

PARTS TRACKING FOR FABRICATION, INSTALLATION AND MAINTENANCE AT THE EUROPEAN XFEL

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Abstract

DESY has established a powerful configuration management solution for the construction of the European XFEL. It tracks the status and location of accelerator components during fabrication and installation, and it contains workflows for reviews, change control and the handling of non-conformities. It provides extensive progress monitoring and reporting for the production and installation of accelerator components. This way, it collects on-the-fly a comprehensive documentation of the accelerator, which serves as a thorough foundation for asset and maintenance management during the upcoming operation. The paper gives an overview of the application and summarizes its status, benefits and experience.

INTRODUCTION

In parallel with the construction of the European XFEL, a configuration database is set up which aims to provide a register of all systems, sub-systems and components along with their interconnections. It provides design models and drawings, work instructions and check lists, test records and maintenance manuals, and this way helps to standardize and thereby optimize procedures during the construction and upcoming operation and maintenance of the facility.

quality and availability during fabrication and installation, and later on enable efficient maintenance activities. The following chapters give a brief overview of configuration management activities in different project phases at the European XFEL.

CONFIGURATION MANAGEMENT: BUILDING DIGITAL FACILITIES

Configuration management (CM) is a systematic approach to managing the complexity product development, which has its focus on ensuring that the products conform to their documented requirements. "Configuration" emphasizes that complex products are built from numerous parts which all have to be matched, and which have to behave according to their individual specifications in order to enable the product to function as a whole [1].

DESY has established a powerful CM solution which tracks the status and location of parts, provides workflows for reviews and change control, and offers extensive reporting capabilities. It is based on an Engineering Data Management System (EDMS) [1].

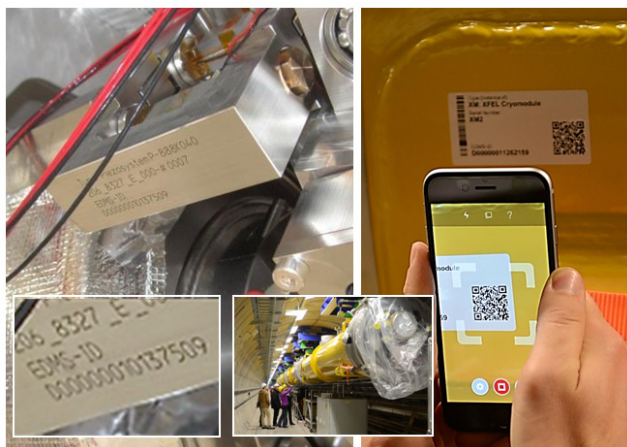


Figure 1: Part identification by engraved EDMS-Id (left) or QR-code label with EDMS-link (right).

One of the major challenges is to identify (Fig. 1) and keep track of the status and whereabouts of the many different parts and components in order to ensure their

	Pos 1	Pos 2	Pos 3	Pos 4	Pos 5	Pos 6	Pos 7	Pos 8	Pos 9
Cavity (CW-FE)	Qty: 1000000	Qty: 1000000	Qty: 1000000	Qty: 1000000	Qty: 1000000	Qty: 1000000	Qty: 1000000	Qty: 1000000	Qty: 1000000
... (many rows) ...									

Figure 2: Configuration of an accelerator module, capturing all its containing parts, their installation dates, and their test records.

Configuration management was started at the European XFEL already in a very early design phase. It is from then on a continuous activity, which lasts throughout the entire project and beyond. The configuration database is intended to be kept available and up-to-date for the whole lifetime of the facility, ready to serve as a basis for maintenance and upgrades for several decades. Figure 2 shows the configuration of an accelerator module as recorded in the EDMS.

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FABRICATION: TRACKING PARTS PRODUCTION AND ASSEMBLY

The components for the European XFEL facility are contributed from numerous collaboration partners. Often, they have sub-contracted the series production of the parts to industrial vendors, and concentrate on the assembly, test and installation of the components. They perform their work both at the laboratory's home locations and at the XFEL facility.

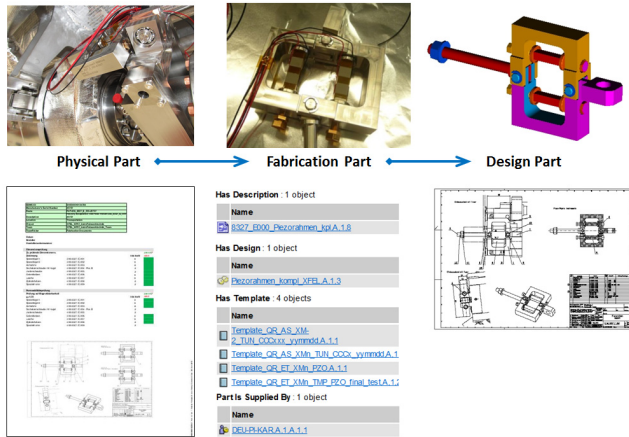


Figure 3: Parts tracking concept: Physical part records store status and test records of individual components (left). In the EDMS, they are linked to fabrication parts which provide fabrication instructions, which in turn back-link to the design documentation.

Every important physical part of the facility is uniquely identified. All those parts and all their related documentation are registered in the EDMS, which manages the inventory of the accelerator. Figure 3 illustrates the concept of the configuration database.



Figure 4: Installed position of a physical part.

Documents and acceptance test records have to be delivered at the latest, when the components are installed in the facility (Fig. 4). But often, the information is already provided during production. Many partner labs and sub-contractors are connected to the EDMS and upload their documentation along as they work.

This in-process documentation enables fabrication progress tracking, and it allows monitoring which parts and

supplies are available at which locations. Furthermore, it helps to involve experts from several collaboration partners into reviewing quality documents and taking decisions.

As shipping and assembly of physical parts are also tracked, the EDMS can also provide detailed reports of the configuration of components and the whereabouts of parts.

INSTALLATION PROGRESS TRACKING

The parts tracking mechanisms used in fabrication can also be applied to installation activities. Incoming components are identified with labels, and work records, test and inspection certificates are added to the EDMS, which in turn provides installation progress reports and captures the configuration of the beamline sections. Figure 5 shows an excerpt from an installation progress report for a linac section, including the installation status of accelerator modules, rf stations and racks.

Figure 5: Excerpt from linac installation progress report.

MAINTENANCE MANAGEMENT: STATUS AND CONDITION MONITORING

At first glance, maintenance work will follow the same scheme as fabrication and installation activities: Parts are modified or replaced, tested and brought back into operation. The accompanying work records, test results and design updates will be captured in the EDMS, thus ensuring the configuration information is kept up to date.

For maintenance planning, additional information about the utilization and current condition of components is wanted. For this purpose, part characteristics such as e.g. total operating hours or hours of cold operation or under RF power, can be stored in the database. When such data is recorded for a component, it is also automatically propagated to the sub-components. If e.g. a day of cold operation is recorded for an accelerator module, the information is also added to all its cavities and other cold components. Figure 6 shows an example for utilization information of an accelerator module (total operating hours, cold operating hours, etc.), which is propagated to

its containing cavities. The cavity records contain further operational parameters, such as e.g. their maximum operating gradients.

One important benefit of the configuration database approach is that utilization information is stored with the component, implying that in case components need to be exchanged at some point, every component will keep a correct record of its individual life history. Another benefit is the integrated view of the facility: While many operational parameters and condition information are available in local control systems, the configuration database can generate integrated and correlated views across sub-systems.

CONCLUSION

Configuration data has become an essential ingredient in the production and installation of accelerator components for the European XFEL. It is accessible anywhere and at any time: The same information can be accessed in the tunnel and in meetings, and at sub-contractor and collaboration partner places around the world. This way, it improves the communication and exchange of information across sub-systems, when for example communicating the status of work, following-up on changes, and making decisions.

Most information is collected “in-process”, i.e. along with production and installation activities. This is achieved by developing table-based, machine readable checklists which the project teams fill out as they perform their tasks. One benefit is that this way the teams are guided through their activities, helping to perform them in a repeatable and reproducible manner, as another benefit, in-process data collection helps to keep the configuration database up-to-date.

The EDMS provides a very thorough central technical documentation. Furthermore, it enables efficient processing of huge amounts of quality control documents. It

contains several hundreds of thousands of work and inspection certificates, many of which are required by legal regulations and will be relevant for years of maintenance

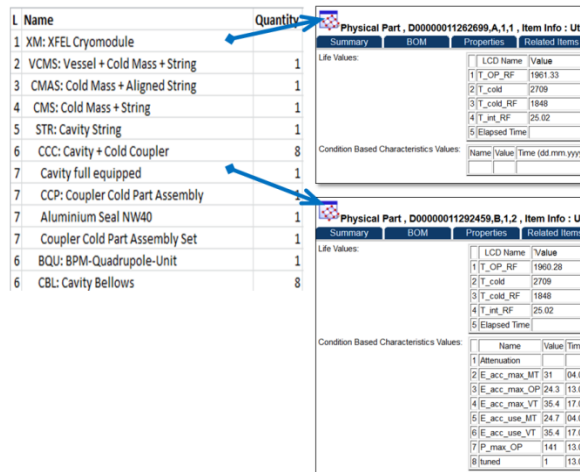


Figure 6: Information about the usage of a cryomodule (top) and a containing cavity (bottom).

and upgrade activities.

Centralized configuration databases are increasingly used for accelerator maintenance management [2]. By correlating configuration and status data across sub-systems, they can easily take into account neighbourhood and series/lots effects when analyzing events and planning maintenance activities.

REFERENCES

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