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Comparison of OSIRIS/LCODE/QV3D simulations with the measurements of the proton beam in AWAKE experiment

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AWAKE (the Advanced WAKEfield Experiment at CERN) aimed to demonstrate the first controllable self-modulation of a long ultrarelativistic proton beam in plasma and acceleration of electrons in the wakefield from the resulting train of microbunches. The experiment fully completed these tasks in 2017 and 2018. Three main diagnostics: OTR, CTR screens and imaging stations measured longitudinal and transverse portraits of the proton beam after seeded self-modulation in 10 meter plasma cell, and an electron spectrometer registered accelerated electrons with energies up to ~2 GeV depending on the plasma density.

Now the AWAKE collaboration is focused on development of the 2nd stage of the experiment (AWAKE Run II) in order to demonstrate the acceleration to higher energies preserving the quality of the electron witness. One of the most important questions lying on the way to AWAKE Run II is the predictable power of codes used for simulations of the proton-driven wakefield accelerators. It can be examined only by comparing the simulations to experimental data. The results presented in this work show the benchmarking of OSIRIS, LCODE and QV3D codes with measurements of the proton beam taken with the main AWAKE diagnostics.

Primary author: GORN, Aleksandr (Budker Institute of Nuclear Physics, Novosibirsk, Russia)

Co-authors: PUKHOV, Alexander (uni duesseldorf); PETRENKO, Alexey (CERN); Ms BACHMANN, Anna--Maria (CERN); LOTOV, Konstantin (Novosibirsk State University); MOREIRA, Mariana (IST, CERN); TURNER, Marlene (CERN/TU Graz)

Presenter: LOTOV, Konstantin (Novosibirsk State University)

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