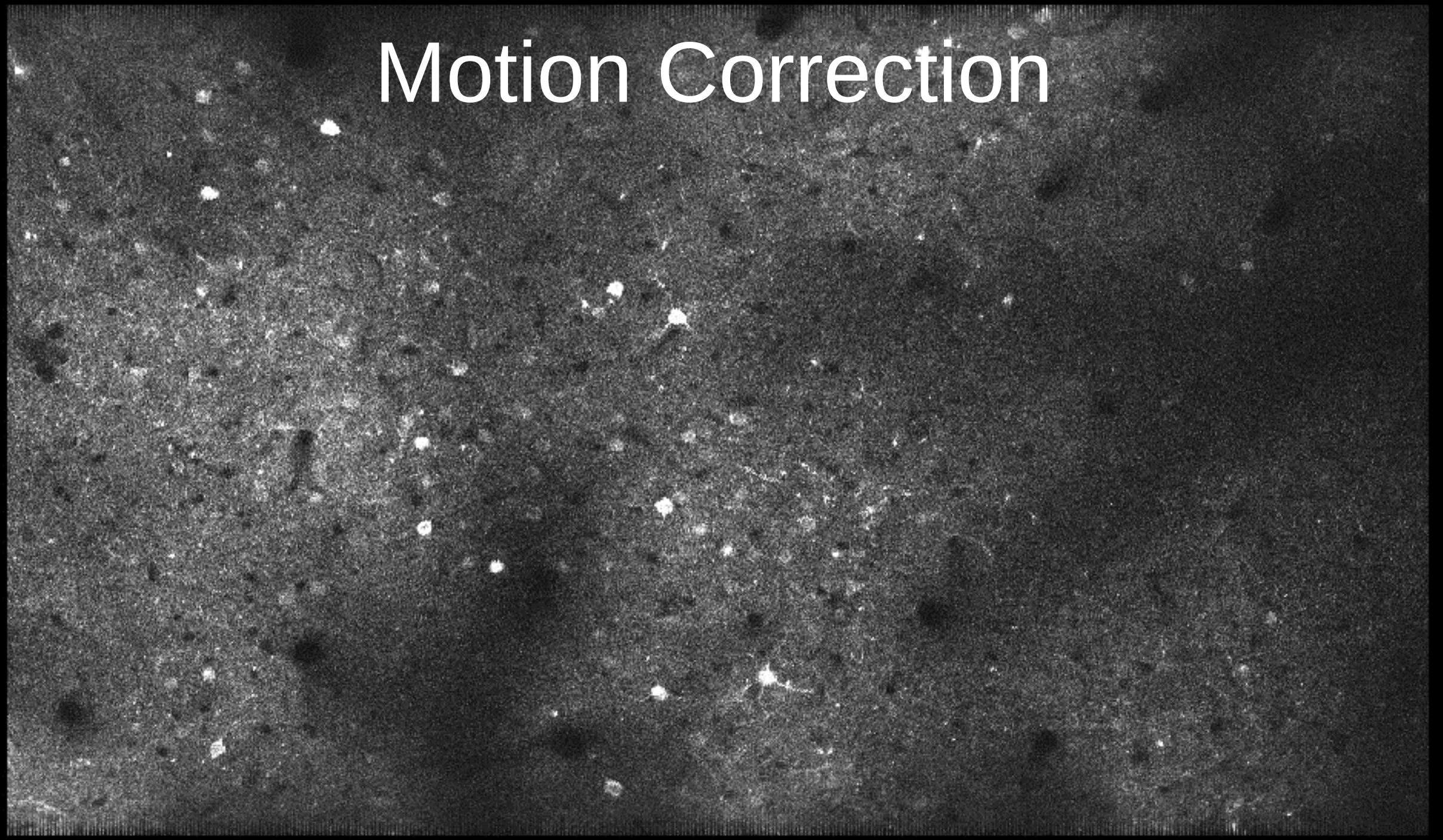
Motion Correction



Why should we care?

- Behaviors ➔ brain movements!
- Movements can be in XY (as in video)
- Also movements in Z (harder to spot)
- First let’s correct XY movement

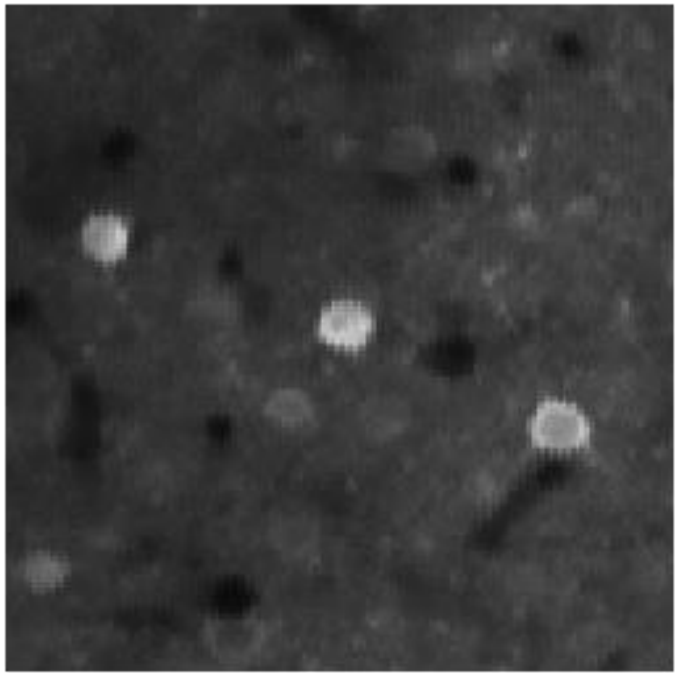
XY registration

- 1: compute reference image to align all frames to
- 2: compute rigid shifts relative to reference image
- 3: compute non-rigid shifts relative to reference image
- 4: benchmarking results

1: compute reference image

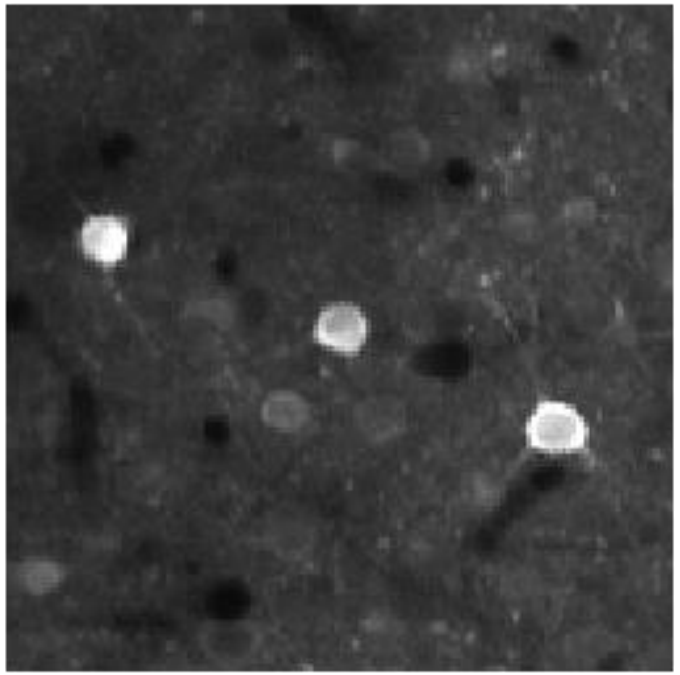
a) Take 250 random frames and compute correlation matrix
b) Take as the seed the frame with the most correlated neighbors
c) Take the mean of the seed and the top 20 most correlated frames

average of 250 frames

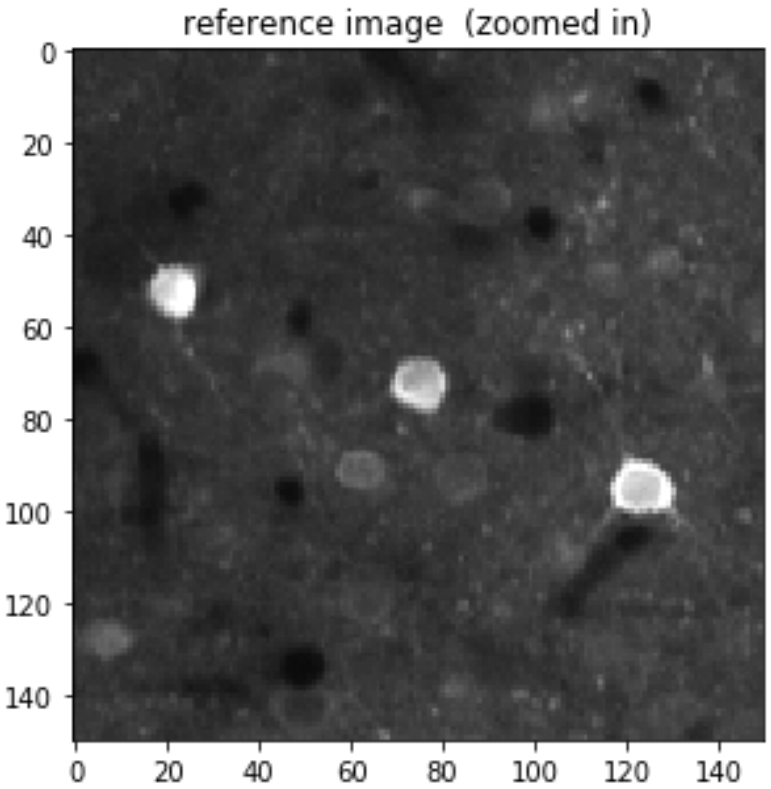


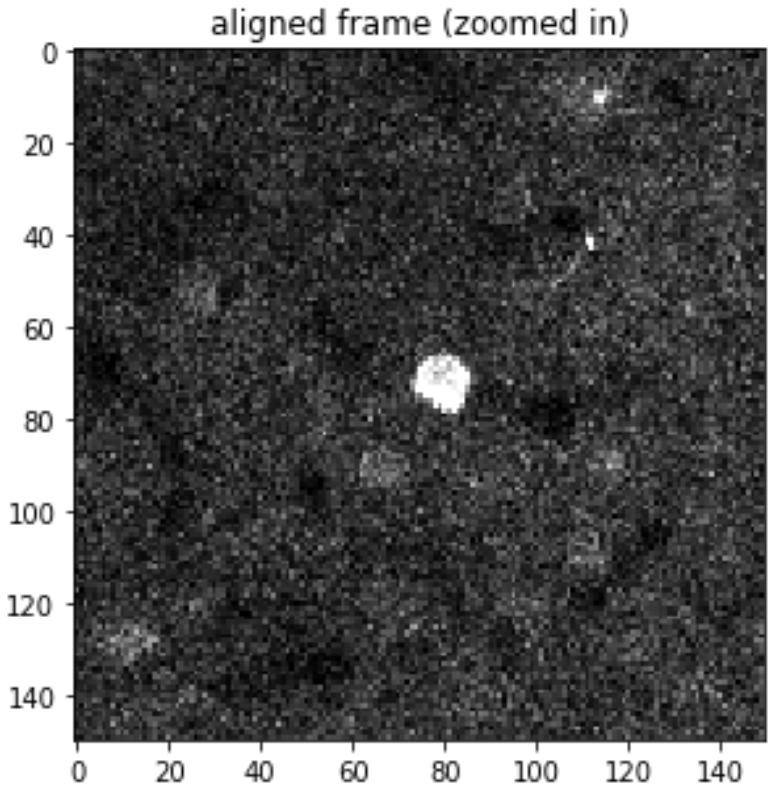
vs

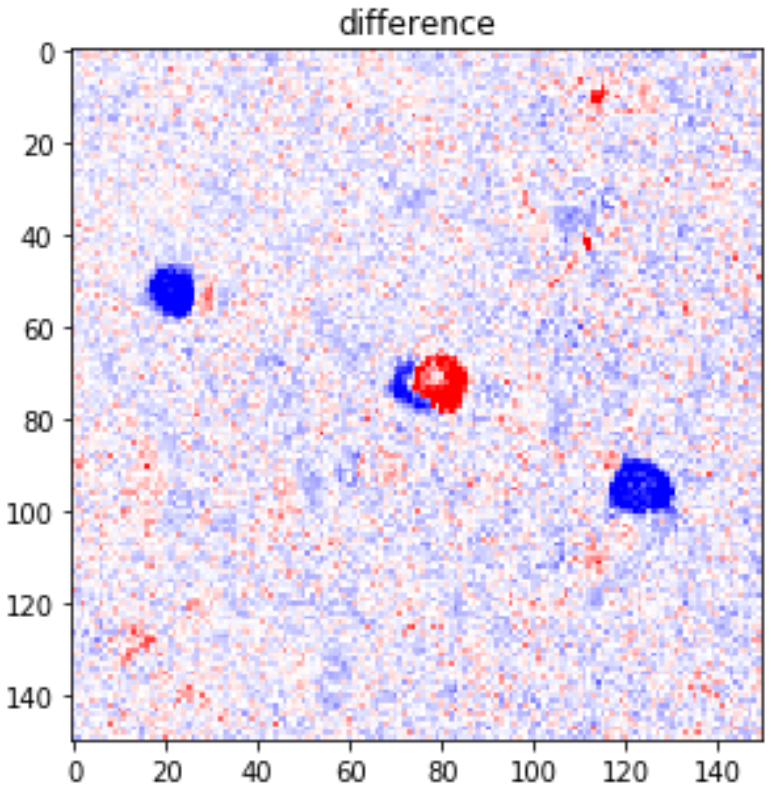
iteratively aligned average of 250 frames



2: rigid registration

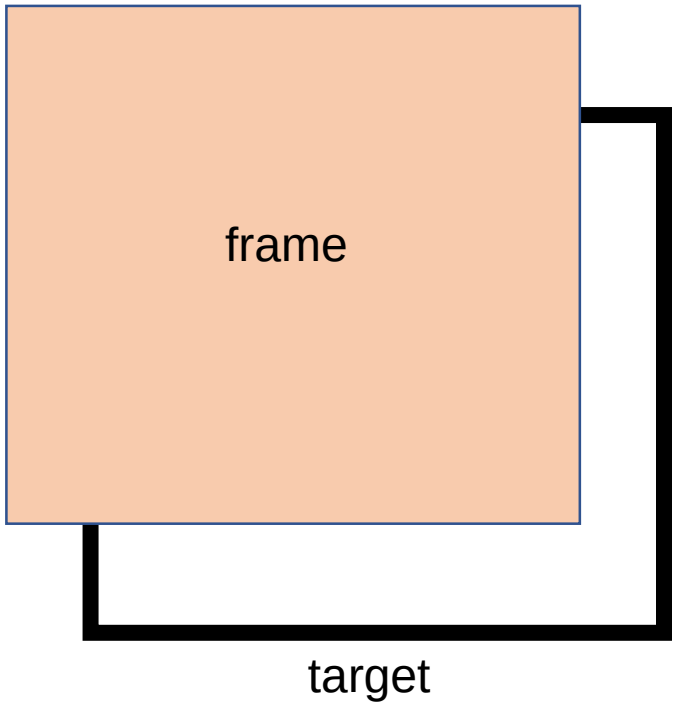


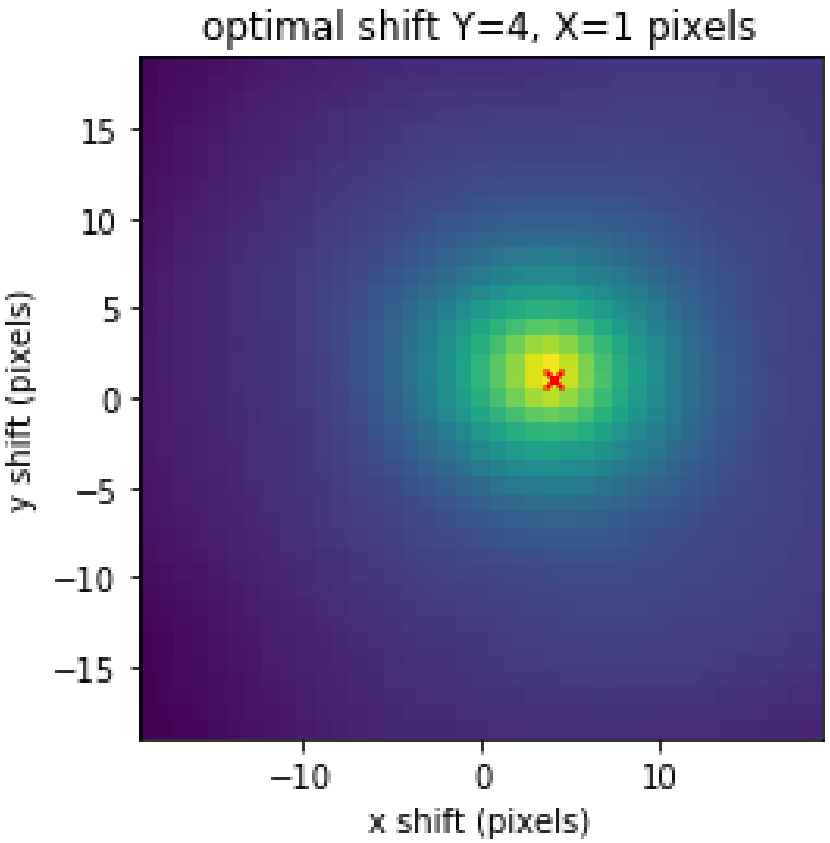


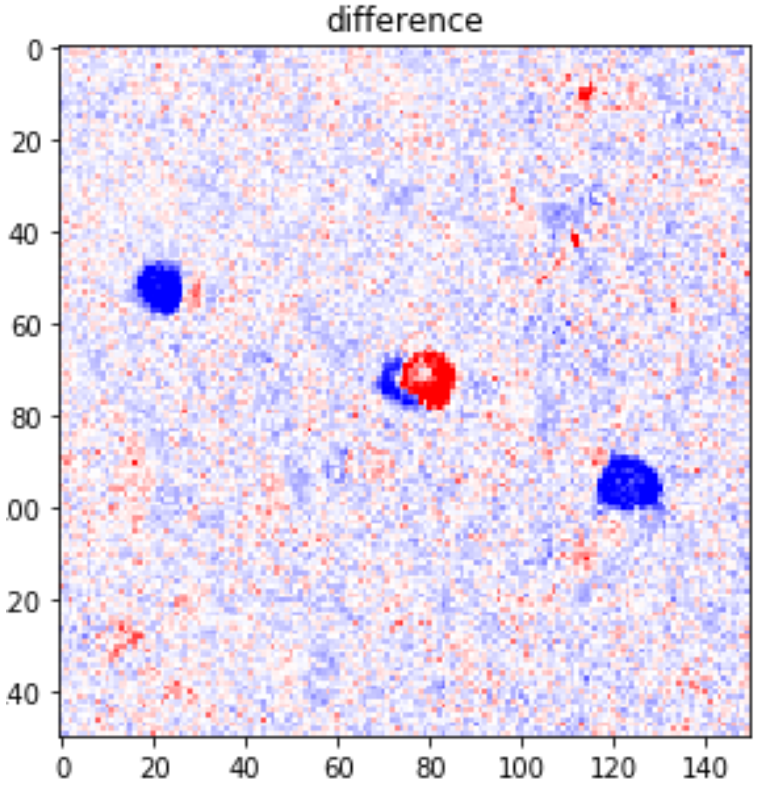


2: rigid registration

Cross-correlation between frame and reference:







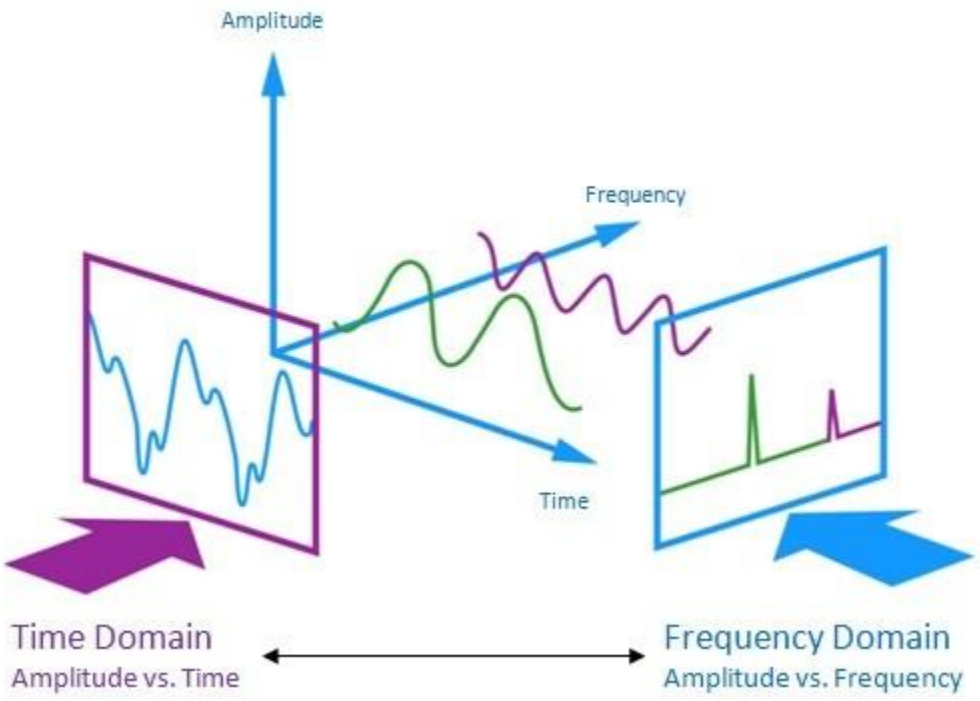
2: rigid registration

Cross-correlation is slooowww, but…

Cross-correlation is the same as the **convolution** of the frame with the reference.

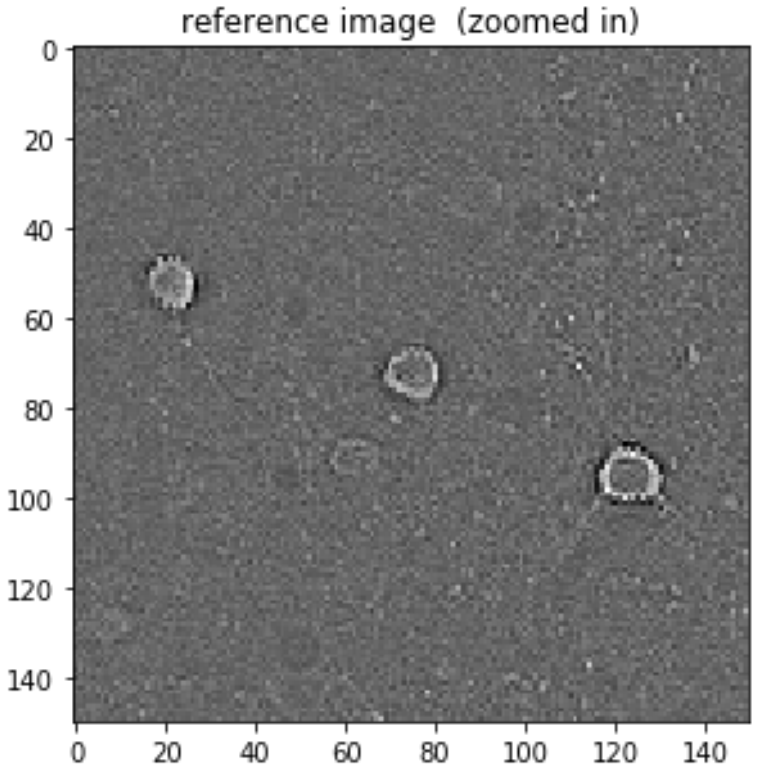
convolution theorem: convolution = multiplication in the frequency domain
➔ Take FFT of reference and frame and multiply

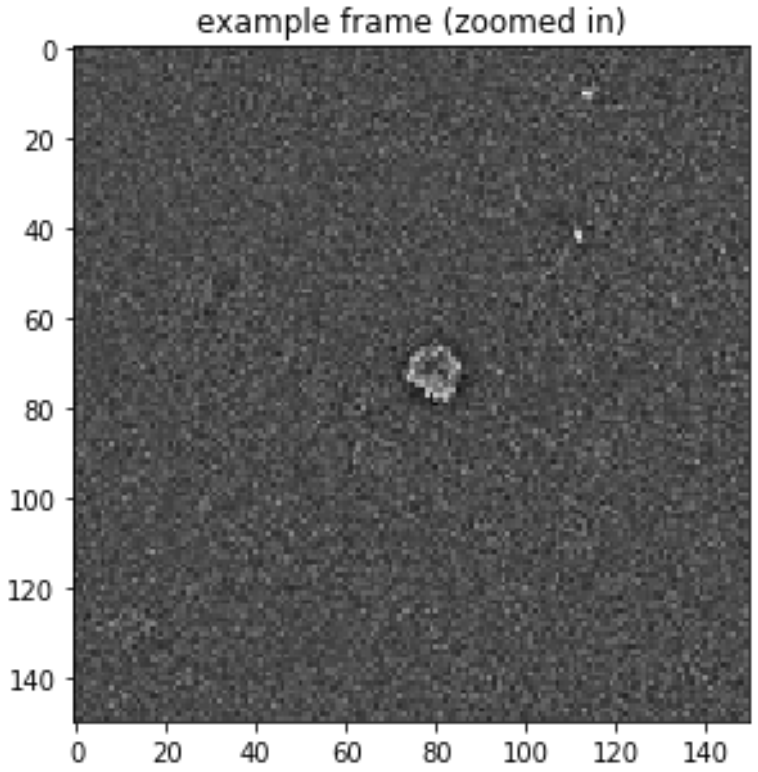
100x faster

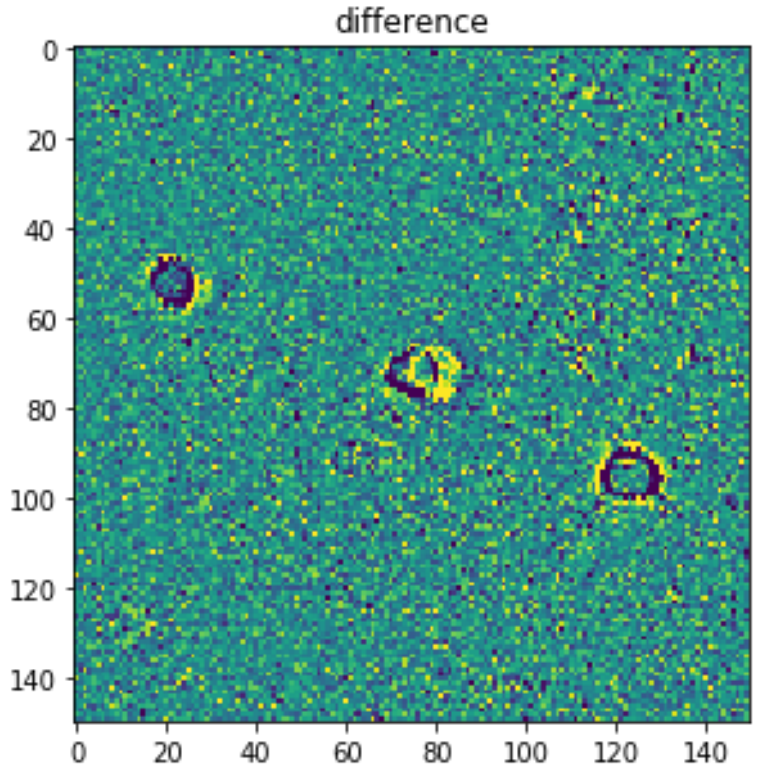


2: rigid registration

But this still isn’t the best approach
Get better results if you whiten: phase-correlation



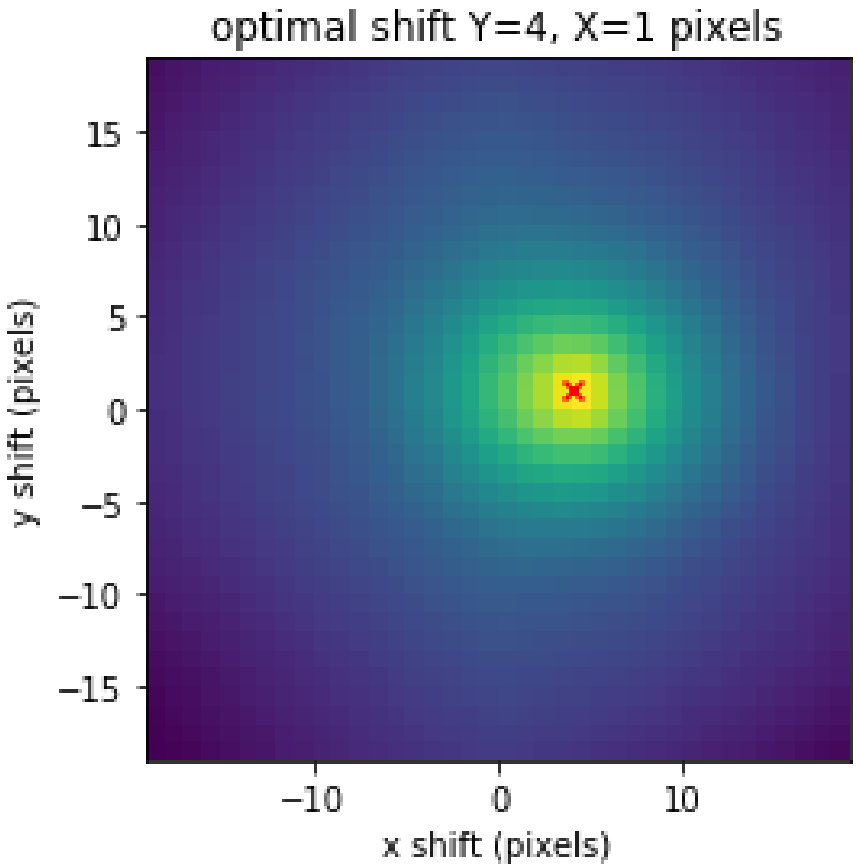




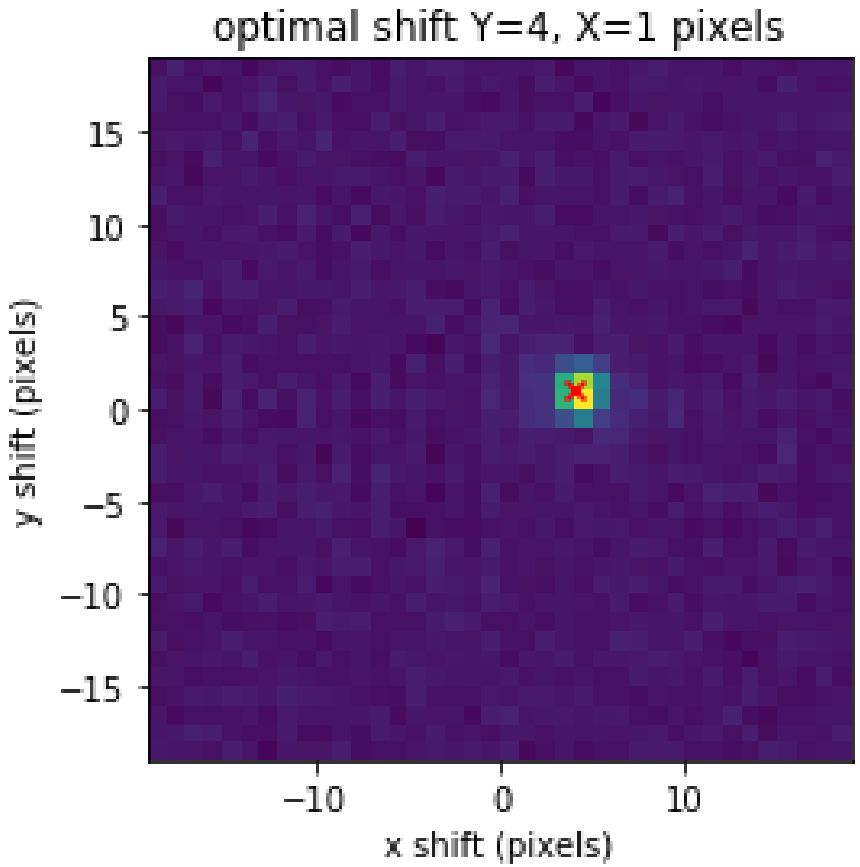
2: rigid registration

But this still isn't the best approach
Get better results if you whiten: phase-correlation

cross-correlation

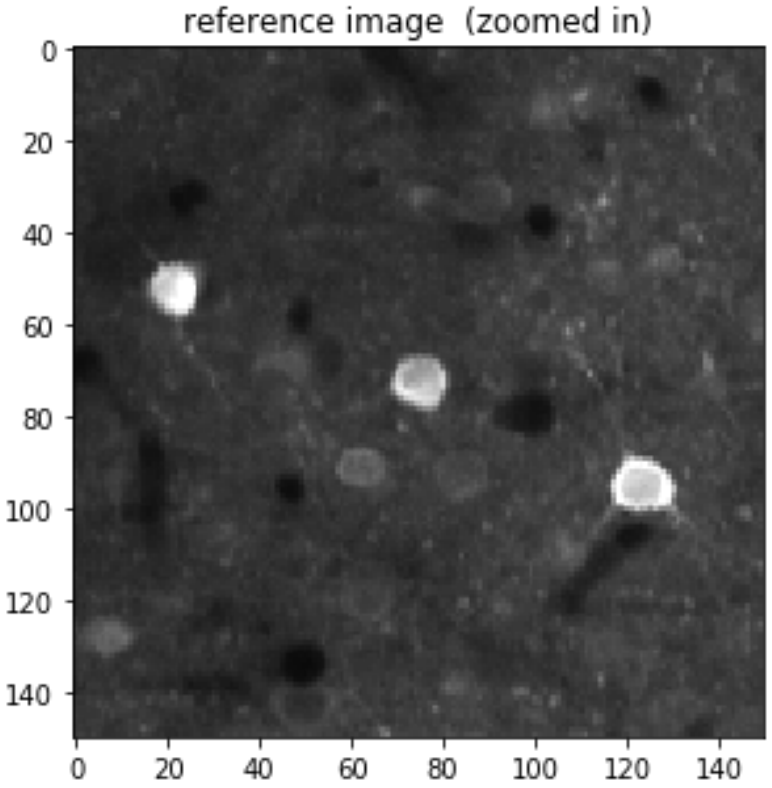


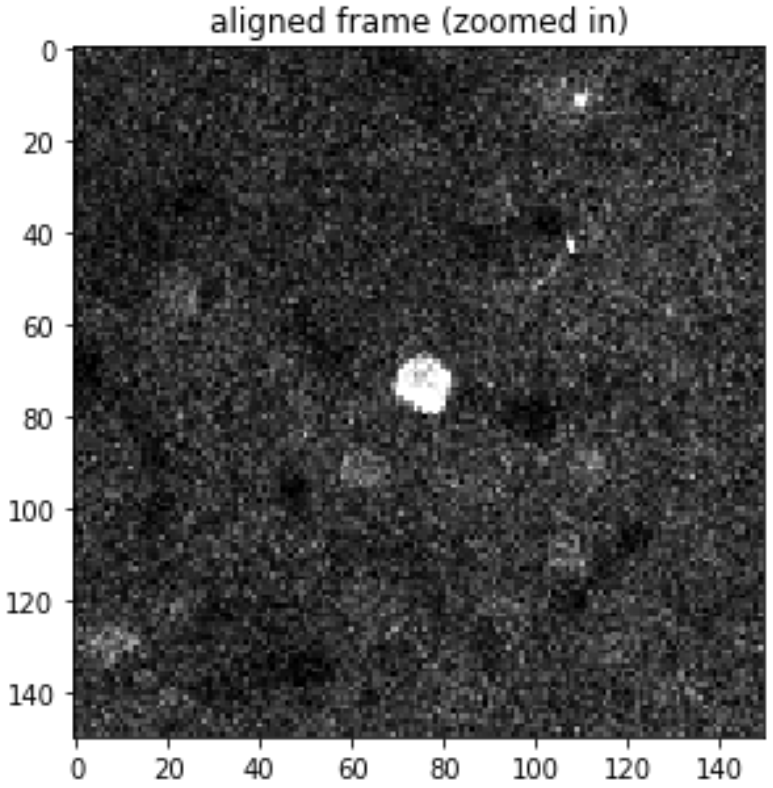
phase-correlation

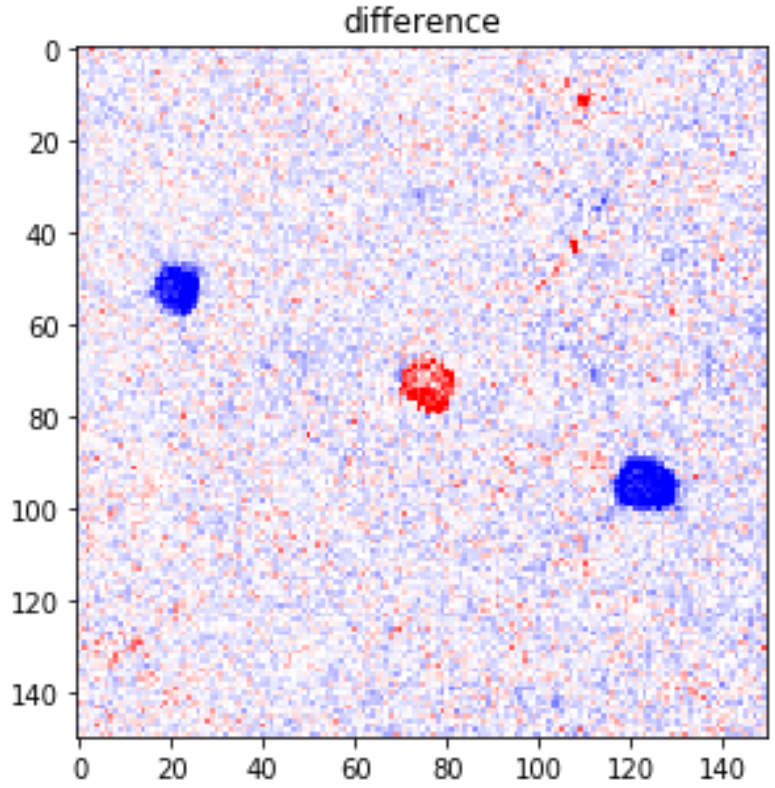


2: rigid registration

Move frame by calculated integer shifts (4,-1)

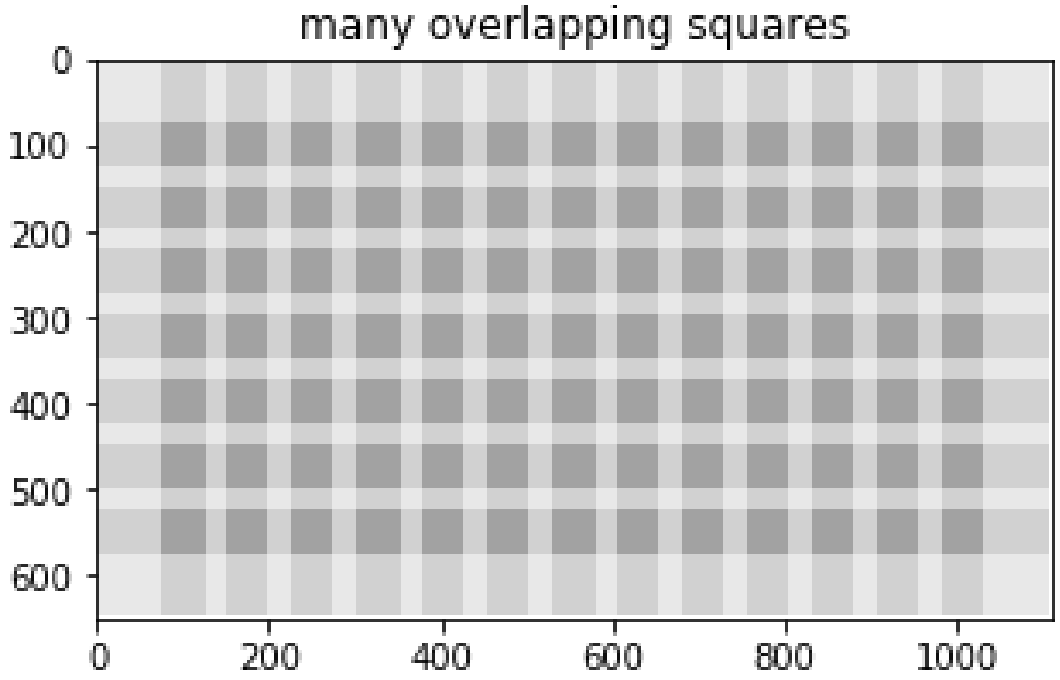






3: non-rigid registration

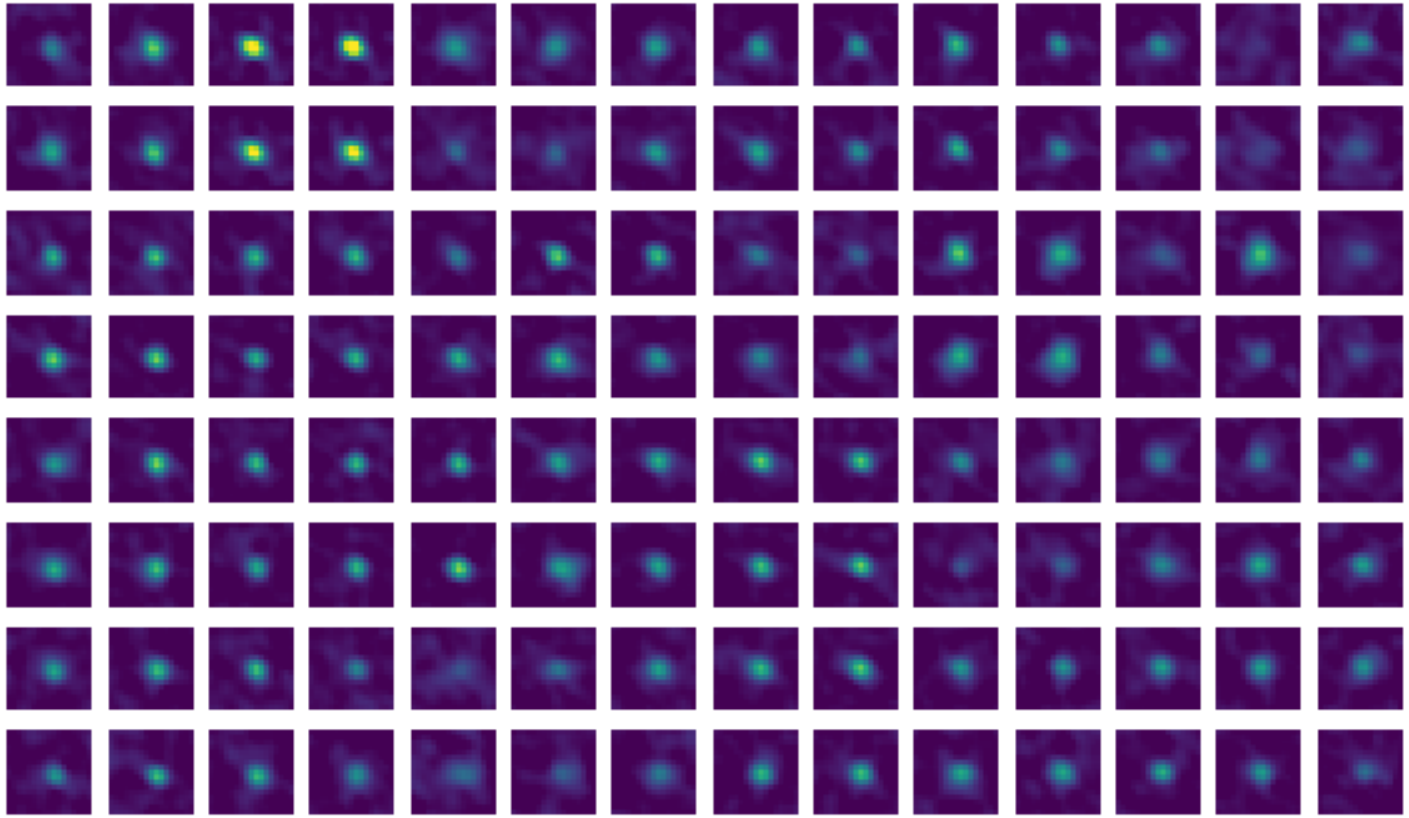
Divide field of view (FOV) into over-lapping blocks



Now we will compute the phase-correlation between each block and the reference image

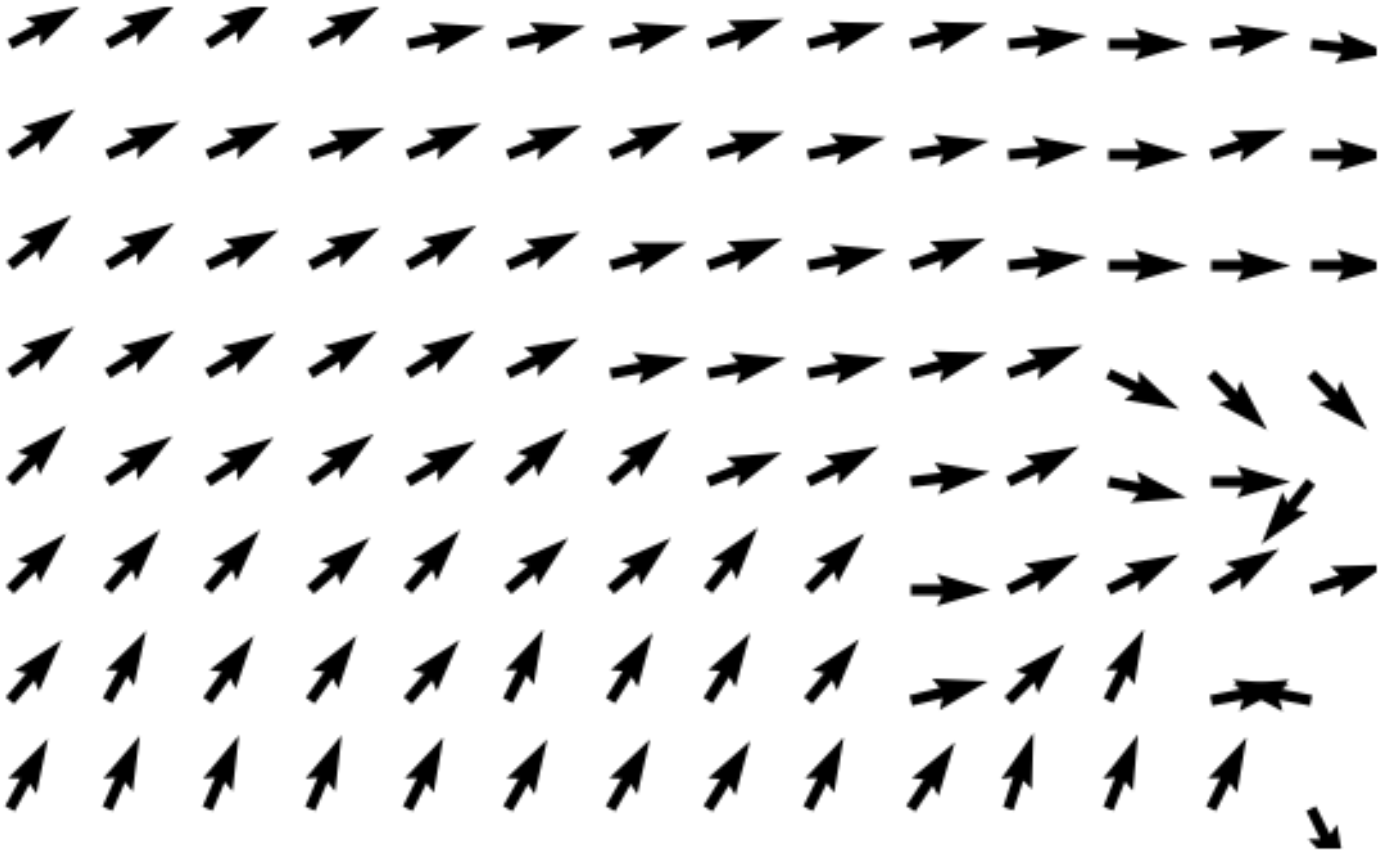
3: non-rigid registration

Phase correlation of each block



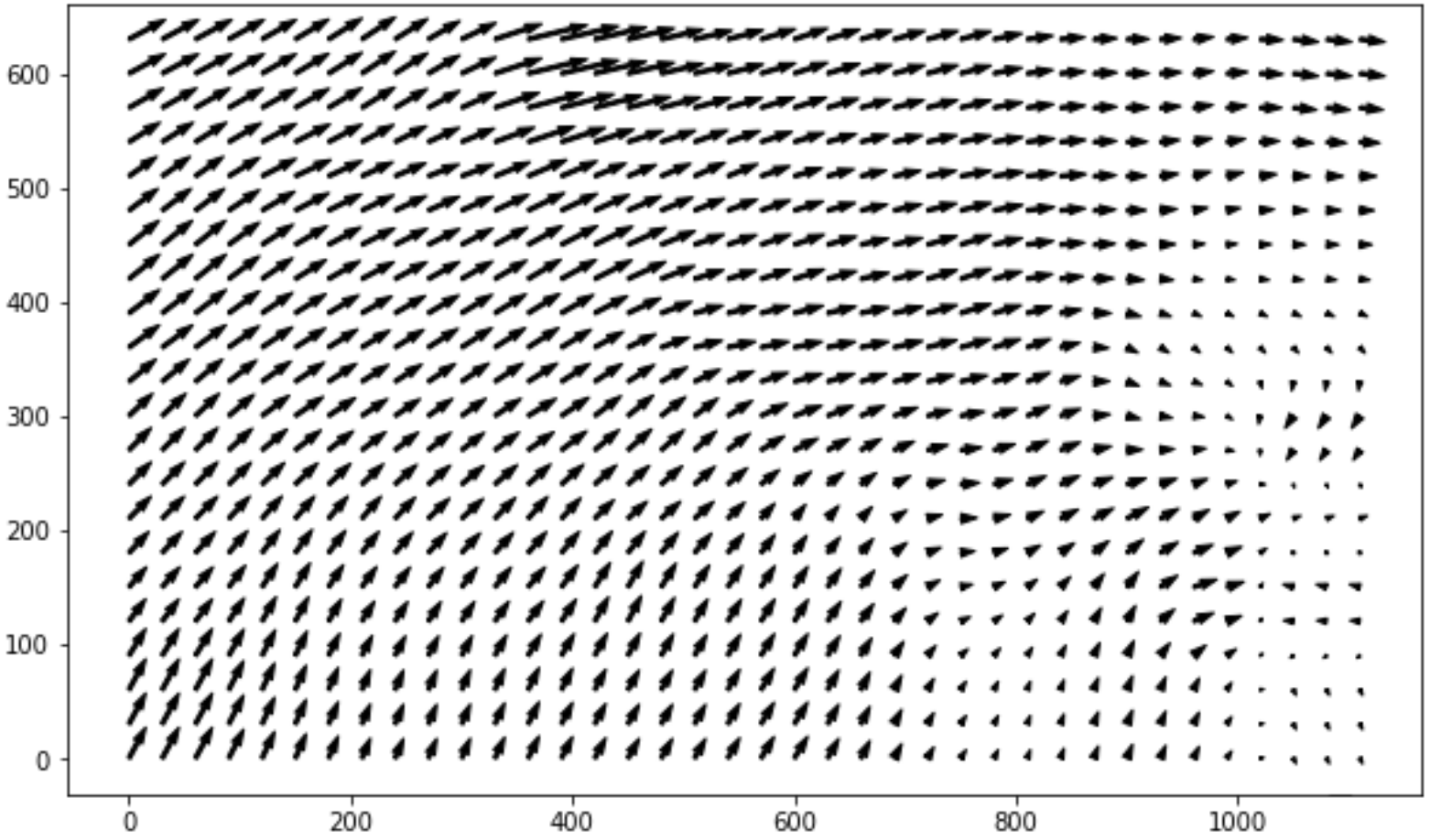
3: non-rigid registration

Phase correlation of each block



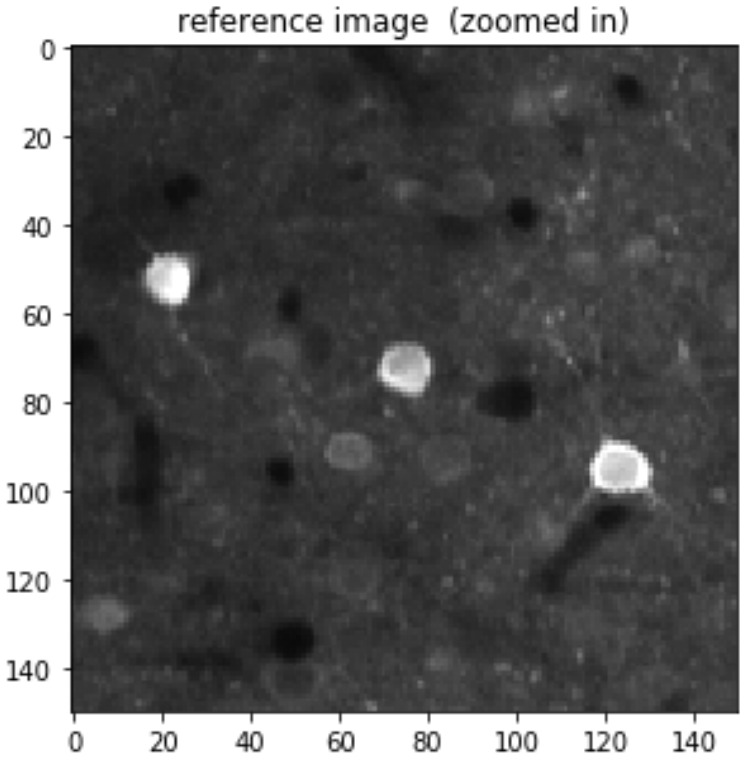
3: non-rigid registration

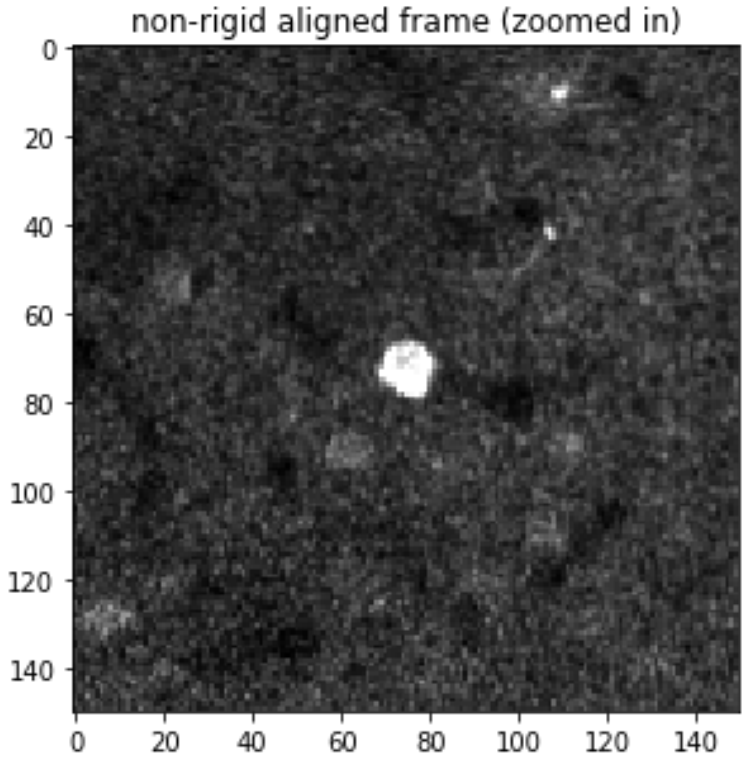
Phase correlation of each block

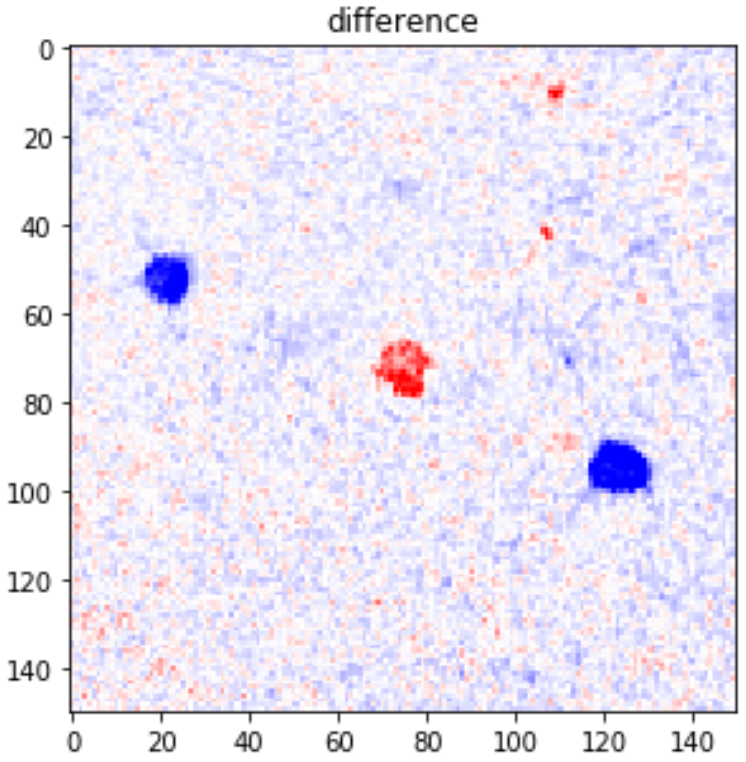


Upsample to get shift for each pixel using bilinear interpolation

3: non-rigid registration

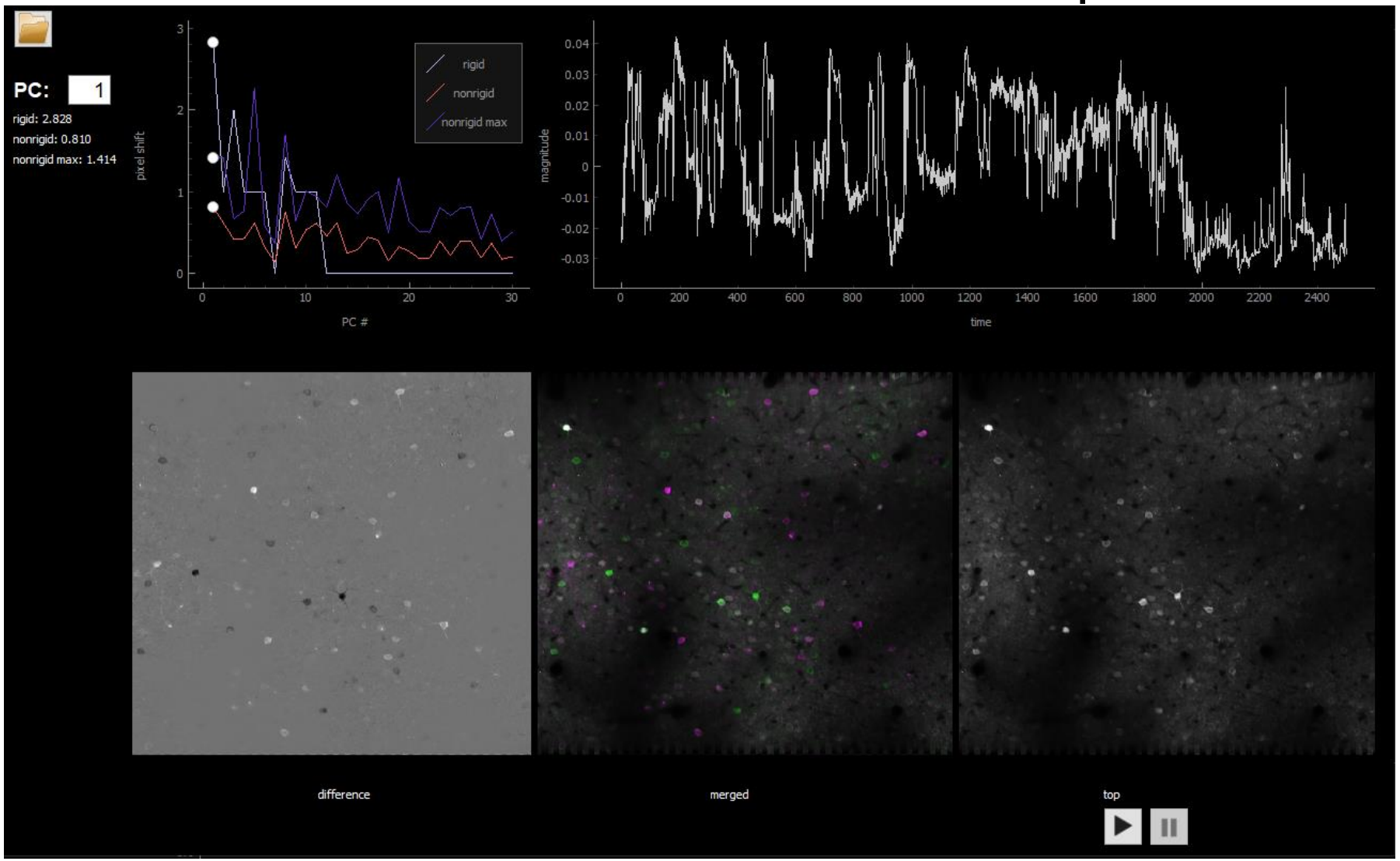






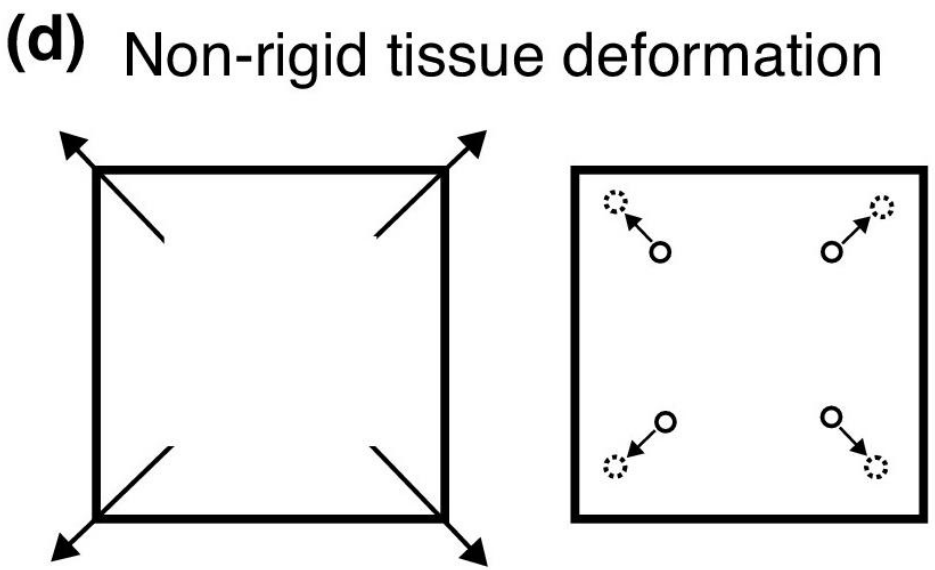
4: benchmarking registration

Take PCA of whole movie and see if PC's correspond to motion

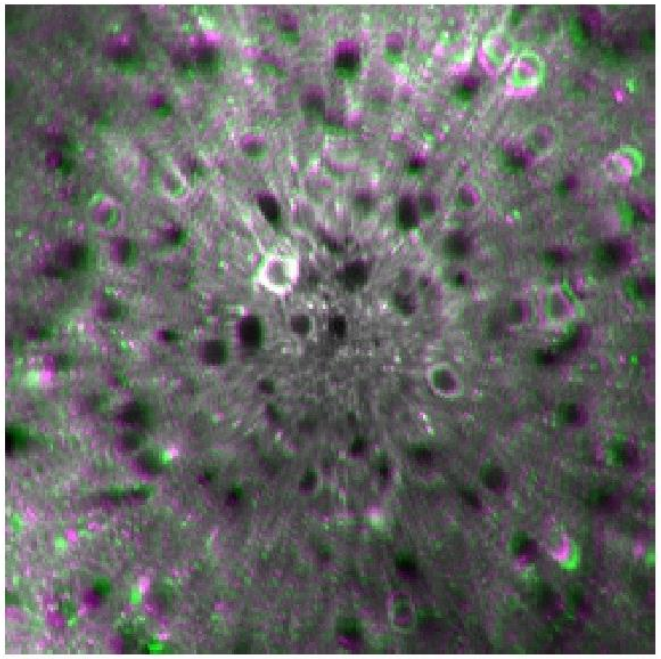


4: benchmarking registration

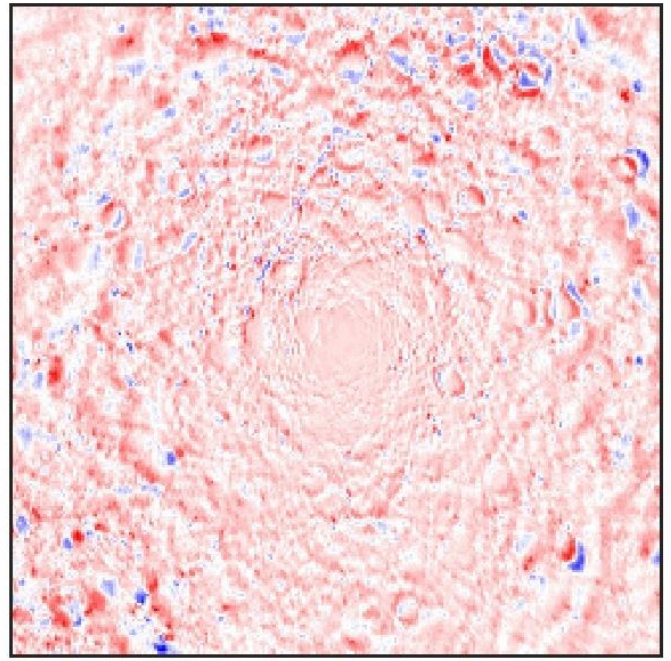
What do different brain movements look like?



merged

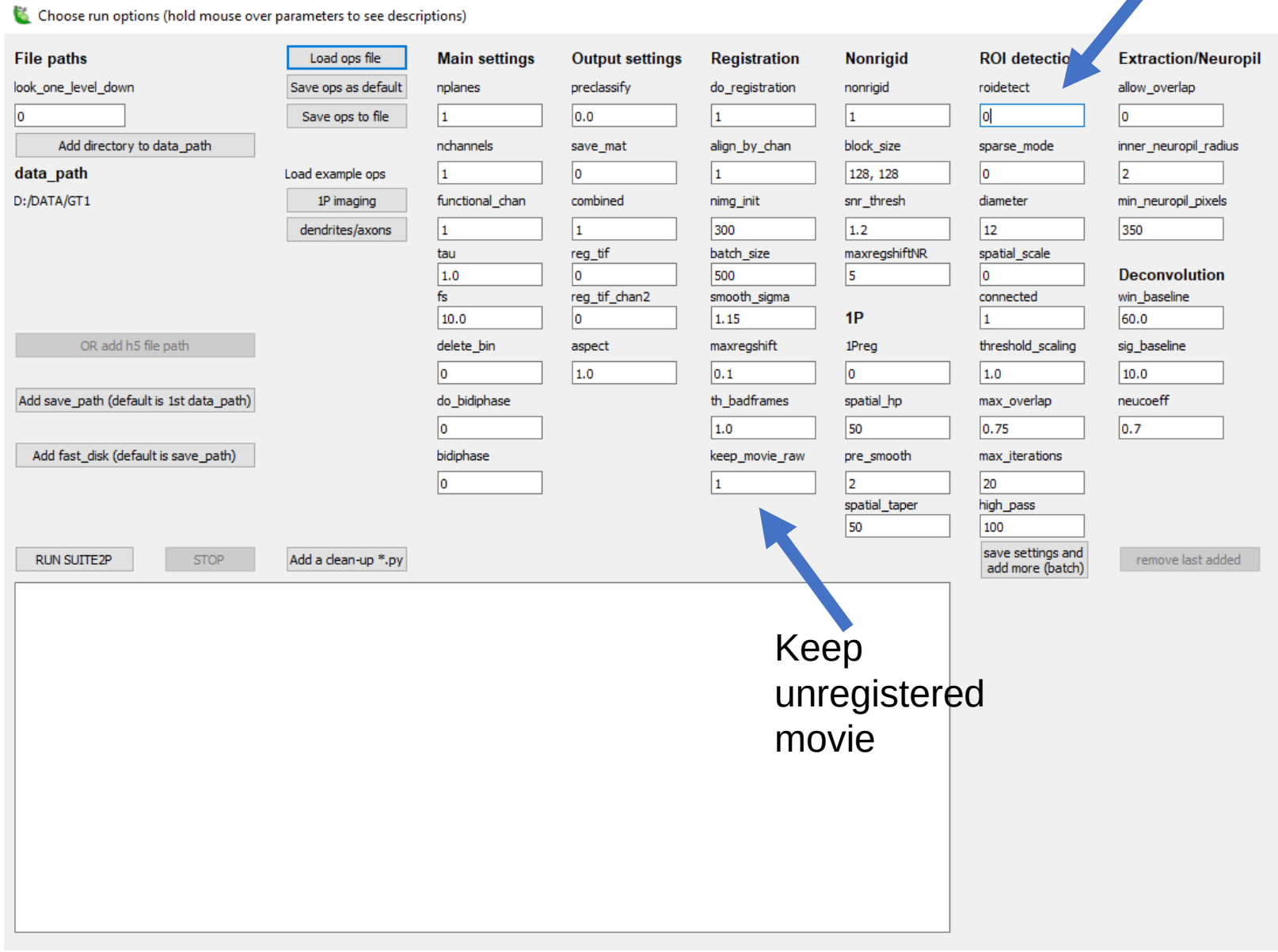


difference



Let’s run registration!

Don’t run cell detection

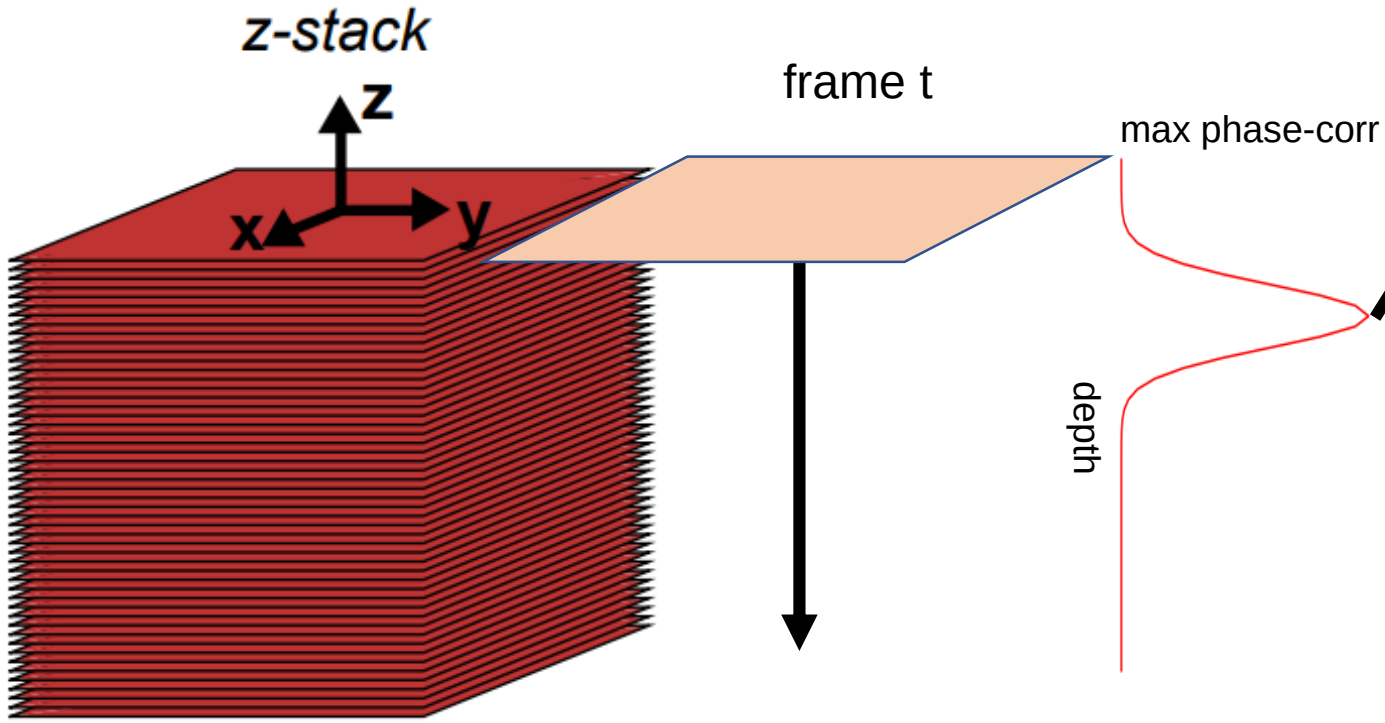


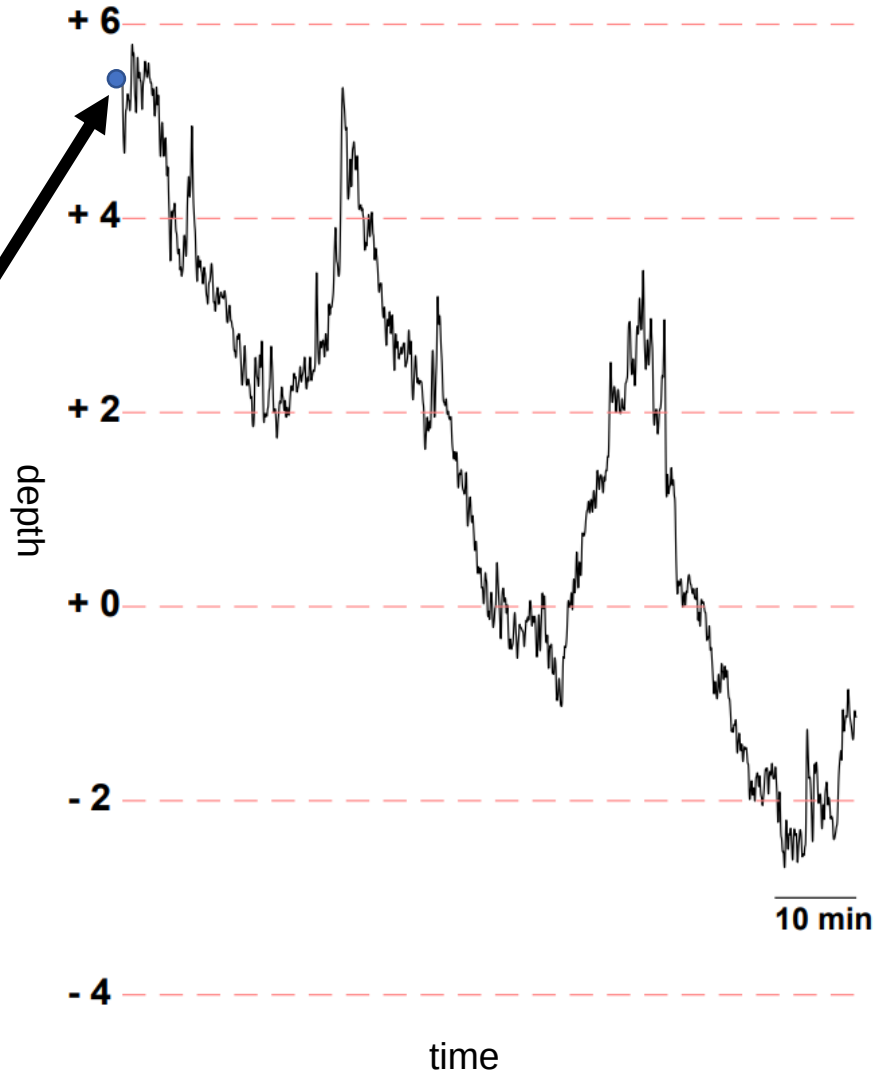
Keep unregistered movie

Drift in Z

How to compute it?

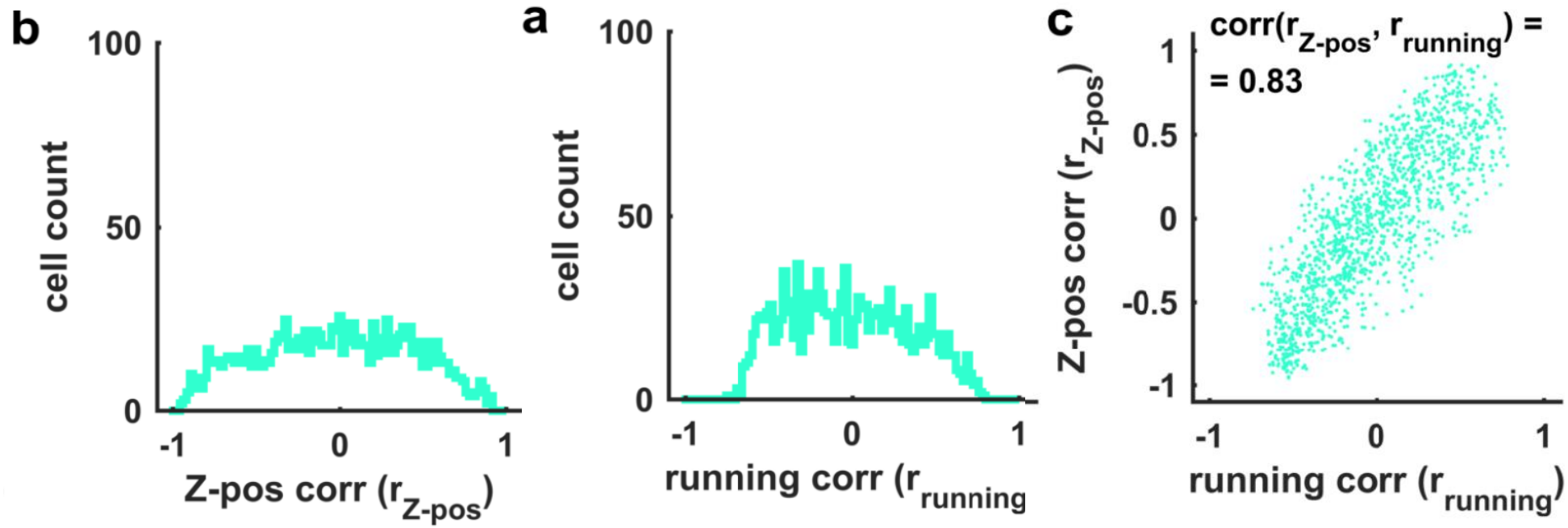
Take a z-stack and align each frame to it



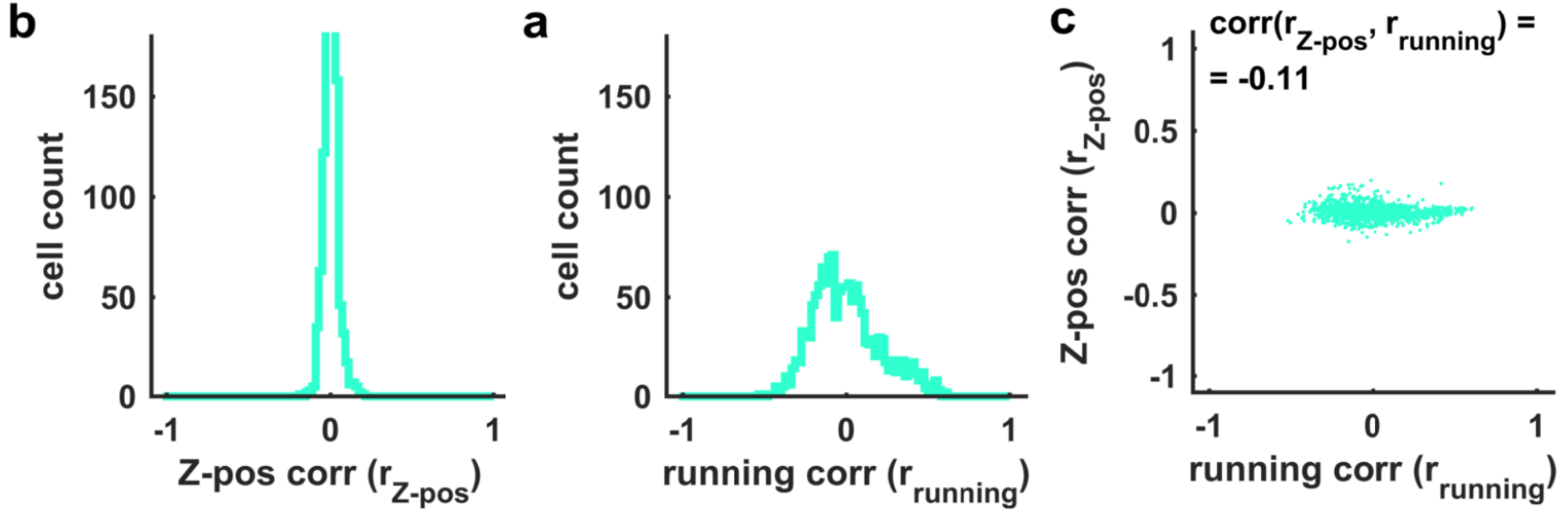


How does this drift affect neural activity?

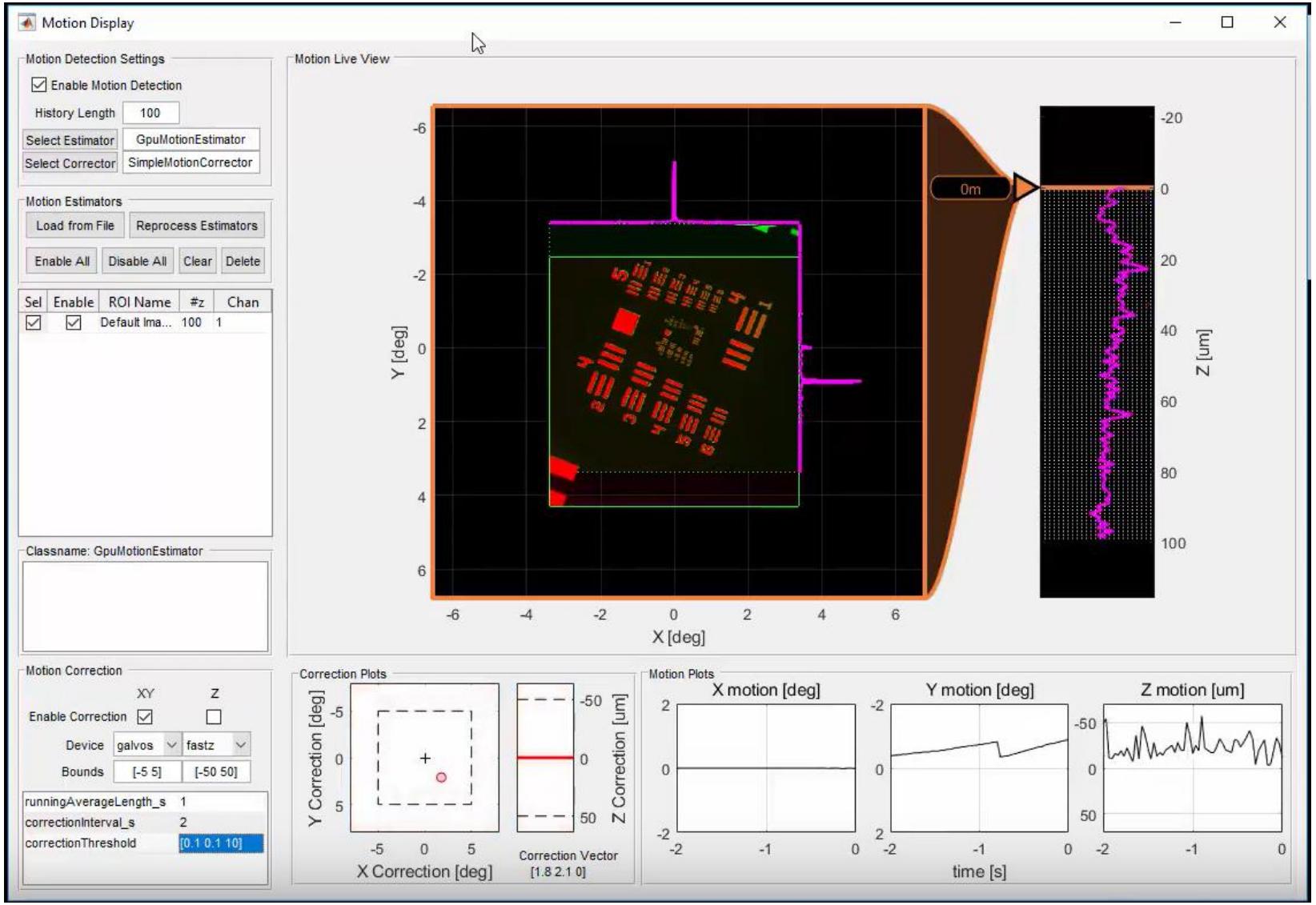
Drift in Z



"z-corrected"



Scanimage 2018 (free version) has automated z-drift correction!



Motion correction summary

- Be aware of different types of brain movements and how they might affect neural activity

- Perform online Z correction (if possible)