qBase. A Databased Application for Advanced Failure-Handling and -Tracking to Increase Accelerators Reliability @ DESY

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Abstract

During operation of DESY's accelerator facilities, different failures and their root causes are repeatedly observed and analyzed to increase the existing high availability:

- subsystems or components,
- operational issues,
- failures of complex technical systems.

The in-house developed database application **qBase.** links the three most important sources of information particulary from the accelerators **PETRA III**, **FLASH** and **European XFEL** together and makes them accessible throughout DESY's Accelerator Division for advanced analytical investigations:

- expert knowledge from the operators' electronic machine logbooks (elogs),
- status information and measured values from associated databases,
- and detailed root causes from written failure event reports.

1 : Motivation! – DESY's Quality Initiative for Accelerators

- The Quality Assurance Programme is a quality initiative that was launched by the management in 2019.
- It complements the already existing efforts of the individual groups in the division.
- The long-term aim is to establish a quality assurance system that focusses on the management of processes and knowledge, as well as increasing / stabilising the availability of the accelerator facilities.
- Both locations of DESY in Hamburg and Zeuthen have been taking part in the initiative, since September 2022.

"Developing a knowledge database supports the implementation of the Quality Programme and is a step towards the realisation of our digitalisation strategy."

Wim Leemans, Director of the Accelerator Division

3 : Performing Analysis

1) *"List all Failure reports linked to 'power supplies' or 'Netzgeräte' performed from group 'MFL' and group 'MXL'."*

2) Define an a) appropiate filter or b) an applicable calculation and run the filter/calculation.

3) If needed, restructure the results for more details, according to your request.

4) Generate tables, pivots, diagrams out of the results or download or email the complete set of data for further activities outside the database.

5) Provide the filter/calculation to the community as a new public tool and share your knowledge to let others learn.

```
F like '%Netzgeräte%' OR F like '%power supply%' and ( T = 'MXL' OR T='MFL')
```


Excursus : Root Cause Analysis with 8D

By launching the Accelerator Division's Quality Assurance Programme in 2019, the 8D – method was established as one of the key processes shown in figure 1. Since the implementation the number of failures with downtime have been visibly reduced. [1] The diagramm in figure 2 shows the reduction of failures by processing failure management with 8D.

8D in a nutshell:

- method to solve technical issues,
- non sequential process in 8 disciplines,
- documentation (paper, QDX, »SQL«, …). [2]

It can be customized by:

- paralize a couple of steps,
- adapting the effort per discipline,
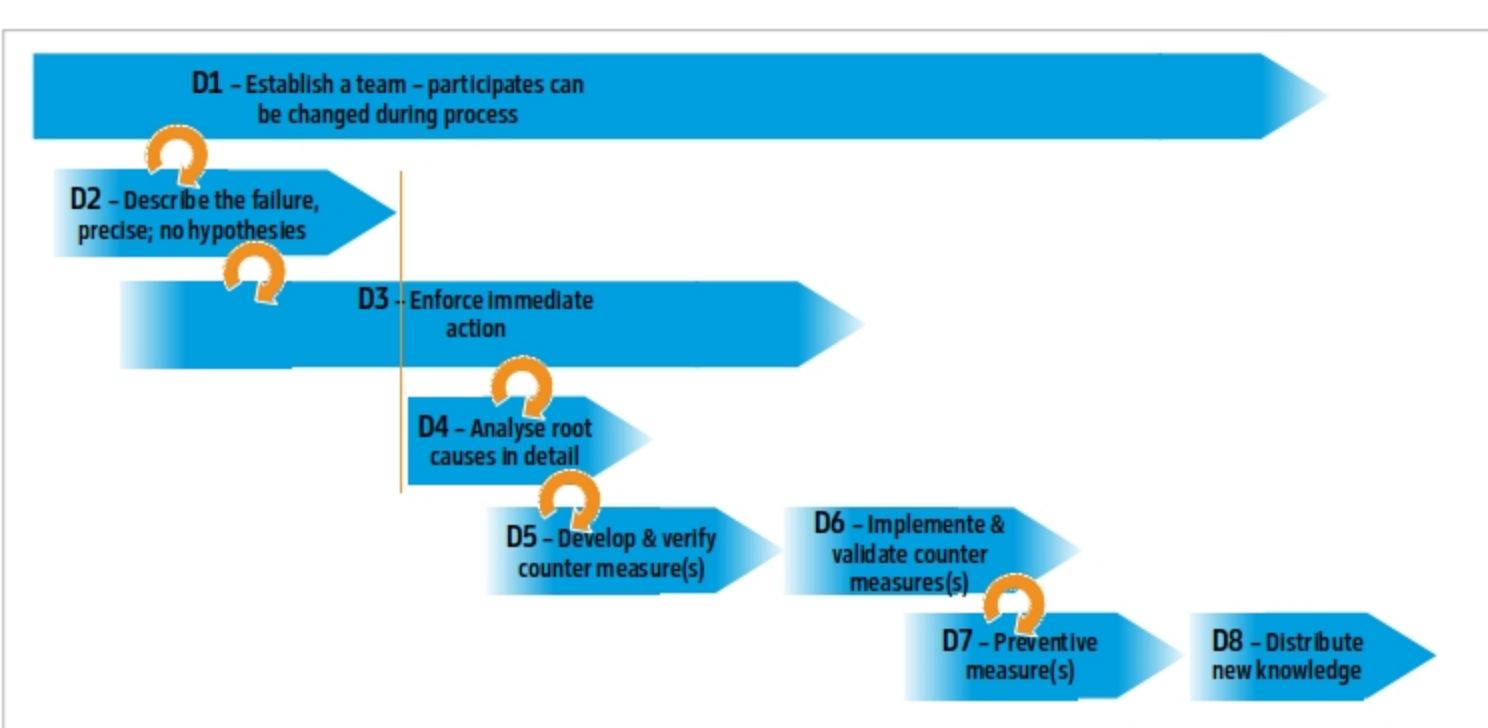- reducing to a 4D report: D2 → D3 → D4 → D6.

Figure 1: Performing an 8D or the reduced alternative 4D follows a simple flow chart. Process according VDA. [3]
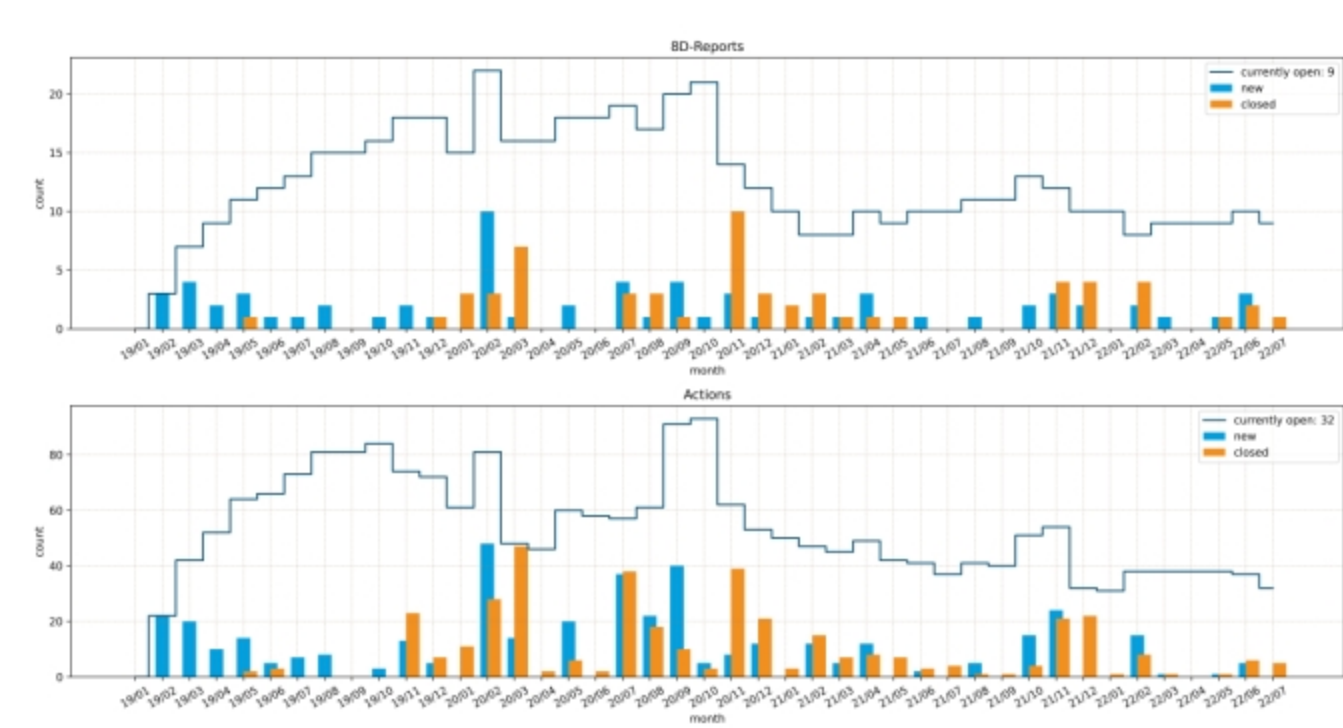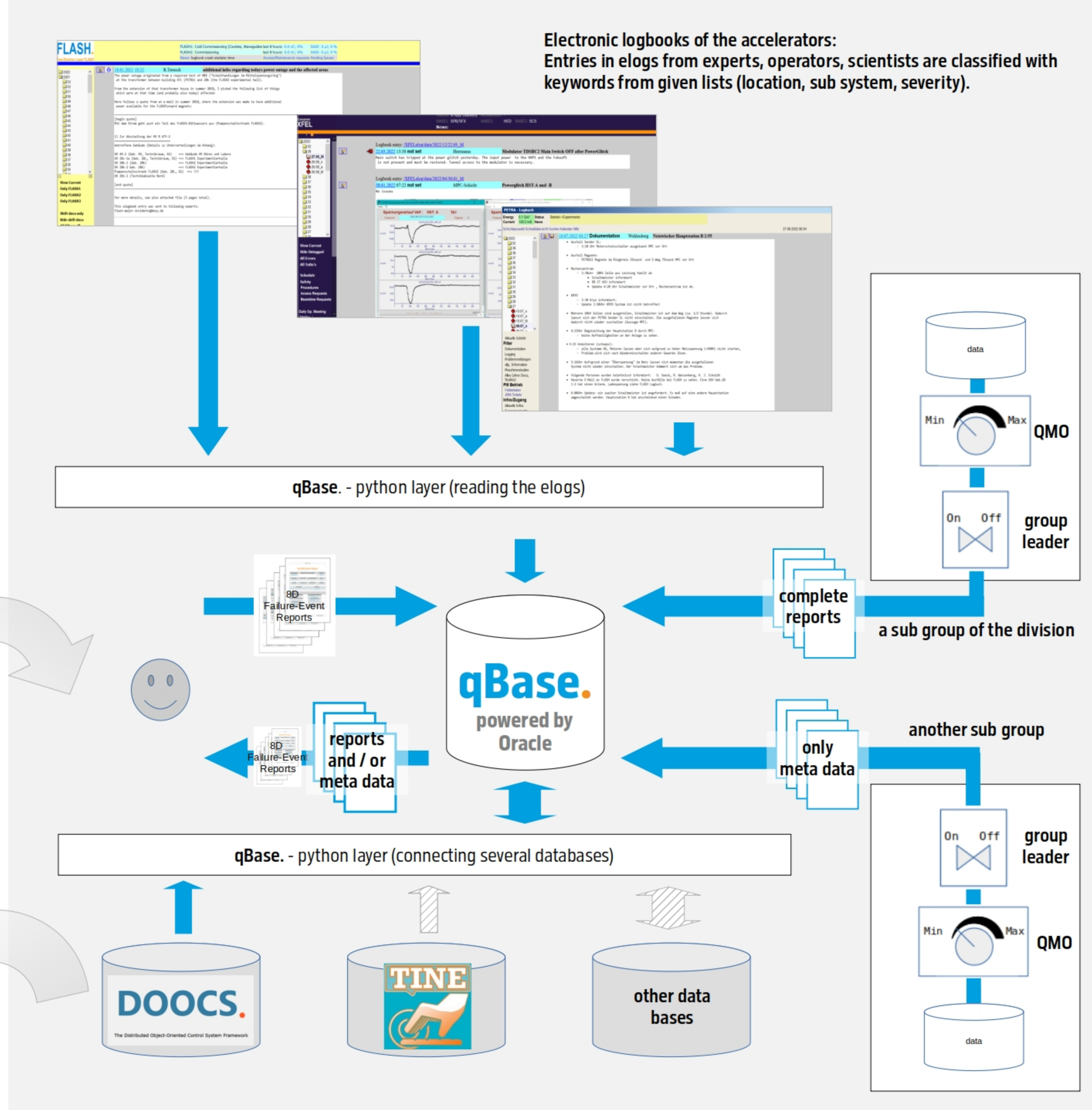
Figure 2: 8D's initiated and completed each month (top), associated measures (bottom). Data from European XFEL. [3]

[1] J. Branlard et al., "Four years of successful operation of the European XFEL", presented at the International Conference on RF Superconducting (SRF'21), FRIB, Michigan State University, Michigan, USA, June 2021, paper MOOFAV06
[2] Verband der Automobilindustrie e. V. (VDA), Austausch von Qualitätsdaten QDX-Quality Data eXchange V2.1, VDA Berlin 2017
[3] Verband der Automobilindustrie e. V. (VDA), 8D-Problemlösung in 8 Disziplinen, VDA Berlin 2018

2 : Implementation! – Getting Connected with the IT Landscape

Electronic logbooks of the accelerators:
Entries in elogs from experts, operators, scientists are classified with keywords from given lists (location, sub system, severity).

qBase. - python layer (reading the elogs)

qBase. powered by Oracle

qBase. - python layer (connecting several databases)

DOOCS.

TINE

other data bases

4 : Failure Tracking, a Preview to qBase. V2.0.0:

Extension of the given functionality of **qBase. V1.4.2.**:

- Mapping of the technical structures of the accelerators and the technical systems.

- Alignment of components to the structures (figure 1).

- Linking of failures with structure and components.

- Linking individual failures to error chains.

- Failure analyses, measures as digital 8D reports.

Figure 1: Each failure and its measures are linked to the accelerators section and the technical SubSystem.

Conclusions about critical systems or components can be derived from the resulting fault trees. The resulting and growing fault trees identify critical substructures and components.

Conclusion and Future Perspectives

Conclusion:
The final goal to develop and install a knowledge database for the entire accelerator division is still in its beginning and we noticed already that more and more colleagues from several sub groups are interested in using this database and they do.

Future Perspectives:
The first step of a knowledge transfer has been well-established and we assume that this will grow in the future due to the fact that 8D reporting, supported by more functionalities of the database particularly calculating statistics like MTBF and MTTR, becomes common in the failure management.

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ACCELERATOR RELIABILITY WORKSHOP
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