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A new fast-cycling system for AMS at ANU

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ABSTRACT

In order to perform higher precision measurements, an upgrade of the ANU accelerator is underway. Fast switching times on the low-energy side, with maximum settling times of 30 ms, are achieved by holding the injector magnet field constant while changing the energy of the different isotopes by changing the pre-acceleration voltage after the ion source. Because ions of the different isotopes then have different energies before injection, it is necessary to adjust the strength and steering of the electrostatic quadrupole lens that focusses the beam before entry into the accelerator. First tests of the low-energy system will be reported. At the high energy end, a larger vacuum box in the analyzing magnet has been designed, manufactured and installed to allow the transport of differences in mass as large as 10% at constant terminal voltage. For the cases where more than one isotope must be transported to the detector an additional refinement is necessary. If the accelerator voltage is to be kept constant, then the trajectories of the different isotopes around both the analyzing and switching magnets must be modified. This will be achieved using bounced electrostatic steerers before and after the magnets. Simulations have been performed with the ion optic code COSY Infinity to determine the optimal positions and sizes of these steerers.

1. Introduction

Due to the exigencies of sharing a large accelerator with an active nuclear physics program, and limitations imposed by existing hardware, AMS at the Australian National University [1] (ANU) has for many years operated in a sequential slow-cycling mode. Counting times for the rare isotope are typically two to five minutes, and are dictated by the requirement to maximize the fraction of time spent on counting the rare isotope(s) when switching times between isotopes are 10–15 s. Ion source output can, however, vary appreciably during these counting times, which limits the precision that can presently be achieved to ~3%. In order to perform higher precision measurements, an upgrade of the ANU accelerator is underway to allow a fast-cycling procedure. Here we describe the various components of the upgrade and its present status.

2. Upgrade of the ANU accelerator and actinide measurements

The ANU AMS system is based on a 15 MV tandem accelerator. As high energy is required to apply certain techniques of isobar separation effectively, this makes the ANU tandem particularly well-suited for the heavier isotopes with severe isobaric interferences e.g., ^{36}Cl and ^{53}Mn, but it is sufficiently flexible that it can also be run at lower voltages ~4 MV for actinide measurements [1,2]. A schematic layout of the ANU 15 MV tandem facility is shown in Fig. 1. The caesium sputter ion source is a 32-sample MC-SNICS. Negative ions from this source are pre-accelerated and mass-analysed by the mass-energy product 56 MeV amu/e^2 injection magnet, which allows high resolution mass analysis for all stable isotopes in the periodic table. The injection beam line also features a fast (rise-time ~50 ns) electrostatic chopper that allows attenuation of beam currents that would be too high for injection into the tandem accelerator (e.g. ^{35}Cl) or counting rates that would be too high for the detector (e.g. ^{234}U). An electrostatic quadrupole triplet with steering capability focusses the beams to a waist inside the accelerator tank. This waist is the object point for the lens formed by the electric field at the entrance to the acceleration tube which then focusses the beams into the stripper canal in the high voltage terminal.

The 14UD accelerator is capable of voltages up to 15 MV and is routinely operated above 14 MV. Both a gas stripper and a foil stripper are available at the terminal. The double focusing high-energy analyzing magnet has a radius of 1.27 m and a mass-energy product of 225 MeV amu/e^2 at its maximum field of 1.7 T. Its vacuum box has an opening in the bending direction of

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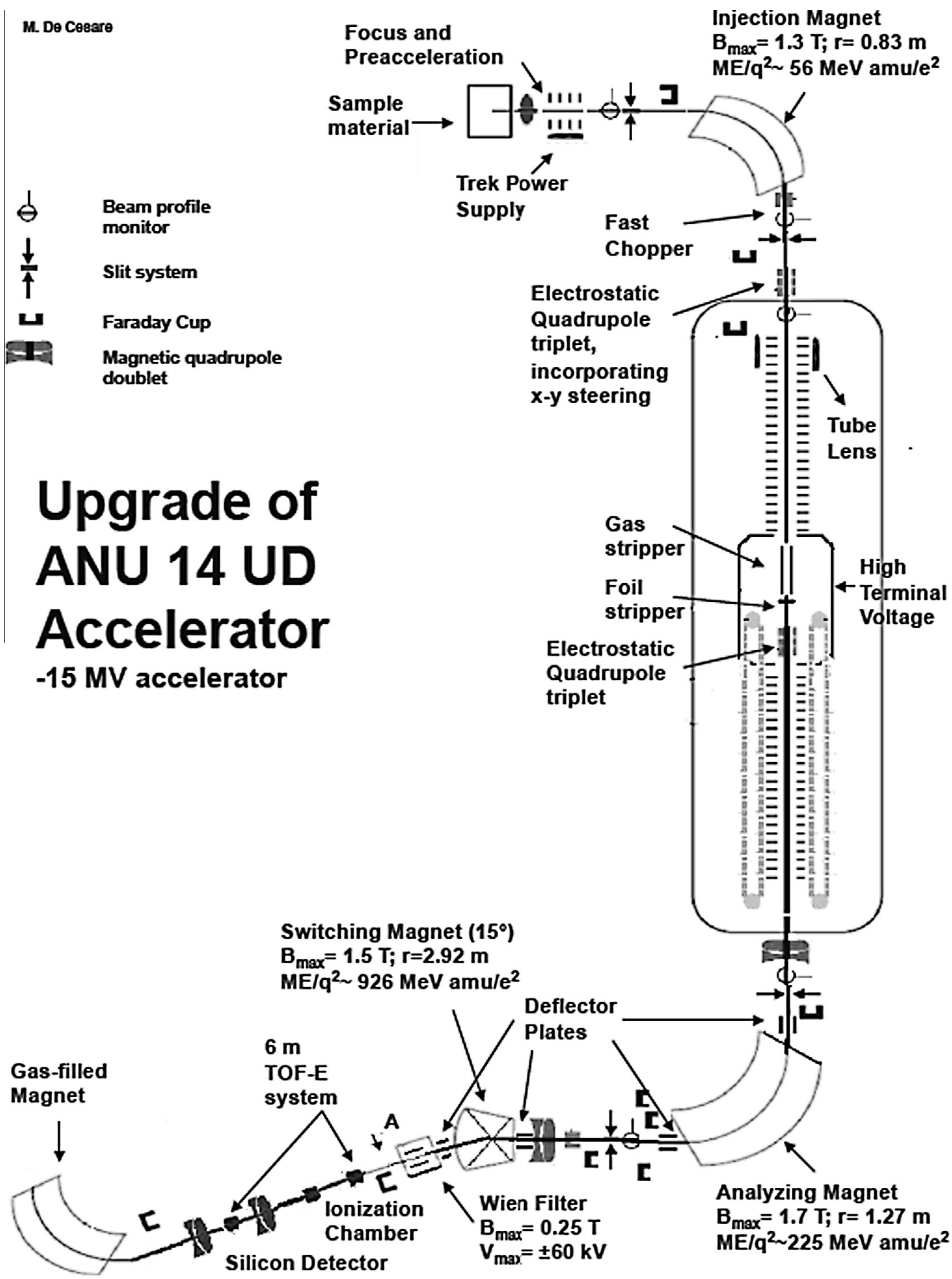

Fig. 1. Schematic layout of the ANU 14UD accelerator and the 15° beam line that is used inter alia for AMS of actinides showing actual and planned upgrades for fast-cycling AMS operation. In the actinides beam line A denotes a selectable 3 or 6 mm diameter aperture. The accelerator and analysing magnet are vertical, while the switching magnet bends in the horizontal plane. The upgraded part includes the ±10 kV TREK power supply in the pre-acceleration to switch between different isotopes, the new analyzing magnet chamber and the offset Faraday cups after the analyzing magnet. The deflector plates before and after the analyzing and switching magnets will be installed at a later date. Note that the ionization chamber is removed when either the time-of-flight system or the gas-filled magnet are being used.

only 59 mm at the exit from the magnet. This is insufficient to allow ^{35}Cl, for example, to be transmitted at the same time as ^{36}Cl when the latter is on the central axis, and has been a major inhibiting factor to the development of a fast-cycling capability. Two beam lines are available for AMS, one equipped with a multi-element gas ionization detector, the other with a 6 m time-of-flight system, a gas-filled magnet, and an ionization detector. Wien filters on both beam lines provide the final analysis stage to remove ions with the same mE/q^2 but different E/q.

In the slow-cycling mode, different isotopes are injected into the accelerator by changing the magnetic field in the injection magnet. On the high-energy side, the analyzing and switching magnets are held fixed while the terminal voltage as well as the electric field in the Wien filter are changed in order to transmit