Instrument Shop Profile

This is the second in a series of articles that profile PSL departments.

The UW-Madison Physical Sciences Laboratory's (PSL) instrument shop, through the work of a dedicated team of specialists and machinists, makes parts and instruments to the design specifications of the many PSL customers it supplies.

Although the shop will do projects for any customer, most of PSL's business comes from research universities, both local and national.

Bill Cotter, as shop supervisor, meets with clients about design specifications and materials. He schedules the work requests and assigns the jobs to the member of shop most expert in that area. Cotter started working with PSL in 1983 and enjoys fishing, woodworking and antiquing in his spare time.

John Randall and Tim Sailor are the two lead workers. Their work includes helping others with setup, getting stock, inspecting parts and assigning jobs when Cotter is away. Randall has been with PSL for 14 years and he enjoys working on large projects such as the Wisconsin Hydrogen Alpha Mapper. In his spare time Randall plays the bagpipes and attends a men's Bible study.

Sailor, a member of the shop for 12 years, runs the computer numerical control lathe which PSL acquired last August. He likes working on small projects and making first-time prototypes. Even at home he enjoys metalworking and woodworking.

Paul Sannes and Bill Koenig are the two computer numerical control (CNC) milling machine specialists. The CNC has 3D capabilities and can efficiently create almost any part with the proper programming. Sannes and Koenig have done all of their own programming for the CNC since it was acquired in 1991. Sannes has been with PSL for 10 years, really likes working on the CNC, and spends his free time playing softball, skiing, hunting and fishing.

PSL helps Space Physics program map hydrogen in the galaxy

Researchers from the UW-Madison Space Physics program and PSL are working together to build a telescope that will detect warm ionized hydrogen particles throughout the galaxy.

The telescope, known as Wisconsin Hydrogen Alpha Mapper (WHAM) is designed to allow researchers to map the Hα density in the galaxy in significantly less time than the current, smaller telescope, which was also built by PSL.

Because of its greater light-gathering capacity and newer electronics, WHAM will be able to map the entire northern hemisphere in two or three years as opposed to the 20 or more years required by the current system.

PSL is in charge of designing and building the part of the telescope known as the siderostat. The siderostat includes the light-collection casing, the mechanics and electronics to make it move, and the software allowing it to interact with the control panel being built by the Space Physics department. The siderostat stands almost 14 feet high and weighs about 5 tons.

Light enters through an aperture greater than two feet in diameter and reflects off two mirrors through a lens where it is focused into a beam that travels to the spectrometer to be (continued on page 2)
The WHAM siderostat slowly rotates in the PSL shop, testing the motors and moving parts.

WHAM expected operational by summer

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analyzed.

In addition to providing a casing for the mirrors and lens, the siderostat has to be able to rotate in order to map the sky. Ken Kriesel, in charge of the mechanical engineering portion of the WHAM project, designed the mechanical parts that enable the siderostat to move. The two main motions are the rotations around the vertical and horizontal axes that allow the siderostat to map from north to south and from horizon to horizon across the top of the sky.

Grant Emmel, overseeing the electronics on the project, says that Kriesel gave the capability of movement to the siderostat but he actually makes it move. His job includes designing circuits and writing software to coordinate controls, motors and moving parts. He also has to integrate the Space Physics control system software with that of the siderostat. According to Emmel, most of the work left to be done on WHAM is the integration of these two parts.

PSL hopes to have WHAM operational and installed at Pine Bluff by late spring. Ron Reynolds, the researcher in charge of the WHAM project, hopes to run WHAM for a year here in Wisconsin before transporting it to Kitt Peak, Arizona where it will remain until it is done mapping the northern hemisphere.

Computing Services Group moves to DoIT

Over the next several months the computer services group at the Physical Sciences Laboratory will be moving to the UW-Madison Division of Information Technology (DoIT).

PSL will, however, continue to provide instrumentation software services through its Electronics division. These include software for data acquisition, embedded systems, motion control, system control, console/display and networking.

This move is part of the overall campus plan to consolidate all distributed computing and teleprocessing activities under one office as recommended by the Symon Report on Campus Computing Activities.

The PSL and DoIT staffs will be making every effort to ensure that the move is as smooth and problem free as possible.

Any questions regarding the move may be directed to Esther Olson, Assistant Director @ 877-2295. For information about continuing services, please contact Phil Robl, Lead Electronics Engineer @ 877-2260.
PSL to drill deep into antarctic ice

PSL’s drafting, mechanical engineering, and electrical engineering departments are designing an improved hot water drill and winches for use in drilling holes in the Antarctic polar ice for the Antarctic Muon and Neutrino Detector Array (AMANDA).

AMANDA, under the direction of Bob Morse of the UW-Madison High Energy Physics Department, is looking for the elusive neutrino particles which have no mass, no charge, travel at the speed of light, and are hypothesized to originate in pulsars, quasars, and black holes.

One in a billion neutrinos passing through the ice interacts with the water molecules, creating a muon. As the muon races through the ice, it causes a phenomenon called the Cherenkov light. This occurs when a particle passes through a medium faster than light can go through that same medium. The Cherenkov light is the light equivalent of a sonic boom. Detectors buried in the ice pick up these signatures, allowing researchers to determine from which direction the muons, and therefore the neutrinos, came.

Currently the AMANDA project has four holes going 1000 meters into the ice (drilled in 1993 by a hot water drill designed by Bill Mason of PSL). However, Morse wants to increase the number of holes in order to get better resolution and wants to drill the holes deeper in order to get past bubbles in the ice that can distort the neutrino signatures. The contract for the Polar Ice Coring Office (PICO), which oversees drilling and logistics for all snow and ice research funded by the government, was awarded to the University of Nebraska-Lincoln last year. UNL subcontracted the design of the hot water drill and the winch to PSL.

Because the five new holes are going to be larger and deeper than the four existing holes, there are several design challenges for the new drill. The drill has to be able to pump more water and pump it at a higher pressure to compensate for the longer hose. Since the holes will be 3000 meters deep, the drill has to be able to withstand 5000 pounds per square inch of external pressure. Sending and receiving signals through 3200 meters of cable also poses a design difficulty because the signal degrades as the square of the length—a signal will degrade four times as much in a cable twice as long.

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The original PSL drill at work in the South Pole, 1993

Far infrared interferometer helps scientists study density of plasma

Don Holly of the PSL is working with the UW-Madison Symmetric Torus (MST) plasma research group to build an interferometer that will provide spatial resolution of plasma density.

An interferometer is a device that measures how long it takes light to travel through a substance. The interferometer sends out two laser beams, only one of which passes through the substance. The substance alters the speed of the light beam passing through it, causing it to become out of phase with the other beam. When the beams are recombined, the interference signal caused by them being out-of-synch with each other, shows how much the speed of the first beam was altered by the substance. From this, the density of the matter can be calculated.

Plasma is the phase of matter one step beyond gas, where the temperature is around 5 million degrees and the ions and electrons float separately instead of being held tightly together as they are in solids, liquids and gases. Because it is so hot, regular methods for measuring density are not possible.

The far infrared interferometer (FIR) - named for the laser beam wavelength, which is in the far infrared part of the spectrum - will use 11 beams through the plasma and one reference beam. The 11 beams will allow researchers to tell the shape and density at different locations within the plasma.

Plasma is electrically conductive and can be produced and held in a magnetic field. Researchers hope to eventually use plasma as an oven for fusion reactions, making fusion an economically viable energy source.
Drill
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To overcome these problems PSL created a modular drill head including a power and telemetry module, a navigation pack module, and a sensor module. The drill has weights on the end to ensure that it hangs straight.

The drill works by shooting hot water (about 90 degrees Celsius) out of a nozzle at the end. As the water melts through the ice ahead, it cools and then is pumped out of the hole and back into the water heaters to be reheated and reused. It will take about 3 days of nonstop drilling for each hole. After the hole is drilled, the team has only about half a day to get the photodetectors in place before the water filling the hole freezes in place.

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In his 10 years with PSL, Koenig's favorite project involved making a model for the Helical Symmetric Experiment with the CNC. When not in the shop, he enjoys playing pool, outdoor sports and working the pit crew for auto racing.

Ron Smith and John Sine use their unique welding skills for vacuum welding as well as many other PSL jobs. Smith has been with PSL for 12 years and particularly likes working on the monochromators. He spends his free time watching auto racing and traveling. Sine joined PSL 12 years ago. He also likes to travel and enjoys spending time with his daughter.

Leon Siverling is the vacuum specialist. It is his job to clean the vacuum chambers and check them for leaks. He has to make sure they will pump down to the necessary vacuum level. Siverling joined PSL, then known as the Midwestern University Research Association, 36 years ago. He enjoys fishing and hunting.

Don Furman and Don Dressler are two instrument makers who use their skills and experience to make modern, state-of-the-art parts on the manual milling machines and lathes. Furman has worked for PSL for 17 years. Dressler has been with the shop for 15 years and enjoys the variety associated with the job. When not in the shop he can be found hunting, fishing and bicycling.