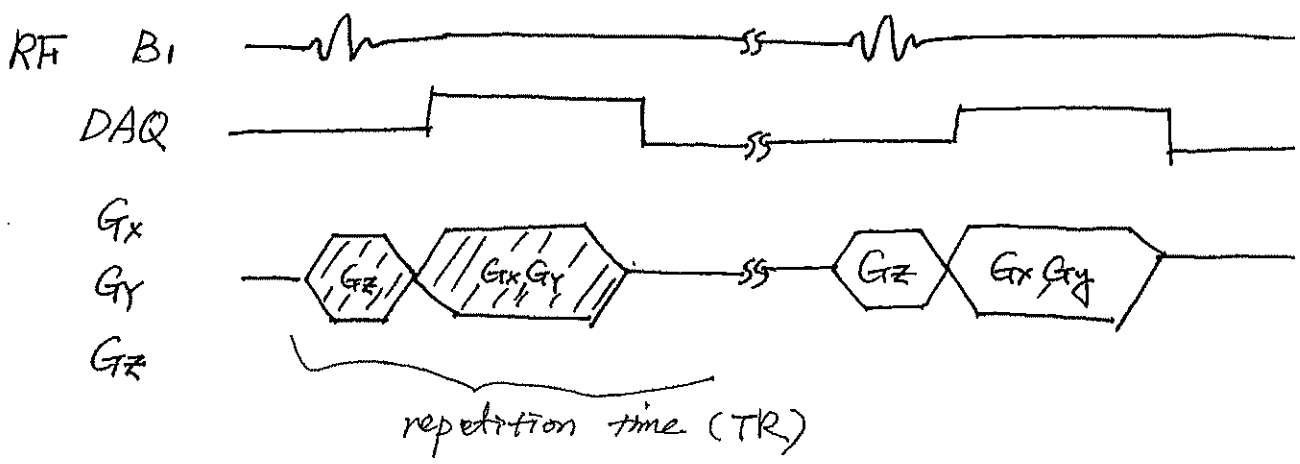
2D imaging (chap5)

Basic process:

- $B_1^+ \cdot G_z$ 1) selectively excite slice Δz 3-5 ms
- DAQ, $G_x G_y$ 2) record FID, vary G_x G_y during signal read out 5-30 ms
- 3) wait for relaxation 5 ms - 5 sec (can change image contras
- 4) Repeat measurement



2 portions to understand

1) selective excitation

2) signal read out ← will cover this first chap5

$\boxed{p. 71}$

$$S_r(t) = i\omega_0 K \int_V M(\vec{r},0)\, e^{-i\omega_0 t}\, e^{-i\gamma\int_0^t \vec{G}(\vec{r})\vec{r}\, d\tau}\, dV$$

$$\overset{n}{\equiv} i\omega_0 K \iint_{xy} M_{xy}(\vec{r})\, e^{-i\omega_0 t}\, e^{-i\gamma\int_0^t \vec{G}(\vec{r})\vec{r}\, d\tau}\, dxdy$$

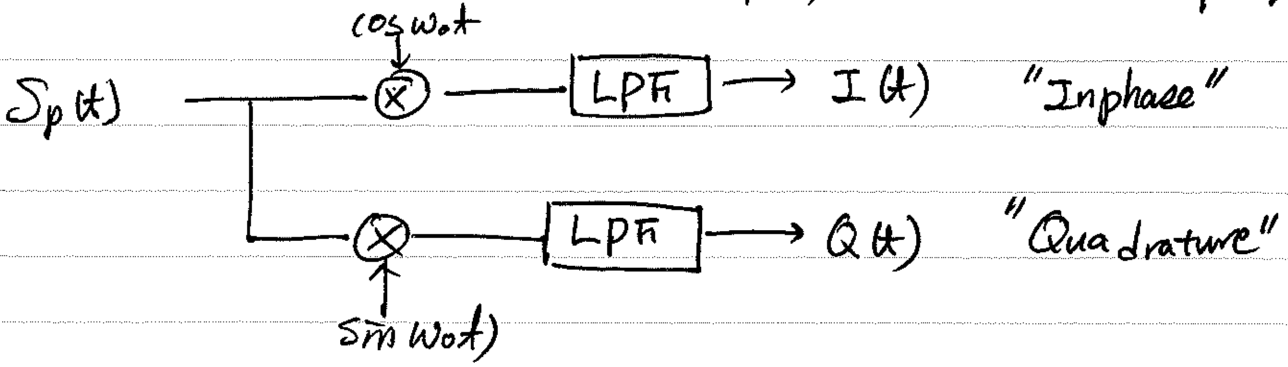
$$S_r(t) = S(t)\, e^{-i\omega_0 t} = \partial(t)\, e^{-i[\omega_0 t + \phi(t)]}$$

$$S(t) = S_r(t)\, e^{i\omega_0 t} = \partial(t)\, e^{-i\phi(t)}$$

*single receive coil ; sensitive to the rate of change of M only along one axis

$$S_p(t) = \mathrm{Re}\{S_r(t)\} = \partial(t)\cos(\omega_0 t + \phi(t))$$

$$= \partial(t)\cos(\omega_0 t)\cos t(\phi(t)) - \partial(t)\sin(\omega_0 t)\sin(\phi(t))$$



$$I(t) = \left(\partial(t)\cos(\omega_0 t + \phi(t)) \cdot \cos\omega_0 t\right) * \boxed{LPF}$$

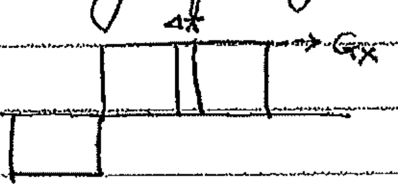
$$\Longrightarrow \partial(t)\cos\phi(t)$$

$$Q(t) = -\partial(t)\sin\phi(t)$$

$$S(t) = I(t) + iQ(t) = \partial(t)e^{-i\phi(t)}$$

* FOV in "frequency encoding" & "phase encoding" direction

- Frequency encoding

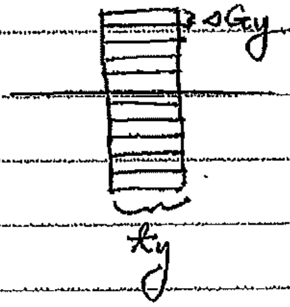


$$\Delta k_x = \frac{\gamma}{2\pi}\int_0^{\Delta t} G_x \, dt$$

$$= \frac{\gamma}{2\pi} G_x \Delta t$$

$$FOV_x = \frac{1}{\Delta k_x} = \frac{2\pi}{\gamma G_x \Delta t}$$

- Phase Encoding



$$\Delta k_y = \frac{\gamma}{2\pi}\int_0^{t_y} \Delta G_y \, dt$$

$$= \frac{\gamma}{2\pi} \Delta G_y \, t_y$$

$$FOV_y = \frac{1}{\Delta k_x} = \frac{2\pi}{\gamma \Delta G_y \cdot t_y}$$

- $$2\pi = \underbrace{\underbrace{FOV_y}_{cm} \cdot \underbrace{\gamma \Delta G_y \cdot t_y}_{rad\ cycles/cm}}_{\text{amount of phase over FOV}} = FOV_x \cdot \gamma G_x \cdot \Delta t$$