



Managed and Operated by
Consolidated Nuclear Security, LLC

High Explosives Science and Pantex Explosive Mission

Oklahoma Baptist University – Science Club

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Safety Share

Texas Tech Explosive Accident

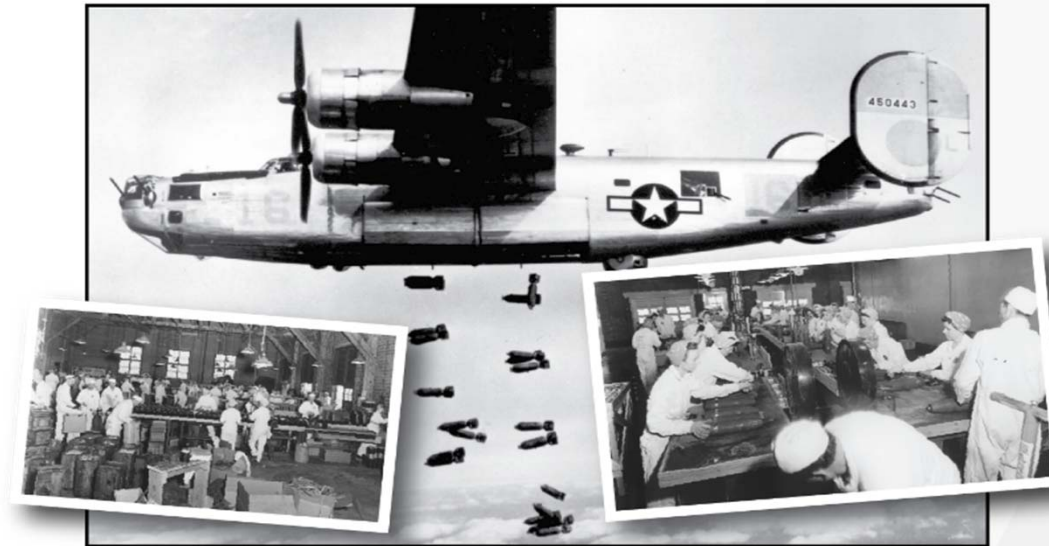


Pantex Mission Overview

- **Provide the Nuclear Deterrent**
 - Carry out nuclear weapon life extension programs
 - Surveil active weapons systems
 - Stage and surveil plutonium pits
- **Dismantle and Disposition Retired Weapons**
- **Deliver High-Explosives Expertise**
 - Develop, test, and fabricate high-explosives components

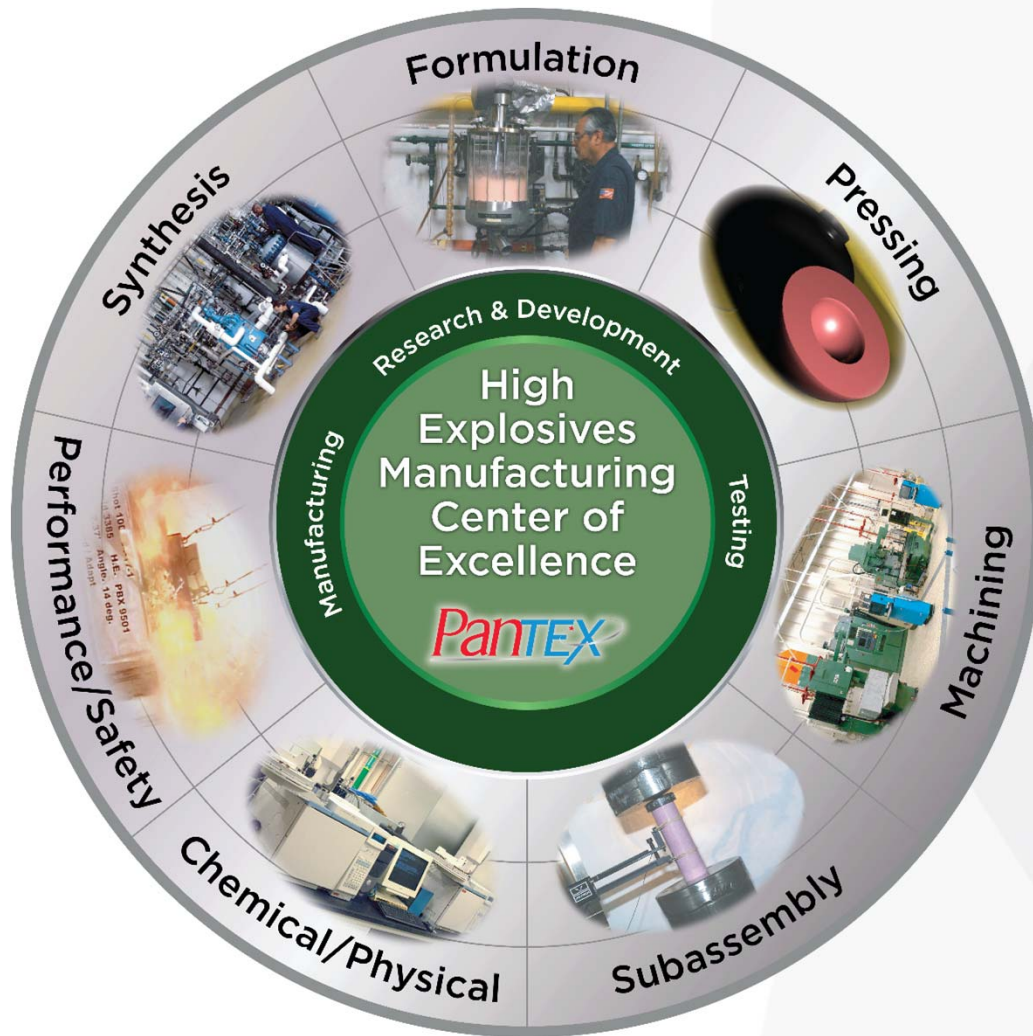


A Proud History of Service to our Nation



- **1942** – Last of 14 bomb-loading plants constructed during WWII. Produced 250- and 500-pound bombs during WWII. Peak employment 5,254 (60% female)
- **1945** – Pantex closed
- **1947** – Texas Technological College established agricultural research farm
- **1951** – Pantex recaptured by the Atomic Energy Commission and refurbished for nuclear weapons work
- **1956** – New weapons designs and facility designs come to Pantex operations
- **1960** – New high explosives mission
- **1965** – Surveillance mission begins
- **1991** – Disassembly mission
- **2013** – Life Extension Mission

Elements of Explosives Technology Operations



Explosives 101

In general, explosives are classified by two criteria:

- The stimuli to which they respond
- The degree of response once initiated

The degree of response gives two broad categories:

- High Explosives
- Low Explosives

Explosives 101

Deflagration

- Burning; the rapid chemical reaction between a fuel and oxidizer
- Produces heat, light, gaseous products
- $<$ supersonic

Explosion

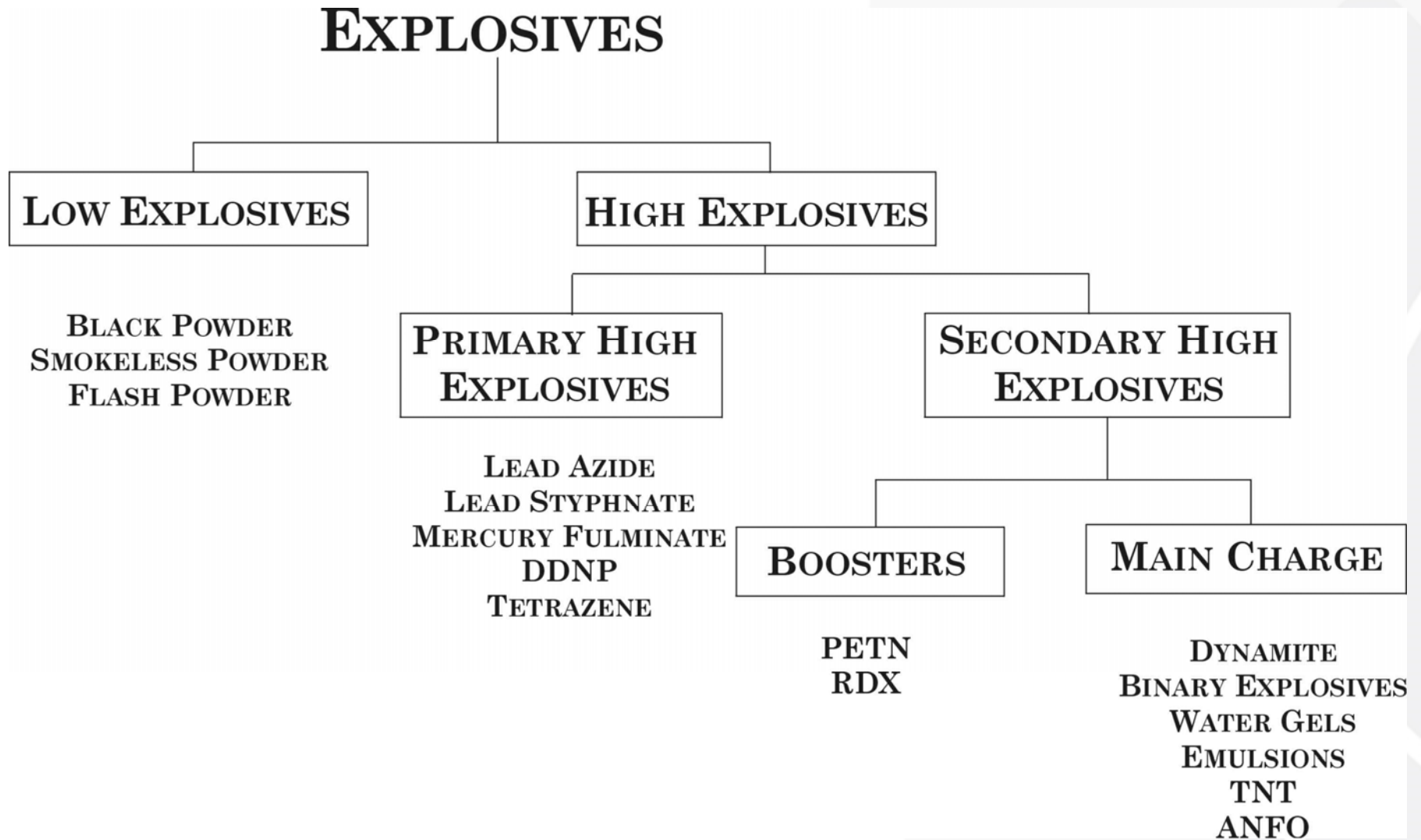
- Rapid expansion of matter into a greater volume, with energy transferred into mass motion and heat
- Can be mechanical or chemical
- Can be supersonic

Explosives 101

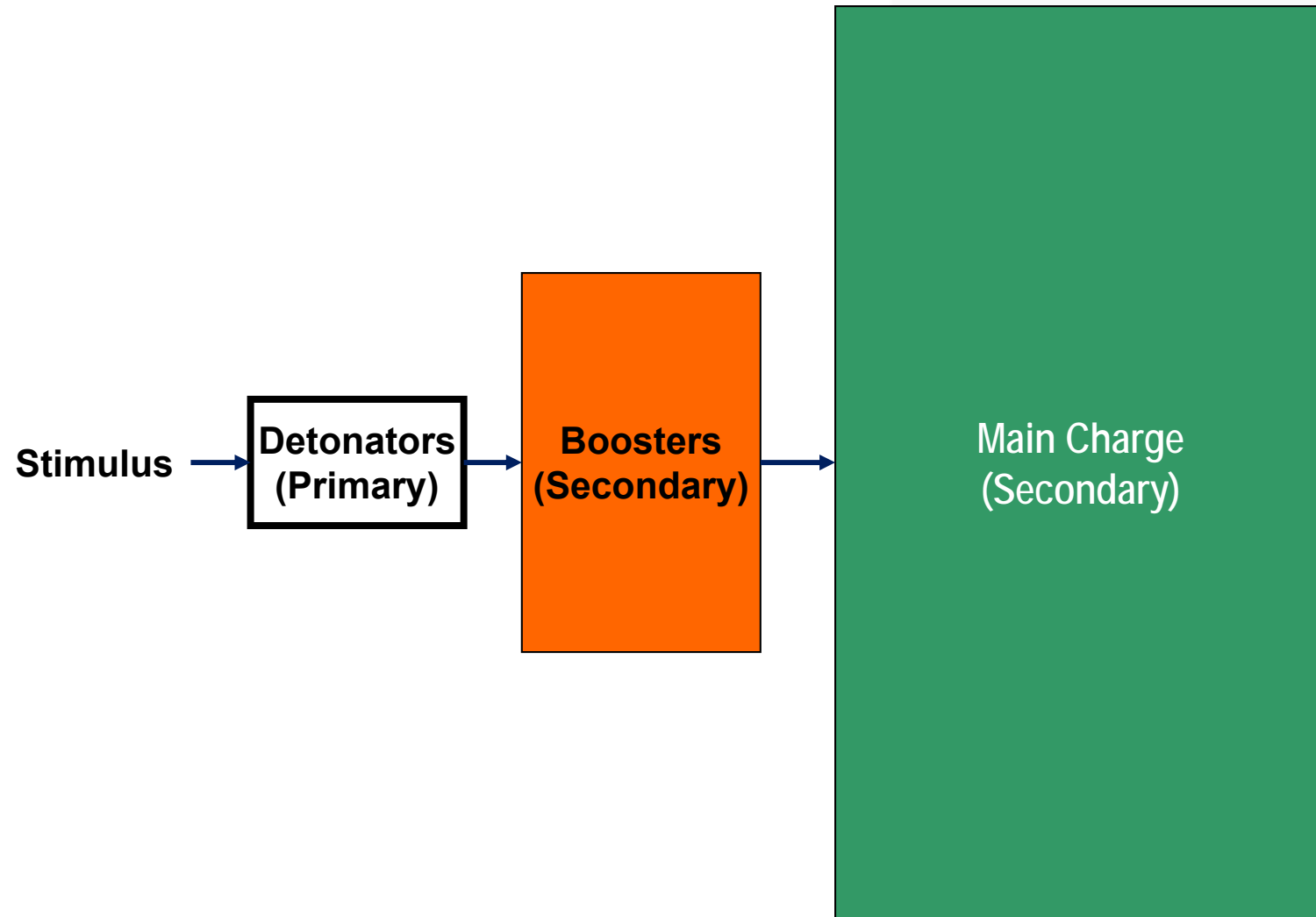
Detonation

- Rapid chemical reaction initiated by the heat accompanying shock compression
- Liberates sufficient energy to sustain a shock wave
- Propagates shock wave at supersonic speed

Explosives 101



Explosives 101



Explosives 101



296 g/mol

296 g

Total 12 moles gas

1.8 g/cm³

22.4 L/mol

0.164 L

269 L

>1600x increase in volume in μs !!

Explosives 101

Extremely Sensitive Primary Explosives (extremely shock, friction, or spark sensitive)

- Lead azide
- Mercury fulminate
- Lead styphnate
- DDNP (diazodinitrophenol)
- Tetracene

Explosives 101

Secondary Explosives

Most organic explosives

- PETN, HMX, RDX, TNT, TATB, etc.

Nitrate Esters

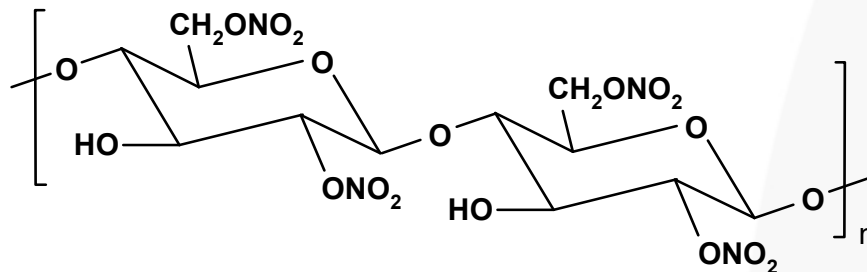
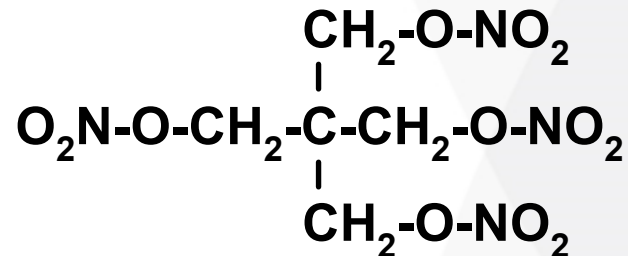
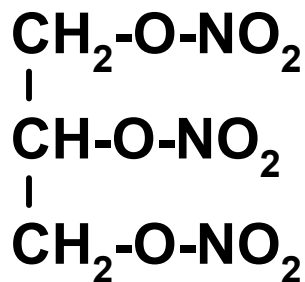
Aliphatic Nitramines

Nitrated Aromatics

Explosives 101

Nitrate Esters - Characterized by $-O-NO_2$ group

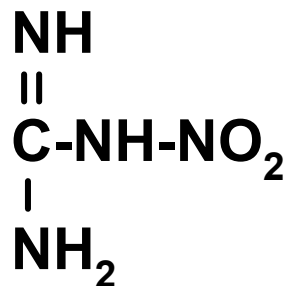
- Nitroglycerin NG
- Pentaerythritol tetranitrate PETN
- Nitrocellulose NC



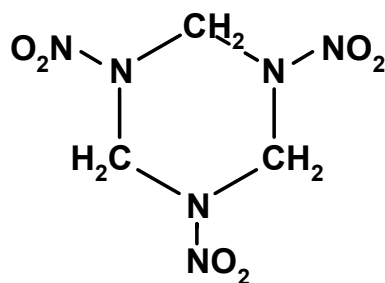
Explosives 101

Nitramines - Characterized by -N-NO₂ group

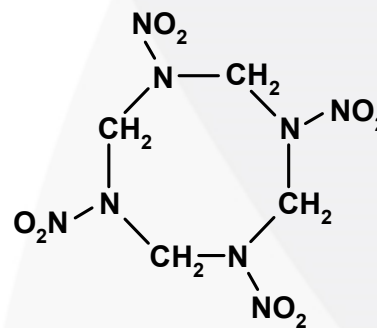
- NQ Nitroguanidine
- RDX Research Development Explosive
- HMX High Melting Explosive
Her Majesty's Explosive
High Molecular Weight Explosive



NQ



RDX

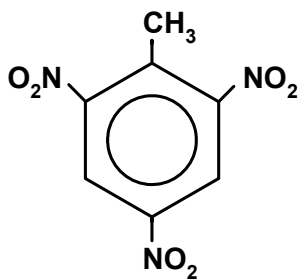


HMX

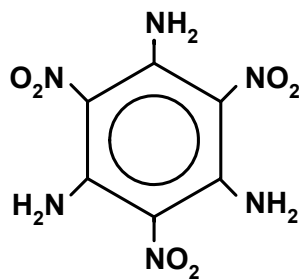
Explosives 101

Nitrated Aromatics Characterized by $-C-NO_2$ group on aromatic rings

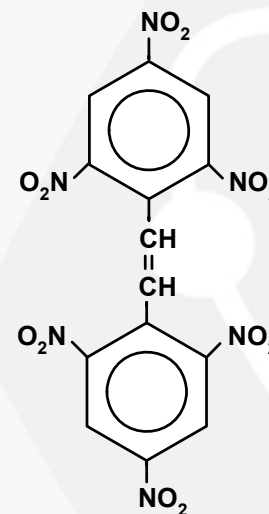
- TNT Trinitrotoluene
- TATB Triamino-trinitrobenzene
- HNS Hexanitrostilbene



TNT

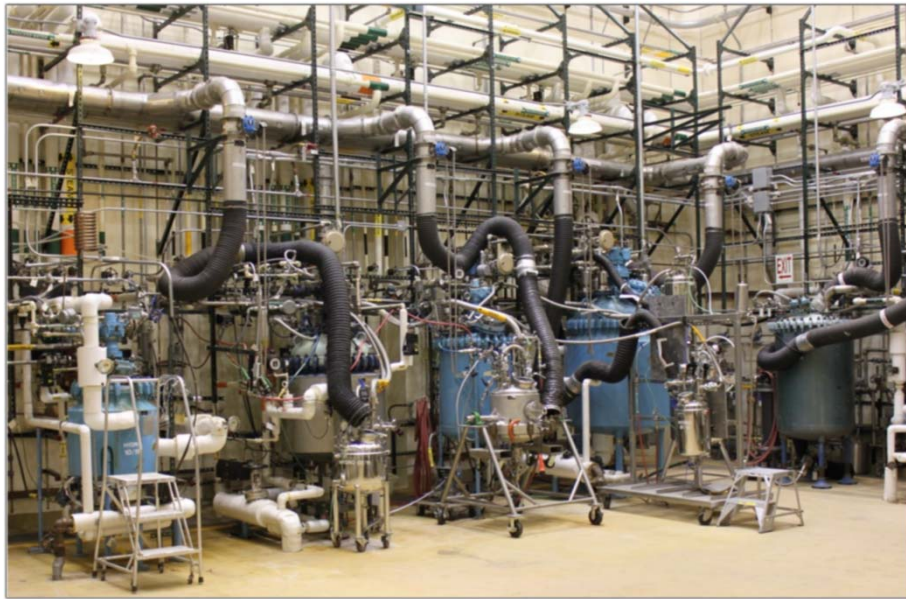


TATB



HNS

HE Synthesis Facility/Equipment

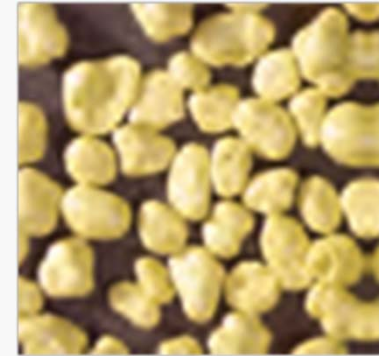


- Two identical processing bays with glass-lined reactors
- Freeze Dryer
- Steam Oven



HE Formulation Facility/Equipment

- Direct and reverse slurry process
- Stainless steel or glass kettles
 - 10 L, 30 L, 100 L, 100 gallon, 300 gallon
- Automated formulation controllers



HE Pressing Facility/Equipment

Concurrent independent pressing lines for CHE and IHE

- Two 30,000 psi isostatic presses with space for a third
- 600 kV digital radiography
- Rough machining with vertical turret lathe
- Density and dye penetrant
- Two storage magazines 2,300 lbs each
- Successfully demonstrated a minimum throughput of 900 main charges per year
- Future addition of new HE pellet press
- On track to be authorized for WR main charge production March 2019



HE Machining Facility/Equipment



Pantex Testing Science

Chemical/Physical

Thermal

Mechanical

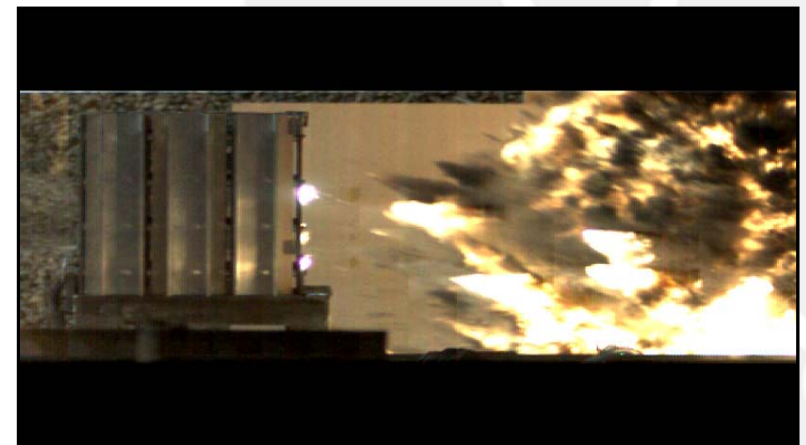
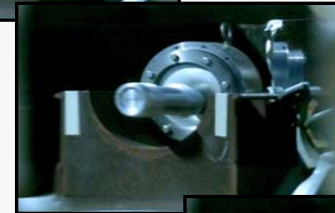
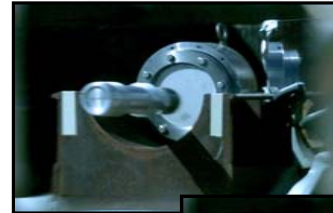
Performance

Sensitivity

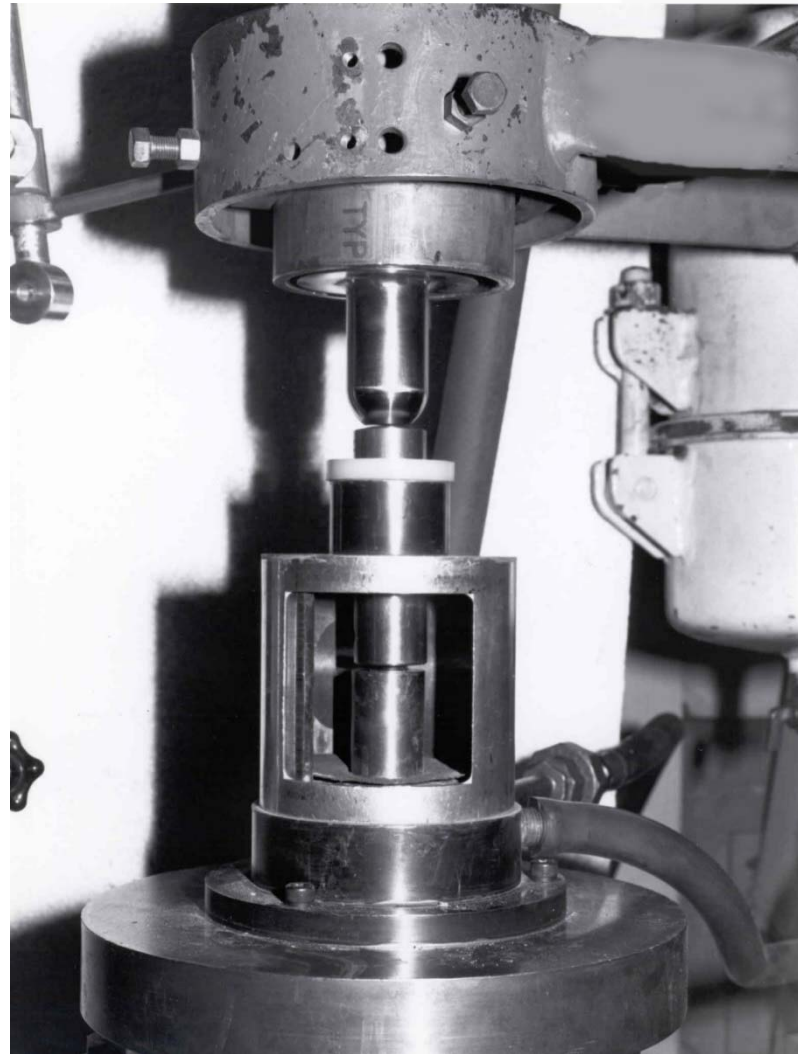


HE Sensitivity and Safety

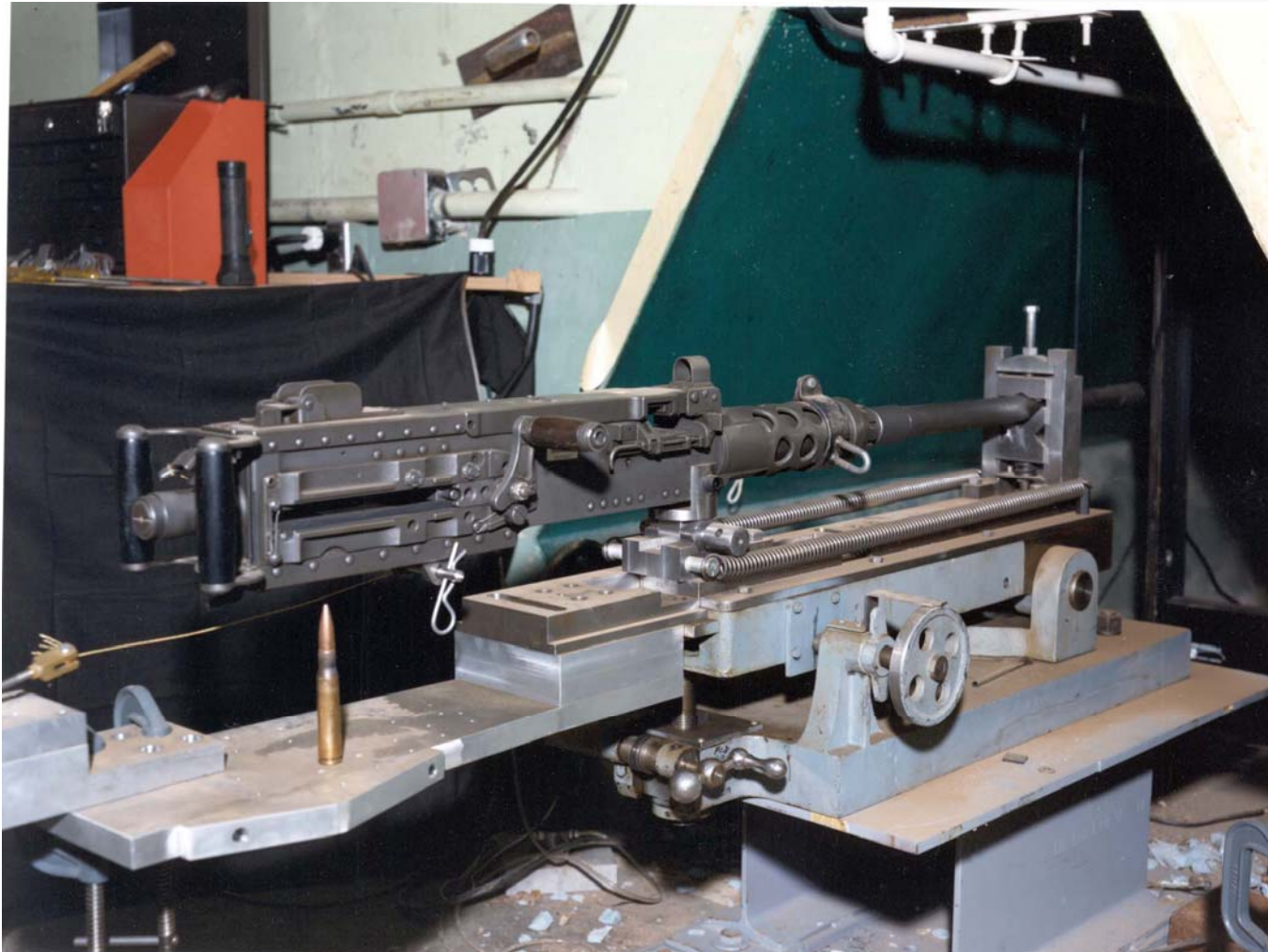
- Shock Sensitivity
 - Card Gap
 - Cap Test
 - Gas Gun (HE response & materials) – Large Scale Shock to Detonation (SDT) Test for IHE Qualification
 - Rifle bullet testing (IHE Qualification Test)
- Material Response
 - Fragmentation Barrier (primary penetration)



High Explosives Drop Hammer Impact Test



Gun Test: .50-Caliber Rifle Bullet Test



HE Mechanical Testing Element

Tensile and compression testing of high explosives

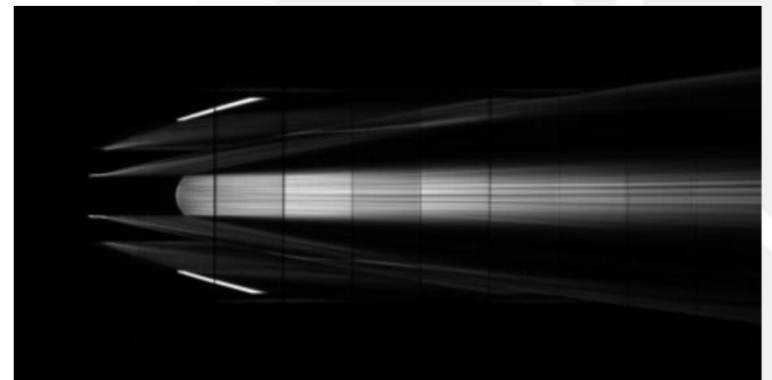
- Both Qualification and Surveillance testing
- Quantify the strength of HE under high stress
- Stress and strain limits
- Stress applied to through the elastic phase and through the plastic phase to failure
- Strain measured by a extensometers on opposite sides
- Stress measured as a function of strain and curve produced



HE Performance Testing Element

Testing Capabilities

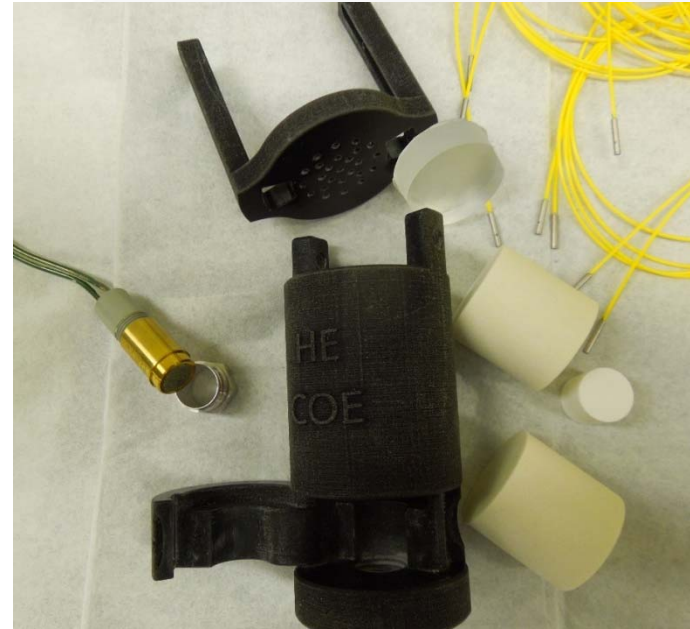
- Film Streak Camera – Cordin 75C
- Digital streak camera – Cordin 131HD
 - Temporal resolution – Down to 1.0 ns
- Many high speed “phantom” cameras
- Timing digitizers
 - Rate sticks, ECOT, Implosion Timing Tests, etc.
- Pendulum and conventional skid apparatus
- Gas guns for impact testing (susan and stevens test)



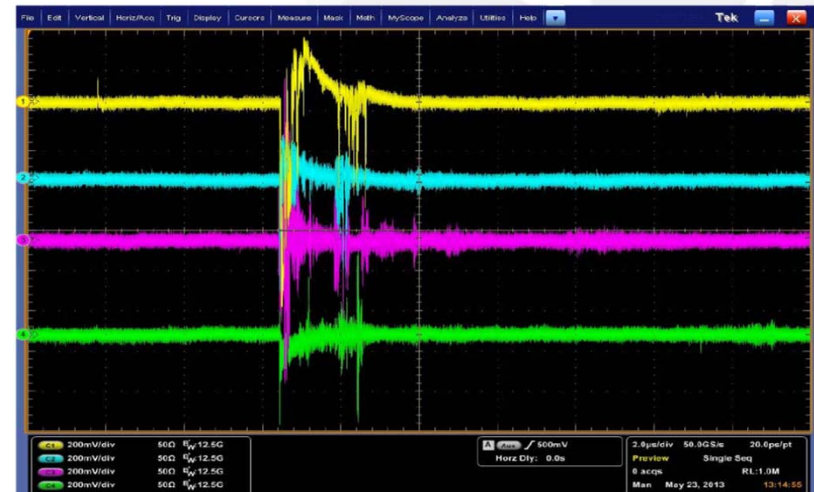
HE Performance Testing Element (cont.)

Photon Doppler Velocimetry (PDV)

- Measures the particle velocity of the explosive surface (as opposed to the shockwave velocity)
- Fiber optics components
- Laser based
- High-Bandwidth Digital Oscilloscopes
 - Up to 50 GHz bandwidth
 - Sampling rates used are typically 50 GSa/s (gigasamples per second)



PCR (Pulse Correlation Reflectometry)

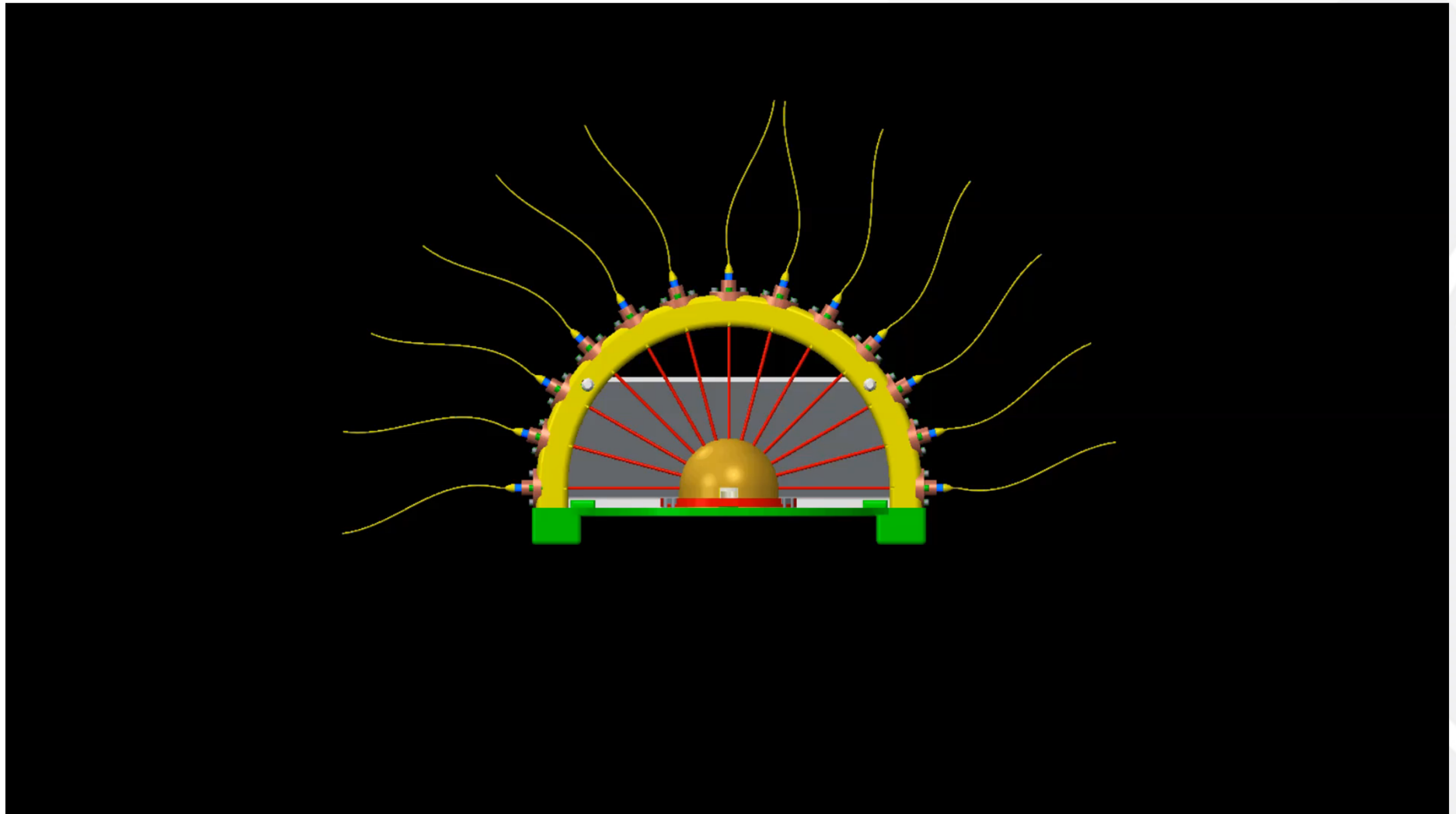


Pendulum Skid Test

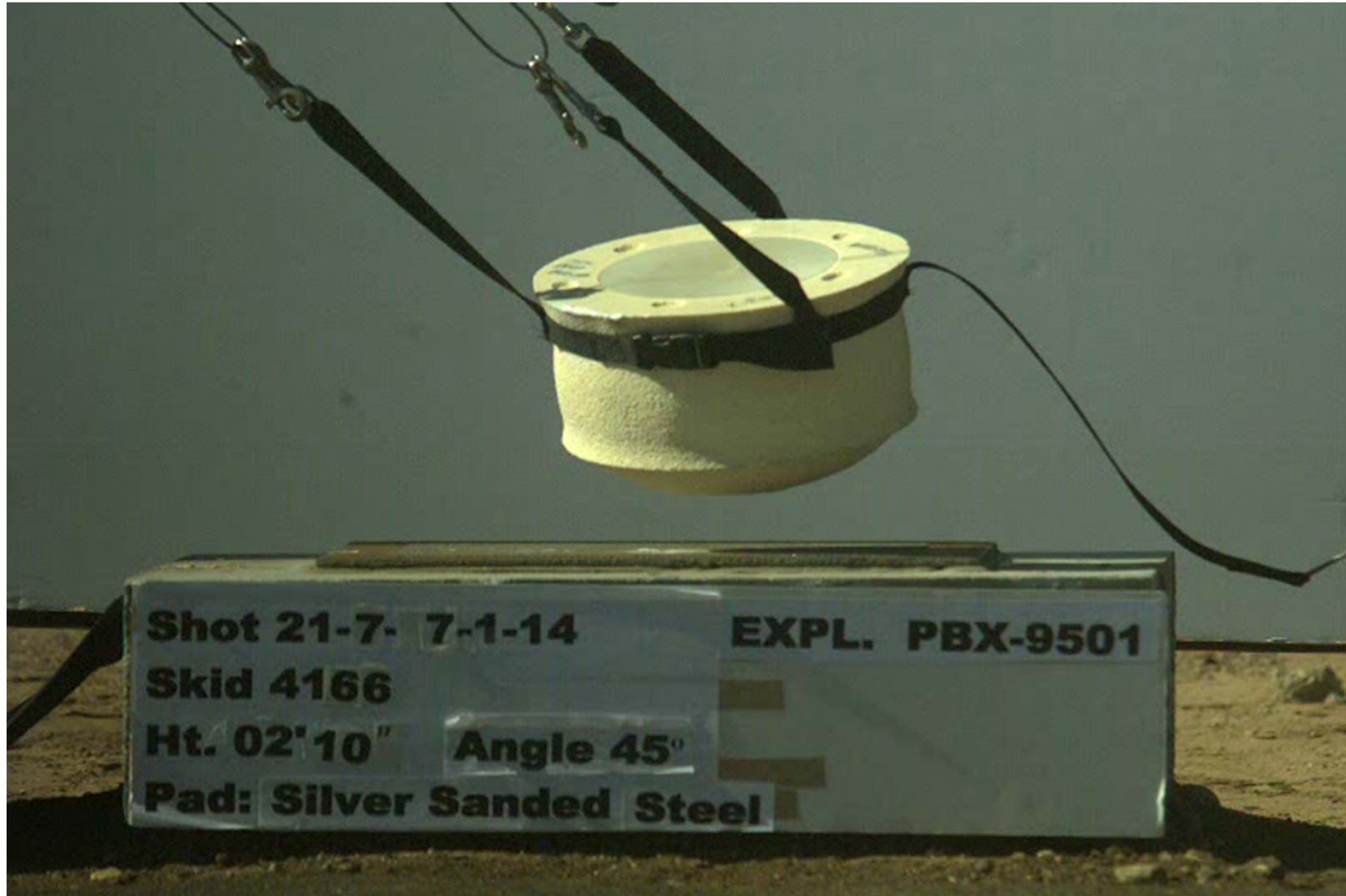


EO10

SAX – Spherical Acceleration Experiment



Standard Skid Test



EO10

DOT Fragmentation Test



Laboratory Wall Safety Test, 270 g HE

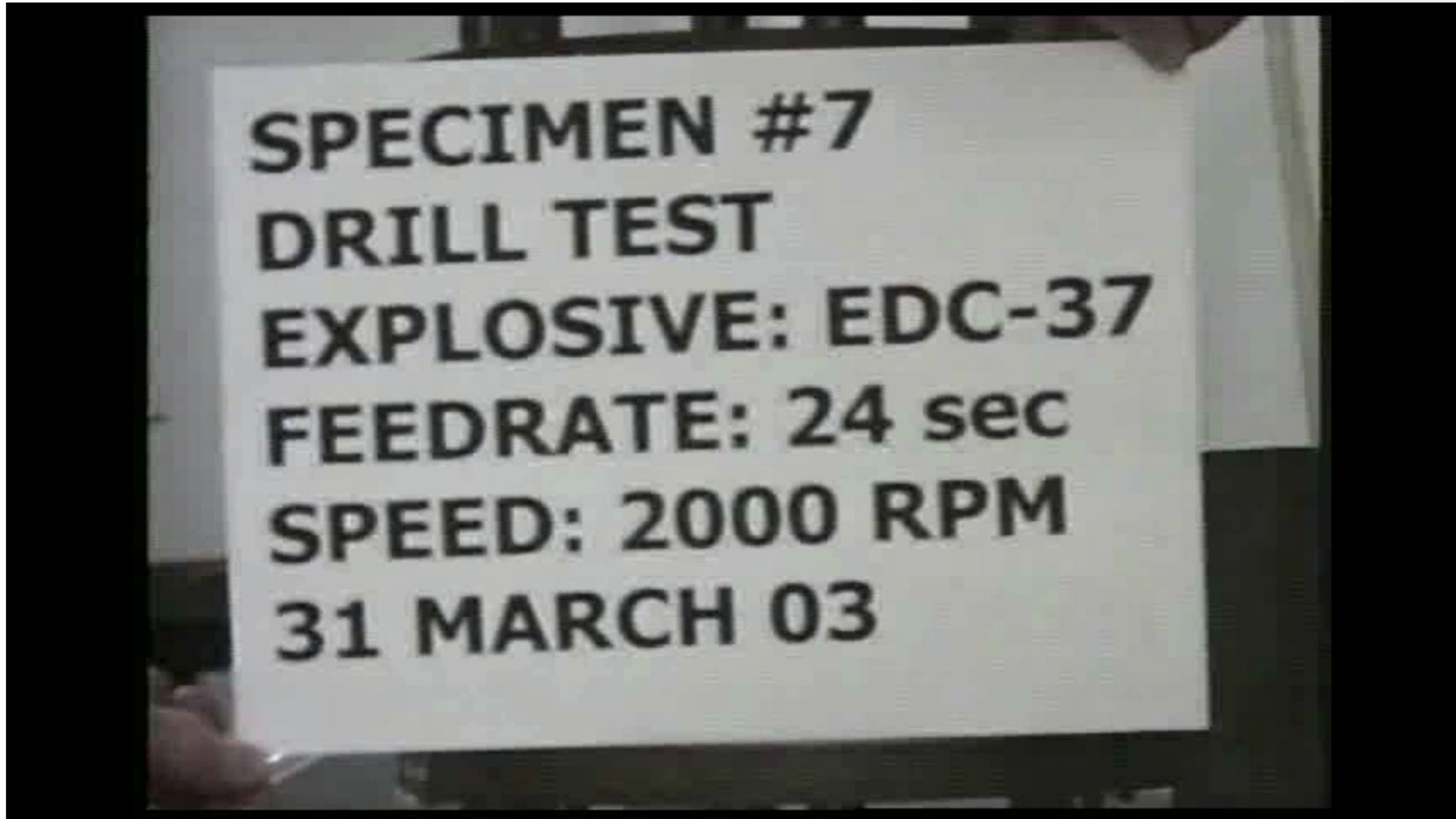


T+198.386 ms

Electrical Insult Test

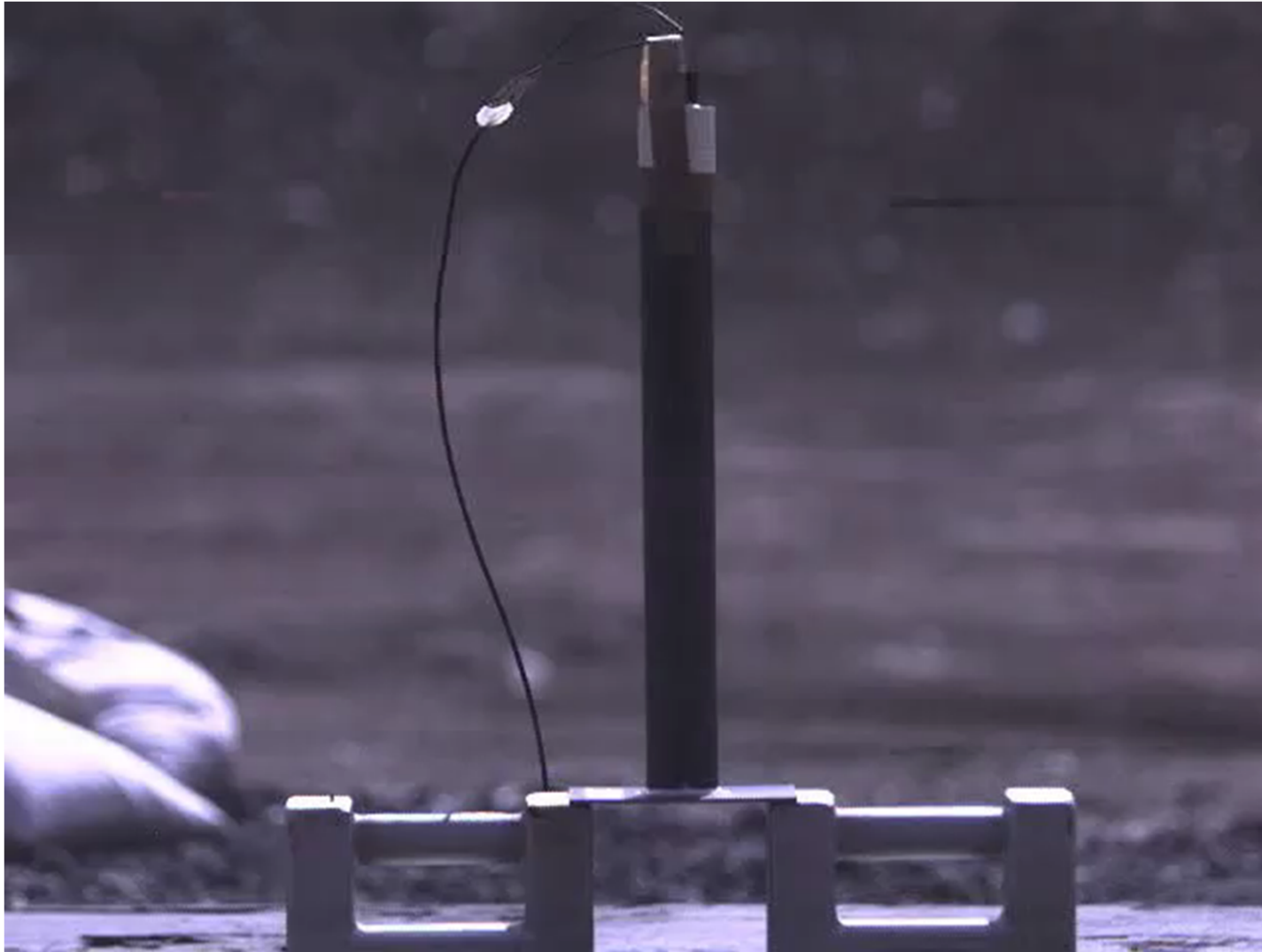


Machining Drill Test



EO10

Dirt Gap Test



Environmental Chamber Demo



Questions?

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