# ALADDIN LIGHT SOURCE CONTROL SYSTEM IMPROVEMENTS

**John P. Stott and David E. Eisert**
Synchrotron Radiation Center, University of Wisconsin-Madison
3731 Schneider Drive, Stoughton, Wisconsin 53589-3097, U.S.A.

## Abstract

The improvement plan[1] is now being implemented, with modifications to reflect:

- the requirement for regular operation of the ring as a user facility
- no major shutdowns planned for some time
- our experience with an Ethernet local area network (LAN)
- further thoughts about the LAN requirements for a storage ring control system

The original Multibus microcomputers have been replaced by VMEbus based 68000 systems, with VMEbus to Multibus adapters being used to permit the temporary use of the original device i/o interfaces until new hardware is installed. The new microcomputers are linked directly to the facility-wide Ethernet, eliminating the need for a gateway or additional interface hardware on the VAX main computers, however the control system packets must now share the LAN with DecNet, LAT and TCP/IP packets from many other nodes. The existing console terminals are being retained for the present, but both are now being run by a dedicated MicroVax II. The reasons for these choices, experience with introducing them at an operational facility and our plans for the future will be discussed. The integration of undulator and beamline front-end control into the system[2] is also discussed.

## Introduction

The original Aladdin control system[3] was developed in the late 1970s, based on a system used at Fermilab. It reflected the 'small' size of the machine and the current technology. Aging of the system, advances in technology and increased performance requirements led to a proposal for the upgrading of the system[1] as part of a general rebuilding of the facility. This project, which was intended to solve major problems with the storage ring, was not funded but, since most of the other problems were solved anyway, the need to improve the control system still exists. The previous proposal has been modified both because the facility must remain operational throughout and as a result of further thought about our needs.

## System Overview

The major components of the system, shown in Figure 1, are described in the following sections.

### Local Area Network

The original system used hardwired parallel data links between the single main computer and the three microcomputers. These links were unreliable, because of the large number of individual high-speed lines, and inflexible, since they only provided access for one main computer. The development of low-cost network interfaces made a Local Area Network (LAN) a much better choice for the new system. The proposal was to use an Arcnet LAN to link the microcomputers through a gateway to an Ethernet LAN

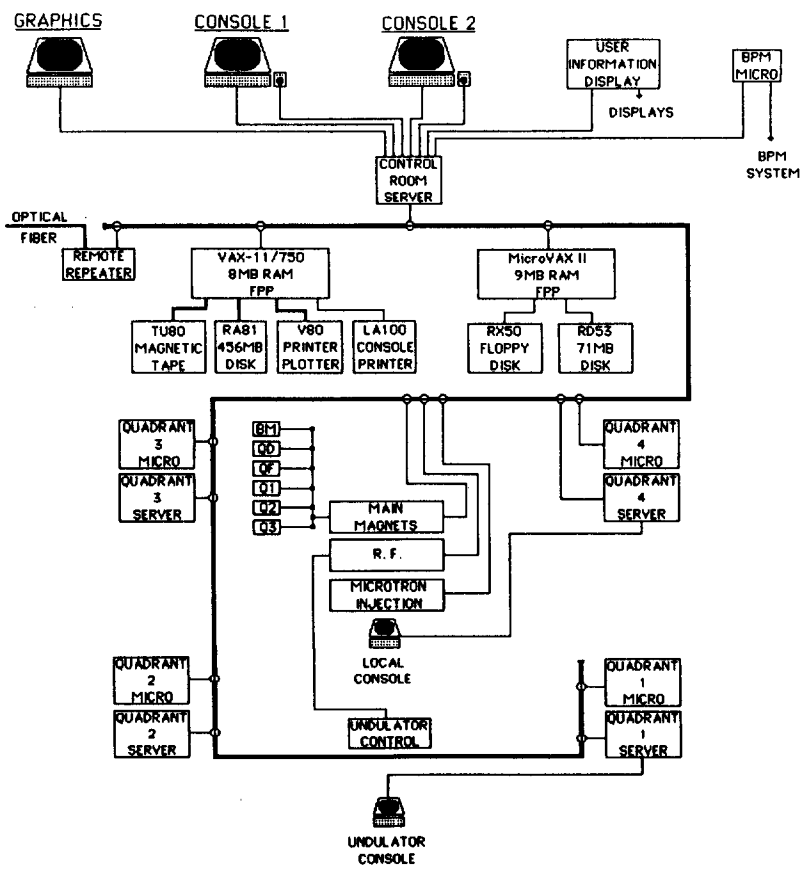


**Figure 1: Aladdin Control System Schematic**

which linked the main computers. Arcnet is a well-established, simple, cheap, token-bus network and very well suited to this application. However, the need for a gateway and the lack, until very recently, of commercial interface modules for our systems were points against it. The decision was therefore made to use Ethernet throughout:

- the performance of Ethernet is quite adequate for our needs. The system can be structured so that the lack of determinacy is not important and the Ethernet can be segmented so that traffic levels are not excessive.
- a simple VMEbus-Ethernet interface is available at moderate cost.
- it is more convenient and cheaper not to have an Ethernet-Arcnet gateway.

Installation of the network was simplified because the Ethernet cable was already in place around the ring to provide service to beamline users and the VAXes already had Ethernet interfaces. The VMS software driver for the Ethernet interface is standard and permits control programs, Decnet and LAT to share the same interface. We have not observed any significant performance limitations, but an additional interface can be used if we run into them.

The Ethernet uses standard coaxial cabling within the main SRC building. It is linked to two adjacent buildings by fiber optic segments using DEC remote repeaters (one of which is shown in Fig. 1). The LAN in the adjacent Physical Sciences Laboratory (PSL) is then linked to the main campus through a 30 km Wisconsin Bell fiber optic cable using multiplexers developed by PSL. The LAN is carried around the campus on a broadband cable and is linked to internal LANs in several buildings through DEC bridges. The store-and-forward capability of the bridges, coupled with the error recovery methods implemented in Decnet, TCP/IP, LAT and other protocols allows one logical Ethernet segment to greatly exceed the Ethernet physical segment limits. The traffic filtering performed by the bridges keeps the traffic on the broadband backbone to tolerable levels.

We plan to install a bridge between the SRC Ethernet and the extended Ethernet in order to limit the extraneous traffic. The bridge will also allow us to restrict access to the control system micros so that off-site nodes will have to connect via controlled accounts on the SRC VAXes. The advantages of a single integrated LAN, which allows our local users easy connections between beamlines and campus laboratories, will be retained. A HEPnet router and a Bitnet gateway on the extended Ethernet provide similar capabilities for most outside users.

## Computer Room

The control system uses two main computers at present, a VAX 750 and a MicroVAX II. The 750 is used for data logging and as a backup for the MicroVAX. It is mainly used for word processing, programming and calculations. The MicroVAX runs the operator consoles. The computer room also contains a 32 port terminal server, which provides access for SRC staff terminals and other computers to the VAXes, using the LAT protocol on Ethernet. Two LN03 laser printers are also connected to the server and can be accessed from any computer on the network.

## Control Room

The control room contains the following equipment:

- Terminal Server – a Decserver 100 provides eight RS232 ports to connect equipment in the control room to the appropriate computer
- Operator Consoles

  **Display** – a 512 x 512 x 8 color text/graphics display

  **Keyboard** – used for command and data input

  **Trackball** – used for cursor and analog device control, three buttons may also be used for commands

  **Oscilloscopes** – several oscilloscopes with various capabilities are used to observe signals from the machine.

  **Spectrum Analyser** – used with a tracking oscillator to observe the tune signals from the beam in the storage ring.
- BPM Micro – a Micro/PDP-11 used to operate the electrical beam position monitor system and return readings to the VAX through the terminal server.
- Graphics Display – identical to the console displays, used for displaying graphical data for the operators.
- User Display – a simple terminal with video output, used to drive the displays which provide ring status information and messages to the users.

## Microcomputers

Figure 2 shows a schematic of a typical microcomputer, the components are:

**Backplane** – the VMEbus is used for the backplane

**Processor** – single board computers with 12.5MHz 68000 microprocessors, up to 512kB of mixed RAM, NVRAM, EEPROM and EPROM, two RS232 serial ports and 16 parallel i/o lines.

**Network** – an Ethernet interface with 512kB of dynamic RAM and a LANCE network interface

**Control** - 32 line optically isolated digital output for digital control

**Status** – 32 line optically isolated digital input for status readbacks

**D/A** – 8 or 16 channel analog outputs with 12 bit resolution

**A/D** – 32 channel differential analog inputs with programmable gain and 12 bit resolution

**Breakout Box** – this is a patch panel which provides the interconnections between the cables from the computer interfaces, each of which provides many channels with one function, and the equipment, which requires several channels with a mixture of functions

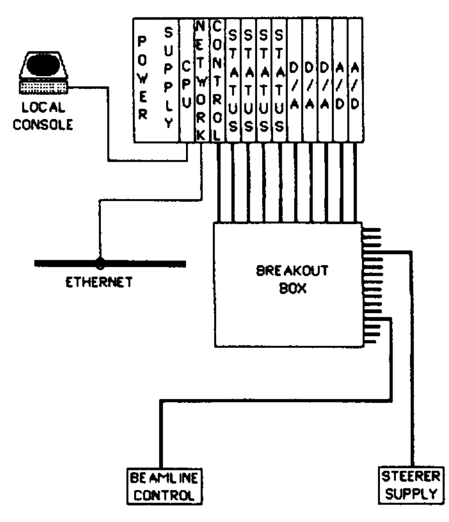


Figure 2: Control System Microcomputer

**Terminal** – local console functions are available on a terminal connected directly to the processor

The three new microcomputers which replace the original micros ('Main Magnets', 'R.F.' and 'Microtron/Injection' in Fig. 1) are equipped with VMEbus-Multibus interfaces (not shown) which allow them to control the existing Multibus i/o modules. This has allowed us to improve performance and reliability by replacing the old CPU modules and data links immediately without changing the i/o wiring. It also means that the old Multibus i/o modules can be replaced by VMEbus modules gradually, without any major downtime.

The quadrant microcomputers handle the user beamline interfaces described later, storage ring vacuum monitoring and the corrector magnet power supplies.

## Power Supply Controllers

Controllers are being developed for the main magnet power supplies. These microprocessor based controllers will be built into the power supplies and linked to the main magnet control microcomputer by a multi-drop serial data link. They are shown in Fig. 1 as BM and QD .... There are two changes from the previous proposal. Firstly, the controllers will be intelligent and will be able to ramp the power supply automatically when instructed to do so, as well as providing the standard setting and reading capabilities. Secondly, a multidrop RS232 data link will be used in place of MIL1553. The use of intelligent controllers reduces the performance requirements for the data link, since a broadcast 'start ramp' command replaces writing individual data points, and an RS232 port is a standard feature of the cpu boards. A second RS232 port can be used to provide local control of each individual power supply. The analog input and output sections of the controllers will be optically isolated from the digital sections to minimise noise, consistent with the 14-16 bit resolution required, and to accomodate floating power supply regulators.

**Backplane** – the computer section uses the VMEbus backplane with slots for single height modules.

**Processor** – 10MHz 68000 microprocessor, 64kB of RAM and 64kB of EPROM and two RS232 serial ports for local console and multi-drop data link.

**I/O** – two 16 bit parallel buffered i/o ports with handshaking are provided to connect the analog interfaces and some status and control lines.

## Quadrant Servers

The quadrant servers are DECserver terminal servers which use the LAT protocol to provide RS232 terminal connections to any VAX on the Ethernet. They are primarily intended to allow beamline users to connect terminals and personal computers but also provide access for local consoles as indicated in Fig. 1.

## Beamline Control

User control of the photon beamline front-ends is a feature of light sources and must be integrated into the control system. The original control system had some limited provision for monitoring and the upgrade proposal included more extensive provisions. These are now better developed, the components involved are (Fig. 3):

**Quadrant Micro** – provides the interface between the control system and the beamline controllers for the three bending magnets in a quadrant of the ring. Monitors beamline pressure and takes protective action if it deteriorates.

**Beamline Controller** – contains the hardware to control the valves and shutters for all three ports on a bending magnet. Provides a junction box for the various components.

**User Panel** – contains the hardware control logic for a beamline, the user operated switches to operate the valves and shutters, status indicators and connectors for user interlocks.

**Front End** – the assembly of valves and shutters between the beamline and the storage ring.

- Photon shutter – a water cooled shutter to absorb the light before it can strike the front-end valve.
- Front-end valve – isolates the beamline from the storage ring.
- Radiation shutter – blocks the aperture in the radiation shielding to absorb high energy radiation when the beamline is not in use.
- Ion Gauge – ensures that the front-end valve is closed if the vacuum in the first part of the beamline is poor.
- Beamline valve – provided on some beamlines to reduce operation of the front-end valve.
- Ion Gauge – ensures that the beamline valve is closed if the vacuum in the second section of the beamline is poor.
- Ion Pumps – the beamline vacuum is maintained by ion pumps and provision for monitoring their currents, as an additional vacuum readback, will be added.

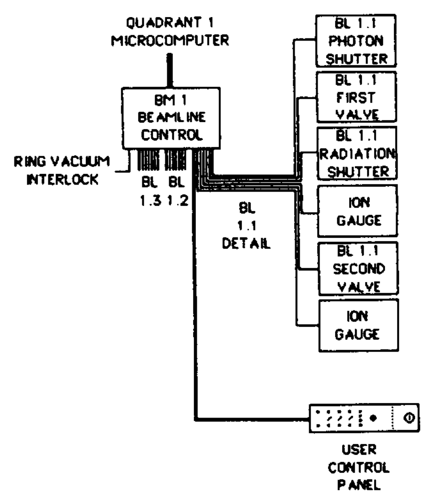


**Figure 3: User Beamline Control**

## Undulator Control

Control of the undulator has been provided by using a single-height VMEbus system to drive the stepping motors and read the shaft encoders. The microcomputer is connected to the 'r.f.' VMEbus system by an RS232 serial link. A local terminal, connected to a terminal server, can be used to control the undulator using the VAX resident software. The undulator can also be controlled from one of the operator consoles in the control room. The undulator beamline is still being planned and details of the monochromator control and user interface have yet to be worked out. Further details of the undulator control are given in another paper at this meeting[4].

## Summary

The present status of the various components and plans for their future improvement are summarised below.

**Consoles** – the original console terminals are still in use and are proving reliable. We hope that the decreasing cost of suitable replacements, such as VAXstations or the Macintosh II, will be matched by the availability of funds in the near future.

**Main Computers** – the VAX-750 has been supplemented by a MicroVAX II which runs both console terminals. This has allowed the 750 to be used for other work and provides on-site redundancy, since the 750 can also run the consoles. The MicroVAX will itself be supplanted by the use of intelligent console terminals.

**Data Links** – the parallel data links have been replaced by Ethernet. This is much more reliable and flexible, since any computer on the Ethernet can now run the ring. Normally, the MicroVAX runs the consoles and the 750 does data logging. The data packet formats used are still those that were used on the old data links, we plan to develop a new, more flexible format (possibly based on MAP).

**Microcomputers** – the Multibus i/o modules are still in use but they are now linked to the VMEbus systems and will gradually be replaced by VMEbus modules. The Multibus cpu, memory and data link modules have all been removed.

**Main Power Supply Control** – the original centralised isolated analog i/o system is still being used. New controllers, which will be built in to the individual power supplies, are being developed and should be ready next Spring.

**Software** – no major software improvements have yet been made, although many minor improvements have resulted in significantly better overall system performance.

**Data Base** – the data base is still resident on the VAX and the proposed distributed structure will be implemented, along with software and data format improvements, when time permits.


## Acknowledgements

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## References


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