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High spatio-temporal resolution PIV of laminar boundary layer relaxation instability at the free surface of a jet[1] MATTHIEU ANDRE , PHILIPPE BARDET, The George Washington University — In high-speed free surface flows, microscale instabilities can lead to dramatic macroscale effects such as waves, breakup, or air entrainment. The importance of jets in practical applications requires a better understanding of the mechanisms leading to these instabilities. This experimental study focuses on laminar boundary layer relaxation (LBLR) instability. This has received fewer attention than other instabilities due to the small scale, the high Reynolds number and the proximity of an interface. The experiment features a $20.3mm \times 146.0mm$ laminar slab wall jet exiting a nozzle into quiescent air (Re=3.1×10^4 to 1.6×10^5). The free surface is flat near the nozzle exit then the LBLR leads to 2D capillary waves which can become very steep eventually resulting in primary breakup and air entrainment. The inception and growth of the capillaries are investigated using time-resolved PIV coupled with PLIF to track the free surface. A magnification of 4 allows a spatial and temporal resolution better than 0.1mm and 0.1ms, respectively. These high resolution results show the role of vortices -created by the roll-up of the shear layer below the surface- in the formation of capillaries. Vortices and waves are a coupled system; the waves can sustain, damp, or amplify.

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