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WEKA — Keynote Address

WEKA01 09:50 30 **The CSS Story**

***M.R. Clausen**, J. Hatje, J. Penning, H.R. Rickens (DESY)*

Control System Studio (CSS) is designed to serve as an integration platform for engineering and operation of todays process controls as well as machine controls systems. Therefore CSS is not yet another replacement of existing operator interfaces (OPI) but a complete environment for the control room covering alarm management, archived data displays diagnostic tools and last not least operator interfaces. In addition we decided to use CSS as the platform for the whole engineering chain configuring EPICS based process control databases, configuring and managing the I/O, editing state notation programs, configuring role based access rights and many more. Due to the ease of use of CSS as an Eclipse based product, we decided to use the CSS core also for all our stand alone processes. This helped us to reduce the diversity of running products/ processes and simplified the management. In this presentation we will describe our experience with CSS over the last two years. How we managed the transition from old displays to new ones, how we changed our alarm/ message philosophy and last not least which lessons we learned.

WEKA02 10:20 30 **Evolution of Control Systems for Large Telescopes and Accelerators : A retrospective**

***Y.S. Mayya** (BARC)*

Particle accelerators and telescopes are big instruments of experimental physics. Even though markedly different in design & construction, particle accelerators and telescopes complement each other in answering man's most profound questions on the nature and origin of universe. Today's particle accelerators are mammoth microscopes peering in to the structure and properties of building blocks of matter with ever larger energies or particle intensities. On the other hand, telescopes look outside in to the cosmos to ever greater distances and time. As they become bigger and more powerful, both accelerators and telescopes have been continuously pushing the frontiers of technology in all spheres- detectors & front-end electronics, control, communication and computing. This has resulted in electronics which is smaller, consume less power, faster, more accurate, more reliable and support higher capacities. In this keynote address, the speaker traces over two decades of association in building control and information systems for world's big telescopes such as GMRT (Giant Metre-wave Radio Telescope, 90's) and MACE (Multiple Atmospheric Cerenkov Emission, today) in India and large particle accelerators such as LHC (90's) and FAIR (today). While tracking the evolution of related technology over the years, the talk analyses the choices made, lessons learnt, failures and successes, performance and life cycle management issues.

05-Dec-12 12:00 – 13:15 VECC/SINP Campus Auditorium Main Lecture Hall

WEIB — Overview of Control System

Chair: C.K. Pithawa (BARC)

WEIB01 12:00 25 **Implementation of Control Systems for Cyclotrons at VECC: A Status Report**

S. Pal *(DAE/VECC)*

The modernisations of the control of various subsystems of the Room Temperature Cyclotron (K130) and implementation of the subsystems control for Superconducting Cyclotron (K500) have been done at Variable Energy Cyclotron Centre (VECC), Kolkata. The architecture, realization and present status of the development of the control systems are elaborated in this presentation.

WEIB02 12:25 25 **Review of Control Resources for J-PARC Accelerators**

N. Kamikubota *(KEK)*

J-PARC consists of three big accelerators : 181-MeV LINAC (now upgrading to 400-MeV), 3-GeV RCS (Rapid Cycle Synchrotron), and 30-GeV MR (Main Ring). Beam operation of LINAC started in November, 2006, followed by RCS in 2007, and by MR in 2008. Since 2009, J-PARC accelerators have been providing high-intensity proton beams to experimental facilities. In this report, we focused on three components; sever CPU for MR,control network, and disk system. Improvement, upgrade, and troublesduring 6-year operation will be reviewed.

WEIB03 12:50 25 **Indus-2 Control System: A Closer Perspective**

P. Fatnani *(RRCAT)*

Indus-2, the 2.5 GeV Synchrotron Radiation Source (SRS) facility at RRCAT Indore is a national facility and being operated on round the clock basis to provide synchrotron radiation to users as well as carrying out machine studies. The accelerator as a whole is a widely distributed system and employs a distributed control system for its monitoring, control and operation. The control system has continuously evolved since the start-up and continues to do so. The talk will throw light upon various sub-systems, components of the control system, viz. hardware, software, databases, communication protocols, their evolution, various issues and approaches, current status and future possibilities. It will cover different aspects concerning Control system architecture, VME control hardware, SCADA software, Realtime software, Profibus protocol, Web based software tools, Machine parameter database and System diagnostics tools and techniques.

WEIC — Latest Trends in GUI

Chair: Y.S. Mayya (BARC)

WEIC01 14:45 25

Web2cToGo: Bringing the Web2cToolkit to Mobile Devices

R. Bacher *(DESY)*

The Web2cToolkit is a collection of Web services. It enables scientists, operators and service technicians to supervise and operate accelerators and beam lines through the World Wide Web. The toolkit includes a synoptic display viewer and editor, an archive viewer, a messenger service, a logbook facility, an administration manager and an HTTP gateway to control systems. Recently, a novel view (Web2cToGo) has been added which is especially designed for mobile devices such as tablet computers or smartphones running iOS, Android or other mobile operation systems. Web2cToGo is a frame which embeds instances of all kinds of Web2c tools. It provides a single-sign-on user authentication and authorization procedure. Web2cToGo supports single- or multi-touch user gestures and is available as a platform-independent browser-based Web application or as a platform-dependent native app. This paper describes the conceptual design of Web2cToGo and the technologies used behind the scenes as well as the experiences gathered so far. It presents an outlook of ongoing developments including user-device interaction based on voice recognition.

05-Dec-12 15:10 – 15:40 VECC/SINP Campus Auditorium Main Lecture Hall

WECC — Latest Trends in GUI

Chair: Y.S. Mayya (BARC)

WECC02 15:10 15 **EPICS Channel Access Using WebSocket**

A. Uchiyama *(Sokendai) K. Furukawa (KEK) Y. Higurashi (RIKEN Nishina Center)*

Web technology is useful as a means to widely inform of accelerators and beam status. For this purpose, WebOPI[1] as to web-based system using Ajax (Asynchronous JavaScript and XML) with EPICS was implemented by SNS. On the other hand, it is often necessary to perform the accelerator control from various locations as well as central control room during the beam operation and the maintenance. However, it is not realistic to replace GUI-based operator interface (OPI) with Web-based system using Ajax technology because of interactive performance. Therefore, as a next-generation OPI over the web using EPICS Channel Access (CA), we developed a client system based on WebSocket, which is a new protocol provided by Internet Engineering Task Force for Web-based system. WebSocket is a web technology providing bi-directional, full-duplex communication channels over a single TCP connection. By utlizing Node.js and WebSocket access library named Socket. IO, a WebSocket server was implemented. As a result, Web-based client systems became available not only in the central control room but also with various types of equipment for accelerator operation.

WECC03 15:25 15 **Qt Based GUI System for EPICS Control Systems**

A. Rhyder*, R.N. Fernandes, A. C. Starritt (ASCo)*

The Qt based GUI system developed at the Australian Synchrotron for use on EPICS control systems has recently been enhanced to including support for imaging, plotting, user login, logging and configuration recipes. Plans are also being made to broaden its appeal within the wider EPICS community by expanding the range of development options and adding support for EPICS V4. Current development options include graphical and non graphical application development, 'code-rich' C++ development and simple 'code-free' GUI design. Additional development options will allow developers to manage the GUI framework's data needs themselves when required, as an alternative to letting the GUI objects manage their own data using the framework's Qt based EPICS data classes. Developers will be able to choose to manage the GUI data needs using the framework's Qt based EPICS data classes, or alternative data systems such as PSI's CAFE.

Control Databases

WEPD01 **Data Logging System Upgrade for Indus Accelerator**

***R. Mishra**, R.K. Agrawal, P. Fatnani, B.N. Merh, C.P. Navathe (RRCAT) S. Pal (DAE/VECC)*

An accelerator has various subsystems like Magnet Power Supply, Beam Diagnostics and Vacuum etc. that are required to work in a stable manner to ensure required machine performance. Logging of system parameters at a faster rate plays a crucial role in analysing and understanding machine behaviour. Logging all the machine parameters consistently at the rate of typically more than 1 Hz has been the aim of a recent data logging system upgrade. Nearly ten thousand parameters are being logged at varying intervals of one second to one minute in Indus accelerator complex. The present logging scheme is augmented to log all these parameters at a rate equal to or more than 1 Hz. The database schema is designed according to data type of the parameter. The data is distributed into historical table and intermediate table comprising of recent data. Machine control applications read the parameter values from the control system and store them into the text-files of finite time duration for each sub-system. The logging application of each subsystem passes these text files to database for bulk insertion. The detail design of database, logging scheme and its architecture is presented in the paper.

WEPD03 **Control System Studio Archiver with PostgreSQL Backend: Optimizing Performance and Reliability for a Production Environment**

***M. Konrad**, C. Burandt, J. Enders, N. Pietralla (TU Darmstadt)*

Archiving systems based on relational databases (RDB) provide a higher flexibility with regard to data retrieval and analysis than the traditional EPICS Channel Archiver. On the other hand they can suffer from poor performance compared to the Channel Archiver for simple linear data retrieval operations. However, careful tuning of the database management system's configuration can lead to major performance improvements. Special care must be taken to ensure data integrity following power outages or hardware failures. This contribution describes the hardware and software configuration of an archiving system used in the production environment at the S-DALINAC. It covers performance and reliability aspects of the hardware as well as tuning of the Linux operating system and PostgreSQL server optimizations.

Control System Interoperability

WEPD07 **Control System configuration for Fast - High Voltage Capacitor Charging Power Supply**

T.S. Kolge *(BARC-APPD) N. Pasula, A.S. Patel (BARC)*

Pulse power supply applications usually require short and intense burst of energy that may be delivered by rapidly discharging a energy storage capacitor. For these applications capacitor charging power supply[1] will be used in which the energy storage capacitor will acts as load. Initially the capacitor will acts as short circuit, So the topology must be such that it can withstand short circuit condition, the series load resonant converter topology is one which can be suitable for this application. Because series load resonant topology shows inherent short circuit proof and it can provide constant current at a frequency where switching frequency is half of resonant frequency (i.e. fs 0.5fr). In this paper an attempt has made to design a 30kV, 3kJ/s CCPS with a proper controlled rectifier and inverter module. The control system parameters are minimized and optically isolated communication through fiber optics are used to achieve less failure rate in system operation. This topology can be used for charging different energy storage capacitors. The above rated design is more Electromagnetic compatible (EMC), it is tested and verified the simulation results with practical results.

Experimental Data Acquisition

WEPD09 **Fast Data Acquisition System for Booster Supplies Readback**

K. Saifee*, A. Chauhan, P. Fatnani, P. Gothwal, C.P. Navathe (RRCAT)*

The booster synchrotron at RRCAT is used to inject electron beam in Synchrotron Radiation Sources Indus-1 & Indus-2. The booster gets 20 MeV beam from Microtron, ramps up its energy to 450/550 MeV which is then extracted for injection in Indus-1/Indus-2. The ramping cycle repeats every second. For this, various magnet power supplies are fed with synchronous reference voltage & current waveforms and accordingly they feed the magnets with current waveforms of ~800 msec. A system was required to synchronously capture data of all power supplies to analyze changes on cycle to cycle basis. Global data acquisition system polling data at 1 Hz can't acquire sufficient points to do this. So a VME and PC based system has been developed for parallel and fast capture of data from 13 such power supplies. VME station has a CPU,13 ADC cards and one control card. User can select- permit to capture, start delay, samples and time interval between samples. Advantages are' Isolated, simultaneous capturing on 13-channels, capturing synchronized with an event and selectable capturing-rate and samples. It involved reconfiguring ADC boards, developing RTOS OS-9 Device Driver & programs for CPU Board and GUI for PC using LabVIEW.

WEPD10 **Embedded CAMAC Controller: Hardware/Software Co-optimization for High Throughput**

***P.M. Nair**, A. Behere, M.P. Diwakar, K. Jha, C.K. Pithawa, P. Sridharan (BARC)*

Advances in technology have resulted in availability of low-power, low form-factor embedded PC based modules. The Embedded CAMAC Controller (ECC) is designed with ETX standard Single Board Computer having PC architecture with Ethernet connectivity. The paper highlights the software and hardware design optimizations to meet high throughput requirements of multi-parameter experiments and scan mode accelerator control applications. The QNX based software is designed for high throughput by adopting design strategies like multi-threaded architecture, interrupt-driven data transfer, buffer pool for burst data, zero memory copy, lockless primitives and batched event data transfer to host. The data buffer and all control logic for CAMAC cycle sequencing for LIST mode is implemented entirely in hardware in Field Programmable Gate Array (FPGA). Through this design, sustained throughput of 1.5MBps has been achieved. Also, the host connectivity through Ethernet link enables support for multi-crate configuration, thus providing scalability. The ECC has been installed for accelerator control at FOTIA BARC, Pelletron and LINAC Pelletron TIFR and for multi-parameter experiments at NPD.

WEPD11 **Client Server Architecture Based Embedded Data Acquisition System on PC104**

***J.J. Patel**, P.K. Chattopadhyay, R. Jha, P. Kumari, R. Rajpal (Institute for Plasma Research)*

The data acquisition system is designed on embedded PC104 platform Single Board Computer (SBC) with running Windows XP Embedded operating system. This is a multi channel system which consists of 12 Bit, 10 MSPS Analog to Digital Converters with on board FIFO memory for each channel. The digital control and PC104 bus interface logic are implemented using Very High Speed Hardware Description Language (VHDL) on Complex Programmable Logic Device (CPLD). The system has provision of software, manual as well as isolated remote trigger option. The Client Server based application is developed using National Instrument CVI for remote continuous and single shot data acquisition for basic plasma physics experiments. The software application has features of remote settings of sampling rate, selection of operation mode, data analysis using plot and zoom features. The embedded hardware platform can be configured to be used in different way according to the physics experiment requirement by different top level software architecture. The system is tested for different physics experiments. The detailed hardware and software design, development and testing results will be discussed in the paper.

WEPD12 **A Large Channel Count Multi Client Data Acquisition System for Superconducting Magnet System of SST-1**

K.J. Doshi, *J.A. Dhongde, Y.S. Khristi, H.A. Masand, B.A. Parghi, D.A. Patel, S. Pradhan, U.A. Prasad, A.N. Sharma, P.A. Varmora (Institute for Plasma Research)*

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 it's 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.

WEPD13 **Serial Multiplexed Based Data Acquisition and Control System**

N.C. Patel, *C.K. Chavda, K.G. Patel (Institute for Plasma Research)*

Data acquisition and control system consist of analog to digital converter, digital to analog converter, timer, counter, pulse generation, digital input / output etc depending upon requirement. All the components of the system must communicate with personal computer (PC) for data and control signal transmission using any one of the communication protocol like Serial, Parallel, USB, and GPIB etc. Serial communication is advantageous over other protocol like long distance data transmission, less number of physical connection, ease of implementation etc. The developed serial multiplexed system can control different module like ADC (for a small analog channel density, moderate sampling rate and local on-board memory) module, DAC (for controlling pressure valve, biasing voltage etc) module, DIO (for system status monitoring and status control) module, Timer card (for generating delayed pulse for triggering and synchronizing with other system) using single serial port. A LabVIEW based GUI program is developed for the individual communication of each module.

WEPD14 **VEPP-2000 Logging System**

A.I. Senchenko, *D.E. Berkaev (BINP SB RAS)*

The electron-positron collider VEPP-2000 has been constructed in the Budker INP at the beginning of 2007 year. The first experiments on high-energy physics has been started at the end of 2009. The collider state is characterized by many parameters which have to be tracked. These parameters called channels could be divided into continuous (like beam current or beam energy) and pulsed. The main difference is that the first one related to the moment of time while the second one to the beam transport event. There are approximately 3000 continuous

channels and about 500 pulsed channels at the VEPP-2000 facility. The Logging system consists of server layer and client layer. Server side are a specialized server with an intermediate embedded database aimed at saving data in case of external database fault. Client layer provide data access via API, CLI and WUI. The system has been deployed and is used as primary logging system on VEPP2000.

WEPD15 **Development of an Automated RF Test Bench**

***D. Sharma**, A. Gupta, P.R. Hannurkar, A. Jain, A.K. Tiwari (RRCAT)*

An automated Radio Frequency (RF) test setup has been created for the characterization of solid state RF power amplifiers and associated RF components. The setup has been built using PC based instrument control scheme. Various instruments have been connected using RS232, USB, GPIB and Ethernet busses to a controlling computer, and a data acquisition card is used for measurement and interlock purposes. The acquisition and control software has been created to perform various measurement tasks rapidly, and to generate required measurement data in a report. The hardware connection provides single terminal for various operations and the software provides consistency in measurements and report generation along with help in taking care of instruments and human safety. Also, this system is aimed to provide interactive yet simple interface to the operators.

WEPD16 **Development of Data Acquisition Software for VME Based System**

***A. Kumar**, A. Chatterjee, K. Mahata, K. Ramachandran (BARC)*

A Data Acquisition system for VME has been developed for use in accelerator based experiments. It is in use at BARC-TIFR laboratory. The development was motivated by the growing demand for higher throughput in view of the increasing size of experiments. The VME based data acquisition system provides a powerful alternative to CAMAC standards on account of higher readout speeds (100 ns/word) resulting in reduced dead time. Further, high density VME modules are capable of providing up to 640 channels in a single VME crate with 21 slots. The software system LAMPS[1], earlier developed for CAMAC based system and used extensively in our laboratory and elsewhere has been modified for the present VME based system. The system makes use of the VME library to implement Chain Block Transfer Readout (CBLT) and gives the option of both Polling and Interrupt mode to acquire data. Practical throughput of ~250 ns/word in zero-suppressed mode have been achieved. The developed software currently supports CAEN[2] V785 ADC, V775 TDC and V862 QDC and V830 Scalar Modules. The design, development and architecture of this DAQ system will be discussed.

WEPD18 **Microcontroller Based DAQ System for IR Thermography by Hot and Cold Water Flow Method**

***M.S. Khan**, S.M. Belsare, K.D. Galodiya, S.S. Khirwadkar, T.H. Patel (Institute for Plasma Research)*

There are many Non Destructive Technique used in science and industry to evaluate the properties of a material, component or system without causing damage Infrared Thermography is one of them. Different types of IR thermo-graphy are used for different purpose. We are using hot and cold-water flow IR Thermography method to evaluate the Performance of Plasma Facing Components (PFC) for Divertor Mock-up. The Set-up is designed in such a way that hot and Called Water can flow in both direction inside mockup, like left to right and right to Left using electric motor. Eight numbers of Solenoid Valves have been used for selection of Water Flow Direction, thermo-couples for temperature measurement of water, IR camera to take the images and many others devices. Which needs a very good and versatile DAC system. We have developed a DAC system usingμcontroller and LabView for the acquisition of various parameters and controlling & synchronization of other system. Development of DAC is described in this paper

WEPD19 **Smart Structured Measurement Process for Versatile Synchrotron Beamline Data at ANKA**

***T. Spangenberg**, D. Haas, W. Mexner (KIT)*

An unstructured measurement process might deliver the needed quantity of primary data for an experiment. But the achievement of the scientific results depends more and more from the offered opportunities of embedding these measurement data into its specific context with a meta data description and a complete life cycle management. Obviously the design of a measurement process influences the potential applicability of an experimental setup for its scientific purpose and of course its options to fulfill a contemporary data management. ANKA's Tango based environment offers in principal varying approaches with different implementation efforts and coverage of scientific or information technology requirements. At ANKA we have set up a smart structured measurement process which stand out due to its seamless integration into the overall data management, the support of recent control concepts for fast data generation as well as its support of well time-tested SPEC based scan systems. The presented measurement process focuses to the minimal implementation for all involved components without a break of well accepted habits.

WEPD22 **Post-Mortem Analysis of BPM-Interlock Triggered Beam Dumps at PETRA-III**

***G.K. Sahoo**, K. Balewski, A. Kling (DESY)*

PETRA-III is a 3rd generation synchrotron light source dedicated to users at 14 beam lines with 30 instruments. This operates with several filling modes such as 60, 240 and 320 bunches with 100mA or 40 bunches with 80mA at a positron beam energy of 6 GeV. The horizontal beam emittance is 1nmrad while a coupling of 1% amounts to a vertical emittance of 10pmrad. During a user run unscheduled beam dumps triggered by Machine Protection System may occur. In many cases the reason can be identified but in some it remains undetected. Though

the beam is lost some signature is left in the ring buffers of the 226 BPM electronics where last 16384 turns just before the dump are available for post-mortem analysis. Scrutinizing turn by turn orbits and the frequency spectrum measured at a BPM can improve understanding of such a beam loss and may help to increase the efficiency of operation by eliminating the sources. Here we discuss in detail the functionality of a Java GUI used to investigate the reasons for unwanted dumps. In particular, the most effective corrector method is applied to identify correctors that might have perturbed the golden orbit leading to violations of the interlock limits.

Latest Trends in GUI

WEPD23 **Design & Implementation Of LabVIEW™ Based GUI for Remote Operation and Control of Excimer Laser for Plasma Wakefield Accelerator Experiment**

***K.K. Kizhupadath**, R.A.V. Kumar, K. Mahavar (Institute for Plasma Research) S. Joshi, A. Sharma (Nirma University)*

The paper describes the development of GUI based control software for control/operation, maintenance and data logging of a Coherent CompexPro 102 Excimer Laser (ArF, 193 nm) using LabVIEW™ instrument control software. Excimer laser will be used to generate the lithium plasma for the Plasma Wake Field Acceleration (PWFA) experiment which is currently being pursued at the Institute for Plasma research, Gandhinagar. The LabView™ drivers for the system were developed and various control modules for laser control & operation, maintenance (gas refill), energy calibration as well as logging were developed and integrated into a single screen GUI. Automated calibration of the internal energy meter with an external one has also been implemented. The modules can be used independently or as an integrated system. The laser is interfaced to the control PC through a RS-232-to-USB interface.

WEPD24 **STARS on Android**

***T. Kosuge** (KEK)*

STARS (Simple Transmission and Retrieval System) is a message transferring software for small scale control systems with TCP/IP socket, which works on various types of operating systems. STARS is used as beamline control system and it controls optical devices (mirror, monochrometer etc.) of beamline at the Photon Factory. We have succeeded to run STARS GUI Client on Android with STARS Java interface library this time. This success brings capability of handy GUI terminal development with smartphones and tablet devices. The handy GUI terminal helps beamline users when checking movement near optical devices. We will describe detail of "STARS on Android".

WEPD25 **Development of EPICS Channel Access Embedded ActiveX Components for GUI Development**

***A. Roy**, R.B. Bhole, S. Pal (DAE/VECC)*

The paper describes the integration of EPICS Channel Access protocol and Microsoft ActiveX technology towards developing a generalize operator interface (OPI) building facility for Windows platform. EPICS is used as the development architecture of the control system in Superconducting Cyclotron (SCC). Considering the operators' familiarity and compatibility with third party software, it was decided to use MS-Windows platform at operator interface level in SCC during commission. Microsoft Visual Basic (VB) is used on trial basis as OPI building platform to incorporate user specific features e.g. file system access for data storage and analysis, user authentication at OPI level etc. A set of EPICS Channel Access embedded ActiveX components is developed to ease the programming complexity and reduce developmental time of the OPI for Windows platform. OPIs, developed using these components and containing hundreds of process parameters, are being used reliably over a considerable period of time.

Software and Hardware Technology

WEPD26 **Development of Fast Controls for Beam Wire Scanner for SuperKEKB**

***A. Roy** (DAE/VECC) K. Furukawa, N. Iida (KEK) T. Okazaki (EJIT)*

Recent development towards the data acquisition system of the wire scanner (WS) systems of the SuperKEKB injector linac (LINAC) and beam transport lines (BT's) is described. A VME based system, comprised of charge sensitive ADC (CSADC) board, scaler board, DAC board and Event receiver board, has been installed. The primary aim of the system is to utilise global linac event timing system for synchronized and mode-dependent data acquisition. A set of EPICS device driver has been developed for new hardware e.g. CSADC, scaler and DAC boards. The combination of latest versions of firmware and EPICS device driver forμResearch Finland (MRF) Event receiver board is also evaluated and further incorporated in this system. The application software is developed for simultaneous acquisition of multiple beam mode data during multimode injection of the LINAC. The developed system is tested successfully after integrating with the existing wire scanner driving mechanism. The system enables the beam size measurements at four consecutive locations, that derive Twiss parameters and ensure the reliable beam transport to four downstream storage rings.

Latest Trends in GUI

WEPD27 **Graphical User Interface (GUI) for Testing CAMAC modules**

***S. Kulkarni**, P. V. Bhagwat, A. Chatterjee, J.A. Gore, A.K. Gupta (BARC) S. Kailas (BARC, Physics Group)*

A new program (GUI) for testing CAMAC modules (CAMAC ADC, DAC, Input Gate, Output Register) is developed using Labview and dynamic link libraries (DLLs). On start-up, the program initializes the CAMAC Controller via PCI bus interface, thus enabling communication with CAMAC modules. It can test CAMAC modules through different controls like slider bars, buttons etc. and display status of individual channels with soft panel meters and LEDs. The GUI is extremely useful in

troubleshooting hardware problems of CAMAC modules and also in developing new modules.

WEPD28 **Re-envisioning the Operator Consoles for Dhruva Control Room**
***S. Gaur**, M.P. Diwakar, N.C. Gohel, P.M. Nair, C.K. Pithawa, P. Sridharan (BARC)*
Control Room design is undergoing rapid changes with the progressive adoption of computerization and automation. Advances in man-machine interfaces have further accelerated this trend. This paper presents the design and main features of Operator consoles (OC) using new technologies for Dhruva control room. The OCs have been designed so as not to burden the operator with information overload but to help him quickly assess the situation and timely take appropriate steps. The consoles provide minimalistic yet intuitive interfaces, context sensitive navigation, display of important information and progressive disclosure of situation based information. The use of animations, 3D graphics, and real time trends with the benefit of hardware acceleration to provide a resolution-independent rich user experience. The use of XAML, an XML based Mark-up Language for User Interface definition and C# for application logic resulted in complete separation of visual design, content, and logic. This also resulted in a workflow where separate teams could work on the UI and the logic of an application. The introduction of Model View View-Model has led to more testable and maintainable software.

PC vs Embedded Systems

WEPD33 **Embedded PC Based Controller for Use in VME Bus Based Data Acquisition System**
***G. Gaurav**, B.B. Biswas, S.K. Jain, M. Kalra, D.A. Roy (BARC)*
An embedded PC based Controller module, named System Controller Module (SCM), has been developed at Reactor Control Division(RCnD), BARC. This module uses standard PC-104 bus based CPU module integrated with a protocol translator card to provide an interface between the CPU module and VME bus. The signal interface between PC-104 bus of CPU module and translator card is achieved through stackable connectors. SCM can be interfaced with 16-bit slave I/O modules on VME bus for Data Acquisition and Control. This development provides low cost PC based platform for developing I/O intensive embedded system requiring high processing power. SCM module is fully compatible with PC architecture and is available in Double Euro modular form factor. Module has self diagnostics features to test software integrity using onboard watchdog timer. The module provides dual Ethernet link for communication. The SCM has been assembled, integrated and successfully tested along with VME based high speed data acquisition system (Machinery Protection System), which has been developed in RCnD for condition monitoring of rotating machines. SCM acts as a configuration controller and data manager for this system.

WEPD34 **A Low-Cost High-Performance Embedded Platform for Accelerator Controls**

***L. Pivetta**, A.I. Bogani, S. Cleva (ELETTRA)*

Over the last years the mobile and hand-held device market has seen a dramatic performance improvement of the microprocessors employed for these systems. As an interesting side effect, this brings the opportunity of adopting these microprocessors to build small low-cost embedded boards, featuring lots of processing power and input/output capabilities. Moreover, being capable of running a full featured operating system such as GNU/Linux, and even a control system toolkit such as Tango, these boards can also be used in control systems as front-end or embedded computers. In order to evaluate the feasibility of this idea, an activity has started at ELETTRA to select, evaluate and validate a commercial embedded device able to guarantee production grade reliability, competitive costs and an open source platform. The preliminary results of this work are presented.

WEPD36 **FPGA Based PCI Bus Add on Card for the Laser Marker System XY2-100 Protocol Converter**

***V.W. Meshram**, P. Deshpande (RRCAT)*

Laser maker system is used to mark images on the metal using the Yttrium vanadate (Nd:YVO4) laser with 5 watt continuous power and 40 kW peak power. Marking resolution is 635 DPI, working distance is 150 mm and spot size is 40 μm. PC is running graphical user interface (GUI) and communicates with microcontroller based system controls laser marker control (LMC) system over RS232. The LMC consists of the laser power control and galvo positioning system. This work deals with designing the PC based LMC replacing the microcontroller based system with PCI bus and designing FPGA based protocol converter. The important component of this system is galvo controller which controls the positioning of the galvos as well as communicates with the host controller. The input is in the form of serial XY2-100 protocol. The PCI bus add-on card developed by using Xilinx FPGA XC3S400. The hardware has two major components namely the PCI bridge which takes care of the PCI bus and the FPGA chip takes XY2-100 protocol and send it to galvo controller. The complete hardware was developed and tested. The software for FPGA was developed using VHDL.

WEPD38 **A Wireless Control System for the High Temperature Superconducting ECR Ion Source PKDELIS**

***R.N. Dutt**, Y. Mathur, U.K. Rao, G.O. Rodrigues (IUAC)*

A wireless control system based on MODBUS protocol has been developed for operating the High Temperature Superconducting ECR ion source, PKDELIS [1] and associated systems on a 200 kV high voltage platform. The communication channels for the two high voltage platforms are implemented in the ISM band [2]. M/q measurements have been automated for a fast scan of ion species from the extracted beam. A Labview© based system provides an excellent GUI interface and a seamlessly integrated system. Organization wide connectivity over Ethernet from the control room has been implemented. The system has been in regular use and has proven to be rugged and reliable.

WEPD39 **Development of a General Purpose Ethernet Enabled Microcontroller Based Module**

***M. Chatterjee**, D. Koley, P.Y. Nabhiraj (DAE/VECC)*

A General purpose Ethernet enabled control and data acquisition module based on PIC microcontroller has been developed. This module supports multiple general purpose analog and digital inputs and outputs for interfacing with various equipments. The remote control, configuration and monitoring of the equipment are achieved through an embedded web server. A strict authentication process is built in the web server to access for control and configuration parameters that ensures the operational safety of the equipment under control. At present, this is being used for remote control of the ECR beam line vacuum systems and monitoring of various parameters like dual vacuum Gauge readings, pumping speed etc. These modules form a distributed control architecture enhancing the reliability of the controlled system, enables fast fault diagnostics and thereby reducing the downtime of the system significantly. In this article, the development of the hardware and software for the Ethernet enabled microcontroller based module is presented.

WEPD42 **Microcontroller Based Test Facility or System for 352.2 MHz 1 MW Klystron Based Radio Frequency Power System for LEHIPA**

***S. Rosily**, M.M. Pande, S. Sharma, S. Shrotriya, P. Singh (BARC)*

This paper discusses details of a "Microcontroller based test facility or system for 352.2 MHz 1 MW Klystron based Radio Frequency Power Amplifier System for LEHIPA" which includes control, test and validation of interlock and protection parameters of high power DC supplies and other auxiliary systems connected to a 1 MW Klystron based RF System. This system is exposed to high RFI from the power amplifier and its connected systems. Hence, it needs to be well isolated at all interfaces. Also, fast response of the order of very fewμseconds is necessary for the protection of such a high power system. Fault tolerance and self diagnostic features are other key application requirements. This system handles 64 signals with mostly non-standard signal formats including frequency modulated optical signals and simultaneously perform complex floating point calculations with critical timing requirements. These are not achievable using typical process control systems. Hence, tailor-made solutions for signal transmission, control hardware and software have been designed to meet these challenges. EMI/EMC qualification tests relevant to this application are also discussed.

WEPD43 **A New Scheme for Direct Estimation of PID Controller Parameters**
***S. Srivastava**, V.S. Pandit (DAE/VECC)*
This paper presents a novel scheme for the direct estimation of a PID controller parameters(Kp, TI, Td).The proposal discussed here is only applicable to first and second order stable systems. The formulation begins with system parameter identification (Transfer function of the process), which was calculated by applying weighted-recursive least square method. The pole zero cancellation technique was applied to estimate PID controller parameters ;which in-turn results into the matched coefficients of the system parameters to the Controller parameters. An additional tuning parameters 'α' is proposed in our method, which provides an additional flexibility of tuning the response time of the controller without disturbing the controller parameters. The proposed scheme was bench marked using real time cases of DC Motor speed control and Cruise Control. The effectiveness and robustness of the proposed auto tuning algorithm is verified by the simulation results.

WEPD44 **FPGA Data Block FIFO for the APS ID Measurement System**
***J.Z. Xu**, R.I. Farnsworth, I. Vasserman (ANL)*
A Hall probe insertion device (ID) measurement system has been developed to characterize the IDs at the Advanced Photon Source (APS). The system uses the latest state-of-the-art field programmable gate array (FPGA) technology to synchronize the position and Hall voltage measurements. Data block first-in-first-out (FIFO) has been implemented to transfer the data from the FPGA to the host computer during measurement. The system is capable of continuous scanning measurements on a full 6 meter bench at 1 ms per data point with the position resolution of 1 micron and Hall voltage precision of 5-1/2 digits.

WEPD47 **Low-cost EPICS Control Using Serial-LAN Module XPort**
***N. Kamikubota** (KEK) N. Yamamoto (J-PARC, KEK & JAEA) S.Y. Yoshida (Kanto Information Service (KIS), Accelerator Group)*
In J-PARC MR (Main Ring), we are interested in a commercial product, XPort, a low-cost serial-LAN converter [1]. We have introduced it in two different cases. (1) Two RF-amplifiers with GPIB were introduced. We asked a company to add a XPort for remote control rather than GPIB. Serial messages of GPIB are transported to an EPICS IOC (I/O controller) over our control network. (2) We developed an electric circuit board with manual switches. An on-board FPGA chip has connections both to switches and to XPort pins. Status of switches can be read remotely as UDP messages through XPort. In both cases, messages are converted into EPICS-style records using AsyncDriver of EPICS. Implementation details and operational reports are given.

Control System Interoperability

WEPD48 **Facility-Wide Synchronization of Standard FAIR Equipment Controllers using White Rabbit**

S. Rauch *(GSI), R. Bär, D.H. Beck, M. Kreider, W. Panschow, C. Prados, W.W. Terpstra, M. Thieme, M. Zweig (GSI)*

The standard equipment controller for the new FAIR accelerator facility is the Scalable Control Unit (SCU). It synchronizes and controls the actions of up to 12 purpose-built slave cards, connected in a crate. Facility-wide synchronization is a core FAIR requirement and thus precise timing of SCU slave actions is of vital importance. The SCU consists primarily of two components, a daughter board with CPU and a carrier board with FPGA, interconnected by PCI Express. The CPU receives configuration and set values with which it programs the real-time event-condition-action (ECA) unit in the FPGA. The ECA unit receives event messages via the timing network, which also synchronizes clocks using White Rabbit. Matching events trigger actions on the SCU slave cards such as ramping magnets, triggering kickers, etc. Timing requirements differ depending on the action taken. For softer real-time actions, an interrupt can be generated for complex processing on the CPU. Alternatively, the FPGA can directly fire a pulse or bus operation. The delay and jitter achievable in each case differs and this paper examines their timing performance to determine which is appropriate for the required actions.

Control Databases

WEPD52 **Diamond Light Source Control Systems RDB**

K. Vijayan*, M.T. Heron, S.J. Singleton (Diamond)*

The functionality of the Diamond Light Source Relational Database (RDB) will be described in this article. An Oracle-based RDB and web-based GUIs allow recording of system configuration information and configuration change management. Information about the hardware components that make up each beam line crate is stored in the RDB; for each item of control equipment, the status, location and name of the person responsible for the item are held. The Diamond Control System is based on EPICS and has of the order of 500,000 process variables (PVs); the RDB maintains a record of the names of these PVs and validates new names against the Diamond Naming Convention, allowing consistency of naming style to be maintained and avoiding name duplication. Machine operational details such as alarm logs are stored in the RDB and viewed using a web browser. All process data recorded by the control software are archived using the EPICS Channel Archiver; the Archiver configuration for each technical area is maintained in the RDB. A further application using the RDB is the electronic logbook (ELOG) which is used to record activities by Diamond Operations and Beamline groups.

THIA — Status Report of Control System

Chair: R. Bacher (DESY)

THIA01 09:30 **Trombay Programmable Logic Controller TPLC-32**

U.W. Vaidya *(BARC)*

Until recently Computer Based Safety and Safety-related Control and Instrumentation systems in Indian NPPs and other nuclear utilities were custom built embedded systems. This approach needs enormous development and verification & validation efforts. Further requirement change management during plant operation becomes intricate due to dependence on custom System Designer. Current scenario worldwide is development of such systems using Qualified Configurable, Programmable Platforms (PLCs) offering several advantages over custom built approach. Trombay Programmable Logic Controller TPLC-32 is one such qualified platform designed and developed inhouse by Reactor Control Division, BARC. It facilitates configurable and programmable environment to build safety and safety related Control and Instrumentation Systems. TPLC-32 hardware is designed around 32 bit processor based in-house developed Single Board Computer on VME bus and intelligent Input/Output modules on proprietary I/O bus. The hardware design is carried out as per IEC60987 standard. The Platform software development is carried out following well documented, well controlled, fully reviewable software engineering process based on AERB SG-D25 guide and IEC 80880 standard including verification and validation by an independent team. The Application Development Environment (ADE) software package of TPLC-32 facilitates defining complete system configuration and application development in the form of function block diagrams based on IEC 61131-3 standards. Platform architecture, development process, platform salient features and C&I system developed using TPLC-32 platform will be discussed in the talk.

THIA02 09:55 **Current Status and Upgrade Plan of the Data-Acquisition System in SACLA**

T. Sugimoto*, A. Amselem, Y. Furukawa, T. Hirono, Y. Joti, T.K. Kameshima, A. Kiyomichi, T. Ohata, M. Yamaga (JASRI/SPring-8) T. Abe, R. Tanaka (RIKEN SPring-8 Center, Innovative Light Sources Division) T. Hatsui, A. Tokuhisa (RIKEN SPring-8 Center)*

This paper presents current status and upgrade plan of a data-acquisition (DAQ) system for SACLA user experiments. The X-ray Free-Electron Laser facility in SPring-8, SACLA, has achieved first SASE lasing in June 2011, and has delivered X-ray laser beams to users from March 2012 [1]. For the user experiments at SACLA, a dedicated DAQ system has been developed. The DAQ system is currently capable to operate with maximum 10 sensors of multiport Charge-Coupled Device (MPCCD) for X-ray detection. With this configuration, the MPCCD generates 10 MBytes data per accelerator beam shot, which is equivalent to 5 Gbps data rate at 60 Hz beam repetition. During the first experimental period from March to July 2012, the DAQ system carried out 25 experimental proposals that covered atom, molecular and optical physics, ultrafast science, material science, and structure biology.

In this paper, we present an overview of the DAQ system with special emphasis on the high-speed data cache, and data visualization by on-site PC clusters. An upgrade plan of the DAQ storage more than 3 PBytes and the on-line data-analysis with the off-site 10 PFlops supercomputer ("K computer") are also discussed.

THIA03 10:20 25 **The IUAC Tandem-LINAC Control System**

A. Kumar *(IUAC)*

The 16MV Tandem Van de Graff accelerator at IUAC is one of the earliest machines to go for a PC based control system. The PDP11, supplied with it, was replaced by an IBM PC running DOS before the accelerator was commissioned in 1989. The present system, commissioned in 1997 to include the LINAC, runs on a network of PCs under the GNU/Linux operating system. We have followed a distributed approach by grouping the signals, around 1000 in total, based on the location. Each group is connected to a server computer, by hardware interfaces like CAMAC, VME and custom hardware. The signals connected to each server PC are handled by a server program and they are accessible to the outside world, over a TCP/IP network, using a unique identifier consisting of a Label, Function and Unit. The features like a user interface, monitoring for alarm conditions, data logging and partial automation are handled by several client programs, communicating to multiple servers to access the hardware. The communication is done by passing a message packet and waiting for the reply. The message consists of the unique signal identifier and commands for setting/reading analog and digital parameter values. The development of the control system also resulted in low cost equipment for science education[1]. It also helped further development of the control system by additions like client programs in Python language. This feature enabled accelerator users to write simple scripts for tasks like setting the LINAC resonator parameters based on calculations, writing routines for partial automation etc. The system is cost effective, scalable and simple. It has shown very high reliability and ease of use during the past two decades of operation.

THCA — Status Report of Control System

Chair: R. Bacher (DESY)

THCA04 10:45 15 **An Update on ConSys Including a New LabVIEW FPGA Based LLRF System**

***T. Worm**, J.S. Nielsen (ISA)*

ConSys, the Windows based control system for ASTRID and ASTRID2, is now a mature system, having been in operation for more than 15 years. All the standard programs (Console, plots, data logging, control setting store/restore etc.) are fully general and are configured through a database or file. ConSys is a standard publisher/subscriber system, where all nodes can act both as client and server. One very strong feature is the easy ability to make virtual devices (devices which do not depend on hardware directly, but combine hardware parameters.) For ASTRID2 a new LabVIEW based Low-Level RF system has been made. This system use a National Instruments NI-PCIe7852R DAQ card, which includes an on-board FPGA and are hosted in a standard PC. The fast (50 kHz) amplitude loop has been implemented on the FPGA, whereas the slower tuning and phase loops are implemented in the real-time system. An operator interface including live plots from the regulation loops are implemented in a host program on Windows. All three levels have been implemented with LabVIEW. The LLRF system is interfaced to ConSys through LabVIEW shared variables.

BREAK 11:00 20 **Tea Break**

THCA05 11:20 15 **PLC-based Control System for 10 MeV Linear Accelerator at EBC Kharghar, BARC**

***A.S. Chachondia**, G. Ganesh, R.K. Patil (RCnD) B.B. Biswas, D.P. Chakravarthy, L.M. Gantayet, M.B. Patil (BARC) K.C. Mittal (BARC-EBC) M.K. Mukesh Kumar (BARC-APPD)*

Currently the 10MeV Linac is being used for different research applications and industrial use. The control system in operation was developed using CAMAC based DAS, backed by Hard-wired Interlock System. It is proposed to replace the CAMAC system with a state-of-the-art indigenously developed PLC that is verified to the level of a Class IB computer-based system used in nuclear power plants. A PLC node comprises of two VME bus based CPU boards (PowerPC MPC7447, 600MHz) working in redundant mode. The Inputs and Outputs are common to both CPUs. The intelligent I/O boards are hot swappable. The PLC hardware and software has undergone rigorous verification and validation. A user-friendly development environment is provided to the process engineer for building the application using pre-defined function blocks. The LCS developed using PLC is to be used for operating the Linac irradiation facility, remotely as well as locally in a fail-safe mode, with sequential start-up and sequential shut-down. Apart from system status monitoring, data archiving, alarm generation and set-point adjustments, it shall monitor the important parameters and trip the GM HV, KM HV and EG PS on fault conditions.

THCA06 **Status of the Ultra Fast Tomography Experiments Control at ANKA**
11:35 25
D. Haas, *B.M. Balzer, A. Cecilia, S. Cilingaryan, A. Kopmann, W. Mexner, H. Pasic, T. Spangenberg, P. Vagovic, M. Vogelgesang (KIT)*
X-ray imaging permits spatially resolved visualization of the 2D and 3D structure in materials and organisms which is crucial for the understanding of their properties. Additional resolution in the time domain gives insight in the temporal structure evolution and thus access to dynamics of processes allowing to understand functionality of devices and organisms and to optimize technological processes. Such time resolved dynamic analyses ofμsize structures became now possible by the new ultrafast tomography at the TopoTomo beamline of the synchrotron light source ANKA. At TopoTomo the whole experimental workflow has been significant improved in order to decrease the total duration time of a tomography experiment in a range of minutes. To aim the goal of a Tango based control system for ultra fast tomography with a data throughput of several 100 MB/s, detectors and computing infrastructure have been optimized. Multi GPU based computing allows a high speed data processing by using a special reconstruction scheme. Furthermore data management infrastructure will allow a life cycle management of data sets accumulating to several TByte/day.

06-Dec-12 11:50 – 12:35 VECC/SINP Campus Auditorium Main Lecture Hall

THCB — Control Database

Chair: T. Kosuge (KEK)

THCB01 11:50 15 **HyperArchiver: an Evolution of EPICS Channel Archiver**

***M. del Campo**, I. Arredondo (ESS Bilbao) M.G. Giacchini, L.G. Giovannini (INFN/LNL) J. Jugo (University of the Basque Country, Faculty of Science and Technology)*

Data storage is a primary issue in any research facility. In the EPICS middleware based accelerator community, Channel Archiver has been always considered the main reference. It works with Oracle and MySQL, probably the best well known relational databases. However, demanding requirements at minimum costs have fostered the development of a wide range of alternatives, like protocol buffers (SLAC), MSDPlus (Consorzio RFX), SciDB (BNL) or Hypertable (IFNF). This document launches a tool called HyperArchiver, which was firstly developed at IFNF (Italy) and eventually customised by ESS Bilbao (Spain). Based on a NoSQL database named Hypertable, it focuses on large data sets management with maximum scalability, reliability and performance. Besides the update and further customization made at ESS Bilbao, HyperArchiver is presented with a set of GUIs, in order to provide an easy use and integration with any general control system. A LabVIEW VI and two cross-platform PyQt GUIs for both Hypertable data retrieval and HyperArchiver control have been developed and successfully tested at ESS Bilbao.

THCB02 12:05 15 **EPICS MySQLArchiver - Integration Between EPICS and MySQL**

***A. Roy**, R.B. Bhole, S. Pal, D. Sarkar (DAE/VECC)*

The performance evaluation and analysis of inter-system dependency of the various subsystems of the Superconducting Cyclotron demand a well configured data logging, archiving and historic analysis facility for massive number of control parameters along with on-line failure analysis facility of every system. EPICS is used as development architecture of the control system of these systems with MySQL used as database for large amount of relational data management. This combination requires integration between EPICS and MySQL server. For this purpose, MySQLArchiver as an EPICS Extension is developed for data logging and archiving of control parameters into MySQL database. This extension also provides a web based tool for online monitoring of control parameters and historic analysis of archived data. This paper describes the software architecture, implementations, as well as method of configuration for any other EPICS based control system as a utility. This facility is also elaborated with examples, web page views and experiences of deploying it in SCC.

THCB03 12:20 **Using Memcached as Real-time Database in the SPARC Control System**

E. Pace, *G. Di Pirro (INFN/LNF)*

The first implementation of the SPARC control system was based on a distributed TCP/IP data server: each front-end CPU had its own server to distribute data to the console. We decided to move the system to a NoSQL key value database. We decided to use an open source database Memcached. This is a database that is high performance key -value cache optimized for speed only. For this reason we could use Memcached not for storing data, but a s a channel of communication between front-end processors and consoles. Th e first object that we have installed is the camera system. We chose this class of elements because the amount of data is high; cameras are at least 640x480 with 8 bit. In this first installation we made some speed test: we increased the speed transfer and the data transfer is now independent from the number of high level CPUs that are using the same image. The success of this installation convinced us to bring the entire data transfer of SPARC control system to use Memcached as data server.

THIB04 12:35 25 **Control System Interoperability, an Extreme Case: Merging DOOCS and TINE**

P. Duval, *A. Aghababyan, O. Hensler, K. Rehlich (DESY)*

In controlling large facilities one is rarely able to manage all controllable elements via a common control system framework. When the standard framework must deal with numerous 'foreign' elements it is often worthwhile to adopt a new framework, rather than 'disguising' such components with a wrapper. The DOOCS[1] and TINE[2] control system frameworks fall into this scenario. Both systems have a device server oriented view, which made early mapping attempts (~2001) immediately successful. Transparent communication, however, is but a small (albeit important) part of the control system merger currently taking place. Both systems have well-established central services (e.g. archiving and alarms), and possess a general 'culture' which might dictate to a large extent how something is actually 'done'. The long term goal of the DOOCS/TINE merger is to be able to make use of any tool, from either the DOOCS or TINE toolbox, on any control system element. We report here on our progress to date, concentrating on the REGAE accelerator, and plans for the XFEL accelerator (to begin commissioning in 2015).

THIC01 14:30 25 **Tango for Experiment Control**

J.M. Meyer, *L. Claustre, A. Götz, S. Petitdemange, O. Svensson (ESRF) T.M. Coutinho (CELLS-ALBA Synchrotron)*

The Tango[1] control system framework contains the communication bus with the standard communication modes as well as the basic hardware access modules, GUI tools and development kits, services and bindings to commercial products to set up a control system. Tango was developed by several synchrotron light sources that have to support not only the accelerator complex but also a lot of experimental end stations. For synchrotron experiments we have to control the whole process from basic hardware access over data taking to data analysis. This paper describes in the first part the special features of Tango allowing flexible experiment control. The dynamic configuration, the rapid hardware interface development and the sequencing and scanning framework are some examples. The second part gives an overview of some packages developed in the Tango community for experiment control: A HKL library for diffraction computation and diffractometer control, a library to control 2D detectors and a data analysis workbench with workflow engine for on-line and off-line data analysis. These packages are not part of Tango and can be used with other control systems.

THCC — Software and Hardware Technology

Chair: D. Sarkar (DAE/VECC)

THCC02 14:55 15

Controls Architecture for the Diagnostic Devices at the European XFEL

O. Hensler *(DESY)*

The X-ray laser is an 3.4-km-long facility which runs essentially underground and comprises three sites above ground. For controlling all diagnostic devices like toroids, BPMs or BLMs, it is planned to use the new MTCA.4 crate standard instead of VME. ATCA is an emerging standard from the Telecom Industry and adapted with the PICMG MTCA.4 branch for physics usage. The communication on the backplane utilizes the high speed serial PCIe communication plus precise clock lines and SATA interface. The MTCA.4 hardware supports hot-plug mechanism and remote monitoring and control via IPMI over Ethernet. Some of the diagnostics will be connected to 16Bit ADCs with up to 125Mhz sampling rate from Struck company or to an internal DESY development call DAMC2. The software architecture is based on the DOOCS control system known from the FLASH accelerator. The raw data from the ADCs will be read via DMA transfer by one server process. Then this raw data will distributed locally on the CPU using a message passing system based on the ØMQ project. The receiving server processes are calculating these data into engineering units then. Everything works in an event driven way.

THCC03 15:10 15

PC Based Real Time Data Exchange on 10GbE Optical Network Using RTOS

R.P. Gupta*, H.D. Dave (Institute for Plasma Research)*

The traditional embedded systems are expensive to adapt to the new requirements. The Personal Computer based systems offer alternatives for industrial controls. It reduces the capital cost and provides a solution for multiple applications. However, limitations of PC based controls should be resolved. PC operates on a non-real time OS with non-deterministic response to real time events and data. The real-time pre-emptive kernel for Linux uses Xenomai for better solution. A real-time 10GbE data exchange optical network using Xenomai extension for Linux is demonstrated. The hardware based on Intel82599 10GbE Ethernet PCIe network card supports IEEE1588 standard for synchronization, deterministic response to real-time interrupts and events. The benchmark testing comprises multiple nodes and data sources, for data exchange among nodes, which would improve the performance of PC control systems. Data sources and consumers include time synchronization, hardware and software events broadcasting. A single fiber cable is used for exchange of measured status and calculated control data among nodes. Moreover, the open source Ubuntu Linux RTOS will help the future development.

THCD — Software and Hardware Technology & Data Integrity and Security

Chair: R. Baer (GSI)

THCD04 15:45 15

Master Slave Topology Based, Remotely Operated, Precision X-ray Beam Profiler and Placement System for High Pressure Physics Experiment at Indus-2 Beam Line

H.S. Vora, *S.K. Deb, V.K. Dubey, T. Ganguli, C.P. Navathe, P. Saxena, I. Singh, M.N. Singh, A.K. Sinha, A. Upadhyay (RRCAT) C. Narayana (JNCASR)*

RRCAT has commissioned a beam-line on Indus-2 synchrotron facility for carrying out Angle Dispersive X-ray Diffraction Measurement. A typical high pressure measurement is carried out by placing the sample in the Diamond Anvil Cell (DAC) with the sample located in a region of beam diameter within 50-100 μm. The X-Ray beam has to pass through the DAC to ensure maximum illumination of the sample with the X-Rays. An X-Y beam scanner/locater cum placement system is developed, which scans an area of 10 x 10 mm^2 with resolution of 10 to 100 μm in rough scan mode and fine scans selected area with programmable resolution of 2.5 to 25 μm. The scanner acts as slave to the PC in which master GUI grabs the data on serial port and plots the image of X-ray beam. It also analyzes and detects the coordinate with maximum intensity. Thus the DAC can be placed at the desired location with an accuracy of 2.5μm anywhere within 10 x 10 mm^2, for performing experiment. Developed system takes only ~5 minutes to search the beam and a few seconds to place DAC at any the desired location within the scanned area.

THCD05 16:00 15

A Flexible and Testable Software Architecture: Applying Presenter First to a Device Server for the DOOCS Accelerator Control System of the European XFEL

A. Beckmann, *S. Karabekyan, J. Pflüger (European XFEL GmbH)*

Presenter First (PF) uses a variant of Model View Presenter design pattern to add implementation flexibility and to improve testability of complex event-driven applications. It has been introduced in the context of GUI applications, but can easily be adapted to server applications. This paper describes how Presenter First methodology is used to develop a device server for the Programmable Logic Controls (PLC) of the European XFEL undulator systems, which are Windows PCs running PLC software from Beckhoff. The server implements a ZeroMQ message interface to the PLC allowing the DOOCS accelerator control system of the European XFEL to exchange data with the PLC by sending messages over the network. Our challenge is to develop a well-tested device server with a flexible architecture that allows integrating the server into other accelerator control systems like EPICS.

THCD06 16:15 **Design Development and Analysis of a Comprehensive Open Source System for Proactive Management of Security Aspects of a Control Network**

S.S. Tomar, *S.N. Chaudhari, H.S. Chouhan, V.K. Maurya, A. Rawat (RRCAT)*

Control networks can only be assumed to be secure, when they work in complete isolation and all communication ports of the constituent control devices are disabled and are closely monitored for security breaches on 24X7 basis. With more and more control systems being developed using Common Out of The Shelf (COTS) computers, using windows OS, the chances of virus attacks on such control networks is extremely large. Handling zero day virus attacks or virus attacks with unknown cure, is a serious challenge for control network administrators. Another important aspect, somehow related to the security of the control network, is the rising temperatures of the control devices, because of 24X7 operation. All this is difficult to handle manually or using disconnected systems and hence there is a requirement of a comprehensive system which can do all this automatically. In this paper we will discuss the various security related parameters of the control networks and then present a simplified design followed by development details of a comprehensive open source system for proactive management of the security aspects of the control network.

PC vs Embedded Systems

THPD02 **What it Takes to Make a System Reliable**

M.R. Clausen*, S. Rettig-Labusga, B. Schoeneburg (DESY)*

What is a reliable system and how is reliability defined? This depends on the actual situation and in which environment the system is operated. If you can rely on a scheduled downtime of the controlled system every week, reliability is defined in hours or weeks. In this case the system must run just longer than the scheduled downtime. If the system has to continuously operate for months and even years, your requirements are rising. In cases where continuous operations must be guaranteed even during software or hardware updates, redundant systems come into play. The hardware selection process is driven by basic requirements like 'no moving parts' or 'redundant power supplies'. This implies the selection of possible (fan-less) CPU boards with passive cooling. It also implies no hard discs and reduces therefore the selection of possible operating systems. Continuous operation during updates requires redundant controllers/ CPUs also in addition to redundant power supplies. The latter has a lot of impact on the software running inside the controllers. We will describe the selection process of the components we have chosen and summarize our experience of several years of operations.

Software and Hardware Technology

THPD03 **PLC Controlled Search & Secure Safety Interlock System for Accelerator**

V. Sharma *(BARC-EBC) S. Acharya, S. Gond, K.C. Mittal, R.N. Rajan (BARC-APPD)*

PLC based search and scram system is designed and commissioned to ensure the accelerator cell being free from any human occupancy before we start the accelerator. Search and Scram units which are controlled by PLC have been installed at different places inside the cell area. The operator of the accelerator has to clear all the units by pressing the secure button. Clearing each of the unit and pressing the button ensures that there is nobody left inside the cell after all the units are cleared. If someone remains trapped inside cell even after search and secure operation successfully performed, he can press any emergency button located on each of the Scram unit to switch off the accelerator immediately. The operation is time limited so if the operator fails to do the search operation in time, the entire system will get tripped and will require to the operator to do the entire operation again. This system generates HV ON enable signal. If any of the door is opened or Scram is pressed the HV supply switches off and radiation ceases off immediately. This system has the merit that it offers timing and sequence flexibility but retains the safety merit of hard wired circuit.

Status Report/Overview of Control System

THPD04 **Machine Throughput Improvement Achieved Using Innovative Control Technique**

***V. Sharma**, K.C. Mittal (BARC-EBC) S. Acharya (BARC-APPD)*

A 10MeV, Electron beam, RF Linac is operational at EBC, Kharghar, Navi Mumbai. The beam output scans one meter length in a scan horn. The product under irradiation is placed in a conveyor trolley where trolley is one meter long and one meter gap between the trolleys. With the constant speed of 5mtrs/min operation of trolley, the dose utilization is 50% since the beam falls in the gap between the trolleys. We have modulated the speed as 5mtrs./min when trolley gap is under the beam and 0.1 mtrs./min when trolley is under the beam. This way the beam utilization for the irradiation goes up to 98% hence 48% rise in productivity. A 20kV 10KJ Electromagnetic machining (EMM) facility is developed by APPD/BARC. In this EMM facility a large value capacitor is charged by a DC supply to a constant voltage. This charged capacitor is then discharged using triggered spark gap into a coil to generate intense magnetic field. This magnetic field generates the eddy current into the job piece to do the forming. We have used a PLC based control system to control the machine.

Software and Hardware Technology

THPD05 **Design and Analysis of Second Harmonics Modulator for DCCT**

***K.D. Joshi**, K. Reju (BARC)*

DC Current Transformers (DCCT) are widely used in the world of particle accelerators. DCCT is a device which produces even harmonics, predominantly second harmonics corresponding to DC beam current flowing through two toroids. The second harmonics is detected by digital synchronous detector implemented in programmable logic. Current proportional to the detected second harmonic is passed through the toroids in a feedback loop such that the flux due to the DC beam current is cancelled by it. This feedback current is the measure of average beam current. The high permeability toroids, excitation and output windings are collectively called magnetic modulator, which is a key component of DCCT. Design and analysis of a second-harmonic magnetic modulator used as a detector for DC Current transformer for high resolution current measurement is presented.

THPD06 **FLogbook: From Concept to Realization**

***B.S. Srivastava**, R.K. Agrawal, K.G. Barpande, P. Fatnani, C.P. Navathe (RRCAT)*

Indus-1 and Indus-2, the Synchrotron Radiation Source (SRS) facilities at RRCAT Indore are national facilities and being operated on round the clock basis to provide synchrotron radiations to users as well as carrying out machine studies. Both of these accelerators are widely distributed systems and employ many sub systems for their operation. These sub-systems are also made up of heterogeneous type of hardware and software modules. To keep the whole system up and running, the faults & failures encountered during machine operations are attended at site and all observations and rectifications information are to be recorded electronically by the crew members. FLogbook has been conceived and developed to meet such needs. This web based software

operates in the Intranet environment over a three tier architecture. It mainly uses JavaServer Pages (JSP), JavaBeans and SQL databases for designing its building blocks. Using relational database, the package supports logging, e-mailing, searching & commenting the faults of various sub systems. This paper explains the salient features of FLogbook and also briefly describes the architectural design of the complete package.

THPD09 **Development of a Monitoring System for the FL-net Protocol**
***M. Ishii**, T. Masuda, S. Ueda (JASRI/SPring-8) T. Fukui (RIKEN/SPring-8)*
At SPring-8 and SACLA, we are using the FL-net for many control systems as a communication protocol between front-end computers and PLCs. The FL-net is one of the Ethernet-based open standard protocols for a factory floor network authorized by the Japan Electrical Manufacturers' Association. It is a UDP/IP based master-less token passing protocol and supports a cyclic transmission. At SACLA, we had some troubles in a data acquisition by using the FL-net for beam line equipment protection system. In a network based control system, an analysis of network packets is an effective way at troubleshooting. We developed a monitoring system for the FL-net protocol, which captures and analyzes all packets of an FL-net network segment, detects protocol failure events, and stores the event information into a relational database. We can easily refer to the stored information in the database via a web browser. The monitoring system is highly portable software based system without dedicated hardware implementing a protocol stack. In this paper, the design of the monitoring system for the FL-net will be presented.

THPD10 **Modular Beam Diagnostics Instrument Design for Cyclotrons**
***N. Chaddha**, R.B. Bhole, S. Pal, S. Sahoo (DAE/VECC) P.P. Nandy (VECC)*
The Cyclotrons at VECC, Kolkata i.e. Room Temperature Cyclotron (RTC) and Superconducting Cyclotron (SCC) comprise of internal and external beam diagnostic systems. These systems provide the beam developer with position, intensity, beam profile, a visual impression of the size & shape of ion beam, and operational control over diagnostic components like 3-finger probe, Beam Viewer probe, Deflector probe, Faraday cup, X-Y slit, Beam viewer etc. Automation of these components was initially done using customized modules for individual subsystem. An expansion of this facility and various levels of complexity demand modular design to cater easy modification and upgradation. The overall requirements are analysed and modular cards are developed based on basic functionalities like valve operation, probe/ slit/ viewer control, position read-out, interlock, aperture control of beam line and communication. A 32-bit Advanced RISC Machine (ARM) based card with embedded EPICS is chosen as the master controller and FPGA/ microcontroller is used for functional modules. The paper gives a comprehensive description of all modules and their integration with the control system.

THPD11 **Facility Monitoring System using Storage Area Network for VEC and SCC**

***T. Bhattacharjee**, R.B. Bhole, K. Datta, S. Pal, A. Roy, T. Samanta, D. Sarkar, Mr. Saxena (DAE/VECC)*

The facility monitoring system of cyclotron operational parameters at VECC is developed and commissioned recently. Storage Area Network(SAN) is used to isolate the control LAN and office LAN which ensures secured access of the control systems from outside world. EPICS gateway service and modified channel access save/restore tool have been used to integrate EPICS based control system of VEC and SCC with office network. This paper describes the implementation details and operational experiences of the overall facility monitoring system.

THPD12 **Design and Implementation of an IEEE 802.15.4/ZigBee based Star Network for Data Acquisition and Monitoring**

***S. Guha**, T.K. Bhaumik, C. Mallik, P.Y. Nabhiraj (DAE/VECC)*

ZigBee based wireless technology is used to provide a low cost, low power, secured, PAN solution for monitoring of parameters from several distributed vacuum pumping modules installed in the SCC injection line. The parameters include On-Off status of the modules, RPM of pump, input current and pressure reading of different vacuum gauges. The ZigBee stack is written in a simplified form so that each node can create a network and can join to any established network when powered on. End nodes can be replaced through a little modification in the firmware codes. End node consists of sensors, signal conditioning circuits, micro-controller and ZigBee Transceiver whereas the central node consists of micro-controller, Transceiver and UART interface. This paper highlights the future approach of utilizing this network for data acquisition related with environmental temperature, relative humidity, noise, water leakage from inaccessible areas of Cyclotron Vault, Pit, Basement and ECR Highbay for the ease of maintenance also demonstrate the development of an environment monitoring system powered by solar cells covering a wide area.

THPD13 **SocketCAN Device Support for EPICS IOCs**

***C. Burandt**, U. Bonnes, J. Enders, M. Konrad, N. Pietralla (TU Darmstadt)*

A large number of devices used at the S-DALINAC are controlled by IOCs running on standard personal computers via CAN bus (Controller Area Network). CAN interface controllers for PCs are commercially available from different manufacturers but although they all share the same basic functionality, most of them have a vendor-specific API. Moreover, traditional CAN drivers can usually be accessed by only one process at a time which avoids the use of sniffer programs for debugging. In contrast to that the SocketCAN network stack [1], included in recent Linux kernels, provides access to the CAN bus via network devices (BSD sockets) which can be accessed by multiple applications at the same time via a vendor independent interface. A set of open source CAN drivers provides access to controllers of different vendors. This contribution describes an EPICS device support that makes use of the SocketCAN framework and thereby is independent from the API of a specific vendor. The device support has been used successfully in a

production environment at the S-DALINAC since almost two years.

Status Report/Overview of Control System

THPD14 **Status of the Migration of the S-DALINAC Accelerator Control System to EPICS**

C. Burandt, *U. Bonnes, J. Enders, F. Hug, M. Konrad, N. Pietralla (TU Darmstadt)*

The S-DALINAC is a recirculating superconducting electron LINAC which has been in operation for twenty years. The control system had been developed in-house and, while being moderately reliable, has become very hard to maintain and nearly impossible to adapt to new requirements. The replacement of the old analog low-level RF control system by a modern digital solution in 2010 became a primer for the introduction of an EPICS-based control system. Several important subsystems have been migrated since then, but the process has not been completed yet. This contribution overviews the current status of the new control system and developments planned for the future. Basic hardware aspects are described as well as client software and operator interfaces. The general network infrastructure has been restructured in context of the ongoing migration and is also presented.

Software and Hardware Technology

THPD15 **Multichannel High Voltage Power Supply Controls Solution Using Compact Distributed Ethernet Based Boards and Qt Based GUI**

J. Antony *(IUAC)*

Compact low cost Ethernet based remote controller boards have been developed and tested for distributed control of many DC-DC high voltage power supplies(0-2000V) to be used in large Neutron detector array at IUAC. The boards can be distributed over LAN using network switches for interconnect. Each board has its own unique MAC and IP address for independent read write operations. A 24 channel power supply system, each channel having a compact two layer board with the DC-DC HV converter, mounted on top layer, has been built and tested successfully to power detectors. A user friendly GUI has been developed using Qt as the preferred language which is compatible to both Linux and Windows. The advantage of such a system is that, it is easily expandable to a large number of power supplies, low cost, globally accessible, multiple users in a network can set or read any power supply value through a software control panel developed either as a simple browser based HTTP client or versatile HLL interface using LabVIEW, C++ etc. and OS independent.

Status Report/Overview of Control System

THPD16 **Fast Digital Feedback Control Systems for Accelerator RF System using FPGA**

P.S. Bagduwal*, P.R. Hannurkar, M. Lad, D. Sharma, N. Tiwari (RRCAT)*

Feedback control system plays important role for proper injection and acceleration of beam in particle accelerators by providing the required amplitude and phase stability of RF fields in accelerating structures. Advanced digital technologies allow development of control systems for RF applications. Digital LLRF system offers inherent advantages like flexibility, adaptability, good repeatability and low drift errors compared to analog system. For feedback control algorithm, I/Q control scheme is used. Properly sampling of down converted IF generates accurate feedback signal and eliminates the need of separate detector for amplitude and phase. Controller is implemented in Vertex-4 FPGA with proper control algorithm which offers fast correction with good accuracy and also controls the amplitude and phase in all four quadrants. Single I/Q modulator work as common correctors for both amplitude and phase. LO signal is derived from RF signal itself to achieve synchronization between RF, LO and FPGA clock. Control system has been successfully tested in laboratory with phase and amplitude stability better then ± 1% and ±1°. With minor modification same systems can be used at any frequencies.

Software and Hardware Technology

THPD17 **API Manager Implementation and its Use for Indus Accelerator Control**

B.N. Merh*, R.K. Agrawal, K.G. Barpande, P. Fatnani, C.P. Navathe (RRCAT)*

The control system software needed for operation of Indus accelerators is interfaced to the underlying firmware and hardware of the control system by the Application Programming Interface (API) manager. PVSS-II SCADA is being used at the layer-1 (L1) for control and monitoring of various sub-systems in the three-layered architecture of Indus control system. The layer-2 (L2) consists of VME bus based system. The API manager plays a crucial role in interfacing the L1 and L2 of the control system. It has to interact with both the PVSS database and the L2. It uses the PVSS API, a C++ class library, to access the PVSS database, whereas in order to access the L2, custom functions have been built. Several other custom functionalities have also been implemented. This paper presents the important aspects of the API manager like its implementation, its interface mechanism to the lower layer and features like configurability, reusable classes, multithreading capability etc.

Status Report/Overview of Control System

THPD18 **Adaptive Fuzzy Control for Transfer Channels in Particle Accelerators**

S. Berlik *(University of Siegen) H. Ehrlichmann (DESY)*

Long-term objective of this work is to develop a fuzzy technology based control framework to be applied in particle accelerators. Main motivation for this is the promise of fuzzy systems to exploit the tolerance for imprecision, un-certainty, and partial truth to achieve tractability, robustness, and low solution cost. Intended areas of application are

manifold: we think on automatic operation, optimization of the operating conditions and yields; applied to various stages in the processing of circular and linear accelerators. As a first step towards this goal a fuzzy control system for a transfer channel in a particle accelerator has been developed. For it we built up the machinery, i.e. algorithms, data structures, integration in the existing control system and did a first proof-of-concept. Special emphasis is given on handling high dimensional data streams and the immanent challenges as sparsity and equidistance of the data.

THPD19 **Drive System Control for Kolkata Superconducting Cyclotron Extraction System**

***T. Bhattacharyya**, S. Bhattacharya, T. Das, C. Nandi, G.P. Pal (DAE/VECC)*

The K500 Superconducting Cyclotron at VECC, Kolkata uses two electrostatic deflectors, eight passive magnetic channels, one active magnetic channel and two compensating bars as its extraction elements. Except the active magnetic channel, all the other elements can be moved radially, typically by ±6 mm around a centre position. This maneuverability is due to the fact that not all the ions, spanning the operating region of the cyclotron, will have the same optimum beam extraction radius. At the end of the beam extraction channel, the beam is shaped and aligned by a pair of water cooled slit. The slit movement is pneumatically controlled as it has to be operated in high magnetic field. The computer controlled drive system can move the elements precisely. The paper will describe the drive system and its control mechanism.

THPD20 **RF Distribution and Control System for Accelerators of the VEC-RIB Facility**

***H.K. Pandey**, S. Basak, D.P. Dutta, T.K. Mandi (DAE/VECC) A. Kumar, K. P. Ray (SAMEER)*

RIB facility at VECC has several heavy ion linear accelerators like RFQ, two IH-LNACs and one buncher cavity operating at 37.8 MHz and two IH-LINACs with one buncher cavity at 75.6 MHz. Some more RF cavities are being designed at the third harmonic of 37.8 MHz and will be added in the RIB beam line. All the cavities have separate RF power amplifiers with proper amplitude, phase and resonance frequency tuning and control system for efficient and stable operation. The LLRF control system has been operational for the power amplifiers of the existing RF cavities and improved design and development is carried out. The main features of the RF control system are phase and amplitude control of the RF input to the amplifiers and tuning of the RF cavity to the desired resonant frequency with automation using feedback control. It will also have various interlocks for the safety of the load as well as the amplifier. A micro-controller based data acquisition and processing system is being used for control and local/remote operation. The RF distribution system as well as the design details of RF control system will be presented in this paper.

THPD21 **Testing of Inductive Output Tube based RF Amplifier for 650 MHz SRF Cavities**

S. Ghosh *(DAE/VECC)*

A 650 MHz IOT based RF amplifier has been developed in VECC. It can be used to power several cavity modules in high energy high current proton linear accelerator to be built for ADSS programme in India and in Project-X at Fermilab, USA. The IOT based amplifier requires different powers supplies, water cooling and forced air cooling for its operation. A Programmable Logic Controller (PLC) based interlocks has been incorporated to take care of systematic on/off of the power supplies and driver amplifier, water flow, air flow and other interlocks for the safe operation of the RF System. In addition to that EPICS based RF operating console and data logging/monitoring system has been added.

THPD22 **Controls for a 10 Petawatt Class Laser Facility**

D.A. Pepler *(STFC/RAL)*

Computerised controls are vital to the operability and flexibility of large-scale physics facilities (such as accelerators, synchrotrons and high-power lasers) in providing fundamental services, for example, automatic configuring of specialist hardware, motion control, firing of shot sequences, enabling precision trigger distribution, vacuum monitoring and control, data acquisition and analysis. The proposed 10PW Laser facility, in line with other major physics facilities around the world, will require a complex computer control system. This is expected to be modeled on the existing Vulcan Laser[1] control system and consist of a dozen or so Windows based PCs each of which will be running a separate and dedicated application to control a particular area or function of the facility. This paper will present an overview of the existing Vulcan laser and provide a status report on the development towards the 10PW which will require the control system to be designed to allow autonomous operation of the 10PW facility as well as to be fully integrated with the existing Vulcan laser controls for combined and synchronized 10PW plus 1PW operations.

THPD26 **Integrated Control System for LEHIPA**

S.K. Bharade*, T. Ananthkrishnan, A. Basu, G. Joshi, P.D. Motiwala, C.K. Pithawa, P. Singh (BARC) S. Singh (LEHIPA Project, Physics Group)*

The Low Energy High Intensity Proton Accelerator (LEHIPA) is a 20 MeV 30 mA proton accelerator which will be achieved in multiple stages. LEHIPA consists of several sub systems/devices located at different positions of the beam path which includes ION source , RF Power , RF Protection Interlock System, Low Conductivity Water plant, Low Level RF control Systems, Vacuum System, Beam Diagnostics & Beam Line Devices. All these subsystems have their own local control systems (LCS) which will coordinate the operation of the corresponding subsystem. The control system for LEHIPA is thus being designed as a Distributed Control System with different teams developing each LCS. The control system will assist the operator to achieve a beam of desired characteristics by interacting with various sub systems of the accelerator in a seamless manner,protect the various parts machine by generating the necessary interlocks ,keep track of various parameters

monitored periodically by suitably archiving them, alarms annunciation and trouble shoot from the control room. This paper describes approach to system design of ICS.

THPD27 **Control Scheme for Remote Operation of Magnet Power Supplies for Infrared Free Electron Laser**

***L. Jain**, M.A. Ansari, V.P. Bhanage, C.P. Navathe (RRCAT)*

Infrared Free Electron Laser (IRFEL) is under development at MAASD, RRCAT Indore. The IRFEL machine consists of 90keV thermionic gun as electron source, beam transport line, 25MeV Linear Accelerator (LINAC) and an undulator magnet. There are fifty magnets on beam transport line. These magnets are energized by precision power supplies. These power supplies have local as well as remote control and will be located at equipment hall. The control room and equipment hall are at approximate distance of 300 m. We have planned a three layer structure for centralized operation of Beam Transport line Magnet Power Supplies (BTMPS). These layers are device interface layer, the equipment control layer and the presentation layer. Presentation layer is linked with equipment control layer on Ethernet. Whereas equipment control layer will be linked to device interface layer by RS-485. Device interface layer consist Magnet Power Supply Controllers (MPSC). Each MPSC has one master and five slave controllers linked on isolated SPI bus, which will control five BTMPS. We have developed slave controllers and a master as prototype of MPSC. This paper describes MPSC prototype and proposed control scheme.

THPD28 **A Distributed CAN Bus Based Embedded Control System for 750 keV DC Accelerator**

***A. Kasliwal**, T.G. Pandit (RRCAT)*

This paper describes a distributed embedded system that uses a high performance mixed signal controller C8051F040 for its DAQ nodes and is based on CAN bus protocol for remote monitoring and controlling of various subsystems of 750 keV DC accelerator based irradiation facility at RRCAT, Indore. A PC with integrated PCI CAN card communicates with intelligent DAQ nodes over CAN bus and each node is interfaced with a subsystem. An opto- isolated SN65HVD230 CAN driver is interfaced between each node and physical bus. Remote frames and message prioritizing are used for efficient control. The PC application is developed using LabVIEW 8.6. The proposed system is more reliable and noise immune as compared to previously [1] used systems that initially used a centralized system based on C8051 controller. This was then upgraded [2] to a distributed system that used micro-controller AduC812 and communicated over RS485 link. The new system has been integrated and tested satisfactorily for its designed performance with test jigs that simulated the actual subsystems with a bus length of 75 meters. First the complete scheme of the system is presented, then the hardware and software designs are discussed.

THPD29 **Data Acquisition System for 50 kW Solid State RF Amplifier**

***D. Sharma**, A. Gupta, P.R. Hannurkar, A. Jain, A.K. Tiwari (RRCAT)*

A high power solid state RF amplifier system working at 505.8 MHz has been developed at Raja Ramanna Centre for Advanced Technology, Indore. In order to monitor functioning of the amplifier system, and to avoid any failure by tacking appropriate preventive action, a data acquisition system has been embedded into the amplifiers. The system performs power measurement of around 72 numbers of RF signals using RF detectors and directional couplers. It also measures 8 heat sink temperatures and monitors various digital status parameters. Fast digital interlocks have been implemented using FPGA, for safe shutdown of the system in case of any fault. This interlocking can work on complex logic and still is independent on software, which provides flexibility as well as very short (of the order of tenμseconds) interlock latency. The functions of the data acquisition system includes acquisition and scaling of signals, sharing data with remote systems, embedded data logging, monitoring of system parameters and providing local and remote user interfaces.

Software and Hardware Technology

THPD30 **High Voltage Controller System for Spectroscopy Diagnostics of SST-1**

***H.D. Mandaliya**, P.V. Edappala, R. Jha, R. Rajpal, M. Shah (Institute for Plasma Research)*

We have developed special instrumentation for spectroscopy diagnostics of the SST-1 Tokamak. Light output in the visible spectrum is guided through fiber optics from the Tokamak ports to the diagnostics Hall, where photo multipliers tubes and other instrumentation electronics are kept. High Voltage(0 - 1500 V) bias generation electronics is required to bias these PMTs. Total 14 PMTs to be biased for overall requirements of the diagnostics. We have developed modular electronics for HV bias generation, which consist of one controller and seven HV modules. We have designed and developed FPGA based controller card which controls seven HV modules. The Slot-0 card is having Spartan 3E FPGA and Standalone Controller Area Networking (CAN) controller. 32-bit RISC processor Microblaze has been deployed into the FPGA. We have used Hitek make HV supply modules which is programmable. In the HV modules, Analog Device Inc. make iCoupler, digital isolators are used to break the ground loops and to avoid ground-lifting problem. Various features like Manual mode/Remote mode operation, HV ON/OFF, HV Value setting through remote GUI have been developed on LabVIEW software.

THPD32 **Progress of the JINR e-Linac Accelerator Test-Bench Control Systems**
***M.A. Nozdrin**, N. Balalykin, V. Minashkin, V.Y. Schegolev, G. Shirkov, G.V. Trubnikov (JINR)*
Due to Joint Institute for Nuclear Research participation in ILC collaboration, e-linac accelerator test-bench is being created in Laboratory of high energy physics of JINR. The bench is designed for several goals: accelerating structures and diagnostics testing, photoinjector prototype creation and investigation, radiation resistance studies of different materials etc. In addition, several proposals of FEL creation on the basis of the e-linac exist. Current setup, results of the test-bench control systems evolution since 2009 and future plans are presented. The most important updates include radiation control system calibration, verification and installation and an upgrade of the video control system.

THPD33 **Qt Based Control System Software for Low Energy Accelerator Facility**
***A. Basu**, S.K. Gupta, S.B.V. Nagraju, P. Singh, S. Singh (BARC)*
Qt based control system software for low energy accelerating facility is operational in Trombay, BARC. LEAF is 50 keV negative ion electrostatic accelerator based on SNICS ion source. Control system uses Nokia Trolltech's QT 4.x API for control system software. Ni 6008 USB based multifunction cards has been used for control and read back field equipments such as power supplies, pumps, valves etc. Control system architecture is designed to be client server. Qt is chosen for its excellent GUI capability and platform independent nature. Control system follows client server architecture. This paper will describe the control system.

THPD35 **Modeling and Simulation of Indus-2 RF Feedback Control System**
***D. Sharma**, P.S. Bagduwal, P.R. Hannurkar, M. Lad, N. Tiwari (RRCAT)*
The Indus-2 synchrotron radiation source has four RF stations along with their feedback control systems. For higher beam energy and current operation, amplitude and phase feedback control systems of Indus-2 are being upgraded. To understand the behavior of amplitude and phase control loop under different operating conditions, modeling and simulation of RF feedback control system is done. RF cavity base band quadrature domain model has been created due to its close correspondence with actual implementation and better computational efficiency which make the simulation faster. Correspondence between base band and actual RF cavity model is confirmed by comparing their simulation results. Base band Cavity model was studied under different operating conditions. LLRF feed back control system simulation is done using the same cavity model. Error signals are intentionally generated and response of the closed loops system is observed. With implementation of feedback control loop, broadening in the RF cavity bandwidth was also observed in terms of reduction in cavity fill time. Simulation will help us in optimizing parameters of upgraded LLRF system for higher beam energy and current operation.

THPD36 **An Embedded System Based Computer Controlled Process Automation for Recovery and Purification of ^{99m}Tc from (n, γ)^{99}Mo**

A. De *(DAE/VECC)*

^{99}Mo produced ^{99m}Tc (t1/2=6hr, 140keV γ-ray) is the most useful radioisotope for nuclear diagnostics. High specific activity ^{99}Mo is supplied globally mainly by five old reactors whose routine or unscheduled maintenance shutdown causes supply irregularities that adversely affects patient management in nuclear medicine centres. ^{99m}Tc may also be produced via ^{98}Mo(n,γ) in a natural MoO_3 target in reactor or by ^{100}Mo(n,2n)^{99}Mo or ^{100}Mo(p,2n)^{99m}Tc reaction in cyclotron. To meet the crisis proposals are there to produce ^{99}Mo by ^{100}Mo(n,2n)^{99}Mo or ^{99m}Tc directly by ^{100}Mo(p,2n)^{99m}Tc in a cyclotron. Of the several separation methods of ^{99m}Tc from molybdenum, the most common are adsorption column chromatography, sublimation and liquid-liquid solvent extraction. The conventional methods besides being cumbersome are often hazardous, polluting, require skilled manpower and facilities like fume hood and so are not always practically feasible for hospitals. To address these, VECC and BRIT, Kolkata have collaborated to develop an embedded system based automated ^{99}Mo/^{99m}Tc generator from low specific activity ^{99}Mo using solvent extraction technique, supervised by a PC based GUI.

THPD38 **Outsourcing Insourcing and Integration of a EPICS Control System to SPES**

M.G. Giacchini*, G. Bassato, G.P. Prete (INFN/LNL)*

The new project of a facility for the Selective Production of Exotic Species (SPES) is starting at LNL. The conceptual design of its control system has been done. A preliminary tests have been carried out on the SPES Target apparatus. The control system of the Target Laboratory, the most innovative and critical part of the entire facility, is developed using EPICS[1] and is in production since begin 2010. The reduced manpower available and the costs cutting makes the software project design a strategic choice. Neither less the complexity of the apparatus itself makes the control system a key point for the SPES. The software architecture, the guidelines and the common software platform has been realized focusing on the idea of develops parts of the system on outsourcing or in collaboration with research institutes offsite. The paper summarizes the EPICS software project[2] which satisfying these requirements.

THPD40 **Instrumentation Architecture for ITER-Diagnostic Neutral Beam Power Supply (DNBPS) System**

***A.M. Thakar**, U.K. Baruah, R. Dave, H.A. Dhola, S. Gajjar, V. Gupta, D.C. Parmar, A.M. Patel, B.M. Raval, N.P. Singh (Institute for Plasma Research) J.Y. Journeaux, D. Lathi, B. Schunke, S. Svensson (ITER Organization)*

A Neutral Beam Injection system is used for either heating or diagnostics of the plasma in a tokamak. The Diagnostics Neutral Beam system [1] for ITER based on acceleration of negative ions; injects a neutral (Ho) beam at 100KeV with specified modulation into the plasma for charge exchange recombination spectroscopy. DNBPS system consists of HVPS, HCPS and RF Sources. The system operates in a given operating sequence; very high electromagnetic transients are intrinsically generated during operation. Instrumentation is to be provided to operate the DNBPS system remotely with required control and protection. The operation is to be synchronized with ITER operation as directed by CODAC. Instrumentation functionality includes

- Acquisition of injector performance parameters,
- Operation and control of necessary auxiliaries,
- Protection of DNB components and power supplies using interlock system,
- To ensure safe operation of high voltage hazardous systems and
- To facilitate test and maintenance of individual subsystem.

This paper discusses about proposed DNB instrumentation architecture. The design generally follows the protocols from the ITER- Plant Control Design Handbook.

THPD43 **Electron Cyclotron Resonance Ion Source Control System**

***H.M. Kewlani**, S. Gharat, L. Mishra, K.C. Mittal, P. Roychowdhury (BARC-APPD) D.P. Chakravarthy (BARC)*

The control system of Electron Cyclotron Resonance (ECR) ion source is computer based control system. Main components of ECR ion source are microwave generator, plasma chamber, solenoid magnets, high current power supplies, extraction electrodes, high voltage power supplies, beam measuring devices and vacuum system. All the electronics devices have their built in microprocessor base electronic interface, which can be remotely accessed by serial or Ethernet link. Two numbers of Ethernet to four port serial converter modules are used to extend the serial interface capabilities of computer. Serial interface of all the devices are connected to the extended serial ports of the computer. Serial link of high voltage power supplies are optically isolated using optical isolators to overcome EMI and EMC problems. Software has been developed in house for remote operation of the ECR ion source electronic devices like magnetron power supply, high voltage power supplies, high current power supplies, microwave power measurement and vacuum gauges.

THPD44 **The CS-framework as a Control System for the HITRAP Facility at GSI**
***D. Neidherr**, D.H. Beck, H. Brand, F. Herfurth (GSI)*
At the GSI accelerator complex in Darmstadt Germany the linear decelerator HITRAP is currently under commissioning. The aim is to provide highly charged ions up to bare uranium at cryogenic temperatures for various experiments as for instance tests of the theory of quantum electrodynamics. The ions are delivered with kinetic energies of about 4 MeV/u from GSIs experimental storage ring (ESR) and are slowed down in several steps until they are trapped and cooled down in a Penning trap. Whereas for the ESR as well as for the first sections of the linear decelerator the GSI accelerator control system is used the cooler trap as well as the subsequent transfer section to the experimental area are controlled with the LabVIEW based CS-framework developed at GSI. This framework is an object-oriented, event driven and multithreaded framework with SCADA functionality, which is currently in use at many different experiments world-wide. For the HITRAP facility additional features like an online beam monitoring, realized with the integration of a LVOOP class capable of reading out IMAQ cameras, as well as a new GUI were implemented, which allows automatic scans of beam elements.

THPD45 **Overview of Control System for 30MeV RF Source**
***R.B. Chavan**, S. Chandan, K. Dixit, K.C. Mittal, V. Yadav (BARC-EBC) A.R. Tillu (BARC)*
Control system for RF source of 30 MeV, 3 kW RF Linac for neutron generation is being developed. The system consists of two 15 MeV linac structures, each powered independently with klystron rated for 7.5 MW(pk)/7.5 kW(avg). Two klystron modulators of 160kV, 110A, 7usec and 250Hz feed pulsed power into the klystron, which produces RF power at 2856 MHz. The klystrons will be driven by low power RF driver amplifiers programmed for matching phase, frequency and power into the linac. Both the driver amplifiers are controlled through RS-232 Protocol. The HV pulsing and RF drive for the klystron has been interlocked with water flow, arc detector, SF6 gas pressure etc. The control system is designed using Real time embedded controller, where pulses for synchronization are being generated in FPGA. Most of the power supplies like electromagnet, HVDC, etc. are on RS-232 protocol. These power supplies are controlled via suitable RS-232 to Ethernet converter. State machine topology is being used to design the logic. The database for logging data is developed in SQL. This paper describes the details of the software implementation and hardware used to realize the control of the RF power source.

THPD46 **Simulation Analysis of Analog IQ based LLRF Control of RF Cavity**

S. Basak *(VECC) A. Chakrabarti, H.K. Pandey (DAE/VECC)*

This paper presents the simulation analysis and results in Matlab Simulink of the analog Inphase-Quadrature (IQ) based LLRF control of RF cavity voltage. The RF cavity parameters were selected to be one of the RF cavities in our RIB project. All the subsystems in the IQ based RF control were modeled using the Simulink blocks/components. The envelope simulation was carried out using the IQ model of RF cavity. The PI controller was properly tuned to achieve good control performance in time. The simulation graphs showing the time evolution of the RF cavity voltage with a step changes of the input reference signal is presented. The simulation graphs showing the control response time needed to correct a disturbance is presented. Further the effects of beam currents (if not ignored) on the cavity voltage can been studied through the simulation graphs. The simulation results showing the amplitude and phase Bode/Nichols plots of the control loop and the gain and phase margin values obtained from them are presented, which are good enough for stability. Thus the control simulation RF cavity voltage is done in Simulink and the results obtained are presented.

THPD47 **Introduction of Non-Standard EPICS Controllers**

I. Badillo*, I. Arredondo, M. Eguiraun, D. Piso, M. del Campo (ESS Bilbao) J. Jugo (University of the Basque Country, Faculty of Science and Technology)*

Although EPICS is a mature software framework, the study and validation of new configurations of EPICS systems is very valuable, since new ideas open its evolution and improvement. So, the goal of the present work is to introduce new technologies under EPICS control structures and test different configurations with innovative hardware in this kind of applications. More specifically, it is intended to validate the use of non-stardard EPICS controllers. This paper presents a test bench using LabVIEW together with EPICS. LabVIEW eases and speeds up the development of control structures, avoids the hardware dependent developing costs and offers almost absolute compatibility with all kind of hardware used in control and data acquisition. To validate its use, it is mandatory to make a study facing this solution and EPICS standard methodology, specifically CODAC system used in ITER. To do so, a test bench is defined running both methods and its results compared. Following this scheme, the next step is to make a similar experiment introducing wireless links and replacing as many wires as possible.

THPD48 **Reachability in a Finite Distributed System Protocol Model by Backward Traversal**

T. Samanta *(DAE/VECC) S. Mukherjee (VECC) D. Sarkar (IITKGP)*

Distributed system protocol verification has the intrinsic problem in mechanizing the reasoning pattern and the resultant state space exploration. The former arises in case of theorem proving approach due to the ingenuity involved in constructing a proof and the latter is encountered in model checking approach while carrying out composition of a large number of processes that constitute a typical distributed system. A combined approach of the above two methods has been devised that eventually considers the reachability in finite distributed system protocol model. It computes the reachability in backward traversal on the fly. Due to the complications in implementation, the Protocol Verification algorithm[1][2] is modified to reduce the number of states explored and hence the complexity of the algorithm. In this paper a C++ implementation of the on-the-fly backward traversal algorithm is reported.

THPD49 **Design Considerations for Development of Rugged Data Acquisition and Control System for Radio-active Ion Beam (RIB) Facility**

K. Mourougayane*, A. Balasubramanian, G. Karna, P.S.P. Penilop (SAMEER) D.P. Dutta, T.K.M. Mandi, H.K. Pandey (DAE/VECC)*

The RIB facility is equipped with state of the art systems, Linear Accelerators (LINACs), High current Magnetic sources, High Power RF Transmitters and associated High voltage and high current systems to produce and accelerate Radio Active Ion Beam. Developing a Data Acquisition and Control System for RIB facility need expertise on multiple domain covering Data Acquisition, Instrumentation, Control Systems to meet the functional requirements and Electromagnetic Compatibility (EMC) aspects of system design to ensure Electromagnetic Interference (EMI) free operation. SAMEER-Centre for Electromagnetics, Chennai collaborated with VECC in the Research and Development Project to develop all necessary hardware and Control System to monitor and control the RIB facility. Through this project, a unique system called 'Distributed Data Acquisition and Control System was designed and indigenously developed. The D-DACS systems are qualified for the functional, Electromagnetic Compatibility (EMC) requirements as per IEC standards. The design approach and techniques used in developing the customized D-DACS system for controlling and monitoring the RIB facility will be presented in this paper.

THPD50 **FPGA Based Amplitude Control System for Accelerating Cavities**

M.S. Dey, *A. Singh (VECC) S. Ghosh, A. Mandal, S. Seth, S.S. Som (DAE/ VECC)*

The FPGA (Field Programmable Gate Array) based digital controller has been implemented for Low level RF voltage control of a 650 MHz cavity. The flexibility of implementing any appropriate control strategy and to have a compact single board solution, FPGA is chosen. The superconducting Cavity is designed to be operated at 650 MHz and 30 kW, CW mode. The voltage from pick-up coil has been fed to the controller after down conversion. The signal is digitized using high speed ADCs. The controller has been tested with different set points and gain parameters from a software connected to the board with serial interface. The FPGA signal processing has been verified according to the required strategy of the reference controller. Some experimental results have been presented for different cavity operational conditions.

FRIA — Status Report of Control System

Chair: P. Duval (DESY)

FRIA01 09:30 25

The New White Rabbit Based Timing System for the FAIR Facility

D.H. Beck, *R. Bär, M. Kreider, C. Prados, S. Rauch, W.W. Terpstra, M. Zweig (GSI)*

A new timestamp and event distribution system for the upcoming FAIR facility is being developed at GSI. This timing system is based on White Rabbit[1], which is a fully deterministic Ethernet-based network for general data transfer and synchronization. White Rabbit is developed by CERN, GSI and other institutes as well as partners from industry based on Synchronous Ethernet and PTP. The main tasks of the FAIR timing system are time synchronization of more than 2000 nodes with nanosecond accuracy, distribution of timing messages and subsequent generation of real-time actions (interrupts, digital signals …) by the nodes of the timing system. This allows precise real-time control of the accelerator equipment according to the beam production schedule. Furthermore the timing system must support other accelerator systems like post-mortem and interlock. It also provides interfaces between the accelerator control system and experiments at FAIR. This contribution focuses on the design principles of the timing system, its integration with other components of the control system, the present status and the planned implementation.

FRCA — Status Report of Control System

Chair: P. Duval (DESY)

FRCA02 09:55 15

Status Report and Maintenance Issues of VME Based Cryogenic Control System at IUAC

J. Antony, *T.S. Datta, D.S. Mathuria (IUAC)*

The Cryogenic Data Acquisition and Control system (CRYO-DACS) at IUAC was commissioned successfully in the year 2002 and has been continuously in operation since then with uptime better than 95%. The aim of CRYO-DACS is to control and acquire many analog and digital cryogenic parameters of super conducting LINAC and related equipments like beam-line cryostats, helium compressors, cryogenic distribution etc. The complete system is implemented using two VME crates, housing I/O modules, placed far apart and interconnected using Ethernet. The software implementation and maintenance have also been trouble-free which used IOWORKS as the development tool for embedded CPUs running VxWORKS. The OPC Client was developed using VB6 & MSACCESS RDBMS for data logging, viewing and trending under Windows 2000 stable server. In summary, this paper will elaborate the implementation, use and related failures faced for last 10 years and the subsequent corrective actions taken to keep the system running for such a long time round the clock along with some future plans.

FRCA03 10:10 15

Development of a Car-borne Survey System KURAMA

M. Tanigaki, *Y. Kobayashi, R. Okumua, N. Sato, K. Takamiya, H. Yoshinaga, H. Yoshino (Kyoto University, Research Reactor Institute)*

We have developed a car-borne survey system named as KURAMA (Kyoto University RAdiation MApping system) for the establishment of air dose rate map in Fukushima and surrounding area as a response to the nuclear accident at TEPCO Fukushima Daiichi Nuclear Power Plant on March 11, 2011. KURAMA is developed with LabVIEW. The monitoring data tagged by GPS location data are shared with remote servers over 3G mobile network, then processed by servers for a real time plot on Google Earth and other various purposes. A CompactRIO-based KURAMA-II is developed for the autonomous operation in public vehicles. More than a hundred of KURAMA and KURAMA-II now serves for the drawing up the radiation map in the East Japan by Japanese government. The outline and present status of KURAMA and KURAMA-II are introduced.

FRCA04 **Control System for BARC-TIFR Pelletron**
10:25 LP
S. Singh *(LEHIPA Project, Physics Group) J.A. Gore, S. Kulkarni, P. Singh (BARC)*

Pelletron is 14 MV tandem Accelerator operating from past 20 years. It was operating on DOS based control system. Its control system software and CAMAC controller hardware has been changed recently. Control system software is is a two layer software namely Scanner and operator console. First layer which runs at equipment interface layer interacts with all CAMAC crates acts a server , known as Scanner. Scanner is developed in LINUX and uses TCP/IP protocol suite for interaction with CAMAC and operator interface. Scanner uses shared memory to store machine's runtime data. Operator console is a Graphics interface software developed by using QT APIs. Operator interface is source code portable between MS windows and LInix.

FRCB — Status Report of Control System

Chair: P. Fatnani (RRCAT)

FRCB01 11:05 15

Maintaining an Effective and Efficient Control System for the Electromagnetic Calorimeter of the Compact Muon Solenoid Experiment During Long-term CERN Large Hadron Collider Operations

***O. Holme**, D.R.S. Di Calafiori, G. Dissertori, W. Lustermann (ETH) S. Zelepoukine (UW-Madison/PD)*

The sub-detectors of the Compact Muon Solenoid (CMS) multipurpose particle detector at the CERN Large Hadron Collider (LHC) have been collecting physics data from particle collisions for almost three years. During this period, the Electromagnetic Calorimeter (ECAL) Detector Control System (DCS) has contributed to the high level of availability of the experiment. This paper presents the current architecture of this distributed and heterogeneous control system alongside plans and developments for future improvements. To ensure that the system can efficiently operate and adapt to changes throughout the required operation lifetime of more than a decade, the potential legacy aspects of this kind of control system must be carefully managed. Such issues include evolving system requirements, turnover of staff members, potential benefits from new technologies and the need to follow release schedules of external software dependencies. The techniques and results of the work to continually maintain, improve and streamline the control system are presented, including the use of metrics to evaluate the impact of this effort.

FRCB02 11:20 15

Development of the Control System for PEFP 100-MeV Proton Linear Accelerator

***Y.-G. Song**, Y.-S. Cho, J.-H. Jang, H.-J. Kwon (KAERI)*

The 100MeV proton linear accelerator of the Proton Engineering Frontier Project (PEFP) has been developed and will be installed in Gyeongju site. After the installation, the beam commissioning of the 100MeV linac will be performed. The PEFP is currently developing control systems including the machine control system and user interface for remote control and monitoring. The final goal of the PEFP control system is to construct a network attached, distributed control system, and a standard communication protocol among the local subsystems. In this paper, we will present the details of the distributed control system development for PEFP 100-MeV proton linac.

FRCB03 **RF Control System for 400 keV RFQ**
11:35 15

G. Joshi, *T. Ananthkrishnan, S.K. Bharade, P. M. Paresh, C.K. Pithawa, C.I. Sujo (BARC)*

An RF control system has been developed for the 400 keV, 350 MHz RFQ coming up at BARC. This single cavity system consists of the functionalities of amplitude stabilization and frequency tracking for both continuous and pulsed mode of operation. The amplitude stabilization is implemented by modulating the attenuation across a fast modulator placed in the drive path. The frequency tracking is achieved by driving the FM port of a signal generator with a signal proportional to the phase shift across the resonator. The whole system is under computer control via CAMAC hardware. The paper describes the system architecture, housing & wiring of the system in a single instrumentation rack and development & testing of computer control.

FRCB04 **VEPP-2000 Collider Control System**
11:50 15

A.I. Senchenko, *D.E. Berkaev, A.S. Kasaev, I. Koop, V.R. Kozak, A.N. Kyrpotin, A.P. Lysenko, Yu. A. Rogovsky, P.Yu. Shatunov, Y.M. Shatunov, A.S. Stankevich (BINP SB RAS)*

Electron-positron collider VEPP-2000 has been commissioned at Budker Institute of Nuclear Physics. The first experiments on high energy physics has been started at the end of 2009. The paper presents architecture, implementation and functionality of hardware and software of the collider control system. The hardware of the system consists of high current main field power supplies, steering coils power supplies, pulse-elements, RF subsystems and some other special subsystems (such as vacuum, temperature, etc.). The system is based on modern industrial protocol CAN-bus and specialized electronic BINP manufactured blocks according the standard. The paper describes implementation of different subsystems based on CANbus devices, and operating characteristics and their possibilities. Other standards and protocols like CAMAC, VME and so on also used in the system. The software according to hardware system consists of interacting subsystems responding on different acceleration facility parts. Control system software is based on several TCP/IP connected PC platforms under operating system Linux and uses client-server techniques.

07-Dec-12 12:05 – 13:05 VECC/SINP Campus Auditorium Main Lecture Hall

FRCC — PC vs Embedded Systems & Experimental Data Acquisition

Chair: A. Roy (DAE/VECC)

FRCC01 12:05 15 **Design of the Data Acquisition System for the Nuclear Physics Experiments at VECC**

P. Dhara *(VECC) P. Maity, A. Roy, P.S. Roy, P. Singhai (DAE/VECC)*

The beam from K130 room temperature cyclotron is being extensively used for nuclear physics experiments for last three decades. The typical beam energy for the experiments is approximately 7-10MeV/nucleon for heavy ions and 8-20MeV/nucleon for light ions. The number of detectors used, may vary from one channel to few hundreds of detector channels. The proposed detector system for experiments with the superconducting cyclotron may have more than 1200 detector channels,and may be generating more than one million parameters per second. The VME and CAMAC based data acquisition system (DAQ) is being used to cater the experimental needs. The current system has been designed based on various commercially available modules in NIM, CAMAC and VME form factor. This type of setup becomes very complicated to maintain for large number of detectors. Alternatively, the distributed DAQ system based on embedded technology is proposed. The traditional analog processing may be replaced by digital filters based FPGA boards. This paper describes the design of current DAQ system and the status of the proposed scheme for distributed DAQ system with capability of handling heterogeneous detector systems.

FRCC02 12:20 15 **A FPGA Based High Speed Data Acquisition Card**

J.A. Gore*, P. V. Bhagwat, A. Chatterjee, S. Kulkarni, K. Mahata, S.K. Pandit, V.V. Parkar, A. Shrivastava (BARC) S. Kailas (BARC, Physics Group)*

A FPGA based, high speed,two channel,analog input card with a maximum input sampling rate of 1 Giga samples per second (Gsps)per channel has been designed and tested. The card has got an on-board cPCI interface but has been designed in a way that it can also work as a stand-alone system. The card can function as a platform for developing and evaluating different FPGA based hardware designs. Recently, the card has been used to develop a direct sampling Low Level RF (LLRF) controller for controlling the electromagnetic fields of a prototype heavy ion RFQ. It has also been tested for acquisition of data in nuclear physics experiments. Pulses from surface barrier and silicon strip detectors were acquired at an input sampling rate of 1 Gs/s employing ^{241}Am and Am-Pu sources. The design developed for this makes use of pre-triggering. This paper discusses the functionality, salient design issues and features of the card. Finally the hardware designs of above mentioned applications related to different areas of LLRF control and nuclear pulse acquisition are explained and the results obtained are presented.

FRCC03 12:35 LP **Development and Performance Analysis of EPICS Channel Access Server on FPGA based Soft-core Processor**

***S. Sahoo**, T. Bhattacharjee, S. Pal, D. Sarkar (DAE/VECC)*

A soft core processor is a flexible hardware description language (HDL) model of a specific processor (CPU) that can be customized for a given application and synthesized for an FPGA as opposed to a hard core processor which is fixed in silicon. Combined with an on-board ethernet port, the technology incorporates integrating the IOC and digital control hardware within a single FPGA thus reducing the overall hardware complexities of field devices. In this paper, the technical details of porting EPICS Channel Access Server on MicroBlaze soft-core processor are explained. The EPICS performance on the Microblaze processor is analyzed. For this, the CPU load and server processing time for different numbers of Process Variables (PVs) have been studied for this platform. On the basis of the analysis, critical parameters of EPICS on this embedded platform have been derived and a few modifications in the channel access protocol are proposed for MicroBlaze soft-core processor.

FRCC04 12:50 LP **Digital Pulse Processing Techniques for High Resolution Amplitude Measurement of Radiation Detector**

***P. Singhai**, P. Dhara, A. Roy (DAE/VECC) S. Chatterjee (HITK)*

The digital pulse processing techniques for high resolution amplitude measurement of radiation detector pulse is an effective replacement of expensive and bulky analog processing as the digital domain offers higher channel density and at the same time it is cheaper. We have demonstrated a prototype digital setup with high-speed sampling ADC with sampling frequency of 80-125 MHz followed by series of IIR filters for pulse shaping in a trigger-less acquisition mode. The IIR filters, peak detection algorithm and the data write-out logic was written on VHDL and implemented on FPGA. We used CAMAC as the read out platform. In conjunction with the full hardware implementation we also used a mixed-platform with VME digitizer card with raw-sample read out using C code. The rationale behind this mixed platform is to test out various filter algorithms quickly on C and also to benchmark the performance of the chip level ADCs against the standard commercial digitizer in terms of noise or resolution. The paper describes implementation of both the methods with performance obtained in both the methods.

FRID01 14:45 25 **Introducing the !CHAOS Control Systems Framework**

L. Catani, *F. Zani (INFN-Roma II) C. Bisegni, P. Ciuffetti, D. Di Giovenale, G. Di Pirro, L.G. Foggetta, G. Mazzitelli, A. Stecchi (INFN/LNF)*

The analysis of most recent developments on high-performance software technologies suggests that new a design of distributed control systems (DCS) for particle accelerators may profit from solutions borrowed from cutting-edge Internet services. To fully profit from this new technologies the DCS model should be reconsidered, thus leading to the definition of a new paradigm. In this paper we present the conceptual design of a new control system for a particle accelerator and associated machine data acquisition system (DAQ), based on a synergic combination of a non-relational key/value database (KVDB) and network distributed object caching (DOC). The use of these technologies, to implement continuous data archiving and data distribution between components respectively, brought about the definition of a new control system concept offering a number of interesting features such as a high level of abstraction of services and components and their integration in a framework that can be seen as a comprehensive control services provider for GUI applications, front-end controllers, measurement and feedback procedures etc.

FRCD02 15:10 15

Process Control for Parallel Run of Two Helium Liquefiers at VEC Centre, Kolkata

S. Pal, *U. Panda (DAE/VECC) R. Basak (West Bengal State Electricity Distribution Company Limited)*

Two helium liquefiers are working in tandem while one is always connected with the superconducting cyclotron. High pressure (HP) and low pressure (LP) controls are necessary to maintain varying helium flow to the cold box. Since these two liquefiers share the same HP and LP pipelines, any pressure fluctuation due to rapid change in flow sometimes causes trip to the liquefiers. To overcome this problem there is a need for fast responsive HP control. Introduction of derivative gain in the PID loop for fast action is not desirable as it creates instability to the control system. This problem was rectified by introducing a novel control scheme based on the forced opening of the unloading valve to push back helium gas to buffer tank by changing the offset of PI control as a function of Buffer Tank pressure. A simulation using Matlab Simulink was performed initially to check the performance of pressure control loop. The same is implemented in the control loop of the new liquefier and an experiment was performed. The experimental results obtained will be discussed in the final paper.

Boldface papercodes indicate primary authors