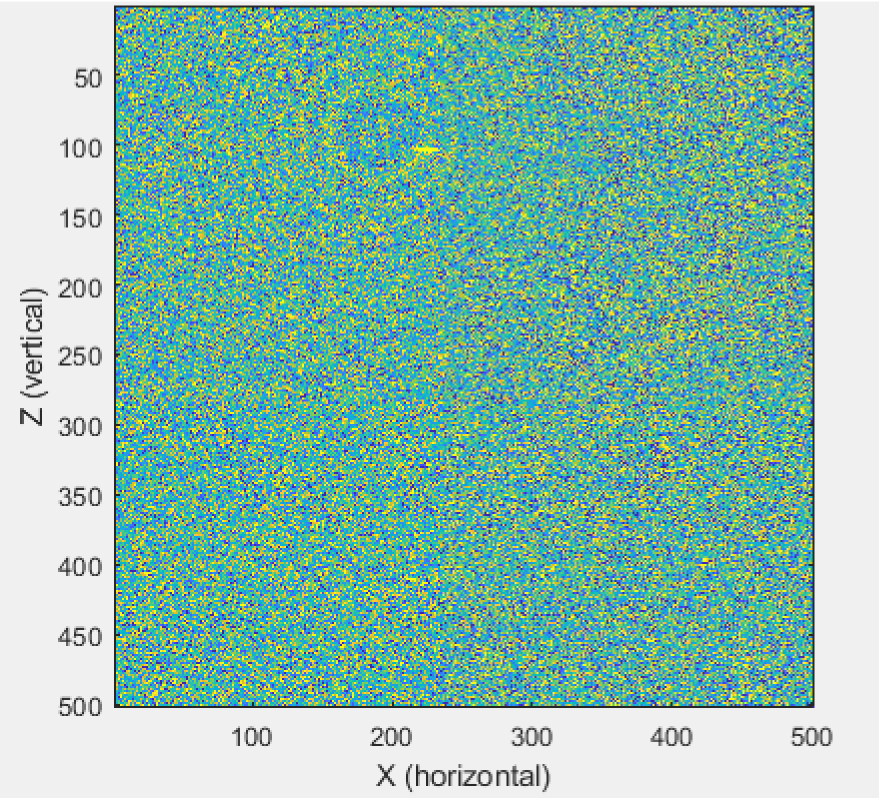
We use atom number from pixel summing in this section. From centre we take a region which is 6σ wide in both x and y directions. Where σ is the standard deviation of the gaussian fit to the cloud with high atom number (~3000).

Fringe removal.

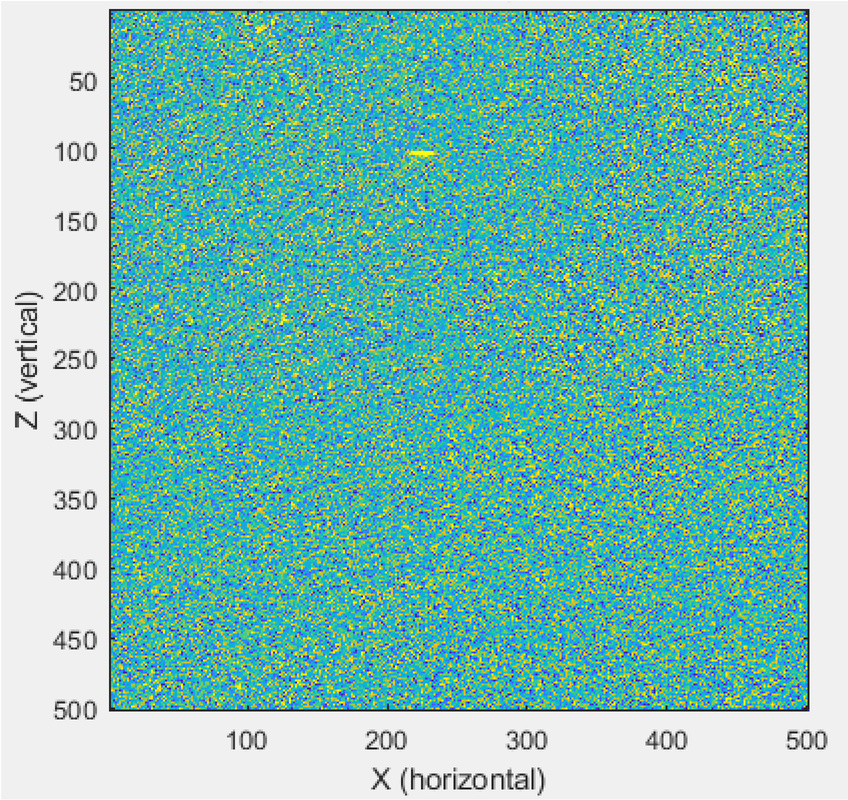
The fringes in images can be removed by two techniques,
One use linear superposition of different background images (sup) as described in PHYSICAL REVIEW A 82, 061606(R) (2010) which we call superposition algorithm here. The second uses principal component analysis (PCA) as described in Appl. Phys. Lett. 113, 144103 (2018).

Both algorithms are good at removing fringes as shown below. Sup takes ~ 1min and PCA ~2mins for ~100 background images. It will be lower for lower background images.

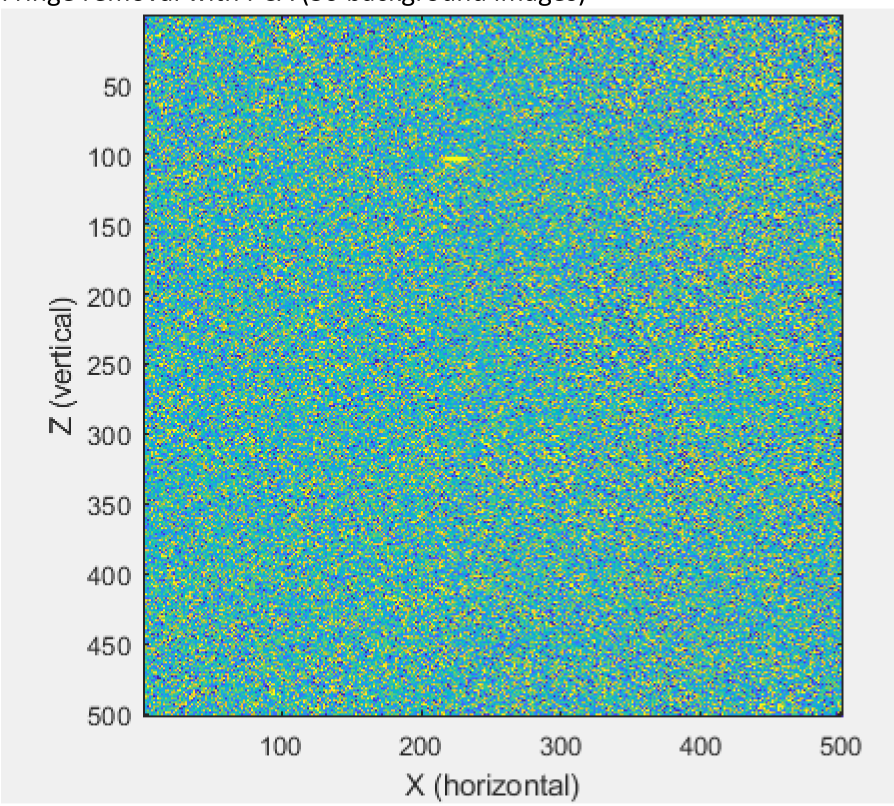
No fringe removal.



Fringe removal with Superposition (30 background images)

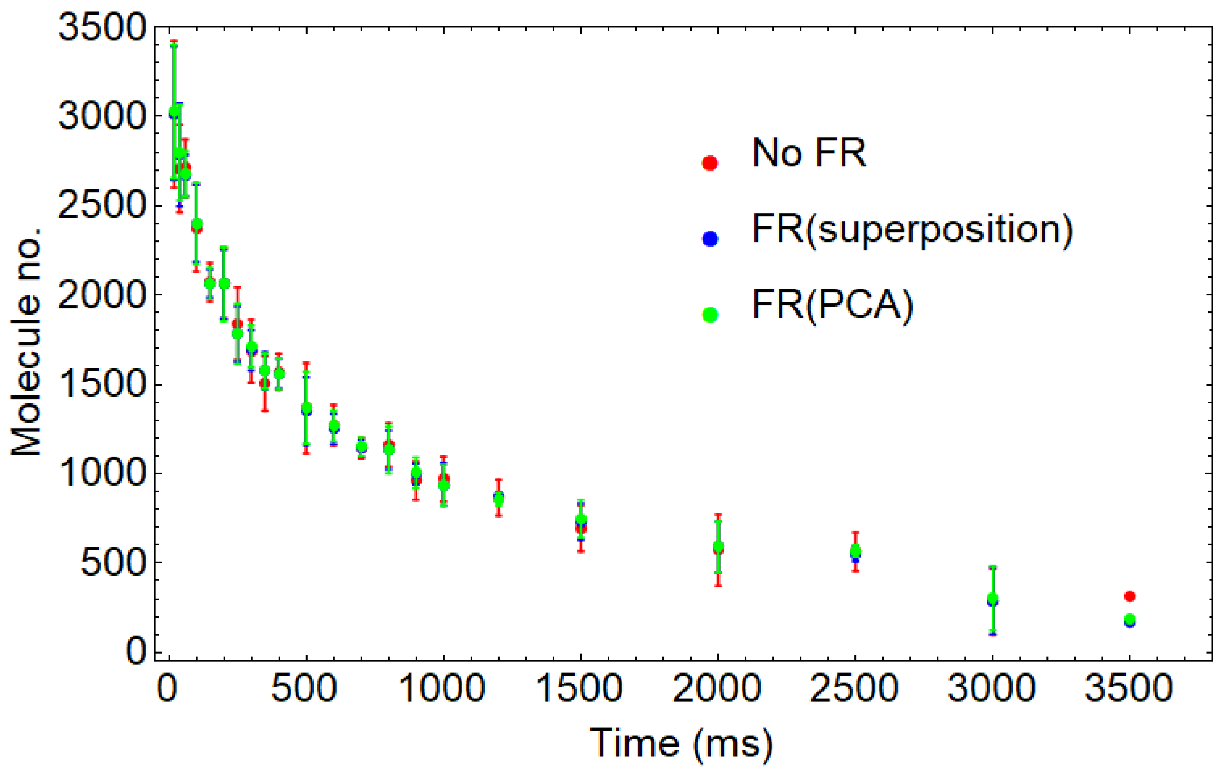


Fringe removal with PCA (30 background images)



Fringe removal statistics

To check the if the fringe removal is better for our experiment and not, we analysed data using the above algorithm for a molecule decay curve. I choose data which has one of the lowest shot-to-shot fluctuations. The results are shown below.



Importantly, the mean relative errors ($\sigma_{at.no.}/$at.no. x 100) for each method are,
No FR -> 14%
FR sup -> 11%
FR PCA -> 11.1%

If we take only the low molecule no. values, i.e. for time >= 1500ms.

No FR -> 8.7%
FR sup -> 6.7%
FR PCA -> 7.1%

For time 1200 ms,

No FR -> 11.7%
FR sup -> 2.9%
FR PCA -> 4.3%

To summarize, the algorithm for sup is faster and better at reducing the noise compared to the PCA algorithm. On average the noise can be reduced by ~ 3 % for the data set we used. The interesting thing is for some of the time points the reduction in noise is 3 times after using fringe removal.
In my opinion, this is best we can do with the imaging. Rest of the noise is shot-to-shot fluctuation.