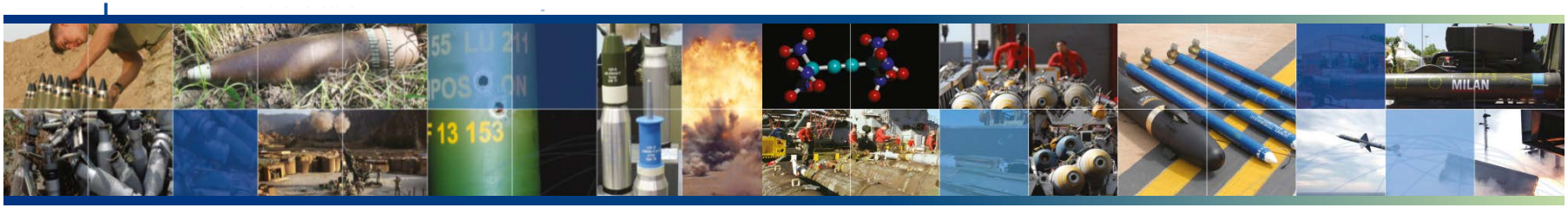
MSIAC

Munitions Safety Information Analysis Center

Supporting Member Nations in the Enhancement of their Munitions Life Cycle Safety



Gap Test Calculations and Correlations

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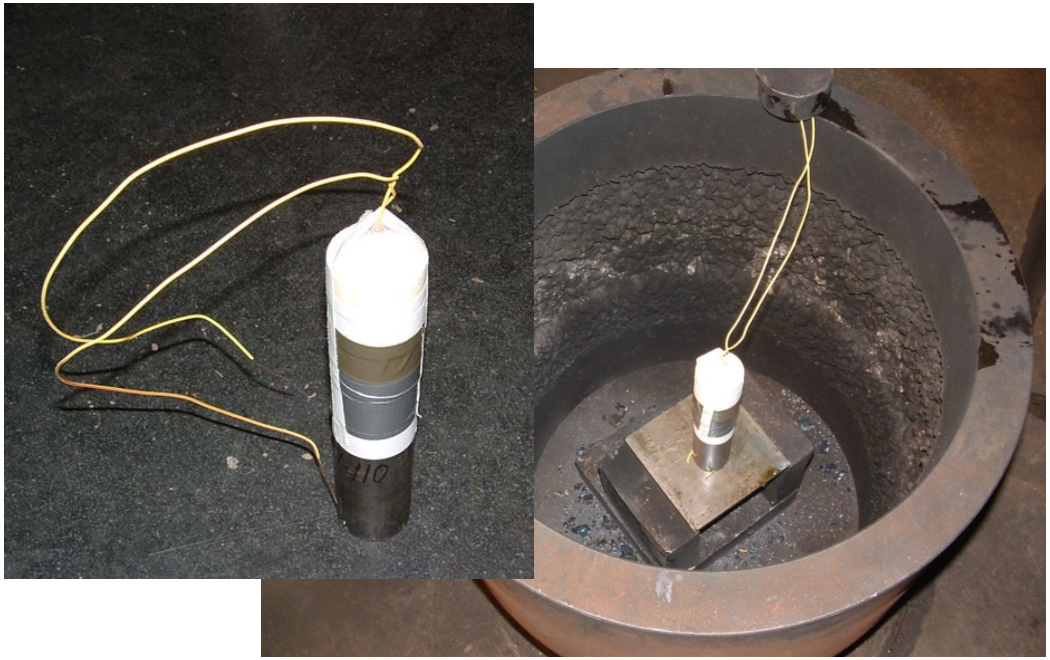


OVERVIEW

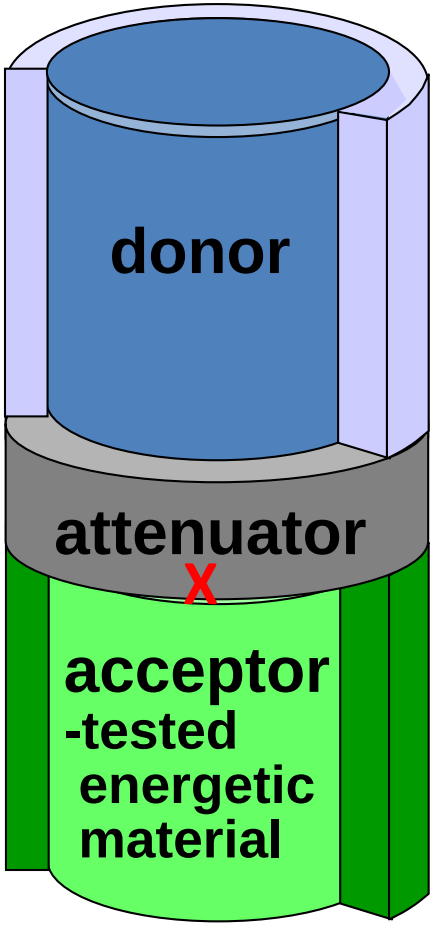
- Introduction
- Gap test shock pressures
- Correlations
  - SSGT vs. LSGT
  - LSGT vs. density
  - Critical diameter vs. LSGT
  - Held criteria vs. critical diameter
  - Gurney energy
- Conclusions

M. Voisin, “Critical Diameter Correlations”, MSIAC Report L-202, SEP 2016.
P. Peron, E. Baker, and V. Pouliquen, “NEWGATES 1.11 User’s Guide”, MSIAC Report L-148, Ed. 4, SEP 2017.

Introduction

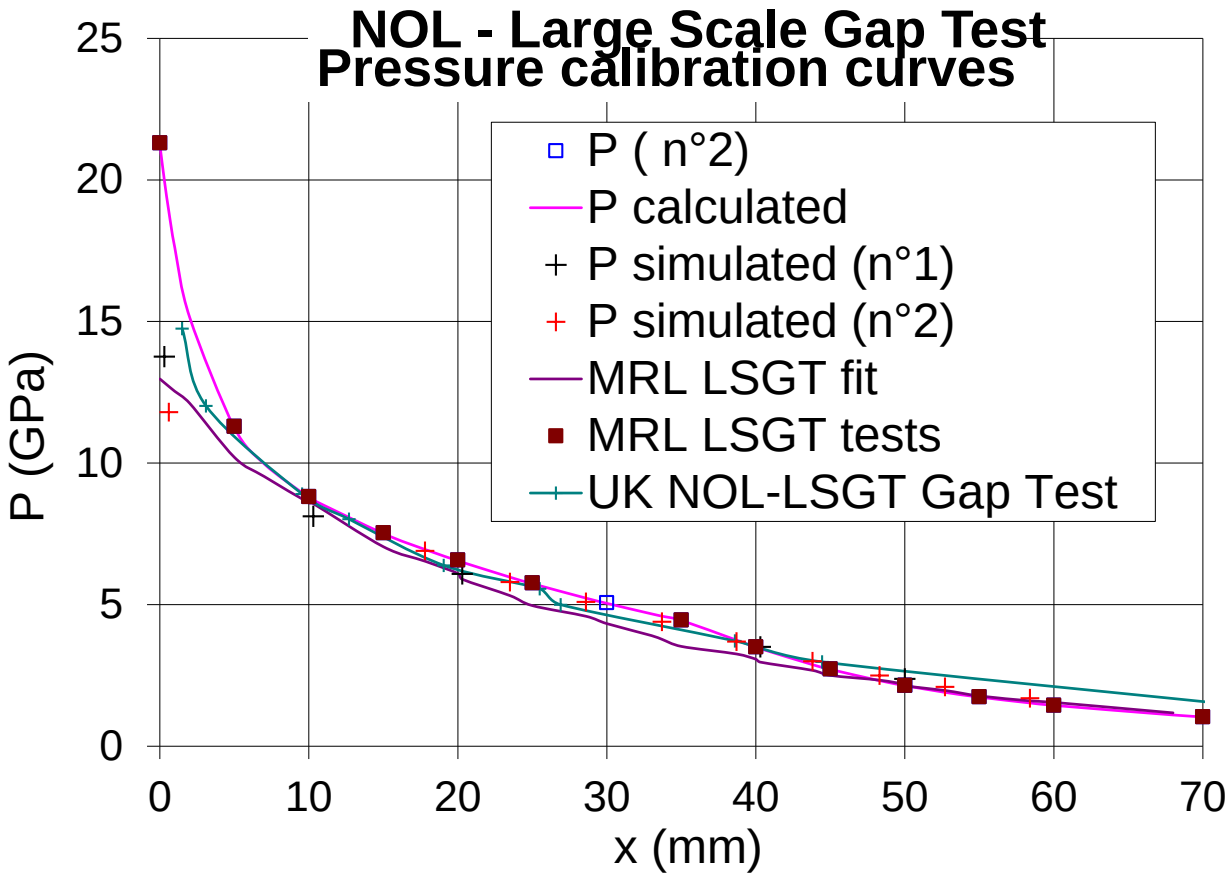
- NEWGATES: NIMIC Excel Worksheets on Gap TESts
  - developed in Excel, Version 1.11 released in 2017
  - gap test references, data and calculations
  - 10 gap tests (dimensions, scope, principles)
  - pressure calibration curves
  - time calibration curves
  - shock curvature calibration curves
  - 1455 gap test results
  - Unreacted Hugoniots
- Laboratory test characteristics correlation study: “Critical Diameter Correlation”, Voisin M. , MSIAC Report O-171 (2016).
- New correlations in NEWGATES: SCGT, LSGT, d_{crit}

GAP TEST SHOCK PRESSURES



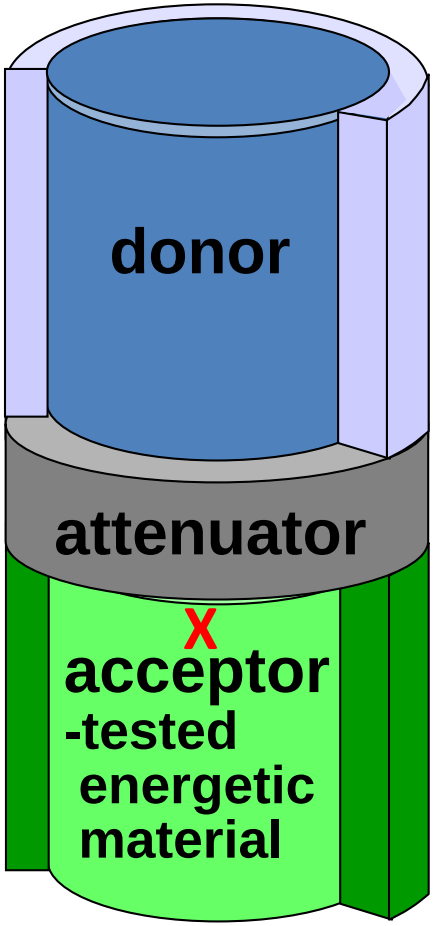
Reported gap test "incident pressures" represent the shock pressure in the attenuator material just before arriving to the acceptor

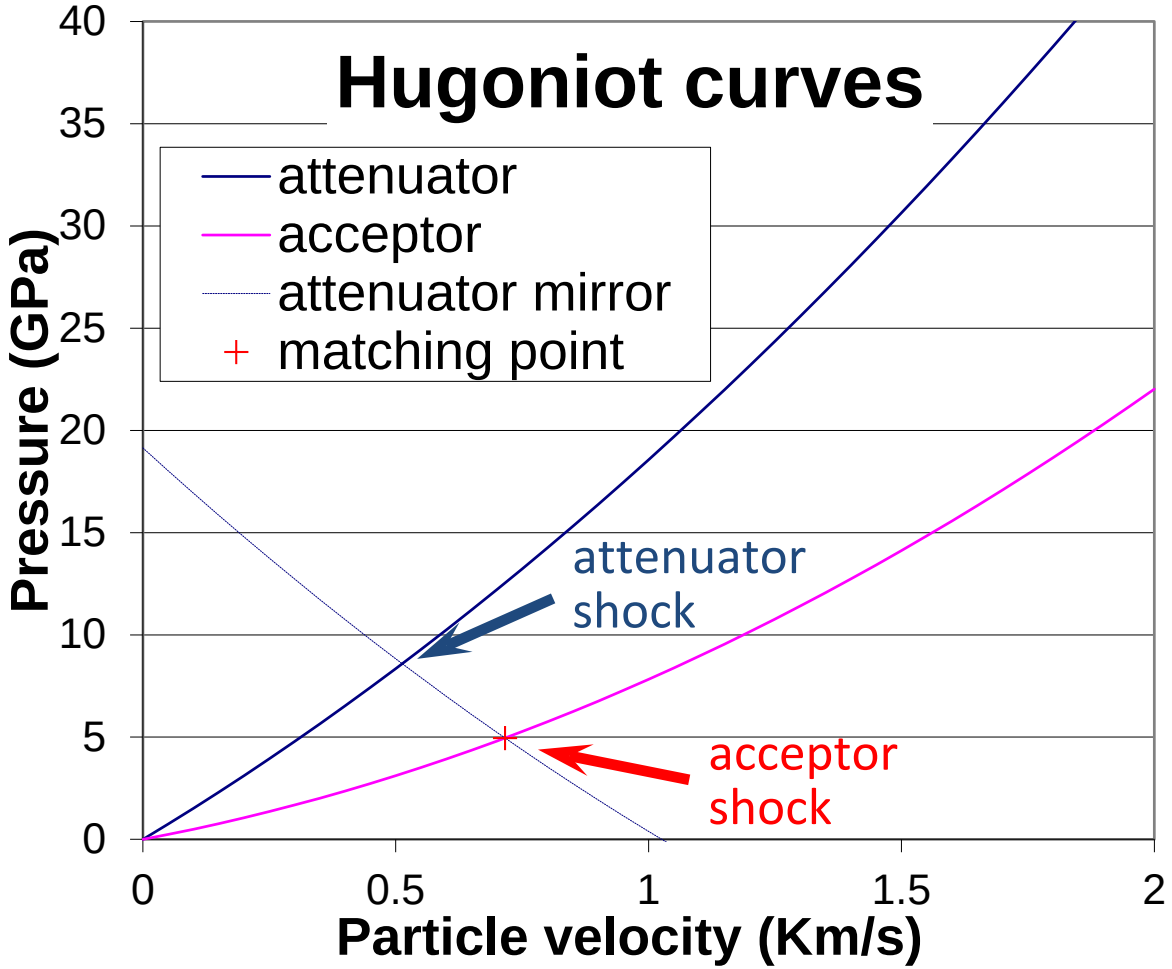
– requires a pressure calibration curve



Attenuator vs. Acceptor Shocks

The shock pressure in the acceptor material just after the shock arrives can be calculated using Hugoniot matching

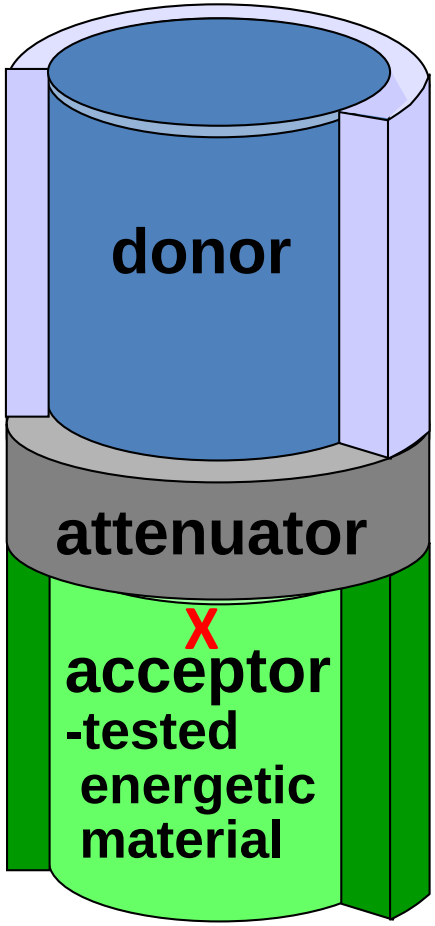


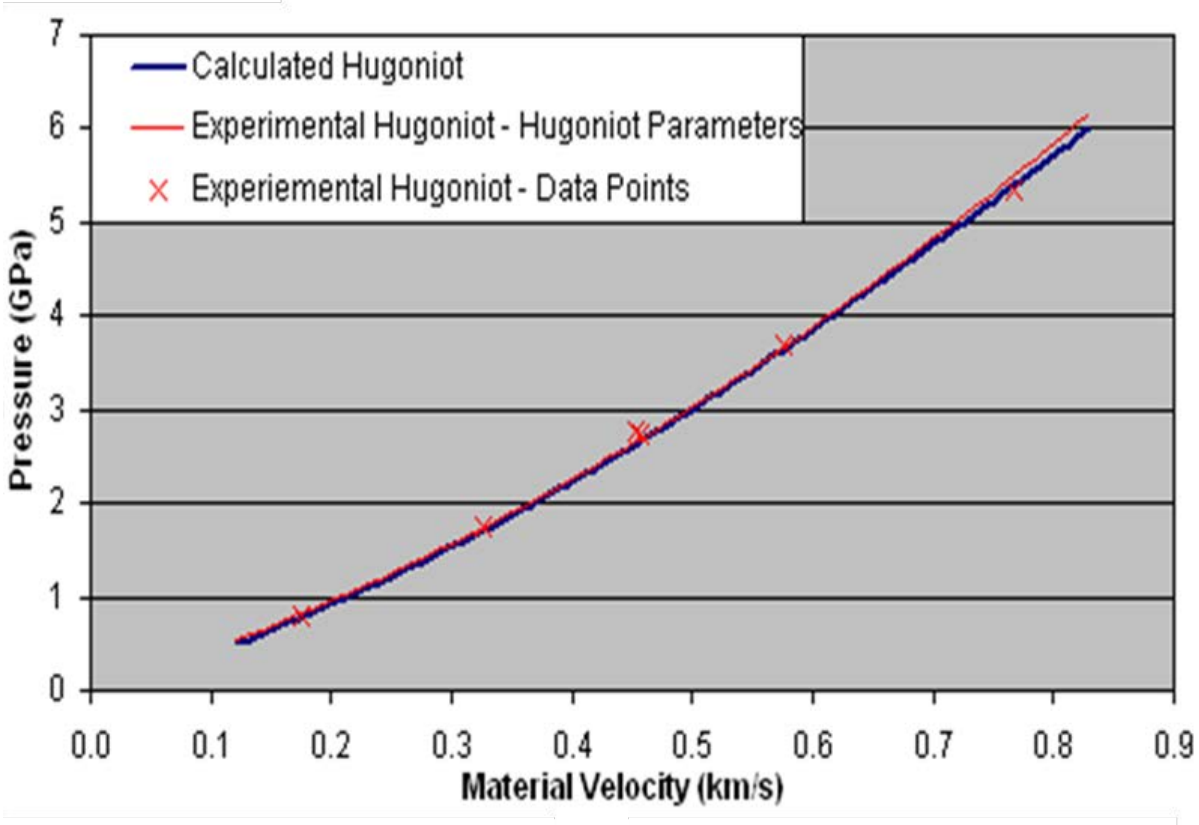


NEWGATES can calculate the initial acceptor shock pressure –requires the acceptor material unreacted Hugoniot

ACCEPTOR HUGONIOT

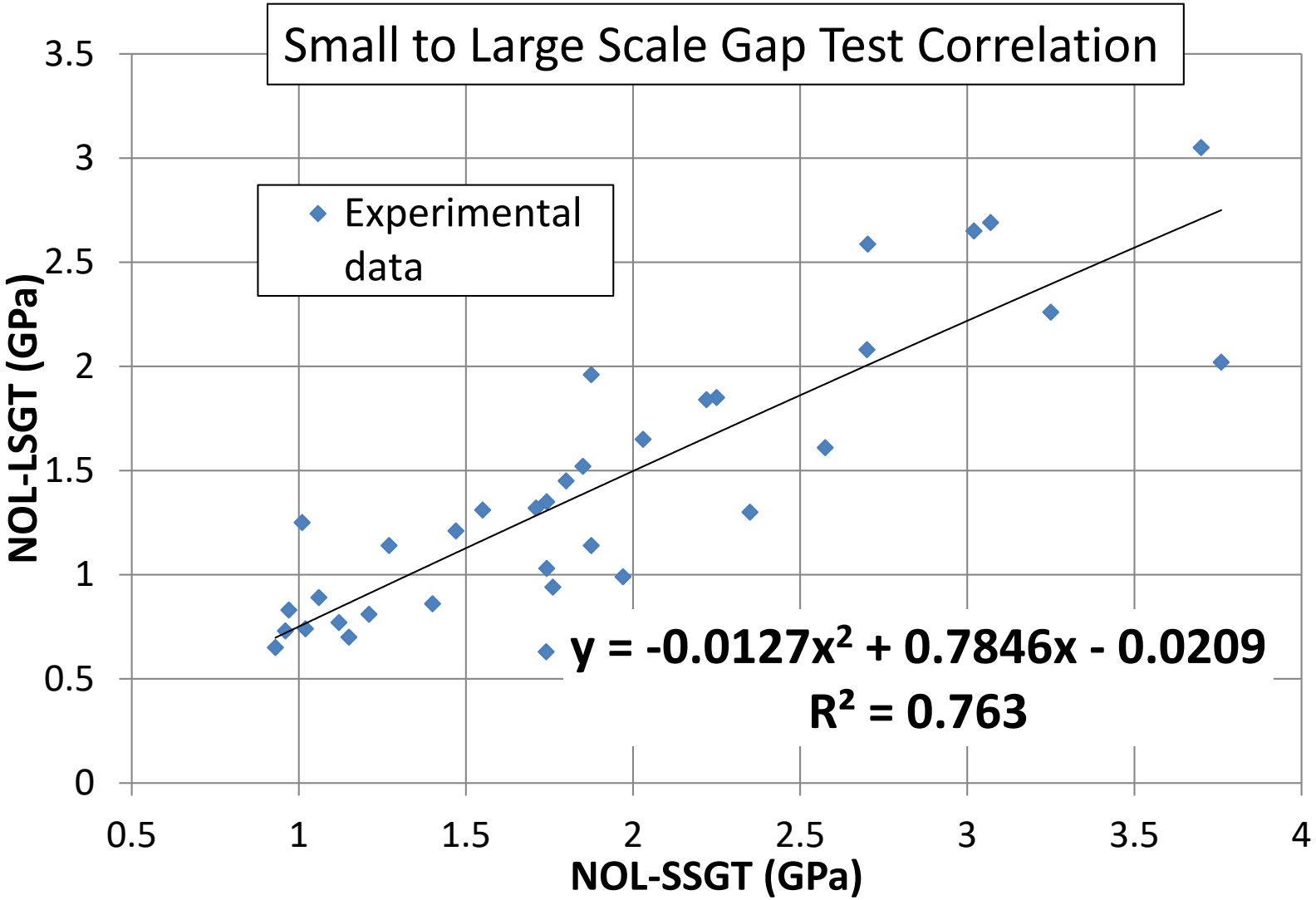
NEWGATES includes a model to calculate the acceptor unreacted Hugoniot based on Hugoniots of the acceptor ingredients





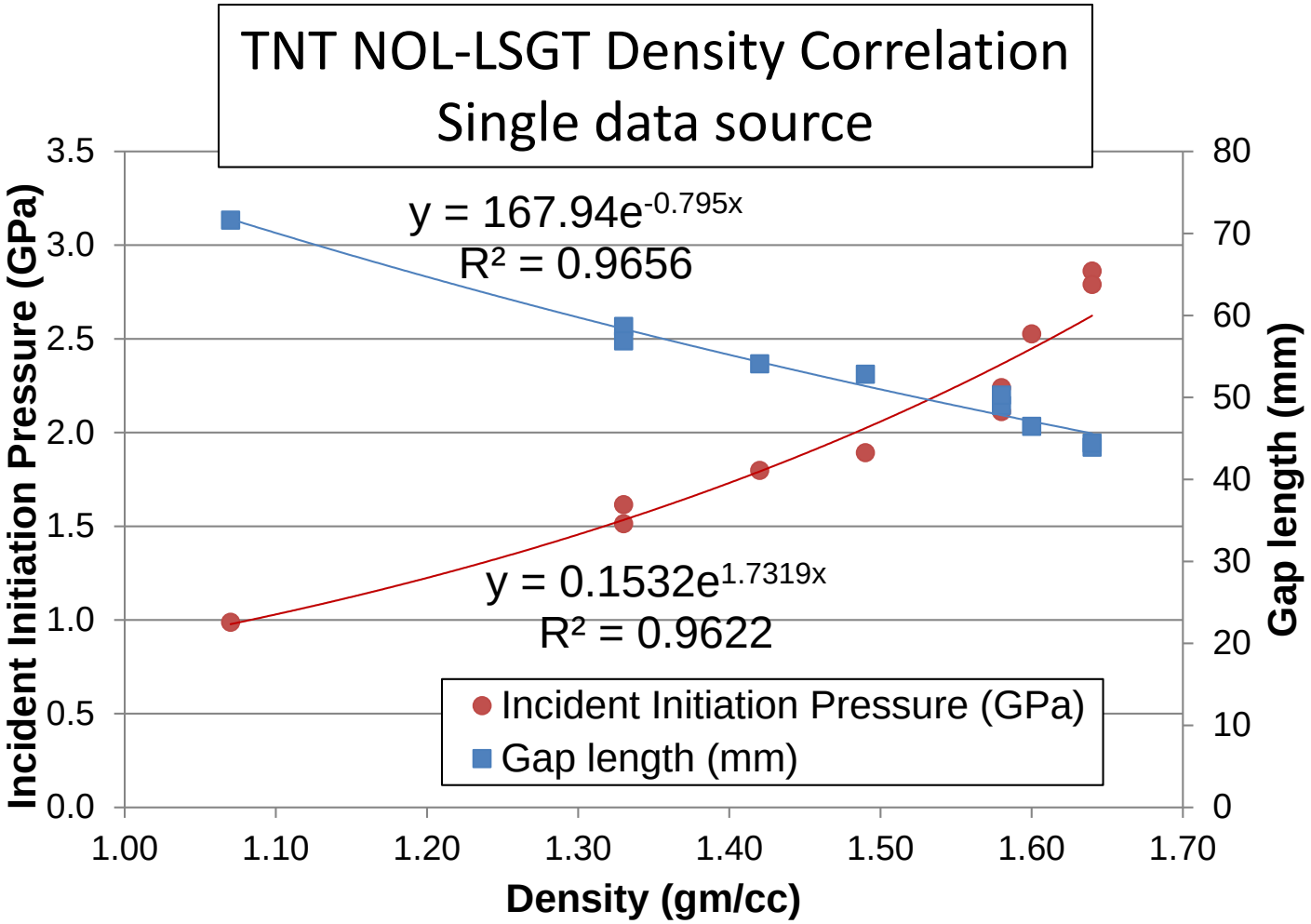
Calculated mixed Hugoniot: Rowanex 1400

SSGT vs. LSGT



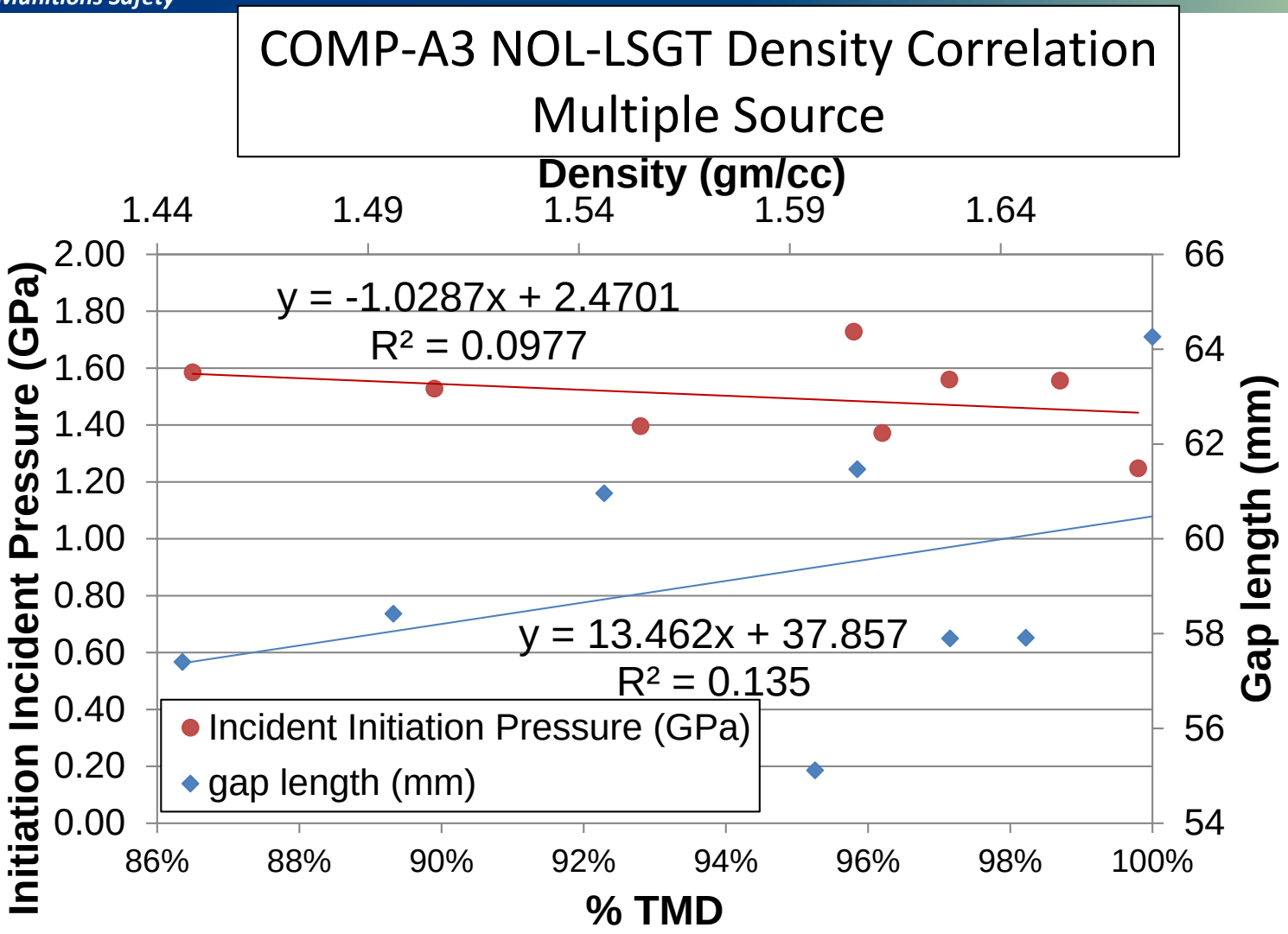
-Extended original correlation by D. Price (1966)
-Removed larger critical diameters and added more data

LSGT vs. Density



Donna Price, A. R. Clairmont, Jr., and J. O. Erkman, "The NOL Large Scale Gap Test III. Compilation of Unclassified Data and Supplementary Information for Interpretation of Results," Naval Ordnance Laboratory, White Oak, Maryland, United States, AD-780 429, Mar. 1974.

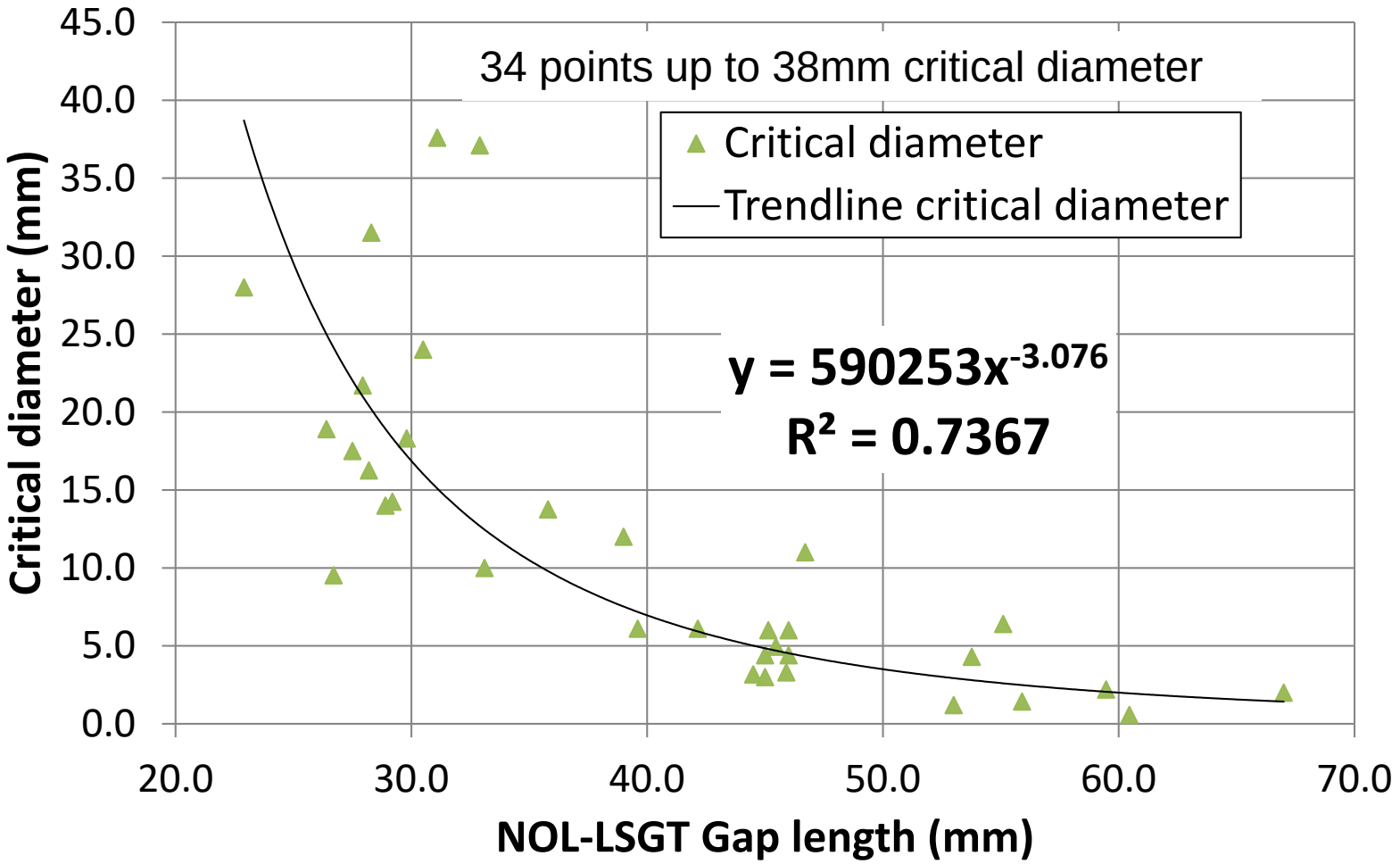
LSGT vs. Density



Ingredients and processing are very important!

- Study included CH-6, TNT, AP/Wax, PBX9404 and CompA-3
- More dense, less shock sensitive

CRITICAL DIAMETER NOL-LSGT



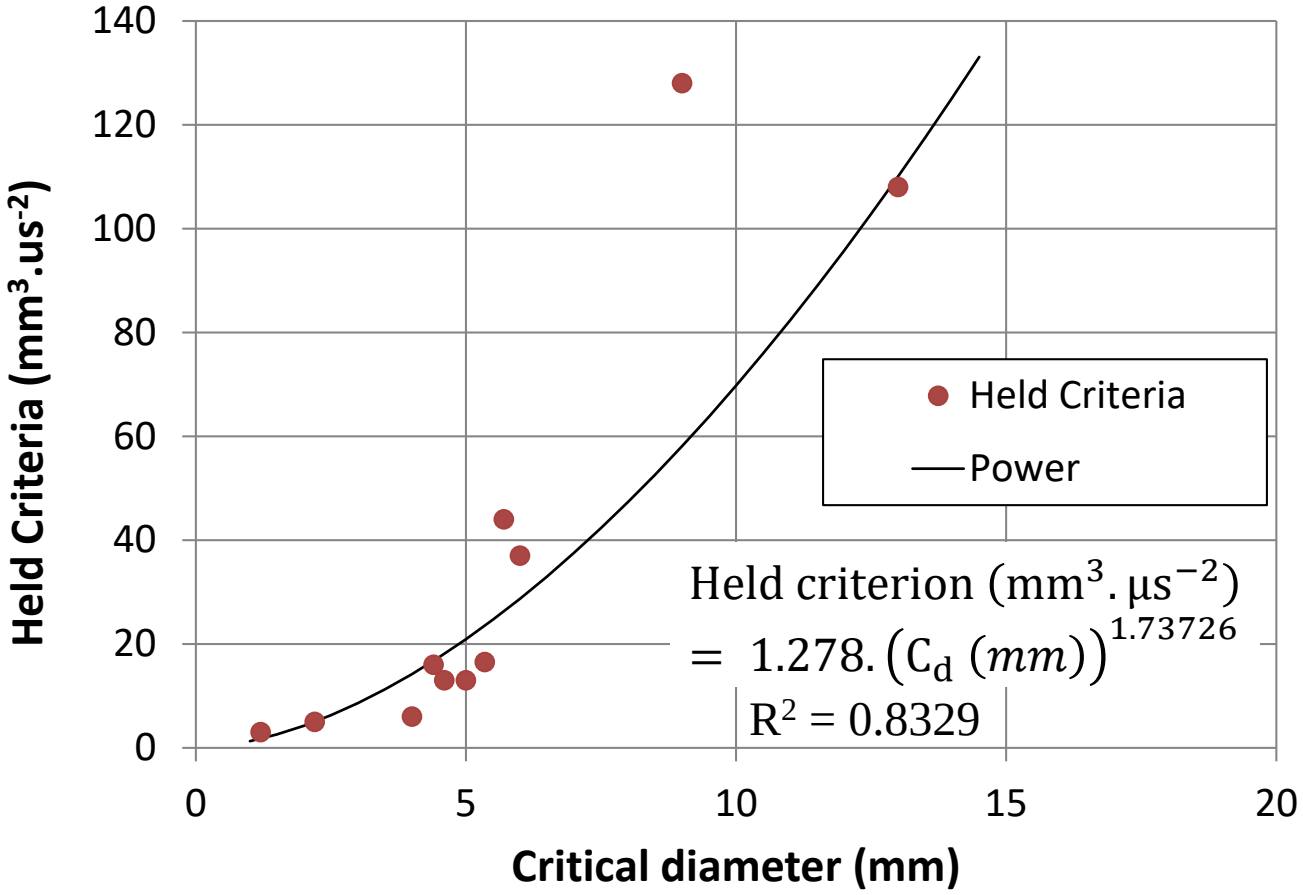
Not a fundamental physically based relationship!

-Low shock sensitivity and critical diameters have been observed

-Fine grained RDX explosives

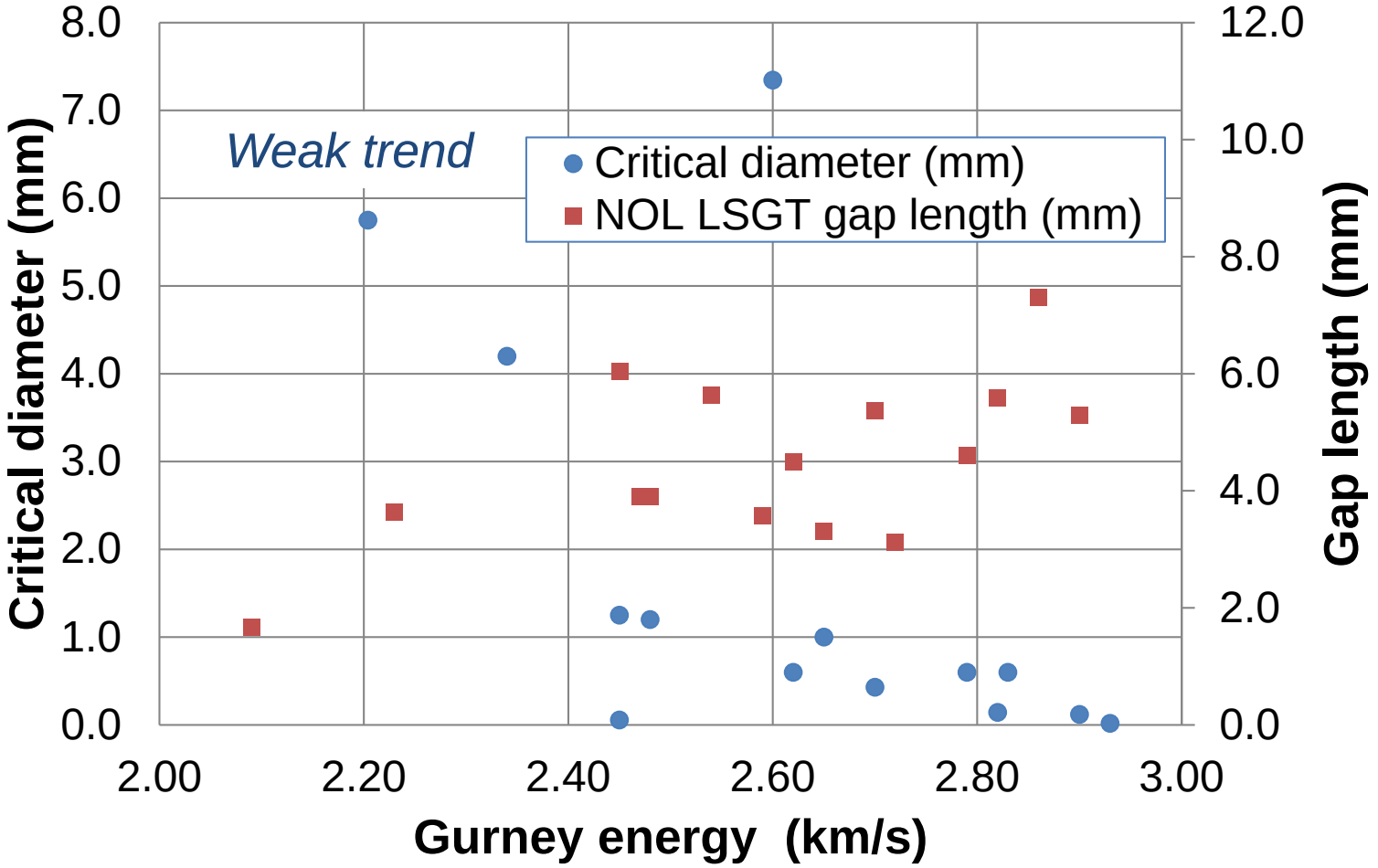
-Higher performance reduced sensitivity rocket propellants

HELD CRITERIA VS. C_d



Data from 1.2mm to 13mm critical diameters

GURNEY ENERGY



Also investigated LSGT to:

Rotter figure of Insensitiveness
Detonation velocity
Detonation pressure

No correlations!

CONCLUSIONS

- Investigated laboratory test characteristics correlations
- Correlations:
  - NOL-SSGT to NOL-LSGT
  - NOL-LSGT to critical diameter
  - critical diameter to Held criteria
  - NOL-LSGT to density for a given explosive
- Weak correlation
  - NOL-LSGT to Gurney energy
- No Correlations:
  - NOL-LSGT to Rotter figure of Insensitiveness
  - NOL-LSGT to detonation velocity
  - NOL-LSGT to detonation pressure
- NEWGATES now includes correlations
  - NOL-SSGT to NOL-LSGT
  - NOL-LSGT to critical diameter

It is important to realize that these correlations only provide rough estimates, and should not be construed as accurate results!

Questions?