



## Cancer.

### No other word causes more dread in the hearts of men ...

Cancer claims the lives of tens of millions each year around the world and there are very few medical procedures available to properly diagnose or treat this disease.

Modern physics, particularly nuclear physics, has played an important role in the design of the tomographs – such as the X-ray, CAT, MRI, SPECT and PET systems – used to diagnose and monitor the progress of the disease. It also provides the cyclotrons and reactors used to produce the radionuclides and radiopharmaceuticals, such as  $^{99}\text{Mo}$  and  $^{18}\text{F}$ , used to diagnose and treat the disease.

We have been fortunate in Canada to have access to two of the most important systems to produce life-saving radionuclides and radiopharmaceuticals: the NRU reactor at Chalk River outside of Ottawa and the 500 MeV TRIUMF cyclotron on the south side of the campus of the University of British Columbia in Vancouver. The NRU reactor is celebrating its 50<sup>th</sup> anniversary and the TRIUMF project is celebrating its 40<sup>th</sup> anniversary. Together, both projects have touched the lives of hundreds of millions of patients world wide in a way that few realize.

The NRU reactor has made substantial contributions to the science, technology, energy, health and economy of Canada since it began operation in 1957. For instance, the medical isotopes produced in NRU play an important part in the treatment and diagnosis of more than 20,000,000 patients around the world each year. No single reactor facility provides more medical isotopes than the NRU reactor which was designed and built by Dr. George Volkoff and his colleagues in the 1950's. For a period of ten years, 1957 to 1967, the NRU system was also considered the most advanced and powerful reactor of its type in the world.

The TRIUMF project has, at its heart, the world's largest and most powerful negative hydrogen ion cyclotron. A special and close relationship between MDS Nordion and TRIUMF, which began in the 1980's, has seen the establishment of a facility run jointly by TRIUMF and Nordion that produces much-needed life-saving radionuclides and radiopharmaceuticals off both the 500 MeV main cyclotron and a fleet of smaller 30 MeV dedicated cyclotrons designed by TRIUMF and built by a world-renowned Canadian high tech manufacturer (these smaller cyclotrons, the TR30 cyclotrons, are known as the TR series of cyclotrons in recognition of their parentage).

Last year, the NRU facility was in the news over matters relating to its operation. The proposed replacements to this venerable system, the two MAPLE reactors, were found deficient in their design and operational capabilities and have been shut down indefinitely. The 10 MWth (megawatts thermal) MAPLE reactors were

underdesigned by a factor of four, and it was determined that the enriched fuel elements, when placed into their designated locations within the reactor matrix, resulted in a k-positive excursion that was deemed to be problematic. It is evident that the designed output of the MAPLE reactors was far below the amount necessary for the designed purpose. The MAPLE issue is now, unfortunately, before the lawyers. From a physics and public health standpoint, nothing will be made right by throwing this matter to the lawyers and seeing the litigants fighting it out in court.

It would help to take a look at what's out there when it comes to small research reactors. In comparison to MAPLE, the TRIGA reactors produced by General Atomics use the "warm neutron principle" as an inherent feature in the design. In a water-cooled reactor, the general result from a sudden power excursion is a catastrophic accident. This is because the neutrons from the fission reaction remain "cold" from interacting with the cold water around the fuel and maintain their ability to cause further fissioning of uranium atoms in the fuel. This, in turn, results in the temperature of the fuel continuing to increase rapidly until it finally melts.

To get around this problem, TRIGA uses hydrogen that is part of the fuel itself. Therefore, as the fuel temperature increases when the control rods are suddenly removed, the neutrons inside the hydrogen-containing fuel rod become warmer than the neutrons in the cold water outside the rod. These warmer neutrons inside the fuel cause less fissioning in the fuel and escape into the surrounding water. The end result is that the reactor automatically reduces power within a few thousandths of a second, faster than any engineered device can operate. In other words, the fuel rods themselves act as an automatic power regulator, shutting a TRIGA reactor down without engineered devices.

In the mean time, what about the future supplies of the much-needed life-saving radionuclides and radiopharmaceuticals? The NRU system cannot be kept in operation forever. We need to work the problem and find viable solutions. One possible solution to this impasse is to dust off the drawings from the NRU reactor, bring them up-to-date and build an NRU-II reactor at Chalk River. The design of this system is a proven and profitable one and an NRU-II reactor will pay for itself in under a decade. Perhaps AECL and SNC could be asked to study this proposal and report back to Parliament.

Such an NRU-II project would also allow AECL to bring into play a new generation of physicists and nuclear engineers to prepare Canada for any other new reactor systems that may be considered in the future. People are the most valuable assets in an organization

and it takes five to ten years to bring them up to the point where they have the requisite skills and recognized authority to do their jobs. To help training of manpower, I would like to recommend that a new Canadian Chair should be established by the Government of Canada at the UBC Department of Physics and Astronomy and be named the *George Volkoff Chair for Neutron Physics and Astrophysics*.

To address a shortfall of expertise in Canada, special emphasis for this Chair should be on neutrons in astrophysics and applied physics and should include undergraduate and graduate level instruction in the area of neutron diffusion and dynamics (see the article about George Michael Volkoff in this edition of *CUPJ*).

The September 2008 issue of *CUPJ* celebrates the 40<sup>th</sup> anniversary of the creation of the TRIUMF project. We are fortunate to have been given the opportunity to interview Dr. Erich Vogt, one of the members of the TRIUMF Study Group and a former director of TRIUMF. We have a contribution from the present TRIUMF Director Dr. Nigel Lockyer about the TRIUMF Five Year Plan. The third and final Volkoff article talks about Volkoff's participation in the TRIUMF project. Finally, there are papers from TRIUMF summer students. TRIUMF is one of Canada's largest employers of undergraduate summer students.

Looking into the future, 2009 has been designated the International Year of Astronomy. The next edition of the *Canadian Undergraduate Physics Journal* will feature articles on astronomy and astrophysics by students from across Canada.

I have an uncle now fighting lung and liver cancer. He is a retired doctor and a former chief surgeon of Edmonton General Hospital. He is a former Chief Medical Officer for the Province of Alberta and for the RCMP in western Canada. As I watch him fight his brave fight with cancer, I leave a human and non-partisan challenge to Parliament, AECL and Nordion.

Work the problem and stay out of court. Make sure no patient is left waiting for their much-needed life-saving radionuclides and radiopharmaceuticals. If you can't sort things out, I will come to the steps of Parliament and speak out on behalf of all those patients whose lives depend on others doing their jobs in a decent and compassionate fashion. We owe it to them to work the problem.

Patrick

**PATRICK BRUSKIEWICH**  
EDITOR-IN-CHIEF  
patrickb@phas.ubc.ca