

## SUMMARY OF 1976 PROTON LINEAR ACCELERATOR CONFERENCE

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When I was asked to summarize this conference, I decided to enlist the help of my colleagues to develop a broader insight than I would have by myself. So, Lee Teng, Don Young, Cy Curtis, and I got together last night to review the conference. Two hours later I decided that we had so much material that it was impossible to do justice to it all. However, from this review emerged a few observations about the conference and the material presented which I would like to share with you.

Many interesting things have happened during the course of the conference which I'm sure we will all long remember. Those of us that went on the canoe trip yesterday afternoon found that Canada is a very big country. We drove 120 miles and canoed perhaps as much as 3 miles. In the course of these travels, other motorists must have been surprised to see a "steam boat" coming down the Trans-Canada highway.

We've all been impressed by the adaptability of our hosts. The first morning the system of getting badges seemed somewhat awkward, but the next morning we found that it was much improved. The first coffee session took quite a bit of time for everyone to get coffee. By the second coffee session, procedures were simplified and it went much better. This adaptability will be a tremendous asset to our colleagues here at Chalk River when they come to building large accelerators. In this business you better be adaptable and the quicker you can adjust, the better. Our hosts' good judgement was pointed out by Dr. Mooradian in his banquet address when he stated that they had chosen to give up another Alvarez linac section in order to sponsor the banquet. That clearly shows they know how to order their priorities.

We've heard papers about many accelerators. The new operating machines are the UNILAC at Darmstadt, Japan's KEK facility, and the BEVALAC at Berkeley operating with the SUPERHILAC as an injector. The HILAC isn't new and the BEVATRON isn't new but the marriage is new and we found these developments very exciting. We've heard about many improved machines; LAMPF has been improved and is now operating at average beam currents ten times what was available earlier; the SUPERHILAC has been improved and they're now providing an additional preaccelerator of the Widerøe type. The BNL linac is constantly being improved as is the Fermilab machine. Fermilab is introducing a second preaccelerator, in order to be able to experiment with negative ion acceleration. Polarized protons are being utilized routinely in the ZGS facility at Argonne; at

LAMPF they'll soon be operating with polarized protons as a regular part of their schedule. The interest in deuterons is apparent. Deuterons have been accelerated in machines which were designed for only protons. In addition, we have heard many very interesting and exciting things about accelerators that are under construction - the new CERN injector, the RILAC machine in Japan, the meson factory in the USSR, as well as the USSR's heavy-ion accelerator. We have all been intrigued by spiral-loaded cavities, split-ring cavities and the options which these introduce into existing accelerators which can be very useful for extending the range of research that will be available from these devices.

A few general observations should be made about this conference. First of all, this conference had a higher level of international participation than its eight predecessors. This participation is apparent in the spectrum of papers that has been given and it is a very welcome opportunity for all of us to have this chance to interact with our colleagues from abroad. We thank all of you for coming.

The increasing interest and importance of heavy ions in the research activities around the world is apparent by the number of papers and their content. Another interesting development is the increasing emphasis of medical applications of both proton linacs and heavy-ion linacs. These devices are now joining the electron linacs in the arsenal of medical devices in the war on cancer. It has been interesting and significant to look at the potential applications of linacs as energy-related devices. Certainly, the exposure that we have had to the possibilities of linacs becoming the initiating component for fissile material generation is a matter that we will all look at from a different perspective than we did before we came to the conference. The use of linacs to produce intense neutron beams for materials testing has been brought into focus for us as well. The possibilities of heavy-ion accelerators for pellet fusion have suddenly become of interest to accelerator builders. If the time sequence had been slightly different, this may have been a much more active part of this conference. These potential applications indicate that these matters may be important factors in the future of many of us.

As you look back at previous conferences and compare the content of the proceedings, it is apparent that the current papers have been much more of an applied nature. I would believe that this is going to be characteristic of conferences in the future. It seems fairly obvious that linacs are approaching the

point where they're going to be of interest in many applications besides basic physics research.

Superconductivity has come slowly, yet it is apparent that superconductivity is going to be an increasingly active field for not only magnetic components of accelerators but also for accelerating cavities. In superconducting cavities it's clear that the gradients that were hoped for a few years ago are going to be difficult to achieve; however, that doesn't mean that the accelerators using superconducting cavities are going to be any less useful. Multipactoring is still a problem; however, this is something which additional experience will minimize.

Many relatively old ideas have come back at this conference. They are old ideas in the sense that they were proposed as options at one time, but now have reappeared as working parts of new systems. For instance, the Widerøe or Sloan type of linac - for many years the Widerøe structure wasn't given serious consideration and now it's a part of many modern heavy-ion accelerators. The Alternating Phase Focussing structure now appears to be a viable option. This was suggested first about 15 years ago, but was not actively pursued because the need wasn't, at that time, apparent. The requirement for longer duty cycles and higher beam currents necessitates higher efficiencies, consequently an interest in the APF is renewed. More efficient buncher schemes haven't been seriously considered recently but now will again be emphasized. It was also interesting to note that the higher fields available from superconducting magnets makes solenoidal focussing a viable option again. The use of permanent magnets is again being studied. All of these factors and many others which I haven't mentioned may be incorporated in the PIGMI Program at Los Alamos. Hopefully, this will lead to a new generation of more efficient, less expensive linacs.

Computer control is now a completely accepted way of life and has become a necessary method for controlling modern accelerators. It seems obvious that microprocessors are an exciting feature of the future accelerator control systems. They will certainly yield less expensive and more versatile control systems.

In addition to getting much valuable technical information, all of us have had a very enjoyable time. This has been an event which has given us an opportunity to come to know our colleagues in Canada on their home ground. We have seen where they live, where they work, and now better understand their motivation for designing and developing accelerators. This we all sincerely appreciate. I welcome the opportunity and the privilege of offering, on behalf of all of us, sincere thanks to our hosts, to the Organizing Committee and others in the Chalk River Laboratory who have made this such

a valuable and enjoyable occasion. The conference arrangements have been super. The social events have been outstanding. It's been a pleasure to visit you in your homes. The banquet was superb, and I don't believe I've ever attended a banquet where the after-dinner speaker got the attention of the entire audience with such a provocative discussion as was given by Dr. Mooradian. We thank you for this as well.

In addition, I would like to carry to you and to your wives the thanks of those of us who had the opportunity to bring our wives with us. If you have noticed that things haven't been quite the same as usual at home, it's because your wives have been so busy taking care of the wives that we brought along. I know that our wives sincerely thank you for that interruption in your own home life. They have really enjoyed it. We look forward to having the opportunity to reciprocate in the future for the many amenities that we have enjoyed here.

The time has come when we must think about the future. This conference has been the 9th in a series which started in 1961 at Brookhaven. The 8th conference was held four years ago at Los Alamos, New Mexico. At that time, there was some discussion about whether the conferences should be reconstituted in some other form or whether they should be dropped entirely. The determination of what was appropriate evolved over the next couple of years. We have heard at this meeting of many new projects that are under consideration, proposals that are being made, machines that are being built. I believe that it's important for all of us to get together and have the opportunity to discuss our mutual problems in an environment such as we have enjoyed here. This has been a unique series of conferences in that its structure is narrow enough that you don't become inundated with all of the problems of all circular machines and every other type of accelerator. These factors have helped make this a worthwhile series. The previous conferences have been rotated from one location to another and it has been the responsibility of the host of the current conference to interact with people at other laboratories and determine who should host the subsequent conference and when enough new work has been completed that another conference should be scheduled. This has been a format which has worked well before and I would suggest that we commend it to the organizing committee of this conference.

So we've come to the end and I wish to again thank our hosts at Chalk River Nuclear Laboratory for their gracious hosting of this conference. We have had a great time. Thanks again.