## **Optical Engineering**

at the

# **College of Optical Sciences**

wp.optics.arizona.edu/visualopticslab/other-info/

### Milster Research Group Activities 2013

- Hyper-NA Imaging and Near-Field Optics: Investigate potential and application of hyper numerical aperture (NA >1.5) imaging systems, including induced polarization and plasmonic effects. Currently working with NA~2.8 for surface science, red blood cell *in vivo* plasmonic imager, Au nano particle continuum emission in biological cells.
- Optical Data Storage: Investigate future generation optical data storage systems, secure data destruction and data recovery.
- Computer Generated Holography and Diffractive Optical Elements: Explore applications in microscopy, lithography, illumination, bio and other areas. Develop micro and nano gray-scale direct writing using a maskless lithography tool (MLT). Currently working on fabricating diffractive patterns on curved substrates for exoplanet research.
- **Statistical Imaging**: Investigate properties of coherence, speckle and statistical image distortions due to rough surfaces and other causes.
- OPTISCAN Project: Optical simulation software for physical optics and lens systems.

#### Ultra Wide FOV Camera



X-ray Phase Contrast Imaging (with Stanford)

Researcher: Jihun Kim (To be joined)





**Researchers:**  Bo Miller (Ph.D. student) Minwoo Yang (Undergraduate student)

#### **Holographic Data** Storage Simulator (with Hitachi)



Researcher: Kenichi Shimada (Visiting) Researcher)

#### Head up Display for **Mobile Applications**



Researchers: Garret Odom (U.G. student) Minwoo Yang (U.G. student)

Researchers: Chris Summit (Ph.D. student) Sunglin Wang (Ph.D. student)

wavelength ( $\lambda$ )

Develop analytical model

for designing EOT nano-

apertures.

Develop optimization processes

#### Prof. Russell Chipman, Optical Sciences

#### Polarization in Optical Design

- Extending optical design methods for new generations of optical systems
  - Microlithography
  - Liquid crystal applications
  - Metamaterials
  - Space instrumentation
- Aberrations
  - Wavefront aberration
  - Amplitude aberration
  - Polarization aberration
    - Retardance aberration
    - Diattenuation aberration
  - Skew aberration
  - Depolarization



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#### Polarization Remote Sensing

- NASA is making a major investment in space-based polarization imaging for global aerosol mapping
  - Significant unknown in solar energy balance
- Multi-Spectral Polarimetric Imager
  - Built several generations of optics for NASA's Imaging Polarimetry program
  - Shown here on a high altitude research plane
  - Being proposed for space-based global monitoring





#### Hong Hua - 3D Visualization and Imaging System Lab

Advanced wearable display and augmented reality technologies:

- Development of new display methods: lightfield displays, occlusion capable displays, fovea-contingent display, etc.
- Advanced optical system design, instrumentation, and metrology using freeform optics
- Lightfield capture and display technology
- Understanding visual perception with various display technologies

![](_page_4_Picture_6.jpeg)

![](_page_4_Picture_7.jpeg)

![](_page_4_Figure_8.jpeg)

![](_page_4_Picture_9.jpeg)

#### Imaging technology: endoscopy and microscopy

![](_page_4_Picture_11.jpeg)

![](_page_4_Picture_12.jpeg)

![](_page_4_Picture_13.jpeg)

### Jose Sasian - State-of-the-Art Optical Design

![](_page_5_Picture_1.jpeg)

Novel compact high numerical aperture systems form microscopy and inspection

Immersion systems with NA=1.65, large field of view, and compact Optics Express, 2013

# ILLUMINATION DESIGN GROUP

![](_page_6_Picture_1.jpeg)

Lightpipe design

Reflector design

> Freeform optics for wallwashing (artwork lighting)

Design, Optimization, Tolerancing, Fabricating, Testing illumination / nonimaging optics

- Design an illumination system with a team
- Learn how to use design software
- Propose systems to design
- Optimize, tolerance, fabricate, & test

<u>Illumination Design Group Meeting</u> When: Friday, 26 August 2016, 4 – 5 pm Where: Meinel 447 Contact: John Koshel (403A) <u>ikoshel@optics.arizona.edu</u>

Green #3

O White #3

0

0

O White #2

O White #1

**CVrHimhl** 

**Current Project:** 

- Illumination of Rothko's
- Green on Blue painting (UA
- Art Gallery)
- Design nearing completion
- Then fabricate & test
- New project soon

### **Ron Liang: Applied Optics Lab**

- Design
  - Illumination
  - Imaging
- Fabrication
  - Diamond turning
  - Molding
  - 3D Printing
- Testing
  - Interferometric methods
  - Non-interferometric methods

More information, please visit: https://sites.google.com/site/ualiangaol/ 8/18/2016

![](_page_7_Figure_12.jpeg)

![](_page_7_Picture_13.jpeg)

![](_page_7_Picture_14.jpeg)

![](_page_7_Picture_15.jpeg)

![](_page_7_Figure_16.jpeg)

![](_page_7_Figure_17.jpeg)

125 pixel 150

![](_page_7_Figure_18.jpeg)

Ron Liang

### Large Optics Fabrication and Testing

![](_page_8_Picture_1.jpeg)

- We are at the technical forefront in large optics, enabling the next generation of telescopes
- We development and implement of state of the art engineering, manufacturing, alignment, and measurement procedures

#### Interested, see Professor Dae Wook Kim

![](_page_8_Picture_5.jpeg)

LSST Telescope

![](_page_8_Picture_7.jpeg)

![](_page_8_Picture_8.jpeg)

25-m Giant Magellan Telescope 8.4-m mirror segments

### **Adaptive Optics**

PI: Michael Hart, Meinel 629, 520-626-5265, mhart@optics.arizona.edu

#### Correcting wave-front aberration; putting light back where it belongs

#### HOW IT HELPS:

Angular resolution: see smaller details Sensitivity: better detection of faint objects Astrometry: better measurement of source positions *Confusion*: separate closely-spaced sources

#### WHAT IT'S USEFUL FOR:

Astronomy Medical pathology Earth remote sensing Laser communications Precision agriculture Etcetera

Security Search and rescue Retinopathy

#### Jupiter's moon lo

![](_page_9_Picture_9.jpeg)

# 4.8 μm Sulfur volcanoes on lo resolved by LBT Interferometer and eclipsed by Europa

![](_page_9_Picture_11.jpeg)

#### New technology developments ongoing at OSC:

- Tomographic wavefront sensing
- Robust. ceramic deformable mirrors
- Computational image restoration
- And a whole lot more...

![](_page_9_Picture_17.jpeg)

### **Greivenkamp-Tear Film Interferometer**

![](_page_10_Picture_1.jpeg)

Measure the outer surface of the human eye with high accuracy (~100x improvement over existing devices\*)

### Schwiegerling – Ophthalmic Optics

We develop diagnostic equipment and novel lens designs for the eye.

![](_page_11_Picture_2.jpeg)

#### **Practical Optics Workshops (POW)**

- Augment the regular curriculum with a set of focused activities that provide valuable practical skills.
- These will be offered throughout the year and will be scheduled around classes.
- Watch for announcements and sign up quickly, space is limited.

![](_page_12_Picture_4.jpeg)

Interferometer workshop

![](_page_12_Picture_6.jpeg)

Handling and cleaning optics

![](_page_12_Picture_8.jpeg)

Computer controlled metrology

#### Plus much more!

Don't get left out.

![](_page_12_Picture_12.jpeg)

Assembly and alignment

residual after 30 modes

![](_page_12_Figure_14.jpeg)

Data reduction and error analysis

![](_page_13_Picture_0.jpeg)

![](_page_13_Picture_1.jpeg)

![](_page_13_Picture_2.jpeg)

![](_page_13_Picture_3.jpeg)

### Thank You

![](_page_14_Picture_1.jpeg)

### **Optical Engineering Courses**

	MS					
	<u>Fall</u>	Spring	Fall	Spring		
basic	501	503	506	515		
curriculum	502	505	517	516, 524, or 585		
	512R		521	thesis		
			512L	515L		
Other						
recommended	502L	503A if needed	696C			
classes		508, 510R, 511R	521L			
		505L, 511L				
	PhD					
	<u>Fall</u>	Spring	<u>Fall</u>	Spring	Fall	Spring
basic	501	503	506	515		
curriculum	502	505	517	516, 524, or 585	521	516, 524, or 585
	512R	508	507	511R	696A	
			512L			
Other					513	
recommended	502L	505L	696C	515L, 511L	521L	510R
classes					500ABC	623
					541	
					586	
	502L	Applied Optics Lab	696C	Practical Optics	513	Optical Testing
	503A	Math Methods for Opt	521L	OptoMech lab	500ABC	Photonic Comm
	508	Prob and Stats	515L	Fab & Testing Lab	541	Intro to Lasers
	505L	Physical Optics Lab	511L	Lasers & Solid State Lak	586	Polarization in Optical Design
	510R	Photonics			510R	Photonics
	511R	Optical Physics & Lasers			623	Polariized Light & Polimetry
	511L	Lasers & Solid State Lab				