



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

**Main author:**

CARPENTER Matthew H

**Co-authors:**

Cantor Robin, STAR Cryoelectronics, 25-A Bisbee Ct., Santa Fe, NM 87508

Carpenter Matthew H, STAR Cryoelectronics

Friedrich Stephan, Lawrence Livermore National Laboratory, 7000 East Ave., Livermore, CA 94550

Hall J Ad, STAR Cryoelectronics, 25-A Bisbee Ct., Santa Fe, NM 87508

Harris Jackson, XIA LLC, 31057 Genstar Rd., Hayward, CA 94544

Ponce Francisco, Lawrence Livermore National Laboratory, 7000 East Ave., Livermore, CA 94550

Warburton William K, XIA LLC, 31057 Genstar Rd., Hayward, CA 94544

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  $\mu\text{m}$  x 200  $\mu\text{m}$  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.

This work was supported by the US Dept. of Energy under contracts DE-SC0004359 and DE-SC0006214.