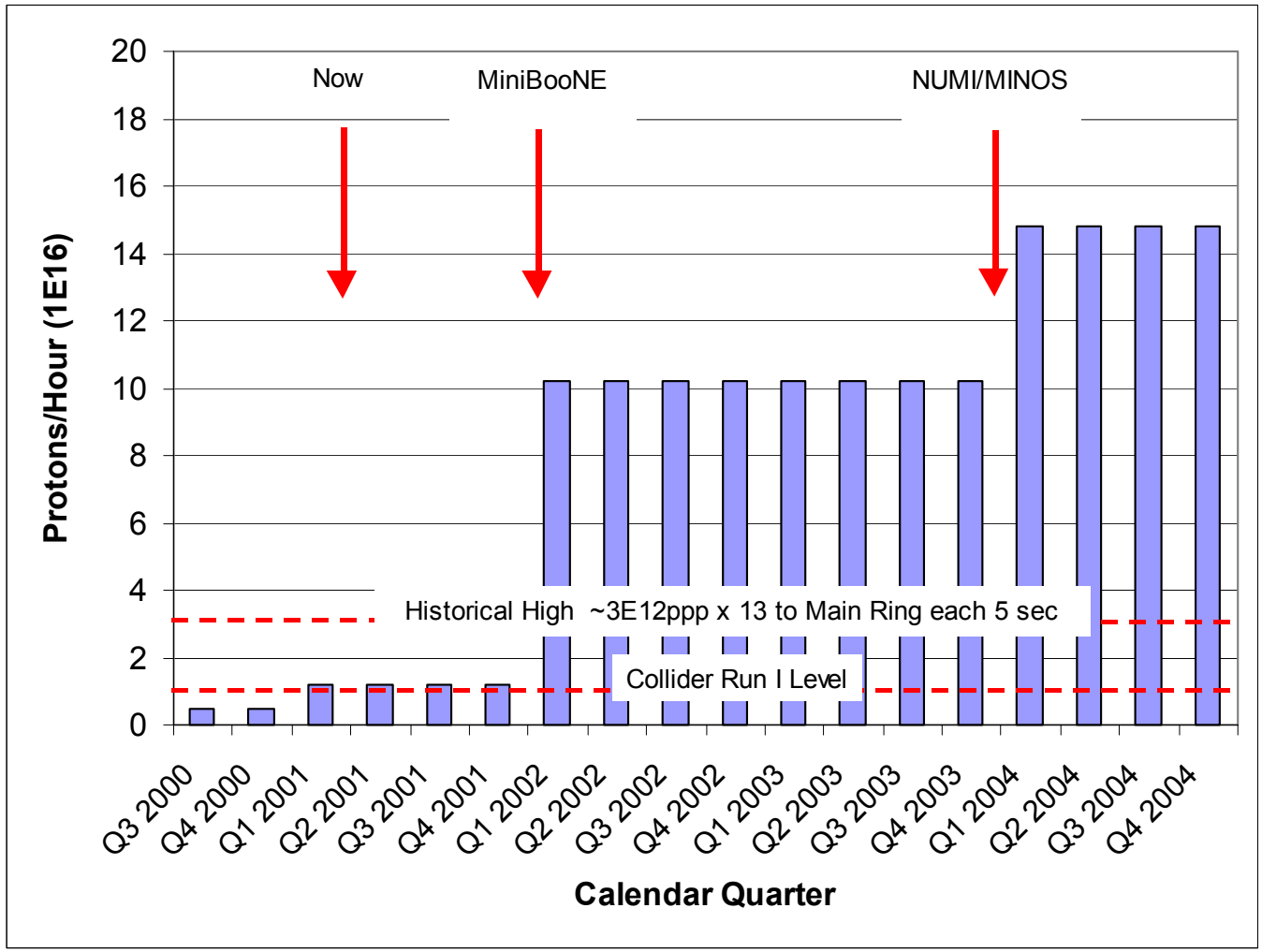
Snowmass 2001
July 13, 2001

Fermilab Booster Performance and Challenges

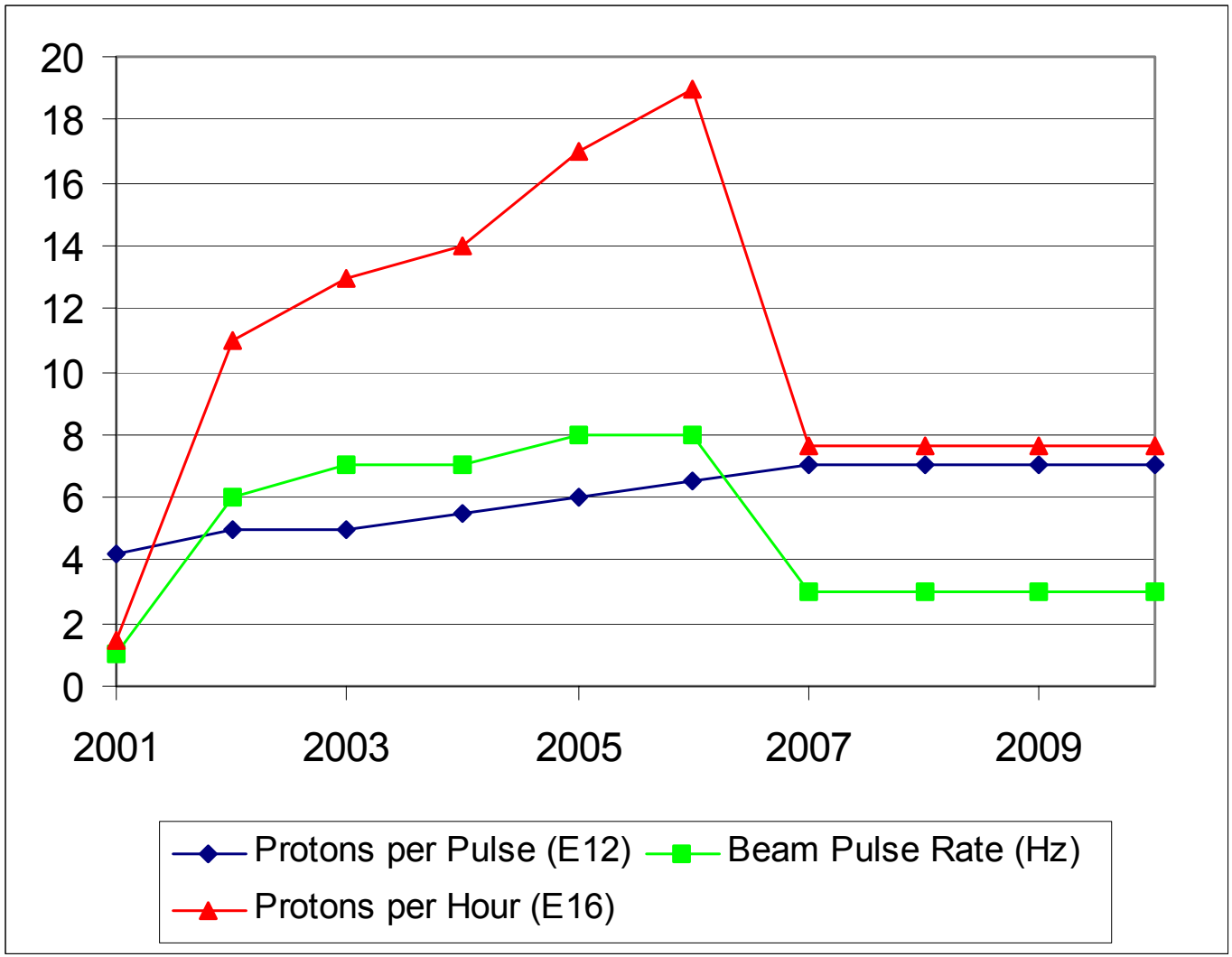
8 GeV Proton Requirements From Booster

- RUN II Stacking ---
  5E12 @ 1.467 sec (0.68 Hz) = 1.23E16 pph
- MiniBoone ---
  5E12 @ 5 Hz = 9.00E16 pph
- Run II + NUMI ---
  6 (1 pbar, 5 NUMI) x 5E12 @ 1.867 sec (3.2 Hz) = 5.80E16 pph
- Run II + NUMI + MiniBoone = 1.48E17 pph

Demand Schedule for 8GeV Protons



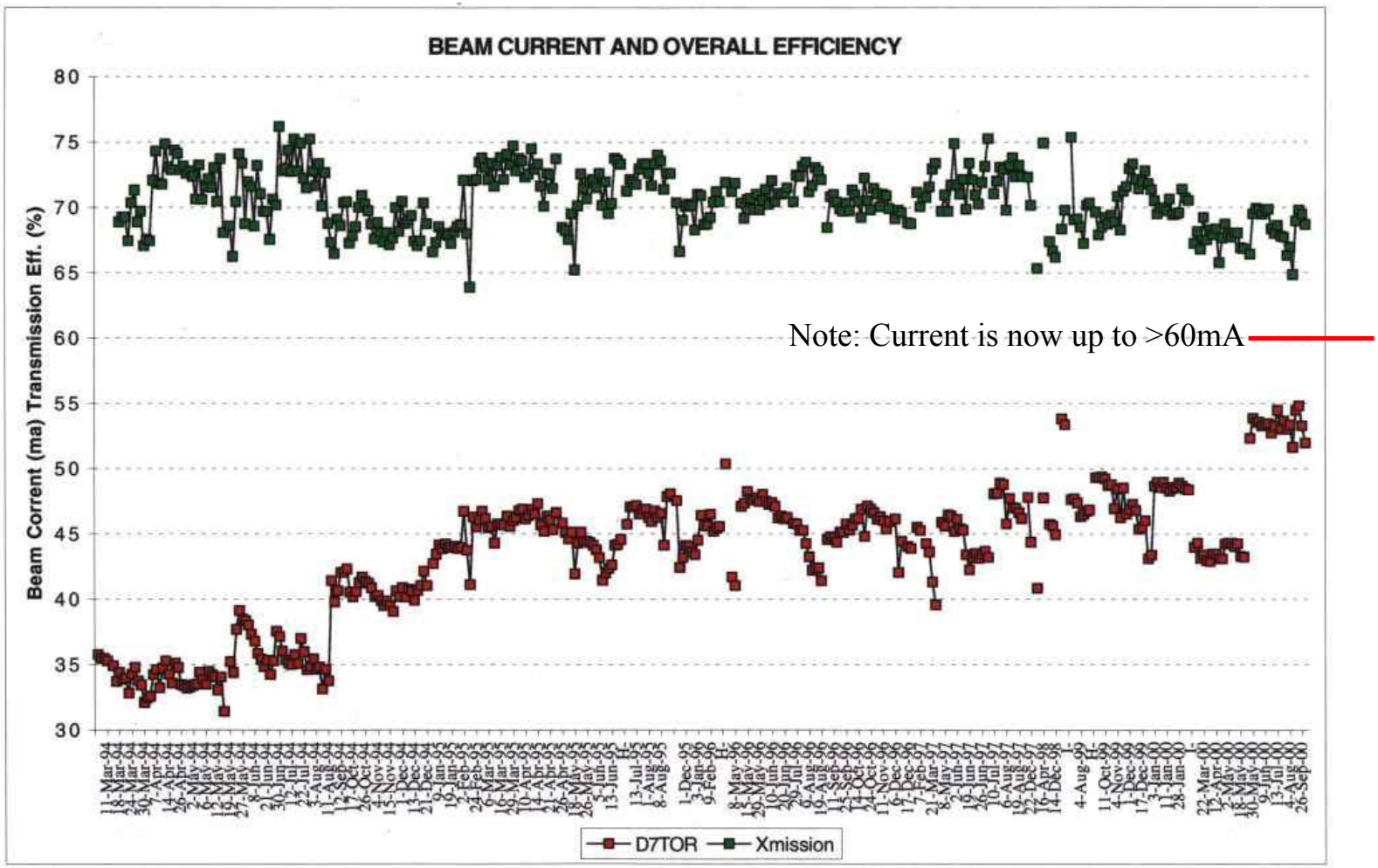
Proposed 8 GeV Proton Production by Year



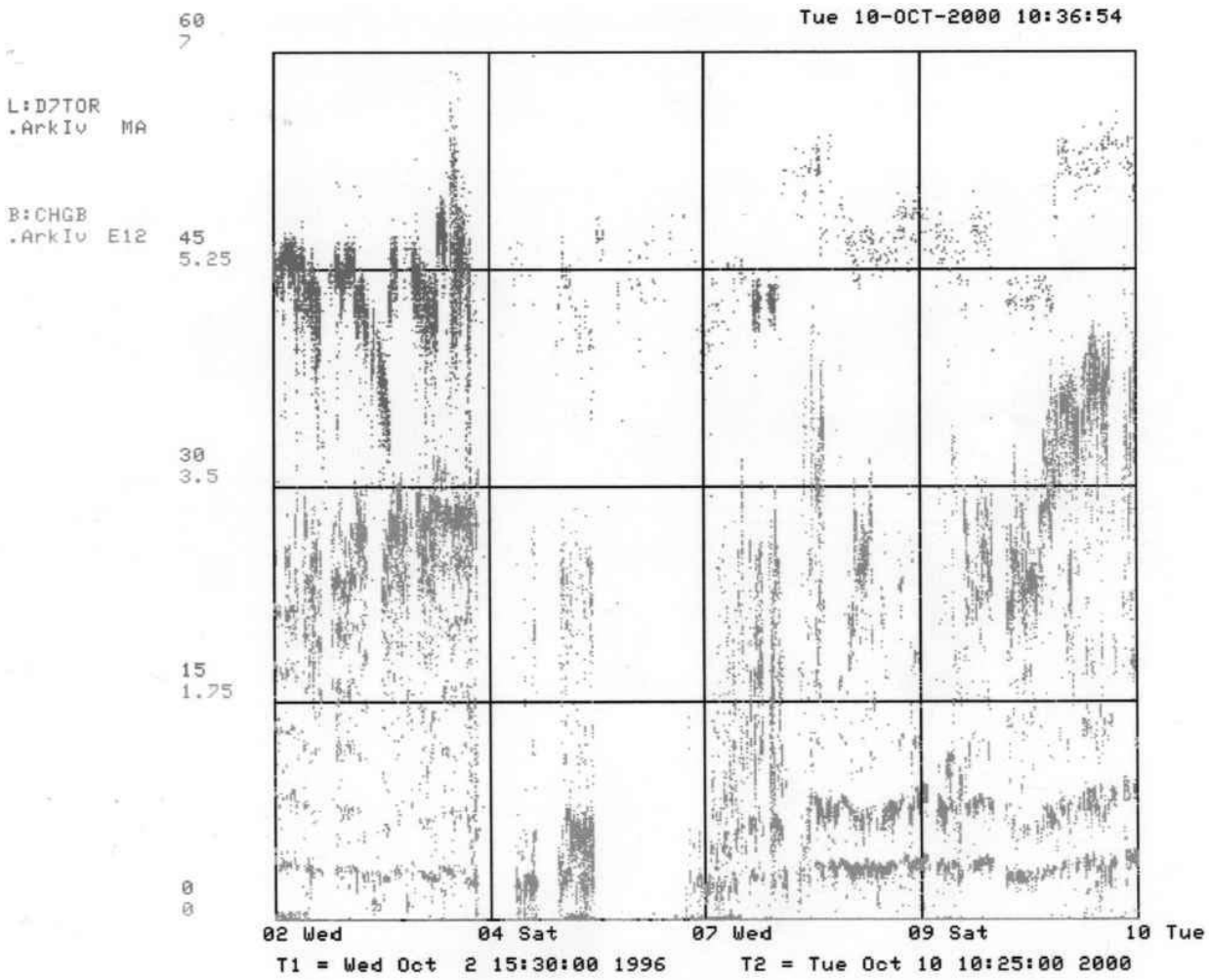
The Challenge

- To meet the increasing demand for protons from a 30 year old machine without destroying it and within the radiation safety regulations of the FRCM
- Increase the per pulse intensity 25%
- Attack the causes of beam loss and resultant radiation
- Mitigate the effects of unavoidable beam loss and radiation
- This, of course, is a challenge to the entire program of the Laboratory. There will be no new Booster for the next 6 years (minimum), therefore every proton utilized by any Fermilab HEP experiment in this time frame (RunII, MiniBooNE, NUMI, SY120) must be accelerated by the present Booster.

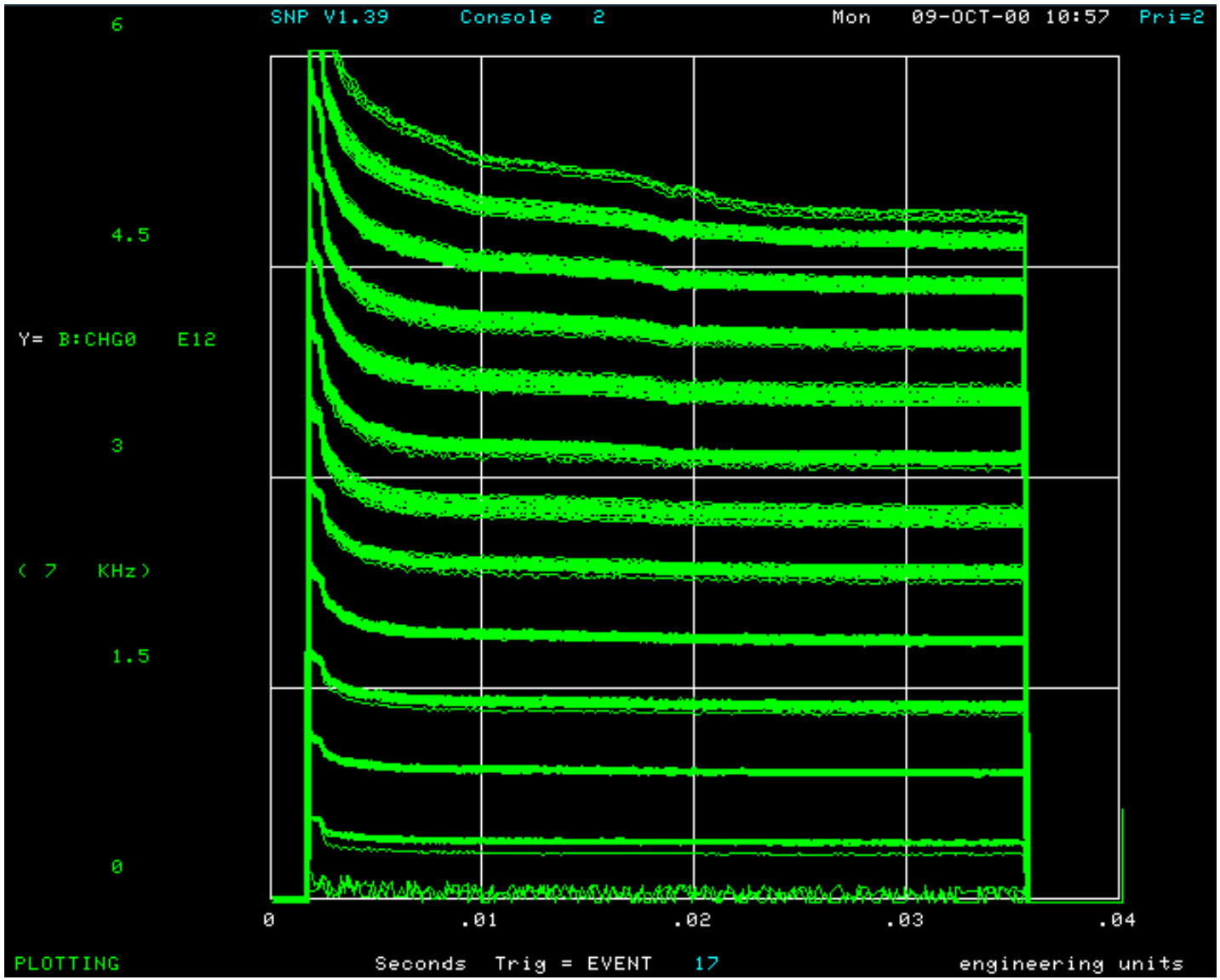
Six Years of Linac Beam Current Improvements



Booster Taking Advantage of Linac Improvements



Booster Intensity Up to 12 Injected Turns

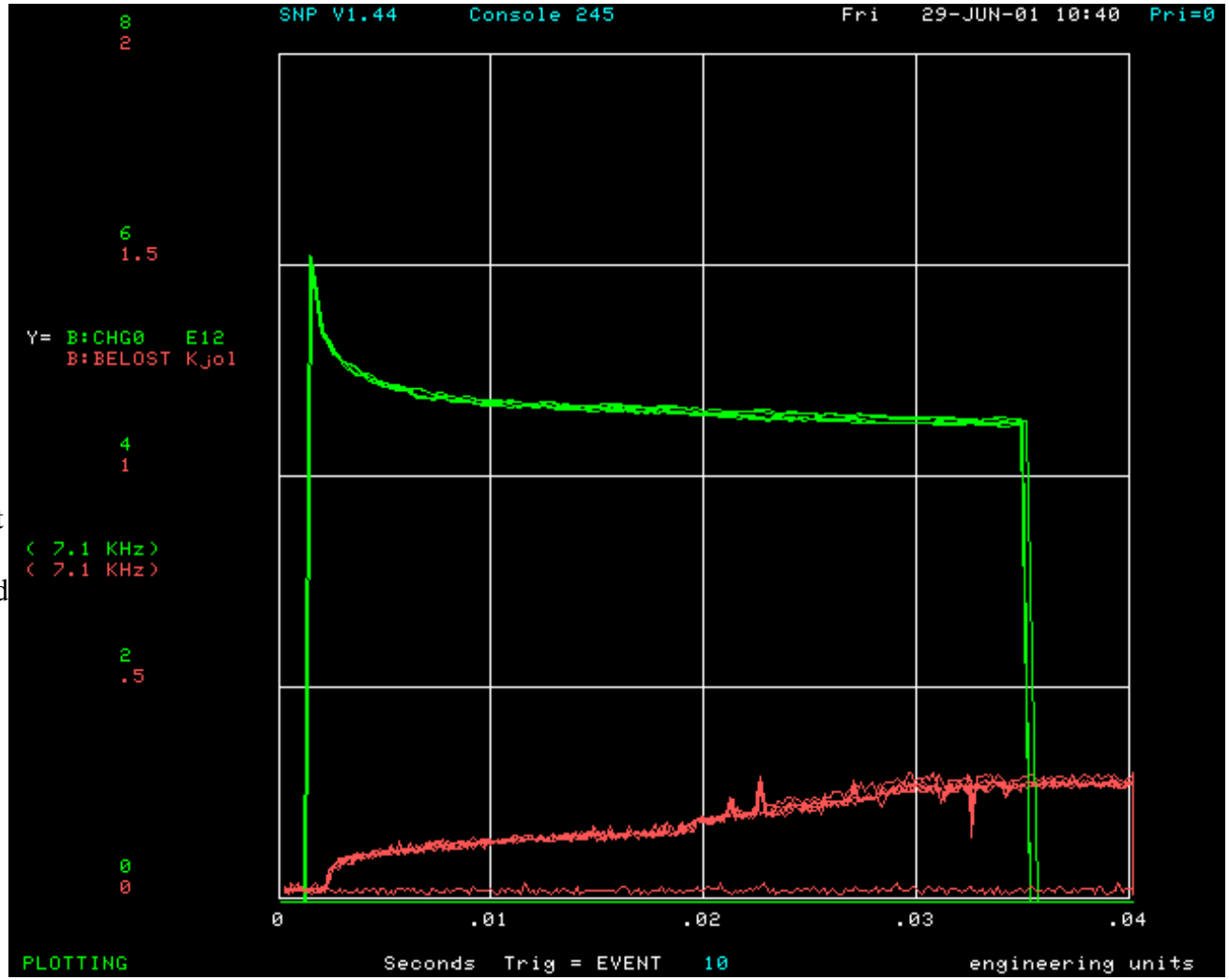


Intensity and Energy Lost vs. Time at High Intensity

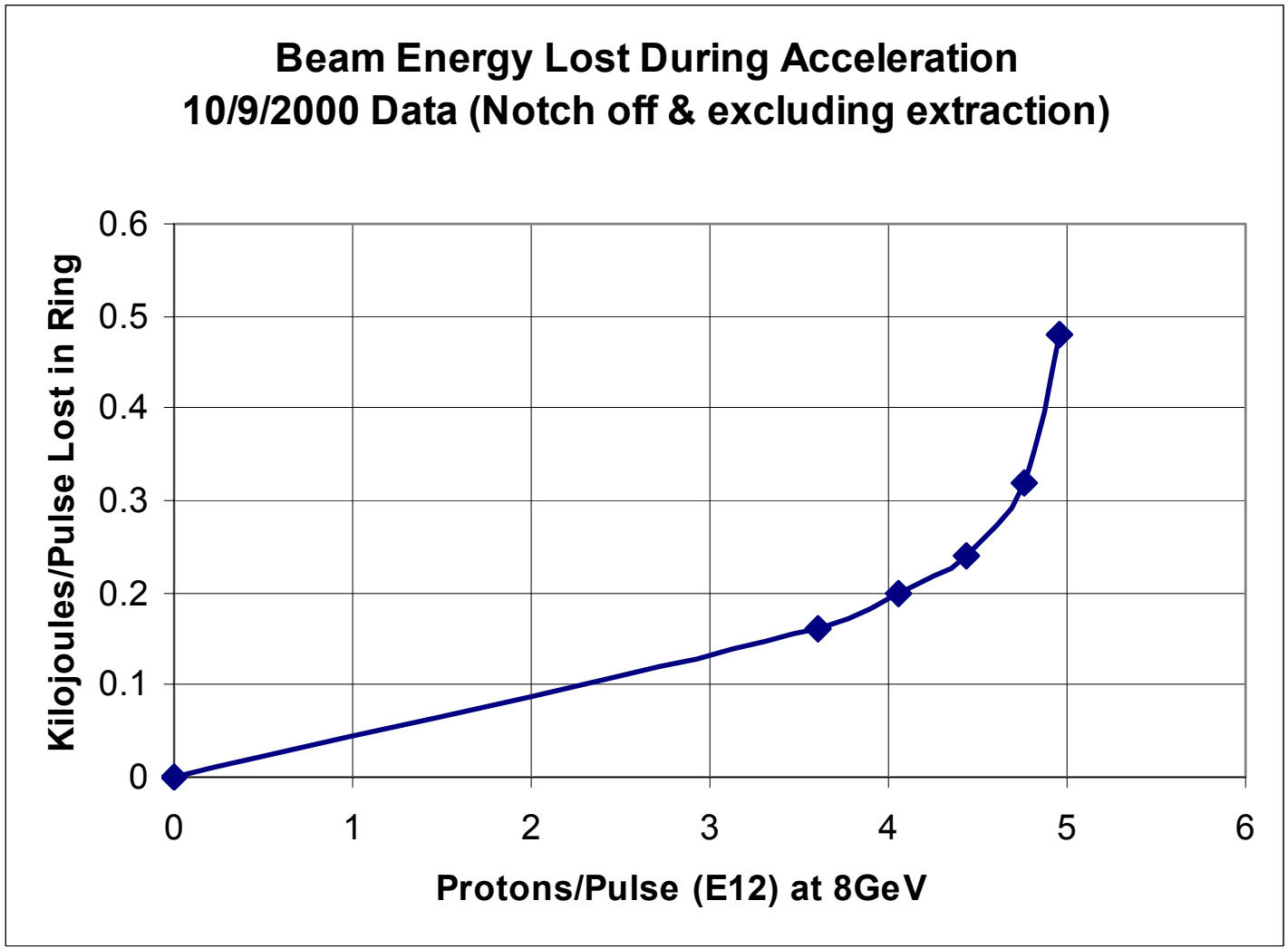
CHG0 is Booster charge through acceleration cycle.

BELOST is integral beam energy lost during acceleration

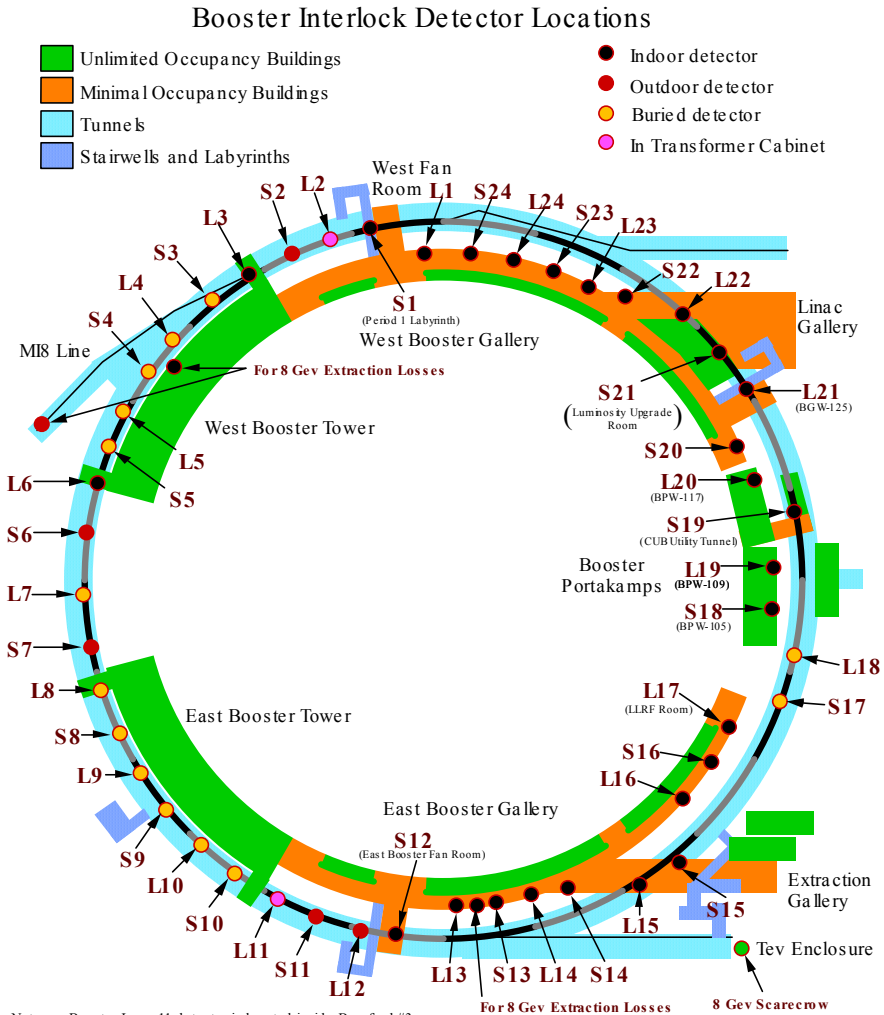
NOTE: 300 joules at 5Hz over 470 meter circumference would be 3.2 Watt/meter



Beam Energy Lost in Ring vs. Per Pulse Intensity



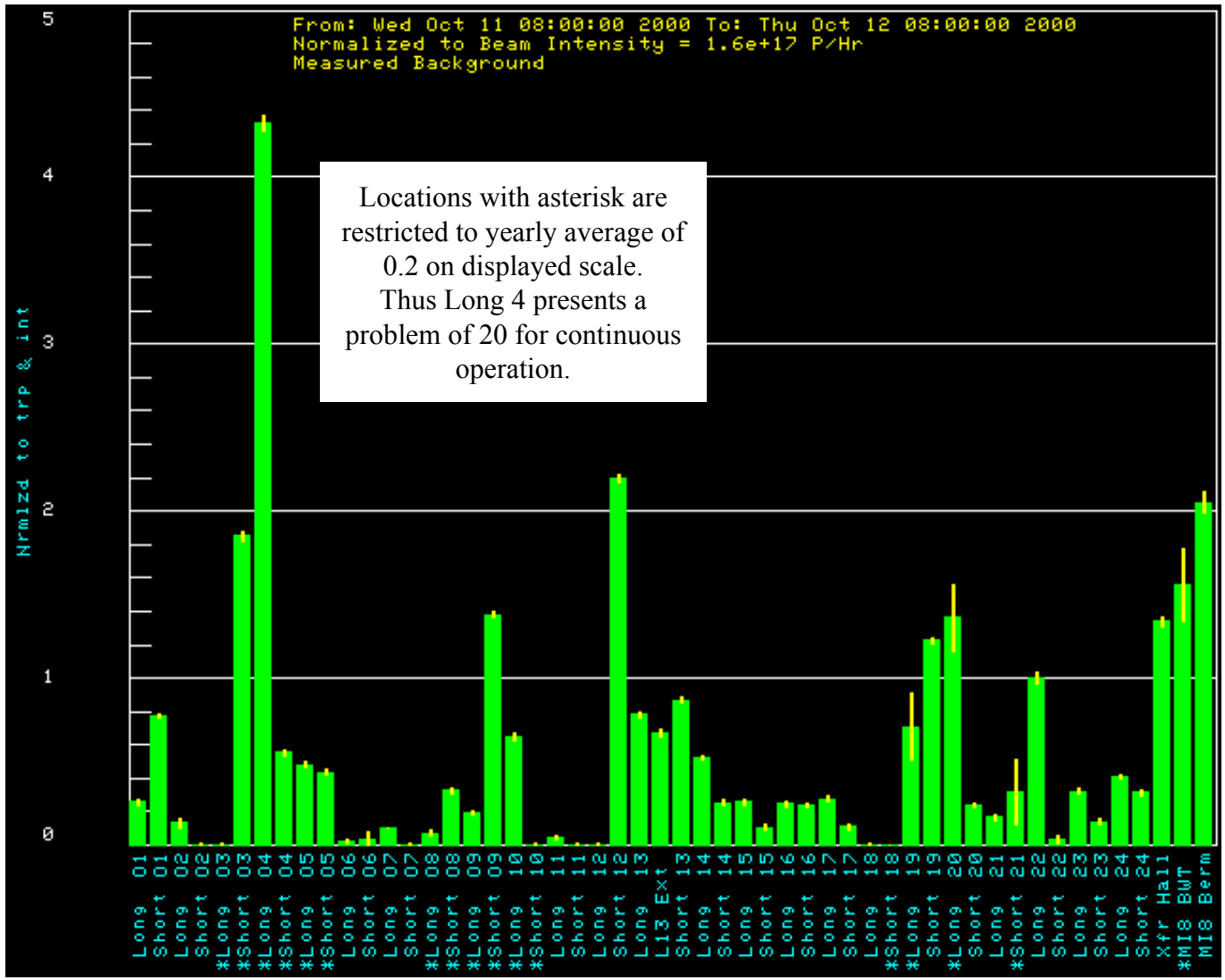
Surrounded by Chipmunks



Note: Booster Long 11 detector is located inside Brenford #3.
Booster Short 19 is located in the CUB Utility Tunnel on the West side of the LCW Piping.
Booster Short 12, located in the East Booster Fan Room, requires an AC-33 key.
Booster Long 21, located in BGW-125, requires an AC-2 key.
Booster Short 21, located in the Luminosity Upgrade Room, requires an AC-2 key.
Booster Long 7 located in a manhole in the road between the Booster Towers.
Booster Long 2 detector is located in the YBW1 transformer cabinet.
The 8 Gev Line Sarecrow is located in the Tev enclosure.

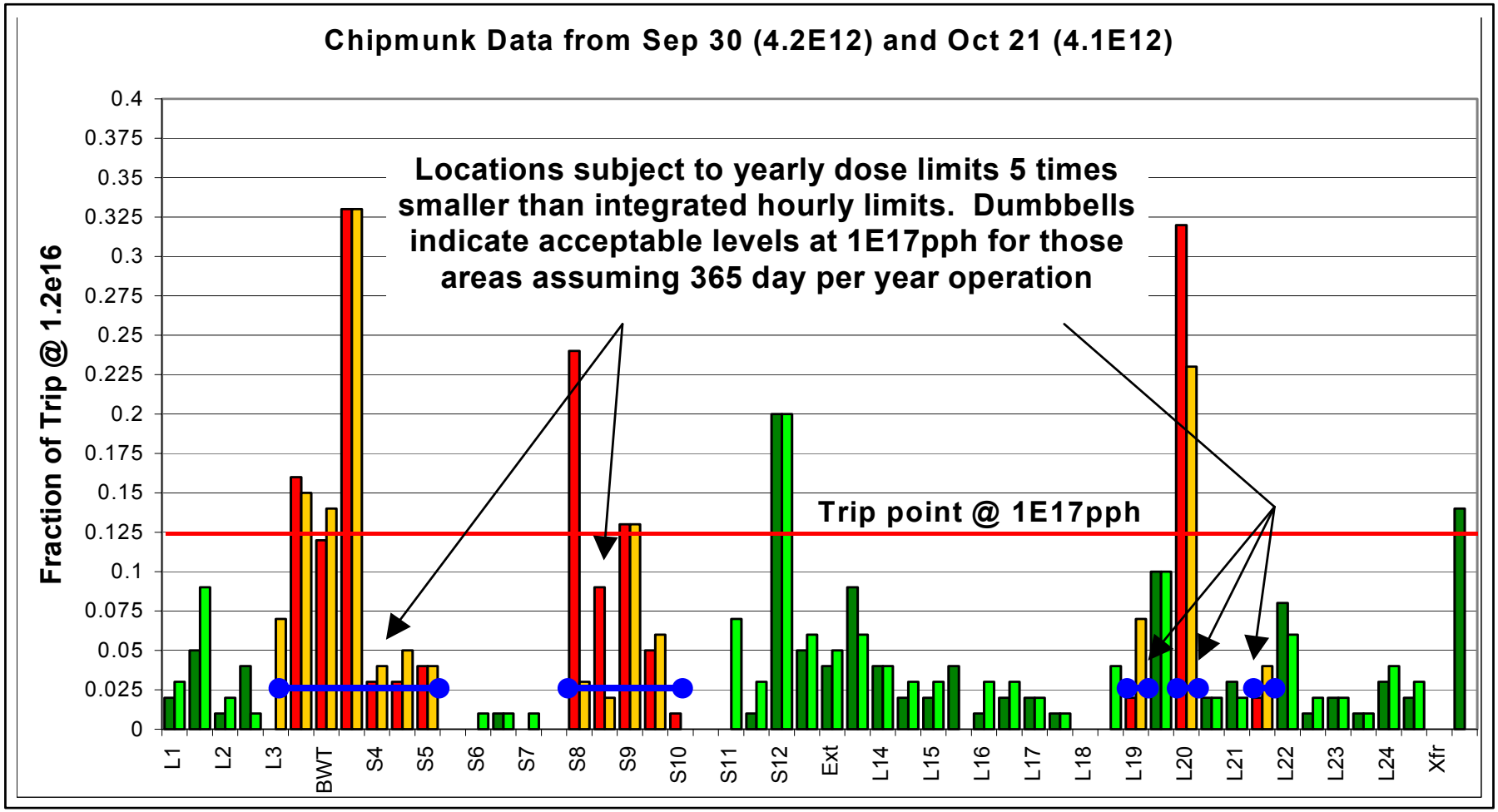
Typical Booster Interlocked Chipmunks

Normalized to Individual Trip Points and MiniBooNE + NUMI Rates

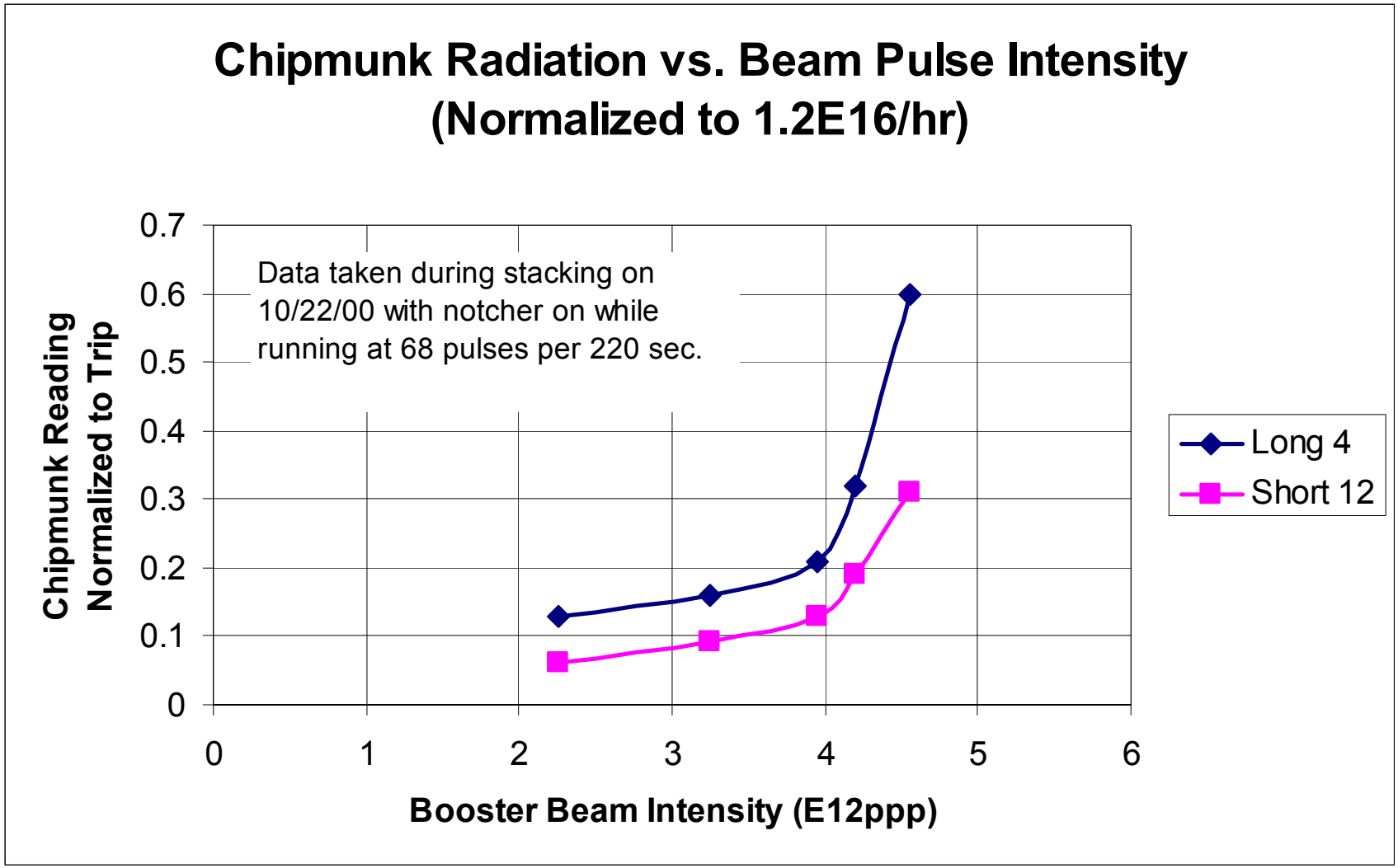


Locations with asterisk are restricted to yearly average of 0.2 on displayed scale. Thus Long 4 presents a problem of 20 for continuous operation.

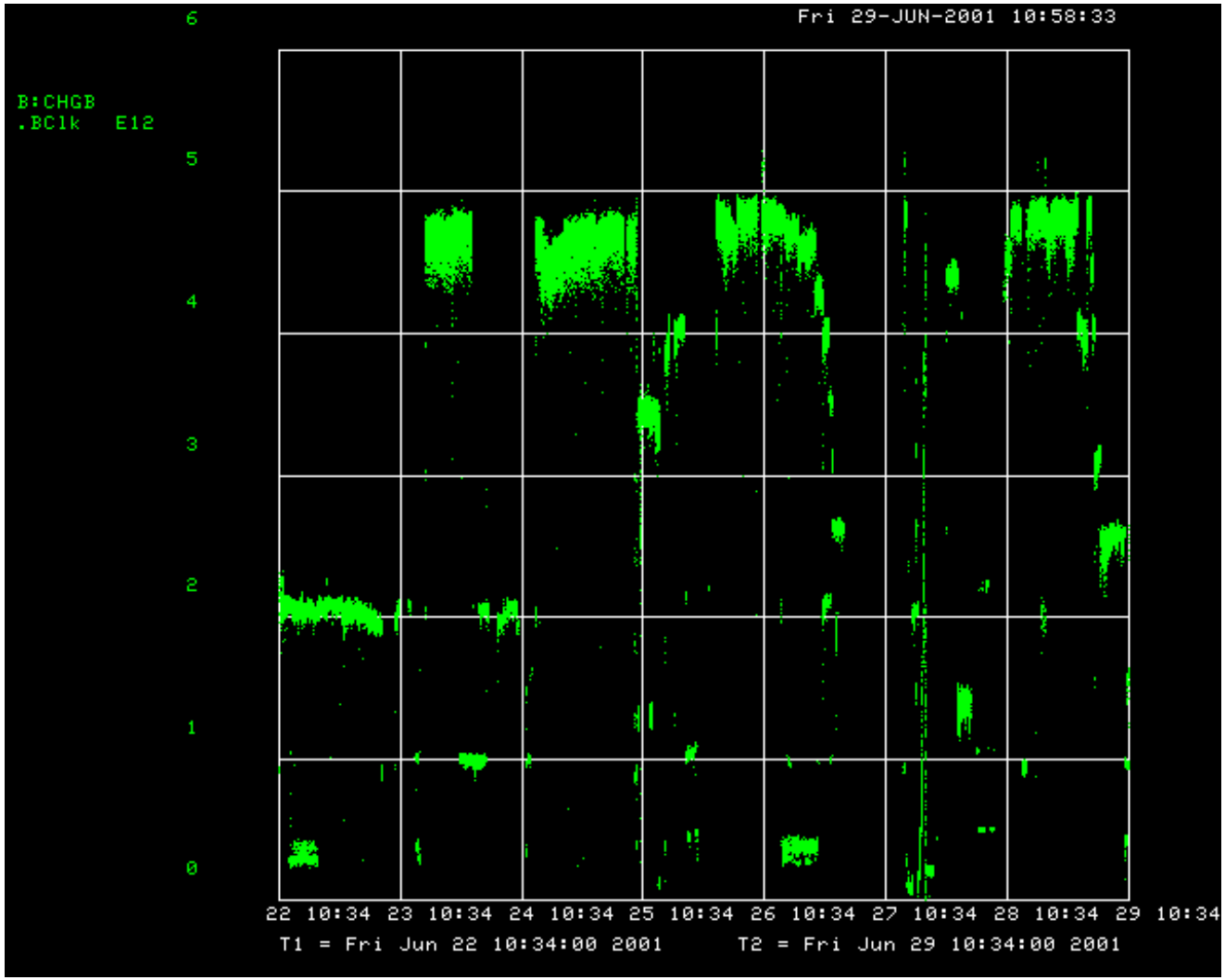
Performance Relative to Interlocked Radiation Detectors



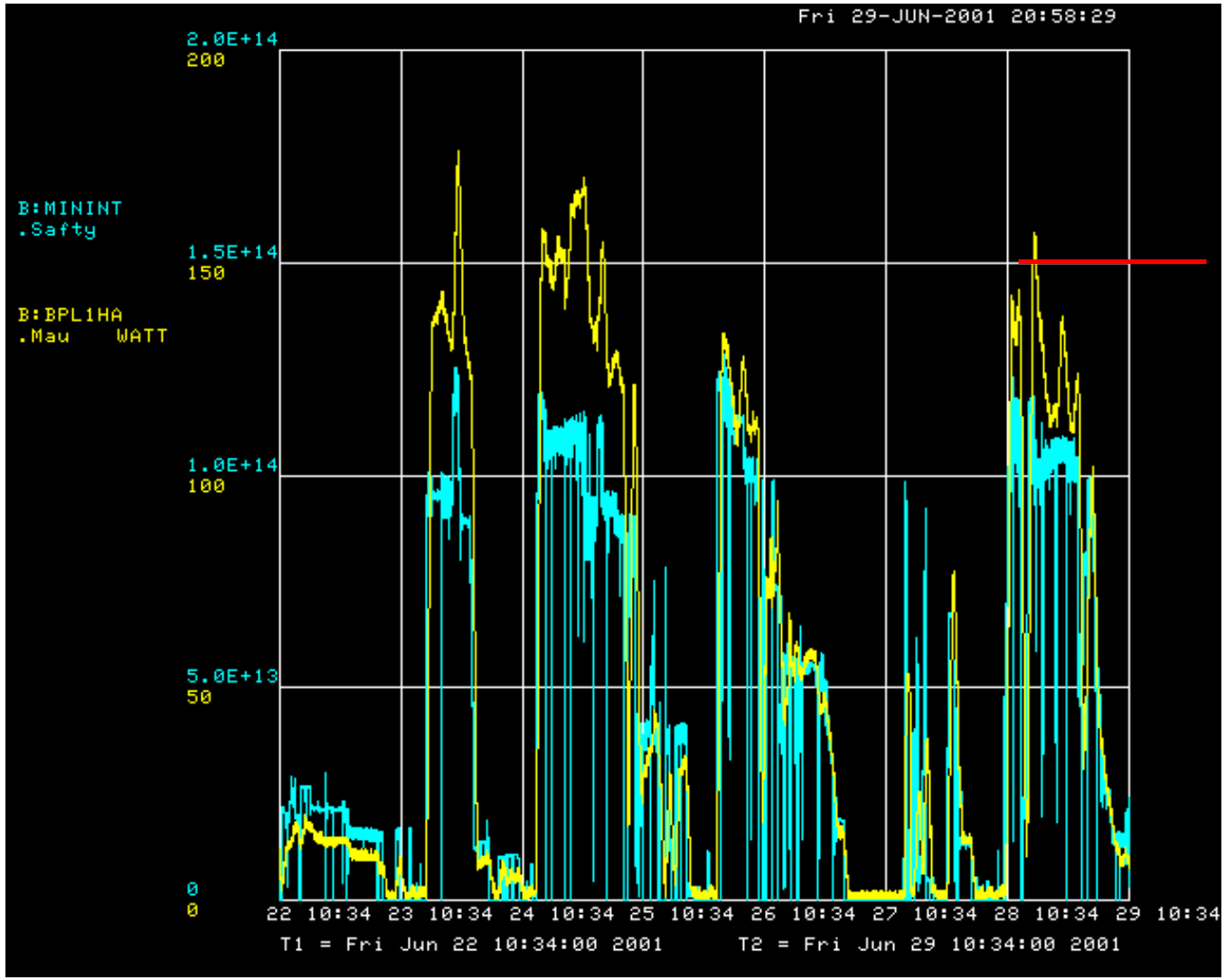
Selected Chipmunk Signals vs. Per Pulse Intensity



Booster Operational Intensity --- Last Week of June

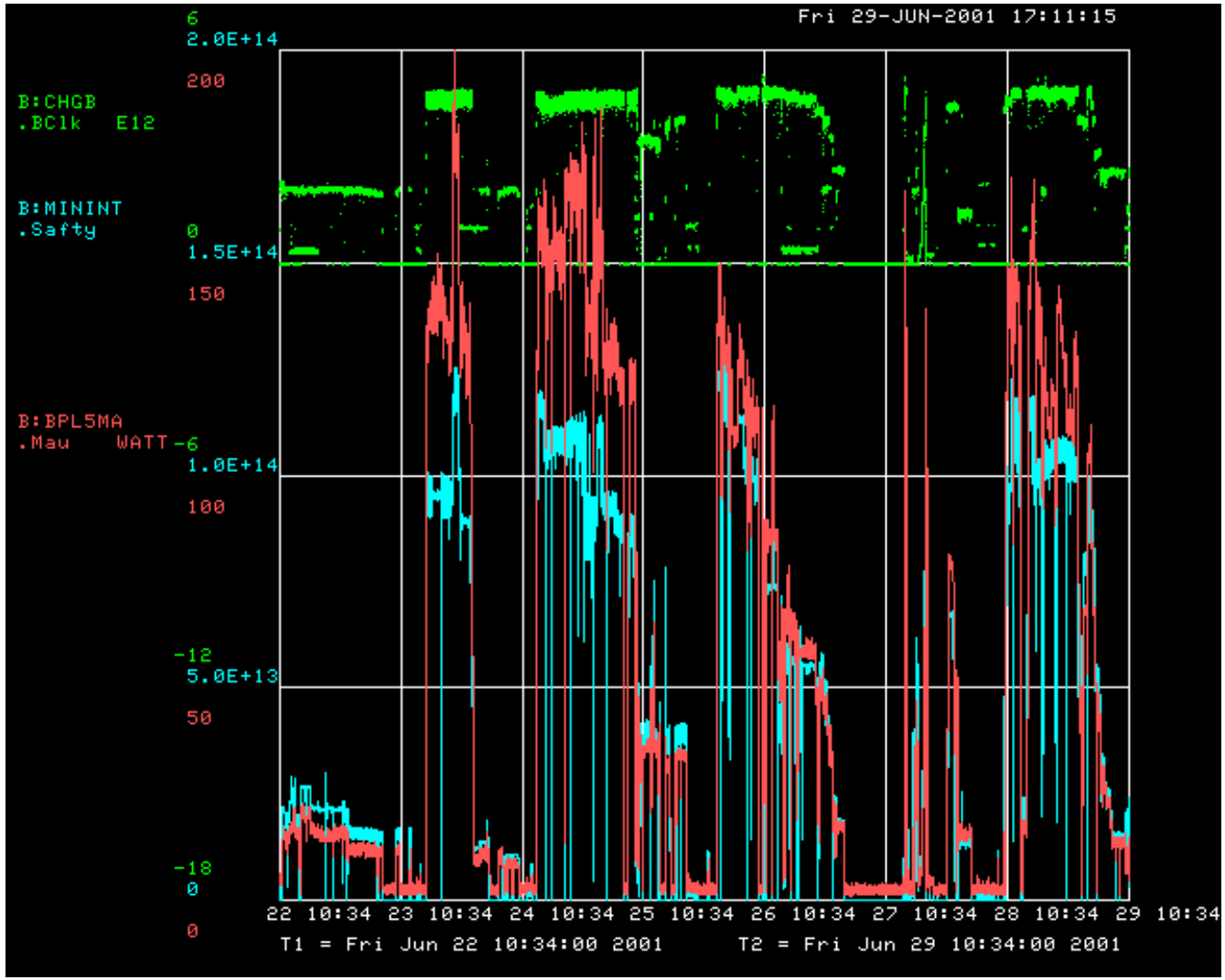


Proton Rate and Power Lost --- Last Week of June



6E15/hr

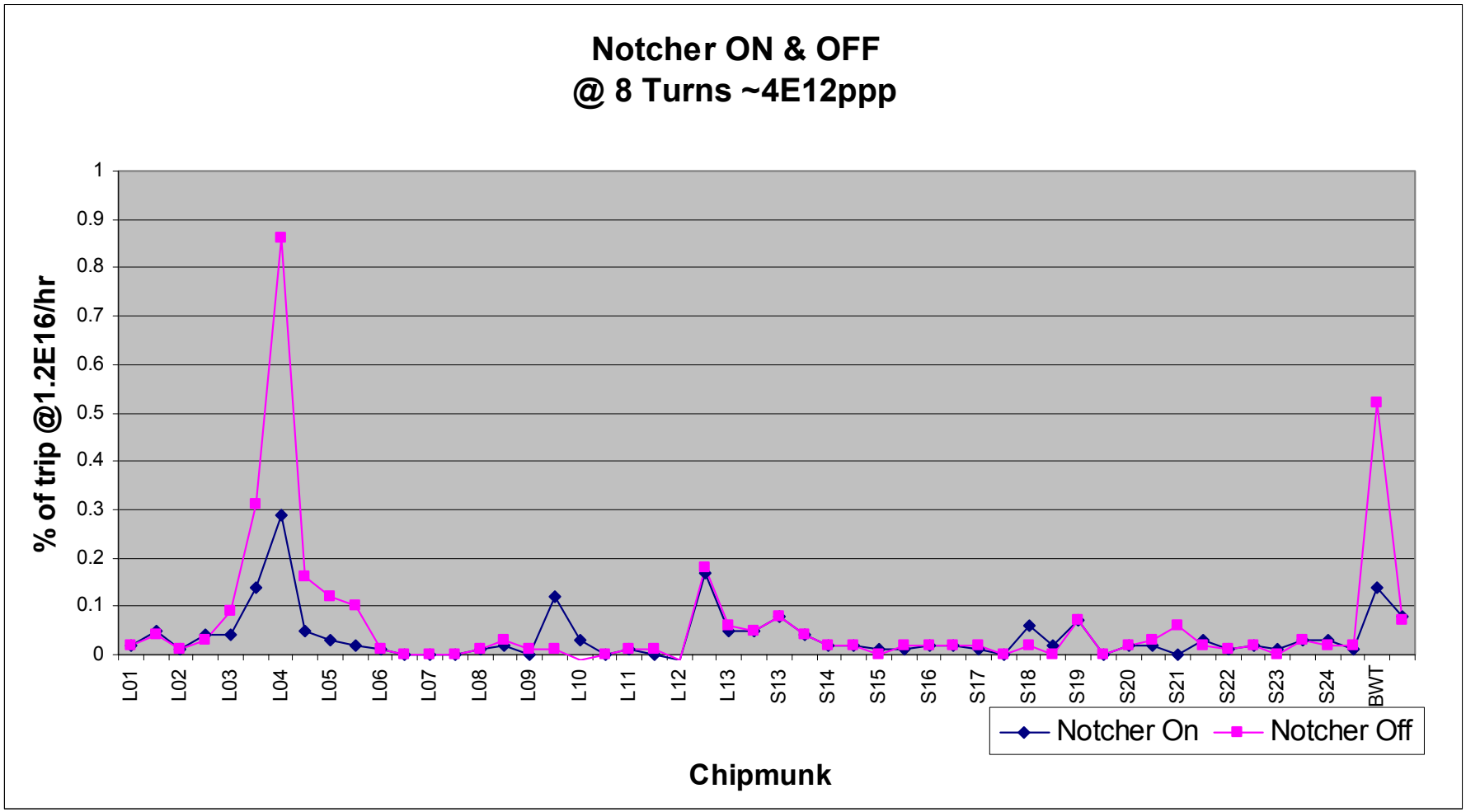
Intensity, Rate and Power Lost --- Last Week of June



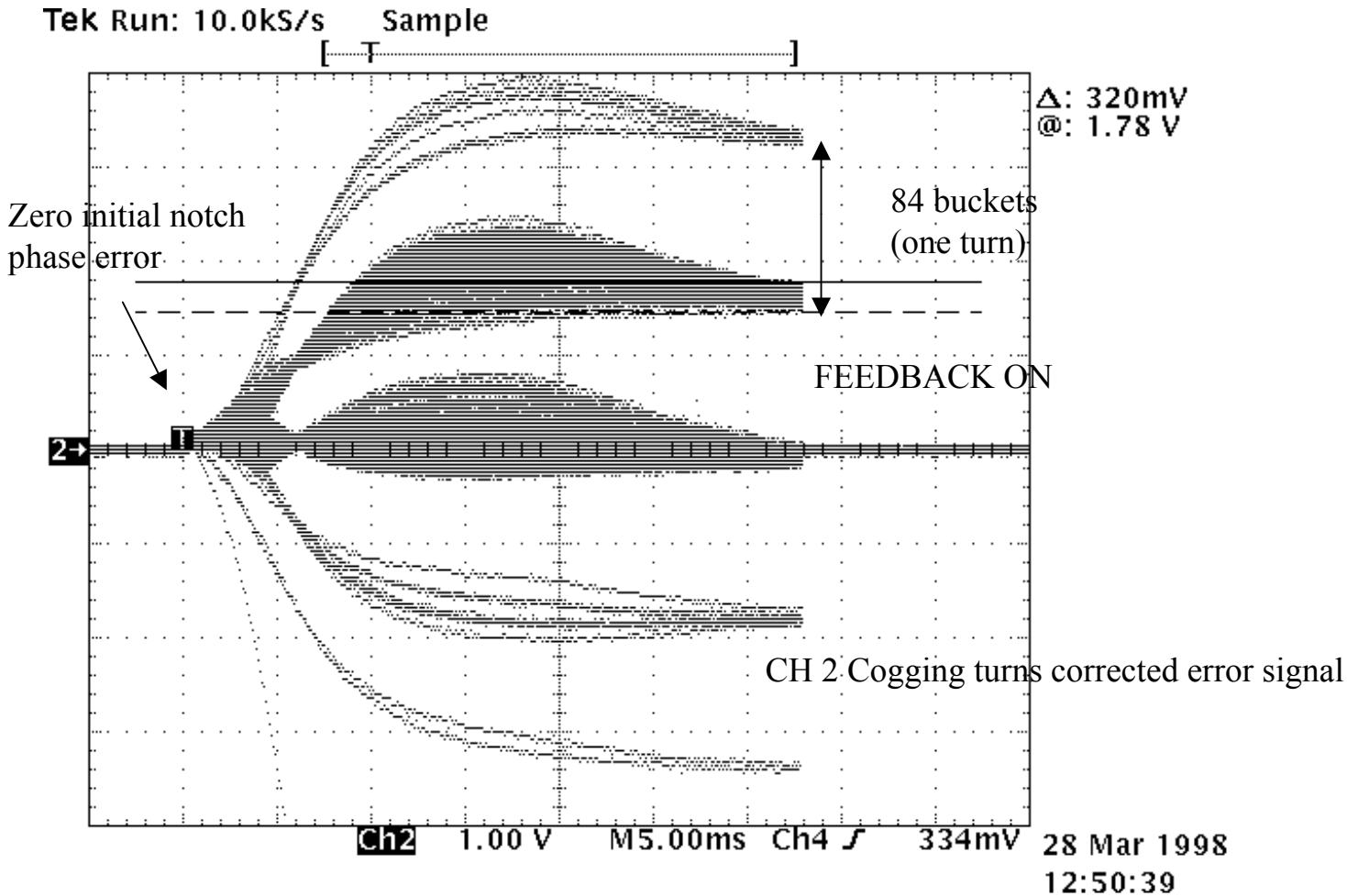
Active Avenues of Attack

- Ion Source R&D
- Notched beam operation and active cogging planned
- Local beam orbit control with ramped dipole correctors
- Improved beam loss monitor data acquisition system
- Larger aperture MI-8 EPB magnets in design
- Collimator/Scraper system in mechanical design
- Increased RF cavity aperture R&D program
- Additional shielding (options are extremely limited)
- Equipment upgrades/replacements to permit high repetition rate operation up to 15 Hz

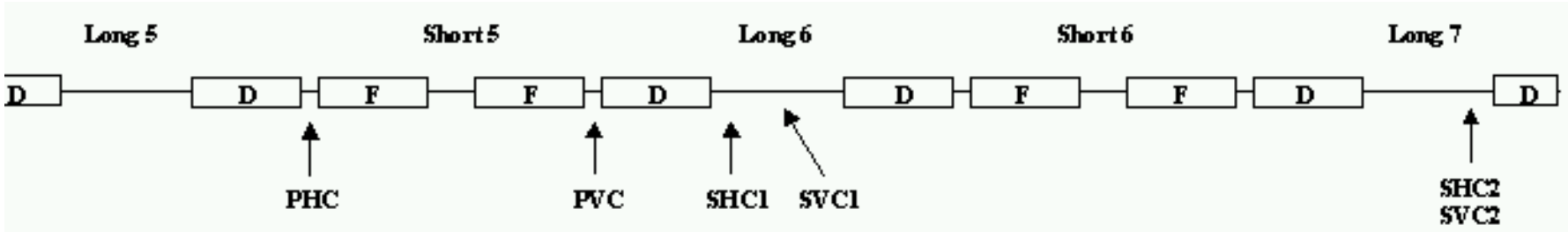
Booster Chipmunks with Notcher On & Off



Active Gap Cogging in Booster



Planned Booster Collimator Layout



PHC is in upstream mini-straight section of Period 5
PVC is in downstream mini-straight section of Period 5
SHC1 is 20cm from upstream end of Long 6 straight section
SVC1 is 300cm from upstream end of Long 6 straight section
SHC2 and SVC2 are both located 60cm from downstream end of Long 7 straight section

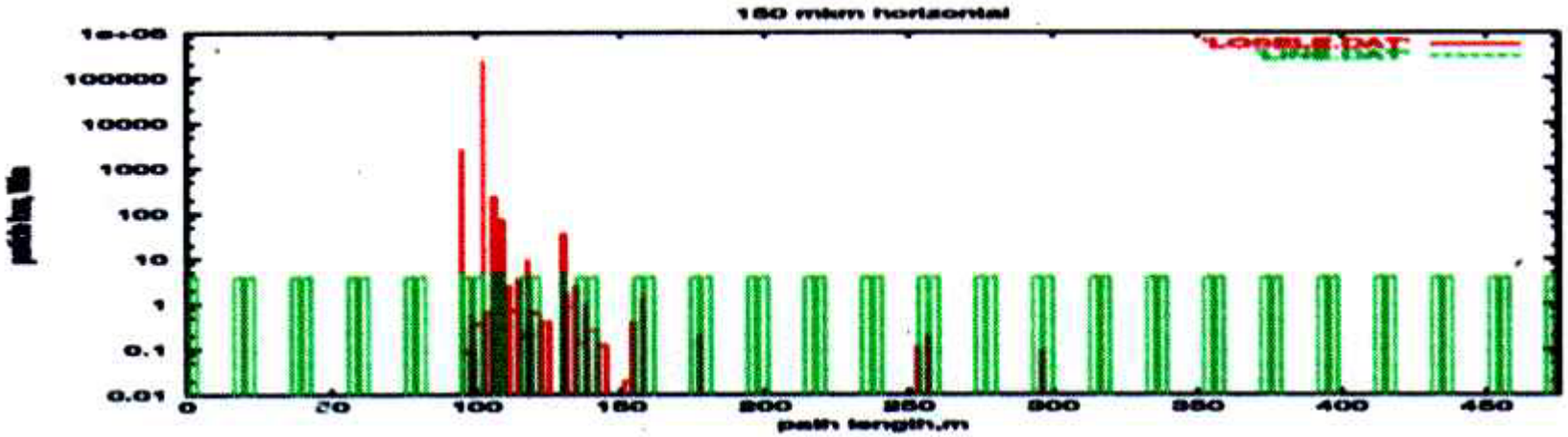
Booster collimation tracking

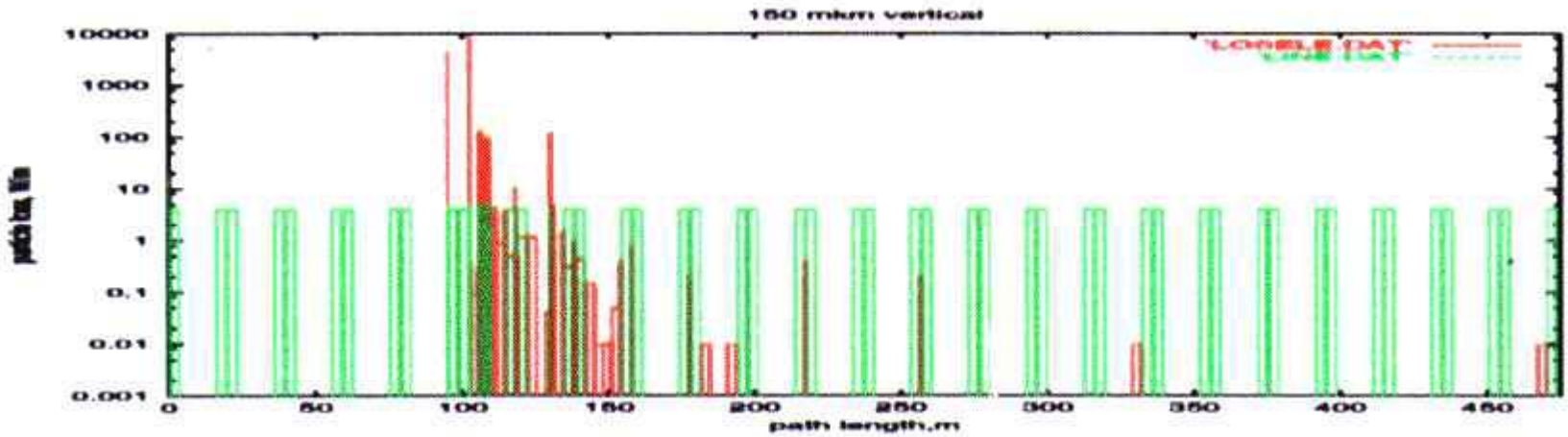
Oleg Krivosheev

November 3, 2000

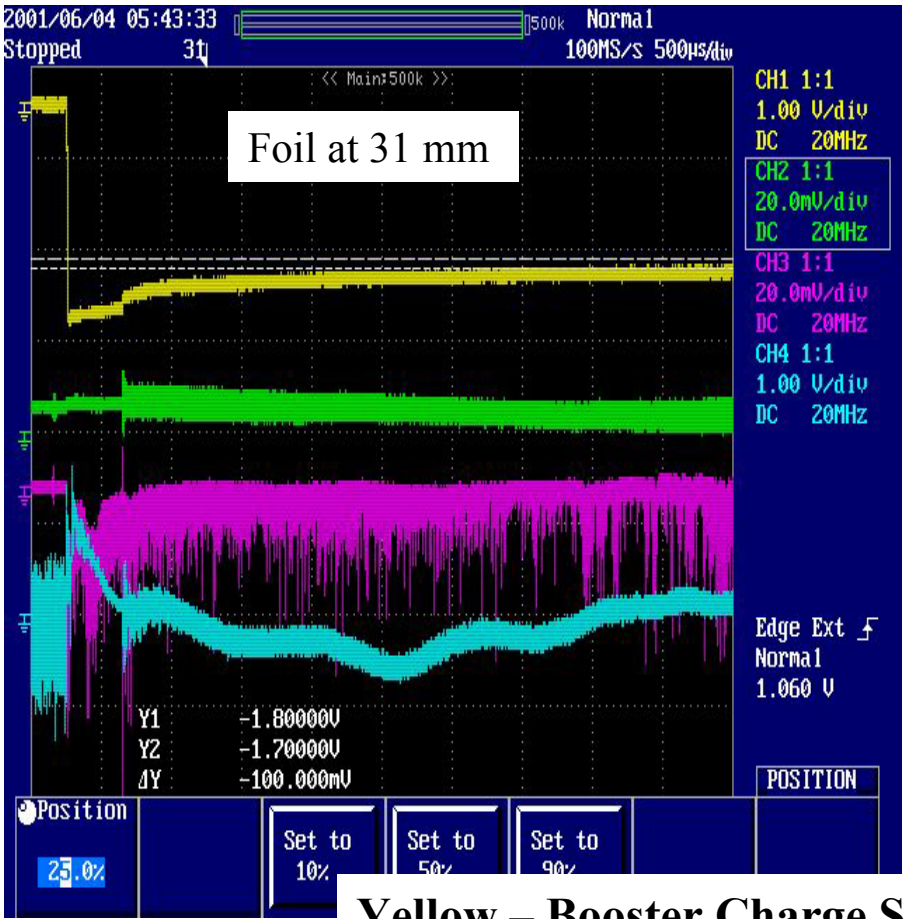
Abstract

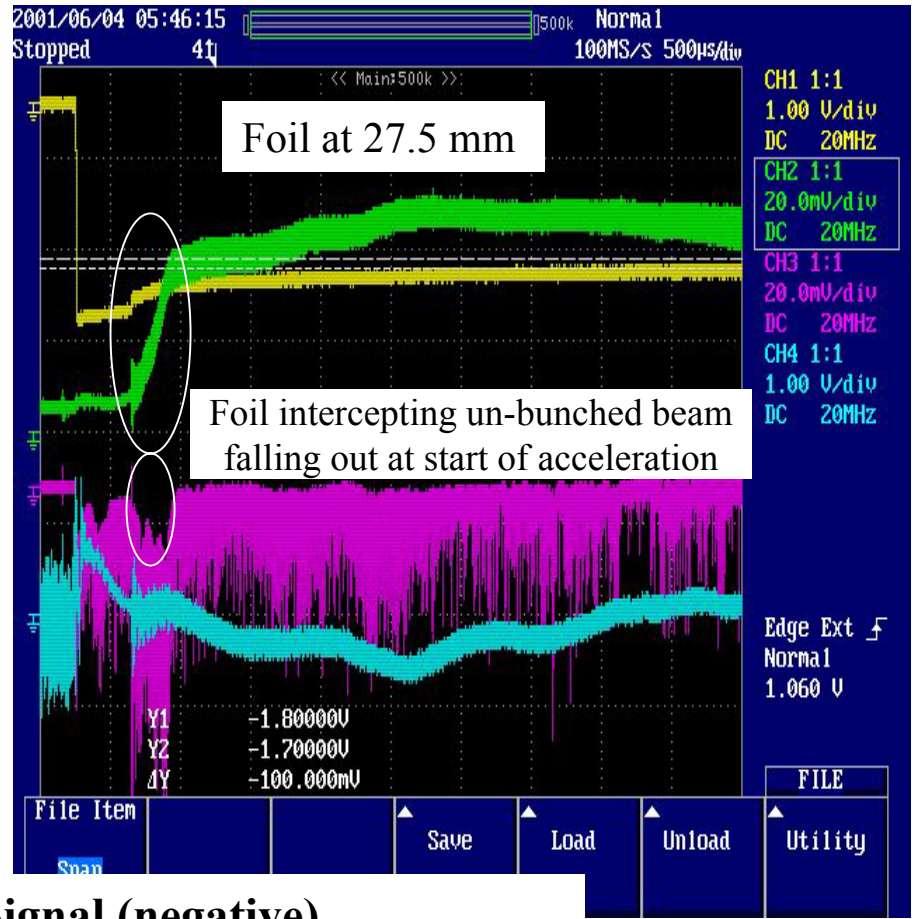
Tracking studies with proposed Booster collimation system are discussed



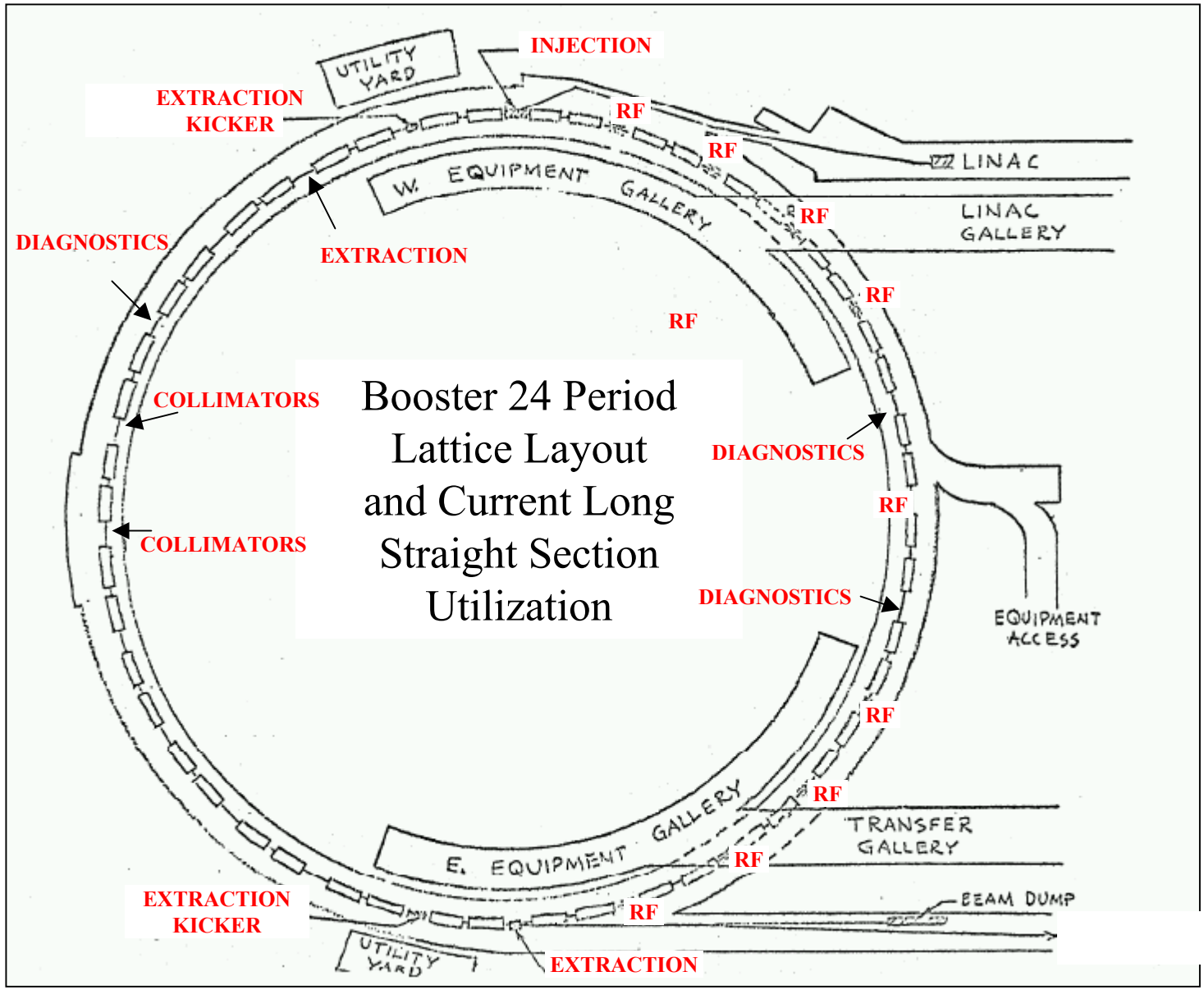


Signals from Horizontal Primary Collimator





Yellow – Booster Charge Signal (negative)
Green – Secondary Emission Signal from Isolated Foil
Pink – PhotoTube Signal at 90 degrees to Foil
Blue – Horizonal Position Signal Near Foil


Booster 24 Period Lattice Layout and Current Long Straight Section Utilization
INJECTION
UTILITY YARD
EXTRACTION KICKER
RF
RF
RF
RF
RF
RF
RF
RF
RF
RF
RF
W. EQUIPMENT GALLERY
E. EQUIPMENT GALLERY
LINAC
LINAC GALLERY
TRANSFER GALLERY
EQUIPMENT ACCESS
BEAM DUMP
DIAGNOSTICS
EXTRACTION
COLLIMATORS
COLLIMATORS
DIAGNOSTICS
DIAGNOSTICS
EXTRACTION KICKER
UTILITY YARD
EXTRACTION

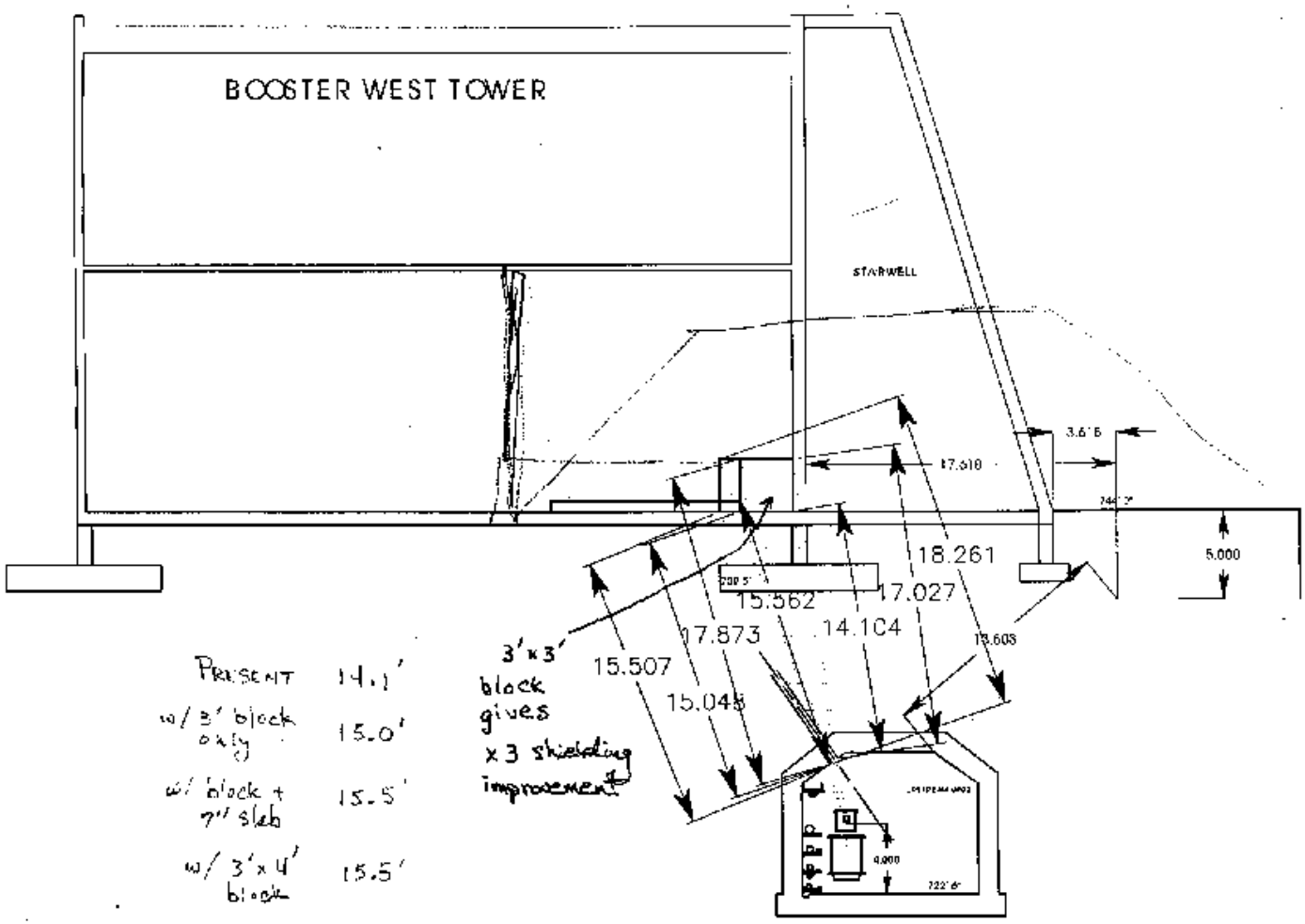
Proposal for Further Improvements

- 400 MeV line scrapers as diagnostic tool
- Splits machine betatron tunes
- Booster electron lens
- Inductive insert
- Conductive strips inside gradient magnets
- …… ?????

Challenges To Beams Division Retreat Working Groups

- Beam Losses - to consider new possibilities and prioritize current activities and ideas to attack causes and mitigate effects of Booster beam loss and resulting radiation
- Operations - to consider how to enhance operational performance given decreased Booster reliability and much higher tunnel radiation levels
- Pbar Production and Recycler - to consider how to most efficiently use pbars once they are produced
- Path to Run IIB - to consider how to budget protons and other resources to achieve IIB goals within a context where the Collider program is NOT the only game in town

Summary

- Booster beam loss reduction and control and equipment maintenance and upgrades are key to entire future planned Fermilab high energy physics program!
- Booster -- "Probably the ***finest*** accelerator in the entire known universe as we know it (Tomlin, 1994)."
  NEEDS YOU!

Tower Building with Possible Added Shielding