INSERTION DEVICES II

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Five presentations were given:

1- Alexander Temnykh, LNS-Cornel Univ.: Apparatus for periodic magnetic structure tuning
2- George Rakowsky , NSLS: Measurement of small-gap insertion devices
3- Johannes Bahrdt, BESSY: Magnetic measurements of Apple II Type undulators
4- Alexander Temnykh, LNS-Cornel Univ.: Some aspects of the use of vibrating wire technique for a wiggler magnetic field measurement
5- Oleg Chubar, ESRF: RADIA, a 3D magnetostatics computer code

1-Apparatus for periodic magnetic structure tuning (A Temnykh)

- The measuring equipment is similar to conventional pulsed wire setup but it is treated here in the frequency domain. The length of the vibrating wire is an integer number of the magnetic structure period. The wire covers a longitudinal portion of the magnetic structure.
- The wire motion is analyzed using a sinusoidal input current at various frequencies.
- Measurements using sufficient number of vibrating modes (16) enable the longitudinal reconstruction of the magnetic field from derived field harmonics.
- Localized field errors can be determined within a spatial resolution of 2 cm and a typical R.M.S noise of 1.5e-4 in terms of dB/Bmax.
- The measuring equipment is simple and cheap and can be used in very small aperture magnet
- As pointed out from the audience, a detailed comparison of the method with conventional measurement techniques (Hall probes) could nicely complement the study.

2-Measurement of small-gap insertion devices (G Rakowsky)

- The presentation is a detailed overview of the various measurement techniques used in insertion devices. Their limitations are analyzed when the measurements of very small gaps (smaller than 3 mm) structures are considered.
- Field integral measurements:
  A number of methods become useless due to the very confined space:
  - rotating coils
  - translating coils.

  Partially usable:
  The stretched wire can be used for the measurement of the normal integrated multipoles only.
  The pulsed wire technique may be the only reliable alternative:
  - allows first and second integral measurements in both planes
  - possible tuning of electron trajectory.

- Local field measurements:
  Presently, the only reliable method is based on Hall sensors (phase shimming) but:
  - the spatial resolution of conventional sensors is not adequate
  - the vertical hall sensors (SENTRON) could be suitable if adapted to the need (90 degree rotation of the sensor)

3-Magnetic Measurements of Apple II type undulators (J Bahrdt)

- Apple II type undulators will represent 50 % of permanent magnet insertion devices at BESSY within end of year 2002.
- Apple II structure are very complicated, the field quality is strongly dependent on magnet block homogeneity and geometrical tolerances. Specific shimming methods have to be adapted to the need (virtual shimming based on block displacements, small magnet shims and magic fingers).
- The magnet blocks from different suppliers have similar non homogeneous magnetization. A dedicated measuring setup (mini stretched wire bench) has been constructed to fully characterize individual magnet blocks.The resulting data are used in a sorting algorithm to minimize both field integral components and optical R.M.S phase error on the complete structure.
- Magnetic measurements seem to confirm the predictions within a few specific errors to be understood.
- Developments aiming at the reduction of the time spent on magnet block characterization appear as key issues for large scales production.

4-Some aspects of the use of vibrating wire technique for a wiggler magnetic field measurement (A Temnykh)

- The usual field measurement methods for insertion devices are performed along straight lines. They generally allow good prediction of the trajectory experienced by particles inside the insertion device field. The magnetic field seen by a particle along the wiggling path can be in some specific cases slightly different from the field along a straight line. Form this difference a number of undesirable effects on the beam dynamics can originate.
- The presented measuring method rely on the vibrating wire with an added dc current
- The ratio Idc/(wire tension) is made equal to the quantity (particle charge)/momentum to reproduce the particle trajectory.
- The field integral is measured using the first vibrating mode.
- The predicted integrals (using measured field across a single pole) are in agreement with measurements.
- The measurements confirm an effect predictable at the magnetic design stage. It can be derived using non-linear integration in the calculated 3D field for example.

5-RADIA, a 3D magnetostatics computer code (O Chubar)

- The RADIA code is a 3D magnetostatic software based on volume integrals.
  It provides fast computation of the magnetic field and field integral from conductors, permanent magnets and iron like materials in 3D space. It should be seen as a complementary tool to 3D F.E.M codes.
- The magnetic field and field integral along a straight line are calculated analytically from elementary uniformly magnetized volumes (polyhedrons)
- The software includes space transformations and various types of symmetries to allow simplification of the models.
- Soft iron like materials can be described with non-linear properties. A dedicated relaxation method is used for materials with non unit permeability
- RADIA is written in C++ and take full advantage of the class structure available in this programming language
- The software is presently interfaced with Mathematica on various platforms (Windows, Linux and MacOs operating systems). It can be downloaded from the ESRF web site.
- Future developments include in particular the release of the code as a DLL for possible interfacing with other codes.