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DOE/NRC Public Forum On A Regulatory Framework for Fusion

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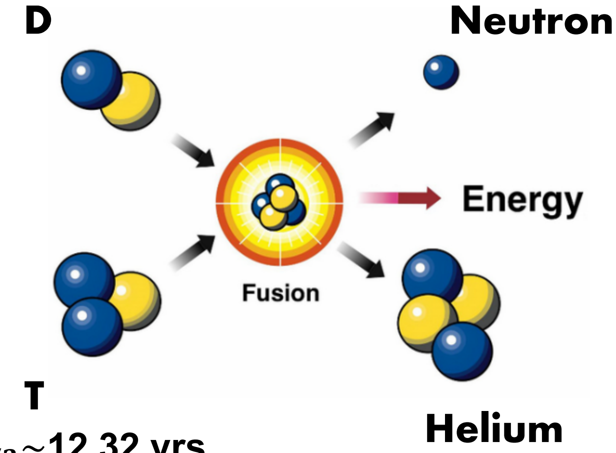
All fusion energy approaches are pursuing the Lawson criterion

- The deuterium-tritium (DT) fusion reaction fuses heavy hydrogen and produces helium, a neutron, and energy
- Lawson triple product $nT\tau_E$ defines the threshold for ignition for a given fusion type (e.g. DT fusion)
- The required temperature T is largely set for a given fusion type
- Variations between fusion approaches on plasma density n and energy confinement time τ_E
- **Due to the physics of fusion, there is no risk of meltdowns, no long-lived radioactive waste, and no usage of special nuclear material**



$\tau_{1/2}$~12.32 yrs

There are three general approaches to fusion energy

Magnetic Fusion Energy (MFE)	Magneto-Inertial Fusion (MIF)	Inertial Fusion Energy (IFE)
Low n High τ_E	Medium n Medium τ_E	High n Low τ_E
Commonwealth Fusion Systems tokamak energy (a faster way to fusion) CTFusion (As Brilliant as the Sun) TYPE ONE ENERGY tae TECHNOLOGIES iter (china eu india japan korea russia usa)	generalfusion ZAP ENERGY COMPACT FUSION SYSTEMS Helion Energy HYPERJET FUSION CORPORATION	NIF UR LLE first light

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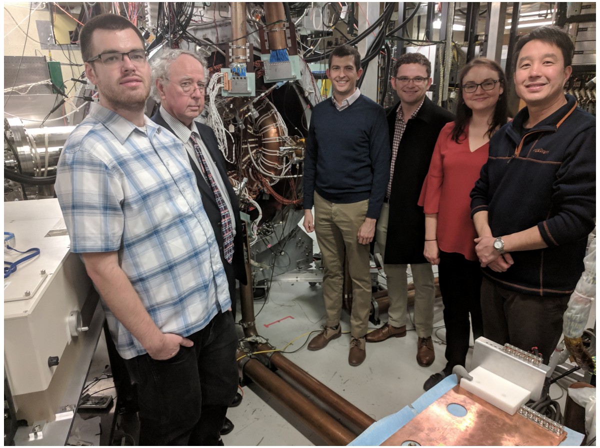
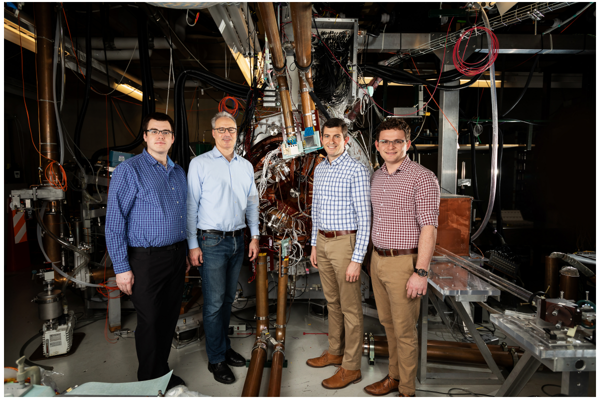
CTFusion Overview

- CTFusion was founded in 2015 as a spin-off company from the University of Washington in Seattle

- Currently in the concept exploration (CE) phase of development funded by ARPA-E

- Actively working with the University of Washington in a joint effort to increase the technological readiness level (TRL) of our fusion energy concept





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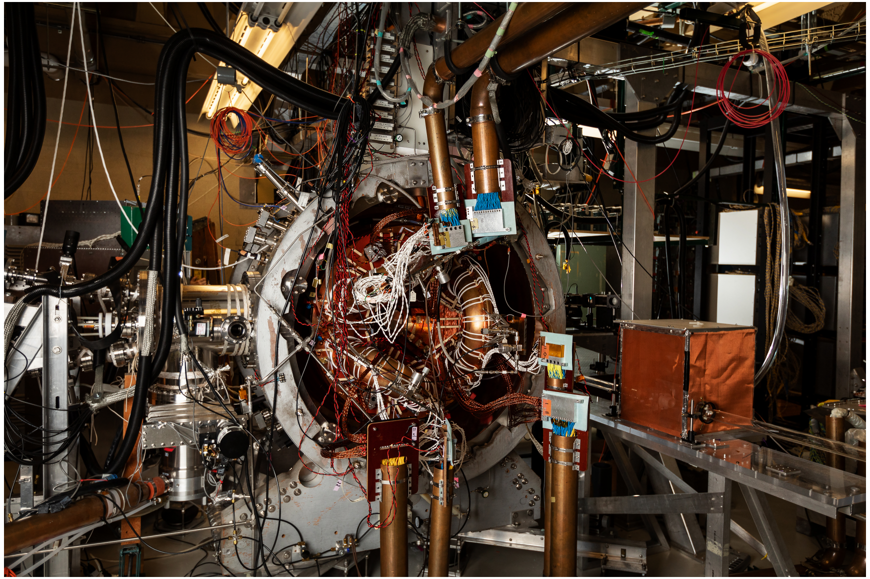
CTFusion is developing an alternative approach to MFE in collaboration with the University of Washington

- Sustained spheromak magnetic confinement with no toroidal field coils or central solenoid
- Steady, inductive power injection and current drive for continuous operation
- Demonstrated technology at small-scale at low plasma temperatures (e.g. T < 100 eV)
- Ongoing ARPA-E project aims to reach higher plasma temperatures and other key technical milestones to increase TRL
- Proof-Of-Concept (POC) to follow completion of CE phase of development path



HIT-SI3 Experiment at University of Washington

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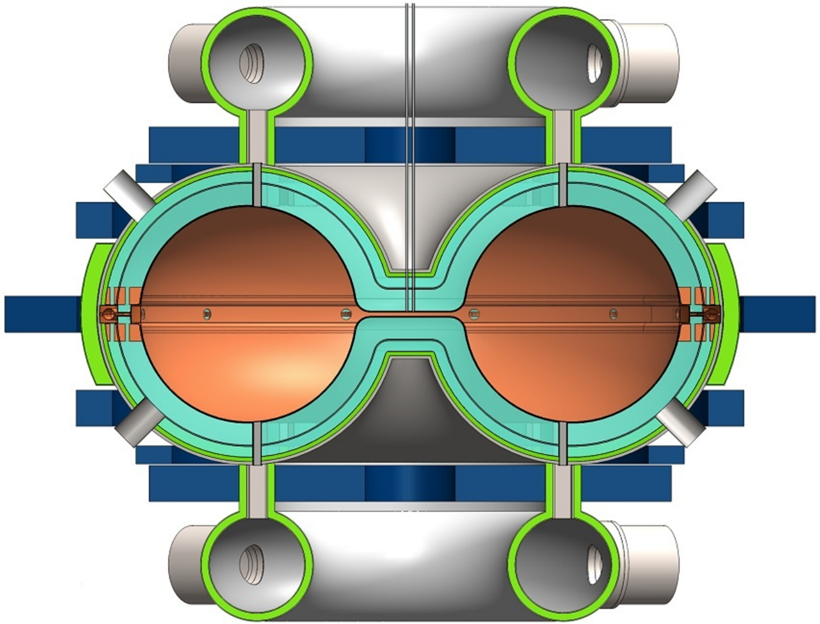
CTFusion is developing the technology needed for flexible, low-cost fusion power plants

Patented Dynomak™ technology **simplifies** the production of fusion energy by **unifying** magnetic confinement, heating and current drive

- Spheromak Magnetic Confinement with Imposed-Dynamo Current Drive (Dynomak™)
- Flexible Power Outputs 100 -1000+ MW for Generation of Heat and Electricity
- Customizable to Customer Needs



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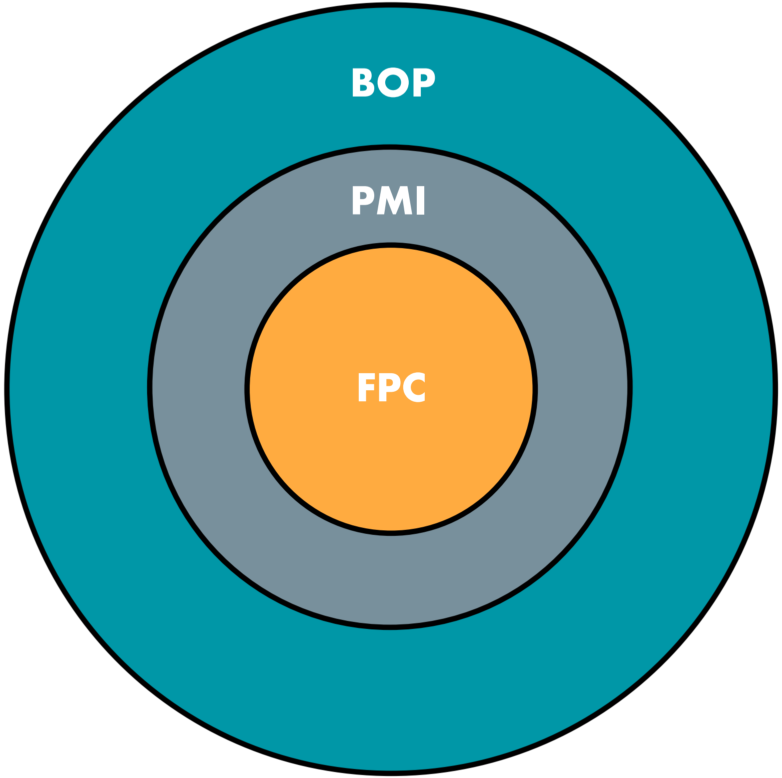
An Overview of CTFusion’s Approach to Magnetic Fusion Energy (MFE):
A Thermal Fusion Power Plant with a Unique Fusion Power Core (FPC)

Fusion Power Core (FPC)
- Deuterium-Tritium (DT) Fusion Plasma
- Spheromak Magnetic Confinement
- Imposed-Dynamo Current Drive (IDCD)
- Resistive Heating to Ignition

Plasma-Material Interface (PMI)
- Consumable, Low-Activation, Solid Material Wall
- Electrically Insulating Plasma Facing Coating
- Cooled by Molten-Salt Primary Cycle in BOP

Balance-Of-Plant (BOP)
- Neutron Moderation, Heat And Tritium Generation in Molten-Salt Primary Cycle
- SC-CO_2 Secondary Cycle Generates Electricity
- Tritium Extraction and Recirculation for Closed-Fuel Cycle



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A variety of approaches to the FPC, but more commonality in PMI and BOP subsystems for a DT fusion power plant

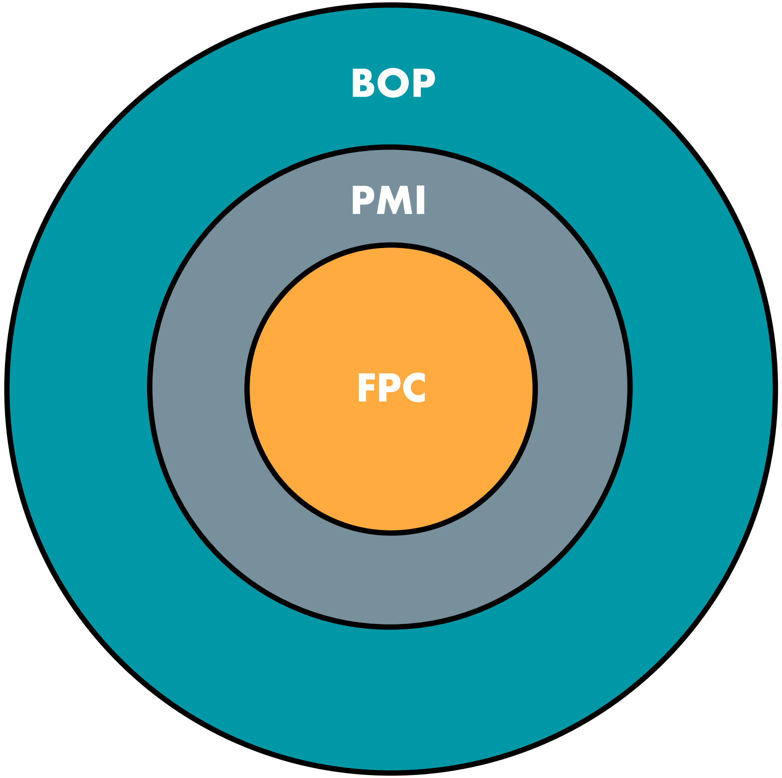
Given a FPC using deuterium-tritium (DT) fuel, the design of PMI and BOP often share these characteristics:

Plasma-Material Interface (PMI)

- Made from solid or liquid material
- Directly interacts with fusion plasma
- Neutrons impact interface, which can cause low-level activation dependent on material choices

Balance-Of-Plant (BOP)

- Solid or liquid blankets
- Moderates DT fusion neutrons and cools PMI
- Contains Li to produce T on-site for closed fuel cycle
- Converts heat into electricity



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Even in early stage R&D, regulations will affect development paths and timelines

- Current focus at CTFusion is developing our FPC, which will not require the usage of tritium until later stages of R&D
- However, regulatory considerations already affect our design process of future devices
- Design to minimize on-site tritium inventory and make material choices for our PMI and BOP to reduce neutron activation
- **Effective regulation will ensure fusion power plants will pose a minimal safety risk to the public**

Technological Readiness Level (TRL)

R&D Phases

Concept Exploration (CE)

- Small-scale demonstration
- No tritium input

Proof-Of-Concept (POC)/ Performance Extension (PX)

- Medium-scale demonstration
- No tritium input, low-level DD fusion neutron production

Net-Energy/FNSF/Pilot Plant

- Reactor-relevant plasmas
- **Tritium usage**
- **DT fusion neutron environment**

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The physics of fusion and fission are different, which encourages different approaches to regulation

- Fusion has no risk of meltdowns, no long-live radioactive waste, and no usage of special nuclear material

- Risk-informed evaluations used at the NRC for the fission sector are recommended to develop the regulatory framework for fusion energy

- Emphasis on risk-informed regulatory processes is also encouraged by the Nuclear Energy Innovation and Modernization Act (NEIMA)

- DOE has already taken important steps to support the commercial fusion energy industry by establishing regulatory precedents for fusion energy devices at DOE facilities

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Engagement and support of the public is needed to develop effective regulation and for commercial deployment

As with any new technology, public support is imperative for success in a competitive marketplace

Public engagement while developing the regulatory framework for fusion is needed

Effective regulation will facilitate the safe adoption of fusion energy while respecting local and regional viewpoints

International coordination would help accelerate worldwide adoption as part of coordinated fight against climate change

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Effective regulation is complementary to the efficient deployment of fusion energy as a needed tool in the fight against climate change

- Fusion will work in concert with renewables to achieve 100% clean energy
- Effective regulation can encourage more private sector investment in current and near-term R&D phases
- A risk-informed approach to regulation will be most effective and consistent with NEIMA
- Fusion can have a significant impact on climate change while posing a minimal safety risk to the public
- **Effective regulation is needed and complementary with this mission**

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