IPAC21, MOPAB075, Campinas, Brazil, May24-28, 2021

PROPOSAL OF THE SOUTHERN ADVANCED PHOTON SOURCE AND CURRENT PHYSICS DESIGN STUDY

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Introduction

Early from 2016, scientists from the Institute of High Energy physics (IHEP), have proposed to build a mid-energy fourth generation storage ring light source neigh-bouring the China Spallation Neutron Source (CSNS), in Guangdong Province, the south of China. This light source, together with the CSNS, is expected to able to benefit multi-discipline scientific researches in the south of China. Two injector options are under consideration for this moment and their preliminary designs are given.

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* work supported by Guangdong Basic and Applied Basic Research Foundation(2019B1515120069).

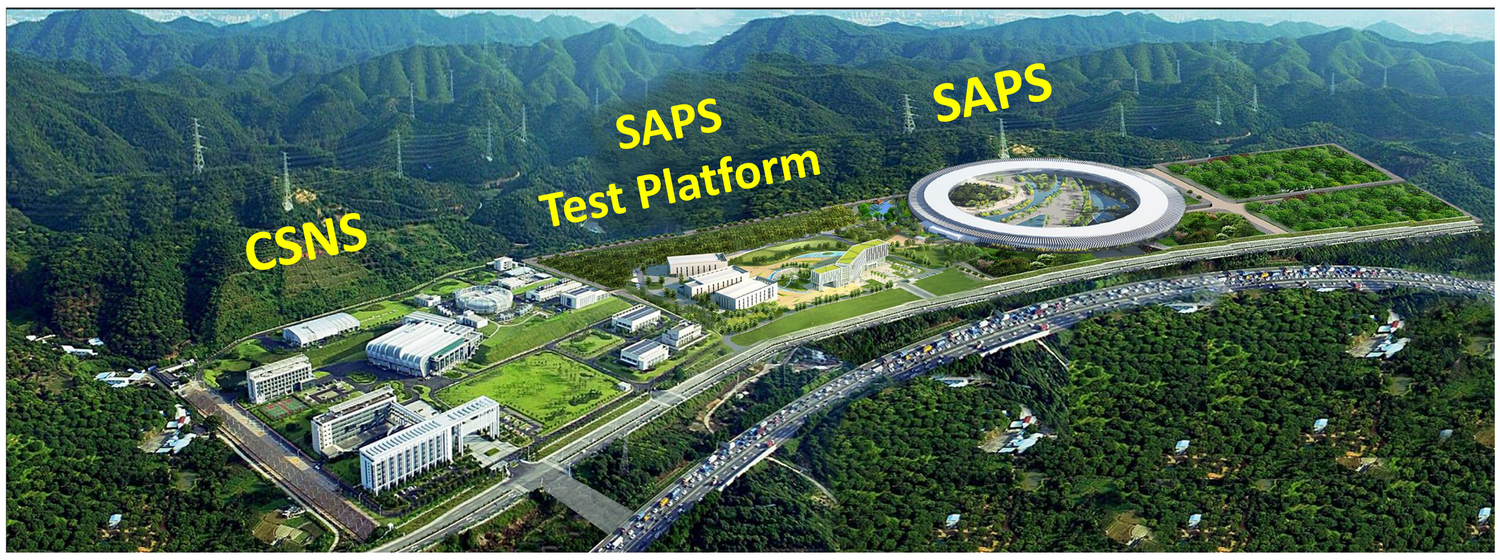

Figure 1: China Spallation Neutron Source (CSNS, in operation), SAPS Test Platform (from 2021 summer) and SAPS (proposed location)

Candidate Ring Lattice

One candidate ring lattice has been design with the H-MBA concept with the beam energy of 3.5 GeV. 7BA lattice has been chosen, featuring longitudinal gradient bends (LGBs) and high-gradient horizontally focusing anti-bends (ABs) .

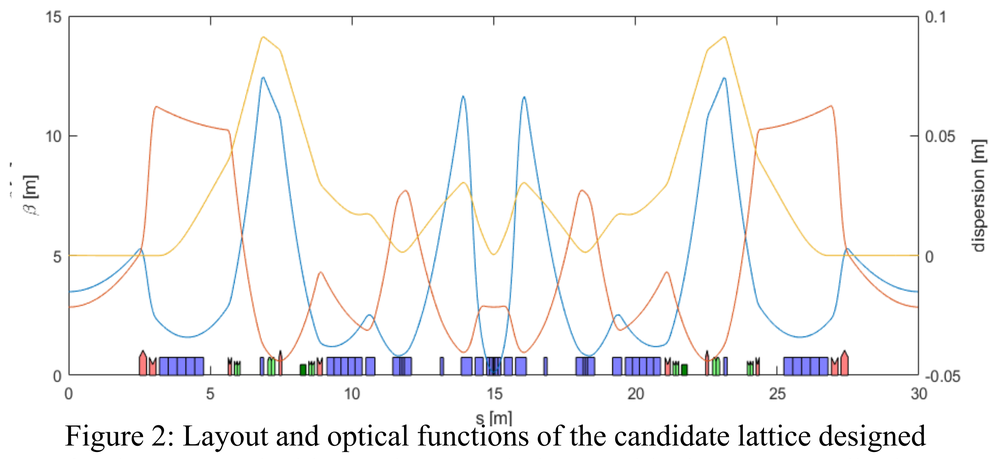

Figure 2: Layout and optical functions of the candidate lattice designed for the SAPS. The blue, red, green, dark green blocks represent dipoles, quadrupoles, sextupoles and octupoles, respectively.

Table 1: Main parameters of the candidate ring design

Parameters	Values	Unit
Beam energy	3.5	GeV
Natural emittance	31.8	pm·rad
Circumference	1080	m
Natural energy spread	1.10×10^{-3}	
Length of straight section	5	m
RF frequency	166.7	MHz
RF voltage	1.2	MV
Corrected chromaticity (H/V)	1	
Momentum compaction factor	1.37×10^{-5}	
Harmonic number	600	
Natural bunch length	4.6	mm
Betatron tune (H/V)	81.23/64.18	
Radiation energy loss per turn	0.898	MeV/turn
Damping partition[*x*/*y*/*z*]	1.55/1/1.45	
Damping time[*x*/*y*/*z*]	18.1/28.1/19.3	ms

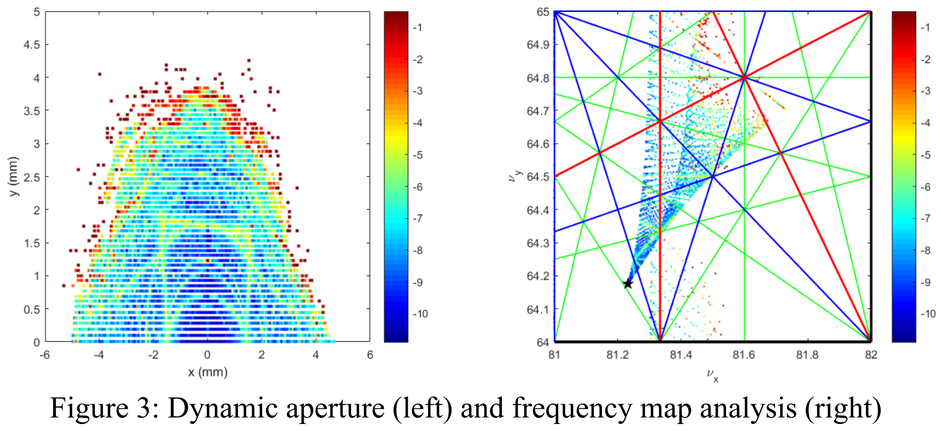

Figure 3: Dynamic aperture (left) and frequency map analysis (right)

Injector Option A: Linac + booster

A 150 MeV S-band Linac [1] and an energy booster with TME lattice are studied as an injector option.

The Linac consists a DC thermionic electron gun (150 keV, 50 Hz, 1.6 ns), a bunching section (50 MeV) and an accelerating section (150 MeV). The booster (1 Hz, 240.5 m) has a three-fold structure lattice. Each super-period consists of nine identical TME cells and two matching cells.

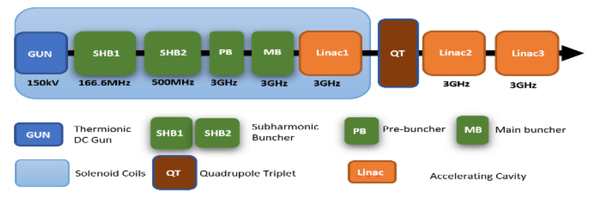

Figure 4: Layout of the 150 MeV Linac

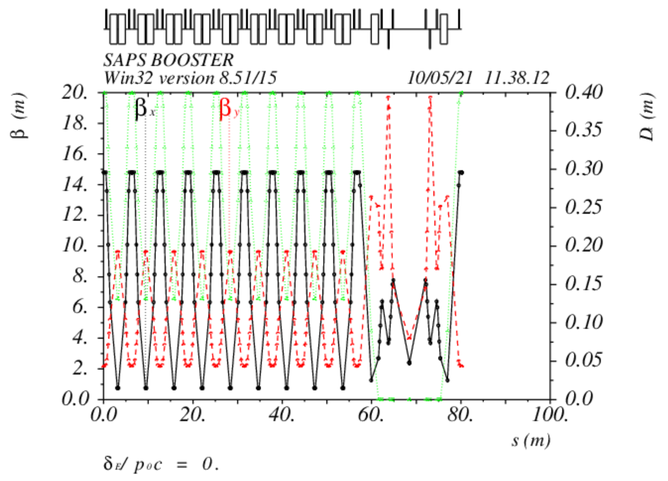

Figure 5: The booster TME lattice and its parameters

Injector Option B: Full energy Linac

A full energy Linac option with C-band RF photo gun and C-band accelerating structures is under study. It is designed in such a way that it can be used for Free Electron Laser (FEL) in the near future. Please refer to [3] for more information.

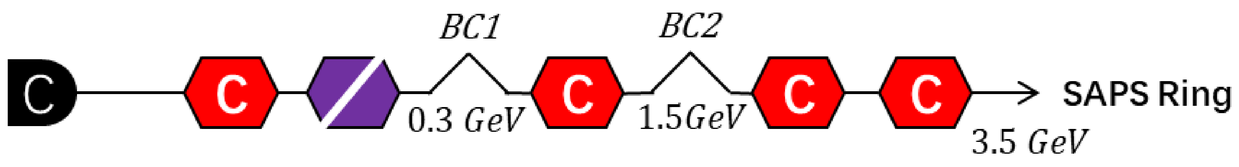

Figure 6: Layout of the booster TME lattice and the optical func-tions along the lattice

Other studies

Error study has been conducted for the present ring design. With prescribed errors, the alignment error has been found to be dominant in reducing the dynamic apertures. Please refer to [5] for more information.

Collective effects like Intra-beam Scattering (IBS) has also been evaluated. Preliminary studies indicate that the beam emittance is sensitive to the beam current intensity and the coupling factor. 3rd harmonic cavities and the inserting devices are considered to damp the emittance.

In addition, novel techniques like introducing the laser modulation in the ring has also been studied. Simulation results suggest that soft X-ray pulse of attoseconds is feasible. Please refer to [6] for more information.

Related contributions at this conference

[1] TUPAB044, Y. Han, etc., “Preliminary Study of the on-axis swap-out Injection Scheme for the SAPS”
[2] TUPAB045, Y. Han, etc., “Preliminary design of the low energy injector for the SAPS”
[3] TUPAB046, X. Liu, etc. “Full Energy Linac Injector for the SAPS”
[4] TUPAB047, B. Li, etc., “Bunch Compressor Design in the Full Energy Linac Injector for SAPS”
[5] THPAB104, J. Chen, etc., “Magnetic error effects of the storage ring for the SAPS”
[6] MOPAB055, W. Liu, etc., “Generation of coherent attosecond X-ray pulses in the SAPS”