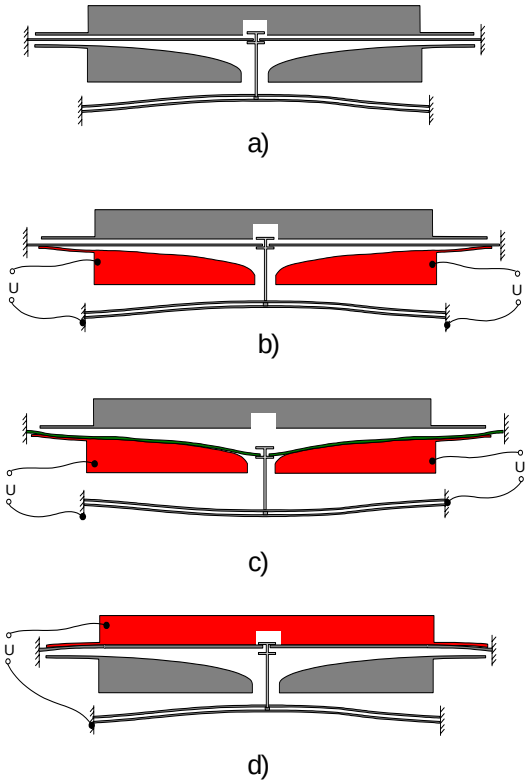
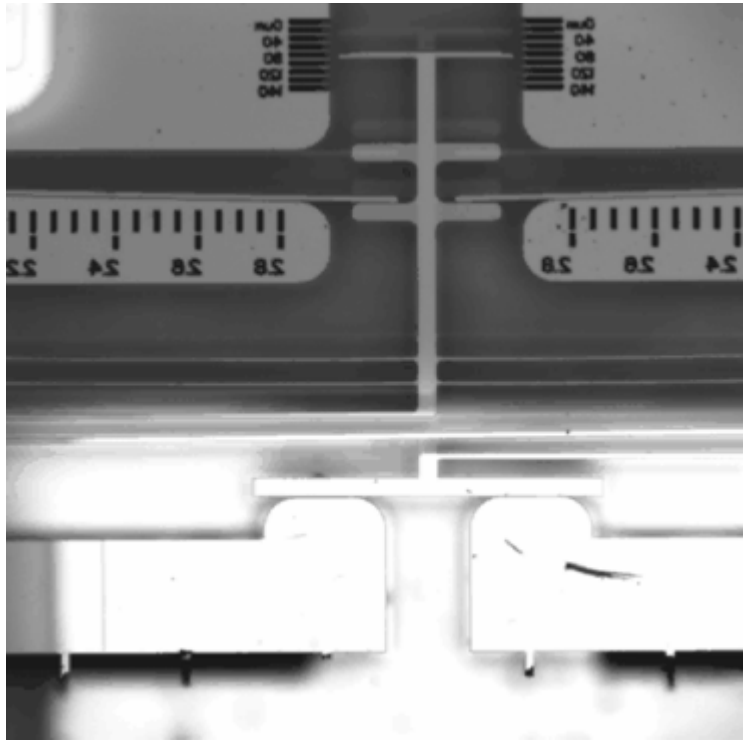
Alex Slocum's MEMS Research

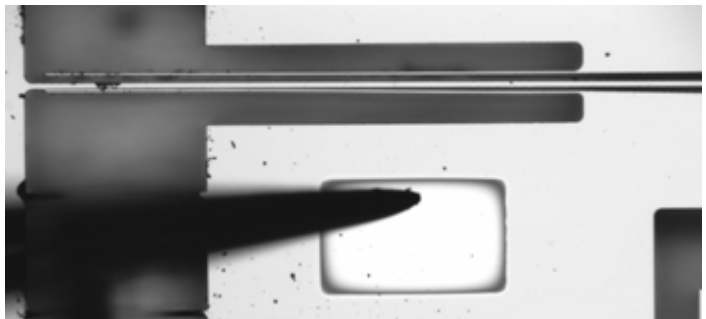
- Relays
  - Bistable structures actuated with starting-zone electrostatic zippers
- Assembly
  - Kinematic and elastic averaging structures
- Nanogate
  - High precision flow control
  - RF filter
  - Molecule sorter
- XY flexure
  - X and Y axes fully decoupled

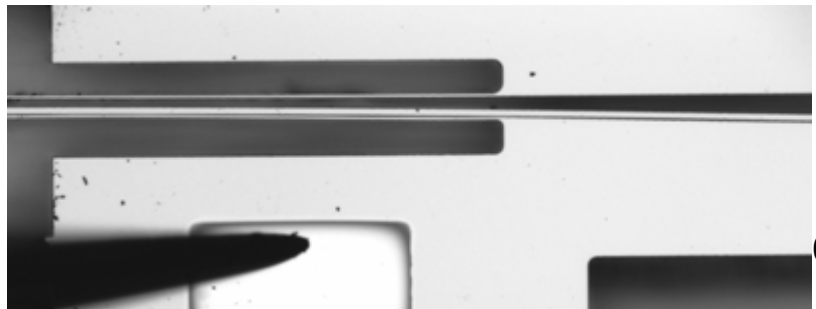
Electrostatic Zipper Actuators
Jian Li's Ph.D. thesis

- The fundamental new elements are the compliant starting zones (**inflexible** made *flexible*)



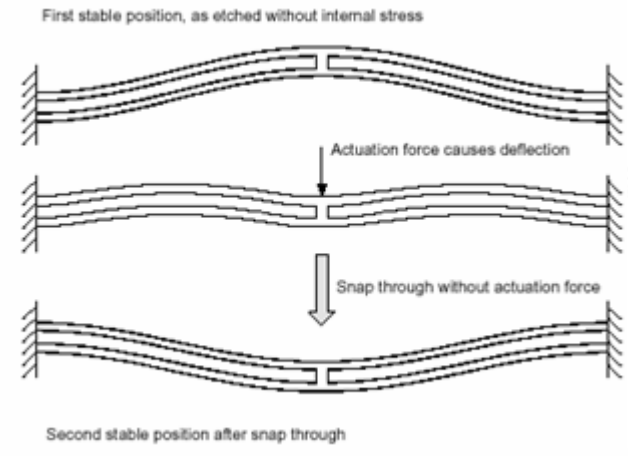


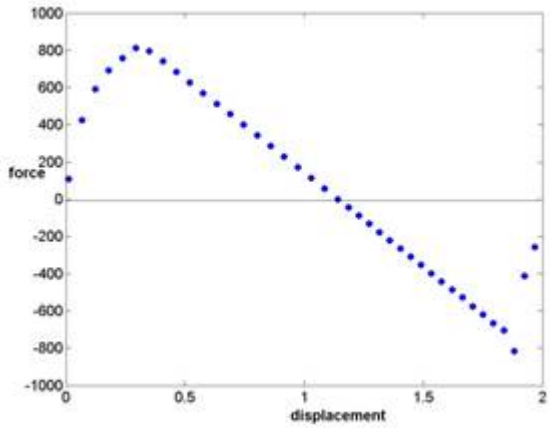


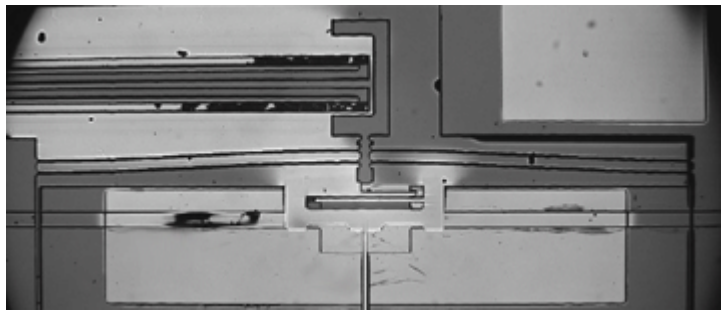


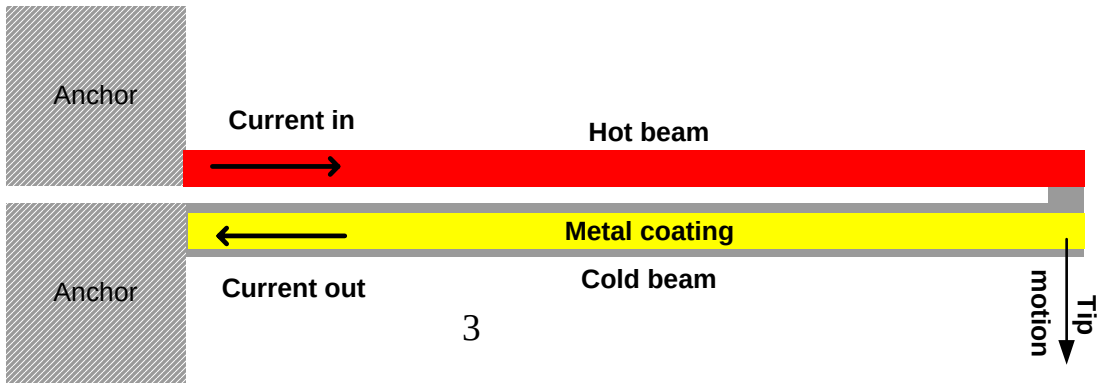
Bistable Relay Elements
Jin Qiu's Ph.D. thesis

- A through-wafer etched bistable double-beam can be bistable without any initial preload
  - Two beams are coupled at the middle, thus quenching the 2nd mode which is unstable
- Prof. Michael Brenner **(formally of MIT)** developed the optimization algorithm to give 1:1 force ratio (actuate/contact force)

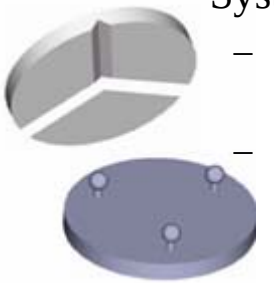




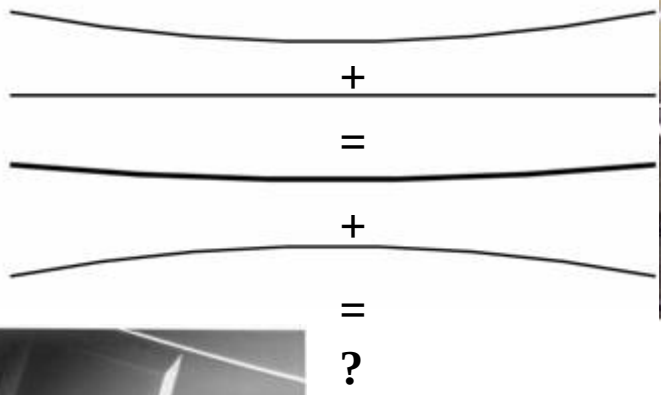


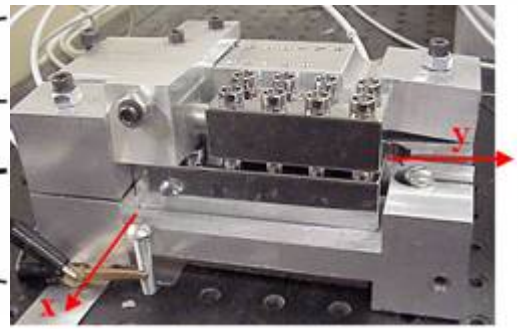


Exact Constraint Design: Wafer Alignment
Alexis Weber's S.M. Thesis

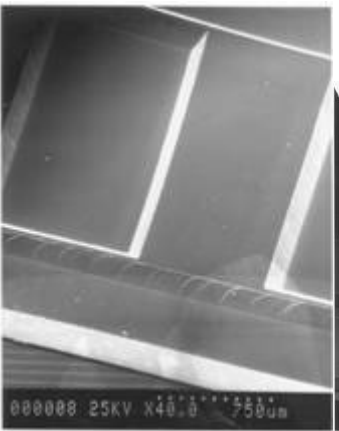


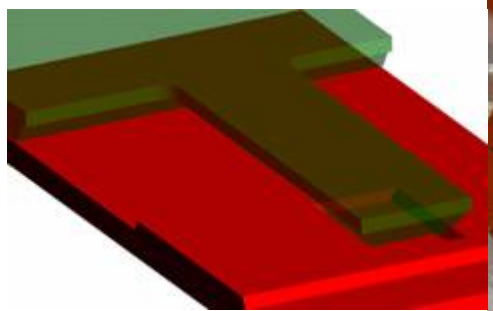
- Systems such as micro engines are formed from a stack of bonded wafers
  - The stack must be bonded one wafer at a time, because each added wafer must be optically positioned with respect to the stack
  - Problems can occur if a concave wafer (R) is bonded to a flat wafer, and the resulting concave wafer (R/2) is then to be bonded to a convex wafer (-R)
    - As the stack thickness, wafers may crack when forced to an opposite signed curvature surface
- It would be desirable to be able to align all the wafers simultaneously, and then press them together for bonding
- Design kinematic/elastic averaging features into wafers:

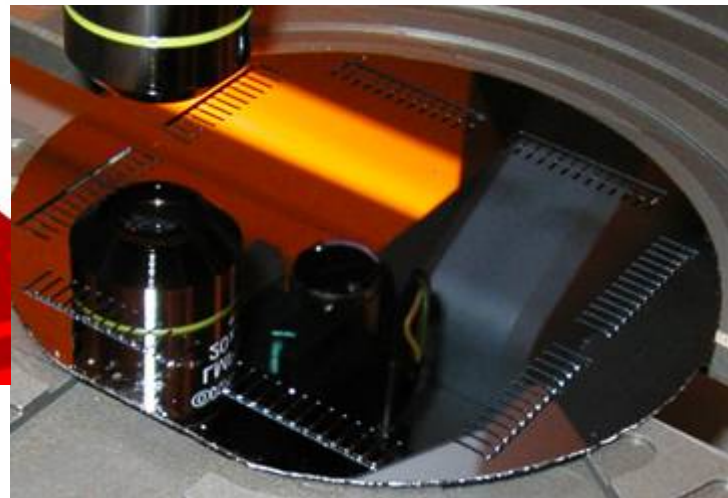




	X [μm]	Y [μm]	Error [μm]
Average Accuracy	0.88	-1.08	1.41
Repeatability	0.63	1.06	1.06

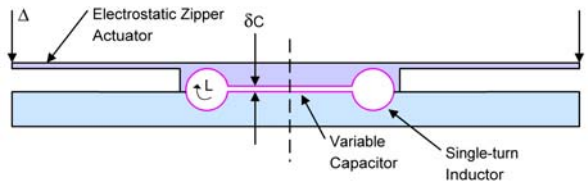






Nanogate Research Area

Dr. James White's Post-Doc
Hong Ma's Ph.D. research

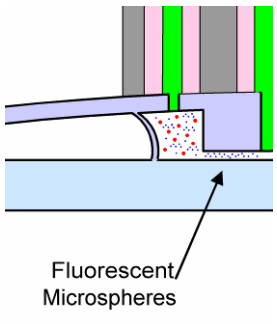


Electro-Mechanically Tunable RF LC Tank

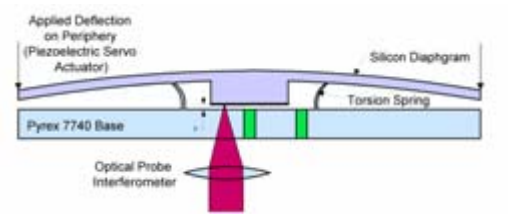
"Frequency Agile" communications, (100M world phones by 2006)

Secure networks, electronic surveillance.

Sensor networks, unstructured (short-range) communication systems.



Mechanically Controllable Separations
Liquid Phase
market
Scientific Instruments



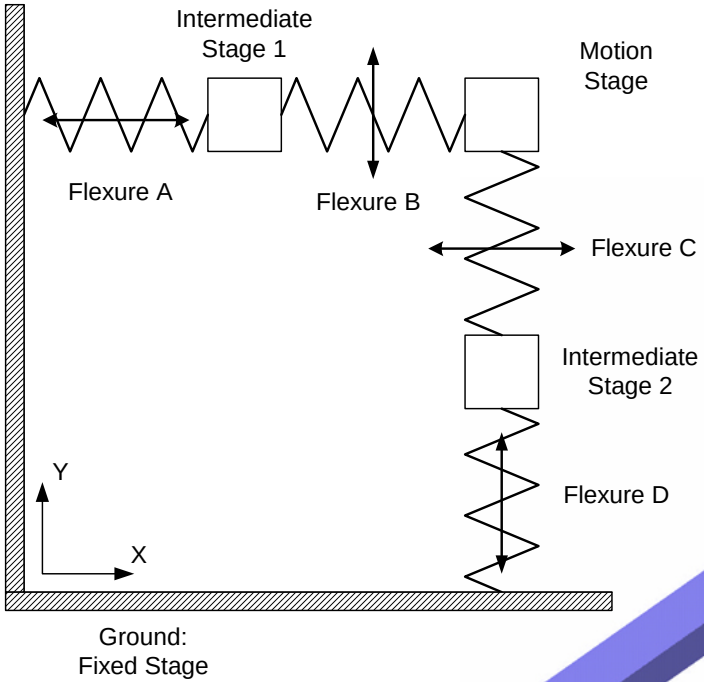
Core Technology

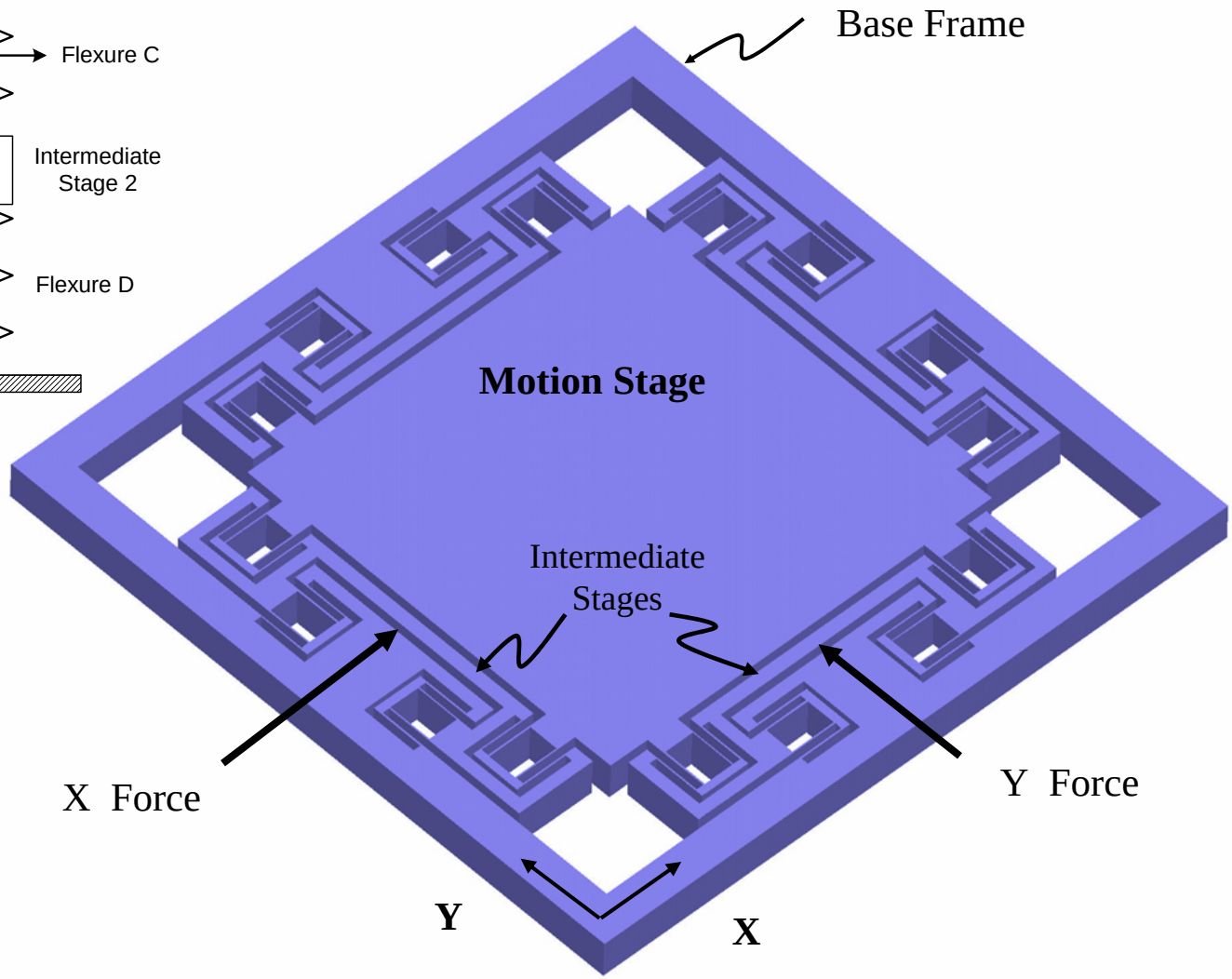
MEMS Surface
Force Apparatus
Angstrom-Level Gap
Control
Force /
Displacement
market
Scientific
Instruments

Ultra-High Precision Valve
"Small Gap Chromatography"
markets
Miniaturized Gas Sensor
Gas Flow Servo Valve

2 DOF X-Y Flexure Stages

Shorya Awtar's Ph.D. Thesis





Slocum, MIT 2003