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REPORT FROM WORKING GROUP 2 — RFQs & LINACS

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This Working Group concentrated on issues associated with low-β, low q/A accelerating structures and Radio Frequency Quadrupoles (RFQs). Since a large number of outstanding presentations and contributions were already made, as evidenced by the articles in this proceedings, we will simply present, in their bare form, the questions that were raised and the collective answers to those questions in the following. The issues dealt with in this group included specifications of longitudinal and transverse beam emittances, radioactive contamination issues, tunability over large dynamic range, stripping and separator issues, normal conducting and superconducting RFQs, injectors, high voltage platforms, cyclotron options and general issues of parameters and design.

KEY WORDS: Radioactive beams, post-accelerator

QUESTIONS AND ANSWERS

Q. What is the specification for longitudinal emittance?

A. With prebunching before RFQ1, a specification of 20 π keV-ns seems possible. With this specification, energy resolutions of 0.1% are easily achievable.

Q. What is the specification for transverse emittance?

A. A variety of ion sources (as discussed here by R. Kirchner) have emittances of 10 π mm-mr or less at 60–100 keV energies. The normalized emittances of such sources are about 0.01 π mm-mr. ECR ion sources generally have larger emittances due to the axial magnetic fields. There are also low-field ECRs for low charge states and higher field ECRs for higher charge states. ISL beams from the high charge state ECRs would bypass RFQ1. Hence, if RFQ1 had a normalized admittance of at least 0.2π mm-mr it would have a high transmission for most known ion sources.

Q. Are there issues related to contamination or radioactivity in resonators (superconducting or normal) due to beam losses?

A. This should not be a performance issue, but should be quantified. Transmission losses should be minimized, but the main issue is probably related to access for maintenance rather than performance.

Q. What are the issues related to diagnostics for tuning a broad range of intensities (10^2–10^{13} pps)?

A. There is experience with such beams, e.g. at the Bevalac, NSCL, and GANIL.

Q. What are the issues related to stripping?

A. There are many issues here. P. Bricault presented calculations done to choose the optimum energy for the first stripping of Uranium beams. A good choice for the first energy seems to be about 200 keV/A. More detailed optimizations are required, including the cost of accelerating voltage at various energies and the practicality of foils and gases at various energies. A. Schempp discussed the idea of capturing and accelerating more than one charge state between the first and second strippers to gain a factor of 2 to 3 in beam intensity. This concept needs further investigation.

Q. Is the stripper loop concept likely to be useful at the ISL?

A. F. Selph presented the present status of his studies. It seems that the main remaining question is the beam quality at the output of the ring. Detailed simulations which include realistic foil thickness and the associated multiple scattering and energy loss/straggling effects are now needed. Such a ring has the potential to increase final beam intensities by a factor of 4 to 20, depending on whether one or two rings could be used. However, it is not clear that the beam degradation issue can be solved.

Q. Could a gas-filled separator play an important role in the ISL post accelerator?

A. M. Nitschke made an informal presentation on the features of a gas-filled separator and some previous experience. If used in place of the second stripper, it could provide a "Z" discrimination to remove certain beam impurities left by the high resolution separator. However, transverse emittance would be degraded; quantitative simulations of this device must be done.

Q. What is the present beam parameter list and best guess for the block diagram of the post accelerator?

A. We discussed these issues and with the help of a concept for RFQ1 proposed by A. Schempp have revised parameters.

Q. What are the special issues with the RFQs, especially RFQ1?

A. A preliminary design study by H. Schneider shows that the previous transverse emittance specification of 1π normalized is very hard to deal with. Also the longitudinal emittance after adiabatic bunching is very large. A. Schempp's proposal is to use a 10 MHz RFQ with a prebuncher/chopper to achieve excellent longitudinal emittance and an admittance of at least 0.2π mm-mr (normalized). Such an RFQ could start at 1 keV/A which may eliminate the need for the HV platform.

Q. Does the 100 nsec pulse spacing specification pose special problems?

A. With the present concept for a 10 MHz RFQ1 this is a perfect match. It would still be OK with a higher frequency RFQ as long as a 10 MHz prebuncher/chopper were used.

Q. Are the specifications for RFQ1 achievable? (mass 6 to 240 1 + ions, CW operation, good transverse and longitudinal emittances).

A. A. Schempp says this can all be done over an energy range from 1 to 10 keV/A with about 200 kW of RF power. A detailed design study of this RFQ should now be carried out.

Q. What are the possible roles for superconducting RFQs?

A. K. Shepard's experience is that he expects 50 MHz to be the lowest feasible frequency for superconducting RFQs, at least for now, due to mechanical stabilization requirements. Hence, they are most likely to play a role in the intermediate velocity regime of the post accelerator, and not at the low end.

Q. Is more than one injector for the post accelerator required or desirable?

A. The present concept for RFQ1 solves all of the basic problems for the first acceleration stage over the entire dynamic range of the proposed facility. However, for masses less than 25, RFQ1 is not required to reach 10 keV/A, so a bypass or alternate beamline may be desirable. Also, a high charge state ECR ion source would produce beams which would bypass RFQ1.

Q. What are the special problems associated with the HV platforms?

A. It is desirable to operate the primary production target and ion source at the highest voltage achievable. 60 kV has been used at ISOLDE for years, but at lower intensities than the ISL. It is speculated that 100 kV may be possible at the ISL, but this is not proven, and may require some R&D. With RFQ1 operating at an input energy of 2 keV/A, it would have to be on a HV platform at up to 380 kV. This seems possible, but if the input energy is reduced to 1 keV/A, the voltage requirement is reduced to 140 kV, and the HV platform may possibly be eliminated entirely by using a single cell rf cavity for velocity matching. This deserves further study.

Q. What structures are appropriate for the intermediate energy sections of the post accelerator?

A. There are several options for these sections: IH, RFQ, DT linacs, and superconducting or normal. In the relatively long section after RFQ1 and before the first stripper

(1+ beams) transverse focusing is an issue due to the rigidity of these beams. The solutions chosen here are likely to vary from lab to lab.

Q. What are the possible roles for cyclotrons in the ISL post accelerator?

A. D. Clark gave a presentation on some of the options for using cyclotrons for either all or various sections of the post accelerator. In principle, cyclotrons could be used for the entire complex. One advantage the cyclotrons provide is an inherent high mass resolving power. However, a detailed solution based on cyclotrons has not been worked out. More work is required here to make cost, efficiency, and performance capability comparisons.