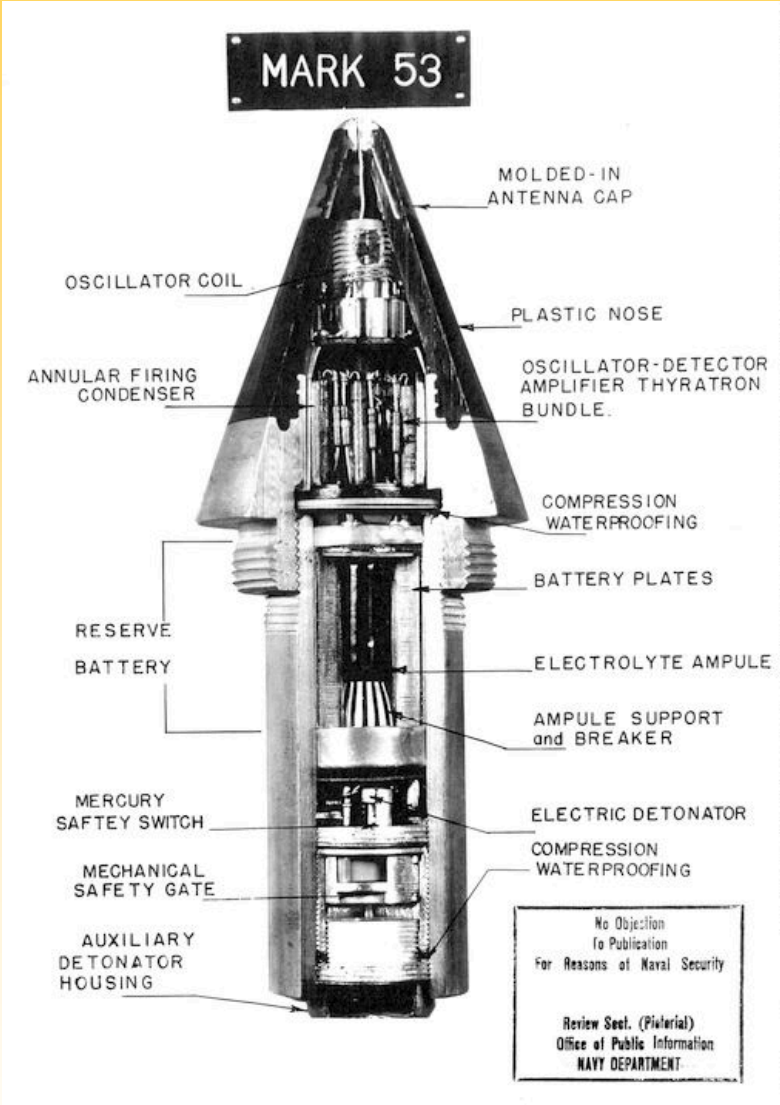
New Mexico Tech

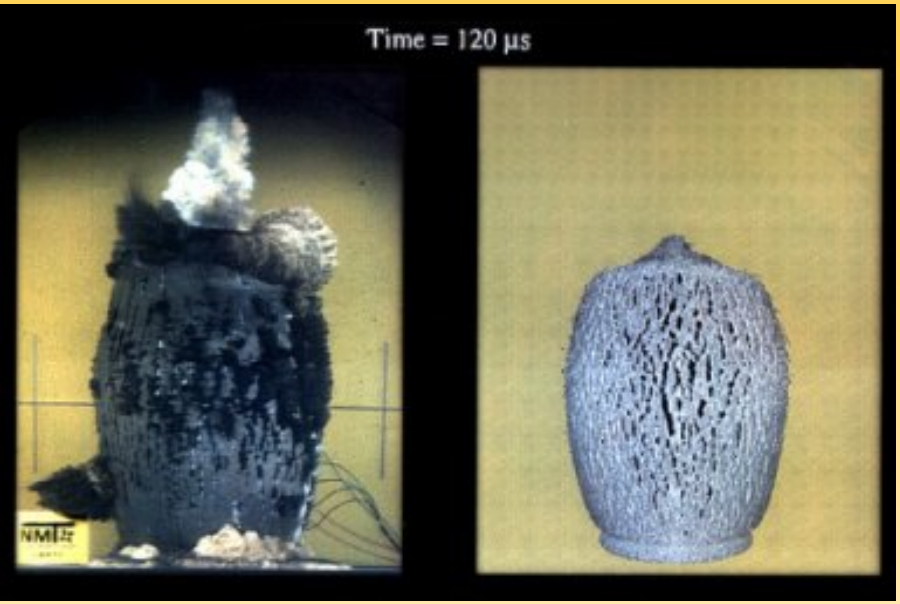
RESEARCH & ECONOMIC DEVELOPMENT

Dr. Van D. Romero
Vice President

Proximity Fuse



Weapons Systems to Technology Development

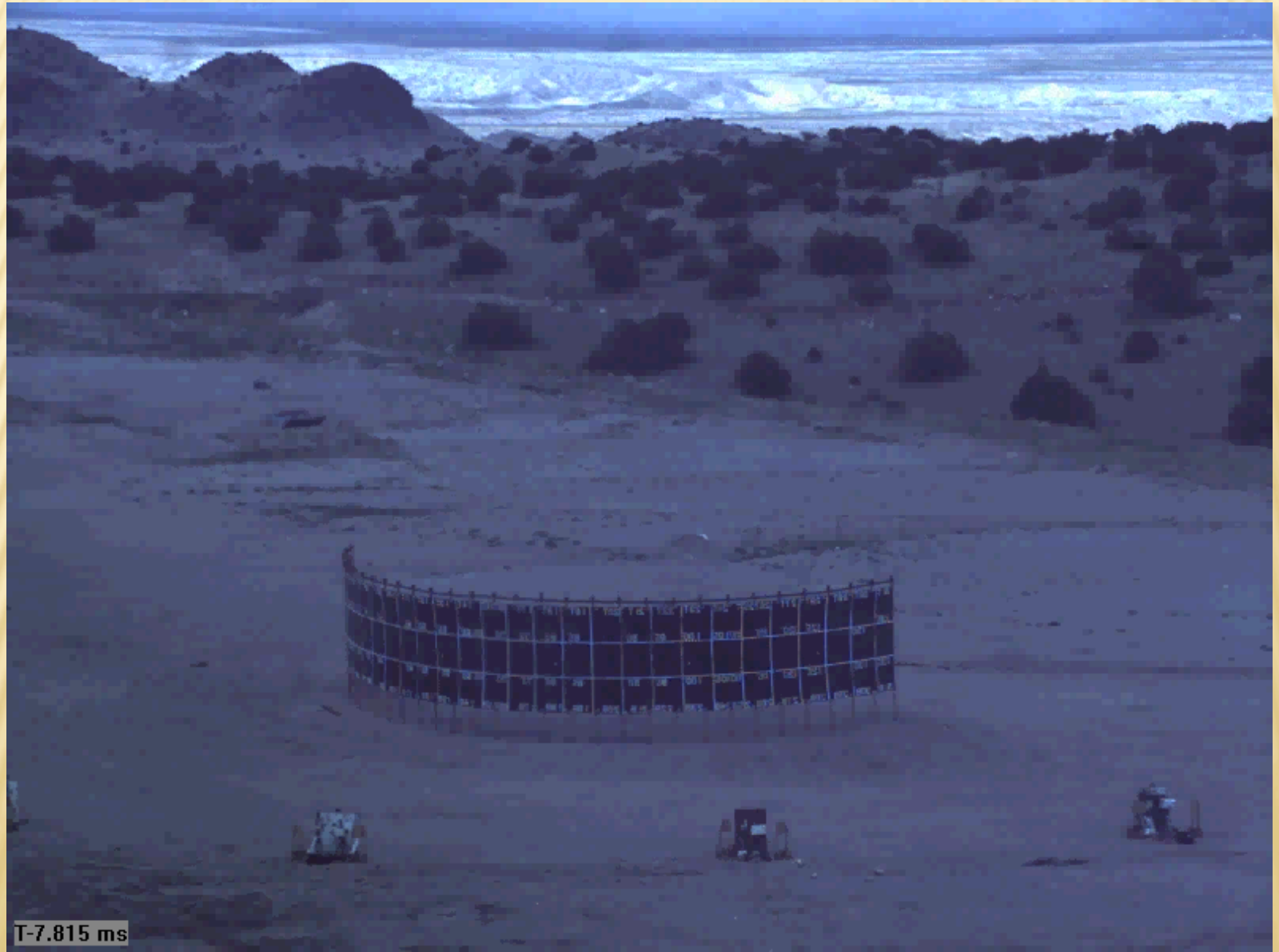


20mm/30mm
Tomahawk
Patriot
Phalanx
90 mm
155 mm
Hel Fire
4.2 mortar
40 mm
120 mm
Sat Arm
Tow
Standard
Tow2B
Missile
Ammram
Tow2A
105 mm
Roded
Side
Warheads
Winder
Hawk
Chaparral

- Detection
- Investigations
- Improved Construction Techniques
- Windows
- Earthquake Protection

Artillery Testing

Arena Test



Reactive Armor

Program Objectives

–Evaluate blast overpressures and damage from an ENE in an urban setting

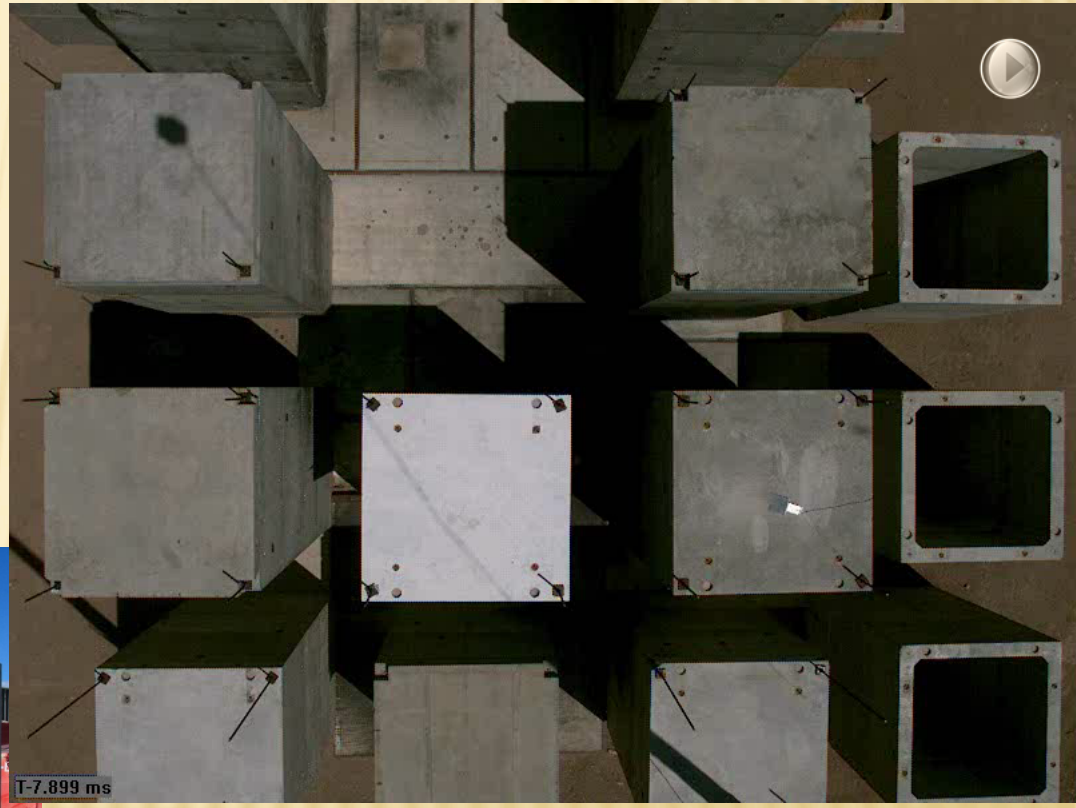
–Design and construct a scaled urban environment

–Use data from TSWG sponsored research at DRDC Canada to develop a detailed computational fluid dynamics computer model

–Perform calibration tests at EMRTC

–Combine all results into a comprehensive data base

–Deliver a software tool that will predict damage in an urban environment from ENE's



3-1-1 RULE


THE Sun
THE DAY BRITAIN
WAS GROUNDED
Plot to blow up 9 jets foiled
24 Brit Muslims held in raids
400,000 in airport chaos
BOTTLE BOMBERS
SENSATION AS McCLAREN DROPS BECKS


3-1-1 for Your Carry-Ons
Play Your Part
3 3-ounces or less size containers of liquid or gel.
1 1 quart-size, clear plastic, zip top bag holding 3-ounces or less containers.
1 1 bag per traveler placed in the security bin.
Transportation Security Administration
www.tsa.gov


SHAVE

INDUSTRIAL DIAMONDS

Developing Technology for Agencies

Can We Help First Responders?

RESPONDER TRAINING BENEFITS THREAT REDUCTION

15 POUNDS OUTSIDE BUS

15 POUNDS INSIDE BUS


New Mexico Tech
Center for
Domestic
Preparedness
NATIONAL DOMESTIC PREPAREDNESS CONSORTIUM
LSU
A&M

SHORT COURSES

- Incident Response to Terrorist Bombings
- Prevention and Response to Suicide Bombings
- Explosive Principles and Interactions: Safety and Applications
- Fundamentals of Explosives Engineering
- Improvised Explosives Awareness and Recognition
- Border Security

EMRTC EXISTING BUSINESS UNITS

- **Energetic materials**

  Explosives & ballistics research, test & evaluation programs

- **Cyber security**

  Development of cyber intrusion & detection methods & tools

- **Training programs**

  Customer awareness, recognition, safety & training for full-scale explosive environments

EMRTC BUSINESS DEVELOPMENT THRUSTS

EMBRACE STRATEGIC PARTNERSHIPS

- **Cyber kinetic test range** (Playas site)

  National resource to characterize integrity, speed, accuracy & reliability of electronic systems challenged by cyber-warfare tactics of the global battlefield environment

- **Data center threat protection** (Socorro site)

  National training, development, test & evaluation center that is responsive to physical & cyber threats (accidental, malevolent) to commercial & Government data centers

- **Border security** (Socorro & Playas sites)

  National training, development, test & evaluation center that is responsive to border threats that challenge the *health, security, safety & financial* interests of the United States

EMRTC BUSINESS DEVELOPMENT THRUSTS

EMBRACE STRATEGIC PARTNERSHIPS

- **Electronic infrastructure security** (Socorro site)

  Perform original RDT&E responsive to electronic system vulnerabilities to severe environments (triggered by accidents, attacks & acts-of-nature)

- **Electromagnetic resilience of cyberspace assets** (Socorro & Playas sites)

  Perform original RDT&E responsive to electronic systems (space, ground, air & naval) vulnerabilities when subjected to advanced adversarial electromagnetic illumination conditions

- **Home-made** ("improvised") **explosives** (Socorro site)

  Perform original RDT&E responsive to fabrication, recognition, effects, neutralization & training of explosives assembled with easily-accessible commercial chemicals

ACADEMIC PROGRAMS

- Explosive Chemistry
- Materials Engineering
- Mechanical Engineering
  (Distance Education)

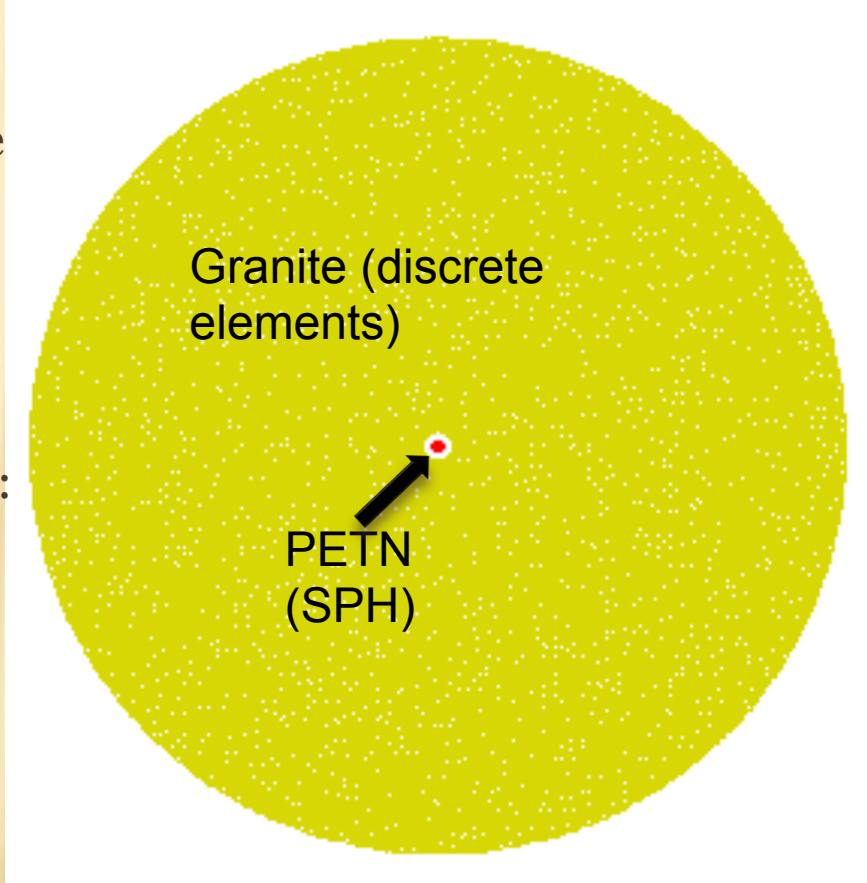
OVERVIEW OF THE SIMULATION CONFIGURATION

Simulating a cylindrical sample of Barre granite:

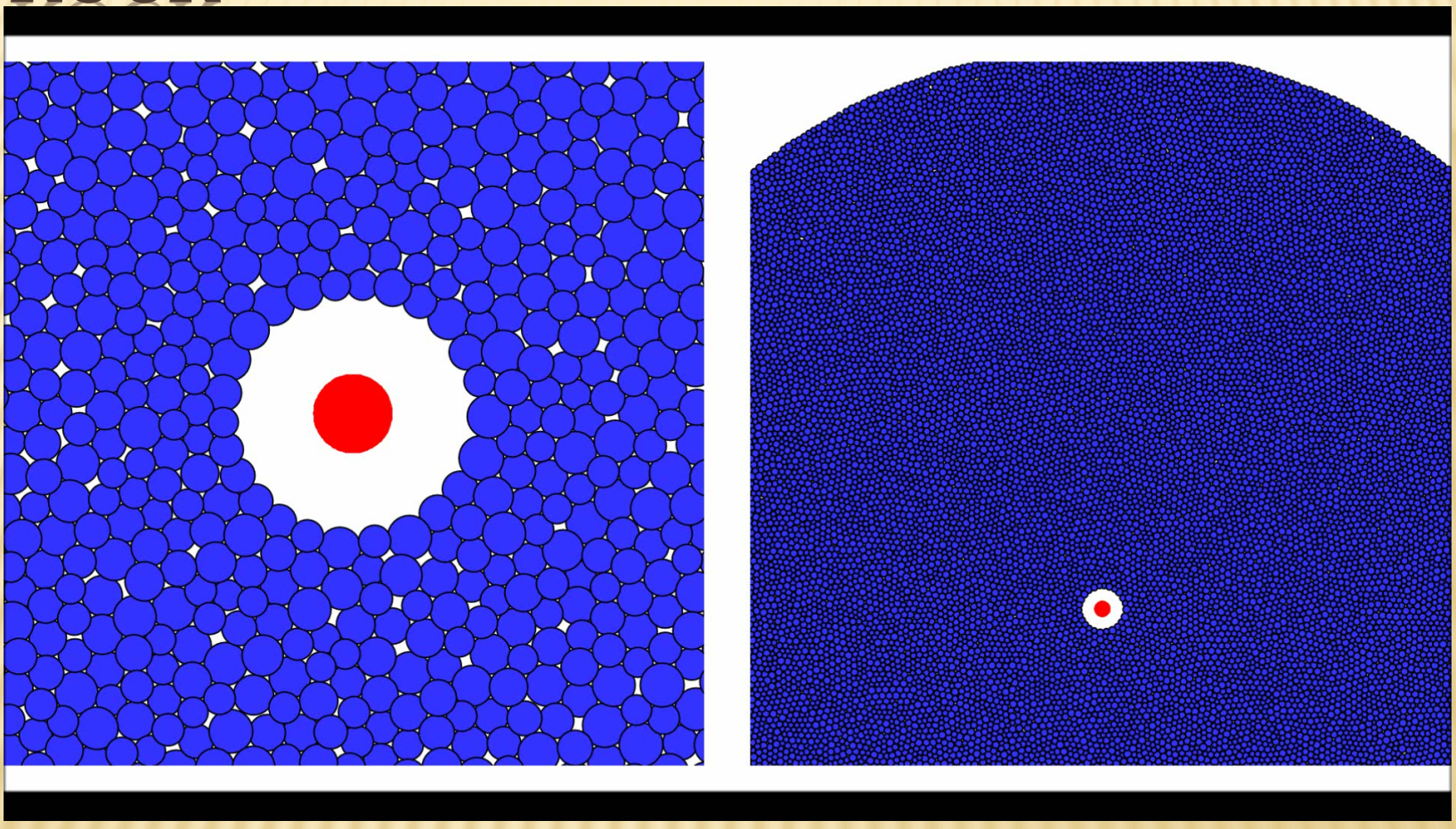
Tensile strength	7.37 MPa (1x/2x/5x/10x)
Poisson ratio	0.12
Diameter	144 mm
Borehole dia.	6.25 mm

PETN in the center of the borehole with:

Vacuum "coupling"	
Diameter	1.65 mm
Density	1.32 g/cm^3
Energy	5.73x10^6 MJ/kg (approx. 16 kJ/m total energy here)



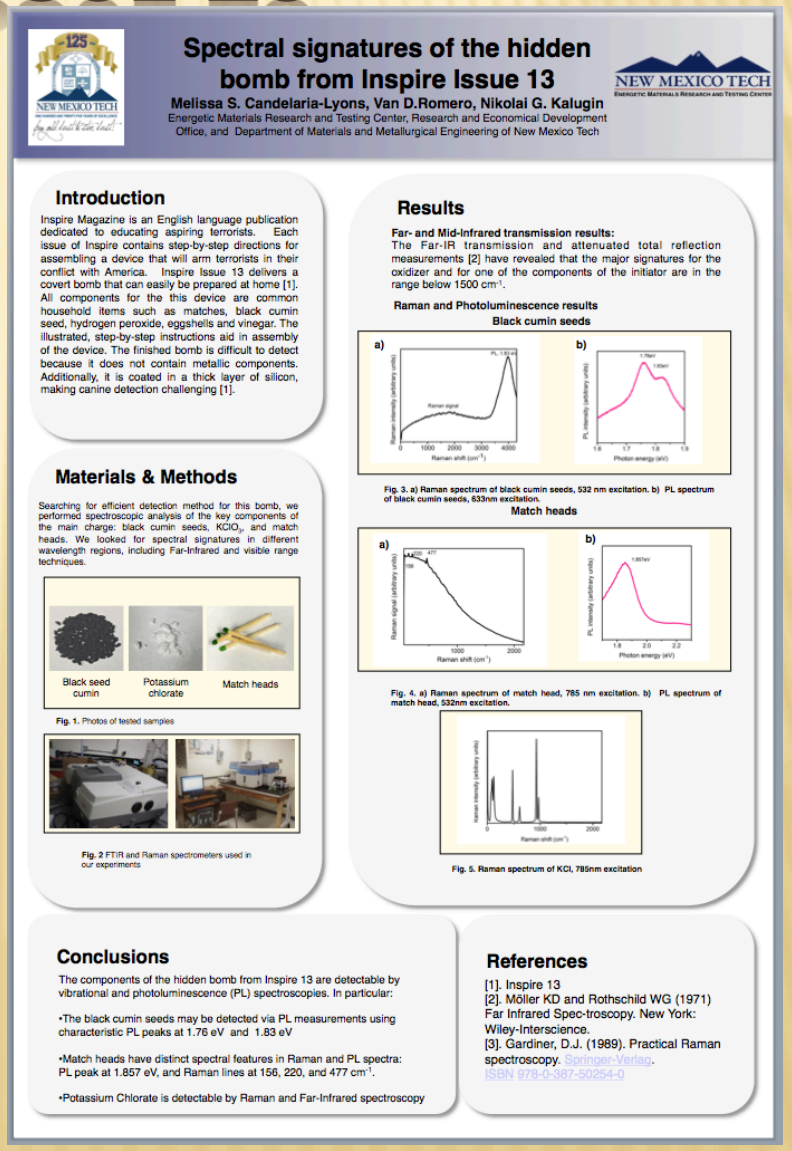
GAS PENETRATION – 10X STRENGTH ROCK



CA2 is able to fully model gas flowing through rock cracks.

SPECTRAL SIGNATURES OF THE HIDDEN BOMB FROM INSPIRE ISSUE 13

- Terrorist Literature on making a suicide bomb from commonplace materials
- "Undetectable"
  - No metallics
  - Silicone coating
- Unique spectral signatures for detection methods



Spectral signatures of the hidden bomb from Inspire Issue 13

Melissa S. Candelaria-Lyons, Van D.Romero, Nikolai G. Kalugin
Energetic Materials Research and Testing Center, Research and Economical Development Office, and Department of Materials and Metallurgical Engineering of New Mexico Tech

Introduction

Inspire Magazine is an English language publication dedicated to educating aspiring terrorists. Each issue of Inspire contains step-by-step directions for assembling a device that will arm terrorists in their conflict with America. Inspire Issue 13 delivers a covert bomb that can easily be prepared at home [1]. All components for the this device are common household items such as matches, black cumin seed, hydrogen peroxide, eggshells and vinegar. The illustrated, step-by-step instructions aid in assembly of the device. The finished bomb is difficult to detect because it does not contain metallic components. Additionally, it is coated in a thick layer of silicon, making canine detection challenging [1].

Materials & Methods

Searching for efficient detection method for this bomb, we performed spectroscopic analysis of the key components of the main charge: black cumin seeds, $KClO_3$, and match heads. We looked for spectral signatures in different wavelength regions, including Far-Infrared and visible range techniques.

Fig. 1. Photos of tested samples

Fig. 2 FTIR and Raman spectrometers used in our experiments

Results

Far- and Mid-Infrared transmission results:
The Far-IR transmission and attenuated total reflection measurements [2] have revealed that the major signatures for the oxidizer and for one of the components of the initiator are in the range below 1500 cm^{-1}.

Raman and Photoluminescence results

Black cumin seeds

Fig. 3. a) Raman spectrum of black cumin seeds, 532 nm excitation. b) PL spectrum of black cumin seeds, 633nm excitation.

Match heads

Fig. 4. a) Raman spectrum of match head, 785 nm excitation. b) PL spectrum of match head, 532nm excitation.

Fig. 5. Raman spectrum of KCl, 785nm excitation

Conclusions

The components of the hidden bomb from Inspire 13 are detectable by vibrational and photoluminescence (PL) spectroscopies. In particular:

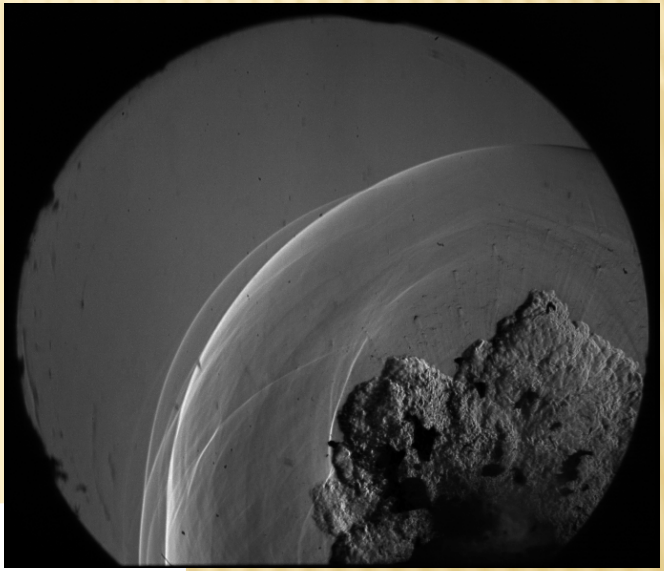
- The black cumin seeds may be detected via PL measurements using characteristic PL peaks at 1.76 eV and 1.83 eV
- Match heads have distinct spectral features in Raman and PL spectra: PL peak at 1.857 eV, and Raman lines at 156, 220, and 477 cm^{-1}.
- Potassium Chlorate is detectable by Raman and Far-Infrared spectroscopy

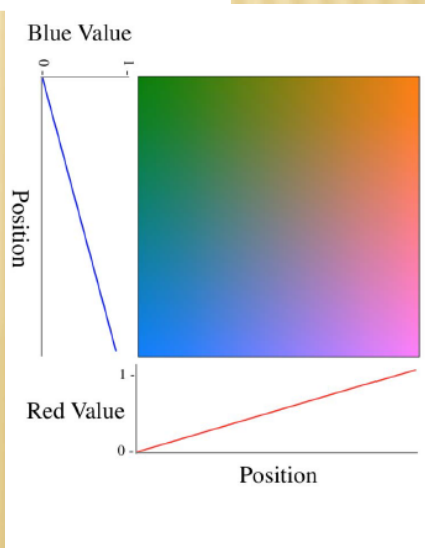
References

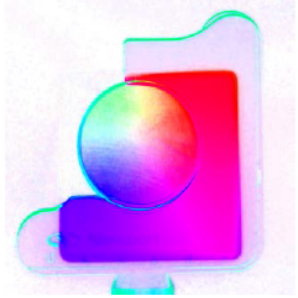
[1]. Inspire 13
[2]. Möller KD and Rothschild WG (1971) Far Infrared Spec-troscopy. New York: Wiley-Interscience.
[3]. Gardiner, D.J. (1989). Practical Raman spectroscopy. Springer-Verlag. ISBN 978-0-387-50254-0

OPTICAL DIAGNOSTICS FOR ENERGETIC MATERIALS RESEARCH – ANDERSON, SMITH, MIER, HARGATHER

- Refractive imaging techniques used to study energetic events
  - Schlieren
  - Shadowgraph
  - Background Oriented Schlieren (BOS)
- Quantitative and qualitative measurements
  - Shock speed
  - Quantitative density fields
  - Turbulence measurement and flow visualization
- Laboratory and field-scale techniques

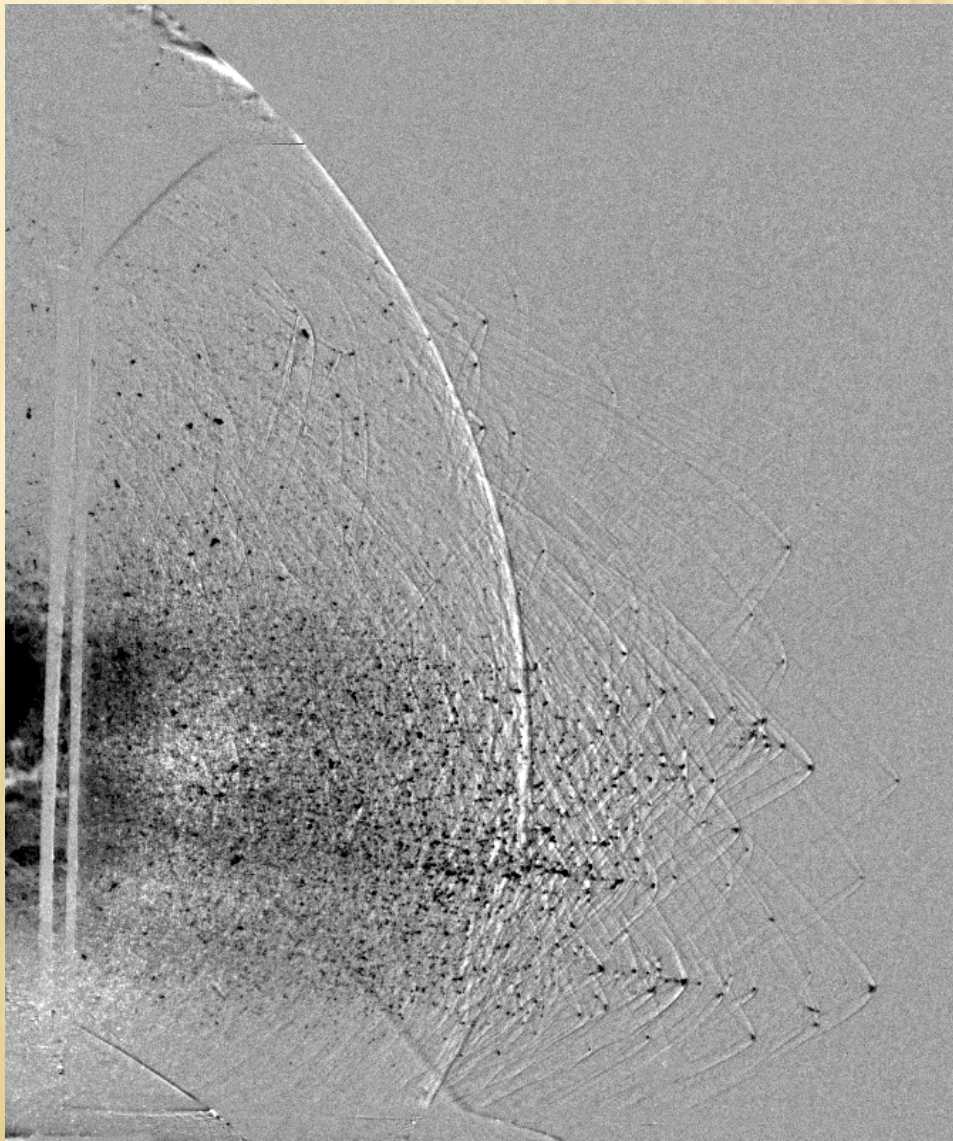






THREE-DIMENSIONAL SHOCK WAVE AND FRAGMENT TRACKING FOR WARHEAD CHARACTERIZATION

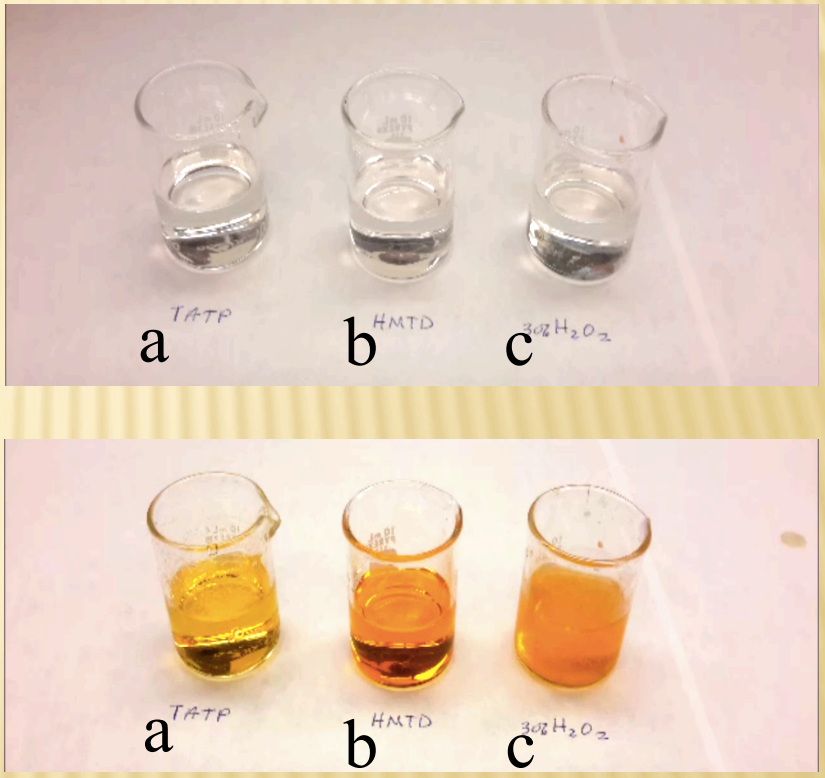
- Stereoscopic imaging to identify three-dimensional positions
- Retroreflective shadowgraph and background oriented schlieren imaging to image shock waves
- Measurement of three-dimensional position, velocity, acceleration for fragments and shock waves
- Authors: Winter, Locke, Hargather



DETECTION OF PEROXIDE-BASED EXPLOSIVE VAPORS BY EXPLOITING TITANIUM OXYSULFATE AS A COLORIMETRIC SENSOR:

Tompkins, Payne, Simitz, Henneke

- Titanium Oxysulfate [$TiO(SO_4)$] is a detection solution for peroxide-based explosive (PBE) vapors
- Color change occurs when PBEs complex with the Titanium (IV) cation:
  - Vapor detection occurs within ~1 minute
  - Differentiation between PBEs is possible
- Method may be adapted to a portable detection device



Titanium oxysulfate before and after the reaction with a) TATP, b) HMTD and c) 30% H_2O_2

SHOCK DRIVEN REACTIONS IN NANO-ALUMINUM AND WATER ROCKET PROPELLANTS:

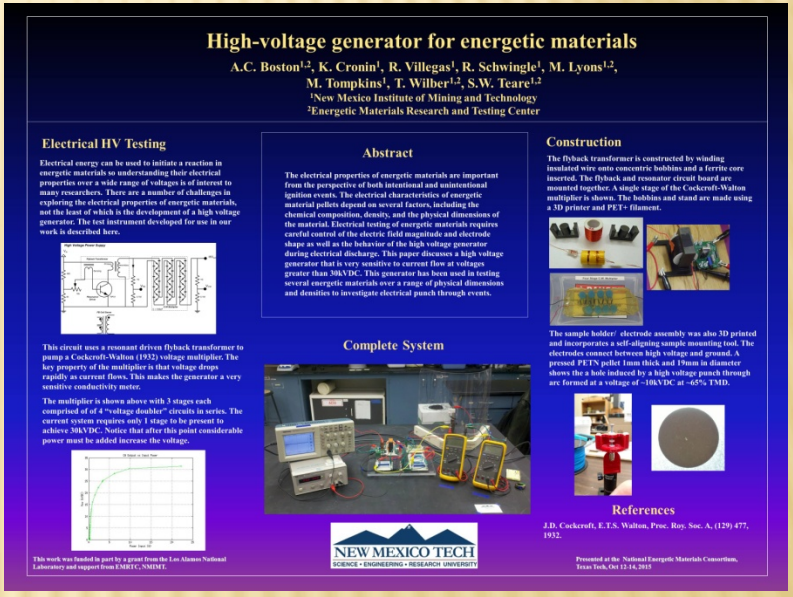
Schmitt, Bowden, Tappan, Henneke

- Nanoaluminum (nAl) and water (ALICE) is a potential rocket propellant, but the detonation characteristics need to be understood:
  - Critical diameter via rate-stick detonation
  - Detonation velocity for different diameter charges
- Small-scale sensitivity experiments: ESD, Drop Hammer, Friction

Nanoaluminum and water suspension

HIGH-VOLTAGE GENERATOR FOR ENERGETIC MATERIALS (TEARE@EE.NMT.EDU)

- Current efforts are on understanding the electrical properties of energetic materials under high-voltage stress.
- PETN is pelletized at densities from 0.6 to 0.95 TMD and thicknesses of 1 to 5mm and stresses up to 30kVDC are used.
- Punch-through arcs have been obtained on PETN pellets and a full data set covering the ranges of interest is being generated.



- This work has involved undergraduate and graduate students from electrical engineering, mathematics and materials science and combines knowledge of high voltage electronics, explosives and 3D printing.
- The successes from this work are being applied to a wider range of energetic materials in the coming year.

MYTHBUSTERS