3 MV Tandem accelerator system

General description

The purpose of this project is the acquisition of a 3 MV Tandem electrostatic accelerator.
The accelerator will be remotely operated with from the control room with the aid of computers. The required software will be provided together with the accelerator system.
The beam will be generated by an ion sputtering source and a source of He\(^+\) ions.

The ion beam goes through the low-energy region of the accelerator system, from the ion sources to the entrance in the acceleration tank. The high voltage terminal, which is situated inside the acceleration tank, is charged electrostatically. The voltage on the terminal can reach 3 MV (3 millions volts). In the middle region of the tank, the electric charge of the ions is changed from negative to positive, such that the ions are further accelerated up to the exit from the tank.

The accelerated beam passes then through the analyzing magnet, where the energy of the ions is selected and further through the beamline extension.

There is a microprobe beamline extension at the end of which there is a target chamber, where nuclear measurements will be conducted, including Rutherford Back Scattering and Proton Induced X-ray Emission.

The system will also include a beamline extension for ion implantation, consisting of a surface scanner and an implantation chamber.

The accelerator tank will be filled with SF\(_6\). During maintenance operations, the SF\(_6\) will be transferred to an auxiliary reservoir.

The system will allow the possibility that the charge exchange from the region of the high-voltage terminal should be effected not only on gas, but also with the aid of stripper foils.

In order to minimize the emission of X rays in the region of the acceleration tank, the tank will be screened with a layer of lead.
## Technical specifications

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<th>Item</th>
<th>Name</th>
<th>Content and specifications</th>
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| 1    | Injection Beamline | • Source of Negative Ions by Cesium Sputtering with liquid cooling system; turbo-molecular pump station; extractor-einzel lens assembly; preacceleration tube; source isolation valve; one y-steerer; isolation transformer; all necessary power supplies with remote control for ion source; and interconnecting tubing, bellows and supports and safety enclosure.  

The source produces negative ions of sputterable elements. The negative ions produced in the source are focused and accelerated at about 80 kV. The currents must be of 100-300 $\mu$A for $^1$H $^-$, $^{12}$C $^-$, Si $^-$, P $^-$, Au $^-$, and 20-100 $\mu$A for $^{11}$B $^-$, Ni $^-$, Cu $^-$, As $^-$.  

• Cathodes for the sputtering source. |
| 2    | He$^-$ ion source system | One RF-charge exchange ion source with air and liquid cooling system; one turbo-molecular pump station; one gap-einzel lens assembly; one preacceleration tube; one source isolation valve; one y-steerer; one isolation transformer; all necessary power supplies for ion source, and interconnecting tubing, bellows, supports and safety enclosure. |
| 3    | Low Energy Beamline | One inflection magnet at $\pm 30^\circ$; one ion source bias power supply; one turbo-molecular pump station; one electrostatic X-Y steerer; one Faraday cup; one double slit; one beam profile monitor; one multi-unit BPM controller; one rack mounted oscilloscope; one electrostatic einzel lens; all necessary power supplies; interconnecting tubing, bellows and supports. |
| 4    | 3-MV Tandem electrostatic accelerator | All metal/ceramic accelerating tube sections on each side of high voltage terminal; turbo-molecular pumped gas stripping in high voltage terminal; corona triode point and energy stabilizer circuit; generating voltmeter; capacitor pickoff; pressure tank; and control console with remote control of accelerator.  

The Tandem electrostatic accelerator will have charging systems generating about 250 $\mu$A og current on the high voltage terminal. The vacuum system will allow the operation in ultrahigh vacuum, between $1 \times 10^{-8}$ Torr and $5 \times 10^{-8}$ Torr in the absence of the beam or tube conditioning. |
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<td>Foil Stripper for terminal of the electrostatic Tandem accelerator. The device will produce positively charged ions from the incident negative ions. Lead Shield attached to the outside of the accelerator tank, to reduce the x-ray intensity from accelerator. Performance Specifications for the Accelerator: Insulating Column Voltage 3.00 Megavolts Voltage Stability Better than 1 kV Voltage Ripple &lt;=500 V peak-to-peak Singly Charged Ion Energy Range 1.0 to 6.0 MeV Charging Current Rating of the order of 250 microamps (50 Hz Power) Electrical current of the most probable charge state measured in a Faraday cup beyond the analyzing magnet for ions of C, Si, Au will be of the order of 5-10 μA at 3 MV.</td>
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<td>Focusing and Analyzing System</td>
<td>One analyzing magnet at ±15° and exit ports at 0°, ±15°, ±30°, and ±45°; one magnetic quadrupole triplet lens; one beamline isolation valve; one magnetic Y steerer; one Faraday cup; one turbo-molecular pump station; interconnecting tubing, bellows and supports.</td>
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<td>6</td>
<td>Raster Scanner Beamline</td>
<td>One beamline valve; one Faraday cup; one turbo-molecular pump station; one rough out valve; one raster scanner; one neutral beam deflector; one beam profile monitor; one single slit; interconnecting tubing, bellows and supports.</td>
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| 7 | Manual Implant Endstation | • Water cooled 150 mm maximum diameter platen; quick access flange; positive and negative ion suppression cylinders; 150 mm chamber isolation valve; rough out valve; mask holder; suppressor power supply; dose integrator; and necessary supports.  
• Table with 2 rotating supports of adjustable height for HPGe detectors. |
| 8 | Microprobe beamline extension | Beamline isolation valve; beamline insulator; double slit; object aperture box with four apertures ranging in size from about 200 μm to 6 mm; Faraday cup; two magnetic X-Y steerers; turbo-molecular pump station; two beam profile monitors; electrostatic quadrupole triplet lens; electrostatic quadrupole quadruplet lens; and bellows, interconnecting tubing and supports, and all necessary power supplies. The microprobe extension lines will allow the obtaining of beam diameters of 20 μm – 2 mm in the target chamber. |
|   | Target Chamber System | • Target Chamber System with Silicon Surface Barrier detector, preamplifier, amplifier and power supply for RBS measurements; computer controlled motorized target manipulator; microcomputer with multichannel analyzer card and software for automated data collection and data analysis; target load lock; turbo-molecular pump system with isolation valve, forepump, vacuum controller for automatic chamber and/or load lock pump down; CCD camera; chamber insulator and isolation valve and collimator; and supports.

• PIXE Analysis System including an ~30 mm$^2$ Si(Li) detector; detector electronics; filter holder; MCA board; interconnecting cables; and PC with analysis software.

• Movable Detector Support Arm in RBS (Rutherford Back Scattering) Chamber to allow movement of the solid state detector.

• Additional Solid State Detector and Insulated feedthrough for use with movable detector support arm.

• Support Electronics for Detector including detector preamp, detector bias supply, detector amplifier, and MCA/ADC 4000 channel card.

• Foil Holder mounted on the movable detector with positions for six foils. Foil position controlled from outside of vacuum chamber.

• 1-2 additional ports in chamber.

• $\gamma$ ray detector, preamplifier, amplifier, and bias supply for measurements with target chamber insertion pocket to allow detector solid angle at target to be maximized and Additional MCA/ADC 4000 Channel Card integrated into system.

• Table with 2 rotating supports of adjustable height for HPGe detectors.

• Vacuum service cart consisting of a roughing pump or equivalent; active metal trap; thermocouple gauge; interconnecting fitting with long flexible bellows; and mobile cart. |
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<td>SF$_6$ gas handling system</td>
<td>SF$_6$ Gas Handling System with about 8 hour pump out or in time.</td>
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