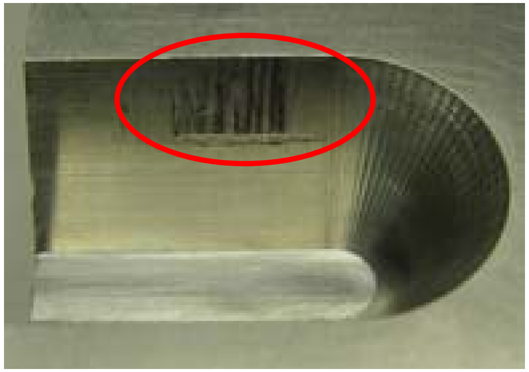
USING CONSTRAINTS IN MECHANISM DESIGN

Alternatives to motion with physical contact

Problems you can not avoid with contact:

- Surface topology (finish)
- Wear and Fretting
- Friction
- Limited resolution, at best on order of microns….



Wear on Groove

Next generation applications require nanometer level fixtures, i.e.:

- Fiber optics
- Photolithography

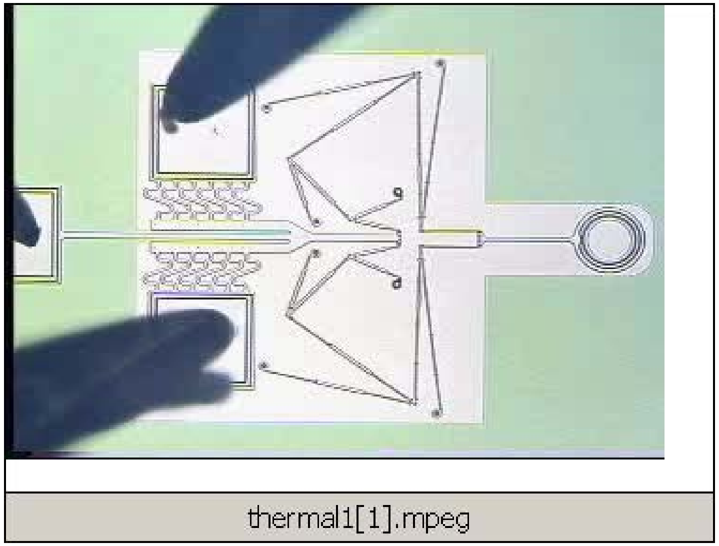
Compliant mechanisms:

- Mechanical reduction to interface with larger scale actuators
- Motion through strain
- Small and moderately sized motions in comparison to mechanism size
- Can be made to emulate machines

Compliant mechanism examples

University of Michigan: Prof. Sridhar Kota

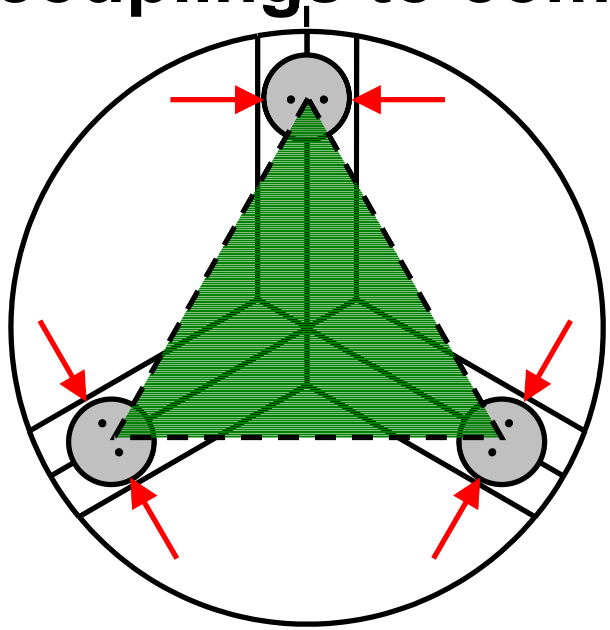
- http://www.engin.umich.edu/labs/csdl/index.htm

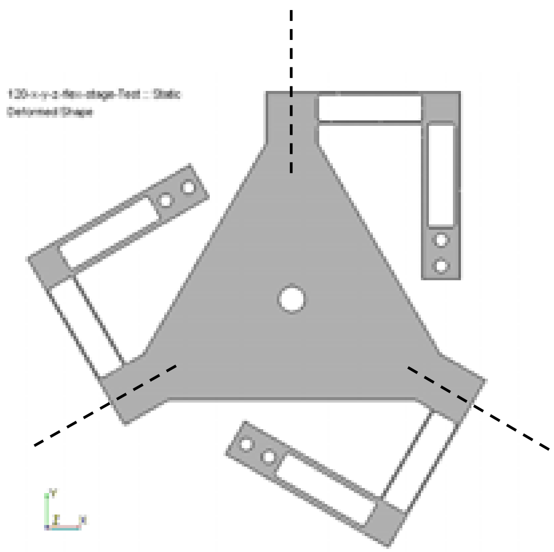


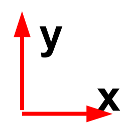
Why compliant mechanisms in precision fixtures

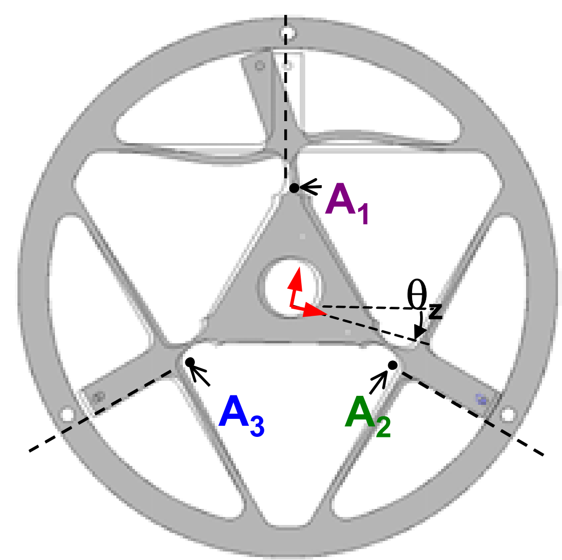
- Repeatable/low hysteresis
- No assembly
- No contact

From kinematic couplings to compliant stages









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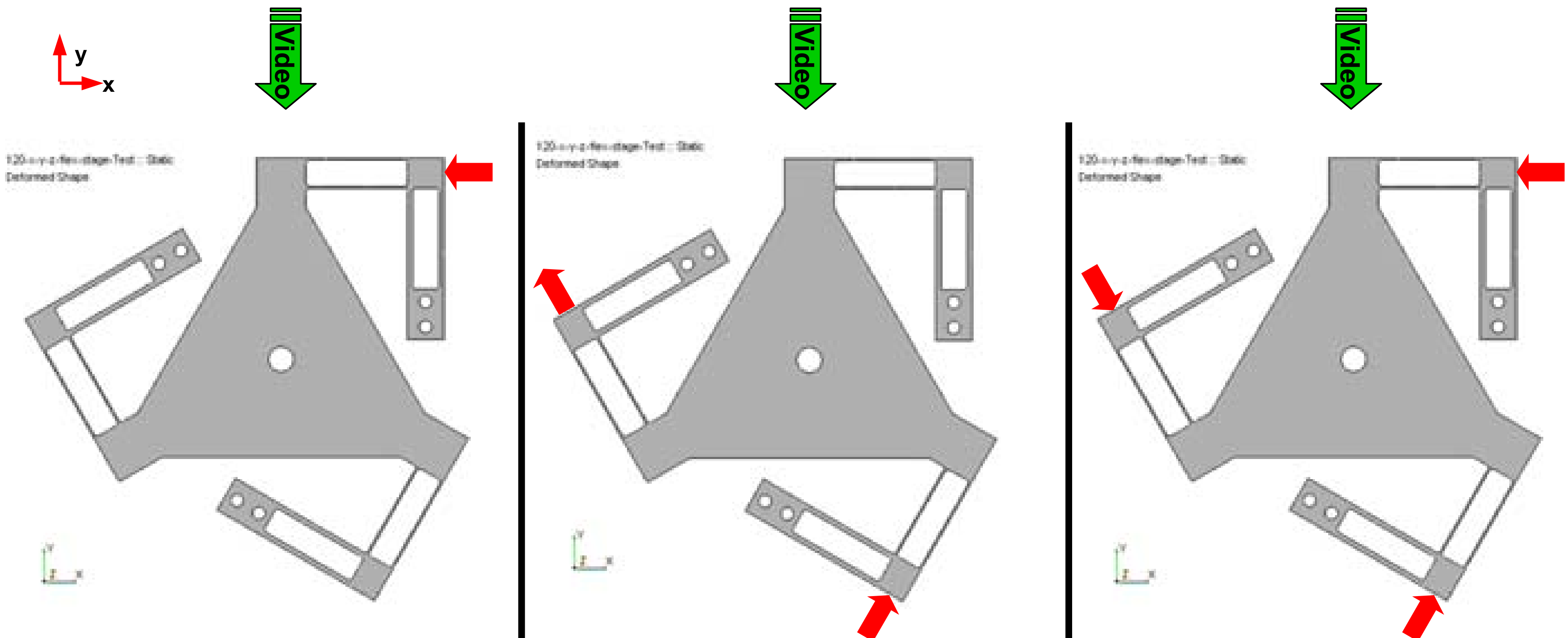
Constraint based compliant mechanisms

High volume, low cost, multi-degree of freedom alignment

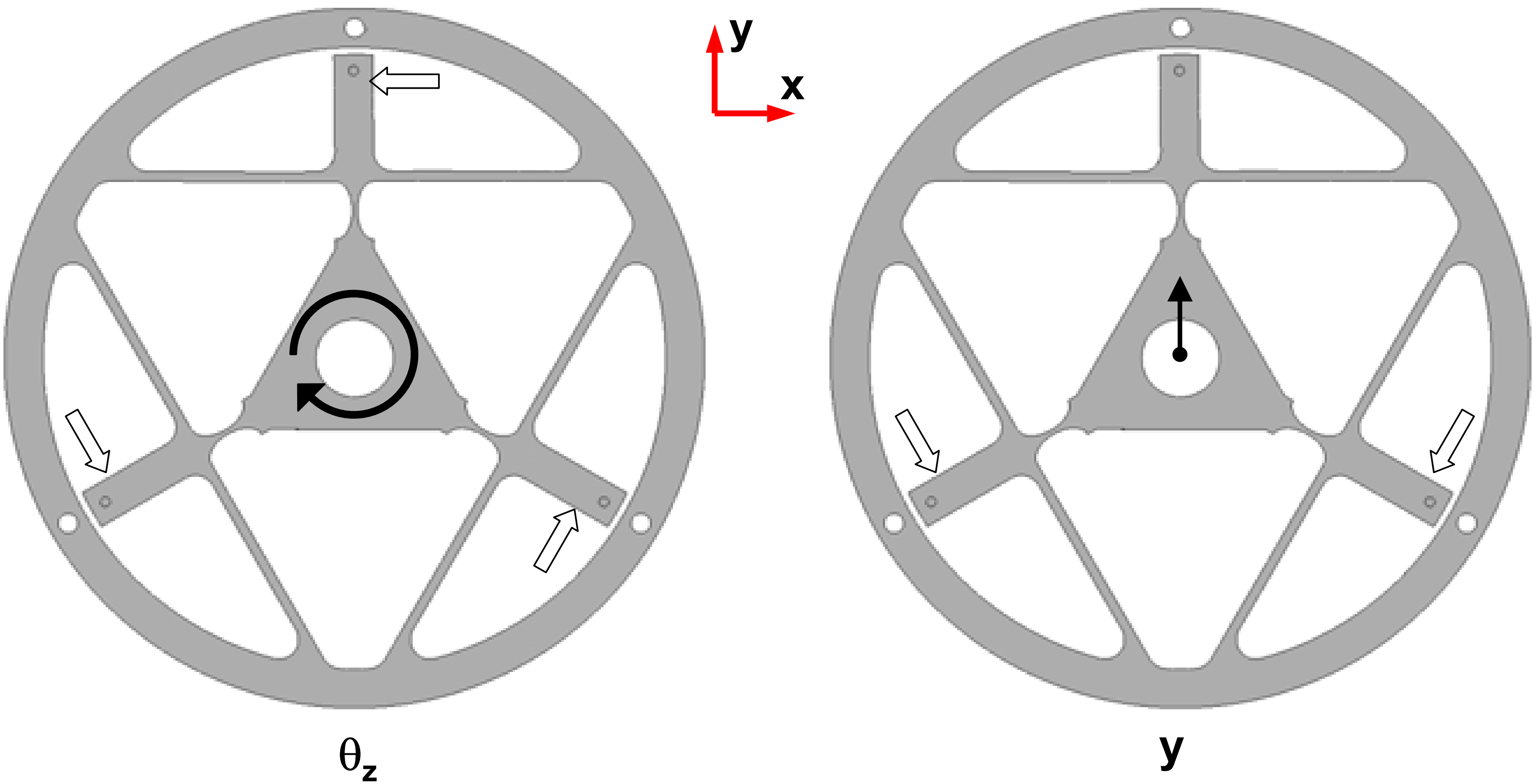
Example 3 DOF flexure system:

Target applications: Opto-electronic packaging/alignment



x and θ_z | y | θ_z

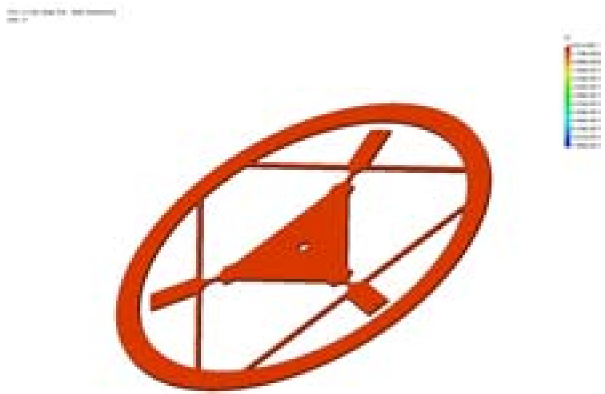
Constraint based compliant mechanisms cont.



Constraint based compliant mechanisms cont.

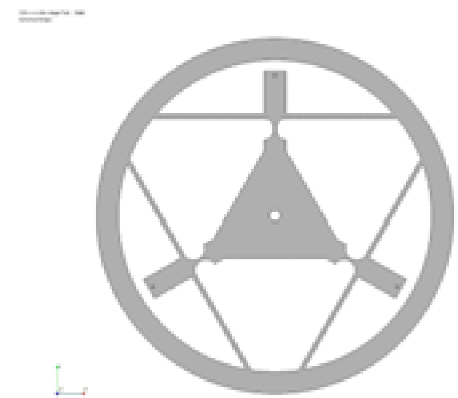
Example 6 DOF alignment capability

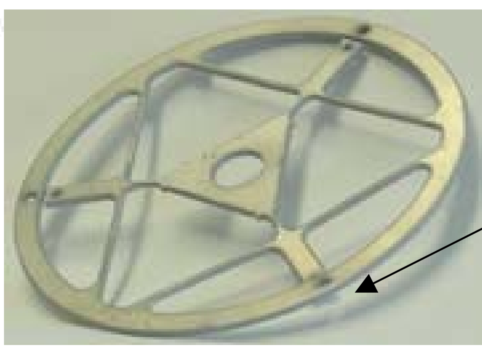
Target app.: Micro and meso scale positioning (I.e. opto-electronics)

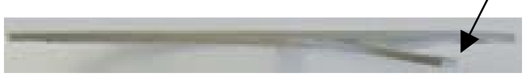


Video

Video

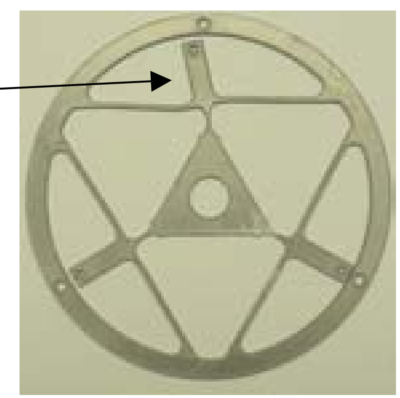






Permanent set due to plastic deformation

Have option to rely on elastic deformation



z , θ_x , θ_y

x and θ_z

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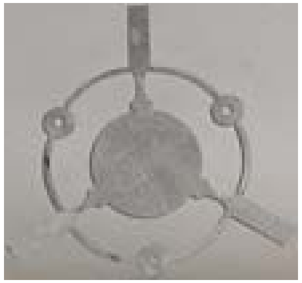
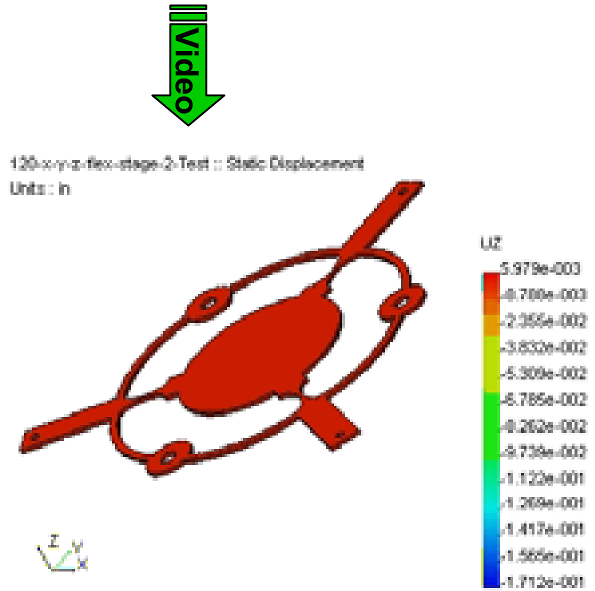
Constraint based compliant mechanisms cont.

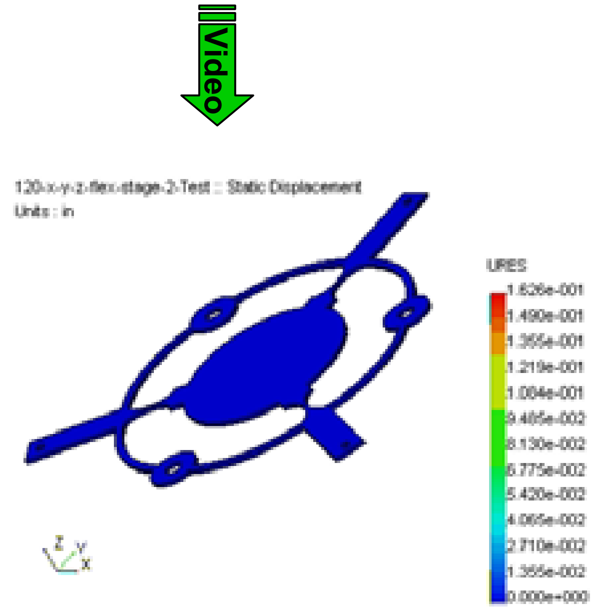
Example 6 DOF alignment capability

Target app.: Micro/meso scale positioning (I.e. opto-electronics)

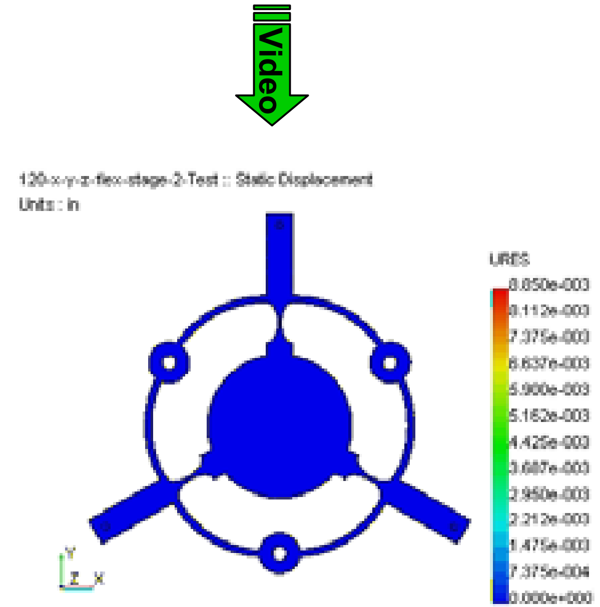




z , θ_x , θ_y



z

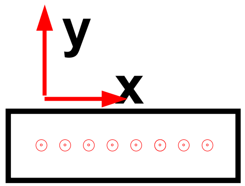


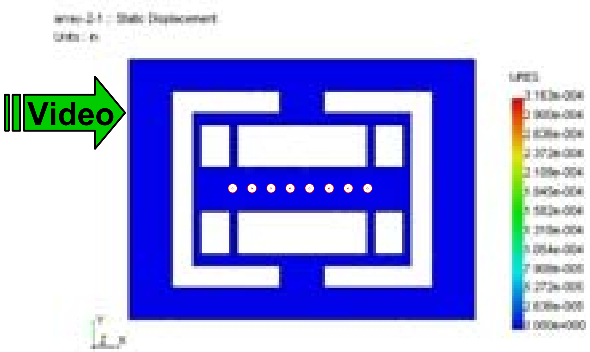
θ_z

Constraint based compliant mechanisms cont.

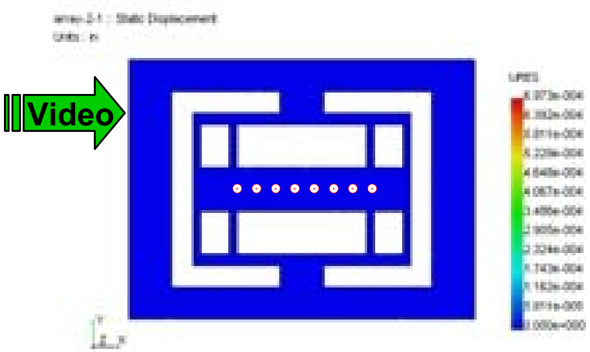
3 DOF active alignment [x, y, z] & 2 DOF passive alignment [z, θ_y]

Good fit for wire-EDM (stacked sheets) ~ order of $ 1 - 10

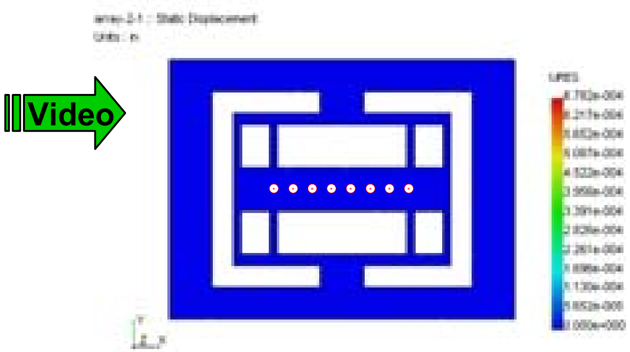




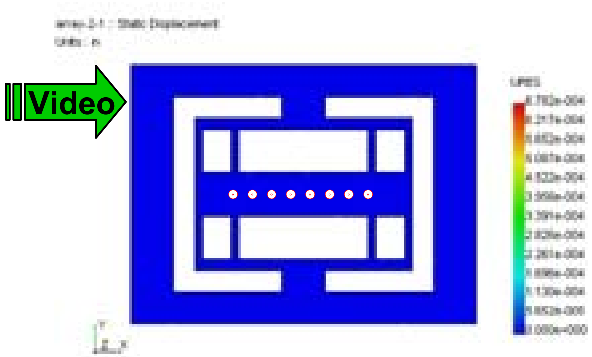
Δx



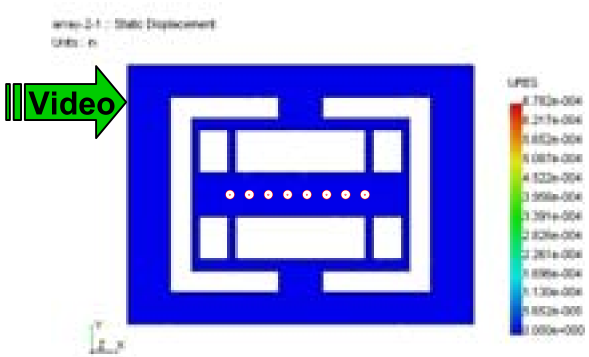
Δy



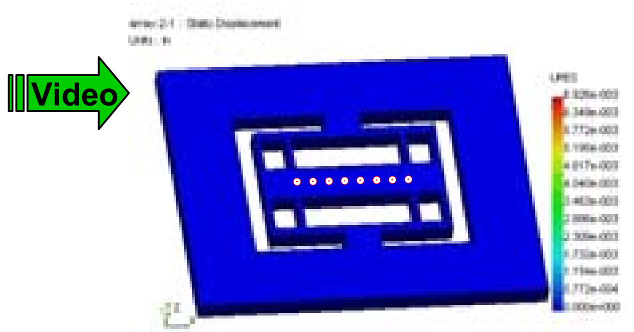
$\Delta\theta_z$



Δx & $\Delta\theta_z$



Δx & Δy



$\Delta\theta_y$

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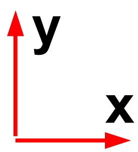
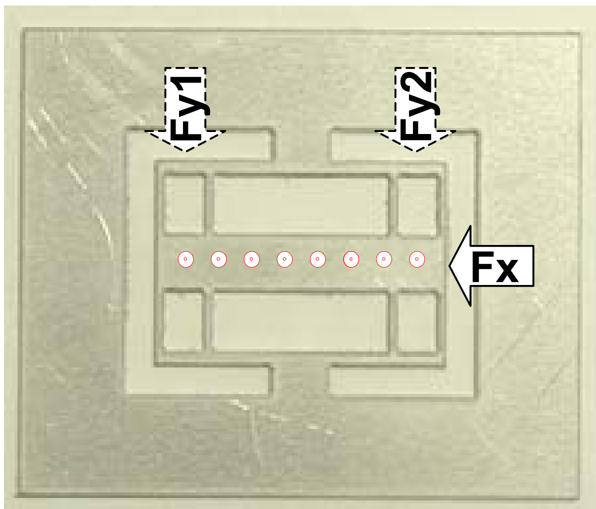
Constraint based compliant mechanisms cont.

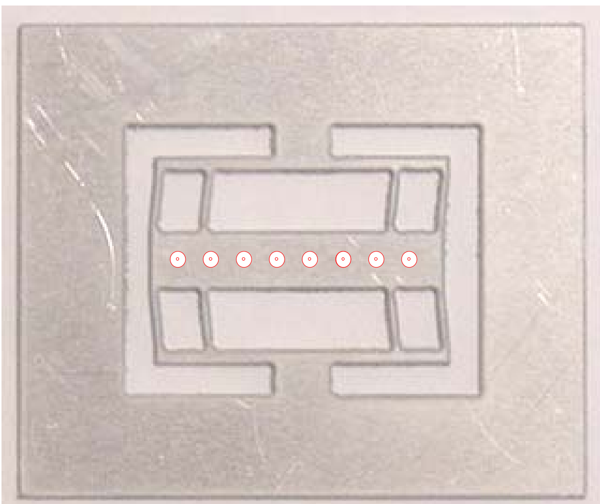
Plastic deformation can be utilized for position keeping

Device should be potted in place to avoid stress relief





Initial position



Plastically flexed

Constraint based compliant mechanisms cont.

Static or flexible kinematic coupling

Components biased toward each other

Flexure takes up bias, provides mating force in z direction