



**STOPPING TIME:**





**STOPPING TIME:**

**from flashes...  
to lasers**

**STOPPING TIME:**

**from flashes...  
to lasers**



**STOPPING TIME:**

**from flashes...  
to lasers**



A blue-tinted image of a water splash, showing a crown-like shape with many small droplets rising from it. The background is a solid blue color. The text is overlaid on the splash.

**STOPPING TIME:**

**from flashes...  
to lasers**

**speed up clock:**

**see things that  
go slowly**

A blue-tinted image of a water splash, showing a crown-like shape with many small droplets rising from it. The background is a solid blue color.

**STOPPING TIME:**

**from flashes...  
to lasers**

**speed up clock:**

**see things that  
go slowly**

**slow down clock:**

**see things that  
go fast**

A blue-tinted image of a water splash, showing a crown-like shape of water droplets and ripples. The text is overlaid on the splash.

**STOPPING TIME:**

**from flashes...  
to lasers**



**how can we  
slow down clock?**

**slow down clock:**

**see things that  
go fast**

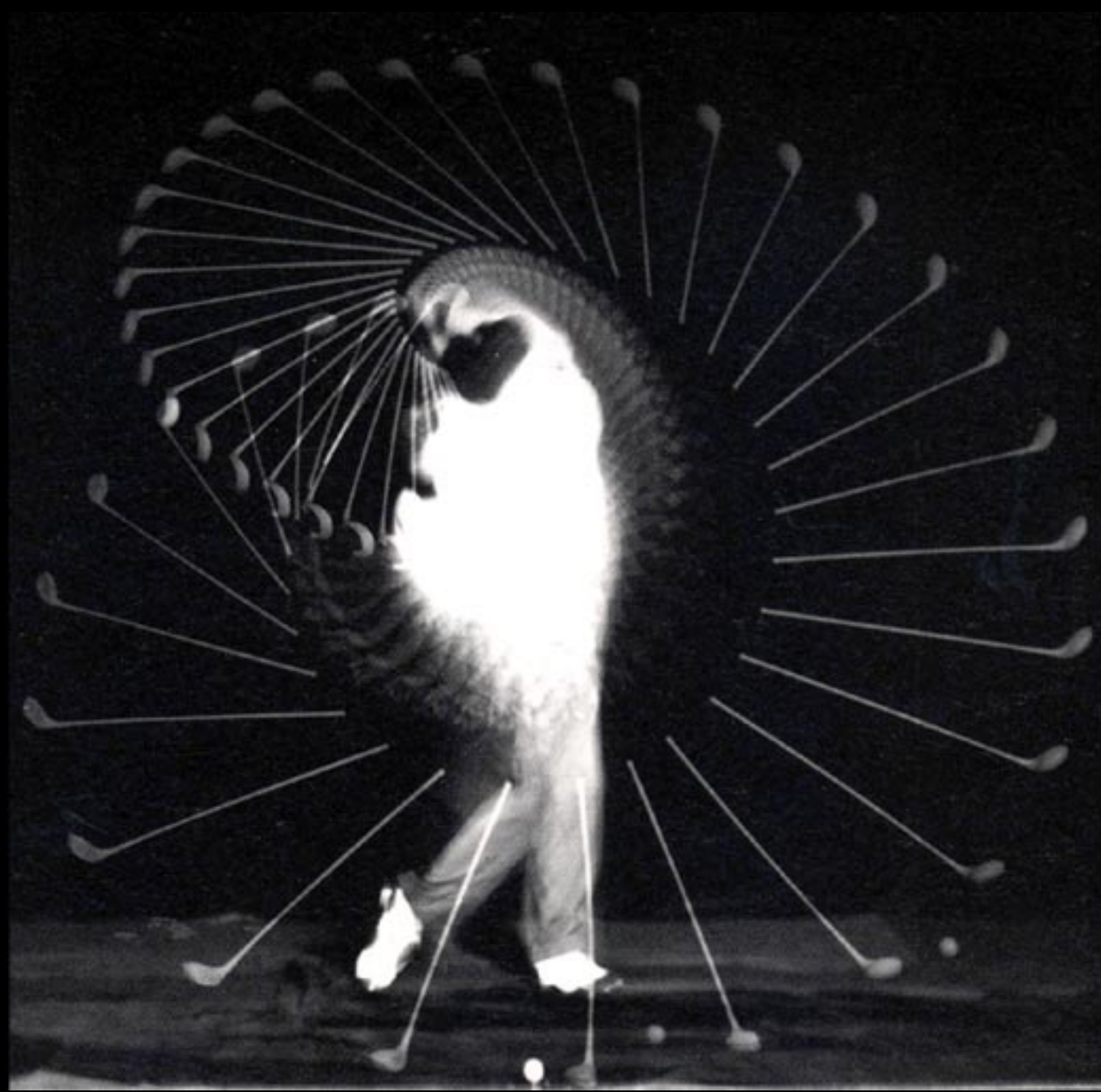
**speed up clock:**

**see things that  
go slowly**

A blue-tinted image of a water splash, showing a crown-like shape of water droplets and ripples. The background is a solid blue color. The text is overlaid on the splash.

**STOPPING TIME:**

**from flashes...  
to lasers**

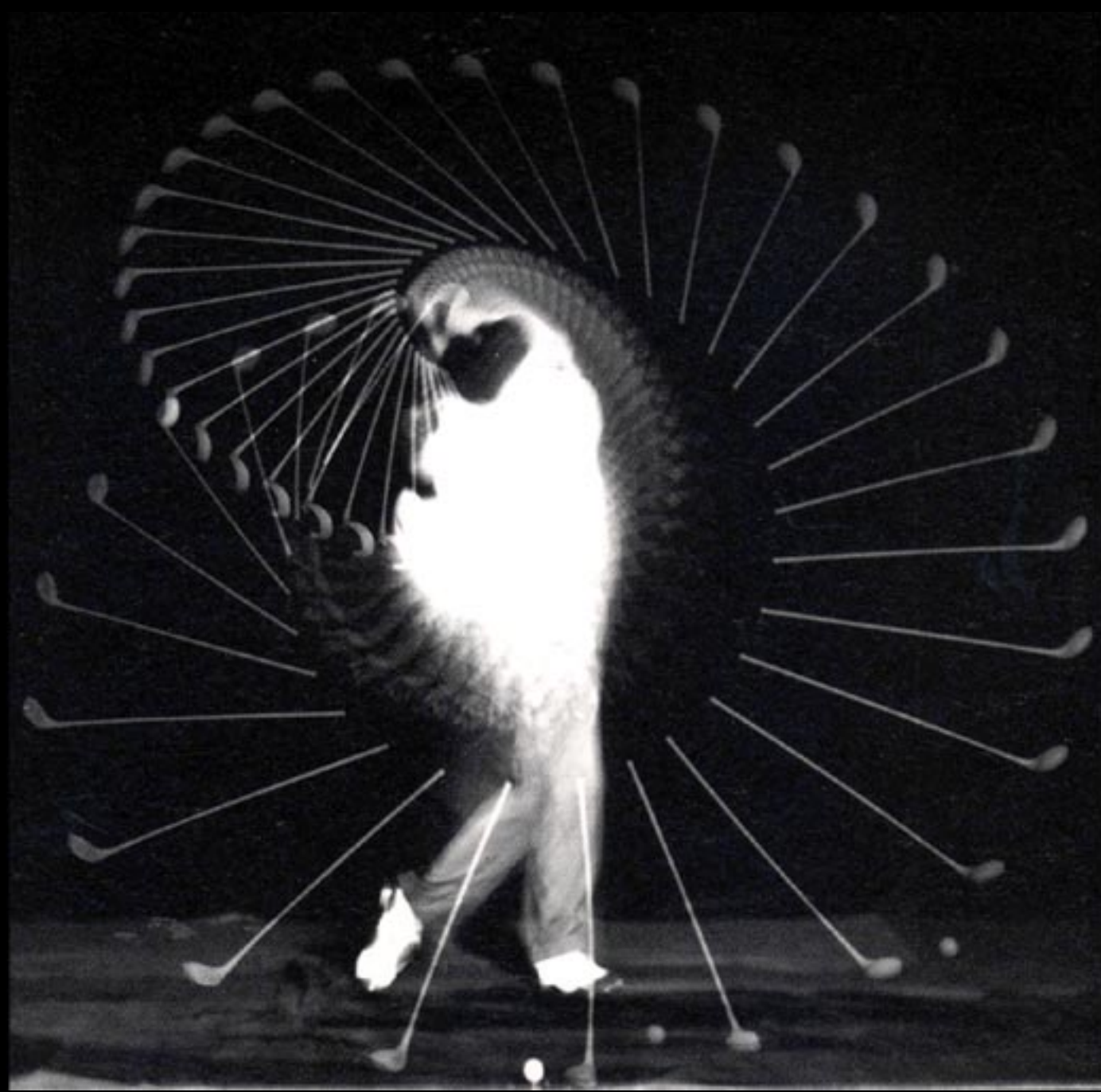


**Harold Edgerton**

**1903 – 1990**

**STOPPING TIME:**

**from flashes...  
to lasers**

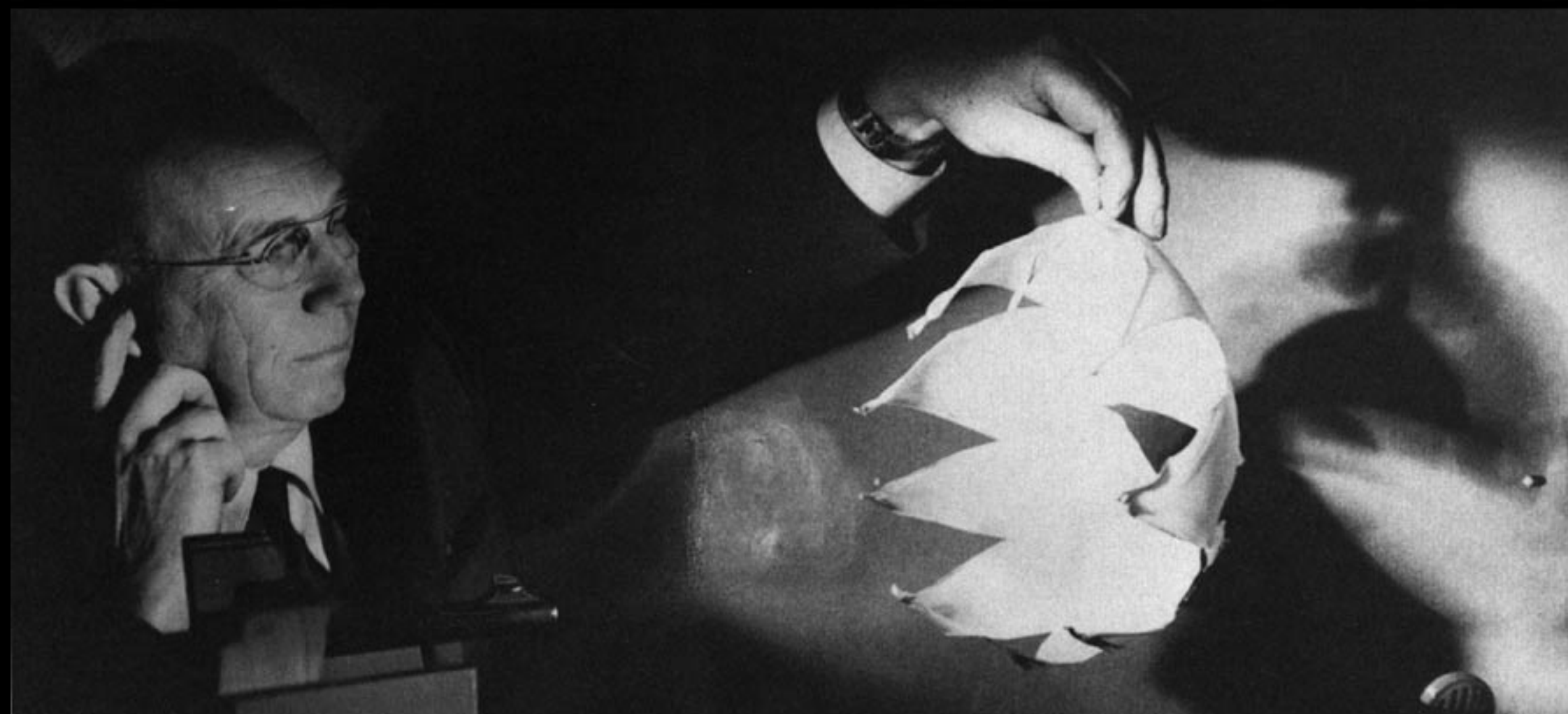


**Harold Edgerton**

**1903 – 1990**

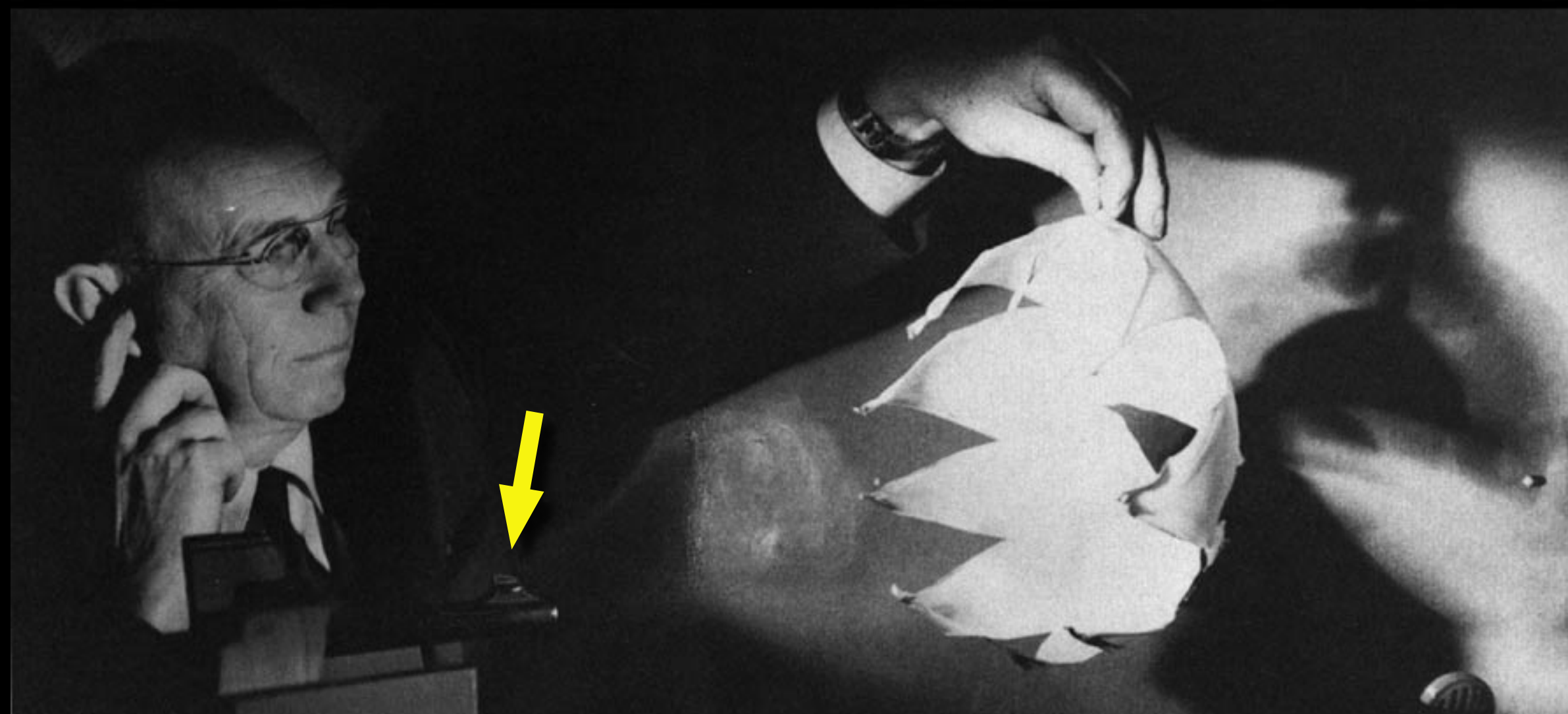
**STOPPING TIME:**

**from flashes...  
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**STOPPING TIME:**

**from flashes...  
to lasers**



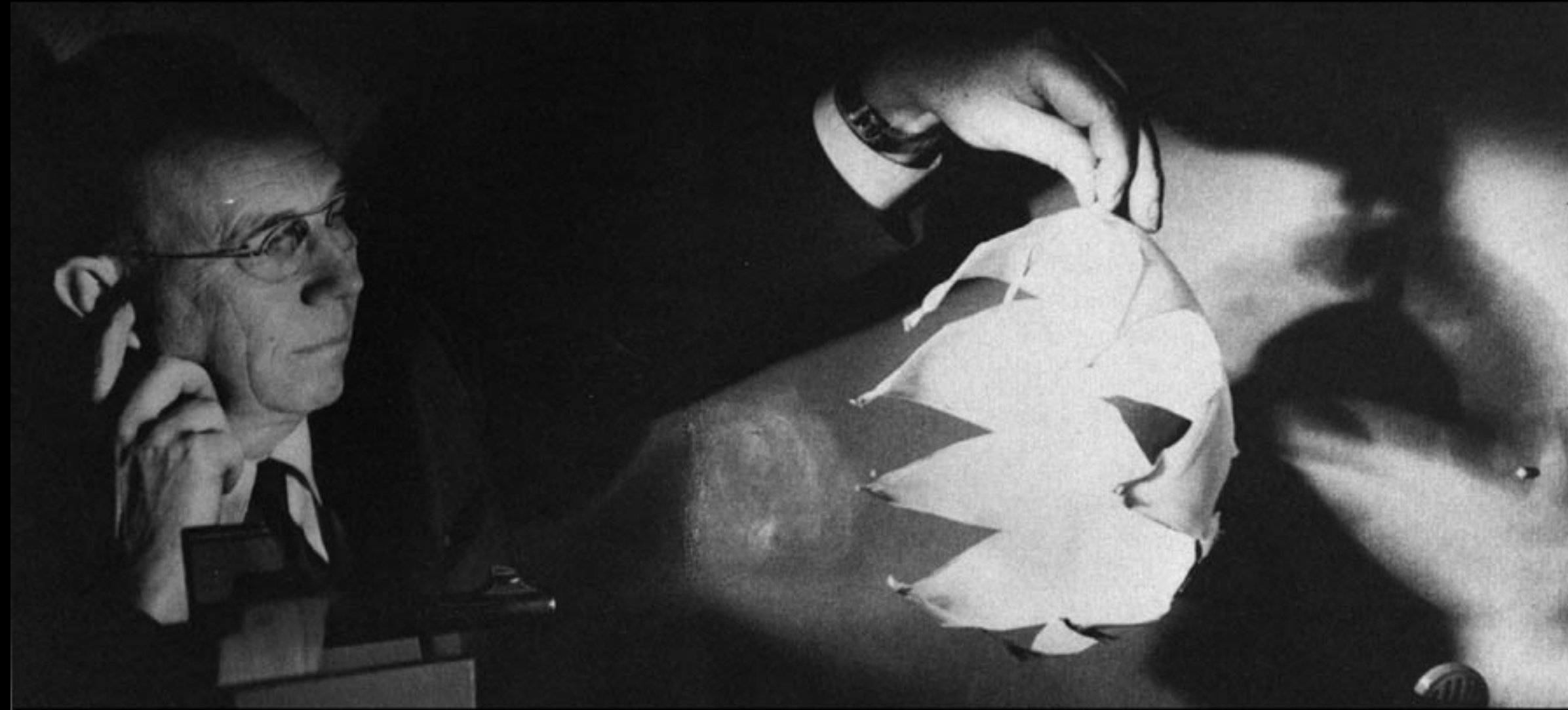
**STOPPING TIME:**

**from flashes...  
to lasers**

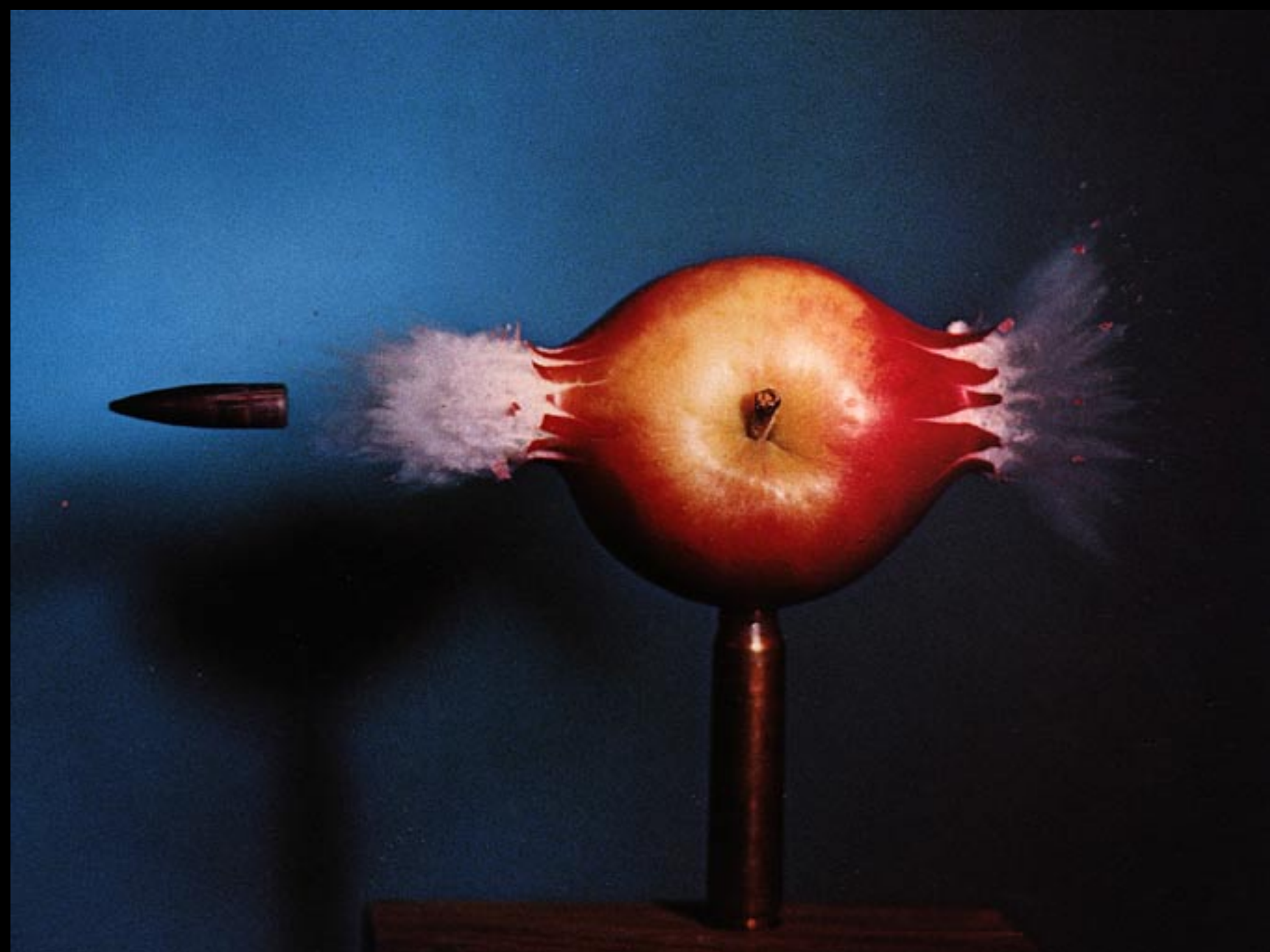
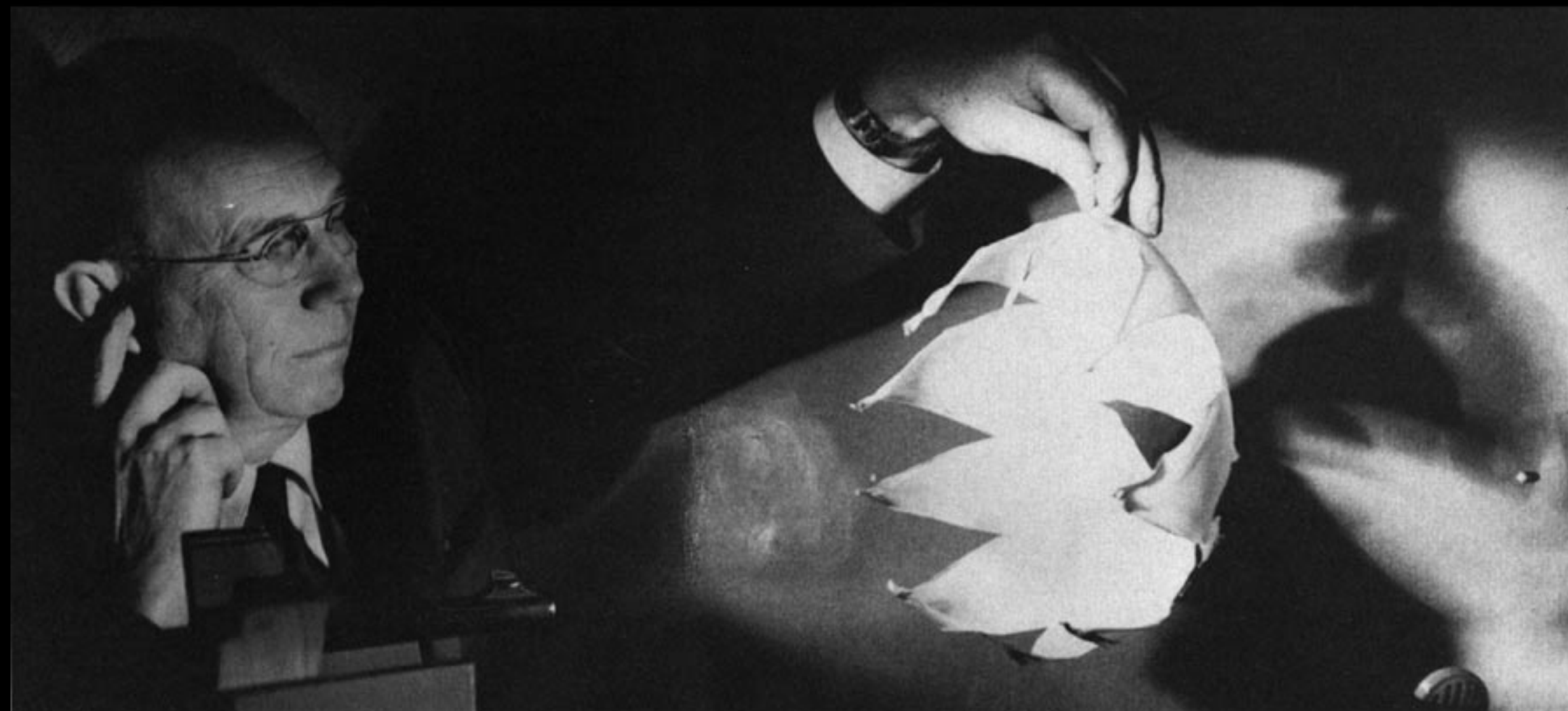


**STOPPING TIME:**

**from flashes...  
to lasers**

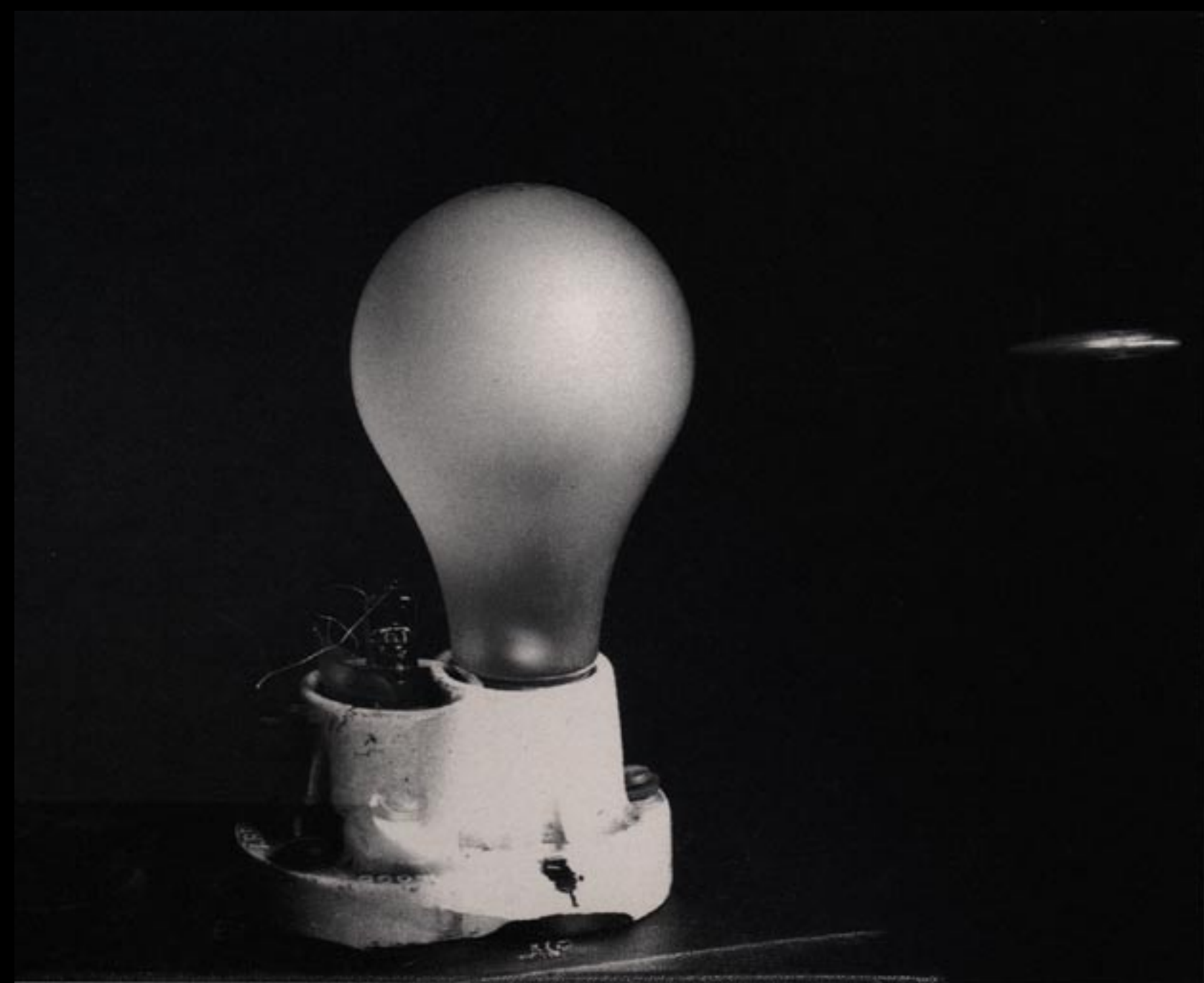


**STOPPING TIME:**  
**from flashes...**  
**to lasers**



**STOPPING TIME:  
from flashes...  
to lasers**





**STOPPING TIME:**

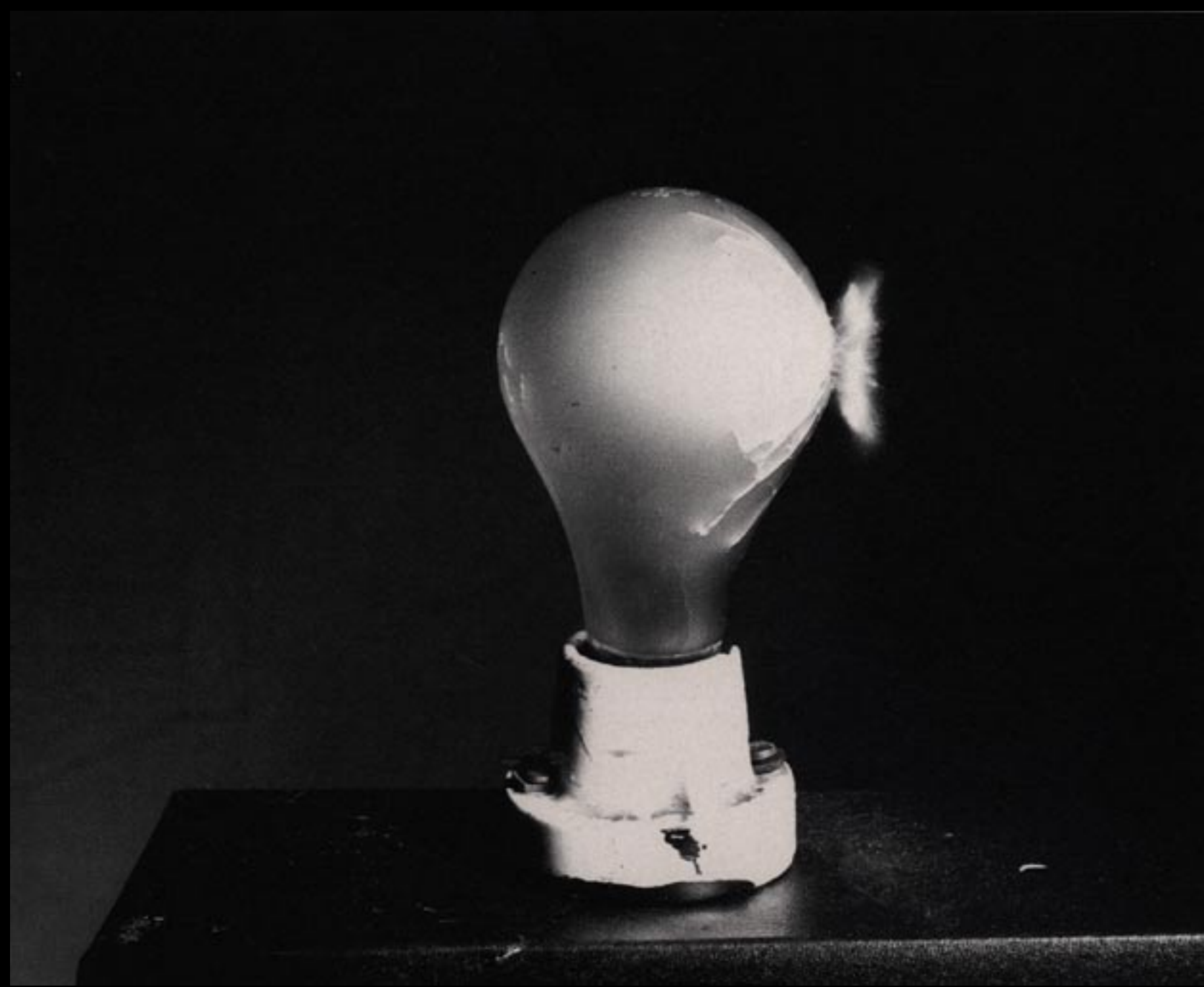
**from flashes...  
to lasers**



**STOPPING TIME:**

**from flashes...**

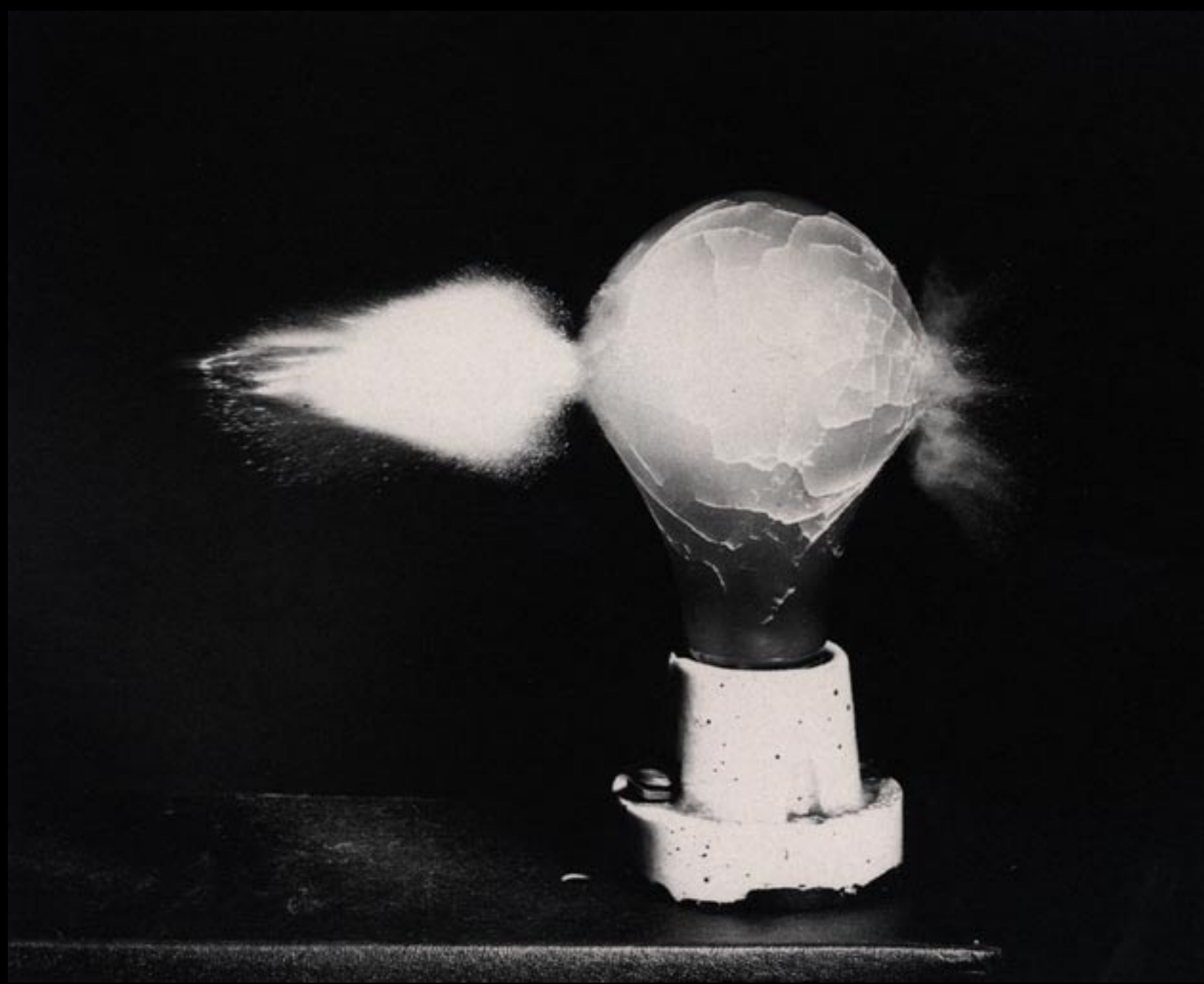
**to lasers**



**STOPPING TIME:**

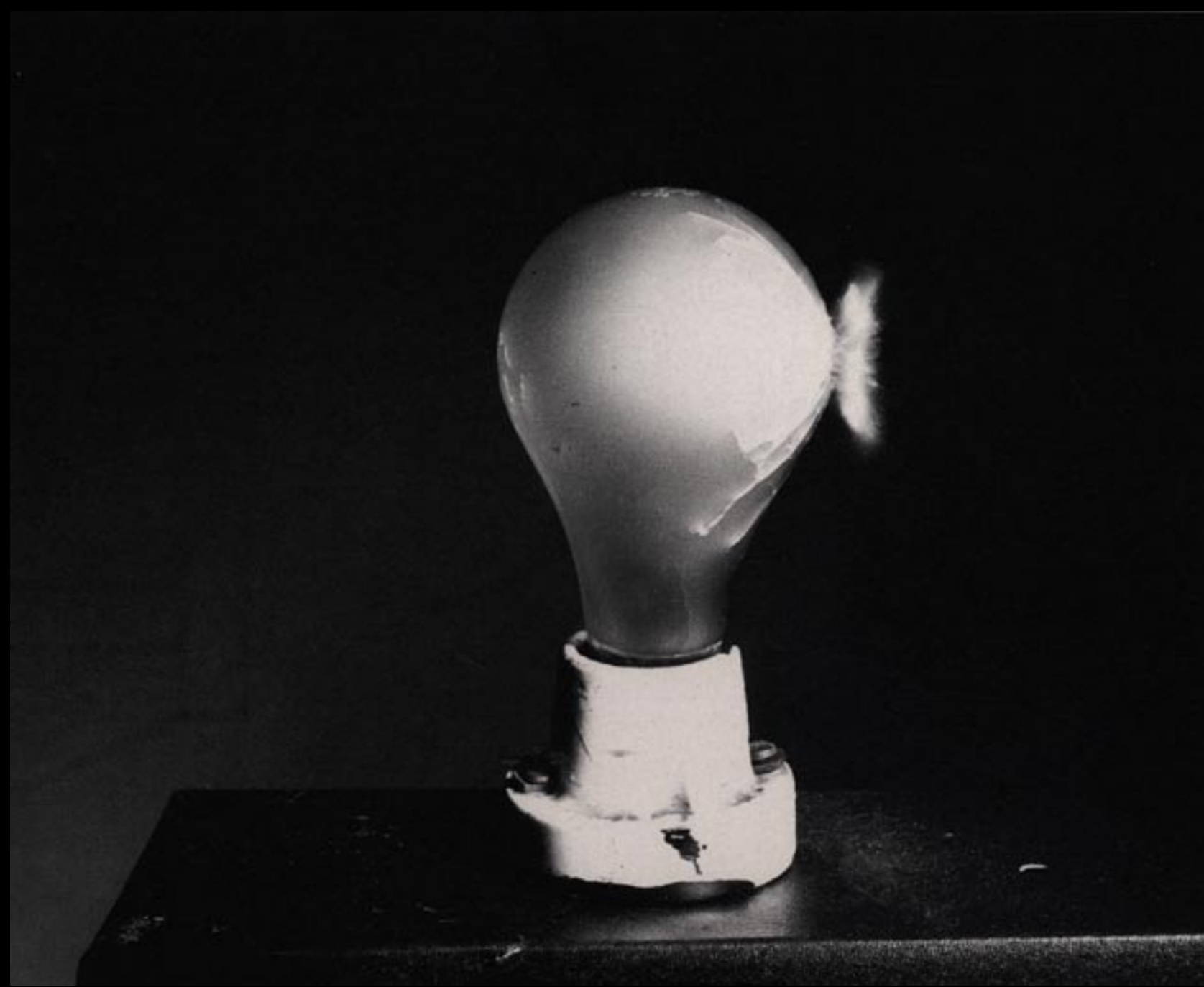
**from flashes...  
to lasers**





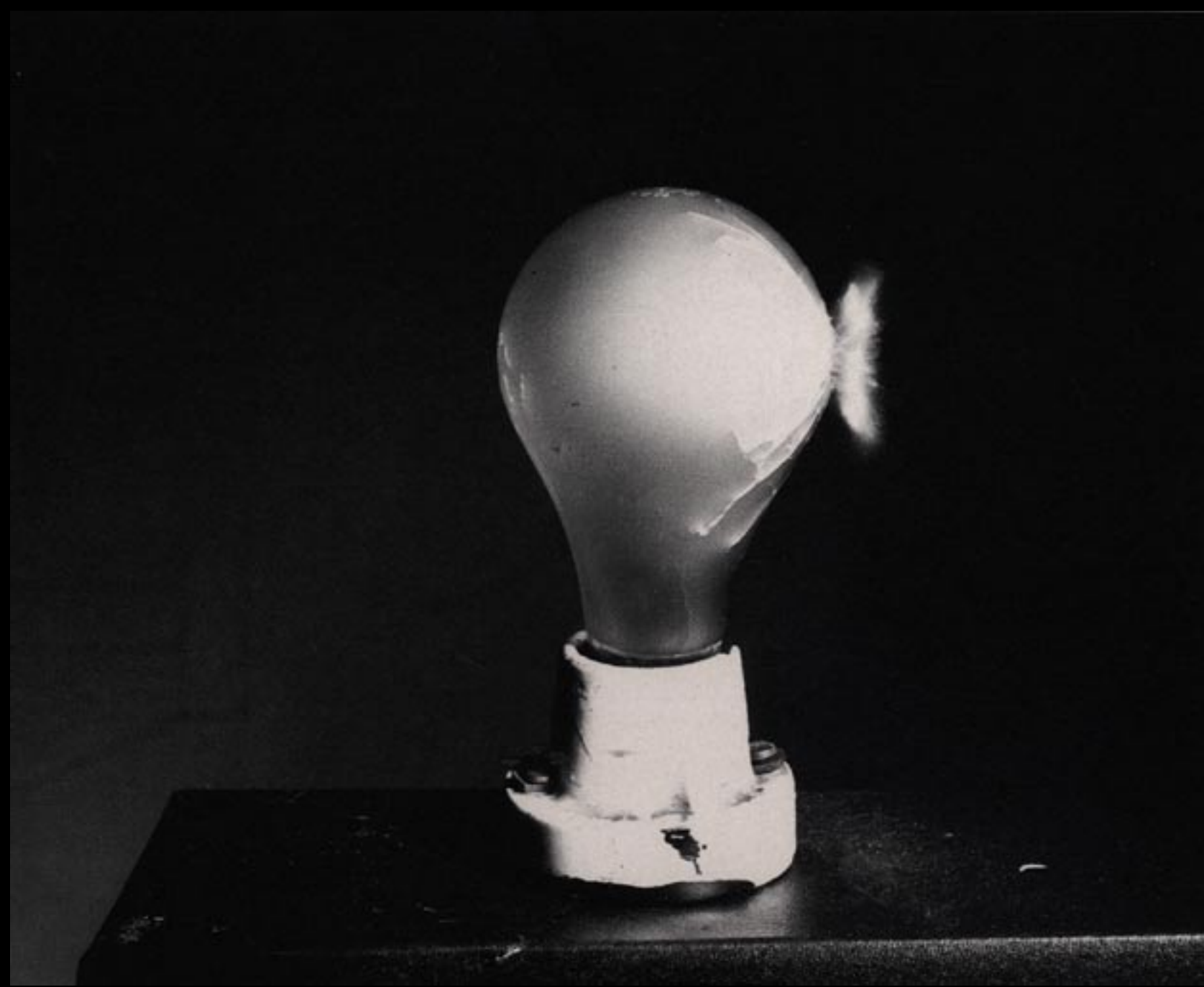
**STOPPING TIME:**

**from flashes...  
to lasers**



**how do you capture  
a bullet in a bulb?**

**STOPPING TIME:  
from flashes...  
to lasers**



**how do you capture  
a bullet in a bulb?**

**STOPPING TIME:  
from flashes...  
to lasers**



**flash exposure:**

**about 1 microsecond**

A blue-tinted photograph of a water splash, showing a crown of water droplets and ripples. The text is overlaid on the splash.

**STOPPING TIME:**

**from flashes...  
to lasers**

**flash exposure:**

**about 1 microsecond**

**that's one millionth**

**of a second!**

A blue-tinted photograph of a water splash, showing a crown of water droplets and ripples. The text is overlaid on the splash.

**STOPPING TIME:**

**from flashes...  
to lasers**



**flash exposure:**

**about 1 microsecond**

**1 microsecond is  
to a second**

**that's one millionth**

**of a second!**



**STOPPING TIME:**

**from flashes...  
to lasers**

**flash exposure:**

**about 1 microsecond**

**what a second is**

**to 2 weeks!**

**that's one millionth**

**of a second!**

A blue-tinted image of a water splash, showing a crown-like shape with many small droplets. The background is a solid blue color.

**STOPPING TIME:**

**from flashes...  
to lasers**



**(one second)**



**STOPPING TIME:  
from flashes...  
to lasers**

**in 1 s light travels**

**300,000,000 m**



**(one second)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 s light travels**

**300,000,000 m**

**that's from here to  
the moon and back!**



**STOPPING TIME:**

**from flashes...  
to lasers**

1/1,000 S

**1 ms**

**(one millisecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 ms light travels**

**300,000 m**

**1/1,000 s**

**1 ms**

**(one millisecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 ms light travels**

**300,000 m**

**that's from here to**

**San Francisco**

**1/1,000 s**

**1 ms**

**(one millisecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**



1/1,000,000 S

**1  $\mu$ S**

**(one microsecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1  $\mu\text{s}$  light travels**

**300 m**



**(one microsecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1  $\mu\text{s}$  light travels**

**300 m**

**that's the length  
of an aircraft carrier**



**(one microsecond)**



**STOPPING TIME:**

**from flashes...  
to lasers**

A close-up photograph of a diamond-shaped microchip being held by tweezers. The chip has a central square area with a grid of small features. The background is a bright, glowing yellow and orange light.

$1/1,000,000,000$  s

**1 ns**

**(one nanosecond)**

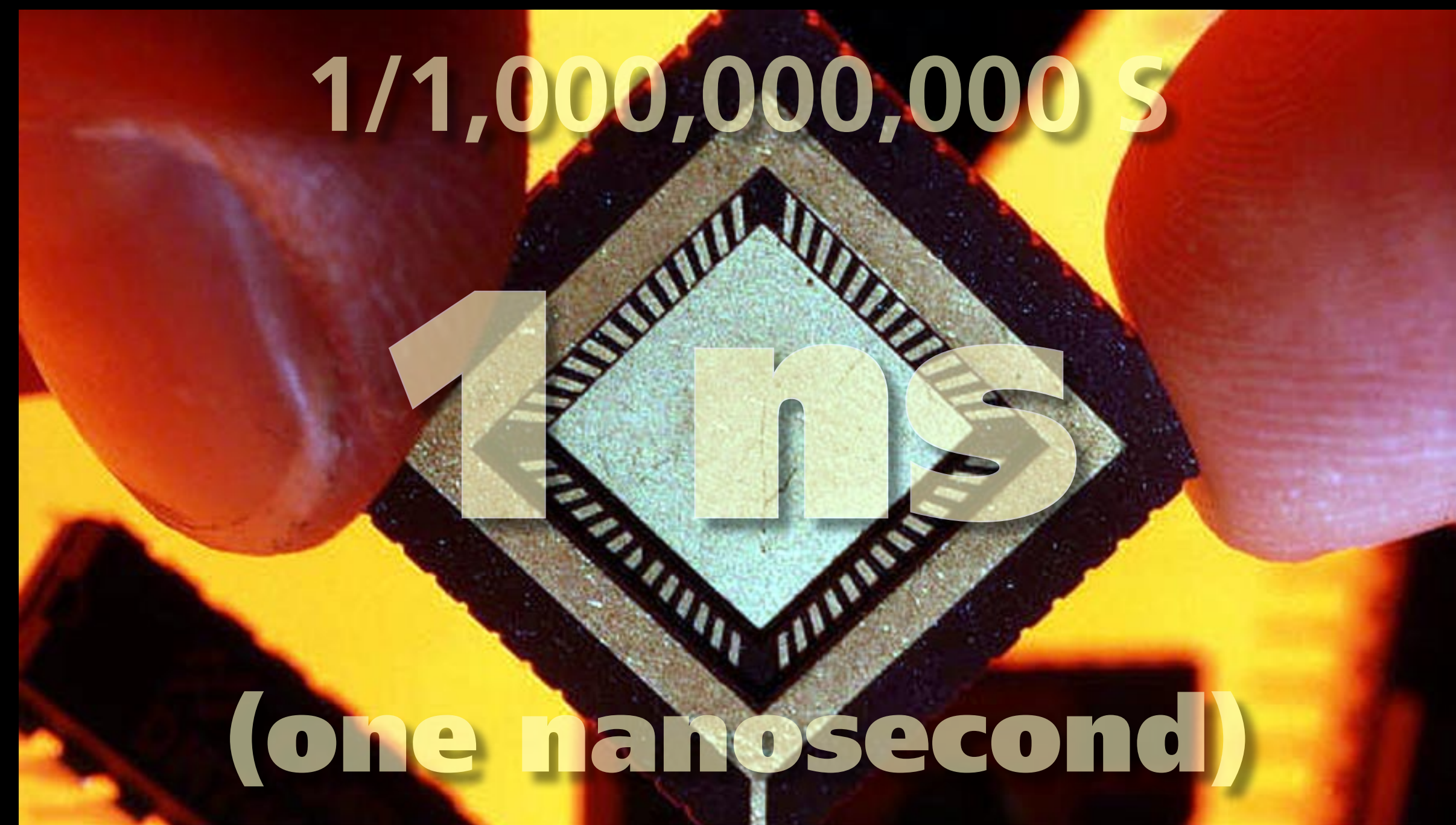
A high-speed photograph of a water splash on a blue background. The splash is captured in mid-air, with many small droplets and a central crown-like shape. The water is clear and the background is a solid, vibrant blue.

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 ns light travels**

**0.3 m**



**STOPPING TIME:**

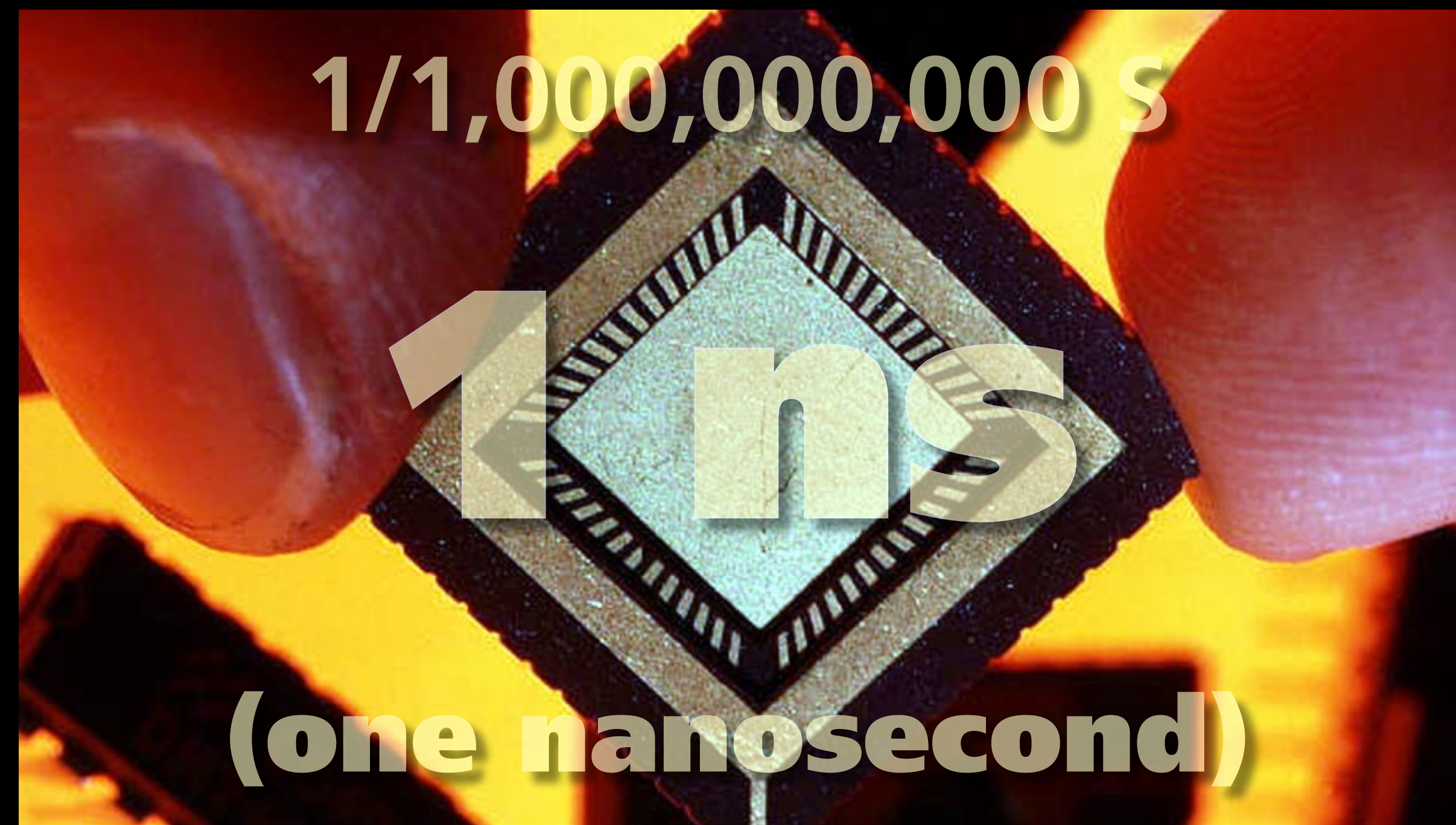
**from flashes...  
to lasers**



**in 1 ns light travels**

**0.3 m**

**that's one foot**



**STOPPING TIME:**

**from flashes...  
to lasers**

1/1,000,000,000,000 S

1 ps

(one picosecond)

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 ps light travels**

**0.3 mm**

**1/1,000,000,000,000 S**

**1 ps**

**(one picosecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**



**in 1 ps light travels**

**0.3 mm**

**that's a few times  
the width of a hair**

**1/1,000,000,000,000 S**

**1 ps**

**(one picosecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

$1/1,000,000,000,000,000$  S

**1 fs**

**(one femtosecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 fs light travels**

**0.3  $\mu\text{m}$**

**1/1,000,000,000,000,000 S**

**1 fs**

**(one femtosecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

**in 1 fs light travels**

**0.3  $\mu\text{m}$**

**that's few thousandths  
of the width of a hair**

**1/1,000,000,000,000,000 S**

**1 fs**

**(one femtosecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

1/1,000,000,000,000,000 S

**1 fs**

**(one femtosecond)**

**note that the shorter  
the time interval...**

**...the smaller the scale  
things happen on**

**STOPPING TIME:**

**from flashes...  
to lasers**



$1/1,000,000,000,000,000$  s

**1 fs**

**(one femtosecond)**

**so a 'flash' of a few femtoseconds shows...**

**very fast events  
on a small scale**

**STOPPING TIME:**

**from flashes...  
to lasers**



**a flash of just  
a few femtoseconds**

**is a lot of light**

**1/1,000,000,000,000,000 S**

**1 fs**

**(one femtosecond)**

**STOPPING TIME:**

**from flashes...  
to lasers**

$1/1,000,000,000,000,000$  S

**1 fs**

**(one femtosecond)**

**a flash of just  
a few femtoseconds**

**is a lot of light  
in very little time**

**STOPPING TIME:**

**from flashes...  
to lasers**



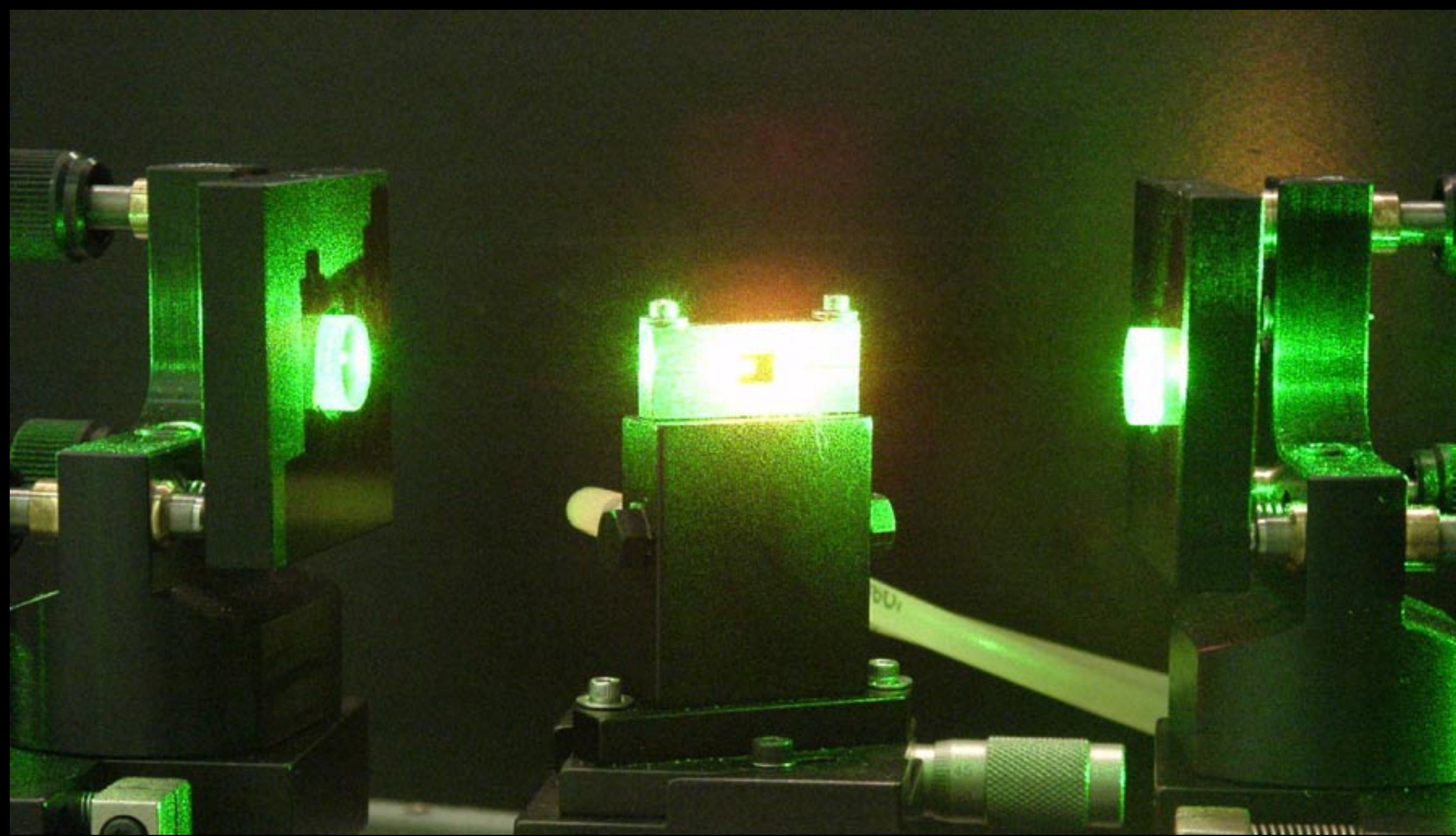
**a flash of just  
a few femtoseconds**

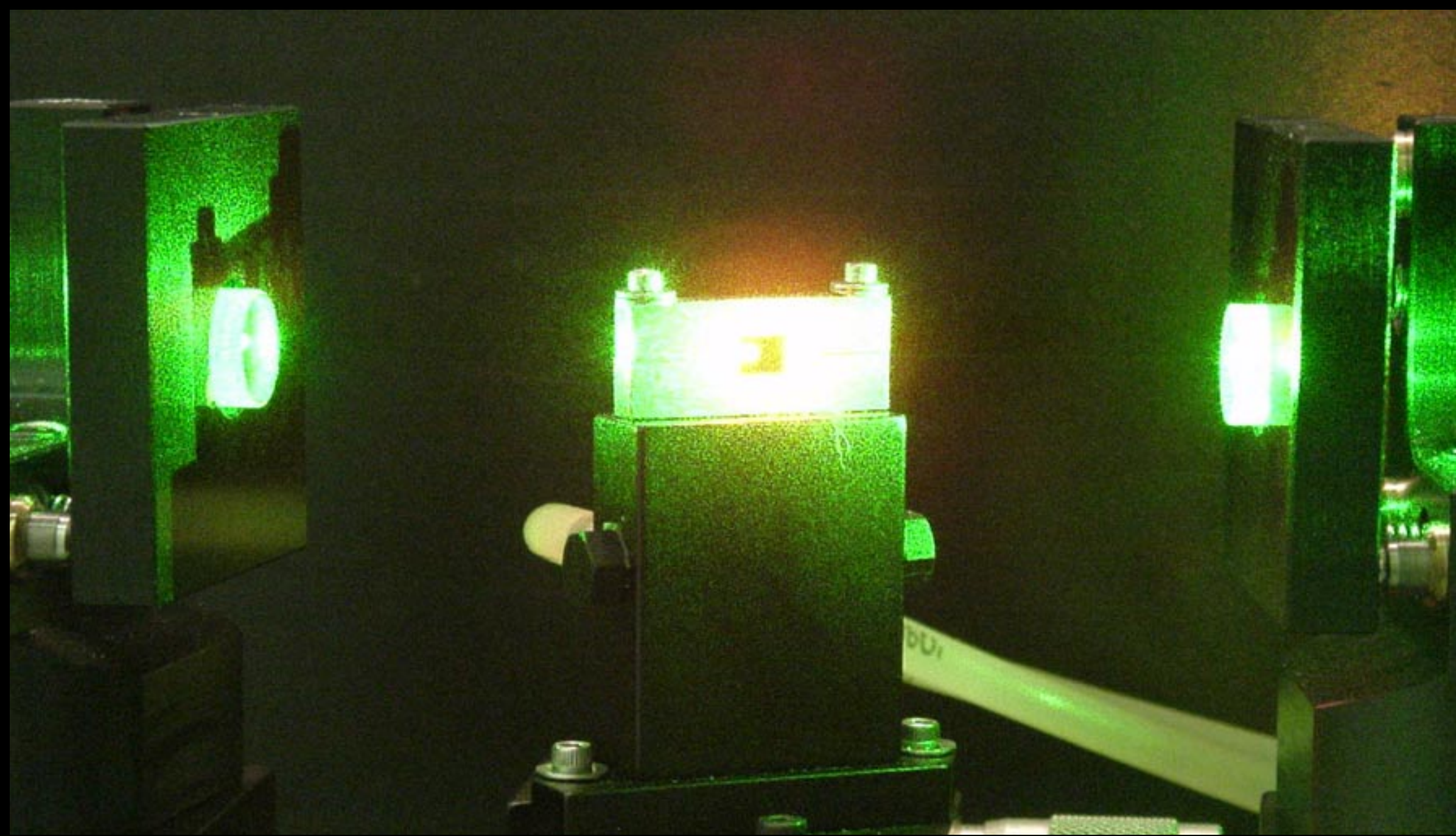


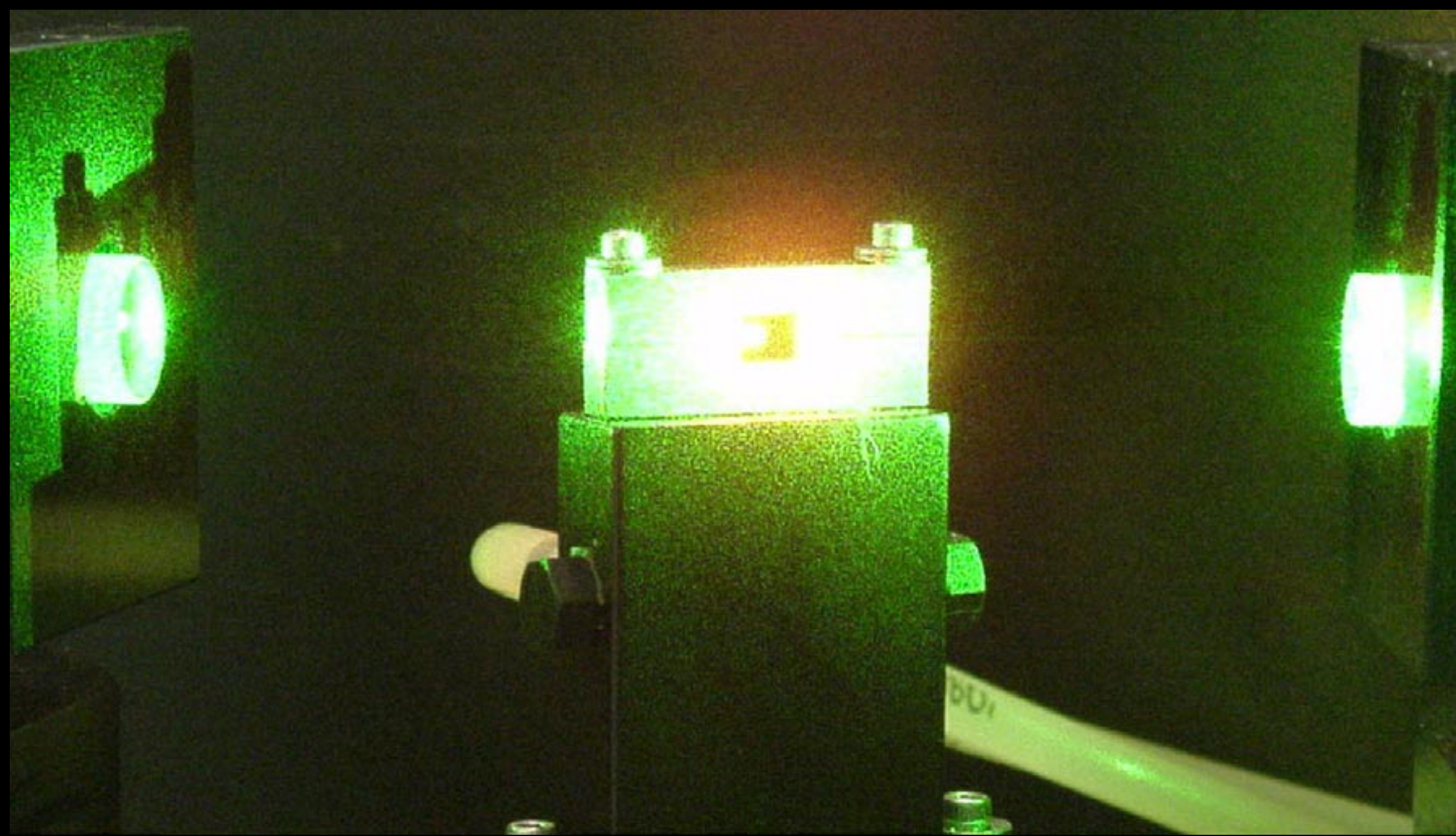
**is a lot of light  
in very little time**

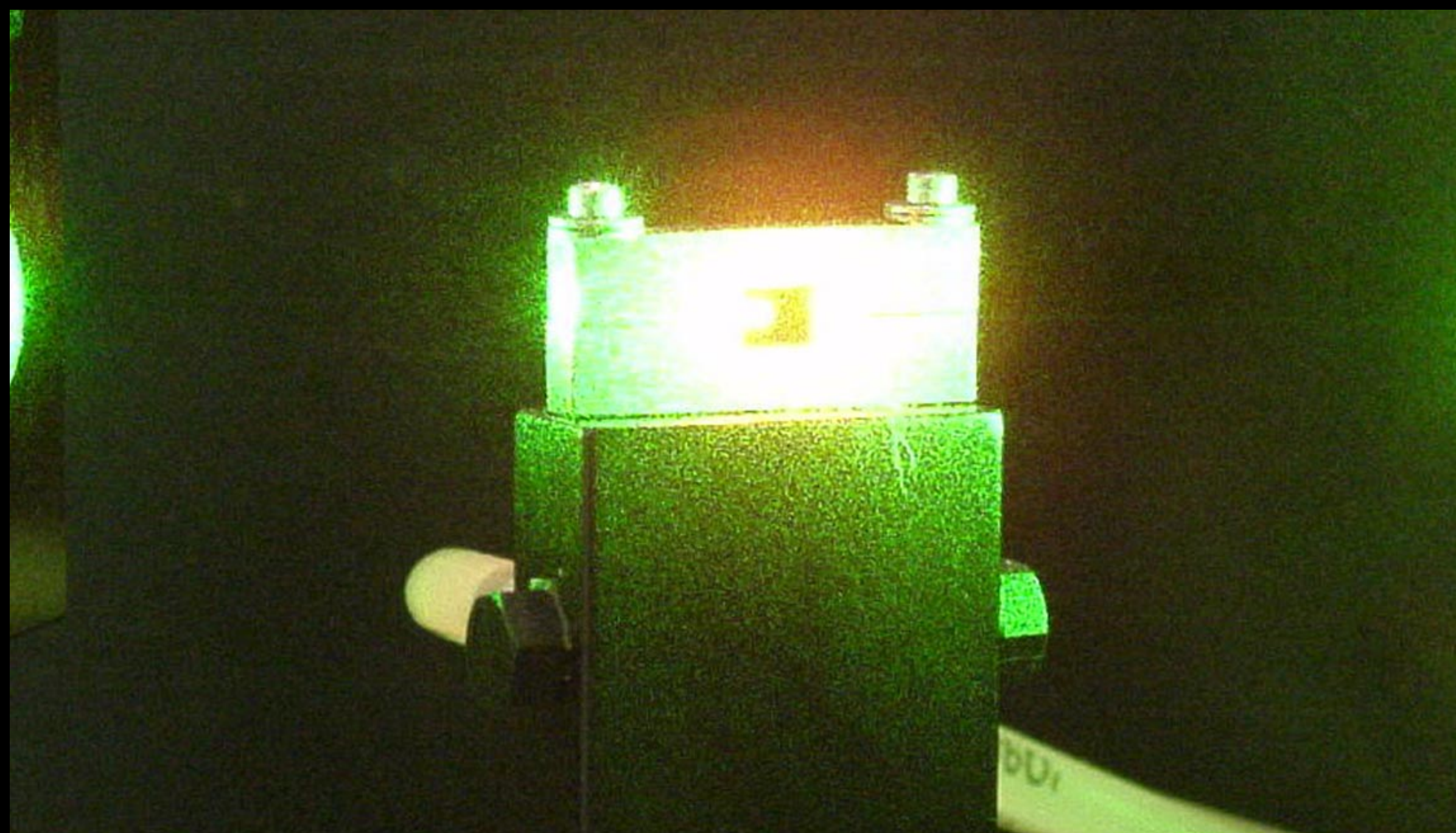
**STOPPING TIME:  
from flashes...  
to lasers**



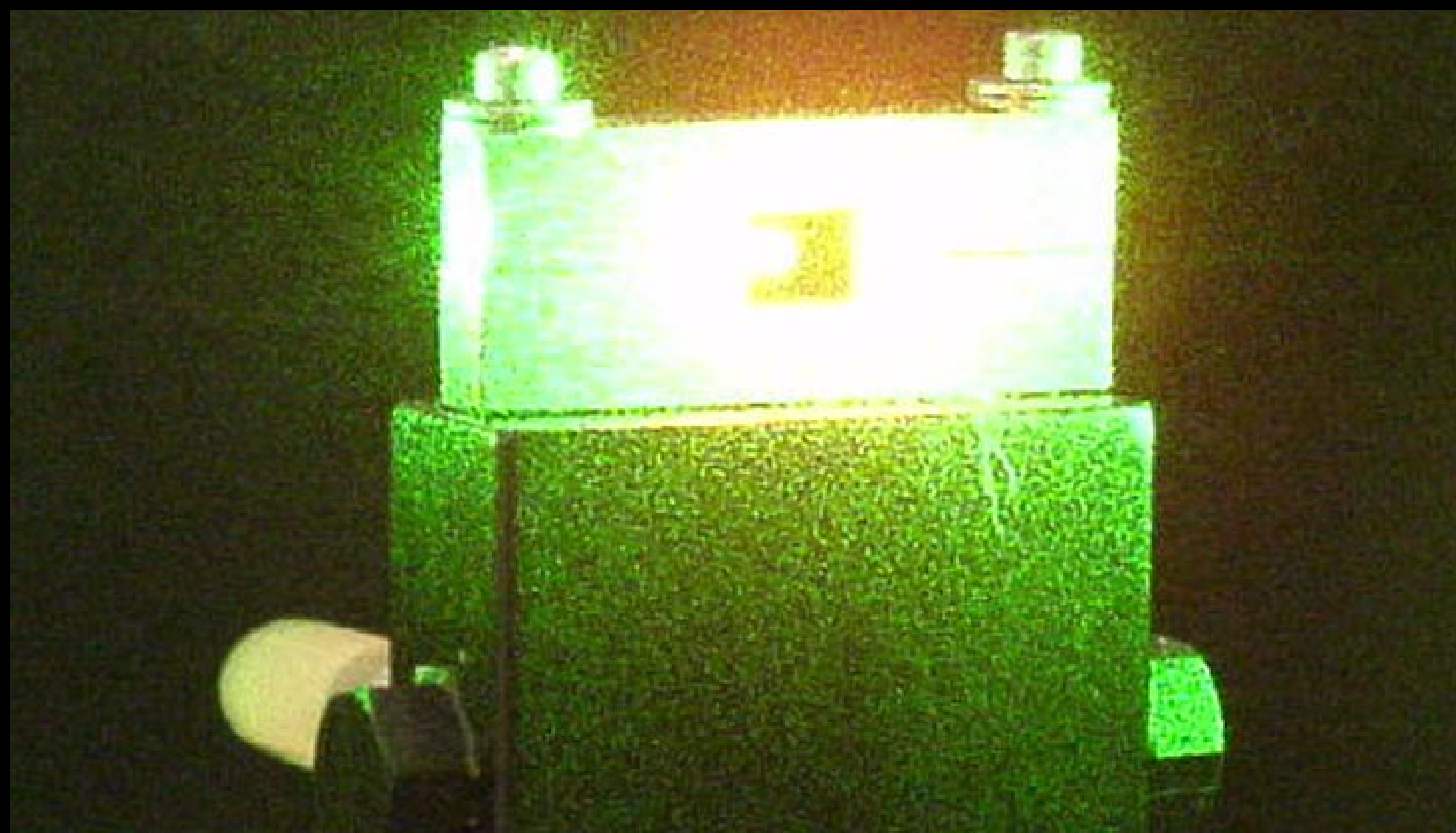


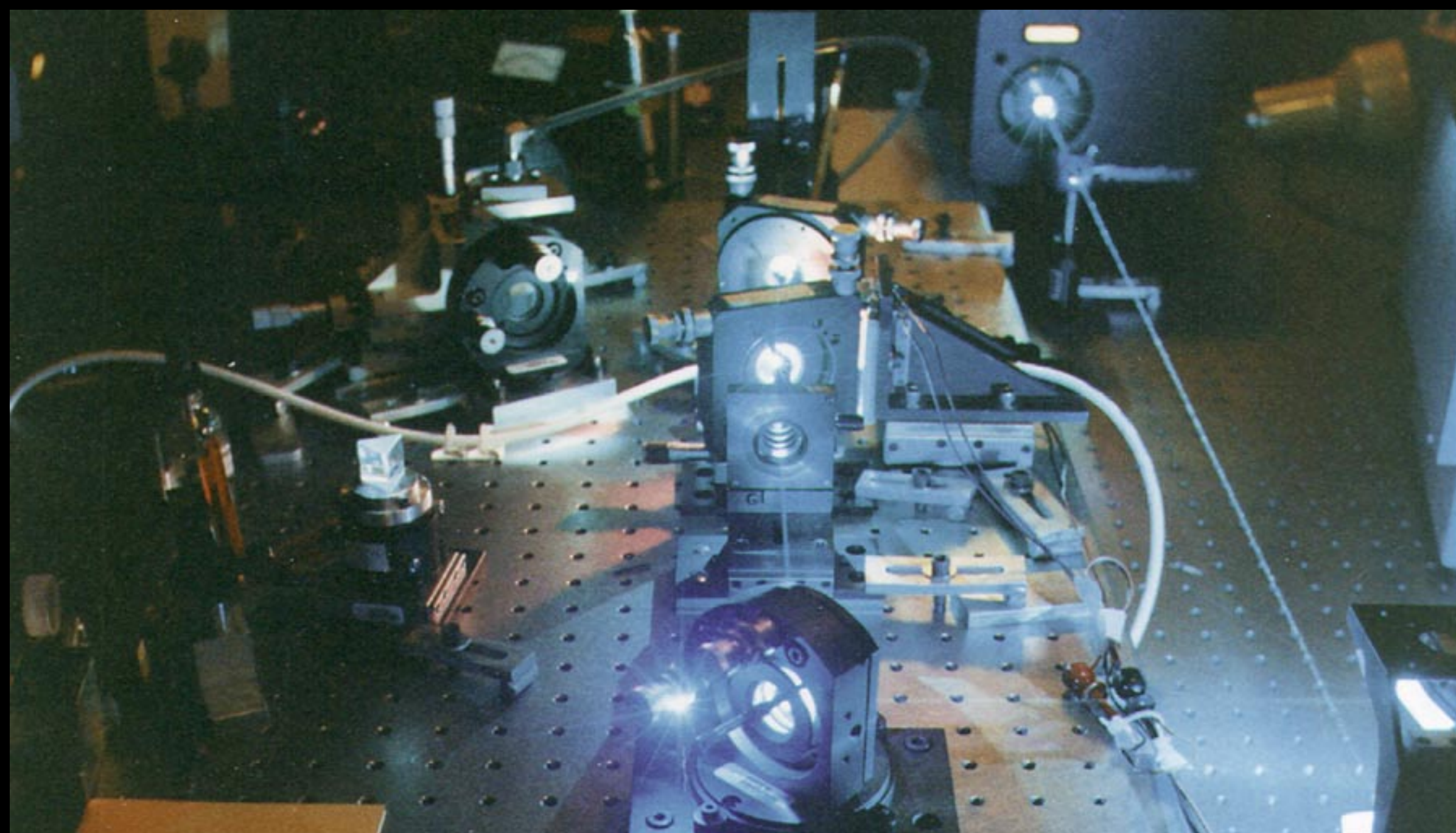




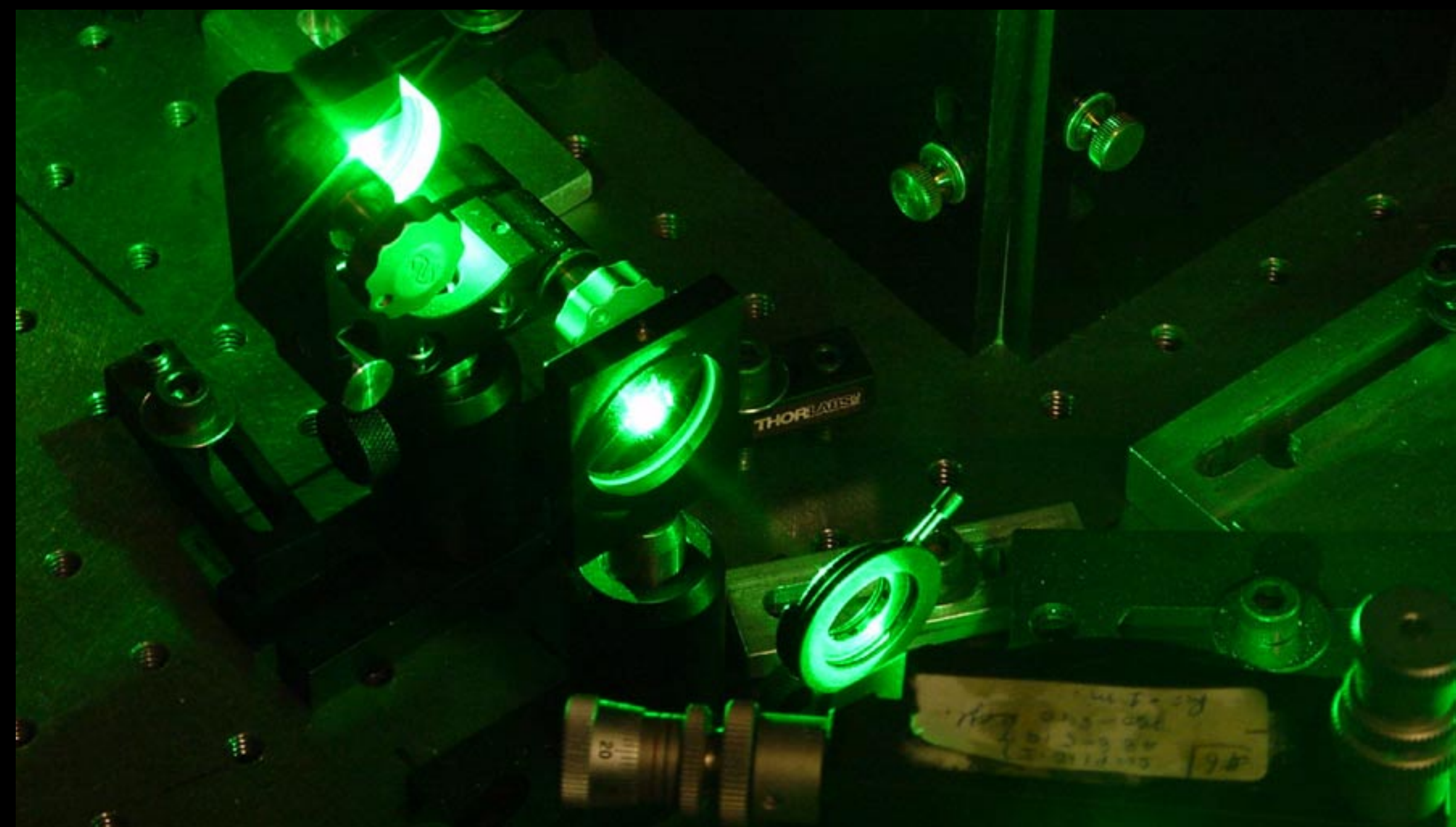
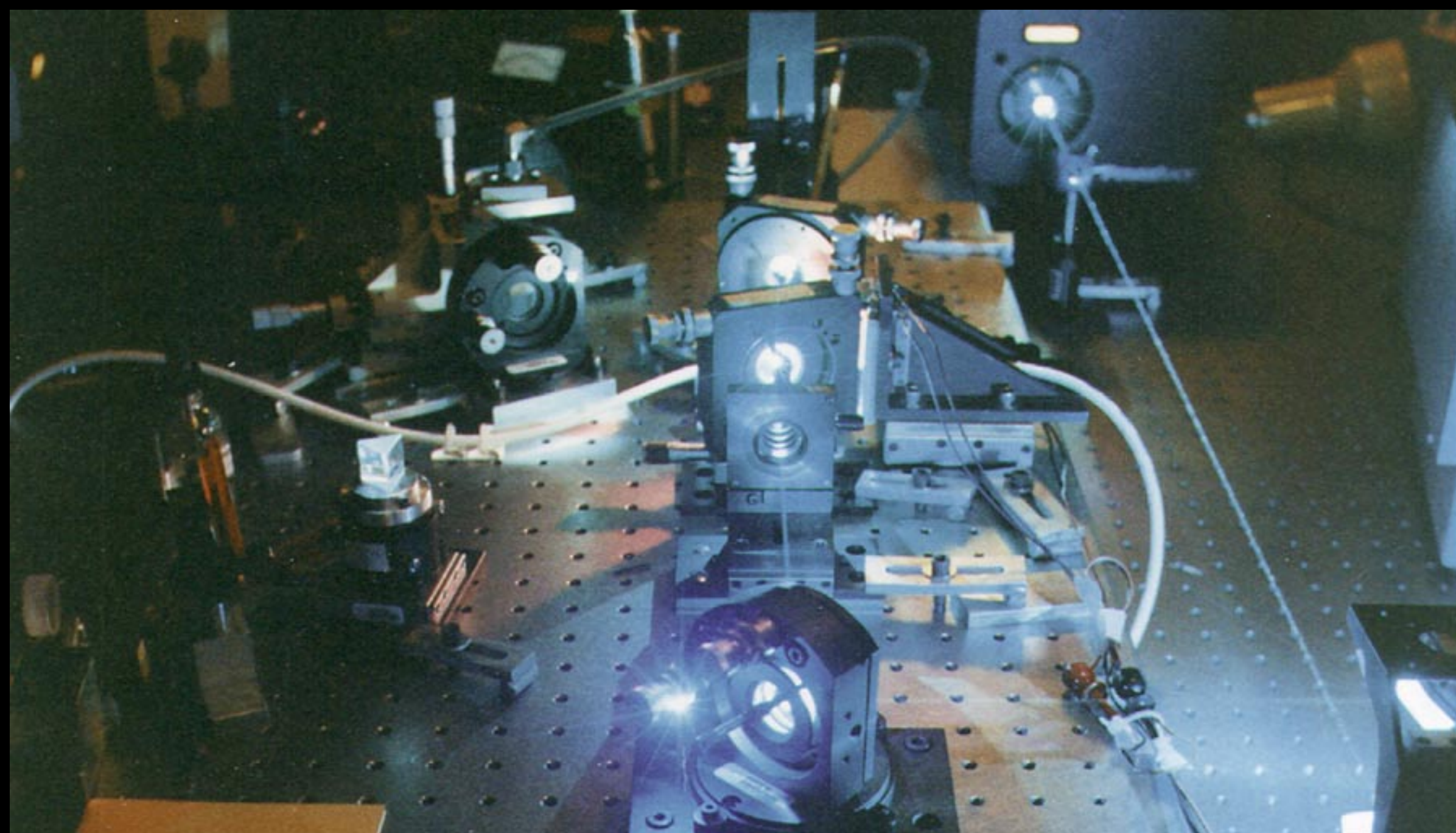


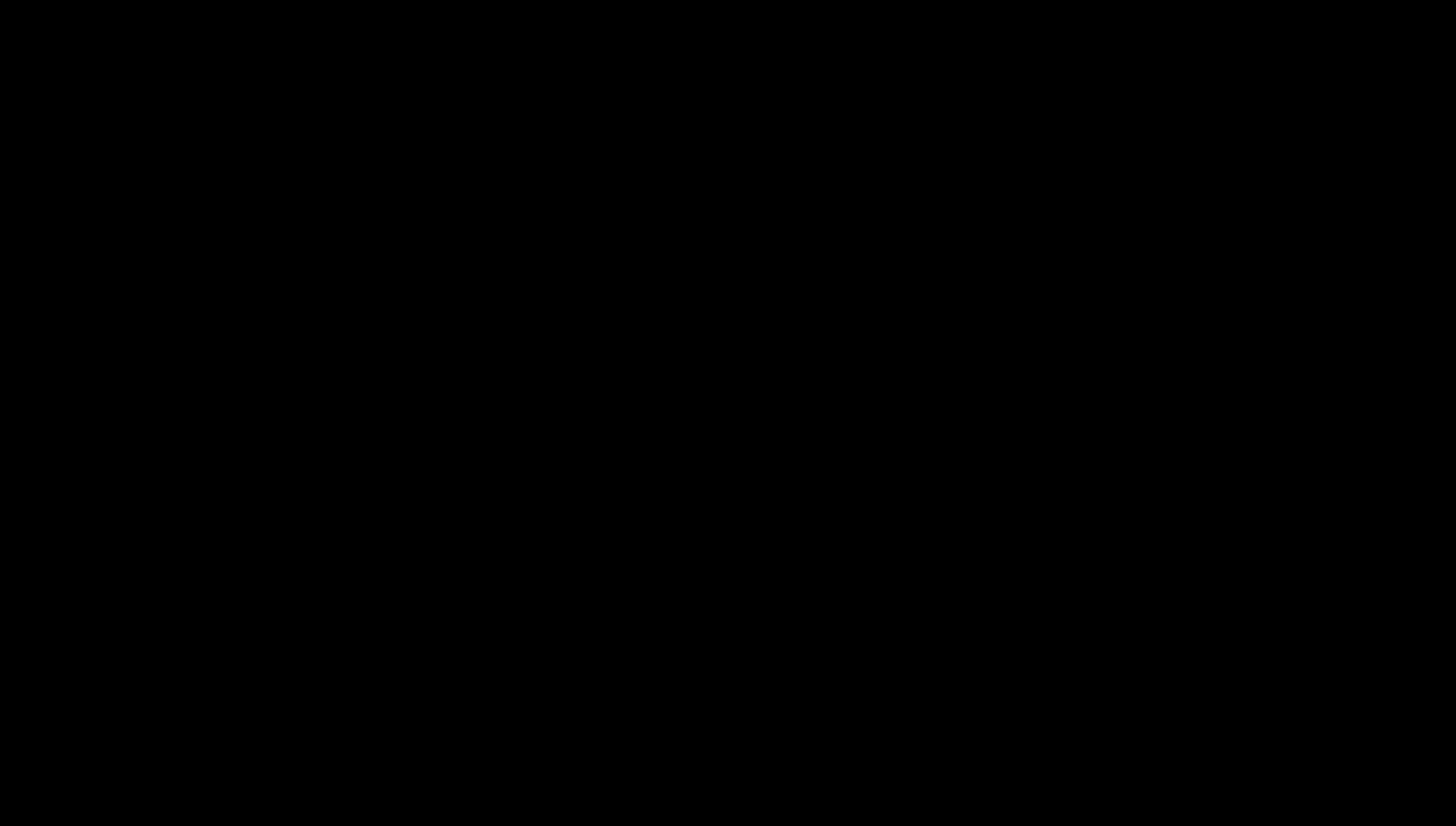
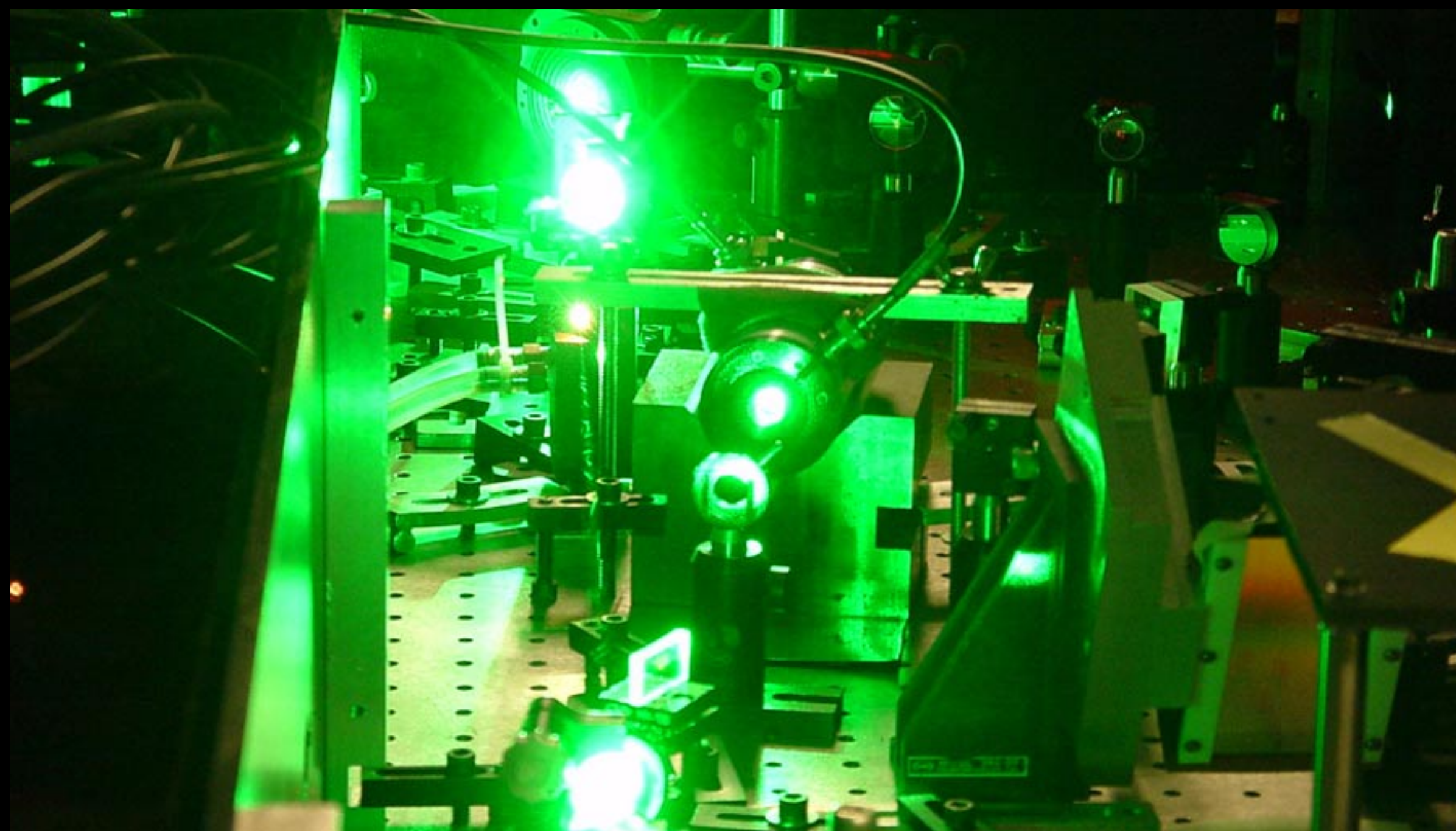
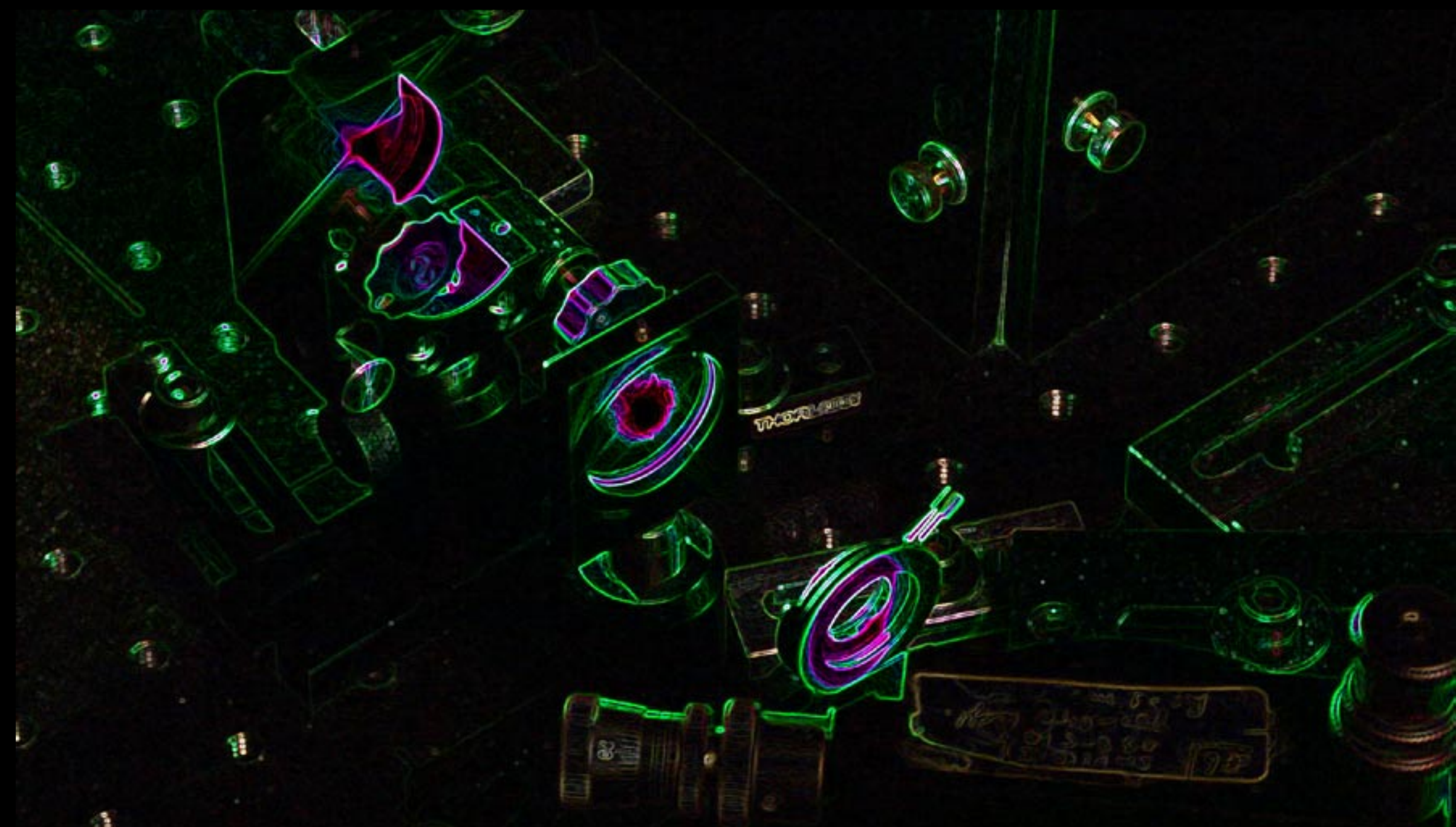
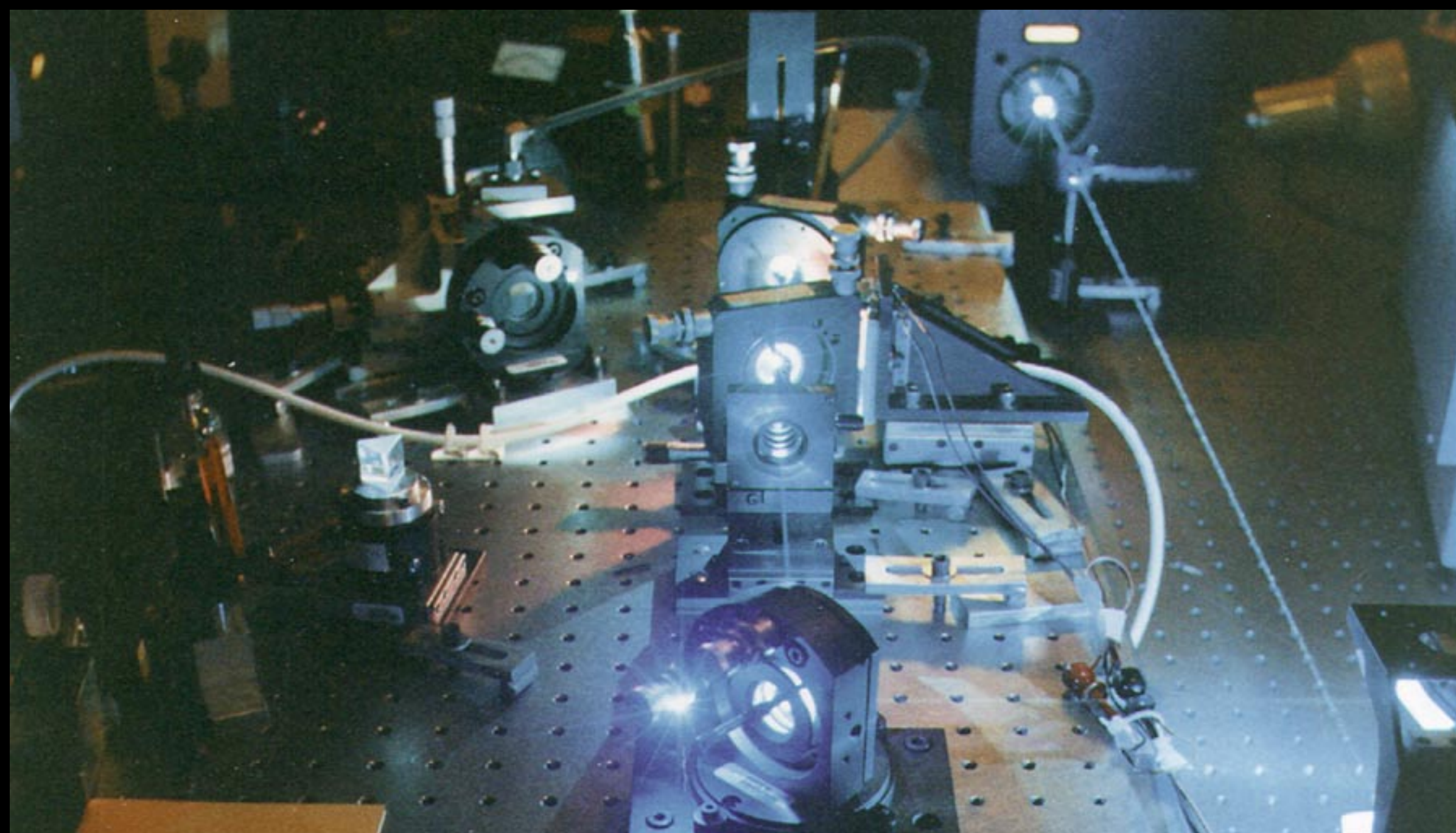


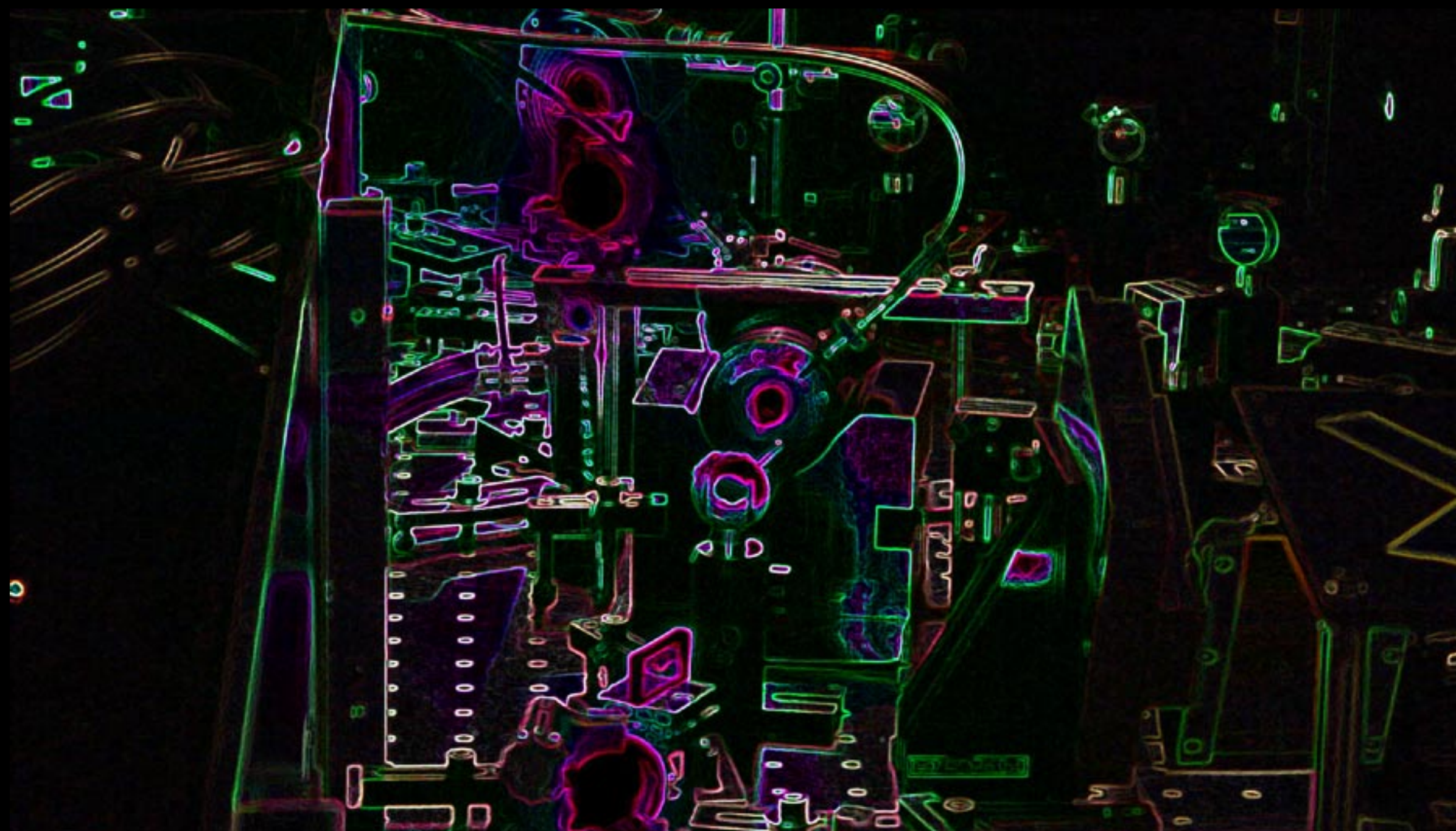
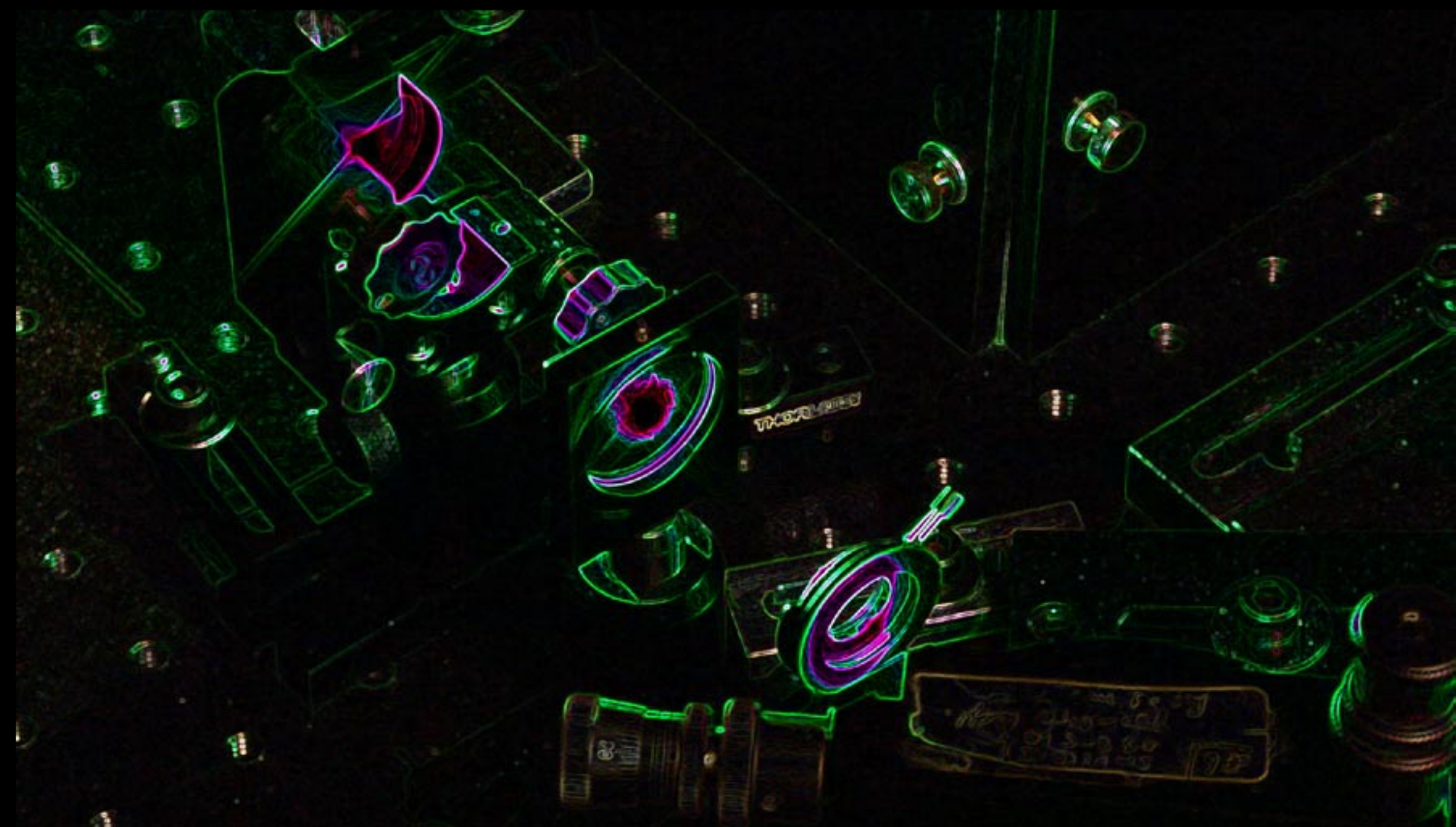
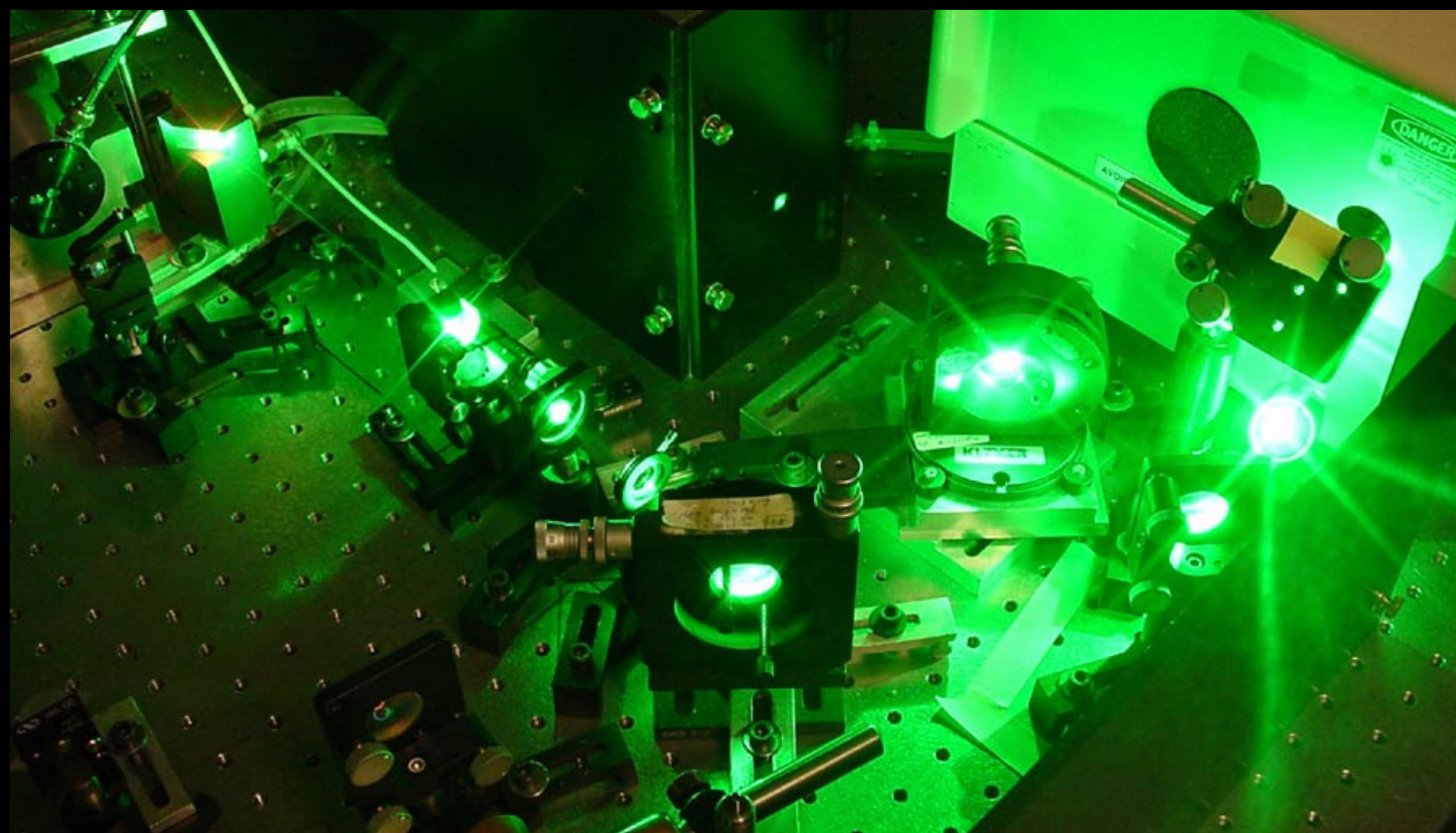


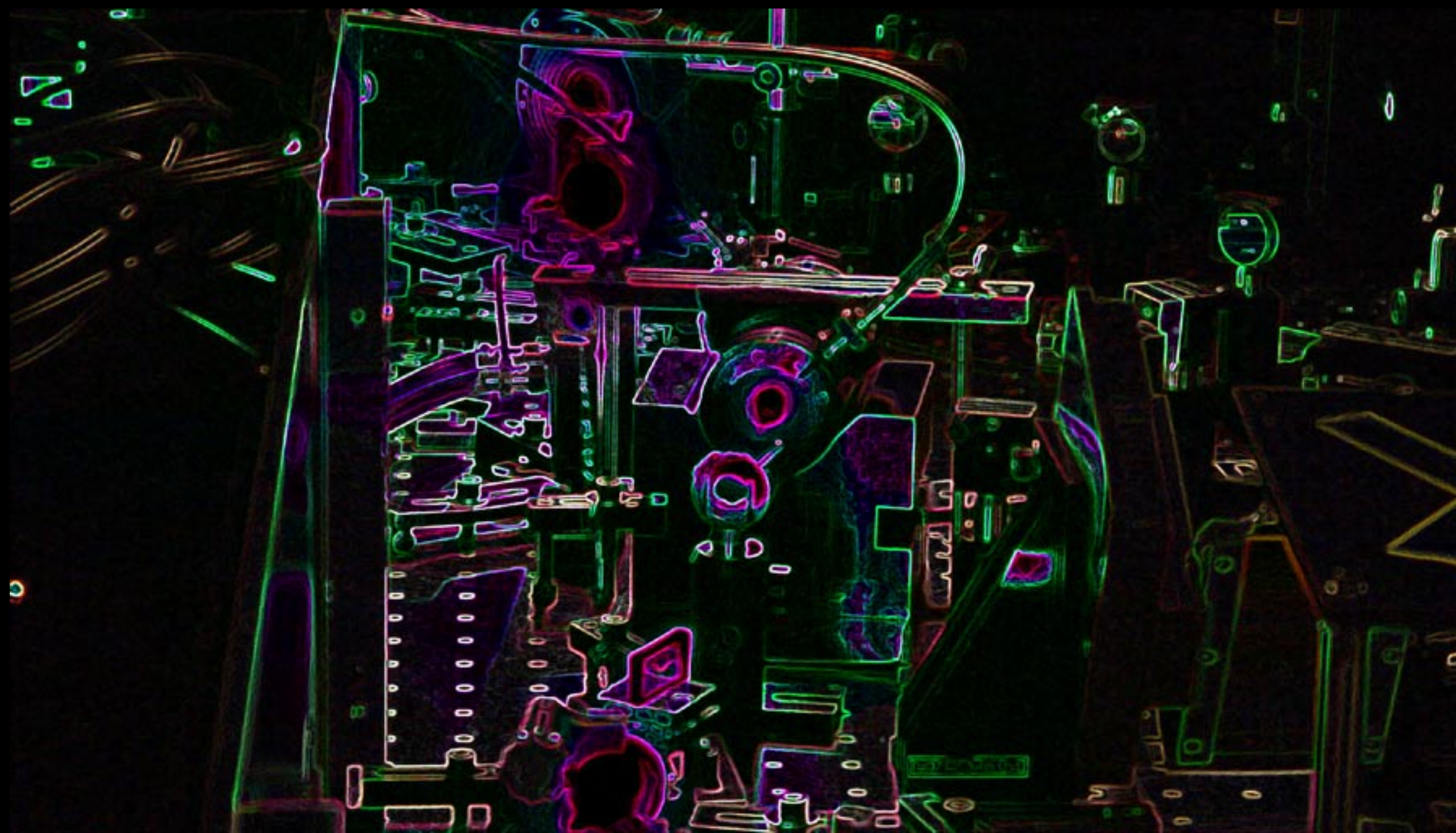
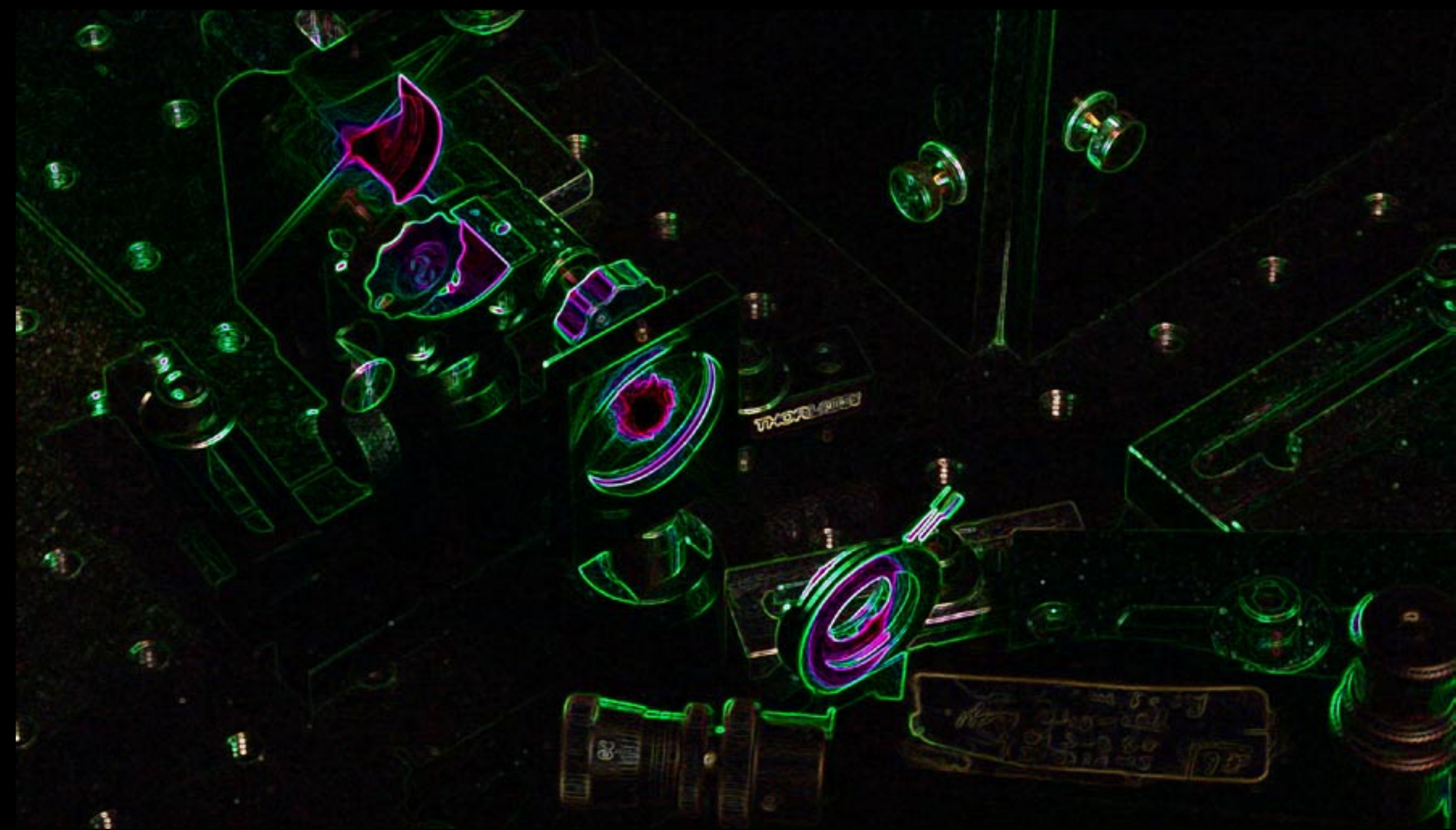
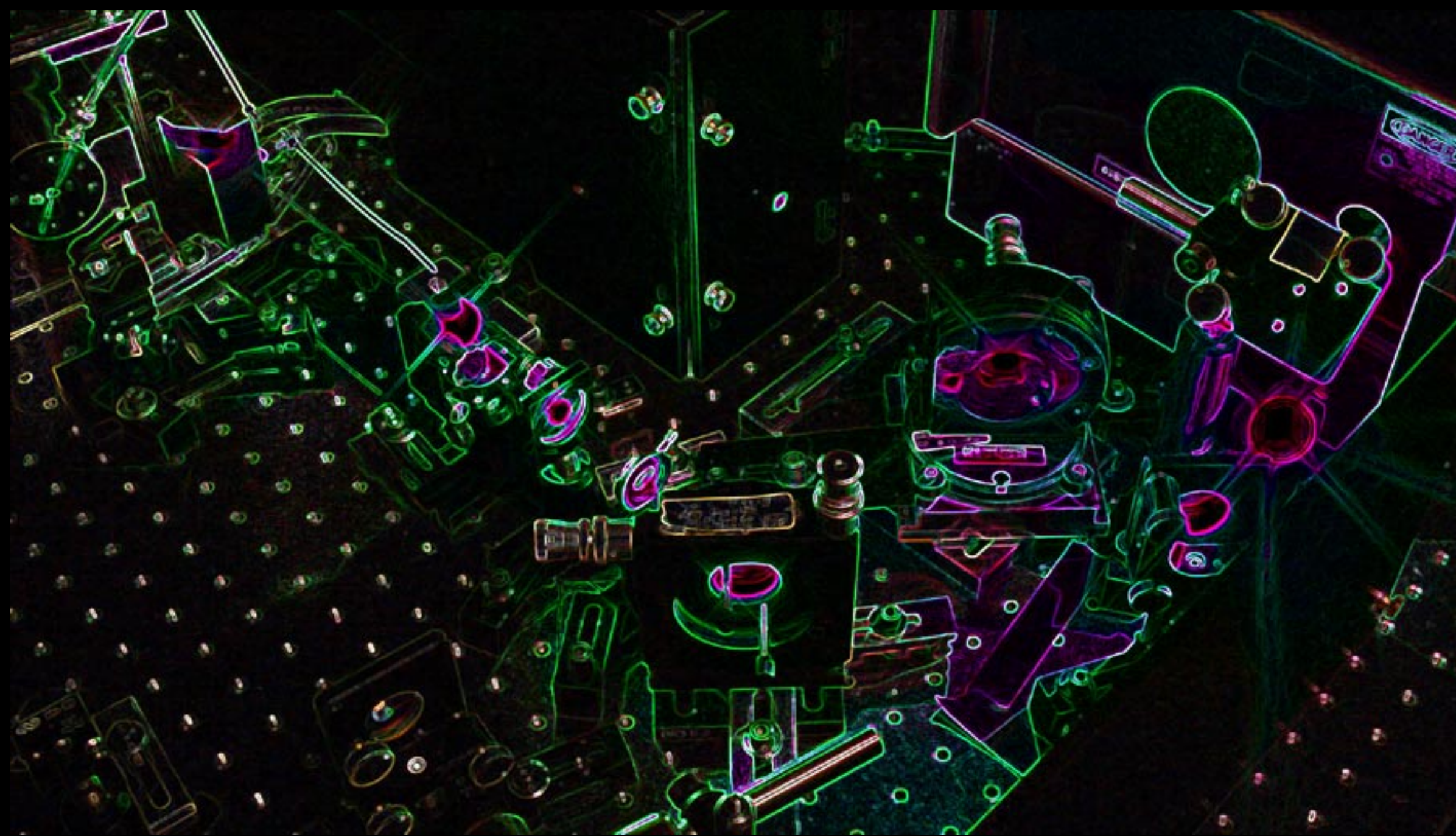












**femtosecond pulses**

**open door to**

**extremely fast**

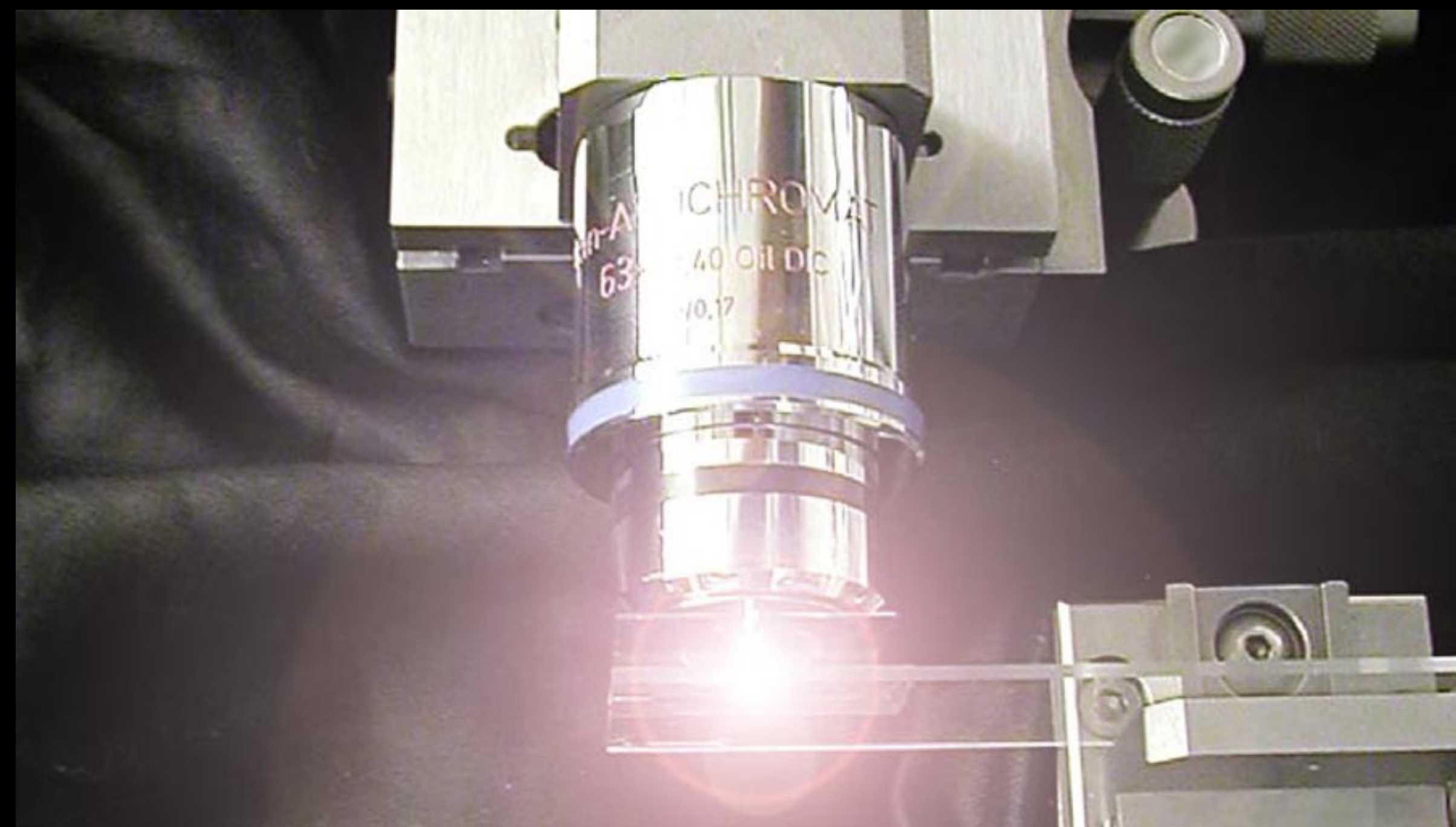


**extremely hot**



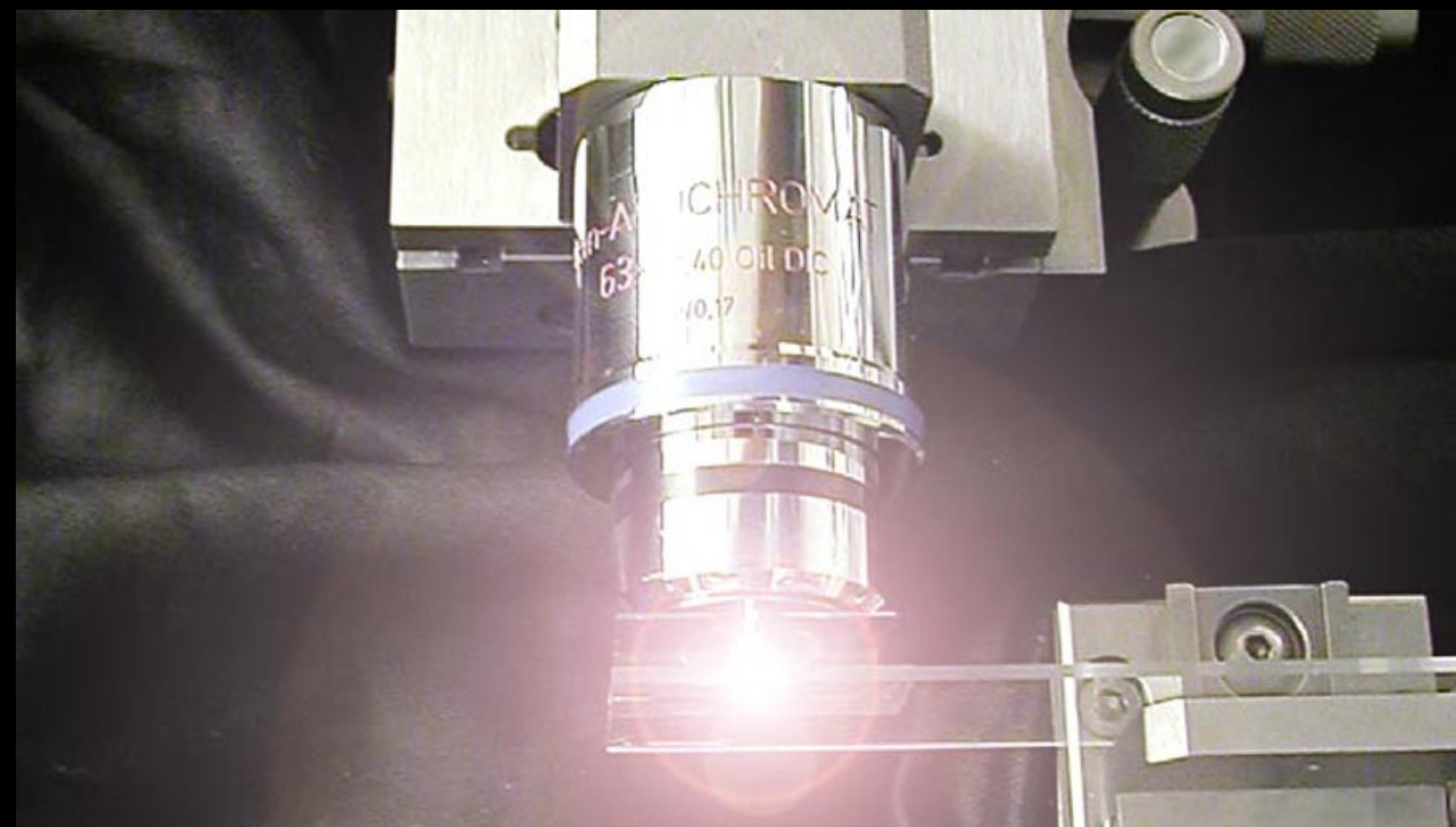
**STOPPING TIME:**

**from flashes...  
to lasers**



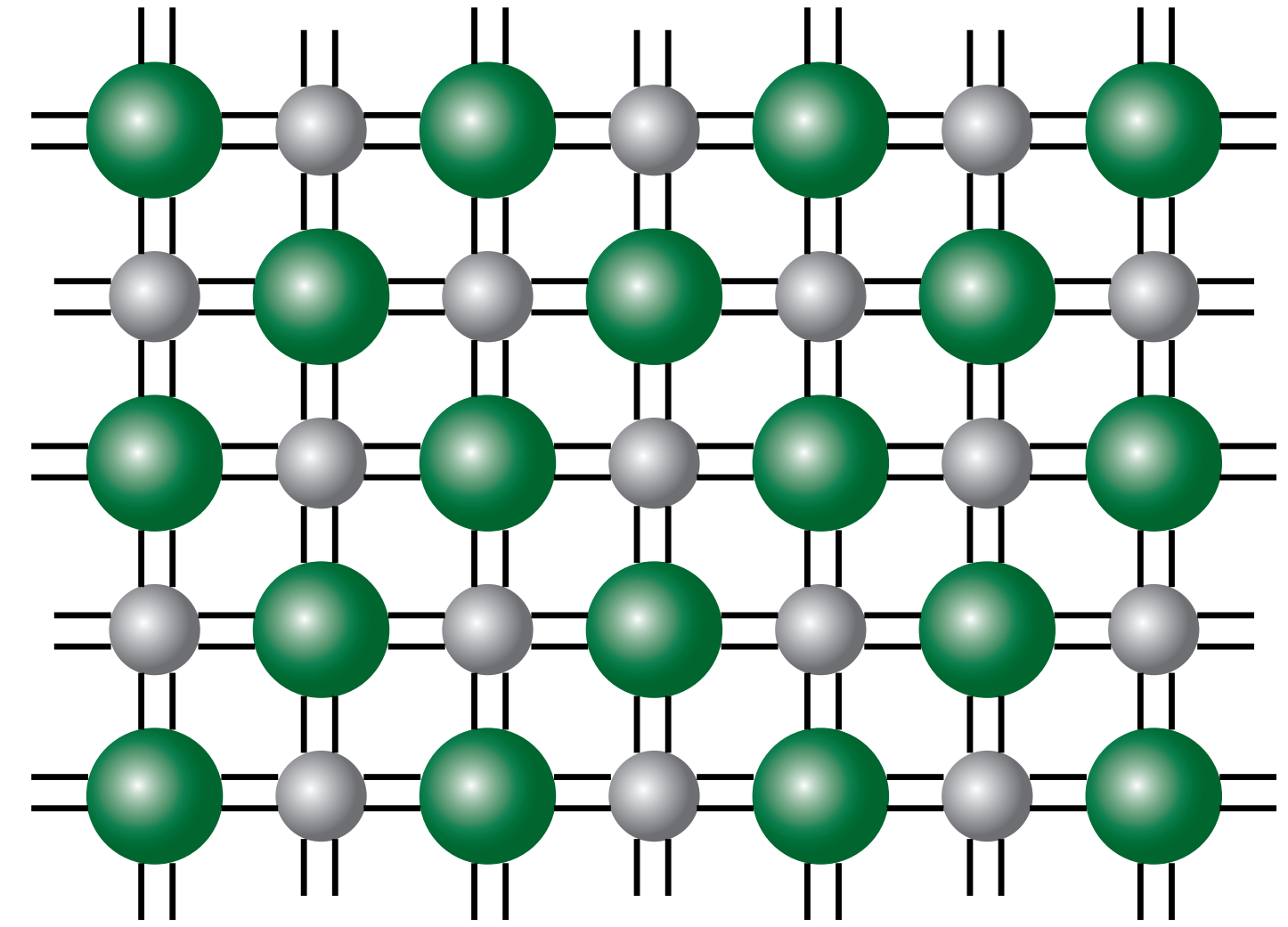
**extremely fast**

**STOPPING TIME:  
from flashes...  
to lasers**



**extremely fast**

**STOPPING TIME:  
from flashes...  
to lasers**

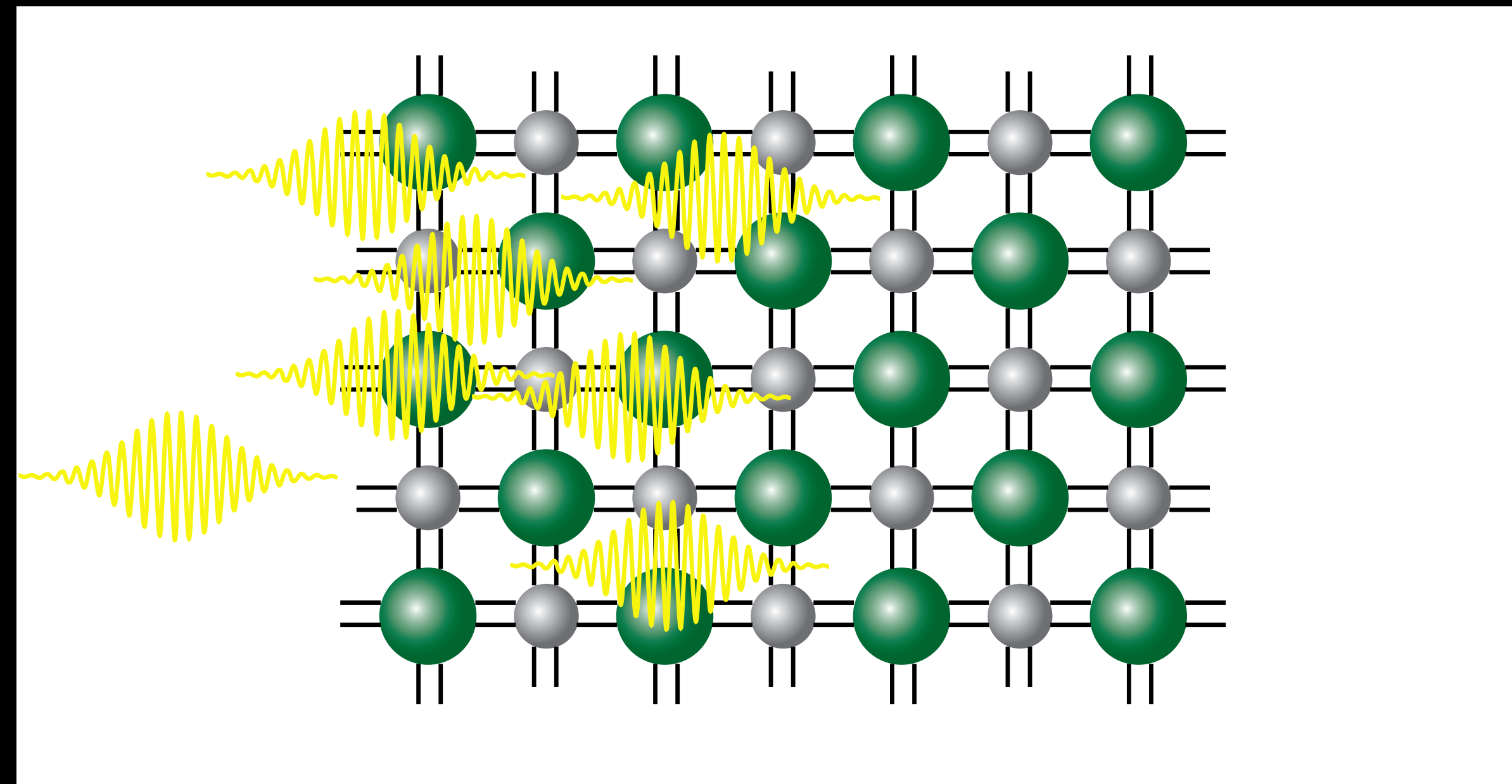


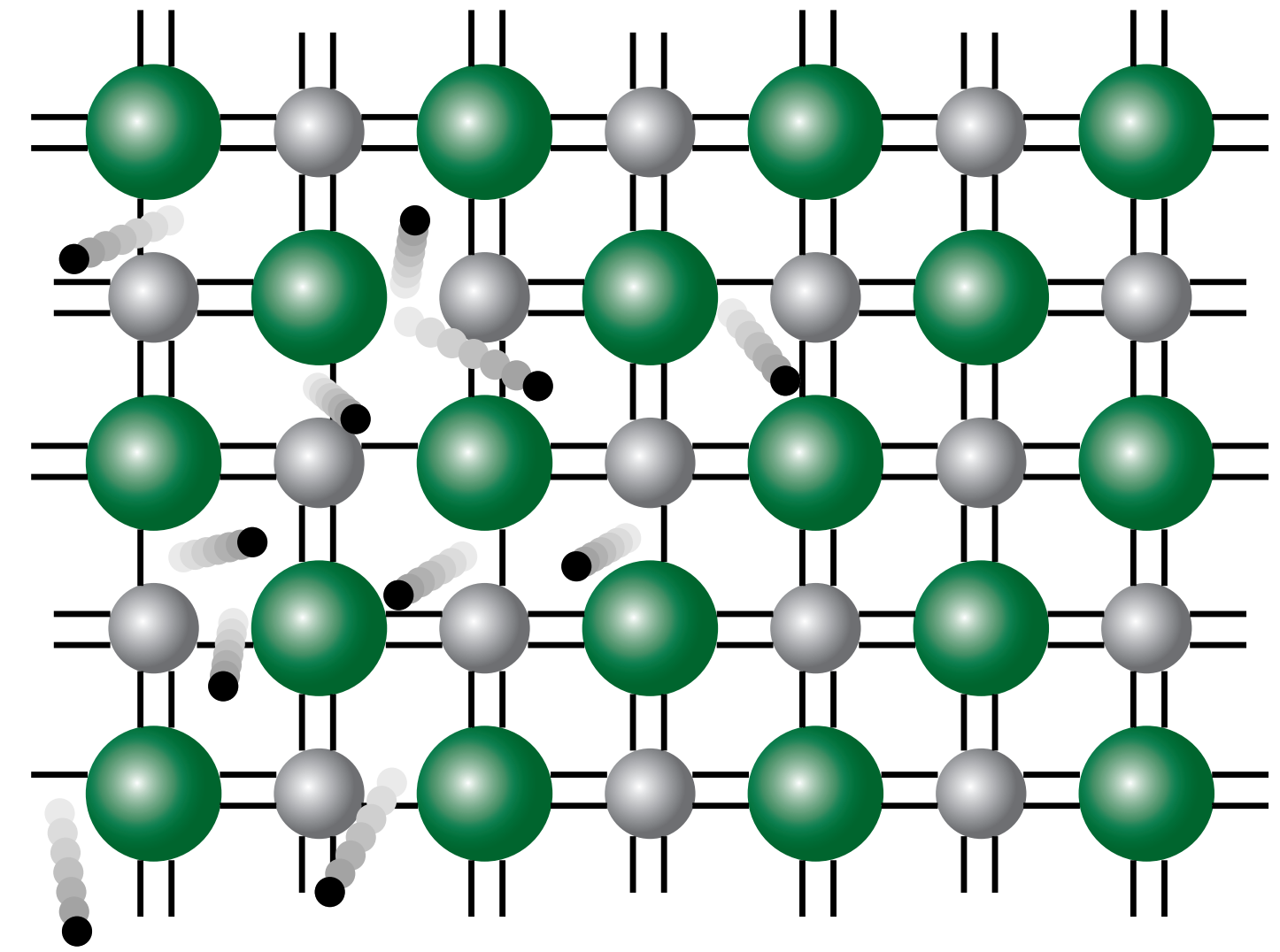
**extremely fast**

**STOPPING TIME:**

**from flashes...  
to lasers**



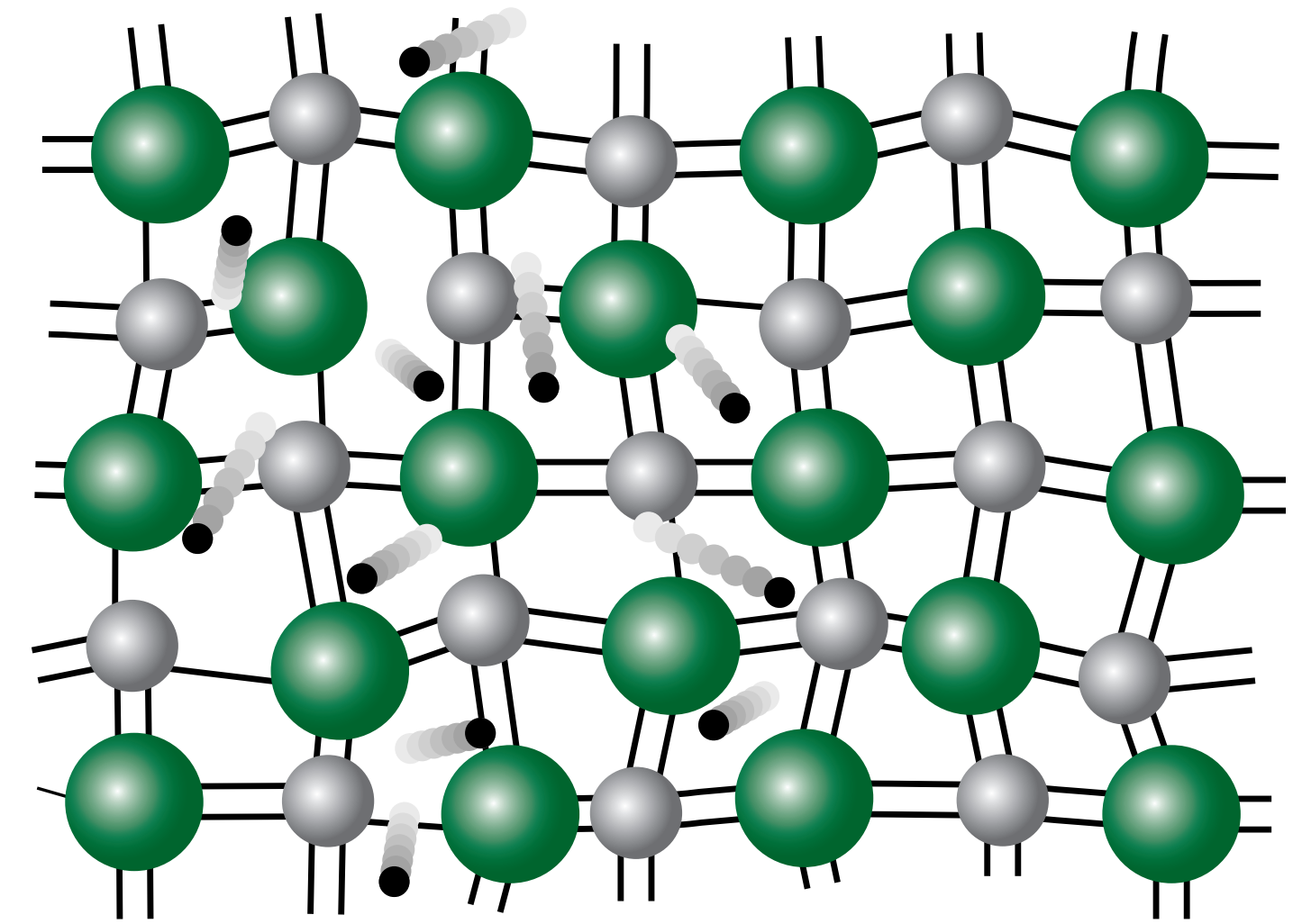




**extremely fast**

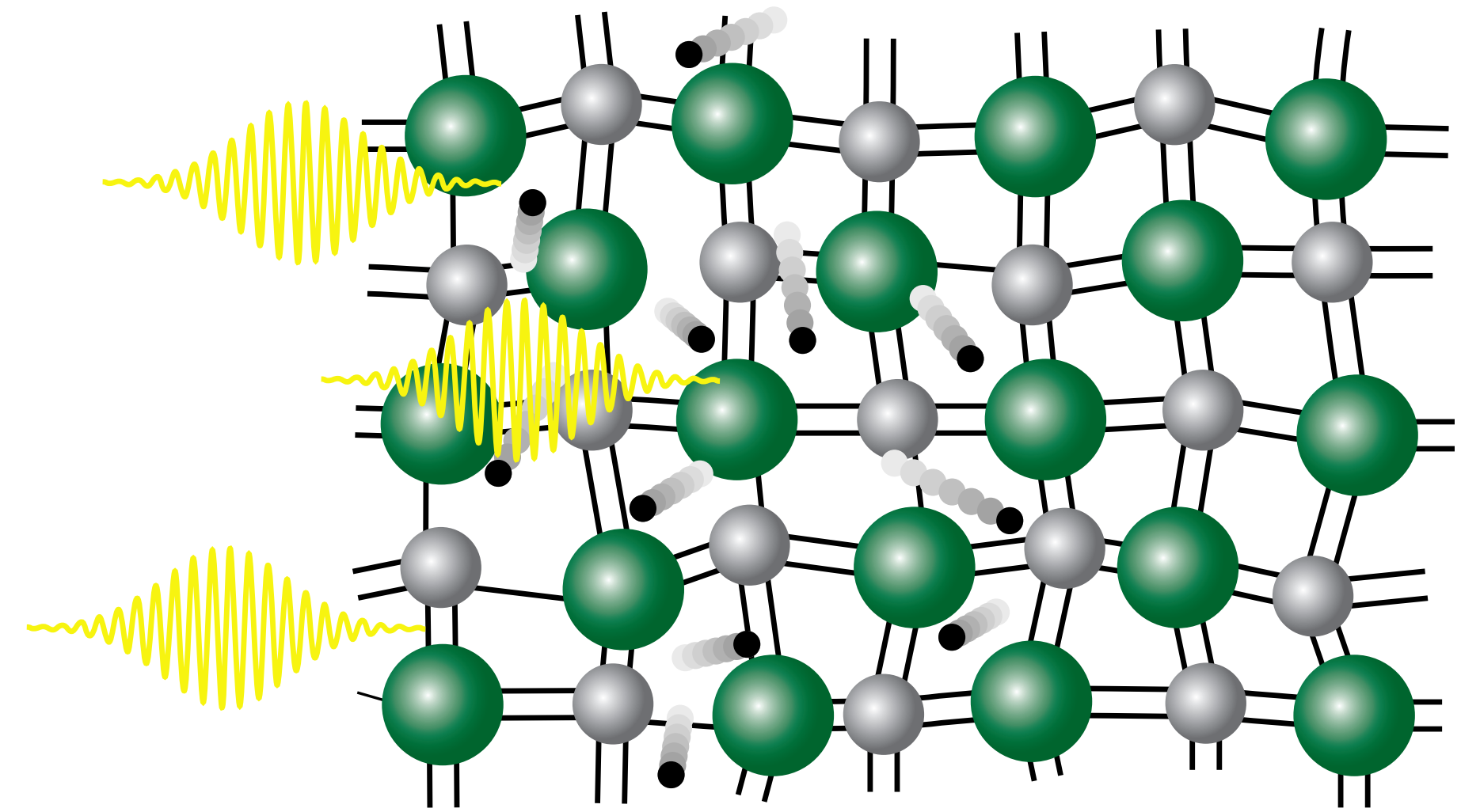
**STOPPING TIME:**

**from flashes...  
to lasers**



**extremely fast**

**STOPPING TIME:  
from flashes...  
to lasers**

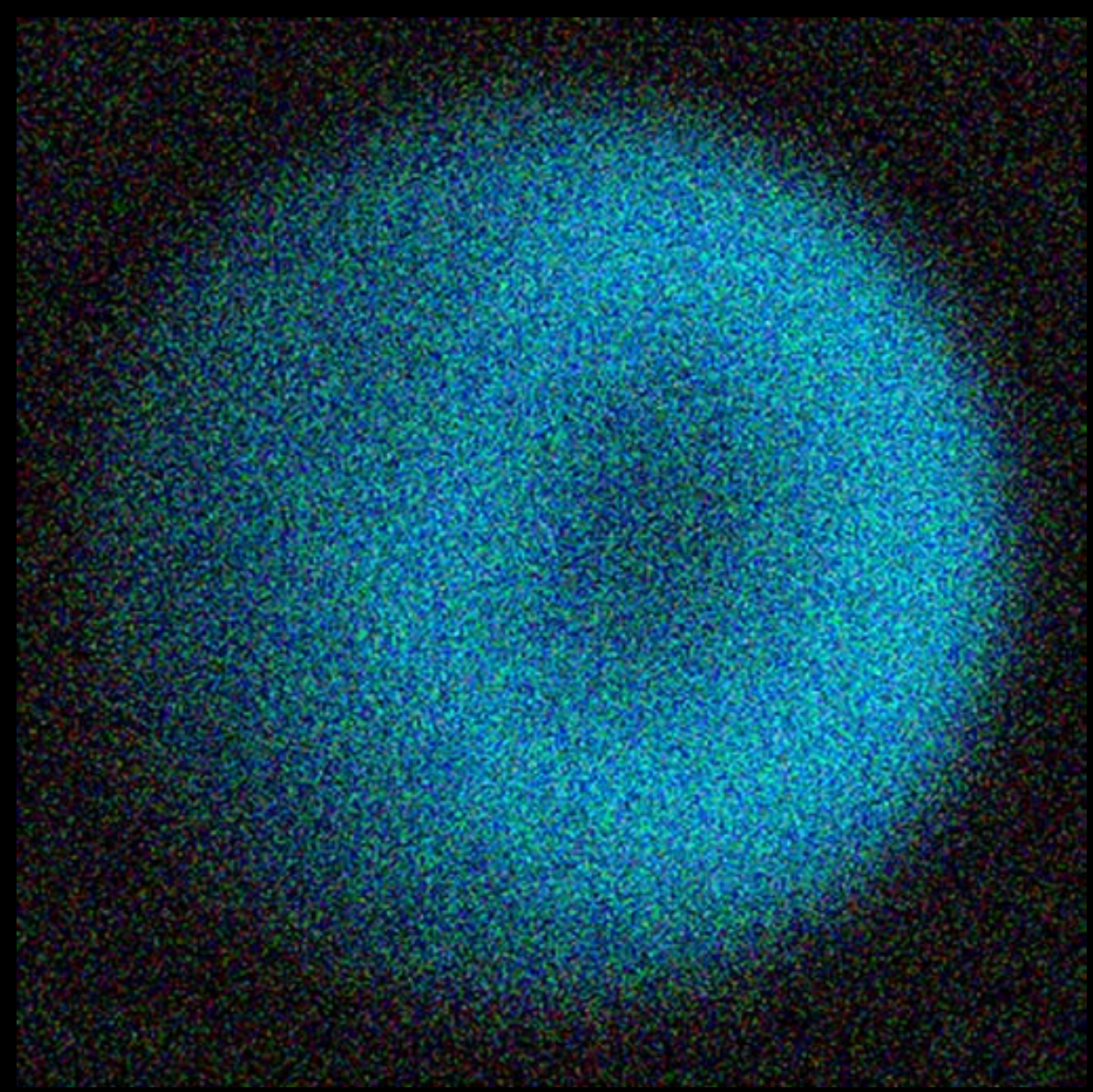


**extremely fast**

**STOPPING TIME:  
from flashes...  
to lasers**



**extremely hot**



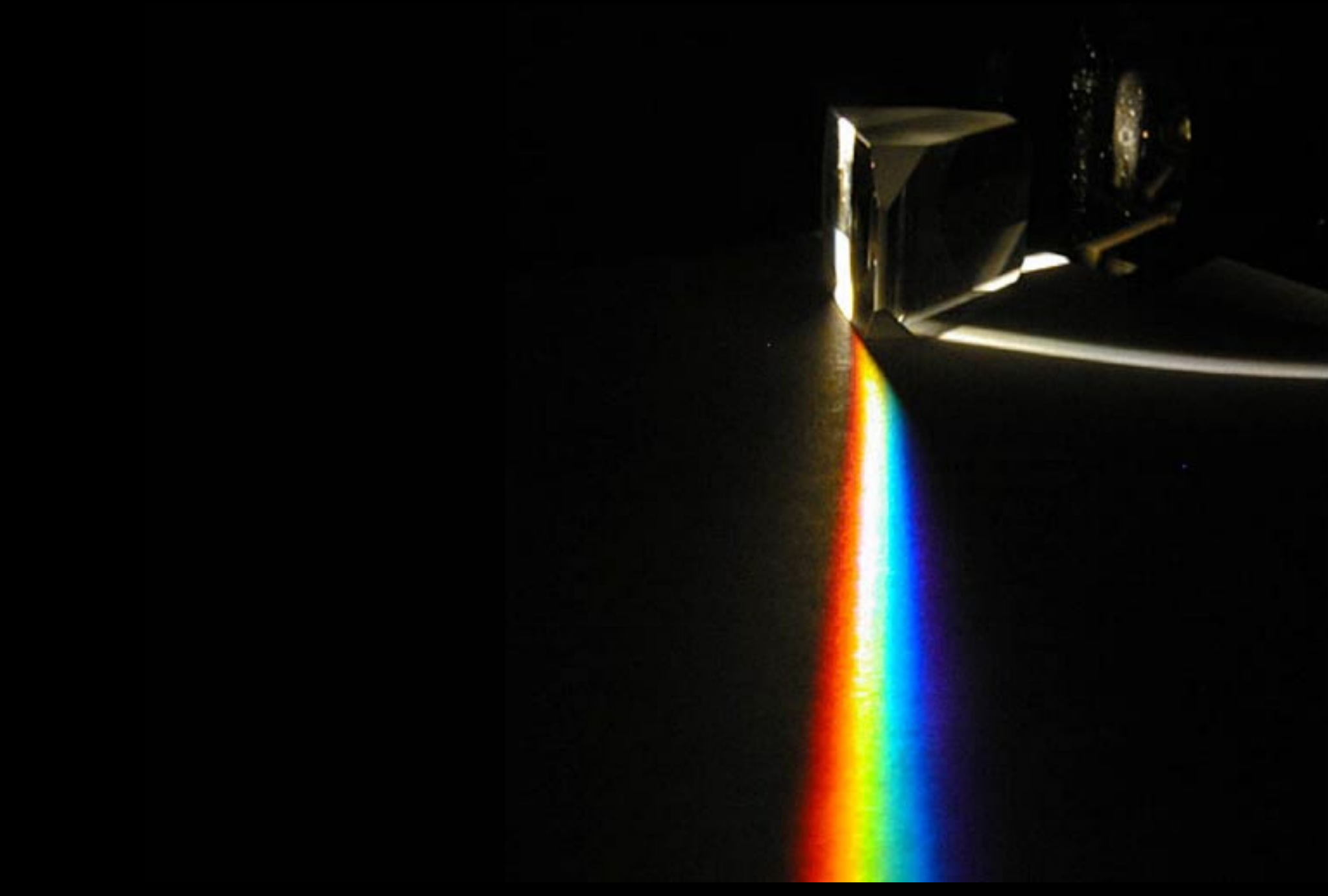
**STOPPING TIME:**

**from flashes...  
to lasers**

**usually matter  
controls light**



**extremely hot**

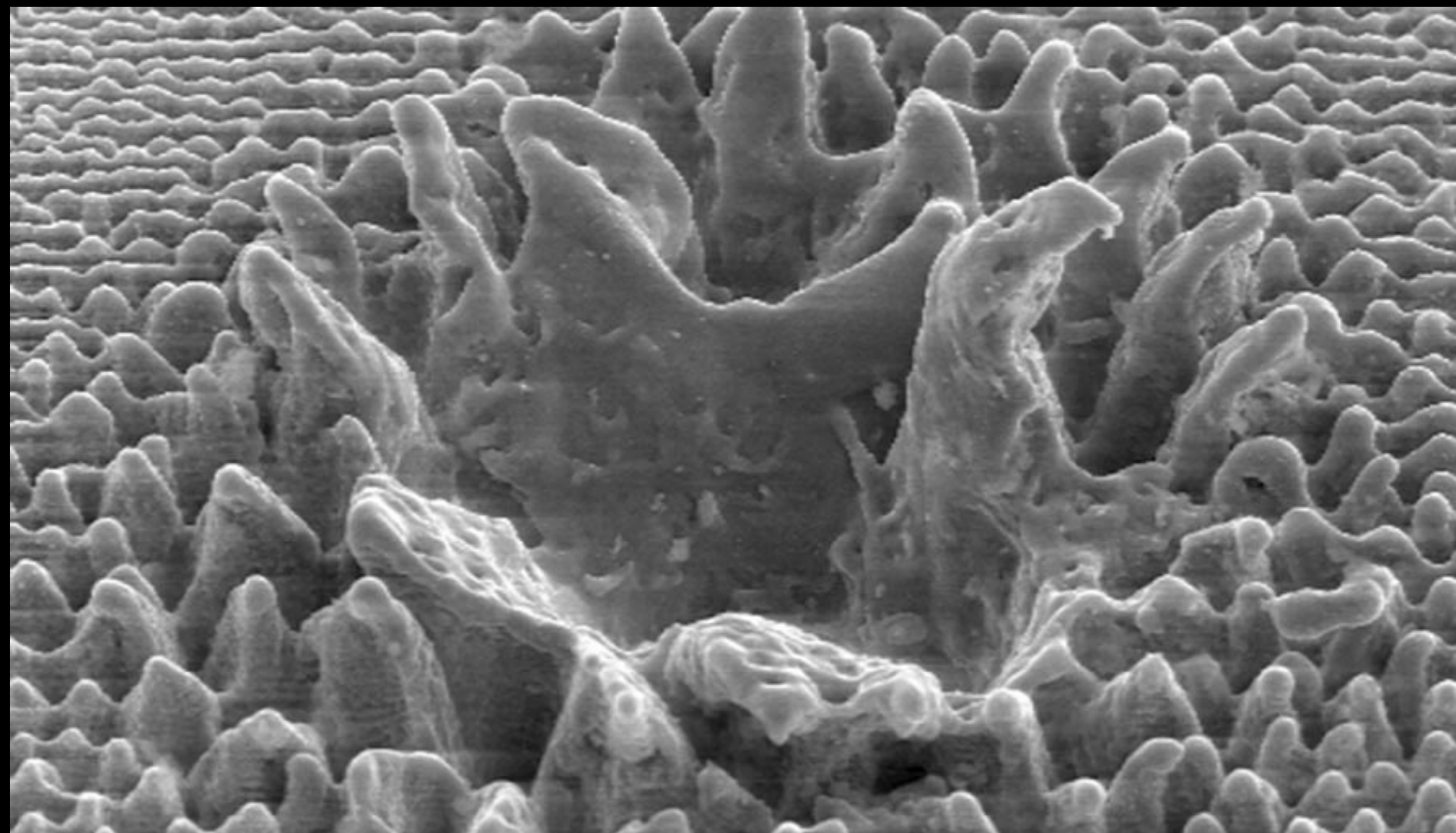


**STOPPING TIME:**

**from flashes...  
to lasers**

**at very high intensity**

**light controls matter**



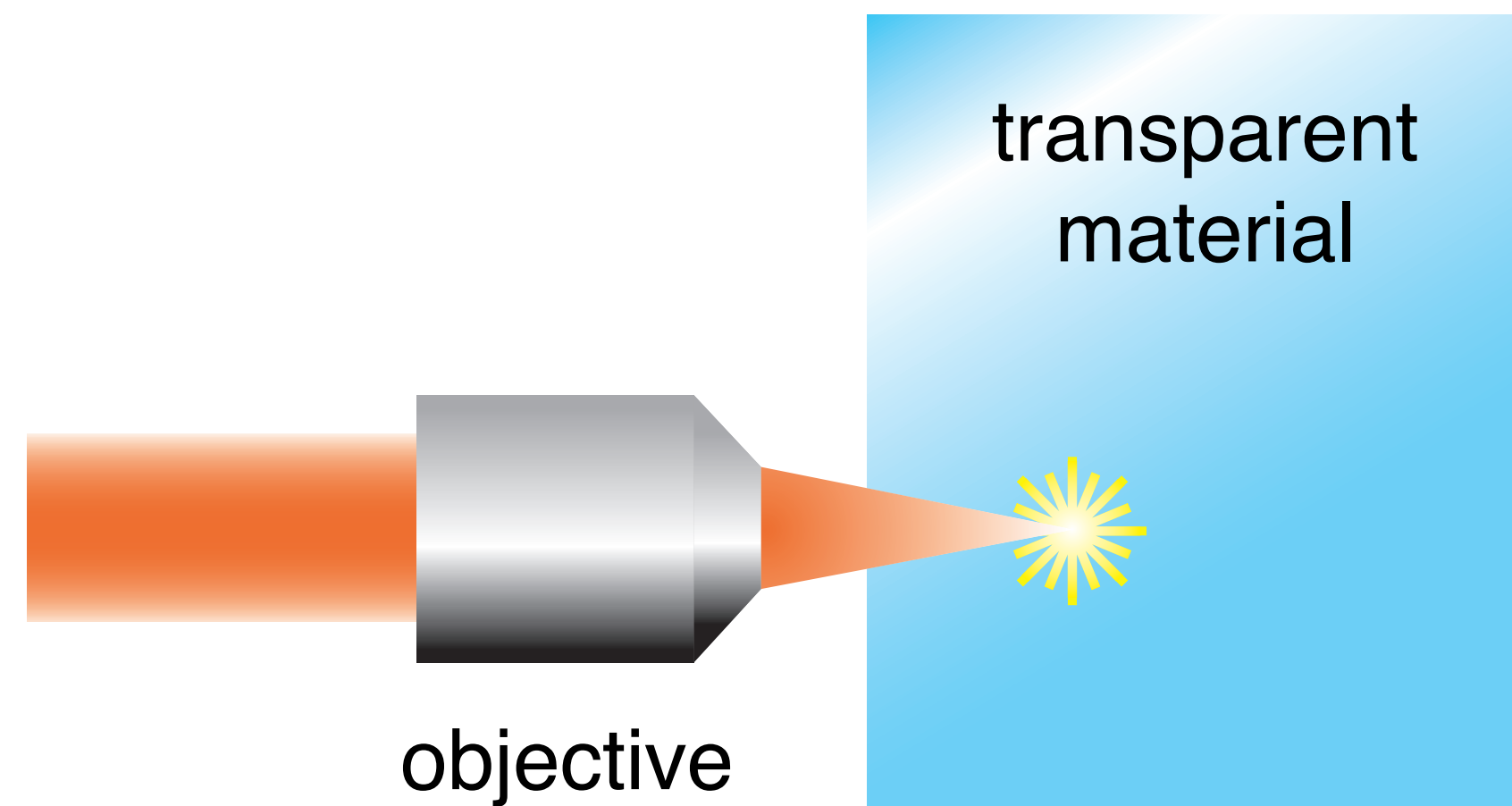
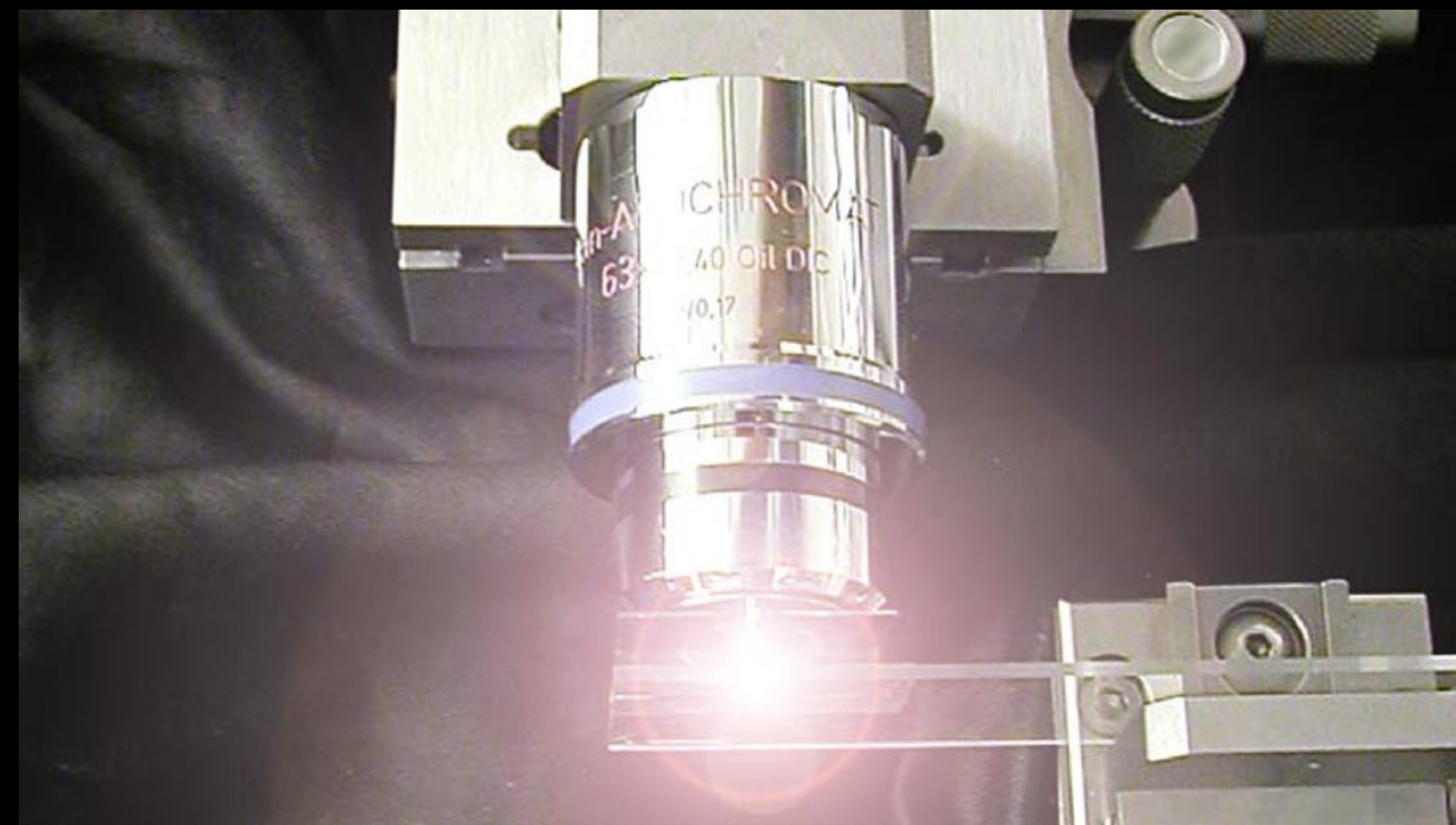
**STOPPING TIME:**

**from flashes...  
to lasers**



**at very high intensity**

**light controls matter**



**STOPPING TIME:**

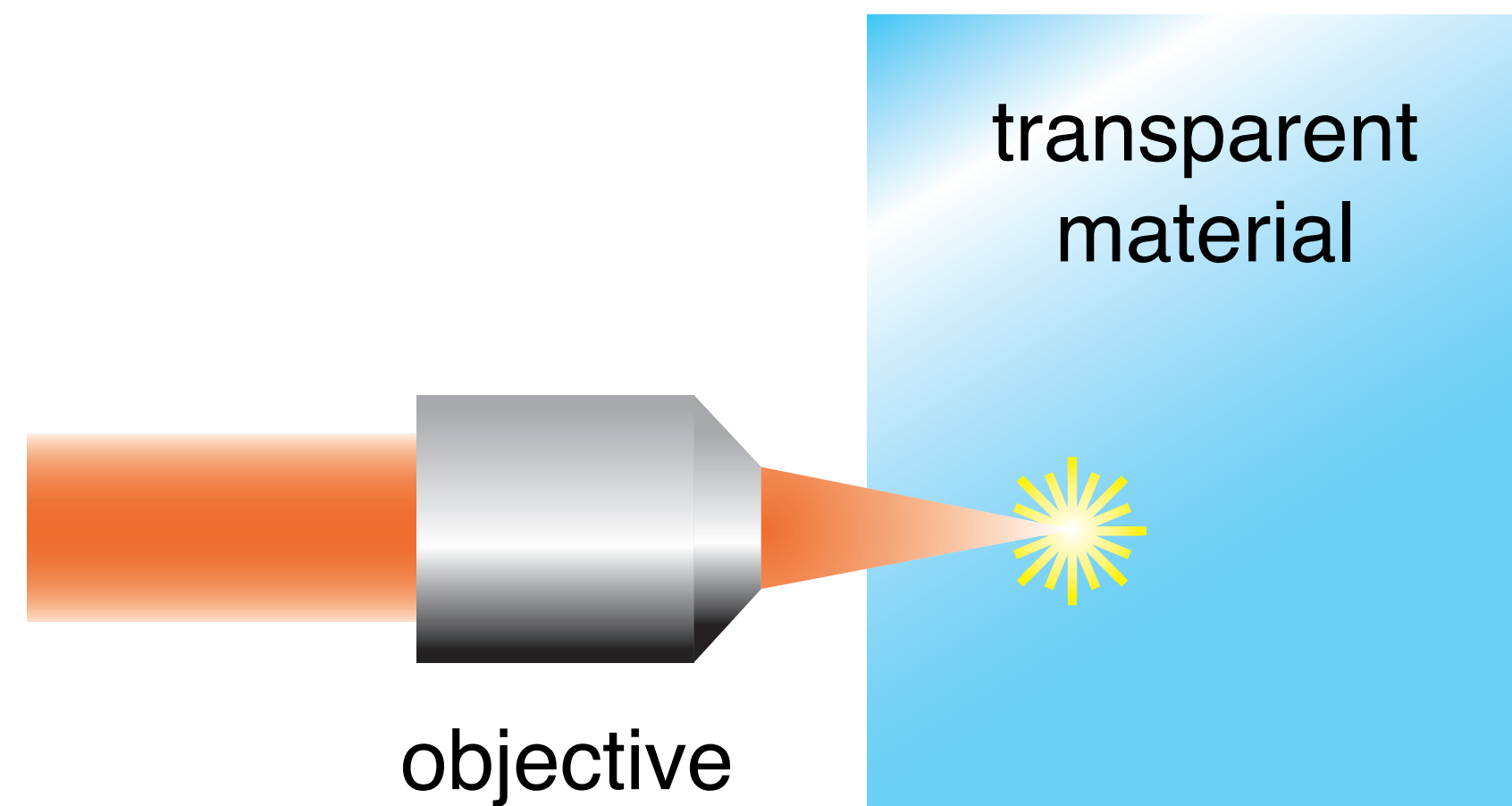
**from flashes...  
to lasers**





**at very high intensity**

**light controls matter**



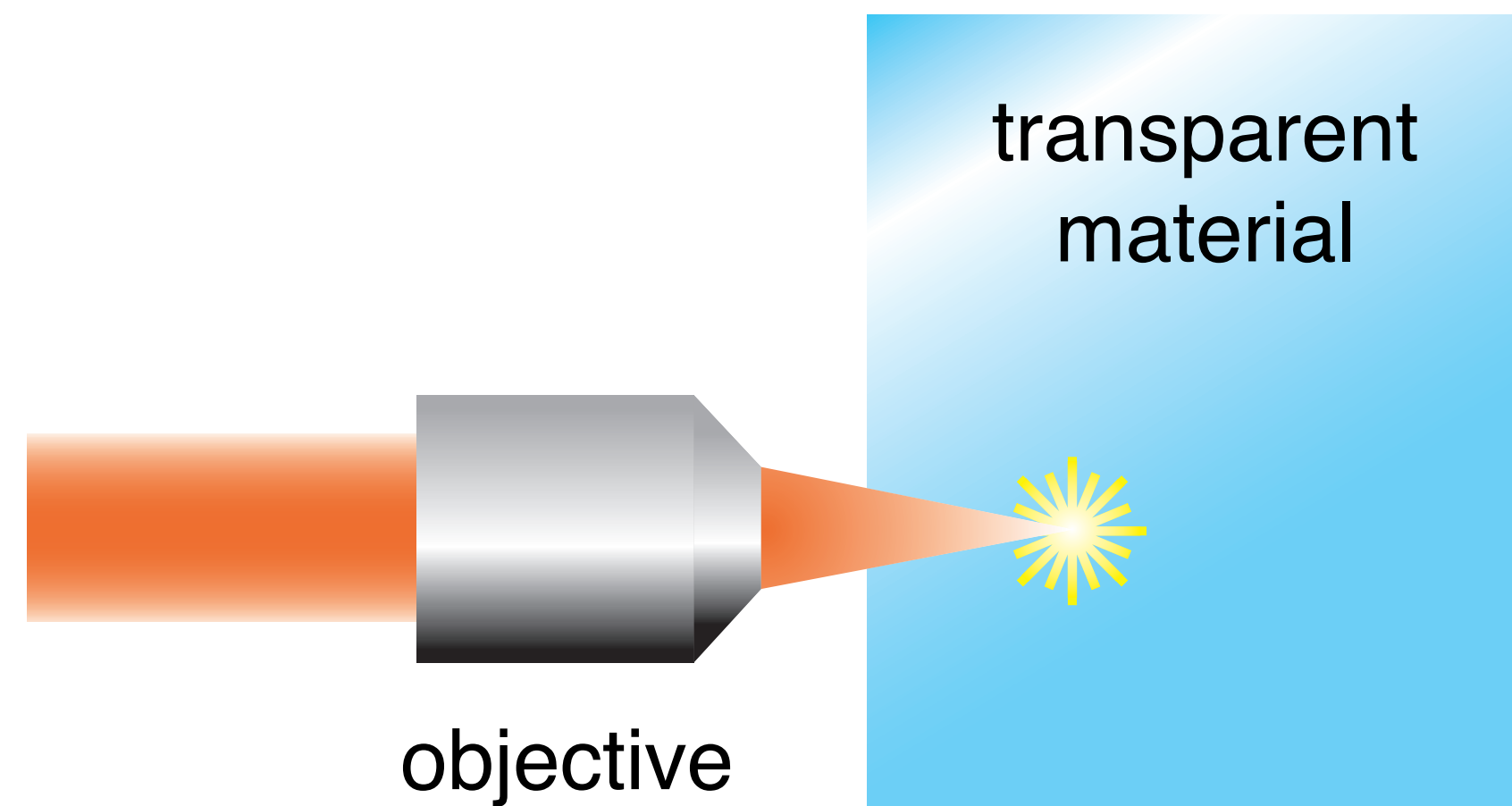
**STOPPING TIME:**

**from flashes...  
to lasers**



**at very high intensity**

**light controls matter**



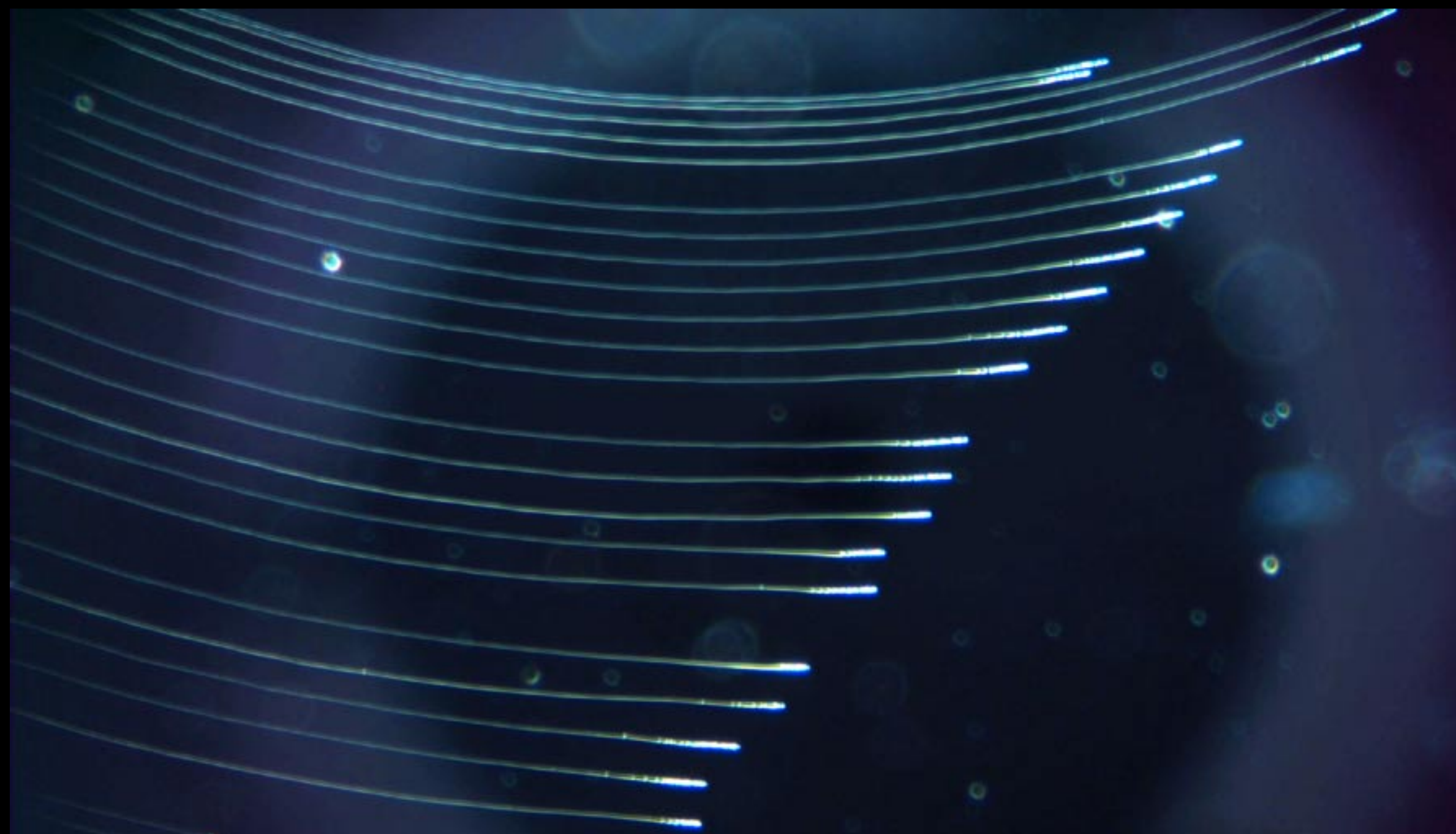
**STOPPING TIME:**

**from flashes...  
to lasers**

A blue-tinted photograph of a water splash, with many droplets in mid-air, serving as a background for the text.

**at very high intensity**

**light controls matter**



**STOPPING TIME:**

**from flashes...  
to lasers**



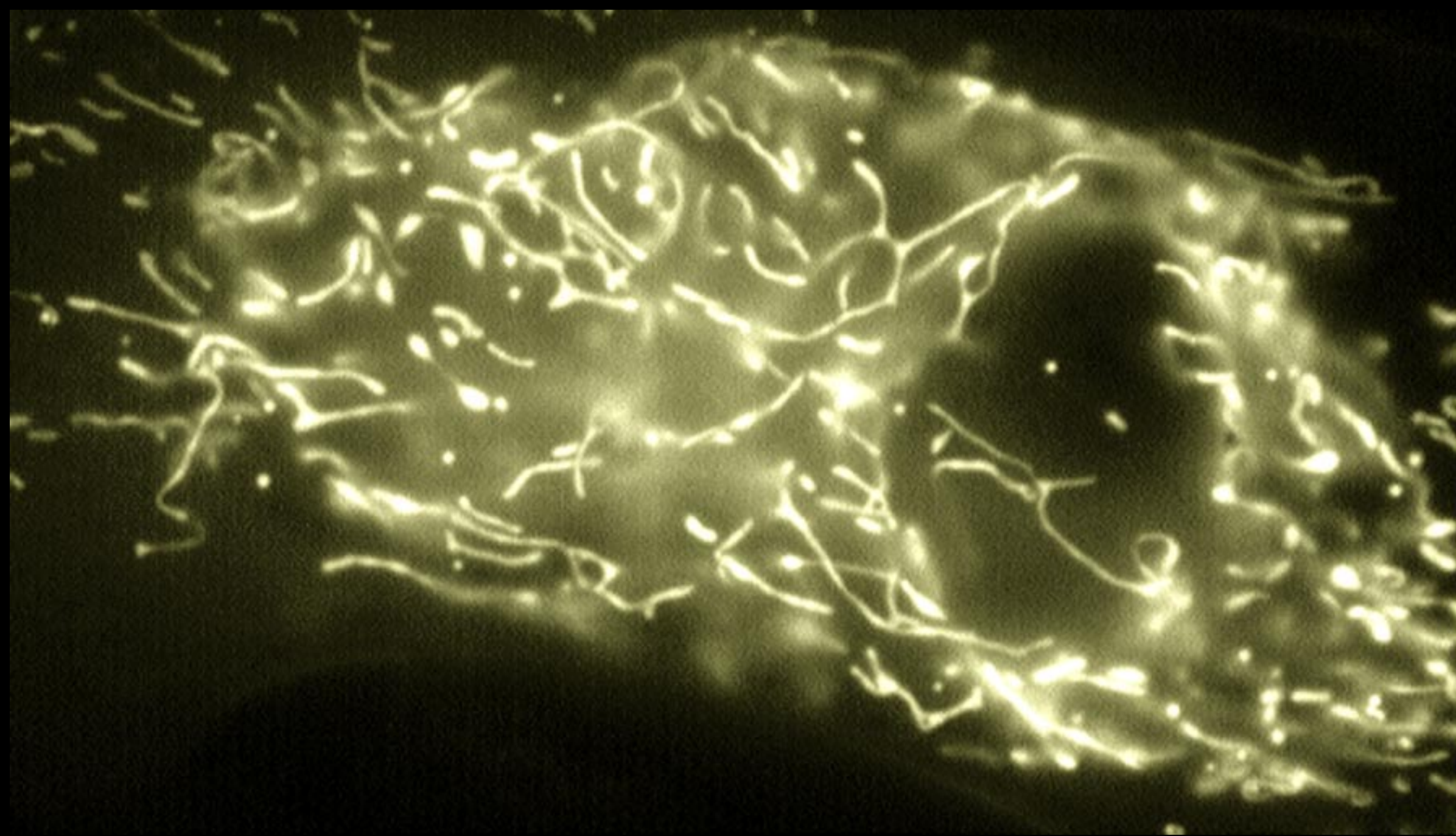
**even at low energy**

**high intensity!**



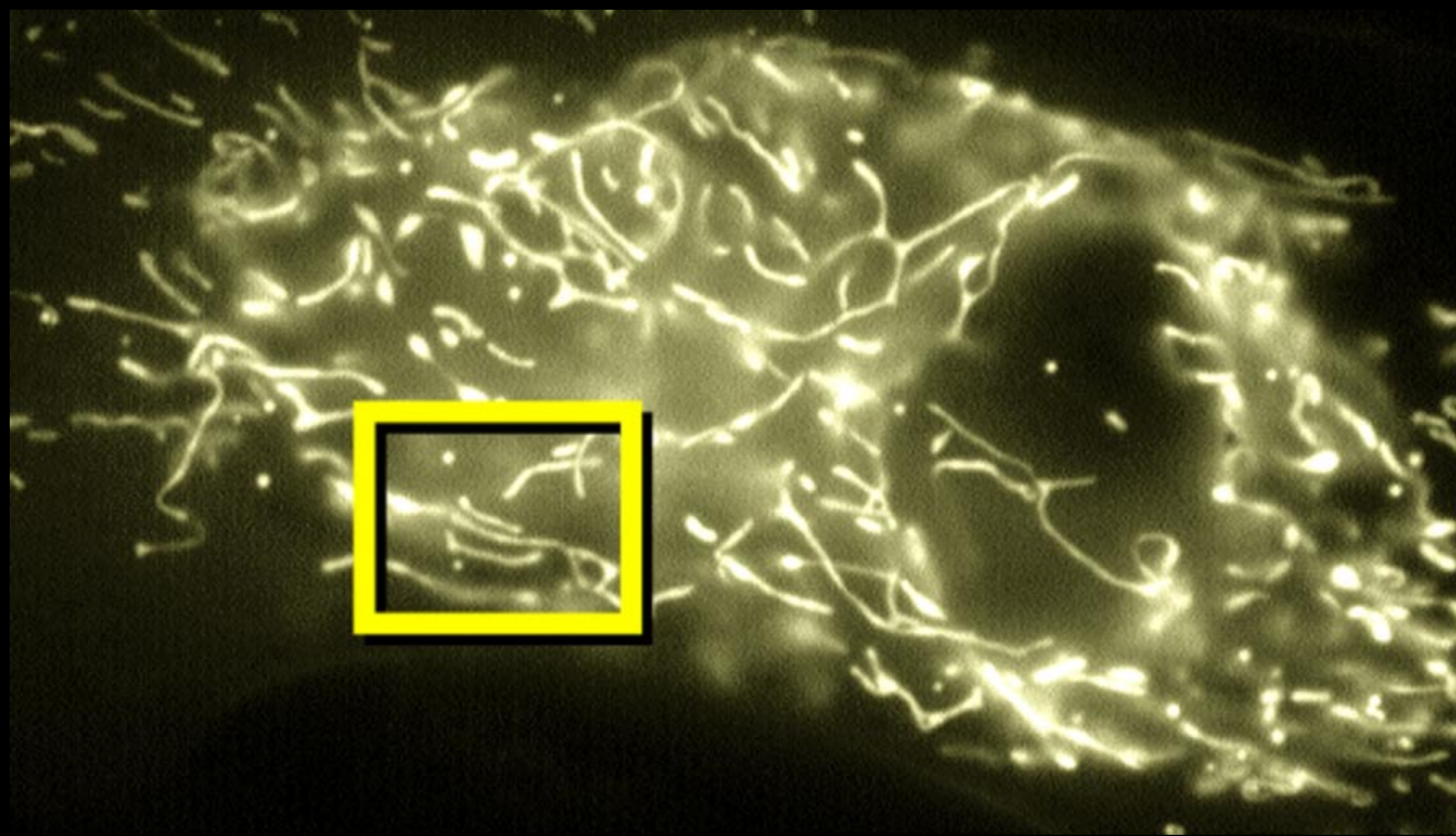
**STOPPING TIME:**

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to lasers**



**STOPPING TIME:**

**from flashes...  
to lasers**



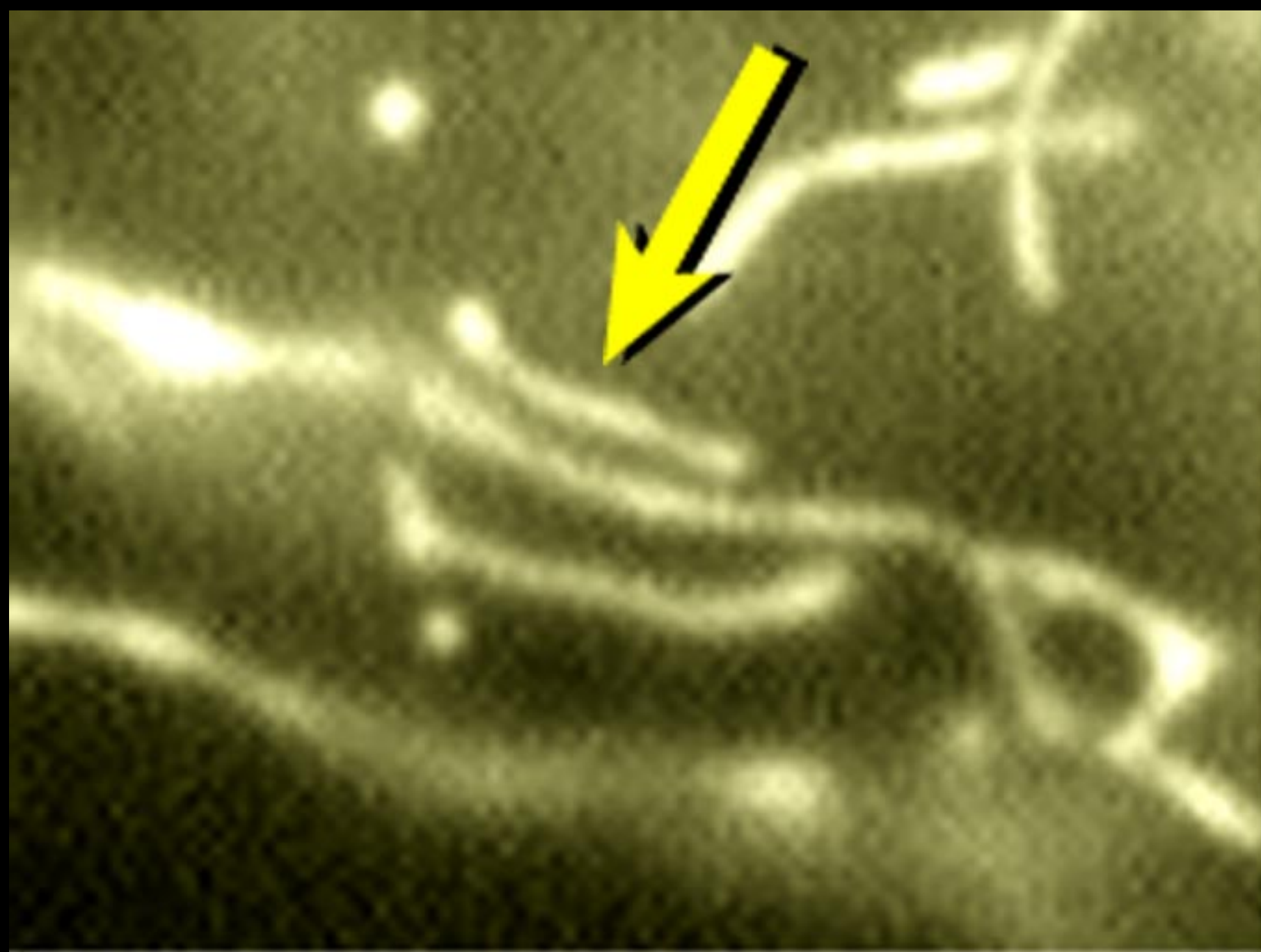
**STOPPING TIME:**

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to lasers**



**STOPPING TIME:**

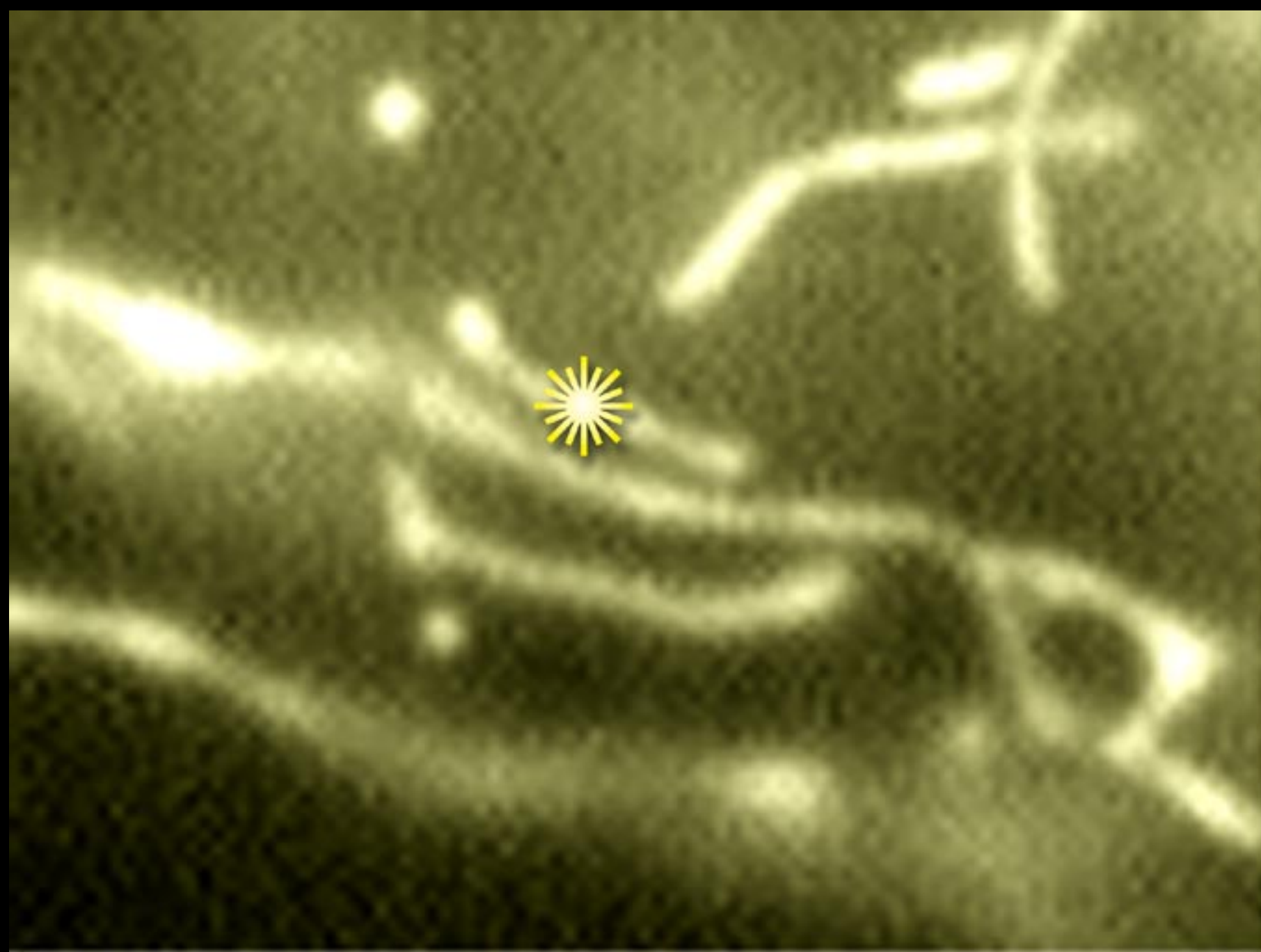
**from flashes...  
to lasers**



**STOPPING TIME:**

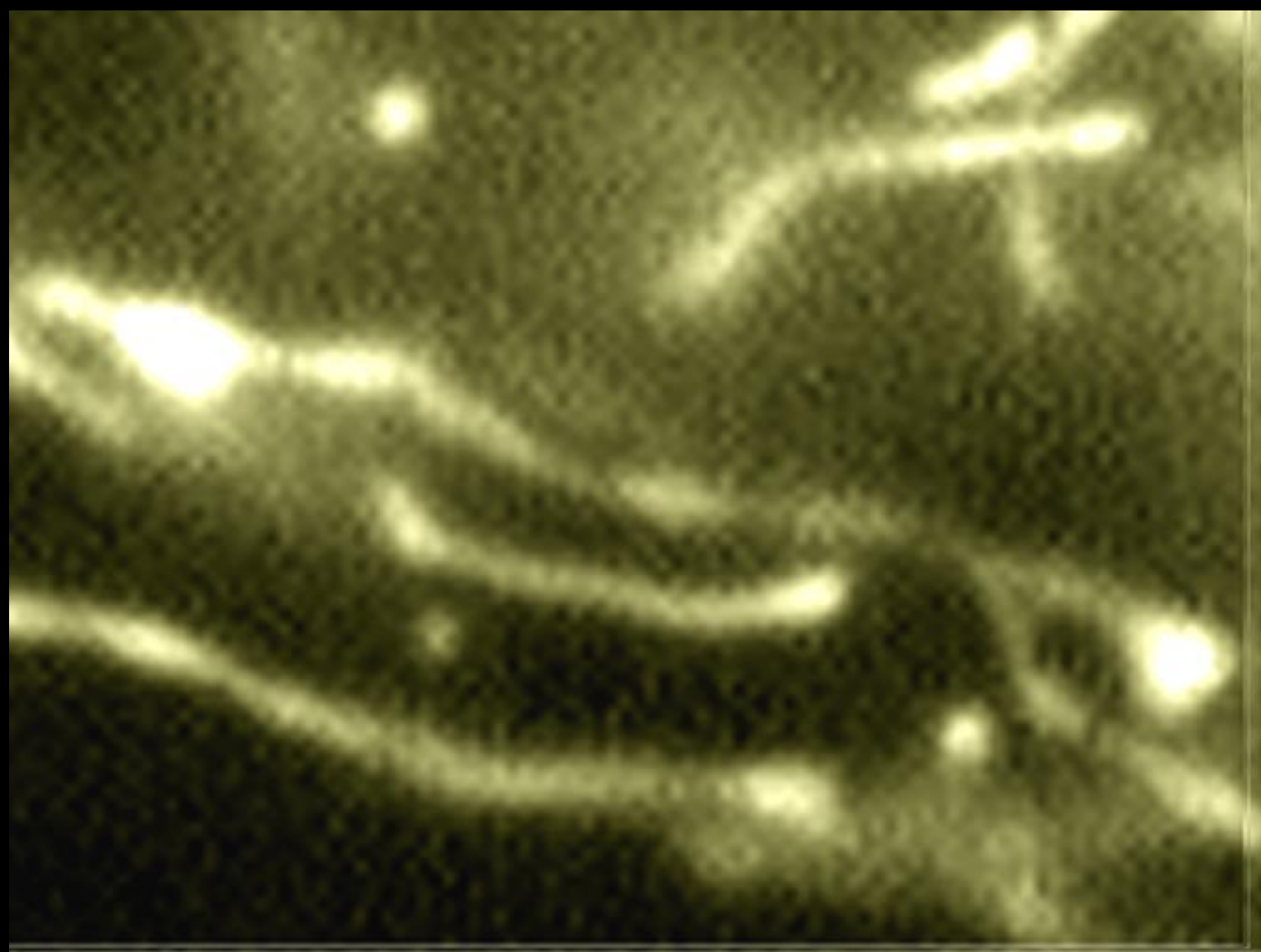
**from flashes...  
to lasers**





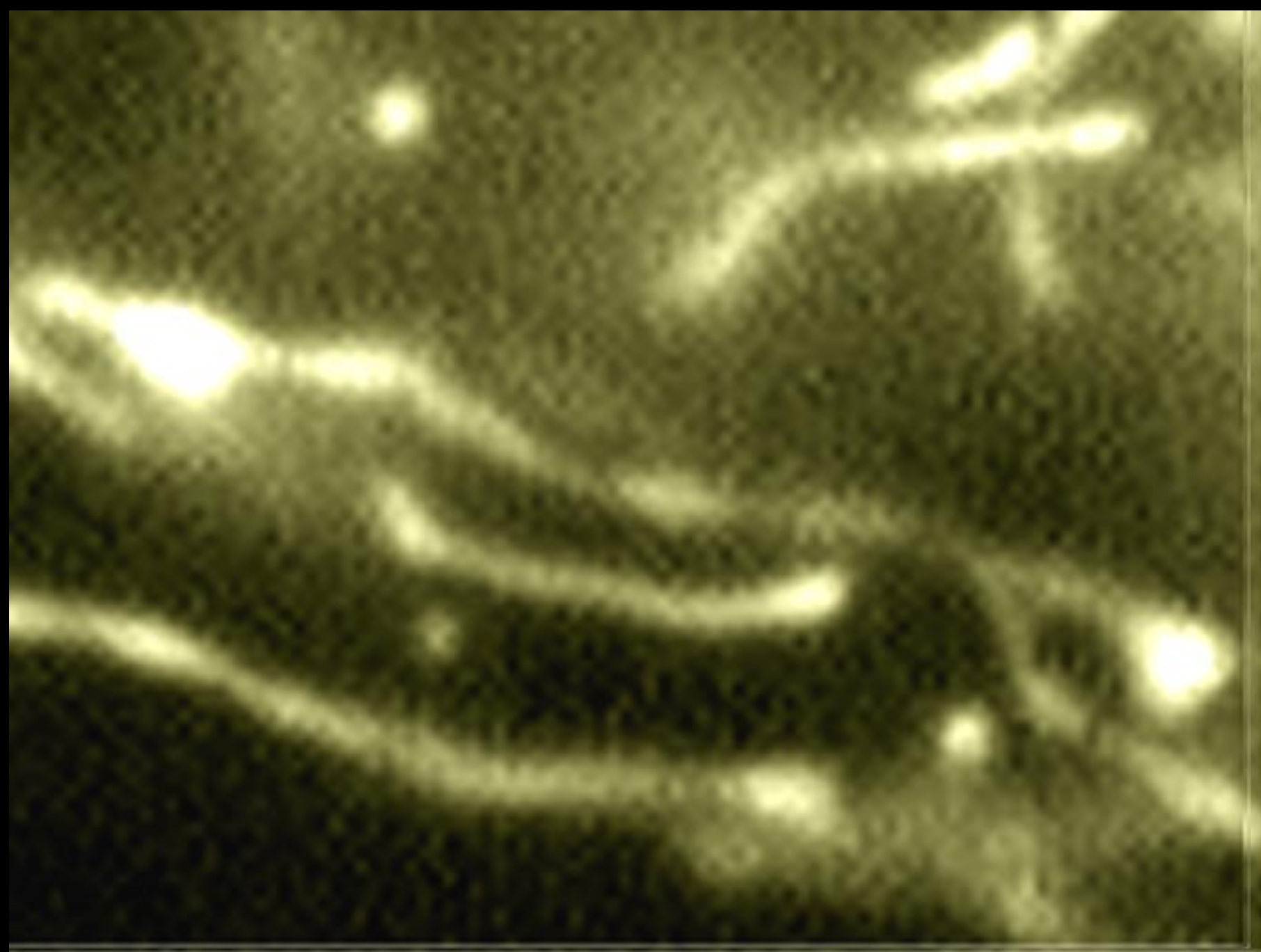
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**from flashes...  
to lasers**



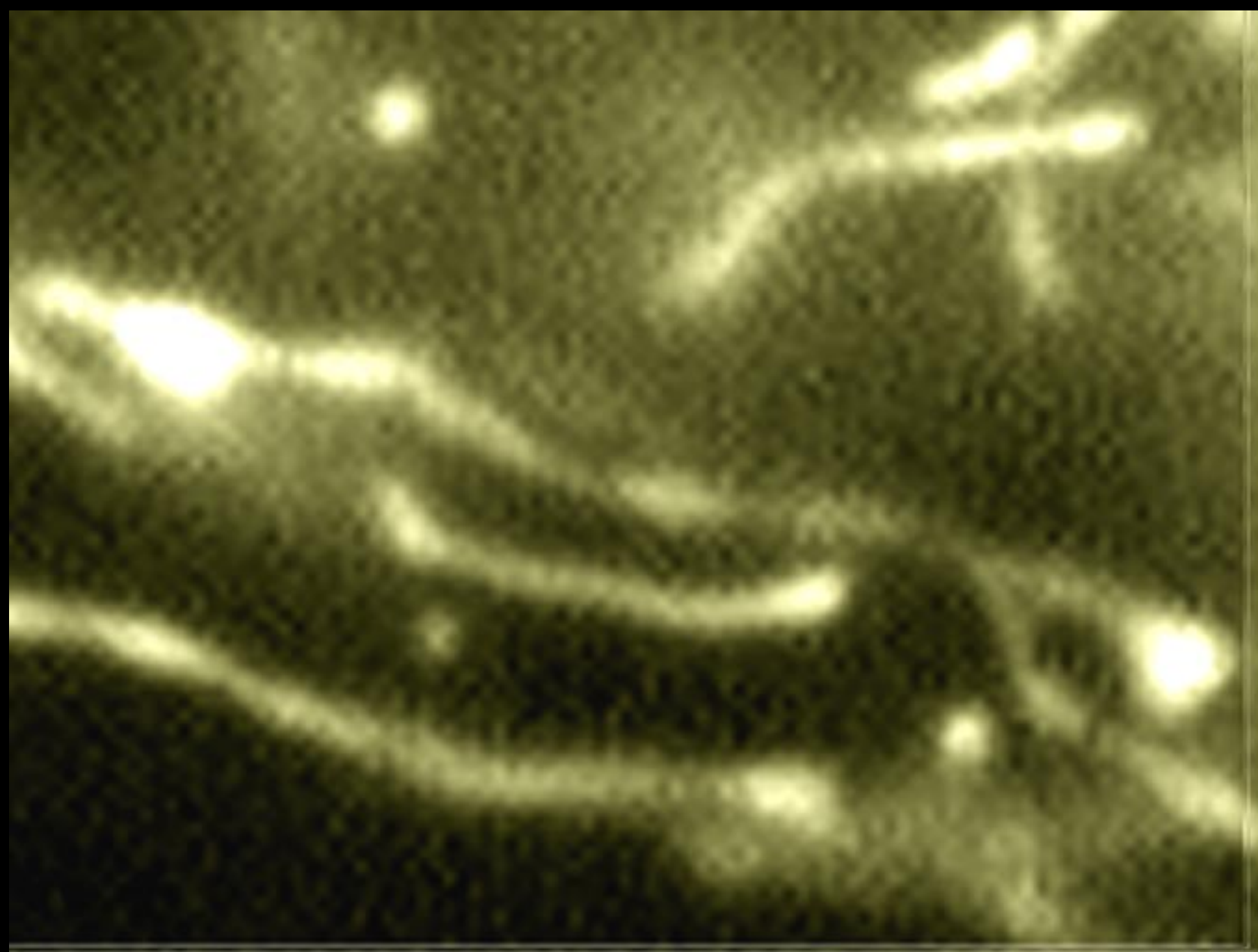
**STOPPING TIME:**

**from flashes...  
to lasers**



**STOPPING TIME:**

**from flashes...  
to lasers**



**manipulating the  
machinery of life!**



**STOPPING TIME:  
from flashes...  
to lasers**

**view very fast events**



**STOPPING TIME:**



**from flashes...  
to lasers**



**view very fast events**



**shape matter with light**



**STOPPING TIME:**

**from flashes...  
to lasers**



**view very fast events**



**shape matter with light**



**do cell nanosurgery**



**STOPPING TIME:  
from flashes...  
to lasers**

A blue-tinted image of a water splash, showing a crown-like shape with many small droplets above it. The text is overlaid on this image.

**STOPPING TIME:**

**from flashes...  
to lasers**

**On the Web:**

**<http://mazur-www.harvard.edu>**