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## Assembly and integration process of the high-density detector arrays for Simons Observatory

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The Simons Observatory (SO) will measure the cosmic microwave background (CMB) temperature and polarization using a suite of new telescopes in the Atacama Desert in Chile. The SO will use multichroic transition edge sensor (TES) bolometer arrays spanning six frequency bands from 27GHz to 280GHz.

The SO will pioneer use of a densely-packed multiplexing architecture based on the microwave SQUID multiplexer (umux), in which each TES is inductively coupled to a single microwave resonator through an rf SQUID. Each TES array is housed in a 8-inch-diameter universal focal-plane module (UFM), comprising ~2000 TESes fabricated on a 150mm silicon wafer, coupled to 28 umux chips and other cryogenic multiplexing circuitry, with either gold-plated Al feedhorns or silicon lenslets for optical coupling. A few dozen electrical lines enter the UFM to provide biasing and readout functions, while one or two pairs of coaxial transmission lines carry the 2000 detector signals in 2000 separate frequency channels. Flexible circuitry mates to conventional connectors to the silicon components, along with some 12k wire bonds for interconnections and grounding in a typical UFM. Robust packaging methods are therefore crucial.

We present the assembly and integration of the SO UFM. We separate the integration into two stages: the integration of the universal microwave-multiplexing module (UMM), and then the integration of the UMM with the detector and optical coupling components into the UFM. We first integrate the UMM with a copper base for screening and validation, then transfer the UMM onto the detector wafer stack and its optical coupling components to assemble the UFM. Procedures, including chip gluing, wire bonding, and aligning of parts, are done with highly automatic tools, and therefore are repeatable and uniform, as will be needed for the production of the 49 UFM. We will describe optimization of the assembly methods for the best performance.

### Less than 5 years of experience since completion of Ph.D

Y

### Student (Ph.D., M.Sc. or B.Sc.)

Y

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