Contribution ID: **162** Contribution code: **THO07** Type: **Contributed Oral Presentation**

Parametric design and optimization of SOLEIL II vacuum chamber thermal properties

Thursday 18 September 2025 09:40 (20 minutes)

In the context of the upgrade to SOLEIL II, a 4th-generation synchrotron, the use of Multi-Bend Achromat lattices significantly reduces natural emittance but requires smaller vacuum chambers (12–16 mm), leading to higher power density on chamber walls with limited cooling space. In some cases, there is no room for crotch absorbers, and chambers must fit between magnet poles with less than 1 mm clearance. These constraints demand high thermo-mechanical stability, making design highly challenging and and it is often difficult to identify the most efficient direction for further optimization. This paper presents a parametric thermal analysis and optimization method for SOLEIL II vacuum chambers. Simulations are conducted using ANSYS DesignXplorer, with key parameters identified through sensitivity analysis of their impact on thermal performance. The heat-flux map, imported from Synrad+, provides precise power distribution. From multiple parameter combinations, a predictive temperature map (response surface) is generated, enabling estimation of thermal behavior without lengthy simulations. An optimized parameter set is proposed to streamline the design while ensuring performance.

Footnotes

Funding Agency

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Session Classification: Simulation session 1

Track Classification: SIMULATION: FEA methods