

| Sensor | FS1-1 | FS1-2 | FS1-3 | FS1-4 | FS1-5 | FS1-6 | FS2-1 | FS2-2 | FS2-3 | FS2-4 | FS2-5 | FS2-6 | FS3-1 | FS3-2 | FS3-3 | FS3-4 | FS3-5 | FS3-6 | FS4-1 | FS4-2 | FS4-3 | FS4-4 | FS4-5 | FS4-6 |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | #N/A | #N/A | IPO | #N/A | #N/A | IP1 | #N/A | #N/A | IP2 | #N/A | #N/A | IP6 | #N/A | #N/A | #N/A | IP10 | #N/A | IP14 | #N/A | IP18 | #N/A | #N/A | IP22 | IP23 |
| | | | | | | | | | RAKE | | | | | | RAKE | | | | RAKE | | | RAKE | | |

| Sensor | NS1-1 | NS1-2 | NS1-3 | NS1-4 | NS1-5 | NS1-6 | NS2-1 | NS2-2 | NS2-3 | NS2-4 | NS2-5 | NS2-6 | NS3-1 | NS3-2 | NS3-3 | NS3-4 | NS3-5 | NS3-6 | NS4-1 | NS4-2 | NS4-3 | NS4-4 | NS4-5 | NS4-6 |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | #N/A | #N/A | TC0 | TC3 | TC1 | TC4 | #N/A | TC2 | KU3 | #N/A | OP0 | #N/A | KU6 | TC6 | #N/A | KU5 | OP1 | KU0 | #N/A | OP2 | TC15 | #N/A | OP3 | KU7 |
| | | | | | | | | | TC9 | RAKE | | | TC7 | | RAKE | | | | RAKE | | | RAKE | | |

| Further Instrumentation | | |
|-------------------------|--------|---------|
| Location | Sensor | Working |
| TS1-1 | TC8 | |
| TS2-1 | TC10 | |
| TS3-1 | TC12 | |
| TS4-1 | TC14 | |
| R1-1 | IP3 | |
| R1-2 | IP4 | |
| R1-3 | IP5 | |
| R2-1 | IP7 | |
| R2-2 | IP8 | |
| R2-3 | IP9 | |
| R3-1 | IP11 | |
| R3-2 | IP12 | |
| R3-3 | IP13 | |
| R4-1 | IP15 | |
| R4-2 | IP16 | |
| R4-3 | IP17 | |
| R5-1 | IP19 | |
| R5-2 | IP20 | |
| R5-3 | IP21 | |
| KU3 | TC9 | |
| KU4 | #N/A | |
| KU6 | TC5 | |
| pitot | TC11 | |

| | |
|---------------------|------------|
| Ionisation Probe | Light Blue |
| Pressure Transducer | Yellow |
| Thermocouple | Orange |
| Optical Probe | Red |

| Item | Location | DAQ | Channel | Measurement | Instrument | Supplier | Range | Signal | Excitation | S/R |
|------|----------|------|---------------|---------------------------|----------------------|------------|--------|-------------|------------|---------|
| IP0 | FS1-3 | PXIe | PXI Slot2/ai0 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP1 | FS1-6 | PXIe | PXI Slot2/ai1 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP2 | FS2-3 | PXIe | PXI Slot2/ai2 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP3 | R1-1 | PXIe | PXI Slot2/ai3 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP4 | R1-2 | PXIe | PXI Slot2/ai4 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP5 | R1-3 | PXIe | PXI Slot2/ai5 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP6 | FS2-6 | PXIe | PXI Slot2/ai6 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP7 | R2-1 | PXIe | PXI Slot2/ai7 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP8 | R2-2 | PXIe | PXI Slot6/ai0 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP9 | R2-3 | PXIe | PXI Slot6/ai1 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP10 | FS3-4 | PXIe | PXI Slot6/ai2 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP11 | R3-1 | PXIe | PXI Slot6/ai3 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP12 | R3-2 | PXIe | PXI Slot6/ai4 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP13 | R3-3 | PXIe | PXI Slot6/ai5 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP14 | FS3-6 | PXIe | PXI Slot6/ai6 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP15 | R4-1 | PXIe | PXI Slot6/ai7 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP16 | R4-2 | PXIe | PXI Slot7/ai0 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP17 | R4-3 | PXIe | PXI Slot7/ai1 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP18 | FS4-2 | PXIe | PXI Slot7/ai2 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP19 | R5-1 | PXIe | PXI Slot7/ai3 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP20 | R5-2 | PXIe | PXI Slot7/ai4 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP21 | R5-3 | PXIe | PXI Slot7/ai5 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP22 | FS4-5 | PXIe | PXI Slot7/ai6 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| IP23 | FS4-6 | PXIe | PXI Slot7/ai7 | Flame Presence | Ionisation Probe | Bruce Ewan | TBC | -5 to 5V | 60V | 100 kHz |
| OP0 | NS2-5 | PXIe | PXI1Slot4/ai0 | Flame Presence | Optical Probe | Bruce Ewan | TBC | -5 to 5V | 30V | 100 kHz |
| OP1 | NS3-5 | PXIe | PXI1Slot4/ai1 | Flame Presence | Optical Probe | Bruce Ewan | TBC | -5 to 5V | 30V | 100 kHz |
| OP2 | NS4-2 | PXIe | PXI1Slot4/ai2 | Flame Presence | Optical Probe | Bruce Ewan | TBC | -5 to 5V | 30V | 100 kHz |
| OP3 | NS4-5 | PXIe | PXI1Slot4/ai3 | Flame Presence | Optical Probe | Bruce Ewan | TBC | -5 to 5V | 30V | 100 kHz |
| OP4 | NS4-5 | PXIe | PXI1Slot4/ai4 | Flame Presence | Optical Probe | Bruce Ewan | TBC | -5 to 5V | 30V | 100 kHz |
| OP5 | NS4-5 | PXIe | PXI1Slot4/ai5 | Flame Presence | Optical Probe | Bruce Ewan | TBC | -5 to 5V | 30V | 100 kHz |
| TC0 | NS1-3 | PXIe | SC1Mod4/Wall | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC1 | NS1-5 | PXIe | SC1Mod4/ai1 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC2 | NS2-2 | PXIe | SC1Mod4/ai2 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC3 | NS1-4 | PXIe | SC1Mod4/ai3 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC4 | NS1-6 | PXIe | SC1Mod4/ai4 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC5 | Ku6 | PXIe | SC1Mod4/ai5 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC6 | NS3-2 | PXIe | SC1Mod4/ai6 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC7 | NS3-2 | PXIe | SC1Mod4/ai7 | Gas Temperature (Wall) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC8 | TS1-1 | PXIe | SC1Mod4/ai8 | Temperature (surface) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC9 | KU3 | PXIe | SC1Mod4/ai9 | Temperature (kulite body) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC10 | TS2-1 | PXIe | SC1Mod4/ai10 | Temperature (surface) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC11 | pitot | PXIe | SC1Mod4/ai11 | Temperature (kulite body) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC12 | TS3-1 | PXIe | SC1Mod4/ai12 | Temperature (surface) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC13 | NS3-1 | PXIe | SC1Mod4/ai13 | Temperature (kulite body) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC14 | TS4-1 | PXIe | SC1Mod4/ai14 | Temperature (surface) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| TC15 | NS4-3 | PXIe | SC1Mod4/ai15 | Temperature (pitot) | K-Type Thermocouple | TC-Direct | 1100°C | Conditioned | None | 5 kHz |
| KU0 | NS3-6 | PXIe | SC1Mod1/ai0 | Pressure | Kulite | | | | | 100 kHz |
| KU1 | NS3-6 | PXIe | SC1Mod1/ai1 | Pressure | Kulite | | | | | 100 kHz |
| KU2 | NS3-6 | PXIe | SC1Mod1/ai2 | Pressure | XTEH-10L-190M-50BARA | Kulite | | 0-100 mV | | 100 kHz |
| KU3 | NS2-3 | PXIe | SC1Mod1/ai3 | Pressure | Kulite | | | | | 100 kHz |
| KU4 | NS3-6 | PXIe | SC1Mod1/ai4 | Pressure | Kulite | | | | | 100 kHz |
| KU5 | NS3-4 | PXIe | SC1Mod1/ai5 | Pressure | Kulite | | | | | 100 kHz |
| KU6 | NS3-1 | PXIe | SC1Mod1/ai6 | Pressure | Kulite | | | | | 100 kHz |
| KU7 | NS4-6 | PXIe | SC1Mod1/ai7 | Pressure | Kulite | | | | | 100 kHz |
| PB1 | NS3-6 | PXIe | PXI Slot3/ai0 | Pressure | 113824 | PCB | 68 bar | 0-5 V | 20-30 V | 1 MHz |
| PB2 | TS3-6 | PXIe | PXI Slot3/ai0 | Pressure | 113825 | PCB | 68 bar | 0-5 V | 20-30 V | 1 MHz |

| | |
|---------------------|--------------|
| Date | 22 May 2015 |
| Time | 14:17:40 |
| Test Number | 66 |
| Mixture Composition | 40%CH4/60%H2 |
| Ambient Temperature | 6 oC |
| Ambient Pressure | 977 mbar |
| Wind Speed | 2 m/s |
| Wind direction | SW |
| Relative Humidity | 65.00% |
| Equivalence Ratio | 0.40 |

General Comments: (weather, rig configuration)

Weather: Cool but sunny and dry.
 Tube configuration:
 4 x 3m tube sections
 igniter 250mm from beginning of tube section

Test with 15 rows of congestion (row 8 on central flange with 7 rows projecting upstream into tube 2 and 7 rows projecting downstream into tube 3). This test represents the lowest EQR value using the 60H2/40CH4 mixture and at the lower exhaust temperature of 350 C (but with the same exhaust duct velocity). The combustion is extremely weak with a peak pressure of only 0.08 bar. Usefully, the OPs provide flame arrival information at each station and this is very low at 50 - 90 m/s. The flame structure is not sufficiently sharp or intense to enable flame IP sensor signals.

Headlines

Max overpressure
 mbar

Max. flame speed
 m/s
 [ionisation probes]

Max. temperature
 °C

Mass Flow
 kg/s

m/s
 [optical probes]

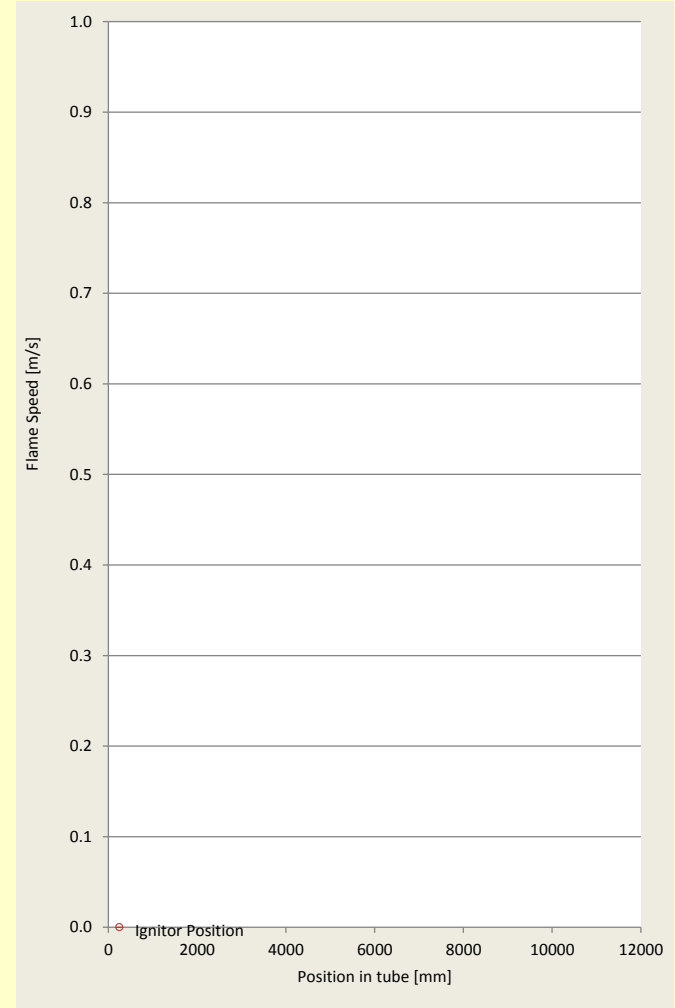
Initial Temperature
 °C

Location of igniter mm

Time of ignition seconds

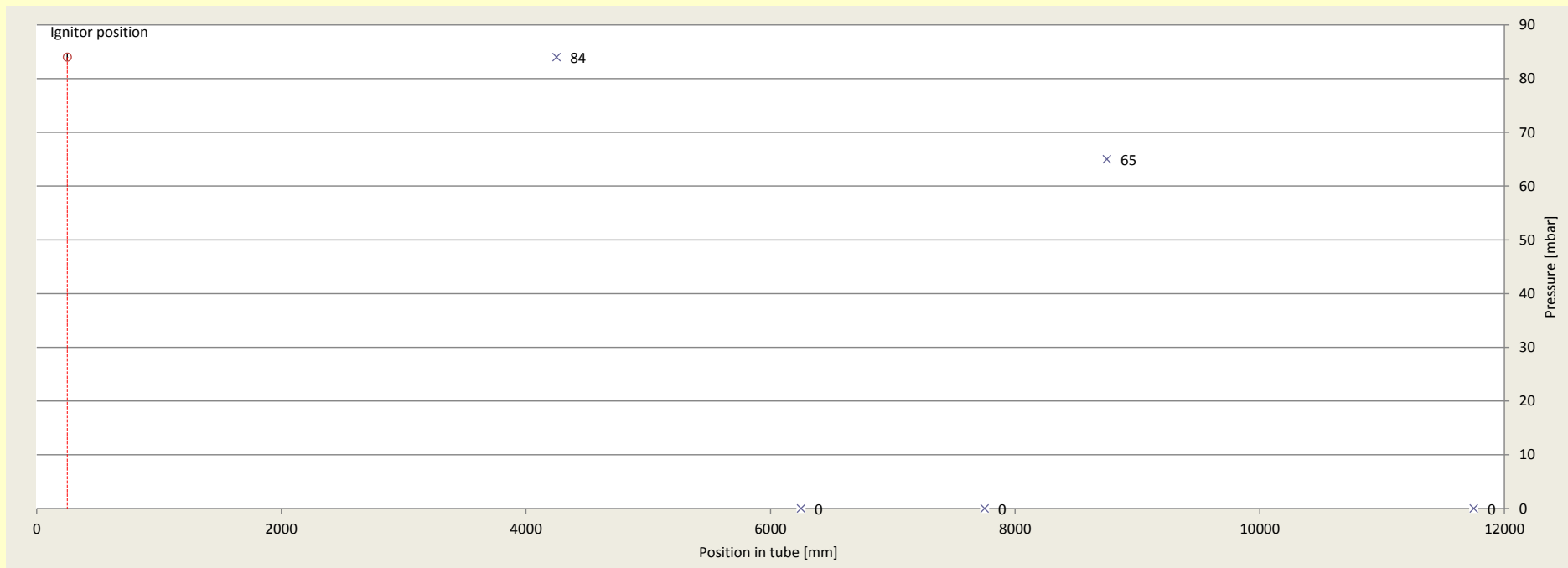
| IP Number | Location label | Data Name | Position in tube (mm) | Flame arrival time (s) | Avg Flame speed from last sensor (m/s) |
|-----------|----------------|-------------|-----------------------|------------------------|--|
| REF | #N/A | Flameion_0 | #N/A | | |
| IP1 | FS1-6 | Flameion_1 | 2750 | | |
| IP2 | FS2-3 | Flameion_2 | 4250 | 1.3290 | |
| IP3 | R1-1 | Flameion_3 | 4750 | NS | |
| IP4 | R1-2 | Flameion_4 | 4750 | NS | |
| IP5 | R1-3 | Flameion_5 | 4750 | NS | |
| IP6 | FS2-6 | Flameion_6 | 5750 | NS | |
| IP7 | R2-1 | Flameion_7 | 6000 | NS | |
| IP8 | R2-2 | Flameion_8 | 6000 | disconnected | |
| IP9 | R2-3 | Flameion_9 | 6000 | disconnected | |
| IP10 | FS3-4 | Flameion_10 | 7750 | NS | |
| IP11 | R3-1 | Flameion_11 | 7250 | NS | |
| IP12 | R3-2 | Flameion_12 | 7250 | NS | |
| IP13 | R3-3 | Flameion_13 | 7250 | NS | |
| IP14 | FS3-6 | Flameion_14 | 8750 | 1.4052 | |
| IP15 | R4-1 | Flameion_15 | 9250 | NS | |
| IP16 | R4-2 | Flameion_16 | 9250 | NS | |
| IP17 | R4-3 | Flameion_17 | 9250 | NS | |
| IP18 | FS4-2 | Flameion_18 | 9750 | NS | |
| IP19 | R5-1 | Flameion_19 | 10750 | NS | |
| IP20 | R5-2 | Flameion_20 | 10750 | NS | |
| IP21 | R5-3 | Flameion_21 | 10750 | NS | |
| IP22 | FS4-5 | Flameion_22 | 11250 | NS | |
| IP23 | FS4-6 | Flameion_23 | 11750 | NS | |

0.0



Location of igniter mm

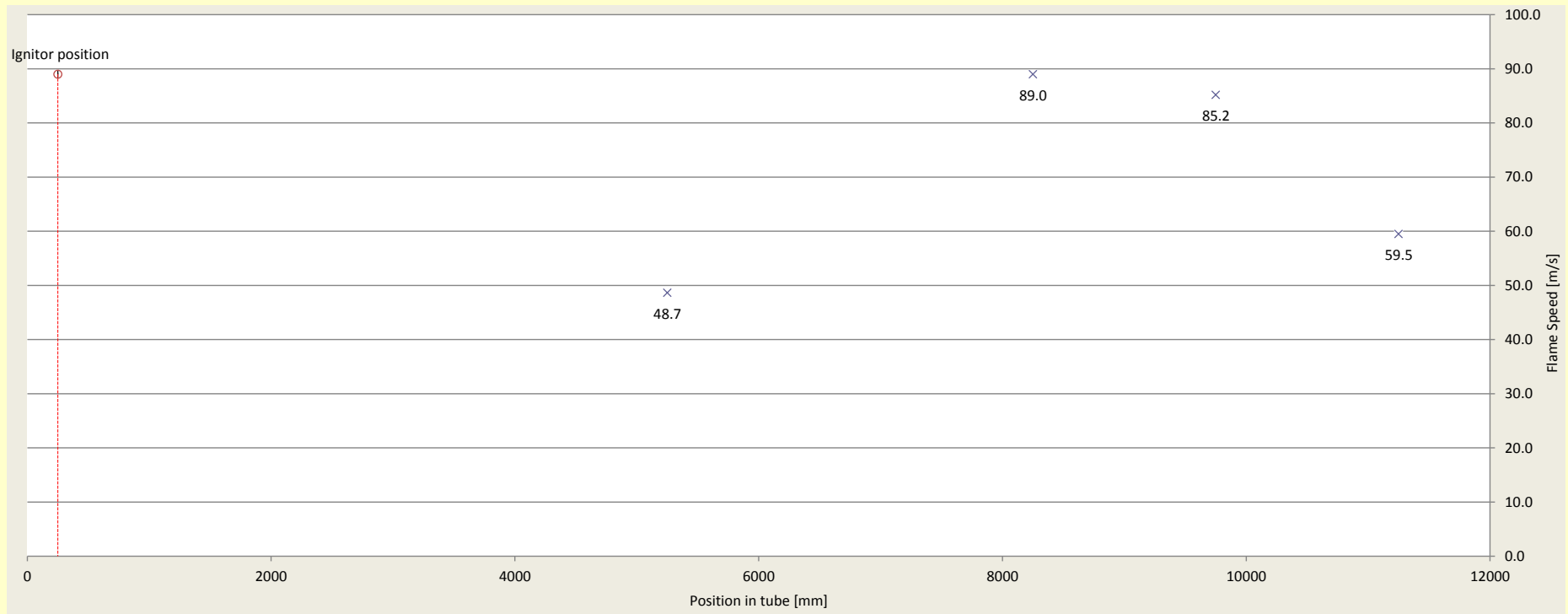
| Transducer number | Location | Position in tube [mm] | ΔP_{max} [mbar] |
|-------------------|----------|-----------------------|-------------------------|
| KU0 | NS3-6 | 8750 | 65 |
| KU1 | 0 | #N/A | |
| KU2 | 0 | #N/A | |
| KU3 | NS2-3 | 4250 | 84 |
| KU4 | 0 | #N/A | |
| KU5 | NS3-4 | 7750 | 0 |
| KU6 | NS3-1 | 6250 | 0 |
| KU7 | NS4-6 | 11750 | 0 |
| PB2 | TS3-6 | 8750 | |



Location of igniter mm

Time of ignition seconds

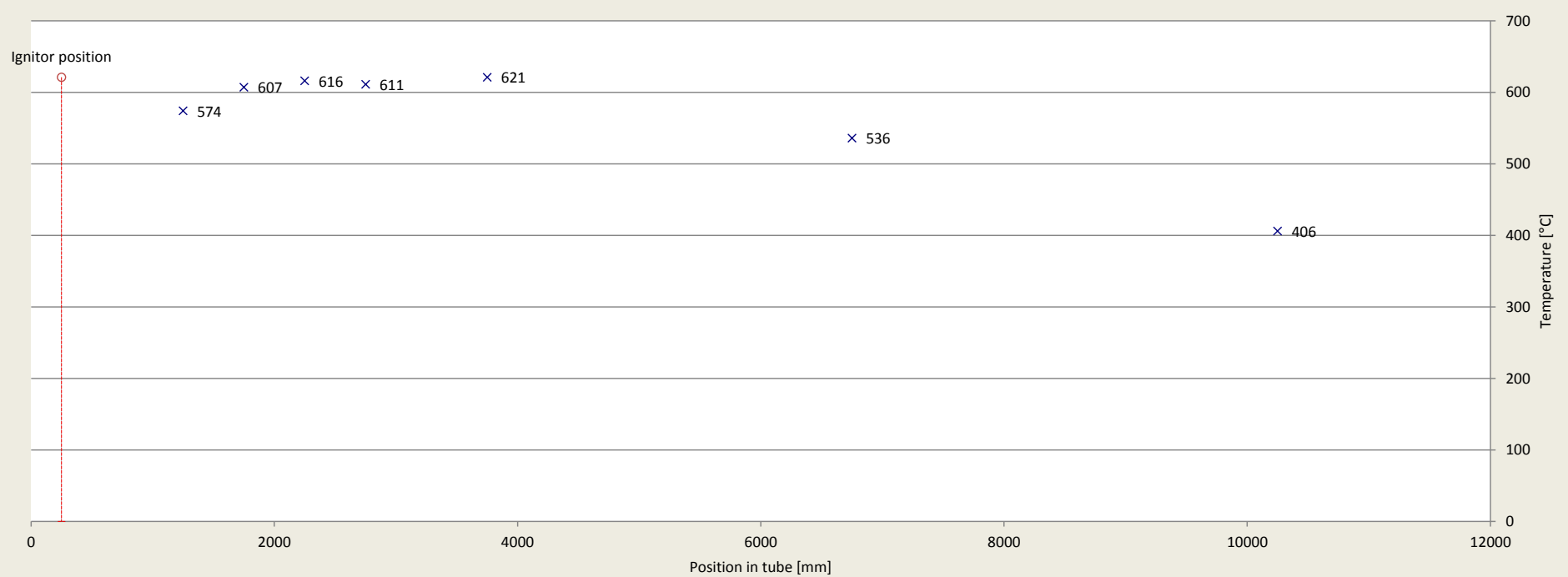
| OP Number | Location label | Position in tube (mm) | Flame arrival time (s) | Average flame speed (m/s) |
|-----------|----------------|-----------------------|------------------------|---------------------------|
| OP0 | NS2-5 | 5250 | 1.3648 | 48.7 |
| OP1 | NS3-5 | 8250 | 1.3985 | 89.0 |
| OP2 | NS4-2 | 9750 | 1.4161 | 85.2 |
| OP3 | NS4-5 | 11250 | 1.4413 | 59.5 |
| OP4 | 0 | #N/A | | |
| OP5 | 0 | #N/A | | |

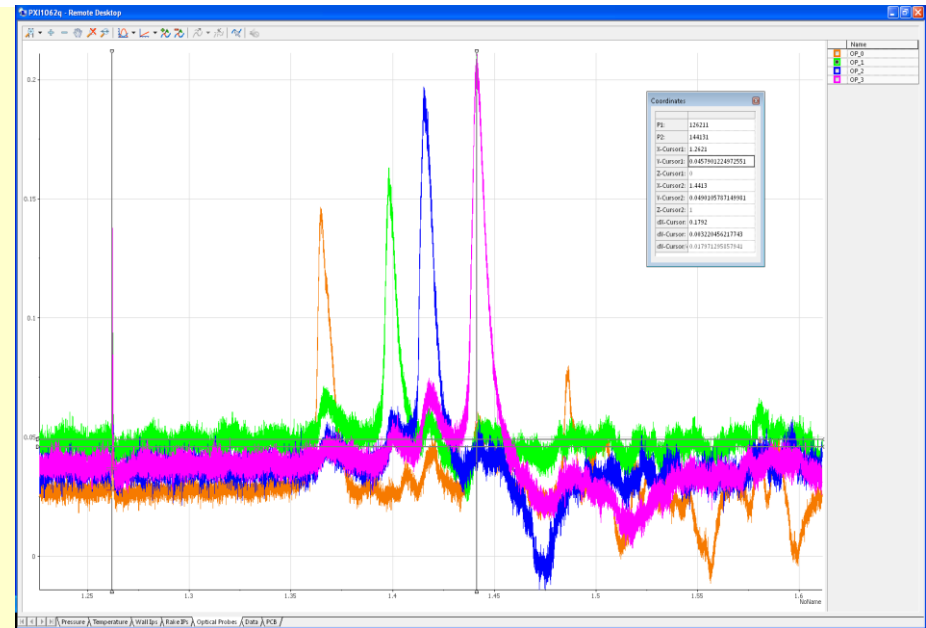
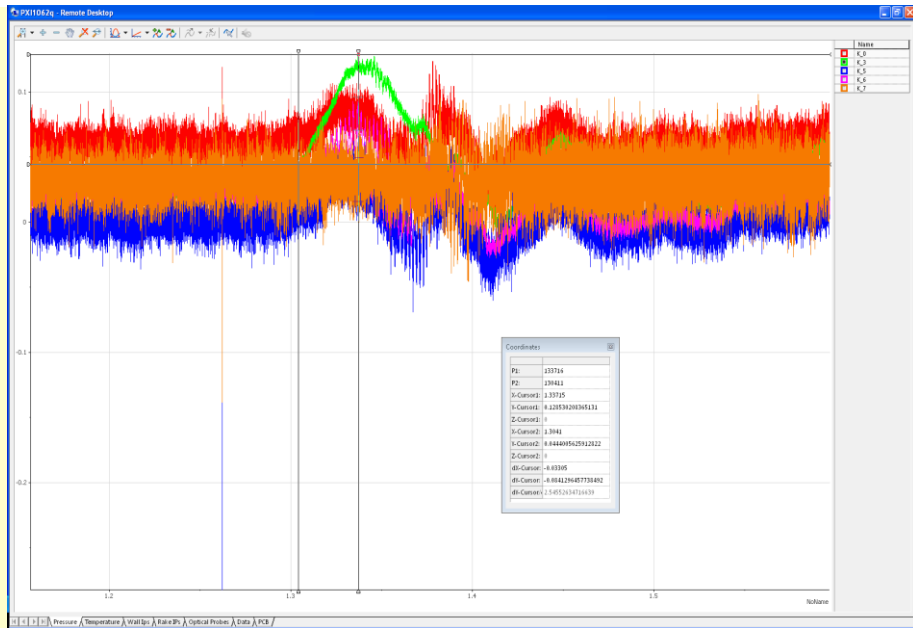


Location of igniter

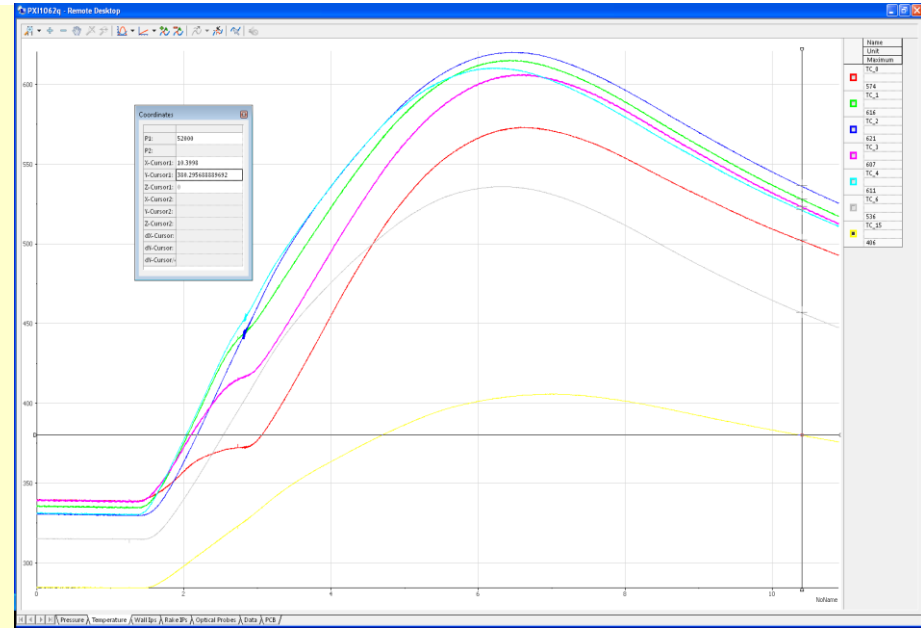
250 mm

| Thermocouple number | Location | Position in tube (mm) | T _{max} (deg C) |
|---------------------|----------|-----------------------|--------------------------|
| TC0 | NS1-3 | 1250 | 574 |
| TC1 | NS1-5 | 2250 | 616 |
| TC2 | NS2-2 | 3750 | 621 |
| TC3 | NS1-4 | 1750 | 607 |
| TC4 | NS1-6 | 2750 | 611 |
| TC5 | Ku6 | #N/A | |
| TC6 | NS3-2 | 6750 | 536 |
| TC15 | NS4-3 | 10250 | 406 |





NO DATA / IMAGES



Ionisation Probes

Temperature