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Design and tolerance studies of the Undulators for the EuPRAXIA@SPARC_LAB Free-Electron Laser lines

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The EuPRAXIA@SPARC_LAB facility will be the first plasma-driven free-electron laser user facility and will host two different beamlines: the AQUA beamline, a SASE FEL designed to operate in the water window down to 3-4 nm, and the ARIA beamline, a seeded HGHG FEL operating in the VUV spectral range from 50 to 180 nm.

The beam driving *these* FELs is accelerated up to 1-1.2 GeV by an X-band normal conducting linear accelerator followed by a plasma wakefield acceleration stage.

The main FEL amplifier of AQUA consists of an array of ten APPLE-X permanent magnet undulator modules, each 2 m long and with a period length of 18 mm. The HGHG configuration for ARIA works with a modulator and four APPLE-X permanent magnet undulator modules with a period of 10 cm and 4.8 cm *respectively*.

The main design studies of such undulators are discussed, evaluating the tolerance of resistive wall wakefields, magnetic field errors and misalignments, as well as their impact on the FEL performance.

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