Laser Dazzler Effects and Applications

NATO Military Police Close Protection Forum 2023

17 May 2023

Joint Intermediate Force Capabilities Office (JIFCO)

US Dept. of Defense

Agenda

- What are Laser Dazzlers?
  - General effects & applications
- Human Effects & Injury Risks
  - Effects: Hailing/Warning, Distraction, Visual Suppression
  - Conditions affecting performance
- Hardware
  - Power output, wavelengths, form factors
  - Engineering controls for effects and safety
- Policy & Regulatory Considerations
  - Safety standards, laser safety review boards

What are Laser Dazzlers?

Low power visible laser devices intended to have reversible non-lethal effects

- Temporarily overwhelming an adversary's visual sense by emitting a credible glare source
- Providing an unequivocal, non-verbal warning
- Providing the target an opportunity to clarify intent

Advantages:

- Relatively low-cost
- Relatively small form factor
- Reliable effects, short & long range
- Low risk of injury

General Applications & Effects

Applications:

- Convey Protection
- Entry Control Points
- Urban Operations
- Long Range Vehicle & Vessel Hailing
- Dismounted Patrol

Effects:

- Unambiguous Hailing/Warning
- Glare
- After Images
- Temporary Visual Suppression

Example Vignette: Urban Operations

EoF CROWS

Solid-State Active Denial Technology

MANEUVER TO OBJECTIVE:

- Coalition forces conducting operations in megacity across the continuum.
- Joint Forces must maneuver through urban areas to reach objectives.
- Noncombatants number in the tens of thousands and attempt to lead normal lives.
- Civilian vehicle and foot traffic impede movement of friendly forces.

INTERMEDIATE FORCE CAPABILITIES (IFCs):

- **Dazzling Laser and Acoustic Hailing Device** mounted on **Escalation of Force (EOF) Common Remotely Operated Weapon Station (CROWS)** warns pedestrians/vehicle operators to give way.
- **Vehicle Mounted Solid-State Active Denial Technology (SS-ADT)** clears roads of non-compliant individuals.
- **Vehicle Mounted Radio Frequency Vehicle Stopper** protects friendly forces from vehicle-borne improvised explosive devices.

OPERATIONAL IMPACT:

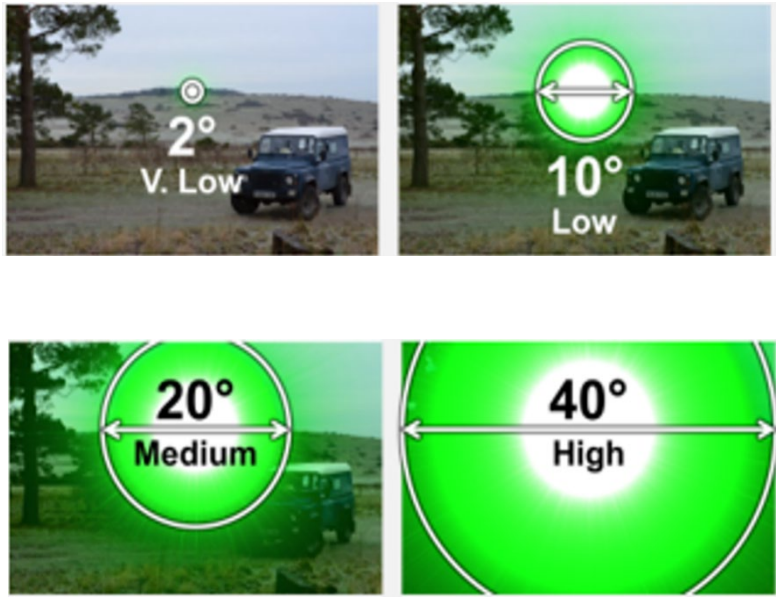
- Help to prevent unnecessary destruction and loss of life.
- Expand decision time and space in ambiguous situations.
- Enable proactive operations while reducing risk in information space.

Human Effects

Irradiance $(\mu W/cm^2)$

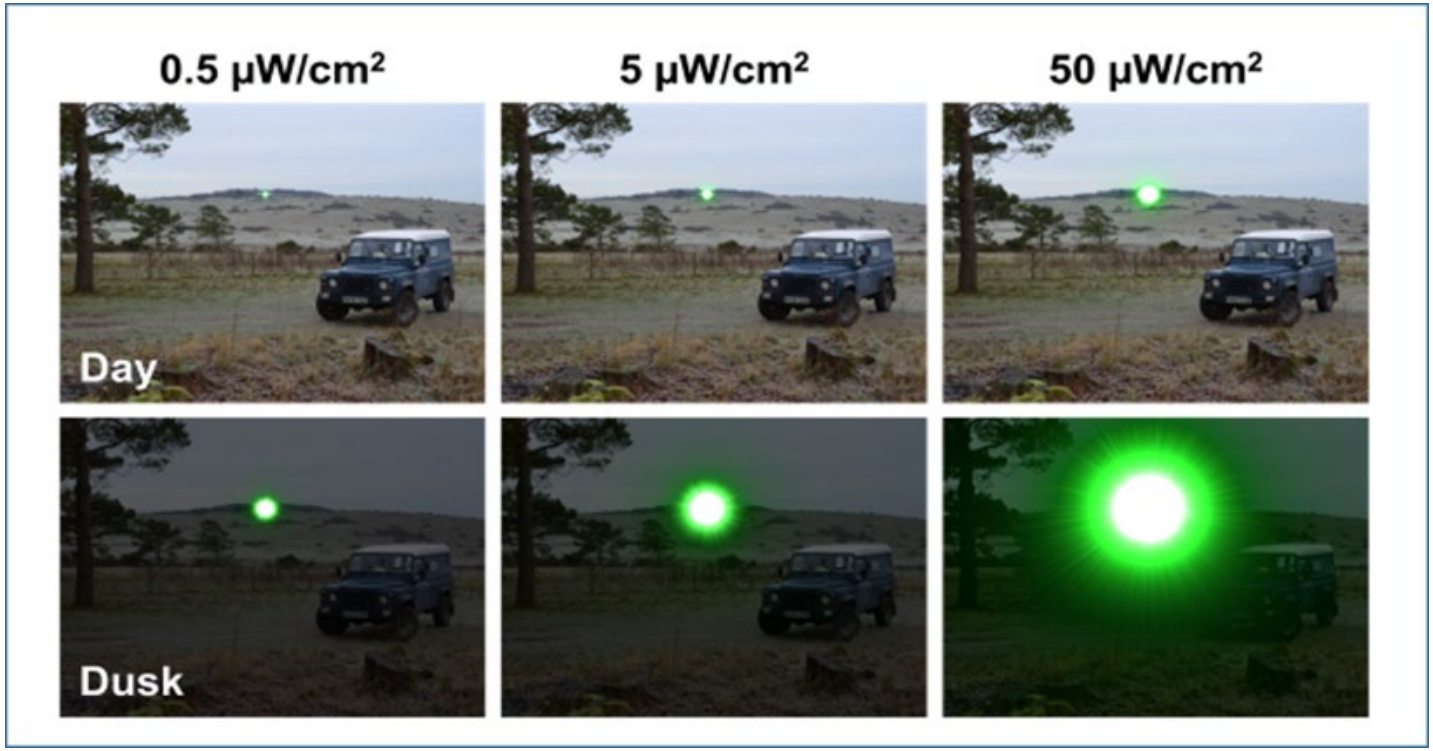
+ ⟶

Visible Detection ⟶ Unambiguous Warning ⟶ Visual Suppression

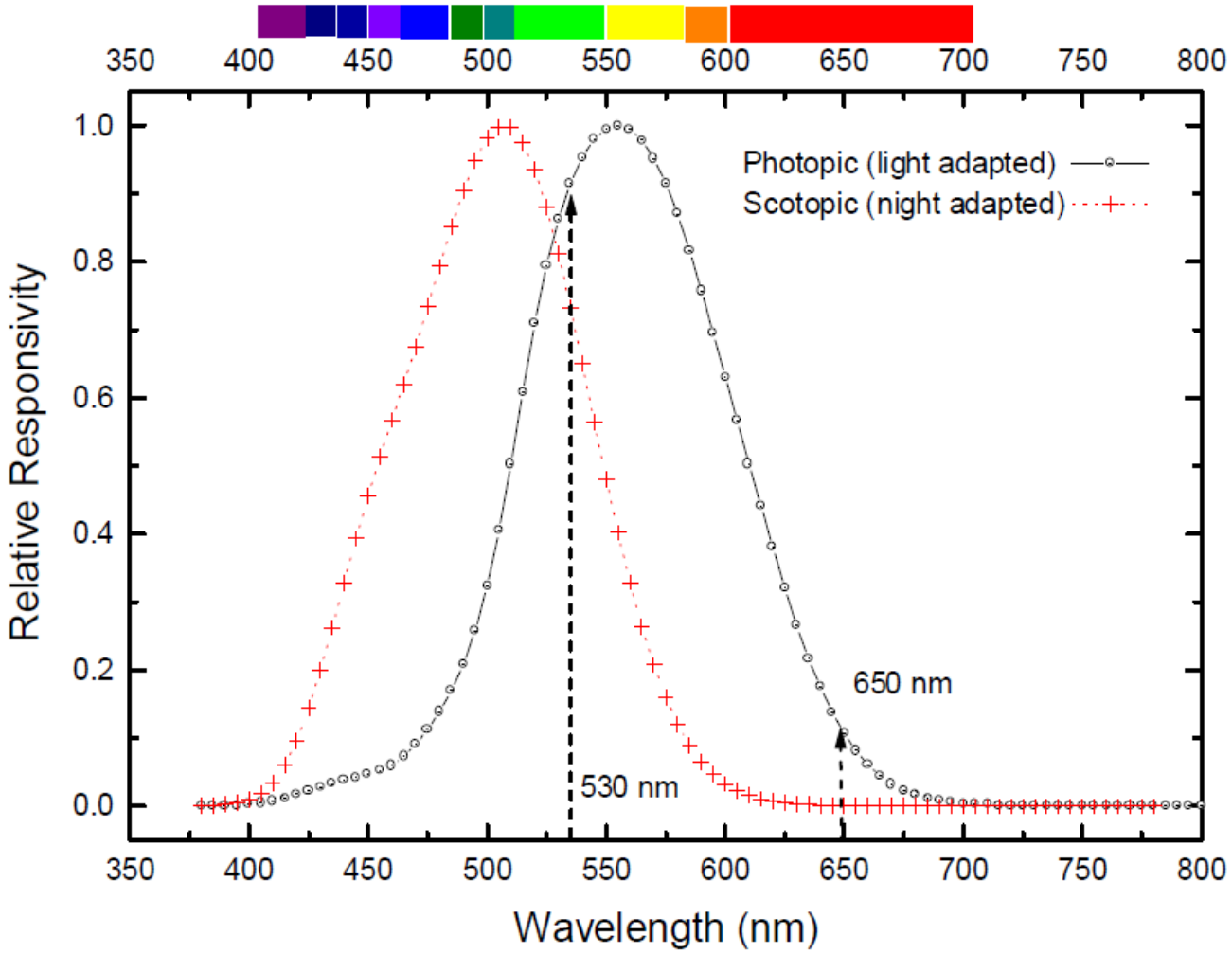


- Size of glare in visual fields increases as irradiance on target increases
- Glare effects often increased behind glass through scattering

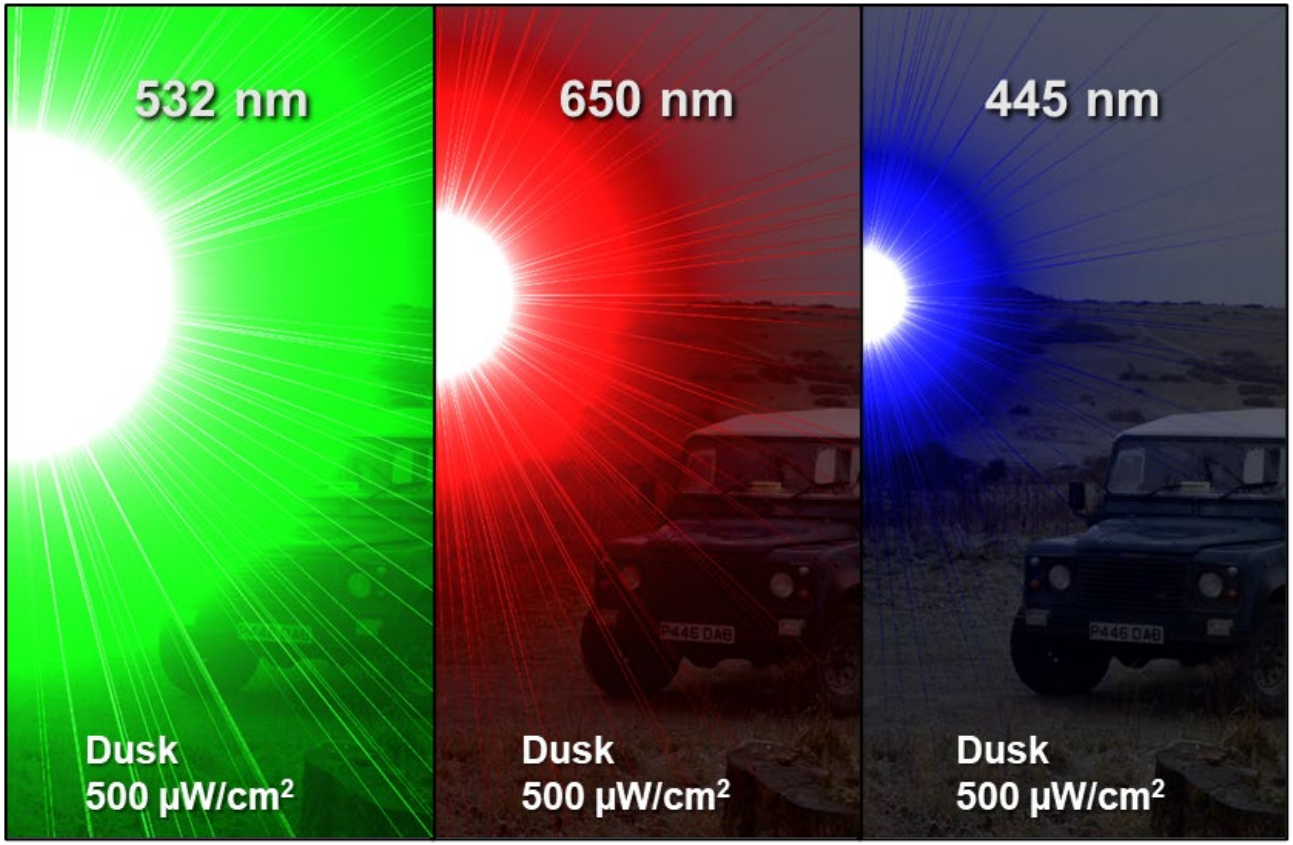
Effects of Ambient Lighting



Dazzler Wavelengths



Dazzler Wavelengths



Williamson, C. A., McLin, L. N., Rickman, J. M., Manka, M. A., Garcia, P. V., Kinerk, W. T., & Smith, P. A. (2017). Wavelength and ambient luminance dependence of laser eye dazzle. Applied optics, 56(29), 8135-8147.

Safety & Injury Risks

- Laser device can cause injuries to eyes and skin
- However, visible laser dazzlers do not pose any risk of skin injuries and eye injuries can be prevented with administrative (training, rules of engagement) and engineering controls
- Desired non-lethal effects can be achieved well below thresholds for injury and laser hazard standards
- US Department of Defense uses American National Standards Institute (ANSI) Z136.1
- Maximum permissible exposure (MPE) for ¼ second exposure
  - 2.5 $^{mW}/_{cm^2}$
  - 0% risk of injury when below MPE
- Nominal Ocular Hazard Distance is defined as distance from laser source where peak irradiance falls below MPE

Laser Technology & Form Factor

Laser Technology:

- Solid state, diode-pumped
- Output: mW to tens of Watts
- Wavelengths (i.e., colors):
  - A lot of options now: red, green, blue, etc.
  - Most common is a frequency doubled Nd:YAG (neodymium-doped yttrium aluminum garnet) – 532nm (green)

Form Factors:

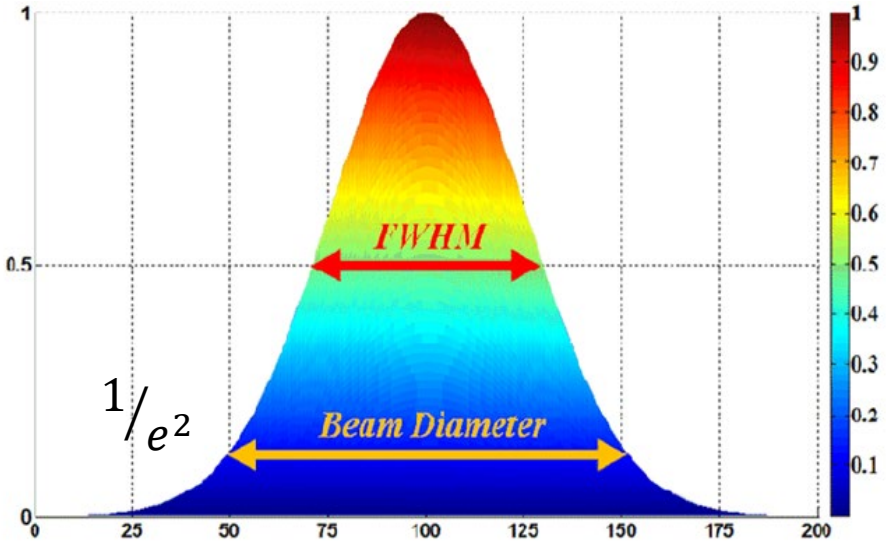
Handheld

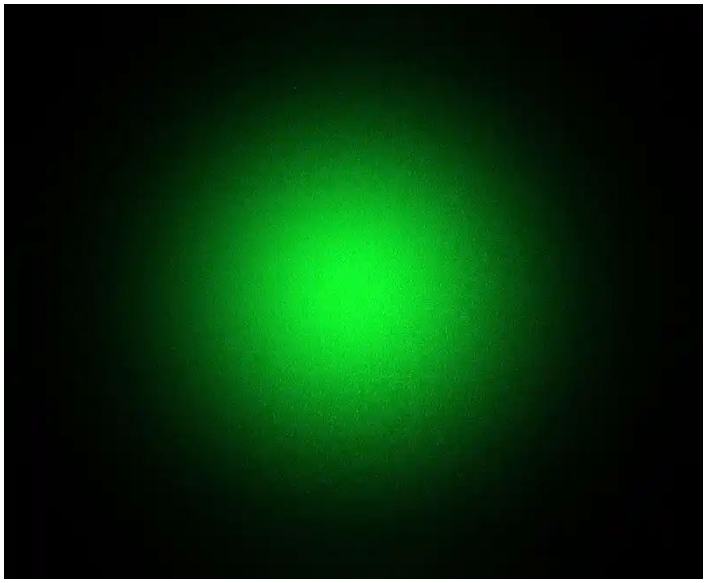
Weapon-mounted

Platform-mounted

Laser Spot Size & Beam Profile

- Laser spots are not uniform in intensity
- Spot sizes can be defined by different conventions

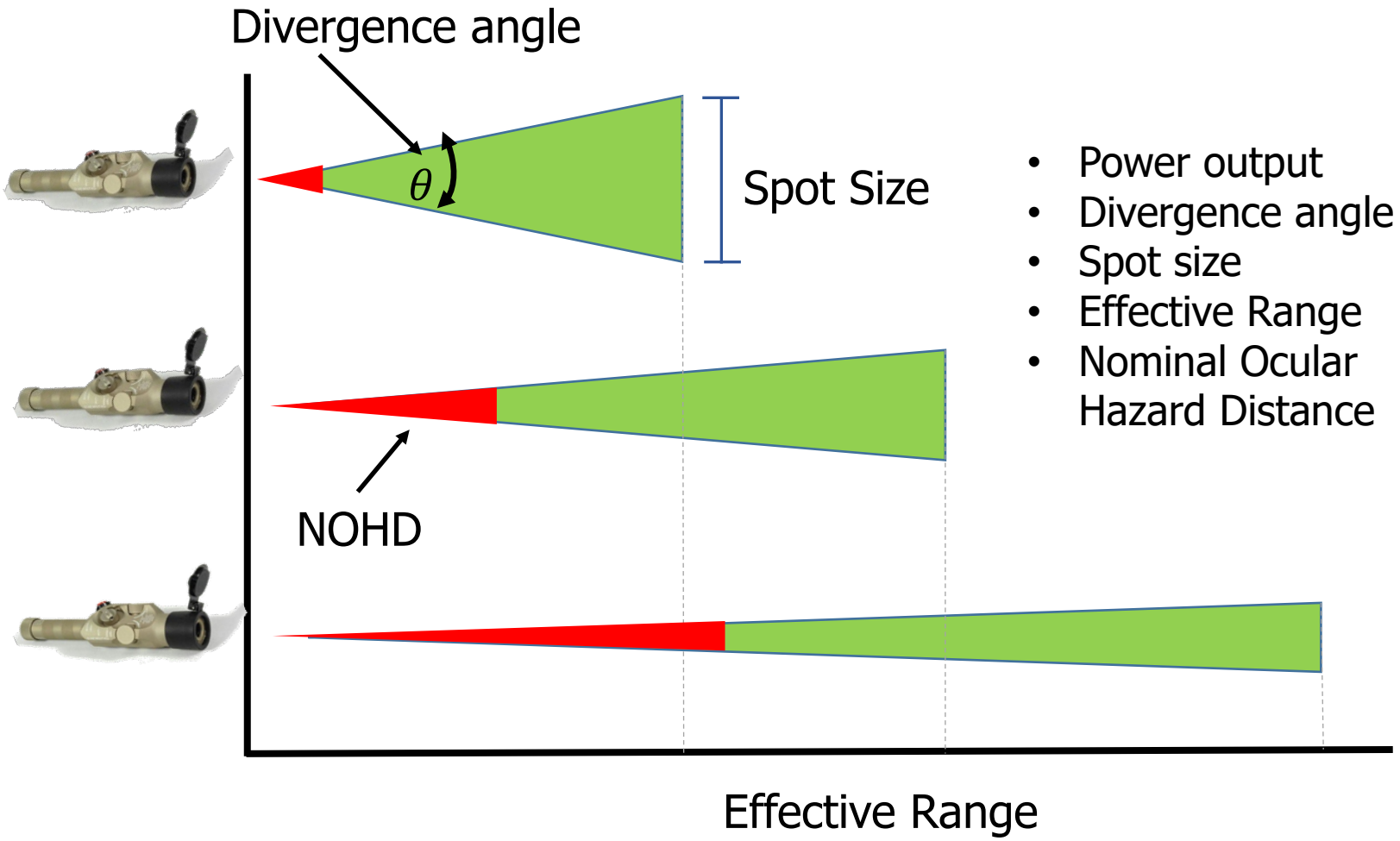




- You could also define an "effective spot size"

Images from: *https://en.wikipedia.org/wiki/Gaussian_beam*

Hardware Trade Space

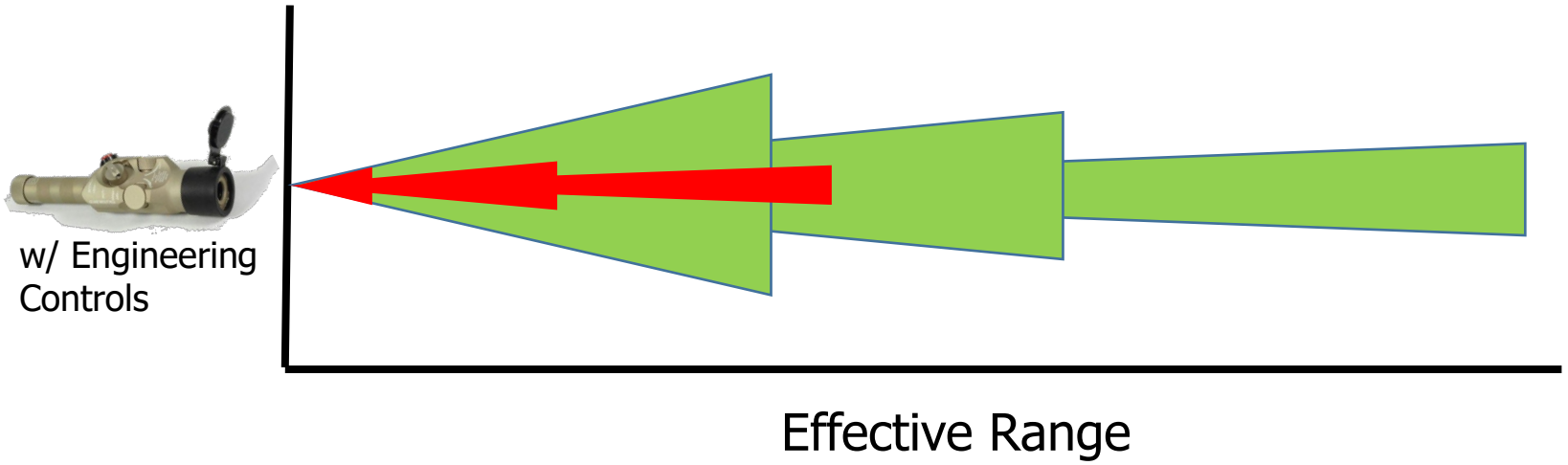


- Power output
- Divergence angle
- Spot size
- Effective Range
- Nominal Ocular Hazard Distance

Engineering Controls

- Engineering controls can be utilized to maximize utility for a given laser source

- **Example:** Integrated laser range finder output used to automatically adjust laser divergence to maximize effect and minimize risk of injury based on range to target



Fielded Systems

US Navy:

- B. E. Meyers "GLARE" LA-9/P – 250mW output power includes a safety control module
- Long Range Ocular Interrupter (LROI): Green Dazzling Laser; Warning: 3000m; Suppression: 2000m
- Hailing Acoustic Laser and Light Tactical Systems (HALLTS): Integrates a BE Meyers LA/9-P with acoustic hailing
- Optical Dazzling Interdictor, Navy (ODIN) to disrupt unmanned aerial systems and other platforms

LA-9/P

LROI

USMC:

- B.E. Meyers 532-VPS GLARE RECOIL

Fielded Systems

US Air Force:

- BE Meyers GLARE RECOIL

GLARE RECOIL

US Army:

- Z-bolt Laser System Model MBP-5-ARMY; 3-5 mW output power
- Green Laser Interdiction Systems (GLIS) – B.E. Meyers GLARE MOUT; 250 mW output power

GLARE MOUT

Z-Bolt

US Coast Guard:

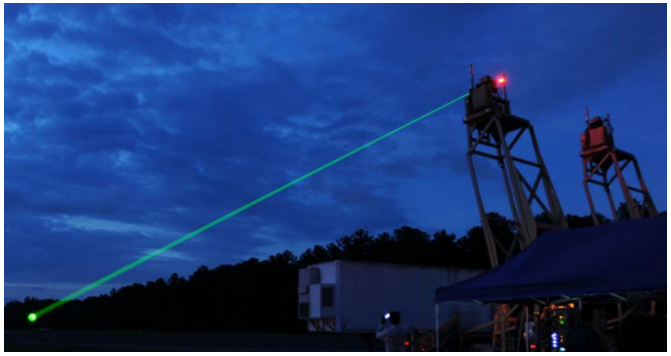
- LA-9/P
- CG-HALLTS

CG-HALLTS

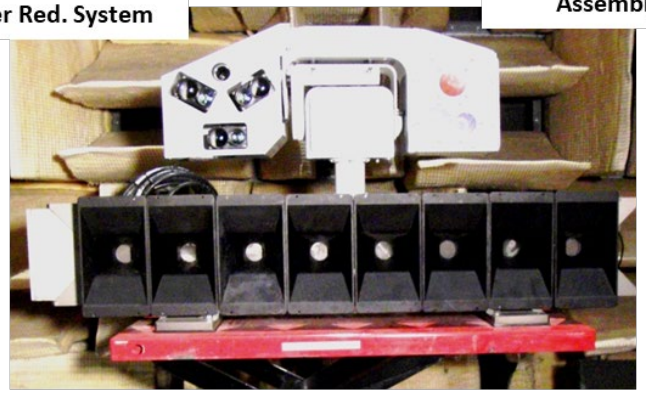
JIFCO-developed Distributed Sound and Light Array (DSLA) Prototype

Performance Specifications:

- Dazzling Laser Output Power:
  - 8 watts; Coherent TracER Green Forensic Laser System
    - Wavelength: 532 nm
    - Spot-Size: 3m
    - Cooling: Air-cooled
    - Weight: 10 lbs
- Acoustic Output:
  - 145 dB Acoustic Output with beamforming
- Bright White Light:
  - Maxa Beam Model MBS-430-AY; 12,000 candlepower; Range 3500m; 1^0 spot; 40^0 Flood; 3.2 lbs



Mini-DSLA mounted on a Tower



Enhanced Mini-DSLA System

Regulatory & Policy Considerations

- Laser devices, as compared to other light-emitting devices, are subject to much more regulatory review, control, marking, & procedures
  - Hazards standards
  - Institutional laser safety review boards
- Regulatory compliance can sometimes be a hurdle to train, test, & employ with laser dazzlers
- Training and administrative & engineering safety controls are key to safe and effective use for both the operator and targeted individuals

Regulatory & Policy Considerations

- 1995 United Nations Protocol on Blinding Laser Weapons
  - "It is prohibited to employ laser weapons specifically designed, as their sole combat function or as one of their combat functions, to cause permanent blindness to unenhanced vision…"
  - "…take all feasible precautions to avoid the incidence of permanent blindness to unenhanced vision. Such precautions shall include training of their armed forces and other practical measures."
- Non-lethal laser dazzlers are not prohibited by this protocol as they are intended to have non-injurious, temporary effects; however, each new device may have to be evaluated for compliance

Questions?