



WP4 Task 4.3 Performance of LH2 components and explosion consequences.

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16-17.09.2026



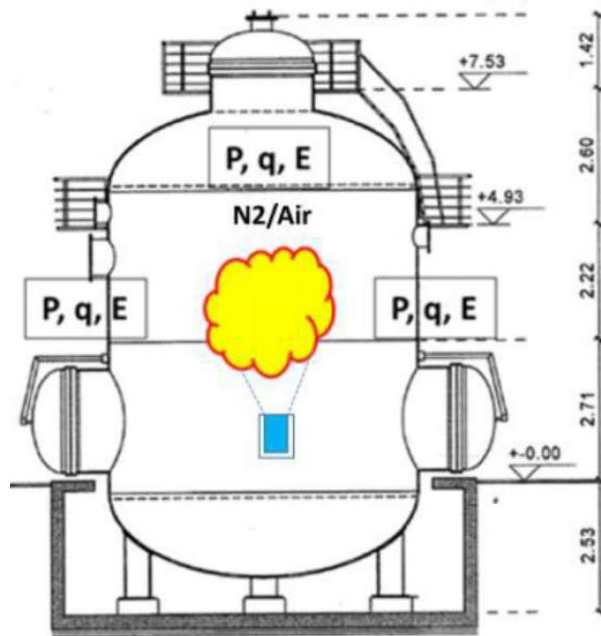
ELVHYS project No. 101101381 is supported by the Clean Hydrogen Partnership and its members. UK participants in Horizon Europe Project ELVHYS are supported by UKRI grant numbers 10063519 (University of Ulster) and 10070592 (Health and Safety Executive)

KIT Experimental Tasks 4.3.1

- ❑ Task 4.3 Performance of LH2 components and explosion consequences (Lead partner: **KIT**)

The scale of an LH2 explosive process (BLEVE-like) inside the transferring line.

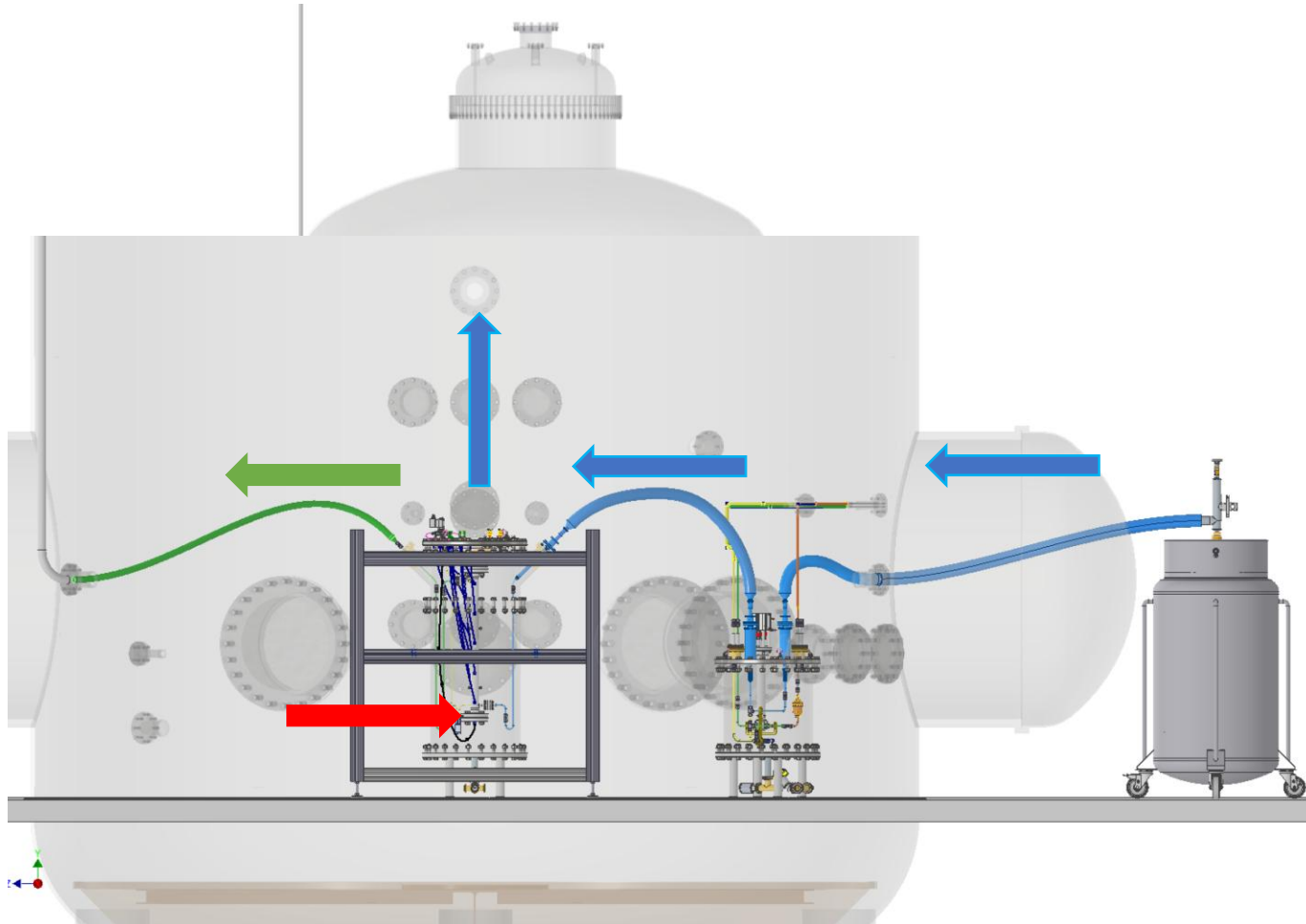
- ❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)



- Blast Wave Structure: Resolve the multi-peak structure of the blast wave using BOS technology.
- Process Separation: Disentangle the physical explosion (pure BLEVE-Boiling Liquid Expanding Vapor Explosion) from the chemical combustion process.

KIT Experimental Task 4.3.1

❑ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)

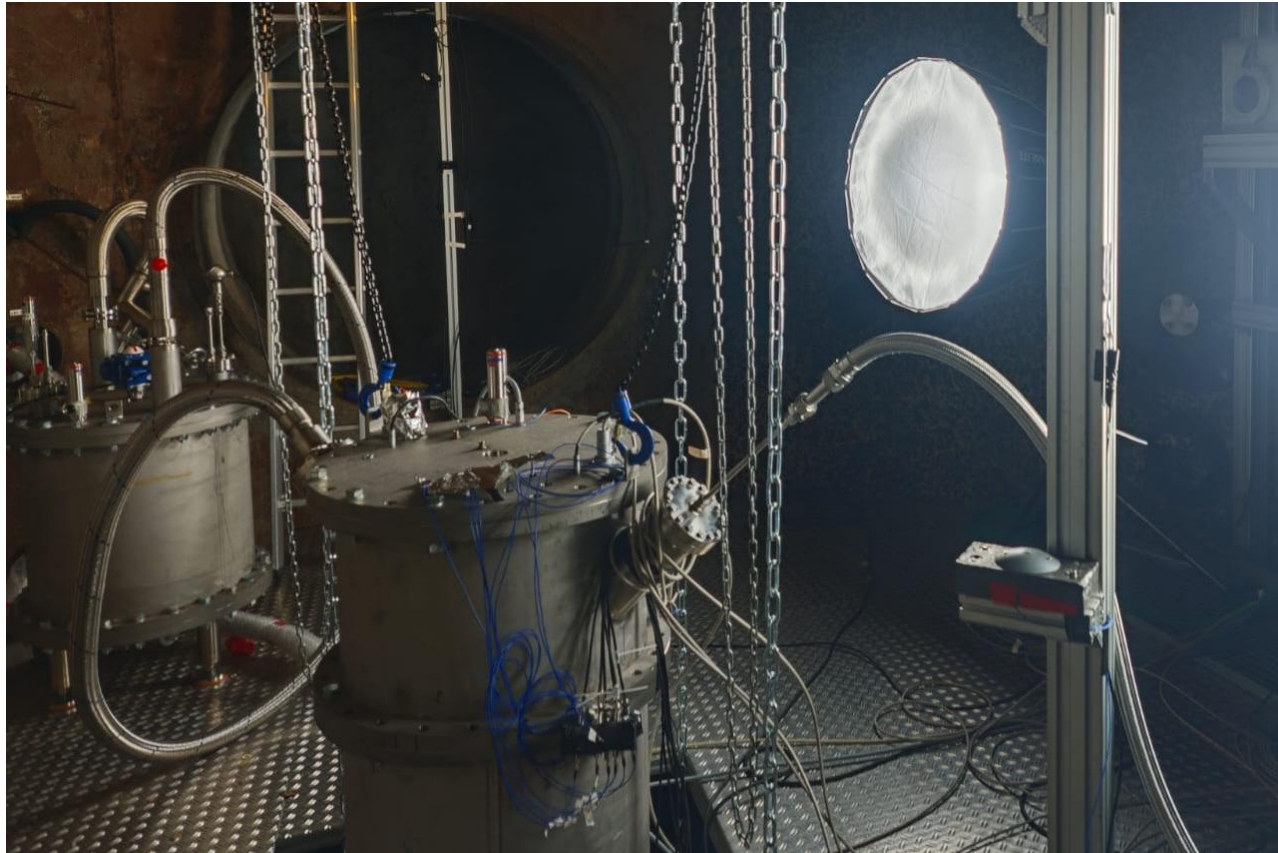


Tasks in V220

- Ultra Fast Camera Set + Inert Box
 - Flicker free lights
 - Patterned background
 - Sealing V220
 - Floor + Structures
 - Lifting system
 - Tanks
 - Vacuum system
 - Safety valves
 - Piping
 - Feedthroughs (exterior/V220/LH2/Vacuum)
 - Sensor mounting (O₂, Pressure, Temperature)
 - Data acquisition
- Control program (LabView, Signal Express)
-Signal reading devices (Feist, LS, NI)

KIT Experimental Task 4.3.1

- ❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)

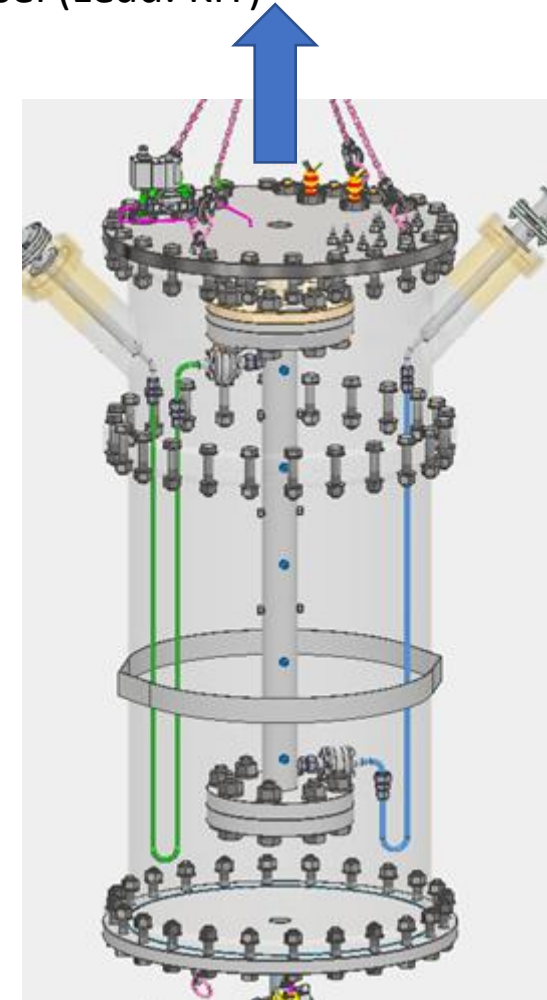


KIT Experimental Task 4.3.1

❑ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)

- Dimensions: L=1000 mm; Di=50 mm
- Hydrogen inventory: ≈ 125 g ($h \approx 900$ mm)
- P = addressed above and below critical pressure
- $T_i = 20$ K (only initial T known $\rightarrow$ heating)

Pressure (bar)	5	12	12,8	15	20
Ignited	x	x		x	x
Unignited	x	x		x	x



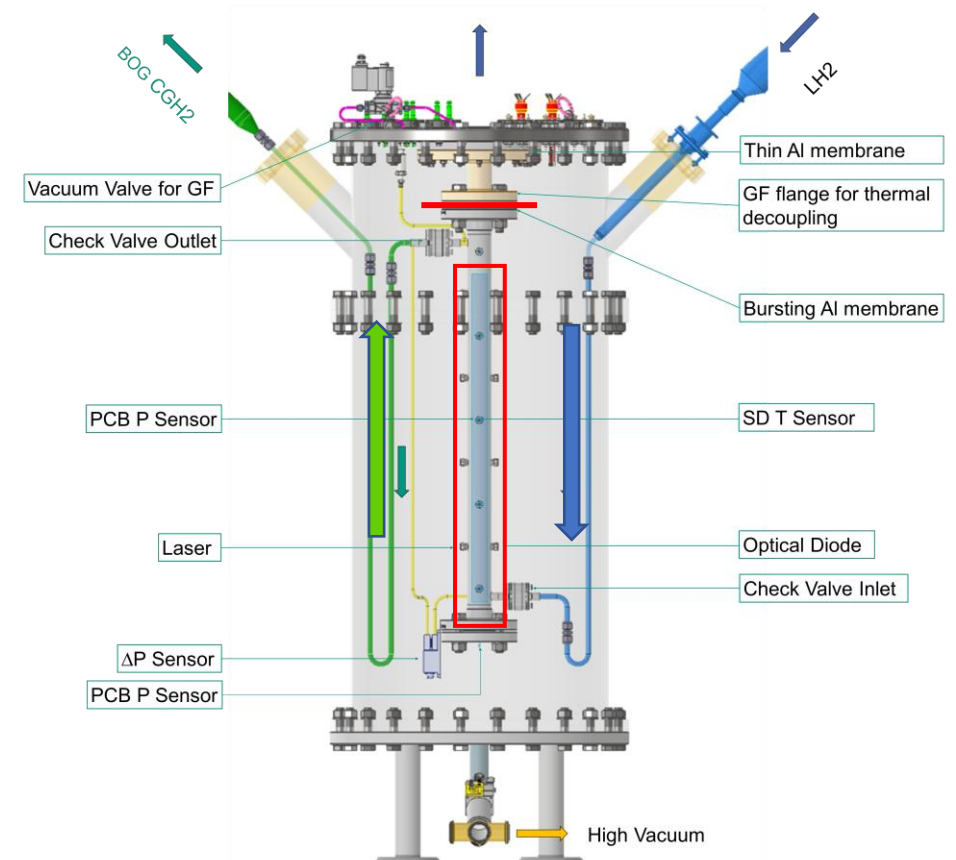
KIT Experimental Task 4.3.1

❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)

Internal measurements (cold):

- Dynamic pressure (5+1 positions along the tube): **Cryogenic piezoelectric**
- Static pressure (1 static in tee): **1-30 bar cryo**
- Differential pressure (prototype to be tested): **0-8 mbar**
- Temperature (5 positions along the tube at the same level as piezoelectric: diodes) **Silicon Diodes**
- Interface position (level) dynamic (thermo diodes)

Shock Tube Cut view



KIT Experimental Task 4.3.1

❑ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)



PRELIMINARY TESTS with LN2

- Use the same facility and arrangement to fine tune (departs from simplified to full operation)
- **LN2**
- Flow of 0,8 L per minute (ca. 25 l in 30 min)
- Membranes were tested producing a range of 8 to 25 bar

Test of 01.12.2025 open; no vacuum

KIT Experimental Task 4.3.1

❑ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)



GENERAL CONDITIONS AND ADDITIONAL ACTIVITIES

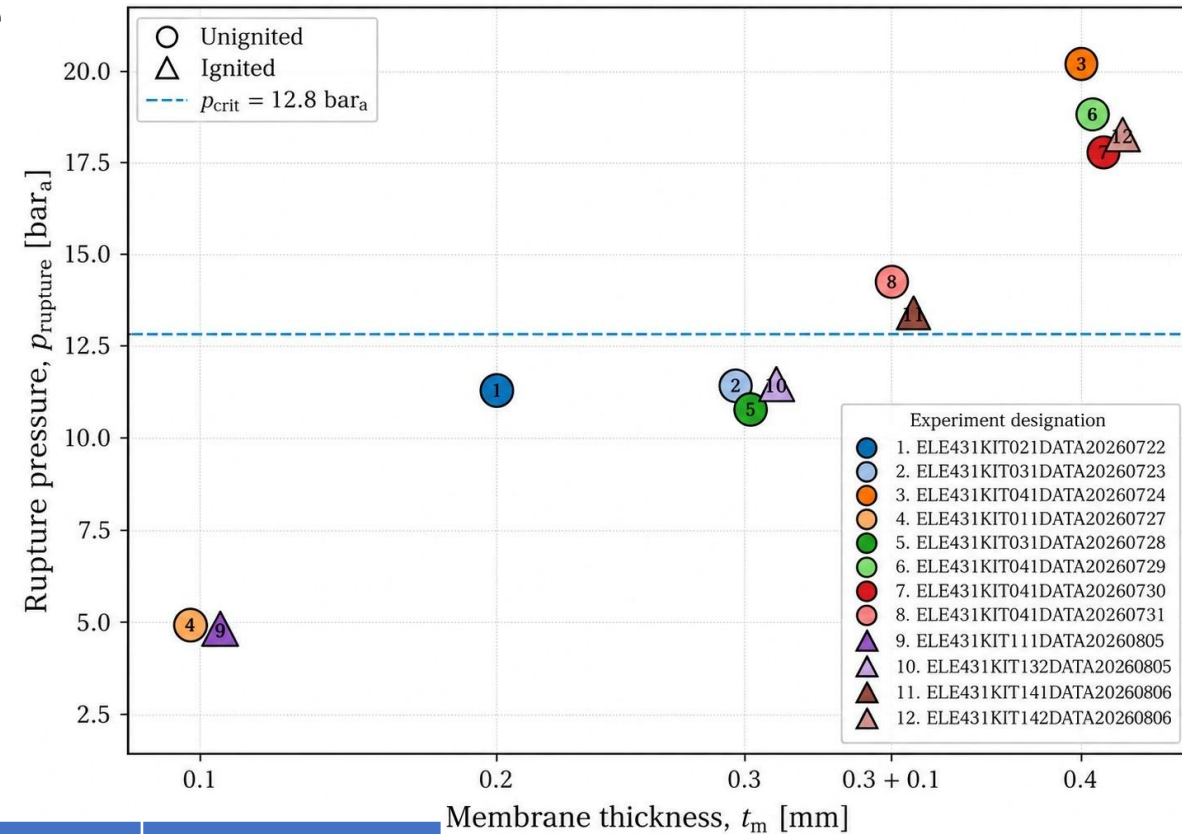
LH2

- Each experiment required 50 to 60 L of LH2 to be performed.
- Membranes 5 different thicknesses. Rupture close to analysed for LN2
- Adaptations were introduced for the ignited tests to protect equipment
- Inertized atmosphere had 10% oxygen
- Vacuum tanks at ca 10×10^{-2} mbar

KIT Experimental Task 4.3.1

□ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)

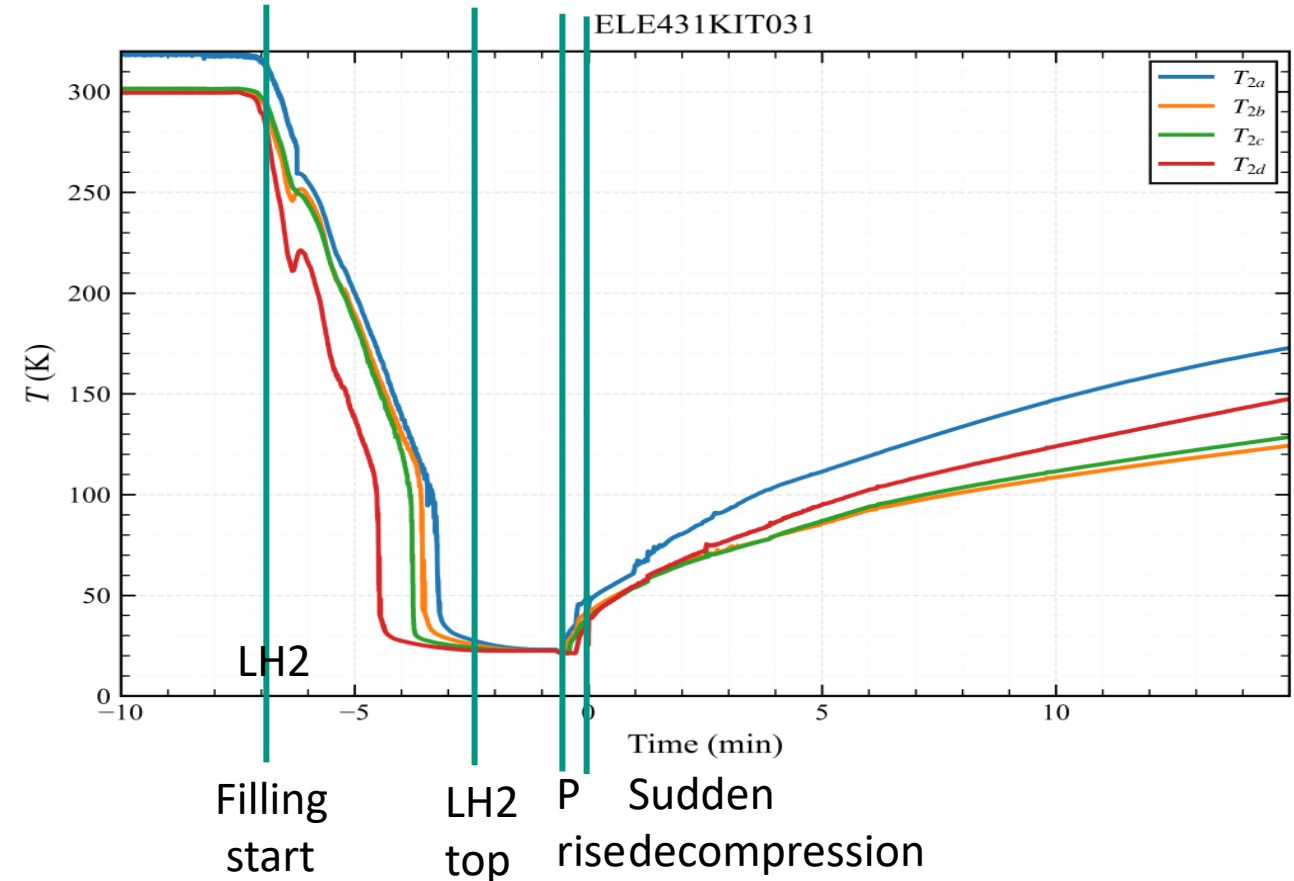
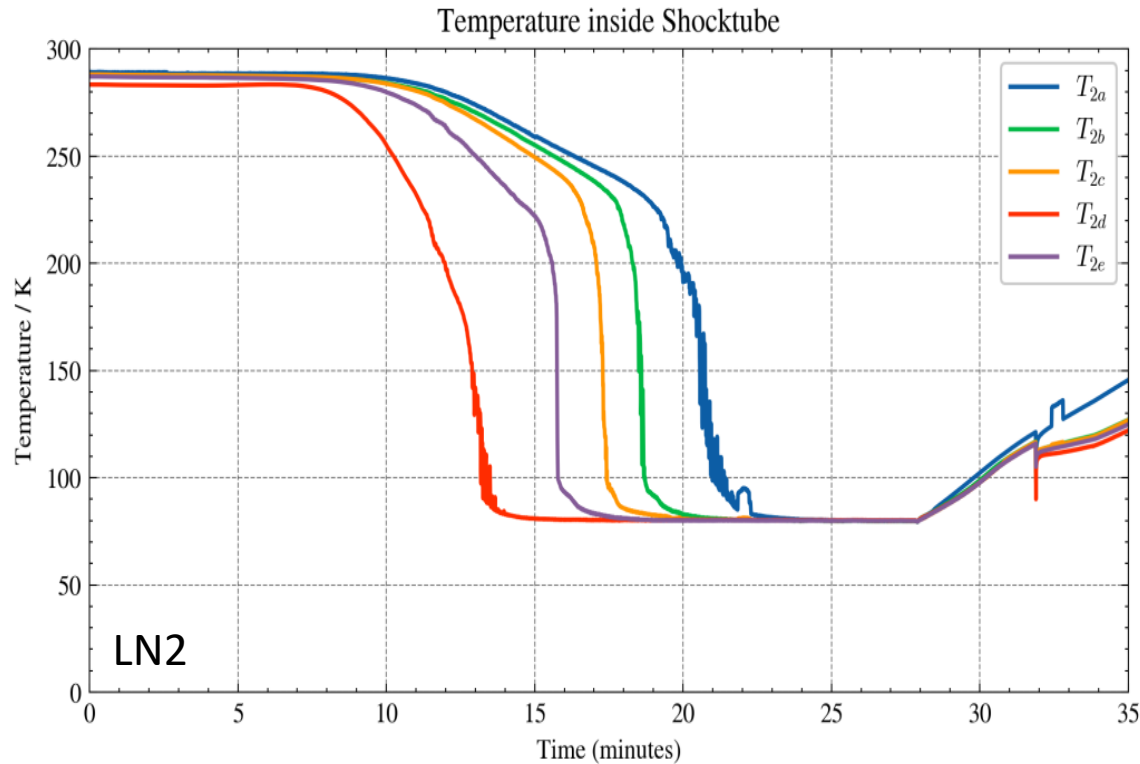
- Ignited and unignited successful
- Above and below critical pressure
- Raw experimental results by ends of July 2026



Rupture Pressure (bar)	5	12	12,8	15	20
Ignited	4,80	11,23		13,24	18,22
Unignited	4,87	11,21-11,26-10,79		14,17	20,27-18,75-17,84

KIT Experimental Task 4.3.1 LN2 & LH2

❑ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)



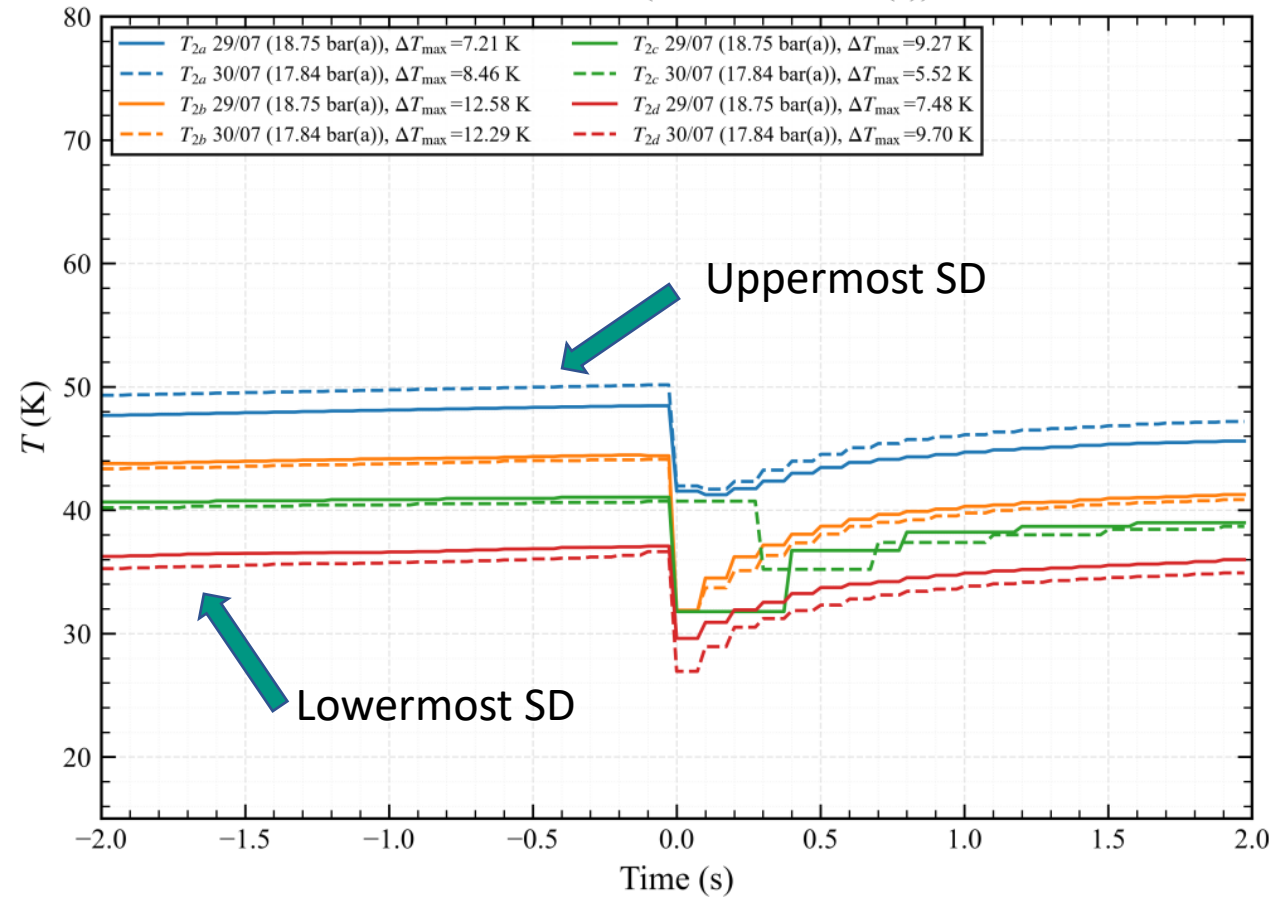
Successful filling

- Filling with LH2 is faster (higher pressure) (20 vs 7 min)
- Temperature of 20 K was reached by all the SD diodes : 90% filling

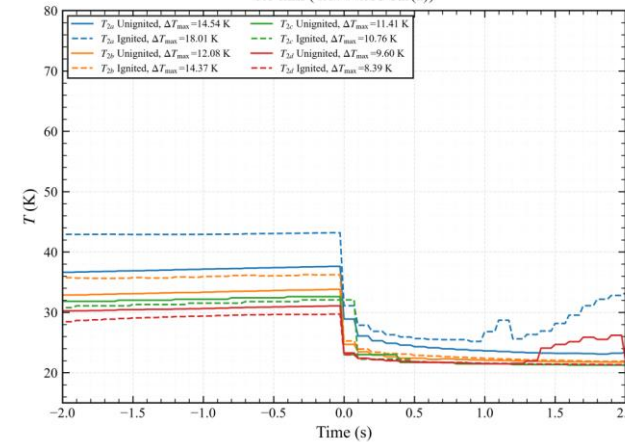
KIT Experimental Task 4.3.1 LH2

□ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)

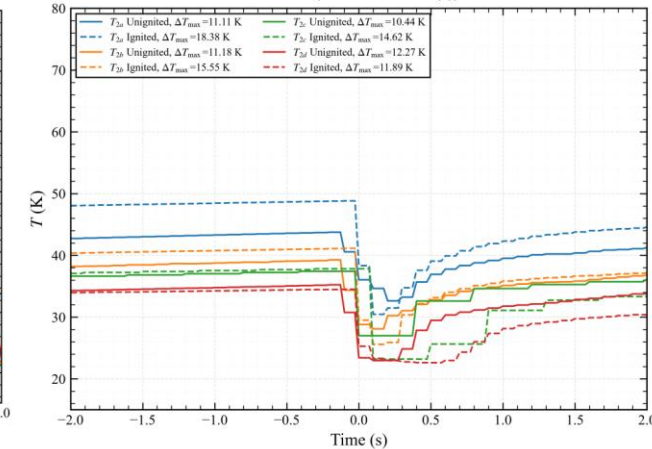
0.4 mm Conrad (18.75 / 17.84 bar(a))



0.1 mm (4.87 / 4.80 bar(a))

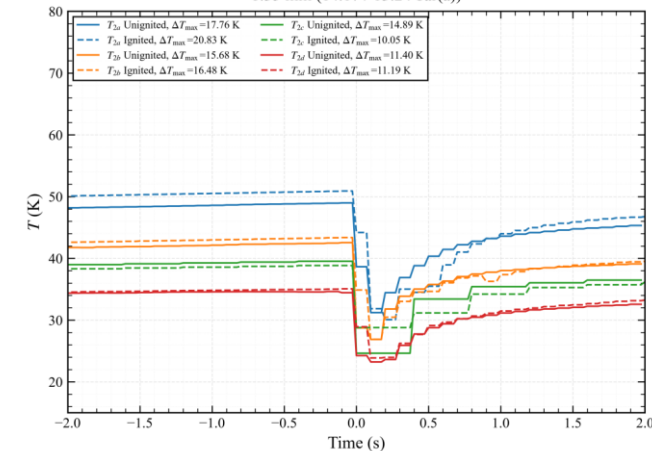


0.3 mm (10.79 / 11.23 bar(a))



Ruptures depicted at
ca. 5, 11, 14 bar

0.35 mm (14.17 / 13.24 bar(a))

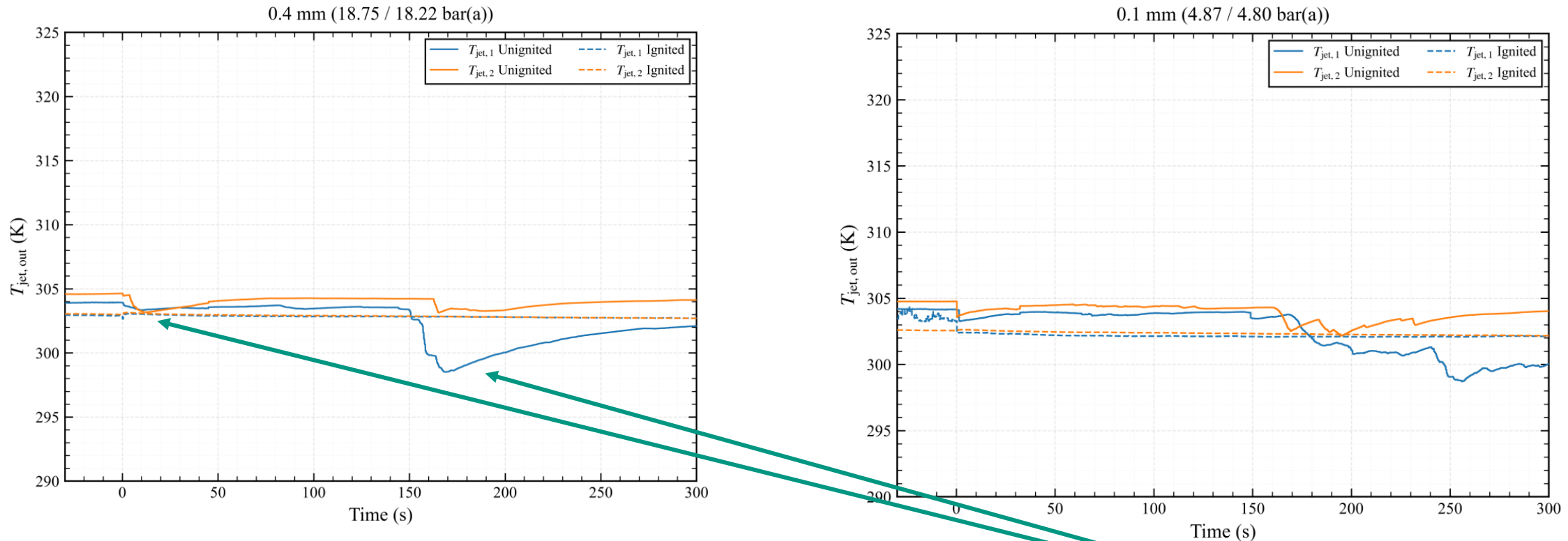


Comparison of cooling in rapid expansion from ca 18bar to ambient
(rapid rupture)

Between two experiments with same conditions (heating procedure)

KIT Experimental Task 4.3.1

Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)

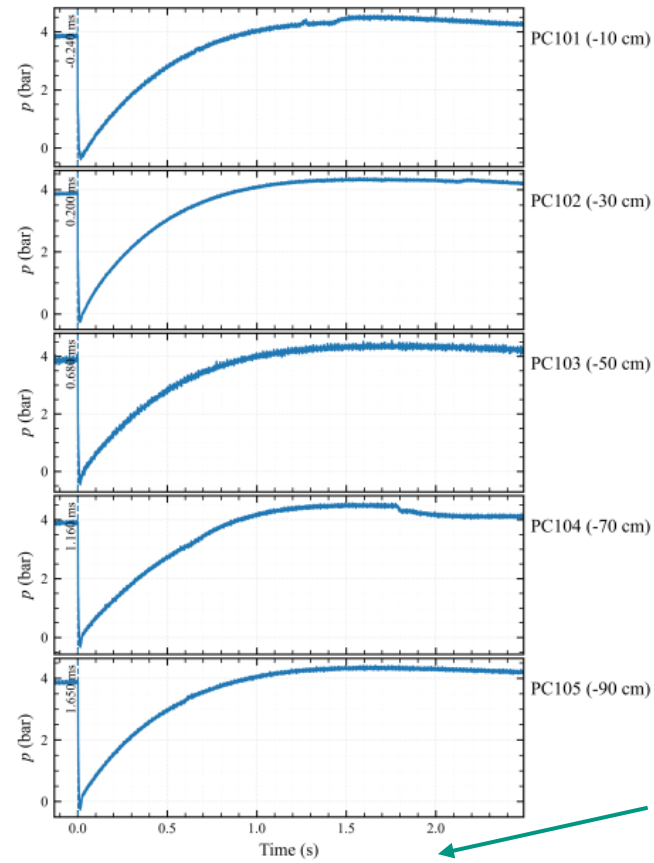


- We added two external temperature sensors (SD), but we consider they aren't fast enough
- But we're still going to include the information in the report
- The temperature is lowered by jet and then the cold cloud goes down cooling the surrounding of the sensor

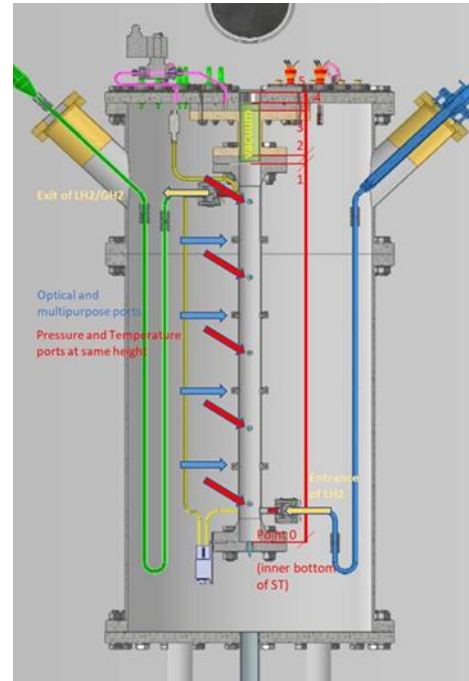
KIT Experimental Task 4.3.1

Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)

ELE431KIT011



5 bar



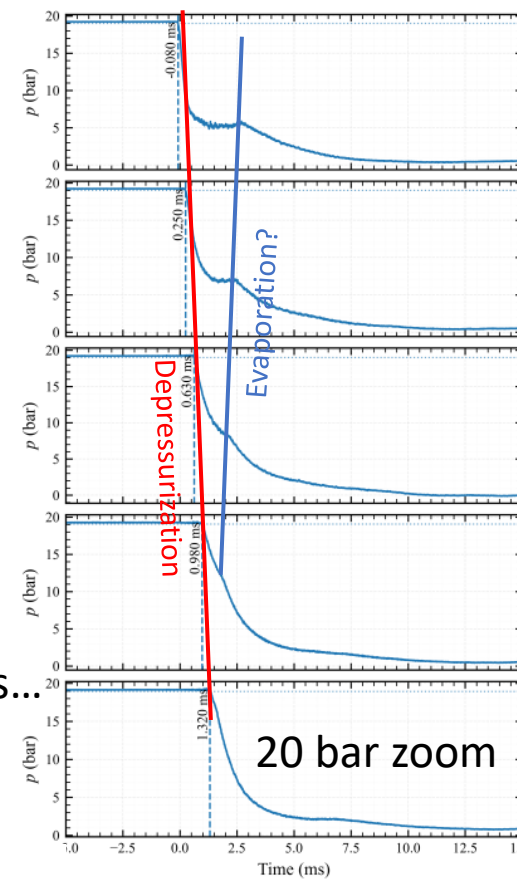
Calculation of the velocities...

Linear fit: 421.8 m/s, $R^2=0.9996$

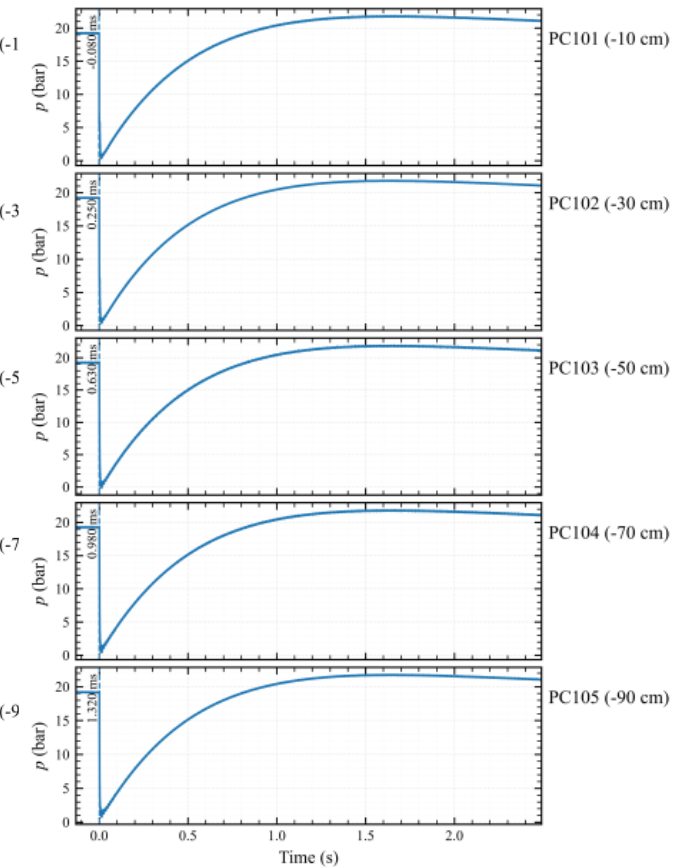
Linear fit: 511.8 m/s, $R^2=0.9980$

Linear fit: 566.3 m/s, $R^2=0.9996$

ELE431KIT041 — depressurization onset



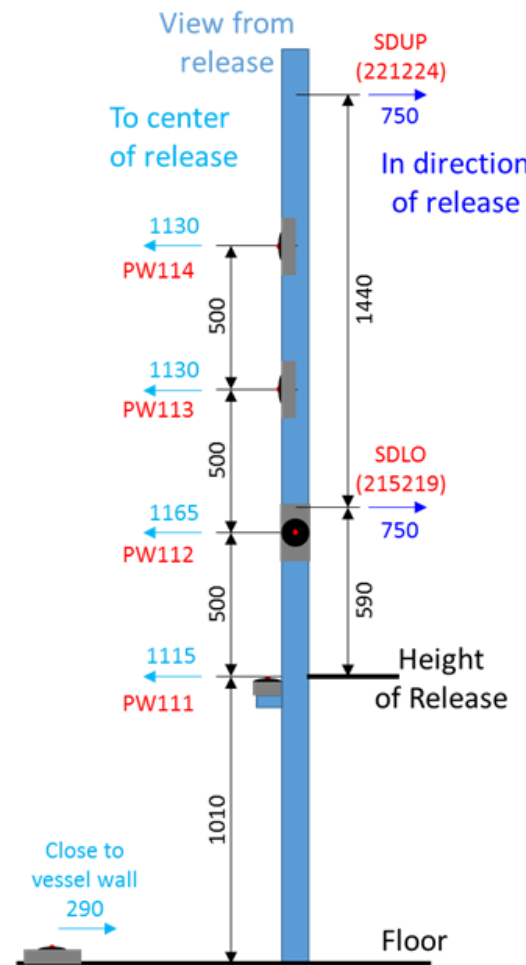
ELE431KIT041



20 bar

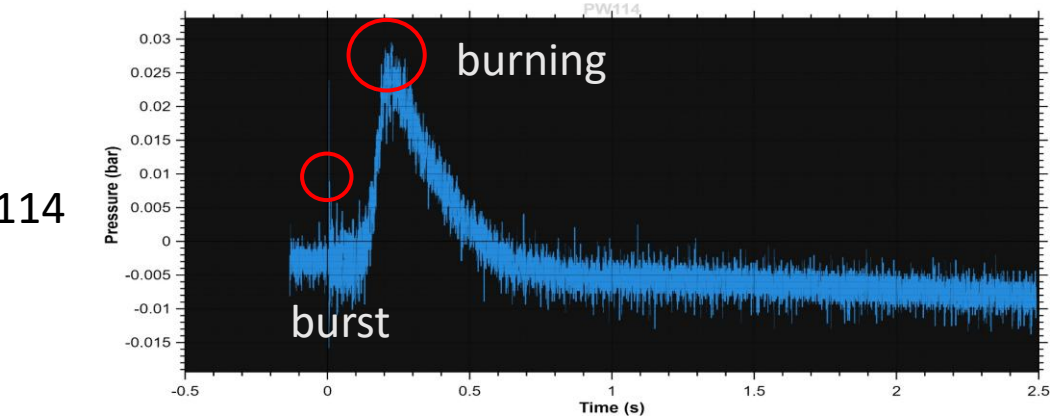
KIT Experimental Task 4.3.1

❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)



Different pressure sensors at ca. 1m away from the jet axis.

The pressure wave in the case of the unignited is lower than those for the ignited



114

I

PW111 (bar_a)	PW112 (bar_a)	PW113 (bar_a)	PW114 (bar_a)	PW115 (bar_a)
0.060	0.045	0.207	0.029	0.291

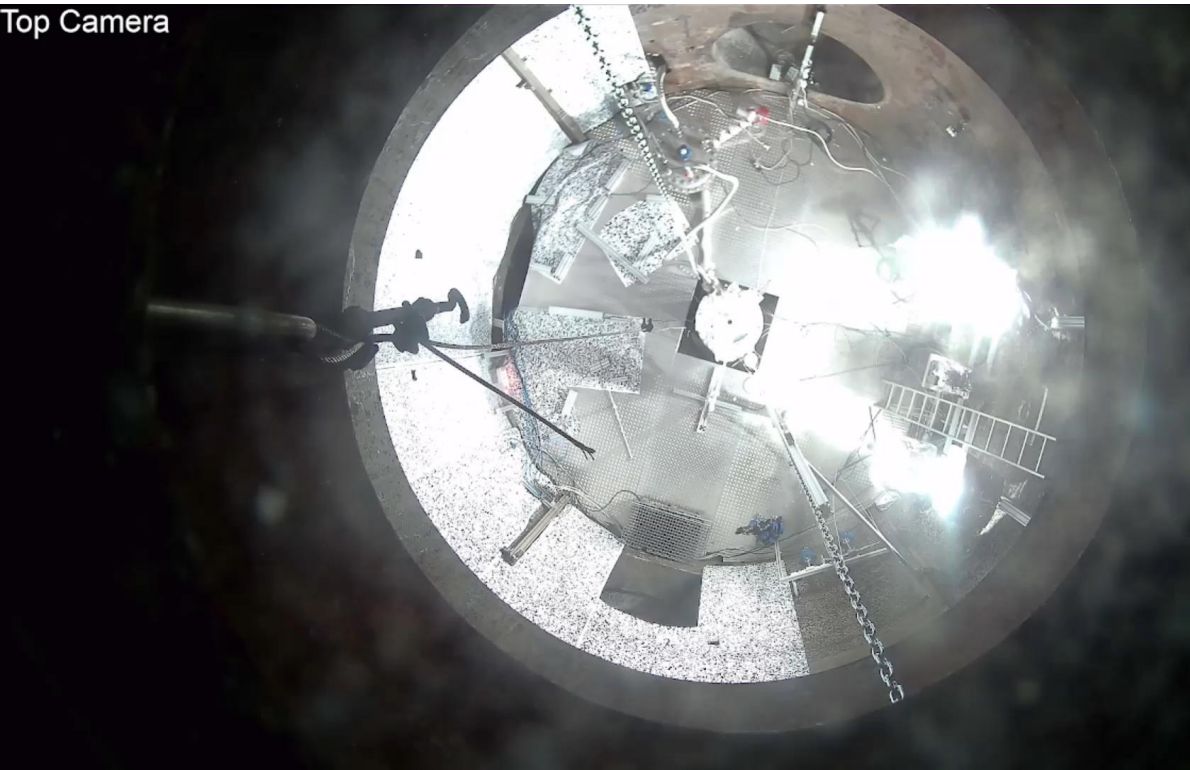
U

PW111 (bar_a)	PW112 (bar_a)	PW113 (bar_a)	PW114 (bar_a)	PW115 (bar_a)
-0.00126	-0.00681	0.00610	-0.00121	-0.00635

KIT Experimental Task 4.3.1 LH2

- ❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)

Top Camera



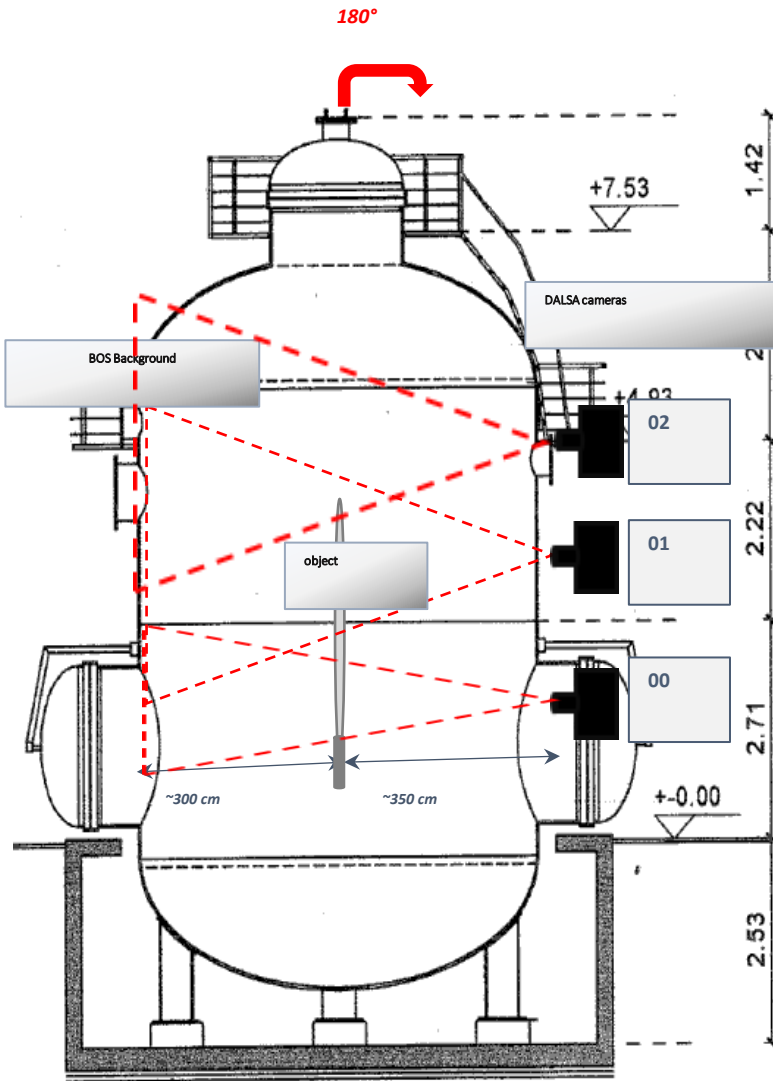
Camera 3



Webcams: Test of 06.08.2026; vacuumized $10e-2$; rupture pressure 13,2bar; NO heater used

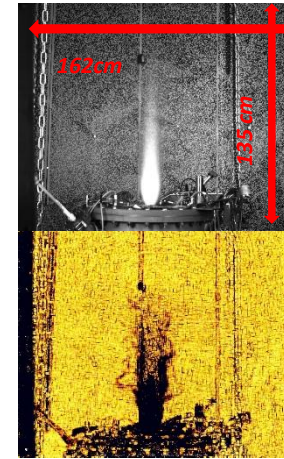
ELVHYS, preliminary experiments

FAST CAMERA
100 fps

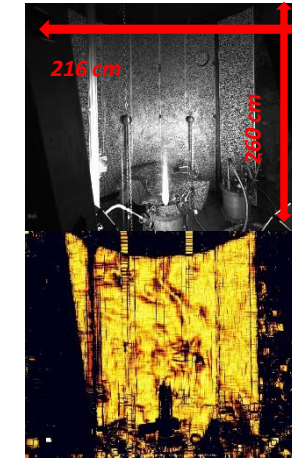


original image

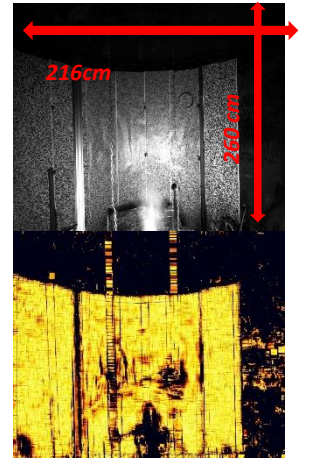
BOS image



camera 00



camera 01



camera 02

KIT Experimental Task 4.3.1 LH2

- Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)



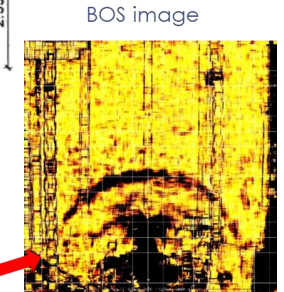
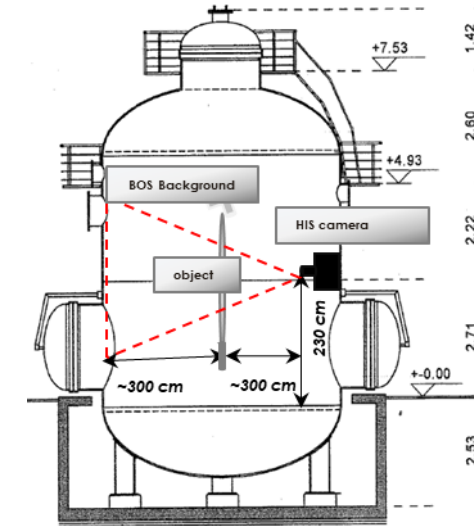
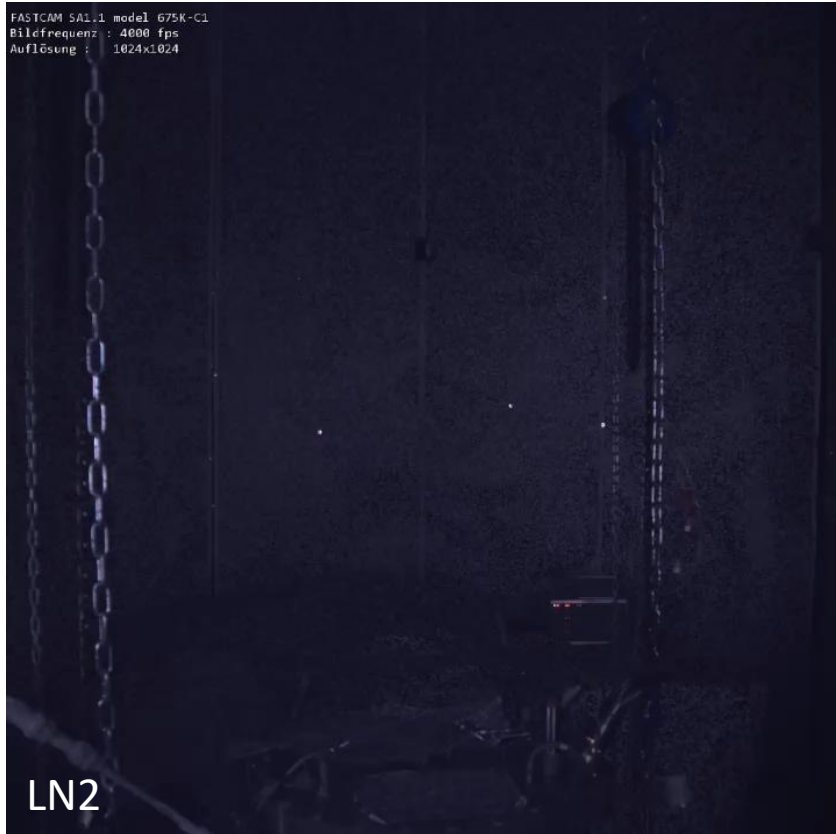
DALSA: Test of 31.07.2026; vacuumized $10e-2$; rupture pressure 14,1bar; NO heater used. UNIGNITED



DALSA: Test of 06.08.2026; vacuumized $10e-2$; rupture pressure 13,2bar; NO heater used. IGNITED

KIT Experimental Task 4.3.1 LN2

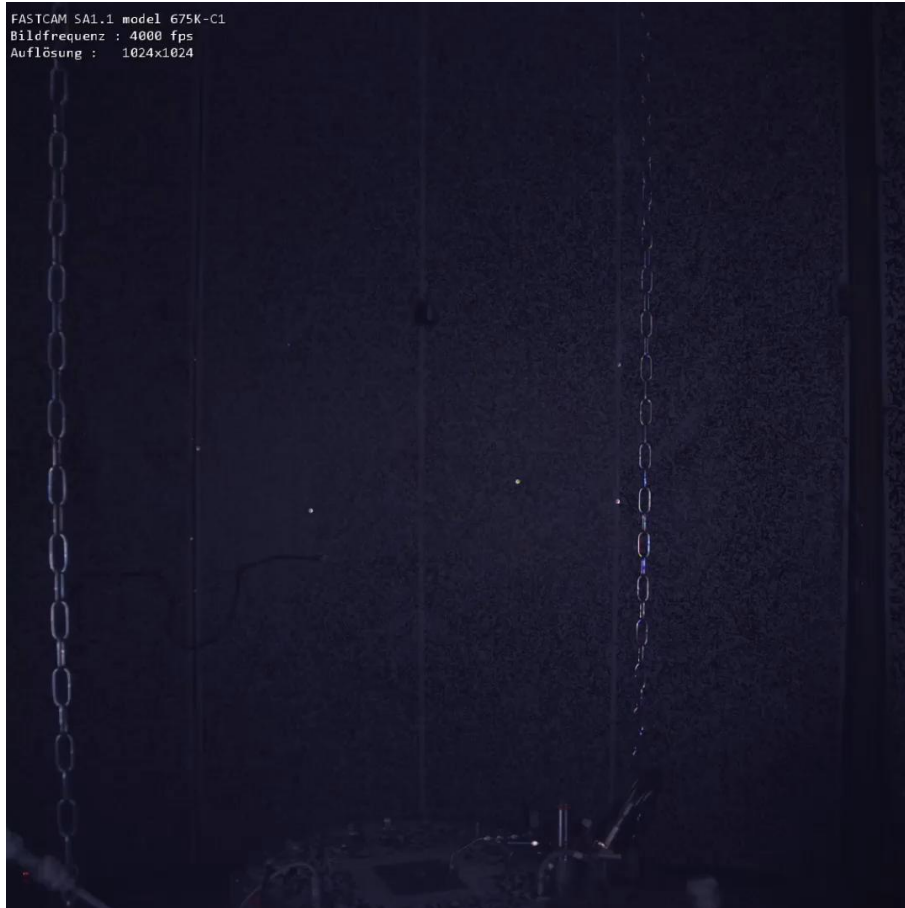
❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)



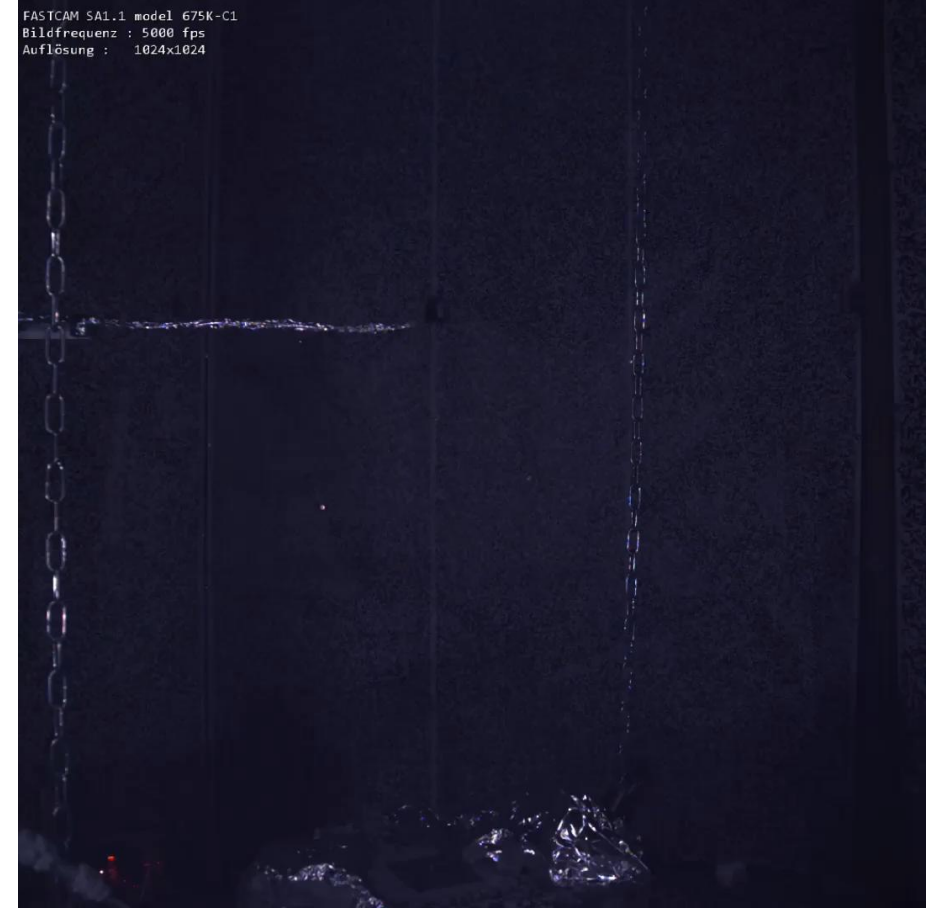
Photron Fast camera: Test of 16.04.2026; vacuumized; rupture pressure 22 bar; 0,5 mm; heater 100 W
ELE431KIT051HSVC20260416

KIT Experimental Task 4.3.1 LH2

- ❑ Sub task 4.3.1 BLEVE tests with a shock tube filled with LH2 in an A2 vessel (Lead: KIT)



HSC: Test of 31.07.2026; vacuumized $10e-2$; rupture pressure 14,1bar; NO heater used. UNIGNITED. Photron 4000fps

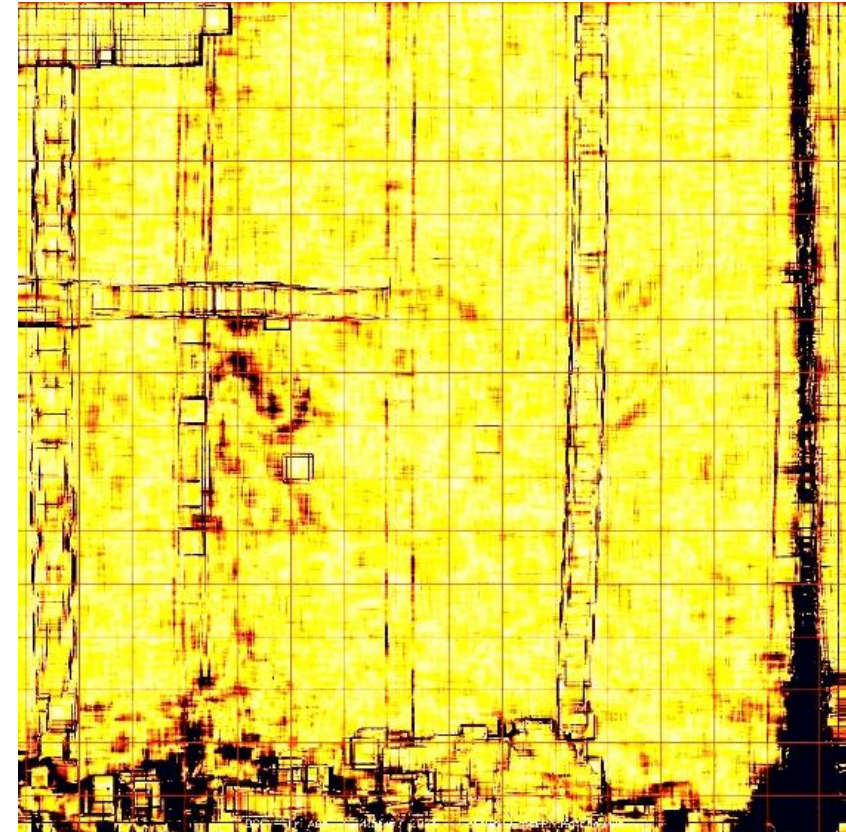
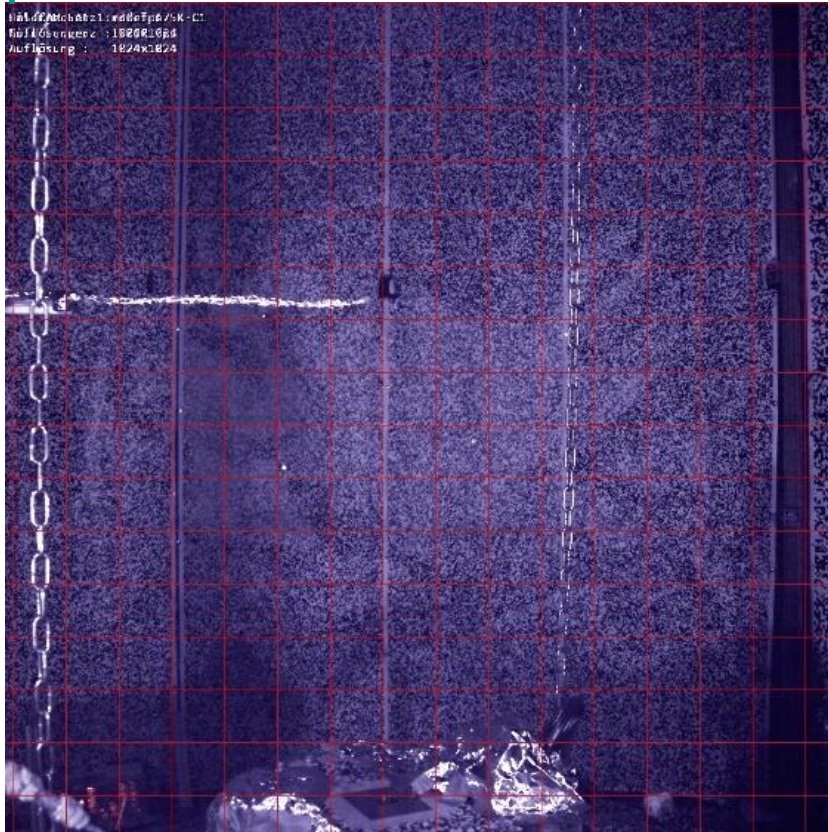


HSC: Test of 06.08.2026; vacuumized $10e-2$; rupture pressure 13,2bar; NO heater used. IGNITED. Photron 5000fps

ELVHYS, preliminary experiments, optical results

High Speed Camera
(HSC)
Processing example

LH2



HSC: Test of 06.08.2026; vacuumized $10e-2$; rupture pressure 13,2bar; NO heater used. IGNITED. Photron 5000fps

KIT Experimental Task 4.3.1

- ❑ Sub task 4.3.1 **BLEVE tests with a shock tube** filled with LH2 in an A2 vessel (Lead: KIT)

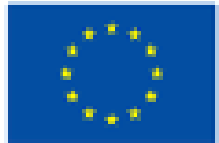
Conclusions and perspectives

- The system proved to be useful and worked reliably. It could be used for another campaign. Easily adaptable. Video (FC,HSC,WC),Pressure(5 E,6 I), Temperature (2 E, 5I)
- It could be enhanced if is pressurized via intermediate LH2 tank (up to 20 bar with current set up).
- Rupture pressures around the critical pressure of LH2 was successfully addressed.
- Ignition does not occur when spark is directly exposed to the jet . It has to be mixed with air first.
- The overpressure wave generated by the sudden rupture was detangled to the overpressure wave generated by the ignition of the LH2.
- Processing of data is currently ongoing and the results will be published within the frame of ELVHYS.



Thank you for your attention

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the European Union



UK Research
and Innovation

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