Earthquakes and Loss of Coolant Accidents (LOCA) can damage nuclear power plants cores, which set safety requirements. With recent earthquake in Japan combined with reassessment of seismic hazard in the US by the Nuclear Regulatory Commission, these events are seeing a renewed interest. During earthquake, the dynamic structural response of fuel bundles is significantly affected by the presence of flowing water. For example, with axial flow the bundle effective damping increases by a factor 6 compared to damping in dry environment and 3 in stagnant water. The effective stiffness of the assembly also increases with axial flow. These effects point towards a strong coupling between fluid and structure. To study this fluid structure interaction problem an international team was assembled to conduct closely coupled experiments and simulations. At the George Washington University, a unique facility has been designed; it operates on a large six degree of freedom shake table to simulate ground motion in a Pressurized Water Reactor sub-assembly with high-Reynolds number axial flow. The facility is an index matched experiment that allows instrumenting transients with non-intrusive optical diagnostics. Several laser based diagnostics had to be developed to simultaneously record response of fluid motion and structure vibration at multiple scales. Experimental data are the first velocity fields coupled with structure response obtained in such a challenging environment and indicate several sources of hydrodynamic damping. In parallel, large eddy simulation strongly coupled with structural code are performed on DOE leadership computing facilities.

Philippe Bardet is an Assistant Professor at the Mechanical and Aerospace Engineering Department of the George Washington University (GW). He received his Ph.D. in nuclear engineering from the University of California at Berkeley in 2006. After his doctoral studies, Dr. Bardet was a lecturer and postdoctoral fellow at UC Berkeley, before postdoctoral training at the California Institute of Technology. He joined the Faculty at GW in August 2010. His current research is focused on understanding vorticity interaction with liquid-gas interfaces, instabilities and vortex breakdown in swirling jets, Fluid-Structure Interactions in nuclear reactor cores during seismic events, and the Very High-Temperature Gas cooled Reactor. His research group is currently developing non-intrusive laser diagnostics for measuring water vapor temperature, dissolved gas concentration in liquids, as well as velocimetry techniques, both particle based and seedless. Dr. Bardet teaches courses in Fluid Mechanics, Thermodynamics, and Experimental Methods.