Office of Nuclear Physics SBIR/STTR Exchange Meeting

Courtyard Gaithersburg Washingtonian Center, Gaithersburg, MD

Note: The ordering of the abstracts matches the ordering of the talks.

Day 1: August 13, 2019

Nuclear Physics Gamma-ray Imaging System for Real-Time Rare Isotope Harvesting, Monitoring and Radiochemical Separation – NP Imager

Ethan Hull, PHDS Co.

Grant Title: Nuclear Physics Gamma-ray Imaging System for Real-Time Rare Isotope Harvesting, Monitoring and Radiochemical Separation – NP Imager

NP SBIR/STTR Topic: **Instrumentation**

DOE Nuclear Physics missions include the production, harvesting and radiochemical separation (purification) of rare isotopes as part of both Nuclear Physics Research and Radioisotope Production. The two fields have a unique connection in the projectile-fragment harvesting research at the National Superconducting Cyclotron Laboratory (NSCL), where a recirculating aqueous beam stop captures rare isotopes from the beam and accumulates them in various collection systems including resin columns. As many as 100 different isotopes can be present with an overall activity as high as ~ 1 Ci. Direct gamma-ray imaging of the resin columns, beam stop, and collection vessels is extremely useful with this large plurality of gamma rays. A new high-purity germanium (HPGe) imaging detector system called the NP-Imager (Nuclear Physics Imager) provides HPGe spectroscopy and gamma-ray imaging at the same time to produce dynamic radiological-location maps of the isotope distributions during these radiochemical processes. The development of the NP Imager and some early Phase-II results demonstrate great promise for this technology.

Low Cost, High-Density Digital Electronics for Nuclear Physics

Wojciech Skulski, SkuTek Instrumentation

Grant Title: Low Cost, High-Density Digital Electronics for Nuclear Physics

NP SBIR/STTR Topic: **Electronics**

I will present our approach towards delivering prototypes of high density digital pulse processors with up to forty channels digitizing at 14 bits @ 100 MHz. We developed hardware, firmware, and Linux software running on embedded ARM processors. We performed several measurements with different kinds of detectors, including high purity germanium. Our digital pulse processors provided the state of the art performance with these detectors. These developments provided a foundation for designing the digital pulse processing system for LUX-Zeplin experiment.

A Magnetized Injector for Electron Cooling Applications
Christopher Mayes, Xelera Research, LLC, New York
Grant Title: A Magnetized Injector for Electron Cooling Applications
NP SBIR/STTR Topic: **Accelerator**

No abstract information

NP Low Energy Facilities and the SBIR/STTR Program
Key Note Speaker: Clay Dickerson, Argonne National Laboratory

No abstract information

Techniques for energetic ion assisted in-situ coating of long, small diameter, beam pipes with compacted thick crystalline copper film
Arthur Custer, Poole Ventura, Inc
Grant Title: Techniques for energetic ion assisted in-situ coating of long, small diameter, beam pipes with compacted thick crystalline copper film
NP SBIR/STTR Topic: **Accelerator**

No abstract information

Development of Gen-II LAPPD Systems For Nuclear Physics Experiments
Michael Foley, Incom Inc.
Grant Title: Development of Gen-II LAPPD Systems For Nuclear Physics Experiments
NP SBIR/STTR Topic: **Instrumentation**

The second year of the Phase II program focused on solving the window sealing process for the ceramic-package capacitively-coupled 2nd generation (Gen-II) LAPPD. Six of six Incom functional ceramic tiles incorporated high QE bialkali photocathodes have now been produced by the Incom vacuum transfer process (same as the baseline Gen-I LAPPD). Thick-film metallization sealing processes co-developed with the University of Chicago for the ceramic tile bases show a substantial improvement over earlier attempts using thin-film coatings. In addition, one UChicago in-situ LAPPD was fabricated. New characterization techniques have substantially improved our understanding of the metal seal. Photocathode deposition with good QE and sealing of both glass and ceramic LAPPDs is now a routine Incom process. New signal boards with pixelated capacitive signal-pickup electrodes were designed and tested on fully integrated and sealed Gen-II tiles using full-area capacitive-coupling geometry. They exhibited an excellent transmission of signals. Additional testing electronics and measurement protocols were developed for our 2nd Dark Box Test Station. Sales of Gen-I LAPPDs continue on plan. Prototype Gen-II modules have now been supplied for lifetime, high fluence and PID TOF testing to early adopters. The Phase IIA funding is allowing Incom to continue the R&D required for lower-cost high yield manufacturing of Gen-II devices with uniform signal performance.

Some of the remaining technical challenges include further optimization of LAPPD design and internal component stack up to suppress dark count noise, high voltage instabilities, secondary path leakage currents and charge sharing across multiple anode strips or pads. Continued business development and commercialization are also critical path items.

Jefferson Lab and the NP SBIR/STTR Program

Key Note Speaker: Cynthia Keppel, Thomas Jefferson National Laboratory

No abstract information

Accurate Spin Tracking on Modern Computer Architectures for Electron-Ion Colliders

Dan Abell, RadiaSoft LLC

Grant Title: Accurate Spin Tracking on Modern Computer Architectures for Electron-Ion Colliders

NP SBIR/STTR Topic: **Accelerator**

No abstract information

High Power, High Repetition Rate, 700-850 nm Pulsed Laser

Wenyan Tian, Q-Peak Inc.

Grant Title: High Power, High Repetition Rate, 700-850 nm Pulsed Laser

NP SBIR/STTR Topic: **Accelerator**

We report an all-fiber, linearly polarized, 140-W, 1064-nm fiber laser based on a three-stage Ytterbium fiber amplifier system seeded by a gain-switched diode laser at a pulse width of 21 ps and a repetition rates of 0.5 GHz. We will report frequency doubling to produce 532-nm green laser using a Lithium Triborate (LBO) nonlinear crystal. We will report the status of generating 700 to 850 nm pulsed laser using a synchronously-pumped optical parametric oscillator (SPOPO) based on LBO nonlinear crystal.

Design and Fabrication of the ASoC: Analog to digital converter System on Chip

Isar Mostafanezhad, Nalu Scientific, LLC

Grant Title: Design and Fabrication of the ASoC: Analog to digital converter System on Chip

NP SBIR/STTR Topic: **Electronics**

Readout electronics for modern particle imaging based identification detectors must be compact, low power, deliver acceptable timing resolution and be robust to pile-ups. The solution is to integrate full waveform sampling, analog buffering and feature extraction and digital signal processing into one single Application Specific Integrated Circuit (ASoC in the following). ASoC can be used as a building block for such readout devices. The prototype fabricated ASoC has 4 channels, operates at 3 GSa/s and has on-chip trigger timestamping, calibration and signal processing capabilities. ASoC also provides 32k storage samples per channel which makes it suitable for large experiments. In this summary, measurements of analog and digital performance of the ASIC together with the next steps will be reported.

IP Access Gateway

Radu Radulescu, Telluric Labs, NJ

Grant Title: <u>IP Access Gateway</u>

NP SBIR/STTR Topic: **<u>Electronics</u>**

<u>No abstract information</u>

Distributed digital data acquisition system with network time synchronization

W. Hennig, S. Hoover Presented by William Warburton, XIA LLC

Grant Title: <u>Distributed digital data acquisition system with network time synchronization</u>

NP SBIR/STTR Topic: **<u>Software</u>**

As radiation detector arrays in nuclear physics applications become larger and physically more separated, the time synchronization and trigger distribution between many channels of detector readout electronics becomes more challenging. Clocks and triggers are traditionally distributed through dedicated cabling, but newer methods such as the IEEE 1588 Precision Time Protocol and White Rabbit allow clock synchronization through the exchange of timing messages over Ethernet.

Consequently, we report here the use of White Rabbit in a new detector readout module, the Pixie-Net XL. The White Rabbit core, data capture from multiple digitizing channels, and subsequent pulse processing for pulse height and constant fraction timing are implemented in a Kintex 7 FPGA. The detector data records include White Rabbit time stamps and are transmitted to storage through the White Rabbit core's gigabit Ethernet data path or a slower diagnostic/control link using an embedded Zynq processor. The performance is characterized by time-of-flight style measurements with radiation from coincident gamma emitters and by time correlation of high energy background events from cosmic showers in detectors separated by longer distances. Software for the Zynq controller can implement "software triggering", for example to limit recording of data to events where a minimum number of channels from multiple modules detect radiation at the same time.

First-principles calculation of magnetized dynamic friction and its application to cooling for the EIC

David Bruhwiler, RadiaSoft LLC

Grant Title: <u>Dynamic Friction In Magnetized Electron Coolers For Relativistic Beams</u>

NP SBIR/STTR Topic: **<u>Accelerator</u>**

Effective beam cooling of high-intensity relativistic ion beams is essential for achieving the luminosity requirements of proposed electronion collider (EIC) designs. One approach is to scale magnetized electron cooling techniques from nonrelativistic CW electron beams to the fundamentally different parameter regime of electron bunches with relativistic gamma factors of order 50. Because the technique would be applied in a previously untested parameter regime, accurate calculations of magnetized dynamic friction are required during the design stage, with the ability to include all relevant physics that might increase the cooling time, including space charge forces, field errors and complicated phase space distributions of imperfectly magnetized electron beams. We present recent work on a new semi-analytic treatment of magnetized dynamic friction, which is the essential physical process for electron cooling. We also briefly discuss other aspects of the project, including simulations of the electron cooling system itself and associated impact ionization effects. We describe the browser-based GUI for the electron cooling code JSPEC, built on the Sirepo framework for cloud computing, and we describe how the use of application container technology for Sirepo enables reproducible computing.

Development of Micro-pattern Detectors with Multi-Dimensional Readout at RDI

Evgeny Galyaev, Radiation Detection and Imaging Tech LLC

Grant Title: A Novel Ionizing Particle Beam Fluence and Position Detector Array using the Micromegas Technology with Multi-Coordinate Readout

NP SBIR/STTR Topic: **Instrumentation**

Radiation Detection and Imaging (RDI) presents project status (Year 2) and the highlights of the experimental results for the micro-pattern gas ionization detector arrays.

Manufacturing and Packaging of Reliable Bialkali Photocathodes

Harish Bhandari, RMD Inc.

Grant Title: Manufacturing and Packaging of Reliable Bialkali Photocathodes via Sputtering

NP SBIR/STTR Topic: **Accelerator**

The future upgrade for the Relativistic Heavy Ion Collider (RHIC) at BNL calls for the implementation of electron cooling strategies, where ultra-cold electron beams will be generated by photoinjectors. Bialkali photocathodes (K_2CsSb) are capable of delivering these electrons with the desired average current (~50 mA) to meet the upgrade requirement. These cathodes, however have to be replaced daily given their short lifetimes. Hence, there's a need for commercially-available photocathodes than can be produced reliably and supplied in sufficient quantities. Here we report on the development of a novel and reliable manufacturing technique for bialkali cathodes via sputtering. In addition, successful strategies for sealing and unsealing of the cathodes in transportable cartridges are being developed. By doing so, these cathodes can be mass produced and stockpiled for their daily use at RHIC. The sealed cathodes can be unsealed at the accelerator and handed off easily to a photoinjector gun to produce the electron beam with the desired emittance and brightness. The cathodes grown via sputtering routinely exhibit QE of ~3-5 % at 532 nm and peak QE of ~20 %. The sputter-grown cathode also have ultra-smooth surface morphology, which addresses the challenge of low emittance desired in these cathodes. The Phase II goal is to design and build a cathode growth chamber, where the cathodes can be evaluated for QE uniformity and also sealed in a transportable cartridge. The presentation will cover the progress on the design and construction of the proposed system, along with data from the sputtered cathodes.

Day 2: August 14, 2019

A Scalable Additive Manufacturing Technology for Large Area Printed Circuit Boards
Nalin Kumar, UHV Technologies, Inc.
Grant Title: A Scalable Additive Manufacturing Technology for Large Area Printed Circuit Boards
NP SBIR/STTR Topic: **Electronics**

In this presentation, an innovative room temperature 3D printing technology for electronic circuits will be presented, including the design of a 2 meter wide printer for manufacturing large area flexible PCBs. Latest results on fabrication of copper lines and vias will be presented. In addition, preliminary results on the modeling and experiments performed for fabricating innovative gas ion detectors enabled by this technology will be presented.

Scintillating Bolometer Crystal Growth and Purification for Neutrinoless Double Beta Decay Experiments
Harish Bhandai, Radiation Monitoring Devices, Inc, MA
Grant Title: Scintillating Bolometer Crystal Growth and Purification for Neutrinoless Double Beta Decay Experiments
NP SBIR/STTR Topic: **Instrumentation**

No abstract information

Long Length Welded NbTi CIC Superconducting Cable for Accelerator Applications
Michael Tomsic, Hyper Tech Research Inc.
Grant Title: Long Length Welded NbTi CIC Superconducting Cable for Accelerator Applications
NP SBIR/STTR Topic: **Accelerator**

The Accelerator Research Lab (ARL) at Texas A&M University has developed a new technology for high-performance superferric magnets that provides a cost-effective basis for fabrication of the arc dipoles for the Ion Ring of JLab's proposed JLEIC. A central element of the design is a cable-in-conduit (CIC) conductor with unique benefits for cost-effective manufacture of superconducting magnets for particle accelerators and for a number of practical superconducting applications.

In the Phase II, Hyper Tech has developed a new method for continuously forming the metal sheath tube onto the ARL CIC conductor, without damaging the cable, and with a He-tight welding of the outer sheath tube. The CIC-CTFF development has particular benefit for the Electron-Ion Collider (EIC). JLab desires a superferric design for the 3 T arc magnets for their Ion Ring. The CTFF process enables the cables to be manufactured in a continuous process in long lengths. Long length cable has been made and the cable has been wound into a dipole magnet configuration.

12-bit 32 Channel 500M Sps Low Latency ADC

Anton Karnitski, Presented by: Dalius Baranauskas, Pacific Microchip, CA

Grant Title: 12-bit 32 Channel 500M Sps Low Latency ADC

NP SBIR/STTR Topic: **Accelerator**

Pacific Microchip Corp. is developing a 12-bit 32 independent channel 500MSps low latency ADC ASIC. Its targeted applications include particle beam control systems, multichannel gamma-ray and other types of detectors. Within the Phase II project, the prototype chip will be designed, fabricated, packaged on a custom chip carrier, tested and made ready for commercialization in the Phase III project.

Long-Term Radiation Rugged Rotary Vacuum and Water Seals in Heavy-Ion Accelerators

Jennifer Lalli, NanoSonic

Grant Title: Long-Term Radiation Rugged Rotary Vacuum and Water Seals in Heavy-Ion Accelerators

NP SBIR/STTR Topic: **Instrumentation**

The Department of Energy’s Office of Nuclear Physics' Isotope Development and Production for Research and Applications Program has identified a need for materials that will survive high radiation environments to support next generation rare isotope beam facilities such as Michigan State University's Facility for Rare Isotope Beams. Current work is ongoing to develop a long-lifetime, rotary vacuum and water seal that can survive 0.5 – 15 MGy/month for up to a year to minimize maintenance within this radioactive environment. Many commercial gaskets and lip seals do not offer the combined mechanical and radiation survivability needed for multiple years of service. The approach for the new seals involves the synthesis of innovative polyorganosiloxanes and composites that offer combined low air and water permeability with extreme radiation durability. New polyorganosiloxanes were developed and exposed to harsh irradiation at the Brookhaven National Laboratory (BNL) NASA Space Radiation Laboratory (NSRL) for a post- exposure durability study. Mechanical and thermomechanical testing of the new materials were conducted pre- and post- irradiation alongside current commercial off-the-shelf (COTS) seal materials. Ongoing work involves permeation, rotational abrasion, and sealing experiments post representative high radiation environment exposure at Brookhaven's Linac Isotope Producer. Radiation durable rotary vacuum and water seals shall be manufactured for use with rare isotope beam facilities for the stable production of new and rare isotopes. These isotopes shall also benefit medical accelerators, advanced imaging needs within the medical community, and military and space applications.

The Relativistic Heavy Ion Collider Facility and its SBIR/STTR Opportunities

Key Note Speaker: Gabriella Carini, Bookhaven National Laboratory

No abstract information

1497 MHz Magnetron Development
Rolland Johnson, Muons, Inc.
Grant Title: A Novel Injection-Locked Amplitude-Modulated Magnetron at 1497 MHZ
NP SBIR/STTR Topic: **Instrumentation**

Muons, Inc. is a leading proponent of Superconducting rf (SRF) Accelerator-Driven Subcritical Reactors (ADSR) with its Mu*STAR concept. High-power, efficient power sources needed to drive SRF cavities are major capital and operating expenses for the such systems. Magnetron power sources, invented a century ago, can be the most cost effective solution for ADSR if some limitations can be overcome. Efforts to address these limitations are discussed, including the 1497 MHz magnetron development project supported by an NP STTR grant to replace CEBAF klystrons.

Multi-Channel Readout IC for Nuclear Physics Experiments
Phaneendra Bikkina, Alphacore, Inc.
Grant Title: Picosecond Digitizer
NP SBIR/STTR Topic: **Instrumentation**

No abstract information

DOE Isotope Program and Facilities and the SBIR/STTR Program
Key Note Speaker: Eva Birnbaum, Los Alamos National Laboratory

No abstract information

Resonant polarimetry and magnetometry
Brock Roberts, Electrodynamic
Grant Title: Resonant polarimetry and magnetometry
NP SBIR/STTR Topic: **Accelerator**

Real time, non-invasive polarization monitors and bunch magnetometers are being collaboratively developed by Electrodynamic, the Thomas Jefferson National Laboratory (JLAB), and Cornell's Laboratory of Elementary-Particle Physics (LEPP). These new capabilities will allow the EIC to automate polarization optimization and beam magnetization. Promising experiments have been conducted on CEBAF (polarimetry) and the GTS (magnetometry) validating our approach. Upcoming beamline testing on the UITF and the GTS will instruct new designs and result in publications and the installation of non-invasive, real time polarimeter and magnetometer systems for both beamlines during Phase II.

High Power Extremely Narrow Linewidth Diode Laser for Polarizing 3He Target
Steven Lu, Raytum Photonics
Grant Title: High Power Extremely Narrow Linewidth Diode Laser for Polarizing 3He Target
NP SBIR/STTR Topic: **Instrumentation**

We develop a fiber coupled diode laser system with output power of more than 200W, linewidth less than 0.1 nm and the lasing wavelength automatically locked to the Rb absorption line. A state of art fiber combiner is developed during this Phase II effort to efficiently couple four diode lasers to not only get the output power of more than 200W but also mix all four beam and provide only one beam spot.

Conductive Ceramic for High Power RF Windows

Alexei Kanareykin, Euclid Techlabs LLC

Grant Title: Low RF Loss DC Conductive Ceramic for High Power Input Coupler Windows for SRF Cavities

NP SBIR/STTR Topic: **Accelerator**

The high-power RF coupler connects the RF transmission line to the SRF cavity, and provides the RF power to the cavity that is used to accelerate the particle beam. In addition to this RF function, the coupler also provides the vacuum barrier for the beam vacuum using RF windows. A variety of electronic processes occur at window and coupler surfaces. RF windows exhibit breakdown at much lower voltages than comparable insulators in DC fields. Here, the breakdown effects include arcing, surface flashover, and other processes produced by electrons. At higher RF fields, there can be electron emission from the cathode metal-vacuum-ceramic interface ("triple junction"). Some emitted electrons will strike the ceramic surface, generating many more free electrons, because the secondary electron yield (SEY) coefficient is high for most ceramics, eventually leading to window failure due to arching and/or thermal runaway. These processes are a major problem for RF windows and couplers, and are responsible for damages and lost beam-time in SRF cavity and cryomodule operation.

Euclid TechLabs LLC planned to develop a new ceramic-based material that are designed to be used as the basis for SRF coupler windows operating in the 325 MHz – 1.3 GHz frequency range. These windows are intended for EIC, ERLs, PIP-II and other SRF technology based projects. In Phase II of this project, 650 MHz high power RF windows made of this new ceramic will be fabricated and tested at high power at JLab and FNAL. This report presents the Phase II (Year I) results of a three-phase program for the development of a new class of materials with a low loss tangent at L-band that is combined with an increased DC conductivity, in order to avoid dielectric charging caused by field emission and secondary electrons. The DC conductivity will provide a mechanism for the discharge of the material. A new SRF component technology based on this new microwave low loss, yet DC conducting, ceramic will be demonstrated as part of this project.

Multi-scale modeling for beam-beam depolarization

Ilya Zilberter, Tech-X Corporation

Grant Title: Multi-scale modeling for beam-beam depolarization

NP SBIR/STTR Topic: **Accelerator**

Accurate simulation of spin precession and orbital dynamics is critical in the design of the next generation of spin-polarized particle accelerators, such as the proposed Electron-Ion Collider at Brookhaven National Laboratory. In this talk we discuss the development of GPUSpinTrack, a spin-tracking code that allows for the rapid simulation of charged particle beams on graphics processors. Particular focus will be on extending the code to track electron beams, as well as ongoing efforts to simulate the Rapid Cycling Synchrotron ring in the EIC.

Update on the Department of Energy SBIR/STTR Program Q/A
Key Note Speaker: Claudia Cantoni, DOE SBIR/STTR Office

No abstract information

Poster/Other Presentations:

Diamond Strip Detectors for Charged Particle Tracking
Joseph Tabeling, Applied Diamond, Inc.
Grant Title: Diamond Strip Detectors for Charged Particle Tracking
NP SBIR/STTR Topic: **Instrumentation**

Diamond grown with chemical vapor deposition (CVD) has proven to be an excellent material to replace silicon for radiation detector applications. In earlier projects, we successfully made high quality thin diamond films suitable for relativistic heavy ion applications. For this project, thicker detector grade diamond films were developed to provide increased signal, sufficient to overcome the additional noise inherent in placing electronics further from the detector. We used several techniques to increase the charge collection result by 4× that of our thin films. We developed a photolithography process to provide 200 μm wide electrical contacts with 25 μm gaps. We produced a strip detector with a sensor area of 48 x 12 mm which was integrated into a detector package and delivered to JLAB for testing and use. These results provide JLAB and other particle accelerator facilities with a material that will increase the lifetime of their particle detectors beyond that available from existing materials. In addition, a path forward now exists for making the large area diamond strip detectors needed for measuring electron beam polarization with Compton scattered electrons and other nuclear physics applications.

Pixel Array Germanium Detectors for Nuclear Physics (Poster Presentation)
Matthew Kiser, PHDS Co.
Grant Title: Pixel Array Germanium Detectors for Nuclear Physics
NP SBIR/STTR Topic: **Instrumentation**

Pixel Array Germanium (PAGe) detector systems are being developed to provide a lower cost, higher resolution, and more readily scalable basis for the next generation of large solid-angle coverage detector arrays for nuclear physics. Recent large-diameter crystal-growth developments have demonstrated limitations to the standard PHDS orthogonal-strip approach, principally due to the unavoidably large inter-strip capacitance created by the length of the strips on the detector. One elegant and extendable solution is a uniform array of hexagonal pixels on a single side of the detector. This approach is inherently scalable as the crystal and detector diameters increase. Development of PAGe prototype detector systems and recent measurements and results will be presented.

Data Processing Electronics for Silicon Photomultipliers

Wojtek Skulski, SkuTek Instrumentation

Grant Title: Data Processing Electronics for Silicon Photomultipliers

NP SBIR/STTR Topic: **Electronics**

I will present our approach towards delivering prototypes of both the silicon photomultiplier (SiPM) carrier boards and the corresponding digitizing electronics. SiPMs offer advantages such as low operating voltage, small size, lack of sensitivity to magnetic fields, and high amplification similar to vacuum photomultipliers. We developed two kinds of SiPM front end prototype boards which were applied in low energy Nuclear Physics experiments. We also developed a two-channel digital signal processor suitable for digitizing the SiPM signals. The digitizer prototypes were purchased by a number of pilot customers. Recently we extended our design effort towards a ten channel unit which is now under development. On a software front we are transitioning our software from a local PC to a distributed, cloud-based data acquisition.

Flat Field Emitter Based on Ultrananocrystalline Diamond (UNCD) Film for SRF Technology

Alexei Kanareykin, Euclid Techlabs, LLC

Grant Title: Flat Field Emitter Based on Ultrananocrystalline Diamond (UNCD) Film for SRF Technology

Euclid TechLabs LLC, in collaboration with BNL, present our recent results to complement and simplify SRF injectors by creating a simple, robust and scalable field emission cathode fabrication technology. To achieve this goal, our material of choice is ultrananocrystalline diamond (UNCD). UNCD has been proven to be a highly emissive material being stable under heavy electrical and heat loads. Thus, it is suitable for high rep-rate/CW applications. A case performance study of a planar nitrogen-incorporated UNCD, (N)UNCD, FEC was carried out in a 1.3 GHz RF electron gun. Electron emission from the (N)UNCD planar surface with excellent emittance, energy spread, and stability was confirmed. A peak current of ~100 mA was achieved. At high rep-rate/CW operation, this current serves as an average current estimate for SRF applications.

Activities Directed Towards HF-FREE ElectroPolishing of Niobium SRF Cavities

Timothy Hall, Faraday Technology Inc.

Grant Title: Acid Free Electropolishing of SRF Cavities

NP SBIR/STTR Topic: **Accelerator**

Under prior and on-going funding from the DOE (SBIR, ARRA, and ORNL P.O.), Faraday Technology has demonstrated the ability to electropolish single-cell, stacked single cells, and nine-cell niobium SRF cavities in low concentration acid electrolytes (5-10% sulfuric acid) using pulse reverse current electrolysis . In contrast to conventional direct current electropolishing in concentrated sulfuric-hydrofluoric acid electrolytes, the FARADAYIC® ElectroPolishing process enables vertically orientated cavity polishing without the need for cavity rotation. This is inherently more scalable and industrially compatible than the oft-used horizontal orientation.

This presentation will review the previous work and present the current status of FARADAYIC® ElectroPolishing activities.

Demonstration of the stopping and release of rare light isotopes at NSCL-MSU facility and medical isotope production at ATLAS

Uma Sampathkumaran, InnoSense LLC

Grant Title: Refractory Oxides with Tunable Porosity and Geometry as Versatile Fast-Release Solid Catchers for Rare Isotopes

NP SBIR/STTR Topic: **Instrumentation**

Through funding from the Office of Nuclear Physics, InnoSense LLC has developed a novel approach to making highly porous monolithic oxides as reactive catchers for rare isotope generation at the Facility for Rare Isotopes. Solid catchers using this technology can make for a very compact system that is compatible with location at the focal plane of the FRIB Fragment Separator to enable parasitic delivery of a second radioactive beam. An apparatus was designed for use at MSU/NSCL for the on-line characterization of the solid catchers via implantation of separated secondary beams of high energy radioactive species. The results of the first on-line test completed in May 2018 will be presented. As an off-shoot of this development, we also successfully developed porous bismuth oxide films as targets for lithium beam irradiation to generate the parent/daughter isotopes of 211-Radon/211-Astatine. This is a truly breakthrough demonstration of the production of the longer-lived noble gas parent isotope of the shorter-lived daughter alpha emitter. Upon refining the production scheme, the potential for overnight domestic delivery of an important medical isotope at the point of use has a high impact. Details of the in-beam tests conducted at the Argonne ATLAS facility will be presented.