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APS Interests in PEP

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As one of the very few high-energy electron storage rings in the world, potentially available for synchrotron radiation studies, PEP represents an opportunity to accomplish certain preconstruction R&D tasks relevant to the successful construction and operation of dedicated user facilities such as the Advanced Photon Source (APS) at Argonne. The discussion below is divided into three topical areas: Accelerator R&D, Insertion Devices (ID) R&D, and Beam Line Instrumentation R&D.

Accelerator R&D:

The APS storage-ring is quite different from PEP in its lattice design. The result is that there are no R&D activities which can be carried out on PEP that are essential to the successful design of APS. Nevertheless, as outlined in the report from the Accelerator Physics subgroup, there is much that can be done to advance the frontiers in research areas which are of common interest.

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We recommend continued dialogue between the accelerator staff of the APS and of PEP to identify subjects where collaborative studies will be mutually beneficial. As mentioned below, the study of the minimum aperture compatible with an 8-GeV low emittance lattice on PEP should be an early subject of study. In order to proceed to test and use x-ray undulators of the type to be provided in quantity by the APS facility, it is essential to achieve 1 cm beam stay-clear in the vertical direction. These studies should be high-priority during the FY1988 dedicated-run, so that the program can proceed to produce undulator beams which will closely resemble those expected from the APS. The R&D program described below can then be carried out in the future years as additional dedicated time becomes available on PEP.

Insertion Device R&D:

The 8-GeV low emittance PEP lattice will provide an excellent opportunity to evaluate the performance of the 3.3 cm period prototype undulators designed for the APS. This prototype will also provide superior spectral quality of the radiation from PEP compared that produced by the 7.7 cm period devices presently in place on the PEP storage ring (see Fig. 1) for use during parasitic running.

The operation of the 3.3 cm period APS prototype undulator will require the use of small-gap ID vacuum chamber (see Table 1). Hence, it is essential to complete the following studies during FY88 prior to the installation of the new undulator:

a) Injection rate studies on the PEP storage ring in the presence of small vertical apertures (scrapers). The minimum aperture should be under 1.5 cm.

b) Study of maximum current that can be stored and its effects on the lifetime of the stored beam in the presence of small apertures.

The undulator performance studies to be carried out during FY89 and beyond are focussed on the spectral characteristics and comparing them with those simulated on the computer. The main goal is to define the minimum mechanical and magnetic tolerance fur these undulators that would adequately meet the APS user needs. This would eliminate the over-design of undulator tolerance factors and consequently hold the undulator costs down.

The operation of the undulator on PEP will also provide an opportunity to study the interaction of the device on the stored-beam. One important APS related issue concerns the stability of the beam in the rest of the ring during the variation in the magnetic gap of the undulator. It is essential to build and test electron and photon beam monitors and feedback procedures needed to stabilize the stored beam to the required accuracy.

Beam Line Instrumentation R&D:

The power densities and their gradients produced by the APS undulators is vary large. Hence, considerable R&D effort is essential to evaluate the performance of the beam line components . This is best performed on the PEP storage ring using the radiation from the APS prototype undulator.

Following tasks have been identified:

a) Evaluation of various cooling schemes for the first optics including liquid Ga cooling and cryogenic cooling.

b) Optimizing the cooling procedures and geometries and comparing the measured thermal distributions with those provided by the finite-element engineering analysis.

c) Testing of the long- and short-term mechanical, thermal and structural stabilities of the front-end components and x-ray optics.

d) Testing of the performance and stability of superlattice optics subjected to large power densities.

e) Comparing ray-tracing procedures and results currently being developed at Argonne for a given undulator beam line optics with an actual beam line performance.

PEP/8 GeV/100 mA/LEO/Envelop of Peak Brilliance

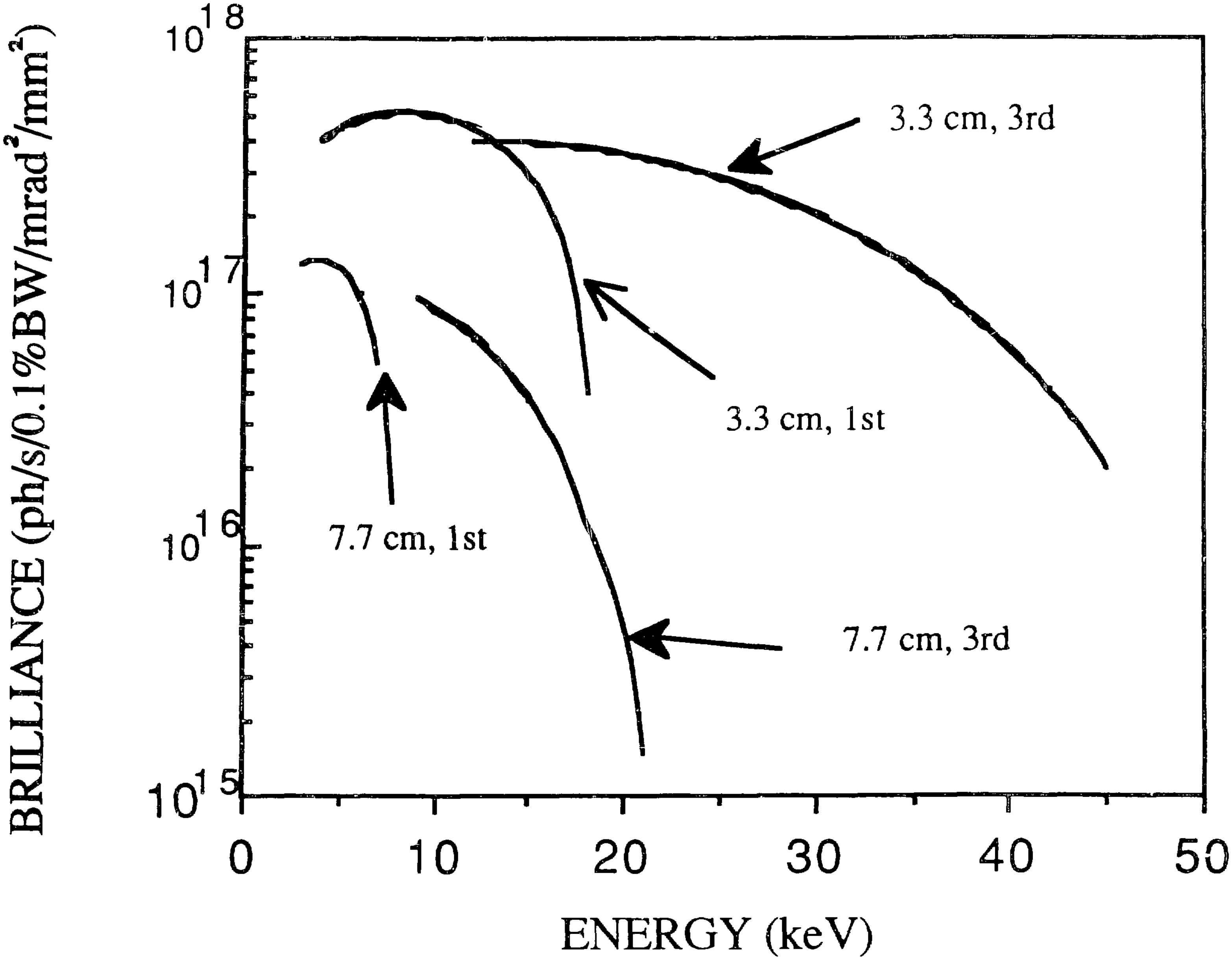

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TABLE 1. PARAMETERS OF TWO UNDULATORS ON PEP

First Harmonic Energy (keV)	LEO 8-GeV PEP 3.3 cm period Nd-Fe-B Hybrid			CBO 14.5 GeV PEP 7.7 cm period Pure REC		
	Gap (cm)	K	Brilliance* 10^{17}	Gap (cm)	K	Brilliance* 10^{15}
6.0	1.15	2.0	4.8	3.14	2.6	2.9
8.0	1.36	1.6	5.1	3.62	2.1	3.0
10.0	1.55	1.3	5.0	4.04	1.8	3.0
12.0	1.77	1.0	4.5	4.42	1.5	2.9
14.0	2.03	0.8	3.5	4.80	1.3	2.7
16.0	2.44	0.6	2.2	5.20	1.1	2.6

* Brilliance is calculated for a 2.0 m long undulator using the specified horizontal and vertical emittance values for the CBO or LEO and 100 mA of stored current. The units are ph/sec/0.1%BW/mrad^2/mm^2. The values for brilliance result from a Monte-Carlo calculation.