Supplementary Information

In vivo optical modulation of neural signals using monolithically integrated two-dimensional neural probe arrays

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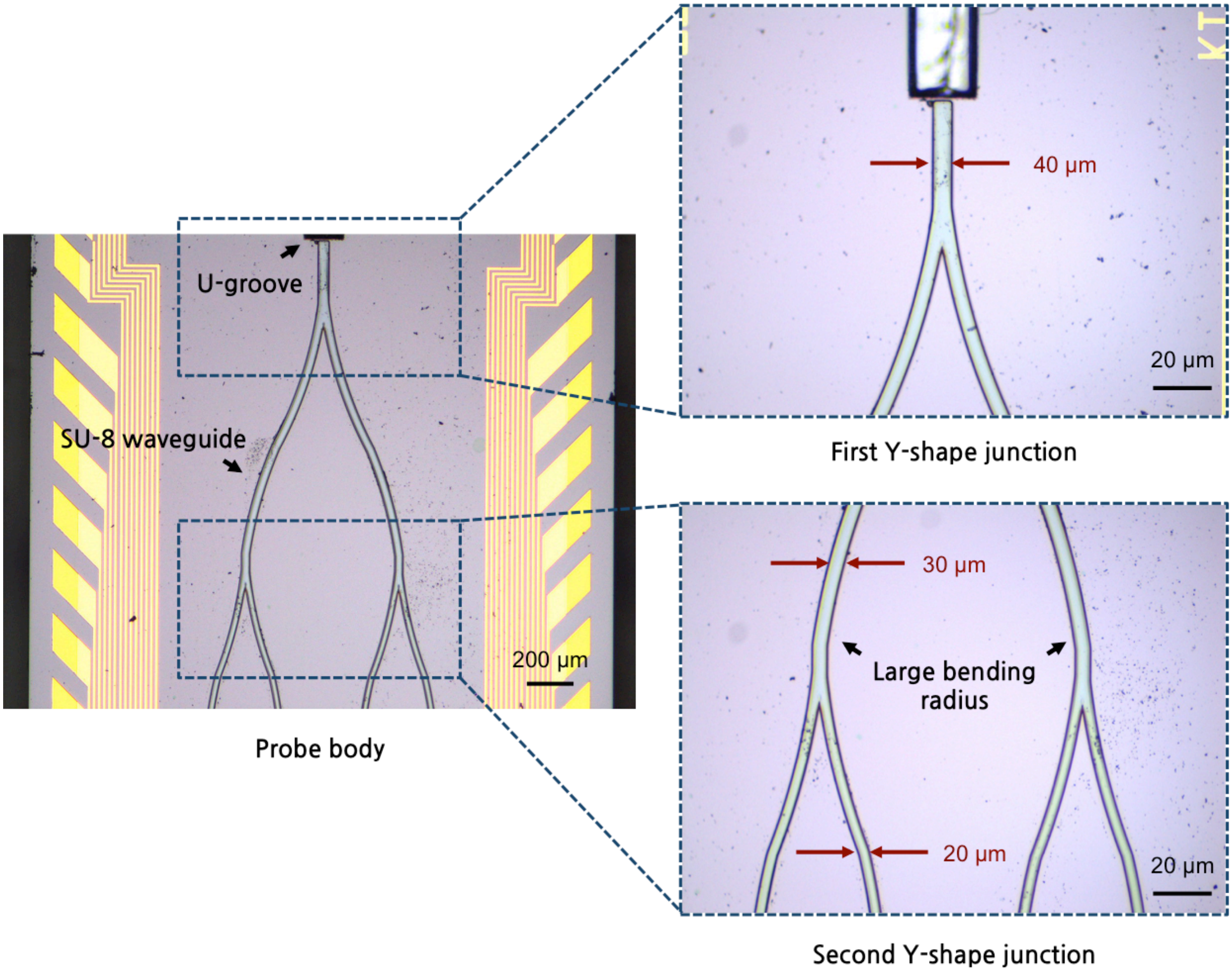


Figure S1. Optical images showing the Y-shape optical splitters.

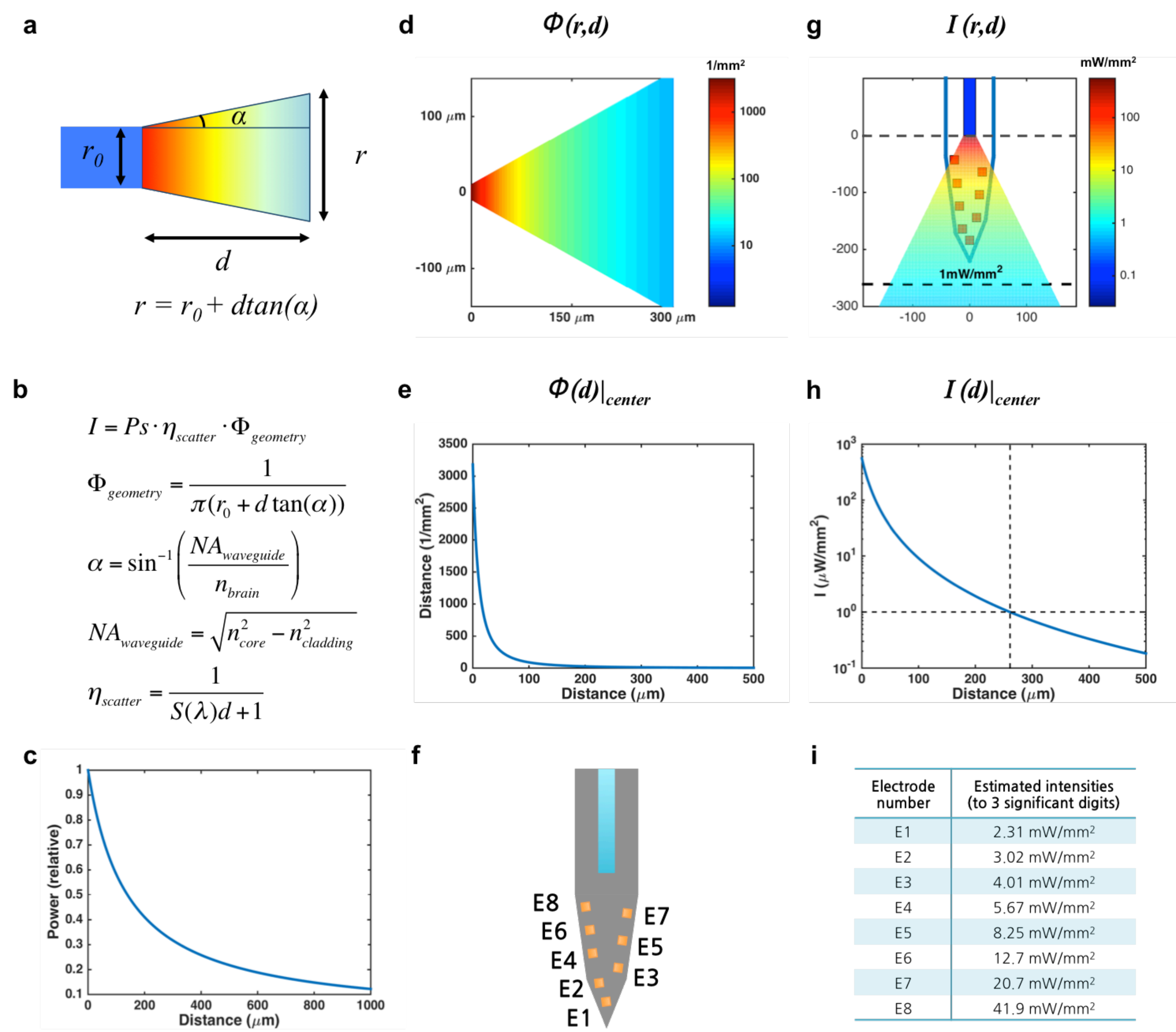
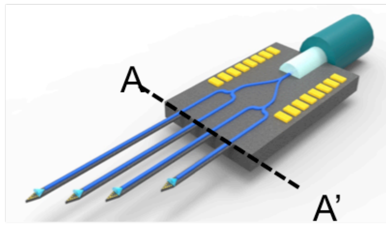


Figure S2. Estimation of optical intensities in brain (a) A schematic the triangular light propagated along the axial distance, *d*, from the waveguide (blue box with a radius of r_o). Since our waveguide was a rectangular structure, an equivalent radius was computed (*i.e.* $r_o = 9.77$ μm). (b) *I* is intensity, *Ps* is the source power, $\eta_{scatter}$ is 1/d scattering model for $d < 1$ mm to estimate power attenuation (Aravanis et al, 2007 and Stark et al, 2012), $\Phi_{geometry}$ is geometric dispersion of light inversely proportional to area of cone cross-section, *NA* is the numerical aperture of the waveguide, *n* is refractive index, and *S* is mean scattering coefficient at certain wavelength (*S*(blue) = 7.2, Stark, 2012). Note, $\Phi_{geometry} = 0$ when $r > r_o + dtan(\alpha)$. (c) Estimated relative power attenuation, $\eta_{scatter}$, over *d*. (d) $\Phi_{geometry}$ as a function of *r* and *d*. (e) $\Phi_{geometry}$ along the fibre centre. (f) Numbering of 8 microelectrodes. (g) Light intensity map with a source (blue light, 175 μW at the end of waveguide) as a function of *r* and *d*. (h) Intensity along d at the fibre centre. (i) Summary of the estimated intensity at each microelectrode.

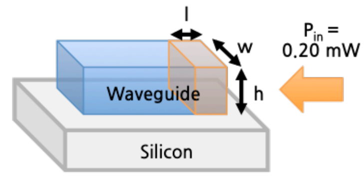
a



b

	Loss (dB)	Input (mW)	Output (mW)
1. Coupling	-14.3	32	1.19
2. Junction	-7.45	1.19	0.21
3. Propagation (after 1 mm)	-0.23	0.21	0.20

c



d

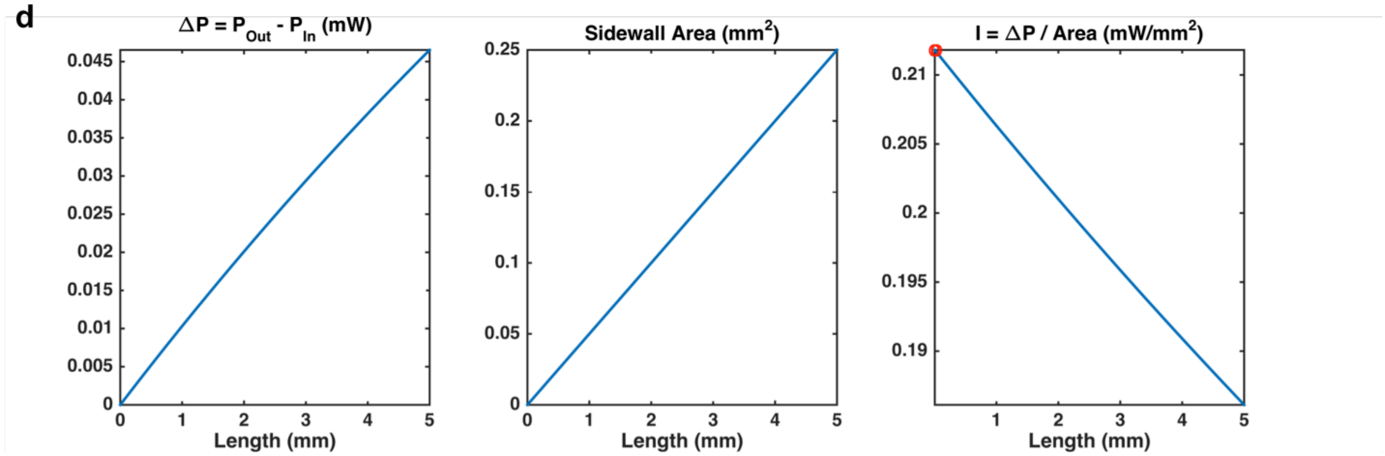


Figure S3. Estimation of leakage intensities A worst-case estimation of the light lost through the sidewall. (a,b) First, we compute the input power at A-A' starting with an input power of 32 mW. (c) Then, we assume 100% of the propagation loss is due to the sideway leakage. To compute the intensity, the sidewall area must be defined which depends on the length along the waveguide. (d) Numerical computation shows that the worst-case intensity of ~0.21 mW/mm^2 is estimated at A-A'.