100 MEV PRE-INJECTOR FOR 3rd GENERATION SYNCHROTRON LIGHT SOURCES

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Abstract

The Swiss Light Source (SLS) pre-injector is a 100 MeV S-band linear accelerator, which has been supplied as a turn-key system by ACCEL Instruments GmbH in April 2000. This design provides a successful base for modern Synchrotron Light Source pre-injectors as recently contracted for DLS and ASP. Within the paper a review on beam performance and reliability of the SLS linac will be given, further planned improvements for DLS and ASP will be presented. The layout is shown in Figure 3.

PERFORMANCE

The layout with a thermal electron source, a bunching section (one sub harmonic prebuncher (SPB), two 3GHz traveling wave bunchers (PBU and FBU)) and two 3GHz traveling wave accelerating structures allow to reach beam parameters as given below:

Accelerated particles	electrons
RF frequency (S band)	2997.924 MHz
Energy	≥ 100 MeV
Charge	≥ 1.5 nC per pulse
Pulse to pulse energy variation	> 0.25% (rms)
Relative energy spread	> 0.5% (rms), ± 1.5% (full width)
Repetition rate	adjustable from single shot up to 5 Hz
Normalised emittance (1s)	> 50 π mm.mrad in each plane (x, x') or (y, y'

Main components of the linac as the electron source (Figure 1), the bunching and accelerating cavities (Figure 5) are produced in house, supplies and standard components are bought in.

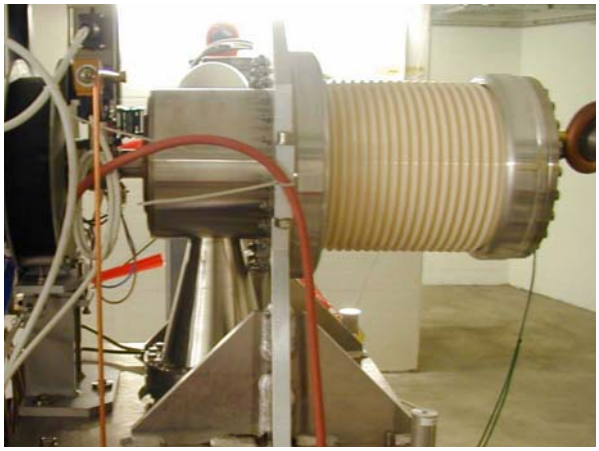

Figure 1: Electron Source

MULTIPACTING

Major reason for beam degradation in the beginning of SLS operation was multipacting in the low field sub harmonic prebuncher. A thoroughly analysis took place (Figure 2) showing that it could only be soft multipacting, which can be overcome by clean assembly and rf conditioning. A handling and cleaning procedure was established proving the calculations.

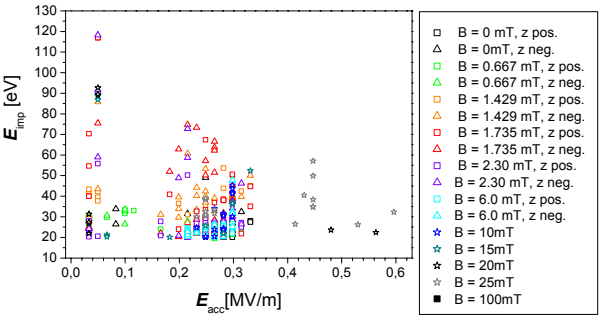

Figure 2: Results of Multipacting Simulations

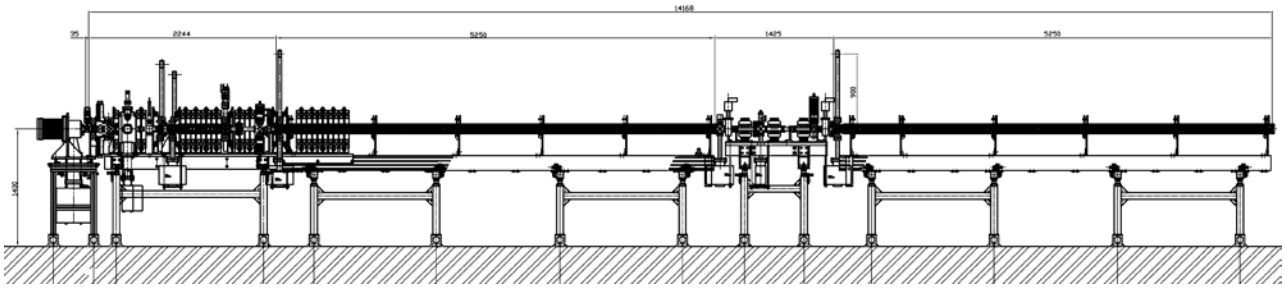

Figure 3: 3rd Generation Light Source injection linac side view

PROPOSED CHANGES

Based on the good operation experience with the SLS Linac only minor changes (Figure 4) had been implemented for the DLS and ASP Injector Systems:

1. in the drift between SPB and PBU a few cm have been added to improve the mounting and maintenance possibilities, performed PARMELA calculations confirmed the decision
2. no current transformer between final buncher and acceleration section 1 will be used to avoid negative impact from ferrites in the solenoid field
3. in the waveguide runs RF windows are shifted from the vertical wave guide to the horizontal; this allows adding of one pump between each RF window and the cavity
4. SPB will be installed under clean-room conditions to reduce multipactoring
5. an amplifier with higher duty cycle will be included to aid SPB conditioning

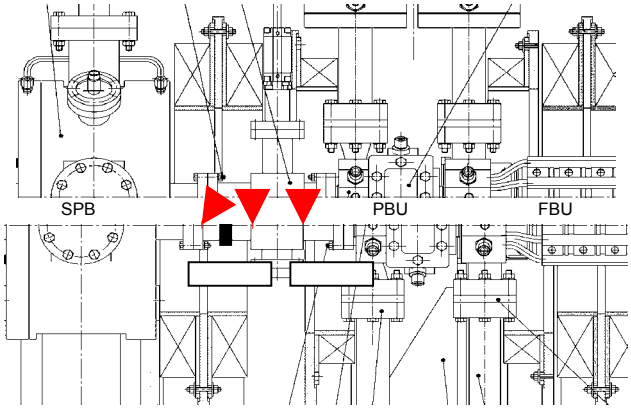

Figure 4: Mechanical design changes from the SLS linac

RELIABILITY

Based on a list of failures which had been provided by SLS on our request we estimated MTBF periods of the SLS linac.

32 events within the first 15.000 operation hours have been reported by the customer, the resulting MTBF is about 450 hours. A closer look shows that two events have occurred during installation, twelve are just interlocks recorded and seven could have been covered by scheduled maintenance, which now will be performed. This reduce the amount of failures to 11 and increase the MTBF to above 1300 h. While 40% of those failures had been related to the 3GHz drive amplifier it was decided to choose a different manufacturer.

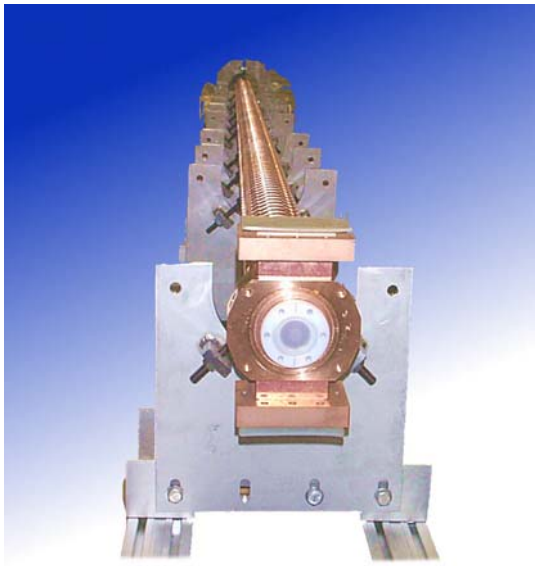

Figure 5: 5.2m long 3 GHz S-Band accelerating structure

CONCLUSION

Based on the SLS operation experience the 100 MeV ACCEL linac design had been evaluated, showing the requirement of only minor improvements. The major source of problems related to the multipacting of the 500 MHz sub harmonic low field pre buncher had been deeply analyzed and a solution was found improving the system reliability even further.