SOUTH DAKOTA BOARD OF REGENTS
ACADEMIC AFFAIRS FORMS

Intent to Plan for a New Program

UNIVERSITY:	**SDSU**
DEGREE(S) AND TITLE OF PROGRAM:	**Master of Science in Applied Physics**
INTENDED DATE OF IMPLEMENTATION:	**2018-2019 Academic Year**

University Approval
To the Board of Regents and the Executive Director: I certify that I have read this intent to plan, that I believe it to be accurate, and that it has been evaluated and approved as provided by university policy.

Barry H. Dunn

President of the University

2/9/2018
Date

1. What is the general nature/purpose of the proposed program?

South Dakota State University (SDSU) requests authorization to plan a Master of Science in Applied Physics. Applied physics is intended for a particular technological or practical use. It is usually considered as a bridge between physics and engineering. Applied physics supplies innovative and crosscutting solutions for questions in science, medicine, engineering, and industry. It connects the fundamental physics at the microscopic level and the new applications that are needed by the economy at the macroscopic level. It offers a bridge for engineers and scientists outside of physics who need the fundamental physics to develop new technologies, and a bridge for scientists who want to engineer solutions for the grand challenges of both today and tomorrow. The intent of the program is to prepare graduates who want to be an industrial physicist, working in an area of commercial, medical, industrial, or national interest.

The Department of Physics at SDSU has identified three initial emphases for the program: materials science, nuclear science, and biophysics. Examples of application of these emphases include developing advanced materials to replace the rare earth elements in modern technologies (95% of which come from one source, China), developing radiation detectors for use by NASA in orbit around the Sun, and supporting new medical devices and procedures in healthcare.

Moreover, the M.S. in Applied Physics would be flexible enough to tackle other new challenges via the inclusion of graduate coursework in Biology, Chemistry, Math, or Engineering. For example, studies of the health effects of radioisotopes used in radiation therapy, or the enhanced delivery of drugs with magnetic nanoparticles could require effective collaboration among multiple disciplines. Students with interests in developing new methods of non-destructive testing could collaborate with the Materials Evaluation and Testing Laboratory (METLAB) faculty in Mechanical Engineering department, as well as faculty studying radiation-resistant instrumentation for applications in power generation and space technologies in SDSU Electrical Engineering.

The University does not request new state resources.

2. What is the need for the proposed program (e.g., Regental system need, institutional need, workforce need, etc.)? What is the expected demand for graduates nationally and in South Dakota (provide data and examples; data sources may include but are not limited to the South Dakota Department of Labor, the US Bureau of Labor Statistics, Regental system dashboards, etc.)?

Driving innovation and breaking through disciplinary silos will require an enhanced understanding of physics at many levels, from the geophysical to the quantum and the nuclear. Applied physics is inherently multidisciplinary, facilitating such industries as energy production, aerospace engineering, nuclear medicine and pharmaceuticals, biophysics, meteorology, environmental management, and materials science.

The U.S. Bureau of Labor and Statistics does not report statistics for Applied Physicists. However, it does report the overall employment of physicists and astronomers, which is projected to grow by 14 percent from 2016 to 2026.[1] This is twice as fast as all other occupations combined, with about 2,800 new jobs over that period nationally. By comparison, the growth of architecture and engineering jobs are expected to grow by 7% over the same time period, with 193,200 new jobs.[2]

Applied Physics graduates find work in other fields besides a physics-related area or in engineering. Biochemists and Biophysicists are projected to grow by 11%.[3] Computational skills learned from applied physics research often lead to employment as a computer research scientist, which is expected to grow by 19%.[4] Applied mathematical skills would support financial analysis and banking services, which will grow by 11%.[5] Materials scientist positions are expected to keep pace with the national average, growing by 7%.[6] Although nuclear engineers in power, medical, and industrial applications are expected to grow by only 4%, much of the nuclear workforce will be retiring.[7] The number of available jobs will exceed the number of new jobs.

In 2015, physicists that worked in hospitals averaged an annual salary of $162,870, physicists in areas of scientific research averaged $116,820, and those that worked in the federal, state, and local government averaged $111,510.[8] The national average salary in all architecture and engineering categories, given average weekly wages in May 2016 was $84,302, and the average annual salary

[1] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Physicists and Astronomers, on the Internet at https://www.bls.gov/ooh/life-physical-and-social-science/physicists-and-astronomers.htm (visited *November 25, 2017*).
[2] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Architecture and Engineering, on the Internet at https://www.bls.gov/ooh/architecture-and-engineering/home.htm (visited *November 25, 2017*).
[3] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Biochemists and Biophysicists, on the Internet at https://www.bls.gov/ooh/Life-Physical-and-Social-Science/Biochemists-and-biophysicists.htm (visited *November 25, 2017*).
[4] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Computer and Information Research Scientists, on the Internet at https://www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm (visited *November 25, 2017*).
[5] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Financial Analysts, on the Internet at https://www.bls.gov/ooh/business-and-financial/financial-analysts.htm (visited *November 25, 2017*).
[6] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Chemists and Materials Scientists, on the Internet at https://www.bls.gov/ooh/life-physical-and-social-science/chemists-and-materials-scientists.htm (visited *November 25, 2017*).
[7] Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Nuclear Engineers, on the Internet at https://www.bls.gov/ooh/architecture-and-engineering/nuclear-engineers.htm (visited *November 25, 2017*).
[8] USA Wage, Highest Paying Industries for Astronomers and Physicists, on the internet at http://www.usawage.com/high-pay/industries-o192010.php (visited *November 25, 2017*).

for the Sioux Falls area was $68,494.[9] Thus, the M.S. in Applied Physics aims to facilitate employment in high-need areas that pay more, or similarly, provide the workforce for industries that would pay higher-wage jobs.

SDSU has received letters of support from Avera Cancer Institute, Sanford Underground Research Facility, and Northern Plains Power Technologies. They are all based in South Dakota: Avera is in Sioux Falls, Sanford near Rapid City, and Northern Plains near Brookings. Their letters positively support the proposed Applied Physics program, and expect the program to provide occupations in the following areas.

- Radiation therapy, medical imaging, chemotherapy, and drug delivery (Avera);
- Engineers for physics experiments, support of commercialization efforts, and development of new experiments that can/must be done at Homestake (Sanford Underground);
- Engineering service on distributed generation plant, energy storage and their interconnects, and low-inertia power system (Norther Plains Power).

The above list is only a fraction of occupations that are related to Applied Physics graduates. Occupations relevant to the Applied Physics program in South Dakota and their industry projections in 2014 - 2024 are as follows.[10]

- Construction (9.13%)
- Finance and Insurance (6.38%)
- Government (2.88%)
- Health Care (10.57%)
- Information (0.18%)
- Manufacturing (7.03%)
- Professional, Scientific, and Technical Services (13.23%)

Labor statistics also show that physicists tend to collect in hubs, such as around a national laboratory like Los Alamos National Laboratory, or metropolitan centers like Boulder, Minneapolis, and Chicago. Sioux Falls and Rapid City could become such hubs for health care and technology, and benefit from the synergy provided by applied physicists as evidenced by letters of support from Avera Cancer Institute at Sioux Falls, and Sanford Underground Research Facility near Rapid City (see Appendix B)[11].

Nationally, graduates of applied physics programs have found exciting careers in national research labs, NASA, Boeing, Lockheed Martin, GE/Motorola, BP/Exxon Mobil/Chevron, and many other companies that use advanced engineering methods, physics, chemistry, and specialized materials.

Thus, a unique opportunity exists for a M.S. in Applied Physics to fill a niche in South Dakota (see Appendix B). It can provide a highly educated workforce that will facilitate new directions in applied science and advanced engineering to diversify and grow the economy of South Dakota.

[9] Bureau of Labor Statistics, U.S. Department of Labor, *Midwest Information Office*, Occupational Employment and Wages in Sioux Falls – May 2016, on the Internet at https://www.bls.gov/regions/midwest/news-release/occupationalemploymentandwages_siouxfalls.htm (visited *November 25, 2017*).

[10] https://www.southdakotaworks.org/vosnet/dashboards/defaultana.aspx?menuid=MENU_START_PAGE_DASHBOARD_ANA&pu=1&plang=E

[11] Letters of support from Avera Cancer Institute at Sioux Falls, and Sanford Underground Research Facility near Rapid City are attached at Appendix B.

3. How would the proposed program benefit students?

The program will prepare students to enter the workforce directly as valued technical experts that can be employed by a variety of local and international industries, work in academia, or do research in government funded laboratories or agencies upon completion of the degree.

Establishing a graduate degree in the Department of Physics at SDSU will strengthen the undergraduate program in physics. It will increase the number of projects and faculty/graduate-student mentors for experiential learning (undergraduate research) and will enhance recruiting for undergraduate physics majors. Furthermore, it will improve the effectiveness of introductory physics courses through the use of dedicated physics graduate teaching assistants (GTAs) for laboratory teaching rather than graduate students drawn from other disciplines. Thus strong undergraduate and graduate programs will help each other succeed. Applied Physics program can be accredited by the Accreditation Board of Engineering and Technology (ABET). We have intentions of seeking accreditation by Applied and Natural Science Accreditation Commission in 5 years, but not immediately.

Existing entities in South Dakota that could potentially employ applied physicists would include but not be limited to 3M, Xcel Energy, Black Hills Corporation, Avera Health, Sanford Health, Daktronics, Northwestern Energy, the Sanford Underground Research Facility, the South Dakota Department of Environment and Natural Resources, Marmen Energy, RESPEC, and Raven Industries. Recent SDSU physics graduates and current undergraduate students are working for aforementioned companies. Also please refer to the Appendix B for letters of support for the M.S. in Applied Physics program.

4. How does the proposed program relate to the university's mission as provided in South Dakota Statute and Board of Regents Policy, and to the current Board of Regents Strategic Plan 2014-2020?[12]

The program is related well to the mission of South Dakota State University to provide graduate programs in the physical sciences offering a rich academic experience through student-centered education, and research. The proposed M.S. in Applied Physics supports the statutory mission of SDSU as provided in SDCL 13-58-1: *Designated as South Dakota's land grant university, South Dakota State University, formerly the state college of agriculture and mechanical arts, shall be under the control of the Board of Regents and shall provide undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, home economics, nursing and pharmacy, and other courses or programs as the Board of Regents may determine.*

Board Policy 1:10:2 South Dakota State University Mission Statement provides: *The legislature established South Dakota State University as the Comprehensive Land Grant University to meet the needs of the State and region by providing undergraduate and graduate programs of instruction in the liberal arts and sciences and professional education in agriculture, education, engineering, human sciences, nursing, pharmacy, and other courses or programs as the Board of Regents may determine (SDCL 13-58-1).*

The M.S. in Applied Physics also aligns well with the current Board of Regents Strategic Plan

[12] South Dakota statutes regarding university mission are located in SDCL 13-57 through 13-60; Board of Regents policies regarding university mission are located in Board Policies 1:10:1 through 1:10:6. The Strategic Plan 2014-2020 is available from https://www.sdbor.edu/the-board/agendaitems/Documents/2014/October/16_BOR1014.pdf.

2014-2020.

Goal 1: Student Success

- *Grow the number of undergraduate and graduate degrees awarded.*
- *Improve system first year retention rates.*
- *Improve institutional four-year and six-year graduation rates.*

Goal 2: Academic Quality and Performance

- *Increase the number of accredited programs.*
- *Continue to approve new graduate programs.*
- *Grow the number of students participating in experiential learning.*

Goal 3: Research and Economic Development

- *Increase grant and contract expenditures.*
- *Increase the number of invention disclosures.*
- *Increase the number of graduates from STEM programs.*

In addition, the *2020 Vision: The South Dakota Science and Innovation Strategy* report supports physics graduate education to increase research opportunities within the state.[13]

5. **Do any related programs exist at other public universities in South Dakota? If a related program already exists, explain the key differences between the existing programs and the proposed program, as well as the perceived need for adding the proposed new program. Would approval of the proposed new program create opportunities to collaborate with other South Dakota public universities?**[14] *If there are no related programs within the Regental system, enter "None."*

There is no other public university offering a degree in M.S. in Applied Physics focusing on materials science, nuclear science, and biophysics in South Dakota.

The University of South Dakota (USD) and the South Dakota School of Mines and Technology (SDSM&T) offer the M.S. in Physics and the Ph.D. in Physics. However, the key difference between existing programs and the newly proposed M.S. in Applied Physics is that existing programs focus largely on particle physics related activities at the Homestake Mine in Lead, SD. The graduate physics programs at SDSM&T and USD support Homestake physics experiments and related projects such as Large Underground Xenon Experiment, Center for Ultra-low Background Experiments at Dakota, or Underground nuclear and particle physics.

While a M.S. in Applied Physics can certainly complement efforts at the Sanford Underground Research Facility (SURF), such as support of the engineering for particle physics, the M.S. in Applied Physics takes a much broader approach to materials science, nuclear science, and biophysics for industrial or medical/health applications. Thus many other collaborations on the SDSU campus and between regental institutions may occur.

One focus area of the Applied Physics program at SDSU will work on material growth and processing for electronic devices, wind turbine, hybrid car batteries and electric motors, and

[13] SD EPSCoR REACH Committee, *2020 Vision: The South Dakota Science and Innovation Strategy* (2013), available from http://sdepscor.org/sdepscorHome/wp-content/uploads/2015/07/2020-Vision.pdf.
[14] Lists of existing system programs are available through university websites and the RIS Reporting: Academic Reports database available from http://apps.sdbor.edu/ris-reporting/AcademicProgramReports.htm.

medical application such as drug delivery. Another focus area, medical and health physics, will prepare students to work in hospitals and health related private/government sectors. The mission of the graduate program at SDSU will be to train students for leading industry workforce who can bridge the gap between practical engineering and fundamental physics.

The B.S. in Physics degree already incorporated the Applied Physics emphasis into the curriculum, and it has been successful. Recent graduates are hired in companies looking for engineers with a physics background; Nuclear Power Plant at Minnesota, Boeing as Missile defense system engineer, and Motor engineering company in Iowa to name only a few. The proposed graduate program will include courses offered by Electrical Engineering, Mechanical Engineering, and Civil Engineering, Chemistry, Geographic Information Sciences, and Biology departments in the plan of study. It is optimal for SDSU to offer the graduate program in Applied Physics based on the accessibility of both engineering and science coursework.

One of many differences of the Applied Physics program from Physics is that Applied Physics programs may be accredited under the Accreditation Board for Engineering & Technology (ABET). It is the University's intention that the M.S. in Applied Physics at SDSU should be ABET accredited through the Applied and Natural Science Accreditation Commission.

6. **Do related programs exist at public colleges and universities in Minnesota, North Dakota, Montana, and/or Wyoming?** *If a related program exists, enter the name of the institution and the title of the program; if no related program exists, enter "None" for that state. Add additional lines if there are more than two such programs in a state listed.*[15]

There is no other public college or university offering a degree in M.S. in Applied Physics focusing on materials science, nuclear science, and biophysics in Minnesota, North Dakota, Montana, or Wyoming.

	Institution	**Program Title**
Minnesota	None	
North Dakota	None	
Montana	None	
Wyoming	None	

The only M.S. in Applied Physics program found at any regional institutions occurs at Iowa State. However, they do not actively recruit students into that program, but offer the degree to those who are leaving the Ph.D. program early.

Universities nationwide offer graduate degrees in Applied Physics, including but not limited to Stanford, Columbia, Harvard, Cornell, Texas A&M, Johns Hopkins, Yale, Rice, Northwestern, Michigan, Caltech, and Carnegie Mellon. The Air Force Institute of Technology and the Naval Postgraduate School both offer the M.S. in Applied Physics to support critical defense interests.

The M.S. in Applied Physics program from SDSU will be unique in the region. This program provides an exclusive opportunity for students who wish to pursue graduate studies intending to work in non-academic careers, including jobs in manufacturing industry, healthcare, and

[15] This question addresses opportunities available through Minnesota Reciprocity and WICHE programs such as the Western Undergraduate Exchange and Western Regional Graduate Program in adjacent states. List only programs at the same degree level as the proposed program. For example, if the proposed program is a baccalaureate major, then list only related baccalaureate majors in the other states and do not include associate or graduate programs.

government.

7. Are students enrolling in this program expected to be new to the university or redirected from other existing programs at the university?

Yes, students enrolling in the M.S. in Applied Physics program are expected to be new to the university. Enrollment in other graduate programs will not be affected.

8. What are the university's expectations/estimates for enrollment in the program through the first five years? What are the university's expectations/estimates for the annual number of graduates from the program after the first five years? Provide an explanation of the methodology the university used in developing these estimates.

The program will grow in total enrollment from 2 in the first year to 10 by the fifth year. The enrollment limitations are based on space, instrumentation, faculty availability, research grant funding, and available graduate teaching assistant (GTA) positions in the Department of Physics. The department will financially support up to ten GTA positions based on FY18 budget. It is expected that research faculty are to be actively engaged in various grantsmanship opportunities to win external funds to support Graduate Research Assistant positions.

Graduates of SDSU's undergraduate program currently enroll in graduate programs outside of South Dakota. Students would be recruited primarily from the SDSU undergraduate program along with international students (i.e., Nepal and Korea) for the proposed M.S. in Applied Physics. Moreover, SDSU graduates from chemistry, biochemistry, and engineering programs will contribute to the pool of candidates.

M.S. in Applied Physics	FY19	FY20	FY21	FY22	FY23
Estimated Total Enrollment	2	7	10	12	12
Estimated Graduates	0	2	5	5	6

9. Complete the following charts to indicate if the university intends to seek authorization to deliver the entire program on campus, at any off campus location (e.g., UC Sioux Falls, Capital University Center, Black Hills State University-Rapid City, etc.) or deliver the entire program through distance technology (e.g., as an on-line program)?[16]

	Yes/No	***Intended Start Date***
On campus	Yes	**2018-2019 Academic Year**

	Yes/No	***If Yes, list location(s)***	***Intended Start Date***
Off campus	No		

	Yes/No	***If Yes, identify delivery methods***[17]	***Intended Start Date***
Distance Delivery (online/other distance	No		

[16] The Higher Learning Commission (HLC) and Board of Regents policy requires approval for a university to offer programs off-campus and through distance delivery.
[17] Delivery methods are defined in AAC Guideline 5.5.

delivery methods)			

Undergraduate courses for the B.S. in Physics will continue to be shared among SDSU, USD, and SDSM&T, the graduate courses for the M.S. in Applied Physics will be delivered independently at SDSU. Most of the graduate courses are already approved, and the Department of Physics at SDSU is authorized to offer those courses independently.

10. What are the university's plans for obtaining the resources needed to implement the program?

Graduate Research Assistants will be supported on graduate teaching assistantships and other external funds. The external funding sites includes NSF, NASA, NIH, to name a few. The graduate program would be supported by applying the same PHYS program fee applied to the B.S. in Physics.

	Development/ Start-up	Long-term Operation
Reallocate existing resources	No	Yes
Apply for external resources[18]	No	Yes
Ask Board to seek new State resources[19]	No	No
Ask Board to approve a new or increased student fee	Yes	Yes

11. Curriculum Example: Provide (as Appendix A) the curriculum of a similar program at another college or university. *The Appendix should include required and elective courses in the program. Catalog pages or web materials are acceptable for inclusion.* **Identify the college or university and explain why the selected program is a model for the program under development**.

The attached curriculum in Appendix A is for a Master of Science in Applied Physics from the New Jersey Institute of Technology (NJIT). The information can be found on the internet at http://physics.njit.edu/academics/graduate/ms-appliedphysics.php.

The model curriculum from the New Jersey Institute of Technology most closely parallels SDSU's current M.S. degree credit requirements. Like SDSU, NJIT requires a minimum of 30 credit hours, and offers both a traditional thesis-based (Option A) and a non-thesis (Option B and Option C) M.S. degree. It includes the basic topics that an M.S. in Applied Physics would offer, but allows more flexibility in the electives; 12 hours of core courses, 3 hours of thesis, and 15 hours of electives for a theses-based option, or 12 hours of core courses, 6 hours of project, and 12 hours of electives for a non-thesis option.

[18] If checking this box, please provide examples of the external funding sites identified
[19] Note that requesting the Board to seek new State resources may require additional planning and is dependent upon the Board taking action to make the funding request part of their budget priorities. Universities intending to ask the Board for new State resources for a program should contact the Board office prior to submitting the intent to plan.

Appendix A

Curriculum Example: Master of Science in Applied Physics, the New Jersey Institute of Technology

The program is for students with an undergraduate degree in physics, applied physics or engineering who wish to apply physics to optical science, microelectronics, device physics, materials science, surface science, laser physics, solar phenomena, and other related areas.

Admission Requirements
A bachelor's degree in physics, applied physics, or related areas from an accredited institution is required. An undergraduate GPA above 3.0 is required. Students must submit GRE (general test) scores. In addition, applicants are required to provide letters of recommendation from their previous academic institutions. Students for whom English is not their native language are required to have TOEFL scores no lower than 550.

Degree Requirements
A minimum of 30 degree credits; (600 or 700 level), including a 6-credit thesis or a 3-credit project is required. Of the 30 credits, 18 must be physics courses (including 3 credits of mathematical physics or applied mathematics). The remaining 12 to 15 credits are elective courses.

Seminar
In addition to the minimum 30 degree credits required, all students who receive departmental or research-based awards must enroll each semester in Phys 791/26:755:791 (Applied Physics Seminar).

Required
Advanced Classical Mechanics (Phys 611/26:755:611) 3.0
Classical Electrodynamics (Phys 621/26:755:621) 3.0
Quantum Mechanics (Phys 631/26:755:631) 3.0
Statistical Mechanics (Phys 641/26:755:641) 3.0

Project or Thesis (required)
Master's Project (Phys 700/26:755:700) 3.0
or
Master's Thesis (Phys 701/26:755:701) 6.0

Electives
12 credits if completing a master's thesis; 15 credits if completing a master's project: Selected in consultation with a graduate advisor.

Appendix B

- Letter of Support from Avera Cancer Institute, Sioux Falls, SD

Avera Cancer Institute

Prairie Center
1000 E. 23rd St., Suite 340
Sioux Falls, SD 57105
605-322-3000
800-657-4377
Fax: 605-322-3250

December 27, 2017

Dear Dr. Huh,

The Avera Cancer Institute at the Avera McKennan Hospital and University Health Center would like to express its support for the development of a M.S. in Applied Physics at South Dakota State University. Such a degree will contribute to the highly educated workforce that South Dakota will need to develop the best health outcomes for its citizens facing cancer and other diseases.

The Avera Cancer Institute currently offers several different types of external radiotherapies that use X-rays, gamma rays, or electron beams. Internal brachytherapy uses a removable or implantable tiny radioactive source that delivers a localized radiation dose. Chemotherapy often occurs in conjunction with radiation therapies to treat different cancers.

Research facilitated by the M.S. in Applied Physics would support the characterization and calibration of machines used in radiation therapy and medical imaging, new methods of radiation shielding and dosimetry, simulations of radiation therapies, the testing of new methods or instrumentation, studies of the biochemical effectiveness of chemotherapies, and development of new drug delivery mechanisms via magnetic nanoparticles.

Thus it is possible that all three emphases for the degree (materials science, nuclear science, and biophysics) would augment the Avera Cancer Institute's capabilities for cancer research and cancer treatment.

Sincerely,

Kris Gaster, RN, CNS
Assistant Vice President of Outpatient Cancer Services
Avera Cancer Institute

Sponsored by the Benedictine and Presentation Sisters

Lbhd. 7276-111 PS (Rev. 1/11)

- Letter of Support from Sanford Underground Research Facility, Lead, SD

December 28, 2017

Dr. Yung Huh
Interim Department Head
Department of Physics
South Dakota State University
SDEH 255, Box 2222
Brookings, SD 57007

Dear Dr. Huh,

The Sanford Underground Research Facility (SURF) would like to express its support for the development of a M.S. in Applied Physics at South Dakota State University. Such a degree will contribute to the highly educated workforce that South Dakota will need to take full advantage of a knowledge-based economy that is driven by activities at SURF.

Applied Physics would help address the workforce needs of SURF and its partners by serving as a gateway between undergraduate students with engineering degrees and the world-class research possible at the graduate level within the State of South Dakota. In addition, it would support the engineering that is needed to make current and future physics experiments at SURF successful.

Students that go directly into industry from Applied Physics would provide value in growing and sustaining commercialization efforts arising from research at SURF. One such example is the use of germanium crystals used in physics detectors at SURF that could have biomedical applications as well.

The new degree has potential to boost STEM education in South Dakota through interactions with the Sanford Underground Research Facility, South Dakota's universities, and the highly-educated workforce that results. We support the development of this program and look forward to future collaborations in this area.

Sincerely,

Michael J. Headley
Executive Director, SDSTA
Sanford Laboratory Director

- Letter of Support from Northern Plains Power Technology, Brookings, SD

January 29, 2018

To: Yung Huh, Interim Department Head and Professor of Physics
South Dakota State University, SDEH 255, Box 2222
Brookings, SD 57007

Dear Dr. Huh,

Northern Plains Power Technologies (NPPT) would like to express its support for the development of an M.S. in Applied Physics at South Dakota State University, and would be interested in assisting you to develop ideas for thesis-based plans of study as well as apprenticeships for plans of study that support real-world power systems analysis but do not include a thesis.

NPPT is a power engineering consulting firm based in Brookings, South Dakota. We focus on high-quality engineering services for and specialized R&D on distributed generation plants, energy storage, and their interconnects; and low-inertia power systems such as island grids or remote communities, in which events happen quickly because of the small system size.

NPPT frequently finds itself working on projects in which in-depth, advanced knowledge of physical phenomena is an important element of success. Examples include cases involving arcing or flashover between two conductors at significantly different voltages; understanding of the force generated when fault current flows in opposite directions in two conductors in close proximity; determining the likely causes of decreasing impedance to remote earth being measured in a battery plant, *before* it results in a fire; or determining the risk for destruction of the microelectronics in a rooftop photovoltaic plant subjected to an electromagnetic pulse originating from a nuclear burst over the US. NPPT is not alone in seeing an increase in such projects, and it is becoming more important than ever that Universities produce graduates with in-depth advanced knowledge of both the electrical engineering of the power system, and the physics of the underlying phenomena.

For that reason, we believe the M.S. in Applied Physics would foster exactly the kind of advanced and cross-cutting engineering that is needed, and that would be of interest to Northern Plains Power Technologies. We hope your program will meet with a successful review and will be implemented.

Sincerely,

Michael Ropp, Ph.D., P.E.
Northern Plains Power Technologies
Michael.ropp@northernplainspower.com

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