Universal entrainment of oil in water by an impulsively started disk
IVO PETERS, University of Southampton, MATTEO MADONIA, DETLEF LOHSE, DEVARAJ VAN DER MEER, University of Twente — We experimentally investigate the oil entrainment in the wake of a disk, started impulsively from an oil-water interface. The experimental setup consists of a thick layer of oil floating on a deep layer of water, with the initial position of the disk exactly at the oil-water interface. As the disk is pulled down, part of the oil is entrained into the water bath and forms a smooth funnel shape. The shape and its temporal evolution depends on the relative contribution of gravity, surface tension, and inertia. We first show that there is a regime where both gravity and surface tension can be neglected and all shapes collapse. However, boundary integral simulations under these same conditions show a systematic difference in the shape compared to the experiments. We explain this difference by taking into account the influence of a disk-bounded starting vortex on the funnel shape. The surprising conservation of universal behavior in the experiments is explained by the growth-rate of the starting vortex, which follows the same scaling as the unperturbed funnel shape.