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STATUS OF THE 2.5 GeV LIGHT SOURCE ANKA

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Abstract

ANKA is a 2.5 GeV synchrotron light source under construction in Karlsruhe. ANKA will offer full service in X-ray lithography, mainly for micro- and nanofabrication, and in analyzing, and investigating non-destructively various properties of samples. During the first operational period only the light from the bending magnets (1.5 T) will be used, later four long straight sections and one short straight section can be equipped with insertion devices. The light source is scheduled to get into operation in the year 2000. At present, the 53 MeV racetrack microtron as pre-injector is already commissioned. The 500 MeV booster synchrotron is being assembled, a 500 MeV electron beam is expected during the summer period. The girders, the cooling pipes as well as the cable trays are already installed. The assembly of the magnets, the r.f.- and the vacuum-system will take place up to September 99 and we expect to get a 2.5 GeV accelerated beam at the end of 1999.

1 BUILDING

The building consists of three parts: a) the ANKA-hall, b) an annex and c) the cooling tower with the HVAT-system. The annex contains the control room, laboratories and the supplies for the electricity, water and heating/cooling. The floor within the hall is a single concrete slab with a thickness of 55 cm and without any insulation joint.

Within the ANKA-hall the following parts have already been installed: 53 MeV-microtron, the shielding around the microtron, the cable trays, the cooling pipes, the stands for the different racks as well as the girders for the magnets (see fig. 1). The commissioning of the microtron and the booster will be done from a temporary control room within the storage ring (see fig. 1). The cooling complex including the HVAT-system will be finished in May 99. The storage ring with a circumference of 110 m covers only 35 % of the hall. In the space left it is possible to build beamlines with a length of 27 m.

Figure 1: Status of the inside of the building as of March 99, showing the assembled girders, cooling pipes and cable trays. Furthermore the shielding around the microtron and the provisional control room for the commissioning of the injector can be observed.

2 INJECTOR

The 53 MeV racetrack-microtron has been installed and commissioned [1]. The accelerator of this machine is an s-band linac with an energy of 5.3 MeV. The synchrotron light coming from the relativistic electrons accelerated within the turns 4 to 9 of the microtron bending magnets is shown in fig. 2 (this is the first synchrotron light produced at the light source ANKA). A 53 MeV beam with a pulse length of 1.2 μs and a maximum current of 16 mA has been reached. This pulse shape can be changed from 0.4 to 1.2 μs. The pulse shape of the beam at different energies is shown in fig. 3 for turns 3, 5 , 7 and 9. This graph shows that there are no important beam losses during the acceleration from 26.5 MeV to 42.4 MeV. The next step in the commissioning phase of the microtron is to check the 250 MHz-chopper which should deliver a beam with a 500 MHz-structure according to the rf-system of the booster synchrotron.

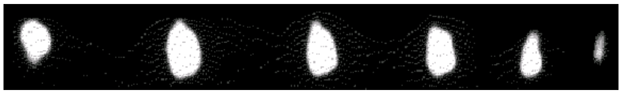

Figure 2: Synchrotron light coming from one of the main dipoles in the microtron. Shown is the light obtained from turn 4 to turn 9 (from right to left)

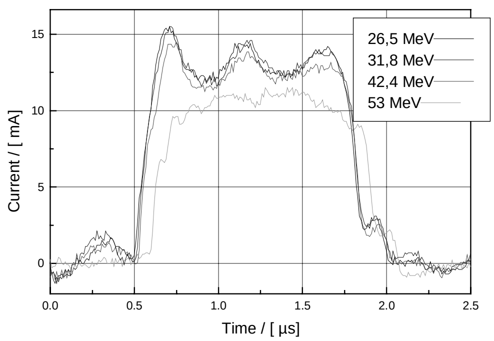

Figure 3: Pulse shape of the beam within the racetrack microtron at the turns 3, 5, 7 and 9.

The installation of the injection line and the 500 MeV booster is under way and the starting up of this complex will be in May 99. We expect to obtain a 500 MeV accelerated beam within summer 99. The assembly of the extraction line is foreseen for August 99. The company Danfysik in Denmark is building the whole injector as a turn key system.

3 MAGNETS

The series production of all quadrupoles (type Q320 and Q390) and the sextupoles (type SH and SV) is finished and all magnets have been delivered to ANKA[2]. 75 % of the bending magnets have been produced and the manufacturing of the rest will be finished in May 99. Parallel to the production of all magnets extensive mechanical and magnetic measurements have been performed in order to correlate the magnetic measurements to the geometry of the magnets. Figure 4 shows the specific magnetic field versus current for a typical bending magnet.

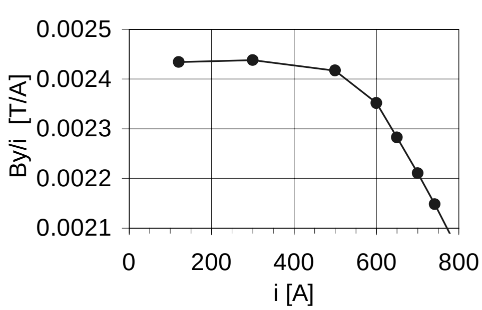

Figure 4: Specific magnetic field versus current for a bending magnet, nominal current is around 650 A

The magnetic measurements of all quadrupoles have been completed. Within the different families all quadrupoles reach the required specifications of $\Delta gL/gL \leq 4\cdot10^{-3}$. Figure 5 shows the specific integrated gradient versus current for a typical Q320 quadrupole. The measurements of the sextupoles and the bendings are under way. The installation of all magnets will be finished by the end of June 99.

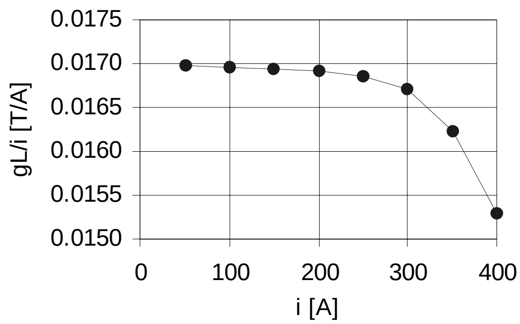

Figure 5: Specific integrated gradient versus current for a typical Q320 quadrupole, nominal current is around 350 A

4 VACUUM

The production of all elements of the vacuum system is under way. Half of the complicated dipole- and two third of the straight-section-chambers have been delivered and tested. Each element is after the production cleaned, baked and tested. The leakage rate is below $2\cdot10^{-10}$ mbar·l/s and the thermal desorption rate below $2\cdot10^{-12}$ mbar·l/(s·cm^2). In order to have an optimized clean system, the long straight sections will undergo a glow discharge cleaning process. This will be done at the Daresbury Laboratory. The installation of the vacuum-system will start in June 99 and we expect closing the vacuum system in mid-October 99. The crotch absorbers have to absorb a power of up to 8.5 kW each. According to the operation scheme of ANKA (running only for 8 hours per day) the absorbers have to undergo a large number of cycles. For the optimization of this number of cycles a special design of the crotch absorbers has been performed [3].

5 RF-SYSTEM

The rf-system consists of 5 parts: a) cavity with the low level electronics, b) the waveguide system with the circulator, c) the klystron, d) the high voltage power supply and e) the controls. The waveguide system including the circulator has been tested and delivered [4]. The installation will take place during March and April 99. Two of the cavities including the low level electronic have been tested and will be delivered to ANKA in April 99. The factory acceptance test of the high voltage power supply (HV-PS) for the klystrons have been performed successfully. This device will be installed within April/May 99. The subsystems of the first klystron have been assembled, the first klystron will be delivered by the end of April 99. We expect that the first rf-plant consisting of 2 cavities, the waveguide-system, the 250 kW klystron including the 400 kW HV-PS will be finished in June 99. The second plant should be ready in August 99. The rf-system has three levels of control: the machine control, the transmitter control and the fast interlock. For the transmitter control and for the fast interlock a new design has been made, which is described elsewhere [5].

6 POWER SUPPLIES

All power supplies are in the production phase. They will be delivered to ANKA in April/May 99. The acceptance test with the real load should be performed within July 99 after the installation of the magnets.

7 THE CONTROL SYSTEM FOR THE ACCELERATOR

The control system of the accelerator is based on client and server PC's running under WinNT and the LonWorks field bus with intelligent nodes and standard I/O modules to connect the individual devices directly to the server PC's. These server PC's communicate via CORBA with client PC's in the control room. All operator control is performed through Java applets/applications. The first real-world test of the system was performed on the 50 MeV microtron of ANKA during the period from October 98 to March 99, controlling it's vacuum system and power supplies [6]. At the moment, the present version of the control system is being optimized. In addition, the control of the RF system and the power supply ramping procedures will be tested to be able to control the booster synchrotron and the storage ring later this year.

8 TIMING SYSTEM

The timing system and instrumentation are at the moment under construction. The timing system will be based on commercially available delay generators. Two sets of delay generators are foreseen: one set is controlling the injection trigger chain into the synchrotron (triggering the gun, the microtron, klystron and the injection kickers), the second one is controlling the ejection from the synchrotron and is triggered by a revolution clock of the storage ring. With this system a gap in the filling can be produced in order to reduce ion effects on the stored beam. In the first stage the injection of single bunches and the storage of single bunches is not foreseen.

9 BEAMLINES

The optical components and experimental stations for eight beamlines are under construction. Three beamlines will be devoted to lithography. The beamlines for analytical services cover techniques from spectroscopy to diffraction and are taking advantage of the large spectral range from IR to hard X-rays emitted by the bending magnets. Two beamlines, a soft X-ray beamline for microscopy and spectroscopy and a beamline for protein crystallography, are planned and waiting for approval. In addition, one X-ray beamline is under construction which will be operated by the Max-Planck society.

Table 1: The beamlines and their main parameters

	Spectral range	Power or Photon flux
X-ray lithography I	1 – 4 keV	6 W
X-ray lithography II	3 – 8 keV	40 W
X-ray lithography III	4 – 30 keV	100 W
Soft-X	0.09 – 1.4 keV	$>2 \cdot 10^{10}$ph./s
R-spectroscopy	$4 - 10^4$ cm^{-1}	$>1 \cdot 10^{13}$ph./s
Fluorescence analysis	1 – 30 keV	$3 \cdot 10^{13}$ph./s
Protein crystallography	5 – 20 keV	$1 \cdot 10^{12}$ph./s
Diffraction	5 – 20 keV	$2 \cdot 10^{11}$ph./s
Absorption	2.4 – 30 keV	$2 \cdot 10^{11}$ ph./s
Grazing incidence diffr.	6 – 20 keV	$1 \cdot 10^{11}$ph./s

10 SUMMARY

All subsystems for the erection of the storage ring ANKA are in the production state or have already been delivered. The microtron reached already the specifications and the commissioning of the booster will start in May 99. The magnet system including the power supplies will be finished in July 99. The rf-system should be running in August 99. The vacuum-system will be closed in October 99. The commissioning will start in November 99 and the first stored beam is expected at the end of 99. The installation of the beamlines will start in spring 2000. The first exposure for the LIGA-technique is foreseen for summer 2000.

REFERENCES

[1] D. Einfeld et al., The injector for the synchrotron light source ANKA, these proceedings

[2] D. Einfeld, A. Krüssel, M. Pont, Magnetic Measurements of the ANKA Storage Ring Magnets, these proceedings

[3] S. Hermle, D. Einfeld, E. Huttel, G. Heidenreich, Layout of the Absorbers for the Synchrotron Light Source ANKA, these proceedings

[4] D. Einfeld, F. Pérez, S. Voigt, A. Fabris, C. Passotti, M. Svandrlik, Status of the R.F.-System for the ANKA Storage Ring, these proceedings

[5] D. Einfeld, F. Pérez, S. Voigt, M. Humpert, Interlock and Control for the rf-System of the ANKA Storage Ring, these proceedings

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