Sandia National Laboratories

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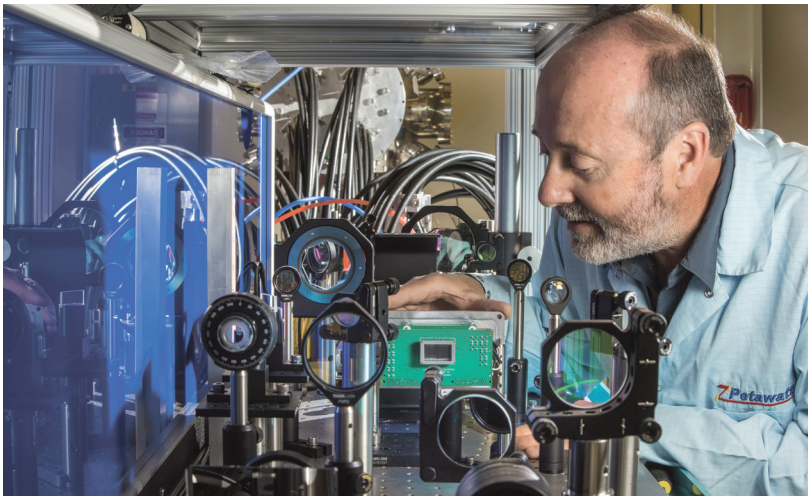
FURI CAMERA: ULTRA-FAST DIGITAL X-RAY IMAGER

Patent Pending
Technology Readiness Level: 5
Key elements demonstrated in relevant environment

TECHNOLOGY DESCRIPTION



High Energy Density (HED) physics and inertial confinement fusion experiments rely on successively monitored images for data collection. Currently, gated X-ray imaging and spectroscopy in the 0.1-10 nanosecond (ns) time scale in HED physics utilize Micro-Channel Plate (MCP) detectors. Unfortunately, MCP detectors suffer from small to moderate dynamic range, difficulty in calibration, and can only capture a single frame along each line of site. HED experiments carried out at Sandia's Z-Machine facility, led to the development of the Furi camera—a high speed, multi-frame, time-gated Read Out Integrated Circuit (ROIC)—as a more efficient replacement for MCP detectors. The Furi camera is capable of taking images with an exposure time of only 1.5 ns, and taking extremely close sequential images within the same experiment.

Furi was developed to take two, 2 ns X-ray images with high, 25 µm, spatial resolution. It consists of a 1024 x 448-pixel array of 25 µm pixels with two frames of 1.5 million electron in-situ pixel storage, the associated readout decode circuitry, parallel output analog buffering for pixel data read off and high-speed timing generation and distribution blocks.

The system is designed to be completely configurable based on the specific experimenters needs. Various shutter speeds can be set based on experiment parameters, as well as scalability to a greater number of frames for future iterations of imagers. The current silicon detector used on Furi is sensitive to 4-6 keV X-rays or 532 nm visible light. The detector is bonded to the ROIC using a 3-dimensional interconnect. This allows different detectors to be bonded to the ROIC enabling the camera to be used in a wider area of applications.

This novel high-speed camera will allow researchers the new ability to view a succession of chemical, nuclear, or biological reactions that occur in nanoseconds—making it a valuable research tool for industry or universities.

TECHNOLOGICAL BENEFITS

- Sequential X-ray backlighting images for experiments
- First full sized ROIC fabricated for a planned suite of time-gated, multi-frame, burst mode, high speed imagers
- Less costly
- Configurable to meet experiment parameters

POTENTIAL APPLICATIONS

- High Energy Density physics
- Inertial Confinement Fusion experiments
- Any experiment requiring multiple high speed X-ray back-lit images

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