

Balloon “High frequency” feasibility study

**A few thoughts on  
Telescopes and Optics**

Luca Lamagna

Physics Department, “Sapienza” University of Rome

ASI/COSMOS Meeting, Bologna, Jan 20<sup>th</sup>, 2017

# CONTEXT

FACT: balloons are intrinsically time and budget-limited projects

Therefore, we need solid, light and low-power technology and, if needed, quick and effective R&D solutions.

POSSIBLY, balloon platforms can turn into powerful tools to advance CMB science and at the same time provide TRL significant advances in instrument technology.

# Key issues

- Which is the “best” design?

Clearly science-driven, but a context-based FOM is needed to translate science drivers into key requirements for the instrument parameter space.

- Which R&D is needed to optimize this design?

Project time and money are not endless!

- Which output from R&D is needed to feed into an end-to-end sim of science performance?

Strong interaction between instrument R&D and e2e simulations

# Telescopes

## Reflective

- Mostly off-axis
- Low loss per unit aperture
- Intrinsically achromatic
- Comparatively easy to model
- Weight
- Huge heritage in modeling and characterization (e.g. Planck)

OLIMPO, LSPE/STRIP, CORE...

## Refractive

- On-axis
- Lossy
- Chromatic
- Need material characterization to model systematics
- Large and/or thick elements are tough to build and to cool down
- Easier replication/mass production

SPIDER, LSPE/SWIPE

# Apertures

- The larger, the better?
- Which resolution (science/strategy driven: low- $l$  pol, high- $l$  pol/delensing, SZ, point sources, foregrounds...synergies?)
- Characterization issues (e.g. far field region is really far – can we effectively model/reconstruct far field performance in polarization across an accurate set of near field measurements?)

# Low-I adds complexity

- Exceptional stability required due to the large coverage needed for low-I polarization
- Residual contamination from the atmosphere or its fluctuations may leak into polarization due to system asymmetries, so additional modulation is always needed
- Be it boresight rotation or polarization modulation, small apertures mean more feasibility...

# There is more along the optical chain...

- Rad windows need high transparency, low spurious pol (materials? Foam supported thin layers?) → AR coatings (dielectric deposition/lamination, or 3D surface shaping are a solution)
- Pol modulators (HWPs, metal-mesh HWPs, rHWPs, etc.)
- Filters

EVERYTHING is currently limited to comparatively small apertures (< 50cm)

Broadband means even more headaches...

AND WHAT IF WE WENT FOR SPECTROMETRY? Some significant experience in this room (SAGACE, OLIMPO)

# Environment-related issues

- The stratosphere is not the ground
- The stratosphere is not L2

Shields/baffles need a lot of dedicated effort to control environment-related systematics.

R&D must take account for this issue, taking care of payload/operation/launch constraints.



# Focal planes

- Single-mode vs Multi-mode means resolution vs image «quality» (if it doesn't wash out the required information)
- Single mode performance is well understood with huge experience from the community
- Multi-mode is sort of a niche, but can turn into a Pandora's box (also significant for detector technology/design: LSPE/SWIPE, PIXIE)

# Fancy ideas

- Interferometry?

# Fancy ideas

- Interferometry?
- Spectral/spatial??

# Fancy ideas

- Interferometry?
- Spectral/spatial??
- ON A BALLOON???

# Fancy ideas

- Interferometry?
- Spectral/spatial??
- ON A BALLOON???
- ON MANY BALLOONS?????

# Fancy ideas

- Interferometry?
- Spectral/spatial??
- ON A BALLOON???
- ON MANY BALLOONS?????
- Ok, just kidding...

# Fancy ideas

- Interferometry?
- Spectral/spatial??
- ON A BALLOON???
- ON MANY BALLOONS?????
- Ok, just kidding...
- Or maybe not 😊

# End of the line...

- Please help us fill the following form:

it is URGENT that \_\_\_\_\_

So we SUGGEST \_\_\_\_\_

And POSSIBLY \_\_\_\_\_

But anyway, it is MANDATORY \_\_\_\_\_

Oh, by the way, we got this nice new crazy idea:

---

Thanks!