



**Northern Illinois  
University**

# **NIU Physics Department Research**

**Laurence Lurio  
Chair Department of Physics  
August 27 Meeting of the Board of Trustees**

August 27, 2015

# Overview of Research



- Research program is focused into three main areas: Condensed Matter Physics (CMP), Particle Beams (Beams) and High Energy Physics (HEP).
- Strongly collaborative with Argonne National Laboratory (ANL) and Fermi National Accelerator Laboratory (Fermi)
- 24 Faculty, with seven sharing joint appointments at the national labs.
- Annual external funding typically fluctuates around \$2M (current year \$2.3M). Funding split fairly evenly between CMP, Beams and HEP.

# Research Centers



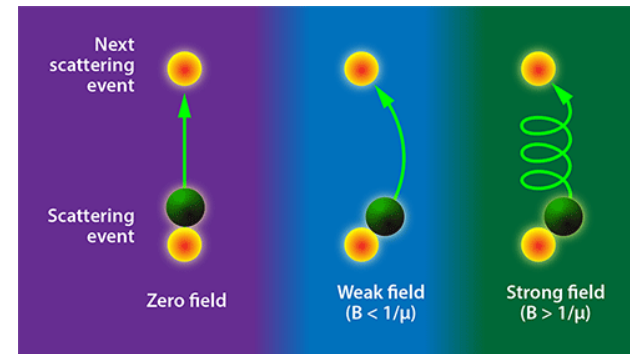
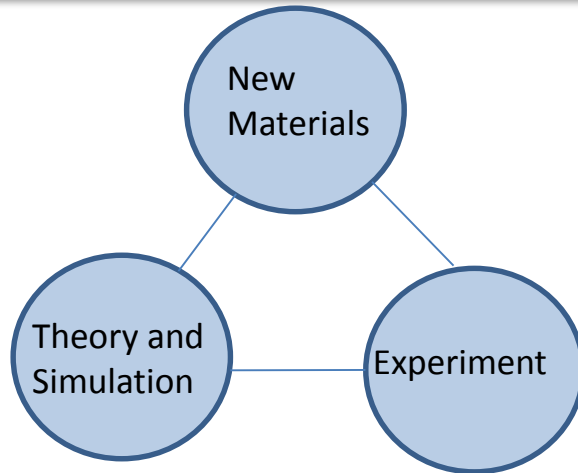
- **INSET** “Institute for Nanoscience Engineering and Technology.” Provides personnel, equipment and administrative support for developing new materials based on the unique properties of structures a few tens of atoms big. Closely integrated with ANL’s nanoscience initiative.
- **NICADD** “Northern Illinois Center for Accelerator and Detector Development.” Provides personnel, computational and administrative support for developing new accelerator and detector technology. Closely integrated with Fermilab’s accelerator and detector research programs.

# How does physics research fit into the university mission

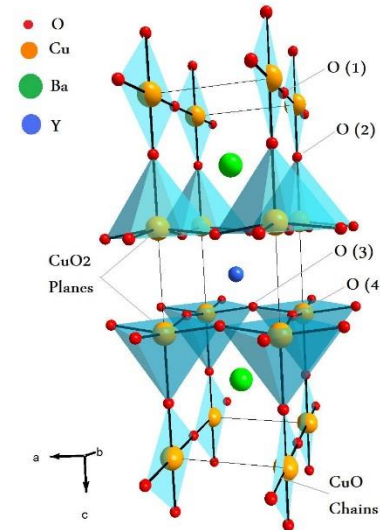


- The vision of Northern Illinois University is to be the premier student-centered, research-focused public university in the Midwest, contributing to the advancement of knowledge for the benefit of the people of the region, the state, the nation, and the world.
- NIU Physics' strategy of collaboration with the nearby national labs meshes well with the university research vision:
  - National labs have great facilities but they need to collaborate with a university partner to have access to students. This helps the labs carry out their research mission and train the next generation of scientists to work in specializations needed by the labs.
  - The Chicago region contains 2 of the nations 17 national labs. We can take advantage of our placement in this high tech region to achieve national and international impact.

# Condensed Matter Physics Research



- **Zhili Xiao:** New measurement provide insight into the mechanisms of giant magnetoresistance. Could lead to faster computer hard drives.
- **Bogdan Dabrowski:** New results may lead to understanding how high temperature superconductors work. Could lead to lossless power transmission and high power magnets for medical imaging, levitated trains and particle accelerators.



# High Energy Physics Research



- NIU Physics is involved in projects at both Fermilab in Batavia Illinois, and at the Large Hadron Collider in Geneva Switzerland.
- mu2e and g-2 projects at Fermilab will look for rare events and small deviations from expected properties that may overturn the standard model of particle physics.
- Experiments at CERN (ATLAS) will look for new particles being created in colliding particle beams.



# New HEP faculty



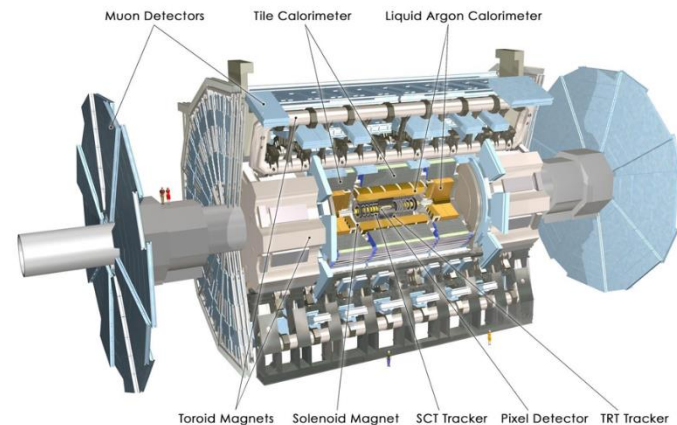
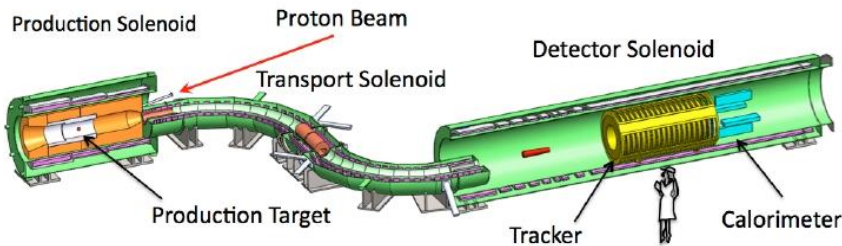
- Two new faculty hired this past year in HEP have already received over \$1M in new money for research at Fermilab and CERN



Vishnu Zutshi



Jahred Adelman



# Beams Physics Research

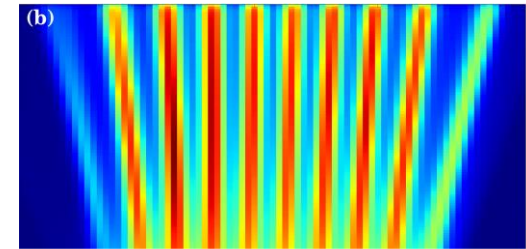


## President's Initiative to develop a Cluster of Research Excellence in partnership with Fermilab and led by Swapan Chattopadhyay (former director of UK Cockroft institute).

- Design of new acceleration methods
- Design of better sources for particle beams.
- Design of higher intensity electric field cavities.
- Chattopadhyay in first year at NIU received \$580K base grant from the NSF to support accelerator research group
- New high profile hire Dr. Mike Syphers from MSU, will be joint with Fermilab focusing on beams research and education (this past Tuesday)



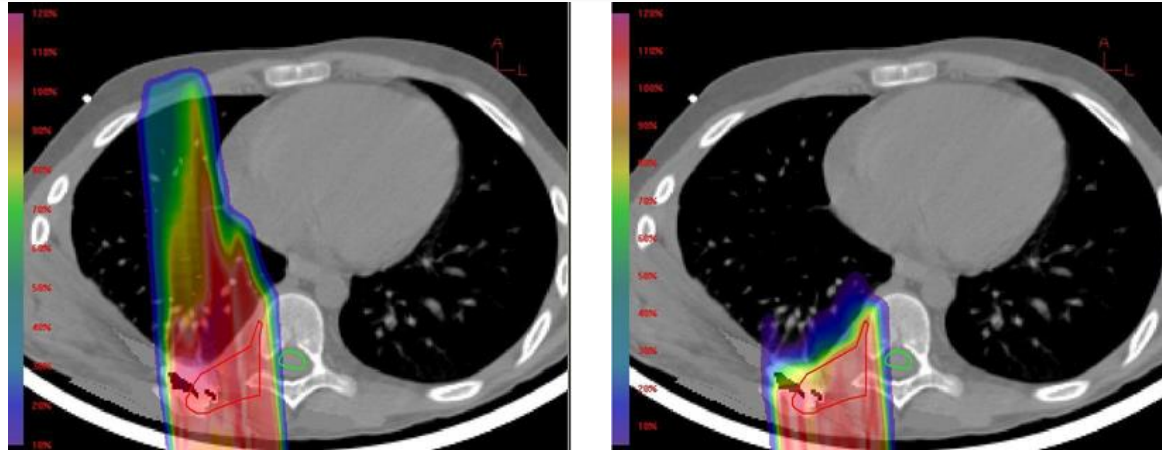
Swapan Chattopadhyay



- How the shape of a particle beam changes as it moves down the accelerator. NIU PhD. Student Francois Lemory and Prof. Philippe Piot



# Proton Therapy and NIU Proton Imaging Research



Dose overshoot into the lung (left) with x-ray treatment can be eliminated with proton imaging rather than x-ray imaging (right).

figure courtesy of Dr. Reinhard Schulte, MD Loma Linda University.

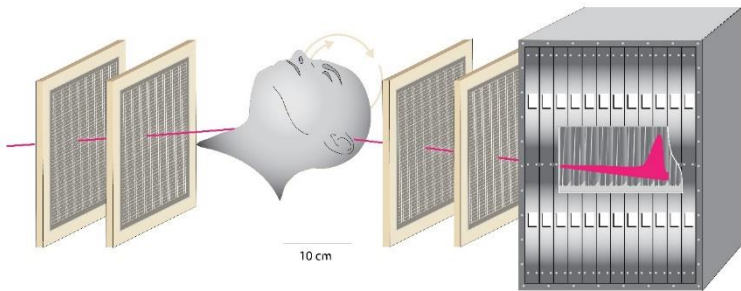
- Proton computed tomography provides 1) more accurate and 2) more convenient imaging with 3) lower dose than conventional X-ray tomography
- In 2010 NIU received funding to build a second generation imaging system that 1) could collect data and 2) reconstruct an image in clinically useful times (<10mins)
- Had detector, computing, and medical physical expertise in NICADD and the Computer Science Department

# Detector completed in late 2013

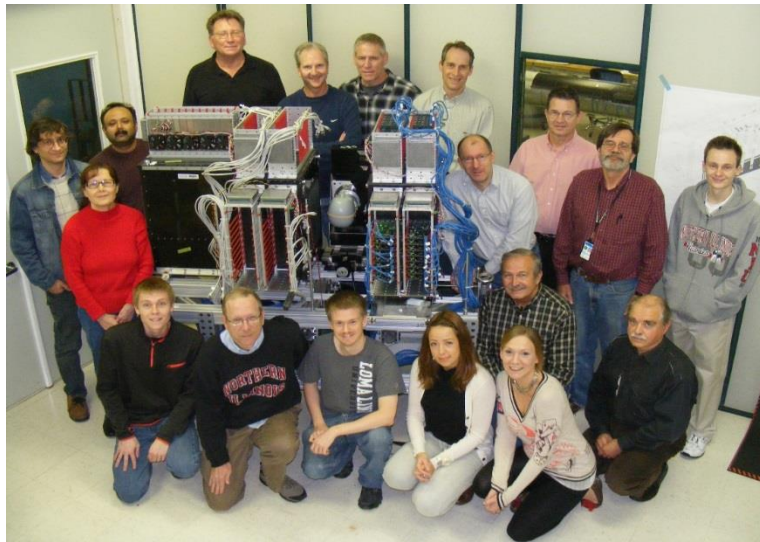


## Commissioning Underway

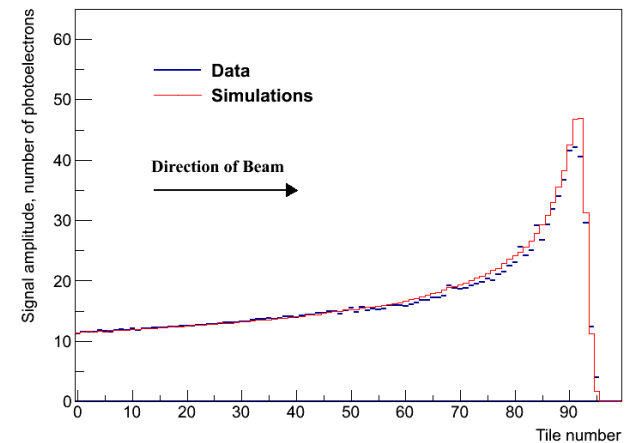
NICADD/NIU, FNAL, Dehli pCT Detector Schematic



- Figure at left shows the basic principle of operation. Protons are tracked before and after target and energy measured. Trajectory and energy information from 2 billion protons are analyzed by computer to image the target.
- Figure below shows energy deposition in NIU Detector for a sample of protons. There is excellent agreement between detector and simulation. (Data Collected at NW Proton Center)



Range Detector Response to a 225 MeV Beam



# Phantom image using NIU software and high performance computing



**Data collected at NW Proton Center May 2015 using LLUMC Detector.  
This is the 1st 3D image of human like anatomy using protons**



Data transferred to NIU.



NIU's  
High Performance Computer Cluster  
(Gaea)

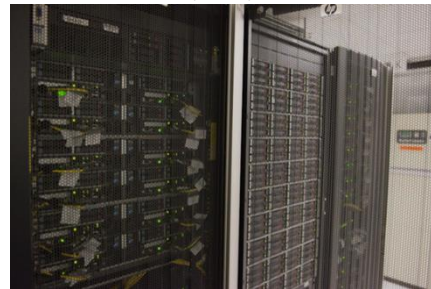


Image reconstructed in 69 seconds.

# Summary



- Faculty are active in condensed matter, high energy and beams physics.
- Three recent hires in past year have all been successful at obtaining major new funding for the program. New high profile hire has just accepted NIU offer.
- Strategy of close collaboration with National Laboratories has significantly leveraged NIU's resources.