

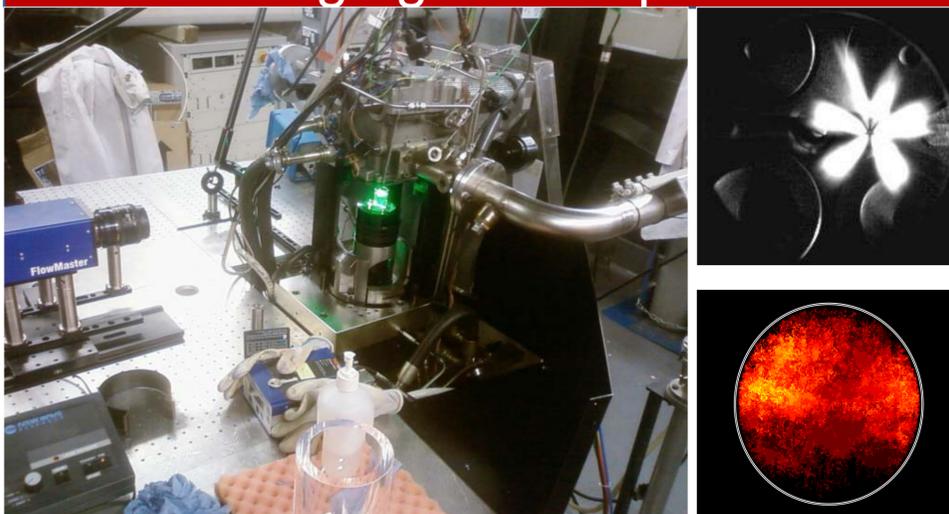
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Optical Diagnostics of Flow and Combustion

Introduction

- Optical techniques are one of the most effective means to provide comprehensive and detailed information of flow field, species and temperature distribution in combustion process.
- As non-intrusive in-situ techniques which do not interfere with the flow or combustion process, optical diagnostics offer the validation for modelling..
- Combining the optical engine with multiple diagnostics technologies, experimental researches of in-cylinder flow and combustion process will strengthen the capability of future engine R&D.
- Advanced optical technologies such as LIF/LII/PIV are used to apply 2D diagnostics in gasoline, diesel and bio-fuel spray and combustion.

Optical Engine & Imaging Techniques



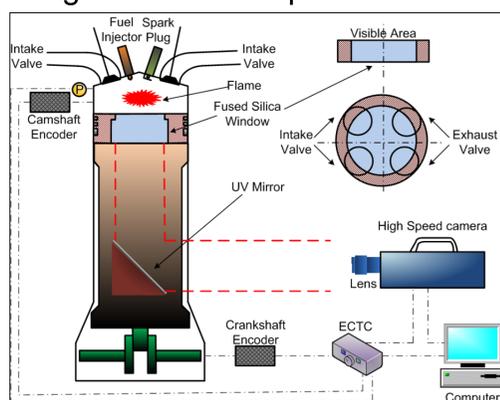
Optical engine

In cylinder Spray & Flame

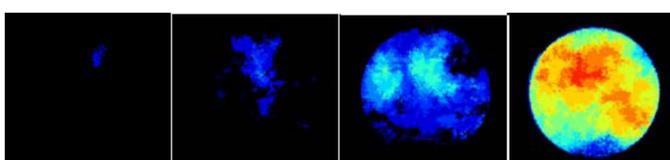
- Optically-accessible piston and quartz liner
- Maximum speed 2000rpm, combustion allowed
- Camshaft replaceable for different combustion mode: PFI/GDI/HCCI
- Fundamental studies of in cylinder flow field, fuel mixture distribution, combustion process and products, combining with spectroscopy and laser diagnostics techniques



Spray image



Optical engine layout



Flame images of HCCI Operation

Laser & Spectrograph Diagnostics

- PLIF (Planar Laser Induced Fluorescence): quantitative measurement of in-cylinder fuel mixture and combustion product distribution with high temporal & spatial resolution
- PLII (Planar Laser Induced Incandescence): 2D soot formation and distribution measurement
- Intensified CCD camera allows frame speed up to 1.5Mfps



2D PLIF/PLII system (DANTEC)

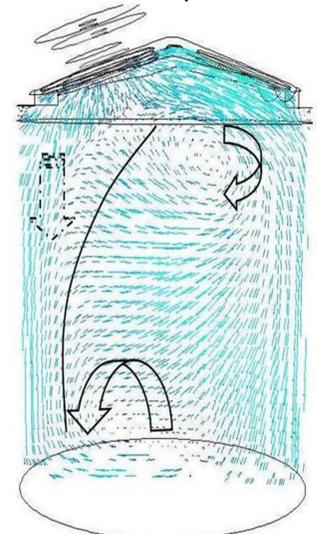
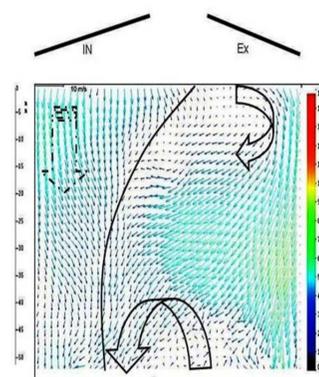


Intensified CCD Camera



High speed PIV system (7.5k Hz)

- 2D Time-resolved PIV (Particle Image Velocimetry): continuous velocity measurement with acquisition rate >7,500 fps



In-cylinder flow by PIV (Left) and CFD (Right)



Spectrograph

- Analysis of the electromagnetic radiations from molecules or atoms
- Acquisition rate up to 10,000Hz
- Wavelength band: 150-800nm
- Intermediate product (OH/CH3O/C2/...) detection during the combustion process

Present work

- Laser diagnostics based on laser sheet. Research on flow, spray and combustion characteristics in the optical engine cylinder (e.g. Using high speed PIV to diagnose the flow)
- Using PLIF as a method to analyze the intermediate product in the combustion process of an potential alternative fuel, e.g., 2,5-Dimethylfuran (DMF)
- Research on the combustion characteristic of blending fuels (gasoline & DMF, gasoline & ethanol, ethanol & DMF)
- Unconventional combustion mode researches such as dual-fuel injection optical analysis - different fuel (e.g. ethanol & gasoline) with DI or PFI