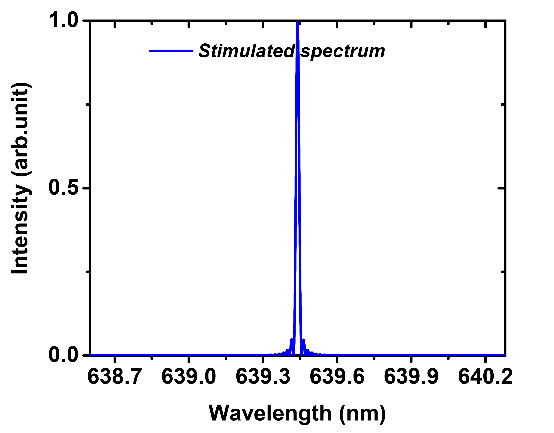
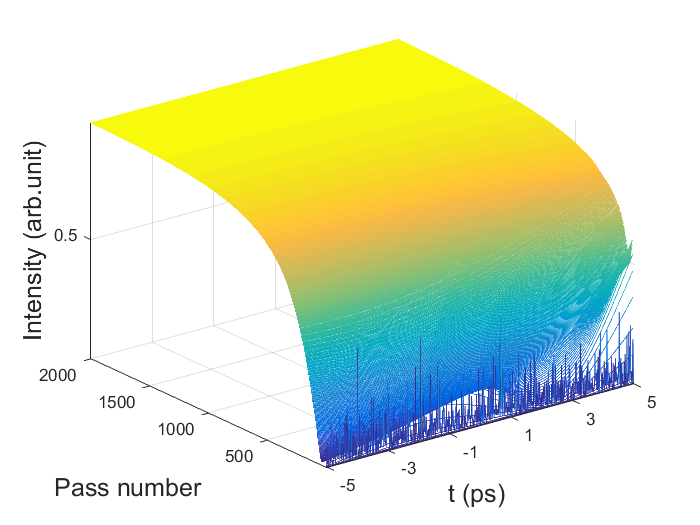


**(b)**

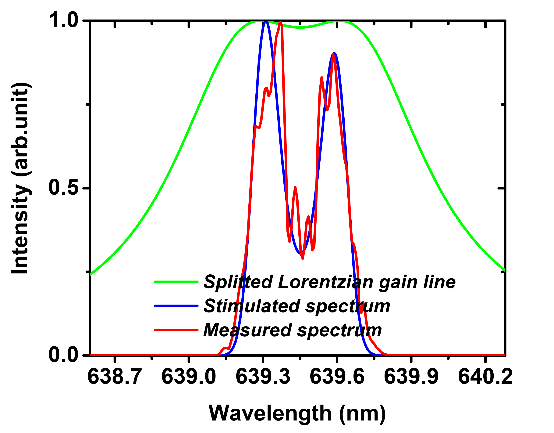
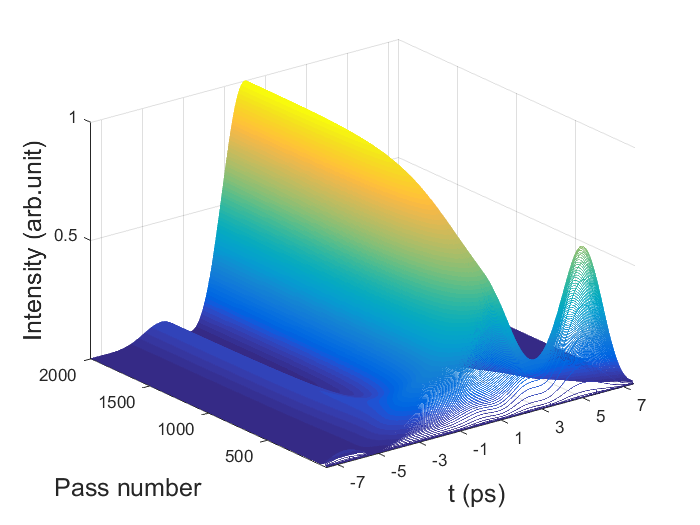
**(a)**



**(d)**

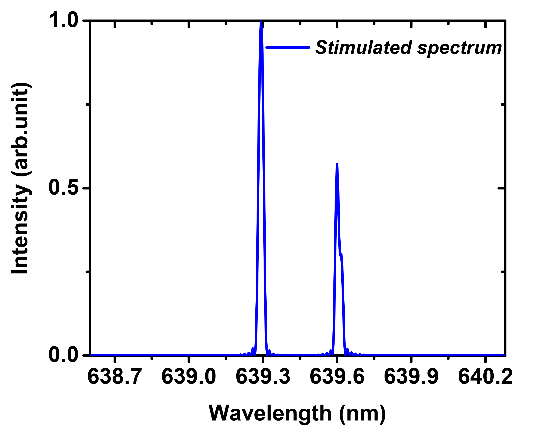
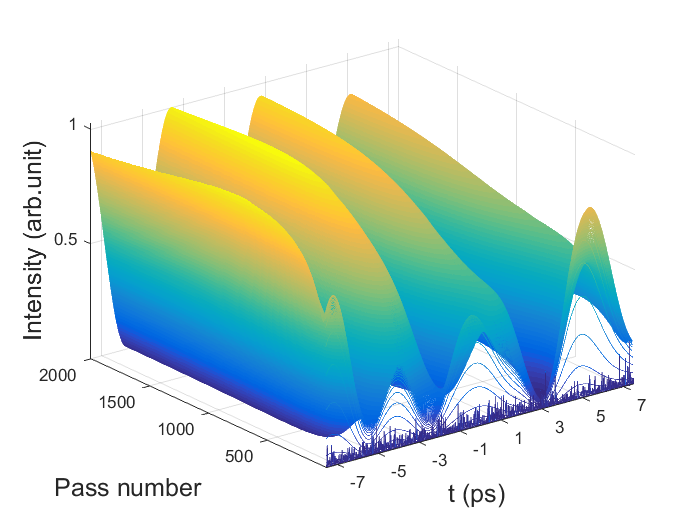
**(c)**

Fig 1. Pulse evolution in the cavity



**(a)**

**(b)**



**(d)**

**(c)**

Fig 2.

The model of the self-started Kerr-lens mode-locking procedure consists of a laser gain media and an intensity modulator. The laser gain media can be thought of as an amplifier that has a gain line shape, which can be modeled by a frequency filter. As for the amplifier, the saturation effect should also be taken into account and its effect on the gain factor *g* is given as

,(1)

Where *g*ss is the small-signal gain factor, *P* is the signal power, *P*sat is the saturation power. With regard to the gain line shape, Pr3+:YLF laser is solid-state laser with a gain-line shape corresponds to Lorentzian profile which belongs to homogeneous broadening [2016, Li Qing-Song]. The gain coefficient can be expressed as

,(1)

among which  is the central frequency and  is full width at half-maximum of the laser gain-line shape. Owing to the spatial-temporal narrowing of the signal by Kerr-lensing effects of the gain media, the intensity of the intracavity laser is modulated passively. The model of the intensity modulation can be briefly thought of as a Gaussian profile in the time domain and be written as

,

where *t*0 is the reference time, and *Δt* is the duration of the modulation signal.

After the laser crystal, the signal propagates in the atmosphere, where it experiences no chromatic dispersion or nonlinear effect, and can be modeled by the linear differential equation

,

where *L* is the cavity round-trip loss, and can be solved by using the finite element method. After one round trip, the signal is fed in the gain media again and completes another round trip. The process is repeated until equilibrium is reached.

As shown in Figure 1,

[2016, Li Qing-Song]. “The effect of the depth of single longitudinal mode modulation in Q-switching pre-Pr3+:YLF laser”