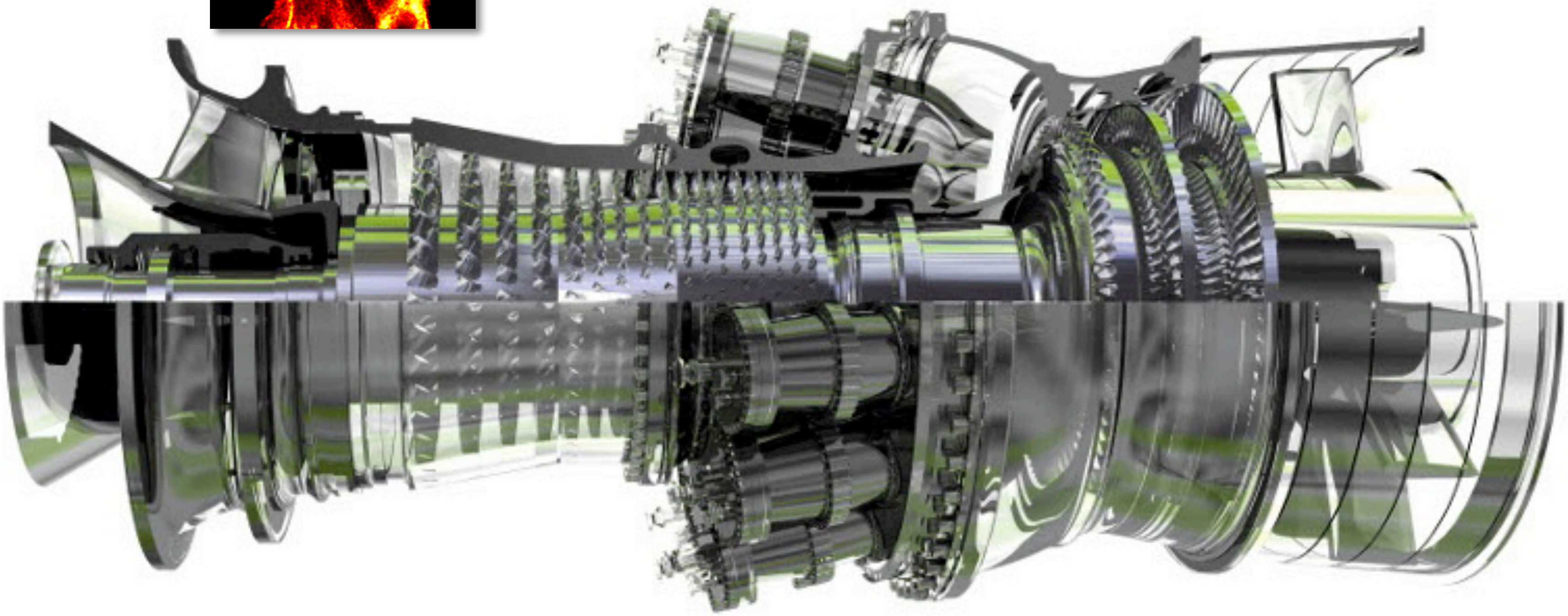
SAND2013-0392P

COMBUSTION RESEARCH FACILITY

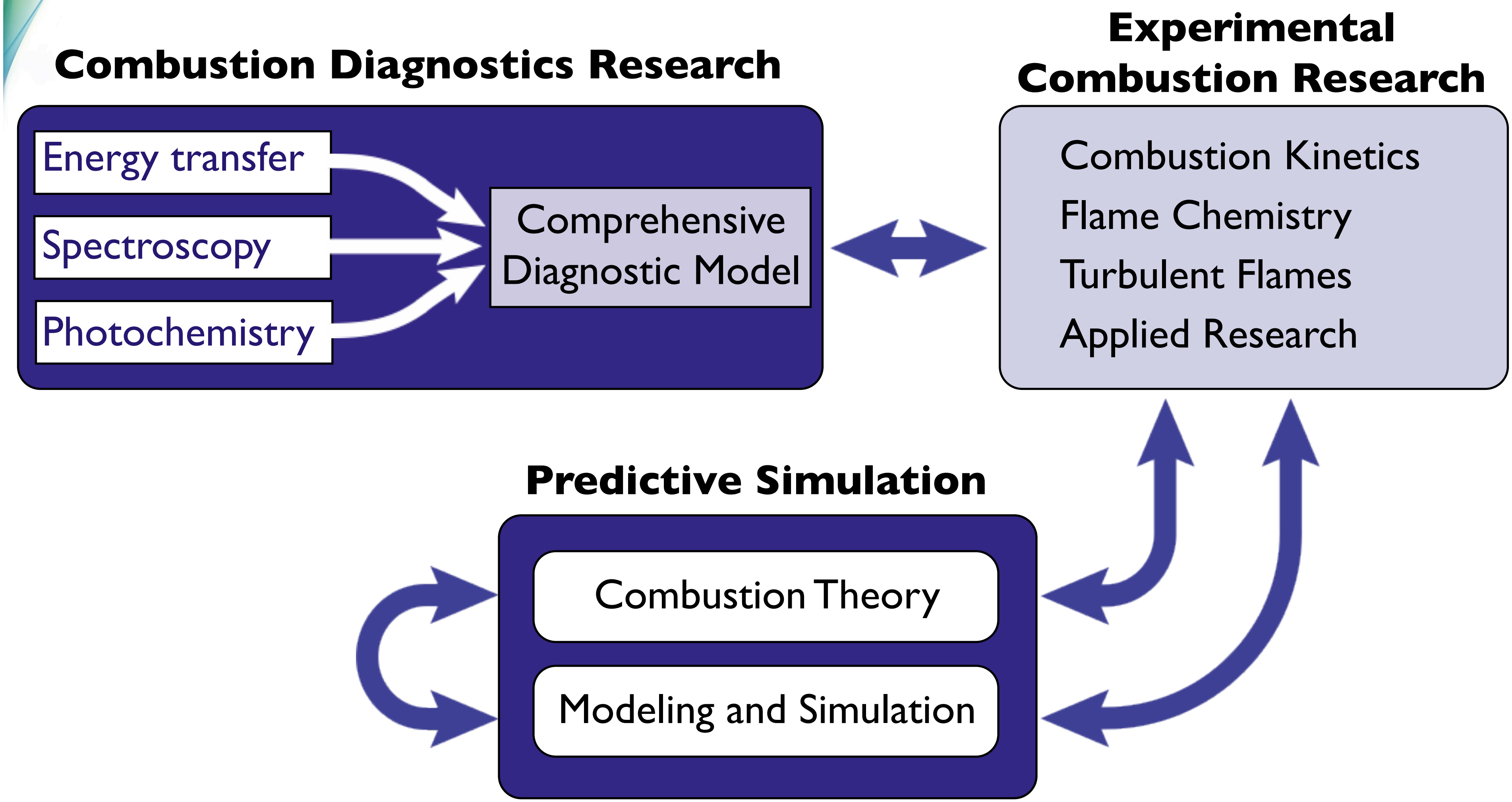
Diagnostics to Go

Andy McIlroy

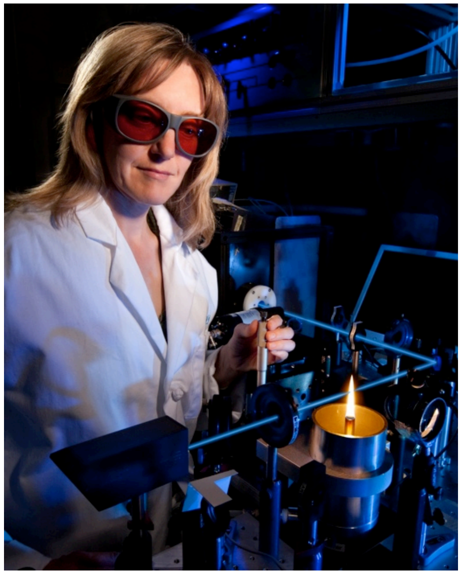
Senior Manager



CRF Diagnostics Ecosystem

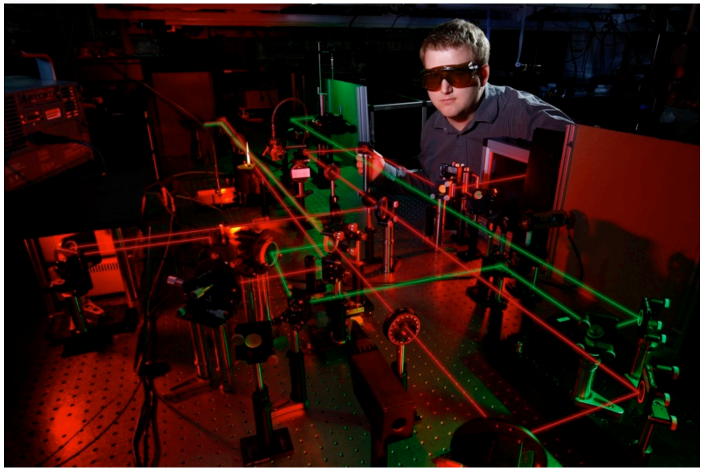


Diagnostics Investment at the CRF



Fundamental Combustion

- 6 Laboratories
- 7 Staff Scientists
- 8 Postdocs
- 4 Technologists

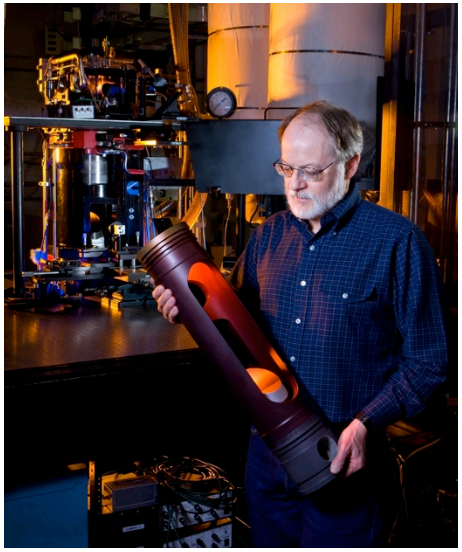


Diagnostic Development

- 4 Laboratories
- 3 Staff Scientists
- 3 Postdocs
- 3 Technologists

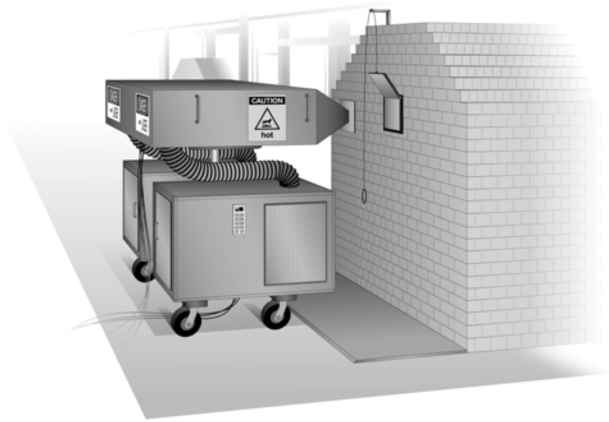
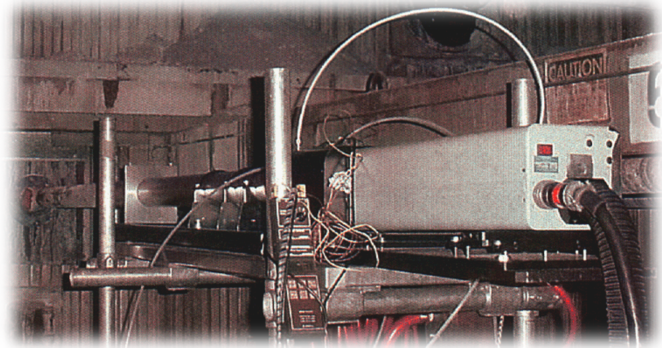
Applied Combustion

- 10 Laboratories
- 8 Staff Scientists
- 8 Postdocs
- 5 Technologists



Past CRF Fielded Diagnostics

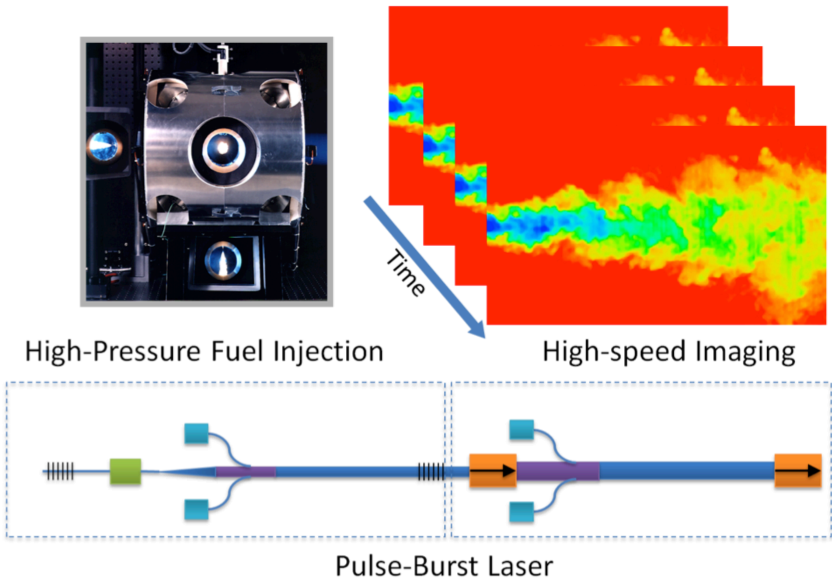
- Steel Furnace
- Glass Furnace
- Boilers
- Pool Fires
- Cloud LIDAR
- Microfluidic detection
- Gas leak detection

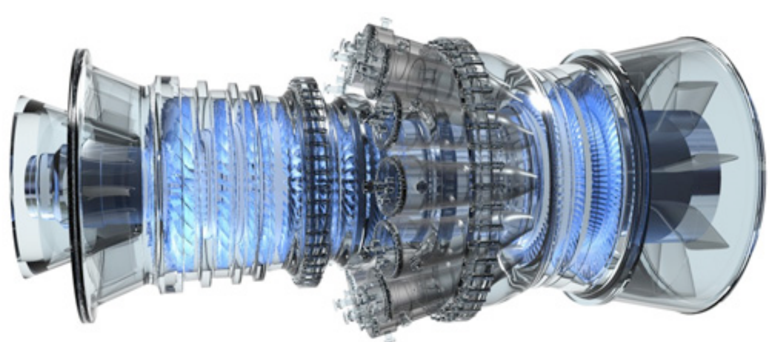


New Opportunities

- Developing cutting edge, portable high speed imaging capability



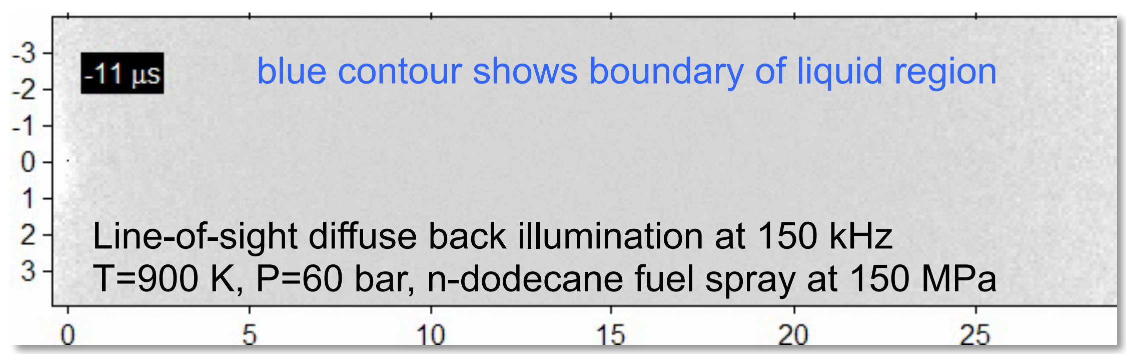
- Developing and applying targeted diagnostics for partners



Quantitative Imaging of Turbulent Mixing Dynamics in High-Pressure Fuel Injection

Jonathan Frank, Lyle Pickett, Sean Moore, Scott Bisson

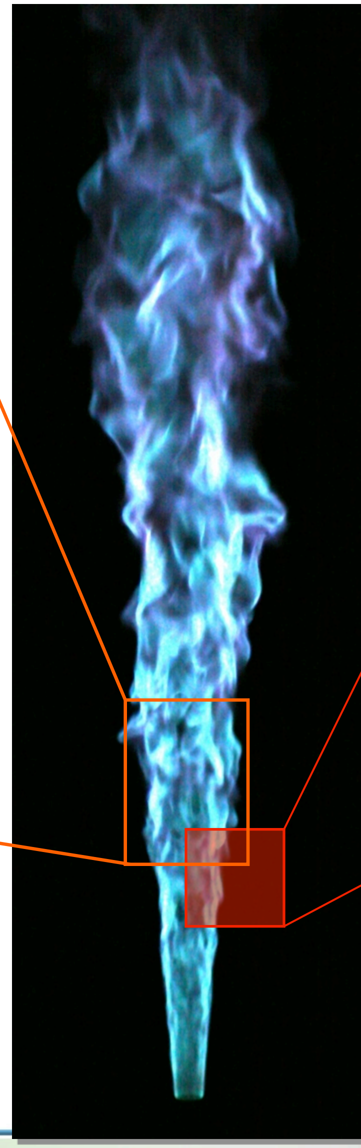
- Project Purpose: Develop quantitative high-speed imaging capability to provide new understanding of high-pressure fuel injection dynamics, enabling predictive simulations of engine combustion
- R&D Goals & Milestones
  - Develop pulse-burst laser system: 100 KHz, 5 ms, 30 mJ/pulse @ 355nm
  - Staged construction of fiber laser, amplifiers, harmonic generation
  - Prepare high-pressure diagnostics & spray chamber
  - Study dynamics of fuel injection and effects on combustion
  - High-speed velocity and scalar imaging of fuel vapor mixing, ignition, and flame stabilization
- Duration: FY13-15
- Total Budget: $2.3M
  - LDRD funded



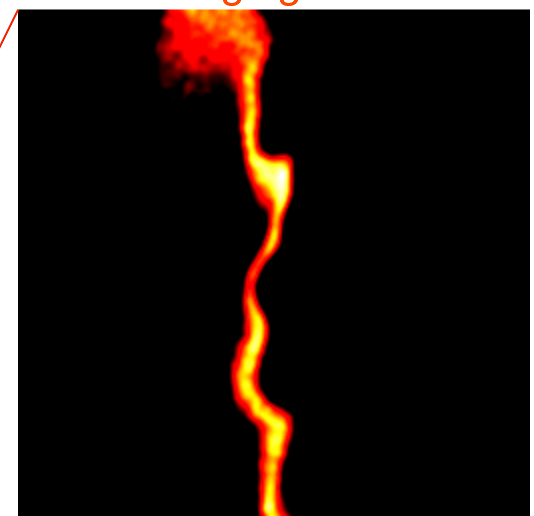
Extend Capability from Line-of-sight to Spatially Resolved Measurements

Line-of-sight Measurement

Flame luminosity at 15 kHz

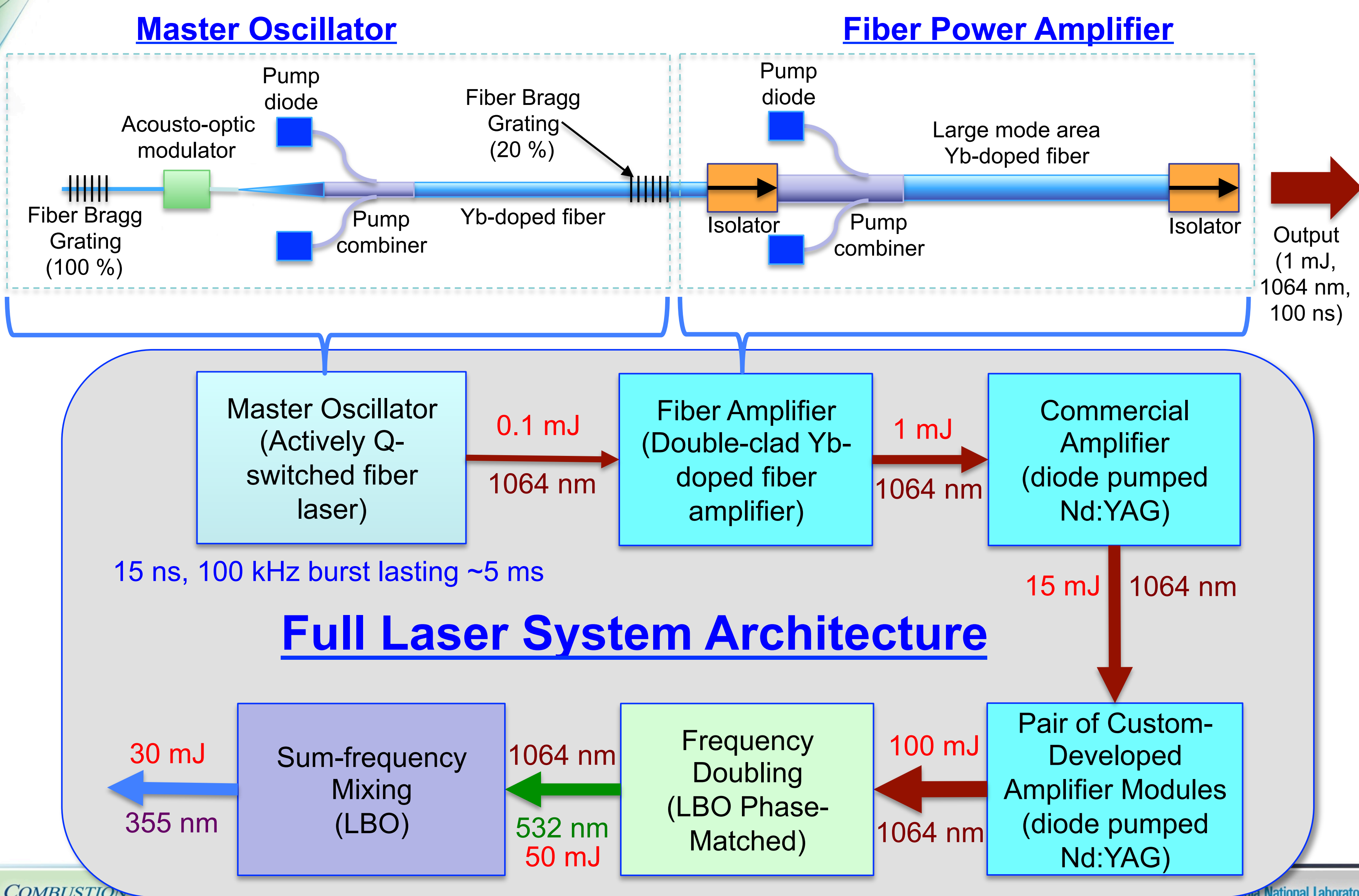


Planar Imaging Measurement



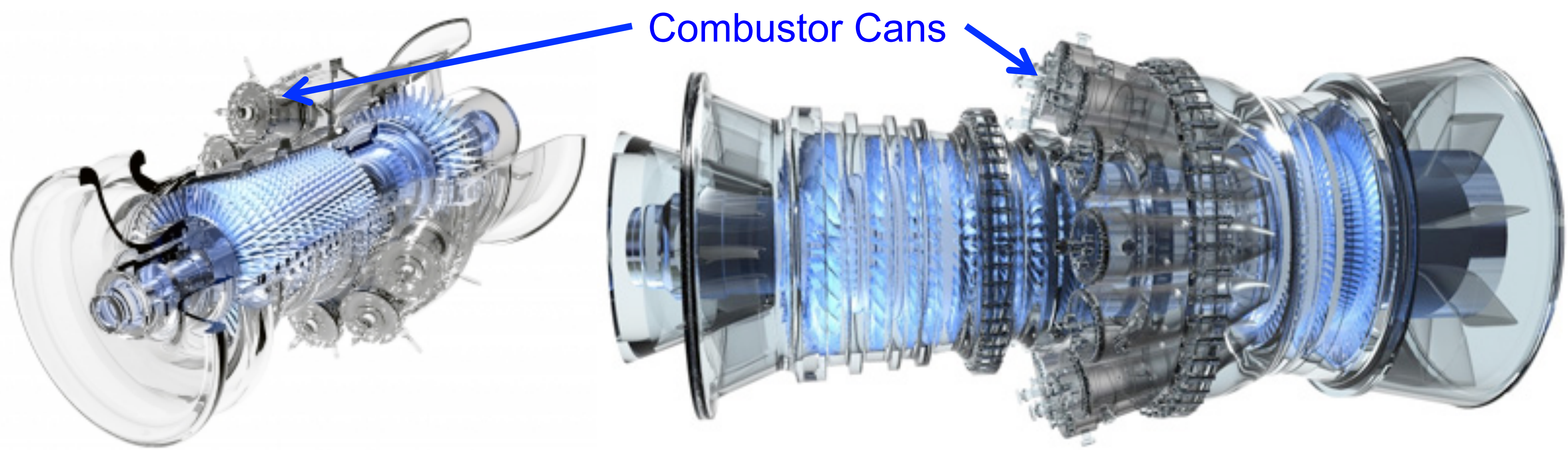
OH LIF Imaging at 10 kHz

Fiber- and Diode-Based System Promises High Power and Rep. Rate in Compact Package



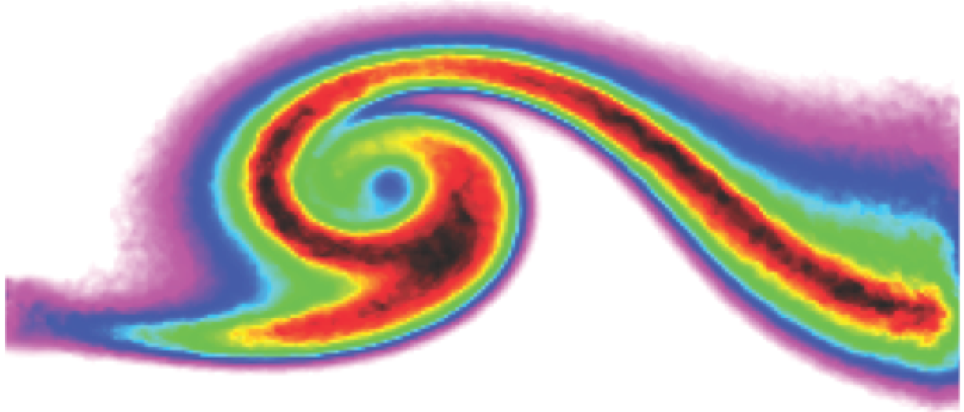
Field Application of CO Diagnostic for Turbine Combustors

- Gas turbine generators provide reliable base load power
- Integration with intermittent renewables would be enhanced by enhanced 'turn down' capability – operating at less the full rated power, preferably as low as 40%
- Existing systems exceed permitted CO emissions below ~80%
- Efforts to date have failed to identify CO formation mechanism
- Strong desire to measure spatial distribution of CO in a turbine combustor at low load

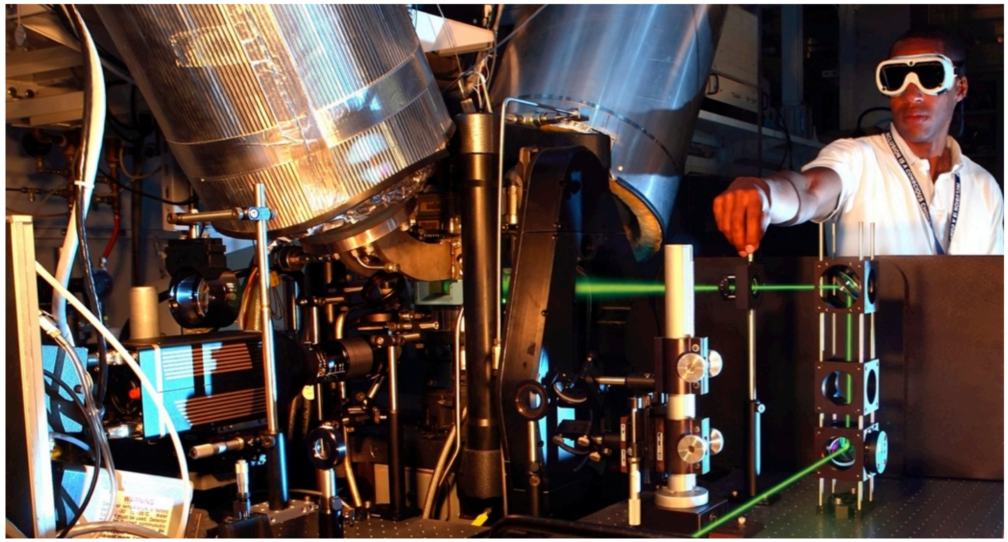


Why the CRF for CO Diagnostics?

- Tom Settersten: World expert in CO spectroscopy

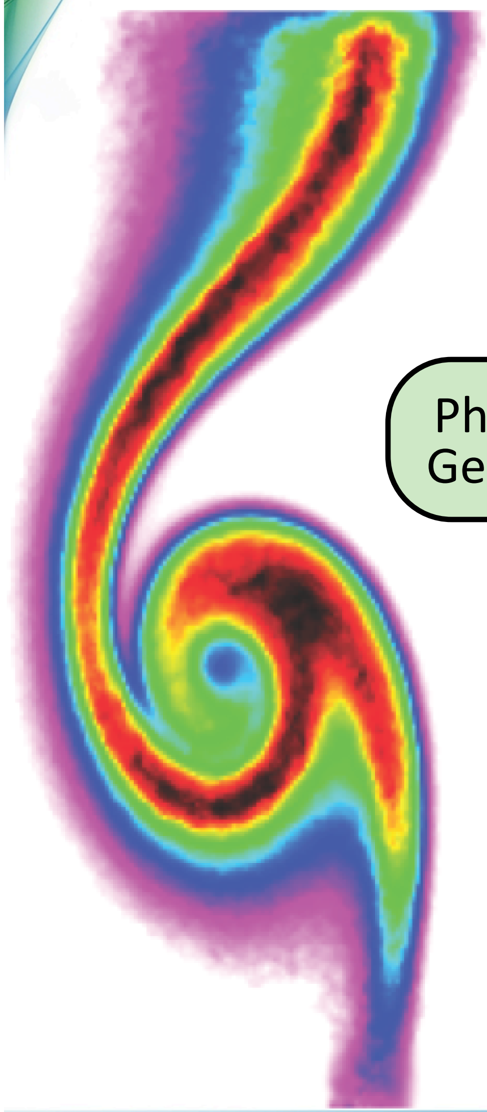



- Paul Miles and Isaac Ekoto: World experts in applying CO diagnostic

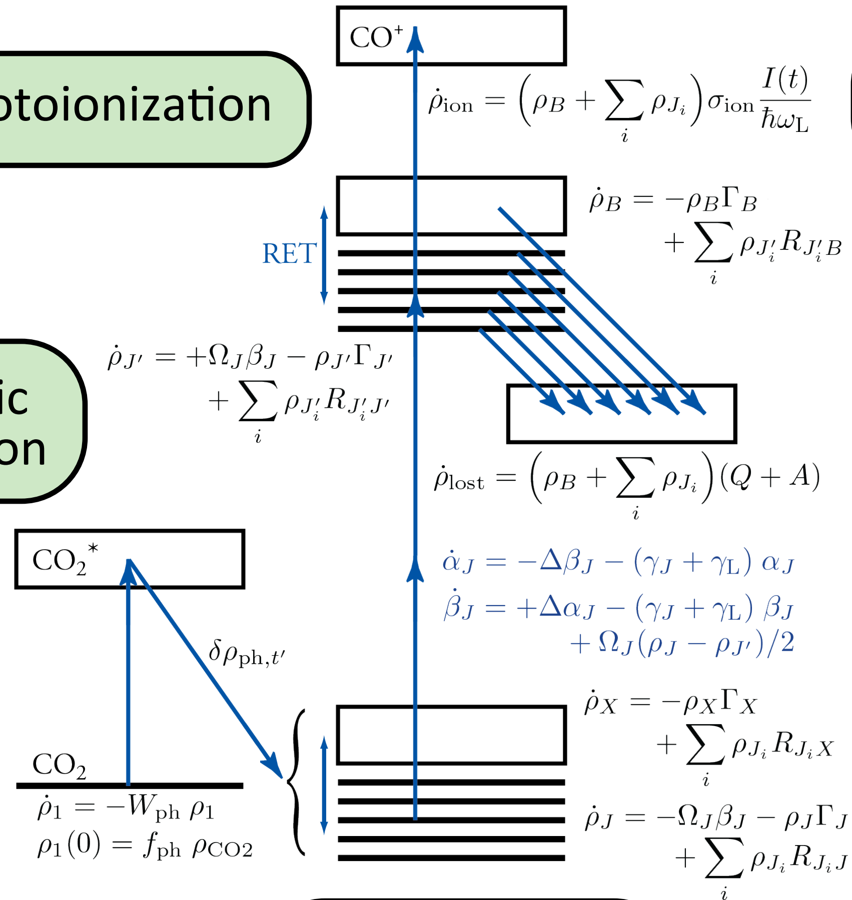
Challenges of Quantitative CO Imaging

Detailed spectroscopic investigations inform predictive models



Photoionization

Photolytic Generation



Molecular Energy Transfer

High-Res. Spectroscopy

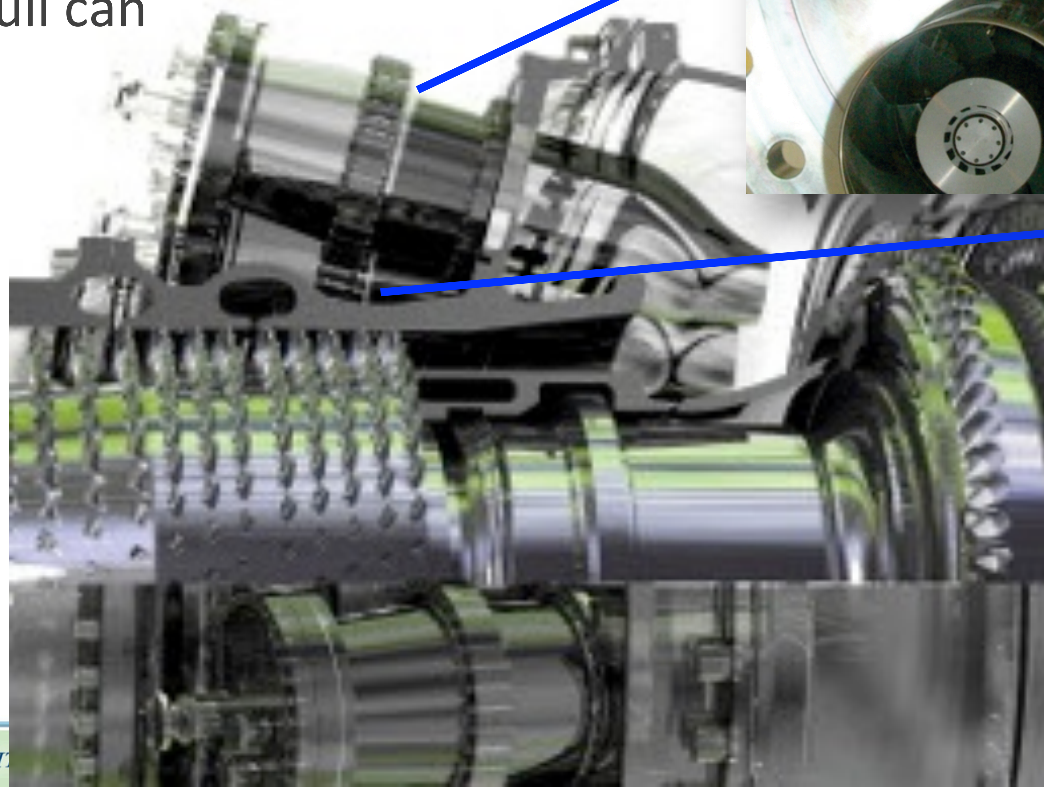
Predictive Quenching

Two-photon Absorption

Pressure Broadening

Test Plan

- Optical engine test-bed
- Laser/materials assembly
- GE-GRC optical test rigs
- GE-GRC single injector at T&P
- GE-P&W full can



Combustor Can
End View