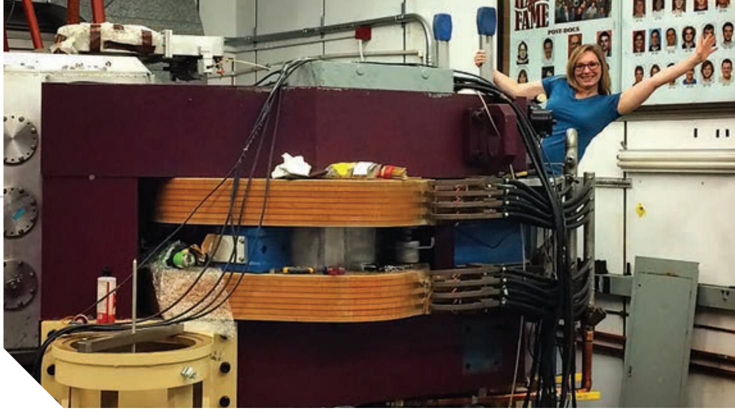
When Physics Becomes Art



Louisiana State University's Erin Good with the split-pole spectrometer she uses in her experiments, located at Florida State University in Tallahassee. The fourth-year fellow is the winner of the 2019 SSGF Essay Slam, an annual writing contest open to current and former fellows.

Nuclear physics captured my imagination as a child. Living within the 10-mile evacuation radius of a nuclear power plant that is famous for a meltdown will do that to you. But I didn't think I'd be a grad student studying the subject and creating experimental works of art in epoxy and metal.

To explain: I build detectors. Some are mundane metal boxes, filled with hundreds of wires, that I've pumped full of gas thousands of times. Some are gorgeous, sparkling cone-shaped constructions of silicon wafers that stand proudly at attention in starkly empty chambers.

They never work properly the first time. Hours and hours are spent troubleshooting. Is it the detector? Is it the electronics? Is that a faulty wire? Is there a leak or – on a rough day – did I forget to turn it on? It may take a while, but I always figure it out eventually.

They're delicate in some ways – a fingerprint on the mirrored surface of a silicon wafer or the bursting of a shiny foil window are tragedies – but sturdy in others. They operate under gas pressures that would suffocate humans and measure radiation doses that would kill us, yet carry on contentedly.

The detectors measure qualities of the charged particles that contact them – protons, deuterons, tritons, alphas and more. What they quantify depends on the detector and on the reaction.

They're all different, but in one way they're the same: I built them. You can't work with something for months on end without making it personal. When you're the expert on a detector's every little setting and quirk, it becomes special to you. Of course, they'll be sent around or installed at another lab permanently, but I'll always think of them as my creations.

My detectors work with a phoenix reborn: an old, well-loved split-pole spectrograph, a gigantic, exquisitely designed magnet we acquired when a small university accelerator lab closed.

The old behemoth got a makeover after its long truck ride down I-95 – new lab, new concrete pedestal to sit on. It was polished and painted to within an inch of its life and now sits proudly in the middle of the facility.

The spectrograph is a marvel – a 34-ton monstrosity in steel with a power supply the size of a walk-in closet. It bends the paths of charged particles to sift them by their speed and charge, creating finely sorted groups as they exit the magnet, but on its own it's silent. To be heard it needs my detectors.

My detectors work in tandem with the magnet to tell us things. A beam of particles comes into a chamber ahead of the magnet and hits a target of our choosing, creating the nuclei we want to study. They remain in the chamber while lighter, leftover nuclei continue surging into the magnet.

My focal plane detector sits at the magnet's exit and tells us where the leftover particles land and how much energy they have. This is the instrument that's filled with gas and wires, enclosed by fragile mylar foil windows. When it's placed just so, it precisely resolves the particle groups, focusing them into the narrowest points possible.

My silicon array sits in the target chamber just ahead of the magnet. It's the shiny array that looks like a space-age lampshade and surrounds the beam before it hits the target. The array tells us what nuclei we created that were left behind in the chamber and what particles they shoot out as they calm down.

If all goes well, my detectors and this colossal magnet will be together for years. Other nuclear physicists will use them to study how nuclei are excited, how they decay, and how they behave differently at different angles. With that information, they'll figure out how the protons and neutrons are arranged in various nuclei, gleaning information about intrinsic characteristics such as spin and how often they react with other particles at different energies.

I'll use the magnet with my detectors to see how many times a specific neon nucleus decays after its formation. That will help me figure out how many times a different oxygen nucleus captures an alpha particle in a stellar explosion called an X-ray burst. With that snippet of information, we'll try to better understand which elements are created where in the universe and why astronomers see what they see when stars explode.

Hopefully, I'll work on figuring out where the elements are made for a long time and use other detectors that work in totally different ways from the ones I've built. I look forward to meeting other detector designers and hearing about how their frustration and dedication came together to create a vital tool for research.

Maybe I'll build more detectors in the years to come, or maybe I'll never touch another soldering iron. Either way, I've left a legacy in detectors at a lab that will use them for years.