



January 2019
Volume 2, Number 1

AAD News

A newsletter of the ANS Accelerator Application Division

Your AAD Leadership Team

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Message from the Chair

It is a pleasure to present to you the next issue of the Accelerator Applications Division Newsletter. Remember, this is **your** newsletter. If you are not a member of AAD, please consider joining and contributing to this vibrant and scientific community. The AAD was organized to promote the advancement of knowledge of the use of particle accelerator technologies for nuclear applications for scientific, industrial, and medical purposes.

This issue's **Spotlight Article** was submitted by Niowave Inc. with focus on its superconducting accelerator and medical isotope program. The Niowave team presented seven papers at the 2018 Annual Meeting, including one in the AAD-sponsored technical session.

The **Awards, Scholarships, and Support** sections lists those AAD members and students honored this past year by the ANS. Strong and effective dedication to education is a common trait of the recipient. The AAD Executive Team is proud to support AAD-related activities of students and younger members through contributions to the annual Student Conference, the AAD Scholarship, ANS travel awards, the Young Members Group. Students and young members are the future of a strong AAD. You can see by recipient thank-you notes that this support is much appreciated.

However, as noted in **AAD at a Glance**, membership has been relatively flat. It is recently and generally acknowledged that professional society memberships

have been declining and belt-tightening activities are commonly reported. The AAD Executive Committee will continue to look for ways to address this challenge, in addition to its “real job” of finding ways to address the ANS Nuclear Grand Challenges. Stay tuned! Your input on addressing these challenges are welcome and may be sent to any Executive Committee member for consideration.

Sincerely,

Reg Ronningen



Spotlight Article: Niowave’s Medical Isotope Production Using Superconducting Electron Linear Accelerators

By Chase Boulware, John Diemer, Terry Grimm, Amanda Grimm, Rob King, William Peters & Mike Zamara

Niowave is a domestic supplier of fission and photoneutron based radioisotopes. In February 2018, they produced their first batch of radioisotopes for nuclear medicine imaging. The isotopes produced, Mo-99 (a generator for Tc-99m) and Xe-133, account for the majority of the 30 million

medical procedures performed annually worldwide.

Niowave’s fission method uses a superconducting electron accelerator to split uranium atoms without the need for a nuclear reactor or weapons grade uranium. Superconducting accelerators offer the lowest-cost

pathway to high average power electron beams for a variety of commercial and research applications. These systems are robust and flexible in terms of the beam energy and pulse structure, with duty cycles up to and including continuous operation.

(cont. on next page)

Niowave's Medical Isotope Production using Superconducting Electron Linear Accelerators (cont.)

“Arrays of uranium rods are irradiated by X-rays and neutrons generated by the electron beam in a liquid metal target designed to handle >100 kW average beam power.”

Commercialization of superconducting RF accelerators has been driven by balancing cost across the main subsystems. Niowave's accelerators use normal-conducting RF guns driven with thermionic cathodes to produce high average currents >10 mA. The emission is gated to produce high-brightness bunches that are then accelerated to tens of MeV in superconducting cavities. Advances in superconducting cavity design have allowed Niowave to build resonators of a reasonable size at 350 MHz. Low frequency also helps control the microwave source costs, with tetrode tube amplifiers now operating at 60 kW CW, with magnetrons under development for higher powers.

Arrays of uranium rods, both natural and low enriched, are irradiated by X-rays and neutrons generated by the electron beam in a liquid metal target designed to handle >100 kW average beam power. Fission of the uranium atoms produces many valuable isotopes, which are then isolated from one another, chemically purified, and attached to a radiopharmaceutical for shipment to hospitals. The radiopharmaceuticals consisting of Tc-99m and Xe-133 are used to image inside the body and diagnose disease, while some of the other fissioned isotopes (beta-emitters) can be used for cancer therapy.

In addition to Niowave's uranium-based production system is a closed-loop cycle to produce high-purity Ac-225 and other alpha

emitters from Ra-226 for cancer therapy. The commercial-scale system will produce 10 Ci per week of Ac-225 from a nitrate-based solution of Ra-226. The electron beam impinges on a photon converter to irradiate the Ra-226, inducing a photon-neutron reaction to Ra-225, which decays to Ac-225. Ac-225 is eluted continuously from the target vessel then centrifugal contactors are used to harvest and purify Ac-225 through a separation cascade. Unlike other production methods, including proton linacs (spallation of Th-232) and proton cyclotrons (Ra-226 bombardment), Niowave's method does not generate any Ac-227 contamination in the Ac-225 product. Niowave's superconducting linacs can handle higher production output (>500 Ci per year using a 20 MeV, 210 kW beam) than any other method. Demonstration-scale production of 10 mCi batches of Ac-225 at Niowave's HQ has begun and will be complete by April 2019.

Nearly all of the U.S.'s medical isotopes come from foreign suppliers. After shortages of molybdenum-99 in 2009 and foreseen shutdowns of entire production systems in 2016, multiple US companies joined the scene. This increased number of suppliers will strengthen the supply chain by reducing the cost of the isotopes and the risk of supply disruptions.

Niowave, a spin-off from Michigan State University's Facility for Rare Isotope Beams (FRIB), will build additional production facilities to capture a significant fraction of the existing medical imaging market. Furthermore, Niowave will work with medical companies to attach the new isotopes to pharmaceuticals that can treat a broad range of cancers. Most of the isotopes currently extracted are for medical purposes, however, Niowave is also isolating strategic radioisotopes for industrial, national security, and R&D purposes.

“Demonstration-scale production of Ac-225 at Niowave's HQ has begun and will be complete by April 2019.”



Over the last decade, Niowave has developed a variety of complex niobium cavity shapes in collaboration with universities and national labs, such as this double-spoke niobium cavity, shown in the Niowave clean room being fixtured for electron-beam welding.

Awards, Scholarships, and Support

- Two AAD Members received **2018 ANS Holly Compton Award in Education**: **James F. Stubbins** the Donald Biggar Willett Professor of Nuclear, Plasma, and Radiological Engineering at the University of Illinois at Urbana Champaign; and **Paul Philip Hood Wilson**, the Grainger Professor of Nuclear Engineering in Nuclear Engineering and Engineering Physics at the University of Wisconsin-Madison. Prof. **James F. Stubbins** also received the **Landis Public Communication and Education Award**.
- Stephen Taller** from University of Michigan won an **Innovations in Nuclear Technology R&D Award** for his work "Application of Multiple Ion Beam Irradiation for the Study of Radiation Damage in Materials", presented at the 2018 Annual Meeting.
- Four students received **2018 ANS Student Travel Awards** supported in-part by AAD:
 - Yuqiao "Joy" Fan**, North Carolina State University
 - Ran Kong**, Purdue University
 - Ralph Wiser**, The University of Texas at Austin
 - Will Derdeyn**, University of Wisconsin - Madison
- 2018/2019 ANS AAD Scholarship recipient is **Elise Anne C. Koskelo** from Pomona College.
- Student Conference AAD Best Paper Award** recipient is **Gerit Bruhaug** from Idaho State University.



Prof. James F. Stubbins



Prof. Paul Philip Hood Wilson

I attended the 2018 ANS annual meeting with the travel grant from ANS student program. I want to express my gratitude for the contribution from you and the Accelerator Application Division! Your contribution makes it possible for me to be part of the ANS meeting!

Thank you so much for your support and generosity throughout my undergraduate education! I hope that my education prepares me to work as a researcher in accelerator science either as a student intern....or for my PhD.

I am writing to thank you and your Divisions for your support of the 2018 ANS National Student Program. It was an exciting opportunity to meet new people in nuclear and the experience reaffirmed that I will devote my career to this field. Thank you for providing me with that opportunity!

I am profoundly grateful to your Division for contributing to the Student Program and making my attendance possible. I would not have been able to attend without your support!

Congratulations to all the recipients!

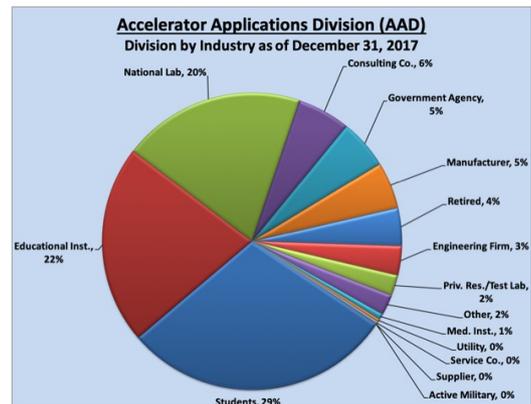
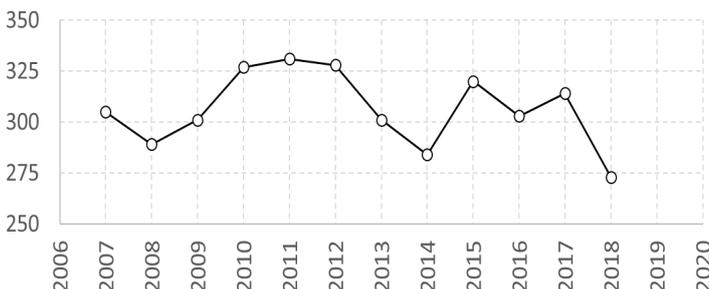
AAD at a Glance

Membership numbers for AAD are produced at the end of the year. As a reminder, ANS includes two division affiliations with your annual membership.

The graph below shows that over the past ten years, AAD has membership remains rather constant, oscillating around 300 members. The pie chart shows the membership of

ADD by industry as of December 2017. Educational Institutions, National Labs, and Students categories remain strong contributors.

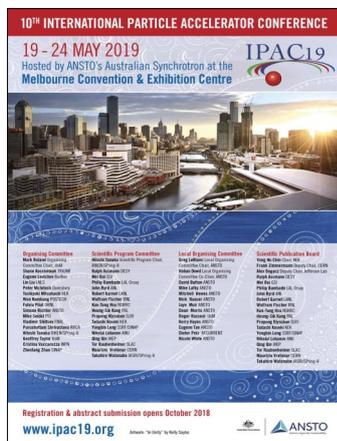
AAD Membership



Upcoming Events

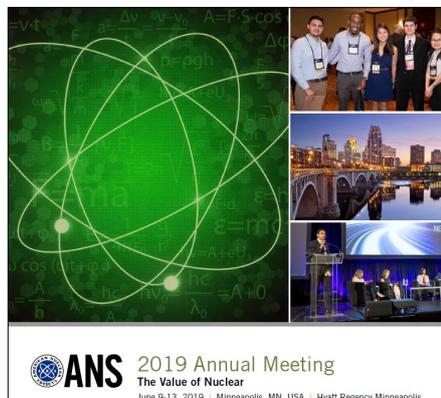
IPAC'19

The 10th International Particle Accelerator Conference (IPAC'19), will be held in Melbourne, Australia in **May 19 – 24, 2019**. Cutting-edge accelerator research and development results from across the globe will be presented. With over 1000 delegates this is the main international event for the worldwide accelerator community and industry. Registration and abstract submission is open at: www.ipac19.org



ANS Annual Meeting

The American Nuclear Society is excited to invite you to join us in the north star state, Minneapolis, MN from **June 9 – 13, 2019** for the 2019 ANS Annual Meeting. In addition to an impressive list of government and industry leaders, we are also planning several outstanding hot-topic technical sessions and popular plenary speakers which will attract professionals from across the nation and internationally. Registration and abstract submission is open at: www.ansannual.org



WNU RT School

World Nuclear University, in collaboration with Rosatom Technical Academy and International Atomic Energy Agency, will conduct 5th Radiation Technology School in **October 14 – 25, 2019** in Obninsk, Russia. The school is open for young professionals in nuclear and radiation technologies. Selected applicants will develop a broad overview in radioisotope production, medical and industrial uses of radiation, radiation protection, and regulatory framework. More details at: www.world-nuclear-university.org

www.world-nuclear-university.org



International Topical Meeting on Nuclear Applications of Accelerators

The purpose of International Topical Meetings on the Applications of Accelerators (AccApp's) is to provide an international forum for discussing the various applications of particle accelerators. These meetings are focused on the production and utilization of accelerator-produced neutrons, photons, electrons and other particles for scientific and industrial purposes; production or destruction of radionuclides significant for energy, medicine, defense, or other endeavors; safety and security applications; medical imaging, diagnostics, and treatment.

Full paper proceedings from the AccApp'17 are available online at:

<http://accapp17.org/wp-content/2017/data/about.html>

AccApp'20 will take place in April 2020 at the IAEA headquarters in Vienna, Austria. This meeting will be a great opportunity for nuclear physicists, accelerator physicists, nuclear engineers, and other experts in the international community to meet and discuss their research face-to-face. More details on the exact dates and abstract submission are coming soon. We look forward to seeing you in Vienna!



Have a Story to Tell?

Would you like to contribute a news item or article to a future edition of the ANS ADD Newsletter? Member contributions to the newsletter are always welcome. Please send your article to Valeriia Starovoi (starvale@isu.edu).

