Muckpile Shape Prediction with a Physics-Informed AI Framework for Blast Modeling

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DIRS

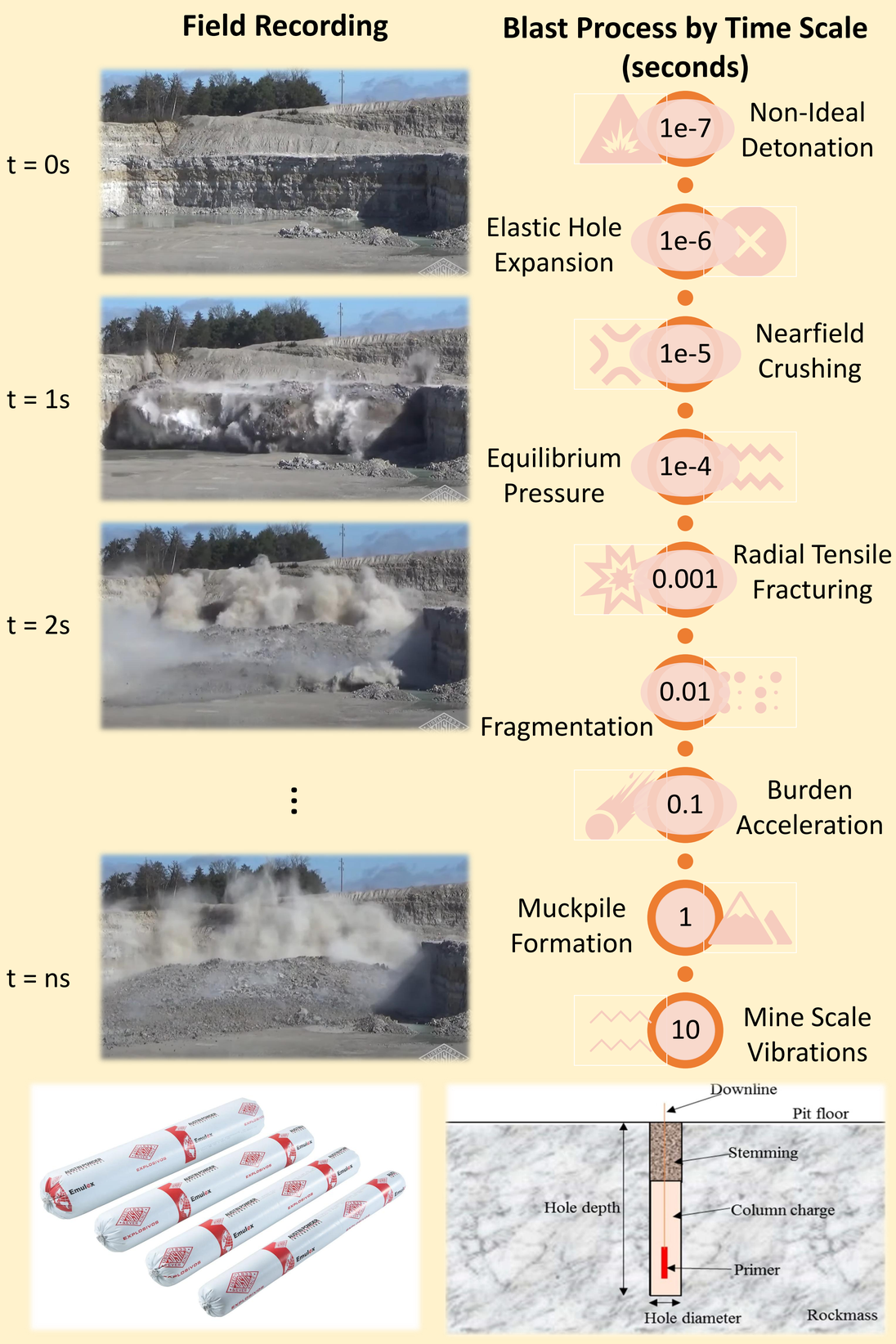
AUSTIN POWDER

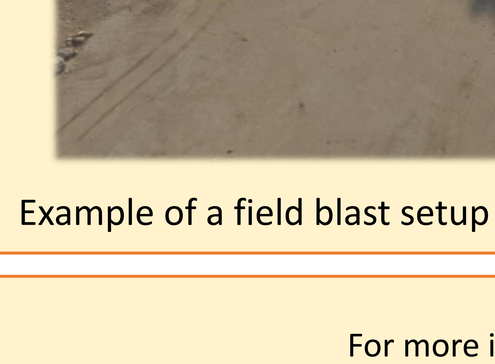
I. Introduction

Blast control is vital to mining efficiency and safety. The *muckpile*—the rock pile left after a blast—shapes downstream loading and hauling performance. By fusing physics-based simulation with modern AI algorithms, our team aims to *see seconds into the future*: predicting the post-blast muckpile directly from the pre-blast terrain and explosive setup.

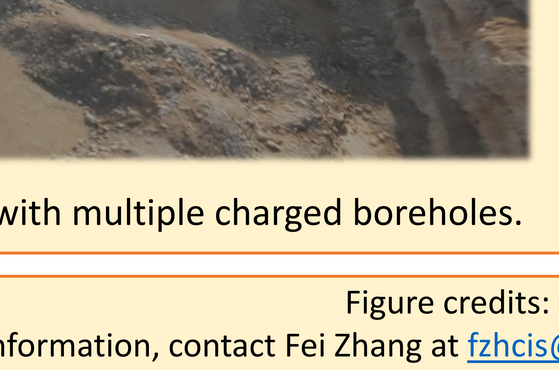
II. What Happens When a Blast Unfolds

Blasting is an inherently complex process involving explosive detonation, rock fracturing, and gas–rock interactions.

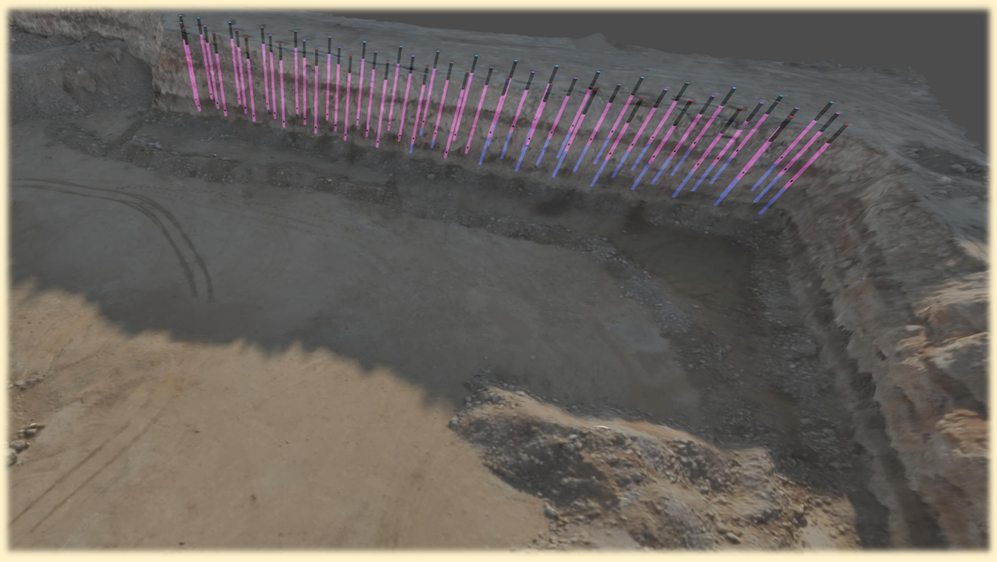




Emulsion explosives.(1)

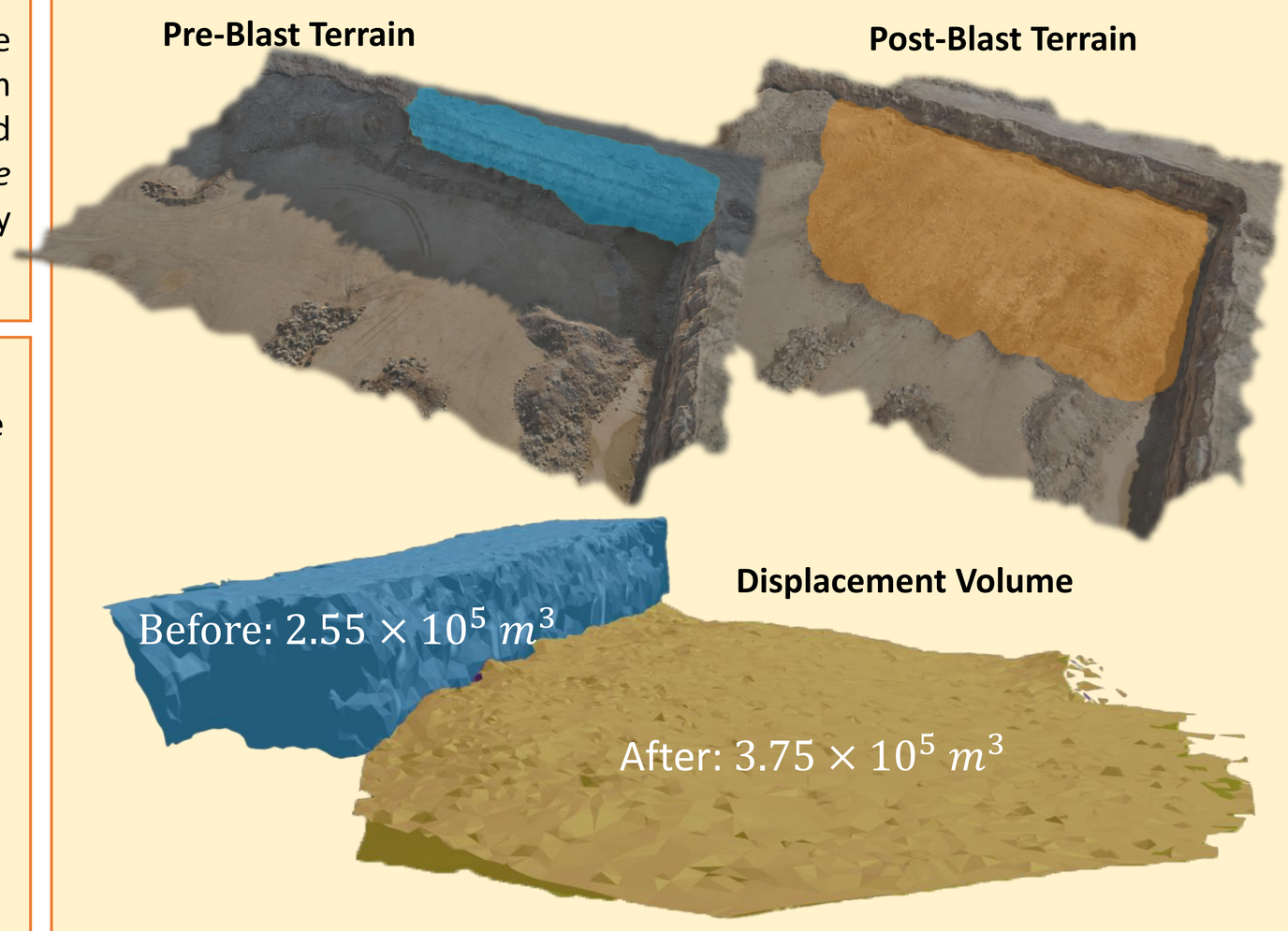


Charged blast-hole schematic .(2)



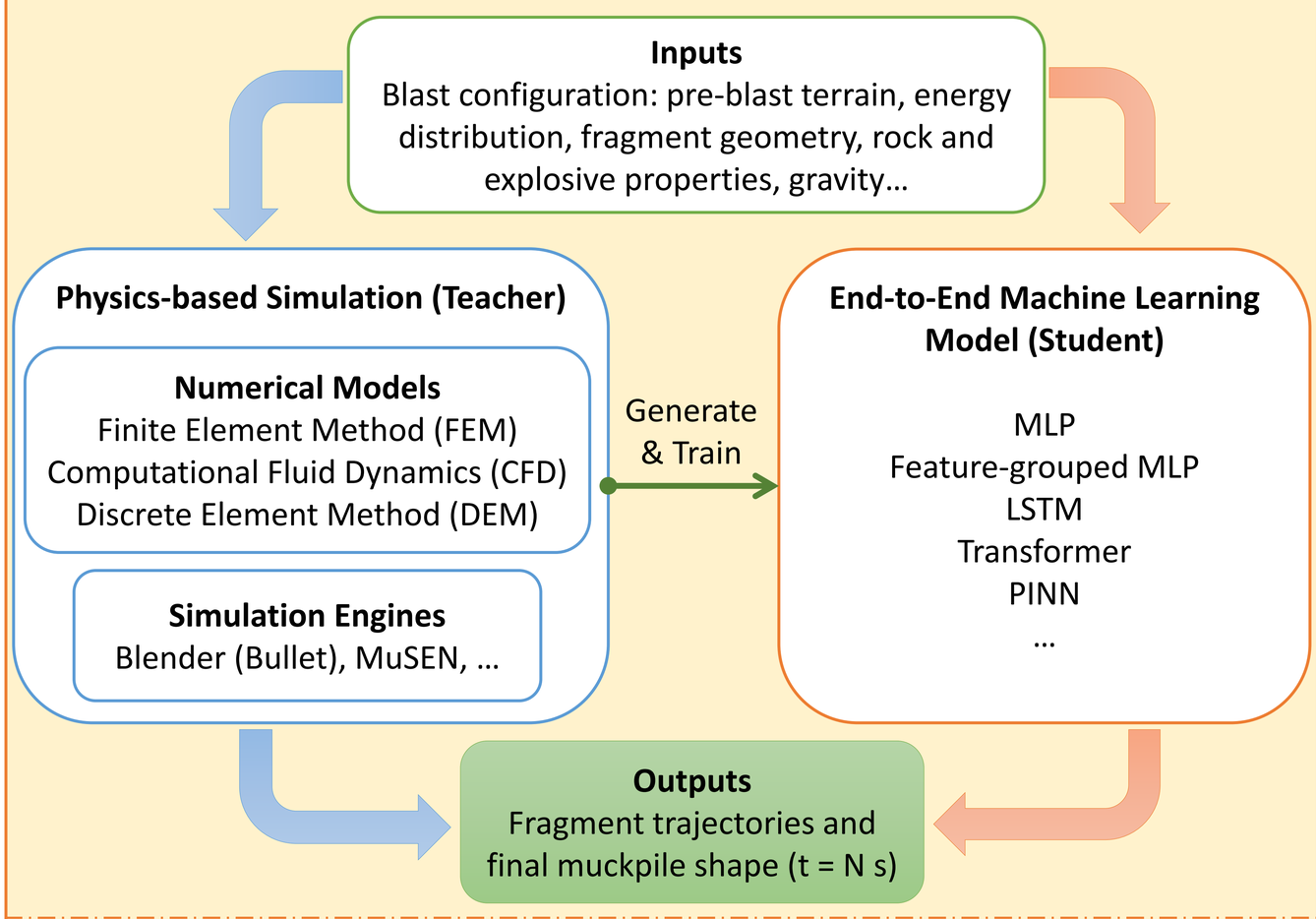
Example of a field blast setup with multiple charged boreholes.

III. Muckpile Formation in 3D Models

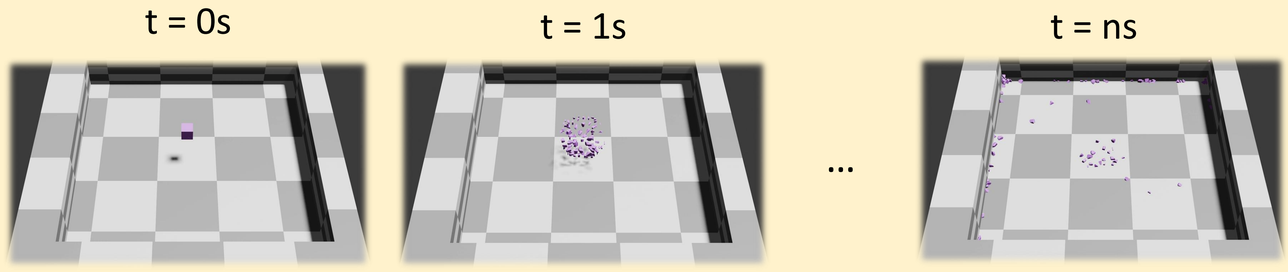


Example of displacement evaluation using 3D models derived from drone videos and Structure-from-Motion.

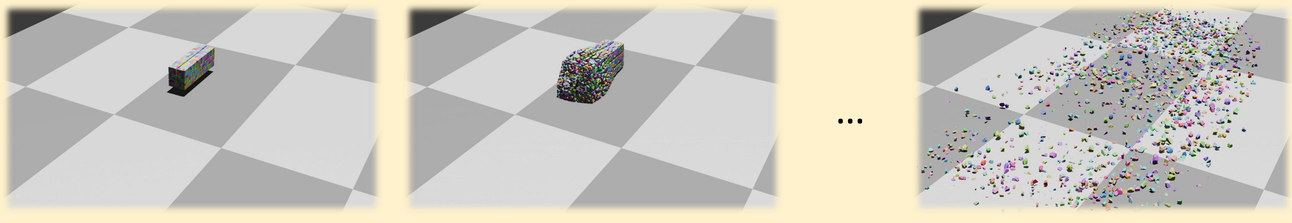
IV. Physics–AI Co-Development Workflow



V. Prototype Experiments



Experiment #1: Single-point blast test. A cube model (100 shards) subjected to a single impulsive force field, simulating a localized explosion.



Experiment #2**:** Sequential-blast test. A bench-shaped model (2000 shards) subjected to two sequential impulsive force fields, simulating multi-point detonation.

Figure credits: (1) Austin Powder ; (2) O-Pitblast .

For more information, contact Fei Zhang at fzhcis@rit.edu, or visit https://github.com/fz-rit/blast-simulation-showcase