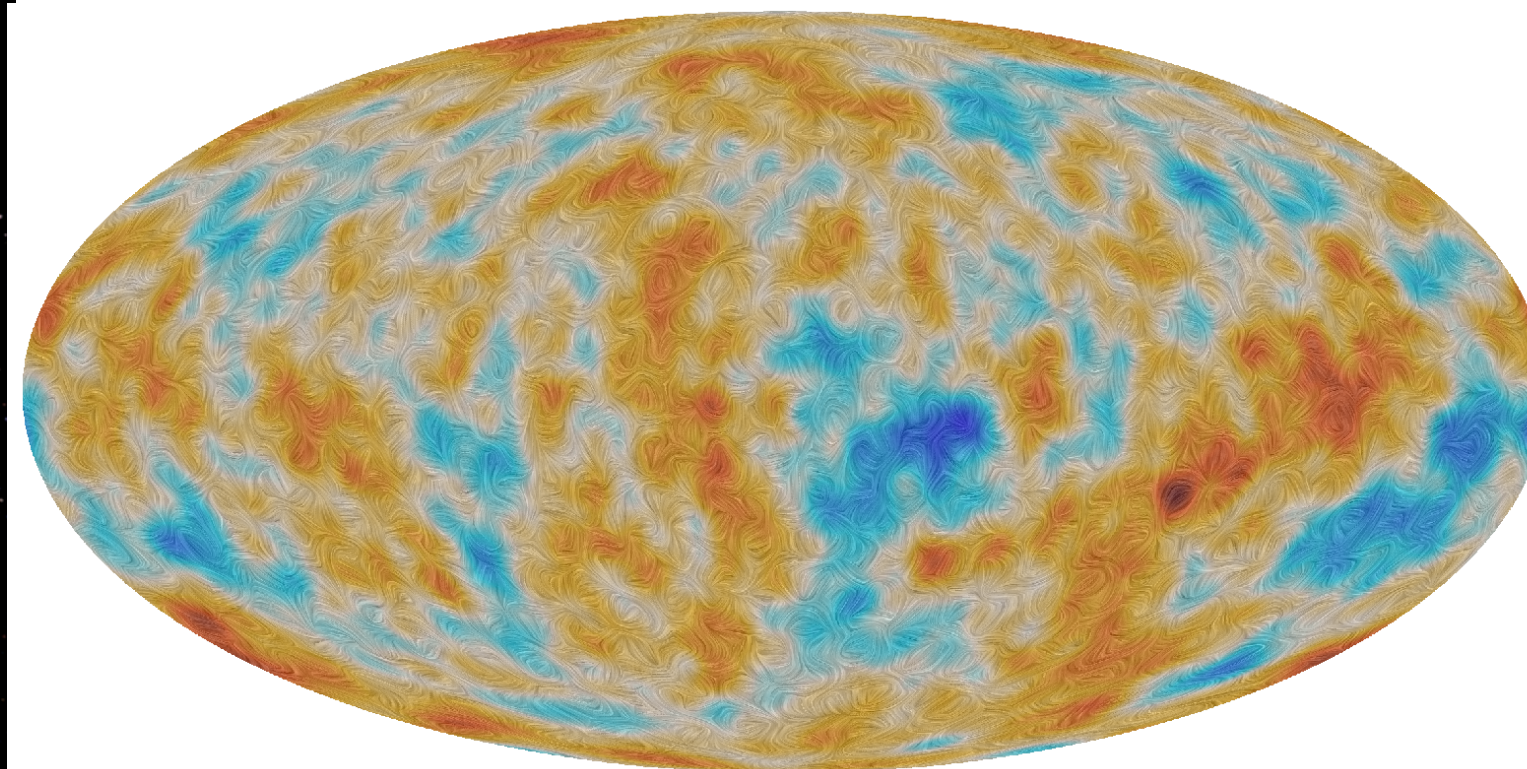
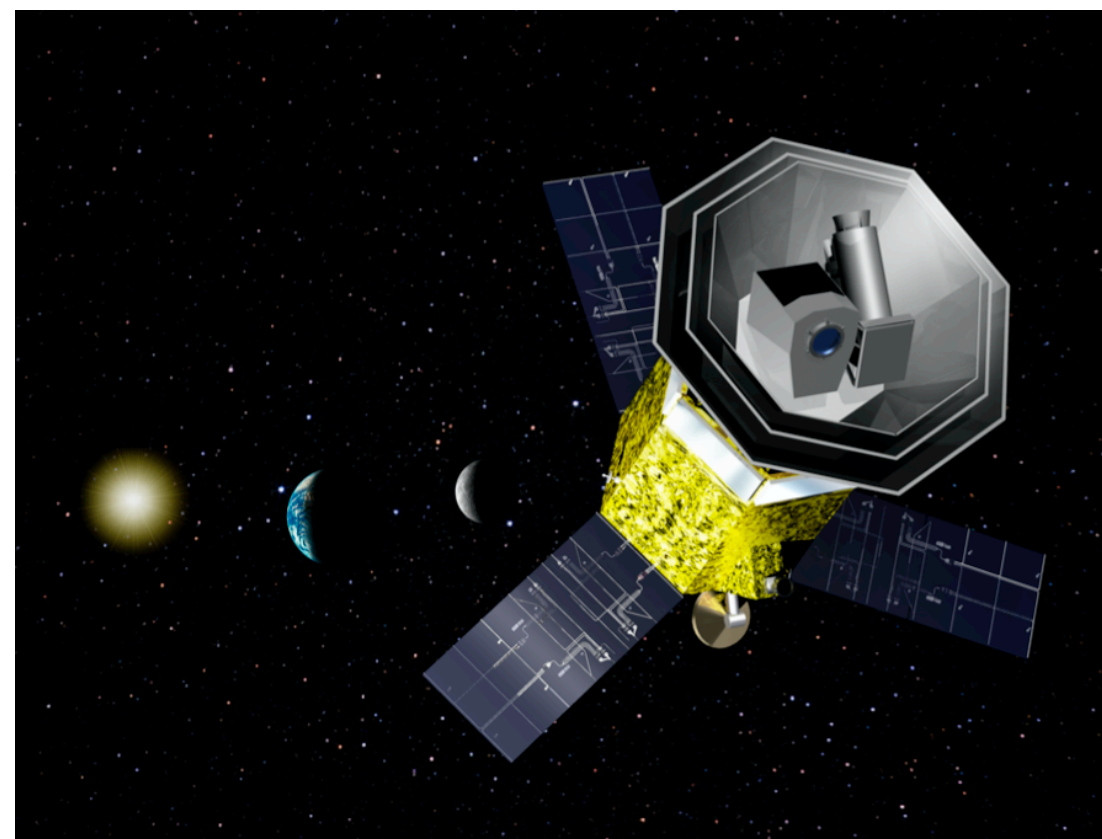


LiteBIRD overview



- Lite (Light) satellite for the study of *B*-mode polarization and Inflation from cosmic background Radiation Detection
- JAXA's L-class mission selected in May 2019
- Expected launch in late **2029** with JAXA's H3 rocket
- **All-sky 3-year survey**, from Sun-Earth Lagrangian point L2
- Large frequency coverage (**40–402 GHz**, 15 bands) at **70–18 arcmin** angular resolution for precision measurements of the CMB *B*-modes
- Final combined sensitivity: **2.2 $\mu\text{K}\cdot\text{arcmin}$**

Hazumi+ SPIE 2020



Slide courtesy: G. Signorelli.

LiteBIRD readout system: INFN contributions



INFN is part of the ASI-lead italian contribution

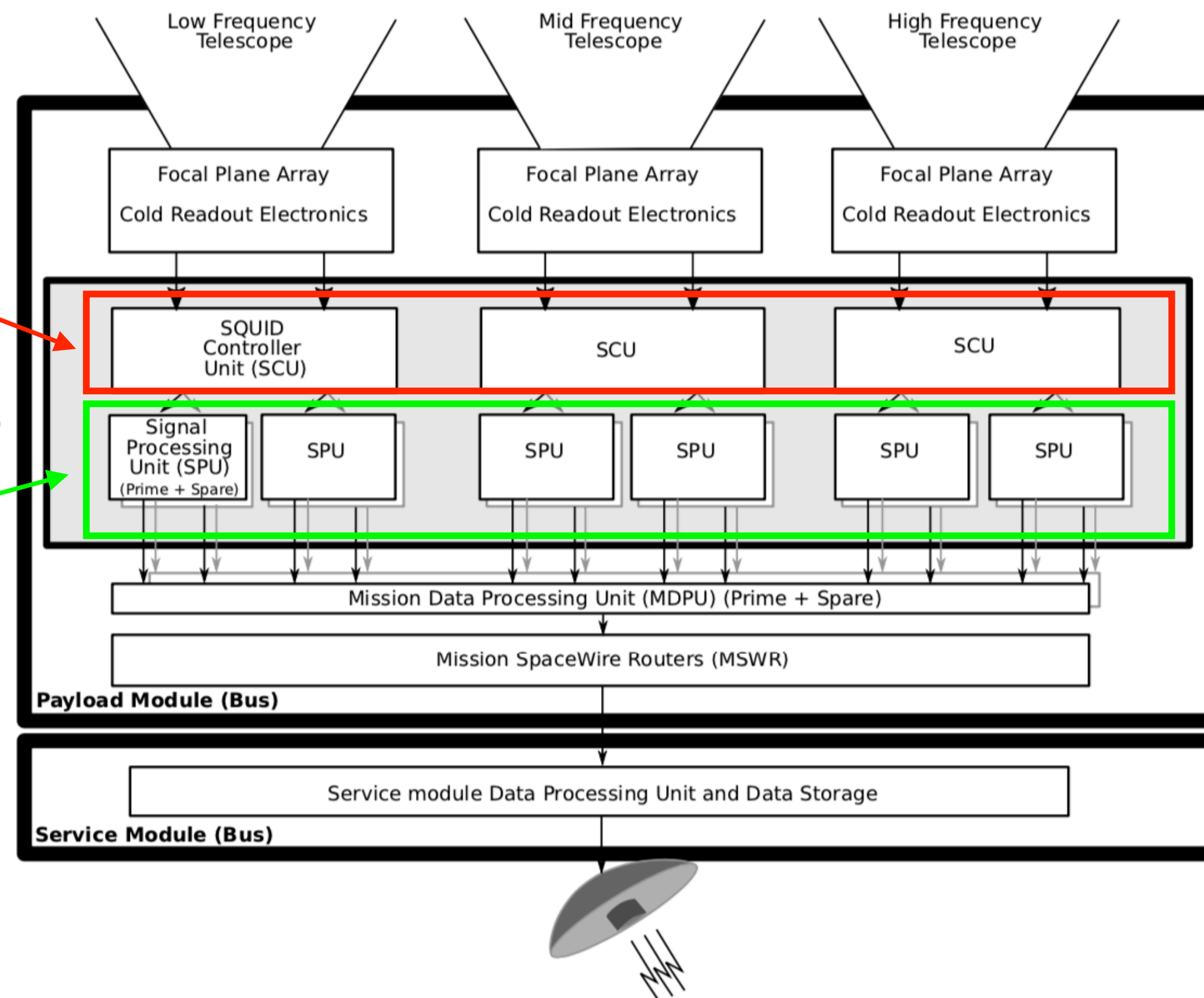
- hardware and software/simulation/analysis
- PI(lead), MIB, FE, MI, TS, RM1, RM2

Two main hardware contributions:

- SQUID Controller Unit (SCU) for 3 telescopes: electronics, thermo-mechanical design, interfaces, shielding
- Flight qualification of critical components: in particular, DAC LTC1668 (required, but not qualified yet)

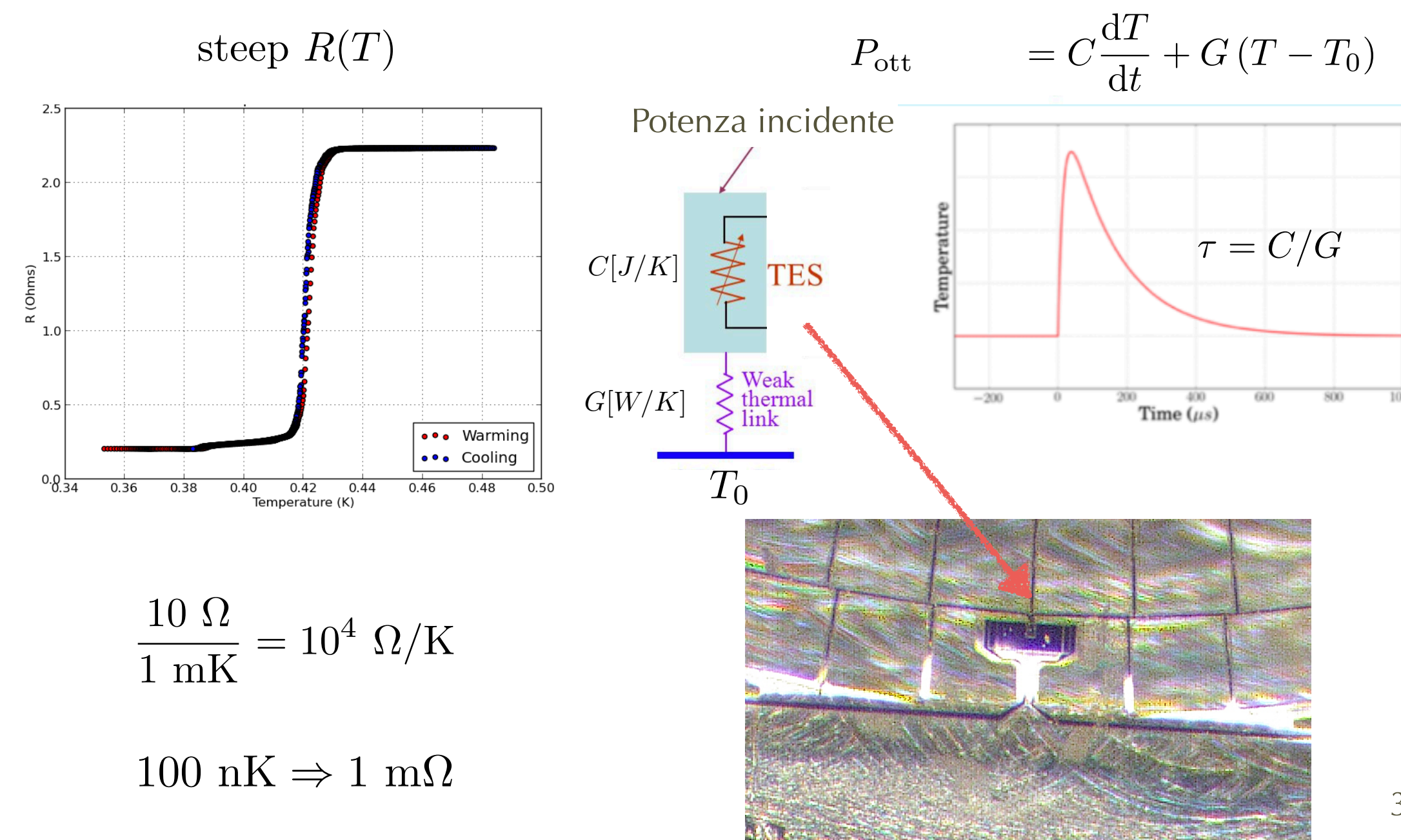


Warm
Readout
Electronics
(WE)



Transition-Edge Sensors

- “Thermometers” that enable us to measure tiny temperature variations
- Superconducting films at their phase transition



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Proposed Activity @ INFN-LNF

Foreseeable activity as of today:

- (Non)destructive irradiation testing @ X-Lab (Dabagov and Hampai), with extrapolation at longer wavelengths, and X-ray circuitry diagnostics on specifically dedicated and instrumented optical bench.
- Thermal balance test and correlation to models with the software Thermal Desktop (thanks to the 'pocket' cryostat belonging to Giovanni Delle Monache, and that will be provided to the effort).
- Involvement in data analysis, modelling and simulations for the physical processes of interest, at 'cosmological' level, with Luca Porcelli and if a PhD student of Unical will join the team.
- Involvement in PA/QA of the flight hardware.
- Possibility of hiring PhD students, thanks to the involvement of Sandra Savaglio (Unical).

Proposed Team and FTE Sharing

Team Members as of today:

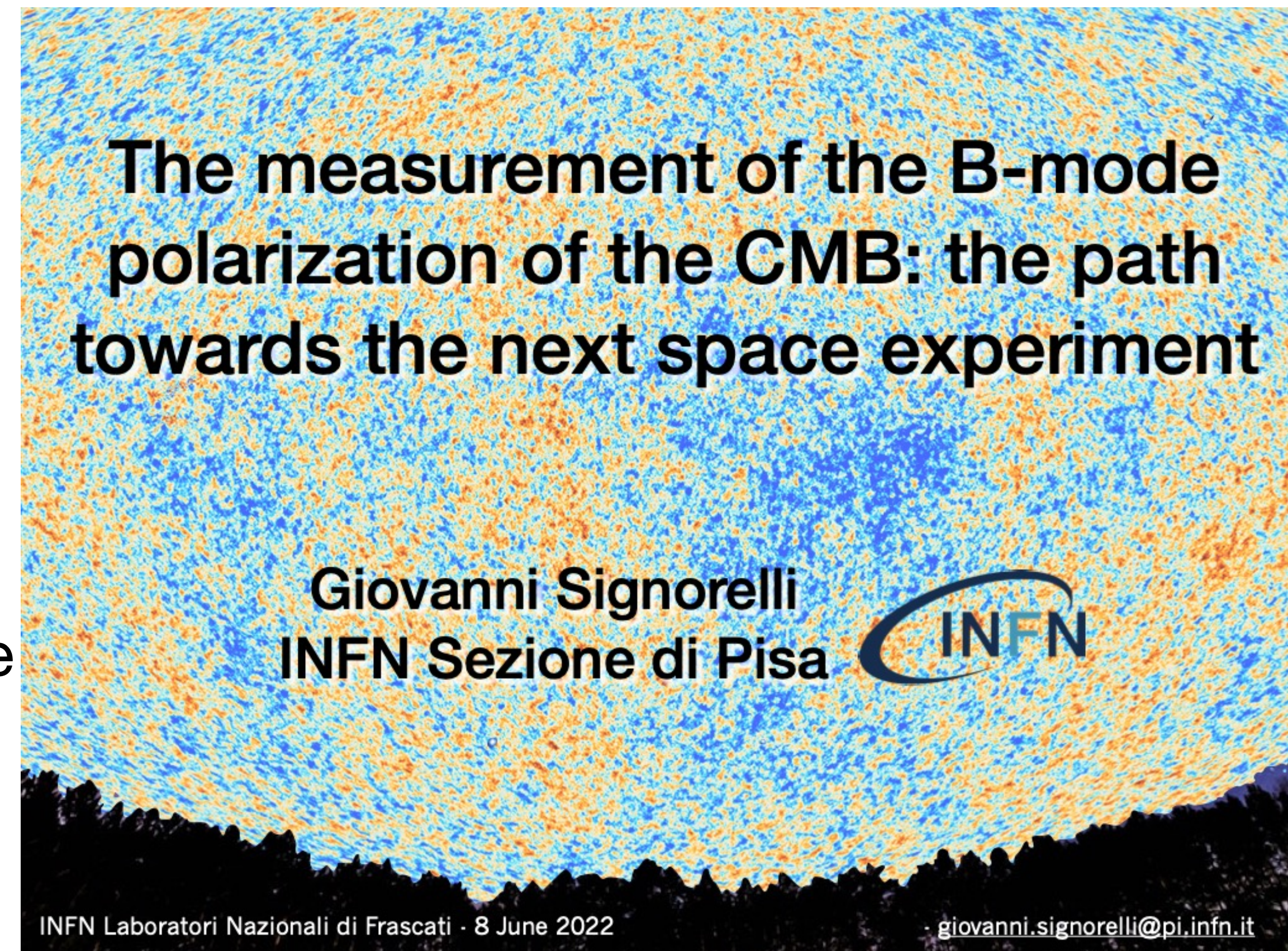
- Luca Porcelli (Staff Researcher - III Level - LR) = 40% FTE.
- Sultan Dabagov (Executive Researcher - I Level) = 40% FTE.
- Dariush Hampai (Staff Technologist - III Level) = 40% FTE.
- Valeria Guglielmotti (Postdoctoral Researcher) = 40% FTE.
- Giovanni Delle Monache (Staff Technologist - III Level) = 30% FTE.
- Sandra Savaglio (Full Professor @ Unical) = 30% FTE.

We are very open to people and ideas, and very welcoming for inclusion of further team members here at INFN-LNF.

LiteBIRD-LNF x 2023

Objective: starting up the local activity and ‘properly’ joining the wider collaboration.

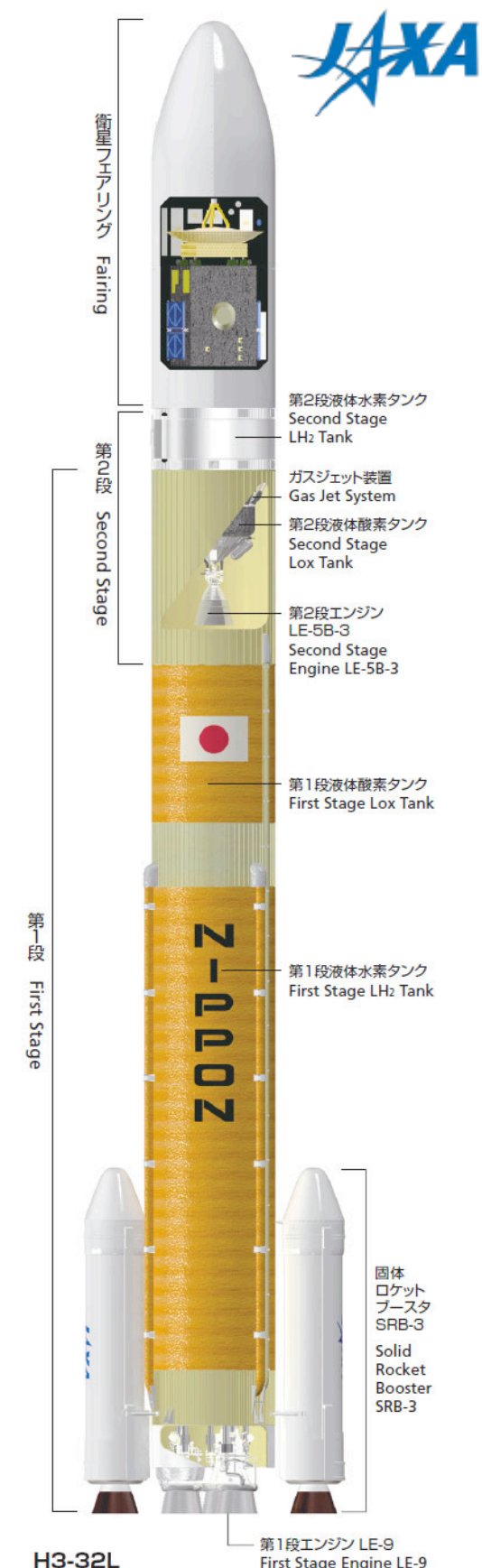
- **2022 Results:**
 - N/A.
- **2023 Objectives:**
 - Starting up the local activity.
 - Joining the wider collaboration.
 - Starting the setup a (non)destructive irradiation testing chain and procedure for the electronics of interest @ X-Lab.
 - Starting the setup and instrumentation of the ‘pocket’ cryostat for tests on the electronics of interest.
 - Starting the teaming with the wider collaboration in order to get involved in data analysis, modelling and simulations for the physical processes of interest, at ‘cosmological’ level.



Slide courtesy: G. Signorelli.

LiteBIRD-LNF x 2023

Objective: starting up the local activity and ‘properly’ joining the wider collaboration.



- **FTE (LNF):** L. Porcelli (RL, 40%), S. Dabagov (40%), D. Hampai (40%), V. Guglielmotti (40%), G. Delle Monache (30%) + S. Savaglio (Unical, 30%) = 1.9 FTE (2.2 FTE)
- **Richieste CSN2 2023 (overall, TBD):** missioni 10k, consumo 40k, altri cons 5k, inventario 40k, license SW 20k, apparati ...k, servizi ...k
- **Richieste LNF 2023 (mesi-uomo):** Elettronica 0.5; Impianti Fluido 0.5; Criogenia 0.5
- **Fondi Esterni:** N/A