

# THE SCIENCE OF LASERS

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International  
Laser Display Association

# 2010 Super Bowl halftime show

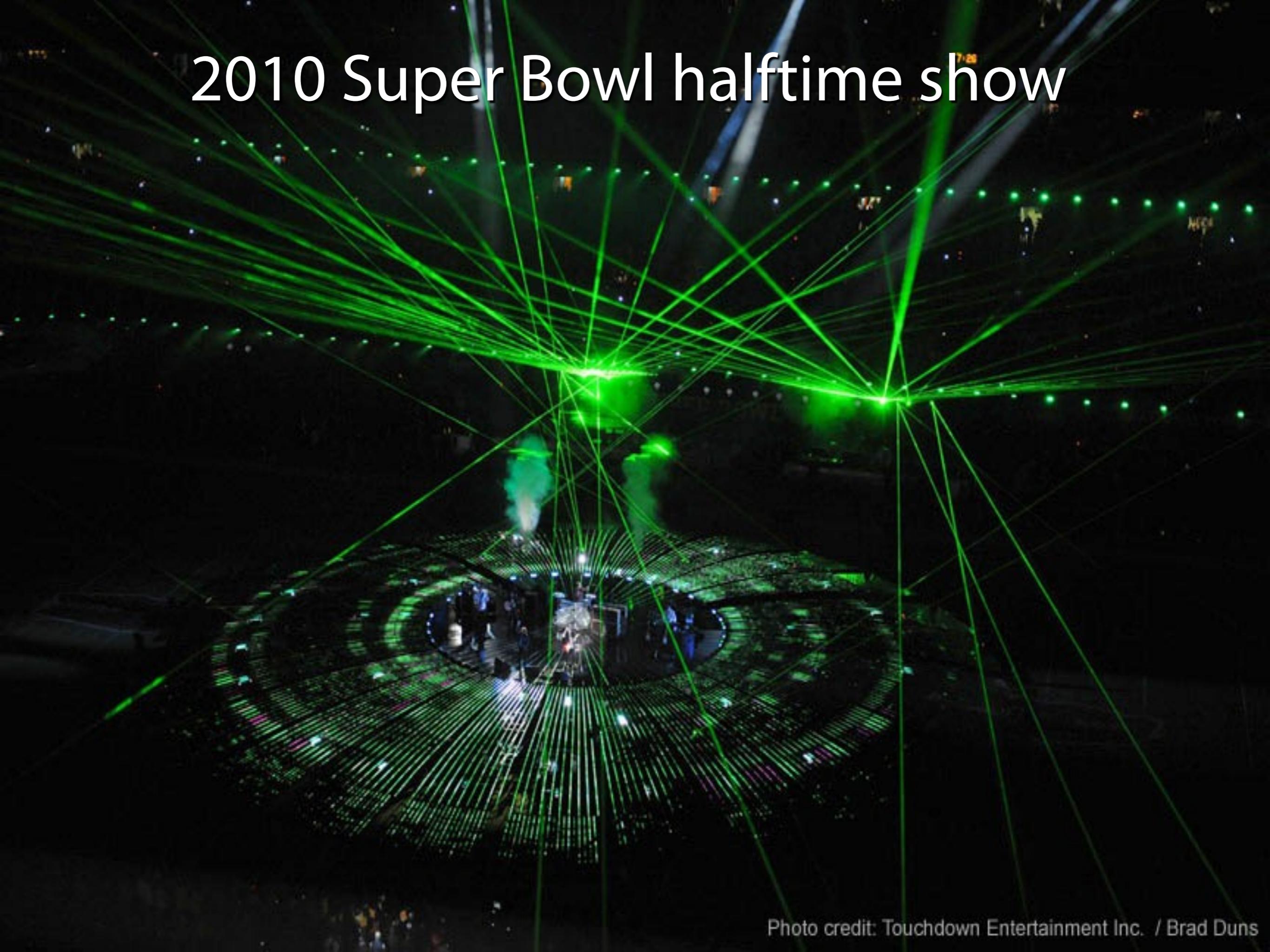
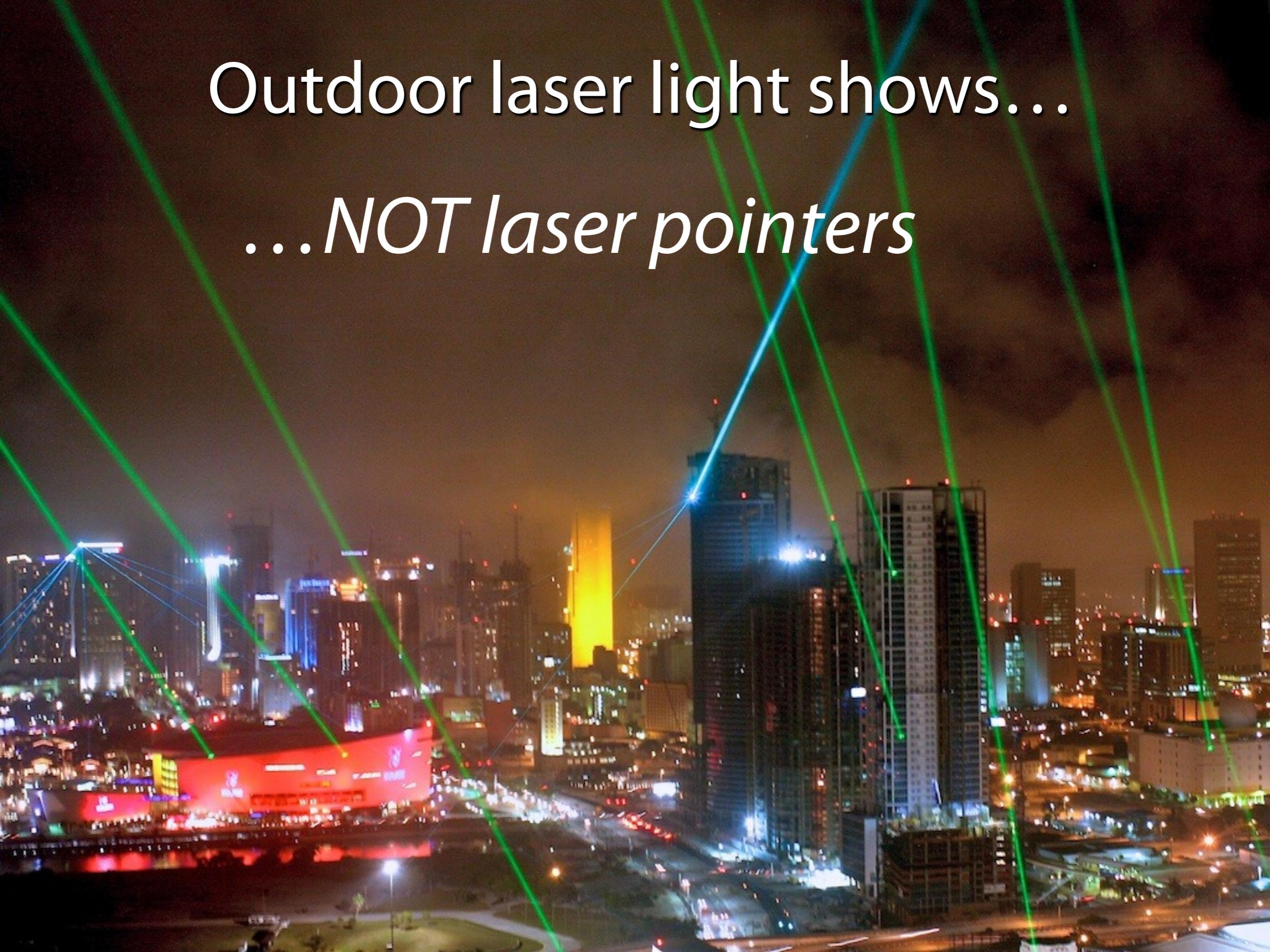


Photo credit: Touchdown Entertainment Inc. / Brad Duns

# Outdoor laser light shows



Outdoor laser light shows...  
...NOT *laser pointers*



SAE G10T  
Laser Safety Hazards  
Subcommittee

FAA Advisory Group



# Advisory Circular

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**SUBJECT: OUTDOOR LASER OPERATIONS**

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**Date: 12/30/04****AC No: 70-1****Initiated by:** AFS-400/  
ATO-R      **Change:****1. PURPOSE.**

a. This **Advisory Circular (AC)** provides information for those proponents planning to conduct outdoor laser operations that may affect aircraft operations in the National Airspace System (NAS). Also, the AC explains why notification to the Federal Aviation Administration (FAA) is necessary, how to notify the FAA of the planned laser operation, and what action the FAA will take to respond to such notifications.

b. In addition, to assist proponents in providing information to be used by the FAA in its review of outdoor laser operations, the AC includes:

- Appendix 1:
  - Notice of Proposed Outdoor Laser Operation(s) and Instructions;
  - Tables 1, 2, and 3, Maximum Permissible Exposure Limits;
  - Tables 4 and 5, Correction Factors;
  - Graphic Examples and Descriptions of Airspace Flight Zones;
- Appendix 2: FAA Regional Office Addresses; and
- Appendix 3: Glossary.

c. The **FAA's interest in these types of operations** does not supersede or invalidate any existing rules or ordinances promulgated by other Federal, state, county, or local government. The proponent is responsible for compliance with these requirements.

**2. AUTHORITY.**

a. The **FAA** has the authority to regulate the safe and efficient use of the navigable airspace (Title 49 U.S.C., Section 40103, Sovereignty and Use of Airspace, and the Public Right of Transit).

b. The **Food and Drug Administration (FDA)** has the authority to regulate light emitting products and electronic product radiation (Title 21, U.S.C. Section 360hh.).

3. **EFFECTIVE DATE.** This advisory circular becomes effective December 30, 2004.

**4. NOTIFICATION FORM.****a. Why is it necessary to Notify the FAA?**

(1) In recognition of the FAA's role in promoting aviation safety, the FDA requires notice to the FAA as a condition of a variance for outdoor laser operations.

(2) Early notice of the planned activity provides the FAA the opportunity to minimize the potentially hazardous adverse effects of laser operations on aircraft operators in the navigable airspace. The possible effects are flash blindness and afterimage created when a laser beam interferes with the vision of the pilot or air crewmember, and glare when the laser beam illuminates the windshield of an aircraft.

(3) The FAA recognizes that there are varied demands for the use of airspace, both by aviation and non-aviation interests. While a sincere effort is made to find equitable solutions to conflicts over the use of this national resource, the FAA must give primary consideration to aviation operations.

**b. Who should file a Notice?**

Any person/proponent who plans to conduct laser operations in the navigable airspace should file notice with the FAA. Navigable airspace is airspace above the minimum altitudes of flight prescribed by regulations including airspace needed for the takeoff and landing of aircraft (49 U.S.C. Section 40102).

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NEVER aim at aircraft

Don't aim at head & eyes

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About LaserPointerSafety.com

Site map (list of all pages)



Keep up-to-date on laser pointer incidents and issues by following @laserptrsafety on Twitter.

## Concerned about laser pointers? Want them used safely?

Welcome to LaserPointerSafety.com. We are an independent resource for [users](#), [regulators](#), [pilots](#), [media](#) and others concerned with handheld portable lasers.

While laser pens are useful and fun, they are all too often misused. This website has details about why you should [never aim laser pointers at aircraft](#), as well as [news](#), the [latest statistics on aircraft incidents](#), a [FAQ](#), a [video from the FAA and Air Force](#), and much more information. Check the menu at left for a complete list of our pages. For the latest updates to the site, see our [What's new](#) page.



*A helicopter being deliberately targeted by a laser pointer. The light is a distraction and, if bright enough, can cause temporary flashblindness. A video of the incident is [here](#).*

## New laser safety glasses for pilots

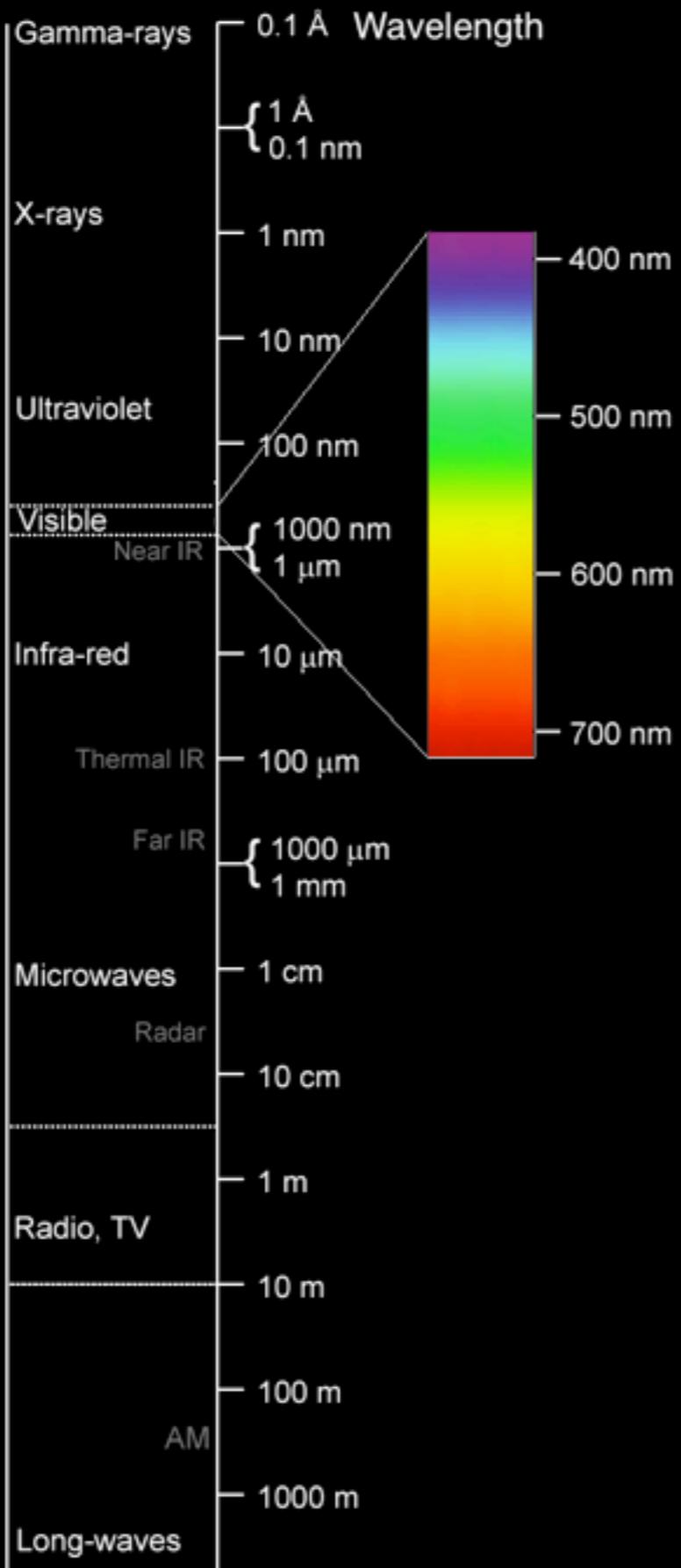
Anti-laser glasses are now available to pilots, which dim most common laser pointer colors, without adversely affecting color recognition of instruments, displays, and airport/runway lighting. More information on these glasses, and how they can help, is on the new [Protective eyewear for pilots](#) page.

“The Science of Lasers”

“The Science of  
Laser Pointers and Handheld Lasers,  
of the Type that are  
Misused by the General Public,  
in 20 minutes”

**WHAT IS  
LASER LIGHT?**

# The Electromagnetic Spectrum



Visible  
light



# LASER CHARACTERISTICS

Laser power  
Beam spread  
Color

## LASER CHARACTERISTICS

Laser power

Milliwatts (mW)

# Power range

1 to 1000 milliwatts (1:1000)

## LASER CHARACTERISTICS

Beam spread or  
divergence

Milliradians (mrad)

# 10 mrad divergence

Typical handheld: 1-2 mrad







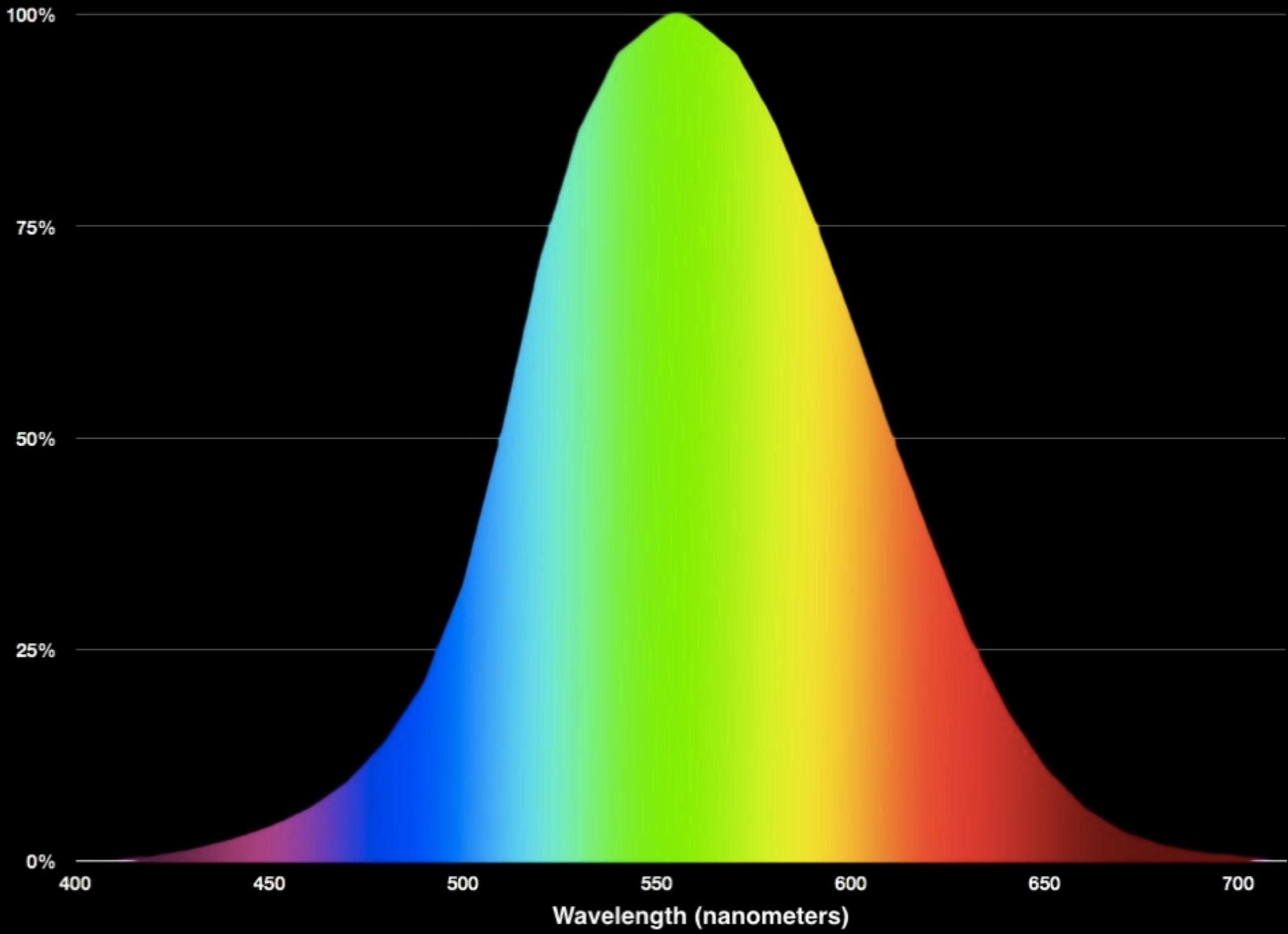


# LASER CHARACTERISTICS

## Beam color



# Green light appears brightest to the human eye



# HAZARDS OF LASER LIGHT

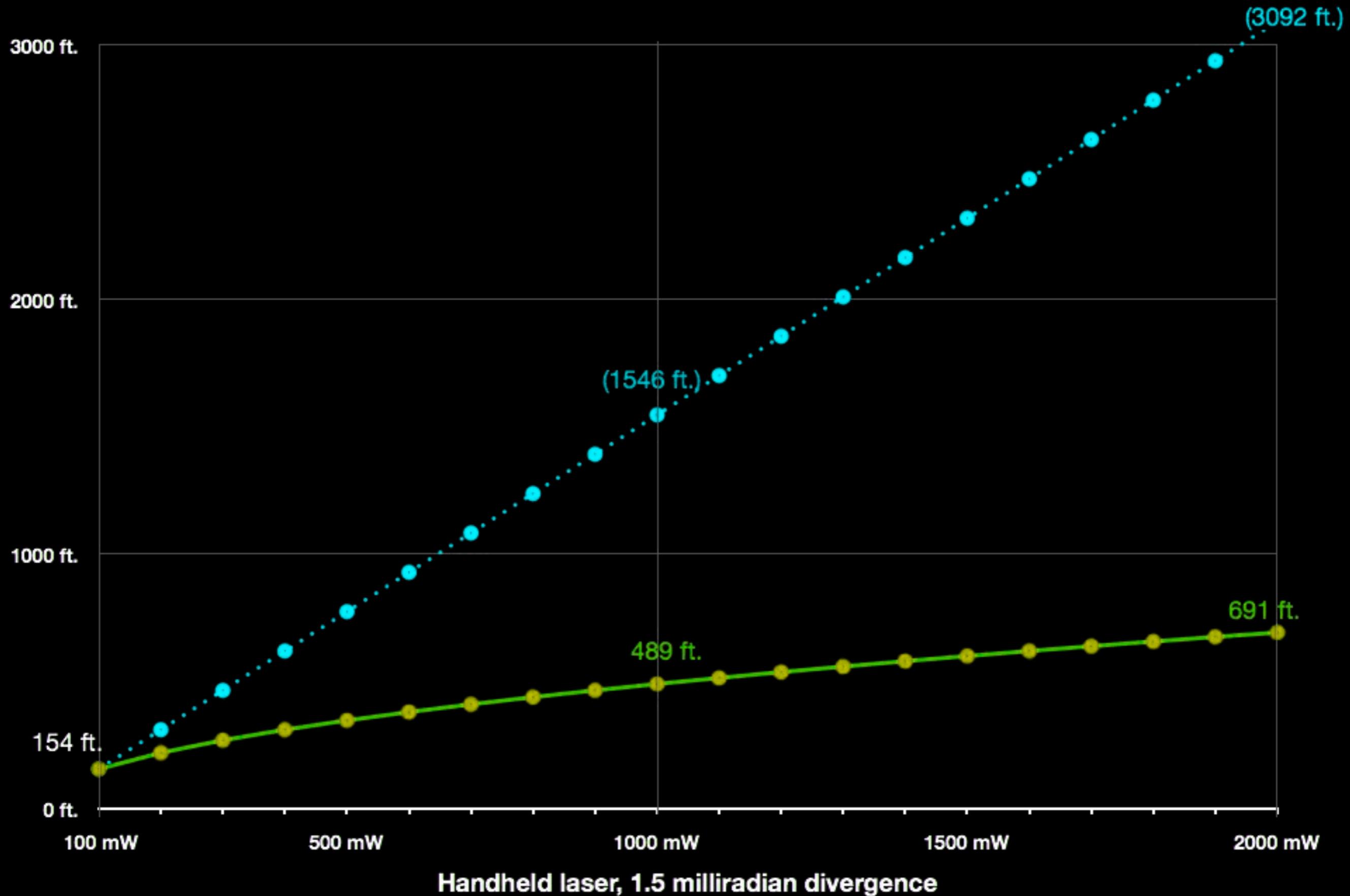
Laser power  
is not the same as  
laser hazard

# Power range

1 to 1000 milliwatts (1:1000)

$$\sqrt{1000} = 31.6$$

## Laser power vs. eye safety distance (NOHD)



# Hazards for pilots

Visual interference hazards

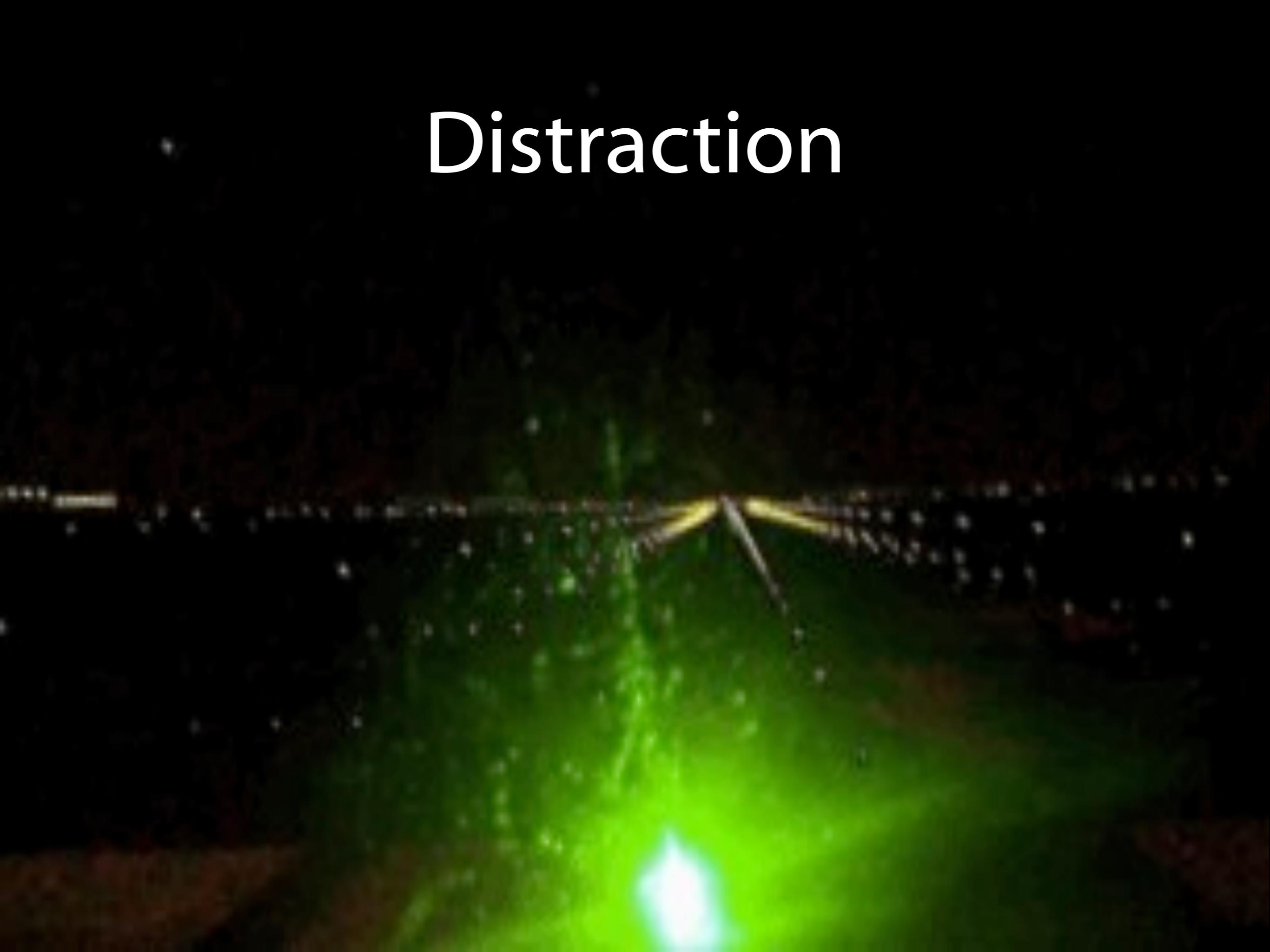
Eye injury hazards

Visual interference  
hazards

# Cockpit view (no laser)



# Distraction



# Distraction demo

# Glare & disruption



Glare demo

# Temporary flashblindness



# Flashblindness/afterimage demo

# Eye injury hazard

109 million people have had  
strong laser light  
in their eyes

# Audience-scanning laser shows

Very common in Europe, Asia

Deliberate exposure to multi-watt laser beams

# Audience-scanning laser shows

30+ years of shows

109 million people exposed to lasers

11 billion flashes of laser light in their eyes

Exceeds safety standards (MPE) by 10, 20, 100 times

# Audience-scanning laser shows



Result: 8 probable eye injuries in 30+ years,  
out of 109,000,000 viewers

From continuous wave visible lasers

# Eye injury demo

Lasers close-up  
are very different from  
lasers at a distance



# Typical helicopter incident



# Usually is NOT a steady glare

- From FAA simulator video:



# Hazard summary

# Eye injury hazards

Secondary concern – injuries are very unlikely

Very few or no permanent retinal injuries

3-5 temporary injuries from 9400+ incidents

# Visual interference hazards

Primary concern -- thousands of incidents

Can involve temporary eye effects

Concern during critical phases of flight

# Critical phases of flight

Landing, takeoff

Critical maneuvers

Emergency situations

Helicopter low-level maneuvers and hovering

WHY PEOPLE  
AIM AT AIRCRAFT

# Some laser misusers



Why do average  
citizens aim at aircraft?

Why not cars (at the same rate)?

# Aircraft

10 per night

# Cars (at same rate)

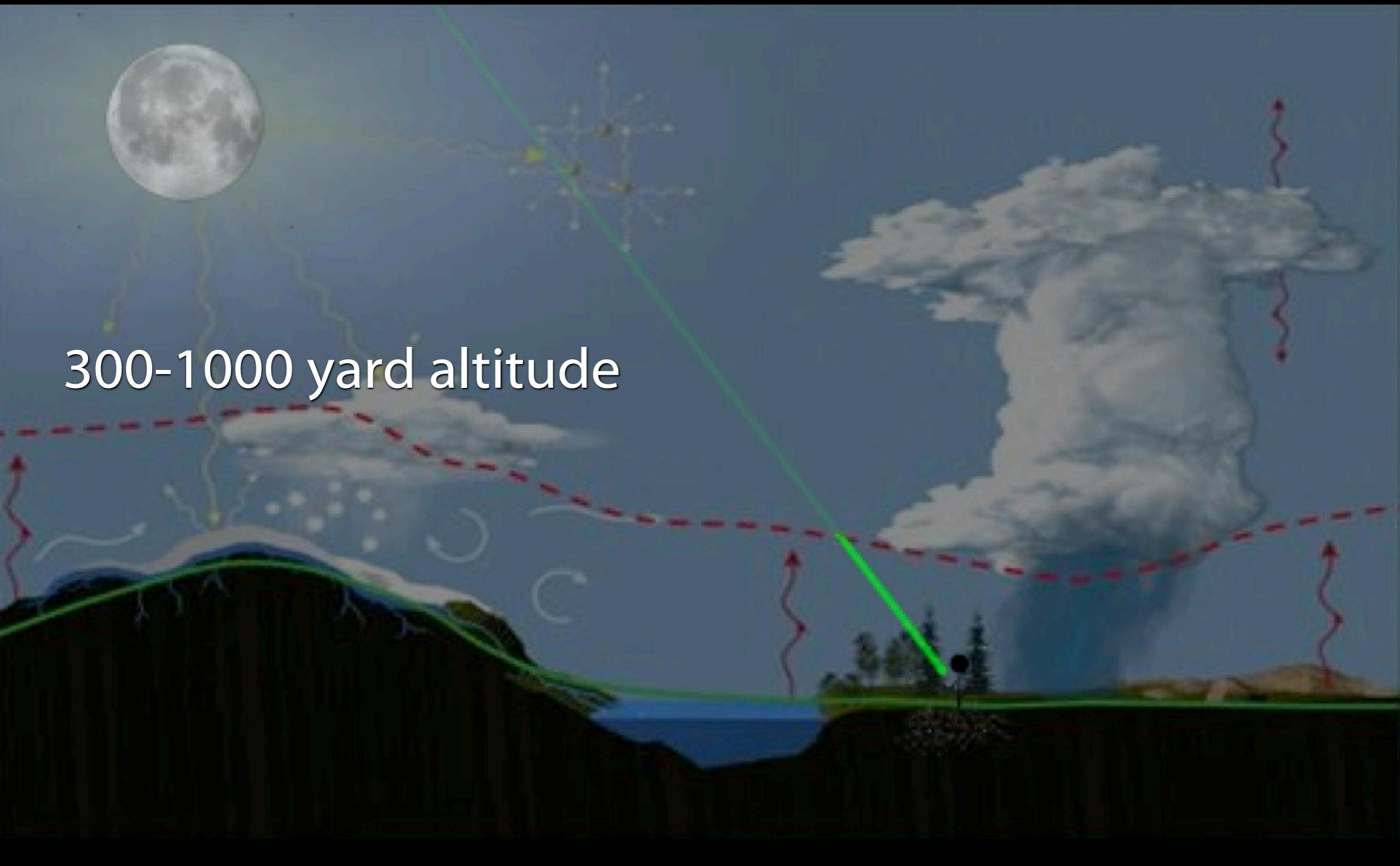
3000 to 10000 per night

Beam  
does not appear  
to reach  
an aircraft





# Planetary Boundary Layer



Beam does not appear to reach

Think beam will hit bottom of aircraft

Think beam is a small dot

“I pointed the laser  
at the helicopter  
to see if it would reach”

“I wondered whether  
the beam could hit  
the belly of the plane”

“It doesn’t look like  
it shoots that far  
into the sky”

“I did not realize  
the effect it would have  
on the pilot”

“I wanted to say ‘hello’  
to the pilot”

WHAT CAN  
BE DONE?

# Laser pointer users

Education  
Continued prosecutions

Laser sellers and  
manufacturers

Pre-sale education  
Labels



DO NOT aim at or near aircraft. Laser light can startle, flashblind, or injure pilots. Misuse may result in arrest, fines and/or imprisonment.

# Food and Drug Administration

Regulates lasers

# Lawmakers

Enact well-crafted laws

# Press

Help accurately inform

ILDA

LaserPointerSafety.com

# Individual pilots

Learn how to recognize and recover  
Consider protective eyewear

**Laser protective eyewear  
specifically designed for pilots**



Pilot groups, airlines  
and FAA

Mandate education, FAA video,  
simulator training

# Last line of defense

Accidents  
Deliberate intent

Ban, restrict or tax  
lasers?

# New South Wales

Approx. 25x reduction

# United States

About 140 incidents per year

# Laser Safety Tax

\$5 per milliwatt

**BARGAIN**  
**BEACHWEAR**  
GREEN LASER \$ 7.99  
MB HOODED SWEAT: 5.99





\$32.99

**ONLINE ONLY****1 DAY EXTRA SAVINGS**

Applies only to items sold by

Exclusions apply. See details.

**TODAY ONLY****EXTRA 5-15% OFF**

learn more

## Other Items Related to Your Search

Astronomy 50mw 532nm  
Astronomy Green Laser\$16.94 ~~\$19.48~~Laser Shop MAXIS LASER  
High Power 100mW Green\$322.56 ~~\$370.95~~Mpo 150mw Green Laser  
and Star Projector with 6\$96.69 ~~\$111.20~~Green Green 30mw Laser  
Pointer Pen Style Star\$20.90 ~~\$24.04~~Generic 20mw 532nm  
Astronomy Powerful Green\$17.53 ~~\$20.16~~Generic 50mW Green Laser  
Pointer w/ Silver Body\$27.40 ~~\$31.54~~**Unknown 100mW 532nm High Power Fixed Focus Green Laser Pointer Pen**

Item# SPM5836523402 | Model# 100w-green-lasre-pointer-1685566



(Be the first to rate and review this item)

**\$32.65**Additional \$4 savings  
Applied at cart

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Quantity

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[See More ▾](#)**Overview**100mW Green Laser Pointer Includes a Gift Box and Batteries.  
Excellent for pointing at the night sky and can be seen for miles.[Read full description...](#)

In Stock and Available for Ground Shipping.

Sell your product on

[Learn more.](#)

**ONLINE ONLY****1 DAY EXTRA SAVINGS**

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learn more

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Astronomy 50mw 532nm Green Laser

\$16.94 \$19.48

Laser Shop MAXIS LASER High Power 100mW Green

\$322.56 \$370.95

Mpo 150mw Green Laser and Star Projector with 6

\$96.69 \$111.20

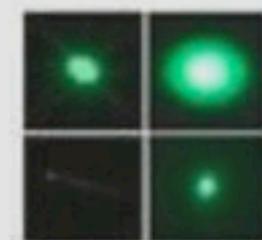
Green Green 30mw Laser Pointer Pen Style Star

\$20.90 \$24.04

Generic 20mw 532nm Astronomy Powerful Green

\$17.53 \$20.16

Generic 50mW Green Laser Pointer w/ Silver Body

\$27.40 \$31.54**Unknown 100mW 532nm High Power Fixed Focus Green Laser Pointer Pen**Item# SPM58365 Model# 100w-green-lasre-pointer-1685566**\$532.65**

Ship

Quantity



Ship

In Stock from Emily Fair

Calculator

Shipping

See More ▾

## Overview

100mW Green Laser Pointer Includes a Gift Box and Batteries. Excellent for pointing at the night sky and can be seen for miles.

[Read full description...](#)

In Stock and Available for Ground Shipping.

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Similar to luxury, gas tax

Collected by IRS

No new FDA authority or funding

Sets prices back to pre-2000 levels

# Thank you

Lasers provided by  
AixiZ Service & Wicked Lasers

Questions?

(end)