S.M. 1/14/68

SIMON FRASER UNIVERSITY

MEMORANDUM

Paper S-114

Triumf

To: Mr. D. A. Meyers, Secretary of Senate.	From: B. L. Funt, Dean of Science.
Subject: TRIUMF	Date: February 6, 1968

I suggest that for the March meeting of Senate, the question of TRIUMF be placed on the agenda. In addition to the need of Senate being aware of the implication of this major project, it is important that we develop a policy towards:

(1) staff appointments funded completely from external research funds,
(2) status of the appointments should the external funding cease.

B. L. Funt

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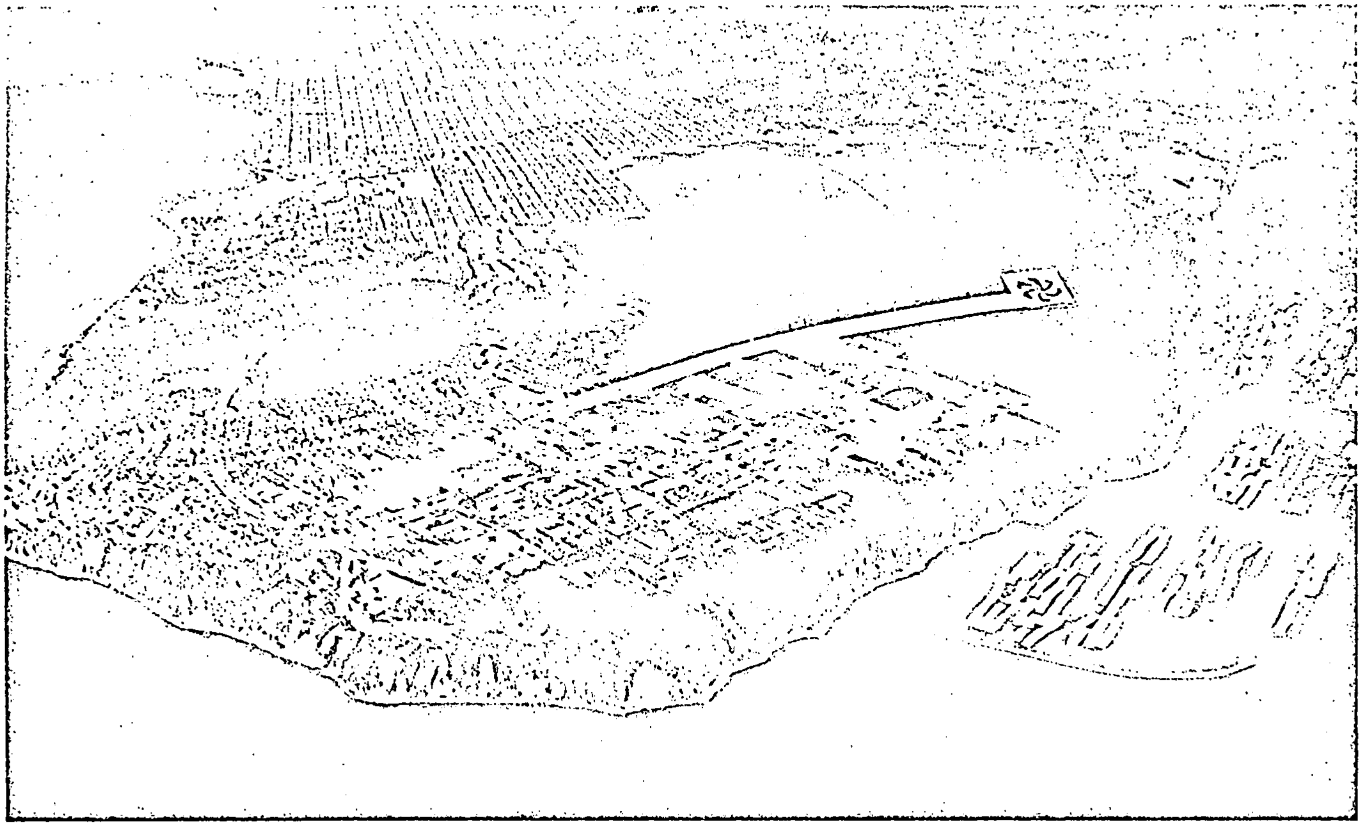
enc.

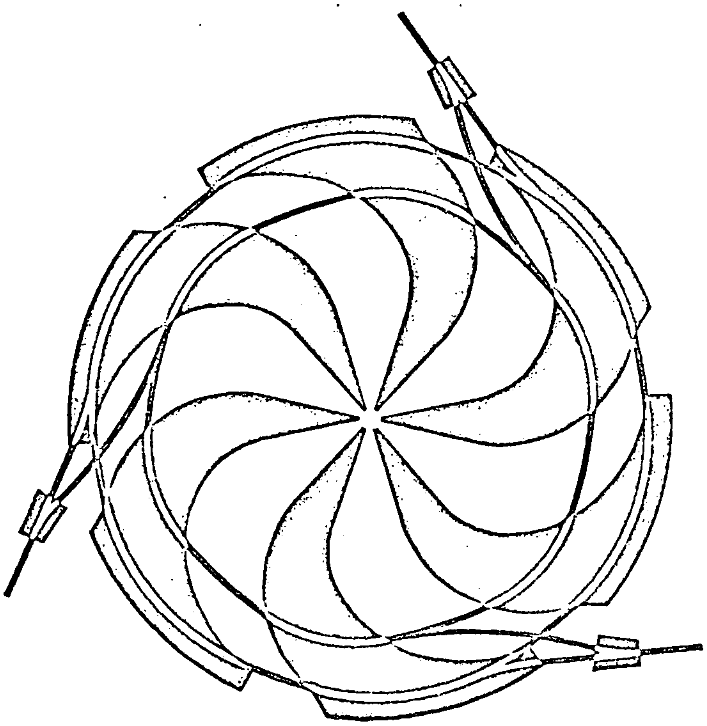
S.M. 1/4/68

Triumf

TRIUMF



TRI - UNIVERSITY MESON FACILITY



UNIVERSITY OF BRITISH COLUMBIA
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UNIVERSITY OF ALBERTA

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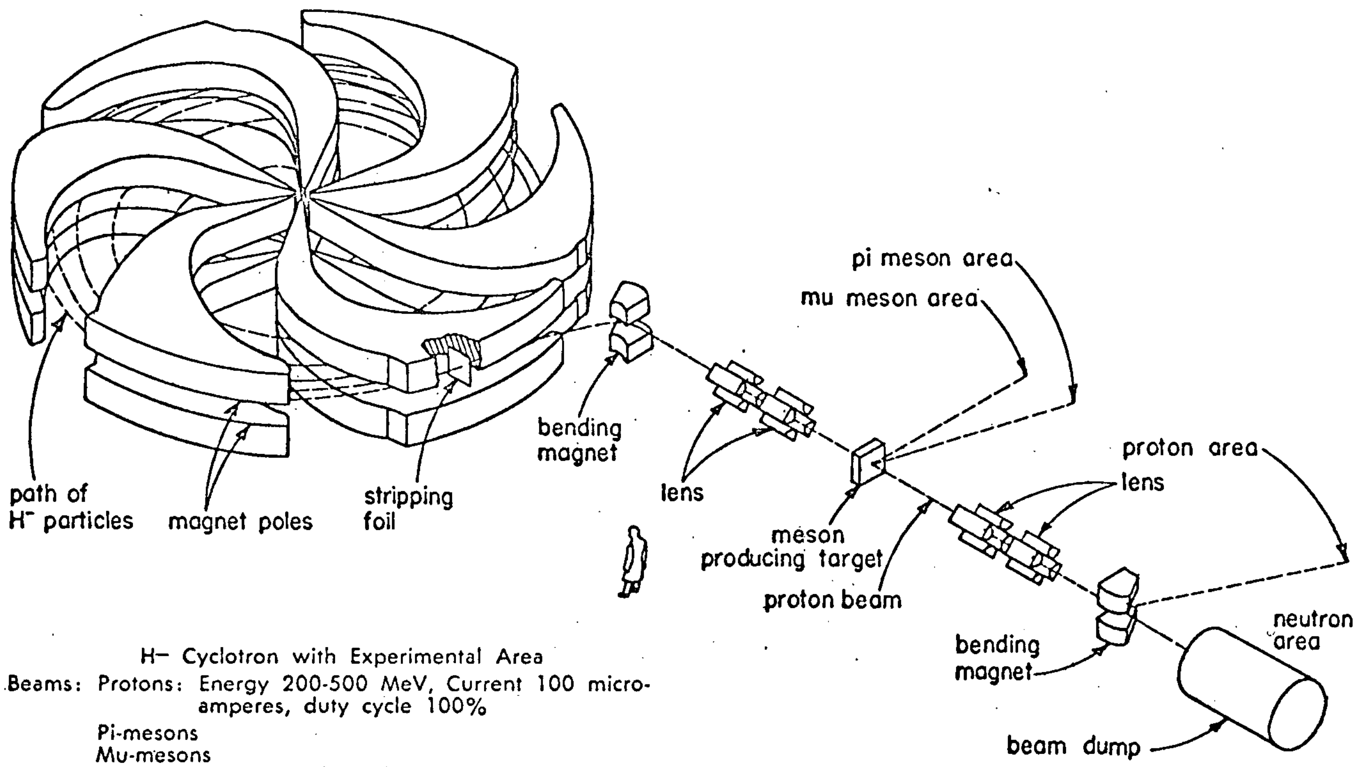
The TRIUMF Project

The "Tri-University Meson Facility" (TRIUMF) will enable nuclear scientists on Canada's West Coast to pioneer a major new field of science, intermediate energy physics, by a major breakthrough in the technology of accelerators, the sector-focused H⁻ cyclotron. The conjunction of the right field and the right machine comes at the right time to continue the growth of the presently strong nuclear research programme in British Columbia into one of the best in the world. The project is proposed by a group of 36 scientists who are staff members of the three West Coast universities in British Columbia: the University of British Columbia, Simon Fraser University, the University of Victoria. A measure of the opportunity which TRIUMF offers is the decision by the nuclear physicists at the University of Alberta (Edmonton) to work with TRIUMF in lieu of other major plans. TRIUMF is expected to be the first project of its kind to be completed anywhere in the world. As such it will attract scientists and graduate students from across Canada and abroad. As a by-product to its nuclear science TRIUMF will provide major facilities for chemistry and materials science. The development of the project offers challenges to Canadian industry and the TRIUMF research programme promises to stimulate the development of new industry and technology in British Columbia.

The Research Facility



H⁻ Cyclotron with Experimental Area
Beams: Protons: Energy 200-500 MeV, Current 100 microamperes, duty cycle 100%
Pi-mesons
Mu-mesons
Neutrons: Thermal Flux of 10^{13} neutrons/cm^2sec

The research facility for TRIUMF consists of an accelerator and an experimental area as shown on the drawing. It would be located on a site given to the project by the University of British Columbia.

The TRIUMF accelerator is a new version of a cyclotron. As in all cyclotrons, electrically charged particles of low energy are brought into the machine at its center between the poles of a large magnet. The magnet guides the particles in a circular path. A suitably designed electric field boosts the energy of the particles, each boost making them travel in larger circles so that they spiral outward, as shown, until the particles achieve a high energy at the outer edge of the machine. Two very recent innovations make it possible to achieve an intense beam of particles outside the cyclotron. The first of these is the unusual shape of the magnet consisting of six spiral sectors as shown in the drawing. This keeps the particles in step with the boosting mechanism and allows an almost unbroken stream of particles to pass through the machine. The second is the use of negative hydrogen ions (H⁻ ions) which are produced from hydrogen atoms by adding an extra electron instead of removing one to leave a proton. The use of the H⁻ ions makes it now possible to get almost all of the accelerated particles out of the cyclotron. At the outer edge of the machine a stripping foil removes the two electrons from each H⁻ particle changing it into a proton. Because the proton has an electric charge opposite to that of the H⁻ ion, the magnetic field makes it swing out of the machine as shown. Both of these innovations have been successfully tested in the last two years in machines producing proton beams of energy about 50 MeV. TRIUMF would be the first project to extend this use to the higher energies (500 MeV) required to produce the unusual kinds of subatomic particles called mesons. The proton beams of TRIUMF would have an intensity 1000 times greater than that of any existing machine at this energy.

The various beams available in the TRIUMF experimental area are shown on the drawing. Secondary beams of mesons are produced when the proton beam passes through a suitable target. Experiments with the proton beam itself can be carried out simultaneously. The neutrons produced in the beam dump yield a flux of thermal neutrons comparable to that of a nuclear reactor. For all of these beams TRIUMF yields a higher intensity than any existing accelerator facility. No other project planned anywhere in the world has all the beam qualities listed in the drawing.

Research Staff and Graduate Training

The TRIUMF Study Group now includes 42 physicists and chemists on the staff of the four participating universities. Members of this group presently have about 90 graduate students. When the project comes into full operation (1972) these numbers might grow to 90 staff members (including 20 postdoctoral fellows) and 180 graduate students. In addition the machine will be staffed by about 80 technical personnel. It will provide an ideal research opportunity for many of the large numbers of graduate students in science expected by 1972.

Research Aims

As the first facility with very intense beams of mesons and high energy protons TRIUMF would open up new areas in the understanding of nuclear processes, contribute to the long-range exploitation of nuclear energy and provide new tools for materials science.

The atomic nucleus consists of fundamental building blocks, neutrons and protons, held together by the very strong nuclear forces which provide nuclear energy. These forces act through the exchange of other subatomic particles (called mesons) between the neutrons and the protons. The hierarchy of particles and forces is still a scientific mystery whose study constitutes the field of elementary particle physics—pursued throughout the world with large accelerators of much higher energy but much lower intensity than that of TRIUMF. On the other hand, the structure of atomic nuclei, whose study constitutes the field of nuclear physics, has been pursued with low energy accelerators (energy below 100 MeV). TRIUMF aims to straddle the unexplored middle ground between the two fields. Some of the research problems in this new field of intermediate energy physics are:

1) photographing the structure of nuclei with new tools capable of providing much clearer pictures than heretofore; the nucleus exhibits an astonishingly rich variety of substructures and changes in shape whose understanding will extend nuclear technology and tell us more about the interior of stars;

2) probing new sources of nuclear energy, for example the release of neutrons in the collisions of high energy proton beams with heavy nuclei;

3) forming new nuclear systems consisting of atomic nuclei with added mesons; many major surprises are expected in such systems;

4) examining the structure of the mesons themselves under more controlled conditions than are possible with the weak beams presently available;

The above list will grow—many of the greatest rewards in such a new field of science cannot be anticipated now.

The proton and meson beams of TRIUMF would be useful in many new chemistry experiments studying the deposition of energy in materials. The neutrons in the beam dump would be used, like those from a nuclear reactor, to study the structure and vibrations of matter, to make radioctive isotopes, for the analysis of metallurgical and other specimens for industry and research. TRIUMF would offer the first such facilities in Western Canada.

Side Benefits for Industry

Major components of the facility include six 600 ton steel magnet cores, two 50 ton water-cooled hollow conductor coils, a 25 Mc/sec radiofrequency accelerating system, a large high vacuum system, an ion source and injection system, beam focusing magnets, beam bending magnets, etc.

The coils will require 2 megawatts of highly stable D.C. electric power. Another 2 megawatts is needed for the radiofrequency system. The total power required for the facility may rise to as much as 10 megawatts.

It is clear that TRIUMF will provide a challenge to a wide variety of Canadian industry. The operation of the project will require many new research tools which will encourage the development of local industries particularly in the area of electronics and instrumentation.

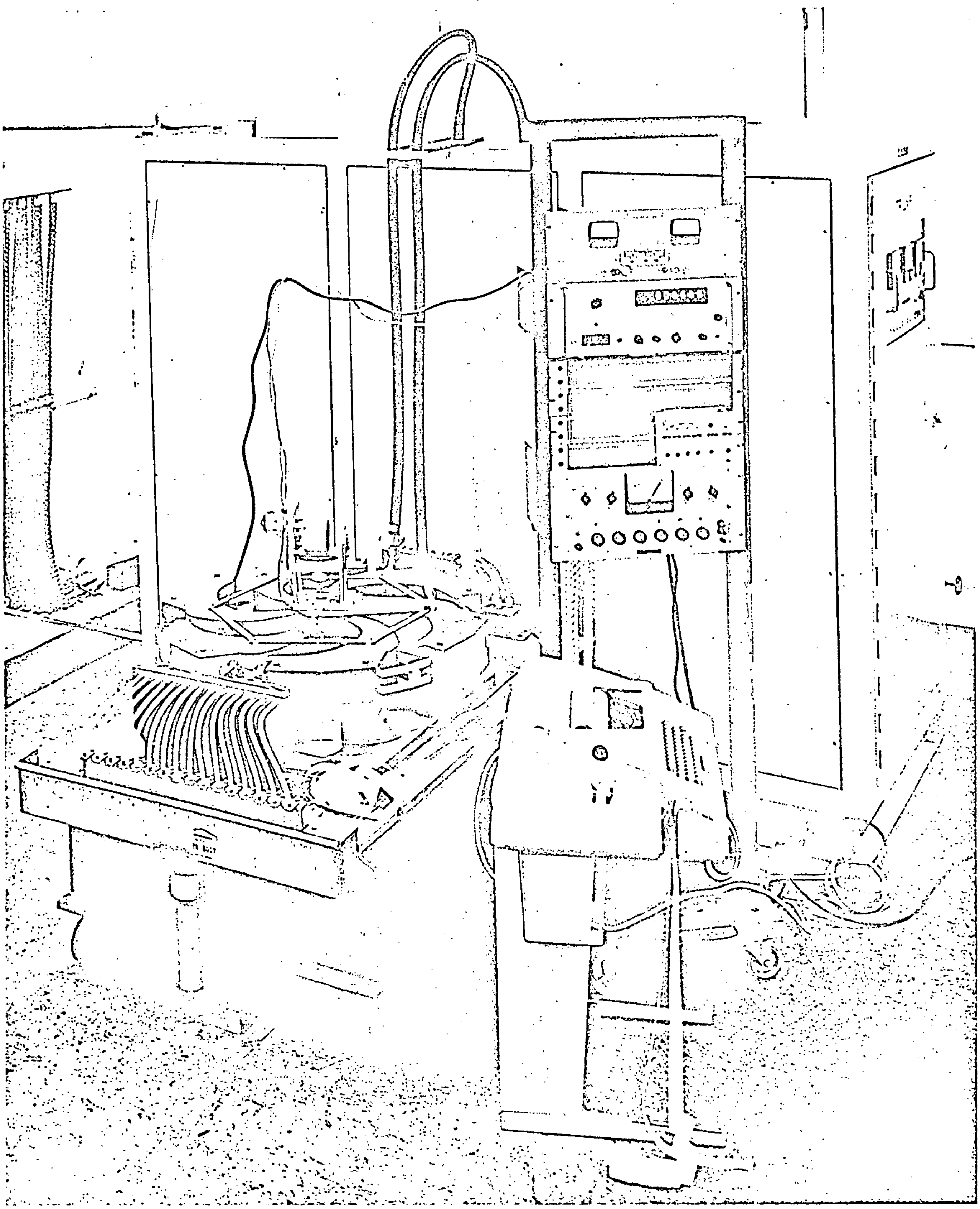
Timetable and Cost

The project will take 5 years to build. The design study has shown that construction will cost $19,000,000. Of these costs $4,000,000 are for a building, $8,000,000 for the accelerator and control system and $7,000,000 for the beam transport system, moveable shielding and other items associated with the experimental area. The project would require about $3,000,000 in annual operating costs after completion.

TRIUMF constitutes an opportunity for a major research facility, unique on the world scene; it enjoys unparalleled cooperation of scientists from four universities whose enthusiasm for the project forecasts an exciting and stimulating period in Western Canada.

S.M. 1/11/68

Triumf



A model magnet (one-twentieth scale), its 150 kilowatt power supply and computerized measuring equipment being used to design the TRIUMF accelerator.