MEMORANDUM: Runtime Guidance for Spring 2026 Run Campaign

To: DIII-D Team
From: Richard Buttery for the DIII-D management & DIII-D User Board Research Council
Date: October 28 2025

Context: 2026 represents a critical junction in the U.S. fusion program. Commercialization in the private sector is accelerating, with new facilities coming on line soon to prepare for, and new technologies emerging that need to be tested in the plasma environment. National initiatives under FESAC, the National Academies and DOE roadmapping have identified critical research questions that must be addressed, and the U.S. program is now embarking on a mission to close the gaps.

DIII-D is perfectly primed for this mission, with recent advances in heating, shaping and power handling adding more flexibility and relevance than ever, while various fusion technologies and associated public and private sector teams have been engaged to test new concepts. This has seen a dramatic expansion of private sector users, with multiple fusion industry partners engaged on AI, materials and other fields. With high levels of flexibility and machine availability, an ability to execute hundreds of studies per year, and world leading measurements, DIII-D serves as the critical tool to qualify the techniques necessary for fusion in the plasma environment.

This Run Time Guidance provides a framework for an 8-week campaign in the Spring 2026. This is the second campaign of FY26, with the first already being planned for the end of 2025 (guidance attached for reference), while a short tile testing campaign is envisaged in summer 2026 to assess tile technologies. This Spring campaign provides a vehicle for new recipients of DOE funding awards under FES's Tokamak Research ('TR') structure, as well fusion industry users, theory and international partners to advance the fusion commercialization agenda and address the DOE Fusion Roadmap.

The purpose of this guidance is to drive research that demonstrably accelerates fusion energy. Given the breadth of plasma research in the United States, it would be easy to divide runtime topically to yield incremental advances. However, DIII-D users and Tokamak Research program award winners have identified key objectives to ensure critical progress is made. ***Our thanks go to the team for the great set of ideas raised, and to Group Leaders for collating this input.***

The Research Council ('RC', a User Board representative body) has reviewed these ideas with the DIII-D Management Team (MT). Precise allocations are mostly not made yet, to retain flexibility for emergent TR structures and DOE roadmapping. Instead, we focus on goals, to provide context to users as we enter the Research Opportunities Forum (ROF), and subsequent down-selection. Guidance for allocations to the TR structures will be made once structures are in place. It is further recommended that experiments should report against the quantitative metrics defined under the Tokamak Research program, ensuring that outcomes demonstrate measurable progress toward closing the science and technology gaps specified for each Category 2 topic.

Program Directions for Spring 2026

Closure of critical research gaps can be accelerated through recent capability advances at the facility. In particular, the new shape and volume rise enables DIII-D to push performance limits in the core and pedestal, and to reach more relevant low collisionality / higher opacity regimes for divertor, ELM and core-edge integration studies. Increases in electron heating are driving configurations closer to fusion burning plasma physics regimes, and new measurement techniques are closing out crucial questions of divertor science and core-edge integration.

Critical goals to be advanced are described below, organized under the Tokamak Research structure. The underpinning approaches are (i) innovate in particular techniques, (ii) integrate, to resolve trade-offs and reach performance goals, (iii) understand, to project to fusion power plants with confidence, and (iv) test new fusion technologies. **One major initiative** is identified, alongside further important goals to pursue at more modest level, with **key objectives called out in bold** under DOE's TR structure. The precise balance of time will be identified after consultations with DOE and TR leaders, with additional time to other topics possible.

Sustained Burning Plasmas

Major Initiative: "Prepare for High Power Density Burning Plasma Devices" should be adopted as a major organizing principle for the burning plasma field under the SBP category 3 leadership, with the key criterion being "***what is most urgently needed to enable the success of high Q operation in upcoming facilities?***". With the U.S moving toward burning plasma devices, preparation of their operation brings critical challenges that must be overcome to ensure they reach performance goals. These devices must reach burning plasma conditions at higher power density and without the strong torque injection of most present devices. Challenges include access to H-mode and reaching confinement and Q goals at low P_{Heat} / P_{LH}, achieving maximum Q ($\geq$1) with a radiative L-mode edge, ramp up and stability at low torque, accurately predicting H-mode density peaking, impurity control, fast ion impacts, benign ELM and radiative divertor techniques. Consultation with private sector partners and their collaborators should be pursued to help ensure work in these topical areas is well targeted to this goal.

At more modest level, the below goals and guidance are noted:

Expand Advanced Tokamak (AT) high β performance and stability: the AT has reached an important point, with high ECH power combining with off-axis beam upgrades to bring high β scenarios with broad current profiles into reach for the first time. Plasmas are showing favorable properties, and we recommend ongoing effort to **sustain discharges at the highest possible β, assessing and optimizing energy and fast ion confinement**, as part of a longer-term focus under the pertinent TR structure. This work will now fold in efforts under the previous "Integrated High β_P Scenario Task Force", and be conducted under the TR "BP Core" structure.

Critical current drive assessments: Work to get the best possible model validation for LHCD, helicon and top launch ECCD should be pursued, subject to system funding and availability. This work will be performed under the TR "H&CD" structure. LHCD team should prepare the terms for, and execute, a review of its potential in May 2026.

Exhaust Handling

Consistent with the TR structure, a focus should be on Core-Edge Integration for FPP pursued under the TR core-edge group to exploit the final year of the Shape and Volume Rise (SVR) divertor. This will build on record-breaking results, and further work in the end-of-2025 Pedestal Limits Thrust, with a goal **to develop a full-core-edge integration, with radiative divertor and ELM mitigation techniques**, while obtaining critical measurements and tests in low collisionality high opacity conditions, that are crucial to resolving reactor relevant transport and particle dynamics in the divertor, pedestal and core. Objectives set are to (i) **demonstrate and determine the limits to highest possible performance in reactor-relevant conditions on DIII-D** (absolute and normalized metrics), (ii) **integrate dissipative divertor and benign ELM techniques**, and (iii) **obtain critical measurements for model validation** to enable confident projection of integrated solutions to FPPs.

At more modest level: **Work to understand, control and extend detached divertor operation** should be pursued, utilizing SVR's flexibility (anticipating a greater focus in 2027 with the Stage

2 ‘Chimney’ Divertor). Particular focus should be devoted to **validate detachments scalings and models to increase confidence in FPP divertor scenarios**, and any reference needed for Stage 2.

Plasma Material Interactions: *At modest level:*
Work to address critical issues, raise TRL and down-select from a range of reactor-relevant materials should continue, guided by concepts for fusion power plants and the needs of private fusion approaches. Approaches may span tungsten and advanced tungsten alloys (including additively manufactured forms), liquid lithium, ceramics, boron-based concepts, and other innovative new concepts for materials or structures to meet a pressing demand from the private sector. A modest amount of time is needed given the efficiency of these studies.

Control of Damaging Transients: *At modest level:*
Integration of benign ELM techniques with divertor detachment should be pursued, exploiting the SVR to access low collisionality with high opacity conditions. With the limited runtime available, it is important to investigate and deeply understand underlying physics and limiting phenomena in one or two regimes, rather than attempt to document all benign ELM scenarios.

Resolve the physics and prevention of runaway electrons should be the main focus of disruption mitigation research. This remains one of the greatest challenges for tokamak-based fusion, with fallback mitigation schemes that DIII-D has pioneered, vital; it is important to retain momentum.

Other work on tearing stability and integrated stability control should be pursued with experiments integrated into scenario developments for burning plasmas and steady state as far as possible.

Theory and Simulation Validation (including AI and control): *At modest level:*
AI for ELM control: An imaginative thrust was proposed to use turbulence measurements as a basis for ELM control. With an AI Task Force already planned for the end of 2025, it is overly ambitious to complete this thrust in 2026, but a start should be made in 2026, with a view to **testing initial principles of an AI ELM predictor** in readiness for possible 2027 follow up runtime. Further work by the AI Task Force may be appropriate if there is strengthening industry demands from more private sector or government funded partners.

Work to advance fusion control is also important where a continued focus on **integrating AI** techniques is encouraged, as well **adapting control for FPP-limited diagnostic capabilities** and incorporating such measurements or their limitations into FPP relevant control schemes. “Efforts should also continue to develop and test new measurement techniques where such are essential for an FPP and are well aligned with DIII-D capabilities.

Embed theory and model validation in all work: this a fundamental approach in many parts of the DIII-D program, and indeed is required if one is to confidently project techniques pioneered on DIII-D to FPP. Whole specific needs may arise from the US theory and model validation programs, where possible, these should be embedded in the studies and allocations of the pertinent topical areas, but where urgent U.S. strategic needs emerge, additional time may be allocated.

Additional Considerations:
Industry run time set aside: in addition to specific allocations on technology issues, **two days will be reserved for further needs emerging from private fusion** approaches, and to invite participation and proposals from the community for this time.

PhD time: the use of dedicated runtime for PhD students has been one of the great successes of DIII-D, not only providing training for the next generation, but also leading to exciting studies that address mainstream issues. With the short 2026 campaign, it is proposed that the PhD committee still meet to assess and recommend allocations for 3 days of PhD dedicated run time, but time should be charged to pertinent topical thrusts.

Pellet fueling technology is important to continue to advance, but is expected to be embedded in the above studies, although if not possible, dedicated run time could be set aside.

International partnerships: Additional time will be set aside at modest level for two cross-cutting activities than span TR areas and engage international partners on long term initiatives:

- **The International Partnership** on **Long Pulse Tungsten Compatible Steady State Scenarios** should continue, with a long-range goal to develop integrated high performance long pulse solutions for the Tungsten environment, thereby closing key gaps amongst to close key gaps in respective partners on the extrapolability of pioneered solutions. In 2026, work on **DIII-D should focus on the impact and control of high Z impurities at high performance**, particularly for issues bearing on the design of the DIII-D tungsten wall. TF work should also support establishing high performance H-Modes in WEST and resolving steady state scenario challenges with tungsten for KSTAR.
- **Negative Triangularity** it is important to maintain momentum and US leadership on this exciting reactor concept, where DIII-D continues to offer unique vital insights. In 2026, work should focus on ways to **maximize performance and stability** at high β, as well as behavior in high T_e and low torque regimes. The working group should also continue to map out the path and research needs for this scenario, including preparing for a closed pumped NT divertor.

DIII-D Tungsten Wall Change Preparation Working Group – this DIII-D specific group exists to plan and prepare for a change for DIII-D to a tungsten wall, defining operating and diagnostic requirements, guiding engineering, identifying requirements, and coordinating preparatory studies. The majority of the work is analysis and advisory, but a ROF submission category will be provided should any dedicated experiments be needed.

A modest (2-3 days) Director's Reserve will be set aside to respond to emergent issues.

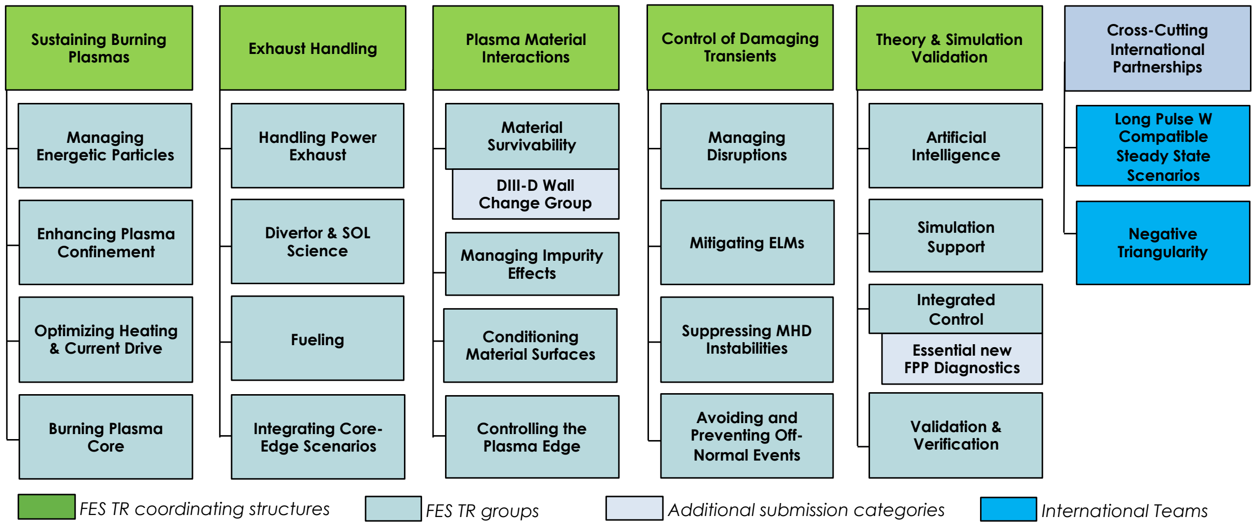
Recommendation on Execution: It is recommended that the various groups overseeing this program take large blocks of time and internally manage them as far as possible. This aids the efficiency of operation as synergies can be exploited between studies in the same field with the closely networked relationship of scientists in a given group understanding each other's studies. Groups should aim to allocate whole day blocks at least, but ideally take a multiday or 1 week block at a time. (A calendar week on DIII-D accounts for about 3-3.5 days of rundays, after allowing for typical machine availability and contingency needs – if a calendar week is taken, a group could administer its own contingency). Half day allocations are strongly discouraged.

Next Steps in Run Planning

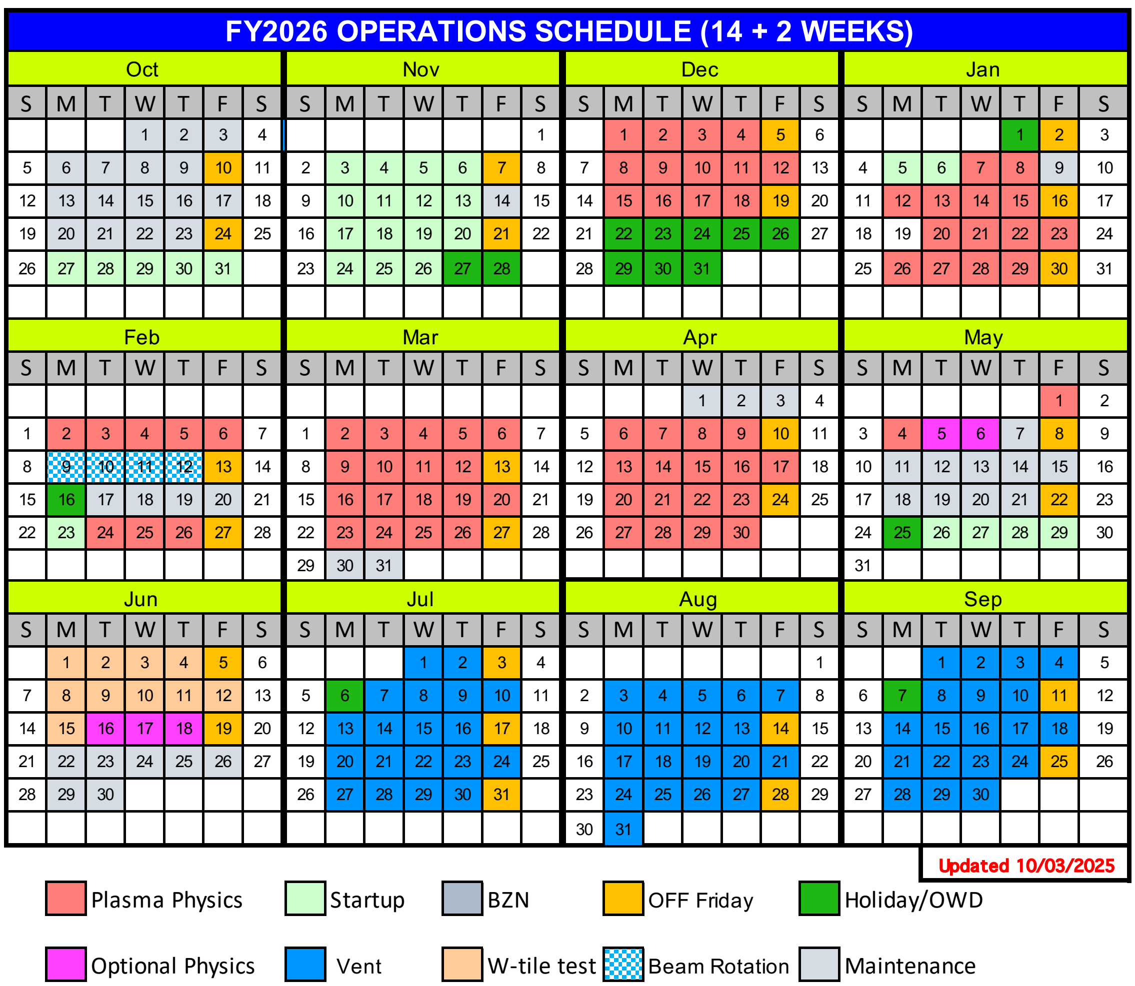
The Research Opportunities Forum will launch in October to solicit proposals from the fusion community across the entire DIII-D program. The research leadership will meet with the RC and DOE, and the TR Management Council, around the end of October to determine allocations to the five Category 3 areas of the TR program, which will then oversee and down-select programs to meet the above and other goals in November. Scheduling and Mini-proposal writing will occur in the Dec-Feb, with a view to begin execution late February.

ROF submission categories and the current FY 26 run schedule are attached below.

FES TR Structure and ROF Submission Categories



Expected Schedule for FY26:



MEMORANDUM: Runtime Guidance for End of 2025 Run Campaign

To: DIII-D Team
From: Richard Buttery, Craig Petty, George Sips, David Pace and Research Leadership
Date: August 2025

Dear DIII-D Team,

This memo provides guidance for a prioritized run campaign to execute 5.6 weeks (226 hours) of experiments, for the period November 19th 2025 to January 29th 2026.

This run period is being prepared in advance of the rest of the FY26 program (from Feb to June, 2026) in order to allow time for the new NOFO awards to be made, with time to inform the run selection for that period, which will proceed under a Research Opportunities Forum (ROF).

To prepare the End of 2025 Run Campaign, we are pursuing an expedited process to develop the program. This avoids a ROF (which needs more time than is available), in favor of a prioritized approach to allocate all its run time. Priorities for this short campaign have been identified through discussions with DIII-D research leadership, the User Board Council and DOE-FES.

The goals and thrust/task force (TF) allocations for the End of 2025 Run are detailed below. Research Division is now charged with setting up or extending the relevant thrust/TF teams to deliver experiment plans to meet these objectives. DIII-D Group Leaders will oversee this activity, with key steps being:

- An EoI is about to be separately released for any new thrust or TF positions.
- Each thrust/TF team to identify specific experiments to be executed to meet the guidance.
- We will review these with the research leadership to confirm they meet this guidance.
- Thrust/TF leaders will then appoint experiment leaders to develop mini-proposals to be reviewed by thrust/TF teams in the usual way, for execution on DIII-D

The 7 identified priorities are described below and summarized in the table right. This run campaign provides 32 calendar days of operation. With historic machine availability at about 83% this affords 26.5 run days of experiment time, of which 5 are set aside for contingency completions to make a total of 10.5 contingency days, and 21.5 days allocatable for experiment selections on below topics.

TF/Thrust (& parent Group)	Rundays
AI for fusion control TF	4
Wall conditioning (PIT)	4
Pedestal limits w/SVR (FPP)	5
FI turbulence suppress'n (BP)	1.5
LH assessment (PIT)	2
Advanced Tokamak (FPP)	3
PhD / Directors Reserve	2

1) Development of AI techniques for fusion control Task Force – 4 days

Use of AI systems to develop power plant relevant control techniques that address the decreased diagnosability and control of fusion power plants, and new or improved 'synthetic' measurements that go beyond capabilities of existing diagnostics. This task force should also include advanced real time prediction and control of discharge trajectories and instabilities, and involve private partners. A task force is used to reflect the multi-disciplinary nature of this goal.

2) Novel wall conditioning techniques for fusion power plants – 4 days

This is a critical issue for managing plasma-wall interactions and sustaining high performance of fusion devices. A range of novel techniques and materials should be explored, including those of interest to private sector partners. Studies may include use of boron and lithium, conditioning in negative triangularity and 3D magnetic scenarios, using DiMES-based injection and high-Z dust (using Mo- and W-coated low-Z powders). These studies will quantify surface evolution to demonstrate how wall conditioning, in collaboration with private-sector partners, contributes to boundary stability and reactor-relevant performance.

3) Push the limits of the pedestal to close key core-edge integration ('ITEP') gaps using the Shape and Volume Rise Divertor – 5 days

This should push the limits of SVR divertor, which has already achieved unprecedented pedestal pressures in DIII-D to expand further in pressure and density. Studies should aim to (i) scope the limits of performance, (ii) access critical fusion-relevant regimes of high opacity with low collisionality to understand and predict reactor core-edge interactions, and (iii) test dissipative divertor physics and benign ELM operation, potentially leading to the first observation of detachment with small ELMs at high performance.

4) Completion of Confinement Enhancement via Turbulence Suppression by Fast-Ion-Driven AE-Modes in high-performance regimes Thrust – 1.5 days

This thrust addresses a crucial power plant performance issue, where new insights indicate fusion products and their driven instabilities could improve thermal ion confinement (and thus raise fusion performance or permit more compact and cheaper power plant designs). This thrust has made great progress in 2024-25, but had its runtime curtailed by program reductions, with 1.5 days of well vetted experiments to run that are critical to explore and understand this phenomenon in high-performance scenarios that should be completed.

5) Lower Hybrid Critical Wave Propagation Assessments – up to 2 days

The thrust should address the most critical research question for this key reactor technology of where the wave propagates. While present power levels may not be sufficient to provide current drive measurements (though these should be sought if possible), measurements of temperature rises should be utilized, along with development and exposition of other key diagnostics such as hard X ray sensors, to assess propagation and exposition of the wave. Up to 2 dedicated days are proposed, with high priority attached to additional work in startup and piggyback. Supporting work to optimize diagnostics for these measurements is a top priority.

6) Assess and Expand the Potential if the Advanced Tokamak Path – 3 days

With recent advances in ECH power, as well as the SVR divertor, the facility is ready to exploit its double off axis beams, to provide the first assessments of the limits and potential of broad current profile Advanced Tokamak scenarios that predicted with high q_{min}, ρ_{qmin} β_T and β_P. These exciting regimes have the potential to meet the reactor challenge through better normalized performance and thus safer, higher q_{95} operation. Work under this thrust should make a start by focusing on extending this regime down in q_{95}, assessing critical physics for reactor projection (stability, energetic particle and transport), and exploiting novel RF schemes including top launch technology. Studies may also start to assess benign ELM and dissipative divertor integration.

7) PhD Runtime / Directors Reserve – 2 days

Though more is expected as part of NOFO studies later in year, a small amount of runtime is set aside for PhD students, particularly those needing critical data as funding expires. Any unspent time is allocatable to above or other studies through the usual Director's Reserve process.

Additional time to extend the goals of these thrusts may be possible later in 2026, but is subject to the review and selection processes that will be undertaken for that later campaign, which will involve a full ROF process commencing in Fall 2025.