



Contribution ID: 278

Type: talk

Progress towards laser plasma electron based free electron laser on COXINEL

Tuesday, September 17, 2019 4:40 PM (20 minutes)

The Free Electron Laser (FEL) application of Laser plasma acceleration (LPA) requires the handling of energy spread and divergence. The COXINEL (ERC340015) manipulation line designed and built at SOLEIL [1, 2] consists of variable permanent magnet quadrupoles [3] for divergence mitigation and a decompression chicane for energy sorting, enabling FEL amplification. The COXINEL line, installed at Laboratoire d'Optique Appliquée, uses electrons generated and accelerated by ionization injection for robustness using a 30 TW laser. The electron position and dispersion are independently adjusted [4]. The undulator radiation emitted presents a wavelength stability of 2.6 %, a gap driven tuneability and a linewidth control. However, the electron used for the first experiments deviated from the baseline reference case, because of the rather simple LPA configuration and the limited laser energy. With currently achieved performance on different LPA experiments, FEL effect is within reach. Further calculations indicate that in the seeded configuration, the FEL radiation is red shifted with respect to the seed wavelength and present an interference fringe pattern. Those behaviours can be interpreted with simple theoretical models, which can further enable a full temporal reconstruction of the FEL pulse temporal amplitude and phase distributions.

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Session Classification: WG4 - FEL

Track Classification: WG4 - Application of compact and high-gradient accelerators