JA-1 **Shear flow effects on NTMs**

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| **TG priority:** Moderate | **Start date:** 2013 | **Status:**  On-going | **Personnel exchange:**  No |
| **IO priority:** | **End date:**  N/A | **Motivation:** Understand shear flow effects that significantly alter NTM stability | |

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| **Device /**  **Association** | **Contact**  **Person** | **2016 TG Request** | **Activity (from JET/JA spreadsheet)** | | | | |
| **2015** | **2016** | **2017** | **2018** | **2019** |
| CCFE | T Hender | Modelling |  |  |  |  |  |
| IPR | A. Sen | Modelling |  |  |  |  |  |
| PPPL | S. Gerhardt | Data mining |  |  |  |  |  |
| CNR, Italy | E. Lazzaro | Modelling |  |  |  |  |  |
| DIII-D | R. La Haye | Data mining |  |  |  |  |  |
| SPC (EPFL) | J. Graves | Modelling |  |  |  |  |  |
| IPP | M. Maraschek | Data mining |  |  |  |  |  |
| CEA | P. Maget | Modelling |  |  |  |  |  |

**Purpose:** Study the effects of shear flow, arising from injected momentum and from diamagnetism, on tearing mode stability. The aim is to explain NTM stability results from machines including DIII-D, AUG, JET, TCV and NSTX, and to make improved predictions for NTM stability in (the low flow) ITER.

**Background:**

* Several experiments show significant effects on NTM stability from changes in plasma flow. On DIII-D changing the flow from co to counter (through balanced) is found to be destabilising for 2/1 NTMs. While on AUG for 3/2 NTMs decreasing the flow from either the co or counter direction is destabilising.
* NSTX results have helped break the degeneracy in the data between flow and flow shear, and suggest it is flow shear that causes the effect (this is expected theoretically).

**Results for 2015**

* The main activity has been completing MHD non-linear stability analyses in cylindrical and toroidal geometry for (classical) 2/1 tearing modes. It is demonstrated:-
  + For sub-Alfvenic flows that a non-sheared flow has no effect on the stability
  + That linearly toroidal sheared flow is destabilising, and poloidal flow shear stabilising. In both cases the growth rate is symmetric with respect to the sign of flow (this is important because the opposite flow symmetry of the DIII-D and AUG results).
  + That helical flow is not symmetric - helical flow twisting with magnetic field is stabilising and vice-versa.
  + Nonlinearly because poloidal flows are generated, co and counter toroidal flows are not symmetric with respect to the saturated island width (though both are destabilizing for the case examined).
  + Initial toroidal calculations show the centrifugal induced Shafranov shift affects the q-profile, which in-turn alters the stability.
* These results are reported in a paper from a sub-set of the JA-1 team (D Chadra et al, NF **55** (2015) 053016).

**Plans for 2016**

* JA-1 and JA-2 share many common personnel, so effort on JA-1 will be limited in 2016
* The priority is now to non-linearly model the effects of flow shear on the NTM (as opposed to the TM), including diamagnetic flows. This will first be in cylindrical geometry (but with bootstrap effects included) and then extended to toroidal geometry.