

---

## Non-Intrusive Flow Monitoring for Liquid Metal and Molten Salt Cooled Reactors

**PI:** Gary Pickell – *Virginia Tech*

**Collaborators:** Christian Petrie – *Oak Ridge National Laboratory*; Kevin Robb – *Oak Ridge National Laboratory*; Matthew Weathered – *Argonne National Laboratory*; Derek Kultgen – *Argonne National Laboratory*; Brian Risch – *Prysmian Group*

**Program:** Reactor Concepts Research, Development and Demonstration (RC RD&D)

---

### ABSTRACT:

In the proposed three-year program, the Center for Photonics Technology (CPT) at Virginia Tech will collaborate with the Mechanisms Engineering Test Loop Facility (METL) at Argonne National Laboratory (ANL) and Oak Ridge National Laboratory (ORNL) and Prysmian Group, the world's leading producer of optical fiber and cable, to develop a first-of-its kind flow monitoring system with significantly enhanced capabilities for liquid metal fast reactors (LMFRs), as well as other advanced reactors such as molten salt reactors (MSRs). A proven and breakthrough fiber optic sensing technology that enables the harmonic-free interrogation of thousands of grating-based distributed interferometers along an optical fiber that is integrated into a sensing pad that can readily be installed at desired locations in the flow loop will be developed. System reliability will be assured by the nonpenetrating configuration of the fiber optic sensing system that will alleviate degradation concerns upon direct exposure to liquid metal/salt and the ultra-high sensitivity of the acoustic sensors will enable the deployment of the radiation tolerant sensing fiber on the exterior of the piping insulation to avoid elevated temperatures and high levels of radiation. The development of the fiber optic acoustic sensing-based flow monitoring system will provide real-time measurements for the feeder lines and secondary loops to assure the reactor's heat balance, optimize the performance of the heat exchangers and improve the safe operation of LMFRs and MSRs.

The objective of the proposed three-year effort will be to develop and demonstrate the performance of a non-intrusive liquid metal/salt flow monitoring system based on an ultra-sensitive distributed fiber optic acoustic sensing system. The radiation tolerant optical fiber sensors will be configured in a readily deployable "sensing pad" that can be applied around the piping insulation to limit exposure to radiation and high temperatures. Comprehensive theoretical modeling and analysis of liquid metal and molten salt flow will drive the development of the stable sensing algorithms that will generate accurate real-time measurements. The performance of the prototype flow monitoring system will be demonstrated on small-scale flow loops by Virginia Tech. Ultimately, the prototype monitoring system will be field tested in liquid metal and molten salt flow loops at ORNL and METL.

The proposed program is fully supportive of the Office of Nuclear Energy (NE) mission and critical to the workscope to develop advanced instrumentation and sensors for liquid metal (and molten salt) cooled reactors. The successful completion of the project objectives will meet the pressing need for accurate, reliable, and non-invasive flow rate monitors for MSRs. Implementation of this technology will be useful in monitoring clogging and corrosion issues and can also readily be configured to provide distributed temperature measurements. The utilization of a commercially available, one-of-its kind distributed acoustic sensing system with ultra-high sensitivity will represent a step change in the characterization and monitoring capabilities for MSRs and LMFRs that will support operations, monitoring and maintenance activities.