

## Challenging Needs for Diagnostics for SOLEIL II

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With the upcoming upgrade of the SOLEIL synchrotron planned for 2028, we face the challenge of providing high-performance beam diagnostics for all 29 beamlines, whose energy spectra range from deep infrared to gamma rays. Currently, around 300 diagnostic systems, comprising 15 device types, monitor photon beam position, shape, and intensity at SOLEIL beamlines, with some in operation for over 15 years. To ensure a smooth restart post-upgrade, most diagnostics devices must be modernized and standardized for efficient deployment and management. The upgraded source will introduce significant challenges, including photon flux increases up to 100 times and beam spot sizes of  $1\ \mu\text{m}$ , necessitating sub-micron spatial resolution. Conversely, some beamlines will use expanded, lower-flux beams, also requiring precise diagnostics. Often, in situ, real-time measurements of beam characteristics are critical for live beam corrections such as flux control, and sample alignment, while preserving beam coherence—demanding ultra-thin, semi-transparent sensors, especially difficult in the soft X-ray regime. Future diagnostics must thus cover a broad range: energies from soft X-rays to 100 keV, beam sizes from  $1\ \mu\text{m}$  to several mm, and significantly higher photon rates. We are currently identifying existing systems and specifying future beam diagnostics needs in preparation for the upgrade.

Our in-house development focuses on soft X-rays and high photon intensities. One promising candidate for handling soft X-ray energies is thin diamond films with NV centres, which have produced encouraging results as a beam imager in Taiwan [1]. Regarding high photon intensities, silicon carbide (SiC) is an interesting sensor material because it is radiation hard and can be manufactured to a high quality [2]. However, manufacturing a very thin sensor with 80% transmission of the soft X-ray beam remains the main challenge for both materials.

We are seeking solutions for very thin sensors ( $1\text{--}3\ \mu\text{m}$ ) and welcome other creative ideas for efficient beam diagnostics (shape, position, intensity), particularly in the soft X-ray range.

[1] Y.-H. Yang et al., “Eco-friendly, High-Resolution Fluorescence Diamond-Based Broadband EUV and X-Ray Beam Profiler System,” in 2025 IEEE International Instrumentation and Measurement Technology Conference (I2MTC), May 2025, pp. 1–5. doi: 10.1109/I2MTC62753.2025.11079069.

[2] G. Trovato et al., “SiC free-standing membrane for X-ray intensity monitoring in synchrotron radiation beamlines,” J. Synchrotron Radiat., vol. 32, no. 1, Art. no. 1, Jan. 2025, doi: 10.1107/S1600577524010646.

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