

# SLS OPERATION MANAGEMENT: METHODS AND TOOLS

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## Abstract

Users of 3rd generation synchrotron light sources desire not only a high flux on their samples and sub-micron beam stability, they expect at the same time a beam availability close to one hundred percent. To reach and maintain a very high availability put special demands on the operation management of a light source.

We will illustrate the procedures used at the Swiss Light Source (SLS) to deal with beam interruptions and give an overview of the tools used for operation management.

## INTRODUCTION

The Swiss Light Source provides about 5000 hours of User Operation per year since 2001. The availability of the accelerator has been increased from 94% at the beginning to above 98% in 2005, the mean time between failures increased from 30 to 73 hours in the same time. A high availability can only be reached and maintained by the individual effort of all system responsible. But this effort can be supported by providing detailed information about all failures. It is the task of operations management to enable and optimize this information flow. The information of interest in this context is not limited to the primary failure data. The organizational data is of equal importance to enable a quick handling of failures: shift protocols, on-call roosters, task and crew planning. Information on statistics of operation are an important basis to assess priorities for maintenance and upgrade plans. All information needs to be accessible by the relevant parties. This requires Tools for an efficient retrieval and referencing of the data.

## OPERATION INFORMATION SOURCES

The operation relevant information can be grouped into the different data generation:

- **Automatic data logging:** EPICS channel archiver, alarm-handler 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.
- **System staff:** Documentation, on-call rooster.
- **Beamline users:** Beamline usage, problem reports.

## OPERATION INFORMATION TOOLS

### *Automatic Data Logging*

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.

The alarm handler is our central tool to handle failures of the accelerator. It is important to carefully configure the alarms: each failure should raise an alarm, but no false alarms should be raised. With each alarm a guidance and a related command should be provided to analyze and handle the alarm. We defined a standard command for analog alarm channels that shows the alarm limits and provides a realtime strip-chart and an archive view for this channel.

A script for alarm queries in all alarm handler log files allows to filter alarms within time ranges. This is used for automated inclusions of alarms in down-time tickets (see below.) A user interface enables to browse and filter the alarm log files and to copy alarm tables to shift protocols.

We use a PHP based web interface to the archiver that allows to refer to formatted data samples by URLs. Data can therefore be linked from all web-based information viewers. To use references is more efficient than exchanging the data or pictures since it allows the recipient to easily add or remove displayed data or reformat the data views.

### *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 and allows to query for similar problems and provides a knowledge base to eventually solve repeating problems.

In order to provide parallel access and the possibility to query the text we use an electronic log-book. We chose the log book of our digital user office (DUO) [3] in order to have the same application for operation as for system groups and beamlines. 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.

The operation shift protocol generation is done by a dedicated application and submitted via a script interface to the DUO log-book. This was necessary since a lot of the shift information should be added automatically and other data should be copied from the last protocol. Automatic data is 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 past ten hours. Data about known problems and disabled alarms is automatically copied from the last protocol at the beginning of the shift. The application allows to in-

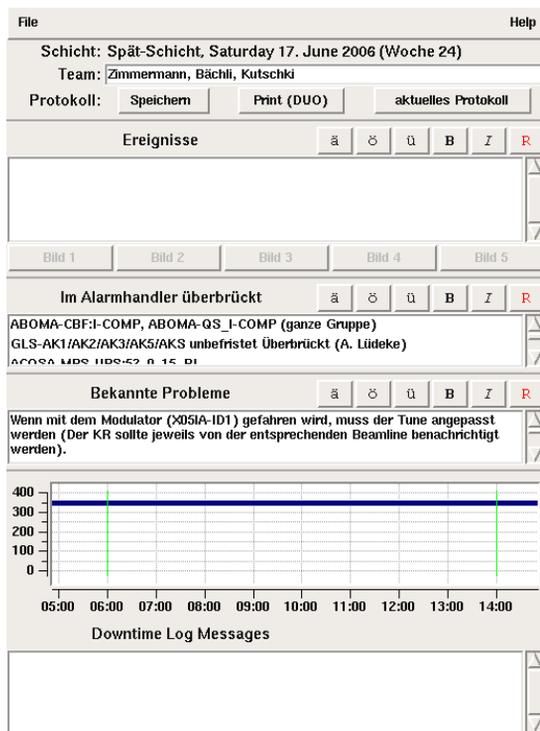


Figure 1: Shift protocol application. Most information is filled in automatically or copied from previous protocols.

clude screen-shots and other pictures 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 information is not required in those protocols.

### Down-time Tickets and other Failure Reports

Down-time tickets are e-mails generated automatically after beam interruptions during user operation. They are filled with all relevant information for this down-time: time and duration of the down-time, links to the shift protocol and a list of the alarms that occurred during and just before the beam interruption. They are directed to the operation manager who assigns the primary failure source and forwards the ticket to the responsible group. The system responsible either accepts or rejects the assignment. In the first case one tries to define actions to reduce the likelihood of a repetition of the failure. In the latter case one can relay the ticket to another suspect or accept it to be of unknown cause. In order to avoid beam interruptions with an unknown course one should try to improve the diagnostics for those types of failures, in order to be able to determine the failure source if the failure reoccurs. The mechanism of down-time tickets can only work if it is accepted by all system responsible as a means to improve the machine reliability. Then it helps to identify repeating problems quickly and to assess appropriate measures to solve them.

In addition we have several subsystem specific failure report mechanisms. E.g. the status panel of each magnet

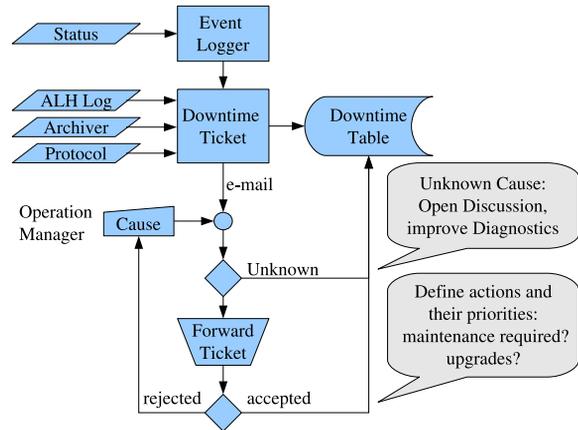


Figure 2: Down-time ticket procedure.

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. Or the controls group uses a simple bug tracker database application.

Those system dependent failure reports supports the procedure, that system experts are informed on every failure of their system, not only of those failures which require their intervention. Because operators tend to solve problems them self repeatedly which should be permanently fixed by the subsystem experts.

### 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 room, a beam-loss or orbit feedback outages. The operator sees 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.

## MEASURES FOR A QUICK RECOVERY

Several independent measures were addressed in order to shorten the mean time to recover from failures.

A good training of the operators is of course a prerequisite for a quick failure recovery. We regularly do two hour

hands-on training during development shifts: one machine expert runs a so-called sabotage application that randomly generates different types of failures while an operator needs to find and solve the failure and to restart the machine. Several other operators watch from the back seats and the performance is shortly discussed afterwards.

The machine restart as well as the restart of any subsystem is automated to a large extent in order to support the operators. Automation does not only speed up the failure recovery, it reduced the frequency of outages due to human mistakes, too.

A remote access to the private accelerator network for on-call staff helps to shorten reaction time, in particular for controls and diagnostics problems. In many cases the on-call staff can now solve a problem from home. This shortens the recovery time and satisfies the on-call staff. The remote access is controlled by the operators: an application allows them to open the remote access for individual accounts, tells the operator who is allowed to log-in and who actually is logged-in. A log-out can be forced, too.

The PSI policy to make wireless phones a standard for PSI staff helps to shorten the recovery time during normal working hours.

## 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 [3]. 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 as a channel. 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 as a basis for the operation statistics, too: user-run periods are extracted to calculate uptime for and the scheduled hours for users and development are calculated from it. It can be edited by the machine manager and viewed from all by a web interface (See Fig.3.) The possibility to download the calendar as PDF or as XML spreadsheet is provided, too.

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

### Staff Planning

A shift leader and two operators overview currently three 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

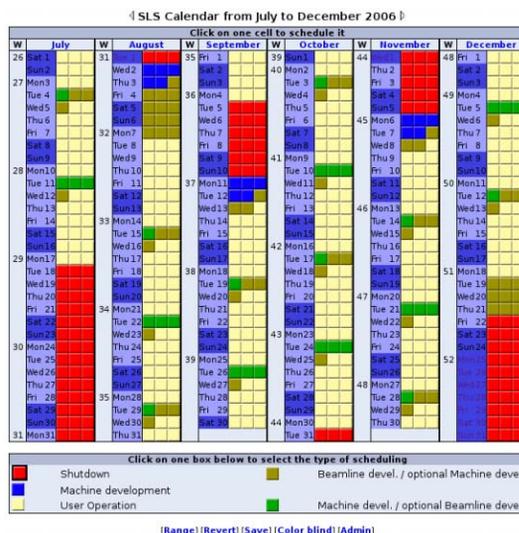


Figure 3: DUO calendar web interface for editing.

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

The run statistics and weekly run overviews are generated automatically. The user run time period is derived from the DUO calendar and the operation status from dedicated channels in the EPICS archiver. The operator messages provide first order descriptions of outages and can be edited by the operation manager.

A reliable yearly statistics of beam outages per system can be generated due to the "cause" assignment of the down-time ticket procedure. This provides the basis for medium and long term decisions on priorities of maintenance and upgrades plans.

## OUTLOOK

The optimization of the information flow is a continuous process. Our next focus will be to extend the down-time ticket mechanism to an extensible event database. Information on outages of feedback systems or failures of the injector will generate entries and new failure conditions can be defined. It will feature alarm filter rules and adding comments and links to failure related information.

## REFERENCES

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- [3] A. Bertrand, H. Weyer, "Digital User Office", Nuclear Instruments and Methods in Physics Research A, 546, 591 (2005).