MRI Simulator Notes

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Tasks

- I computed the required parameters for the proper FOV and pixel size for the simulation.
- I ran the excitation simulation of 2019-12-04 on Supershop and tracked the resource usage.
- I wrote more code for the 2DFT simulation.

Parameter requirements

Summary

▶ The ems are arranged in a grid, with the number of grid points in each dimension being $2r_{\mathrm{grid}} + 1$, with r_{grid} an integer.

▶ The ems are placed at $x = [-x_{\lim} : \Delta x : x_{\lim}]$, where $\Delta x = x_{\lim}/r_{\mathrm{grid}}$ and similarly for y.

▶ The number of samples of k-space taken in the phase-encoding direction (y) is $2r_{\mathrm{pe}} + 1$ and the number of samples taken in the frequency-encoding direction (x) is $2r_{\mathrm{fe}} + 1$, with r_{pe} and r_{fe} integers.

▶ We require the field-of-view to satisfy $FOV_x \geq 2x_{\lim}$ and $FOV_y \geq 2y_{\lim}$.

▶ We require a pixel dimension of $\Delta x \times \Delta y$.

▶ For the field-of-view requirements, we use

$$FOV_x = \frac{1}{\Delta k_x},$$

where Δk_x is the spacing between k-space samples in the x direction, and similarly for y.

▶ For the pixel size requirements, we use

$$\delta_x \approx \frac{1}{2k_{x,max}},$$

where δ_x is the spatial resolution in x and $k_{x,max}$ is the maximum sample of k-space in the x direction, and similarly for y.

For the FOV requirements, I find

$$\frac{r_{\mathrm{fe}}}{k_{x,max}} \geq 2x_{\lim} , \quad \frac{r_{\mathrm{pe}}}{k_{y,max}} \geq 2y_{\lim} .$$

For the pixel size requirements, I find

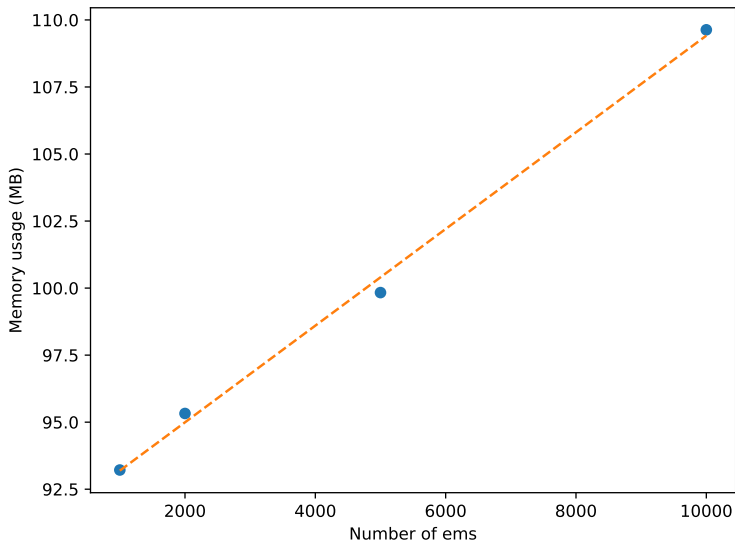$$\frac{x_{\lim}}{r_{\mathrm{grid}}} = \frac{1}{2k_{x,max}} , \quad \frac{y_{\lim}}{r_{\mathrm{grid}}} = \frac{1}{2k_{y,max}} .$$

Resource usage on Supershop

Summary

- The memory usage as a function of the number of ems is shown on the following slide for 1000, 2000, 5000, 10000 ems.
- The maximum CPU usage from `top` that I observed was 969% for 10^9 ems (I did not run the simulation to completion). I suppose this means Python is using multiple cores automatically?
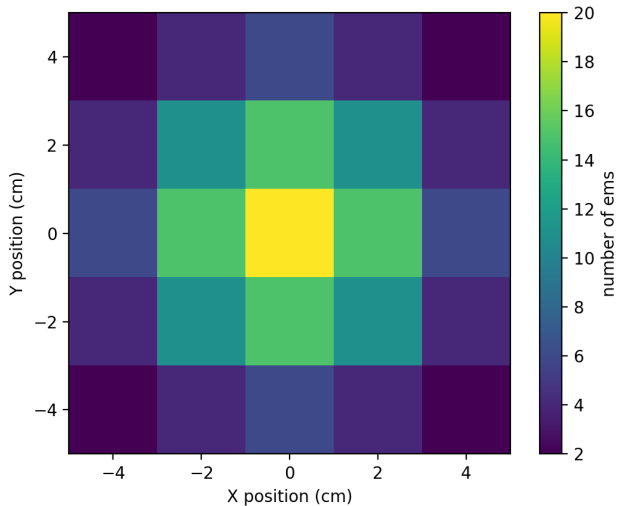
1.8 kB per em

2DFT simulation
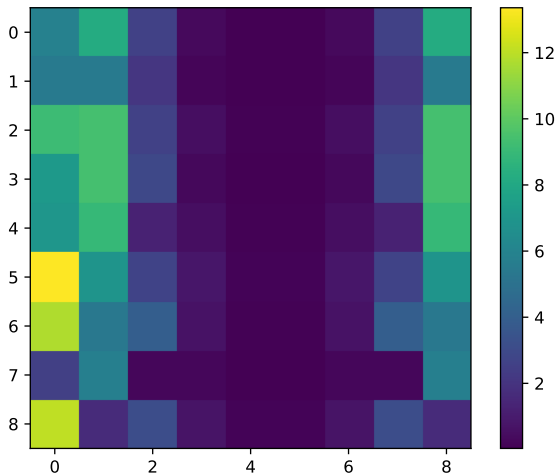
Summary

- I simulated a 2DFT pulse sequence with ems distributed as shown in the next slide.
- The reconstruction is the slide following.

Distribution of ems

Reconstruction

Comments

- It looks like the reconstruction has a spatial shift.
- The intensity values don't look quite right either.