Insertion Device

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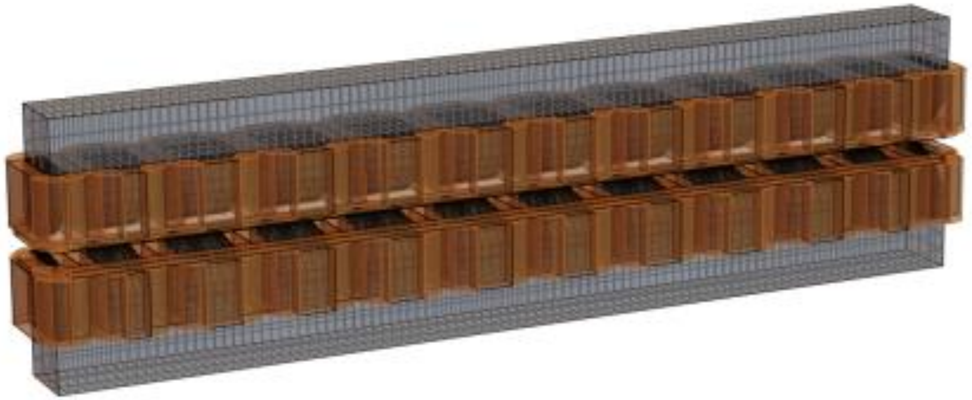
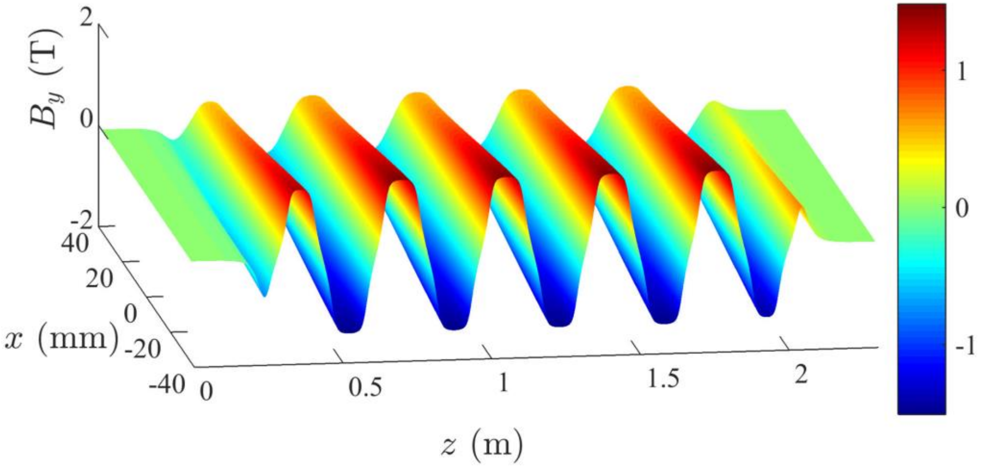
목차

Development of Insertion Device

- 1953: Magnetic Array
- 1951:Theory of Undulator
- 1958: Robinson Wiggler
- 1976: Feasibility of Undulator
- 1977: Development of Undulator





Features of the Wiggler for machine control

- K factor

Undulator

- Small K parameter($K \ll 1$)
- Narrow Radiation Angle
- Multiple Peaks
- Low Brightness

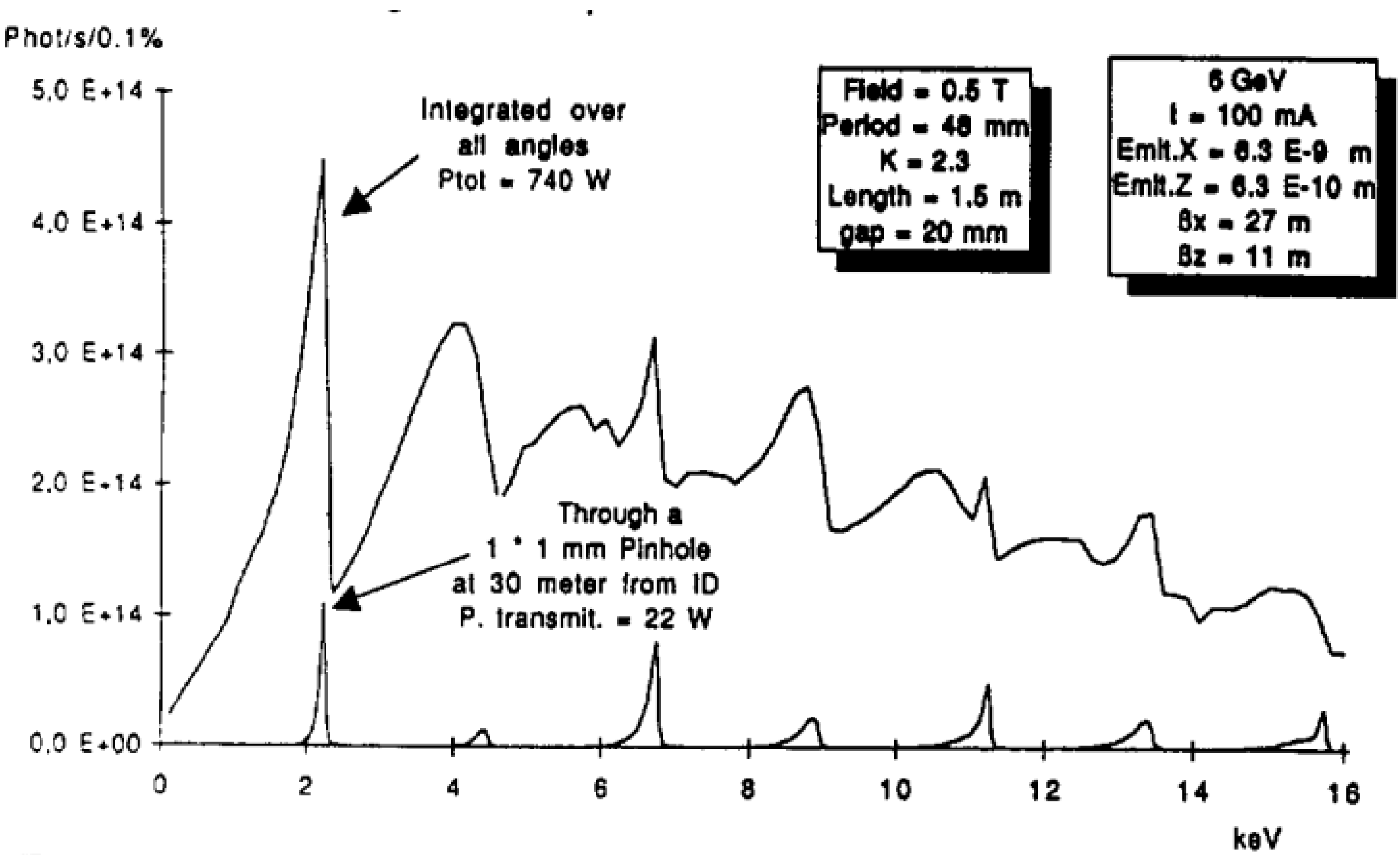


Fig. 3 Spectrum of an undulator installed at the ESRF

Wiggler

- Large K parameter($K \gg 1$)
- Wide Radiation Angle
- Continuous Spectrum
- High Brightness
- Multi Usage

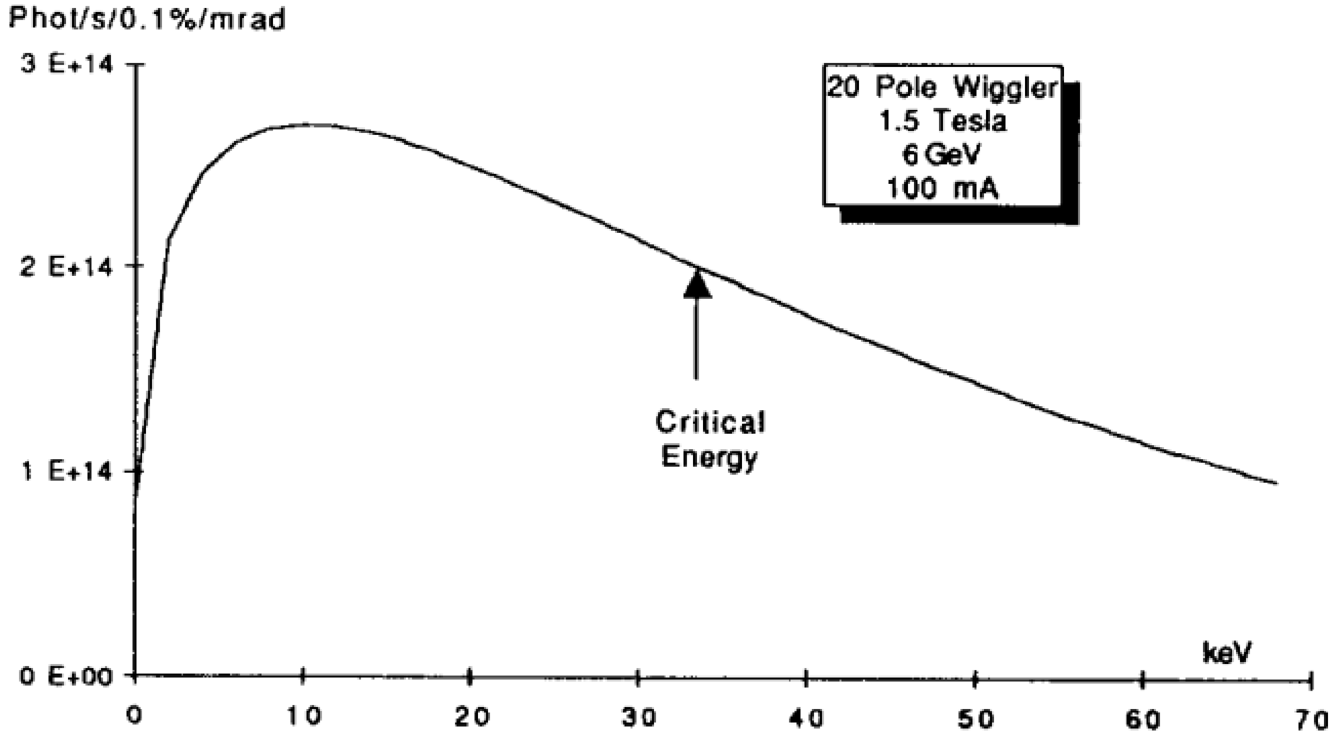


Fig. 2 Flux from a Wiggler installed at the ESRF

Comparison

	Undulator	Wiggler
K Parameter	$K \ll 1$	$K \gg 1$ (Generally $K > 3$)
Radiation Angle	Narrow	Wide
Spectrum	Harmonic Waves	Continuous Spectrum
Total Spectrum Width	Narrow	Broadband
Coherence (Time, Spatial)	Coherent	Incoherent
Usage	FEL(Free electron LASER)	XRD, XRD

Comparison

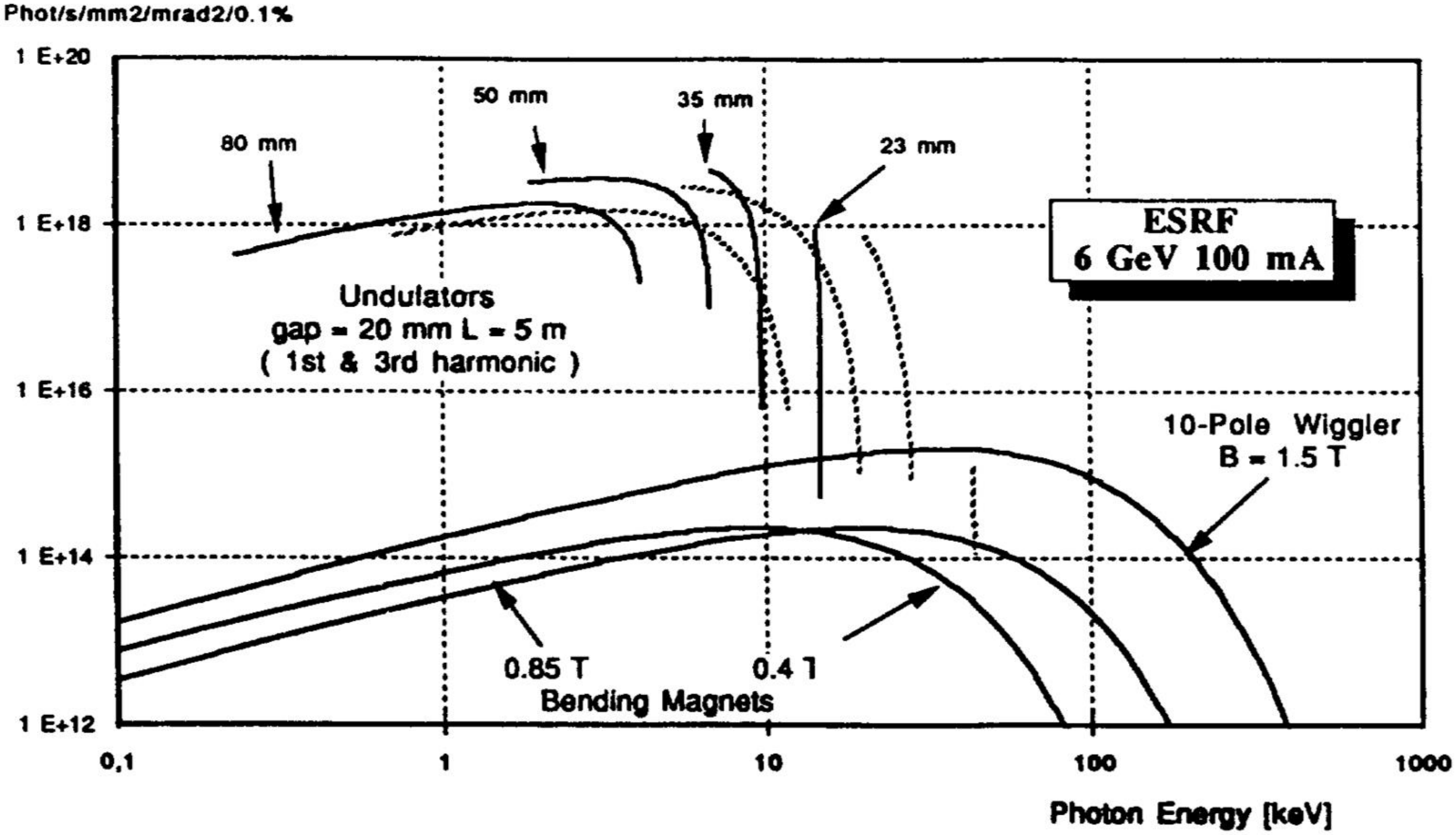


Fig. 4 Brilliance of various undulators and wigglers installed at the ESRF

Quantities of Synchrotron Radiation

- Spectral Flux

- Spectral Brightness

Computation of The Synchrotron Radiation

- $\mathcal{F}(\omega, \vec{n}, \vec{u}) = \alpha \Delta\Omega \frac{\Delta\omega}{\omega} \left| \sum_{j=1}^{\mathcal{N}} \overrightarrow{A_j(\omega)} \vec{u} \right|^2 = \alpha \Delta\Omega \frac{\Delta\omega}{\omega} \sum_{i=1}^{\mathcal{N}} \sum_{k=1}^{\mathcal{N}} (\overrightarrow{A_k\ (\omega)} \vec{u})(\overrightarrow{A_k^*(\omega)} \vec{u})$

- $\alpha = \frac{\mathrm{e}^2}{4\pi\epsilon_0 \hbar \mathrm{c}}$ (Fine Structure Constant)

- $\overrightarrow{A_j(\omega)} = \frac{\omega}{2\pi} \int_{-\infty}^{+\infty} \vec{n} \times \left(\vec{n} \times \overrightarrow{\beta_j}\right) e^{i\omega\left(t - \frac{\vec{n}\overrightarrow{r_j}}{c}\right)} dt$ (Complex Amplitude Vector)

Polarization of Synchrotron Radiation

- $P_1 = \frac{\mathcal{F}_x - \mathcal{F}_z}{\mathcal{F}_x + \mathcal{F}_z}$ Normal Linear Polarization Rate
- $P_2 = \frac{\mathcal{F}_{45} - \mathcal{F}_{135}}{\mathcal{F}_{45} + \mathcal{F}_{135}}$ Linear Polarization rate at 45 Degrees
- $P_3 = \frac{\mathcal{F}_R - \mathcal{F}_L}{\mathcal{F}_R + \mathcal{F}_L}$ Circular Polarization rate
- $P_1^2 + P_2^2 + P_3^2 \leq 1$

Citation

- Sympletic tracking methods for insertion devices: a Robinson wiggler example Ji Li,∗ J¨org Feikes, Tom Mertens, Edward Rial, Markus Ries, Andreas Sch¨alicke, and Luis Vera Ramirez Helmholtz-Zentrum Berlin f¨ur Materialien und Energie GmbH (HZB), Albert-Einstein-Straße 15, 12489 Berlin, Germany
- Bharti, Amardeep & Goyal, Navdeep. (2019). Fundamental of Synchrotron Radiations. 10.5772/intechopen.82202.
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- Elias, Luis R. and Fairbank, William M. and Madey, John M. J. and Schwettman, H. Alan and Smith, Todd I. (1976) Observation of Stimulated Emission of Radiation by Relativistic Electrons in a Spatially Periodic Transverse Magnetic Field 10.1103/PhysRevLett.36.717
- R. H. Helm, M. J. Lee, P. L. Morton and M. Sands, "Evaluation of Synchrotron Radiation Integrals," in IEEE Transactions on Nuclear Science, vol. 20, no. 3, pp. 900-901, June 1973, doi: 10.1109/TNS.1973.4327284. keywords: {Synchrotron radiation;Magnets;Damping;Electron beams;Storage rings;Linear accelerators;Particle beams;Linear approximation;Compaction;Energy loss}.
- Ji Li (Helmholtz-Zentrum, Berlin), Jörg Feikes (Helmholtz-Zentrum, Berlin), Tom Mertens (Helmholtz-Zentrum, Berlin) Edward Rial (Helmholtz-Zentrum, Berlin), Markus Ries (Helmholtz-Zentrum, Berlin) et al. (2022) Sympletic tracking methods for insertion devices: a Robinson wiggler example