Machine Gun Suppression Lessons Learned

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(U) Overview

- (U) Basic Design Principals
  - (U) Noise Reduction
  - (U) Flash Control
  - (U) Weapon Operation
  - (U) Materials and Heat
- (U) Test Techniques
  - (U) Sound and Flash
  - (U) Operating Group Velocity
  - (U) Blowback
  - (U) Recoil
  - (U) Thermal
  - (U) Dispersion

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(U) Noise Reduction Principles

- (U) Reduction in primary blast wave strength
  - (U) Pressure reduction is done with baffling and volume increase.
  - (U) Temperature reduction is accomplished by heat transfer to surfaces inside suppressor
- (U) CFD modeling is effective at looking at techniques to reduce blast
- (U) A suppressor with complex baffle structure and strong clamping of pressure may have bad blowdown and back-pressuring.

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(U) Flash Reduction Principles

- (U) Flash control is about elimination of ignition sources and starving the fuel rich propellant flow of oxygen.
- (U) Adding salts to propellants can shift ignition temperature higher but not eliminate ignition sources.
- (U) A flash hider disrupts the Mach Disk of flow that is not ignited. Will not work with suppressors where ignition has already occurred in the can.
- (U) A suppressor, because of the complex surfaces will almost always ignite the propellant through shock heating when oxygen is present in the can for the first few shots.
- (U) Extreme flow restriction in the can could reduce flash at exit for initial shots.
- (U) Focus on suppressor flash should be on reducing oxygen, mixing and peak temperature at exit.
- (U) Can be accomplished by shielding core flow with lower velocity propellant gas and expanding flow.

(U) Weapon Operation

- (U) A good suppressor will work well with the weapon.
- (U) Important to have fast blowdown of barrel.
  - (U) Reduces blowback
  - (U) Reduces weapon overpowering.
  - (U) Critical for machine gun suppressors.
- (U) Important to use 2-D CFD to model overpowering and blowback when designing suppressors.
- (U) Suppressor weight, location and barrel stiffness can change nodal frequencies and dispersion.

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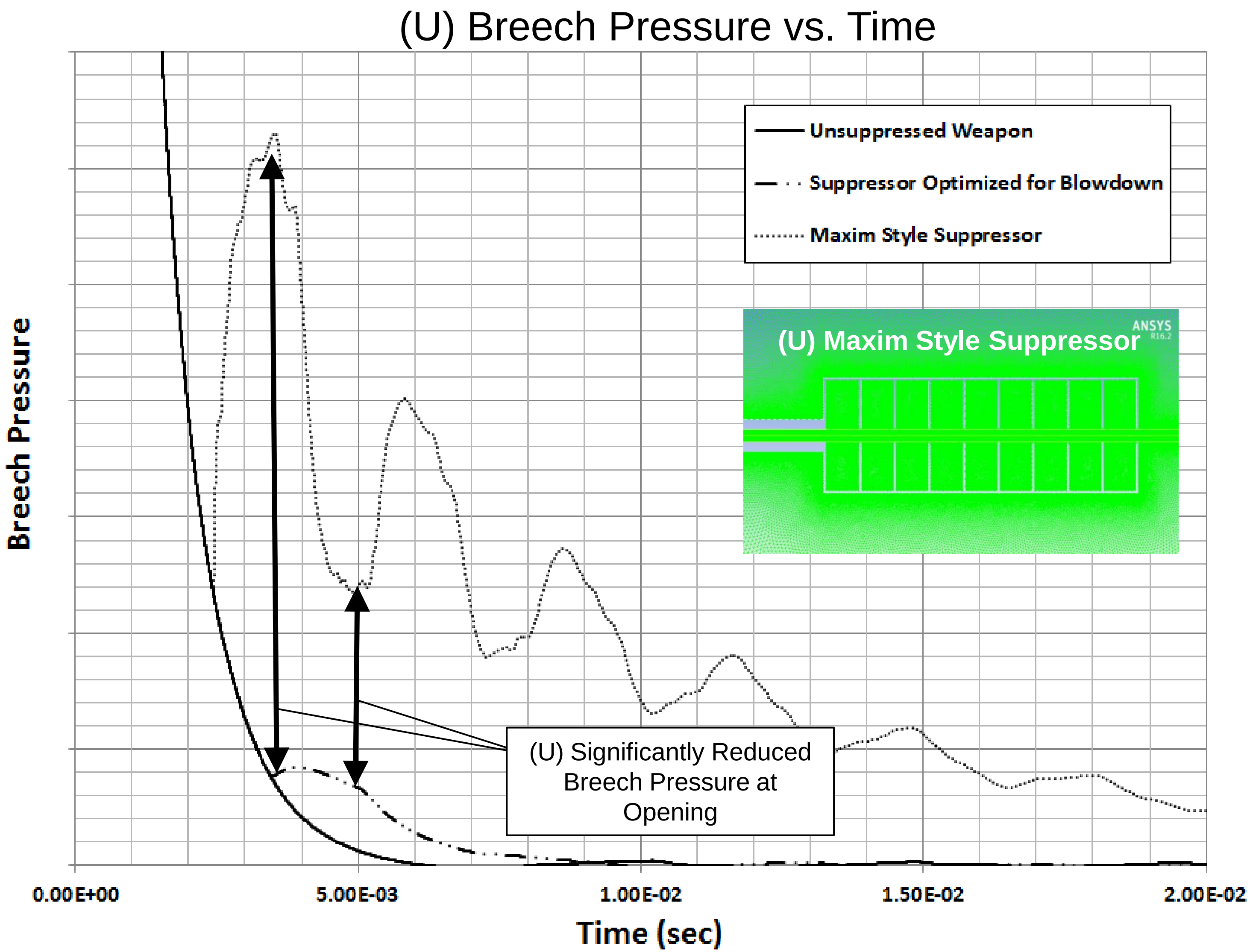
(U) Materials Selection and Heat Load

- (U) Look at heat load (maximum firing rate and duration) and design material accordingly.
- (U) Approximately 20-40% of available energy in propellant is transferred to a cool suppressor.
- (U) Heat transfer rate slows as suppressor heats up to gas temperature.
- (U) Gas turbine blade materials and fabrication techniques are applicable to machine gun suppressor design.

(U) ANSYS Fluent
2D Weapon Blowback Analysis



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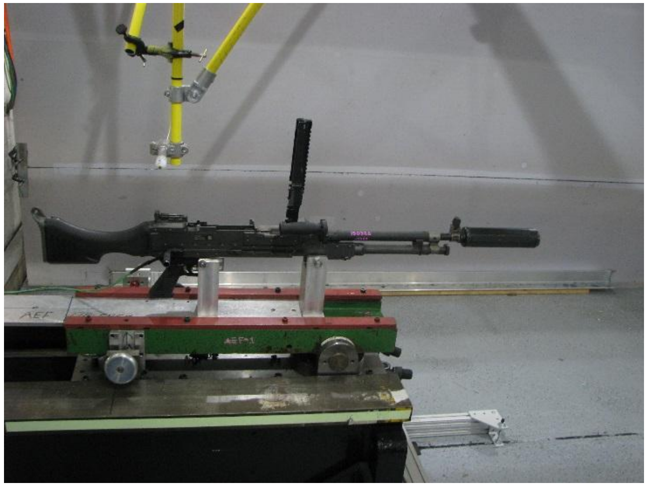
(U) Test Setup –Blast and Flash

(U) 3 Blast gages and high-speed video

(U) 170 degree – 1m blast gage



(U) Gigahertz sensors and Canon open shutter

(U) Downrange viewing mirror

(U) Blowback and Bolt Velocity Measurement

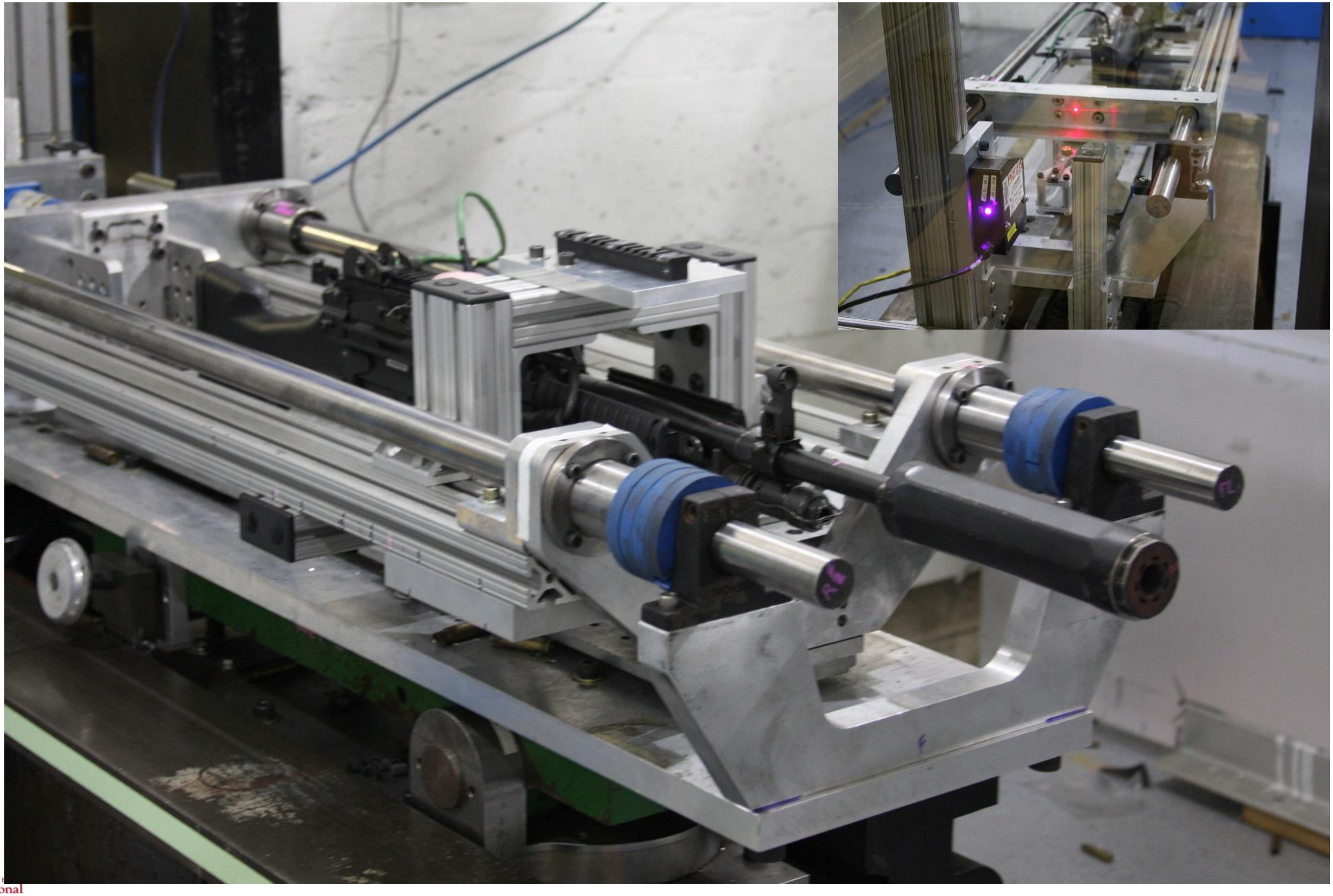
(U) Blowback gage

(U) Blowback gage mount

(U) Laser position of bolt

(U) Nylon bolt adapter for laser location

(U) Free-Recoil Impulse Measurement



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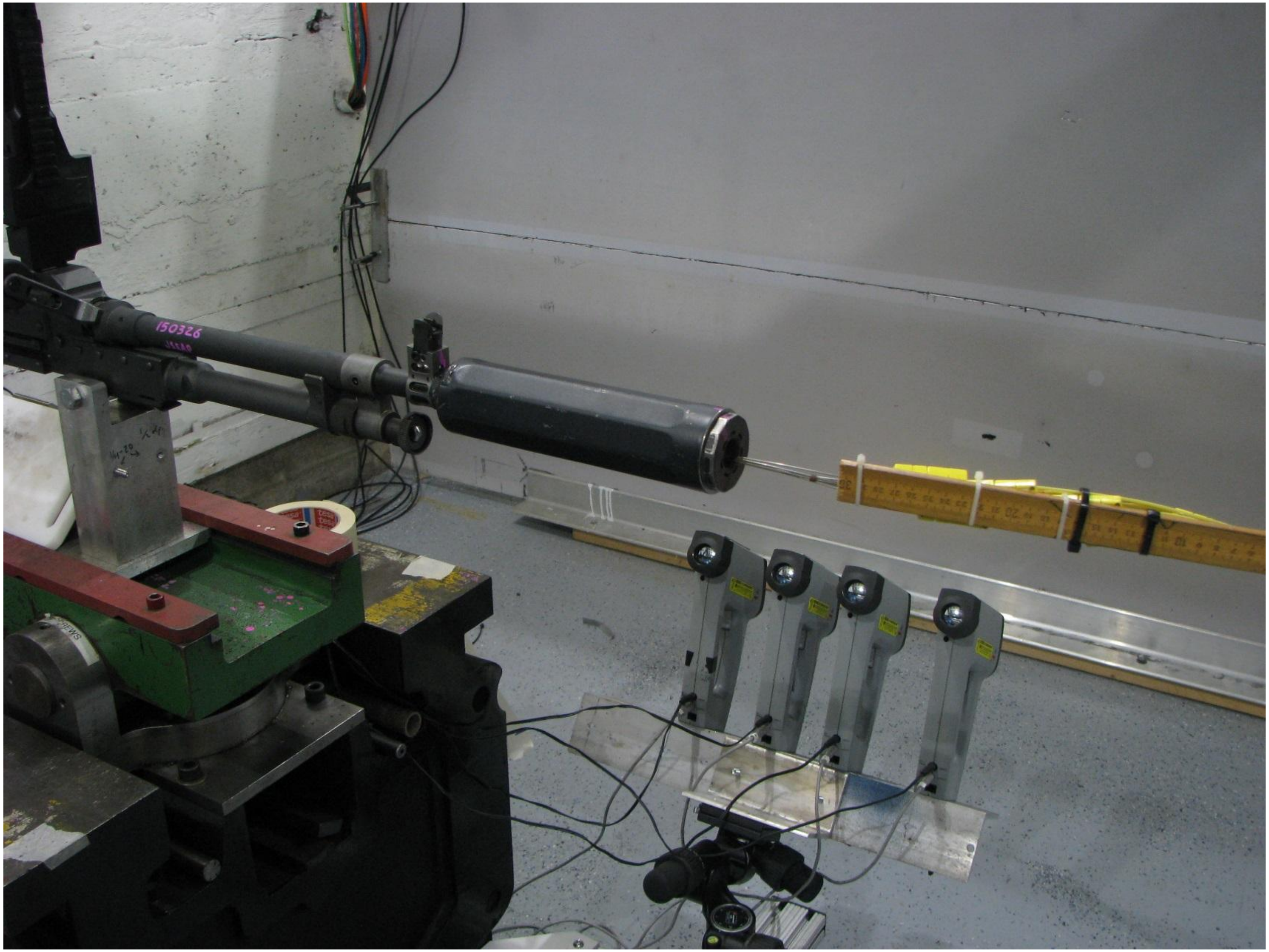
(U) External and Internal Temperature Measurement



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(U) M240L – 1 Minute Cyclic Endurance

(U) Performance Parameters and Measurements

(U) Performance Parameter Table

Performance Parameter	Measurement
Flash Suppression	**Relative Light Increase**
[redacted]	**Average**
	20 Round Burst - M80A1 - First Round Flash (3 Round Burst Warmer)
	20 Round Burst - A131 Old - First Round Flash (3 Round Burst Warmer)
	M80 Old - First Round Flash
	M80 New - First Round Flash
	M80A1 - First Round Flash
Sound Suppression	**Relative Sound Reduction**
[redacted]	**Average**
	20 Round Burst - M80A1 - First Round Flash (3 Round Burst Warmer)
	20 Round Burst - A131 Old - First Round Flash (3 Round Burst Warmer)
	M80 Old - First Round Flash
	M80 New - First Round Flash
	M80A1 - First Round Flash
Dispersion	Relative Dispersion Degradation in Burst
Weight	Relative Weight Increase
Length	Relative Length Increase
Diameter	Relative Diameter Increase
Impulse Reduction	% Reduction in Impulse
Human Eye Photometry - Flash	Burst at Night - Neutral Density Filter at 44.2m
Themal Heating Per Shot	Thermal Load in Joules Per Shot (20 Rnd Burst)
Thermal Cooling Rate / Deg-C	Thermal Cooling Rate (Watts) / Deg-C (20 Rnd Burst)
Aggressive Fire Survivability	1 minute cyclic- max gas block temp Deg-F
Aggressive Fire Survivability	1 minute cyclic- max suppressor temp Deg-F
Bolt Velocity	Percentage Increase In Bolt Velocity
Blowback	Percentage Increase In Blowback
Firing Rate	Percentage Increase in Firing Rate
Single Shot Dispersion - SDX Avg	SDX Change Relative to Baseline
Single Shot Dispersion - SDY Avg	SDY Change Relative to Baseline
Single Shot Dispersion - SD Avg	SD Change Relative to Baseline
Mount Burst Dispersion - SDX Avg	SDX Change Relative to Baseline
Mount Burst Dispersion - SDY Avg	SDY Change Relative to Baseline
Mount Burst Dispersion - SD Avg	SD Change Relative to Baseline
Soldier Burst Dispersion - SDX Avg	SDX Change Relative to Baseline
Solider Burst Dispersion - SDY Avg	SDY Change Relative to Baseline
Soldier Burst Dispersion - SD Avg	SD Change Relative to Baseline

(U) Conclusions

- (U) Higher temperature and thicker materials required
- (U) Flash will likely always be higher than standard flash hider
- (U) Large sound reduction not possible with high volume fire considering blowback and heat
- (U) Dispersion can be affected by changes in nodal frequencies of the barrel