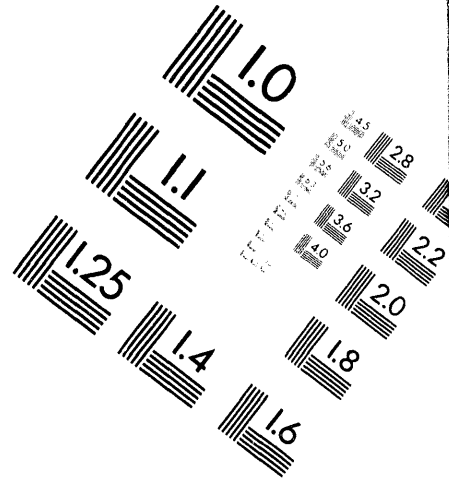
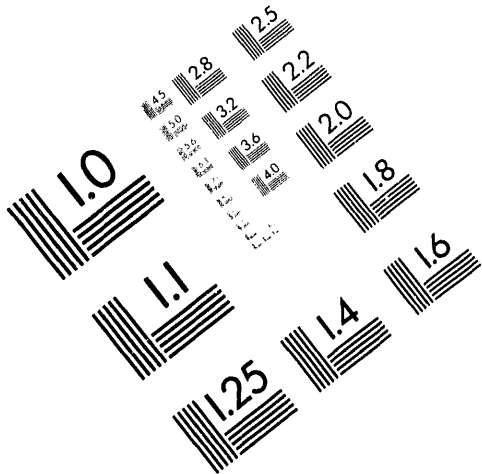




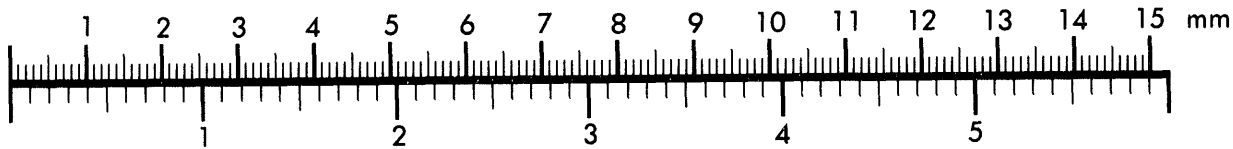
AIM

Association for Information and Image Management

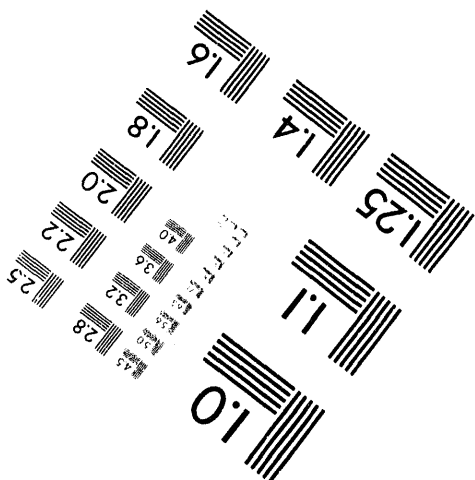
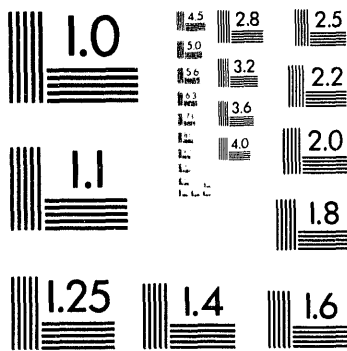
1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202



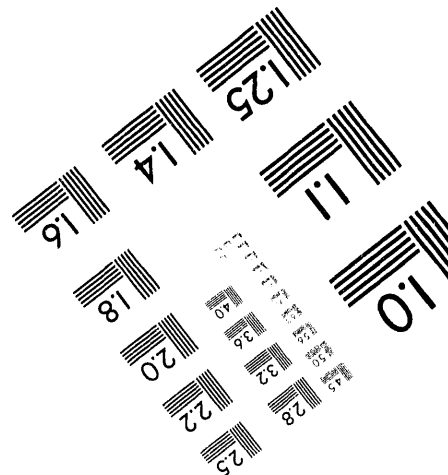
Centimeter



Inches



MANUFACTURED TO AIM STANDARDS
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1 of 1

Submitted to the
1994 Joint USA-Russia Energetic Material Technology Symposium
Livermore, California (May 18-25, 1994)

**THE DEVELOPMENT OF LASER IGNITED DEFLAGRATION-TO-
DETONATION TRANSITION (DDT) DETONATORS AND PYROTECHNIC
ACTUATORS**

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(POSTER ABSTRACT)

The use of laser ignited explosive components has been recognized as a safety enhancement over existing electrical explosive devices (EEDs). Sandia has been pursuing the development of optical ordnance for many years with recent emphasis on developing optical deflagration-to-detonation (DDT) detonators and pyrotechnic actuators. These low energy optical ordnance devices can be ignited with either a semiconductor diode laser, laser diode arrays or a solid state rod laser. By using a semiconductor laser diode, the safety improvement can be made without sacrificing performance since the input energy required for the laser diode and the explosive output are similar to existing electrical systems. The use of higher powered laser diode arrays or rod lasers may have advantages in fast DDT applications or lossy optical environments such as long fiber applications and applications with numerous optical connectors. Recent results from our continued study of optical ignition of explosive and pyrotechnic materials are presented. These areas of investigation can be separated into three different margin categories: 1) the margin relative to intended inputs (i.e. powder performance as a function of laser input variation), 2) the margin relative to anticipated environments (i.e. powder performance as a function of thermal environment variation), and 3) the margin relative to unintended environments (i.e. responses to abnormal environments or safety).

*Presenter

†This work was supported by the United States Department of Energy under Contract DE-ACO4-94AL85000.

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The Development of Laser Ignited DDT Detonators and Pyrotechnic Actuators

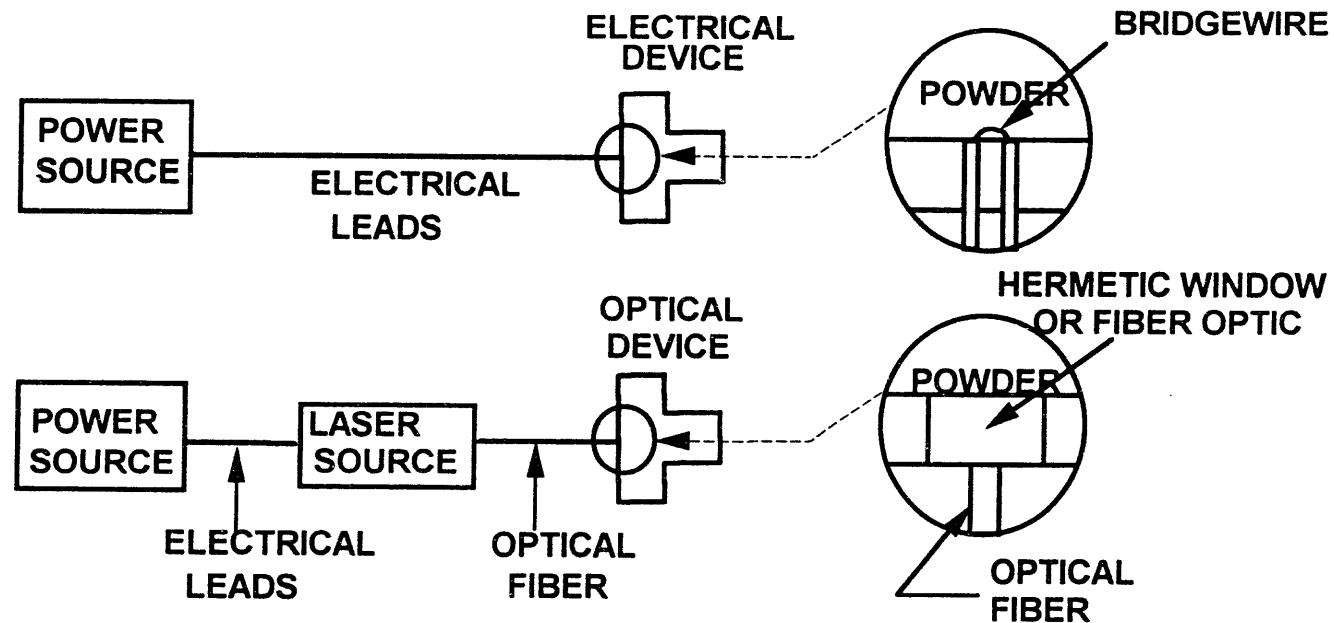
J. A. Merson and F. J. Salas
Explosive Subsystems and Materials
Sandia National Laboratories

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System Motivation and Overview



The absence of a bridgewire and electrical leads eliminates ESD, CAF and corrosion concerns. No fire and EMR concerns are also reduced.

Optical energy from the laser is absorbed by the powder to raise it to the autoignition temperature.



Acronyms

LDI: Laser diode ignition

ESD: Electrostatic discharge

CAF: Conductance after fire

EMR: Electromagnetic radiation

CB: Carbon black



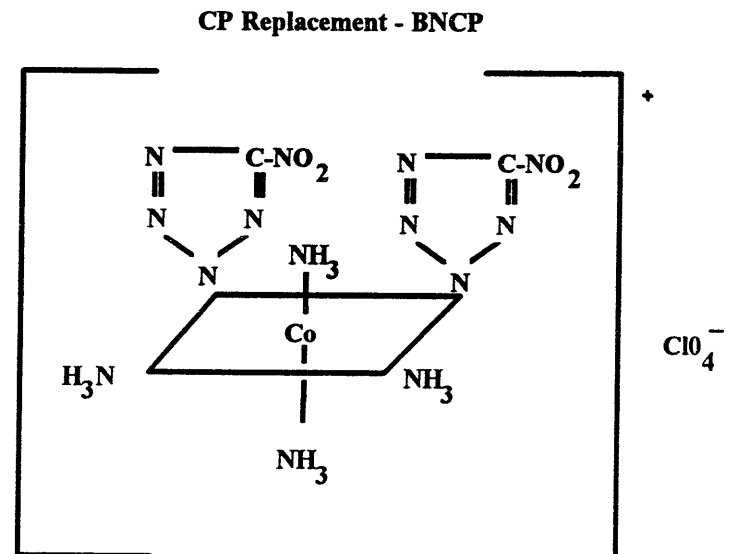
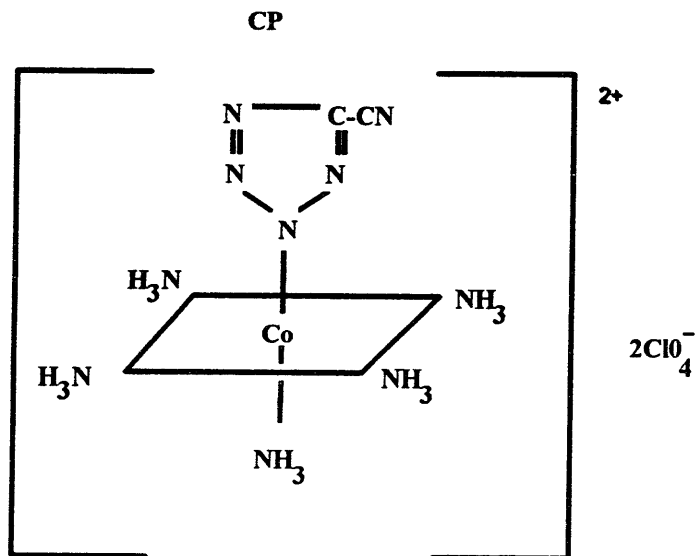
DDT Explosive Structures

CP:

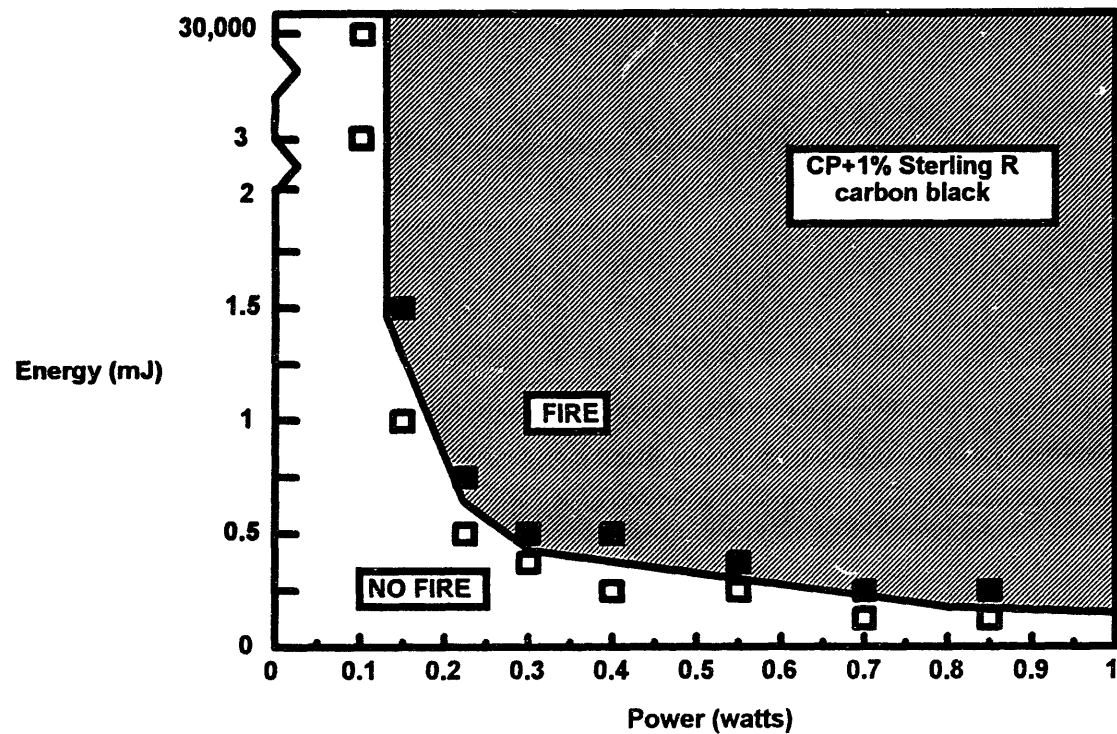
Pentaamine(5-cyano-2H-tetrazolato-N²) cobalt(III) perchlorate

BNCP:

Tetraamine-cis-bis(5-nitro-2H-tetrazolato-N²) cobalt(III) perchlorate



Ignition Threshold for Doped CP

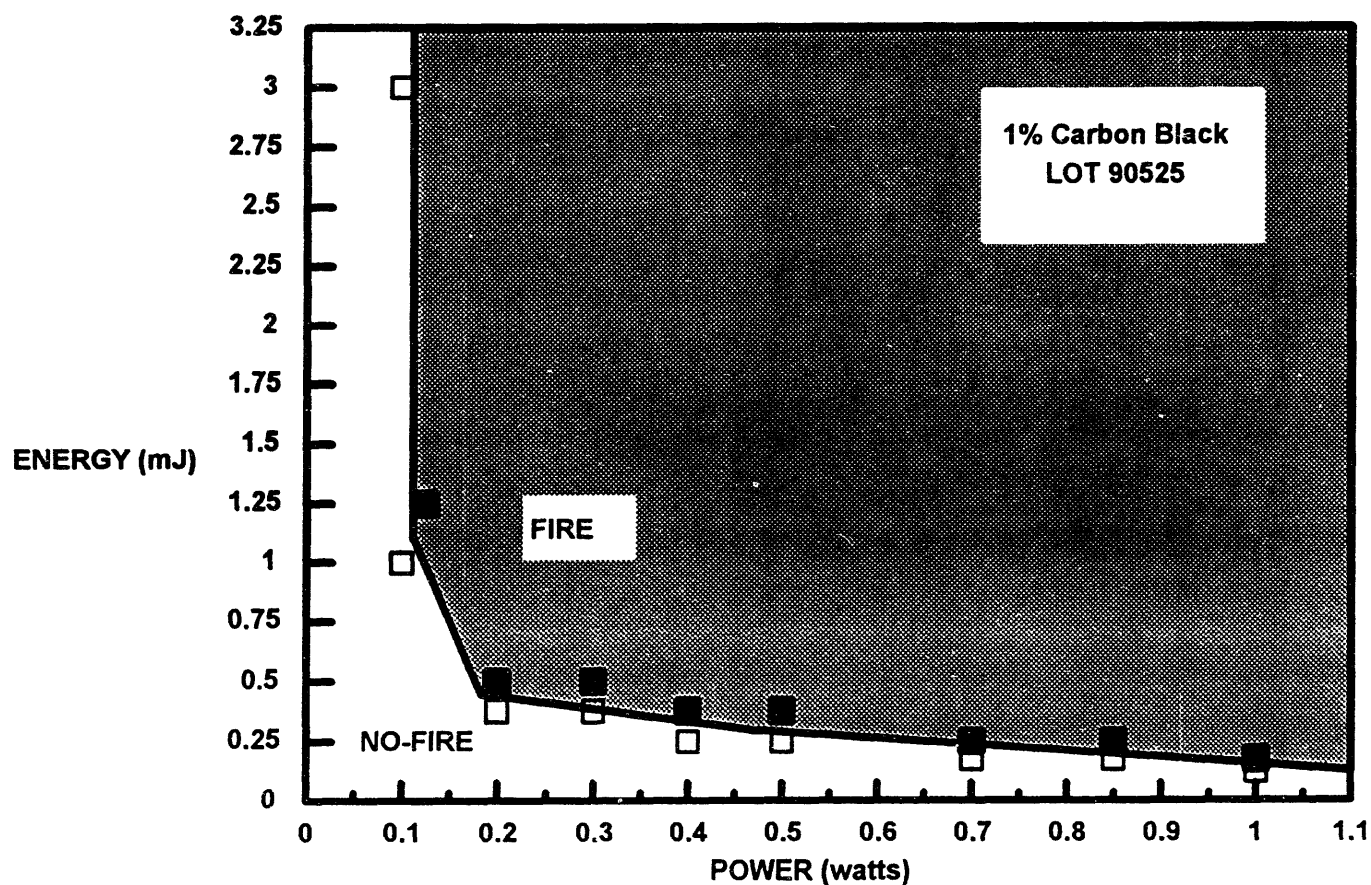


LDI is a thermal process; dopant is added to some powders to increase absorptance of laser energy.



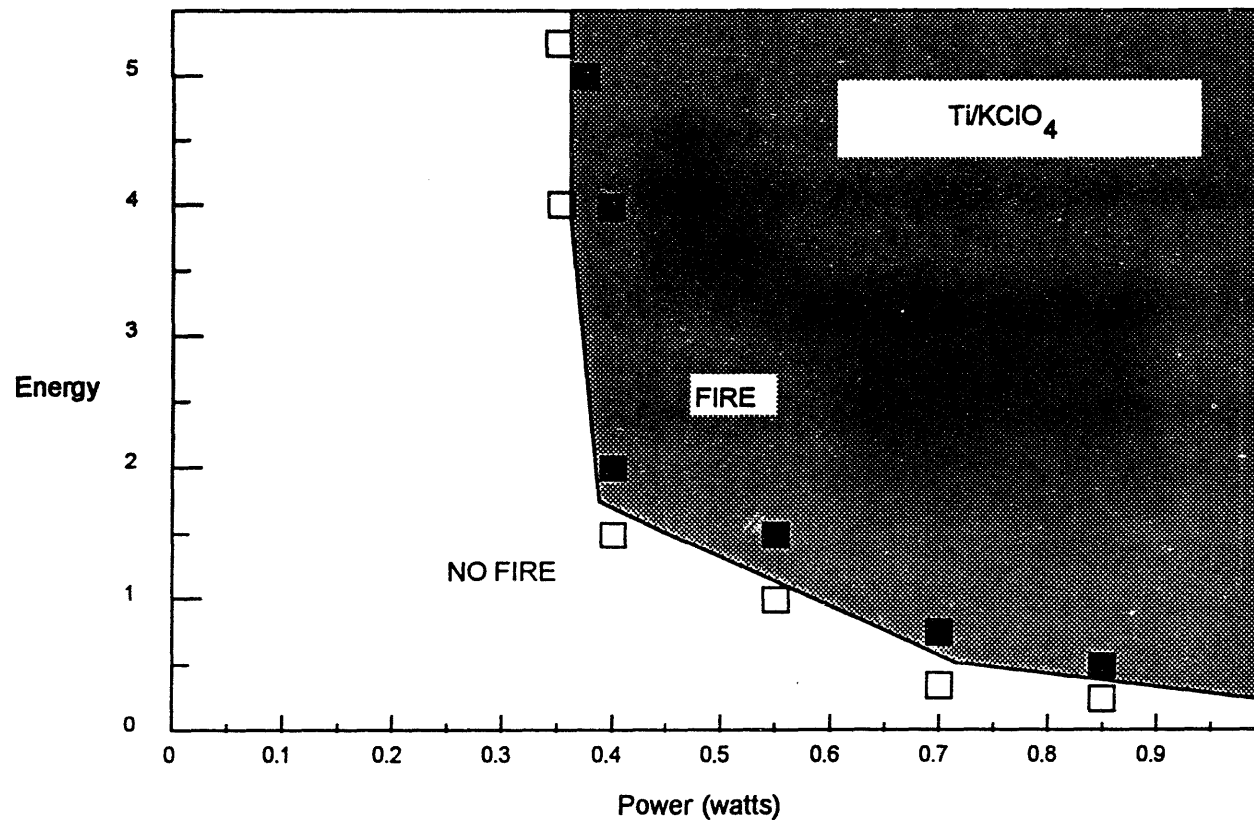
Ignition Threshold for Doped BNCP

All explosive and pyrotechnics display this minimum energy and minimum power behavior.



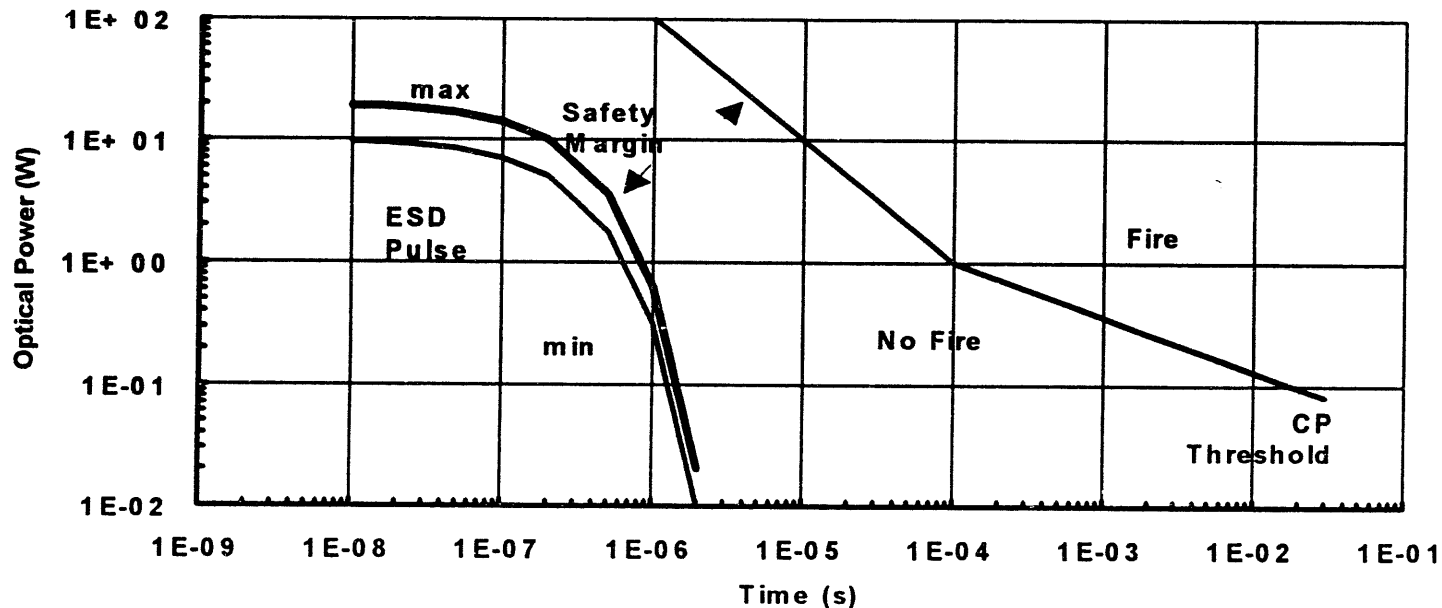
Ignition Threshold for Ti/KClO₄

Thermal properties, such as thermal conductivity and the autoignition temperature, determine minimum requirements.



ESD and Ignition Energy vs. Time

Maximum optical energy and power output from the laser diode exposed to ESD is insufficient to ignite either CP or Ti/KClO_4



ESD Sensitivity Summary

Explosive components are immune to ESD due to Faraday cage around the charge cavity.

The threshold for diode damage from ESD pulses is variable and dependent on each individual diode.

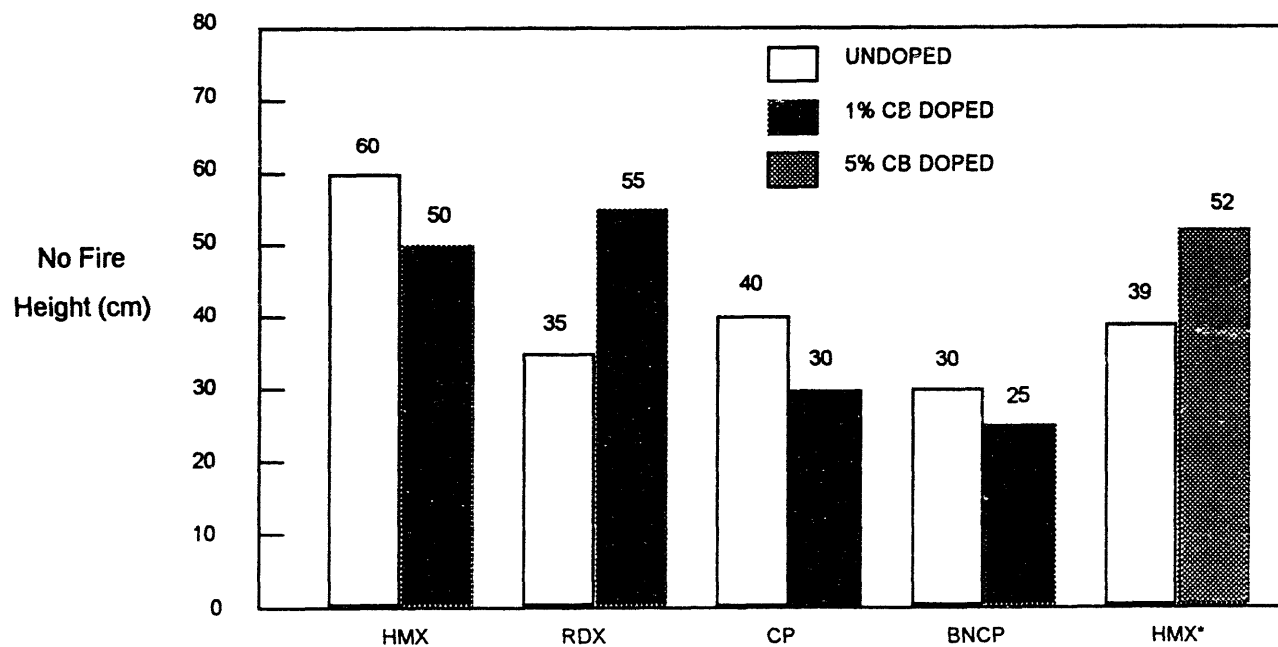
The optical output from laser diode exposed directly to the ESD pulse is insufficient to ignite explosives.

The time duration of the ESD induced optical pulse is too short and the optical energy is too low for ignition.



LDI Energetic Material Safety

No significant change in explosive safety with addition of dopants.



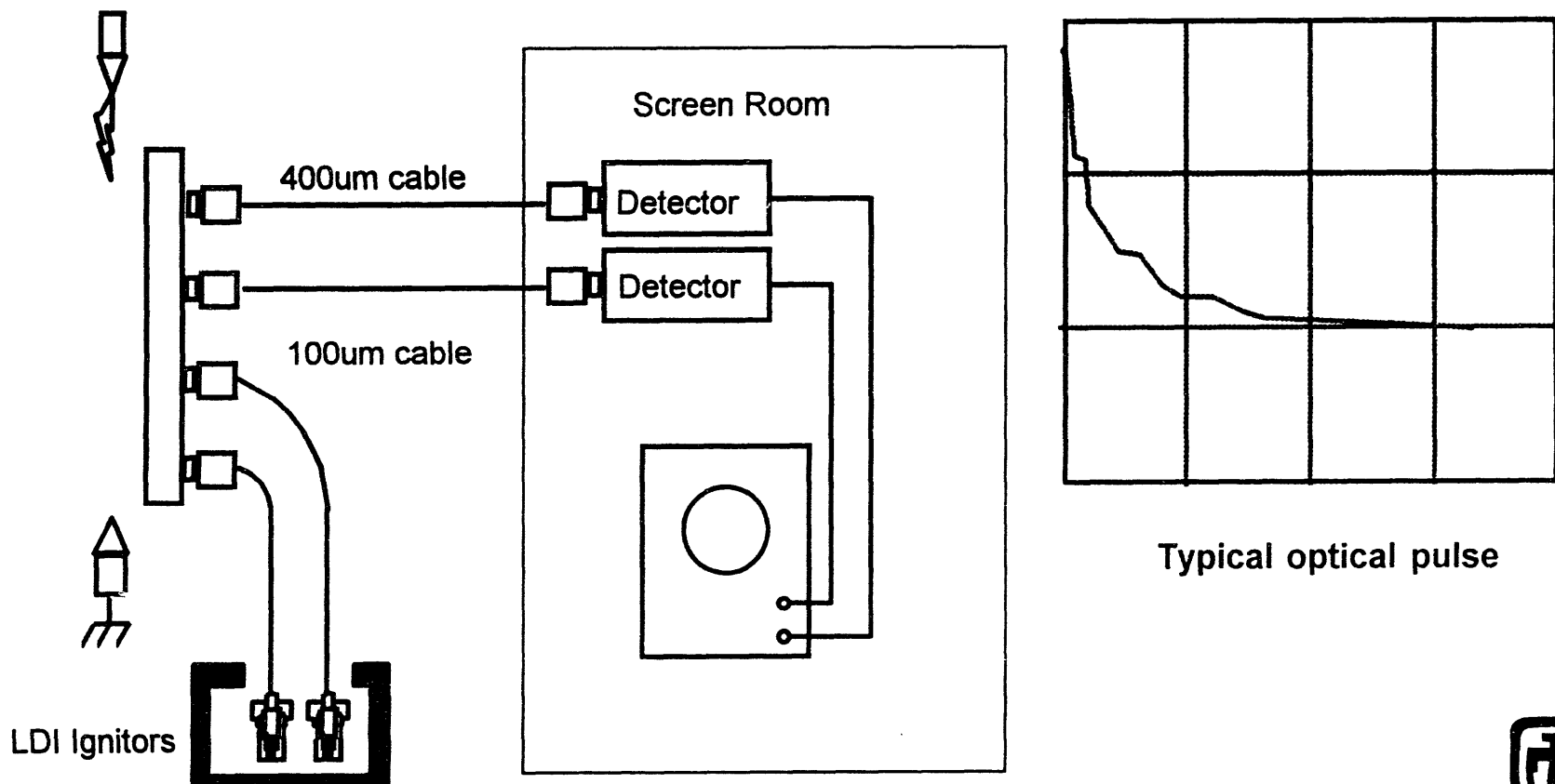
Data from J. Fronabarger UPI report # MTR-336

* 50% Height, J. Stimmel, M-1 LANL



Sandia Lightning Simulator

Lightning simulator test demonstrated insensitivity to optical flash



Lightning Test Results

Lightning Pulse - 200KA (non-continuing current)

Optical Measurements:

No CP ignition charges functioned

No visible damage in post-mortum

Optical powers of 1.5 Watts coupled to 100 micron fiber

Optical powers of 22.4 Watts coupled to 400 micron fiber

Insufficient energy contained in coupled pulses to ignite material

Pulse is “double decaying exponential” with 300 microsecond pulse width. Pulse energy in 100 micron fiber is less than 5 microjoules



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