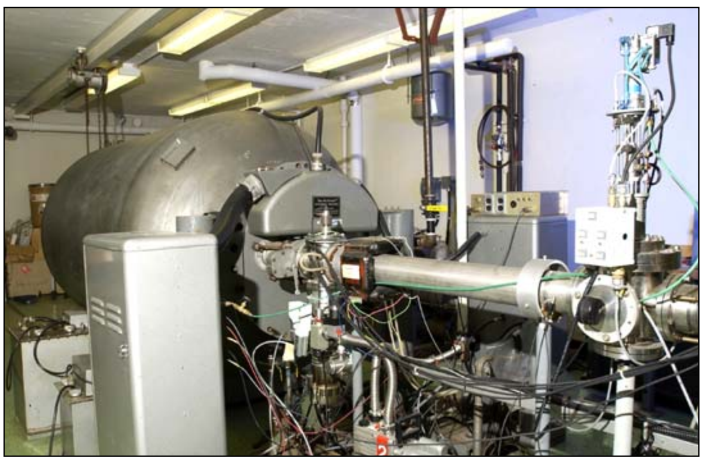
DEFENCE DÉFENSE

Defence R&D Canada – Ottawa

3 MV Van de Graaff (VdG) Accelerator Facility

DRDC Ottawa operates a Van de Graaff (VdG) particle accelerator facility suitable for calibration of neutron – and, to a lesser extent, gamma ray – detectors. The facility can also be used to test spacecraft electronics for vulnerability to low-energy proton irradiation. The 3 MV "KN" accelerator is ideal for the production of monoenergetic neutron, gamma rays at levels allowing detection instrument calibration, and can produce protons at energies suitable for simulation of space environments.



3 MeV Van de Graaff accelerator tank.

Van de Graaff control panel.

The VdG can be operated in *neutron, gamma ray or proton* modes.

Neutron Mode: The production of monoenergetic neutrons is achieved via the acceleration of either protons or deuterons up to approximately 3MeV, and allowing them to impinge upon various targets. Neutrons are then produced with well-defined energies depending upon particle energy and angle from the beam line. Our VdG target room provides a special "low scatter" facility to mitigate lower-energy neutron production. The table below lists the available reactions and neutron energy range.

Reaction (Beam Particle in **bold**)	Threshold Particle Energy (MeV)	Approximate Neutron Energy Range Spanned (MeV)	Comments
^{45}Sc(**p**,n)^{45}Ti	2.908	Around 20 keV only	Very Low-yield
^{7}Li(**p**,n)^{7}Be	1.881	80 keV - 1 MeV	Most monoenergetic
T(**p**,n)^{3}He	1.019	0.8 MeV - 2 MeV	High Yield
D(**d**,n)^{3}He	1.0 (exothermic)	2.5 MeV - 6 MeV	Lower Yield
T(**d**,n)^{4}He	1.0 (exothermic)	14 MeV - 18 MeV	Reasonable Yield, Fusion

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DRDC Ottawa provides detailed information for each irradiation, including neutron spectra, dose and dose rate. Typical dose rates are of the order of mRem/h at 1 m from the target.

Beam monitoring is accomplished via either a Faraday Cup or a current drawn directly from the DUT. Vacuum feed-throughs are available for powered devices.

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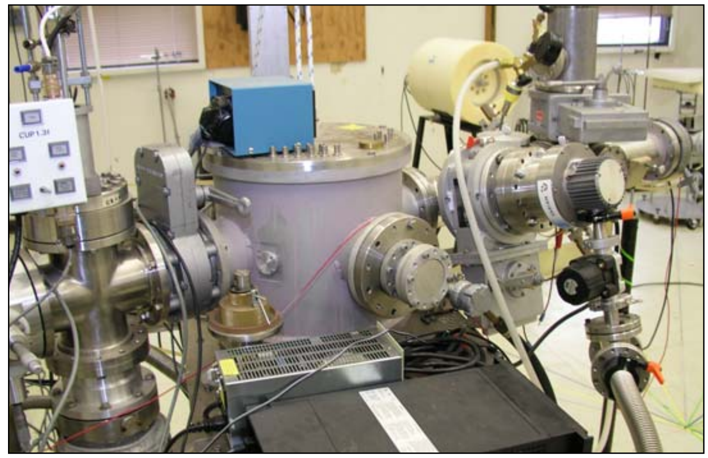
Van de Graaff equipment under test at angular beam energies with reference long counter at 0°.



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Van de Graaff Proton irradiation chamber (centre of beam line).

Gamma Ray Mode: For many applications, especially those involving nuclear fission fields, it is important that gamma ray detectors be calibrated at energies that are not obtainable with conventional radioisotopic sources. To achieve this, DRDC Ottawa runs a proton beam into a LiF target at energies below the threshold for neutron production. This produces (by means of the $^{19}F(p,alpha)^{16}O$ reaction) photons with energies around 6 MeV. Again, spectroscopic and dosimetric information is routinely provided.

Proton Mode: One important aspect of radiation damage to space-based electronics is their vulnerability to low-energy proton irradiation – producing displacement damage and other effects. DRDC Ottawa has a dedicated, turbo-pumped, evacuated chamber that may be placed at the end of the VdG beamline, allowing calibrated proton irradiation. Total fluences at the device-under-test (DUT) range from 10^{10} protons/cm^2 and up.

Availability
This technology is available to the Department of National Defence and other Canadian government departments, as well as allied nations, industry and academia through a variety of business models. For information, please contact the Business Development Office.

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