

## Cranfield contribution to CRF Hydrogen enrichment Investigation

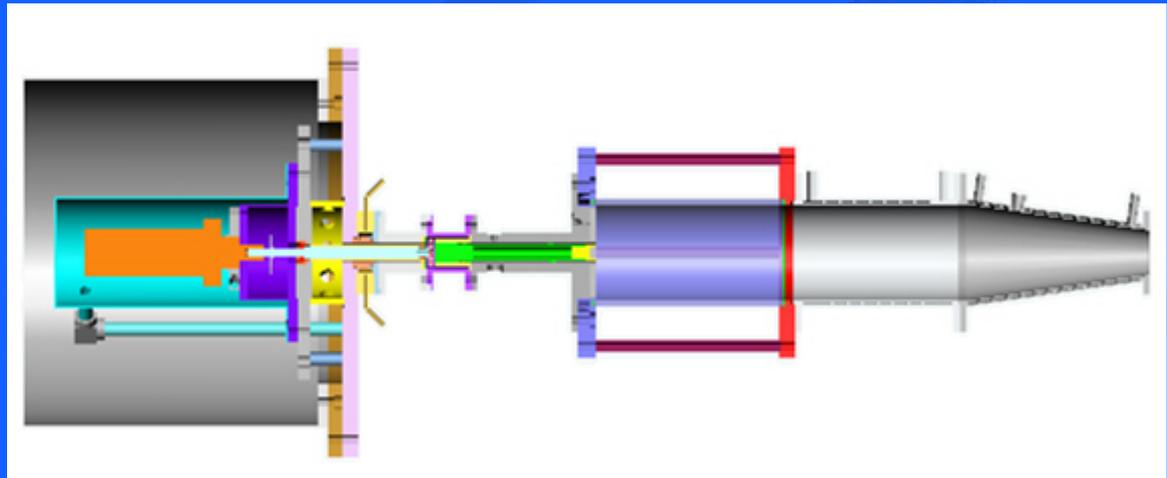
### Experimental Aims

In order to investigate the effect of induced pressure perturbations the following diagnostics will be implemented and phase locked to the burner

CH\* Chemiluminescence will provide information regarding reaction flame location and is indicative of reaction rate.

Stereoscopic PIV will yield fully resolved flow field information, flame speed and flame front identification

**Adam Ruggles**  
**James Kelman**  
**Doug Greenhalgh**



# CH\* Chemiluminescence

---

## Experimental Status

- A Phantom V7 High Speed CMOS camera was coupled with a Lavision Intensifier
- A Band Pass filter 400 – 455nm was placed in front of the camera arrangement
- All flame conditions recorded

Problem identified is that the Phantom Camera is not a light measuring device, rather a wavelength based camera.

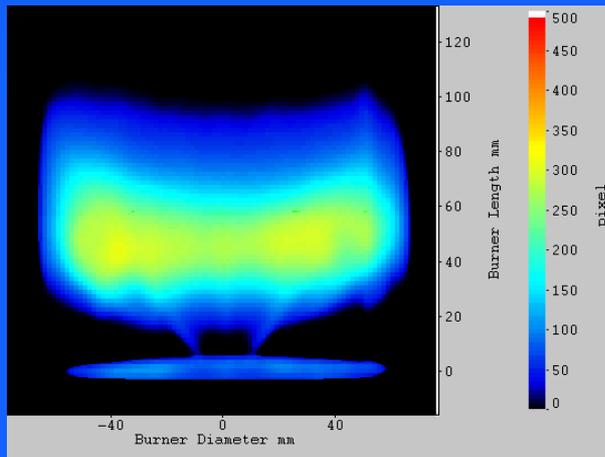
An investigation with a CCD camera and intensifier was performed and completed yielding a suitable calibration check for the phantom data

The Phantom data has been corrected and awaiting analysis. Process interrupted by SPIV timetable.

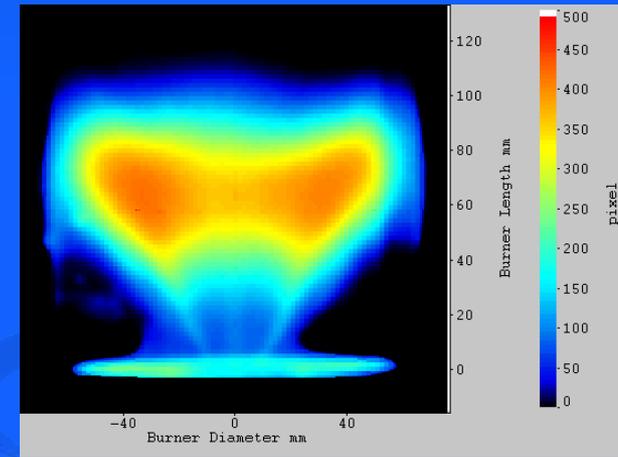
# CH\* Chemiluminescence

## Experimental Results

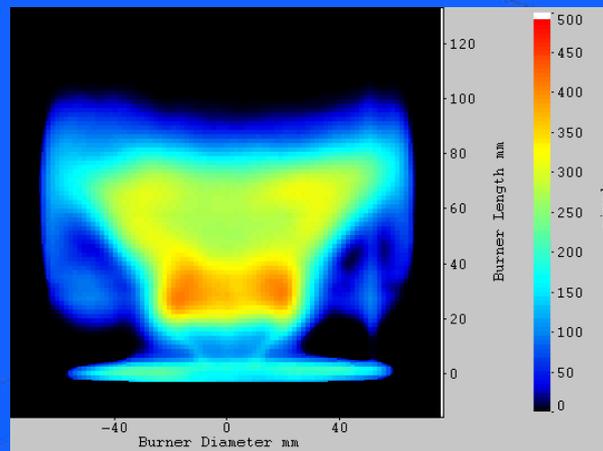
- All 144 flames were recorded
- Example; Flame 13 – 80m/s,  $\Phi = 0.8$ , pure CH<sub>4</sub>,



100Hz



200Hz



400Hz

# Stereoscopic PIV

---

## Experimental Status

- A limited 2D PIV low speed acquisition campaign completed. Annulus imaged. Allowed setting of appropriate seeding density and 'delta T'
- Completion of this work resulted in the destruction of one silica duct

## HS-SPIV Equipment Arrival

- Delivery of the HS-SPIV equipment took place in April however the system was plagued by faults:
  1. New Wave Pegasus Laser Cooling system had corrosion already causing blocking and preventing switch on.
  2. The synchroniser unit that coordinates the Laser and Cameras possessed 'drift' meaning the laser would fire when the cameras were electronically closed resulting in black images. Loss rate ~1200 images out of 2048
  3. Cameras were not being triggered at the same time so the same image number as recorded showed different times (verified by imaging a stopwatch).
  4. Numerous software problems with image acquisition
- Laser and synchroniser were returned to US for repair/replacement. Revised software supplied
- Equipment was returned 24<sup>th</sup> July 2006

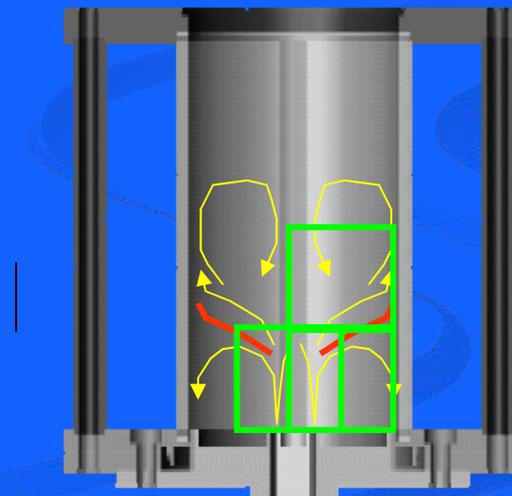
# Stereoscopic PIV

## HS-SPIV Equipment Arrival

- Time spent verifying system works correctly. Although system still possesses fundamental flaws (unable to achieve small  $\Delta T < 6\mu s$ ) it is capable of being used for this work and with current time constraints.
- Cold flow imaging completed corresponding to below strategy 4<sup>th</sup> August. Processing begun
- Hot flow imaging to commence 14<sup>th</sup> August
- Success of hot flow imaging dependent upon life time of remaining silica tubes and available time with equipment (other groups demand time with it). Completion date of this activity is unknown

### Imaging strategy

1. SPIV. An area 56mm x 56mm will be imaged at the Corner Recirculation Zone
2. SPIV. An area 56mm x 56mm located 56mm downstream of CRZ will be imaged
3. 2D PIV used to image annulus as internal reflections make SPIV impossible in showing symmetry of annulus injection

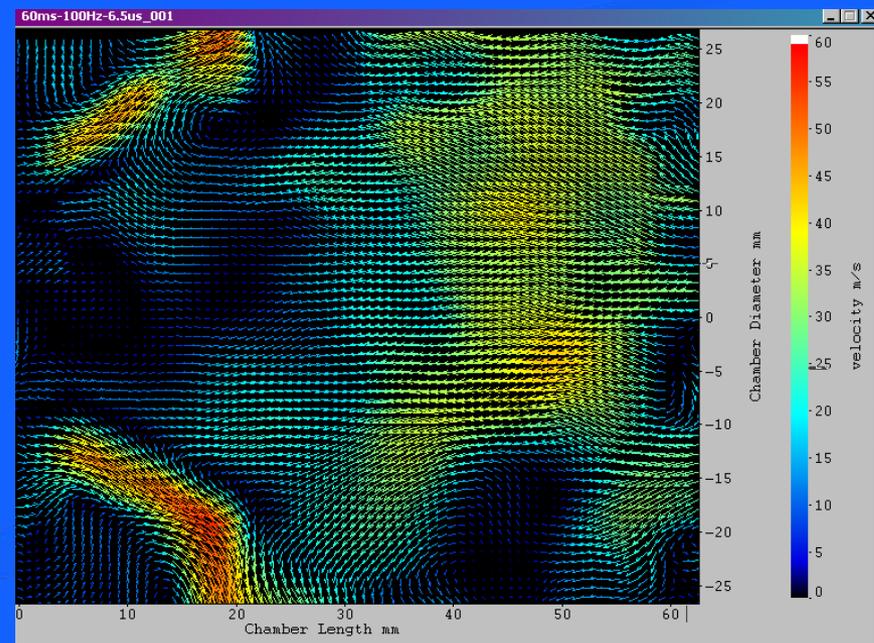
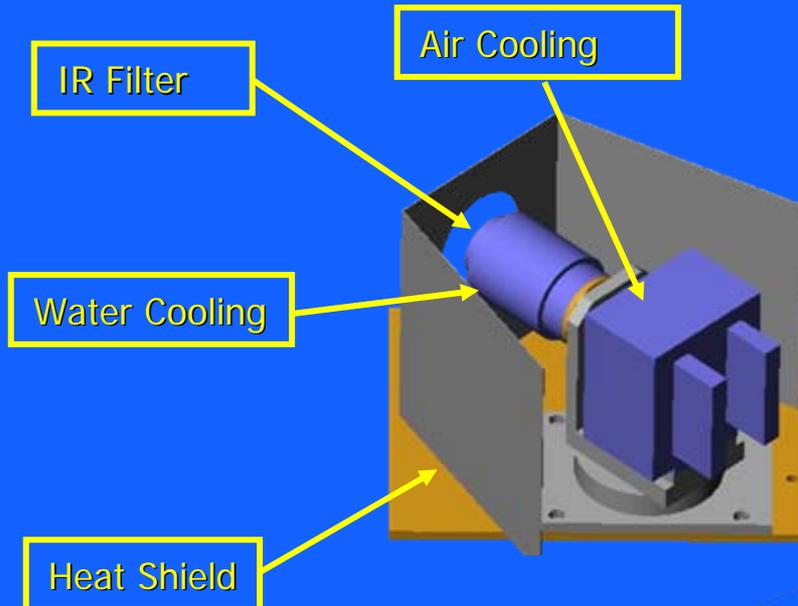


# Stereoscopic PIV

## Experimental Setup

- The forward scatter arrangement is being utilised to maximise signal to noise ratio from particles and common imaging area (Imaging from opposite sides of light sheet).
- This arrangement also minimises lost imaging area due to internal reflections
- Cameras positioned at  $45^\circ$  with scheimpflug angle approx  $23^\circ$
- Cameras protected with heat shields, chilled air directed over camera head body, a water cooled jacket wrapped around the lens body, and IR absorbing filters screwed onto the lens fronts.

Example: Instantaneous image 60ms 100Hz Combusting Flow, Annulus



## Future work

---

### Unstable regime

- CH\* Chemiluminescence Analysis
- Stereoscopic PIV campaign and associated image processing

### Stable regime

- The burner will be modified to run in a stable mode
- Key flame numbers will be investigated with CH\* Chemiluminescence and SPIV
- CRF reference flame will be run and imaged with the intention of connecting the CRF burner with the Cranfield burner and link the both databases.