Blast Dosimeter Response within Mini Shocktubes

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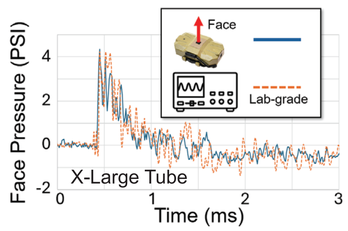
BACKGROUND / OBJECTIVE

- Requirement to capture, export and assess injury potential from blast exposure in operations and training

3 x pressure sensors in single device (0-100 PSI)
Synchronous time base (100 kHz)
Event duration: 15 to 90 ms (no dead time)
Pre-trigger to ensure peak is never missed

Data compares well with laboratory-grade reference sensor



Objective:

Demonstrate the feasibility of Mini Shocktubes as an alternative to explosives for blast sensor testing (functionality, repeatability, accuracy)

MINI SHOCKTUBES

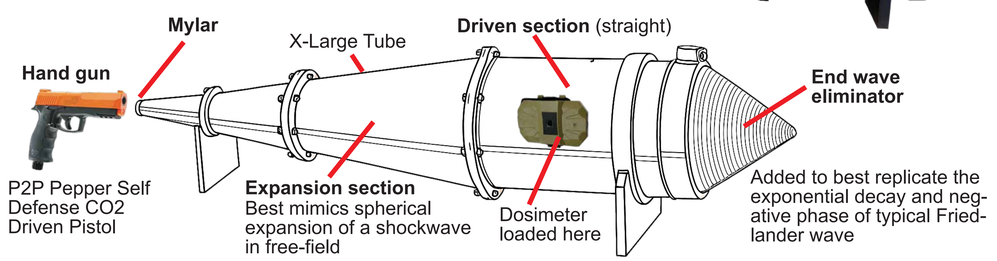
As shockwave profile repeatability is paramount, miniaturized versions of Advanced Blast Simulators (ABS) were designed for systematic testing

Built using off-the-shelf and 3D-printed components

Do not require power or data acquisition system

A 0.0005" Mylar placed at the tube inlet removes variability of the hand gun

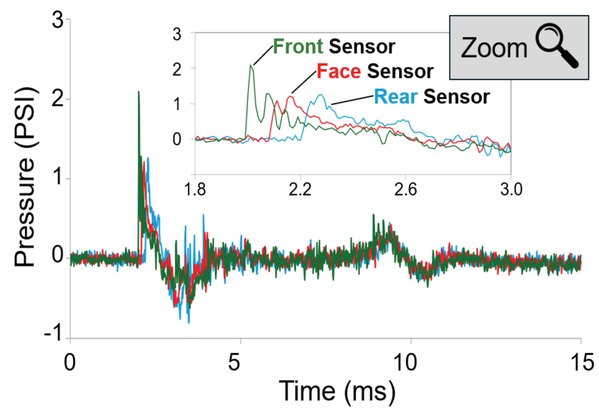
Nominal incident pressure ranges



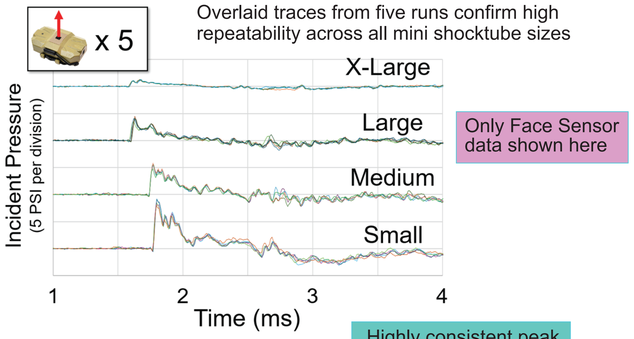
PRESSURE TRACES

Representative Friedlander waves

- Distinct arrival times across the three sensors reveal directional blast characterization capability
- Enabled through coherent timing across sensors and high-rate sampling

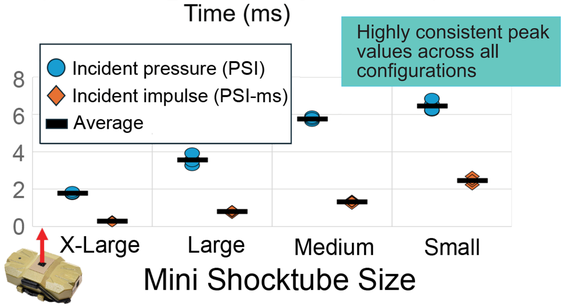


HIGH REPEATABILITY



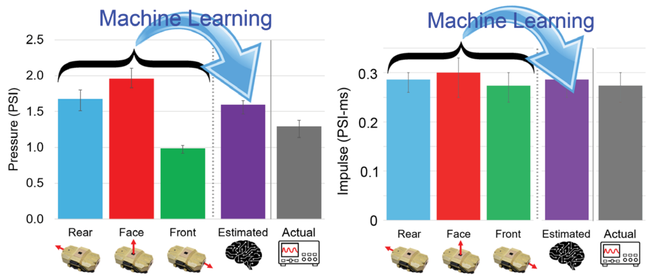
Overlaid traces from five runs confirm high repeatability across all mini shocktube sizes

Only Face Sensor data shown here



Highly consistent peak values across all configurations

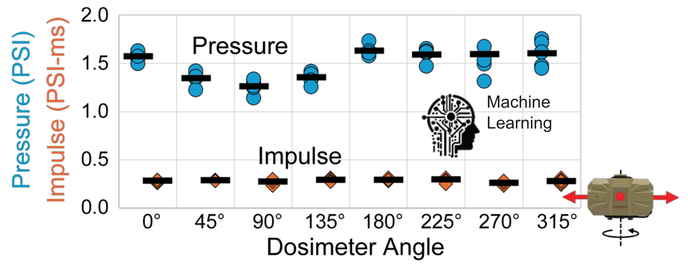
DISCUSSION



- Machine-learning algorithms developed to estimate incident (side-on) blast pressure and impulse
- Previously validated in full-scale blast tests
- Estimated peak incident pressures/impulses calculated for all 4 shocktube sizes and compared to reference:
  - Slight overestimation for the "X-Large" tube
  - Slight underestimation for the "Small" tube
- Algorithms robust even under non-ideal laboratory shockwave condition

Example shown: Average of 5 tests conducted at a 225° angle in the X-Large tube

- Dosimeter sensitivity to rotational orientation tested by rotating in 45° increments in the "X-Large" tube (peak pressures approximately 1.5 PSI)
- Estimated pressures and impulses consistent across all orientations
- Demonstrates that the multi-sensor setup and algorithms effectively compensate for device orientation



CONCLUSION

- Growing concern over repeated exposure to low-level (<1 PSI) overpressures highlights the usefulness of Mini Shocktubes
- The "X-Large" shocktube provides a practical, non-explosive way to evaluate dosimeter performance in low-pressure regimes
- Machine-learning (ML) algorithms estimate blast pressure and impulse, validated against full-scale tests. Close agreement across all four shocktube sizes
- Minor expected deviations occur, but overall performance robust under laboratory conditions
- ML algorithms produced consistent results across all rotational orientations, demonstrating effective compensation for directionality
- Potential for in-situ blast dosimeter calibration through using Mini Shocktubes

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Military Health System Research Symposium
MHSRS 2026