

Spin refocusing through double Rapid Adiabatic Passage (RAP)

María Florencia Pascual-Winter

Laboratoire Aimé Cotton, Orsay, France

The people

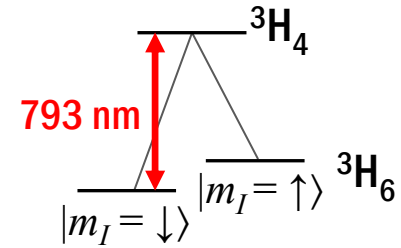
Robert-Christopher Tongning
Anne Louchet-Chauvet
Thierry Chanelière
Jean-Louis Le Gouët

The topics

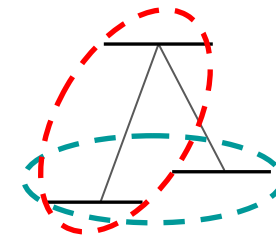
- 1) Geometrical interpretation of refocusing by RAPs
- 2) Experimental results we understand
- 3) Experimental results we do not understand

Context

- $\text{Tm}^{3+}:\text{YAG}$



- Quantum memory



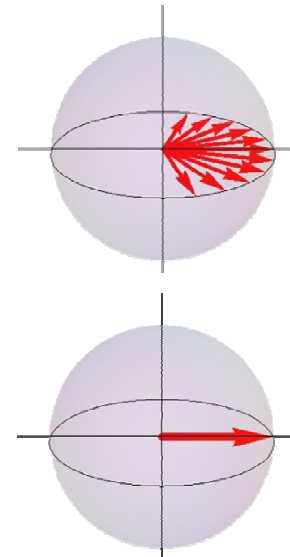
- Inhomogeneous broadening



Dephasing of coherences



Refocusing protocol



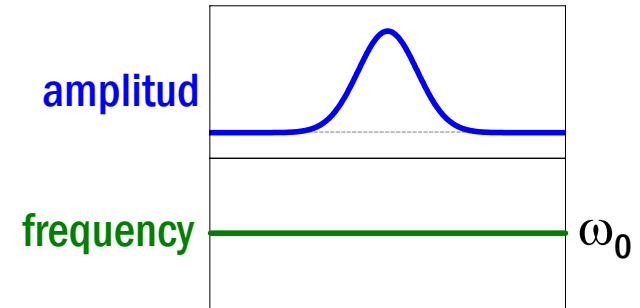
Refocusing protocol

- Photon/Spin echo $\rightarrow \pi$ -pulse

High powers ($\Omega \sim \tau^{-1} \sim \Gamma$)

Optical: propagation problems

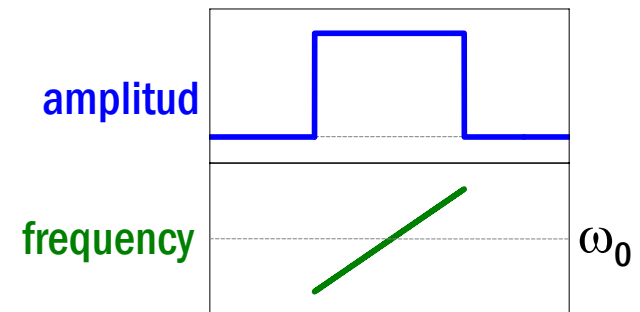
Spin coherences: rf noise



- Rapid Adiabatic Passage (RAP)

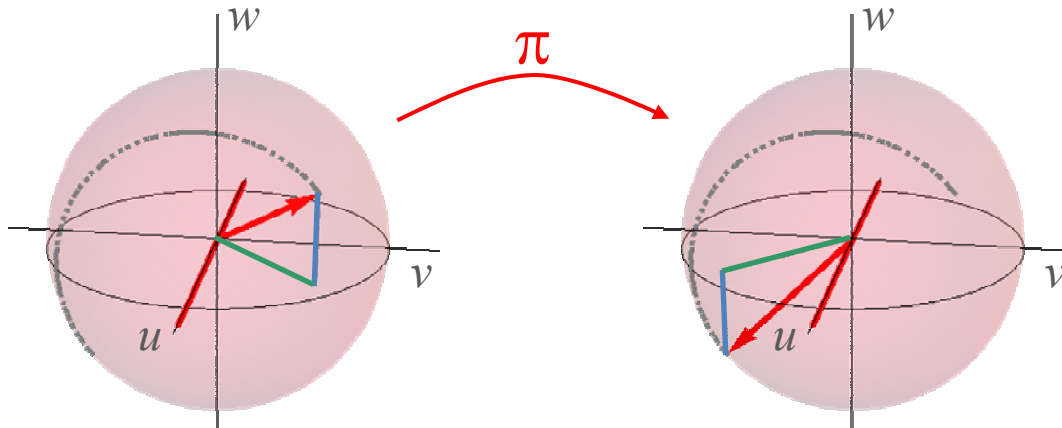
$$\Omega^2 \gg r$$

$$r = \Delta_0 / T_{\text{PAR}}$$



Refocusing protocol

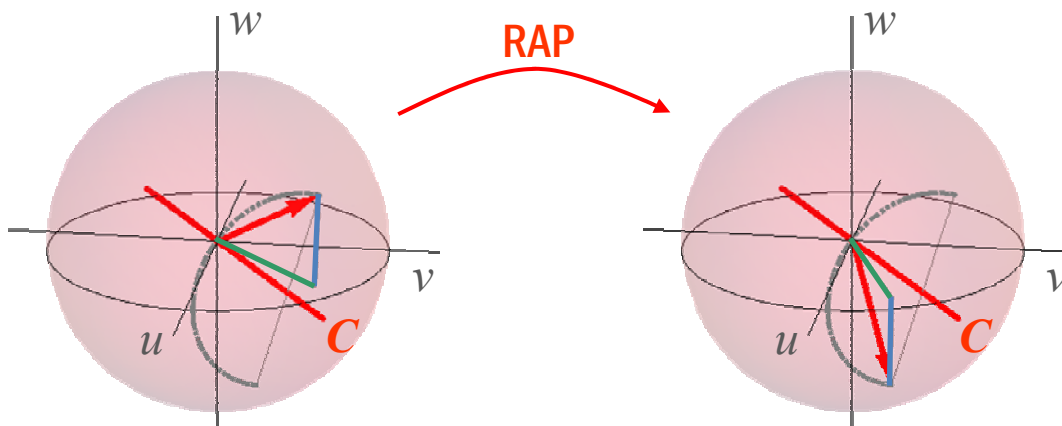
- Photon/Spin echo $\rightarrow \pi$ -pulse



Vertical: population inversion

In-plane: u-reflection

- Rapid Adiabatic Passage (RAP)



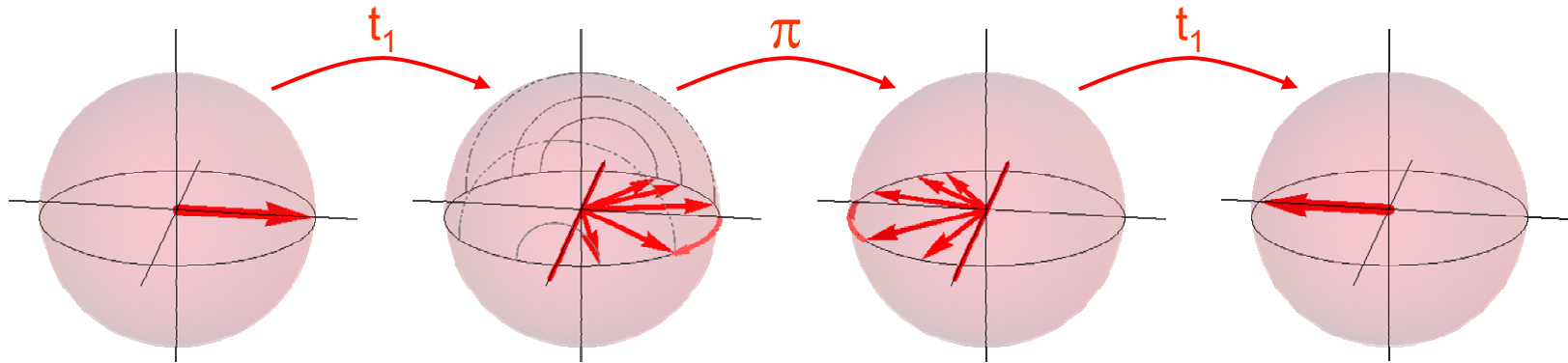
Vertical: population inversion

In-plane: C-reflection

$$C = C(\omega_{ab}) !$$

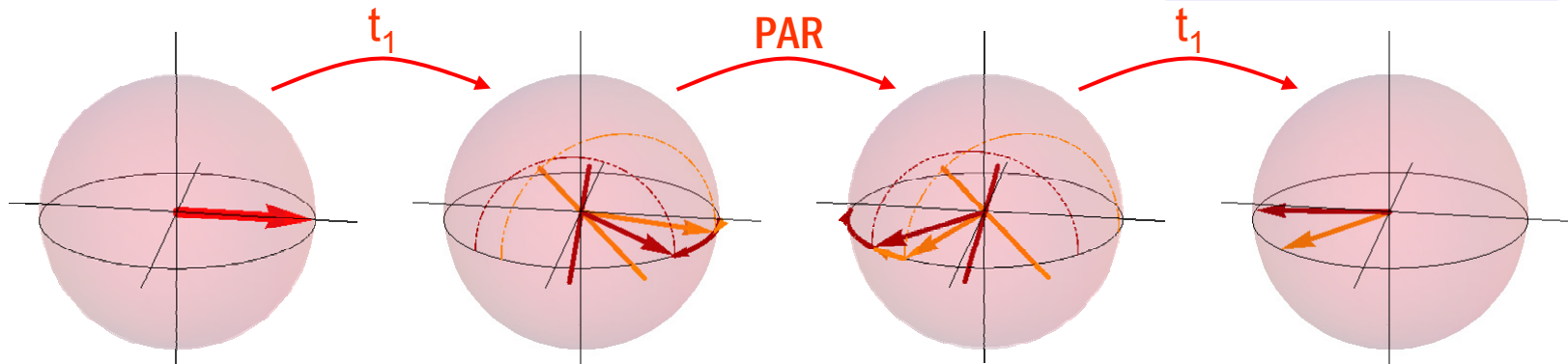
Refocusing protocol

- Photon/Spin echo $\rightarrow \pi$ -pulse



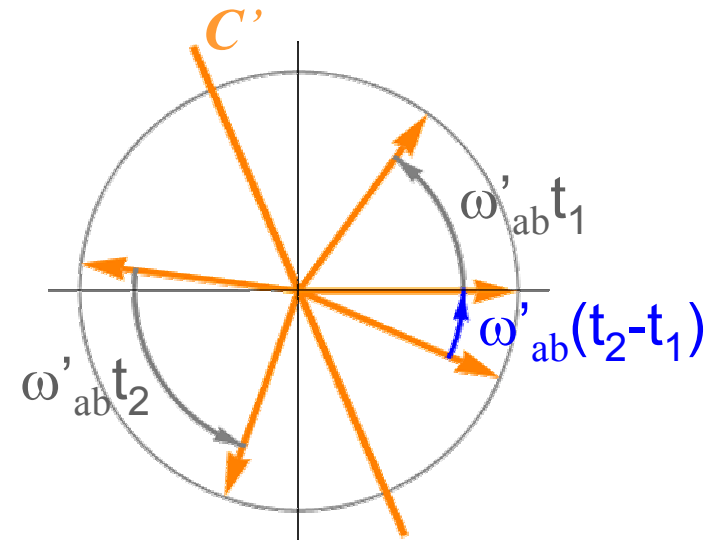
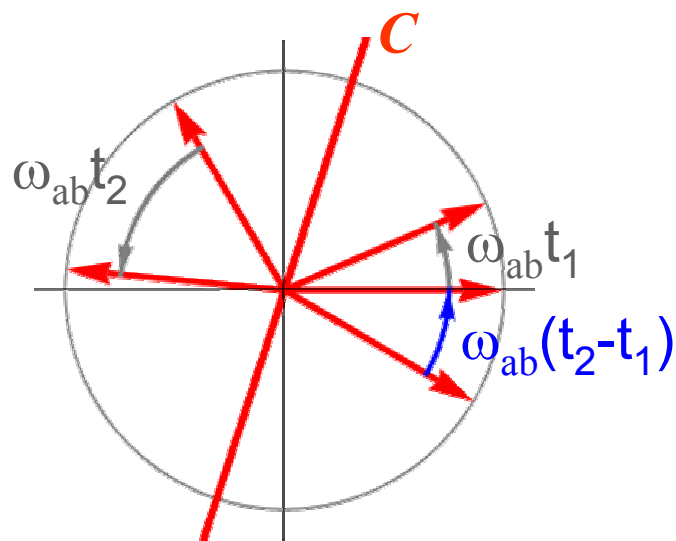
- Rapid Adiabatic Passage (RAP)

Apply 2 RAPs



Refocusing protocol

Double Rapid Adiabatic Passage



Refocusing instant:

$$t_{\text{refocus}} = \text{end of 2}^{\text{nd}} \text{ RAP} + (t_2 - t_1)$$

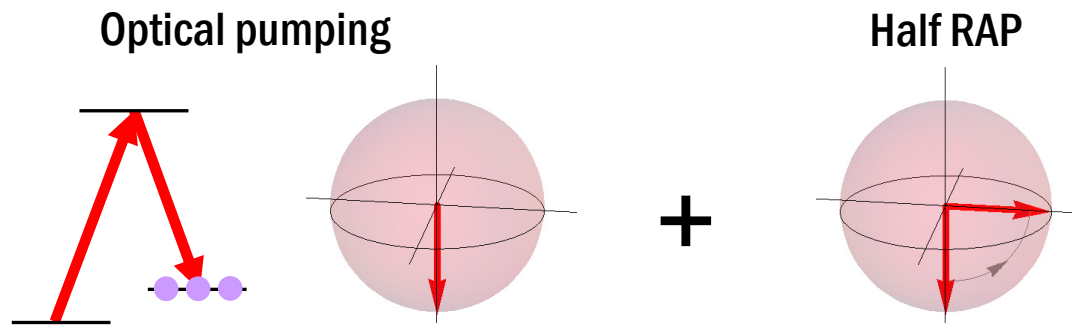
Refocusing condition:

$$t_2 \geq t_1$$

Refocusing spin coherences

The experiment

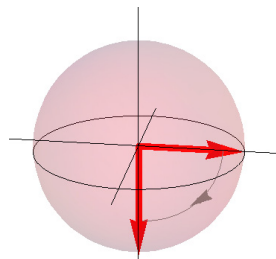
1) Preparation



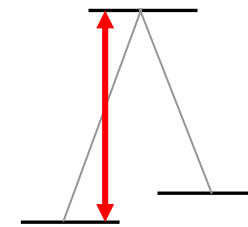
2) Double RAP

3) Optical measurement of the refocusing efficiency

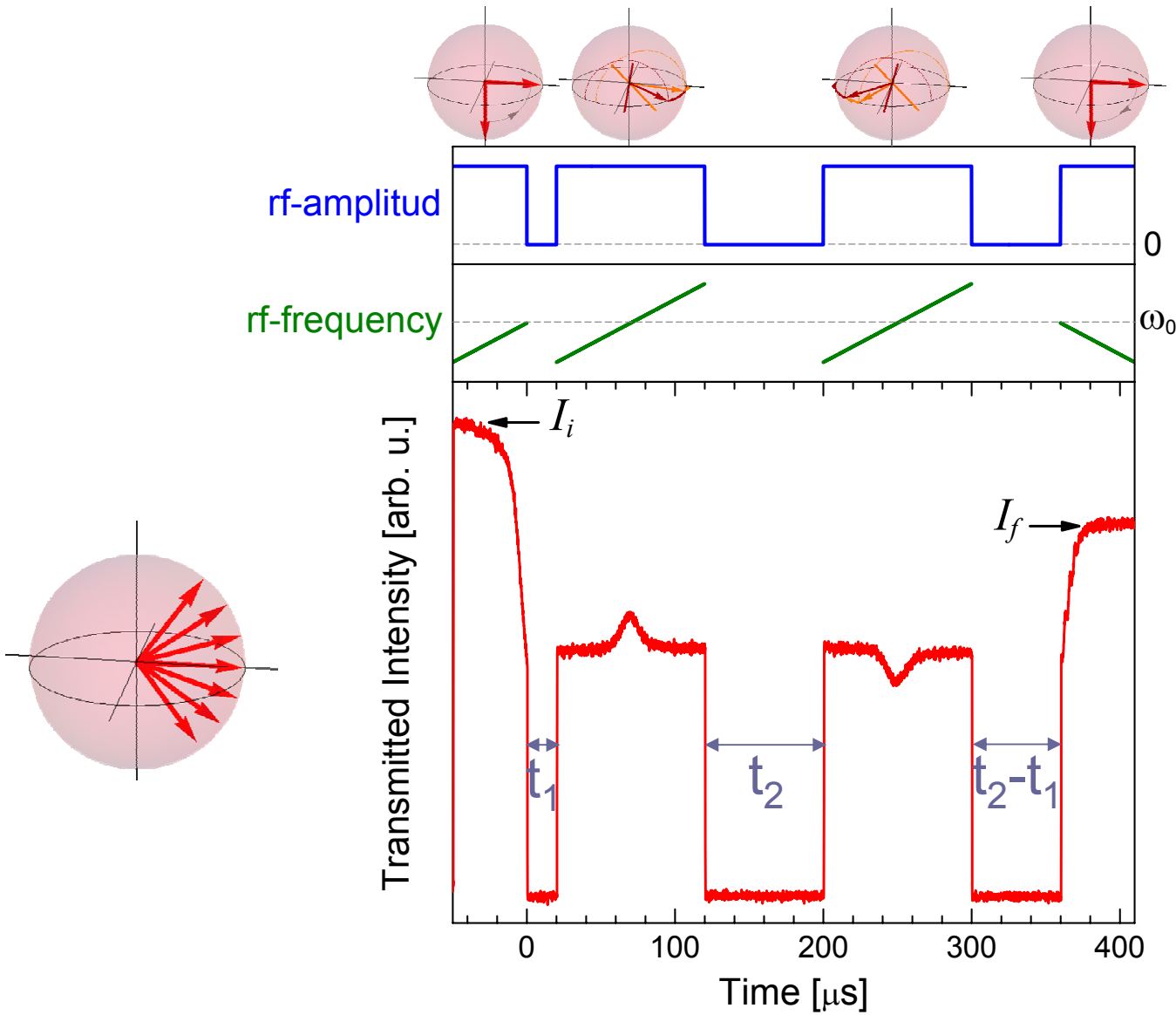
Inverse Half RAP



Optical probe



Refocusing spin coherences

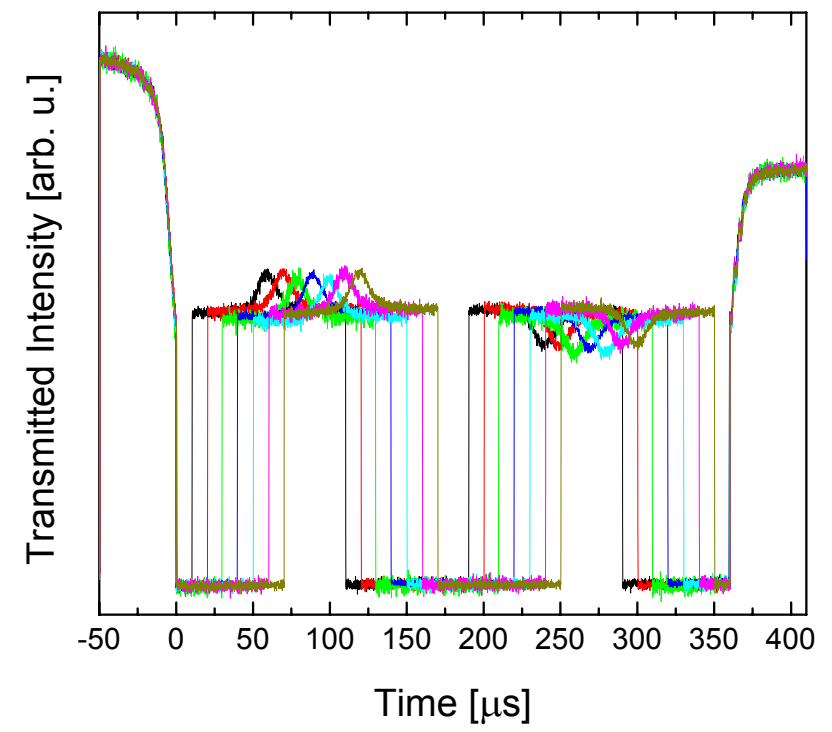
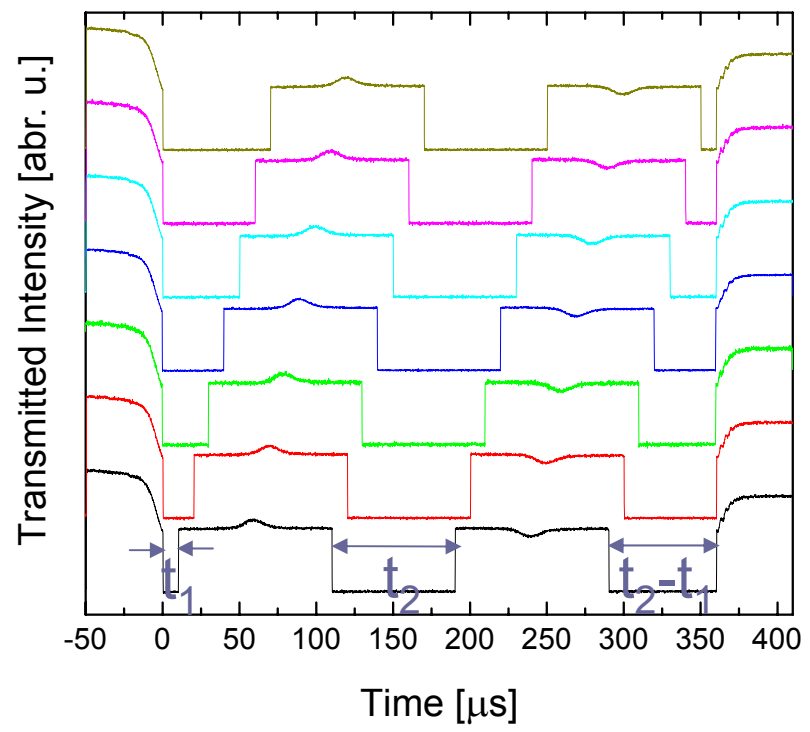


$$\Gamma_{\text{inh}} = 600 \text{ kHz}$$

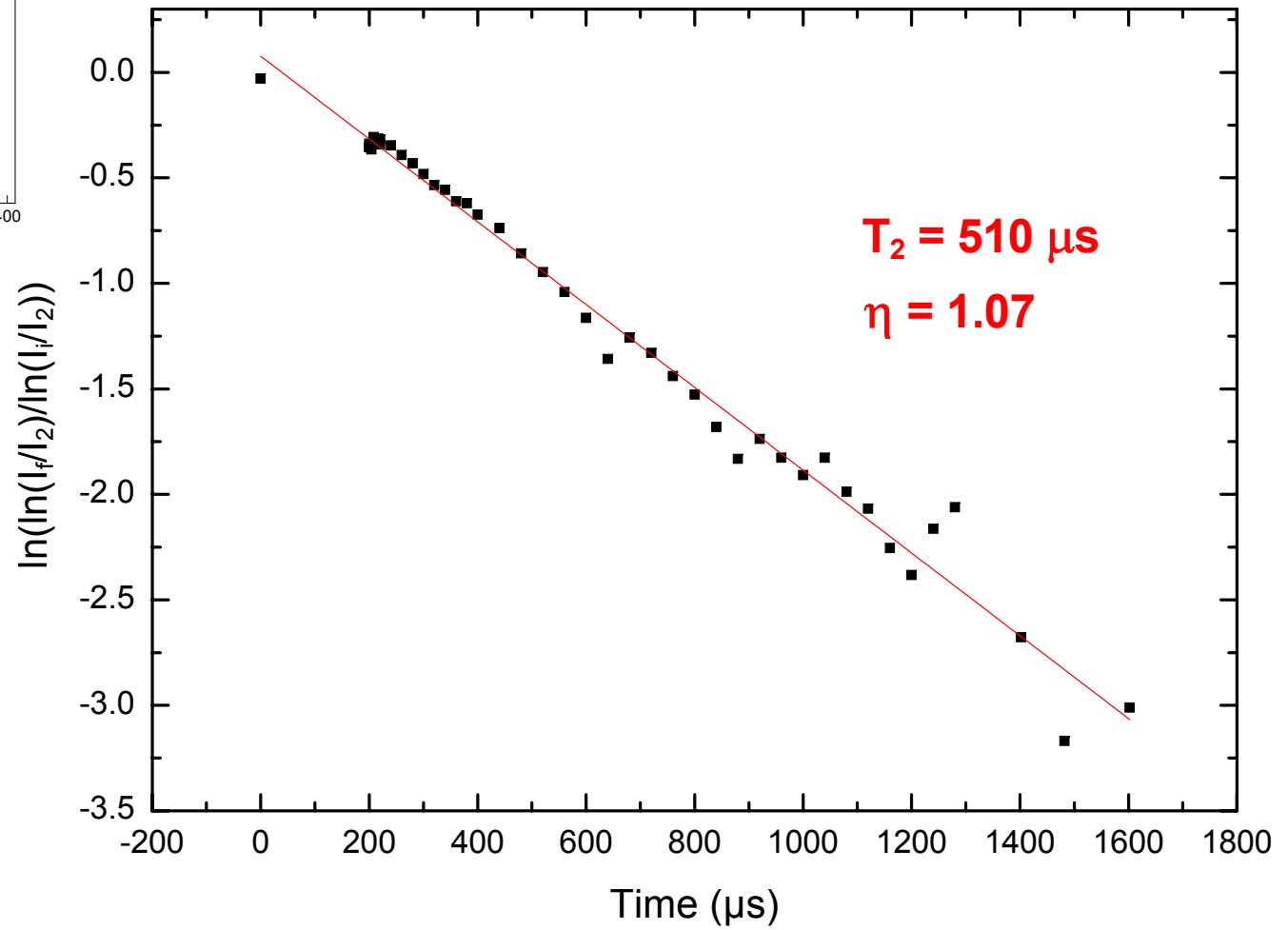
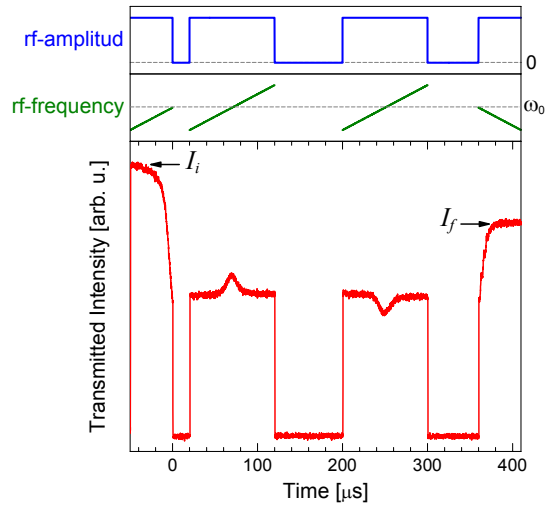
$$\Delta_0 = 4 \text{ MHz}$$

T_2 & η

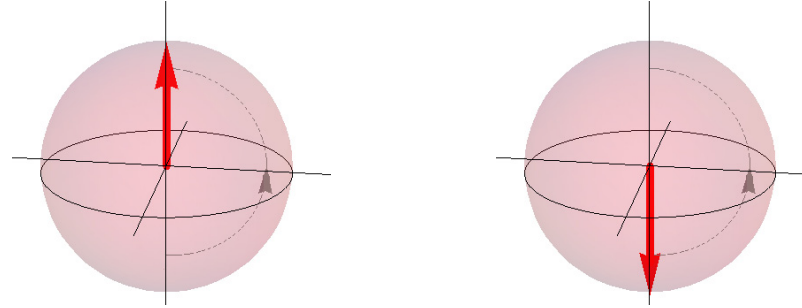
Refocusing spin coherences



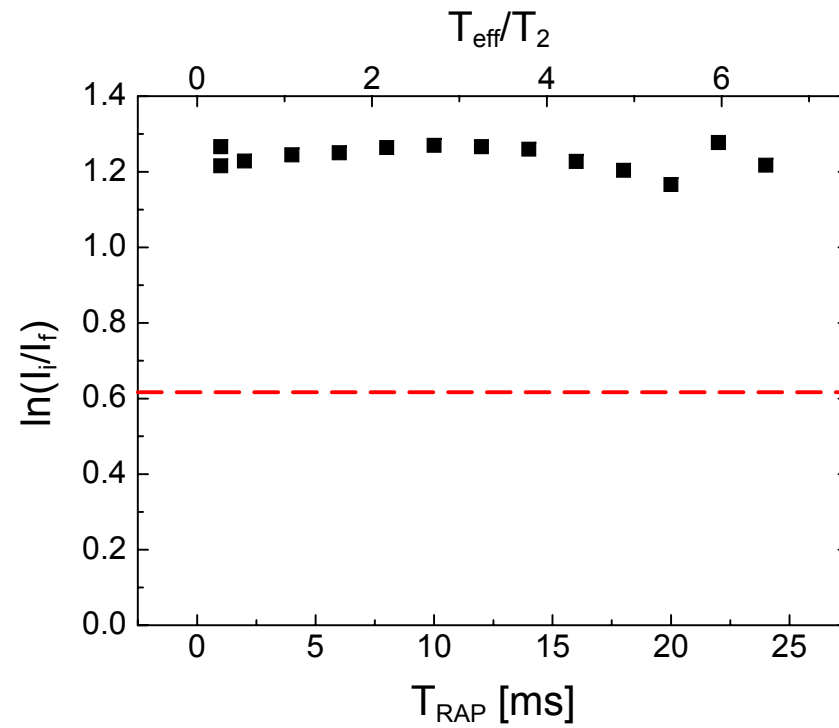
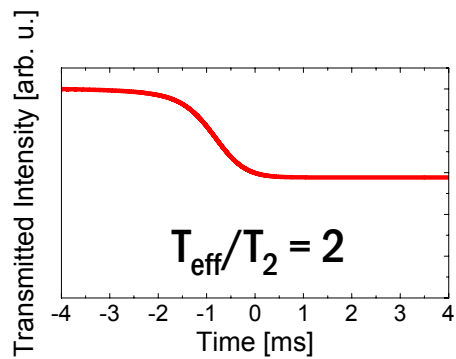
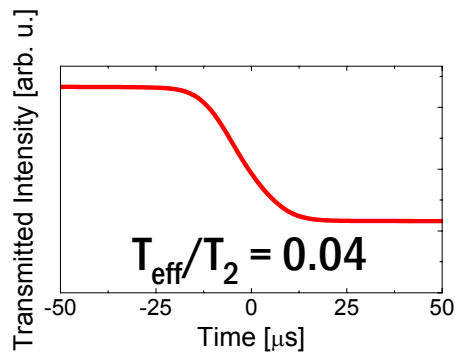
Refocusing spin coherences



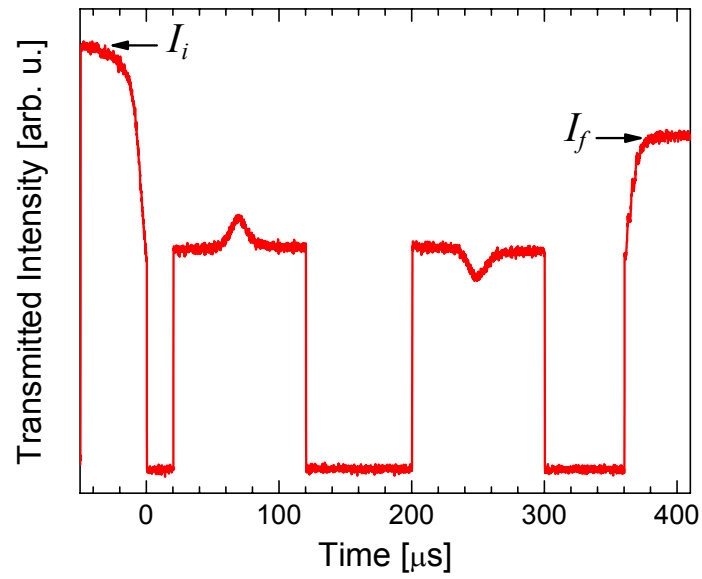
Just one RAP



$$T_{\text{eff}} = \pi \Omega / \Delta_0 T_{\text{RAP}} = 0.2 T_{\text{RAP}}$$



The puzzle...



VS.

