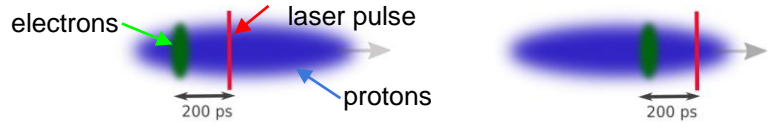


Measurement Concept

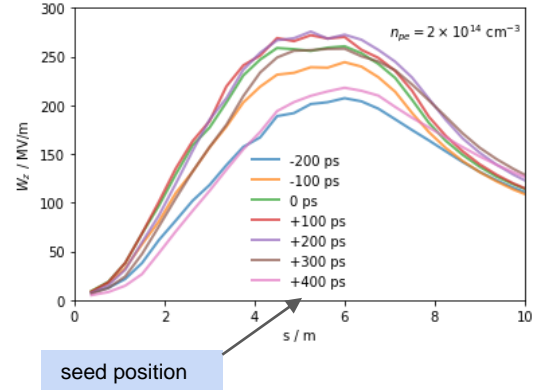
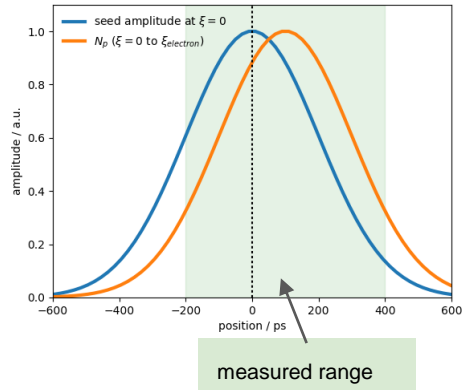
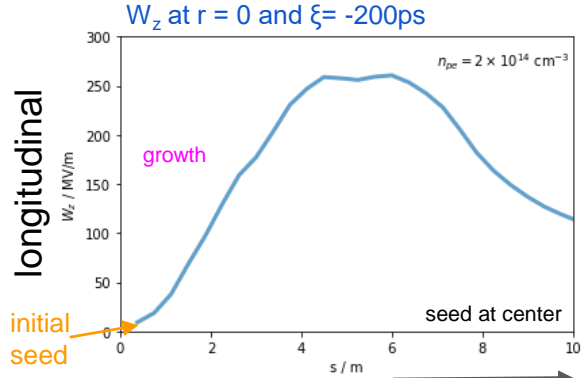
all simulations performed with LCODE (2D cylindrical, quasistatic)



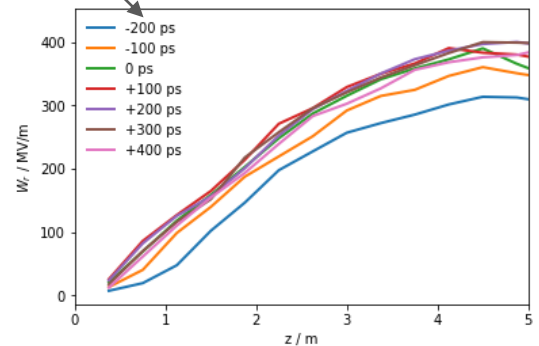
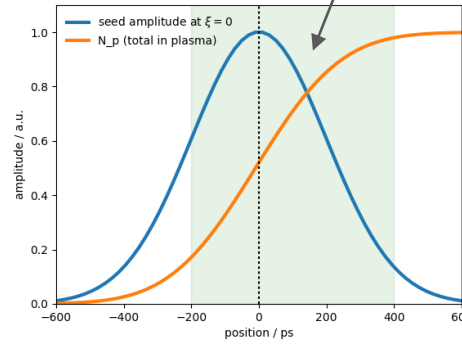
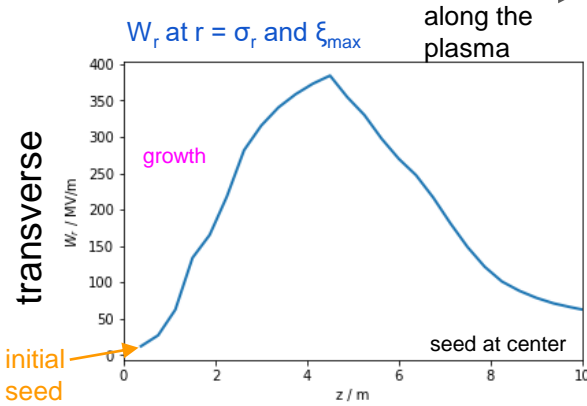
wakefields amplitudes along the 10m plasma in AWAKE



How to measure?



accelerate electrons



measure radial proton bunch distribution

Seed Position Scan

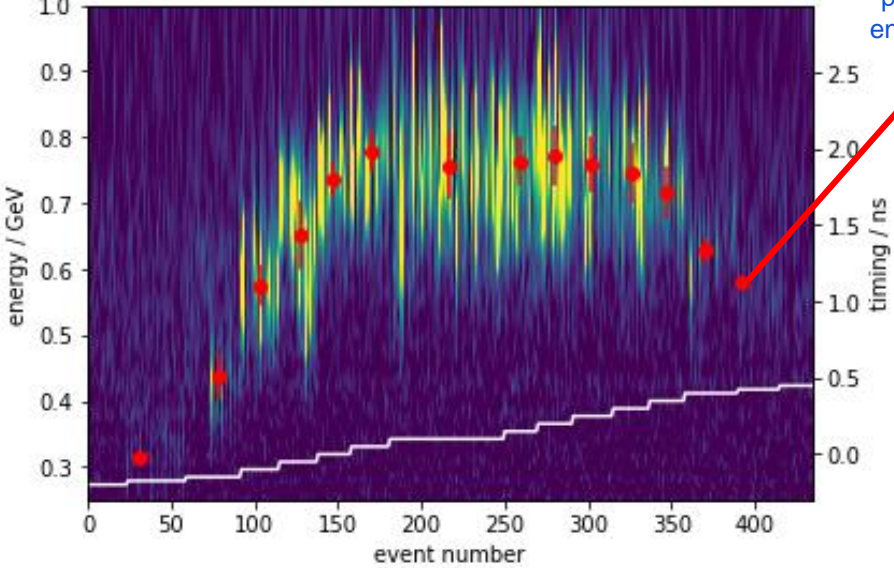
longitudinal wakefields

Preliminary

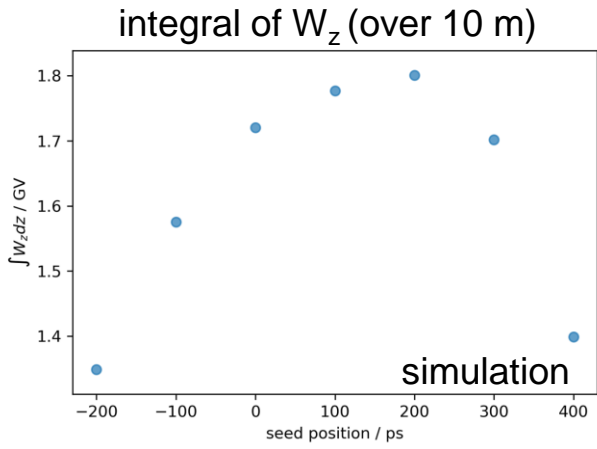
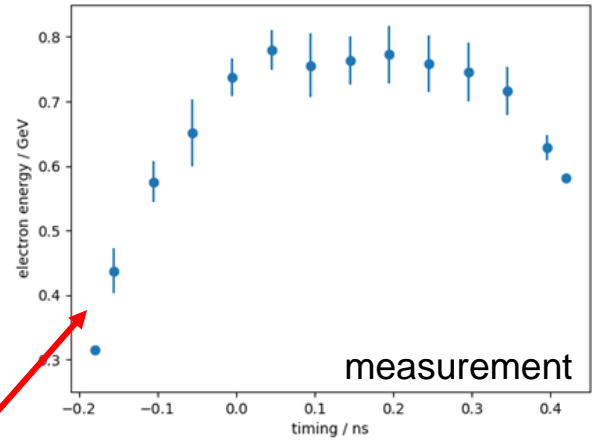
change laser pulse and electron bunch position together



waterfall plot of the measured electron energy spectrum as a function of the laser pulse seed position



identify the peak energy

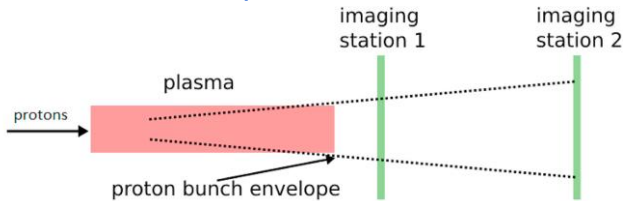


measured peak electron energy follows the same shape as the integrated longitudinal wakefield amplitude!

Seed Position Scan

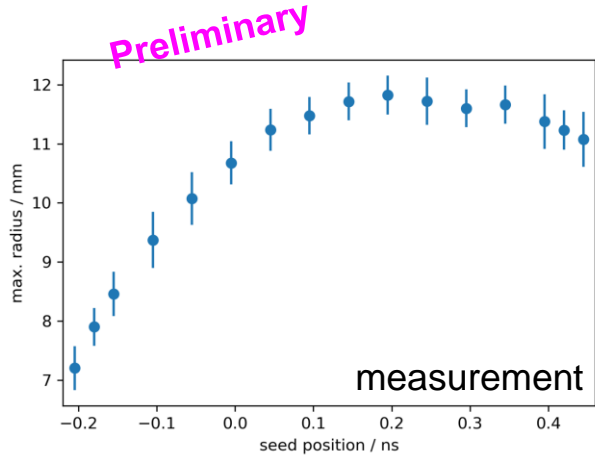
transverse wakefields

Measurement setup:



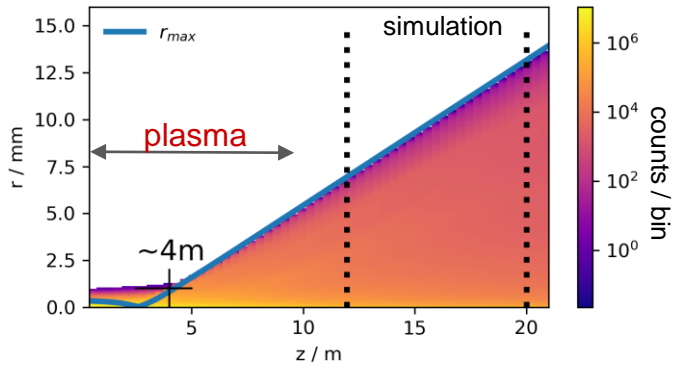
measure maximum radius of defocused protons

M. Turner et al., NIM A 909 (2018), 123-125.

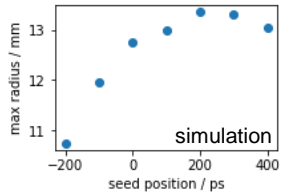
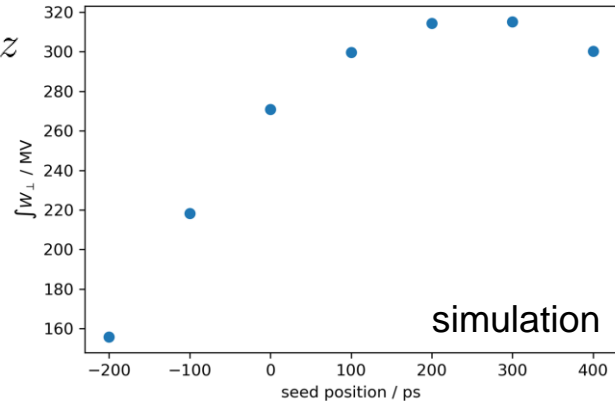


maximum radius of the defocused protons follows the same shape as the integrated (0-4m) transverse wakefield amplitude!

radial proton bunch density during self-modulation



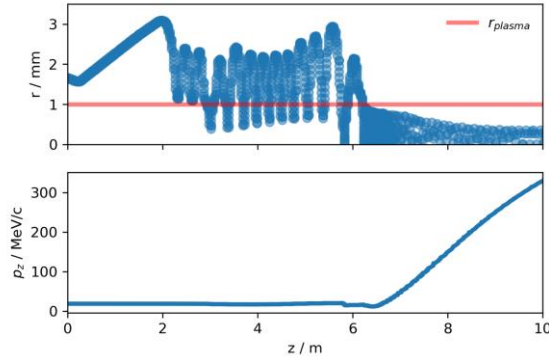
$$\int_{0m}^{4m} W_r dz$$



M. Turner, PhD Thesis (2018).
 M. Turner et al., J. Phys.: Conf. Ser.874 012031 (2017).
 M. Turner (AWAKE Collaboration), Phys. Rev. Lett. 122, 054801 (2019).

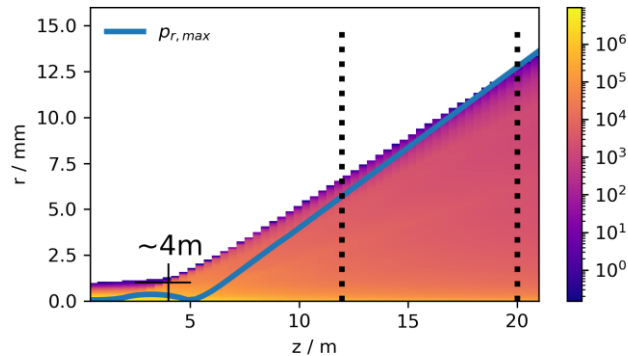
Ongoing studies...

electron acceleration dynamics



electron dynamics complicated as wakefields phase is evolving along the plasma due to the self-modulation process

defocused proton trajectories



where do protons exit? which ones are the outermost on the screen?