CAVITIES AND CRYOMODULES MANAGING SYSTEM AT AMTF

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Abstract

800 SRF cavities and 100 SRF cryomodules are under test in the AMTF Hall at DESY, Hamburg. Testing of such a large volume of components requires a management system which can store the measurement data. In addition the system should simplify tasks which are recurrent. In the case of the system developed at AMTF, communication with external databases has also been developed. An added complication is that not all the test procedures are identical for each component, and therefore the management system keeps track of all work done for each of the individual components. In the case of the vertical acceptance tests for the 800 SRF cavities, the management system provides an interface for specifying a decision of the next step each cavity (e.g. send for module assembly or retreatment). This paper describes the most important parts of this system.

INTRODUCTION

Limited time, manpower, capacity of test infrastructure and amount of processed information caused necessity of having a tool, that would make easier to manage available resources effectively and provide space for data required to proceed with tests. The tool should also provide access to common data space from multiple locations at the same time, restricted however by user's permissions. In response for these requirements IFJ team designed and developed a system dedicated for managing tests at AMTF (Accelerator Module Test Facility) [1].

OVERVIEW OF THE SYSTEM

In the managing system test of every object is divided into steps, that have to be performed in defined order. Every following step depends on previous ones – activity connected with the step can be started only if appropriate criteria are met. In case of unexpected events (e.g. cold leak) test sequence may be changed by authorized person. Test progress contains information about past and future steps for selected object and is up-dated according to activities and decisions. The managing system allows also to view summary for AMTF - current status of test infrastructure and all tested objects.

Test of every object provides measurement data, that have to be saved for further analysis and transferred to the external data base. Results of measurements require appropriate representation in the data base, transfer procedures and user interface. The managing system implements all these functionalities. Results of measurement are formatted into XML files and then uploaded to the internal data base (AMTFMEAS). Data are assigned to appropriate test and activity (step) to be easily accessed and avoid an ambiguous situation. In this point results can be viewed and analyzed in dedicated sections, i.e. preparation, vertical test and module test. After approval by authorized persons the data are finally transferred to the external data base (XFELDB).

IT REALIZATION

AMTF managing system is realized as server - side Java application (Tomcat 7). It is implemented on Linux (Ubuntu) server encapsulated in Apache 2 server with jdk connection (see Fig. 1). Java application is connecting with external Oracle database server. Functionality of the system on the clients computers is completely independent from operating system and internet browser used. Clients computers requires only Internet browser with enabled JavaScript. Application have an access control realized in two steps. First is htaccess on the Apache side. Second is a realized in the application. Application have implemented privileges system with special permissions for special groups of users.

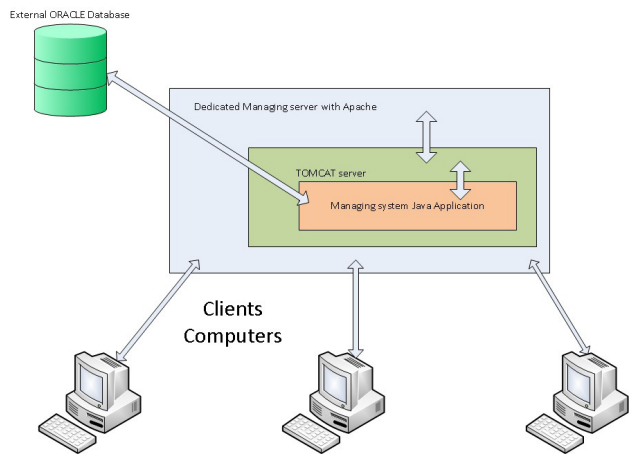

Figure 1: Basics of the IT realization of AMTF Managing system.

AMTF STATUS

From the planning of the works point of view important part of the system is a summary created from all components tested and staying at AMTF. Managing system provides two such summaries. One is directly accessible from the system (see Fig. 2). In this summary view user can find cavities which are during the testing or preparation for the testing (upper part of the view). In addition summary tables for cavities are available. In those tables user can check how many cavities are currently stored at AMTF and how many have been sent to vendors or for assembly of the cryomodules.

Second part of the AMTF status table is so - called "AMTF monitor" (see Fig. 3). In this tool all important parameters

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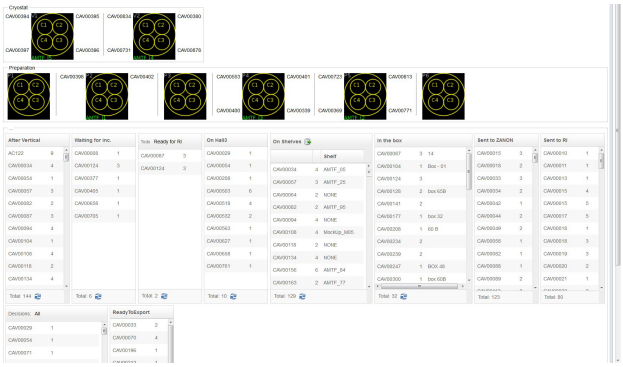

Figure 2: Status of the cavities in AMTF including storage places.

for 5 test benches (2 vertical and 3 horizontal for cryomodules) are displayed. Part of those information (such as vacuum and cryogenic status) are gathered from DOOCS [2] and EPICS [3] control systems. Rest, such as cavities position and actual status, are taken from AMTF Managing system. AMTF Monitor is a standalone website and it can be accessed from DESY intranet. It is constantly displayed at AMTF providing status data for personnel.

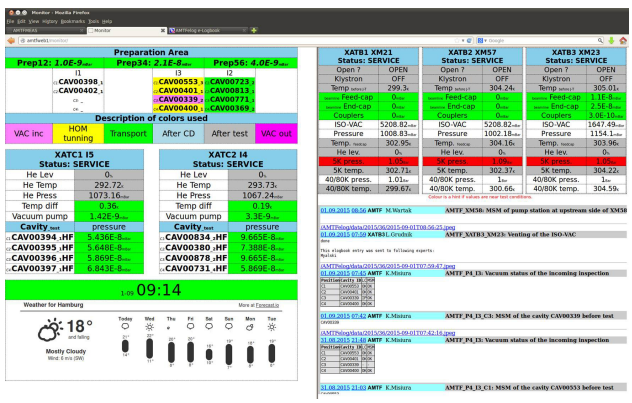

Figure 3: AMTF monitor. Status info with all information displayed constantly at AMTF.

PREPARATION DATA

After delivery to the AMTF the cavity has to pass the incoming inspection and is prepared for high power test. The very first RF activity is measurement of RF spectrum and comparison with reference data from manufacturer, in order to calculate so-called "field flatness". Afterwards in preparation phase HOM (Higher Order Modes) couplers are tuned - it requires multiple RF spectrum measurements in different input-output configurations. In general, measurement of RF spectrum is performed during all key parts of cavity test, i.e. incoming / outgoing inspection, HOM couplers tuning, vertical test, test in module. The managing system makes it possible to view and compare RF spectra measured for a cavity during its entire history (see Fig. 4). Additionally the system checks for new reference spectra (e.g. after welding into tank or assembly into module) and download them automatically.

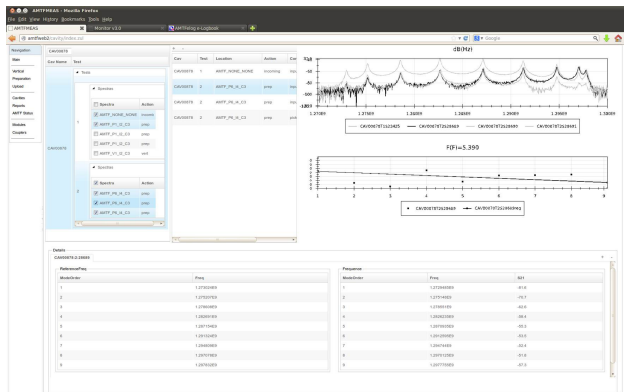

Figure 4: Data from spectra measurements.

VERTICAL TEST DATA

In order to determine single cavity performance it is measured in vertical test-stand. According to results of vertical test a key decision is made on follow-up (e.g. assembly into module, retreatment and so on), therefore deep analysis of measurement data is required. The system allows to view relation of quality factor and radiation versus electric field and compare it with acceptance criteria and results of previous tests. After selecting curve and point it is possible to see more detail information (e.g. power traces, quality factors, vacuum and cryogenic conditions). Data from vertical measurement is shown on Fig. 5. Additionally the system provides automatic report generation, what significantly decrease time needed for document preparation after test.

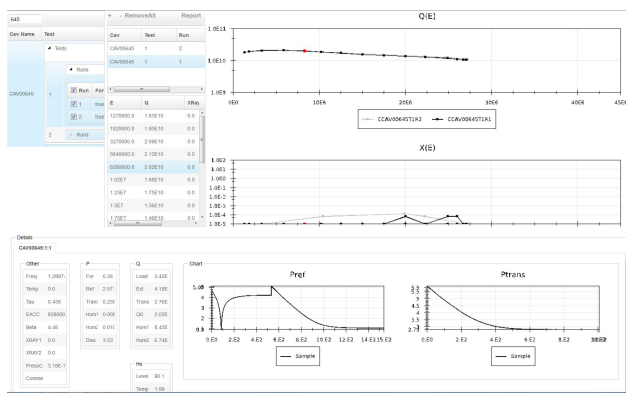

Figure 5: Vertical measurement results.

CAVITIES DECISIONS

After vertical test of single cavity a decision about next steps is taken by responsible person (cavity owner). Following decisions are available for cavity owner in the system:

- Send to Saclay

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- Send back to RI
- Send back to EZ
- Handover to FLA
- Retest at AMTF
- Retest at Hall3
- Retreatment at Hall3 and retest at AMTF
- Retreatment at Hall3 and retest at Hall3
- Clean room for leak check and new assembly
- Obacht inspection
- Send to EZ for chimney repair
- Send HiGrade cavity to EZ for tank assembly
- Send HiGrade cavity to RI for tank assembly
- Store and wait for decision

Special window for taking a decision is shown in Fig. 6.

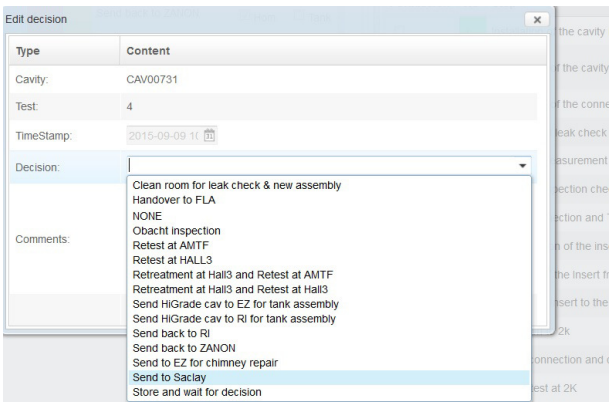

Figure 6: Decision of the next step for cavities.

CRYOMODULE DATA

Before placing a module in the XFEL tunnel all its components (i.e. cavities, coupler, tuners, LLRF, vacuum and cryogenics lines, magnet) have to be tested once again at AMTF. Test procedure consists of steps that simulate future module operation with the beam (i.e. calibration, flat-top, heat-loads), which are crucial to determine module performance. It is also important, that all high power measurements require special vacuum and cryogenic conditions, so the module parameters are checked also from this point of view. The managing system makes possible to analyse results of measurements for module and compare results for cavities in-module with vertical test as well. Below the most important info panels and sections of the cryomodule part of the system are described.

Cryomodule Calibration

Cryomodule calibration is an important step during test. To be able to analyse the data acquired during calibration special panel have been implemented. This panel let user to check all of the calibration values including the plots. Available plots shows power forwarded and reflected, response from the cavity and fit from this response necessary for further calculations. Cryomodule calibration view is shown on Fig. 7.

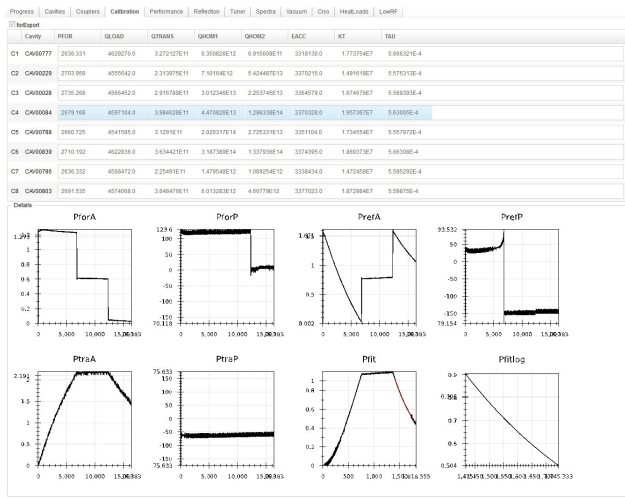

Figure 7: Cryomodule calibration.

Flat - Top Measurement

Single cavity measurement in the cryomodule, so - called "Flat - top" is a complex activity where a lot of data is collected with dedicated application. Those data are uploaded to the system after the test. However, there is another part of system which allows operator to enter manually most important cavities parameters during the test (see Fig. 8). This step requires interpretation of data by a person directly testing the cavity.

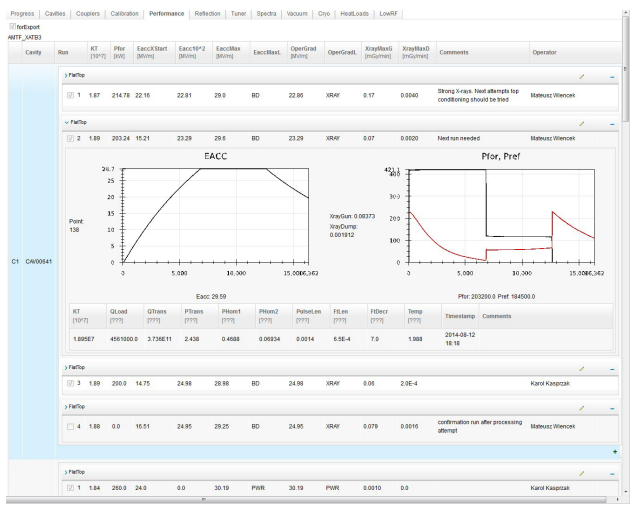

Figure 8: Flat - top measurement.

Vacuum and Cryogenic Data

As already mentioned, AMTF managing system collects not only the RF measurements results. The vacuum data describing conditions during and after the test (including mass spectrometry of the beam line) is stored as well. Cryomodule vacuum view is shown on Fig. 9.

During the cryomodule test at AMTF most important cryogenic parameters are measured as well. The cryogenic

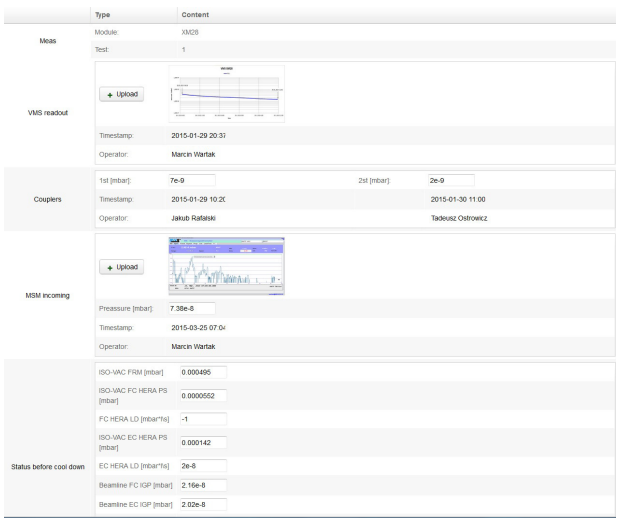

Figure 9: Vacuum data.

part of the system (see Fig. 10) allows cryogenic operators to manually insert results of the Heat Loads measurement and RF operators to insert calculated quality factor of the cryomodule basing on the Heat Loads at 2K circuit.

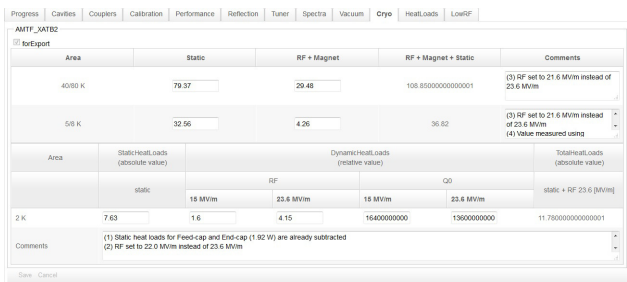

Figure 10: Cryogenic data.

CONCLUSION

Experience earned during tests in AMTF leads to conclusion, that cavity and module managing system is necessary part of the project. The system has proven its high usefulness in coordination of work, communication between teams, transferring measurement data and making appropriate decisions. These reasons are important in case of limited time and manpower, especially when there is no room for mistakes. Despite life time of the managing system is limited by end of tests at AMTF, it will be important source of experience for the future.

ACKNOWLEDGMENT

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