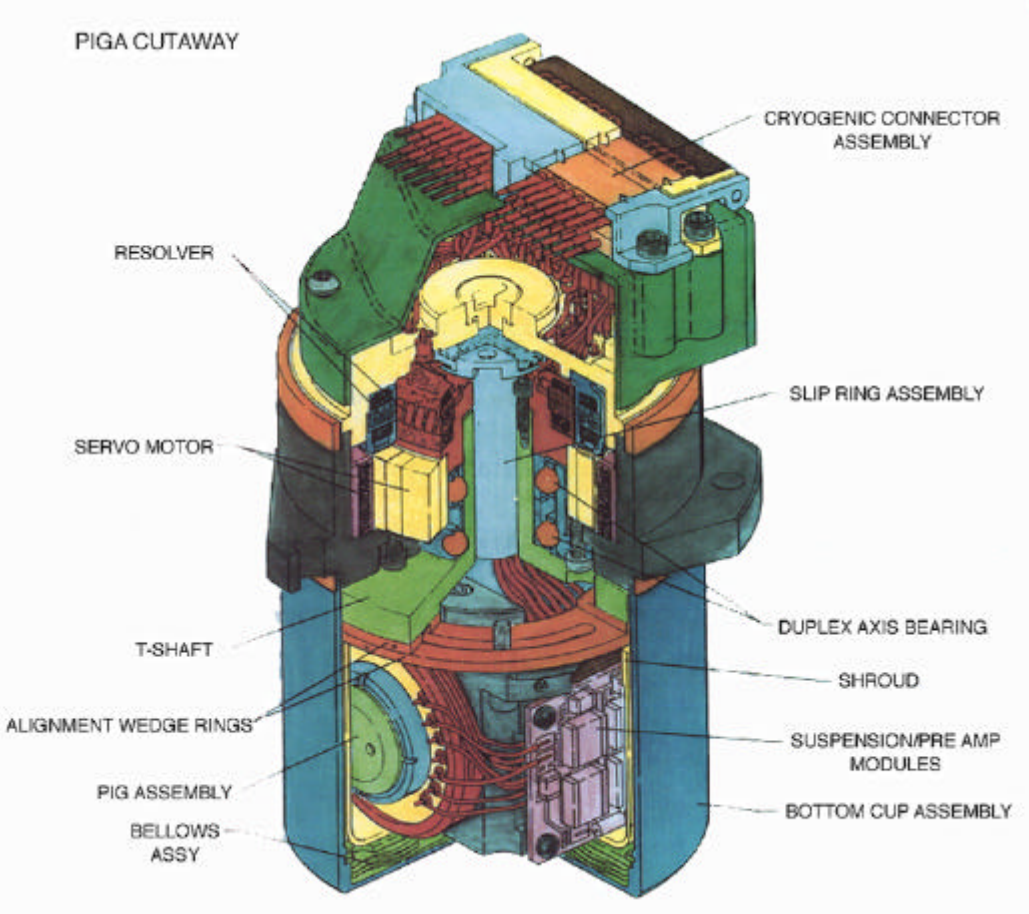
MilliPOGA

PENDULOUS OSCILLATING GYRO ACCELEROMETER

A STRATEGIC-GRADE SOLID-STATE ACCELEROMETER

sensor@mssainc.com

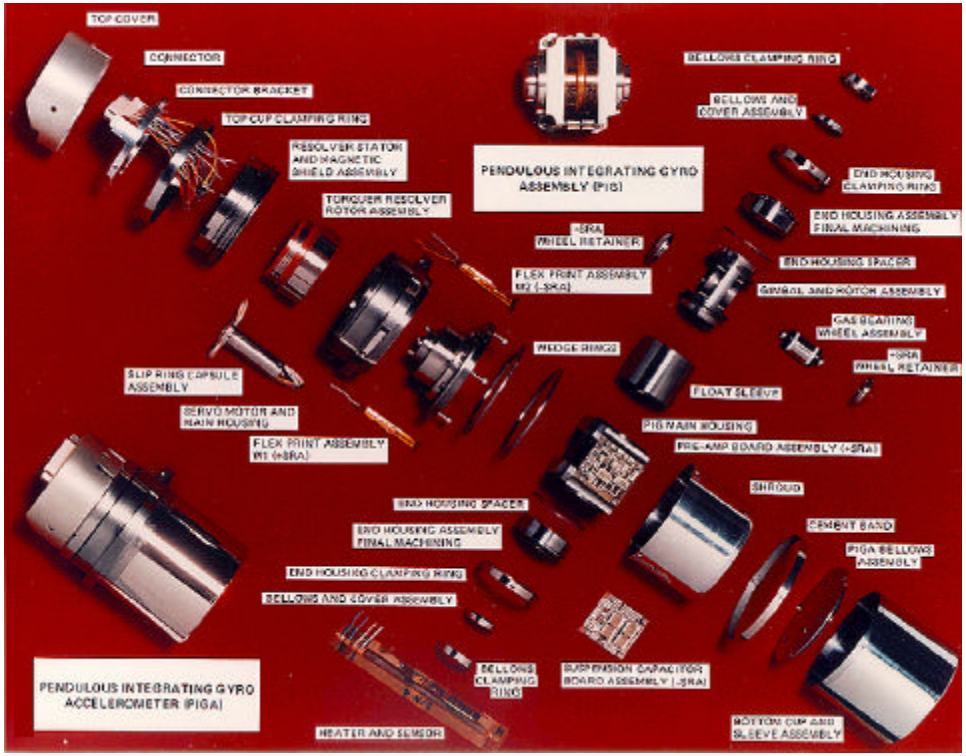
PENDULOUS INTEGRATING GYRO ACCELEROMETER (PIGA)



BASED ON A PENDULOUS SDF GYRO MOUNTED ON A PLATFORM ROTATING ABOUT GYRO INPUT AXIS

PLATFORM ROTATION PRODUCES GYROSCOPIC TORQUE THAT BALANCES PENDULUM TORQUE TO MEASURE ACCELERATION

MilliPOGA MOTIVATION



HIGH COST, INTENSIVE ASSEMBLY OF COMPLEX PARTS BY HIGHLY SKILLED HANDS-ON LABOR; SPECIALIZED MATERIALS AND PROCESSES

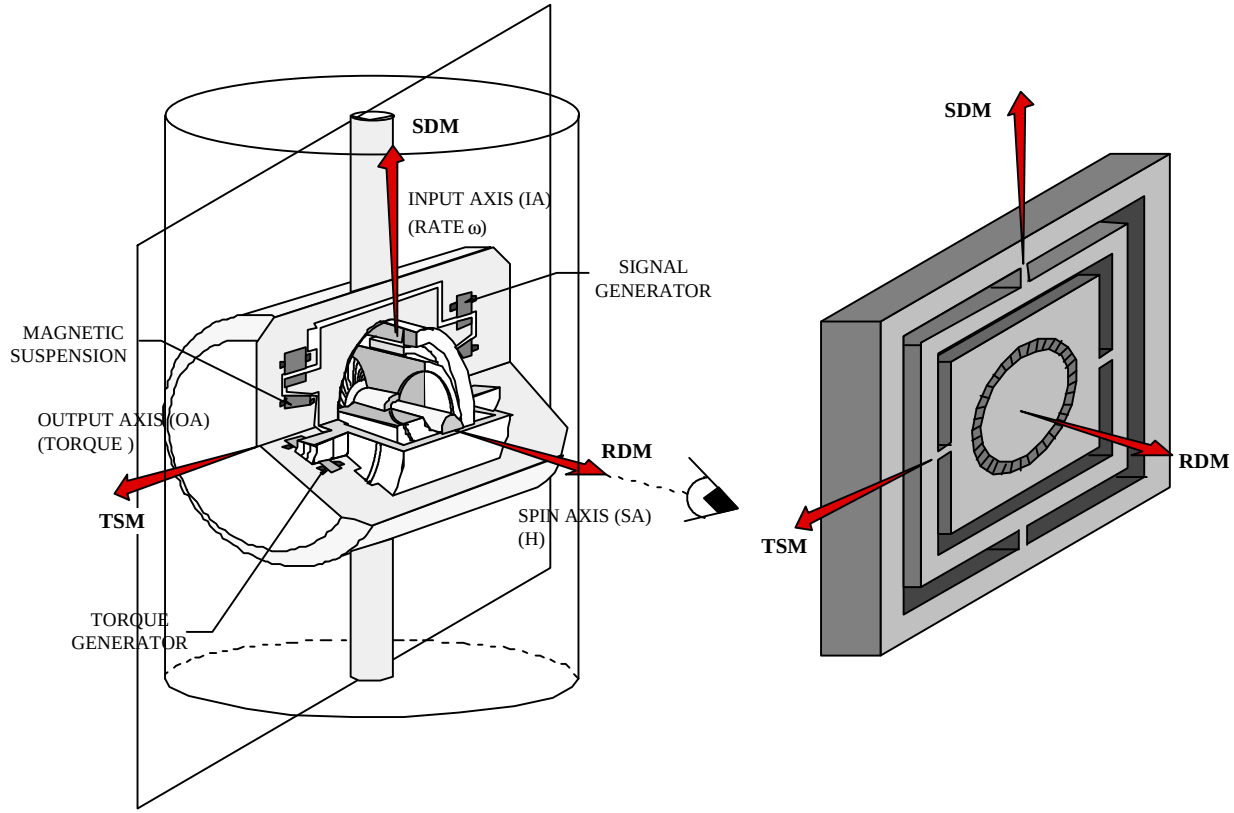
Why POGA

- POGA is a Pendulous Gyro Accelerometer
- Retains virtues of PIGA; eliminates troublesome parts
- No other accelerometer has performed as well as the PIGA
- POGA is the next step (logical successor) in PIGA evolution

POGA / PIGA Virtues

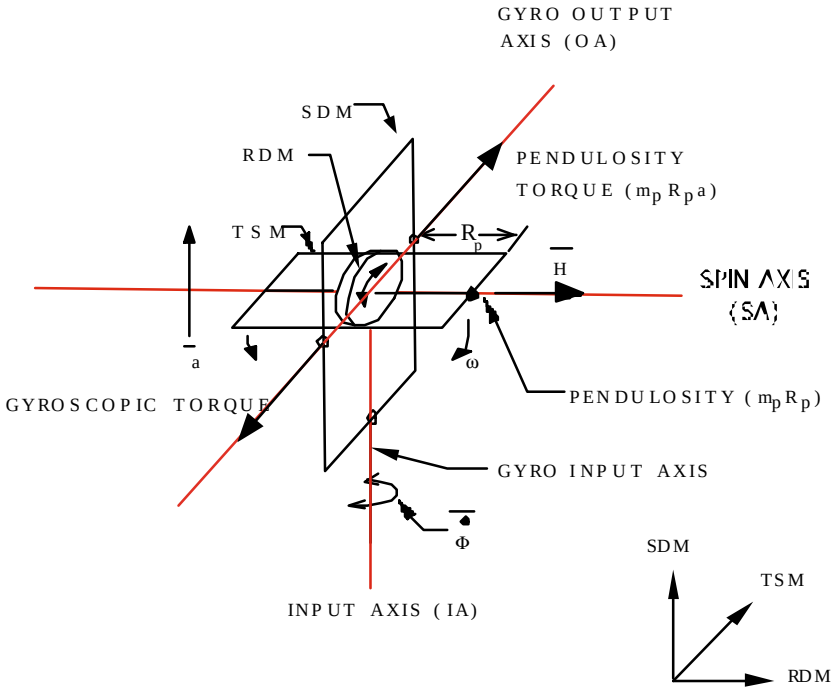
- Both balance two inertial torques: pendulous with gyroscopic
- Both have scale factors that depend solely on rigid body motions
- Neither depends on magnetic material and / or voltage reference stabilities
- Both have velocity storage

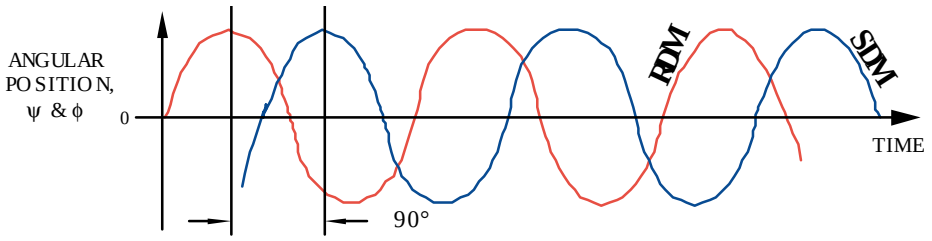
CONVENTIONAL TO PLANAR CONVERSION



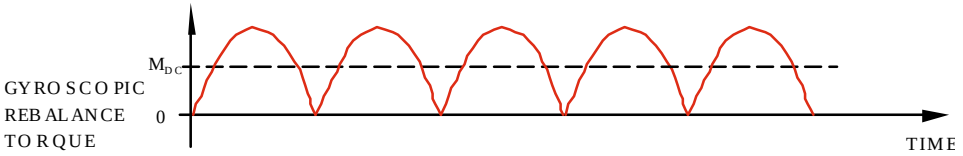
EXTRA GIMBAL CONVERTS SDF TO MILLIPOGA
PLANARITY REQUIRES THAT CONTINUOUS ROTATIONS ARE REPLACED BY ROTOR AND PLATFORM OSCILLATIONS

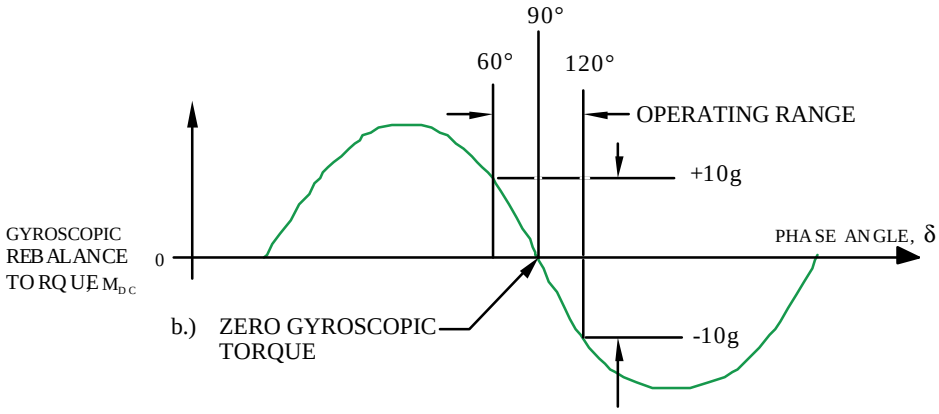
MilliPOGA
PRINCIPLE OF OPERATION





a.) δ = 90° = PHASE ANGLE FOR ZERO GYROSCOPIC TORQUE





GYROSCOPIC TORQUE BALANCES PENDULOUS TORQUE

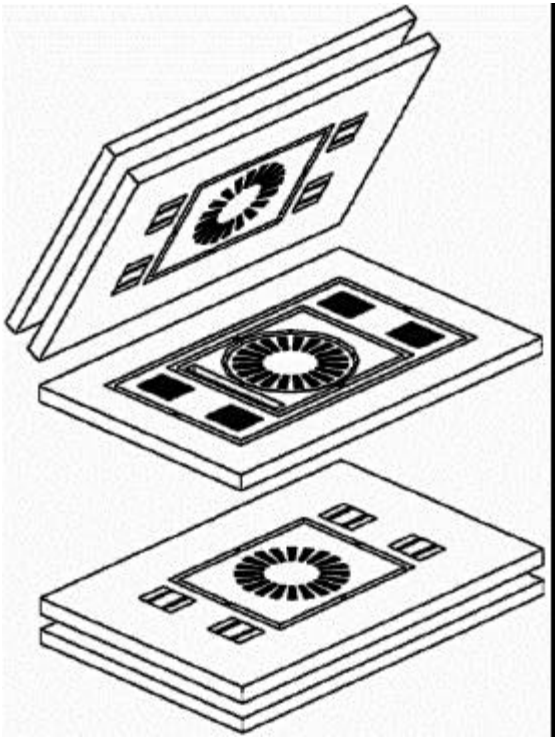
$$I_T\ddot{\vartheta} + D_T\dot{\vartheta} + K_T\vartheta = \sum M_{OA} = m_p R_p a - \left\{\frac{I_R\tilde{\psi}\tilde{\phi}}{2}\omega^2\cos\delta + M(2\omega)\right\}$$

$$a = \frac{I_R\tilde{\psi}\tilde{\phi}}{2m_p R_p}\omega^2\cos\delta + M(2\omega)$$

ADVANTAGES OF MilliPOGA TO CONVENTIONAL DEVICE

- DRY INSTRUMENT
- HIGHER RELIABILITY-NO WEARABLE COMPONENTS
- ESSENTIALLY ALL SILICON CONSTRUCTION, PLASMA ETCH PROCESSING
- INFRASTRUCTURE SUPPORTED BY EXPANDING MEMS INDUSTRY
- COMPLETE FABRICATION IN ONE FACILITY PROVIDES FULL PRODUCT CONTROL
- BUILT-IN ALIGNMENT ELIMINATES LABOR SKILLS AND FIXTURING

MilliPOGA CONCEPT



All silicon construction

Fabrication by plasma etching

Flexure support of moving parts

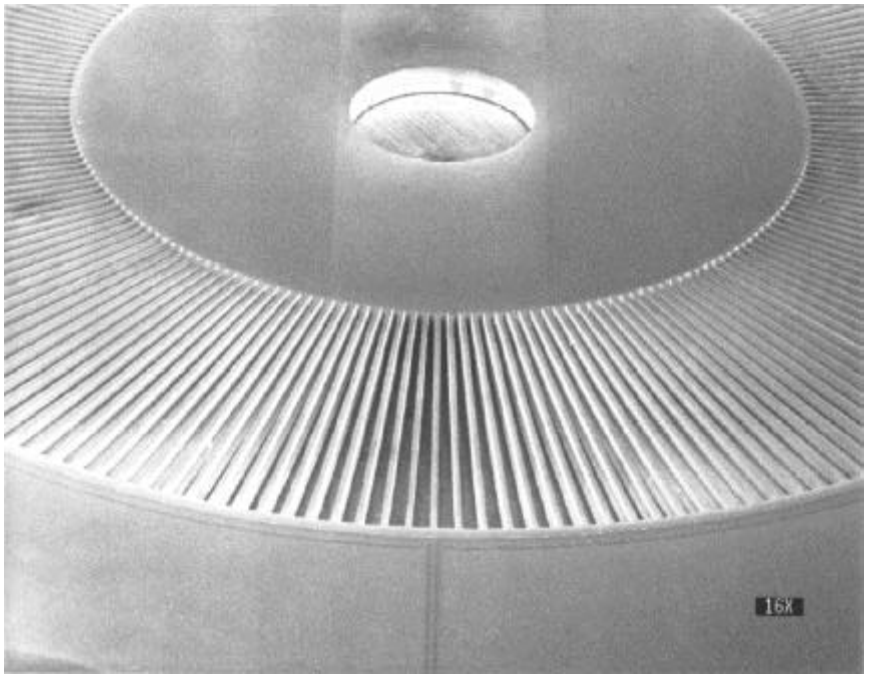
All capacitive actuator drives

Optical read-out of oscillating members

Dry instrument

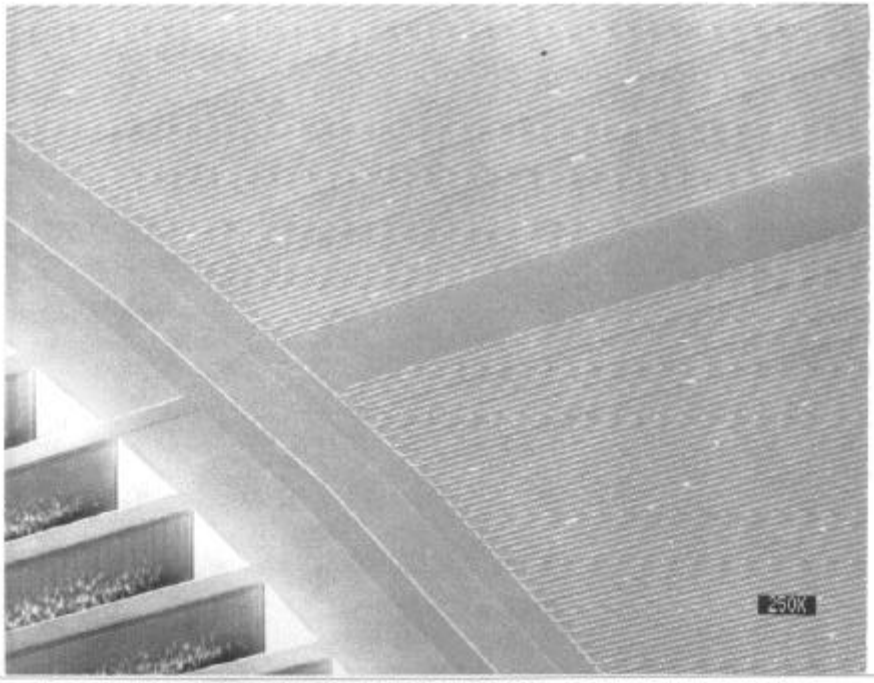
PLASMA ETCH FABRICATION OF RADIAL FLEXURES

ALLOWS OSCILLATION OF ROTOR IN PLANE

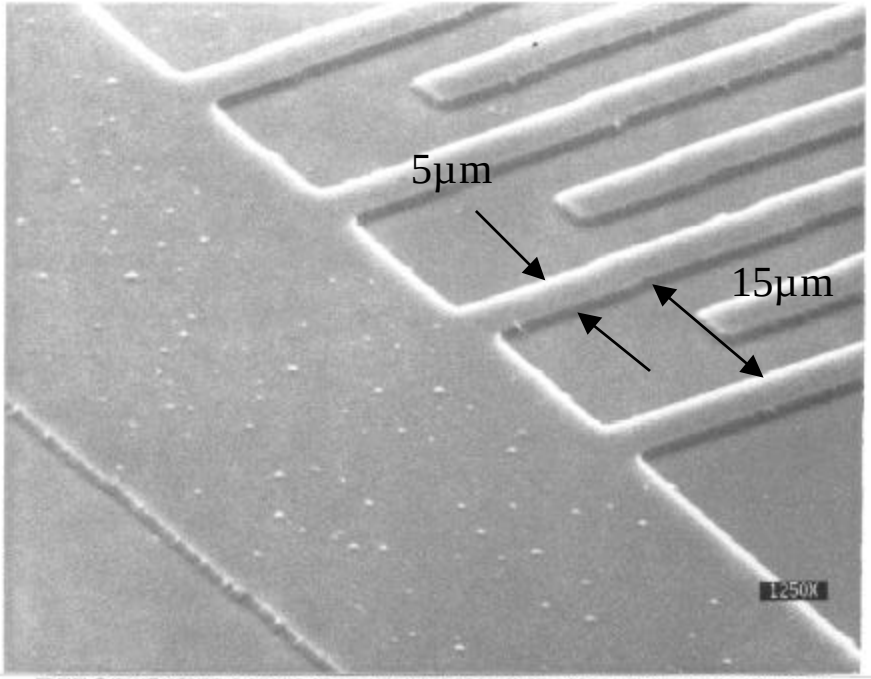


- THROUGH-WAFER PROCESSING
  - 200-300 MICRONS
- HIGH ASPECT RATIO
  - GREATER THAN 100
- HIGH PRECISION
- FABRICATION BY KIONIX, ITHACA, NY

Kionix, Inc. Fabricated RIE POGA RDM with Electrostatic Drive



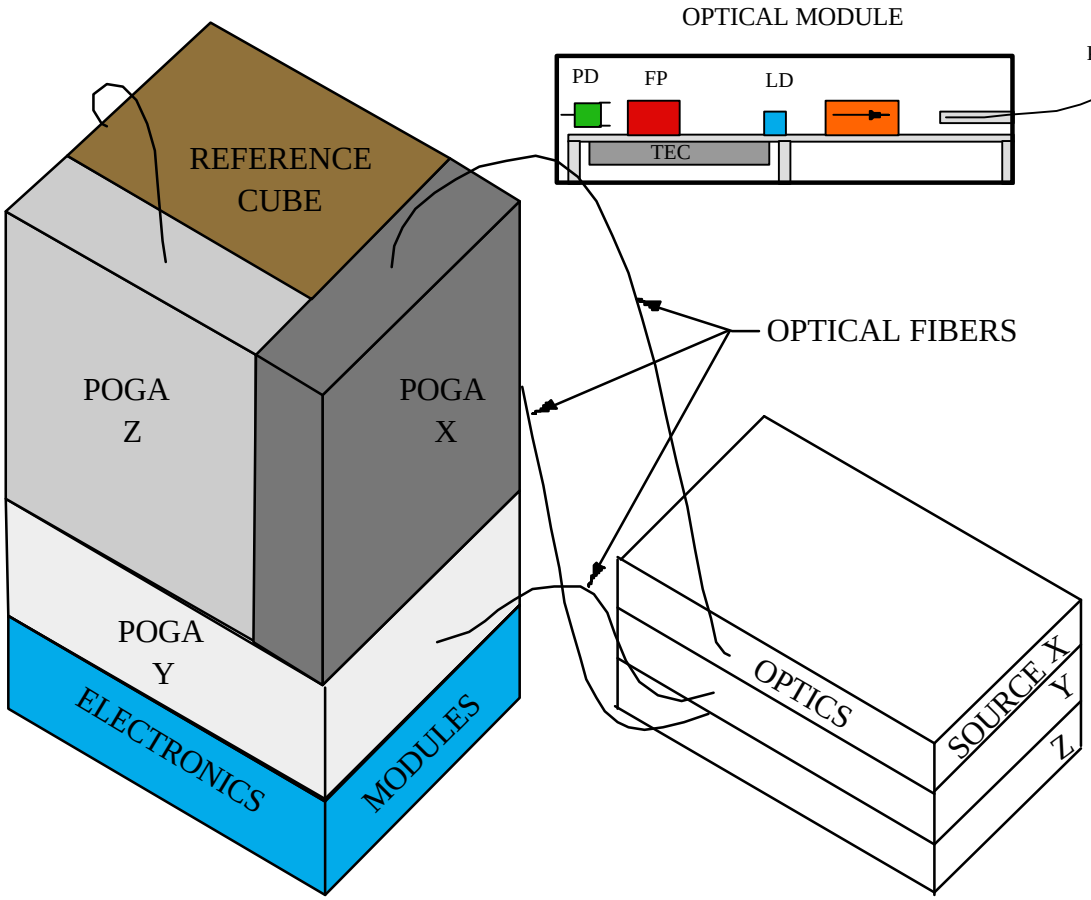
PHOTOGRAPH OF THE PICK-OFFS AT 250X.
WAFER SECTION.



PHOTOGRAPH OF THE PICK-OFFS AT 1250X.
WAFER SECTION.

Electrostatic Drive, 4000 Fingers

CONVENTIONAL SYSTEM CONCEPT



- LASER DIODE WAVELENGTH STABILIZED BYFABRY-PEROT IS PIGTAILED TO ACCELEROMETER

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