



Contribution ID: 67

Type: Poster

## EX/P6-04: First Operations of the Real-Time ECRH/ECCD System for Control of Magnetohydrodynamics Instabilities in the FTU Tokamak

*Thursday, 11 October 2012 14:00 (4h 45m)*

Time-controlled injection of powerful Electron Cyclotron (EC) waves is an effective way to reduce the tearing instabilities that can develop close to low rational  $m/n$  (poloidal/toroidal mode numbers) magnetic surfaces in tokamak operations at high beta (plasma/magnetic pressure). A Real Time Control (RTC) system including fast data acquisition/elaboration and actuator's control is being implemented in FTU tokamak. Most of the elements of the control chain of the prototype system have been successfully tested in plasma operations. Main objectives are the detection and control of  $m/n = 3/2$  and  $2/1$  (N)TM, and of the sawtooth activity. The actuator is the newly installed fast (poloidal angular velocity  $= 1^\circ/0.01s$ ) steerable two-beam ( $2 \times 0.4MW \times 0.5s$ ) 140GHz EC launcher. The RTC system uses signals from standard diagnostics: electron temperature from 12-channels ECE (EC Emission) grating polychromator, 2x8 magnetic from the Mirnov coils and 2 ECRH power monitors. This set of signals undergoes a two-stage elaboration through the control chain. Main task of the first stage is MHD activity detection and location. In the second stage the controller provides time and space references for the EC power injection. The diagnostics codes act in a timescale (1-50microseconds) significantly shorter than the time step of the controller (1ms). The architecture of the system allows taking advantage of available a-priori information about the probable location of the unstable perturbation. A fast magnetic equilibrium reconstruction and a fast EC ray tracing codes have been implemented for these purposes. The main algorithms blocks in the detection stage are ECE-ECE, ECE-Mirnov and ECE-ECRH cross-correlation in the time domain, and SVD (Single Value Decomposition) of Mirnov signals in time and space domain. The cross-correlation algorithms are used to locate the magnetic island and SVD provides an independent marker of the instability through its frequency detection. The control system is implemented with the open-source framework MARTE (Multi-threaded Application Real-Time executor) on Linux/RTAI real-time operating system. The capabilities of effective detection, false positive resilience, and mode number discrimination are discussed through the application to actual plasma data. The process of validation of RT tools by comparison with off-line analysis is also described.

### Country or International Organization of Primary Author

Italy

**Primary author:** Mr SOZZI, Carlo (Italy)

**Co-authors:** Dr BRUSCHI, Alessandro (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr MORO, Alessandro (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr SIMONETTO, Alessandro (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Mr GROSSO, Andrea (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Dr BOTRUGNO, Antonio (C.R.

Frascati, Associazione EURATOM-ENEA, Italy); Mr TILIA, Benedetto (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Dr MARCHETTO, Chiara (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr GALPERTI, Cristian (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr FARINA, Daniela (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr MINELLI, Daniele (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr ALESSI, Edoardo (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr LAZZARO, Enzo (Istituto di Fisica del Plasma CNR); Dr IANNONE, Franco (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Prof. D'ANTONA, Gabriele (Dipartimento di Elettrotecnica, Politecnico di Milano, Milano, Italy); Dr RAMPONI, Gabriella (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr GUSTAVO, Granucci (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr FIGINI, Lorenzo (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr BONCAGNI, Luca (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Dr PANELLA, Maaurizio (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Dr D'ARCANGELO, Ocleto (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr TUDISCO, Onofrio (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Dr PLATANIA, Paola (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr FERRERO, Roberto (Dipartimento di Elettrotecnica, Politecnico di Milano, Milano, Italy); Dr CIRANT, Sante (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr GARAVAGLIA, Saul (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr NOWAK, Silvana (Istituto di Fisica del Plasma, IFP-CNR, Associazione EURATOM-ENEA-CNR sulla Fusione); Dr VITALE, Vincenzo (C.R. Frascati, Associazione EURATOM-ENEA, Italy); Ms MELLERA, Vittoria (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy); Dr BIN, William (Istituto di Fisica del Plasma CNR, Associazione EURATOM-ENEA, Milano, Italy)

**Presenter:** Mr SOZZI, Carlo (Italy)

**Session Classification:** Poster: P6

**Track Classification:** EXW - Magnetic Confinement Experiments: Wave-plasma interactions; current drive; heating; energetic particles