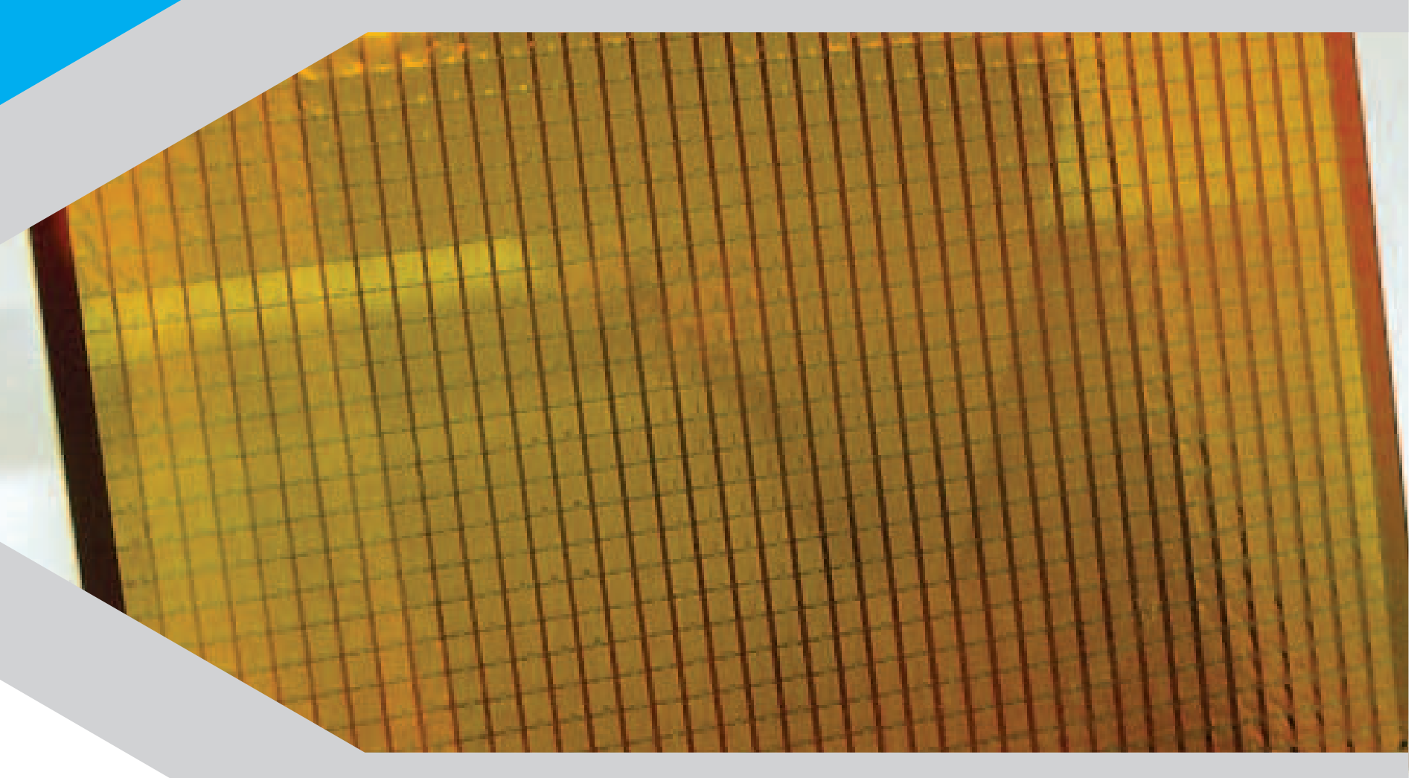
FOCAL PLANE ARRAYS FOR WIDE FIELD IMAGING, SPECTROSCOPY, AND INTERFEROMETRY



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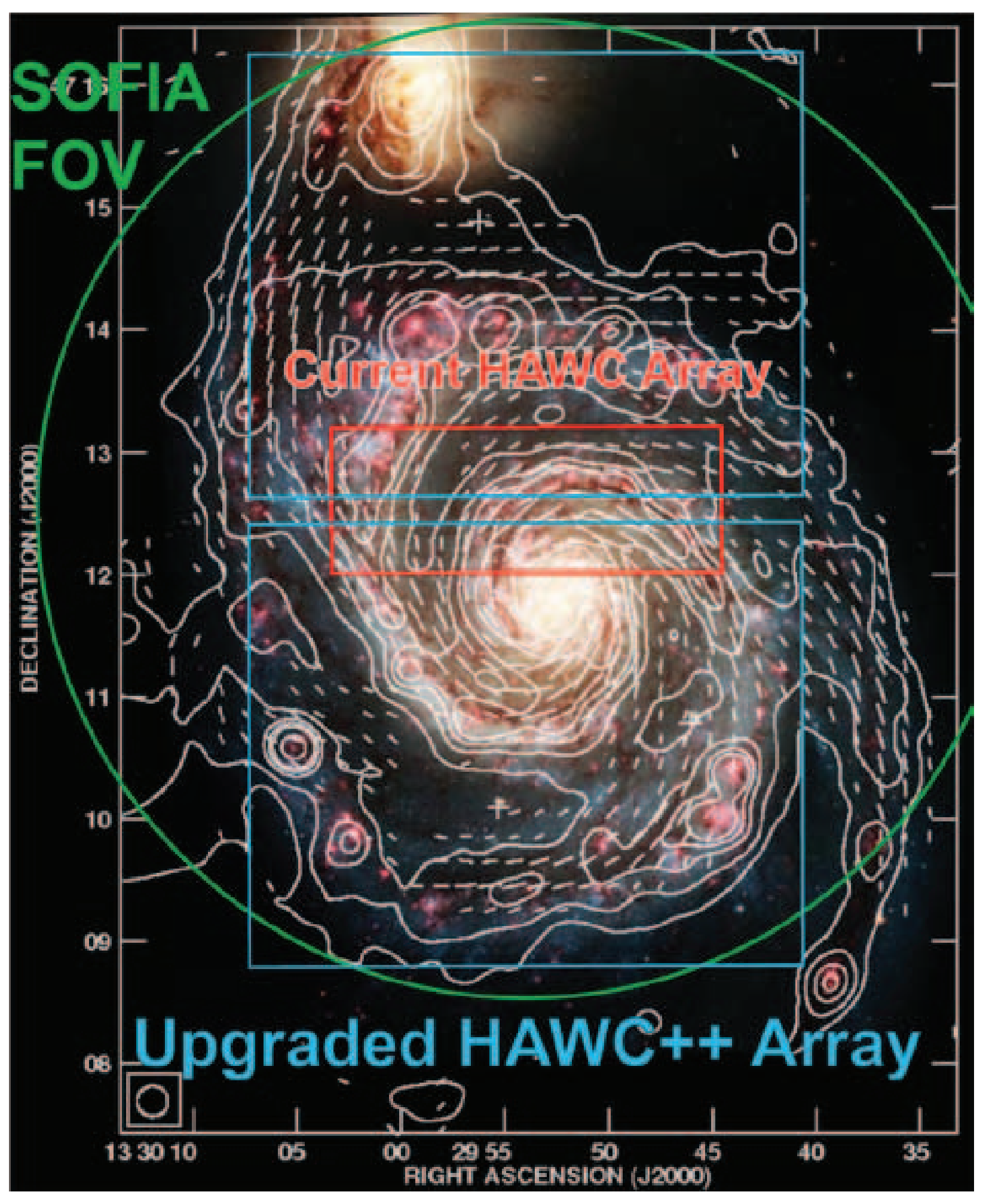
We are developing large format (up to 2,560 pixel) mosaic arrays for far-infrared wavelengths to increase the utilization of valuable focal plane real estate made possible with modern telescopes.

The detector array packages are compact, robust, light-tight, and modular, with the possibility of even larger mosaics in the future.

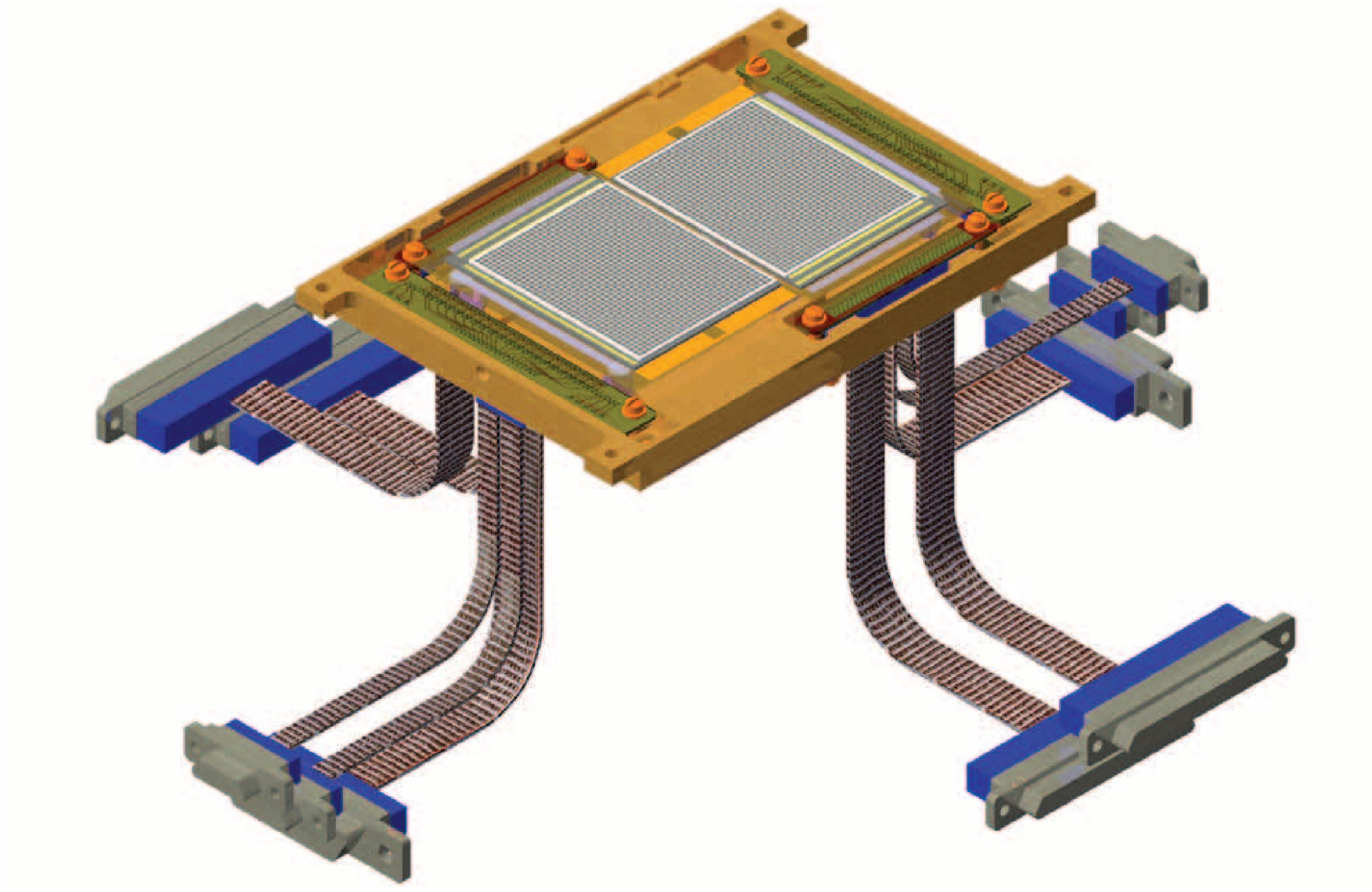
Such large focal planes can be used in spectrometers to produce simultaneous wide spatial/spectral coverage.

We highlight the detector arrays for HAWC+ on SOFIA (a far-infrared polarimeter/camera) and BETTII (a far-infrared spatial/spectral interferometer).

Both should achieve first light in 2015.

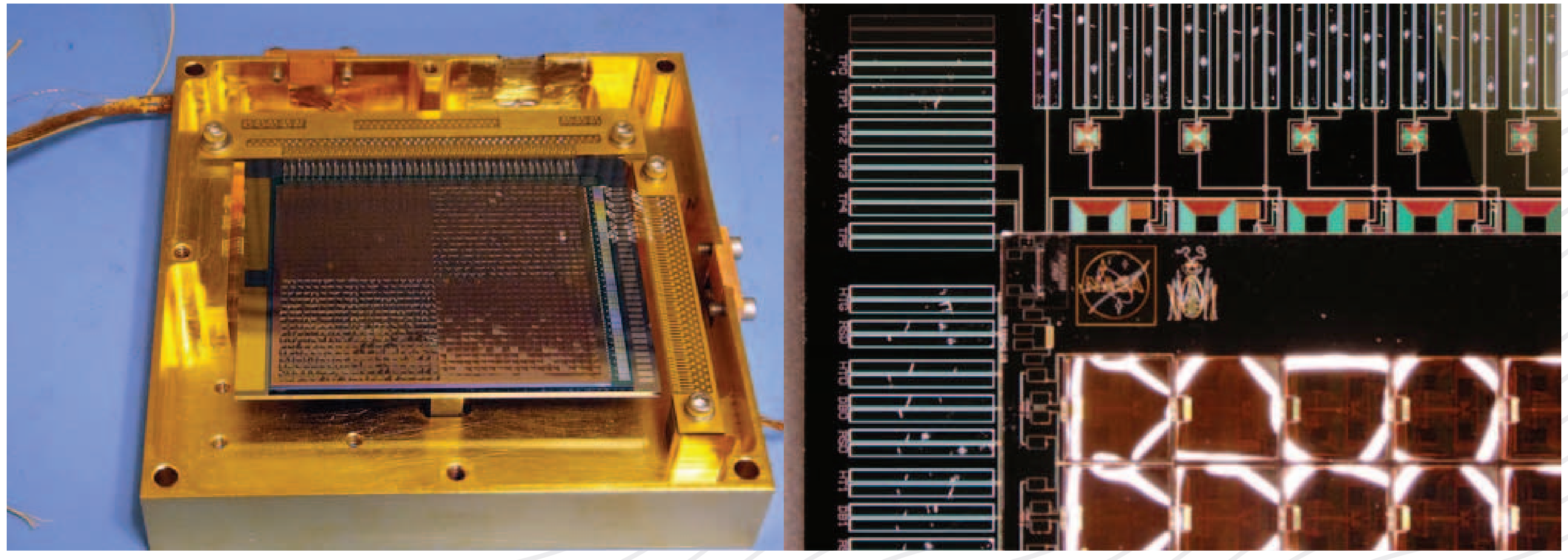


One near-term application of these arrays is in the HAWC+ instrument upgrade for SOFIA, which will feature a nearly order-of-magnitude increase in mapping speed, predominantly via increasing the number of pixels from 384 to 2,560. Sensitive polarimetry is enabled by using two focal plane arrays, one per polarization, in a differential mode. These two FPAs operate from 50 to 250 microns, with optical power varying by a factor of 100. Each FPA has two 32x40 arrays of superconducting transition edge sensor bolometers bump-bonded to a SQUID multiplexer readout.

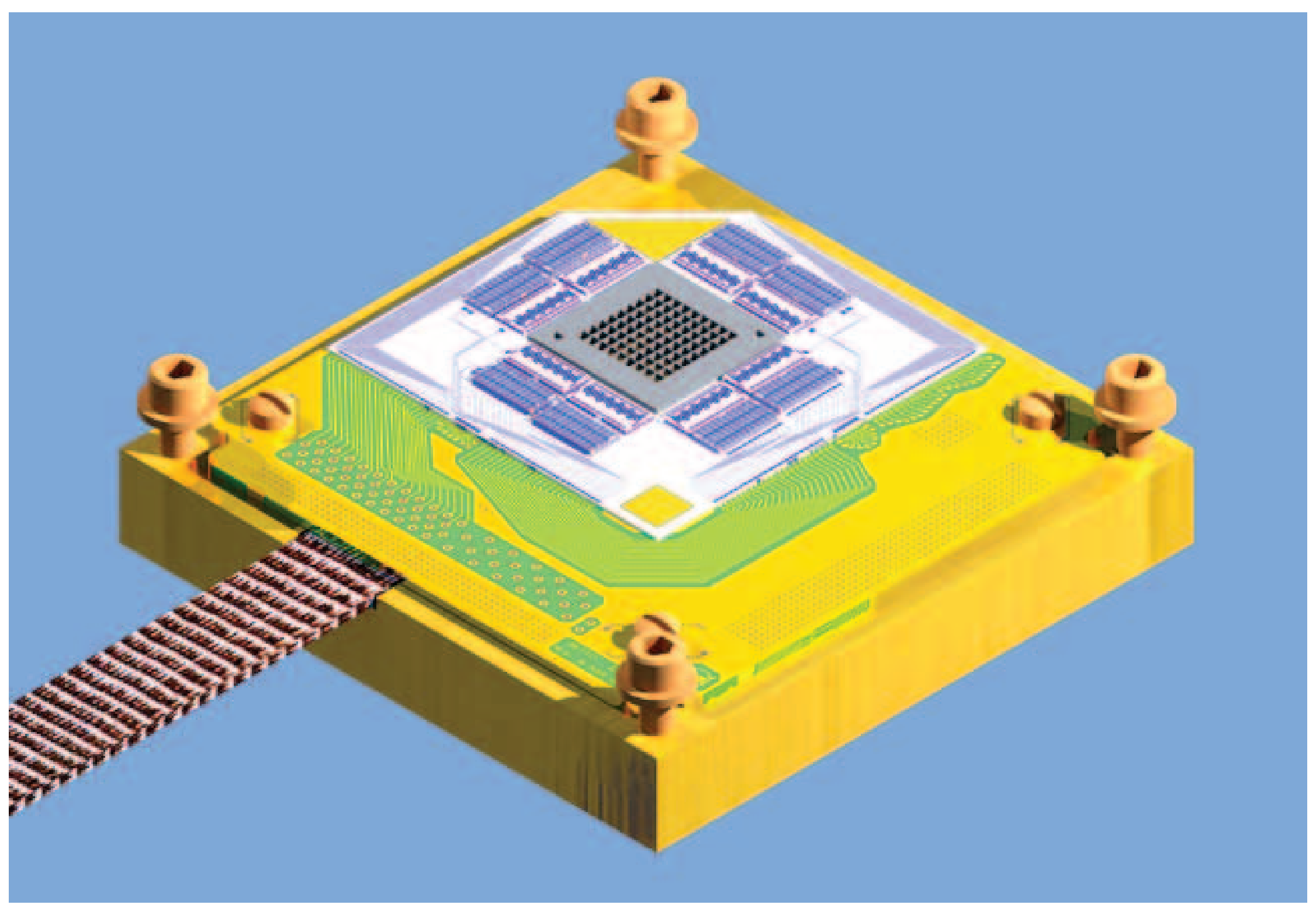


Above: Rendering of a completed 2,560-pixel (64x40) HAWC+ array, one of two required for the simultaneous dual polarization operation. Not shown is a lid/baffle assembly on top. The size of the package base is 86x132mm.

Below Left: A 32x40 array in a test package for characterization; separate quadrant designs can be seen. This unit has all the features of the above design, but with only one half. Below Right: In this enlargement, the SQUID multiplexer can be seen through the individual pixels' membranes. The TES is the small gold rectangle to the left of each translucent, brown pixel.

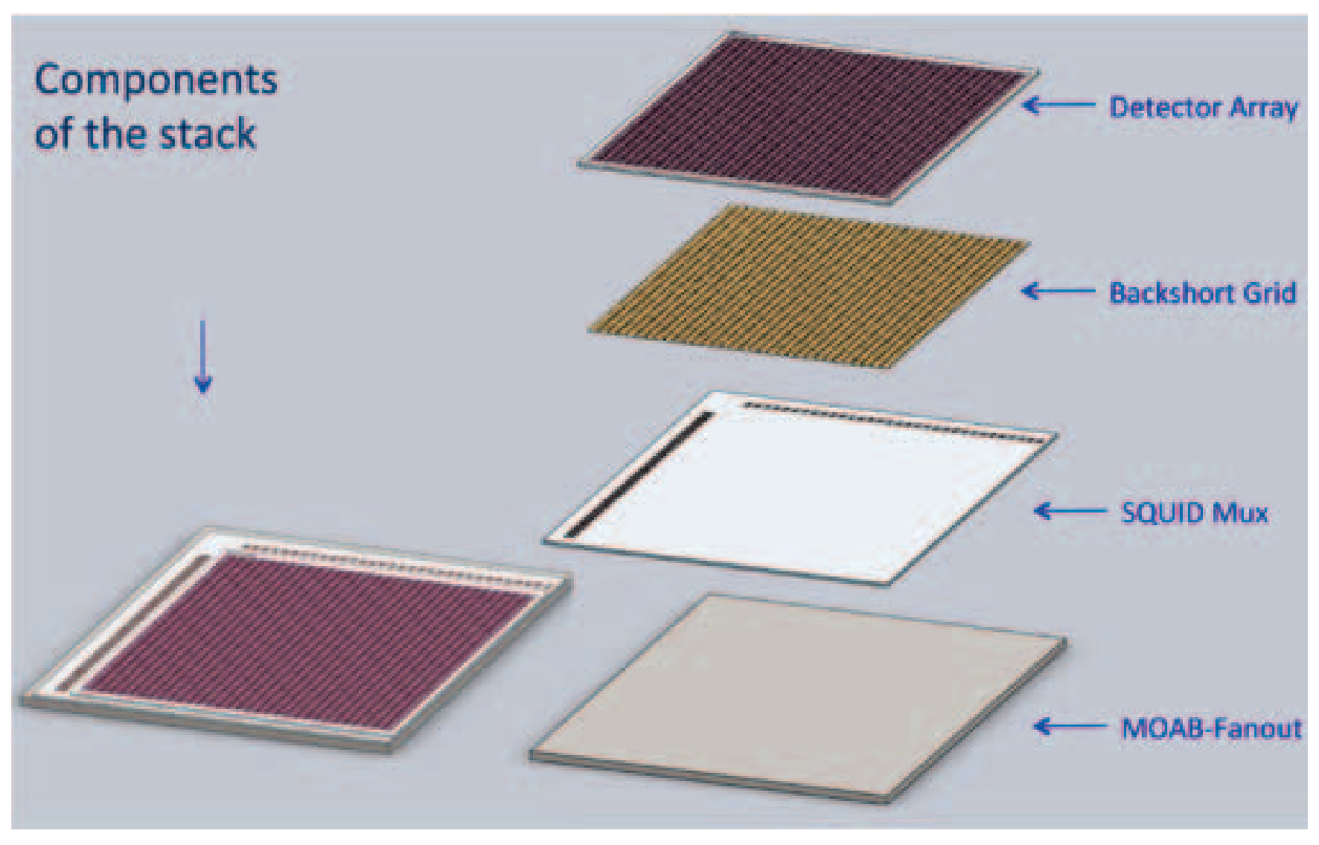


For direct-detecting interferometers, pixel speed can to a certain extent substitute for array format. BETTII will use four focal plane arrays to span both output ports of the interferometer at two wavelength bands of 30-55 and 55-90 microns. The focal plane arrays consist of 9x9 arrays of superconducting transition edge sensor bolometers suitably optimized for the high backgrounds and rapid modulation times for a balloon-borne broadband interferometer.

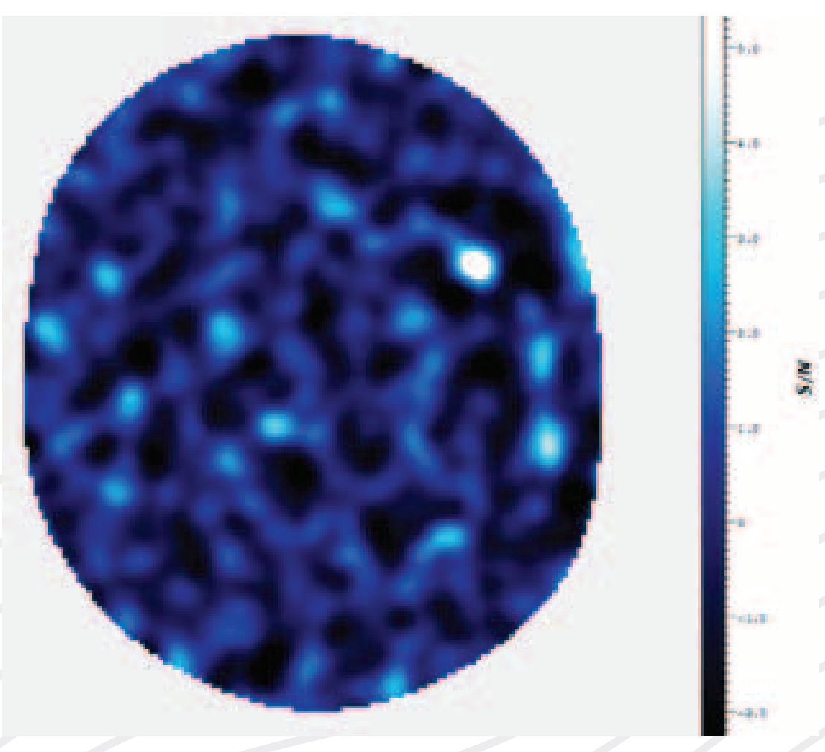


In contrast to the HAWC+ arrays, where the optically active area dominates, for the 1cm BETTII detector area the packaging dominates the size.

Above: Rendering of a BETTI array, one of four required for the simultaneous dual band amd dual output operation of the interferometer. The package is under 60mm on a side. The array is back-illuminated and the "frontshort" and lid are removed for clarity.



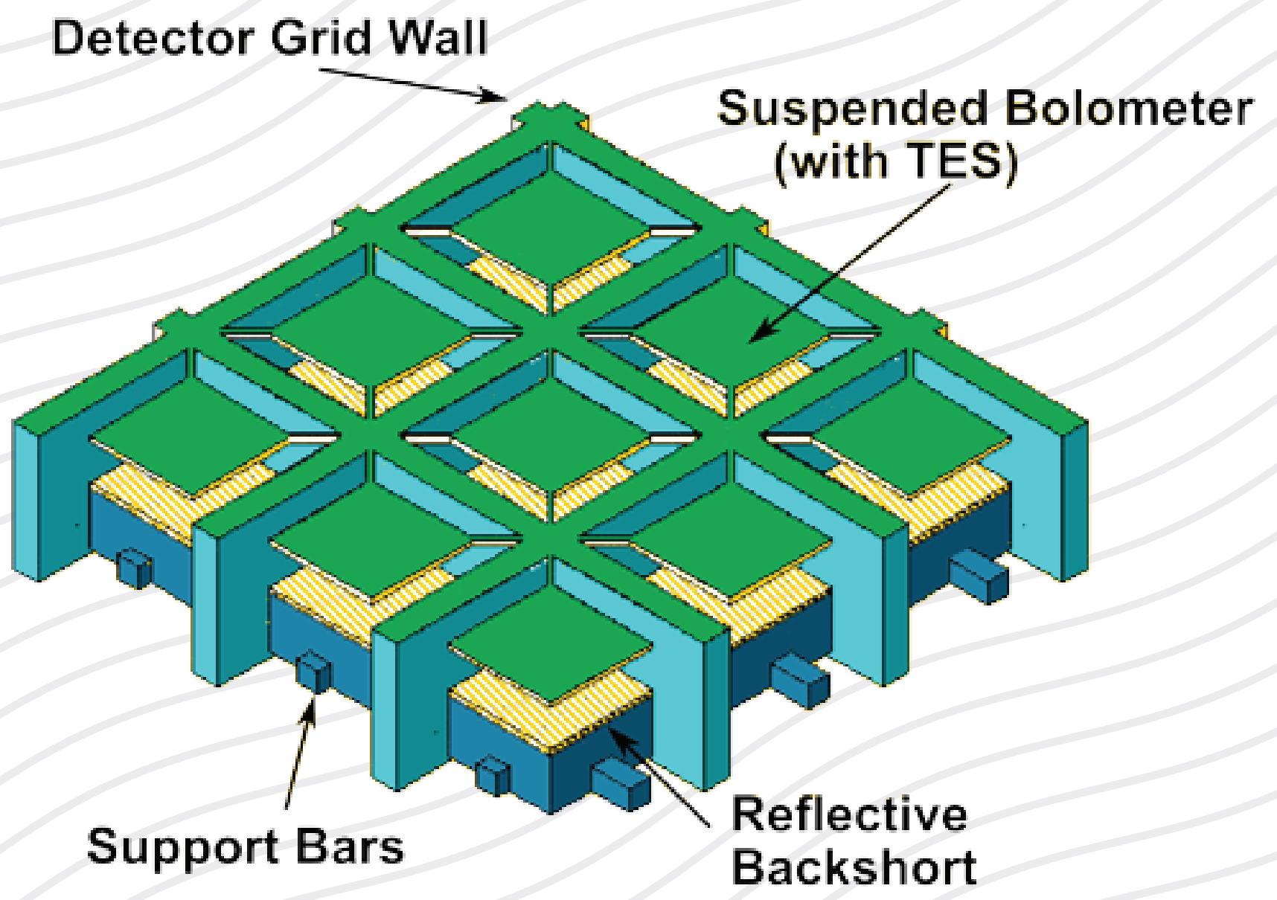
Above Right: This general assembly view shows how the Backshort Under Grid (BUG) array architecture goes together to form a hybridized array. (BETTII SQUID readouts are arrayed around the perimeter).



Right: The near-confusion limited 2 mm GISMO Deep Field map. Of the 95 mJy/beam RMS in the map, 60 mJy is due to confusion noise!

Below: A general view of the BUG architecture shows how backshorts are incorporated to tune absorptivity & how connections are made through s/c bump bonds to a backside SQUID readout circuit.

3-Dimensional View:



Cross-sectional View: