Superconducting undulator with a variable configuration of the magnetic field.

Kanonik P.V., Bragin A.V., Khruschev S.V., Mezentsev N., Shkaruba V.A., Tarasenko O. A., Tsukanov V., Volkov A., Zorin A.V., Erokhin A.I.
Budker Institute of Nuclear Physics, Novosibirsk

Superconducting undulator design.

Based on coils developed at the Budker Institute of nuclear physics for a superconducting undulator with a period of 15.6 mm, a model of a superconducting undulator with variable polarization (SCUVP)with a period of ~40 mm is proposed. The undulator consists of two superconducting undulators placed mutually perpendicular and powered by currents independently. Depending on the different currents values in the windings of the undulator, there is a possibility to create both an elliptical undulator with different elliptic coefficients, and planar undulators with linear radiation polarization at a zero angle both horizontally and vertically. The paper presents numerical calculations of the undulator fields and its spectra.

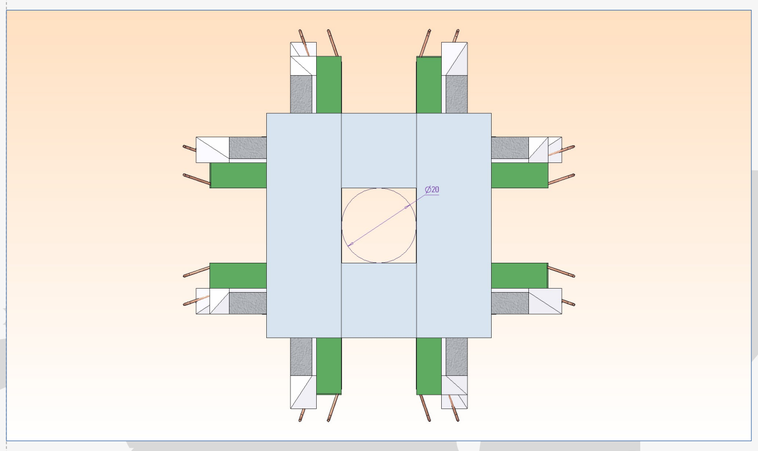


Figure 1: Front view of the undulator.

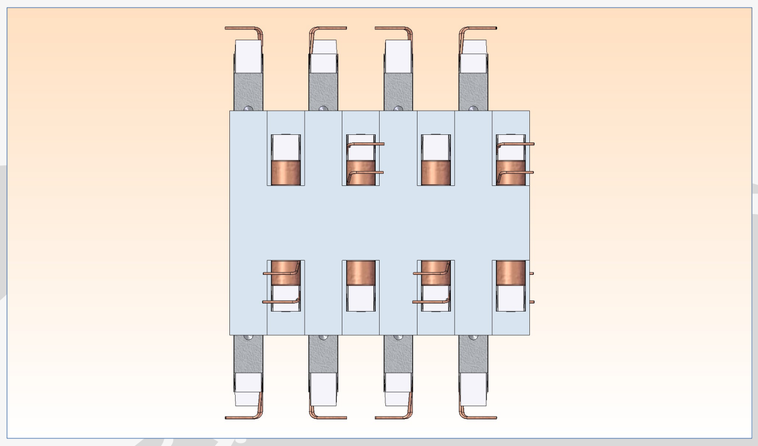


Figure 2: Cross section undulator across.

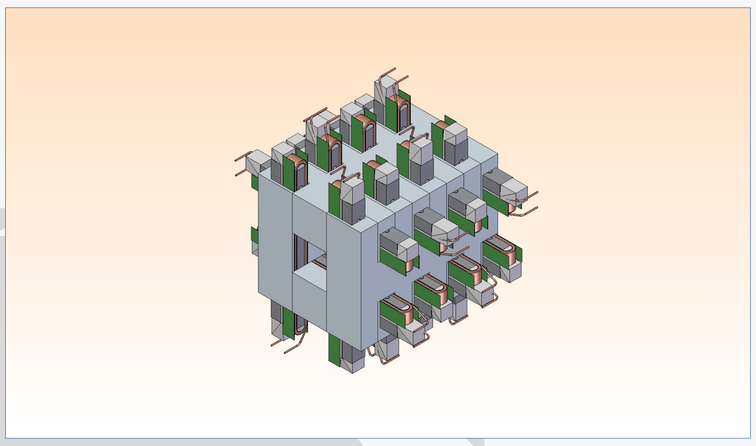


Figure 3: Isometric view of the undulator.

Each period of the proposed undulator consists of 8 coils. The four coils are mutually perpendicular relative to the other four. The coil is wound with a superconducting Nb-Ti wire 0.55 mm in diameter and measures 7.2 mm wide, 146 mm long and 13.9 mm high. The coil is 3 layers wide and 12-11 turns high. In total, 36 turns with current. The core has a size of 4.2 mm, consists of magneto-soft iron and a saturation field of 2 Tesla. The undulator clearance is 2 cm.

Modeling undulator and spectral properties of photons.

To calculate the spectral properties of photons, a program was written in Mathcad to simulate the real conditions of an undulator. The simulation is based on the analytical formula of the magnetic field from a current conductor of finite length. The coil in this case is represented as the sum of the turns. One turn is represented as the sum of conductors with a current of finite length. The result was an undulator 2m long, 44 periods, with a gap of 20 mm, and a magnetic field, 0.5 Tesla. The program used a current of 480 amperes, limited by the critical characteristics of the superconducting wire. The length of 2 meters was chosen on the basis of the fact that this is the standard size of manufactured undulators at the Institute of Nuclear Physics.

The Spectra program version 10.02 was used to calculate the photon spectra. The supposed photon stream was viewed at a distance of 30 meters, at a solid angle of 10 microradians.

Nominal magnetic field Bz, Tesla	-0.5-- +0.5
Nominal magnetic field Bz, Tesla	-0.5-- +0.5
Period, mm	40-45
Phase error, grad	<3
Vertical/horizontal beam aperture, mm	16/16
Pole gap, mm	20
Period number	44
Magnet length, mm	~2200
Flange to flange distance, mm	~2840

Figure 4: Undulator parameters table.

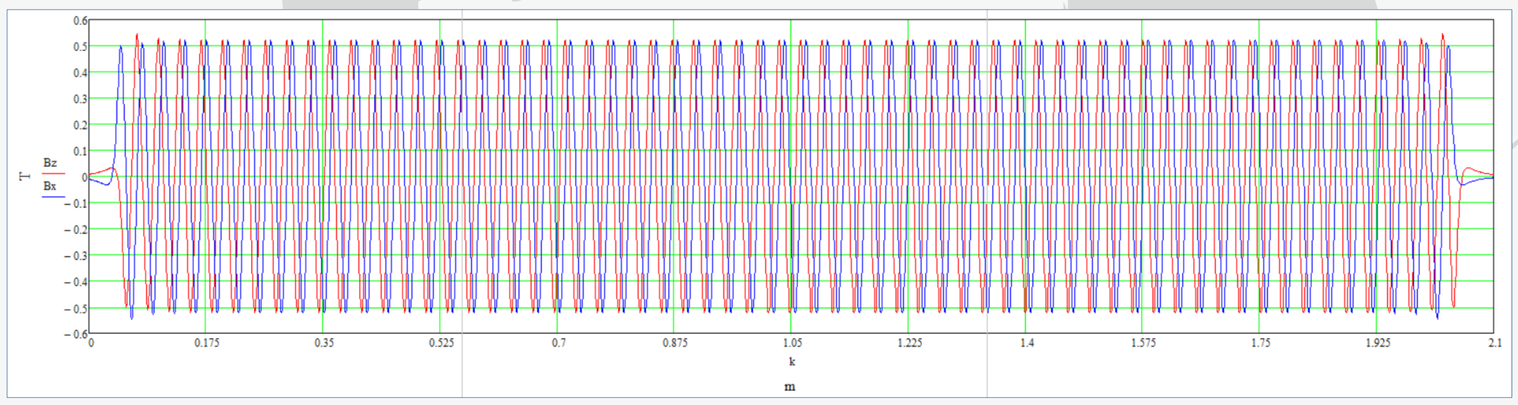
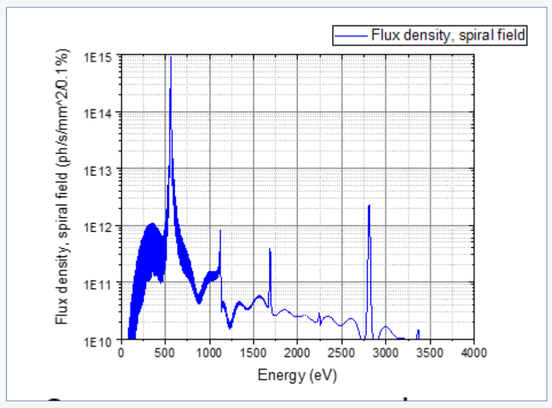


Figure 5: Modeling magnetic field.

Spiral undulator with changeable helicity Bx=0.5 Tesla, Bz=0.5Tesla Spectrum at zero angle



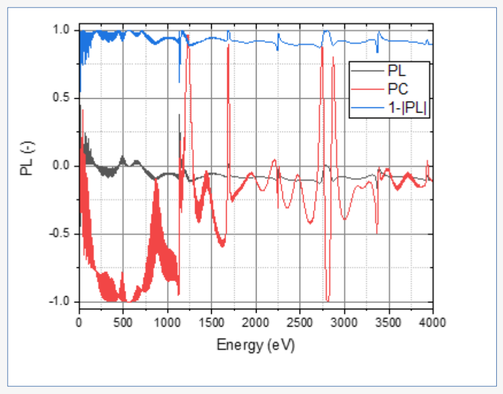


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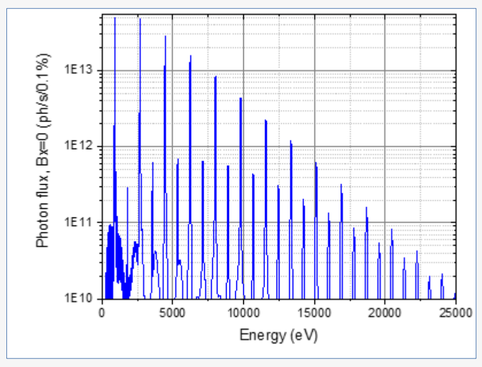
Figure 6: Graphs of the spectral properties of photons. Flux , circular and linear polarization.

Undulator with horizontal Linear polarization Bx=0, Bz=0.5 Teslaa Spectrum at zero angle



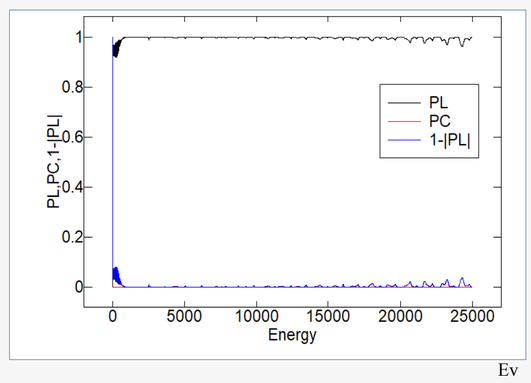


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Figure 7: Graphs of the spectral properties of photons. Flux , circular and linear polarization.

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