EMITTANCE MEASUREMENTS AT THE 100 KEV BEAM STAGE OF THE INJECTOR LINAC OF THE IFUSP MICROTRON

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Abstract

The injector linac consists of a 100-keV electron gun, a beam conforming stage, and two acceleration structures. The beam focalization is made by solenoids, and correcting coils are provided for steering. In this work we describe the beam emittance measurement on the beam conforming stage. Some results are shown.

INTRODUCTION

The Instituto de Física da Universidade de São Paulo (IFUSP) is building a two-stage 38 MeV continuous wave racetrack microtron. Figure 1 shows an isometric view of the accelerator and the beam transport line [1], where it can be seen that the beam is generated and pre-accelerated in a linear accelerator.

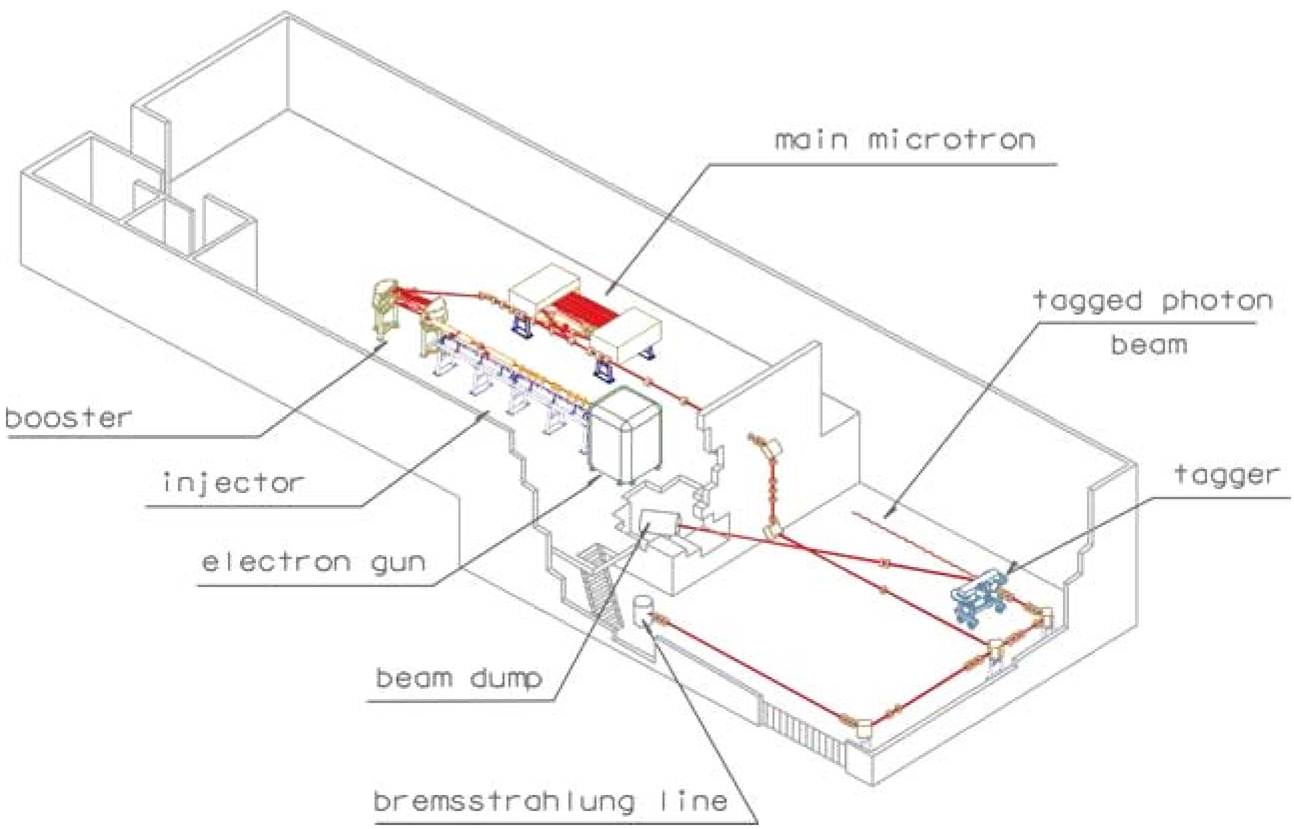

Figure 1 - Isometric view of the accelerator in the accelerator building.

The injector linac consists of a beam conforming stage, with chopper and buncher systems, and two acceleration structures [2] (the first one with variable β, and the second one divided into two parts with different β). There is a 3-mm diameter collimator at the entrance to the first acceleration structure.

The beam focalization is made by solenoids, and correcting coils are provided for steering. Figure 2 shows the injector stage in detail.

This work describes the beam emittance measurement of the 100 keV beam on the conforming stage of the injector linac of the IFUSP Microtron [3].

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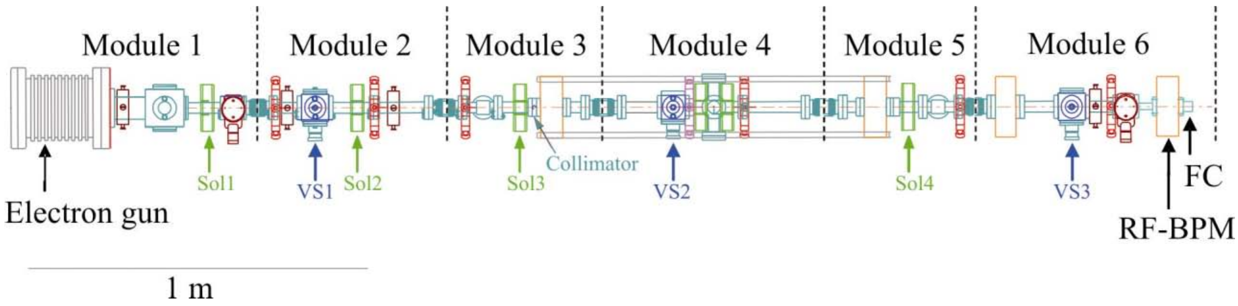

Figure 2 - The conforming stage of the injector linac of the IFUSP microtron: FC stands for Faraday Cup, and RF-BPM for radio frequency beam position monitor.

METHODOLOGY

The electron gun in the injector linac is an electrostatic gun with a cathode specifications shown in Table 1.

Table 1– Cathode specifications.

Manufacturer	Varian EIMAC Salt Lake
Model	Y809
Cathode type	Dispenser
Emission area	0.1 cm^2
Emission	3 mA – 6.5 V

The commissioning of the optical system of the conforming stage succeeded in taking the beam through all the 3.5-m length of this stage [4]. The correcting coils made possible the passage of the beam by a collimator located at the entrance of the first chopper cavity in the Module 3 (see Figure 2). This collimator limits the beam size to a 3-mm diameter.

After the collimator a fluorescent screen can be positioned for beam monitoring. The distance between the collimator and the fluorescent screen is 41 cm.

The emittance measurements involve the identification of a beam waist in the fluorescent screen, using the focal configuration of the lenses located upstream.

Figure 3 shows the beam diameter as a function of the excitation current of the second lens, located in Module 2.

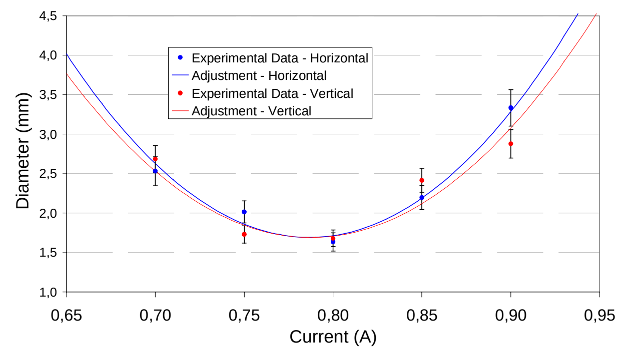

Figure 3 – Beam diameter as function of the excitation current in the second lens.

A 2nd degree polynomial was fitted to the experimental data, by the least squares method, allowing for the determination of the minimum beam diameter (waist). The beam emittance was found using the following relation [5]:

$$\varepsilon = \frac{\sqrt{R_{col}^2 R_W^2 - R_W^4}}{L} \quad (1)$$

Where ε is the beam emittance, R_{col} is the collimator radius, R_W is the beam waist radius and L is the distance between the collimator and the fluorescent screen.

RESULTS

The beam diameter at the waist position was measured with two different lens configurations, for two different energies (80 keV and 90 keV). Two different cameras were used (with different resolutions) to observe the fluorescent screen and make the measurement.

The emittance was calculated and the results are presented in Figure 4.

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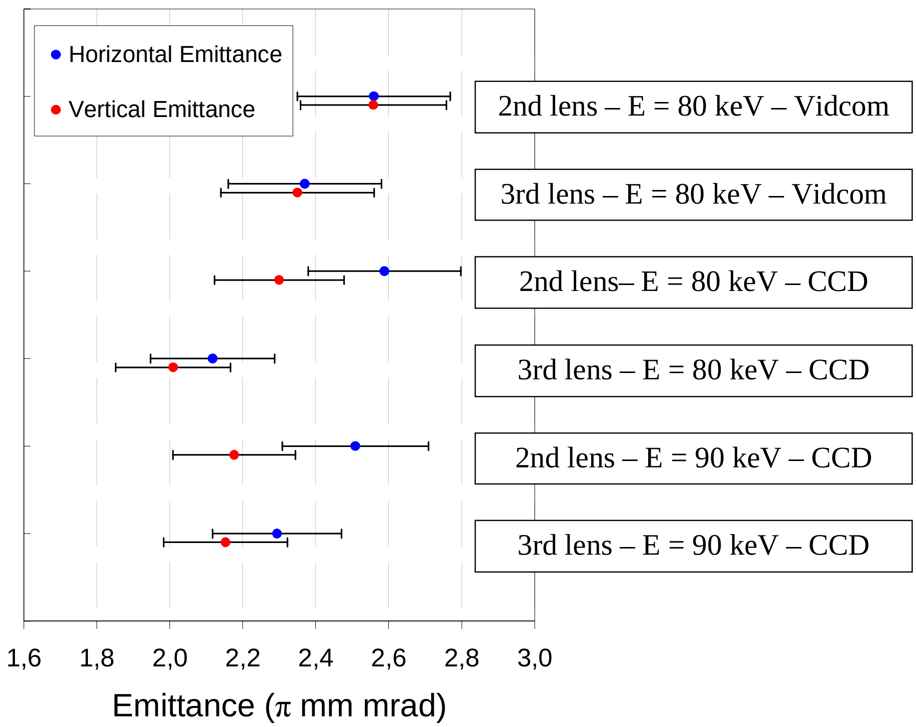

Figure 4 – Emittances obtained on different measurements.

An increase in the emittance was expected for the 90 keV beam energy relative to the 80 keV beam (about 6%). This increase was not observed due to the limitation imposed by the collimator.

The data obtained at different measurement conditions and on both the horizontal and vertical directions show good compatibility. The beam emittance in the conforming beam stage, obtained by a weighted average of the results, is $(2.32 \pm 0.05)\ \pi\cdot\text{mm}\cdot\text{mrad}$ [6].

CONCLUSION

We successfully commissioned the 100 keV beam stage of the IFUSP Microtron injector linac. Beam characteristics are compatible with the required specifications for the linac operation.

Emittance was measured and found to be $(2{,}32 \pm 0{,}05)\ \pi\cdot\text{mm}\cdot\text{mrad}$, for both beam energies analyzed, showing the limitation imposed by the collimator placed at the entrance of the chopper cavity.

Commissioning of the RF distribution and control systems is under way, and should be finished in a couple of months. Then we will be able to start the operation of the chopper and buncher systems and the accelerating structures up to the booster entrance.

ACKNOWLEDGEMENTS

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