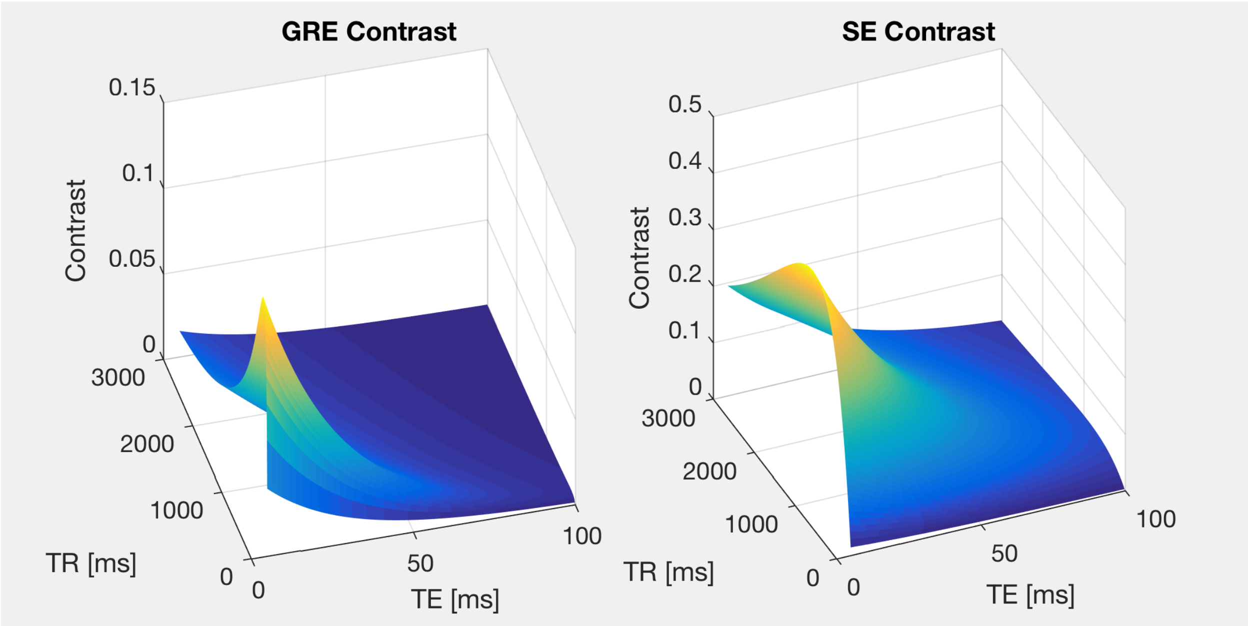
# HW3 Solutions

Problem 1.

```
Gradient Echo : Optimal TE = 5.0ms
                Optimal TR = 140.0ms

Spin Echo     : Optimal TE = 5.0ms
                Optimal TR = 920.0ms

For optimal T1 contrast, the spin echo sequence is 6.57x longer!
```

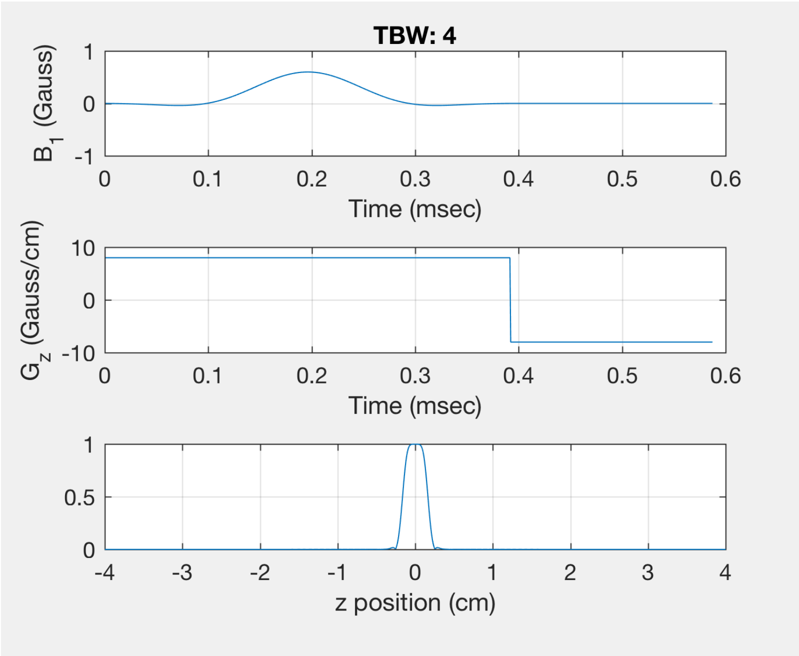


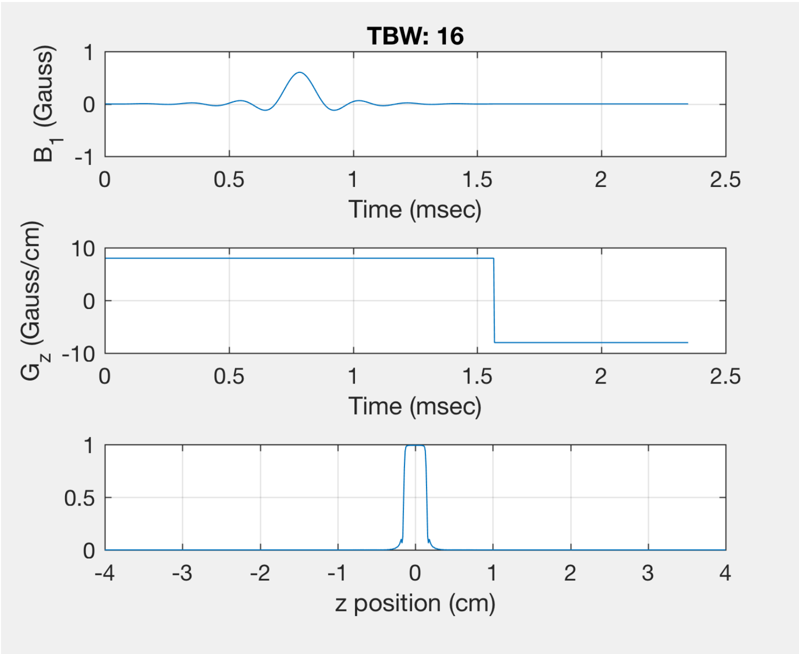
# HW3 Solutions

Problem 2.

A.

$f_0 = \gamma B_0$ = (42.576 MHz/T)*(3.0T) = **127.728 MHz**
BW = $\Delta f_0 = \gamma G_z \Delta z$ = (42.576 MHz/T)*(8 G/cm * 1T/10,000G)*(0.3cm) = **10.2 kHz**

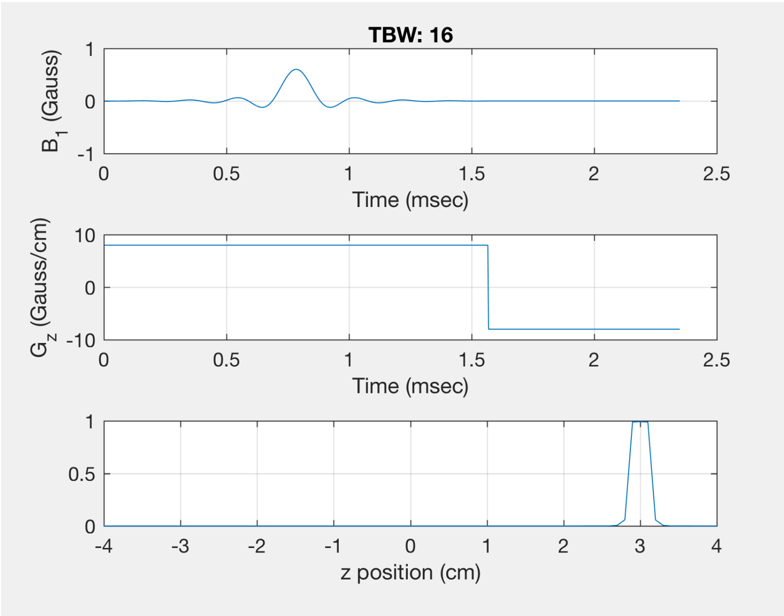



B.

# HW3 Solutions

$f_0 = \gamma(B_0 + G_Z{*}z)$ = (42.576 MHz/T)*(3.0T + (8G/cm)*(1T/10,000G)*(1cm)) = **127.762 MHz**
BW = $\Delta f_0 = \gamma G_z \Delta z$ = (42.576 MHz/T)*(8 G/cm * 1T/10,000G)*(3mm) = **10.2 kHz**




C.

$\gamma_{31P}$ = 17.235 MHz/T

$f_0 = \gamma B_0$ = (17.235 MHz/T)*(3.0T) = **51.705 MHz**

BW = $\Delta f_0 = \gamma G_z \Delta z$ =  (17.235 MHz/T)*(8 G/cm*1T/10,000G)*$\Delta z$ = 10.2 kHz

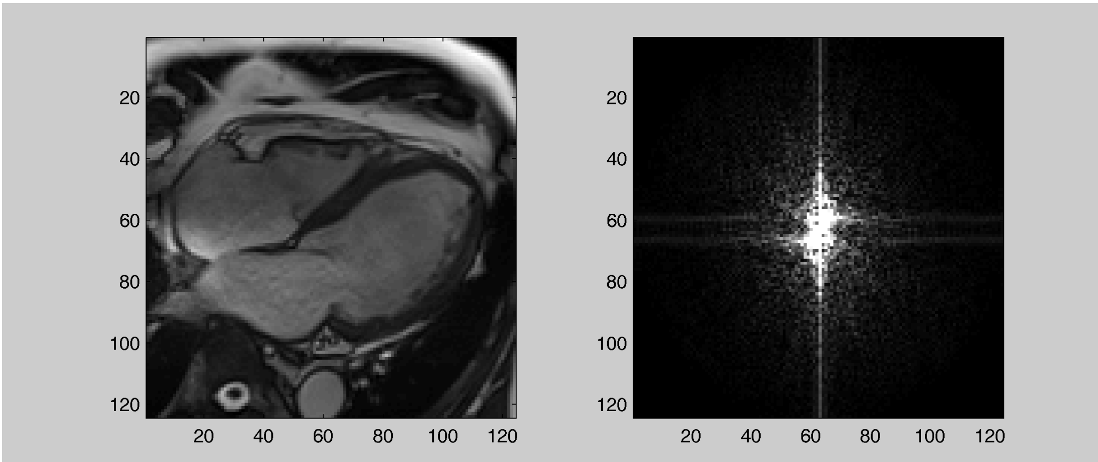
$\Delta z$ = (0.0102 MHz) / (17.235 MHz/T)*(8 G/cm*1T/10,000G) = **0.74 cm**

**The slice gets *thicker***

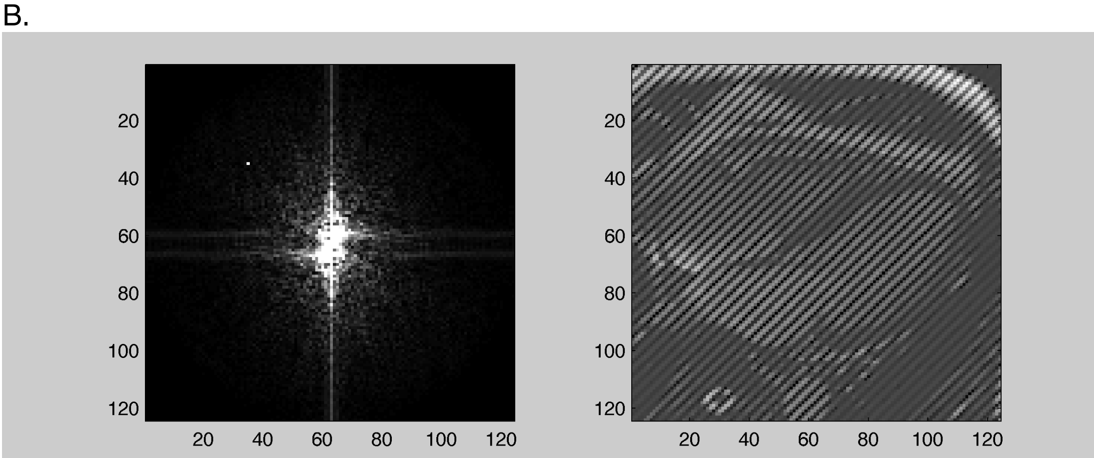
# HW3 Solutions

Problem 3.

A.



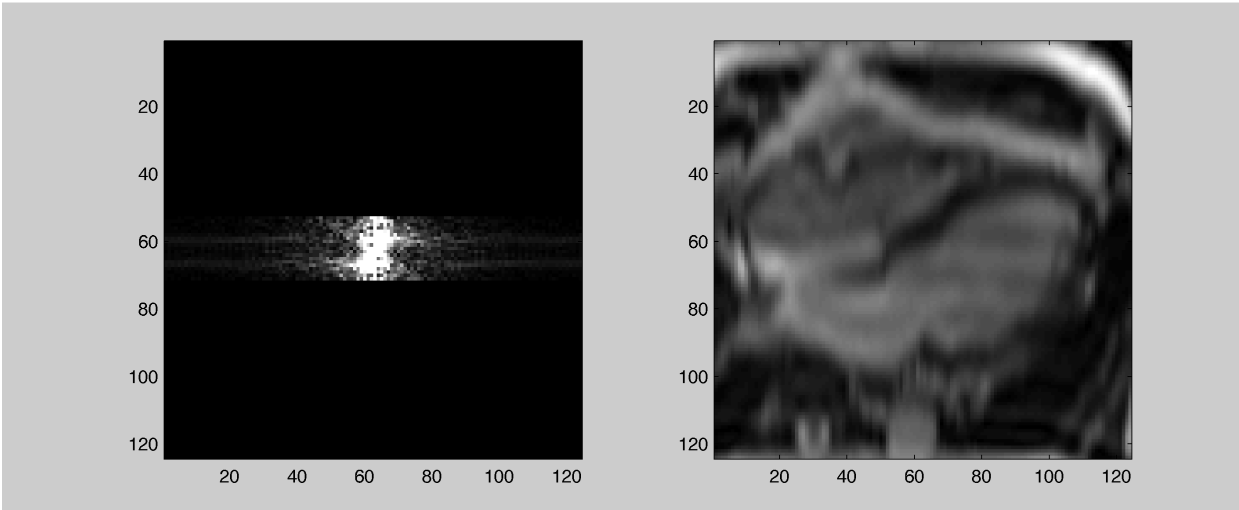

B.




The noisy spike leads to an over exaggerated spatial frequency depending on its position.

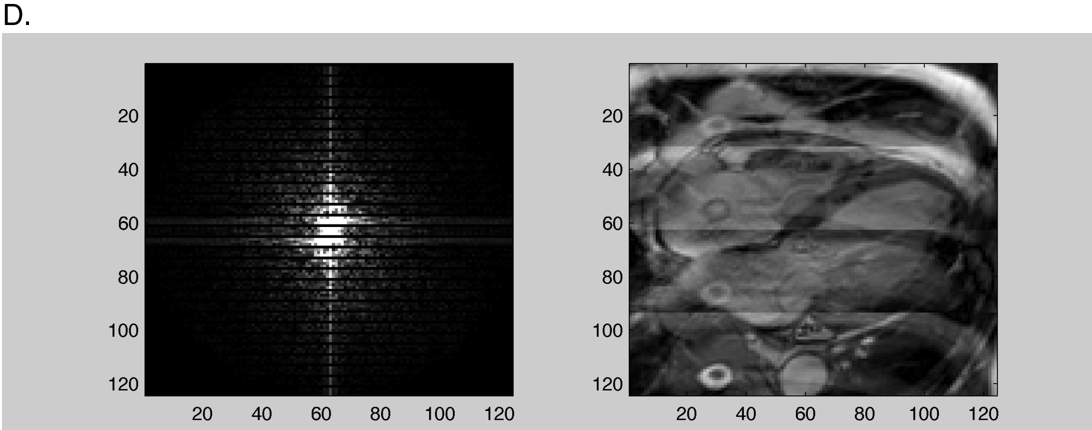
# HW3 Solutions

C.




The spatial resolution is reduced by removing the high frequency information.

D.




Removing every other line leads to aliasing in the y-dimension because the effective FOV was reduced.

HW3 Solutions

Problem 4.

A. Given $\Delta x \Delta k = 1/N$:

$\Delta x = 1/(N*\Delta k)$

since $\Delta k = \gamma*G*\Delta t$ …

**$\Delta x = 1/(N*\gamma*G*\Delta t)$**

B. Since $FOV = N*\Delta x = N/(N*\gamma*G*\Delta t)$

and $\Delta f = G*FOV*\gamma$ …
$\Delta f = \gamma*G*( N/(N*\gamma*G*\Delta t) )$

**$\Delta f = 1/\Delta t$**

C. $\gamma$ = 42.576 MHz/T, N=128, $\Delta x$=2mm

G = 20mT/m:
$\Delta f = G*N*\Delta x*\gamma$ = (20 mT/m * 1T/1000mT * 1m/100cm)*(128)*(0.2 cm)*(42.576 MHz/T)
= 217.99 kHz
**$\Delta t = 1/\Delta f$ = 4.59 μs**

G = 40mT/m:
$\Delta f = G*N*\Delta x*\gamma$ = (40 mT/m * 1T/1000mT * 1m/100cm)*(128)*(0.2 cm)*(42.576 MHz/T)
= 435.98 kHz
**$\Delta t = 1/\Delta f$ = 2.29 μs**

D. At 3.0T, $f_0 = \gamma*B_0$ = (42.576 MHz/T)(3.0T) = 127.728 MHz

So, 127.728 $\times 10^6$ cycles of precession are completed per second.

In dwell time, $\Delta t$, the number of rotations, $N_{rot}$ is given by:

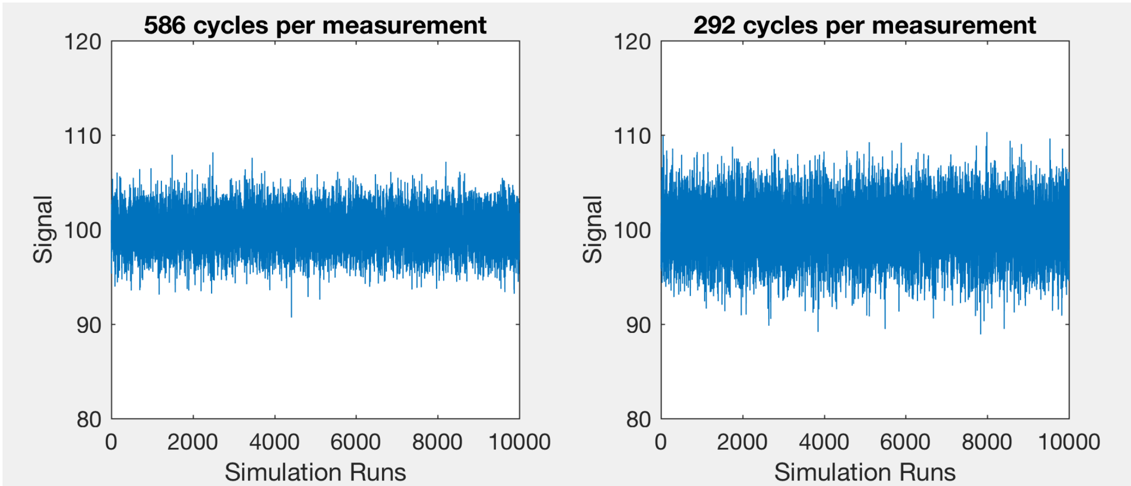
$N_{rot}$ = ( 127.728 $\times 10^6$ cycles/s )*($\Delta t$)

for $\Delta t$ = 4.59 μs:
= ( 127.728 cycles/μs ) * (4.59 μs)
**$N_{rot}$ = 586 cycles**

for $\Delta t$ = 2.29 μs:
= ( 127.728 cycles/μs ) * (2.29 μs)
**$N_{rot}$ = 292 cycles**

E.

HW3 Solutions




```
586 Cycles
Measured signal: 99.94+/-2.07
SNR            : 48.32

292 Cycles
Measured signal: 100.04+/-2.94
SNR            : 34.08
```