3rd AVA Topical Workshop – Machine Experiment Interface
10-11 October, Cosylab, Ljubljana, Slovenia

ABSTRACTS

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1. Challenges in AD/ELENA operation
Lajos Bojtar, CERN

We give an overview of the AD operation from the point of view of the interface between the AD experiments and the machine. Specific examples of difficulties to deliver good quality antiproton beam to the experiments are selected from 20 years of operation. The sources of difficulties are various, arising from physics, beam instrumentation, difficult to detect equipment failure, the control system and human factors. We present the changes and challenges in the beam delivery because of the ELENA machine, which will deliver beam to the experiments from 2021.

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2. Sustainable Accelerator System Integration and Control Room Operation *Ralph Steinhagen, GSI*

Accelerator technology evolves, so do best practice and people. Thus, operation and its supporting control system should also follow continuous integration (CI) and improvement principles (e.g. 'poka yoke') in order to avoid gradual obsolescence and eventual unmaintainablility. This presentation will high-light some of the more practical technical aspects related to vertical and lateral control system integration of accelerator-equipment and machine-experiment interfaces from a early prototype-, through commissioning- up to nominal operation phases.

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3. ARTEMIS as an example of control systems for physics experiments at large user facilities.
Jeffrey Klimes, GSI

The Antisymmetric Trap for the Measurement of Electron Magnetic Moments in Ions ARTEMIS), which is located on the low-energy beamline of the HITRAP facility at GSI, can be divided into several subsystems for different aspects of the experiment. In addition, ARTEMIS itself can be considered a subcomponent of the larger HITRAP facility, or of GSI and so on. The result is that the control system for the experiment is dependent on that of the systems above it in such a hierarchy, and the design of the experiment must account for this meshing between systems. As an example of control systems being used in modern physics experiments, ARTEMIS's existing control system will be presented. Various components of the control system at the experiment level will be introduced, such as the LabView Projects for ion production and control as well as monitoring ambient variables. In addition, the means of integrating ARTEMIS within HITRAP and GSI will be investigated with a focus on defining the separation between the levels of control.

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4. Data acquisition, data analysis and simulation tools in a test bench environment

Bruno Galante, CERN

The Cold Cathode Test Bench (CCTB) is part of the BI-EA section at CERN. Aim of the test bench is to study a novel material, carbon nanotubes (CNT), for the emission of a cold, low energy electron beam. Different small experiments are conducted in order to investigate the CNT properties. Hence, there is the need to interface with different machines, often of different kind, due to fulfill different requirements for different experiments. To do so we have decided to develop a series of LabView routines in order to communicate with the instruments and save the data. LabView offers indeed a simple and straightforward way to communicate with different instruments while keeping the structure of the program basically unaltered. At the same time the collected data is saved onto text files in order to allow for data analysis. For the data analysis part another tool, Matlab, is used. It allows more freedom with the line coding and moreover offers several modules that are very useful for some analysis. It is surely possible to do everything with LabView or Matlab. However, it seemed straightforward for us to enforce the strengths of each tool using them for single tasks.
The last part regards the simulation of electron emission and electron gun design. For this task we use CST Particle Studio. With this simulation program is possible to simulate everything at the same time. It has in fact a tunable module for field emission which allows to simulate the emission from CNTs. With the particle tracking module it is then possible to define different gun geometries and in the end simulate the whole gun.

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5. Instrument read-out & Experiment optimisation in simulation: Current and past experience

Volodymyr Rodin, ULIV

Effective methods of data acquisition during the experimental phase require minimum mistakes which may come from: a) human factor; b) a misunderstanding of your setup. In this contribution, the second part will be mostly covered, based on some examples from the past. These include energy spectrometer with fringe field effect and current transfer line studies with stray field effect. Full implementation path will be shown beginning from the designing phase and subsequently coming to the data saving. For these cases, the list of software tool includes CAD modelling, finite element methods of the electrostatic or magnetic field, radiation shielding analysis and particle tracking. The electronic and hardware part of the setup covers field measurements, power supply control, automatized collimators with a precision feedback system, control of data acquisition on detectors and alignment with translation stage. Thus sophisticated user interface should be developed to merge input/output elements and simplify experimental control.

Combination of both examples gives a great overview of a small experiment where small beam size or high resolution in energy, control of bunch charge are required.

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6. Use of FPGAs in real-time signal processing

Miha Cerv, Cividec

Over the years, FPGAs proved themselves to be a very useful tool in physics experiments. Their ability of reconfiguration and parallel processing makes them ideal for various applications in accelerators, where huge amount of information must be processed fast and efficiently.

During my talk I will briefly explain, what FPGAs are and how they can be used. I will present my experience with FPGAs used for real-time signal analysis. I will show, what the advantages are over other means of data processing, what are the challenges in FPGA programming, and what are some techniques to overcome them.

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7. Practical use and remote control of CX-4 cryogenic amplifiers.

Ilia Blinov, Stahl

Cryogenic GaAs (Gallium-Arsenide)-FET technology allows eletronics to operate in deep-cryogenic operation, even in strong magnetic fields, as they are present in NMR, FT-ICR or antimatter ion traps. Our latest product, the CX-4 is a highly sensitive voltage cryogenic amplifier, intended for such low-temperature, low-noise applications.

In our case, a customized GaAs FET transistor is used as front-end stage, which is thermalized to the ambient temperature. The FET converts the pickup electrode AC voltage to an output current AC component, and the latter is converted in a room temperature amplifier to voltage again.
The amplifiers can be controlled in an easy way using the provided LabVIEW source code blocks, or by self-written program code. Standard program compilers/interpreters like C++, BASIC or Pascal/Delphi dialects may be used for own code writing, also generic command-line terminal programs (e.g. HyperTerminal) will do. The physical connection to a control PC is provided via USB, also other ways of connectivity are being currently discussed.
At the GSI facility we implemented this novel concept, and we did characterizing measurements with a single-pass non-destructive ion counter, based on the novel CX-4 amplifier.

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8. High precision power supply and it's integration to the industrial control system

Indrajeet Prasad, Foton

A power supply is a very essential part of a typical system. Stability and efficiency of a power supply are one of the important factors for beam storage and energy ramping in a storage ring and beam transportation. Its integration and communication with an industrial control system is also a vital step for a power supply for remote access and control. FOTON is designing and building a suitable power supply for use in the beamlines and rings within AVA and close collaboration with COSYLAB is enabling smooth integration of its control system design for the Power supply.
The main aim is to build a reversible power supply based on voltage multiplier circuit design which can be remotely communicated using an industrial control system. Standard power supplies based on voltage multipliers have fixed polarity. We are building a PS that can be electronically reversible and can be controlled and ran remotely using the user interface designed on an industrial control system.
The presentation will consist of the circuit design process along with the initial draft of the prototype. The presentation will also include the steps and a few details of the communication between this power and COSYLAB's Industrial control system.
The presentation will show the 4-step reversible multiplier circuit which was designed at FOTON and it is now on the next step of its design & communication process. The next steps are to build the PS prototype on PCB with final consideration of design & elements. The presentation will also emphasize on the software integration of the PS for efficient communication with COSYLAB's remote user interface.

9. Status of the integration of the CCC in CRYRING

David Haider, GSI

The Cryogenic Current Comparator (CCC) and the cryostat that surrounds it are planned to be installed in the storage ring CRYRING@GSI in summer 2020. After a short testing phase the measurement of the beam current should be integrated into the accelerator control system based on FESA (Front-End Software Architecture) to help the operators during the commissioning. The main challenge in the design of the data acquisition, however, is the big number of different devices and data types that are related to the monitoring and operation of the re-liquefaction cycle of the cryostat. Temperature and pressure readings, heating power and valve controls, to name a few, are all planned to be processed by an industrial PC and a feedback loop will be implemented to stabilize the cryogenic operating conditions.

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10. Electron Cooling at LEIR

Bianca Veglia, ULIV

Electron cooling is a technique widely used in storage rings to reduce the phase-space volume of the charged and heavy particles of a circulating beam. It requires a beam of cold electrons co-moving with the ions in a section of the machine at small relative speed. The Coulomb interactions acting between the two species of particles are responsible for the energy transfer from the heavy particles (ions, protons or antiproton) to the lighter electrons. LEIR storage ring is equipped with an electron cooler operating at low energies. The machine interface allows to perform experiments giving useful information to evaluate the efficiency of the cooling process. In this contribution, we discuss results and ideas for further analysis.

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11. Surface Data Acquisition and its Challenges

Liam Soomary, University of Liverpool

The surface characteristics of a photocathode define many important factors of the photoemission, including the intrinsic emittance, the quantum efficiency and the work function of the photocathode. At STFC Daresbury, Multiprobe (SAPI) is a system which complements ASTeC's Transverse Energy Spread Spectrometer (TESS) and Multi-Alkali deposition chamber (which is under construction) in order to produce and analyse quality photocathodes, by using its multiple R&D facilities including, but not limited to XPS, AFM, LEED and UPS. The search for high performance photocathodes is a priority in the accelerator science community, as such in this talk the importance of reliable means of data acquisition are discussed, as well as how the use of machine to experiment interfacing is necessary in order to achieve accurate results.

12. Simulation results for the new degrading foil properties

Siara Fabbri, University of Manchester

At the ALPHA Experiment at CERN, we will be optimizing the capture, manipulation, and delivery of antiprotons for use in antihydrogen creation and measurements. In the current experimental configuration, over 99% of antiprotons are lost during the capture process as a result of the 5.3 MeV initial kinetic energy of the beam. ELENA is a new storage ring coming online which will lower this initial kinetic energy of the beam to 100 keV. We present simulation results for the new degrading foil properties and location in the ALPHA CT penning trap. We further propose techniques for manipulating, detecting and extracting on the anticipated larger-numbered antiproton plasmas.

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13. Optical beam profile measurements using adaptive optics

Milena Vujanovic, ULIV

A high dynamic range, adaptive masking method to image the beam halo has recently been developed. It uses a digital micro mirror-array device as a spatial filter to remove the high brightness part of the beam and focus any measurements onto the weaker tail distribution, using longer exposure times.

This talk, will show results recently obtained at Diamond Light Source in the UK. It will highlight how the DMD and the entire optical system are controlled, how data readout from the DMD and camera are done and how the resulting beam images are analysed.

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14. Towards Sympathetic Cooling of Single Protons and Antiprotons

Markus Wiesinger et al, MPG

We, the BASE collaboration, perform most precise tests of the CPT symmetry in the baryon sector by measuring properties of the proton and antiproton.

Our recent 300 ppt measurement of the proton magnetic moment at the proton g-factor experiment in Mainz is limited by statistics. The reason is that the current use of sub-thermal cooling of a single proton by a resistive method is extremely time-consuming and leads to cycle times of hours.

To overcome this limitation sympathetic cooling by laser-cooled Be+ ions in a common-end-cap Penning trap is being developed: The method not only promises to produce (anti)protons with mK temperatures within tens of seconds but also achieves separation of the cooled and the refrigerator ion.

We present the current setup of the proton g-factor experiment and report on the status and recent achievements, such as in-trap detection of fluorescence photons using SiPMs at 4K, located 12mm from the Be+ ion cloud.