RADIATION MONITORING SYSTEM FOR ELECTRON ACCELERATORS AT ATOMINSTITUTE VIENNA

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INTRODUCTION

The Atominstitute Vienna has two Van de Graaff accelerators installed, with a maximum voltage of 2 MV and 400 kV respectively. Both accelerators are used only in electron mode, therefore the affect of X-rays produced by the electron beam on adjacent rooms and the operators area has to be monitored and limited. This is of great importance all the more than both accelerators are installed in rather normal laboratory rooms in the basement of the building. There is no special shelter as it is usual for such radiation facilities. To determine the maximum permissible beam current and/or to prescribe restricions in adjecent rooms hitherto it was necessery to make tedious measurements of the dose rate in areas affected by radiation from the accelerator. Whereas the dose rate at the workplace of the operator and the experimental area was monitored continuos, there was no possibility to do this for the neighbouring rooms, especially above the accelerator. It was in the responsibility of the operator to operate the accelerator within prescribed limits. For the 2 MV accelerator, when operated with external beam, the dose rate due to scattered electrons had to bee considered too.

As the accelerator area must not been accessed during operation, an interlock system with redundancy 2 and video monitoring of the area is provided. This is not described in detail here.

By official order it was neccessary to update the complete monitoring system for both accelerators. This system is nearly identical for both accelerators (no electron doserate to consider for 400 KV because of distance) and is described in brief for the 2 MV accelerator. In a second step of the project it is planned to use the acquired parameters of the accelerator system for automatic operation of the accelerator.

REQUIREMENTS and DRAFT

The absolute dose rate limit by official order was fixed to 25 μSv/h for all locations in the vicinity of the accelerator area. The first step was to find out the critical locations to decide how many detectors are required and where they have to be positioned.

In the operator area the maximum dose rate occurs at the barrier between accelerator area and operator area. This position requires 3 detectors. One is a filtered GM-detector for the X-ray doserate, the others are identical proportional ß-detectors with thin entrance windows, but one of them with a ß-absorber of perspex and therefor sensitive only for X-rays. The difference of the proportional detectors is a good measure for the electron dose rate. By comparison of the three detectors malfunctions can be detected. The reading of the proportional detector should not be lower then that of the unfiltered one. The reading of the filtered one should be equal to that of the GM-detector. A function test by natural radiation is self evident.

The maximum dose rate in adjacent rooms is found above the accelerator, at a position depending on the experimental arrangement. Extensive investigations for different cases showed that the position on the ceiling of the accelerator area exactly above the standard position of the X-ray target (gold) is a sufficient worst case approximation for all arrangements used and all electron energies from 0.5 to 2.2 MeV. As there is no practical possibility to locate detectors on the floor of the room above (this is the experimental area of the research reactor Triga Mark II) it was decided to mount a GM-detector at this position on the ceiling. To get a measure for the dose rate on the floor above the GM-detector is mounted inside a filter of lead and aluminium which simulates the absorption of the ceiling. This method would work perfect for a concrete filter but lack of space prevented this. Therefor a correction with an experimental determined function depending on the voltage of the accelerator is necessary.

Beside the accelerator voltage it is neccessary at least for plausibility tests to acquire the beam current. For external beam this may be difficult or impossible in a direct way. Acquiring all partial currents in the accelerator allows by balance-sheet of this currents to get the beam current without direct measurement. Considering the planned second step of the project it is useful to acquire all data which are normally displayed on the control panel and all logical states of switches and relays. This allows the simulation of the control panel on the computer screen.

The data acquisition applays therefore to several analog and digital signals as inputs. The only output at present is a failsafe logical output to shut down the accelerator. When acquiring data one has to keep in mind the possibility of transient signals everywhere in the accelerator wiring. They occure during voltage break downs in the accelerator tube or tank. Isolating amplifiers and isolating logical modules are therefor a must for each signal line. Data acquisition and evaluation is done on an intelligent board independent of the host computer which is free for other jobs such as operating the accelerator as planned for the future. Beside the main task of the program that is monitoring the radioation levels, giving warnings or shutting down the accelerator there are also a lot of routines watching the technical status of the accelerator and giving hints to the technical service personal.

OPERATION

Switching on the main power switch of the accelerator powers the computer. When ready the program ACMOS (ACcelerator MOnitoring System)is loaded from the disk and starts with a selftest. After a detector test with background radiation a login screen is displayed and a floppy disk is requested for the logfile and a log file on the disk is created and/or opened if it exists already for this day. Each day has its logfile which is stored on the disk. When starting the system another day the logfile is transfered to floppy disk. The login requires a password which is given by the master user which decides also the different permissions connected to this password (external beam, warning light in the accelerator area off, part of the interlock system off for service purposes, etc.). Only the master user can alter the warning and shut off levels, the permissions and several calibration factors. When a key switch on the operating panel is activated the power up procedure of the accelerator is continued via the computer and the actual status is stored in the log file and also printed. The computer screen shows all the acquired data after some averaging. The actual dose rate for display is measured in time preset mode with sliding averaging, whereas for limit evaluation and for the logfile this is done in preset count mode to speed up the response. Each time any of the acquired data differs significant from that of the last entry in the log file a new actual data set of all operating parameters and acquired data is added to the log file. If necessary this entry contains also messages for the technical service personal or the reason for shut down if this happened. This messages are always displayed on the screen and printed. Depending on the relevance some messages on the screen are accompanied by an acoustic signal and some messages have to be quit by the operator.

Shut down can be initiated by the operator, by a limit condition or if a fatal error in the system is detected. It causes another entry in the log file and closes it. When the shut down is caused by main power off the computer power is switched off with time delay to allow correct saving of the log file. The operation of the computer is monitored by a watchdog system which also causes a shutdown in the case of a hangup of the program.

The system is in use with only minor modifications since January 1996.