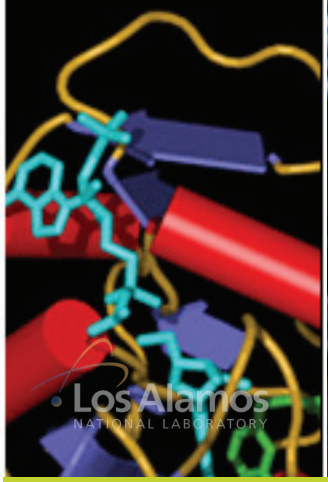
AOT & LANSCE The Pulse

April 2012

INSIDE






# Rhiannon Meharchand

## *Finding her place as a leader*

Offered a chance to tackle as much work as she'd like for a big nuclear energy project, Rhiannon Meharchand instantly knew she wanted the job. Now, after just eight months as a postdoctoral researcher in Neutron and Nuclear Science at the Los Alamos Neutron Science Center (LANSCE), she's an integral part of a collaboration involving four national laboratories and six universities.

Meanwhile, her mentor Fredrik Tovesson, also of Neutron and Nuclear Science (LANSCE-NS), is cheering her on. "Most postdocs wouldn't be up to taking so much responsibility," he said. "She's done outstandingly well." Meharchand was recently selected for a Director's Postdoctoral Fellowship.

With the new time projection chamber (TPC) being test-driven at Los Alamos's Weapons Neutron Research facility, she is getting a nuts-and-bolts experience—everything from building and maintaining an instrument to designing an experiment.

Commonly used in high-energy physics experiments since the 1970s, time projection chambers are machines that detect particles after they have been accelerated and smashed together. Typically, the machines take up an entire room or small building. This, however, is a miniature version of the device, making it "a tool unlike any other in the world," Meharchand said.

Manufactured by Lawrence Livermore National Laboratory, which leads the project, this new time projection chamber is roughly two feet tall and shaped like a hexagon. The active area of the detector is intensely powerful, yet no bigger than a coffee can.

The National Nuclear Security Administration needs this improved version–and Los Alamos expertise–to generate more refined measurements

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# From Alex's Desk



Colleagues,

Interesting times! With the Voluntary Separation Program departures completed, reality is checking in as to how we are going to perform/deliver and accomplish our work with less people. Adding to that, we are in the middle of our scheduled maintenance with a lot of work to be done. Well, the options here could be: panic/stress *or* slow down a little and think. This time could also bring an opportunity to take a broad look not only at our workload, but also to prioritize what needs to be done. I know this is easier said than done, but it just needs to be done. It would be unrealistic for me to propose, and for us to think, that there is a trivial way out. There is, however, a manageable way to have a realistic and balanced approach when setting our priorities. During this whole process, staying focused—from driving to and from work, to mentoring students and postdocs, and to performing your job—is very, very important.

On a different note, during the last week of March we hosted two very important events.

The first was the LANSCE User Group Executive Committee (LUG-EC) on-site meeting, where we welcomed the newly elected members Mark Bowden (Pacific Northwest National Laboratory), Emil Bozin (Brookhaven National Laboratory), Luka Pocivavsek (University of Pittsburgh), Terry McQueen (John Hopkins University), and, as the student representative, Bryan Zeck (North Carolina State University). In addition to a variety of topics that included review of the LUG-EC charter as well as the frequency and venue for the LANSCE Users Meeting, the committee also elected Mark Bowden as vice chair. Mark will be assisting June Matthews (MIT), who is the current LUG-EC chair.

**'This time could also bring an opportunity to take a broad look not only at our workload, but also to prioritize what needs to be done.'**

The LANSCE Advisory Board (LAB) meeting also took place the last week of March. The LAB chair is Arthur Kerman (MIT) and new members include Ka Yee Lee (University of Chicago), Rob McGreavey (ORNL), and John Browne (former LANL director), in addition to Raymond Juzaitis (NSTec), Brian Maple (UC, San Diego), John Peoples (Fermi National Accelerator Laboratory), and Don Frazier as current members. We presented and received good feedback related to LANSCE's scientific breath and its impact to LANL's future.

To note, the 2012 National User Facility Organization (NUFO) will be hosted by LANSCE and held in Santa Fe June 18–20. This year's meeting will focus on "Strengthening the Relationship Between University Research and National User Facilities." The two-and-a-half day meeting will include tours of some of LANSCE, the National High Magnetic Field Laboratory (NHMFL), and the Center for Integration of Nanotechnology (CINT). For additional information visit: lansce.lanl.gov.

Last but not least….Keep focused and be safe!

*LANSCE Deputy Division Leader Alex Lacerda*

***Meharchand . . .*** of plutonium-239. As the new device creates three-dimensional pictures of nuclear fission events, scientists will be able to achieve neutron-induced fission cross-section measurements with unprecedented accuracy. Such measurements are crucial for the global quest to design the next generation of nuclear power plants and for defense applications.

Passionate about the possible applications, Meharchand hopes that a deeper understanding of the fission process will help developers move forward with fast nuclear reactors, which incinerate waste as they produce electricity. "We need to understand what's going on well enough to have predictive power—to be able to show how certain fuels will behave in these systems," she said.

Meharchand came to Los Alamos to round out her graduate research experience, and now she finds herself in the thick of coordinating in-beam experiments. If the detector malfunctions overnight or on the weekend, Meharchand is one of three on-call shifters who come in to make minor repairs. For any major problem, Meharchand is on the phone the next morning with Livermore scientists to find out how to repair it.

In weekly phone conferences with up to 30 members of the Neutron Induced Fission Fragment Tracking Experiment collaboration, she gives project updates and discusses what must be done before a fully instrumented TPC can officially go live. She must verify that all systems are working before the next beam run in August.

"I've never done anything like this before," Meharchand said. "I've learned a lot of technical skills, I've learned how to work inside a larger collaboration, and I've been learning how a national lab works."

Tovesson said she has a "leadership personality" that was sparked long ago. As a highly motivated graduate student, Meharchand helped start several student organizations at Michigan State University, including a chapter of the Association for Women in Science, a national organization.

For a go-getter like Meharchand, Los Alamos offers the right balance of autonomy and collaboration. "Even as a postdoc, if you have an opinion, it's given weight and that's nice," she said.

### Rhiannon Meharchand's favorite experiment

**What:** The start of the 2011-2012 LANSCE Run Cycle. There's just something about the start of a beam experiment—seeing weeks, months, sometimes years of planning come together, never flawlessly, but nearly always successfully (after a good deal of last-minute troubleshooting). Working with other scientists, students, and postdocs, for as long as it takes, to get the job done. Watching the first signals arrive that tell you the experiment is working. It's exhausting and exhilarating, all at once.

**Where:** The Weapons Neutron Research facility at LANSCE.

**Who:** Scientists from 4 national labs and 6 universities, 10 of whom traveled to LANSCE to help set up the experiment (the rest helping remotely).

**Why:** Despite only having had a few months to familiarize myself with the instrument, the collaborators, and the WNR facility, there I was, helping to prepare for months of data collection with this new world-leading detector. The goal: characterize and test the limits of the partially-instrumented TPC by examining fission output from U-238, U-235, and Pu-239 samples.

**The "a-ha moment:"** Huddling around a single computer monitor with very accomplished scientists and watching the first data of the year come in. Feeling relieved—even though I was in a new place with new people doing very different science than what I'd done before, the excitement of experimenting was exactly the same.

## Claire White selected for Outstanding Student Research Prize

Claire White (Lujan Center, LANSCE-LC) will receive the first-ever Prize for Outstanding Student Research from the Neutron Scattering Society of America. The Society created the award to recognize graduate and undergraduate students performing exceptional research in North American neutron facilities. A committee of experts in the field of neutron science reviewed the nominations. White will receive the award and a $1,000 honorarium during the American Conference on Neutron Scattering in Washington, D.C.

White is a former Lujan Neutron Scattering Center user and a Director's Postdoctoral Fellow in LANSCE-LC and Theoretical

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***White...*** Division. The Neutron Scattering Society cited her for "pioneering a new methodology to elucidate accurate structural representations of complex materials by combining neutron diffraction and computational chemistry."

The award is based on research she performed as a graduate student at the University of Melbourne, Australia, in the Geopolymer and Minerals Processing group. She helped develop "geopolymers," a greener class of concrete capable of replacing conventional, cement-based concrete, which accounts for 5-8 percent of all human-produced carbon dioxide emissions. White combined neutron diffraction and computational chemistry to analyze metakaolin, a cement additive and geopolymer precursor. With this new methodology she showed, for the first time, that metakaolin contains III-coordinated aluminum, an uncommon and highly strained local environment. A more accurate understanding of the nanostructural behavior of geopolymer precursors and concrete enables White and her collaborators to begin to answer key questions regarding the long-term performance of this important alternative concrete.

In 2009, she used the Lujan Center's neutron powder diffractometer (NPDF) and high-intensity powder diffractometer (HIPD) to help generate new tools that can produce higher quality total scattering data. The tools remove the incoherent scattering contribution from elements such as hydrogen. White, who has a doctorate in chemical engineering, continues to study the nanostructure of geopolymers. She employs computational methods and a variety of experimental techniques, many of which are based at the Lujan Neutron Scattering Center. Technical contact: Claire White

## Insight into the mechanism of toxicity of the Alzheimer's disease-related tau protein

Alzheimer's disease is a progressive, degenerative disorder that attacks the brain's nerve cells (neurons), resulting in loss of memory, thinking and language skills, and behavioral changes. It is the most common form of dementia, affecting as many as 5.1 million Americans. From a molecular standpoint, the disease is characterized by neurofibrillary tangles (NFTs) and amyloid plaques found in the brains of affected patients. The extracellular amyloid plaques consist of deposits of the amyloid- peptide, and the intracellular NFTs are composed of aggregates of the hyperphosphorylated tau protein. In addition to Alzheimer's disease, NFTs have also been linked to the pathogenesis of more than 20 other neurodegenerative disorders that are collectively termed tauopathies. Tau's role in the development of neurodegenerative diseases is still unclear, but a link between pathological tau aggregation and cognitive impairments has been shown. Moreover, the identification of multiple tau gene point mutations that result in hereditary tauopathies is evidence that tau malfunction alone is sufficient to cause neurodegeneration. However, two key features of tau pathology are still unclear: 1) the molecular basis of the early aggregation events, such as the structural fluctuations that trigger the aberrant accumulation of tau into NFTs rich in -sheets in vivo, and 2) the mechanism by which tau aggregation causes neuronal dysfunction. In a paper accepted for publication in the journal *Biochemistry*, a collaboration between University of New Mexico, Max Planck Institute, German Center for Neurodegenerative Diseases, and the LANSCE Lujan Neutron Scattering Center (LANSCE-LC) shows that highly charged and soluble tau protein is very surface active and selectively inserts into model membranes (anionic lipid monolayers), inducing membrane morphological changes.

The scientists used complementary neutron and x-ray scattering techniques to resolve molecular-scale structural details of human tau protein (hTau40) associated with lipid model membranes. The neutron scattering experiments assessing lipid bilayer structural integrity before and after the addition of the hTau40 revealed that tau selectively disrupts anionic lipid bilayers even at lipid packing densities higher than those of a cell membrane. However, hTau40 leaves neutral lipid bilayers intact. The results suggest that electrostatic interactions play an important role in modulating tau – membrane interactions, with hTau40 displaying a strong affinity toward the anionic membrane. Moreover, both air/water and anionic lipid membrane interfaces induce the disordered tau protein to adopt a more compact conformation with density similar to that of a folded protein. The results demonstrate the structural plasticity of the tau protein and that multiple mechanisms can induce the structural compaction accompanying disordered-to-order transitions in the protein to render it aggregation-competent. The research provides some structural insights into the dual roles that the lipid membrane plays in catalyzing tau misfolding and aggregation and in serving as a target for tau aggregates to exert toxicity via membrane destabilization. Interactions with the tau protein disrupt lipid membrane structure, both on a molecular scale of disrupting lipid packing and on a morphological scale of completely disrupting the integrity of lipid bilayers.

These findings suggest possible membrane-based mechanisms of tau aggregation and toxicity in neurodegenerative diseases. Because anionic membranes are known to induce tau fibrillization, this lipid membrane-induced structural compaction may render the otherwise soluble and stable tau aggregation-competent, or proaggregant, and seed the assembly of tau into fibrils. The inner leaflet of the neuronal cell membrane contains several anionic lipid species. Upon the detachment of tau from microtubules due

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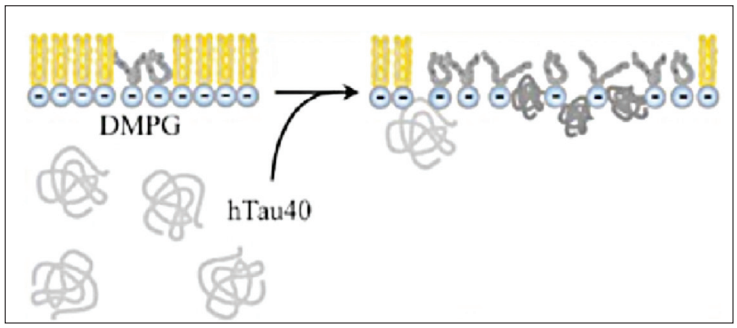
***Insight . . .*** to yperphosphorylation that occurs early on during the pathogenesis of Alzheimer's disease, association of free tau with anionic lipids in the plasma membrane could seed the formation of the paired helical filaments found in the brains of Alzheimer's victims. Furthermore, tau's interaction with anionic lipid membranes disrupts lipid packing and compromises membrane structural integrity, providing a potential mechanism of protein aggregate-induced toxicity in diseased cells.

Reference: "Interaction of Tau Protein with Model Lipid Membranes Induces Tau Structural Compaction and Membrane Disruption," *Biochemistry* (in press); doi:org/10.1021/bi201857v. Researchers include Emmalee Jones, Philip Camp, Briana Vernon, and Eva Chi (University of New Mexico); Jacek Biernat and Eckhard Mandelkow (Max Planck Institute and the German Center for Neurodegenerative Diseases); Manish Dubey and Jaroslaw Majewski (LANSCE-LC).

This research benefited from the use of the Lujan Neutron Scattering Center at LANSCE funded by the DOE Office of Basic Energy Sciences. The work supports the Lab's Global Security mission area and the Science of Signatures science pillar.

*Technical contact: Jaroslaw (Jarek) Majewski*




*Schematic illustration of adsorption of human tau protein (hTau40) to the anionic lipid monolayer (DMPG) at the air/water interface, which causes damage of the lipid packing order.*

## Celebrating service

Congratulations to the following LANSCE & AOT Division employees celebrating service anniversaries this month:

| | |
|---|---|
| Danny Vigil, AOT-RFE | 30 years |
| Leopoldo Chavez, AOT-IC | 15 years |
| Keith Stephens, AOT-OPS | 15 years |

# Stewardship Science Academic Alliance Center of Excellence meets

Scientists from the Stewardship Science Academic Alliance (SSAA) Center of Excellence for Radioactive Ion Beam Studies for Stewardship Science visited LANSCE on March 12-13. This is the only center for nuclear physics research in the National Nuclear Security Administration (NNSA)- sponsored SSAA. Professor Jolie Cizewski (Rutgers Universit) heads the Center, which includes participants from Rutgers, University Radioactive Ion Beam/ Oak Ridge Associated Universities, Tennessee Technological University, Colorado School of Mines, University of North Carolina, Michigan State University, LANL, and Lawrence Livermore National Laboratory. The SSAA's goal is to create opportunities for scientists in physics disciplines that are important to NNSA missions. An important focus of the program is the training of students and postdocs who will contribute to scientific discovery in nuclear physics and potentially be employed at one of the national laboratories.

The center brought 15 participants including 4 postdocs, 9 graduate students, and 1 undergraduate student to the meeting. The center described many of its nuclear physics projects in 14 presentations. To acquaint these visitors with LANL programs, Lab researchers gave talks regarding LANSCE and one each from Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT) on flash radiography, Safeguards Science and Technology (N-1) on safeguards, Space Science and Applications (ISR-1) on space science, and Nuclear and Particle Physics, Astrophysics and Cosmology (T-2) on modeling of basic nuclear physics reactions. The group toured the LANSCE Weapons Neutron Research (WNR) and Lujan facilities. The work supports the Lab's Nuclear Deterrence and Global Security mission areas and the Materials for the Future science pillar.

*Technical contact: Alex Lacerda*

*Participants from the SSAA Center and some of the LANL researchers.*

# HeadsUP!

## Bike safety

Good weather is here, and more bikers and walkers are out. The Lab's Traffic Safety Committee provides the following reminders:

To cyclists:

- Slow down from high roadway speeds when crossing a bridge or sidepath.
- Set a personal maximum speed of 10 mph in these areas. The sidepath on the Los Alamos Canyon Bridge is about seven feet wide, so in these close quarters you will be overtaking pedestrians with little spare space. When overtaking someone (either cyclist or pedestrian), slow down even further and move to the side of the path away from a cyclist or pedestrian, especially if you are overtaking from the person's rear.
- The use of a bell or other auditory device does not take the place of caution. Sometimes a cyclist ringing a bell or calling out "on your right/left" has resulted in a startled pedestrian (or fellow cyclist) who has behaved unpredictably, especially if lost in their thoughts or their earbuds, which can result in a collision.
- If you are riding on a downhill slope, control your speed unless you are alone on the bridge or sidepath. A high speed collision would be dangerous, not to mention reckless. Riders who want to go fast should take to the roadway.

To walkers:

- Pay attention and walk predictably and to one side or the other. If someone is overtaking you on a bike, don't suddenly change course, because the cyclist may not be able to stop or adjust to your new line.
- Wearing headphones and listening to music makes you less obvious to someone overtaking you and trying to get your attention. It also makes it easier to startle you.

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*News of the Isotope Production Facility's production of cancer-fighting actinium was recently featured on the PR Newswire news screen in New York City's Times Square.*