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Nomination of Ms. Evgenya Smirnova for the
Outstanding Doctoral Thesis Research in Beam Physics Award

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It is a pleasure to write this letter of nomination for Ms. Evgenya Smirnova for the Outstanding Doctoral Thesis Research in Beam Physics Award. Dr. Smirnova has demonstrated in her thesis research the first accelerator based on a photonic bandgap (PBG) structure. The advantage of this structure is that it supports only the accelerator mode and suppresses the higher order modes that can be excited by wakefields. Dr. Smirnova designed, fabricated and tested this structure on the 17 GHz Haimson Research accelerator at MIT. The results of this research were published in Physical Review Letters in 2005.

We believe that this first demonstration of a PBG accelerator structure is a major advance in accelerator science and engineering. The field of accelerator science has been characterized by a series of "evolutionary" advances. One example of such an evolutionary advance is the use of damping and detuning to develop the structure for the Next Linear Collider (NLC) project. The damped, detuned structure is an excellent design, but it is still a disk loaded waveguide, similar to the structures built many decades earlier. The PBG structure is a totally new approach to the design of accelerator structures. In the structure developed by Ms. Smirnova, the structure uses an array of rods to replace the wall of the cavity. These rods reflect the design mode, a TM_{01}-like mode, while not confining any higher order modes, such as the dipole mode responsible for beam deflection.

The PBG accelerator was first proposed by Smith, Schultz, Kroll and coworkers. They proposed a square array of rods. To further analyze these structures, Evgenya Smirnova developed a computer code, called the photonic band gap structure simulator (PBGSS). Using the PBGSS code, unique calculations were performed, in which the fundamental and higher frequency global photonic band gaps were determined. These universal curves proved useful in PBG cavity design. In addition, for very long wavelengths, where the numerical methods of the PBGSS code are difficult, she derived the dispersion curves using an approximate, quasi-static approach. She further studied numerically the eigenmodes of the 2D PBG cavity formed by a defect (missing rod) in the triangular array of metal rods using the SUPERFISH and HFSS codes. Using the global band gap

curves calculated by the PBGSS code, and the results of SUPERFISH and HFSS simulations, she designed a 2D PBG cavity with reduced higher order modes. According to this design, PBG cavities were constructed for cold test and the results were excellent. That work was published in two major journal articles and represents a major advance in the fields of electromagnetics and accelerators.

Thus, Dr. Smirnova, in the first phase of her thesis research, analyzed the basic theory of the photonic bandgap structure. She produced a generalized theory of metallic PBG structures for both square and triangular arrays of rods. Two major advances came from this theoretical work. First, it was shown that a square array is not usable for an accelerator due to the lack of circular symmetry, while a triangular or hexagonal array is usable. Secondly, it was shown that the ratio of rod radius to spacing in the lattice is a critical parameter of the theory. In particular, if this ratio is too large, above about 0.2, dangerous higher order modes can be excited. Hence, all experimental research was conducted with this ratio at or below 0.2.

Dr. Smirnova then validated these theories by building PBG structures with various rod diameters and cold testing them. This work established the accuracy of the theory. It also paved the way for the design and fabrication of the 17 GHz PBG accelerator test structure. This fabrication was extremely difficult because of the need to design a complete structure and then tune it accurately. The design followed the procedure invented by Kroll and coworkers. The tuning was ultimately accomplished by a technique of controlled copper etching, work carried out in collaboration with Los Alamos National Lab.

The PBG accelerator experiments were conducted at MIT on the Haimson 17 GHz, 25 MeV research accelerator. Using 2 MW of power from a 17.14 GHz klystron, gradients of up to 35 MeV/m were demonstrated in the PBG structure. The experiment showed clear energy gain in the high resolution energy spectrometer at the end of the beam line. The gain was consistent with theoretical predictions. This experiment is the first to show high gradient acceleration with a PBG accelerator structure.

Dr. Smirnova received her Masters degree in Physics at the Nizhny Novgorod State University in Russia in 2002 and her Ph. D. in Physics at MIT in June, 2005. Ms. Smirnova was recognized as one of the most outstanding students at MIT. In her course work, her homework assignments were often used by the teaching assistants or faculty as the solution set for the assignment! She is a truly outstanding young scientist with an extremely bright future ahead of her. She has remained in the field of accelerator science and technology by accepting a postdoctoral position at the Los Alamos National Laboratory. Her ultimate goal is to accept a faculty position in accelerator physics after her postdoctoral position is completed. Several institutions are already showing interest in her even at this early date.

Dr. Smirnova's accomplishments have received major publicity in the scientific press. Her research was published by APS in Physics News as Update Number 741 #2. A copy of that press release is included with the materials submitted in support of this nomination. As the members of the committee are undoubtedly aware, these Physic s News updates are read by a large fraction of the APS membership. The results on the PBG structure thus call attention to a major new idea in our field at a time when such attention is very valuable.

Dr. Smirnova's research has also been publicized on Physics Web (http://physicsweb.org/articles/news/9/8/10/1#0508102). A copy of that article has been supplied with this nomination. This publicity was followed by a brief article in Physics World in the September, 2005 issue, page 4 (the first science report in the issue). A more complete article for Physics World, reviewing the research advance and its implications, is in preparation by Drs. Katsouleas and Muggli of USC and will appear soon in Physics World.

In summary, Dr. Smirnova is a brilliant young scientist who has made a major advance in accelerator science, both theoretically and experimentally. Her work has been highly recognized by the Physics community. She has a very bright future ahead of her in accelerator physics and engineering, including, most likely, an academic career. I very strongly support her for the Outstanding Doctoral Thesis Research in Beam Physics Award.

Richard Temkin