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AWAKE, a Self-modulated, Proton-driven Plasma Wakefield Acceleration Experiment at CERN PATRIC MUGGLI, Max Planck Institute for Physics, AWAKE COLLABORATION — Proton (p^+) bunches available today carry large amounts of energy (kJ). They are therefore potential drivers for plasma wakefield acceleration experiments aiming at large energy gain along a single long plasma. However, these p^+ bunches are also long ($\sim 10\ cm$). In dense plasmas, such that the plasma period is shorter than the bunch length, they are subject to the self-modulation instability (SMI) [Kumar, Phys. Rev. Lett. 104, 255003 (2010)]. The SMI forms a train of short bunches that can resonantly drive accelerating wakefields to the GV/m level. Based on this scheme, the AWAKE experiment at CERN will use the 400 GeV bunch with 3×10^{11} p^+ of the SPS. Numerical simulations show that over 10 m of plasma with a density in the $1 - 10 \times 10^{14}\ cm^{-3}$ range the SMI can grow, and saturate when seeded. Seeding also allows for deterministic injection of the witness bunch. Externally injected MeV electrons can reach GeV energies in $\sim GeV/m$ accelerating gradient. Operating at low plasma density, i.e., larger accelerating structure, but with large average gradient eases the injection process and the bunches production and alignment. The physics program and the experimental set-up of the AWAKE experiment will be presented.

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