

Attachment 1 – DAGSI Research Topic Template

NOTE: Under the Cooperative Agreement, Technical Directorates have three options for topics. First, a topic can strictly be considered in the pool for the state allocation of funding. DAGSI will work across the TDs for this allocation. Second, the TD can be prepared to be a funding partner with the State of Ohio. This would include: providing additional funds to support additional recipients of a topic, or expand the proposers team to include additional members on a topic. Third, the TD may elect to fully fund a topic not selected for State of Ohio funding or to pursue University teams outside the State of Ohio. Contact lindsay.kotouch.2@us.af.mil for questions.

1. **Research Title:** Fluid-Structure Interaction (FSI) Characterization via Event-Based Imaging in Wind and Water Tunnels

2. **Individual Sponsor:**

Dr. Abigail Juhl AFRL/REESM
AFRL/RX Bldg. 654, Rm. 317
2977 Hobson Way
WPAFB, OH 45433-7333
Abigail.juhl.1@us.af.mil

3. **Academic Area/Field and Education Level:**

Aerospace Engineering, Mechanical Engineering, Fluid Dynamics, Material Science, Computer Science, and Structural Mechanics/ Dynamics (BA/BS, MS or PhD level)

4. **Objectives:**

- Develop experimental protocols for integrating and calibrating asynchronous event cameras in both water tunnel and wind tunnel testing environments.
- Formulate computer vision and signal processing algorithms designed to reconstruct continuous, quantitative velocity and vorticity fields directly from sparse, asynchronous event data.
- Conduct synchronized diagnostic testing using high-speed Particle Image Velocimetry (PIV) alongside event cameras to benchmark flow field reconstructions.
- Establish validation pipelines comparing high-temporal-resolution event camera measurements against theoretical and computational FSI models.

Description: Characterizing highly dynamic fluid-structure interactions (FSI) in real-time remains a bottleneck in aerodynamic design. Traditional frame-based high-speed cameras impose a severe trade-off between frame rate, spatial resolution, and data storage capacity, often leading to motion blur or missed transient physics at high frequencies. Event cameras resolve these limitations by operating

asynchronously. Instead of capturing global frames at fixed intervals, each independent pixel reports changes in local log-intensity (events) with microsecond-level temporal resolution. This provides an incredibly low-latency data stream that is ideal for tracking rapid structural vibrations, boundary layer transitions, and particle motions in wind and water tunnels. The overall objective of this research is to pioneer the use of event-based cameras for the quantitative analysis of dynamic fluid-structure interactions (FSI). The academic partner will design and execute tunnel experiments requiring the characterization of hydrodynamic or aerodynamic loading. The research will focus on developing novel algorithms—such as event-based optical flow, spatio-temporal clustering, or particle tracking—to convert raw event streams into dense 2D/3D velocity vector fields. From these velocity fields, quantitative vorticity maps will be calculated to capture dynamics. Standard high-speed PIV measurements will be collected simultaneously to serve as a high-fidelity benchmark. The experimental velocity, vorticity, and structural deflection datasets obtained from the event camera will then be rigorously compared against numerical FSI simulations to validate model accuracy across highly transient regimes.

5. **Research Classification/Restrictions:** Ability to obtain clearance for the DAF (must be a U.S. citizen)
6. **Eligible Research Institutions:** Open to all Ohio-based academic institutions.
7. **PA Approval Number:** AFRL-2026-3878