MAGNETIC SHIMS STUDIES FOR APS-U HYBRID PERMANENT MAGNET UNDULATORS*

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ABSTRACT:
- For the newly designed and fabricated APS Upgrade (APS-U) hybrid permanent magnet undulators (HPMUs), the development of magnetic shims has been critical to successfully tuning the undulators to meet the tight APS-U physics requirements.
- Different types of side and surface shims have been developed and applied for this purpose.
- The side shims are primarily used for trajectory tuning, and the surface shims are for phase and multipole tuning as well as trajectory tuning.
- Current design, applications, and measurement of the shims for the newly designed and fabricated APS28 (28 mm period) undulators are presented in this paper.

INTRODUCTION:
- New undulators and new physics requirements for APS-U storage ring. The first article of APS28 undulator on measurement bench:
  - Development of new shims is critical to for tuning new APS28 undulators. Key factors: gap dependent signatures and magnetic stability.

SIDE SHIMS:
- Placed on sides of a pole
- Secured to the keeper
- Stackable 0.5-mm-thick

Trajectory tuning (APS28#12S)
- 6 pairs of side shims
- Locations (red dots)
- Normal dipole signature

Trajectory before tuning:

Trajectory after tuning:
CONCLUSION:

- After several design iterations and tests, the current design of side shims and surface shims have been proven successful.
- With a newly developed phase tuning method and an algorithm-guided tuning methodology all 13 newly fabricated APS28 undulators have been tuned to the APS-U specifications.
- The design has also been successfully extended to the shorter undulator period lengths of 25 mm and 21 mm for the APS-U.