TURNING ON THE HIGH BEAM

Karlen, inside the new ARIEL facility. PHOTO: JEFF VINNICK

A new UVic-led particle physics facility will attract scientists from around the world

By Kim Westad

Creating cutting-edge technology isn't that different from learning to play a musical instrument, building a car from scratch or even writing a sports slogan—you just do it.

So says University of Victoria physicist Dean Karlen, who believes the best way to learn, discover and create, even for highly trained physicists, is by doing.

"You don't learn to play piano by reading about playing the piano," says Karlen, the principal investigator for a brand new particle physics laboratory being built in Vancouver.

ARIEL—or the Advanced Rare IsotopE Laboratory—is a major expansion to TRIUMF, Canada's national research facility for particle and nuclear physics. Located on the University of British Columbia campus, TRIUMF is owned and operated by a consortium of 18 Canadian universities, including UVic.

At the heart of ARIEL is an electron linear accelerator (called the e-linac) and an underground beam tunnel that will advance Canada's capabilities in particle and nuclear physics, materials science, and environmental remediation.

It will also be a testing ground for producing critical medical isotopes, which are used to diagnose and treat cancer, heart disease, Parkinson's and Alzheimer's.

The e-linac—the first of its kind in Canada—has been designed and built by a 13-university consortium led by Karlen. The project also involves industry partner PAVAC Industries and researchers in the US, UK, Germany and India.

The e-linac uses a new and efficient way of accelerating particle beams—known as superconducting radio frequency technology. Superconductors are materials that conduct electricity with no loss of energy when cooled to very low temperatures.

The e-linac design consists of five cylinders, or cavities, placed end to end. Each cavity contains nine disc-like cells made from pure niobium, a superconducting metal often used to strengthen jet and rocket engines.

When cooled, these niobium cells can store enough electromagnetic energy to accelerate particles to close to the speed of light.

At full power, the e-linac will deliver up to 500 kilowatts of beam power—the same as 5,000 light bulbs concentrated into a square millimetre. Once it exits the accelerator, the particle beam strikes a target to produce a variety of isotopes for pure and applied research, including medical research.

The e-linac is housed in a specially built hall, surrounded by 1.8-metre thick concrete walls. "It's a one-of-a-kind accelerator," says Karlen. "We're not copying another design. It has unique features that make it suitable to pursue the science in which TRIUMF is currently a world leader."

This September, the e-linac was activated for the first time and produced its first particle beam. The test used a diagnostic system created by two graduate students and staff at UVic. They also designed the software for the operator interface—both "tremendous achievements," says Karlen, who co-supervises the students.

By the time ARIEL is finished in 2021, a second beam line will have been added, effectively tripling the amount of science that can be done at the site.

When completed, ARIEL will put Canada at the forefront of world isotope production and will attract scientists from around the world to participate in experiments, says Karlen.

"It's exciting for future generations. They'll come up with new ideas on how to use this that we haven't even thought of yet. It opens up a whole new realm of imagination in science."

UVic knowledge

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An isotope is a variant of a basic element. Every chemical element has more than one isotope. An example is carbon-14, widely used for dating organic material, which is an isotope of the more abundant carbon-12.

There are a limited number of facilities around the world capable of producing medical isotopes. Expanding the range of production facilities and varieties of isotopes will help maintain Canada's leading role in medical isotope delivery.

The ARIEL project has allowed UVic to offer a graduate program in accelerator physics. Four new students started this fall. Students learn to break down problems, slowly rebuild and isolate the issues. "These are things you only learn by being involved hands-on," says Dean Karlen.

ARIEL is a joint initiative between UVic and TRIUMF, with support from the BC Knowledge Development Fund, the Canada Foundation for Innovation, the National Research Council of Canada, and in-kind contributions.

Meet Dean Karlen at *bit.ly/uvic-karlen*