ISBN: 978-3-95450-200-4 doi:10.18429/JACoW-PCaPAC2018-WEP32

THE DESIGN AND DEVELOPMENT OF AN AUTO-CONDITIONING SRF CAVITIES SOFTWARE

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Abstract

As one of the major components of ADS Injector II, SRF (Superconducting Radio Frequency) cavities are used to transmit the intense-beam proton reliably, stably and efficiently. Before starting the process of transmitting particle beams, SRF cavities are routinely conditioned to achieve its optimized status in the deliverable energy. The whole conditioning process is involved in various types of hardware devices and is also a heavy task for engineers to manually operate these equipment. In this paper, the software ANSC is presented in details, which is used to automatically condition SRF cavities. At the present, ANSC is in the stage of testing. During the testing, ANSC indeed can achieve comparative results compared with manually operated conditioning.

INTRODUCTION

As China Accelerator Driven System (C-ADS) Injector II achieved the expected target of 25 MeV[1], how to make an improvement in efficiency is our current focus[2]. In every accelerator physics experiment[3], engineers of SRF are always required to condition SRF cavities by manual operation to ensure that these cavities can reach their optimal deliverable energy. The task is heavy for the engineers and manual operation is also low in efficiency. In order to get rid of the difficult situation, our engineers in the ADS control group are developing an Auto-Conditioning SRF Cavities program called ANSC. Currently, ANSC is in the stage of testing and obtained some positive feedback during the testing process. ANSC is based on the distributed control system EPICS, which has been widely used in accelerator field. Therefore, it is totally compatible with current control system in ADS and is also convenient to update the software in the future. During the development of the program, python and Epics Qt are core components in which Epics Qt is used to customize GUI and python is exploited to carry out the auto-conditioning process.

In the following sections, ANSC will be described in detail.

THE GUI OF ANSC

Because of flexibility and practicality of Qt,it is widely used in software development. At the same time, Epics Qt combines Qt's advantages with EPICS'. As a consequence, it is chosen as GUI design tool of ANSC. In reality, Epics Qt demonstrates its high performance in displaying PVs by Channel Access.

In ANSC, there are two main user interfaces: setting GUI and operation GUI. Setting GUI in Fig. 1 is responsible for setting some basic parameters; Operation GUI in Fig. 2 is used as setting auto-conditioning related parameters and an entry for executing auto-conditioning process.

In the Setting GUI, the key status information is set such as vacuum fluctuation, vacuum protection status and MPS (Machine Protection System), which is key for engineers to execute the auto-conditioning process. Operation GUI is used before the beginning of the process. Its main function is to set important parameters and thresholds such as vacuum thresholds, auto-conditioning up steps and down steps, then start the auto-conditioning process. In addition, scanning frequency and phase can be executed.

Figure 1: Setting GUI of ANSC.

Figure 2: Operation GUI of ANSC.

REALIZATION OF AUTO-CONDITIONING PROCESS

The function of the GUIs is totally carried out by Python. Taking the complexity of auto-conditioning SRF cavities and restriction requirement in time into account, the program consists of four threads, including auto-loading thread, protection thread, exception dealing thread and main thread. The auto-loading thread takes charge of

12th Int. Workshop on Emerging Technologies and Scientific Facilities Controls PCaPAC2018, Hsinchu, Taiwan JACoW Publishing
ISBN: 978-3-95450-200-4 doi:10.18429/JACoW-PCaPAC2018-WEP32

increasing power; the protection thread is used to monitor status of devices and takes proper protection actions, and the exception dealing thread deals with other accidents such as disconnection of PVs.

Figure 3: The display of the result of ANSC.

In Fig. 3, the phenomenon of carrying out the auto-conditioning process is displayed. Figure 4 is the user interface to display historical information in execution of ANSC.

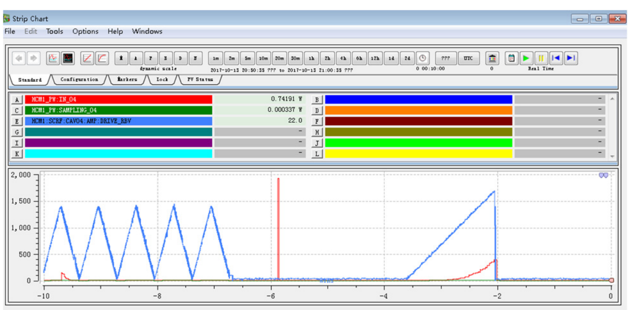

Figure 4: The display of historical records.

ANALYSIS OF PERFORMANCE

After the comparison of new user interface and old user interface in Fig. 5., it is definitely assured that the user interface of ANSC is more easy for users to use and is more beautiful than the old user interface.

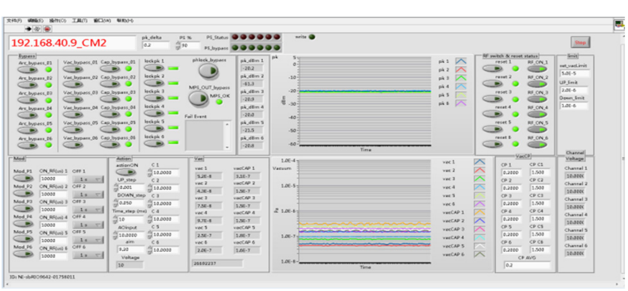

Figure 5: The user interface of old conditioning program.

During the testing, ANSC can meet basic requirement of auto-conditioning SRF cavities. It is used to increase power by automatically operating PVs and also monitors all kinds of alarms in the proceeding. To a great extent, ANSC can reduce the burden of engineers taking charge of SRF and also improve the efficiency in conditioning SRF cavities. Therefore, it demonstrates that auto-condition program is certainly alleviate the burden of engineers.

On the other hand, conditioning SRF cavities is complex and is extremely restricted in speed in some aspect. For example, when ARCA happens in the process, it is dealt instantly within a few µs, which is beyond the capability of software. Thus, it is necessary to come up with a new solution to complement EPICS's shortage in micro-second time. In addition, how to ensure multi threads harmoniously is another practical problem.

CONCLUSION

Until now, the testing task of ANSC is mostly completed. there are some serious prolems needed to be tackled; otherwise, the reliability of ANSC would be threatened greatly. For example, when ARCA is detected, ANSC is asked to cut down power supply within a few us which is beyond python because python is incapable of dealing with the special situation in such short time. As for the emergencies described above, some methods are being tried.

How to build a well model in theory is our final goal so that ANSC can totally replace humans and set them free from boring and repeated task. Meanwhile, increasing the robustness and reliability of ANSC is also critical for our future work. According to these difficulties, full automatic process is a long way.

ACKNOWLEGEMENT

During carrying out the work referred in the paper, we get many help form co-workers in ADS Linac control group. The authors wish to thank the numerous persons who participated in activities on ADS control group.

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