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LNLS: THE BRAZILIAN SYNCHROTRON LIGHT LABORATORY

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In this paper, we present briefly the status of the <u>Laboratório Nacional de Luz Sincrotron - LNLS</u> (National Laboratory for Synchrotron Light) of Brazil as of January 1989 and discuss future plans for the installation.

1. Introduction

The first discussions about a synchrotron light source in Brazil started in 1981/1982. Due to the, at the time, small size of the interested scientific community, the project was not considered to have a high priority and the final decision about building a light source was not taken until about five years later. At the end of 1986, the Brazilian Ministry of Science and Technology and the National Council for Scientific and Technological Development (CNPq) set up the Laborátorio Nacional de Luz Sincrotron - LNLS (National Laboratory for Synchrotron Light). The city of Campinas, an industrial and technological center located about sixty miles west from the city of São Paulo was chosen to site the Laboratory.

During the first half of 1987, the initial staff was given the task of finding suitable temporary quarters to house the Laboratory, planning the facility, purchasing basic equipment, and hiring the personnel. Hardware development began in 1987, when the temporary premises were occupied by the technical and administrative staff. Total investments by the end of 1988 reached about US\$11 million. At the moment, LNLS has a technical staff of about 65. The work is concentrated on the design and construction of a 100 MeV LINAC, to be used as a pre-injector for the light source.

The aims of LNLS are threefold: (1) Design and build, as much as possible in Brazil, a synchrotron light source. This demands setting up, practically from scratch, a group in Accelerator Physics and Engineering. (2) Operate a synchrotron light source for the Brazilian and, eventually, international, scientific community. (3) Set up the first National Laboratory, open to outside users, in Brazil.

2. Present Stage

2.1. Pre-Injector The characteristics of the LINAC are given below:

Frequency	2856 MHz.
Mode	2π/3
Repetition Rate	0.5 to 30 Hz.
Structure	TW
Output Energy	100 MeV.
Energy Dispersion	<2%
Macropulse Current	200 mA.
Pulse Length	100-200 ns.
Output Emittance(100MeV)	<0.42 mm.mrad.

The accelerating structures and one electron gun have been purchased from the Institute of High Energy Physics of the Academia Sinica (People's Republic of China), through a scientific and technical cooperation agreement. In parallel there is a collaborative effort with Brazilian industries to machine and braze more accelerating structures, in case the positron option is made later on. A second electrostatic electron gun is being built at LNLS. Power supplies, including the 75 Mwatt modulators for the klystrons are being developed at home. The same is the case for magnetic lenses, solenoids, current monitors, control system, and the other components of the LINAC. By the time of this writing, all the components to assemble the first two accelerating structures (50MeV LINAC) are on hand or being shipped by outside suppliers. This LINAC will be assembled and commissioned during 1989. The full 100 MeV LINAC will be assembled and commissioned over the next two years.

Additional details about the LINAC can be found in the contributions by L. Liu <u>et al</u>¹, W.A. Ortiz <u>et al</u>², and J. Franco <u>et al</u>³ in these Proceedings.

2.2 Project One

The original project for LNLS, called from now on Project One⁴, was prepared in 1985 in collaboration with H. Wiedemann (SSRL). It was a high brilliance, 2-3 GeV electron storage ring, with full energy injection. The injection scheme was based on a 100-200 MeV LINAC, followed by a booster synchrotron. Project One was prepared at a time when insertion devices were just coming into focus as the most important components for a state-of-art light source. The ring of Project One had an insufficient number of straight sections.

Very early in the discussions of the light source for LNLS, the decision was taken to completely revise this project when the time came to tackle the final design. In the meantime, the staff acquired more experience, not only on accelerator physics and on scientific instrumentation for light sources, but also on the realities of the Brazilian science budget during years of economic hardship. It was seen that, in order to deliver photons to the scientific community within schedule, not only technical considerations, but also political and economic ones, dictated the need for revision of Project One.

The parameters for this revision were established by the Governing Board of LNLS. They were: (a) the new ring should be built within the original schedule, i.e., commissioned by 1992; (b) it should be a scientifically interesting light source; (c) it should be technically within reach of the human, material and financial resources available to LNLS; (d) the LNLS technical staff should assume full responsibility for its design and construction; and (e) it should not jeopardize the final goal of a source along the lines of that of Project One.

2.3. VUV Ring

Within these guidelines, the Project Division of LNLS decided to reevaluate the injection scheme of Project One. By completely redesigning its booster synchrotron, and, in fact, changing its very concept, it would be possible to have a VUV light source available to users within schedule. It might also be possible to use it as a non-optimal injector into the X-ray ring, delaying the construction of a multi-ring, optimized, injection system for a later phase of the project. Instead of shrinking, the LNLS project actually grew: the best way to satisfy the Board's guidelines would be to add a VUV ring to Project One! The increased cost of the Project would be spread over a longer time base, a condition which seemed acceptable to the Board.

For use in Materials Research and in Atomic and Molecular Physics, two areas for which there is an immediate need in Brazil, it was decided that the critical wavelength should be around 1 nm. From the construction point of view, it was decided that the machine should have a simple conception, with few elements, and a minimum number of straight sections for insertion devices. It should have a large dynamic aperture and be relatively insensitive to errors. Within these constraints, the brilliance should be maximized. Early in 1989, the technical staff of LNLS established the preliminary set of parameters given below:

Injection energy -	100 MeV.
Operational Energy -	0.1 - 1 GeV.
Circumference -	44.452 m.
Magnetic Lattice - Chasman-Green,	4-fold symmetric
Bending Field (max.) -	l.5 Tesla.
Number of Bendings -	8.
Number of Quadrupoles -	20.
Number of Sextupoles -	8.
Horizontal Tune (1 GeV) -	3.27.
Vertical Tune (1 GeV) -	1.17.
Natural Horizontal Emittance -	0.185 mm.mrad.
Momentum Compaction Factor -	.031.
Energy Spread (1GeV) -	0.056%.
Natural Horizontal Chromaticity -	-4.22.
Natural Vertical Chromaticity -	-4.57.
Horizontal Betatron	
Damping Time (1 GeV) -	8.3 ms.
Vertical Betatron	
Damping Time (1 GeV) -	7.4 ms.
Synchrotron Damping Time -	3.5 ms.
Critical Wavelength -	1.24 nm.
Max. Stored Current (estim) -	200 mA

The schedule for the VUV ring is as follows:

Final design -	1989
Prototypes: construction and test -	1990
Construction of components -	1991
Assembling and commissioning -	1992

The ring lay-out is shown in Figure 1.





FIGURE 1 - (a) Lay-out of VUV ring. (b) Detail of 1/4 of the ring, showing front-ends for beam lines.

The most serious remaining problem is that of injection and accumulation at low energies (ca. 100 MeV), with all the attendant problems and risks during commissioning and operation. Careful consideration is being given to these questions, which we believe can be successfully resolved.

3. Conclusion

In a relatively short time, considering the virtually nonexistent availability of previous experience with accelerator physics and engineering in Brazil, LNLS will achieve its proposed aim of assembling and commissioning a LINAC pre-injector before the end of 1989. A major revision of the storage ring project has led LNLS to opt for a VUV ring as the circular machine to be built following the LINAC. It is due to be commissioned by 1992.

This light source will play a major role in training machine physicists, instrumentation developers and users of LNLS. This is an overriding consideration in the present scientific and technological environment in Brazil.

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