Elongation of plasma channel for electron acceleration  

LIMING CHEN, Advanced Photon Research Center, Japan Atomic Energy Agency — Experiments for the laser guiding studies has been carried out with the 30 fs, 100 TW Ti:Sapphirer laser pulse interaction with the long slab (1.2x10 mm$^2$) and discharged capillary of underdense plasma. Formation of extremely long plasma channel with its length ($\sim 10 \text{ mm}$) 10 times above the Rayleigh length is observed when the laser pulse power is much higher than the critical power for relativistic self-focusing. The long self-guiding channel formation is accompanied by the quasi-monoenergetic electron acceleration with a low transverse emittance ($< 0.8 \pi \text{ mm mrad}$) and high electric current (up to $\sim 10 \text{ nC/shot}$). In order to continuously elongate plasma channel, a 4 cm-scale discharged capillary was used. We successfully demonstrated laser-plasma acceleration of high-quality electron beams up to nearly GeV. Our results exactly verified the prediction of laser-wakefield acceleration through a cm-scale plasma channel in the “blowout bubble” regime, where a micro-scale plasma cavity produced through the ultra-relativistic laser-plasma interactions plays an essential role in the self-injection and acceleration of electrons.