LABVIEW CONTROL SYSTEM OF THE CRYOGENIC COMPLEX FOR THE KAON RF-SEPARATOR AT IHEP

A.Ageyev, V.Alferov, A.Bakay, V.Fedorchenko, A.Kholkin, V.Krendelev, A.Lutchev, D.Vasiliev,
Institute for High Energy Physics, Protvino, Moscow Region, 142281, Russia

Abstract

The superconducting RF separator is used for the separation of kaons at the OKA experimental setup at IHEP. The separator consists of two deflecting niobium cavities housed in the cryostats. Their cooling is provided by one large commercial helium refrigerator and two custom heat exchangers, located near cavities. The cryogenic complex for the separator provides liquid superfluid helium with the temperature of 1.8K as well as liquid nitrogen. The paper describes the arcvhitecture and the LabVIEW based software of the control system.

INTRODUCTION

The cryogenic complex comprises the vacuum system (CVS) and provides cooling of two deflecting niobium cavities RF1 and RF2 of the superconducting RF separator which is used for separation of kaons for the experiments at the OKA setup [1]-[4] at IHEP. The cryogenic helium plant KGU-500 is the main cold generating unit of the CVS. It produces both the cool and liquid helium of the same 4.6K temperature. The other parts of the cryogenic complex are: two heat exchangers located in the liquid helium baths (LHB) of intermediate cooling; large vacuum heat exchanger (HEX); heat exchangers at the entrances into the RF1 and RF2; pumping machine (PM). The control system provides measurements of about 500 analog parameters and 300 digital signals and generation of tens of commands.

ARCHITECTURE

On a lower level of the control system there are 40 custom equipment controllers based on Analog Device and Atmel programmable devices. They provide data acquisition, calculation of operating parameters, and generation of digital and analog commands for the following tasks:

- temperature measurements with various sensors;
- digital measurements of liquid Ni and He levels;
- analog measurements of He level;
- vacuum pump motors current measurements;
- vacuum measurements;
- turbine rotation speed measurements;
- controls of heaters power supplies;
- measurements of Ne contamination of gaseous He;
- valve position measurements;
- various measurements and generation of digital signals.

Equipment controllers are connected to three personal computers (PC) by means of CAN field buses. Each PC controls one of three physically separate groups of equipment: KGU, LHB, and HEX/RF. The fourth PC is used as a local Data Socket (DS) server. The PCs are connected by a dedicated Ethernet technology network (TLAN). Simplified block diagram of the control system is shown in Figure 1.

We use the Data Socket Connection program, which is a part of the LabVIEW package Developer Suite Core. All CAN masters are simultaneously clients and servers, so all the data are available on each console. The DS server is a client for the following users: three operator consoles; server for clients TLAN, a public LAN and SQL server hosting an archive of the CVS. As a result, all operators and other users of the TLAN can get data from both the DS and SQL servers.

CONTROLS AND DATA PRESENTATION

LabVIEW based software for control and monitoring consists of the following programs:

- **PK09.vi** installed on the KGU PC;
- **RF.vi** installed on the HEX/RF PC;
- **OM.vi** installed on the PM PC;
- **DS server.vi** installed on he DS server of TLAN;
- **CRYOVIEWER.vi** installed on computers of clients of the DS server of TLAN.

Every program presents the main window synoptic sirquit of the equipment group with sensors and actuators as well as a parameter values. One can change parameters by putting new data into an appropriate control field. Color is a status indicator. One can draw a time graph of any parameter. Additional windows permit tuning, calibration and other manipulations with various parameters. Graphical presentation of the HEX/RF group is shown in Figure 2.

DATA ACQUISITION AND CONTROL SYSTEM

The CVS data acquisition and control system developed at IHEP allows to display on the operator's console all the main parameters required for manual or remote control. After full commissioning the system shall provide control of the following parameters:

- temperature measurements of cryogenic components, of nitrogen and helium flows in 72 points;
- temperature measurements of pumps of the PM in 42 points;
- interstage pressure measurement of the PM by means of differential pressure transducers in 3 points;
- medium and high insulation vacuum measurements by PMT-6-3 and PMT-4 sensors in 32 points;
- liquid helium level measurement in 3 vessels;

- helium and nitrogen pressure measurement in 11 points;
- helium mass flow rate measurement in 2 points.

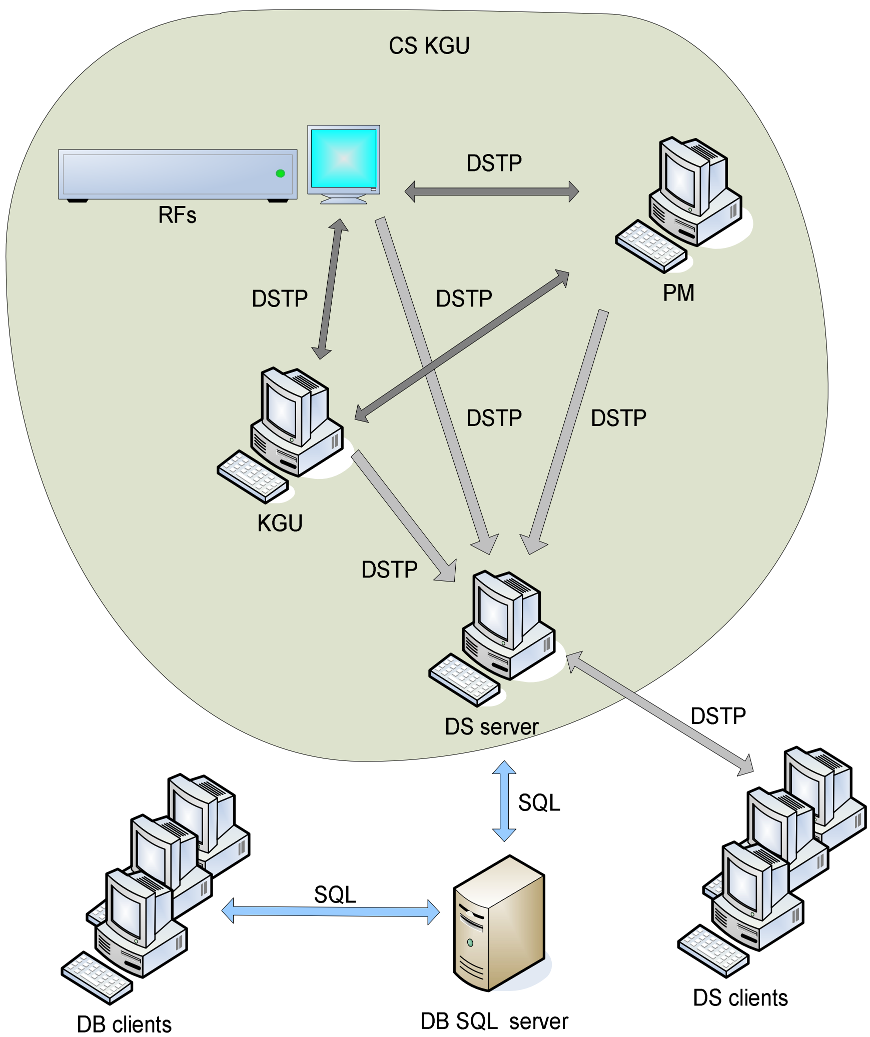

Figure 1: Block diagram of the control system

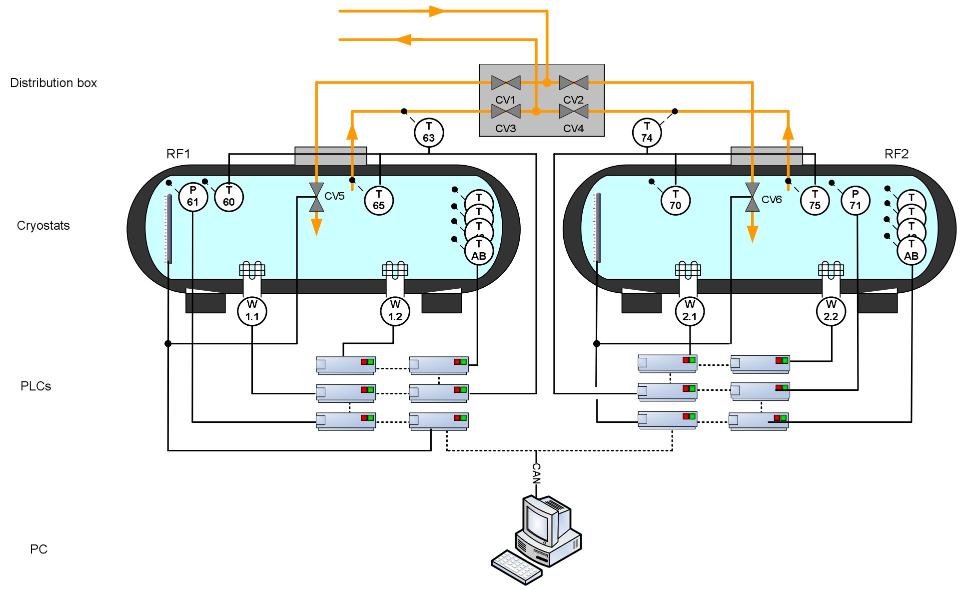

Figure 2: Data presentation of the HEX/RF equipment

CONCLUSION

The cryogenic complex for the OKA experiment at IHEP has been in operation since December 2006. It allowed to provide 1000 liters of superfluid helium at 1.8K for the RF cavities during several days of operation and thus start a research program with separated kaon beams in 2008-2009.

LabVIEW has proven to be an efficient, easy to learn and easy to use programming environment for data acquisition, monitoring and presentation. The control software is currently being refined to improve the functionality and user interface. Particularly, it is planned to implement control of closed loops by low level equipment controllers rather than mid-level computers with real time operating system.

REFERENCES

[1] E.S.Ageev et al. “Experiments with Charged Kaons on the RF Separated Kaon Beam at IHEP U-70. Proposal on the Precise Measurements of the Kaon Decays at IHEP U-70”, 5 November 2003. Available: http://www.oka.ihep.su/Members/zopeadmin/oka-papers/pred.ps (in Russian).

[2] Bakay A.I. et al. “Cryogenic 1.8K Test Facility for Cryostats with Superconducting Cavities of RF-Separator”. Atomic Energy, v.93, No.6, December 2002, p.p.445-448 (in Russian).

[3] Ageyev A.I. et al. “Status of Superconducting Radiofrequency Separator Cryogenic System”, RUPAC-2004, October 4-9, 2004, Dubna, Russia. http://accelconf.web.cern.ch/AccelConf/r04/papers/THFO04.pdf

[4] Ageev A.I. et al. “Commissioning of Superconducting Radiofrequency Separator Cryogenic System”, RUPAC-2006, September 10-14, 2006, Novosibirsk, Russia. http://rupac2006.inp.nsk.su/ready/tufo04.pdf