PEP-31 Pedestal structure and edge relaxation mechanisms in I-mode

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| **TG priority:** High | **Start date:** 2011 | **Status:**  On-going | **Personnel exchange:**  Yes |
| **IO priority:**   | **End date:**   | **Motivation:** Physics Basis |

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| **Device /****Association** | **Contact****Person** | **TGRequest** | **Activity (from JEX/JA spreadsheet)** |
| **2012** | **2013** | **2014** | **2015** | **2016** |
| C-Mod  | J. Hughes A. Hubbard | Desirable | Committed | Analysis | Analysis | Committed |   |
| AUG | F. RyterR. McDermottE. Wolfrum | Desirable | Committed | Committed | Committed | Committed |   |
| DIII-D | R. GroebnerP. Gohil | Desirable | Considering | Considering | Analysis | Not doing |   |
| EAST | X. Gao T. Zhang | Desirable |   |   |   |   |   |
| JET | C. Maggi | Desirable | Not doing | Not doing | Not doing | Not doing |   |
| KSTAR | J. Ko | Desirable |   | Considering | Considering |   |   |
| NSTX-U | S. Kaye | Desirable | Not doing |   |   | Considering |   |
| TCV | O. Sauter | Desirable | Considering | Considering | Analysis | Analysis |   |

**Results for 2015**

* Analysis of I-mode pedestal and edge fluctuation data continued (AUG, C-Mod, DIII-D). All three devices demonstrate temperature pedestal formation without a particle barrier, along with changes in edge fluctuations. New I-mode experiments were performed on C-Mod, extending I-mode operation both to very high magnetic field (8 T) and to balanced double null equilibria. Scheduled experiments on EAST and KSTAR have not yet produced I-modes, but more work is necessary on both devices to access the appropriate discharge configurations and parameters. To date, C-Mod is the only machine to identify I-modes in discharges with favorable grad-B drift for H-mode access. JET discharges with elevated H-mode power threshold, but with favourable grad-B drift, have been examined for evidence of I-mode without success.
* *Publications:* There are now multiple publications either published or submitted on edge turbulence in I-mode on C-Mod, AUG and DIII-D. In addition, a TG paper, co-sponsored by PEP and T&C groups, is approaching readiness for publication. “Multi-device Studies of Pedestal Physics and Confinement in the I-mode Regime” was presented at the 2014 IAEA FEC by A. Hubbard, and has been expanded in 2015. It includes data from AUG, C-Mod and DIII-D. The paper concludes that I-mode is robust over a wide range of global and dimensionless parameters, with no indication of a physics limit which would prevent application to burning plasmas. Operation at high magnetic field is seen to facilitate high confinement I-mode operation and prevent H-mode formation. Projections indicate that at 5.3T ITER could enjoy a generous window for I-mode access.

**Plans for 2016**

* AUG plans six I-mode discharges for turbulence studies between January and March 2016, and further experiments may be proposed for the next campaign. C-Mod experiments accessing 8T I-modes and exploring divertor/SOL physics will continue in 2016. Existing exploratory proposals on EAST and KSTAR will be tried again. There exists an outstanding I-mode proposal for JET, which requests reversed field operation. In addition a proposal has been submitted to seek I-mode phenomena in H discharges with elevated H-mode power threshold. Experiments on TCV are expected to receive reversed field run time in 2016.

**Purpose:** I-mode access and sustainment are sought on multiple devices, with experiments that carefully document edge profiles and fluctuations. Devices that have experience with I-mode will expand their operating space and take ample measurements in order to improve the understanding of I-mode formation and H-mode suppression. Devices that have not made positive identification should run initial experiments to reproduce I-mode phenomena with unfavourable grad-B drift direction and high input power.

**Background:** I-mode is an operational regime which exhibits good energy confinement (H98~1), combined with particle and impurity confinement comparable to that in L-mode. The enhancement in energy confinement is associated with an edge temperature pedestal that forms without a density pedestal. It is most often obtained with the ion grad-B drift directed away from the X-point (the unfavorable drift direction for H-mode access). Observations of the transient I-mode phenomena date back over a decade [1], but more recent experiments on C-Mod and AUG have shown that this high-confinement regime can be maintained in steady state, with pedestal collisionality \*ped~0.1, and with no ELMs needed for pedestal regulation [2]. There are several outstanding questions that can be addressed by a multi-machine study of I-mode, including: (1) What are the relevant mechanisms for suppressing transition into traditional H-mode? (2) How does the temperature pedestal structure (e.g. width, gradients) and transport differ from comparable H-mode plasmas? (3) What role do pedestal fluctuations play in regulating transport and what is their drive?

**Description:** I-mode access and sustainment will be sought on multiple devices, with experiments that carefully document edge profiles and fluctuations. There is a natural focus on producing I-mode phenomena with unfavourable grad-B drift direction and high input power.

[1] M. Greenwald *et al.* Nucl. Fusion **37** (1997) 793; F. Ryter *et al.* Plasma Phys. Control. Fusion **40** (1998) 725; R.J. Groebner *et al.* Plasma Phys. Control. Fusion **40** (1998) 673.

[2] D. Whyte *et al.* Nucl. Fusion **50** (2010) 105005; A.E. Hubbard *et al*. Phys. Plasmas **18** (2011) 056115.