A NEW HERA CRYOGENIC CONTROL SYSTEM - REQUIREMENTS AND OBJECTIVES -

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Abstract

The HERA cryogenic control system has to be updated. With regard to the high reliability of the industrial system used for many years and due to the acquired experience DESY is searching for a current generation control system with low rate of failures and many skills related to flexibility and integration facilities. Besides the most important requirement, a reliability of more than 99,5%, there are long-dated objectives. The medium-term objectives are migration and integration of DESY controls, a long-term objective is the fully automatic control.
Based on a restricted tendering procedure we have decided in August 99 for a new cryogenic control system.

1 INTRODUCTION

We have started the project work for a new HERA cryogenic system in 1998 by a survey of current generation control systems. In addition we have organized a Workshop (CPC'98) at DESY to elaborate concepts and strategies for the next generation cryogenic controls. Based on the workshop results and our requirements we describe in the paper the DESY strategy for new cryogenic controls for HERA due to hardware and software. We present the results of our evaluation of state-of-the-art industrial controls and describe our new system after call-for-tenders.

History

All the HERA cryogenic equipment has been controlled up to now by a commercial control system, EMCON D/3, bought in 1984. The EMCON D/3 system was a real progressive DCS-system (distributed control system) for this time. After the start of operation of the cryogenic plant in 1986 the installations of the HERA tunnel, controlled by the DESY SEDAC fieldbus, has to be integrated into the system. This was done in 1989 by PADAC computers used as a gateway between SEDAC and the D/3-system. In 1990 the HERA accelerator operation was started. Four years later the PADAC gateways were replaced by EPICS gateways. The last software update of the actual cryogenic control system was in 1993.

2 REASONS FOR A NEW CRYOGENIC CONTROL SYSTEM

There are several reasons of different importance to replace the running cryogenic control system.

2.1 "Hard" Reasons

- The Y2K-problem

The most critical aspect is the incompatibility concerning the year 2000 problem (Y2K). The version D/3-5 of the actual control system, updated in 1993, is not Y2K-safe.

- Hardware related problems

The spare parts are nearly worn out and moreover some important parts are not available due to components which are not on the market, so in case of no system replacement there has to be development to substitute these parts. Also the support time for the I/O-hardware is not really sure and the probability for failures will increase.

- New installations in the cryogenic area

In the last years new cryogenic components have been installed at DESY, e.g. CTA (cryogenic test area) or TTF (TESLA test facility). In the future the TTF equipment will be provided with liquid helium from the HERA plant by a transfer line. The running control system is at its capacity limit, so there is no solution possible using the current system to control the new cryogenic installations.

2.2 Strategic Objectives

- Decreasing the number of different systems in the area of cryogenic and improve the integration facilities into the existing DESY environment.

At the moment there are several systems used to control the HERA cryogenic systems. The objective is a homogeneous system with no additional layers but with standard interfaces to improve the integration into other DESY controls. Nevertheless the new system should make interfaces and functions available for the different needs of machine physicists, control specialists and operators.

- Progress in Automation

Actually a lot of operations are executed by sequence programs. This should be extended to all critical and most of the standard operations. In the future it should be easier to handle critical situations and moreover the system should give advice to the operator e.g. based on an expert system.

3 REQUIREMENTS AND CONSTRAINTS

A new cryogenic control system has to fulfil lots of requirements according to DESY and it has to take care of constraints given by the existing installation.

3.1 Requirements

The most important requirement is reliability. The cryogenic system from HERA has to be available 24 hours per day and 365 days per year. There is only one shutdown scheduled every two years for maintenance. Due to the long thermal time constant of cryogenics every failure of the cryogenic control system causes a beam loss of more than 2 hours; a failure of 8 hours causes more than 3 days beam loss. Therefore the cryogenic control system has to be very reliable to guarantee that there is no failure effecting loss of the cryogenic system. In the past the reliability for the cryogenic control systems was 99.5 %.

Another important requirement is functionality according the DCS-architecture especially for engineering and maintenance. Finally the flexibility to adapt the control system to the user requirements should be taken into account. Due to the application area of the new system (HERA, new installations) a lot of flexibility is necessary.

3.2 Constraints

To replace or update the cryogenic controls it is necessary to take notice of several constraints.

- Time Constraints

Every major change in the system has to be scheduled according the fixed HERA shutdowns. Therefore the only possibility to replace or to update a major part of the control system will be the next long shutdown between May 2000 and January 2001.

- Legacy of Hardware and Software

The new cryogenic control system has to handle the hard- and software legacy. The DESY SEDAC fieldbus is the best example for the hardware legacy. It was out of the question that it is possible to replace all the equipment in the HERA tunnel due to financial and technical reasons. One example for the software legacy is the future use of temperature conversion programs.

- Manpower resources and group skills

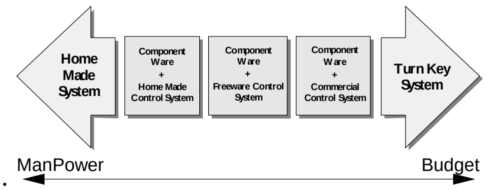
At DESY manpower resources are limited more and more. So we have to find out a solution fitting this situation.

- Budget

The budget designated for a new cryogenic control system was strictly limited. Therefore it was very important to determine the requirements as good as possible to obtain an optimized relationship between cost and utility.

4 OPTIONS FOR NEW CRYOGENIC CONTROLS AND THE SELECTION PROCESS

In general several solutions were possible to replace or to update the HERA cryogenic controls. With regard to the requirements and constraints we have to think about a realization fitting the manpower and budget situation and maximises the employment of standards. In picture 1 the options considering the different aspects are shown



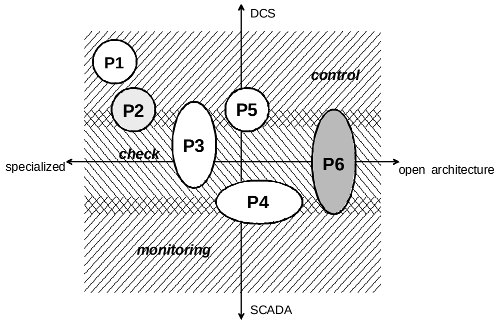
In addition to an intense internal discussion we organized the CPC'98-Workshop (cryogenic and process controls) in November 1998. We invited specialists for cryogenic and process controls of several research laboratories (Fermi National Laboratory, Jefferson National Laboratory, CERN, BESSY-II) to talk about their solutions and to discuss several points of interest related to cryogenic controls and controls in general like redundancy and automation. A major point was the discussion for and against the use of industrial systems.

As a result of the workshop our opinion grew strong that only a solution with a commercial system would be practicable. One argument was the lack of manpower during the conversion time to develop such control applications. This disqualifies all home-made and freeware solutions. In addition the application of EPICS was not possible due to the non-availability of redundant system components.

After the move of the long shutdown from November 1999 to May 2000 because of internal reasons, we redated the running D/3-system in a 4-weeks shutdown to 1995 to bridge over the first months of the year 2000. There was no other chance to avoid this risk.

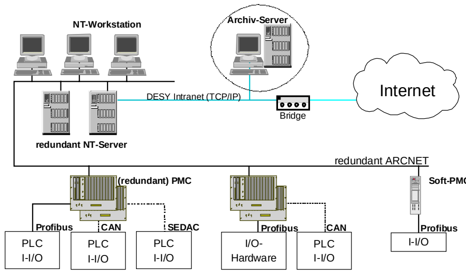
Based on this situation and all the information we decided in spring 1999 to conduct an invitation to bid based on a specification written according to our requirements and constraints and with regard to our brief market survey and to our product evaluation phase. This specification describes a DCS-system with horizontal and vertical consistency of the engineering tools and system configurations. The restricted tendering procedure consists of two phases, the public application for the tendering, and the tendering itself. In total 24 companies have applied for the tendering. Due to our evaluation we have chosen 9 companies for the tendering. We have received 7 offers and analyzed them with regard to the specification and due to their relation between cost and functionality.

Picture 2 shows different products arranged according the SCADA/DCS (supervisory control and data acquisition). architecture and according their openness. Except the D/3-V5 system (P2, the actual cryogenic control system) all the products were offered due to the tendering process. With regard to the restricted tendering procedure it is not allowed to publish the names of the products except the name of the chosen product Cube form ORSI (P6). As you can see the Cube system offers the best openess for integration and a good DCS-functionality. Moreover this product has a very flexible structure for the use in totally different applications. The difference in the investment between the ORSI solution and the specialized DCS-system P1 was really remarkable.



5 THE SELECTED CRYOGENIC CONTROL SYSTEM

The selected system is Cube 3.01 from ORSI offering the most economic solution based on our specification.
It is a system with nearly total DCS-functionality. The only lack will be the flat namespace, but the Cube tools provide an object oriented view. In addition to the DCS-functionality the system supports many PLC-systems (i.e. Allen Bradley, Siemens) as a SCADA system. This extends the area of application of the system for future requirements. In addition the system contains a soft-PLC to increase the area of application further. The request for flexible integration facilities is met by the existence of OPC and ActiveX-functionality based on the COM/DCOM protocol. At DESY this should be the interface to the ACOP and TINE-based protocol layer used for the interfacing between the multitude of DESY control systems [1]. In addition an OPC client is available, the OPC server is not yet released but it should be available up to November this year. The importance of OPC for connection of control applications is growing up more and more. There are performance measurements proving the suitability of this standard for process controls [2]. OPC will play an important part for future control systems.
All the configuration of logic, continuous control and sequences is done by IEC1131-based engineering tools. The employment of the IEC1131 development simplifies the handling and the maintenance. Simultaneously there is an overall documentation available which is one key requirement for quality assurance. Cube supports Profibus-DP and –FMS as a fieldbus standard. In the contract we have agreed on the full support of SEDAC and CAN (CAL/CMS, polling, event) fieldbusses which is a very important aspect of using the system in future on the DESY site. This was one of our base constraints to reach an integrated system for the HERA cryogenics. In addition the system offers lots of modules for supplementary functions, like MESAD for maintenance management and MES-applications (manufactoring execution systems).



In picture 3 the system design for the DESY cryogenic control application is shown in principle. The layout consists of NT-workstations as the HMI, redundant servers (NT-based) for the historical data, the alarm data, etc., and the process computers, called PMC (programmable multifunction controller). All these components are connected by a redundant ARCNET network. The PMC form the interface to the process either via I/O-hardware or via fieldbus connections. As you can see we will use the three types of fieldbusses (Profibus, CAN, SEDAC) and mixed configurations with I/O-hardware and fieldbusses. The use of a Cube soft-PMC (soft-PLC) is planned for an experimental installation.
The connection to the DESY Intranet is done by the redundant Cube servers. We are thinking about the configuration for the long-term archiving of more than 1 year e.g. by an ORACLE database depicted as the Archiv-Server.

6 CONCLUSION AND FURTHER WORK

The HERA cryogenic control has to be updated related to problems in software and hardware of the old system. After an intensive product evaluation we decided for the Cube system form ORSI as the most economic solution with regard to our specification describing a DCS-system. Since September 1999 the engineering process has started to convert the existing HERA cryogenic control system and to implement the new installations.
In the next month ORSI has to engineer all details according the specifications. In addition the CAN and SEDAC software and the SEDAC hardware has to be developed and tested. In spring 2000 we will conduct with ORSI the FAT and the SAT (factory/site acceptance test). In parallel all required preparations have to be completed to start with the commencement of operation during the shutdown starting in May 2000.

REFERENCES

[1] Phil Duval, "The TINE Users Manual", DESY internal document.
[2] DCOM, OPC and Performance Issues Al Chisholm, Intellution Inc 2/ 3/ 98