Supplemental information: Realization of an all optical exciton-polariton router

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In this supplemental information, we give some details about the model we use to simulate the dynamical operation of the polariton router.

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To simulate the dynamical behavior of the polariton router, we use two coupled semiclassical Boltzmann equations describing the populations of the S1 confined state of the island and that of the excitonic reservoir[1], as follows:

$$\frac{dN_{S1}(t)}{dt} = W_R n_R(t)(N_{S1}(t)+1) - \frac{N_{S1}(t)}{\tau_{S1}} + P_{inj}(t) \tag{S1}$$

$$\frac{dn_R(t)}{dt} = -W_R n_R(t)(N_{S1}(t)+1) - \frac{n_R(t)}{\tau_R} + P_c \tag{S2}$$

$N_{S1}(t)$ is the S1 polariton population, n_R the population of the excitonic reservoir, W_R the relaxation rate from the excitonic reservoir into S1, and τ_{S1} and τ_R the S1 state and the excitonic reservoir lifetimes. Moreover, $P_{inj}(t)$ describes the resonant injection of polaritons into the state S1 with a ps-pulse excitation and P_c describes the non resonant CW excitation.

Knowing the dynamics of N_{S1}, we deduce the polariton tunneling and their propagation into the wires. The polariton flux $\phi_{pol}(x,t)$ in the wires per unit time, which is shown in Fig.3(g-h), is given by :

$$\phi_{pol}(x,t) = \frac{N_{S1}(t)}{\tau_{tunnel}} \times \exp\left(-\frac{|x|}{v_g(t)\tau_{pol}}\right) \tag{S3}$$

where τ_{pol} is the polariton lifetime within the wire and $v_g(t)$ is the group velocity of the polariton flow. $v_g(t) = \frac{1}{\hbar}\left.\frac{\partial E(k)}{\partial k}\right|_{E=E_1(t)}$ and depends on the energy of S1 given by : $E_1(t) = g_R n_R(t) + E_1(0)$ and shown in Fig.2(j) of the main text. τ_{tunnel} is the tunneling time from the island to the wires.

We explain below the values of the parameters used in the simulation.
Although the measurement of the linewidth of S1 was limited by our spectral resolution, we extract $\tau_{S1} = 9\,ps$ and $\tau_{pol} = 17.5\,ps$ from the cw experiment presented in the main text [see Fig.1(e) and Fig.2(i)]. Since $1/\tau_{S1} = 1/\tau_{pol} + 2/\tau_{tunnel}$, we deduce $\tau_{tunnel} = 37\,ps$, which is compatible with the value expected for the structure design[2].

Using these values, the simulation in Fig.3(g) (considering only pulsed resonant excitation) does not use any fitting parameter.

For the simulation of Fig.3(h), the presence of an excitonic reservoir requires two additional parameters τ_R and W_R. To reproduce the dynamics of the emission, we use $\tau_R \approx 250\,ps$, which is in good agreement with the measured value in ref (3). $W_R \approx 2.10^{-4}\,ps^{-1}$ is our fitting parameter and the order of magnitude seems to be in agreement with the literature[4].

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