CUPJ – Dr. Erich Vogt’s Interview – Full Transcription
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By Katy Hally and Patrick Bruskiewich

Katy: To begin with, could you tell me a little bit about yourself?

Erich: Yes, well you know I’m very ancient now; I was born in 1929 in Manitoba, in a little Mennonite village, about 40 miles outside of Winnipeg. And I grew up in this village of about a thousand people; it was a homogeneous village with everybody speaking a German dialect.

Katy: How did you become interested in physics?

Erich: I think I had a general interest in nature. I came to physics as a naturalist, not as a person seeing it as a profession. I was growing up on the prairies, so I was aware from the time before I went to school about the Milky Way. Because the village had very few lights, the sky was very brilliant – you even could see things like Andromeda, the nebula in the Milky Way – and I wondered what it was all about.

And you know, one of the biggest gifts we have – as I said in my summer student lecture – is the human sense of wonder. On the Canadian prairie where I grew up there were these wonderful bird migrations in the spring. We had a long, cold, Presbyterian winter, then the spring arrived just like a sudden burst and there were just millions of birds which came through. I got my mother to give me a bird book when I was very young. I had a great deal of pleasure, growing up in a rural community in which you were close to the forest and the birds and the stars and that’s what got me interested in nature.

Katy: Did you plan to become a physicist when you began university?

Erich: I was not focused on a career in physics because it seemed a remote occupation at the time. In fact until I was in third year university I was majoring in honors English. I was keeping my options open by taking extra subjects but switched over to physics in third year and never regretted the decision. One of my five children – my oldest son David – has a PhD in mathematics and teaches at UBC, but he got an honors degree in English and in physics in the same year. In Canada fortunately we don’t have to specialize too early.

I was a reasonably good student and went to this school in a little village called Steinbach, which was surrounded by Ukrainian communities, and then to the University of Manitoba. At the University of Manitoba I did reasonably well as a student. I began to understand what physics was about and who did it. I had one or two very good professors as a student, and I decided to go to graduate school at Princeton, which was then the foremost school – still probably is in North America – for physics…

Katy: It’s definitely one of them.

Erich: There were so many people there. Einstein was alive and was at the Princeton Institute for Advanced Studies.

Katy: Yeah, I heard you attended lectures by Einstein.

Erich: Well I heard his last lecture, and saw him frequently.

Katy: What was that like?

Erich: Well, he was a very good lecturer, but actually at the time he was working on things which didn't seem very productive. He wasn't in the main stream of physics at the time anymore, although we all knew he what he had done 50 years earlier. He had become a legend, of course, because of general relativity. He was famous as celebrity and he deserved fame. But he was also, I think, a very interesting person; a terrible husband and father, but he knew it. You know, the world is full of terrible husbands and fathers, but unlike most Einstein knew he was a terrible husband and father.

Katy: Probably a very good realization…

Erich: Yes, it is. Yes, better than the people who don't realize that they are. And, at Princeton at the time there were, of course, people who were brighter. I knew very well, Neumann, John Von Neumann, who started computers and whatever. He was just so much brighter than anyone else around that people thought he was from Mars; he was so very very intelligent. And I had, worked with Wigner, who was also a very impressive person, and I knew most of the founders of Quantum Mechanics; Pauli was around, and Bohr.

Patrick: So how did you become Eugene Wigner's PhD student?

Erich: Well, I came to Princeton on fellowship and told them I was going to do my PhD in theoretical physics. I expressed interest in my correspondence with Princeton in what he was doing, and he looked at the crop of students and fortunately he decided that I should be the one who worked with him that year. We had a very close association; I worked there for three years.

Katy: What did you work on?

Erich: I worked with him on nuclear physics. It was just the time when nuclear physics as we know it today was immerging. The big question of the day was, how could you have a model, called the shell model, as simple as the model which you had for electrons around atoms? How could that work, because the nuclear force was so extremely pathological at short range. It was very strong, and so the Hamiltonian was not at all an average Hamiltonian. But in atoms you have the average nuclear field of the nucleus which keeps them going in orbits but the neutrons and protons have to lift themselves by

their bootstraps and you can say that they create their own average field. But then, if you want to say something as brave or as foolish as that, you have to say why was that a reasonable approximation, because the average of the interactions was very different from the interactions and would make any orbits disappear very rapidly. As a matter of fact, my thesis with Wigner was on that subject, about why the shell model orbits last as long as they do. If you read Murray Gell-Mann's – I know Murray, he's a friend of mine – his autobiography, he worked on the same problem with Weisskopf at MIT.

Patrick: So they reached the same conclusion as you did?

Erich: No, their work wasn't successful. He says in his autobiography that Wigner did it better and he was referring to my work. It was very much under Wigner's guidance. But it was a central problem of the day; it was just at the time, in the early fifties, when new fields were immerging. You know, microelectronics – we called it solid-state physics at the time or condensed matter physics a little later – was an immerging field. Particle physics and cosmology emerged as serious fields of science for the first time. And nuclear physics – because we had only reached several MeV in accelerators – was then the queen of sciences. The Second World War was just over and the Manhattan project had given physics, and the branch of nuclear physics, the dominant role among the sciences. Every bright young scientist wanted to go into this field. Now they have far more choices; for example they can go into microbiology, which was then just immerging. I remember when the very first talk on, when I was a student, about DNA.

Patrick: By Watson and Crick?

Erich: No, it was by a Nobel Laureate, Bragg, who was head of the Cambridge lab where Watson and Crick worked. It was a wonderful idea, and created an entirely new field of science. Watson and Crick were physicists.

Patrick: Max Delbrook as well.

Erich: Yes, I heard Max Dellbrook lecture as well. It was a time when all these fields were emerging. And at that time, physics was still significantly more unified than it is now. At Princeton I had just been married, and we had three children during those three years. My wife was a librarian at the Institute where Einstein worked, and so, to earn money, I worked on solid state theory in the summer at Bell Labs. So I was really a student of Wigner's for the 27 winter months, but he did not mind that I was doing other things than nuclear physics in the summer.

Patrick: Were you working with Shockley and Bardine?

Erich: Well, I occupied an office with Walter Brattain who was one of the Nobel Prize winners. Shockley had just left. I worked on semi conductors and with Conyers Herring. Phil Anderson was in the same small group, and Walter Kohn.

Patrick: The same Dr. Walter Kohn who gave a talk at your symposium?

Erich: Yes, he gave a lecture at my little affair a few weeks ago. Physics was still unified; we all went to a New York meeting, which was the annual meeting of the American Physics Society – the same way that the Canadian Association of physicists have one annual meeting – and I heard Fermi lecture there.
Patrick: What were you impressions listening to Fermi's lectures?

Erich: Well, they were all different personalities, you know. Fermi was perhaps the best public speaker of the whole bunch; he was really very very impressive.

Patrick: He was considered the pope of physicists, wasn't he?

Erich: Yeah. He was the last, people often think of him as the last of the complete physicists because not only interested in all fields; he was also both an experimentalist and a theorist. And, in that way he was a very rounded and gifted person. But I was also very lucky to meet many of the people working with Wigner. When I was still a 24 year old graduate student there was a big nuclear physics conference, the only one which took place in the 50s, at Brookhaven labs. I was to give the opening talk and in the front row were Bethe, Breit, Weisskopf, Wigner, and many other people. I was hardly older than you are now, and it was good experience. I got to know all of those people very well.

Katy: Of all these remarkable people that you met, was there one that stood out as a really interesting character?

Erich: Well, they all had different personalities and one could tell interesting stories about them all. The most terrible man among them was Pauli. Pauli liked to be rude to people.

Katy: I've heard stories.

Erich: Yes. When I was at a seminar he spoke at in Britain, a graduate student asked a question, and he said 'I don't mind answering stupid questions, but I won't answer stupid questions from fools.' Which was enough to make one not ask another question right away.

Katy: I would imagine so.

Erich: Yes. But they weren't all that way; the range of personalities was the same as it is in everyday life. Probably the one that had the wildest character was George Gamow. He was usually drunk.

Patrick: Was he?

Erich: Oh yes. Even early in the day.

Patrick: Even early in the day…Do you think that was why he was so creative with his thoughts?

Erich: No, no, I think he was just a generally creative person.

Patrick: I still read some of his books from the sixties; they're wonderful things to read.

Erich: Yes they were, he was well known as a wonderful person at writing popular books in science, as well as a very gifted physicist. Teller, whom I knew well too, was, on the other hand, not a very nice person either.

Patrick: Was his a personality that either liked you or didn't like you? Was there any grey in his sensibilities?

Erich: He constantly needed or wanted reinforcement.

Patrick: He was a chemist by training wasn't he?

Erich: No, a physicist. He and Wigner were very close friends, that's why I knew him. They met in 1927, the year after Quantum Mechanics was born. And they, as students then, immediately understood that you had the whole universe now to describe in terms of this new science and that's what they dedicated their life to doing. Szilard was another of those. There were three or four who were sort of in the second-tier of quantum mechanics.

Patrick: Did they meet at Gottingen?

Erich: Yes, that's where they met, but they both came out of Budapest. Von Neumann came out of Budapest too.

Patrick: Yes, the three Martians.

Erich: No, there were more, there were about five or six of them.

Patrick: George Placzek? No, he was Czechoslovakian.

Erich: Yes, yes, but there were more Hungarians that were involved in the Manhattan project. But as I say, Neumann was simply so quick and intelligent, he never seemed to work more than about an hour a day. He was, again, a childhood friend of Eugene Wigner's, and Wigner was always very impressed with him.

Patrick: Supposedly you could ask him to quote back a specific paragraph on a specific page of a book such as Thucydides *The History of the Peloponnesian War*…

Erich: He remembered every page he read, like Murray Gell-Mann who can remember every page that he's ever read. But Neumann at that time had just started working on the hydrogen bomb and was very busy with it. He did all his work in the morning and in the afternoon he'd be bored, so he'd sit in Wigner's office. I happened to be one of those students of Wigner's who saw him once a week regularly for an hour to tell him what I was doing, and Neumann would just be sitting there, you wouldn't know what he was doing, or what he was thinking and it could have been intimidating.

Patrick: Did he ever ask any questions?

Erich: No, no he just sat there silently. Yes, it would have been more disturbing really if he had asked a question, everyone knew how bright he was. But that didn't happen. It was a time, as I say, when the whole physics community was smaller, and the advent of quantum mechanics had unified it much more. These disciplines like microbiology had not yet split off. Nowadays people think they're either a particle physicist – or even worse a string theorist – and they have almost no contact with physics as a whole. Growing up in that early era I still believe that the deepest best physicists have a general interest in the subject as a whole, and that physics still is almost by definition the one discipline in which you ask the question "What's it all about?" That's what attracts me.

Patrick: So physics is more philosophical than philosophy then.

Erich: Yes, and so that's what attracted me to physics. I was very lucky to have every opportunity that I could have had. When I left Princeton, I went overseas for a post-doctoral year in England, to work with Rudolf Peierls. Rudolf Peierls had been the leader of the British effort in Los Alamos. I worked with him for two years – one year then and one year 15 years later – first at Birmingham and then later at Oxford. And so I probably knew 90% of the key people who worked on the Manhattan project.

Patrick: Is this how you met George Volkoff?

Erich: No, I met George in Canada, because I had come from Winnipeg and – I don't know why, I had many offers across the United States when I finished my post-doctoral year – I just wanted to come back to Canada. It was partly because we had at Chalk River then a world leading laboratory in the prime field, nuclear physics. And it was the time when there were people who were just dreaming, or developing rather, CANDU.

Patrick: What year would this have been?

Erich: 1956, when I came back to Canada. Deep River was a good community to settle. We had three little babies, as I mentioned before, and it was an easy place to raise them. I

now have two granddaughters in honors physics at UBC, one in fourth year and one entering first year.

Patrick: Madeleine is fourth year. Who is entering first year?

Erich: Her sister, Gabrielle. That's a new thing, you know. At the time I started, physics was almost entirely a male discipline. Princeton, by its charter, was not allowed to admit women students, even graduate students. Yale already had women graduate students when Princeton was entirely a male world.

Patrick: When did Princeton change its charter?

Erich: It started admitting women students, I think, in the middle of the 1960s. In the fifties, there was just no thought of it. Einstein found Princeton amusing too. You know, he loved words. He corresponded with all sorts of people, because he enjoyed being a celebrity; it wasn't that he was this aloof person who had celebrity imposed on him, he really thrived on it. For example, he wrote letters regularly to the Queen of Belgium.

Patrick: Yes. They played music together; he played the violin, she played the piano?

Erich: I don't know about the queen, but he definitely played the violin (badly). I sat with him at concerts, my wife and I are both very fond of baroque chamber music and we went to many string quartet concerts with Einstein sitting right next to us. Anyway, he wrote to the Queen of Belgium, and she asked him "What do you think of Princeton?" And Einstein wrote back, "Dear Queen," which was the way he started letters, not 'Your Majesty', "you asked what I thought about Princeton." He says "It is a quaint, ceremonious village, inhabited by intellectual pygmies on stilts." Well, that was the kind of turn of phrase that he really enjoyed. People quote him on many things, but he enjoyed that kind of word play. Everybody has a different sense of humor, some have none; I don't think Pauli had any that we know of.

Katy: About your time at Chalk River, what did you work on there?

Erich: I've written about it; in *Physics in Canada*, there's an article called 'The Golden years of Chalk River'. The decade when I was there – the mid-'50s to mid-'60s, before I came here to start TRIUMF – was a very exciting time. Many things, including the whole discipline of nuclear structure, emerged at that time from a new machine – the tandem accelerator – that they built; they also built the NRU reactor at Chalk River. And CANDU was developing. I spent about half my time at Chalk River working not on fundamental science but on applied science for the CANDU reactor, things like the hydriding of zircaloy alloys. I published papers on this and many other things as well. That of course is part of the excitement at a lab like Chalk River, instead of teaching you have to interest yourself in many other things that are going on in addition to your research.

Patrick: Can ask you a question? Do you think using uranium-zirconium hydride would be a technical solution to the little problem the MAPLE reactors are presently having?

Erich: The MAPLE reactors, I've written about that too, in a letter three years ago in *Physics in Canada*. It was a terrible scandal, it should never have happened. It's because Chalk River threw out its brains ten years ago; they had terrible leadership, and they decided to throw out fundamental science. And when they built CANDU the person that led it was Bennett Lewis, one of Rutherford's students. Whenever he ran into a problem he would just use the world-leading scientists he had around him to solve it, he'd call a meeting and they'd solve a problem. Nowadays, they have dozens of vice presidents, none of them are allowed to interfere with any of the others, and none of them has any brains working for them anymore.

Patrick: So they are top heavy. Is it a problem that is fixable?

Erich: It's a national scandal. CANDU I think still is the greatest scientific, technical achievement of Canada.

Patrick: Do you think that they'll be able to fix their little problems?

Erich: The MAPLE reactor? No.

Patrick: No, not about the MAPLE reactor, the way they manage themselves.

Erich: Unlike thirty, forty years ago, at Chalk River they now have nobody around who could properly calculate neutron flux with a quite complicated, but straightforward assembly. They got it wrong with MAPLE.

Patrick: Yes, they put in enriched fuel and suddenly the reactivity is positive, it's a big surprise to them but it's not a big surprise to anyone else.

Erich: That's right, I mean, that just should not have happened. For the MAPLE reactor, they made some unwise decisions when they started. They made it too small.

Patrick: Yes, that I noticed, they made it 10 MW thermal instead of 40 like TRIGA.

Erich: 10 MW instead of 40, but it would've been far better to build a larger reactor in which the problems would be somewhat simpler. They were cocky.

Patrick: Even I could recognize that and I don't have any formal training as a nuclear engineer.

Erich: They simply got it wrong, and as a result wasted more than half a billion dollars. It's a costly learning mistake for Canada. It's one that will put a black mark on the whole industry.

Patrick: Here's a 64,000$ question, do you think that they should dust off the NRU design and build a new NRU reactor?

Erich: Well, they certainly could do that, that's certainly one of the solutions.

Patrick: Because the one they presently have is 50 years in age.

Erich: I know NRU very well because in May 1958, they had an accident. They dropped a broken rod on top of the reactor, and – being in theoretical physics and not normally acquiring any dose – I was the first person sent in with a vacuum cleaner.

Patrick: Oh my goodness!

Erich: And in 30 seconds, with a 30 ft. rod, I got 5 rads of radiation.

Patrick: So this was an irradiated fuel element that had been dropped? Oh gosh.

Erich: Yes. And, and I got what was then an annual dose.

Patrick: In 30 seconds. At 30 feet.

Erich: Yes. So it was hot stuff. But there were many other people cleaning up, in fact later that week they had a young Naval Officer Jimmy Carter, who was one of the people who came and held the vacuum cleaner for a short while.

Patrick: That was organized by Admiral Rickover.

Erich: Of course, America had an interest in Chalk River. So they had people there, including people who got involved in the cleanup of NRU. But NRU was a much more challenging project than the MAPLE reactor, because the problems of cooling and that sort of thing – you know with the materials, things like the problem I worked on, the hydriding of zircaloy – could very easily have curtailed the project. But they solved the problems.

And that's what physics is all about; physics is all about understanding the world you're in, but also then being able to apply it properly. When I was young, there was still the feeling that we had just won the war, to a significant extent with physics because of radar and the bomb project and many other things. And the feeling was there among the physicists that they could be useful, and that they should be. I think that was a very healthy thing because it kept their feet on the ground and generally lead to better science, better physics. Not everybody is the same; there are some people, then and now, that are

mathematics nerds and will never be able to do an experiment or whatever, but the vast majority of the main stream of physicists found that physics was practical.

Katy: So what brought you to British Columbia?

Erich: First of all, it's something completely romantic. Growing up on the Canadian prairies, I had decided when I was very young, before I started school, that I would eventually end up in British Columbia.

Katy: Why?

Erich: Because of the oceans and the mountains. We lived on a flat prairie, which was interesting enough in its own way; but it was a very Presbyterian world, and one which I didn't particularly resonate with. So I decided that I would eventually end up here and the opportunity arose, but it was more than that. I was involved in the project here, called the Intense Neutron Generator. It was an enormous project, a billion dollar project.

Patrick: This was proposed for Chalk River?

Erich: Yes, that's correct, and I was one of the people that were leading this project.

Patrick: And this was a billion dollars in 1956?

Erich: Yes, it was as big as the LHC is now. But at the time, if you worked on it, you came to realize that it was too early. It could not be built.

Patrick: Was that because of the technology?

Erich: Yes, yes it was. Both the technology of the accelerators and the technology of the target. In fact, Ernest Lawrence, in California, had spent a billion dollars ten years before that on a very secret project to do the same thing. The basic idea was to use protons of roughly one GeV, or deuterons, to produce neutrons more cheaply than a reactor. They built a linear accelerator in California, and the technology was such that the tubes had to be huge. You could fly airplanes through the tubes.

Patrick: My God, that is big, you're talking 20-30 meters.

Erich: Something like that, the airplanes were smaller back then, maybe 15 meters. They spent a billion dollars on it, and that's more money than has been spent on any single project, except the Life in Space program. More than any accelerator project.

Patrick: In today's dollars that must be like thirty billion, forty billion dollars.

Erich: But they couldn't get the current up, and this project foundered because in order to get the neutron fluxes to produce lots of neutrons, they used enriched uranium. The idea is simply that if you put a 1 GeV proton beam into any heavy material, the proton gets captured by the nucleus of the heavy material, and neutrons boil off, roughly one neutron for every twenty million eV you put into the nucleus. That was known at the time already, and works.

But they used uranium as a target. In order to use uranium more efficiently they enriched it more and more. Until finally it was my supervisor Wigner who said, "You're using an accelerator to tickle a reactor, why not just throw away the accelerator and keep the reactor?" And so the idea was too early.

Also, the target technology was too difficult. If you take a target this big and try to deposit 3 or 4 MW of power in it, it's very very difficult, especially if in addition you have a lot of radioactivity. And so the technology was too difficult. Frankly, in 1960 when Canada seriously proposed the *Intense Neutron Generator* project, it was too big a challenge. It could not have been built. Germany had a proposal, in the 1980s, that was again too early. And now finally one is building these intense neutron targets.

Patrick: Where is that being done?

Erich: Well, they're building one in Europe, one at Oak Ridge, and one in Japan. But at the time, in 1960, I knew I wanted to be teacher. It's a reasonable vocation, it has nothing to do with being a physicist, but you either like to teach, or you don't. I knew I would like to teach – I did already enjoy lectures and teaching at Chalk River – so I wanted to go to a Canadian university. John Warren here had built up a nuclear physics group; I knew Volkoff and Gordon Shrum very well. They invited me to come down here in 1964 to give a series of lectures, which I did, and I was immediately offered a job.

Patrick: Was Dr. Shrum the head of the department at the time?

Erich: No, George was. Schrum retired in '61, and I came in '65. So I came as a young professor here, and started teaching immediately. But nuclear physics had been unleashed at Chalk River, with the tandem accelerator; there were machines at almost every university in Canada. Because of solid state detectors and multichannel analyzers, all the technology had come together, and the interest in applying quantum mechanics – which had at first been on atoms – now had shifted to nuclear physics, on all the quantum levels of the atomic nucleus. It was a subject which the technology had came along to do it properly in the 1960s. Everyplace in the world did it. John Warren had been training a number of outstanding students at UBC.

Patrick: Dr. Warren built the first accelerator in Western Canada, did he not?

Erich: I think do, yes, and he had some very good students also. He trained a significant number of the PhDs in nuclear physics by 1965. But nuclear physics had grown, and it became possible to build new machines, for which the questions that were asked were

different. They weren't any longer questions about the orbits of protons of neutrons and protons inside a nucleus or nuclear structure, they were about the role of mesons and holding the nucleons together. For the soup inside the nucleus, what role did the mesons play?

Patrick: When you came to UBC, was the idea of building a meson facility then being discussed here?

Erich: Yes! That's what brought me here. When I came here, there had been a competition in North America, to build a meson factory in the United States. Hantz Bethe had led the American jury which decided what kind of machine they should build, and they built a Los Alamos Linac. Which was a mistake, because the runner up – the one that Dr. Richardson, a Canadian, had proposed in California – was better.

Patrick: That's what was built here at TRIUMF?

Erich: Yes, and we understood that.

Patrick: Hantz Bethe very rarely made errors like that.

Erich: I knew Hantz very well, he just died. No, he made some colossal errors of that sort. In 1947, he said, in a stentorian voice "No one will ever build a cyclotron above 10 MeV, because the proton gets relativistic, its mass increases, it gets sluggish, and you can't accelerate them synchronously like you can at low energies." He had forgotten the ingenuity of experimentalists that if you split the magnet up into sectors like an orange then you can vary the orbit time at different energies. That came along in the next year.

Patrick: And this is essentially the magnet design of TRIUMF.

Erich: Yes, it's an extreme of that, the spiral ridged, sector-focused cyclotron. And that was Richardson's idea, to use a machine for 500-800 MeV, not 10 MeV.

Patrick: It was mentioned in a talk at your symposium that one of the key questions that needed to be answered was the stability of the H- ion in the field of a 500 MeV cyclotron.

Erich: Yes, I worked on that, and I had a grad student who worked on that, because if we hadn't determined that it is possible that we couldn't have built the machine.

Patrick: This is Lorentz stripping and things like that?

Erich: To put it simply, if you want to build a very intense beam like TRIUMF has, you need to be very efficient in getting it out, otherwise the machine will become too radioactive. You need be able to extract more than 99% of the beam. And the trick which emerged at the time, to do that, was called H- stripping; instead of using protons, you add

electrons onto the hydrogen and obtain an H- ion. If you accelerate an H- ion instead of the proton, it goes around the machine the other way. When you want to get it out you simply put a thin film, as thin as tracing paper, in its path and the electrons get removed. They then automatically exit because they turn in the other direction. The problem with H- was that any object traveling within a strong magnetic field has a v x B force, which is an electric field in its rest frame. That can simply pull off the electrons from the H- ion, and therefore render the beam useless, neutralize it. And that's called H- stripping. We had to understand that process.

Patrick: The second electron is only bound with what, 1 eV or something like that?

Erich: It's a bit more than ¾ of an eV. Anyway, it's a problem. There had been rough calculations on that, but they weren't easy calculations because of the geometry of the problem. It was a problem that we solved both experimentally and theoretically. But we started building before we had it totally solved, and by the time we had it solved we found that we had to use twice as much steel because we had to reduce the magnetic field somewhat. The previous estimates, before our experiments and before our calculations, were a factor of 2 too optimistic.

Patrick: And so you ended up with twice as much steel because of that factor of two.

Erich: Yes, that's right. That was not negligible because it made the magnet very big.

Patrick: It's 3,400 tons or something like that.

Erich: Yes, and that's the main reason why the TRIUMF project – which in those days' dollars was supposed to cost 23 million – went up to 27 million in 1972 dollars. In current dollars that would be about half a billion.

Patrick: Would you like to walk around while we talk a little more about TRIUMF?

Erich: Sure. Sure. I've done all kinds of things, some of which are very unrewarding, like being the academic vice president in the university's administration. But I always taught.

Katy: So is teaching the most interesting job of all the things that you've done?

Erich: Yes, when I get up in the morning, and consider who I am, I think of myself as a teacher, first and foremost. Well, after being a father and grandfather.

Patrick: You're very proud of your children and grandchildren, I can see that.

Erich: Yes I am, even though a few of them became lawyers. In the next generation, my two granddaughters are rediscovering a love for physics.

I can't give the tours into the basement of TRIUMF anymore, because the magnetic field is too high. I have a pacemaker, and the magnetic field interferes with it.

Patrick: So TRIUMF has changed a little bit in the forty years of its operation.

Erich: Oh yes, as I said in my summer student lecture, nature has a sense of humor. We built it for reasons which were perfectly valid at the time, but then new things came along which changed the program completely. One of the changes was muons for material science. The decay of the muon became a very important subject for fundamental research here.

Patrick: This is in the middle 70s, late 70s?

Erich: Middle 70s. Well, we started these experiments in the '70s, no 80s, early 80s.

Katy: When was TRIUMF first operational?

Erich: Well, we had our very first beam in December 1975. You see, we were funded in '68, April of '68; it was the same week that Mr. Trudeau became the Prime Minister.

Patrick: Was it Mr. Sinclair that worked with the file in Ottawa for TRIUMF?

Erich: No, it was Jean-Luc Pepin. He came here to check us out personally, and I got to know him well. And he became confident that we could do the things that we were proposing to do, and he then became our champion in Parliament and in the Cabinet. And George Laurence – I knew George very well – he was the head of the agency that funded us at the time. He had built a test reactor before Fermi built his reactor in Chicago.

Patrick: Is this the same Laurence that did his little NRC study on the reactor?

Erich: Yes.

Patrick: I wrote about Dr. Laurence's test pile in the last CUPJ (April 2008).

Erich: Yes, he built that reactor at NRC with graphite, just like Fermi did, and uranium. But the graphite had too much boron contamination, and therefore the reactor did not work. Someone in Fermi's group recognized that they had to have pure graphite and they arranged to purify the carbon before they built his pile at Stag Field in Chicago.

Patrick: Fermi went through nine iterations before it finally went critical, you don't read about that in the history books.

Erich: There was a Hungarian, Szilard, who had almost a childhood dream about building a reactor. Szilard was a part of the team, although nobody could get along with him, and he was also the one who suggested that they would need ultra pure graphite.

Patrick: He was another one of Wigner's friends wasn't he?

Erich: Yes, he was.

Katy: How does the TRIUMF cyclotron operate?

Erich: We have the main beam, at 500 MeV, going under that pile of concrete, and then we have it strike a target and mesons pour out, pi mesons which last a billionth of a second and after they break up. They may produce a muon which lasts a long time, for a microsecond, a millionth of a second. And these magnets collect pions or muons and use them for experiments. That's why it's called a meson factory. And then we have a number of different channels where we collect mesons or muons, several targets, and finally at the end, where it says '500MeV isotope production,' the beam is dumped into a beam dump. There are two experimental halls, one on either side of the accelerator. It's been running since 1975, for more than thirty years, which is a long lifetime for a machine. But it has gone through a number of evolutions since then, in what the program is.

Katy: How safe is it?

Erich: The cyclotron is under all that concrete. We have five meters of concrete which separates the operating cyclotron and the beam line from anyone walking through here, to remove the stray neutrons which come about when an occasionally lost proton will strike any material. As I said before, you produce neutrons, but here you need to shield the people from neutrons. I always give my first year class a problem on how much shielding does it require; you need about 15 cm of concrete to reduce the neutron by a factor of two, that's the half the distance of the neutrons in concrete, and so you get a factor of 10 to the 5 when you have five meters of concrete. And that's enough that people here working at TRIUMF will get little radiation dose. Nobody here now gets more than one rad per year although a few people get close to that. In 200 years of operation, if that's how long we go, there will probably be one extra case of cancer from radiation. That's trivial compared to the number of cancers here from stray chemicals around or other things that people do, so it's not a hazardous place. By far the greatest threats here to safety are, first, getting an electrical shock somewhere and, second, getting a piece of concrete dumped on you, when they move them about, or something like that. And so TRIUMF is a safe place

Katy: What do you think is really special about TRIUMF and its particular accelerator when compared with other facilities in the world?

Erich: Well, there were three meson factories which were built; one in the United States, one here and one in Switzerland. The one in the United States was a pulse machine, a Linac. Because the mesons arrived in pulses not nearly as useful, and that's what that machine is no longer operating as a meson factory. The one in Switzerland is a cyclotron like ours, of roughly the same energy, and it still has a very useful life and is doing many things just like we are. And so, really we are one of two facilities in the world. We're not at the energy frontier, like the machine at FermiLab, or the new machine at CERN. They have ten thousand or a hundred thousand times more energy than we have in the beam, but we have a thousand times more intensity, or ten thousand times more, and enough energy to create mesons, and therefore we create far more mesons.

In 1983, Carlo Rubbia at CERN in Europe discovered the partners of light – the gauge bosons responsible for the weak interaction – which unified the weak interaction with electromagnetism. When they discovered the W and Z particles there they found them directly in enormous detectors. Here, in that same year, we discovered the most important property of those gauge bosons' interactions, namely that they are left-handed; in these interactions, traveling directly towards the front, they always spin around their axis in a left-handed way. And we did that because we have such an intense source of muons. These gauge bosons cause the muons to break up into an electron and two neutrinos and the handedness of the interaction gets transferred to the electron. Therefore if you look at muon decay, and have an intense enough beam of muons, you can measure the handedness of the electrons and rule out the right-handed electrons. In fact, they just repeated that experiment here in a collaboration with the Russians, called the TWIST experiment.

Patrick: Is this the experiment Dr. Mike Hasinoff was involved in?

Erich: Yes. And there are many things like this that have helped to make TRIUMF's reputation too. But the point of that story is that it's a complimentary approach, the intense low energy machines to those of high energy. And so we can do things that are also very important. And that's why Carlo Rubbia was here at my celebration, because we work hand in hand with them. Some of our people work at CERN and many Europeans work here.

Katy: So what was your role in founding TRIUMF? You tend to speak of it as 'we,' like it's an integral part of yourself.

Erich: Well, now you're asking me to be somewhat immodest. I will be like Woods, the atomic-spectroscopist at John Hopkins, was once at a trial. He was called as a witness for the defense, and he was known as a very modest man. The lawyer said to him, 'Professor Woods, some people think you are the best physicist at John Hopkins.' He said 'Yes, I am.' 'Some think you're the best in the United States, 'Yes I am.' And his friends asked later on, 'What prompted you to say that?' and he said 'What could I say? I was under oath.'

Well, I knew from my work at Chalk River that meson factories and other alternatives could be built, and I knew that we had, under John Warren here, a large group of nuclear physicists who were ready to build something new. When I came here in 1965, I instigated meetings, some of which George Volkoff came to originally, about building a new machine. And from those discussions – it wasn't my idea, but one of the other people here – it emerged that we should kidnap Richardson's negative ion cyclotron which had been turned down in the United States, modify its parameters so that it would be much less costly, and build it here as a meson factory. We decided to do that. I was the chairman of the committee that made the first proposal.

Patrick: Mike Raddock and Malcolm MacMillan were part of that.

Erich: Yes, Mike Raddock, Gus Jones, Karl Erdman, John Warren, Bruce White, Dave Axen and others were all part of the original group that was crucial in getting the design ready. We got some design study funds, and then after two years, we had spent only about 150,000$, we had made a proposal for a 23 million dollar facility.

Patrick: That's a 150 to 1 return.

Erich: Yes, and so it was risky. My main role at the time – I was a theorist – was not as one who designed equipment, but as a promoter. And so I was the one who went to Ottawa a lot to talk to all the people, and we were lucky in getting funding. George Volkoff used to say, "Erich, I bless you for going to Ottawa, but you don't have a hope in hell of getting that much money to fund a machine. But I'll support you anyway." I thought he was wrong, though we were lucky in a way, because no other project a tenth that size had ever materialized in Canada before.

Patrick: So they were either very small or very large, nothing in between.

Erich: That's right.

Patrick: Has that changed at all over the years?

Erich: No, I think that that's still true. We were very ambitious, and that's why we got three universities together – a year later four – to make TRIUMF, for Tri-University Meson Facility. We had an enthusiastic minister and a very supportive deputy in George Laurence, and the funding agency, and we moved ahead rapidly then. Then we were given the money to build it. Those were interesting years too. John Warren, who was an experimentalist, was the first director of TRIUMF, and he was followed by Richardson, another experimentalist, during the construction phase. I came in 1981 when the project was ready to go, and as a theoretical physicist I directed the project for 14 years. I had been chairman of the board of TRIUMF before that, and was still involved with all of the negotiations with Ottawa, but those were the years in which I also spent time in useless activities such as university administration.

Patrick: Were you here when the right honorable Prime Minister came and said, “Well, I don’t know what this is but I’m glad we have one?”

Erich: Yes, I introduced him at the opening ceremony in 1976. I said to the Prime Minister that he should feel a little like Queen Isabella of Spain when she sent Columbus out to discover the new world. And he said, with some humor, “No one has ever compared me to a Queen before.”

Patrick: Karl Erdman tells me that initially some of the equipment we received was actually on extended loan from National Labs and the state, and they were conveniently tested to destruction and never returned.

Erich: Yes, well, they were never seriously interested that we should give them back.

Patrick: When did the life science program start up here at TRIUMF?

Erich: Well, the life science program started up as soon as we started producing isotopes, and that’s what’s being produced in this building. We knew we had a very intense proton beam at the beam dump that could be used for isotope production. I went to Ottawa, with Jack Samples, to work with what was at that time the commercial products division of AECL to initiate isotope production here. It’s produced by a company that is called Nordion; they’ve made many tens of millions of dollars of profit in this particular operation, unlike the MAPLE reactor, where they’ve lost hundreds of millions of dollars.

Patrick: But that was written off by the federal government, wasn’t it?

Erich: Well, they’re still negotiating because Nordion had, I believe, laid down payments on the MAPLE. I’m not sure; I don’t know the details of that. Anyway, TRIUMF produces isotopes with its main and smaller cyclotrons.

Anyway, a large part of the Life Sciences program started as the PET program, Positron Emission Tomography. The first PET machine at TRIUMF was thought of about 1981 in St. Louis. Then the Montreal Neuro heard about it. The Montreal Neurological Institute ordered a tomograph and a cyclotron. The Provincial Minister of Sciences at the time was Pat McGeer, who showed an interest in the potential of the science.

Patrick: Yes, I talked with Dr. McGreer about two months ago.

Erich: I picked him up at the airport one day he was returning from Montreal Neuro. He said they had this new machine called PET and he told me a bit about it. It was clear at once to me that it was a superbly simple thing in which you simply have positron emitters, they travel a millimeter and decay when they encounter and electron with two photons back to back, and that defines a line, unlike other imaging systems that they had at the time, and then you could image things with far less radioactivity. So we decided

rapidly that we would build one. I was director at the time and we got a group together lead by Brian Pate, who was a nuclear chemist here.

Patrick: Originally you had a contract with AECL about a PET tomograph and then you cancelled that and decided to design your own from scratch?

Erich: PET just became the obvious thing to do, and the hospital then – partly under Patrick McGeer's instigation – got Donald Calne and a number of other people to come and use the PET, and within a very few years they became – with the PET machine we built, and the isotopes shipped to the hospital regularly – the top institution in North America for studying motor neuro-diseases like Parkinson's and Alzheimer's and that sort of thing. And they still are there at the top.

Patrick: This continues to be one of Dr. McGeer's interests.

Erich: Well, he works on the brain, not particularly in the motor neuron sector, but they now still have a very strong group. We assigned Tom Ruth, a TRIUMF chemist, to run the machine; it's now run by a nuclear physicist in the physics department, she's just excellent.

Patrick: That would be Dr. Vesna Vossi.

Erich: Yes, and you could talk to her too. But it's been a major success story. That was one branch of the medical sciences that we got into. Others have come about because of the production of isotopes. That blue object is a 13MeV cyclotron which produces the isotopes for our PET machine. We got a local company called Ebco to build cyclotrons here, and these small cyclotrons are the best in the world. This company builds these machines and sells them all over the world.

The TR-13, the first such baby cyclotron, is that blue object over there which produces the PET isotopes for the UBC PET Group.

Patrick: This is the group that Tom Ruth is Part of (see CUPJ April 2008). You must have played a role in their program.

Erich: I have. Early on they wanted to scan an average brain, not diseased, and so they used me. I had a two hour session having my brain scanned by the UBC PET. You have your eyes bandaged shut and you lie there for two hours. I had some psychological problems with that, but it worked, and I still have the PET photographs they took of me at home.

Patrick: So they used you as the baseline subject in their study?

Erich: Yes, yes.

Patrick: Did they find that the myelin density was super high?

Erich: No, no. My kids have a fine sense of humor about my inadequate brain. Next to the TR 13 is where we built detectors and things, I'm not even sure what detectors they're building right now, but we built some major components for the LHC.

Patrick: This is T2K, I think.

Erich: Is this T2K?

Patrick: I think it might be T2K, the neutrino oscillation experiment in Japan, yes.

Erich: If you stand on top of the cyclotron – I did more tours than anybody else at TRIUMF – you can still take quarters, and get them to string together because of the strong magnetic field everywhere in the building.

Katy: Yes, they have a table with paperclips up there.

Patrick: I know you can't go up there anymore because of your pacemaker.

Erich: Yes, it's a major source of disappointment for me because I used to always enjoy taking my classes up. But I've done, as I say, more public tours than anyone. Perhaps that's because I'm not really teacher, I'm a ham. But some people would argue that that has nothing to do with teaching, and they're probably right.

The big building which houses the accelerator and experimental halls was built by the three universities of BC. It cost three million dollars at the time, which was quite a lot of money.

Patrick: Was it the building itself or the things that had to be put inside the building that was so expensive?

Erich: No, it was the building itself.

Another part of the life sciences program was pion therapy, which in the end didn't work. It was such a good idea; even before the meson factory, it was suggested that pions, which decay in a billionth of a second, would be wonderful for cancer, because they're little depth charges which you can deposit them wherever you like. We were the first to really anywhere seriously begin pion treatment, although the other two meson factories did it too. We treated a lot of patients and it was BC Cancer Agency which installed this facility. Now we treat ocular melanoma with proton beams.

Patrick: Why did they discontinue using pions? Did they determine that protons are more effective?

Erich: Yes, they found out eventually that it had some success, but this business of a depth charge, in fact when the proton slows down at the end of its range, it deposits energy similarly and more simply.

Patrick: The Bragg peak…

Erich: Yes, the Bragg peak. It allows you also to use protons for the same purpose. Around the world tens of thousands of patients have been treated with proton therapy, and that's changed ocular melanoma from being 50% fatal to being almost never fatal anymore. That's certainly a success for that kind of a treatment. We didn't actually pioneer that; it was pioneered more by the Swiss meson factory and also by the Harvard Cyclotron people.

Patrick: Yes, and then that produced the Massachusetts's General Hospital.

Erich: Yes, but we have now a facility for doing that here.

If you're interested in nucleon-nucleon interactions, then you want a higher energy, 800MeV not 500 MeV, for meson production. The Linac costs are linear in energy, and the cyclotron costs go up as the cube of the energy. And so, at 800 MeV – which the Bethe panel recommended – the Linac was cheaper, but at 500 MeV the cyclotron was much cheaper. Therefore we decided to build it at an energy where it could compete.

Patrick: Is that where the lines crossed?

Erich: Yes. They crossed a little higher than that. It was just a natural thing to do, and that's why it became the instrument of choice; when we really decided to build a meson factory it forced us down to being a project of reasonable cost. It cost much less than the Los Alamos Linac machine.

And so, here you see a picture of the magnets, and over there the vacuum tank, 60 feet across. Now, we got a local manufacturer, John Warren and I – I was his deputy director over the years, before I became director, because I was the one who went to Ottawa – and we decided that we would get a local firm to do it. This was against the advice of our consulting engineer, which was, correctly, that this firm had never built anything bigger than a hubcap, and how could you get them to build something as big as a vacuum tank. But we thought it important that we do that, and in fact that vacuum tank lead to a hundred thousand dollars worth of business for Ebco Industries, building tunneling machines and all sorts of other things.

Patrick: And that was, what, about a million dollar project for them at the time?

Erich: Yes. Ebco also built the resonators between the poles.

Patrick: My office used to be two doors down from the Mr. Eppich's office. I shared an office with Karl Erdman for five years. For several years I managed their marketing of the cyclotron, I took them from the research phase to commercial viability. I had fun, Karl Erdman and I shared an office and I learned a great deal from Karl.

Patrick: So we're now in the muon resonance area.

Erich: Here we have a muon beam line, whose primary purpose is to take low-energy muons to a place where you put them into a small sample, like high-temperature superconductors or whatever. And they're particularly useful at getting you information about the magnetic field of the sample because the muons come to rest and begin to precess about the magnetic field of the sample, because they have a magnetic moment. That technique was already understood as possible long before we started going, but nobody had enough muons, and it has now become a major discipline of material science. Jess Brewer just won the Brockhouse medal this week for pioneering that work. And so we have a lot of people from all over the world, for example the University of Tokyo, who come and use TRIUMF for material science.

Again, we can see the various beam lines. The cyclotron is behind us, and there is lots of equipment all over the place. The federal government has by now spent about a billion dollars at TRIUMF; it was originally 27 million dollars to build it and it has now gone up to about 50 million dollars a year for the lab. But you know, it's a large lab now, 300 people and users from all over the world. It's now a partnership, TRIUMF, between seven or eight universities, not only the original three but Alberta, Manitoba, University of Montreal, Carleton, who are all partners in the operation. That was also new when we started. This was the first multi-university partnership in Canada, you know, in which universities got together. Until then you'd either have a federal lab or an individual university. That was a model that probably would have worked well for the tiny universities in the Maritimes, because none of them really dominate, although I suppose Dalhousie is the biggest.

Katy: It is.

Patrick: So it was UBC, SFU and U of A?

Erich: And UVic.

Patrick: UVic, so U of A joined the following year?

Erich: Yeah. They abandoned their plan for a VandeGraff when they joined. Which helped us too.

You know, when I was director for 14 years we had a major proposal for a KAON factory that was never approved by Parliament. ISAC which is TRIUMF's main new thing, was a consolation prize for the KAON factory.

Katy: Yes, I saw an article about it, I wanted to ask you a question, but Patrick said it would be an interview in itself.

Erich: Yes, I was interviewed about KAON in May by Eve Savoy of the CBC. Maybe that's the article you saw, about a month ago.

Katy: Yes, it was discussing the fact that Japan is now building one, twenty years after the fact, and we'd missed out.

Patrick: So you were twenty years ahead of your time.

Erich: Well, we were the only ones at that time proposing it; to begin it would have been a partner to the LHC just like we were a partner to the CERN machines before that. But, you know, one doesn't always win. We lost that one, eventually.

Part Two: Teaching and Other Things

Patrick: Shall we go back to your office and finish the interview by talking a little bit about pedagogy and teaching and schooling, and about what you think the future of physics has in store for young bright undergraduates?

Erich: Well, I'm by nature an optimist, and I think that physics is as exciting as it ever was. There's new problems in physics now, fundamental problems, and an enormous number of options.

Katy: What do you think is the greatest achievement in physics to date?

Erich: At what time?

Katy: Overall.

Erich: In physics?

Katy: Yes, what one event do you think had the biggest effect on physics?

Erich: In the last century?

Katy: In any time period you choose.

Erich: I think Newton is still easily the most amazing physicist in the world has ever produced, because he invented science, not only physics. Before Isaac Newton, people wanted to know how the planets moved but they didn't want to know why. And Newton

was the first to propose the law of gravitation answers multiple questions, and led to the Clockwork Universe. After Newton, that's the way that science has worked.

And so he was amazing, but we've had other people since then. Since I had known Einstein, three years ago when it was the centenary of the major, miracle year 1905, I gave a lot of talks about him. But I think in the last century there were two scientists that stood a head and shoulders above everybody else; one was Rutherford, and one was Einstein. They were comparable. There were a lot of people, the Fathers of Quantum Mechanics, who were also great physicists, but didn't rank with those two. Now, this view I've just given you, is not one that everyone shares, but there's lots of people, everyone agrees on Einstein.

However, the theorists only play a part of what's going on. You know, there was a poll of the greatest scientists of all time, and there was only one experimentalist in there, Rutherford. Faraday wasn't included – Faraday obviously should be in that group – and there were others that should have been. Physics is still an experimental science. For example, Richard Feynman, whom I knew, was a wonderful lecturer and did some very amazing things. But his total impact on physics, compared to that of Ernest Rutherford for instance, is negligible, yet he was ranked ahead of Rutherford in that poll simply because people had seen him on TV or whatever, or read the book.

Katy: What would you say is the most important thing you've learned throughout your career?

Erich: Well, I think I always came equipped with a good sense of wonder, and curiosity and I've learned how to try to keep that intact. I've learned to appreciate that nature uses a surprising variety of vehicles, I mean human personalities, to further its great work. And I've learned that working at science, just what a pleasurable career it is. Three of my five children are lawyers, and they all earn five times what I ever could have earned, but I don't think they're happier than I have been, because I have friends all over the world, and have been involved in intellectual activity, which is what I always wanted to do. So I've learned how to cherish that, and still do. That's why I come in every day and why I continue teaching. You know, if you look at Rate-My-Professor.com, you know how to get it… one of my students two years ago said 'Wonderful professor, but he must be at least 200 hundred years old!'

Katy: Yes, that was quoted in an article about you.

Erich: I enjoyed that. Because I was able to use my personality in very different ways. When I was a 35 year old teacher at UBC I could wear beads, and I was one of them, and they had empathy with me. Now that I'm older, they no longer identify with me as easily and I have to work at it differently. I think I've learned a lot, and continue to learn a lot about teaching. I wrote an article, a guest editorial in the American Journal of Physics last year on teaching first year physics (*The Special Joy of Teaching First Year Physics,* American Journal of Physics, Vol.75, p.581, 2007).

Katy: Yes, I've read that.

Erich: Basically, my view about teaching is that you have to try to establish a resonance with the class. You have to get them to like you, because you cannot teach them the things that you're supposed to, you can only inspire them to go out and do the homework themselves and put it together for themselves, and to give them a few clues about how to do that homework. That's the purpose of the lectures. I think lectures work, but at some places, like MIT now, they have abandoned first year classes, and I think that's a mistake.

Patrick: When did they do that?

Erich: About two years ago.

Patrick: And why did they do that?

Erich: Well, they have all the people connected to computers and they have courses on the computer that they can go to. It's not the same, I think that it's like giving up the concert hall. I think that you can still communicate it in a way that you cannot simply communicate on TV.

Patrick: You've taught over 40 years at UBC, and for 25 of those years you taught for nothing? That's when you were director at TRIUMF?

Erich: Yes, and also in UBC administration, and then I went into retirement. Amusingly, only two or three years ago they started giving me a small amount of money – I retired 14 years ago at 65 – because some other professors had retired and demanded money when they wanted them to teach. And so they felt that it was no longer reasonable not to pay me the same amount, though I would have continued to teach for free.

Patrick: One of my special moments in my life was getting my Master's of Science, and after the convocation I saw you in your wonderful garment given to you by a gentleman, and if I can remember it was the president of Princeton who gave you the …?

Erich: No, you're thinking of George Volkoff, who got the first UBC president's PhD gown, and I've worn that sometimes.

Patrick: Oh, that must have been it. It was a remarkable. Dr. Volkoff got the Companion of the British Empire at a very young age as well.

Erich: Yes, that's right.

Patrick: So this was the garment that you were wearing? It was the most remarkable…

Erich: Well, I have several PhD gowns from the various honorary degrees that I have. Nowadays they don't usually give you the garment anymore, but they used to. It was rare enough that they used to do that. When I went to Queen's or Manitoba, for honorary degrees, they still gave you the gowns. I'm not sure why you'd want to have them, but …

Patrick: I was joking with Stephen Toope, President Toope recently about how distinguished Cambridge professors look in their gowns and how humorous it would be if students at UBC had to wear gowns to their classes.

Erich: You know, did I tell you the story of Pyotr Kapitsa?

Patrick: No.

Erich: You know he was one of the greatest Russian physicists of all time; I met him in '68 and took him out for dinner and beer, when he first emerged from Russia. Kapitsa had worked with Rutherford at Cambridge, and in 1935, when he went back to Russia on a holiday, they kept him there.

Patrick: Stalin arranged for Kapitsa's entire lab to be shipped to Moscow from Cambridge.

Erich: Yes. But when he came back in '68, 33 years later, he went back to Trinity, and they invited him for dinner in the senior common room. He accepted, and when he came to the college, his old college, he was delighted to see the same porter still at the door. So he said to the porter, "I'm sorry, I have a problem, I don't have my gown anymore, could I borrow somebody's gown?" The porter looked at him and says, "What do you mean, professor, borrow somebody's gown? I'll get you yours."

Patrick: They still had it?

Erich: They still had it, 33 years later.

Patrick: That's a wonderful story. Kapitsa, of course, isn't as well know in the west as he should be, but he's one of the few people to have gotten the better of Joseph Stalin, and to disagree with him.

Erich: Yes, he had a direct phone line to Stalin. He had the courage also in 1938, when Beria was the head of the secret police and Landau got arrested, to phone Stalin and tell him that it was a mistake. And Landau was released. Otherwise he would have certainly been executed. And by doing that, Kapitsa was risking his own life, but he always had that kind of courage.

Patrick: Landau was someone who could easily have won five Nobel prizes. Or at least two, maybe three?

Erich: Well, it's not so clear. He was, first of all a theorist, and he was like Oppenheimer. Now, Oppenheimer, I think, would have won the Nobel Prize for neutron stars or whatever, if he had lived long enough so that they were actually observed. But he didn't. George Volkoff was a student of Oppenheimer's. George was more responsible than anyone for bringing me here. We were good friends, and I think in many ways I was perhaps his closest friend. We were neighbors, and I saw him a great deal all the time when George was here.

Patrick: George taught for many years as well, he taught undergraduate physics. How many years did he teach undergraduate physics? I happened to talk to Pat McGeer several months back and I guess Pat was one of his students.

Erich: Yes, well he taught, George came here in about '39 or '40, and then in '43 he was chosen for the Montreal lab. He came back in '46, and, and all those years Gordon Schrum was the department head, and George would then have taught, he taught until he became department head in '61. So 15 years.

Patrick: 15 years. And he was teaching the first year general science course, or the first year physics course?

Erich: No, I think that he taught more third and fourth year courses.

Patrick: Third and fourth year.

Erich: He sometimes taught first year, but not always. And George was a very good teacher. George was one of the smartest people that ever came out of UBC, but he had the disadvantage, also, of his parents disappearing in the cauldron of Stalin's Russia. And that gave him somewhat a sense of despair. That's why he would say, 'You don't have a chance of succeeding.'

Patrick: Yes, with the TRIUMF factory.

Erich: But another reason he said that was that George was CAP president in1962-1963 and he and one or two other people, including Karl Erdman, proposed a particle physics accelerator for UBC in the early 1960s which didn't go anywhere. And that experience led George to be pessimistic about big projects.

Patrick: Maybe that project wasn't big enough.

Erich: It probably was big enough, but it wasn't George's natural thing to do all of the necessary homework you have to do to put a proposal together and get it funded.

Patrick: I guess as you mentioned earlier, a part of what you did was to go and to convince people in Ottawa.

Erich: Yes, my message always was, simply, you *have* to do this, you have no choice. George's general philosophy was 'You win some you lose some,' which doesn't work. Politicians want you to be more enthusiastic than that. And so, if you were, if you were asked, you know, I got, TRIUMF is a collective effort of an enormous number of people, and I've always got, because of my big mouth, more than my share of the glory. I mean I was the one who got the Order of Canada for it.

Patrick: You're being modest, Erich.

Erich: No, no it's true. Well, I mean, you need people in certain roles. I had things to do with the basic idea of TRIUMF and instigating it, but…

Patrick: You know, there are not too many people who had Eugene Wigner as their PhD advisor and were able to interact with the remarkable physicists of the twentieth century, and to do cutting edge physics in Chalk River and the like.

Katy: While we're on the subject of awards, you've won, or been awarded lots of, like a very big variety of awards and honorary degrees and had buildings named after you, and all that sort of thing. What does that sort of recognition mean to you, do you appreciate it?

Erich: Well, I can honestly say I've never sought an honor. Because I was very open about everything and always very conspicuous, I got, I think, at least my share of awards, ok? I never had to go and seek them.

Patrick: Are you asserting that George's saying of 'You win some, you lose some' applies here?

Erich: No, no, I think that it's always, of course, the esteem of one's colleagues and one's family that one wants more than anything else. And I've had my share of that too, and so those things are the most meaningful. When you get an honorary degree, sometimes it's because the university wants to put on a good show; they want to get somebody conspicuous who will give a good convocation address, and you try to give them their money's worth, but it's not such a big deal.

Patrick: At your symposium on May 4th, I sat next to some students that you taught some years ago, and they said that they a vividly remember the first time that they walked into your class and you taught them physics. It was no longer a tedious subject but something that was enjoyable and something they really could relate to.

Erich: Yeah. The things, probably which mattered to me most, don't come up even in Carl Weinman's Method of Teaching on Campus. I meet students almost every week that I taught a long time ago and for some of them it was a life changing experience. I'm not exaggerating, they decided as a result of the course to go in a completely different direction. That's an awesome responsibility, because when it happens, for the good, you know you think that 'That's perhaps the best feedback I know of'. In fact I think the best feedback about teaching is the considered opinion of people years later, about who, which teachers really mattered. Rather than the instantaneous response, when they say, "Hey, he wears nice sweaters," and that sort of thing. Well, I mean, the instant response has its own value, because everything is fresh in their mind, but I think it's the later, considered response. I have been very fortunate to have many people who have written me letters later on, on what it meant to them.

Katy: Do you consider that influence to be one of your best achievements during your career?

Erich: I think my effect on young students has been, for me, more important than creating TRIUMF or the things that I was able to achieve as a research physicist.

Katy: Do you have any advice for young physicists who are just finishing their educations and starting their careers?

Erich: Yes, my advice is always – as I say to my students – to try to discover who they are and what they're best at, whether it be physics or mathematics or communication, or whatever. I always tell students in science to keep the most options open for their development, by taking as much mathematics as they can without getting bored with it. Some people like mathematics for its own sake, but you can always go on to any other discipline from mathematics. From mathematics and physics, you can go into chemistry and biology, or medicine later on. There is a hierarchy of the sciences, and so I tell them to recognize that hierarchy, but to take a mixture of things which really keeps them engaged in the course of their studies. To find something that really excites them. I could have found many things – I was very lucky that way, I could have been interested in history or English, or whatever – but science for its own sake really won out for me.

Katy: Earlier you mentioned that you switched from English to Physics in your third year of university; was that change triggered by a specific event?

Erich: No, it was a buildup; I thought that I would get more pleasure out of a career – even then I was thinking I would have an academic career eventually – an academic career in Physics than I would in English.

Patrick: It reminds me a bit of Galileo going from medicine to mathematics; he thought it was more interesting to do the mathematics than the medicine.

Erich: Yes, well you have to find out what you're good at. When I was in high-school in this little town, I really enjoyed music, and I spent more time practicing the piano than on anything else by far, but I had no gift for it. I knew that almost right from the beginning, but I enjoyed it, and high school was easy enough that I didn't need to focus on the normal academic subjects. And so it kept me busy and occupied and out of mischief in high school. But it was clear that I could never never have been a concert pianist. I didn't have the talent for it. And I knew that.

I think people need to discover what they are good at and to do it, to try to come terms with themselves and then follow that line. I had lots of outstanding students, with enormous gifts who somehow could not understand themselves well. And nature is very wasteful, it often dissipates those gifts completely unless a person can develop the self-discipline to not only understand themselves but to pursue those things where they do have some talent.

Katy: How do you feel about retirement?

Erich: Well, I never had any trouble with the thought of growing older because it's something that we all do, parts wear out, that's why I now have a pacemaker and some cardiac problems and whatever. But I've always enjoyed teaching and even puttering in research now; I don't do the kind of intensive research that I did thirty years ago, but I still get a great deal of pleasure out of doing something in nuclear astrophysics, and get intense pleasure out of the teaching that I do. And so, in that sense, I think retirement is important for people, that one gives way for younger people to get the positions. You know, with the governments now doing away with retirement, some people stay on long beyond when they should and deny a young person that position at the university. We all have pensions, and I'm an excellent model of showing that you can still teach, if that's what you care about, or still do research even if you're not paid for it. It's not a question of going hungry. And so I think that retirement is a very healthy thing. When I was academic vice president, some people didn't want to retire, and I always had a slogan, 'Where there's death there's hope.'

Patrick: Oh boy! Well, on that joyful note, thank you very much Erich for a wonderful interview…

Erich: Well, do you know what I told my friends, like Karl and them, when they reached 75?

Patrick: What did you say?

Erich: I used a Canadian analogy that life is like the three periods of hockey, and after you finish three quarter centuries you go into sudden death overtime.

Patrick: Oh… I had a chance to have a cup of coffee with Pat McGeer a few weeks back, and Pat kept looking at his watch, and then he says "I've got to go I have a tennis match." And I looked at myself, and Pat is...

Erich: He's not 82.

Patrick: There we go.

Erich: So I had a deal with my department, which I plan to stick to, namely that I would teach – when I made this deal I was not being paid – but I would teach as long as I achieved some of the highest student ratings in the department, and if that was no longer true then I would stop. You know, there are some very able young teachers coming along, and one of these years, Jamie Matthews is going to be much better than me.

Patrick: Oh, Jamie is a remarkable remarkable teacher (See the interview of Dr. Matthews *Space is a MOST important place to be* in the January 2008 CUPJ).

Erich: Yes, yeah. And so I'm going to, by my own rules, have to step down before long. In time it will happen, it's a natural thing and I have just an enormous number of things which give me pleasure that I plan to do.
Katy: Like what?

Erich: Well, I still enjoy music enormously and chamber music particularly. I have 16 grandchildren; I can spend a lot of time seeing what they're doing. Some of them are very interesting, well they're all interesting.

Patrick: I guess Madeline and Gabrielle will have a few interesting physics questions to toss your way.

Erich: Yes, and, and I still believe in books. There's something called the Folio Society, that puts out wonderful editions of the best books of the past. And I just got over three thousand dollars worth of Folio books for the next year's round of 16 birthdays and Christmas presents for my grandchildren. They all opted for that rather than for sports equipment or something like that, I get them the catalogue and they give me a list of books they want. One of the best things I can do for them is to give them a fondness for books. We're very lucky to live in a time when it's possible to develop such a hobby, and to watch them reading books, and whatever.