THE VIVITRON PROCESS CONTROL

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ABSTRACT

The VIVITRON, a 35 MV electrostatic accelerator in construction at the CRN since 1985, needs a dedicated process control system. The Vivitron structure, with seven porticos (large field-shaping shields) in the tank and sophisticated beam handling in the terminal, requires control equipment inside the tank under extremely severe conditions. The study and design of the control system started in 1987. Several steps are necessary to achieve the full control system. The first step, concerning the generator tests, starts now. The present temporary control set up is described.

1. THE SPECIFIC PROBLEMS OF THE CONTROL

The Vivitron is a Van de Graaff tandem accelerator, under constru tion at the Centre de Recherches Nucléaires at Strasbourg, France [1], [2]. Unlike in most other machines, more than half of the 1000 process parameters are located in the accelerator tank at DC voltage levels between 0 and 35 MV, and in the injector [3].

These parameters have to be controlled by equipment which is highly stressed by its physical environment. The problem of protecting electronic devices against the surrounding stress inside an accelerating vessel is difficult. The design of these device protections should achieve EMC (electromagnetic compatibility) in order to avoid equipment damage during 35 MV breakdown flashes with an energy of up to 440 kJ. Moreover, the equipment and the data links will be stressed by the electrostatic field (1.7 to 10 MV/m), the X-rays, the vacuum, and the SF6 gas pressure of up to 11 bar.

2. THE FULL SIZE ARCHITECTURE

A multi-level structure (Fig. 1), based on optical LANs, will be implemented in order to achieve the throughput, the loop time delay, the topology and the operator interface. The first step layout appears on Fig. 2. The different levels of the system [6] are :

Level 3 crates are in charge of the field equipment I/O interfaces, the handling, switching and buffering of the I/O data and the low speed communication interface and protocol. All these field equipment crates are star connected to level 2 concentrators by means of plastic optical fibre links which enable data transmission over an electrical field of 2 MV/m.

Level 2 concentrators provide low speed communication with level 3, computing power and high speed communication with level 1 by means of a LAN.

Level 1 includes the operator interface, the LAN interface, the real time process controller handling the mass storage and the data base. These components are not completely defined yet but will be based on a classical workstation cluster.

As the behavior of this new process is not well-known, no automation is required for the first step. The operator interface and the data switching will be dominant. Later, processing power will grow from level 1 to levels 2 and 3.

3. THE TEST OF THE VOLTAGE GENERATOR

The most important measurement for this first step is the terminal voltage. The GVM (Generating Volt Meter) which register the electric field along the tank in a standard electrostatic accelerator may be disturbed in the Vivitron where the internal electrode structure obscures the field.

Therefore, the terminal voltage is given by the sum of all the inter-electrode voltages. The only way to determine the terminal voltage is to measure the current along the calibrated resistor chains in each section. We developed a powerless floating current measurement device for the Vivitron (Fig. 4), starting from an original Munich design [4]. The information is fed to the outside ground level by a plastic optical fibre. The measurement range extends from 1 μA to 1 mA with an accuracy of about ±1%.

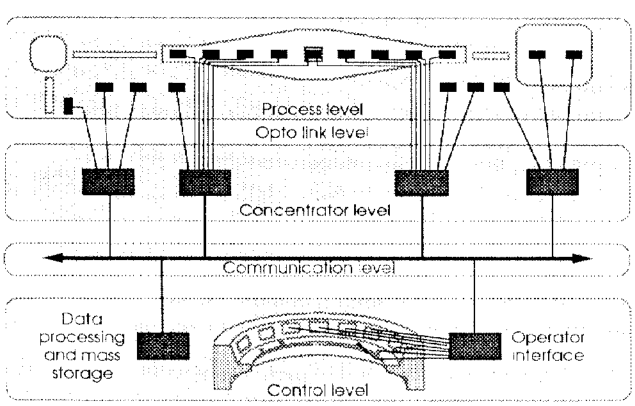

Fig.1 Full size architecture

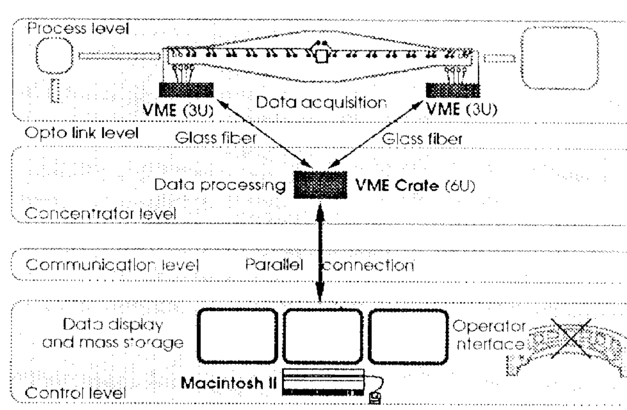

Fig.2 Architecture Step 1

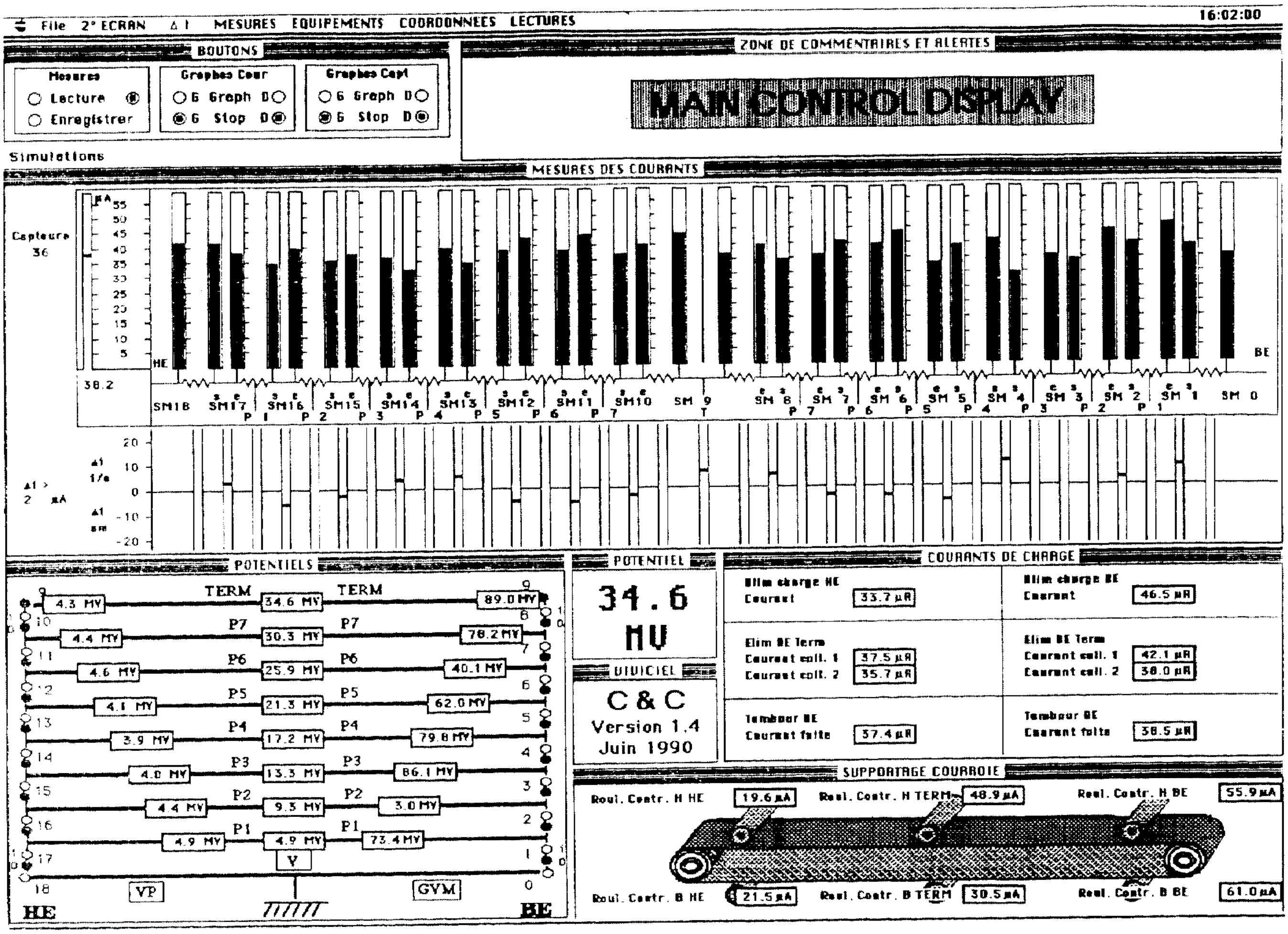

Fig.3 The operator control display in the first step

For the first step, we locate no crate inside the tank. Data acquisition and control is achieved by two level 3 diskless 3U VME crates, one at each end of the machine. They are equipped with opto-isolated TTL I/O, 12 bits analog I/O, and timer /sequencer I/O boards. They communicate with level 2 by two serial opto links.

Level 2 consists of a 6U VME crate with hard disk. This concentrator is in charge of the downloading of the level 3 crates, and the message switching. As the control of these tests is made near the accelerator, communication between level 2 and level 1 is made by a NuBUS - VME Micron parallel interface.

Level 1 is a Macintosh II which provides process control and operator interface with multi-screen display (Fig. 3). It runs under MacOS.

The VME crates all run under OS9 real-time operating system for this first step. Communication between the two operating systems is achieved via a mailbox (shared memory), located in the VME concentrator.

4. CONCLUSION

The control system of the Vivitron has some special aspects. One of these concerns the high physical stress applied to the equipment inside the accelerating tank which requires specific developments. Good experience has been gained in this field with the MP tests [5]. In order to start the voltage tests of the Vivitron, temporary control equipment has been installed around the machine. This equipment is made according to the principles that will be used for the full control system with parts and modules of the final crates and communication links.

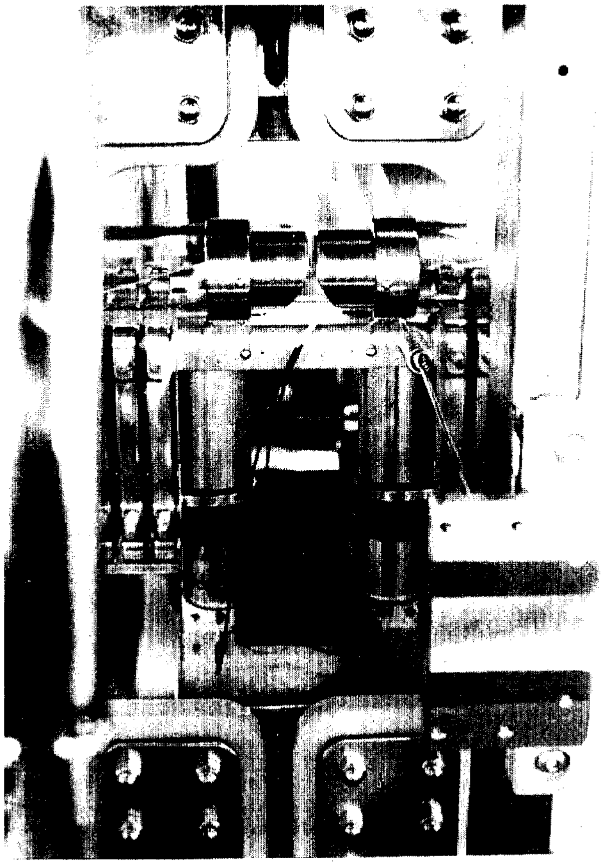

Fig.4 The current measurement in a dead section

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