# Design and Fabrication Highlights Enabling a 2 mm, 128 Element Bolometer Array for GISMO

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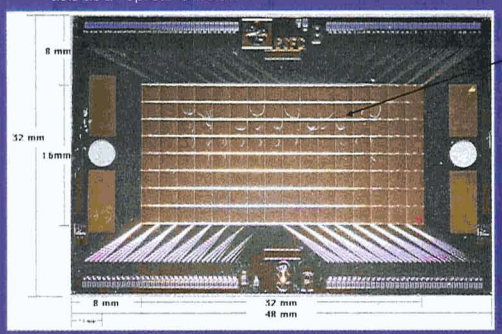
- **Goal:** Design and fabrication of a background limited, 128 pixel Tran-sition Edge Sensor (TES) bolometer array for the Goddard IRAM Super-conducting 2-mm Observer (GISMO)

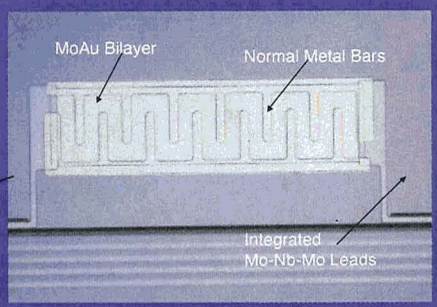
- Design approach: The array design is based on our BUG (Backshort Under Grid) detector architecture; a square grid array fabricated on 1.4 $\mu$m Silicon-On-Insulator (SOI) wafers with 1/4 wavelength resonance backshort, optimized for 2 mm

- Result: The GISMO array, having 8x16 pixels on a 2 mm pitch, covers an area 16x32 mm. The bolometers are 1.4 $\mu$m thick and fabricated on the top layer of SOI wafers. The 500 $\mu$m handle wafer is etched into a square grid to support the bolometer array and provide the 1/4 wavelength backshort spacing. The backshort is a reflective copper coating plated onto the alumina detector board.

## GISMO Array Design

- Detector for 2-millimeter radiation fabricated on 1.4 $\mu$m SOI wafers with 500 $\mu$m thick supporting square grid. The array is mounted on a copper plated alumina board, the copper coating acts as an optical reflector.



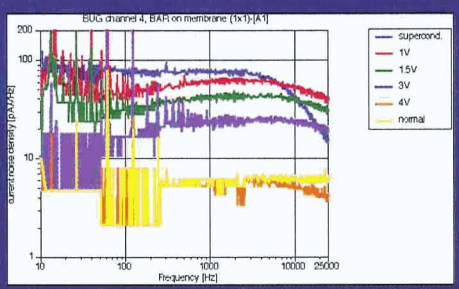




GISMO utilizes the "zebra" design TES, also successfully used for Goddard's FIBRE instrument at CSO. The design incorporates a relatively thick gold film covering the sensors edges and extending 2/3 of the distance across the sensor in an interdigitated comb design. This design significantly suppresses out-of-band 1/f noise in the sensor.

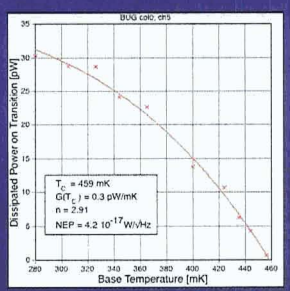
## Fabrication sequence:

- Batch sputter-sputter Mo-Au deposition
- Dry etch gold TES
- Sputter Nb-Mo leads (enhance critical current)
- Dry etch Mo-Nb-Mo leads
- Lift-off normal metal gold zebra stripes
- Lift-off aluminum bonding pads
- Mask detector body on 1.4 $\mu$m SOI top layer
- Wax wafer to temporary backing wafer
- Mask detector square grid from back-side
- Deep Reactive Ion Etch square grid through 500 $\mu$m handle wafer
- Release from wax
- Reactive Ion Etch detector body on front side
- Deposit bismuth 400 Ω absorber on back-side of detector

## Detector Characterization

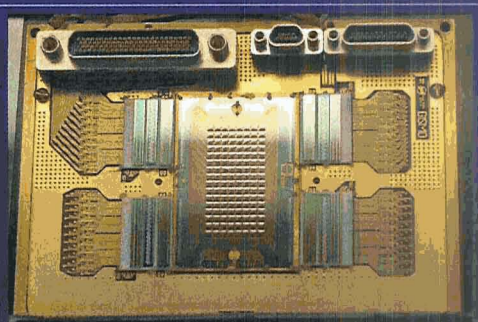



Frequency dependent noise of BUG detector with Zebra design normal metal bars. The noise levels in the region of operation are well within the desired target to permit background limited detector performance.




Detectors shown, have a measured thermal conductance, G=0.3 pW/mK @ 460 mK

- GISMO will be operated at the IRAM 30m telescope at Pico Veleta, Spain, during the summer months.
- 150 GHz, Sky Noise = $1.6 \times 10^{-16}$ W/√Hz
- GISMO 2 mm pixel NEP = ~$4 \times 10^{-17}$ W/√Hz



The GISMO array seen here fully populated with four columns of NIST 1x32 SQUIDs, Nyquists, and Goddard shunt resistors. The array is mounted on a copper-plated alumina board, fastened to flexures machined into the base of the gold-plated copper detector box. The readout connectors are soldered into the 8-layer G10 detector board.