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REALIGNMENT OF THE LINAC2 LEBT DURING THE 1994/1995 MACHINE SHUTDOWN

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Introduction

During the time that the RFQ2B was still on the test stand in the South Hall, it was found that the output beam of the RFQ was rather missteered. When this RFQ and the source, which form one assembly, was installed at linac2, the transmission through the linac was optimized by moving the whole source-RFQ assembly in the transverse planes (without touching the individual elements). This had only limited succes due to lack of diagnostics tools (which in its turn is due to lack of space). Therefore it was decided to disassemble the "ensemble" source-RFQ during the 1994/1995 machine shutdown and centre the beam using an emittance measurement device at the RFQ entrance position.

In the beginning of 1994 beam measurements were made on the source of RFQ2A in the South Hall. This source is a copy of the RFQ2B ion source. Measuring the beam directly behind the source (i.e. NO focusing elements between source and emittance measurement gear; just a drift), it was found that already there the beam was missteered. Close inspection of the source/pre-injector revealed that this ensemble was well centered on the beam axis but not mounted perpendicular to it. As a consequence, the beam came out of the source with an angle. **The Linac2 source was found to have the same problem,** which was due to the transfer of mechanical tolerances.

During the 1994/1995 shutdown period emittance measurements have been made and various elements of the Low Energy Beam Transport (LEBT) moved in order to centre the beam. The results of these measurements are described in this report.

LEBT layout for emittance measurements and first results

Figure 1 shows the layout of the measurement line. The position of the slit of the emittance measurement device is virtually at the same postion as where the RFQ input would normally be. A first set of measurements was made to determine the exact beam centre at the RFQ input position as it has been during 1993-1994 (figure 2): 0.4 mm in X, 0.1 mm in Y, 1 mrad in X' and 8 mrad in Y'.

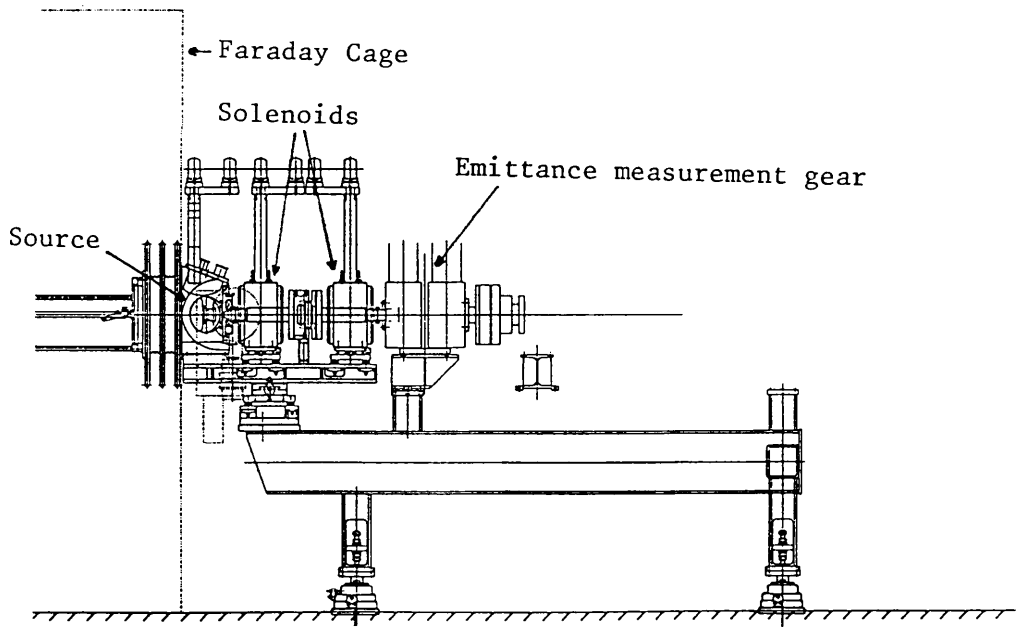

Figure 1: Layout of the linac2 LEBT beam line for emittance measurements

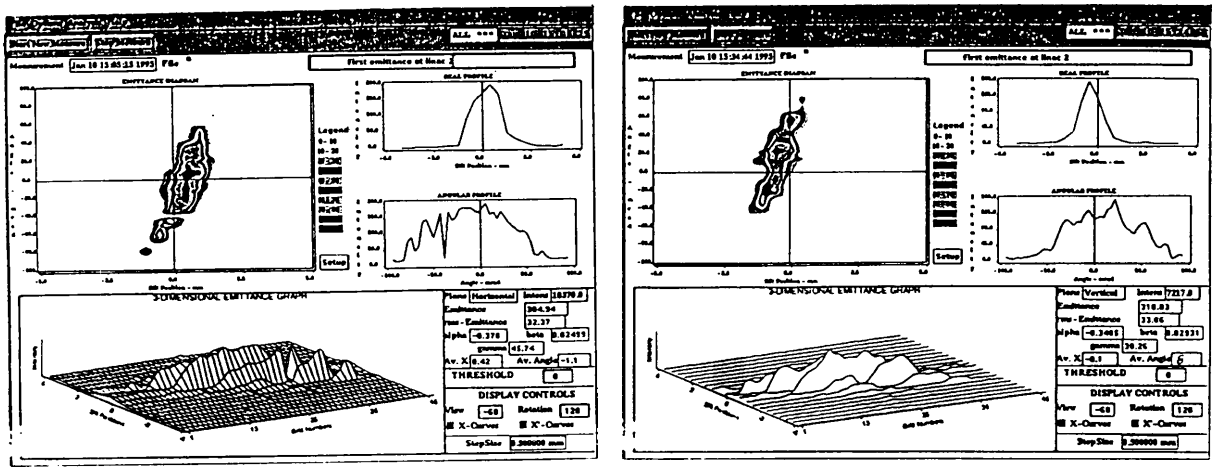

Figure 2: Emittances of the X-X' and Y-Y' plane near the RFQ input position.

Beam alignment procedure

This procedure consisted of moving the various elements of the beam line in order to centre the beam. Table 1 shows the shift in beam centre due to the mechanical shift of various elements. Mechanical movements were always checked by micrometer readings.

Beam centre shift	SOL2 +1 mm hor. shift*	SOL1 -0.5 mm hor. shift	Source lift 0.5 mm cage side
Δ<X> (mm)	-0.55	+0.1	+0.05
Δ<X'> (mrad)	-3.4	+0.9	+2.
Δ<Y> (mm)	-0.22	-0.04	0.
Δ<Y'> (mrad)	-5.	-1.8	-1.1

* Sign convention : positive means towards right relative to the beam direction

Table 1: Effect of mechanical shift of some elements on the beam centre

It should be noted that these figures are relative ones and only indicative for the beam shifts really obtained (e.g. in the case of the solenoids they also depend on the absolute position of the beam with respect to the solenoid axis).

By shifting the elements mentioned above as well as by tilting the table supporting the ensemble source-sol1-sol2 a well centered beam was finally obtained (figure 3): 0,1 mm in X, 0.1 mm in Y, 1 mrad in X' and 3 mrad in Y'.

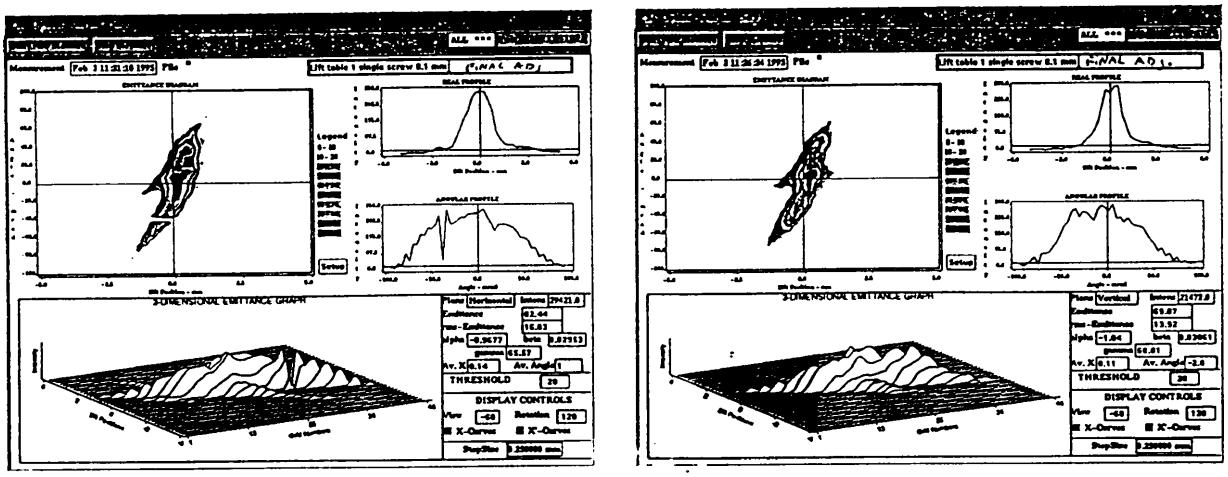

Figure 3: Emittances of the X-X' and Y-Y' plane near the RFQ input position.

Other measurements

The beam centre has also been measured as a function of time along the beam pulse. A -2 mrad drift was found in Y' between the start of the flat top and 60 μs later in the beam pulse. Some effect on the angular beam centre has been seen as a function of source arc current (less than 1 mrad for a 10 % change in arc current).

Results with the operational beam through the linac

After the reinstallation of the RFQ, operation was started with the linac2. It was found that with the new alignment, the RFQ had become significantly less sensitive to changes in the solenoid currents (before the realignment the RFQ would spark quite easily as a consequence of change in solenoid current).

The transmission through the linac has been improved by 1 % and the intensity of the beam passed on to the booster increased by ~ 5 mA with respect to last year (for the same source and RF conditions). Also the trajectory of the beam through the LT and LTB lines have been improved.

Steering Element

In order to obtain more flexibility in terms of beam steering it was decided to insert a pulsed steering element between the second solenoid and the RFQ. Though weak (0.4 mm/A) and somewhat imperfect (some coupling between the two transverse planes) this allows for some steering of the beam entering the RFQ.

Conclusion

The alignment of the beam in the linac2 LEBT has been significantly improved, and with it the operation of the linac2 as a whole. However, during the shutdown there was insufficient time to optimize the linac itself. This will still have to be done during another MD.