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*Editorial*

# Preface to "Oscillator-Amplifier Free Electron Lasers an Outlook to Their Feasibility and Performances"

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Free Electron Lasers (FELs) are certainly among the most interesting devices, belonging to the realm of coherent radiation sources. These lasers are now widely used all over the world and are the highest performing in terms of brilliance, monochromaticity, coherence, directionality and polarization control.

Despite their undoubted success and reliability as experimental devices, their wider use is still hampered by their size and cost, which require large laboratories and significant financial efforts.

It would be therefore desirable to develop more compact and economical FELs with, e.g., higher repetition rates and larger average brightness.

A future prospect, pursued by many worldwide research institutions, would be to build FEL facilities in the VUV-X region, using compact accelerators and shorter undulator sections.

Within this context, the most natural solutions are those of designing high gradient accelerating devices, capable of providing high-quality electron beams and non-standard undulator lines.

Both solutions might concur with the reduction in either the size or the cost, but although these are the most obvious, they are not the only ones.

"Alternative" undulator lines should be studied to prevent the use of hundred meters of magnetic devices, necessary to provide the saturation length, in standard FEL architecture. However other solutions can be adopted, including a combination of non-linear harmonic generation, seeding, hybrid devices, coupled oscillators amplifier systems, etc.

This Special Issue is devoted to "non-conventional" FEL architectures and describes different strategies, which have been proposed in the past and examines both the underlying physics and the different aspects of the relevant design, with particular reference to feasibility and relevant performance.

The ideas and the proposals described here have reached some level of maturation and can be employed in the near or middle future as the paradigm for the design of compact FEL architectures.

The Special Issue contains nine contributions which can be grouped into the following topics:

(A) Discussion of FELdevices based on the design of wave undulators.

Wave undulators are undulating devices provided by electromagnetic waves aimed at reducing the size of the undulator line.

In particular, in [1], the design of a CARM-type microwave source is described along with the relevant use for the operation of FEL devices. In [2], an FEL design employing a recirculated electromagnetic undulator provided by a high-power laser in a resonator cavity is described in detail.

(B) Design of combinations of seeding and non-linear harmonic devices.

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Ref. [3] deals with the design of an FEL device driven by the e-beam from a Super-Conducting and producing tunable radiation from 100 to 2 micrometers. Ref. [4] describes the use of two beam energies' harmonic generation and self-seeding schemes. The theoretical aspects and design formulae for SASE/higher order harmonic FEL are described in [5].

(C) Hybrid and oscillator/amplifier devices

The article in [6] focuses on the possibility of coupling different emission mechanisms (Cerenkov, Smith–Purcell, etc.) to provide a high-performance, small-size FEL-type devices. High-repetition-rate X-ray FELs are described in [7,8] within the context oscillator/amplifier architectures. Ref. [9] describes an accurate modelling of the coupling of low/high-gain undulators.

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