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A VUV frequency comb for the excitation of the 229-thorium isomer

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The isotope 229-thorium features a low-energy (8.28 ± 0.17 eV) nuclear-excited state, the so-called thorium isomer [1]. This unique property makes it the only nuclear transition accessible with current laser technology and therefore suitable for the operation as a nuclear clock. Such a clock has applications in fundamental physics [2] and the potential to surpass the precision achieved by current atomic clocks [3]. To drive the nuclear transition, we are building a tabletop VUV frequency comb that combines a high-power frequency comb at 1050 nm, nonlinear pulse compression, and a non-collinear enhancement resonator with 10 kW circulating power to produce high power per comb mode (≥ 1 nW/mode) and a narrow comb linewidth (appr. 1 kHz) via high harmonic generation (HHG). Upon completion the laser system will be combined with a 229-Thorium trap for spectroscopy at LMU Munich.

[1] Seiferle, B. et alt. Energy of the 229Th nuclear clock transition, Nature 573, 243 (2019)
[2] Safronova, M.S. et al. Search for new physics with atoms and molecules. Rev. of Mod. Phys. 90, 025008 (2018)
[3] Campbell, C.J. et al. Single-Ion nuclear clock for metrology at the 19th decimal place. Phys. Rev. Lett. 108, 120802 (2012).

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