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Emittance growth study of an electron beam in a double-alpha magnet compressor used in an Inverse Compton Scattering X-ray source

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An Inverse Compton Scattering (ICS) X-ray source is under development at the ELSA electron RF linac of CEA DIF. The X-rays are emitted by the interaction of a 30-MeV electron bunch with a visible (532nm) or infrared (1064nm) Nd:YAG laser pulse. The radiation spectrum lies in a 10-100 keV range. The electron bunches duration is 30 ps after compression in double-alpha magnets. In such a system, electron trajectories are curved with a short radius, resulting in a noticeable degradation of the beam emittance, that might be a limitation cap to our source yield optimization in our effort to raise the bunch charge from 0.1 to 3 nC.
In the specific case of strongly curved trajectories, the symmetry hypotheses used for space charge calculation in several simulation codes are questionable, especially when calculations are made in the reference particle frame, leading to inaccurate compensation of electric and magnetic components of Lorentz force. We ran simulations of electron beam dynamics within the double-alpha magnets, using codes with different architectures (PIC, PIC Slice, envelope) and space-charge routines such as CST MWS and TraceWin/Partran, that rely on different models and frame references. We compared these results with experiments in order to evaluate the order of magnitude of these errors and to validate the use of a simulation tool to optimize our ICS source.

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Footnotes

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Yes

Primary authors: PIRES, Abel (Commissariat à l'Energie Atomique et aux Energies Alternatives); CHAUCHAT, Anne-Sophie (Commissariat à l'Energie Atomique et aux Energies Alternatives); COLLET, Martin (Commissariat à l'Energie Atomique); LE FLANCHEC, Vincent (Commissariat à l'Energie Atomique); DELERUE, Nicolas (Université Paris-Saclay, CNRS/IN2P3, IJCLab)

Presenter: PIRES, Abel (Commissariat à l'Energie Atomique et aux Energies Alternatives)

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