Utilization of Thin Low-Z Scrapers in the Electron Storage Rings

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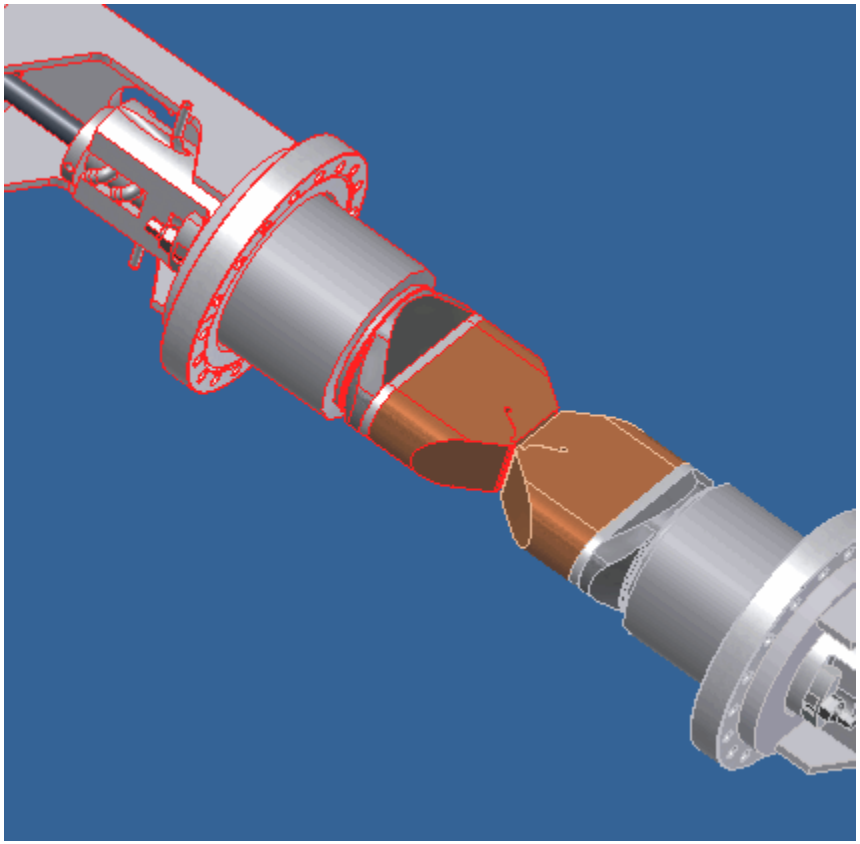
Outline

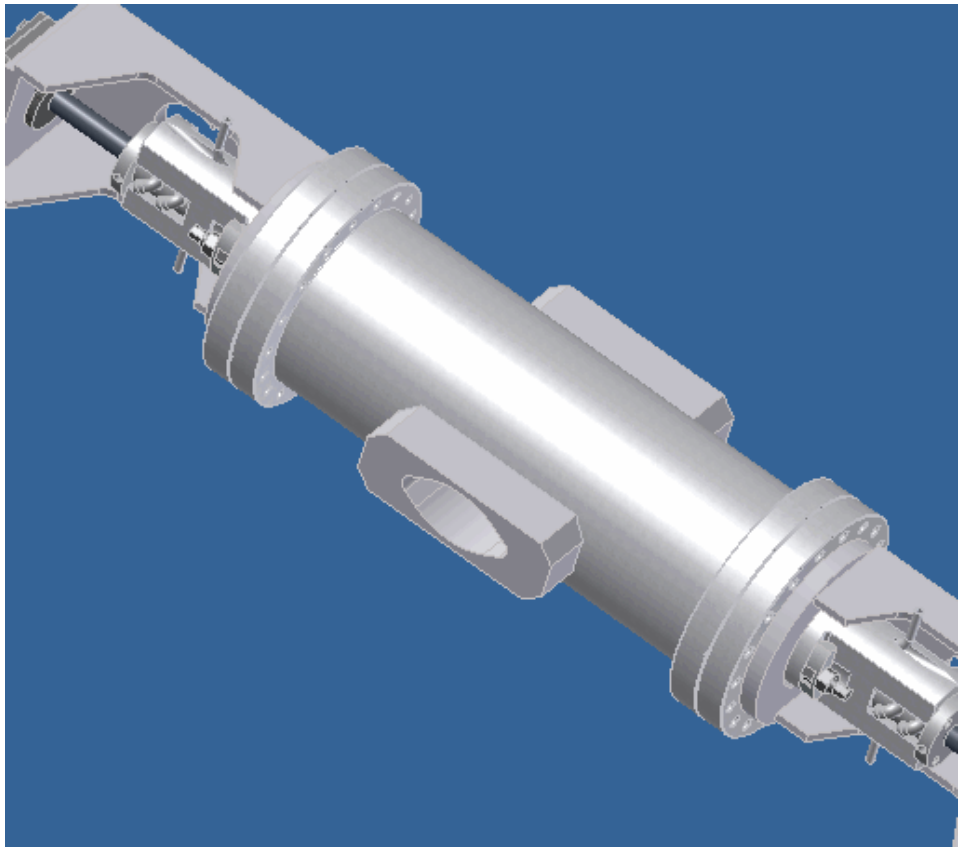
- Use of Scrapers to Locate the Beam Core and to Localize Intentional and Unintentional Beam Dumps
- FLUKA Calculations to Evaluate Thin Low-Z Scraper Effectiveness and Benefits
- Test Measurements at NSLS with Thin Cu Scrapers

Functions of the Scrapers in the Electron Storage Rings

- Provide protection for insertion devices and other storage ring components
- Define momentum aperture for optimum Touschek life time
- Provide a controlled beam dump in self shielded dipoles for RF and interlock dumps

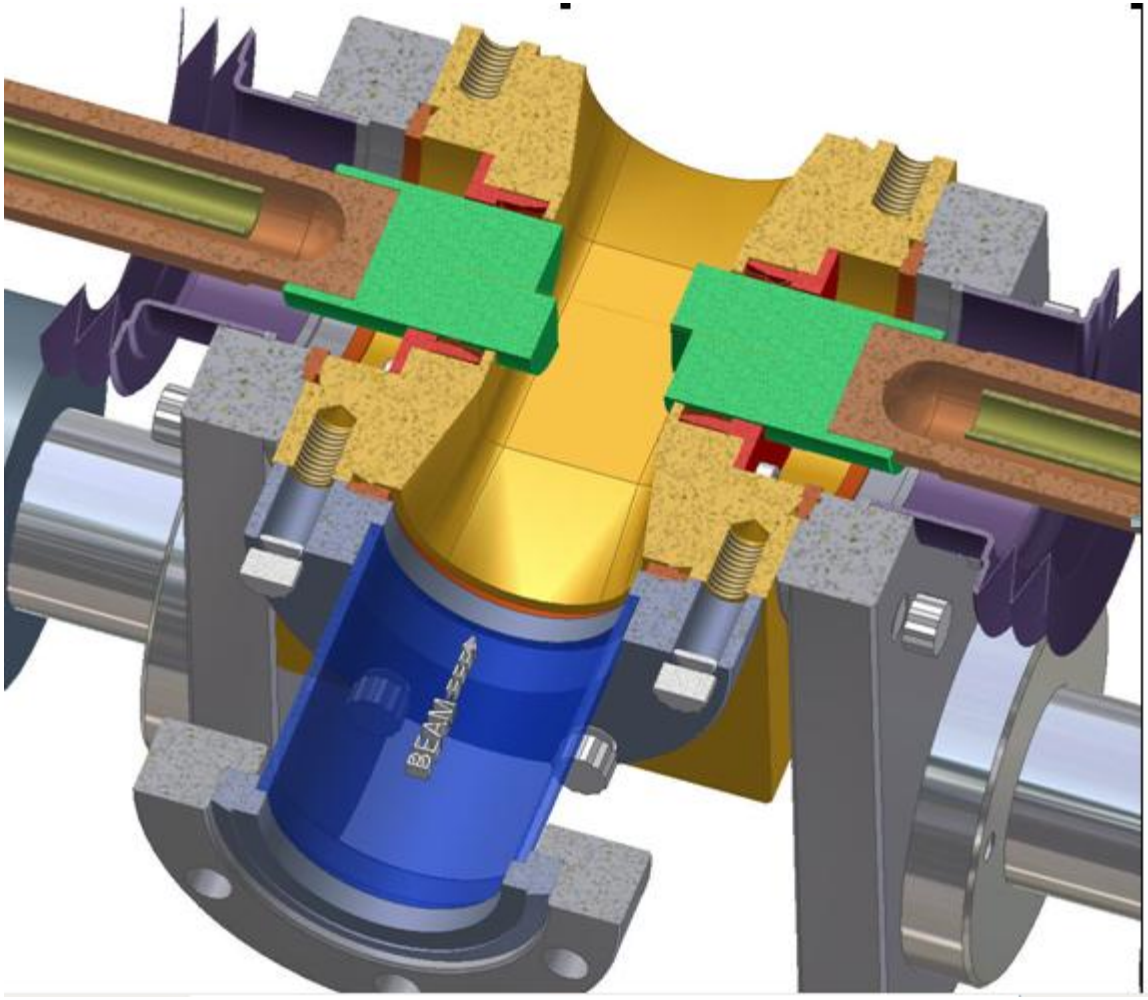
Advanced Photon Source Scrapers





Thickness in beam direction ~75mm Cu (~5.25 X)
Average Beam Energy Loss ~99.5%, Required Local Shielding to Reduce Dose Rates Outside the Shield Wall

NSLS Scrapers

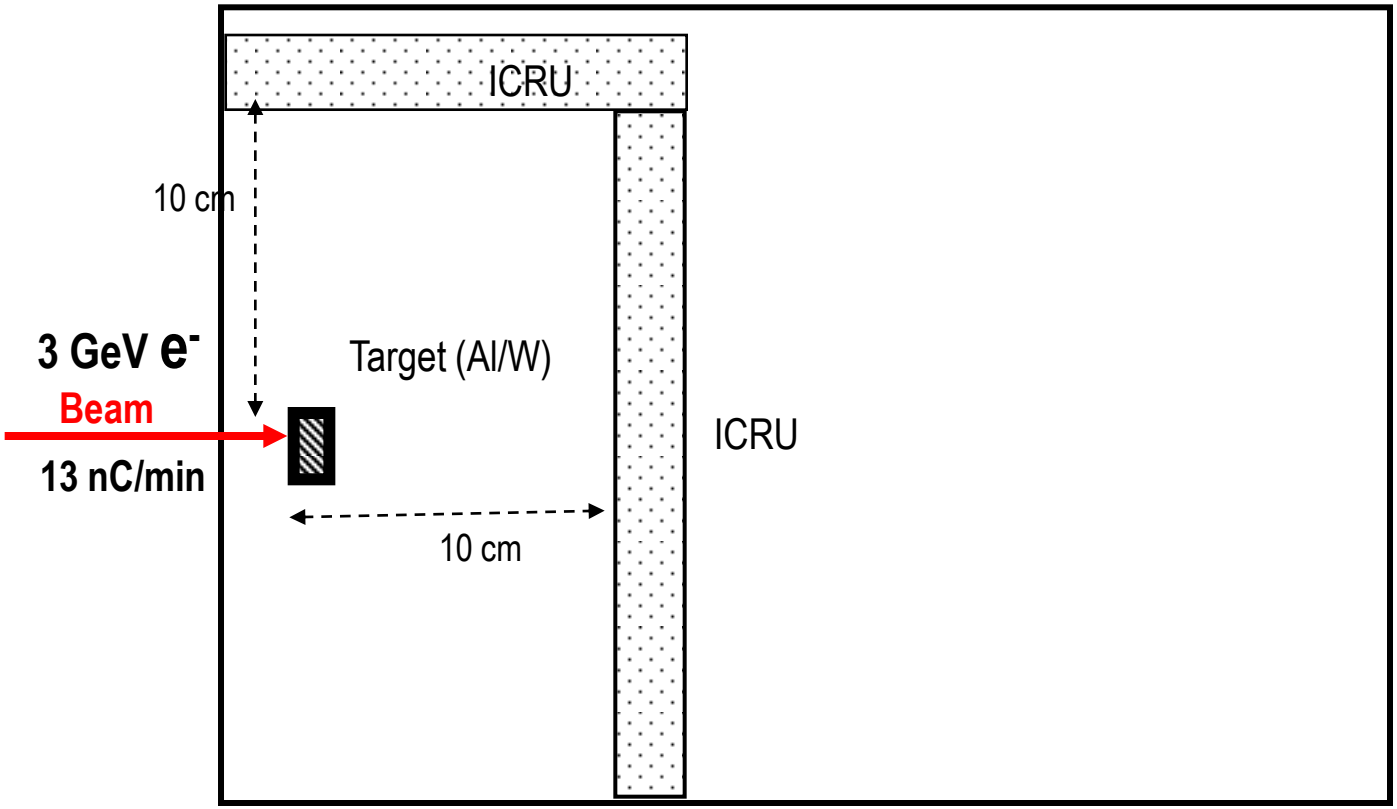


Existing NSLS Scrapers in the Xray Ring are 5 mm thick Cu blades

Thin Low-Z vs. Thick High-Z Scrapers
FLUKA Simulation

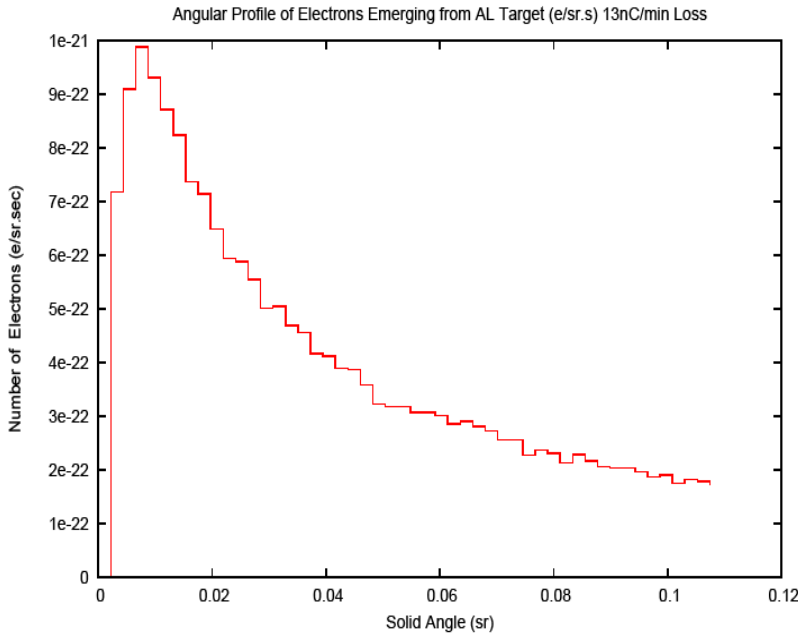
FLUKA Simulation Configuration

Cu 2.0 cm dia x 1.4 cm thick, W 2cm dia x 2cm thick

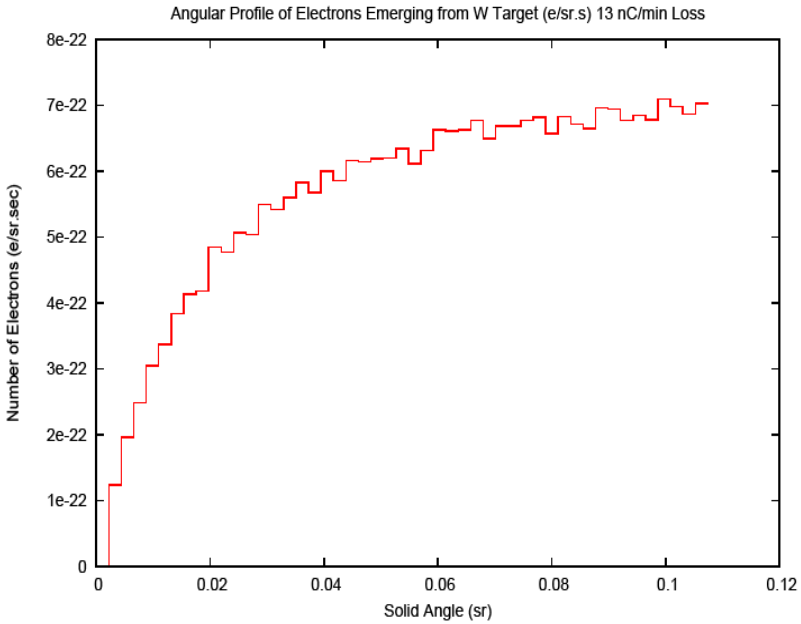


Angular Scattering Profile of Electrons from the Target (FLUKA Results)

Cu Target (14 mm)

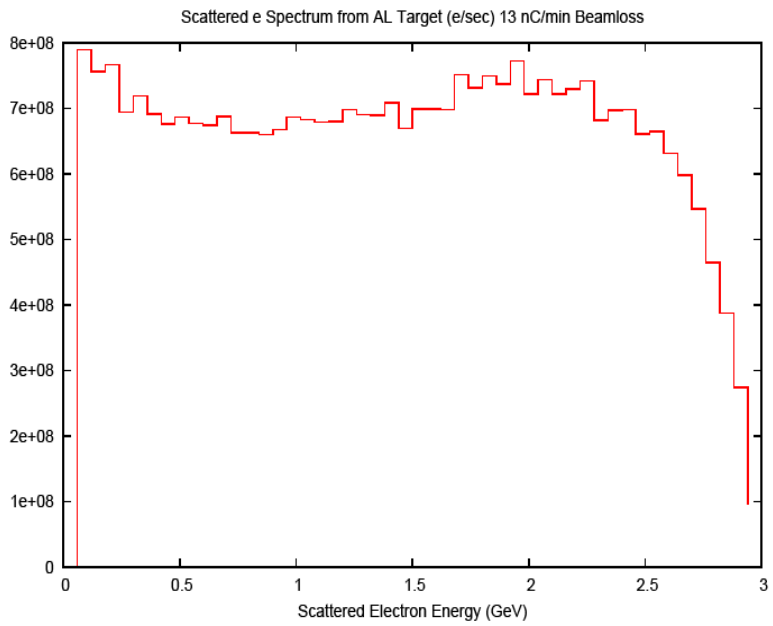


W Target (20 mm)

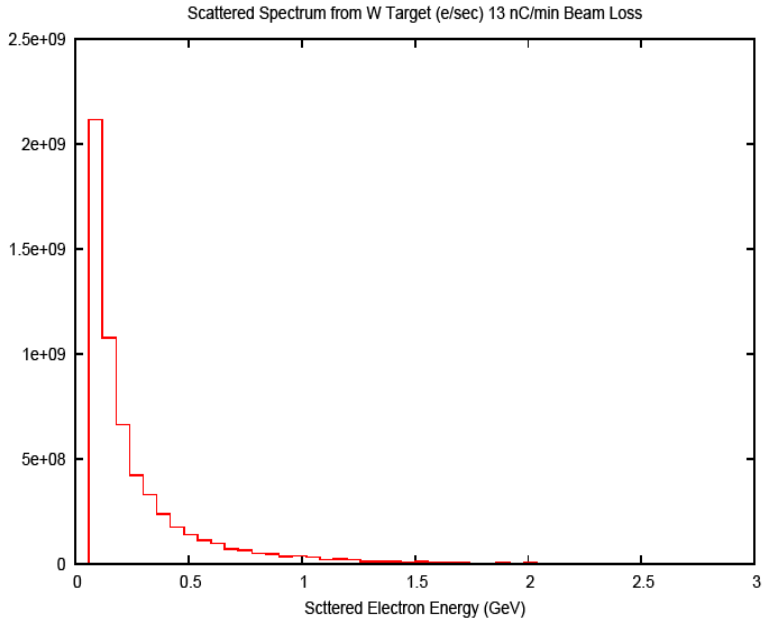


Scattered Electron Energy Distribution from the Target (FLUKA Results)

Cu Target (14 mm)

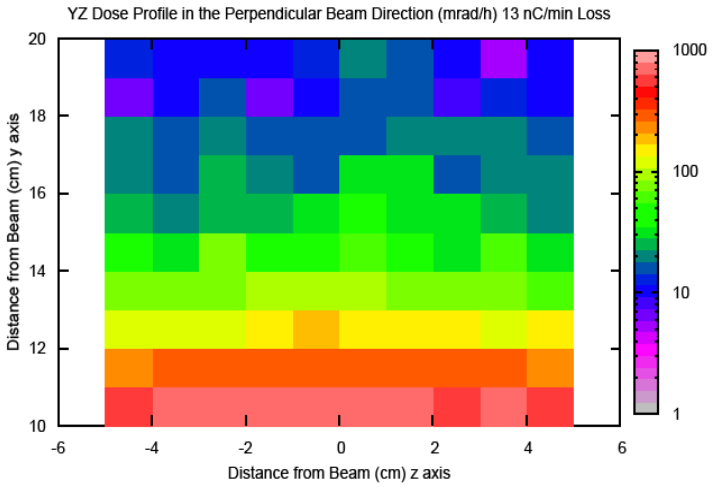


W Target (20 mm)

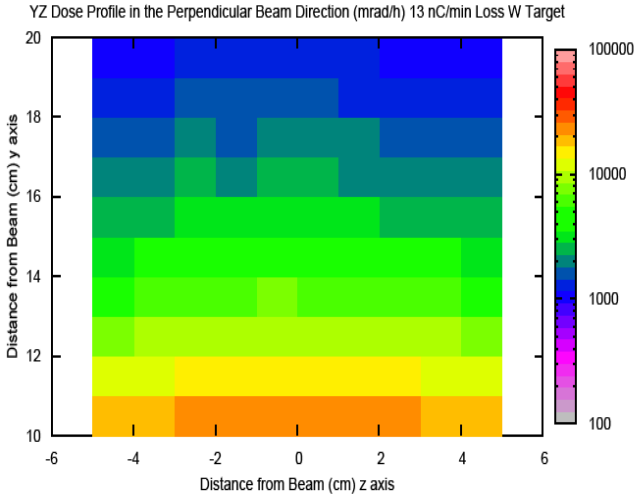


Transverse Directed Dose at 10 cm from Target (FLUKA Results)

Cu Target (14 mm)

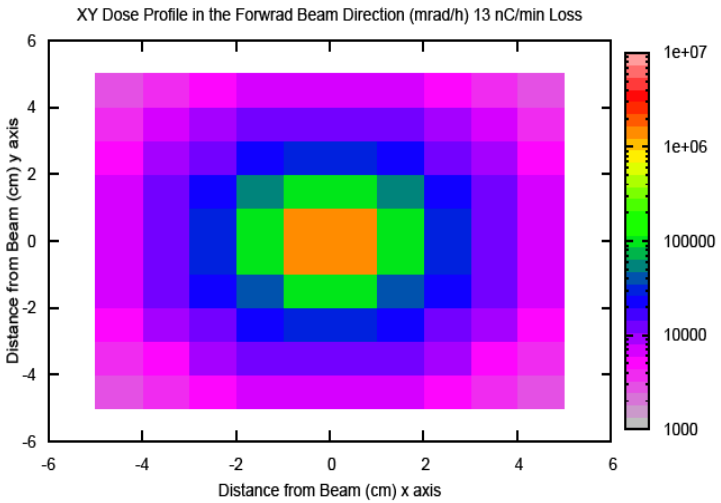


W Target (20 mm)

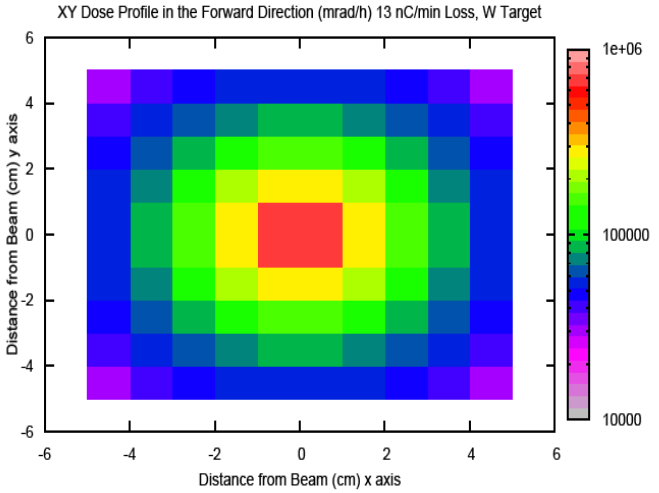


Forward Directed Dose at 10 cm from Target (FLUKA Results)

Cu Target (14 mm)

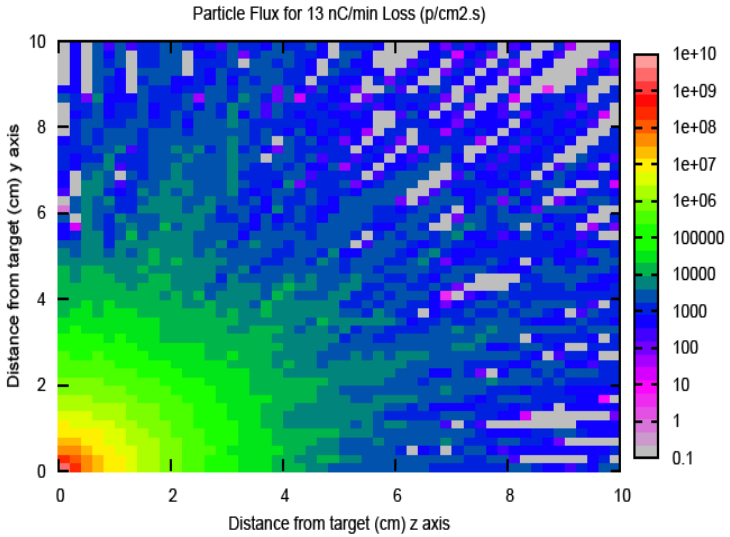


W Target (20 mm)

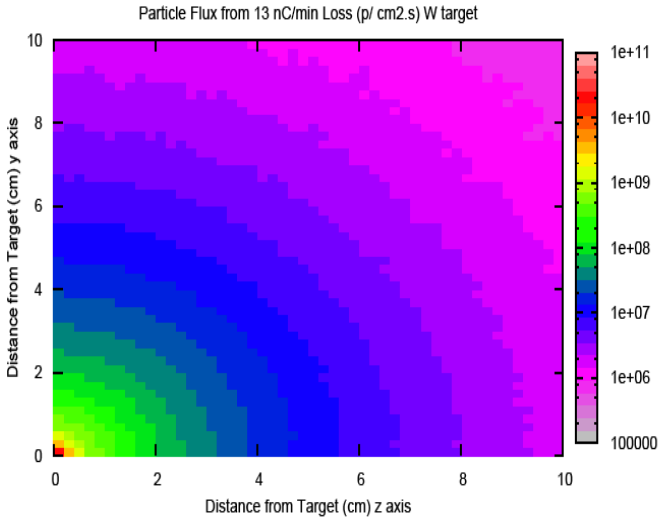


Scattered Particle Flux (p/cm^2.s) (Transverse Direction)

Cu Target (14 mm)



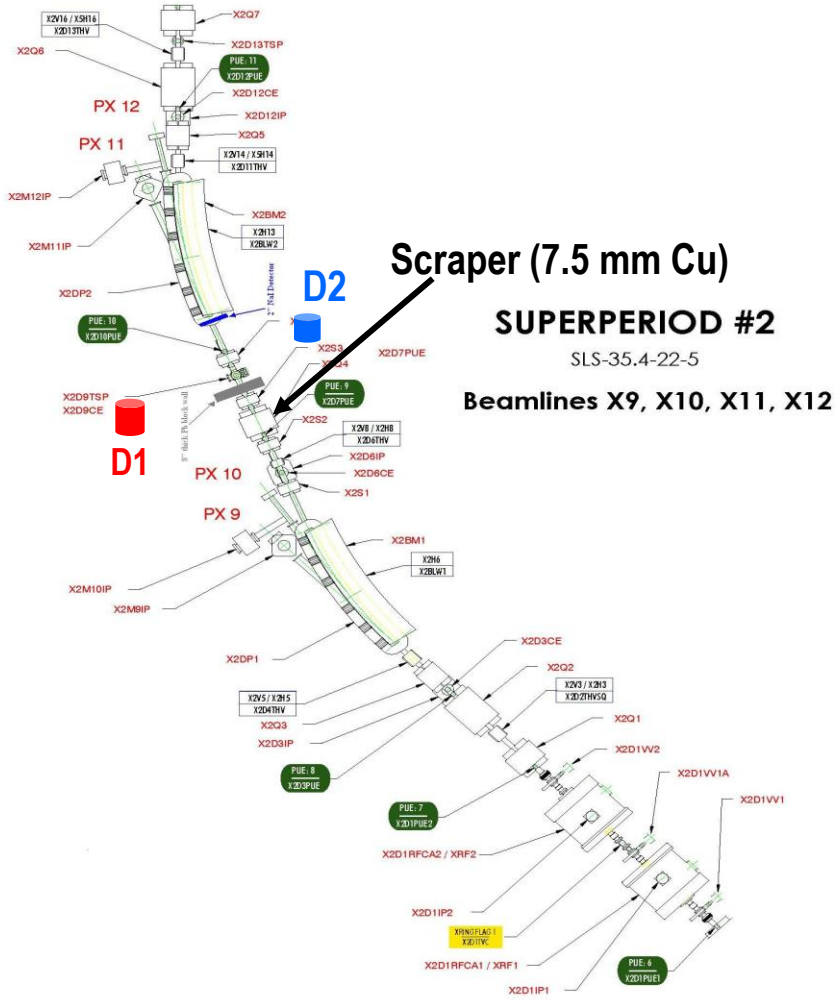
W Target (20 mm)

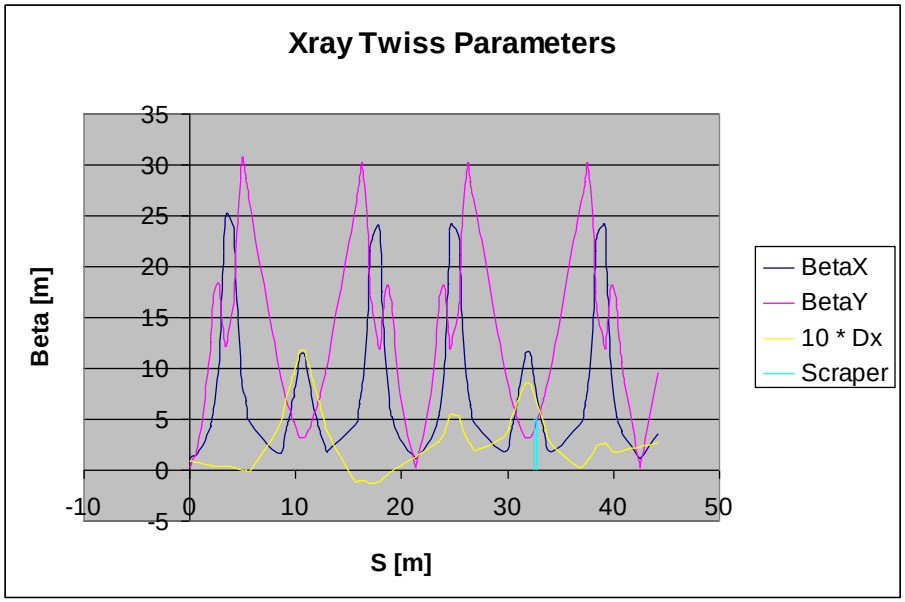


Thin Low-Z Compared to Thick High-Z Scrapers (FLUKA Results)

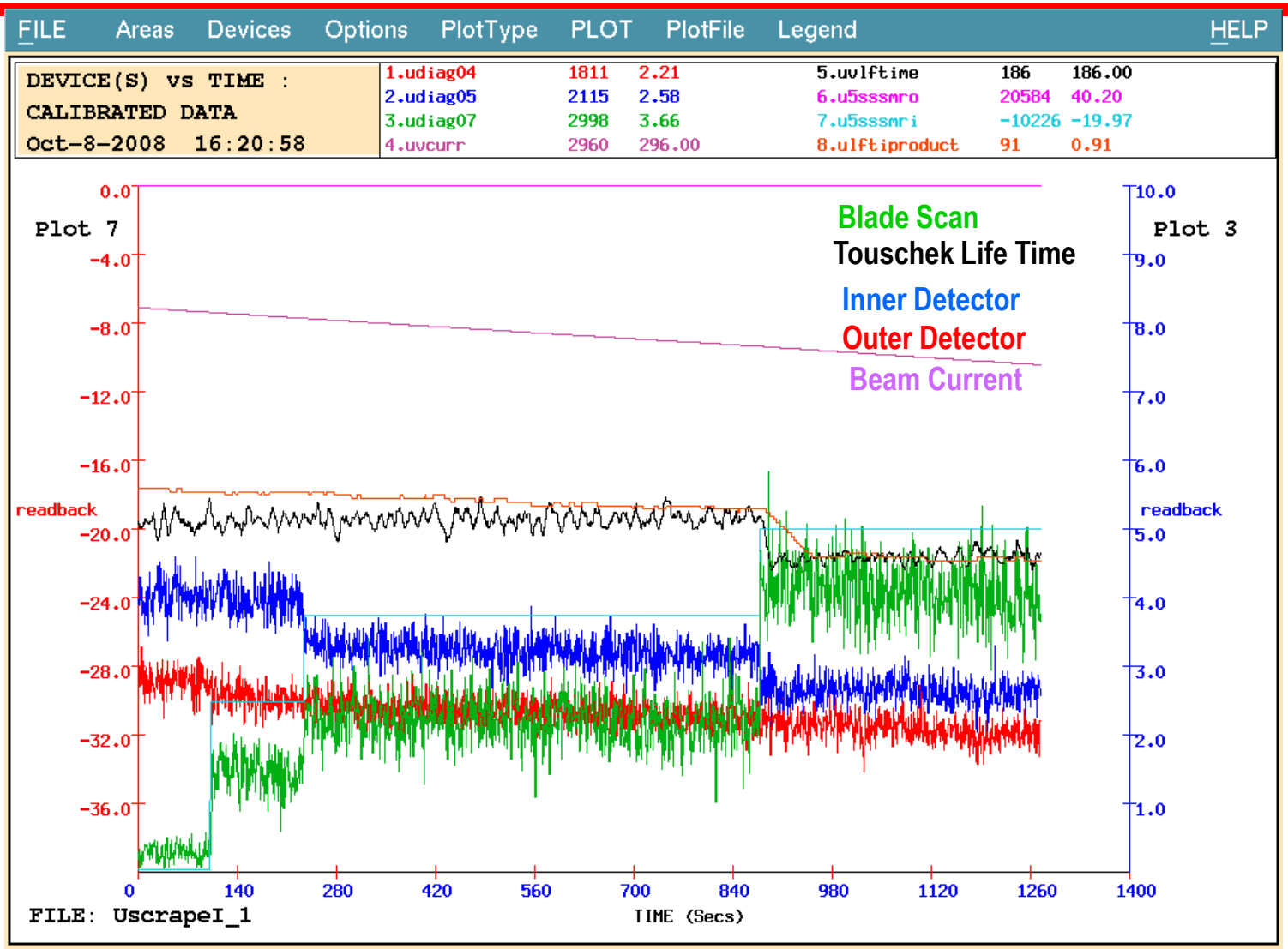
- Small energy-loss for the particles, rendering them mostly in the forward direction and eventually getting dumped in the next bending magnet
- Low photon radiation exposure outside the shield wall with reduced transverse scattering
- Probable low neutron production and reduced neutron dose outside the shield wall

Test Measurements at NSLS with Thin Cu Scraper





Results of the Scraper Study (Scan Results)



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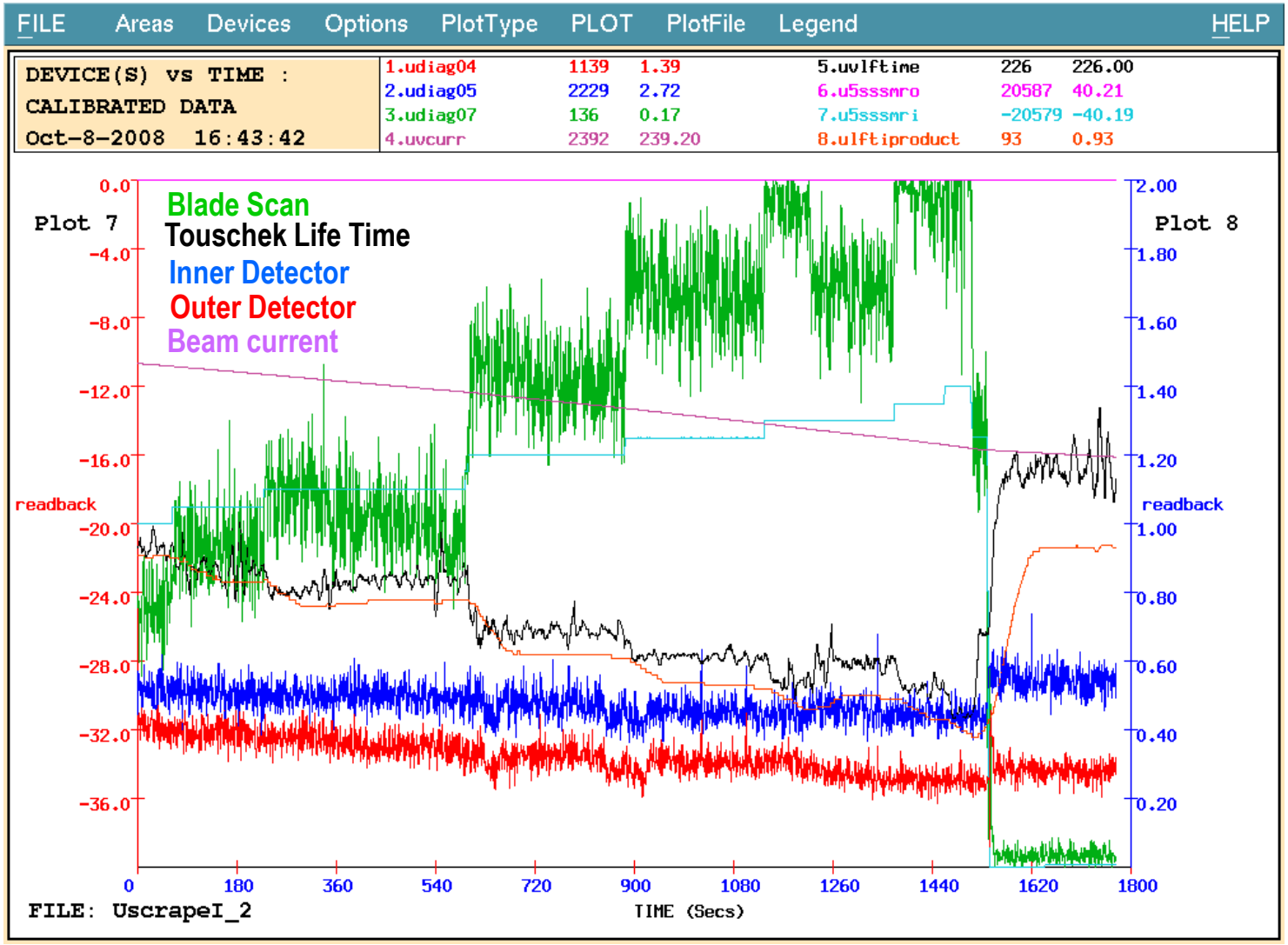

Results of Test Measurements

- Transverse radiation dose in the outboard direction remained practically unchanged
- Transverse radiation dose in the inboard direction showed slight decrease due to more particles dumping in the magnet yoke
- Optimum scraper blade location has minimum effect on beam life time and current

Summary

Thin Low-Z Scraper blades in the Electron Storage Rings have several advantages over thick high-Z scraper blades

- Thin low Z scrapers at the right location, with self-shielded dipole as beam dump, minimize radiation exposure on the experimental floor during intentional or unintentional beam dumps
- Reduce radiation damage to insertion devices by confining the beam scatter and dump
- An optimum position of the scraper blade will have minimum effect on the Touschek life time and Beam Current