Supplementary figure 5a.

Illustration of the circulation around a hummingbird wing throughout the wingbeat cycle, as seen by a parasagittal plane two cm from the midline of the body. The bound circulation of downstroke is in blue, upstroke in yellow. At the end of upstroke, the pronation (black arrow) sustains the bound circulation through turn-around, such that the bound circulation of upstroke is shed simultaneously with the starting vortex of downstroke. The combined vortex is show in green. At the end of downstroke, supination again sustains the bound vortex of translation, and only after upstroke translation begins is the bound vortex shed. However, the stronger downstroke wake convects the vorticity down, and produces separate downstroke vortices - both bound (b) and LEV (c) - and a distinct starting vortex (d).

Cartoon of the wake structure as evidenced from near and far-field PIV.