



Constructing a Dedicated Fuel Spray Beamline at Sector 7-BM

January 28, 2009

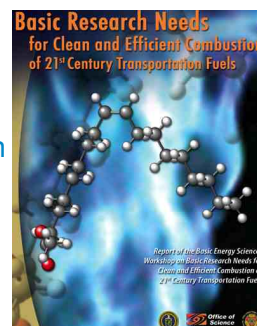
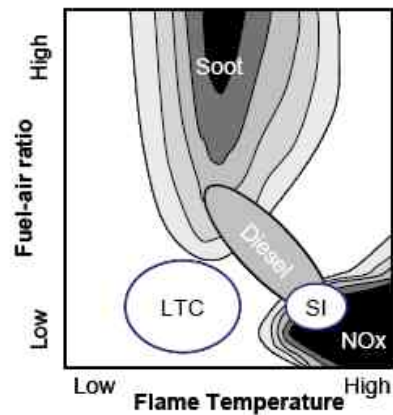
APS/Users Operations Monthly Meeting

Jin Wang

X-ray Science Division

Science and Technology Needs

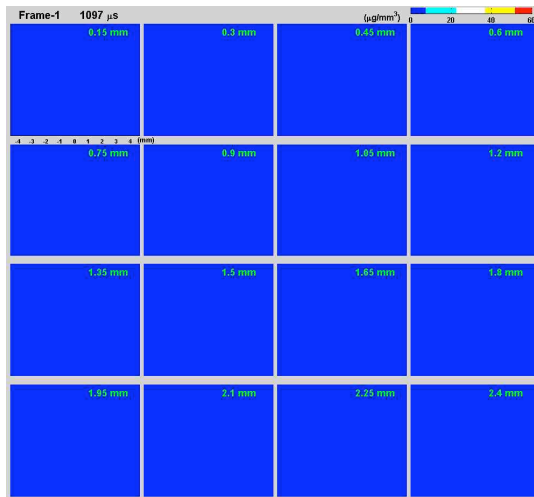
- Optimized fuel sprays to
 - Improve combustion and reduce emissions
- Fuel sprays have been elusive, even more so now.
- We have made breakthroughs
 - With ultrafast x-radiography
 - μ s x-tomography
 - Quantitative fuel mass distribution
 - Validate spray and combustion simulation
- Guiding injection system design
 - Working with industrial partners



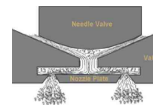
The evolution of fuel sprays plays a defining role ... in determining both combustion efficiency and the formation of ... pollutants. This level of understanding may permit extraordinary new technologies, such as smart fuel injectors ...

Improved Injection Systems

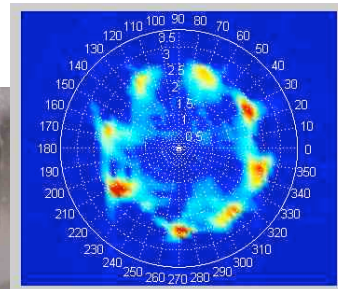
- Through collaborative research
 - Better spray definition
 - Better use of air charge
 - Minimized needle bouncing



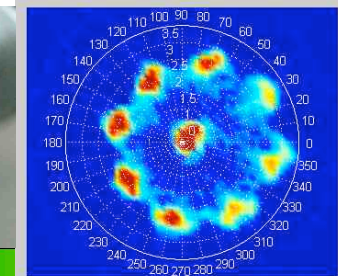
Low-pressure GDI by Visteon Corp.



Prototype



Product

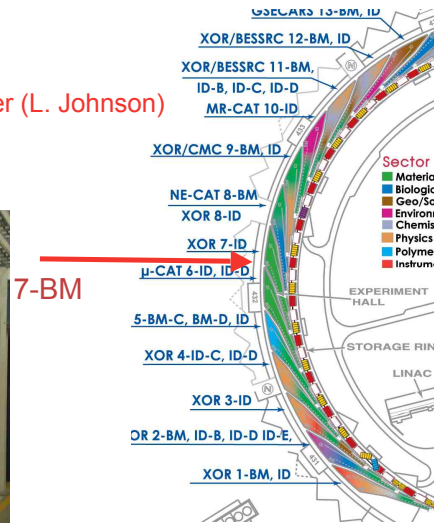


Challenges and Opportunities

- Growing collaborators and partners from both industry and universities
 - Robert Bosch GmbH: diesel, and GDI
 - General Motor R&D: diesel
 - Visteon Corporation: GDI, HCCI
 - Delphi Corporation: diesel, GDI
 - Caterpillar: heavy duty diesel
 - Daimler AG: diesel, GDI
 - Continental AG (Siemens VDO): Diesel, GDI
 - ...
 - Sandia National Lab
 - Air Force Research Lab
 - EPA
 - ...
 - University of Wisconsin at Madison
 - Wayne State University
 - Cornell University
 - Michigan State University
 - Stony Brook University
 - Iowa University
 - University of Illinois at Chicago
 - University of California, Irvine
 - ...
- Most of problems can be tackled by “simple” but fast x-radiographic imaging.
- Requires dedicated beamline at the APS.

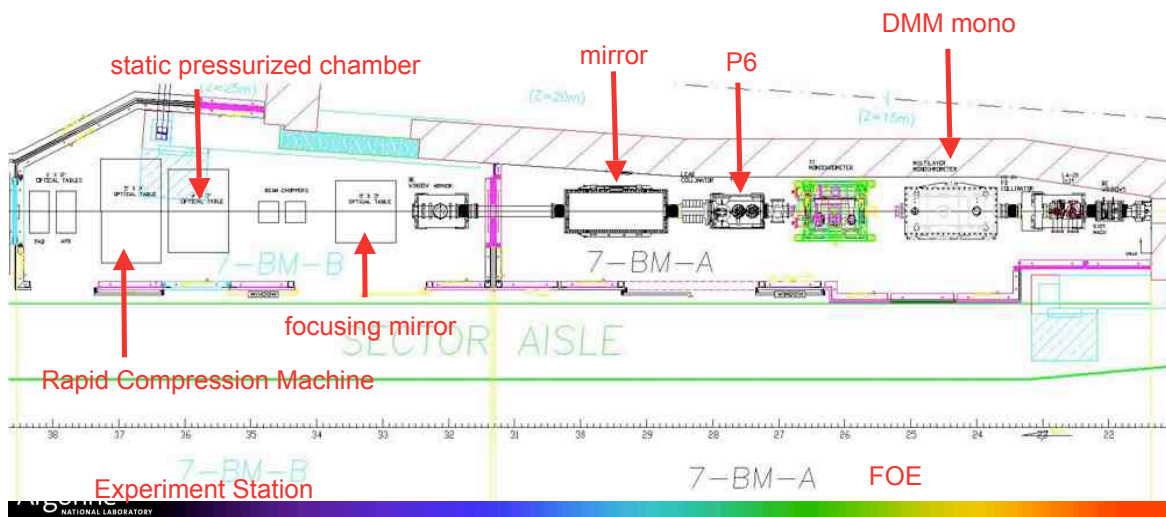
Dedicated Ultrafast Imaging Beamlines

- Provide a centralized facility for transportation engine technologies
 - high-throughput measurement
- OVT/EERE invested \$850K capital (FY2008/2009)
 - Through ANL Transportation Technology R&D Center (L. Johnson)
- Rebuild Sector 7-BM beamline
 - Partially built supported by BES (MHATT-CAT)



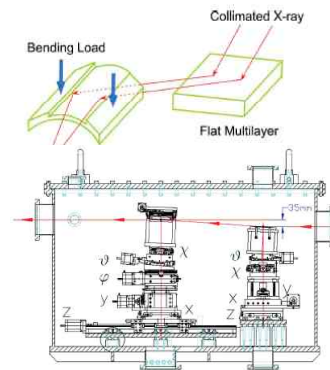
Supported Techniques and Beamline Design

- Ultrafast (μs) x-radiography
- Ultrafast (μs) x-tomography
- High beam intensity
 - Wide-bandpass mono, 10^{13} - 10^{14} ph/s, tunable from 6 to 12 keV
- Flexible beam size



Instruments

- Sagittal focusing double-multilayer monochromator
- Harmonics rejection mirror
 - For use with area detectors
- Secondary KB focusing mirror
 - For use with point detectors
- Modular sample stations
 - Pressurized chambers
 - Unpressurized chambers
 - Rapid compression machines



Construction Team and Progress

- Core members
 - Project Manager: Mohan Ramanathan (AES)
 - Cost & Schedule Coordinator: Yeldez Amer (AES)
 - Principal Mechanical Engineer: Mark Erdmann (MED/AES)
 - Principal Control Engineer: David Kline (BCDA/AES)
 - Beamline: Harold Gibson, Eric Dufresne, Dohn Arms (TRR/XSD)
- Bi-weekly meetings to discuss tasks, progresses.
- Progress to date and Future target
 - Final Beamline design completed and approved by the APS (November 2008)
 - Exhaust system built for various fuels (May 2008)
 - PSS and EPS design completed and approved (December 2009)
 - Beamline control system completed (January 2009)
 - Major x-ray optics components installed (January 2009)
 - Beam to the stations: February 2009
 - Commissioning: February and March 2009
 - Dedication: May 2009

Results and Challenges

- A beamline for absorption-based radiography and tomography with μs temporal resolution
- High-throughput test for a large user community
- Energy research mission - improved efficiency and reduced emissions.

- Operation of the beamline
 - Sustainable support by from OVT and the APS
 - Forming an Industry-Research Institutes Consortium
 - Safe operation with high pressure high temperature
 - Instrument upgrade
 - *Optics upgrade*
 - *Data acquisition and analysis*
 - *ultrafast area detectors (Cornell, APS)*
 - Fluid dynamics theory and simulation support

Im, et al, PRL, in press

