



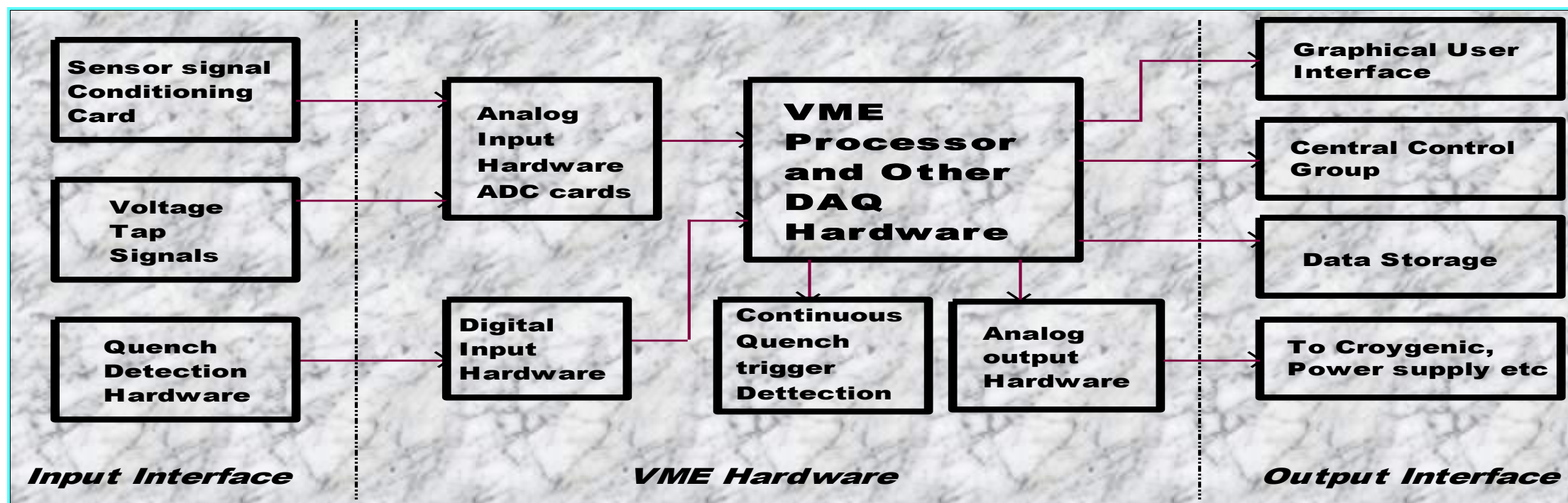
# A Large Channel Count Multi Client Data Acquisition System for Superconducting Magnet System of SST-1

K. Doshi<sup>#</sup>, S. Pradhan, H. Masand, Y. Khristi, J. Dhongde, A. Sharma, B. Parghi, P. Varmora, U. Prasad and D. Patel  
Institute for Plasma Research, Gandhinagar, Gujarat, INDIA  
<sup>#</sup>pushpak@ipr.res.in



**Abstract :** The magnet system of the Steady-state Superconducting Tokamak-1 at the Institute for Plasma Research, Gandhinagar, India, consists of sixteen Toroidal field and nine Poloidal field Superconducting coils together with a pair of resistive PF coils, an air core ohmic transformer and a pair of vertical field coils. These coils are instrumented with various cryogenic grade sensors and voltage taps to monitor its operating status and health during different operational scenarios. A VME based data acquisition system with remote system architecture is implemented for data acquisition and control of the complete magnet operation. Client-Server based architecture is implemented with remote hardware configuration and continuous online/ offline monitoring. A JAVA based platform independent client application is developed for data analysis and data plotting. The server has multiple data pipeline architecture to send data to storage database, online plotting application, Numerical display screen, and run time calculation. This paper describes software architecture, design and implementation of the data acquisition system.

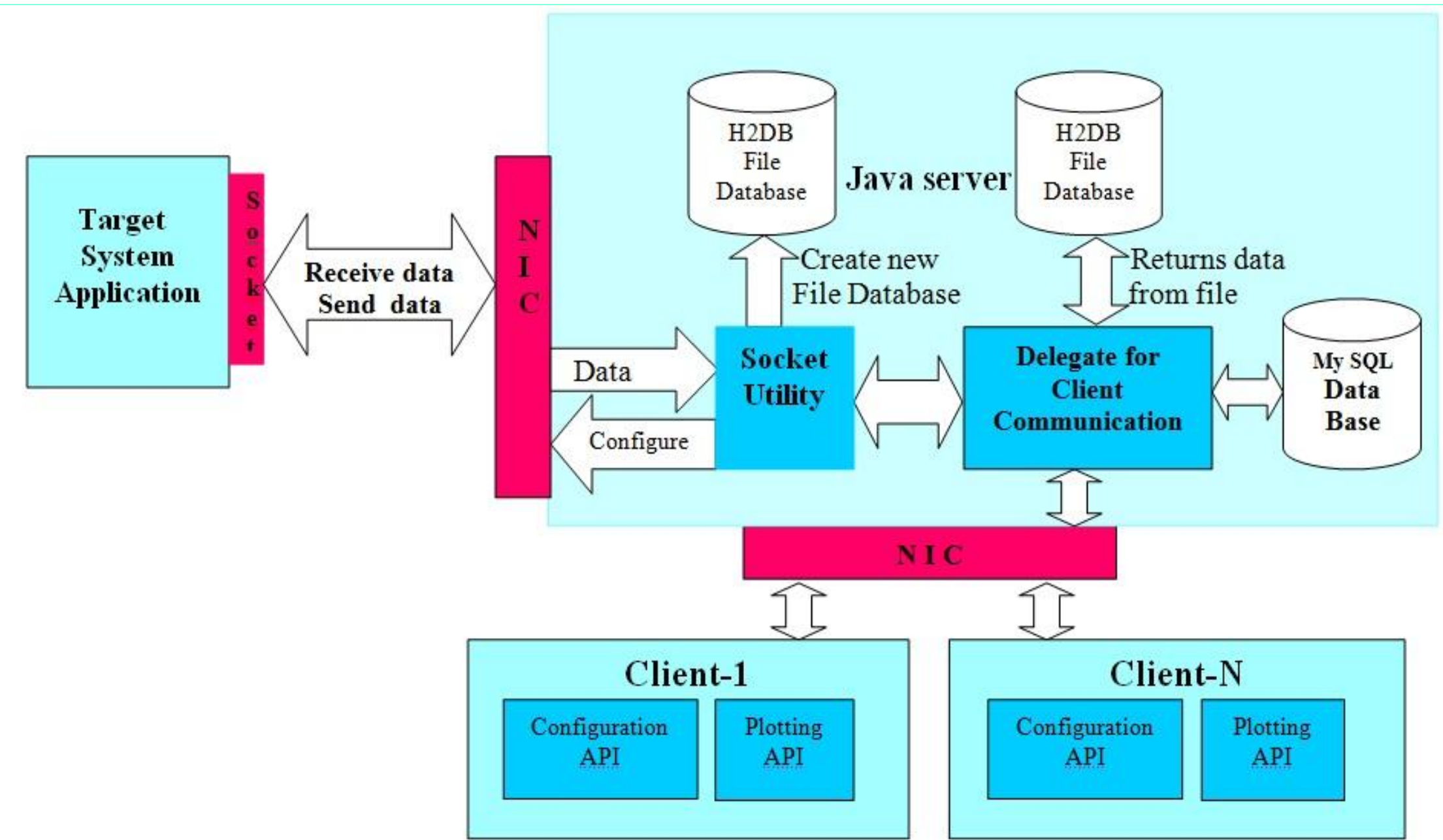
## Block Diagram of Magnet Data Acquisition System



### Scope of Development

- ◆ A dedicated VME based system is configured to realize SST-1 magnet data acquisition system as shown in above block diagram. The software application for this complete system is divided in three interlinked parts.
- ◆ A target board application based on VxWorks RTOS with Tornado IDE.
- ◆ An application server to provide the data to the multiple remote client applications.
- ◆ A web based desktop Client application to access data for data analysis and data plotting for monitoring purpose. This is a platform independent system and resides on Linux or Windows operating system.

## Tools and Technology for Development



Sr No	Hardware / Software	Technology / Modules used
1	RTOS Controller	SBS VG4 Power PC 755 from SBS Technologies
2	IP carrier card	AVME 9660 from Acromag Inc.
3	Analog In card	IP 330 from Acromag Inc.
4	Analog Out card	IP 230 from Acromag Inc.
5	Digital I/O card	VMIC VME 2528 – 128 Bit from VMIC Inc.
6	GPS timing module	BC635VME from Symmetricom Inc
7	Operating System	Target Board Application: VxWorks 5.4/5.5 RTOS Server Application: Platform independent. Client Application: Platform independent.
8	Database	MYSql, H2 Database
9	Application Development Environment/Tools	Tornado IDE 2.0.2, Netbeans IDE 6.7.1, JAVA 6.0
10	Application/Web Server	Tomcat apache server 6.0.20
11	Visualization tools	Live graph, JFreeChart

## Channel Distribution

Sr. No	Sensor Channel details	No. of Channels	Application
1	Temperature Sensors	150	Temperature Measurement
2	Voltage tap channels	224	Quench detection and magnet voltage monitoring
3	Flow meters ( Venturi meters)	32	Flow measurement into hydraulic paths of magnets
4	Hall probes	16	Direction and intensity measurements of magnetic field
5	Linear displacement transducers	12	Displacement measurement in cool down & warm up of cold mass
6	Absolute Pressure Sensor	16	Helium Pressure measurement
7	Strain gages	8	Stress measurement on magnets
8	Joint Resistance Measurement	102	Inter-pancake and Inter-coil joint resistance measurement

## Project Features Summary

### Target board application features

- ◆ Manage analog signal to digital data conversion using ADC cards.
- ◆ Continuously acquire data whenever interrupt occurs.
- ◆ Calibration of the Data acquisition hardware with onboard reference.
- ◆ Apply moving average filter to remove noisy data.
- ◆ Converts programmed digital data into Analog signal using DAC cards.
- ◆ Sends Trigger information to the socket utility for indication of trigger.
- ◆ Continuously transfer acquired data to server socket utility.
- ◆ Get and Set Configuration details to VME send by client application.
- ◆ Manage synchronous time stamping using GPS time from central control.

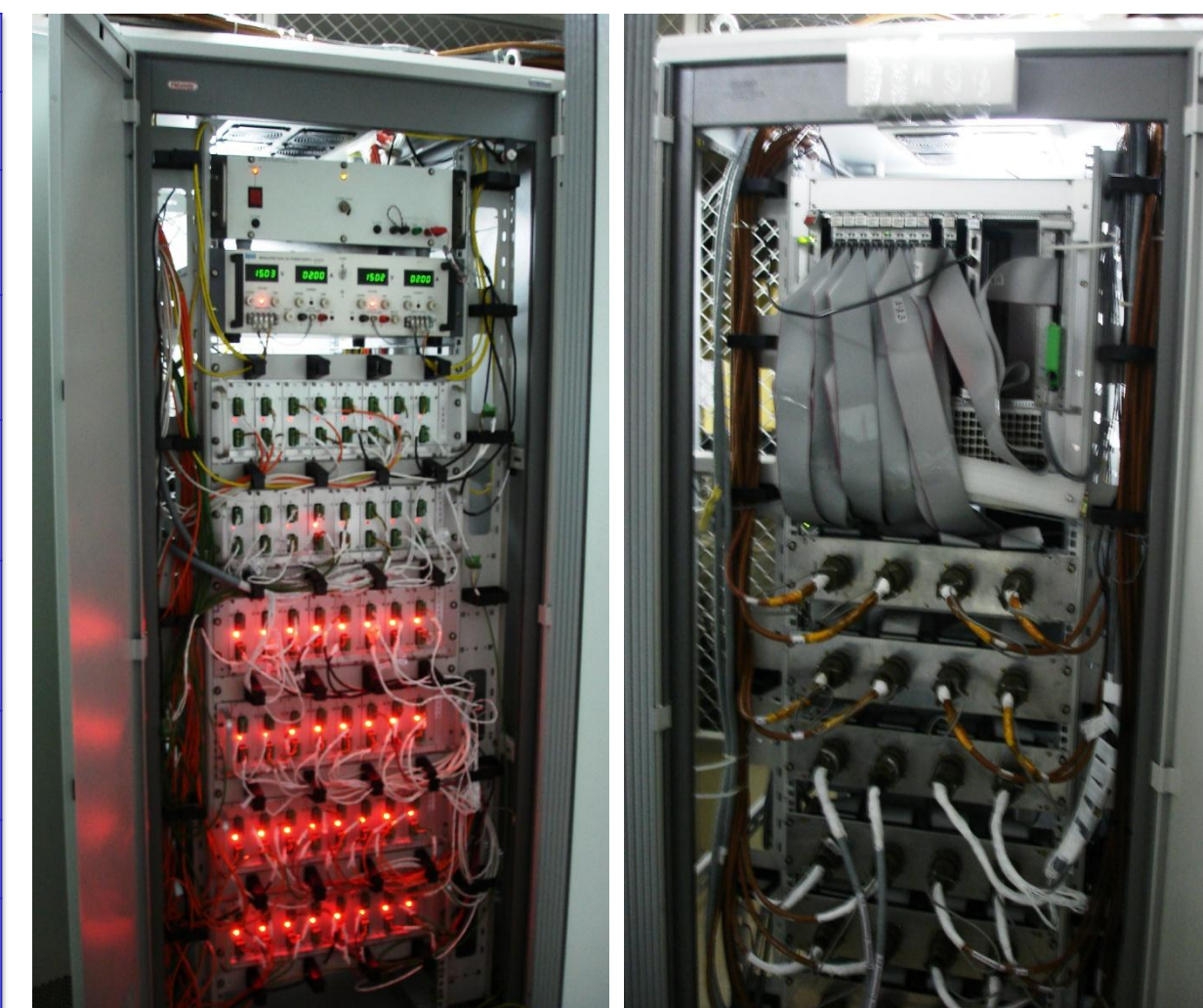
### Server Application features

- ◆ Captures data from the Target board Application.
- ◆ Data synchronization using higher scan rate of configured cards.
- ◆ Provides the captured data to client application as demanded.
- ◆ Stores acquired data into H2DB database for offline usage.
- ◆ Send command /request to target board and interpret response.
- ◆ Handle Error code, exceptions and client requests.
- ◆ Provides the delegate to authenticate user, user creation and role assignment, provides off line data and configuration of the application.
- ◆ Provides socket utility to receive set configuration, get configuration, start acquisition, stop acquisition, acquire raw data and acquire calibrate data commands from the client application.
- ◆ Detect network target connection lost and manage auto connection.

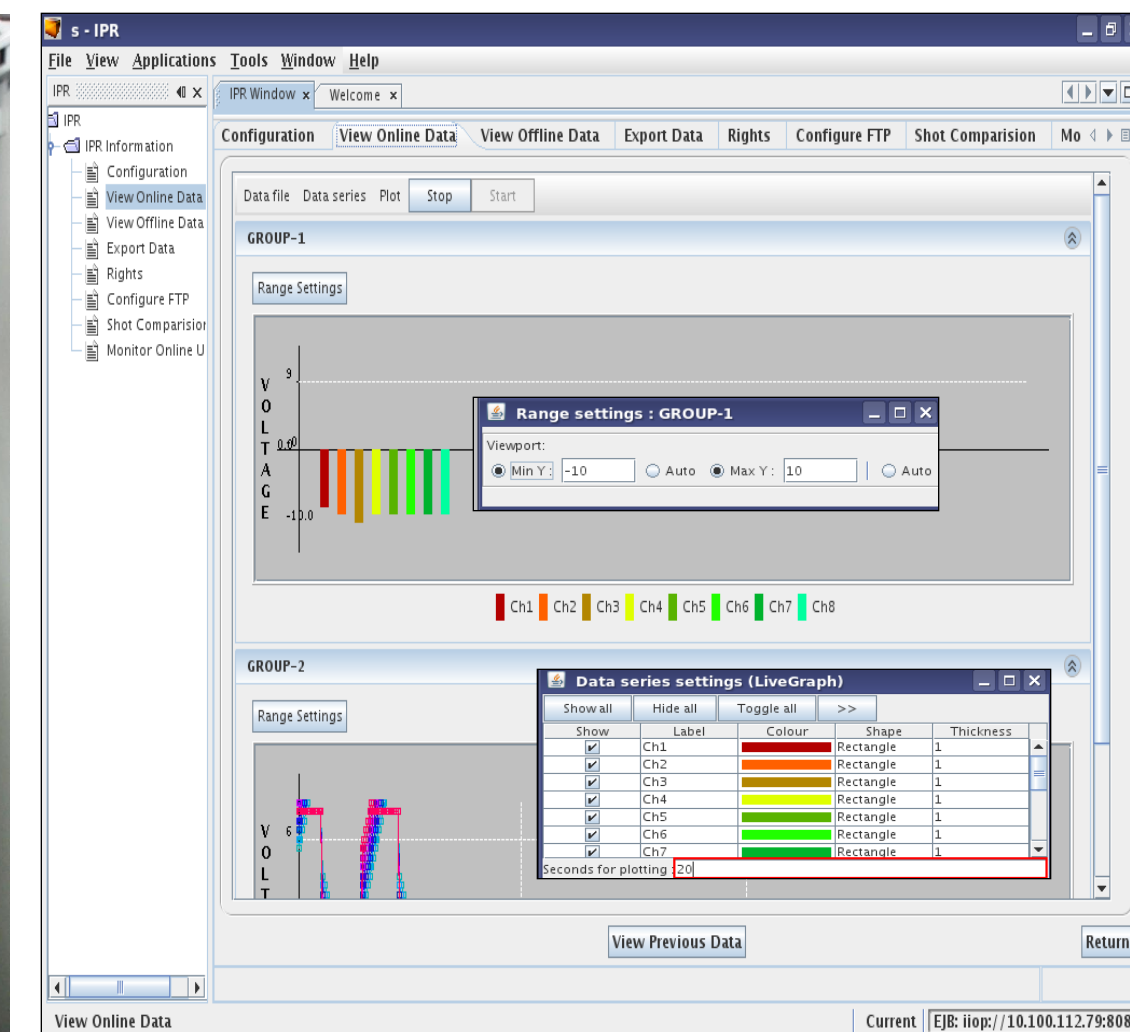
### Client Application features

- ◆ Java client with login facility for the security purpose.
- ◆ user rights as per role assignment.
- ◆ Restriction over multiple administrator for H/W configuration.
- ◆ Remote Start and stop of data acquisition process.
- ◆ Display of on line data for multiple channels.
- ◆ Displays pre-trigger and post trigger data.
- ◆ Remote user access to analyze previous data (Offline Data).
- ◆ Provides the facility for the shot comparison.
- ◆ Facility to export the data in form of excel, binary and csv.
- ◆ Data back-up facility using preconfigured FTP server.
- ◆ Provides the facility to generate report for analyzed data.

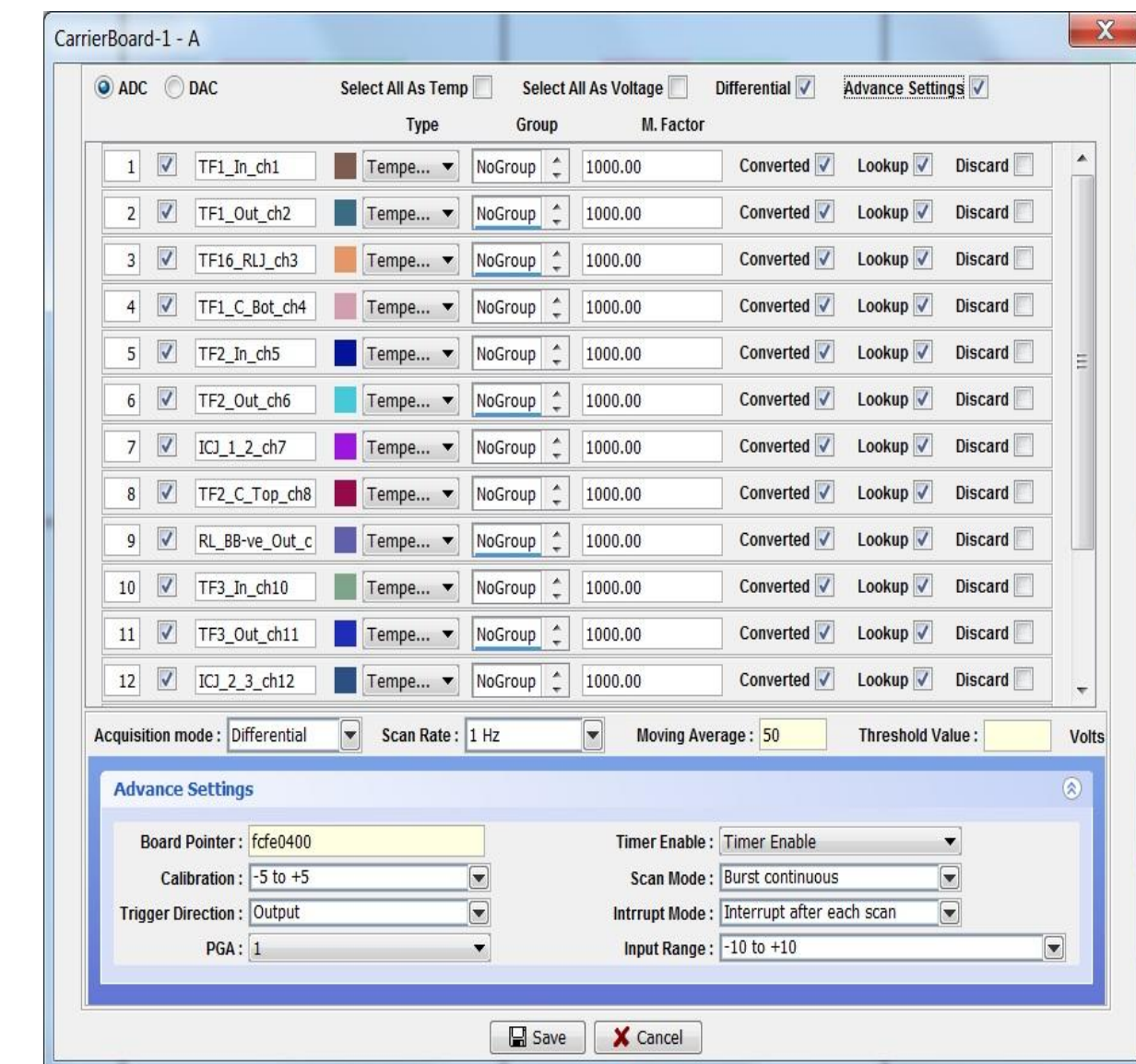
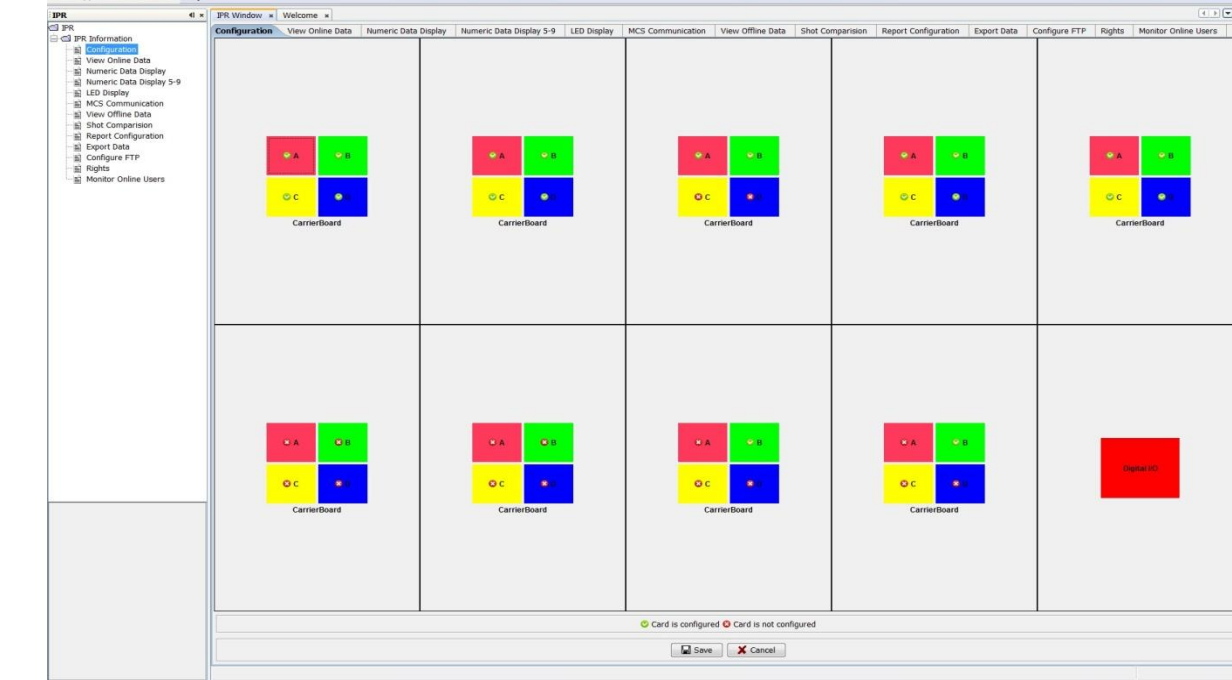
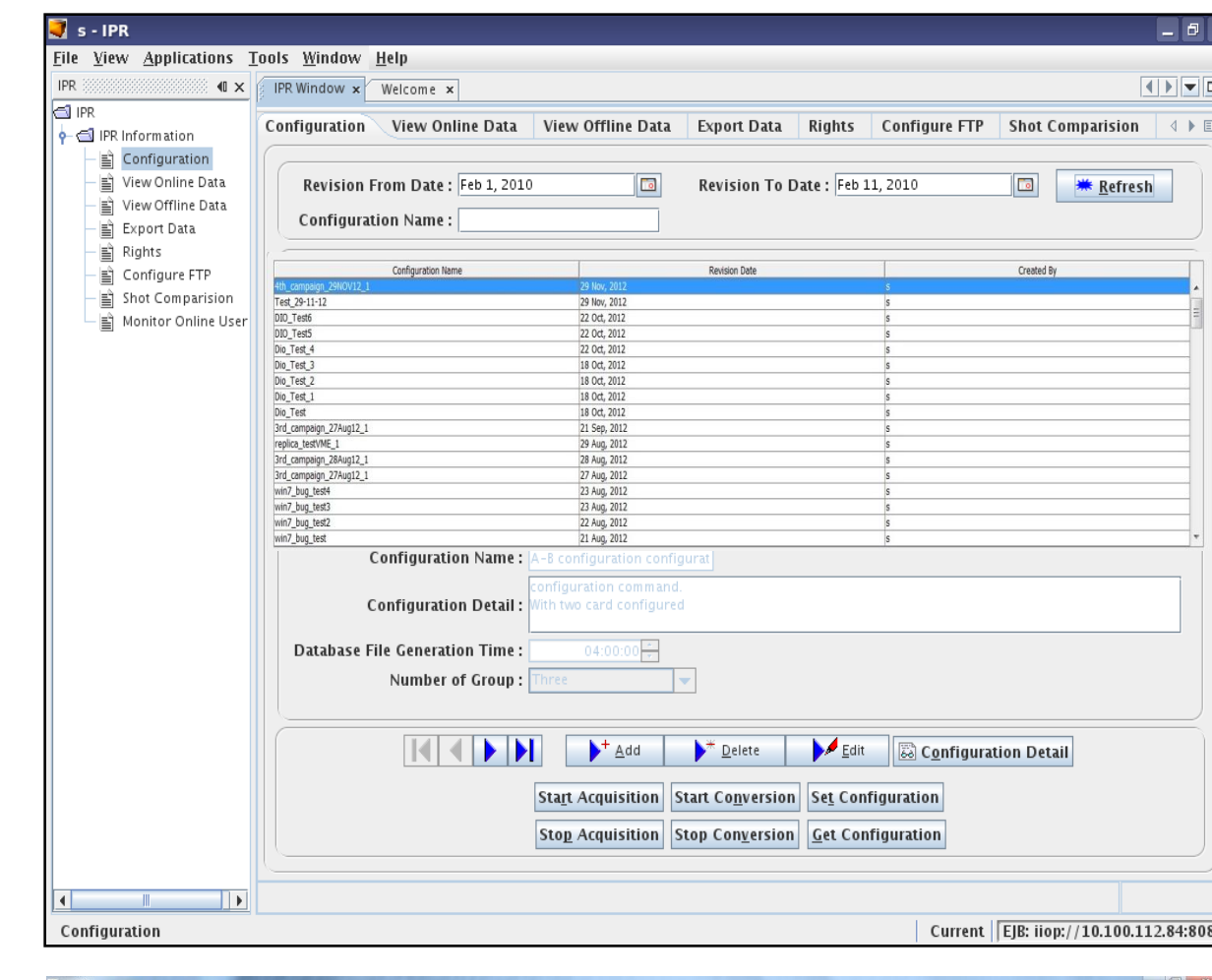
## Hardware Field Implementation



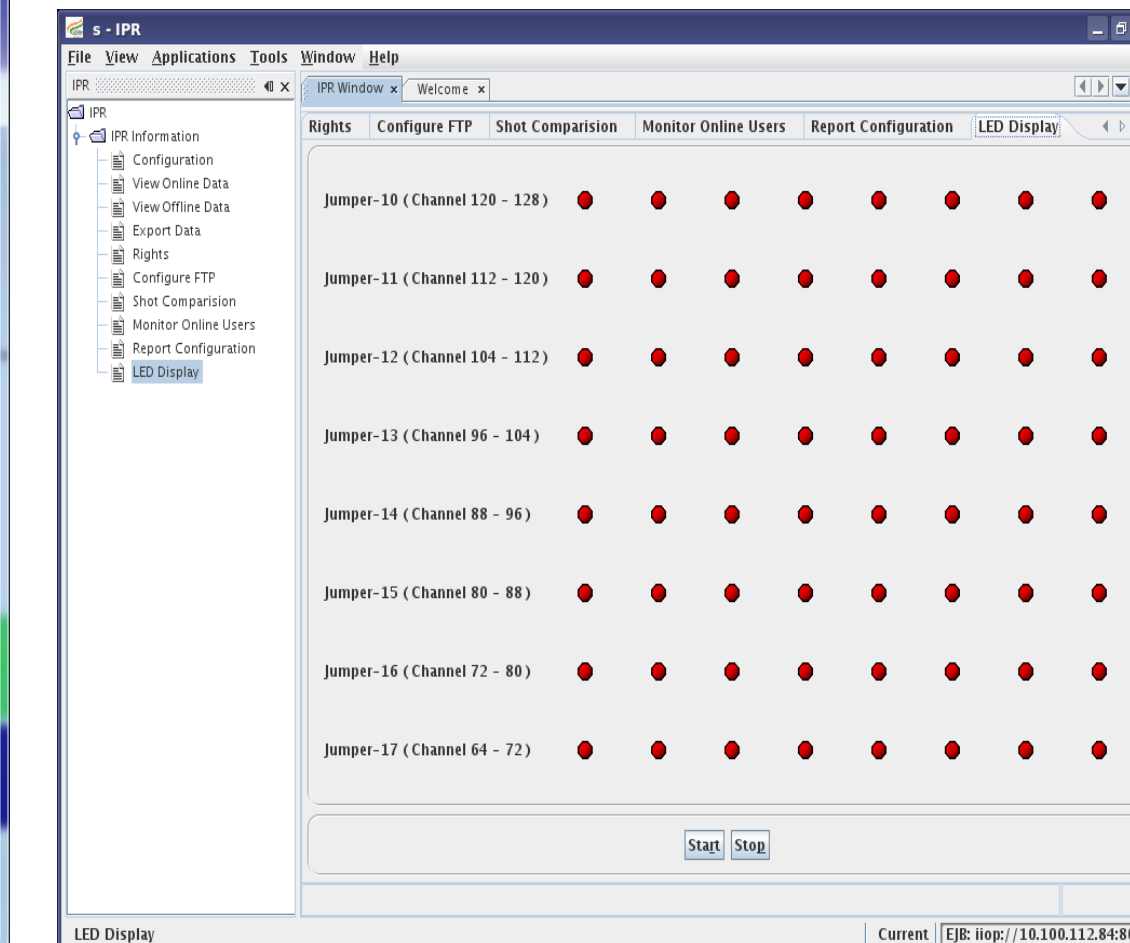
## Data Plotting and Reading



## Hardware Configuration Setup



## Digital I/O Status Window



**Conclusion :** A large channel count multi client DAS was developed for the magnet systems of SST-1. The application has run continuously over several weeks of magnet operation and different modules and features were tested during the execution. The software application has worked satisfactorily as per requirement and will further be modified in client user interface for better visualization and ease of use.