TRIUMF 1992-1993
Annual Financial & Administrative Report

Including summaries of

Pure Research Activities and
Practical Applications of Research

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TRIUMF is Canada's national meson facility, managed as a joint venture by a consortium of Canadian universities. It is operated under a contribution from the National Research Council of Canada.

Consortium Members	*Associate Members*
University of Alberta	University of Manitoba
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Simon Fraser University	University of Regina
University of British Columbia	University of Toronto

FRONT COVER

Positron Emission Tomography in the '90s

The recently installed ECAT 953-B/31 positron emission tomograph, one of three such Siemens models in the world, is used frequently at the UBC hospital. Its brain images—31 horizontal "slices" for each scan—are far more detailed than those of any other machine. Single slices from three different patients are shown, following a series of scans using F-dopa (a TRIUMF radiopharmaceutical carrying a radioactive, positron-emitting fluorine-18 atom): a normal subject; a patient with Parkinson's disease; a patient who had fetal tissue transplanted into the brain. *(Equipment photo: Mindy Hapke, TRIUMF)*

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TRIUMF Information Office

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SCIENCE moves on, and generates wealth.

It is not inappropriate that these annual reports mix science and money. TRIUMF is an enterprise which—perhaps more than any other in Canada—is driven by fundamental science. Its cyclotron and the associated beam lines and experimental facilities provide many unique tools to search for what lies at the heart of matter. This is the oldest frontier of science and remains the most fundamental. It asks: What are the basic building blocks of matter and what are the fundamental forces? These questions in turn have their origin in our human sense of wonder which compels us to enquire: What's it all about?

How does that lead to money matters? Nature is kind and makes us thrive if we strive to unlock her secrets. In modern national economies, which are increasingly based on high technology, a simple verity has emerged. The best combination for successful high technology is world-class science plus world-class scientists. Therefore TRIUMF's excellence at science, reported here impressionistically, leads directly to commercial success in the transfer of high technology which is also reported here. If one takes any measure of success in this matter—such as royalty income earned per government dollar spent—*TRIUMF appears to be second to no other institution in North America.* Inverting the simple verity that reflects well on the quality of TRIUMF's science and its scientists, we then commend to readers who want to know about TRIUMF that they take equal mixtures of science and financial figures. That is the essence of this Annual Financial and Administrative Report for TRIUMF, 1992-93.

The science focus this year is on muons, which continue to surprise. TRIUMF's muons are important for its fundamental science but the emphasis here, this year, is on their use as tools for understanding the nature of materials. Muons tell us about magnetism in materials; and magnetic properties, in turn, are crucial for trying to get a handle on the wonderful new materials which are emerging: high-temperature superconductors, buckyballs, and others. TRIUMF is at the forefront of this research. The account given in the following pages also describes the conditions under which such research thrives: a fertile field of science, highly competent scientists and students addicted to searching compulsively round the clock, and the serendipity of such research, in which Nature often appears to have a sense of humour about precisely when to reveal a great discovery. At least that's how it seems to those most successful in the search.

The work itself is hard, the language earthy and full of jargon which eventually falls away when simpler new laws emerge. For those who wish to read more about TRIUMF's science we suggest the *Scientific Annual Reports,* which provide vignettes of the complete range of TRIUMF's experiments. These reports are available from TRIUMF's Information Office, which can also be helpful to those who want more information on the money matters.

Erich W. Vogt

Each year this Annual Report describes a specific research area to illustrate the total research effort at TRIUMF. We are indebted to Dr. Jess H. Brewer (UBC), who prepared the material for this year's account of muon research.

Those Marvellous Muons!

Muons have a remarkable life cycle. They are "born" when pions (π) disintegrate into muons (μ) and neutrinos (ν):

$$\pi \rightarrow \mu + \nu$$

and "die" an average of 2.2 microseconds later by decaying into electrons or positrons (e), and neutrinos and antineutrinos ($\bar{\nu}$):

$$\mu \rightarrow e + \nu + \bar{\nu}$$

This is not in itself very unusual for the sorts of unstable elementary particles produced in cosmic rays or at accelerators like TRIUMF. The remarkable part is that the *weak* interaction responsible for the birth *and* death of muons seems incapable of creating a right-handed neutrino[1] or a left-handed antineutrino.

One consequence of this failure to pass "through the looking-glass" — in what physicists call *parity symmetry* — is that muons created from pion decay have all their spins lined up in the same direction — they are "100% spin-polarized" at birth. Another important consequence is that when those muons decay, they emit fast electrons or positrons which tend to fly off mostly in the direction each muon's spin axis points at the time of the decay. In effect, these muons "broadcast" their polarization axis via a shower of high-energy particles that can penetrate several cm of solid matter and still be detected easily.

The following definition was first recorded in 1974 and is still apt today:

µSR stands for Muon Spin Relaxation, Rotation, Resonance, Research or what have you. The intention of the mnemonic acronym is to draw attention to the analogy with NMR and ESR, the range of whose applications is well known. Any study of the interactions of the muon spin by virtue of the asymmetric decay is considered µSR, but this definition is not intended to exclude any peripherally related phenomena, especially if relevant to the use of the muon's magnetic moment as a delicate probe of matter.

It is therefore a simple matter to observe what is happening to the muons' spins—much as a magnetic resonance imaging scanner "observes" the state of nuclei in a solid body, except that with muons we have roughly a billion times more sensitivity!

µSR (muon spin rotation/relaxation/resonance) is the acronym used to describe a collection of experimental techniques based on this lopsided decay of spin-polarized muons and the sensitivity of the muon's magnetic moment to local magnetic fields.

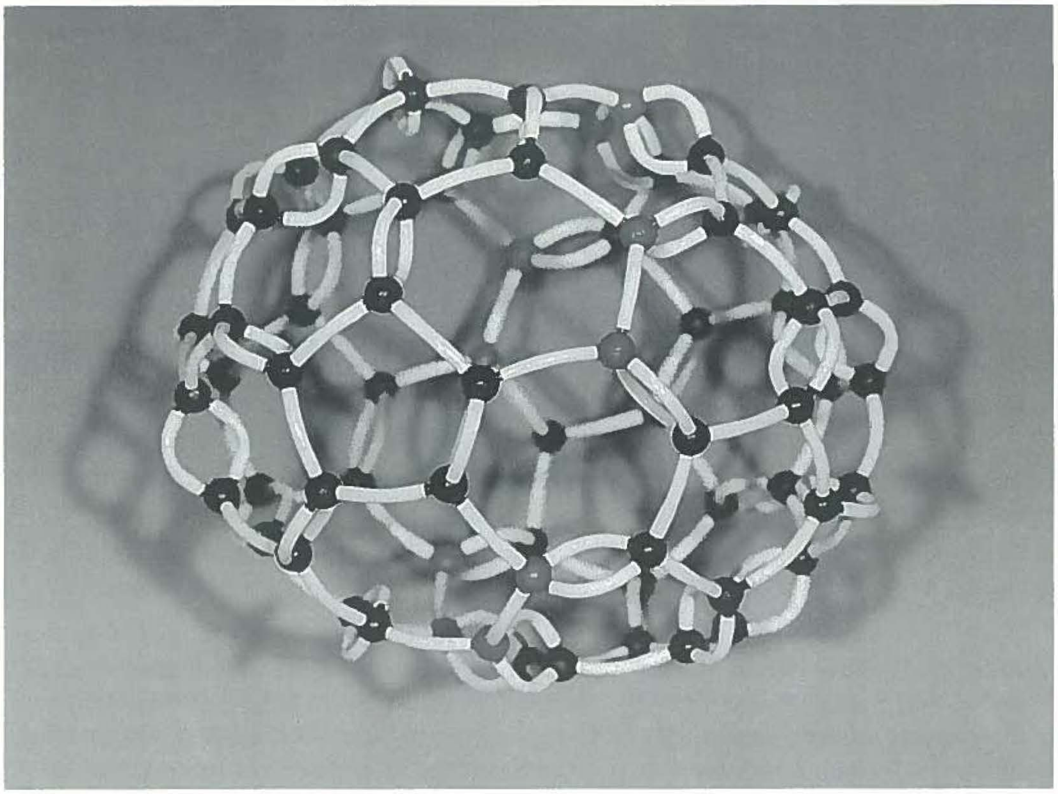
Originally used mainly for delicate tests of fundamental physics, µSR has now become a powerful method for studying the microscopic magnetic properties of materials, the electronic structure and chemical reactions of hydrogen isotopes in matter, quantum transport phenomena in solids, and other important topics in materials science and chemistry.

Each of the major accomplishments of the µSR programme at TRIUMF has its roots in an "enabling" advance of the state of the µSR art, in which TRIUMF has played a central role throughout its history.

For example, the utility of µSR for revealing the magnetic properties of *high-temperature superconductors* is now world-famous; this is primarily due to pioneering µSR studies of magnetic superconductors and related systems at TRIUMF prior to 1986.

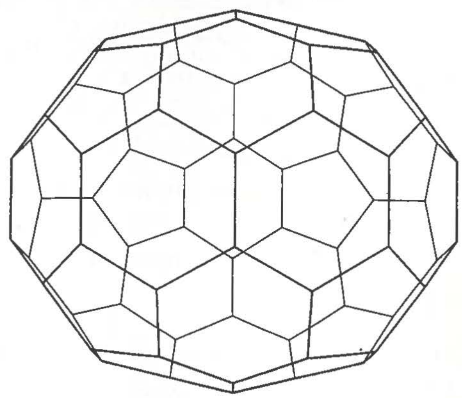
In addition, because the muonium atom (Mu, or μ^+e^-) is like a light isotope of hydrogen whose chemical reactions can be investigated with ease,

[1] A particle spins about an axis parallel to its direction of motion. A "right-handed" particle spins so that if you point your *right* thumb along its velocity, your fingers will curl in the direction of its spin.



The Oddballs!

Some of the more unusual structures examined with μSR are the buckminsterfullerenes (named after the genius whose giant geodesic domes graced EXPO 67 in Montreal, and various other futuristic sites). Patterned with remarkable similarity but on a molecular scale, and commonly known as buckyballs, these new, recently discovered forms of carbon share many unusual properties. TRIUMF researchers look at their structure and conducting properties by attaching muonium "atoms" to these balls. Others, meanwhile, are investigating buckyballs as potential blockers in the replication of the AIDS virus.



μSR provides important tests of the theory of chemical reaction rates; fundamental studies of reactions in gases were made possible by the "surface muon beams" first developed at TRIUMF.

"Level-crossing" μSR spectroscopy techniques discovered and developed at TRIUMF play an important role in the investigation of *free radicals*, many of which can be studied with greater precision and versatility by μSR than by any other technique; several new radicals have been observed for the first time at TRIUMF.

Zero- and longitudinal-field μSR techniques pioneered at TRIUMF have made possible the studies of μ^+ and Mu diffusion that provide the best experimental tests of theories of quantum transport with dissipation — vital to any understanding of modern, solid-state physics.

Finally, TRIUMF is now recognized worldwide as the source of new RF and microwave resonance techniques in μSR, methods whose impact on the structure and dynamics of hydrogen in semiconductors is just beginning to be realized.

In short, µSR has become a versatile and indispensable tool of chemistry and materials science; µSR is perhaps the best illustration of the fact that "esoteric" subatomic physics[2] can and does eventually have an important positive impact on *interdisciplinary* science and technology.

The Art of µSR

Like any accelerator-based research, µSR experiments involve an element of glamour, an ironic mix of boredom and excitement and a large dose of stress. Proposals are often presented years in advance, beam time must be scheduled months before the experiments, and when the appointed week arrives the experiment must be performed as quickly and efficiently as possible on a 24-hour-per-day basis for a minimum of 5 or 6 days in a row. The next chance, if it comes at all, will be months away. Add to this the great variety of equipment that must all be working simultaneously — cyclotron, beam lines, detectors, vacuum systems, cryostats, electronics and computers to name a few — and you have a prescription for endless crises and at the same time about the best training imaginable for young or old experimental physicists.

But the thing that makes µSR unique among TRIUMF's experimental programmes is the unrelenting rate at which new and often unexpected results pour out of the experiment. Whereas most subatomic physics experiments devote months or years of beam time to the determination of the energy- and angle-dependence of one cross section — or, in some cases, to a single number — the typical µSR experiment reveals the behaviour of the muons in a given sample under the current experimental conditions (temperature, applied fields, etc.) in a matter of minutes. Sometimes the behaviour is as expected, allowing one to prepare a "run plan" as much as 24 hours in advance; but more often the results are surprising, and whoever is "on shift" at the time must exercise judgement in choosing the conditions for the next measurement while the current 30-minute measurement is still under way. This aspect of µSR, above all, trains scientists to *think*—much the way one might learn to swim by being thrown off the diving board. The experience is invariably stressful, but can be highly seductive!

ON SHIFT (a µSR Vignette)

The following scene did not really occur, but it very well might have! The target in the beam: strontium-doped lanthanum cuprate[3], a metal with a very low density of conduction electrons. The year: 1985. The experiment: TRIUMF # 336, "Muon Knight Shifts near the Metal-Nonmetal Transition." The setting: the "counting room" (where experimenters live and die!) of the then-new M15 beam line at TRIUMF. The players: the sleepy *Advisor* (who has just finished his 8-hour shift but wants to see the experiment working properly before he leaves) and the relatively fresh and wide-awake *Student*. Both are dressed in the traditional garb of µSR experimenters — jeans, lumberjack shirts and sneakers. The time: 03:00 in the morning, of course.

Advisor (from the dark end of the counting room, staring groggily into an oscilloscope): "There. I think the muon counter is working again. What do you see in the early bins?"

Student (typing at a green-glowing computer terminal): "Just a minute. I was trying to get the temperature regulating at 25°K — I think the cryostat

(Continued on page 23)

[2] Ironically, the "parity violation" so vividly expressed in muon decay was *first* discovered (in the mid-1950s) in the disintegration of *kaons*, one type of "strange" meson, for the copious production of which TRIUMF's proposed KAON Factory is named.

[3] This material, $La_{1-x}Sr_xCuO_4$, was really considered for investigation in Expt. 336, but was finally rejected as being too complicated. The agony of hindsight! In 1986 Bednorz & Müller discovered high-temperature superconductivity in $La_{1-x}Ba_xCuO_4$.

Proton Therapy: A TRIUMF Initiative

In the early years of TRIUMF's pion therapy programme, we recognized the potential for eventually offering proton therapy as well. Each kind of particle beam has its own particular use.

When a pion comes to the end of its short life within a tumour, it is absorbed by the nucleus of the nearest atom. Here the pion's mass is converted into energy, causing this nucleus to break into pieces. These fragments, flying apart, destroy cancerous tissue in a significant volume around the nucleus. So pion therapy is useful for the treatment of large, three-dimensional tumours. Protons act differently. A suitable proton beam will deposit nearly all its energy in a very thin layer of body tissue. It can be used to destroy a flat, extended tumour (eye tumours are often of this kind), or a small tumour close to an important brain structure or the spinal cord, with minimal damage to the healthy tissue very close to the tumour. Protons can also be used to treat abnormal conditions of blood vessels in the brain, called arteriovenous malformations.

In 1992, once the clinical trials for pion therapy were under way, and after several years of planning, we presented the provincial (B.C.) government and other potential (private) funding agencies with a proposal for proton therapy at TRIUMF. The Woodward Foundation has responded with a donation of $500,000 toward the construction of a small facility for the treatment of eye tumours—the first and only proton therapy clinic in Canada.

The target date for the first treatment is 1 April 1994, so most of the biomedical group's staff has been, and will be, dedicated to the development of the proton project. By the end of the 1992–93 year a proton channel was available for preliminary studies of beam characteristics and dosimetry, and the PET group had collaborated in some early experiments to examine the correlations between various factors.

This new facility represents a collaboration between Vancouver General Hospital's Eye Care Centre, the B.C. Cancer Agency, and TRIUMF.

Pion Therapy

As mentioned in earlier annual reports, clinical trials are under way for patients with either brain tumours or prostate tumours. Thirty-two of the former and 76 of the latter had been treated up to March 1993, and these studies will continue.

Because a very intense beam of pions is required, this form of cancer therapy can be provided only at one of the world's three "meson factories". At the beginning of 1993, the Paul Scherrer Institute in Zurich ended its pion therapy programme and is focusing on proton therapy applications. This leaves the TRIUMF pion facility as the only one operating in the world.

PET Programme

TRIUMF's interest and involvement in this technique has made Vancouver one of the world's centres for positron emission tomography. The PET VI scanner built by TRIUMF over 10 years ago is still in use. Last year we described the newly acquired, state-of-the-art Siemens ECAT 953-B/31 scanner (one of only three in the world)—see cover photos. This was its first full year of operation.

The scanners are housed in the hospital on the UBC campus, while a team composed mainly of Simon Fraser University experts works on producing the very complex software needed to obtain the sharpest, most accurate images from these machines. Because of the ECAT's speed, it was possible to perform twice as many scans as with the older machine. And its five-fold increase in sensitivity meant that much smaller amounts of radioisotopes or shorter scan times could be used.

This year's scans included several of patients who, following brain damage due to exposure to MPTP (an impurity in synthetic heroin), had received fetal cell transplants in the brain. This was part of an ongoing programme of research on this problem and on Parkinson's disease.

TRIM

Certain substances, when injected into the body or consumed, may accumulate in specific organs. If the molecules of such a substance carry a radioactive "label" (i.e. a short-lived radioactive atom, such as iodine-123, chemically bonded to the molecule) the radiation emanating temporarily from that organ can provide useful diagnostic information to a physician. Currently, the TRIM programme (TRIUMF RadioIsotopes for Medicine) aims at producing a variety of such radiopharmaceuticals, many of them focused on elucidating heart conditions.

Glucose analogues

Glucose is a major source of energy for the heart, but some diseases can change the pattern of glucose utilization. Treating a patient with radiolabelled glucose analogues can show these changes. We have been developing ^{123}I-labelled glucose analogues as potential heart-imaging agents, and one of them—o-diiodobenzoylglucosamine (o-BGA)—shows promise. A grant from the BC and Yukon Heart and Stroke Foundation has allowed research to continue on other glucose analogues, and we are working on synthesizing and characterizing two of them. Through this grant we may also soon have a cell isolation facility at TRIUMF, capable of carrying out glucose transport studies. This would be shared with other research groups as an *in vitro* screening facility.

Muscarinic receptor-binding

Muscarinic receptors occur in heart tissue and other areas in the body, and their density changes with certain disease states, such as diabetes or heart disease. An iodine-123 atom attached to a chemical that binds to these receptors could make these changes visible. We are examining one such "radioiodinated muscarinic receptor-binding pharmaceutical". It would probably require higher specific activity to be successful. The cell facility mentioned earlier will also be used to verify muscarinic receptor binding of novel radiopharmaceuticals *in vitro*.

Herpes viral nucleoside

We are developing radioactive antiherpes nucleosides, in collaboration with researchers at UBC. Our study of model virus infections in animals has the ultimate goal of imaging virus infections *in vivo* and treating them through radiotherapy. A practical spinoff has been development of *in vitro* radioassays for mutations leading to drug resistance in herpes infections. Patients unresponsive to initial antiviral medication may be rapidly diagnosed, and more effective medications substituted. Antiherpes nucleosides were introduced in the early 1980s; drug-resistant strains of herpes virus already present a significant clinical problem—one certain to increase in the future.

Strontium production

This year we completed a four-year project—we developed a new way of producing the radioisotope strontium-82, which has a half-life of 25.6 days. Delivered on a tin oxide column, this product constantly decays to rubidium-82, whose half-life is 76 seconds. When injected directly into the blood stream of a cardiac patient, the rubidium isotope behaves almost exactly like potassium, except that radiation from its decay conveys accurate information on the viability of heart muscle. The radiation is measured by positron emission tomography (PET). We have transferred our production and processing technology to NORDION International, who use it to supply the North American demand for Sr-82. About 50% of available production time on TRIUMF's 100-MeV beam line has been devoted to this product.

Other initiatives

The TRIM group has also collaborated with colleagues in the Moscow region, exchanging technology potentially useful for improving health care in both Russia *and* Canada. Since 1989 members of the two groups have exchanged several visits, each lasting about a month, to work on areas of mutual interest. Comparable radioisotope production facilities are now available in Moscow and Vancouver, as are collaborations with clinics and other health agencies necessary to bring new developments into use quickly, to the

The largest and most visible facility improvements installed this year have both been described in some detail in earlier annual reports, when these projects began.

First, the dazzlingly complex CHAOS assembly (acronym for Canadian High Acceptance Orbit Spectrometer) was completed on the floor of the meson hall. By March it was being made ready for the first experiment in the summer of 1993, on one of the pion beam lines. A team composed of physicists from the USA, Italy, Switzerland and Canada have worked hard for years to assemble this wonderfully sensitive instrument.

CHAOS is being used to detect and measure the products when a beam of charged pions interacts with a target, usually liquid hydrogen or helium. Particles emitted in such interactions include positive or negative pions, electrons, positrons, and protons. Even neutral pions can be detected, since they usually decay with the emission of two gamma rays, which can be picked up by CHAOS. Basically, CHAOS consists of several concentric layers of detectors. Some of these are wire chambers, each with hundreds of incredibly thin wires; and there are over a hundred scintillators—crystal-clear plastic plates treated with a chemical that emits a tiny flash of light whenever a high-energy particle or ray passes through. The arrangement of all these detectors around the central target area is such that particles ejected from the target in practically any direction will be seen and identified. CHAOS is expected to be used frequently in coming years.

The second major installation is also known by its acronym, DASS/SASP (Dual-arm spectrometer system/second arm spectrometer). Hitherto the most striking piece of equipment in the proton hall has been the medium resolution spectrometer (MRS), a two-storey-high instrument installed on the main beam line in the proton hall. Most experiments here involve detecting and measuring the protons scattered when the proton beam from the cyclotron strikes a target. The MRS can be positioned at any desired angle in relation to the incoming beam, and the spectrometer then captures protons scattered at that specific angle.

Facility tours & visitors, 92–93

This year 3188 visitors toured the TRIUMF site as 353 separate groups, requiring 442 guides. (All these figures were up about 7% from the preceding year.) The total included 1258 students and 1339 members of the general public. The rest were VIP foreign visitors, or Canadian MPs or MLAs; and also many scientists, not directly connected with TRIUMF, but attending conferences or meetings in Vancouver.

Sometimes, however, when the incoming proton strikes a target nucleus, two or more particles may be ejected (possibilities are two protons, a proton and a neutron, or a pion and a nucleon). The SASP is a twin to the MRS, and is designed to collect and measure such particles when it is positioned at the appropriate angle, while the MRS simultaneously records the other. The entire SASP unit is a 130-tonne, 769 MeV/c spectrometer with an energy resolution of about 160 KeV, that will permit study of such interactions in the energy region from 200 to 500 MeV.

The largest part of the SASP is a huge dipole magnet weighing over 100 tonnes. On 10 March 1993, after weeks of preparation and rehearsals, and watched by a substantial number of TRIUMF staff, the dipole was lifted from its testing site in the proton hall extension, and lowered into the depths of the proton hall. The move went well, supervised by a lift master specially engaged for this task. By the end of March the spectrometer was well on the way to completion. The availability of DASS/SASP will open up a whole new range of nuclear physics experiments in the future.

For the Applied Programme, a significant improvement this year was the work done toward building a suitable beam line and treatment room for proton therapy (discussed on page 7).

TRIUMF KAON Ventures Office

TRIUMF's fiscal year 1992–93 was the second full year of operation of the TRIUMF KAON Ventures Office (TKVO). Its mandate continues to be the vigorous pursuit of all financially and technically viable opportunities for commercializing the technologies that evolve from research at TRIUMF. These technology opportunities, and their resultant commercial activity and potential, have exceeded the original forecasts for the TKVO. The 1992–93 royalty revenues to TRIUMF from current licences amounted to more than $800,000. Additional revenue came from consulting activities. These results directly reflect the excellence of the scientific enquiry going on at TRIUMF.

A continuing grant from the Provincial Government to TRIUMF provided the TKVO's funding during fiscal 1992–93.

In commercializing TRIUMF's technology (i.e. transferring it into industry), we give preference to Canadian firms. Where we cannot find an appropriate receptor company in Canada, then the search becomes international. TKVO utilizes five fundamental approaches in transferring technology from TRIUMF to industry:

1. Consulting services for industry
2. Staff secondment
3. Start-up companies
4. Joint ventures with industry
5. Licence agreements with industry

During 1992–93, TRIUMF provided technical assistance to five private-sector companies and one foreign research facility, both through consulting arrangements and through staff secondments.

Although a small team of TRIUMF employees was ready, at the start of the year, to establish its own private spin-off company with technology licensed from TRIUMF, the proposed funding did not materialize, and the project is still in a nascent stage. TRIUMF and the TKVO continue to proceed with caution on joint ventures with commercial partners, because of the potential downside risks. This year, however, TRIUMF started a repositioning strategy: it incorporated a private company, a wholly owned subsidiary of TRIUMF, to benefit from the upside potential of some of its technologies, through share options and other financial vehicles. This new company may also be able to take advantage of tax incentives available for applied research and development. To clarify this situation, TRIUMF is retaining outside consultants for advice on an appropriate approach.

TRIUMF signed two new licence agreements with commercial partners during 1992–93, and was actively negotiating with about five others. Of course, negotiations ebb and flow: during the year some potential licensees withdrew, and others appeared.

Royalty revenue for the year amounted to slightly over $800,000, an increase over the $545,000 received the previous year. The upward trend may slow during the coming year, but some very exciting technologies show tremendous promise for the medium-term future.

During this year, TRIUMF filed for three patents for its technologies, and has two more currently under review with its patent attorney. The year also saw the signing of a general agreement with a Japanese company to cooperate in some research activities with an exciting potential for the future. Also, TRIUMF assisted various industrial partners in obtaining an aggregate of close to $1 million in government funding for applied research. This research has been conducted primarily at TRIUMF, for application by the private-sector sponsors.

The approach taken by TRIUMF and the TKVO is to patent only those technologies that require patenting in order to protect opportunities for commercial application. Thus, during the year, about fifty technologies were presented to the TKVO. Of these, eight were subjected to formal TRIUMF review. The remainder are still subject to review and further development.

TRIUMF's international reputation for science excellence, combined with its success in commercializing its own technologies, has led to requests from other research laboratories, particularly in the countries of the former Soviet Union, to sign letters of intent to cooperate in the commercialization of their technologies. The Ventures Office has worked on these requests in close collaboration with the federal Department of External Affairs, and this has resulted in the signing of several such letters.

TRIUMF and the TKVO continue to disseminate information concerning the current twenty or thirty most promising technologies through the programme (initiated last year) of participation in trade shows across Canada. These ventures are proving to be an ongoing success, particularly since the programme has been enhanced by the purchase of a portable booth by the TRIUMF Information Office. The TKVO continues to produce appropriate support brochures and product sheets on an ongoing basis, and we anticipate that this will become a permanent process.

A functional and efficient network of contacts and associates is essential for effective technology transfer from any facility like TRIUMF. Throughout the past year, the TKVO has maintained and enhanced its connections with both industry and other research institutions and their commercialization offices.

While we have succeeded in the past year in transferring technology from TRIUMF into the commercial marketplace, the future looks even more promising. Projects currently at the negotiation stage should result in a commendable performance in the commercialization of TRIUMF technology for some years to come. The key, however rests in the calibre of the science conducted at TRIUMF: where there is excellence in research, commercial technology will follow.

CURRENT LICENCES

- Isotopes
- Cyclotrons
- Solid Targets

PRODUCTS DEVELOPED

- Imaging software
- Flow meter (fluids)
- Mathematical software

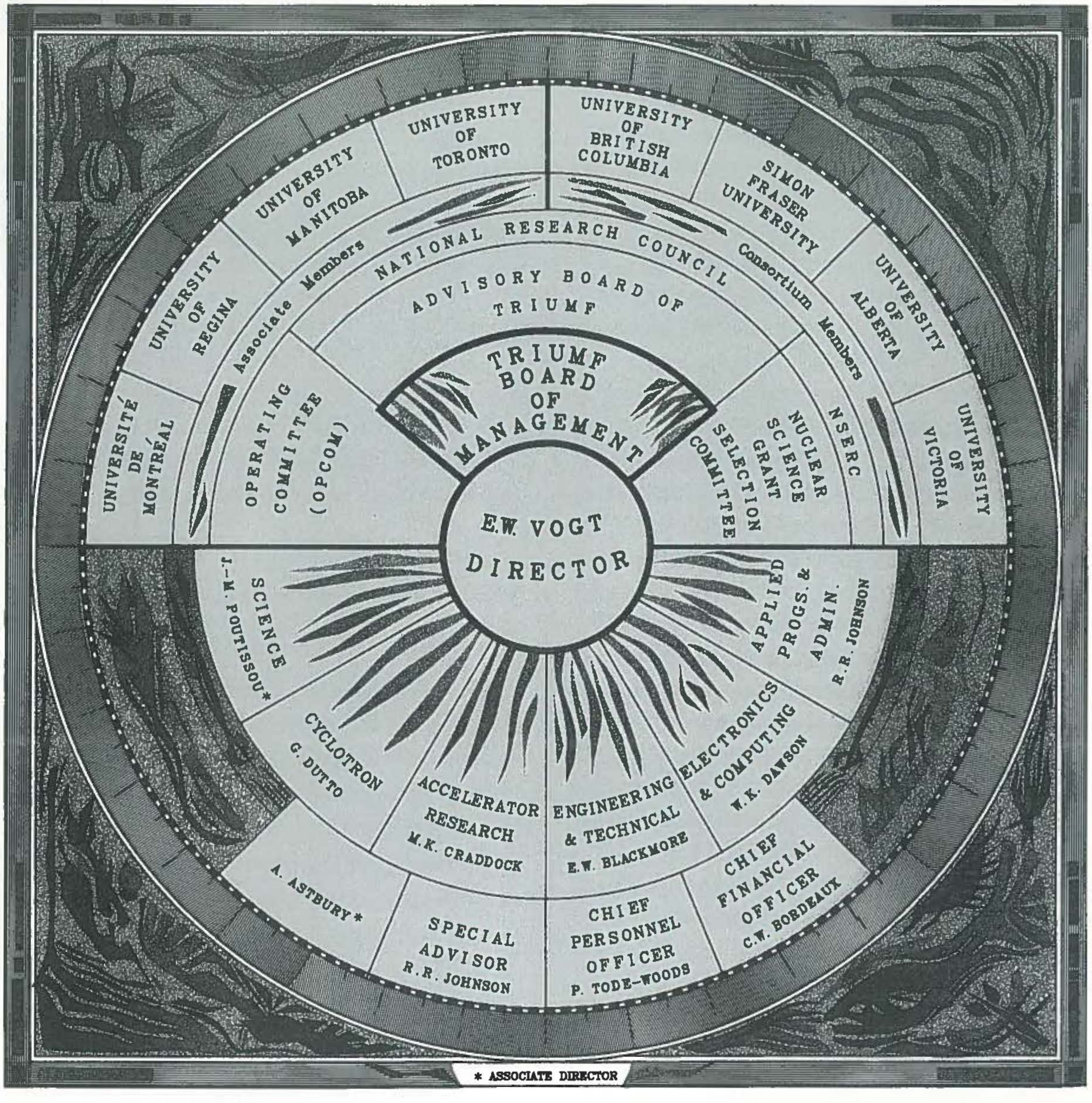
CURRENT OPPORTUNITIES

"Teaming" agreements for further development and subsequent licensing of:

- 3-D medical scanning device
- Remote-controlled vehicle
- Nitrogenous explosives detector
- Drug detector
- Smoke stack emission control
- Radiation detectors
- Vacuum gauge controller
- Imaging of brain virus

Technologies developed have resulted in annual industry sales of $25 million.

Organization Chart



The receipt of $6,400,000 from the Department of Industry, Science & Technology, through the National Research Council, as a supplement to the base budget of $24,860,000, meant that some long-delayed maintenance work could be done and a start made to upgrade some of the facilities. It also allowed staff levels to be kept constant.

The funding of experiments was increased by $567,831 (about 14%) via the TRIUMF Common Grant from the Natural Sciences and Engineering Research Council (NSERC). The bulk of this increase was awarded near year-end, causing a larger fund balance than usual. NSERC awards additional funds for experiments at TRIUMF to grantees at member or affiliated universities. Those amounts are not known to us, as the appropriate universities account for them.

The Medical Research Council continues to award grants for TRIUMF-related experiments, but channels those through universities only. Again, we are not informed about the amounts granted. The major experiment related to the MRC is the Positron Emission Tomography project under the leadership of Dr. Tom Ruth.

Transactions by affiliated institutes remained relatively constant.

NORDION International Inc. used TRIUMF services slightly less than in the previous year, but this did not adversely affect TRIUMF revenues from NORDION. EBCO Industries Ltd's use of TRIUMF services increased considerably due to their starting construction of the TR13 cyclotron. Both NORDION and EBCO have technology transfer licences from TRIUMF which produced $771,405 in royalty income for TRIUMF, an increase of $209,141 over last year.

Negotiations are ongoing with both the federal and the provincial governments, and between those governments, about the future direction of TRIUMF. These discussions have become prolonged, so that we now have a chronic shortfall in the funding base, which requires annual supplements. It is expected that solutions to this *ad hoc* financing will be forthcoming, and that long-range planning can be restored in time.

C.W. Bordeaux
Chief Financial Officer

SOURCE OF FUNDS	*1992–93*		*1991–92*	
	$ million	*%*	*$ million*	*%*
National Research Council	*31.2*	*73.1*	*28.5*	*72.7*
NSERC	*4.6*	*10.7*	*4.0*	*10.2*
NORDION International Inc.	*1.9*	*4.6*	*2.3*	*5.9*
Affiliated Institutions	*2.9*	*6.8*	*3.3*	*8.4*
EBCO Industries Ltd.	*1.1*	*2.5*	*0.3*	*0.8*
Royalty Fund	*0.8*	*1.8*	*0.6*	*1.5*
Investment & Other Income	*0.2*	*0.5*	*0.2*	*0.5*
	42.7	*100%*	*39.2*	*100%*

From the Auditor

Coopers & Lybrand | chartered accountants | a member firm of Coopers & Lybrand (International)

AUDITORS' REPORT

To the Board of Management of TRIUMF

We have audited the statement of financial position of TRIUMF as at March 31, 1993 and the statements of funding and expenditures and changes in fund balances for the year then ended. These financial statements are the responsibility of TRIUMF's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with generally accepted auditing standards. Those standards require that we plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In our opinion, these financial statements present fairly, in all material respects, the financial position of TRIUMF as at March 31, 1993 and the results of its operations and the changes in its fund balances for the year then ended in accordance with generally accepted accounting principles.

Coopers & Lybrand

Vancouver, B.C.
June 4, 1993

NOTE: The excerpts from the Auditor's Report in the following pages are prepared by the TRIUMF Information Office, which takes responsibility for any inadvertent errors or deviations. Copies of the entire Auditor's Report to the TRIUMF Board of Management are available from the TRIUMF Business Office. [Editor]

TRIUMF

STATEMENT OF COMBINED FUNDING AND EXPENDITURES AND CHANGES IN FUND BALANCES

For the Year Ended March 31, 1993

FUNDING	1993	1992
National Research Council	$ 31,260,000	$ 28,455,000
Natural Sciences & Engineering Research Council	4,560,500	3,992,669
NORDION International Inc.	1,946,739	2,283,567
Affiliated institutions	2,909,827	3,301,509
EBCO Industries Ltd.	1,068,660	367,017
Royalty Fund	771,405	562,264
General Fund	222,574	266,794
	42,739,705	39,228,820

EXPENDITURES		
Buildings	80,388	–
Communications	289,592	270,609
Computer	1,843,602	1,704,287
Equipment	2,336,646	2,331,407
Power	1,754,981	1,951,294
Salaries and benefits	26,004,862	24,526,551
Supplies and expenses	9,366,562	7,533,005
	41,676,633	38,317,153

Excess of Funding over Expenditures for the Year	1,063,072	911,667
Fund Balances — Beginning of Year	2,680,373	1,768,706
Fund Balances — End of Year	$ 3,743,445	$ 2,680,373

TRIUMF

STATEMENT OF FINANCIAL POSITION

As at March 31, 1993

	1993	1992
ASSETS		
Cash & Temporary Investments	$ 4,149,436	$ 3,363,172
Funding Receivable (note 3)	1,736,476	942,889
Total Assets	$ 5,885,912	$ 4,306,061
LIABILITIES		
Accounts Payable	$ 1,062,940	$ 808,314
Deferred Funding	Nil	124,352
Due to (from) Joint Venturers		
The University of Alberta	2,935	(8,255)
The University of Victoria	(709)	6,389
The University of British Columbia	1,074,013	688,486
Simon Fraser University	3,288	6,402
	1,079,527	693,022
	2,142,467	1,625,688
FUND BALANCES		
Natural Sciences & Engineering Research Council (note 5)	1,346,111	1,098,471
NORDION International Inc.	100,000	12,351
Affiliated Institutions	(18,215)	(297,992)
EBCO Industries Ltd.	(192,915)	15,735
Royalty Fund	857,725	523,485
General Fund	817,042	801,222
Intramural Accounts	833,697	527,101
	3,743,445	2,680,373
Total Liabilities & Fund Balances	$ 5,885,912	$ 4,306,061

Encumbrances and Commitments (note 4)

TRIUMF

STATEMENT OF FUNDING AND EXPENDITURES

NATIONAL RESEARCH COUNCIL

For the Year Ended March 31, 1993

	1993	1992
FUNDING		
Contributions	$ 31,260,000	$ 28,455,000
EXPENDITURES BY ACTIVITY AREA		
Salaries	21,988,048	20,920,073
Power	1,754,981	1,951,294
Administrative and overhead	1,954,478	1,821,403
Cyclotron and facilities operation	2,256,903	2,357,834
Site services	689,680	366,124
Support services	1,698,138	938,527
Major projects	812,127	373,028
Minor projects and development	732,402	418,857
	31,886,757	29,147,140
Funds recovered — salaries and cost centres	(626,757)	(692,140)
Total Expenditures	31,260,000	28,455,000
Excess of Funding over Expenditures for Year	$ Nil	$ Nil
EXPENDITURES BY OBJECT		
Buildings	$ 54,718	$ –
Communications	255,322	234,348
Computer	1,439,646	1,030,735
Equipment	1,298,291	1,018,735
Power	1,754,981	1,951,294
Salaries and benefits	21,988,048	20,920,073
Supplies and expenses	4,962,681	3,713,907
Salary expenditure recovered	(493,687)	(414,092)
	$ 31,260,000	$ 28,455,000

TRIUMF

NOTES TO FINANCIAL STATEMENTS

For the Year Ended March 31, 1993

1. Joint Venture Operations

TRIUMF is a joint venture established by the University of Alberta, the University of Victoria, Simon Fraser University and the University of British Columbia, having as its goal the establishment and continuance of a national facility for research in intermediate energy science under a contribution from the National Research Council of Canada. As a registered charity, TRIUMF is not subject to income tax.

Each university owns an undivided 25% interest in all the assets, and is responsible for 25% of all liabilities and obligations of TRIUMF, except for the land and buildings occupied rent-free by TRIUMF, which are owned by the University of British Columbia.

These financial statements include only the statements of fund transactions of TRIUMF and do not include the assets, liabilities, revenues and expenditures of the individual joint venturers. The sources of funding include grants and contributions from the NRC, NSERC and governments; advances and reimbursements from other sources; and investment income. The sources and purposes of these funds are:

(a) National Research Council (NRC)
Funding of operations, improvements and development; expansion of facilities (buildings excluded); and general support for experiments.

(b) Natural Sciences and Engineering Research Council (NSERC)
Funding to grantees for experiments related to TRIUMF activities. These funds are administered by TRIUMF on behalf of the grantees.

(c) NORDION International Inc.
Advances and reimbursements for expenditures undertaken on its TRIUMF project.

(d) Affiliated Institutions
Advances and reimbursements for expenditures undertaken on behalf of various institutions, from Canada and abroad, for their TRIUMF projects.

(e) EBCO Industries Ltd.
Advances and reimbursements for expenditures undertaken on the 30 MeV cyclotron project.

(f) Royalty Fund
Royalties from technology transfer agreements.

(g) General Fund
Investment income for discretionary expenditures incurred by TRIUMF.

(h) Intramural Accounts
Net recoveries for internal projects and services. The recoveries of expenditures are charged to the appropriate TRIUMF funding source by Intramural Accounts.

2. Significant Accounting Policies

Basis of Presentation

TRIUMF follows generally accepted accounting principles for non-profit organizations as referred to in the CICA Handbook. Expenditures on capital assets and supplies are expensed as incurred.

Royalty Income

TRIUMF records royalty income when notification and verification of sales are received.

3. Funding Receivable

	1993	1992
Natural Sciences and Engineering Research Council	$ 266,975	$ 423,395
NORDION International Inc.	251,836	305,976
Affiliated Institutions	468,480	103,758
EBCO Industries Ltd.	749,185	109,760
	$ 1,736,476	$ 942,889

Funding receivable from affiliated institutions comprises —		
Funding receivable	$ 1,414,243	$ 597,428
Less: Funding received in advance	(945,763)	(493,670)
	$ 468,480	$ 103,758

4. Encumbrances and Commitments

In addition to the accounts payable reflected on the statement of financial position, outstanding encumbrances and commitments, representing the estimated costs of unfilled purchase orders and contracts placed at the fiscal year end, comprise:

	1993	1992
National Research Council	$ 379,000	$ 445,000
Natural Sciences and Engineering Research Council	65,000	249,000
NORDION International Inc.	9,000	53,000
Affiliated Institutions	58,000	38,000
EBCO Industries Ltd.	7,000	–
Royalty Fund	30,000	20,000
General Fund	5,000	85,000
Intramural Accounts	182,000	4,000
	$ 735,000	$ 894,000

5. Natural Sciences and Engineering Research Council — Fund Balance

	1993	1992
Funding unexpended	$ 1,689,884	$ 1,536,834
Grant accounts overexpended	(343,773)	(438,363)
Fund balance — end of year	$ 1,346,111	$ 1,098,471
Number of grants awarded during year	44	48
Number of grants administered throughout year	97	110

6. Pension Plans

The employees of TRIUMF are members of the pension plan administered by the university that sponsors their employment. TRIUMF records the pension expense as cash contributions are made to the plan based on a prescribed percentage of employee earnings. The pension expense for the year was $1,442,000 (1992 — $1,368,432).

1993 TUEC
(TRIUMF Users' Executive Committee)
Chairman: W.T.H. van Oers
Associate Chairman: B. Jennings
Members: M. Blecher, D. Ramsay, D. Wright
Past Chairman: A. Olin
Liaison Officer: M. La Brooy

TRIUMF Users' Group

(as of March 1993)

497 Members — 158 Institutions — 28 Countries

TRIUMF

M. Adam
W. Andersson
A. Altman
P.A. Amaudruz
W. Andersson
D. Axen
R. Baartman
S. Baer
M.J. Barnes
C. Bennhold
J.L. Beveridge
E.W. Blackmore
C.W. Bordeaux
J. Brack
P. Bricault
D.A. Bryman
K. Buckley
J.W. Carey
G. Chadwick
C. Chen
M. Comyn
M.K. Craddock
J. Cresswell
W. Cummings
P. Delheij
J. Doornbos
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D. Ottewell
B.P. Padley
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J.M. Poutissou
R. Poutissou
M.A. Punyasena
A. Ramos
K.J. Raywood
G. Redlinger
J.G. Rogers
L.Root
J. Roy
T.J. Ruth
M. Salomon
S. Scherer
P. Schmor
H.R. Schneider
J.W. Schneider
R. Schubank
M. Senba
M. Sevior
K-S. Sim
G. Smith
J.E. Sonier
V. Sossi
N. Stevenson
G. Stinson
I.M. Thorson
H. Trottier
A Trudel
S. Veillette
E. Venczel
V.K. Verma
M. Vetterli
J.S. Vincent
E.W. Vogt
G.D. Wait
P. Walden
K. Warman
G. Waters
N. Wilkinson
R. Woloshyn
D.H. Wright
S. Yen
You Ke
M. Zach
M. Zhong

CONSORTIUM MEMBERS

U. of Alberta
R. Abegg
W.K. Dawson
P. Green
L.G. Greeniaus
P. Kitching
N. Kolb
E. Korkmaz
J. Li
W.J. McDonald
P. McNeely
T. Nakano
W.C. Olsen
A.K. Opper
G. Roy
F.M. Rozon
H. Sherif
J. Soukup
T. Stocki
G.R. Mason
A. Olin
C.E. Picciotto
P.R. Poffenberger
P.A. Reeve
L.P. Robertson

Simon Fraser U.
B. Addison-Jones
M.S. Atkins
J. Brodovitch
J.M. D'Auria
M. Dombsky
R. Harrop
K.P. Jackson
P.W. Percival

U. of Victoria
A. Astbury
G.A. Beer
T.A. Hodges
R. Keeler
D.E. Lobb

U. of B. C.
I. Affleck
A. Ambardar
D. Arsenau
J.H. Brewer
K. Chow
T. Duty
D.G. Fleming
S. Gil
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J. Hoey
P. Hoffman
S. Johnston
G. Jones
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P.W. Martin
D.F. Measday
G.D. Morris
C. Orvig
S. Ounsiger
V. Pacradouni
M. Pavan
D. Sirota
R.J. Snooks
N. Suen
D.C. Walker
C.E. Waltham

ASSOCIATE MEMBERS

U. of Manitoba
D.J. Birchall
J. Campbell
C.A. Davis
W.R. Falk
L. Gan
M. Landry
S.A. Page
W.D. Ramsay
A. Sekulovich
K.S. Sharma
J.P. Svenne
W.T.H. van Oers
J. Zhao

U. de Montréal
G. Azuelos
P. Depommier
C. Leroy

U. of Regina
G.M. Huber
G.J. Lolos
E.L. Mathie
S.I.H. Naqvi
R. Tacik
D.M. Yeomans

U. of Toronto
R. Azuma
D. Bandyopadyay
J.D. King
J.D. Powell

TRIUMF Users' Group—Other Institutions

Canada

B.C. Cancer Agency — M.K. Dimitrov
B.C. Cancer Foundation — L.D. Skarsgard
B.C. Cancer Research Centre — D. Garner
B.C. Children's Hospital — H. Nadel
BCIT — B. Pointon
Calgary U. — C.Y. Kim
Carleton U. — M. Dixit, R. Hemingway
Chalk River Nuclear Laboratories — J.C. Hardy, I.S. Towner
EBCO Industries — J.T. Sample
Foster Radiation Lab. — J.K.P. Lee
IBC — J.C. Prior
Kwantlen Coll. — J.B. Pearson
Laurentian U. — C. Virtue
Lion's Gate Hosp. (Vanc.) — P. Cohen
McGill U. — D. Britton
Ottawa Civic Hosp. — N.G. Hartman
Queen's U. — B.C. Robertson
Saskatchewan U. — E.J Ansaldo, C. Rangacharyulu, Y.M. Shin
St. Paul's Hospital — A. Belzberg
University Hospital (UBC) —D.B. Calne, B. Kramer, L-Y. Chan, R. Morrison, B.J. Snow, I. Szaz
Vancouver Gen. Hosp. — A. Celler, S.A. Jackson, B. Lentl, R.A.L. Sutton, W. Thompson, V. Walker
W. Ontario U.— W.P. Alford

Outside Canada

Australia
Adelaide U. — B. Pearce
Flinders U. of South Australia — I.R. Afnan, B. Blankleider
U. of Melbourne — S.A. Long, B.M. Spicer

Belgium
Université Catholique de Louvain — J. Deutsch

Bulgaria
Sofia U. — I. Enchevich

China
Peking U. — Y. Ye

Croatia
Zagreb U. — M. Furic

Finland
U. of Helsinki — J. Niskanen

Germany
DESY — K.M. Furutani, W. Schott
Erlangen U. — H.M. Hofmann
IEK— W. Klug
Karlsruhe U. — H.M. Staudenmaier
KFA Jülich — S. Martin
Max Planck Institut — C. Wiedner
Muenster U. — D. Frekers
Ruhr U., Bochum — H. Freiesleben
Tubingen U. — G. Wagner

Greece
INS — X. Aslanoglou
Patras U. — D.S. Tsatis

Hungary
Budapest Research Inst. for Physics — D. Horvath

India
Hindustan Lever Ltd. — K. Venkateswaran

Israel
Ben Gurion U., Negev — S. Mordechai
Hebrew U. — E. Friedman, N. Kaplan, A. Leviatan, M. Paul
Tel-Aviv U. — J.M. Eisenberg, M. Moinester

Italy
Cons. Naz. D. Ricerche — S. Marco
Milano U. — C. Birattari
Inst. di Fisica, Trieste — N. Grion

Japan
KEK — S. Kanda, Y. Kuno, K. Nakai, K. Yoshitaka
Osaka U. — N. Matsuoka
Tokyo Inst. of Techn. — N. Nishida
Tokyo U. — P. Birrer, K. Kojima, T. Nagae, K. Nagamine, K. Nishiyama, M-H. Tanaka, T. Yamazaki

Korea
Seoul Nat. U. — J.C. Kim
Yonsei U. — J.M. Lee

Netherlands
Kernfysich Vers. Inst. — A.M. van den Berg
Tech. Hogeschool Delft — H. Postma
Utrecht U. — J. Congleton

Poland
Warsaw U. — A. Sliwinski

Russia
INR, Dubna — P. Nomokonov
INR, Moscow — K. Alexei, A.S. Belov, V.N. Bolotov, R. Djilkibaev, V. Gaidach, A. Iliev, N. Ilinsky, I. Kopeikin, A. Krasulin, V.D. Laptev, V.A. Matveev, E.A. Monich, P.N. Ostroumov, V. Paramonov, A. Pashenkov, A. Poblaguev, V.G. Polushkin, P. Reinhardt-Nikulin, J. Senichev, S. Serezhnikov, E. Shaposhnikova, N.A. Titov, A. Zelenski
INR, Novosibirsk — A.A. Bashkeev, A. Kupriyanov
Inst. Theor. & Expt. Phys. — P. Volkovitsky
ITEP — M. Katz

TRIUMF Users' Group—Other Institutions

I.V. Kurchatov Inst. — V. Keilin, I. Kovalev, E. Krasnoperov, E. Meilikhov, V. Selivanov, V. Storchak

LNPI, Leningrad — A. Kotov, D. Seliverstov

Moscow RTI — V.A. Konovalov

Moscow EPI — A.L. Mykaelyan

SPB State U. — A. Bolokhov

Saudi Arabia

King Fahd U. — El-Kateb

South Africa

Nat. Accelerator Centre — D.M. Whittal

Witwatersrand U. — K.P.F. Sellschop, G.C. Smallman

Spain

Valencia U. — A. Ramos, M. Vincente

Sri Lanka

P. Lumumba U. — K. Jayamanna

Switzerland

Basel U. — A. Feltham

CERN — A. Noble, C. Oram, A. Rijllart, P. Weber

Fribourg U. — F. Muelhouser, L. Schellenberg

Mittelenergiephysik — W. Gruebler

PSI — R. Abela, A. Amato, B. Blankleider, F.S.N. Gygax, P. Locher, E. Morenzoni, A. van der Schaaf, H.C. Walter

Zurich U. — R. Engfer, E. Roduner

Ukraine

INR — A. Papash

United Kingdom

Leicester U. — E.D. Davis

Rutherford Lab. — S. Cox

Sussex U. — K. Prassides

United States

Argonne N.L. — M. Barnabas

Arizona State U. — J. Comfort, R.F. Marzke

BNL — E. Kistenov, T.E. Ward, C. Woody

Boeing Def. & Space Gp. — E. Normand

Boston U. — J.P. Miller

Bowdoin Coll. — G.T. Emery

California State U. — E.F. Gibson

California U., Berkeley — M.W. Strovink

Carnegie-Mellon U. — P.D. Barnes, A. Berdoz

CEBAF — D.J. Mack

Centenary Coll. — J. Lisantti

Central Washington U. — W.C. Sperry

Colorado U. — X.Y. Chen, S. Hoibraten, M.D. Holcomb, J.J. Kraushaar, R.A. Ristinen, W.R. Smythe

Columbia U. —G. Luke, T. Uemura

Florida State U. — H.S. Plendl, A.G. Williams

George Washington U. — Z. Papandreou

Harvard U. — J. Sisterson

Hood College — J.M. Stadlbauer

Illinois U. — P.T. Debevec, A.M. Nathan

Indiana U. — R.D. Bent, J.M. Cameron, W.P. Jones

IUCF — P. Schwandt

Johns Hopkins U. — Y.K. Lee

Kent State U. — R. Madey, P. Tandy, J.W. Watson

Kentucky U. — T. Gorringe, M. Kovash, K. Lin, M.A. Pickar

Lawrence Berkeley Laboratory — D.S. Armstrong, J. Batchelder, K.M. Crowe, D.M. Moltz, C. Naudet, G. Odyniel, T. Ognibene

LLNL — S. Han, L.S. Pan

Los Alamos National Laboratory — L.E. Agnew, W.D. Cook, R.E.L. Green, R.C. Haight, C. Laymon, C.L. Morris, S. Stanislaus, W.L. Talbert, D.J. Vieira

U. of Maryland — D. Leinweber, P.G. Roos

Minnesota U. — D. Dehnard

Mississippi State U. — R.B. Piercey

MIT — R.P. Redwine

New Mexico U. — B. Bassalleck, M.D. Chapman, B. Dieterle

New York State U. — D. Gabor

Oak Ridge National Laboratory — D.J. Horen, K.S. Toth

Ohio State U. — K.K. Gan, H. Kagan, R.L. Malchow, S. Shao, C. White

Ohio U. — J. Rapaport

Old Dominion U. — S. Kuhn

Oregon State U. — A.W. Stetz, L.W. Swenson

Pacific Northwest Labs — P.L. Reeder

Pennsylvania U. — H.T. Fortune, P. Hui, M. McKinzie, A. Williams

Princeton U. — R. McPherson

Rice U. — S.A. Dodds, T.L. Estle

Rutgers U. — C. Glashausser, S.K. Kim, G. Thomson

SSC Lab — D.P. Coupal, A. Fry, D.P. Gurd, T. Pal, M. Turcotte, U. Wienands

Stanford U. — S.S. Hanna

SUNY — C-M. Zou

Temple U. — C.J. Martoff, Y. Zhang

Texas A&M U. — R.A. Bryan

Texas Tech. U. — D. Lamp, R. Lichti

UC Santa Cruz — K. O'Shaughnessy

UCLA — B.M.K. Nefkens

User Technology Assoc. — J. Kempton

Virginia Polytechnic Institute and State U. — M. Blecher, K. Gotow, D. Jenkins

(Continued from page 6)

has a clogged needle valve again. . . . There. Yes, we have data again, but you need to shift the timing back 3 nanoseconds on the left counter."

Advisor (fiddling with some switches in the electronics rack): OK, zero the run and try that." *He flicks on a small light in the back of the room and comes up to look over the Student's shoulder.*

Student: "Looks good. Let's take some data!"

Advisor (wearily): "I hope its right this time, I want to sleep." *He sits down in a spare chair and they both wait quietly for a few minutes.*

Student (pecking at the keyboard with a frown): "Funny. The signal is there, but it's relaxing a lot faster than at 40°K."

Advisor: "Do a Fourier transform, let's see if there's a Knight shift."

Student (after typing a few more commands): "What? The frequency *dropped!* That can't be right."

Advisor (groans): "Oh no, the magnet power supply is fried again."

Student (pointing to a glowing display): "No, look — the NMR is still in regulation."

Advisor: "Maybe someone kicked the cryostat. I'll go look." *Exits through counting room door. Returns a minute later.* "It doesn't look any different from outside. What's wrong now?"

Student: "Maybe it's new physics!"

Advisor: "Right, a diamagnetic shift of . . . what?" *He looks at the screen again.* "Five gauss? It would have to be superconducting!"

Student: "Well, the fast relaxation would go along with that."

Advisor: "At 25°K? If this stuff were superconducting at 25°K it would be the hottest thing since the quantum hall effect. They'd know!"

Student (looking up): "Still . . ."

Advisor (with a quizzical look): "Still . . ." *They look each other in the eye for a moment.*

Both, simultaneously: "Naaah!"

Advisor: "OK, pull this sample out and let's measure something reasonable instead."

Student: "You go on home and get some sleep. I'll take care of it."

Advisor: "OK, see you tomorrow. Good night." *He picks up some belongings and exits.*

Student: "Good night." *The door closes. The Student mutters to himself,* "Maybe I'll take a few more points on this sample just to make sure . . . ."

If only it had happened this way!

TRIUMF Users' Group—Other Institutions

Virginia State U. — D. Noakes, C. Stronach

Virginia Tech. — I. Strakovsky

Virginia U. — D.G. Crabb, E. Frlez

Washington U. — V. Cook, J.G. Cramer, C. Gossett, G.A. Miller, W.G. Weitkamp

Westinghouse (Hanford) — E.R. Siciliano

William & Mary Coll. — M. Eckhause, W.J. Kossler, R. Pourang

Yale U. — M. Gai

(Unaffiliated) — M. Halka

Uzbekistan

INR, Uzbek. — A. Avezov, A. Melis

NPI, Uzbek. — D. Mirkarimov

Yugoslavia

Ruder Boskovic Inst. — I. Slaus

[Note: Because of ongoing political changes in Eastern Europe, the affiliations and countries of Users' Group members from that area may now be different from those shown. — Editor]

Pictures of the Year

Clockwise, from top left: After the 110-ton SASP magnet lift—the team relaxes; newly installed section of muon beam line M9B; new beam lines for TISOL; core of the detector for Brookhaven experiment 787; SASP magnet in flight, coming in to land; new remote controlled vehicle.