THE USERS PERSPECTIVE (SOME TRUISMS)

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INTRODUCTION

This contribution to the PCaPAC workshop on control systems for particle accelerators is somehow exotic, because it shows the view of control systems from the user's perspective – user, meaning control system user. Since accelerators, control systems and operators are different, it could only be a very subjective perspective. In this case it is the perspective of a person responsible for beam operation and coordination of PETRA II at DESY (Fig. 1-3). This results in a strong focus on controls for accelerator operation compared to special controls for accelerator components and subsystems.

The requirements for control systems depend strongly on the type and operating mode of the accelerator itself. The routine operation of LINACs, fast cycling synchrotrons or synchrotron light sources (especially with topping up injection mode) is running very stably and with minimal input from the operators. At PETRA II the beam operation is dominated by a lot of manual operations and procedures. PETRA II is a slow cycling storage ring, running as a pre-accelerator for HERA (with electrons, positrons and protons) and as a part time synchrotron light source, operated by a part time shift crew. The accelerator control system is based on windows PC's.

Figure 1: The daily perspective: PETRA console in the central DESY machine control room.

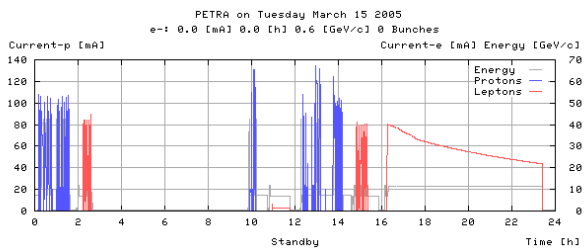

Figure 2: Typical 24h beam intensity history of PETRA operation.

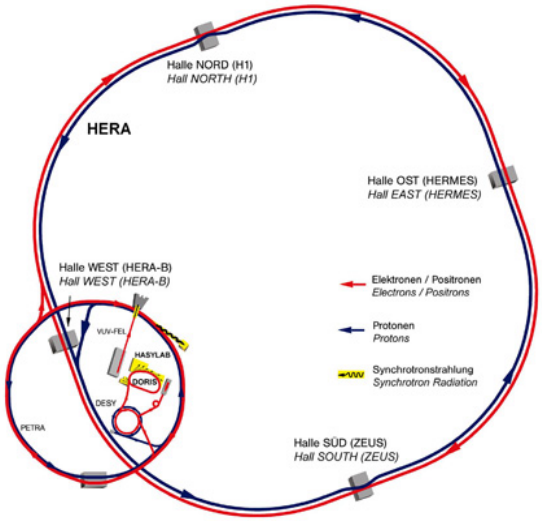

Figure 3: DESY accelerator overview with PETRA as central pre-accelerator.

For better understanding of some of the following statements it will be useful to note a general shortcoming at DESY: a quite low level of discipline of all involved people (including the author).

GENERAL REMARKS

Fortunately (or unfortunately, depending on the point of view), the control system of a particle accelerator is able to compensate deficits, both in machine hardware and machine operating. As a result the control system plays always a central role in operation. Requests for software improvements or upgrades will never stop.

The concept of machine operation (shifts, professional or part time operators, number of people involved in the operation, number of people in the background) defines the requirements and boundary conditions for the control system. When designing a control system, the knowledge of the desired operation concept is highly important. A change in this concept during the machine operation could force substantial changes in the control system.

The control system should match the users capabilities. With professional and well experienced operators the control system of an accelerator could have some imperfections, whereas a part time shift concept with frequently changing operators requires nearly perfect controls.

Since the special operation constraints and requirements at particle accelerators are always different, there is no universal panacea for control systems.

QUESTIONS

Some questions concerning the control system and especially its user interface will be posed to describe the user's point of view. Sometimes a subjective answer will be given.

Online Information

How much information is necessary at the console for accelerator operation? How much is enough?

For sure it's desirable to have access to all possible information concerning status of operation, subsystems and components. In reality however, most of the very specific information concerning subsystems and components will never be used at the operating console. For the daily operation only a well selected part is used and sufficient.

How important is the presentation layer?

It's very important. Most users like to have a homogenous layout of the consoles and applications with suggestive graphical presentations. A classical example for suggestive graphics is the display of beam positions: it can be displayed as a list of numbers, as a standard graphic (BPM vs. BPM number) or as an orbit (BPM vs. betatron phase advance).

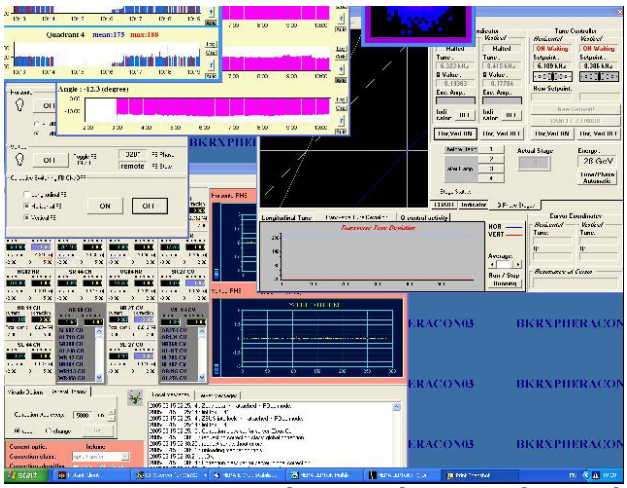

Figure 4: First example: console screenshot with overlapping windows and small fonts.

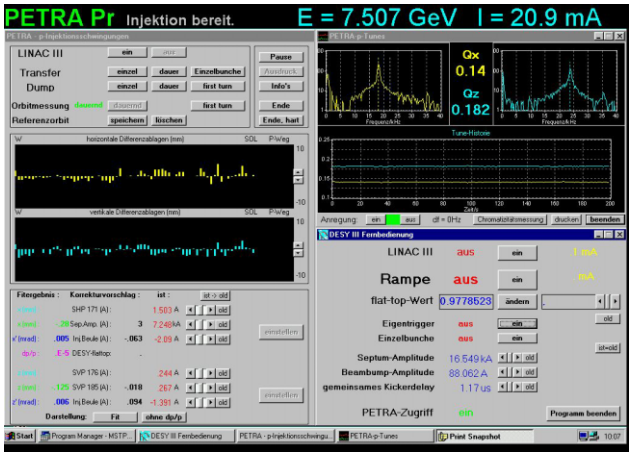

Figure 5: Second example: PETRA console screenshot.

Very important are clearly defined colours (i.e. red=off or failure, green=on, blue=vertical, yellow=horizontal) and large fonts which can be read even during nightshifts. Not amusing are overlapping windows, which usually will pop up in a nearly unlimited number (Fig.4, 5). All this gives a high priority to a real cockpit concept at the console, were windows and displays are switched and grouped, depending on the accelerator situation.

In addition, a clear and precise machine status display is mandatory.

Offline Information

How much archiving is necessary, how much is possible?

The first order solution is, if there are no system limits, to store all available information with the highest possible rate. Usually, it's not possible to analyze offline such amounts of data with a reasonable effort. Sooner or later a substantial data selection must take place. It's a decision within the control system design, when to do this step. An "in-time" data reduction leads to a triggered system, similar to high energy physics experiments. Without such early implementation of "intelligence", data graveyards with exhumation procedures are created.

How important is an easy archive access?

If the archive system should be useful for the operating people it is important to have an archive viewer at the console, allowing fast, easy and suggestive access to the essential parameters.

Do we need special post-mortem diagnostics?

Especially at a slow cycling accelerator like PETRA (with timescales of some minutes), it's very useful to have some kind of "flight recorder". Such an application for short term ring buffering of beam parameters (tunes, orbits etc.) enables the operator to trace sudden beam losses. Again a good viewer at the console is mandatory.

How important is an electronic logbook, integrated into the control system?

The information flux from one shift to the next and from the operators to the experts and coordinators is an essential topic, which can be done written or orally. DESY has now about 15 years of experience with electronic logbooks for machine operation. In comparison to former times nearly perfect e-logbook, management and administration tools are available now. Nevertheless, the operation of a living accelerator should have the highest priority, instead of putting a substantial part of the controls efforts in state of the art logbook applications. But e-logbooks are in vogue…

Operation Panels

How many knobs are necessary, how many are enough?

Similar to the information needed at the console in principle all components and functions should be accessible. But for standard operation only a very limited part of the overall functionality is needed. Again a reasonable selection of knobs, probably depending on the situation is desirable.

How important is the presentation layer? How important are ergonomics?

Due to the frequent manual operations needed to be carried out by the shift crews at PETRA the ergonomics of operation play a non negligible role in the integral operation quality. Well designed and suggestive applications, again with large fonts and defined colours, are very important. Especially for operating applications with frequently used buttons, overlapping windows should be avoided (by a cockpit management).

Procedure Automation

Are automated procedures useful?

Absolutely, no doubt. But

how high should be the degree of automation?

This depends strongly on the complexity of the procedures. For high complexity automation is very useful. The fraction of routine operation is another boundary condition. With frequently changing operation conditions useful automatics are hard to realize.

Highly automated operation could become dangerous: the operators get used to it and will forget a lot of details, which are necessary for unusual situations. Again, the people involved in operating and their capabilities play a major role. At accelerators for high energy physics the dream of one single knob for machine operation ("luminosity on/off") should better remain a dream.

How important is the traceability and transparency of automated actions?

This is simply essential.

How important is an "automatic off" option?

Since no automation will be perfect, certainly a situation will occur, when the automation will disturb the successful operation. Therefore a possibility for switching it off is essential.

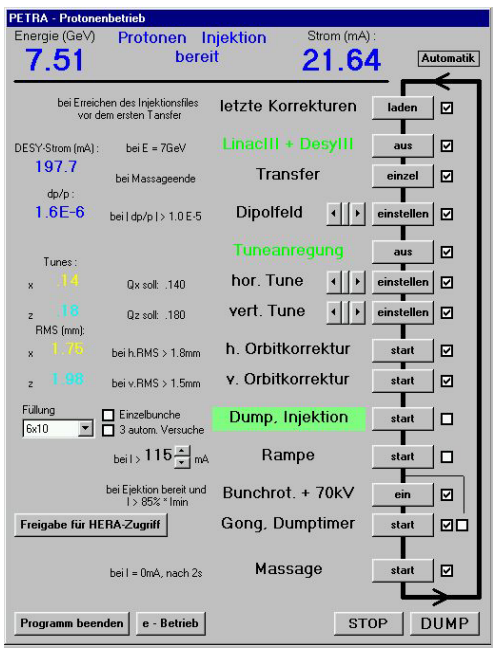

Figure 6: PETRA autopilot.

Figure 6 shows a screenshot of the PETRA-autopilot, running now for 9 years without problems. It has become the central operation application for all operation modes. This console application contains all necessary status information and knobs within one single window, depending on the operation mode. The knobs are arranged as a procedure map. All status information is used to generate a proposal for the next reasonable step. Since this decision is taken once a second, the application reacts instantly to each possible change of machine status (it's not a sequencer!). By setting automation options for each single step, the operator can decide about the level of automation, from none to full automation.

Failure Recognition

How important is a system for fault recognition and alarm generation?

In all cases of accelerator operation a system for fast guidance to the source of (unavoidable) trouble with subsystems or components is mandatory. With increasing procedure automation this topic becomes more and more essential.

How reliable must it be?

The reliability should be as high as possible (a classical truism). False alarms must be avoided. But since the monitoring of all components and the detection of any machine condition blocking the operation is a very complex and non trivial business, this part of a control system should be implemented as early as possible.

Remote Control

Is remote accelerator operation necessary?

No, it isn't. Up to now most particle accelerators have been operated without remote operation.

Is remote operation desirable?

Yes. It makes life much easier, both for the control room getting fast expert assistance and the responsible expert having direct access to his system from outside. But

can remote operation affect the reliability of accelerator operation?

This is the major risk. It must be considered, since unintentional operation could cause major problems. High discipline of the remote operating people is required. Again the traceability and transparency for the operators inside the main control room is absolute essential.

How sophisticated should it be?

A direct console access (i.e. via VNC, Timbuktu), in connection with a well shielded control network is easy to realize and fulfil the basic requirements. But for international accelerator collaborations, foreseen for large future accelerator projects, this might not be sufficient.

(->Global Accelerator Network)

SUMMARY

A good presentation at the console, ergonomics and traceable operation assistance are a major part of any control system for particle acceleration.

THE LAST QUESTION

During the last few decades, the physics and principles of particle accelerators have remained unchanged. While the complexity of accelerators has increased roughly linearly with time, the computing power has grown and is growing exponentially. Where is the impact on control systems?

Can we (the users of control systems) expect a new generation of accelerator controls within the next few years?

ACKNOWLEDGMENTS

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