TC-21 Characteristics of the LOC/SOC transition

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| **TG priority:** Moderate | **Start date:** 2011 | **Status:**  On-going | **Personnel exchange:**  Yes |
| **IO priority:** | **End date:** Not fixed | **Motivation:** Physics Basis | |

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| **Device /**  **Association** | **Contact**  **Person** | **2016 TG Request** | **Activity (from JEX/JA spreadsheet)** | | | | |
| **2012** | **2013** | **2014** | **2015** | **2016** |
| C-Mod | J. Rice | Desirable | Committed | Analysis | Analysis | Analysis |  |
| AUG | C. Angioni  R. McDermott | Desirable | Committed | Committed | Analysis | Analysis |  |
| TCV | B. Duval | Desirable | Committed | Considering | Analysis |  |  |
| DIII-D | S. Mordijck  Y.-S. Na | Desirable | Not doing | Not doing | Considering | Not doing |  |
| Tore Supra | C. Fenzi | Data mining |  |  |  | Done |  |

**Purpose:** The purpose of these experiments is to investigate across the LOC-SOC transition the relation among energy confinement saturation, rotation reversal, density profile peaking, turbulence changes and other related phenomena in a multi-machine comparison and identify the key parameters that regulate the transition (e.g. collisionality) .

**Results for 2015**

* A very nice study of turbulence changes across the LOC/SOC transition was performed by Hugo Arnichand [Nucl. Fusion **55** (2015) 093021]. A comparison of fluctuations measured with reflectometry in Tore Supra, TEXTOR, JET and AUG was undertaken. The common theme is that in LOC plasmas in these 4 devices there is a quasi-coherent mode, identified as being due to TEMs, which abruptly disappears at the transition to the SOC regime. This was achieved with both electron density and plasma current ramps and shot by shot scans. Detailed measurements of the spatial structure of turbulence were also made.
* Crossing the LOC/SOC boundary (with constant parameters) was achieved by raising Zeff with strong gas puffing in C-Mod plasmas, through changes in the collisionality. Detailed gk simulations have been performed and a strong effect on ion thermal transport is observed through main ion dilution, through changes in either the stiffness or critical ion temperature gradient.

**Plans for 2016**

* There will be dedicated run time on C-Mod in 2016, with more turbulence measurements and an investigation of the role of impurity seeding. Further gk analysis will be performed on existing data, and a large database is under construction. Further data mining and analysis will be performed on Tore Supra, AUG, DIII-D and TCV.

**Background:** It has been widely observed that Ohmic energy confinement in tokamaks increases linearly with electron density, and then saturates at a critical density. The behavior in the linear Ohmic confinement (LOC) regime is not well understood theoretically. The commonly accepted ansatz is that at low density, electron turbulence (possibly TEM) regulates the confinement, while in the saturated (SOC) regime, ion temperature gradient (ITG) modes dominate. In fact measured turbulence changes at the LOC/SOC transition are in agreement with this concept. Following the discovery of H-mode, very little effort has gone into the understanding of these Ohmic confinement regimes.

The recent results associating Ohmic energy confinement saturation with core toroidal rotation reversals have shed new light on this old problem.

Immediate goals are to identify the relevant parameters, including the collisionality and the electron to ion temperature ratio, to document concomitant changes in turbulence characteristics and to compare with theory and gyro-kinetic simulations.

The first step is to perform density scans shot to shot at fixed q, measuring the global energy confinement time, toroidal rotation velocity profiles, electron density profiles, electron and ion temperature profiles, Zeff and turbulence characteristics. If possible impurity transport coefficients from LBO, and heat pulse propagation behavior should also be tested. Once the transition density has been found, perform density ramps to document dynamic changes at the transition. Repeat at different q values. Collisionality scans may also be performed with ECH.

A comparison of LOC/SOC transition points from several devices, combined with recent density scans at C-Mod and AUG, suggests that this transition, along with rotation reversals and turbulence changes, occurs at a fixed value of the collisionality.

The primary motivation of these experiments is to test this hypothesis.