



New Directions in Production and Inspection

by

Thomas R. Kurfess, Ph.D., P.E.

Professor

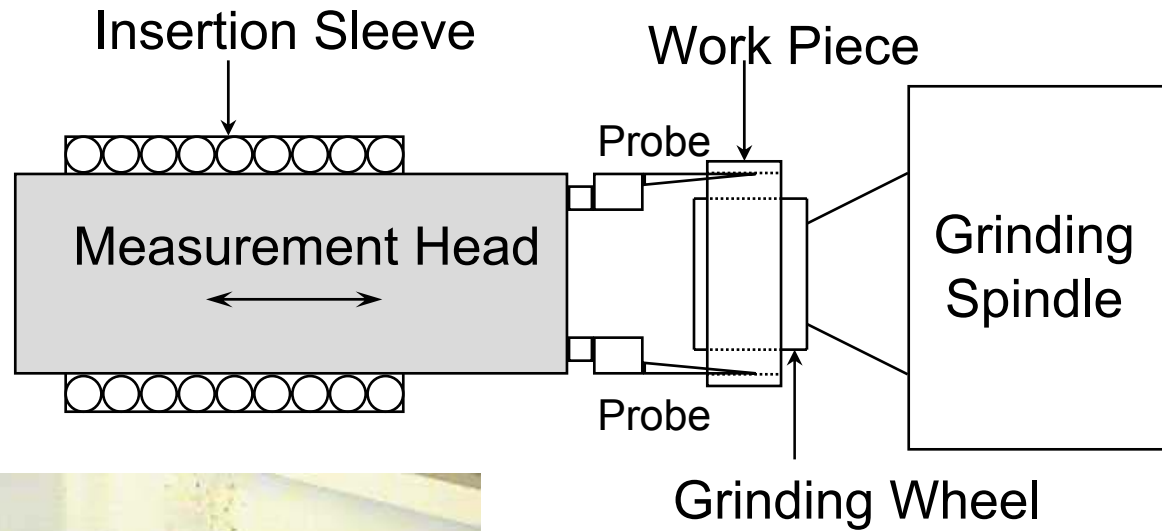
**The George W. Woodruff School of Mechanical Engineering
and the**

Manufacturing Research Center

Georgia Institute of Technology

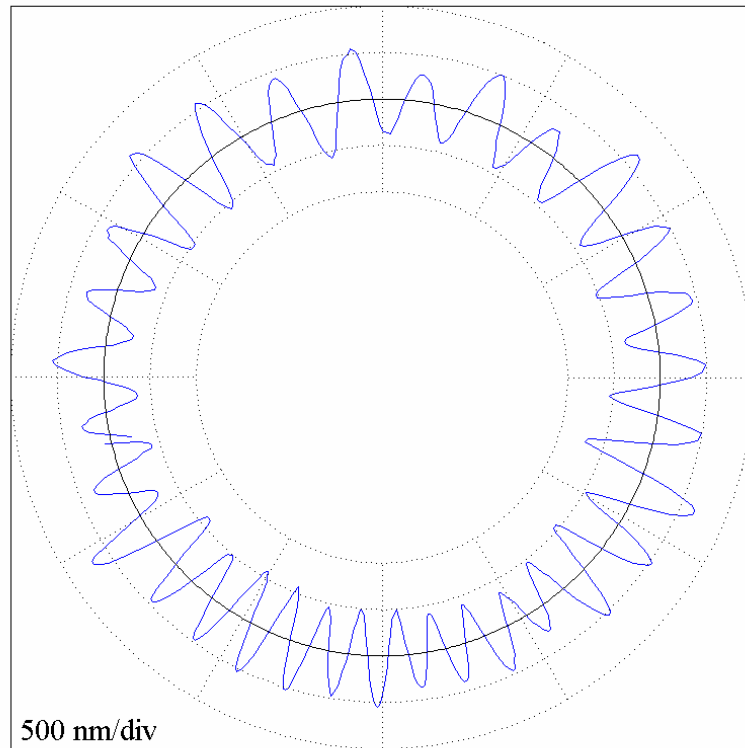
Atlanta, GA 30332-0405

An Old Sensor a New Use



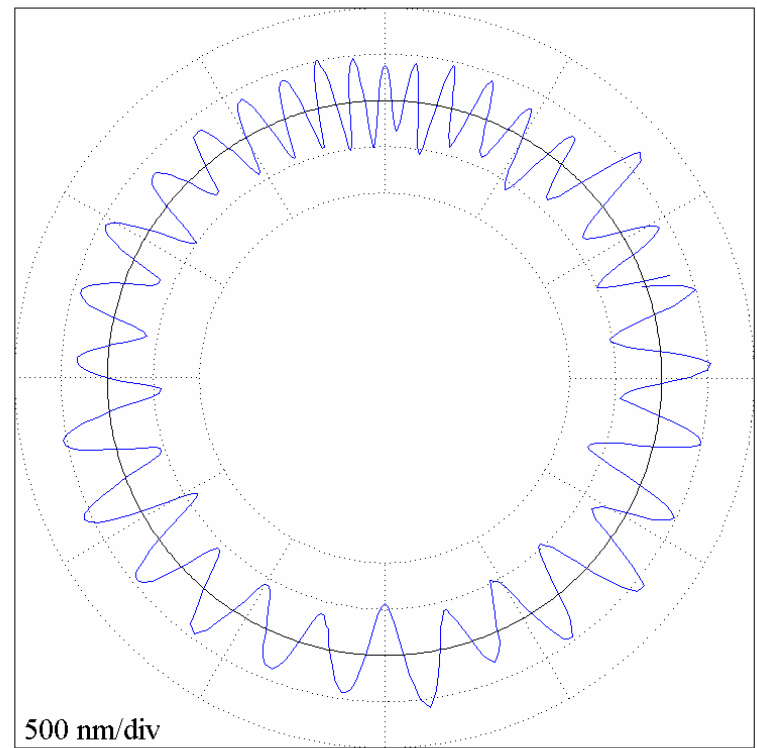
Real-Time Measurement

Probe 1



10 UPR High-Pass Filter

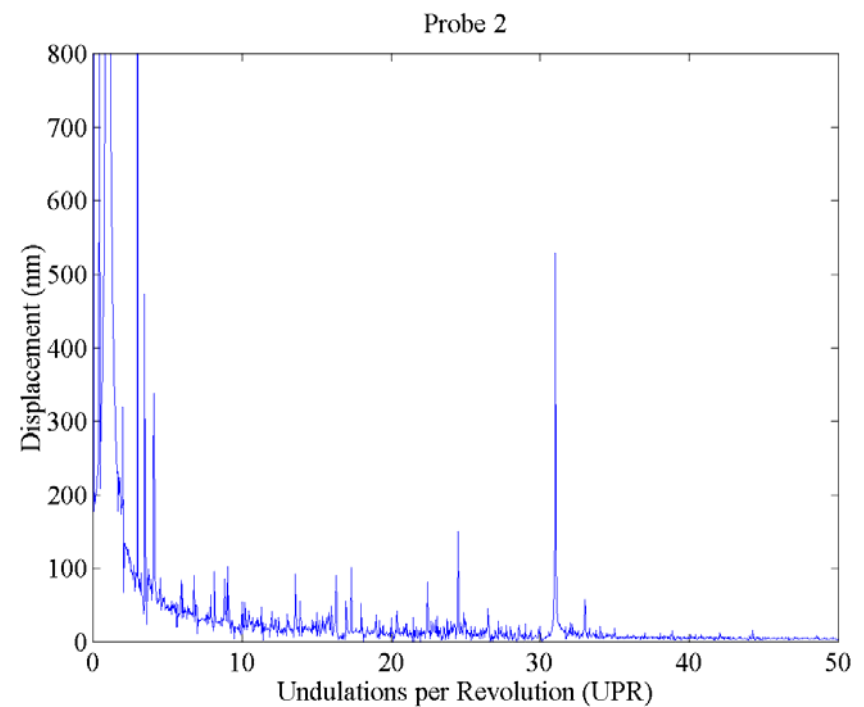
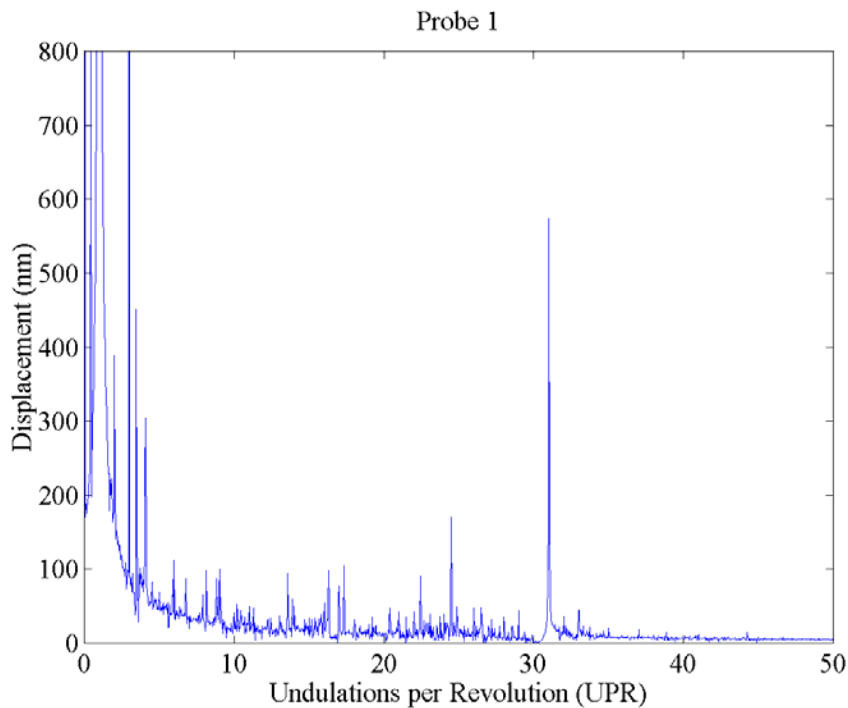
Probe 2



10 UPR High-Pass Filter

Real-Time Frequency Analysis

❖ 31 UPR Indicating High Frequency Chatter.



Part – Turbine Nozzle Segment



Fadal VMC15 Machining Center



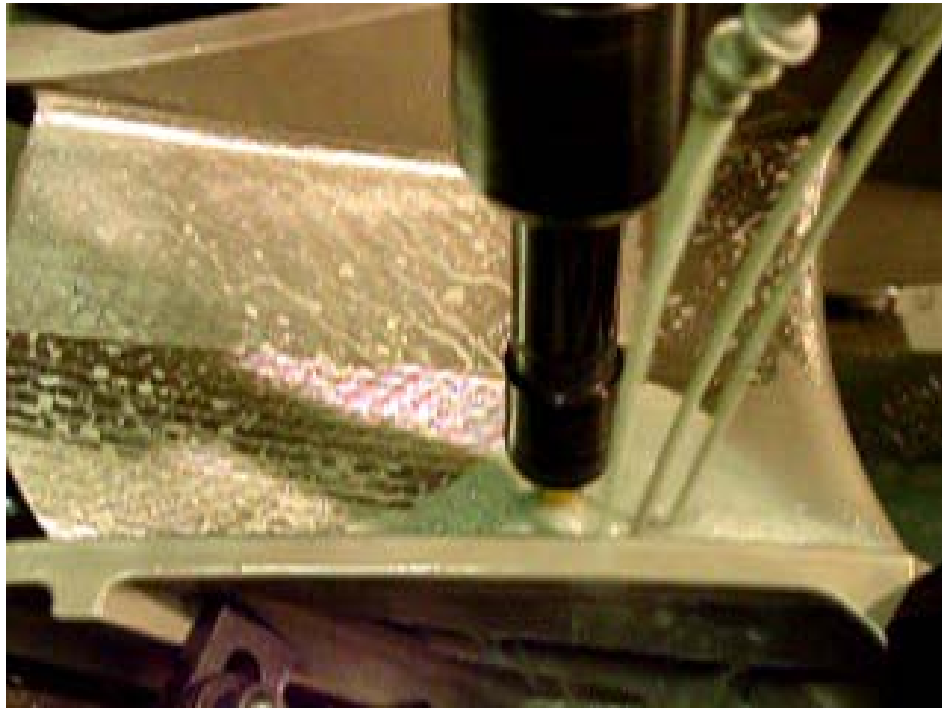
Machine Table

Spindle

Fixture

Fadal CNC Control

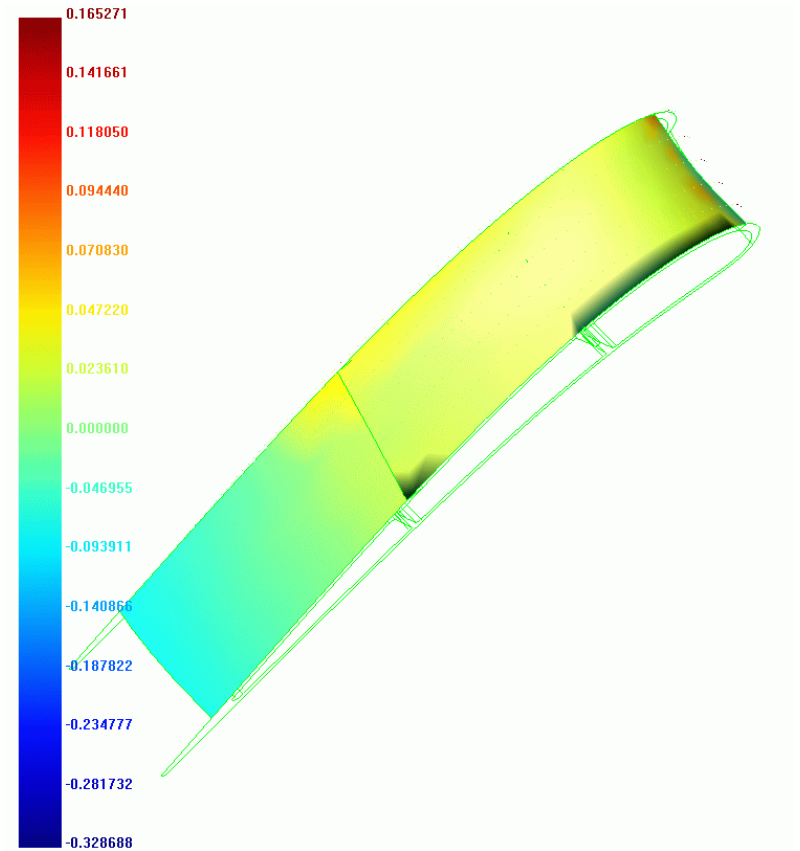
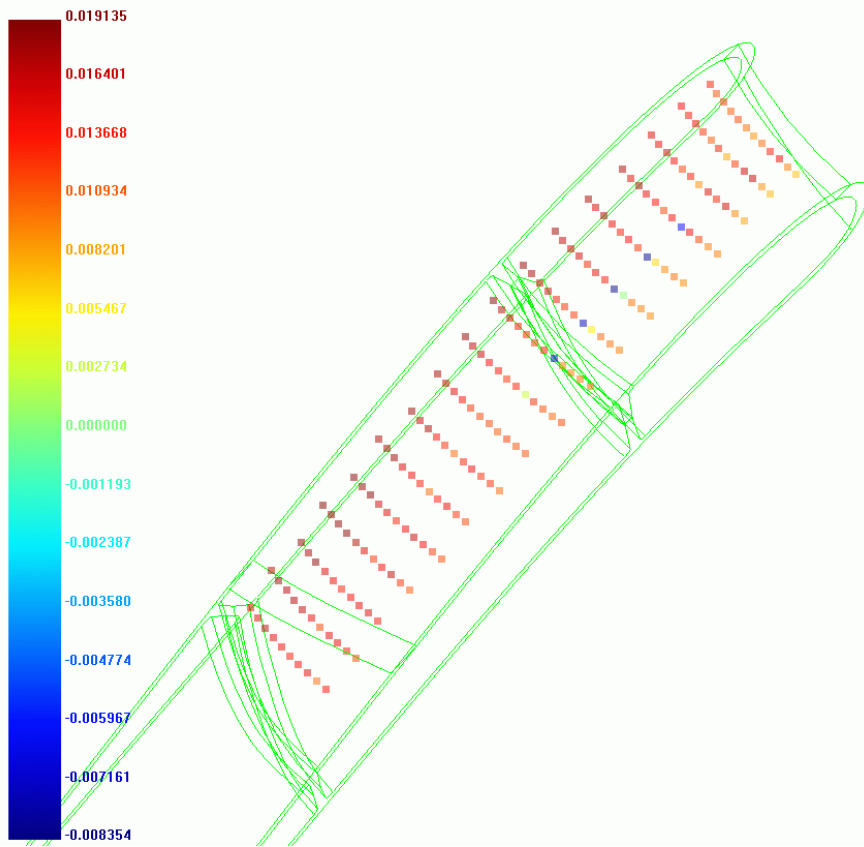
Machining



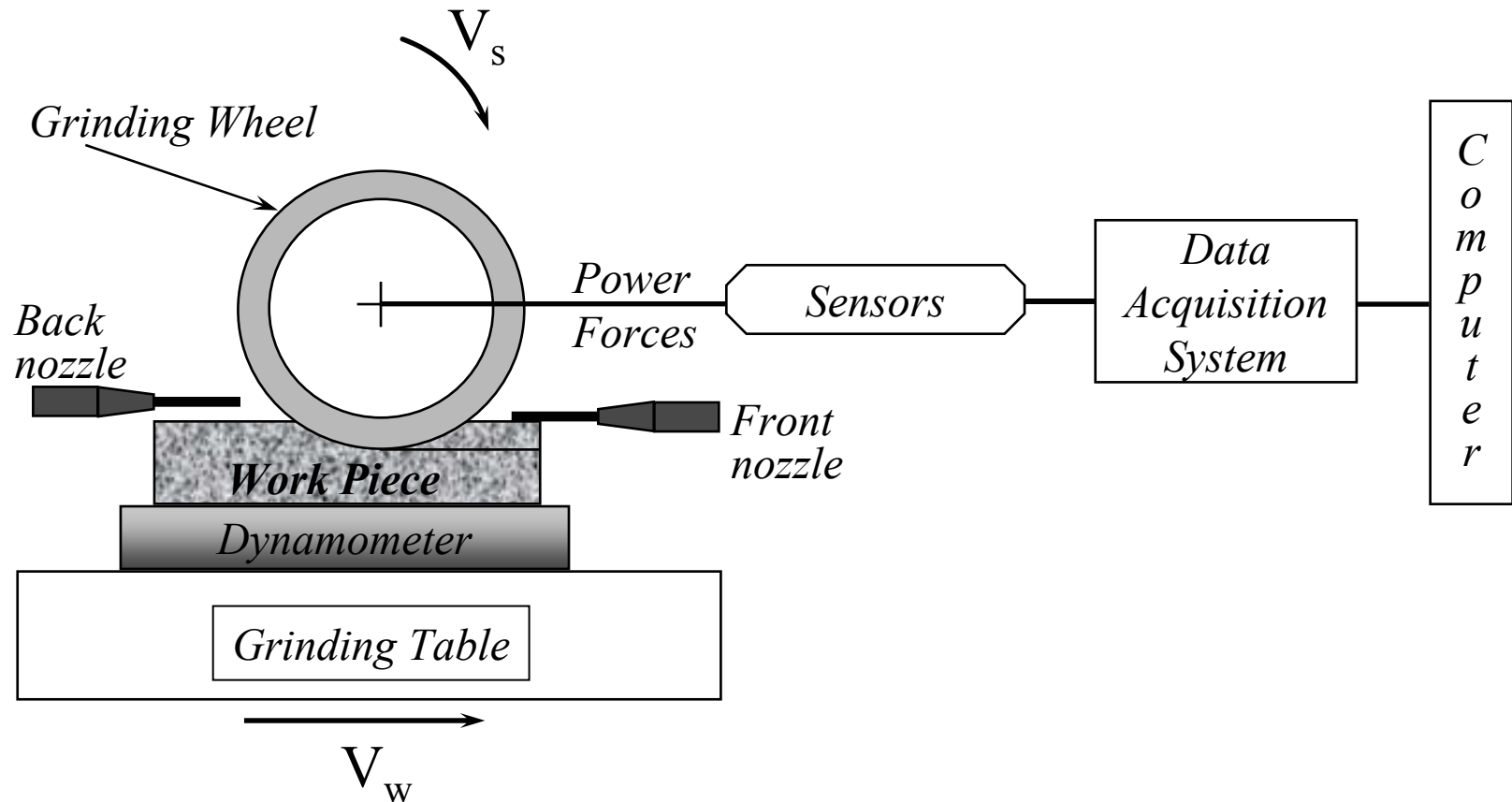
Inspection



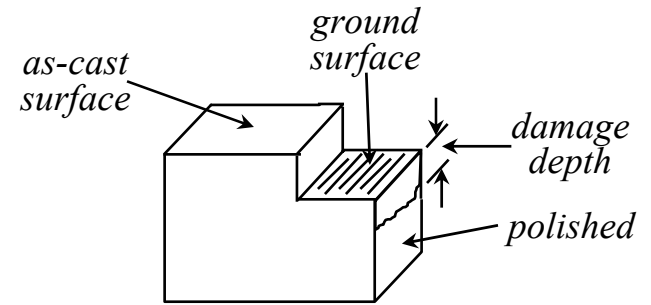
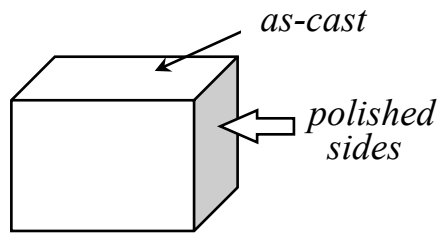
Turbine Nozzle - Results



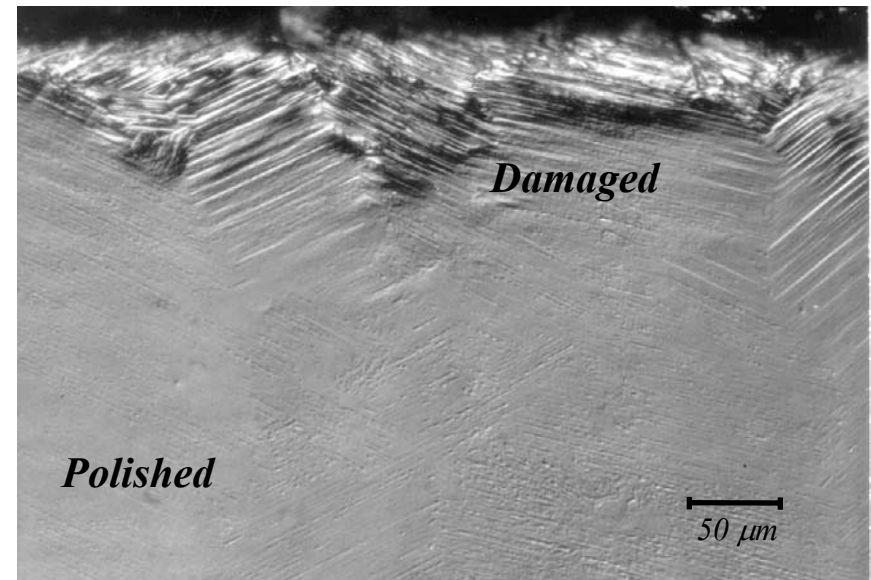
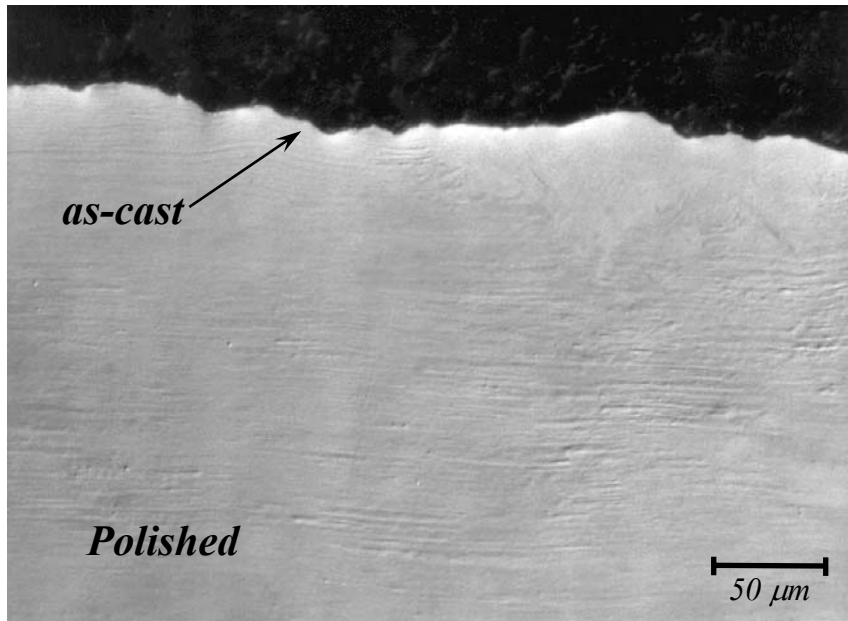
Controlling a Different Parameter - Subsurface Damage (Ti-Al γ)



Subsurface Damage

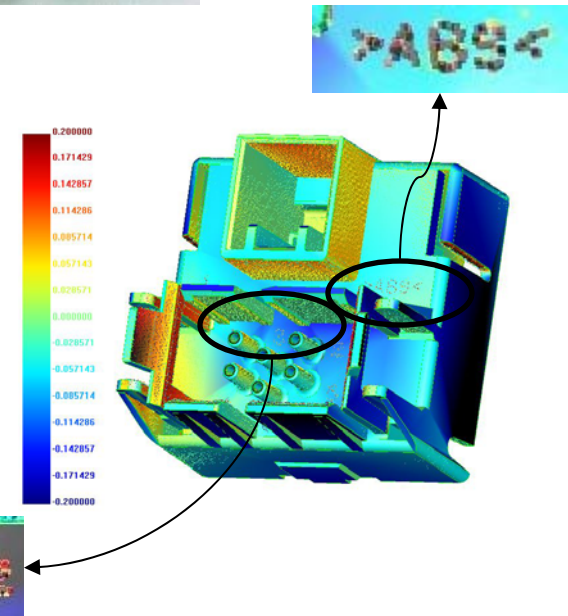
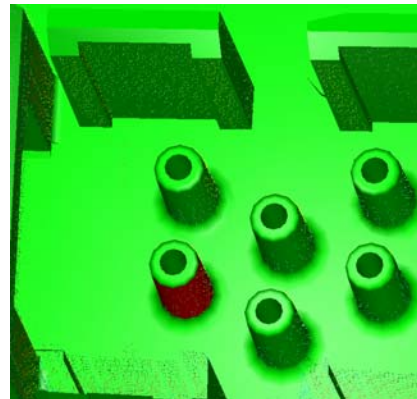
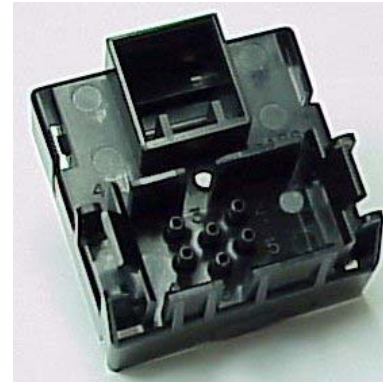
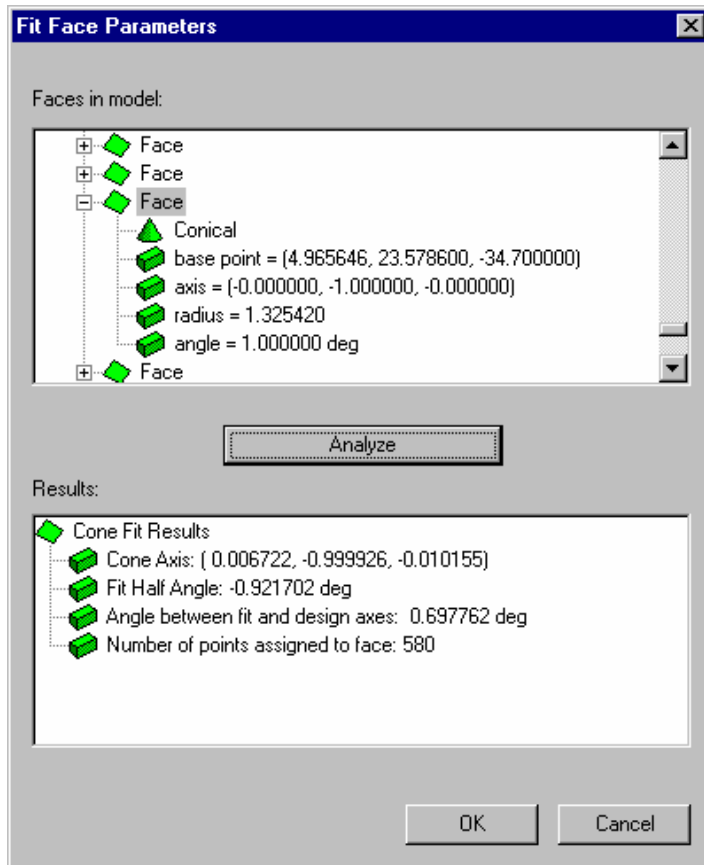


Ground Surface

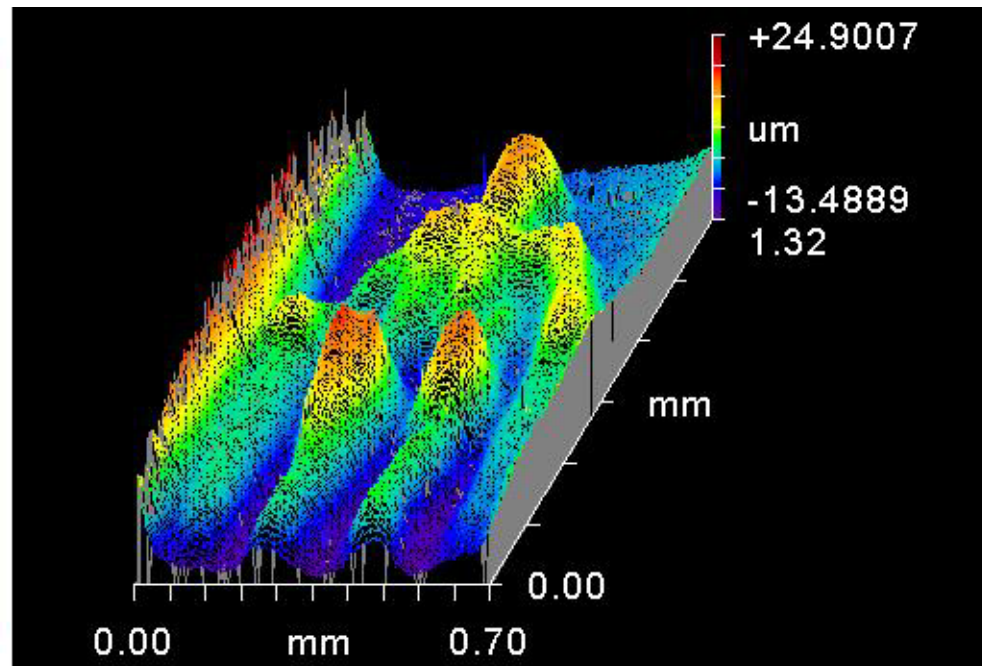
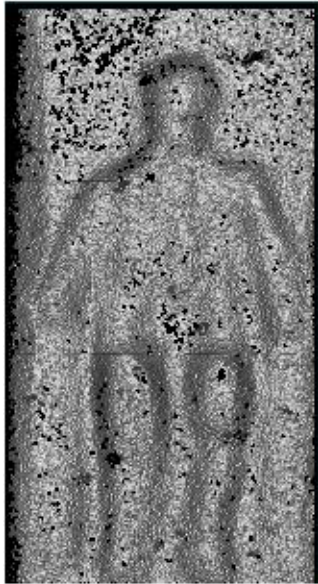


$$V_s = 30 \text{ m/s}, V_w = 0.5 \text{ m/min}, a = 25 \text{ } \mu\text{m}$$

Deviations from Target and Analytics

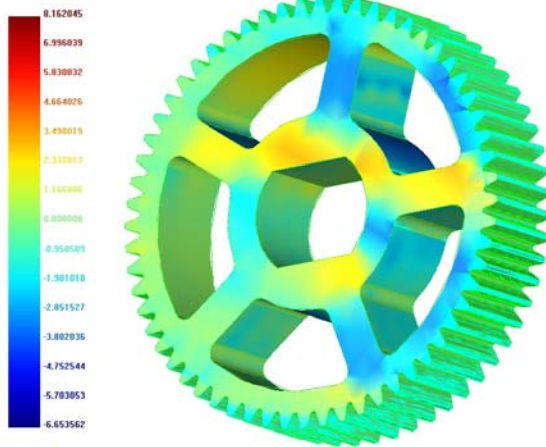


Micro-Metrology - A Penny

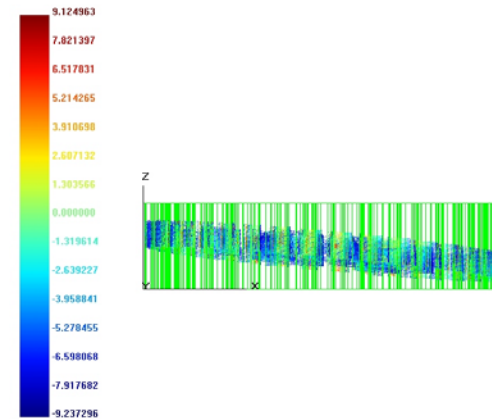


Micro-Gear Analysis – Thinking Small

❖ Microtoming

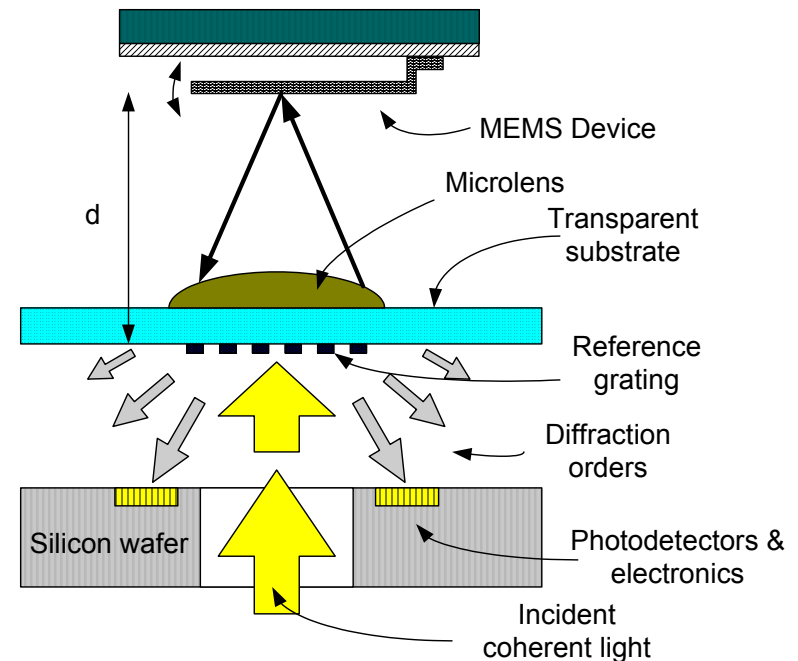


❖ Tomography



Approach: Micro-Fabricated Position Sensing Grating Interferometer

- ❖ Based on intensity measurement of the diffraction pattern created by a grating and microlens
- ❖ Better resolution at focus
- ❖ Compact design.



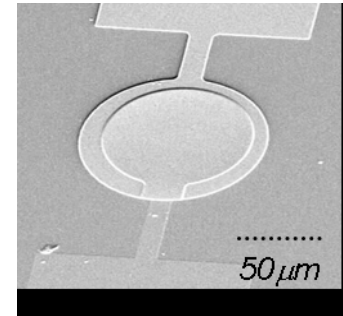
Dynamic Measurement.

❖ MEMS Microphone

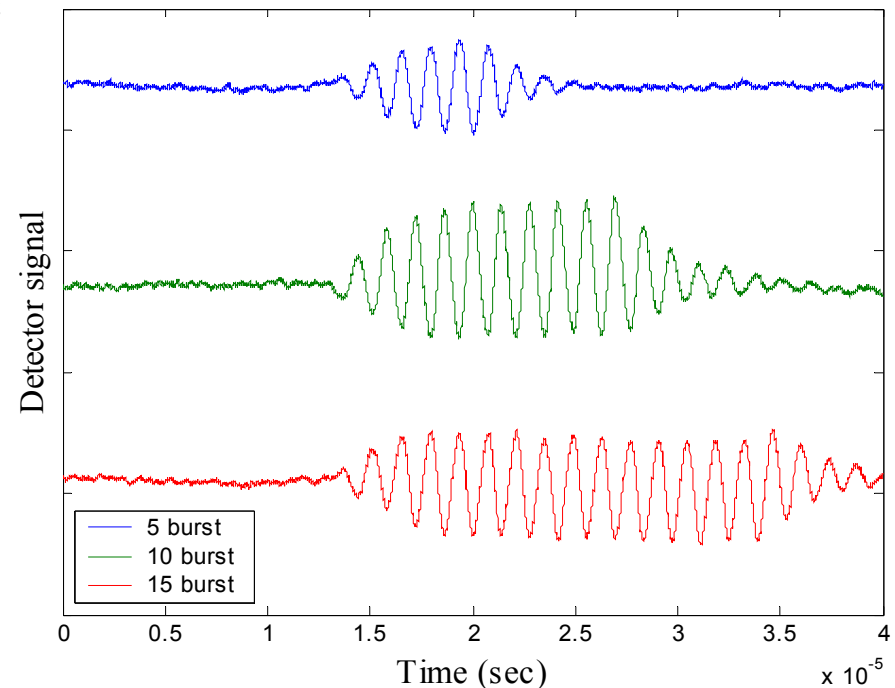
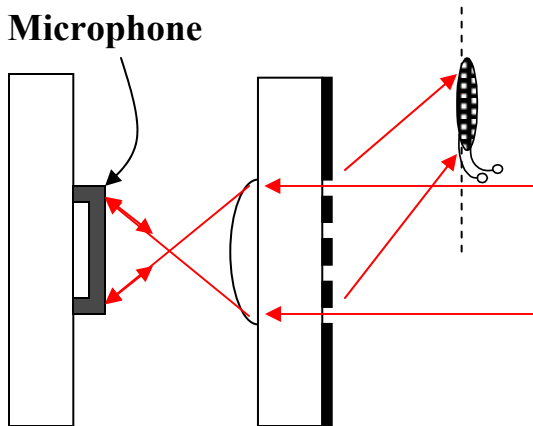
- 160 μm diameter
- Electrostatic actuated at 726 kHz by $100\text{V}(\text{DC}) \pm 16\text{V}(\text{AC})$
- 5, 10, 15 burst

❖ Detector signal

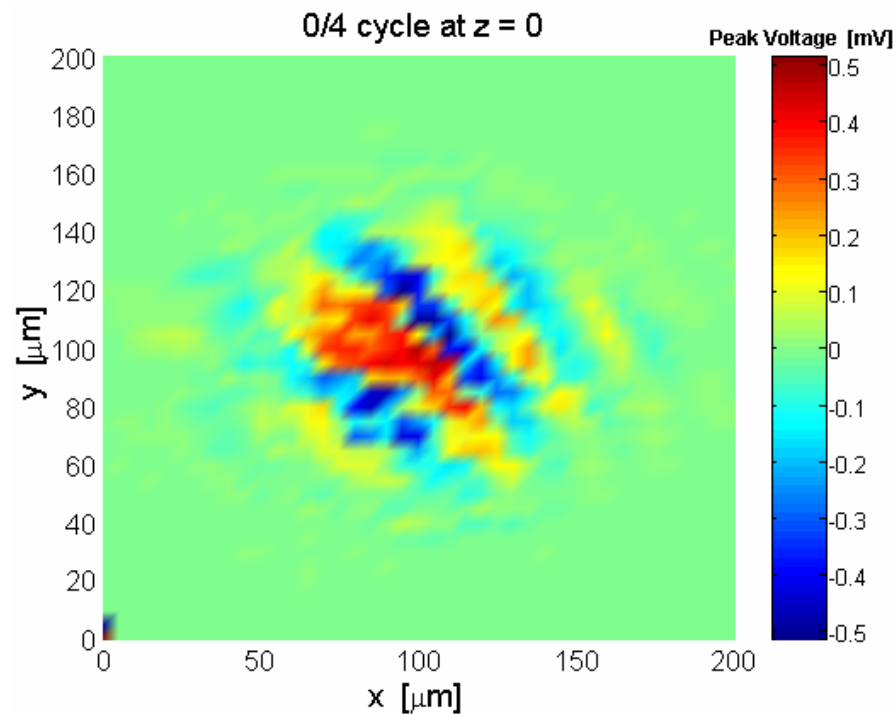
- $720\text{kHz} \approx 10\text{cycles} / 1.39 \times 10^{-5}\text{ sec}$
- Shows ringing.



Microphone



Imaging at Focal Plane ($z=0$)



Optoelectronics Integration

- ❖ Flexible grating fingers
- ❖ Integration of electronics
- ❖ Fabrication of detector array
 - 1 mm pitch
 - 300 μm x 300 μm and
 - 100 μm x 100 μm .

