Canada's TRIUMF: The Tri-University Meson Facility

BY **MAGDA KONIECZNA**

"I don't really know what a cyclotron is," said Prime Minister Pierre Trudeau when he visited TRIUMF in 1976, "but I am certainly very happy Canada has one." In fact, TRIUMF, short for Tri-University Meson Facility, boasts the world's largest cyclotron, capable of accelerating protons to 75 per cent of the speed of light.

Conceived in 1965 and located on the campus of the University of British Columbia (UBC), TRIUMF is Canada's national laboratory for particle and nuclear physics. It is also used to study condensed matter physics and life sciences.

The facility's uniqueness comes from its ability to adapt to different generations of science, said former TRIUMF director Erich Vogt.

"A facility should be judged not so much by whether it attains its initial goals but [by] how it adapts to the sciences and...leads to new opportunities and capitalizes on those," Vogt claimed. "In all of those things TRIUMF gets very high marks and that's why it's continuing to thrive."

Initially named for the collaboration of three local universities – UBC, University of Victoria and Simon Fraser University – the partnership has grown to include two more full members – University of Alberta and Carleton University – and seven associate members.

At its inception, TRIUMF was designed to create pions – the lightest of the quark-antiquark pairs known as mesons – used to probe nuclear structure. During the cyclotron's construction, the Standard Model of particle physics was born, shifting the focus from mesons to muons (leptons like electrons but approximately 200 times as massive), a shift to which the facility readily adapted.

The main portion of TRIUMF is the cyclotron, in which protons are accelerated over a 45-km path by applying "kicks" of electric voltage up to 23 million times per second. Magnets are used to focus the proton beams, which are fired at a target, blowing up the target nuclei one atom at a time to generate other, smaller nuclei. These secondary nuclei can then be collected and formed into another beam, used for experiments in nuclear astrophysics. Blowing up targets also creates pions, which can decay into muons. Protons, pions and muons are all used to probe subatomic structure.

TRIUMF was born at a time of great change in nuclear physics. In the 1950s, the world's first tandem Van de Graaff accelerator was built in Chalk River. This led to the proliferation of low-energy accelerators: more than a hundred were built, including several in Canada. These were good for exploring nuclear structure; however, questions arose about what occurred at higher energies, where mesons became important. And so "meson factories" such as TRIUMF were seen as the future direction of nuclear physics in the early 1960s.

"The origins of TRIUMF came at a time when nuclear physics was the queen of the sciences emerging from the Second World War," Vogt explained. "Nuclear physics really blossomed in the 1950s and 60s when, for the first time, one had machines which were capable of telling us the details of what happened inside the nucleus, what the forces of interactions were, what the building blocks were.

"When the first glorious decade of nuclear physics had spun out, people were interested in questions beyond 'How do neutrons and protons move inside the nucleus?'

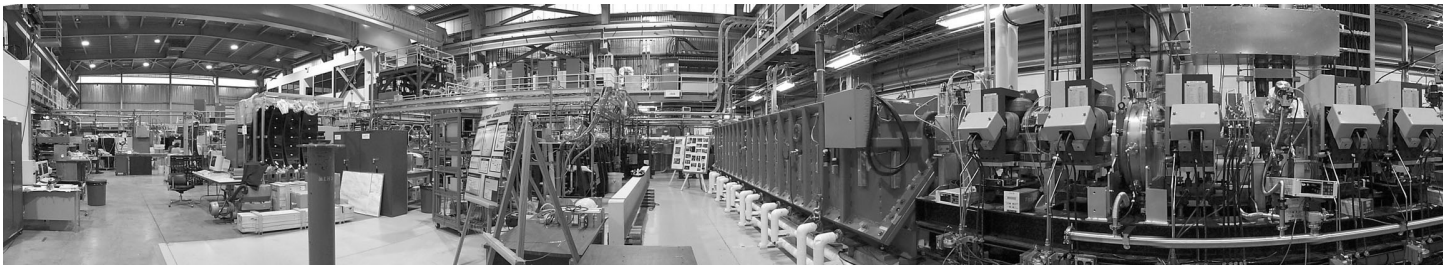
"They were interested in questions such as 'What were the neutrons and protons made of?' and 'Do mesons play a role in the nucleus?' One needed machines of higher energy."

Funding for TRIUMF arrived in 1968, and the facility reached full operating capacity in the early 1980s.

While the TRIUMF facility was driven by curiosity about nuclear physics, particle physics, with its investigations into fundamental forces of nature, rapidly became a more pressing issue. "The muon was beginning to play a very central role in [finding fundamental forces]. It's one of the basic building blocks [of matter] and TRIUMF turned out to be the best source of muons," Vogt explained.

"Among the major successes of TRIUMF were many experiments involving muons for particle physics which had not been envisaged even when the machine originated."

The first key result from TRIUMF came in 1983, as it established the left-handedness of the weak interaction at the same time the Standard Model was confirmed at CERN in



Switzerland.

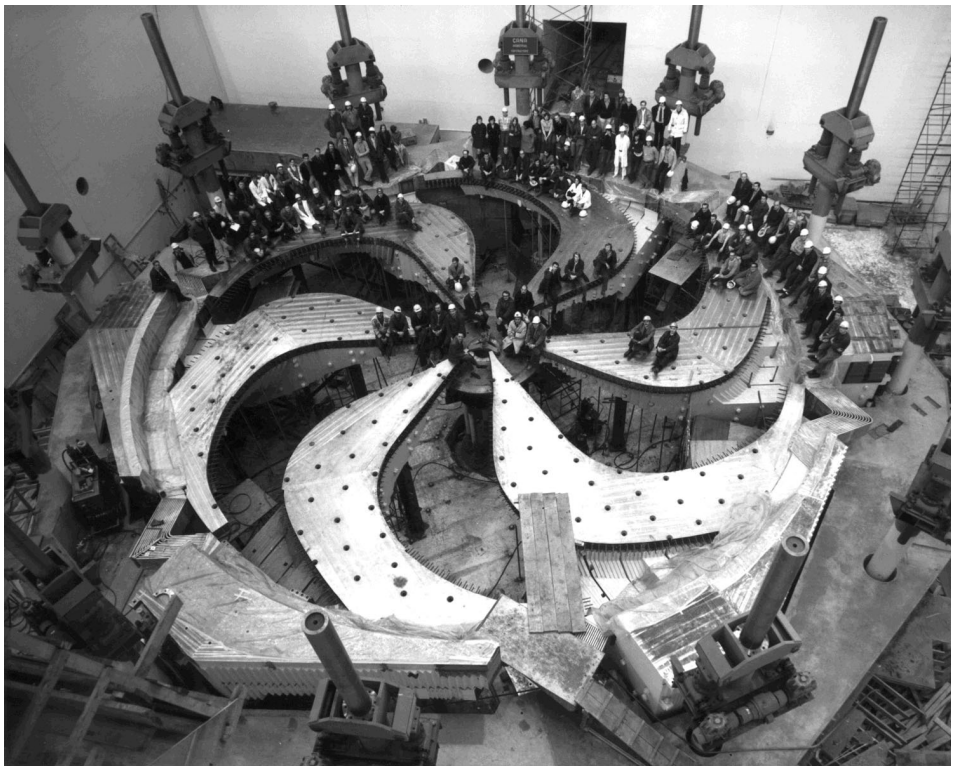
"The initial success which helped put us on the world map at TRIUMF were experiments of that kind," Vogt said. "We were very involved in the events which led to the advent of the Standard Model and have remained so."

Apart from pure physics research, there is also a cancer clinic at TRIUMF, which uses low-energy proton beams to treat cancerous tumours in the eye. MDS Nordion, a private company, is also on-site, using the TRIUMF facilities to build small cyclotrons used to create radioactive substances for medical applications, including cancer treatment.

What is predicted for TRIUMF's future? "That's very hard to say, because that's asking really where will the curiosity-driven science evolve to and that depends in part on what happens on the high-energy frontier," said Vogt.

"The current program of radioactive beams will feed TRIUMF for the next 10 years, but what lies beyond that depends really on how the field evolves. I think TRIUMF remains positioned to capitalize on all kinds of research opportunities as they evolve."

TRIUMF accepts co-op students for four- or eight-month terms throughout the year, as well as summer students. Contact TRIUMF outreach coordinator Marcello Pavan at (604) 222-7525 or *outreach@triumf.ca* for more information. TRIUMF also has summer research awards, detailed at *admin.triumf.ca/docs/studentaward*. Further information about TRIUMF itself may be found at *www.triumf.ca*.



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OPPOSITE: A panoramic shot of the interior of the TRIUMF Meson Hall.

TOP RIGHT: TRIUMF staff of 1972 gather on the lower six sectors of the cyclotron magnet, the inspiration for the TRIUMF logo.

BOTTOM RIGHT: A student helps construct the detector for the TRIUMF Weak Interaction Symmetry Test (TWIST) experiment.