

# COMPREHENSIVE MACHINE STATUS MOITORING & INFORMATION SERVICES USING WEB TECHNOLOGY

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## ABSTRACT

Centre for Advanced Technology (CAT), Indore has a 20 MeV Microtron injector, a 700 MeV Booster Synchrotron, a 450 MeV Storage Ring Indus-1 under operation and another 2.5 GeV Storage Ring Indus-2 is under pre-commissioning stage. In a multi accelerator complex like this an effective system for displaying the status of various machines is considered essential. With rapid spread of Internet technologies, this has evolved into the requirements of a web-based system for most effective use of the information. This paper briefly describes the functionality provided by developed web applications and technologies used to develop these applications.

## THE CONTROL SYSTEM OF INDUS-1 & INDUS-2

The Control System of Indus-1 & Indus-2 is composed of 25 operator console computers, which are connected through 100 MBPS Local Area Network (AccNet). Apart from these machines 6 server machines are also connected on the same network for specific purposes. One of the machines on which web server is installed, is connected with the CAT campus network (CATNet) also to provide the information to users not connected with control room network (AccNet). Indus-1 Control System Computers for different sub-systems are directly connected with their respective ECs (Equipment Controllers) through RS-232 serial link and these ECs in turn are connected with different field devices e.g. Power Supplies, Vacuum Components, Radiation Monitors etc. Indus-2 Control System is based on three layer architecture for Controlling/Monitoring of various field devices. Computers, which provide Graphical User Interface to operators, are connected with *Supervisory Layer Computers (SCADA)* through 100 MBPS Ethernet link and *Supervisory Layer Computers* are connected to *EC Layer Computers* through RS-485 link. The *EC Layer Computers* are finally interfaced to different field devices.

## WEB APPLICATIONS

Three types of web applications have been developed and made operational to fulfil the requirements of system experts, beam line users, machine operators and general users. All of these applications are hosted on the same server and can be accessed using <http://srs.cat.ernet.in> URL from any computer connected with Indus control room network (AccNet) or with CAT network (CATNet).

- Indus On-line
- Fault Information Management System
- Storage Ring Status Information System

## INDUS ON-LINE

During operation of Indus-1 & Indus-2 all Computers involved in controlling/Monitoring different sub-systems, automatically log the status data of various field devices and machine parameters into a centralized DBMS Server. The rate of logging data into DBMS Server is different for different sub-systems and can be set by the operator as per the requirements. These data are the primary source of information for understanding the behaviour of accelerator as well as the performance of the sub-systems. Thus the need of a software was felt which can not only provide historical data generated by the machines but also the live status (with locations) of the devices involved in operation and parameters of the machines to the users and system experts located in entire CAT premises.

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Thus this web application has been developed to provide all the data related to machine to users and system experts so that they can watch the machine performance remotely and if machine is not behaving as required can give necessary instructions to operators sitting in Indus Control Room.

### Description

Presently this web application provides the live and historical (few statistical also) data of Indus-1 sub systems (Microtron Control System, Radiation & Beam Information System, Vacuum Control System, RF Control System and Timing & Pulsed Power Supplies Control System), live and historical data of Transfer Line-3 sub systems (MPS Control System, Vacuum Control System and Beam Diagnostics System) and historical data of Indus-2 sub systems (MPS Control System and Radiation Safety System). To get these data users only require a JVM enabled web browser installed on their machines. Live and historical status data of all the field devices (e.g. Radiation Monitors, Vacuum Gauges, Pumps, Power Supplies, Temperature Sensors etc.) placed at various places and being controlled or monitored from the control room user interface software can be got on this site. Live status data from an individual device can be got synoptically i.e. by clicking down over different parts of image until a specific device is reached (Figure 1). On clicking over the specific device the live status of the device (e.g. Time, set current, readback current, local/remote status On/Off status etc.) are displayed in a new separate window. Refresh rate of the live status of any device depend upon the log rate on which the data are logged into database by user interface software. For example presently the log rate of Indus-1 Radiation Monitoring System is 10 Seconds whereas the log rate of Indus-2 Vacuum Control System is 5 minutes. If the live data is not available the most recent status data of the device is displayed (without 'Live' sign) and as soon as the live data is available in database that data is reflected (with 'Live' sign).

By submitting the filled HTML form the historical data of a specific device can be got in table, graphical or CSV format. Provision for CSV format has been provided so that user could save the data on their local machine and could import these data in other software tool for plotting etc. User can apply filter also to get only desired data. Graph can be drawn on-line between time and the readback data of a specific device (e.g. Radiation Stations) or any computed data (e.g. beam life time). Statistical data (e.g. Indus-1 stored current summary on a specific day) is shown in pie chart. To avoid the misspelling query forms for viewing historical data have been designed in such a way that all the entries are selectable from drop down list.

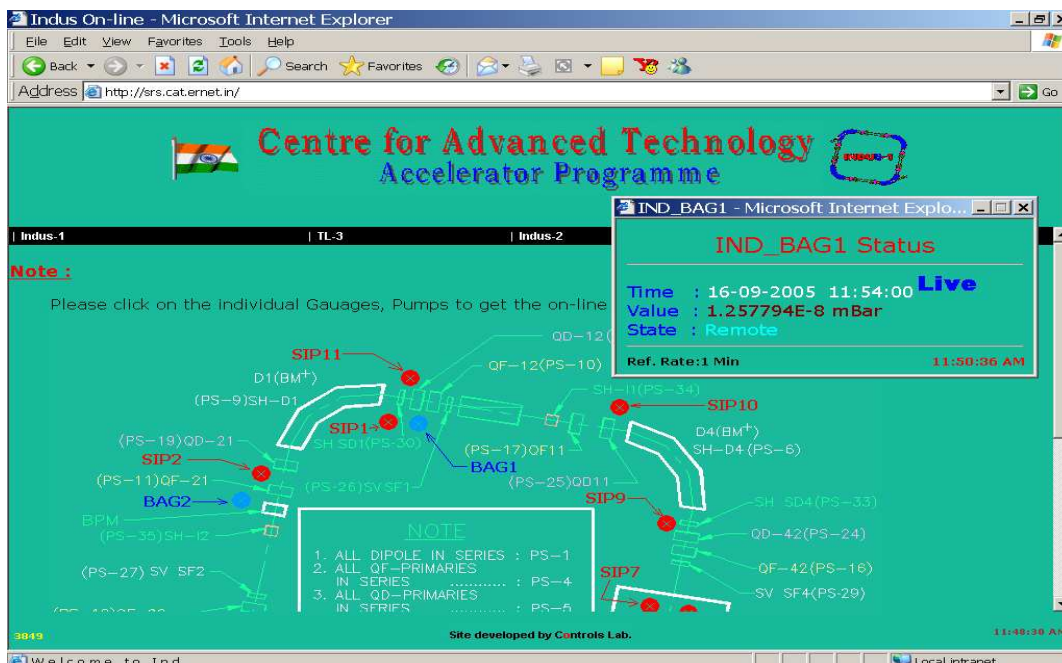


Figure 1: Getting live status of a vacuum component synoptically

For searching the position of a device in the lattice separate query forms for all the subsystems (e.g. MPS System, BDS System, Vacuum Control System etc.) have been provided which returns only that part of the lattice, which contains the searched device. By clicking over 'NEXT' and 'PREVIOUS' hotspots of the image it is also possible to navigate over entire lattice from first cell to last cell and vice versa.

## FAULT INFORMATION MANAGEMENT SYSTEM

The shift crewmembers coming from controls lab in shift operation of Indus-1 and Indus-2 are responsible for proper operation of the subsystems belongs to controls lab. To keep the track of the various type of information of faults encountered in these subsystems (e.g. MPS Control System, Timing & Pulsed Power Supply Control System etc.) during operations of Indus-1 and Indus-2 a paper logbook was used in past. Due to various limitations of paper logbook a Web Based Fault Information Management System was conceived, developed & deployed on Indus Control Room web server, which not only eliminated the limitations of paper logbook but also offered several new features, which were never possible with the paper logbook. This system became operational in May 2004 and since then the operators are using it. This system is very useful when used as a diagnostics tool and for proper follow-ups.

### *Description*

Access to fault information management system has been protected with password so that only authenticated users could use the system. User interface part of the system has been divided into three sections namely Indus-1, Transfer Line-3 and Indus-2. All of these three sections have been again divided into four subsections namely New Fault, Unacknowledged Faults, Historical Faults and Statistical Analysis of Faults.

### *New Fault*

New Fault page provides users option to select the subsystem in which fault has occurred. It includes the list of all the subsystems for which the controls lab crewmembers are responsible. Each subsystem's page (Figure 2) includes the device name, date, time, fault type, fault rectification and faulty system fields. Except fault rectification field all the fields contain the drop down list so that user has to just select the value from the list. When user submits the data, a new page is generated which contains all the submitted data and asks user for confirmation. If user confirms then the data are logged into database and a new page is returned which lists the names of system experts who are responsible for that system otherwise previous page is displayed. System expert names from the database are selected according to data filled in 'faulty device' field. If user wishes to send the logged fault information to any system experts, he/she has to check the names of the system experts and immediately e-mail (Figure 3) is sent to those system experts, which contains the details of the logged information.

### *Unacknowledged Faults*

Unacknowledged Faults section is meant for system experts only. This list contains the faults information for the comments of system experts. Only those system experts can comment over the fault of which faulty system they are responsible. When the system expert comments over the said fault then it is assumed that the fault has been acknowledged and this information is removed automatically from the unacknowledged faults list.

### *Historical Faults*

This section provides the system experts the facility to search the historical faults according to date & system names. The historical faults are returned in a table, which contains the fault date & time, system name, device name, fault description, fault rectification, faulty system and logged by fields.

### *Statistical Analysis of Faults*

This section of the system will facilitate the system experts to view the statistics of faults of any specific system in bar/pie graphs over a given period of time.



Figure 2: HTML form for logging the faults occurred in Indus-1 MPS Control System

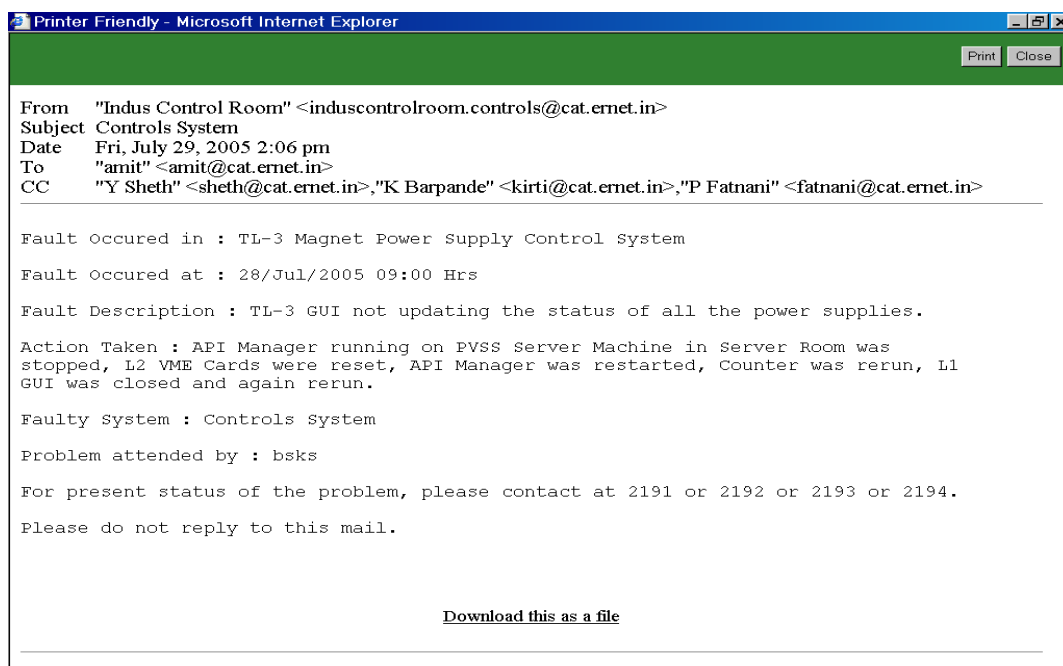


Figure 3: E-mail generated from Fault Information Management System

### STORAGE RING STATUS INFORMATION SYSTEM

This web application has been developed to display the live status of Indus-1 Storage Ring and any important message entered by machine operation in-charge on big size monitors placed at various locations of Indus Complex. The live status of Storage Ring is displayed by three dynamically generated HTML pages, which appear sequentially after every 15 seconds. Description of each page is as follows:

- First Page displays the important message, which is entered by Indus-1 operation in-charge. Message validity period can also be set from 5 minute to 2 days. For entering the notice separate password protected HTML form has been provided. After lapse of that much amount of time the Indus-1 animated logo appears in place of notice information.
- Second Page (Figure 4) displays time, beam current, beam energy, integrated current and lifetime. If beam current is zero in Indus-1 ring this page does not appear and first page appears repeatedly.

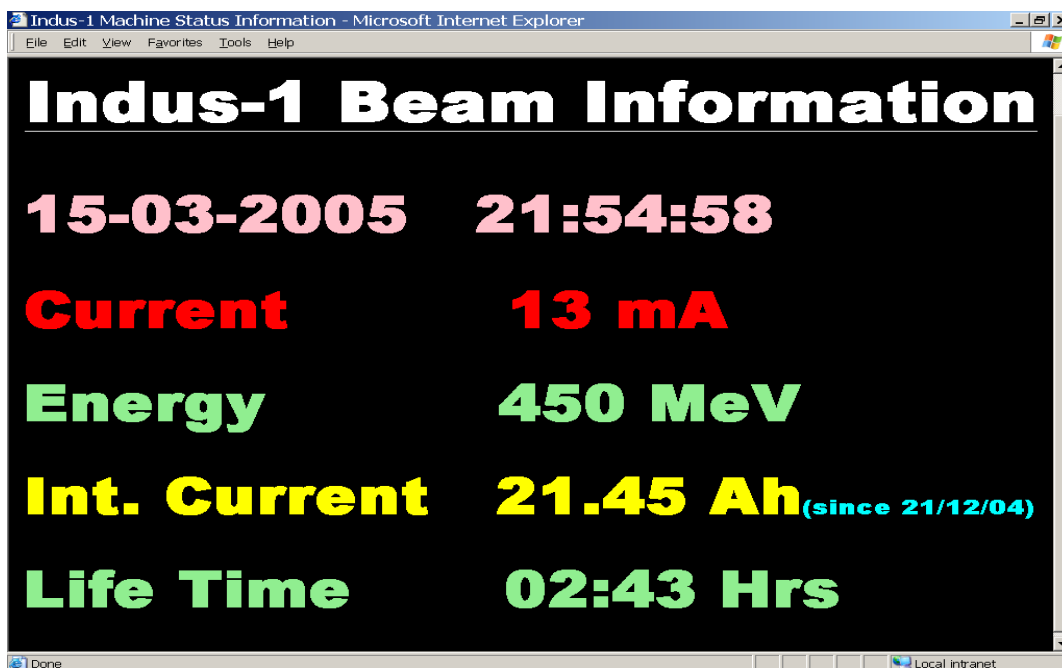


Figure 4: Page2 of the Storage Ring Status Information System

- Third Page (Figure 5) displays graph between stored beam current and time. If beam current is zero this page also does not appear and first page appears repeatedly.

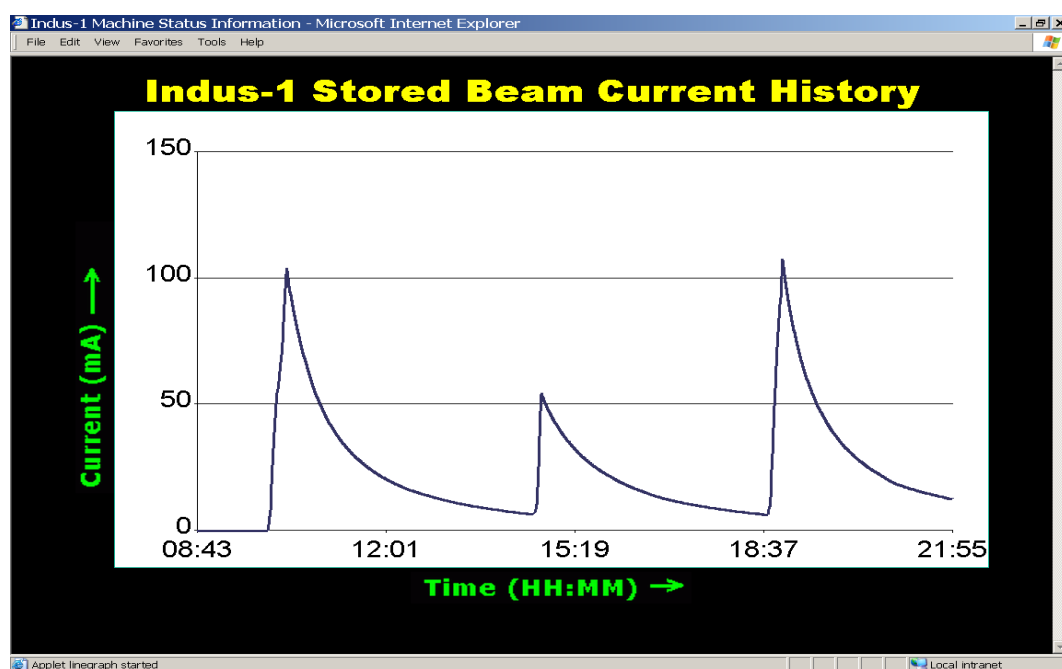


Figure 5: Page3 of the Storage Ring Status Information System

## SCHEME USED

All the three applications are based on three tiers architecture where Web Browser, Java Servlets and DBMS Server are residing on client, middle and data tiers respectively. A middle tier is something that helps connect one endpoint to another and along the way adds a little something of its own. Servlets provide a convenient way to connect clients built using HTML forms or applets to back-end servers. Java applets are being used for drawing the on-line graph. We have used Client side image mapping to display the locations of devices on images (hotspots), which invokes the respective java servlet to display the device status in a new separate window. For sending the e-mails composed with the fault information Active Server Pages (ASP) developed in VBScript have been used. JavaScript codes have been incorporated in html query forms for validation of data filled by users at client end. We are using MS SQL Server 2000 as a centralized DBMS Server. A Type4 JDBC Driver for MS SQL Server 2000 has been used for database connectivity. Database connections pool has also been incorporated to further improve the performance.

## CONCLUSION

These applications provide very useful information to users over web. Using web technologies to make this system greatly eliminates the platform dependency at client end. With introduction of this system, accelerator experts can monitor real-time information anytime, anywhere through a web browser. The information can be very useful to analyse the machine if it is not performing as required or in case of failure. The live and historical data being served by all of the above applications are retrieved from the respective databases. Therefore the user interface software running in Indus Control Room, which controls or monitors the different sub systems must be logging the required data into respective databases. The log rate at which data are logged into databases controls the refresh rate of live data being served to web users. Fault Information Management System is very useful for improving the performance of hardware and software involved in operation. This system has been developed in such a way that with little development work in its relational databases and servlets new systems could be incorporated very easily. If required more pages can be added in Storage Ring Status Information System to display status information of other systems also.

## REFERENCES

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