6. PARTICIPATION IN THE TJ-II PROGRAMME[1]

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6.1. INTRODUCTION

The Portuguese participation in the TJ-II programme has been mainly focused in three research areas:

- Microwave reflectometry;
- Electrode biasing experiments;
- Heavy ion beam diagnostic.

6.2. MICROWAVE REFLECTOMETRY[2]

CFN has developed in 2004 a *fast frequency hopping reflectometer*, operating in the Q-band (33-50 GHz), with wave propagation in X-mode. It can be tuned to any selected frequency, within a fraction of a ms, enabling to probe several plasma layers within a short time interval. This gives the possibility to study important characteristics of radial distribution of plasma turbulence. First results have been obtained in 2005 showing the formation of a velocity shear layer above a certain critical density and demonstrating the good spatial resolution of the reflectometry measurements. In view of the good results obtained with the diagnostic, a new system is being developed to study correlation properties of plasma turbulence. It uses basically the same design of the previous hopping system. The final design has been assessed and the procurement has been initiated.

6.3. ELECTRODE BIASING EXPERIMENTS[3]

Following earlier investigations on the effect of electrode bias on the TJ-II boundary plasma, a detailed comparison between *positive and negative bias at densities above the threshold value to trigger the spontaneous development of ExB sheared flows* has been performed. We found that at high densities negative voltages are easier to impose when compared with positive ones as the forced plasma rotation is in the same direction of the natural rotation. Figure 5.1 shows the time evolution of the main plasma parameters for discharge with negative bias. As the bias is applied, a strong reduction in the H_α emission is observed associated with an increase in the density up to the ECRH cut-off frequency. A stronger reduction of recycling is observed for negative bias, when compared with that observed for positive bias at similar plasma density, resulting therefore in a larger increase in the ratio $\overline{n}/H_\alpha$ (~70%). These results are in agreement with observation in other devices where improvement in particle confinement is in general observed for both polarities, being larger with negative bias.

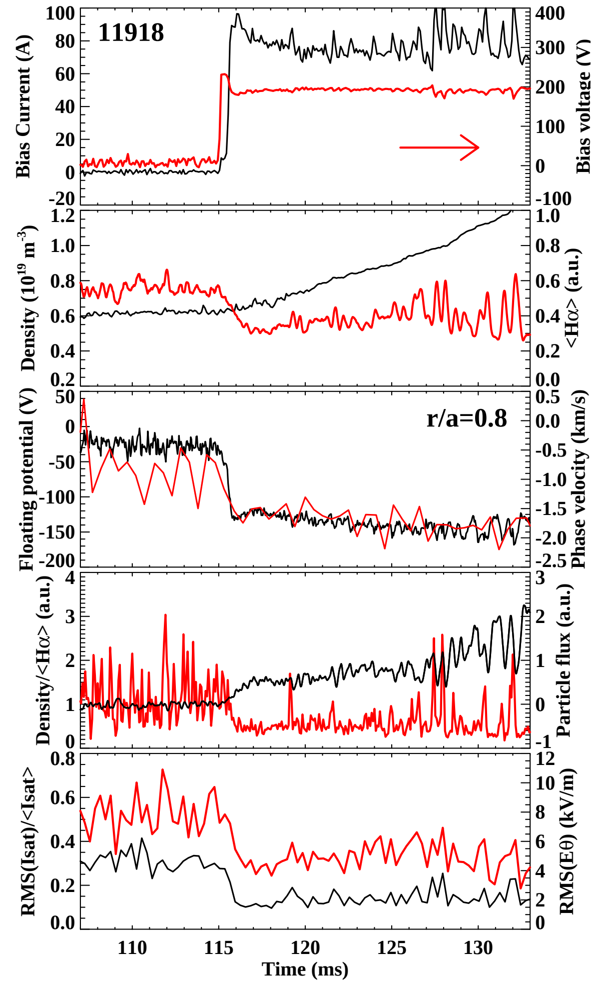

Figure 6.1 – Time evolution of the main plasma parameters for a discharge with negative electrode bias (V_{bias}=200V, $r_{elec}/a \approx 0.9$) at high density.

6.4. HEAVY ION BEAM DIAGNOSTIC[3]

6.4.1. Introduction

This research line included in 2005 the improvement of the multiple cell array detector (MCAD), the revision of the conditioning electronics, the development and testing of a new control and data acquisition system and the beginning of the diagnostic operation.

The revision of the *multiple cell array detector* was finished, including repair of the damaged contacts and cells, duplication of the contacts of the working cells and insulation of the MCAD housing and biasing grids from

[1] Work carried out in collaboration with the Association EURATOM/Ciemat. Contact Person: J. Sanchez
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the TJ-II vacuum vessel. The cells have been modified and improved by insertion of tantalum “wire-balls” into Faraday cup matrix.

Concerning the *conditioning electronics* eight preamplifiers and amplifiers have been repaired and tested. The preamplifier-connector part has been modified and included in a single box, aiming at decreasing the cable lengths and, therefore, the noise.

A 24-channel *control and data acquisition system* has been developed, tested and pushed into operation.

Regarding the *diagnostic operation*, the fist experimental campaigns have permitted clear observations of the primary ions at energies of 80 keV, 90 keV and 100 keV.

6.4.2. Control and data acquisition system

6.4.2.1. System Overview

The new dedicated control and data acquisition system for the multiple cell array detector of the TJ-II heavy ion beam diagnostic (HIBD) is based on in-house designed VME modules and Linux.

The hardware consists of: (i) a VME host running Linux; (ii) four CFN transient recorder boards; (iii) an analogue output board; and (iv) a commercial 32 bit TTL I/O M-Module mezzanine.

The software for the active control of the primary and secondary beam lines has two major components: (i) a server daemon running on the VME host, receiving operation parameters and waveforms to be programmed and controlling board operation; (ii) client applications with graphical user interfaces running on the control room PC’s.

The software for the MCAD acquisition system consists of a daemon controlling acquisition and writing data to the TJ-II database and a graphical application allowing easy configuration of acquisition parameters.

6.4.2.2. Multiple cell array detector

Currently 32 channels are installed, provided by four in-house designed transient recorder modules (VME8i125). Each VME8i125 transient recorder module has 8 channels with 12 bits resolution, 512 kSamples per channel of inboard memory and a sampling rate up to 1.25 MSPS. The end of acquisition signal is defined by a commercial 32 TTL I/O M-Module mezzanine, since the VME8i125 does not provide this information.

The software of the MCAD data acquisition system has two major components (Figure 6.2): a daemon that runs on the VME host and a graphical application that is used to configure all acquisition parameters. The configuration application can be run in any computer (inside or outside the control room). The MCAD daemon: (i) reads the transient recorder module configuration (produced by the MCAD configuration editor application); (ii) programs and arms the transient recorder modules with the configuration provided by the user; and (iii) reads the acquired data from the board memory and writes it (along with configuration parameters) to the TJ-II database.

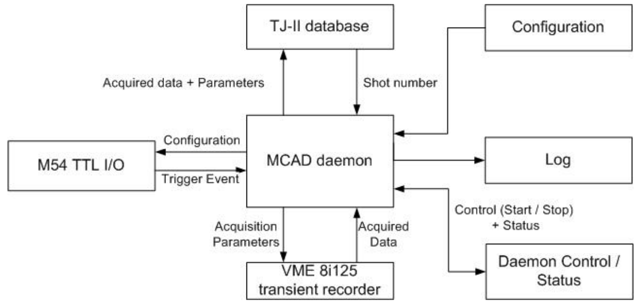

Figure 6.2 - Block diagram of the software of the MCAD data acquisition system

6.4.2.3. Active beam control

The active beam control software has two major components (Figure 6.3): a server daemon that receives the board configuration and waveforms and a pair of clients with graphical user interfaces. Both clients allow the user to configure the trigger type (external or internal), the update rate and the waveform. The main difference between the two clients is the way how the waveform is selected: one client has a set of predefined waveforms (sinus, triangular, sawtooth, and constant) and the other allows the user to interactively design a waveform with the mouse.

The link between the clients and the server is achieved with an Ethernet connection. The communication is done using a custom protocol over TCP/IP. The daemon only accepts connections from specific computers in the control room. Additionally, at a given moment only one client is allowed to be connected to the server. To prevent the possibility of the VME8O board being loaded with garbage (due to waveform data corruption in the network transmission) all the waveform data passes through a software limiter in order to maintain the high voltage power supply within a safe voltage range.

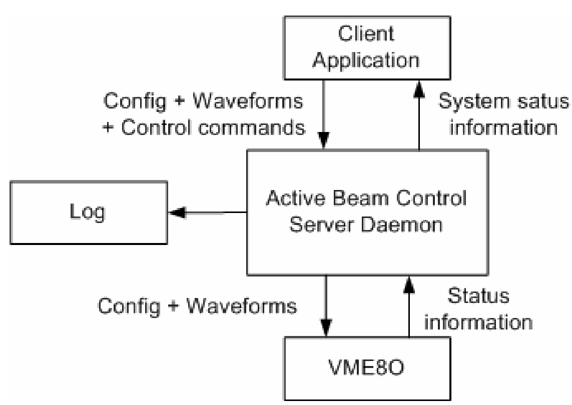

Figure 6.3 - Block diagram of the software for active beam control