Plasma creation with ultra-intense optical light fields has brought laser based acceleration of charged particles in the current research focus. The striking property of laser accelerated ion beams is their very low emittance, both in transversal and longitudinal direction. While the transversal beam characteristic has been successfully applied in projection based imaging application we concentrate here on longitudinal beam characterization and its application in ultrafast diagnostic of strong fields in plasma. As a measure for its emittance we found recently a laser cycle based modulation in the velocity spectrum of proton beams [1]. These beams emerge from thin foils which have been irradiated with femtosecond laser pulses at relativistic light intensities and with very high temporal pulse contrast. As shown in Fig.1 we apply now these beams in a streak-like longitudinal probing geometry. Strong fields at plasma-vacuum interfaces change the velocity distribution of the probe beam abruptly and field dynamics becomes traceable. The recorded probe beam images (cf. Fig.1) which are resolved in proton kinetic energy and one spatial coordinate exemplify how different field components lead to strong gaps, redistribution and trace bending in the spectrogram.

Fig.1 Experimental setup of longitudinal probing of fields in plasma sheets and measured redistribution effect

With help of analytical models and numerical simulation we conclude on field dynamics and draw consequences for beam manipulation in cascaded acceleration schemes.