# MRI Simulator Notes

Liam

Wednesday 11$^{th}$ December, 2019

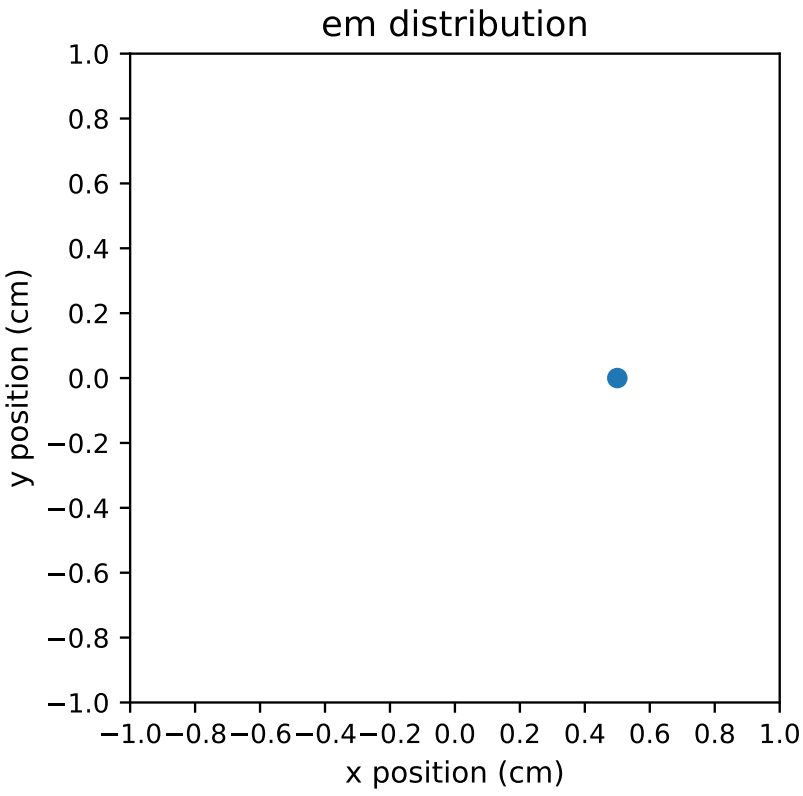
# Tasks

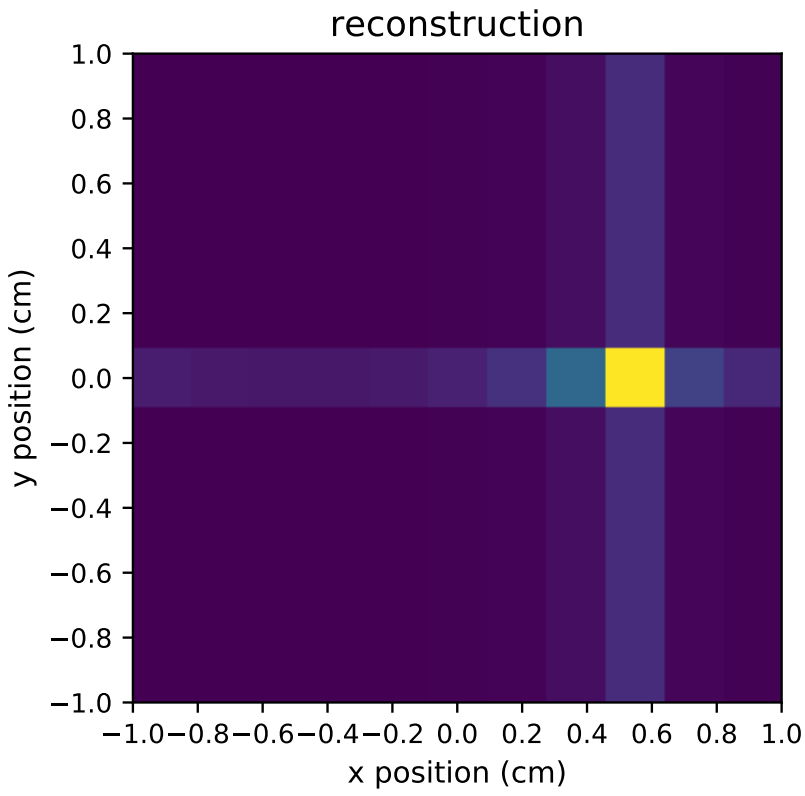
- I ran the 2DFT simulation + reconstruction using single ems placed at different locations to look at the point-spread function.
- I rewrote some pulse sequence functions to incorporate a user-specified TR and TE and ran the 2DFT simulation + reconstruction using the parameters Chuck suggested.
- I looked at the effect on the total memory usage of increasing the number of ems and the pulse sequence length.

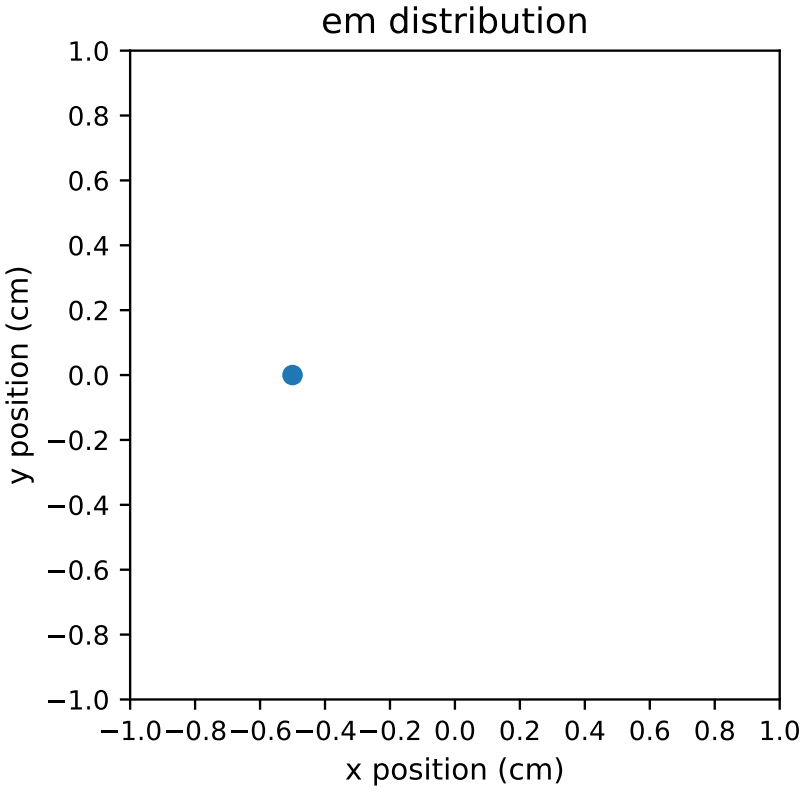
# 2DFT point-spread function

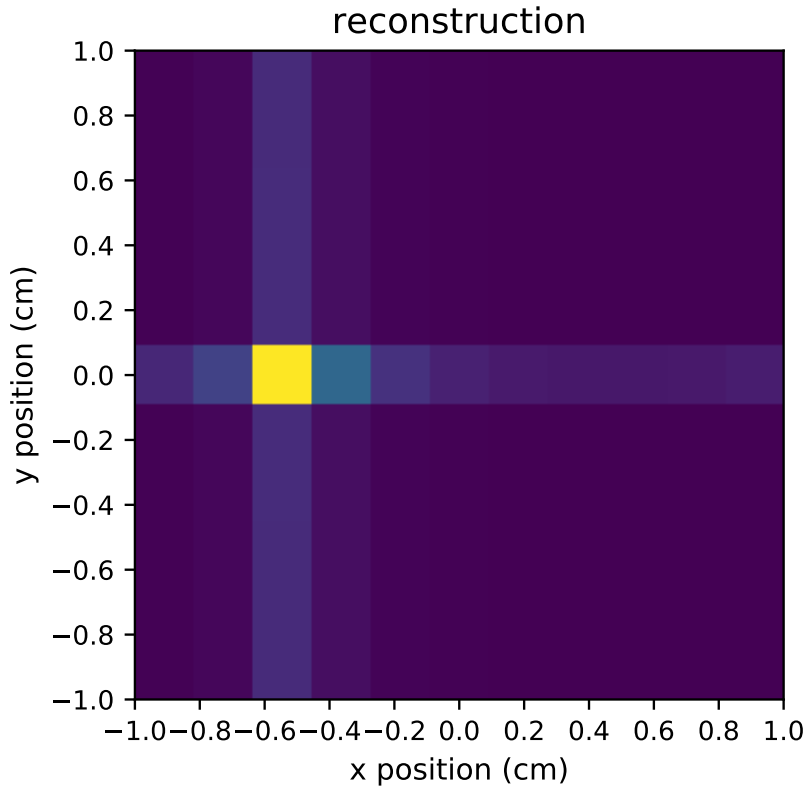
# Summary

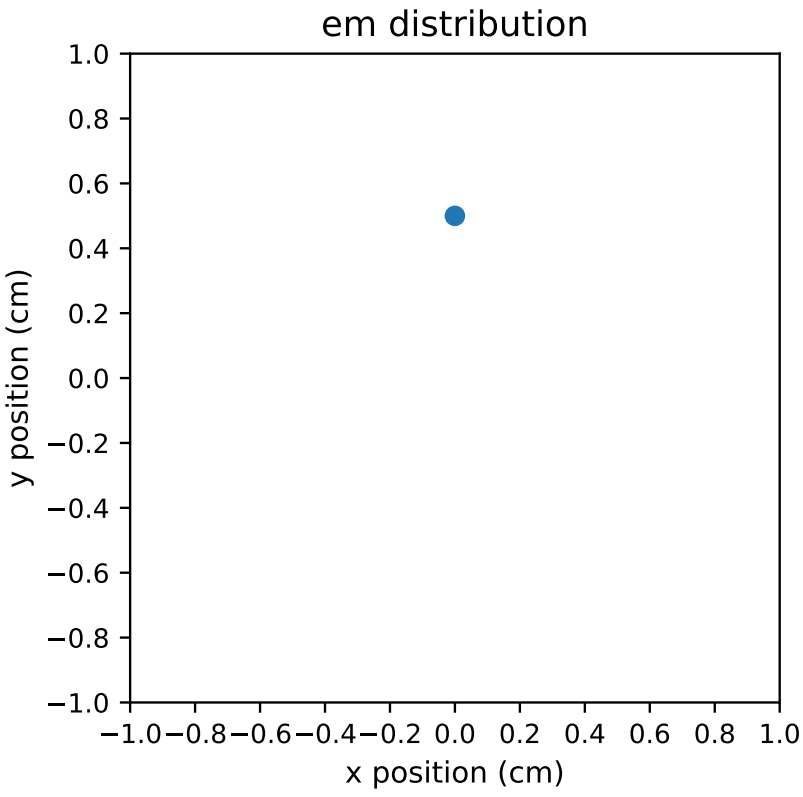
- All the same simulation parameters as in 2019-12-10, which I found to be T1 = 10 ms, T2 = 10 ms, TE = 1 ms, TR = 53 ms.
- I wanted to look at the "asymmetric blurring" I noted in 2019-12-10. Chuck hypothesized it was due to the sum of multiple point-spread functions.
- I placed an em with an offset in $x$, then the negative of the offset, and the same for $y$, to see if the point-spread function is simply reflected about the origin for these reflected offsets.

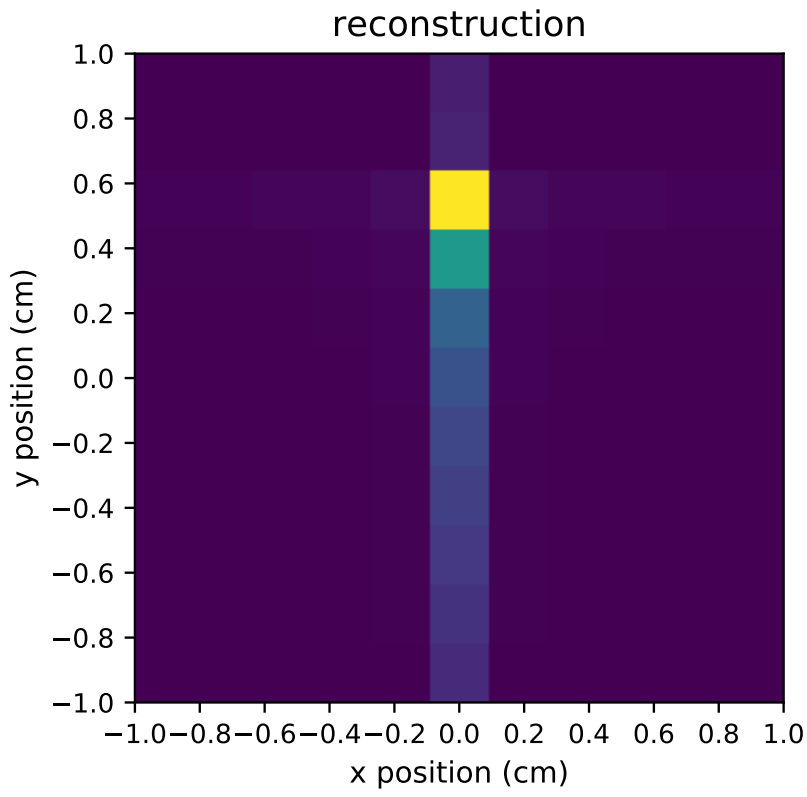

em distribution
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
y position (cm)
−1.0 −0.8 −0.6 −0.4 −0.2 0.0 0.2 0.4 0.6 0.8 1.0
x position (cm)

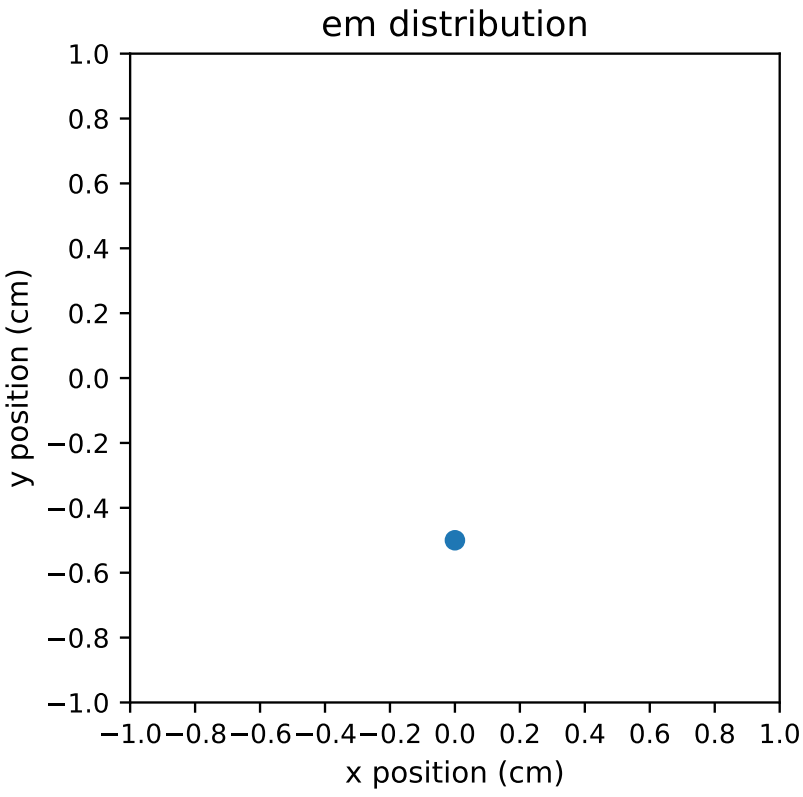

reconstruction
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
y position (cm)
−1.0 −0.8 −0.6 −0.4 −0.2 0.0 0.2 0.4 0.6 0.8 1.0
x position (cm)

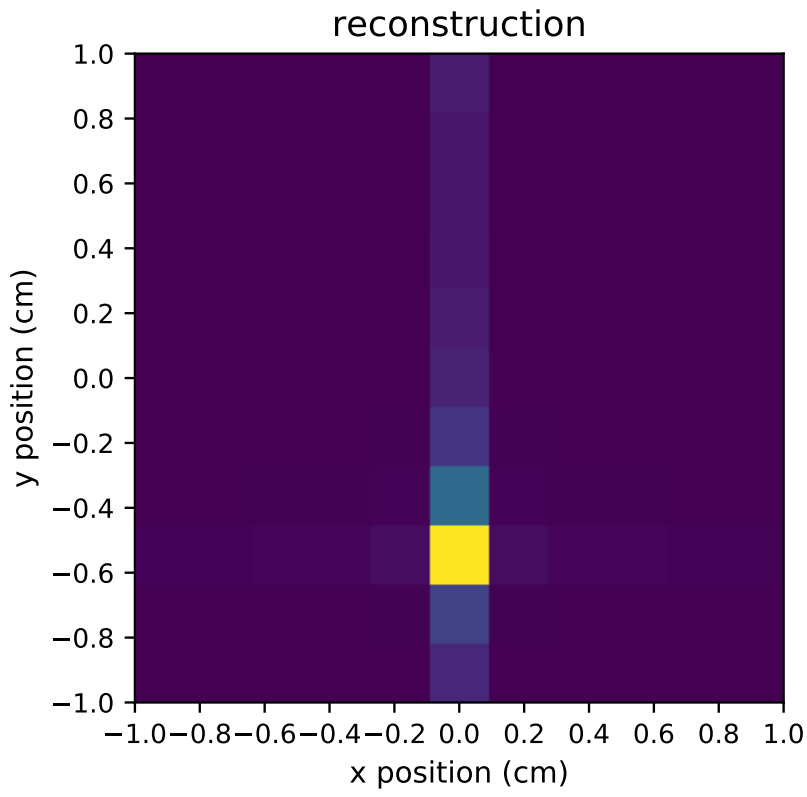

em distribution
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


reconstruction
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


em distribution
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


reconstruction
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


em distribution
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


reconstruction
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0

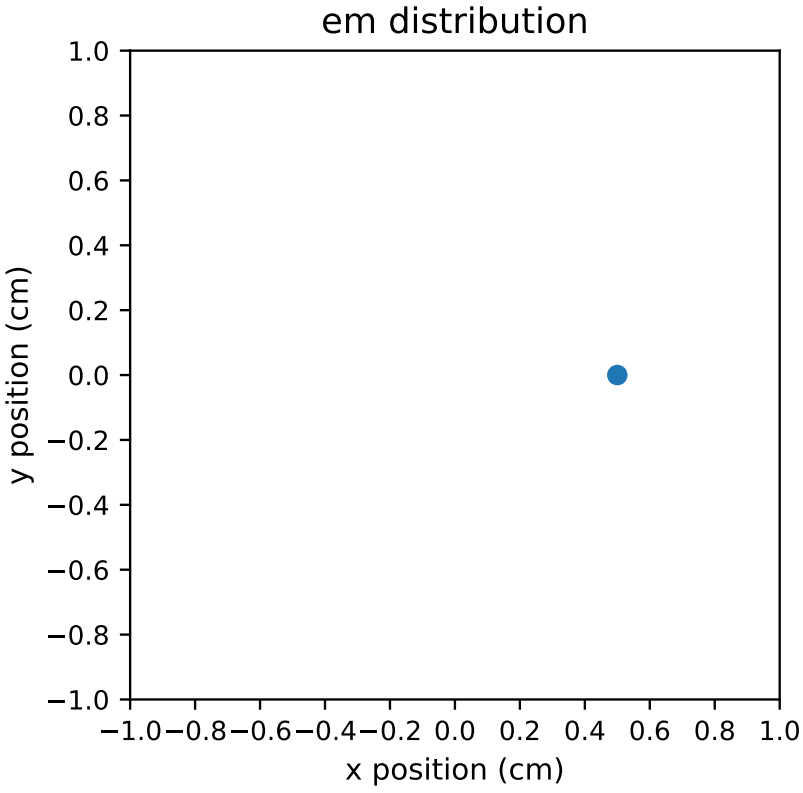
# Comments

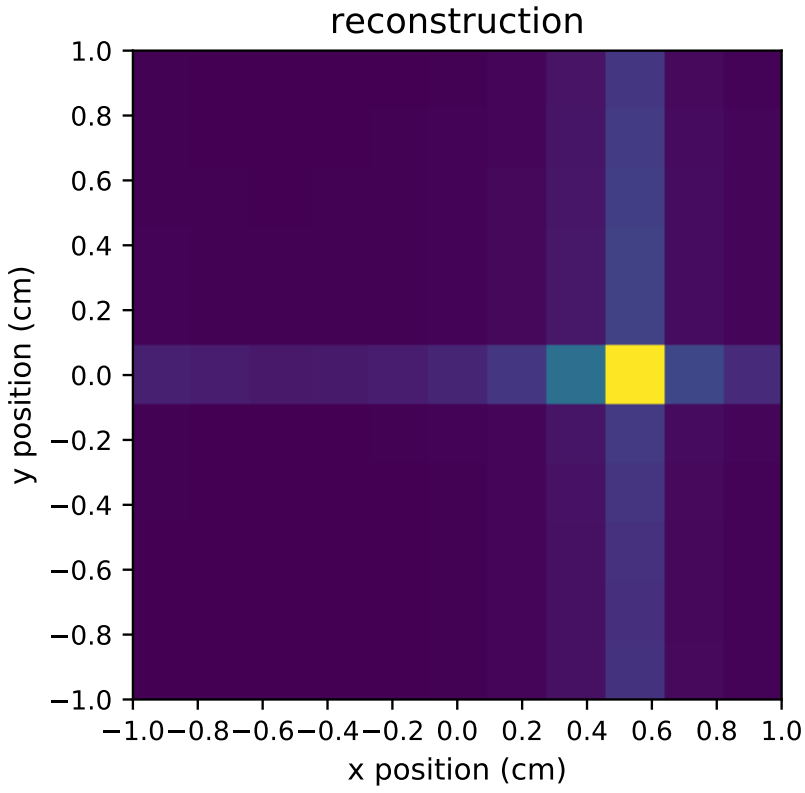
- The point-spread function itself appears to be asymmetric. Not sure what this means regarding the simulation and/or reconstruction. Is this typical in MR?
- By eye, the point-spread function is reflected when the $x$ position is reflected; the same is untrue of $y$. $y$ is the phase-encoding direction, and the k-space lines are scanned starting with maximum positive $k_y$. Could this have something to do with it?

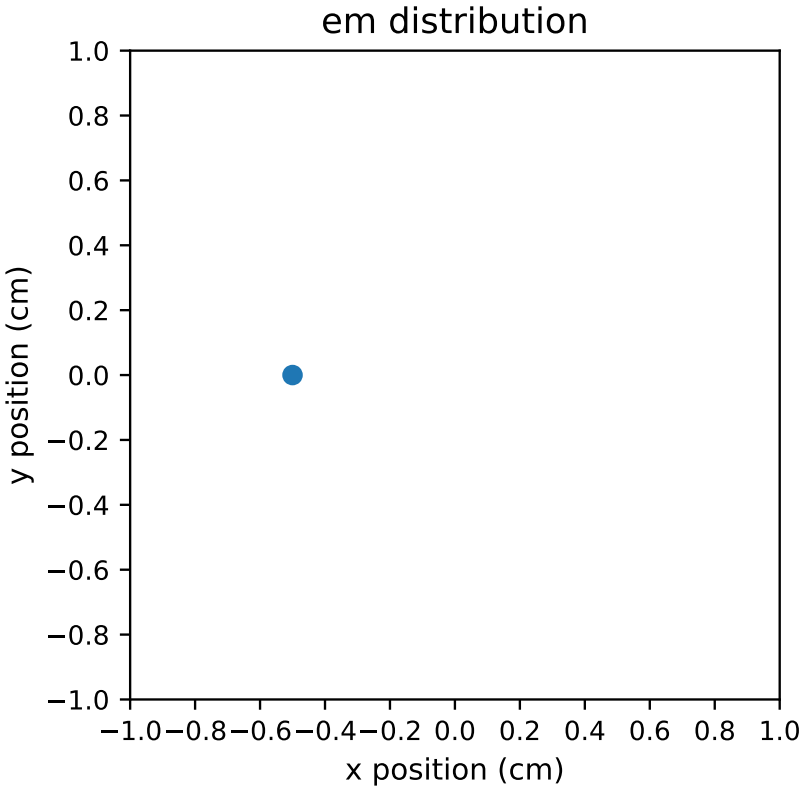
# 2DFT simulation with better parameters

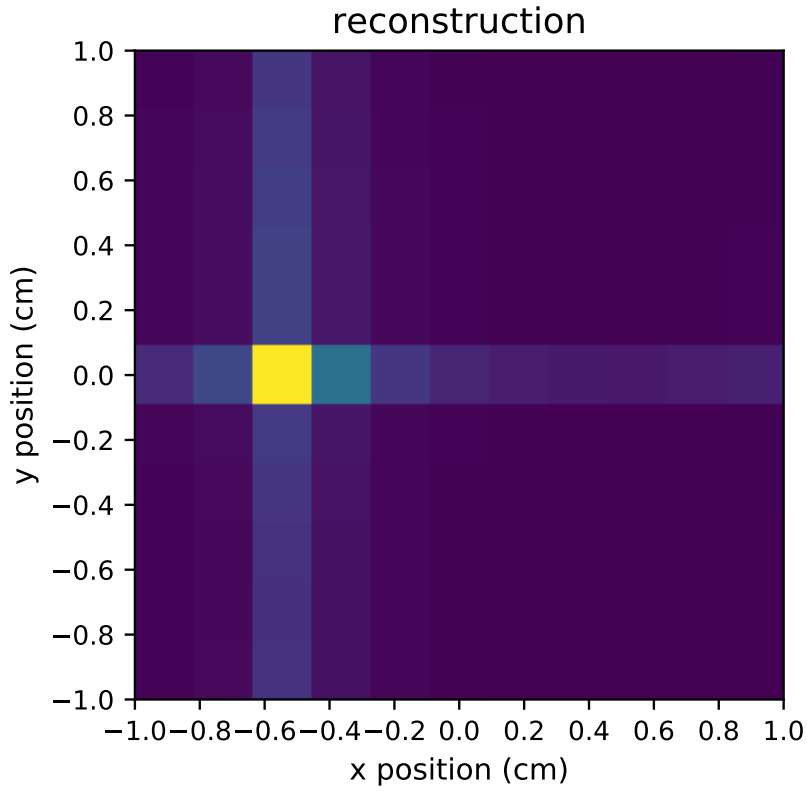
# Summary

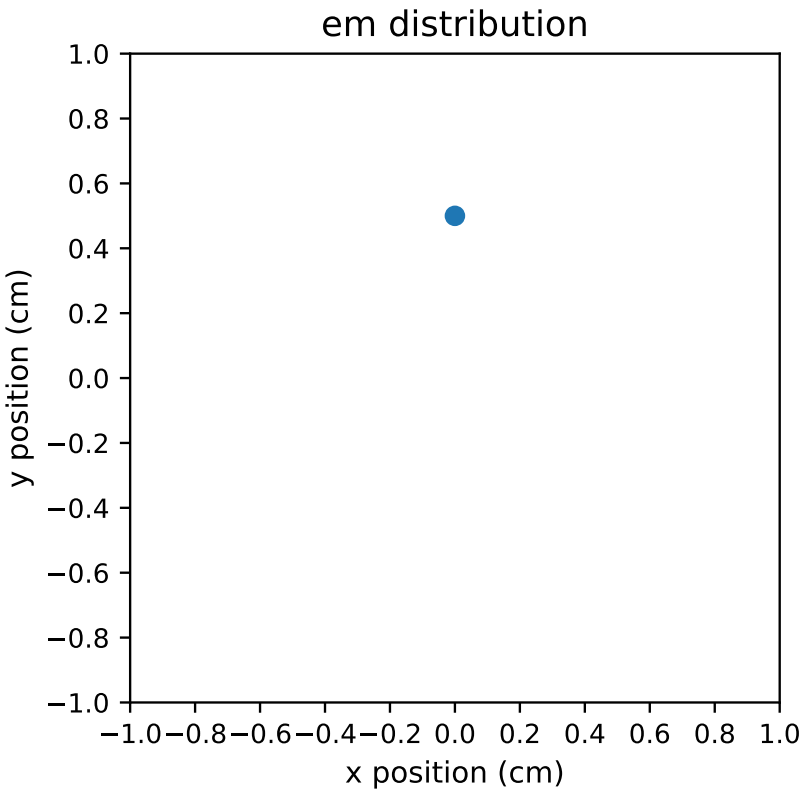
- I redid the simulations of the previous section with the parameters T1 = 100 ms, T2 = 10 ms, TE = 4 ms, TR = 100 ms.

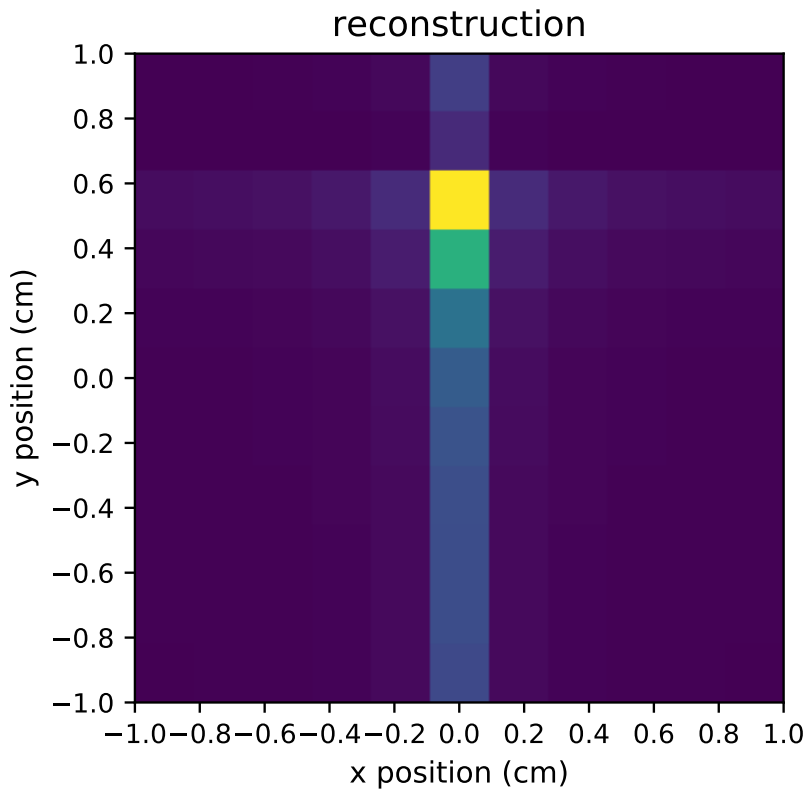

em distribution
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.0 −0.8 −0.6 −0.4 −0.2 0.0 0.2 0.4 0.6 0.8 1.0

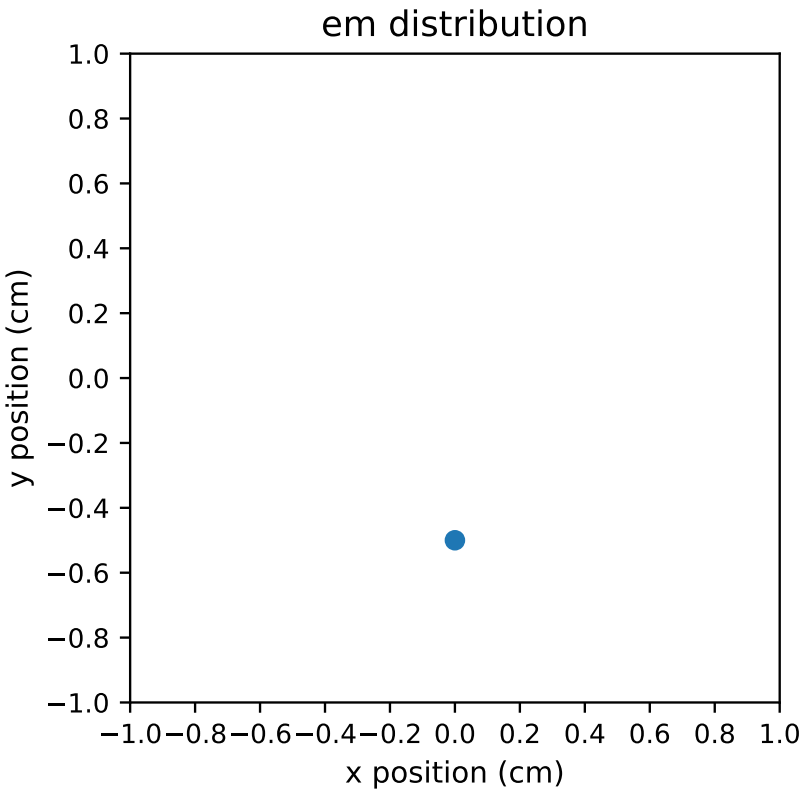

reconstruction
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
−1.0 −0.8 −0.6 −0.4 −0.2 0.0 0.2 0.4 0.6 0.8 1.0

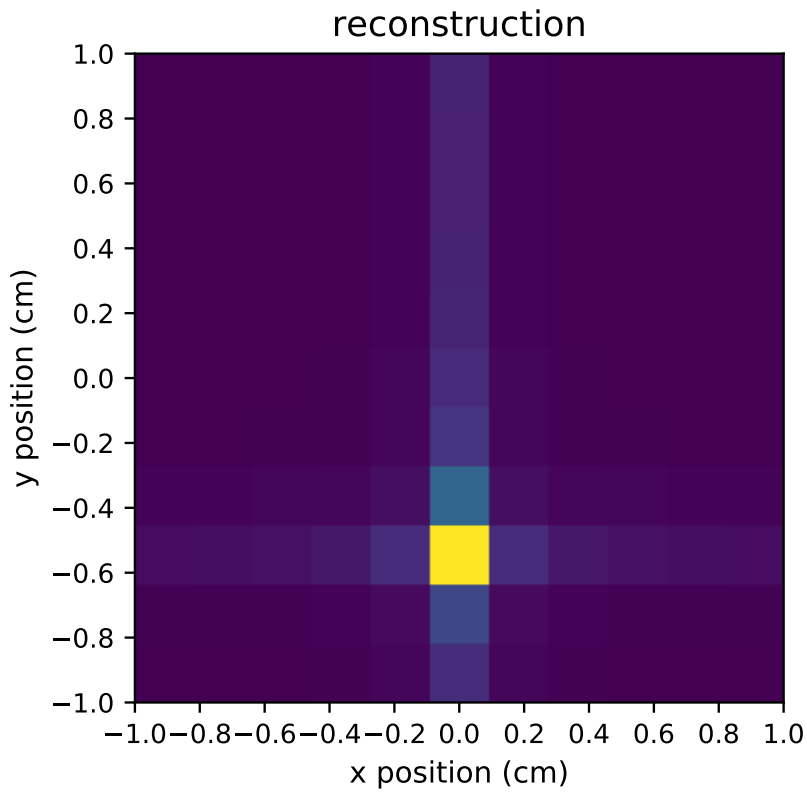

em distribution
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


reconstruction
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


em distribution
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
y position (cm)
−1.0 −0.8 −0.6 −0.4 −0.2 0.0 0.2 0.4 0.6 0.8 1.0
x position (cm)


reconstruction
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0
y position (cm)
−1.0 −0.8 −0.6 −0.4 −0.2 0.0 0.2 0.4 0.6 0.8 1.0
x position (cm)


em distribution
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0


reconstruction
y position (cm)
x position (cm)
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
−1.0

# Comments

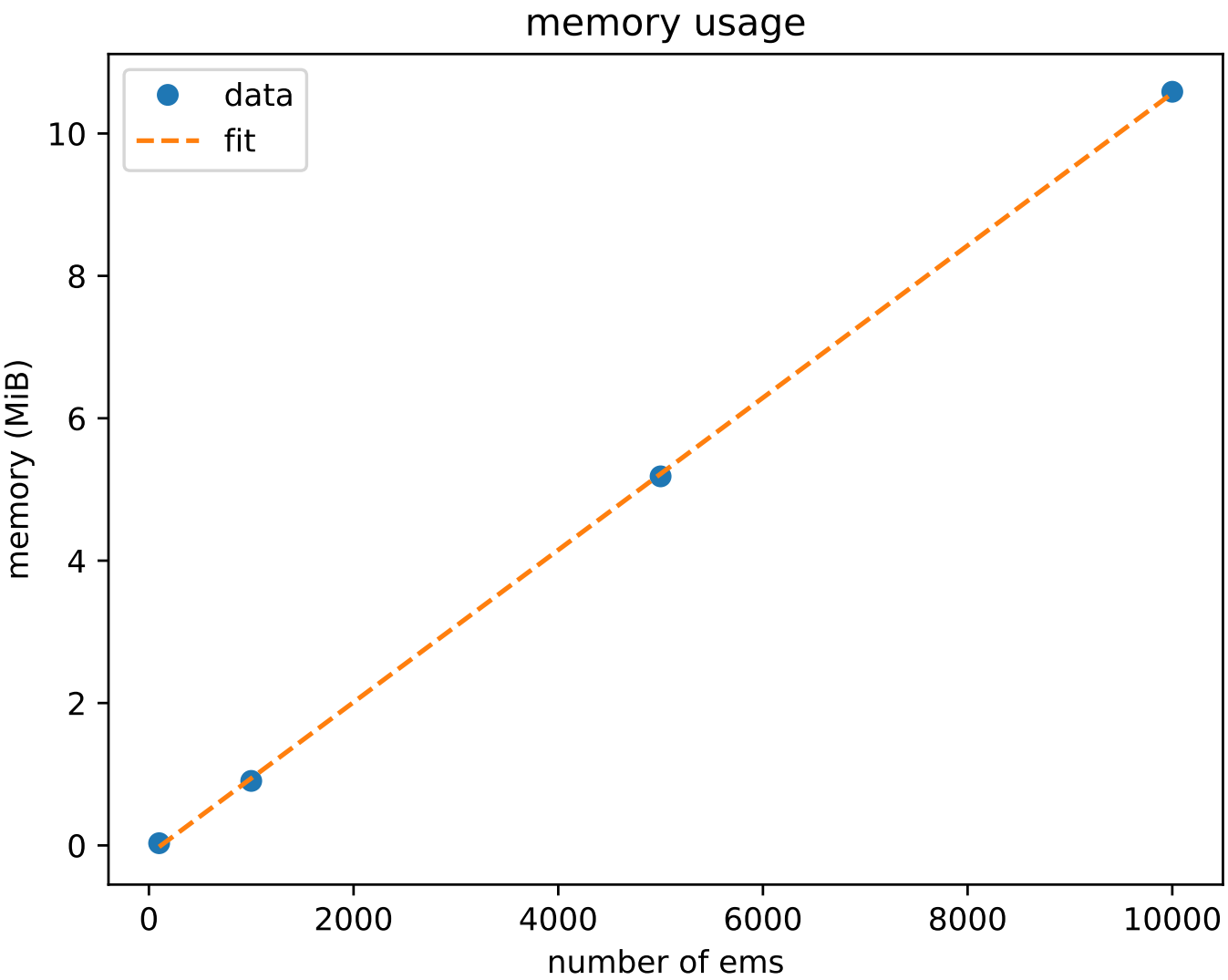
- The reconstructions are similar to those of the previous section.
- There is more blurring for $(x, y) = (0.0, 0.5)$ than in the previous section.
- The point-spread function is reflected in $x$ but not in $y$ when the em position is reflected, again like the previous section.

# Memory usage

# Summary

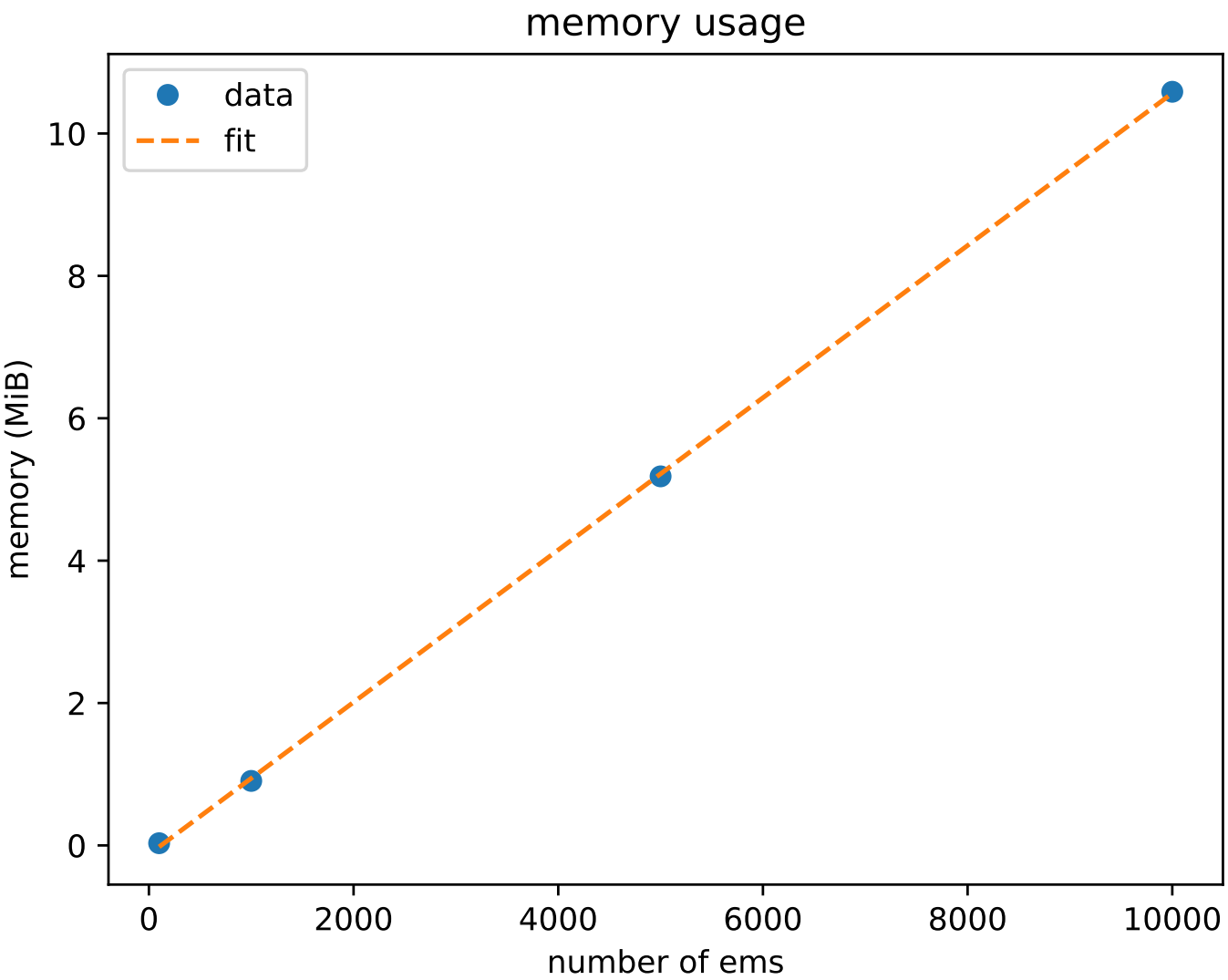
- I instantiated a simulation object `Sim` with a variable number of ems (did not run simulation). I recorded the memory usage of this instantiation command. The plots on the next slides show the results.
- I ran the simulation with a fixed number of ems and varied the pulse length. To save time, I took a single time step for each pulse. I recorded the memory usage of the `run_sim` command. Changing the pulse length only changes the memory usage of the Pulse instantiation command, not the `Sim` instantiation command nor the `run_sim` command.

# Liam's Macbook




1.12 kB per em.

# Supershop




1.12 kB per em.