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A Study of Lubricating Flows in MEMS Bearings

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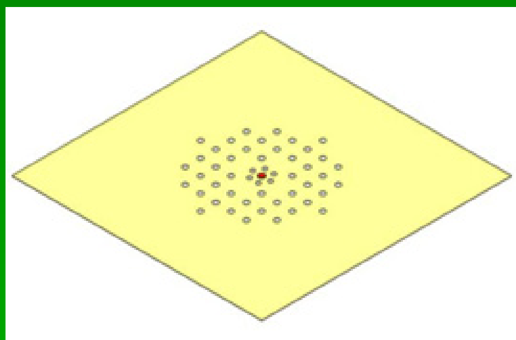
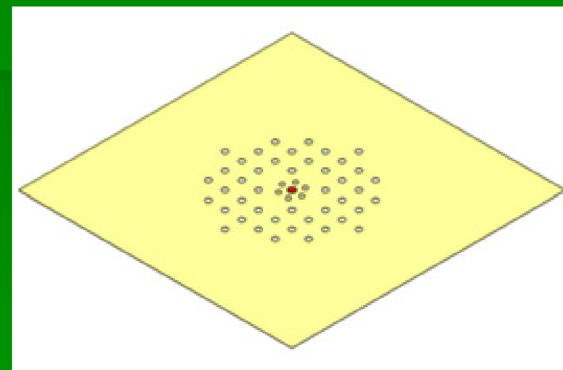
COMSOL09

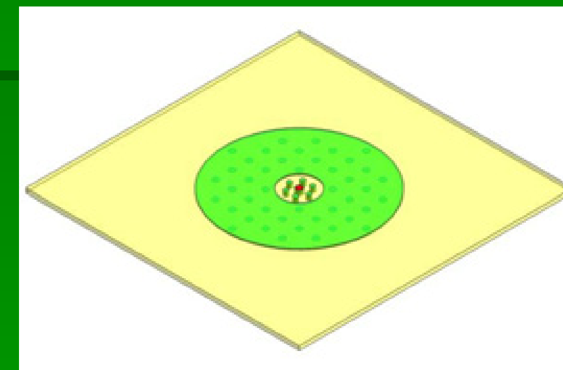
EFAB Manufacturing Process



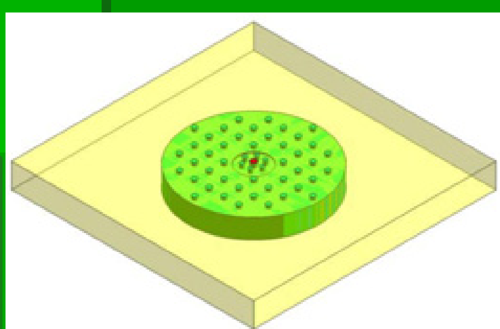
First Structural Layer



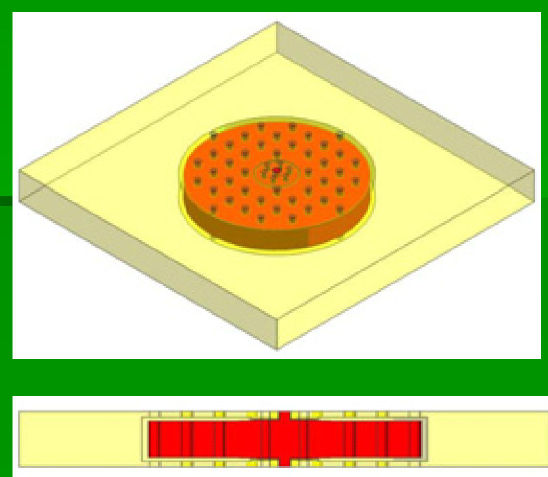
Completed First Layer



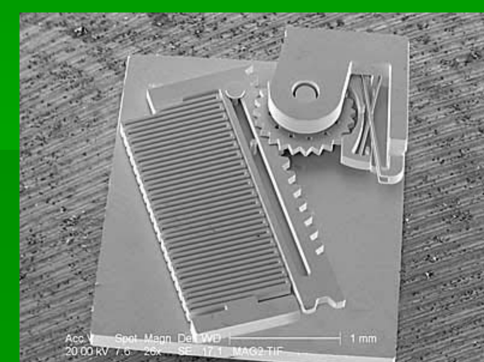
Completed Bearing Surface



Un-etched Assembly



Etched Assembly



Sample Assembly

Governing Equations

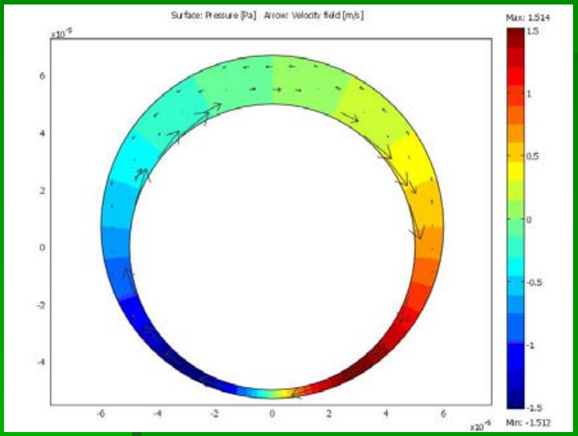
- Mass Conservation (Continuity)

$$\text{div } V = 0$$

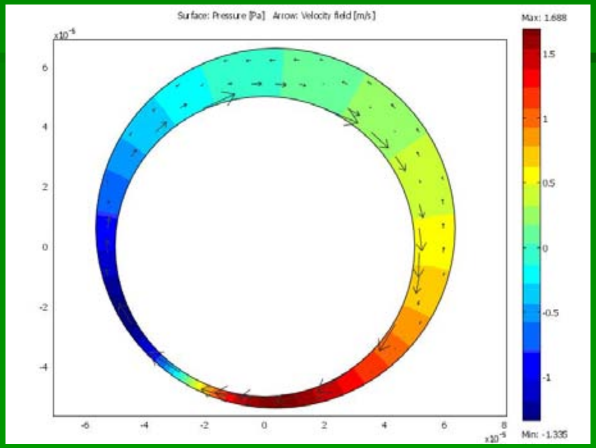
- Momentum Conservation (Navier-Stokes)

$$V \text{ grad } V = \mu \text{ div grad } V - \text{grad } p + \rho \text{ g}$$

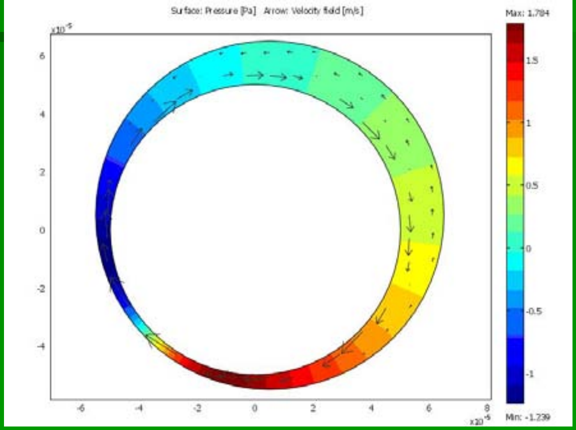
Journal Bearing



0° Offset



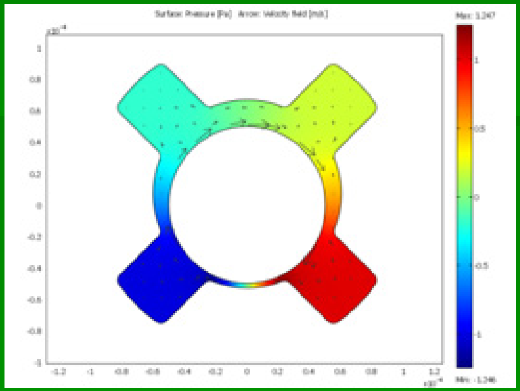
30° Offset



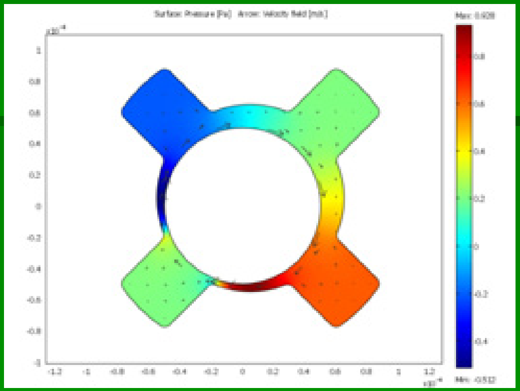
45° Offset

The journal bearing produces the same pressure differential regardless of the shaft offset.

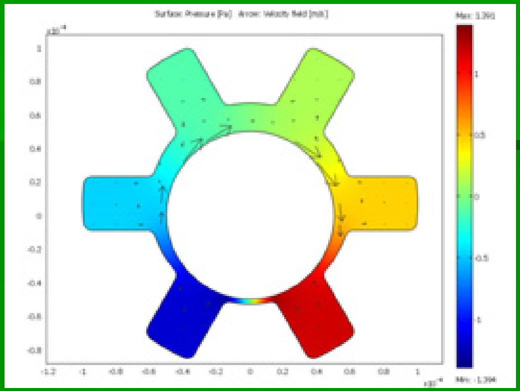
Channel Bearing



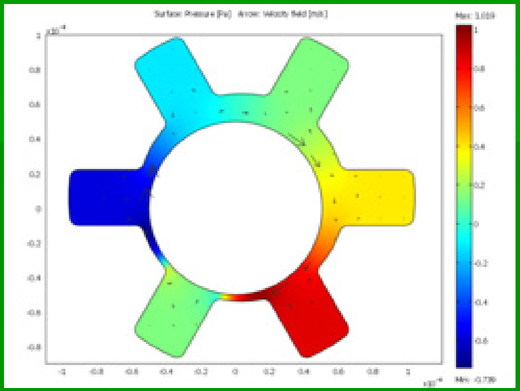
4-Lobe 0° Offset



4-Lobe 45° Offset

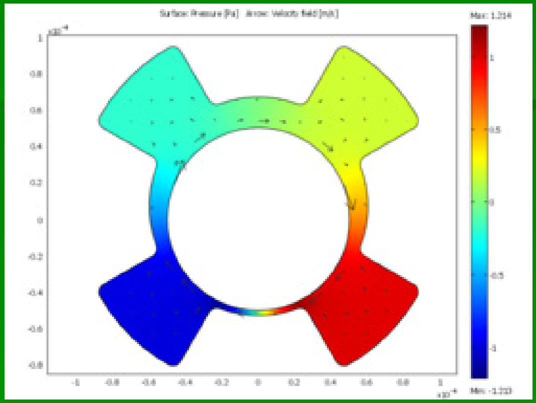


6-Lobe 0° Offset

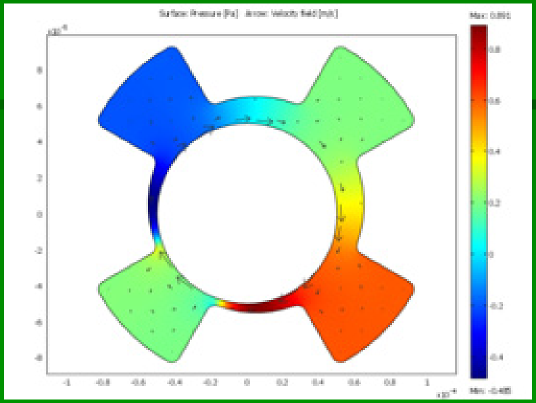


6-Lobe 30° Offset

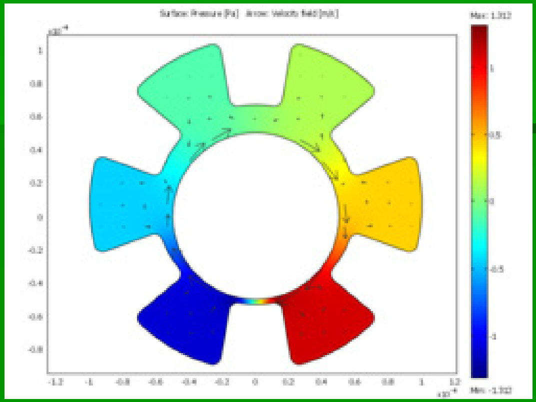
Diffuser Bearing



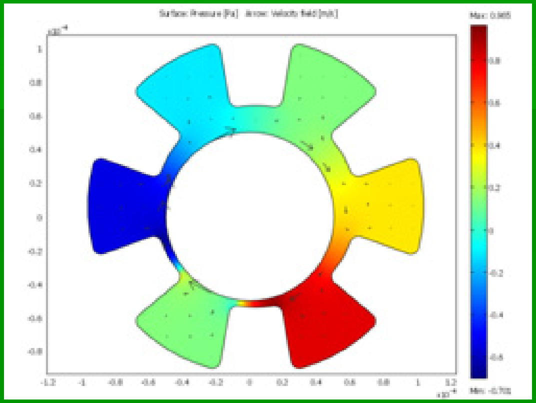
4-Lobe 0° Offset



4-Lobe 45° Offset

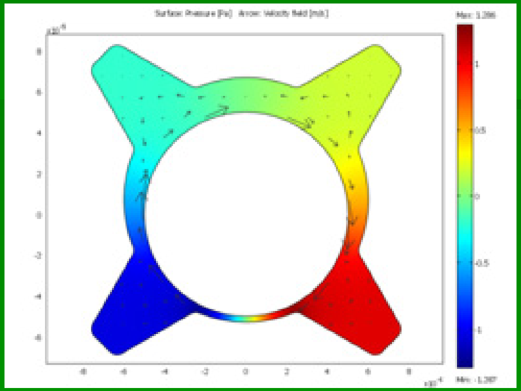


6-Lobe 0° Offset

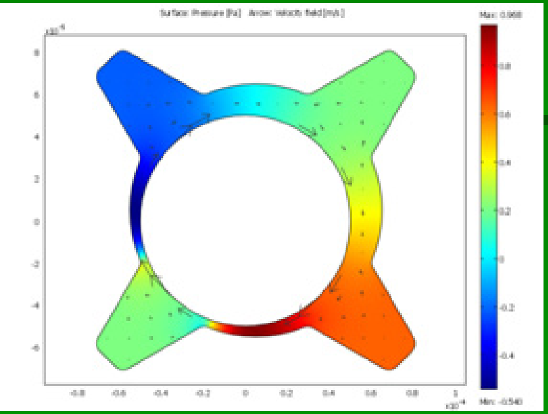


6-Lobe 30° Offset

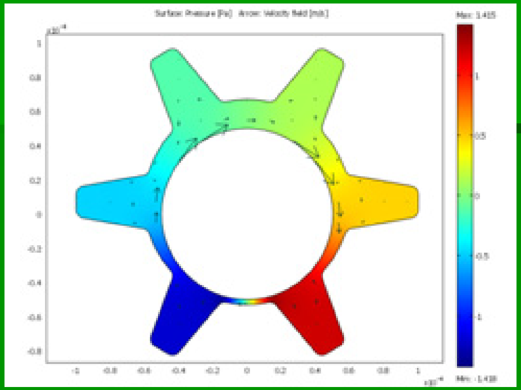
Nozzle Bearing



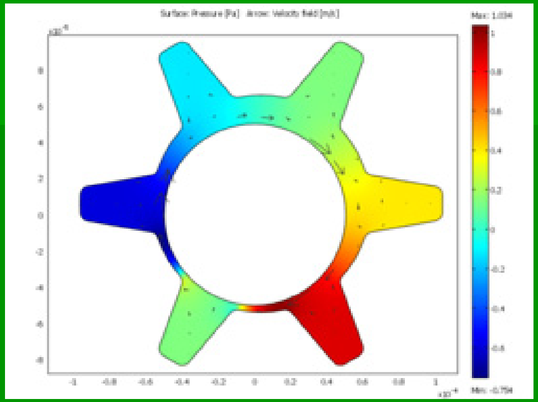
4-Lobe 0° Offset



4-Lobe 45° Offset



6-Lobe 0° Offset



6-Lobe 30° Offset

Computed Pressure Differentials

Configuration	Nominal (Pa)	Offset (Pa)
Journal	3.026 (1.00)	3.023 (1.00)
4-Lobe Channel	2.493 (.824)	1.440 (.476)
6-Lobe Channel	2.785 (.920)	1.758 (.582)
4-Lobe Diffuser	2.427 (.802)	1.376 (.455)
6-Lobe Diffuser	2.624 (.867)	1.666 (.551)
4-Lobe Nozzle	2.573 (.850)	1.508 (.499)
6-Lobe Nozzle	2.833 (.936)	1.788 (.591)

Conclusions

- This study has demonstrated that COMSOL can be used to demonstrate the hydrodynamic performance of proposed MEMS designs.
- Specific features of bearing design determine the resulting flow field and pressure distribution in the hydrodynamic gap.
- The six lobe nozzle design produces the closest performance to the journal design.

Questions?