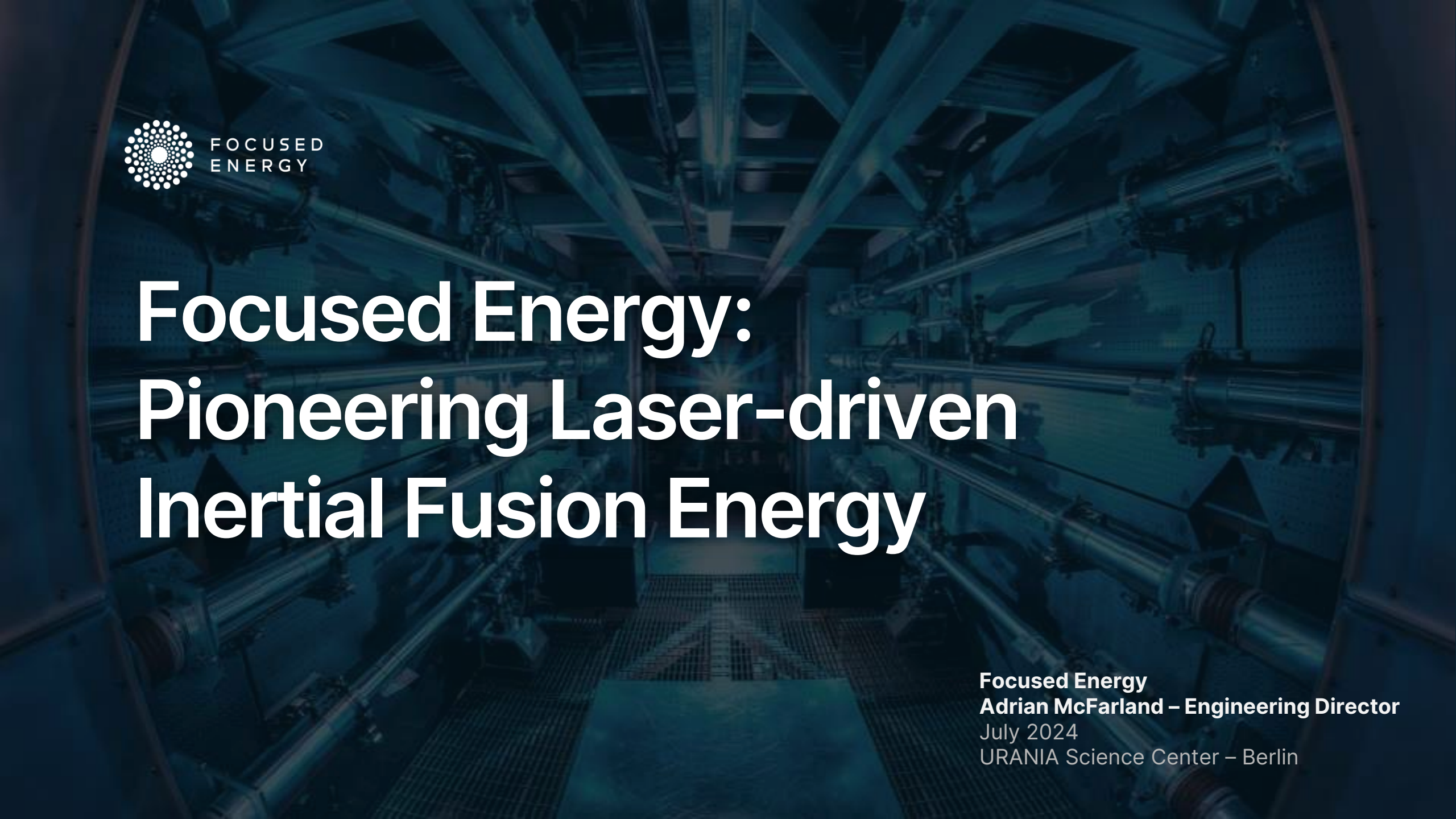

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# Focused Energy: Pioneering Laser-driven Inertial Fusion Energy

**Focused Energy**
**Adrian McFarland – Engineering Director**
July 2024
URANIA Science Center – Berlin

# Focused Energy – Company Profile

**July 2021**
Focused Energy Foundation

**German GmbH** and **U.S. Inc.** company

offices in North California and Darmstadt, Germany

**>70** employees

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# Laser-driven inertial fusion

## Our path to commercial fusion power

### Proven approach

→ Demonstrated ignition science with established core laser driver technology.

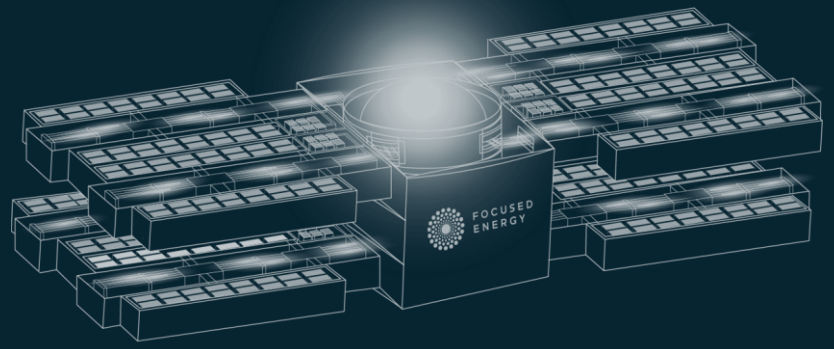
### Modular & reliable

→ Scalable, repairable, and dependable.
→ A component-driven system that is easy to service compared to fully integrated approaches.
→ Cost-effective: no downtime or less maintenance costs.

### Commercial today

→ Modular laser technology and top-tier particle physics expertise enable current commercial opportunities.
→ Establishing manufacturing capabilities to reduce costs ahead of anticipated fusion demand.

### Laser-driven IFE power plant




**Fully modular**, manufacturable, replaceable lasers with external **commercial applications today**.

# Key Technologies in Laser Fusion

## High-Power Lasers

→ High-intensity lasers that deliver precise and powerful energy pulses to initiate fusion.

## Target injection and Tracking

→ AI-driven tracking systems that ensure precise alignment and positioning of injected targets.

## Precision target Design

→ Advanced techniques for high-quality fusion targets with enhanced performance.

## Target mass manufacturing

→ Advanced techniques for mass manufacturing  high-quality DT-fusion targets.

## Diagnostics and Control Systems

→ Sophisticated monitoring and control systems to optimize fusion reactions and ensure machine, personnel and environmental safety.

## Reactor Chamber

→ Advanced design to withstand harsh environment conditions and longevity while housing and facilitating the fusion reactions.

## Tritium Breeding

→ Techniques for breeding tritium from the reactor to ensure a sustainable and continuous fuel cycle.

## Advanced Materials

→Development of materials that can withstand extreme temperatures, radiation and neutron flux in fusion reactors

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# Our Innovations in Laser Fusion

## Precision Target Design

→ Advanced techniques for producing high-quality fusion targets with enhanced performance.

## Integrated Target Tracking

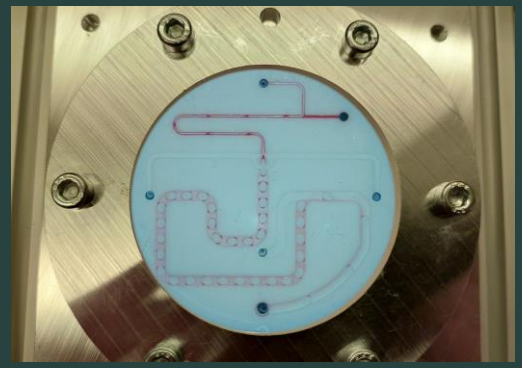
→ AI-driven tracking systems that ensure precise alignment and positioning of targets.

## Laser Stability

→ Innovative methods for enhancing laser stability, ensuring consistent and precise energy delivery and tracking.

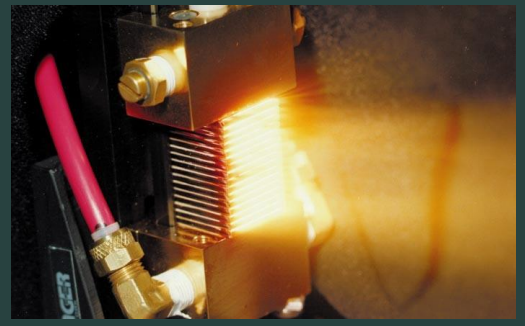
## Target Mass Production

→ Advanced techniques for producing high-quality fusion targets with enhanced performance.



## Laser Efficiency

→ Breakthroughs in laser efficiency using Diode Pumped Solid State Lasers.



## Automated Target Injection

→ Cutting-edge systems for rapid and accurate target delivery into the fusion chamber.

## Integrated Control Systems

→ Advanced AI-driven control systems that provide real-time adjustments to maintain optimal fusion conditions.

## Material Innovation

→ Next-generation materials designed for higher durability and thermal resistance and stress to reduce maintenance.

## Tritium Breeding Optimization

→ Innovative approaches to maximize tritium production and recycling within the reactor.

# Collaboration drives innovation

## National Labs

- ✓ GSI - Helmholtz
- ✓ Lawrence Livermore National Lab (LLNL)
- ✓ Los Alamos National Lab (LANL)
- ✓ Princeton Plasma Physics Lab (PPPL)
- ✓ Laboratory for Laser Energetics (LLE)
- ✓ Fraunhofer ILT
- ✓ Fraunhofer Institute for Optics and Finemechanics (IOF)
- ✓ Laser Zentrum Hannover (LZH)
- ✓ ...

## Universities

- ✓ Technische Universität Darmstadt (TUDa)
- ✓ University of Michigan
- ✓ Imperial College – IC Consultants
- ✓ University of California San Diego
- ✓ ...

## Industry Partners

- ✓ Schott North America, Inc.
- ✓ Extreme Light Infrastructure (ELI) Beamlines
- ✓ Trumpf Lasers SE
- ✓ Oxford Sigma Ltd.
- ✓ Leonardo Electronics US, Inc.
- ✓ RWE
- ✓ ESS – Bilbao
- ✓ Layertec GmbH
- ✓ LASEROPTIK GmbH
- ✓ Heraeus Quarzglas GmbH & Co. KG
- ✓ Schott AG
- ✓ ...

# Maturity Path development

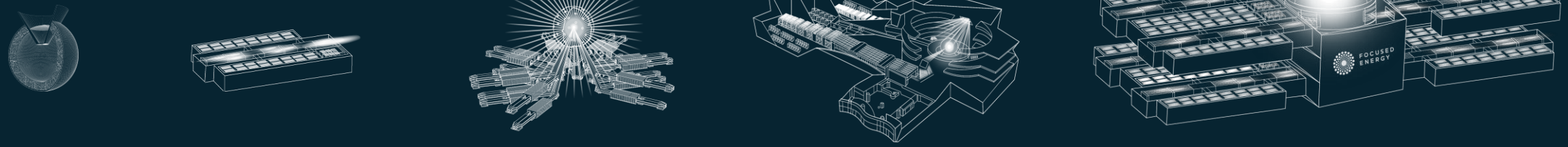
**Target Lab**
Foundational Tech
2022-2032

**SP/LP Beamline**
Foundational Tech
2024-2026

**Sub-Scale Facility**
Integrated Implosion Facility
2026-2030

**Pilot Plant**
Energy and Commercial Validation
2031-2039

**Commercial Laser Fusion Plant**
Fusion Energy to the Grid
2039 onwards




2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039

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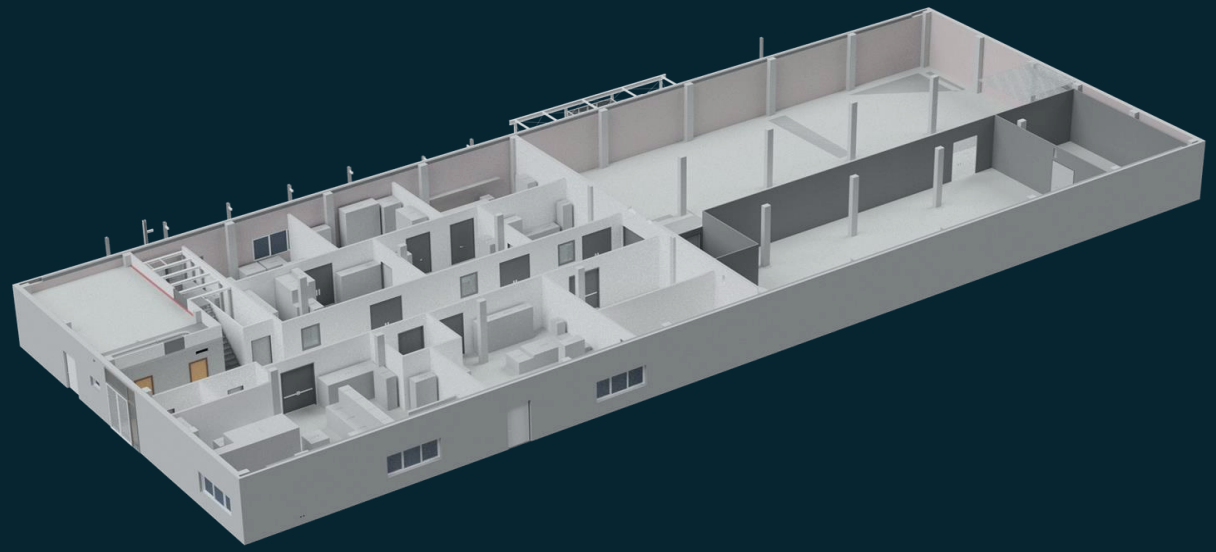
# 2024 -Target Manufacturing

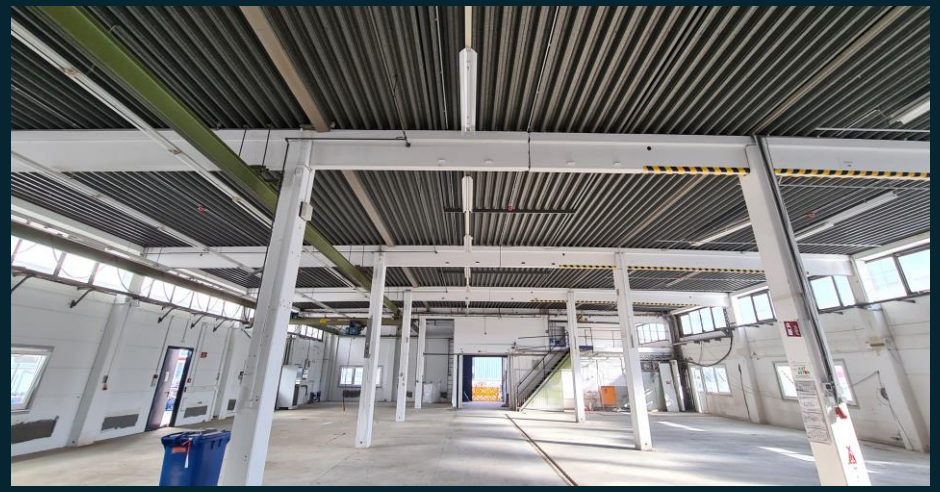
## From Lab to scalable production

**3,500 m²**
in Darmstadt



### Expansion of target production

- ✓ micro-milling
- ✓ laser, coating
- ✓ metrology
- ✓ robots for target injection



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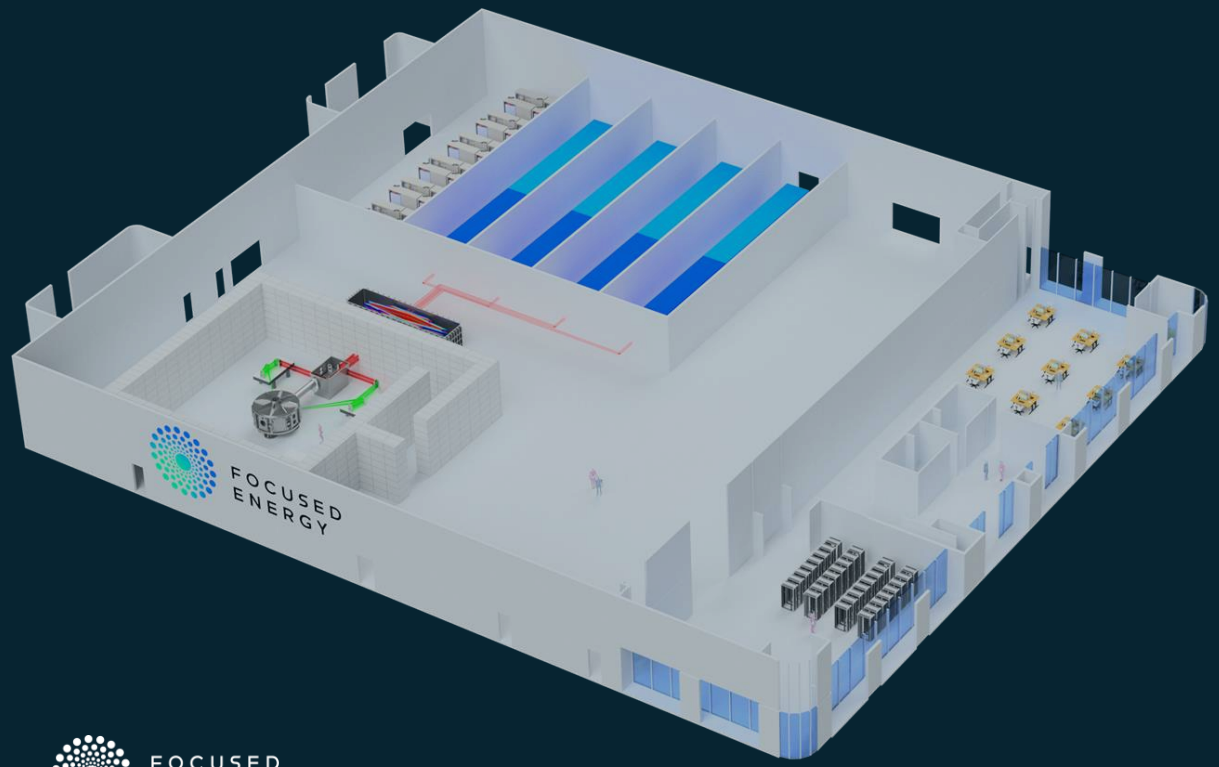
# 2025 -1st Laser Facility

**5000 m²**
in North California

**late 2025**
First systems online




**3 Lasers**
with overall **3 kJ**

→ Up to 14 large (Ø ≥200 mm) and
→ up to 40 small optics
→ 5 gratings

Laser Diagnostics Systems

High voltage Pulsed power

Integrated control systems & Safety systems

Robotic targetry system

Beam Transport

Auxiliary systems

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# 2026 - 2031 - Sub-Scale Facility

**50,000 m²**
area

**32 to 48** Lasers
with overall
up to **50 kJ**

- → approx. 640,000 diodes
- → approx. 224 large (Ø ≥200 mm) and
- → up to 640 small optics
- → approx. 50 gratings

Chamber

- → First wall
- → Blanket

Diagnostics

System Integration

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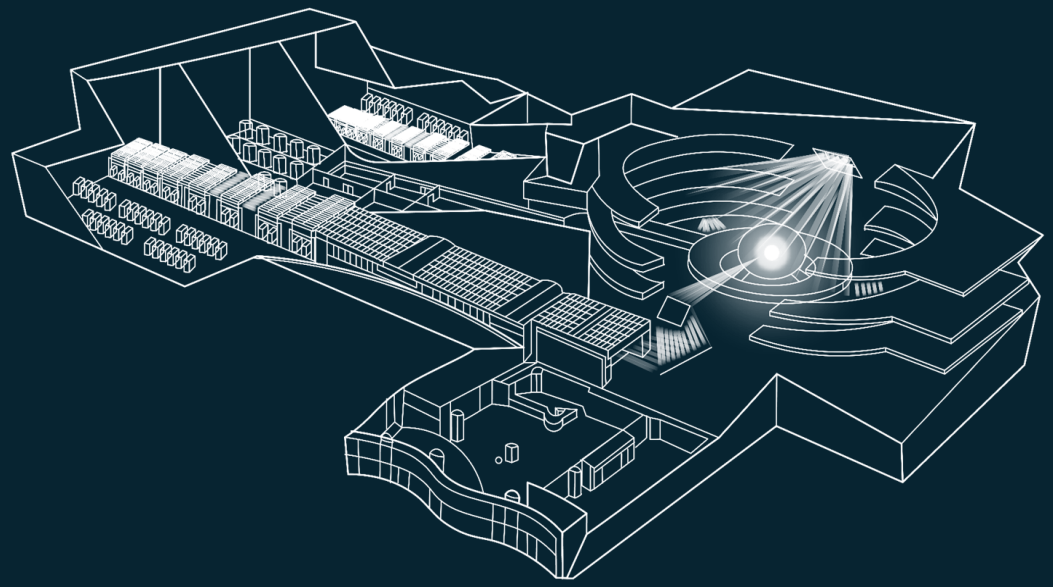
# 2031 – 2039 Fusion Pilot Plant

**300,000 m²**
area



**1,500** Lasers
with approx. **2 MJ**

- → approx. 20 mln. diodes
- → approx. 7k large (Ø ≥200 mm),
  approx. 20k small optics
- → >3,000 of large aperture, high quality non-linear crystals
- → Up to 1,500 gratings

Chamber

- → First wall
- → Blanket

Diagnostics

System Integration

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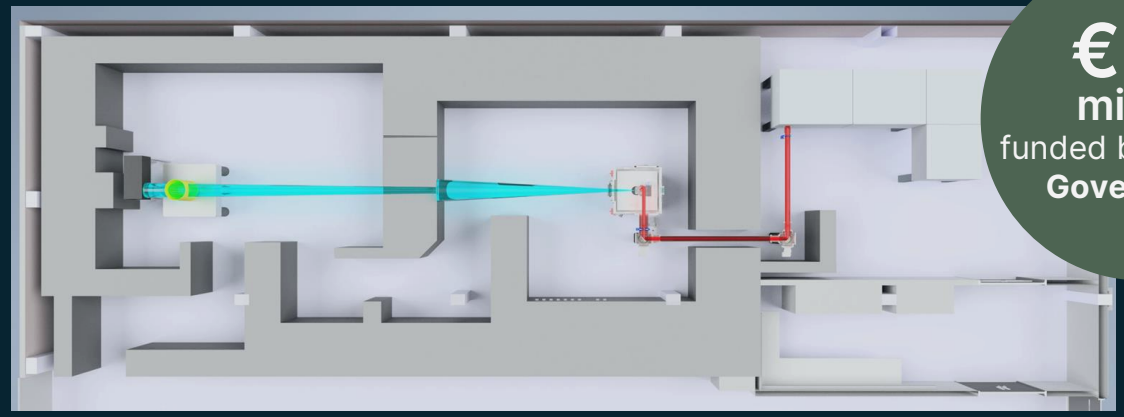
# 2026 - Pilot system launches commercialization

## at former nuclear power plant in Biblis to demonstrate industrial scale

- ➔ Development of a scalable and industrialize solution of commercial **laser-driven imaging system** for nuclear waste scanning
- ➔ Our **Laser-plasma interaction** paves the way for pioneering commercial applications.
- ➔ **Collaborating with partners**, we are poised to commercialize these innovations.



**€20 million** funded by **German Government**

### Project partners

TRUMPF · RWE · Fraunhofer ILT · HZDR Helmholtz Zentrum Dresden Rossendorf · proxivision · Technische Universität Darmstadt

### Associated partners

RWE · GNS

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# Startups are the catalyst 4 Fusion!

## Government programs

United States Department of Energy
U.S. government department

SPRIN-D
BUNDESAGENTUR FÜR SPRUNGINNOVATIONEN

Bundesministerium für Bildung und Forschung

## Industry Associations

- ✓ Fusion Industry Associations
  - → FIA - Fusion International Association
  - → Pro Fusion Germany
  - → Euro Business Fusion
  - → FuseNet Association
  - → Fusion Industrial Liaison Office (FILO)
  - → Fusion4ENERGY (F4E)
- ✓ European Commission
  - → Horizon programme
  - → European Innovation Council
  - → EU SCALING CLUB
- ✓ European Atomic Energy Community (Euratom)
- ✓ IATA
- ✓ ...

## Industry and private partners

- ✓ Schott North America, Inc.
- ✓ Trumpf Lasers SE
- ✓ Oxford Sigma Ltd.
- ✓ Leonardo Electronics US, Inc.
- ✓ RWE
- ✓ ESS – Bilbao
- ✓ Layertec GmbH
- ✓ LASEROPTIK GmbH
- ✓ Layertech
- ✓ Heraeus Quarzglas GmbH & Co. KG
- ✓ Schott AG

## Early Commercialization

- ✓ Targetry
- ✓ LDRS
- ✓ Lasers (Labs)

# ARE YOU SET ?

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# Stable supply chains and Partnerships are the surest path to fusion

**Support us in our road to Fusion!**

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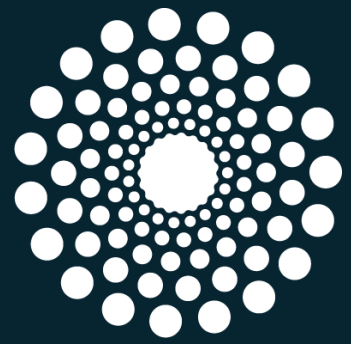

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