IEEE Transactions on Nuclear Science, Vol. NS-26, No. 3, June 1979

BESSY, A 800 MEV STORAGE RING DEDICATED TO SYNCHROTRON RADIATION

D.Einfeld, W.D.Klotz, G.Muelhaupt, Th.Mueller and R.Richter

A Synchrotron Radiation Facility dedicated to Research in the VUV and the soft x-ray region is presently under construction in Berlin (West). The facility includes a 800 MeV Electron Storage Ring, a 800 MeV separated function injector-synchrotron with a classical microtron as a 20 MeV-preinjector, 1500 m^2 experimental area and 4500 m^2 space for laboratories, workshops and offices and infrastructure (Fig.1).

Storage Ring

The storage ring is designed to give a synchrotron radiation spectrum of a critical warelength of λ_c = 2nm. This is realised by choosing a magnetic field in the bending dipoles of 1.5 T and an electron energy of 800 MeV.

Apart from the spectrum the different proposed experiments require very differing beam sizes and beam currents. The most extreme demands derive from the metrological experiments on one side, which require a nearly pointlike beam cross section with moderate currents and from the x-ray lithography experiments on the other side, which require a most intense photon beam with a vertical divergence of ± 2 mrad. These diverging requirements call for a flexible magnet lattice: a doublett structure with a fourfold symmetry was choosen having the following parameters (Tab I)

TABLE I

Parameters of the Storage ring

Lattice:

max.Energy	E = 8oo MeV
Circumference	U = 62,4 m
Structure	separated function DF B FD B DF B FD
Superperiodicity	4
No.of Dipol Magnets	12
No.of Quadrupol Magnets	32
No.of Sextupol Magnets	24 (16)
No.of straight Sections	4
Length of straight Sections	3.2 m
Beam Ports	12 x 15o mrad 8 x 2o mrad
Radius of Curvature	1.78 m
max. Field	1.5 T

Optics:

Emittance (hor.)	$4.1o^{-8}\ \pi$ rad m $< \varepsilon_x < 4.1o^{-7}\ \pi$ rad m
Working Points	$3.5 < \nu_x < 5.3$ $1.3 < \nu_z < 4.9$
Momentum compaction Factor	$o.ooo4 < \alpha < o.1$
Chromaticity	$-14 < \Delta Q_x/(\Delta p/p) < -3.5$ $-1o < \Delta Q_z/(\Delta p/p) < -3.5$
min.Dimensions in the Bending Magnets	$\sigma_x = \sigma_z$ = o.1 mm
max.Amplitude Function	$\beta_x^{max} = \beta_z^{max}$ = 28 m
max.Acceptance (linear $\varepsilon_x = 4.1o^{-7}\ \pi$ rad m)	A_x = 14o $1o^{-6}\ \pi$ rad m A_z = 8o $1o^{-6}\ \pi$ rad m
dto. (with sextupols, $\varepsilon_x = 4.1o^{-7}\ \pi$ rad m)	A_x = 14o $1o^{-6}\ \pi$ rad m A_z = 8o $1o^{-6}\ \pi$ rad m
dto. (linear, $\varepsilon_x = 4.1o^{-8}\ \pi$ rad m)	A_x = 6o $1o^{-6}\ \pi$ rad m A_z = 25 $1o^{-6}\ \pi$ rad m
dto. (with sextupols)	$A_x = A_z$ = 5 $1o^{-6}\ \pi$ rad m

Injection via Kicker and Septum into the vertical Phase plane.

RF

RF-Freyeuency:complete Systems	ν_{HF} = 5oo MHz	125 MHz
Harmonic No.	k = 1o4	26
RF Output power	25 KW	25 KW
Shunt Impedance of the Cavity	3 MΩ	o.5 MΩ
Bunch length ($I \to o$, α = o.1)		6oo psec
Bunch length ($I \to o$, α = o.ooo4)	1o psec	

The large emittance optic is conventional having a max. amplitude function of 10m. The resulting large acceptances with compensated chromaticity allows the excitation of the stored beam, especially in the vertical plane as to be able to illuminate larger areas homogeneously for purposes of the x-ray lithography. The low emittance optic has a drastically reduced acceptance of $5 \cdot 10^{-6}\pi$ rad m, a bit more than is needed for the 6 stand dev.of the stored beam, but up to now not enough for injection, but only a 2-family-solution was tried out.

The frequency of 500 MHz is choosen to increase the Touschek-life time ($\tau_{Touschek} \sim \sqrt{\nu HF}$) and because developed 500 MHz-cavities can be used. The 125 MHz system can be used to decouple the synchrotron frequencies of successive bunches from each other or the 500 MHz - system can be used to make a potential deformation to the 125 MHz-bucket to lower the synchrotron frequency and to increase the longitudinal Landau damping.

The optic with α = 0.0004 was made to try to get a length of the photon puls of σ_τ = 10 psec , which is competitive to Q-switched lasers. Despite the very low storable beam of around 1 mA, this option might be interesting to time resolved experiments.

Berliner Speicherring Gesellschaft für Synchrotronstrahlung m.b.H. (BESSY), Berlin (West), Takustr.3

0018-9499/79/0600-3801$00.75 © 1979 IEEE

Injector

To avoid low instability thresholds and life time limitations, it is desirable to have the injection energy as high as the operation energy of the storage ring. Therefore the max. energy of the injector was set to 800 MeV. To provide the option of testing some features of possible low cost synchrotron light sources (e.g. multicycle injection and storage), a separated function synchrotron was designed, being powered by three different White-circuits for the bending magnets, the focussing and the defocussing quadrupoles. These circuits are phase-locked to each other, but independently amplitude controlled to have a larger flexibility in magnet optics. The Parameters are shown in Table II.

TABLE II

Parameters of the Injector Synchrotron

max. Energy	800 MeV
Injection Energy	20 MeV
Circumference	38.4 m
Superperiodicity	6
Structure	separated function F B D B F
No. of Dipolmagnets (H-Type)	12
No. of Quadrupolmagnets	18
Repetition Rate	10 c/sec
Pulscurrent	5 mA
Emittance (800 MeV)	$1\ 10^{-6}$ rad m
RF-Frequency	500 MHz
RF-Outputpower	2 KW

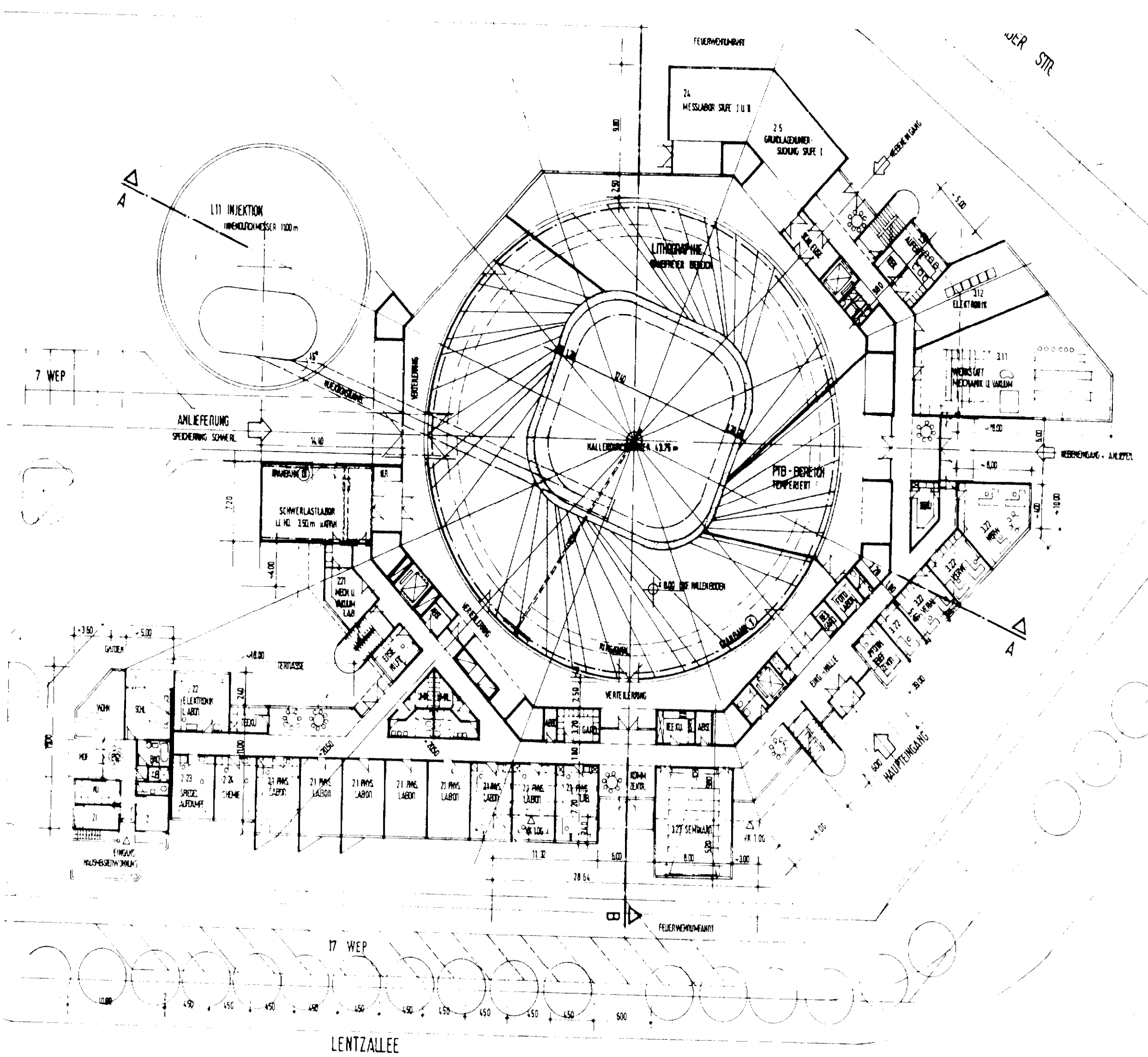

FIG. 1 : Layout of the BESSY-Facility