

HEAVY ION CANCER THERAPY @ GSI SLOW CONTROL AND ONLINE MONITORING

H. Brand, H.G. Essel, H. Hardel, J. Hoffmann, N. Kurz, W. Ott, K. Poppensieker, M. Richter, J. Yang, GSI, Darmstadt, Germany

Abstract

The software control system for the therapy treatment consists of three parts. The operator interface based on FactoryLink ECS¹ used as colourgraphic system, the Frontend-Daemon [1] controlling the hardware and the Therapy Online Monitor TOM. The treatment facility is designed to be operated by a medical assistant.

FactoryLink ECS is used to provide a graphical user interface to the operator, to survey alarm conditions and to provide access to a relational database.

The Frontend-Daemon provides an object oriented access to the distributed control hardware. Long lasting commands and the readout are implemented as POSIX-Threads.

The Therapy Online Monitor TOM displays the requested and measured data, positions and particle integrals point by point, in realtime on a second screen.

Fourtyeight patients were successfully treated with this system at GSI since December 1997.

1 SOFTWARE AND OPERATING SYSTEM

Figure 1 shows on the left side the GUI and on the right side the frontend system connected by RPC² channels.

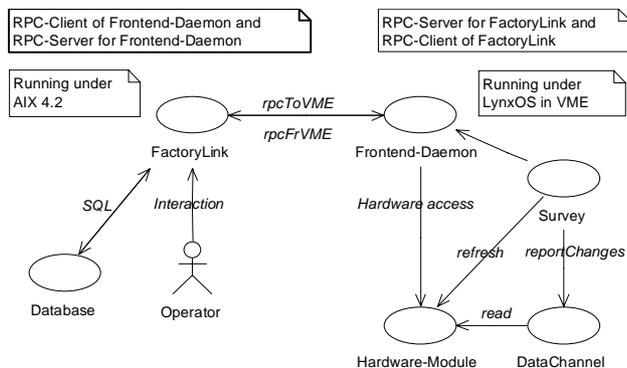


Figure 1: Client-server control system structure

The operator interface based on FactoryLink ECS runs on an IBM RISC-workstation under AIX 4.2. The Frontend-Daemon, build from an extended C++ class

library, runs on an Eltec E7 processor in the VME control crate under Lynx 2.2.

2 FRONTEND SYSTEM

2.1 Class hierachy

The daemon is designed as an RPC-server to configure and to access the associated hardware. Each hardware module is represented by an instance of a class which models its characteristics. Different channels in a single module, e.g. *HVModule* are similarly represented by *HVChannel* objects as shown in figure 2.

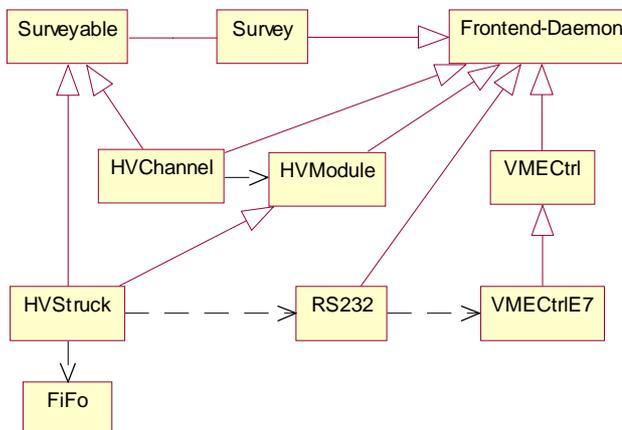


Figure 2: UML³ Class Diagram for High Voltage System

2.1 Configuration

The configuration for all objects is defined in an ASCII file of following format: Classname Objectname [Parameter].

- This file is read during startup or on request and all defined objects are instantiated.
- Then all objects are requested to read their own parameter from the file.
- Then all objects are requested to initialize themselves including their associated hardware.

2.2 RPC Execution

There are two methods to execute remote procedure calls:

- Actions, like VME operations which needs only little time are executed immediately.

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² Remote Procedure Call

³ Unified Modeling Language

- Actions, like changing the high voltage of modules connected via RS232, which need long time are executed asynchronously. The RPC returns immediately. The alarm handler of the supervising software will then be informed directly in case of an error.

2.3 Survey

Several *Survey* objects, implemented as POSIX-Threads, are configured as RPC-clients of FactoryLink. They request the associated *module* objects, i.e. HVModule, to refresh their information about the state of the hardware and the *DataChannel* objects, i.e. HVChannel, to report only changes to FactoryLink which exceed configured limits. Data is converted to physical units where necessary.

3 OPERATING INTERFACE

3.1 FactoryLink

FactoryLink is a collection of asynchronously working tasks connected through the Real Time Data Bus (RTDB), which is shared memory accessible through the FactoryLink kernel (see Figure 3). The activities are data but not event driven. Commands are sent to the Frontend-Daemon via the FLout task. Data is received from the daemon via the FLin task. Alarms and trending data like pressure, temperature and voltages of the ionisation chambers, are stored to a database via the Historian task. The contents of the databases are displayed on operator request.

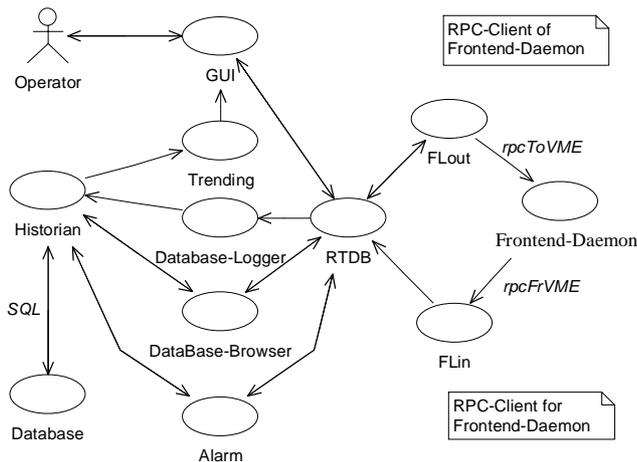


Figure 3: FactoryLink structure

3.2 Graphical User Interface

The graphical user interface consists of two main windows.

- The "Information"-window in the upper part of Figure 4 provides an efficient general overview over the system, i.e. accelerator, scanner magnets,

ionisation chambers, gas-system, PET-camera, patients couch, electronics and network. Components in active alarm conditions are marked with red colour.

- Detailed informations, database contents, logfiles and descriptive alarm messages are displayed in the „Operating“-window on request in the lower part of Figure 4.

Four levels of access control are implemented:

- Everyone is allowed only to view all informations.
- Operators are allowed to operate the system.
- Engineers are permitted to change setup parameter.
- The Supervisor has full control.

4 TREATMENT PROCEDURE

After system startup and test the engineer releases control to the operator, medical physicists and medical assistance.

The medical physicists performs the daily tests, interlock tests and dose calibration, in the morning and treatment plan verification at least once before the patient is treated for the first time and when ever necessary.

The medical assistance performs the patient treatment. A treatment plan is identified by a unique combination of name, date and patients barcode. The current plan is selected from a list of valid plans for the current patient. and it is then downloaded automatically. When the patient is lying on the couch, figure 6, and the position is verified using x-rays the treatment is started. The start procedure checks for data consistency and active alarms and releases control to the interlock system if everything is ok. The progress of the treatment is shown in the „Operating“-window and in the TOM display, figure 5, on a second screen. After treatment is finished or in case of an interlock the measured data is stored on disk and the last treatment point is modified in the current plan as default for the starting point when treatment is continued.

REFERENCES

- [1] H. Butler, D.R. Myers, W. von Rden and J. Yang, "Beamline Operation using an Industrial Control System and Distributed Object-Oriented Hardware Access", IEEE Trans. on Nucl. Sc., Vol. 41, No. 1, February 1994.
- [2] H. Brand, H.G . Essel, H. Hardel, J.Hoffmann, N. Kurz, W. Ott, M.Richter, "Therapy Slow Control System, Data Analysis and Online Monitoring ", GSI Scientific Report 1997
- [3] E. Badura et al., "Control System for Cancer Therapy with a Heavy Ion Beam at GSI", to be published in IEEE Trans on NP 1999

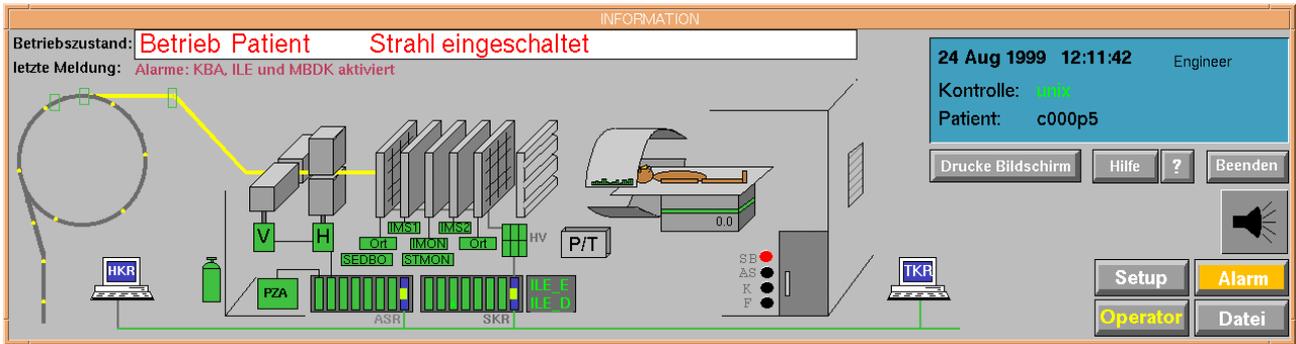


Figure 4: Graphical User Interface

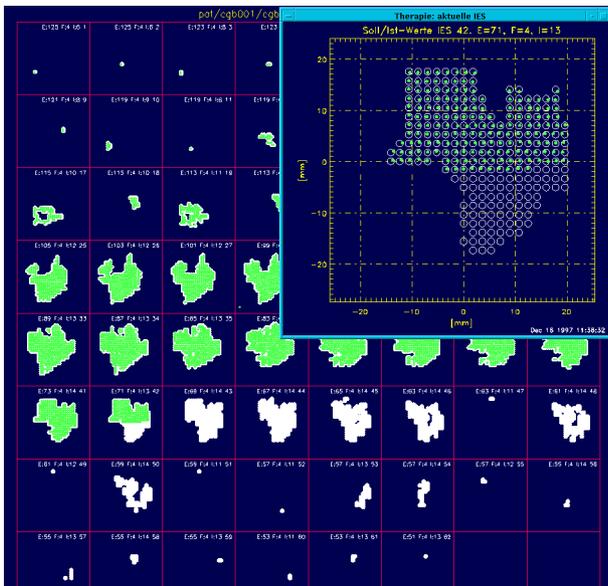


Figure 5: TOM Online Monitor Display

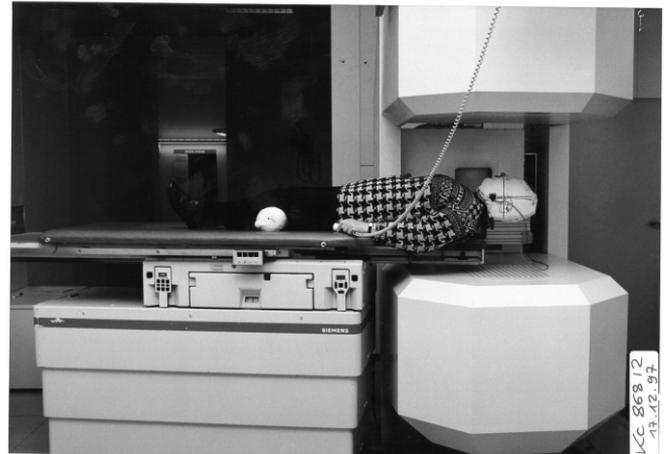


Figure 6: Patient on Couch.