Advancing SABINA: Installation, Commissioning Plan, and Early THz Diagnostics

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Abstract: SABINA addresses the challenge of delivering high-intensity, tunable-polarization THz/MIR FEL radiation. The beamline and APPLE-X undulators are installed and characterized. In 2026, commissioning will validate beam transport, assess undulator performance, and enable first THz measurements for simulation benchmarking and optimization.

SABINA (Source of Advanced Beam Imaging for Novel Applications) [1] is the new THz and MIR Free-Electron Laser currently under installation at the SPARC_LAB facility of INFN-LNF [2].

The facility is designed to generate high-intensity, short-pulse radiation with tunable polarization in the THz and MIR spectral ranges. The electron beam provided by SPARC_LAB, operating in the 30–100 MeV energy range, will drive a Self-Amplified Spontaneous Emission (SASE) process across up to three APPLE-X undulators [3], delivering quasi-monochromatic radiation in the spectral range from 3 to 30 THz with milliJoule-level energies and picosecond pulse durations.

The project is finally transitioning from concept to reality: the full electron beam line - including the dogleg transport system and the APPLE-X undulator chain - is now installed and undergoing final technical validation.

In recent months, significant effort has been devoted to instrumenting the electron beam line and designing the radiation transport line. The undulators have been precisely mechanically aligned, magnetically characterized [4], and integrated into the control system through coordinated operations among experts in several fields. This ensures the flexibility required for variable-polarization operation for an efficient user facility.

SABINA is therefore entering a decisive phase, moving from construction to beam commissioning. The first electron beam on the SABINA's line is scheduled for the early

months of 2026 and will proceed through a stepwise program. The initial stage will concentrate on driving the beam through the full dogleg to verify optics, stability, and transport efficiency. Moreover, a thorough performance analysis of the undulators will be performed to match the simulations with the real conditions and at different beam energies.
In parallel, a temporary diagnostic station for the first detection of THz radiation will be installed downstream of the undulators. This temporary setup will enable early photon-beam characterization while the permanent photon-transport line to the future user area is in installation phase.
The contribution will present the status of SABINA, detailing the implemented beamline, the progress on the undulator system, the planned commissioning strategy, and the expected timeline for the 2026 experimental campaign. Preliminary planning for the first THz measurements - targeted to benchmark simulations and guide final optimization - will also be discussed.

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