TC-10 Turbulence and transport in the L-mode core-edge region

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| **TG priority:** Moderate | **Start date:**   | **Status:**  On-going | **Personnel exchange:**   |
| **IO priority:**   | **End date:**   | **Motivation:**   |

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| **Device /****Association** | **Contact****Persons** | **2016 TGRequest** | **Activity (from JEX/JA spreadsheet)** |
| **2012** | **2013** | **2014** | **2015** | **2016** |
| AUG  | C. Angioni | Desirable | Committed | Committed | Committed | Committed |   |
| C-Mod | J. Rice | Desirable | Considering | Analysis | Analysis | Committed |   |
| DIII-D | G. McKee | Desirable | Committed | Considering | Considering | Considering |   |
| JET | M. Romanelli | Desirable | Not doing | Considering | Considering | Analysis |   |
| NSTX-U | S. Kaye | Desirable | Analysis | Analysis | Analysis |   |   |
| Tore Supra | C. Bourdelle | Desirable | Considering | Committed | Committed |   |   |
| JT-60U | M. Nakata | Desirable |   |   |   |   |   |
| KSTAR | Y. U. Nam | Desirable |   |   |   | Considering |   |

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**Purpose:** provide a reliable model for the L mode edge compatible with integrated modeling to model ITER ramp up phase. Work is organized on 3 axes: 1) nonlinear local gyrokinetic simulations; 2) global nonlinear gyrokinetic simulations; 3) quasilinear models.

**Results for 2015**

Recent progresses are on further detailed comparisons with experiments based on synthetic diagnostics, dedicated studies regarding mean-flow effects and multi-scale simulations that can explain missing electron transport fractions and in some cases even demonstrate an increase in the ion heat channel by cross-scale effects. TGLF has been modified along these lines and shows encouraging first results.

1. **nonlinear local gyrokinetic simulations**

The work on DIII-D L mode edge with various local nonlinear codes has progressed. The actual status is that GENE could reproduce the heat fluxes (electron heat fluxes by separate single-scale simulations) and ECE temperature fluctuations within the experimental error bars of the turbulence drive, the density BES fluctuation level was still underestimated which could also be due to deficits in the implementation of this particular synthetic diagnostic, see [Görler et al., PoP14]. Comparison with gradient-driven global GENE simulations indicates negligible finite-size effects in the radial range under investigation and flow effects have been found to only weakly affect the ion heat transport at nominal values [Görler et al., submitted to FS&T'15]. Furthermore, no substantial difference could be found between the spectral and non-spectral implementation of the ExB shear flow operator. On the GYRO side, the CGYRO multiscale simulations in 2016 will revisit this case, indeed small scale fluctuations are expected to be key for the electron heat transport in the edge where the linear spectrum continuously go from ITG-TEM-ETG. They might even affect the ion heat channel to some degree. In parallel, in particular for the ion channel, it is important to continue identifying differences in numerical schemes and numerical diffusion.

On other L mode edges, CMod, AUG and JT60-U, the local nonlinear gyrokinetic codes could reproduce the experimental heat fluxes within the R/LT uncertainties. One has to note that in the edge region the magnetic shear has also large uncertainties affecting the results of fixed gradient local models. The impact of uncertainties on q and s could be more systematically investigated in these regions.

An interesting effect of flow, flow shear and ExB signs has been identified in absence of electron temperature gradient in GKW [Camenen EPS15]. It is not clear at this stage if it is related to the L mode edge code to code discrepancy.

1. **global nonlinear gyrokinetic simulations**

Global nonlinear XGC1 simulations are making progress, it is shown that accounting for self-consistent mean flows leads to lager heat fluxes and is a key ingredient to model the L mode edge heat flux levels.

1. **quasilinear models**

TGLF modeling of DIII-D cases [Kinsey PoP15] exhibit a larger discrepancy of the electron heat flux towards the edge for larger q. The q impact has not been extensively explored by nonlinear gyrokinetic codes in this parameter regime

 Based on multiscale simulations [Howard 2014-2015] using GYRO, the saturation rule of TGLF has been modified in TGLF-M to account for the mixing of ky modes in cases where the zonal flow decorrelation is weak. TGLF-M is shown to reproduce well the multiscales GYRO runs and leads to better prediction for a high beta poloidal DIII-D pulse.

**Plans for 2016:**

1. **nonlinear local gyrokinetic simulations**

End 2016 expected report on CGYRO results and role of multiscales in the L mode edge region, in particular on the electron heat channel. Continue exploring the numerical schemes impact. Investigate the uncertainties on q and s potential impact. Explore with other codes than GKW the flow, ExB signs impact on heat fluxes, in particular at which R/LTe it becomes a minor effect.

1. **global nonlinear gyrokinetic simulations**

End 2016 expect global simulation for the DIII-D parameters and comparison with Te and density fluctuations using XGC1. Should also have GYSELA simulation of a Tore Supra L mode with turbulence measurements.

1. **quasilinear models**

Explore q and s impact on L mode edge cases using nonlinear and quasilinear gyrokinetic codes to confirm/understand the q impact on L mode edge fluxes modeling. Revisit DIII-D L mode edge database of [Kinsey 2015] using TGLF-M.

**Conclusion:** Plan a L mode edge session in fall 2016 or Spring 2017 to report on CGYRO results, role of multiscales in L mode region, advances on numerical schemes investigation, eventual q impact, on global simulations comparison with power balance fluxes and turbulence measurements and on how to validate further modified saturation rules in quasilinear models to reproduce L mode edge fluxes vs nonlinear simulations and experimental results.