Proposed Personnel Protection Controls for the Top-off Operation at NSLS-II

P.K. Job, Y. Li and S. Buda

RadSynch13 Workshop, May 8-10, 2013

U.S. DEPARTMENT OF ENERGY

BROOKHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES

Overview of Presentation

- Results from Particle Tracking Simulation
- Top-off Injection Accident Scenarios
- Radiological Analysis of Top-off Injection Accident
- Proposed PPS Controls at NSLS-II

Results of Particle Tracking Simulations

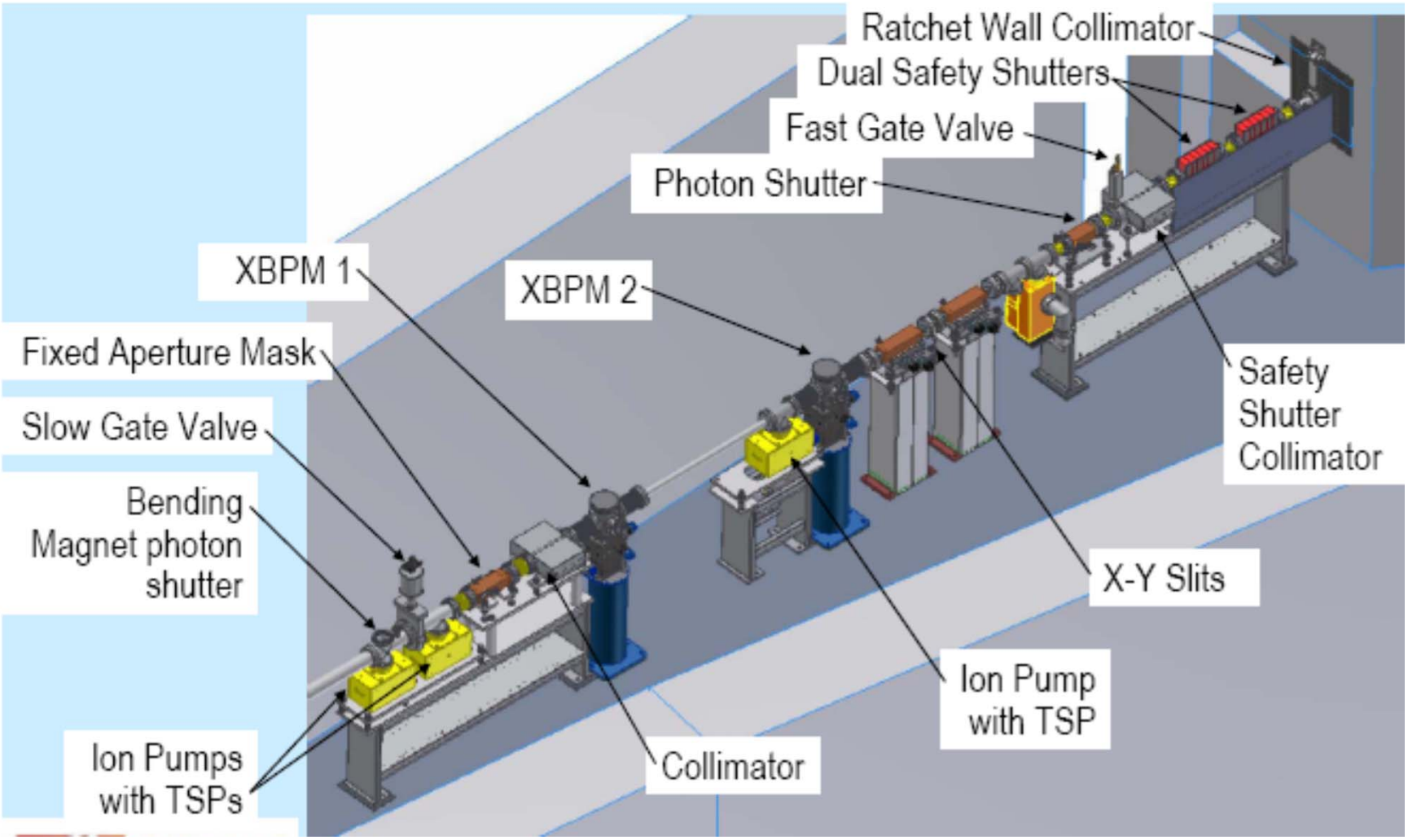
Particle tracking simulations identified that;

- In the event of combinations of magnetic field variations and the beam energy deviations within the bounds of specified limits, the injected electron beam can be confined within the beam line frontend collimators inside the storage ring.
- In the event of interlock failure to detect magnetic field variations and beam energy variations beyond the interlocked range, the injected electron beam could be conveyed down through storage ring ratchet wall to the first optics enclosure of the beamlines.

NSLS-II Shielding Policy Implementation

- < 100 mrem/h – Only administrative controls are required (limiting operation, exclusion zone etc.)
- 100 mrem/h- 2000 mrem/h - One engineered credited control is required (interlocked ARM, magnet interlocks etc.)
- > 2000 mrem/h – Redundant engineered credited controls are required (with minimum common mode failure probability).

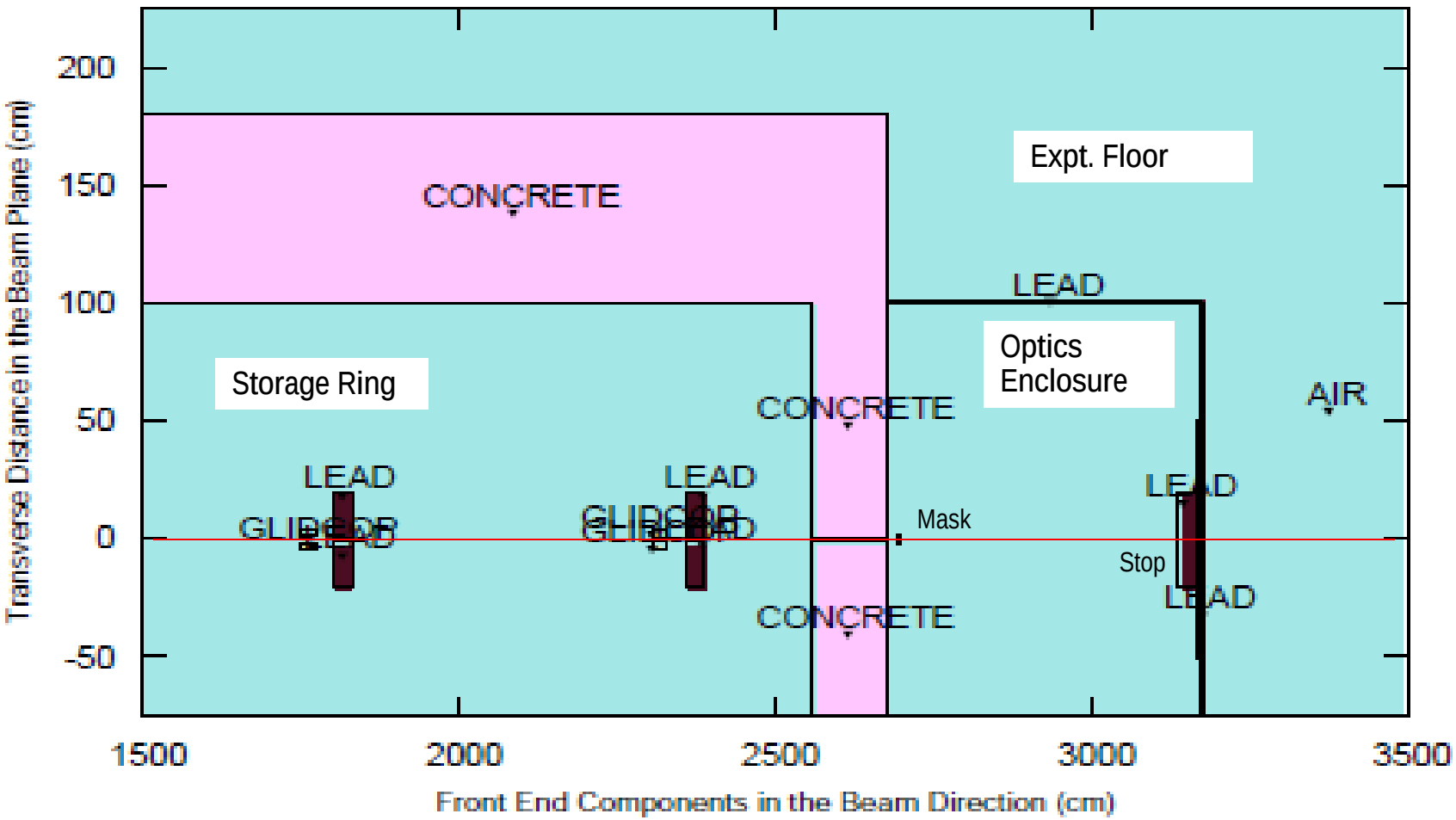
Front End Components Identified for Injected Beam Loss



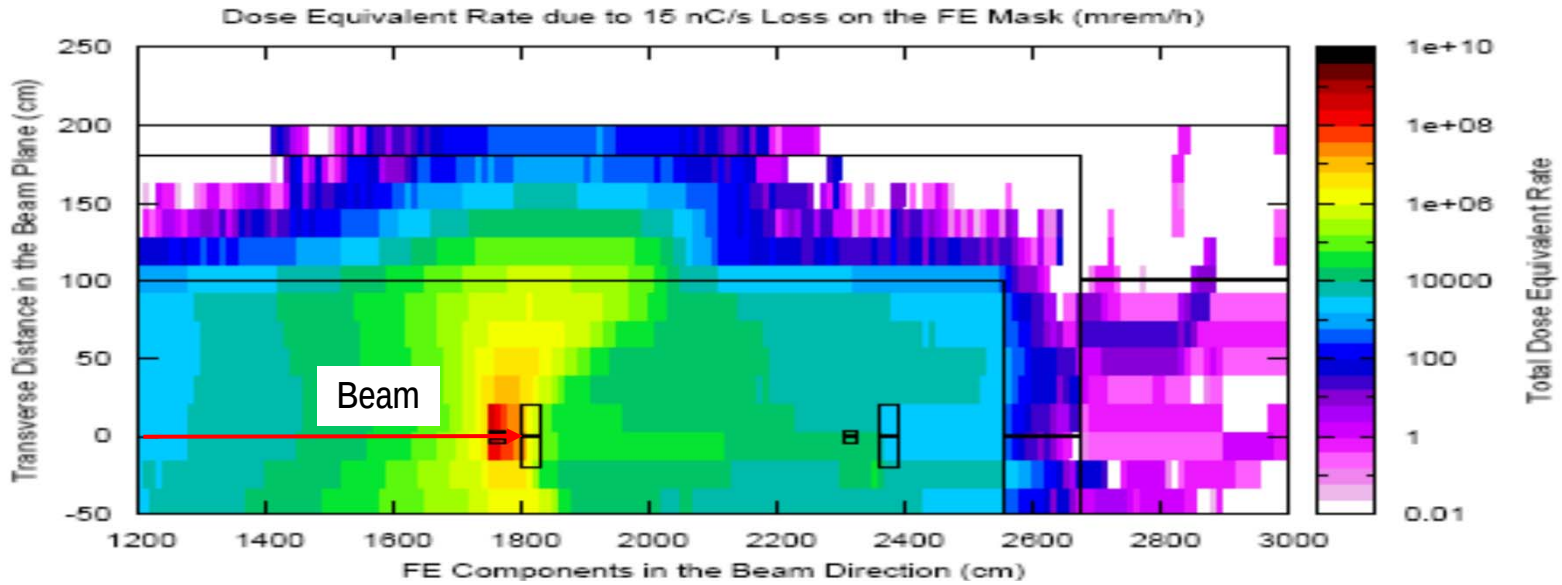
Radiological Analysis of Top-off Injection Accident

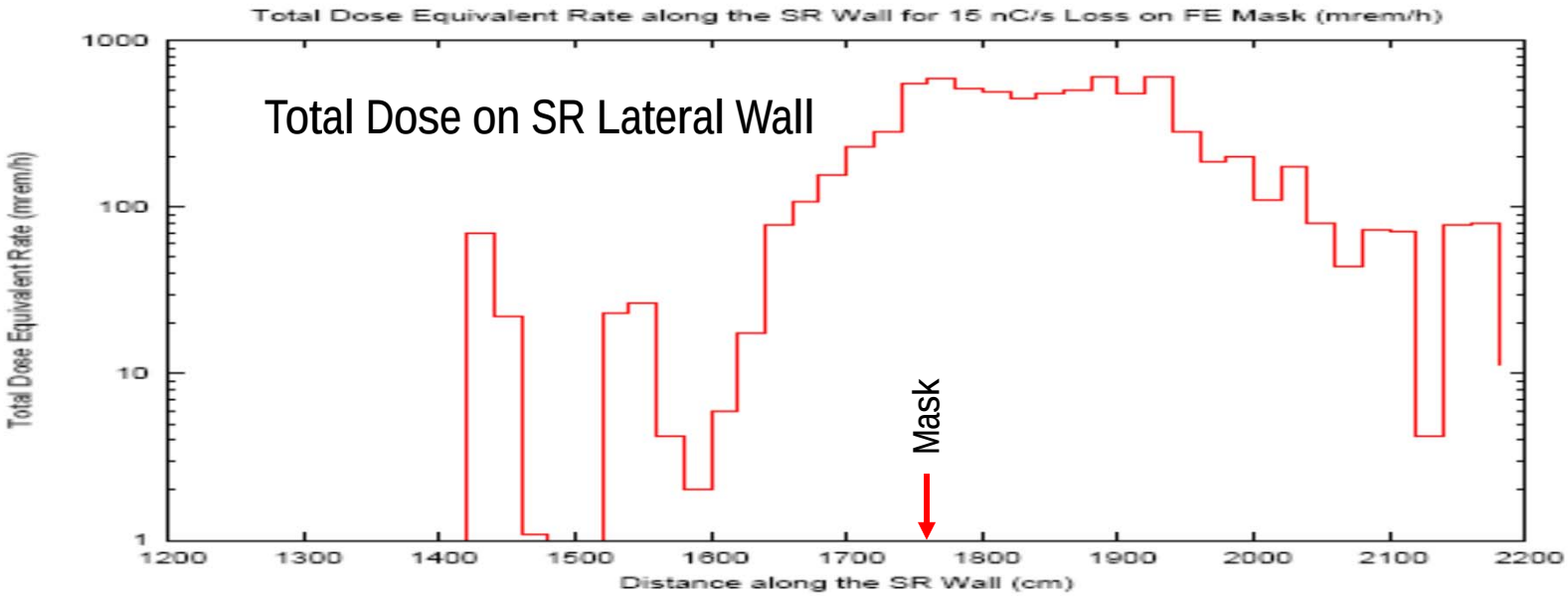
- FLUKA Monte Carlo simulations have been performed to analyze the radiological implications of maximum top-off injection beam loss.
- The full injected electron beam of 15 nC/s was made incident on to the fixed aperture mask or photon shutter at the Front End (FE) inside the storage ring, with FE safety shutters in open position.
- The full injected electron beam of 15 nC/s was made incident on to a beam line component inside the First Optics Enclosure (FOE).
- FLUKA calculated the total dose equivalent rates and neutron dose equivalent rates for these beam loss scenarios at the experimental floor using ICRP74 radiation weighting factors.

Front End & FOE Components in FLUKA Simulation

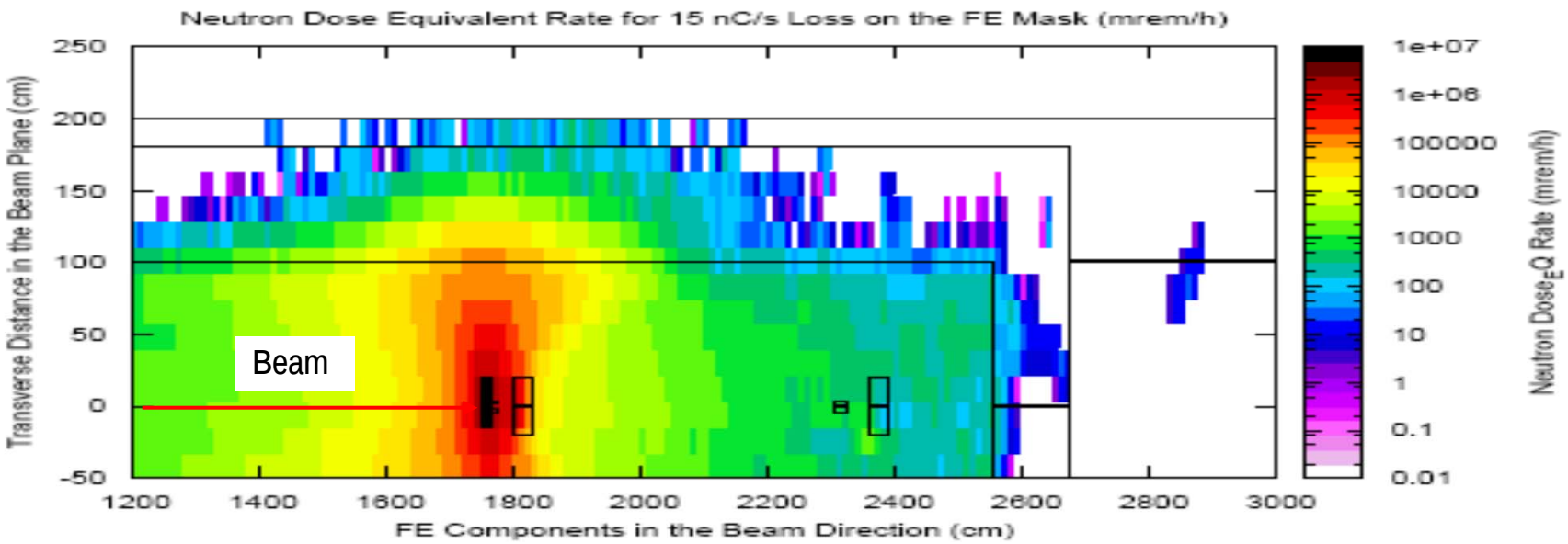


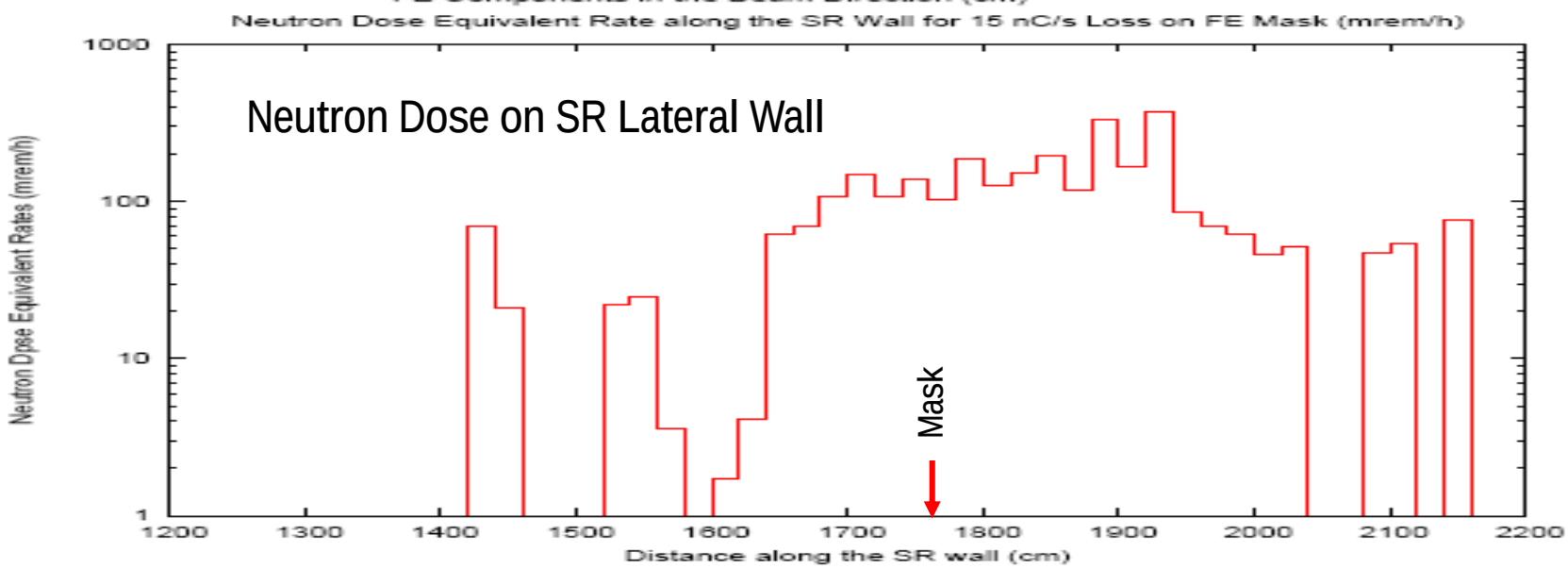
Total Dose Rates for Injected Beam on the Fixed Aperture Mask





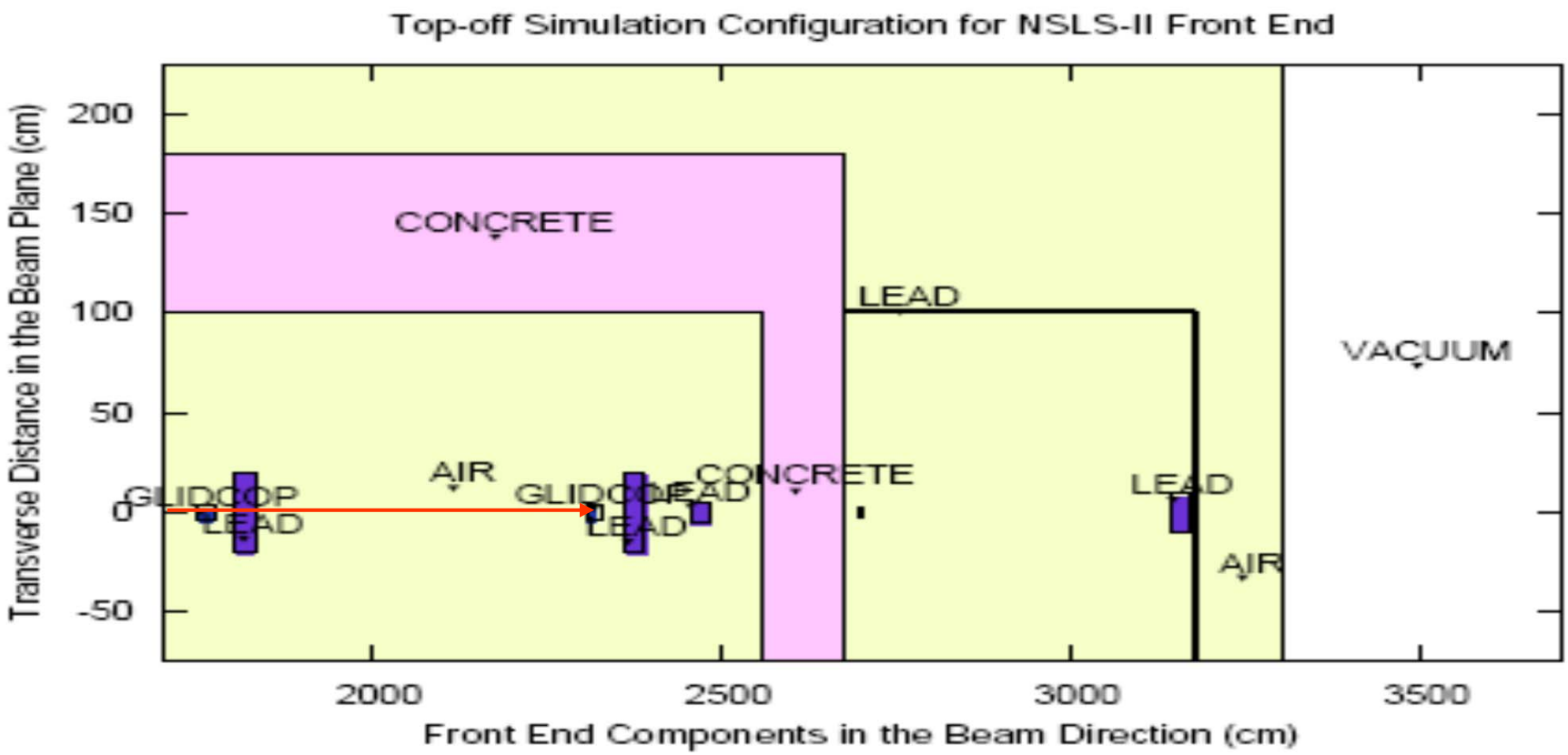
Neutron Dose Rates for Injected Beam on the Fixed Aperture Mask



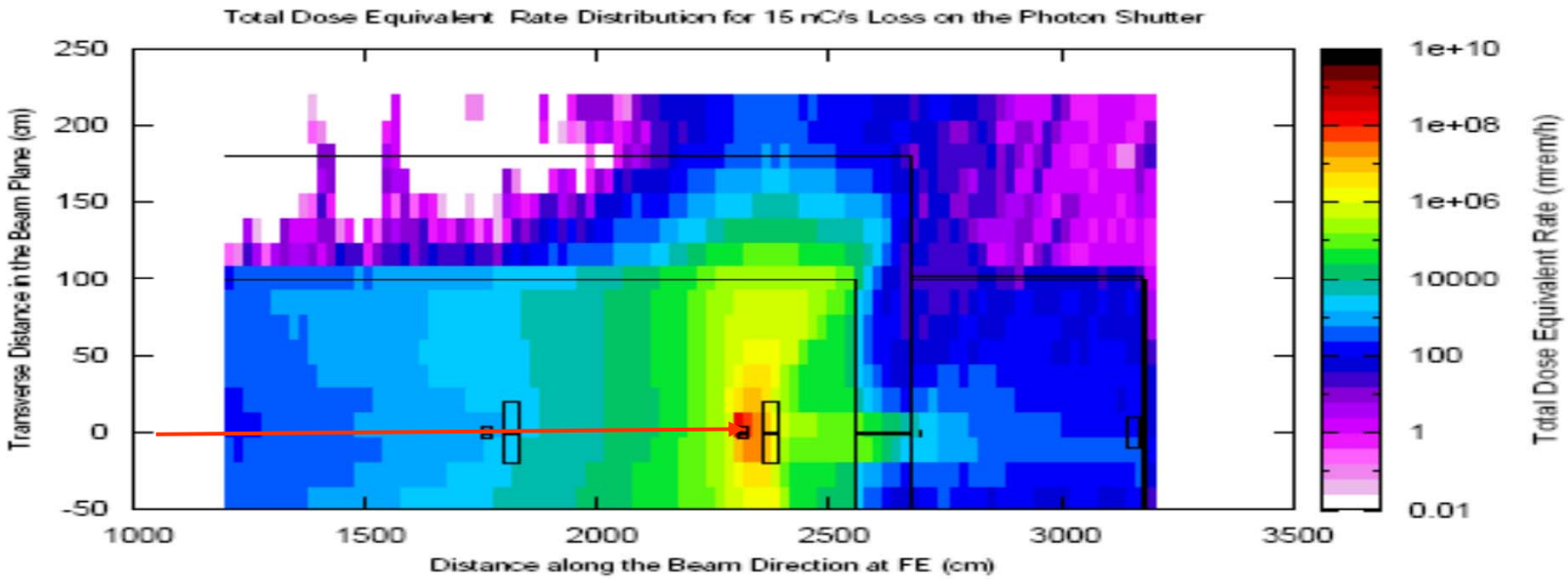


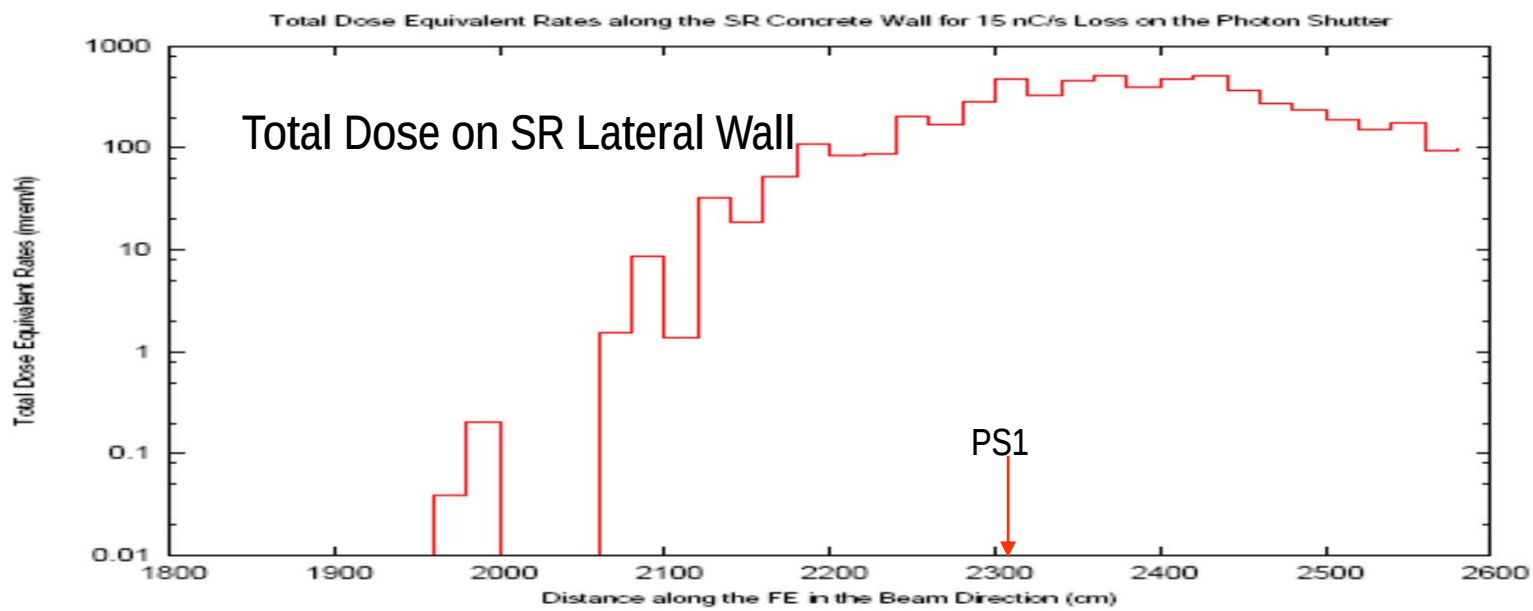
BROOKHAVEN SCIENCE ASSOCIATES

Injected Beam on the Photon Shutter

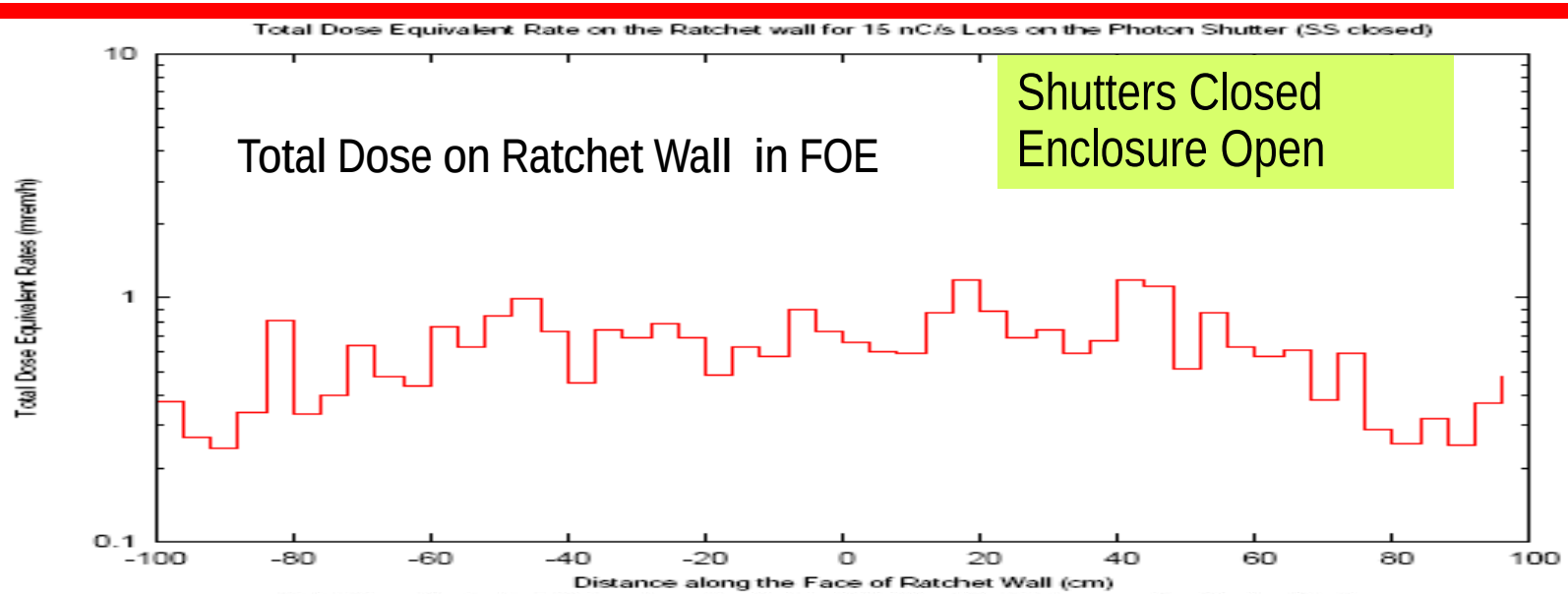


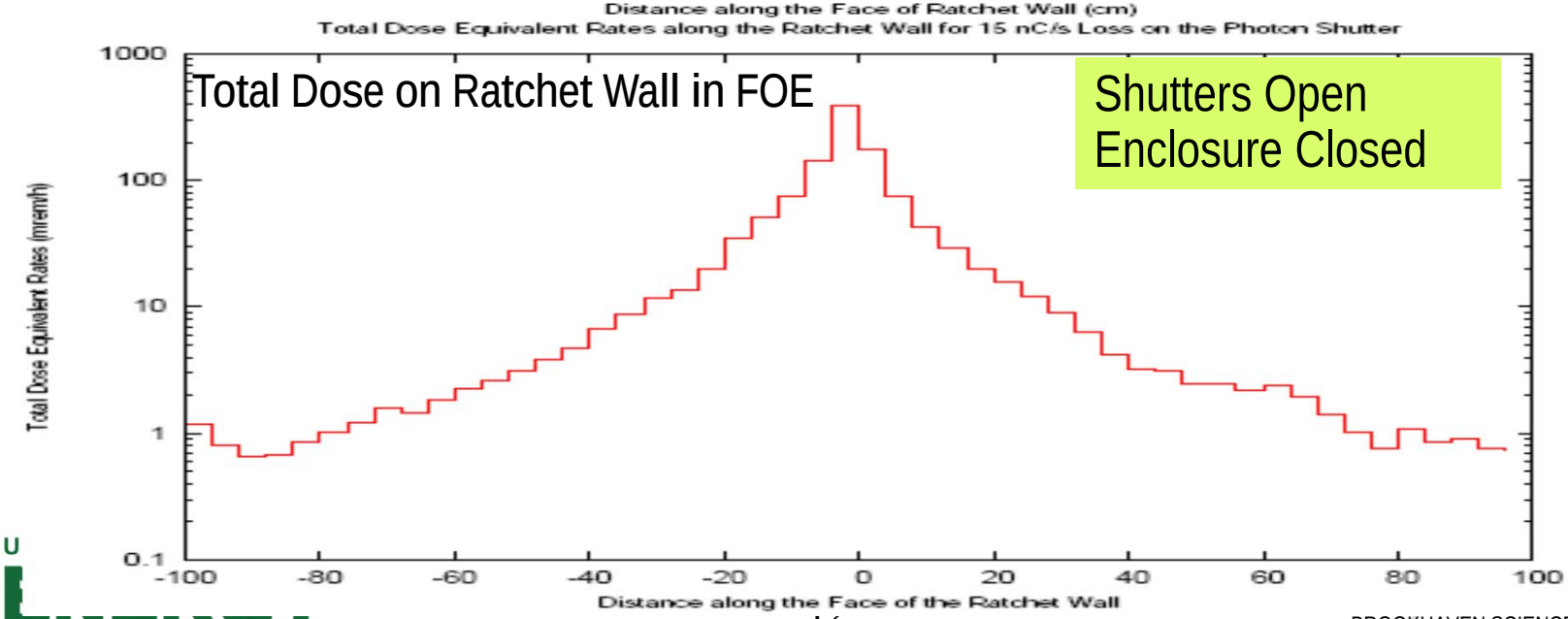
Total Dose Rates for Injected Beam on the Photon Shutter



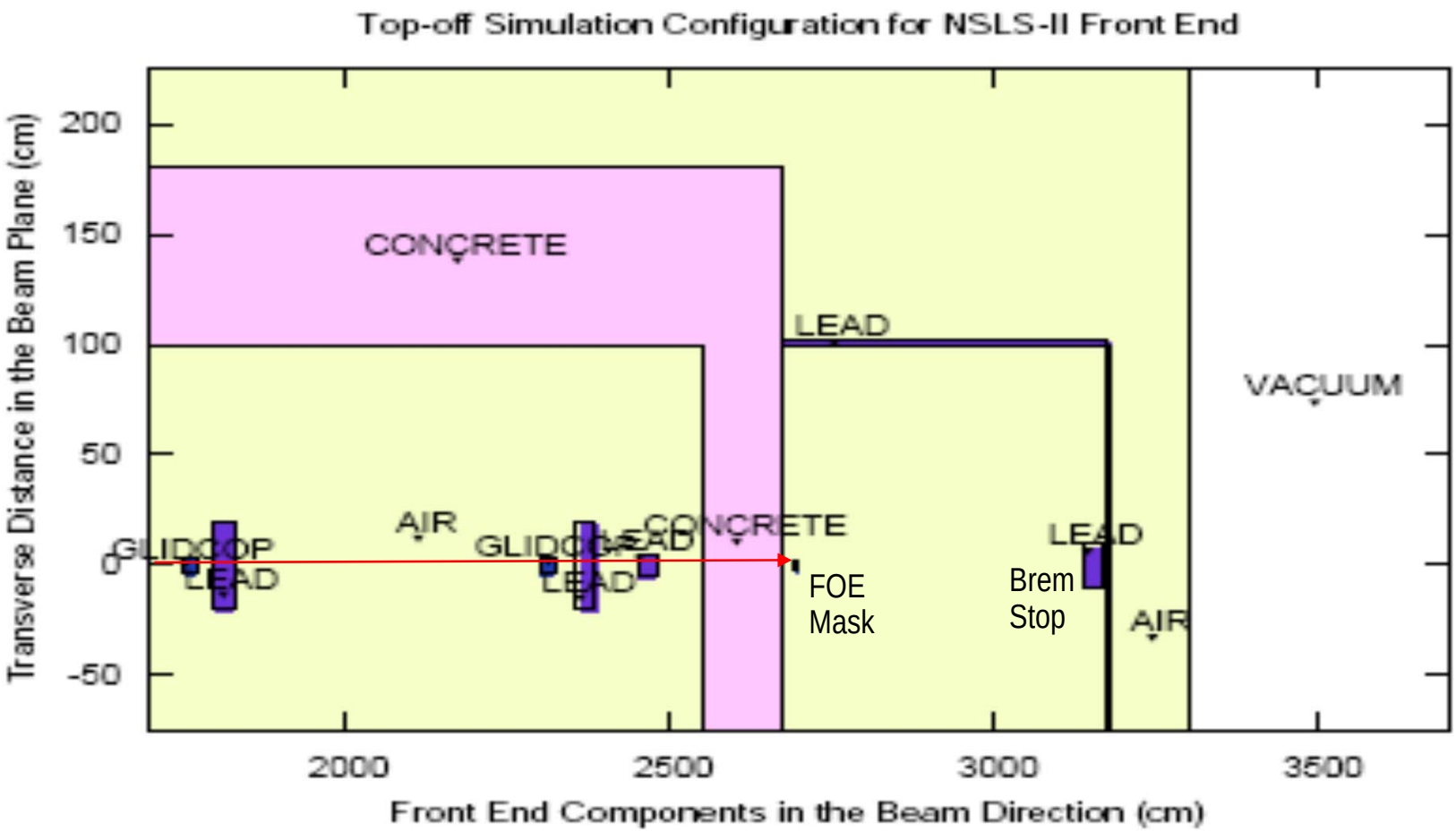


Total Dose Rates for Injected Beam on the Photon Shutter

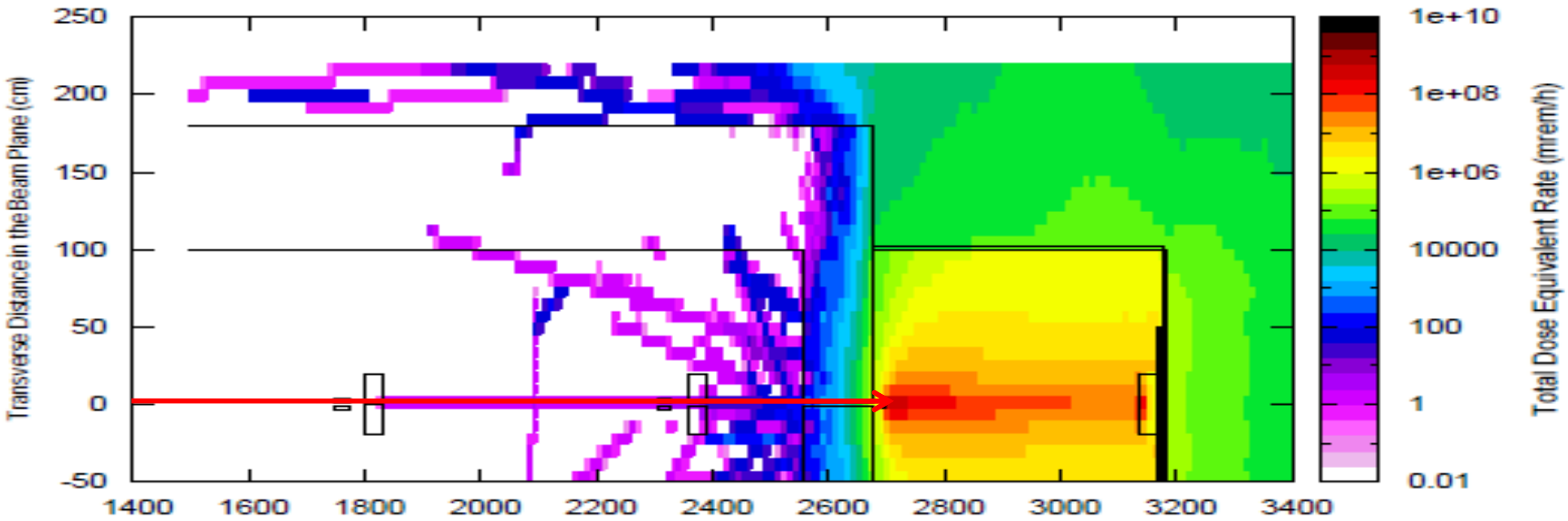


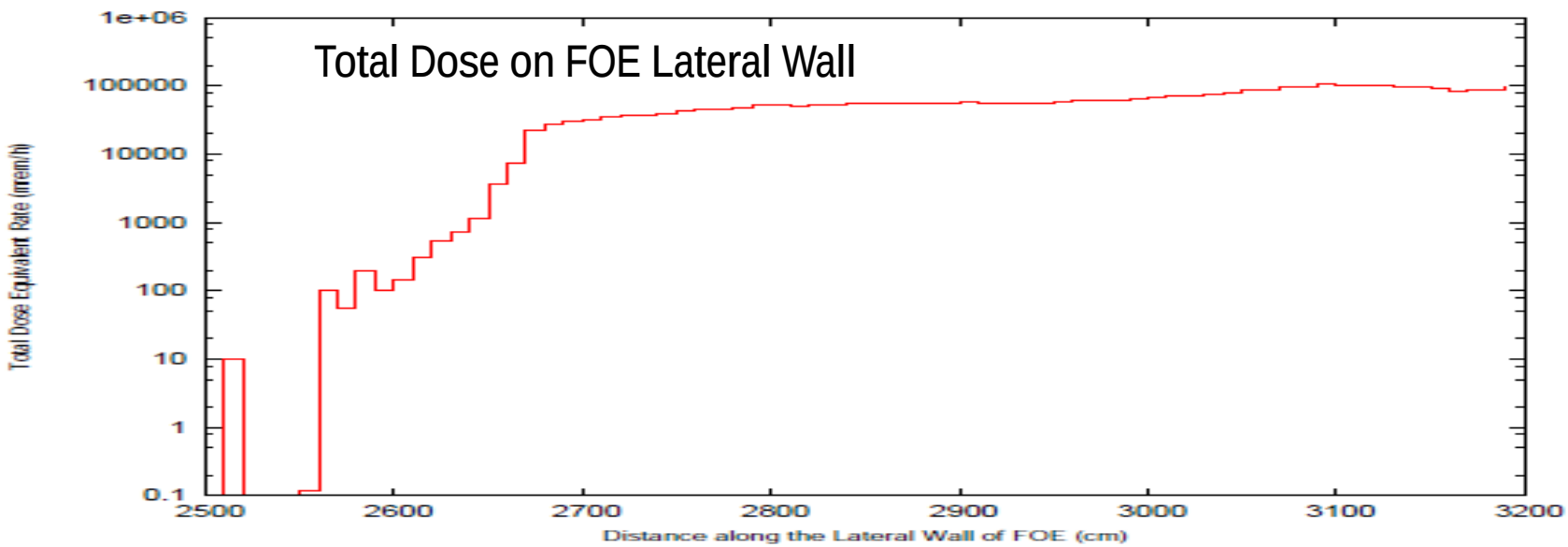


Injected Beam in the First Optics Enclosure



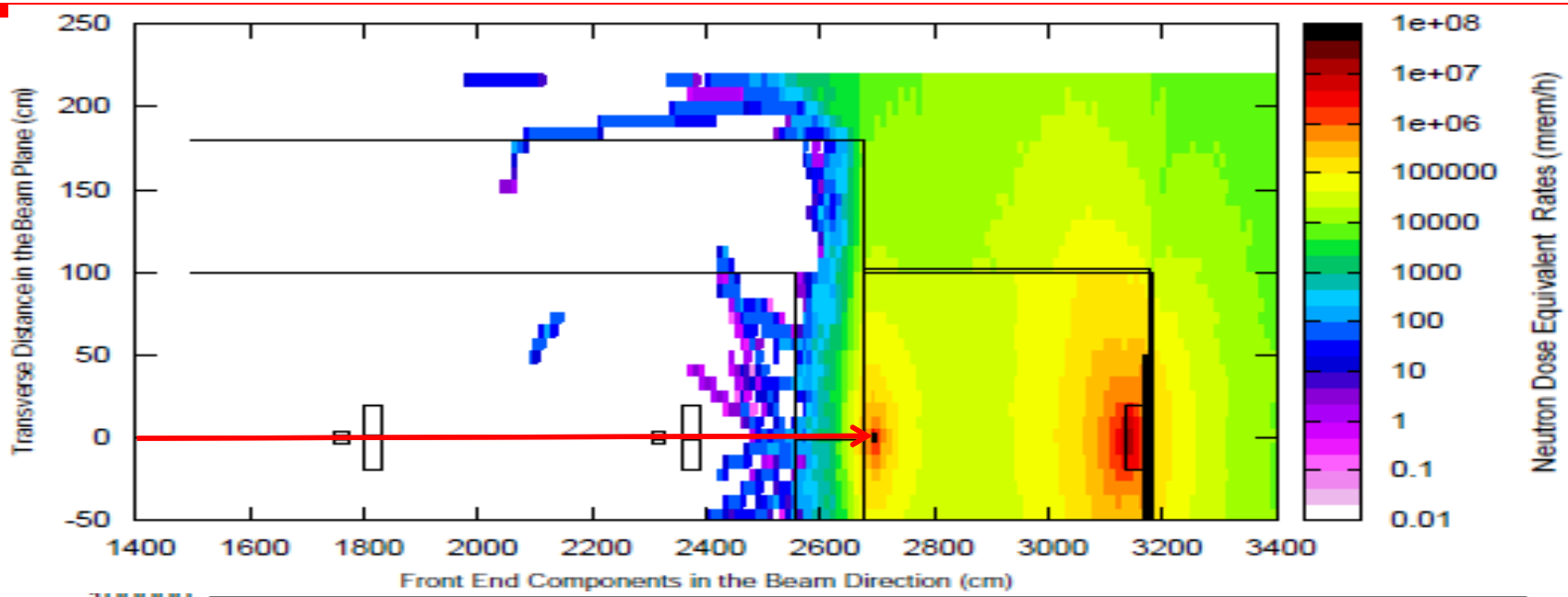
Total Dose Rates for Injected Beam in the First Optics Enclosure

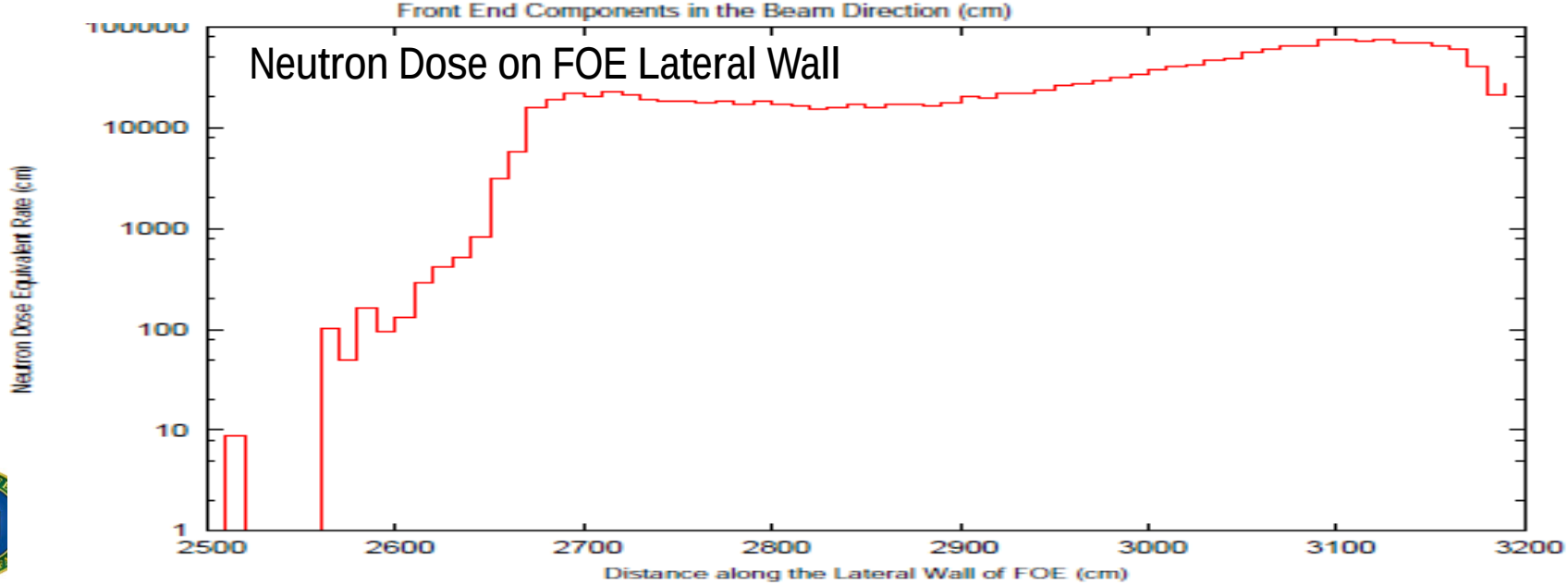




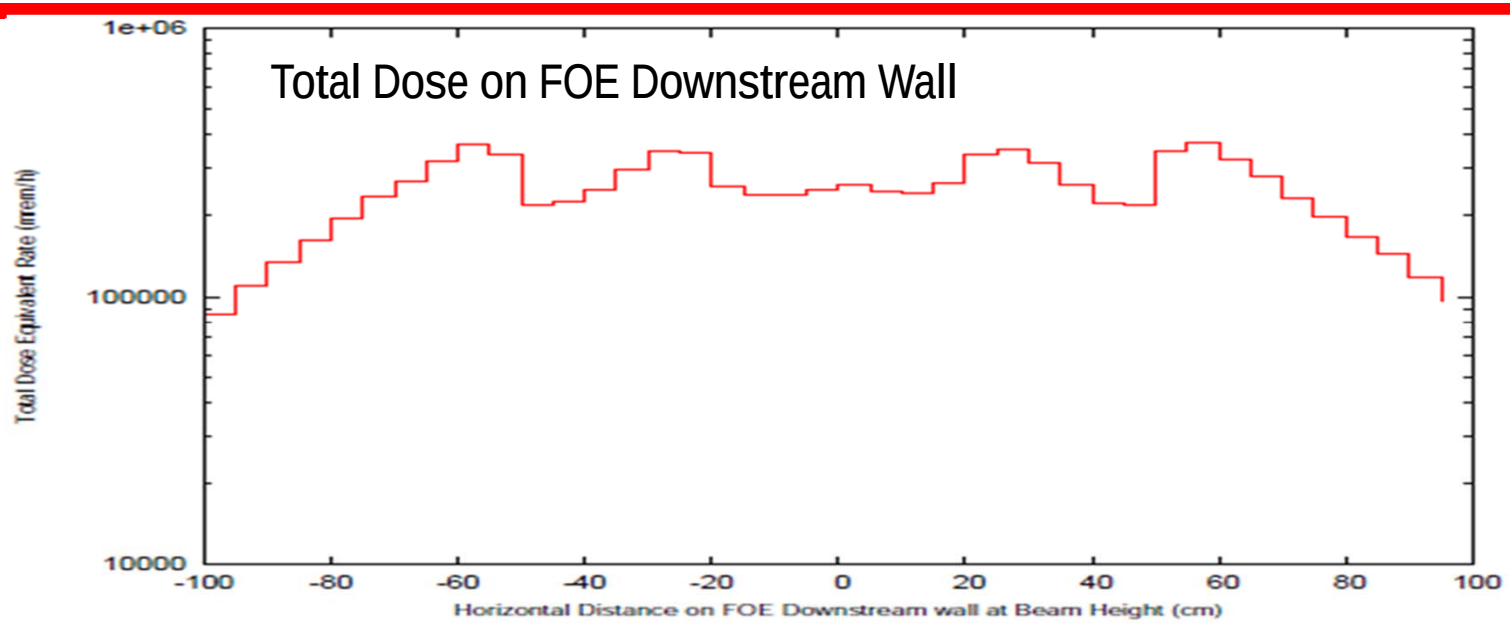
BROOKHAVEN SCIENCE ASSOCIATES

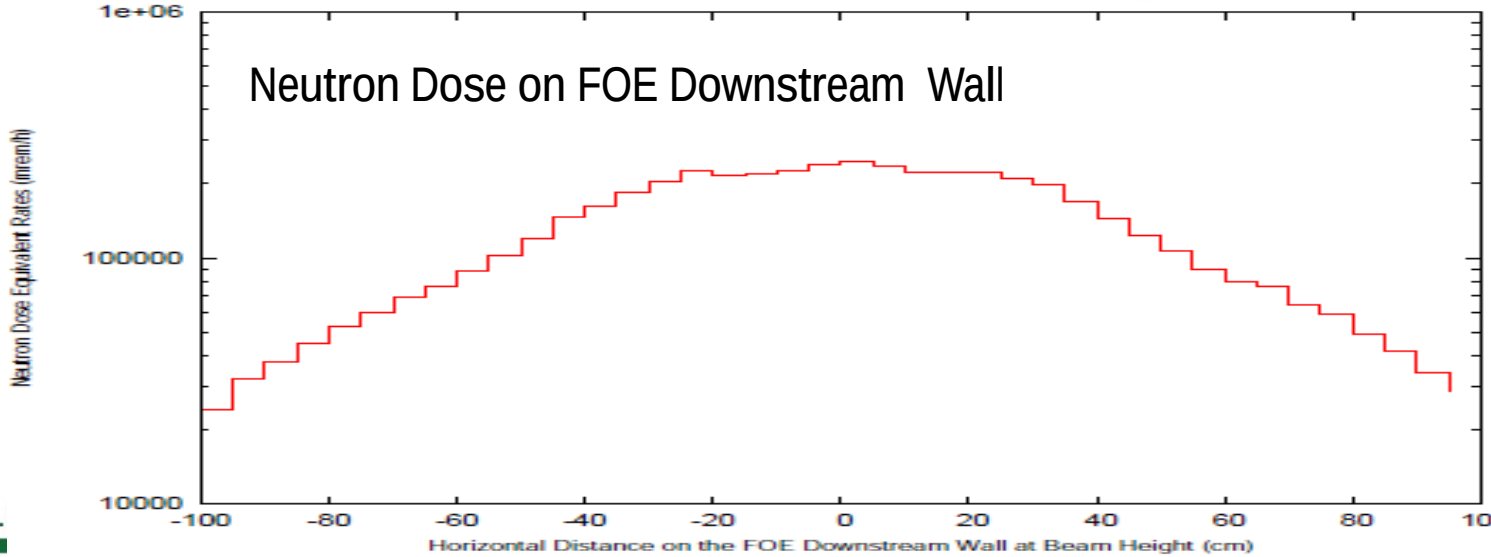
Neutron Dose Rates for Injected Beam in the First Optics Enclosure





Dose Rates for Injected Beam in the First Optics Enclosure





U. ENERGY
KHAVEN NATIONAL LABORATORY
BROOKHAVEN SCIENCE ASSOCIATES

Summary Results of Radiological Analysis

- In the event of a full injected beam loss at the front end inside the storage ring, the total dose rate on the experimental floor will be < 500 mrem/h (5 mSv/h), for the injection loss rate of 15 nC/s. (one credited engineered control is required).
- This corresponds to a total dose of < 0.14 mrem (1.4 μSv) on the experimental floor per top-off injection pulse of 15 nC.
- In the event of full injected beam conveyed down to the FOE, the dose rate at the experimental floor will be ~300 rem/h (3 Sv/h) for the injection loss rate of 15 nC/s. (redundant engineered controls are required).
- The corresponding dose will be ~ 80 mrem (0.8 mSv) per top-off injection pulse of 15 nC. It is highly desirable to prevent even a single errant injection pulse from entering the First Optics Enclosure.

Proposed Protection System Functions

The following are the proposed Personnel Protection System (PPS) functions related to top off injection.

- Permit top-off mode injection with only stable stored beam - stored beam current interlock (minimum stored beam current assumes stable beam, stored beam current is monitored redundantly).
- Permit top-off mode injection only with matched booster and storage ring energies – magnetic field range interlock- (booster dipole current and storage ring dipole current are monitored redundantly).
- Monitor magnet string voltage for shorted turns and inhibit injection, if a short is detected.

Top-off PPS Logic

The details of the PPS logic are still being worked out