Presented at FABIG Technical Meeting 111 "From Research to Practice: Insights From Recent Projects on Hydrogen & Ammonia Safety", 24 March 2026.
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WHEN TRUST MATTERS

Diffusion Ignition in Flange Releases

SAFEN-HICON Update on Experimental Programme

Mike Johnson

24 March 2026

Overview

- Background to experimental programme
- Design details
- Outline of test programme and instrumentation
- Preliminary results and issues

Background

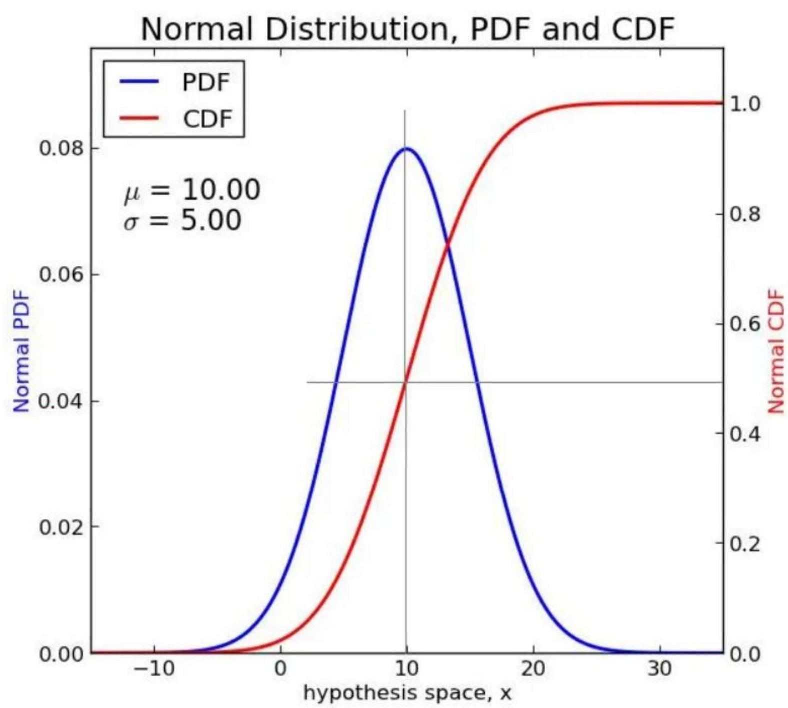
- Experimental programme to assess the potential for diffusion ignition because of ‘sudden’ releases into flange gaps
- The generation of shock waves within the flange gap is considered necessary to give the potential for diffusion ignition
- The experiments needs to be representative of the possible practical situations of sudden release:
  - Release mechanism needs to have a rapid activation time (single milliseconds) to provide a release that generates shock waves
- Design needs to allow a range of conditions to be assessed and to enable repeat measurements at the same conditions
  - Enables statistical analysis if outcomes if nominally identical conditions have different outcomes

Experimental Approach

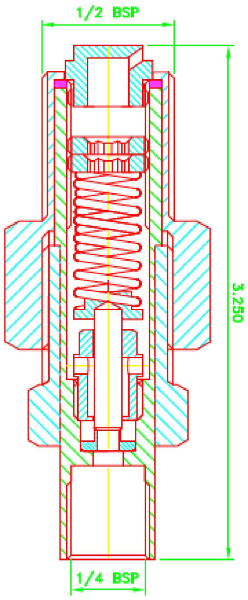
- Need to build statistics on ignition probability
- Proposed to investigate a range of pressures and conditions
- At least 10 tests in each configuration
- Adds up to a lot of tests, so not practicable to use bursting discs
- Approach adopted to use a nozzle to produce repeatable near instantaneous releases

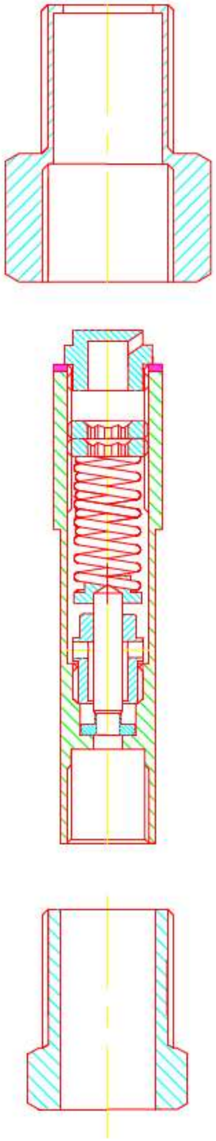
Converting the sampling into statistically relevant data

- The event (ignition) happening at a given pressure P assuming a normal distribution, will show up as a Cumulative Distribution Function.
- Probability Density Function is a derivative of the CDF.

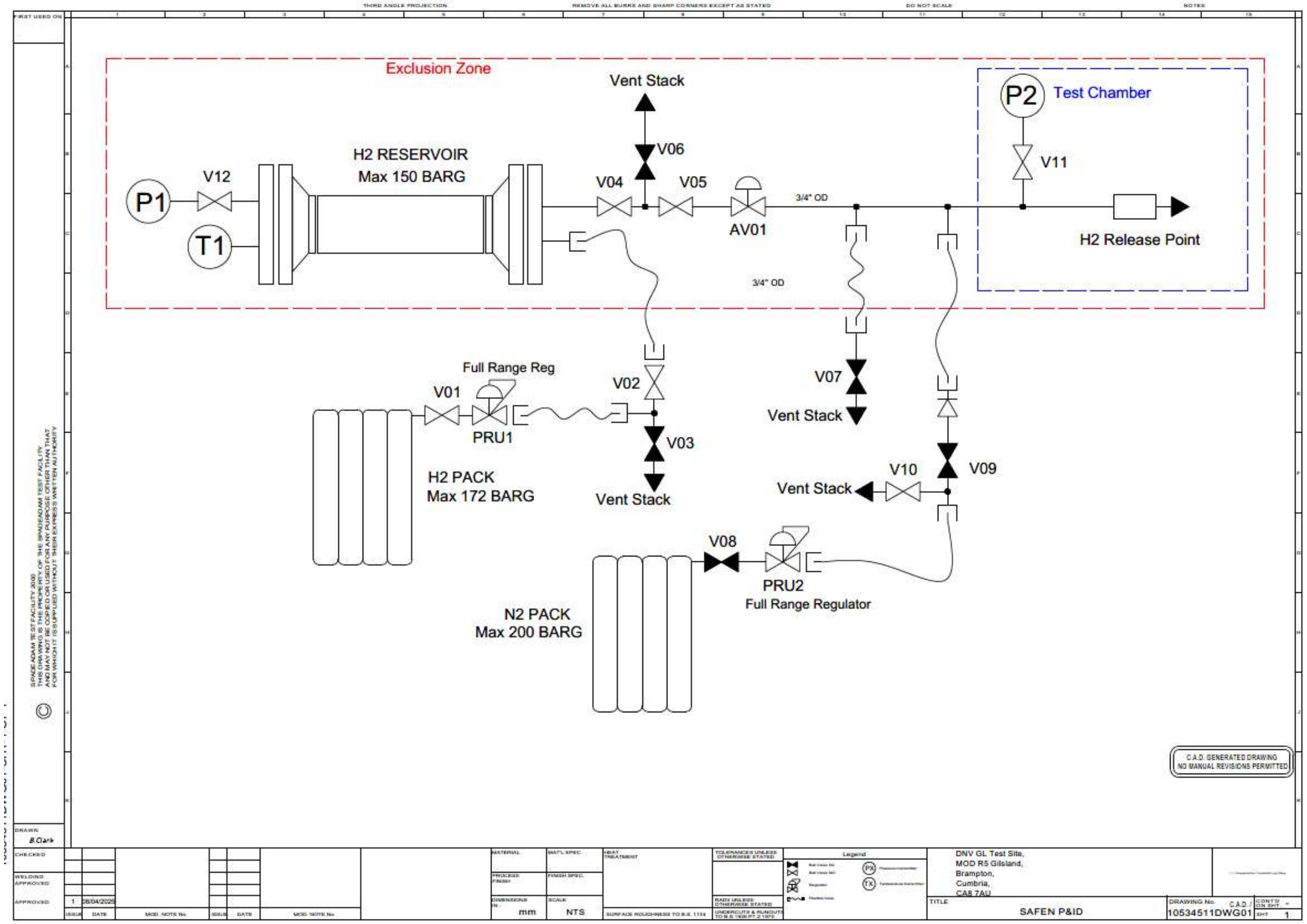


Injector Design



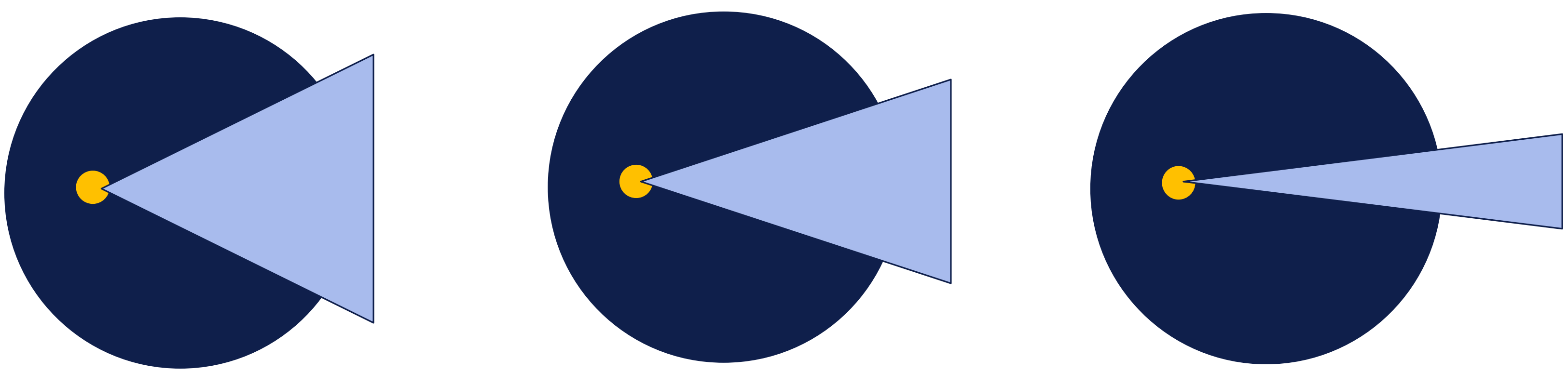


Experimental Arrangement



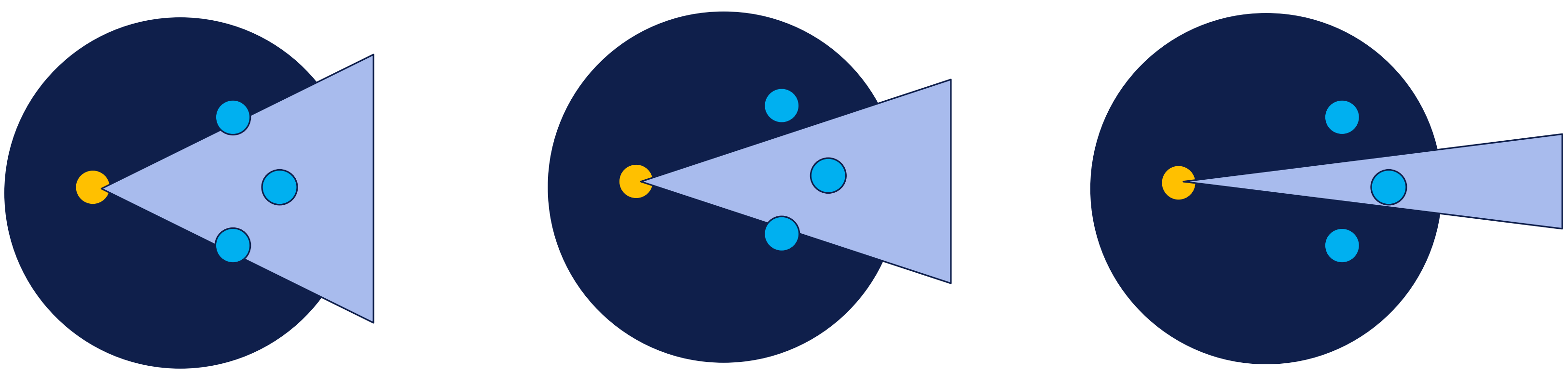
Test Matrix I - Unconfined

- Variations in Flange spacing (5mm, 15mm, 30mm)
- Variations in Nozzle aperture (3mm, 5mm, 7mm)
- Release pressure 40-140bar



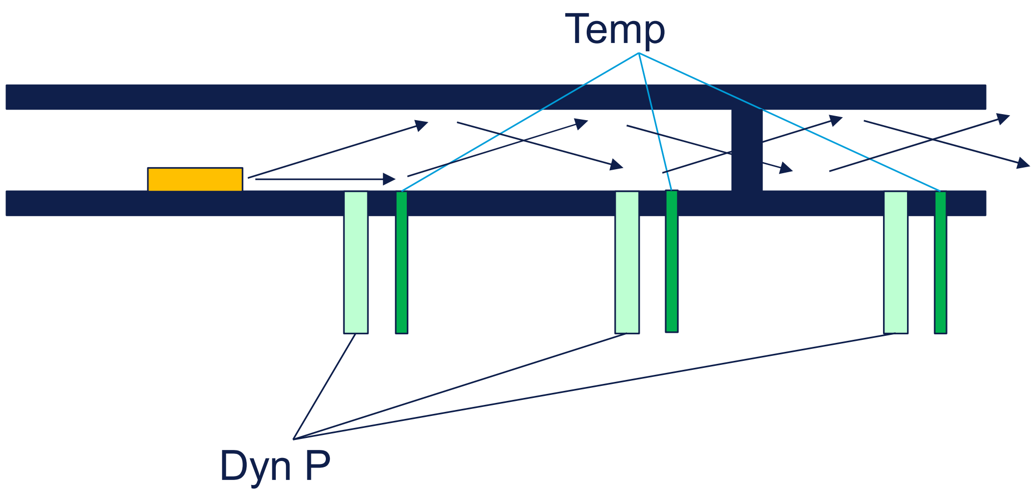
Test Matrix II – 'Confined'

- Variations in Flange spacing (5mm, 15mm, 30mm)
- Variations in Nozzle aperture (3mm, 5mm, 7mm)
- Release pressure 40-140bar
- Variations in Congestion (TBC, eg below)



Instrumentation

- Temperature, dynamic pressure
- Temperature & static pressure in the reservoir
- High Speed Camera perpendicular to the nozzle exit

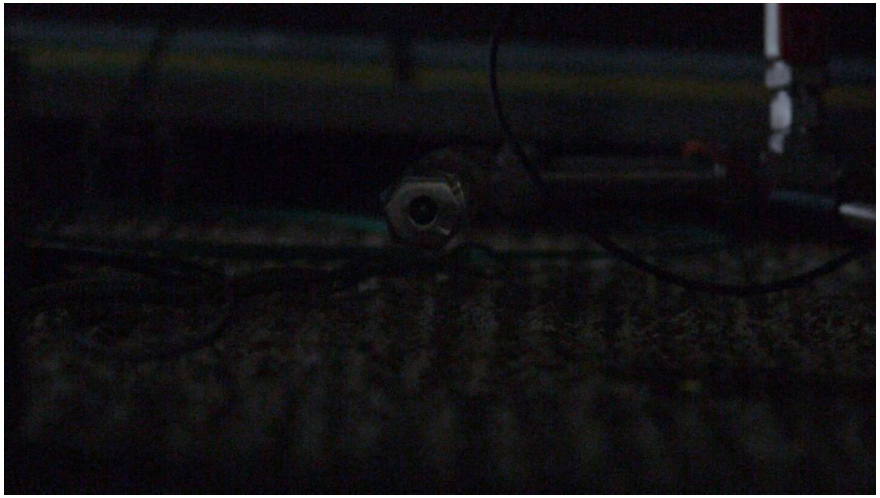


Update on Progress

- Nozzle designed and fabricated
- Preliminary tests conducted first in a pipe then moving to a flange geometry
- Comparison made with bursting disc

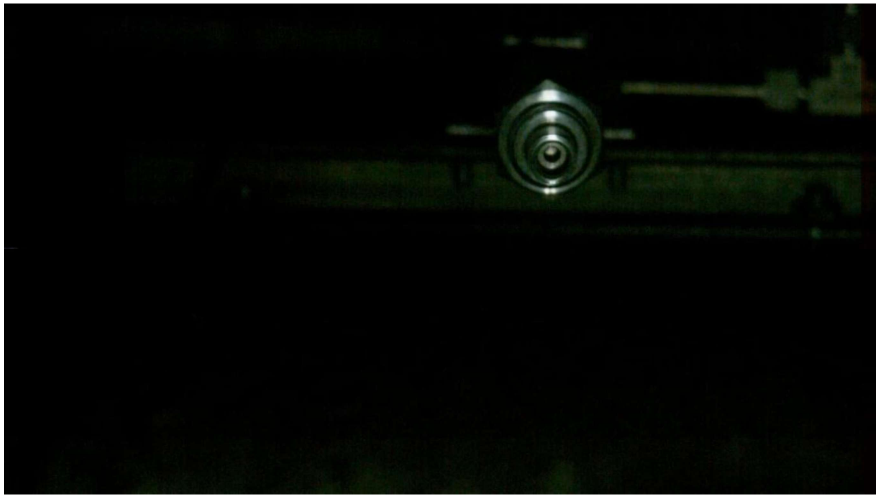
Characterising release times and mechanism

Burst Disc



- 1ms to full release
- Full gas release of control volume

Injector



- 3ms to full release
- Limited gas release of control volume

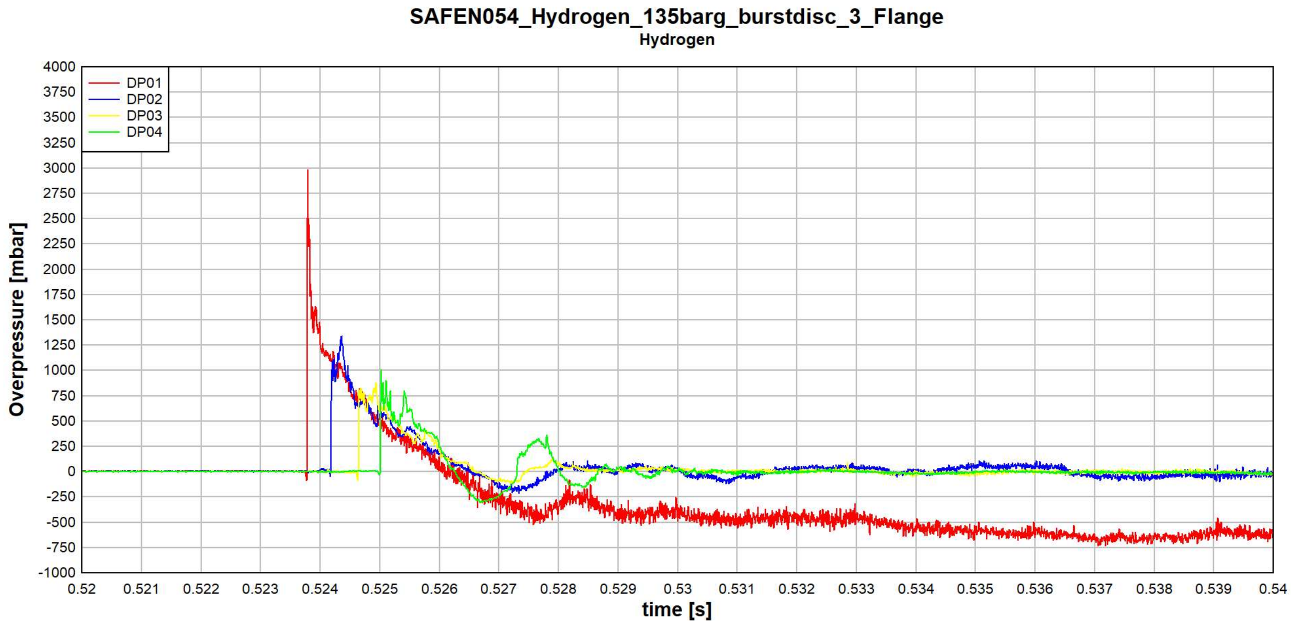
Burst Disc Release - Hydrogen

Burst Disc Release - Hydrogen

Injector Release - Hydrogen

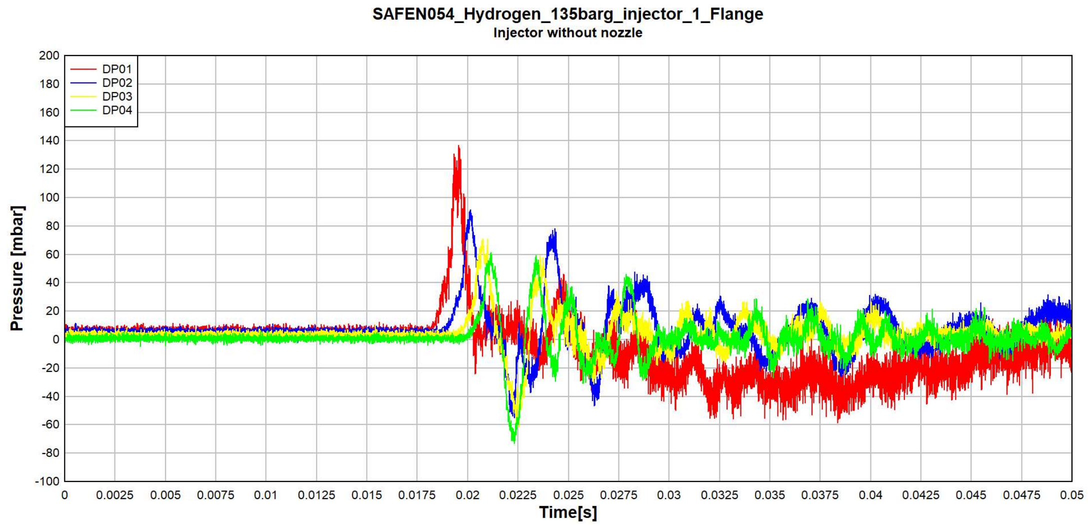
Burst Disc Release - Hydrogen

- Peak pressure 3barg
- Shock speed: ~540m/s
- Small ignition noted



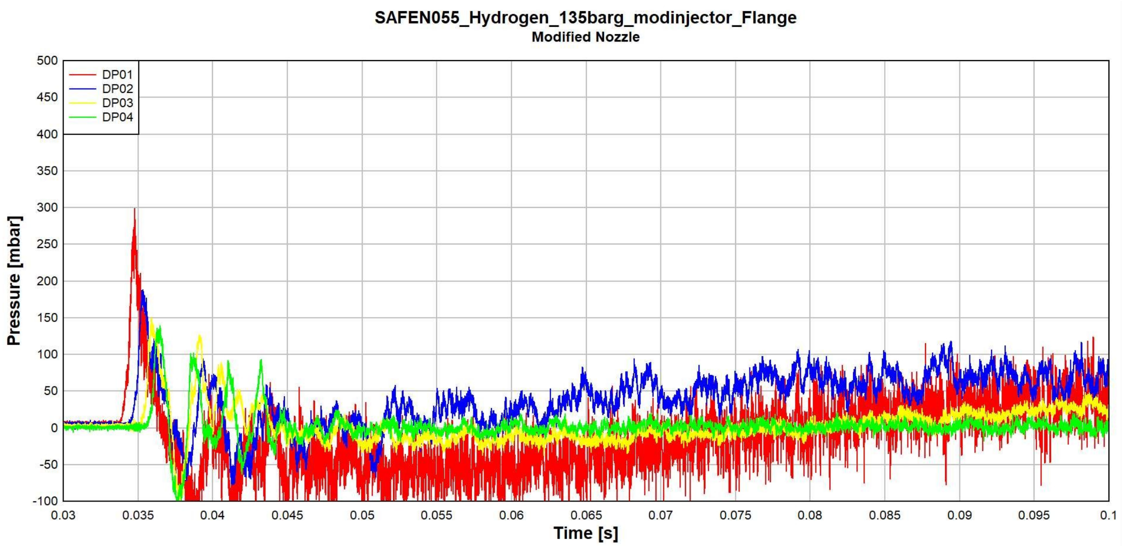
Injector Release - Hydrogen

- No nozzle in front of injector
- Peak Pressure – 130mbar
- Slower duration than burst disc
- No ignition noted



Modified Injector Release - Hydrogen

- Release aperture 3mm x 11mm
- Peak Pressure – 300mbar
- Reduction in pressure duration compared to injector release without nozzle
- No ignition noted



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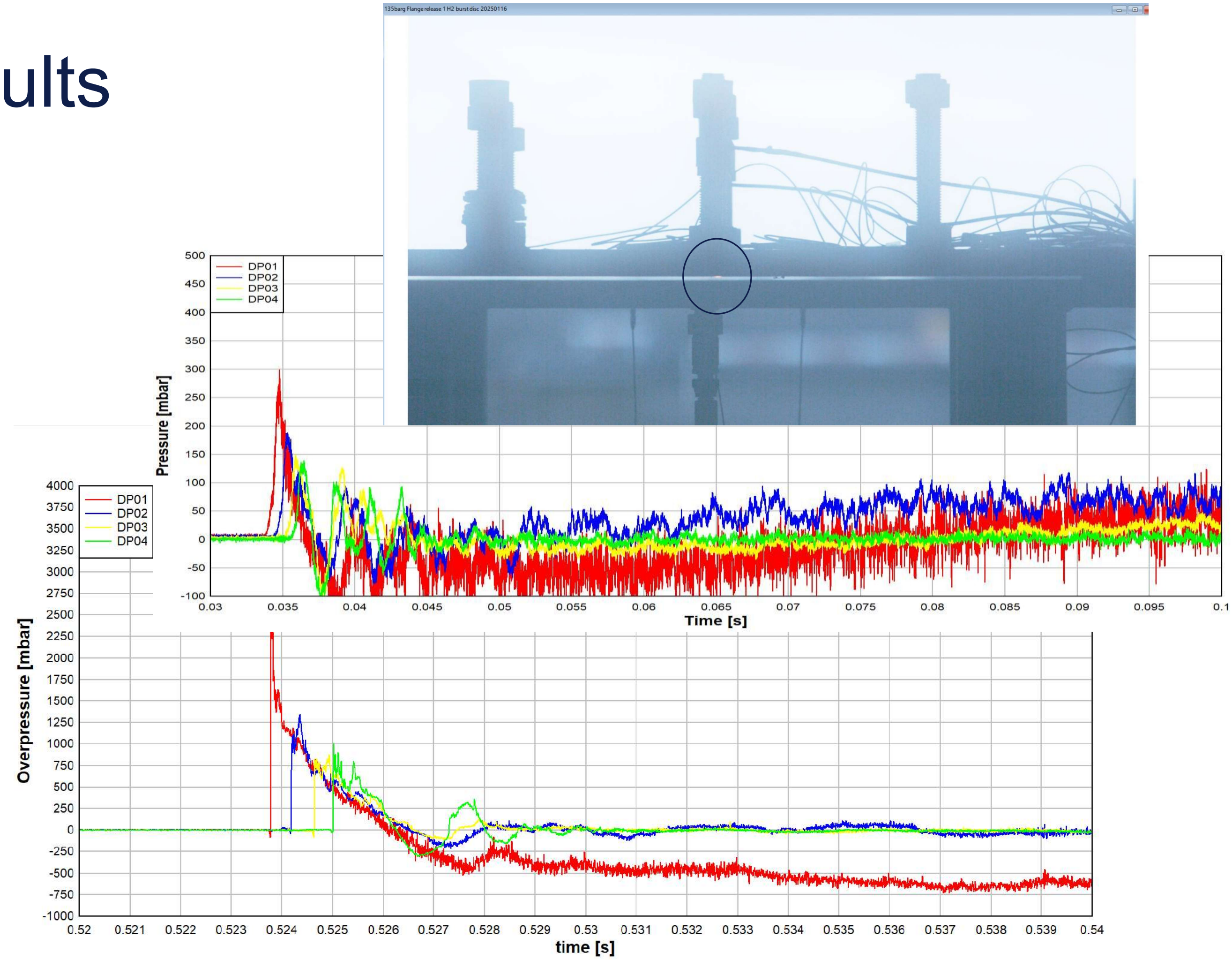
Preliminary Results

- Ignition has not been happening at below 135 bar, while literature has shown ignitions should be happening in a scaled model at ~70 bar.
- We are seeing shocks forming with a burst disc but not enough energy in the injector releases for similar pressures.



Summary of Initial Test Series

- Difficult to find a repeatable configuration that gives comparable behaviour to a bursting disc
- Not practicable to do all tests with bursting disc
- Suggested way forward is to investigate higher pressure first
- Also – a question – what actually happens in a flange failure?

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