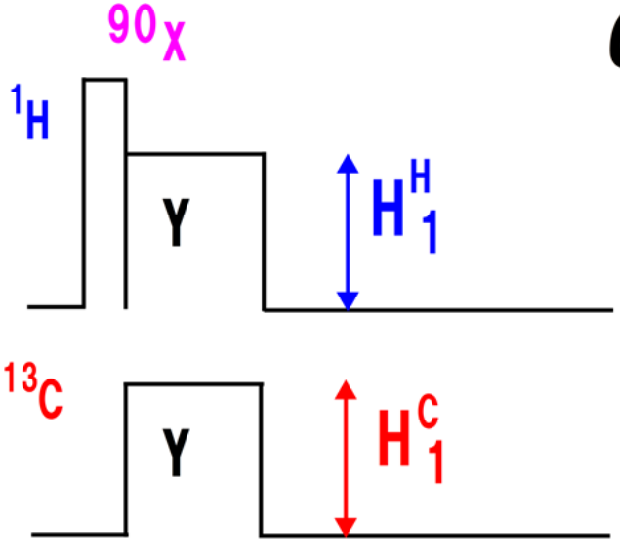
Cross polarization (CP)

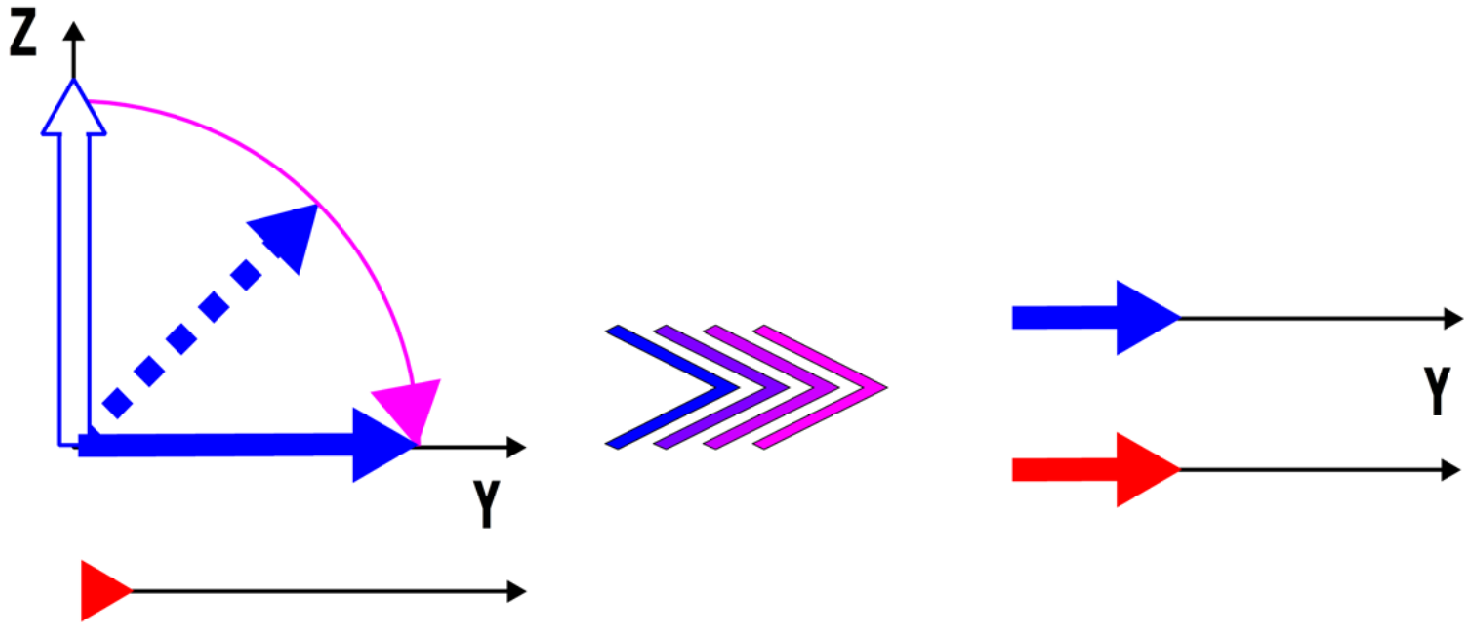


$$\gamma_H H_1^H = \gamma_C H_1^C$$

Hartman-Hahn condition
(H_1:Tesla)

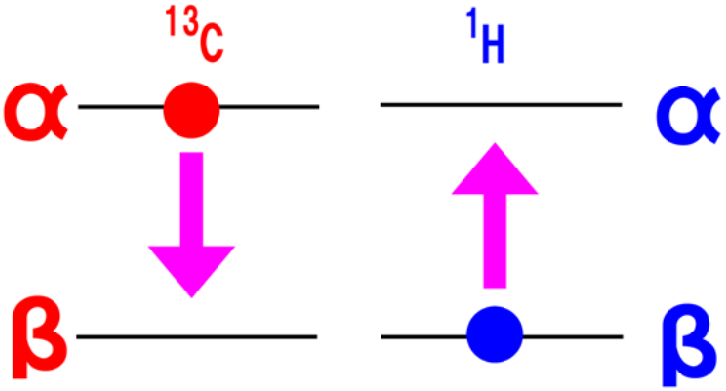
$$\nu_{1H} = \nu_{1C}$$

H-H in Frequency unit



CP-1

CP theory



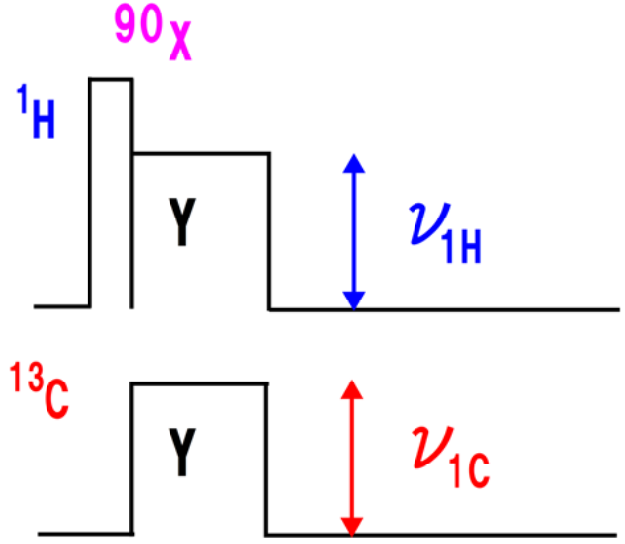
Spin exchange
(Polarization transfer)

$$H_d = d I_Z S_Z$$

$$\langle \alpha, \beta | H_d | \beta, \alpha \rangle = 0$$

Under rf irradiation

$$H_d = d(I_Z \cos\nu_{1H}t + I_X \sin\nu_{1H}t) \times (S_Z \cos\nu_{1C}t + S_X \sin\nu_{1C}t)$$

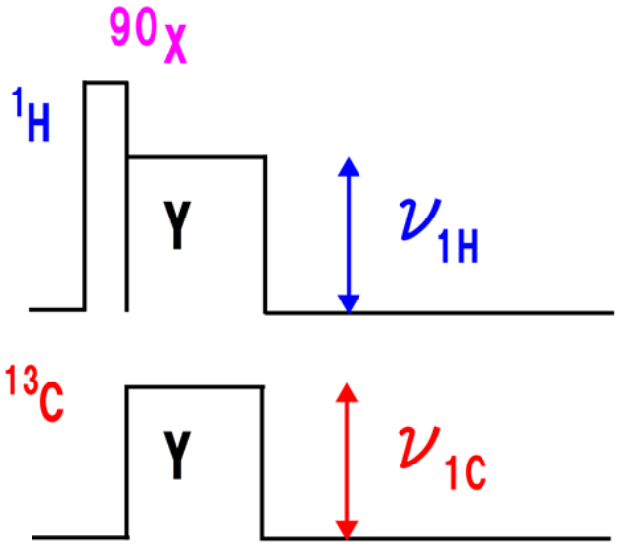


At $\nu_{1H} = \nu_{1C}$

$$\overline{H_d} = d/2 (I_Z S_Z + I_X S_X)$$

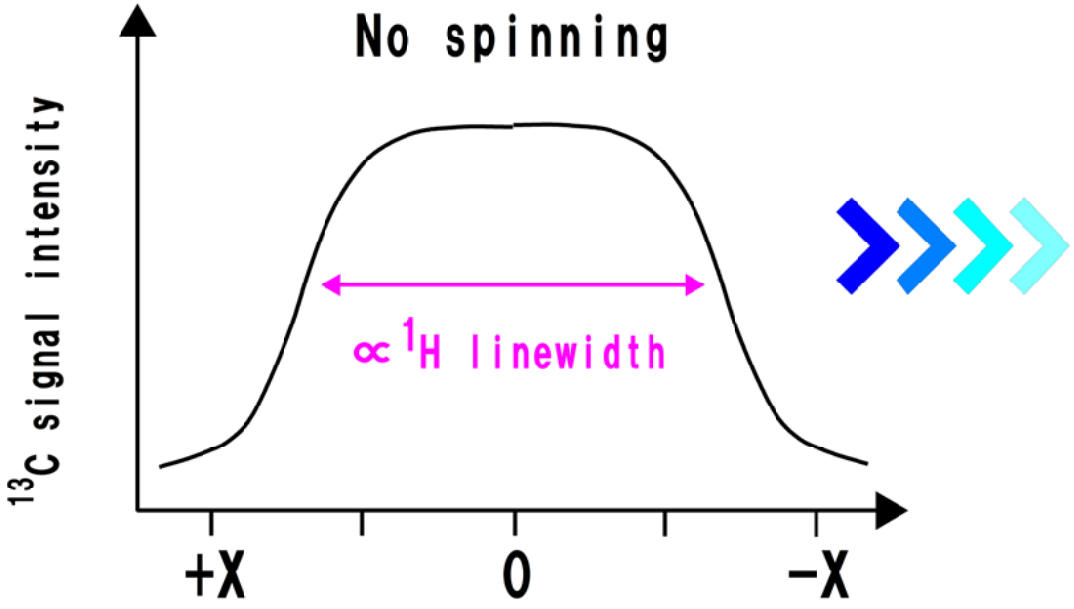
$$\langle \alpha, \beta | \overline{H_d} | \beta, \alpha \rangle \neq 0$$

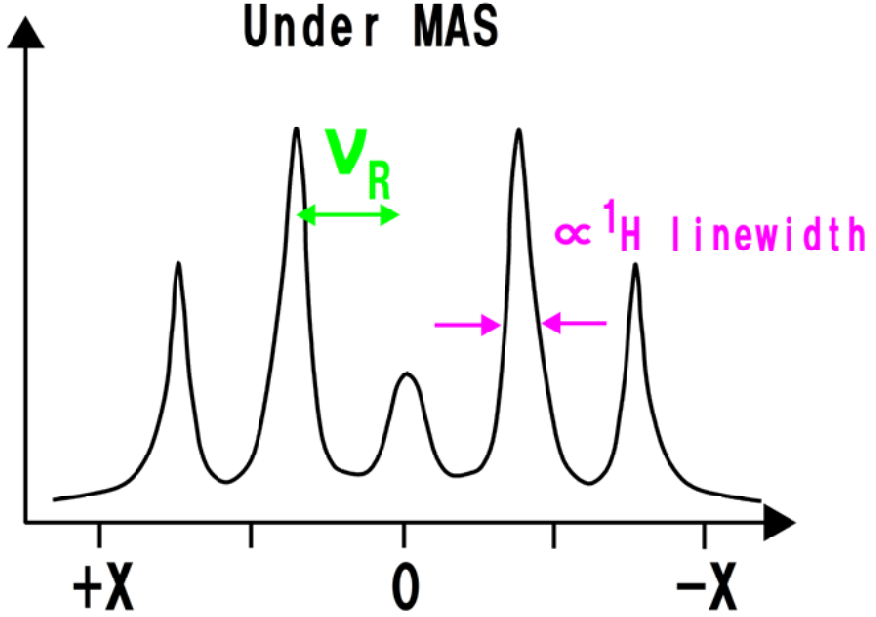
Effect of MAS on CP



H-H condition under MAS

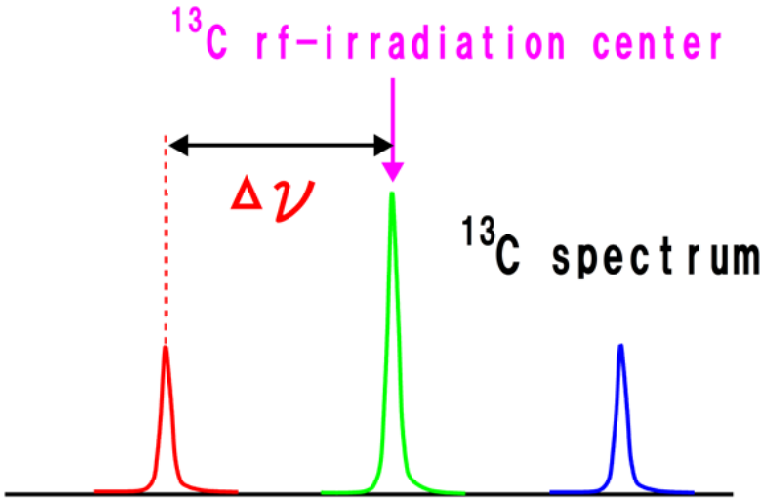
$$\nu_{1H} = \nu_{1C} + n\,\nu_R$$

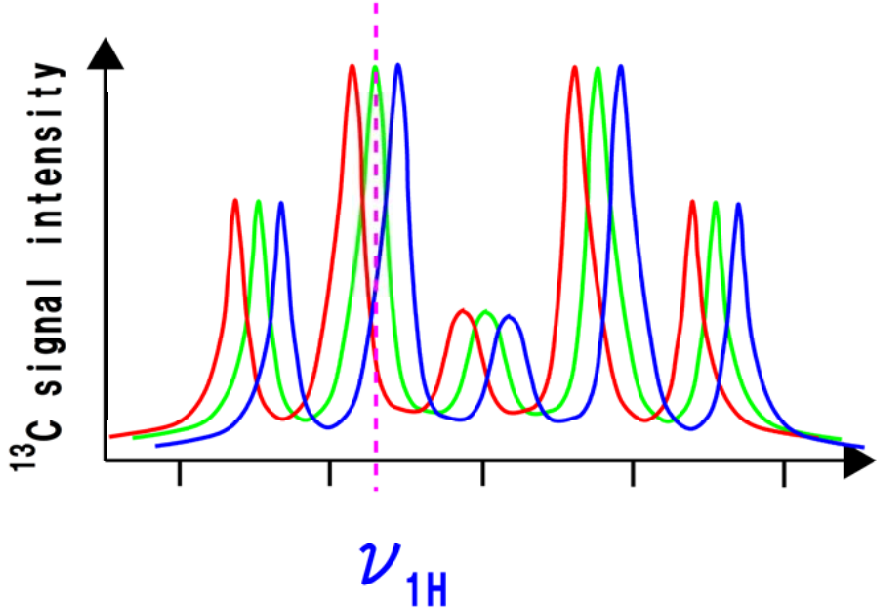




$$\Delta\nu = \nu_{1H} - \nu_{1C}$$

CP-3





CP under MAS

For the on-resonance spin

$$\nu_{1H} = \nu_{1C} + n\nu_R$$

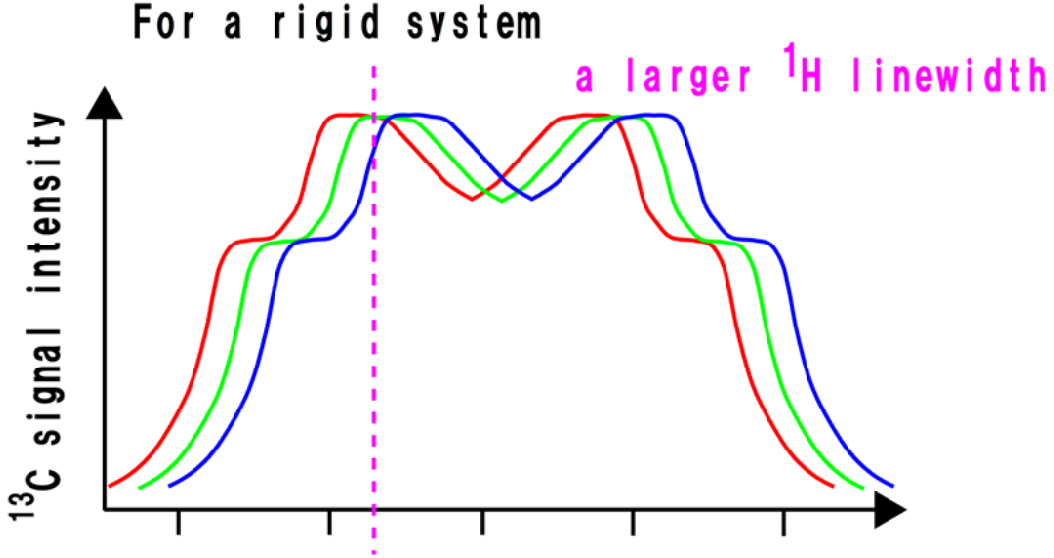
For the off-resonance spins

$$\nu_{1H} \neq \nu_{1C}^{eff} + n\nu_R$$

Effective field

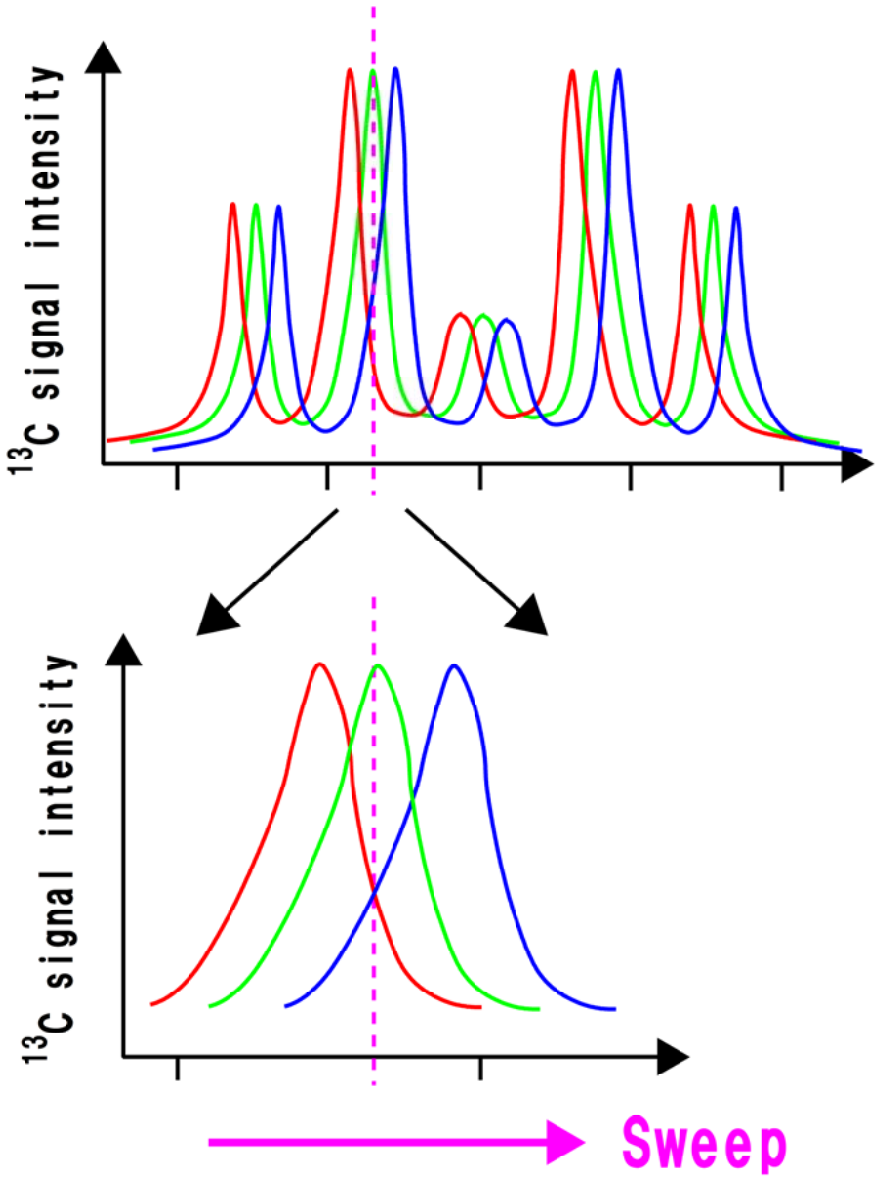
$$\left|\nu_X^{eff}\right| = \sqrt{\nu_{1X}^2 + \Delta\nu_X^2}$$

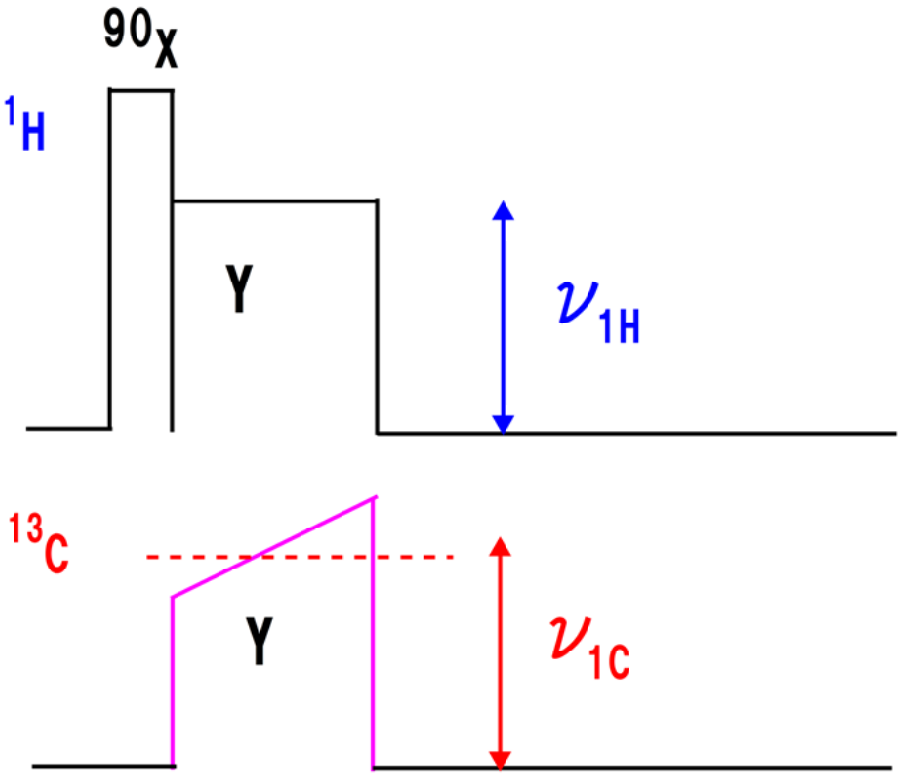
For a rigid system



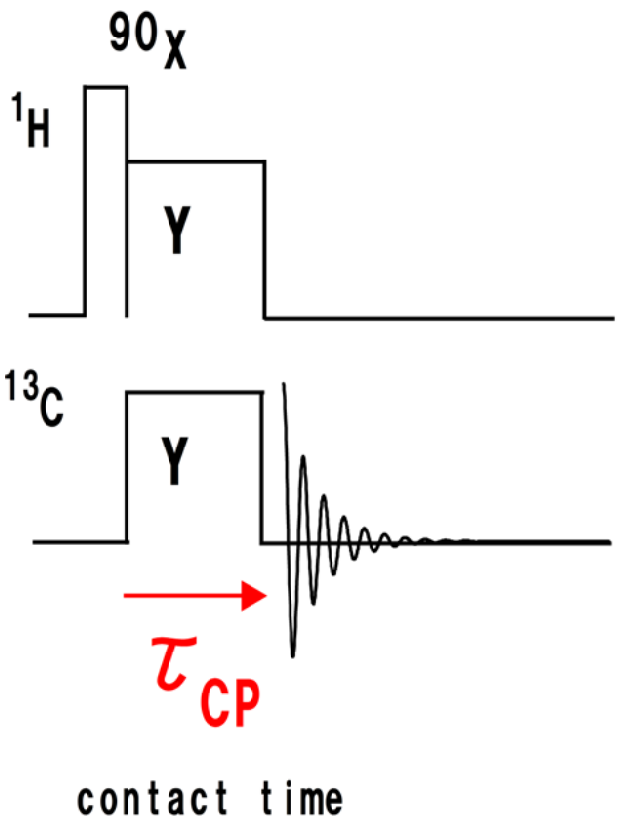
CP-4

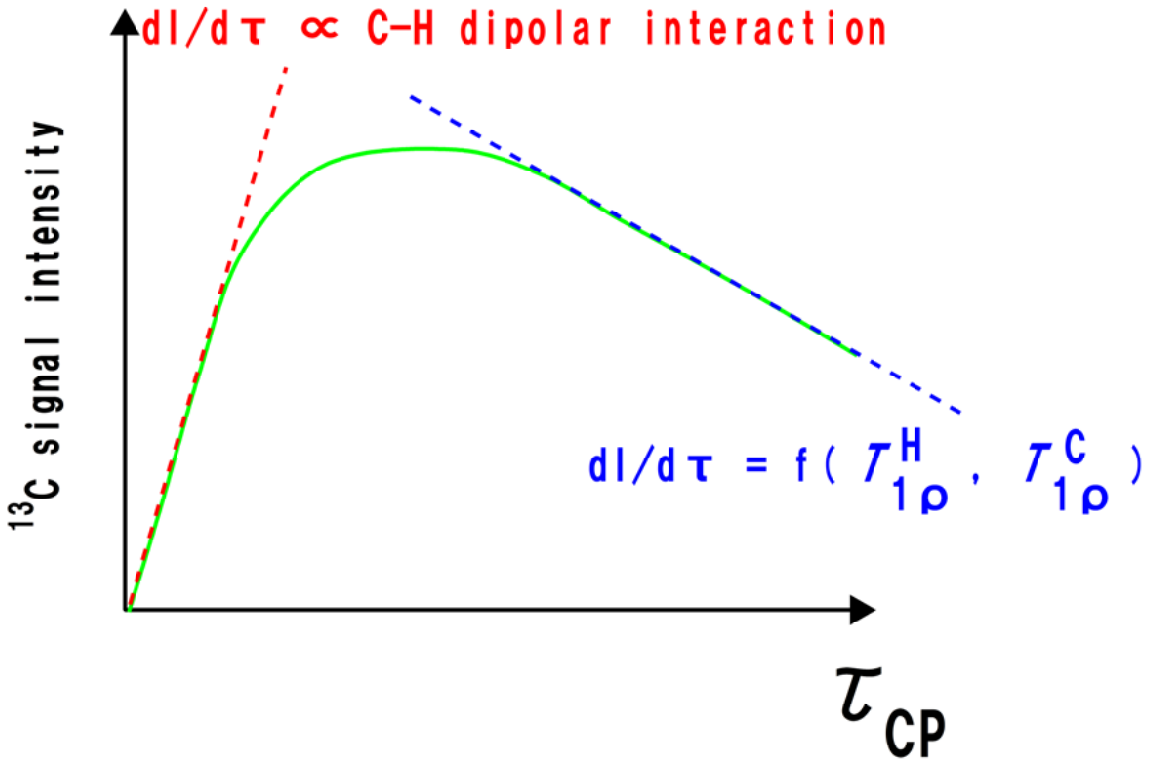
Ramped CP under MAS





CP dynamics



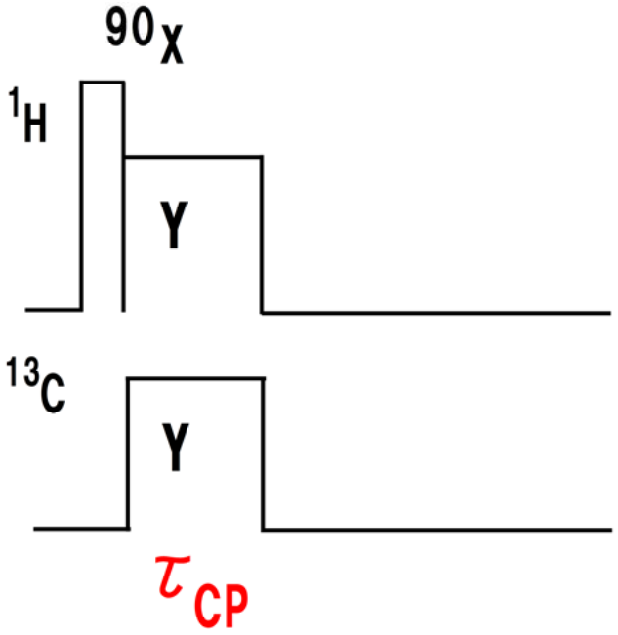


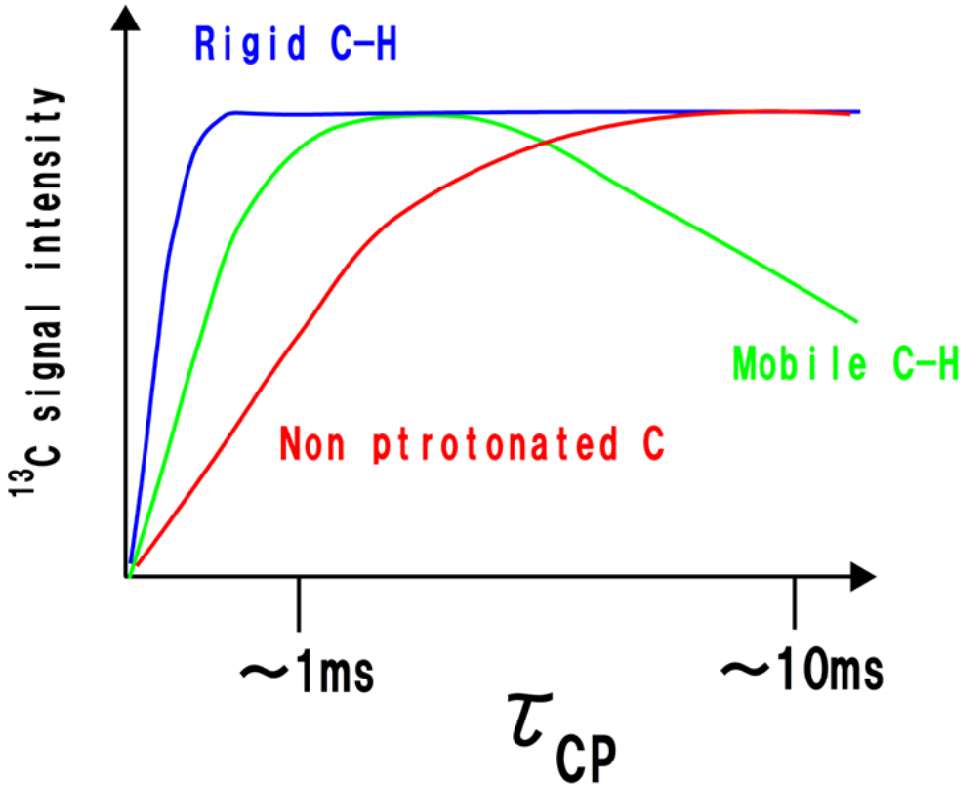
For a rigid C-H : quick buildup

Motional frequency ~ ν_1 : Short $T_{1\rho}$

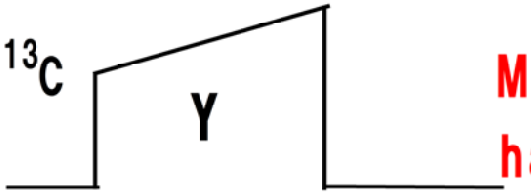
→ quick decay

Optimal contact time





Note! Ramp CP requires
a longer contact time!



Mind if your C-H system
has short $T_{1\rho}$