Commercial Release of a Ta-based Superconducting Tunnel Junction X-Ray Detector for Synchrotron Science

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STAR Cryoelectronics has developed a line of commercial X-ray detectors based on Ta-Al superconducting tunnel junctions (STJs) for synchrotron X-ray absorption spectroscopy (XAS). The detector is built around a cryogen-free cryostat with a two-stage pulse tube cryocooler and a two-stage adiabatic demagnetization refrigerator (ADR) that attains a base temperature < 50 mK on the detector stage. The detector chip is positioned at the end of a 42-cm cold finger for insertion into the sample vacuum chamber to maximize solid angle of collection. As our Ta-Al STJs may operate at temperatures up to 300 mK, the ADR may be controlled well above base temperature for improved hold time, with > 60 hours between ADR regeneration cycles at a setpoint of 250 mK. Two versions of the STJ detector have been developed: a 112-pixel, full-size version with a 78-mm diameter snout, and a 36-pixel mini version with a 32-mm diameter snout for small sample chambers with 2.75" diameter CF ports. Both versions have 200 μm x 200 μm pixels with a typical energy resolution of 9 eV full-width at half-maximum at 525 eV, typically limited by the source line width of the oxygen K line. Each pixel may be operated at count rates up to 5,000 counts/s with minimal degradation in energy resolution, and count rates over 12,000 counts/s/pixel with resolution < 30 eV are possible for increased sensitivity for very dilute samples at bright beam lines. Integrated
preamplifier and signal processing electronics from XIA LLC allow completely remote-controlled tuning and operation of the instrument. The combination of high resolution, high count rates, and user-friendliness allow the STAR STJ detector to take full advantage of modern high-brightness synchrotron beam lines.

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