A 100 MEV INJECTOR LINAC FOR THE SWISS LIGHT SOURCE SUPPLIED BY INDUSTRY

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Abstract

A 100 MeV 'turn-key' injector electron linac for the Swiss Light Source (SLS) is under construction at ACCEL Instruments. The system will be installed, commissioned and handed over to the SLS in late 1999, after a 18 month design and production period.

This paper will present the special needs of an injector for a third generation synchrotron light source and the two specific modes of operation for this linac. The specification of the system and a description of the design results as well as the planned technical realisation will be given.

1 REQUIREMENTS FOR THE SLS INJECTOR SYSTEM

A third generation synchrotron light source is equipped with several types of insertion devices such as wigglers, undulators and wavelength shifters.

These devices can be driven in several operation modes. To drive a Free Electron Laser for example a single bunch mode operation is required. This results in single and multi bunch operation modes, to fulfil the different needs of the users.

1.1 General specification

The SLS accelerating system will consist of a 100 MeV Linac and a full energy booster. The general parameters [1] of the linac are listed in the following table 1:

Table 1: General Specifications

RF frequency	2.997921 GHz
Max. repetition rate	10 Hz
Energy	100 MeV

1.2 Pulse modes

Two modes of operation are foreseen. One single bunch mode[1] and one variable multi bunch mode. The multi bunch mode will cover the range on 50-500 bunches. To reduce the effect of beam loading the multi bunch mode will carry the same charge as the single bunch mode. The basic parameters of both modes are given in table 2.

In addition the SLS layout foresees a top up injection mode, this mode will deliver a low current to the storage ring, to keep the mean current in the storage ring nearly constant.

Table 2: Operation Modes

	Short Pulse	**Long Pulse**
Pulse length	1 ns	100-1000 ns
Pulse charge	1.5 nC	1.5 nC
Emittance	50 π mm mrad	50 π mm mrad
Energy	100 MeV	100 MeV
$\Delta E/E$	0.5 %	0.5 %

2 LAYOUT OF THE SYSTEM

The main components of the injector system are based on components which were developed for the S-Band Test Facility (SBTF) at DESY 2. Adopting these components for the special needs of the SLS project took place during the design phase.

To fulfil the requirements the system consists of three functional sections:

- The electron source
- The bunching section
- The accelerating structures

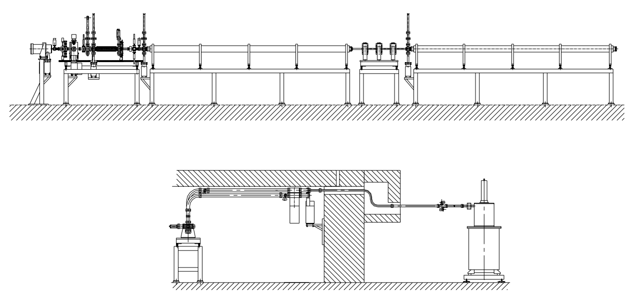

Figure 1: General Layout

2.1 The electron source

The electrons will be provided by a 90 kV DC conventional electron source as shown in Figure 2. The electron emitter is a standard EIMAC cathode YU-171.

The pulser for the electron source comprises two systems, one for the single bunch and one for the multi bunch mode. In the single bunch mode a 1 ns pulse carrying 3 nC will be sufficient to guarantee 1.5 nC at the end of the Linac. The multi bunch mode will be modulated by the 499.652 MHz main ring rf, to insure a high bunch purity.

[1] In this context the bucket length of the ring rf system defines the bunch length of 2 ns

The top up injection mode requires, that even the gun is capable of producing a low charge pulse. For that reason the pulse current can be varied by a factor of forty.

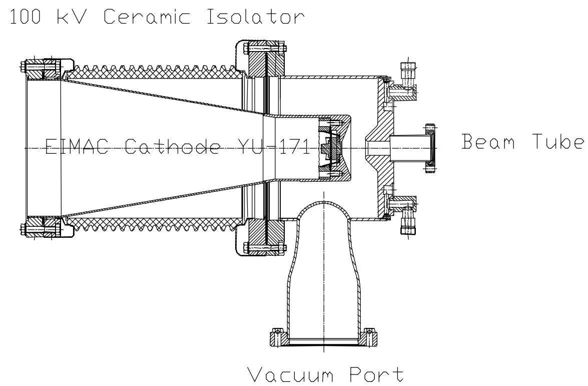

Figure 2: 90 kV Electron Source

The basic parameters of the cathode are listed in the following table:

Cathode YU-171		
Flange	CF	2 ¾
Cathode surface	cm^2	1.0
Emission	A	3
Cathode Radius	mm	5,6
Cathode Typ		Dispenser

2.2 The bunching section

The bunching section, as shown below, will consist of a 500 MHz subharmonic prebuncher as shown in Figure 4, a 4 cell travelling wave buncher as sketched in Figure 5 and a 16 cell travelling wave buncher as shown in Figure 6. At the exit of the bunching section the beam will have an Energy of 3 MeV.

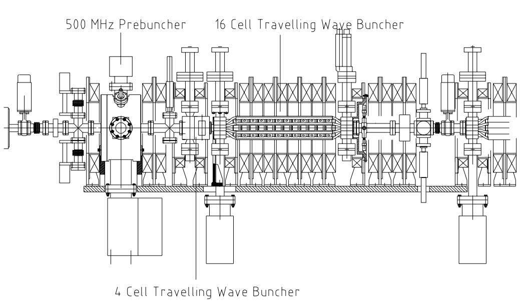

Figure 3: Bunching Section

To compensate space charge effects and rf defocusing the beam is focused by a solenoid magnetic field of up to 0.2 Tesla. This field will be produced by a set of more the 30 pancake coils, which guide the beam until it reaches an energy of 10 MeV.

2.2.1 The 500 MHz subharmonic Prebuncher

The subharmonic prebuncher cavity is a standard nose-cone cavity. The needed rf power will be fed into the system by a coaxial line.

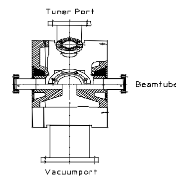

Figure 4: Layout of the 500 MHz Prebuncher

The basic parameters of the buncher are given in the table below:

Table 3: Parameters of the Subharmonic Prebuncher

Frequency	MHz	*500*
Shuntimpedanz	MW/m	37
Q		28000
Amplitude Uo	[kV]	30

2.2.2 Travelling Wave Buncher System

Two travelling wave bunchers will be used to insure a sufficient bunching in order to reach a high transmission rate with low energy spread.

The first 2 $\pi/3$ mode buncher consist out of four cells as shown in Figure 5. The layout had been done for β=0.6.

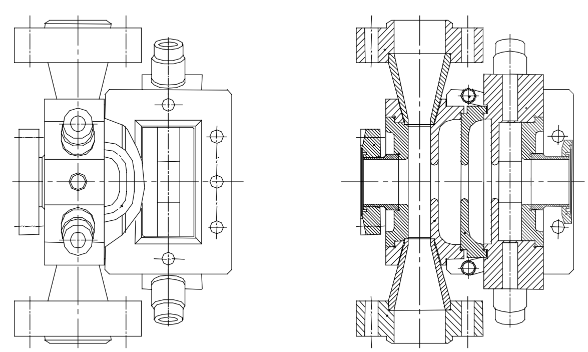

Figure 5: 4 Cell 2 $\pi/3$ mode Buncher

The second buncher, as shown in Figure 6, is optimised for β=0.95, consists of 16 cells and will be operated in the 8π/9 mode.

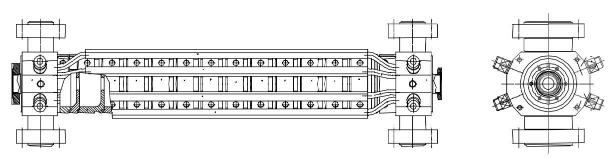

Figure 6: 16 Cell 8 $\pi/9$ Mode Buncher

2.3 Travelling Wave Accelerating Structure

The accelerating structures are of DESY Linac II type.

Table 4: Parameters of the Linac II Structures

length	m	5.2
attenuation	Neper	0.5
group velocity	% of c	3.3-1.2
filling time	ns	750
shunt imped.	MΩ/m	52-62
number of cells		156

3 DESIGN RESULTS

To insure the performance of the system ACCEL carried out simulation calculations for the main components as electron source and bunching system.

The bunching section was optimised for the two different modes mentioned above.

The subharmonic prebuncher will focus more than 80% of the particles into one 3 GHz bucket, for this a gap voltage of 30 kV is needed.
When the beam enters the second travelling wave buncher more than 50% of the particles will populate 20° of the central 3 GHz bucket. The average energy is about 400 keV.

Before entering the first accelerating structure 80% of the particles will be found in 20° of the central bucket at an energy of about 3 MeV.

After passing two accelerating structures of the Linac II DESY type, which will be powered by moderate 18 MW, the beam will have reached 100 MeV. An overall transmission of 96% is designed. The bunching efficiency insures that more then 85% of those particles are within the energy spread acceptance of the booster which will be +/- 1.5%.

4 CONCLUSION

This paper summarises the beam requirements of the injector linac for the 3rd generation light source SLS. It is shown that a Linac with proven and reliable technology can fulfil these needs. The linac components and the design results are presented, showing that the requirements can be reached.

5 ACKNOWLEDGEMENTS

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Beside DESY we also want to thank the SLS staff at PSI for their open and co-operative acting.

6 REFERENCES

[1] Specification for the ELECTRON PRE-INJECTOR LINAC for the SWISS LIGHT SOURCE, SLS SPEC03/RL02

[2] R. Brinkmann, Conceptual Design of a 500 GeV e^+e^- Linear Collider, DESY 1997-048