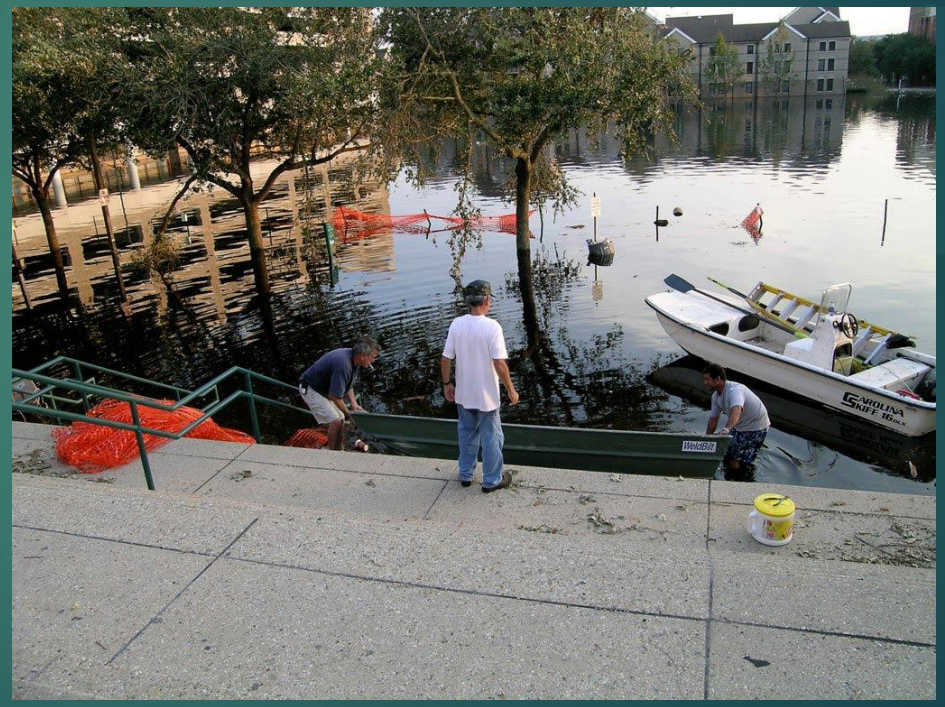
Physics at Tulane University

RECOVERY OF NEW ORLEANS PHYSICS POST-KATRINA (AAPT 2016 WINTER MEETING, NEW ORLEANS)

LEV KAPLAN, CHAIR OF PHYSICS AND ENGINEERING PHYSICS, TULANE UNIVERSITY

Background: Katrina and Tulane

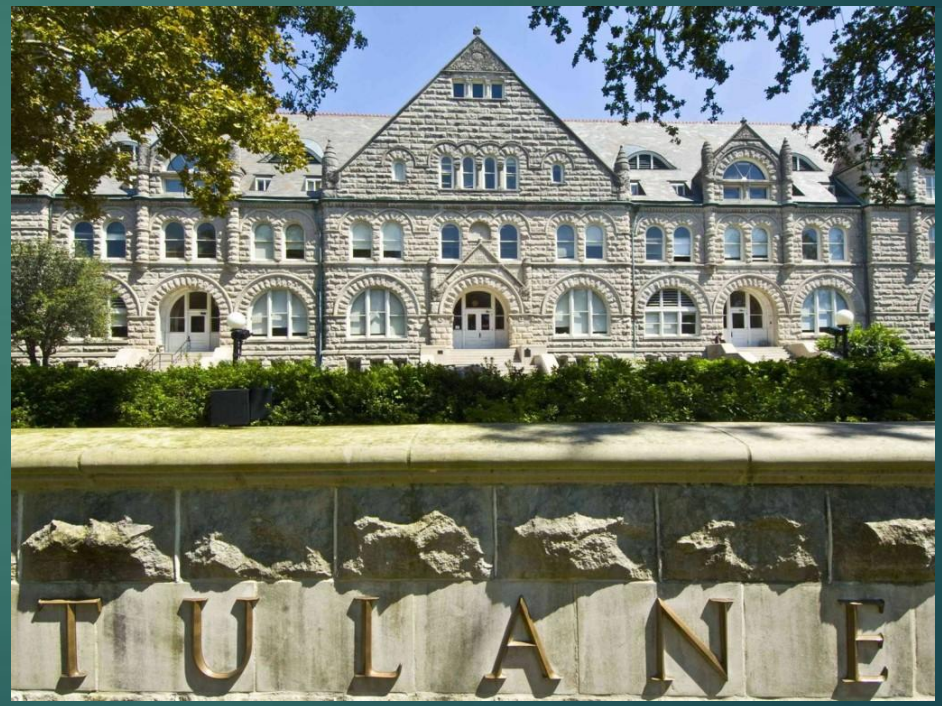
- >50% of Uptown campus flooded after levee failures
- ~ $650 million in damages and losses to university as a whole
- Campus closed for entire fall 2015 semester
- Generosity of universities around the country allows students to stay on track with education (and faculty & staff to get paid)
- Physics research groups hosted by Rice, NIST, Rutgers, U. Illinois, UMass Amherst, Harvard, …



Tree of Thanks tapestry in 1834 Club

Tulane after Katrina

- Remarkably, >90% of students return in January 2006
- Lagniappe semester in summer 2006
- Tulane becomes city's largest employer
- Renewal Plan: includes painful changes (including cuts in Engineering and Medicine) but also strategic decisions for future
- Newcomb-Tulane College as new home for all undergraduates
- New School of Science and Engineering (SSE) created
- Emphasis on civic engagement, new service learning requirement
- Undergraduate applications reach record highs (at one point >43,000 for ~1,600 spots)



Tulane Physics: A Success Story

- Department transforms itself into Physics and Engineering Physics (PEP)
- New undergraduate Engineering Physics program added to complement more traditional Physics program
- Separately, dual-degree Physics+Engineering agreements signed with Vanderbilt and Johns Hopkins
- External advisory board formed
- Research continues to be strong with materials/devices as major focus area
- Engineering faculty hired for first time
- Total undergraduate numbers triple from pre-Katrina years

Tulane PEP Faculty (Fall 2015)

Shiva Adireddy – 2015	Materials Engineering
Nicholas Altiero (SSE Dean)	Computational Mechanics & Fracture Mechanics
Douglas Chrisey – 2012	Materials Engineering
Matthew Escarra – 2013	Photonic Materials & Devices
Ryan Glasser – 2014	Quantum Information & Nonlinear Optics
Norman Horwitz	Industrial Engineering
Jin Hu – 2015	Low Temperature Condensed Matter Physics
Eliot Kapit – 2015	Quantum Simulation & Quantum Computing
Lev Kaplan (Chair)	Quantum Chaos & Quantum Information
James Maclaren (NT Dean)	Theoretical Solid State Physics
Zhiqiang Mao	Low Temperature Condensed Matter Physics
Noa Marom – 2013	Computational Materials Science
Guy Norton – 2011 (Asst Chair)	Theoretical Acoustic Scattering
Wayne Reed	Polymer Physics & Biophysics
George Rosensteel	Mathematical Physics
Michelle Sanchez – 2012	Paralinguistic Speech Problems
Timothy Schuler	Experimental Solid State Physics & Physics Instruction
Jerry Shakov (Asst Chair)	Quantum Control & Physics Instruction
Diyar Talbayev – 2011	Femtosecond & Terahertz Spectroscopy
Frank Tipler	Relativity & Cosmology
Jiang Wei – 2012	Nanodevice Physics
Fred Wietfeldt	Neutron Physics

Tulane PEP mission statement

The Department of Physics and Engineering Physics (PEP) is committed to:

- Educational empowerment at every level
- Attracting and mentoring the finest undergraduates, graduate students, and faculty on an individual basis
- Redesigning traditional boundaries in research, teaching, and outreach in carefully focused areas

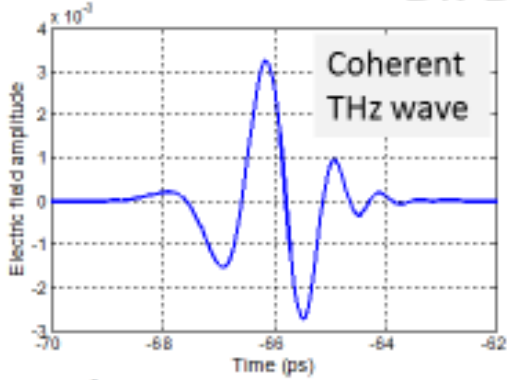
Tulane PEP Research

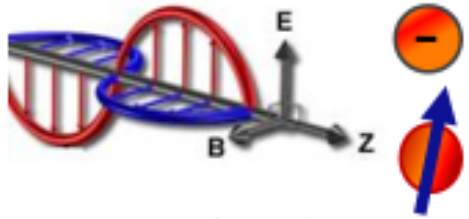
- Six new tenure-track assistant professors hired over 4-year period
- Active areas of research include: Quantum Materials, Photonics, Nanodevices, Quantum Information and Computation, Mathematical Physics, Quantum Chaos, Femtosecond Spectroscopy, Polymer Physics, Neutron Physics, …
- Prof. Zhiqiang Mao – APS fellow 2014
- Prof. Wayne Reed – PolyRMC, $1.9M DOE award, $0.8M NSF co-PI
- Prof. Matthew Escarra – $3.3M ARPA-E award

Tulane PEP Research

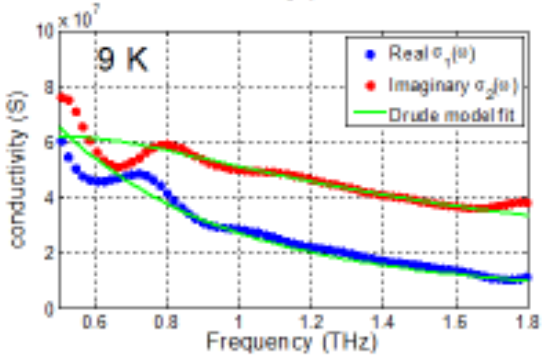
Recent NSF CAREER award

Femtosecond and Terahertz Spectroscopy
Dr. Diyar Talbayev

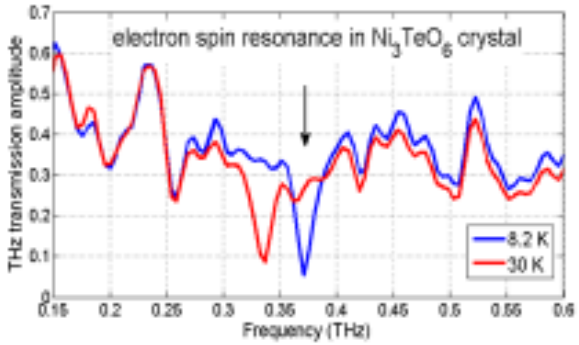




Interaction of Terahertz wave with electron charge and spin



Drude conductivity in CrO_2



Spin resonance in antiferromagnet Ni_3TeO_6

Skylar Deckoff-Jones, 2014
Goldwater award recipient

Tulane PEP Research

Prof. Fred Wietfeldt

Neutron Research group

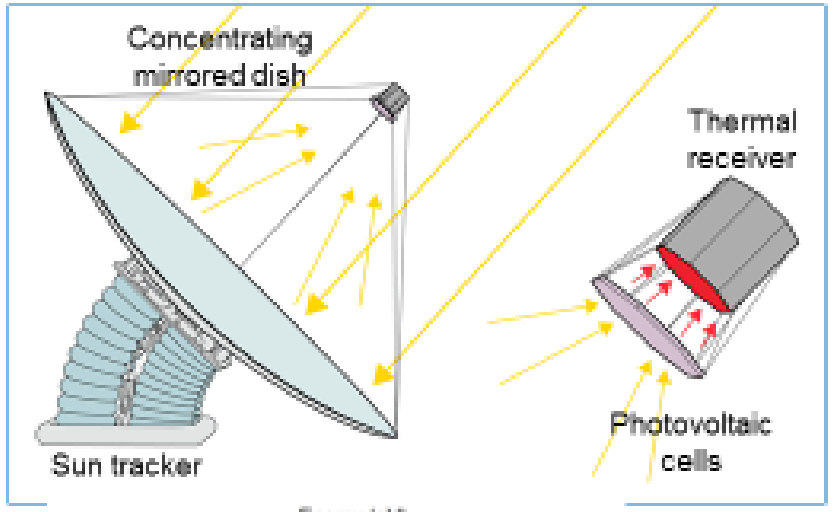
- neutron decay
- neutron interferometry

PI and spokesman on "aCORN" experiment (most precise ever measurement of electron-antineutrino angular correlation coefficient in neutron decay) - a key to important precision tests of the Standard Model

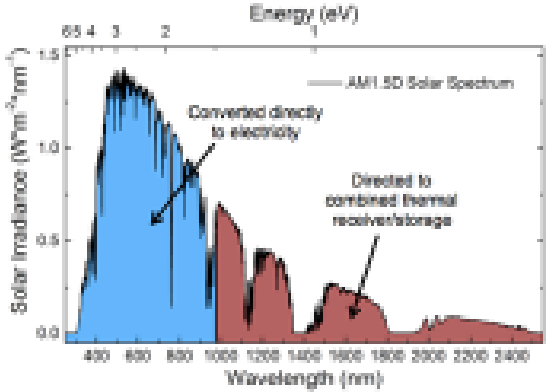
Tulane PEP Research

Full Spectrum Solar Energy Conversion:
High efficiency, modular, dispatchable solar electricity and heat

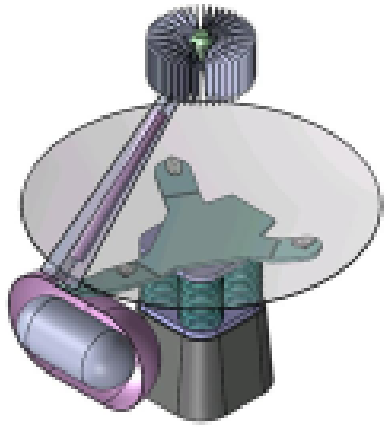
$3.3M ARPA-E project led by Escarra Research Group, in collaboration with four partners in industry & academia



Projected Performance	
Exergetic efficiency	41%
Electrical efficiency	28%
Levelized cost of electricity	8.4¢/kWh
Capital cost	$1.9/$W_e$
Operating temp.	590°C



Current status:
prototyping all components in preparation for integrated field testing in 2017



Prof. Matthew Escarra (arrived Fall 2013)

Tulane PEP Research

Chrisey Lab: High-Throughput Fabrication of Energy Storage Capacitors for Renewables

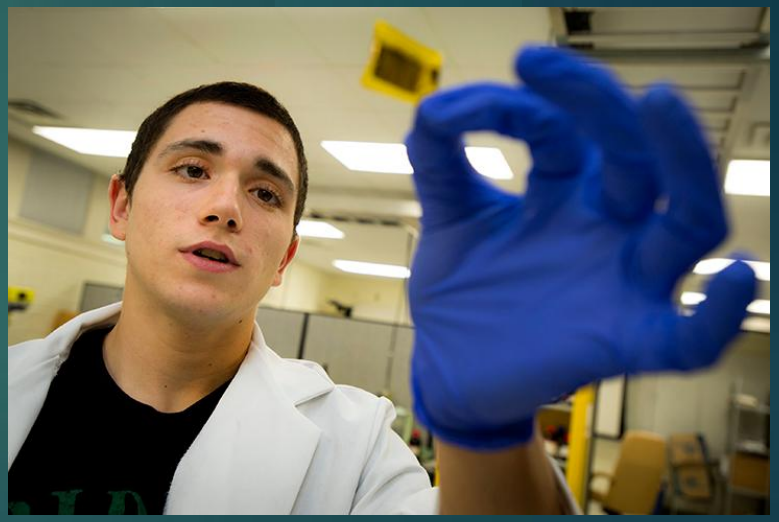
The Chrisey Lab has focused on developing novel solutions to meet the world's growing energy demands. The performance of novel capacitors depends on nanometric control of interfaces between different materials (inorganic and polymeric components).

Research Interests:

- Synthesis of morphologically controlled nanomaterials and their printable inks
- Developing new materials that exceed the energy density and stability limitations faced by existing conventional materials in the storage of electrical energy
- Fabrication of nanometrically engineered thin films, electronics, & sensors via ink-jet printing and photonic curing.

High capacitance, additively manufacturable capacitors

Prof. Douglas Chrisey
11 publications in 2014
H-index = 49



Ben Rosenthal,
Schlumberger Scholar

Tulane PEP Research

Quantum Information and Nonlinear Optics at Tulane

Projects:

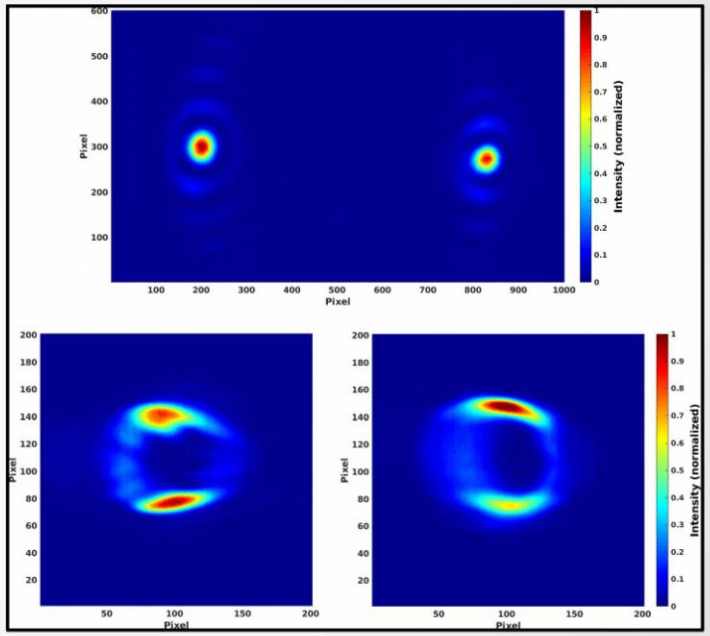
Generating robust quantum states of light.

High-dimensional entanglement.

Direct generation of non-Gaussian optical modes.

Applying quantum enhancements to real-world scenarios.

Utilizing machine learning to enhance quantum information protocols.



Personnel:

Two graduate students (1st and 2nd year).

Three undergraduate students (4th and 2nd year).

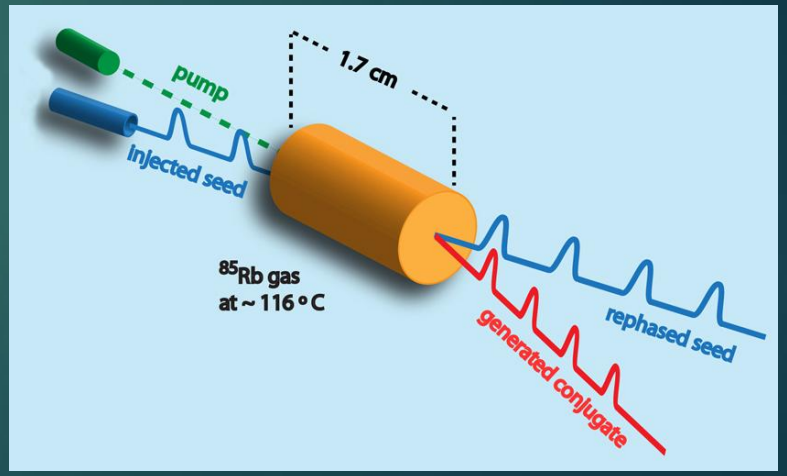
Support:

Louisiana Board of Regents Research Competitiveness Series grant (2015-2017).

Unconditional grant from Northrop Grumman Aerospace Systems (2015-).

Tulane CELT Fund for Faculty/Student Scholarly and Artistic Engagement (Spring 2016).

Prof. Ryan Glasser
(arrived Fall 2015)



Tulane PEP Teaching

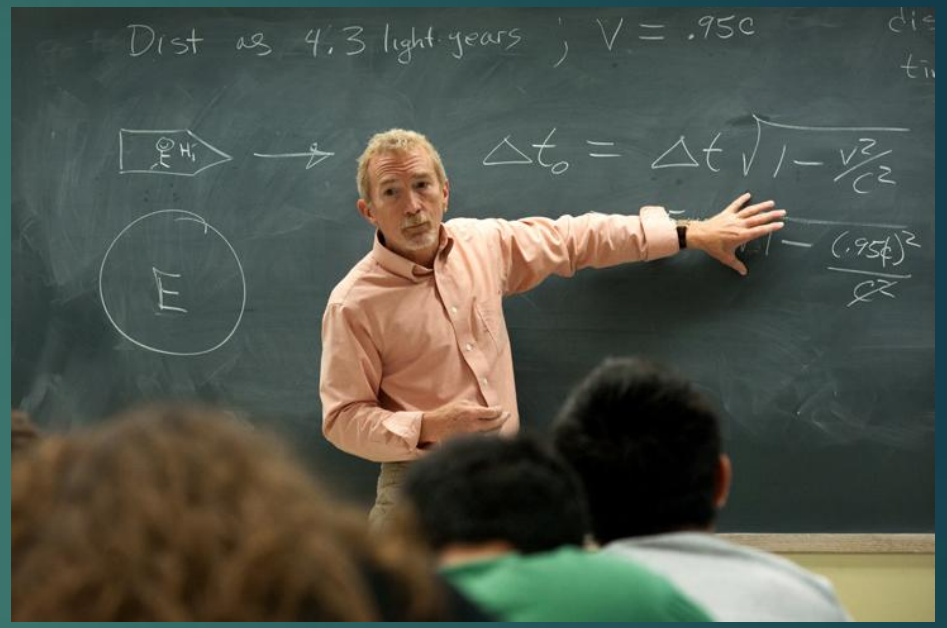
- New Undergraduate Engineering Physics program added 2007
  - "Engineering for the 21st century"
  - Strong science component (Modern Physics 1 and 2, Nanoscience and Technology, advanced physics electives, …)
  - Core engineering: Statics, Mechanics of Materials, Circuitsw, Thermodynamics, Materials Science and Engineering)
  - Computational courses
  - Design component
    - Sophomore Design
    - Required Summer Internship
    - Team Senior Design
  - Electives allow students to tune program in particular direction (e.g. mechanical, electrical, …)

Tulane PEP Teaching

- Engineering Physics provides very broad preparations for our graduates
- E.g. students going on to grad school have continued in fields such as
  - Mechanical Engineering
  - Electrical Engineering
  - Civil Engineering
  - Environmental Engineering
  - Petroleum Engineering
  - Materials Engineering
  - Computational Engineering
  - Nuclear Engineering
  - Aerospace Engienering
- Similarly, graduates going into diverse industries: automotive … wind energy … polymers … communications & control …

Tulane PEP Teaching

- Professor of Practice positions
  - University-wide, largely post-Katrina
  - Full-time teaching (3-3 load)
  - Non-tenured
  - Initial 3-year appointments, 5-year appointments upon promotion
  - Faculty with full voting rights, privileges (with a few exceptions, e.g. tenure, research)
  - 4.5 of these positions in PEP
  - Very helpful in allowing us, as a small department, to teach broader range of courses while maintaining competitive teaching loads for tenure-track faculty



Prof. Guy Norton, twice nominated for Tulane's Weiss Presidential Fellowship for undergraduate teaching

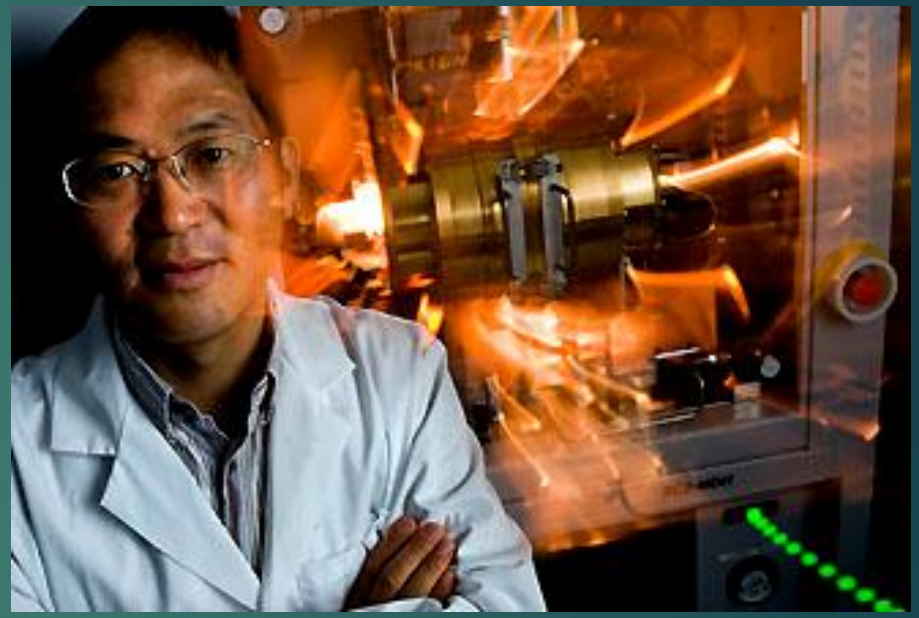
Tulane PEP Teaching

- New undergraduate Physics and Engineering Physics courses introduced post-Katrina
  - Physics for Architects
  - Product and Experimental Design
  - Introduction to Physics Pedagogy
  - Introduction to Neutron Science (*)
  - Computational Physics and Engineering (*)
  - Quantum Information Science and Engineering (*)
  - Kinetics of Material Systems (*)
  - Team Design Project and Professional Practice I and II
  - Summer Internship I and II
  - Elementary Particle Physics (*)
  - Introduction to General Relativity
  - Photonic Materials and Devices (*)
  - Introduction to Manufacturing
  - Electronics Lab
  - Microfabrication and Nanotechnology (*)
  - Electronic Properties of Materials (*)
  - Materials for Energy (*)
  - Processing of Biomaterials (*)
  - Structure of Materials (*)
  - Microcontrollers

(*) = cross-listed at graduate level

Tulane PEP Graduate Teaching

- Cross-listing of courses frequently enables us to serve advanced undergraduates and beginning graduate students in single course (with added work for the graduate students)
- Graduate student numbers have grown more slowly, from ~25 to 32 today
- New Materials track added to Physics PhD in 2015
- Plans for new interdisciplinary PhD program in Materials Science and Engineering
  - Physics and Engineering Physics
  - Chemical and Biomolecular Engineering
  - Chemistry
  - Biomedical Engineering
  - School of Medicine
  - School of Business
  - …



Prof. Zhiqiang Mao

Bridging Research and Teaching

Service Learning and K-12 Outreach

- All Tulane students required to complete two service learning courses to graduate
  - Introduction to Physics Pedagogy
  - Add-on to Senior Design (working with middle school or high school community partners)
- SSE and PEP faculty and students very active in reaching out to New Orleans community
  - Summer courses for motivated high school students through Tulane Science Scholars program (TSSP)
  - Girls in STEM at Tulane (5^{th}-8^{th} grades)
  - CORE Element regional professional development collaboration for STEM teachers
  - Greater New Orleans Science and Engineering Fair
  - NOLA SMILE (Science and Mathematics, Inquiry, Learning and Exploring) for 3^{rd} & 4^{th} grade teachers
  - FIRST Lego League
  - FIRST Robotics Competition

Tulane Science Scholars class for high school students (clean room tour)

Technology Transfer and Start-Ups

- Advanced Polymer Monitoring Technologies, Inc.
  - Founded in 2012 as spin-off from the Tulane University Center for Polymer Reaction Monitoring and Characterization (PolyRMC)
  - Commercializes Smart Manufacturing Process Analyzers
  - Products and services based on Tulane patents, exclusive license with royalties going to Tulane
  - Currently has 12 employees
  - Has provided internships for 19 Tulane students in engineering physics, chemical engineering, law, chemistry, and business

Alex, Reed, CEO
Tulane graduate

Named in 2016 to the Forbes 30 under 30 list in the Manufacturing/Industry category

10 years after Katrina…

Tulane Physics faculty, students, and staff continuing to reach new heights in

- Research
- Undergraduate and Graduate Teaching
- Service Learning and K-12 Outreach
- Technology Transfer and Start-Ups