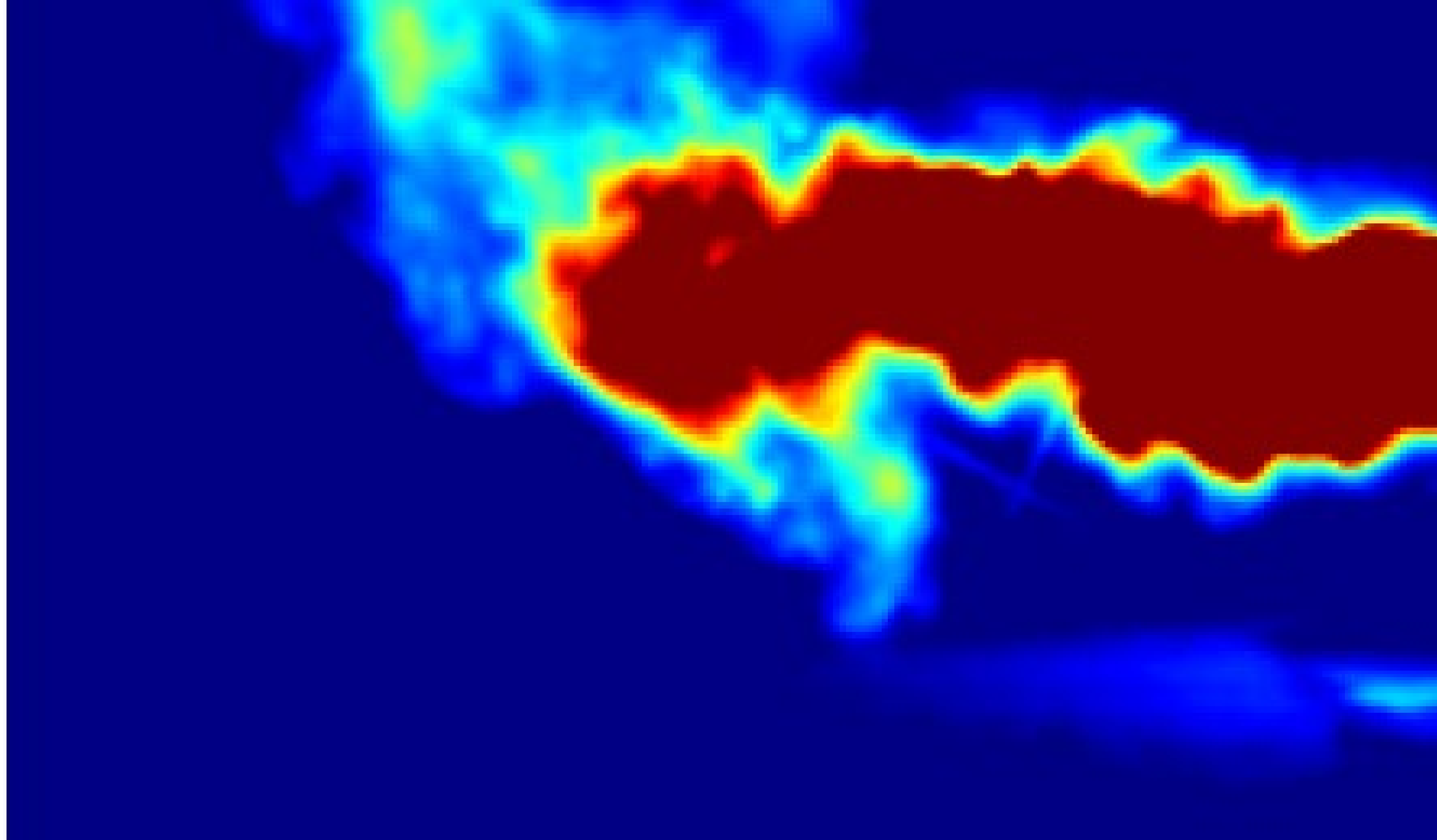

PFPNet
PASSIVE FIRE PROTECTION NETWORK

PFPNet H_2 Jet Fire Project

Introduction

- Jet fires are severe momentum-driven fires of flammable gas/liquid from a pressurized inventory

Introduction

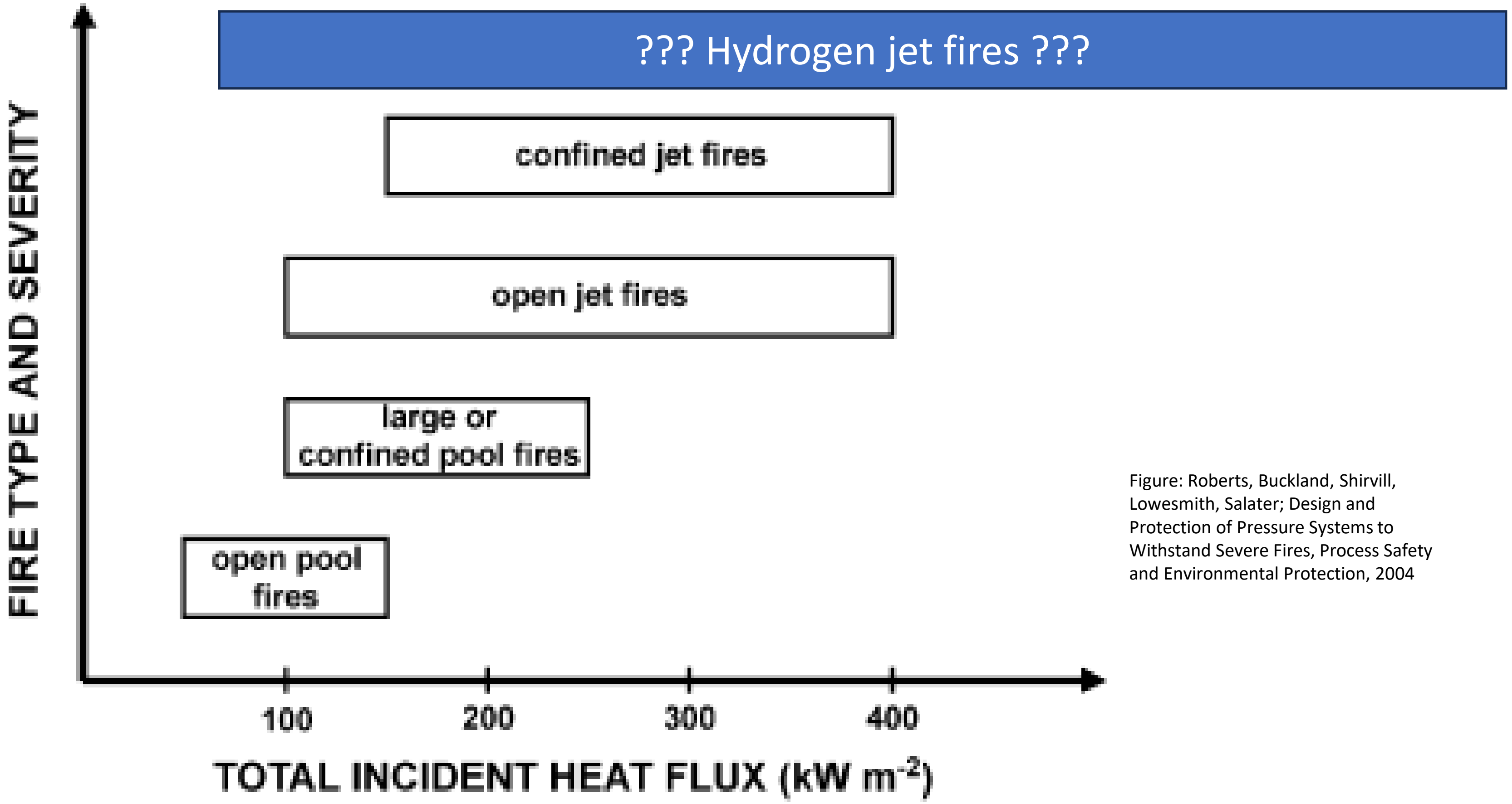

Figure: Roberts, Buckland, Shirvill, Lowesmith, Salater; Design and Protection of Pressure Systems to Withstand Severe Fires, Process Safety and Environmental Protection, 2004

PFPNet H_2 project

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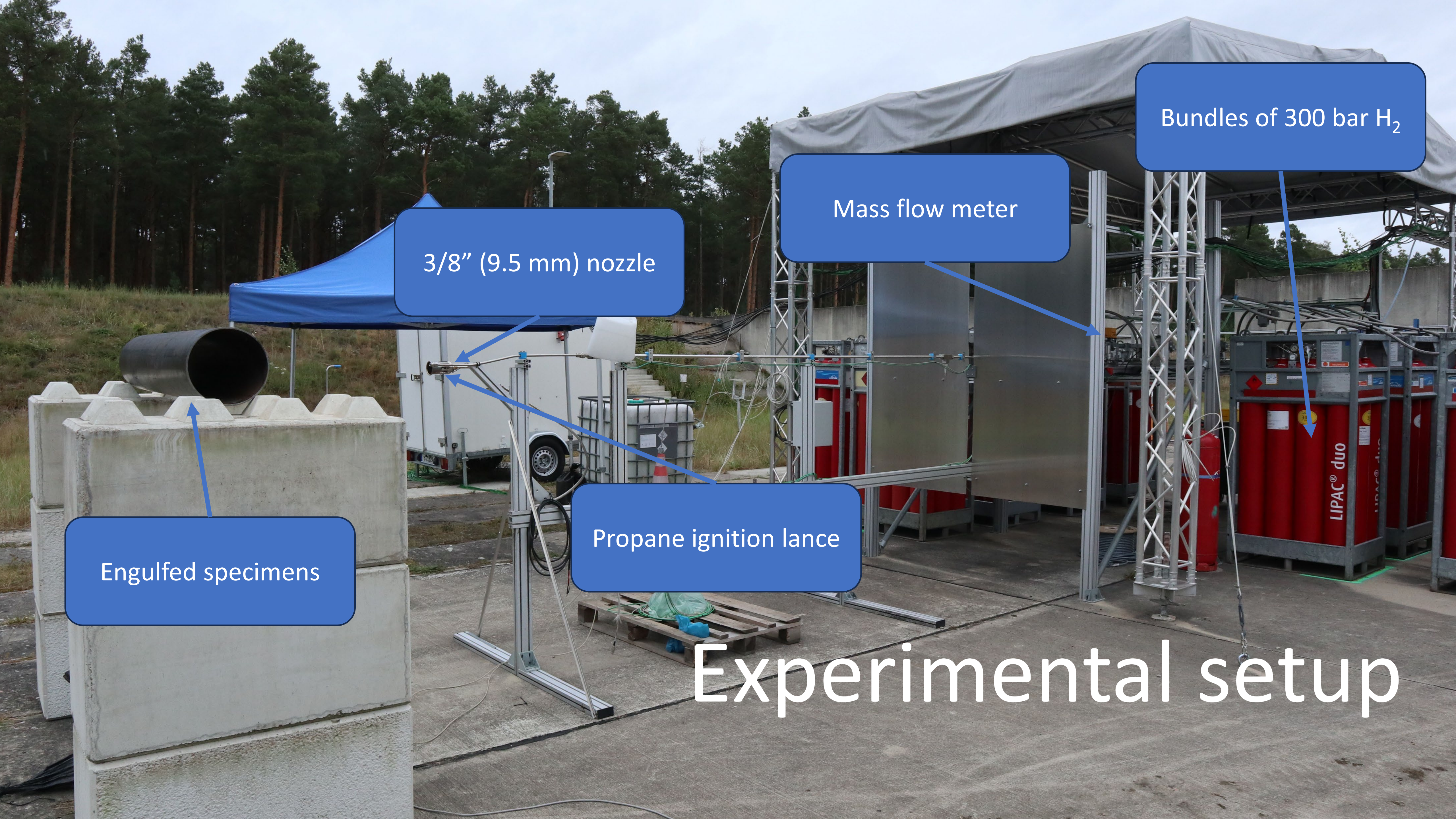
The key questions:

- Can existing PFP materials protect against H2 jet fires?
- Can we model the conditions experienced by an object engulfed in a H2 jet fire?
- Are existing test methods adequate?
- If not, what would a test method look like?



Experimental setup

Instrumentation

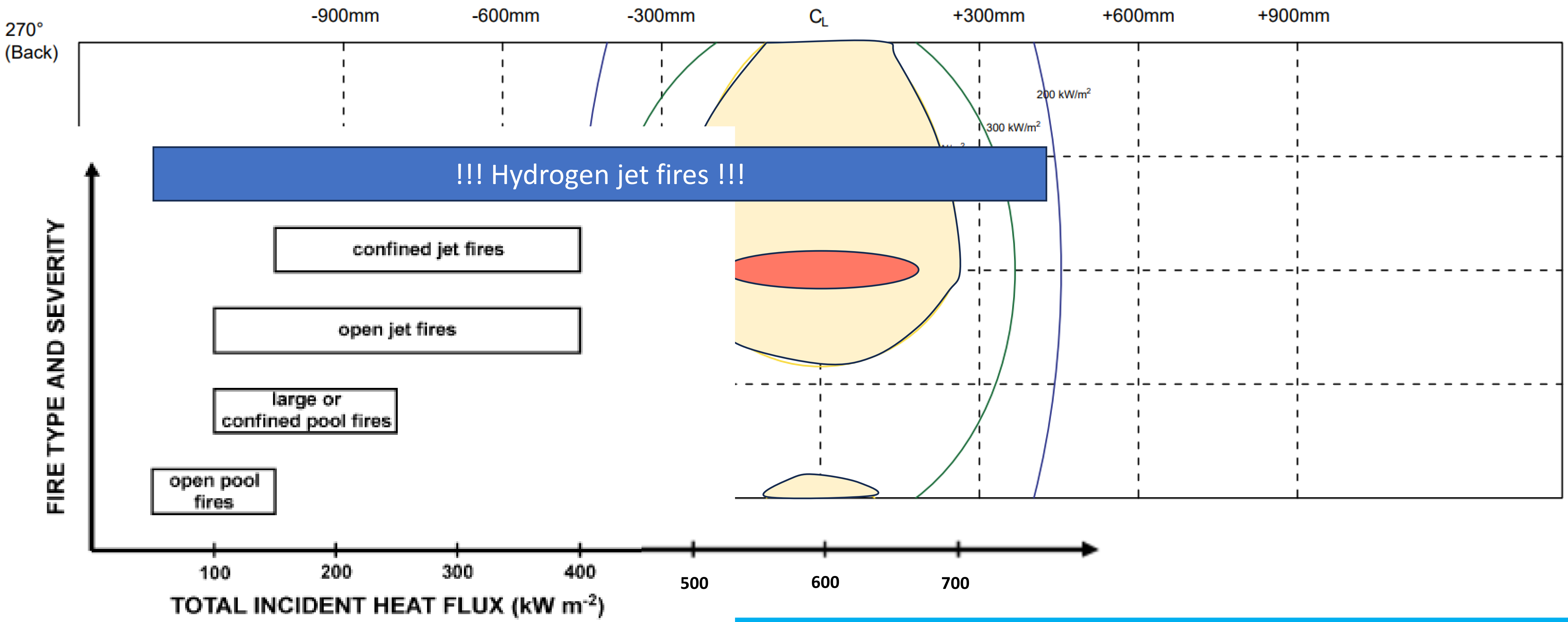

TC2
C2
TC6
FRONT
C6
R5

0.05 kg/s

0.10 kg/s

0.20 kg/s

Heat fluxes

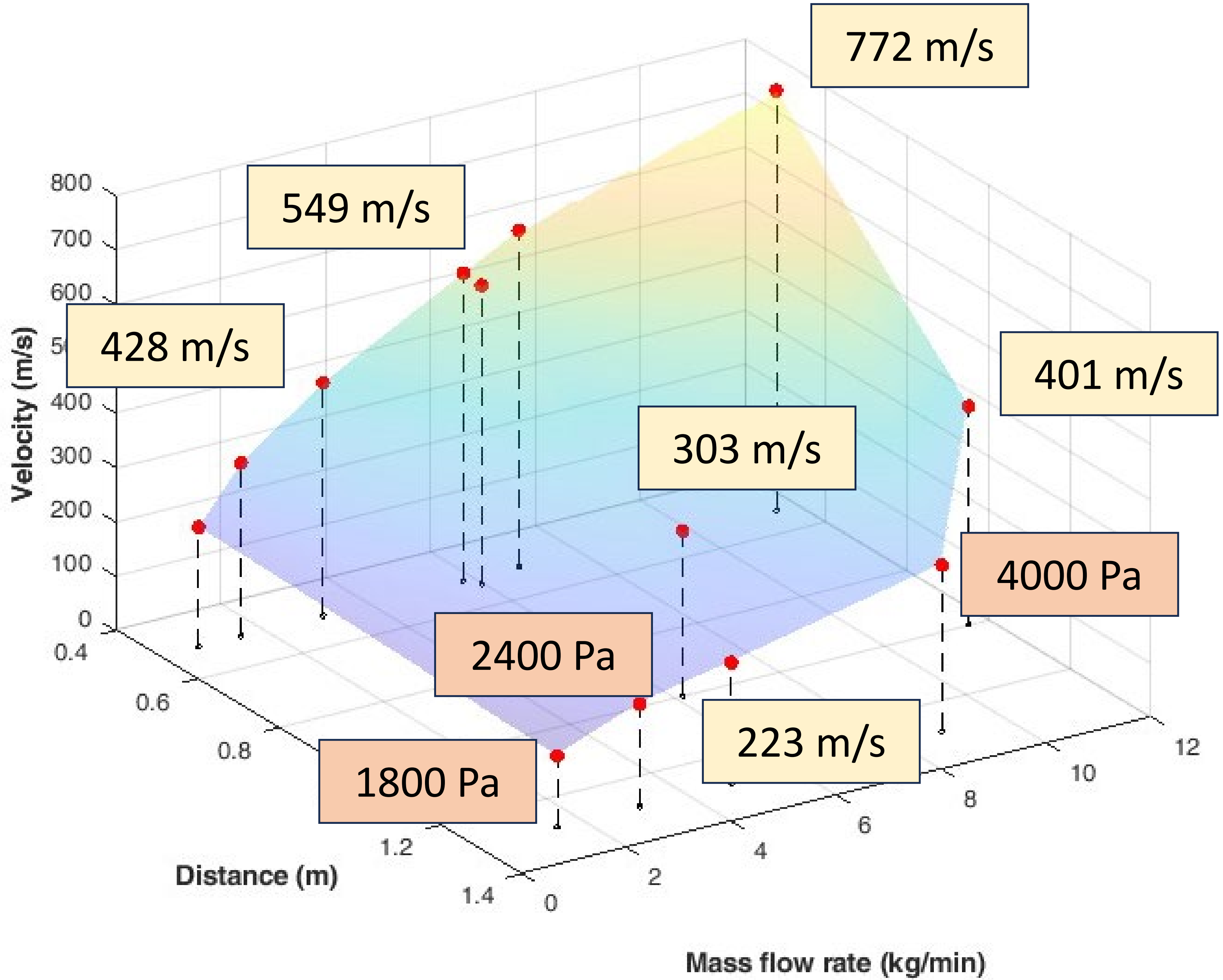


270°
(Back)
-900mm
-600mm
-300mm
CL
+300mm
+600mm
+900mm
200 kW/m2
300 kW/m2
!!! Hydrogen jet fires !!!
confined jet fires
open jet fires
large or confined pool fires
open pool fires
FIRE TYPE AND SEVERITY
100
200
300
400
500
600
700
TOTAL INCIDENT HEAT FLUX (kW m-2)

Velocities

Local dynamic pressures

For reference:
30' from 3 kg/s CH_4 fire
(the basis of ISO 22899-1)
500 Pa



Initial Conclusions

Conclusions

- Localised heat fluxes of 700-750 kW/m^2 were measured
- Increasing the flow rate had a relatively small effect on peak fluxes, but increased the area subjected to high heat fluxes

- Local gas velocities >700 m/s were measured at 1 m distance

Conclusions

- Heat fluxes to objects engulfed in gaseous H2 jet fires are dominated by convection
- The worst case position in the flame is likely to differ to hydrocarbon flames:
  - Hydrocarbon X/Lf (the distance to the object/flame length) is generally ‘worst case’ at 0.4-0.6 (mid flame)
  - Initial results indicate H_2 worst case may be 0.2-0.3 (nearer the release point)
- Unlike CH_4, the areas of highest erosive forces and highest heat fluxes coincide

Conclusions Summary

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- This works did raise questions over the ability of PFP systems to perform as intended…
- …and it does raise questions over the applicability of existing test methods

- A very clear next step was required: initial tests with a range of PFP systems

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PFP Test Programme

PFP Tests

PFPNet sourced 5 different types of PFP material.

1. Penetration & cable transit sealing system
2. Blanket insulation with stainless cladding
3. Cementitious
4. Epoxy intumescent no mesh
5. Epoxy intumescent mesh

Test 1
Penetration seal and cable transit seals

Test 2
Blanket with stainless cladding

Test 3
SFRM (cementitious) with expanded metal mesh

Test 5
Epoxy Intumescent No Mesh

Preliminary conclusions

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- All materials performed reasonably well, none experienced rapid/catastrophic failure
- The rate of temperature rise was significantly increased for all products (in the order of 2x to 3x greater)
- Different modes of failure are possible
- Existing test methods don’t capture the conditions!

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Phase 2 JIP
Test Method Development

Phase 2 JIP - Objectives

- Review the gaseous JF hazards we seek to protect against
- CFD modelling:
  - Validate models against test data obtained in phase 1
  - Use these models to understand influence of pressure vs nozzle size
  - Model a range of release conditions and offset distances to obtain a candidate test method
- Undertake further testing to
  - Confirm the CFD results
  - Develop a test method

Phase 2 JIP - Output

PFPNet PASSIVE FIRE PROTECTION NETWORK

- A draft test procedure suitable for submission to ISO
- A report detailing a validation study of a CFD model (or models) to assist safety engineers in hazard modelling
- A series of tests that demonstrate PFP performance (or lack of performance) in gaseous H_2 jet fires

Questions?