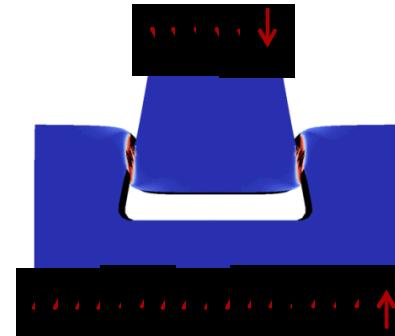
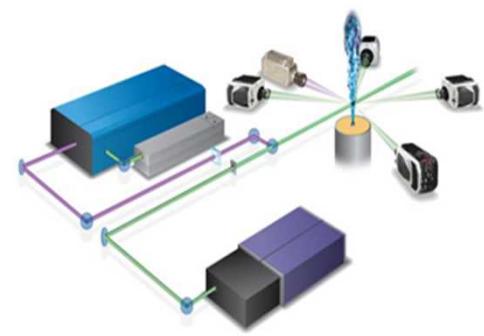


## *Exceptional service in the national interest*



# Diagnostics

Tracie L. Durbin, Manager  
Diagnostic Science & Engineering Department

# ESRF Panel Review

## April 13, 2016



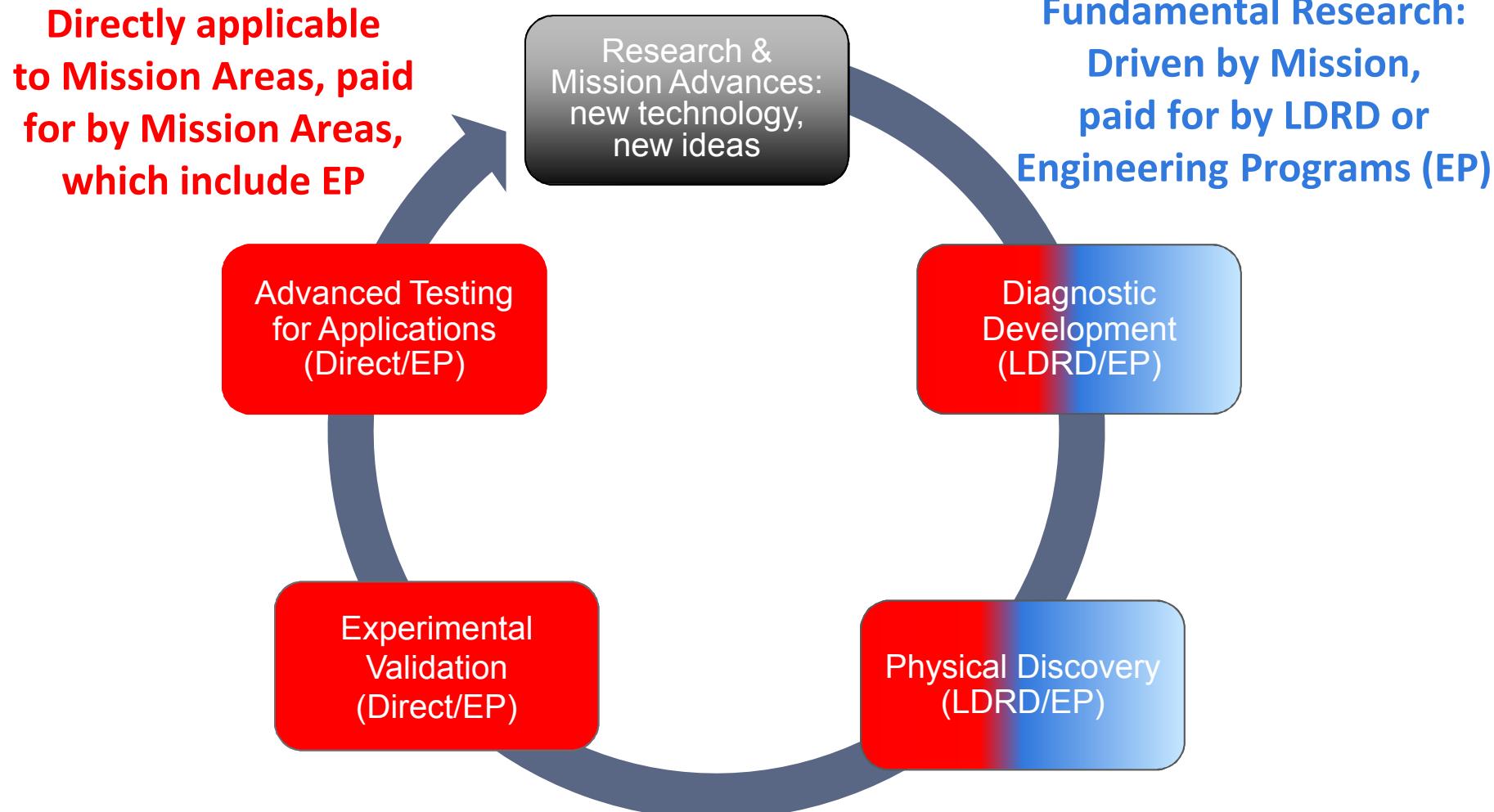
Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000. SAND NO. 2011-XXXXP

# LDRD is key to advancing ESRF strategy

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- **Engineering Sciences LDRD Call**
  - *Novel diagnostics for experimental discovery, validation, and production testing:* The development of predictive system-level models relies upon experimental data for phenomena discovery as well as validation of the multi-scale, multi-physics phenomena underlying the system behavior...
- **Adapted from 2014 ESRF Strategy Document:**
  - **Vision statement:**
    - Robust, well-maintained, and well-used *experimental capabilities that advance the field in diagnostic techniques* and facilitate experimental discovery.
  - **Implementation:**
    - *Objective 2:* Develop advanced diagnostic capabilities for experiments to improve our understanding of engineering phenomena.

# LDRD and direct funding work together to advance diagnostic development and application



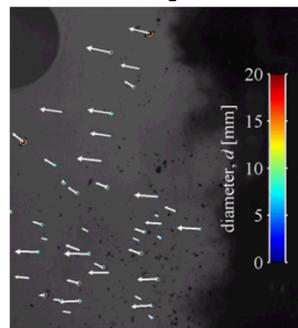
# Many ESRF-LDRD projects have incorporated diagnostics and diagnostic development



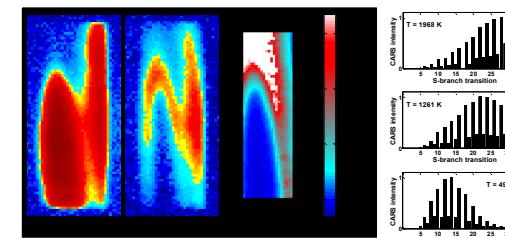
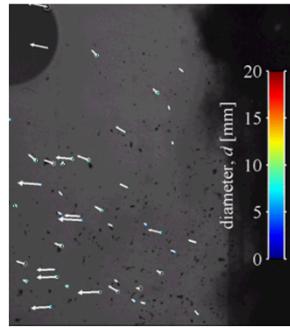
- **2000-2016**
  - 10% of the LDRD projects over the last 15 years were specifically focused on diagnostics
  - Many other projects require diagnostics to obtain the data needed for new physical understanding and validation
- **Current LDRD proposal season in mid-cycle**
  - 16/60 initial idea proposals were diagnostic focused
  - 6 have been selected to move forward to second round

# ESRF contains many technical areas

- ESRF spread across wide range of technical areas:
  - solid mechanics, structural dynamics, combustion, thermal science, fluid mechanics, aerodynamics, energetics materials, electromagnetics, electrical circuit science, and shock physics
- Two technical talks representative of diagnostic development in thermal/fluids



D. Gildenbecher



C. Kliewer

- Following slides contain a brief subset of all diagnostic development efforts in engineering sciences

# Common themes among the diagnostic examples to follow

---

- Sandia National Laboratories has developed a unique capability with state of the art equipment and facilities
- Partnerships with universities and other external collaborators to broaden our knowledge base
- Research is performed with a focus on our national security mission
- Engineering Sciences impacts all of SNL Mission Areas
  - NW = Nuclear Weapons
  - DSA = Defense Systems & Applications
  - EC= Energy & Climate
  - IHNS = International, Homeland, and Nuclear Security

# Fire dynamics – Ground-breaking techniques for diagnostics of harsh environments

CARS =  
Coherent anti-  
Stokes Raman  
spectroscopy

Temperature  
and species  
measurements

1990s

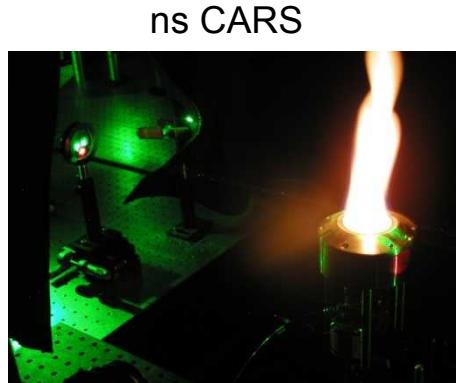
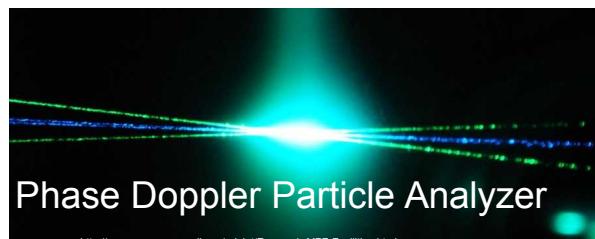
2005

2009

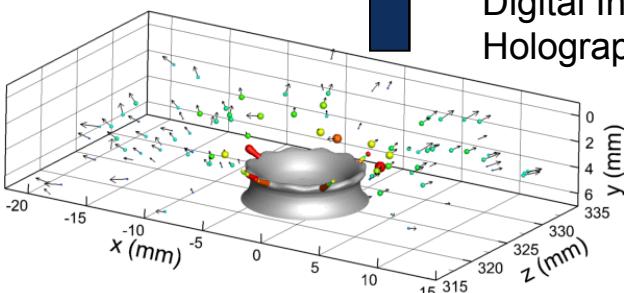
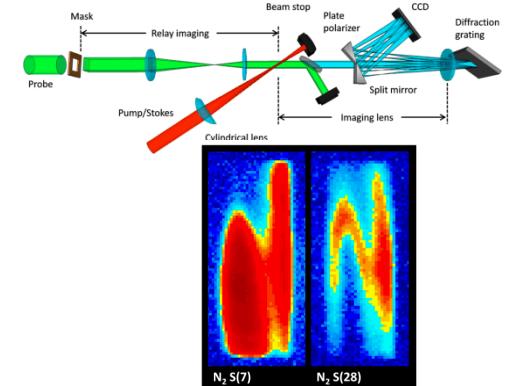
2011

2015

Multiphase  
flow  
diagnostics



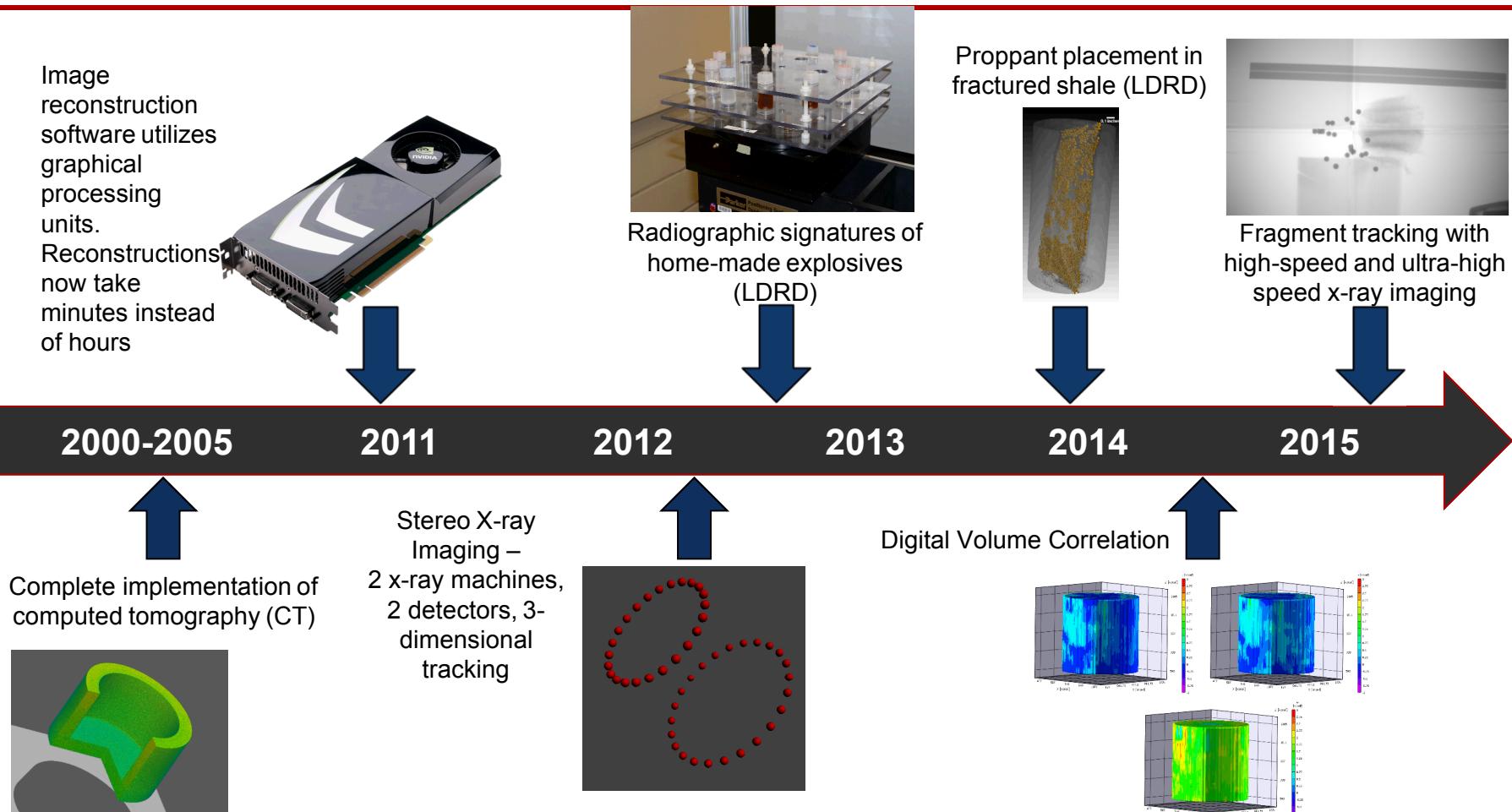
Line/Imaging CARS



Digital In-line  
Holography

Data collected using these techniques is useful for all SNL mission areas: NW, DSA, EC, IHNS.

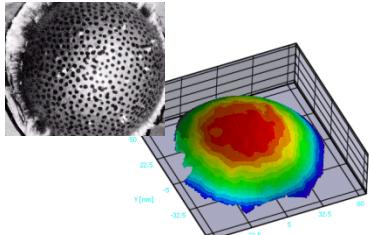
# X-ray diagnostics: Enabling vision in an opaque universe



**X-ray is used for all mission areas from component level testing up through large scale testing.**

# Solid Mechanics – A revolution in full-field engineering measurements

Displacement, velocity and strain



2005

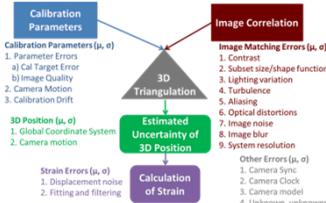


2007



360° coverage

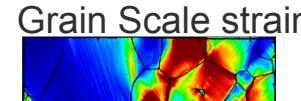
Stereo-DIC Uncertainty Quantification  
From colors to metrology.



2009



2011



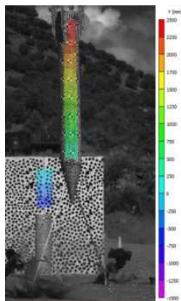
2013



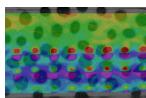
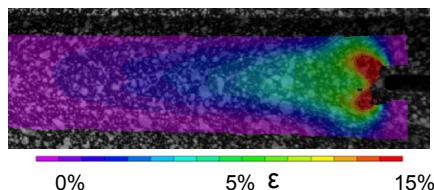
DIC for Material Properties

- Quantified Uncertainty
- More parameters per test
- Parameter interaction
- High-throughput
- Model validation

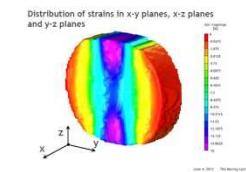
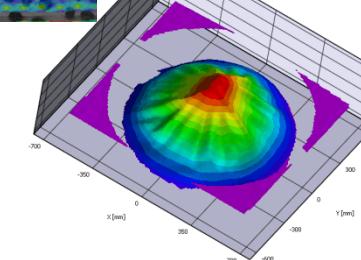
Introduction of DIC to Sandia



Crack-tip and Fracture Strain



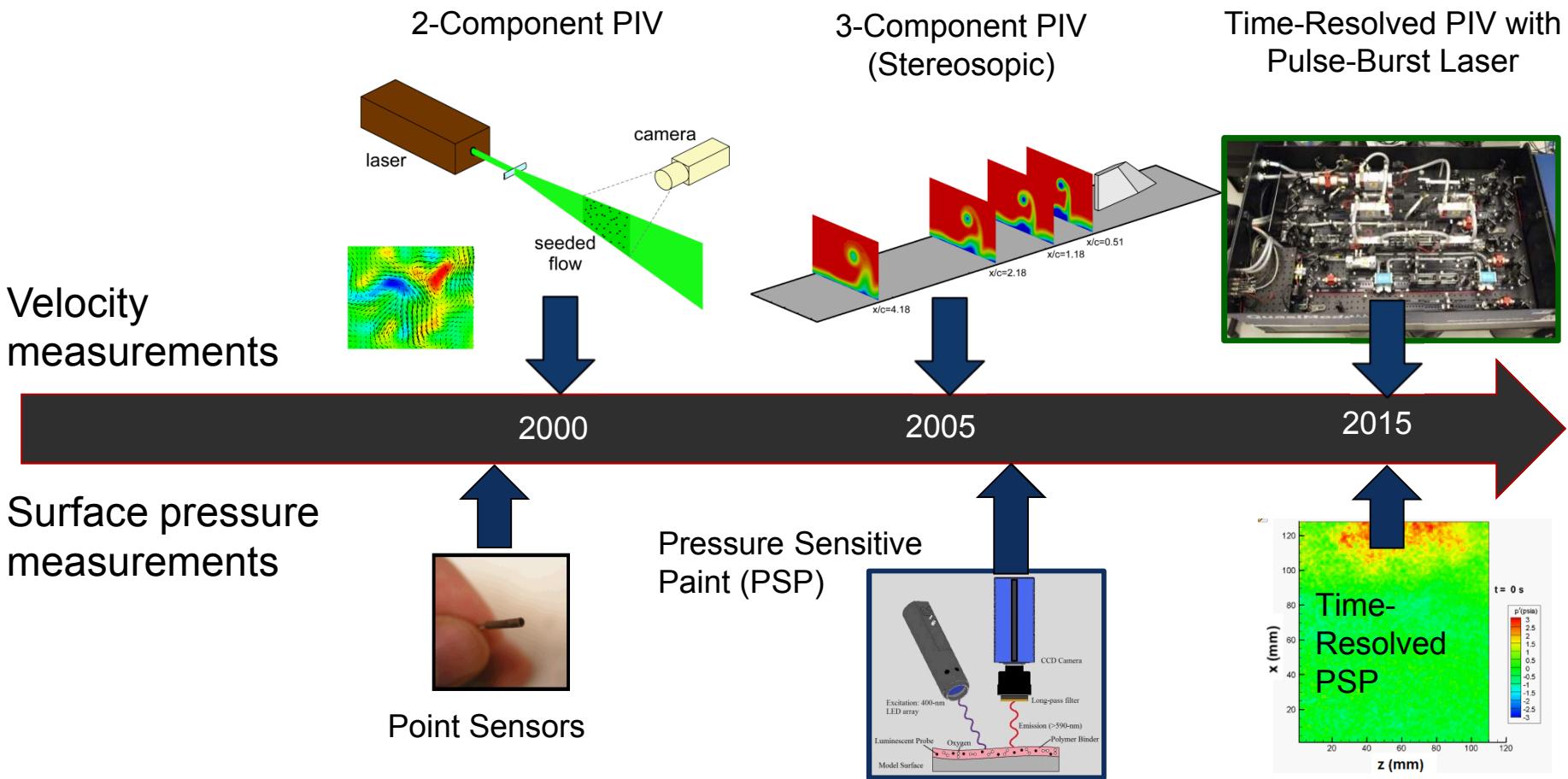
Explosive Panel Deformation



Volumetric DIC

Digital Image Correlation is used for testing in NW and DSA

# Aerosciences – Pushing the limits of spatial and temporal resolution up to hypersonic speeds



Improving measurements for acoustical loading and qualification environments for NW, EC, and DSA Mission Areas.

# Intentional Stewardship: Development of ESRF Diagnostics Strategic Plan

Diagnostic Summit:  
60 staff members  
10 managers  
6 hours



Kick off of Engineering  
Sciences Quarterly  
Diagnostic Seminar Series

4/2015

10/2015

5/2016

6/2016

10/2016

Initial Draft



Identify five areas where  
experimental gaps exist,  
develop roadmaps.  
(for example: metal  
combustion & experimental  
uncertainty quantification)

Fully Developed  
Roadmaps Completed  
in time to influence  
2017 ESRF-LDRD Call

Continued investment in high-fidelity engineering  
diagnostics is vital for discovery and validation