42.58 MHz/T

2 (↓) 1ms (↓)

① . a) $TBW = \tau_{ss} \times BW$ (↓ 2kHz) $\quad 2kHz = BW = \gamma \cdot G_{ss} \cdot \Delta z$ (↑ 0.003 m)

$$G_{ss} = \frac{BW}{\gamma \Delta z} = \frac{0.002\ MHz}{42.58\ \frac{MHz}{T} \cdot 0.003\ m}$$

$$\boxed{G_{ss} = 0.0157\ \frac{T}{m} = 15.7\ \frac{mT}{m}}$$

$$\tau_{ss}^{rise} = \frac{0.0157\ T/m}{180\ T/m \cdot s} = 0.0872\ ms.$$

$$\text{Total } \tau_{ss} = T_{ss} + 2 \cdot \tau_{ss}^{rise} = 1ms + 2 \cdot 0.0872\ ms$$

$$\boxed{\text{Total } T_{s1} = 1.1744\ ms}$$

42.58 mHz/T (↓)

b). $k_{y_{max}} = \gamma \cdot G \cdot \tau_{PE}$ (↑ 25 mT/m) $\quad k_{y_{max}} = \frac{1}{2\Delta y} \approx 416.67\ 1/m$ (↑ 1.2 mm)

$$\tau_{PE} = \frac{k_{y_{max}}}{\gamma \cdot G} = \frac{416.67\ \frac{1}{m}}{42.58\ \frac{mHz}{T} \cdot 0.025\ \frac{T}{m}} = 0.3914\ ms$$

$$\tau_{ss}^{rise} = \frac{\left(25\ mT/m \cdot \frac{1}{1000}\ mT\right)}{180\ T/m\,s} = 0.1389\ ms$$

$$\boxed{\text{Total } \tau = 0.3914 + 2 \cdot 0.1389 = 0.6692\ ms.}$$

c) $rBW_{px} \cdot N = \gamma \cdot G \cdot FOV$

$$G = \frac{rBW_{px} \cdot N}{\gamma \cdot FOV} = \frac{750\ Hz/px \cdot 256}{42.58\ \frac{mHz}{T} \cdot (1.2 \times 256)\ mm} = \boxed{14.7\ \frac{mT}{m}}$$

$$k_{max} = \gamma \cdot G \cdot \tau_{PE}$$

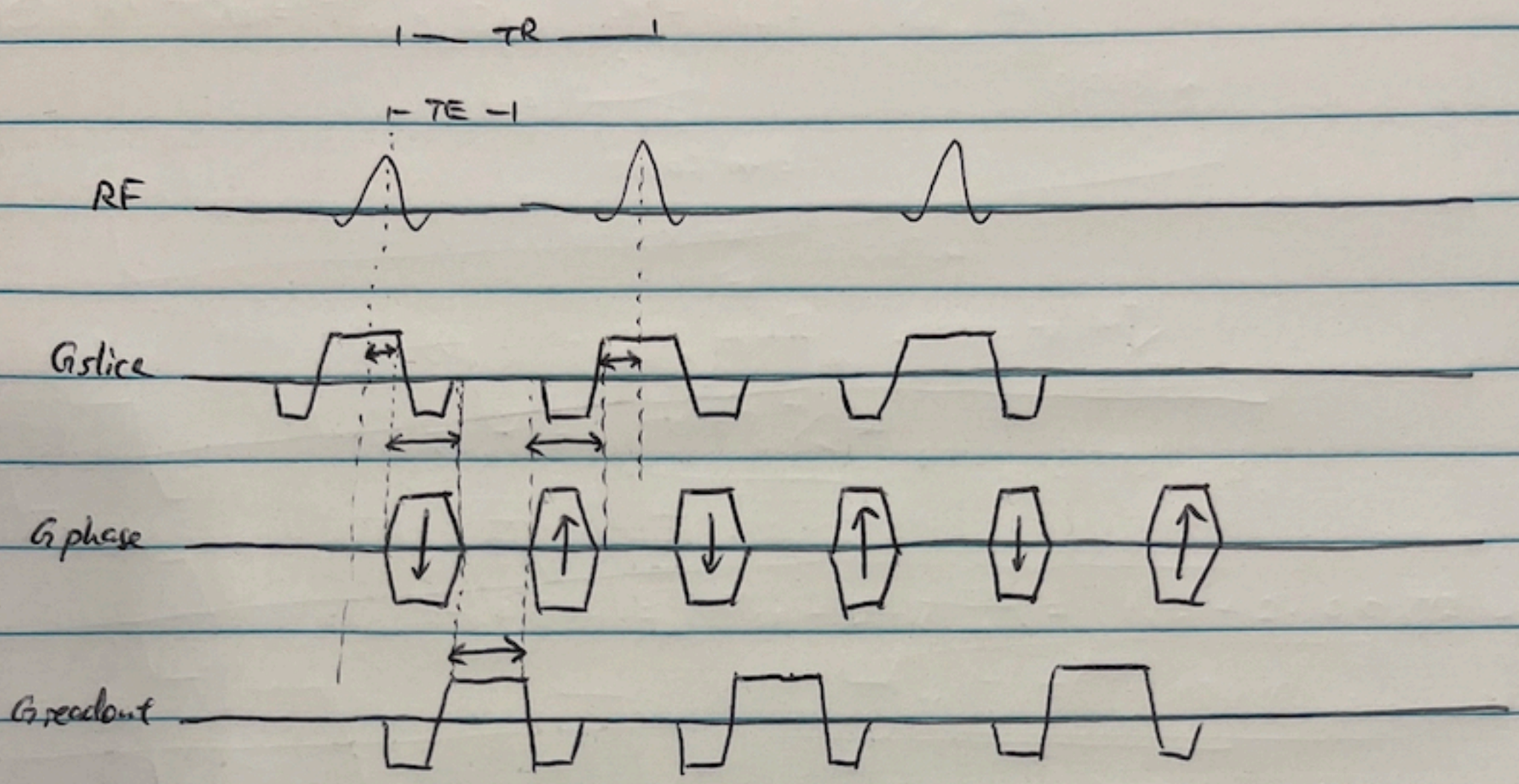
$$\frac{1}{2\Delta x} = \left(42.58\ \tfrac{MHz}{T}\right)\left(14.7\ \tfrac{mT}{m}\right)\tau_{PE}$$

$$\tau_{PE} = \frac{\left(42.58\ \frac{MHz}{T}\right)\left(14.7\ \frac{mT}{m}\right)}{2\Delta x} = \frac{416.67\ \frac{1}{m}}{\left(42.58\ \frac{MHz}{T}\right)\left(14.7\ \frac{mT}{m}\right)} = 0.666\ ms$$

$$\tau_{ss}^{rise} = \frac{14.7\ \frac{mT}{m}}{180\ \frac{T}{ms}} = 0.0817\ ms$$

$$\text{Total } \tau_{ss} = 0.666 + 2 \cdot 0.0817 = \boxed{0.829\ ms}$$

d) 2D bSSFP sequence diagram.



phase encoding freq. encoding.

$$TR = 2 \times (\tau_{ss\ slice\ select}/2) + 2 \times (\tau_{ss} + 2 \times \tau_{ss}^{rise}) + \tau_{ss}$$

$$= 2 \times (1\,ms/2) + 2 \times (0.6692\,ms) + 0.666\,ms$$

$$= \boxed{4\,ms}$$

$$TE = TR/2 = \boxed{2\,ms}$$

e) 1. Increase gradient amplitude.

2. Increase gradient slew rate.

3. Decrease RF bandwidth.