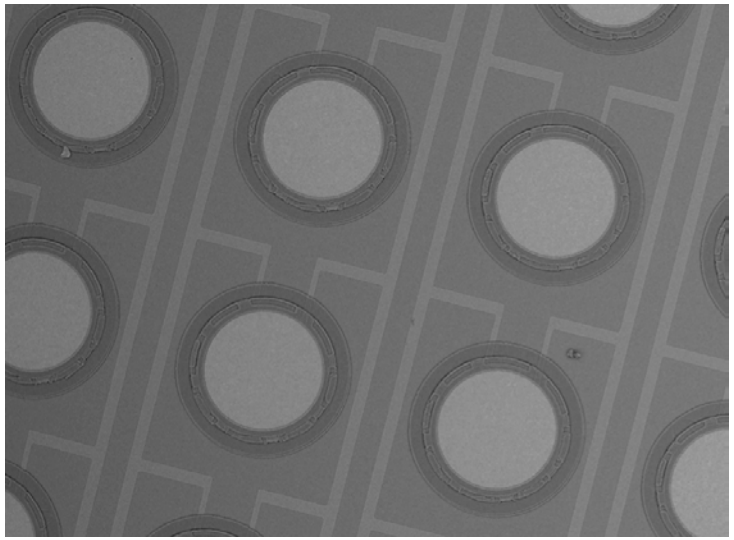
ADVANCED MANUFACTURING FOR ENERGY
SENSORS, HARVESTING, STORAGE

Low-cost Sensors for Natural Gas Pipeline Safety Monitoring

CEC Staff Workshop

July 16, 2015



CEC contract : 500-10-044

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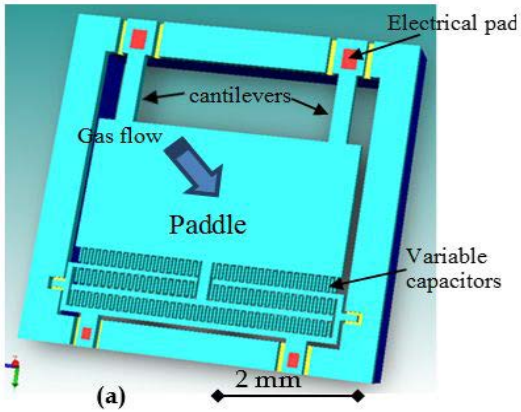
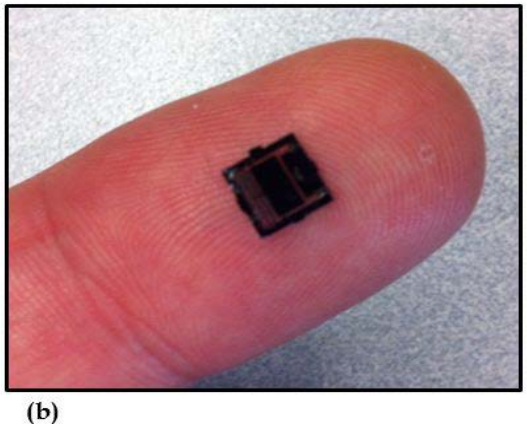
Berkeley
UNIVERSITY OF CALIFORNIA

SENSORS | FLOW AND PRESSURE

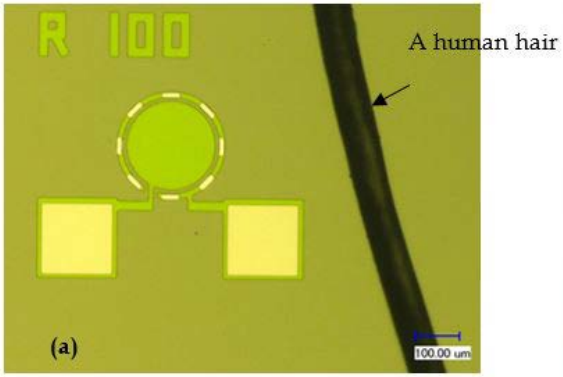
- MEMS for cost effectiveness and widespread deployment
- Detection of over-pressure and leaks

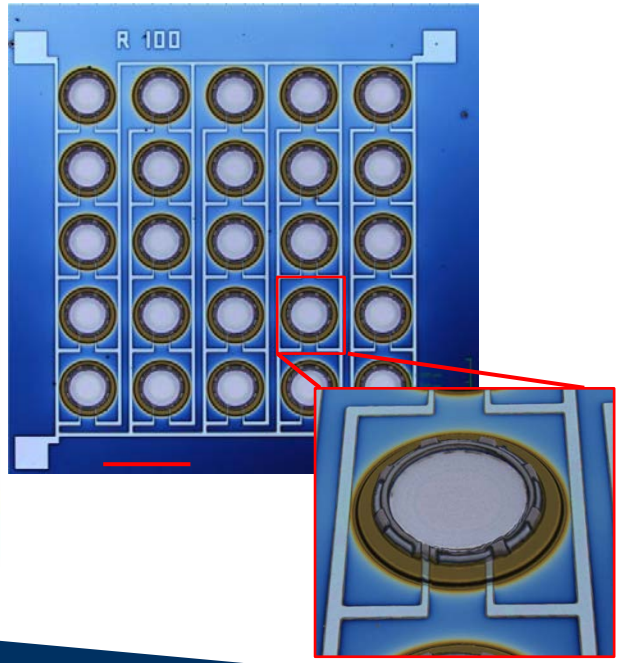




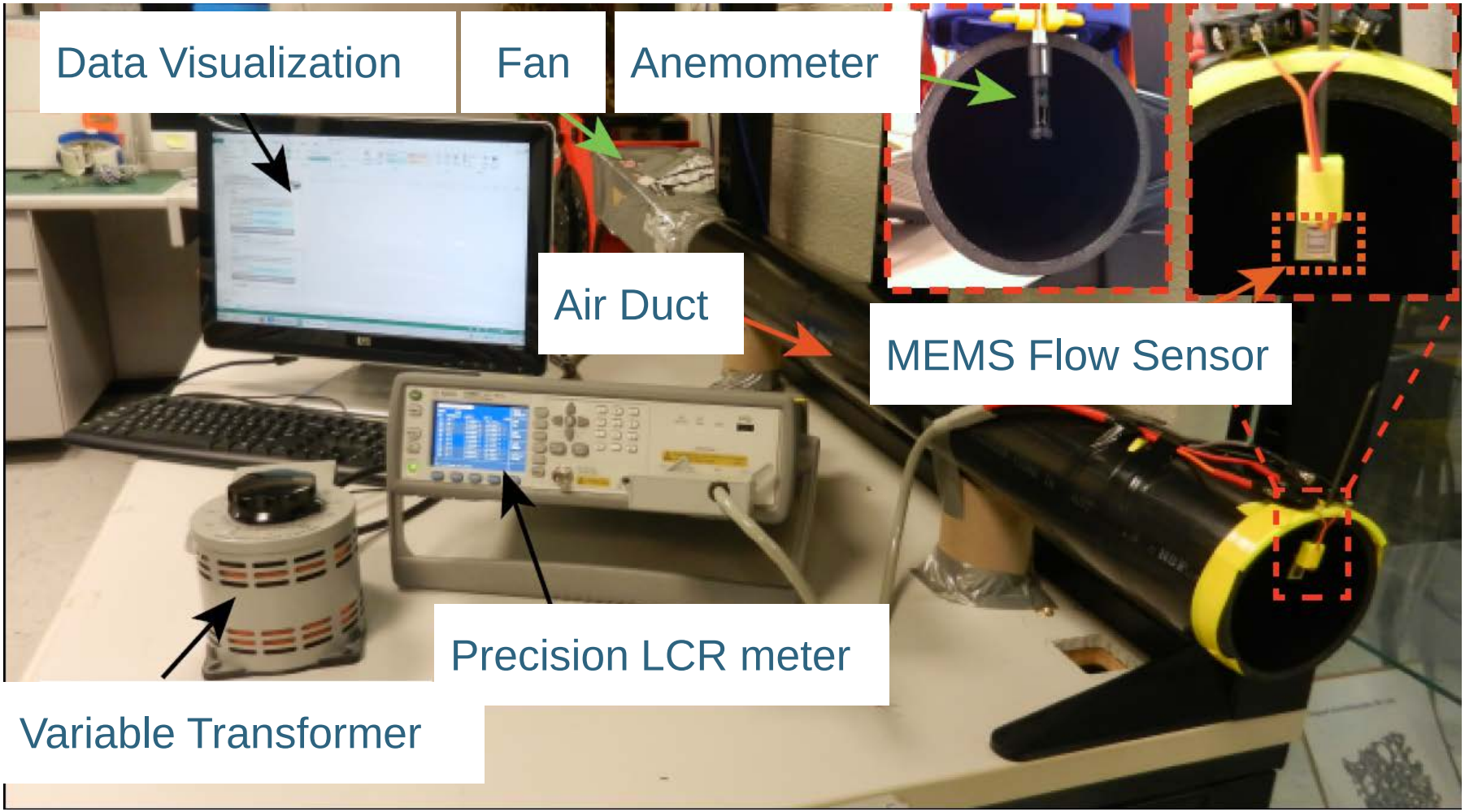
Flow sensor based on a capacitive paddle-deflection principle

Capacitive pressure sensor with an array of individual chambers

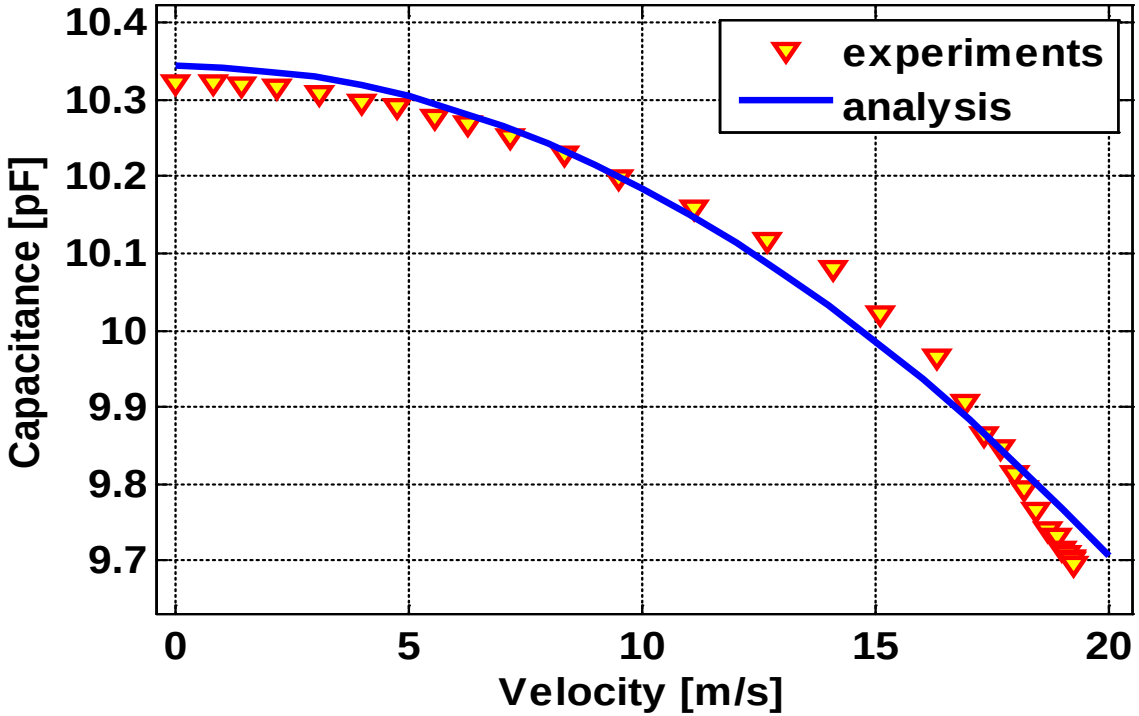




SENSORS | INITIAL MEASURMENT SETUP

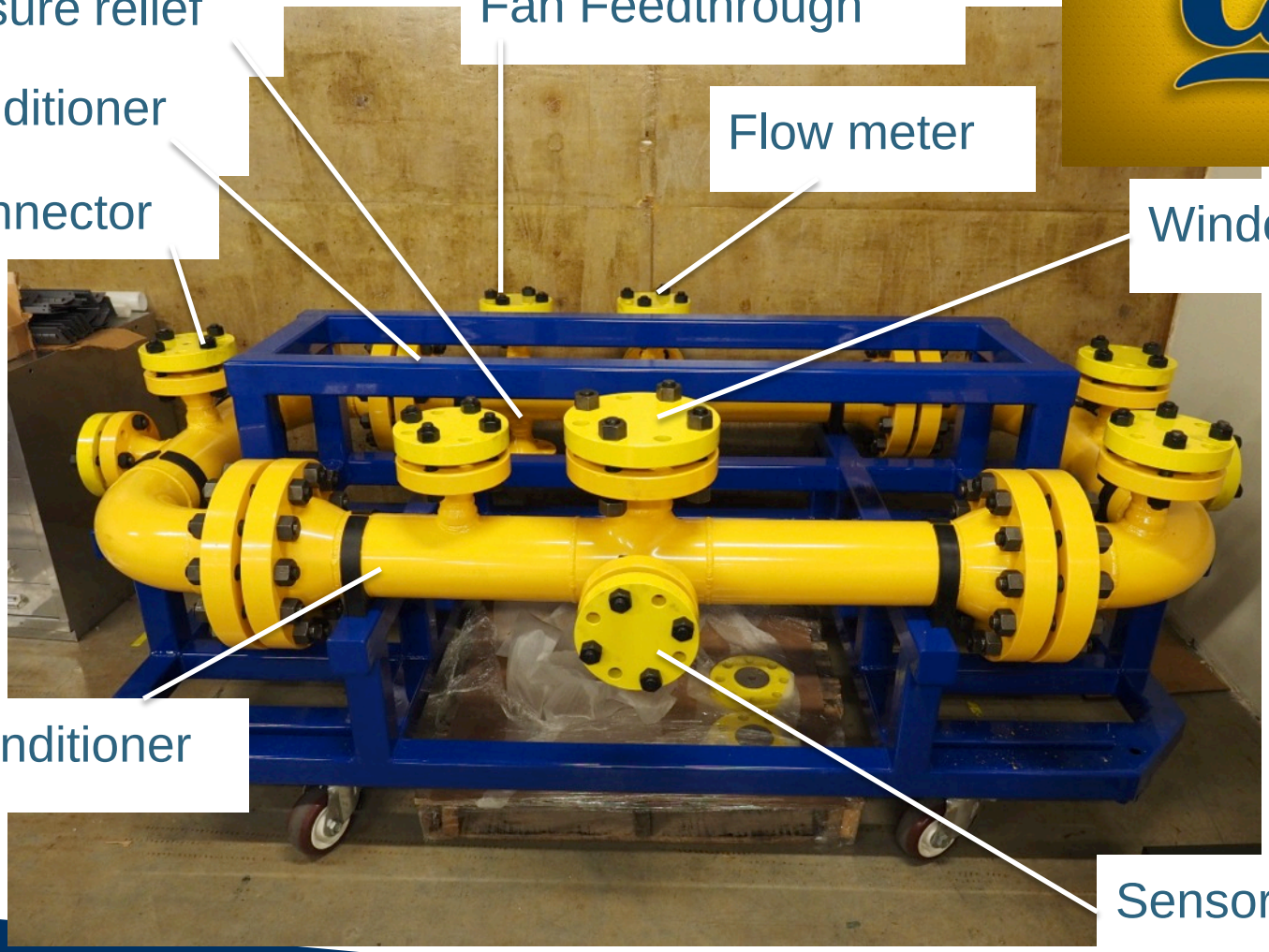


FLOW SENSORS | INITIAL RESULTS



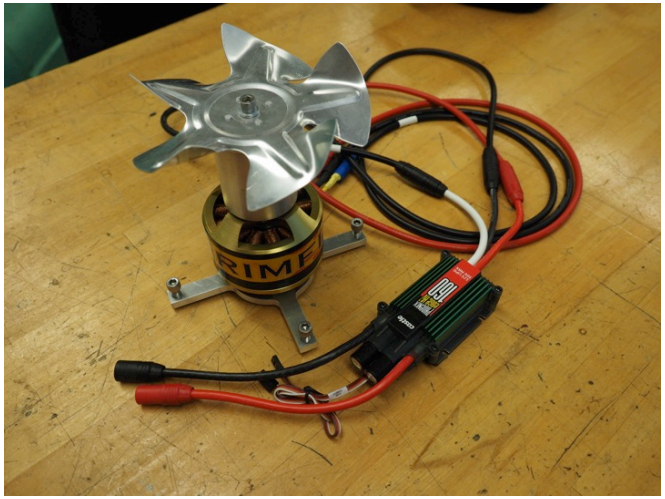
Measurements of capacitance vs. gas velocity in air at atmospheric pressure

GAS SENSORS | TEST BED

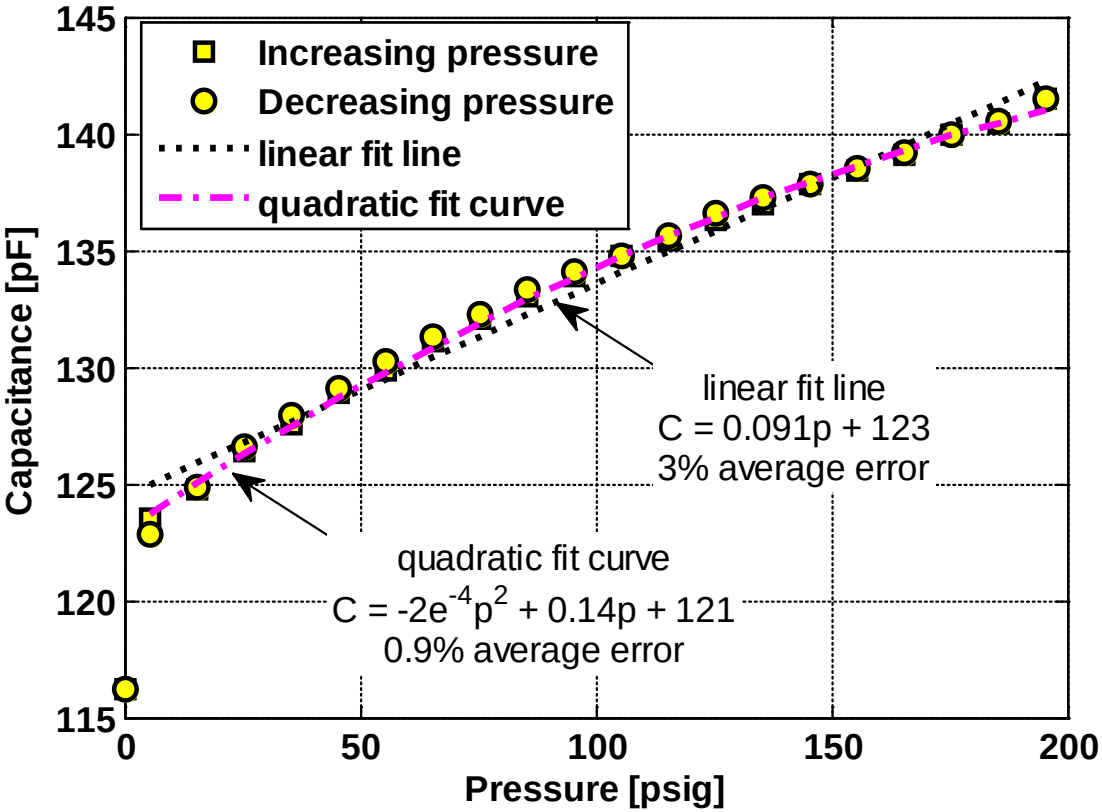


GAS SENSOR TEST BED | SPECIFICATIONS

- Operation with air up to 200 psi
- Certified for methane at 1350 psi
- Flow generated via duct fan
- 6” diameter pipe
- Compressed air cylinders
- Optical windows
- Reference flow meter
- Various 2” and one 4” access ports
- Electrical feed-throughs
- 4’ x 8’ wheeled supporting table



PRESSURE SENSOR | RESULTS



Capacitance vs. pressure. The hysteresis error is 1%. The output capacitance C (pF) is fitted to a linear line: C = 0.091p + 123 with only 3% average error.

GAS SENSOR TEST BED | SUMMARY

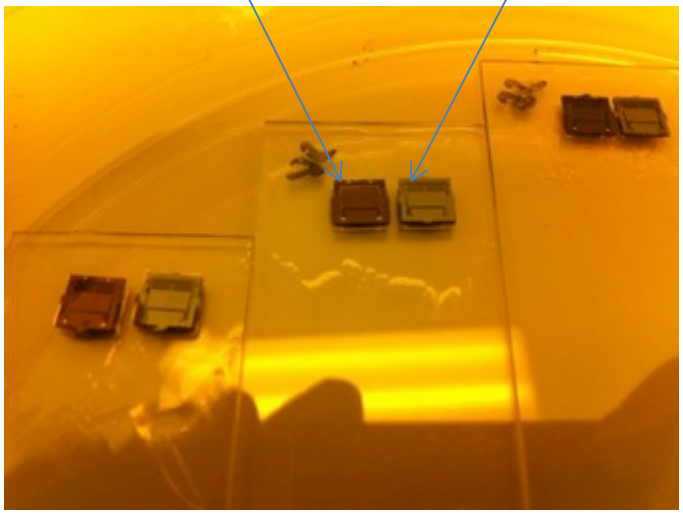
- Low cost flow and pressure sensors for gas pipelines
- Future proof gas sensor test bed has been developed and can be used for follow-up projects
- Initial leakage issues with pressure sensors have been resolved through improved manufacturing process

Backup slides

FLOW SENSORS | ACCELERATED EROSION TESTING

Flow sensor ***with*** SiC coating

Flow sensor ***without*** SiC coating



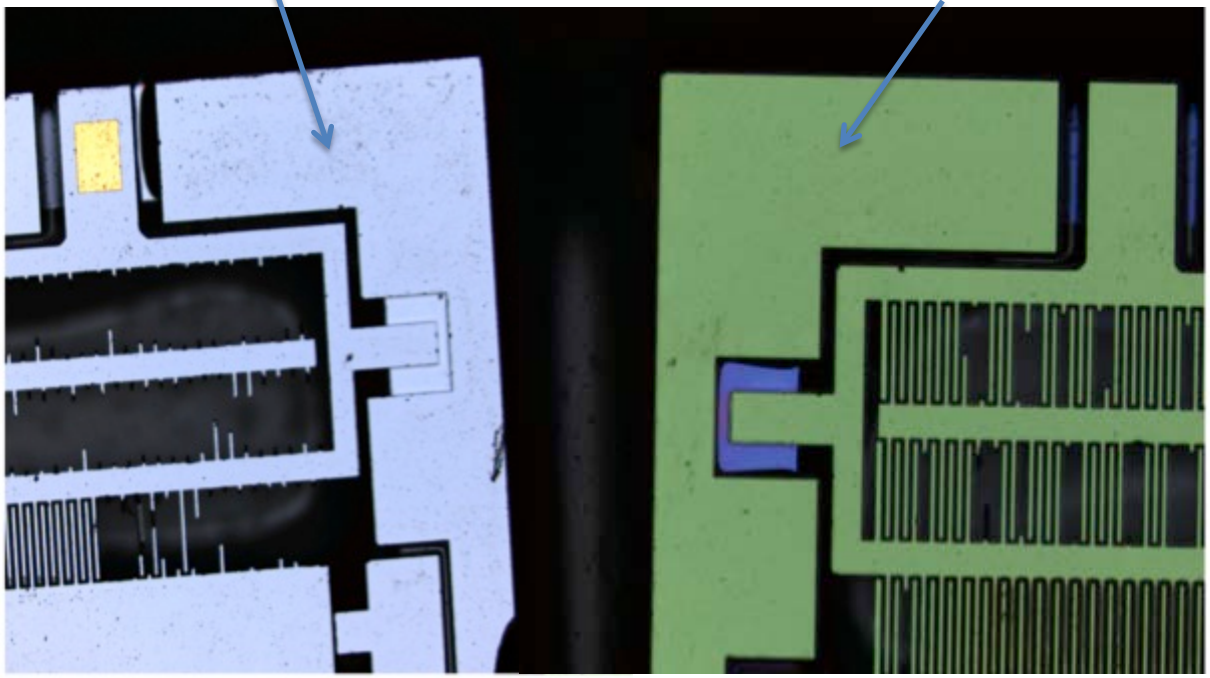
Sample preparation

Sand-blasting in Machine shop Cory Hall

FLOW SENSORS | ACCELERATED EROSION TESTING

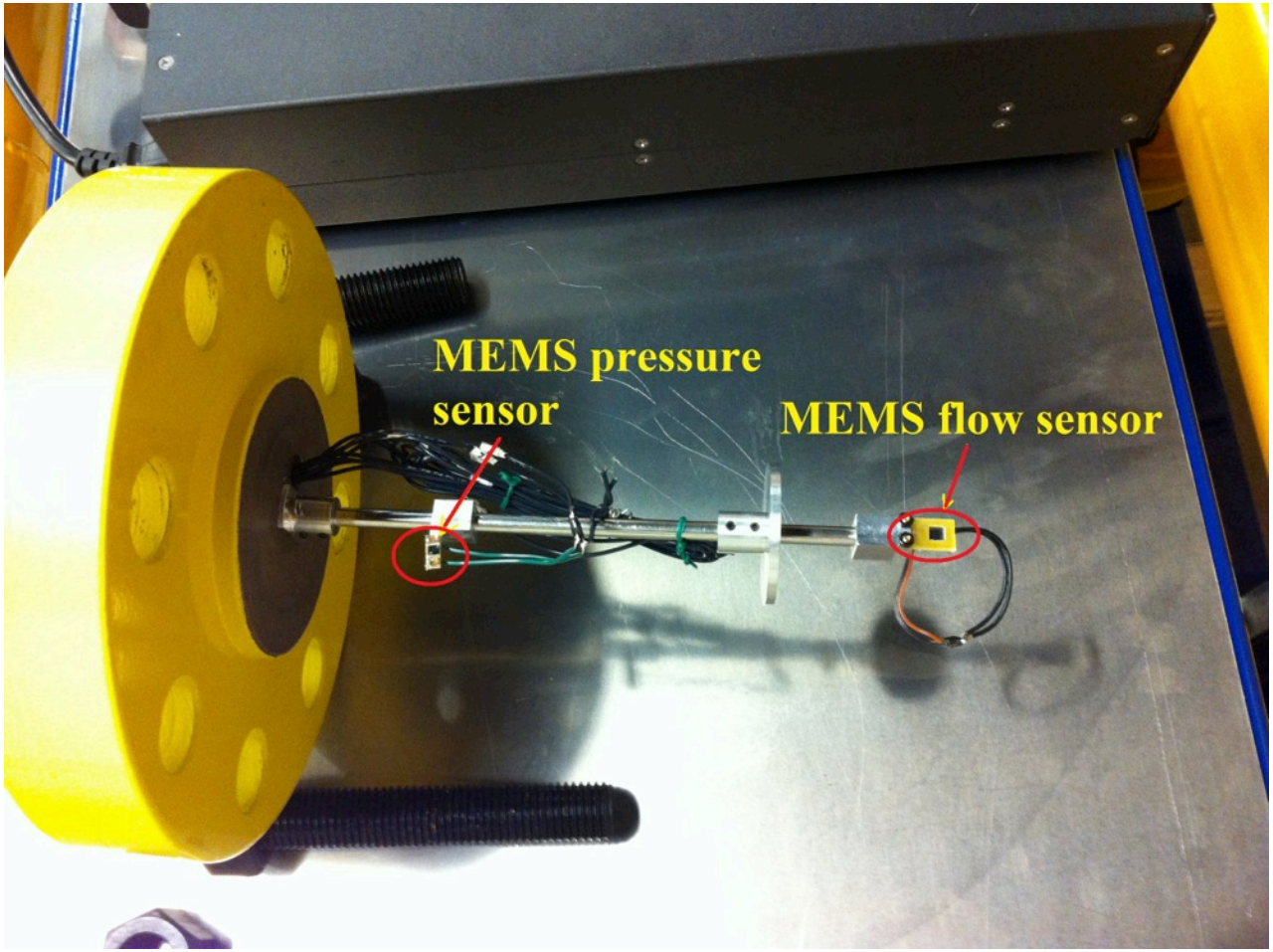
Flow sensor ***without*** SiC coating

Flow sensor ***with*** SiC coating

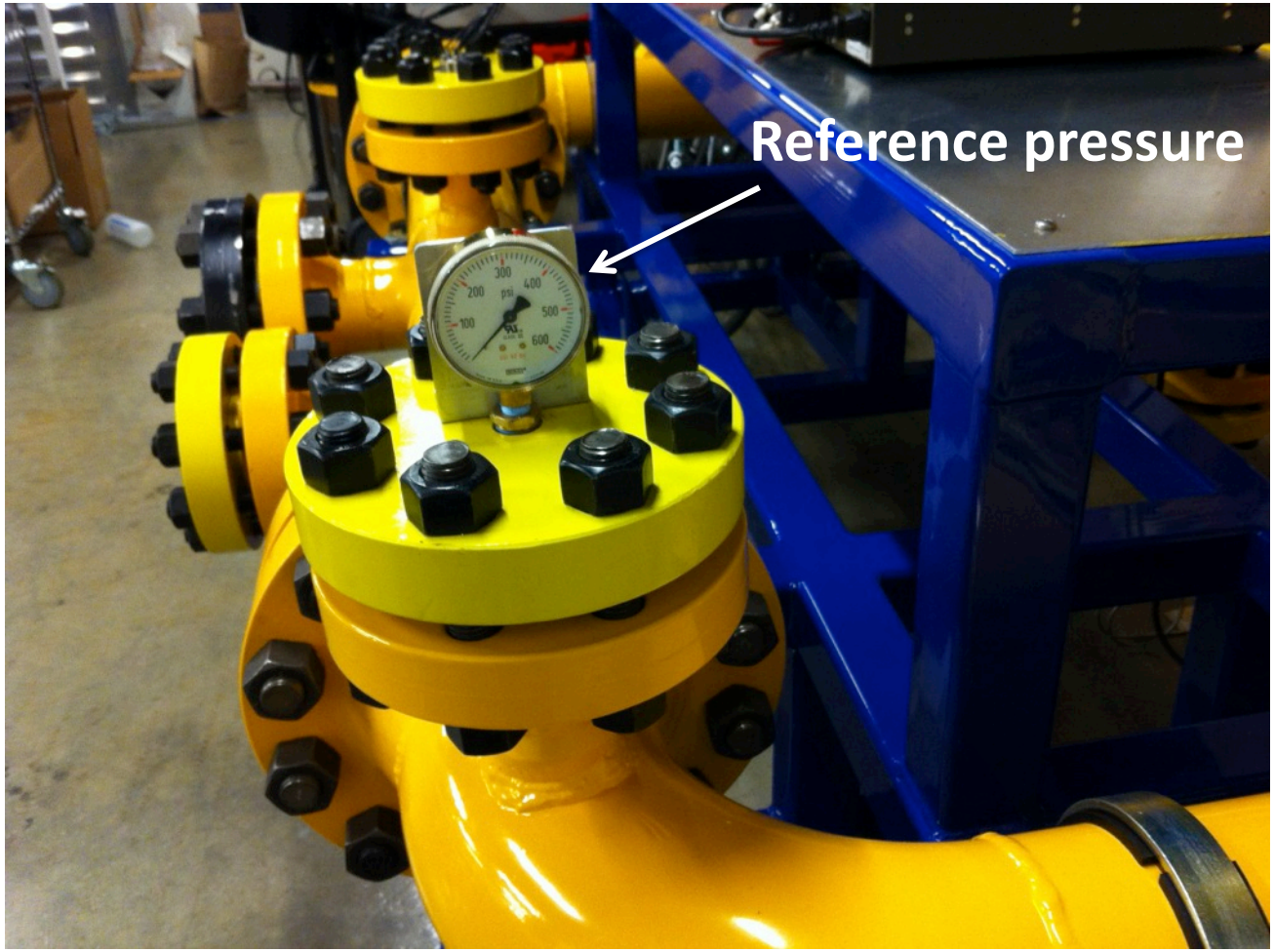


Silicon Carbide coating on the right shows significantly less surface/structural damages

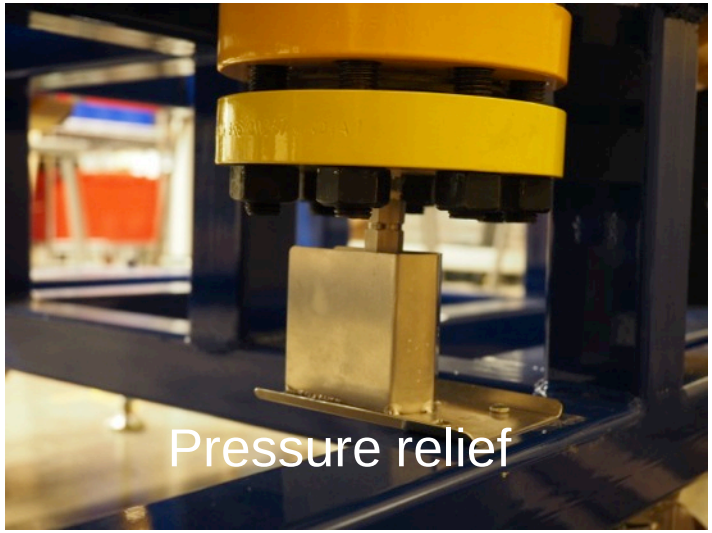
MEASUREMENTS | SET UP

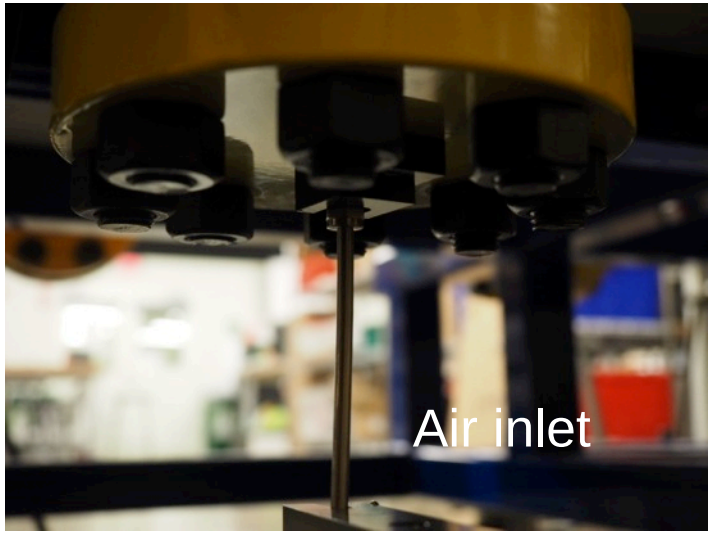


MEASUREMENTS | SET UP

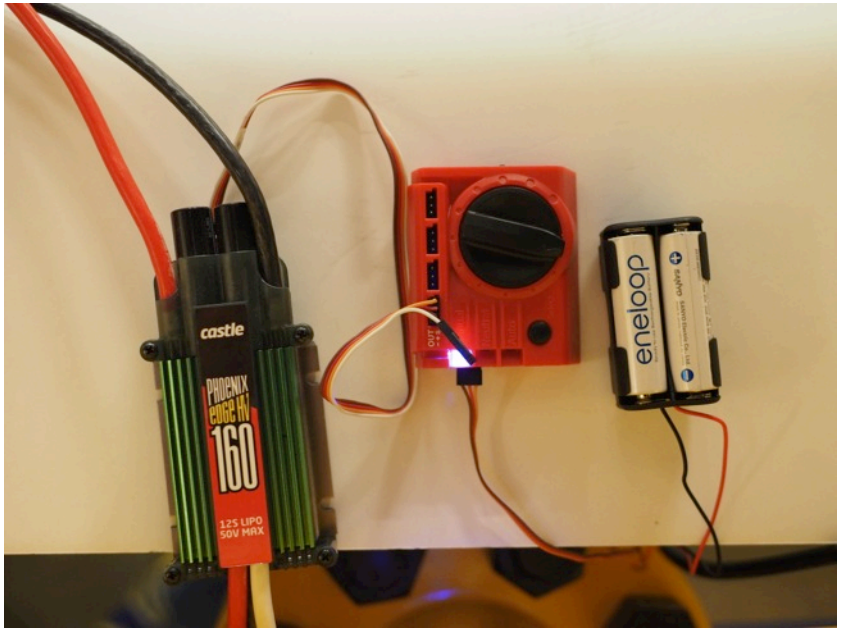


MEASUREMENTS | SET UP

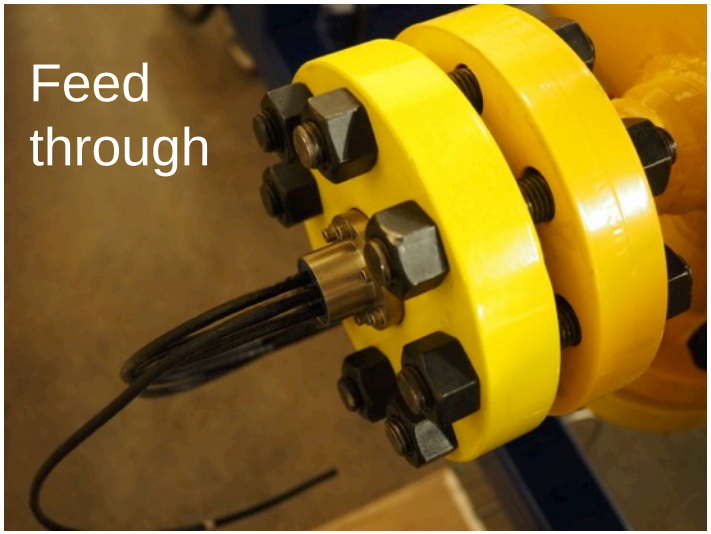




MEASUREMENTS | SET UP



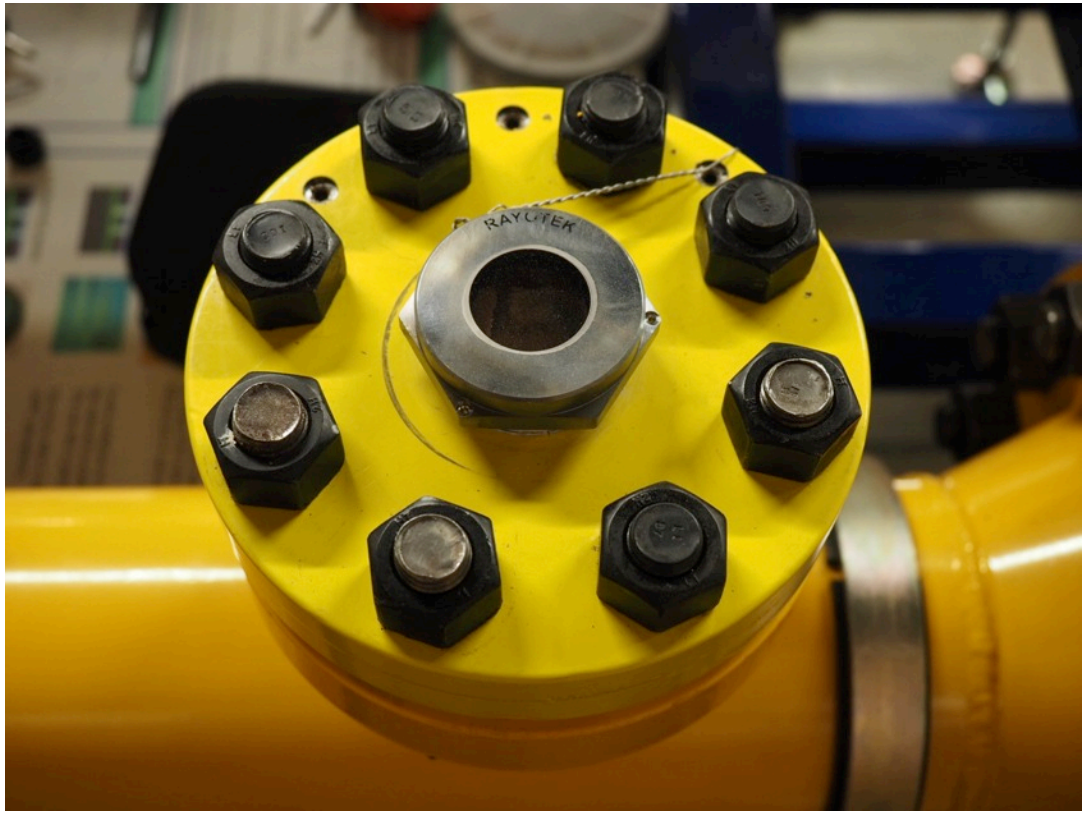
Fan Speed Control



MEASUREMENTS | SET UP

Capacitance Meter

Flow Meter



Optical Window