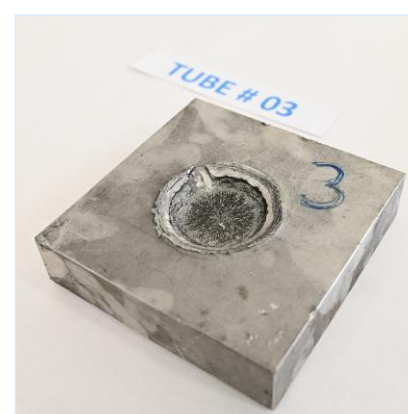




Small-scale characterisation of Urea Hydrogen Peroxide Explosive performance using Heterodyne Velocimetry

1. Context

- Current Home Made Explosive (HME) threat worldwide:
 - Mixing of highly energetic pyrotechnics
 - Synthesis of **peroxide explosives**
- Carbamide Peroxide or **Urea Hydrogen Peroxide (UHP)**, widely used in the dental, cosmetic and pharmaceutical industries, has proven detonable at small-scale under heavy confinement [1].

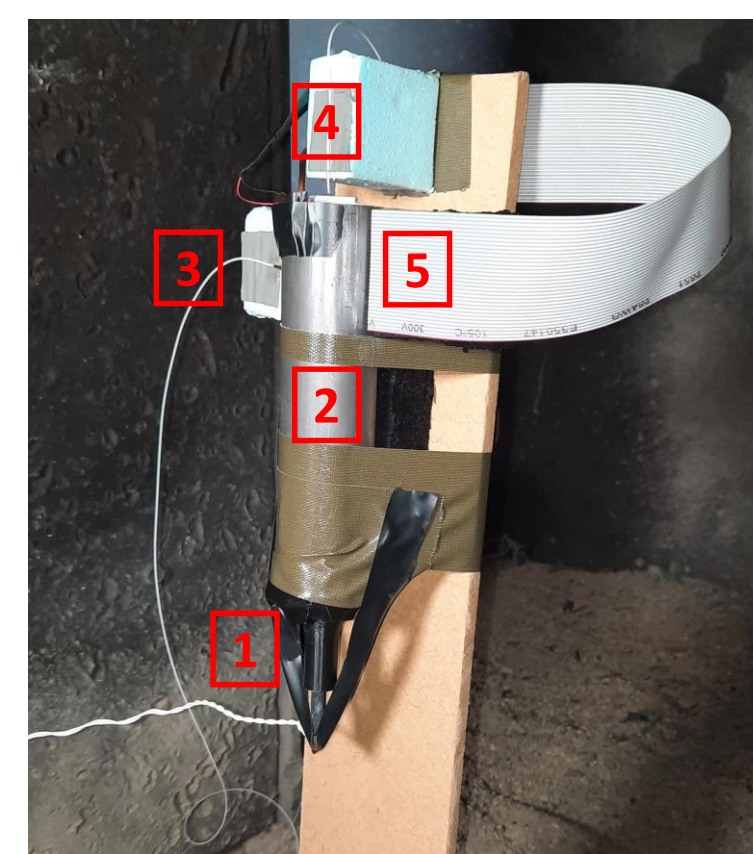


2. Objectives and challenges

- Further small-scale **characterisation of explosive performance** for risk assessment purposes: detonation velocity (VoD), pressure (P_{det}) and metal acceleration.
- **Heterodyne velocimetry (Het-V)**, or Photonic Doppler Velocimetry (PDV) is a powerful tool to carry out advanced detonics investigation, such as a direct measurement of particle velocity in inert materials [2].
- UHP is heterogeneous and exhibits the behaviour of a **non-ideal** (tertiary) explosive. At small scale, UHP detonation requires a strong confinement wherein the shock propagates faster than the reaction wave in UHP.

3. General approach

➔ Charge configuration from previous research, all target data in a single test

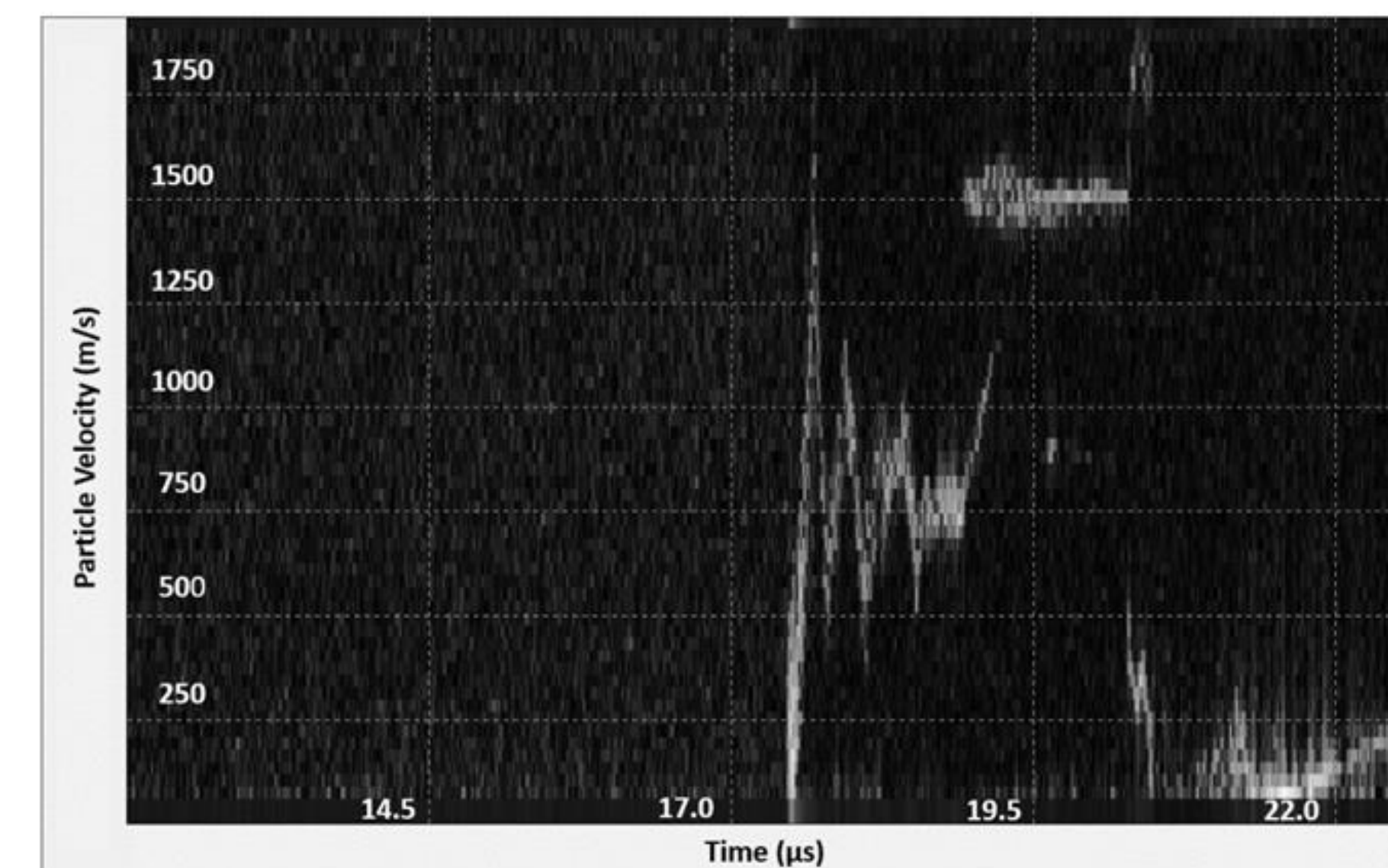


- 1) **Initiation:** N°8 detonator, 8 g PE8 booster
- 2) **Explosive charge:** 80 g loose UHP in 4 mm thick steel (ID=30 mm ; length 150 mm)
- 3) **Het-V probe** for Cylinder expansion
- 4) **Het-V probe** for P_{det} measurement by IWM Impedance Window Method [2]
- 5) **Contact probes** ribbon for VoD record

➔ 8 shots UHP & 2 shots PE8 plastic explosive (86,5% RDX) for reference

4. Preliminary results

- Average **VoD: 3200 m/s** from contact probes, in excellent agreement with measurements using Optimex passive optical probes [1].
- Cylinder expansion – **metal acceleration ability:**
 - Max initial acceleration $54 \times 10^6 \text{ m/s}^2$
 - Radial pressure **4 GPa**
- Best Het-V power spectrum obtained from a 2.8 mm thick PMMA impedance window. Calculation by impedance matching [2] gives an average **2.5 GPa** for P_{det} , a **13% TNT equivalence for brisance**, confirming calculations using empirical correlation [1].



5. What's next

- Improvement of the experimental setup, including hardware, to improve shot-to-shot repeatability and achieve accurate P_{det} measurement, including error estimate.

References

- [1] F. Halleux, J.-F. Pons, I. Wilson, R. Van Riet, M. Lefebvre, Small-Scale Detonation of Industrial Urea-Hydrogen Peroxide, *Propellants, Explosives, Pyrotechnics* **2022**, 47 (2), e202100250.
[2] J.Pachman, M. Künzel, O. Nemec, J. Majzlik, A comparison of methods for detonation pressure measurement, *Shock Waves* **2018**, 28, pp 217-225.

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