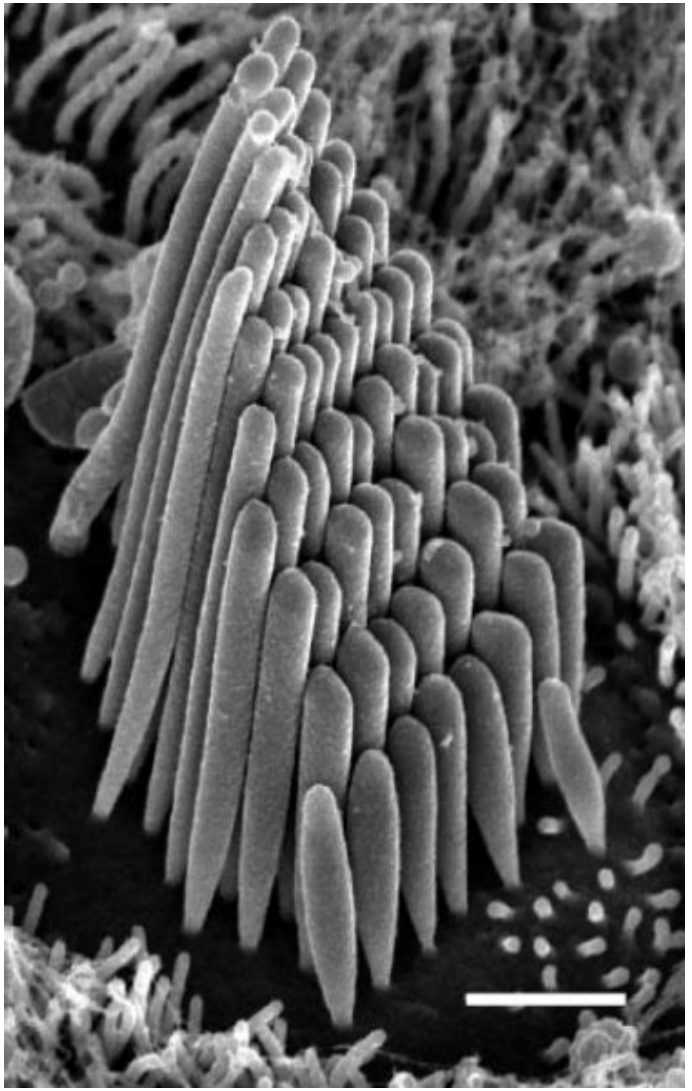
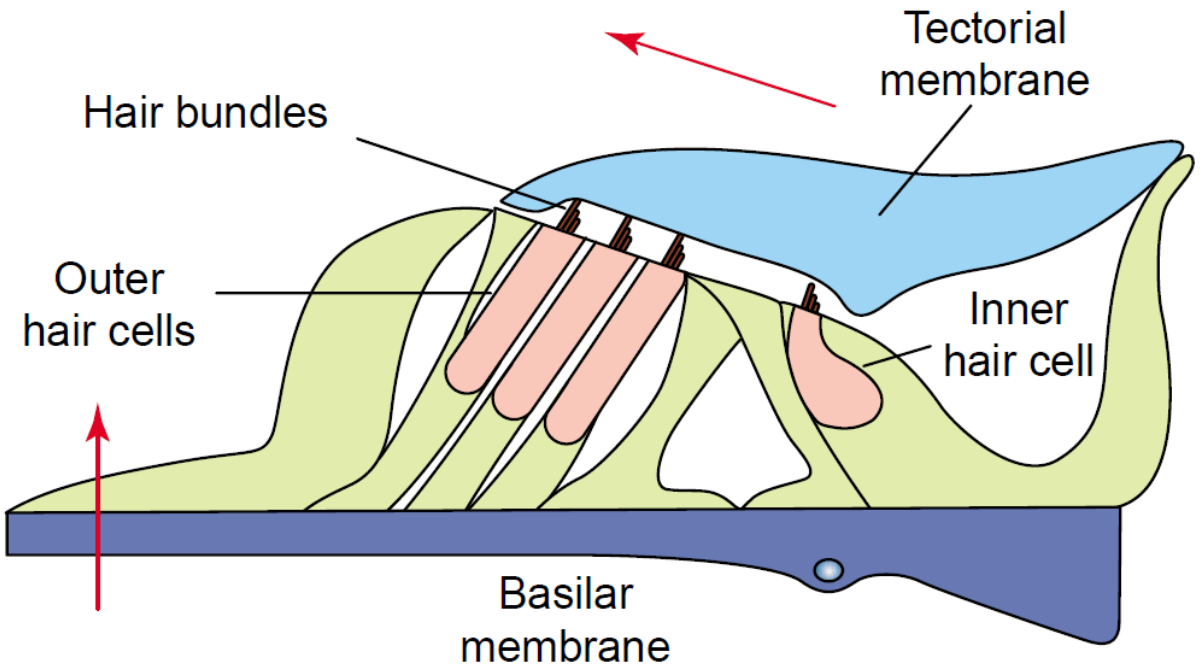


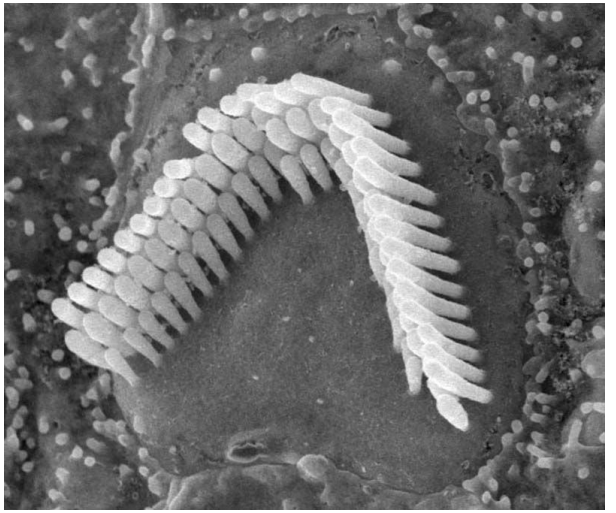
MEMS for High Speed Force Sensing

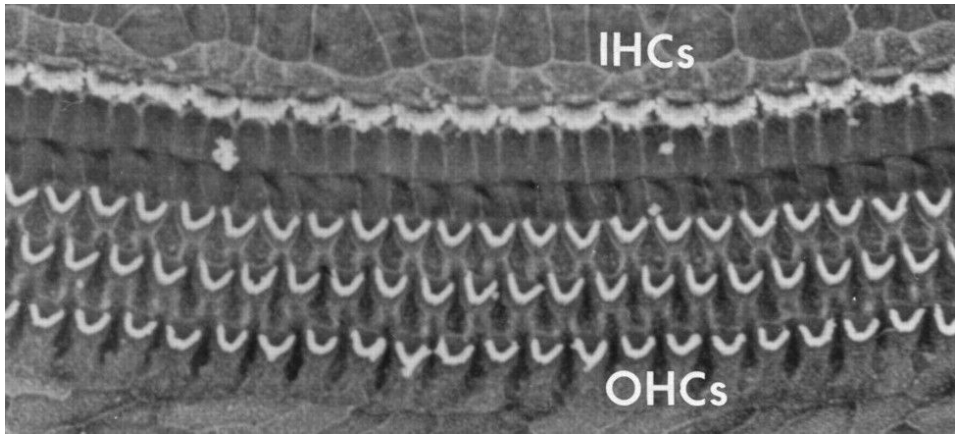
Joey Doll

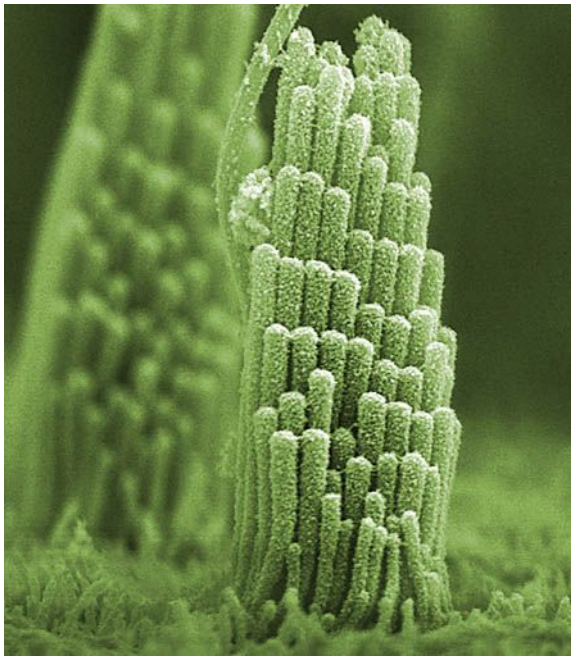
Feb. 23, 2011

Structure of the Cochlea

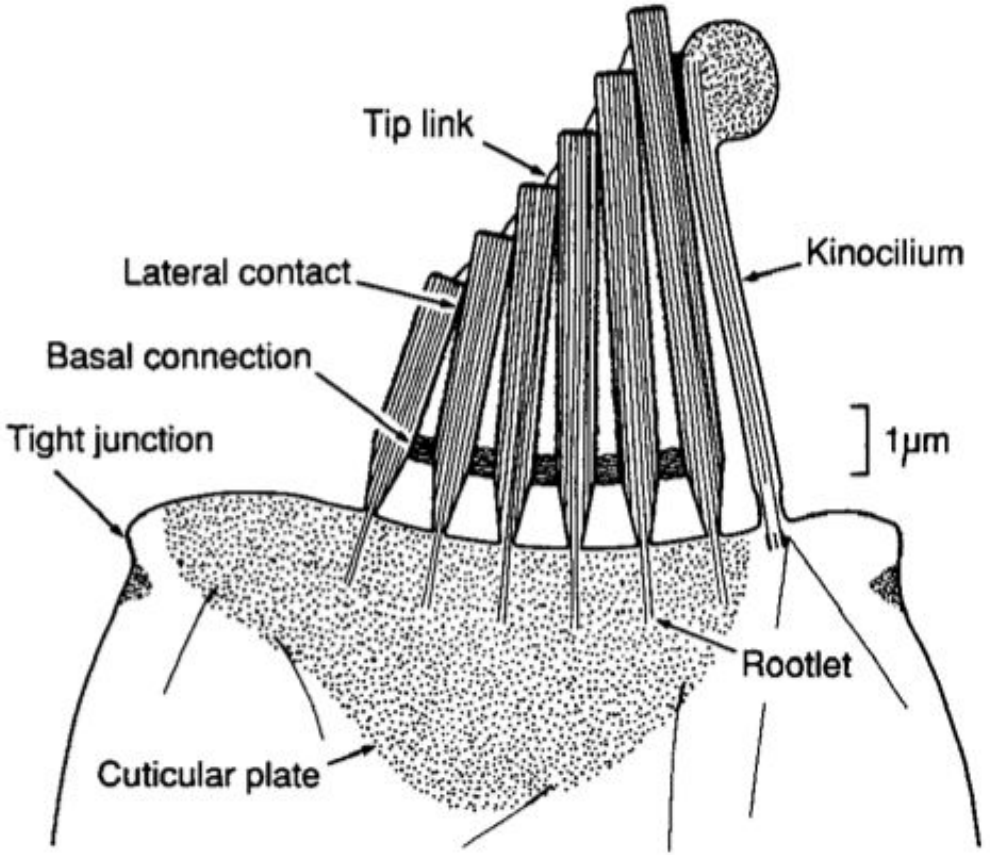


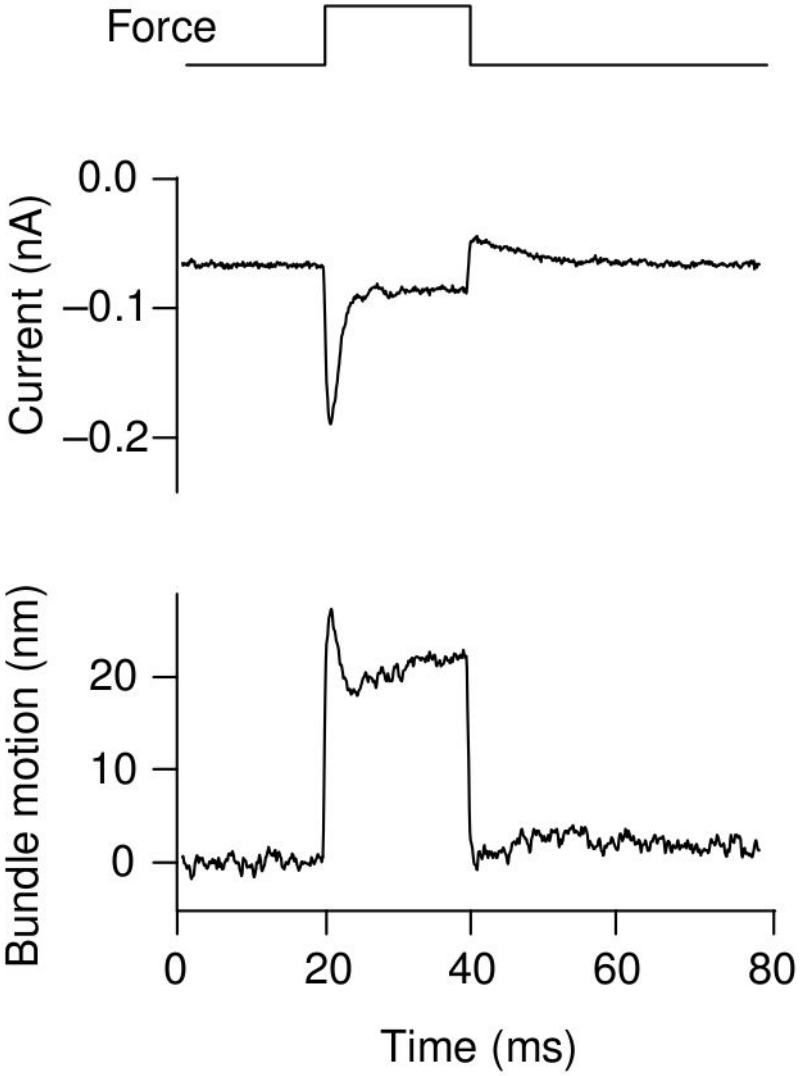




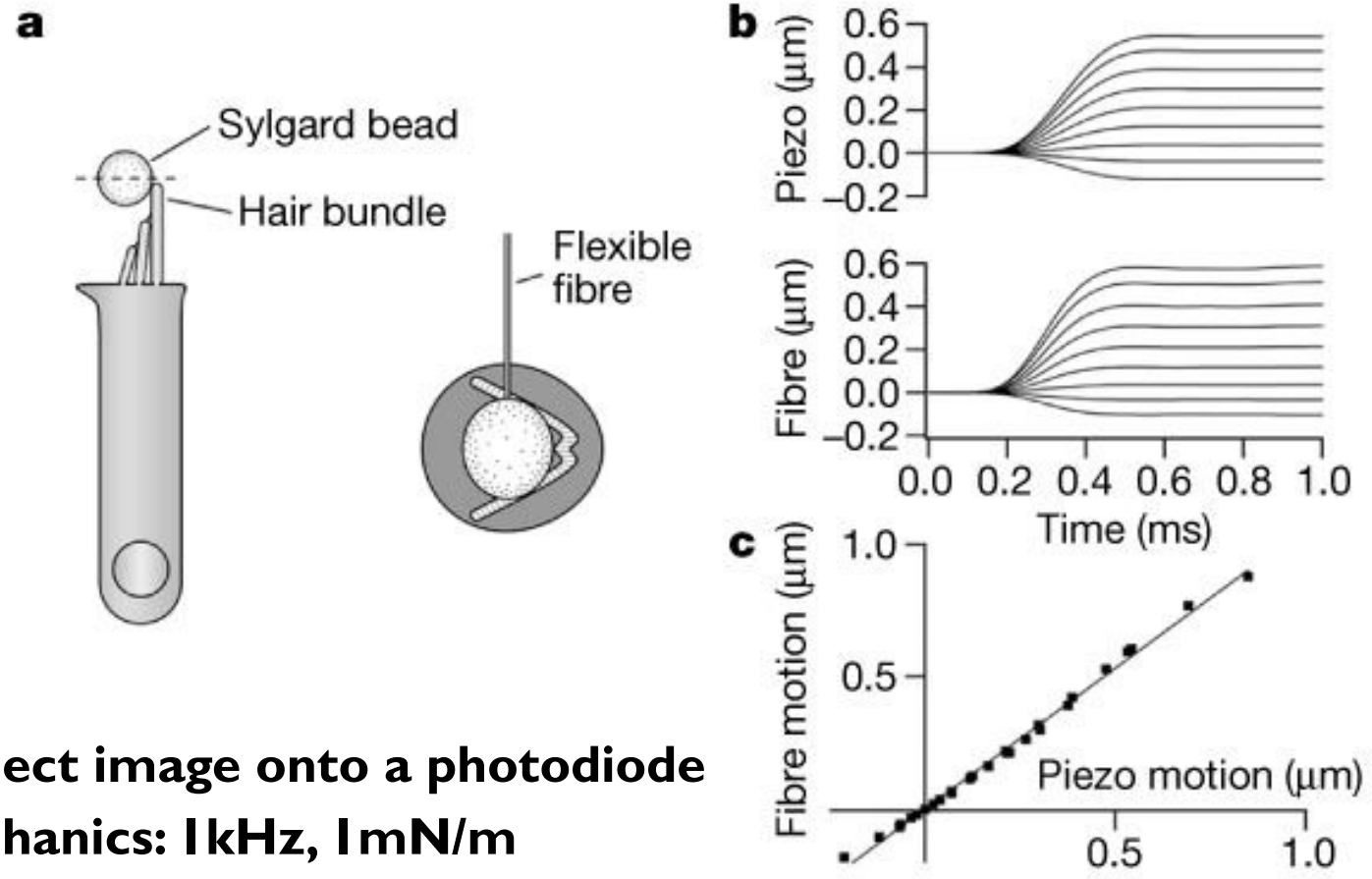


How to Sense Motion





Current Experimental Methods



Project image onto a photodiode

Mechanics: 1kHz, 1mN/m

Kinetics: 5-10kHz, >50 mN/m

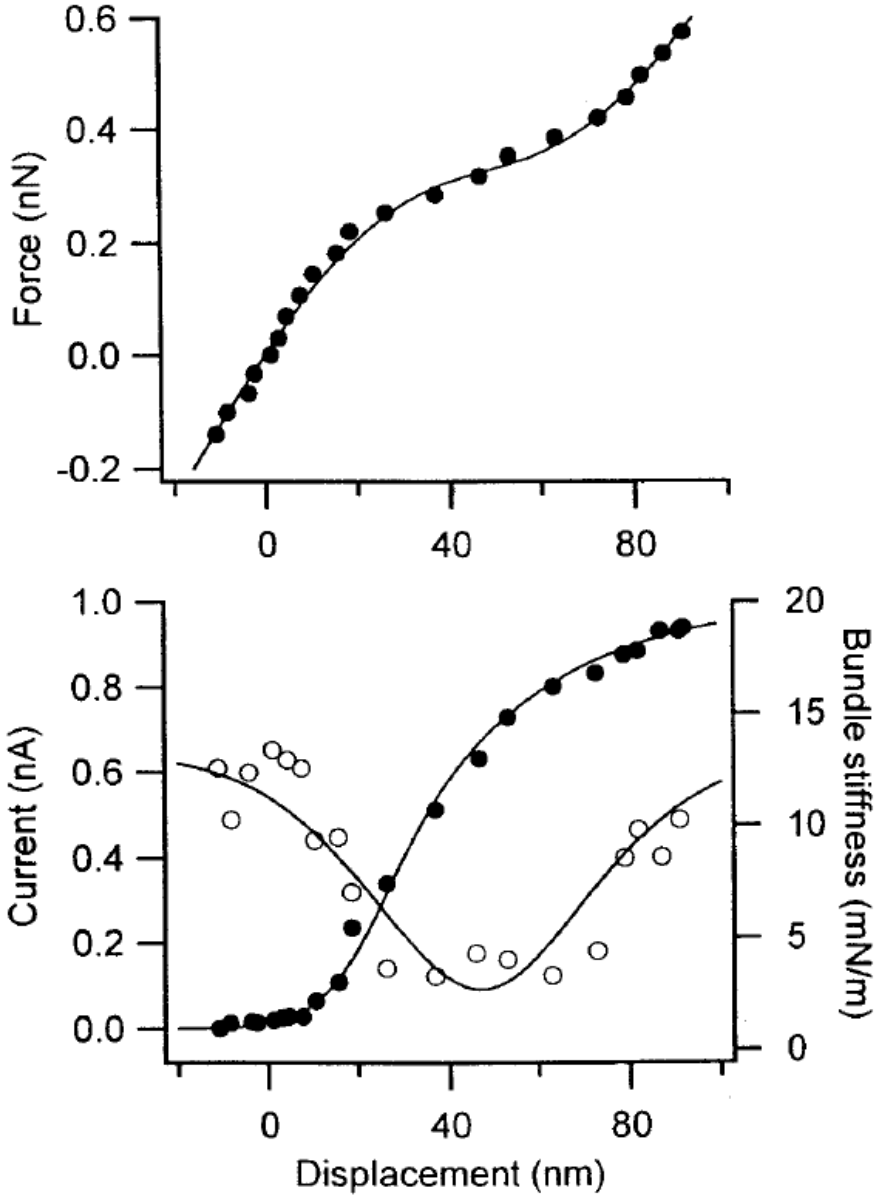
Experiments

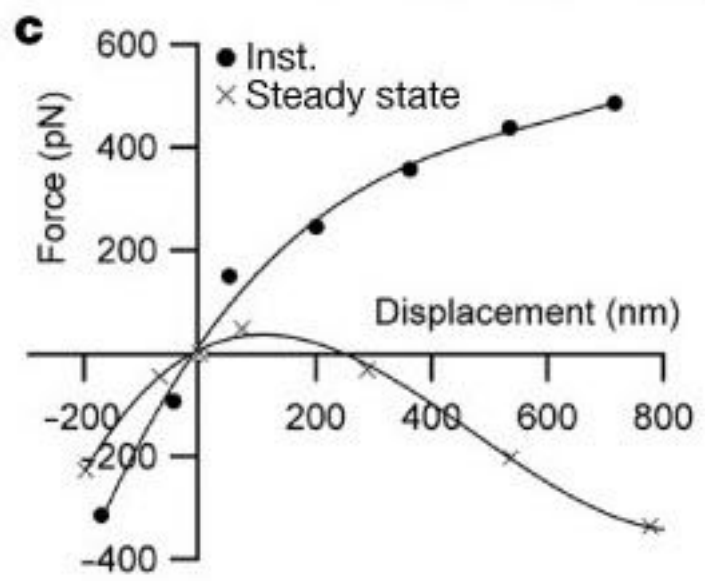
1) Mechanics

2) Kinetics

3) Motility

Bundle Mechanics

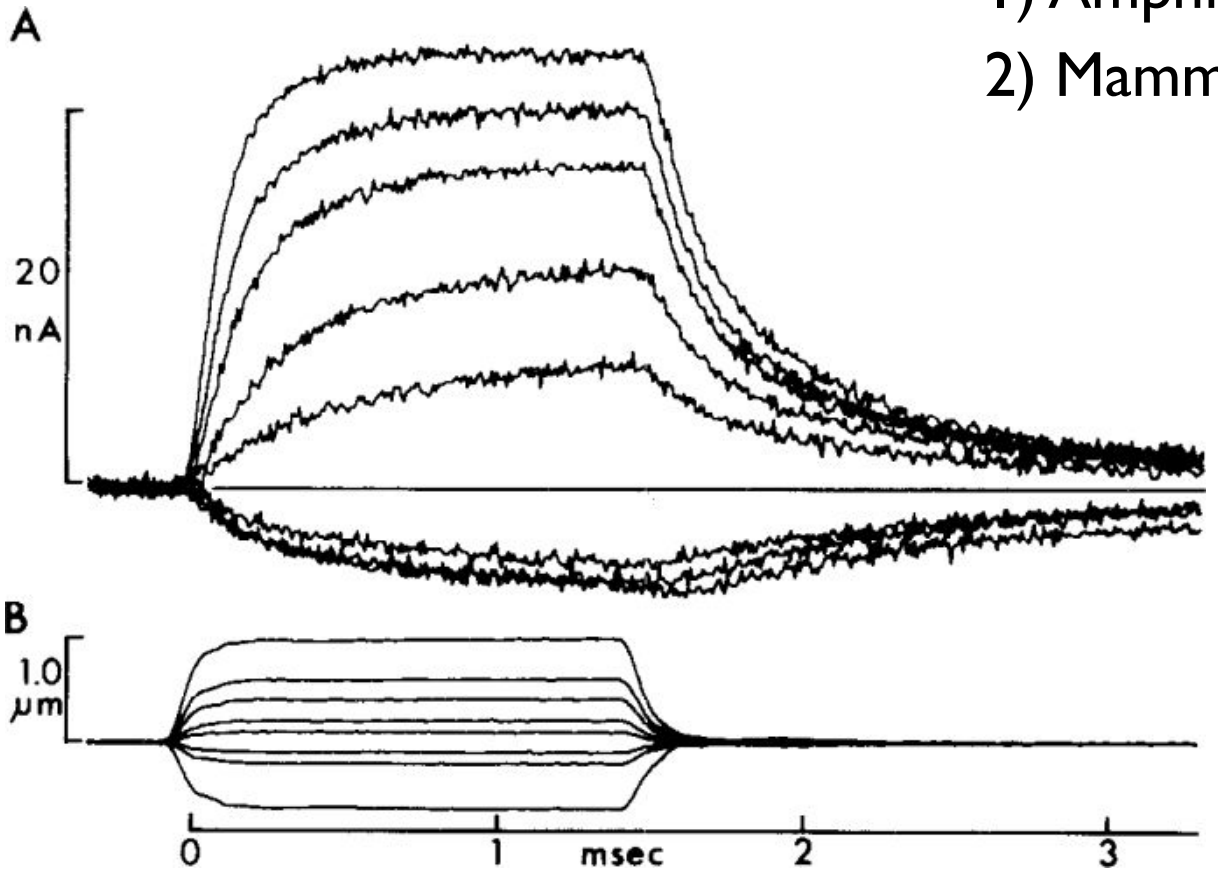


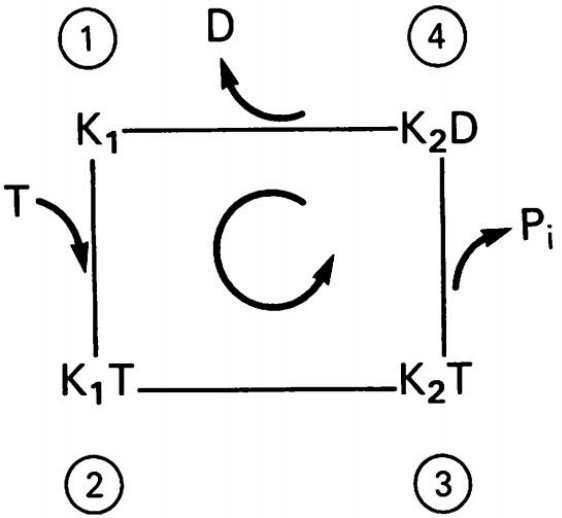


1) Stiffness changes with position, time
2) Measure stiffness quickly before adaptation mechanism kick in

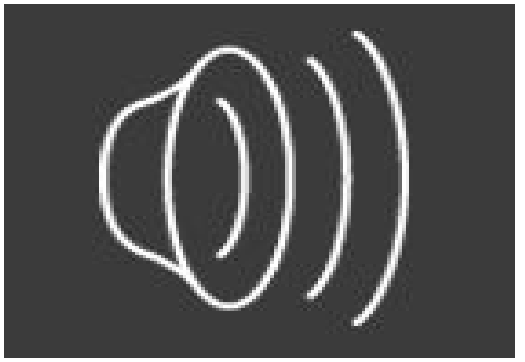
Channel Kinetics

1) Amphibian kinetics ~ 10kHz
2) Mammalian kinetics = faster

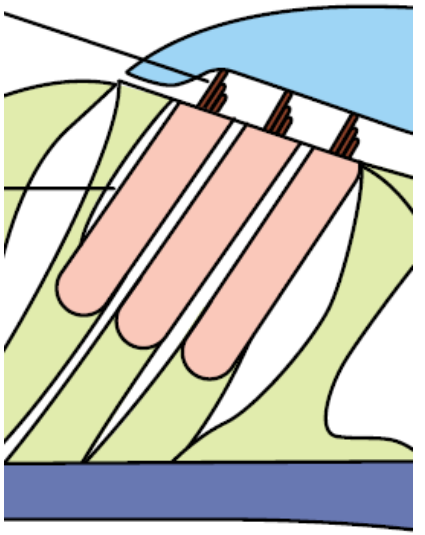




OHC Somatic Motility



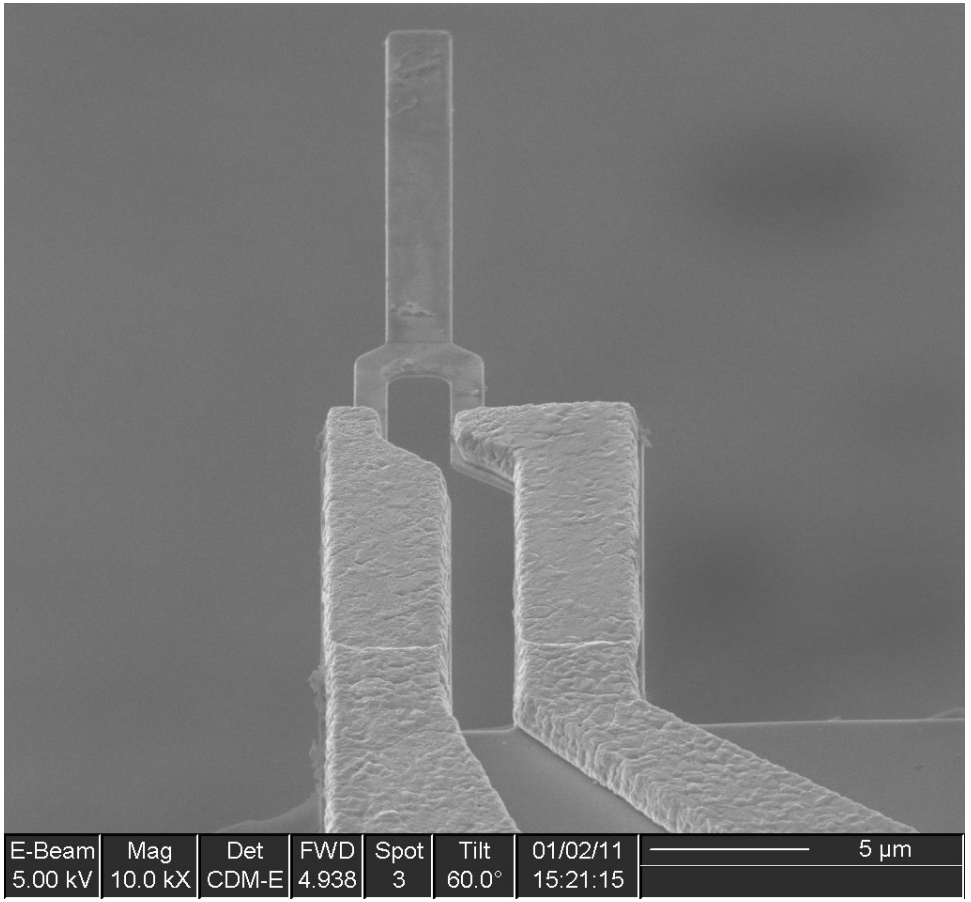
1) OHCs for tuning and amplification (how?)
2) High speed displacement measurement via nonlinear capacitance
3) Motile force not measured to date

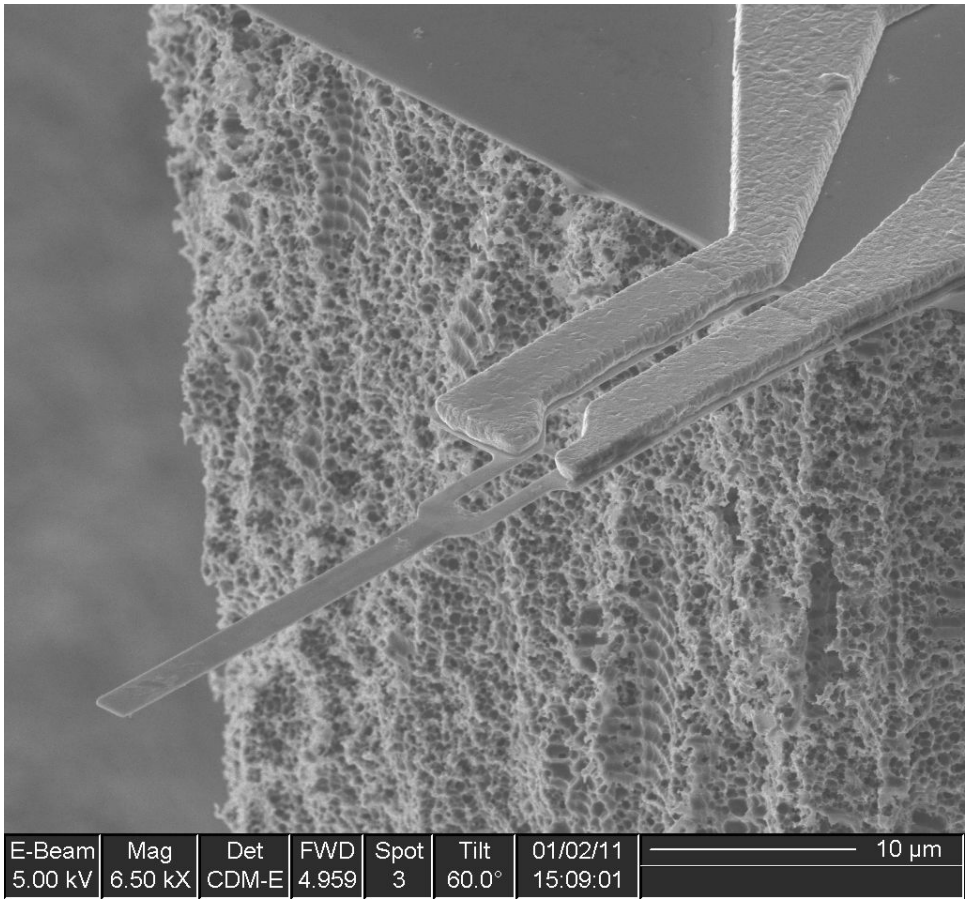


Device Designs

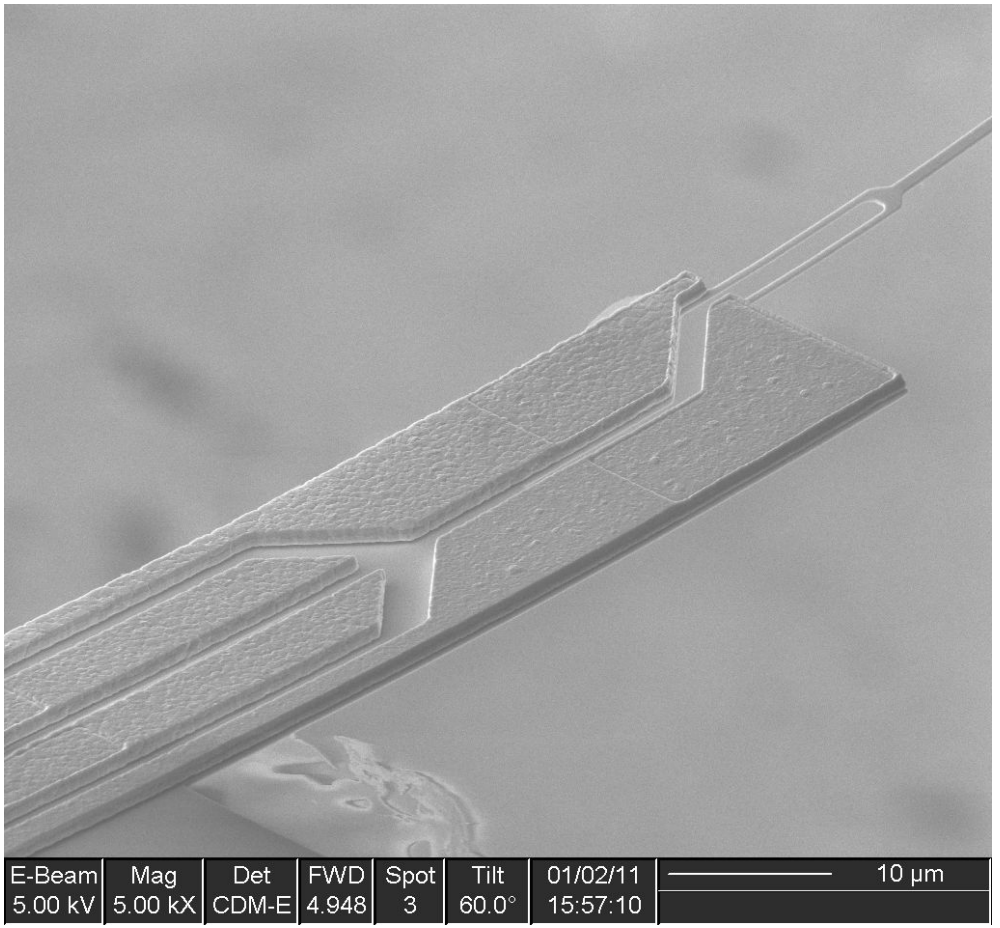
- Mechanics / Motility
  - 0.3 – 4 mN/m
  - 2 – 20 kHz in water (20 – 100 kHz in air)
  - 3 – 30 pN RMS force noise
- Kinetics
  - 10 – 50 mN/m
  - 60 – 200 kHz in water (200 – 500 kHz in air)
- Both types
  - 300 nm thick, 1-2 um wide, 30-200 um long
  - On-chip actuation (thermal and piezoelectric)

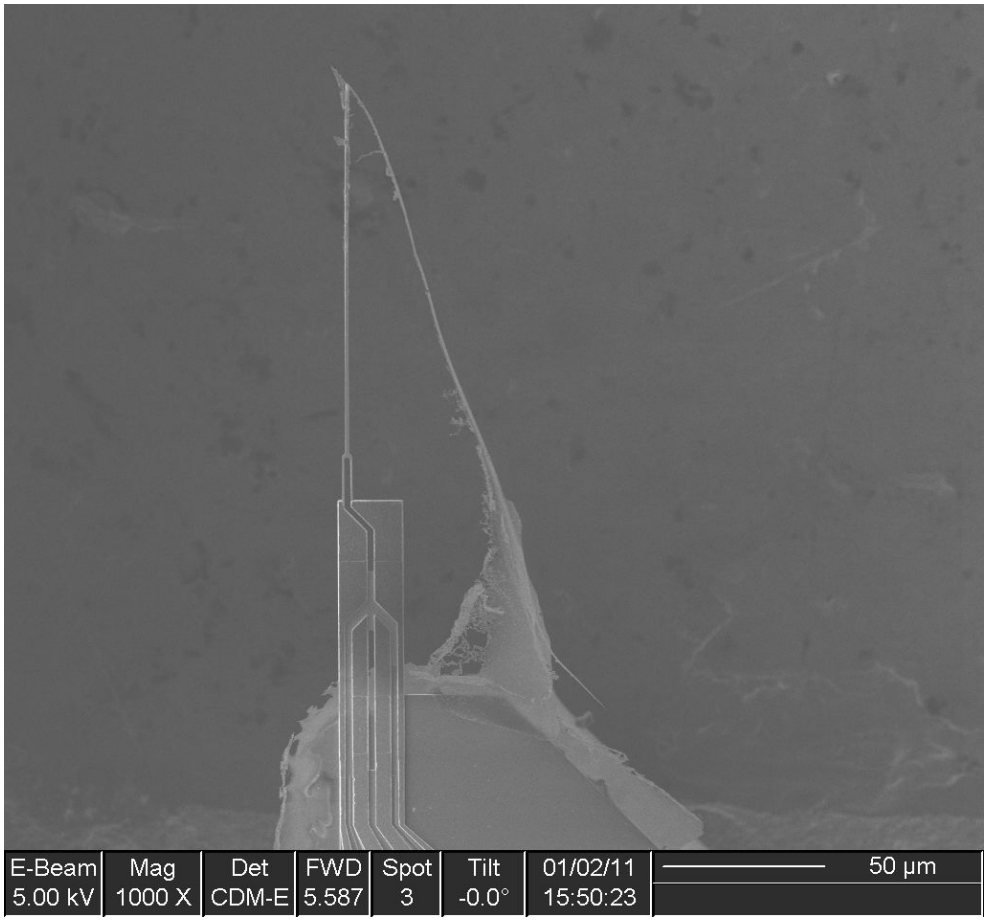
Finished Devices



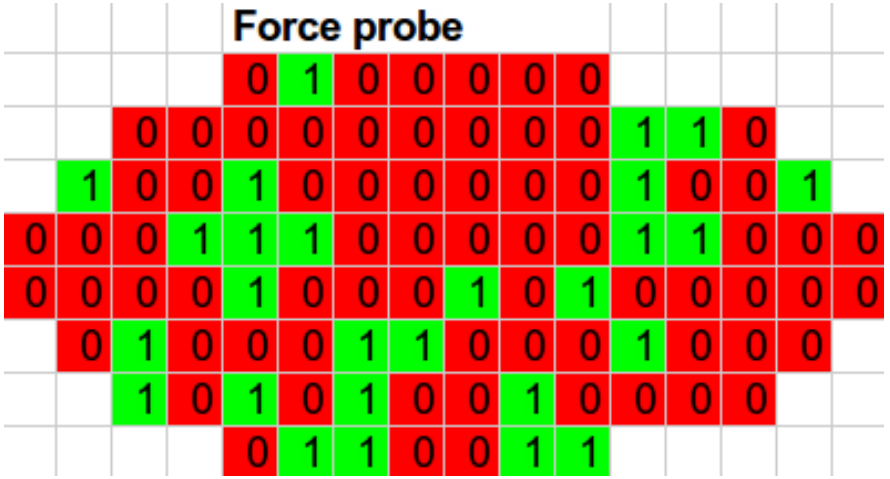


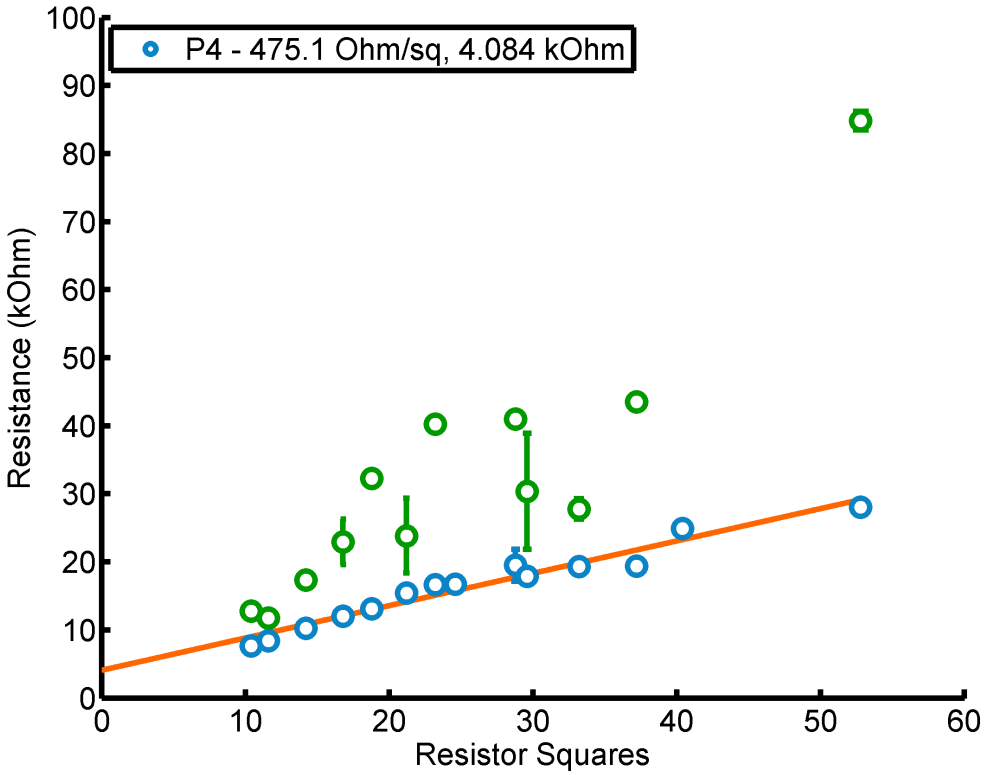
Finished Devices



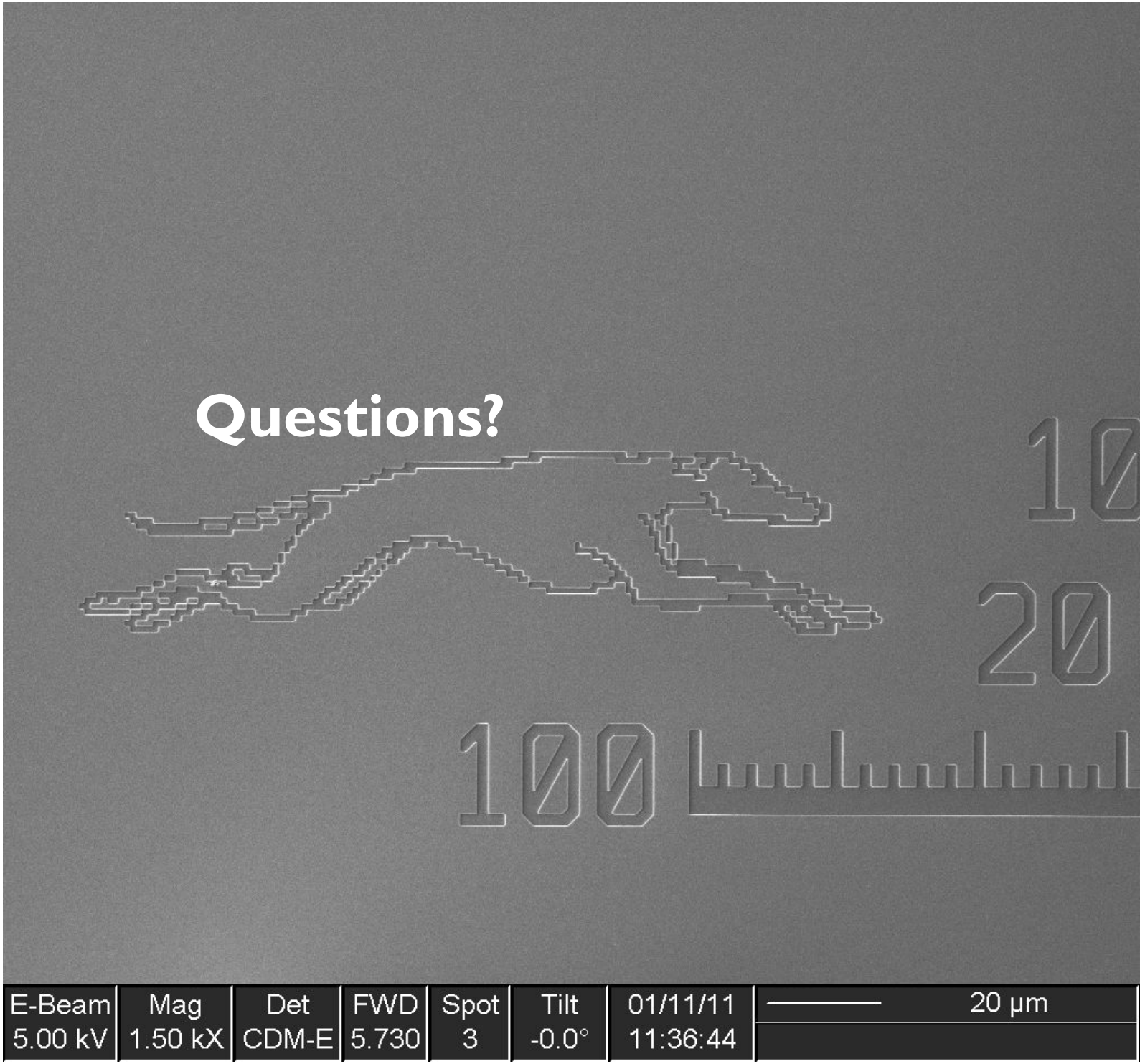


Ongoing Work





Questions?


10
20
100
E-Beam
5.00 kV
Mag
1.50 kX
Det
CDM-E
FWD
5.730
Spot
3
Tilt
-0.0°
01/11/11
11:36:44
20 µm