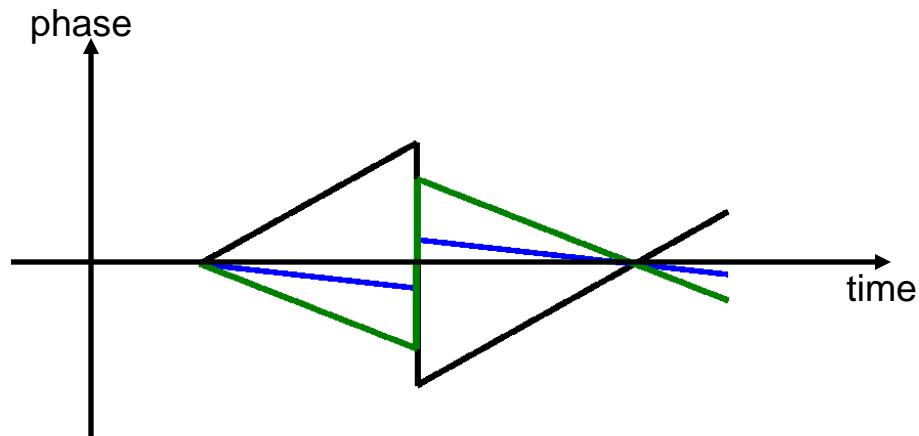
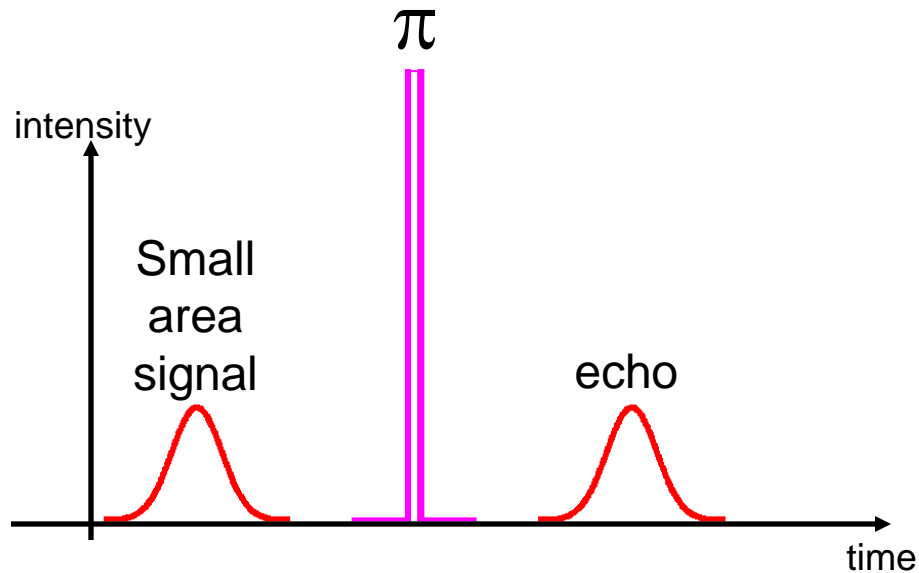


# ***Revival of Silenced Echo for quantum memory***

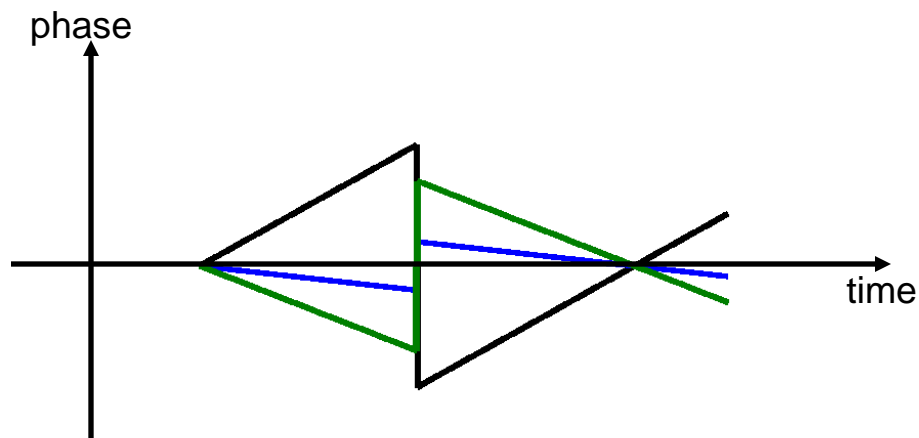
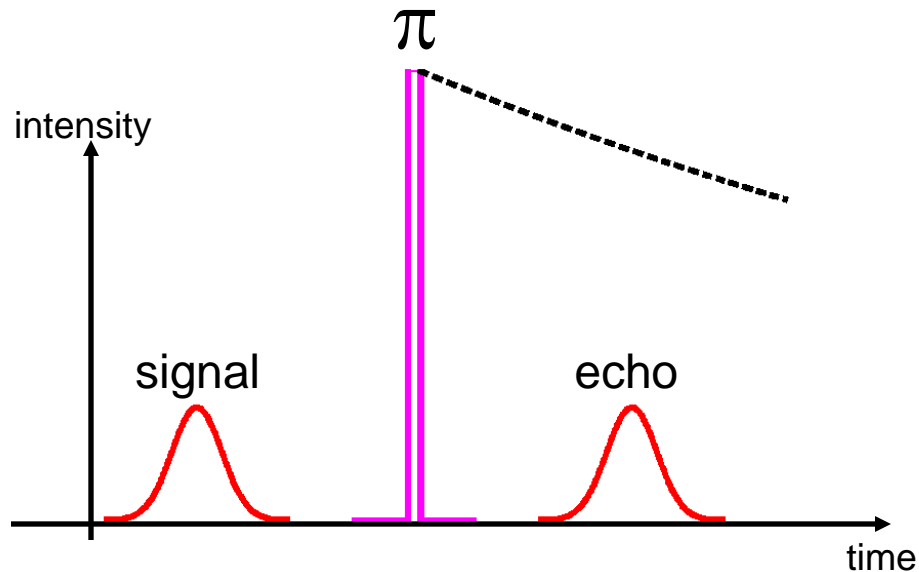
- ROSE avoid limitations of Two-pulse echo (2PE)
- 2PE advantages compared to CRIB, GEM, AFC ...
  - No preparation
  - Compatible with Er
  - Highly multimode
- 2PE drawbacks:
  - Fundamental: Inverted medium - Ruggiero *et al.*, [Phys. Rev. A 79 053851 \(2009\)](#), Sangouard *et al.*, [Phys. Rev. A 81 062333 \(2010\)](#).
    - Spontaneous emission
    - Amplification of the echo
  - Technical: Strong rephasing light pulses spoiling the signal

# ***2PE limitations***

- $\pi$  rephasing pulse
- Coherence rephasing
- Population inversion

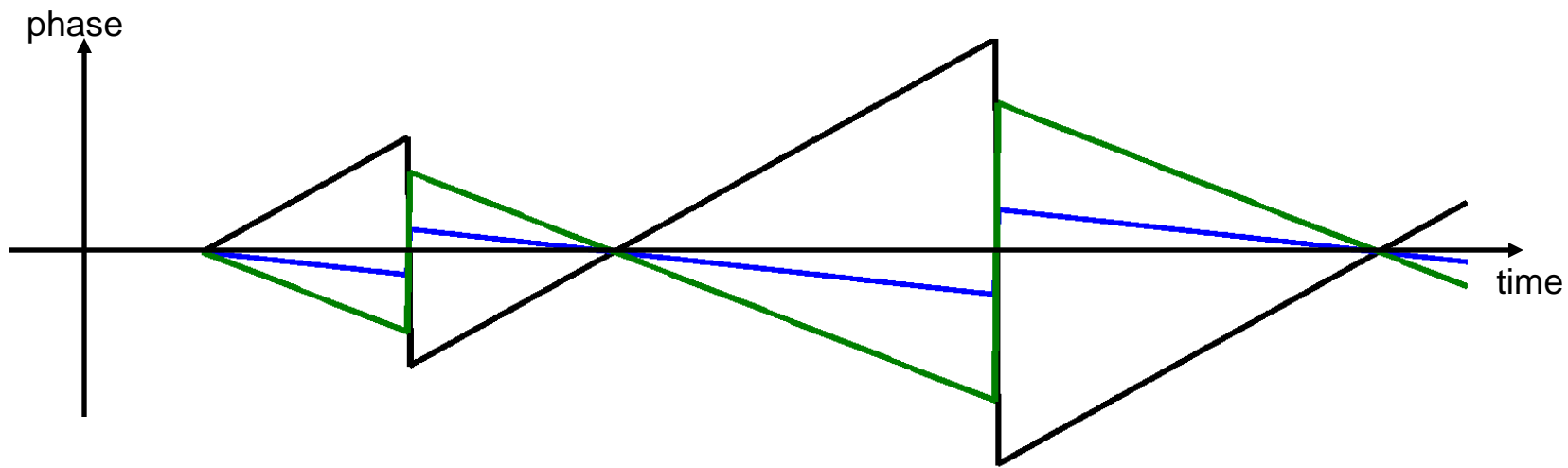
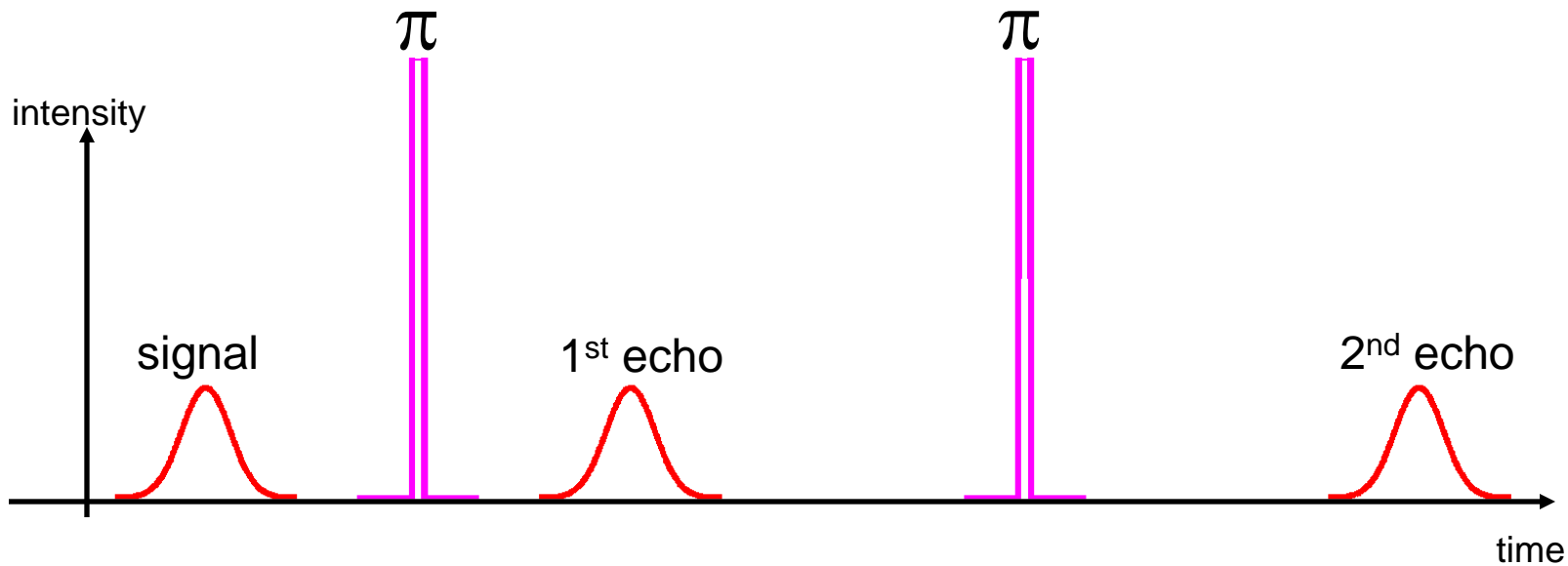


# 2PE limitations

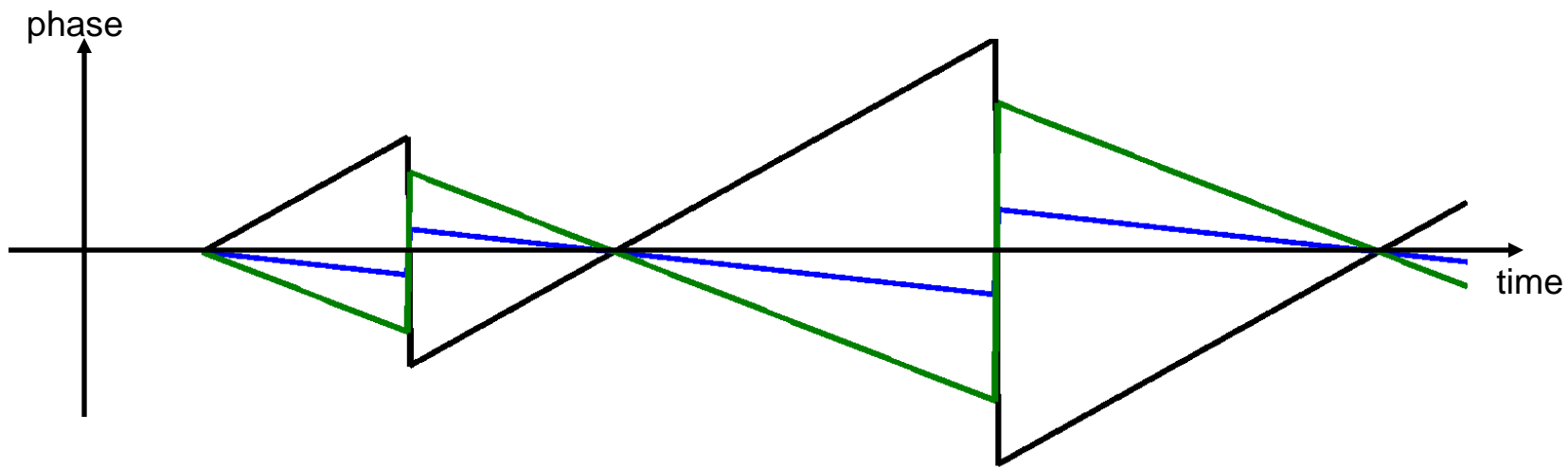
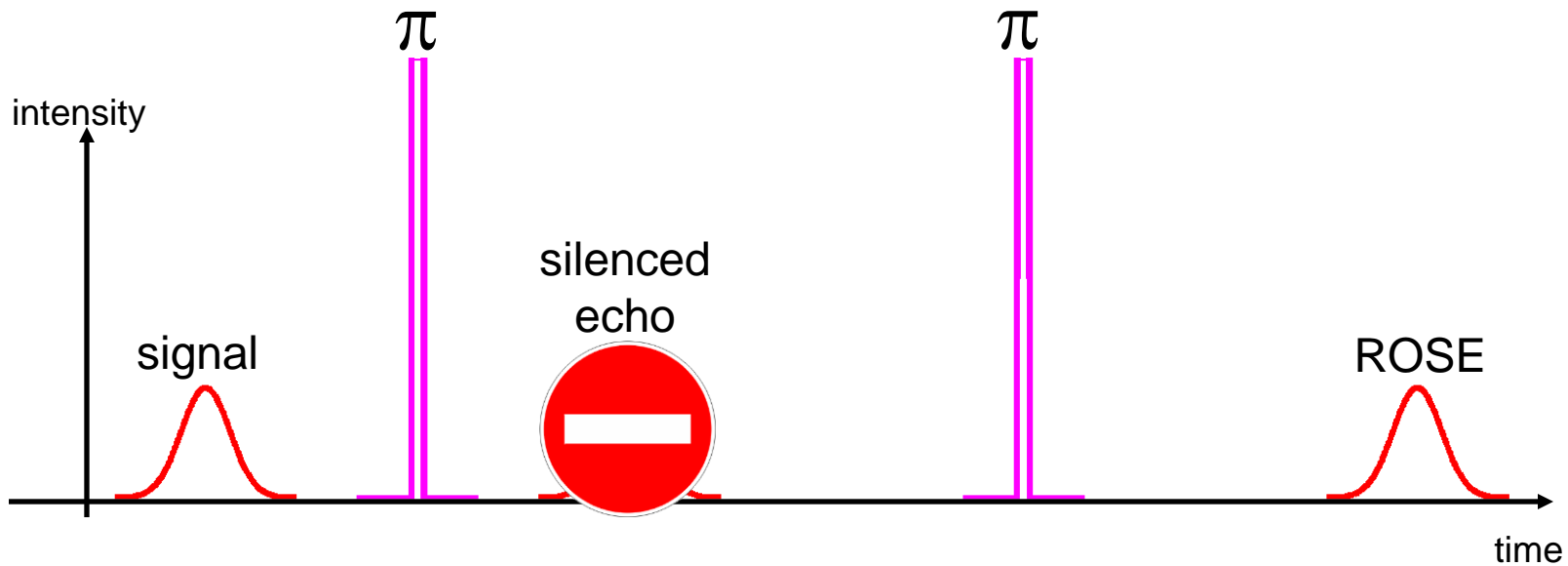


- $\pi$  rephasing pulse
- Coherence rephasing
- Population inversion
  - Spontaneous noise
  - Echo amplification
    - Ruggiero *et al.*, [Phys. Rev. A 79 053851 \(2009\)](#)
    - Sangouard *et al.*, [Phys. Rev. A 81 062333 \(2010\)](#)
    - Ledingham *et al.*, [Phys. Rev. A 81, 012301 \(2010\)](#)

# ***ROSE***

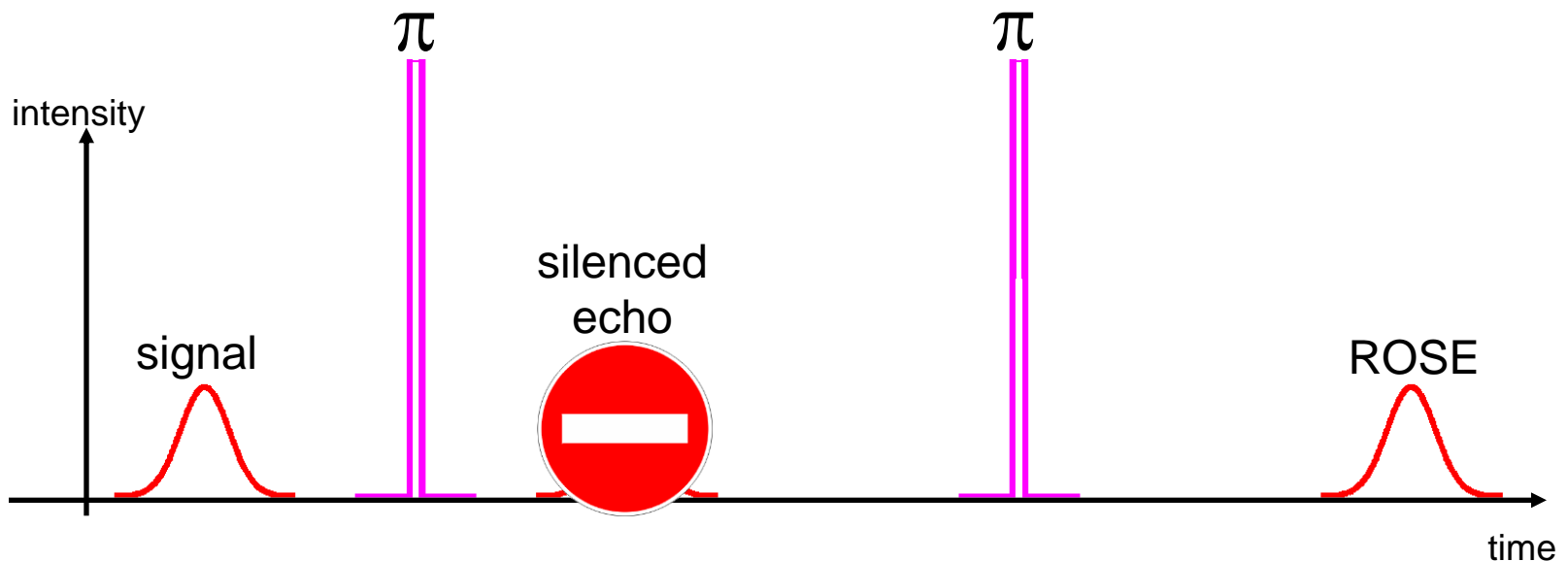


# ***ROSE***

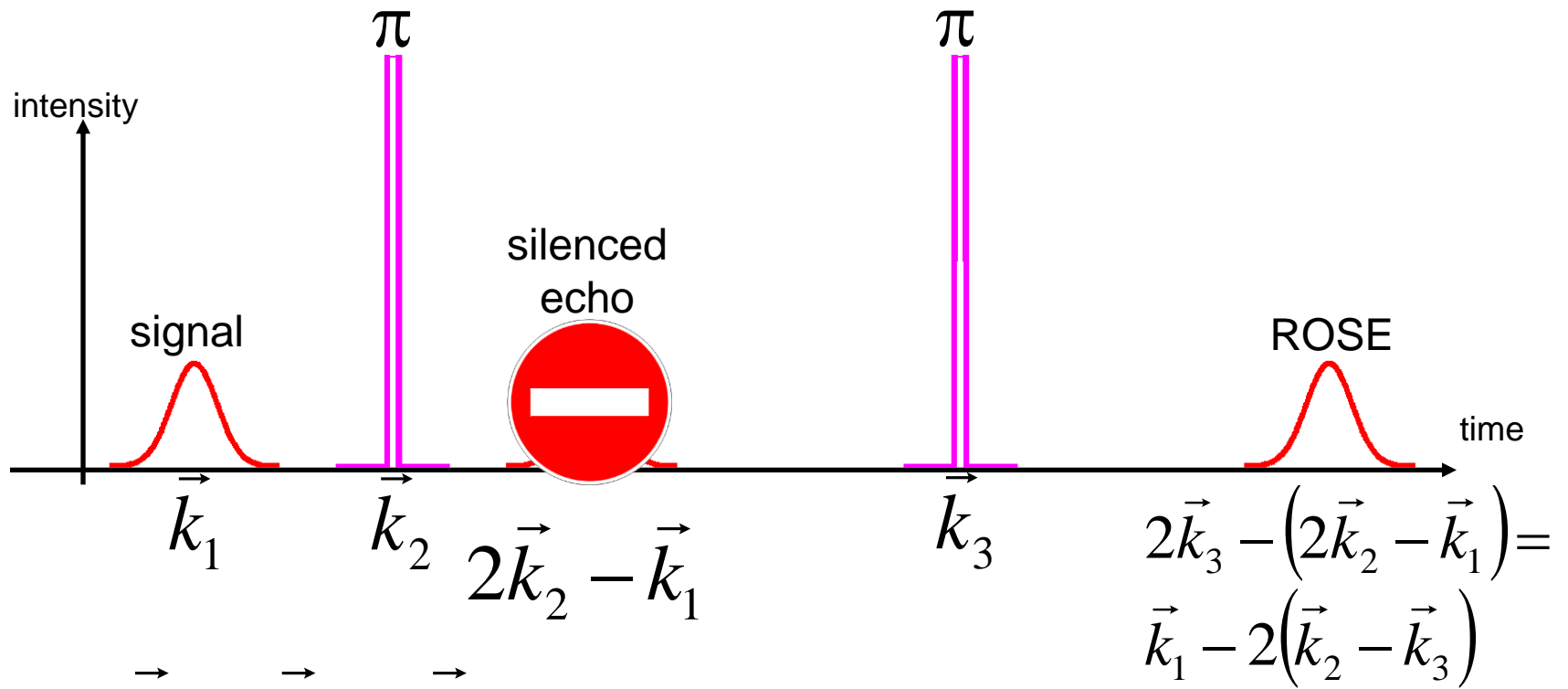


# ***ROSE***

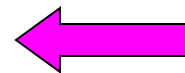
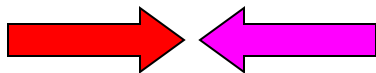
- ROSE emitted in ground state
- Silence the 1<sup>st</sup> echo ?
  - Longdell, [arXiv:1104.4134](https://arxiv.org/abs/1104.4134), Stark effect – HyPER
  - LAC, phase matching condition, Damon *et al.*, [arXiv:1104.4875](https://arxiv.org/abs/1104.4875) !



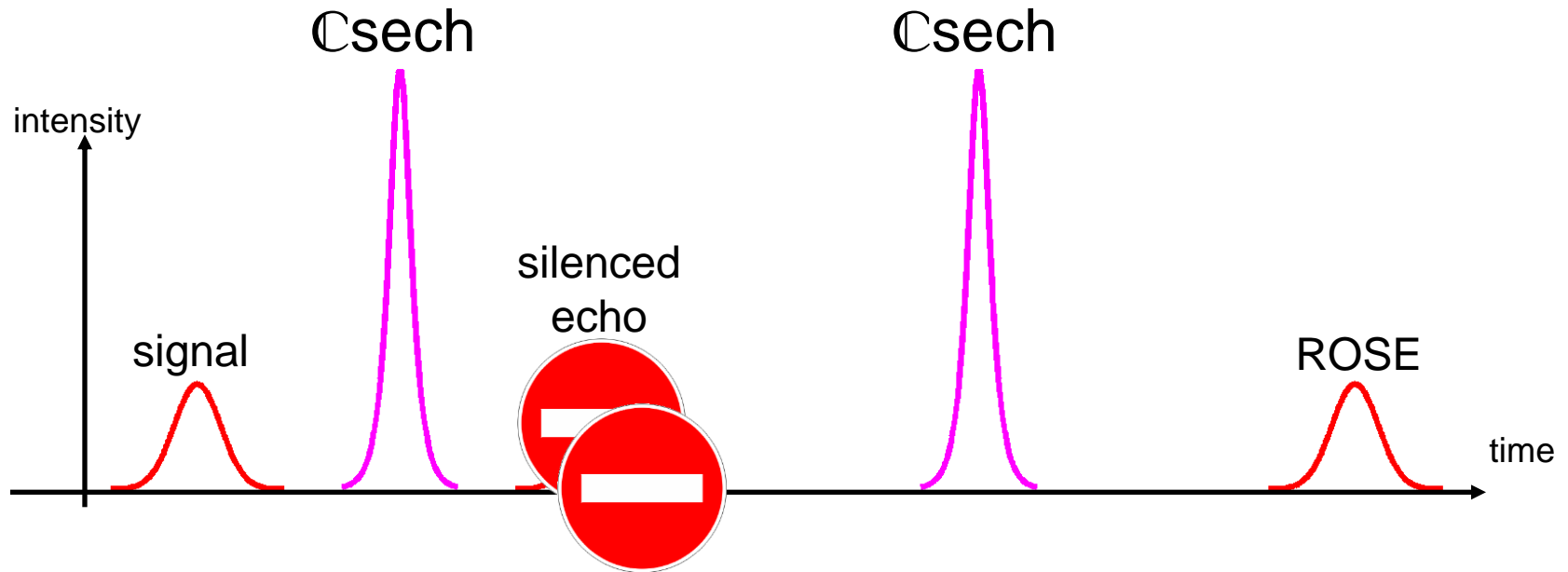
# ***ROSE – Phase matching cond.***



- Ex:  $\vec{k}_3 = \vec{k}_2 \neq \vec{k}_1$
- Counterpropagating signal and  $\pi$  pulses



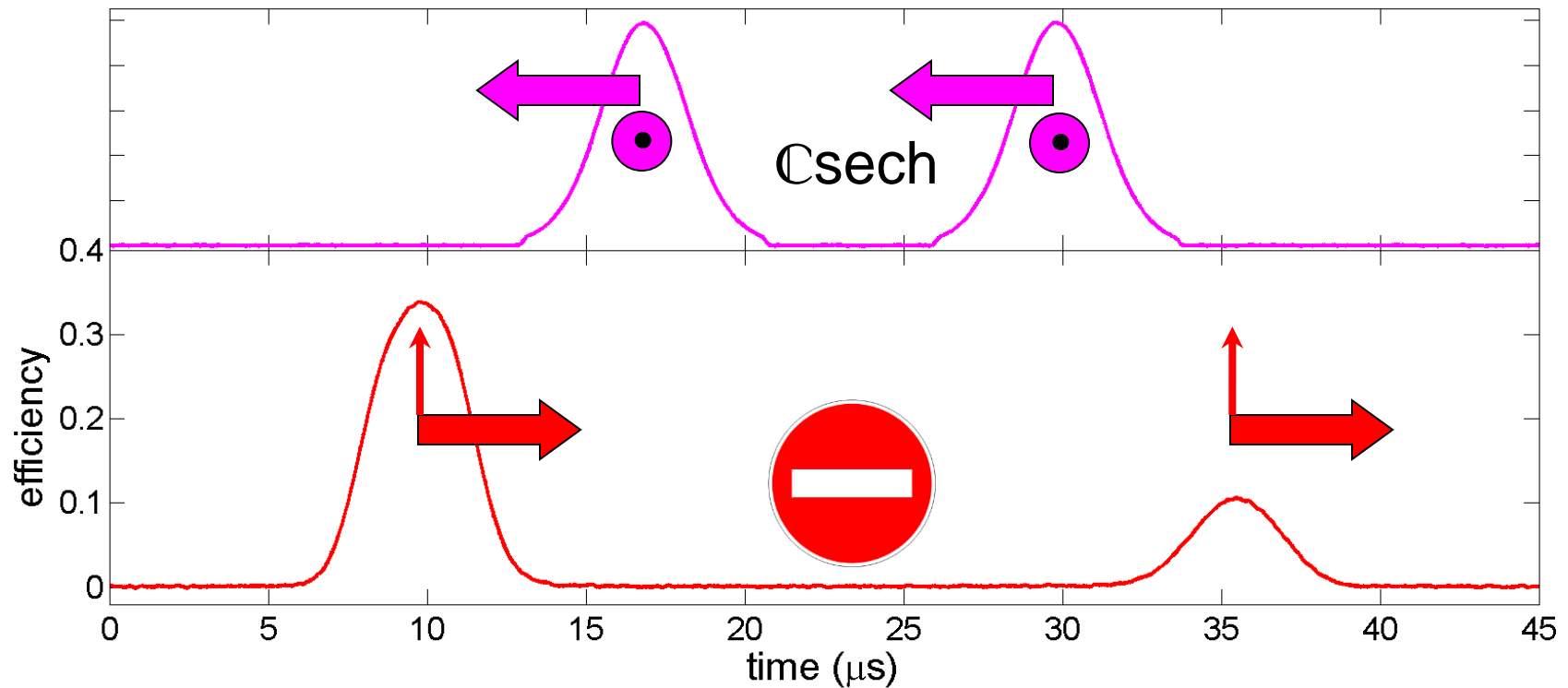
# ***ROSE – Csech***



- $\text{Csech} = \text{sech}$  with chirp
- Robust rephasing
  - Bandwidth optimization
  - Less sensitive to propagation ?
- Silence echo even more



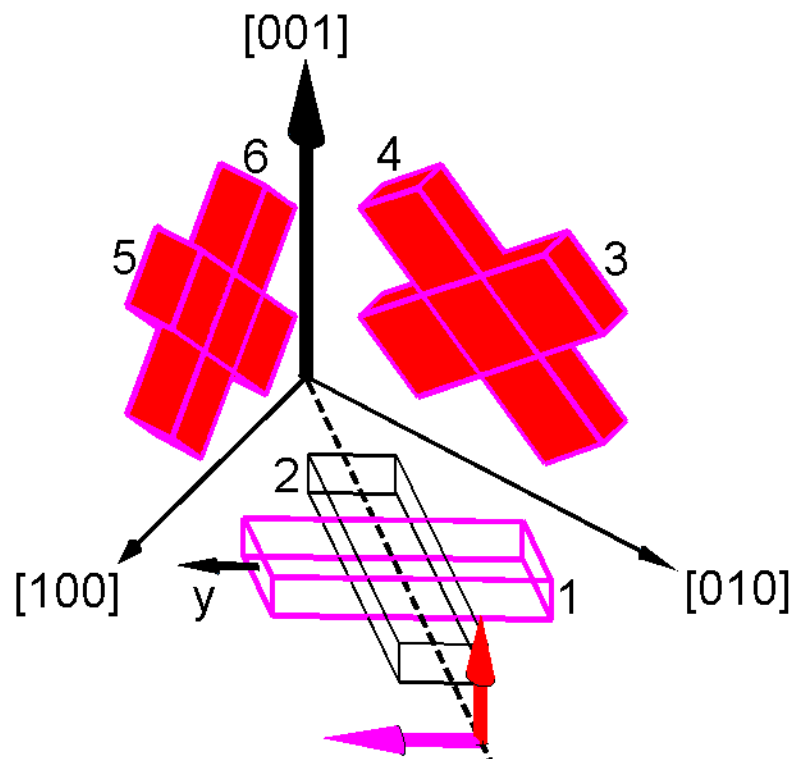
# ***ROSE – experiment in Tm:YAG***



- Tm:YAG: M. Bonarota – nothing today on Er:YSO: V. Damon, [arXiv:1104.4875](https://arxiv.org/abs/1104.4875)
- $\perp$  polarizations
- Efficiency  $(\alpha L)^2 e^{-\alpha L}$

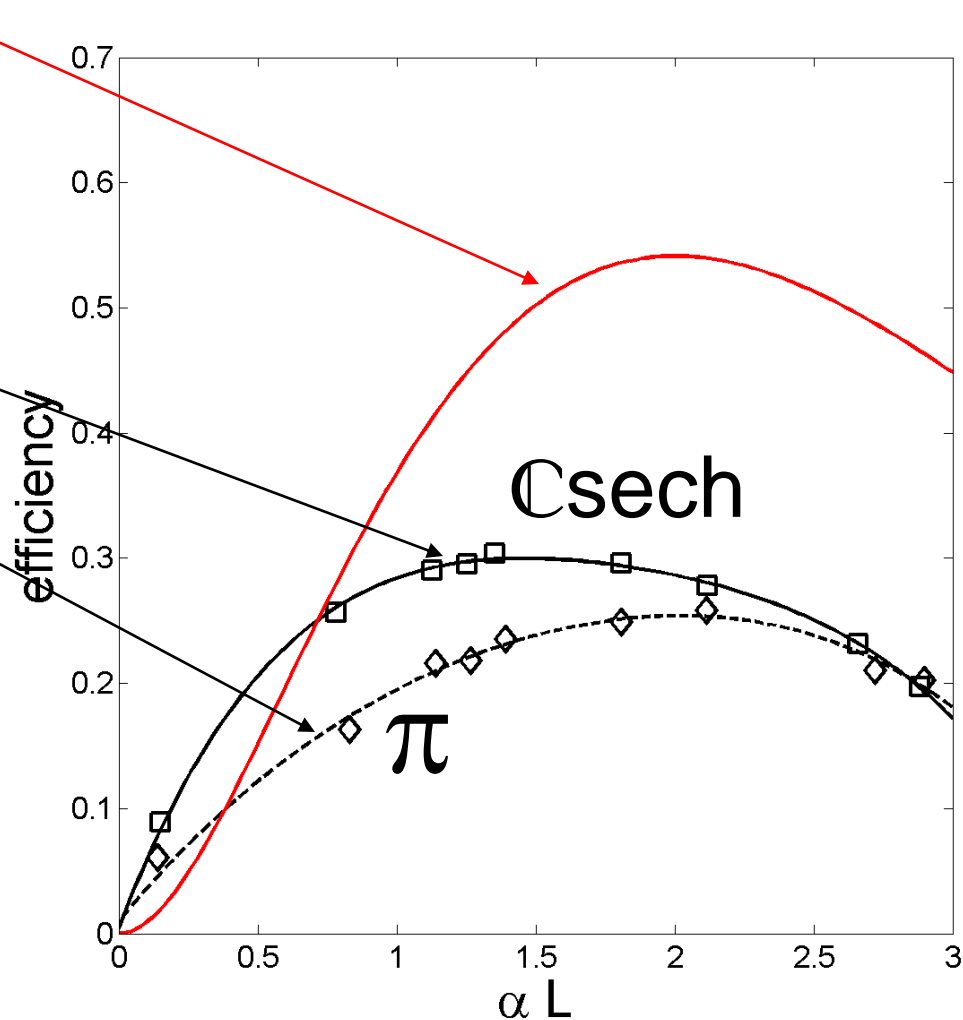
# ***ROSE – experiment in Tm:YAG***

- $\perp$  polarizations
- Bonarota *et al.*, [New J. Phys. 13, 013013 \(2011\)](#)



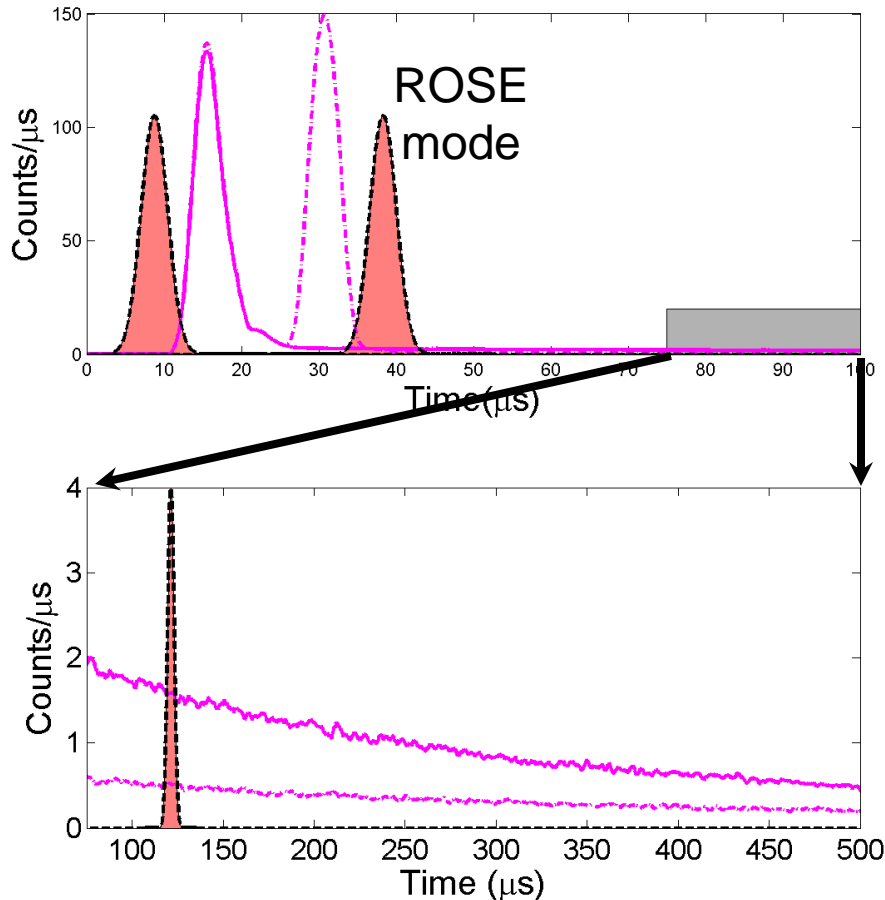
# ***ROSE – experiment in Tm:YAG***

- Efficiency  $(\alpha L)^2 e^{-\alpha L}$
- 30% max.
- Csech better than  $\pi$  pulses
- Need specific study of the propagation

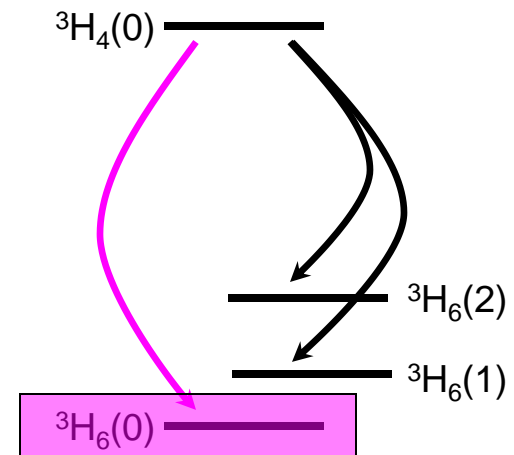


# **ROSE – Preliminary noise study**

- Noise ? without signal
- But  $10^{13}$  photons in Csech



- Extinction:
  - Counterpropagating
  - $\perp$  polarizations
- Spectral filtering of spont. emission  $\rightarrow$  fundamental crystal field level



# **ROSE – Preliminary noise study**

- Noise from the Csech in the ROSE mode
- Reduction of spont. emission after 2nd Csech

