What we have accomplished/what is under construction

The ions accelerated in our 5-MV tandem (TAMIA) ranged from sub-MeV protons for particle-detector calibration to 50-MeV \(^{127}\)I ions for ion-beam analysis experiments with TOF-ERDA. Most of the ion-beam-related experiments performed since the previous SNEAP symposium in Legnaro have employed the single-cathode sputtering ion source (MISS-483M). The automation of the control system and its further developments have greatly improved the usability of the tandem. The fast simultaneous readout and real-time display of several beam-profile monitors together with the storage of all the control parameters of the tandem in a SQL database have both turned out to be invaluable in the beam tuning and diagnostics. The use of a new GVM allows us to run the tandem without slit-stabilization in most cases. The terminal-voltage is usually stable to within 1 kV.

One of the main tasks during 2013 has been the installation of the gas-ready AMS ion source (upgraded 40-cathode MC-SNICS v.2) and related equipment (electrostatic analyzer and quadrupole triplet), including the fast electrostatic deflectors for sequential injection of carbon isotopes. The preliminary results are promising but some fine-tuning is still required for high-precision radiocarbon measurements. A sample-preparation system for feeding gas samples (CO\(_2\)) directly into the AMS source has been constructed and tested off-line.

A concise description of our control and automation system is given in the following.

Automation architecture
The control system consists of the following four blocks: 1) SCADA (Supervisory Control And Data Acquisition), 2) HMI’s (human-machine-interfaces), 3) actuators, and 4) research devices.

The SCADA is realized using the DSC module from NI’s (National Instruments). The DSC includes 1) internal data transmission, 2) storage into the database (data logging), 3) generation of alarms, and 4) user privileges. We have coded a Tasker in SCADA to perform all the higher-level process control. All the devices have in SCADA their own libraries that include their parameters. These parameters define both the structure and functionality of the whole equipment.

The HMI’s do not include any code that would affect the functionality, their only tasks are to transmit the requests to SCADA and show the status of the equipment.

The control of the actuators is realized using automation controllers, mainly with CompactLogix-devices from A-B (Allen-Bradley) but some cRio’s from NI are also in use.

The functionality at the device level is realized using these logics. All the actuators communicate only with SCADA not directly with the HMI’s. Devices that can be easily connected via Ethernet are controlled in Tasker.

The research devices that are connected to and communicate with the control system are realized using the PXI platform, though some of the functions are implemented in a PC. Also these devices are using the parameters in SCADA for data transmission. In some cases, a research device can consist of several PXI platforms and the communication goes directly between the separate PXI platforms.

**Location of program blocks in the system**

**Logics**
- Accelerator personnel safety
  - Radiation dose-rate monitors and door interlocks
  - Ion-source room interlocks (HV-safety)
  - Emergency stop
- Protection of equipment and separate devices
- Protection against and Recovery from tank sparks
- Vacuum system
- Control of protected devices
- Logics including entities
  - Automatic tuning of deflecting magnets

**Tasker (SCADA)**
- Functions that improve the usability of the accelerator
  - Control of the accelerator
  - Automatic Start/Stop-procedures
  - Recipe launching
  - Mass scans
  - Measurement sequences
  - Automatic optimization of the accelerator (“profiler”)
- Control of separate devices
  - Radiation dose-rate monitors
  - NMR / Hall-probe Teslameter
  - Analyzing magnet

**Research devices**
- Measurement sequences
  - AMS measurement, fast switching of isotopes
- Monitoring of ion beam
  - Faraday cups
  - Measurement of currents at beam-defining slits
  - A/D -converters
  - Fast digitalization of BPM signals

**HMI**
The HMI’s are realized using LabView programming.
Device control
Each device has its own display module that includes all indicators and controls. These modules communicate with the corresponding parameters in SCADA. The communication uses the Data Binding property of the indicators and controls. The function of a display module is determined by a device-specific Status parameter. A typical function in a display module is to enable or disable the use of a control. The value of each Status parameter is defined inside the programming environment where the functionality of the device has been realized. The display modules have been realized using the XControl method.

Equipment panel
Those entities that are required to be displayed together are collected in the equipment panel. These panels consist of display modules and an updating program block. Those indicators and controls that do not need any functionality in the display are realized using the traditional display objects of LabView. They also communicate with the parameters in SCADA using the Data Binding property. A program block has been programmed for the observation of the quality of the communication of the display objects. It shows the Data Binding Status if the communication is incomplete.

HMI
The HMI consists of a collection of panels and a program that controls their behavior. This program is rather simple because its main function is just to open and close the panels according to operator’s requests. Furthermore, it takes care of the updating of the HMI.