



**CHARLOTTE**  
*CENTER FOR PRECISION METROLOGY*

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METROLOGY**

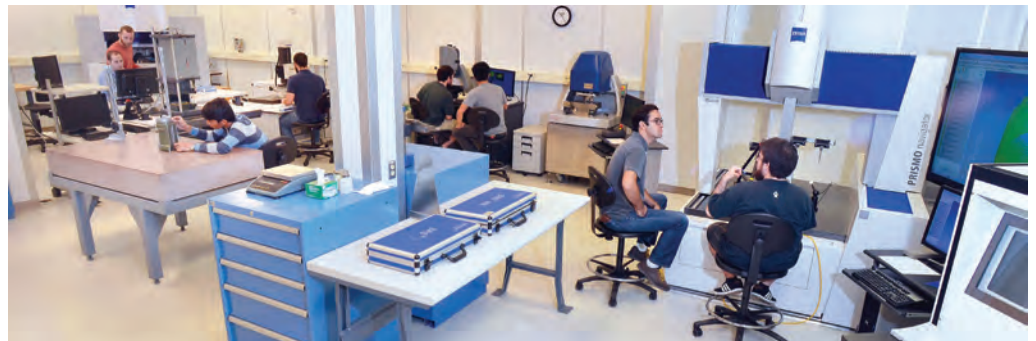
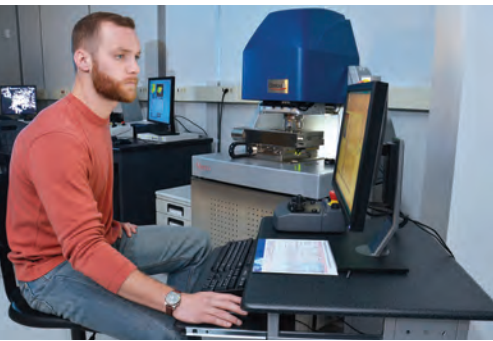
**ATOMS TO AEROSPACE  
EVALUATION TO ENGINEERING  
SENSORS TO SYSTEMS  
ORIGINATION TO OPTIMIZATION  
PRINCIPLE TO PRACTICE  
SCIENCE TO STANDARDIZATION**





The Center for Precision Metrology is an interdisciplinary association of University of North Carolina at Charlotte faculty and student researchers, allied with industrial partners in the research, development and integration of precision metrology as applied to manufacturing. Working with state-of-the art dimensional tolerances on the order of 10 parts per million or better, precision metrology encompasses the methods of production and inspection in manufacturing, measurement algorithms and tolerance representation, and the integration of metrology into factory quality systems.

Through the William States Lee College of Engineering acting as the host college, the interdisciplinary nature of the Center blends the expertise of faculty and student researchers from a number of UNC Charlotte academic colleges and related departments.



## CENTER STATUS & INDUSTRIAL AFFILIATES

Beginning as an industry/university consortium in the early 1990's and then supported from 1994-2005 as a National Science Foundation Industry/University Cooperative Research Center (NSF I/UCRC), the now 'graduated' Center for Precision Metrology is charged with breaking new ground in precision metrology through addressing real-world industrial concerns. Through the associated Affiliates Program, industry and Center researchers collaborate on projects that involve generic and specific manufacturing metrology problems. In support of the Center's research efforts, affiliate members contribute funds and equipment that are directly applied to student projects and stipends. Additional specific research is funded through contracts with industrial partners to address proprietary application and development projects. Government funding sponsors fundamental and large-scale metrology projects.

## TECHNICAL AREAS AND FACULTY CONTACTS

- Precision and Industrial Metrology

Edward Morse  
Jaime Berez  
Stuart Smith  
Kosta Falaggis  
Angela Allen  
Rosario Porras-Aguilar

- Advanced Manufacturing

Steven Schmid  
Brigid Mullany  
Jose Outeiro  
Jaime Berez  
Mahmoud Dinar

- Surface Metrology and Analysis

Brigid Mullany  
Angela Allen  
Jaime Berez  
Steven Schmid  
Stuart Smith  
Jay Raja

- Optics and Optical Metrology

Angela Allen  
Rosario Porras-Aguilar  
Kosta Falaggis  
Thomas Suleski  
Tsing-Hua Her

- Instrumentation and Sensors

Stuart Smith  
Jimmie Miller  
Kosta Falaggis

- Applications of Machine Learning

Harish Cherukuri  
Brigid Mullany  
Mahmoud Dinar  
Thomas Suleski  
Kosta Falaggis  
Jose Outeiro  
Edward Morse

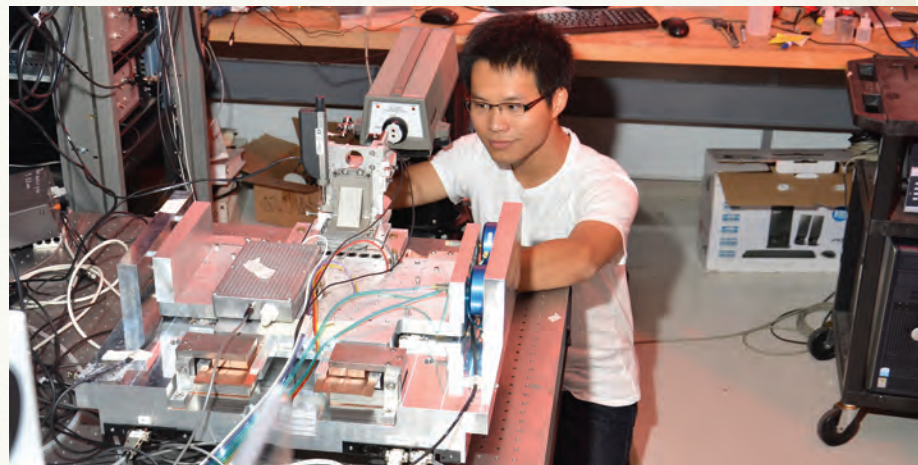
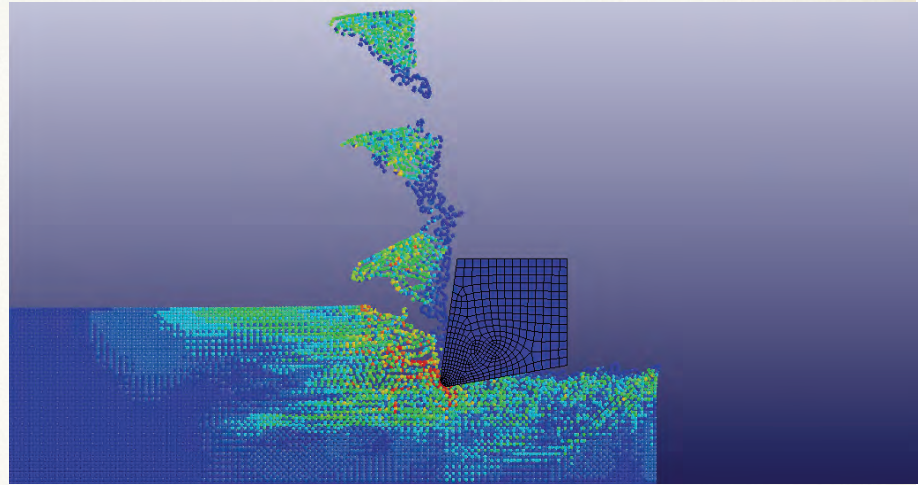


## STANDARDS

Faculty serve as members and experts on national and international standards committees including:

- ASME B5 machine tools
- ASME B46 classification and designation of surface qualities
- ASME B89 dimensional metrology
- ASME Y14 engineering drawing and related documentation practices
- ASME MBE model based enterprise
- ISO TC172 optics and photonics
- ISO TC213 dimensional and geometrical product specifications and verification

The William States Lee College of Engineering provides the majority of the near 30,000 square feet of research facilities, including 3,000 square feet of controlled environment for metrology and instrument development. Additional laboratories are designated for Computer Integrated Manufacturing, Machine Dynamics, Sensor Systems, Nanoscale Science and Engineering, Mechatronics, Instrumentation, Precision Surfaces and Large Scale Metrology.



## PAST AND CURRENT PROJECTS

### METROLOGY PRACTICES & ALGORITHMS

- 3D structure function of surfaces
- 3D tolerance control
- 5 axis coordinate measuring machine (MCM) uncertainty
- Adaptive sampling techniques
- Characterization of structured surfaces
- CMM contact scanning of edges and corners
- Combined moire-interference metrology
- Environmentally tolerant SWLI characterization
- Error budget software for machine tools
- Freeform metrology
- Laser tracker dynamic performance
- MicroCMM baseline metrology
- Non-axisymmetric artifacts
- Open metrology software
- Rough surface metrology
- Part manufacturing information
- Scanned profile uncertainties
- Spectral imaging metrology
- Tolerance specification consistency
- Vision CMM calibration techniques
- Wavelength shifting interferometry

### MACHINE & INSTRUMENTATION DEVELOPMENT

- Compressed sampling microscope
- Computed tomography standards
- Dynamic range extension for optical imaging
- Fast tool servo for diamond turning non-axisymmetric components
- Giant magnetoresistive sensor design
- Grazing incidence metrology
- Instrumentation for crankshaft metrology
- MilliKelvin temperature control
- Nanoimprint lithography positioning stage
- Nanometric dilatometer
- Nanoscale hardness instrumentation
- Speckle scales for two dimensions
- Sub-atomic measuring machine
- Vectored touch sensor
- Wavelength stabilization of laser diodes
- Wettability characterization
- Whitelight fiber optic interferometry probe
- X-ray microscope development

### MANUFACTURING & MACHINING

- Ceramic machining
- Deformation machining
- Diamond films for manufacturing
- Error correction for freeform machining
- Machine tool geometric error correction
- Metals affordability initiative
- Molecular dynamics of machining
- Process damping in milling
- Subscale machining of large components
- Thermal modeling
- Tool tuning for machining centers
- Tool path modulation characterization
- Vibration assisted diamond turning
- Virtual manufacturing



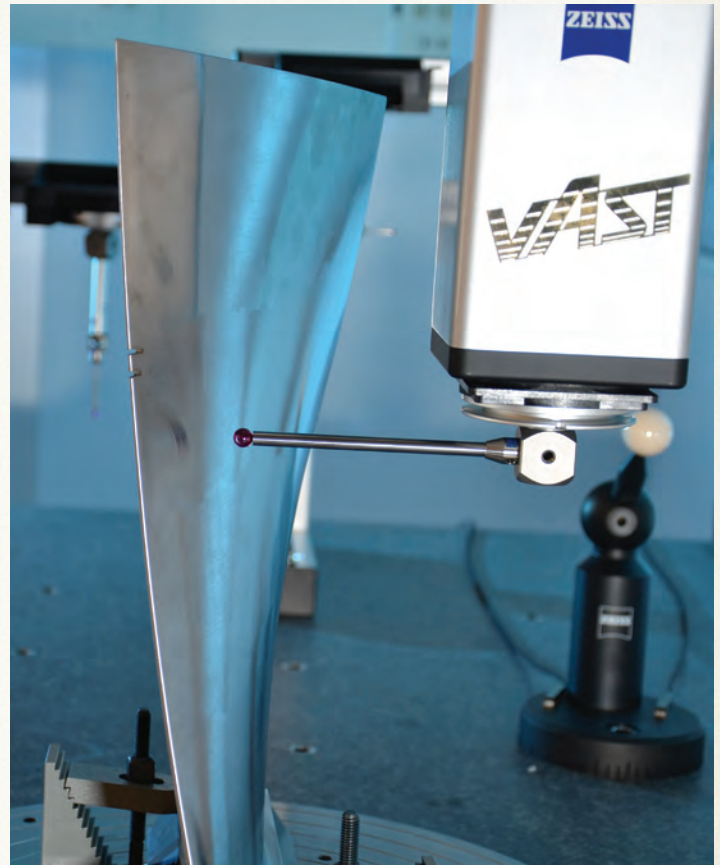
## CENTER RESOURCES INCLUDE THE FOLLOWING:

### MANUFACTURING

- AGIE Mondo sinking EDM
- DMG Mori Seiki NMV5000DCG 5-axis milling center
- EOS M280 laser powder bed fusion
- Haas OM-2 mill with 30,000 rpm spindle
- Haas TL1 CNC lathe
- Haas TM1 CNC mills
- Makino a51nx 4-axis machining center
- Makino a55 machining center
- Makino U3 5-axis wire EDM
- Milltronics SL8-II slant-bed turning center
- Moore Nanotech 350FG diamond turning machine
- Moore Nanotech 650FG diamond turning machine
- NGK 50,000 rpm spindle
- Precitech Nanoform 350 DTM
- QED Q22-XE magneto-rheological finishing machine
- Strausbaugh 6DF lap

### METROLOGY

- Agilent (Keysight), API, HP laser metrology
- API Tracker 3, Faro Ion and Leica AT901 laser trackers
- API and Renishaw telescoping ballbars
- Bruker Contour GT-X scanning white light interferometer
- Digital Surf Mountains surface analysis software
- GOM ATOS ScanBox 4105 automated 3D scanner
- GOM ATOS Compact Scan structured light scanner
- Hart Scientific and Lion Precision temperature measurement systems
- Hart Scientific temperature calibration cells and baths
- Heidenhain KGM grid encoder
- Indigo micro-thermal measurement system
- Innovmetric Polyworks metrology suite software
- Leitz PMM 654 CMM (Quindos)
- Leitz PMM-F 30-20-16 CMM (Quindos)
- Lion Precision and API spindle analyzers and gages
- Mahr Precimar ULM 300
- Mahr MahrSurf LD 260 contour and surface measuring system
- Manufacturing Laboratories Inc. (MLI) MetalMax and Harmonizer
- Mitutoyo RA 1500 Roundtest roundness measuring instrument
- Moore Nanotech 100UMM ultra measurement machine
- Nikon HN-C3030 Gear Measuring Machine
- Nikon MM400 toolmakers microscope
- New River Kinematics Spatial Analyzer
- Taylor-Hobson FormTalySurf and TalyStep profilometers
- Veeco Digital Instruments dimension metrology AFM
- Zeiss F25 microCMM (Calypso)
- Zeiss Prismo 7 Navigator CMM (Calypso)
- Zygo NexView scanning white light interferometer
- Zygo NewView 5000 scanning white light interferometer
- Zygo Verifire AT phase-shifting interferometer



The CPM also has access to the cleanroom fabrication and materials analysis resources of the Center for Optoelectronics and Optical Communications.

**Edward P. Morse, Ph.D. | Center Director**

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