Counting points on surfaces in polynomial time

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We present a randomised algorithm to compute the local zeta function of a smooth, projective surface of fixed degree over the rationals, at any large prime p of good reduction. The runtime of our algorithm is polynomial in $\log p$, resolving a conjecture of Couveignes and Edixhoven. The main ingredients are analytic methods to compute vanishing cycles, namely Puiseux series and their convergence properties.