DIII-D NATIONAL FUSION FACILITY SAN DIEGO

DIII-D 2018 LONG TORUS OPENING EHANCEMENT PROJECT

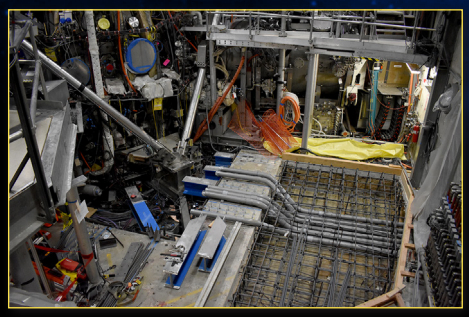
Enabling studies of burning plasma physics and sustainment

The DIII-D National Fusion Facility is undergoing major upgrades in 2018 and 2019

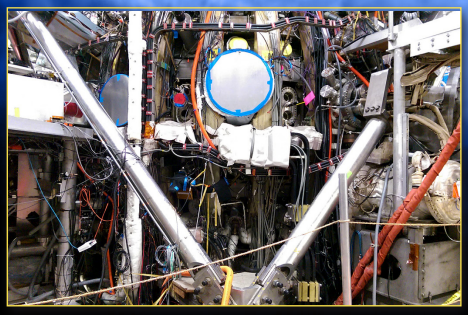
These enhancements will enable very high-pressure plasmas to explore the bootstrap effect and resolve how to achieve self-sustaining configurations

Off-Axis Neutral Particle Beam

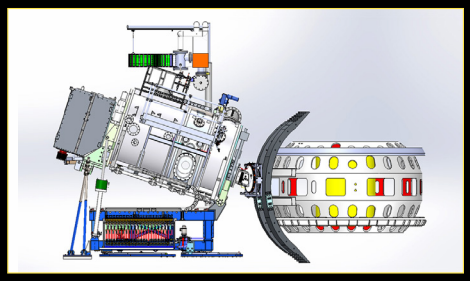
Beam assembly



New support structure



Beam port on DIII-D

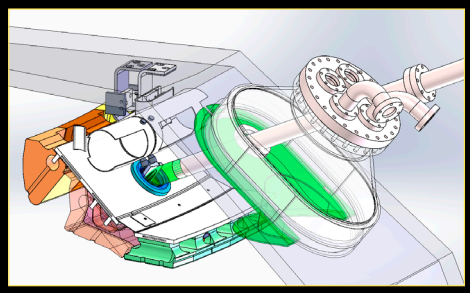


Off-axis neutral beam schematic

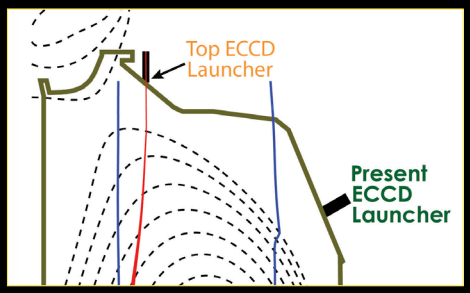
- Converts a 50-ton neutral particle beam from a fixed on-axis installation to a translatable stage that allows it to change injection angle from co-current to entirely counter-current, always in an off-axis injection configuration
- Provides increased off-axis current drive to improve access to high performance, fully non-inductive steady-state scenarios
- 5 MW of injected power with variable energy injection from 40 - 80 kV

Top-Launch Electron-Cyclotron Current Drive

- Increased off-axis current drive improves access to steady-state equilibria at zero input torque
- Applies engineering upgrade of new injection location with well-established electron-cyclotron transmission technology
- 50% - 100% increase in current drive compared to standard launch geometry
- Explore burning-plasma-like conditions with high electron temperatures
- Understand how to control instabilities and edge localized modes in ITER and beyond



New waveguide



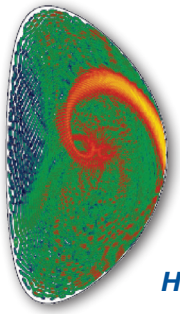
New launch trajectory

WWW.GA.COM/DIII-D

DIII-D 2018 LONG TORUS OPENING ENHANCEMENT PROJECT

Enabling studies of burning plasma physics and sustainment

New High-Frequency "Helicon" Radio Wave Antenna

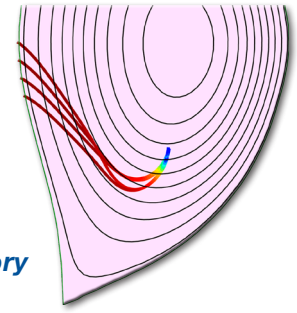


Helicon fast wave

- Provides high-power tests of new technology for efficient sustained current
- Explore higher pressure and temperatures while increasing control of the plasma
- 1 MW of injected power for mid-radius current drive

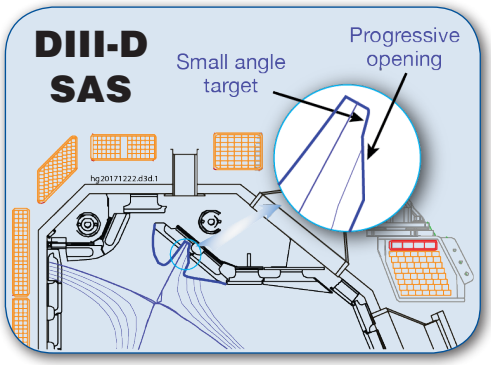
High-field-side LHCD

- First of its kind DIII-D validation of HFS LHCD core wave physics and LHCD coupling
- Impurities and thermal loads mitigated by locating the LHCD coupler on the high field side
- Demonstrate efficient off-axis current drive at rho = 0.6 - 0.8



Wave trajectory

Divertor Improvements and Diagnostics



- Uses of recycling neutrals to enhance divertor energy and momentum dissipation by leveraging divertor closure & target shaping
- Modeling and initial experiments indicate detachment and lowered divertor temperatures achievable for lower upstream densities.
- Realignment of one toroidal region to ensure better diagnostic comparisons, modeling fidelity.
- Also Improved diagnostics (See Diag Sheet)

SAS may significantly widen window for AT operation with cold divertor