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Photoactivation of ^{209}Bi with laser induced bremsstrahlung using DRACO

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Nuclear Physics experiments are usually carried out in large accelerators, whose reduced number restricts the access to these facilities. For this reason, there is a growing interest in developing complementary facilities capable of hosting Nuclear Physics experiments, even at smaller size, to further extend the nuclear data available. In this context, high-power, high-repetition-rate lasers become an appealing complement due to the reduced footprint and lower running costs.

As a proof-of-concept, a photoactivation experiment of ^{209}Bi was carried out using the 150 TW arm of the DRACO laser (HZDR, Germany). Electron bunches of ˜0.1 nC and energy up to 450 MeV were accelerated at 0.1 Hz via the laser wakefield acceleration (LWFA) mechanism and propagated into a thin tantalum converter to obtain the high energy bremsstrahlung photons that were used for photoactivation. After 1 hour of irradiation, corresponding to 370 shots, a short-lived activity of 10-100 Bq was produced, and photoactivation reactions below the pion threshold of up to at least ^{209}Bi(γ,9n)^{200}Bi were observed, with activation levels in agreement with numerical simulations. Further analysis regarding the direct production of lighter elements, such as Pb, will also be presented.

These results show not only the potential of laser-driven accelerators as a useful tool in Nuclear Physics, but also show the possibility of measuring offline the high-energy photon spectrum from the activation yield, with the advantage of being insensitive to pulse pile-up and the strong electromagnetic pulse accompanying the laser shots.

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