

Operation Information Management at the Swiss Light Source

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Abstract

An efficient and reliable flow of operations related information is crucial for the satisfactory performance of an accelerator facility. Several sources of information need to be accessible, like shift schedules, control system data archives, alarm logs and log book entries. Different views on this information are required for different purposes: a shift protocol should summarize the events during an 8 hour shift while an event database should allow you to browse information related to certain types of events. We will present the sources of and interfaces to information related to the operation of the Swiss Light Source. The techniques and applications are presented to collect, manage and retrieve the information. A special focus will be on the advantage to have all data accessible through web interfaces and to allow for references to the data by URLs.

INTRODUCTION

The Paul Scherrer Institute (PSI) is the main federal research center of Switzerland. The department of large research facilities at PSI operates several accelerator complexes as so called user laboratories, where the international scientific community can apply for beam time for particular experiments. The main accelerator complexes are a high energy proton accelerator, providing a one megawatt cw beam for a spallation neutron source, a superconducting cyclotron for proton irradiation cancer therapy and a 3rd generation synchrotron light source, the Swiss Light Source (SLS). The SLS provides about 5000 hours of beam time for User Operation per year since 2001. The average availability of the accelerator is about 97% and the mean time between failures is nowadays between two and three days.

Since 2003 the control room and the operator crews of all PSI accelerators have been merged. The accelerator support sections of the accelerators, like radio frequency or vacuum sections, have been merged, too. This did put special demands on the handling of the information flow for operation. The large number of accelerators to be handled intensifies the need to provide efficient access to all operation related information for all groups. A high availability can only be reached and maintained by the individual effort of all the staff of the accelerator. But this effort needs to be supported by providing detailed information about all failures. It is the task of operations management to enable and optimize this information flow. It should be easy for all staff to access all sources of information, to add contributions to the already existing information and to correlate the different information sources with each other.

OPERATION INFORMATION SOURCES

The operation relevant information can be grouped into the different data generation. At the SLS we use the following

- **Control system information:** EPICS channel archiver, alarm-handler, event recording, set-point snapshots, operation statistics and subsystem dependent log files.
- **Machine operators:** Shift protocol entries, failure reports, operator broadcasts, shift crew planning.
- **Operation managers:** Shift and shutdown schedule and program, operation meeting plans and protocols.
- **Accelerator support staff:** Documentation, event cause documentation, on-call rooster.
- **Beamline users:** Beamline usage, problem reports.

The tools to collect and browse the data from the different source will be described in the following sections.

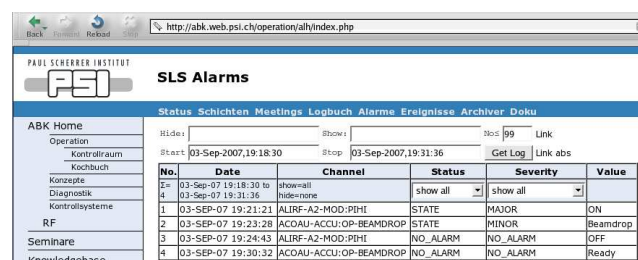
CONTROL SYSTEM DATA TOOLS

The two main tools for automatic data logging used at the SLS are the EPICS alarm handler [1] and the channel archiver [2]. Although they are used at many laboratories and provide a broad range of functionality, they require a careful integration into the general information flow.

Alarm handler

The alarm handler is our central tool to handle failures of the accelerator. Each accelerator failure should raise an alarm, but no false alarms should be raised. We provide guidances and related commands to analyze and handle the alarm. A standard command for analog alarm channels has been defined that shows the alarm limits and provides a realtime strip-chart and an archive view for this channel.

The alarm log files are transferred to the oracle database. A web page for alarm queries allows to filter alarms within time ranges (See Fig. 1).



The screenshot shows a web browser window with the URL <http://abk.web.psi.ch/operation/all/index.php>. The page title is "SLS Alarms" and it features a navigation menu with items like "Status", "Schichten", "Meetings", "Logbuch", "Alarme", "Ereignisse", "Archiver", and "Doku". Below the menu, there are search filters for "Hide:", "Show:", "Show:" and "Link". The main content area displays a table of alarm events with columns for "No.", "Date", "Channel", "Status", "Severity", and "Value".

No.	Date	Channel	Status	Severity	Value
0	03-Sep-07 19:18:30 to	show-all			
1	03-Sep-07 19:31:36	hide-none			
1	03-SEP-07 19:21:21	ALIRF-A2-MOD:PIHI	STATE	MAJOR	ON
2	03-SEP-07 19:23:28	ACOU-ACCU-OP-BEAMDROP	STATE	MINOR	Beamdrop
3	03-SEP-07 19:24:43	ALIRF-A2-MOD:PIHI	NO_ALARM	NO_ALARM	OFF
4	03-SEP-07 19:30:32	ACOU-ACCU-OP-BEAMDROP	NO_ALARM	NO_ALARM	Ready

Figure 1: Web interface to the alarm handler log-data

An additional application allows to browse and filter the alarm log either from the database or from files and to copy formatted alarm tables to shift protocols.

Channel Archiver

The EPICS channel archiver allows to store all types of control system data with a rate of several 10 thousands of values per second. A PHP based web interface to the archiver is used at the SLS. (See Fig. 2).

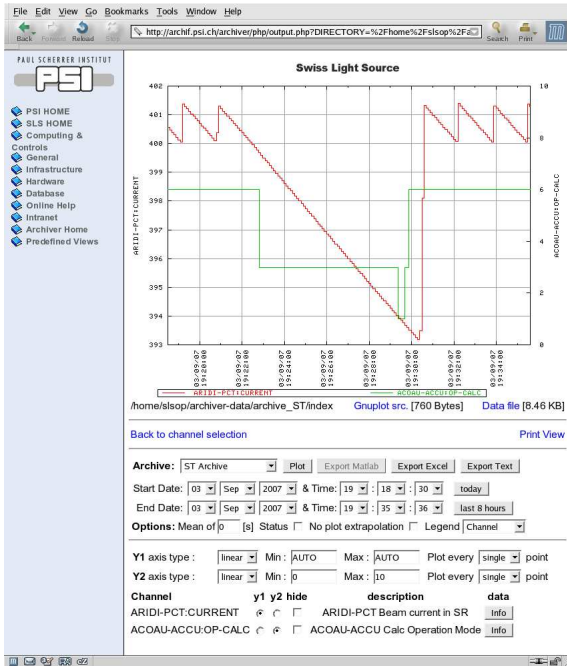


Figure 2: Web interface to the archiver data

The data can be retrieved from different archives. Regular expressions can be used to select lists of the archived channels. The interface allows to plot an arbitrary number of data channels, each to be assigned to one of two individually scalable axis.

Set-point snapshots

An EPICS application allows to define groups of device set-points to be stored into files, provided with comments and keywords defined by the operator [3]. This allows to save a certain setting of the accelerator and to restore this setting later on. We've added additional functionality to this standard tool to ease the usage for the operators. For each type of snapshot we keep a history of the saved and restored snapshots. We allow to compare a snapshot to the actual set-points of the accelerator. All snapshots saved or loaded during a shift are automatically added to the shift protocol. The history allows to compare all actual set-points with the last loaded or saved snapshots of the whole accelerator. This provides a quick overview to the operator, which set-point were changed regarding to the snapshots.

The event recorder

The control system data of the alarmhandler and the archiver is stored as a time sequence. It is important to be able to analyse this data for failure states of the accelerator. Therefore we developed an event recorder that detects those failure states and automatically generates event entries in a database for each event. The primary event entry contains the start and end date of the failure state, the type of the failure state and the type of operation shift when the failure happened. For each event entry it is easily possible to add an arbitrary amount of additional information, like links to the alarm states during the event, links to archived data for control system variables during the event or links to the electronic shift log book for the shift of that event. A certain set of those linked information is automatically added for each type of event. Other data can be added manually afterwards, e.g. by operators or by subsystem experts.

Currently we define three types of events for two operation shift types: beam downtime events, decaying beam events (beamdrops) and orbit feedback failures. The latter two event types have different definitions for user operation and for beamline development shifts.

Each event will be assigned to a certain percentages to a subsystem. A single event, e.g. a beam downtime, may has been caused by a failure of one power supply but the recovery then has been delayed due to problems with the control system. Therefore the responsibility for the event is shared between the different systems. The assignment of causes to the subsystem group is password protected and can only done by authorized people, like defined machine experts or the operations manager.

A web interface is again provided to browse the event database (See Fig. 3) and to filter for event types.



Figure 3: Web interface to the event database

The last column "Info" contains the links to the information for this particular event. This allows the machine expert to determine the cause of an event quickly. A subsystem "Unknown" can be used for cases where the cause cannot be identified by the available information. In most cases this can be replaced later when the reason of the event has been revealed.

The event database helps to identify repeating problems quickly and to assess appropriate measures to solve them. It allows to provide a quick overview of the recent oper-

ation problems without browsing through dozens of shift protocol entries. The assessment of event reasons allows to filter for failure areas and is useful for the long term planning of maintenance work and system upgrades.

OPERATOR APPLICATIONS

Shift Protocols

Shift protocols document the machine operation. On a short term scale, this allows everyone concerned with operations to keep track of what happened recently in machine operation. On a long term the protocols allow to document past failures, to query for similar problems and provide a knowledge base to eventually solve repeating problems.

An electronic log-book is used at the SLS to provide parallel access to the protocols and the possibility to query the text. The log book of the SLS digital user office (DUO) [4] was selected to have the same application for operations as for other PSI groups. The log-book provides a web interface and a script library. The web view can be configured and standard functionality like full text or keyword query, weekly overviews, attachments, etc. is provided. Logbook entries can either be referenced by a unique ID or by the date of the entry. The latter allows to display shift protocols for a given time range. A selection list is displayed in case that more than one protocol is available for the given time range.

The operation shift protocol generation is done by a dedicated application (See Fig. 4) and submitted via a script interface to the DUO log-book. This was necessary since most of the shift information should be added automatically and other data should be copied from the last protocol. For example the accelerator and beamline status information, the shift crew and program, machine setups saved or loaded during the shift and a plot of the beam-current for the shift is added automatically to each protocol (See Fig. 5). Data about known problems and disabled alarms is automatically copied from the last protocol at the beginning of the shift. Screen-shots and other figures can be easily included in the protocol.

Machine development shift protocols are entered in the same log-book. For this protocols the standard editor provided by DUO is used by the machine expert, since automatic supplements are not required in those protocols.

Failure Reports

Several subsystem specific failure report mechanisms are used. E.g. the status panel of each magnet power supply allows to send an e-mail to the power supply group. All relevant control system information about the failure is added automatically, additional information can be added by the operator. The controls group uses a bug tracker database application.

Those system dependent failure reports supports the procedure, that the responsible staff is informed on every failure, even if no intervention of the expert was required to

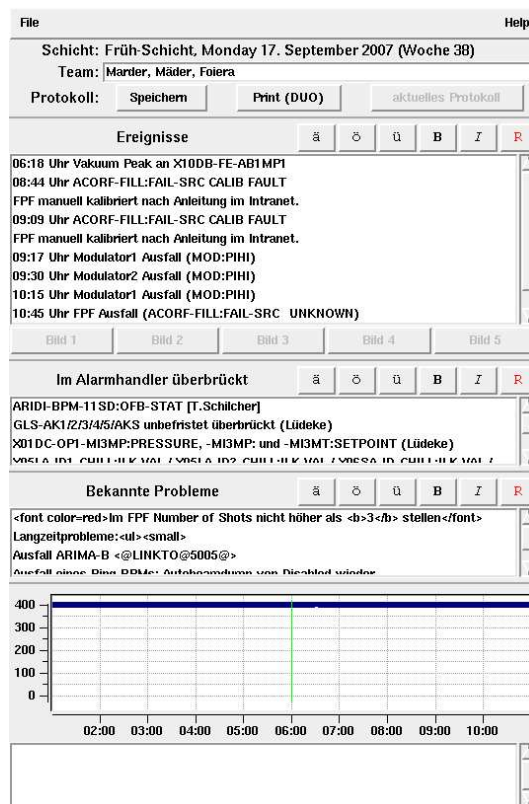


Figure 4: Shift protocol application. Most information is filled in automatically or copied from previous protocols.

recover. Operators tend to solve problems by themselves repeatedly where a report in time would allow to permanently fix the problem by the subsystem experts.

The Operator Wiki

In order to provide the operators with a means to store and share their documentation on operation of the accelerator we implemented a so called wiki server for operations. This web server application is a simple contents management system for a structured collection of documentation (See Fig. 6).

Each member of the accelerator staff is able to add documentation in a simple text format that allows for easy formatting. Templates are provided for the description of operator interfaces that can be simply filled. This wiki knowledge base is very useful for the training of new operators. It now replaces the individual documentation of the operators as well as the documents provided by the subsystem experts. The central storage for all operation related "help's" and "how-to's" and the participation of operators as well as system experts in updating those improved considerably the overall quality of those documentation.

In addition to the wiki we keep many other documentation online. E.g. lists of important telephone number, documentation of modifications on the accelerator in the shutdown and links to electronic logbooks of the vacuum or



Figure 5: Shift logbook entry as generated by shift protocol application.

controls groups. This information is partly kept bi-lingual, in english and german. Although most of the operators do understand english and most of the system experts are familiar with german, the language is still often an obstacle to an efficient communication.

Operator Broadcast Messages

The communication between the control room staff and the experiments is handled by the "Operation Info Panel". It allows the operator to type in short message lines for the general information of the users. A client application running at each beamline allows the users to select their beamline state from "offline", "attended" or "unattended". The "offline" mode prevents the user to close their insertion device gap. During "attended" operation different acoustic alarms are raised for either new messages from the control

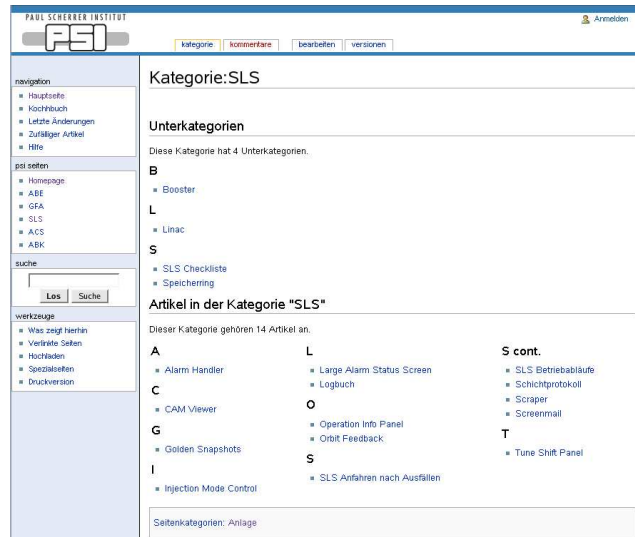


Figure 6: View of the wiki category 'SLS' from the knowledge base.

room, a beam-loss or orbit feedback outages. The operator gets feedback when new messages or alarms are acknowledged at the beamline.

A second broadcast mechanism is in use for unscheduled tunnel access during run periods. Engineers would often like to have short access to the tunnel during run periods, to prepare work for a shutdown. In case of longer beam interruptions the operator can send out SMS to a predefined list of people. DUO is used to register or sign off from this service.

OPERATION MANAGEMENT TOOLS

Operation Scheduling

The yearly schedule is defined by the DUO calendar database. This database is the reference for proposal scheduling of the digital user office [4]. The shift schedule is used as a global reference in many aspects. It is periodically downloaded to an EPICS database to provide the current shift type in the control system. This allows, e.g. to automatically suppress alarms for development shifts, to generate automatic warning messages at the end of a user run, etc. The shift schedule is used to calculate the user-run periods and the operation statistics is calculated then for those user-runs. In addition the total distribution of the yearly scheduled hours for users, development and shutdowns are calculated from the schedule. The schedule can be edited by the machine manager and viewed from the public by a web interface (See Fig.7). The calendar can be downloaded as PDF or XML spreadsheet.

Biweekly beamline- and machine development meetings are held to define the development program and to discuss recent operation events. Agendas are generated from the DUO calendar and edited by the operation manager. Meeting protocols are published within the same week on the

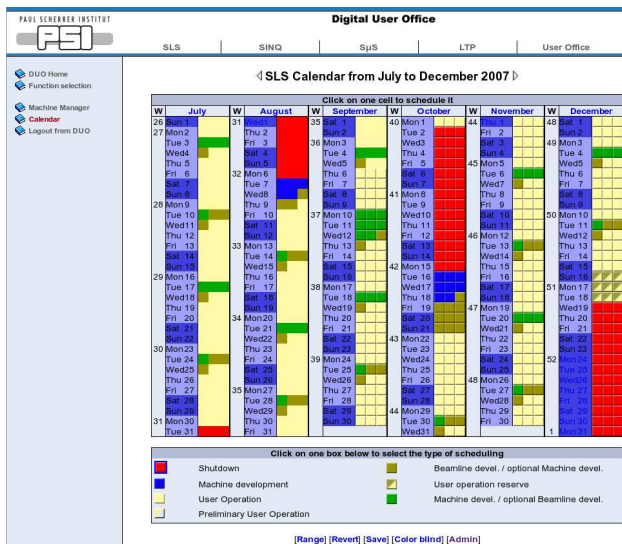


Figure 7: DUO calendar web interface for editing.

intranet and notifications are sent out to dedicated mailing-lists when the agenda or the protocol has been published.

Staff Planning

A shift leader and two operators overview currently four independent accelerator facilities at PSI. The planning is organized and entered to a database by the operators. The on-call staff planning for the different system groups is organized and entered to a database by those groups. Both can be viewed together with the shift tasks from an access restricted PHP web page "Weekly Operation Staff" by all PSI staff. The web view contains links to yearly overviews for the on-call planning of each group and provides links to a list of all on-call staff contacts, sorted by system groups.

Operation Statistics

A plot of the operation statistics is generated automatically each week. (See Fig.8). The user run time period

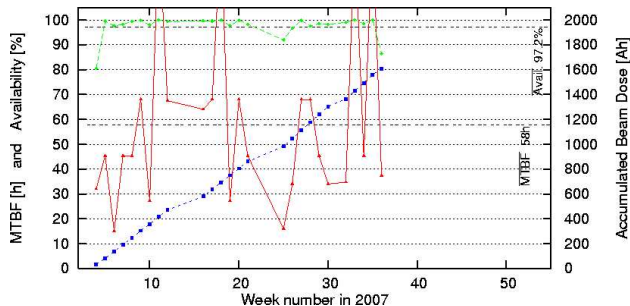
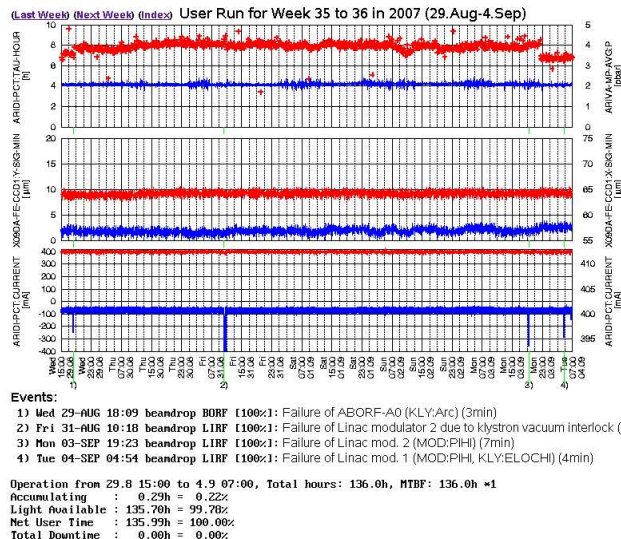


Figure 8: Generated weekly operation statistics overview.

is derived from the DUO calendar and the operation status from the EPICS archiver. It is mailed automatically to the operation manager together with the statistics figures for each week of the current year.

The run statistics and weekly run overviews are generated automatically. The event database provide descriptions of the outages in the weekly overview (See Fig.9). Those weekly overviews allow for a rapid overview of a



Week 35 of 2007; [Shift Plan](#), [Event-DB](#), [Shift Protocols](#)

Figure 9: Automatic web page for user run overviews.

whole year of operation. The plots display main status parameter like the measured beam dimensions, the lifetime and the beam current. The list of events can be easily correlated to the shown data and the links to the event database and the shift protocols allow to analyse further the events of each week.

OUTLOOK

Our next focus will be the enhancement of the interconnections of the different views to the operational data. E.g. the alarm web browser should provide a web link for each alarm that will allow to see a stripchart of the channel that raised the alarm before and after the alarm. This can be used to distinguish a real temperature alarm from an alarm that was raised just by some noise spike. Or it would be possible to display event marker in the archive plot display. A simple but useful extension is to provide links in the navigation bar, that query the other information sources for the time interval of the current data view.

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