GEN IV International Forum℠
Expertise | Collaboration | Excellence

Development of Multiple-Particle Positron Emission Particle Tracking for Flow Measurement

Summary / Objectives:

Flows in opaque systems can present a significant challenge to experimental investigators. Understanding flow phenomena in reactor components often relies on the use of simulation, as well as experiments using **surrogate materials and fluids to allow optical access. Positron emission particle tracking (PEPT) is a radiotracer-based technique** that uses the same technology as the medical imaging platform PET (positron emission tomography). As such, PEPT can be used to directly study flows in opaque systems. The research focus has been on the development and deployment of new **PEPT reconstruction algorithms that allow the simultaneous tracking of multiple tracers, increasing data collection efficiency** and enabling new measurements. Herein Dr. Wiggins will discuss the basics of PEPT, as well as its utility for measurements in pipes, heat exchangers, and pebble beds, among other systems. The data gleaned from such experiments can be used for both fundamental understanding of flow phenomena and **validation of the computational fluid dynamics** models being used for next generation reactor design.

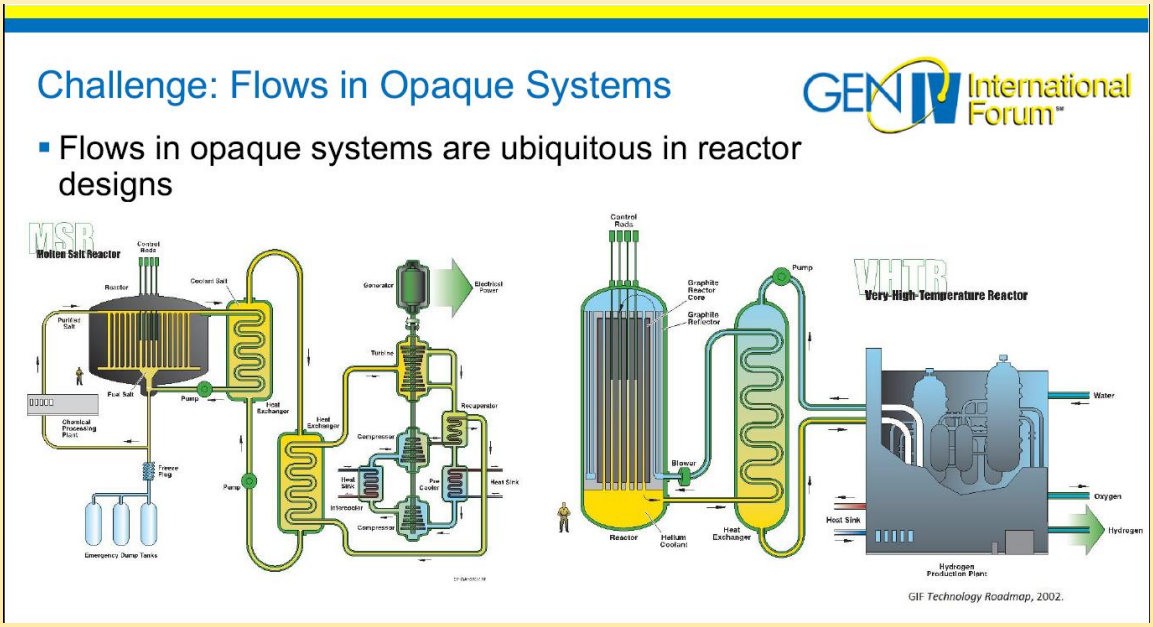
Meet the Presenter:

Dr. Cody Wiggins is currently employed as a postdoctoral research associate at **Virginia Commonwealth University (VCU) in the Department of Mechanical and Nuclear Engineering**. He received his B.S. from the University of Tennessee, Knoxville (UTK) in Nuclear Engineering in 2014 and his Ph.D. from UTK in Physics in 2019. Dr Wiggins's research has focused on **experimental fluid dynamics, including pure and applied research components**.

His primary interest has been in the development and deployment of positron emission particle tracking (PEPT) – a radiotracer-based method for flow measurements in opaque systems. He is now studying thermal hydraulics for advanced energy applications, while maintaining a focus on the advancement of PEPT. Dr. Wiggins was the winner of the American Nuclear Society's "Pitch your PhD" competition in November 2019.

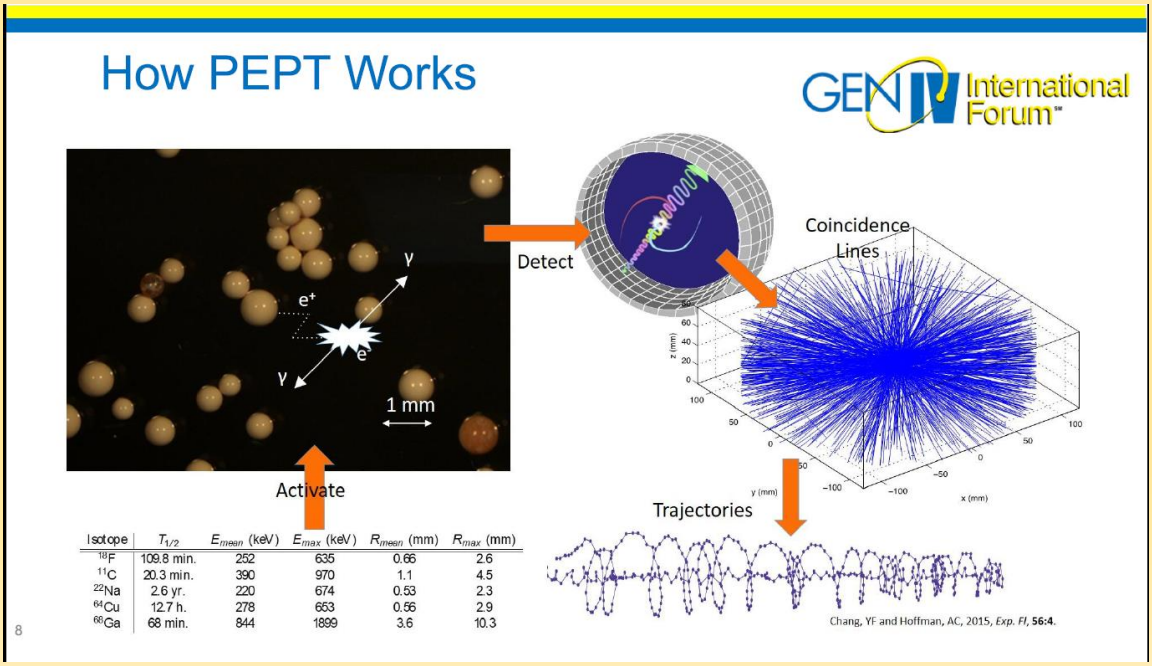
Challenge: Flows in Opaque System

Motivations to develop the flow measurement technique in opaque systems are explained.



Positron Emission Particle Tracking

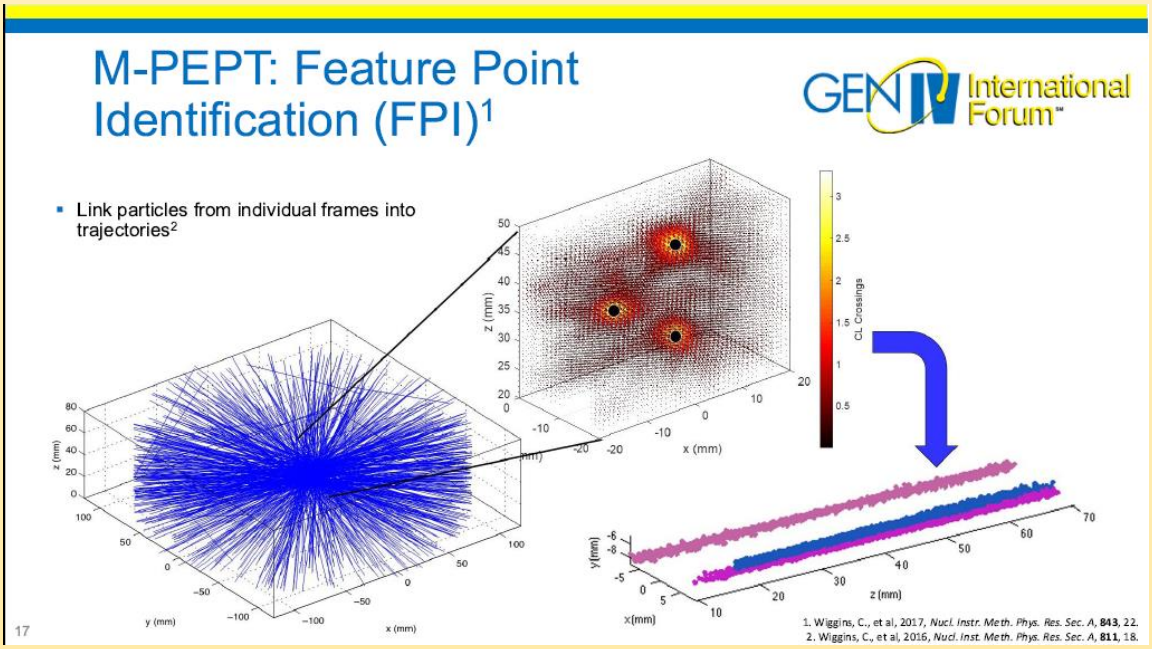
Overview of the principle of Positron Emission Particle Tracking (PEPT) is introduced. And the **limitations of the previous reconstruction methods are evaluated toward the multi-particle tracking.**



Isotope	$T_{1/2}$	E_{mean} (keV)	E_{max} (keV)	R_{mean} (mm)	R_{max} (mm)
^{18}F	109.8 min.	252	635	0.66	2.6
^{11}C	20.3 min.	390	970	1.1	4.5
^{22}Na	2.6 yr.	220	674	0.53	2.3
^{64}Cu	12.7 h.	278	653	0.56	2.9
^{66}Ga	68 min.	844	1899	3.6	10.3

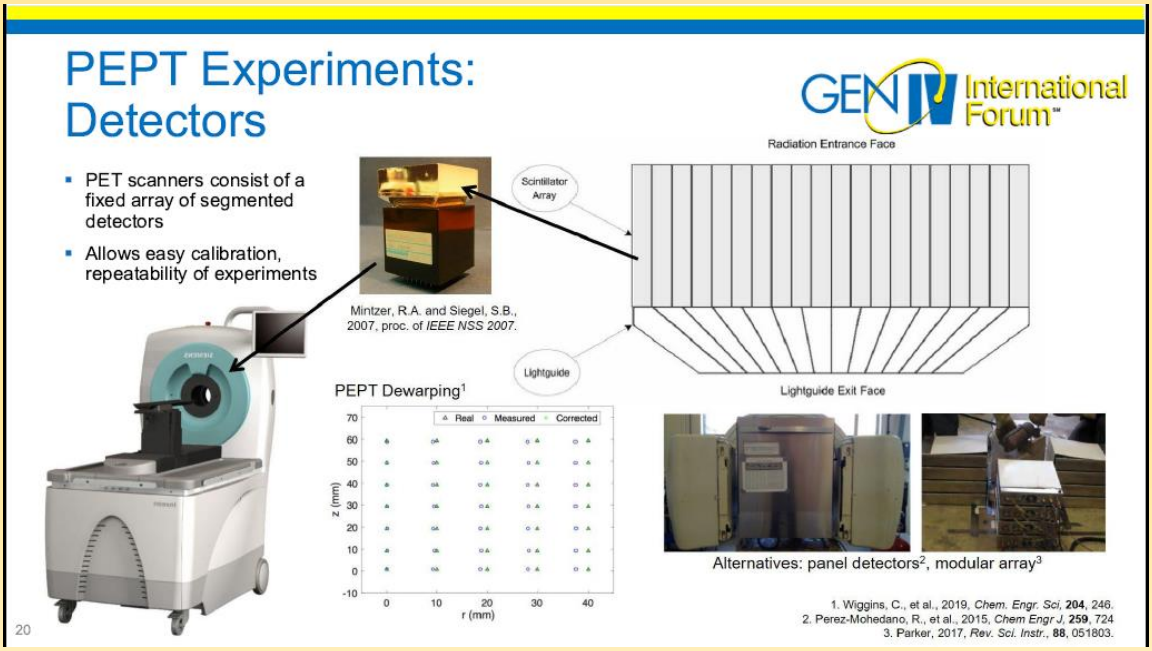
Multi-particle PEPT (M-PEPT):

The newly developed reconstruction method toward the multi particle method is presented.



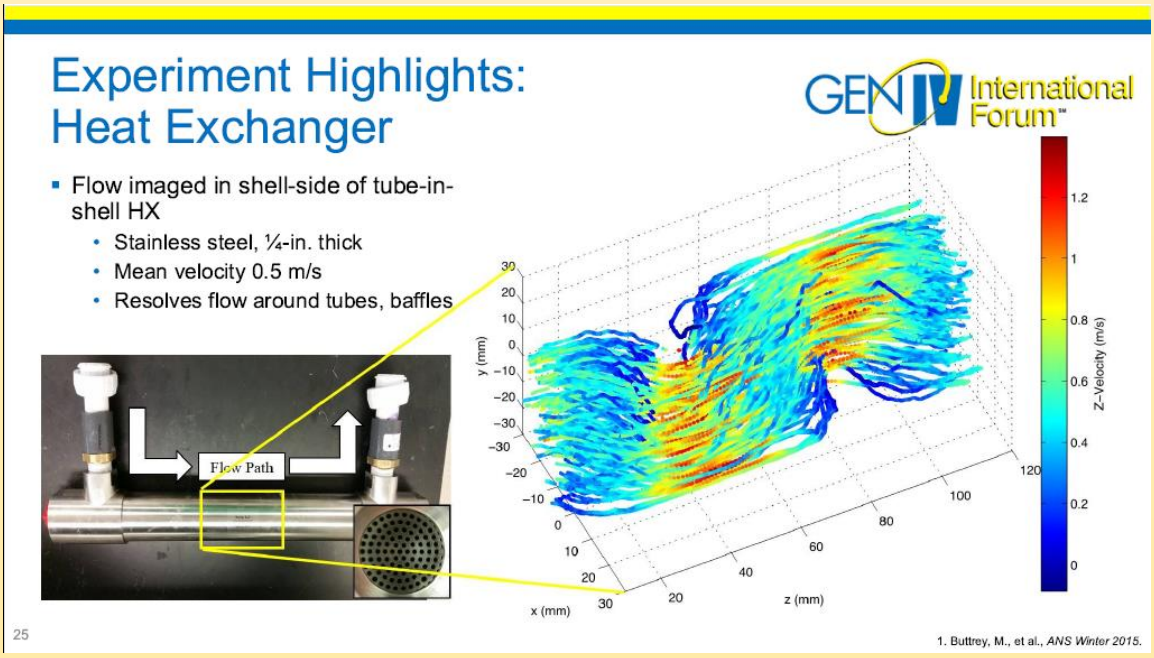
PEPT experiments:

The outline of the actual PEPT experimental system, such as tracer particle, detectors and test loop was introduced.



Experiment Highlights:

Experiment highlights are presented regarding a heat exchanger flow, a baffle flow, a pipe flow, a swirl flow and a packed bed flow.



PEPT future:

The perspective of the development of PEPT measurement in future is presented from the points of reconstruction technique, technology and deployment.