Synbiosys

Stopping km/s Blunt Fragments and Limiting Shock Lensing with a New Advanced Energy Absorbing Composite

Gareth R Tear, Gianmaria Bullegas, Jose Videira

Synbiosys Ltd.

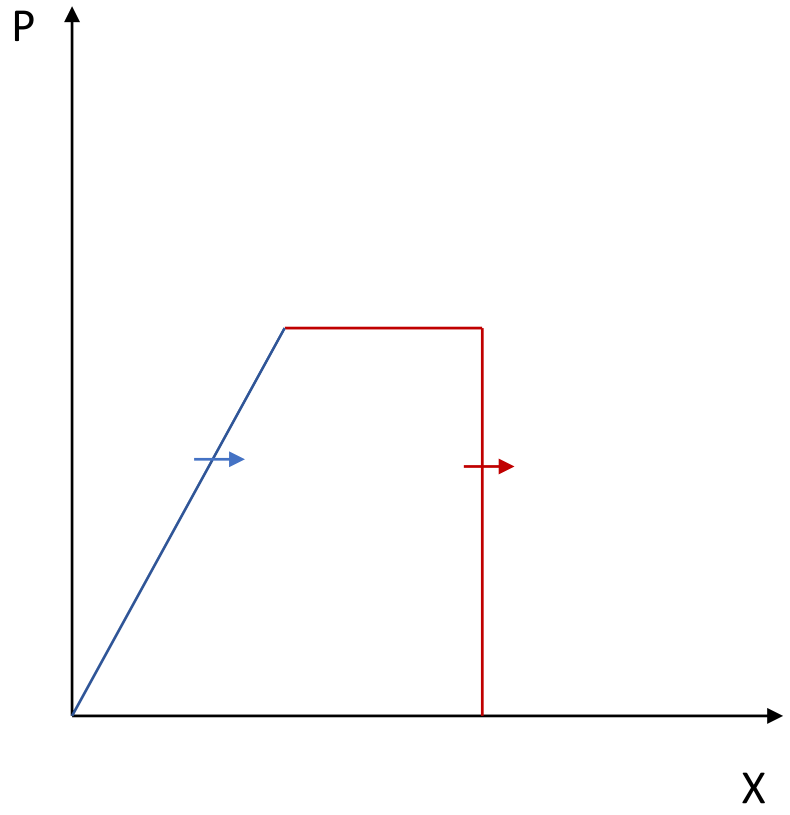
Overview

- Munition initiation usually occurs through hot spot formation during compression
- Currently two broad approaches to reduce hotspot initiation
  - Alter the chemical behavior of the explosive to reduce its sensitivity
  - Alter microstructure of the binder to reduce hotspot intensity
- We are presenting a new process to avoid hotspot formation

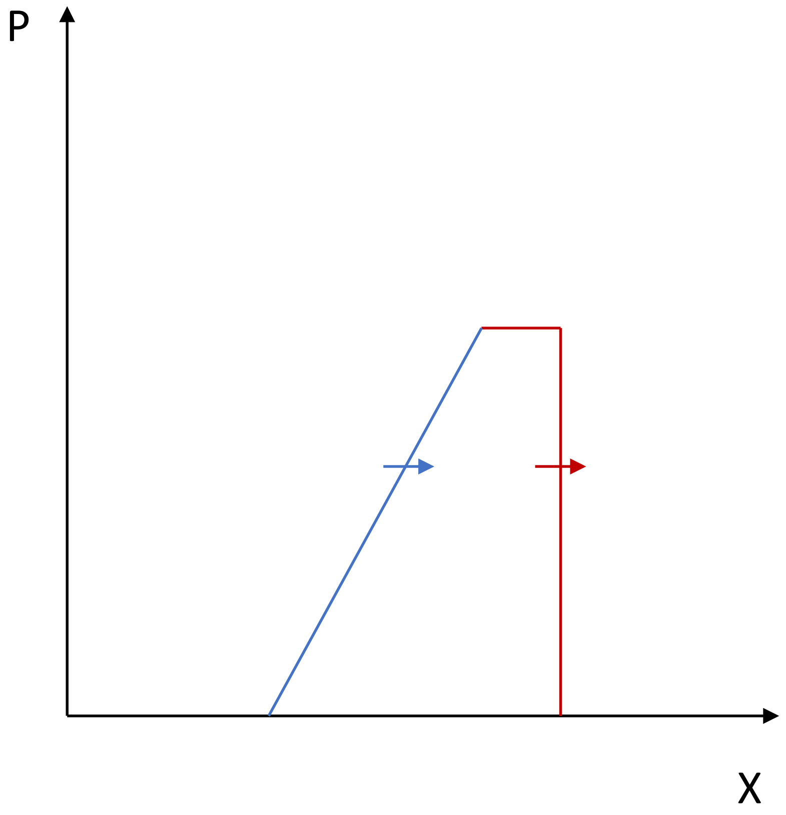
What is the process?

- Shock waves propagate very high transient pressures and temperatures very quickly.
- We need an equally fast energy dissipation mechanism to prevent the initial shock reaching the energetic material.
  - Plastic deformation and fracture aren’t fast enough
- A new transient release phenomena has been proposed which allows the material to partially release at the shock front.

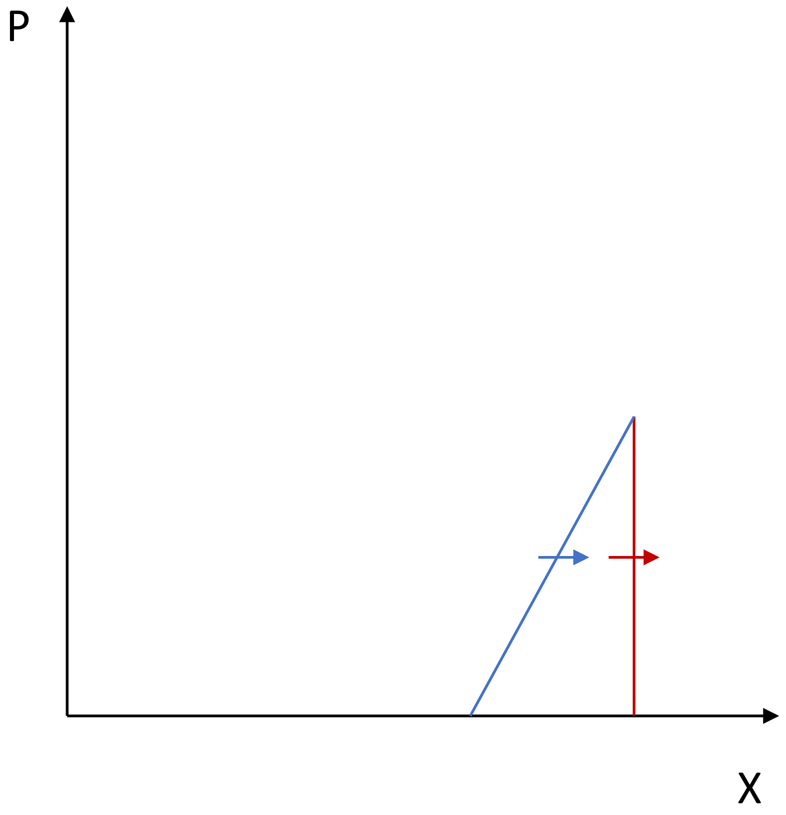
Typical Shock – Rarefaction Profile



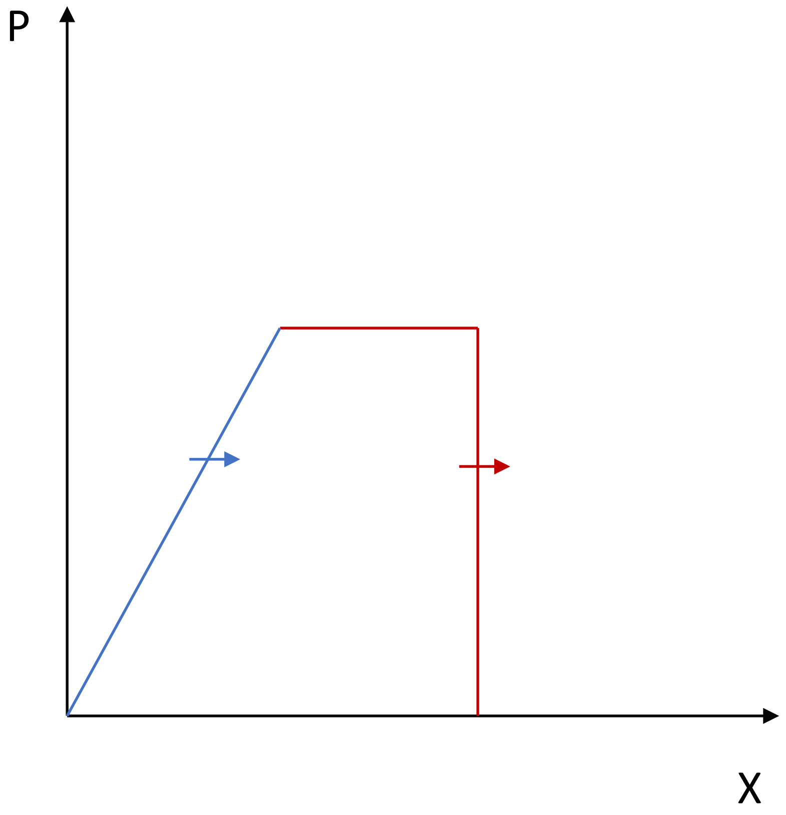
Typical Shock – Rarefaction Profile

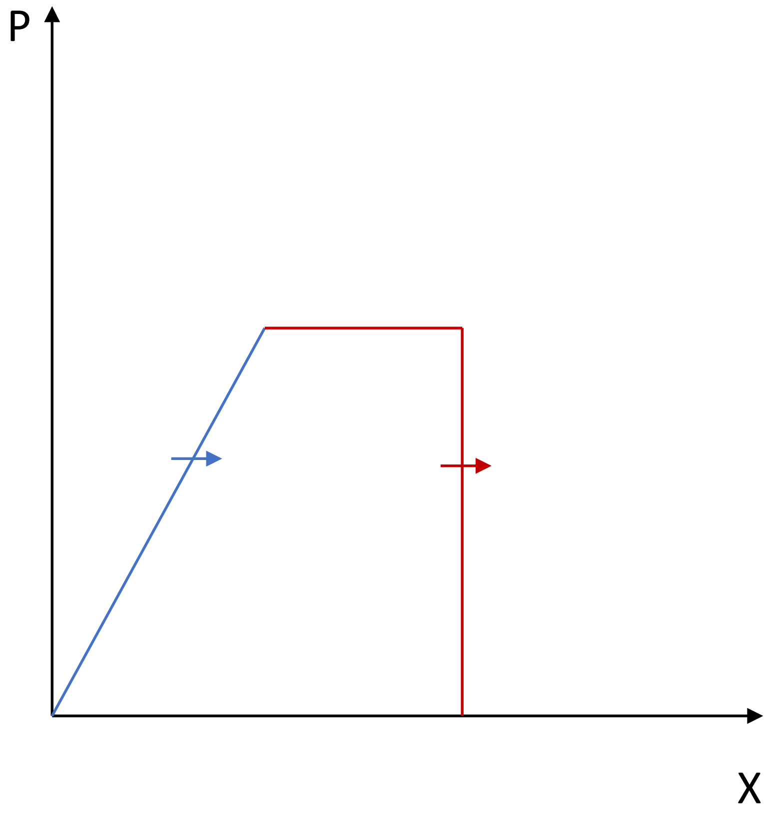


Typical Shock – Rarefaction Profile

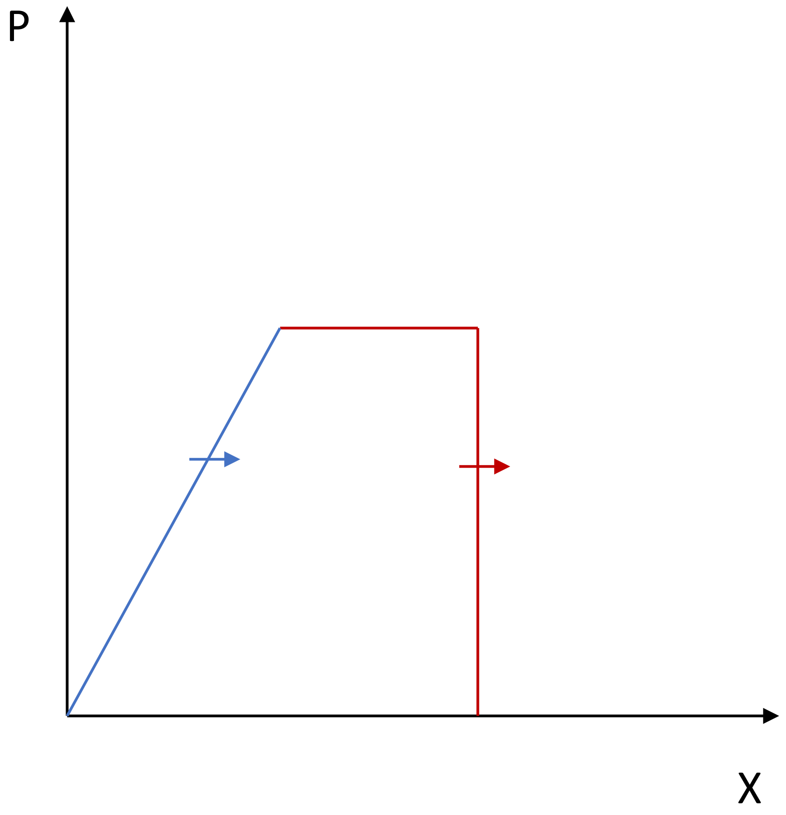


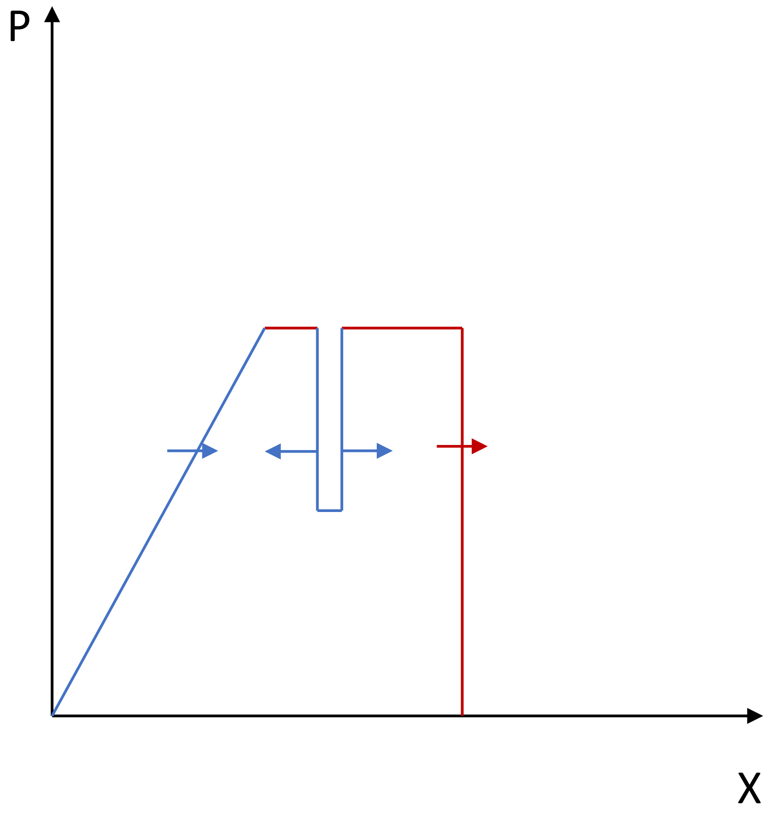
Including Transient Shock Release Phenomena



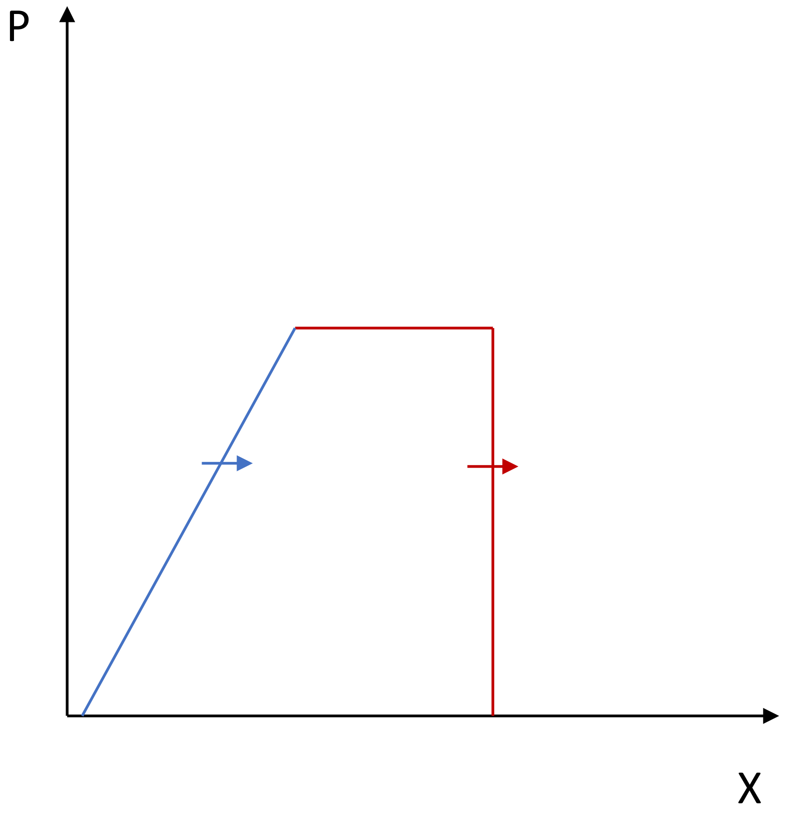


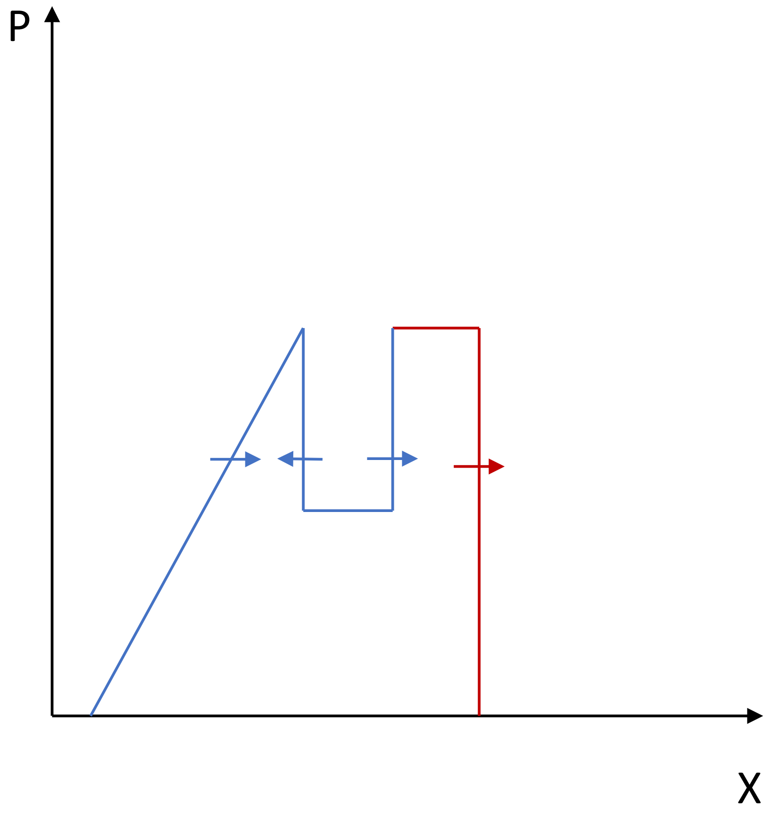
Including Transient Shock Release Phenomena



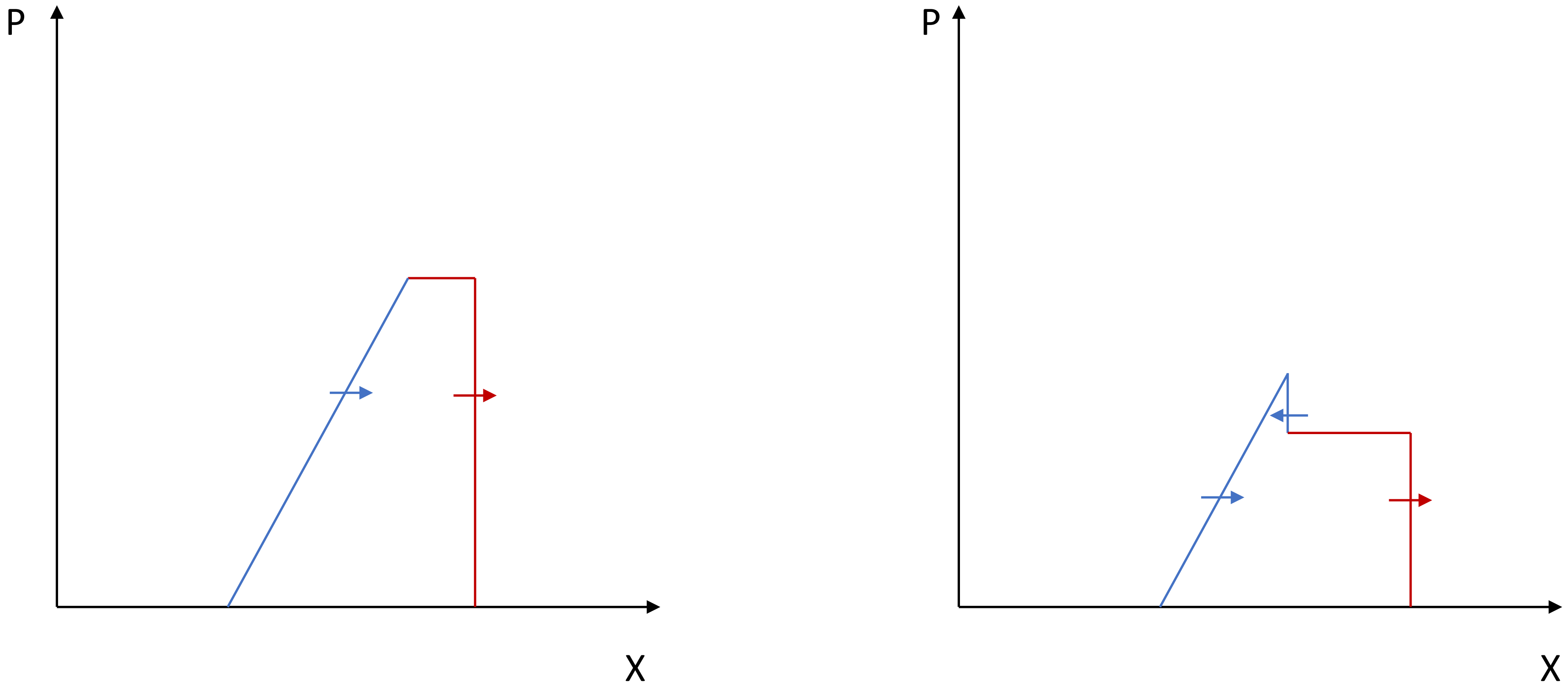


Including Transient Shock Release Phenomena





Including Transient Shock Release Phenomena



Including Transient Shock Release Phenomena

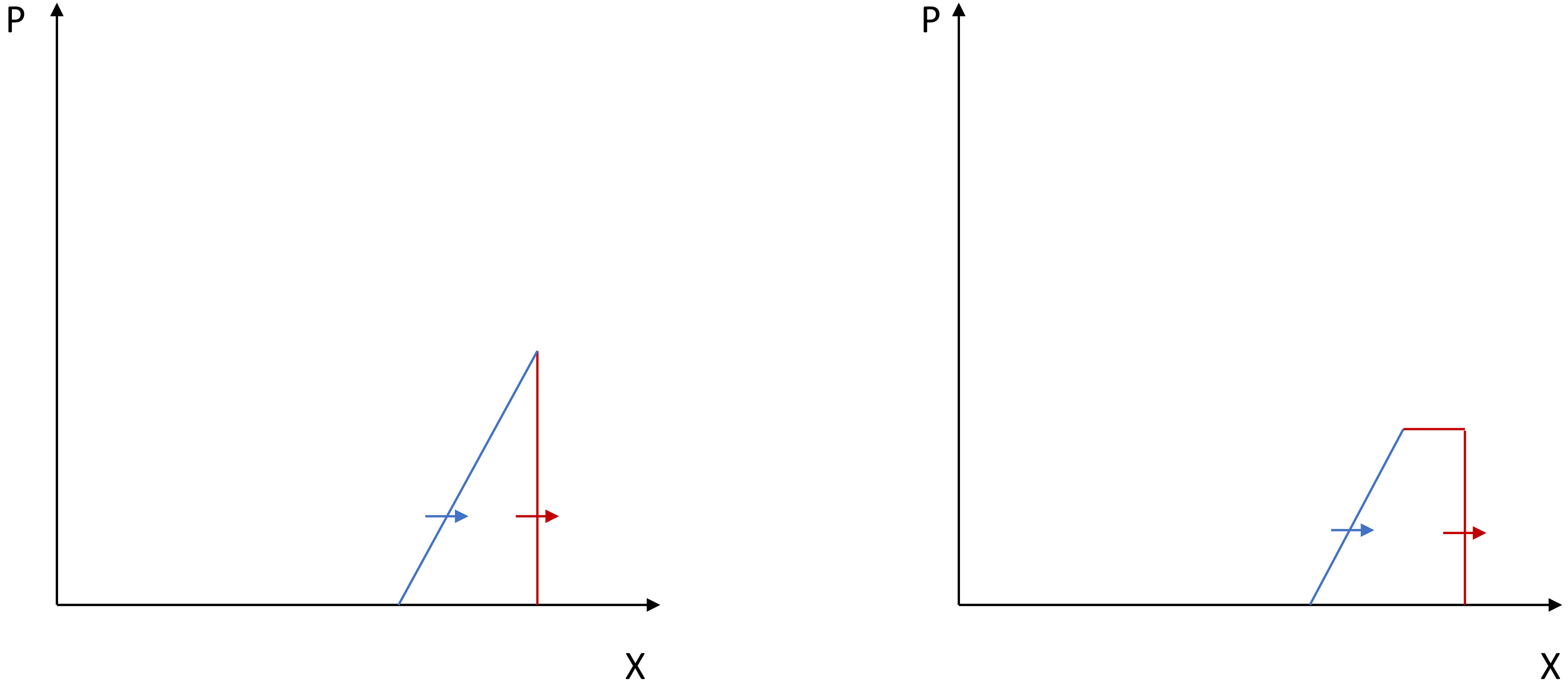


Plate impact experiments

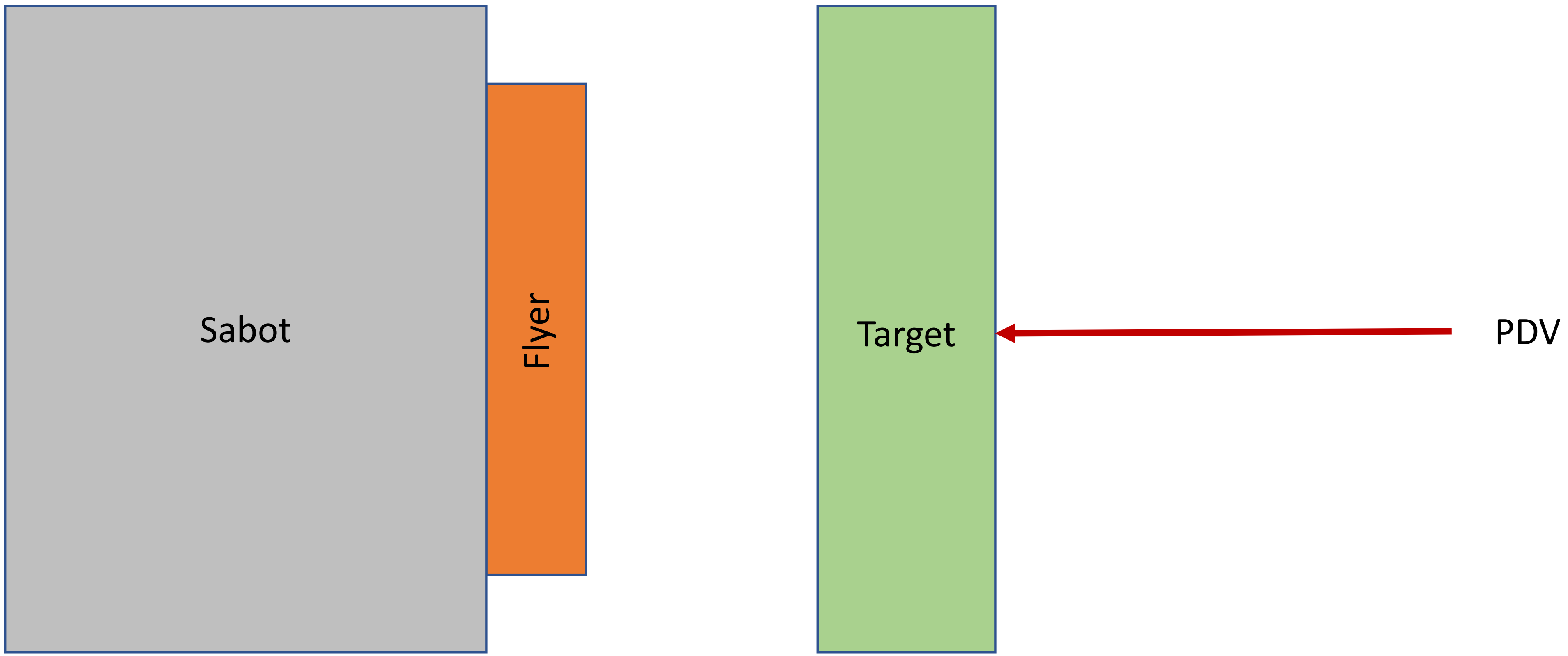


Plate impact experiments

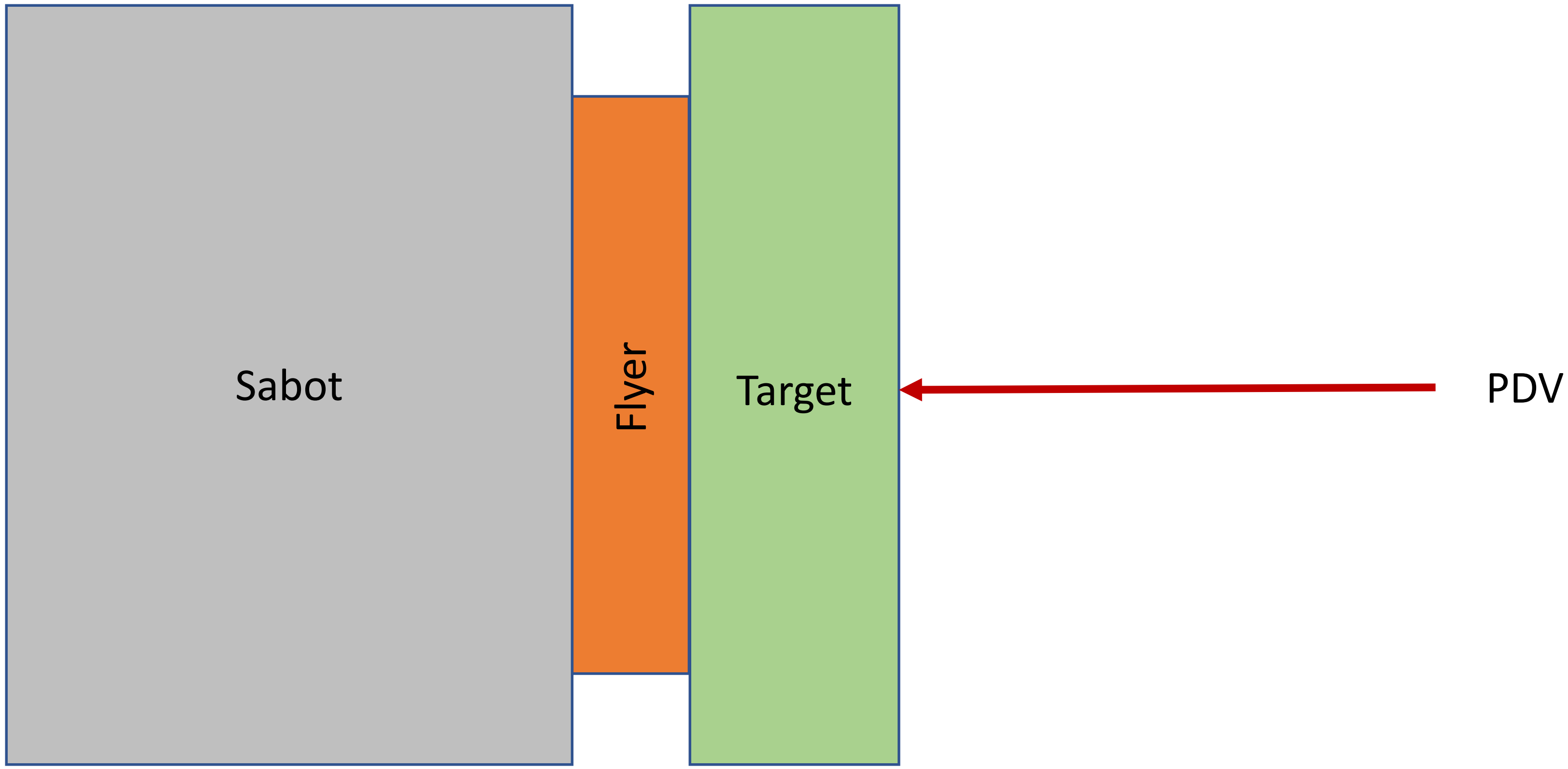


Plate impact experiments

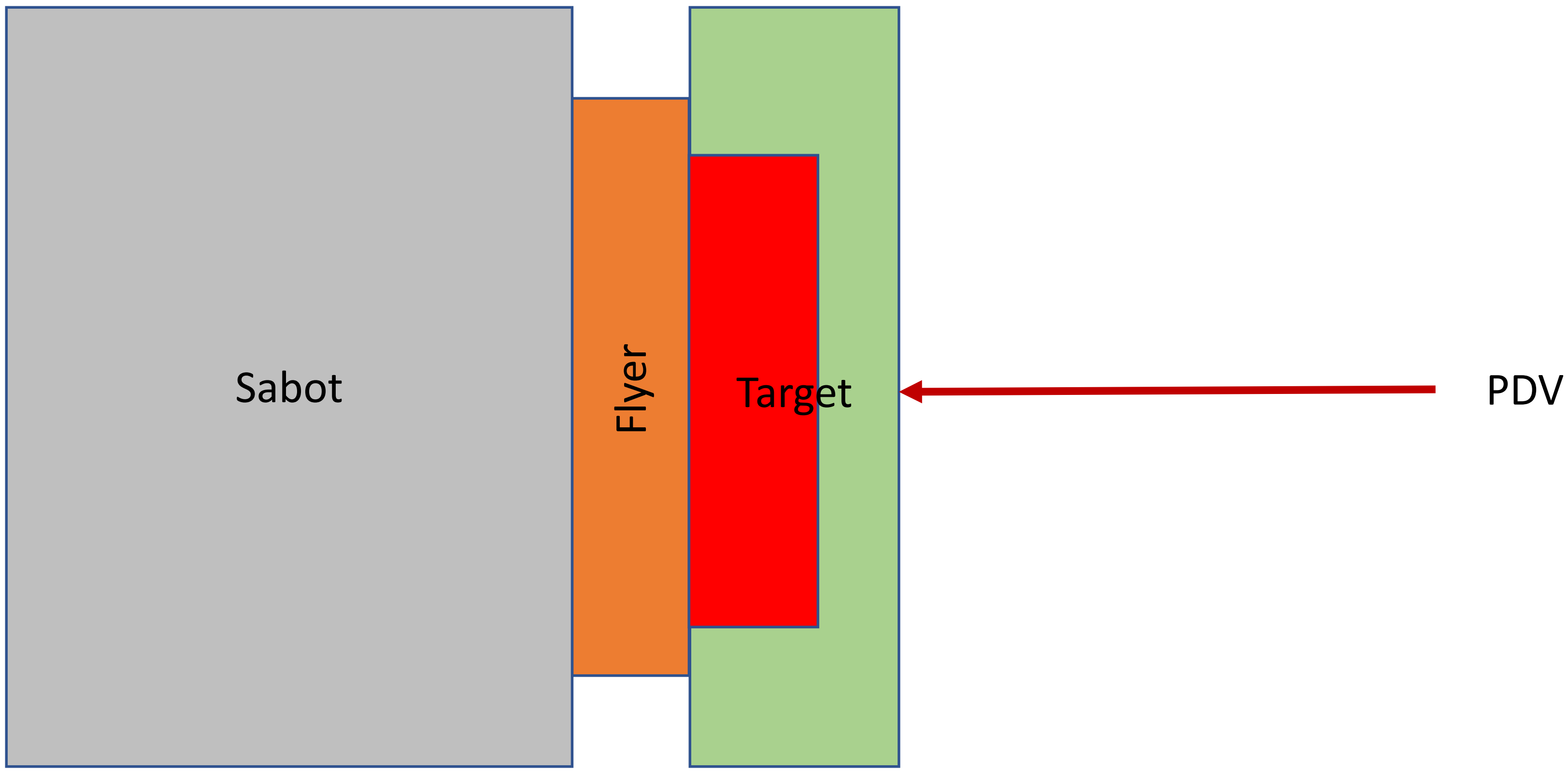


Plate impact experiments

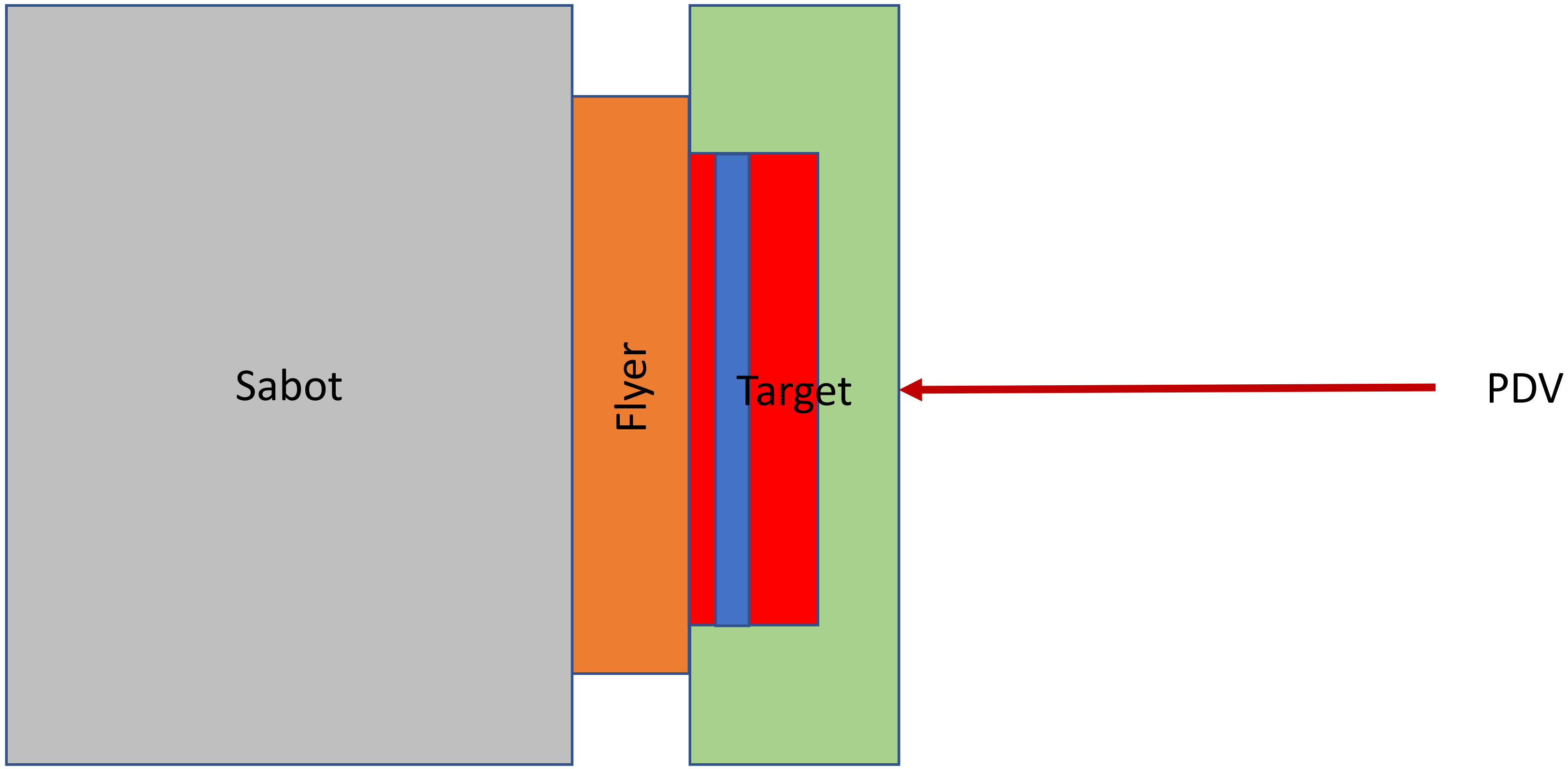


Plate impact experiments

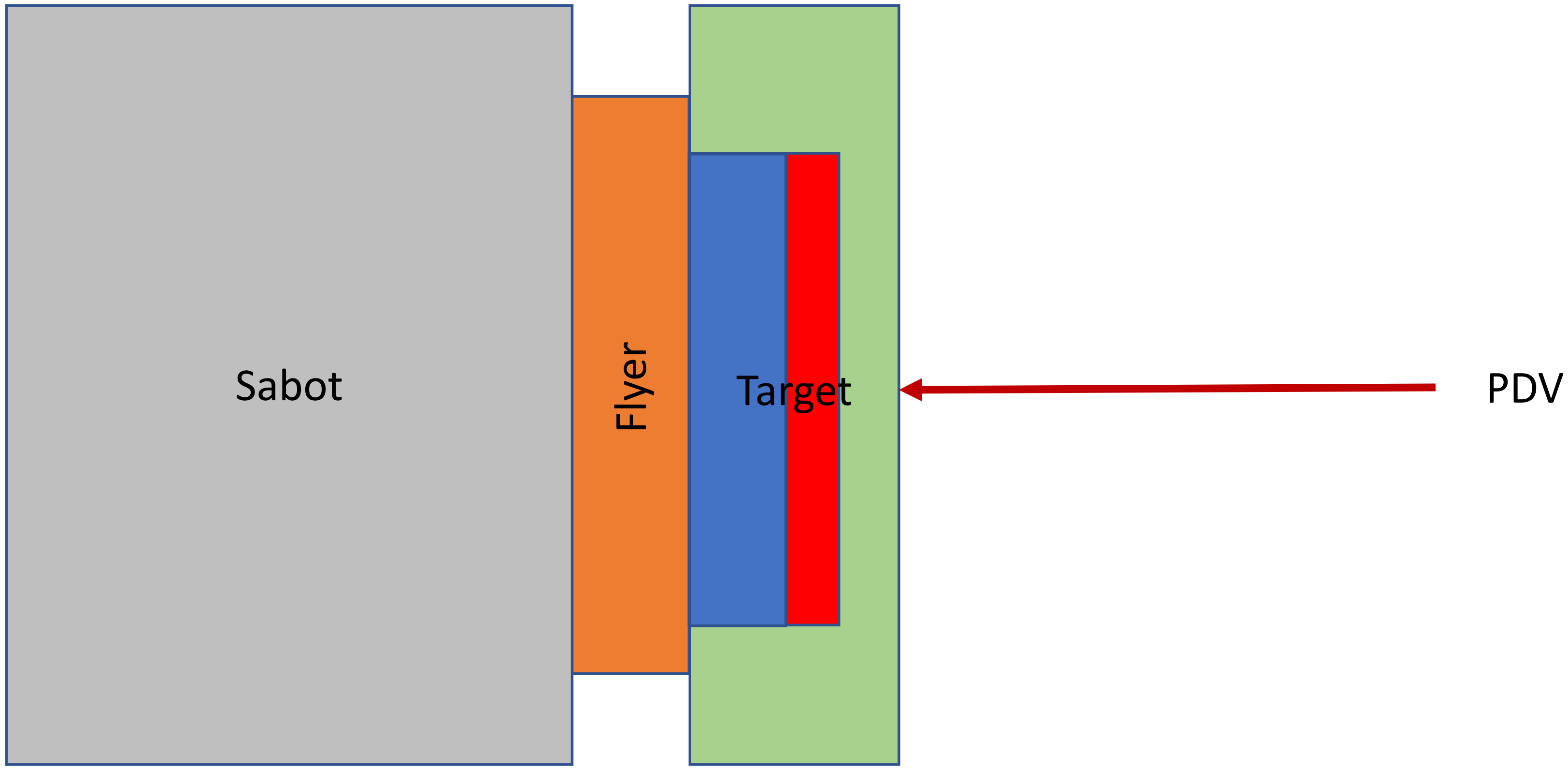


Plate impact experiments

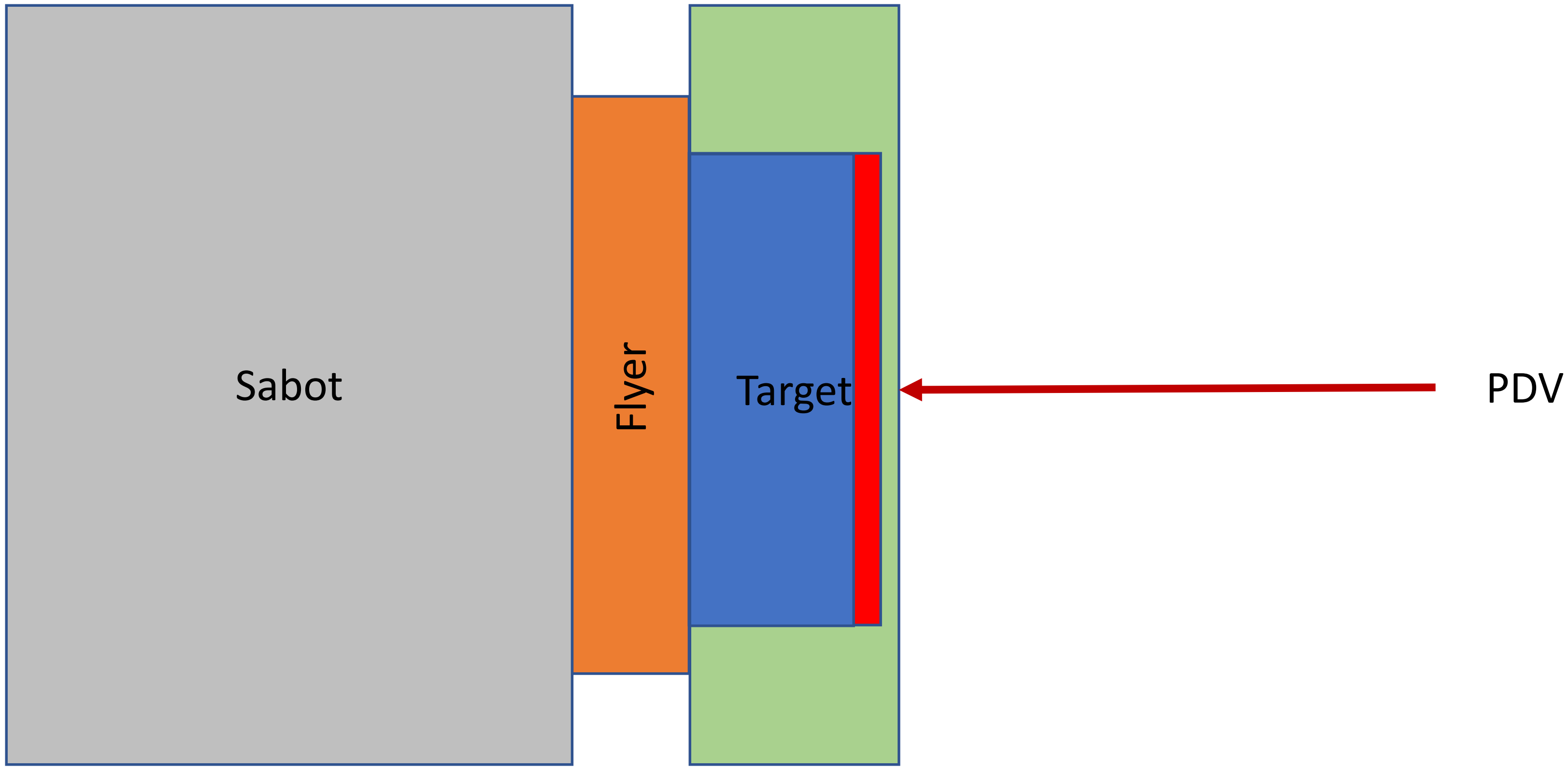
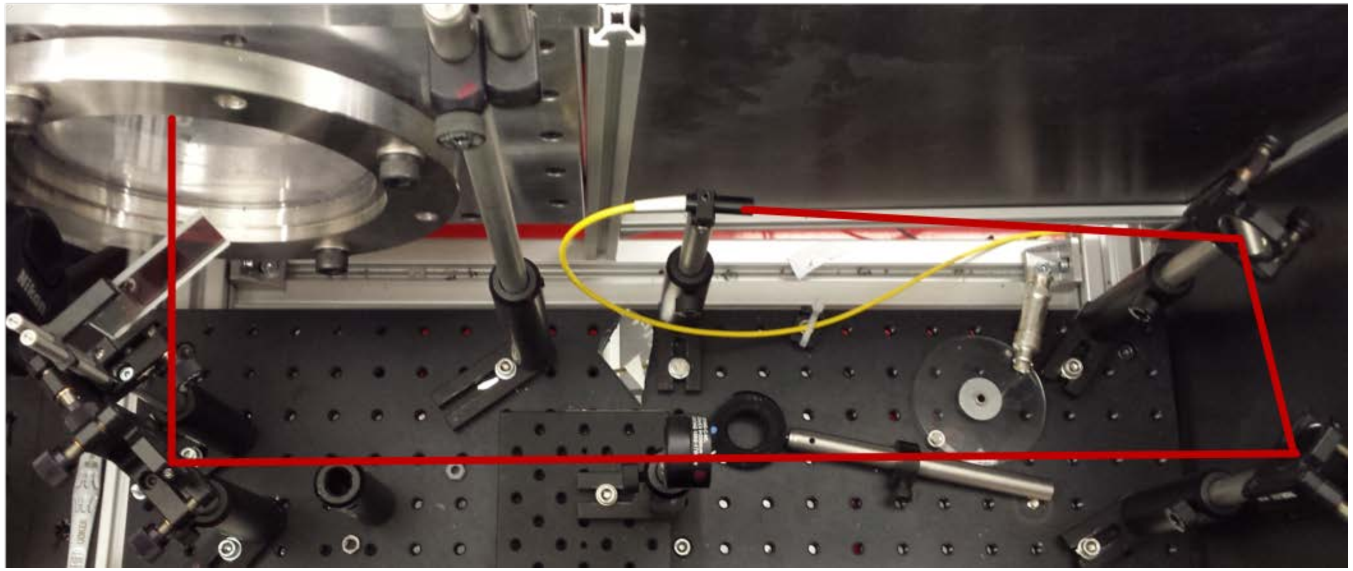
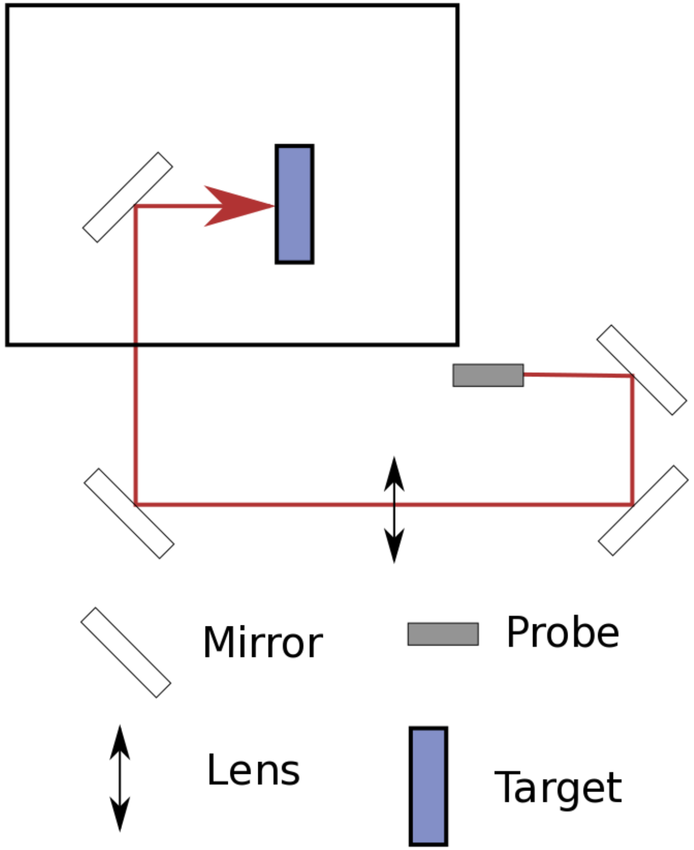
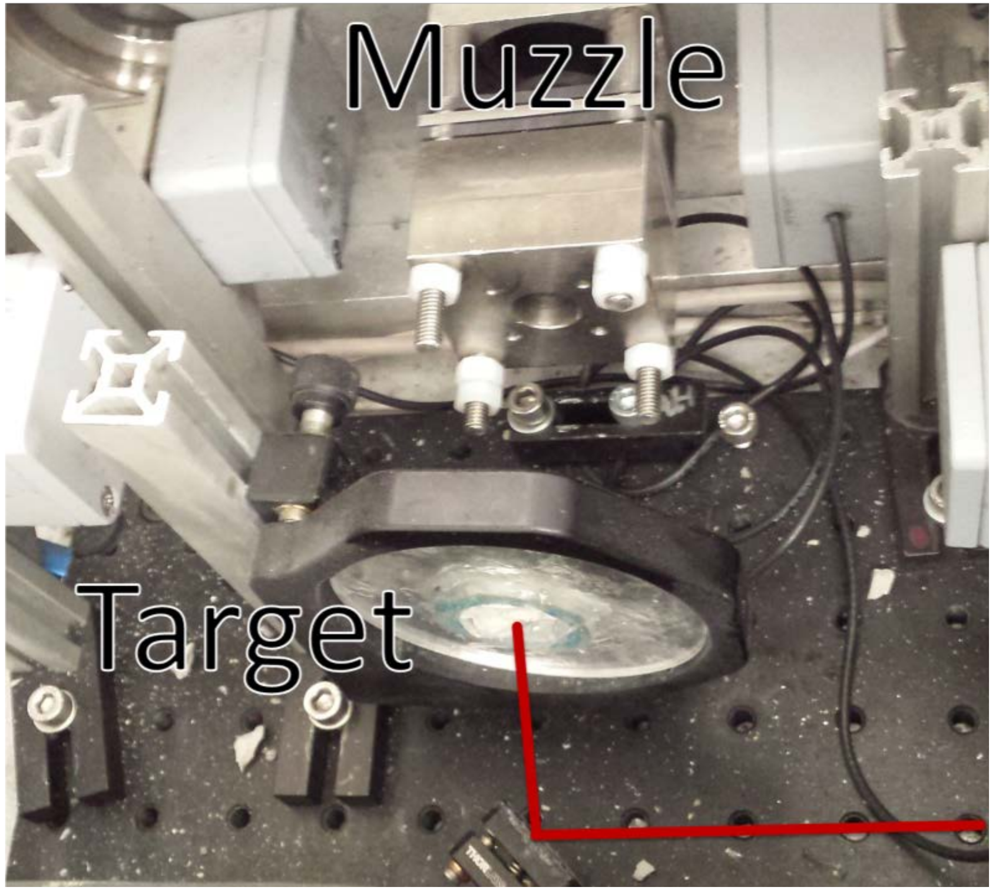


Plate impact experiments



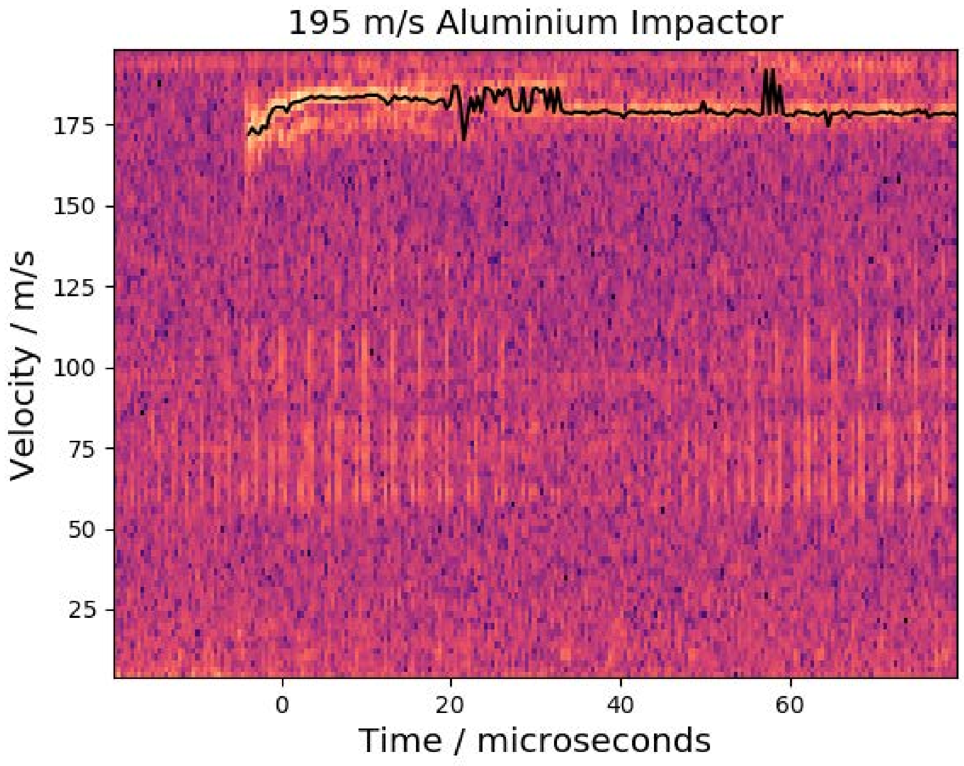


Target Chamber



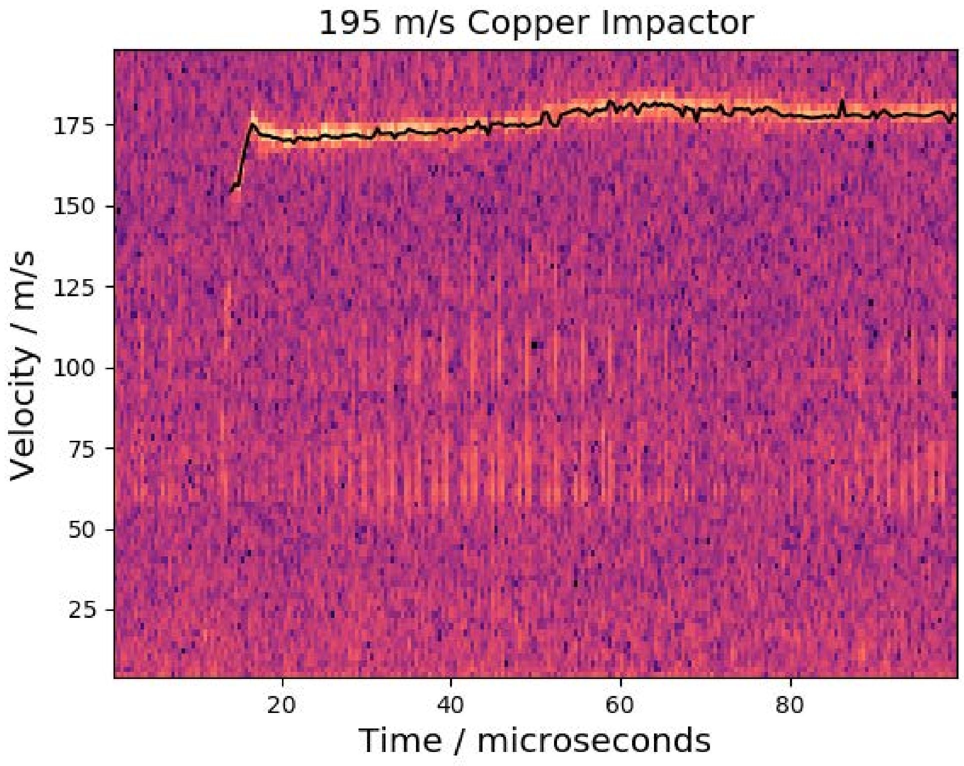
- Light gates measure velocity
- 3” ThorLabs optical mount used to align targets
- Polycarbonate/aluminium sabot stripper used for fragment experiments

Experimental Evidence



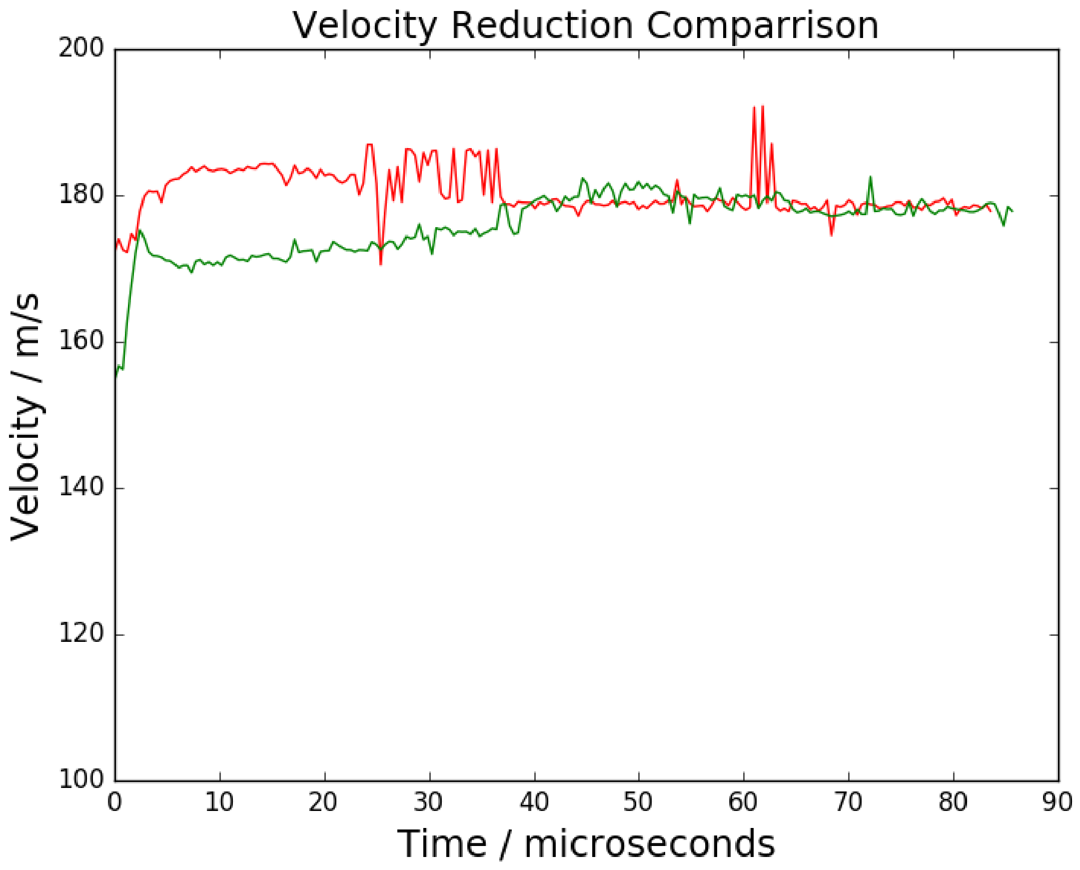
- 195 m/s impactor
- 185 m/s rear surface velocity
- No transient release

Experimental Evidence



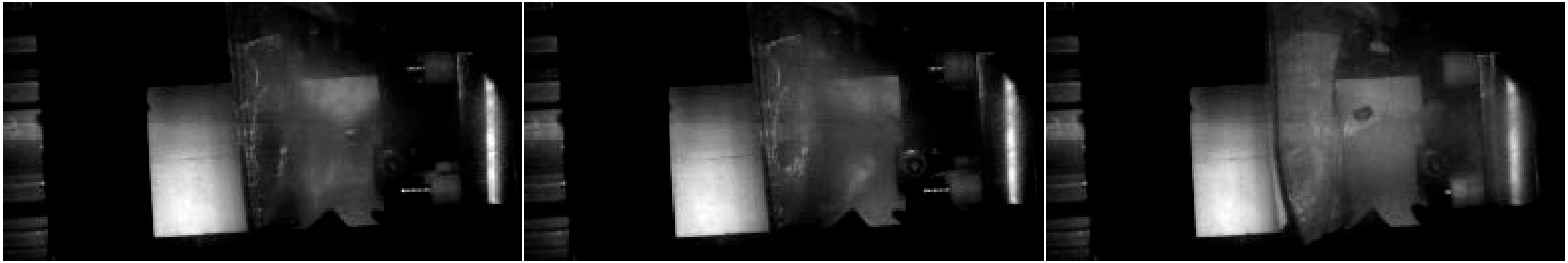
- 195 m/s impactor
- 175 m/s rear surface velocity spike, 160 m/s average
- Unoptimised transient release as evidenced by residual shock peak.

Experimental Evidence



- Same residual velocity – momentum conserved
- Reduced initial shock by 20 m/s
- Average reduction in velocity of 15 m/s for 35 microseconds
- Equivalent energy absorption to a material toughness of $1MJ/m^3$

Experimental Evidence – Fragment Test



- 430 m/s steel STANAG fragment.
- Increasing velocity to work towards km/s protection

Next Steps

- Methodically increase fragment velocity to find maximum
- Investigate other materials
- Investigate 3D geometries
  - We can engineer the shape of the release phenomena
  - Converging shocks can be mitigated using a divergent release geometry

Conclusions

- Currently able to attenuate the shock front in plate impact experiments by 20 m/s
- Able to stop 430 m/s fragments
  - Need to optimize the transient release to get further improvement
  - Theoretical maximum is 7km/s
- Presented is a technology for a family of materials – we are investigating more suitable raw materials for km/s impacts.