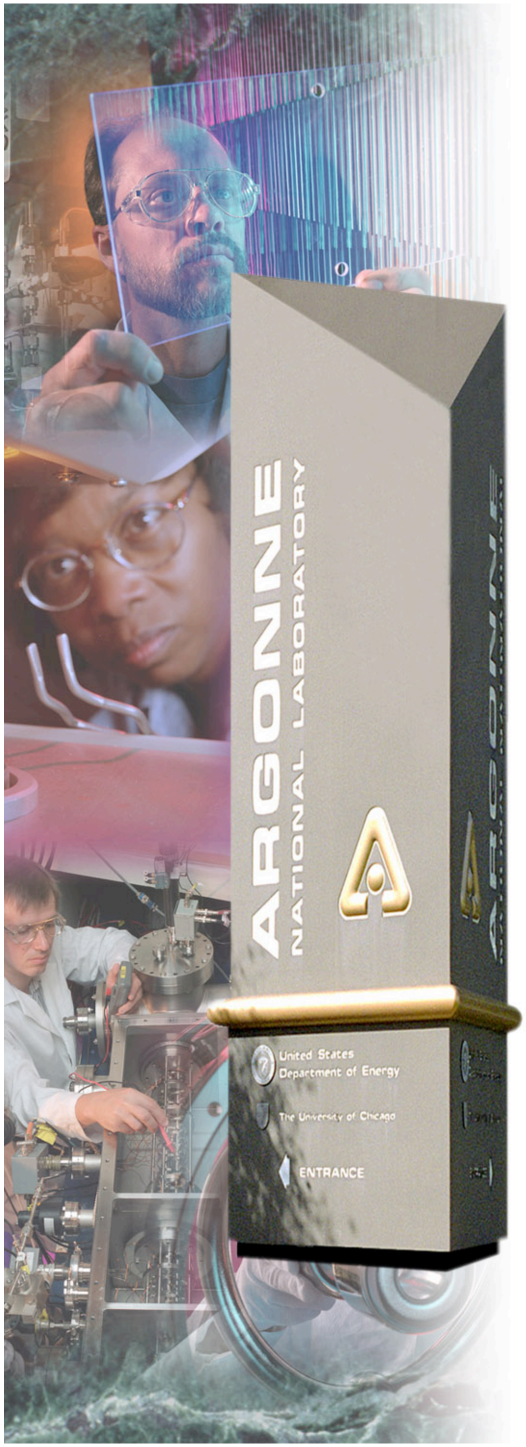

What’s New with APS Insertion Devices

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TWG Meeting
Nov 16, 2005

Argonne National Laboratory

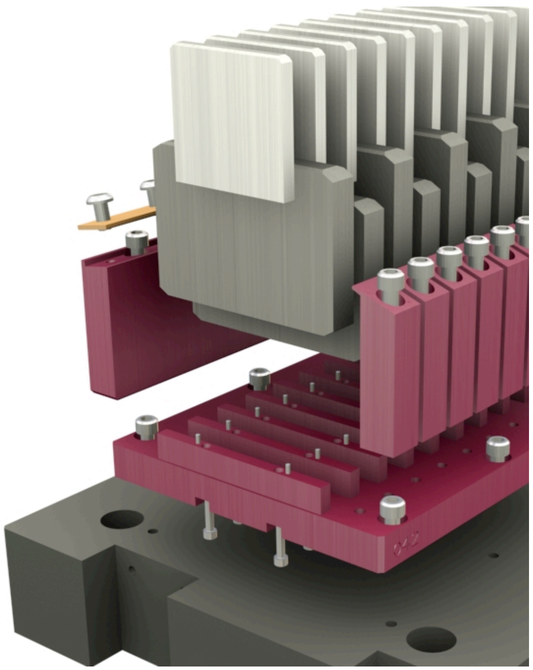
Office of Science
U.S. Department of Energy

A U.S. Department of Energy
Office of Science Laboratory
Operated by The University of Chicago

Recently installed new undulators

Sector 3 (XOR):

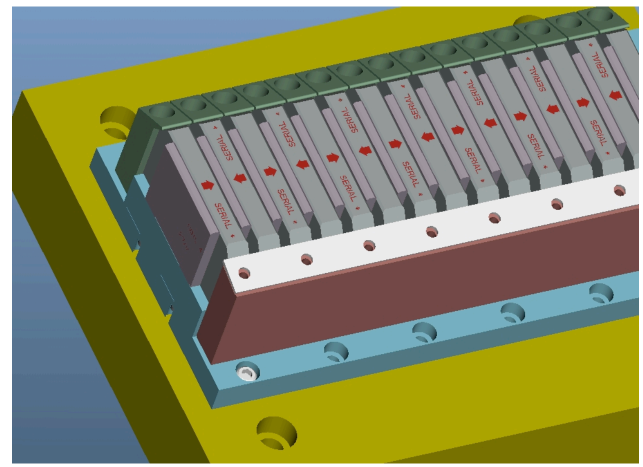
- The 2.7-cm-period undulator had its magnets replaced with new, stronger magnets in Jan 2005
- A new 2.7 cm device was designed, built, and installed in May 2005
- Also in May, the 5-mm-aperture vacuum chamber was replaced with a standard 8-mm ID chamber.



Recently installed new undulators, cont.

Sector 30 (IXS):

- Two newly-designed 3.0-cm-period undulators were installed in May 2005



Canted undulator sectors 23 (GM/CA) and 21 (LS):

- Two more of the 3.0-cm-period undulators, this time in the shorter length, were installed in Sept. 05.

New undulators in preparation

Sector 4 (XOR):

- A newly designed 3.5-cm-period undulator is being built, with installation planned for Jan 2006. The permanent magnets will be of SmCo (instead of NdFeB) for better radiation resistance.

Sector 26 (Nano)

- A 3.3-cm-period Undulator A, removed from LEUTL, is being prepared and retuned to meet storage ring requirements. It will join a newly remagnetized Undulator A for Jan 2006 installation.

IDs Installed as of Sept 2005

Type	Number	Length (periods)	K_{eff}
33-mm undulator	23	72	2.605
33-mm undulator	4	62	2.605
30-mm undulator	2	79	2.07
30-mm undulator	2	69	2.07
27-mm undulator	2	88	1.63 & 1.68
55-mm undulator	1	43	6.57§
18-mm undulator	1	198	0.455§
Elliptical wiggler (16 cm)	1	18	K_y=14.7† K_x≤1.4
Circularly polarized undulator (12.8 cm)	1	16	K_y≤2.86 K_x≤2.75

Device length includes the ends - approx. one period at each end is less than full field strength.
K value is at 11.0 mm gap unless stated otherwise. (CPU and horizontal elliptical wiggler field are electromagnetic, with different fixed gaps.)

† at 24 mm gap (the device minimum), values are for peak K, not K_{eff}

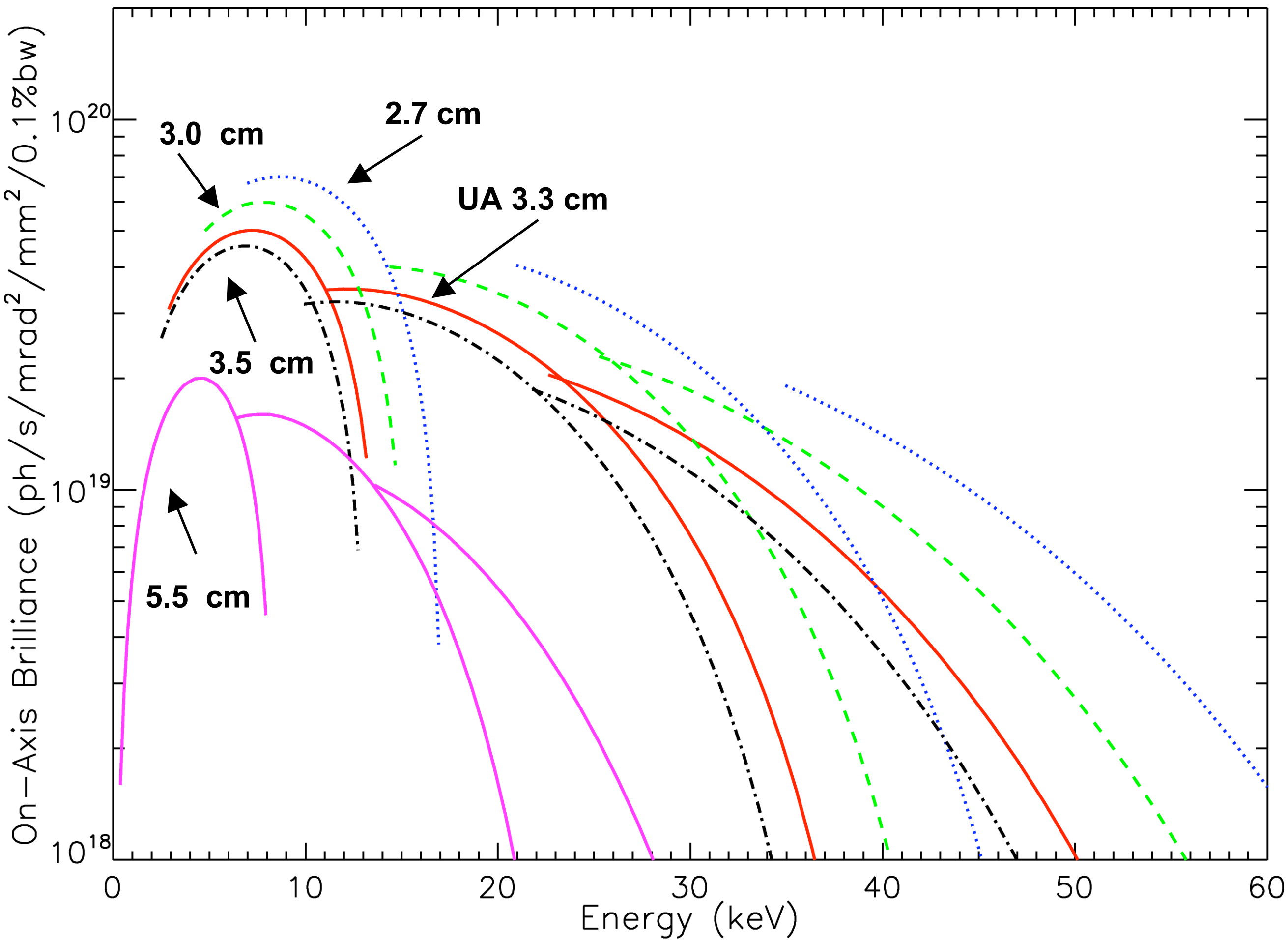
§ at 10.5 mm gap.

New undulators in preparation, cont.

Sector 14 (BioCARS):

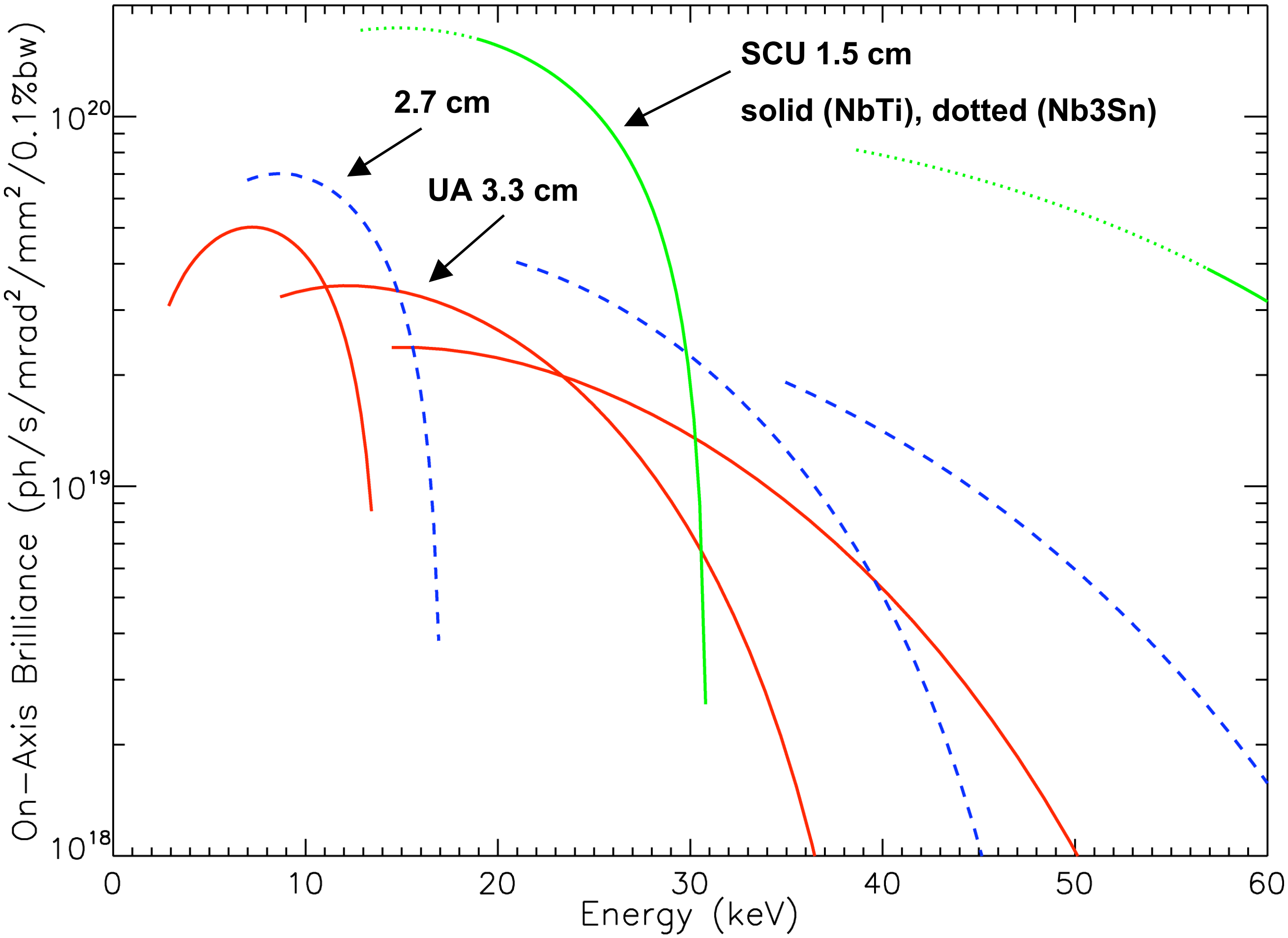
- Magnet requisitions have begun for a new 2.7-cm-period undulator.
- A magnetic design has been completed for a new 2.3-cm-period undulator, and the magnet requisition has been started.
- Installations are planned for Sept & Dec 2006

On-Axis Brilliance: APS planar permanent magnet devices



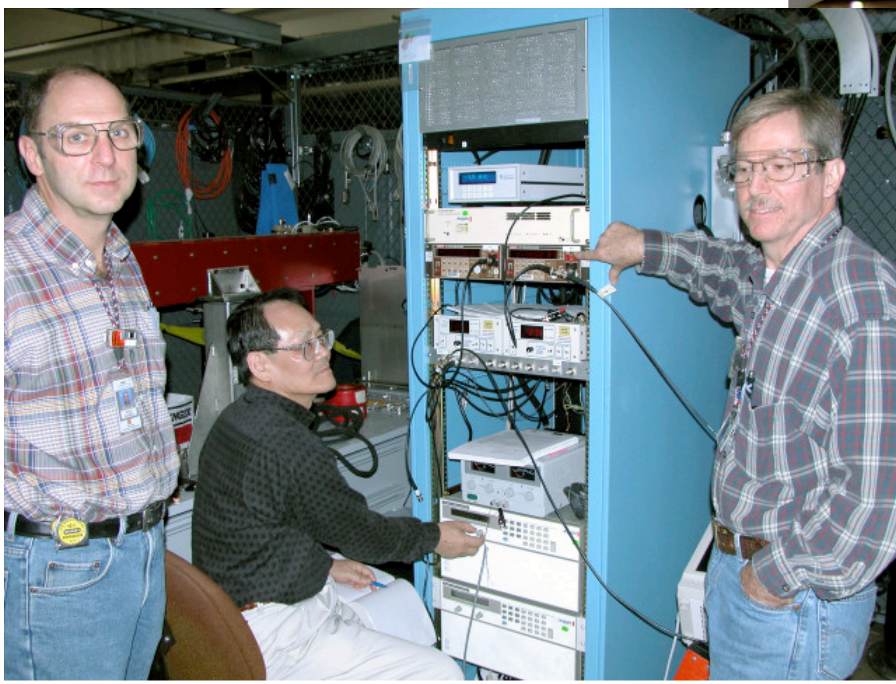
L = 2.4m I = 100mA

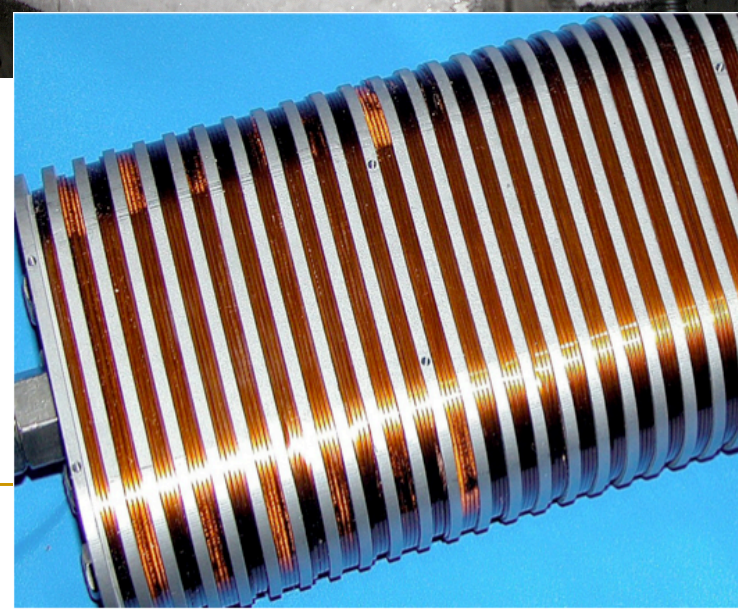
On-Axis Brilliance: Undulator A versus 2.7-cm-period device and 1.5-cm-period SCU (NbTi and Nb_3Sn)



- **Superconducting undulators (SCUs) operate at a pole gap of 8 mm. The assumed magnetic fields on axis are 0.8 T for NbTi and 1.2 T for Nb_3Sn (all lengths 2.4 m).**

Superconducting Undulator R&D

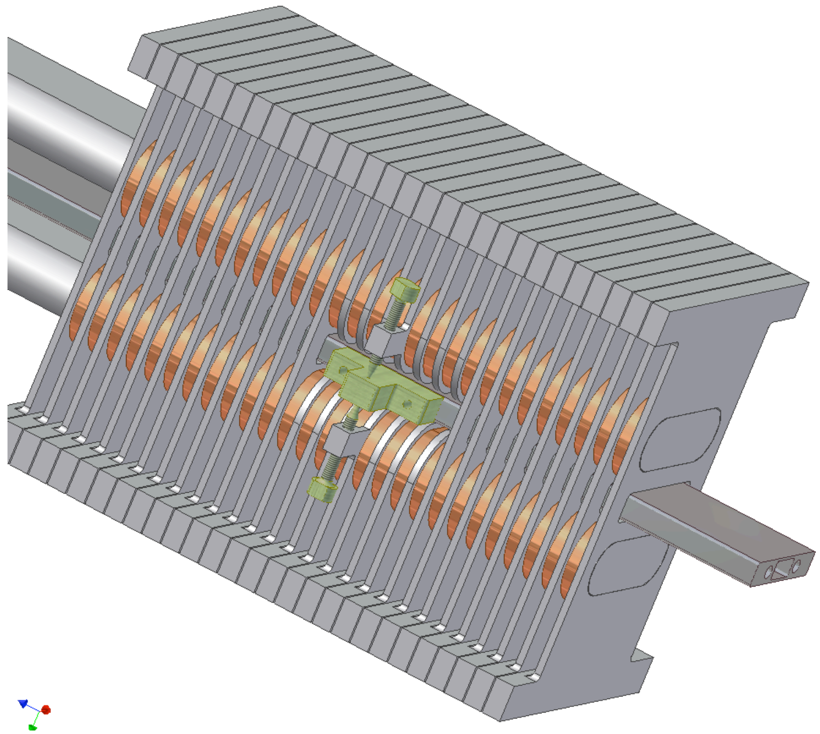




We are pursuing an in-house program so we understand the challenges and solutions. Also, we need to develop magnetic measurement capability.

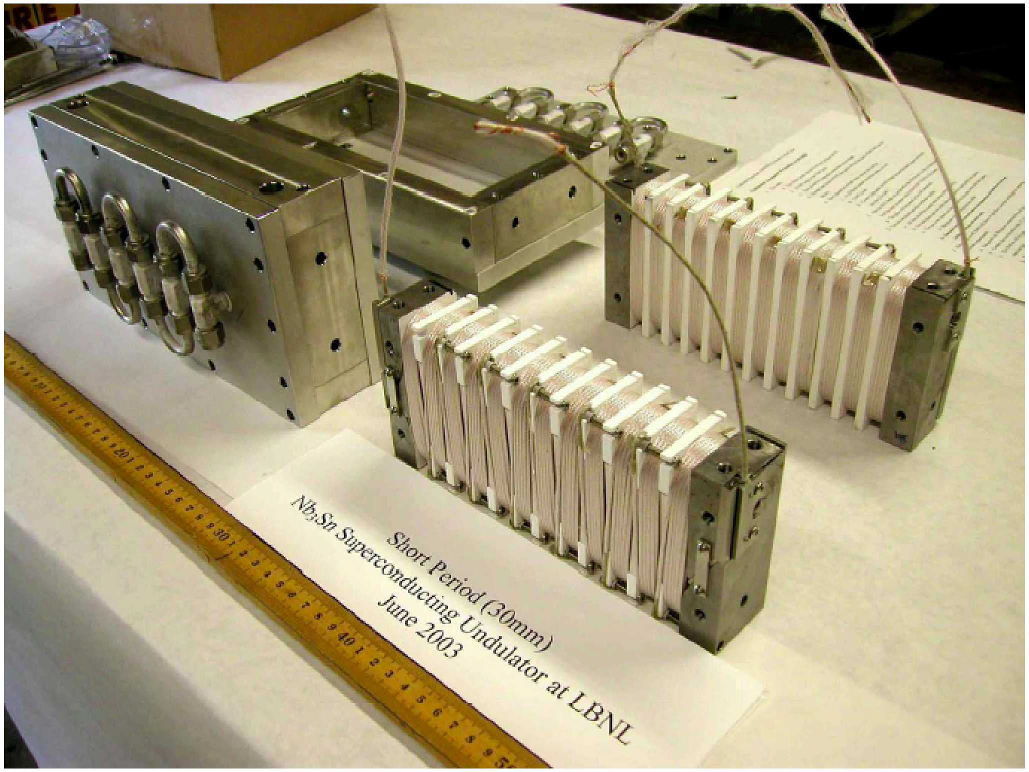
NHMFL-APS collaboration

- Conceptual design for the Nb_3Sn 1.5-cm-period SCU and cryo-system was completed last fall.
- Present project is a demonstration project to demonstrate feasibility.
- Proposal is for a beam tube at LN2 temp.
- The larger gap is achieved using Nb_3Sn conductor with its higher critical current.
- Completion of the demo project is expected in spring 2006.

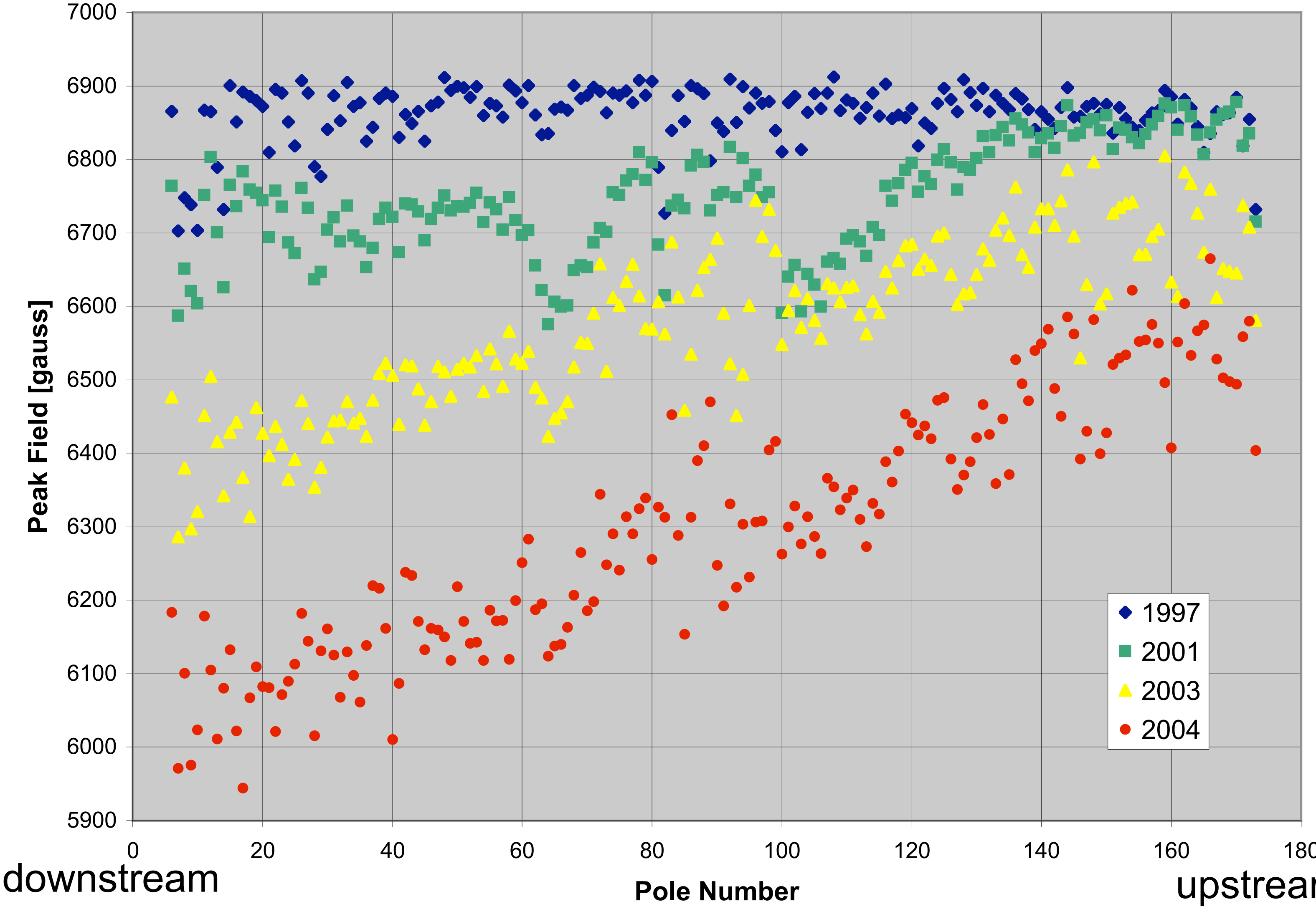


Lawrence Berkeley Lab - APS collaboration

- The LBL team is testing two different superconducting wire insulation schemes that would allow better packing of the windings
- Two test coils will be wound, reacted, epoxy vacuum-impregnated, and tested to determine performance
- A high packing density for conductor makes for a stronger field. However, the conductor must be kept small to prevent flux jumping, which causes premature quenching at currents less that the expected critical current.



Radiation damage to Sector 3 undulators versus time



downstream

upstream

Update on radiation damage

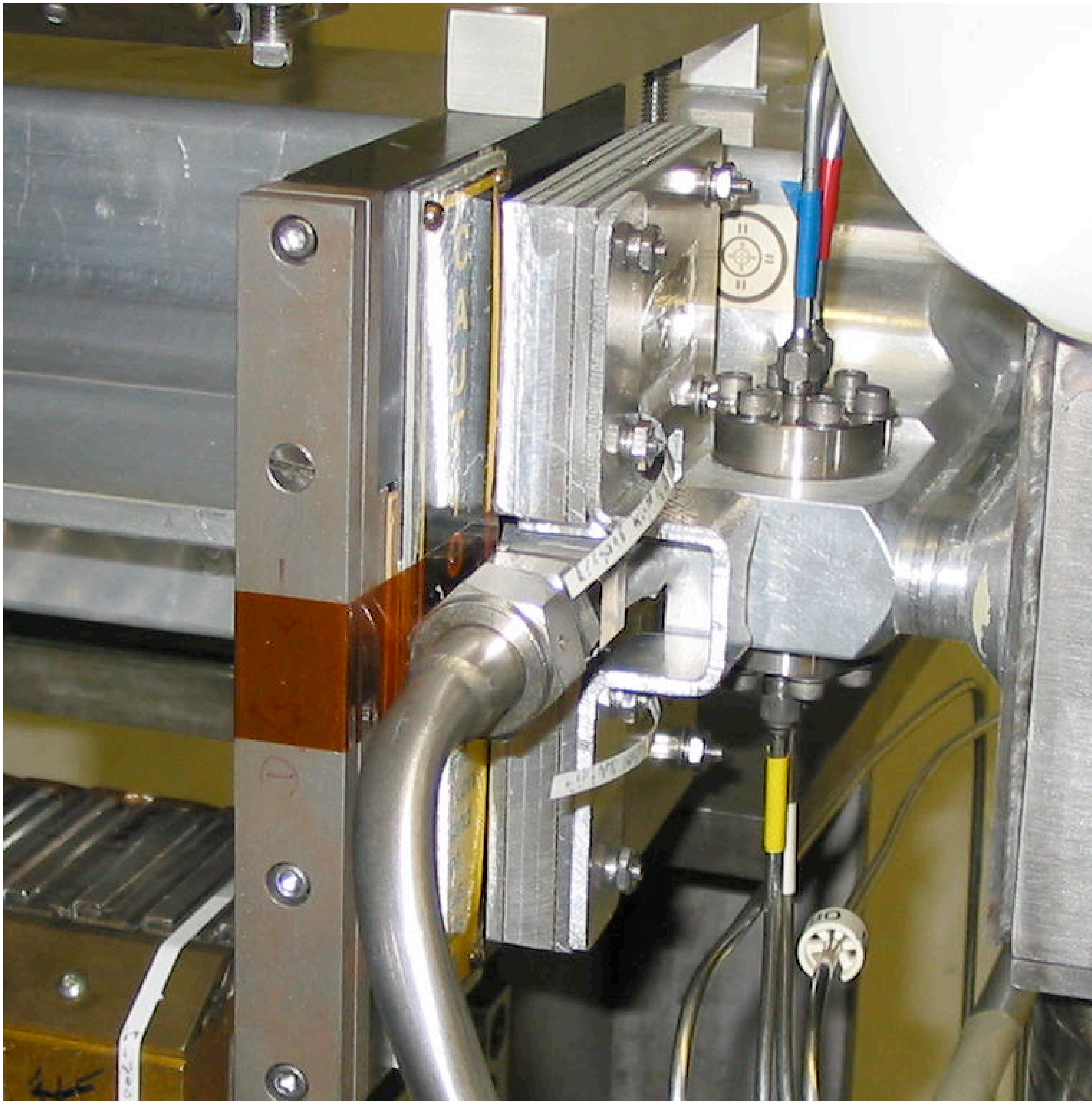
Sector 3 has been suffering from continuing radiation damage since topup began in 2001.

The new and reworked undulators have a stronger field so the small-gap vacuum chamber was no longer needed to reach desired wavelengths. The small-gap vacuum chamber could be replaced by a standard one, and was, in May.

In Sept, the IDs were removed and checked. No radiation damage was seen! Hooray!

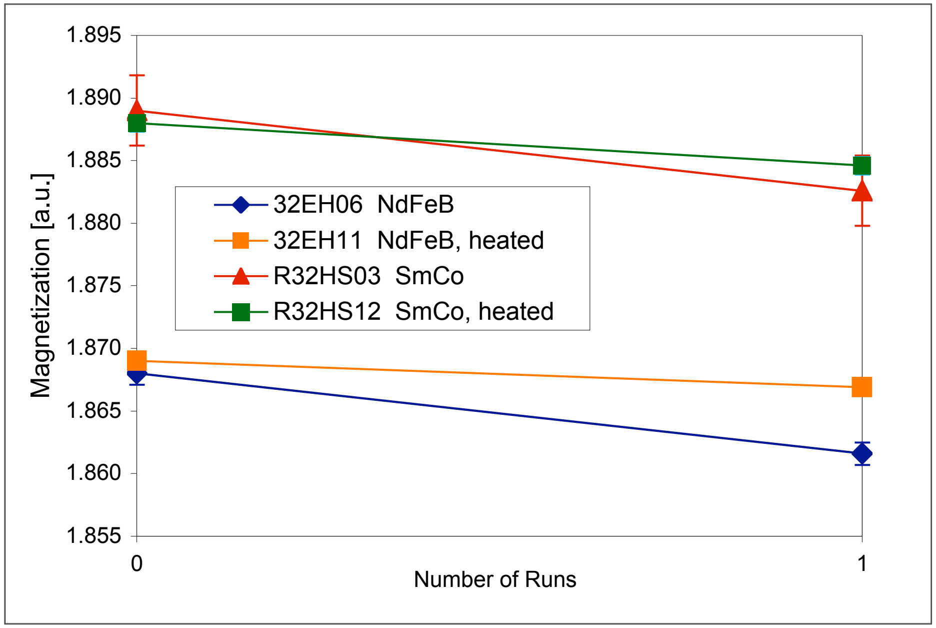
Sector 4 still has a small-gap chamber, and needs it for the CPU. But its Undulator A suffers considerable radiation damage every run.

The SmCo undulator should be more radiation resistant. We hope it will not need remagnetizing every run. (The planned scraper should help too.)

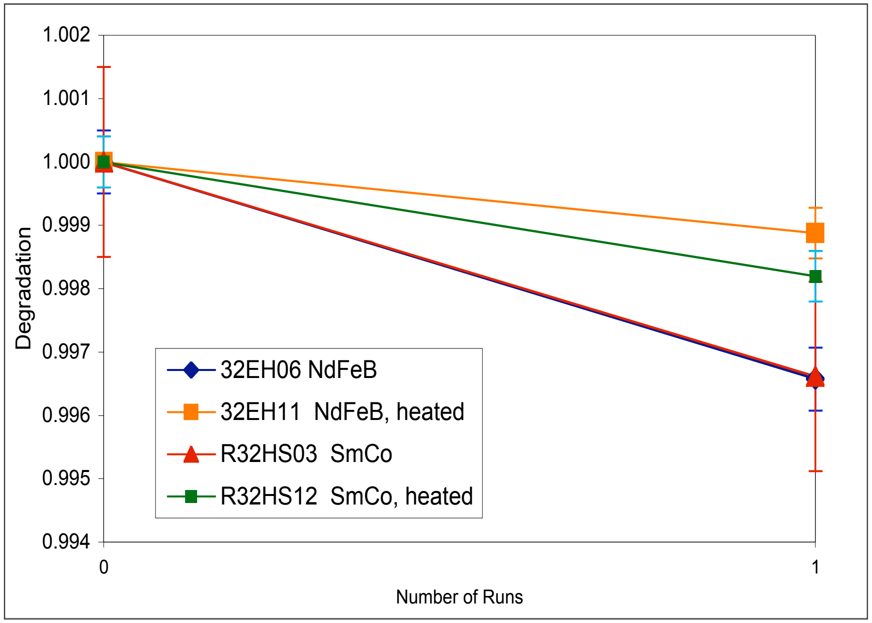


A three-pole "mini-undulator" has been installed. Radiation resistance of different magnet grades will be compared.

Test sample demag results after one run



Normalized



- **Small changes in the sample magnets were observed after one run**
- **Changes in heat treated samples were less than the non-heated ones**
- **Not much difference between non-heated SmCo and non-heated NdFeB (Note that this grade of NdFeB is more rad-resistant than what we use in our undulators. It is also weaker.)**
- **We can conclude that the new SmCo undulator should survive better, but it may not be totally immune to our radiation. Scraper will help!**

Credits (alphabetical order)

- Undulator magnetic design: Shigemi Sasaki & Ken Thompson
- Undulator mechanical design: John Grimmer
- Undulator magnetic structure assembly and maintenance:
  - MD group and Kurt Boerste and Chuck Doose
  - XFE group and John Grimmer, Matt Kasa, Mike Merritt, John Terhaar
- Undulator mechanical supports: John Grimmer, Matt Kasa, Mike Merritt, John Terhaar
- Undulator tuning: Shigemi Sasaki & Isaac Vasserman
- Calculations of radiation output: Roger Dejus & Shigemi Sasaki
- Radiation damage test: Maria Petra and Shigemi Sasaki
- Superconducting undulator: Chuck Doose, Suk Kim, Bob Kustom, National High Magnetic Field Lab, Lawrence Berkeley Lab