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Beam Observation Video Camera System for the P.S. Complex
Status Report

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Introduction

This paper describes the current status of the beam observation cameras installed in the PS complex. Problems related to their reliability and maintenance are discussed. A proposal to consolidate the system including a new camera type and its readout electronics is finally presented with a cost estimate for its implementation.

General

Commonly a beam observation video chain is composed of a screen that produces a light spot when excited by impinging particles. This light is then collected and focused on an imaging device (CCD, Vidicon, silicon-cells, etc) producing an electrical video signal which can be transmitted to a CRT screen in the control room, measuring the X,Y position or / and the intensity of the detected light-spot.
Real applications are often more complicated. A single chain may include more than one screen (up to 12 for the so called "marguerite mechanism"). Screens can be fixed or remotely removable and furthermore a biasing light, which can also be remotely controlled, is used to optimise the image of the light spot on the screen. Thus, a single chain must support all these features (Fig.1).

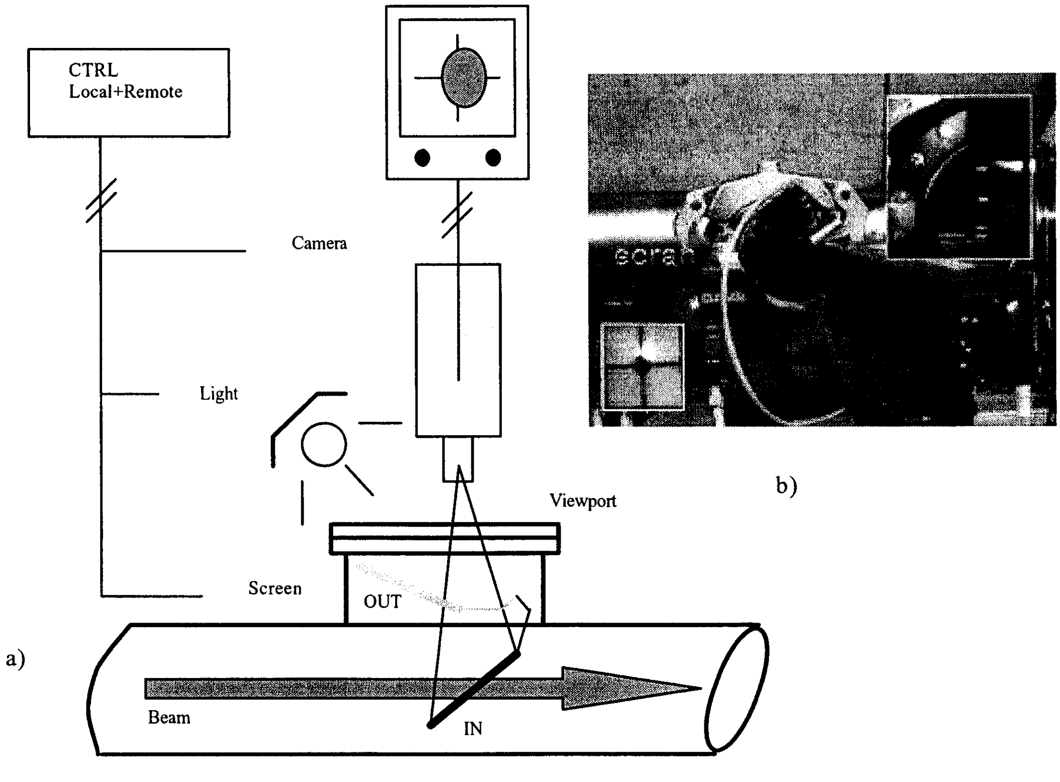

Fig.1 Screen Camera chain a) principle and b) picture.

Historical touch

At the beginning of the PS era, the intensity of the accelerated beam was very low (10^{10}p) compared to now ($3\ 10^{13}$ p), and the electronics for the cameras was designed to be installed directly inside the tunnel. Nevertheless the camera was composed of two blocks; the "head" containing only the Vidicon and the video preamplifier (transistors) was placed near the circulating beam, while the "body" containing all the electronics to drive the whole camera was hidden behind concrete blocks. When the Booster was put into operation and the intensity raised to $>10^{12}$ p the radiation level due to losses became too high to be sustained by the electronics housed in the "body" and also by the transistor pre-amplifier housed in the "head". In 1978 the cameras were redesigned and despite the enormous progress in semiconductor technology, electron tubes (Nuvistors) were chosen as components for the "head" due to their insensitivity to ionising radiation. The electronics still containing semiconductor parts was located outside the accelerator tunnel.

This solution led to the current layout of the camera systems. The inconvenience of this design is the cost of special cabling, the limited distance (80m) between the "body" and the "head" and finally the fact that these cables do not meet the safety rules anymore (<500V on a multi-wire cable).

Actual Status

The PS complex has grown and the number of machines and experimental areas in which cameras are installed is very large: Linac, Booster, PS, AD, CTF3, TT2, TOF, ISOLDE, East Hall and some special applications. That means ~100 camera chains are currently in operation and due to the distance limitation these chains are geographically concentrated in 10 different locations. The concentration stations were installed at different periods in time and have a different layout, which increases the difficulty in repairing and maintaining the system. In 2000 and 2001 an attempt was made to replace the old Vidicon-cameras with modern's CCD where the radiation level seemed acceptable. However only very few locations in our machines have radiation levels low enough such that a CCD can survive for long time. Only 4 CCD cameras are in operation today.

Figure 2 gives an overview of the present layout. We can observe that the system mixes VME with old CAMAC/CIM product. Moreover the camera heads are not all of the same type. The consequence is that in case of failure we are obliged to change both the head and its associated electronics. The same kind of problem occurs for the actuators electronics, which is different for each type of movement. Another point, that is not apparent in the schematic, is the easy way to fully detune the electronics by anyone who can access the front panels. Last but not least, the electronics components used in this design are completely obsolete and cannot be found on the market anymore. In fact the only way to repair defect electronics is to try to find components from another faulty card.

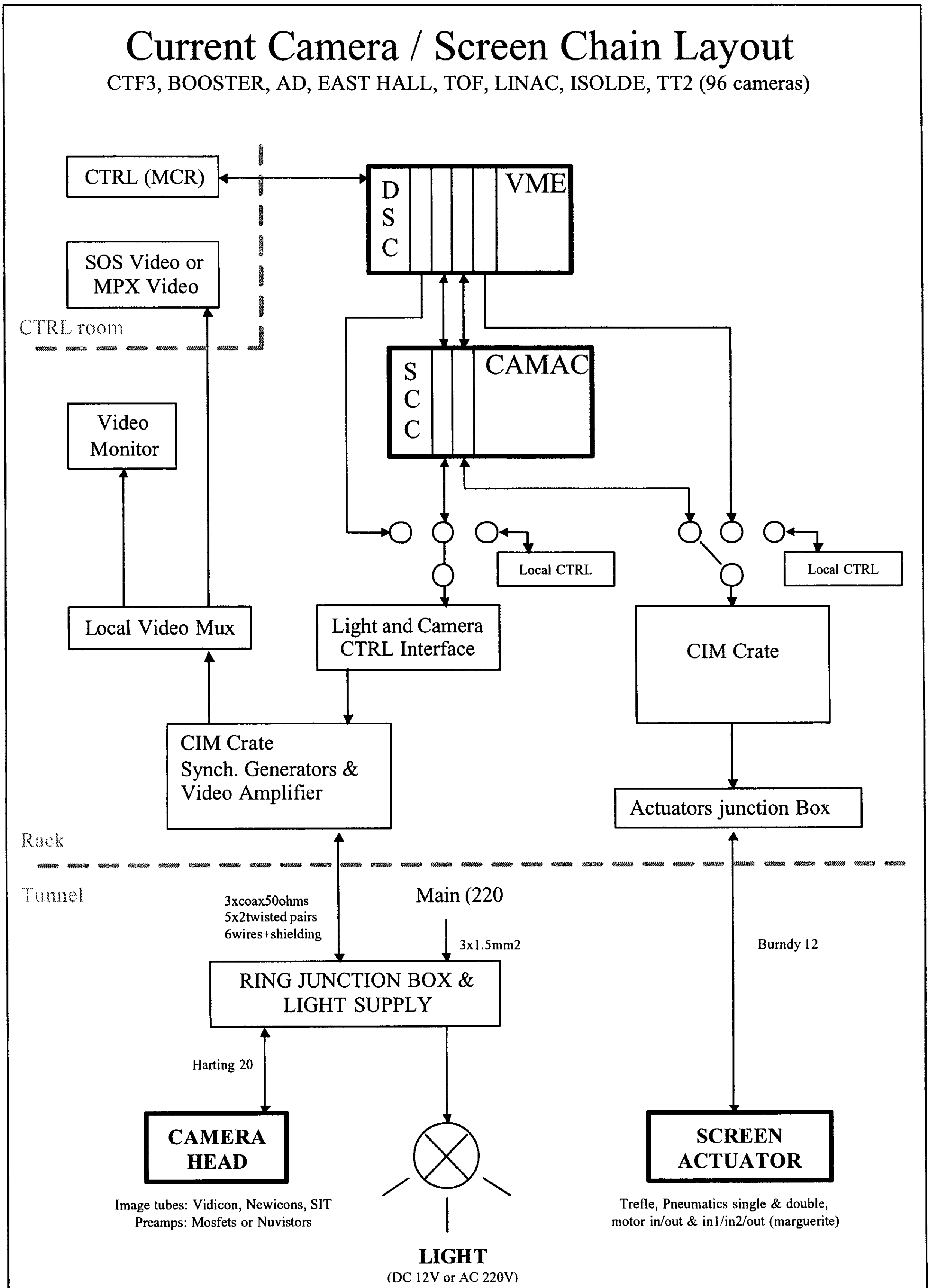

Figure 2: Actual Camera/ screen chain layout

Design considerations for a new TV system

a) minimize the cost; the camera head and the actuators should be kept (with minor modifications) as they are.
b) a major cost factor of the camera chain is the cabling; a new electronics design should re-use existing cables.
c) the type of the installed camera should be standardized in order to simplify the maintenance.
d) a single (VME) unit should supply the control interface for a complete camera / screen chain
e) the modifications should be conceived to work with either the new and the old electronics in order to have the possibility of a gradual implementation.

What has been done?

A new version of the camera head has been developed with radiation-hard components still available on the market. This head is compatible with both the PS and SPS electronics and the mechanisms remain unchanged.

The major enhancements are:

- the capability to transmit the video signal over 1km distance.
- the high voltage needed by the Vidicon is generated locally to meet safety requirements.
- the cabling has been reduced to four twisted pairs instead of 19 wires for the SPS model and a special coax/mixed wires 28 cable for the PS model.
- the cabling and the electronics control compatibility when changing this new radiation-hard head with a commercial CCD (where it is possible) has also been achieved.
- both the new head and the CCD camera can be externally synchronised by a temporal event.

What is going on?

The development of new screen-actuator and light control electronics is almost complete. This new electronics covers all the types of devices in use in our machine (except for the few “marguerites” that would need to much changes).

- Motor-drive IN/OUT
- Pneumatic drive IN/OUT
- 2 positions IN1/IN2/OUT
- 4 positions (Trefle) rotating screens
- Second motor drive for optical filters insertion
- 2 independent current controlled lamped

All these features are obtained with only two twisted pair wires.

What needs to be done

The final VME printed board including all the described features should be designed and produced as well as the printed board for the camera head.

The new VME control/acquisition software interface driver should be specified and written.

The mechanical modifications (even if minor) should be done and documented for the camera head and the actuators.

The IT division and the new AB/CO group should define how to transmit the analogue video signals to the MCR.

Proposal

Having checked the feasibility of the new head and the new actuators/light electronics we are ready to make a proposal for a new compact layout (Fig. 3). Basically this layout combines the SPS development currently under way on camera drive electronics and the new actuator/light electronics in a single VME module. By using the new camera head we can reduce the cabling requirements to only one 6 twisted pairs cable, which already exists in the actual chains (Fig.2 actuators cable). If needed, we can include a video-digitiser in the same module, which has already operated at the SPS for the last 4 years. That will enable profile analysis for each installed camera. As one can see in Fig.3 the way to transmit the analogue video signal from the VME module to the control room is not yet defined but this problem is actually under the investigation of the IT division and the new CO group.

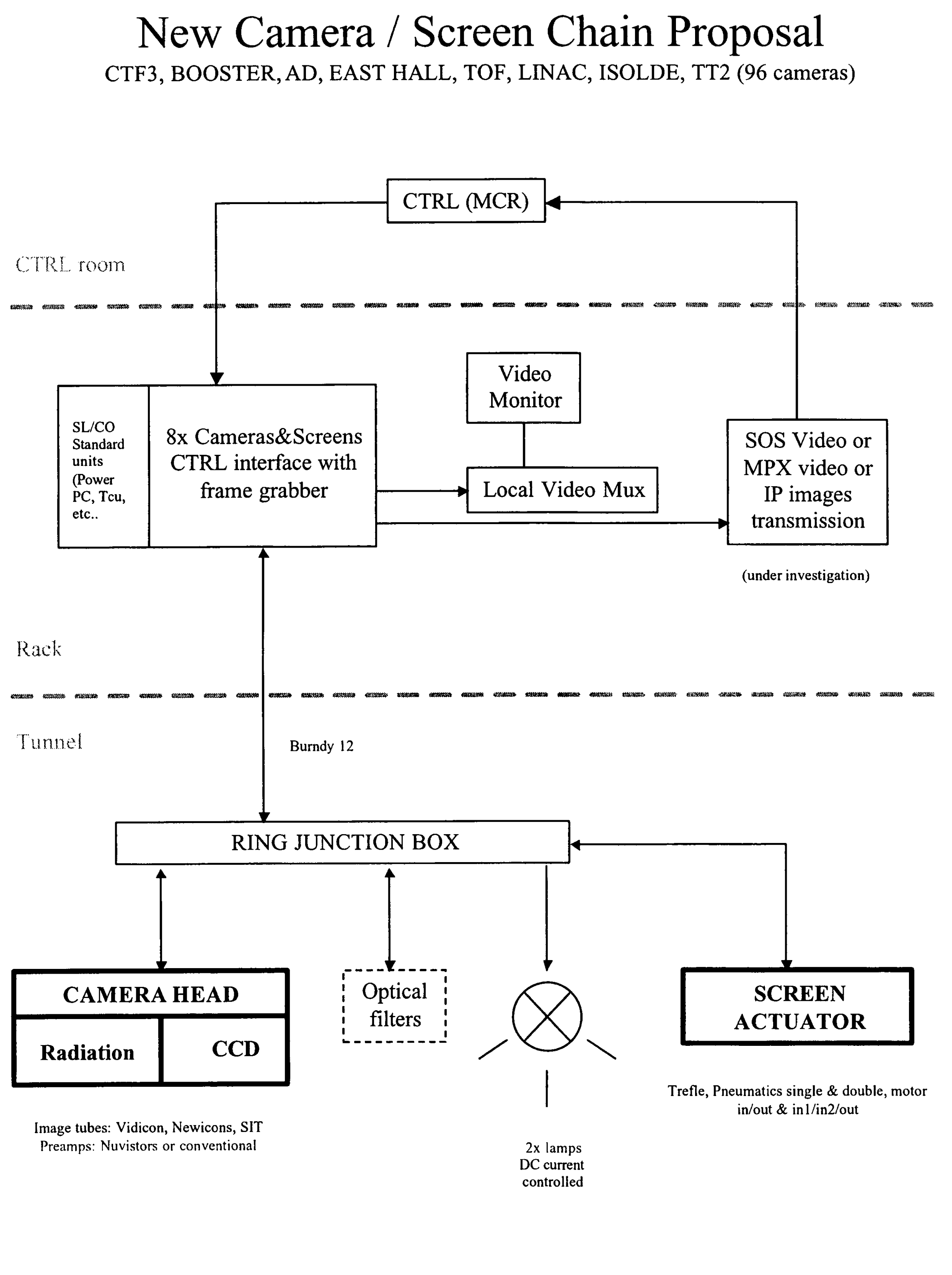

Figure 3: Camera / screen chain layout proposal

The estimated cost

To replace all the actual PS complex camera/actuators chains we need:

13 fully equipped LHC type VME Crates	(20KCHF ea)	260
100 VME camera control cards	(2KCHF ea)	200
100 Modified Head	(1.5KCHF ea)	150
Mechanisms	(various)	50
TOTAL		660 kCHF

Manpower requirements (for the next 4 years)

1 Engineer (electronics/software)	30%
1 Technical Engineer (electronics/electro mechanics)	50%
1 Technician (temporary labour)	50%

This estimation includes the maintenance of the existing system during the same period.

Planning

2002	Final design of VME and Head printed board.
2003	Production of VME modules, test and software application Heads modification and pre-installation in CTF3 & East Hall
2004	Linac & Booster installation, commissioning
2005	PS, TT2, TOF, ISOLDE, AD Installation
2006	Final Commissioning

Conclusions

The current status of the cameras/screens for the PS complex is critical. The MTBF has become too low due to device ageing. The system distribution and its non-standard configuration coupled with the manpower shortage do not enable us to maintain it properly. To improve this situation a strong decision must be taken quickly.
Of course non-negligible cost is involved, but if we want to start the LHC era in good conditions we must pay the price now.