Introduction to Superconducting Undulators

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Concept

X-ray
**Permanent Magnet Undulator**
- Traditional design
- Controlled env.
- Cheaper design
- Low performance

**In Vacuum Undulator**
- UHV vacuum pipe
- Reduced distance of magnets
- Good performance

**Cryogenic Undulator**
- Improved B field
- Increased complexity
- Better performance

**Superconducting Undulator**
- Highest B field
- 4 K design
- Electromagnet
- Best performance
Planar and helical NbTi devices operate in rings (ANL APS, KIT KARA)

$\text{Nb}_3\text{Sn}$ and 2G HTS demonstrators have been built

Most active institutions

US: ANL, LBNL, FNAL
EU: STFC, KIT, XFEL, PSI
China: SHINE
Russia: INP-Budker

Chart based on: https://doi.org/10.1016/j.nima.2018.03.069
SCUs for: ILC, HEP and FELs

• Helical SCUs for the ILC polarized positron source: potential for higher field on axis, shorter length, larger aperture.

• HTS wigglers for the ILC damping rings: potential for improved radiation tolerance and machine reliability

• EuPRAKXIA undulator line: considerably increases operation flexibility

• Gamma-Gamma colliders: potential to improve machine performance

• New FELs and SRs: allow reaching higher beam energies and harder x-ray ranges

• Existing FELs and SRs: significant machine upgrade with minimal investment