Reservoir Microlensing in Polariton Condensates

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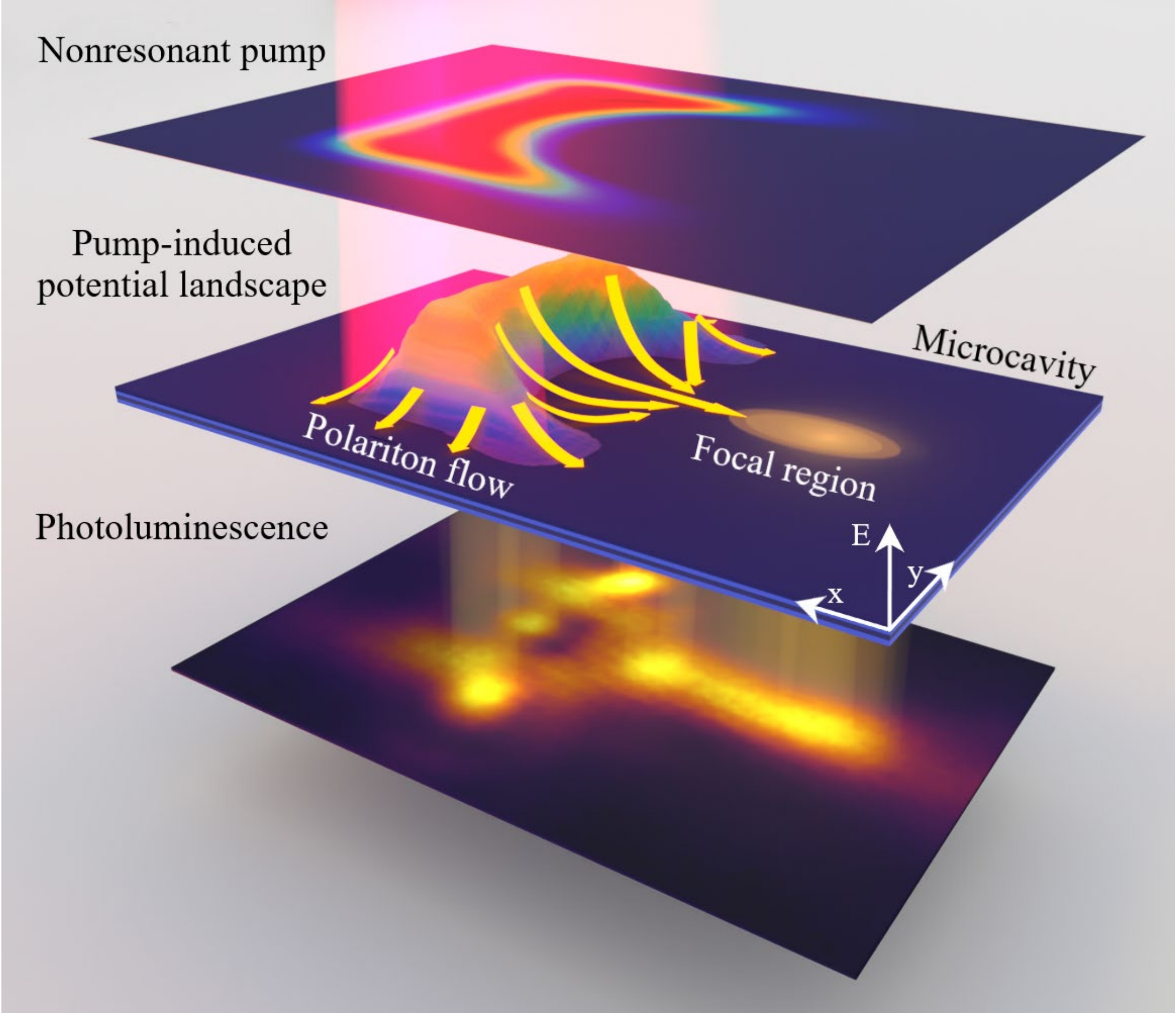


Fig 1. Schematic of polariton lensing effect.

INTRODUCTION

Creating propagating polariton waves away from the pump spots and their control is an important step towards building reprogrammable all-optical circuitry and logic [1]. Nonresonant control over the flow of condensate polaritons is another all-optical way of polariton guiding, which utilizes repulsive nature of exciton-polariton interaction [2] and do not rely on irreversible fabrication methods, nor demand careful calibration, as it is for resonant injection.

In this work [3] we realized recently proposed design of reconfigurable planar microlenses created only by structured nonresonant excitation beams [4]. This, is conceptually (and mathematically) similar to the propagation of optical waves in a medium, where use of lenses is an established method of light guiding.

EXPERIMENTAL DETAILS

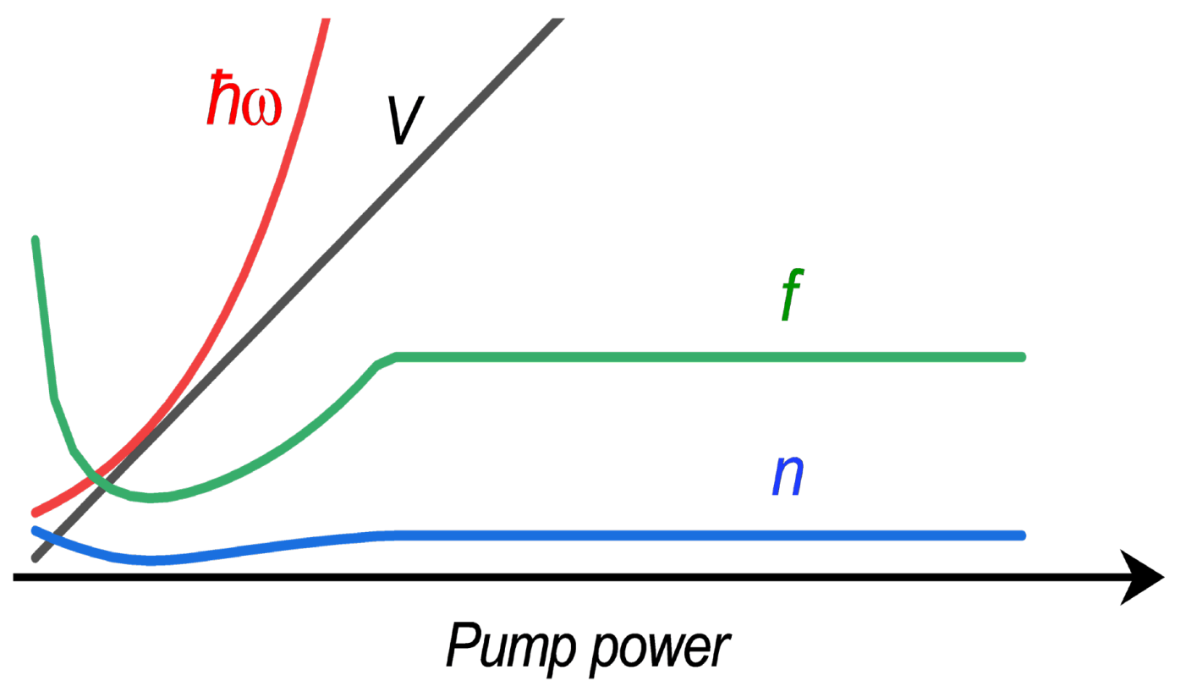
- We used negatively detuned planar microcavity with InGaAs QWs placed in cryostat at 4K.
- Nonresonant CW laser at 783.5 nm structured using phase-only spatial sight modulator.
- Phase patterns generated with modified Gerchbert-Saxton algorithm.
- Photoluminescence (PL) was collected with microscope objective with NA = 0.4 in real-space for transmission configuration.

RESULTS: EFFECT OF PUMP INTENSITY

Strongest response from the polariton microlens system occurs at lower intensities just above threshold – in the region of nonlinear growth of polariton density. Following expressions for [4]:

Effective refractive index *n* and focal length *f*

$$n=\sqrt{1-\frac{V}{\hbar\omega}} \quad + \quad f=\frac{R}{1-n} \quad \Rightarrow$$



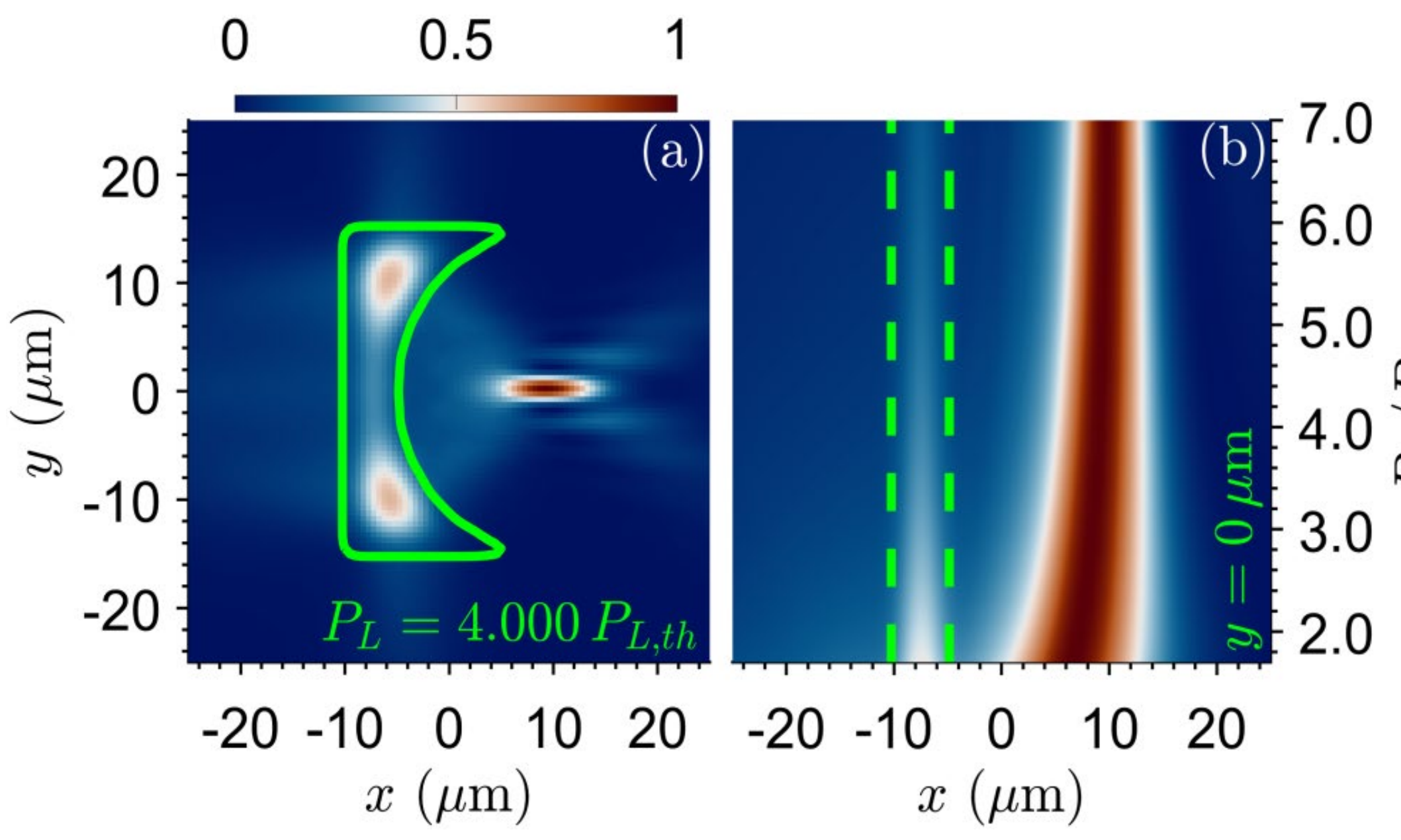


Fig 2. Simulations of condensate density for plano-concave lens for different pump intensities [4].

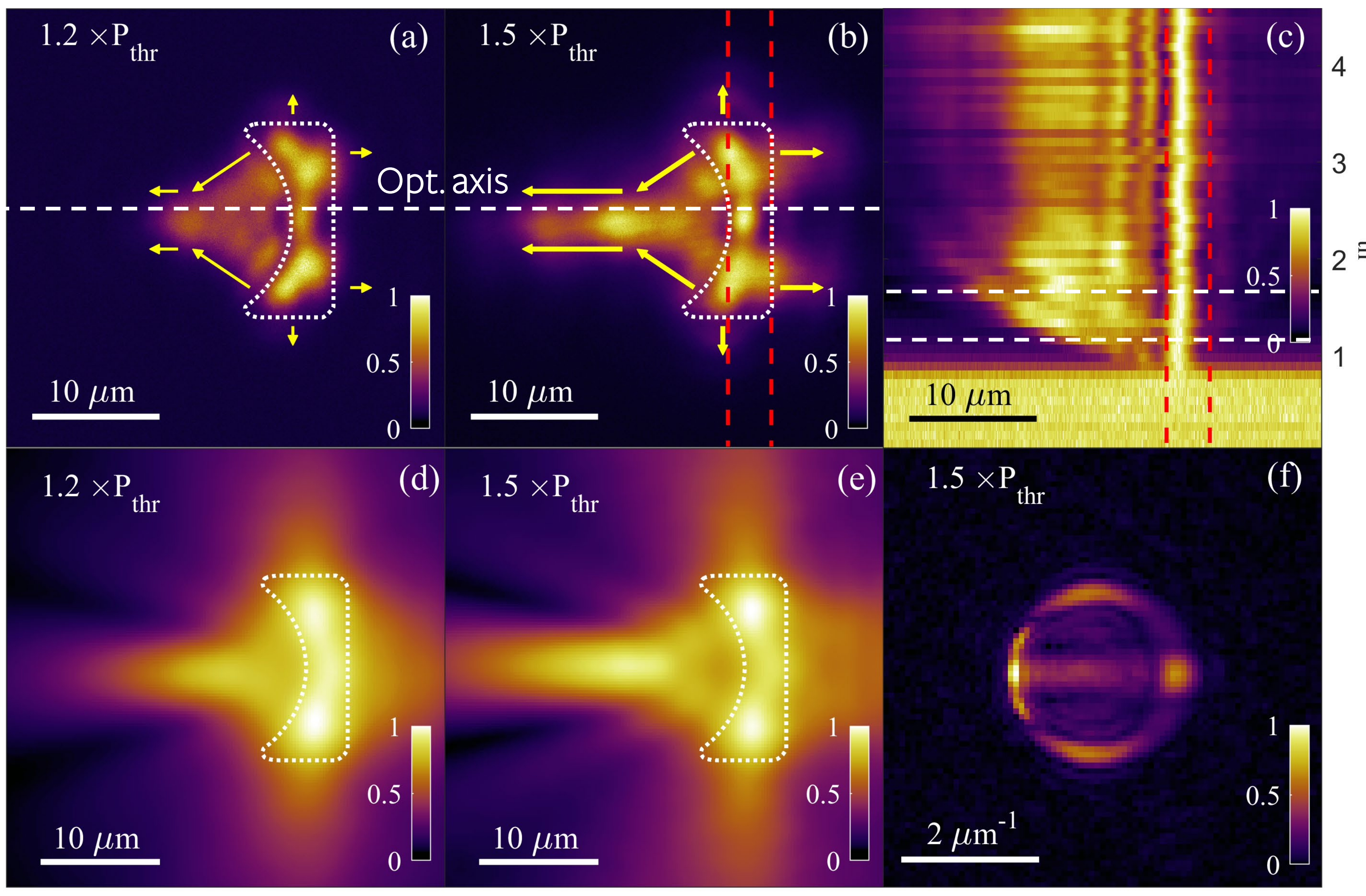


Fig 3. Experimental real-space imaging PL (a-c) and simulations (d-f) for planoconcave lens for different pump intensities.

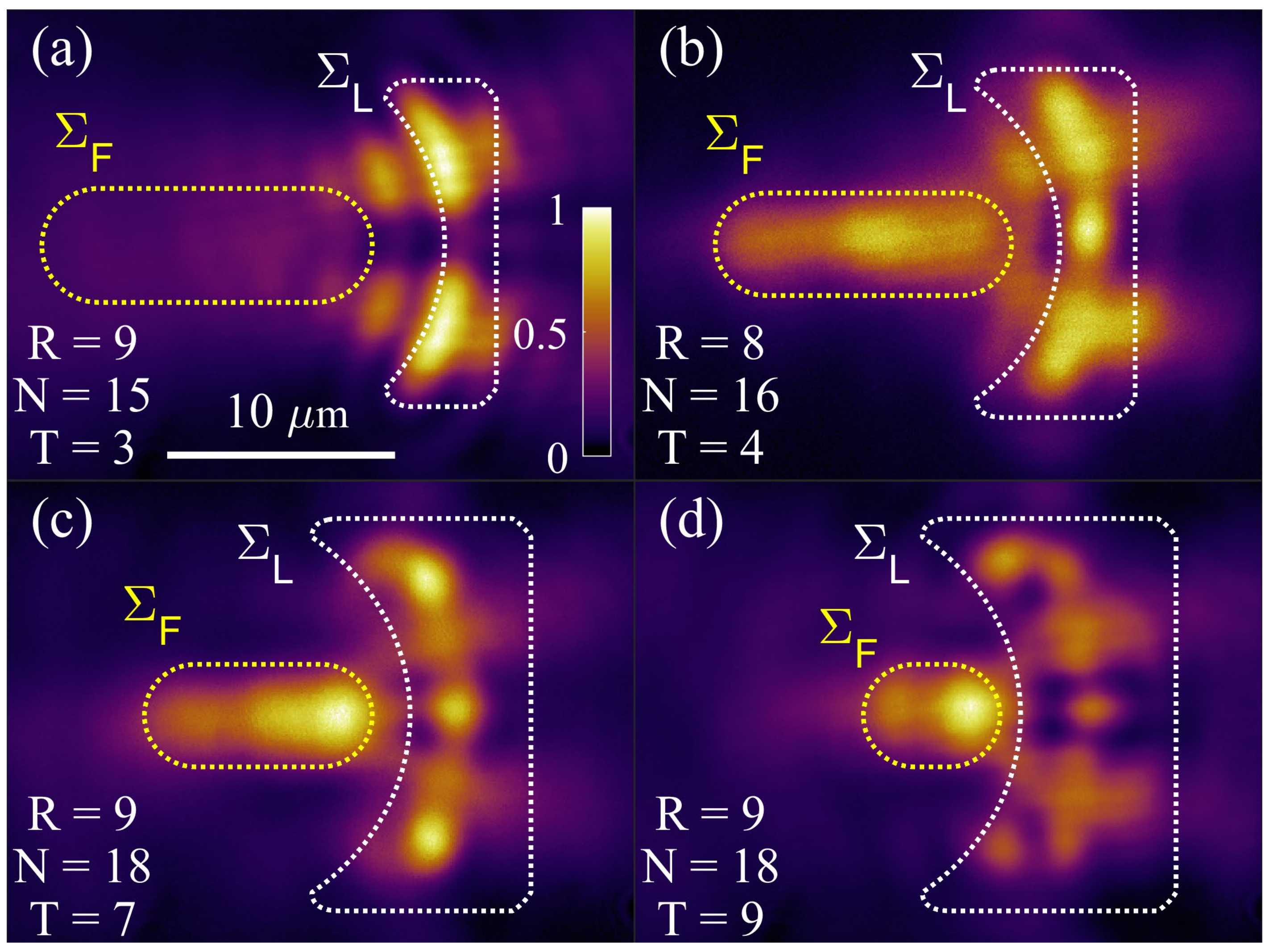


Fig 4. Experimental real-space imaging PL for planoconcave lens for different lens geometries.

RESULTS: EFFECT OF LENS GEOMETRY

Lens aperture (N), thickness (T) and radius of curvature (R) were used to tune the intensity and propagation distance of guided polariton condensate.

Thicker lenses create more intense and close to the pumping area, while thinner lenses create less intense but further separated flow.

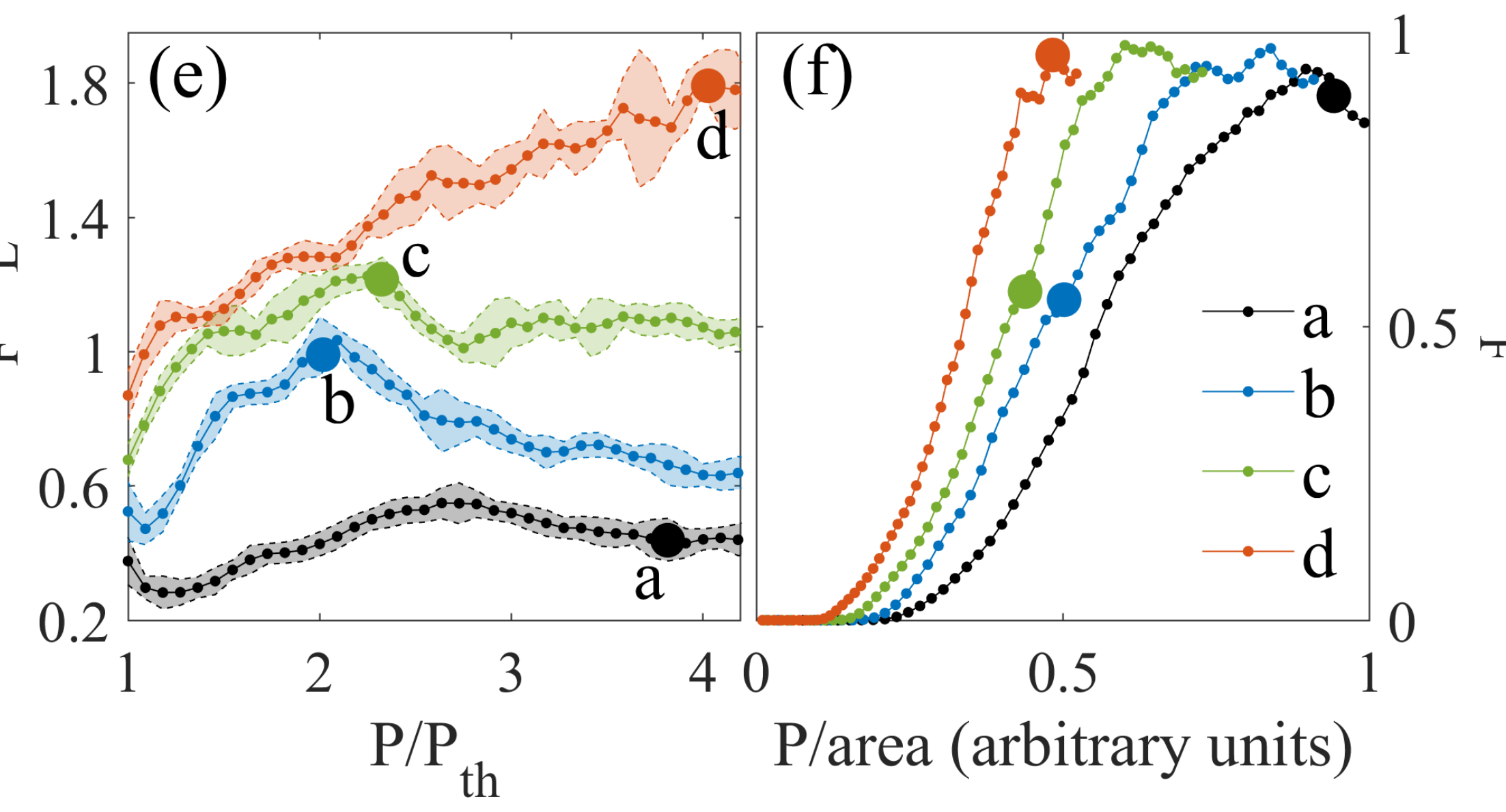


Fig 5. Normalized focusing powers and condensate densities at focal point for different lens geometries.

Thicker lenses create **more stable** (Fig. 5 e) and have **smaller threshold** (Fig. 5 f) at a cost of **shorter focal length**.

Despite short polariton **lifetime** $\approx 5\ ps$ in current sample, we were able to generate polariton condensate flow up to $25\ \mu m$ away from pumping area.

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