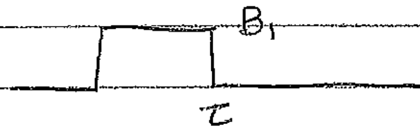
Ex 1 >



$B_1(t) = B_1 \quad , \quad 0 \le t \le \tau$

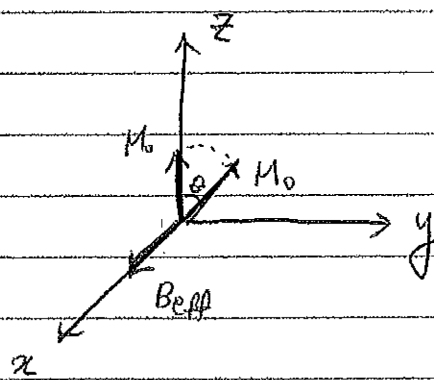
$$\vec{B}_{eff} = \begin{pmatrix} B_1 \\ 0 \\ 0 \end{pmatrix} \quad \text{at on-resonance}$$

$$\frac{d\vec{M}_{ROT}}{dt} = \vec{M}_{ROT} \times \gamma \vec{B}_{eff}$$

$$\Longrightarrow \quad \vec{M}_{ROT}(t) = R_x(\gamma B_1 t) \begin{bmatrix} 0 \\ 0 \\ M_0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ M_0 \sin(\gamma B_1 \cdot t) \\ M_0 \cos(\gamma B_1 \cdot t) \end{bmatrix}$$

Graphically,



tip angle $\theta = \gamma \cdot B_1 \tau$

"tip angle" or "flip angle"

$$\theta = \int_0^{\tau} \gamma \cdot B(t')\,dt' = \gamma \cdot B_1 \tau$$

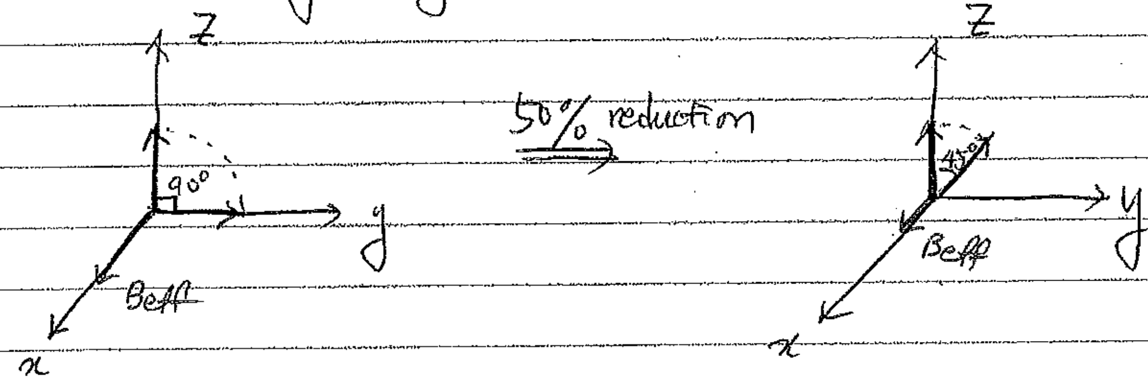
* Numbers

$$\theta = 90^\circ = \frac{\pi}{2}, \quad \tau = 1\,\text{ms}$$

$$\frac{\pi}{2} = \gamma \cdot 1 \cdot B_1 \Rightarrow B_1 \approx 0.06\,G = 6\,\mu T$$

Q : What if $B_1 = 12\,\mu T$

* B_1 inhomogeneity



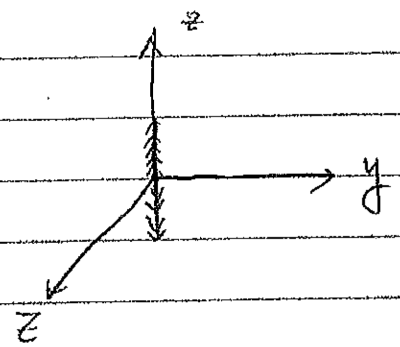
Ex2) No RF pulse, only gradient along z

$$\vec{B} = (B_0 + G_z \cdot z)\,\hat{k}$$

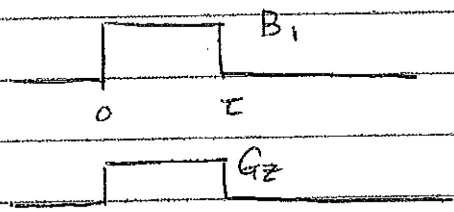
At on-resonance,

$$\vec{B}_{eff} = \left(B_0 + G_z \cdot z - \frac{\omega_{RF}}{\gamma}\right)\hat{k}$$

$$= G_z \cdot z\,\hat{k}$$



Ex3)



RF pulse

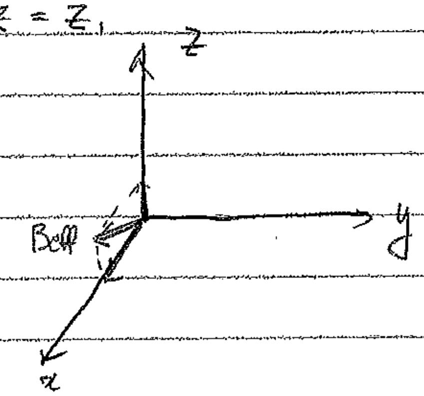
gradient along z

$$\vec{B}_{eff} = \left(B_0 + G_z \cdot z - \frac{\omega_{RF}}{\gamma}\right)\hat{k} + B_1\,\hat{i}$$

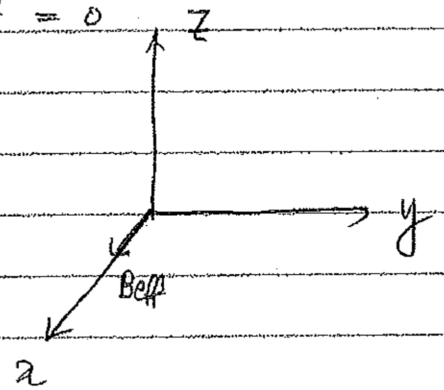
At on-resonance,

$$\vec{B}_{eff} = G_z \cdot z\,\hat{k} + B_1\,\hat{i}$$

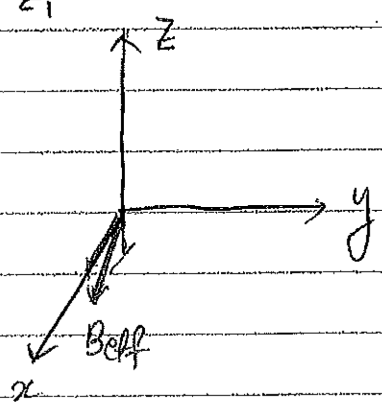
at $z = z_1$



at $z = 0$



at $z = -z_1$

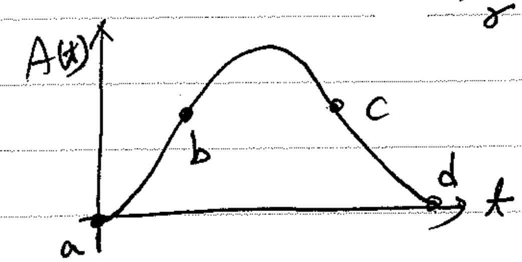


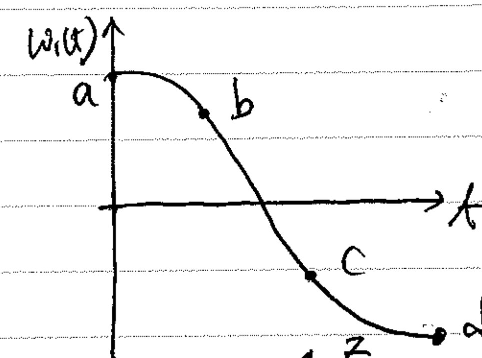
$\Rightarrow$ if $z=0$ (or if $G_z = 0$), similar to non-selective case

$\Rightarrow$ other positions in z, different $B_{eff}(z)$!

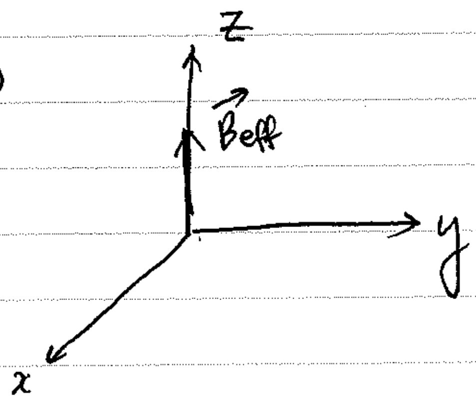
* Adiabatic RF pulse $\qquad B_1(t) = A(t)\, e^{-i\omega_1(t)\cdot t}$

$$\vec{B}_{eff} = \begin{pmatrix} A(t) \\ 0 \\ \frac{\omega_1(t)}{\gamma} \end{pmatrix}$$

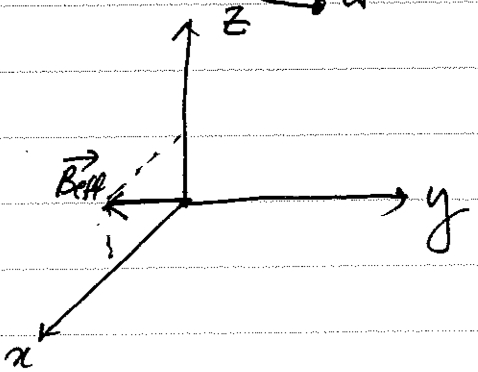




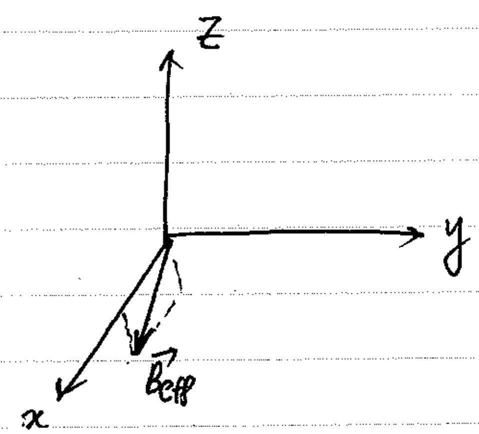
a)



b)



c)



d)