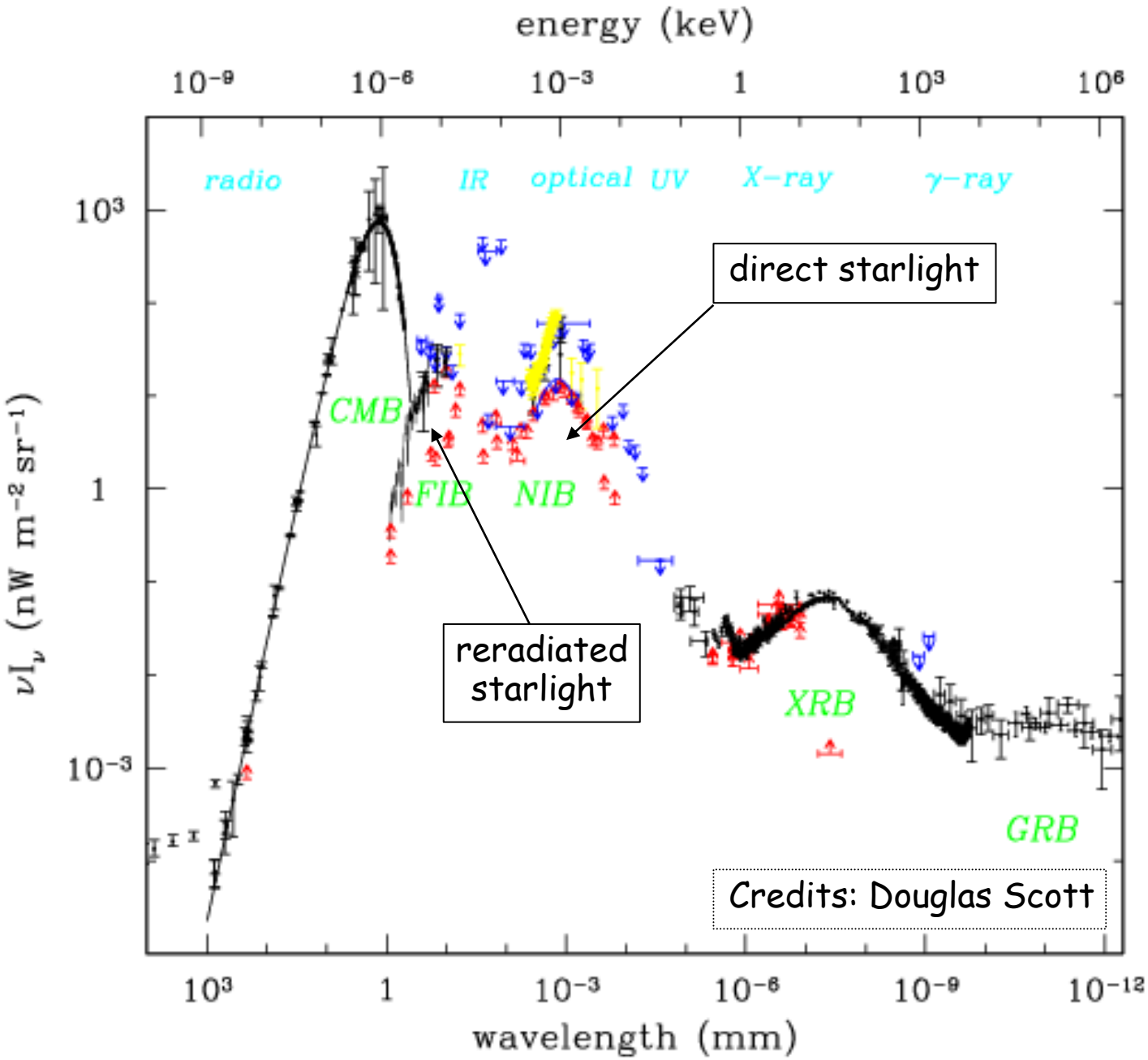
BLAST

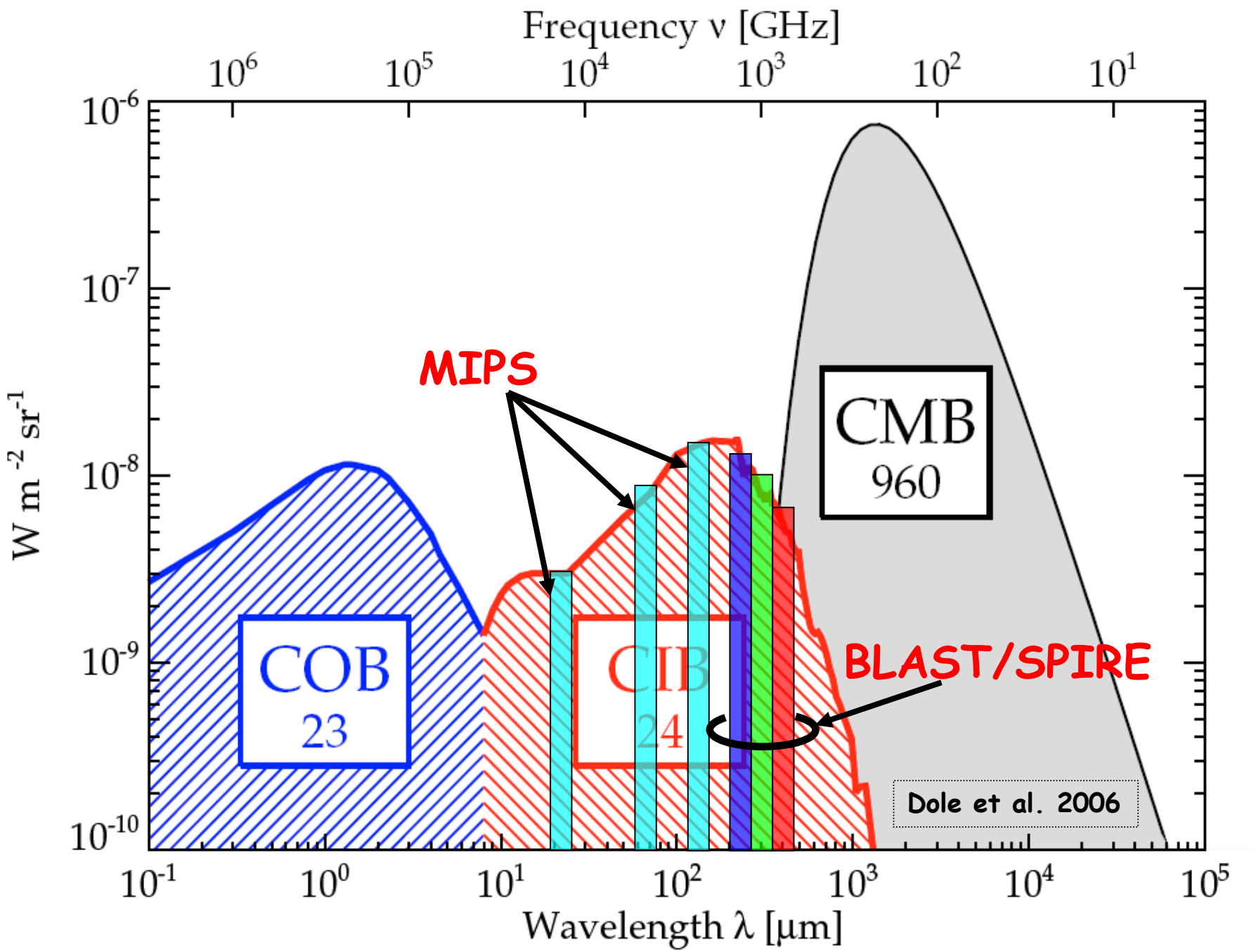
Studying cosmic and Galactic star formation from a stratospheric balloon

Lorenzo Moncelsi, Cardiff University

The Extragalactic Backgrounds

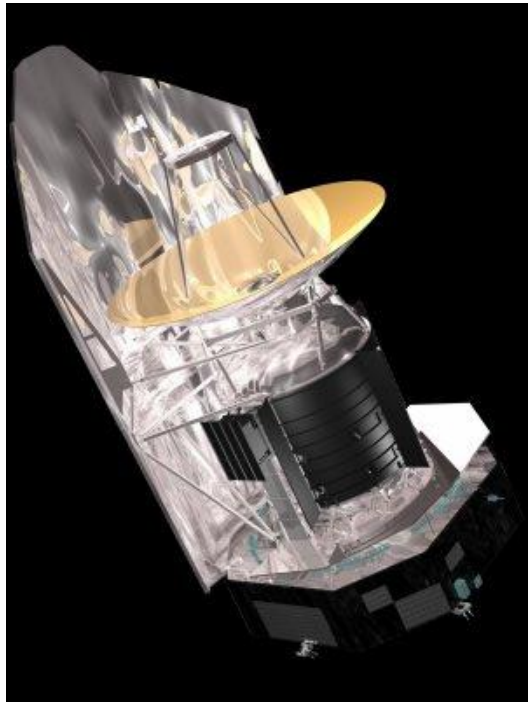


The CIB Background



BLAST forerunner of SPIRE

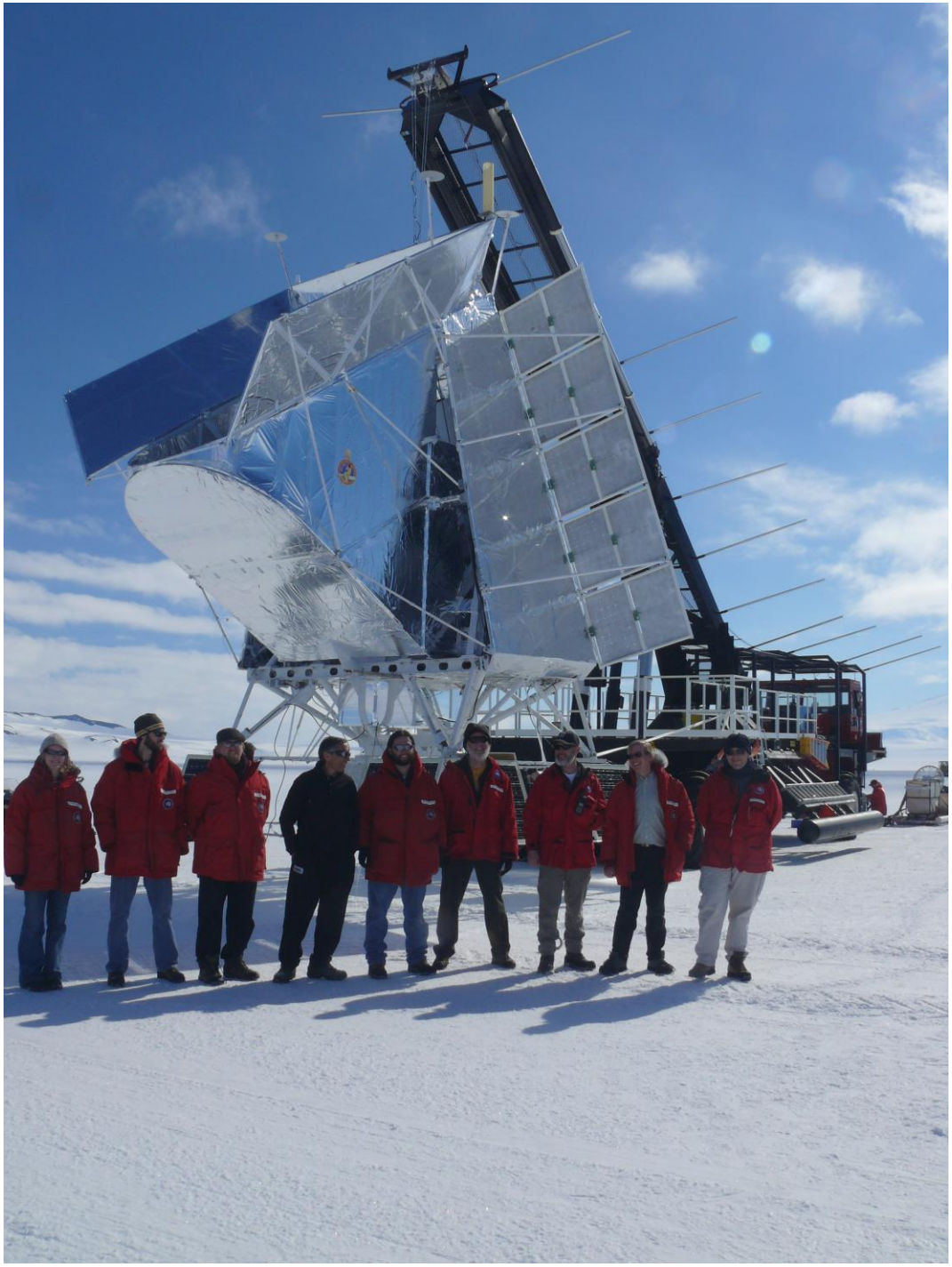
- Same Focal Plane Technology
- Similar Science Motivation



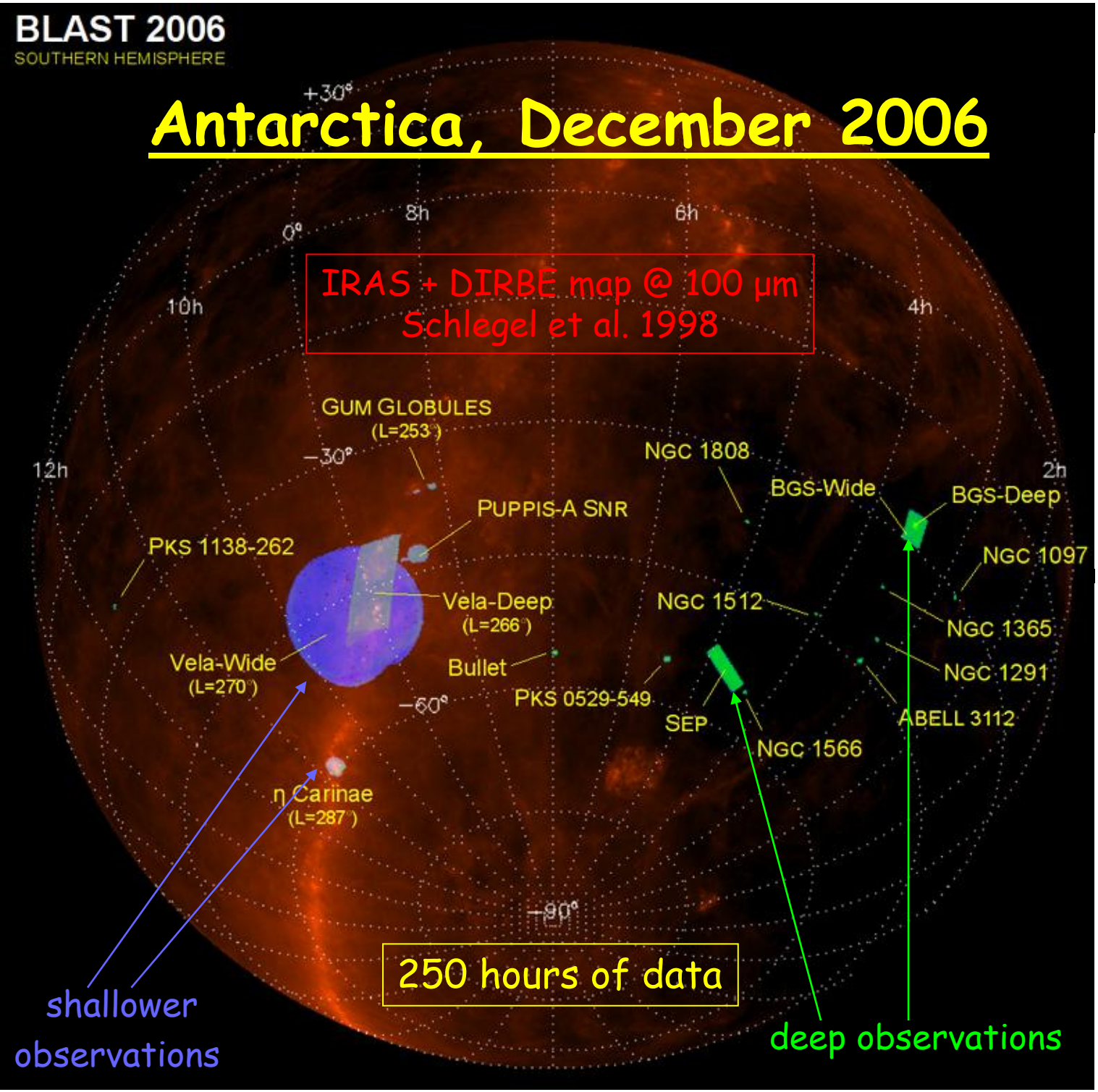
Study the evolutionary history and processes of star formation in our Galaxy and in galaxies at cosmological distances

BLAST:
A Submillimetre Observatory

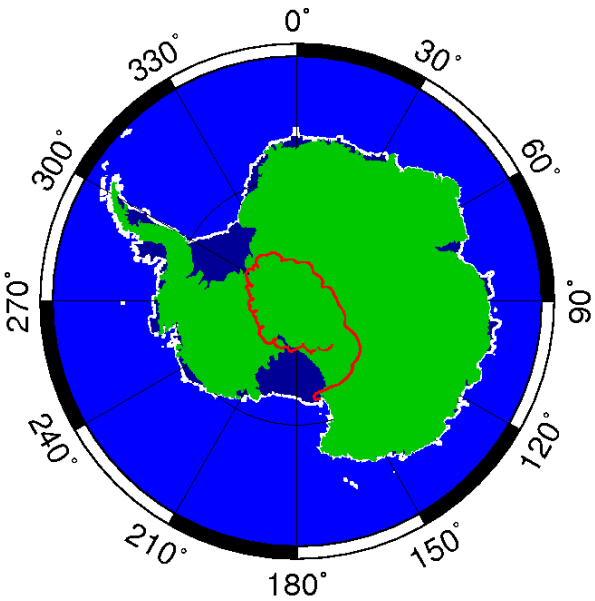
- Arrays of 270 bolometers 250 μm, 350 μm, 500 μm
- 2m Cassegrain Telescope
- Diffraction limited beams 30", 42" and 60" FWHM
- Flown on a high altitude balloon platform
- SPIRE has larger mirror, higher resolution, and has access to more sky
- Most science is accessible to both BLAST & SPIRE

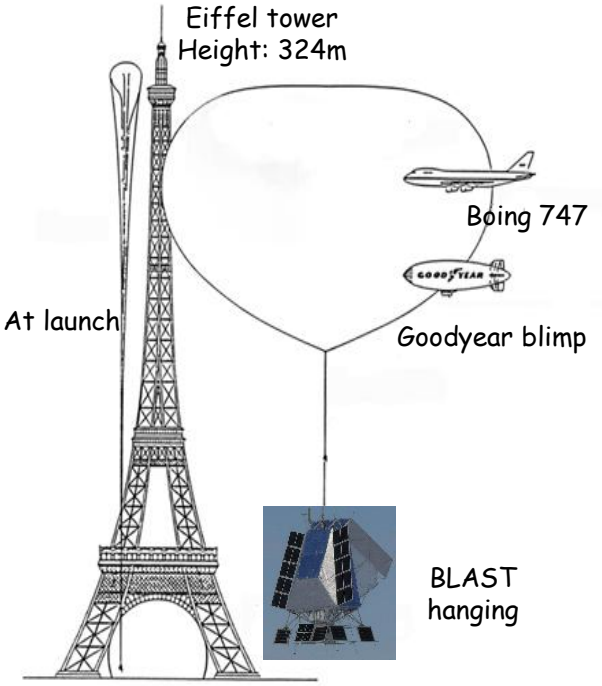


Antarctica, December 2006

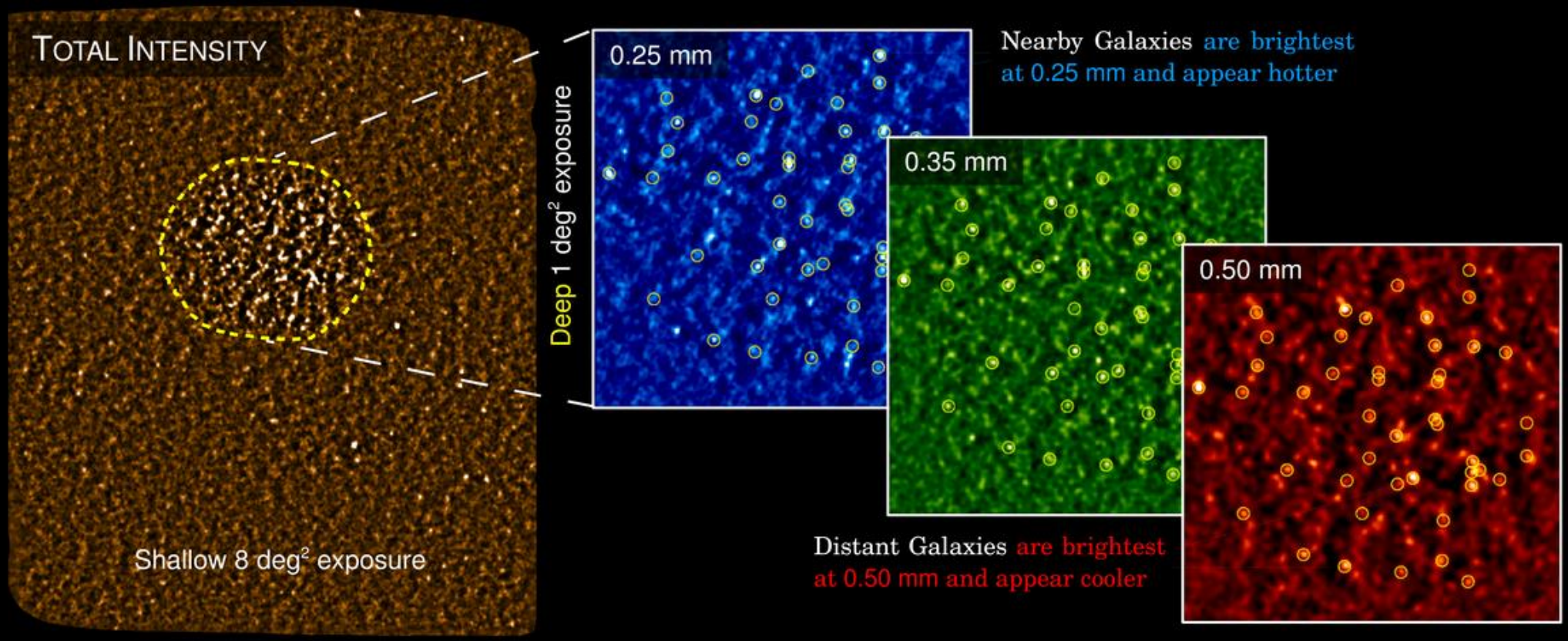


11-day flight at ~39 km
99.5% of the atmosphere

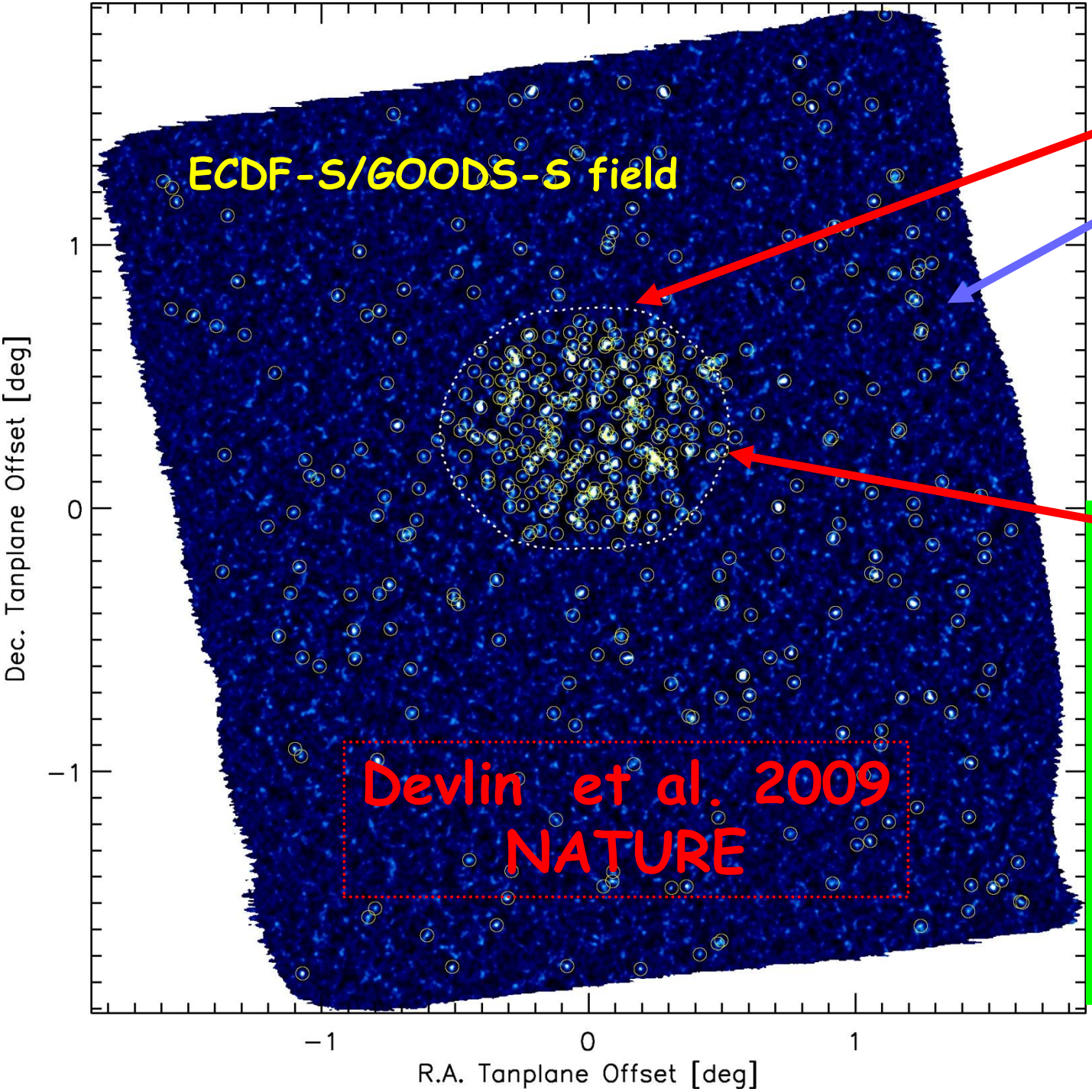




Cosmic History of Galaxy Formation



These images were produced by BLAST during its 2006 flight over Antarctica. Each white spot is the glowing thermal light from galaxies undergoing episodes of massive star-formation. These violent, early stages in their lives are invisible to optical telescopes because the light from their new stars is absorbed by dust. Observing light at three different wavelengths 0.25 mm, 0.35 mm, and 0.50 mm, BLAST is the first telescope capable of detecting and characterizing large numbers of these young galaxies back to when the Universe was only 1/3 of its present age by measuring their brightnesses and colors.
For more information on BLAST see http://blastexperiment.info/



combined map

Deep (0.8 deg^2) +

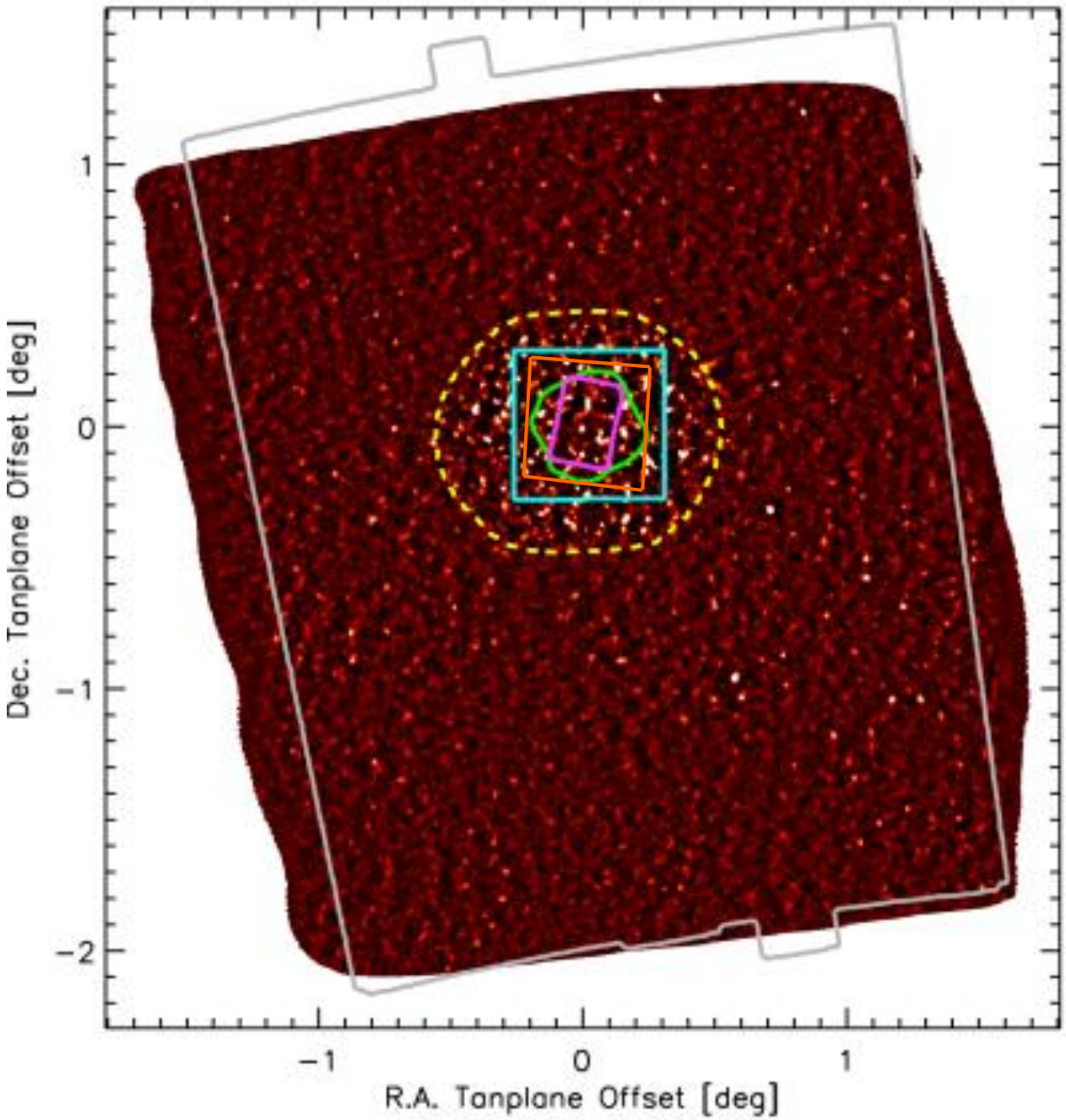
Wide (9 deg^2)

Hundreds of >5.0σ sources

DEEP REGION

- Signal dominates over instrumental noise
- Source confusion arises from finite instrumental resolution
- Cannot resolve individual sources at very faint flux densities

Great ancillary data!



multi-wavelength coverage

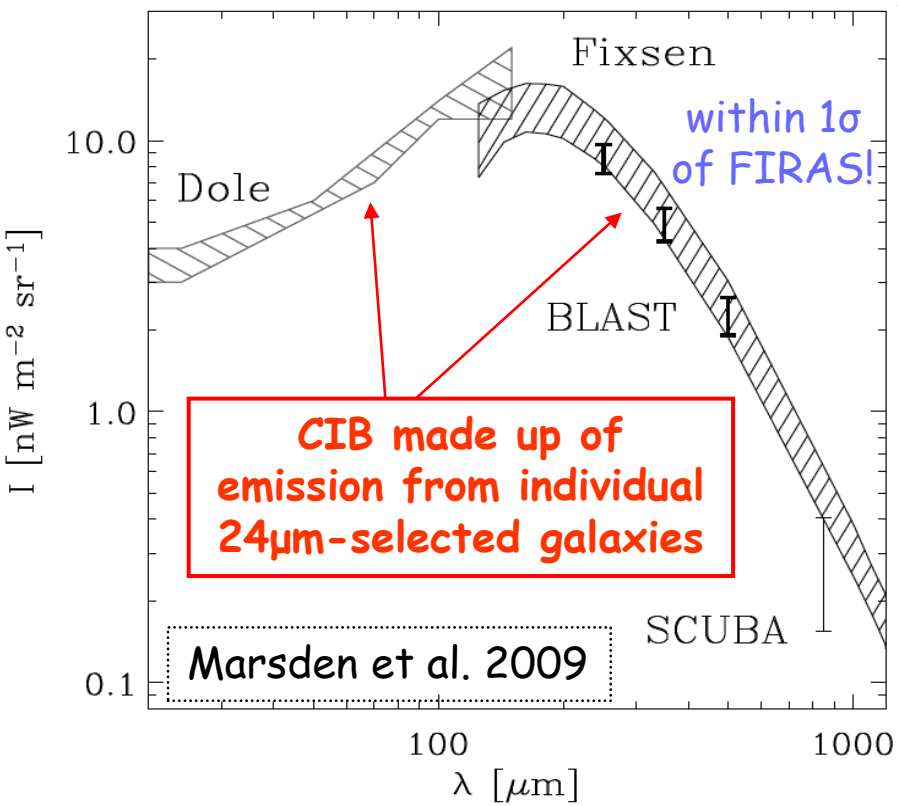
- SWIRE (24, 70, 160 μm)
- BLAST DEEP
- VLA (radio, 1.4 GHz)
- FIDEL (24 μm)
- CHANDRA 2Ms (X-ray)
- GOODS (24 μm)

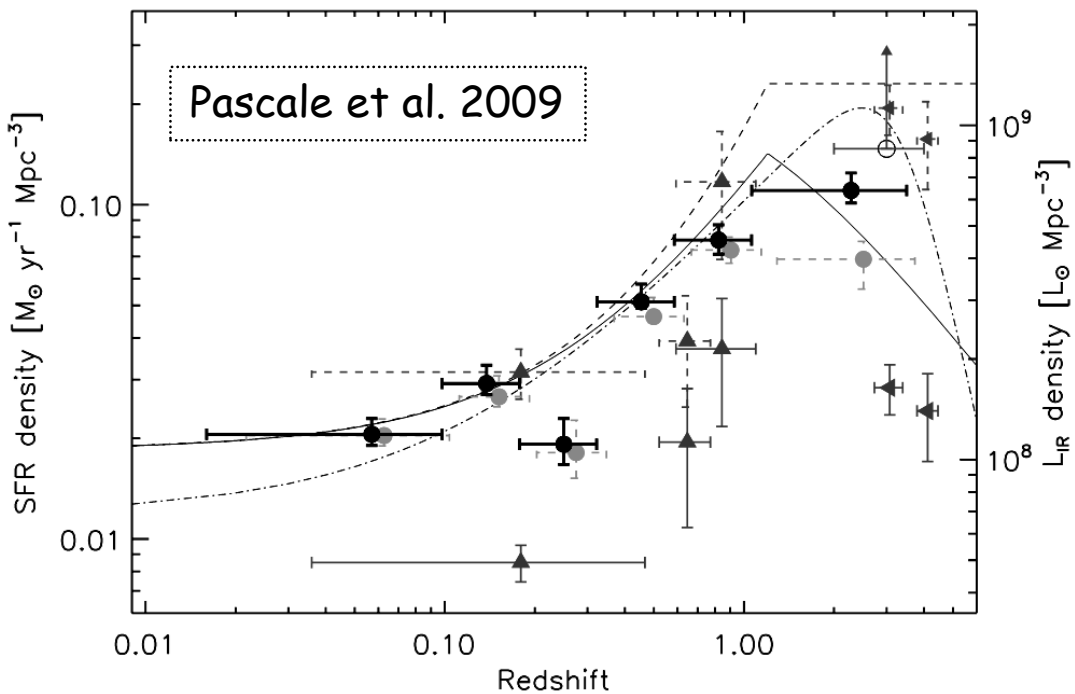
Stacking analysis

-Stack BLAST maps at positions provided by external 24μm, radio, and X-ray catalogues

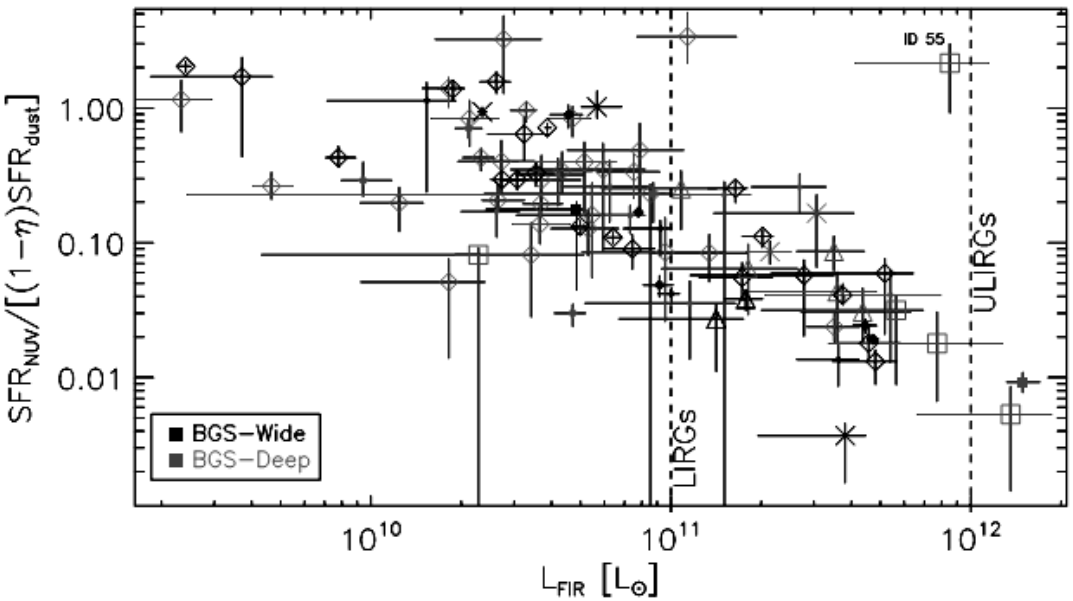
- Measuring the mean flux density at BLAST wavelengths of an externally-selected population of sources individually too dim to be detected by BLAST

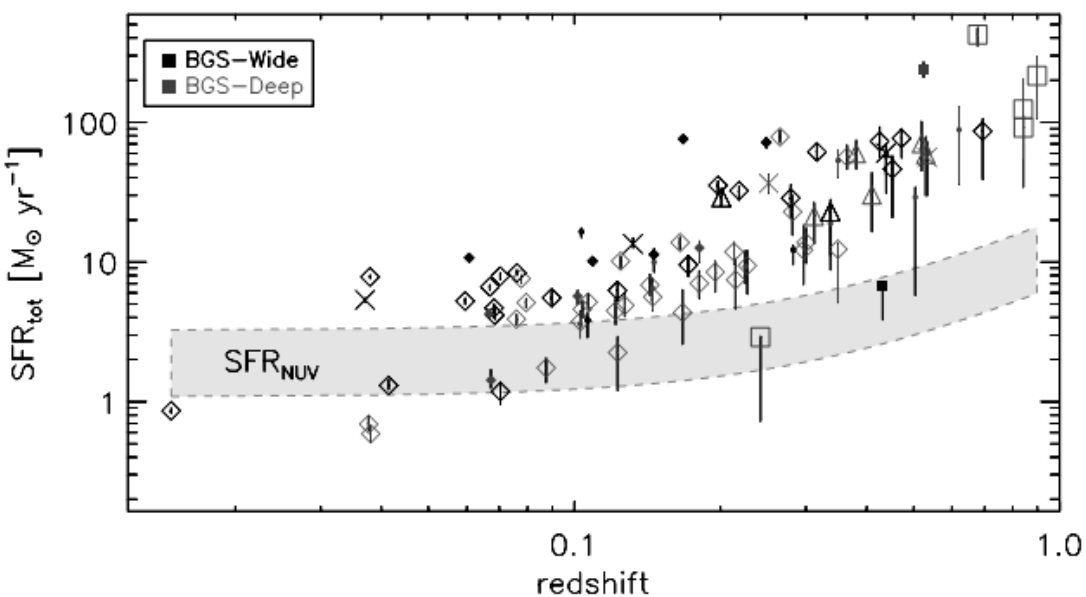
- stacking allows to beat the confusion noise: 24 μm source density is 4 sources/beam at 250 μm. Yet we are safe as long as the catalogue is NOT clustered!!!



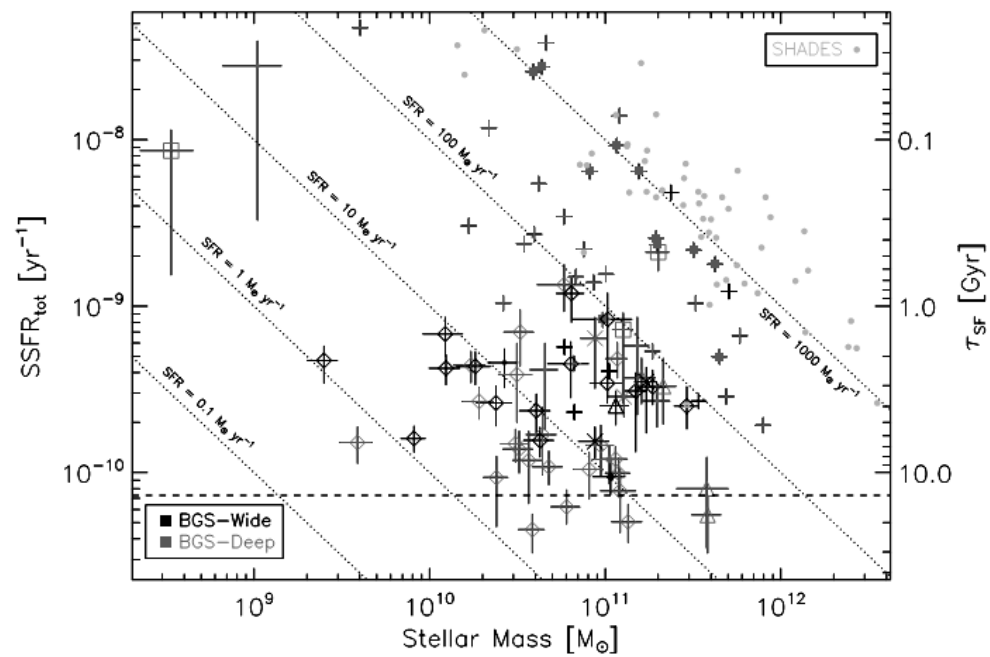


(Un)+obscured star formation and stellar masses



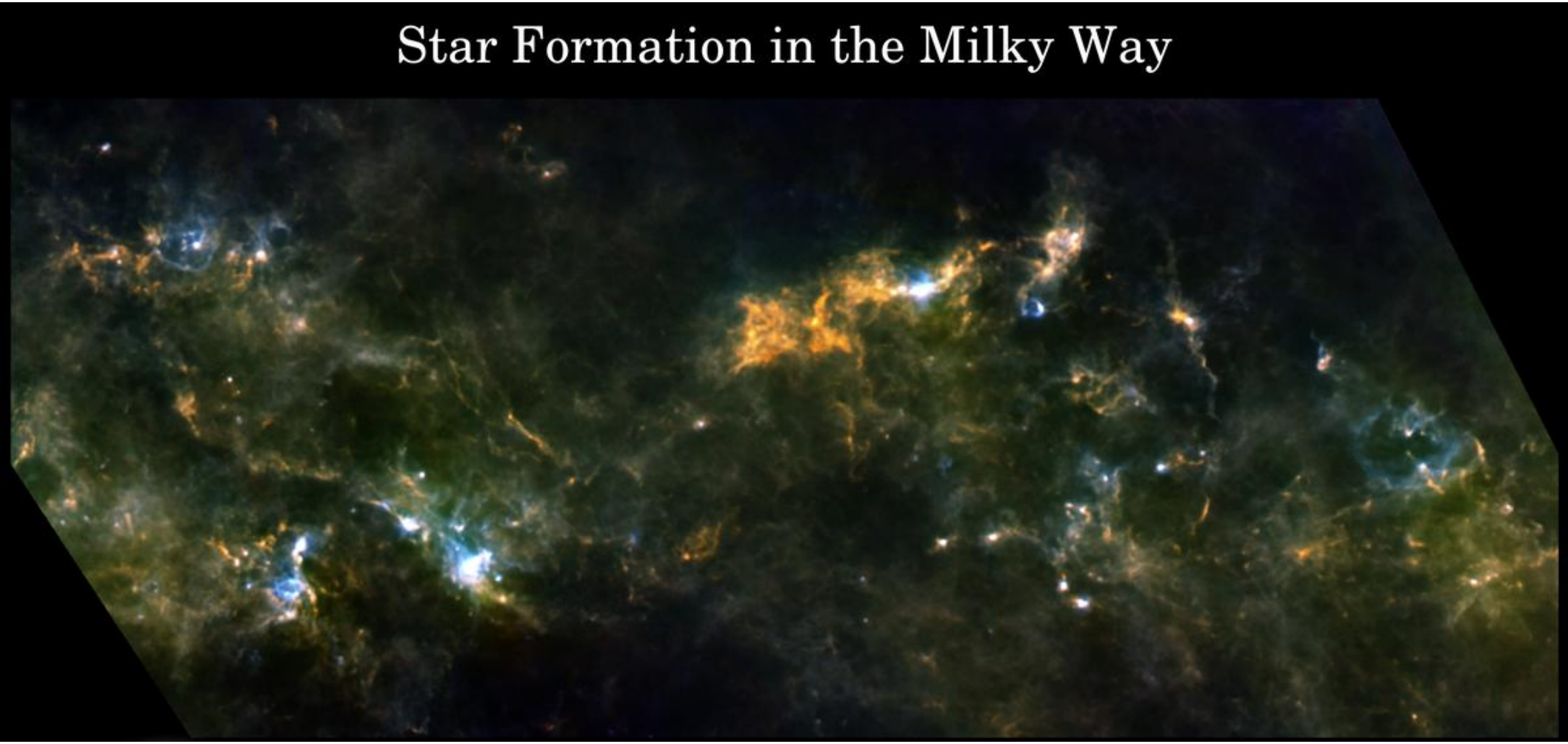


Moncelsi et al. 2010
multi-wavelength study of BLAST galaxies



- -SF at high-z is mostly obscured
- -BLAST galaxies have relatively high M_*
- -Bridge the gap between SCUBA & 24μm
- -presence of AGN in 20% of the sample
- -endorse downsizing

Why BLAST-Pol?



The 50 deg^2 VELA map reveals that there are too many star forming cores/clumps

The lifetime of the cores must be much longer than we calculate using gravitation alone

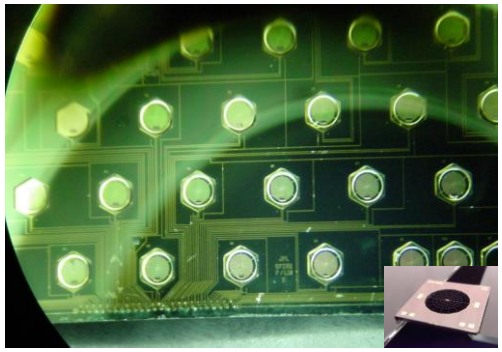
What is holding them up? → **next talk by Ciara!**

The instrument in a nutshell

2m telescope and focusing system

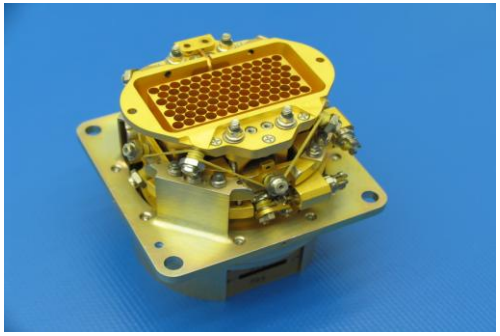
Cryogenics: 11 days hold time

Arrays 270 detectors

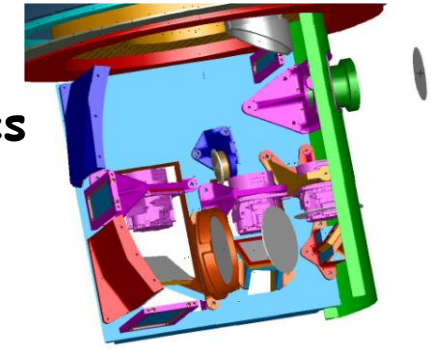


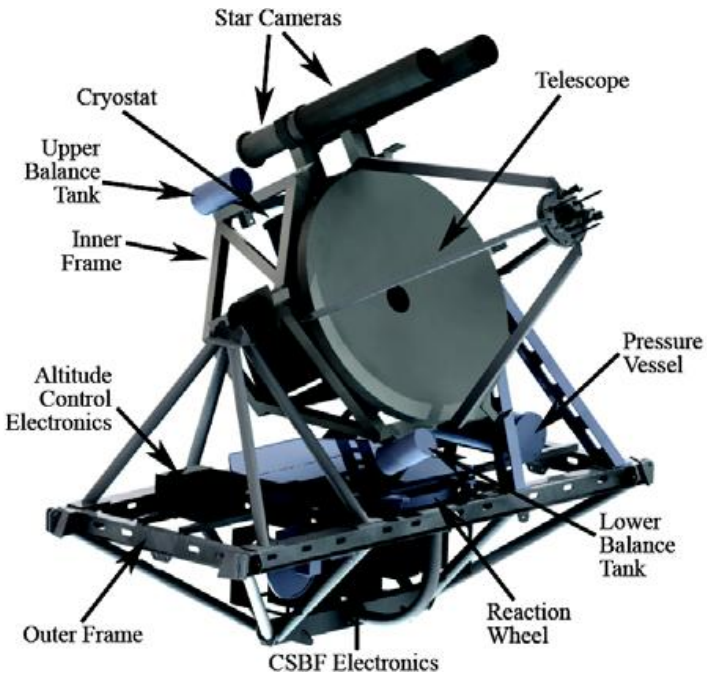
Pointing System: 11 Sensors 3'' reconstruction

Feed horns



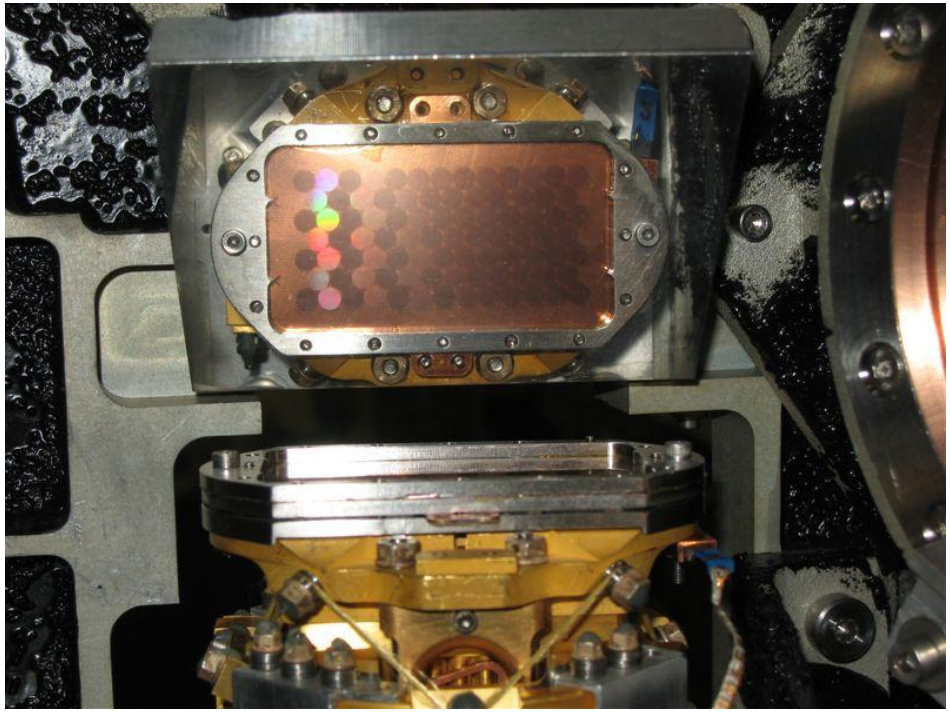
re-imaging optics and filters

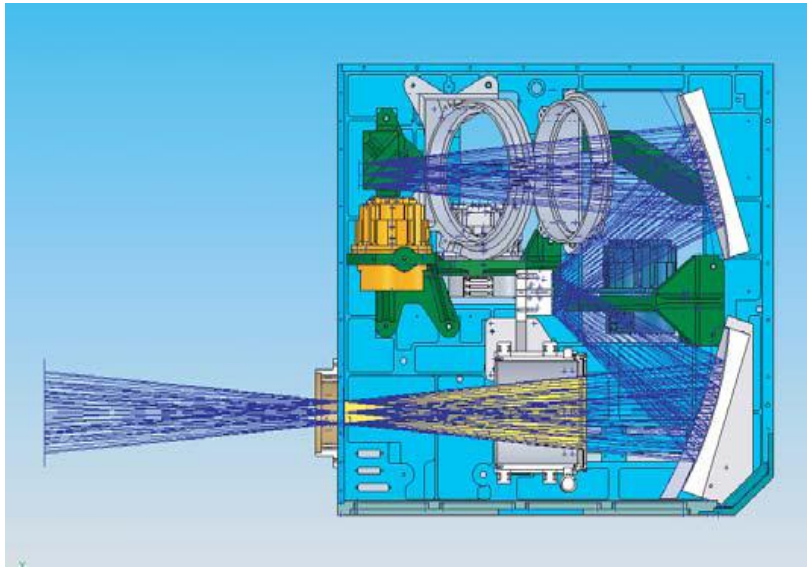




Gondola

Changes to BLAST - Optics

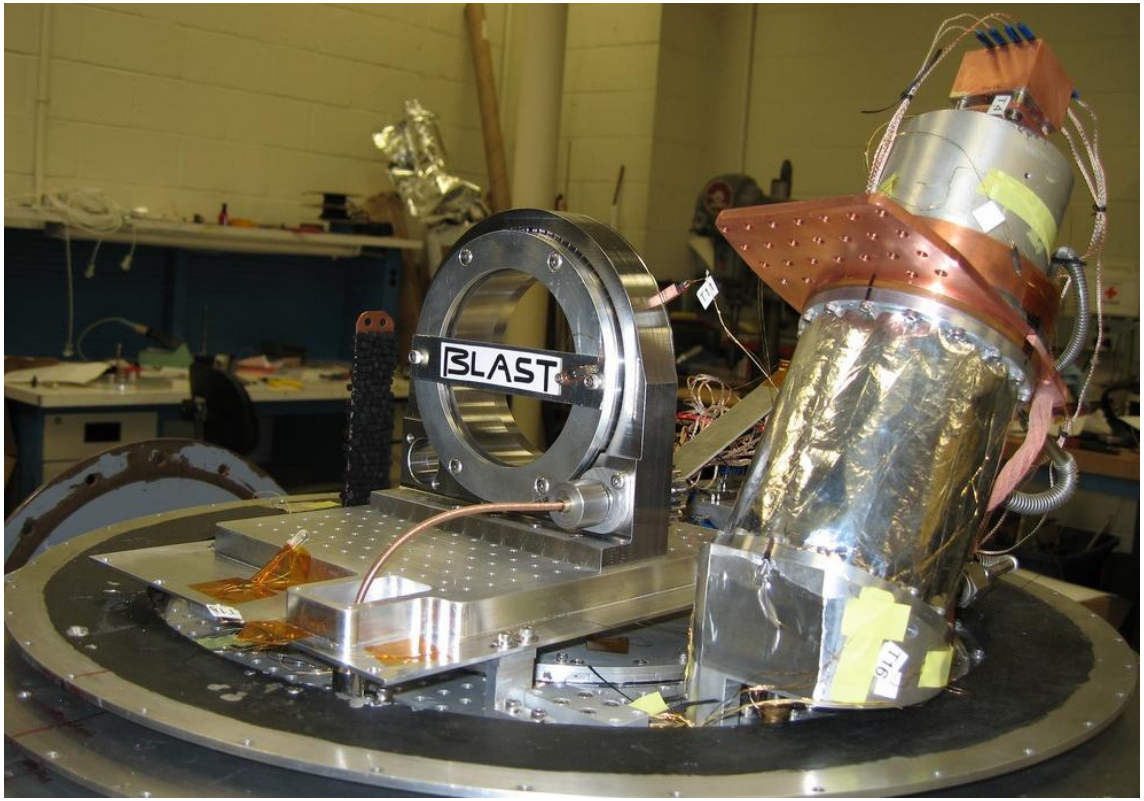


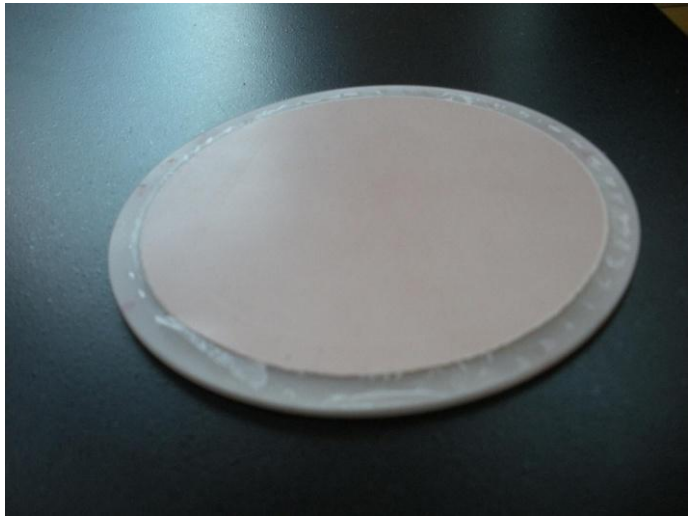


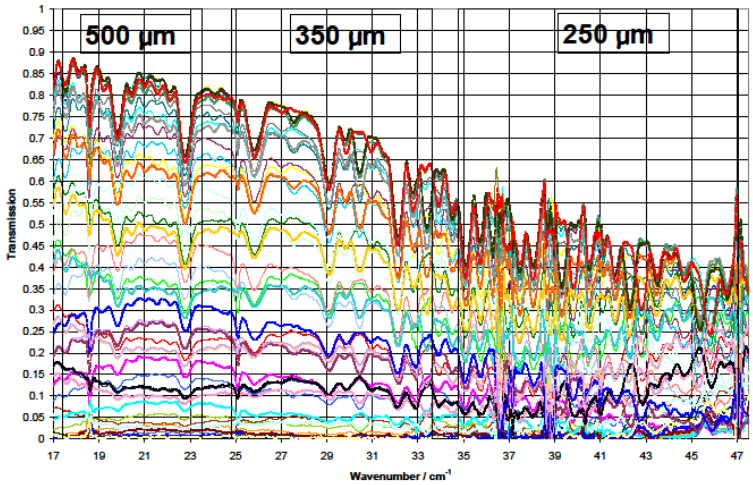
Fissel et al. 2010

- Polarize the existing BLAST detectors
- Develop polarizing grids in front of horns
- <u>Manufactured and tested in Cardiff</u>

Half Wave Plate and Rotator



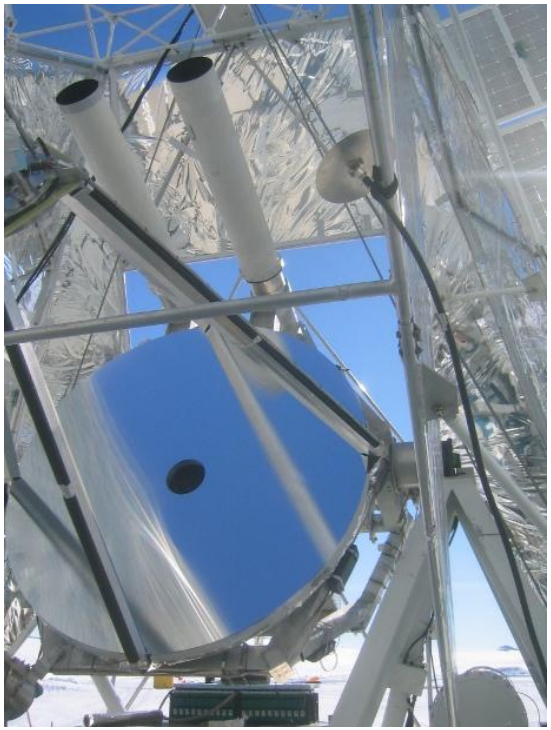




Fissel et al. 2010

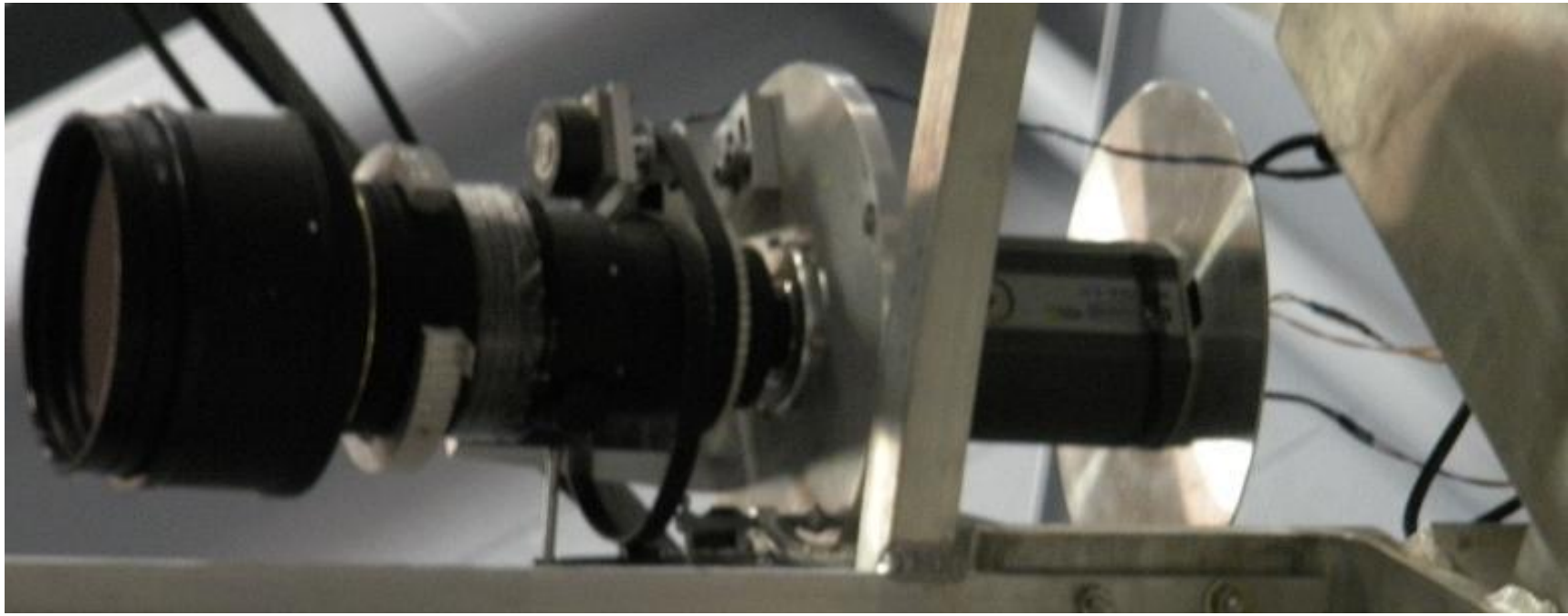
- BLAST-Pol HWP: <u>manufactured and fully tested in Cardiff</u>
  - 10 cm in diameter
  - 5 sapphire layers – 200 – 600 µm -> glued with 6 µm of polyethylene
  - AR coating - Metal mesh filter technology [Zhang et al. 2009]
  - Shape and orientation of the patterns match the refractive index

star camera(s)

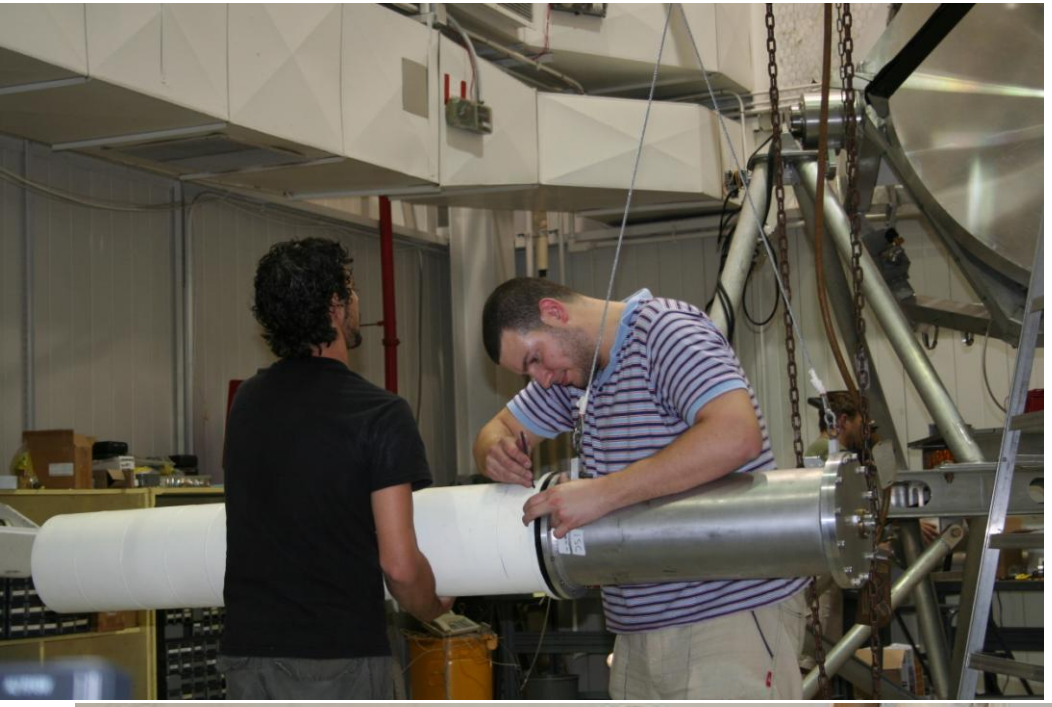


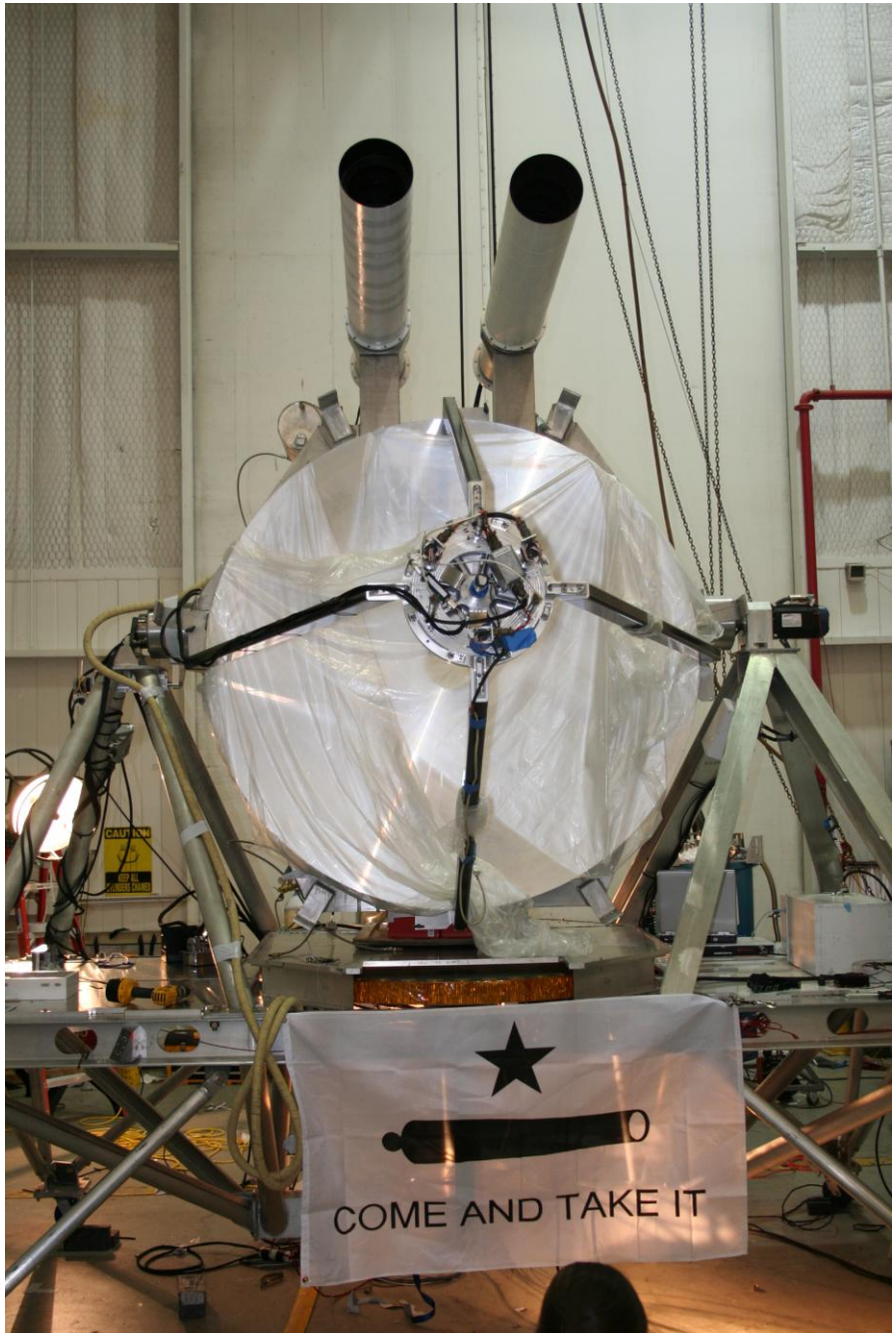
- 1.5 megapixel CCD
- 200 mm f/2 lens
- 2° × 2.5° field of the sky
- 600 nm red filter
- ~200 ms exposures
- sensitive to stars down to mag ~ 9

[100 times fainter than the faintest stars visible at night in an urban neighborhood with naked eye]



star cameras and baffles





Watch the movie: http://blastthemovie.com/