For the spatial calibration, we then computed a polynomial interpolant to estimate power losses throughout the optical system, D, at any point in space expressed in the coordinate system of the SLM,. We define the polynomial interpolation, and we limit the order by enforcing: = 0, except for . We finally compute the interpolant by finding the coefficients that minimize :

Interpolation is shown in (Supplementary Figure 16h).The data points for which absorption is shadowed or blocked by the zero order block are purposefully ignored from this calibration; instead our software issues a warning should the user attempt to photostimulate a neuron located near the zero order (x’=y’=0.5, z’=0). Interpolation error measurements (Supplementary Figure 16i)shows how our model fits experimental measurements within the operating volume, with the known exception of the blocked zero-order.

**Hologram computation procedure.**

We now consider the case where we wish to compute a hologram that targets n neurons in locations () with a desired illumination power pi (in Watts) within each target.

We compute a hologram by specifying the desired target intensity I(x’,y’,z’) in the point cloud :

,

where is the Dirac unitary distribution centered in .

Since , we deduce the required total illumination power : , and the coefficients for hologram computation :

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