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Field Instrumentation & Testing

This course will include both lecture and field demonstrations. The lecture will present principles and strategies for the implementation of three classes of diagnostics: a) high speed photography b) dynamic blast pressure measurements; and c) photon Doppler velocimetry (PDV). The field demonstration will employ the three techniques in two explosive tests. A brief analysis of all diagnostic records will be performed for comparison between the two results.

I. Introduction: High explosive test facilities employ
II. Time Scale
III. Explosive Devices designed for diagnostics
    a. Machining tolerances
    b. Reflective surfaces
    c. Angle of approach
IV. High-Speed Photography
    a. Cameras
        i. Hardware
        ii. Software
        iii. Timing
        iv. Triggering
    b. Lighting
        i. Intensity
        ii. Timing/interfacing
    c. Handshaking
        i. Signal Delay Generator
        ii. Home-brew
    d. Analysis
V. Blast Pressure Gauges
    a. Blast wave intro
    b. Measurement strategies
        i. Side-on
        ii. Stagnation
    c. Types
        i. Piezoelectric
        ii. Piezoresistive
        iii. Passive (intentional and unintentional)
    d. Hardware
    e. Measurement (ADC strategies)
    f. Mounting, layout, and cabling strategies
    g. Analysis
        i. Data processing
            1. Conversion from voltage to pressure

2. Peak picking and integration
3. Orthogonality

ii. TNT equivalence
1. Scaled distance
2. Atmospheric scaling
3. Different models
a. Kinney and Graham
b. BEC
c. Others
4. Damage thresholds

VI. Photon Doppler Velocimetry

a. Interference velocimetry introduction
i. Doppler effect
ii. Typical applications

b. Hardware
i. Laser
ii. Fiber Components
iii. Probe
iv. Amplifier
v. Detector
vi. Digitizer
vii. Kits

c. Up-shifting or down-shifting
d. Mounting, fixture, layout, and cabling strategies
e. Triggering and handshaking
f. Data analysis
i. Analysis tools
1. MatLab
2. Python
ii. Time-Frequency transformation
1. Strategies and implementations
2. Time-Frequency resolution, choosing parameters, and experimental constraints
iii. Peak picking and data fitting
iv. Interpretation of signals
1. Gurney analysis
2. Cylinder wall expansion
3. Projectile velocity

g. Other uses for PDV
i. Waveform analysis
ii. Embedded fibers for continuous detonation velocity
iii. Initiation sequence analysis

VII. Proposed Experiments

a. Two charges, one flake TNT, one c4, at the 100g scale in 1” nom cylindrical tube
b. Both charges fitted with an aluminum (0.125” thick x 1” diam) disc at charge end.
c. High Speed Photography records
i. SIMD16/Kirana: To measure detonation velocity
ii. Phantom cameras: To observe damage record of an object placed in view
d. Blast Pressure measurements collected to compare TNT equivalence between charges
e. PDV record used for Gurney analysis of flyer disc velocity. Gurney energy obtained.