Faraday Rogue Wave

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Background

Faraday wave is a kind of surface wave. It is driven by a monochromatic forcing from the vertically vibrated speaker. In faraday wave, the dominated force is the surface tension. The typical wavelength is about a few centimeters. Rogue waves are rare and extreme large wave with uncertain generation time.
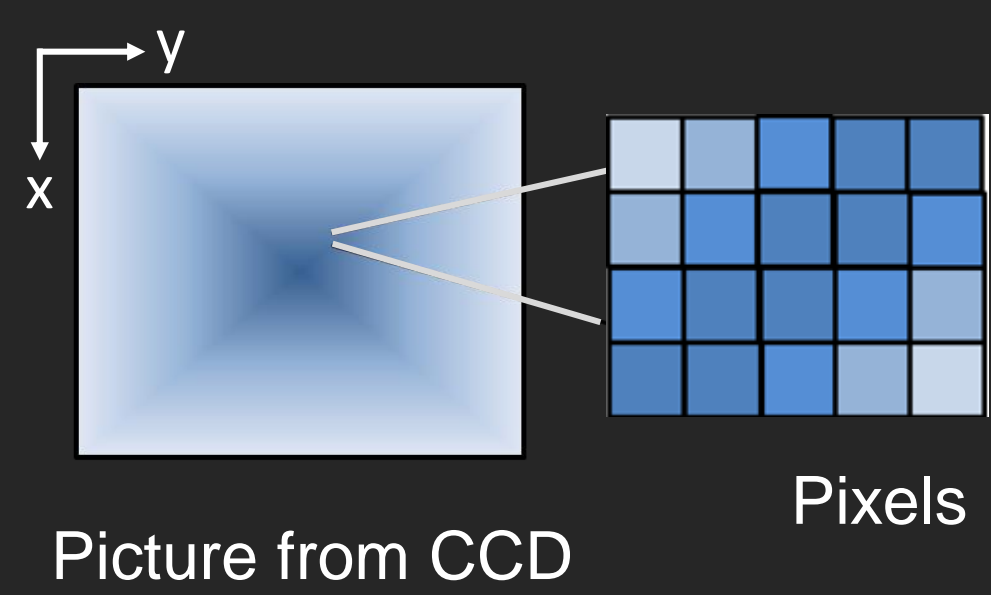
Goal

We want to observe the generation of rogue waves in Faraday wave and explain their origin by finding the arrangement and the motion of surrounding ripples.

Setup

The liquid is composed of 10% of milk and 90% of water to increase the viscosity and decrease the transparency. The diffusing plate can make an uniform light source.

Cylinder sink (10 cm diameter)

Diffusing plate

Light source (3* LED CEO)

Speaker: 200 W (10 inches)
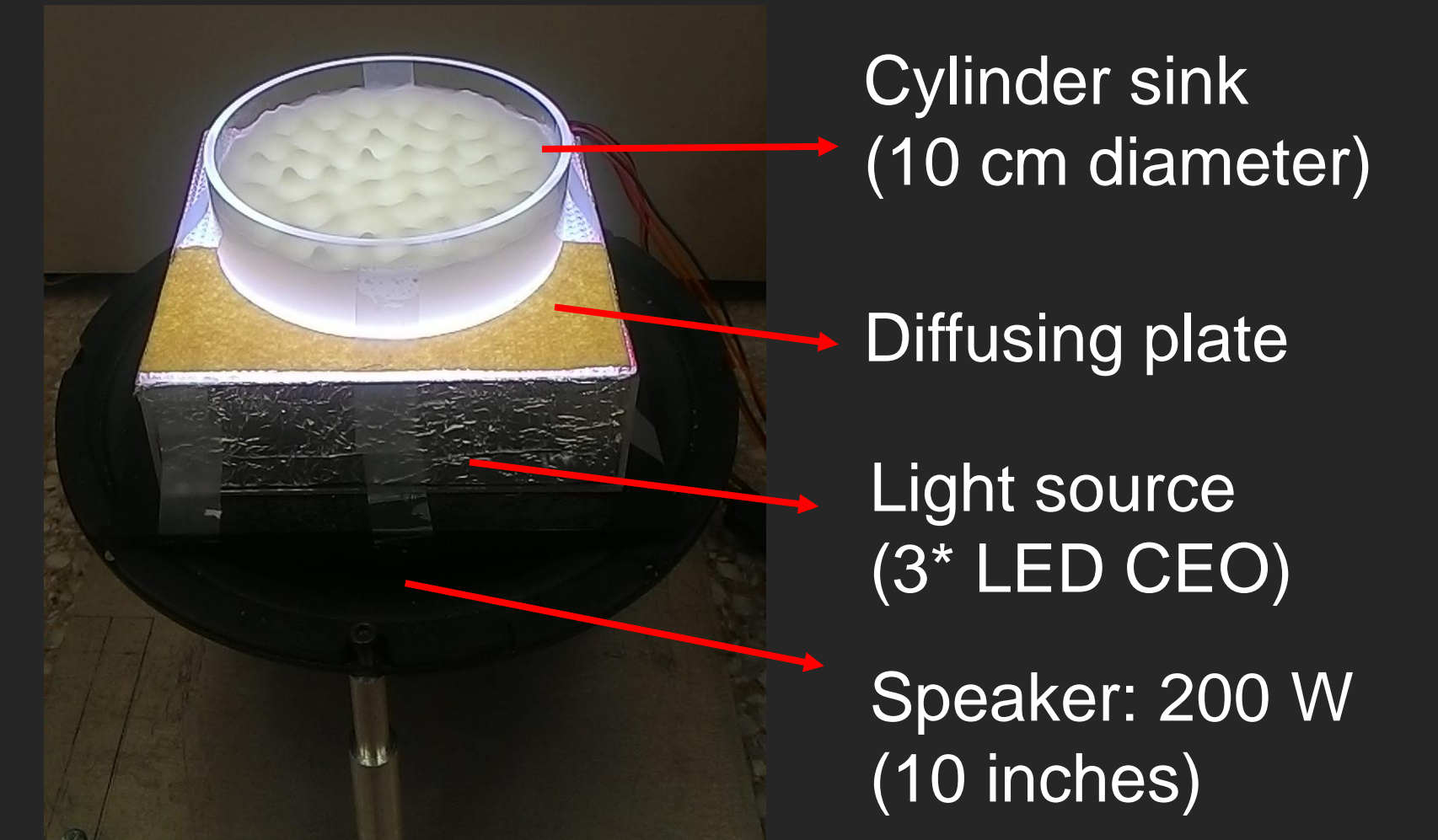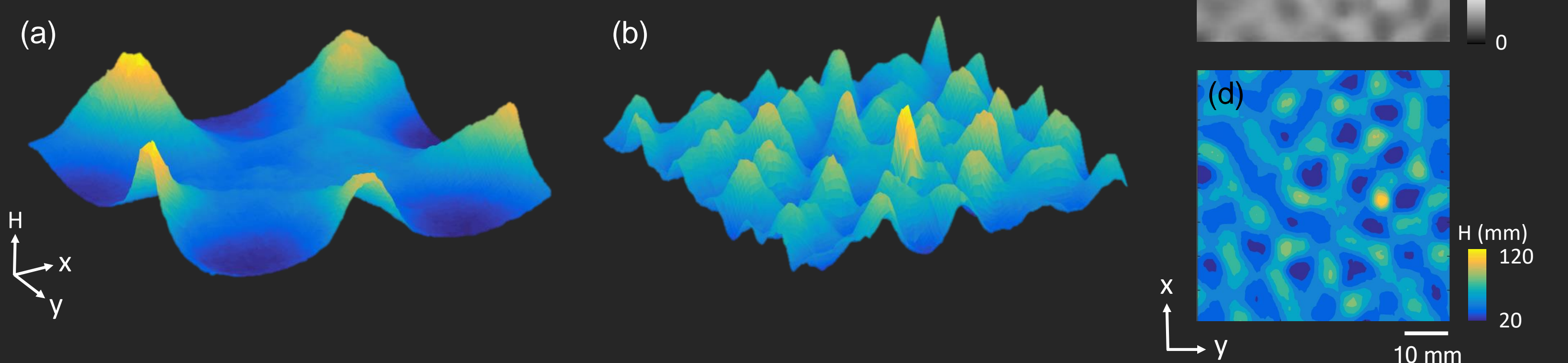
Diffusing light image

Picture from CCD

Pixels

$$I(x,\ y) = Ib(x,y)e^{-H(x,y)}$$

$I_b(x,y)$: the background intensity distribution

The intensity of the penetrated light (I) is inversely proportional to the local wave height (H).
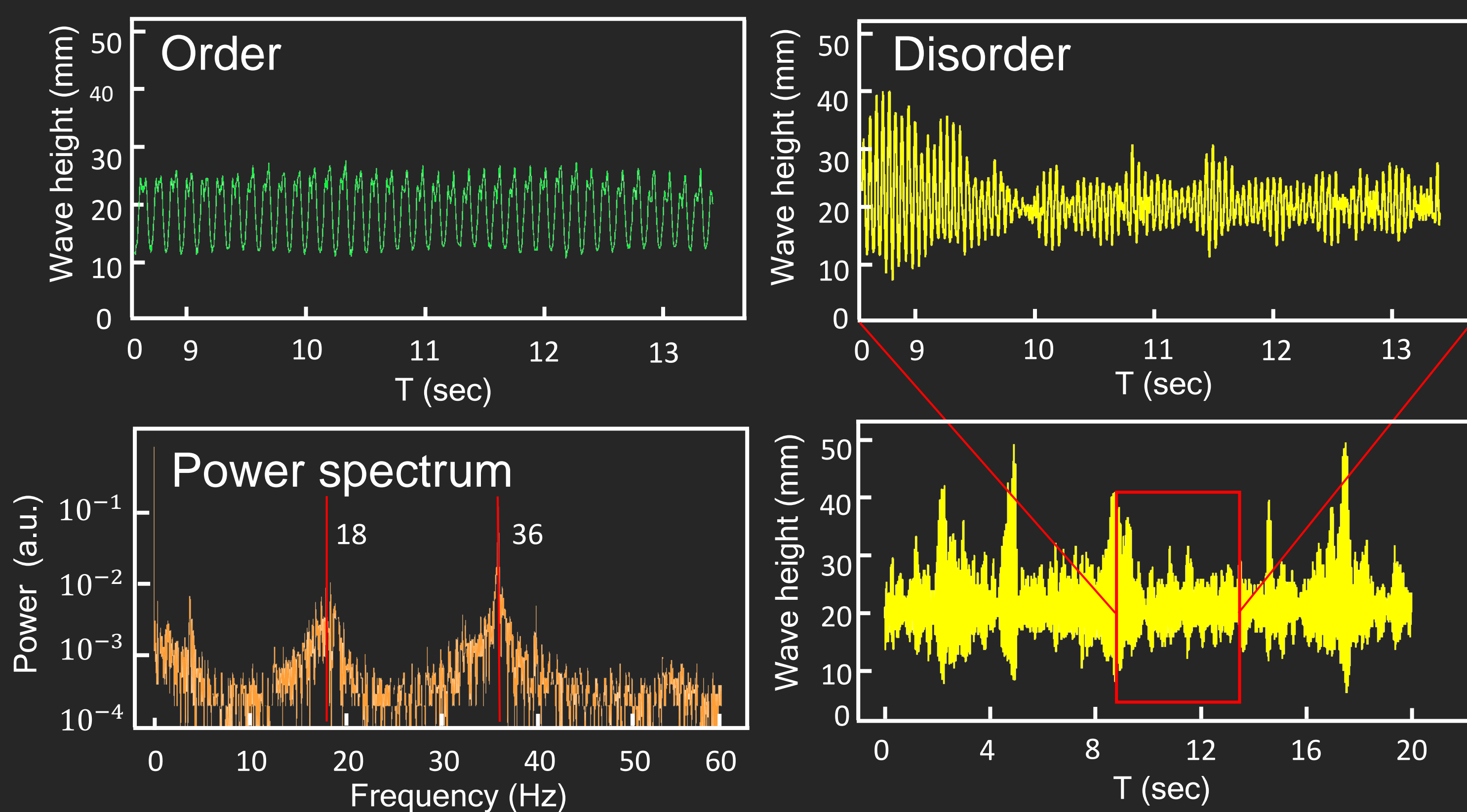
Order & Disorder state

(a) (b) (c) (d)

Three-dimensional images of wave height in the (a) order state driven at 15 Hz, and (b) disorder state driven at 36 Hz. 2D contour plots of (c) intensity and (d) wave height in the disordered state.
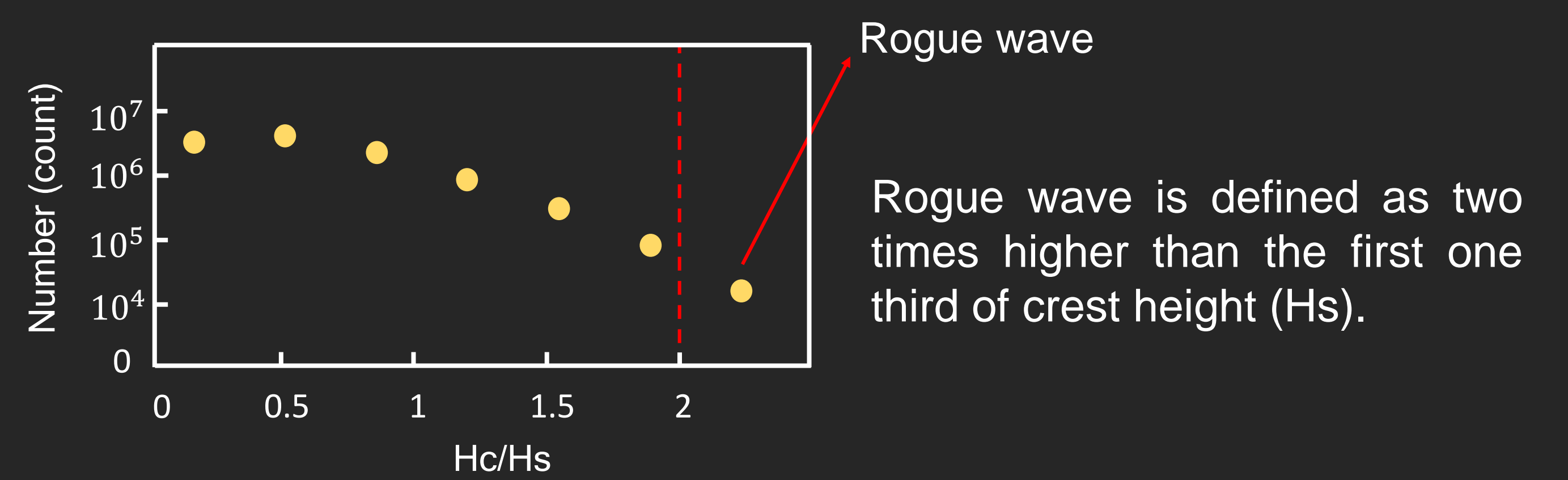
Rogue wave generation

T − τ   T − 0.5τ   T   T + 0.5τ
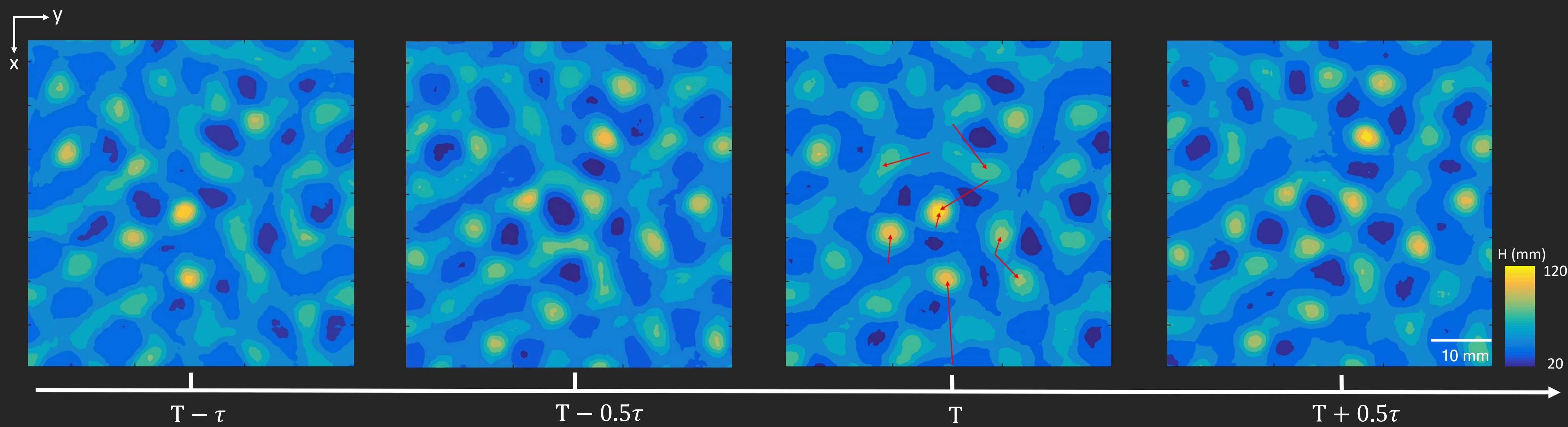
Sequential contour plots of wave height showing the generation of rogue wave at time T. The period of the wave (τ) is half of the driving frequency (36 Hz). The red arrows are pointed from T - 4τ to T.

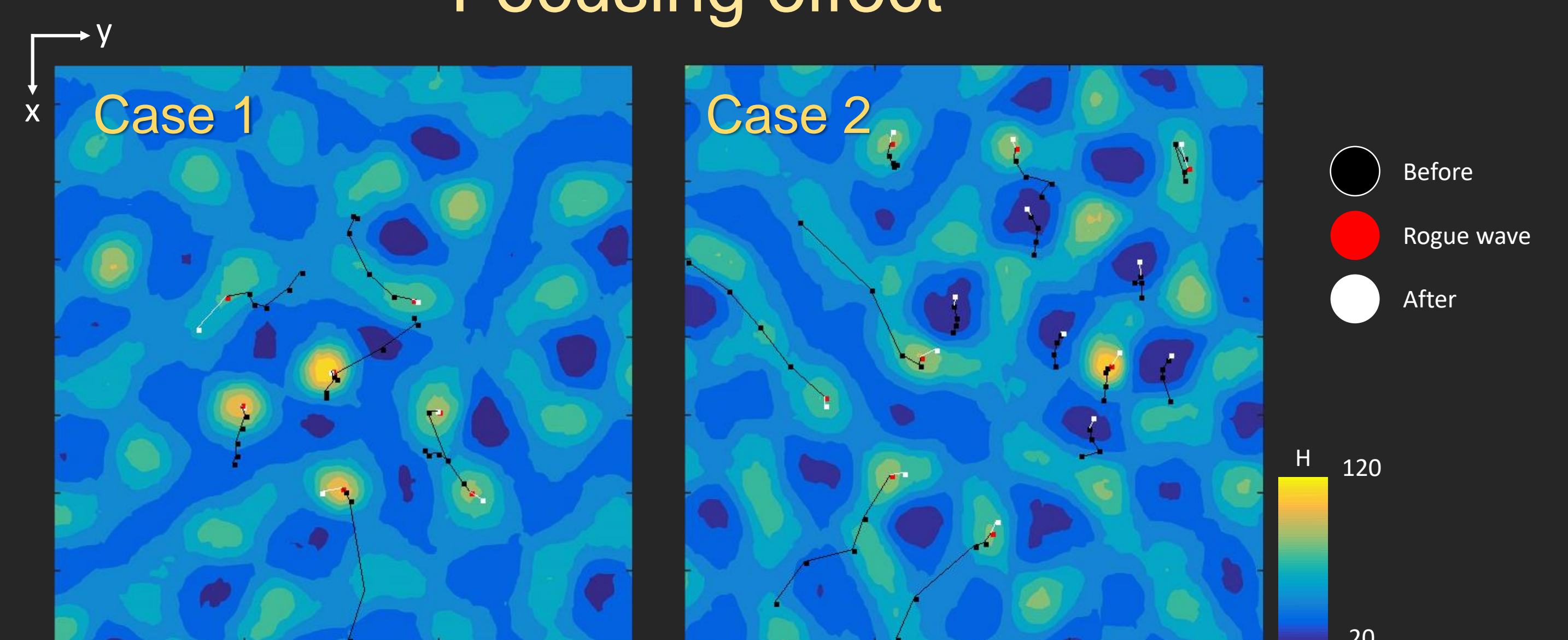## Amplitude and frequency modulations

Order

Disorder

Power spectrum

Wave height statistic

Rogue wave

Rogue wave is defined as two times higher than the first one third of crest height (Hs).

Focusing effect

Case 1   Case 2

Before
Rogue wave
After

Summary

- The wave height difference of surrounding ripples becomes large.

- The velocity of rogue wave becomes slow when it happens.

- Because of conservation of energy, the horizontal kinetic energy of rogue wave transforms into potential energy.

Reference

- H. Xia, PRL 109, 114502 (2012)
- N. Francois, PRL 110, 194501 (2013)
- N. Francois, PRX 4, 021021 (2014)