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The Data Acquisition and Control System for Thomson Scattering on ATF*

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ABSTRACT

The 2-dimensional Thomson Scattering System measuring electron temperatures and densities in the Advanced Toroidal Facility (ATF) is interfaced to a VAX-8700 computer system running in a clustered configuration. Calibration, alignment, and operation of this diagnostic is under computer control. Extensive CAMAC instrumentation is used for timing control, data acquisition, and laser alignment. This paper will discuss the computer hardware and software, system operations, and data storage and retrieval.

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I. Introduction

The 2-dimensional Thomson Scattering diagnostic operating on the Advanced Toroidal Facility (ATF) torsatron at the Oak Ridge National Laboratory (ORNL) measures electron temperatures and densities at 15 points along a vertical chord providing a map of a toroidal cross section with multiple shots. The light source is a pulsed ruby laser. The light is detected by fiber optic bundles which direct the scattered light to 15 polychromators. The light is collected by 5 or 7 photomultiplier tubes, and then measured by 12-channel analog to digital integrators. This system is a modification of the Thomson Scattering system that operated on the Impurity Studies Experiment (ISX) tokamak[1] . The modifications were due to the geometric differences in the machines as well as efforts to improve the system.

The data acquisition and control system that operated and controlled Thomson Scattering on ISX was also modified for ATF. These modifications included conversion to a new computer system, revisions required to utilize a synchronization and timing system, conversion to a new data management facility, and improvements to the user interface and to data storage and retrievel.

II. Hardware

The data acquisition and control system for Thomson Scattering is interfaced to the Fusion Energy Division's (FED) VAX computer system. This system consists of two VAX computers, an 8700 and 8600, running in a clustered configuration. All ATF user and data disks are clustered enabling users to have access to the data from either computer. Both computers have two bit-serial CAMAC highways. At present, all ATF data acquisition is performed on the VAX-8700 with the VAX-8600 used as back-up in case of failure.

The ATF CAMAC system consists of 40 crates supporting 21 diagnostics. Six of these crates support Thomson Scattering. Three crates located in an electrically shielded screen

room, one in the experiment enclosure, and one in the laser room, one floor beneath the experiment, are linked to a bit serial highway of fiber optics interfaced to the ATF CAMAC highway by Kinetic Systems U-port adapters. A bit-serial highway of ribbon cable supports one crate located in the experiment control room.

The Thomson Scattering diagnostic extensively uses CAMAC instrumentation for timing, data acquisition, experiment control, and user interaction. The CAMAC instruments can be functionally catagorized into four groups: data acquisition, translation and alignment, laser diagnostic, and timing.

III. Software

The Thomson Scattering software (TSCAT) can be grouped into three related areas: user interaction, data acquisition and storage, and data display.

The user interaction software consists of a menu of commands. After each shot the experimentalist can select commands to change attenuator or voltage values, setup for calibration shots, display data from the last shot, change spectrometer position, input laser firing times, begin a sequence of shots, and automatically or manually charge laser.

The data acquisition and storage software is entered by the charge command or, when in automatic operations, by the T-30 second ATF trigger. The system displays status information thoughout this process.

Attenuator values, photomultiplier tube voltages, and scattered light signals are written to the terminal screen with the display software. Separate software is used to retrieve, analyze, and display the data between shots or after the day's run.

The Thomson Scattering software uses the services of three software packages. These packages form the central software components for ATF. They are a synchronization and monitoring system $(SAMS)^2$ that provides task management and timing information, a data management system $(DMG)^3$ that provides storage and retrieval capabilities for raw and analyzed data, and the ORNL CAMAC driver package.

IV. Operations

TSCAT provides the user with three modes of operations: manual, automatic, and calibrate.

The manual mode enables the user to start the shot sequence on command. This mode is used when running laser diagnostics and synchronization with ATF is not necessary.

Automatic mode is the usual mode of operation and requires very little user interaction. Laser time, attenuation values, and voltage settings are preset. The shot sequence is initiated by the ATF T-30 second signal. Data is acquired, display, and stored automatically.

Calibration mode is used for wavelength and spectral calibration shots. These shots require little user interaction, but are not synchronized with ATF. Data from these shots are stored in special calibration files.

V. Data storage and Retrieval

One of the major improvements to TSCAT was the data storage and retrieval software. On ISX, data were acquired on a VAX-780 computer and transmitted to a PDP-10 for analysis and storage. TSCAT was essentially a stand-alone diagnostic system. On ATF, TSCAT is integrated into the ATF computer system though it's use of DMG. DMG provides TSCAT with data storage and retrieval though subroutine calls from a run-time library of routines invoked as a sharable image. TSCAT's data are stored using five of the six data models DMG provides; scalar, vector, array, sivdata (single independent variable with constant increment), and nsivdata (single variable with varying increment).

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