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10 m long laser-ionized uniform Rb plasma source for plasma wakefield accelerators

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The World's first proton driven plasma wakefield accelerator experiments AWAKE at CERN has started at the end of 2016. For the first stage of the experiments self-modulation-instability (SMI) is studied. SMI develops as the 12 cm long 400 GeV proton bunch traverses the plasma where it gets transversely modulated over 10 meters by the transverse forces in the plasma. In the second phase of the experiment electrons will be injected and accelerated into the large scale resonant wakefield (~GeV/m) created by the micro-bunches formed as a result of SMI. Plasma density variation as small as 0.2 % can disrupt the injection and acceleration process. Therefore a unique plasma source is built to meet this requirement. The plasma source is a Rb vapor confined in a 10 m heat exchanger tube, which is laser ionized to create a 2 mm diameter 10^14-10^15 cm^-3 density fully ionized plasma. Two reservoirs located at the ends continuously flow Rb vapor into the open 10 m tube. Precise temperature control of the reservoirs allows generating positive or negative density gradients. Here we present the details of the plasma source with measurements and simulations.

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