

FINAL REMARKS

TH. STAMMBACH

PSI, 5232 Villigen-PSI, Switzerland

1 The Conference

The first thing to say in these final remarks, is to thank the local organizers and especially the conference secretariat for their effort in the preparation of this conference, as well as the program committee for preparing the interesting scientific program. The large number of 250 participants demonstrates the interest in the field of cyclotrons and their application. The growing interest in cyclotrons as accelerators can also be seen from such different signs as the fact that www home pages on cyclotrons are frequently visited or the presence of the Joint Universities Accelerator School (an European initiative) at this conference. We should also thank all the authors for their contribution to the content of this conference and M. Craddock for his commemorative talk in memory of J.R. Richardson.

2 The Scientific Program

The centennial of the discovery of radioactivity gave a good motivation to start the conference with a review on the application of cyclotrons. In the sessions of the first day interesting summaries were presented on most of the major research activities that apply cyclotron beams. I recorded a large number of statements that point out the usefulness of cyclotrons as a tool, as e.g.: "all this PET work could not have been done without cyclotrons", "the rate of corrosion could only be quantified with the thin layer activation using cyclotron beams", "certain tumors react only to high LET radiation". In nuclear physics, knowledge on neutron halo and the disappearance of the shell structure in the "terra incognita" in the chart of nuclei comes mainly from radioactive beam facilities.

If on the other side many laboratories are audited and have to justify their programs against their authorities, then this could be due to the fact that we did not do enough for the publicity of our activities and that we failed to bring these achievements to the attention of the public. Nevertheless in certain fields, like the production of isotopes for positron emission tomography (PET) or industrial irradiation, the number of commercially used cyclotrons is booming in an impressive way. In cancer therapy worldwide 25000 patients have been treated with particle beams, but most on a development basis, mostly in large facilities. In this field the next step to hospital based beams is slow, but this step would be impor-

tant if particle beam therapy should become competitive with other methods of treatment. All these applications do not need versatile and variable energy accelerators. They are better served with simple, dedicated, cost efficient and easy to use machines with the property that a "trimcoil can be exchanged in 20 seconds", as one participant mentioned to me, referring to cyclotrons applied in isotope production.

The sessions of the second day on cyclotron subsystems, on various technologies, and on newly operating cyclotrons brought us back to the real world and back to the daily problems of cyclotron operation. Impressive was the large dynamical range, that was covered in the presentations. They range from beam intensities of $4 \cdot 10^4$ part/s, that have to be measured in radioactive beam facilities, up to 10^8 part/bunch in the high power beam at PSI. Likewise the Dee voltage in CYCLONE 44 needed to ensure good mass separation is as low as 6 kV, while a peak RF voltage of 1 MV is necessary to ensure low beam loss in a high power beam facility.

The subject of radioactive beams dominated the sessions on wednesday and thursday. A large number of initiatives were reported in many presentations. It seems that the "radioactive ion beam race" is on, and that many teams went out to find the best passage into the terra incognita in the chart of isotopes. Most impressive at one side of the spectrum are certainly the plans at RIKEN. They intend to build a K2500 superconducting separated sector cyclotron (an SCSSC), with the followup project already on the table. As impressive at the other side of the spectrum is the CYCLONE 44, a cyclotron specially optimized for maximal mass resolution (I had some difficulties to make out the Dee in this cyclotron since the shape of the Dee has been converted from a D to an I). As a consequence of the low output in the production of radioactive ions the heavy ion facilities interested in radioactive beams push their intensities up to the point where space charge forces begin to become visible. New strategies will have to be followed as e.g. flattopping, large phase width or phase profile tuning in order to fight space charge effects.

Also the generation of high power beams found much interest. I counted eight contributions dealing with the feasibility of cyclotrons for the acceleration of beam currents up to 10mA. Very interesting in this respect was the report on TRITRON with the proof of principle for the separated orbit cyclotron. Unfortunately the funds are insufficient to pursue these activities. All funded ini-

tatives on high power beams concentrate on the use of linacs and no funds are available yet to build a demonstration unit using a cyclotron, which I think has better properties for such an application.

Undoubtedly the improvement of ECR sources has had and still has a large impact on the development of accelerators. Still new ideas and innovations were presented and further progress can be expected. No doubt that these sources have reached a high degree of sophistication and only missing is the automatic, computerized control to optimize the source for the particular charge state to be produced. Certain questions, however, are still unanswered and I felt confirmed in my basic experience that ion sources are black magic, when speakers used the words "tricks" and said "that whatever they do, they get the same results".

A special highlight was the panel session on control systems on thursday. It was very interesting to see, how clearly the points became apparent, that often make life difficult for the persons responsible for control systems. First there are conflicting demands for commissioning and routine operation. Second there seems to be an ever present conflict between the specialist with his local controls and the control system engineer who has to guarantee full and fast access to all parameters. Finally there is an obvious mismatch between the lifetime of computers to that of an accelerator (which one speaker brought to the point with the remark that "the part most likely to become obsolete is the PC"). Different philosophies also apply for research facilities on one side, where certain developments that are made in house also need in house support, and for commercial cyclotrons on the other side, where commercial systems serve better.

The program on the last day brought facility reports and the description of new projects from all around the world, demonstrating that this conference is an important platform for the communication over the borders of nations and continents. It is certainly one of the major aims of this conference to promote international collaboration and the exchange of knowledge. That this happens could be seen from the fact that many reports made a reference to an international collaboration in respect to the development of their cyclotrons or certain subsystems.

3 The Champion

I must assume there was a certain plan behind the fact that CYCLOTRON'98 was held in France at the same time as FRANCE98 the world championship in soccer. The GANIL staff intended to demonstrate, that France is the champion, not only in soccer, but also in cyclotrons. Obviously the local organizers did everything to make this conference an outstanding experience, and this very

successfully. Their claim to be the champion is actually supported by the fact that GANIL has hosted this conference twice (but also TRIUMF has hosted the conference twice), and the fact that the number of cyclotrons on site is highest at GANIL (but there is still a problem at $R=1.44\text{m}$ in their cyclotron CIME). The organizers of this conference at GANIL, however, deserve to be called the champions beyond any doubt, based on the excellent food and wine at lunch, based on the wonderful barbecue among the wildlife on the GANIL site (rabbits), based on the wonderful scenery on the seashore for the conference dinner and, last but not least, judged on the natural ease and enormous flexibility with which they mastered all organizational matters. For all this I would like to thank GANIL on behalf of the audience and the International Committee.

4 The next International Cyclotron Conference

The conference ended with the announcement that the International Program Committee had decided to continue the series of International Cyclotron conferences with the 16th conference to be held in 2001, in East Lansing, Michigan, USA.