Recent ID Developments at the APS

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on behalf of the MD group

APS/Users Monthly Operations Meeting

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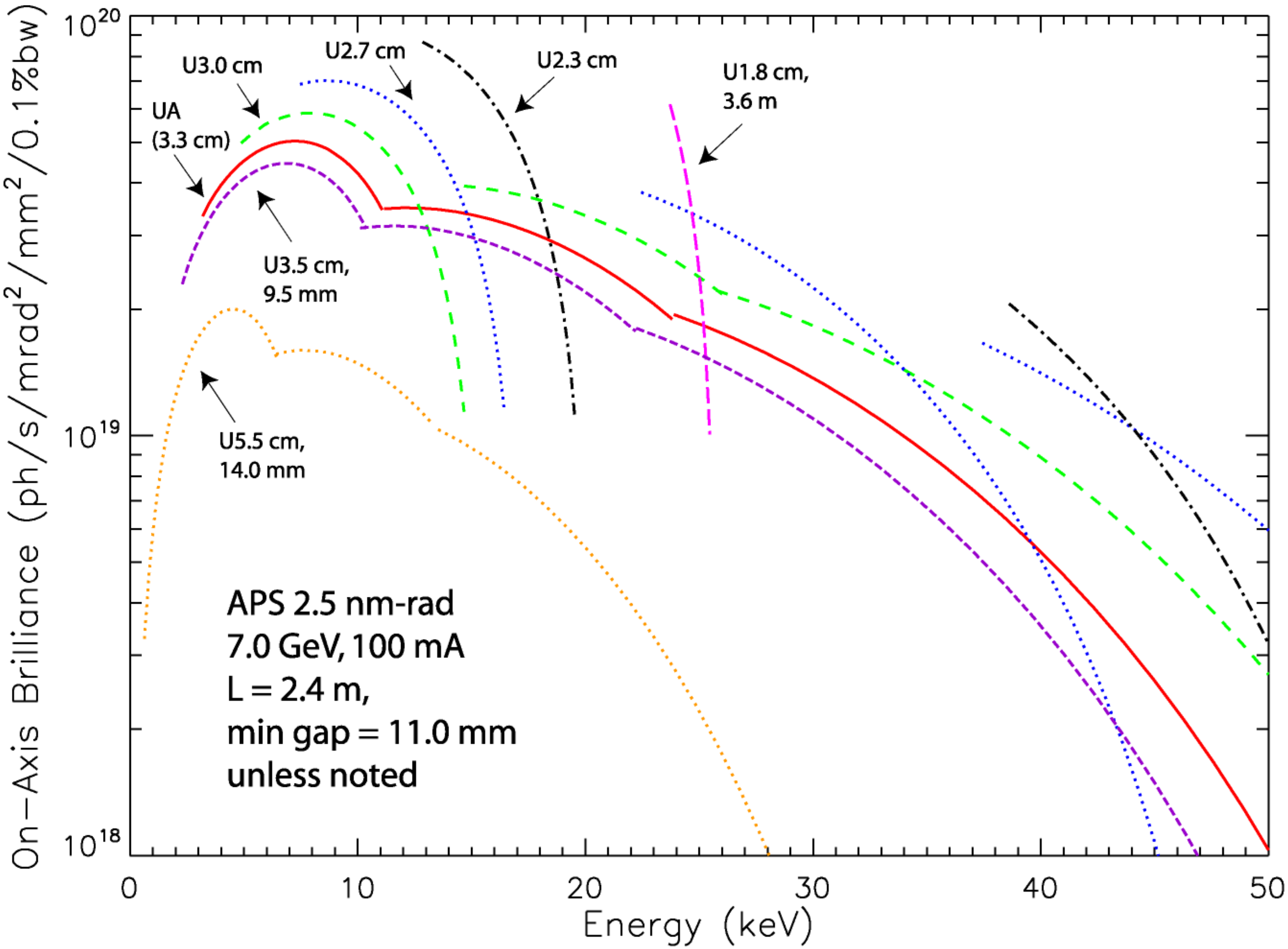
APS IDs installed as of January 2012

Period length	Number	Length (periods)	K_{eff}
33-mm (Undulator A)	23	72	2.74
33-mm	7	62	2.74
18-mm	1	198	0.46
23-mm	3	103	1.17 [a)]
27-mm	3	88	1.78
30-mm	2	79	2.20
30-mm	6	69	2.20
35-mm (SmCo)	1	67.5	3.08 [b)]
55-mm	1	43	6.57
128-mm (Circularly Polarized Und.)	1	16	$K_{x,y}<2.8$

Device length includes the ends - approx. one period at each end is less than full field strength.
K value is at 10.5 mm gap unless stated otherwise. CPU is all-electromagnetic.
[a)] at 10.6 mm gap.
[b)] at 9.5 mm gap.

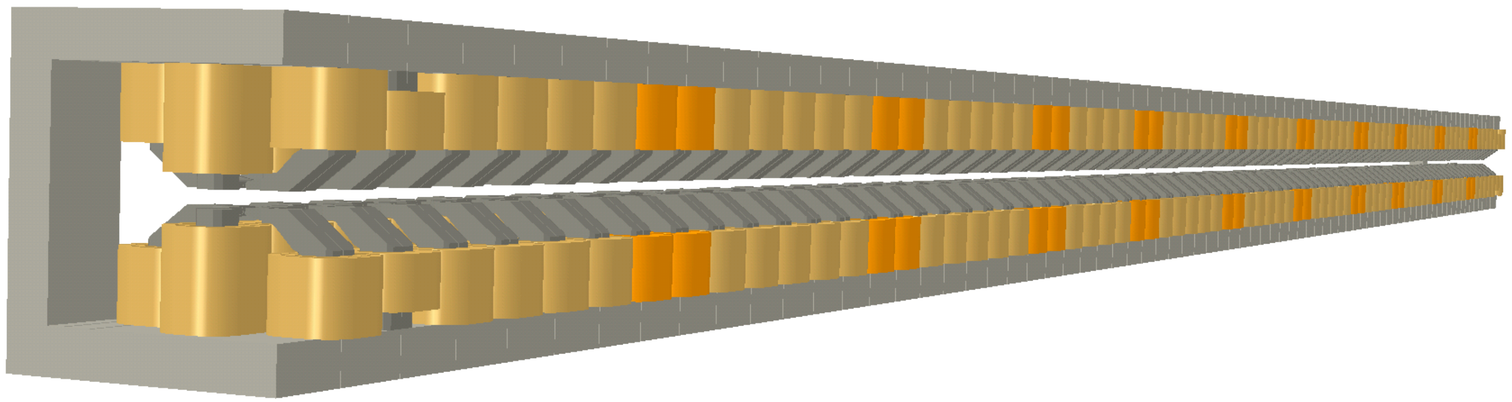
Total: 48 IDs

On-Axis Brilliance: Undulators of Various Period Lengths



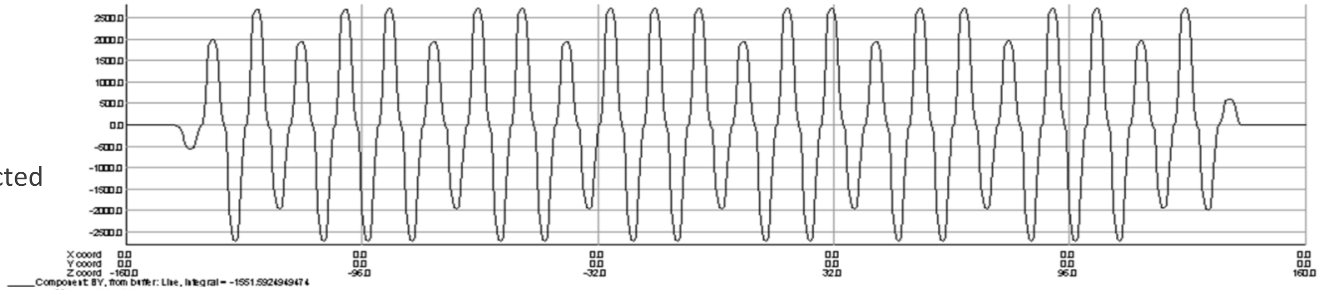
Shorter period gives higher brilliance, at higher photon energies. But tuning range is lost and gaps develop between 1st and 3rd harmonics (seen here for 2.7 and 2.3 cm period lengths) because of limited field strength.

Electromagnet IEX Device Can Be Periodic or Quasi-periodic

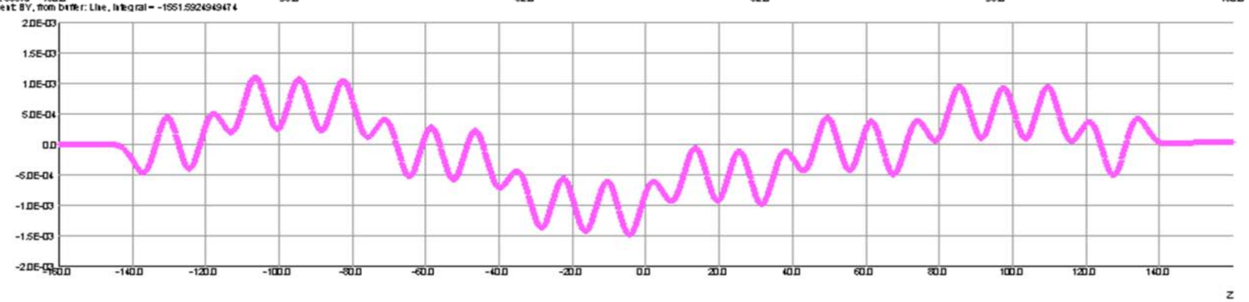


Quasi-periodic Field

The field is reduced at selected poles[1]

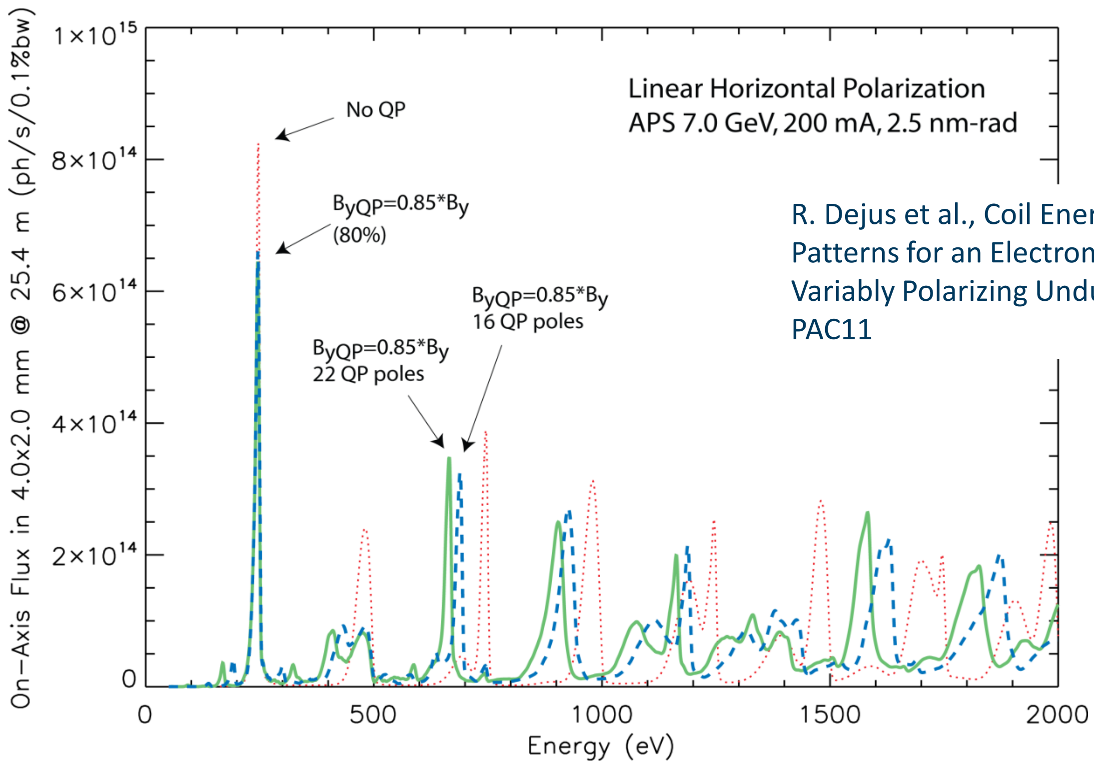


Quasi-periodic Electron Trajectory



[1]S. Sasaki, Overview of Quasi-periodic Undulators, PAC09

Quasi-periodicity Helps to Suppress the Higher Harmonics



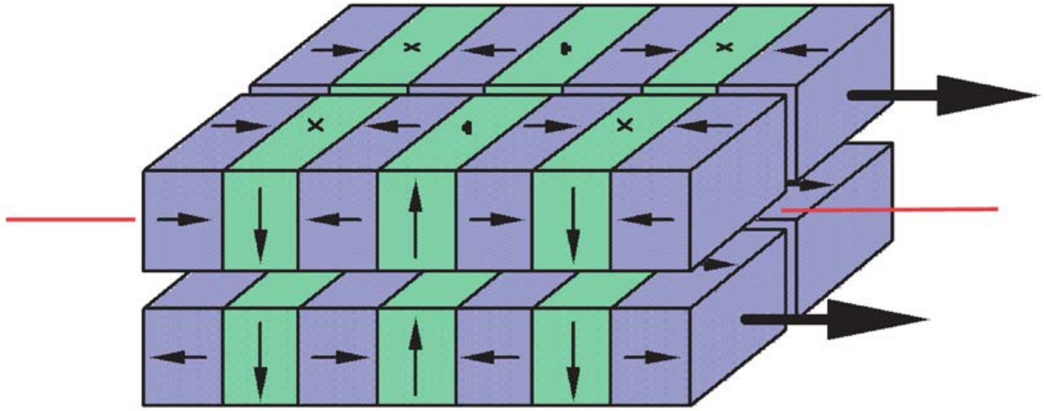
R. Dejus et al., Coil Energizing Patterns for an Electromagnetic Variably Polarizing Undulator, PAC11

Flux in linear horizontal polarization mode at 250-eV first-harmonic energy for two different QP patterns with reduced magnetic field at the QP poles (85% of regular field). The higher harmonics are shifted to lower energies with the QP turned on. The energy shift is smaller for the 16-pole pattern (blue dashed curve). The flux of the third harmonic is reduced to ~ 8% and the second harmonic is reduced to less than 50% for both patterns. The first harmonic is reduced by ~ 20%.

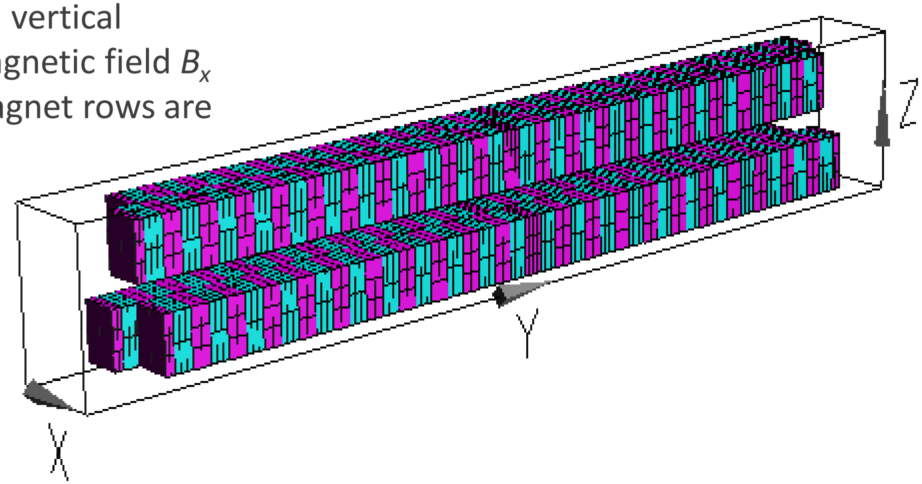
IEX undulator

IEX undulator team

APPLE-II Undulator Magnet Design (Schematic)



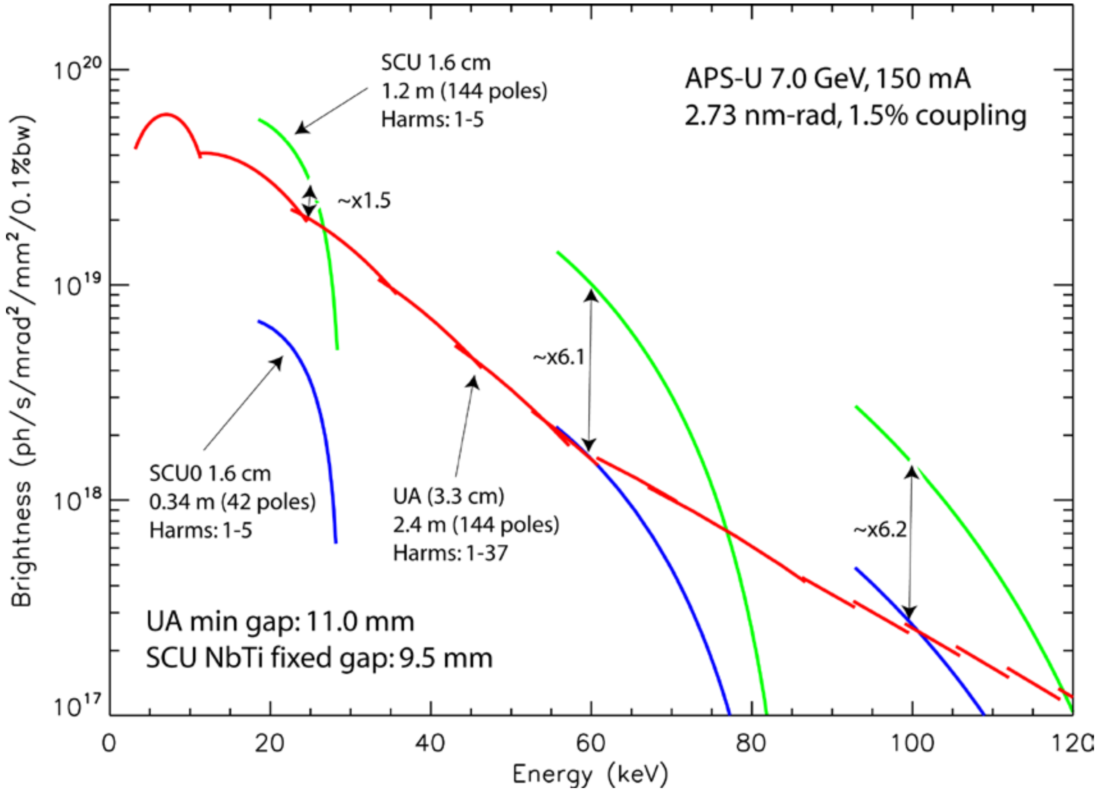
Schematic model of APPLE II device. The magnetization direction of each magnet block is indicated by the small arrows on the magnets. The large arrows indicate the two movable rows: one above the mid plane of the electron beam (red line) and one diagonally located below the mid plane. The case shown here produces only a vertical magnetic B_y in the center. The horizontal magnetic field B_x becomes non-zero on-axis when the two magnet rows are translated to the right.



First two SCU undulators

APS superconducting undulator specifications

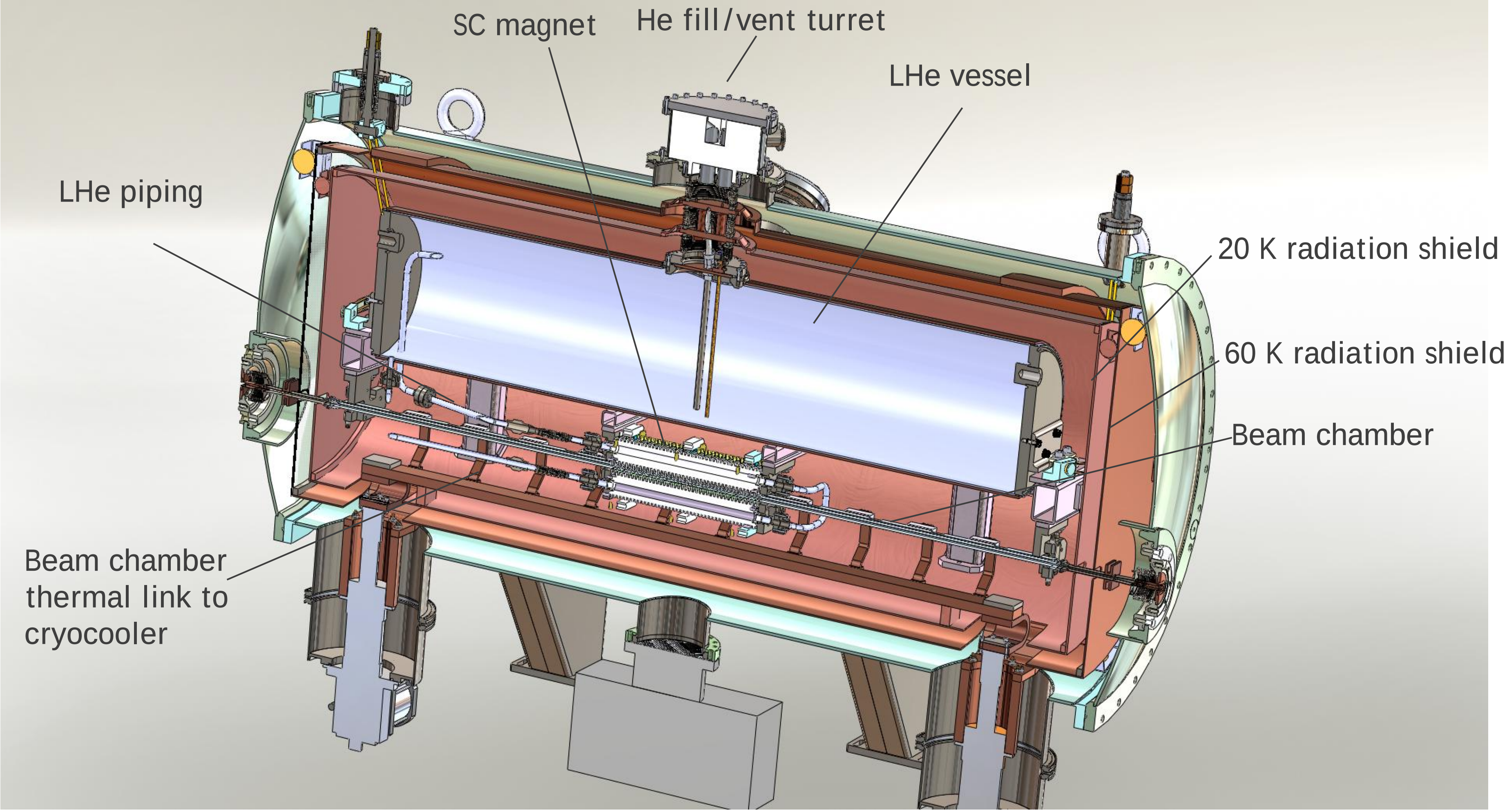
	Test Undulator SCU0	Prototype Undulator SCU1
Photon energy at 1st harmonic	20-25 keV	20-25 keV
Undulator period	16 mm	16 mm
Magnetic gap	9.5 mm	9.5 mm
Magnetic length	0.330 m	1.140 m
Cryostat length	2.063 m	2.063 m
Beam stay-clear dimensions	7.0 mm vertical × 36 mm horizontal	7.0 mm vertical × 36 mm horizontal
Superconductor	NbTi	NbTi



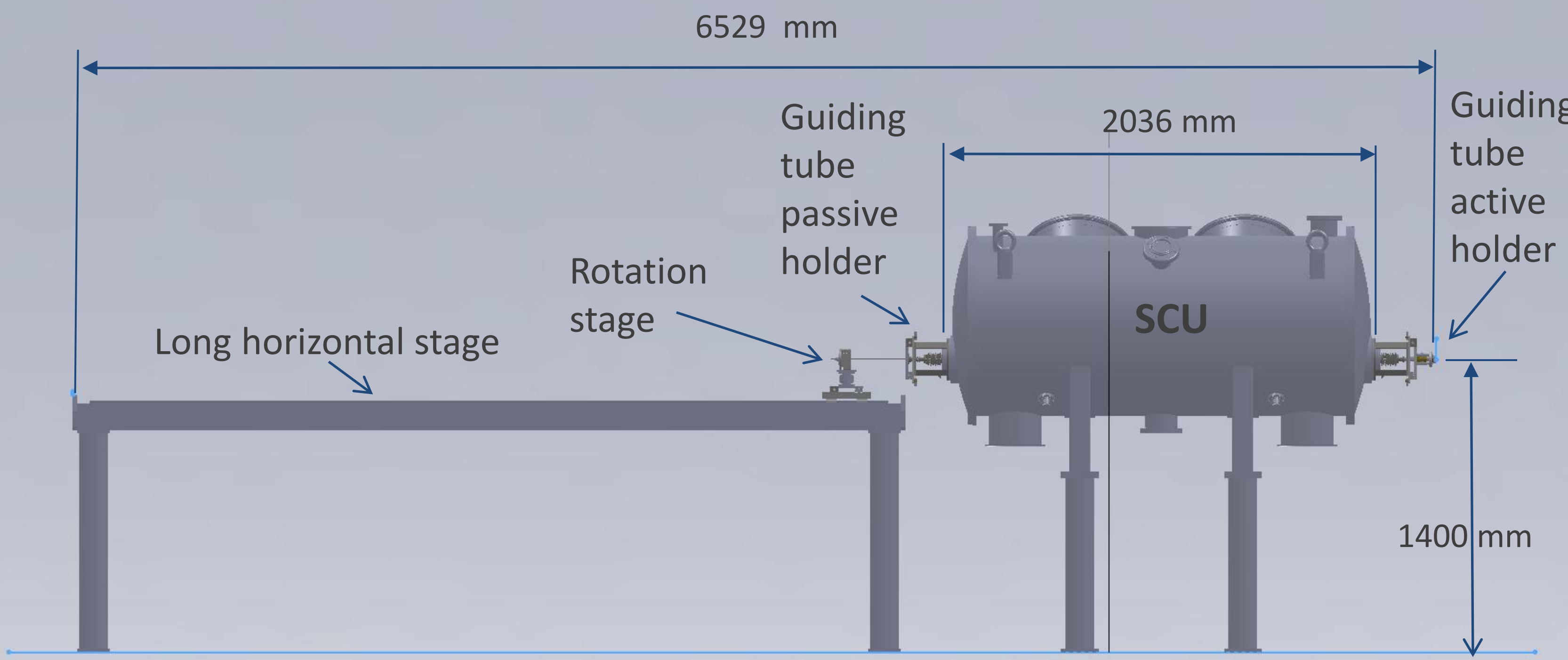
- Tuning curves for odd harmonics for two planar 1.6-cm-period NbTi superconducting undulators (42 poles, 0.34 m long and 144 poles, 1.2 m long) versus the planar NdFeB permanent magnet hybrid undulator A (144 poles, 3.3 cm period and 2.4 m long). Reductions due to magnetic field error were applied the same to all undulators (estimated from one measured undulator A at the APS). The tuning curve ranges were conservatively estimated for the SCUs.

SCU0 cryostat structure

Cryostat contains cold mass with support structure, radiation shields, cryocoolers, and current lead assemblies. SCU0 and SCU1 use the same cryostat design.



Measurement system design concept

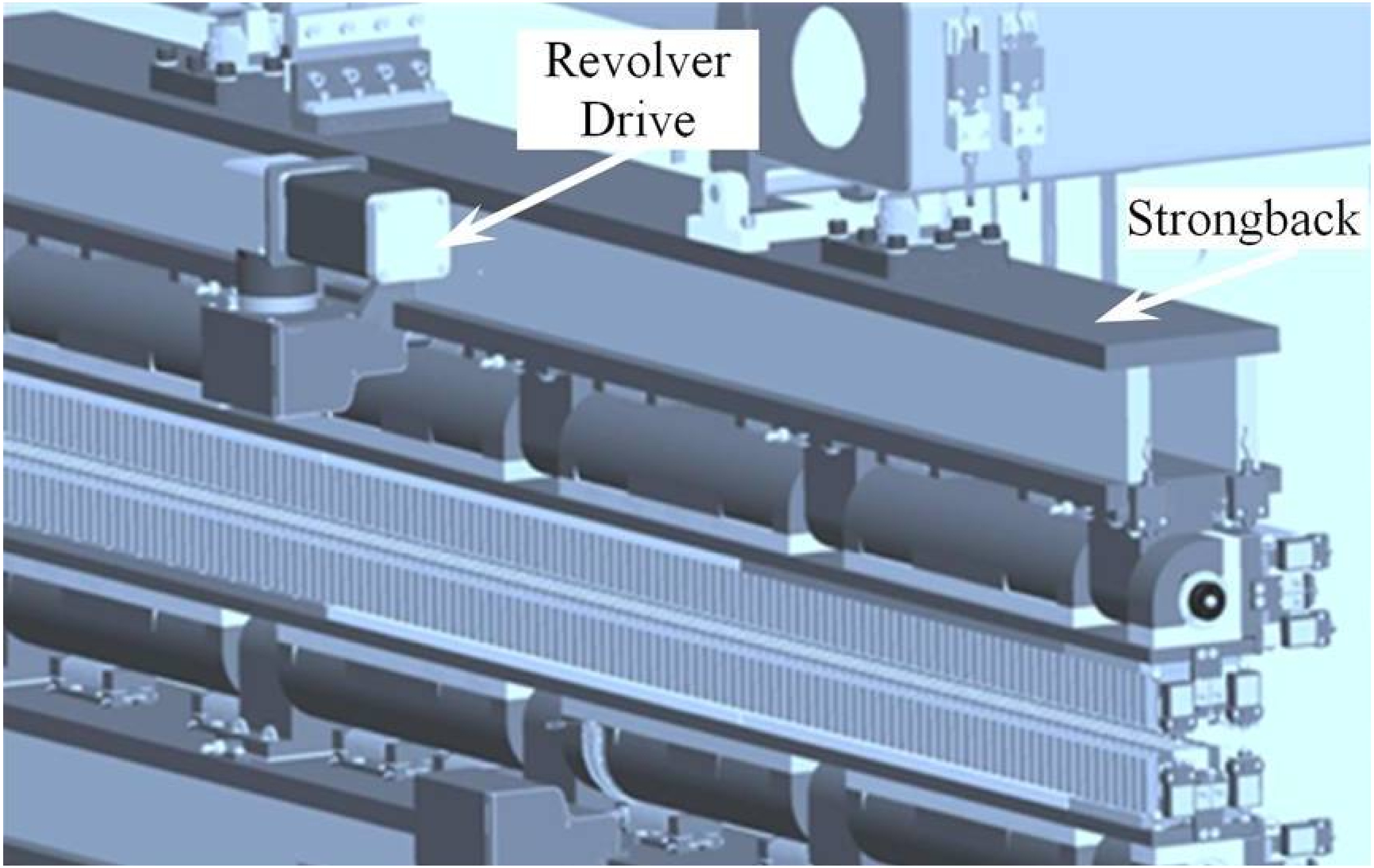


This concept is developed and used by Budker Institute team for measuring their superconducting wigglers.

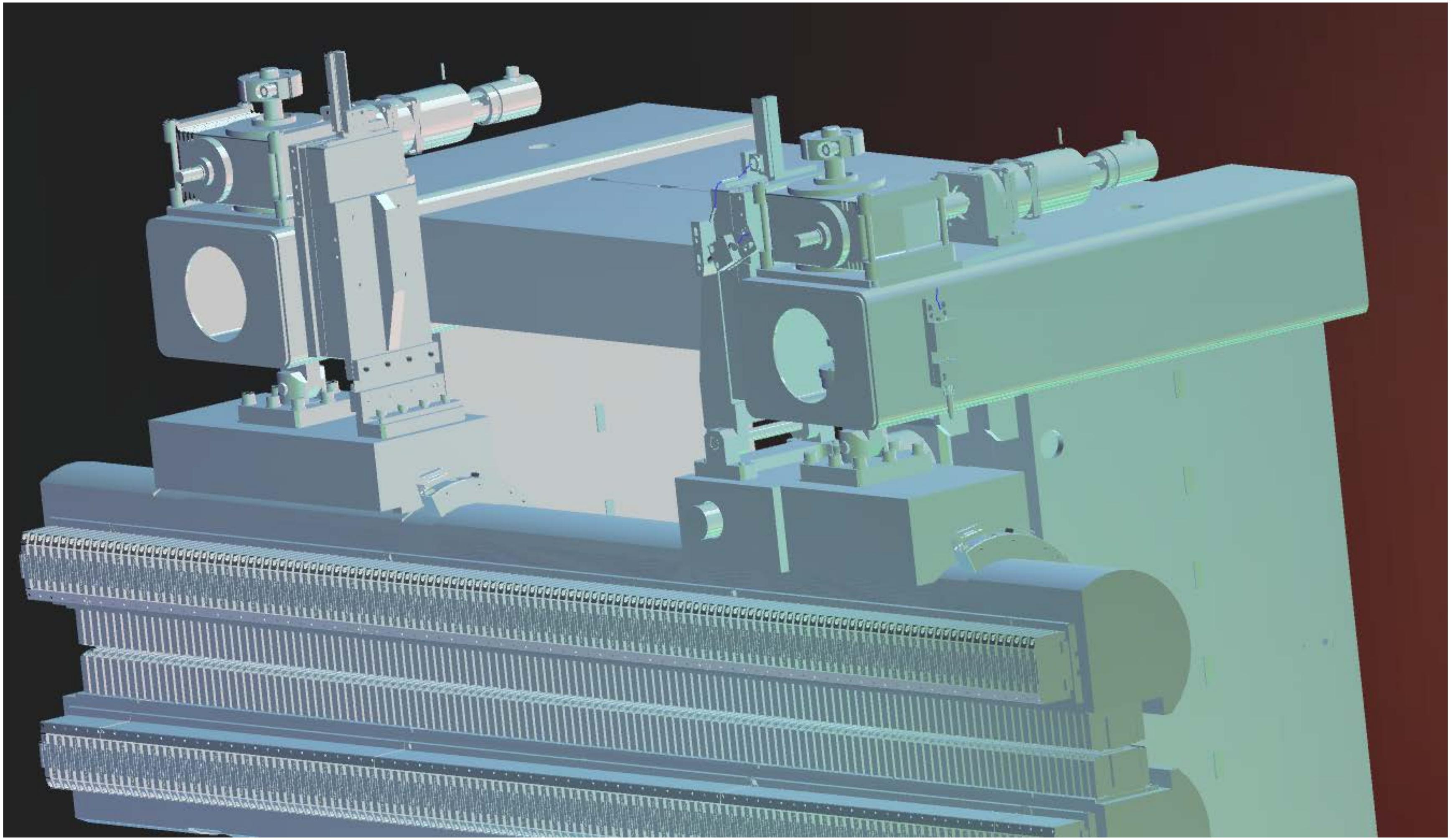
SCU team in the renovated building

SCU team at work

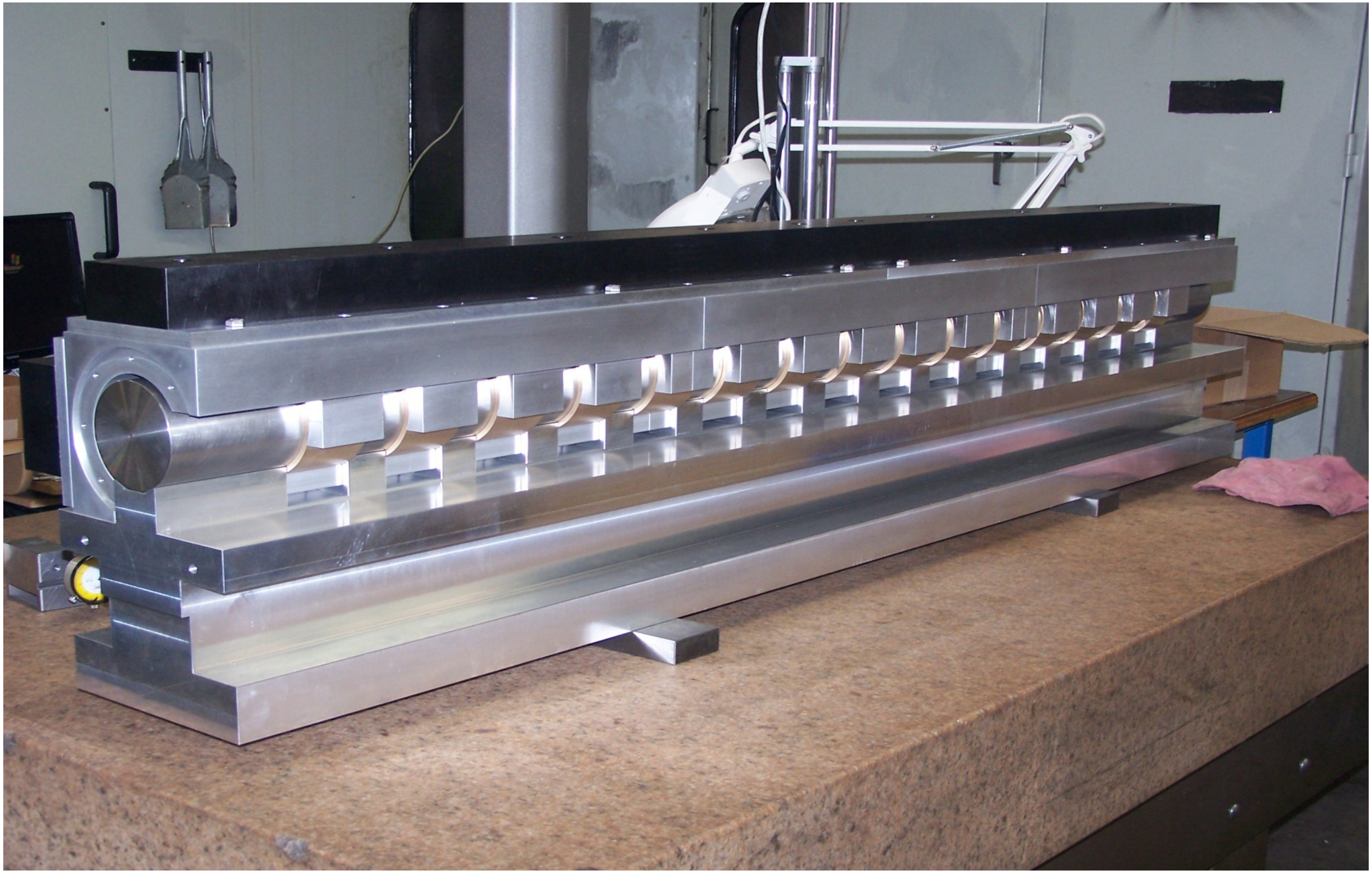
Revolver ID: rotation mechanism concept



Revolver ID: another rotation mechanism concept



Revolver ID: rotation mechanism prototype



Summary

- 2012 plans:
  - install and commission IEX ID and SCU prototype
  - install 3 conventional IDs
  - complete the design of the revolver ID and test prototypes

- Long term plans: APS Upgrade (based on CD-1)
  - continue to build and install conventional IDs
  - design and test EMVPU prototype
  - build and install 3 SCU
  - build and install 6 revolver IDs
  - procure and install APPLE-II
  - build and install EMVPU