

Department of Physics 3-5 Year Hiring Plan

I. Summary: The 3-5 year hiring plan for NDSU's Department of Physics consists of

1. a tenure-track faculty member in experimental Materials Physics with a focus on sustainable energy or biomedical applications.
2. two appropriated GTA positions
3. a tenure-track or senior faculty member in Physics Education Research (PER).

The plan:

- strengthens the exclusive research focus of the Department on Materials Physics and PER and offers promising institutional collaborations
- aligns with the strategic research focus of both CSM and NDSU and, in particular, adopts a leadership role on the college level in DBER/STEM
- factors in the teaching and personnel needs in the Department, and aspires a substantial growth in the number of PhD students. The two appropriated GTA positions increase their total number from 4 to 6.

The Department of Physics has (1) an approved strategic plan with goals for research and creative activity, (2) student learning outcomes and goals for student success, and (3) a written workload policy that addresses teaching loads, research expectations and service requirements. All documents are available at <https://www.ndsu.edu/physics/departmentpolicies/>.

II. Mission Statement: The mission of the Physics Department, *"To engage students, campus and community in the most fundamental of all sciences through excellence in teaching, first-class research, and dedicated outreach,"* translates the key elements of the college mission (*"Through teaching, research, service, and outreach, we provide knowledge, skills, and insight to a world increasingly dependent on science and mathematics"*) and institutional mission (*"With energy and momentum, North Dakota State University addresses the needs and aspirations of people in a changing world by building on our land-grant foundation"*) to the pursuit of North Dakota's premier physics department, thereby emphasizing the central role of engagement and excellence in all its activities.

III. Departmental Information: As of summer 2017, the Department of Physics has 11 faculty members; 9 of those are research-active tenure-track faculty, one is an Assistant Professor of Practice (who also is research active), and one is on a 50% appointment with a contract until May 2018. Three of the tenure-track faculty have shared appointments, one with Polymers and Coatings (40%) and two with the School of Education (20%). The Department of Physics at NDSU offers a BS in Physics and double majors in Mathematics and Physics, Computer Science and Physics, and Electrical Engineering and Physics. Besides the standard major in physics we also have an option in Optical Science and Engineering. The graduate level programs include an MS degree and a PhD in physics. Physics faculty also serve as core members and director in the Interdisciplinary graduate program in Materials and Nanotechnology (MNT).

Research in the Department of Physics is highly focused on two fields, *Materials Physics* and *Physics Education Research*: 7 faculty perform research in Materials Physics (3 experimentalists with expertise in polymer nanocomposite films and materials, nanoscale electronics, and biosensors as well as 4 theorists with expertise in simulation and modeling of soft materials, complex fluids, biomaterials, and electronic structure of nanomaterials). 3 faculty have expertise in Physics Education Research. All faculty (apart from the Chair) serve as PI or Co-PI on at least one major grant. All 9 tenure track faculty

serve as advisor for at least one graduate student. Physics faculty publish about 30 peer-reviewed journal articles annually, almost all in journals ranked within the first quartile of their field.

IV. Specification of personnel needs to cover teaching for all programs: We deliver our educational programs through the following course offerings: 3 courses on the 100- and 200-level, 5 courses on the 300-level, 7 courses on the 400/600-level, and 5 courses on the 700-level. In addition to our physics program offerings, we teach 6 large-enrollment general education courses on the 100- and 200-level and 6 corresponding lab courses. All our courses are required courses for at least one of NDSU's undergraduate or graduate programs. In Fall 2016 our Department has switched from a 2-year to a 1-year course rotation. Since Fall 2016, we are offering 15-16 courses and about 26 labs each Fall semester, and 12-13 courses and about 20 labs each Spring semester. These numbers include 11 large-enrollment courses, 2 graduate courses on the 700-level, one course for the MNT program, 0.5 courses for the School of Education, and 3 one-credit courses annually. Virtually all courses are taught by physics faculty, with occasional exceptions of qualified and interested graduate students. All 46 labs (annually) are taught by graduate and undergraduate students.

- **Number of needed faculty:** The Workload Policy of the Physics Department specifies: *“Typical load is 6-7 credits (2 courses) per academic year for research-active faculty and 12-14 credits (4 courses) per academic year for faculty without a major research assignment”*. The table displays the minimum number of required 3 and 4-credit courses we need to teach each semester in order to cover our programs:

3-4 credit courses	Fall semester	Spring semester
100 and 200-level large-enrollment service courses	6	5
300 and 400/600 level	5	6
700 level	1	1
Service for MNT and STEM programs	1	1
Total number of 3-4 credit courses	13	13

Given the presence of one Assistant Professor of Practice and research-activity of all tenure-track faculty, we need a minimum of 12 faculty to keep our programs running. (This minimum would not allow us to teach any elective courses). Starting Fall 2018 we will have 10 faculty (9 research-active tenure-track faculty and 1 Assistant Professor of Practice). Hence, two faculty hires will be needed to resume our ability to cover our programs and teach our service courses.

- **Number of needed GTAs:** The continuation of teaching 46 labs annually requires 7.6 GTA positions, given one GTA teaches 3 labs per semester. Our current practice of teaching about 50% of our labs employing undergraduate and graduate students (the latter being neither employed as GTA nor GRA) on the basis of \$600-per-lab originates in the availability of only 4 GTAs.

V. Summary of the Department's Strategic Plan: The focus on advancing the Physics Department from AY16/17 to AY20/21 includes (1) increasing the number of GTA positions from 4 to 8 plus a number of other steps to grow enrollment and success rate of PhD students, (2) strengthening our

signature program in physics in which undergraduate students are incorporated early into research, (3) improving undergraduate learning success in large-enrollment service courses and their corresponding labs employing research-based instructional approaches, (4) enhancing departmental research impact with appropriate funding levels and 75% of its publications in top-tier journals, (5) creating a culture of engagement and excellence for faculty and students in a diverse and welcoming department. All goals are tagged to measurable outcomes with details specified in the department's Strategic Plan.

VI. Narrative Outlining of how the Positions Advance the Department:

1) Tenure-track faculty member in the field of experimental materials physics with a focus on sustainable energy or biomedical applications: Our research focus on experimental physics of nanocomposite films and materials and nanoscale electronics with applications to energy-related and biomedical applications is a success model with a promising future. The three physics faculty currently working in this area have attracted nearly \$4M in funding since 2010, with roughly half of that being external competitive funds from NSF, NIH, and DOD. The new faculty member, whose research focus aligns with NDSU's grand challenge goals related to Sustainable Energy and Healthy Populations, will complement this highly productive and interdisciplinary group of experimentalists in the Batcheller Technology Center, will increase productivity in our strongest and best-funded physics field, and will strengthen both the graduate programs in physics and MNT. Most importantly, a fourth faculty member in experimental physics, together with our expertise in modeling and theory, will nucleate a collaborative effort capable of pursuing larger-scale, multi-PI grant opportunities. Potential research themes to be considered for the hire in Materials Physics will fall broadly under the umbrella of *nanomaterials for sustainability, energy and healthcare*, spanning everything from renewable polymeric materials (an area of active interest at NDSU with strong potential for collaboration under new leadership in the College of Engineering) to sensors, LEDs, and solar cells. By casting such a broad 'net', we increase our chances of finding an ideal fit - such as an under-represented minority or an investigator whose instrumentation needs complement those already in the department (*e.g.*, NIR imaging/spectroscopy, rheology, scattering, synthesis, 3D printing, etc.).

2) Increase the number of appropriated GTA positions from currently 4 to 6: Our biggest structural deficiency that slows down both our department's teaching excellence and productivity is the number of appropriated GTA positions. The additional two appropriated GTA positions will address both items. First, we teach 46 physics labs annually that are linked to our large-enrollment service courses. Only 24 out of the 46 lab courses are covered by our currently 4 GTA positions. The remaining 22 labs are taught by undergraduate and graduate students on a \$600-per-lab basis. This model becomes increasingly less sustainable because the \$600 compensation per lab (as compared to the \$1,200 compensation CSM pays for LAs) makes it difficult to identify, recruit, and train qualified students who teach physics labs. Our plan to add a faculty member in PER with a focus on research about the integration of lab courses calls for providing conditions and support that allow for the successful implementation of a research-based, innovative model of teaching our physics lab courses.

Second, the current number of 4 GTAs represents a barrier for faculty to apply for RA support through federal grants. This is because after funding no appropriate pool of graduate students to be taken on as GRA is available. Further growth of our graduate program is limited due to the availability of GTA positions that cover graduate students in their first semesters, prior to finding an advisor and switching to an GRA position. Our graduate program has not only increased from 10 students in Fall 2013 to 17 students in Fall 2017, it has also become more diverse and productive. Our plan to add two faculty members in Materials Physics and PER will lead to additional funding and thus graduate students on GRA positions. The two additional GTA positions will accelerate the recent growth of our PhD program and add an estimated 4-6 students in GRA positions within 3 years.

3) *Tenure-track or senior faculty member in the field of Physics Education Research*: Excellence in teaching and student engagement is one of the pillars of NDSU's strategic vision. CSM, and here especially the Biology and Physics Departments, plays a leadership role in implementing research-based teaching methods and switching from lecturing-centered to active-learning formats of instruction. The new hire in PER will play a key role in facilitating further transitioning toward evidence-based instruction in all our large-enrollment service courses, preferentially with a research focus on the lab component of these courses. While significant progress in research has been made on the institutionalization of active learning in lecture-based courses, research about the interface between lecture-based courses and their lab component is lacking. We currently have insufficient personnel and expertise for implementing innovative evidence-based instructional materials in our physics laboratory courses. The hire in PER together with our plan to request additional GTA support represent a comprehensive effort to rise the quality of our labs to a new level, enhance learning in a lab setting for more than 1000 students annually, and perspective serve as model for other departments. Beyond the focus in lab courses, the new hire will also contribute to multiple interdisciplinary efforts such as serving as a core faculty member of the STEM Education PhD program, facilitating further growth of the LA program, facilitating graduate student professional development and mentoring at the department and University level, and taking on leadership roles in the Faculty Professional Development programs at NDSU (Gateways ND, Faculty Learning communities, Pedagogical luncheons).

The goal of hiring a senior faculty member on the level of Professor is to equip CSM with a recognized national leader who will successfully lead concerted efforts to rise DBER in CSM to the top 25% among comparable programs, is determined to lead large-scale multi-PI grant writing efforts across departments, and brings in knowledge of national developments and funding trends. PER is among the most advanced disciplines in DBER/STEM. This offers unique recruiting potential.

VII. Relation of Hires to University and College Strategic Plans with Respect to Research, Teaching, and/or Outreach: The two faculty hires combine the exclusive focus of the Physics Department in Materials Physics and Physics Education Research with the strategic goals of NDSU and CSM. Specifically, the hire in Materials Physics with a focus on sustainable energy or biomedical applications falls into NDSU's grand challenges of Sustainable Energy and Healthy Populations. The position in Physics Education Research supports NDSU's strategic vision to "improve pedagogical practices". Finally, the two GTA positions register with NDSU's strategic vision item to "increase graduate student enrollment" by providing conditions to add 4-6 graduate students to the physics PhD program.

VIII. Interdisciplinarity, Collaborativeness, and Benefits to Multiple Programs: The two faculty hires exert an impact far beyond the Physics Department. The hire in Materials Physics will strengthen the interdisciplinary MNT program, increase the number of graduate students in that program, contribute to forming a nucleus of material scientists at NDSU that enables the successful submission of large-scale grants, offer opportunities to develop collaborations with the Department of Coatings and Polymeric Materials and the Department of Chemistry and Biochemistry as well as the Colleges of Engineering and Health Professions. Similarly, the hire in PER strengthens CSM's strategic research focus on DBER/STEM, supports multiple NDSU-wide interdisciplinary efforts (Gateways ND, Faculty Learning communities, Pedagogical luncheons), and affects the learning experience of a large group of students from virtually all of NDSU's undergraduate programs. The new hire in PER will be a core faculty member of the STEM Education PhD program. The hire of a senior person in PER would be interdisciplinary and translational by design (with a search open to all DBER fields). The two GTA

positions contribute both to the quality of our physics lab courses for the large-enrollment service courses and to the success of the two new faculty hires. They will also reinforce our efforts to diversify our graduate program, facilitated by our status as Partnership Institution in the APS Bridge Program.

IX. Expected Impact on Revenue Generation: The hire in Materials Physics supports fundamental, high-impact research with potentially large returns on investment through extramural grant support by strengthening the already existing synergy of the faculty working in the Batcheller Technology Center. All physics faculty working in the Batcheller Technology Center serve as PI on at least one major grant. The hire in PER will join a group of faculty who work towards evidence-based approaches to enhance learning outcomes and decrease DFW rates, especially in large-enrollment courses. The two GTAs will teach 3 labs per semester and thus eliminate the need of the Physics Department to receive Enrollment Management Funds for any of its courses/labs. In addition, the two graduate students will contribute to regularly providing tailored help sessions for students in large-enrollment courses, which is one of the goals in the department's strategic plan. Finally, the two GTAs will enhance the ability of physics faculty to secure federal grant support by establishing a continuous pipeline of trained students to serve as GRAs.

X. Required Resources: Recruiting costs for each faculty position are \$2,000, used to place ads in advertising sections of professional organizations such as American Association of Physics Teachers, Materials Research Society, and American Physical Society. This includes access to The Roster of Women & Minorities in Physics (a database of contact, educational, and employment information for several hundred women and minority physicists). Beyond this, we will actively go out, identify talent and recruit high quality candidates by employing the existing networks of our faculty.

Startup package for a tenure-track faculty hire in PER is about \$60,000. Startup package for the hire in Materials Physics is in the range of \$400,000-\$500,000.

9-month scholarship for a GTA position in the Department of Physics is \$18,000.

This plan was written in Aug 2017 and submitted to the Dean of the College of Science and Mathematics on Aug 22, 2017.