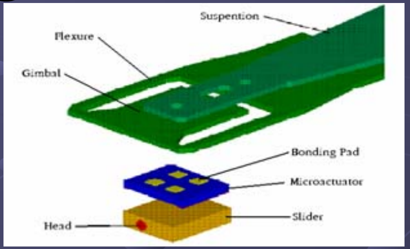
OPTIMAL DESIGN AND FABRICATION OF MEMS MICROACTUATOR

Dr. Nitin Afzulpurkar

Objective

- Optimal design of electrostatic microactuator in hard disk drive as specification.



- Fabricate design with commercial foundry process: MUMS, SOI.
- Test and verify fabricated device performance with specification requirement.

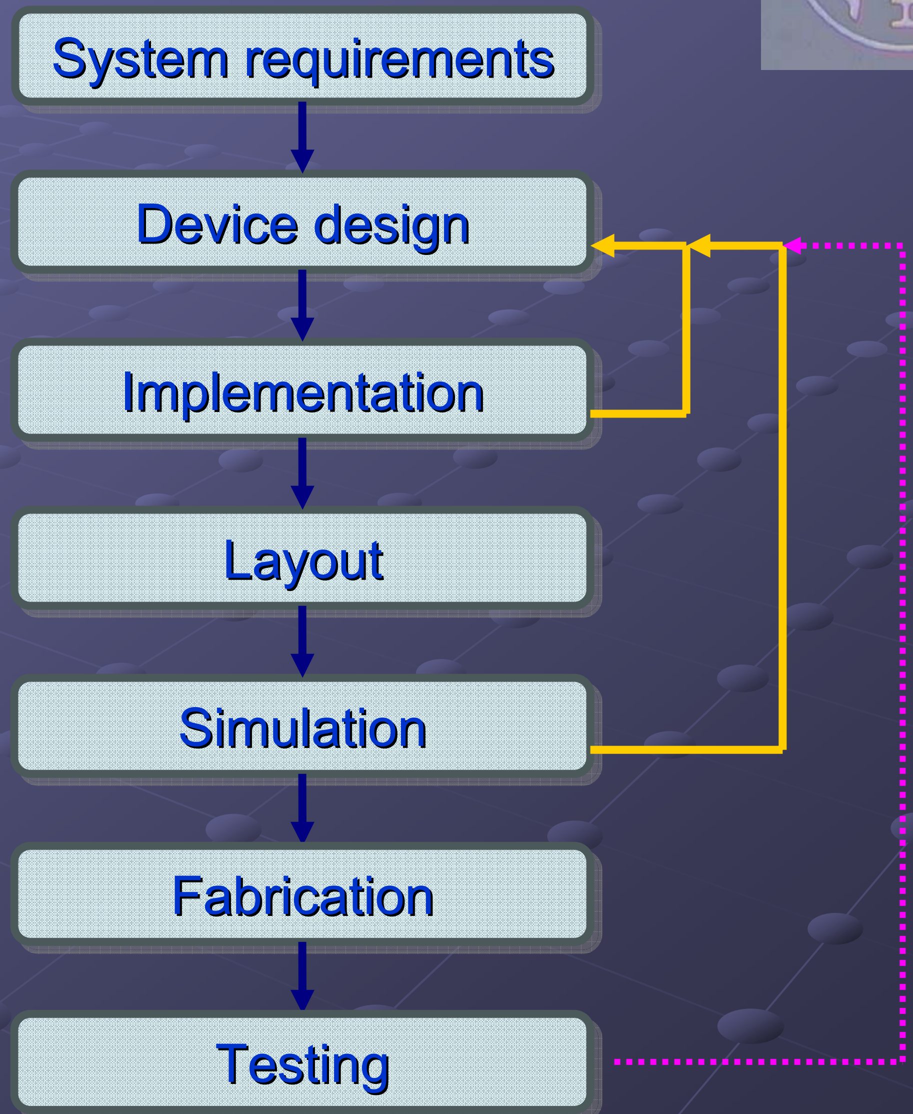
MEMS Processes

Design concept
Fabrication
Parallel pate
Interdigitated
Dynamic model

L-Edit layout

ANSYS simulation

PolyMUMS



Works have been done

Microactuator Design

Transverse

-Motion moving in one axis

maximum 1 μm

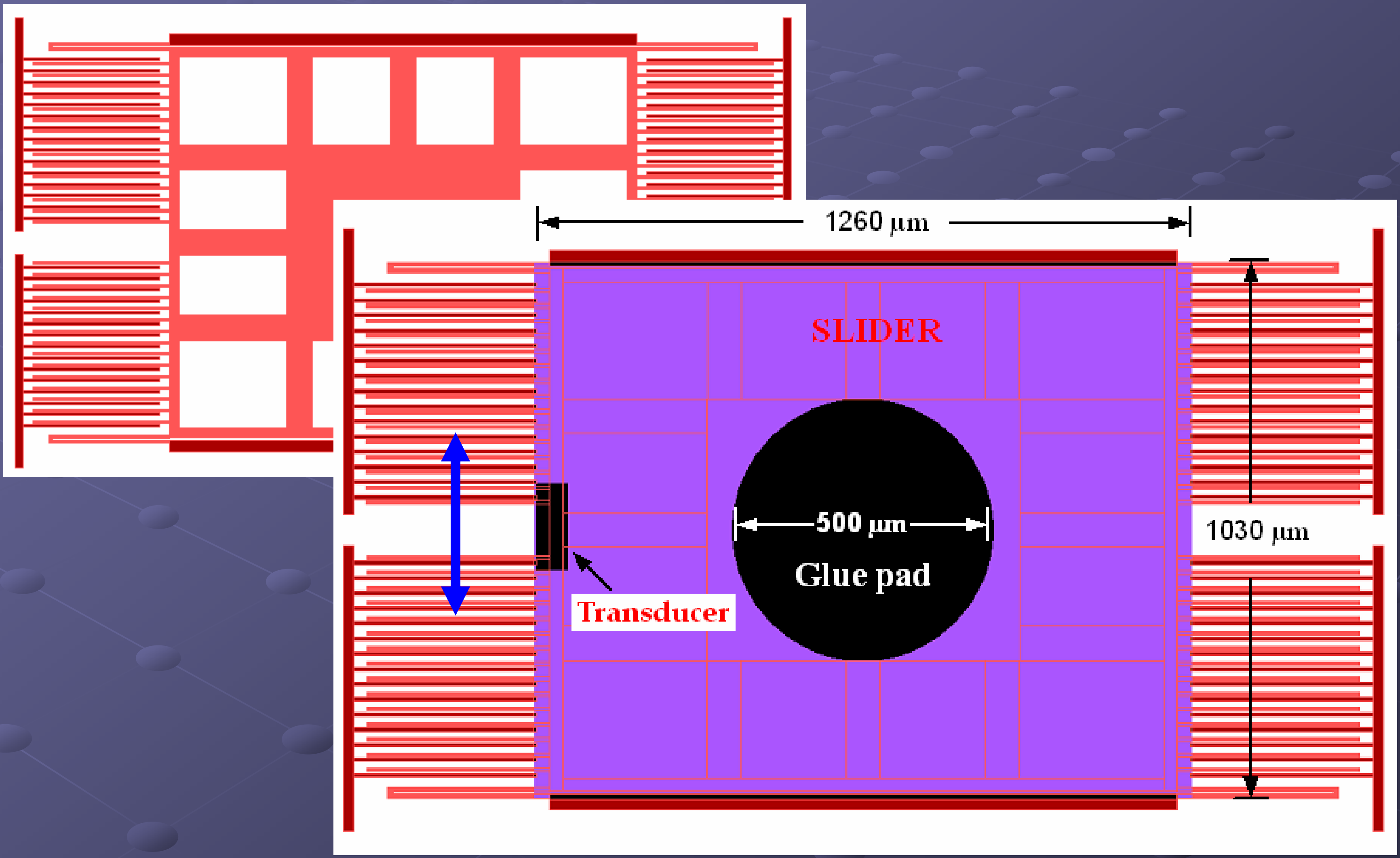
Rotational

-Moving in angular direction

- SOI
  - Design
  - Simulation
- PolyMUMPs
  - Design
  - Simulation
  - Test

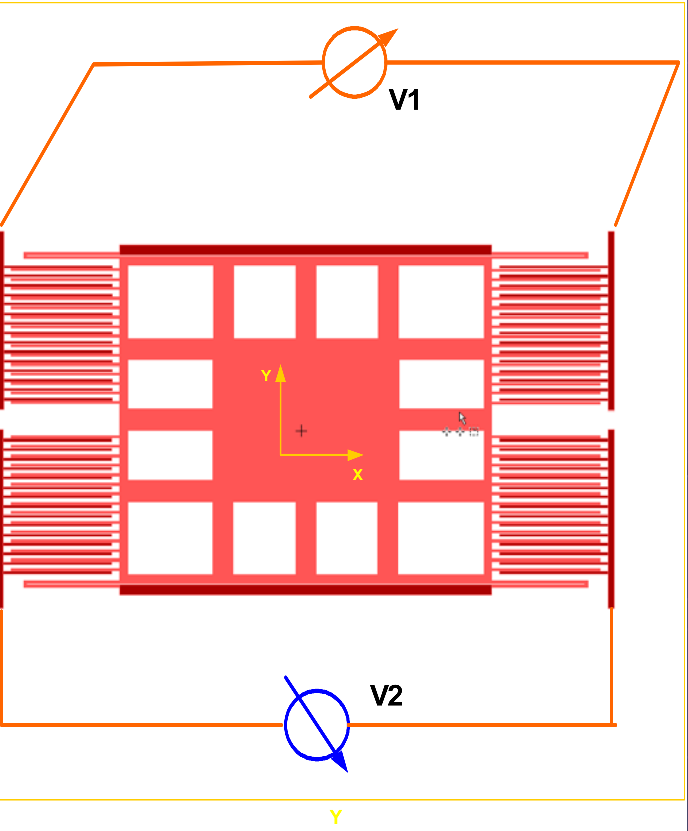
SOI

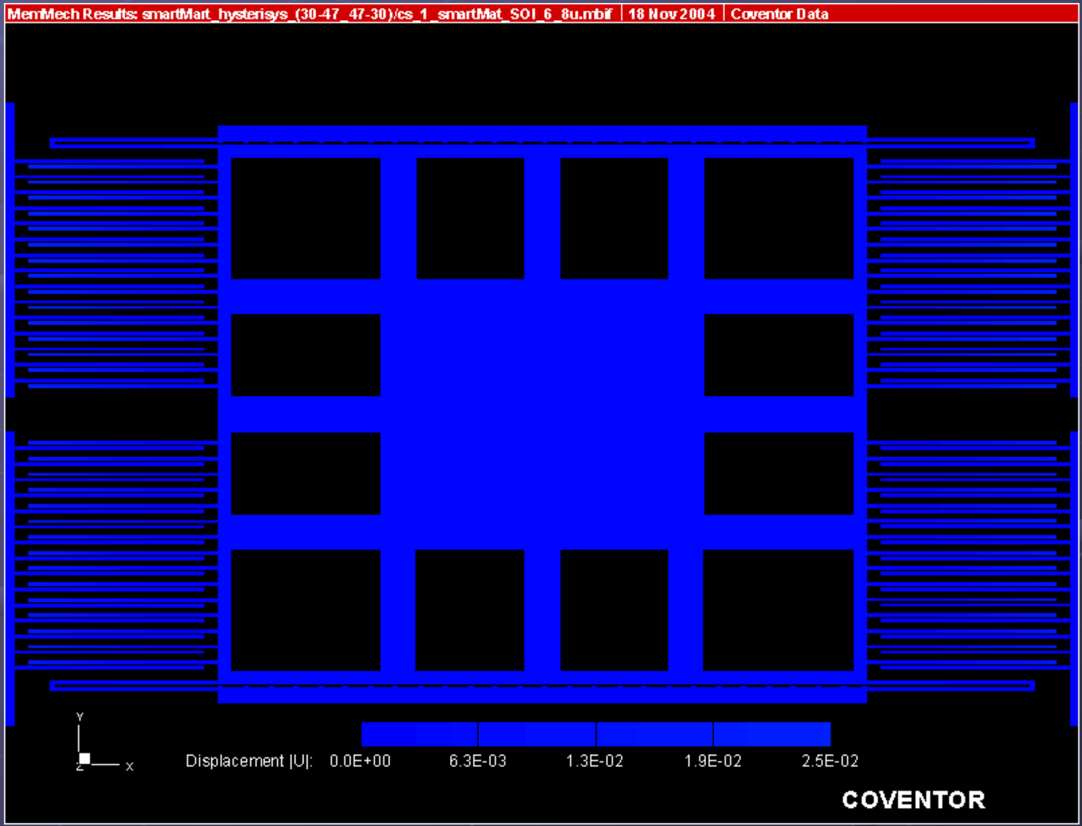
- Transverse Design



Transverse Design

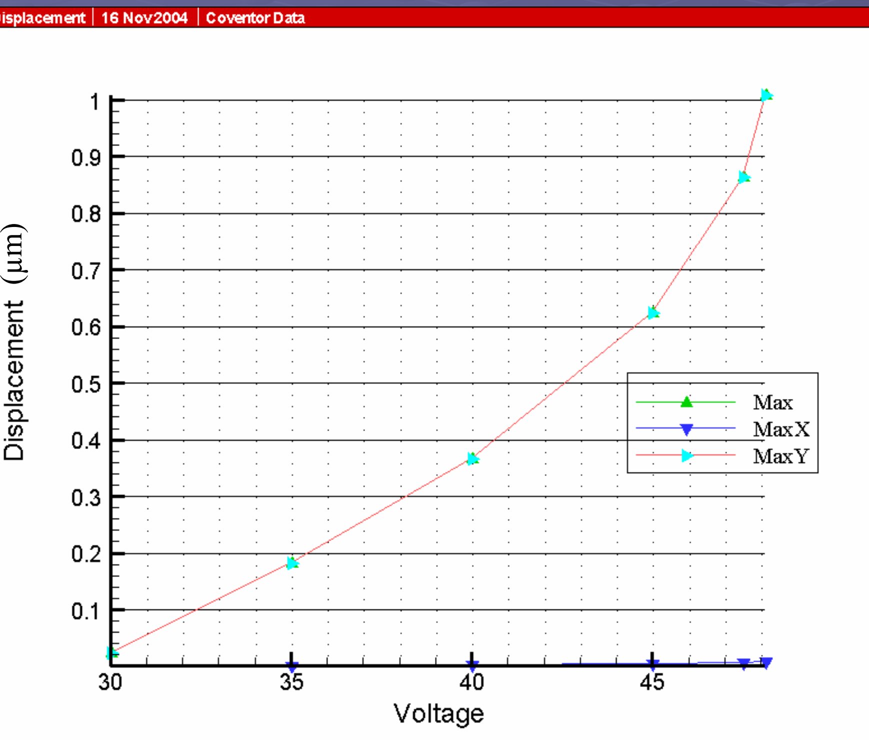
- Simulation

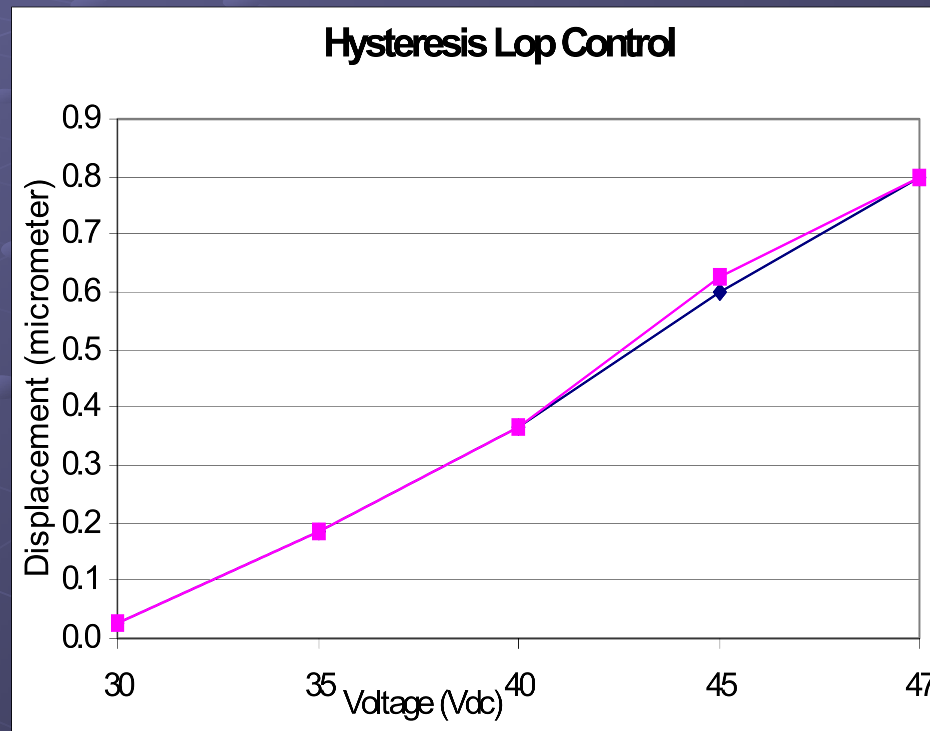




Transverse Design

- Simulation results



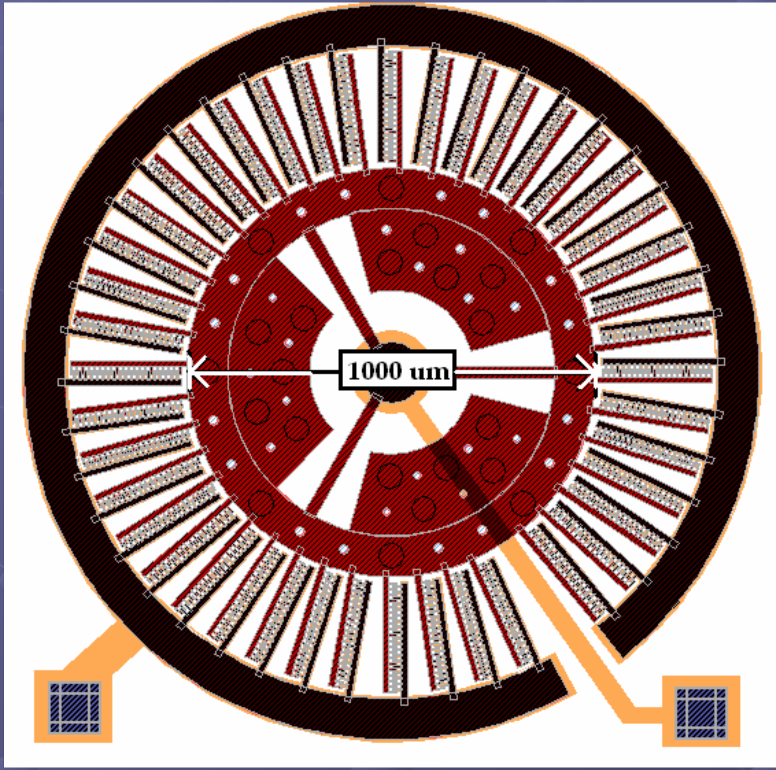


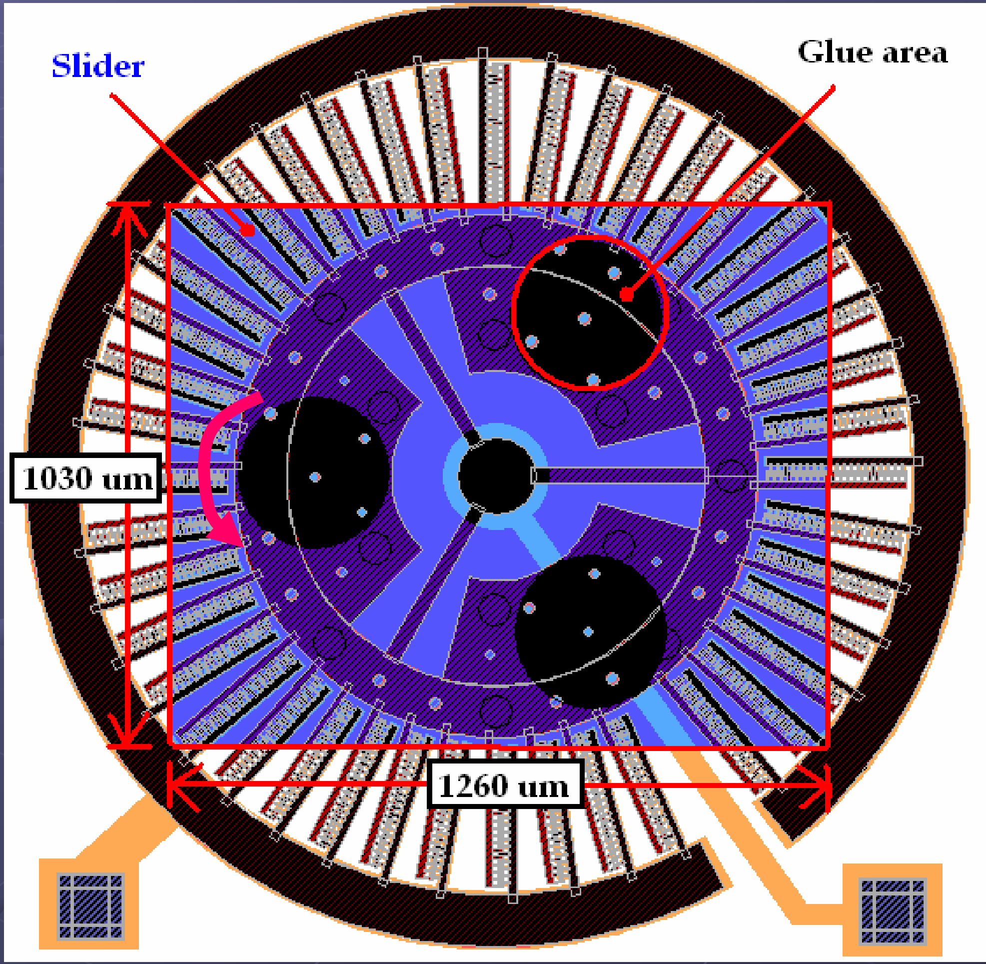
Resonance Frequency is 17.383 kHz

Conclusion of SOI design

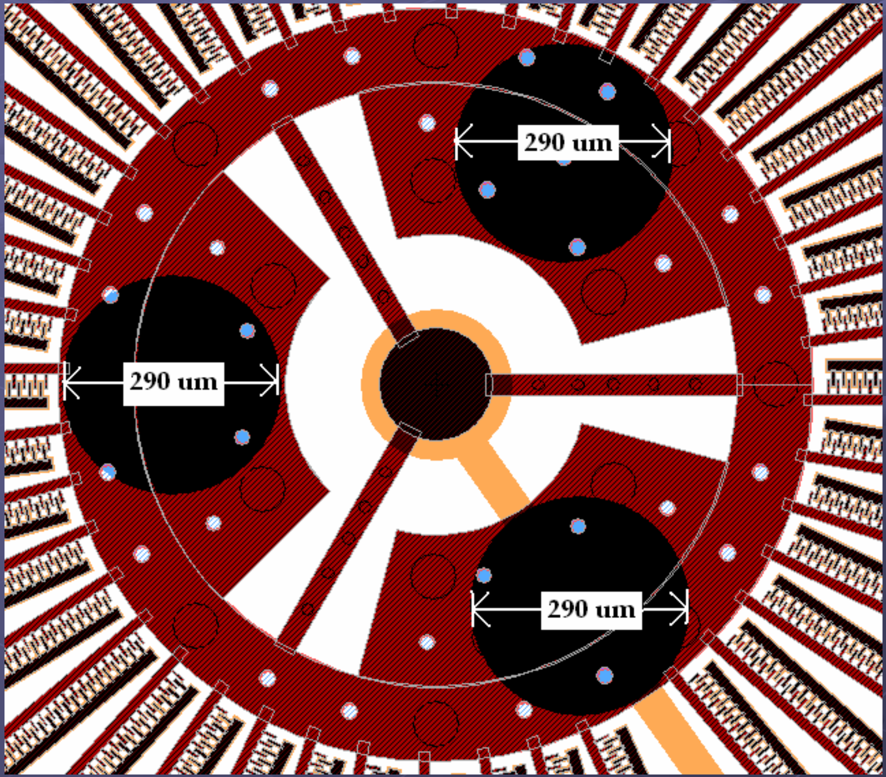
- The model shows maximum displacement of 1 µm at voltage control range of 30 to 48 volts.
- This design is shown to be accurately modeled as a second-order linear system at 30 t0 40 volts and a very small hysteresis loop.
- The resonant frequency is slightly lower than expected, in future work we will either maintain the constant value of folded beam suspension or reduce mass of device.

Rotational Design





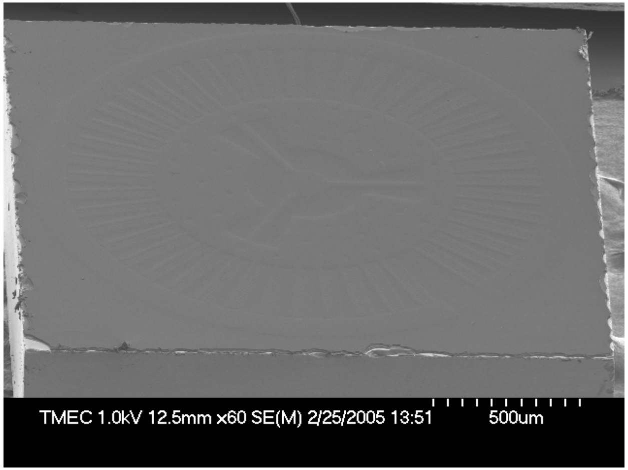
Gluing Pad



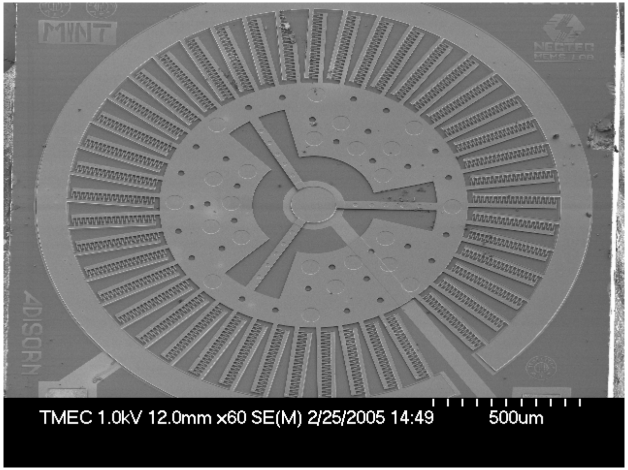
PolyMUMPs

- Wet Etching

1. **Acetone** (30 minute)
2. DI Water
3. **Isopropanal** (2 minute)
4. DI Water
5. **HF 49%** (2-5 minute)
6. DI Water
7. **Methanol**
8. **CPD**

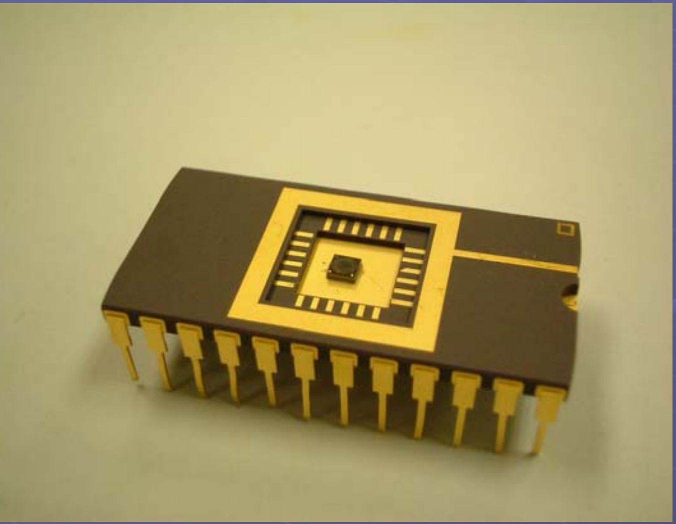


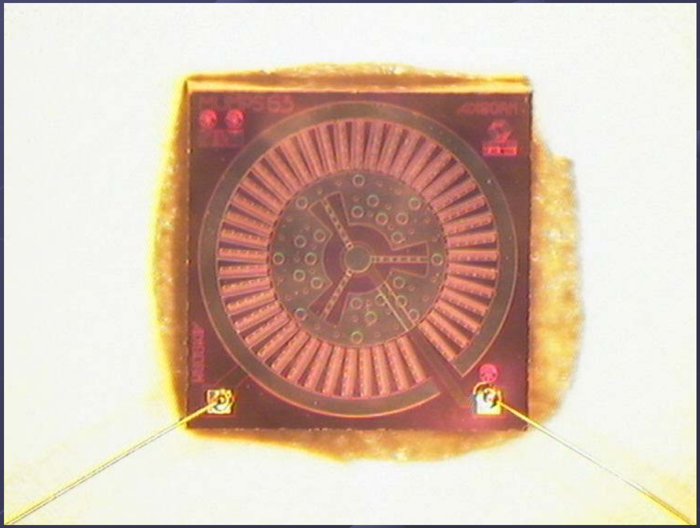
Before etching



After etching

MEMS Packaging and Bonding



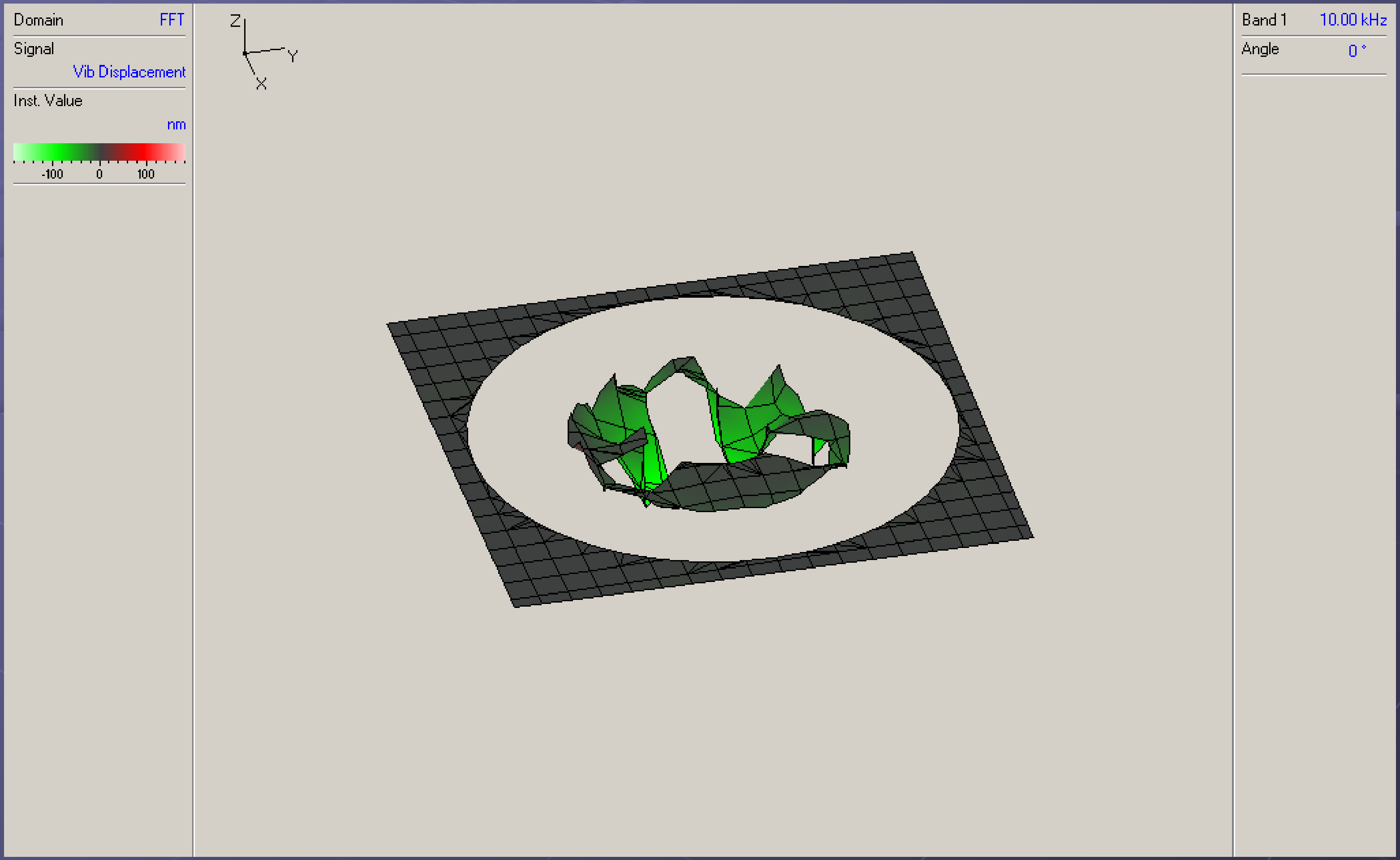


Testing

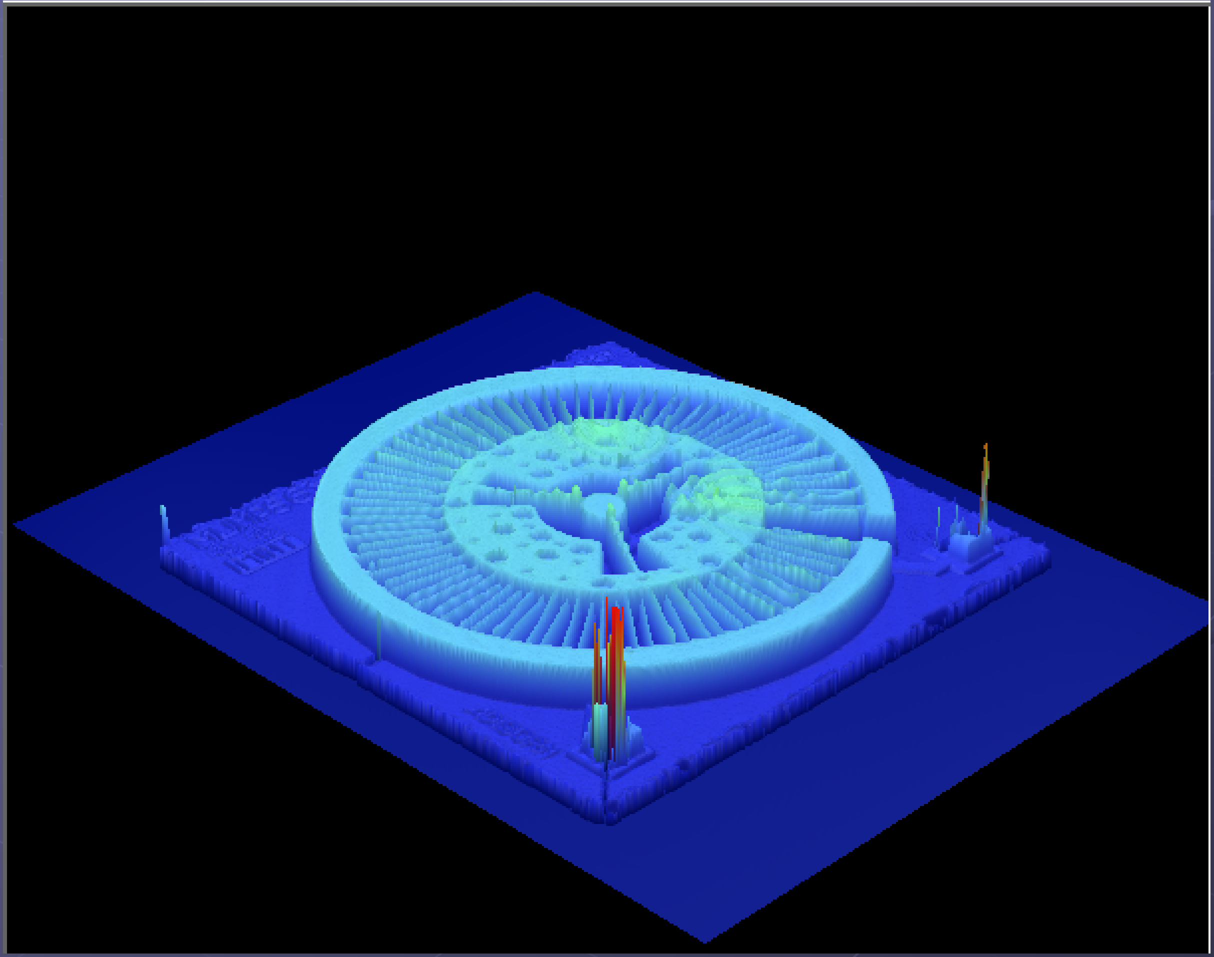
Measuring In-plane and Out-plane motion

- Micro Motion Analyzer (MMA)
- Laser Doppler Vibrometry (LDV)
- Surface profile (Vecco)

Testing result using LDV

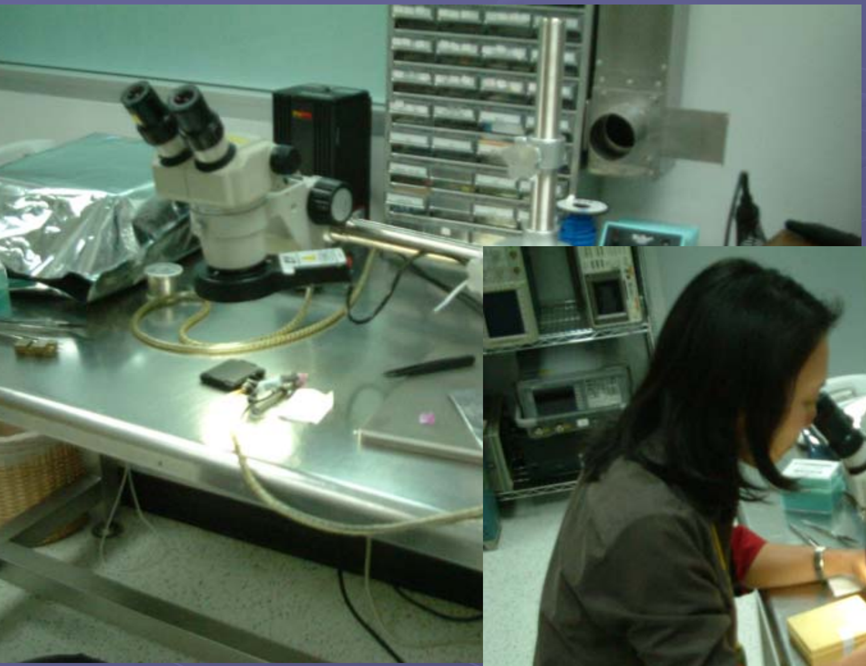


Surface Profile (Vecco)



Comm drive in excel file

Slider Assembly on Microactuator



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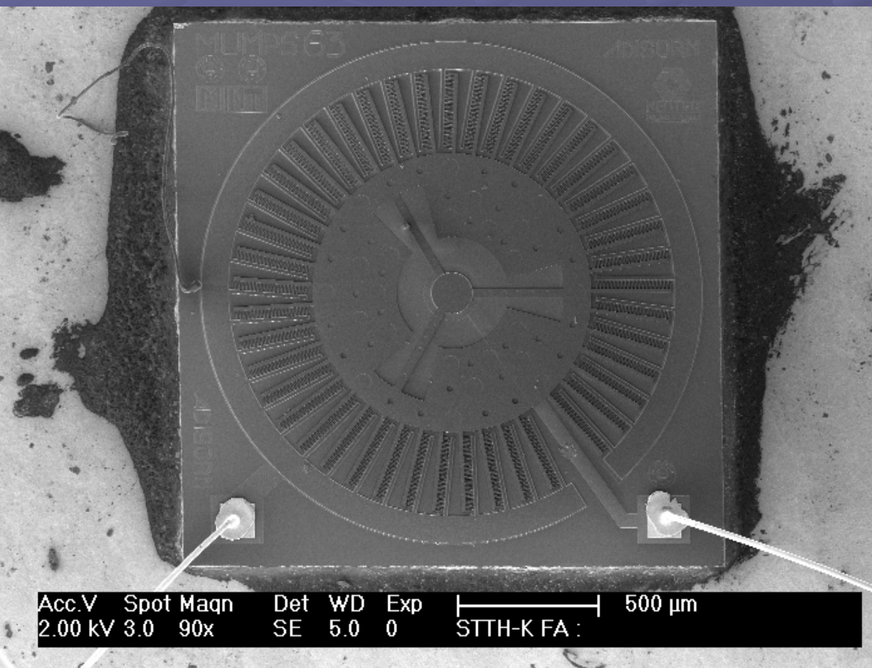

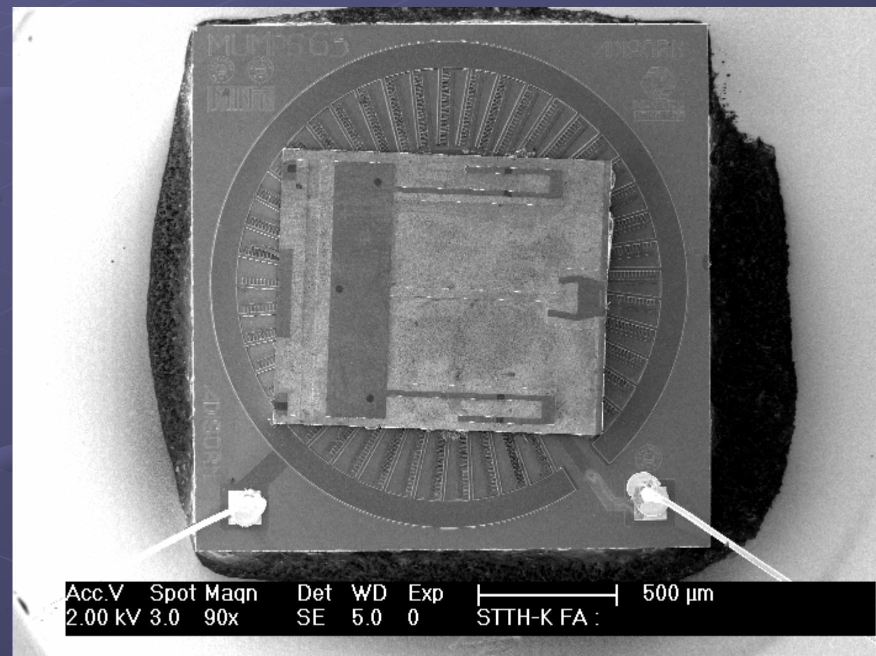

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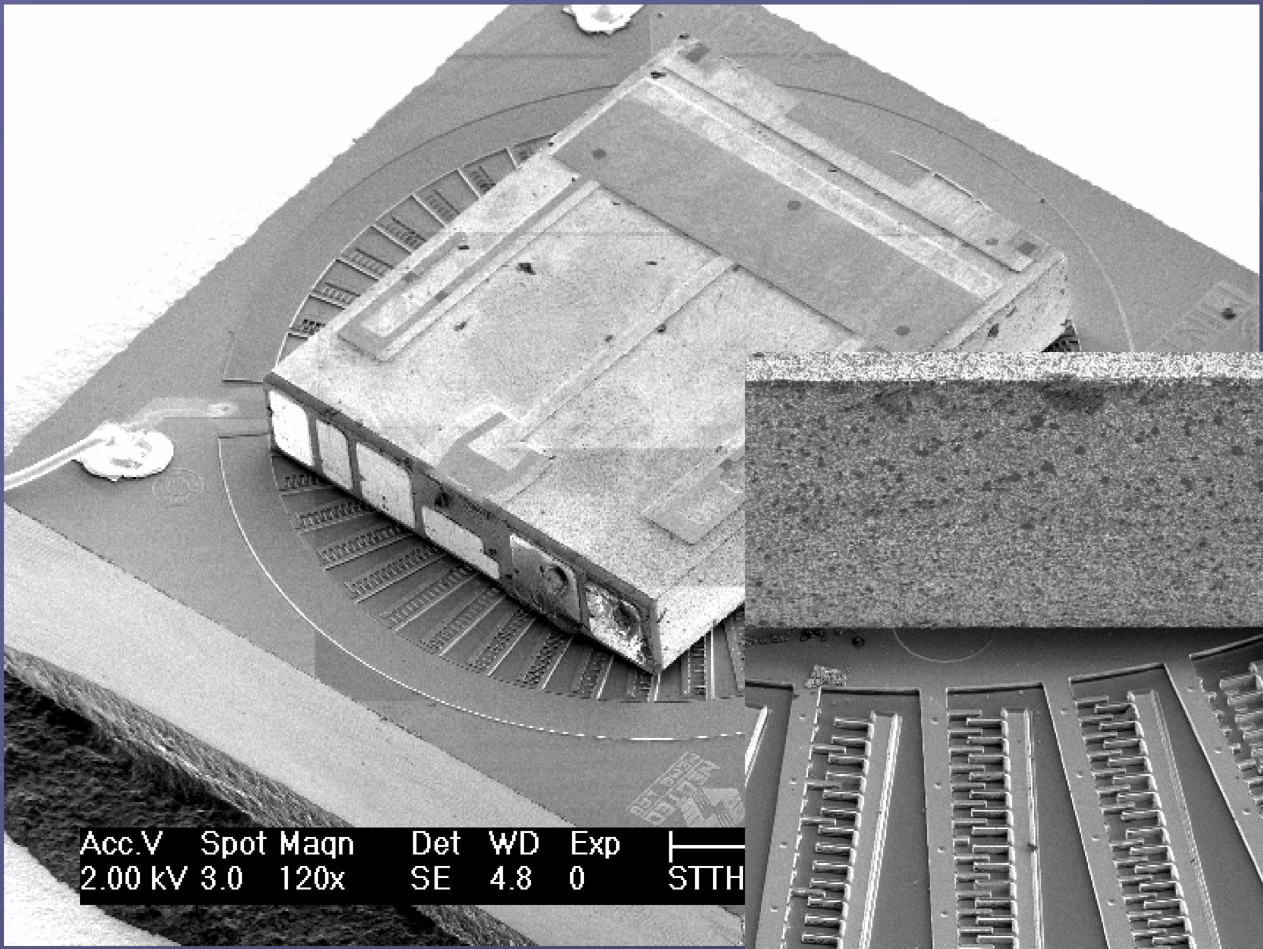

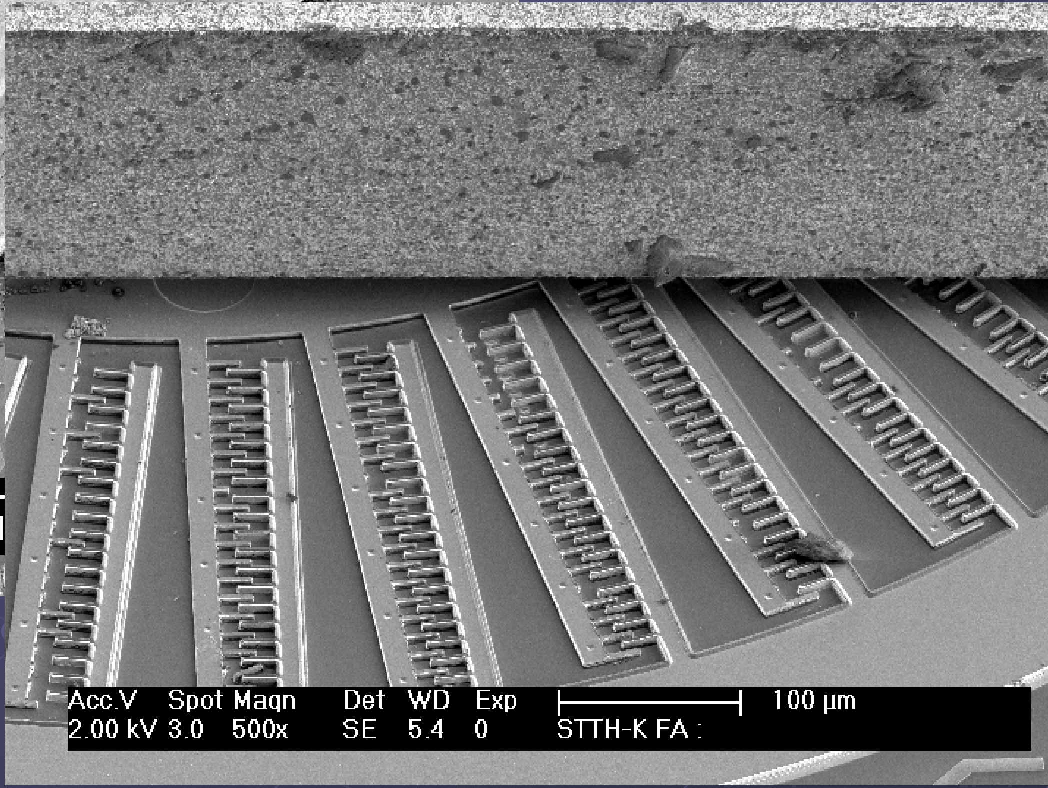

Conclusions

- MEMS processes are accomplished.
- Optimal design of electrostatic microactuator
  - SOI technology
  - Comb drive design
  - Suspension design
- Testing
- Attached Slider

Recommendation for Future work

- Dynamic aspects (etc., Fluid parameter)
- SOI technology is preferred in this application
- Other fabrication technologies give strong structure
- Pre-testing is essential step.
- Assembly slider by semi-manual
- Random testing cover the design
- Information from Fabricator