A DATABASE FOR SUPERCONDUCTING CAVITIES

P.D. Gall*, A. Goessel, V. Gubarev, J. Iversen, DESY, Notkestr. 85, 22603 Hamburg, Germany

Abstract

We look back on more than 10 years experience using a database for superconducting cavities. Originally the database was developed for a cavity R&D program in order to optimize the cavity preparation techniques to get high and reproducible accelerating gradients at high quality factors.

Presently the database takes over more and more an effective part of the quality control system for the whole cavity production and preparation process for FLASH and XFEL on a very detailed level. Currently we try to find out the most effective and safe way to get the production data from the different companies to the database and to control the quality of the cavity production from the Niobium sheets to the complete modules in the linac.

A DATABASE FOR CAVITY R&D

More than 10 years ago a relational database for superconducting cavities was developed at DESY using the ORACLE Relational Data Base Management System (RDBMS).

In an R&D program about 170 9-cell and 80 single cell 1.3 GHz cavities, produced by different European companies, have been prepared and mostly tested at DESY in order to optimize the production and preparation techniques for the superconducting cavities. Therefore selected data are collected into the database to keep track of every preparation step and test result of the cavities. Parameters and results of about 1000 cavity preparations by Buffered Chemical Polishing (BCP), of about 200 treatments by Electro Polishing (EP) and of some accompanying actions, like high pressure water rinsing, heat treatments, eccentricity and frequency tuning measurements etc. of the cavities were stored into the database.

The structure of the database is composed of about 200 tables and 100 so-called views which are logical tables combining several physical tables of the database. We implemented [1] an extensive Graphical User Interface (GUI) to the ORACLE RDBMS on the WEB in order to provide a user-friendly way for viewing and analysing the accumulated data.

Therefore the database is dynamically accessible from everywhere via this GUI based on ORACLE developer 10g FORMS and REPORTS and 6i GRAPHICS: http://tesla.desy.de, choose "*Cavity Database*" and then follow the menu (Fig. 1). Usually the retrieved data are displayed in table and/or graphical representation. As an example Fig. 2 shows in graphical representation some records of RF measurements retrieved from the WEB page *CW Test Results*.

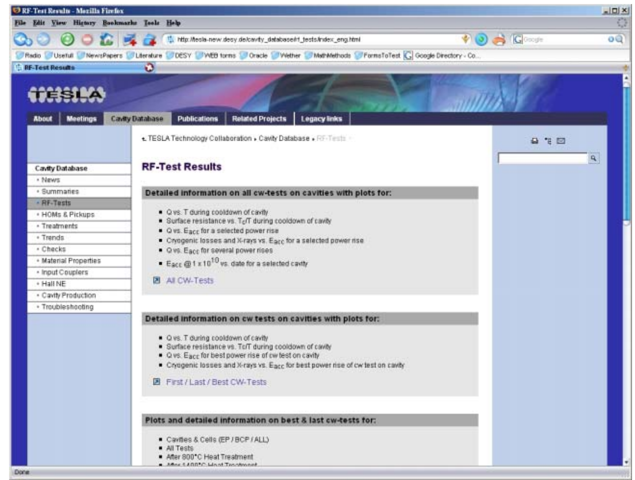

Figure 1: Menu page of the GUI to the database for superconducting cavities.

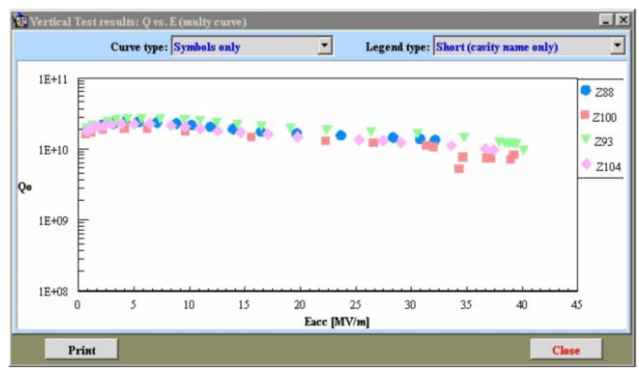

Figure 2: Retrieved records of cw tests from *RF Tests* of the GUI menu in graphical representation.

DATA FLOW INTO THE DATABASE

Based on this quite successful cavity R&D program hundreds of superconducting 9-cell cavities will be ordered from different European companies for TTF/VUV-FEL (FLASH) [2, 3] and the European X-ray Free-Electron Laser (XFEL) Facility [4] at DESY. Therefore the database has to take over more and more parts of the quality assurance for the whole cavity production and preparation process. For that we try to find out the most effective and safe ways to get the data from the different activities and places to the database.

At present data, like the measurements from the entrance control at DESY, information about input coupler assembly, RRR measurements, heat treatments of the cavities and so on, are collected manually via GUI tools (Fig. 3). This way of data storage is the fastest and most efficient for not too big data sets.

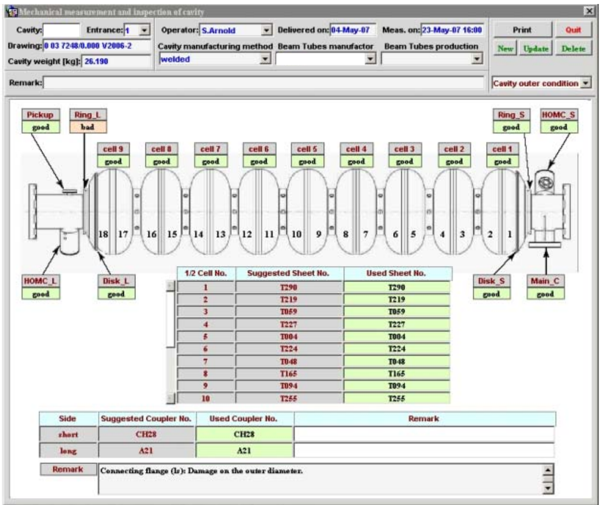

Figure 3: Example of entrance control of a cavity at DESY.

Some years ago DESY implemented a commercially available Engineering Data Management System (EDMS) to support the complex manufacturing process of superconducting cavities. Presently the EDMS supports the quality management during the manufacturing of the cavities and controls the subsequent conditioning process. Measurement results from both steps are attached to the EDMS documents as MS EXCEL-, PDF- and ASCII-files. We developed a special tool based on EDMS JAVA API to extract, parse and load these data automatically from EDMS to the database to make them available for statistical analyses. One advantage of this way of data transfer is that it guarantees the integrity and validity of the data, once they are "released" by the EDMS.

Fig. 4 shows the display of this loading tool for the so-called work packages controlling the cavity conditioning process at DESY. Shown is in addition the EXCEL sheet attached to an EP work-package containing data from the electro polishing process of a cavity.

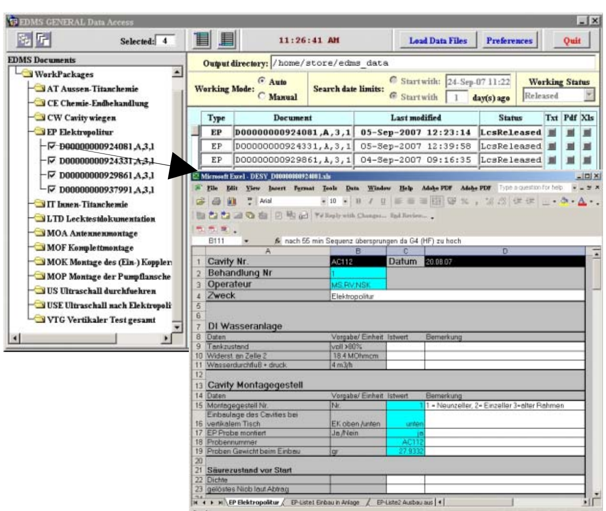

Figure 4: Data loading from cavity preparation at DESY and EXCEL sheet attached to an EDMS document.

The present cavity production-process at the companies consists of many quality assurance steps. After each production step mechanical and frequency measurements are performed and recorded in EXCEL sheets and then attached to the related EDMS document. Once the data are "released" by EDMS they are loaded into the database. The relational database allows easily to trace back a cavity to its components and related measurement results, e.g. via its dumb-bells or end-groups to the half-cells and finally to the Niobium sheets, and also the other way around.

It is still under discussion which data we will get from the companies about the production and the subsequent surface conditioning processes of the superconducting cavities for the XFEL. But it is already decided that all cavities will undergo RF tests under cw conditions at 2 K at DESY before they are assembled to modules. Finally the modules, containing 8 cavities, will also be tested at DESY. ASCII files from these tests will be automatically generated by control software and loaded into the database. This is a fast and reliable procedure as already proven in the R&D phase [1].

QUALITY ASSURANCE

Provided all relevant data are available the database may play an important role in the quality assurance of the whole cavity production and preparation process on a very detailed level. For example one could easily analyse trends of measurements on cavities (Fig. 5) or cavity subunits in dependence of the production date in order to find out early enough if a problem occurs during the production process.

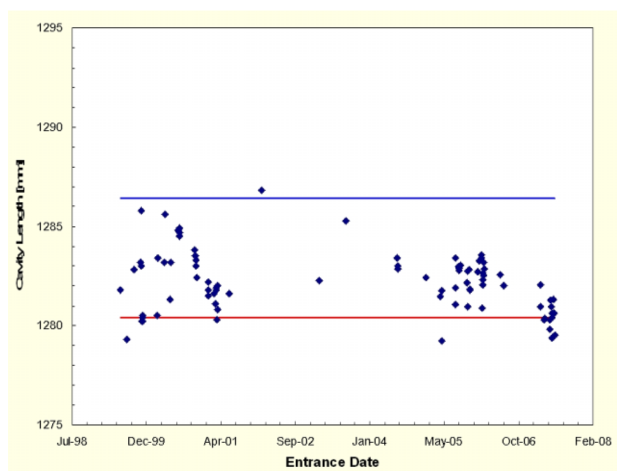

Figure 5: Cavity length measured at DESY as a function of the production date. The maximum and minimum tolerated length is indicated, too.

A statistical analysis of the performance of the cavities in RF tests (Fig. 6) could on the one hand possibly detect early enough problems during the preparation process of the cavities and ask for counteractions.

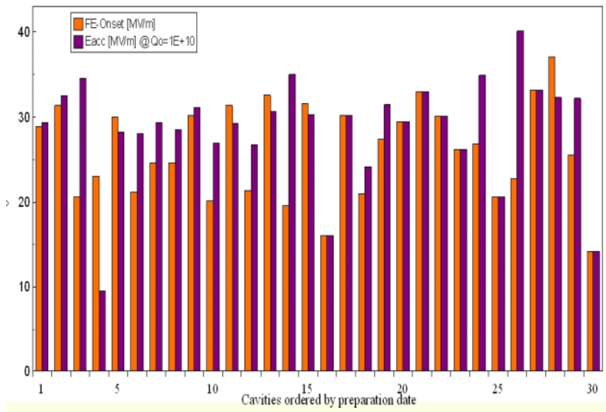

Figure 6: Cavity gradients at $Q_0=10^{10}$ and at field emission on-set ordered by the preparation date.

On the other hand the analysis of RF tests could also be used to select suitable cavities to be assembled to dedicated modules.

If problems arise during the module tests the relational database provides an easy way to trace back the module to its components like cavities, tuner systems, couplers and their sub-components and related measurements. Furthermore a statistical analysis of the module tests may help to install the modules on appropriate places in the linac tunnel in order to get the best performance of the XFEL accelerator.

REFERENCES

[1] P.D. Gall et al., “A database for superconducting cavities for the TESLA Test Facility”, PHYSICA C 441 (1006) 272-276.

[2] R. Brinkmann et al., “An X-Ray FEL Laboratory as Part of a Linear Collider Design”, Nucl. Instr. Meth. A393 (1997) 86-92.

[3] J. Rossbach, “A VUV Free Electron Laser at the TESLA Test Facility at DESY”, Nucl. Instr. Meth. A375 (1996) 269.

[4] “XFEL Technical Design Report”, DESY 2006-097, http://xfel.desy.de.