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► To cite this version:

K. Sato. The upgraded yale MP tandem accelerator. *Revue de Physique Appliquée*, 1977, 12 (10), pp.1345-1345. 10.1051/rphysap:0197700120100134500 . jpa-00244322

HAL Id: jpa-00244322

<https://hal.science/jpa-00244322>

Submitted on 1 Jan 1977

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THE UPGRADED YALE MP TANDEM ACCELERATOR (*)

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Résumé — Les performances et le fonctionnement de l'accélérateur MP converti de Yale tels qu'ils ont été observés après les dernières transformations sont décrits.

Abstract. — The performance and operation of the upgraded Yale MP accelerator are described.

Following our earlier report [1] on the projected upgrading of our accelerator, the current status and operation of the facility will be discussed.

The accelerator now operates at terminal voltages up to 13 MV and gives every evidence of conditioning to higher voltages. Following the initial modifications described in reference [1], our NEC Pelletron charging system has worked extremely reliably for over 16 000 hours with no apparent wear or deterioration. (At the present time our charging current is limited to $\approx 400 \mu\text{A}$ (6 chains); at 13 MV we are using $260 \mu\text{A}$ which is shared among the resistor columns ($80 \mu\text{A} + 80 \mu\text{A}$), the control corona ($40 \mu\text{A}$), and losses ($60 \mu\text{A}$) associated with the use of a 4 curie ^{137}Cs radiation source). Our HVEC stainless steel tubes now have over 12 000 hours of operation with no tracking or evidence of deterioration beyond the damage which occurred during their initial operation when beam induced radiation fields caused by poor beam transmission resulted in substantial deterioration of the glass at several locations in both the column and the tube in section $\neq 1$. (This damage was repaired by grinding off the softened glass and replacing it with epoxy fillets.) Since that time there has been no repetition of this problem. After some initial spark damage to the column resistors, an additional spark gap was designed and installed across each of the $600 \text{ M}\Omega/1200 \text{ M}\Omega$ resistor assemblies; this has eliminated this problem. The insulating gas in the

accelerator is a mixture of 33 % SF_6 , 12 % CO_2 , and 55 % N_2 .

Substantial improvements have been made to the accelerator tube and beam line vacuum by the addition of 2 cryopumps in the terminal and external pumping stations in the adjacent beam lines; during operation the vacuum at the low-energy and high energy ends of the accelerator is typically 5×10^{-8} torr. Largely as a result of this improved vacuum, our beam transmission is now typically 50-60 % (particles) for beams as heavy as niobium. A second factor in this improved transmission has been several modifications which we have made to the ion optics of our UNIS source to improve its emittance. A second benefit of the improved tube vacuum has been the long term retention of voltage conditioning by the accelerator tubes which operate regularly over the range $2 \text{ MV} \leq V_T \leq 12 \text{ MV}$ without the need of any additional reconditioning. Further slow conditioning is expected to move the retention limit to higher voltages. An indication of the present reliability of the accelerator is provided by the fact that over the last 20 months we have been able to run for periods of typically 4 to 6 months between tank openings even during periods of operation at terminal voltages in excess of 12 MV.

Inasmuch as we have now had operating experience with a standard MP, an upgraded MP, and an NEC 12 UD [2] some comparative remarks will be presented on the different design philosophies and operational characteristics represented by these three large electrostatic systems.

(*) Work supported under USERDA Contract No. FY-76-C-02-3074.

References

- [1] SATO K., BENJAMIN J. A., GINGELL C. E. L., PARKER P. D. and BROMLEY D. A., *Nucl. Instrum. Methods* **122** (1974) 129.
- [2] While on leave from Yale and in charge of the installation of the NEC UD machine at Tsukuba University in Japan.