

High Performance MEMS Gyro via Active Layer Gimbal Rotation

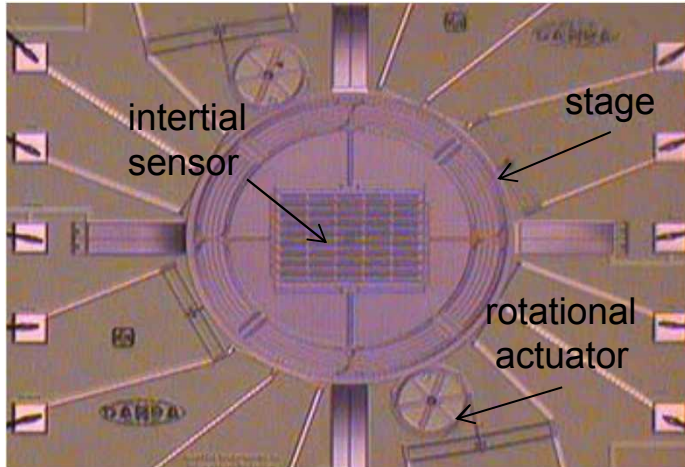
Primary and Secondary Calibration on Active Layer (PASCAL)

PASCAL
Sandia/Draper
2/16/2012





I: Technical Objective and Approach

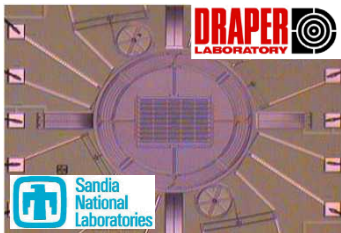


stage/accelerometer (DARPA seedling project)

- Our approach is to fabricate a high performance MEMS tuning fork gyro (modified Draper design with two counter-vibrating masses) simultaneously with a precision rotating stage in the same surface micromachining (SMM) process (modified Sandia SUMMiT™ process). This will result in an no-assembly-required intimately integrated, precisely aligned stage/gyro.
- The stage will allow +/- 90° rotation (0 to 180°) using high force thermal actuators for “Maytagging” operation allowing subtraction of bias and scale factor drift at every rotation.

For this approach to succeed the following technical challenges/objectives must be met:

- High repeatability, precise stage stop and lockdown positioning at each rotation.
- Low resistance, low variation, repeatable electrical connection between the rotatable stage and the stationary substrate (7 electrical signals: proof mass virtual ground, two comb drive signals, two comb sense signals, two Coriolis sense electrodes beneath each proof mass).
- Extra thick, low variation surface films to increase proof mass while maintaining low quadrature error.



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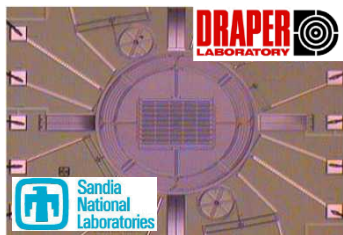
Unclassified





II. Project Goals and Milestones

Goals	PhI	PhII	End Goals
Stage/gyro operation	Controlled motion gyro and stage	N/A	N/A
Stage/gyro connection	Electrical connection to integrated gyro on stage	N/A	N/A
Bias drift (ppm/month)	N/A	10 to 100	1
Scale factor stability (ppm/month)	N/A	10 to 100	1
Size (mm ³)	N/A	100	30
Power (mW)	N/A	100 to 1000	50



- Note: project not funded beyond PhI.





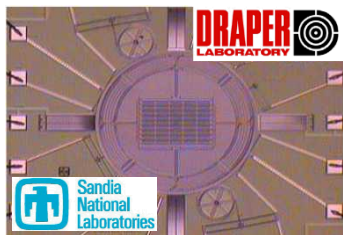
III: Specific Activities in Phase I

- **Near term plans:**

- 1 month – complete first design of integrated surface micromachined stage/gyro.
- 3 months – complete fabrication of 'short loops' and evaluate.
- 6 months – complete fabrication of first design of integrated surface micromachined stage/gyro, preliminary evaluation of stage/gyro.

- **Issues not fully addressed:**

- Packaging – including vacuum packaging.
- Sense/control electronics
- Characterization of gyro performance and effectiveness of MEMS stage 'Maytagging' in reducing bias and scale factor drift.
- A second design/analyze/build/characterize cycle



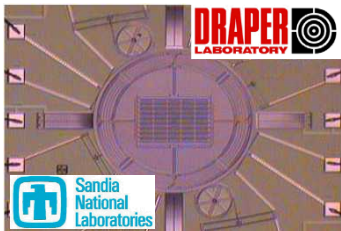


IV: Teaming and Personnel

- **Prime – Sandia at 75% (Stage design and analysis, Integrated fabrication), Sub – Draper at 25% (Gyro design and analysis)**

Personnel	Company	Responsibility	%FTE effort
Paul Galambos	Sandia	PI/PM	1/3
Mike Baker	Sandia	Stage design/analysis	1/3
Mike Shaw	Sandia	Stage/gyro fabrication	1/3
Peter Sherman	Draper	PI Draper	1/12
Murali Chaparala	Draper	PM Draper	1/12
Marc Weinberg	Draper	Gyro design	1/12
Gene Cook	Draper	Detailed gyro design/analysis	1/12

- **Points of contact:**
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