THE UPGRADED MUNICH LINEAR HEAVY ION POSTACCELERATOR

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Abstract

The Munich heavy ion postaccelerator was extended, consisting of two cavities with an interdigital H-type structure now. The frequency is doubled in the second section. A special kind of beam dynamics for 0°-synchronous particle structures was developed, which results in good particle transmission though only one compact quadrupole-doublet is installed over the length of both linacs. Beamtime experience confirms the transport calculations.

Introduction

The new postaccelerator section allows extended investigations of nuclear reactions and accelerator mass spectrometry measurements with heavier ions or higher particle energies.
The main advantages of a tank like the f-booster /1/, /2/ are its high shuntimpedance and simple construction.
Because of this it makes sense to investigate whether the sections of a long accelerator can be built in the same way.
A special kind of beam dynamics allows the number of magnetic lenses to be drastically reduced. The resonance frequency in the new section is doubled, which causes a compact and handsome construction, but also an increase in power density.
We describe the beam transport calculations, the construction of the 2f-booster and the de/rebuncher. Measured RF-data and preliminary beamtime experience are presented.

Beam dynamics

The concept of beam transport through each tank in the longitudinal phase space can be seen from fig. 1. In that example, a $^{58}Ni^{22+}$-beam is accelerated from E_i=2.6 MeV/A to E_f=4.8MeV/A The 0°-synchronous particle structure consists of 30 gaps, the total length being 2.4 m. The shapes of some interesting areas and their relative position with respect to the synchronous particle at the entrance and the exit of the booster section are plotted. At the entrance to the next booster section we choose a new 0°-synchronous particle with lower energy and negative phase relative to the previous one, so that the main part of the calculated area has the same relative position to the synchronous particle as at the entrance to the first section.
This mechanism concentrates the radial defocussing negative RF-phases near the exit of each section. If we install quadrupoles at the front of each tank as shown in fig. 2, the beam diameter is kept small within each cavity. The driftlength between adjacent tanks has to be as short as possible, otherwise more frequent rebunching becomes necessary. An example of the beam transport in longitudinal phase space through the Munich postaccelerator is given in /3/.
Some traces of particles with starting conditions on the phase space surface of a pulse with $\varepsilon_x=3\pi\cdot$ mm·mrad, $\varepsilon_y=2\pi\cdot$ mm·mrad, ε_z=1.1 MeV·ns are shown in fig. 3. The quadrupole doublet between tank 1 and tank 2 is very compact: the total length is 350 mm, the aperture is 30 mm. For the calculations, approximations to the gap field distributions of thinwalled drifttubes /2/ were used, measured with the perturbation technique.

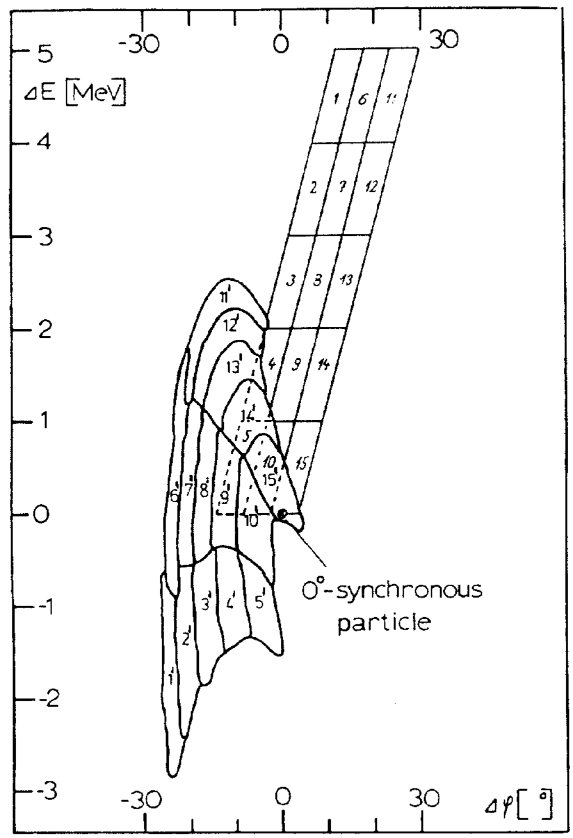

Fig. 1: Transformation of particle position in the $\Delta E/\Delta\varphi$ - plane by passing through a 0°-synchronous particle structure of finite length.

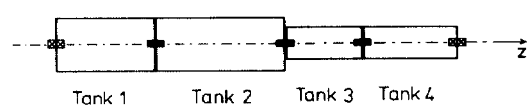

Fig. 2: Arrangement of quadrupole doublets in tanks with IH-structure.

Construction of the 2f-cavity

The cavity oscillates in the TE 111 – mode. As in the case of the f-booster, the 2f-tank also consists of three parts: middle-part, upper and lower half shell (fig. 4).
For given drifttube array and resonance frequency, the sectional tank area has a definite value. The path over which the electrical current has to travel is minimized, if the upper and lower halves of the cavity have each a circular cross-section. The 2f-tank geometry is approximated to that shape /3/. The height of the middle part was considerably increased. This makes the manufactoring of that part and the installation of the quadrupole doublet easier and it also helps a lot to get the desired cross-section of the tank. The resulting

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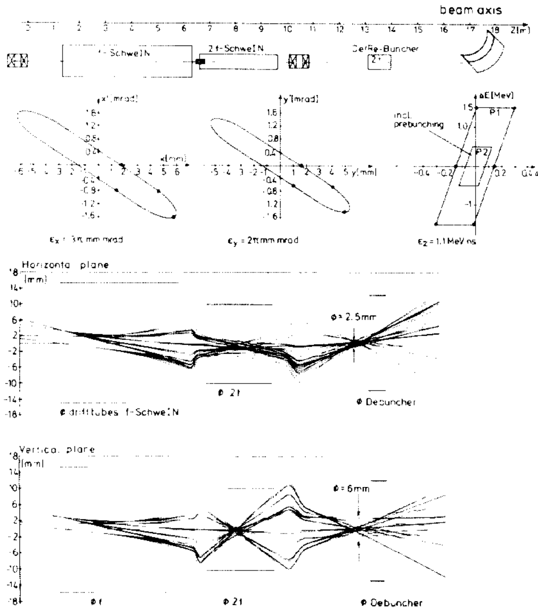

Fig. 3: Particle traces with starting conditions on the phase space surface.

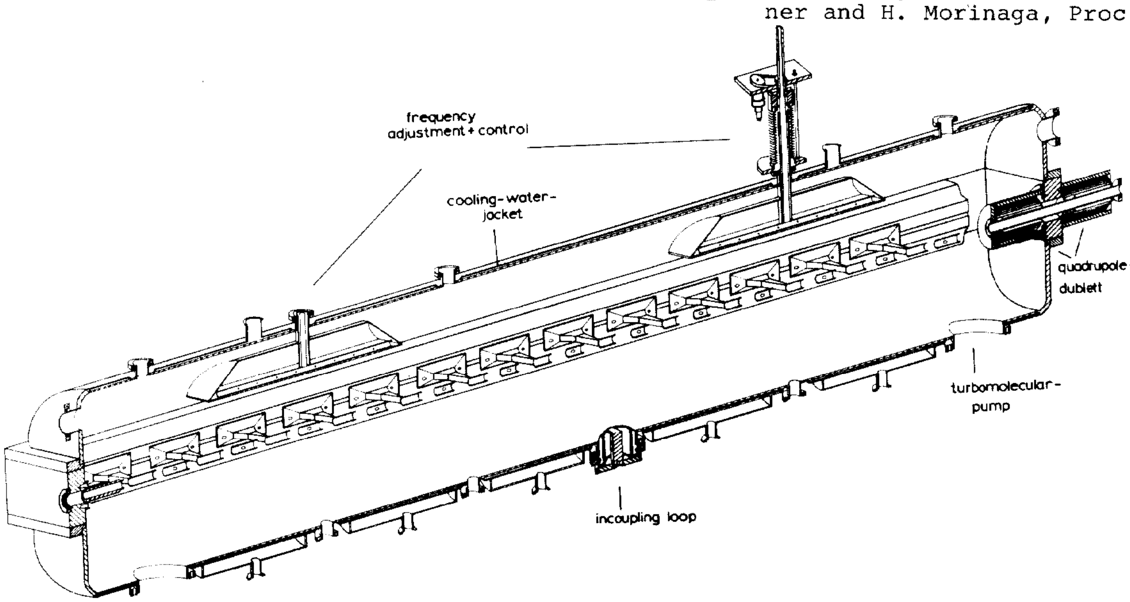

Fig. 4: The 2f-cavity, sectional view.

vacuum forces on the cavity are compensated by a suspension in the middle of the tank. The drifttubes are screwed on massive copper-stems, which are responsible for electrical and heat conduction. Two plungers provide a frequency variation up to 4%; this is needed to get the exact frequency ratio between both tanks for different velocity-profiles.

The de/rebuncher

The calculations in longitudinal phasespace /3/ show, that the energy spread after the 2f-tank is 1.5 10^{-2}, if a tandem dc-beam is injected into the system of the HE-buncher-postaccelerator. This makes the installation of a debuncher necessary, which also may be used as a rebuncher in special experiments. A short IH-structure with resonance frequency 2f was built for that purpose. About 500 W power input suffice to get an effective voltage amplitude of 200 kV at β=0.113 and a drifttube aperture of 25 mm.

Results

The shuntimpedance of the 2f-tank was measured by the perturbation technique for different velocity profiles (fig. 5). Beam time experience confirms these data. The debuncher has not yet been used with beam. At a defined energy window of $\Delta E/E=\pm 3.5\cdot 10^{-3}$ after the postaccelerator, the transmission drops about 30%-40% by applying the 2f-tank voltage. This is in agreement with the calculation. Together with the debuncher, high transmission into an energy window of $\Delta E/E_f=\pm 1.5\cdot 10^{-3}$ is expected. At present, the 2f-tank can stand a RF-power input up to 40 kW in cw-operation. From the power amplifier, a maximum RF-power of 50 kW is available.

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/2/ E. Nolte, R. Geier, W. Schollmeier and S. Gustavsson, Nucl.Instr. and Meth. 201 (1982) 281

/3/ U. Ratzinger, E. Nolte, R. Geier, N. Gärtner and H. Morinaga, Proc. of LINAC-Conf. Seeheim (84)

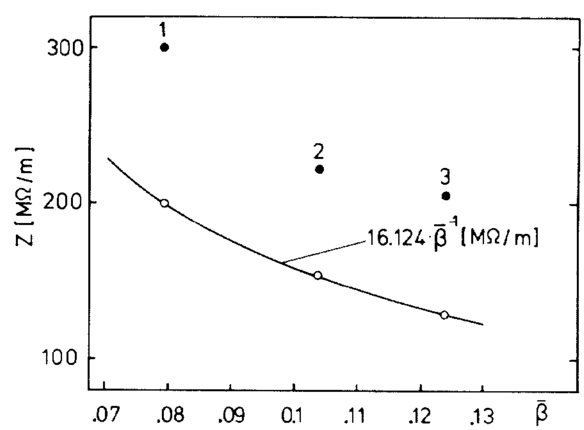

Fig. 5: Measured shuntimpedances ● and measured effective shuntimpedances o $Z_{eff}=Z_0\cdot T^2$; transit-time-factor; β =mean velocity of the structure.