

Overview of Magnetic Fusion Energy Progress at General Atomics

Presented at

Fusion Power Associates

45th Annual Meeting and Symposium:

Fusion Energy: Progress, Challenges and Promise

By

Wayne Solomon

Vice President, MFE Division

General Atomics

December 2, 2024

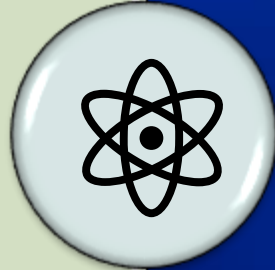
Strengthening the Foundation for Fusion Energy

Enabling Tomorrow's Fusion Power Plants



Delivering Impact Today

Leading charge in fusion research, setting stage for scientific breakthroughs & workforce development



Investing in Technologies

Directly addressing the challenges of creating viable fusion energy



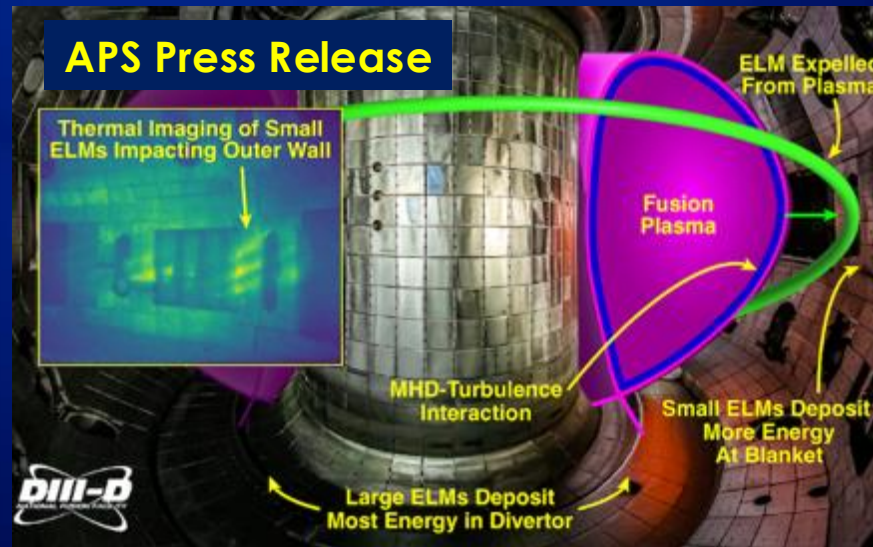
Driving Collaboration and Innovation

Integrating advanced technologies, partnering with industry, shaping global initiatives to accelerate progress

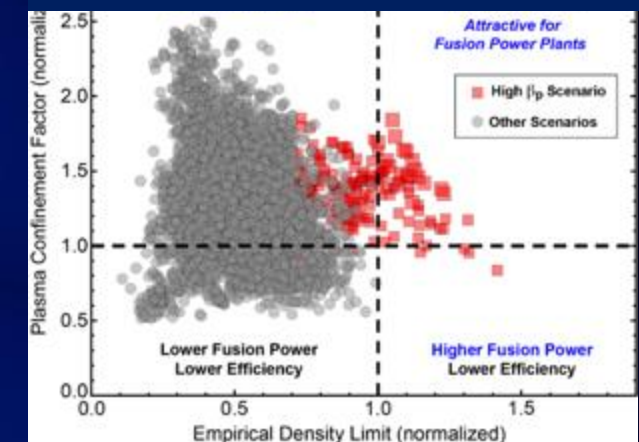
DIII-D Is Delivering on the Priorities of the U.S. Program

- Successful delivery of Run Hours and research milestones
585 Run Hours (104% of Target)
- Strong global recognition of fusion energy research products
 - Three publications within Nature journals
 - Five research results chosen by the American Physical Society (APS) for distribution through press releases
 - Five research highlights published on the DOE Office of Science site

DOE Highlight: Neutral Beam Science



DOE Highlight: Power Plant Scenario



DIII-D Is a Necessary Element for Realizing the White House's Bold Decadal Vision



- The tokamak is the most mature concept for an FPP, but requires better solutions
 - The physics is not done!
- Beyond tokamaks, DIII-D has vital role in developing technologies and expertise for fusion workforce
- Serves as a flexible integrator of a range of fusion technologies
- Fulfills important function as U.S. ITER simulator
- A unique asset, providing U.S. access to new fusion materials and technology facilities around the globe

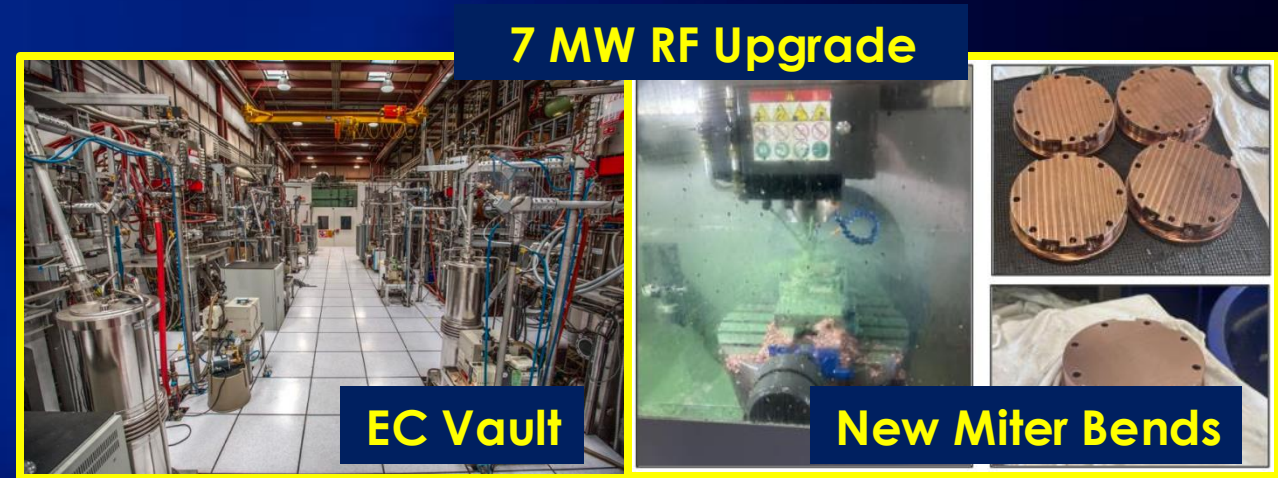
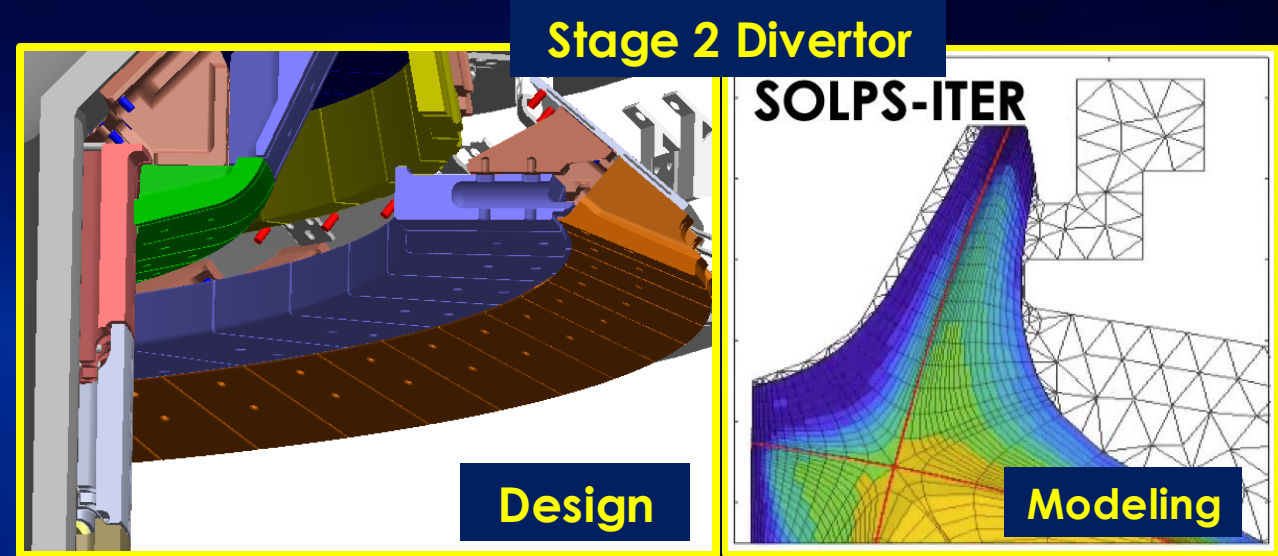
DIII-D is Engaged in a Strategic Realignment to Best Serve U.S. National Goals of Building a Strong Commercial Fusion Energy Industry

- New user access methods have been developed in partnership with DOE and are now returning dividends
 - *13 new participating organizations after the first year*
- Changing the primary wall material from graphite to tungsten over next five years
 - *Significant investment from DOE to ensure that DIII-D provides needed capabilities to industry*



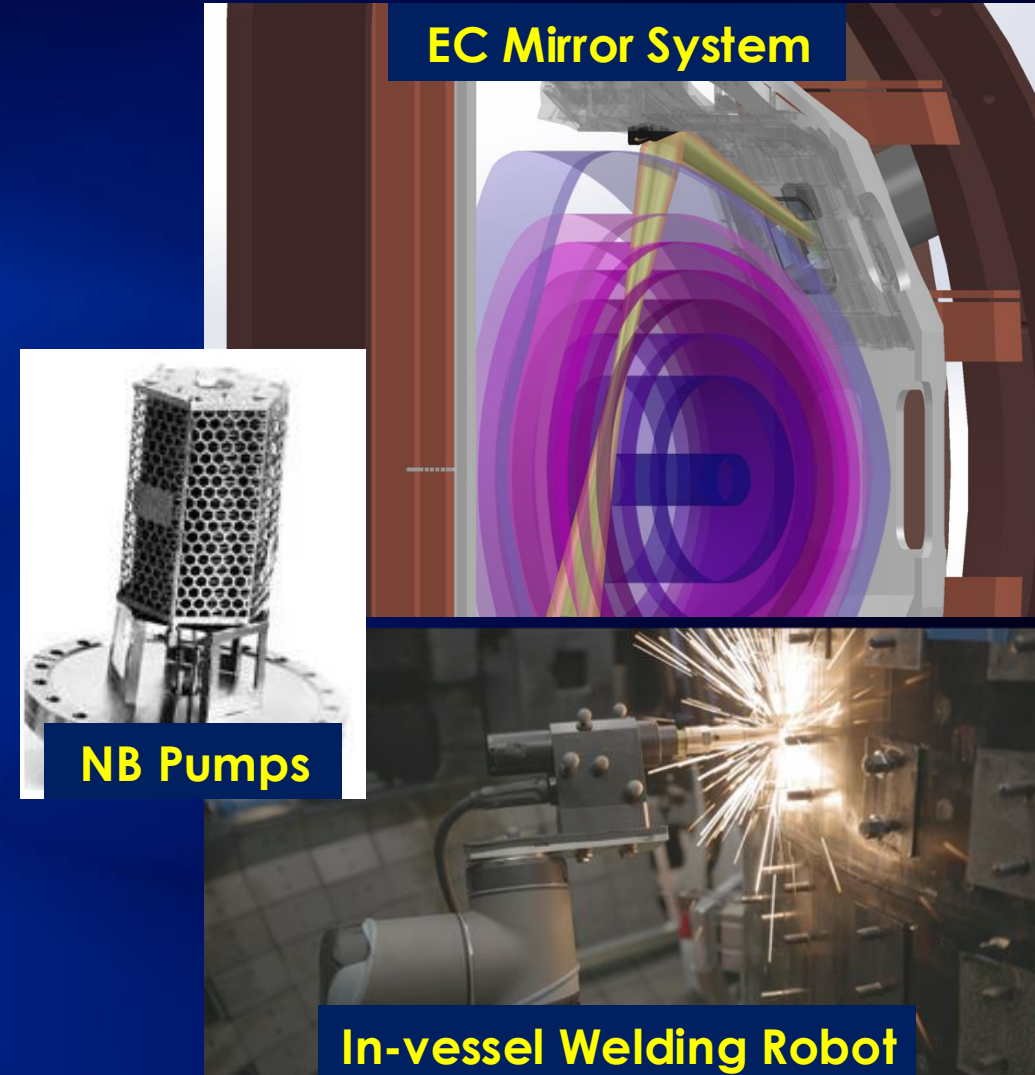
Near-term Major Facility Capability Improvements Boost DIII-D Research in Exhaust Handling, Scenario Development, and Materials Qualification

- **Stage 2 Divertor project will see a new chimney divertor installed in 2025**
 - Experiments to optimize closed divertor performance in 2026
- **Electron Cyclotron heating and current drive upgrade brings 7 MW to the plasma in 2027**
- **Evolution to a new first wall will see all graphite removed by 2027**
 - Eventual full replacement of the plasma-facing wall



General Atomics Investments into DIII-D Expand Fusion Energy Research Capabilities that Benefit the Entire U.S. Program

- **New concept employs in-vessel mirrors to redirect EC power from existing outside launch**
 - Top launch doubles current drive efficiency compared to outer launch
- **Improved neutral beam efficiency through new pumping scheme in drift ducts**
- **In-vessel robot development to improve accuracy & shorten time for new installations**
 - Including Stage 2 Divertor



GA Is Delivering Key Systems to ITER

ITER CS

- Manufacturing of all modules completed
- Testing in process for last three modules
- Four modules stacked at IO

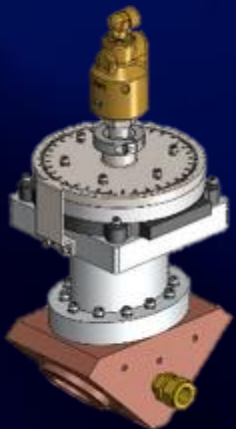


*Completed
Gundrilling
of all six LFSR
Antennas*



ITER Diagnostics

- Initiated manufacturing of LFSR Diagnostic
- Successful Preliminary Design Review for UWAVS
- Preliminary Design Review for TIP in this month



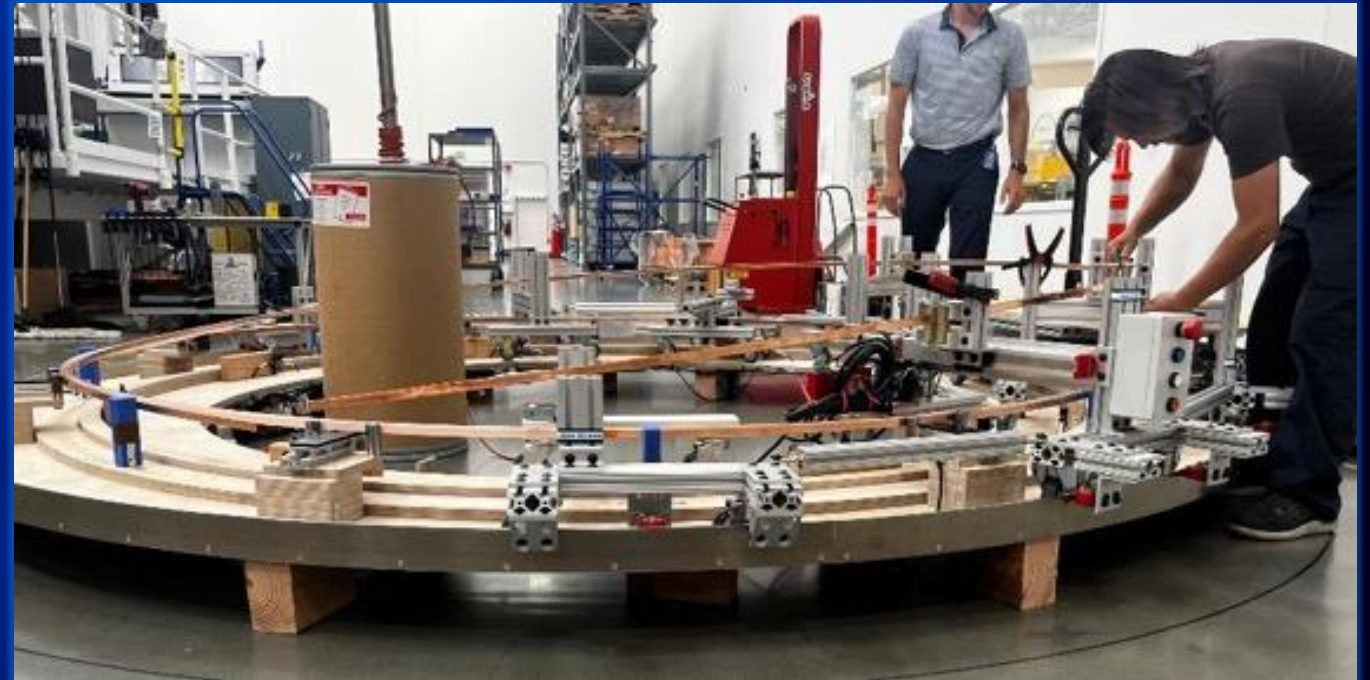
ITER ECH Polarizer Miter Bend

- Completed design and commenced manufacturing

Magnet Development

Prototyping Large Bore HTS Magnet Fabrication

Partnered with Tokamak Energy to produce HTS Magnets for multiple applications

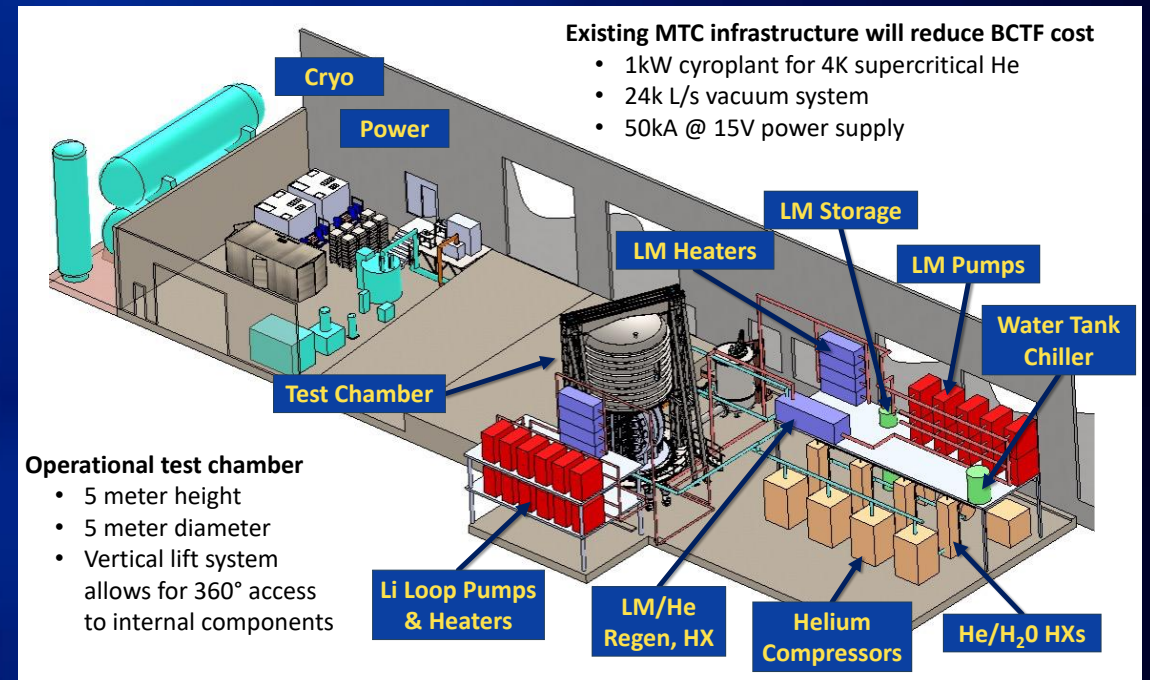
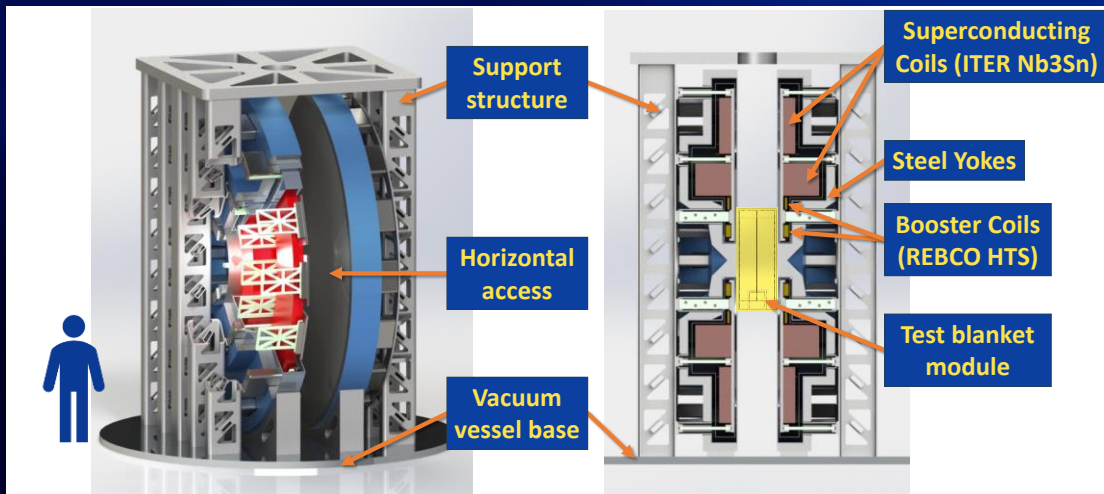


Demonstration of winding process for circular large bore and D-shaped coils in progress

Leveraging Existing Infrastructure Accelerates the Timeline for Blanket Testing

Concept for Fusion Technology DOE User Facility

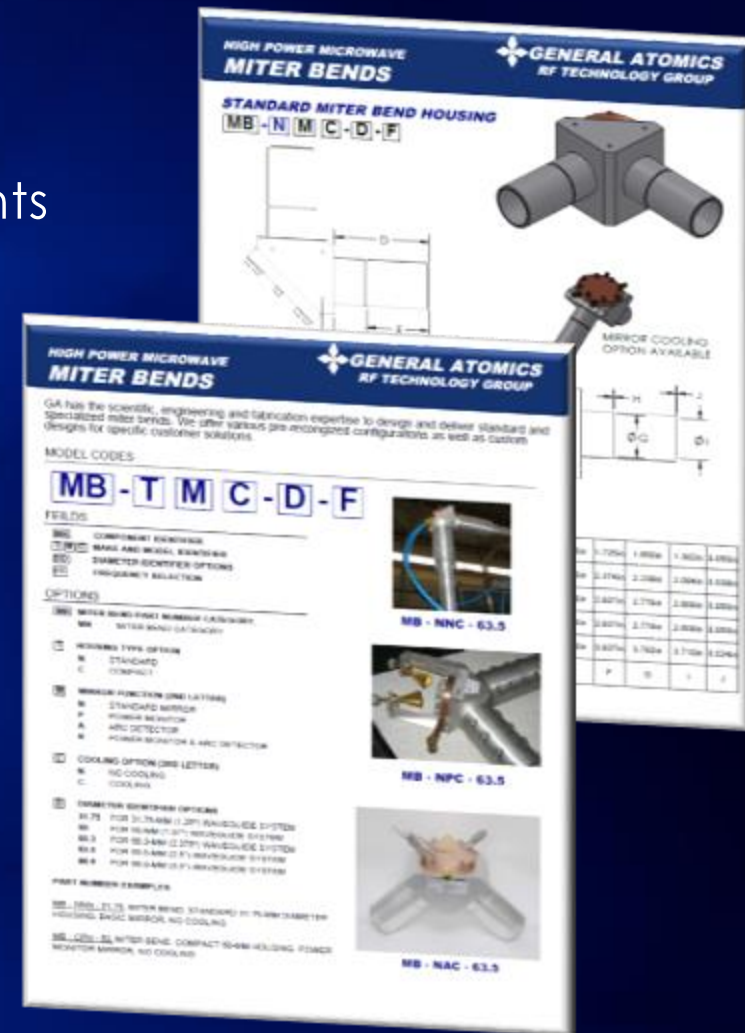
- **Blanket Component Test Facility (BCTF) achievable at Central Solenoid site**
 - High-priority DOE User Facility in Facilities Construction Projects FESAC report
 - Re-uses existing infrastructure to reduce cost and time
 - Provides user facility for entire community
- **Ready for inclusion in 2025 Technology Roadmap**



Investing to Develop a Fusion Technology Catalog

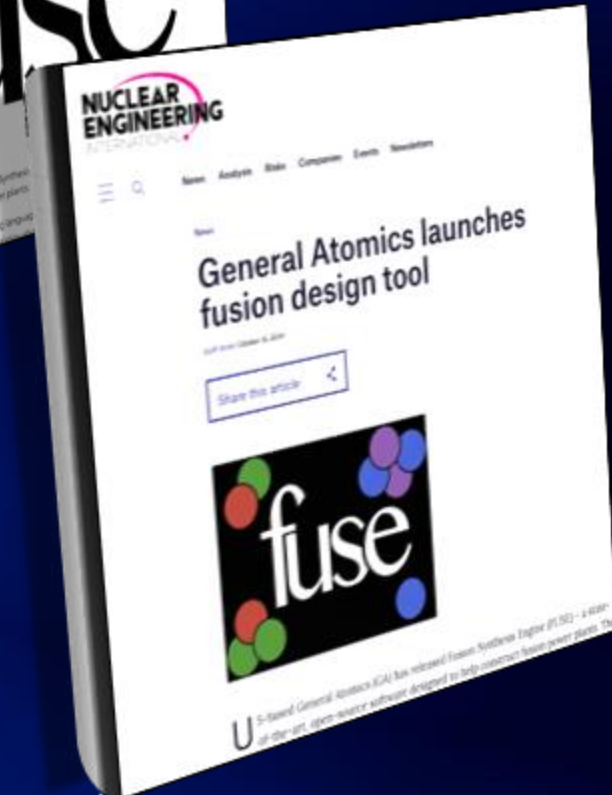
Driving Standards, Quality, and Efficiency for Fusion Innovation

- **Standardization for a Complex System**
 - Establish consistent specifications for microwave components, diagnostic systems, and other fusion technologies
 - Foster unified approach to interoperability between components
- **Quality Assurance & Reliability**
 - Set clear benchmarks for performance and durability
 - Reduce failure rates & improve dependability of fusion systems
- **Efficiency in Supply Chain & Delivery**
 - Streamline procurement with centralized reference
 - Ensure components are available and delivered on time
- **Accelerating Innovation**
 - Provide researchers and developers proven components
 - Encourage advancements by avoiding reinvention of solutions

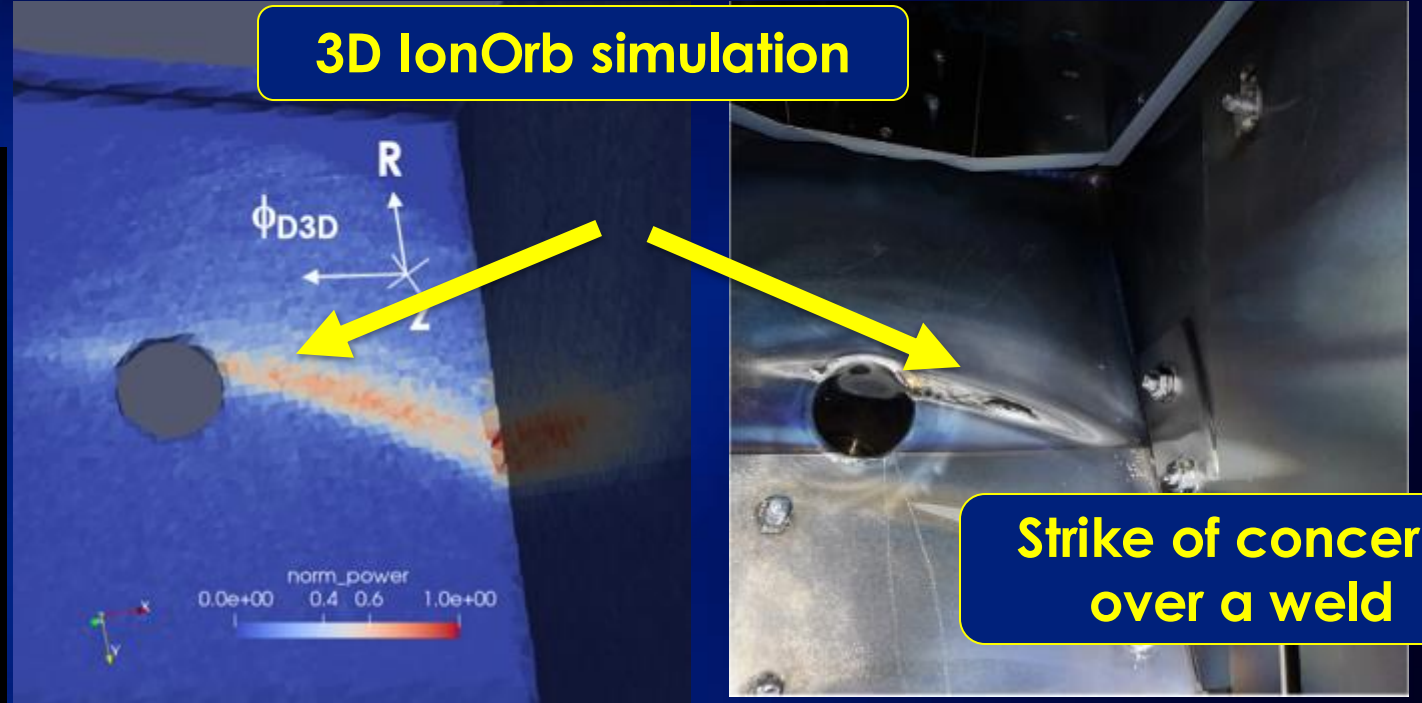


FUSE Design Tool Opened to Fusion Community

- **All FUSE repositories are now openly accessible, licensed under Apache 2.0**
 - Drew attention in the “nuclear” newswires and industry groups
- **Website (<https://fuse.help>) launched for documentation, tutorials, announcements**
 - Live tutorial Nov 13th
 - Week-long code-camp Dec. 9th – 13th
- **6 FUSE-related talks/posters at APS**



Foundational Project to Develop Digital Twin for DIII-D Is Underway and Demonstrating Immediate Value



Digital Twin Platform Development

- Strong Nvidia Partnership 
- Foundational work addressing GA's capability needs beyond DIII-D

IonOrb support DIII-D Operations

- Calculation at Argonne National Lab
- Data back to control room to *inform* ops
- Initial Digital Twin Component

Advancing Fusion Energy with Strong Partnerships to Deliver a Viable Path to Fusion

FPP

Vision

- + Demonstrated expertise
 - + Track record of success
 - + Collaborative approach
- **cornerstone of fusion ecosystem**
- Transformational innovations in fusion science and technology
 - Vital support for workforce development & industry participation
 - Infrastructure that accelerates deployment timelines for fusion

