

A Review of Laser Pointer Incidents and Safety Considerations for the Aviation Environment

Presented to HPS, July 2015

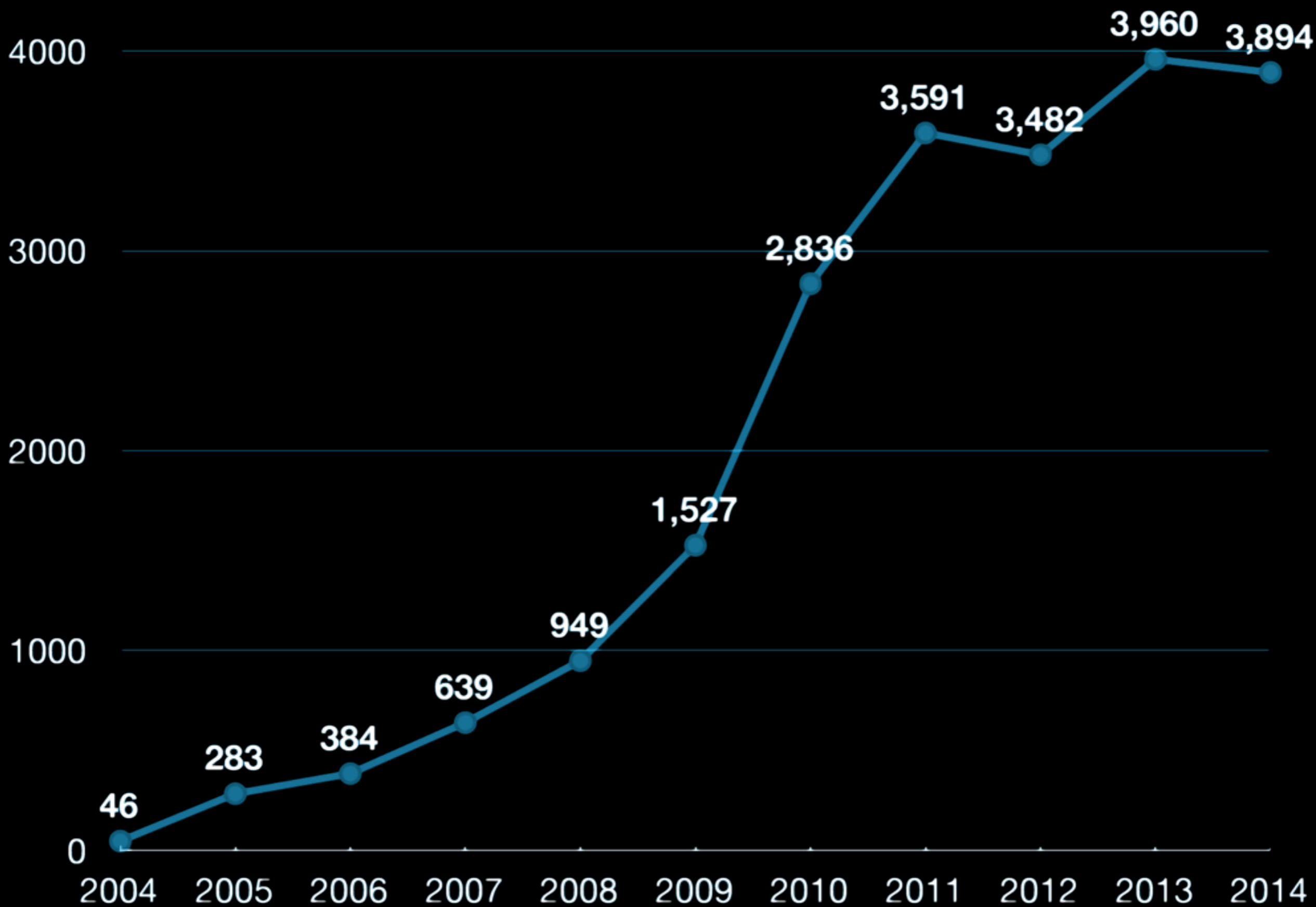
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and editor, LaserPointerSafety.com

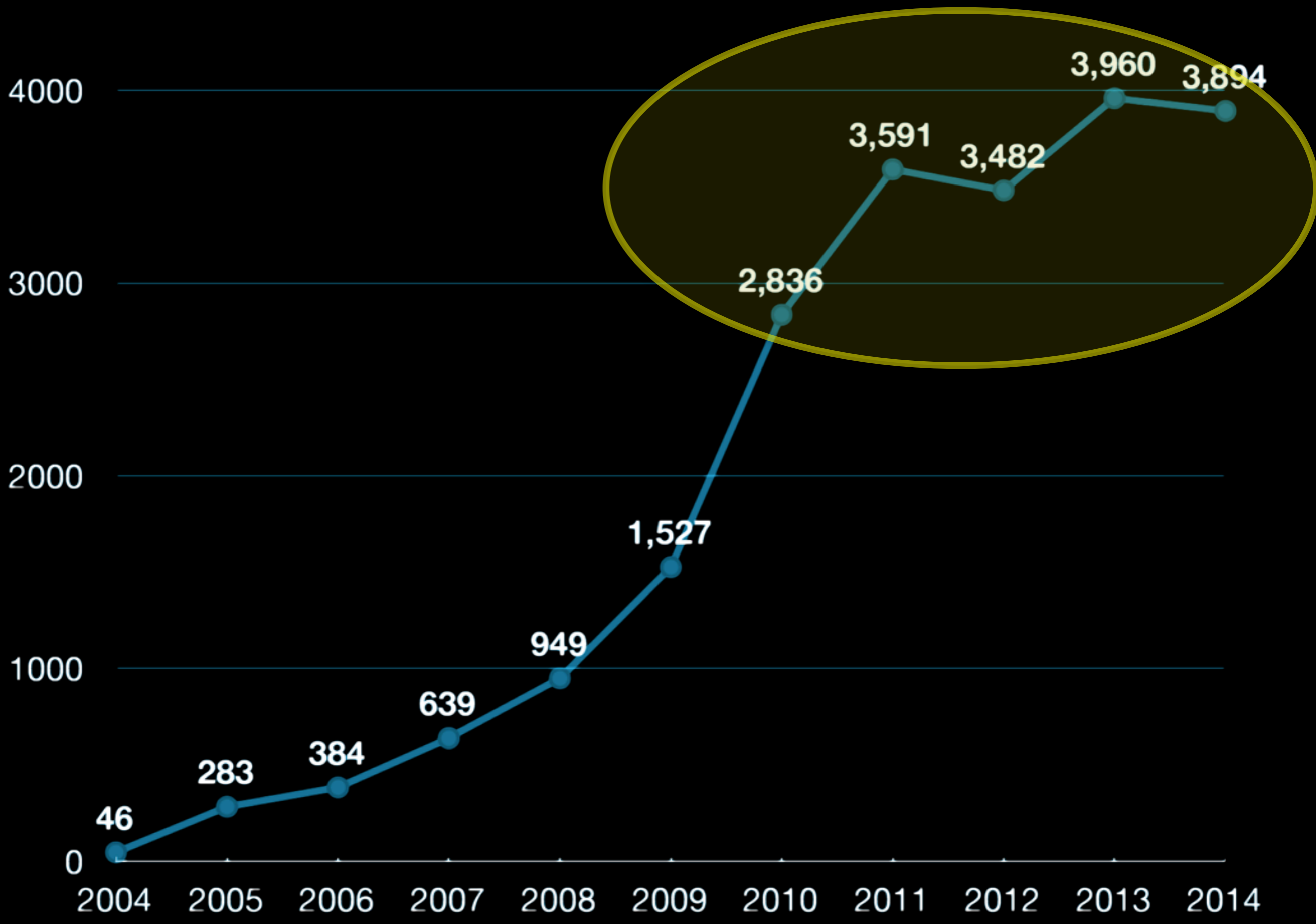
Presented at the
Health Physics Society
60th Annual Meeting
Indianapolis, Indiana
July 2015

Laser illuminations of aircraft are a significant aviation safety problem

Laser illuminations reported to FAA, annual total

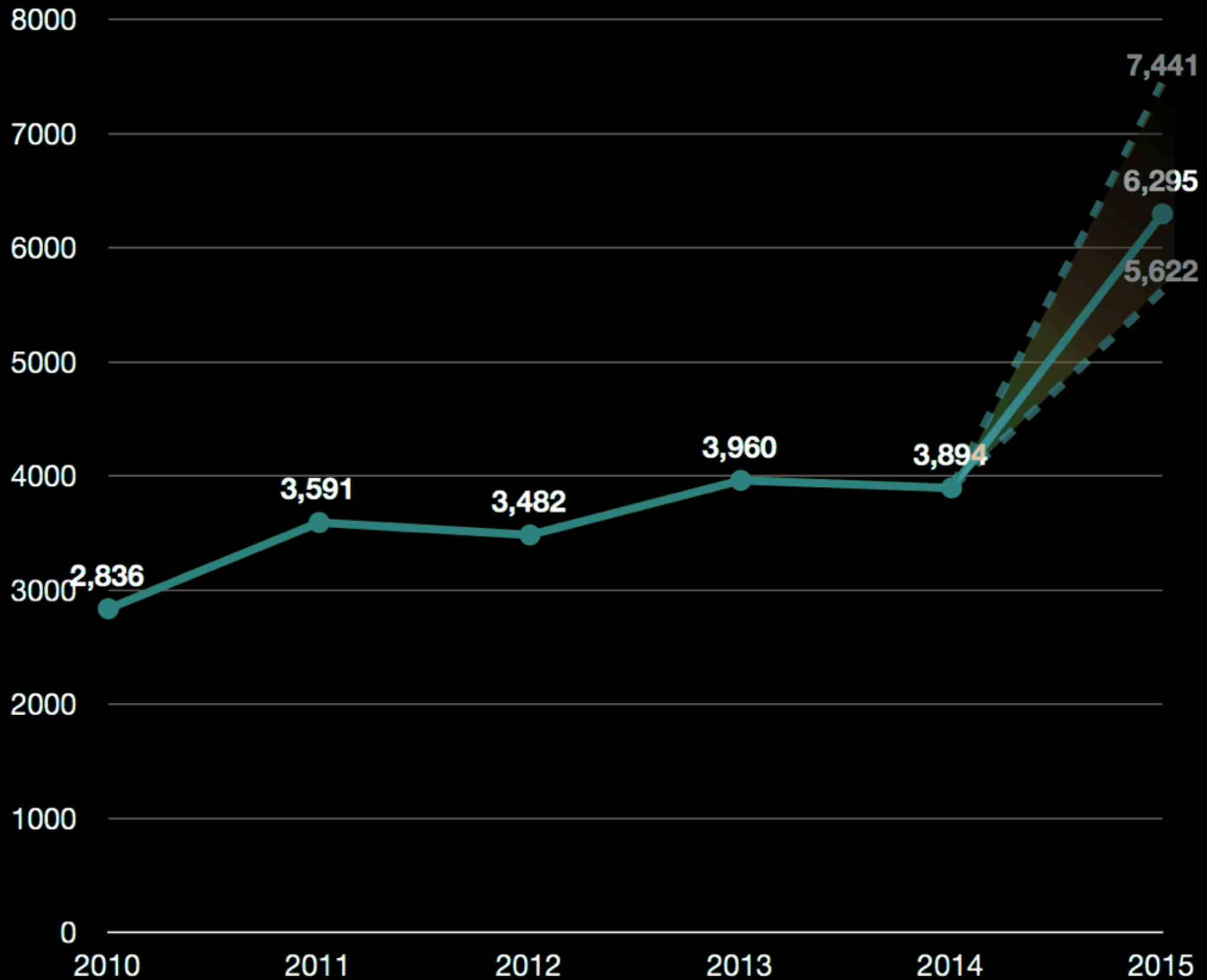


Laser illuminations reported to FAA, annual total



Laser illuminations reported to FAA, annual total

(2015 total estimated based on Jan 1 - July 3 2015 reports)



Currently (July 2015)
almost 15 incidents
per night in the U.S.

What is the problem?

Lasers can be safely managed in airspace

- Many safe outdoor laser operations
 - Including astronomy laser guide stars, laser satellite communications, and laser light shows



Problem is consumer misuse

The screenshot shows the Sears website interface. At the top, there is a search bar with the text "Enter keyword or item #" and a "GO" button. To the right of the search bar are links for "My Profile", "Lists", and "Cart". Below the search bar is a navigation menu with categories like "Departments", "New Local Ad", "Deals", "Gifts & Registry", "Services", "Shopping Guidance", "En espanol", "Share", and "Feedback". A breadcrumb trail indicates the current location: "Computers & Electronics > Desktops > Accessories".

A promotional banner reads: "ONLINE ONLY 1DAYEXTRASAVINGS TODAY ONLY EXTRA 5-15% OFF". Below this is a section titled "Other Items Related to Your Search" with six product cards:

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

The main product listing is for "Unknown 100mW 532nm High Power Fixed Focus Green Laser Pointer Pen". The price is \$32.65, and the power "100mW" is circled in yellow. The product is sold by Emily Fair and is in stock. The shipping section indicates it is available for ground shipping. A "Follow Price" button and a "Quantity" selector (set to 1) are also visible.

Additional details include a star rating of 4.5 (with a note "(Be the first to rate and review this item)"), a "Read full description..." link, and a "Shipping Calculator" link.

What kind of person
deliberately aims a laser
at an aircraft?

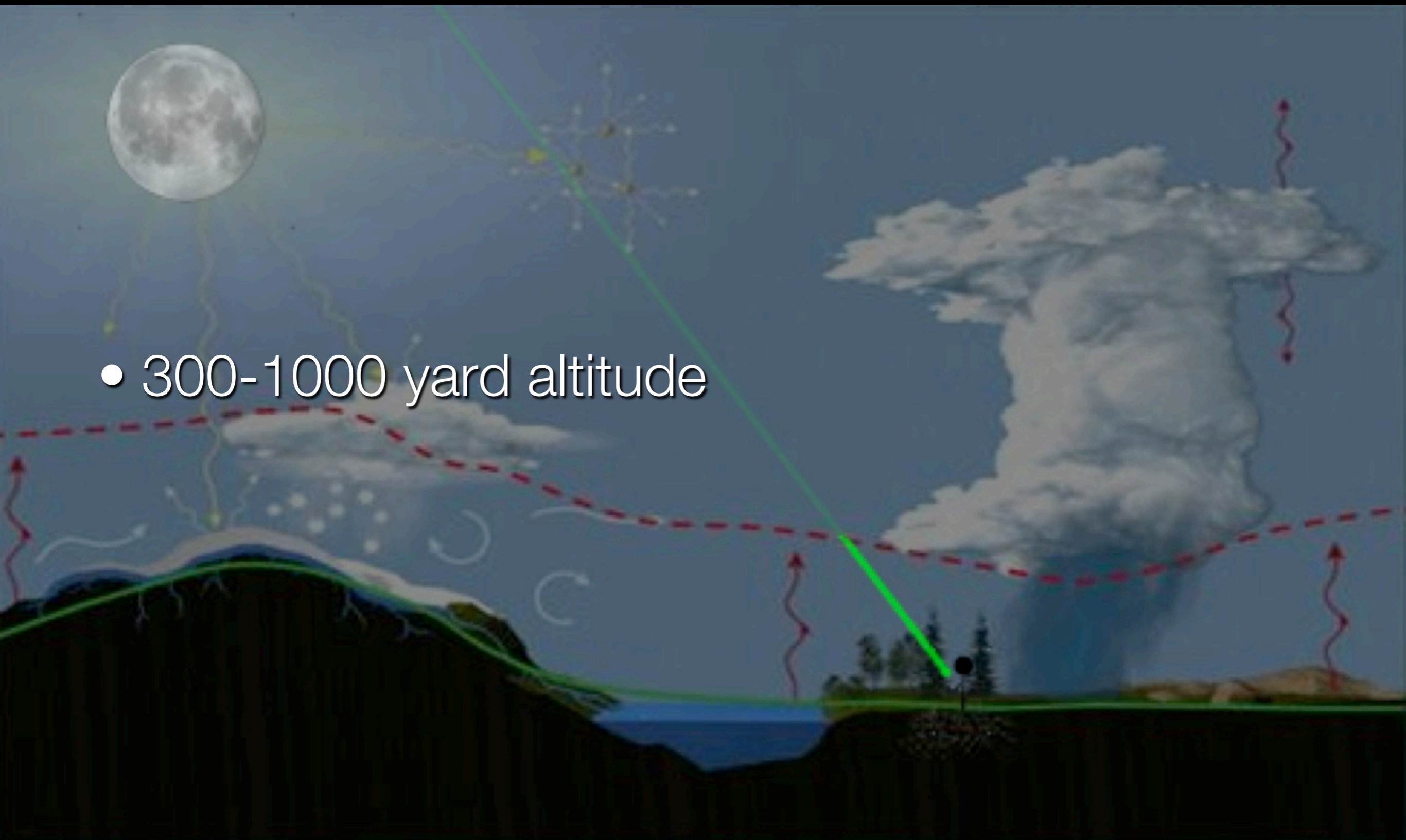
Who deliberately aims at aircraft?

- ✦ 1: Persons who do not realize the hazards
 - ✦ Laser “can’t reach the plane”
 - ✦ Laser will hit underside of plane
 - ✦ Laser will be a little dot at the plane
 - ✦ Laser will be dim like a flashlight



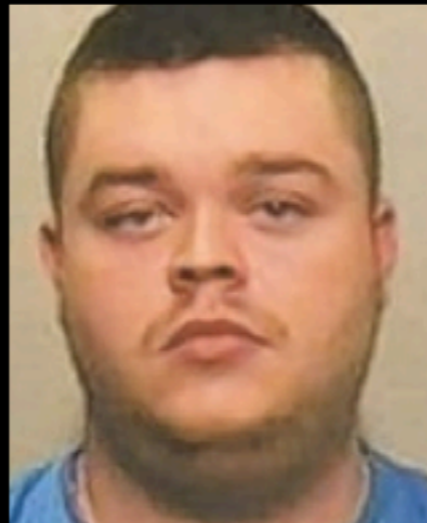
Planetary Boundary Layer

- 300-1000 yard altitude



Who deliberately aims at aircraft?

- ✦ 2: Persons who do not care about hazards
 - ✦ Antisocial or criminal
 - ✦ May be bothered by noise
 - ✦ Often doing something else illegal



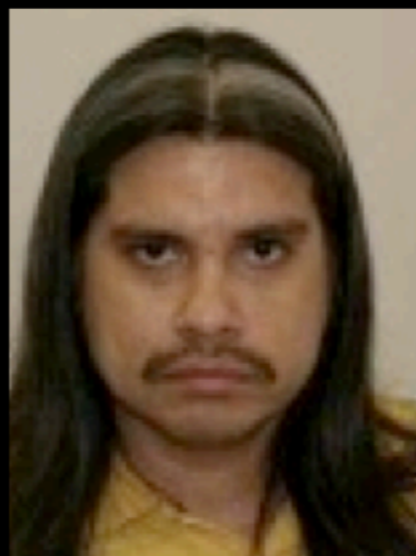
6 months



15 months



24 months



30 months



37 months



168 months

Green lasers = biggest problem

- The “sweet spot” for consumer lasers
 - Most milliwatts per dollar
 - Example: 50 mW, \$25 online shipped from China



Green lasers = biggest problem

- ✦ Over 90% of FAA incidents involve green light
 - ✦ More visible
 - ✦ Lasers tend to be more powerful

Hazards of laser illuminations for pilots

Hazards of laser illuminations

- ✦ **Primary hazard:** Visual interference *when in a critical phase of flight*
 - ✦ Takeoff, approach, landing, emergency, low-level flight (helicopters)
- ✦ **Secondary hazard:** Eye injury

No interference

- On a “runway” in a flight simulator



Visual interference hazard

- Distraction (really, *task* interference)

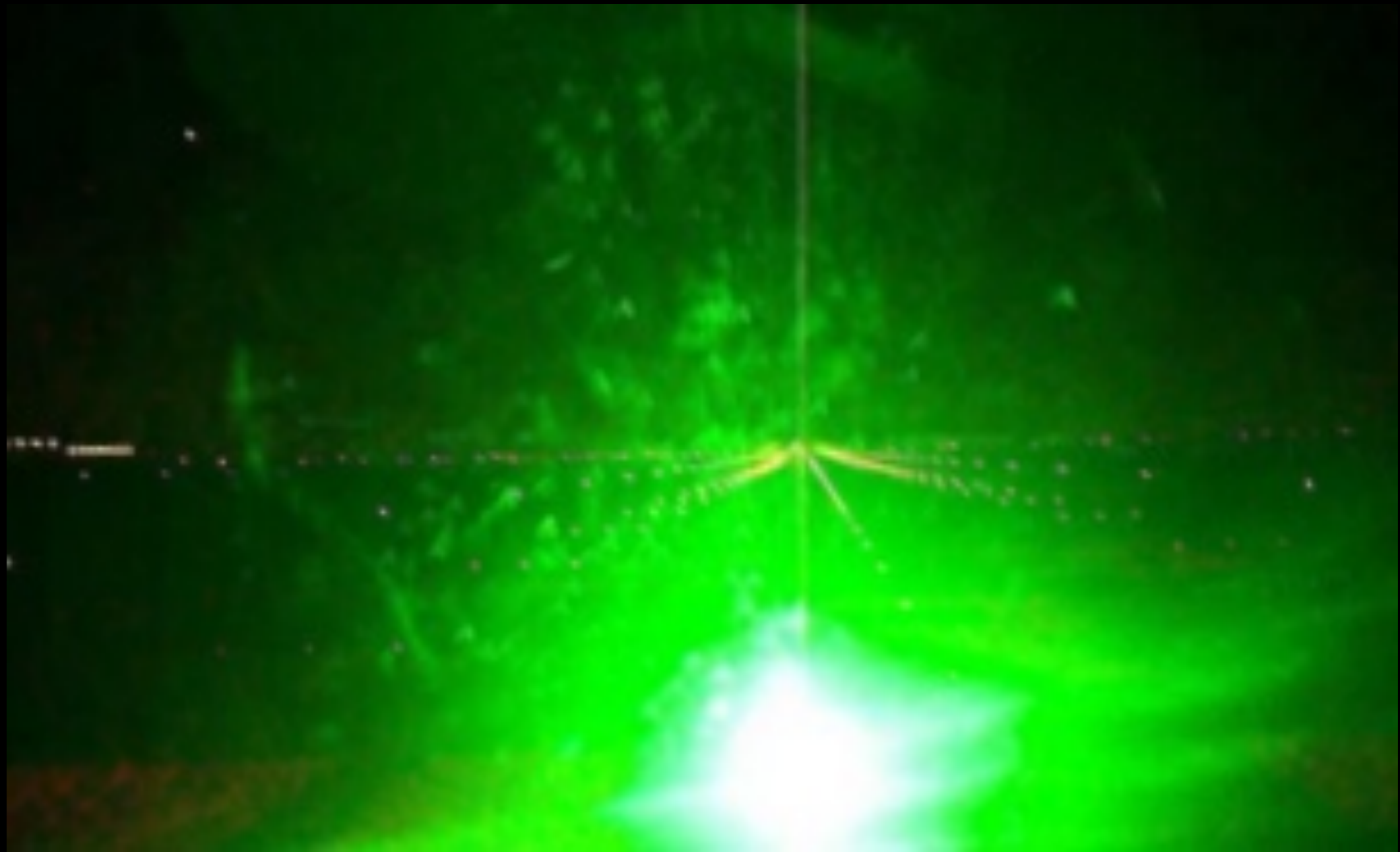




Boeing 777 at 15,000 feet over Buenos Aires

Visual interference hazard

- ✦ Glare



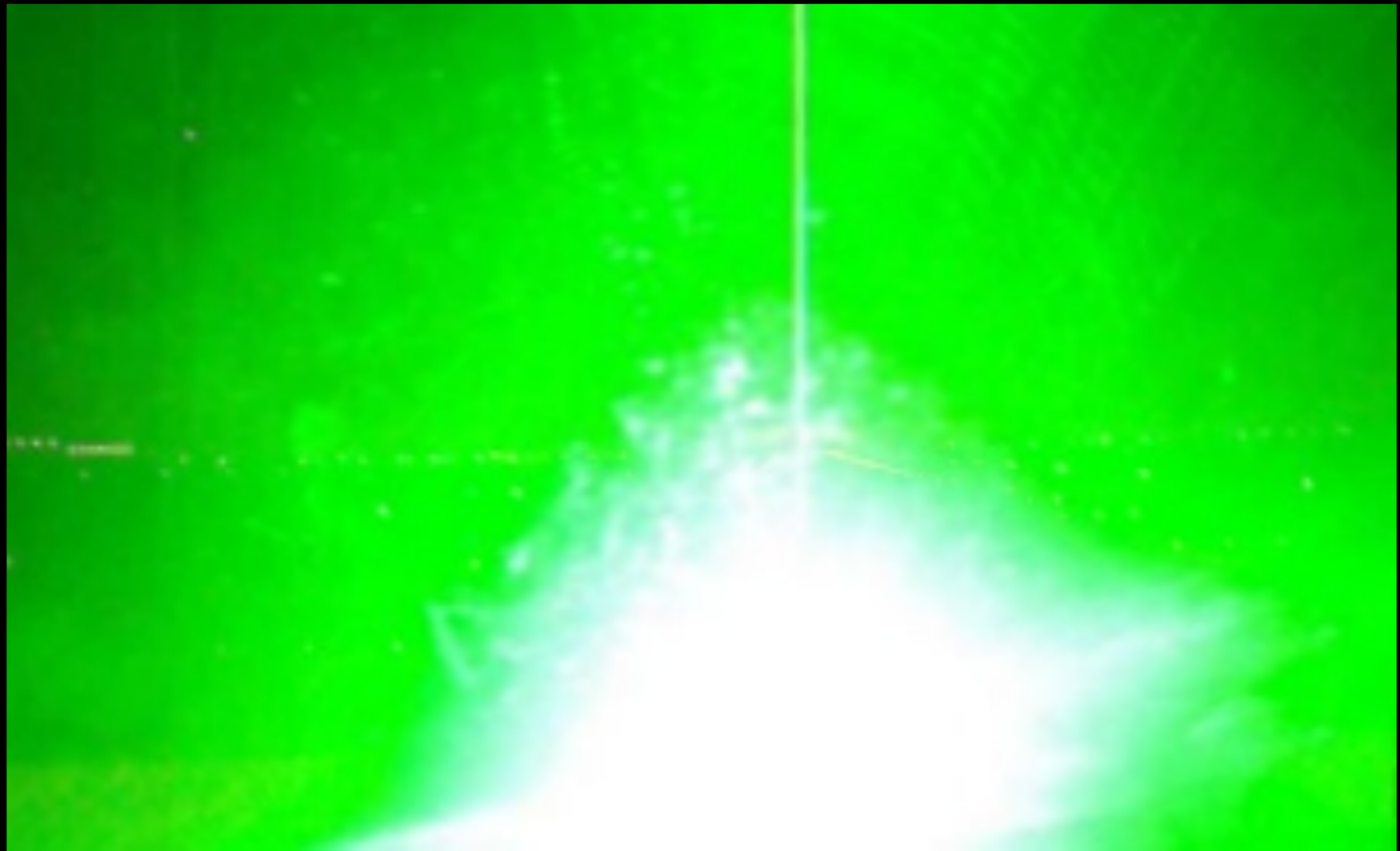
Laser glare as seen from police helicopter



Lat N 32° 10.424' Lon W 111° 5.962' Alt 2510ft S Prng. On los New High alt = 0.05
Lat N 32° 7.593' Lon W 111° 6.385' Az: 85.7° El: -23.8° 13-04-2011

Visual interference hazard

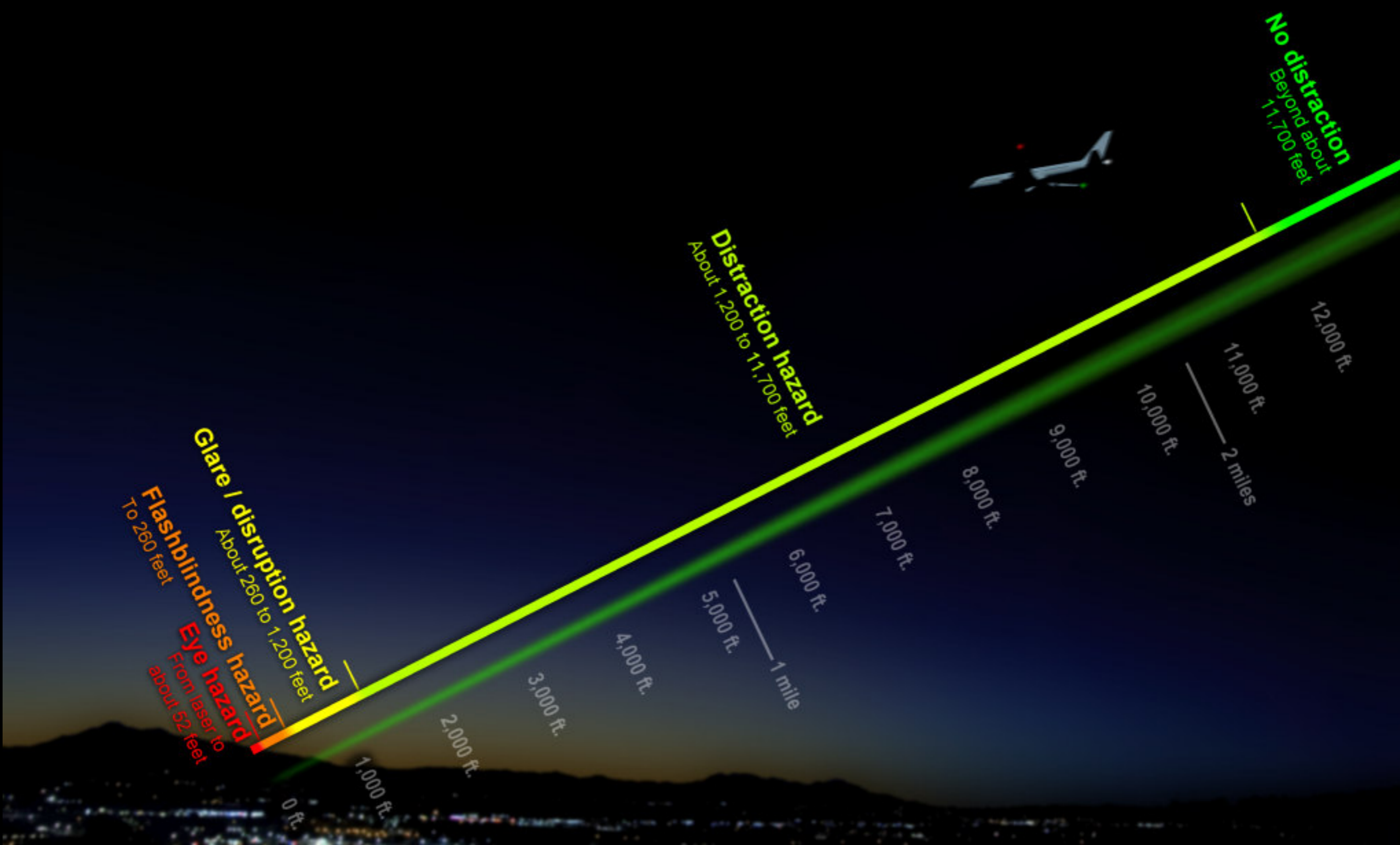
- Temporary flashblindness/afterimage



Hazard distances of a
5 mW, 1 milliradian green laser pointer



Hazard distances of a 5 mW 1 mrad green pointer



“A laser pointer is a hazard
to pilots over 2 miles away”

Most hazards are relatively close to the laser source

- ✦ Of the total eye and visual hazard distance, distraction is 90% of that distance
- ✦ Distraction is a *mental* hazard
 - ✦ Easier to overcome by focusing on the task of flying
 - ✦ Does not interfere with vision

Effects of laser illuminations on pilots



Visual interference effects

- ✦ **Eye:** vision blocking, eye watering, sensation of pain
- ✦ **Body:** headache, “shock”
- ✦ **Task:** Startle, distraction -- remember to “fly the plane”
- ✦ **Post-exposure:** corneal abrasions from rubbing the eye

Adverse eye effects

- ✦ Occur in about 1.5% of all FAA-reported incidents
 - ✦ For 2014, about 43 incidents

Eye injury from laser exposure

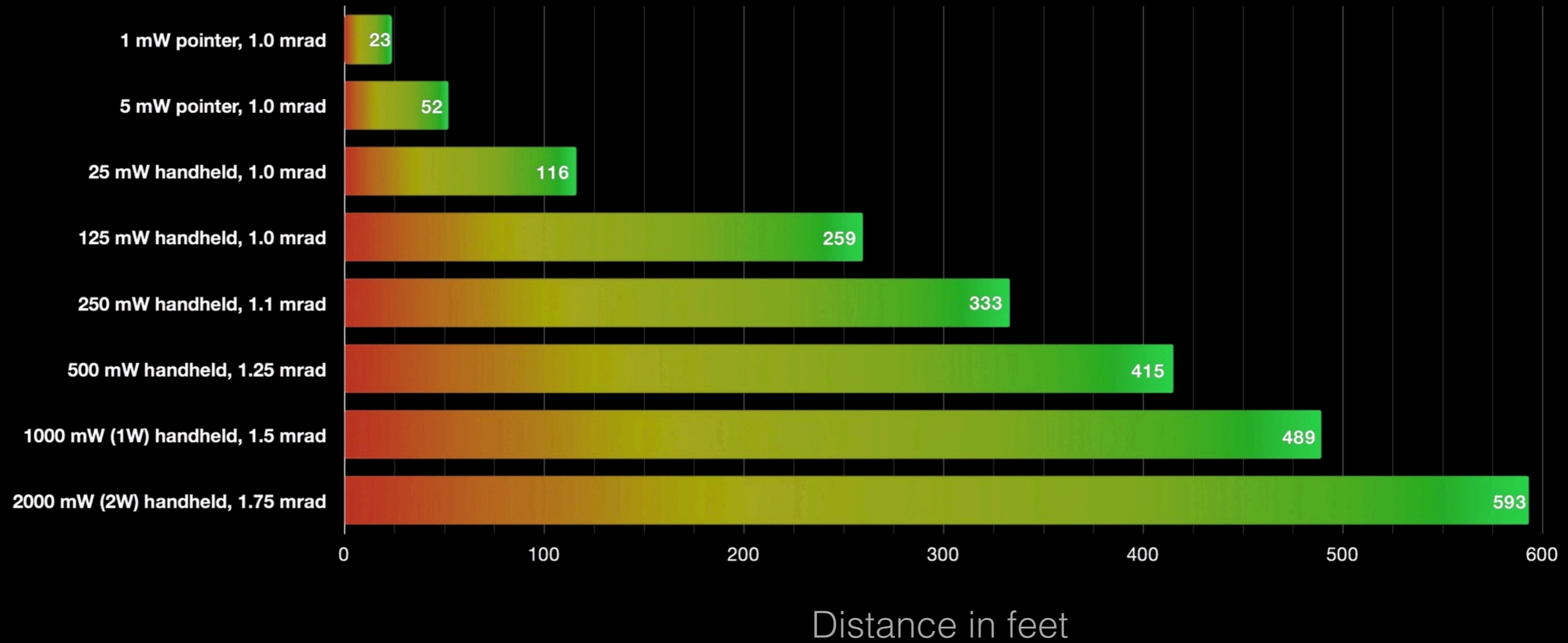
- ✦ **A secondary concern**

- ✦ No documented reports of permanent eye injury in over 21,000 FAA and CAA incident reports
- ✦ FAA, March 19 2015: “The FAA is unaware of any U.S. commercial pilot who has suffered permanent eye damage as a result of exposure to laser light when in the cockpit.”

Why eye injury is unlikely

- Laser exposure may be outside the NOHD

Real-world laser pointer NOHDs



Why eye injury is unlikely

- ✦ Exposure inside the NOHD does not mean certain injury
 - ✦ NOHD has a “reduction” factor
 - ✦ Handheld laser + moving target is unlike lab tests conducted on anesthetized eyes
 - ✦ Lab tests were looking for “minimally detectable lesions” -- may not cause noticeable vision defects

“Afterimages are *not* injuries.
An injury results in a minimally visible lesion
which histologically involves the retinal
pigmented epithelium and the
photoreceptors.”

-- Bruce Stuck

Eye injury caveats

- ✦ This is for consumer visible laser pointers and handhelds (currently < 2 watts) in the U.S. and U.K.
- ✦ Military pilots in conflict areas may have had permanent eye injuries
 - ✦ If so, data would be classified
- ✦ Future perpetrators might be more determined

Could a laser illumination cause an aircraft crash?

- ✦ Illuminations can be managed when not in a critical phase of flight
 - ✦ Enough time to recover
- ✦ In critical phases, can be managed with proper pilot procedures
 - ✦ Look away from the light, “fly the plane”

Could be a contributing factor

- ✦ Aircraft accidents almost always are due to an unforeseen combination of factors
 - ✦ A laser distraction or flashblinding, at the wrong moment, could be a contributing factor

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What can be done?

About 10 times a night, U.S. pilots report seeing or being illuminated by laser beams. The primary hazard is temporary interference with vision – distraction, glare, flashblindness – during critical phases of flight such as takeoff and landing.

Some ways to help reduce the number and severity of laser pointer/aircraft incidents

Laser labeling

- ▶ Manufacturers voluntarily add aircraft safety labels
- ▶ Government can write new laws mandating 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.



User education

- ▶ Educating users via laser sellers' websites, manuals
- ▶ Media coverage of hazards, prohibitions

Pilot training & glasses

Pilots are the last line of defense

- ▶ Provide information on safely reacting to laser illuminations
- ▶ Mandatory simulator training with safe bright light
- ▶ Cockpit-certified laser blocking glasses for 1st responder pilots
(Note: Anti-laser glasses are NOT recommended for routine use)

Arrests & prosecution

- ▶ Fines and jail for anyone intentionally aiming at aircraft
- ▶ News reports of arrests & prosecutions let users know the hazard is serious

If the above does not work, **new laws & restrictions** may be necessary

Limited restrictions

- ▶ Import restrictions to try to keep out illegal lasers
- ▶ At locations where misuse is high (beach resorts)
- ▶ By age (no public possession by youth, teens)

General restrictions or ban

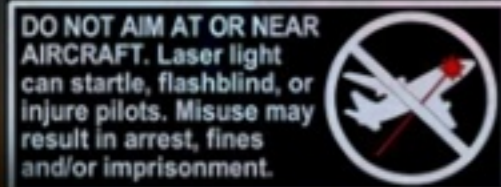
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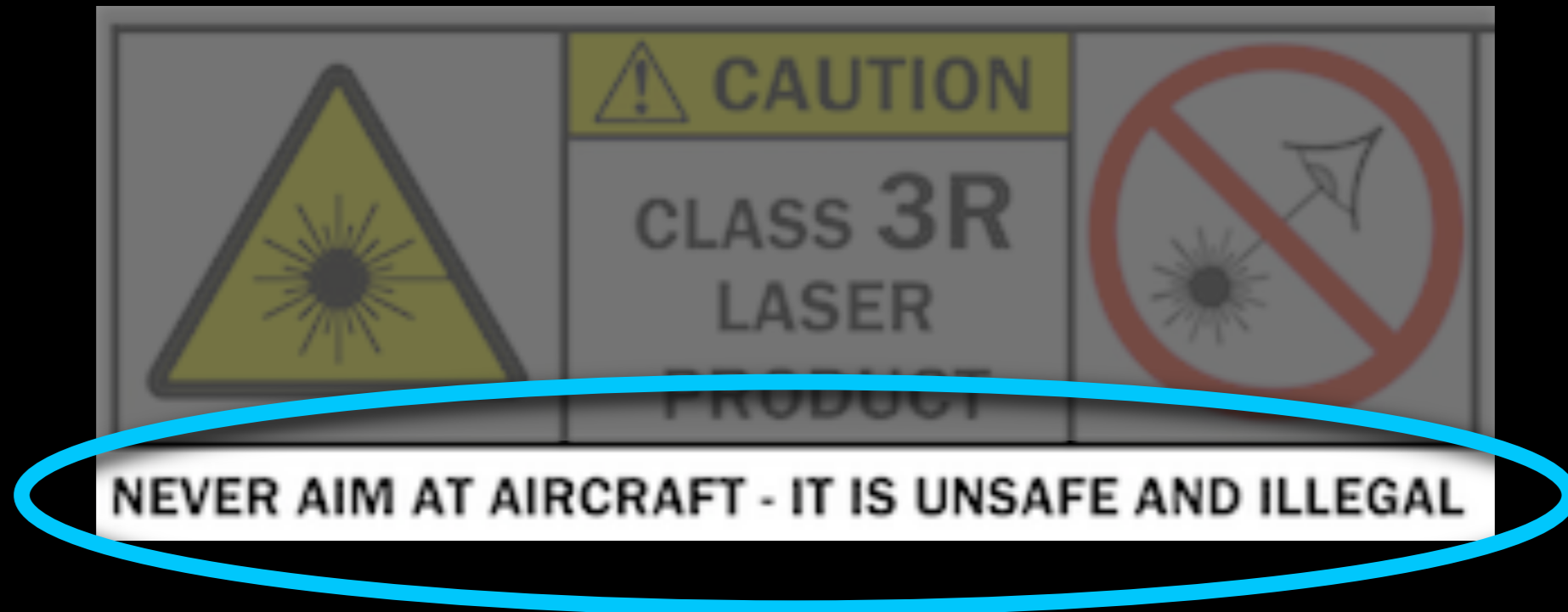
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Add a warning



New labeling format for packaging and larger lasers?

Visit LaserSafetyFacts.com
for more information



Diode Laser

Max. output power: **4.95 milliwatts**

Wavelength: **400-700 nanometers** (visible light)

Min. divergence: **0.5 milliradian**

Output: **Continuous (CW)**

Laser hazard classification: **Class 3R, "Caution"**

Laser Safety Facts



Laser hazards

Eye injury from beam

Do not look into the direct or reflected beam; can cause eye injury up to 110 ft (34 m) away.

Visual interference (glare) with pilots and drivers

Interferes with vision up to 2400 ft (730 m) away. Can be a distraction up to 4.5 miles (7.3 km) away. **NEVER point any laser towards aircraft or vehicles; it is unsafe and illegal.**

Safe use guidance

Class 3R lasers are safe when handled carefully. Do not look into the beam. Avoid accidental exposure to eyes. Do not aim at aircraft. **This is not a toy.** Always supervise children.

Additional safety information online

Scan the QR code above, or visit LaserSafety.info/3R

Manufacturer: [Insert manufacturer name, address, country of origin or import, contact info such as website or phone number; optional UL or similar listing. Text font is Franklin Gothic Book; boldface is Franklin Gothic Demi.]

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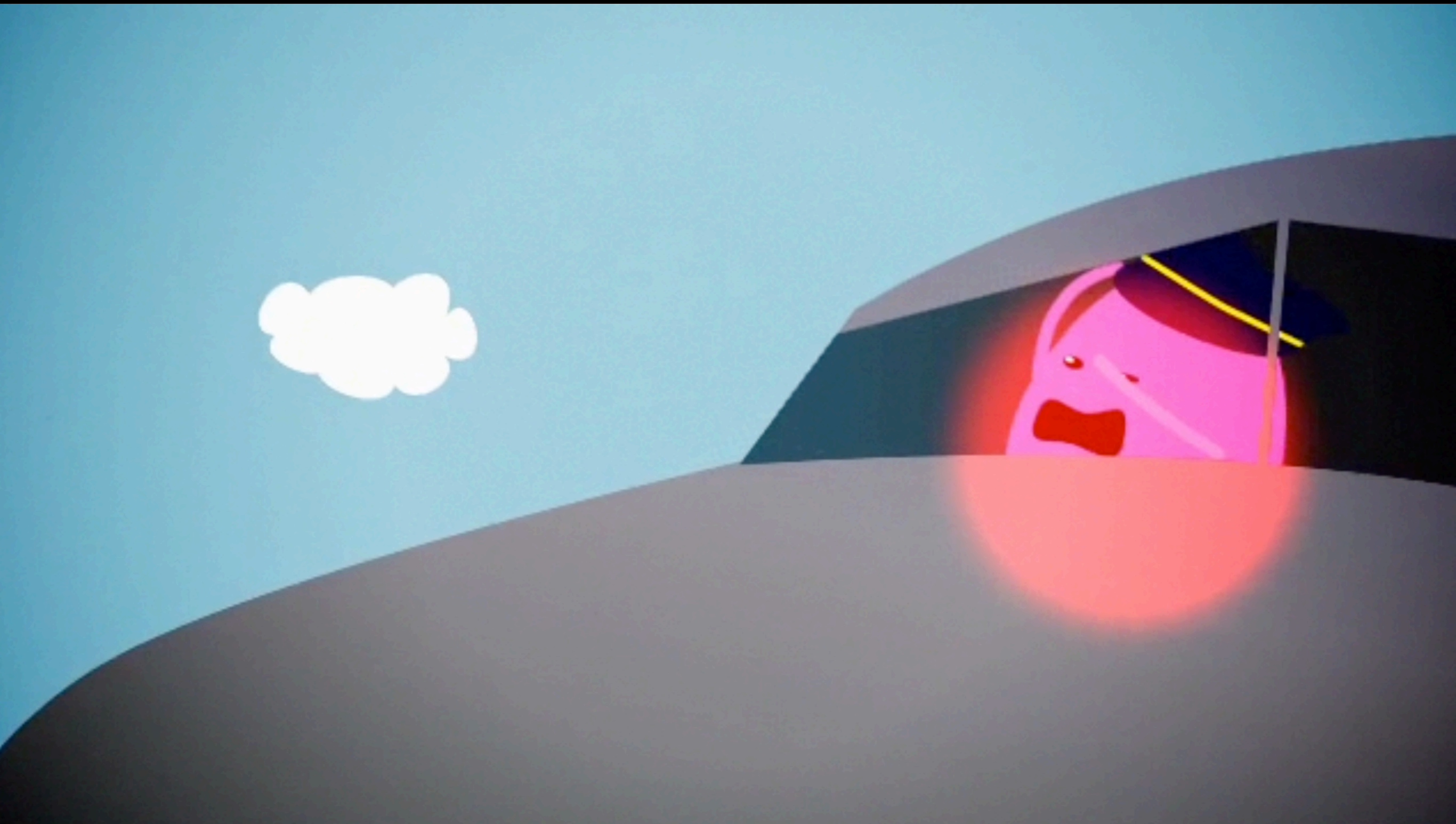
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“Dumb Ways to Blind” video on YouTube
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8 years of prosecutions

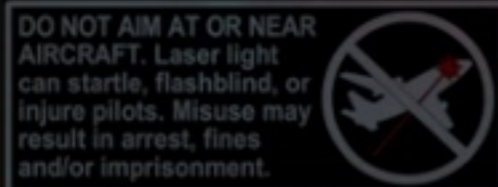
- ✦ 2005-2013: 17,725 FAA incidents
- ✦ 134 arrests (0.75% chance of getting caught)
 - ✦ 80 convictions (0.45% chance of going to jail)

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Laser protective eyewear



Laser illumination procedures

- ✦ “Fly the plane” first
- ✦ Do not look directly at the light
- ✦ Block the light if possible (visor, hand, clipboard)
- ✦ Turn up cockpit lights
- ✦ Inform Air Traffic Control; report incident to FAA
- ✦ Resist the urge to rub your eyes
- ✦ Seek qualified eye care if you have any concerns

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For more information:

LaserPointerSafety.com

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LaserPointerSafety.com

A comprehensive resource, for safe and responsible laser use

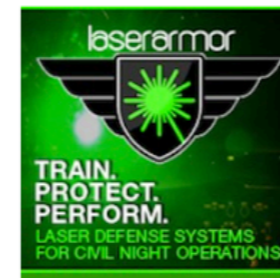


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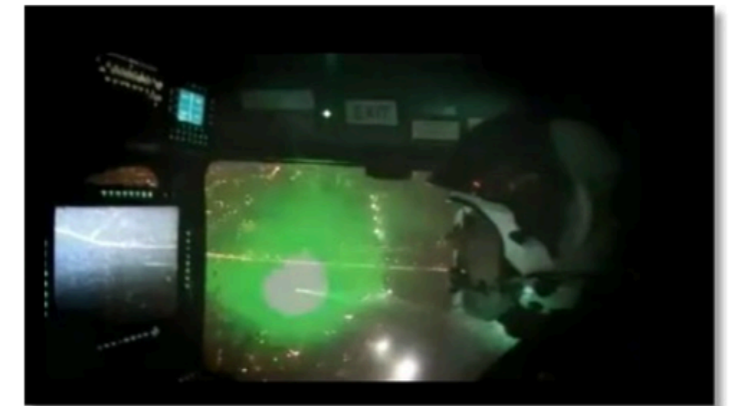
Sponsors



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](#), [how to report incidents](#), [laser safety glasses for pilots](#), 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](#).



Public domain photo from the U.S. FAA, showing how a laser beam spreads over long distances and can fill the windscreen. The FAA's highest-resolution version is [here](#).



Questions?

