LS-CAT at Argonne Helps Enlighten Life Sciences

In early 2012, tracking a nanoparticle's location within a cell was impossible, yet imperative. If researchers could confirm that the ultra-fine particles developed by Gayle Woloschak, radiation oncology, were making their way into the nucleus of a cell, drugs might then be attached to them in an attempt to destroy cancer from within.

“The effort involved in designing and obtaining a first-of-its-kind microscope — the bionanoprobe — is a perfect example of how the partnership between Northwestern and Argonne can work,” says Keith Brister, manager of the Life Sciences Collaborative Access Team (LS-CAT) at Argonne National Laboratory. “The bionanoprobe has the capability of providing three-dimensional maps of exactly where specific elements are located.”

The microscope allowed Woloschak to substantiate the concentration of nanoparticles that reached the nucleus. It also gave researchers like Tom O’Halloran, chemistry, a chance to investigate — at the nanoscale — the changes that occur to an egg when penetrated by sperm.

Housed at LS-CAT, the bionanoprobe is one of seven stations at two sectors managed by Northwestern University at Argonne’s Advanced Photo Source (APS). Three stations are part of the du Pont-Northwestern-Dow Collaborative Access Team (DND-CAT) and are used in materials science research. The other four are at LS-CAT.

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Beyond the bionanoprobe, LS-CAT allows researchers to study the structure of proteins using intense beams of x-rays focused by mirrors and lenses onto tiny crystals of biological samples. Giant, multimillion-dollar detectors collect the transmitted or scattered x-rays needed to calculate the location of atoms in each protein.

Every protein structure that is determined by non-proprietary work at LS-CAT is then deposited into the Protein Data Bank and made publicly available.

“LS-CAT has been incredibly important to the life sciences community and it has ensured Northwestern's involvement in answering cutting-edge structural-biology questions,” says Alfonso Mondragón, molecular biosciences, and the scientific director of LS-CAT. “Northwestern was one of the first institutions involved in the APS, which provides a very important educational resource that is only available due to our relationship with Argonne as well as our proximity to the lab.”

Although the APS is oversubscribed, the collaborating partners of LS-CAT are able to schedule 75 percent of the available time with the beamline, which runs 24 hours a day for a three-month-on, one-month-off cycle. The Department of Energy requires the remaining 25 percent of time be granted to applicants from anywhere in the world.

“What I find absolutely fascinating about the APS are the scientific opportunities that exist here,” says Brister. “Pretty much, any kind of x-ray science can be advanced. A researcher can arrive with some fantasy about doing something new and chances are that we’ll figure out how to do it.”

The user community for LS-CAT typically consists of about 400 researchers from around the nation per year, each typically running one of three basic crystallography experiments over a few days. Brister described the most common tests as those looking to understand a protein to learn more about its role in a biological process, its interactions with a drug, or as part of a genomics project.

“LS-CAT is essential for our x-ray microscopy work and has provided us with a novel tool to explore cell structure and function,” says Woloschak. “Recently, we've been tracking drug delivery using the bionanoprobe and other users have been working to examine new 3D images of cells.”