NEW FACILITIES ON THE 3 MeV VAN de GRAAFF ACCELERATOR DEVELOPED AND PROPOSED

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- A B S T R A C T -

A 3 MeV Van de Graaff accelerator has been in operation at LHRL for 21 years achieving over 77,000 hours operation. With the ageing of the accelerator, there has been a decrease in the amount of fundamental research and an increase in applications work. New ways of expanding accelerator capabilities are continually being sought.

The present accelerator offers a unique tool to be used in assessing the suitability of components and systems for applications in an environment where electrostatic fields and radiation pose a significant problem. It also lends itself as a suitable injection stage to study post acceleration techniques. See Table 1 for standard performance parameters.

1.0 EXISTING AND RECENTLY DEVELOPED FACILITIES

1.1 Beam Lines

Figure 1 shows a layout of the 3 MeV Van de Graaff beam lines. The most commonly used facilities are:

(i) Neutron producing target with multi angle detector positioning.

(ii) 10° elevated beam line for heavy ion implantations.

(iii) 45° elevated facility for neutron experiments.

(iv) XYZ manipulator for high resolution positioning of a target.

(v) Carousel target facility used for measurement of flourine in coal.

(vi) Neutron producing target and 760 mm diameter scintillation tank used in cross section measurement.

(vii) SNIF facility, discussed elsewhere in this paper.

(viii) Multiple target facility for PIXE/PIGME analysis with an annexed external beam facility.

(ix) Goniometer chamber used for channelling and backscattering.

(x) Microbeam facility for PIXE/PIGME analysis of ore samples.

1.2 Heavy Ions

The ion source used is of the RF type where a gas feed of ∿ 10 $atm.c^3h^{-1}$ is ionised by a 100 MHz RF oscillator. This type of ion source is designed to have a high H^+ yield.

Recently nitrogen, carbon, oxygen and neon have been accelerated yielding analysed beams of several microamperes. Heavier ions have reduced the ion source lifetime by up to five times that of hydrogen use.

Limitations are placed on the beam in terms of mass energy product by the maximum angle through which the present analysing magnet can deflect the beam.

1.3 SNIF

A facility has been developed to provide standard neutron beams of known energy and energy spread. Three reactions are used:

i) $^{7}Li\ (p,n)\ ^{7}Be$

ii) $^{9}Be\ (d,n)\ ^{10}B$

iii) $D\ (d,n)\ ^{3}He$

The first two reactions have been extensively used at LHRL whilst the third is under current development using a deuterium gas target.

1.4 Telemetry System

In a single ended accelerator such as the 3 MeV Van de Graaff, a fault condition in the top terminal cannot always be easily analysed due to its isolation inside a pressurised tank. To help overcome this problem a telemetry system has been partly installed that transmits terminal parameters to digital displays or hard copy in the control room. Voltage to frequency converters encode data which is then sent over fibre optic links. These links need to withstand extremely high voltage gradients whilst the electronics is subject to both radiation and electrostatic field effects.

1.5 Low Energy Use

The limiting factor on operating with terminal energies below 700 kV had been the inability to draw adequate corona discharge current when the corona points were fully in. Without this current, the energy stabilisation system could not function and terminal energy fluctuations resulted in loss of beam on target or large energy spreads.

With an extension shaft fitted to a new set of corona points, adequate corona current can be drawn down to 80 kV. Beam transmission is degraded at these low energies but a useable Ne beam of 230 kV has been used.

2.0 PROPOSED DEVELOPMENTS

Two ideas are being evaluated, the first is to upgrade the energy of the accelerator using post acceleration and the second is to get shorter pulses using a room temperature quarter wavelength resonator.

2.1 Post Acceleration

The most likely method to be tried will be that of a core type induction linac using the 3 MeV accelerator as an injector. This scheme lends itself to module stacking so the production of one module alone will lead to an understanding of the principle. Modular voltages up to 500 kV have been achieved.

2.2 Shorter Pulses

Pulse widths to less than 200 pS have been produced using quarter wavelength resonators as bunching elements. Most have been superconducting elements but a room temperature buncher has achieved equally short pulses.

The 3 MeV accelerator can produce the initial pulse to be bunched by two methods. Firstly, and perhaps the easiest to operate, the beam is chopped and bunched in the top terminal. The disadvantage of this method is the relatively low pulse currents. The second method uses a bunched d.c. beam and post deflection. The latter method is still to be fully evaluated in terms of buncher operating frequency and obtainable pulse current.

T A B L E 1

RANGE OF ENERGY	0.7 to 3.0 MV
Direct current beam	700 μA H^+ 500 μA D^+ 200 μA He^+
Pulsed beam, 1 MHz Prep. Rate	10 μA 10 μS 10 μA 3 μS bunched
Pulsed beam, microsecond to one shot operation	Pulse length and current user determinable

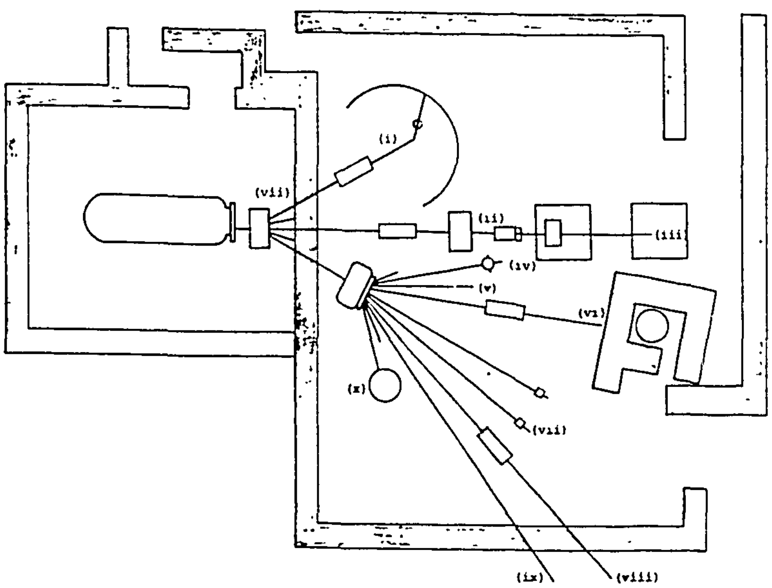

Figure 1 - Beam Line Layout (see text for legend)