Compact and Light-Weight Automated Semen Analysis Platform Using Lensfree on-Chip Microscopy

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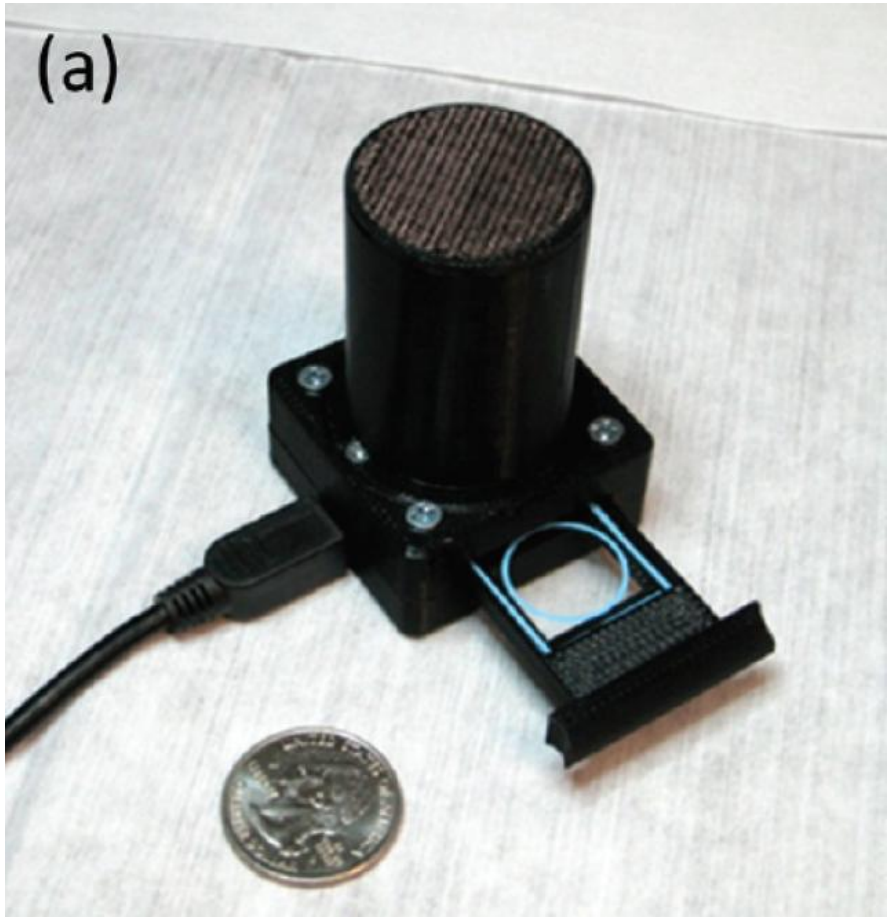
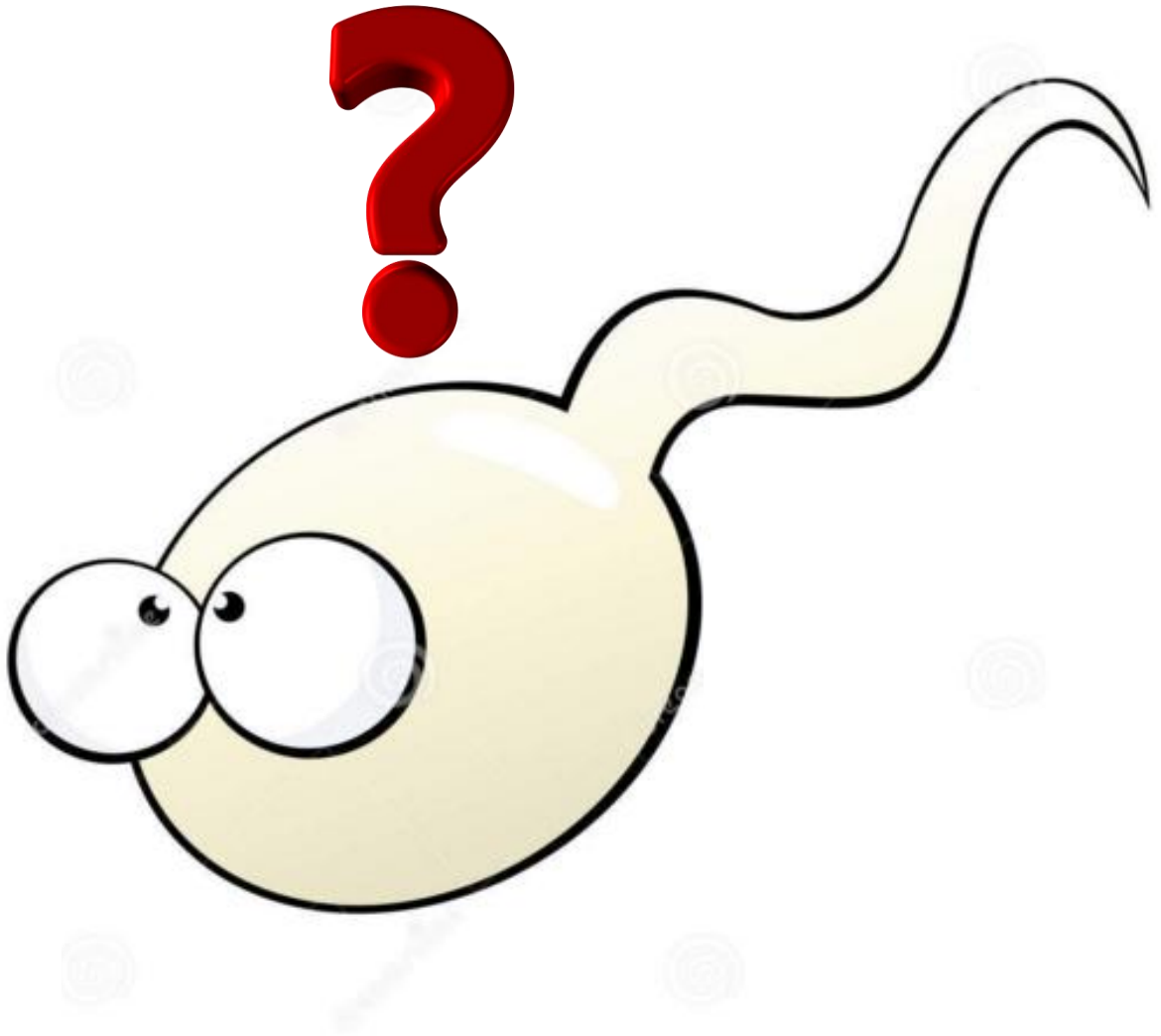
Presenter: DUCK-HA HWANG

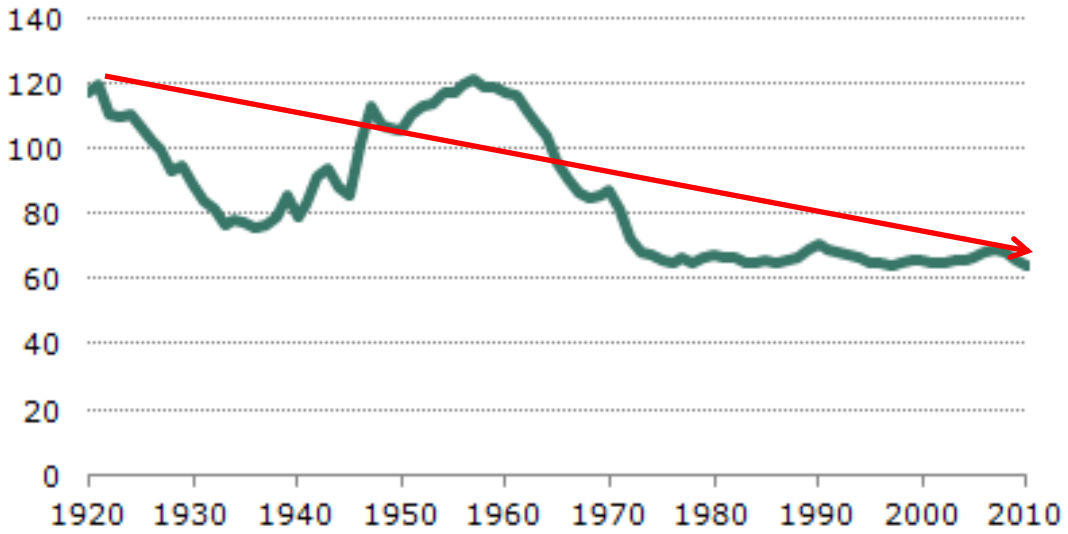

WHAT?


(a)



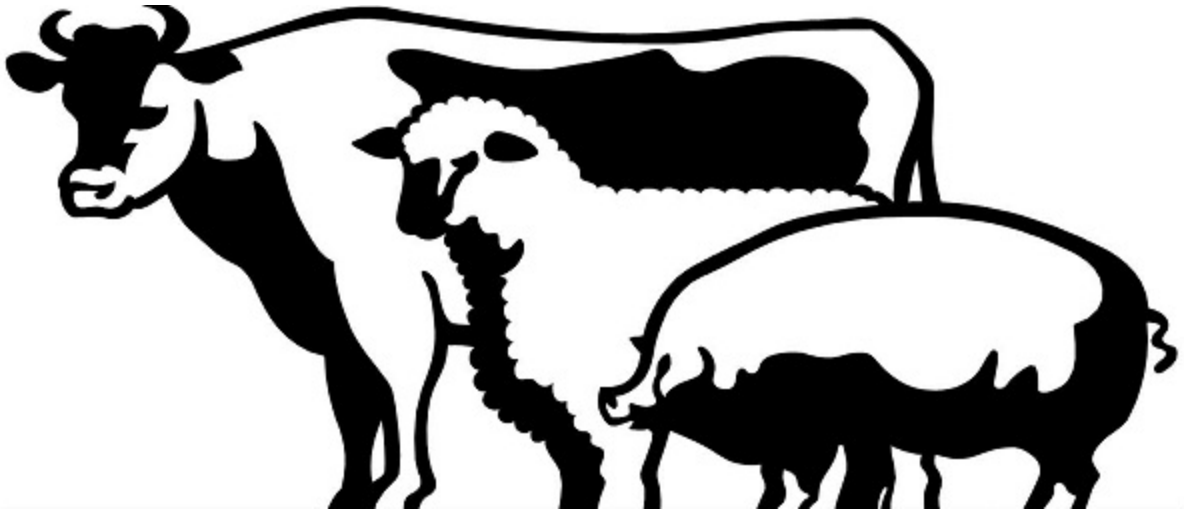
Birth Rates, 1920-2010

Births per 1,000 women ages 15-44



Source: Statistics calculated using data obtained from the National Center for Health Statistics and Heuser (1976), available here

PEW RESEARCH CENTER

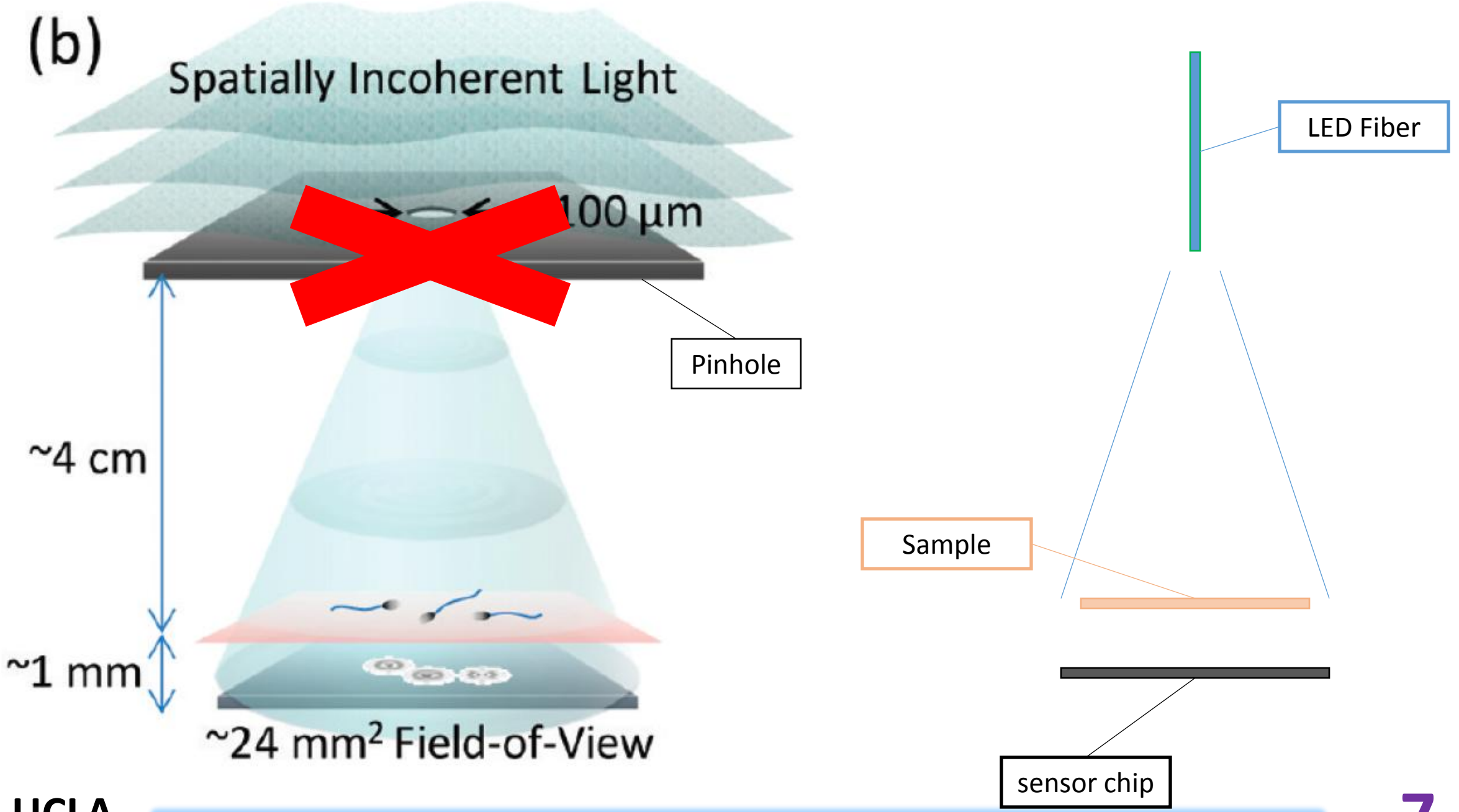


HOW?

Analysis Sperm's fertility

- **Digital subtraction of these consecutive lensfree frames, followed by appropriate processing of the reconstructed images**

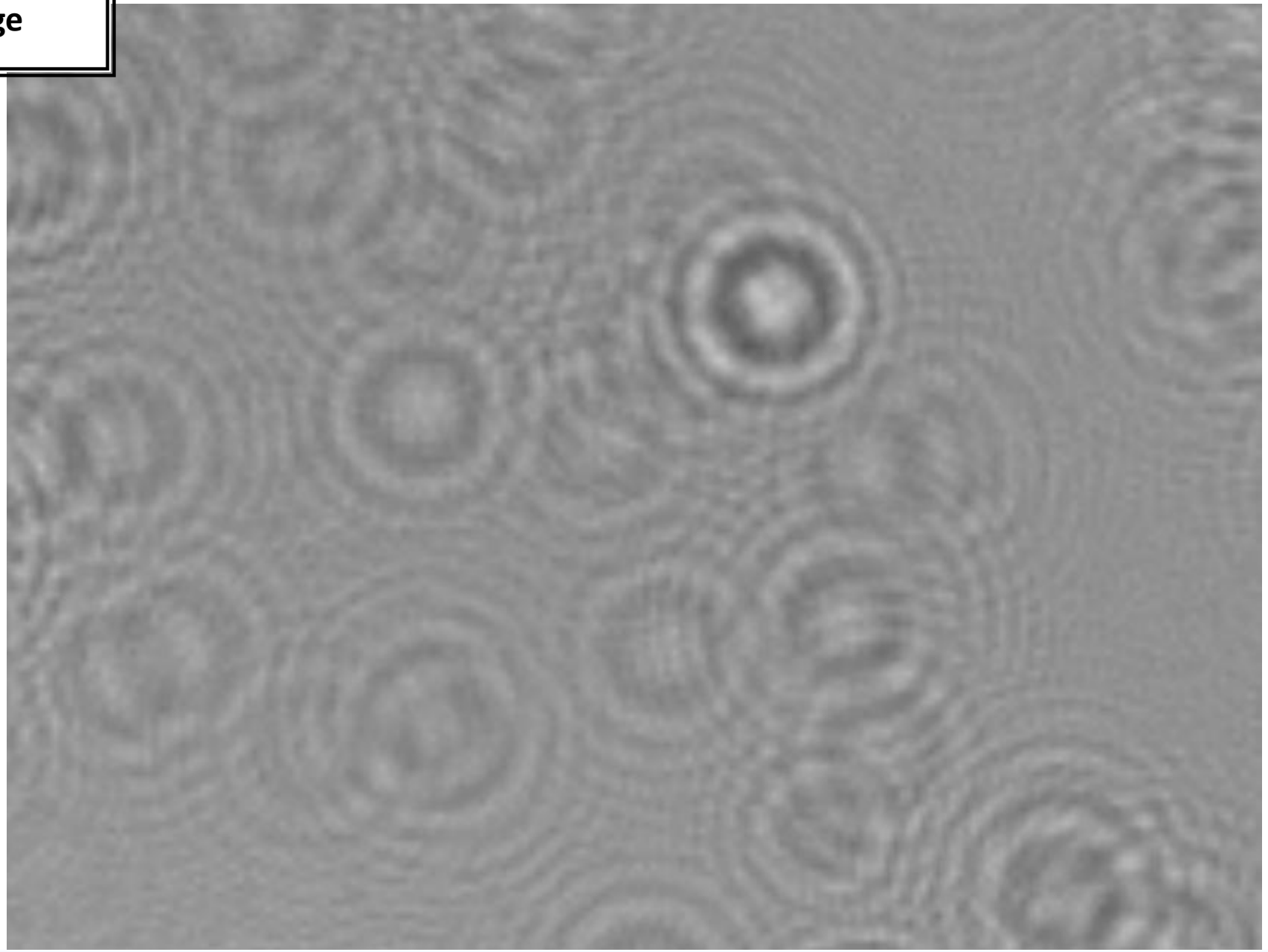
- **Density**
  - Count sperm on the image. (High density, High fertility)
- **Motility**
  - Count moving sperms, Count stationary sperms. (High motility, High fertility)
- **Speed**
  - Calculate speed using the dynamic trajectories of motile sperms(High speed, High fertility)


(b)
Spatially Incoherent Light
100 µm
Pinhole
~4 cm
~1 mm
~24 mm² Field-of-View
LED Fiber
Sample
sensor chip

Recorded Hologram

UCLA

Zoom in Image

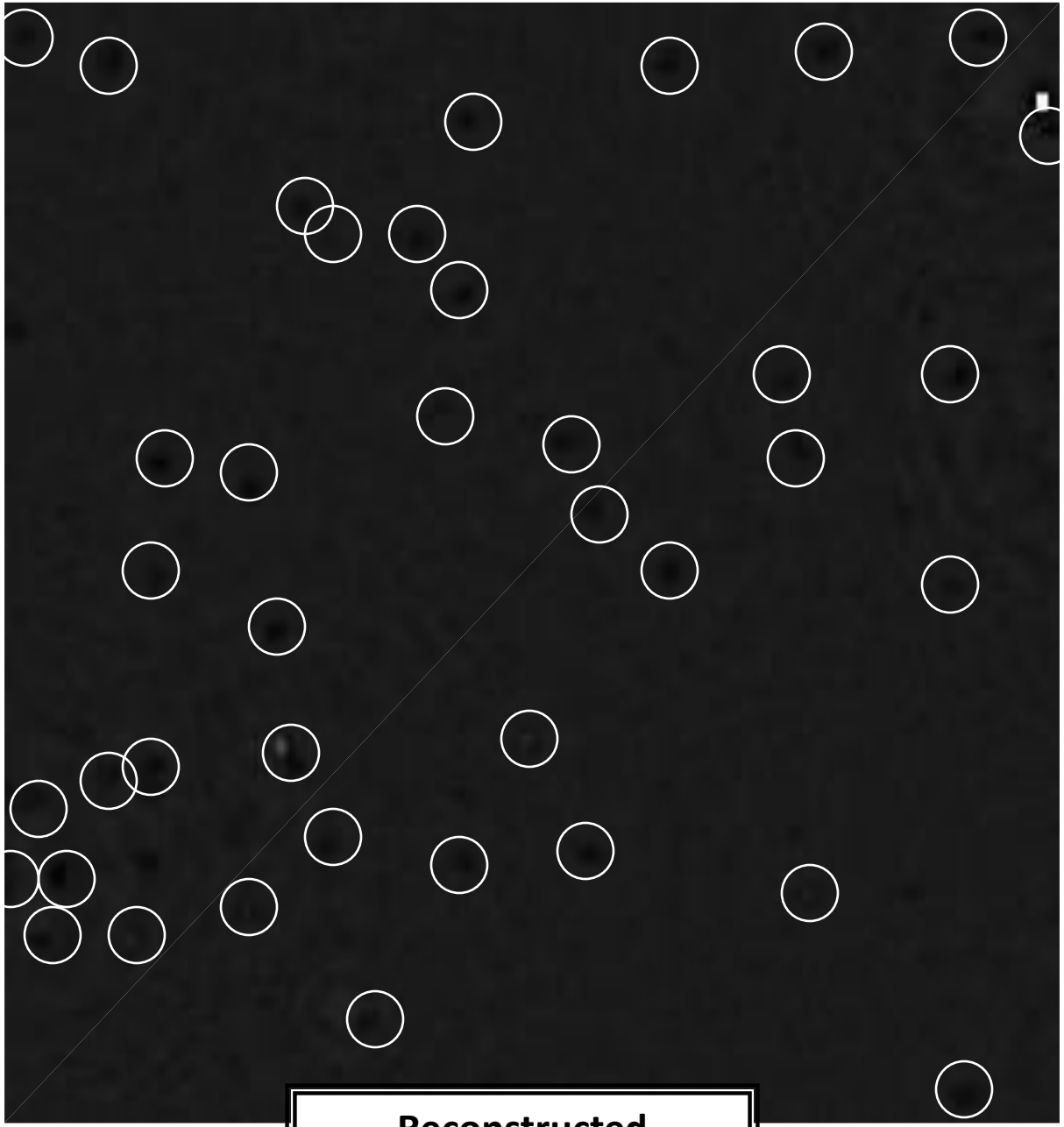


Reconstruct Image
(Computational Process)

- Phase

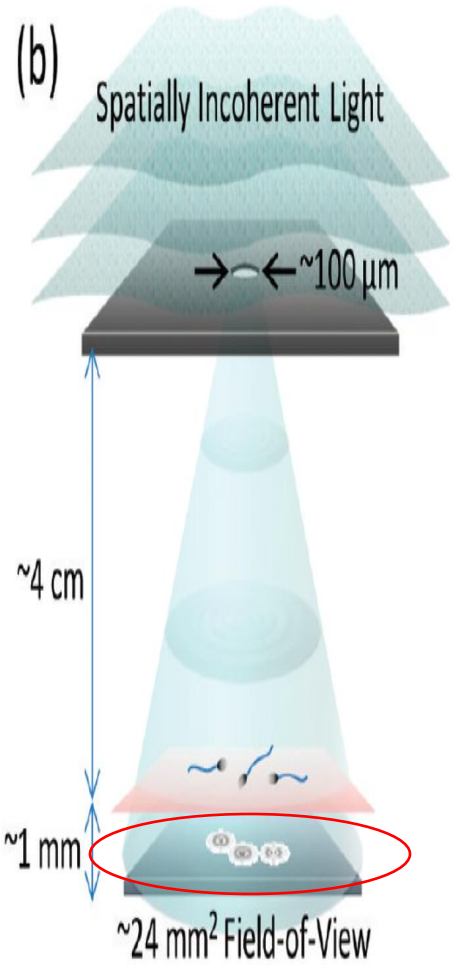
- Amplitude

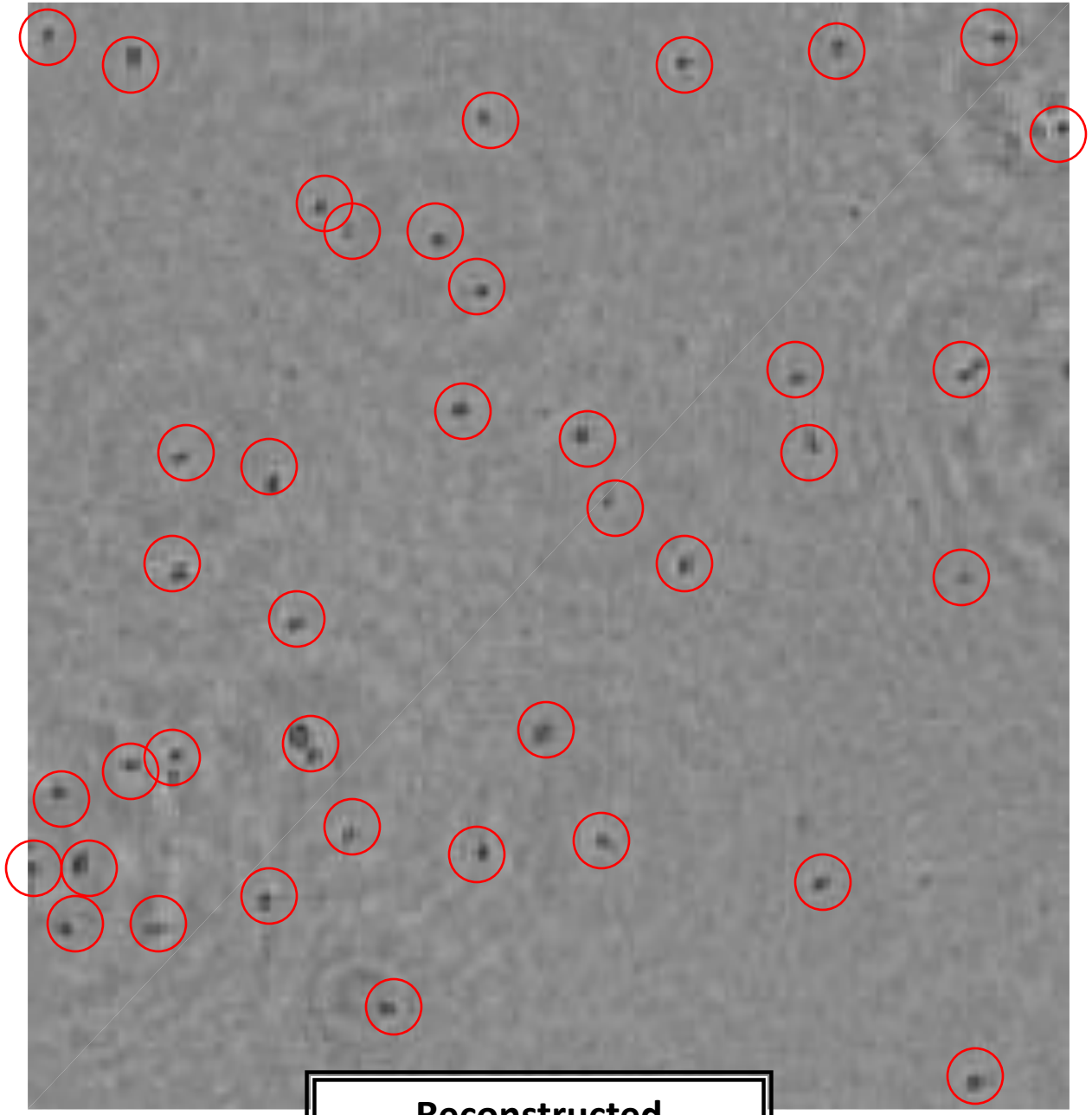
Hologram Image



Sperms' Head

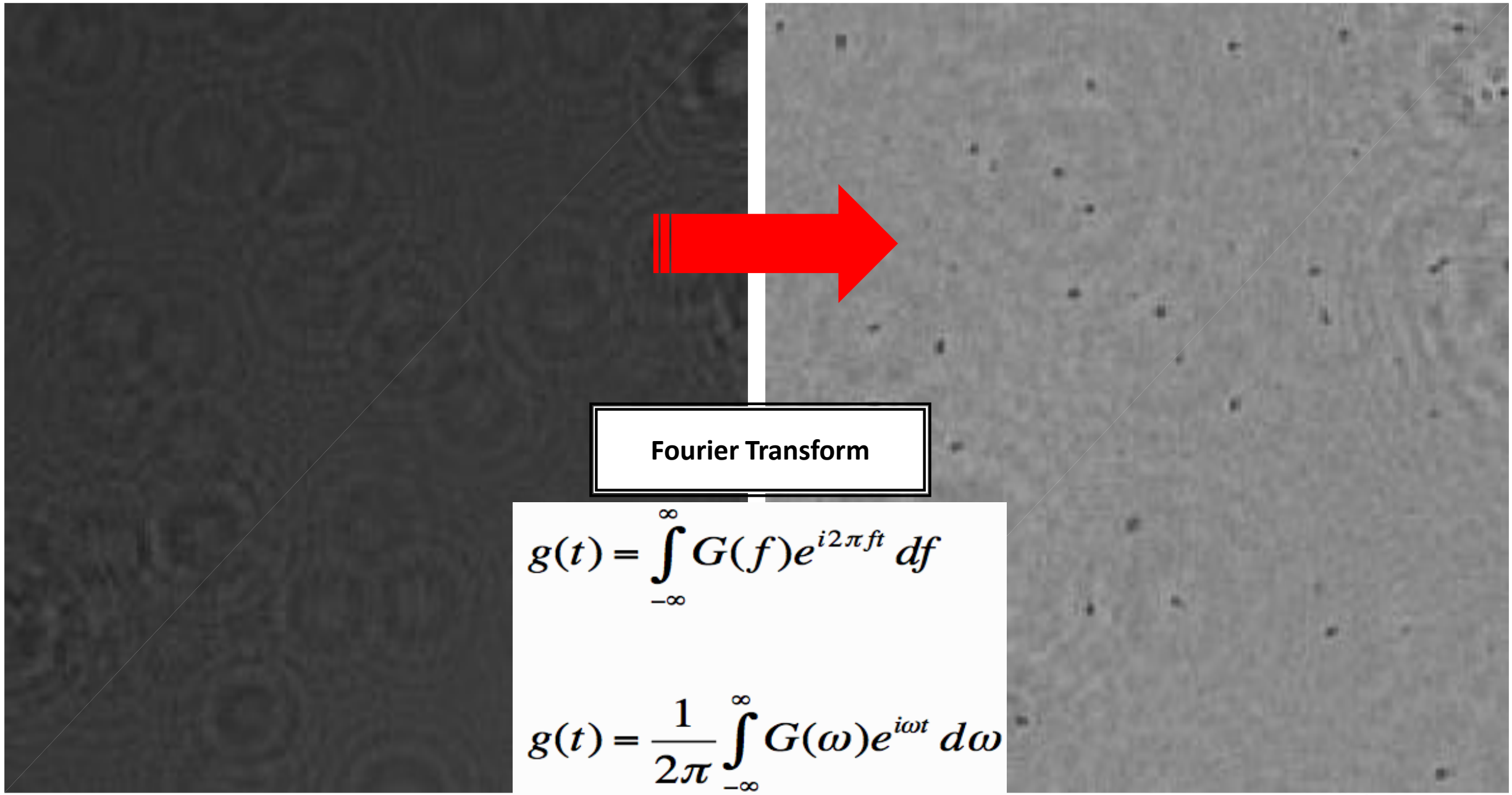
Reconstructed
Phase Image





Reconstructed Amplitude Image

Sperms' Head

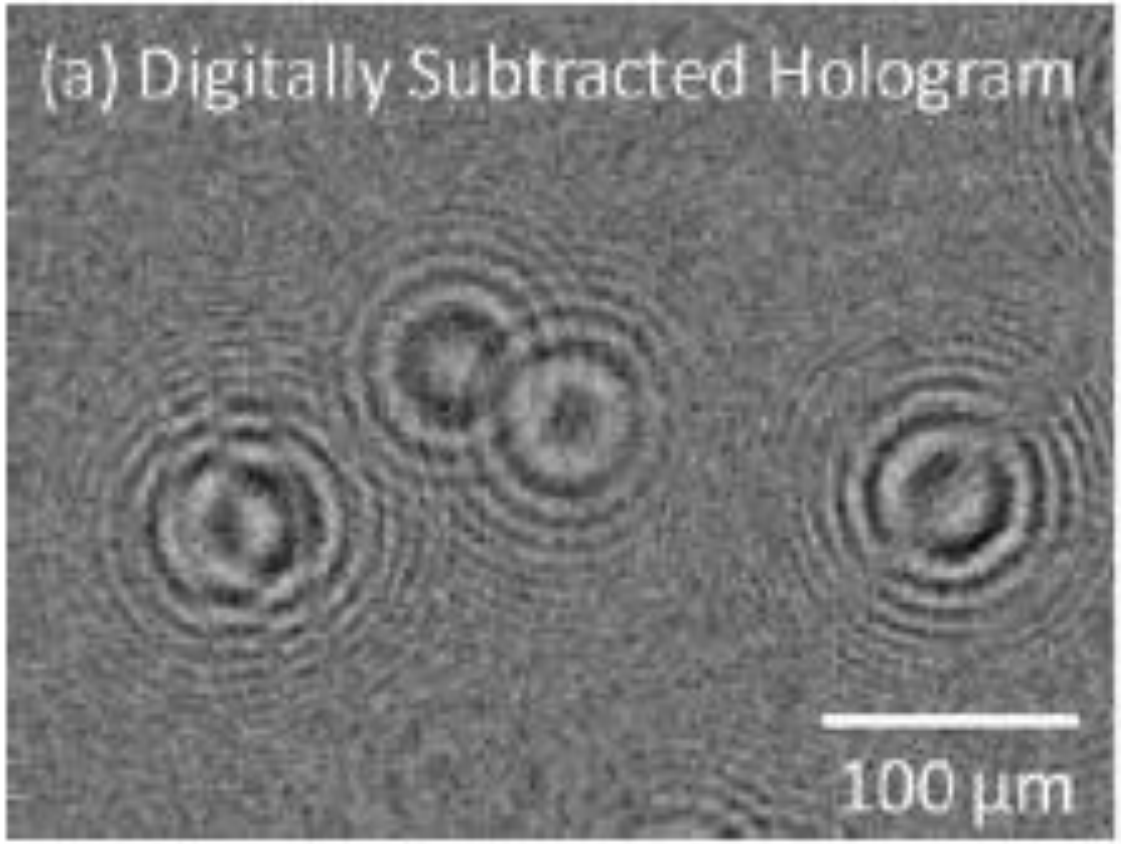


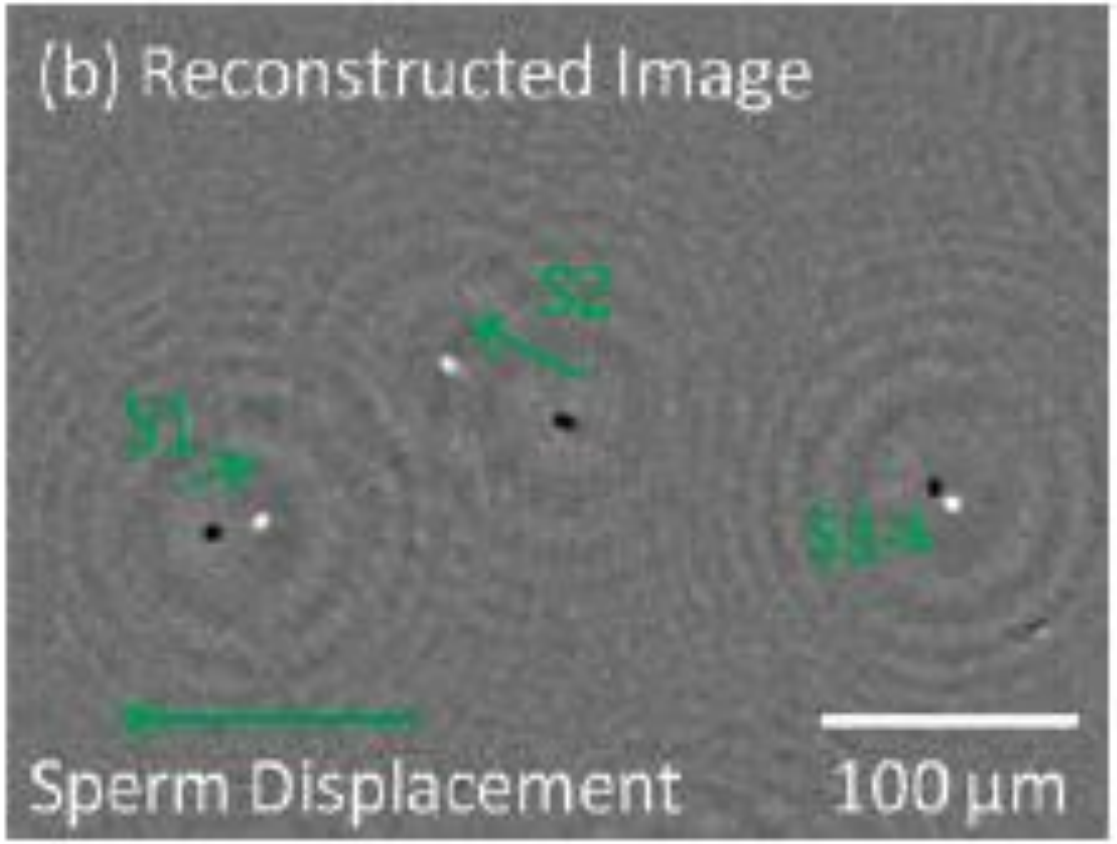
Fourier Transform

$$g(t) = \int_{-\infty}^{\infty} G(f) e^{i2\pi ft}\, df$$

$$g(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} G(\omega) e^{i\omega t}\, d\omega$$

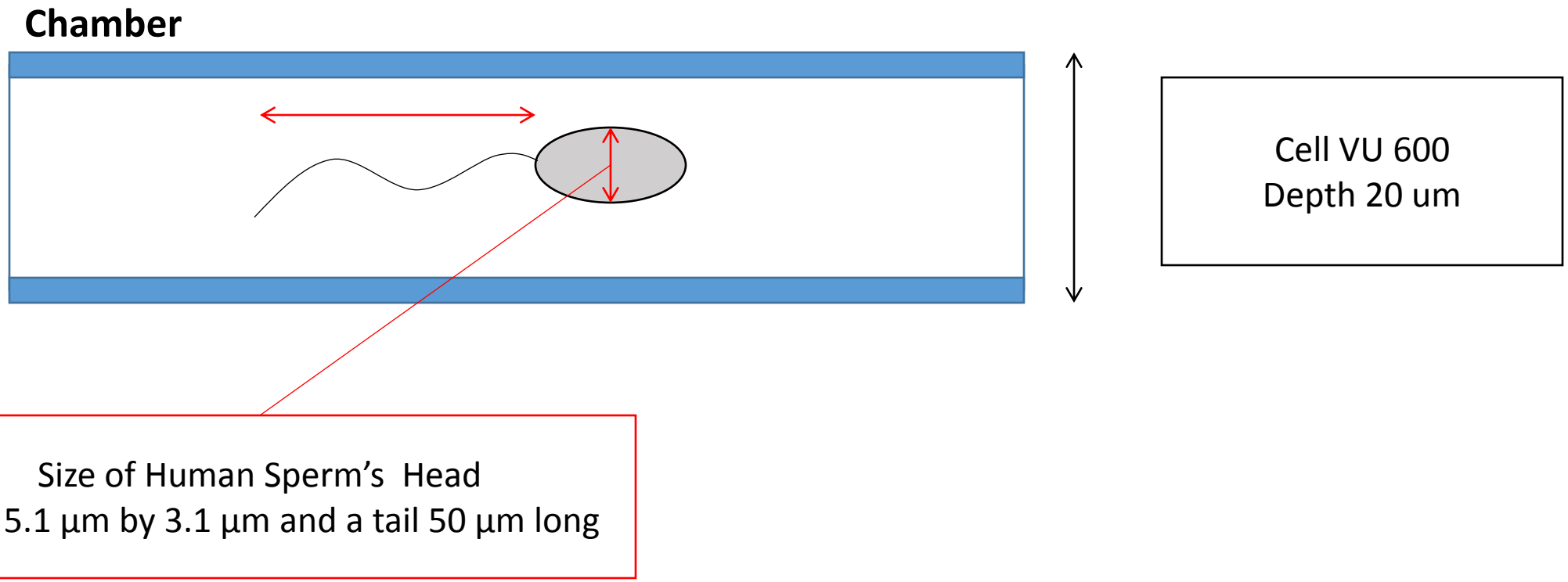
Sperms' 2D Trajectory



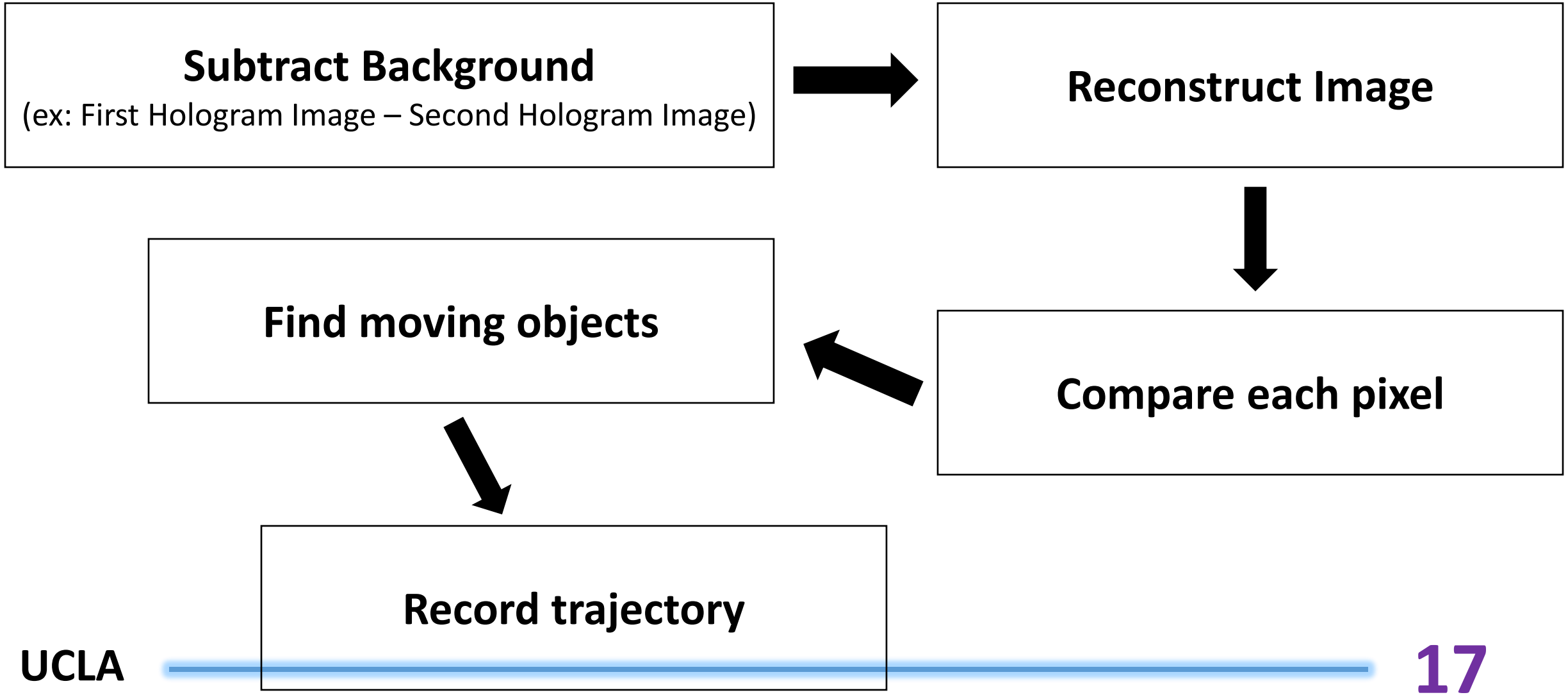


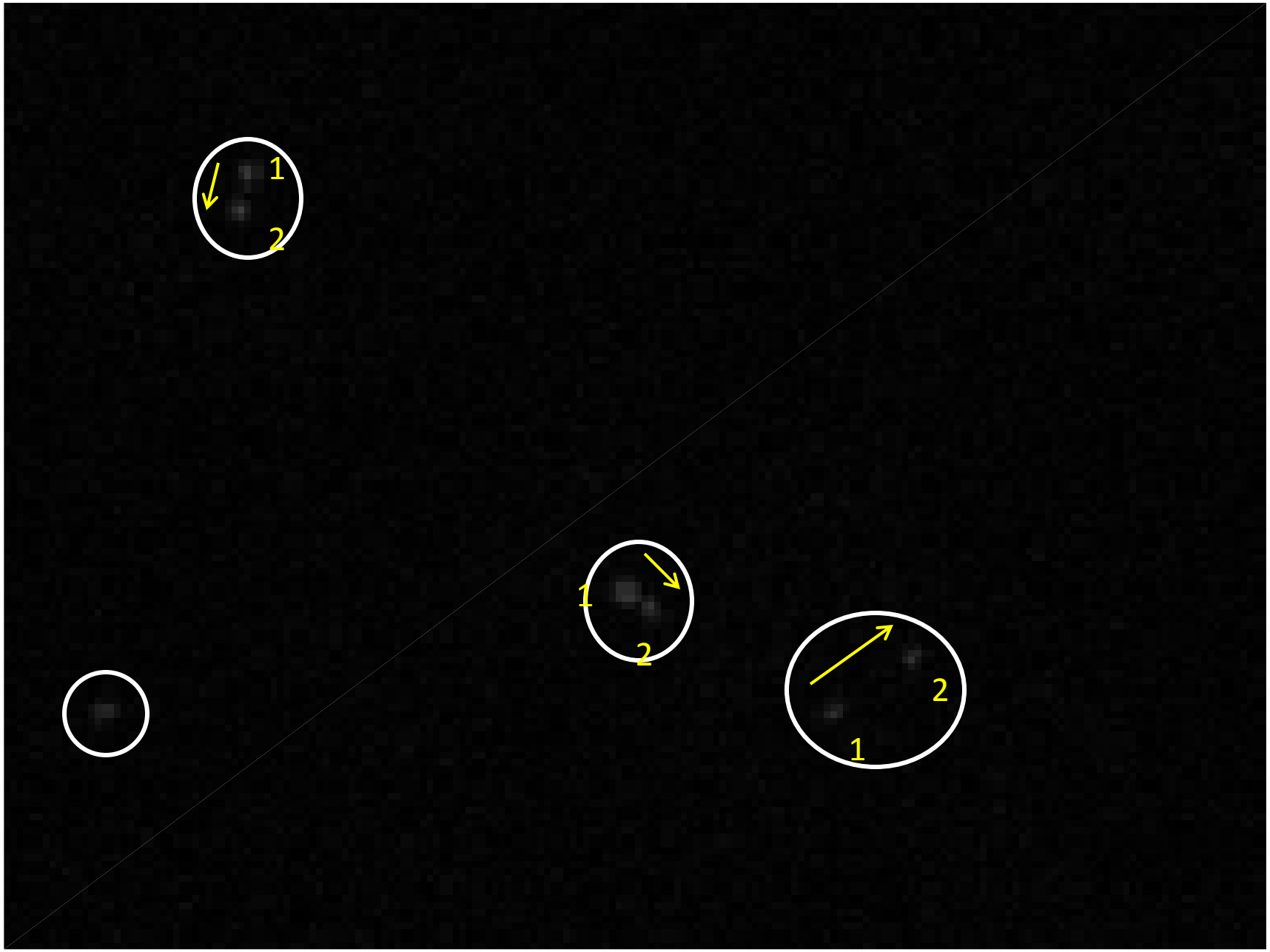
WHY?

~~3D~~-> 2D trajectory

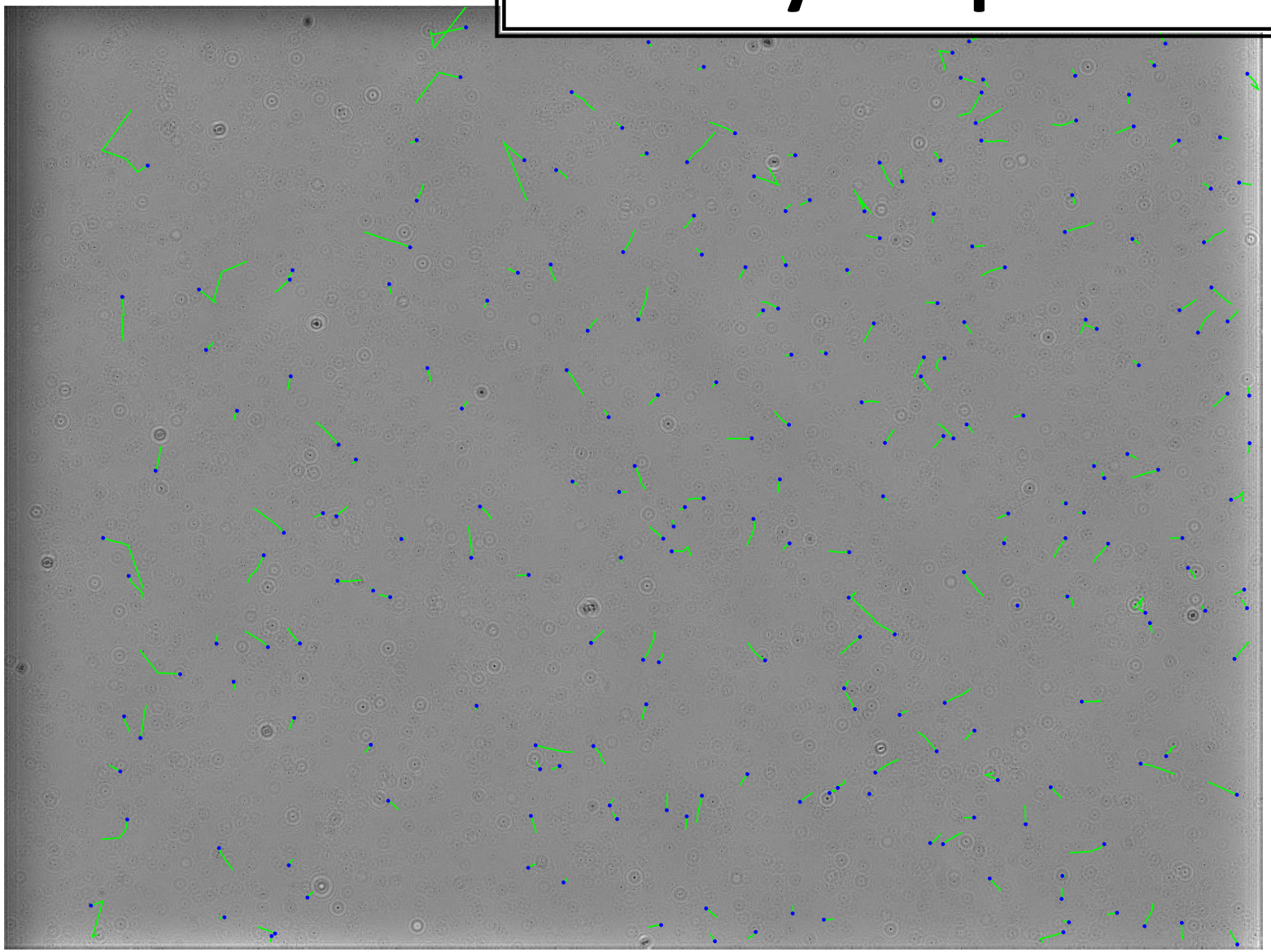


HOW?

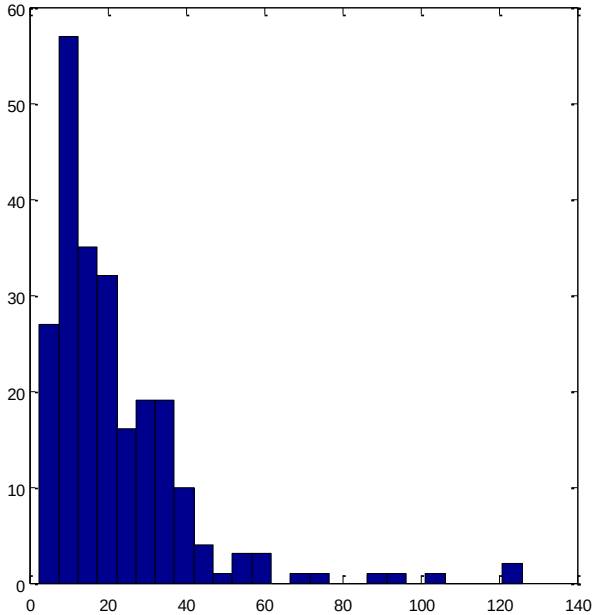

Subtract Background
(ex: First Hologram Image – Second Hologram Image)
Reconstruct Image
Compare each pixel
Find moving objects
Record trajectory


1
2
1
2
2
1

Analysis Sperms



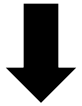
Count (number of sperm): 233
Median (speed): 16.4004 um/sec
Mean (speed): 21.9802 um/sec



Motility

Stationary sperms

Average hologram image
(Combine each frame and divided by number)

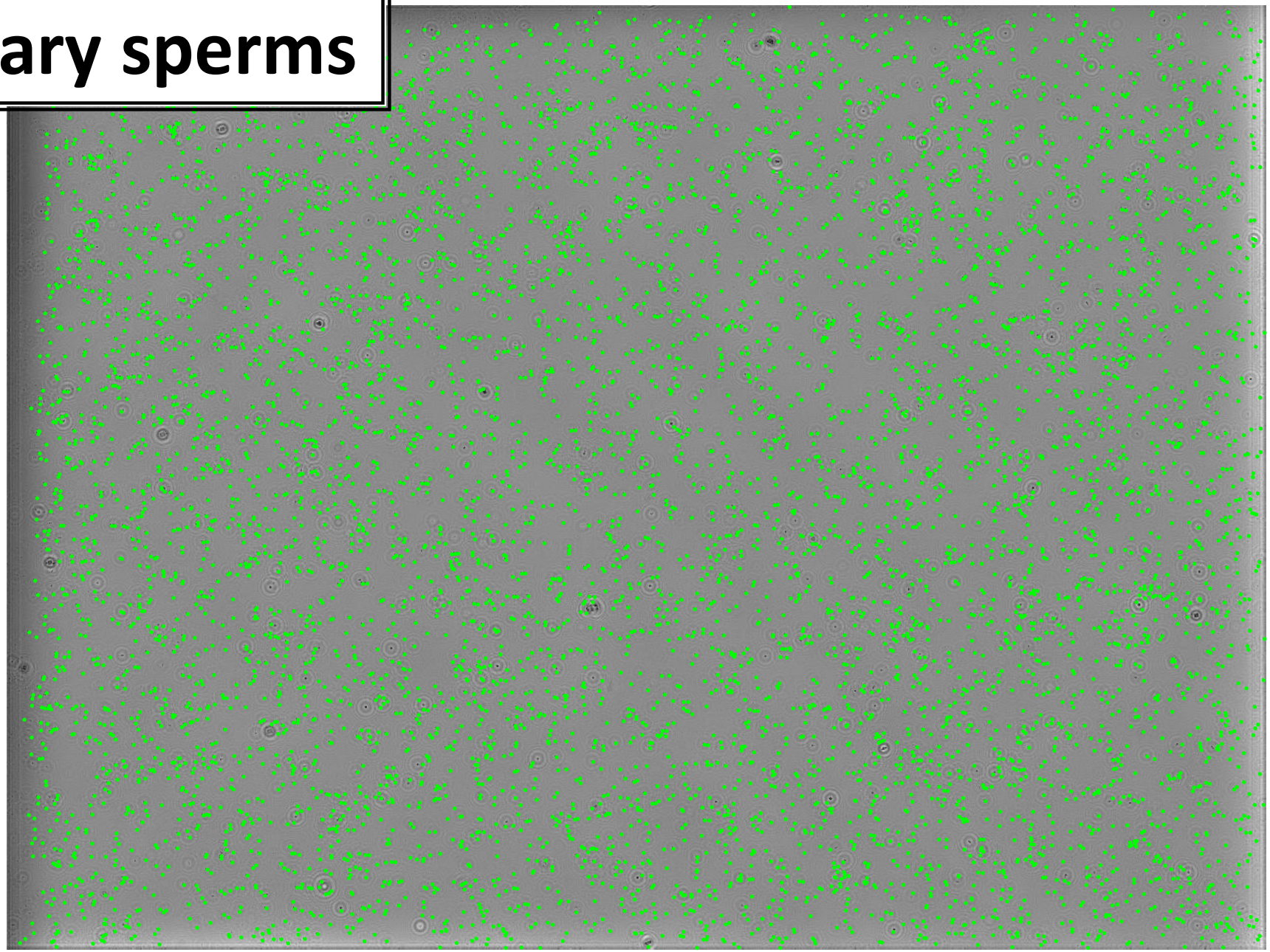


leave stationary ones

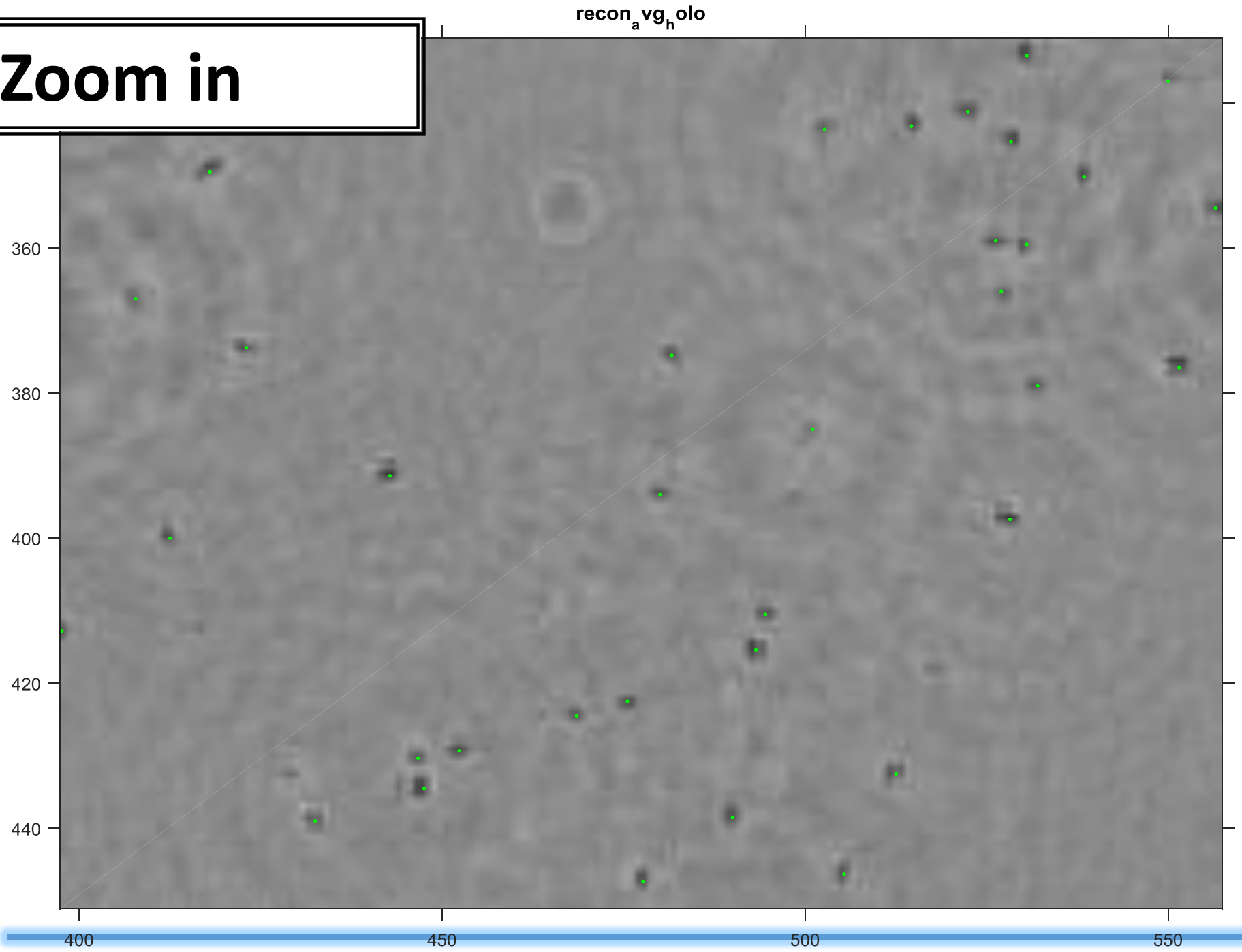
Count stationary sperms

Moving sperms

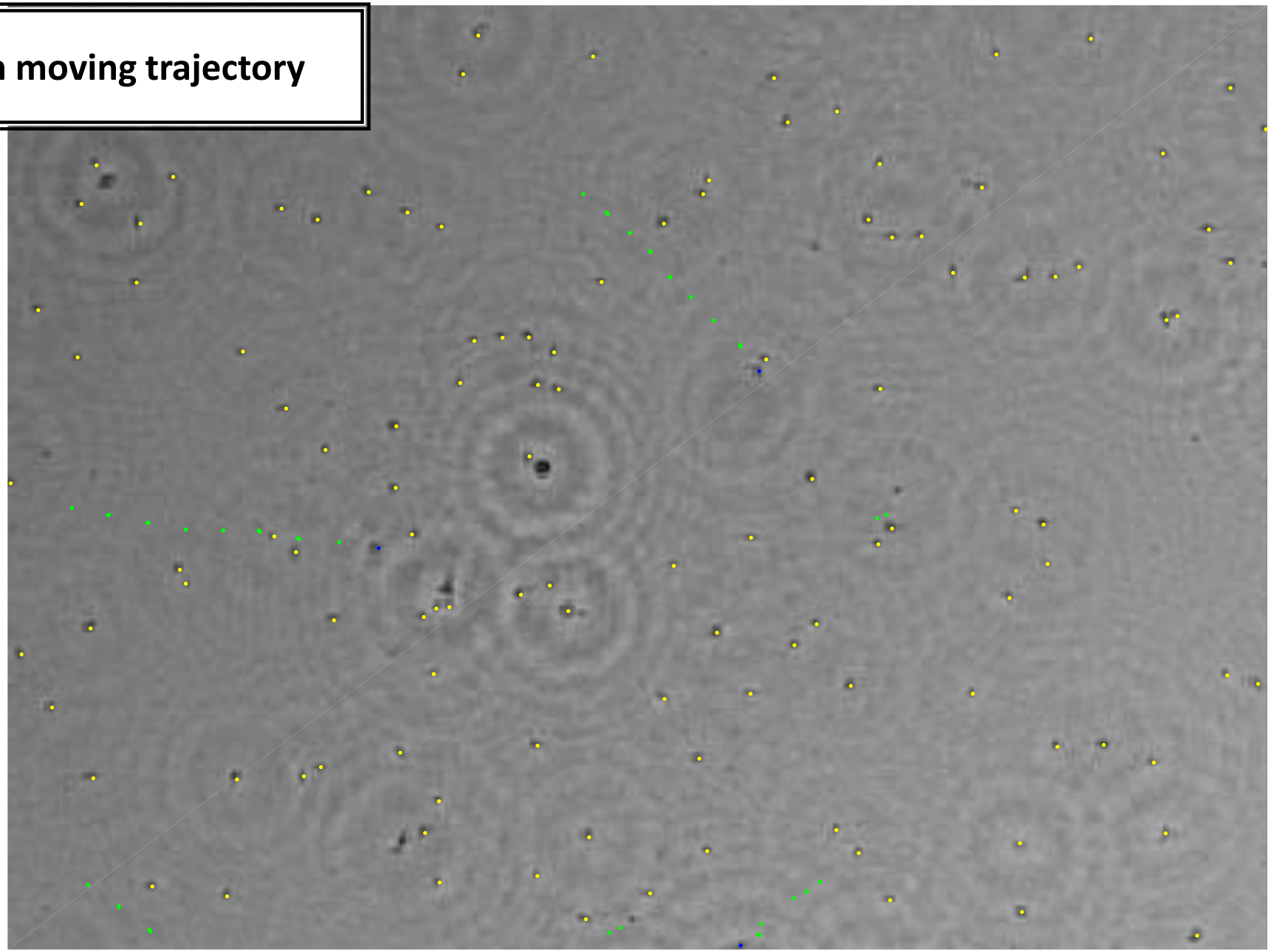
Stationary sperms



Zoom in

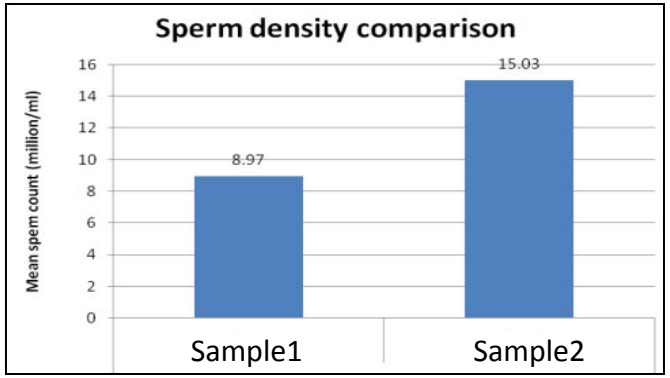


Compare with moving trajectory

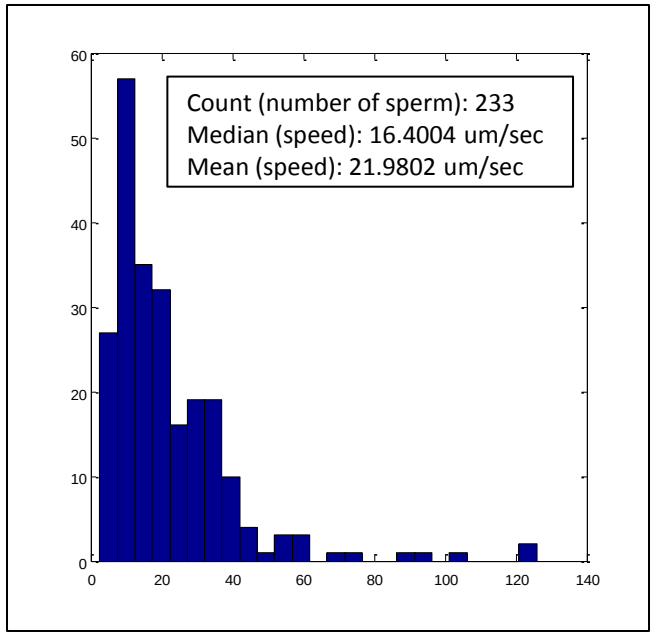


Analysis Fertility of sperms

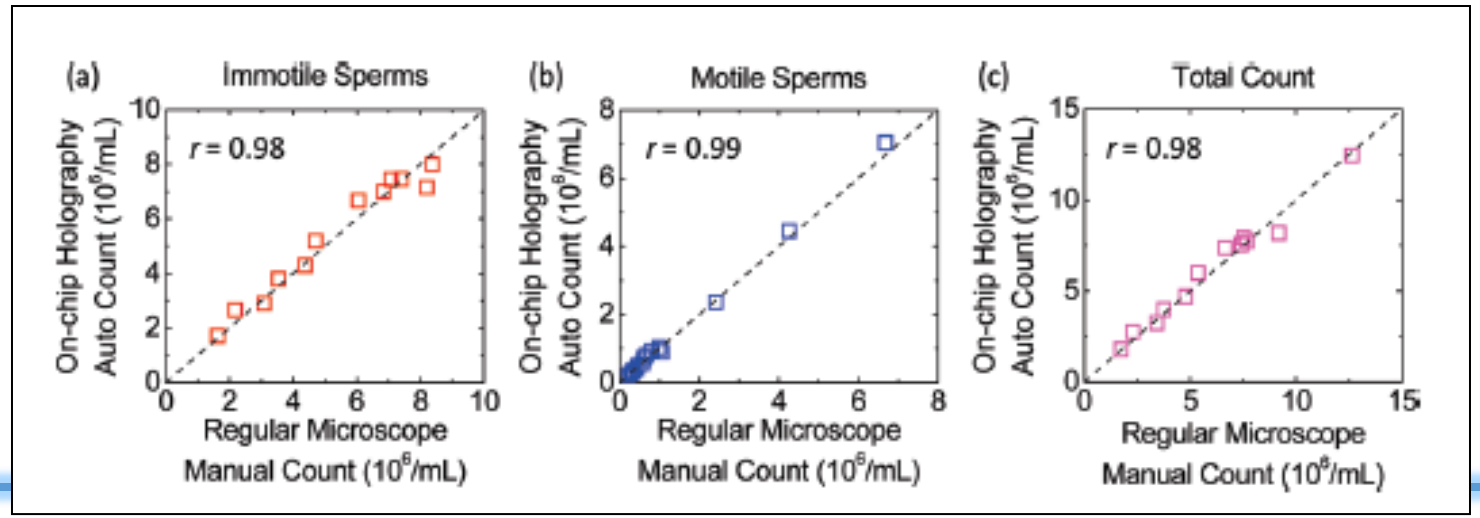
Density



Speed



Motility



WHAT?

Commercialization

- **More widespread Lens-free Microscopes**
  - -Cost effective
  - -Easy user interface
  - -Fast analysis
  - -Simple product
  - -Design

Conclusion

END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A
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