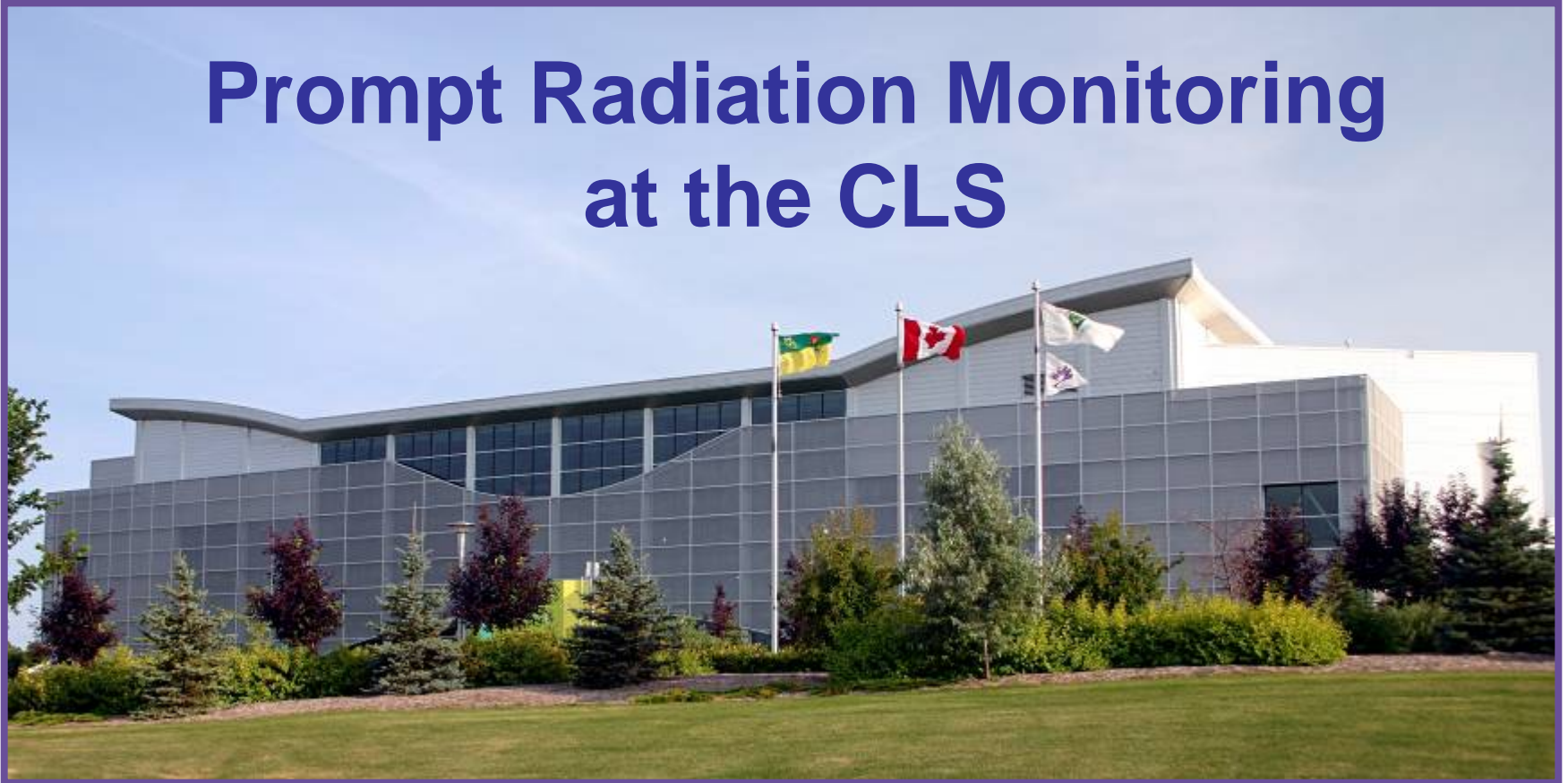


Prompt Radiation Monitoring at the CLS



Grant Cubbon - RadSynch '07
June 8, 2007

Outline

- Intro to CLS
- Machine Parameters
- Shielding Design
- Stored Beam
- Injected Beam
- RF System
- Top-Up Mode (Preliminary Measurements)

Highlights/Firsts

- 1999: Start of construction.
- 2001: Main experimental hall building is complete and ready for occupancy.
- 2002: Start of commissioning the booster ring. (The 2.9 GeV electrons produced are the highest energy achieved by any Canadian particle accelerator.)
- 2003: Start of commissioning the main storage ring.
 - First synchrotron light detected in the Optical Diagnostics Beamline.
- 2004: First x-rays detected in the SGM Beamline.
 - Commissioning of the storage ring is completed.
 - First experimental data recorded on the SGM Beamline.
 - Official Grand Opening.
- 2005: First synchrotron user!!
- 2006: First publications based on CLS data.

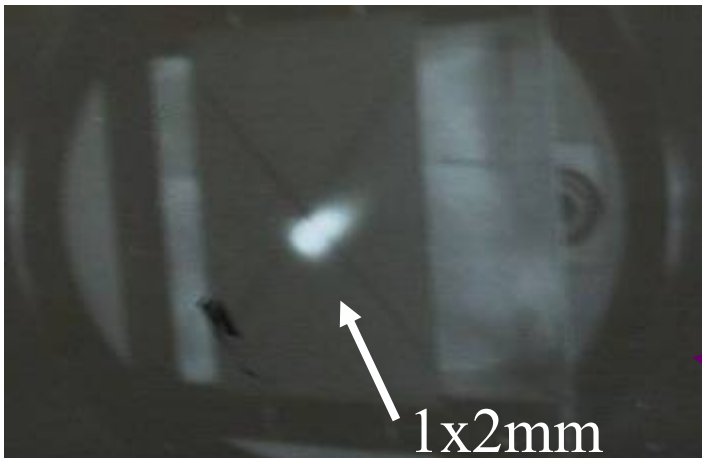
Booster & Storage Rings



Booster Ring



Storage Ring

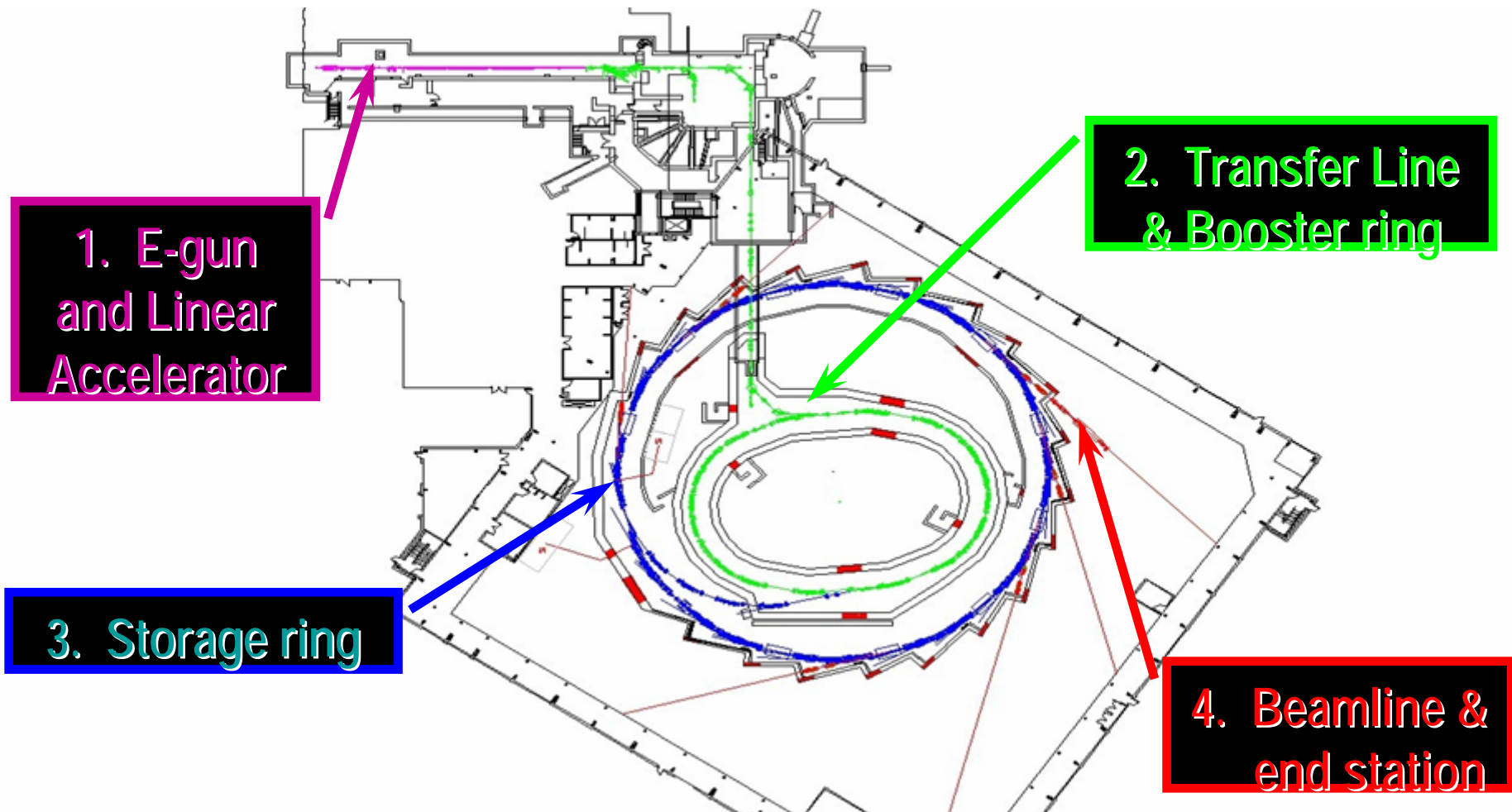


Electron stream

Synchrotron Hall, a Beamline



CLS Facility Major Components



Machine Parameters

- 250 MeV Linac
 - 136 nS pulse, 1 Hz
 - 6 RF sections
 - Energy Compression System
 - 60 mA Avg Current

- 250 MeV \rightarrow 2.9 GeV Booster Ring
 - 1Hz
 - 10 mA Avg circulating (nominal)
 - RF 500 MHz
 - 20 dipoles

Machine Parameters

- 2.9 GeV Storage Ring
 - 500 mA design
 - 250 mA with >16 hour 'lifetime'
 - 12 sections – 24 dipoles
 - RF 500 MHz Superconducting
- 9 Beamlines (Far IR → Hard Xray) installed
 - 7 under construction

Shielding Design

- Design Objectives:
 - Injector < 80 $\mu\text{Sv/h}$ (15 minutes per 4 hours)
 - Storage Ring < 5 $\mu\text{Sv/h}$
 - Beamline Enclosures < 2 $\mu\text{Sv/h}$ (1+1)
 - Nuclear Energy Workers < 10 mSv/a
 - Public (Users) < 1 mSv/a
 - Environmental < 50 $\mu\text{Sv/a}$ (occupancy)
 - Bulk Shielding vs Local Shielding

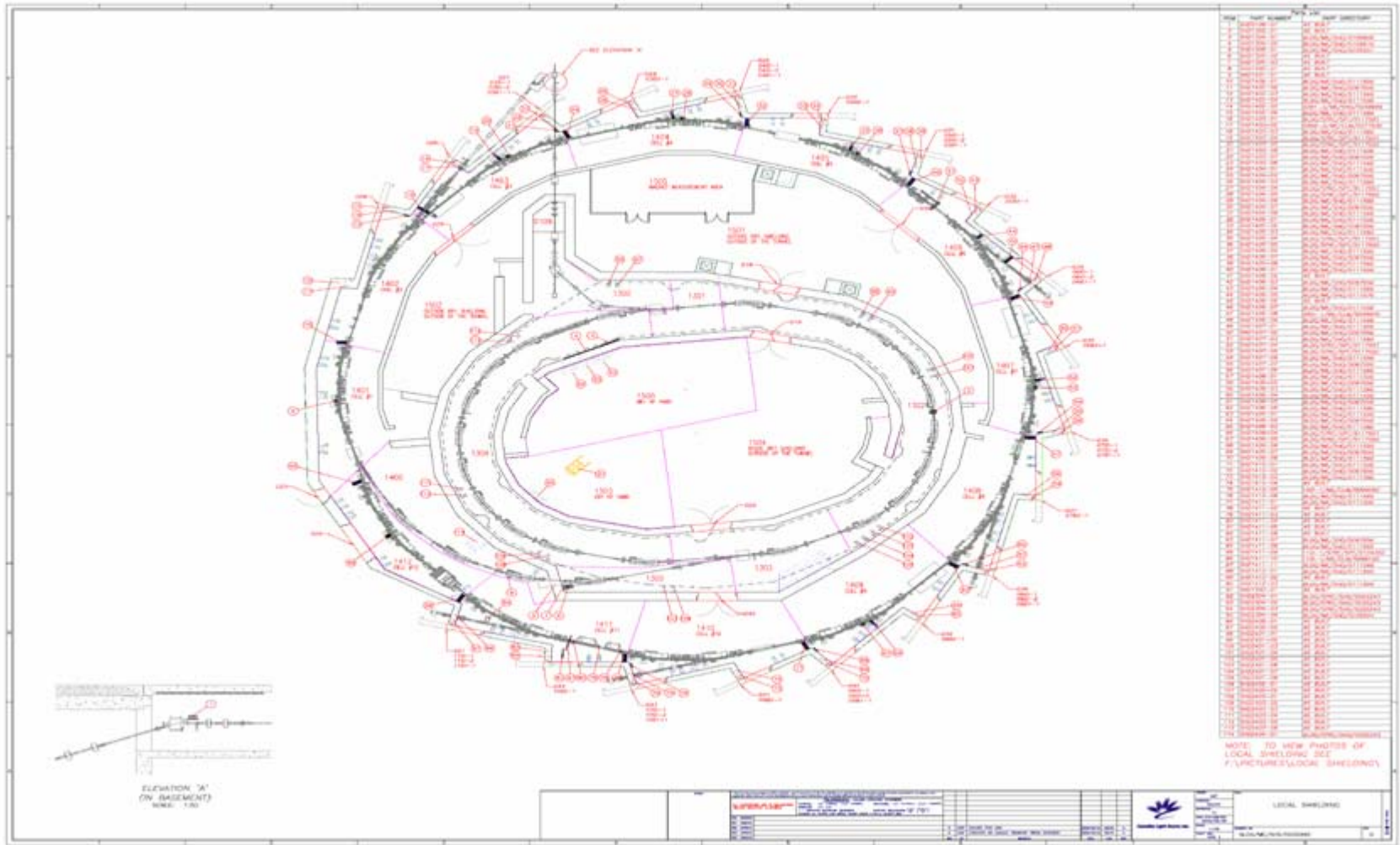
Shielding Design

- Normal Density Concrete walls (2.35 g/cm^3) for accelerator walls
- Additional lead in ratchet walls and as required locally
- Steel and lead in beamline enclosures

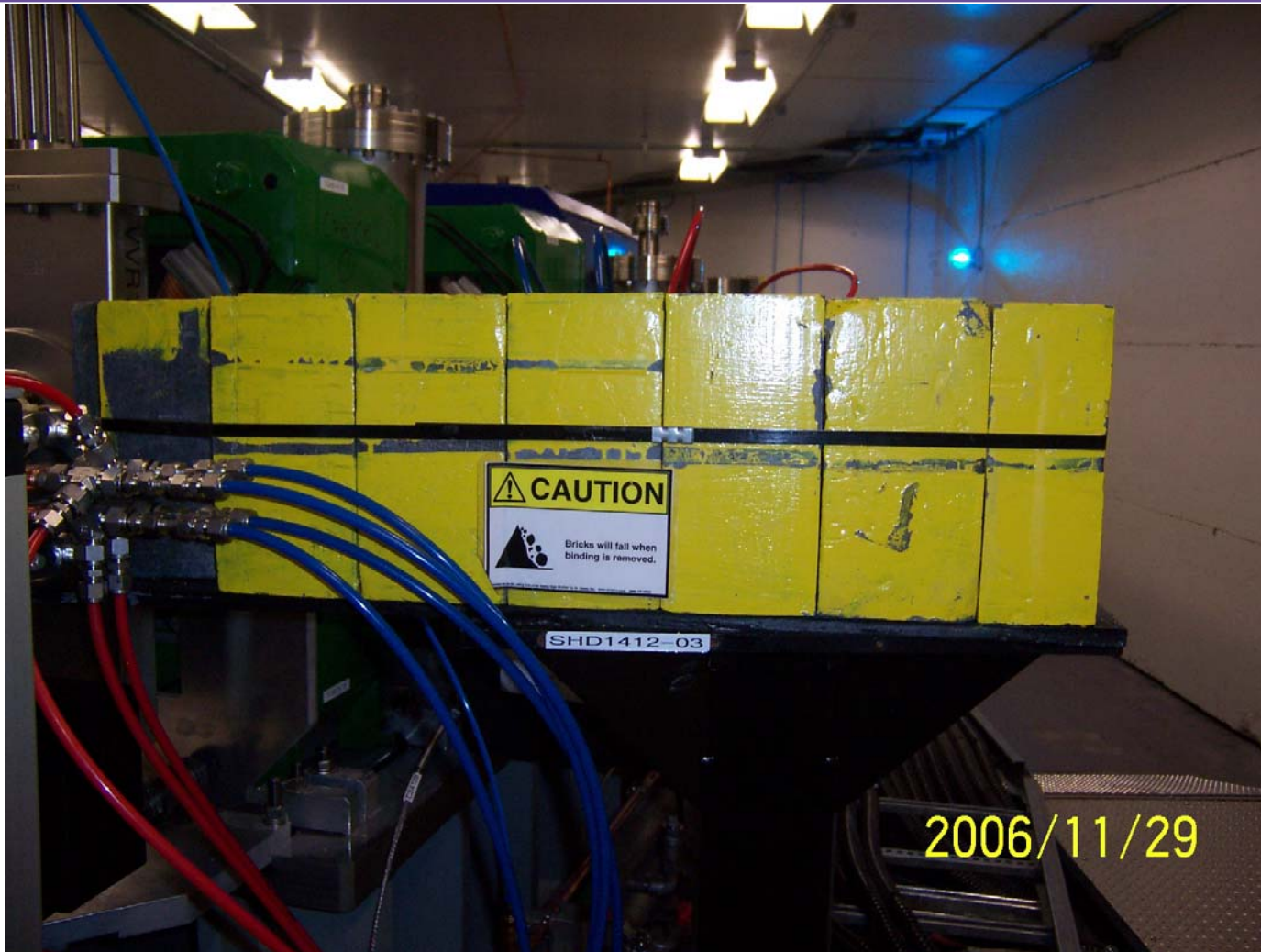
Shielding Design

- Storage Ring Outer Wall Concrete Thickness
 - Side Wall – 46 cm
 - Ratchet Wall Opening – 53.5 cm
 - Opening plugged with 26.7 cm lead + 26.8 cm cement
 - Injection Wall – 92 cm
- Storage Ring Roof Concrete
 - 60 cm

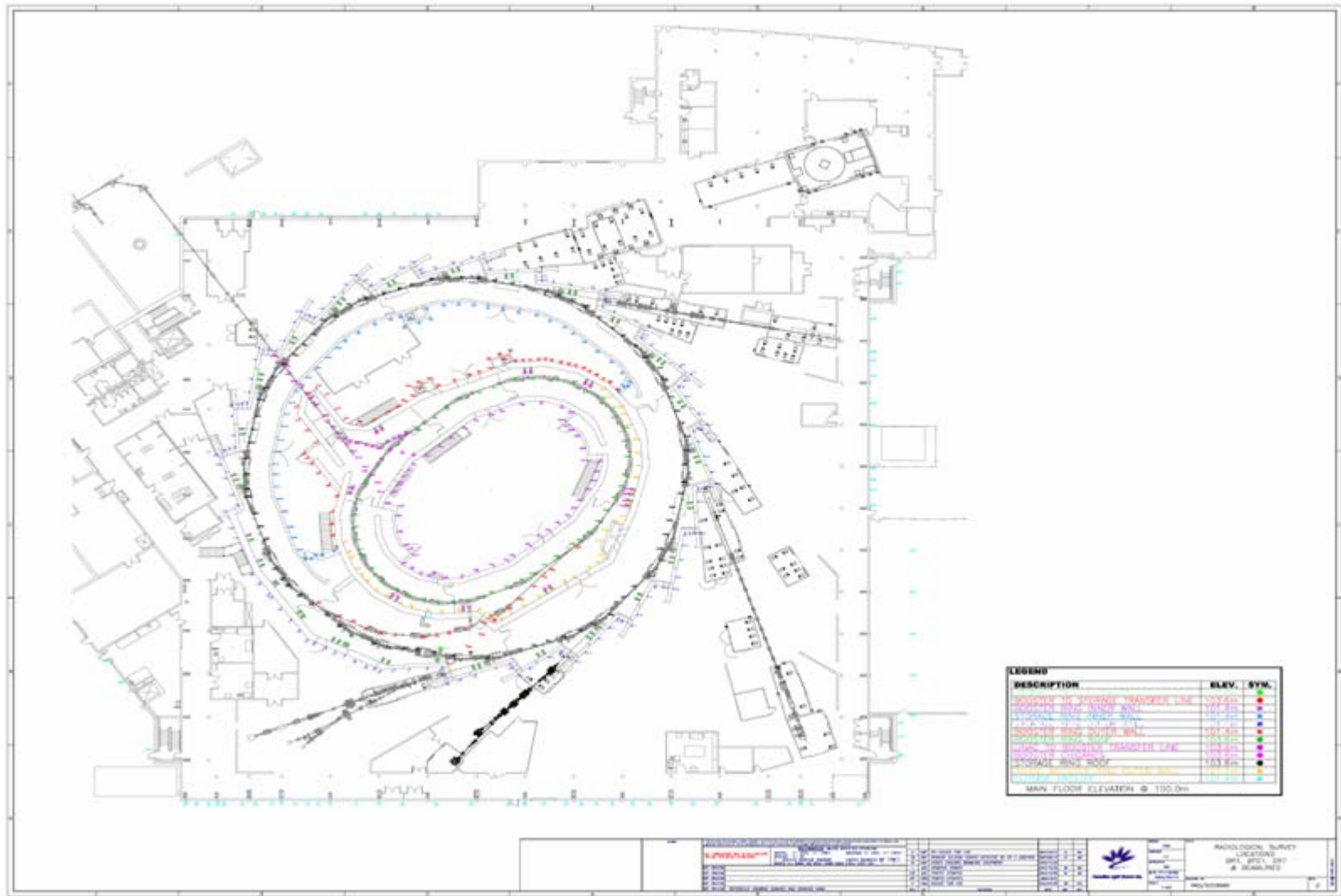
Local Shielding



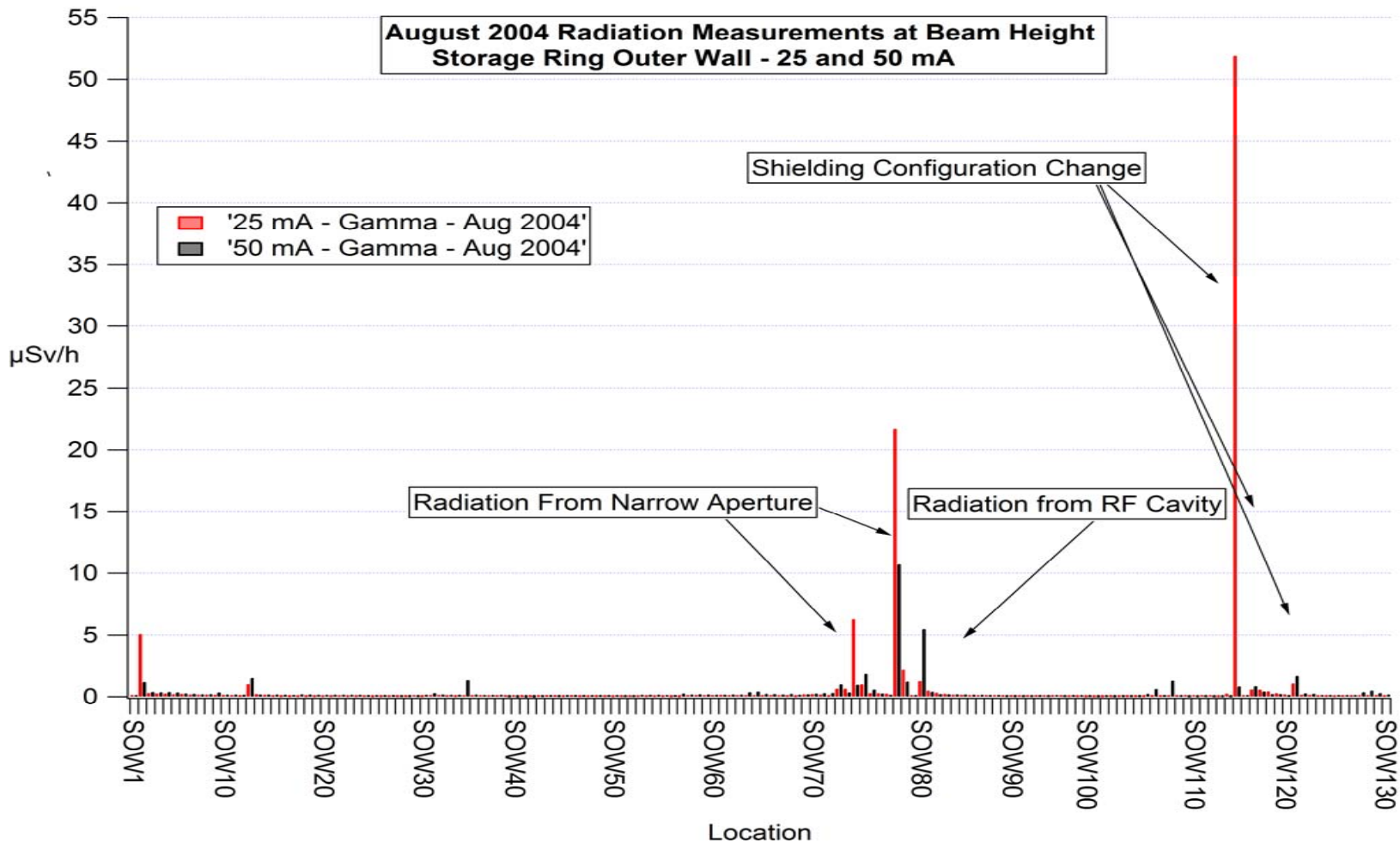
Local Shielding



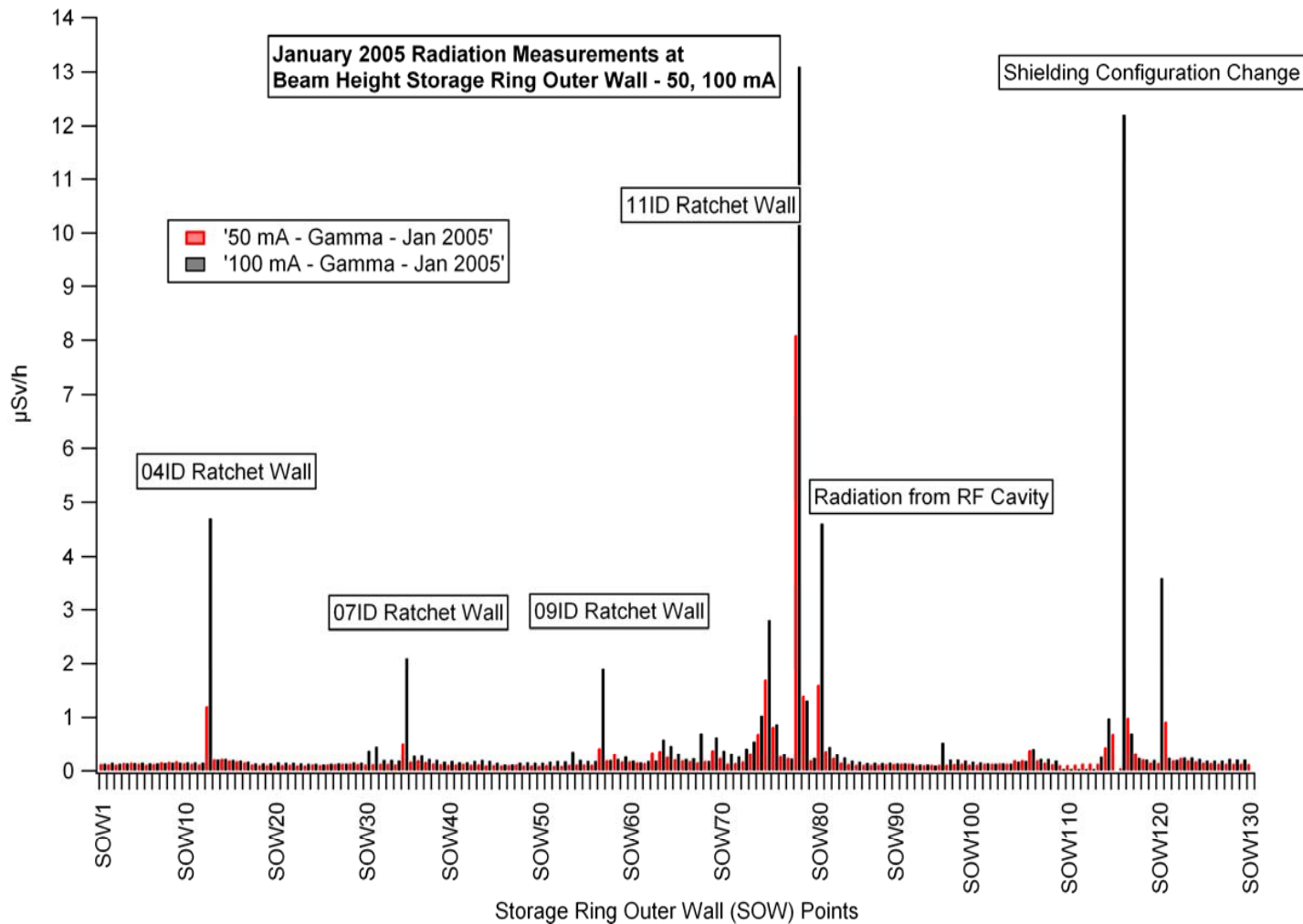
Radiation Measurements



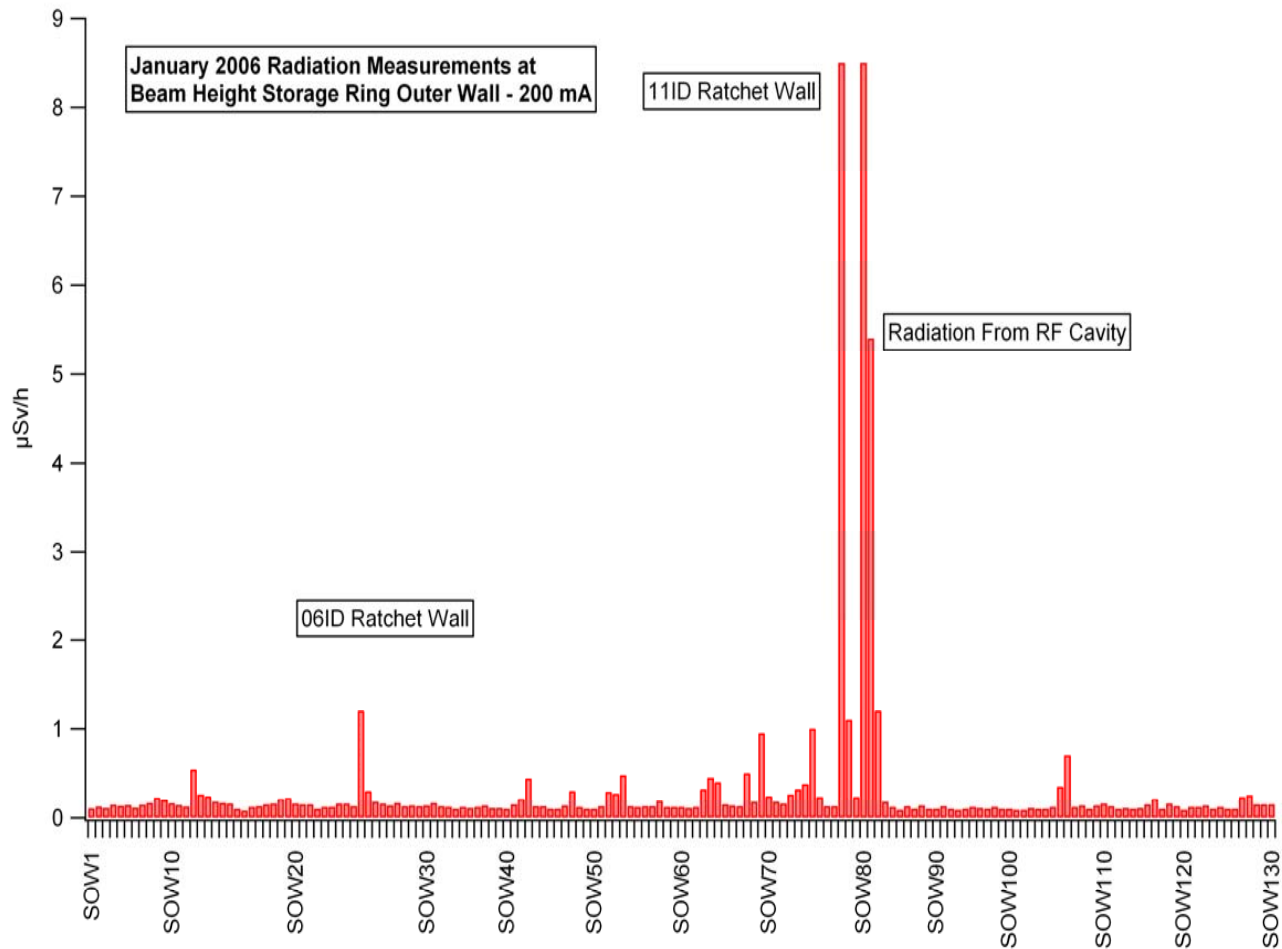
Radiation Measurements Stored Beam



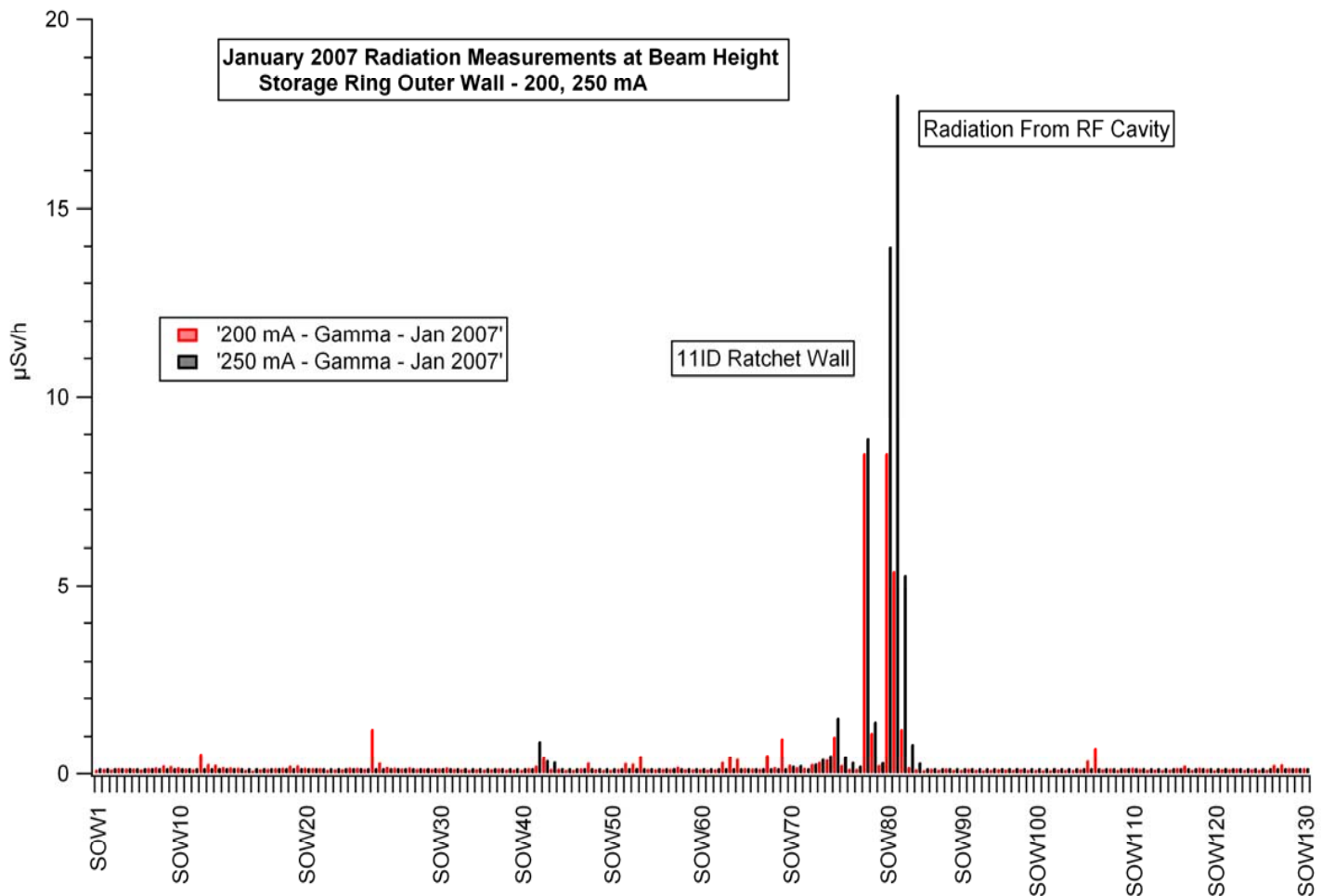
Radiation Measurements Stored Beam



Radiation Measurements Stored Beam

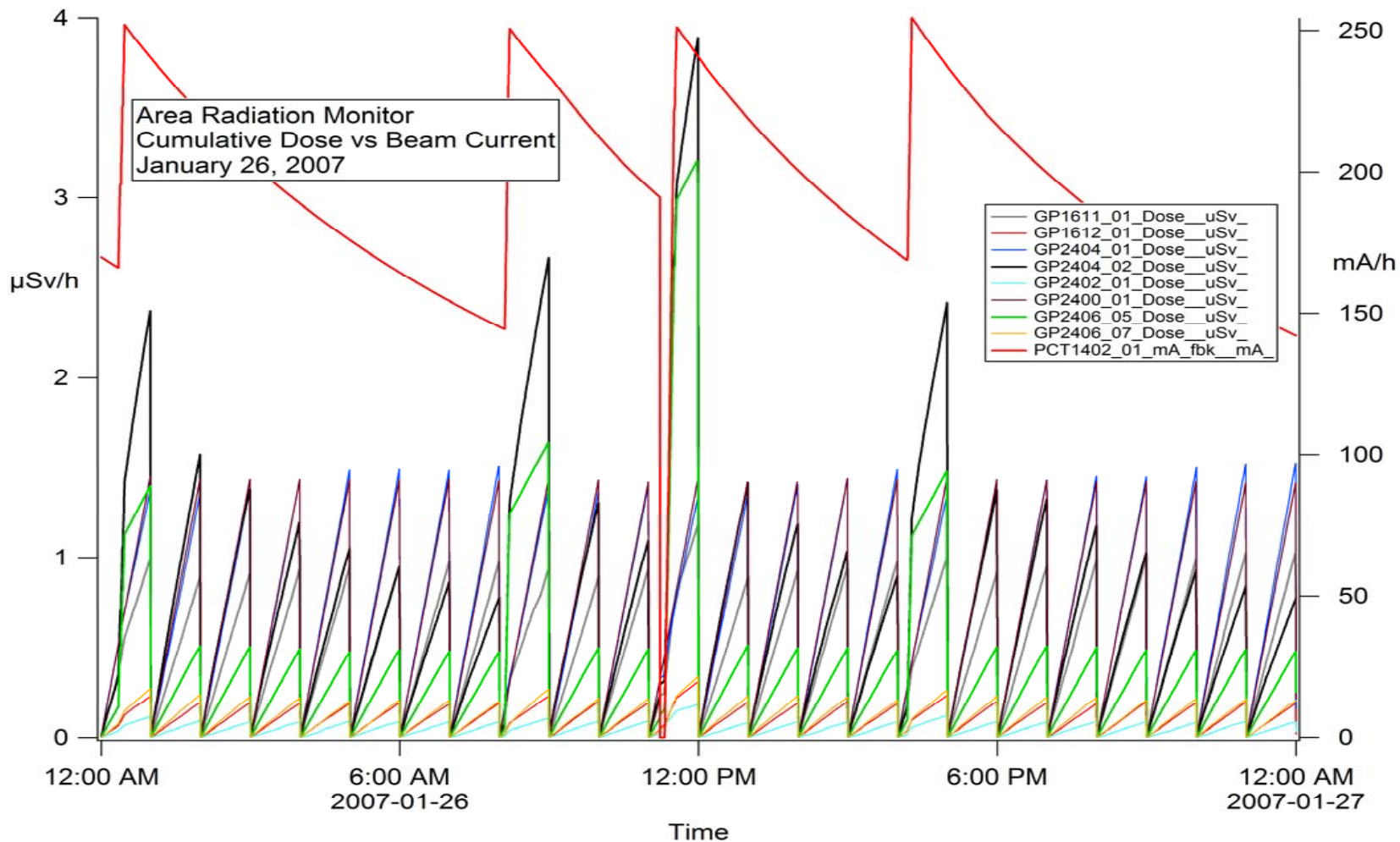


Radiation Measurements Stored Beam



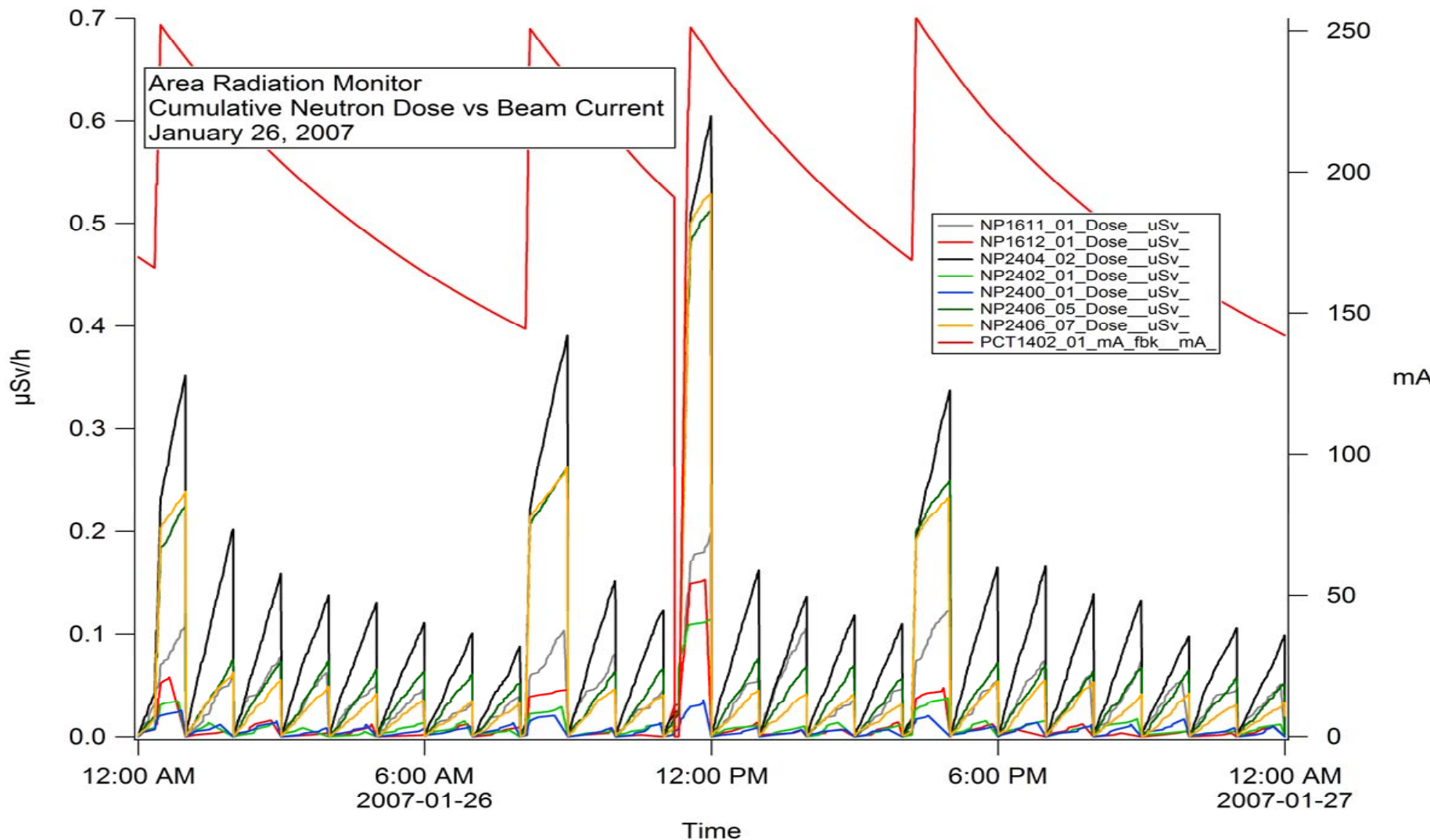


Radiation Measurements Injected Beam



Radiation Measurements

Injected Beam



Radiation Measurements

RF Cavity

Superconducting Cavity Storage Ring Outer Wall Grid Survey – August 2003

| Location | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----------------|------|------|------|------|-----|-----|-----|------|------|------|
| F | 0.17 | 0.41 | 0.69 | 1.3 | 1.8 | 2 | 2.3 | 1.19 | 0.69 | 0.5 |
| E | 0.23 | 0.65 | 0.96 | 2 | 3 | 4 | 4.3 | 1.64 | 1.26 | 0.7 |
| D | 0.3 | 0.56 | 1.16 | 2.3 | 3.5 | 5 | 5.6 | 2.6 | 2.4 | 0.15 |
| C (Beam Height) | 0.39 | 0.72 | 1.45 | 2.2 | 2.5 | 3.4 | 4.1 | 2.6 | 2.8 | 0.2 |
| B | 0.35 | 0.44 | 1.08 | 2.1 | 2.4 | 3.3 | 3 | 1.84 | 1.83 | 0.17 |
| A | 0.33 | 0.41 | 0.81 | 1.65 | 1.6 | 2.3 | 2.5 | 0.9 | 0.5 | 0.06 |

SOW81 = C7

ALL OTHER POINTS IN 0.5 METER INCREMENTS FROM SOW 81

ALL EXPOSURES IN $\mu\text{Sv/H}$

Radiation Measurements

RF Cavity

Superconducting Cavity Storage Ring Outer Wall Grid Survey – February 2007

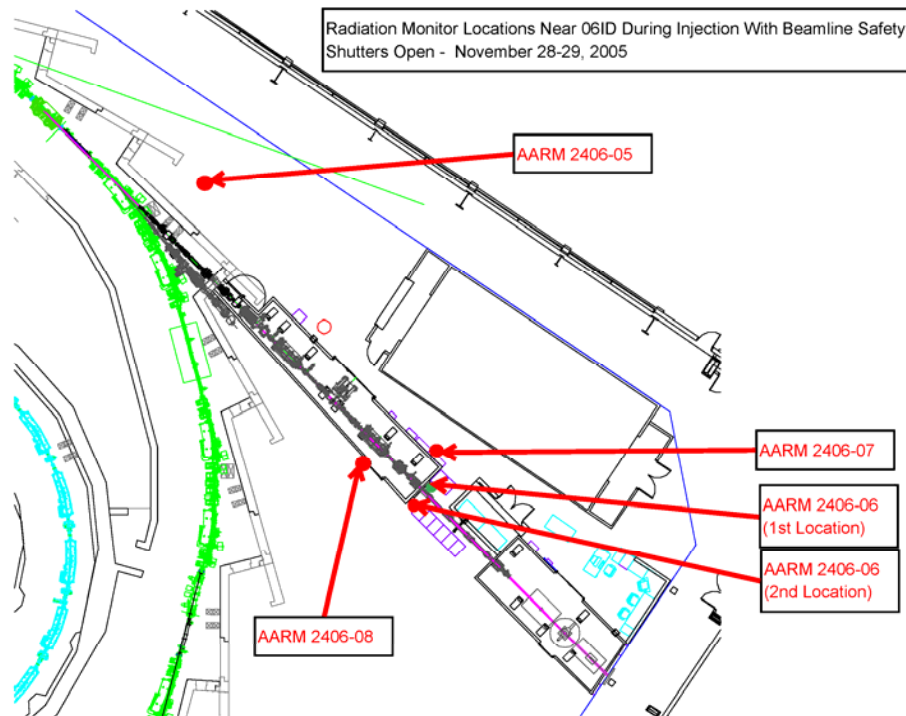
| Location | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-----------------|------|------|------|------|------|------|------|------|------|------|
| F | 1.5 | 1.62 | 3.36 | 6.48 | 9.62 | 13.1 | 15.3 | 6.91 | 3.16 | 3.42 |
| E | 1.71 | 2.7 | 6 | 14.6 | 18 | 27 | 22.7 | 12.2 | 6.24 | 5.56 |
| D | 1.9 | 2.4 | 6.05 | 14.3 | 22.8 | 31.8 | 28.1 | 17.7 | 15.2 | 10.6 |
| C (Beam Height) | 2.09 | 3.7 | 6.02 | 14.3 | 14.6 | 18.5 | 23 | 16.3 | 16.5 | 13.1 |
| B | 1.26 | 3.32 | 5.2 | 13.9 | 15.7 | 20.5 | 21.3 | 10.1 | 11.2 | 11.1 |
| A | 0.88 | 1.86 | 4.98 | 7.4 | 10.3 | 13.5 | 11.6 | 5.62 | 2.93 | 3.4 |
| Floor | 0.72 | 1.47 | 3.41 | 6.42 | 9.71 | 9.23 | 8.45 | 2.4 | 2.47 | 2.45 |

SOW81 = C7

ALL OTHER POINTS IN 0.5 METER INCREMENTS FROM SOW 81

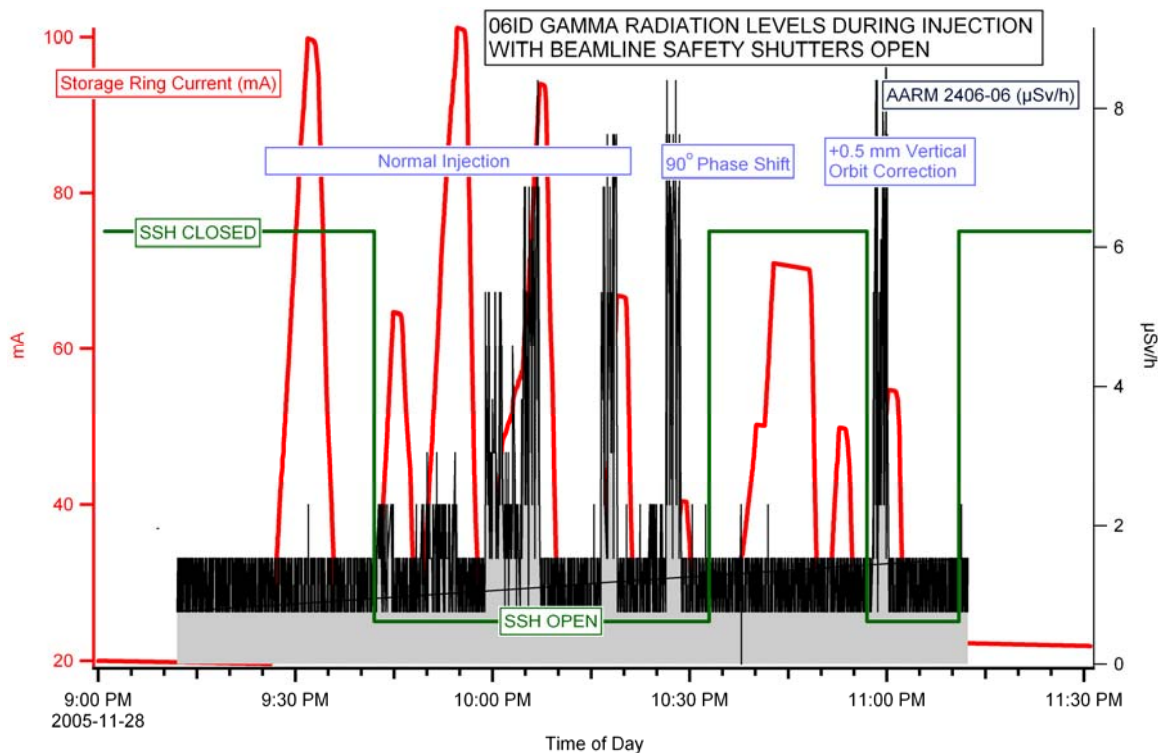
ALL EXPOSURES IN $\mu\text{Sv/H}$

Radiation Measurements Top Up Mode

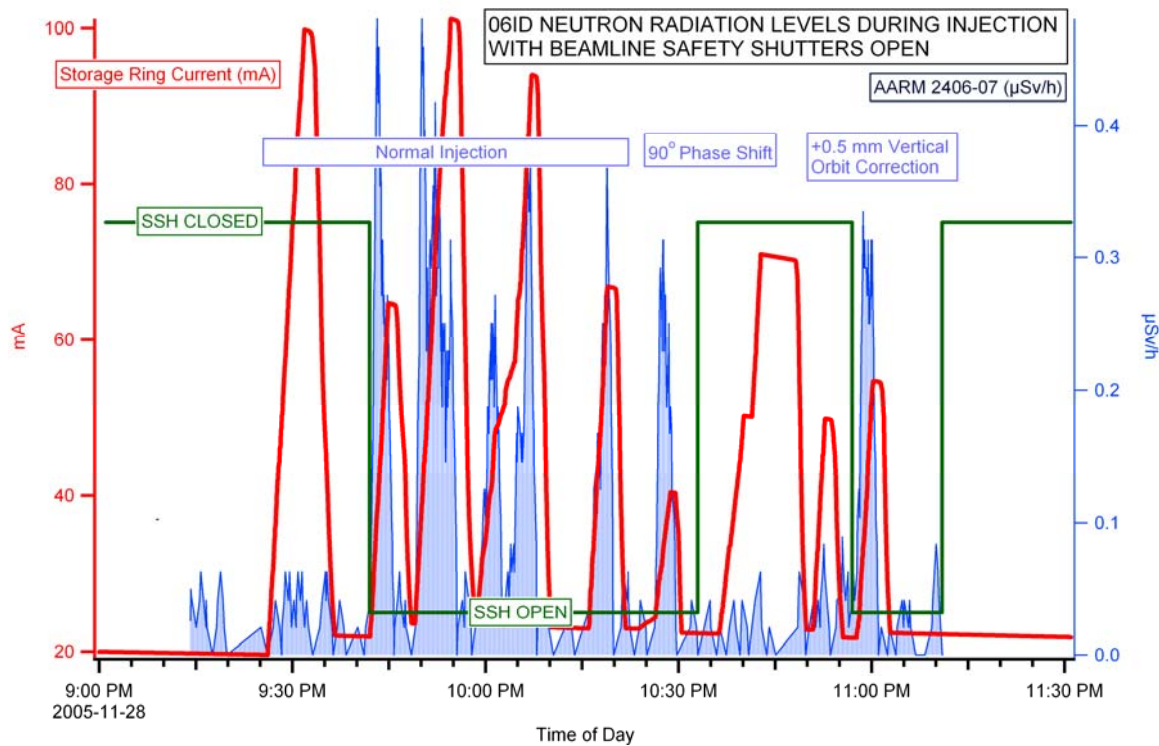




Radiation Measurements Top Up Mode



Radiation Measurements Top Up Mode



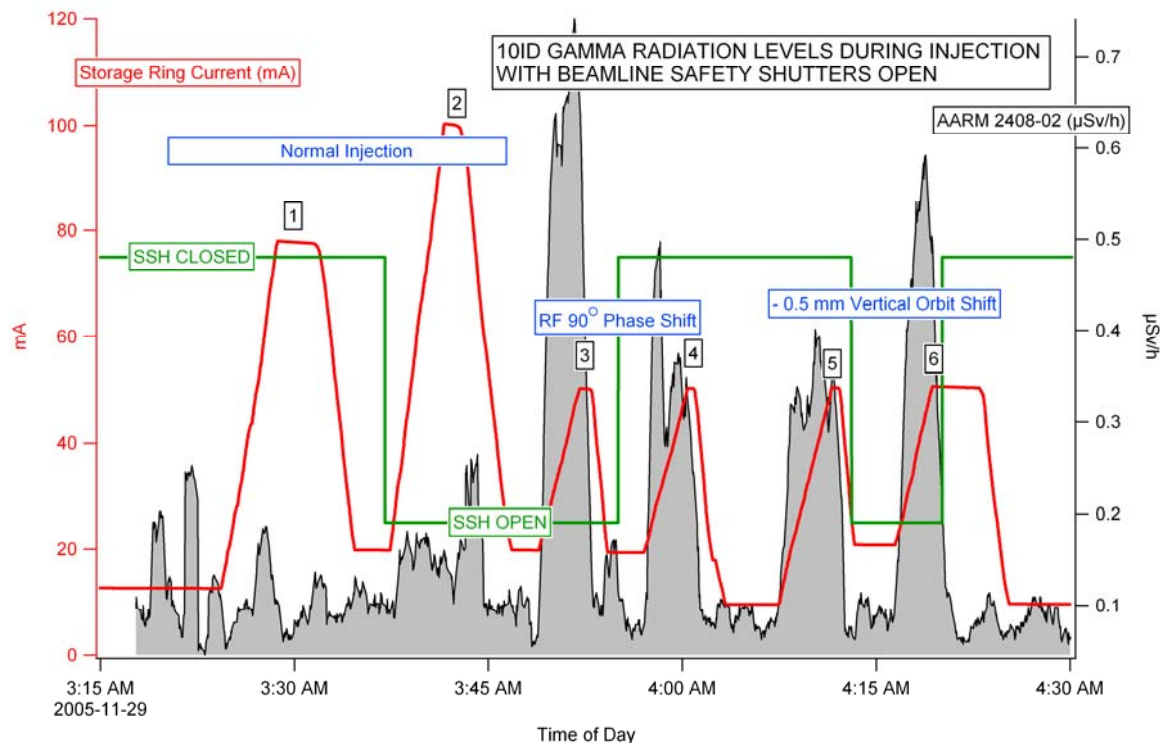
Radiation Measurements Top Up Mode

Radiation Monitor Locations Near 10ID During Injection With Beamline Safety Shutters Open - November 28-29, 2005



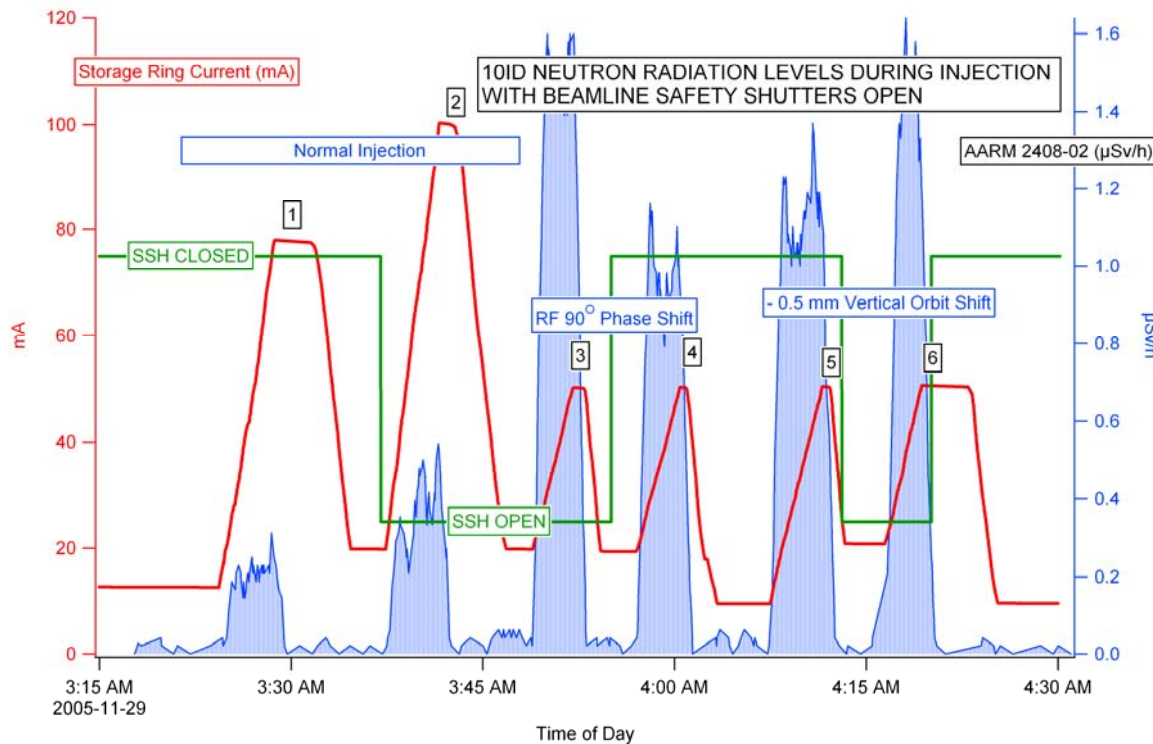


Radiation Measurements Top Up Mode





Radiation Measurements Top Up Mode



Radiation Measurements Personnel Exposures

| Annual Radiation Exposures | 0 – 0.2 mSv | > 0.2 – 1.0 mSv | Total |
|----------------------------|-------------|-----------------|-------|
| 2004 | 214 | 1 | 215 |
| 2005 | 315 | 3 | 318 |
| 2006 | 616 | 1 | 617 |

Thank-you for joining us at
RadSynch 07