Goddard Constellation-X calorimeter team:

R. Brekosky, T. Chen, E. Figueroa, F. Finkbeiner, J. Gygax, R. Kelley, M. Li, F. S. Porter, C. K. Stahle, A. Szymkowiak, N. Tralshawala

Primary research emphasis:

- development of processes for the fabrication of large, monolithic arrays of TES calorimeters

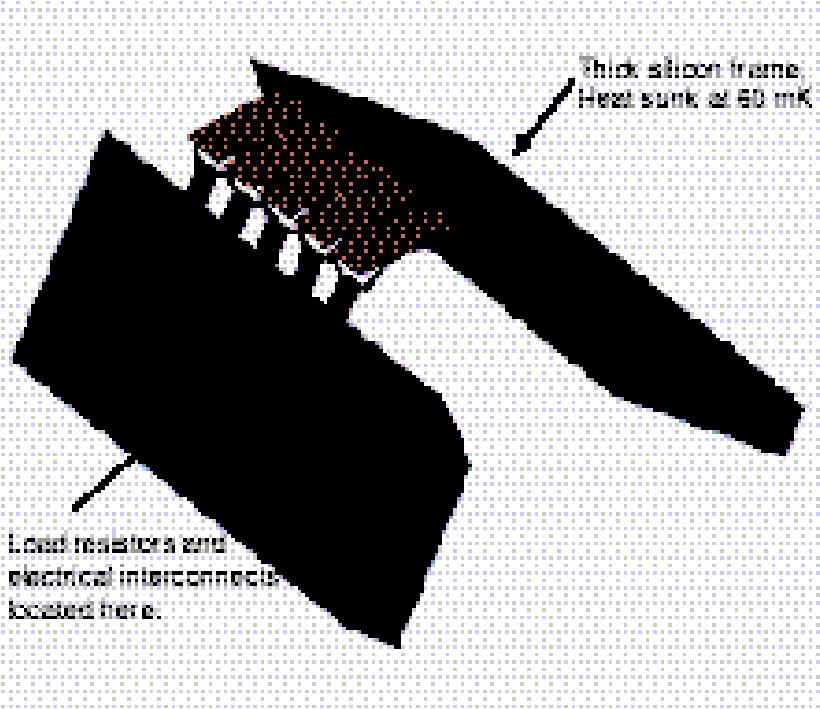
- participate in the optimization of materials and processes for making TES calorimeters that exhibit the performance required for Constellation-X with long-term stability (vis-à-vis exposure to chemicals and temperatures encountered during packaging and integration into the instrument)

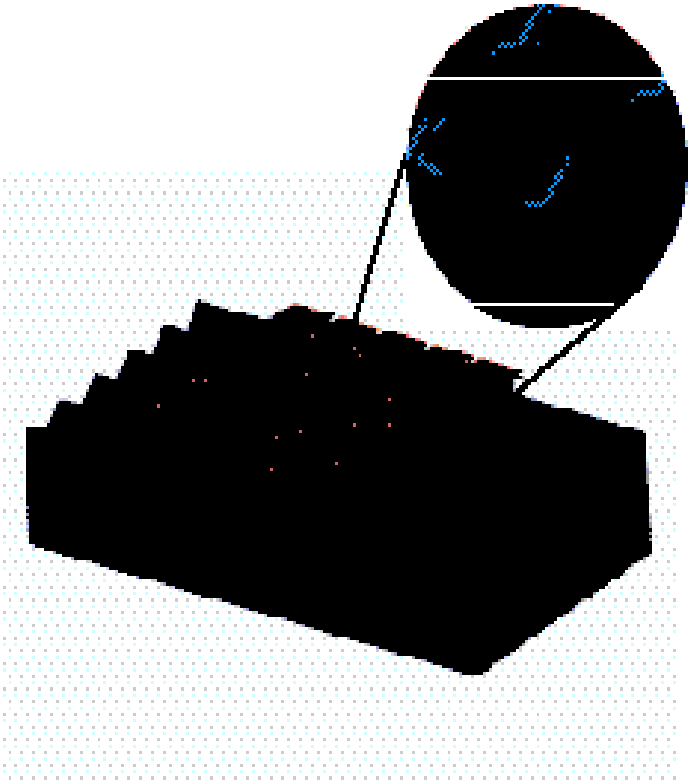
• Goddard “Pop-Up” structure, pioneered for IR bolometer arrays (Moseley and Allen), can be used as a close-packed platform for TES devices.

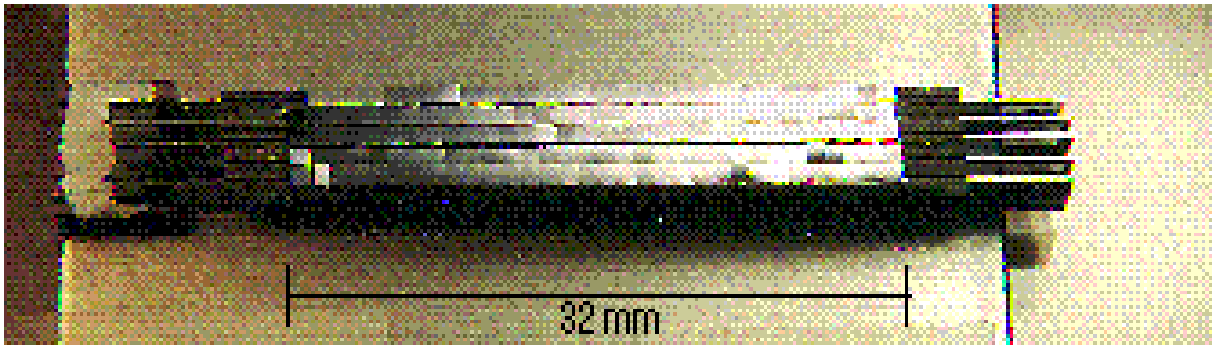
• These are micromachined linear arrays of thin silicon platforms suspended by silicon beams that provide the thermal isolation required for the weak link. The silicon beams are engineered to permit folding, so that the final configuration leaves the platform flat and aligned in the focal plane, and the silicon beams are pulled behind it. The array is formed by assembling rows of such folded structures. The Goddard group has fabricated mechanical test pop-up structures in the 200×200 μm pixel size suited to the original *Constellation-X* array specifications (based on an 8 m focal length).

• Many of the preliminary designs had high yield. Non-linear mechanical analysis has suggested design changes that can reduce the loss of active area due to the cantilevers and the strain-relieving cut-outs that are used to allow the silicon to fold without failing. In order to recover more of the lost active area, the Goddard group has begun the development of absorbers that would be cantilevered over the dead areas in the mechanical structure of the array.

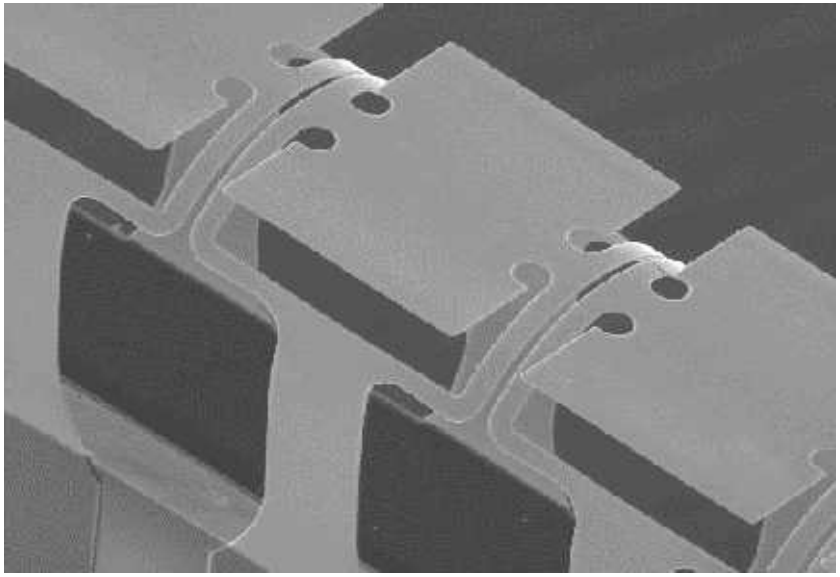
Pop-Up Array Structures

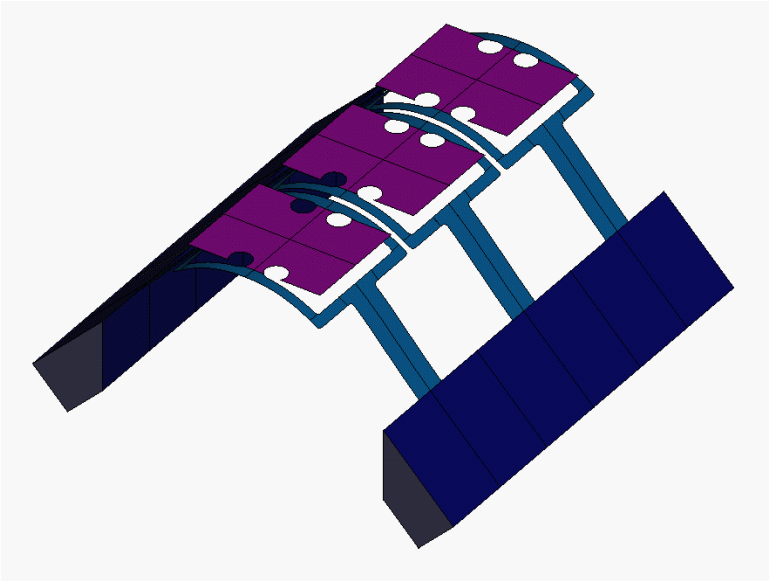


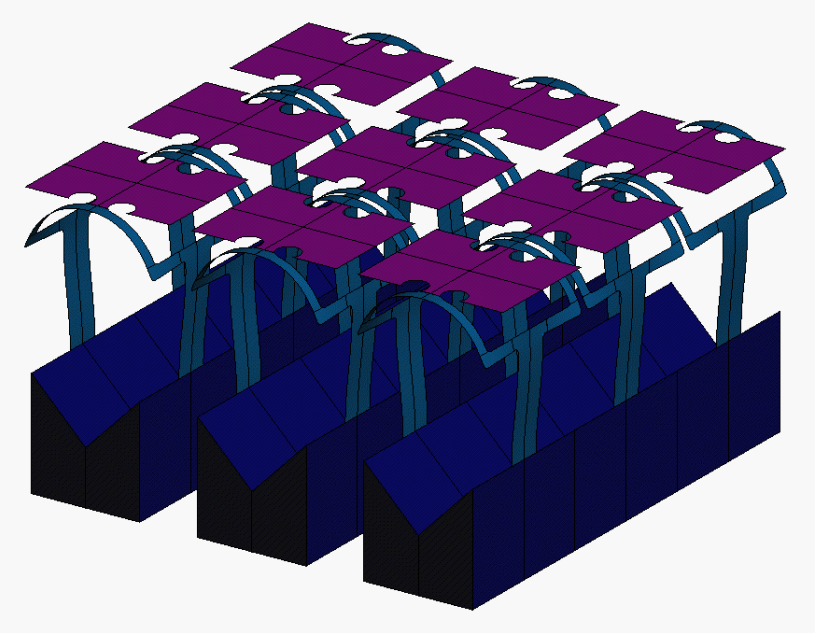




One of the successful pop-up designs and a schematic showing assembly into an array. Note the need for overhanging absorbers to make up for lost filling fraction.







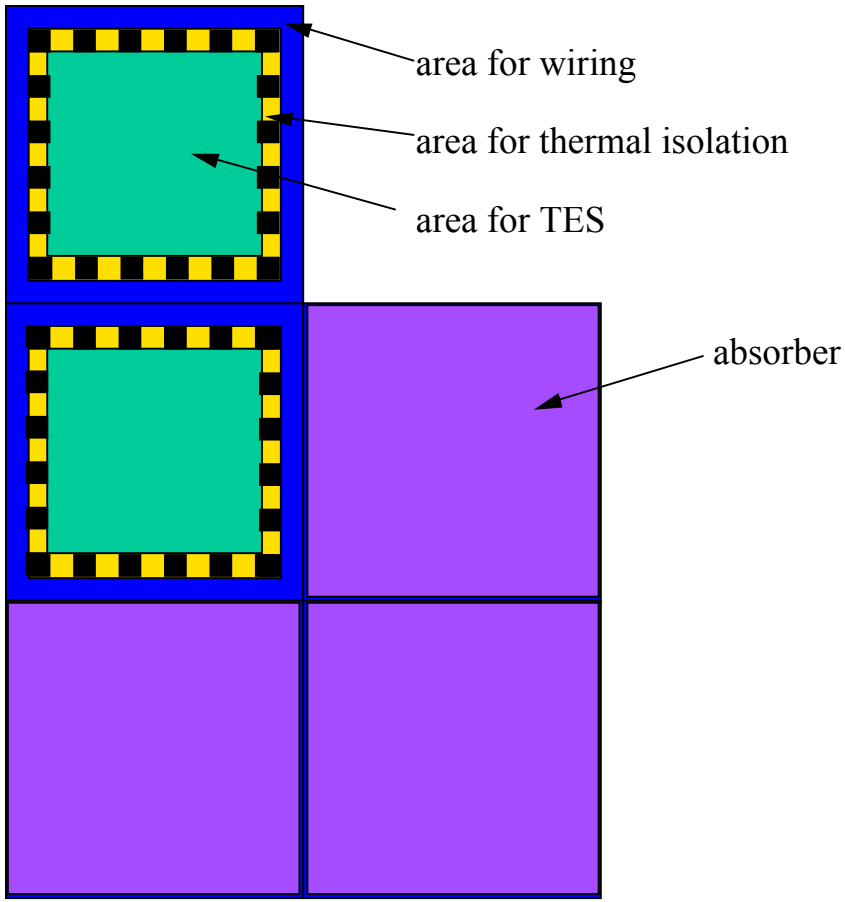
- One of the appealing aspects of the pop-up geometry had been the removal of the weak link from the focal plane, leading to potentially high filling factors without engineering cantilevered x-ray absorbers.

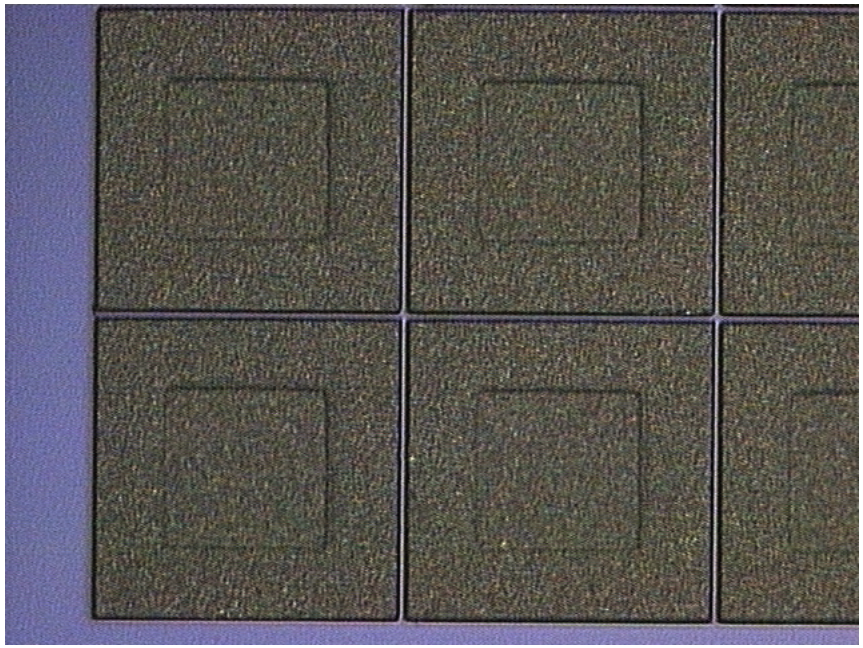
- This potential advantage was not realized in the Constellation-X scale devices due to the impracticallity of scaling down the “hinge” geometry from the IR design.

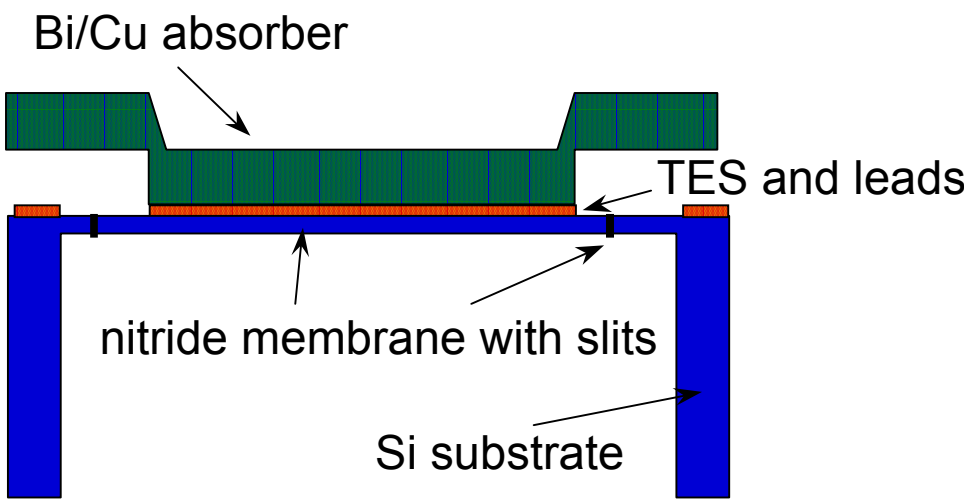
- Clearly we need absorbers that overhang these hinge structures.

- But if we’re taking the development in that direction, we have the opportunity to array structures that contain the thermal links in-plane and require no folding or assemby into arrays. The challenge here is to contain the weak link and adequate area for the TES and electrical contacts within the required pixel size.

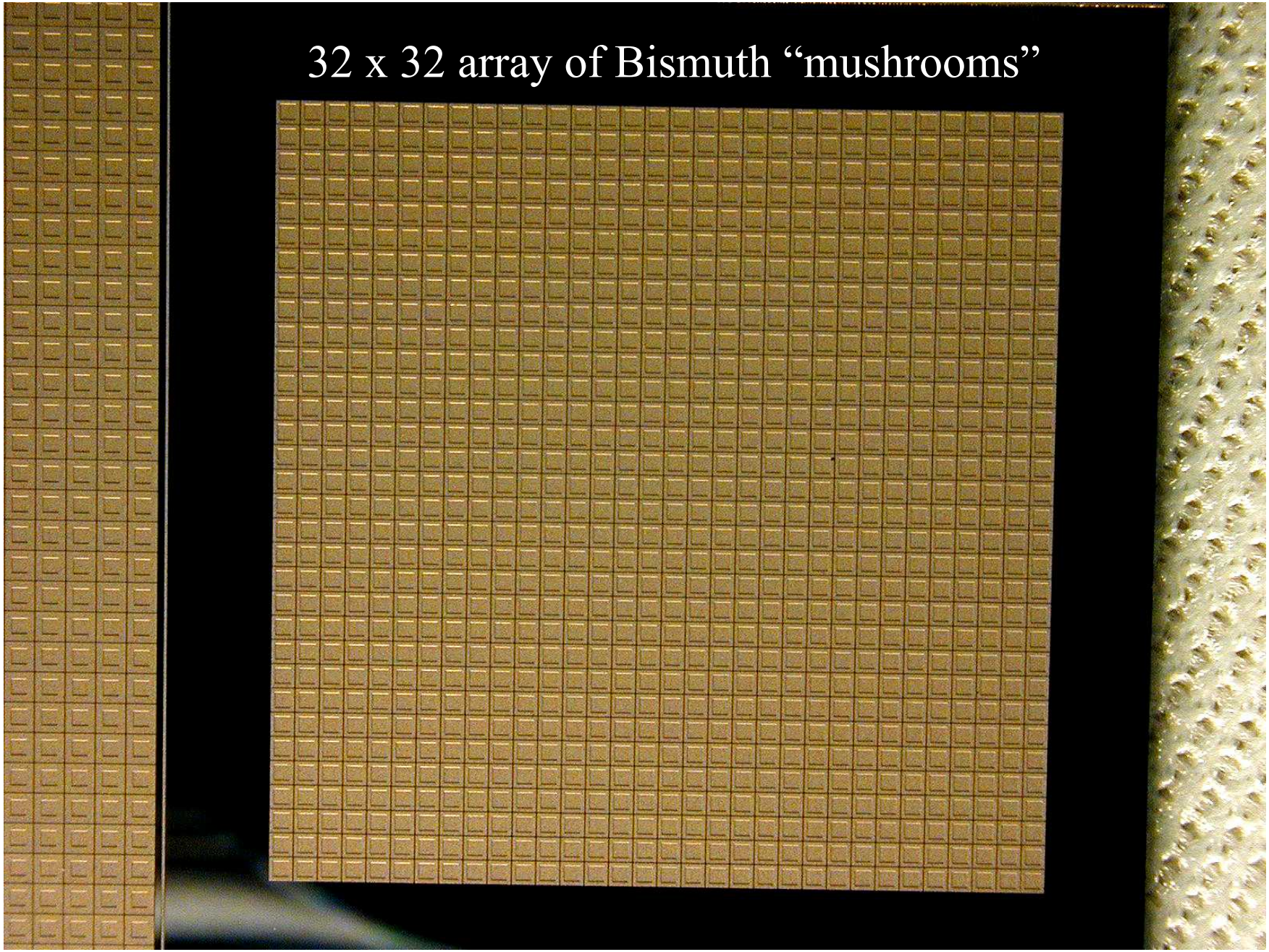
Scheme for high filling fraction

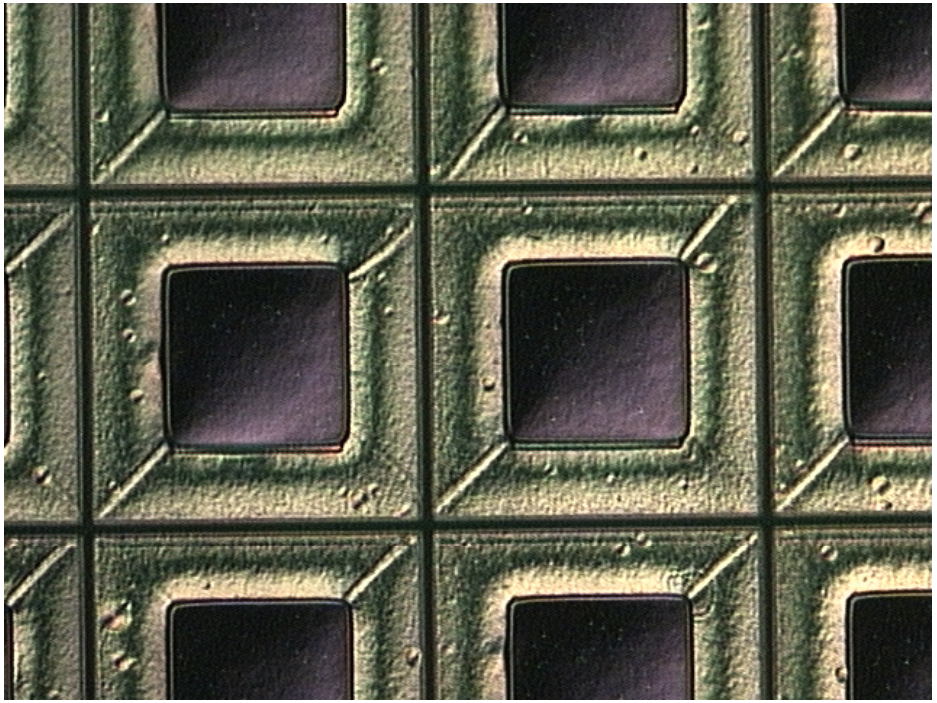




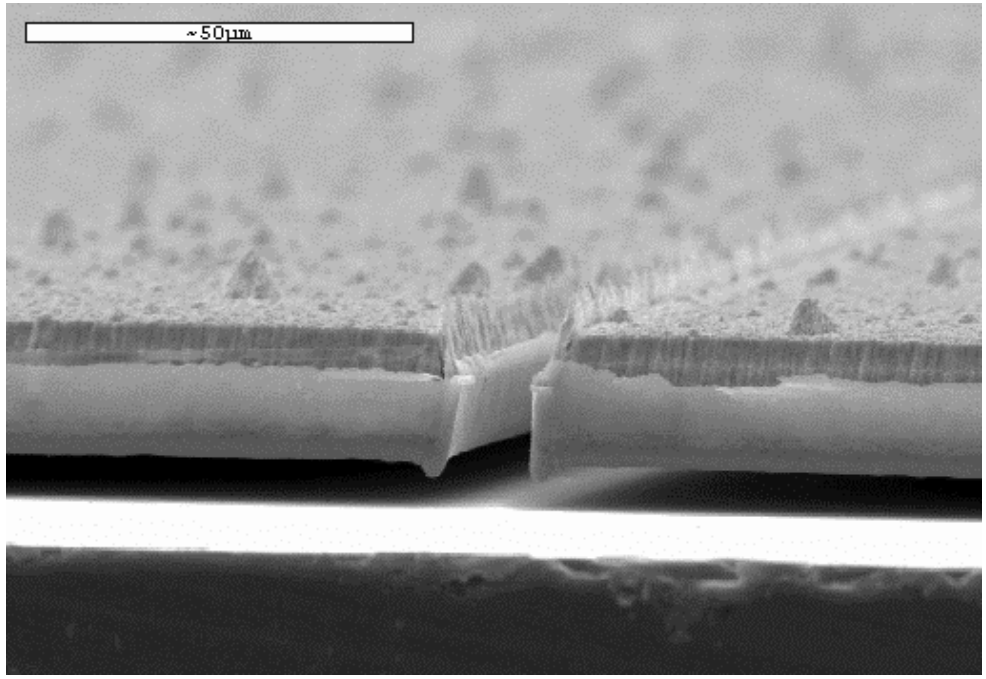


32 x 32 array of Bismuth “mushrooms”

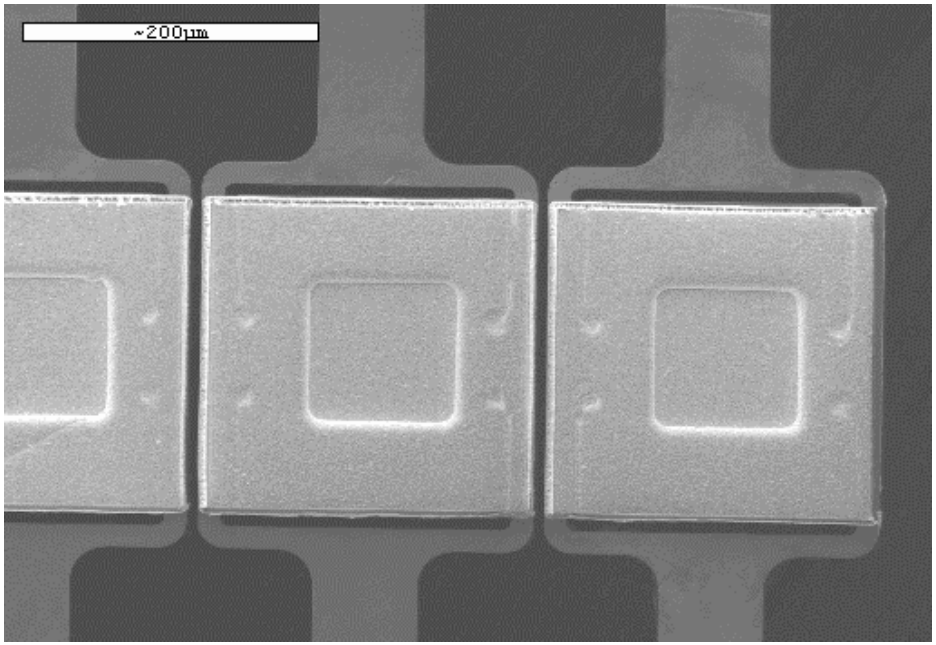


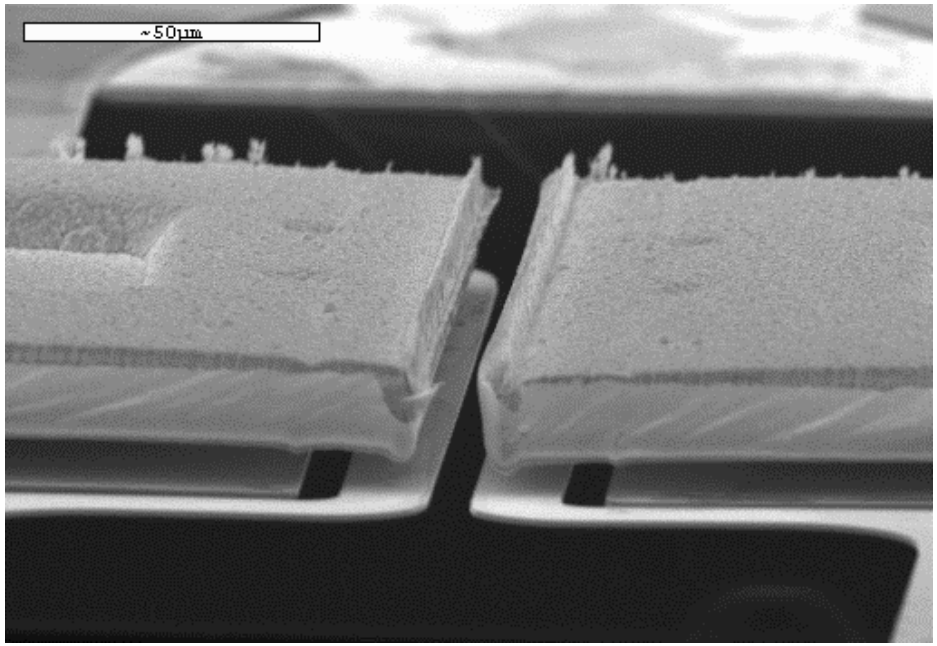


Back view (through nitride!)

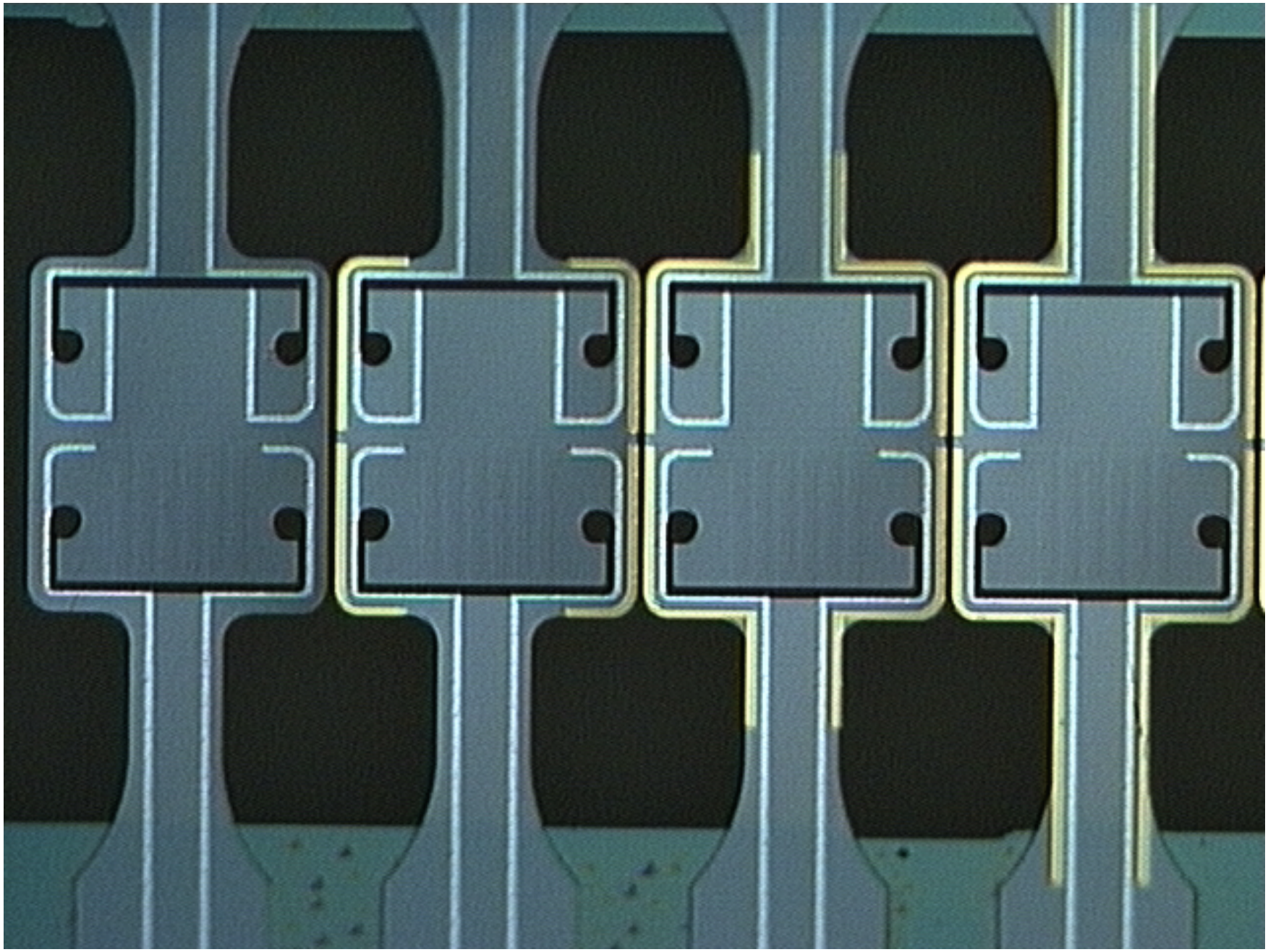


Side view





And, yes, we can also put these overhanging absorbers on the pop-ups



Near term plans:

- continued development of Mo/Au TES bilayers and integrated process *(and read-out in device testing apparatus)*

- measure thermal conductance in test structures and design weak link for array structures

- further develop overhanging absorbers in planar array scheme and on pop-ups

- test integrated devices