Abstracts

Office of Nuclear Physics SBIR/STTR Exchange Meeting
Hilton Washington DC/Rockville Hotel & Executive Meeting Center
Rockville, Maryland

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

Day 1: August 7, 2018

A Magnetized Injector for Electron Cooling Applications

Christopher Mayes, Xelera Research LLC.

Grant Title: A Magnetized Electron Source For Ion Beam Cooling

NP SBIR/STTR Topic: **Accelerator**

Electron cooling is a critical component necessary to achieve the target luminosity at the next generation of electron-ion colliders (EICs) at Brookhaven National Laboratory (BNL) and Thomas Jefferson National Accelerator Facility (JLab). BNL is pursuing coherent electron cooling and non-magnetized, bunch beam cooling, while JLab is pursuing magnetized cooling.

In this project, Xelera Research LLC performed simulations and calculations to develop a prototype design for a magnetized electron injector that can be used as a source for cooling an ion beam. The outcome of Phase I was a prototype design for such an injector, which could meet the needs of the JLEIC machine at JLab. In this Phase II, the design was further optimized and a prototype magnetized electron source is being built in collaboration with JLab and will be characterized at their facility.

Low Cost, High-Density Digital Electronics for Nuclear Physics

Wojtek Skulski, SkuTek Instrumentation

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

NP SBIR/STTR Topic: **Electronics**

I will review the status and the progress of the Phase IIB grant titled Low Cost, High-Density Digital Electronics for Nuclear Physics.

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**

(Unable to present)

Applied Diamond's work under SBIR Grant No. DE-SC0007689 led to the development of thin (<100 μm) polycrystalline CVD diamond particle detectors with high speed, sufficient S/N ratio for typical electronic packages and improved radiation tolerance vs. silicon. Many applications, however, are sensitive to the amount of signal provided, for example, where the preamplifier must be at some distance from the detector or where noise levels from electronics or the environment are not optimal. For these applications, Applied Diamond is providing the needed signal with a thicker detector (up to 500 μm). Lithography processes are developed for the necessary contact width and pitch on a 48 mm long strip detector and packaging provided for a detector suitable for measuring electron beam polarization of the upgraded electron beams at CEBAF (JLAB).

Keynote Presentation

NP Low Energy Facilities and the SBIR/STTR Program

Georg Bollen

Facility for Rare Isotope Beams/Michigan State University

Dr. Bollen is the Experimental Systems Division Director for the Facility for Rare Isotope Beams.

Software-Driven Network Architecture for Synchronous Data Acquisition

Terry Hulett, Crossfield Technology LLC, TX

Grant Title: Software-Driven Network Architectures for Synchronous Data Acquisition

NP SBIR/STTR Topic: **Accelerator**

Crossfield Technology has developed a software-driven network architecture that exploits high-speed ADCs and the tremendous sensor signal processing capabilities of current generation FPGAs for reprogrammable synchronous data acquisition and event building. However, the IP and SW necessary to achieve nanosecond level timing precision and then move the captured sensor data to a large scale HPC style computation environment are either non-existent or extremely expensive. This presentation will explore some potential solutions with proposed solutions that are in development under DE-SC0015151.

Development of Gen-II LAPPDTM Systems For Nuclear Physics Experiments

Michael Foley, Incom, Inc.

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Instrumentation**

Building upon the success of the "all glass Gen I" LAPPD (Large Area Picosecond Photo Detector), we have now demonstrated fabrication of ceramic lower tile assemblies, and successfully sealed them with both fused silica and borosilicate glass windows. To date, twelve commissioning trials of full size detector tiles have been performed (five at Incom and seven at U of Chicago). We have demonstrated photocathode synthesis with and

without vacuum transfer of the window. In one commissioning trial we have achieved a QE of 6% that remains unchanged for 8 months. Another commissioning trial resulted in a fully functional photo-tube that lasted for at least 24 hours with no getter inside. Two other commissioning trials had QE of 20% and gain of 10^7 while the photo-tubes were in the processing tank. The following items to be addressed in Year 2: focused development on the sealing process for "working" Gen II LAPPDs including photocathode synthesis improvements and procurement of electronic readout printed circuit boards for the measurement and testing of the inside-out capacitively coupled detector tiles.

Keynote Presentation

Keynote Presentation

Jefferson Lab and its SBIR/STTR Program

Michael Spata
Thomas Jefferson National Accelerator Facility

Dr. Spata is the Deputy Associate director of the Accelerator Division.

Jefferson Lab has recently completed the 12 GeV upgrade for the Continuous Electron Beam Accelerator Facility and the experimental program is underway. The laboratory's mission is to operate the upgraded CEBAF facility with high reliability for the Nuclear Physics program, prepare for a next generation Electron Ion Collider (EIC) facility and to develop technologies that support the NP community, the larger DOE mission and societal needs. The NP SBIR/STTR program has played an important role in technology development at Jefferson Lab. I will provide an overview of the recent R&D tracks that have been pursued and outline topical areas that are of interest going forward.

Graphene Backing for Radioisotope Targets

Igor Pavlovsky, Applied Nanotech, Inc.

Grant Title: Isotopic Carbon Graphene Foil Targets

NP SBIR/STTR Topic: **Instrumentation**

Thin film specialty isotopic targets are often requested for studies of charged particle induced reactions. These experiments explore the fundamental nature of matter as well as further development of clean energy and medical technologies. All-carbon graphene-based films would be an excellent choice as a backing material due to its high thermal conductivity, high temperature tolerance, low outgassing, mechanical robustness and ease of handling. In this program, we will fabricate a variety of targets with different chemical elements and their isotopic compositions which are of interest for nuclear physics research.

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, 130-W, 1064-nm fiber laser based on a three-stage Ytterbium fiber amplifier system seeded by a gain-switched diode laser with tunable pulse width from 21 to 200 ps at repetition rates of 0.5–1.5 GHz. Timing jitter of our 1-W, 1064-nm fiber laser was measured to be 0.60 ps over 10 Hz–40 MHz when the gain-switched diode laser was operated at a repetition rates of 0.5, 1, and 1.5 GHz. The fiber laser offers an excellent long term power stability and wavelength stability.

How to reduce costs and power usage in front-end electronics by implementing a system-on-chip approach for data acquisition

Isar Mostafanezhad, Nalu Scientific

Grant Title: Design and Fabrication of the ASoC: a System-on-Chip Data Acquisition System

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.

Pixel Array Germanium Detectors for Nuclear Physics

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. The smaller-area pixels also naturally accommodate high-count rate environments.

Ultra-Thin Position-Sensitive Particle Tracking Detectors

Peter Friedman, Integrated Sensors

Grant Title: Novel Position-Sensitive Particle Tracking Gas Detector

NP SBIR/STTR Topic: **Instrumentation**

We report on ultrathin, position-sensitive, particle and particle-tracking detectors for particle beam tuning and real-time beam monitoring. Three configurations are under development: (1) ultrathin plasma panel *Geiger discharge mode* detectors based on 8-12 µm thick mica substrates for detecting and tracking *low intensity*, low energy, exotic beams; (2) ultrathin *avalanche mode* detectors based on 8-12 µm mica windows for detecting *high intensity* beams at rates up to at least 0.5 MHz/cm^2; and (3) ultrathin film detectors based on a 1-2 µm thick scintillator with extremely low energy straggling for medium to high intensity beams for beam tuning and online monitoring at different or simultaneous locations in real time.

Magnetized Electron Cooling – simulations to support the Electron Ion Collider design effort, including computational reproducibility

David Bruhwiler, RadiaSoft LLC

Grant Title: Dynamic friction in magnetized electron coolers for relativistic beams
NP SBIR/STTR Topic: **Accelerator**

Relativistic magnetized electron cooling in untested parameter regimes is essential to achieve the ion luminosity requirements of proposed electron-ion collider (EIC) designs. Therefore, accurate calculations of magnetized dynamic friction are required, 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 analytic treatment of momentum transfer from a single magnetized electron to a drifting ion, and its use for calculations of dynamic friction. We present work with the JSPEC code, including development of a new browser-based GUI. We also present Warp simulations of magnetized electron beams, including partial space charge neutralization via impact ionization of a background hydrogen gas, which could be important for optimal cooling. Our approach enables computational reproducibility, which is important for science in general and for the EIC design effort in particular.

Gas ionization micro-pattern detector development at RDI: Phase II project status and our R&D infrastructure

Jason Holmes, Radiation Detection and Imaging Technologies, LLC

Grant Title: High-density 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) LLC presents the status of the first full year of the DOE STTR Phase II project. The R&D focus is on the development the micro-pattern detector array based on the Micromegas principle however featuring several distinctive ideas such as multi-coordinate readout. Several elements of the R&D infrastructure had to be created to meet the project goals. This talk describes our approach, project status

and the R&D process, and presents our preliminary findings and path to project completion for the next performance period.

A high-performance wire scanner for ultra-high intensity beams

Marcos Ruelas, Radiabeam Technologies

Grant Title: Robust Wire Scanner for High Intensity Beam Profile Diagnostics

NP SBIR/STTR Topic: **Accelerator**

The interceptive nature of wire scanners precludes their use in imaging high-repetition rate beams. In this project, RadiaBeam Technologies is developing a wire scanner using a new wire material: boron-nitride nanotubes (BNNT). BNNT wires have a similar strength to carbon nanotube wires used in other labs but have a much higher temperature tolerance, allowing use with higher intensity beams. RadiaBeam has not observed damage or degradation during preliminary testing at the Thomas Jefferson National Accelerator Facility (JLab). In addition, an unexpected visible light emission was discovered during testing. In our continued studies, RadiaBeam is working with JLab to quantify the viability of BNNT wires in a high speed wire scanner that will be tested in the CEBAF facility and to verify the usefulness of the visible light emission as an alternative detection scheme. In this talk, we will review the previous accomplishments, update on the current engineering progress, and describe the commissioning program, challenges, and proposed solutions.

UNCD Field Emission Cathodes for Accelerator Applications

Eric Montgomery, Euclid Techlabs, LLC

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

NP SBIR/STTR Topic: **Accelerator**

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.

Day 2: August 8

DESIGN AND MANUFACTURE OF TUNABLE PERMANENT MAGNET BASED QUADRUPOLE FOR NEXT GENERATION ELECTRON-ION COLLIDERS

Melania Jasinski, Electron Energy Corp

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Accelerator**

This presentation will report on the latest progress of our SBIR project on the design, construction and testing of a tunable quadrupole permanent magnet system for particle accelerators. The main application of the proposed system will be the new concept electron accelerator proposed to be constructed for electron ion collision research. The use of the permanent magnets instead of electromagnets will drastically reduce the cost of building the accelerator, the operational costs, and allow for a more compact design.

The Relativistic Heavy Ion Collider Facility and the SBIR/STTR Program

Michiko Minty
Brookhaven National Laboratory

Low Z Thin Films for Stripper Foils, Targets and X-Ray Windows

Nalin Kumar, UHV Technologies, Inc.

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Instrumentation**

In this presentation, the latest results obtained during the first year of this Phase II SBIR project will be presented. In particular, a fully automated pulse laser deposition system will be described to fabricate nano-layered stacks of sp3 diamond like carbon, sp2 graphitic carbon and boron with hundreds of layers. The results of free standing foils made with this system will be described. In addition, the results of silicon nitride, silicon carbide, graphene and nano-crystalline diamond windows will be presented for applications in low energy x-ray detectors and gas ion detectors. Furthermore, UHV's capabilities to R&D and manufacture exotic thin films, vacuum sealing and bonding, x-ray tube manufacturing and thin film manufacturing equipment will be described.

Porous Pressed Powders as Solid Catchers of Stopped Rare Isotopes

Uma Sampathkumaran, InnoSense, LLC.

Grant Title: Thermo-Mechanically Stable Tungsten Powders as Solid Catchers for the Fast Release of Stopped Rare Isotopes

NP SBIR/STTR Topic: **Accelerator**

Porous solid catchers of rare isotopes produced at high energies via in-flight reactions will play an important role in high power heavy ion accelerator facilities such as FRIB. Such catchers are complementary to helium gas catchers especially for parasitic harvesting of rare isotopes in the in-flight separators. Here InnoSense LLC (ISL) is optimizing doped tungsten (W) and tungsten carbide powders for long-term use in high temperature beam environments while enabling the stopping and fast release of desired reactive molecular or single elemental rare isotopes. Lightly pressed disks of undoped tungsten did undergo some particle coalescence (Ostwald ripening) and grain growth when vacuum heated to 1400 °C for 12 hours while the doped tungsten powders showed significant grain growth suppression. On-line characterization of the samples is being carried out at with the residual gas analyzer (RGA) apparatus installed at Florida State University with beams from their Tandem (e.g., ^{4}He, ^{7}Li, ^{13}C, and ^{18}O). Beams at NSCL (e.g., primary beam of ^{16}O together with their A1900 fragment separator intense secondary beams of ^{6}He, ^{15}O, and ^{10}C are available for on-line tests of release efficiency, delay times, and sideband formation). We will report on ongoing work.

Development of a Nanomaterial Anode for a Low Voltage Proportional Counter for Neutron Detection

Matthew Craps, NanoTechLabs, Inc.

Grant Title: Same as presentation title

NP SBIR/STTR Topic: **Instrumentation**

NanoTechLabs Inc. in collaboration with Savannah River National Laboratory and Clemson University have been developing of a next generation proportional counter for neutron detection utilizing robust, inexpensive nanostructured anodes while maximizing neutron capture. The concept is based on a controlled parallel plate array of nanoscale anodes to detect the reaction products produced by the interaction of a neutron with boron-10. Typical PCs operate with high bias potentials that create electronic noise. Incorporating nanomaterials into the anode of PCs can theoretically operate at low voltages (eg. 10-100V) due to an increase in the electric field associated with a smaller diameter nano-scale pillars on the anode. In addition to the lower operating voltage, typical high PC voltages (~1200V) could be used to generate a larger electric field resulting in more electrons being collected, thus increasing the sensitivity of the PC.

Nb-on-Cu Cavities for 700-1500 MHz SRF Accelerators

Katherine Velas, Alameda Applied Sciences Co.

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Accelerator**

Alameda Applied Sciences Corporation (AASC) grows superconducting Nb films via Coaxial Energetic Deposition (CED) from a cathodic arc plasma. AASC is coating 1.3 GHz SRF cavities manufactured at Thomas Jefferson National Accelerator Facility (JLab) and continues to improve the technology and coating procedure with the goal of achieving Qo > 10^{10}. In Year 1 of the NP SBIR Phase II grant, AASC set out to improve the CED triggering system, upgrade the vacuum chamber system, optimize thickness control, coat and cryotest multiple SRF cavities. The first cavity coated after implementing improvements reached a Qo of 10^{9}, the highest Q measured on a cavity coated using CED. Further improvements are needed to reach Qo > 10^{10}. Plans include making additional improvements to the vacuum chamber, exploring variations in coating parameters, and working with JLab to assemble all coating hardware inside JLab cleanroom facilities.

Development of a Multicell Superconducting Cavity with a Photonic-Bandgap Coupling Cell

Chase Boulware, Niowave, Inc.

Grant Title: Development of a Superconducting RF Harmonic Cavity for eRHIC

NP SBIR/STTR Topic: **Accelerator**

Next generation light sources and colliders require continuous electron beams with currents up to the ampere level. One example is the proposed collider eRHIC, where hadrons from one of the RHIC storage rings will interact with electrons accelerated in a six-pass energy recovery linac. A possible enhancement to the design involves compensating nonlinearities from the main linac by extra accelerating sections operating at a harmonic of the main frequency. Photonic band gap cells have been recently suggested for use as the harmonic linac cavities to reduce beam distortion from higher-order modes. This Phase II SBIR project built and tested the first-ever multi-cell superconducting accelerating cavity with a photonic

bandgap coupling cell. In addition to building the new cavity design, novel vacuum and RF seals were developed for the waveguide ports. The cavity was tested at cryogenic temperature in its helium vessel, demonstrating high cavity quality factor at a significant fraction of the design fields.

Informal Discussion on Challenges and Best Practices for Commercialization

Michelle Shinn, DOE, Office of Nuclear Physics

I will facilitate a discussion amongst the participants on what does or doesn't work when attempting to make the leap from a NP-funded SBIR/STTR grant to a product or service.

Day 2 – August 10, 2016

The Design and Application of Harmonic Rf Cavities

Brock Roberts, Electrodynamic

Grant Title: Non-Invasive Bunch Length Monitor, Fast Kicker, Bunch Shaper and Photogun

NP SBIR/STTR Topic: **Accelerator**

RF cavities have been designed and constructed that simultaneously and exclusively resonate many harmonic TM_{ono} modes. These modes are axially symmetric and have their electric field maximum along the cavities bore. A periodic beam passing through a harmonic cavity's bore excites these modes whose superposition can be measured at the cavities antenna with a sampling oscilloscope. Processing the detected waveform with the harmonic cavities transfer function yields the Fourier series of the beam, and a near real-time, non-invasive measurement of the beams longitudinal bunch shape and duration. Experiments have been performed on the 130 kV injector at the Thomas Jefferson National Accelerator Facility's Continuous Electron Beam Accelerator Facility. The harmonic cavities sensitivity was near 1 mV/μA and measured beam bunches ranging in width from 45 to 150 picoseconds (FWHM). These measurements were in close agreement with measurements made using an invasive bunch measurement system as well as predictions by a particle tracking simulations. Harmonic cavities also have potential applications when actively driven. Demonstrating fast bunch kicking and bunch shaping using harmonic cavities is the current focus of our research.

Radiation Resistant Magnetic Field Sensor

Vladimir Kochergin, Microxact, Inc.

Grant Title: Radiation Resistant Magnetic Field Sensor

NP SBIR/STTR Topic: **Instrumentation**

All high power target facilities and accelerators, especially the Facility for Rare Isotope Beams (FRIB), require magnetic field sensors to measure magnetic fields in various magnets employed at these facilities as well as in cyclotrons. The currently used and/or commercially available sensors show only limited radiation resistance. MicroXact is developing a new type of fiber

optic magnetic field sensor and instrumentation that will be small, sensitive, inexpensive and radiation resistant. Sensors and instrumentation will work for years without the need for frequent replacement and/or recalibration. The results of the sensor and instrumentation development and qualification will be presented. Wide dynamic range, stable, accurate operation of the sensor will be demonstrated.

Low Cost, High-Density Digital Electronics for Nuclear Physics

Wojciech Skulski, Skutek Instrumentation

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Electronics**

In this talk I will present the progress concerning our Phase II SBIR project titled "Low Cost, High-Density Digital Electronics for Nuclear Physics".

Activities Directed Towards HF-Free Electropolishing of Niobium SRF Cavities

E. Jennings Taylor, 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.

PUMA-V: Polyhedral User Mapping Assistant and Visualizer Tool, CPS Code Enhancements, Extending R-Stream with LLVM for Mapping C++ and QDP++ Codes, and Faster Linear Solvers and Preconditioners

M. Harper Langston, Reservoir Labs, Inc.

Grant Title: Polyhedral User Mapping Assistant and Visualizer (PUMA-V)

NP SBIR/STTR Topic: **Software**

Calculations undertaken by physicists for solving fundamental problems such as Lattice Quantum Chromo Dynamics (LQCD) are prohibitively demanding without expertly optimized software. Such software is very complex and costly to write and maintain without automated tools, especially for advanced heterogeneous architectures. The goal of the Polyhedral User Mapping Assistant and Visualizer (PUMA-V) project was to address this problem starting from existing high-level technology for automatic, mixed static/dynamic, mapping of dense multi-linear algebra algorithms. The PUMA-V project focused on automated tools, an optimization and visualization toolchain, source-to-source compilers, and advanced linear solvers meet this

complexity challenge and increase user productivity. Four areas of engagement made great strides in addressing the needs of the LQCD community specifically and the scientific community in general: 1. Columbia Physics System Code Enhancements, 2. PUMA-V Visualizer Tool, 3. Extending R-Stream with LLVM for Mapping C++ and QDP++ Codes, and 4. Faster Linear Solvers and Preconditioners. More generally, the four original primary goals of this project were focused on (1) the implementation of translation tools interfacing heavily templated LQCD libraries to polyhedral mapping, (2) application of the tools to current theoretical physics simulations related to testing Standard Model (SM) theories, (3) development of new optimized solver algorithms for LQCD, and (4) development and quality improvements. The four engagements listed above address all of these targets, and work continues to develop the capability for fully automating the optimization of complex software. Heterogeneous hardware can provide orders of magnitude improvements in computational rates but presents significantly more complex code development and porting challenges. PUMA-V has begun to address this need in significant ways that will have lasting impact in the near future as well as years to come.

Low-Latency Ultra-High Capacity Holographic Data Storage Archive Library

Ken Anderson, Akonia Holographics

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Software**

In the last 3 to 4 years, the growth of disk areal density has decreased from its 20 year average of 40% down to under 20% per year. This new growth rate is expected to continue or even decrease in the years to come causing serious cost issues when data growth is expected to continue rising at about 45% a year. As these relative costs begin to rise, data storage budgets will begin to dominate overall IT budgets. As 2D data storage technologies like magnetic disk, tape, and flash memory attempt to stack data in 3D, they inherently fail at realizing the scaling potential of a truly 3D storage technology enjoys. Holographic Data Storage is one of the only inherently 3D data storage technologies that can continue to scale as the world's needs scale. The other cost benefit is that the information is stored in plastic and not some rare materials that are too expensive to harvest.

Development of High Quantum Efficiency and High Polarization Electron Source at Svta / Gaassb/Algaasp Superlattice High-Polarization Electron Source

Yiqiao Chen, SVT Associates, Inc.

Grant Title: GaAsSb/AlGaAsP Superlattice High-Polarization Electron Source

NP SBIR/STTR Topic: **Accelerator**

Spin-polarized electron sources are of great interest to DoE for applications in high-precision high-energy nuclear physics experiments at beam energy up to several GeV. Polarized electrons are essential for parity-violating experiments and measurements of nucleon spin structure. SVT Associates has been working on polarized photocathode materials and devices for 15 years to meet DoE's polarized electron source needs. Remarkable improvement including high quantum efficiency (QE) and high polarization has been achieved with DoE SBIR programs. Very recently,

with very high QE and 85% polarization were measured from a photocathode grown on GaAs substrate. SVT and JLab are continuing working on improvement of QE and polarization for GaAs/GaAsP and GaAsSb/AlGaAsP SL photocathodes.

Modular Planar Germanium (MPGe) Detector Systems for High Resolution Gamma-ray Spectroscopy and Tracking Arrays

Ethan Hull, PHDs Co.

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Instrumentation**

Modular Planar Germanium (MPGe) detector systems are being developed for nuclear-physics detector arrays. These detector systems provide excellent spatial and energy resolution with reasonably high % solid-angle coverage in a compact overall forward footprint. Enabled by new larger-diameter germanium crystals, the MPGe systems will provide the basis for the next generation heavy-ion detector arrays. The lower detector operating temperature and electronic trap correction techniques will allow these detectors to survive the extreme radiation-damage in next generation heavy-ion detector arrays. Prototype MPGe detector systems have now been fabricated and demonstrated. Side by side gamma-ray imaging comparisons with other commercial detectors shows that MPGe will also have an extremely positive impact on global nuclear security.

Keynote Presentation

DOE Isotope Program and Facilities and the SBIR/STTR Program

Cathy Cutler
Brookhaven National Laboratory

Radionuclides play a major role in research applications, in environmental studies and in industrial applications as sources as well as in nuclear medicine imaging and therapy. The DOE isotope program has a long history of utilizing its unique national laboratory facilities and expertise to develop and supply radionuclides that are in high demand and commercially unavailable. DOE is actively supporting novel production and purification methods for radioisotopes for use in a variety of applications. Current efforts have focused on developing methods to produce therapeutic radioisotopes with high purity and thus minimal to no impurities as well as high specific activity radioisotopes which can be attached to biomolecules or targeting vectors that selectively distribute within diseased tissues, thus delivering toxic radioactivity to diseased tissue while minimizing or sparing damage to healthy or normal cells. Furthermore, the DOE Isotope Program has increased its production facilities and capabilities to meet increased demand and to allow for assessment of novel production methods. While simultaneously increasing its testing facilities and quality programs to meet the regulations required for radioisotopes of use in clinical trials and in approved drug formulations. This presentation will present an overview of the program and its facilities and programmatic growth areas that have potential for SBIR/STTR funding.

Ferroelectric Based High Power Tuner

Alexei Kanareykin, Euclid Techlabs LLC

Grant Title: Ferroelectric Based High Power Components for L-Band Accelerator Applications

NP SBIR/STTR Topic: **Accelerator**

A fast controllable phase shifter would allow microphonics compensation for CW SRF accelerators. Nonlinear ferroelectric microwave components can control the tuning or the input power coupling for RF cavities. Applying a bias voltage across a nonlinear ferroelectric changes its permittivity. This effect is used to control a phase change of a RF signal or change the resonant frequency of a cavity. In Phase II of the project, 2014-2016, two designs for the new frequency 400 MHz proposed by BNL for the power test. RF power losses and temperature control were studied. Operating temperature in the range of 40 C has been chosen to optimize the tuning range Ferroelectric elements were fabricated and characterized. The engineering design of the ferroelectric based tuner was completed. All tuner components have been manufactured. The BST tuner was assembled and tested with wide range 300 RF phase tunability by 30 C thermo control and fine fast tuning 100 phase over kV/mm bias field.

Digital SQUID Magnetometers for Read-out of Detectors and Magnetic Particles

Masoud Radparvar, Hypres, Inc.

Grant Title: Same as the presentation title

NP SBIR/STTR Topic: **Accelerator**

We have devised a Time-Division Multiplexing (TDM) scheme for minimizing the circuit complexity required for an array of sensors. As a proof-of-concept, we have designed, fabricated, and tested a 4-channel TDM read-out circuit. The proposed scheme can be generalized for a larger number of channels. The read-out circuit comprises an array of ADCs (Analog to Digital Converters) to digitize sensor outputs, a multiplexing unit, a clock controller, and a counter with parallel-to-serial output interface. For demonstration purposes, we employed low-pass phase modulation-demodulation (LP PMD) ADCs running in a synchronous mode of operation. To facilitate independent verification of circuit operation we also placed an on-chip pattern generator to apply a unique pattern to each channel. The multiplexing unit is based on an array of sequentially triggered switches, each controlling the flow of data from a single ADC to a common output bus. In our scheme, the switches are realized using RS-flip-flops with non-destructive readout (RSN) cells with only one RSN cell turned on at a time. Multiplexed output data were stored in rippled counter based on T-flip-flops and read out to room temperature electronics using a serial interface. The chip was extensively evaluated at sampling frequencies up to 12 GHz. By means of embedded pattern generators we proved the correct operation of each channel and of all 4 channels combined. We also were able to perform reconstruction of signal applied to individual ADC. The chip was fabricated using Hypres' 4.5 kA/cm2 process with 4 Nb metal layers.

Keynote Presentation

Update on the Department of Energy SBIR/STTR Program

Chris O'Gwin
DOE SBIR/STTR Office

I will provide a brief overview and update of any recent changes within the last year impacting the DOE SBIR/STTR programs.