STATUS OF THE INJECTOR SYSTEM FOR THE SYNCHROTRON LIGHT SOURCE ANKA

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Abstract

ANKA is a 2.5 GeV synchrotron light source under construction at the Forschungszentrum Karlsruhe. The facility consists of a 53 MeV microtron, an injection line, a 500 MeV booster synchrotron, and the ejection line. The whole injector is being built as a turn key system by the industry (Danfysik, Denmark). The interface between the injector and the storage ring is the entrance of the injection septum. The 53 MeV racetrack microtron is already commissioned. It delivers a beam of 53 MeV, 16 mA, 6 Hz and 1.2 μs. The installation of the injection line as well as the booster synchrotron is under way and the commissioning of the booster synchrotron will start in May 99. We expect to get an accelerated beam to 500 MeV before summer 1999.

1 INTRODUCTION

The ANKA injector is a 500 MeV booster synchrotron for the 2.5 GeV ANKA synchrotron which presently is under construction at Forschungszentrum Karlsruhe (FZK), Germany [1]. The injector complex (fig. 1) consists of a 53 MeV microtron pre-injector, a 500 MeV booster synchrotron, an injection line between the microtron and booster synchrotron, and a ejection line from the booster synchrotron to the ANKA storage ring. The microtron delivers an electron pulse with a duration of 0.5 – 1.2 μs and a current of more than 10 mA. The multi-turn injection process leads to a stored electron current of more than 15 mA in the booster synchrotron. The extracted electron pulse has a duration of ~ 56 ns, a current of more than 7.5 mA and an emittance of 0.15 mm mrad. The whole injection cycle is repeated with a rate of 1 Hz. The microtron has been commissioned at its final position in ANKA. The assembling of the booster will be done in April 99 and a 500 MeV accelerated beam is expected by summer 99. A detailed description of the optics of the booster synchrotron is presented elsewhere [2].

2 THE PRE-INJECTOR

The schematic layout of the microtron is shown in fig. 2, 3 and 4, while its main parameters are listed in table 1. The E-gun is a 70 keV spherical pierce type with a BaO cathode. The maximum gun current is around 500 mA, with a pulse length of 5 μs.

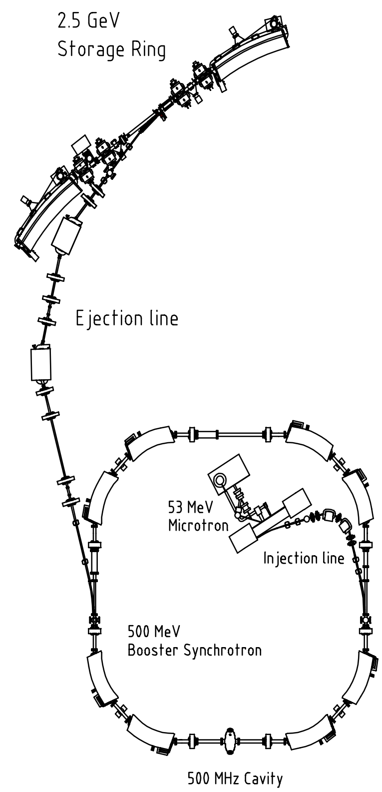

Figure 1: The injector complex of the ANKA project

Behind the E-gun the chopper is located, this will give the beam the 500 MHz structure according to the RF-system of the booster synchrotron.

Starting at the E-gun the electron beam is guided by a constant solenoid field and a horizontal focussing quadrupol singlet. Two achromatic 45° bending magnets deflect the beam to the linac axis. The linac is a side coupled 3 GHz standing wave Los Alamos Type with 7+2*1/2 Cells. The parameters of the linac are listed in table 1. After the first linac pass the beam is reversed and in the second linac pass accelerated in the other direction. After 10 passes through the linac the beam is extracted with a constant energy of 53 MeV with the help of a 15° bending magnet. Fig. 3 shows the top view of the microtron. In the tracks 1 – 9 horizontal and vertical steerers are located which allow to steer the beam through the machine.

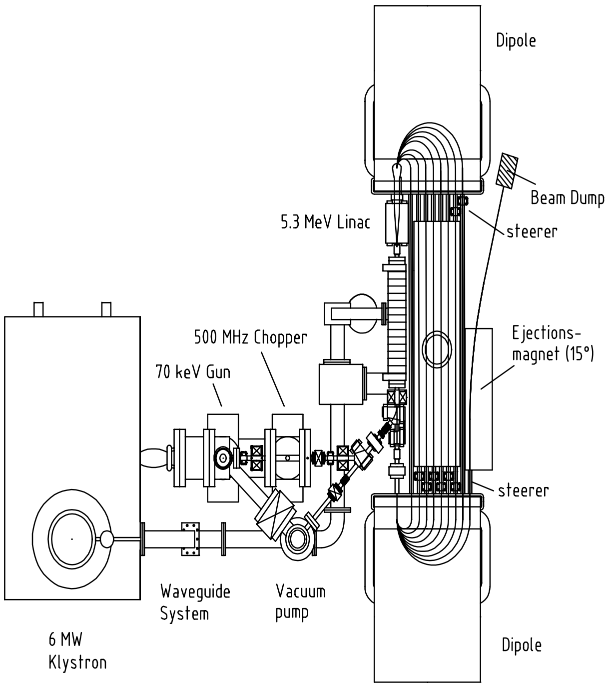

Figure 2: Outline of the ANKA microtron

Table 1: Main parameters of the racetrack microtron

Injection energy	70 keV
No. of Linac passes	10
Energy gain per path	5.3 MeV
Frequency	2.998 GHz
Final electron energy	53 MeV
Emittance (hor/ver)	• 0.2 mm mrad
Energy spread	<0.3%
Pulse current	10 mA
Pulse length	0.4 – 1.4 µs
Repetition rate	0-10 Hz
Klystron	CPI/VKS-8262E
Modulator	Line type pulser
RF-power /peak	6 MW
Q-value of linac	18000
Length of linac	0.4 m
Phase acceptance	13°
Coupling	Side coupled

The RF-power for running the linac is delivered by a 6 MW-klystron fed by a modulator consisting of a line type pulser. The energy for the modulator is stored in a pulse forming network which delivers a primary voltage to a 1:10 pulse transformer. The klystron energy is transported to the linac through a SF 6 filled wave guide system. Within the wave guide system is a –28 dB circulator which protects the klystron from being damaged by reflected RF-power of the linac. A bi-directional coupler is located at the input coupler of the linac. The reflected power signal and the RF-pulse are shown in fig. 5. The RF-pulse has a power of ~ 2.5 MW and a flat top of more than 1.5 µs duration.

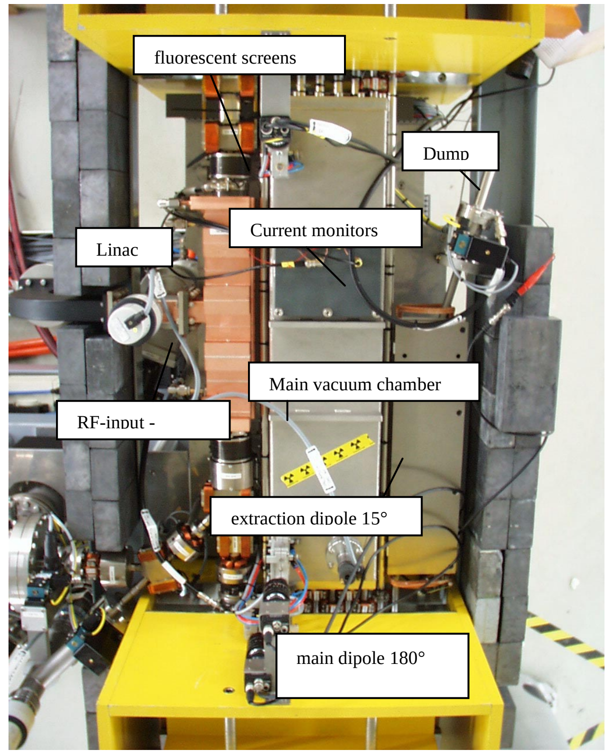

Figure 3: Top view to the ANKA microtron

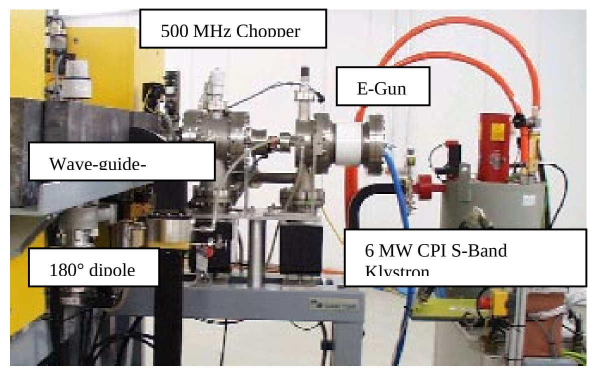

Figure 4: Microtron injection, klystron, linac wave guide, E-gun, 500 MHz chopper

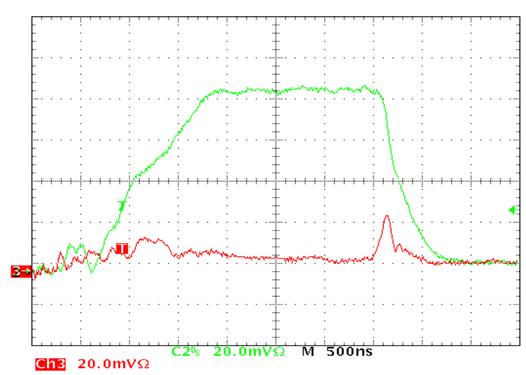

Figure 5: 3 GHz signal measured with a pickup at the end of the linac (green line). Reflected power signal measured in the wave guide (red line)

The diagnostic tools for measuring the properties of the beam within the microtron are summarized in table 2. There are overall 9 current transformers distributed in the racetracks. Three fluorescent screens are located at 10 MeV (track 2) and two additional ones at 15 MeV (track 3).

Table 2: The diagnostic tools of the Microtron

Diagnostic tool	Location	Number
Current transformer		9
Sync. light monitor	180-Bend	1
Fluorescent viewer	track 2, track 3	3
RF-Pick-up	Linac	2
Bi-directional coupler	Wave guide	2

Only the fourth track (20 MeV) has no diagnostic tools. From the fifth to the tenth track the beam can be observed either through the emitted synchrotron light or using the current monitors. The signals from the current monitor at the 5th, 6th, 8th and 10th track are presented in fig. 6. From this figure it follows that the beam losses between turns 5 to 8 are relatively small. A CCD camera is used to detect the synchrotron light which is observed in one of the main dipoles (see fig. 7).

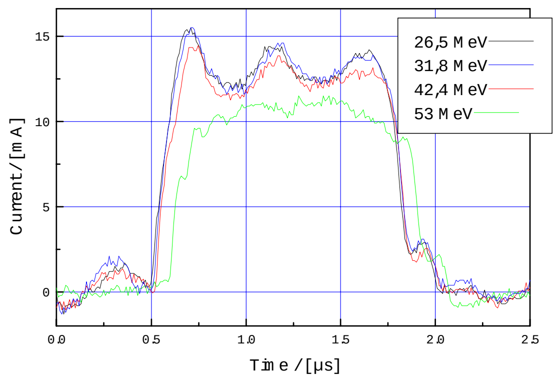

Figure 6: Pulse of the current monitor within the tracks 5, 6 , 8 and 10

The extracted beam has a pulse width of up to 1.2 µs and an average amplitude of 11 mA. The vertical focussing of the microtron was modified during the commissioning by changing the gradient of one of the main dipoles.

Figure 7: The synchrotron light of the accelerated beam within the turns 4 to 10 (from right to left)

Figure 8 shows the size of the extracted beam measured at the beam dump. For this picture the dump was covered with a grid of a spacing of 1 mm. The spot size is about 3 x 3 mm which is close to the theoretical value of 2 x 2 mm. The specifications of the extracted beam are summarized in table 3.

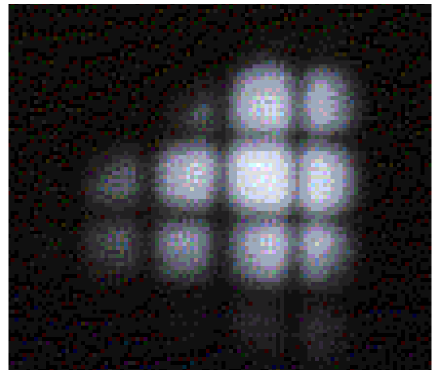

Figure 8: The 53 MeV extracted electron beam. The grid constant is 1 mm.

Table 3: Specifications of the extracted microtron beam

Item	Design	Guaran-teed	Commis-sioning
Current/ mA	15	10	16
Pulse length /µs	1	1	1.6
Energy/ MeV	53	53	53
Repetition rate/ Hz	10	10	6
Frequenz modulation/MHz	500	500	500

3 BOOSTER SYNCHROTRON

The production of all items for the booster synchrotron and the transfer lines is finished. 8 subsystems, according to the number of bending magnets, will be assembled at the manufacturer and shipped to the site of ANKA. The installation of the subsystems at ANKA is foreseen for the end of April. The RF-System (cavitiy, low-level-electronic, etc.) will be delivered by Sincrotrone Trieste. The acceptance test of the RF-system has been performed and the assembling at ANKA will take place also at the end of April. The control system for running the booster will be built by a collaboration of FZK and Jozef-Stefan-Institute in Ljubljana, Slovenia. A test of this system has already been made with the commissioning of the microtron. The part for controlling the booster will also be finished by May 99. The commissioning of the booster synchrotron will start in May 99 and an accelerated beam is expected for summer 99.

REFERENCES

[1] D. Einfeld et al., Status of the 2.5 GeV Light Source ANKA, these proceedings
[2] H.Bach, D. Einfeld, L.Praestegaard, N. Hertel, U. Ristau, R. Rossmanith; The ANKA Injector EPAC 98, June 22-26, Stockholm, Sweden (1998)