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The Brookhaven Free-Electron Laser Experiment*

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Résumé - On décrit l'état d'advancement de l'experience du laser à electrons libres a Brookhaven, ainsi que l'onduleur à aimants permanents déja construit et pret à etre installé sur l'anneau de stockage VUV.

Abstract - The status of the free-electron laser experiment at Brookhaven is reported, with the description of the permanent undulator already built and ready to be installed on the VUV storage ring.

SUMMARY

Free Electron Lasers in the UV spectral region can be built using the electron beam of an electron storage ring. The small beam size and energy spread, and the large peak current obtainable in storage rings can be used to design a free electron laser with a large signal gain in the UV.

The interaction of the electron beam with the laser radiation field modifies the electron beam characteristics, limiting the laser output power. According to our present theoretical understanding of this system, the laser beam output power and line width would make this system a unique coherent radiation source in the UV, possibly extending to wavelengths of the order of 50 nm.

The Brookhaven experiment has the primary objective of studying the physics of the electron storage ring - free electron laser system.

We describe the experimental apparatus: the undulator, the laser system for the amplification experiment, the optical output beamline. The free electron laser uses a permanent magnet undulator with a period length of 6.5 cm and 39 periods. The undulator has been built and its field measured, resulting in satisfactory agreement with the requirements.

Figure 1 shows the undulator, that will be mounted inside a vacuum tank, with this tank removed. From the picture, the mechanical structure of the magnet, with variable gap and the rotatable end magnet blocks to correct the field integrals are visible. Fig. 2 shows the measured field vs. gap.

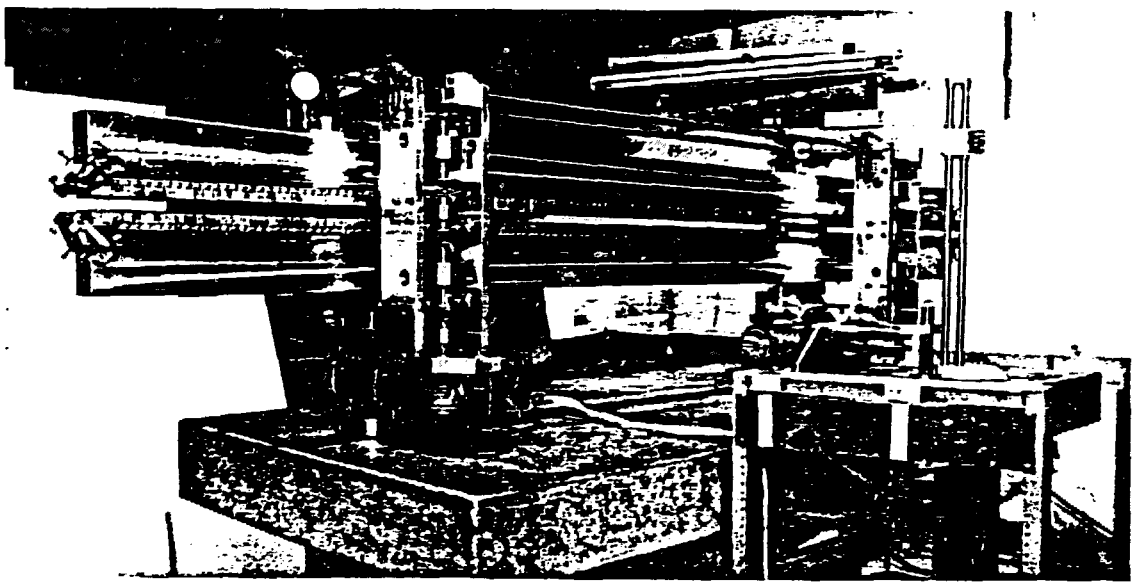

Fig. 1. Permanent Magnet Undulator.

The initial measurements will be done on the spontaneous undulator radiation, and then on the amplified radiation from an Argon laser at 350 μm, using a monochromator and a two-stage demodulation system on the signal from a photodetector, in order to increase the signal-to-noise ratio. For the amplification experiment, the storage ring will be operated at an electron energy of 350 MeV and the magnetic field in the undulator, and consequently its magnetic K value will be kept as high as it is practicable.

As a next step we will try to make the free electron laser to self-start and reach an oscillatory steady state regime with an expected laser output power of the order of 10 W, with a relative line width of 10^{-6}. Subsequently, the system will be operated at shorter wavelengths, by increasing the electron energy in the storage ring.

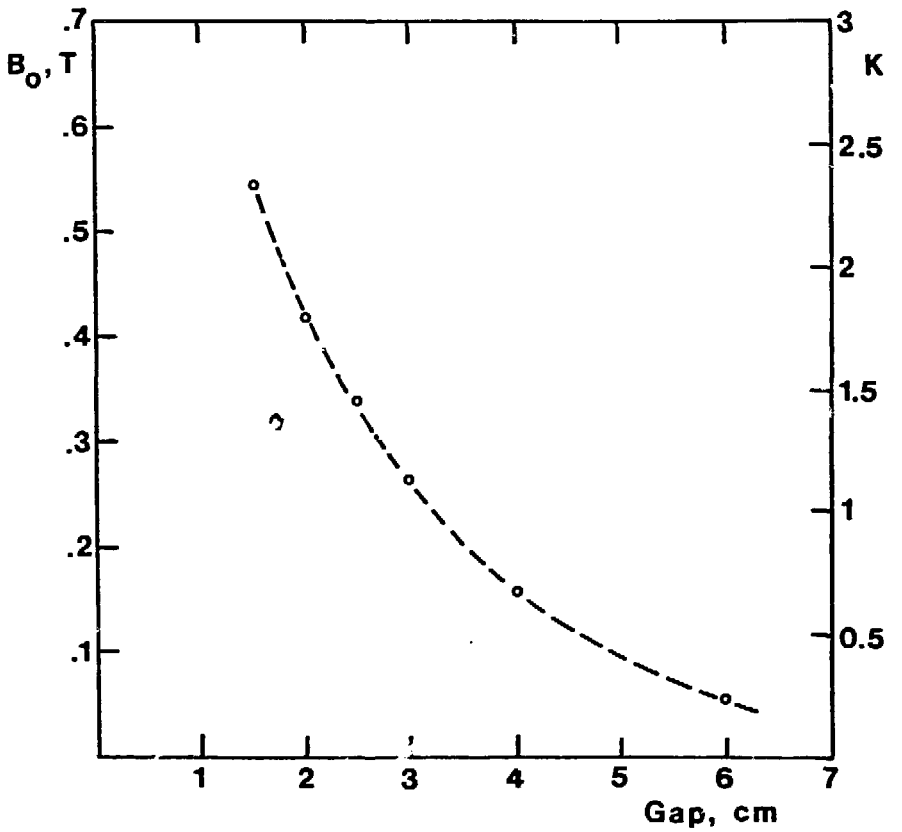

Fig. 2. Measured Undulator Peak Magnetic Field vs. Gap.