

Title: The National Ignition Facility: Pathway to Energy Security and Physics of the Cosmos

Date: Feb 05, 2014 07:00 PM

URL: <http://pirsa.org/14020148>

Abstract: The [National Ignition Facility](https://lasers.llnl.gov/) (NIF), at [Lawrence Livermore National Laboratory](http://www.llnl.gov/) in Livermore, California, is the world's most energetic laser system. NIF is capable of producing over 1.8 MJ and 500 TW of ultraviolet light, 100 times more than any other operating laser. By concentrating intense laser energy into targets only millimeters in length, NIF can, for the first time, produce conditions emulating those found in planetary interiors and stellar environments and creating fusion energy to power our future. The extreme conditions of energy density, pressure, and temperature will enable scientists to pursue fundamental science experiments designed to address a range of scientific questions, from observing new states of matter to exploring the origin of ultrahigh-energy cosmic rays. This talk will describe the unprecedented experimental capabilities of the NIF, its role in strategic security and fundamental science, and the pathway to achieving fusion ignition to create a clean and secure energy future.

PERIMETER  INSTITUTE FOR THEORETICAL PHYSICS

PUBLIC LECTURE *S e r i e s*

Presented by

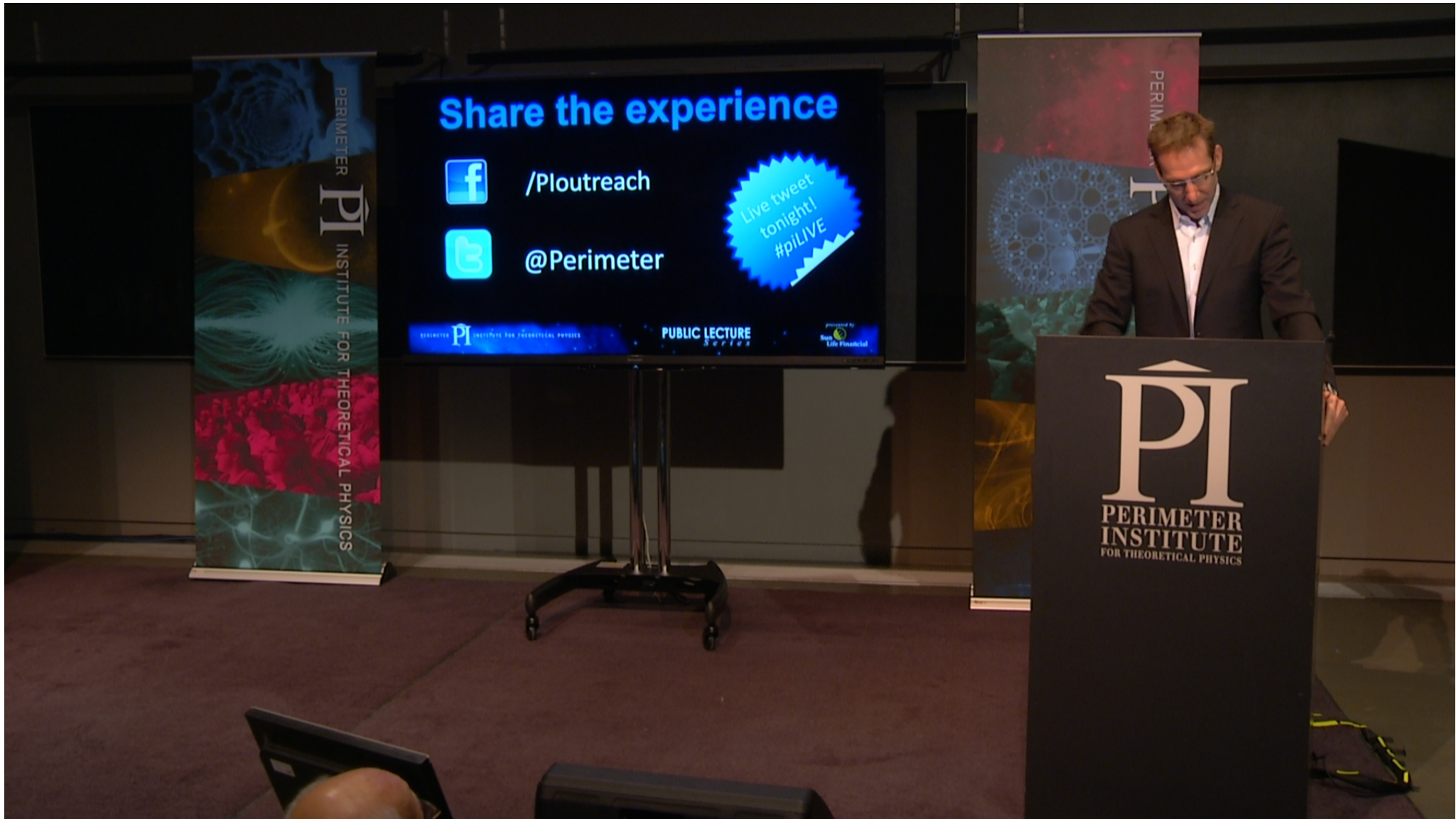
Sun 
Life Financial







The Luke Santi Memorial Award for Student Achievement



Tonight's Lecture

Dr. Edward Moses

Director, Fusion Science and Applications Research
Lawrence Livermore National Laboratory



The National Ignition Facility:
Pathway to Energy Security and Physics
of the Cosmos

Lawrence Livermore National Laboratory



LIFE

The National Ignition Facility



LIFE



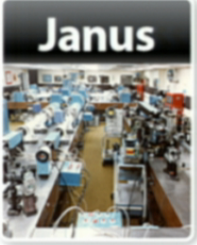




The National Ignition Facility

LIFE





Schedule: Fortunately, we started over 40 years ago

1973	1976	1977	1984	2009
Janus	Argus	Shiva	Nova	NIF
				
100J IR	1kJ IR	10kJ IR	30kJ UV	1.8MJ UV

NIF can demonstrate full-scale performance for a 1,000 MWe plant

The **Fire of Fusion** powers
the stars and galaxies

LIFE

Look down on our world during the day...

LIFE



Now let's look down on our World at Night

LIFE

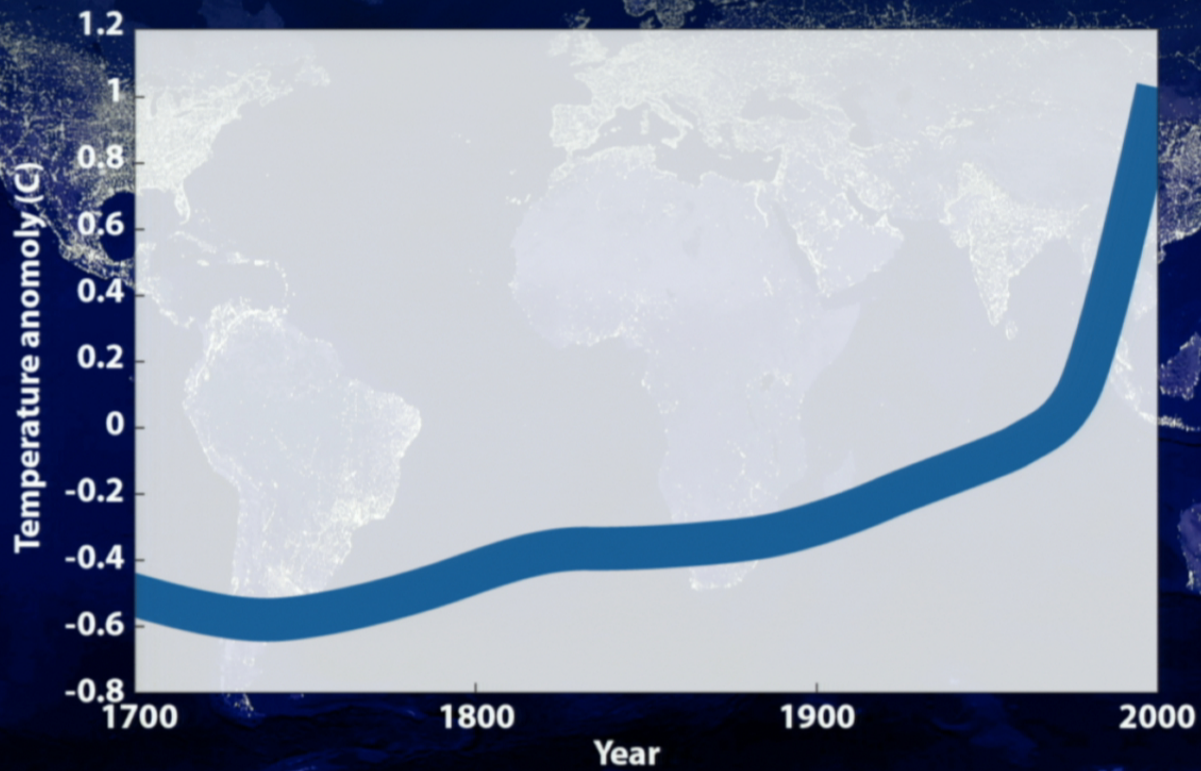


We are everywhere and ...

We are a Voracious Energy Consuming Species

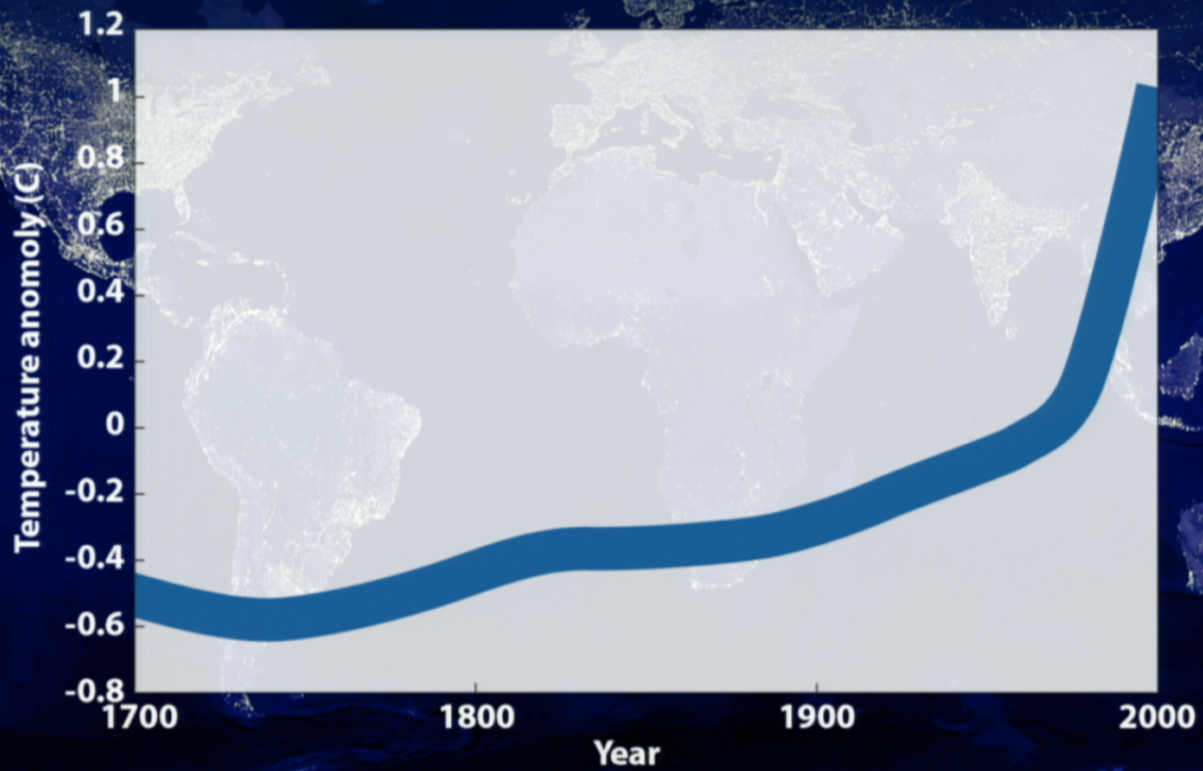
Global temperatures are rising

LIFE



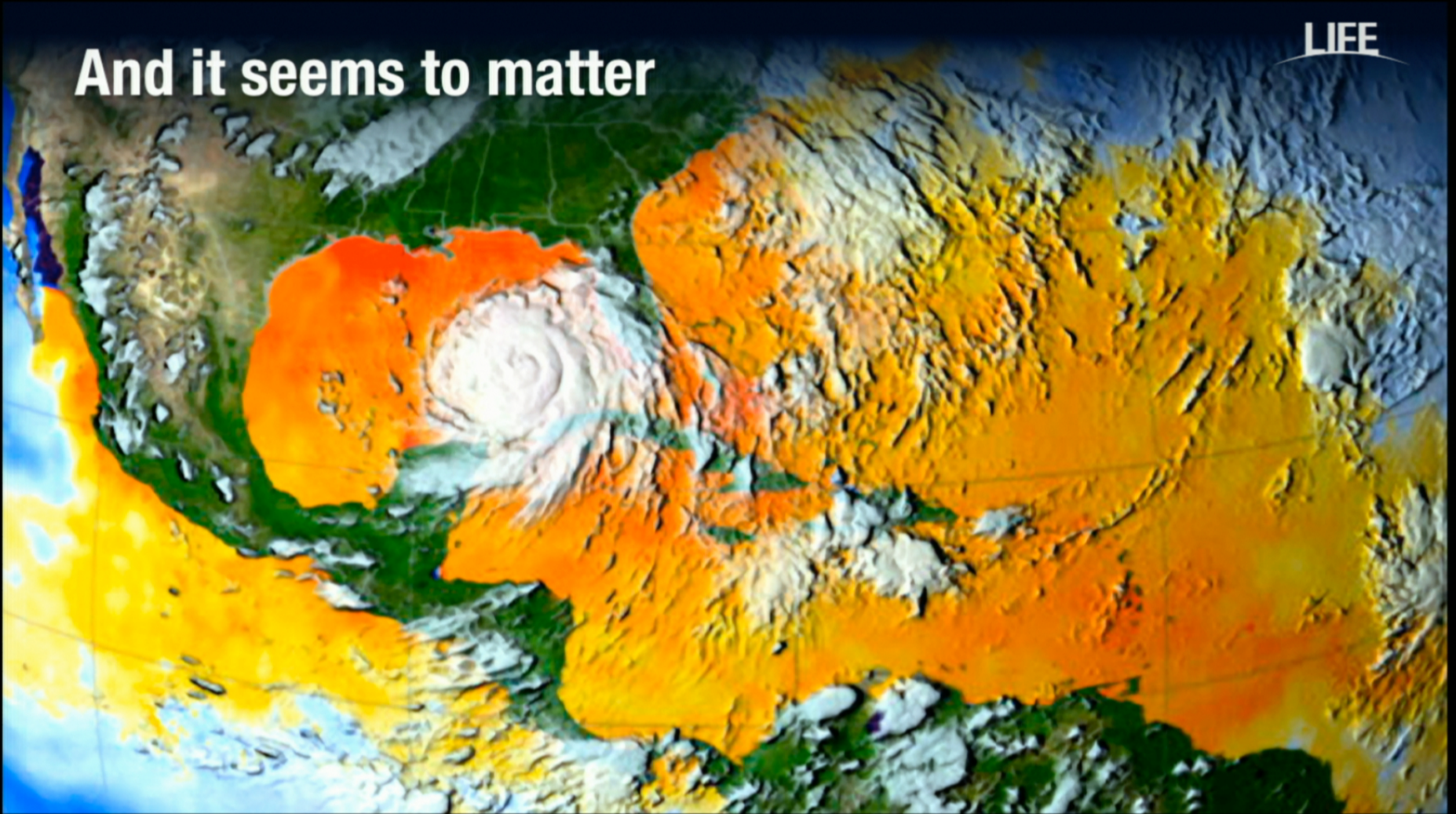
Global temperatures are rising

LIFE



And it seems to matter

LIFE



This, I believe, is the grand challenge of all project management



Mega-Project
1 1,000 megawatt plant



10 Giga-Projects
10,000 1,000 megawatt plants

This, I believe, is the grand challenge of all project management



Mega-Project
1 1,000 megawatt plant



10 Giga-Projects
10,000 1,000 megawatt plants

Alternative 1: Continue using conventional energy sources

Coal



Gas



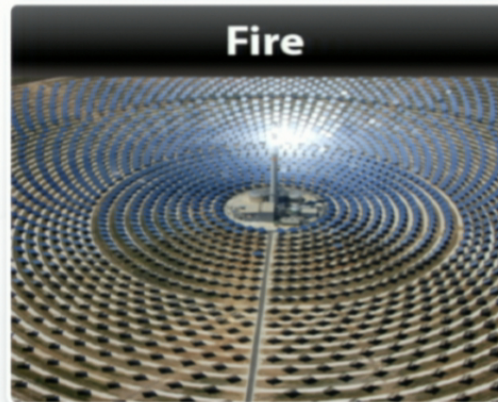
Nuclear



None seem like sustainable long-term solutions

Alternative 2: Expand renewables

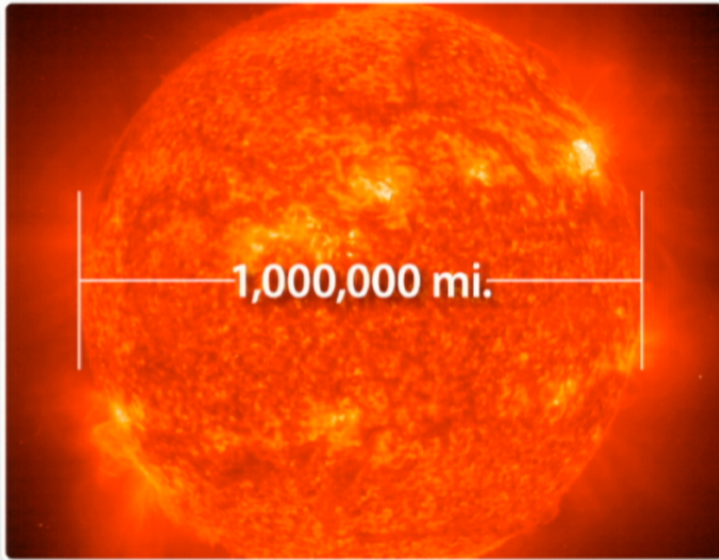
Important but not
sufficient for
baseload power
for Giga-city
future



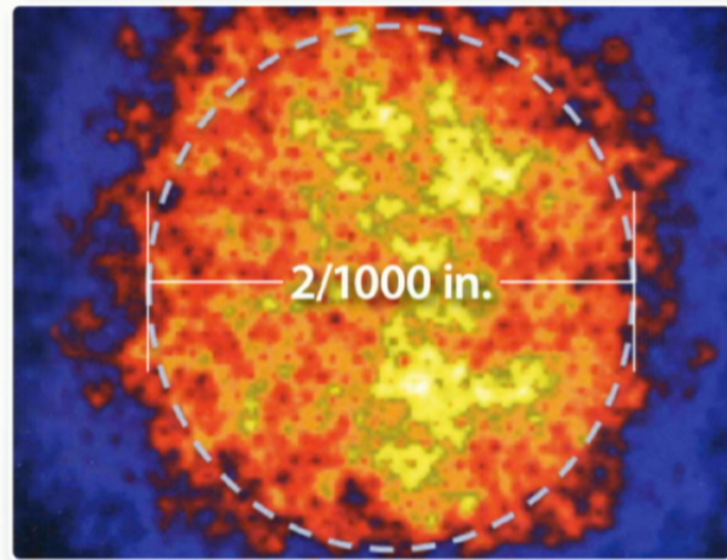
Could we build a miniature Sun on earth?

**... to provide significant carbon-free
energy for humankind forever**

What do we mean by miniature?



**The size of the Sun that
warms us**



**The size of the Sun we need
to create**

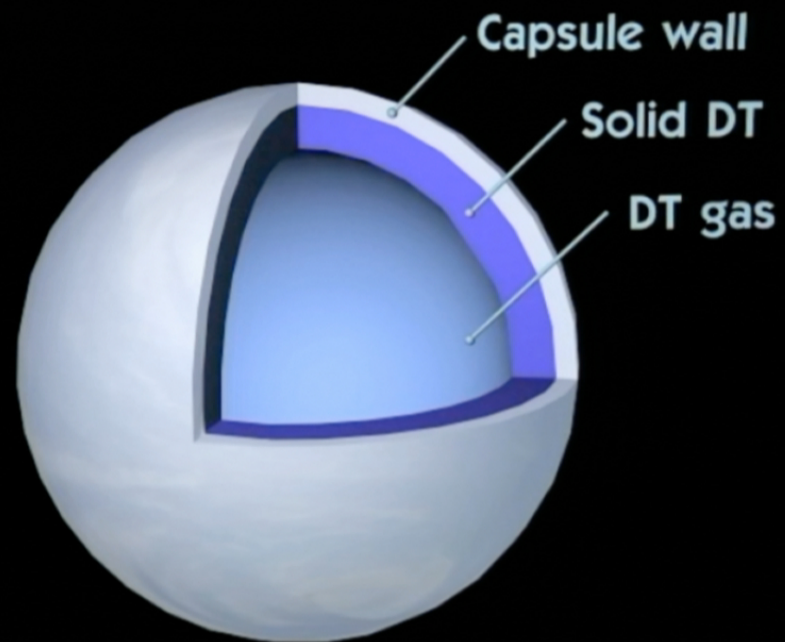
Recipe for fusion on earth

Ingredients: Hydrogen from water

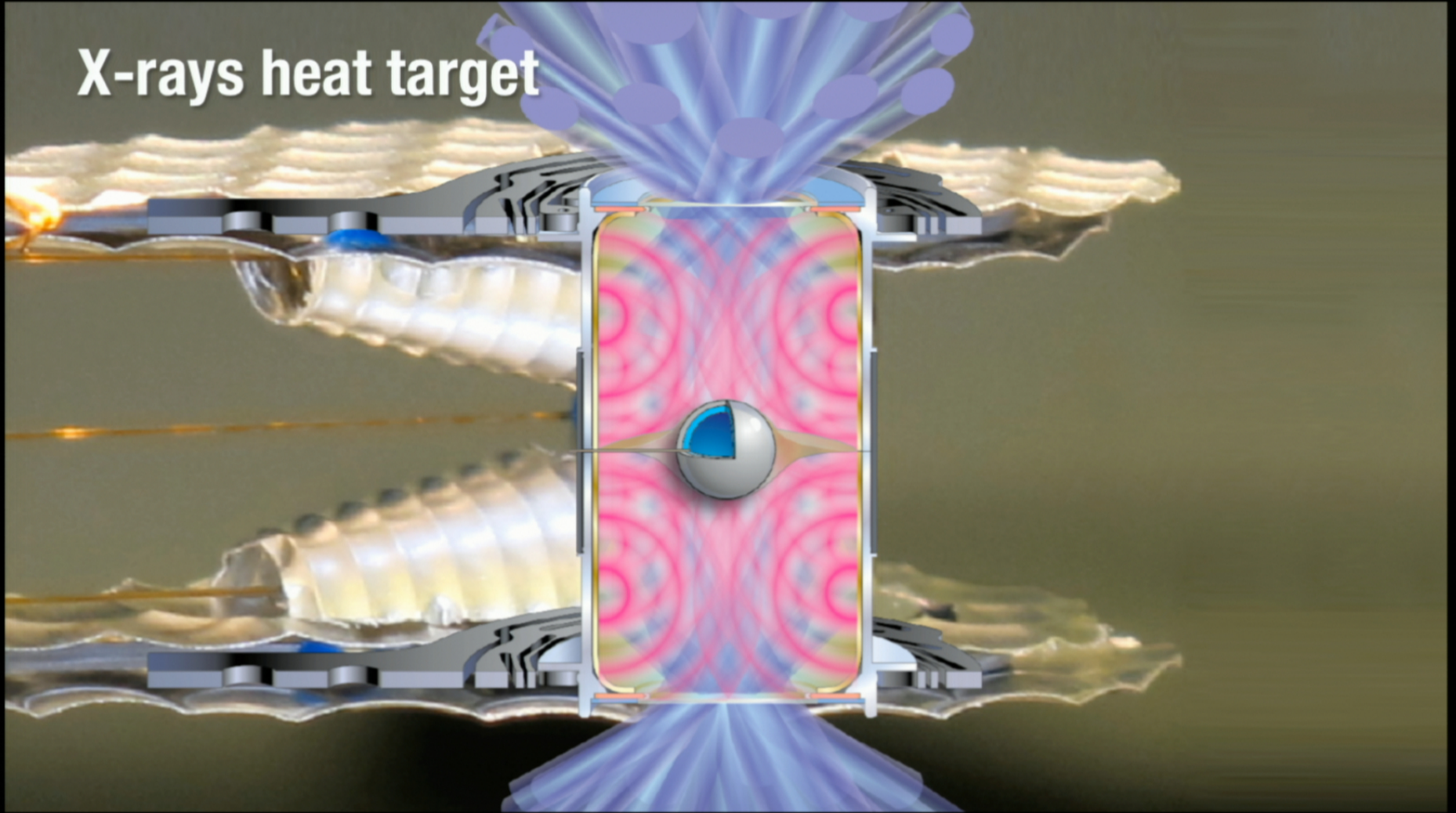
- 1. Filter out heavy water and generate tritium**
- 2. Place in 8 Million degree oven**
- 3. Compress for a few billionth of a second and bring to conditions like inside the center of a star**
- 4. Convert mass to copious amounts of energy**

Here's how

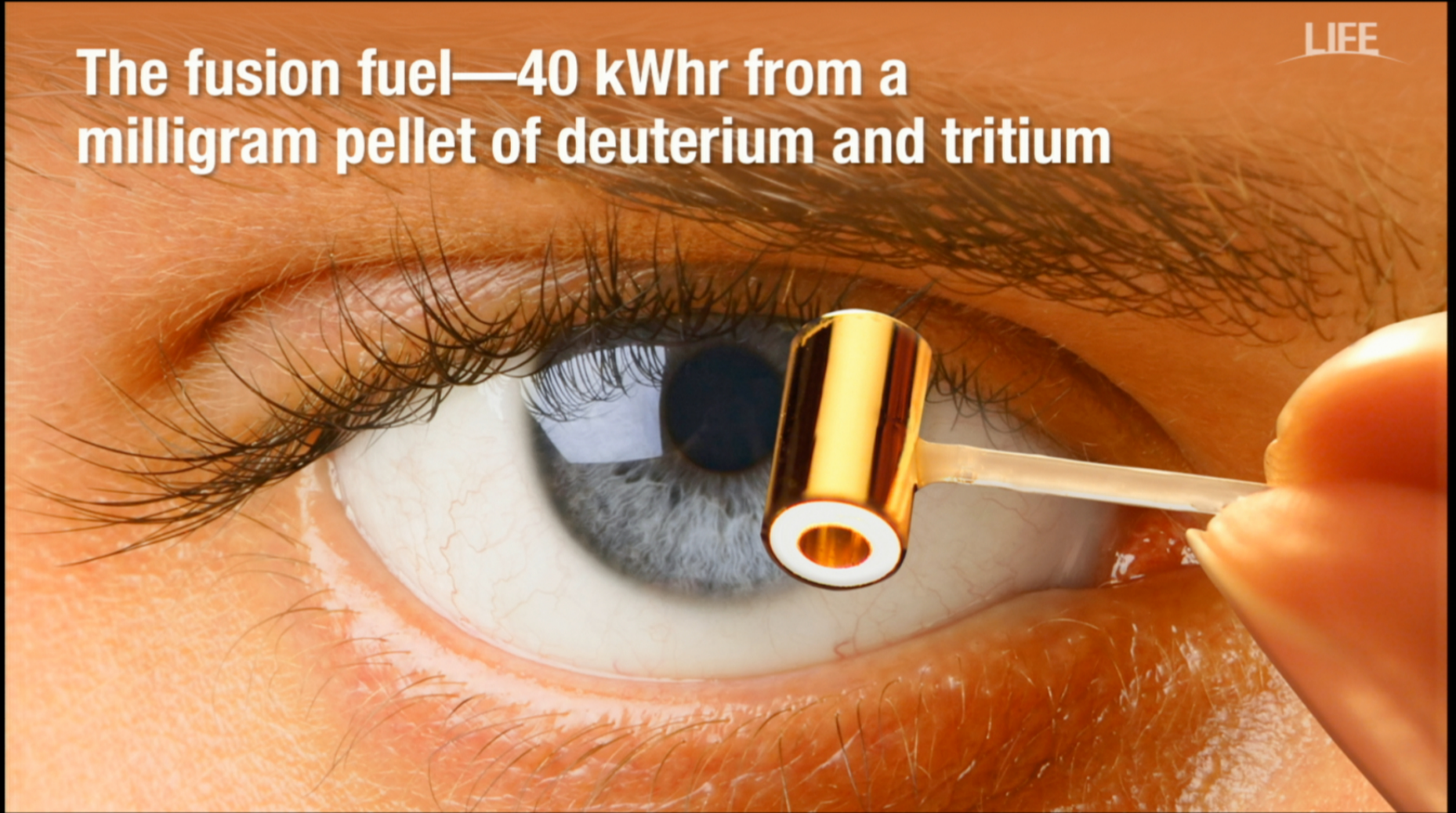
LIFE



X-rays heat target



The fusion fuel—40 kWhr from a milligram pellet of deuterium and tritium

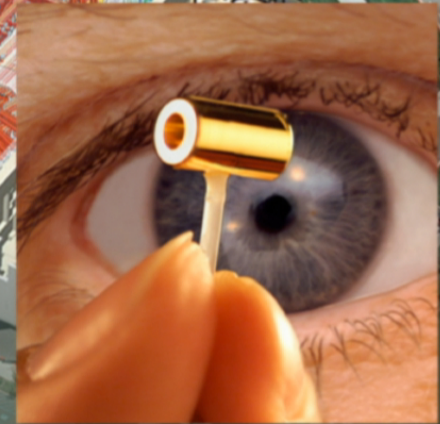


NIF concentrates all 192 laser beam energy in a football stadium-sized facility into a mm^3

Matter temperature 100,000,000 C

Densities 100 x lead

Pressures 100,000,000,000 atmospheres



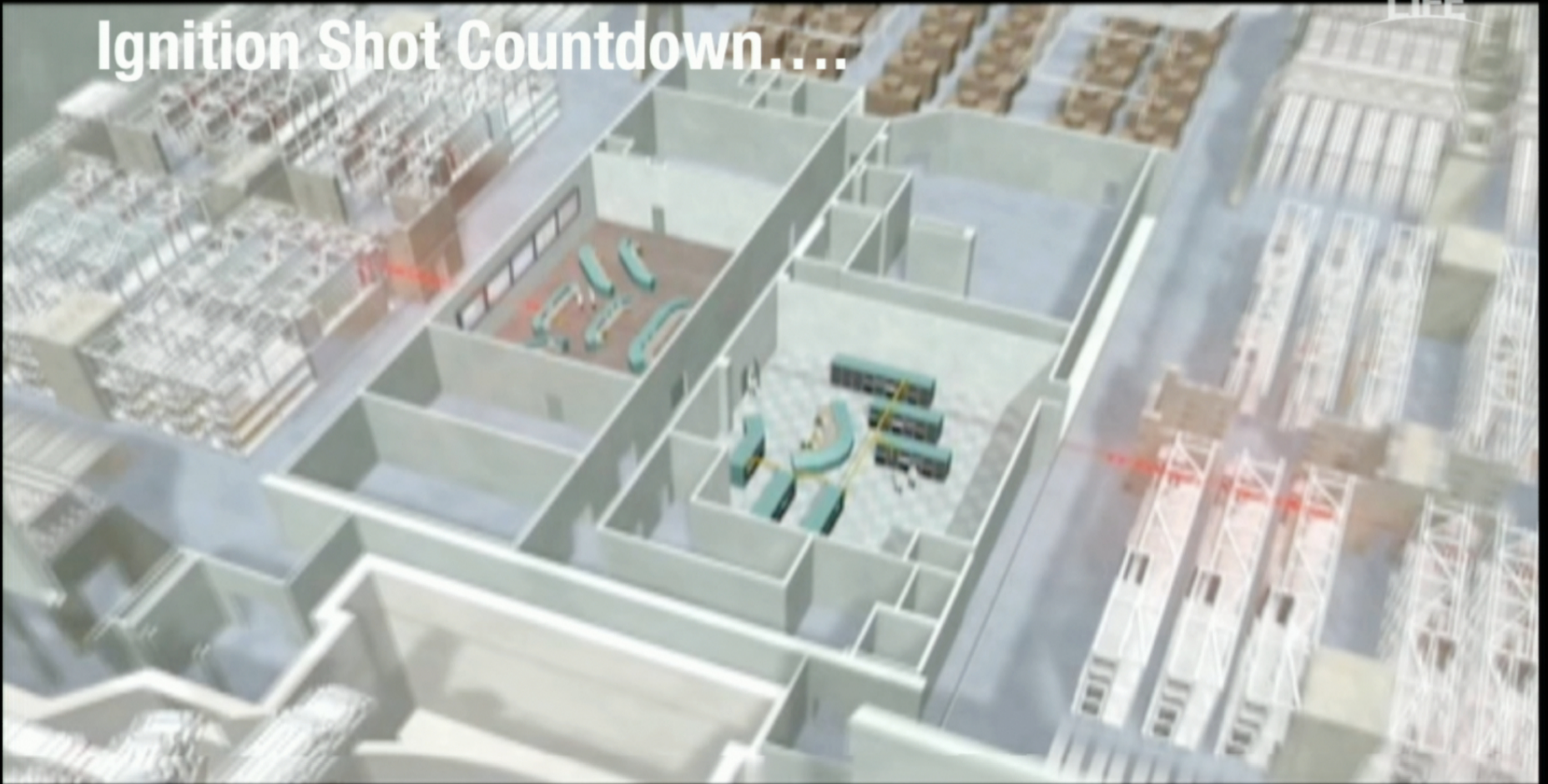
Ignition Shot Countdown...



Ignition Shot Countdown....

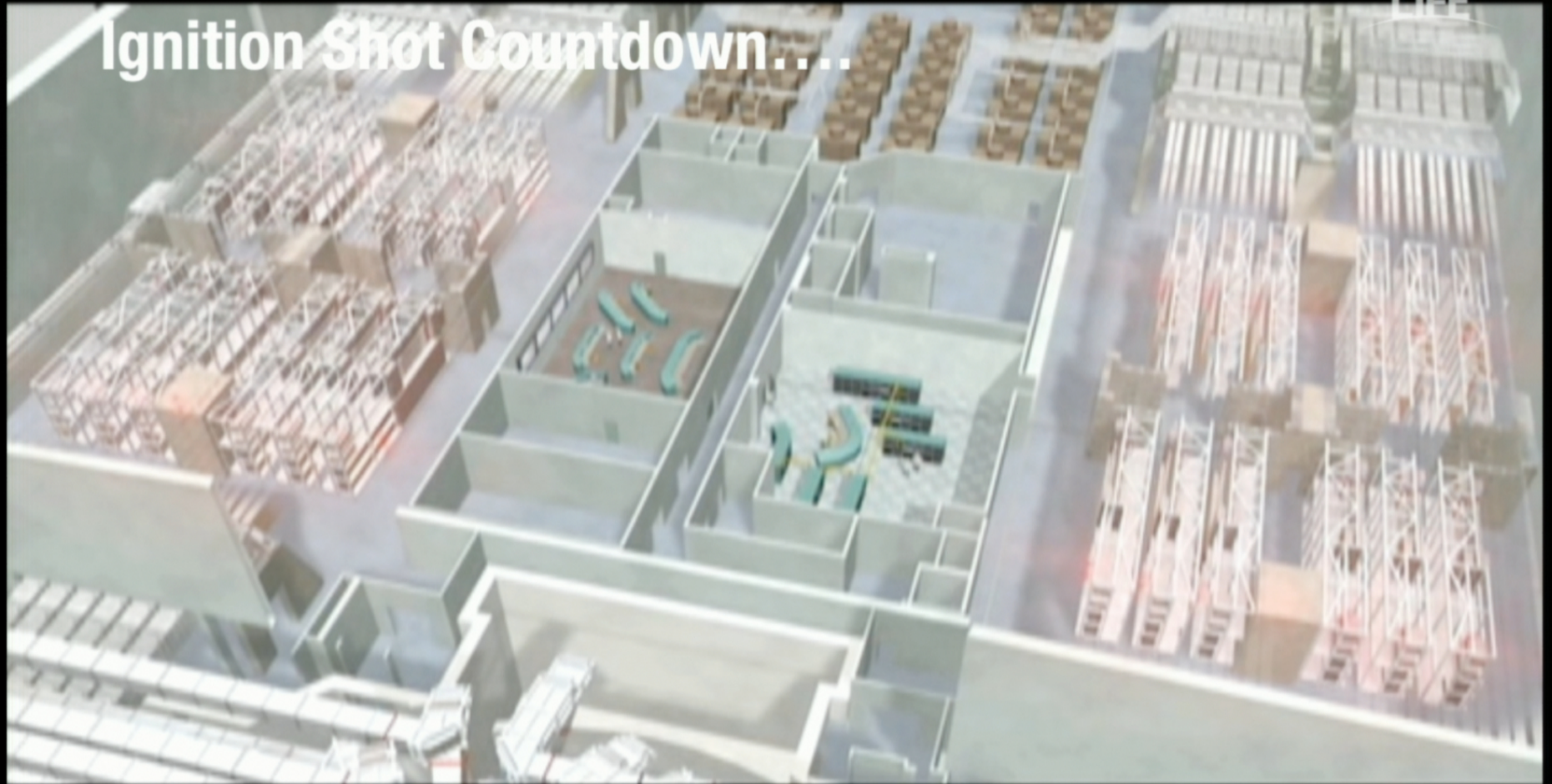


Ignition Shot Countdown...



Ignition Shot Countdown...

LIFE



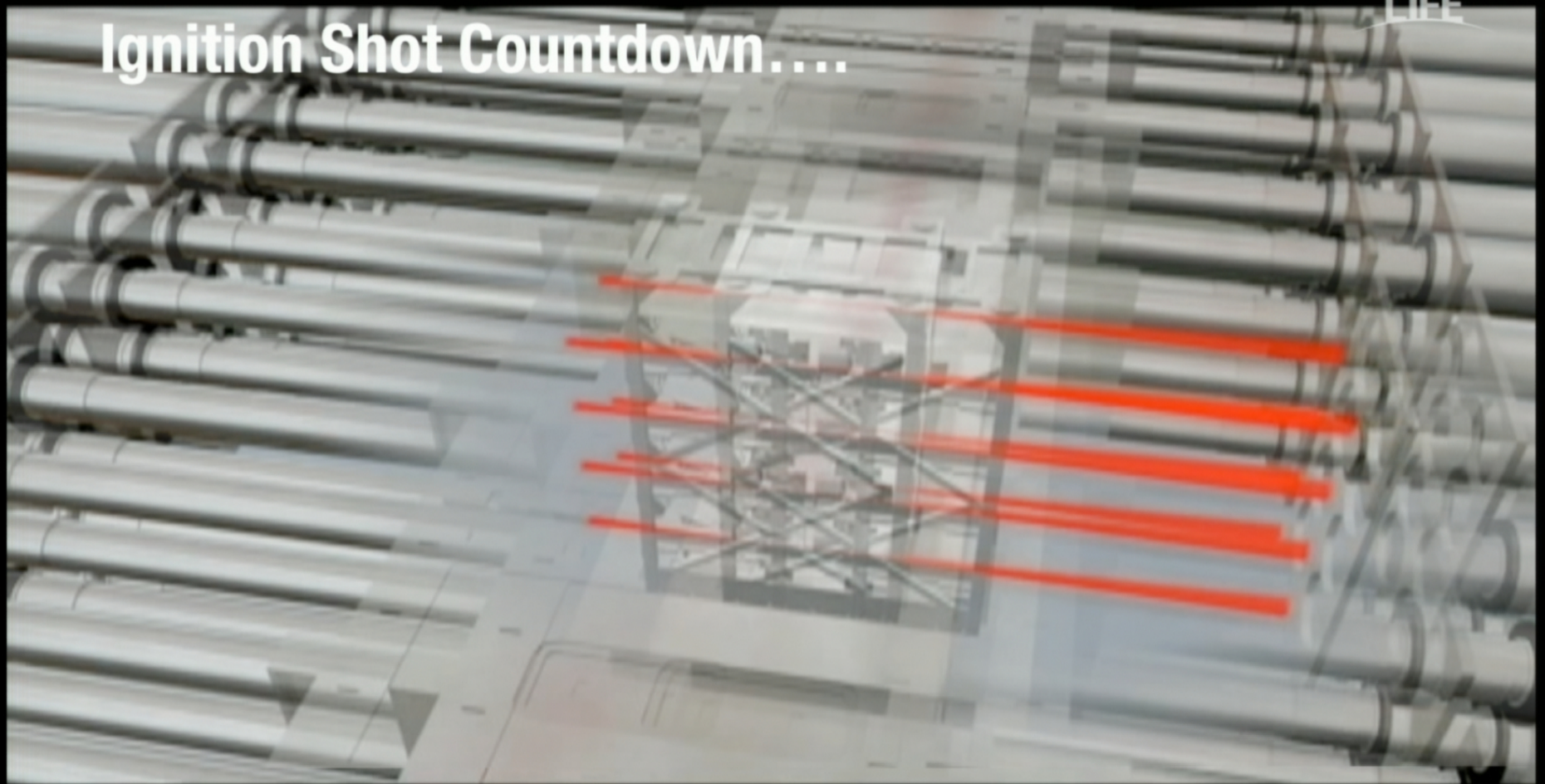
Ignition Shot Countdown....



Ignition Shot Countdown....



Ignition Shot Countdown....



Ignition Shot Countdown....

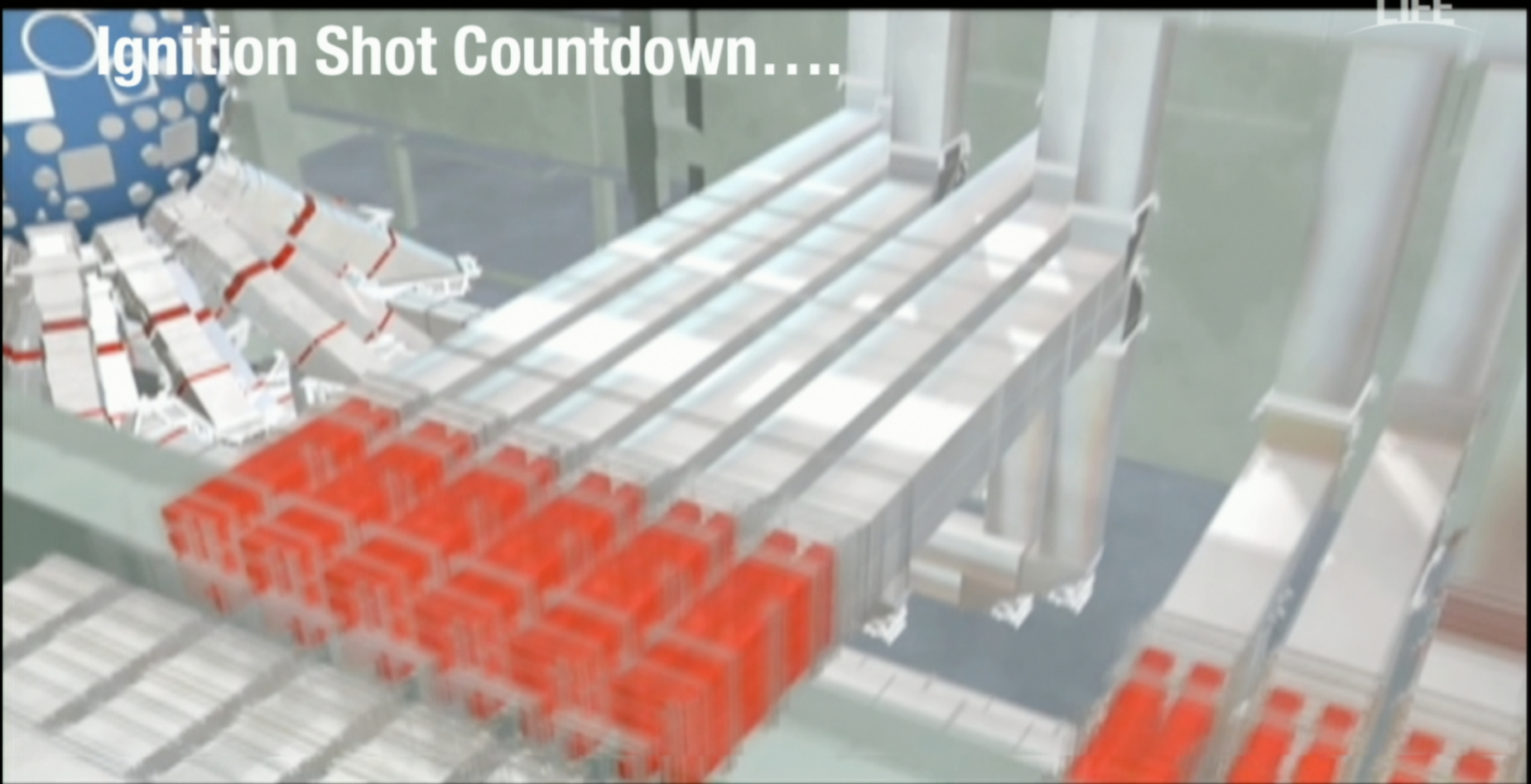
LIFE



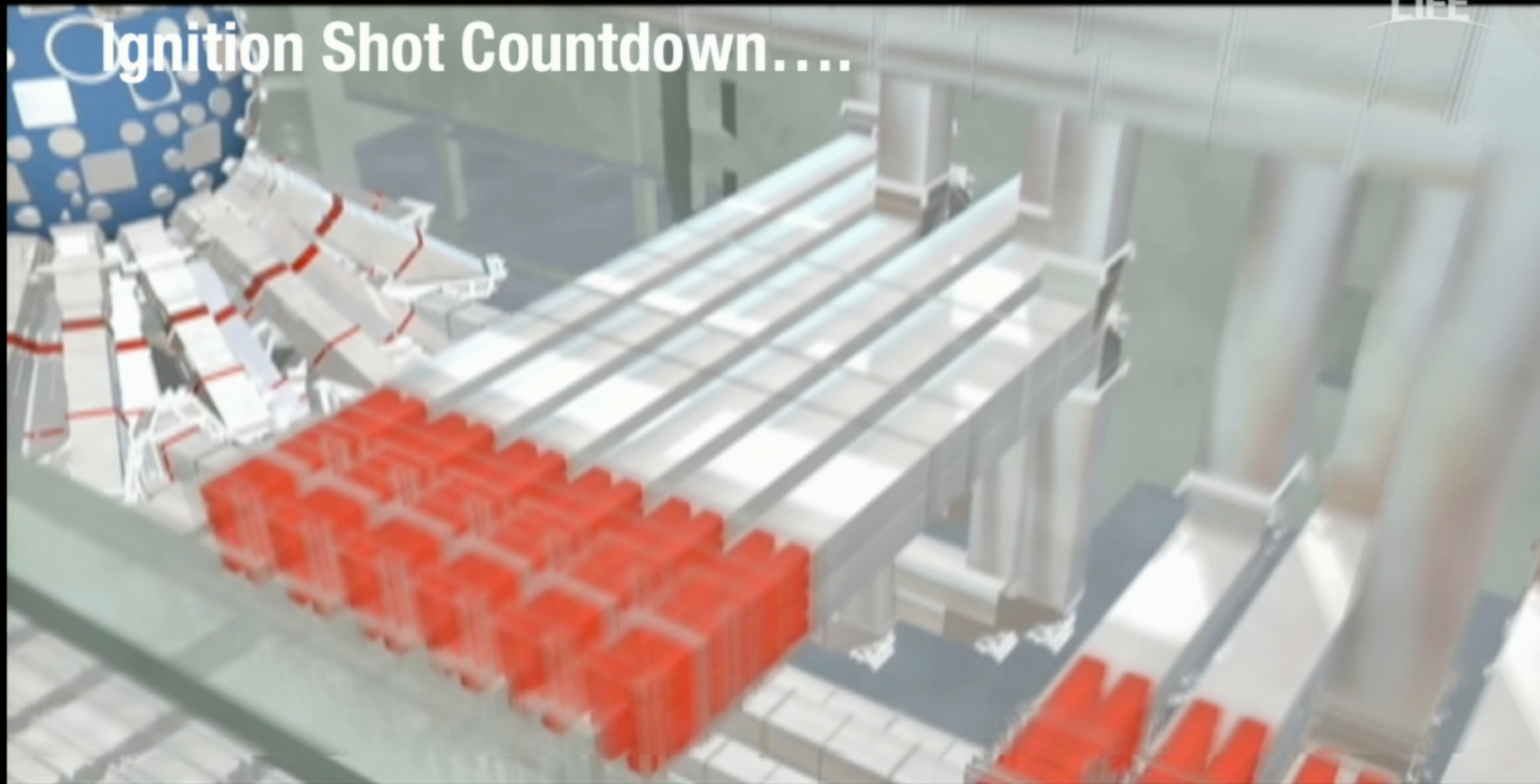
Ignition Shot Countdown....

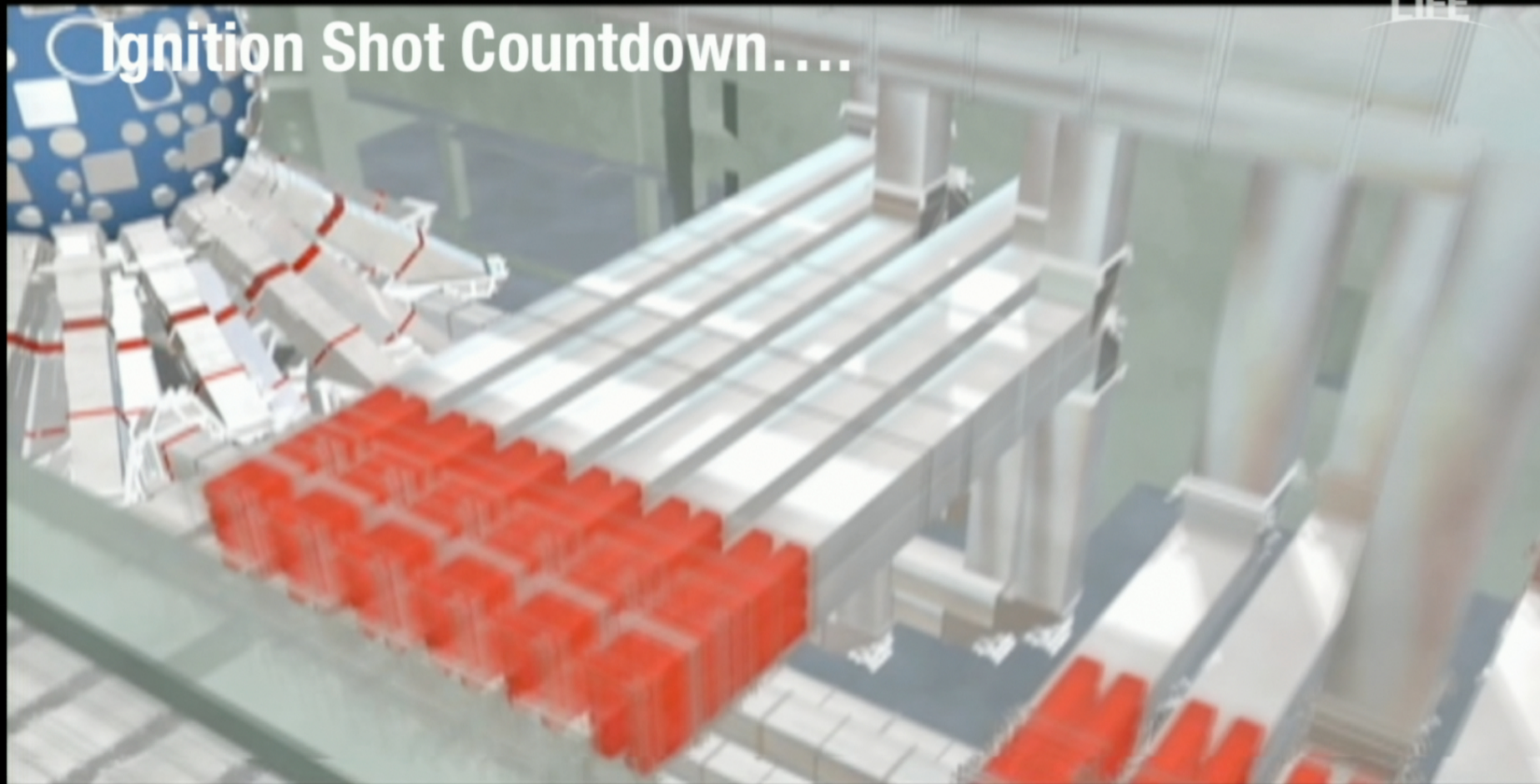
LIFE



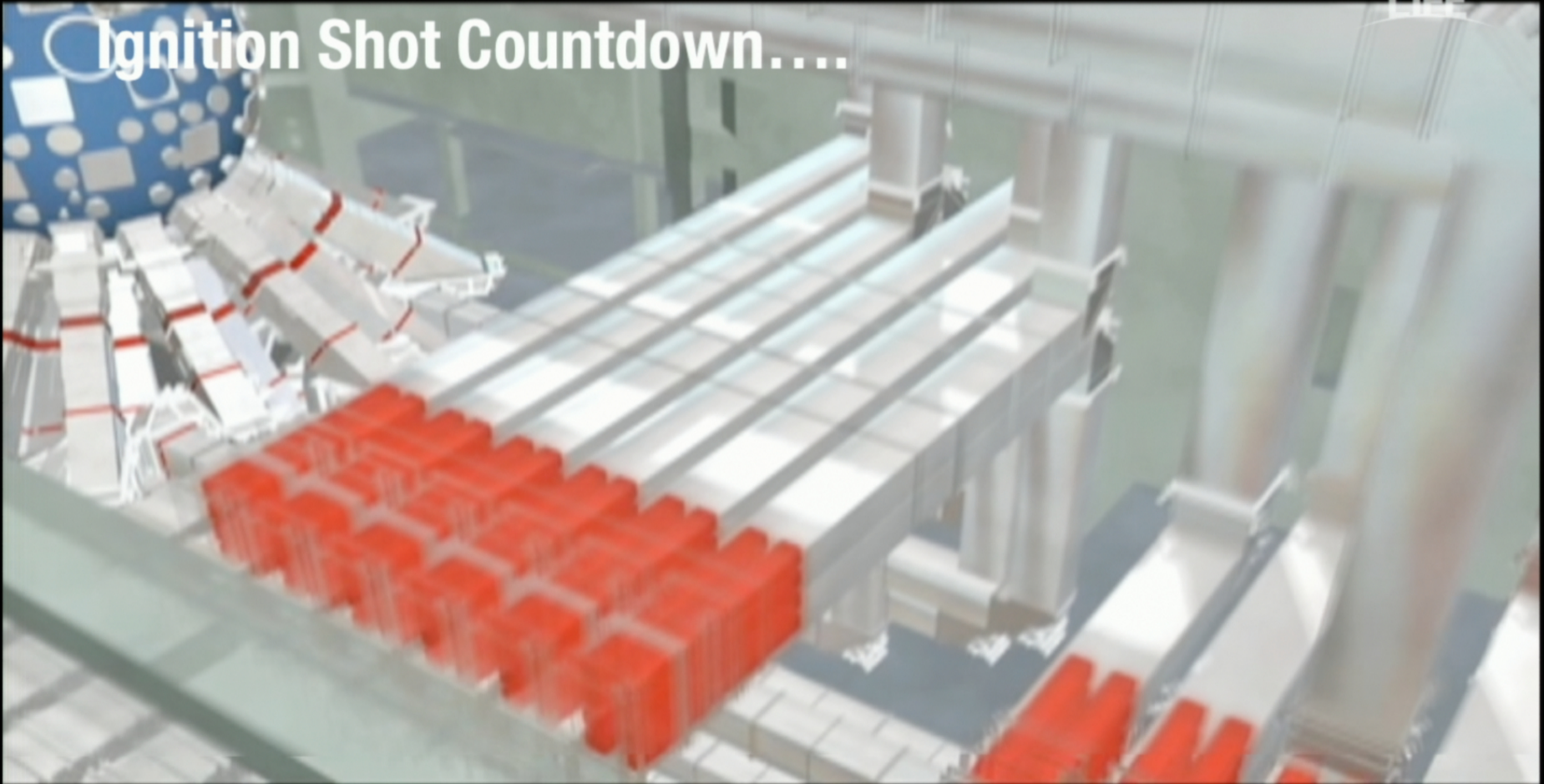


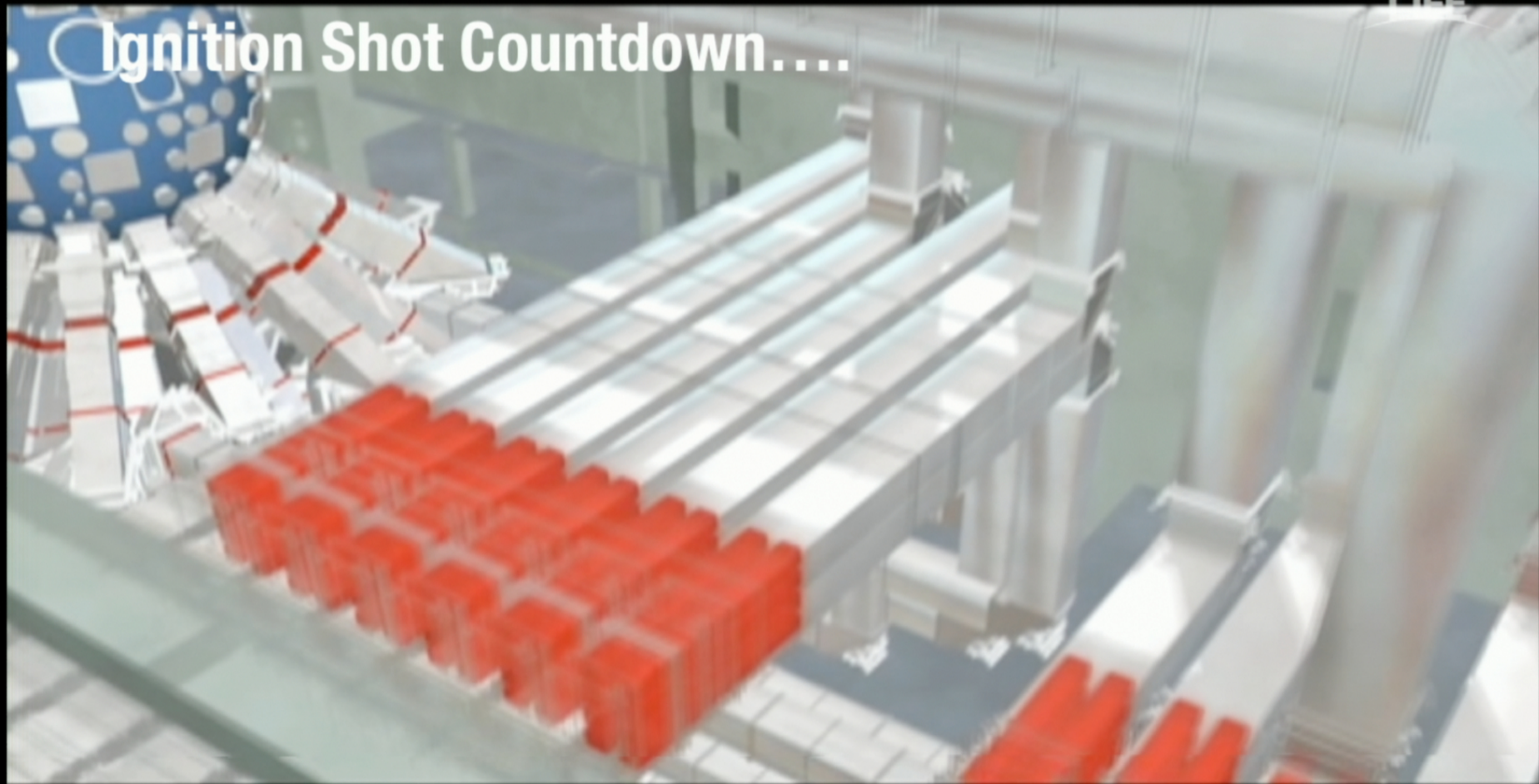
Ignition Shot Countdown....



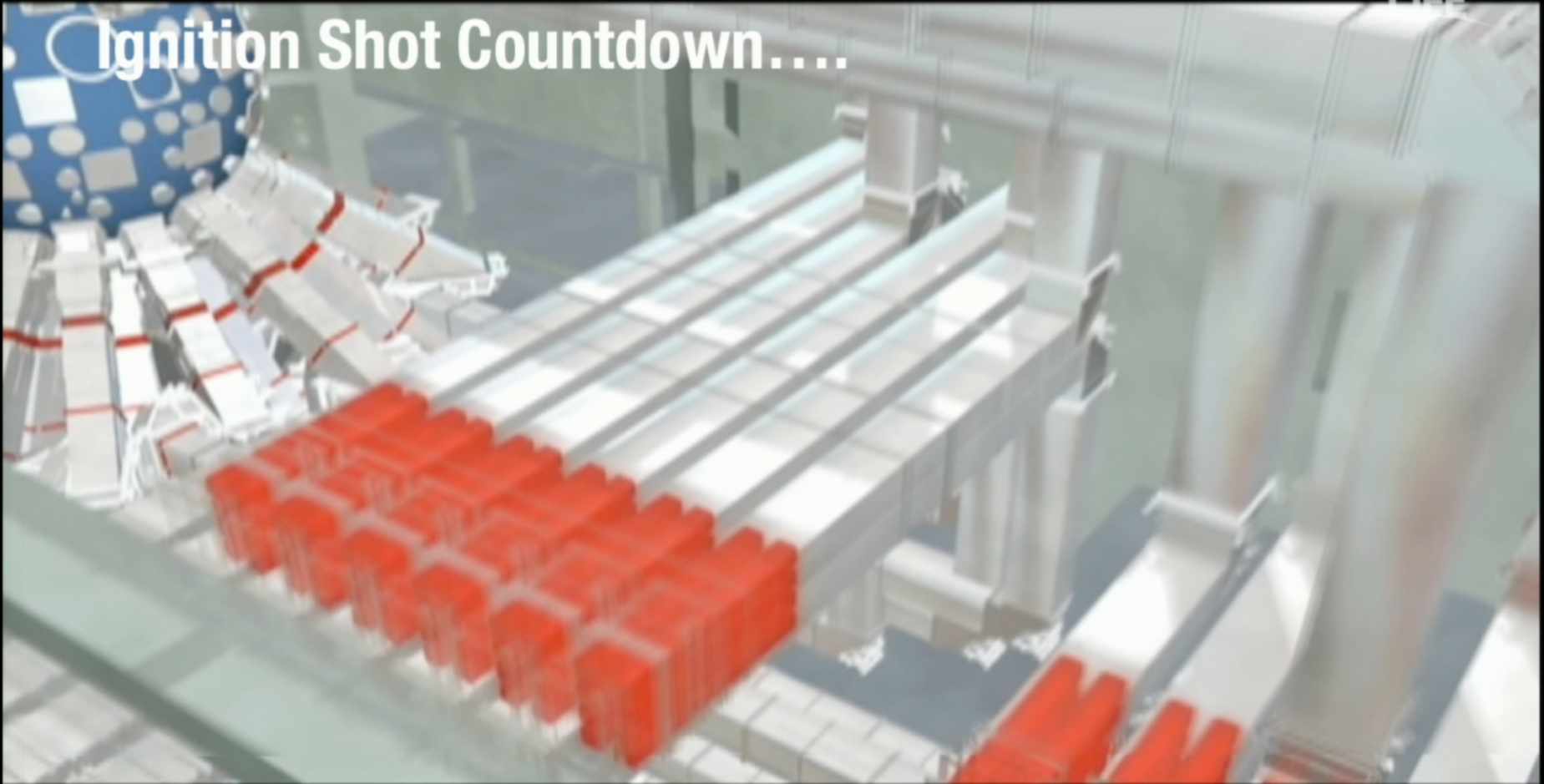


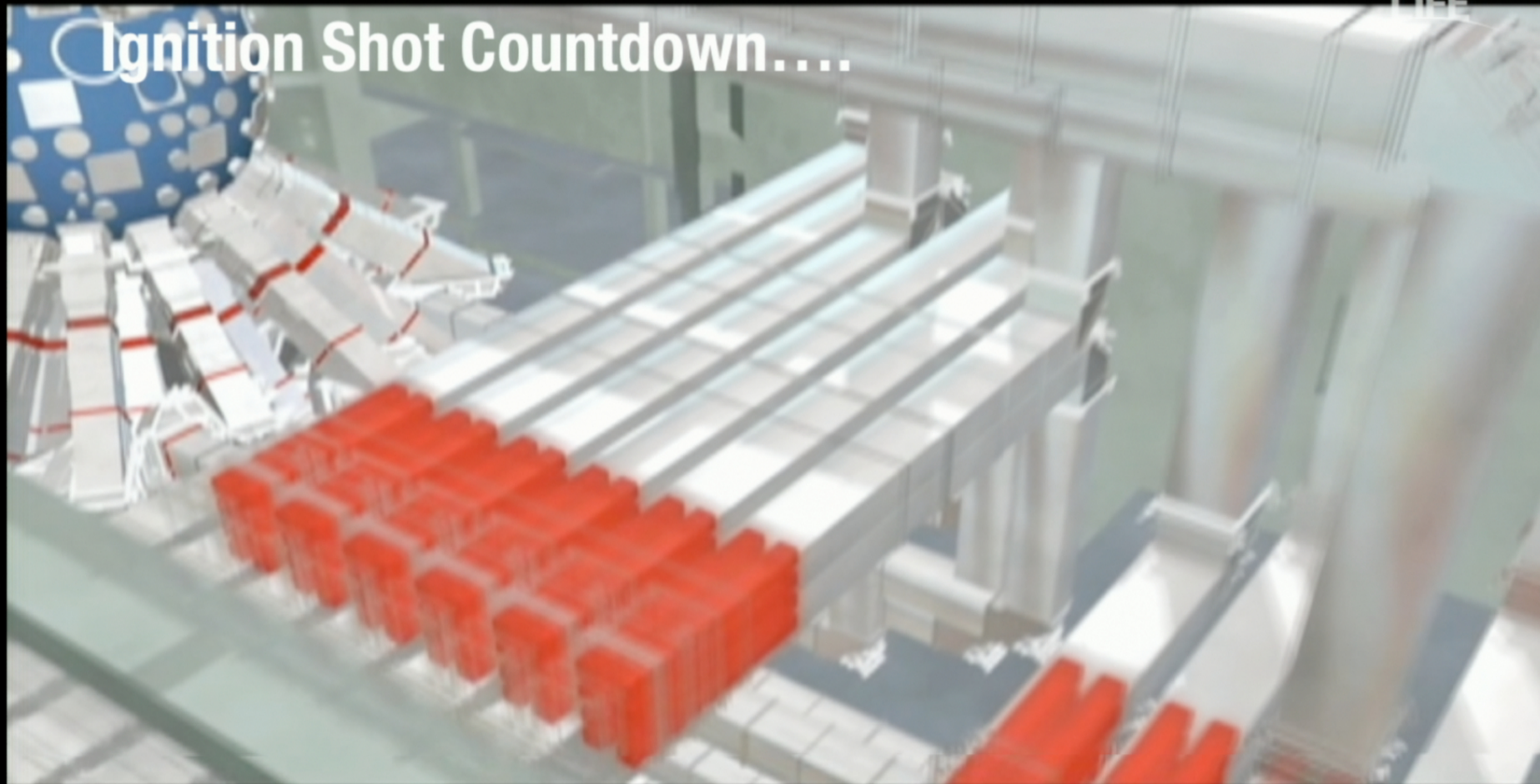
Ignition Shot Countdown....

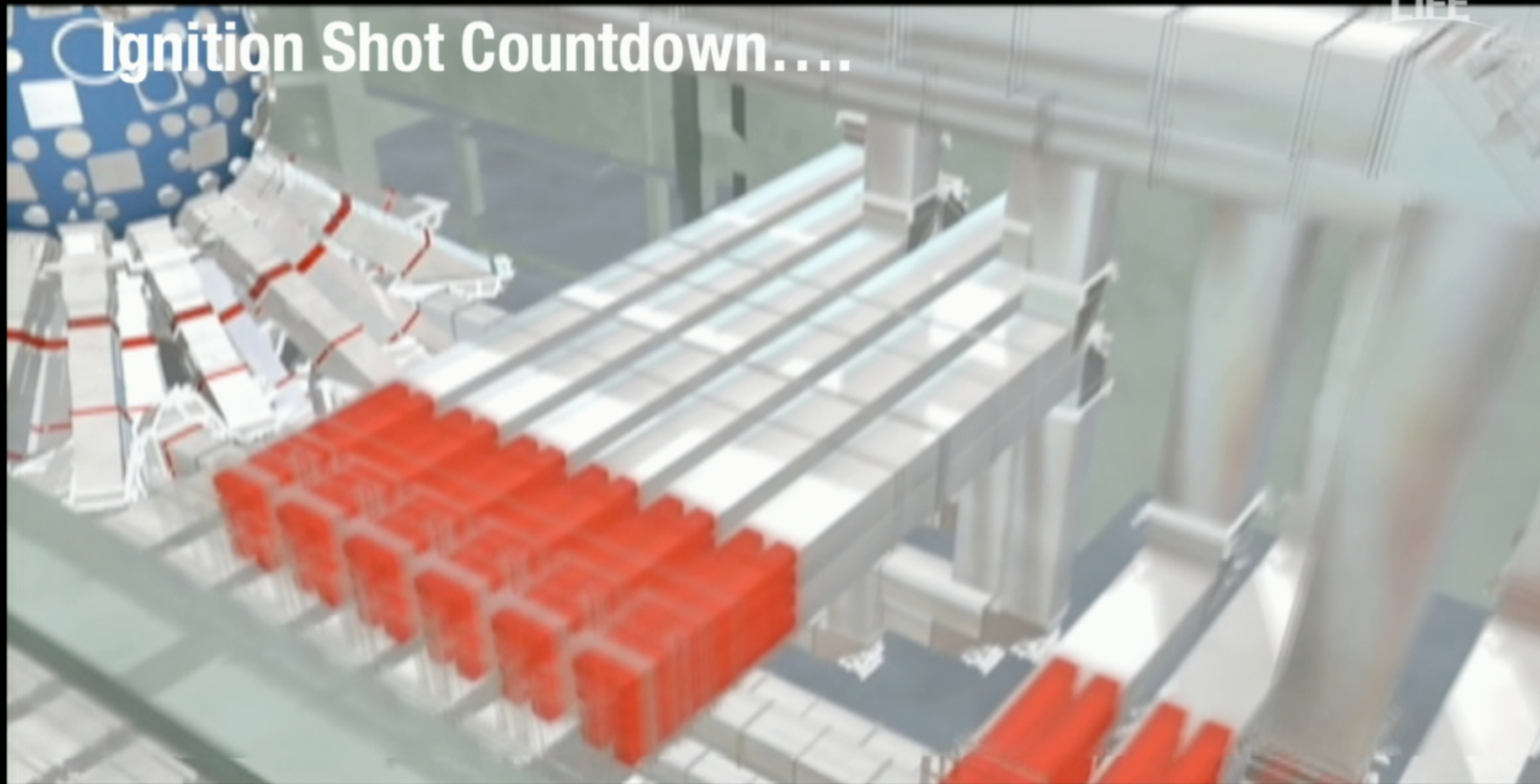




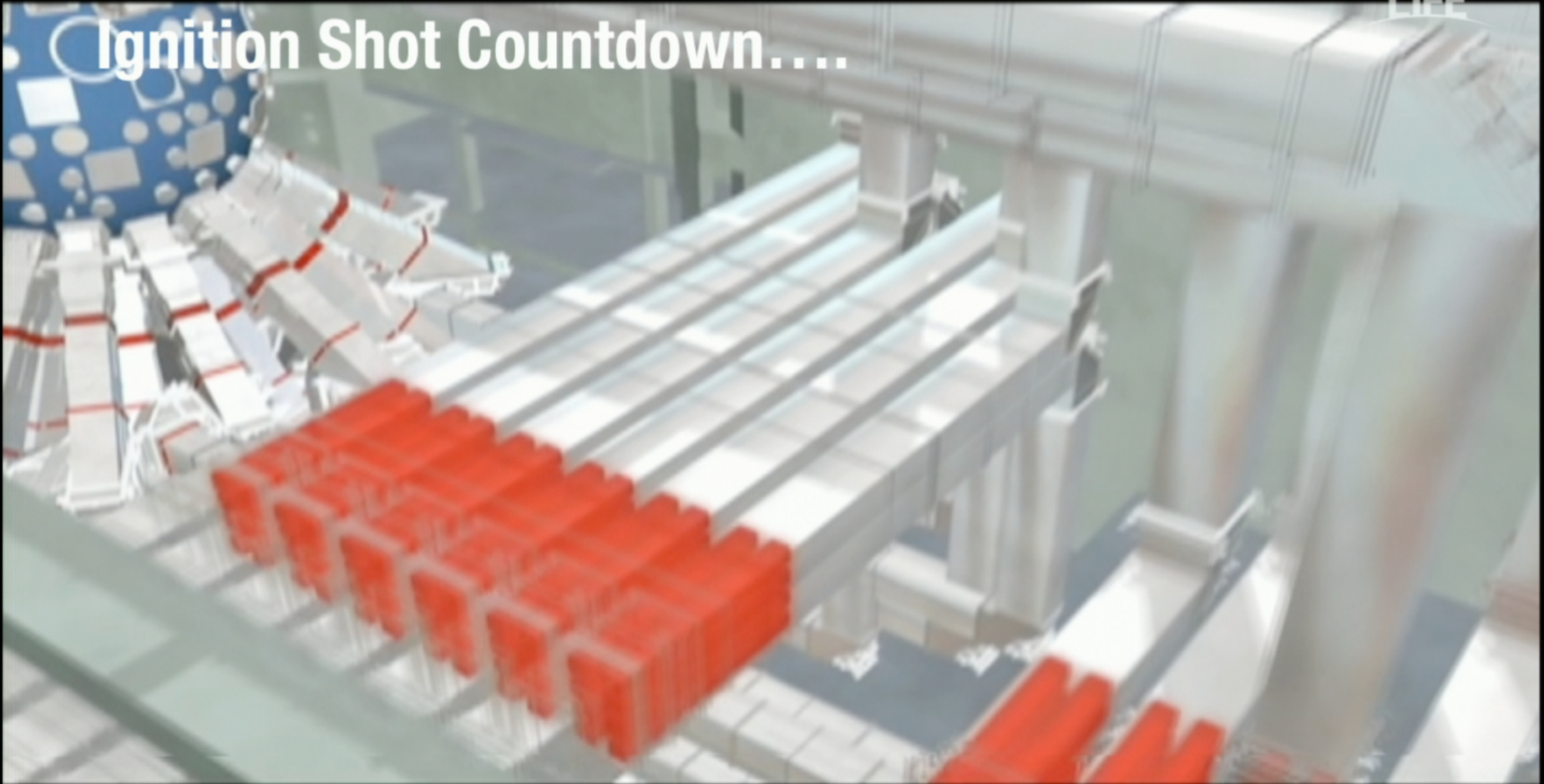
Ignition Shot Countdown....



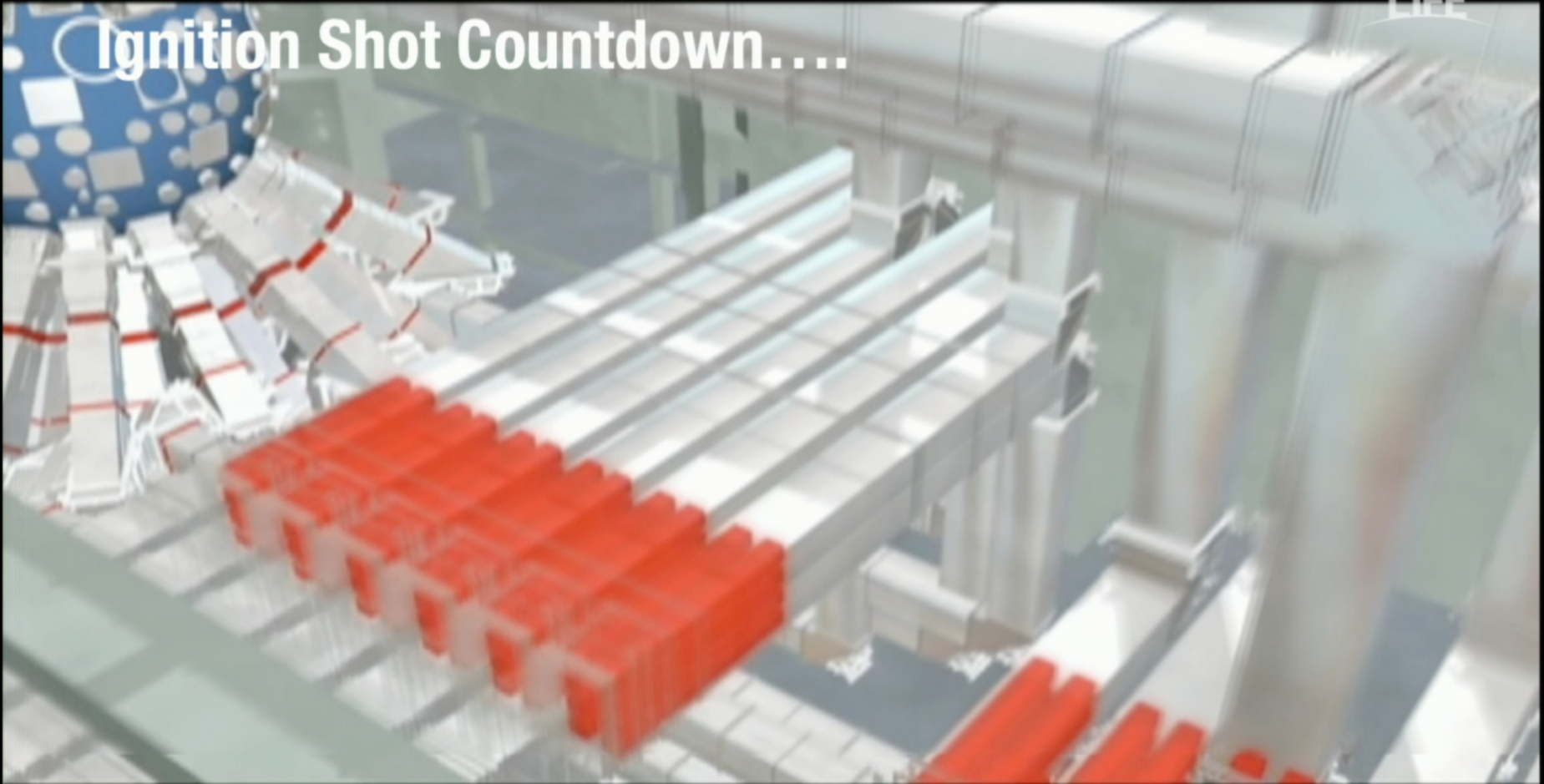




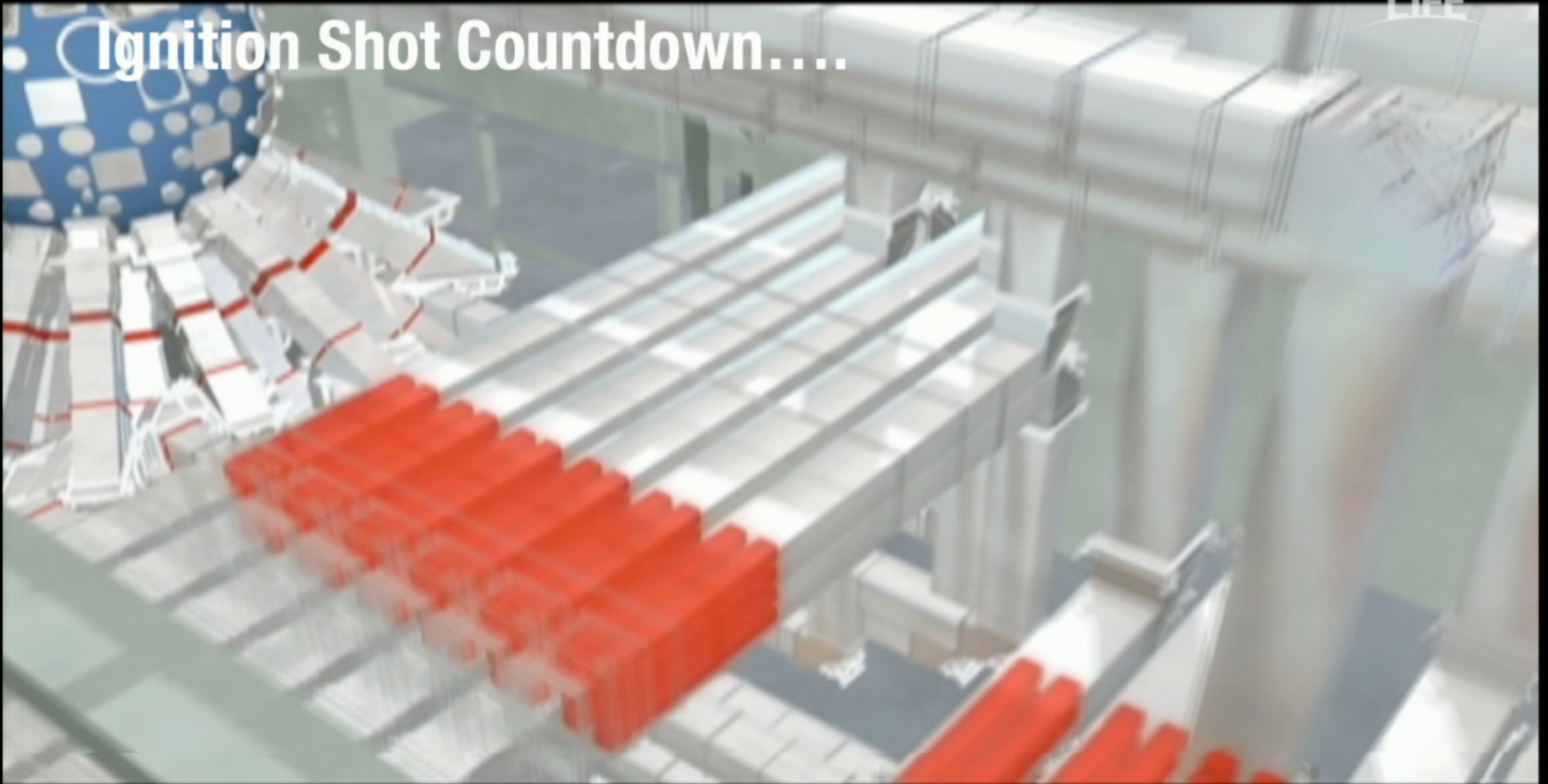
Ignition Shot Countdown....

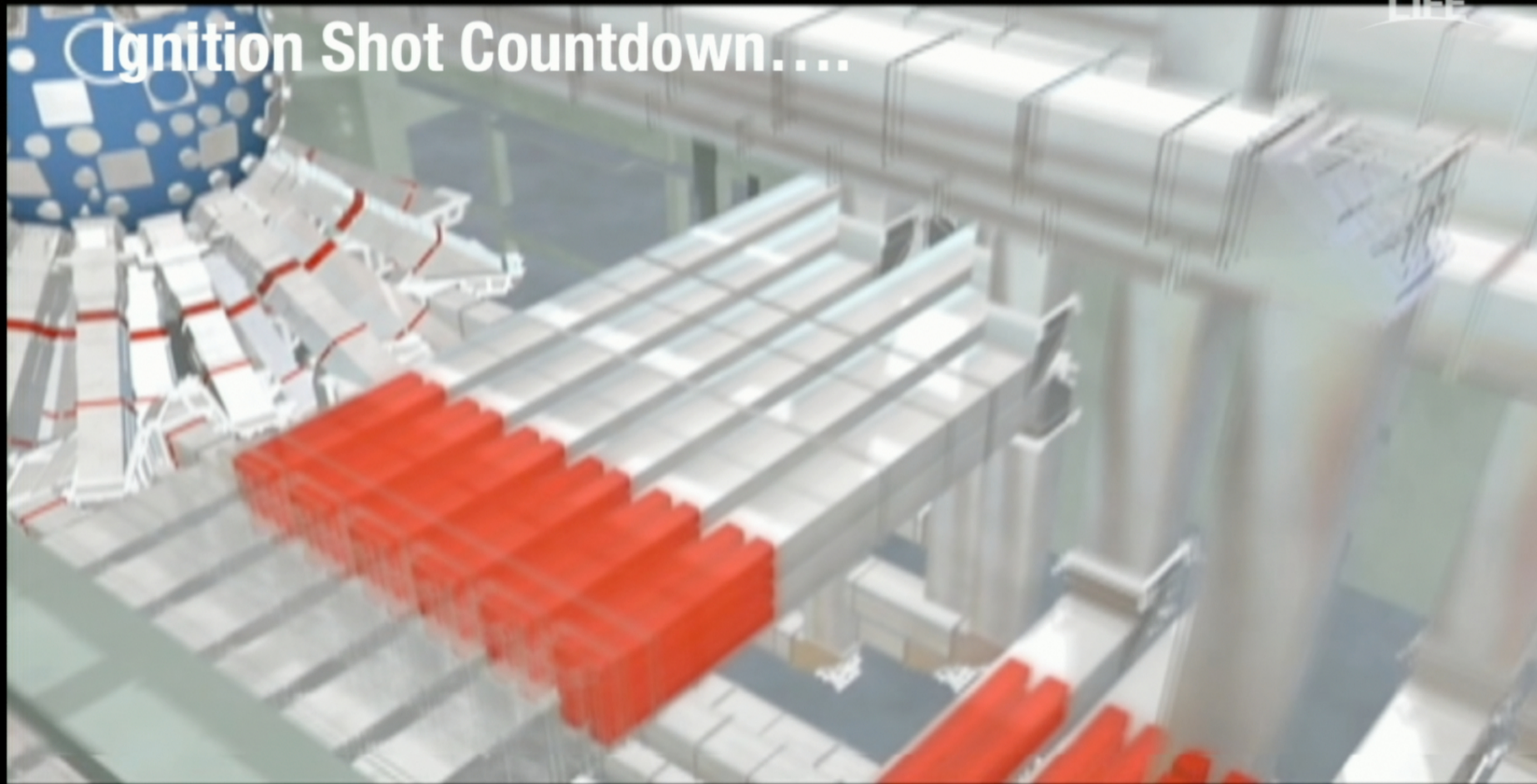


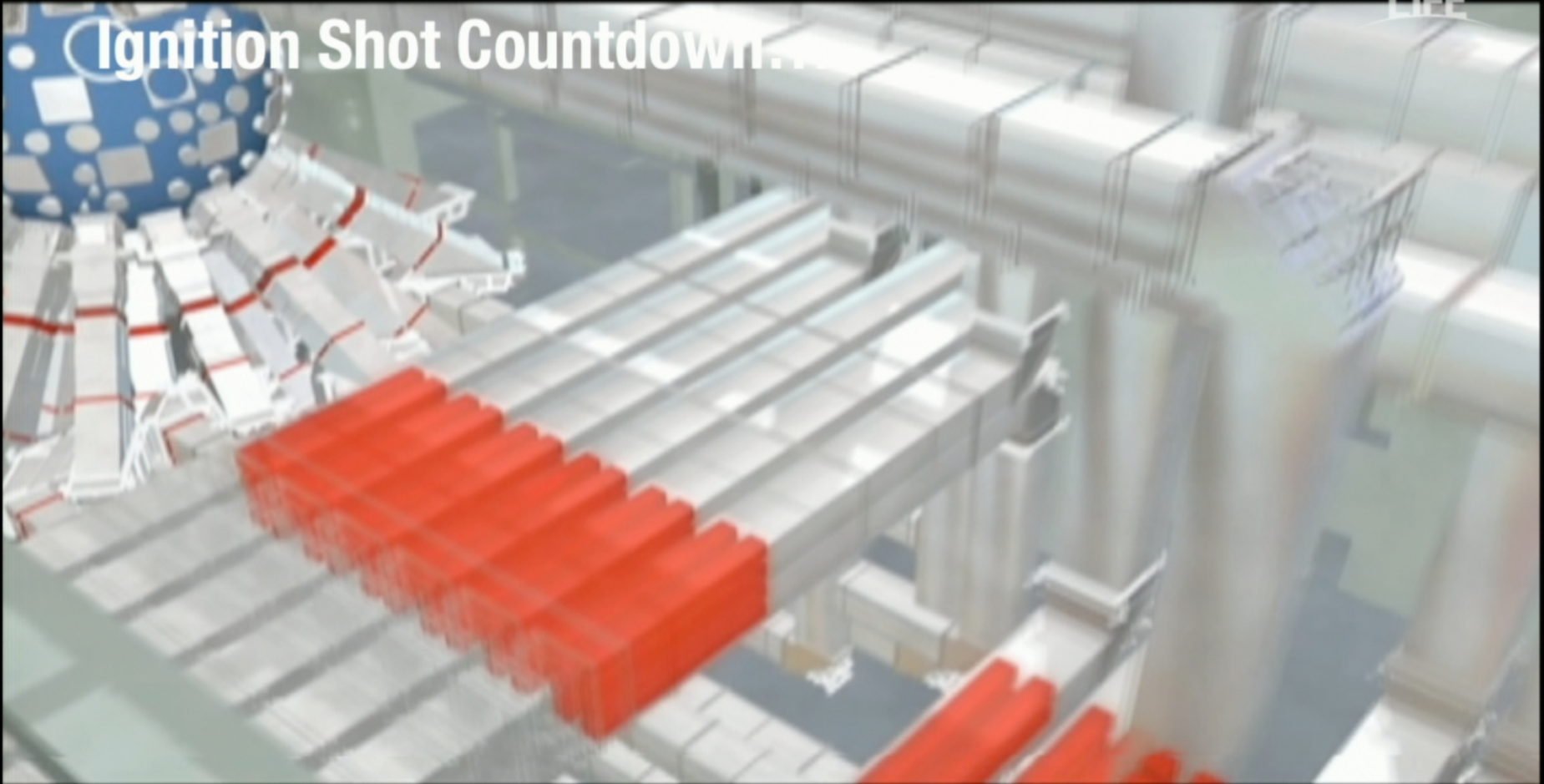
Ignition Shot Countdown....



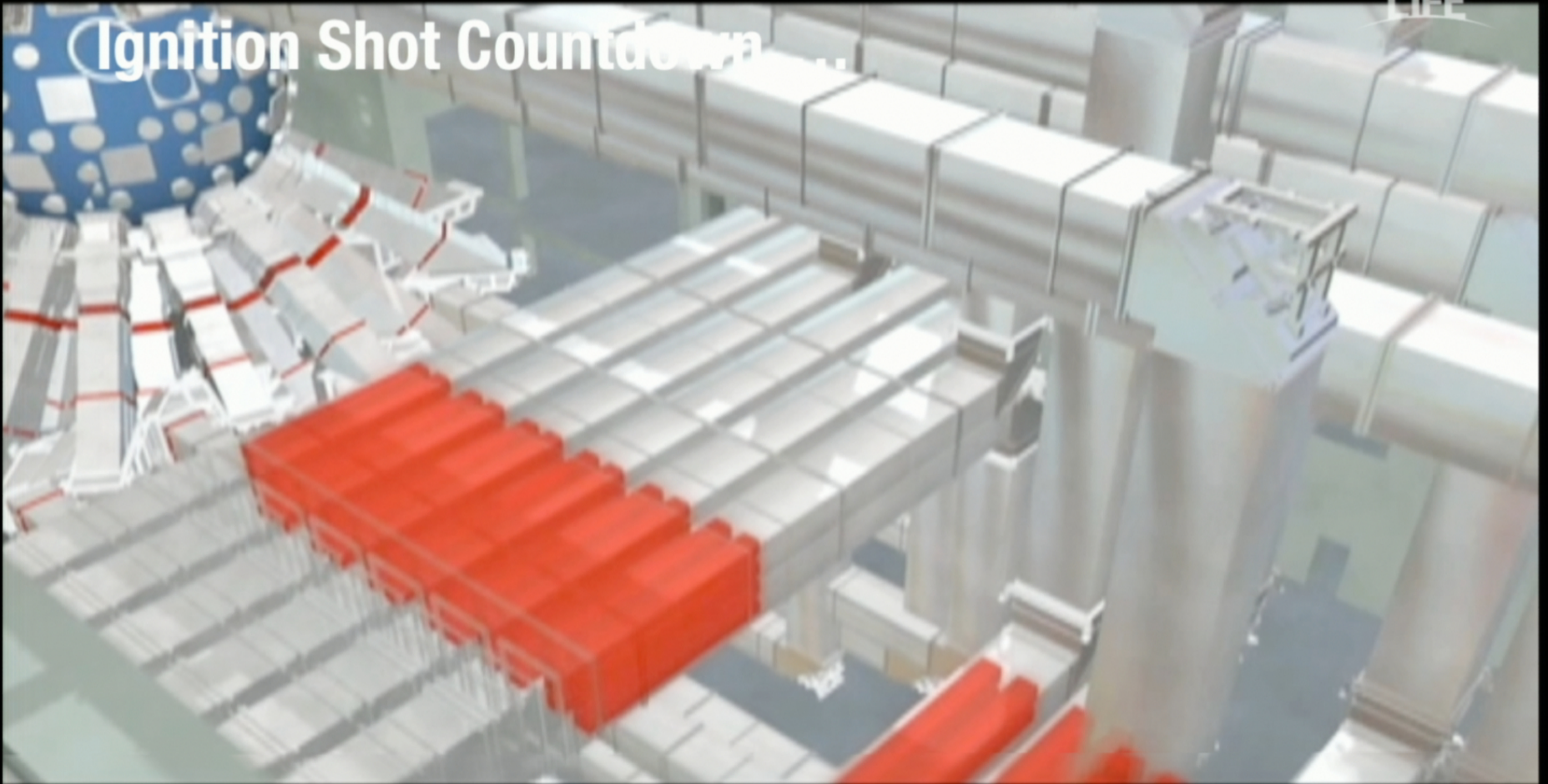
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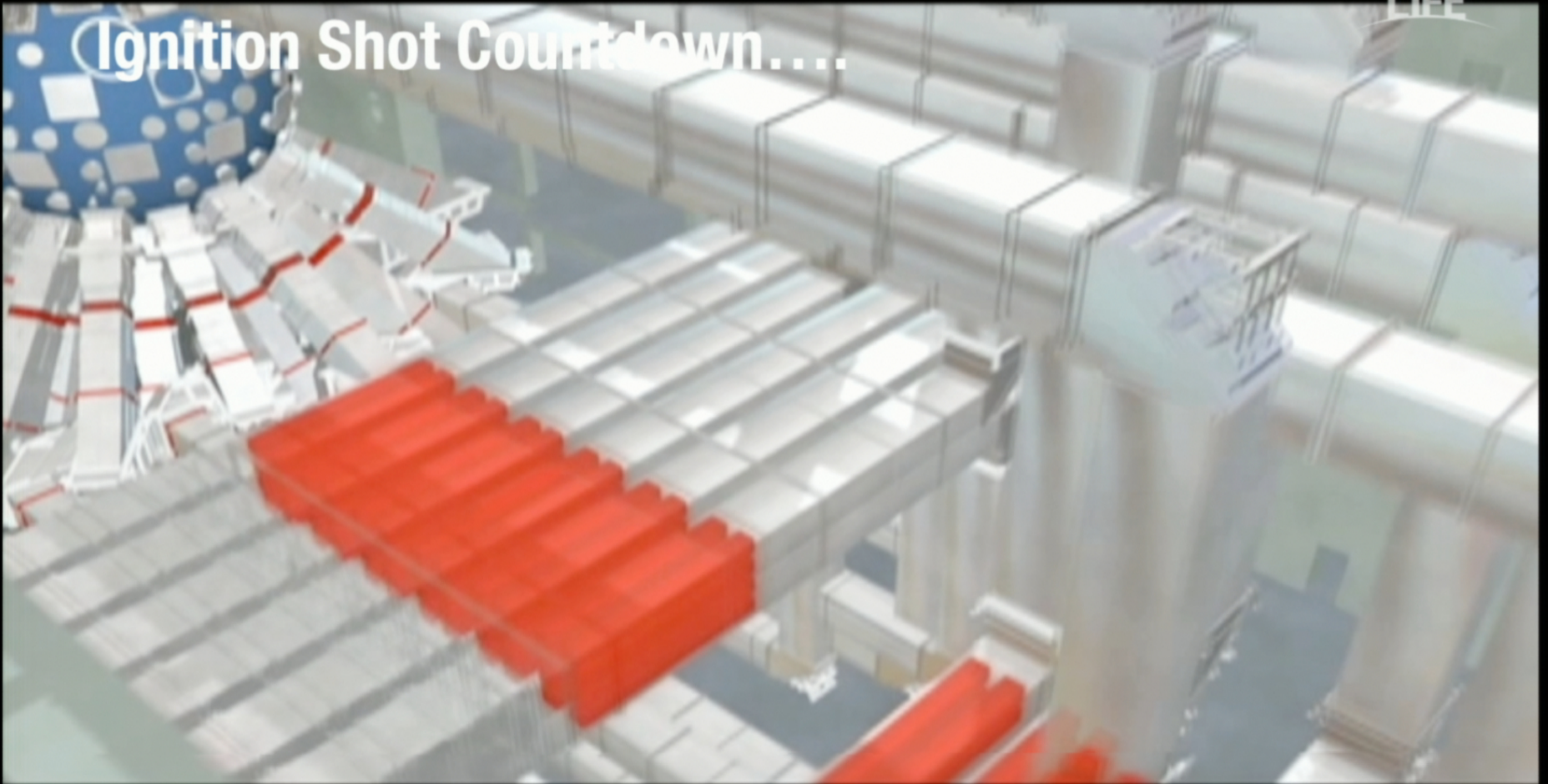




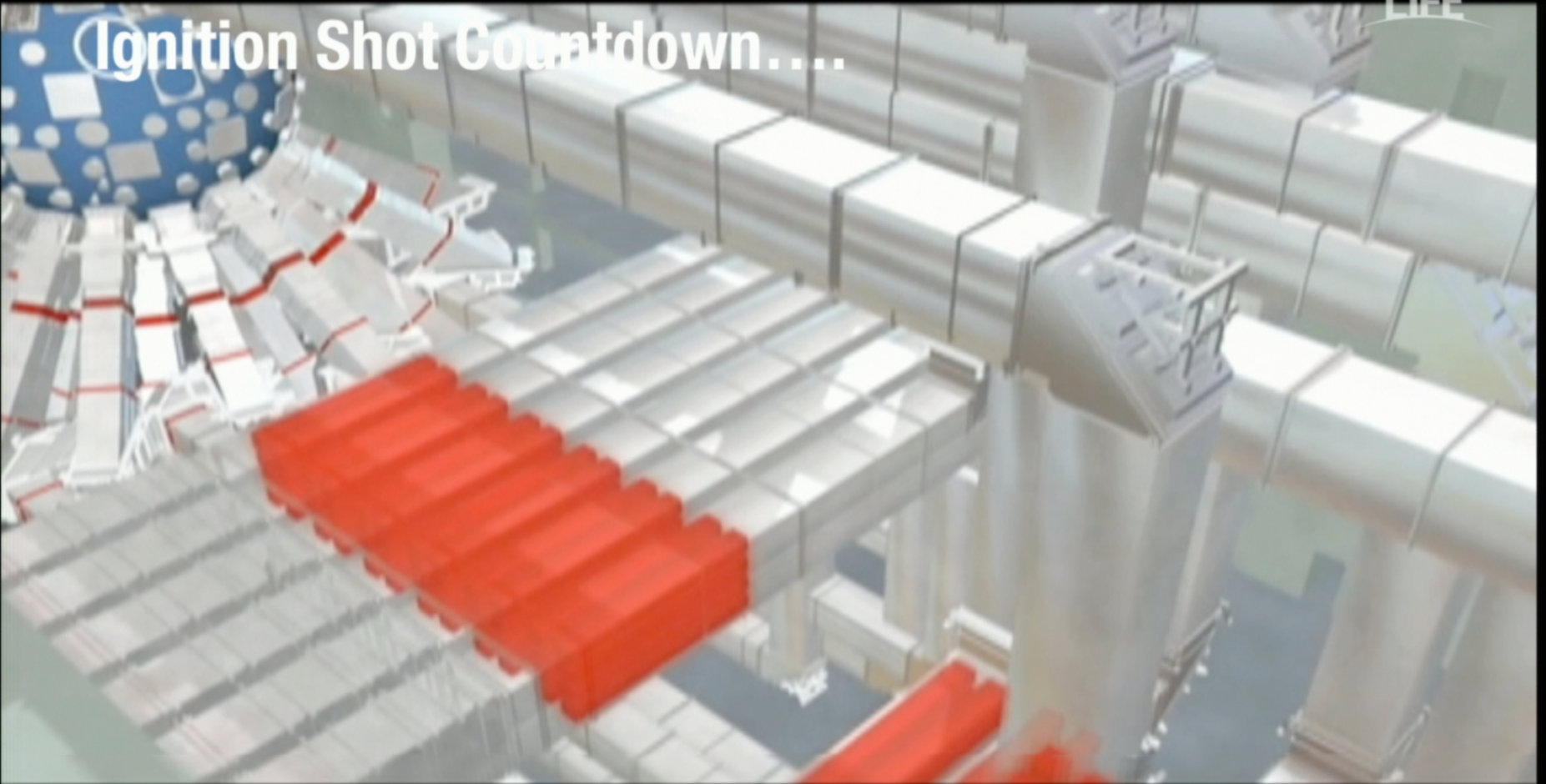
Ignition Shot Countdown ..



Ignition Shot Countdown....



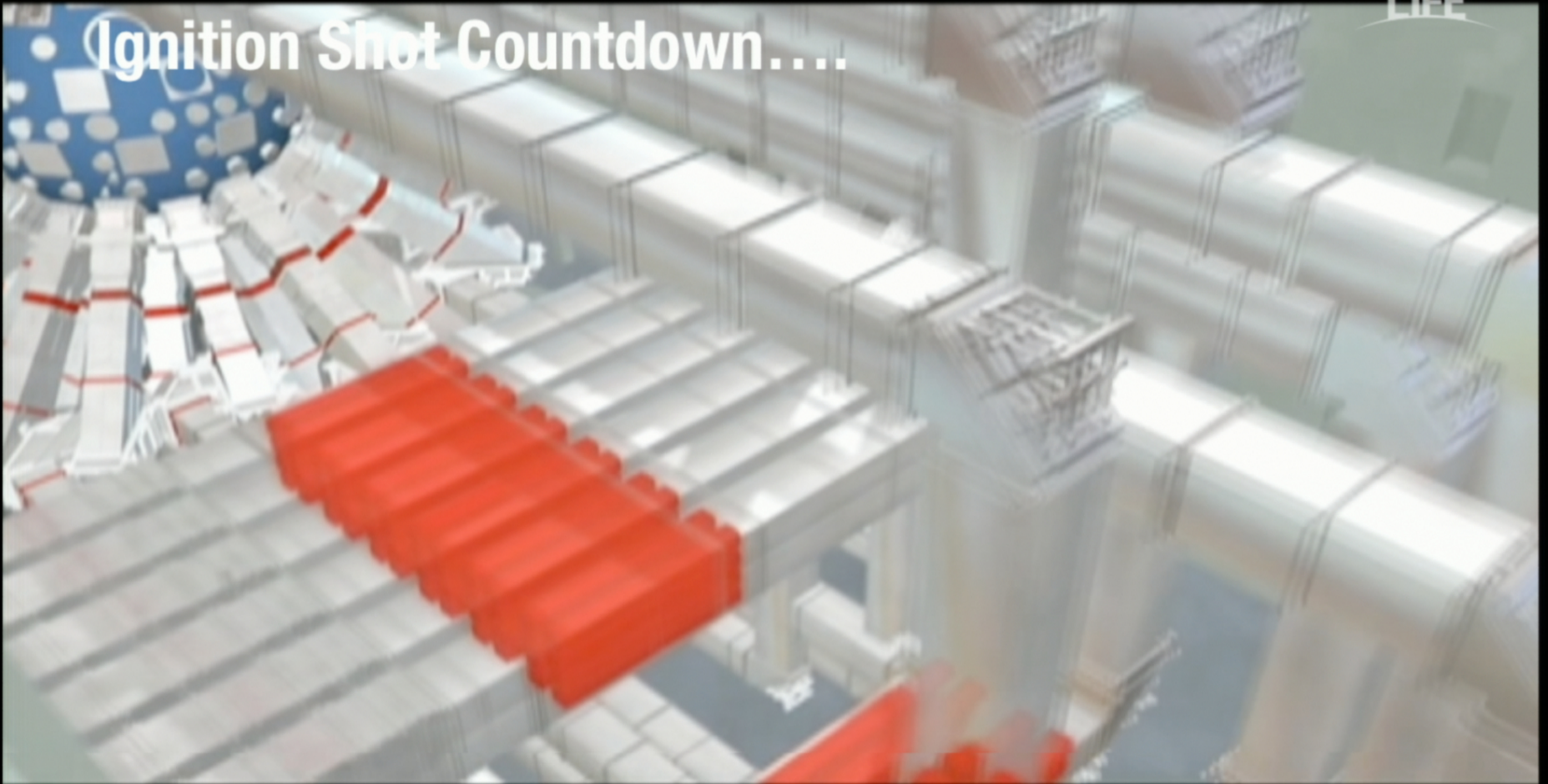
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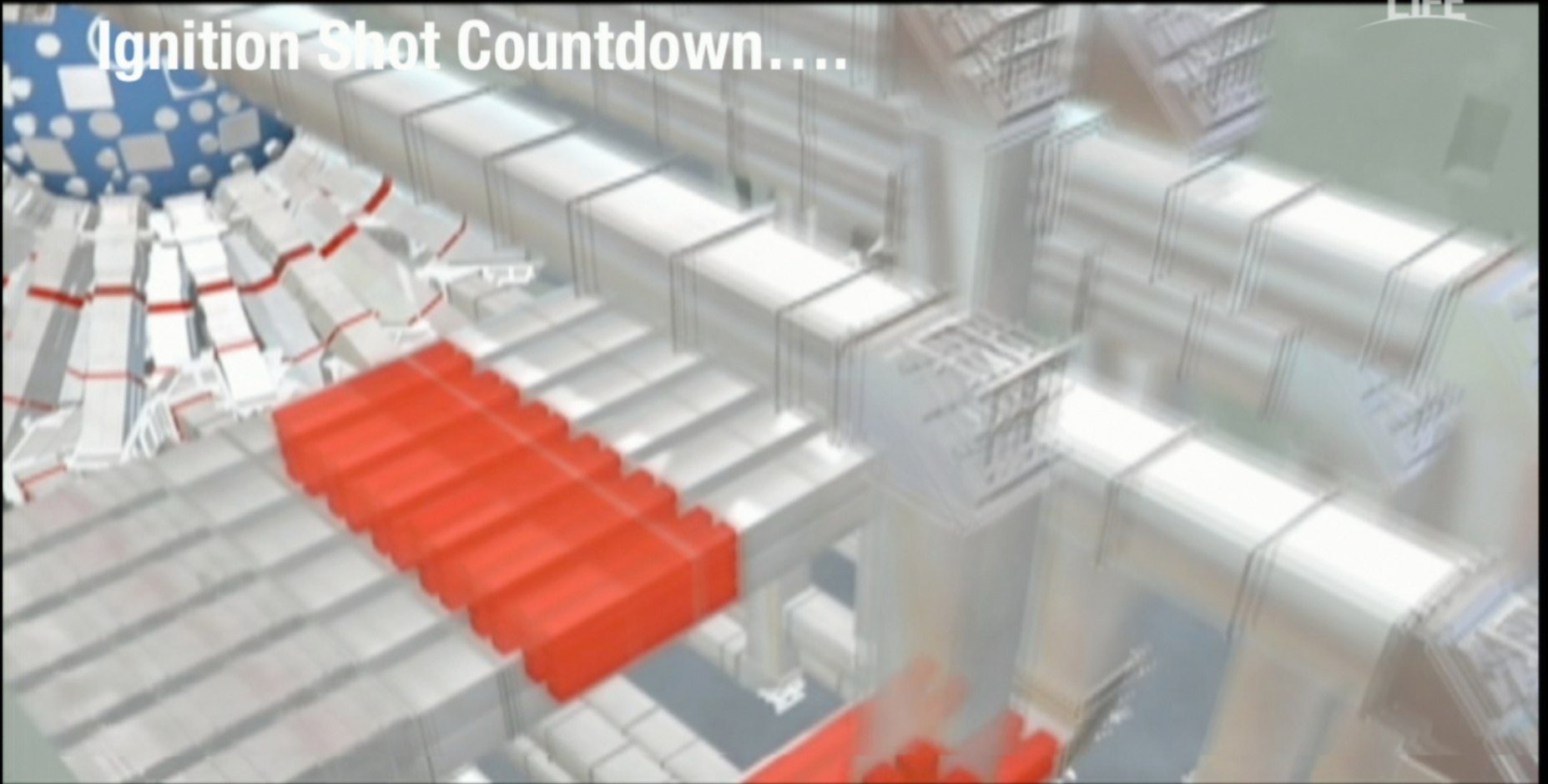
Ignition Shot Countdown....



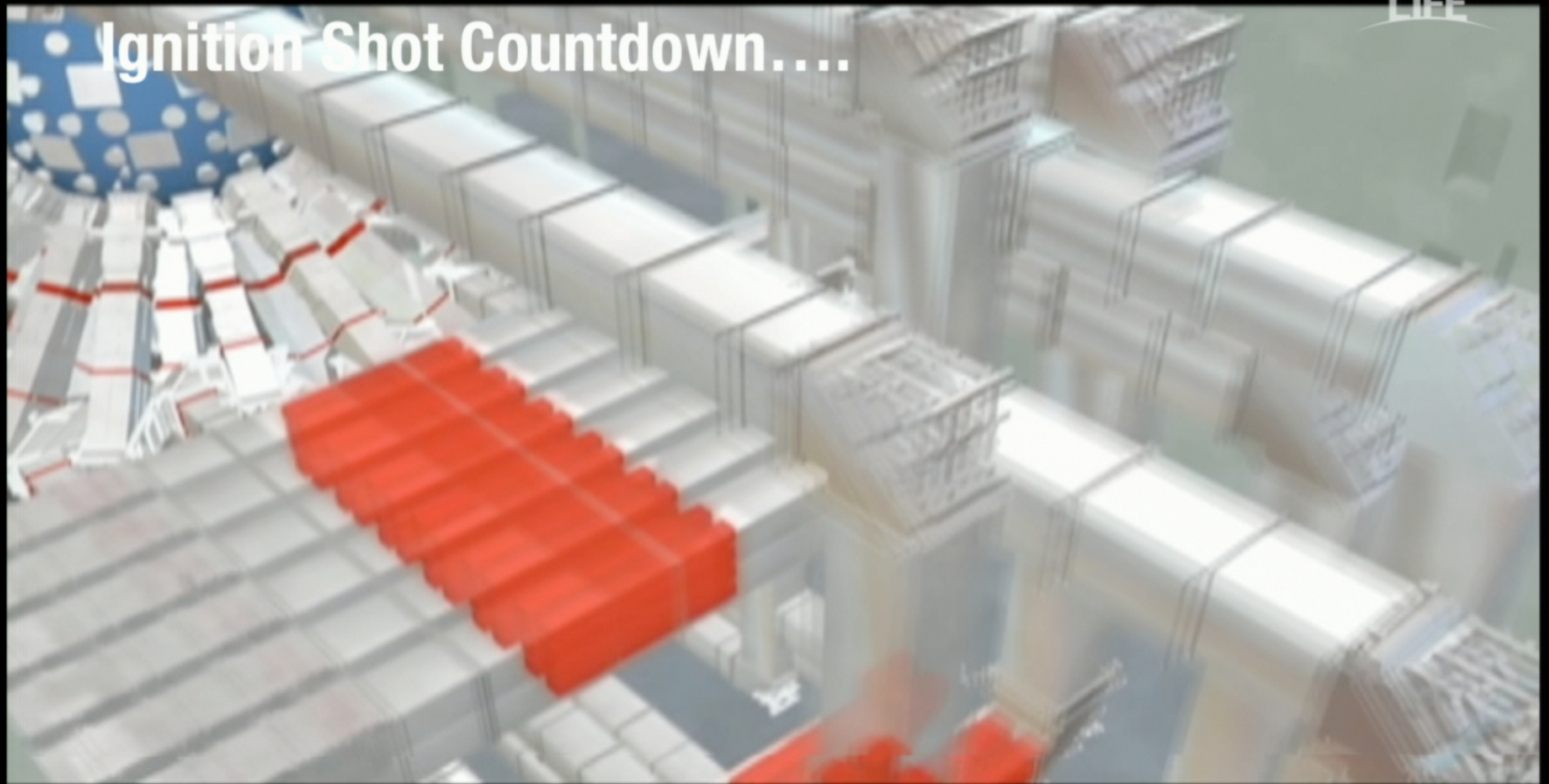
Ignition Shot Countdown....



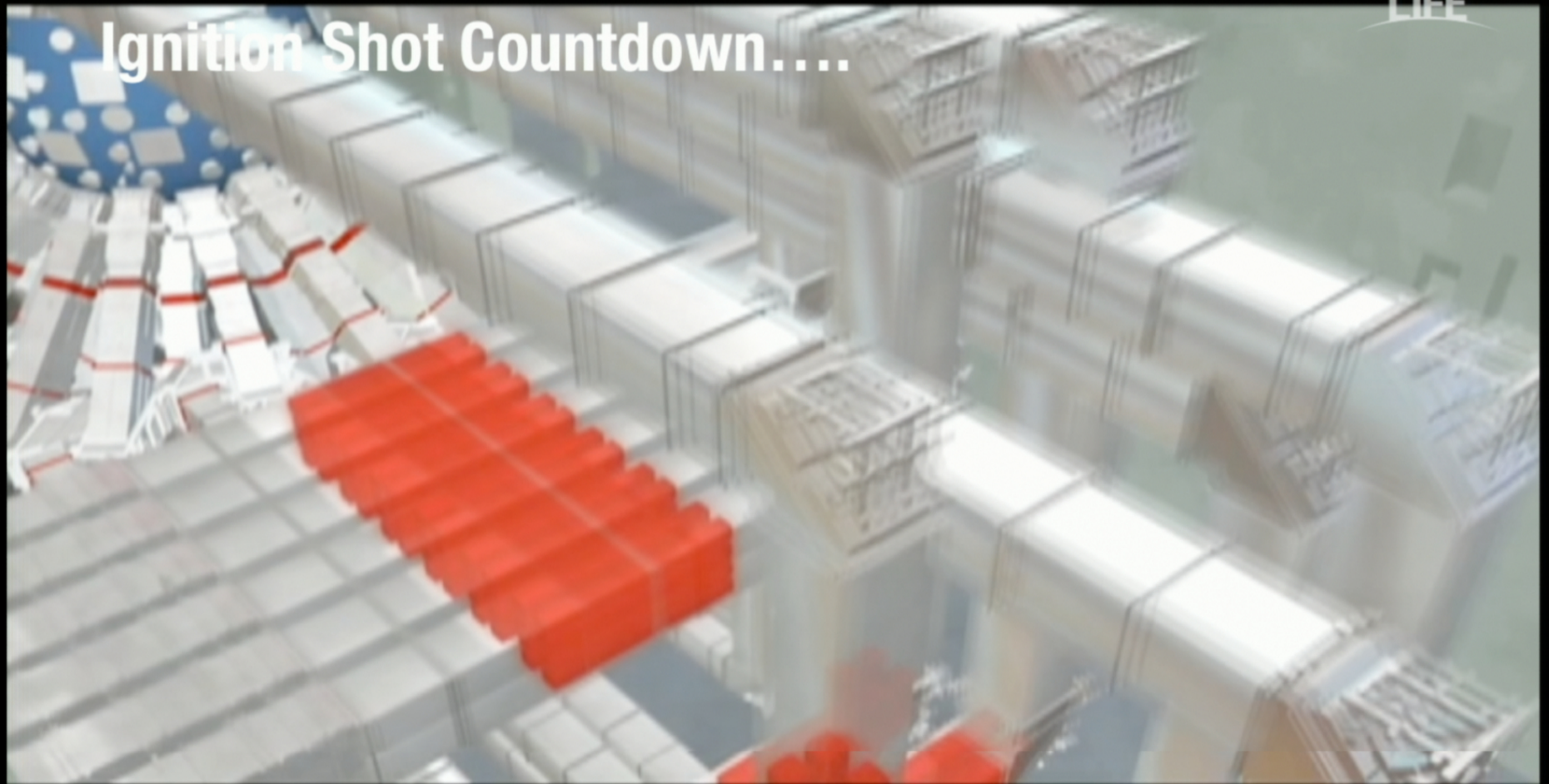
Ignition Shot Countdown....



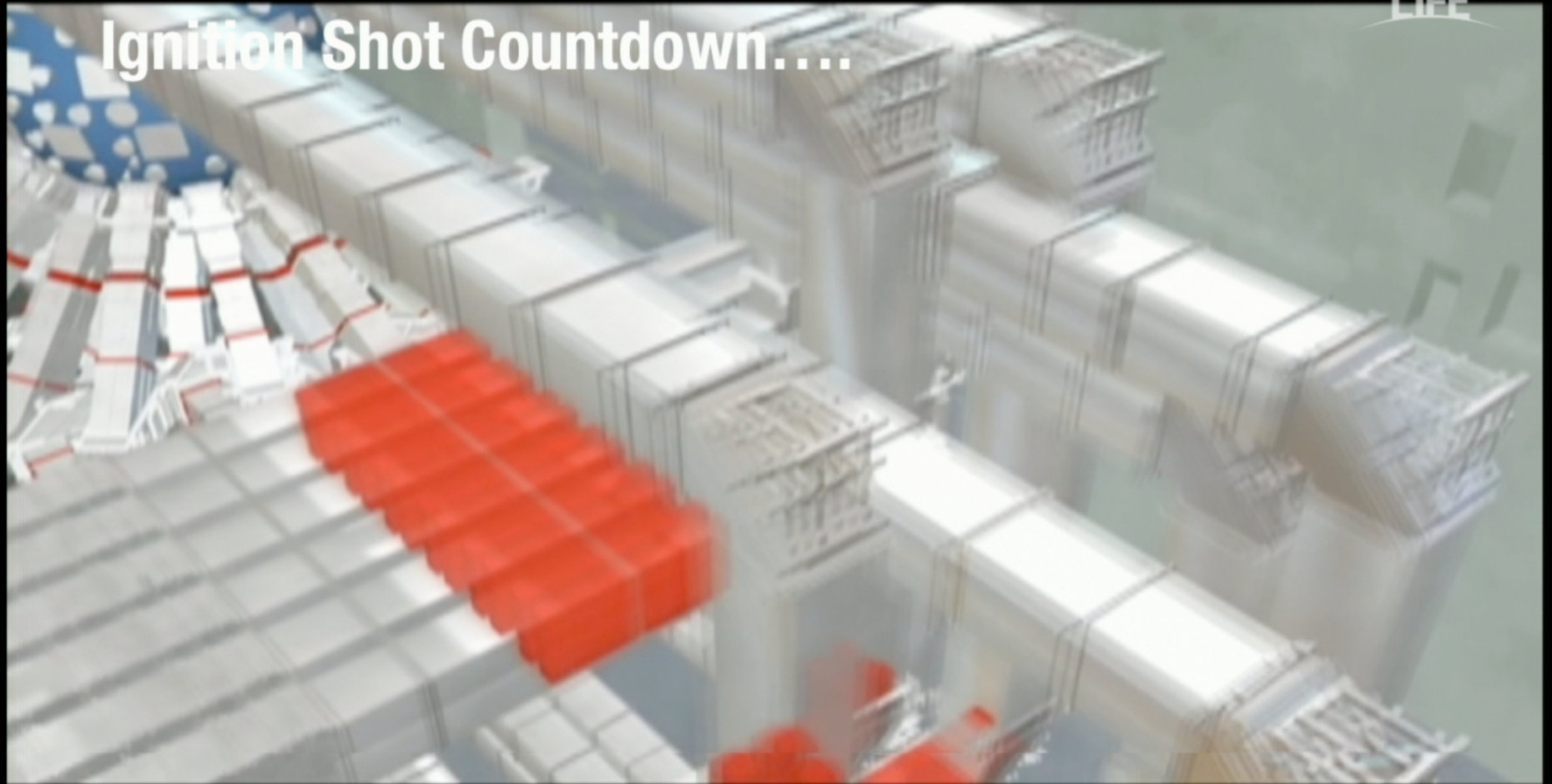
Ignition Shot Countdown....



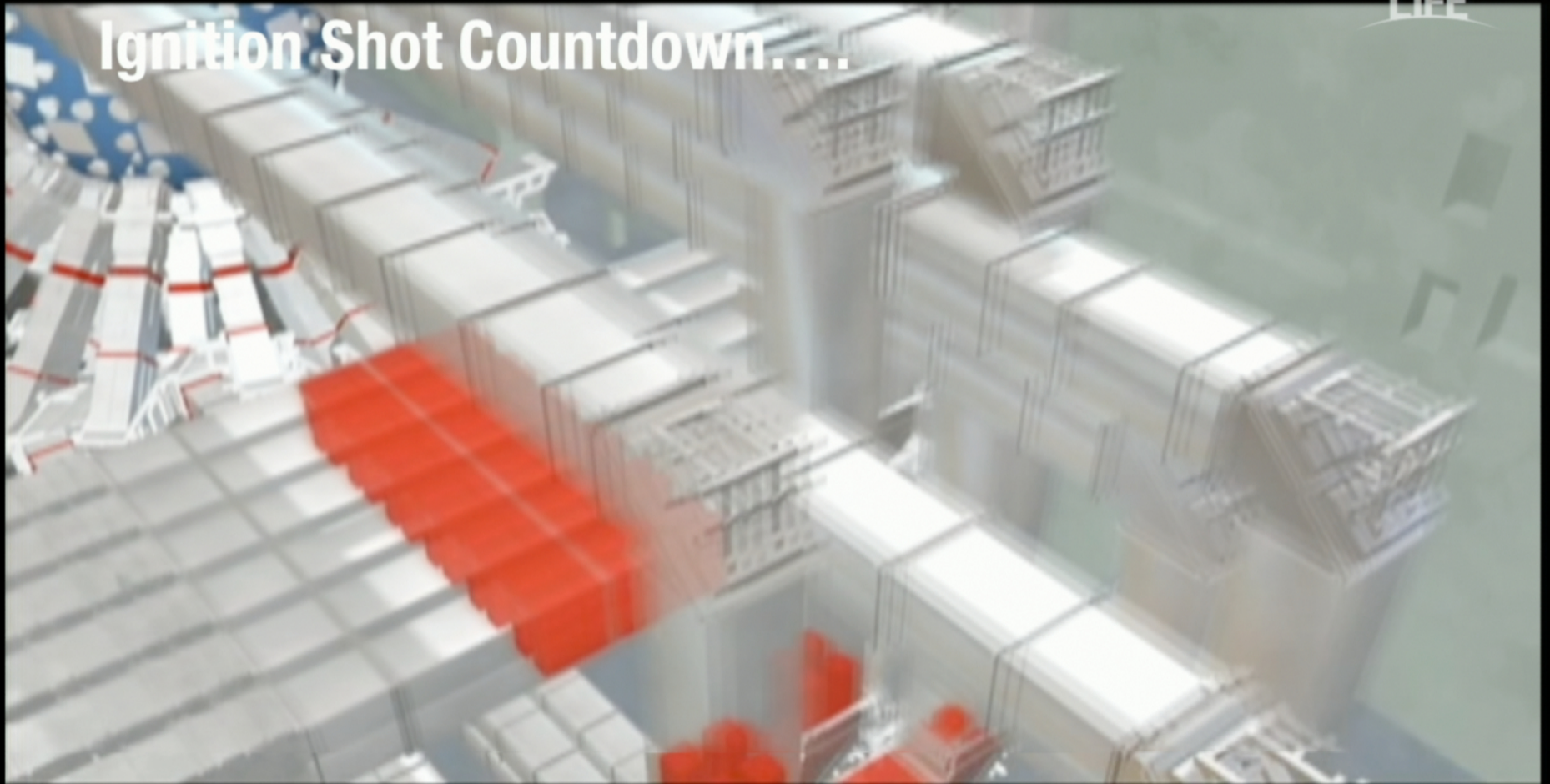
Ignition Shot Countdown....



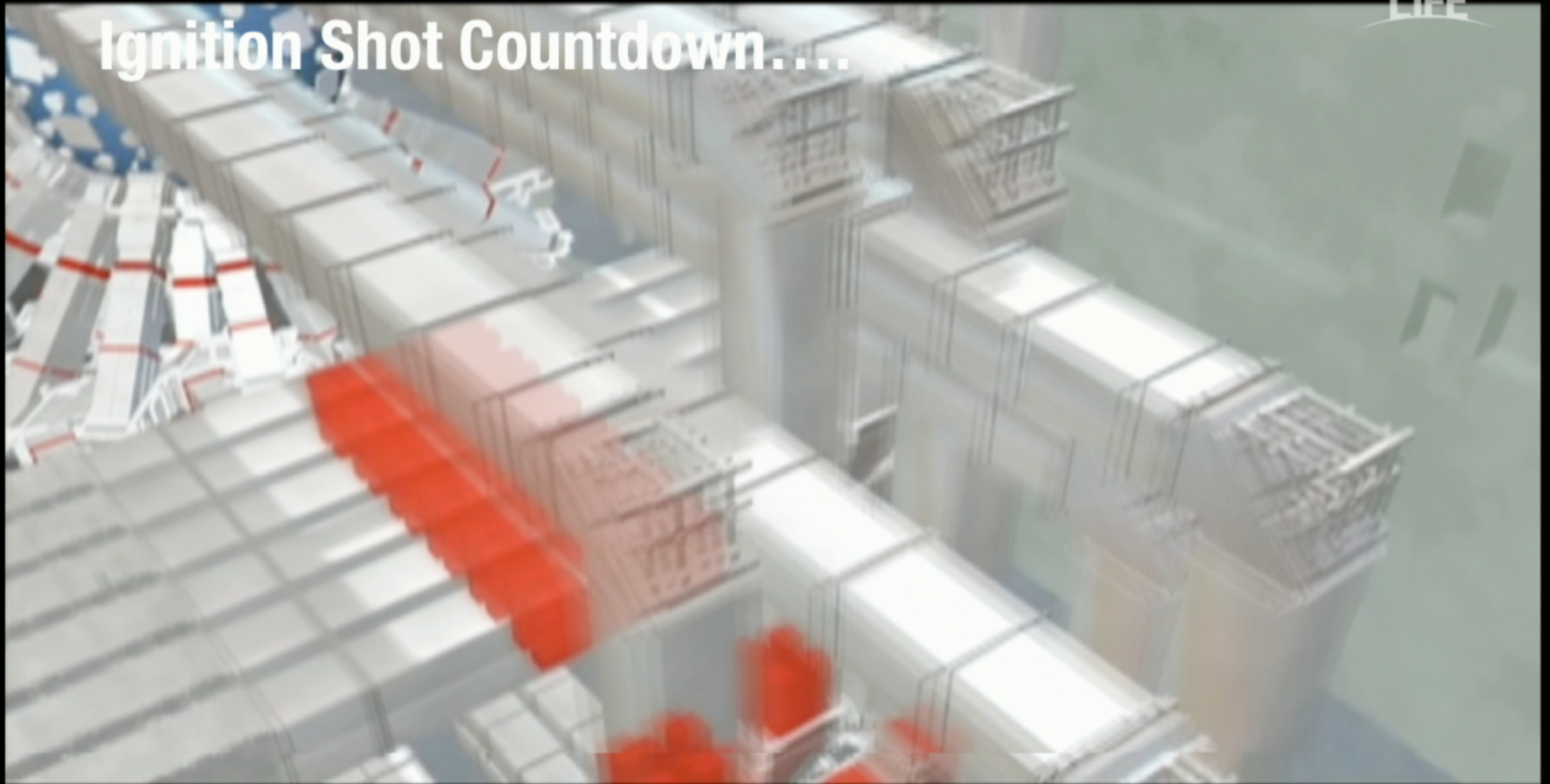
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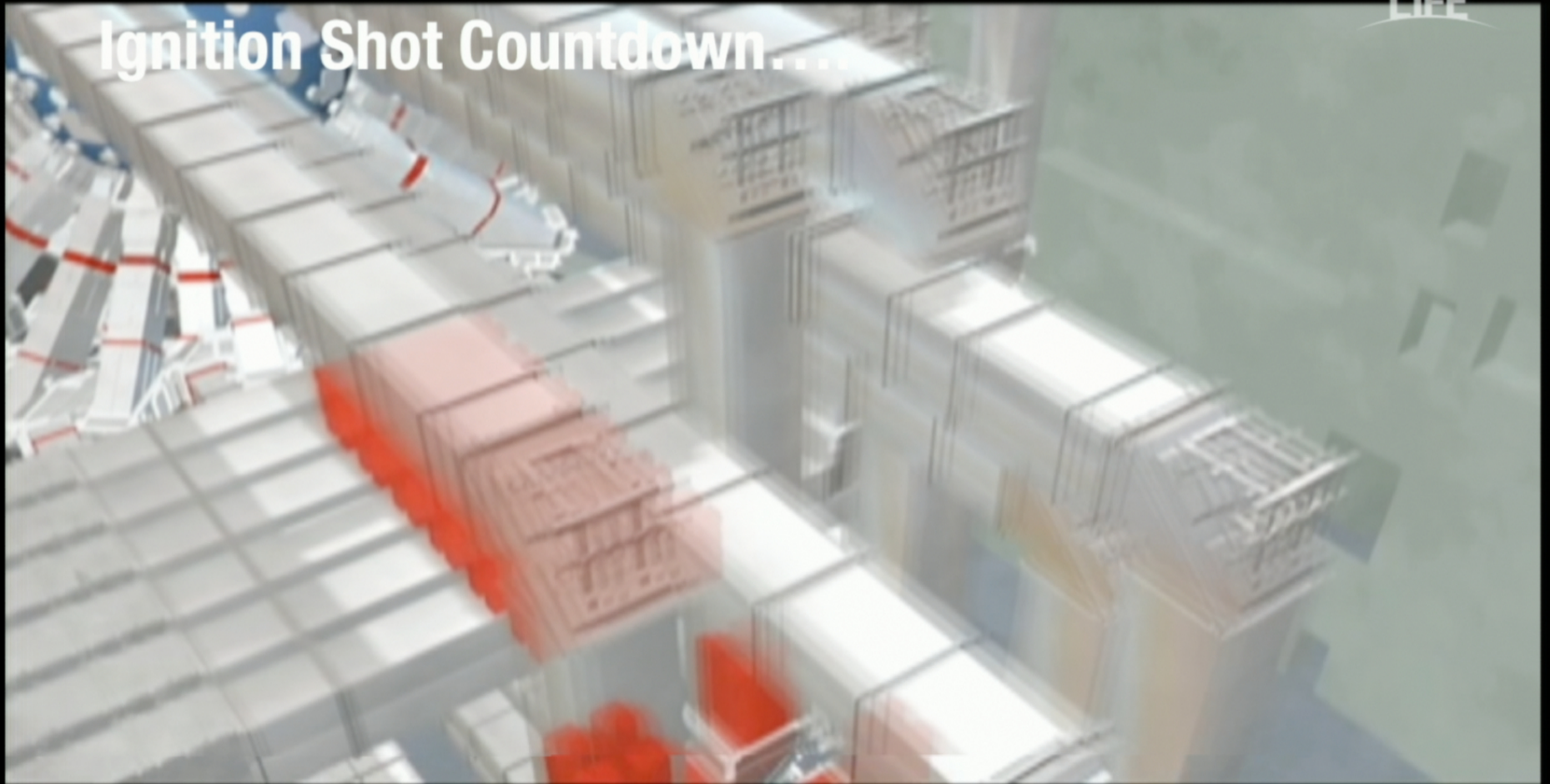
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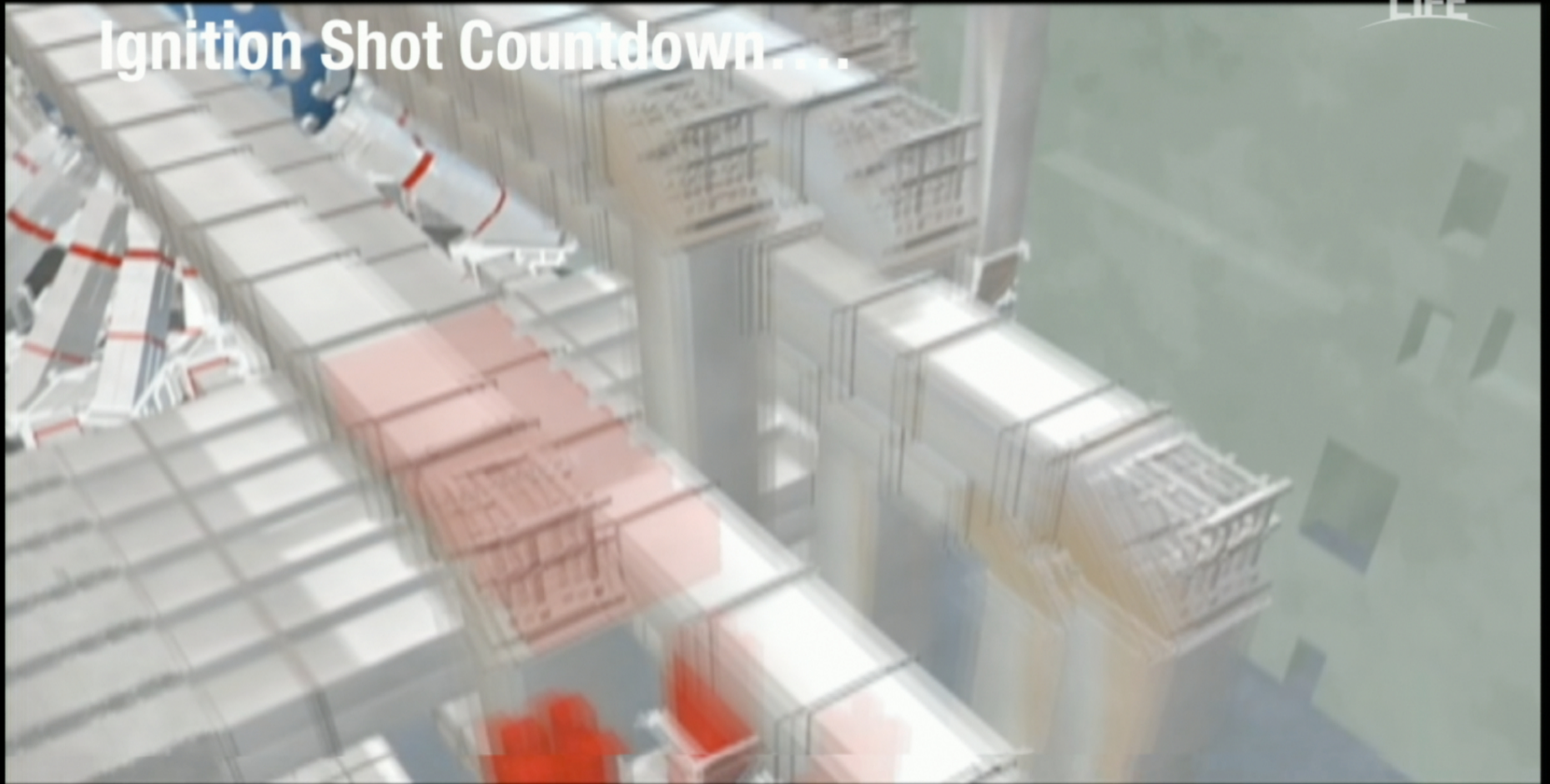
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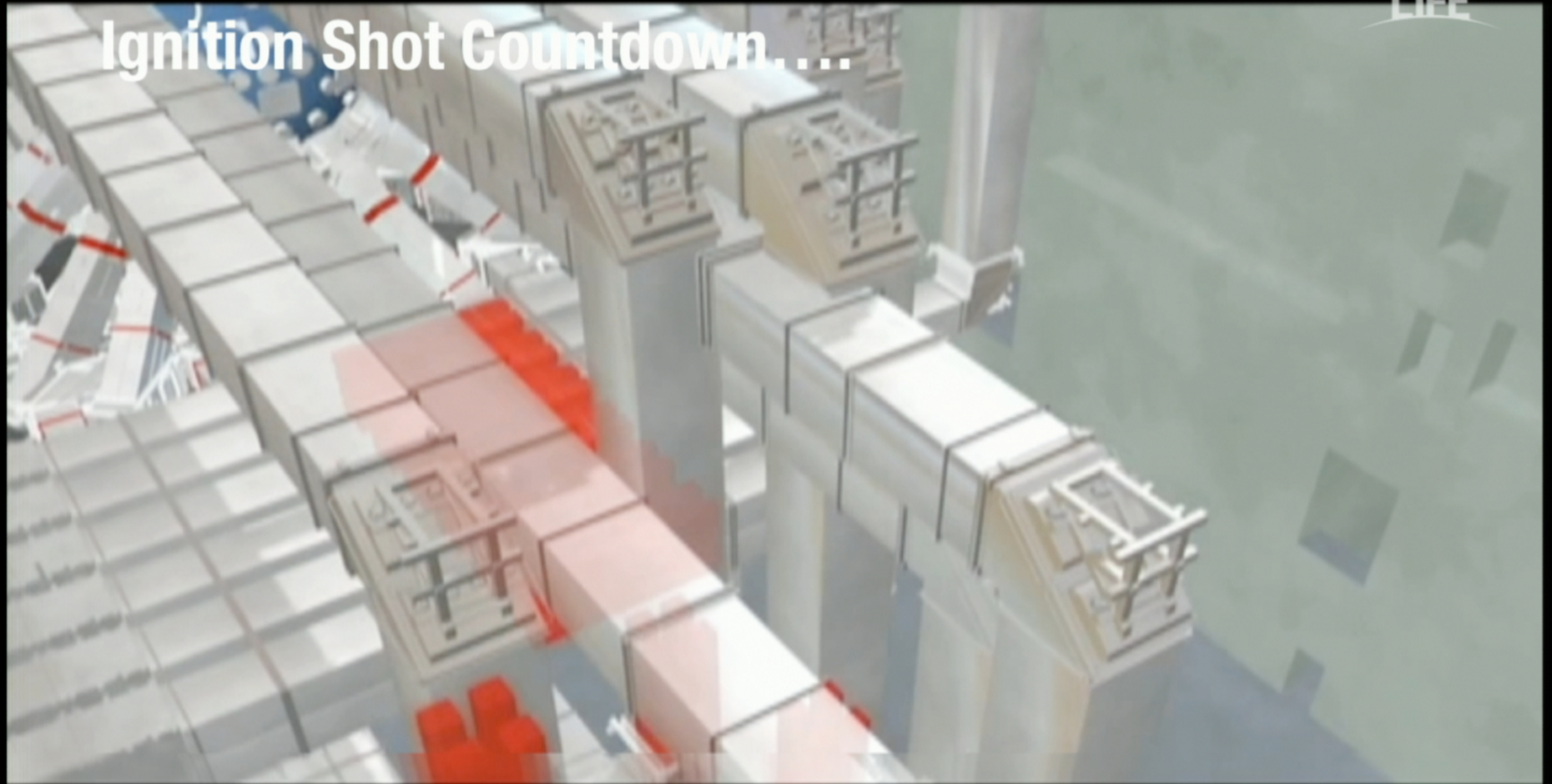
Ignition Shot Countdown...



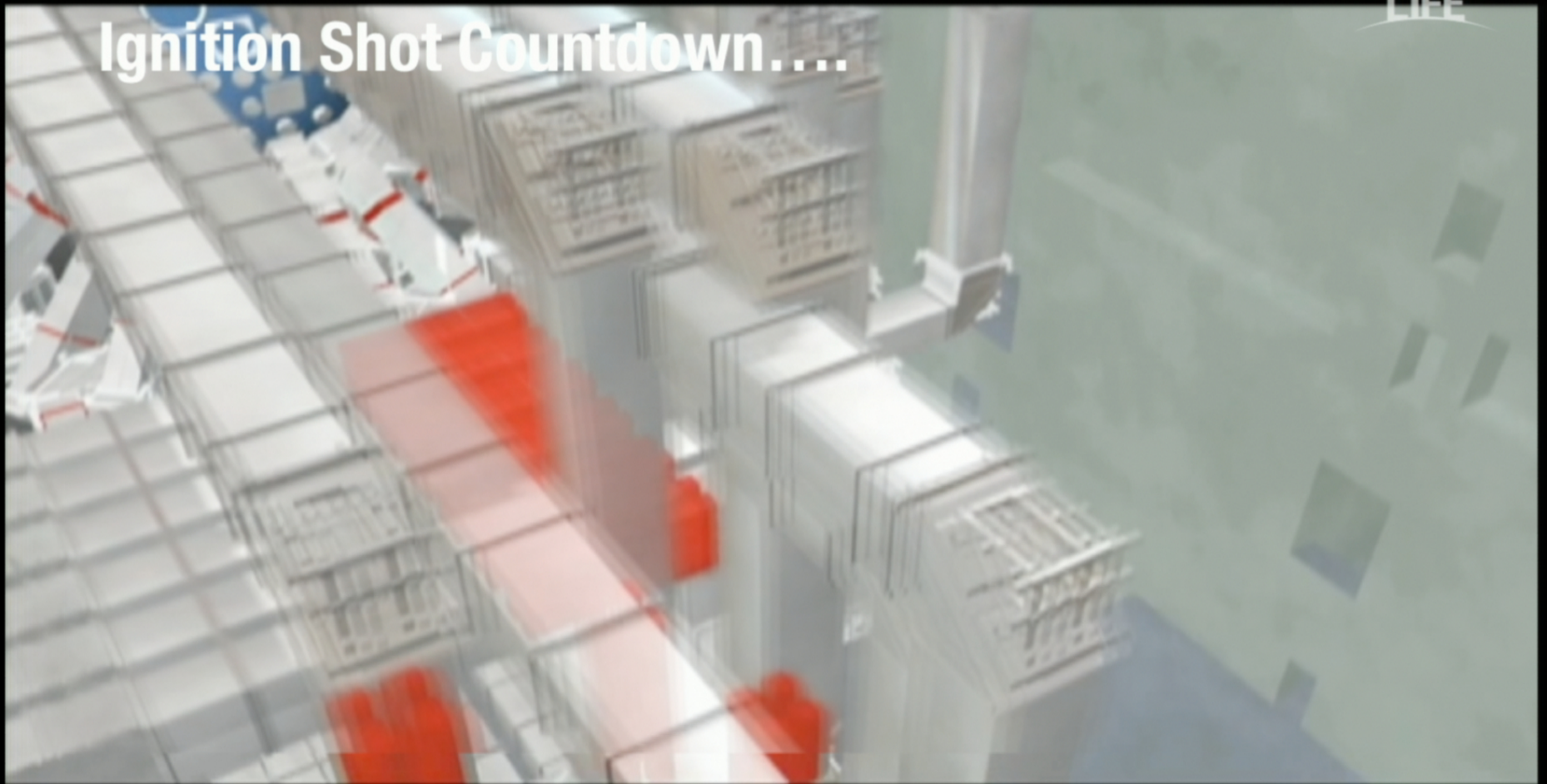
Ignition Shot Countdown...



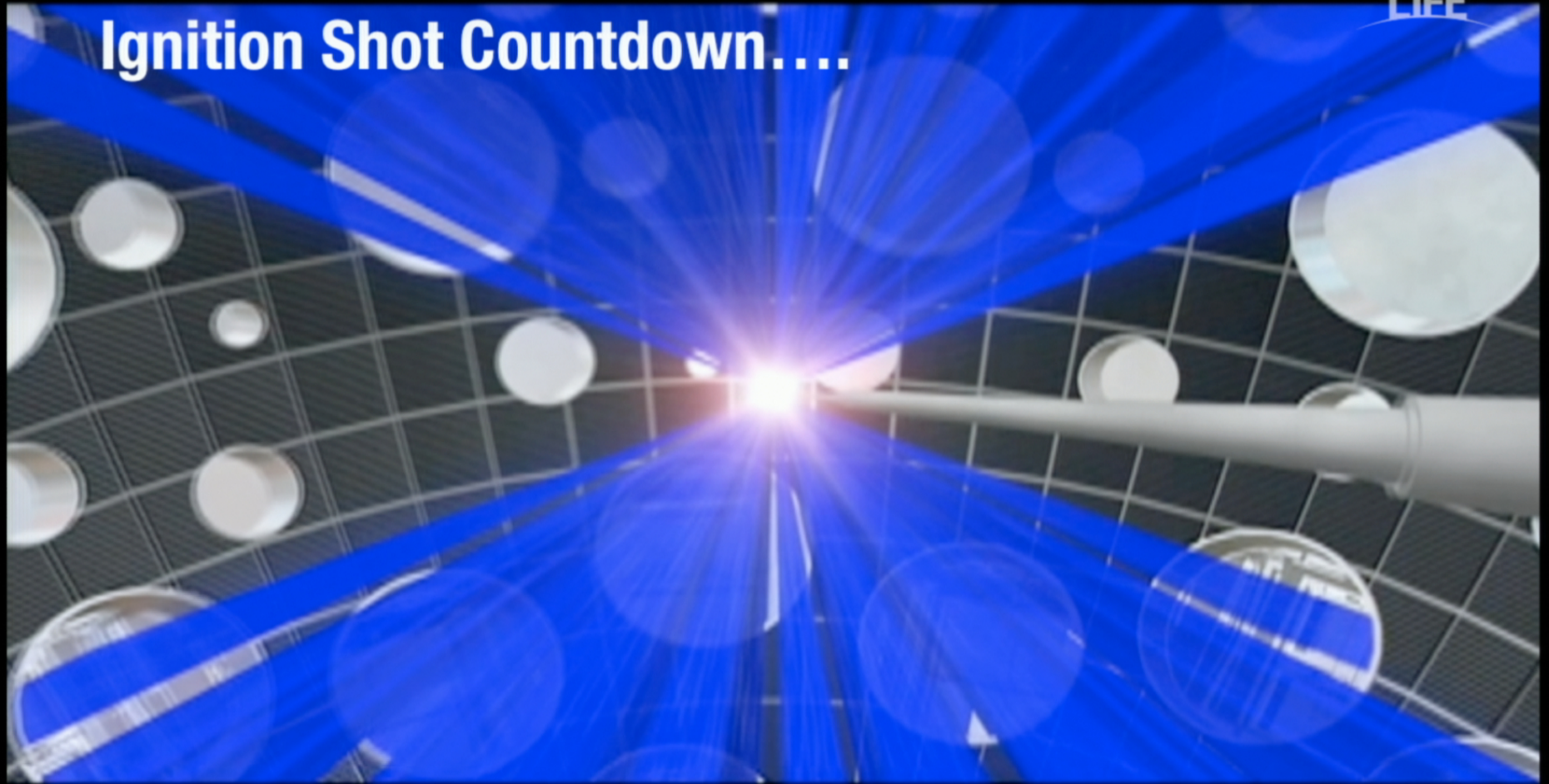
Ignition Shot Countdown....



Ignition Shot Countdown....



Ignition Shot Countdown....



Ignition Shot Countdown....



Ignition Shot Countdown....



Ignition Shot Countdown....

LIFE




Ignition Shot Countdown....

0 billionths of a second



Ignition Shot Countdown....

 billionths
of a second



Ignition Shot Countdown....

8 billionths
of a second



Ignition Shot Countdown....

X-rays

||| billionths
of a second



Ignition Shot Countdown....

19 billionths
of a second

Burn



Ignition Shot Countdown...

LIFE



The real ground breaking

LIFE

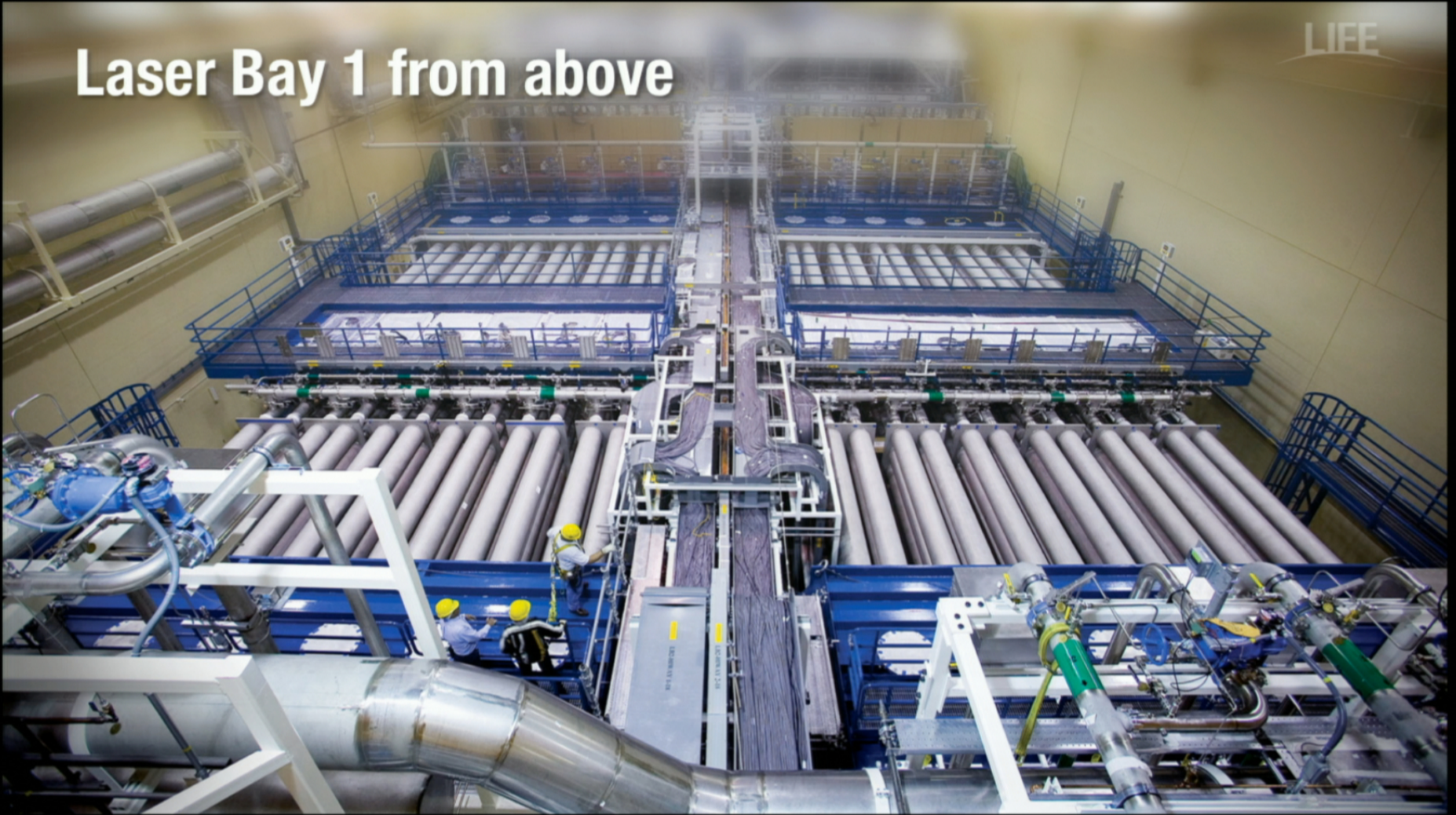


Laser Bay 1 Lasers



Laser Bay 1 from above

LIFE





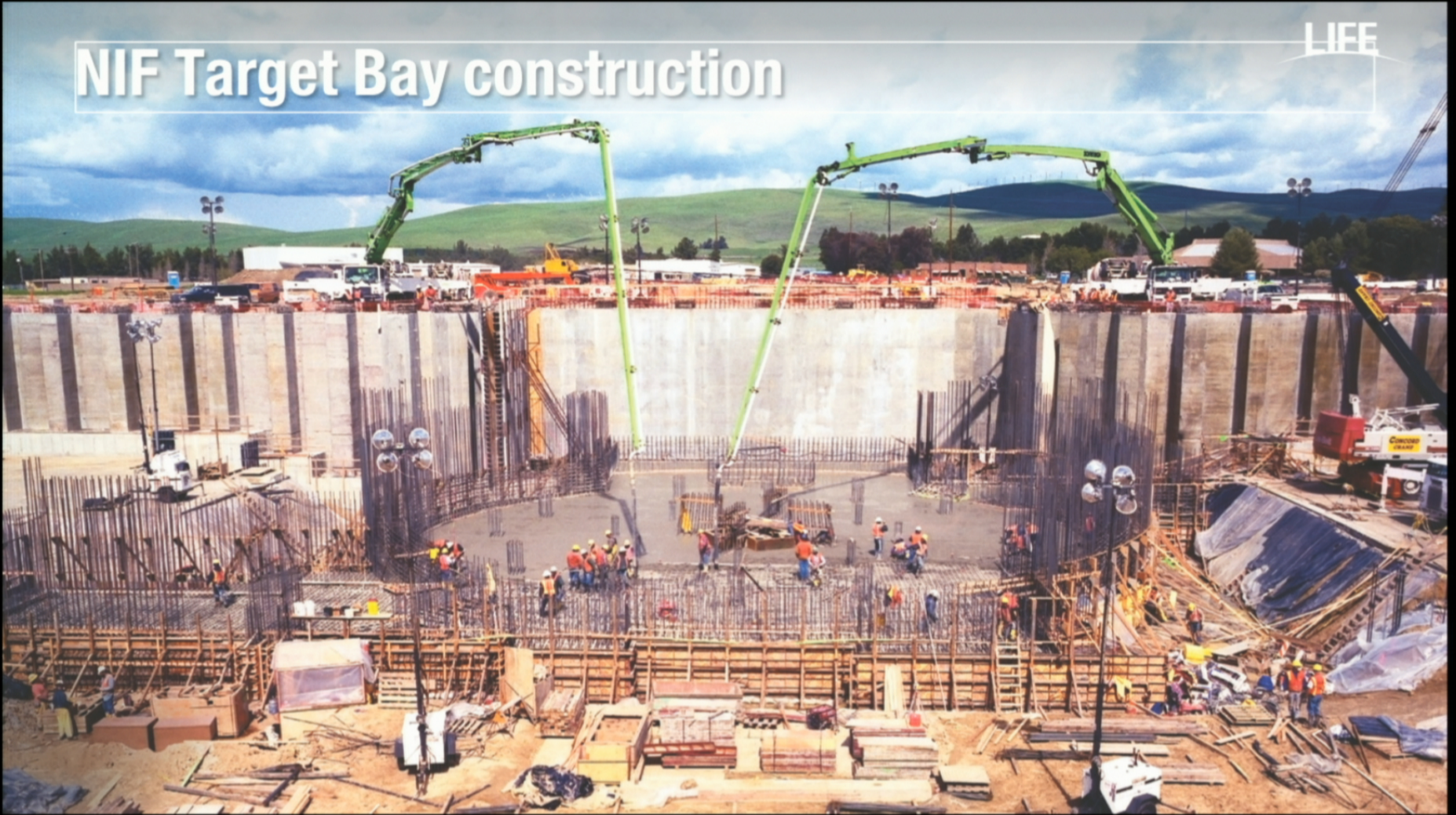


NIF laser glass



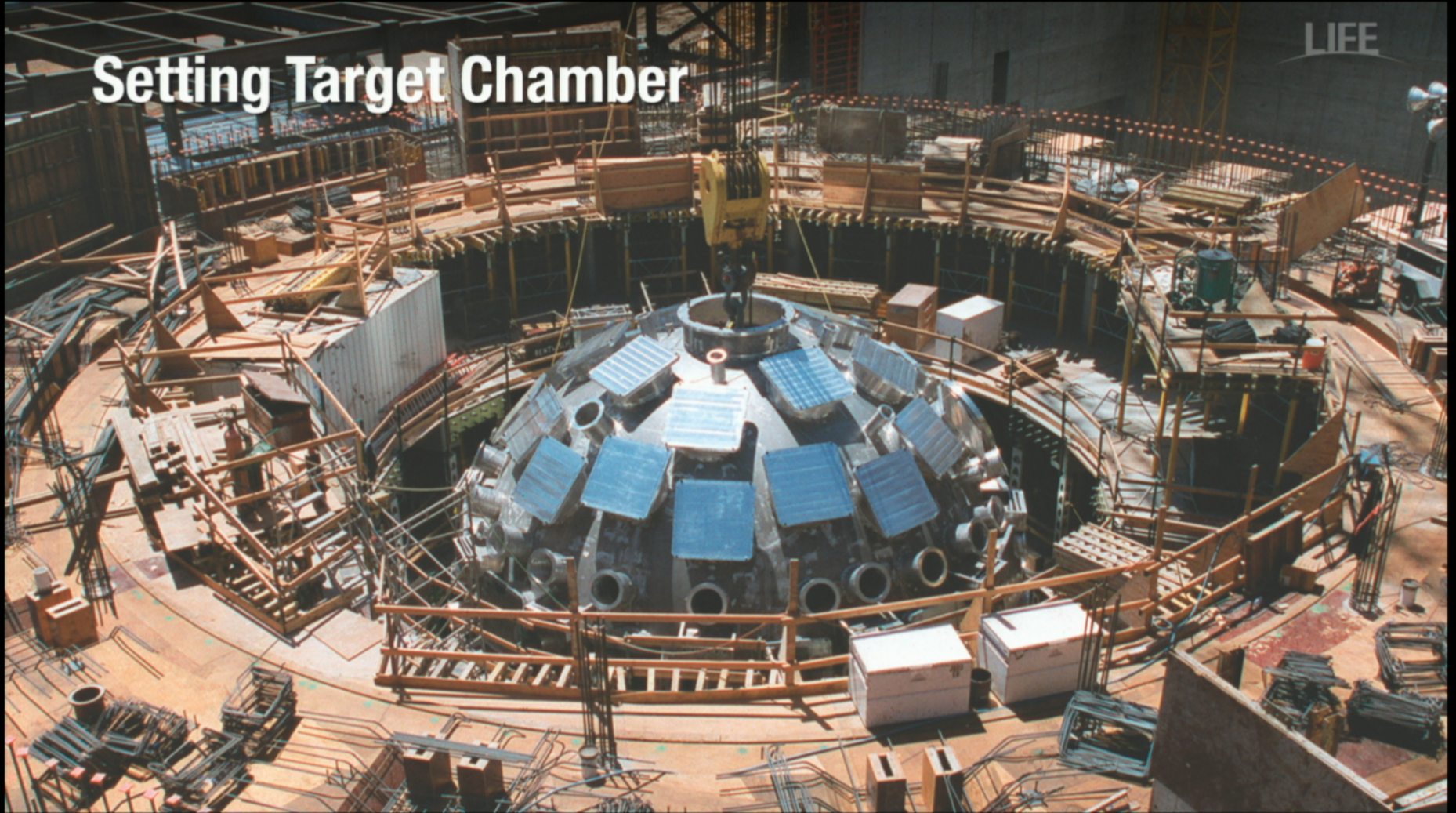
NIF Target Bay construction

LIFE

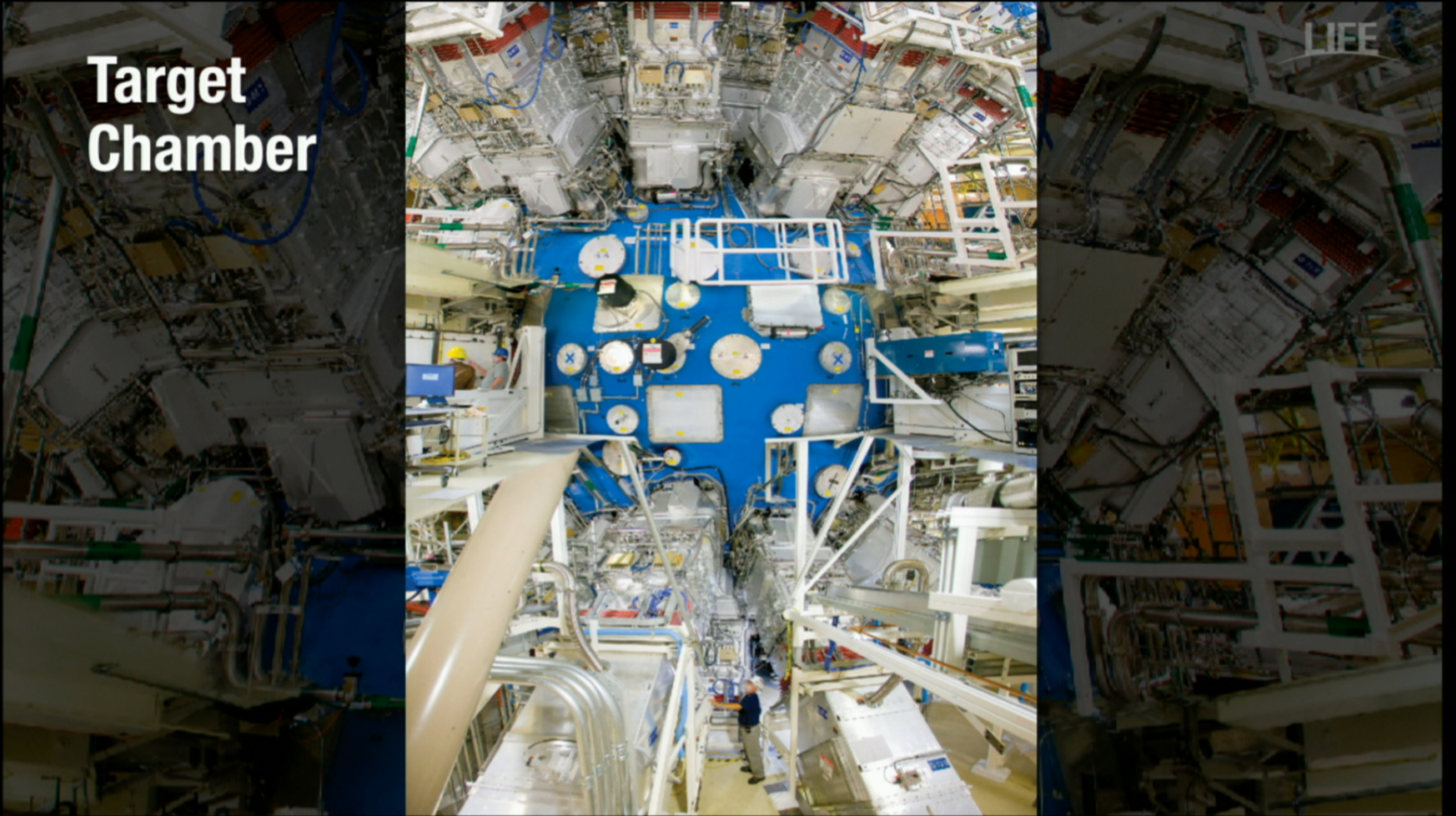


Setting Target Chamber

LIFE



Target Chamber





Target Chamber inspection

LIFE



Operational Target Chamber

LIFE



Operational Target Chamber

LIFE

This is "HERE" for NIF!



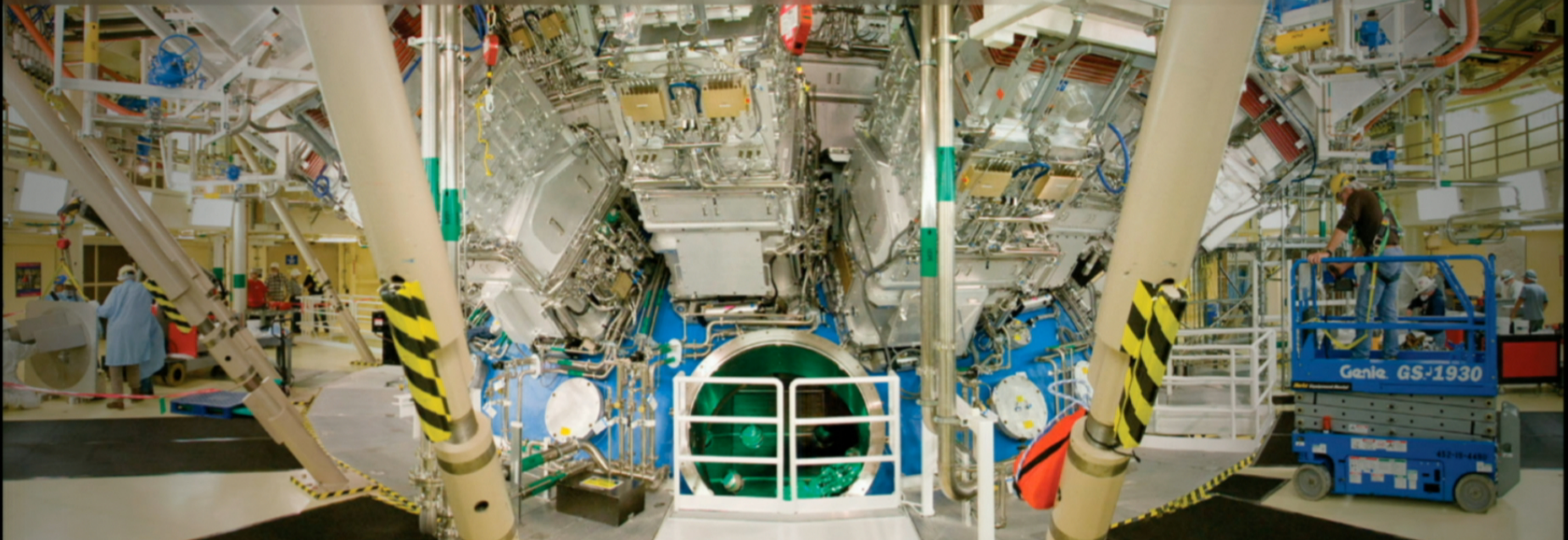






LIFE

The NIF is operating above specifications



July 5, 2012 1.855 MJ 523 TW

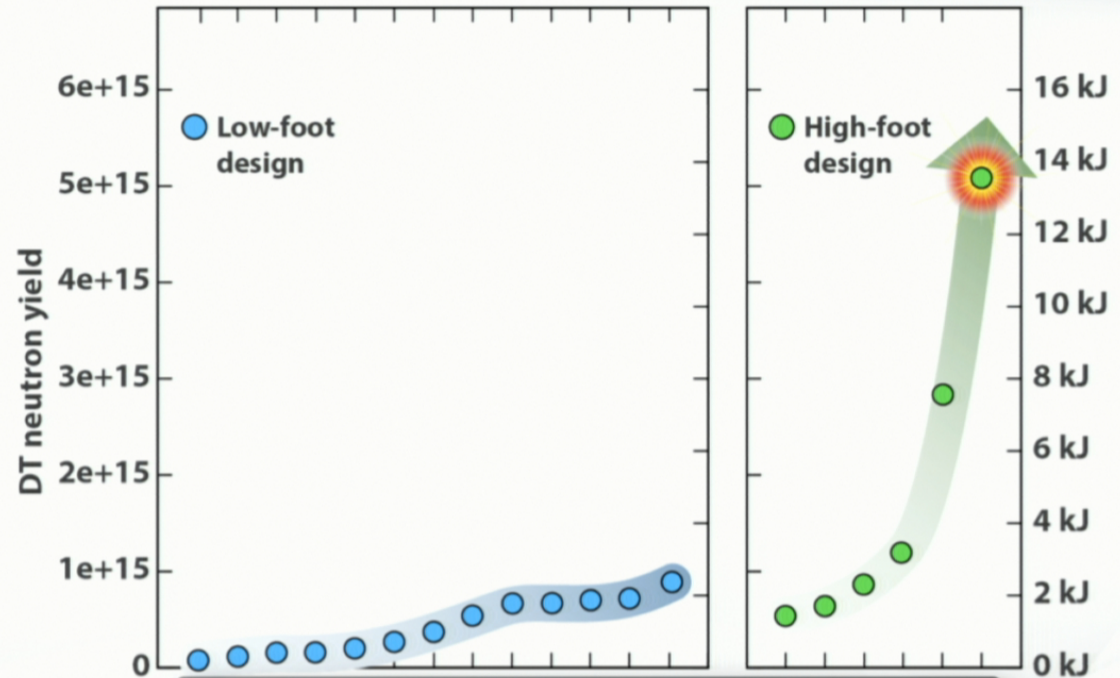
Cluster 4

Cluster 3

Cluster 2

Cluster 1

Yields have increased 100 times since the inception of the National Ignition Campaign



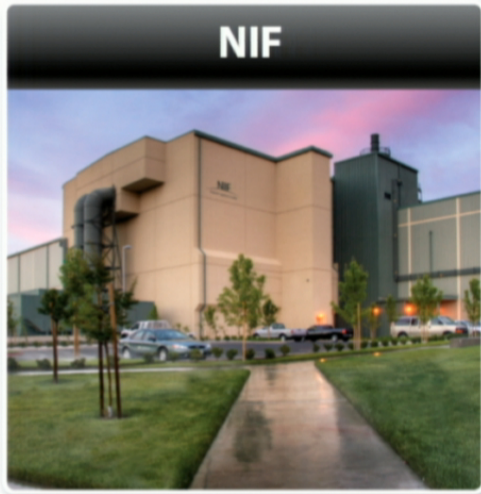
We are on the verge of alpha heating and burn



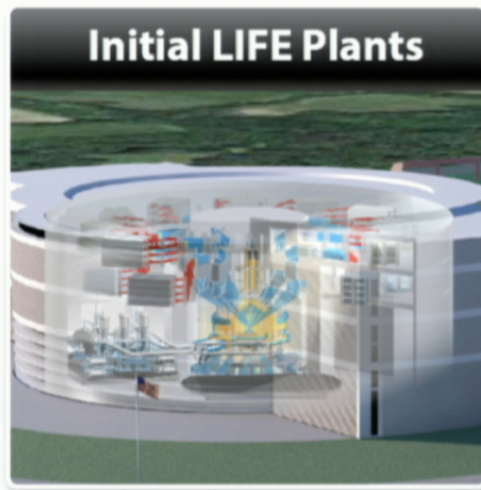
National Academies' study into Inertial Fusion Energy (IFE)

- *“Compelling rationale for establishing inertial fusion energy R&D as part of the long-term U.S. energy R&D portfolio”*
- External reviews were unanimous in concluding that ignition was achievable on the NIF
- *“Planning should begin for making effective use of the NIF as one of the major program elements in an assessment of the feasibility of IFE”*

Fusion energy soon enough to make a difference



Performance

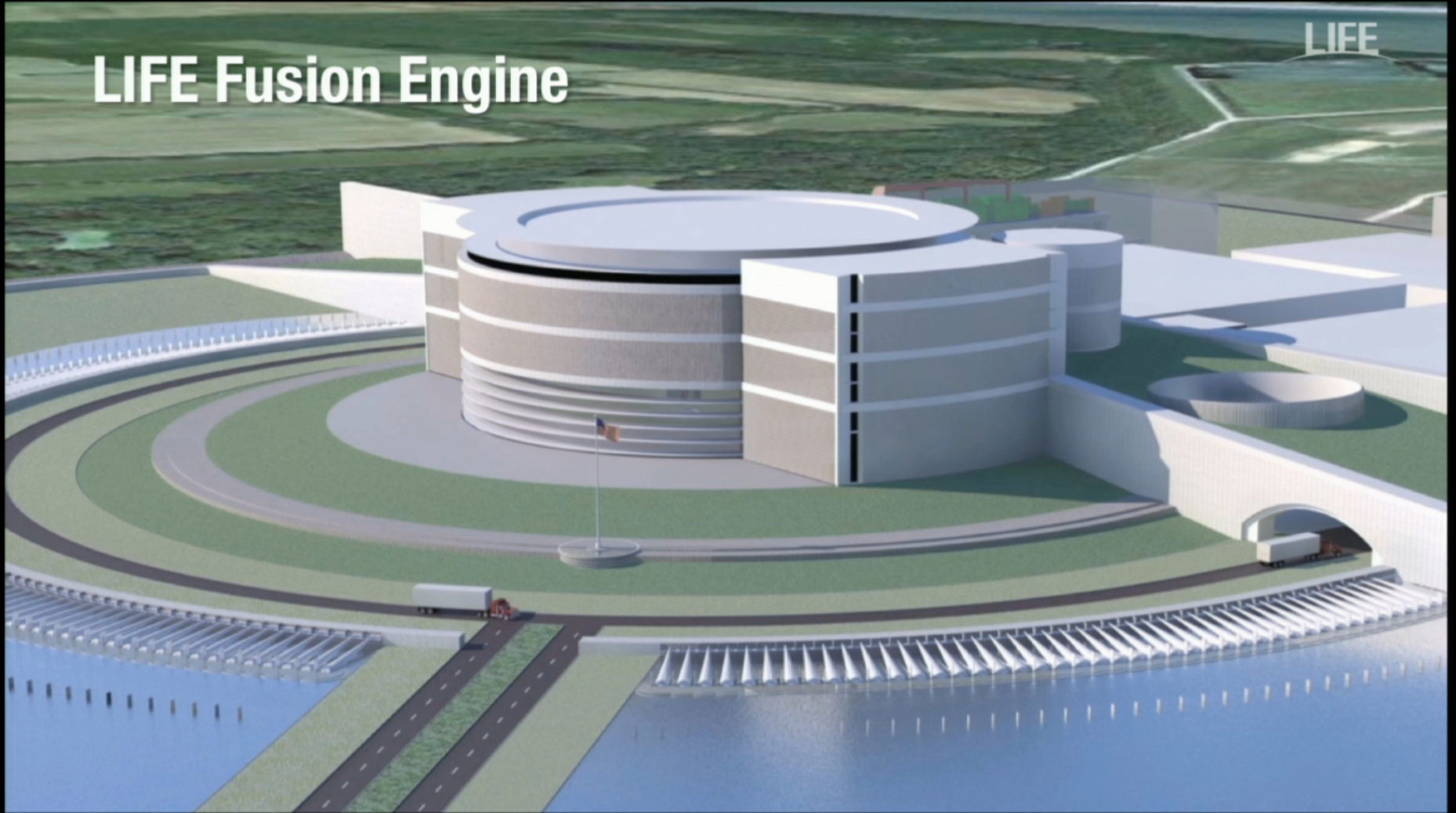


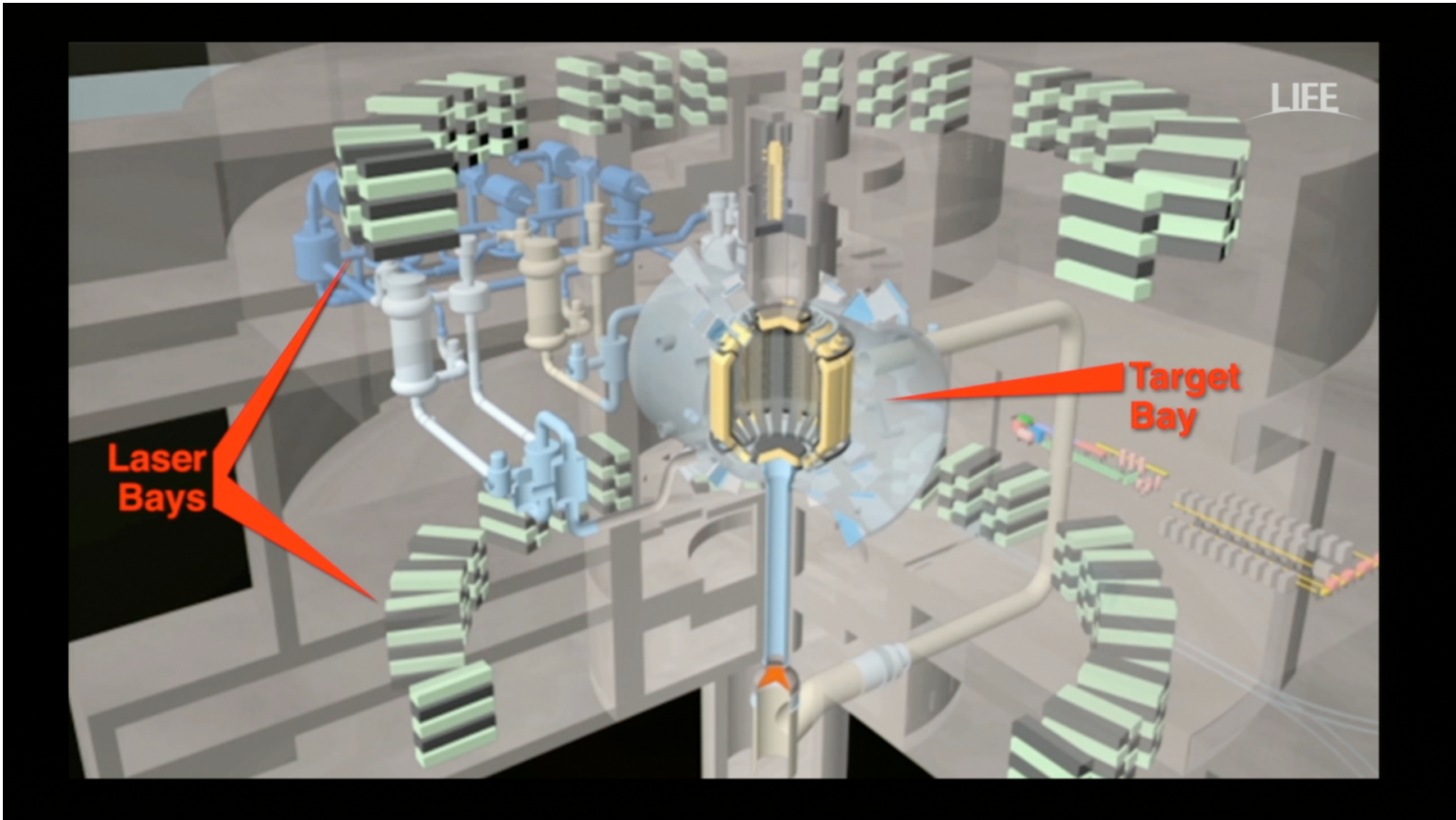
Integration

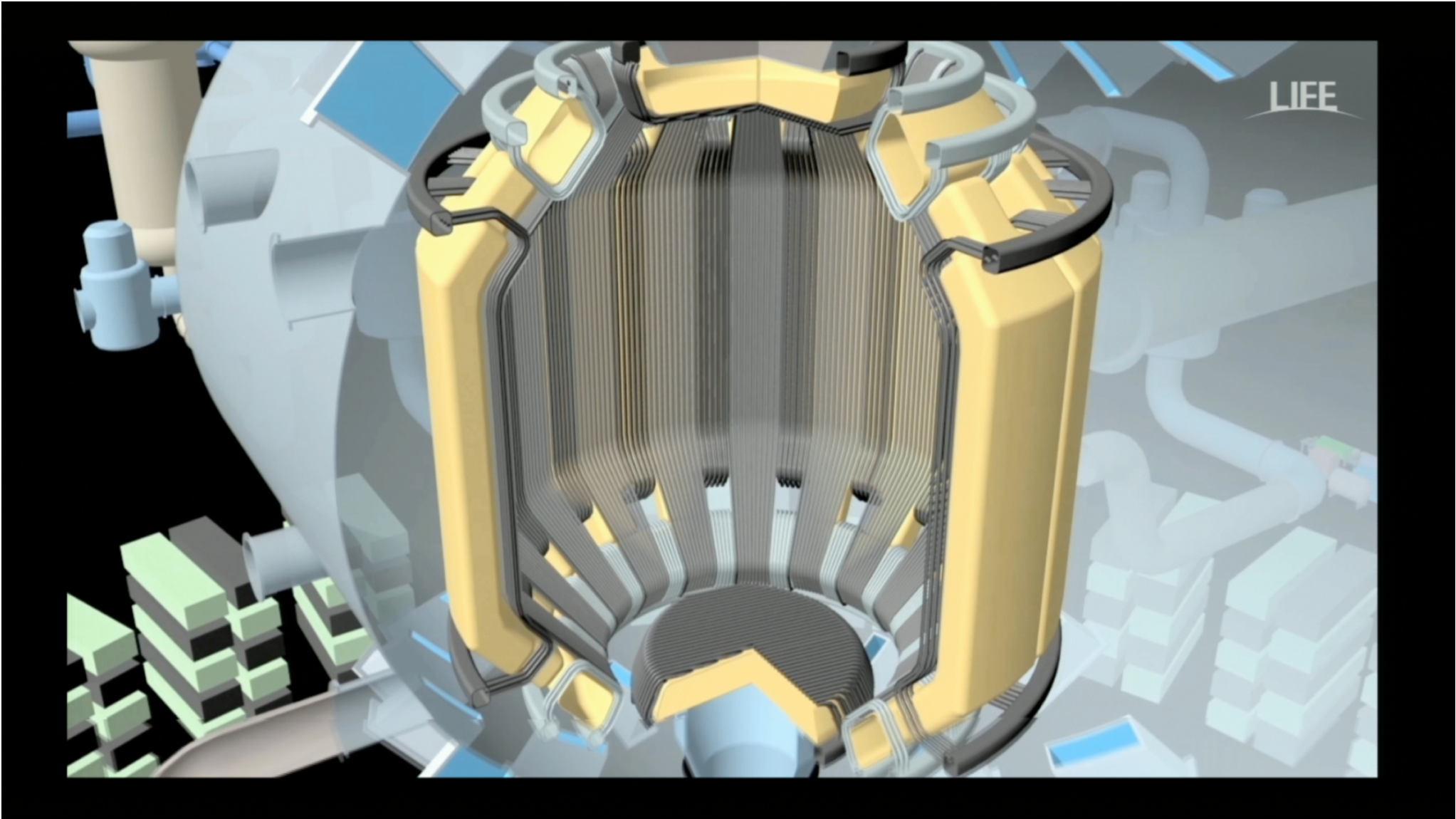


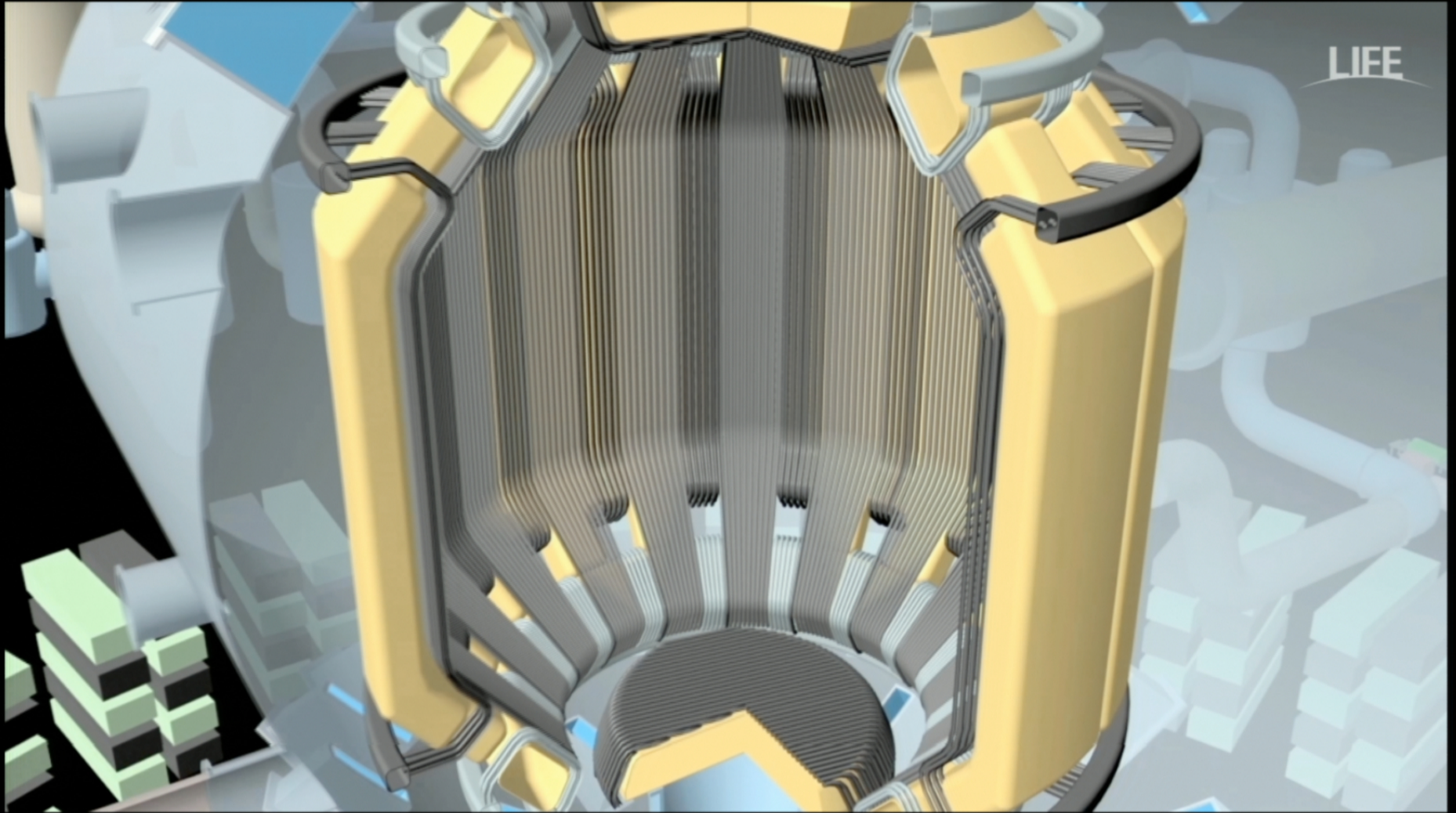
LIFE Fusion Engine

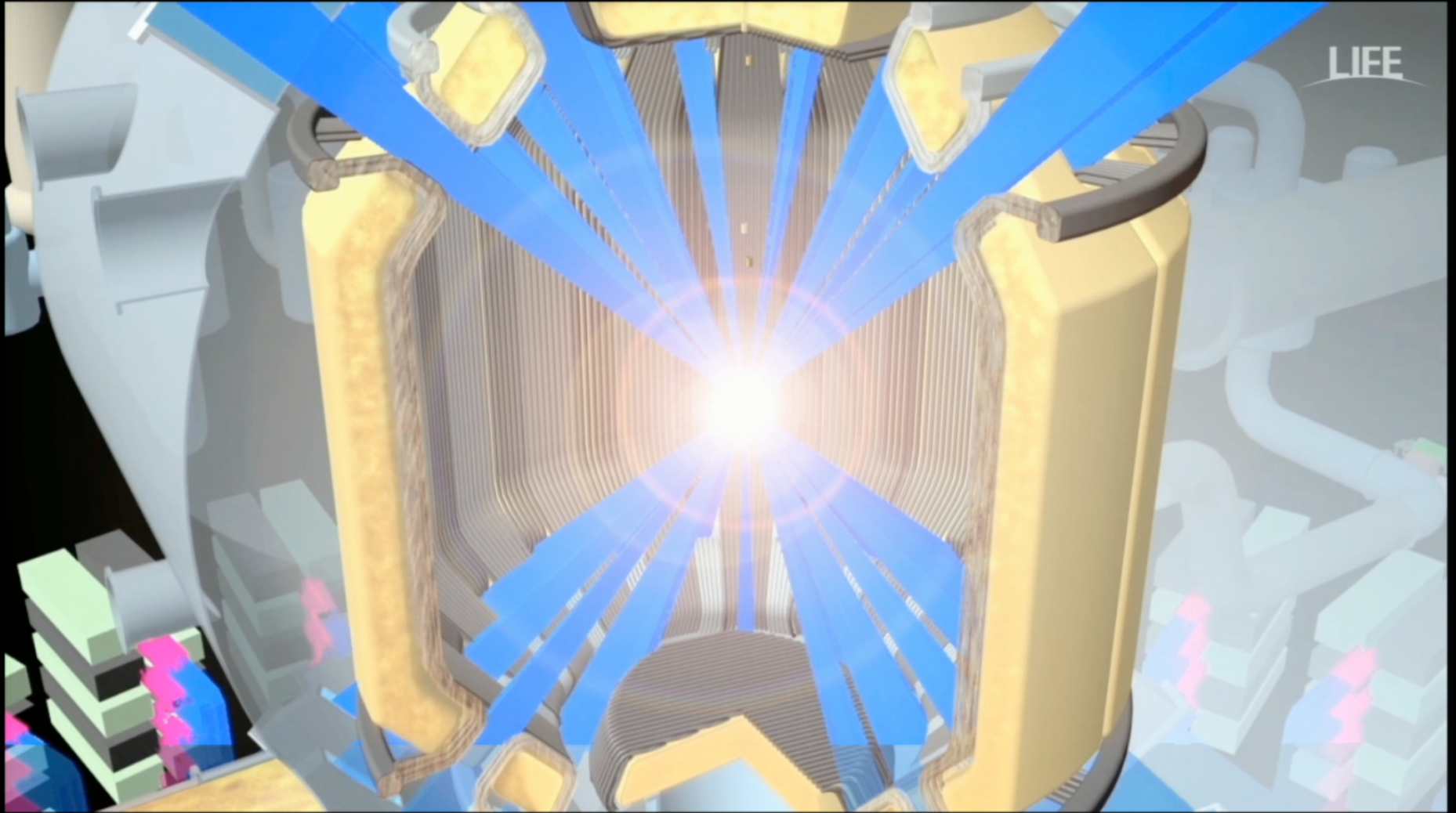
LIFE



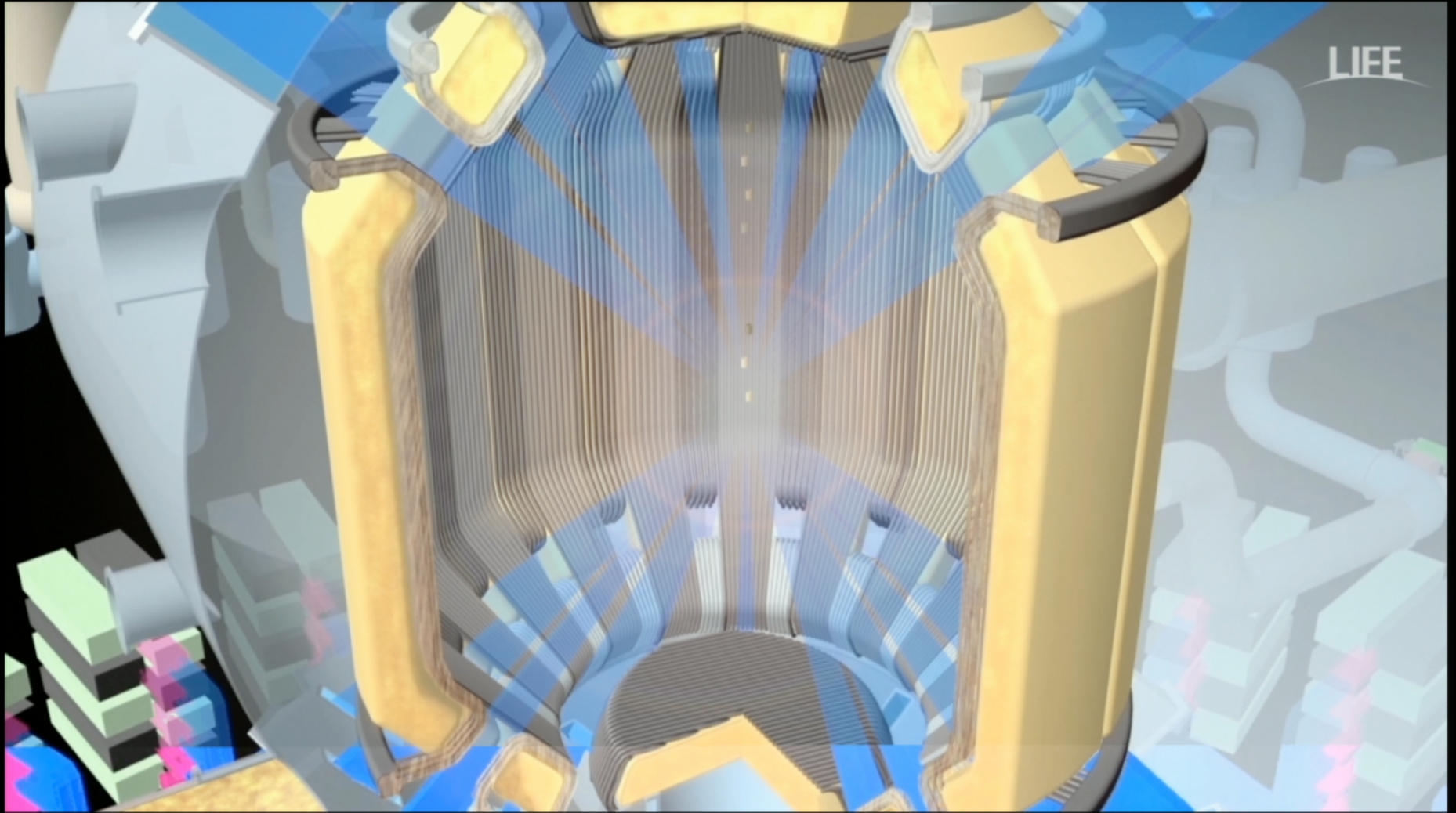


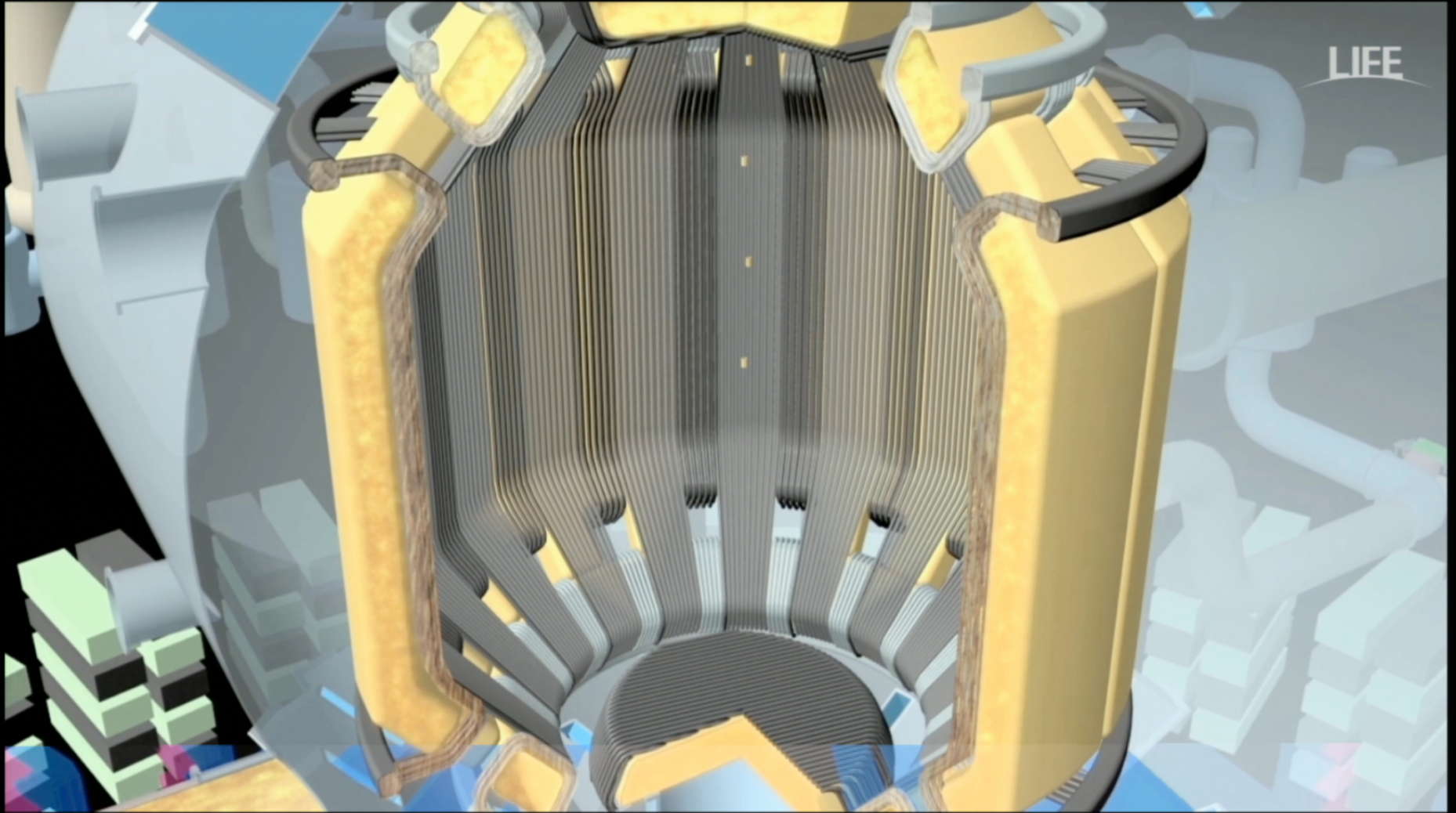


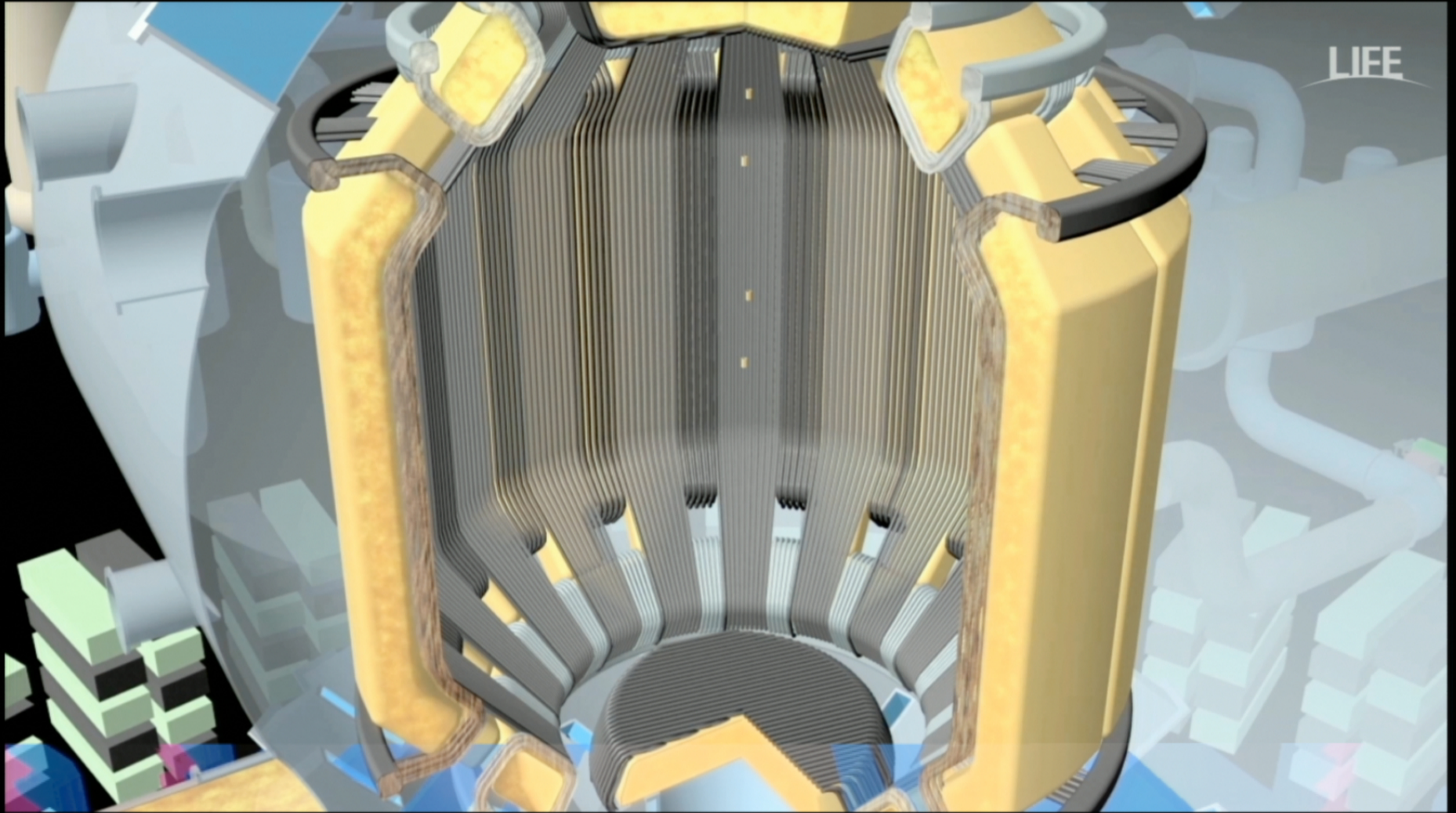












LIFE: An integrated approach to plant design

- 
- Based directly on NIF performance
 - Maximized use of available materials and technologies
 - Systems engineering approach
 - Modular, factory built design for high plant availability
 - Attractive safety bases enabling simplified licensing

LIFE offers an extremely attractive solution



Applications for LIFE

Clean electricity



Desalination



Hydrogen fuel



Process heat



Applications for LIFE

Clean electricity



Desalination



Hydrogen fuel



Process heat



A photograph of a sunset over the ocean. The sun is low on the horizon, creating a bright reflection on the water. The sky is filled with soft, white clouds. In the top right corner, the word "LIFE" is written in a white, sans-serif font.

LIFE

Tomorrow we live on LIFE

A wide-angle photograph of a sunset over a calm, deep blue ocean. The sun is positioned in the upper center, partially obscured by light, wispy clouds. A bright, shimmering path of light reflects off the water's surface, extending from the horizon towards the viewer. The sky transitions from a pale yellow near the sun to a clear, light blue at the top. In the top right corner, the word "LIFE" is written in a white, sans-serif font, with a thin white arc underneath it.

LIFE

Tomorrow we live on LIFE

PERIMETER



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