University of
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HyTunnel-CS

Hydrogen safety in tunnels and confined spaces

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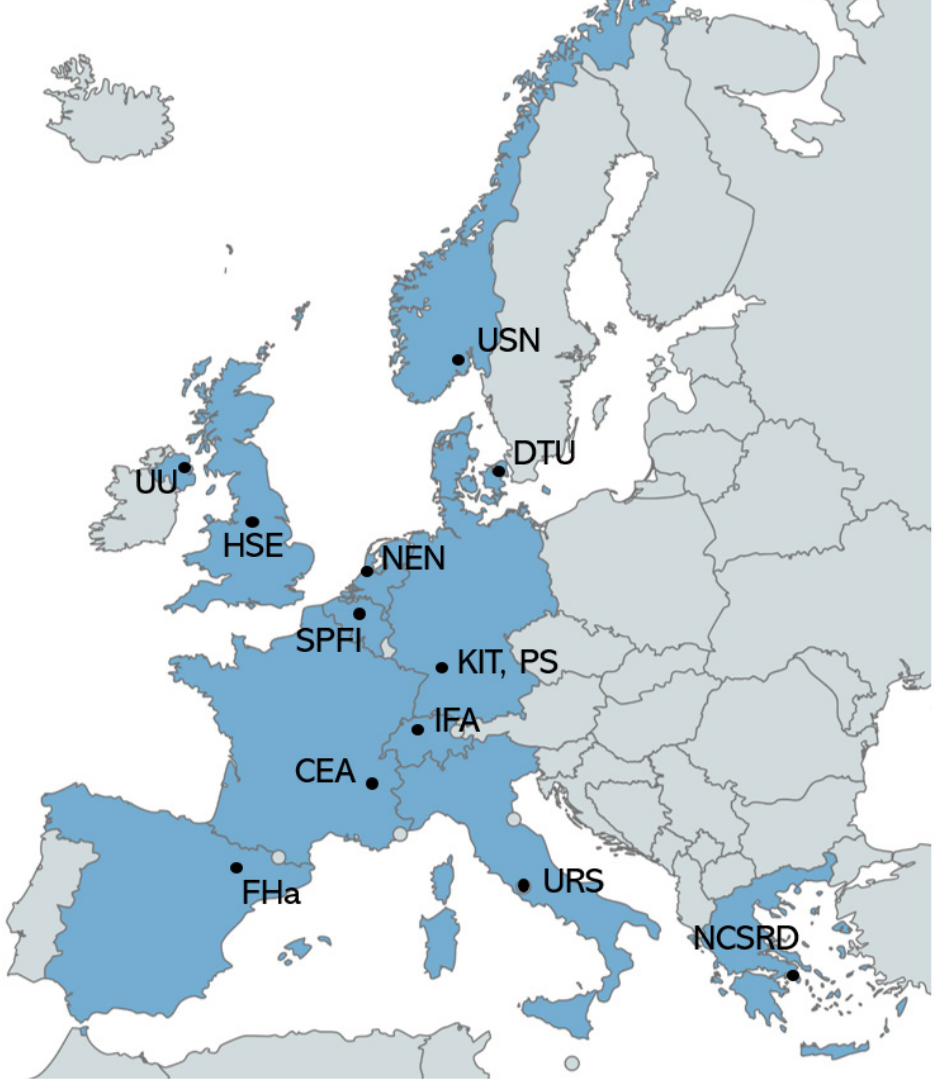
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Acknowledgements

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HyTunnel-CS brief

Aim, objectives, ambition

Aim

- to perform **pre-normative research** for safety of hydrogen driven vehicles and transport through tunnels and similar confined space

Ambition

- to facilitate hydrogen **vehicles** entering **underground traffic systems** at risk below or the same as for fossil fuel transport

HyTunnel-CS brief

Objectives

- Critical analysis of effectiveness of conventional safety measures for hydrogen incidents;
- New CFD and FE models for consequences analysis;
- Generation of unique experimental data (using the best hydrogen research facilities and three real tunnels);
- Engineering correlations for QRA methodology tailored for tunnels and underground parking;
- Addressing explosion and fire prevention and mitigation strategies;
- Advancement of hydrogen safety engineering;
- **Recommendations for intervention strategies and tactics for first responders;**
- **Recommendations for inherently safer use of hydrogen vehicles in underground transportation systems;**
- **Recommendations for RCS**

HyTunnel-CS brief

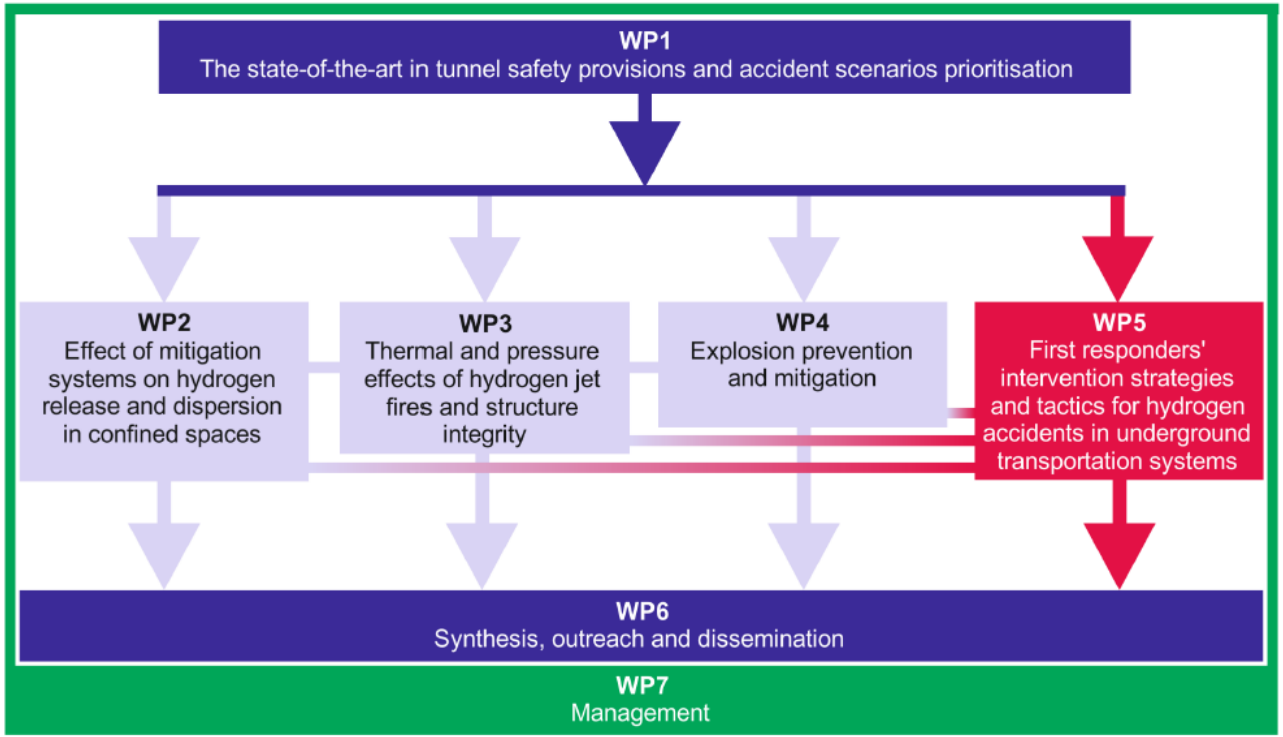
Methodology

Exploiting synergies and complementarities of

- Partnership of
  - Researchers from academia and national research laboratories,
  - Emergency services experts
  - SDO specialists
- Inter-sectoral and cross-disciplinary research
  - Experimental work
  - Theoretical research
  - Modelling effort

Implementation

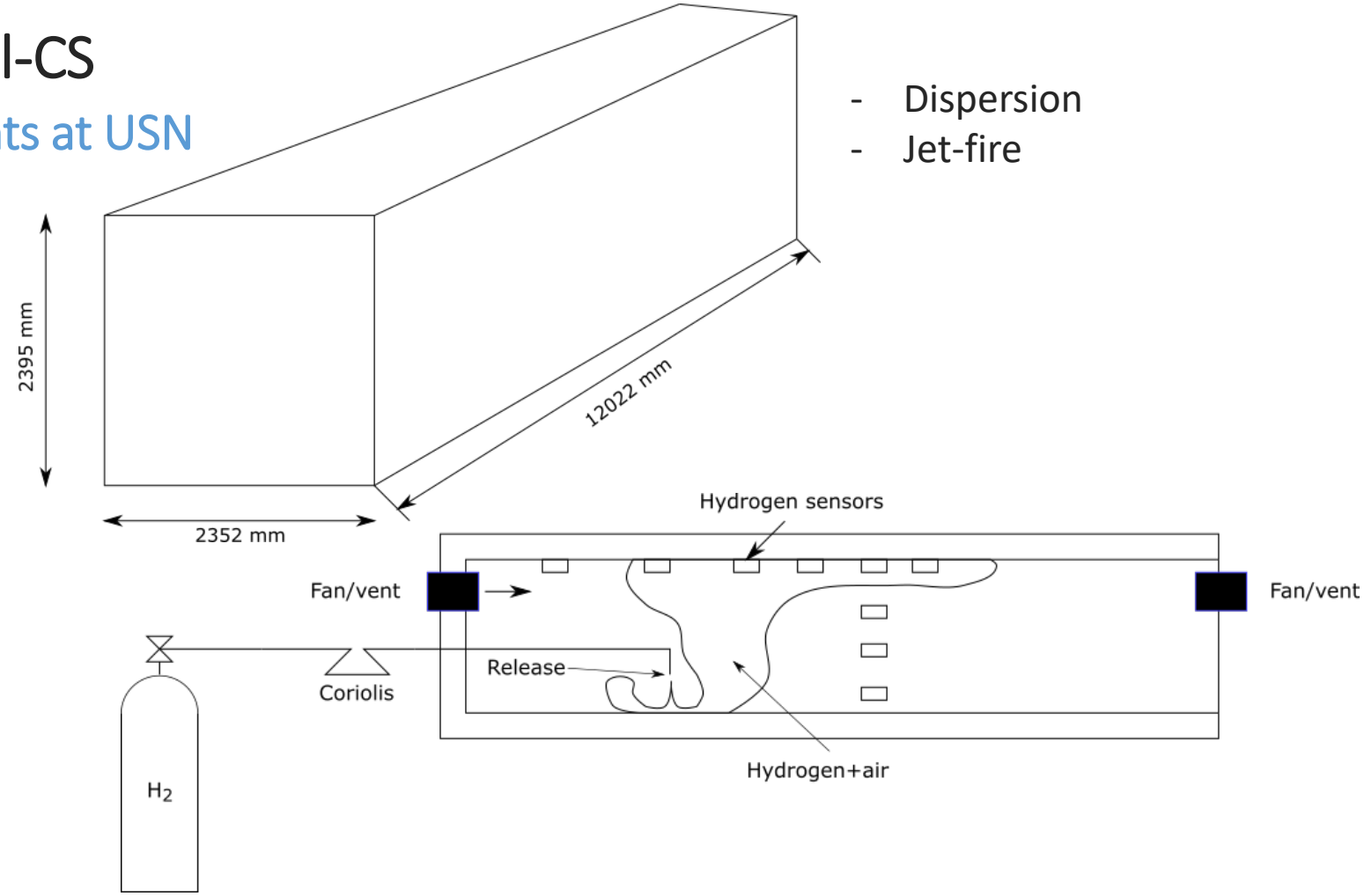
Workpackages



HyTunnel-CS

Experiments at USN

- Dispersion
- Jet-fire



Unignited PPP Experiments USN

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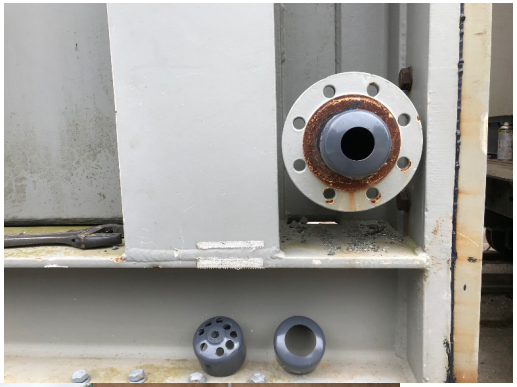
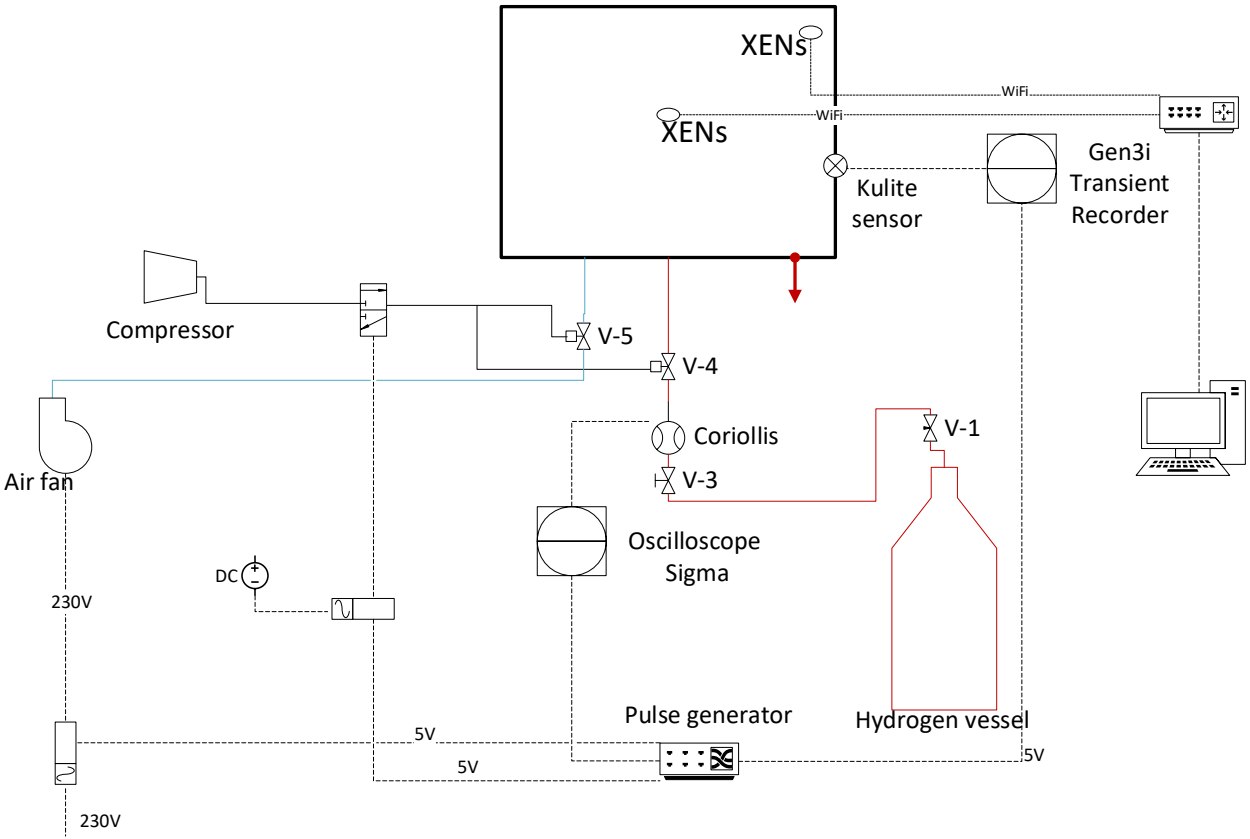
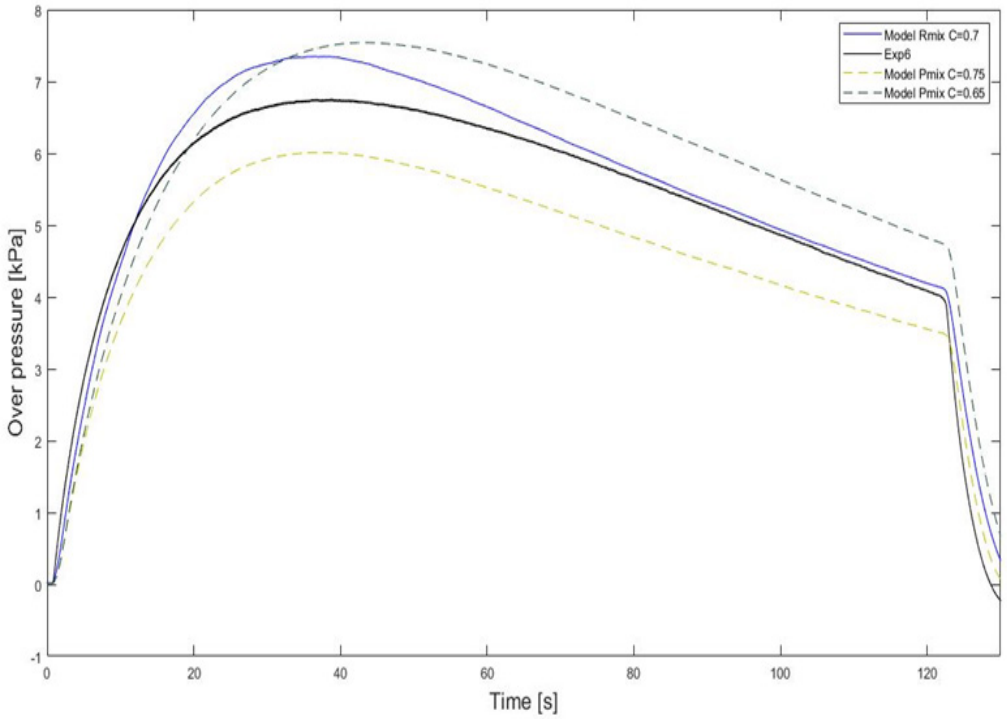


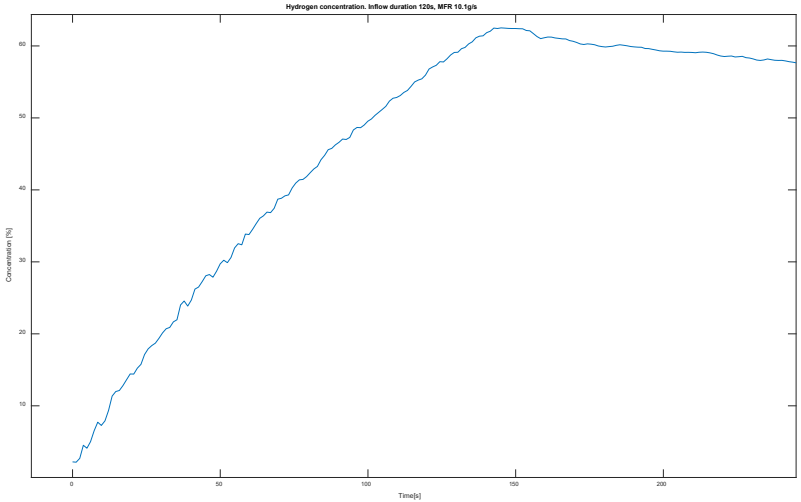
Unignited PPP Experiments USN



Model comparison

- Experiment 6
  - A = 0.0006 m^2 MFR = 10.1 g/s





Simulation of flame acceleration and DDT in train tunnels

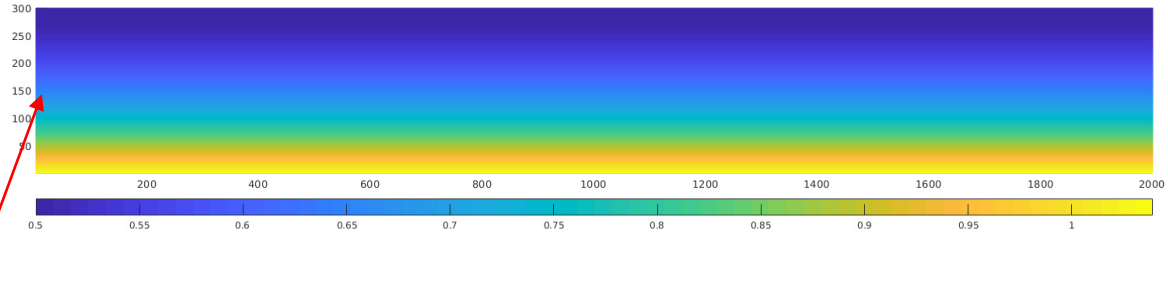
Development of simulation method:

- Reactive and compressible flow
- 2./3. order shock capturing schemes
- Fast deflagrations, detonations and compressible flow problems
- Transition from deflagration to detonation (DDT)
- Turbulent combustion
- Concentration dependant chemistry

Initial development: FA and DDT in concentration gradient

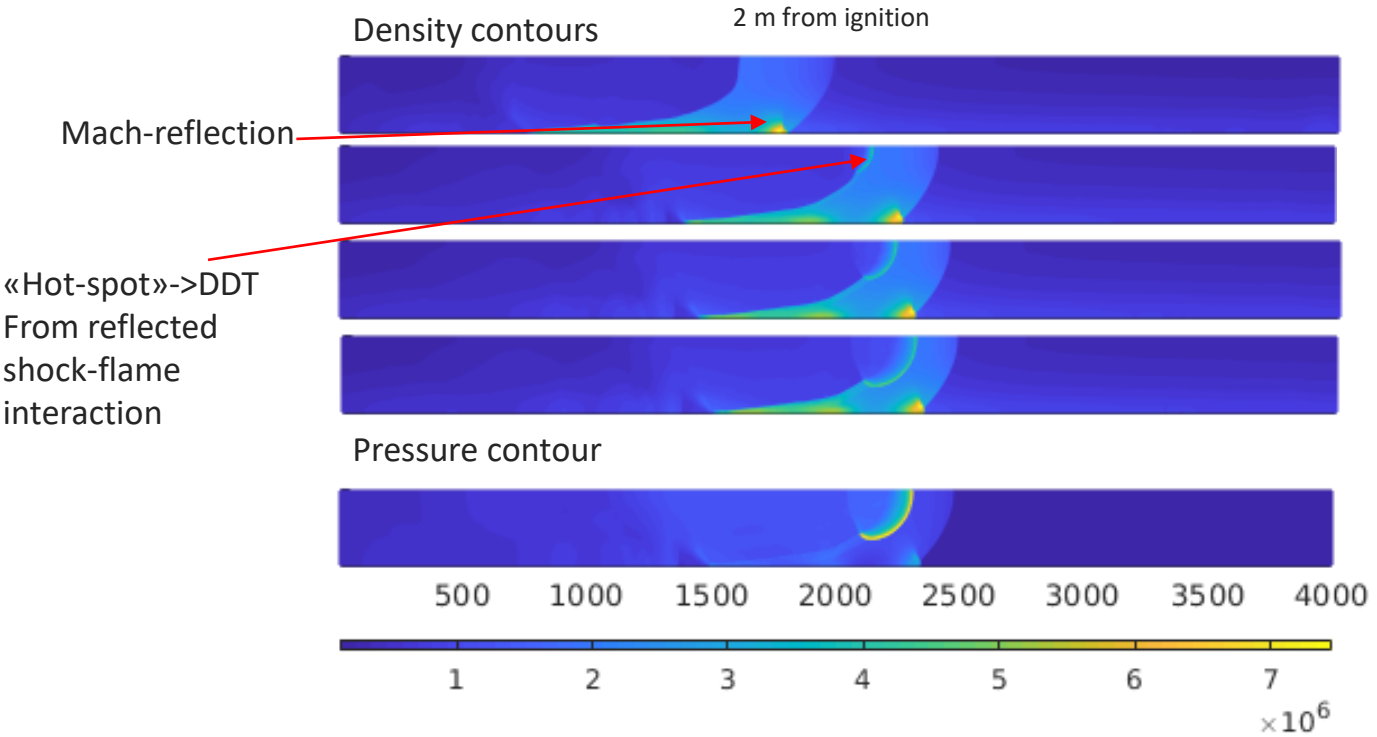
Initial field of density (15% H2 at bottom, 62% H2 at top (6 cm height))

From experiments by Boeck (2015).



Ignition

Initial development: FA and DDT in concentration gradient



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