# MDC-18 Evaluation of axisymmetric control aspects

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| **TG priority:** High | **Start date:** 2012 | **Status:**  On-going | **Personnel exchange:**  Yes |
| **IO priority:**   | **End date:**  N/A  | **Motivation:** Resolve axisymmetric control issues  |

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| **Device /****Association** | **Contact****Person** | **2016 TGRequest** | **Activity (from JEX/JA spreadsheet)** |
| **2012** | **2013** | **2014** | **2015** |
| DIII-D  | D. Humphreys | Desirable | Committed | Considering | Analysis | Analysis |
| AUG  | W. Treutterer | Desirable | Considering | Committed | Committed | Committed |
| C-Mod  | S. Wolfe | Desirable | Considering | Considering | Considering | Not doing |
| EAST  | B. Xiao | Desirable | Committed |   |   |   |
| KSTAR  | S. H. Hahn | Desirable |   | Considering | Considering |   |
| NSTX-U  | E. Kolemen | Desirable |   | Analysis | Analysis |   |
| TEXTOR  | R. Koslowski | Desirable |   | Considering | Considering |   |
| Tore Supra  | S. Bremond | Desirable |   | Not doing | Not doing |   |
| CREATE | G. Ambrosino | Desirable |   |   |   |   |
| ITER  | Y. Gribov | Desirable |   |   |   |   |

**Purpose:** This experiment addresses the ongoing need for axisymmetric control physics results to inform requirements for machine, CODAC, diagnostics, and actuators, by providing validated control models and determining the capability of control algorithms for specific scenarios (e.g. runaway electron control). The task will include joint experiments, modeling, design, implementation, analysis of high order controllers.

**Background:** This experiment is a successor to MDC-13, which was completed in 2009. MDC-13 successfully determined the maximum controllable growth rate and displacement for robust operation in several machines. Guidance was provided to the ITER design, based on machine-independent controllability metrics. Some validation of physics models of plasma response/disturbances was carried out. MDC-18 was initiated to facilitate study of advanced and integrated axisymmetric control issues persisting for ITER.

**Results for 2015**

* Extension of vertical controllability studies in KSTAR and EAST identified requirements for high-accuracy equilibrium reconstruction needed for realtime controllability assessment. Comparisons of L-mode and H-mode accuracies quantified need for good profile measurement to enable good reconstruction (EAST). Specific data on dependence of dZmax on Ip collected (KSTAR).
* Application of realtime feedforward trajectory determination algorithm for ITER Baseline scenario development and control in KSTAR
* Decoupled fast/slow Zp control in KSTAR, integration with (slow) shape control and realtime feedforward trajectory algorithm
* Model-based decoupled MIMO shape/x-point controllers designed and studied in KSTAR experiments
* Initial modeling/simulation of early ITER (non-activating) scenarios to identify axisymmetric control issues
* Assessment of axisymmetric noise studies done for ITER since 1997 to identify remaining needs

**Plans for 2016**

* Achievement and study of ITER Similar Shape control with ITER-like degrees of freedom in KSTAR
* Implementation of real-time feed forward trajectory determination in EAST
* Implementation and study of equilibrium control based on polarimetry-derived realtime current density profile measurements in EAST
* Initial use of realtime MSE for profile constraint in realtime EFIT in KSTAR
* Continued modeling and simulation of target plasma equilibria in early ITER (non-activating) plasma operations to help guide experiments to study axisymmetric control issues
* Study of tradeoffs in choice of control schemes to advise on ITER choices: feedforward/feedback balance, basis variables for shape (gaps vs isoflux points, etc…)
* Study of exception handling approaches for ITER VDE prevention and management
* Initial identification of potential approaches for managing ultimate ITER noise environment