MEMORANDUM

DATE: **June 16, 2017**

TO: **DIII-D** DNH WMS RJB HG

FROM: **David Hill, Wayne Solomon, Richard Buttery, Houyang Guo**

SUBJECT: **Run Time Guidance for FY 2018**

This memo provides initial run-time guidance for the FY18 experimental campaign on DIII-D, which should motivate submission of experimental proposals in the upcoming DIII-D Research Opportunities Forum (ROF). This guidance is the result of discussions amongst the DIII-D leadership following a Research Council meeting where group leaders presented proposals for thrusts and high priority research topics.

Based on current funding guidance, 17 weeks of experiments are planned in FY18. Research groups should review and prioritize ROF proposals to make a proposed plan for the FY18 program consistent with the guidance below. These guidance numbers represent upper limits, and exceed the total available time by approximately 20%. Each group leader should be prepared to present thrusts and other research at a second Research Council meeting in early August, after which the run time allocation will be made. Experiments in FY18 will commence in October 2017. After 2018 experiments, it is anticipated that DIII-D will undertake a Long Torus Opening (LTO) in order to upgrade neutral beams and several other systems to accelerate research on steady state and divertor physics when physics operation resumes in mid 2019.

This guidance identifies four high priority research thrusts (to be conducted and organized within the existing DIII-D group structure). Note that the selected high priority areas do not span the entire program, but instead indicate research lines that are considered particularly important and timely from a programmatic perspective.

This campaign also sees the initiation of a new Core-Edge Task Force, to be led by Tim Luce, with Brian Grierson and Aaro Jaervinen as deputies. Development of the techniques to ensure compatibility between the fusion core and a divertor/PMI solution represents a critical challenge for fusion energy. The new Task Force will be expected to formulate a multi-year strategy and research plan to develop the physics basis to meet this goal, understanding the interaction of different regions and integration of the required techniques at relevant parameters, in order to enable projection to future fusion reactors. Based on the comments and feedback received on this proposal at the Research Council, the Task Force will begin at a modest level of experimental run-time, with the expectation that effort will increase over time as individual research topics mature.

1. **ITER Q=10 Thrust – D&C (up to 8 days)**
   The activities of this thrust should focus on identifying the most promising integrated scenarios for achieving ITER Q=10 equivalent performance in ITER relevant conditions (e.g. low torque, relevant collisionality, ELM control, heat flux control etc). This work is viewed as timely

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given modifications planned to the 210º beamline in preparation for high beta steady-state work after LTO3. The work in this thrust should contribute to Milestone 200.

2. **Divertor Development Thrust – BPMIC (up to 6 days)**
This thrust should focus on validating the physics underpinning the SAS configuration, and more generally should assess the impact of divertor closure on impurity screening and entrainment, and the benefits, principles and trade-off behind magnetic optimization of divertor configuration. Data from this thrust should in particular be directed toward understanding key principles related to neutrals to develop future divertor configurations envisioned for the next 5-year plan. Experiments and data from this thrust should contribute strongly to milestone #203, and also to milestone #201 regarding the ionization profile.

3. **ELM Control Thrust – PedELM (up to 9 days)**
This thrust should evaluate the relative merits and challenges of different ELM control techniques in plasmas relevant to ITER and future devices. A critical aspect to address is understanding access to and sustainment of ELM control at low torque for various techniques. The addition of the new ASIPP power supplies affords significant opportunities to explore this physics. Experimental proposals should clearly identify the specific physics advance being addressed and how the advance is important for achieving ELM control in reactors. Connection to relevant theory and simulation is important to resolve underlying physics questions.

4. **Rotation Physics – BPP (up to 5 days)**
This thrust should continue to pursue a predictive understanding of rotation, with a focus on quantifying the rotation level expected in ITER. Work should explore all relevant mechanisms that can impact the rotation profile, including resonant and non-resonant 3-D field driven torques, intrinsic rotation drive, tearing and locked mode drag, and turbulent transport. Experiments should test if the increased physics understanding can be used to manipulate and control the rotation profile, and should also give priority to new ideas for generating rotation in future devices

In addition to these near-term thrust priorities, two Task Forces are now called out, to organize cross-cutting work that may draw effort from across the program to meet high priority goals:

- **The Joint DIII-D/EAST Task Force (up to 6 days)**: Work should continue to develop the physics basis for long pulse operation for fusion in collaborative studies that engage both facilities. Here DIII-D provides an important role in scoping solutions and assessing physics for complementary studies in long pulse conditions in EAST and future reactors. It is therefore important to extend and understand scenarios at high β_P scenario for higher current operation, and develop the basis ELM and transient control. In addition, studies in 2018 should assess divertor compatibility and use of radiative techniques.

- **Core-Edge Task Force (up to 6 days)**: This newly formed task force must develop a long-range strategic plan and focus on the trade-offs and optimizations needed for a self-consistent high performance core and relevant boundary solution. Integrated high power core-divertor interactions should be studied, with underlying physics behaviors investigated at reactor relevant physics parameters. Neutral dynamics and impurity influxes may also be topical areas of emphasis in this first year of the task force.

Finally, the remaining run time will be divide between the physics groups as follows:

- **Burning Plasmas Physics Group (up to 10 days):** Energetic particle studies should exploit new diagnostic capabilities to understand EP transport and explore the basis for control. Turbulence research should assess impurity transport using the new LBO, as well as pursue leading edge transport model validation and stiffness assessment (exploiting rises in ECH power), with also possible follow-up research on negative triangularity plasmas. L-H physics studies should focus on validation of simulation models and development of a projectable physics basis, and possible improved access for H mode in ITER. Specific experiments targeting future H&CD schemes for DIII-D should also be considered.

- **Pedestal/ELM group (up to 6 days)**: Research should increasingly turn to the understanding of pedestal structure and the role of particles, turbulence and fueling in governing behavior (supporting milestone #201). It is also important to explore further concepts of pedestal optimization to improve performance as well as divertor compatibility, with techniques such as Super H-mode.

- **Dynamics and Control (up to 10 days)**: It will be important to continue work on disruption mitigation to target urgent ITER disruption mitigation questions (including joint SPI experiments with JET and work for milestone #202), and develop improved understanding of runaway electron dissipation, as well as explore novel mitigation tools. Stability work should focus on remaining underlying physics questions and the development of so called "off-normal" condition prediction, sensing and response; a significant effort to integrate and test approaches through piggy-back on other plasmas is expected. Essential preparation for the AT program after LTO3 should be made, with work focusing on issues such as how to optimize fast ion transport and MHD stability.

- **Divertor/SOL and Detachment Science (up to 6 days)**: Activities should follow-up research carried out in the detachment physics thrust in FY17, and focus on elucidating and benchmarking models for additional parameter dependences related to divertor radiation, parallel transport and SOL flows.

- **Advanced Materials Validation (up to 5 days)**: This group should begin studies related to SiC to inform a future workshop discussion of the material as a potential wall material for DIII-D in the next 5-year period, and complete any work needed to finalize analysis from the metal tiles campaign.