Problems in Minimum Ignition Energy Determination

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This Seems Well Understood

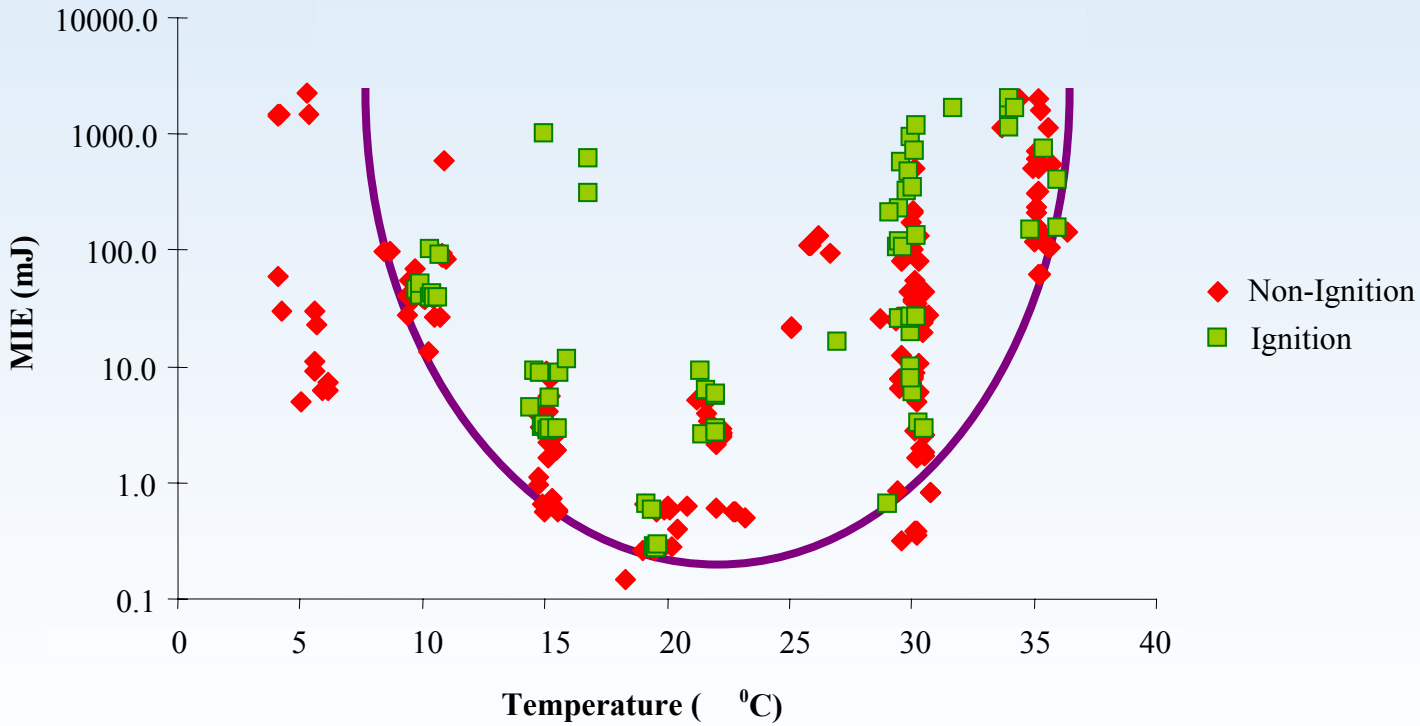
Well, not really.

The determination of minimum ignition energy curves for fuel/air mixtures have been problematical with widely varying results for different groups using different fuels, fuel treatment regimes and ignition sources.

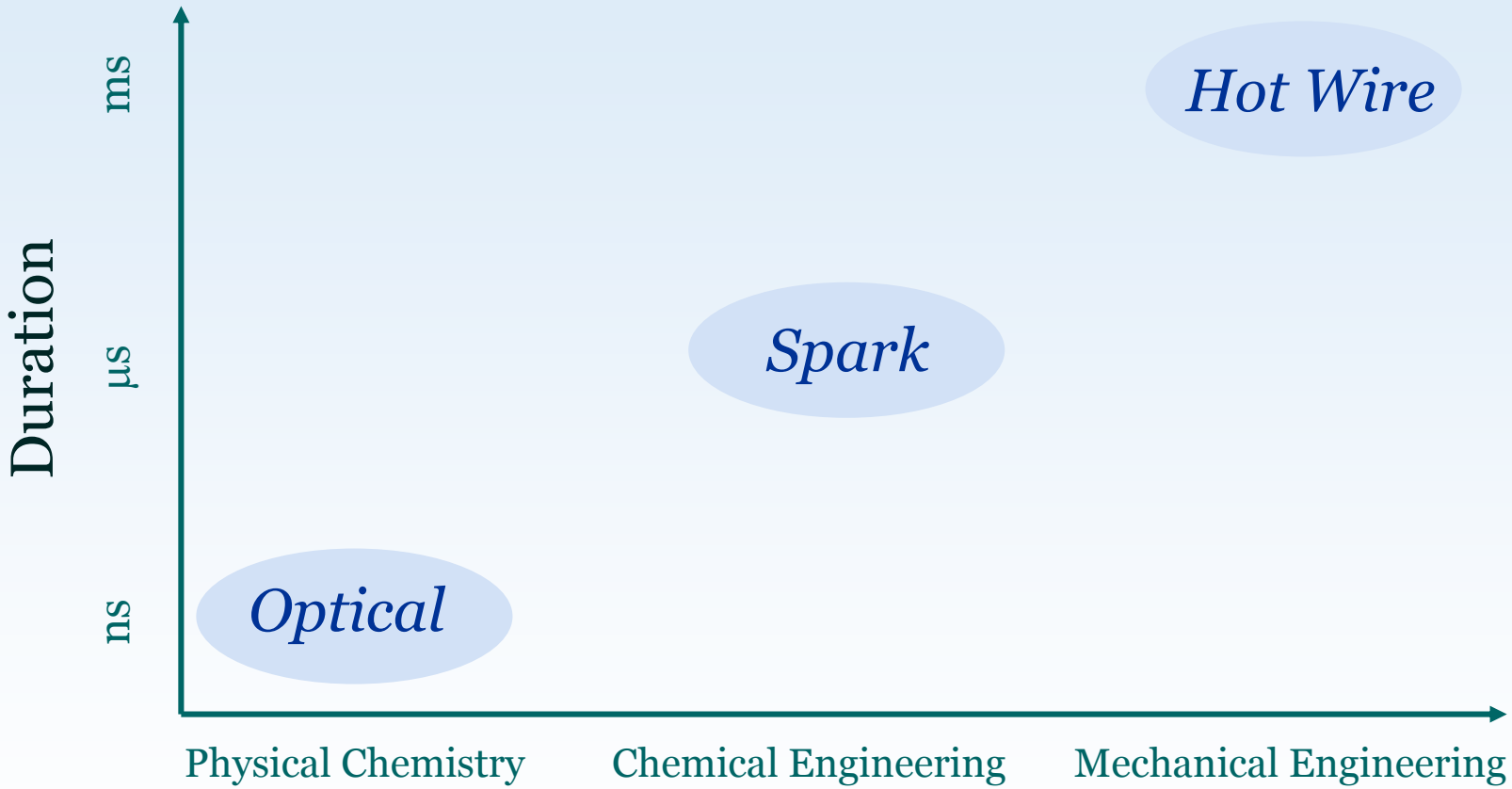
The focus of attention on the root cause of the variations has been in the fuel and fuel treatment. While there is considerable variation in refinery products and handling such variations are also observed for chemically pure fuels.

Perhaps there are other concerns.

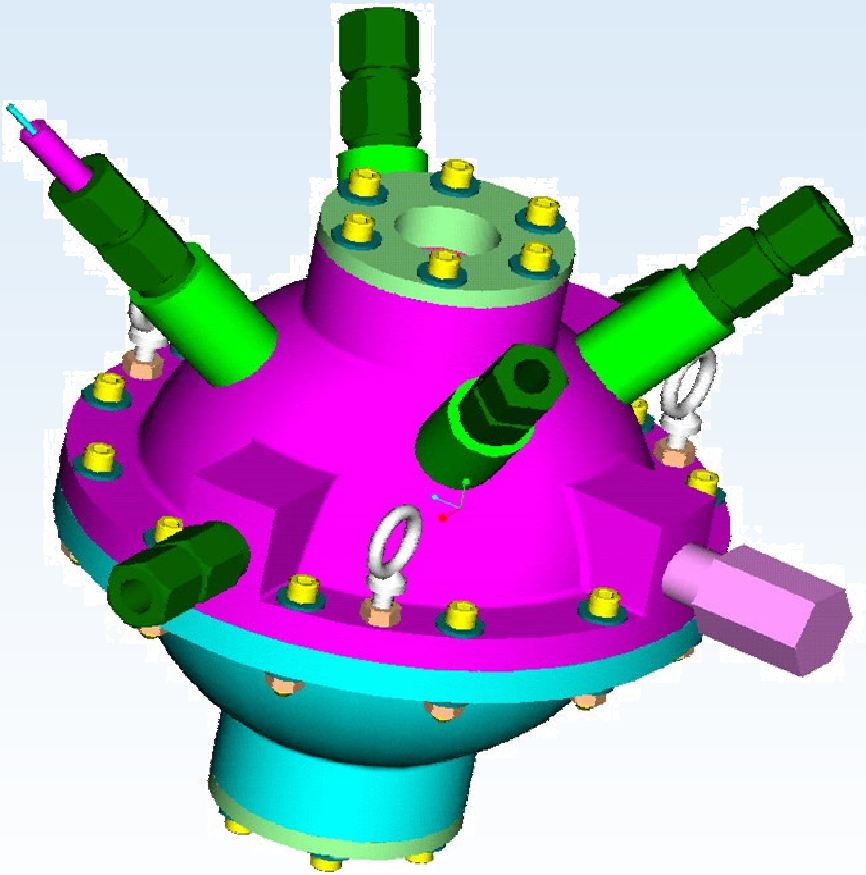
Methanol MIE



Type of Ignition Source



Combustion Vessel



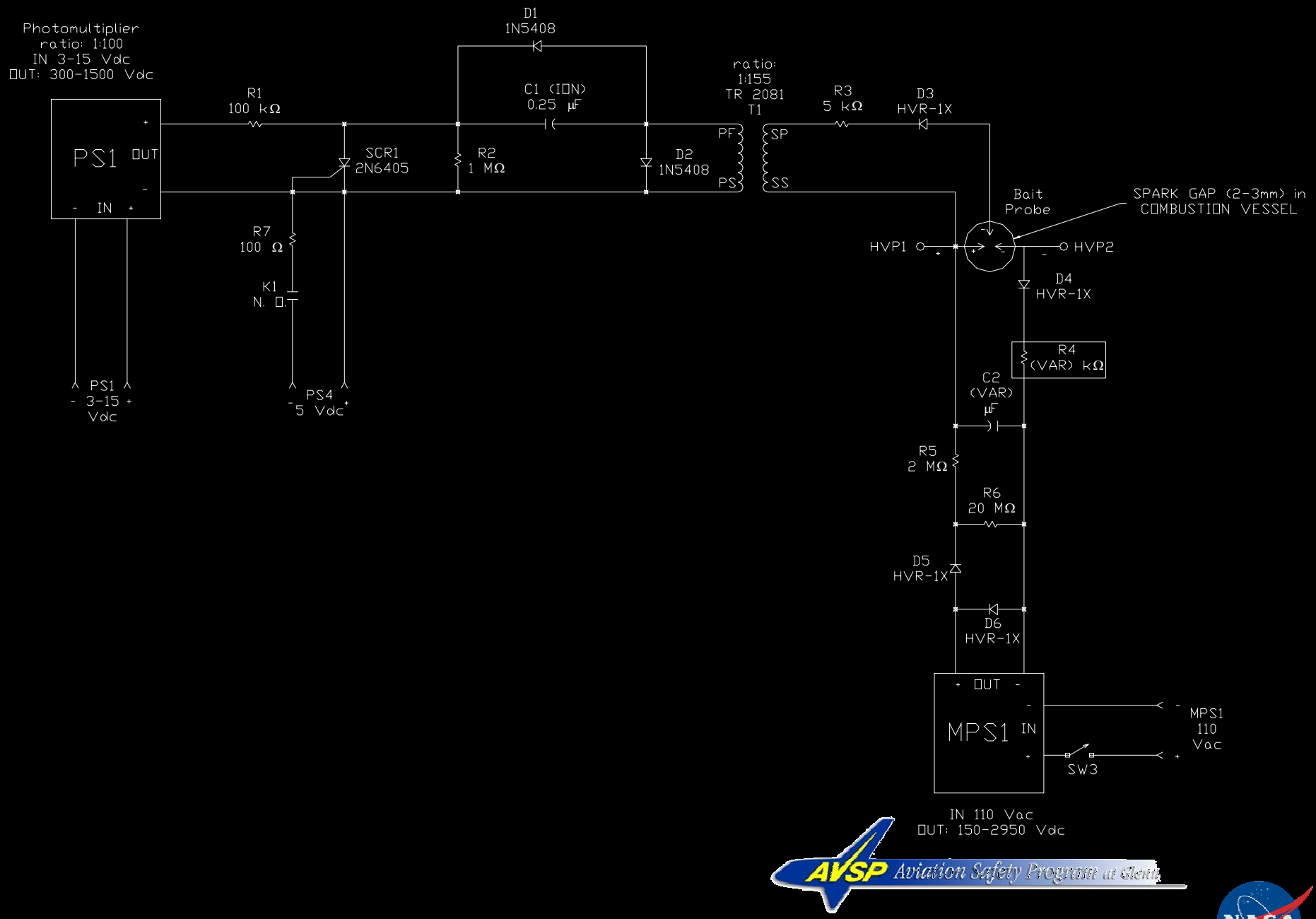
GRC MIE Experimentation Combustion Vessel Apparatus

Sparks Move Around

“Dancing” Spark
30 μs Between Frames

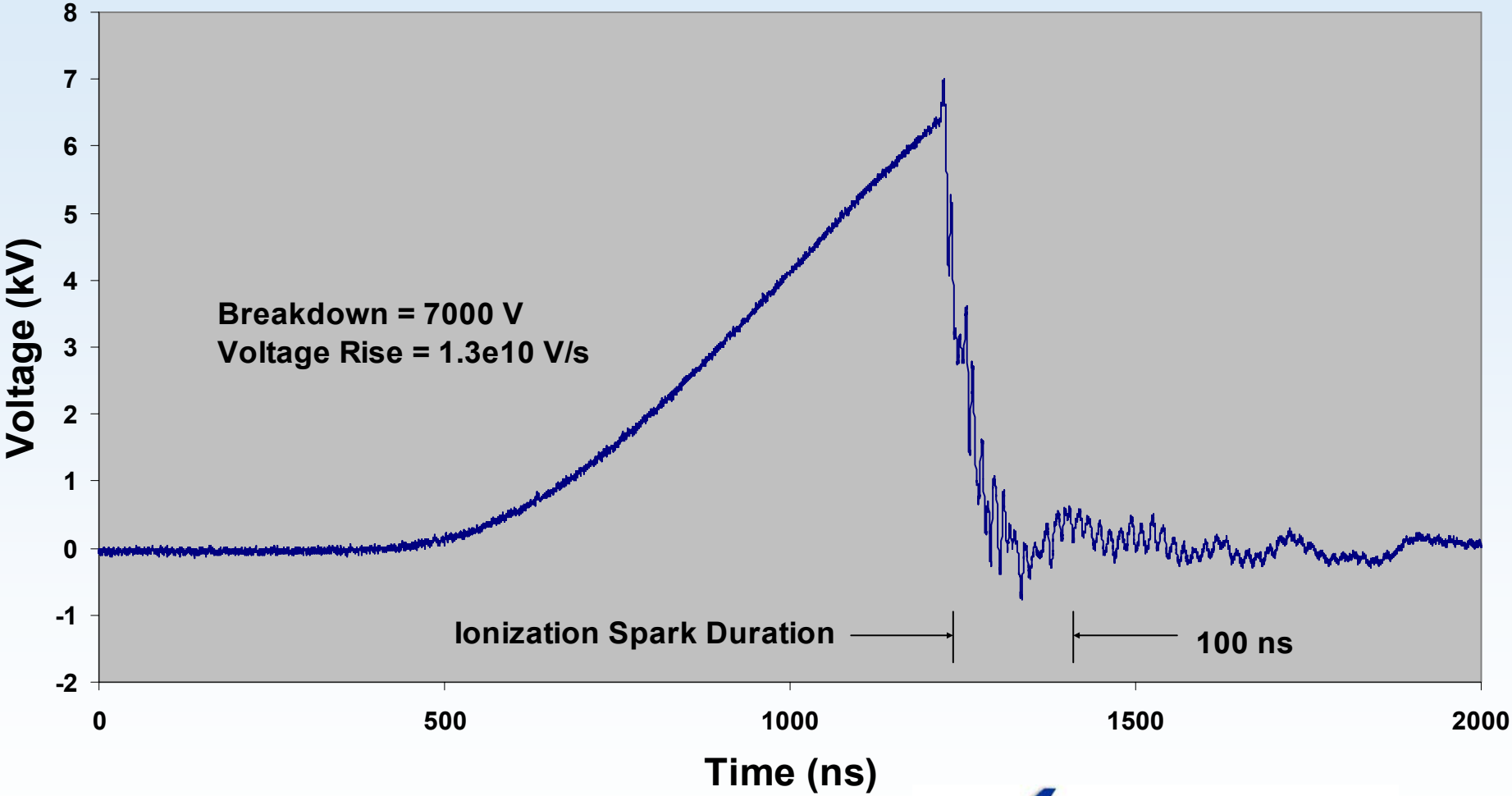
GRC MIE Experimentation

Combustion Vessel Apparatus ~ Internal Configuration


Photomultiplier
ratio: 1:100
IN 3-15 Vdc
OUT: 300-1500 Vdc
PS1
OUT
IN
R1
100 kΩ
D1
1N5408
C1 (ION)
0.25 µF
SCR1
2N6405
R2
1 MΩ
D2
1N5408
ratio:
1:155
TR 2081
T1
PF
PS
SP
SS
R3
5 kΩ
D3
HVR-1X
Bait
Probe
SPARK GAP (2-3mm) in
COMBUSTION VESSEL
HVP1
HVP2
D4
HVR-1X
R7
100 Ω
K1
N. O.
PS1
3-15
Vdc
PS4
5 Vdc
R4
(VAR) kΩ
C2
(VAR)
µF
R5
2 MΩ
R6
20 MΩ
D5
HVR-1X
D6
HVR-1X
OUT
MPS1
IN
MPS1
110
Vac
SW3
IN 110 Vac
OUT: 150-2950 Vdc

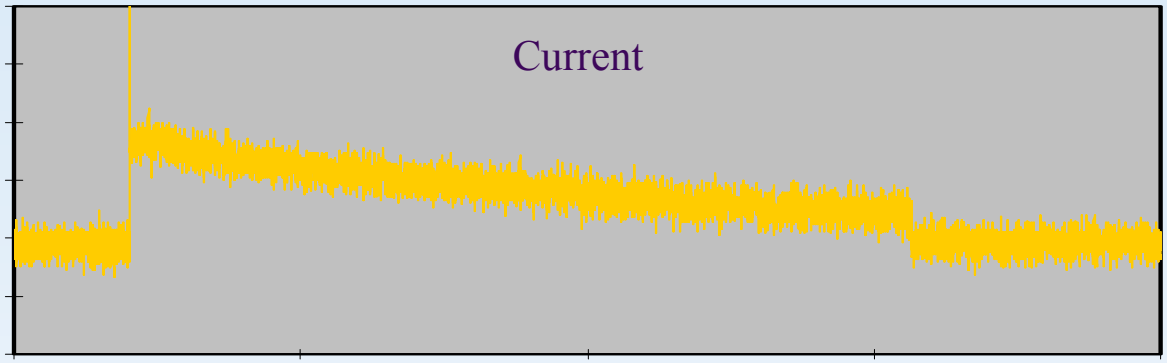
Typical Ionization Profile

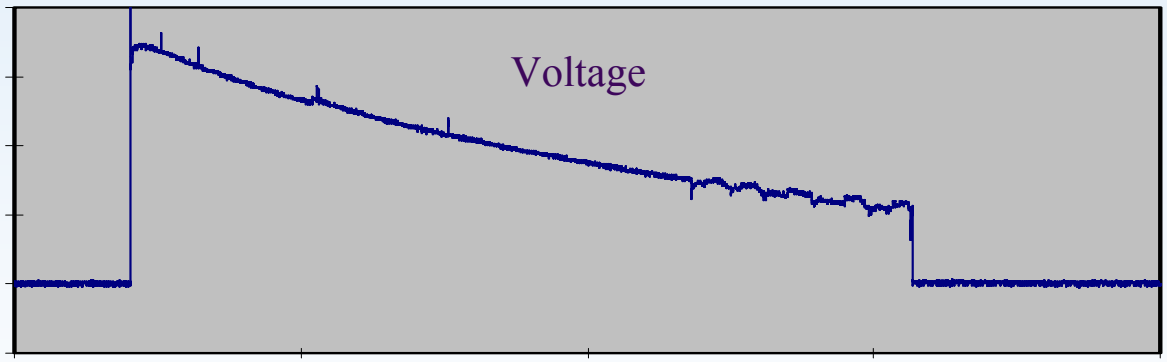
70μJ Spark Energy

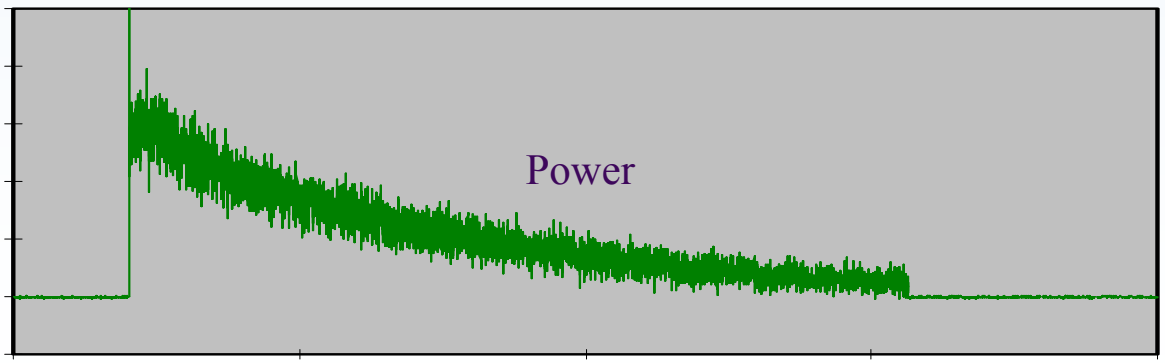


Typical Energy Measurement

Energy = ∫ (Voltage x Current) dt

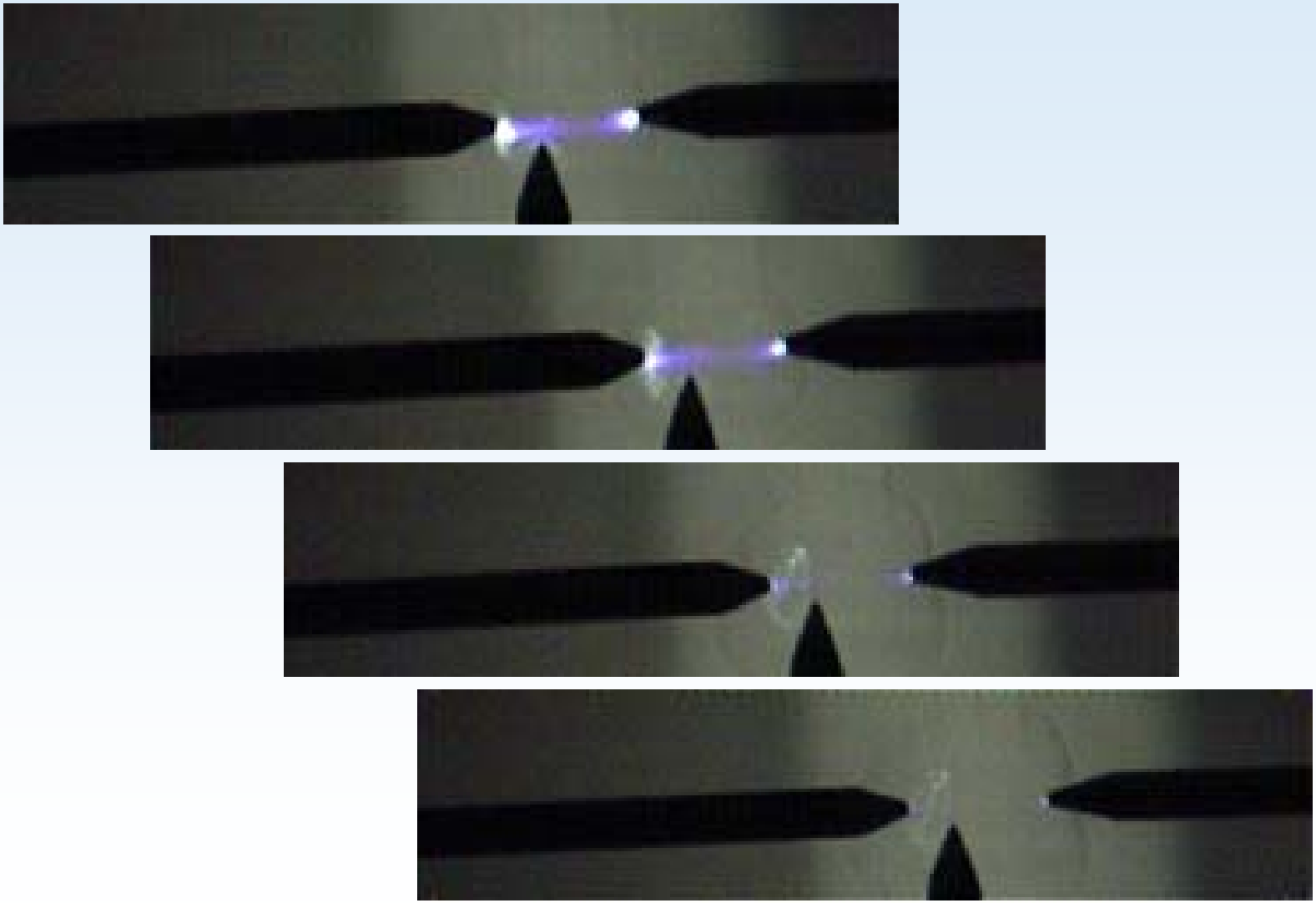




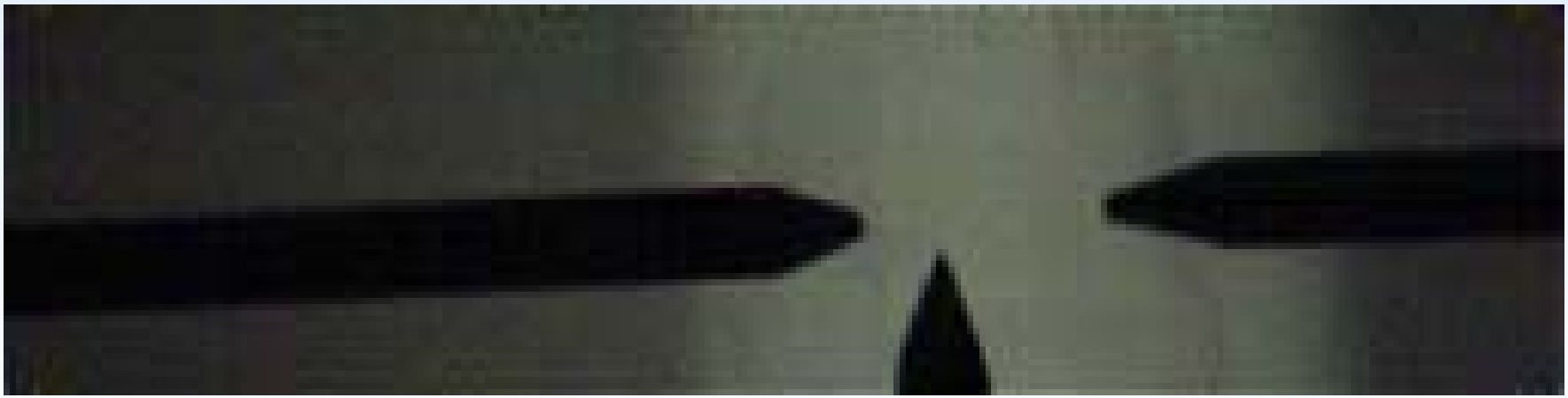


Oscillating Sparks

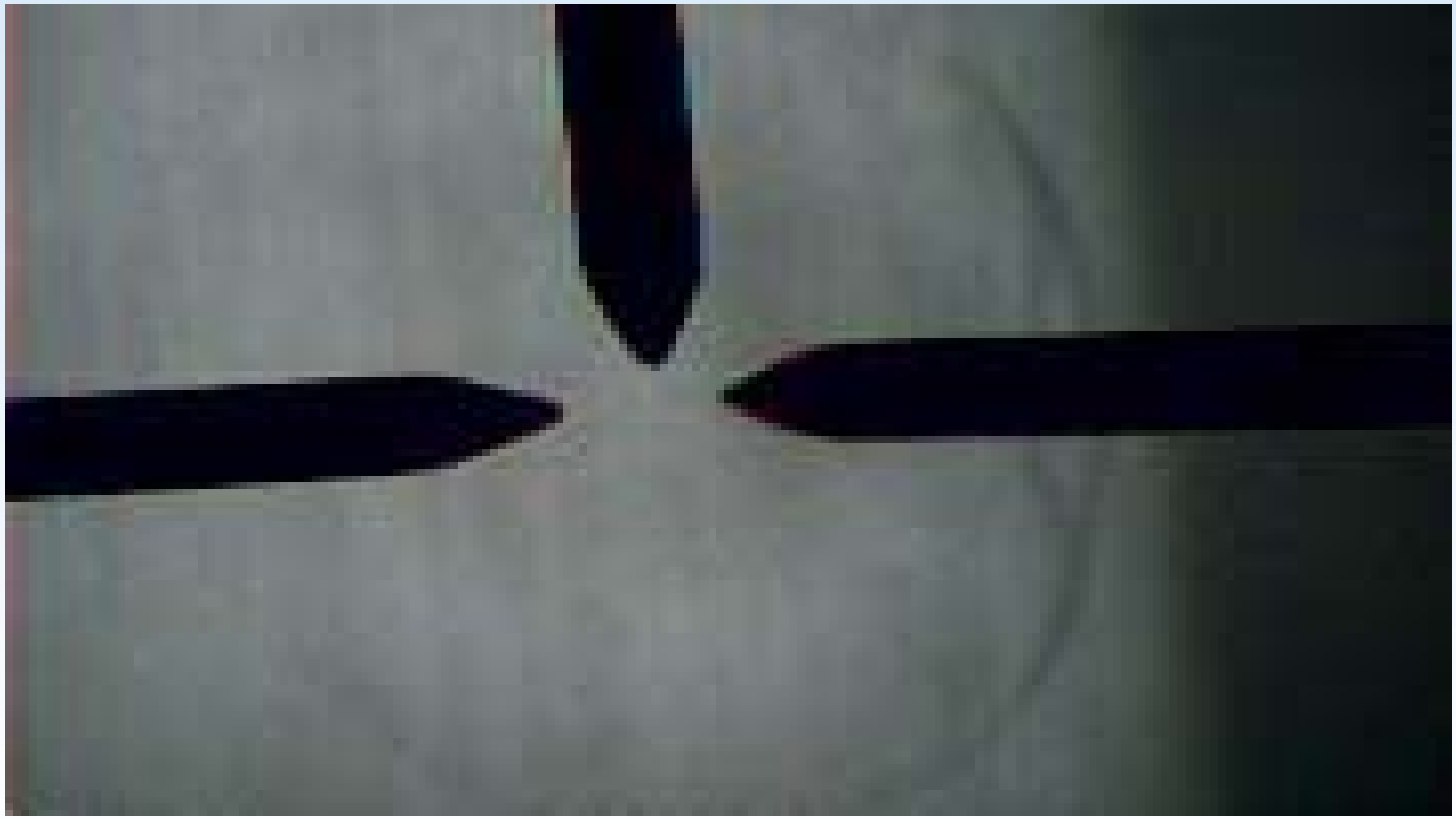
Nice Looking Spark



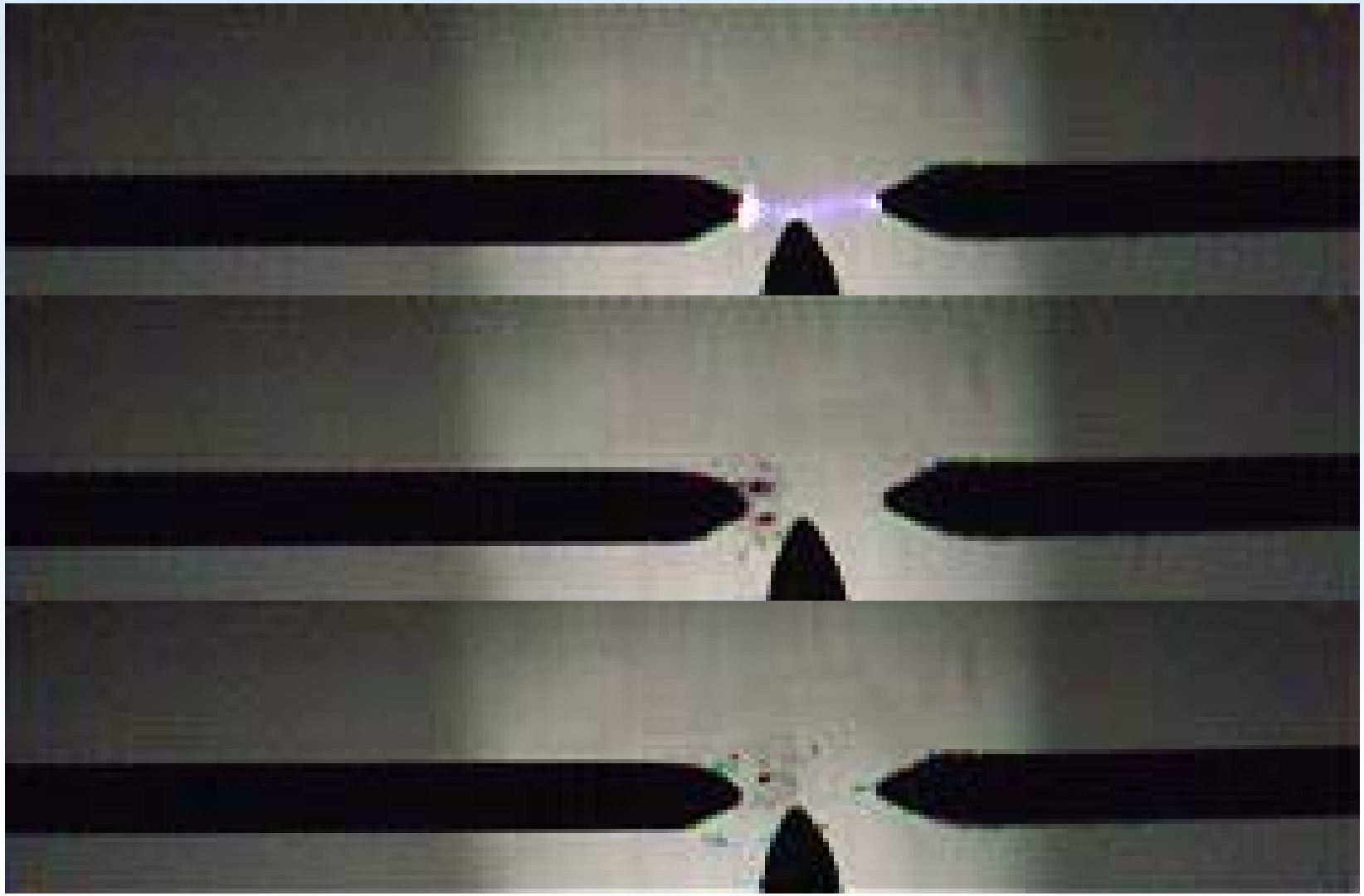
Nice Looking Spark -- Animation



Reaction Wave

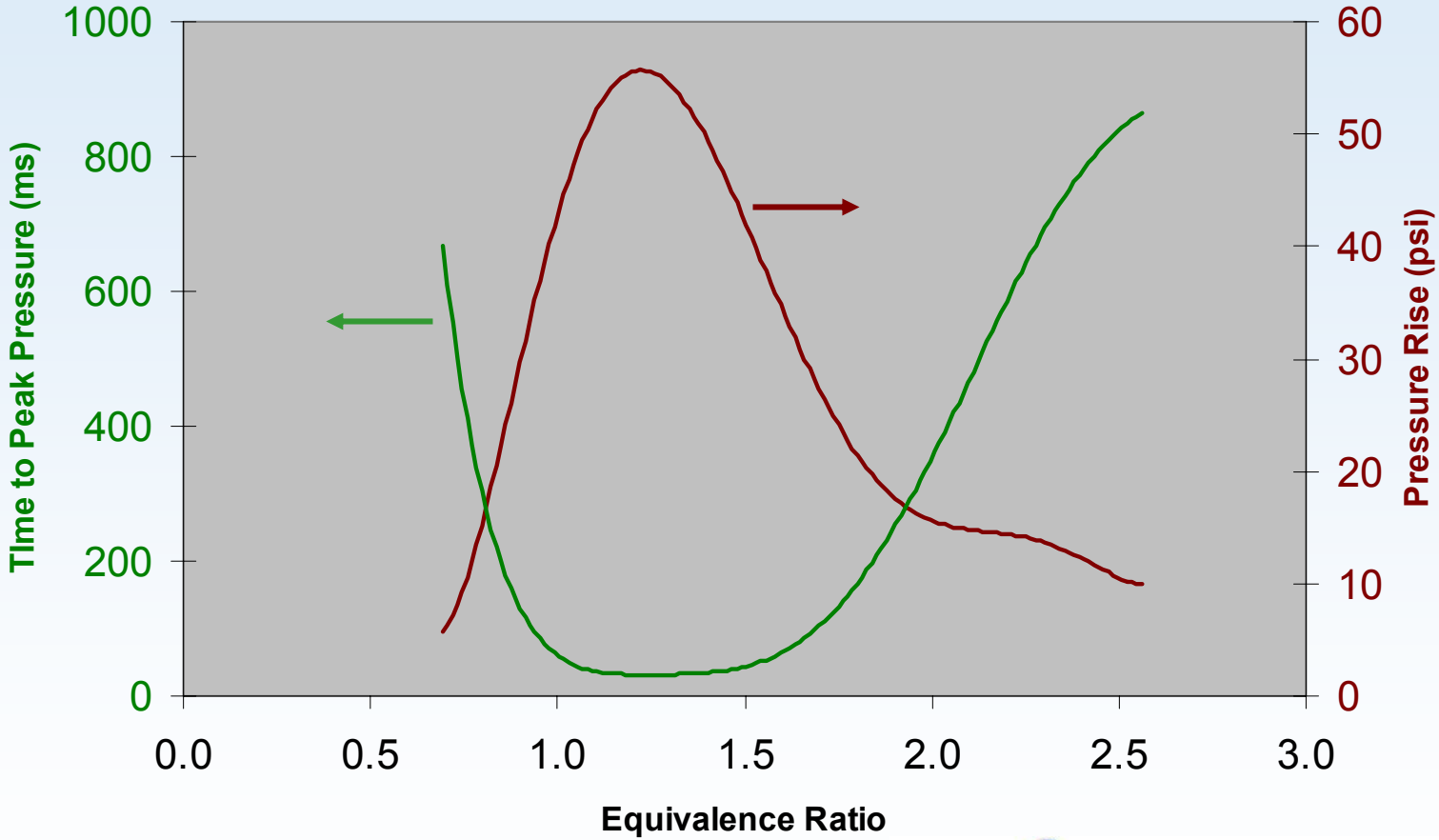


Carbon Build Up

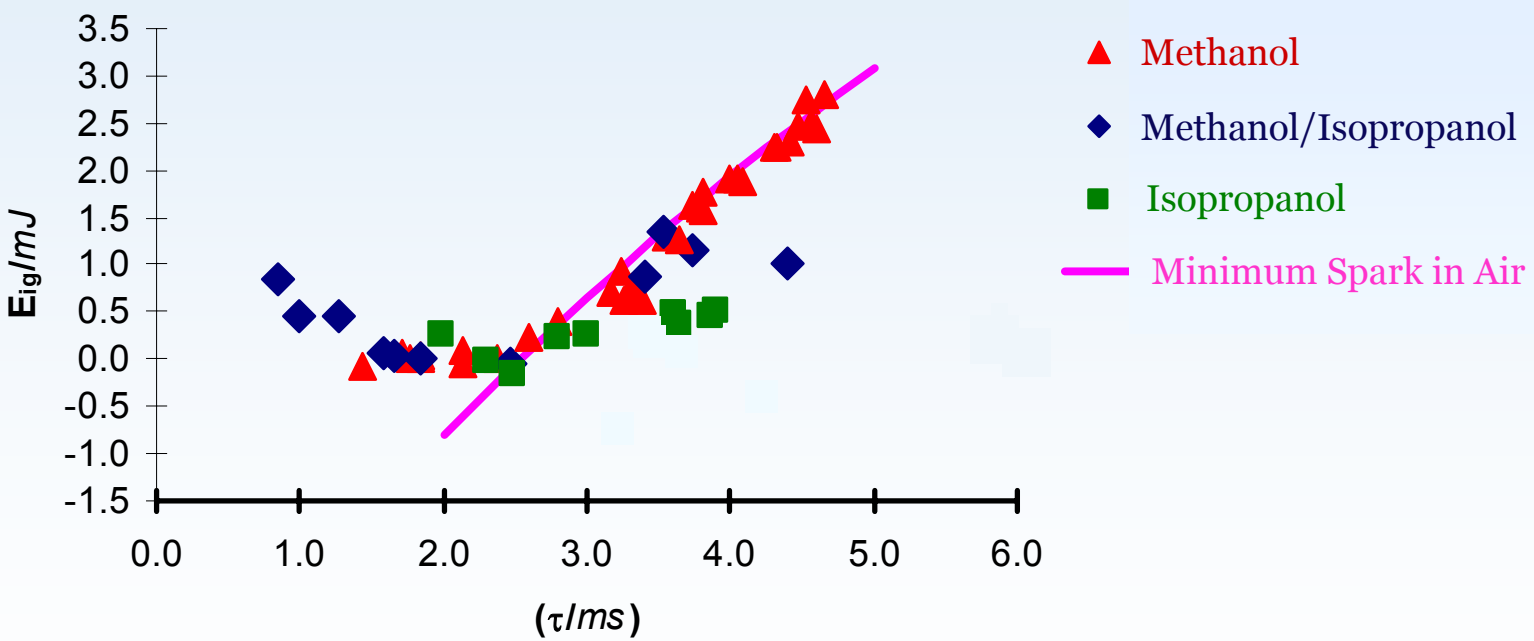


Carbon Build Up --Animation

Methanol

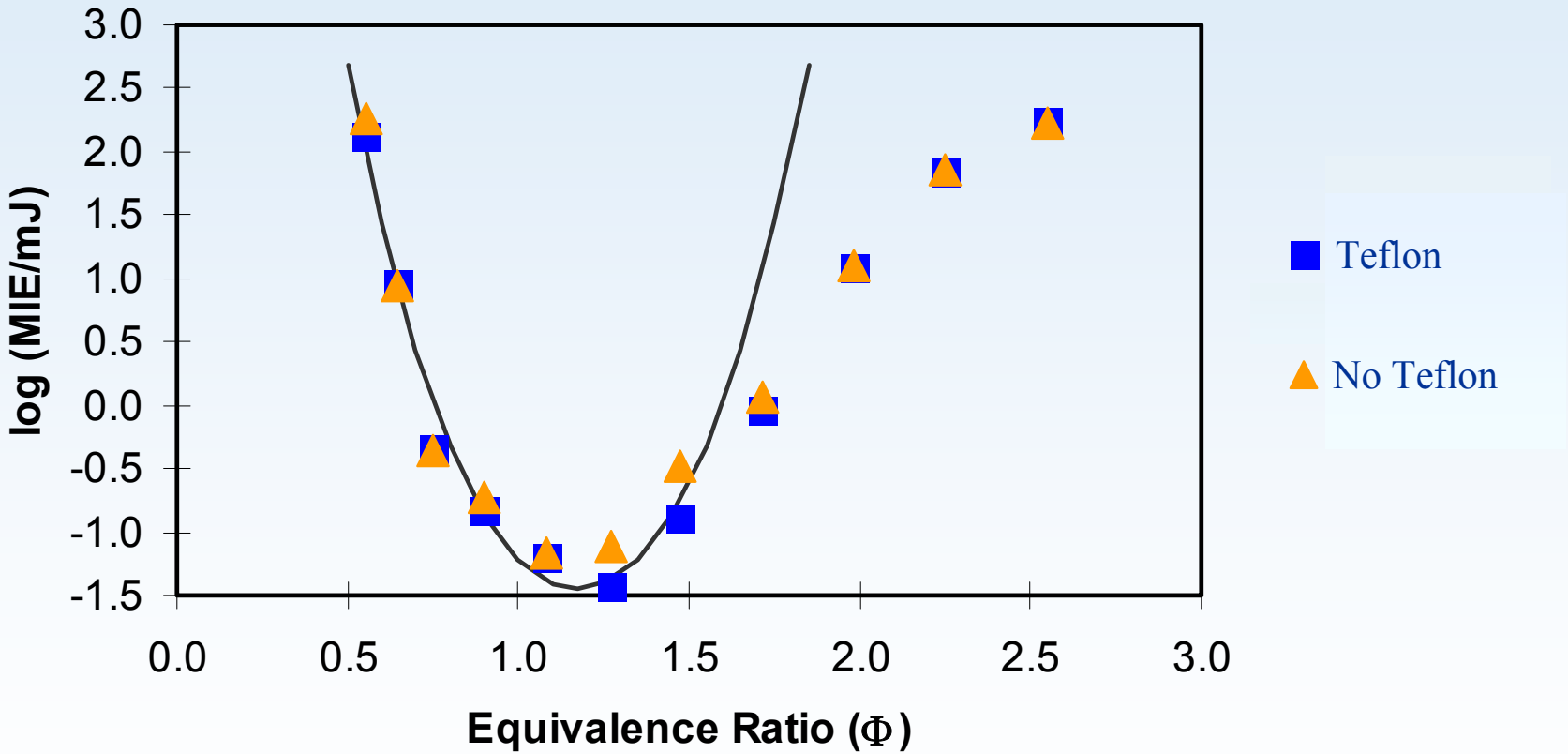

1000
800
600
400
200
0
Time to Peak Pressure (ms)
60
50
40
30
20
10
0
Pressure Rise (psi)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Equivalence Ratio

Effect of Vapor Composition on Minimum Ignition

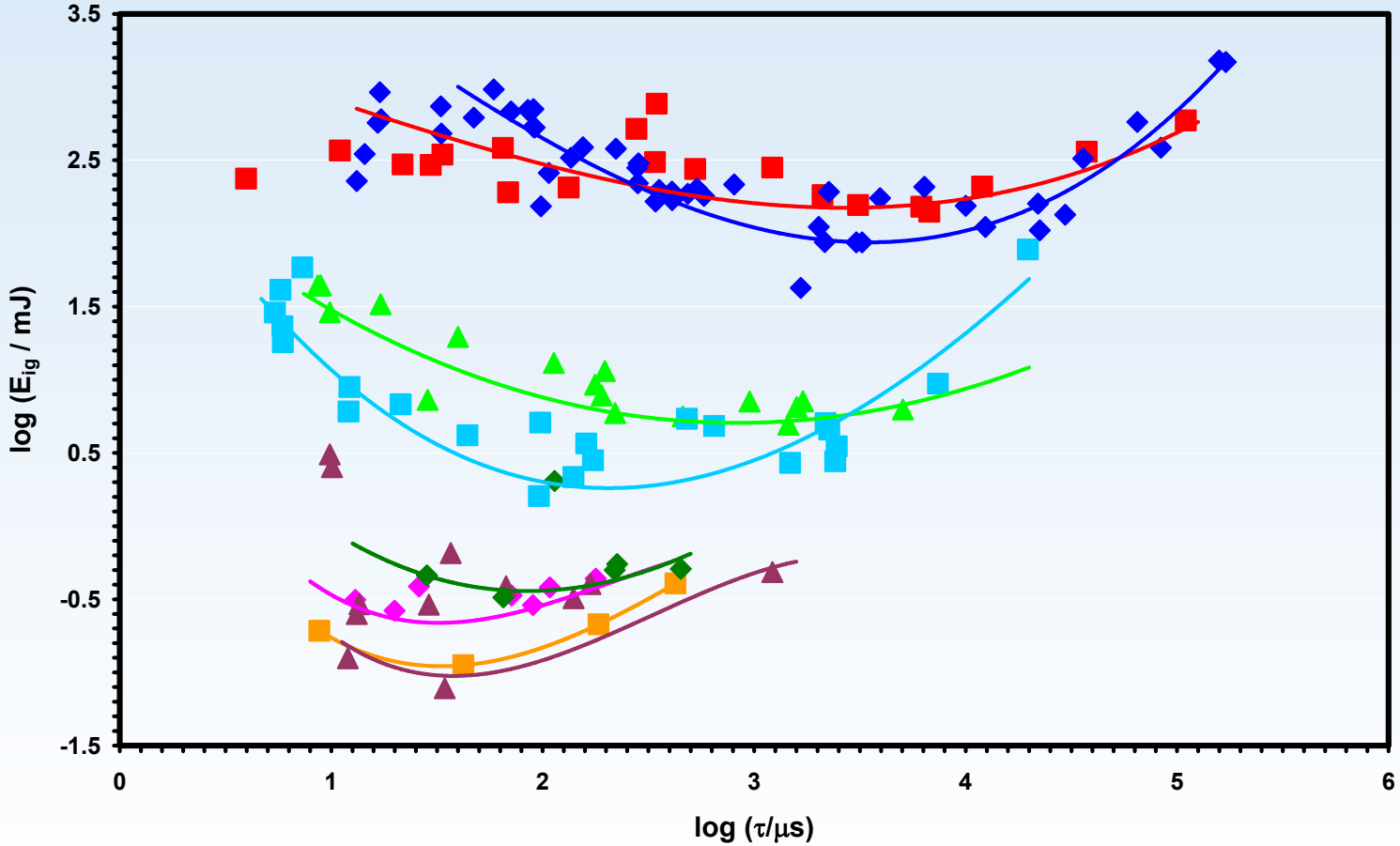


Methanol Minimum Ignition Energy

Effect of Electrical Isolation



Methanol MIE vs Spark Duration

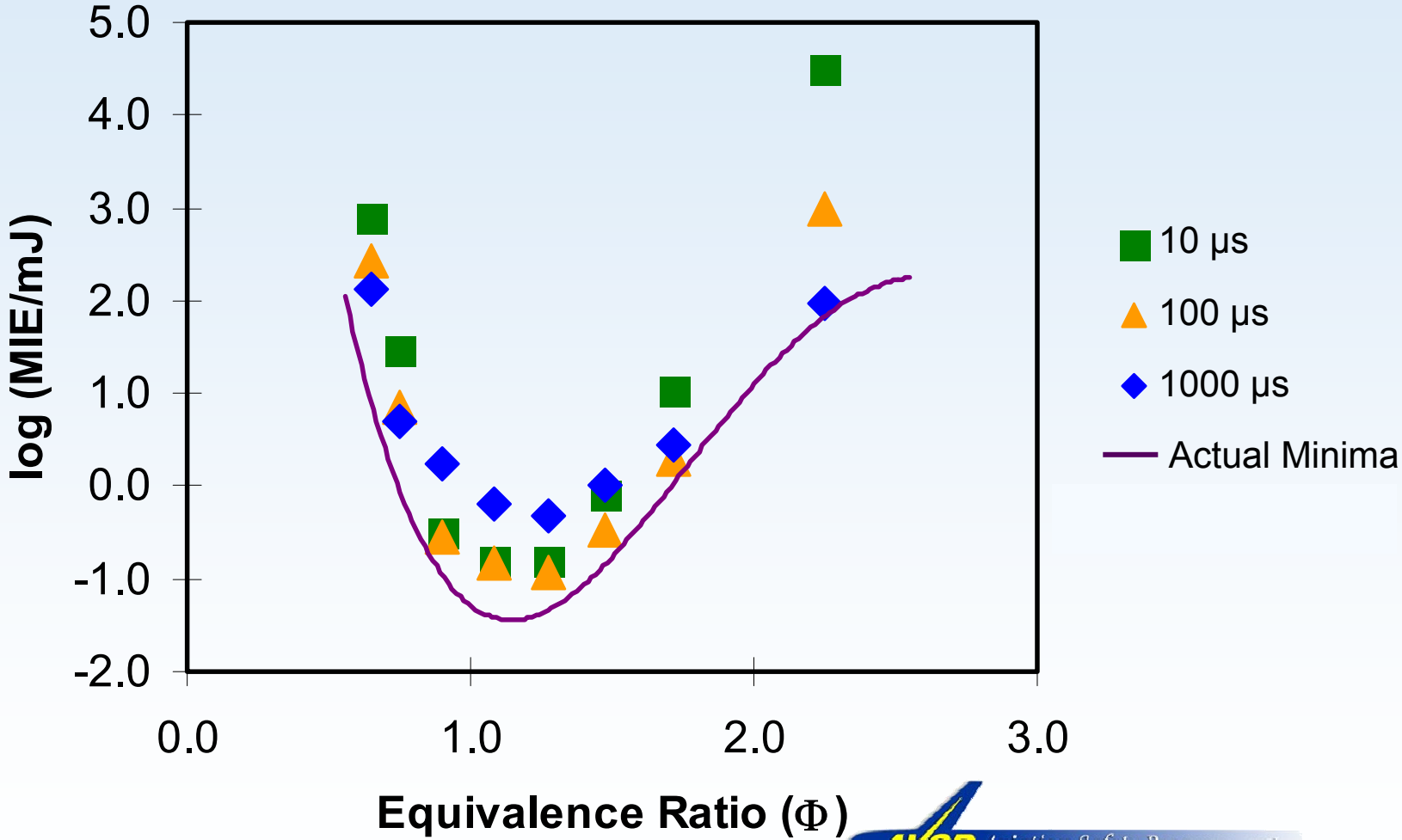


■ — 12.5 °C ▲ — 14.5 °C ◆ — 17.5 °C ■ — 20.0 °C

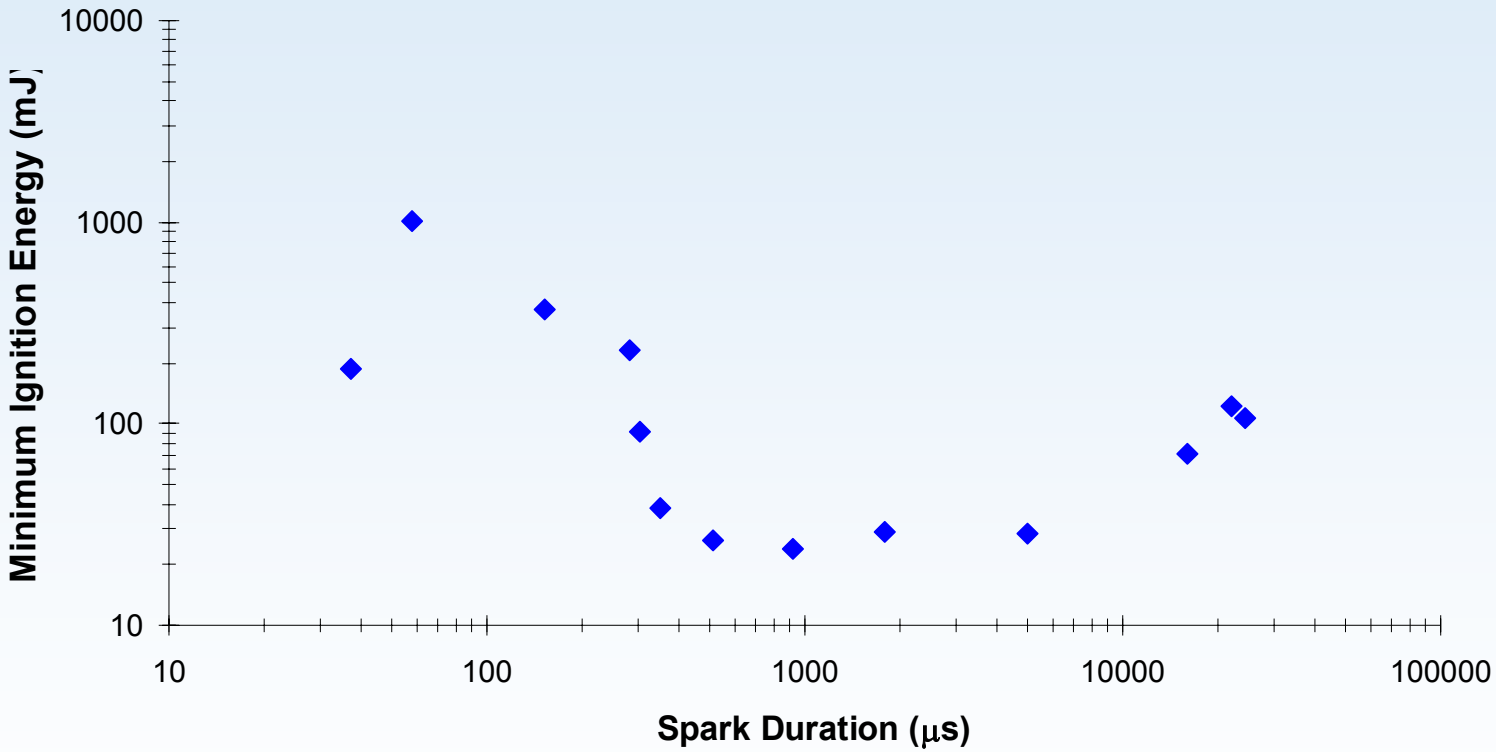
▲ — 22.5 °C ◆ — 25.0 °C ■ — 27.5 °C ◆ — 32.5°C

Methanol Minimum Ignition Energy

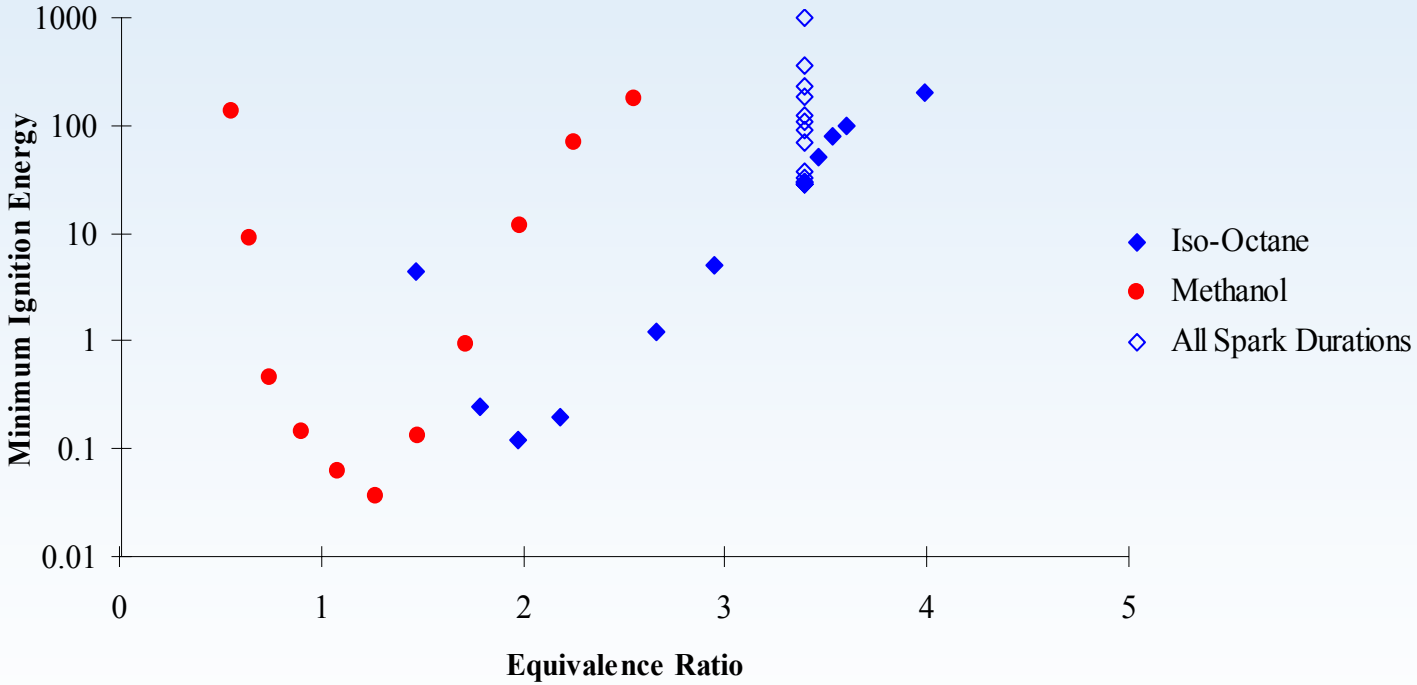
Effect of Varying Spark Duration



Iso-Octane MIE @ 21^{0}C
Effect of Varying Spark Duration



MIE Curves for Methanol and Iso-Octane



Conclusions

MIE Depends Upon Ignition Source and Duration

Shape of MIE *vs* Temperature Curves Varies Strongly with Spark Properties

Not So Easy – Need To Find Spark Duration for MIE at Each Condition