# MDC-16 Runaway electron generation, confinement, and loss

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| **TG priority:** Critical | **Start date:** 2009 | **Status:**  On-going | **Personnel exchange:**  Yes |
| **IO priority:**   | **End date:**  N/A  | **Motivation:**  Understand and mitigate disruptions  |

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| **Device /****Association** | **Contact****Persons** | **2016 TGRequest** | **Activity (from JEX/JA spreadsheet)** |
| **2012** | **2013** | **2014** | **2015** |
| C-Mod  | R. Granetz | Desirable | Committed | Analysis | Analysis | Analysis |
| Aditya  | P. Chattopadhyay | Desirable |   |   |   | Considering |
| AUG  | G. Pautasso | Desirable | Committed | Committed | Committed | Committed |
| DIII-D  | C. Paz-Soldan | Desirable | Committed | Committed | Analysis | Considering |
| FTU  | B. Esposito | Desirable | Committed | Committed | Committed |   |
| JET  | C. Reux | Desirable | Committed | Committed | Committed | Committed |
| JT-60U  | Y. Kawano | Desirable | Analysis | Analysis | Analysis | Analysis |
| JTEXT | Z.Y. Chen | Desirable |   | Committed | Committed |   |
| KSTAR  | J. Kim | Desirable |   | Considering | Considering |   |
| RFX-Mod | P. Martin | Desirable |   | Committed | Committed | Committed |
| TEXTOR  | R. Koslowski | Desirable | Committed | Committed | Committed |   |
| Tore Supra  | F. Saint-Laurent | Desirable | Committed | Not doing | Not doing |   |
| MST | B. Chapman | Desirable |   |   |   |   |

**Purpose in Brief**

* Characterize runaway electron generation and confinement: energy spectrum, time scale, seed generation mechanisms, and conditions for generation during VDE.
* Provide the physics basis for approaches to runaway suppression and mitigation

**Results for 2015**

* Nitrogen puffing into runaway populations present in the quiescent flattop of DIII-D discharges has provided data on the influence of Zeff on RE growth/decay rates. The effect is found to be small, but clearly discernible, and provides an opportunity to compare with theoretical prediction (work in progress with Pavel Aleynikov)
* Full visible spectra of RE synchrotron emission have been obtained during the quiescent flattop of Alcator C-Mod discharges. The spectra are being analysed and compared to theory with the help of Adam Stahl and the Chalmers group. Radially resolved polarisation data was also obtained.
* A gamma-ray 2D imaging camera has just been deployed on DIII-D. It will provde energy-resolved 2D images of high-energy bremsstrahlung emitted via collisions of the RE’s with the background plasma.
* Active use of the RMP coils on MST, configured for m=3, suppresses RE’s (surmised from drop in HXR emission) at sufficiently high RMP amplitude, but m=1 does not.
* The threshold E-field required to produce RE plateaux in HL-2A disruptions is 40 times higher than the Connor-Hastie Ecrit. SMBI injection of *helium* into an established RE plateau dissipates the RE’s.
* RE experiments on ASDEX-U find that the existence of RE’s is highly irreproducible, presumably depending on some unknown parameters. (Same issue reported on C-Mod). Injection of argon increases the RE decay rate, but the deduced argon concentration (from improved spectroscopy) gives a threshold E-field that is 3-10 times lower than expected. This is not understand yet.

**Plans for 2016**

* Ongoing comparison of theoretical models to measurements of impurity-influenced RE growth/decay rates in DIII-D and ASDEX-U.
* Fits of RE synchrotron spectra in C-Mod to theoretical models should allow determination of max RE energy and pitch angle, and maybe discrimination between a broad RE energy distribution and a ‘bump-on-tail’ distribution.
* MST is planning more experiments using its RMP coils to affect RE’s during the flattop, and possibly even during disruptions.
* DIII-D is planning more runs devoted to runaway studies (w/new gamma ray imager) next summer.
* There was some discussion about closing the specific joint experiment to measure the critical E-field during the quiescent flattop on numerous machines and compare to Connor-Hastie Ecrit. The results were published last year, and presented at the IAEA conference. A new joint experiment to look at the same parameters, but during disruption RE plateau may be proposed as a follow-on. More discussion of this is warranted.

**Background:** This is a continuation of MDC-16, which began in 2009.

Avoidance or suppression of runaway electrons during disruptions remains a crucial topic for ITER. Better understanding of their generation, confinement, and loss is urgently needed for specification of ITER’s disruption mitigation system. Gas injection quantities for suppression of runaway avalanche generation need to be verified. Recent experiments on control of the runaway electron beam suggest possible alternatives aimed at slow dissipation of the runway energy.

A recent joint experiment shows that the critical electric field for runaway electron generation is significantly higher than expected. This has important implications to the density requirements for suppression of runaways.

Impurity puffing into established RE populations on a number of machines has been shown to increase dissipation of RE’s

Synchrotron emission spectra and polarisation have been measured, and should provide information on RE energy and pitch angle distribution