ISBN: 978-3-95450-193-9 doi:10.18429/JACoW-ICALEPCS2017-TUPHA130

DESIGN AND DEVELOPMENT OF THE CONTROL SYSTEM FOR A COMPACT CARBON-14 AMS FACILITY *

Kangning Li, Yiwen Bao, Ming HE, Yueming Hu, Shan Jiang, Shengyong Su, Qubo You, JianmingZhou ,CIAE, Beijing,China

Abstract

A compact AMS facility which is special used for further analyzing atmospheric pollution especially in north China via carbon-14 measurement was developed at CIAE (China Institute of Atomic Energy), This machine is a single acceleration stage AMS, running with the highest accelerate voltage of 200kV, The control system is based on distributed Ethernet control system, using standard TCP/IP protocol as main communication protocol. In order to connect to the main control network freely, device-level data-link layers were developed also. A LabVIEW client, developing virtual machine applied environment, provides friendly graphical user interface for the devices management and measurement data processing.

INTRODUCTION

AMS is the most sensitivity technique for long lived radioisotopes and is widely used in many fields. 14C is the most popular isotopes for AMS measurement. Although there is a large AMS system with a terminal voltage of 13MV at CIAE, it can't meet the needs of requirements due to its low transmission efficiency and poor stability in the measurement of 14C. So, a system dedicated to 14C measurement was established by CIAE AMS group. This system is a kind of single stage AMS which only have the ion energy of 230keV. Developing the low energy compact AMS system is the trend of 14C measurement. The single stage AMS system was first developed by NEC with the ion energies of 250keV, and then a compact tandem 14C AMS system(MICADAS) was developed by ETH with the terminal voltage of 200KV.The results of these system shown that they can provide the comparable results to the 0.5MV tandem AMS system in the measurement of 14C, meanwhile these system only require about half floor space and the manufacturing cost is much lower than the 0.5MV AMS system. Accordingly, a single stage AMS system dedicated to 14C measurement is designed and established in our AMS lab. The size of the instrument is $4.6\times2.4m^2$ overall dimension. Negative ion source, 90^0 injection magnet and electric quadrupole lens are located at the high voltage deck, gas stripper canal, 90^0 analyzing magnet, 90^0 electrostatic spherical analyzer and a surface barrier detector are located at the ground potential.

* Supported in part by the major projects of Beijing science and technology commission under grant no.D151100005015002, and the nation science foundation of China, under grant no.11575296, 11675269.

CONTROL DESIGN SCHEME

This AMS facility covers a wide range of different interface devices, from simple traditional serial port to popular LXI interface. The control system include equipments with many functions, such as ion source, cooling system, stripping gas, beam transport devices, motion control, detectors, etc.

Because this machine is compact and needs a concise appearance, wireless LAN based on Industrial IEEE 802.11 is adopted in the control system. Devices with multiple interfaces are connected to the local network via intermediate converters, such as MOXAAWK3121 series. Control system architecture is shown in figure 1.

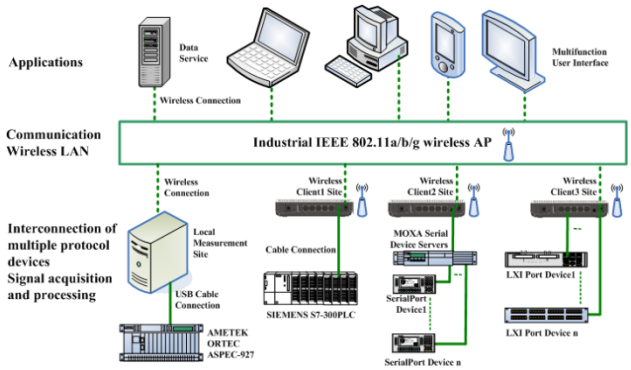

Figure1: This AMS facility control system architecture.

HARDWARE

Wireless LAN mainly comprises one wireless AP site in main control room and three wireless client site in different voltage potential deck. Wireless client sites complete communication with device-level control equipments, realize collection and transmission of control signal, and complete the data transmission with the AP site. Wireless AP site works as a server, realizes communication with other wireless client sites connections.

In device-level, Programmable Logic Controllers(PLCs) are the main components of this control system, adequately applied to many devices control, such as most power supplies, beamlines control, vacuum/temperature diagnostics, motion control, etc.

As the control system has a variety of interface devices, such as serial port232, serial port485, ModBus. We used

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serial device servers(MOXA Nport5650) to convert serial devices into standard Ethernet control protocols.

Hardware of data acquisition system of this machine used AMETEK ORTECASPEC-927 installed in standard VME chassis. It connects with the local measurement site through the USB cable. The local measurement site communicates with LAN via wireless network card.

Other devices with LXI interfaces, such as Sorensen power supplies, monitoring instrument, etc, are directly connected to the LAN.

SOFTWARE

A LabVIEW interface software, developing virtual machine applied environment, provides friendly graphical user interface for the devices management and measurement data processing. Other development tools include Matlab, SQL database management system, STEP7 V5.5 software, etc.

The operators of the instrument include not only skilled personnel (physicists, engineers and technicians) but also the unskilled users that have no insight into accelerator. So, we design different panel for different users at different levels.

In device-level, SW of PLCs was developed with LAD and STL in Step7 V5.5 environment[1].This part realizes the basic flow controlling, interlock controlling and communication with main control PC by CP343-1 module[2,3].

In application-level, SW based on Windows OS adopts ThreadPool approach[4]. Different function is performed by separate thread, such as signal measurement and controlling, detectors data acquisition, data processing and serial device control, etc. ThreadPool approach architecture is shown in figure 2.

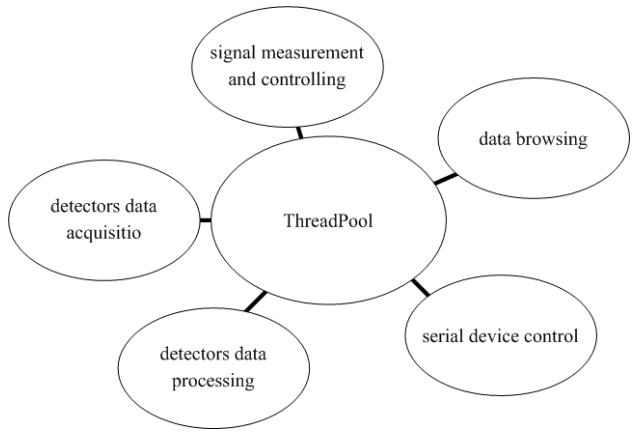

Figure 2: ThreadPool approach architecture.

CONCLUSION

The control system has been successfully applied in Beijing tandem accelerator national laboratory at CIAE for more than one year. The system runs stably and reliably, and achieves the expected goal. With the help of excellent performance of control system, this compact AMS machine has obtained some good data and provided a solid support for the government departments to deal with the serious air pollution in northern China.

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