

Another 200 MeV Upgrade

Linac Afterburner in Booster Tunnel

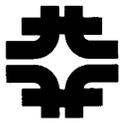
C. Ankenbrandt, J. MacLachlan, M. Popovic, Fermilab

R.P. Johnson, IIT

ICFA-HB2002, April 8-13, 2002

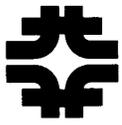
http://www-bdnew.fnal.gov/proton_source/popovic/work/AnotherFNALinacEnergyUpgrade.doc

“Once is Not Enough” --*Jacqueline Susann*



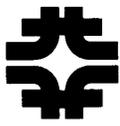
The 23M\$ Afterburner

- Raises Booster H^- injection E from 400 to 600 MeV
 - $\beta\gamma^2$ increases by 1.47, $\beta^2\gamma^3$ increases by 1.88
- Uses 805-MHz Side-Coupled Cavities as in 1993
 - No R & D issues
- Uses existing space for cavities and klystrons
 - Cavities go in Booster tunnel
 - Klystrons are in unoccupied areas of Booster towers
 - Simple penetrations connect klystrons to cavities
- As presently developed has
 - 5 accelerating modules (each with 4 sections of 12 cavities)
 - a longitudinal debuncher and buncher
 - a 600 MeV injection scheme for LSS 11
 - a 1.5 to 2-year construction/installation scheme
 - small operational interference (critical parts not removed)

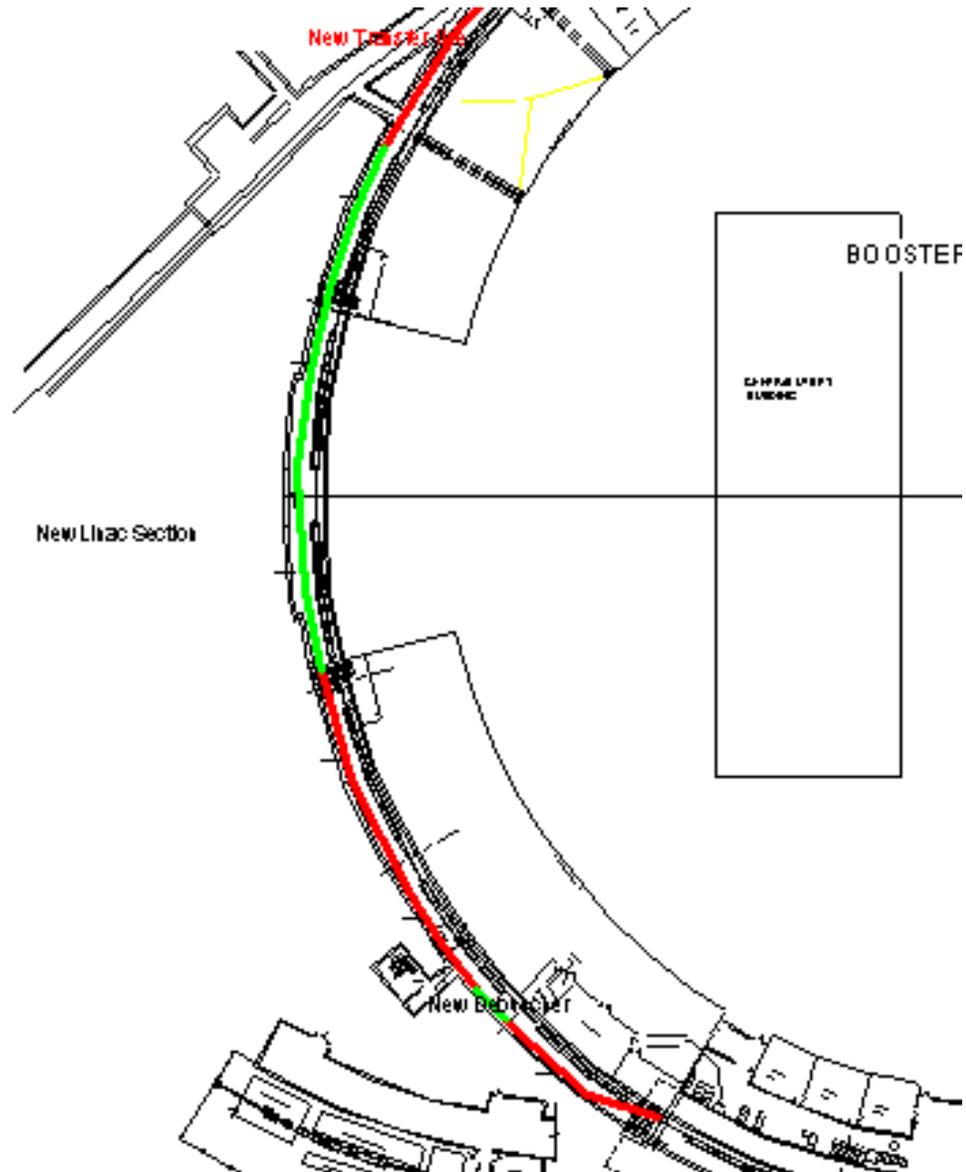


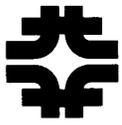
Linac Booster Complex



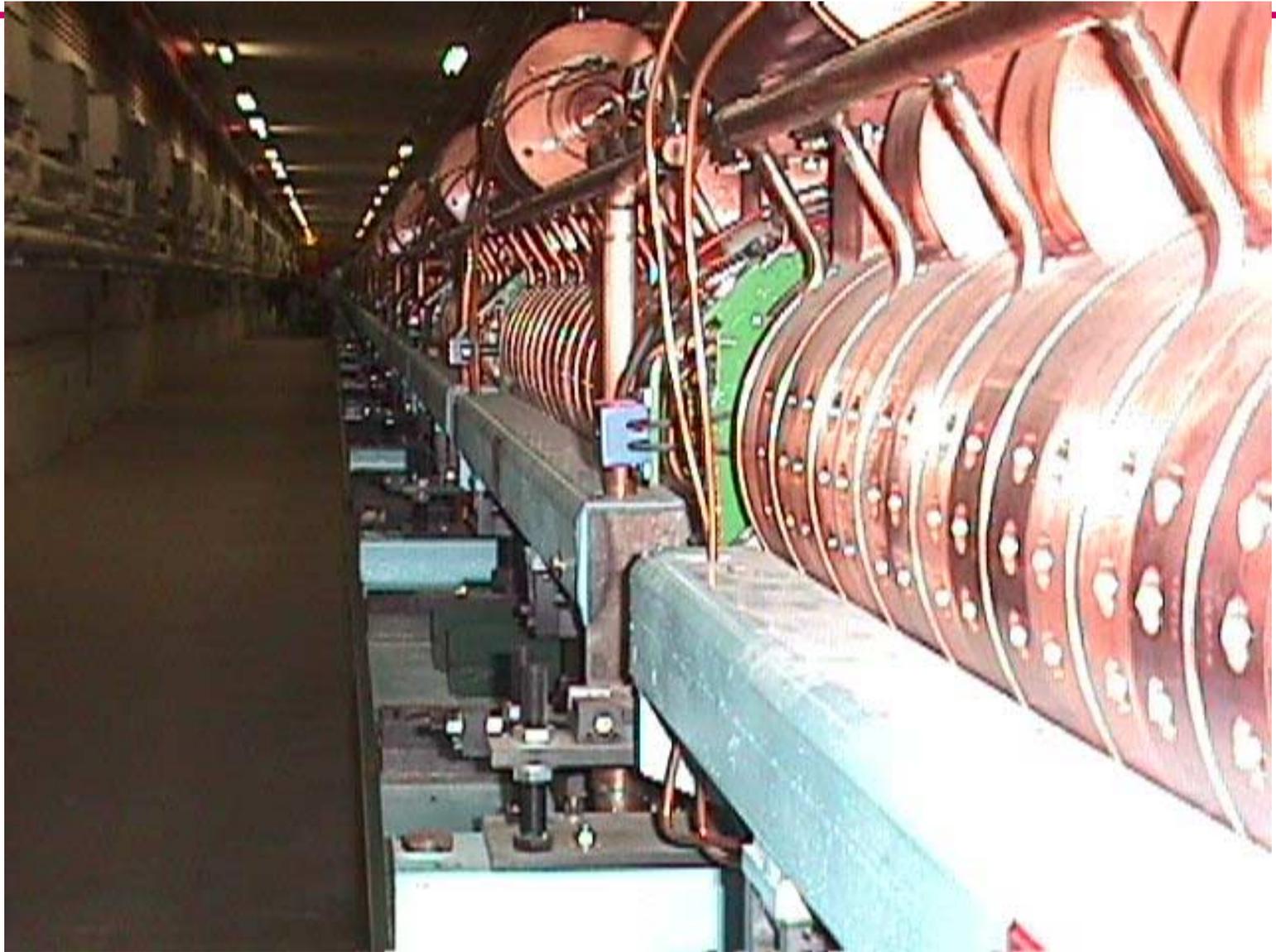


Booster Ring Drawing





Modules

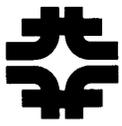




Booster Tunnel

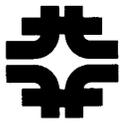


94 inches From Wall to Girder



Booster East Tower



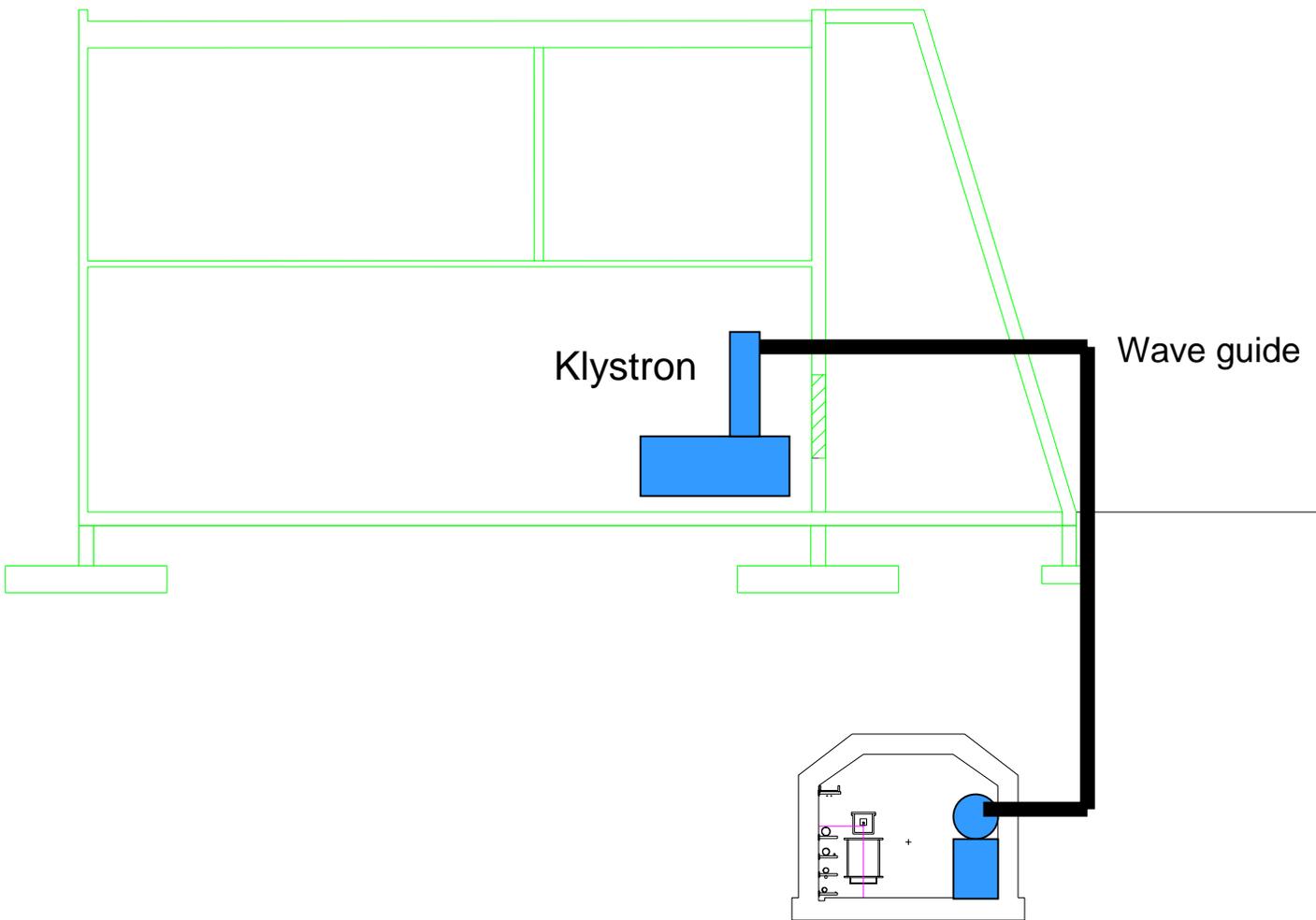


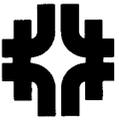
Booster East Gallery



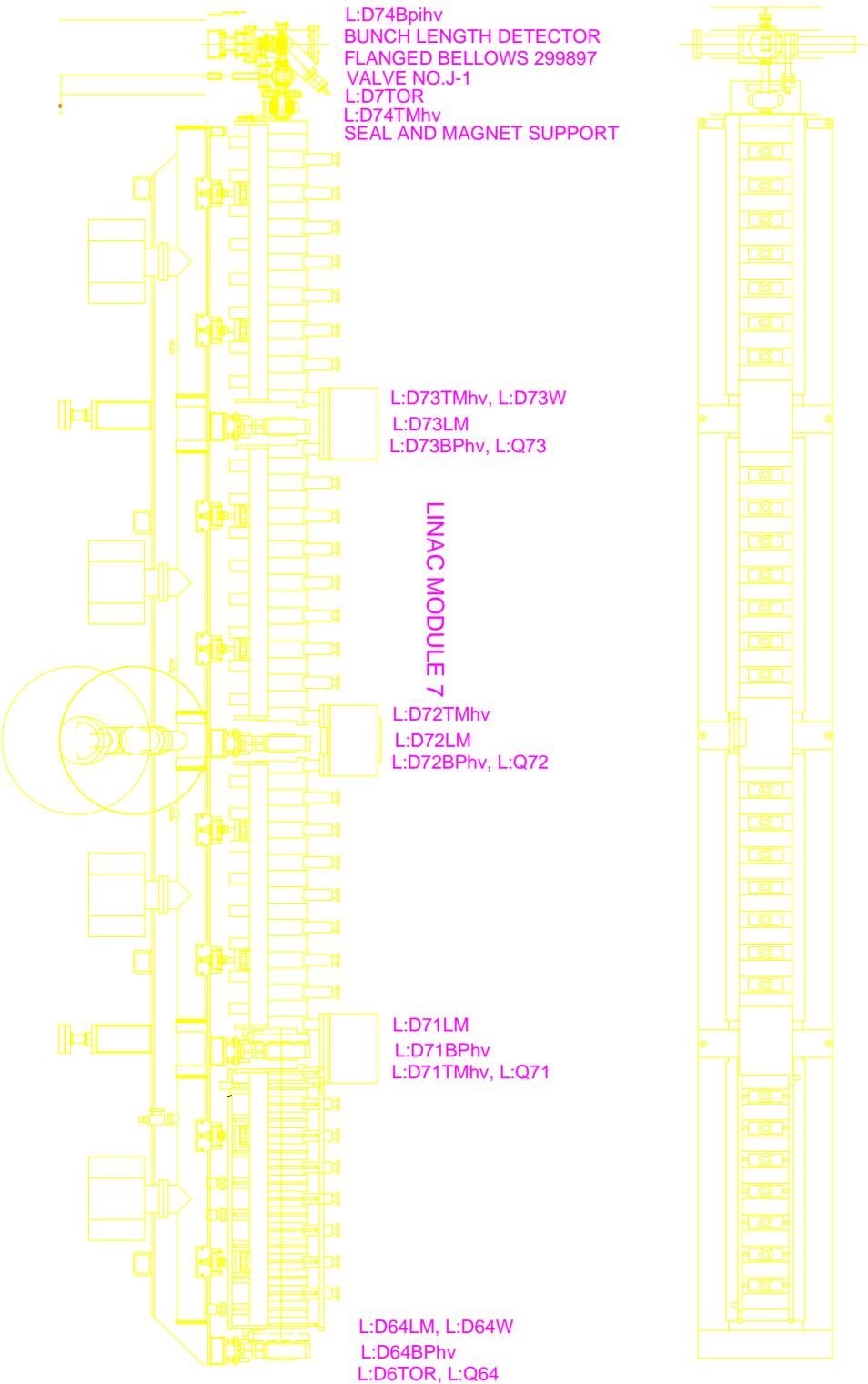


Booster Tower & Tunnel

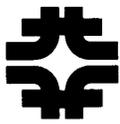




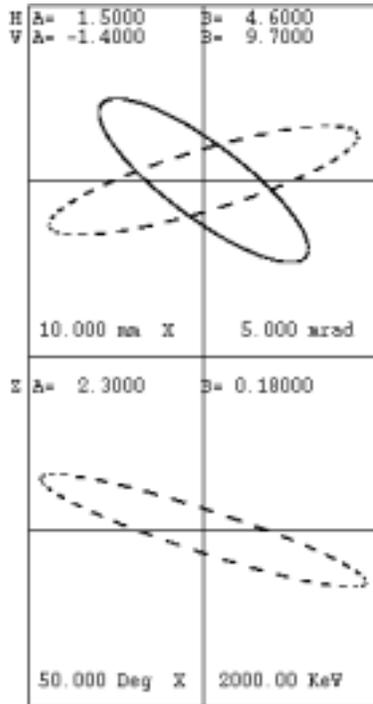
Linac Accelerating Module



Cavity width is 12 inches/Girder width is 32 inches



Trace3D Output for 400 to 600 MeV



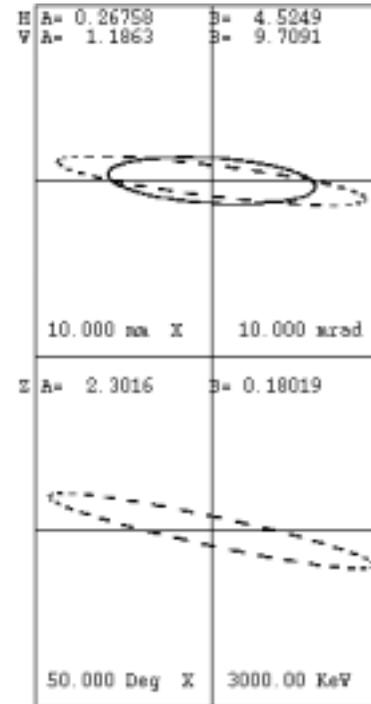
W= 401.5000 587.2113 MeV
 FREQ= 804.95MHz WL= 372.43mm
 EMITT= 7.767 8.000 12000.00
 EMITT= 10.584 6.361 15521.32
 N1= 1 N2=140

PRINTOUT VALUES
 PP PE VALUE

MATCHING TYPE = 8
 DESIRED VALUES (BEAMP)
 alpha beta
 x 0.0000 1.0000
 y 0.0000 8.0000

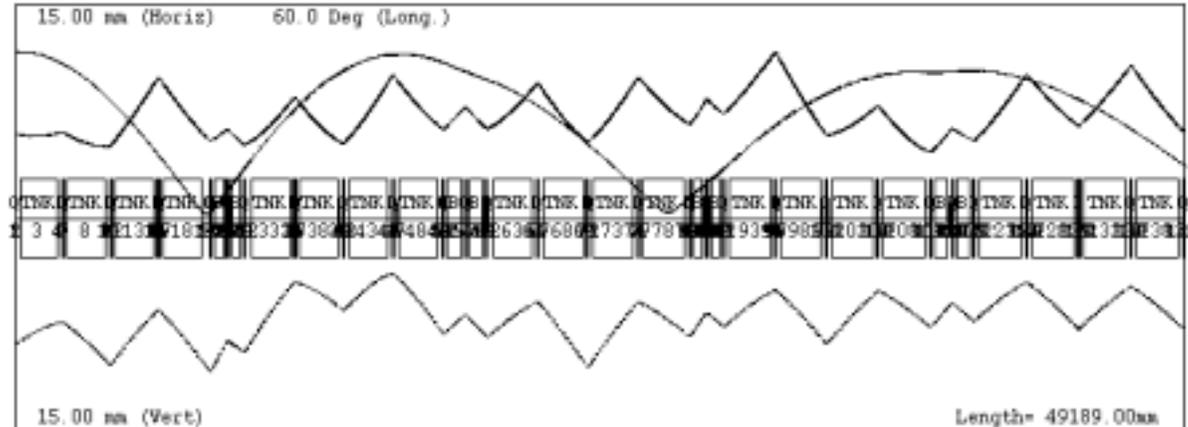
MATCH VARIABLES (NC=4)
 MPP MPE VALUE
 1 11 15.00000
 1 15 -19.95000
 1 20 19.95000
 1 26 -19.00000

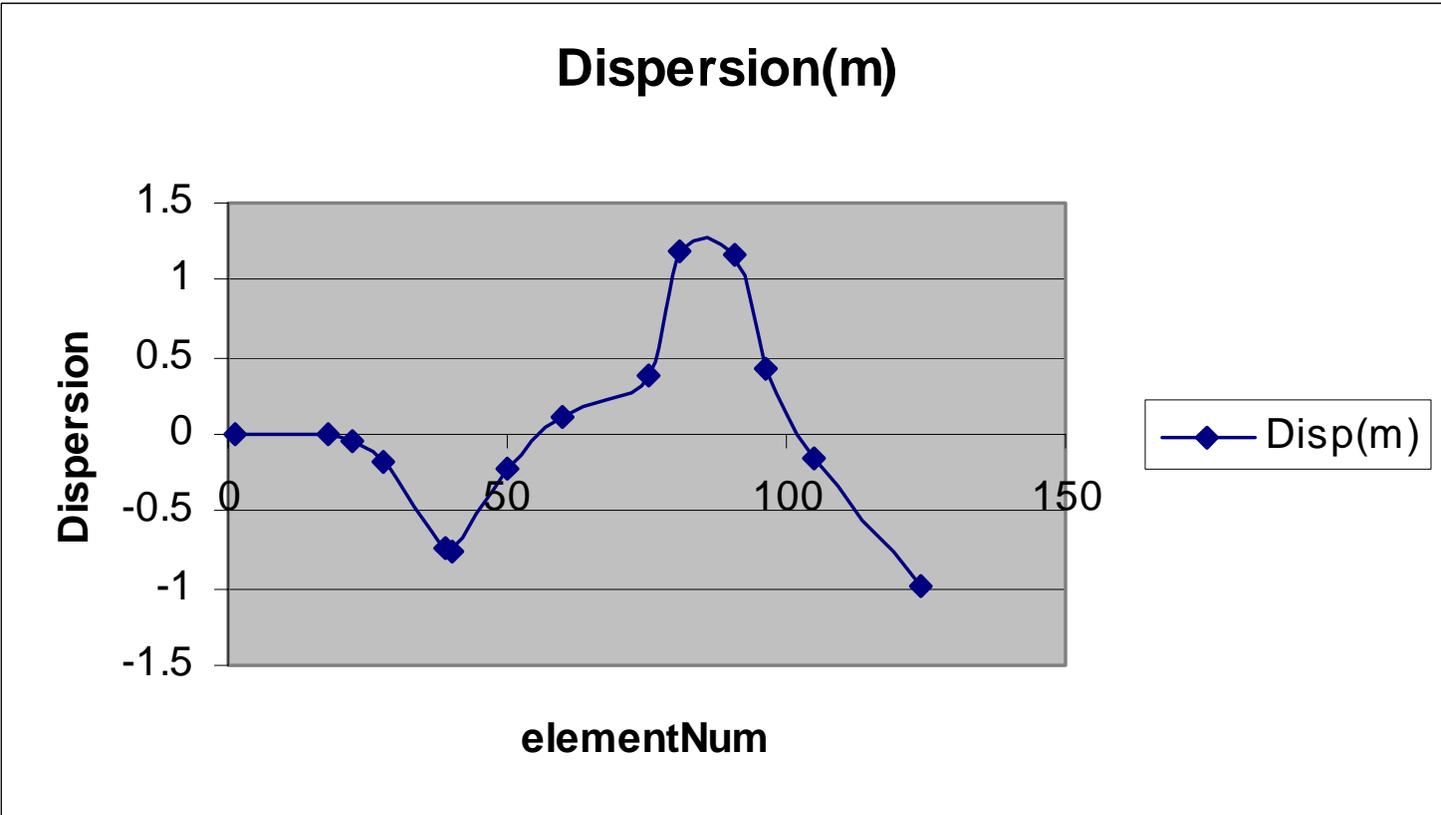
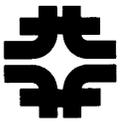
CODE: TRACE3D v61
 FILE: Boolini2Match
 DATE: Apr 8 02
 TIME: 09:12:28



NP1= 1

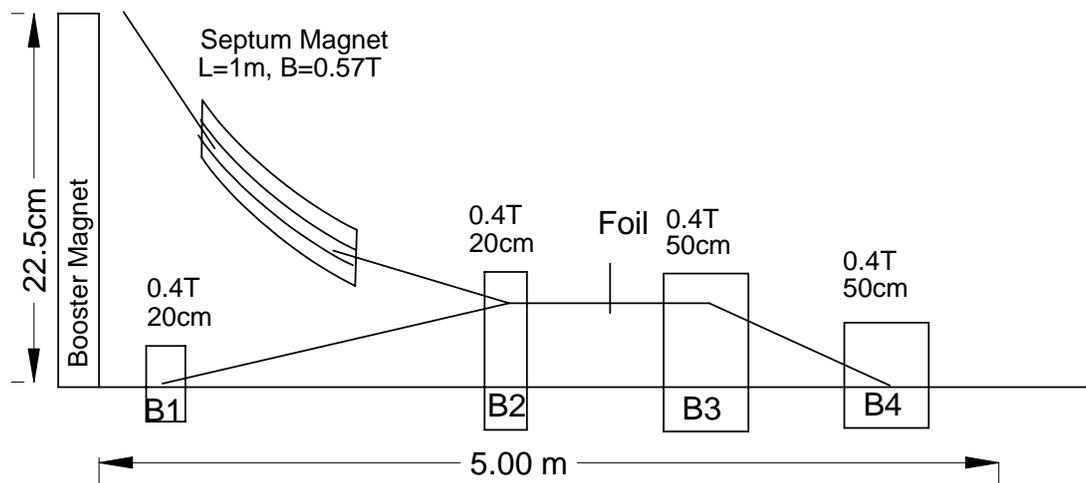
NP2=140

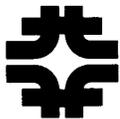






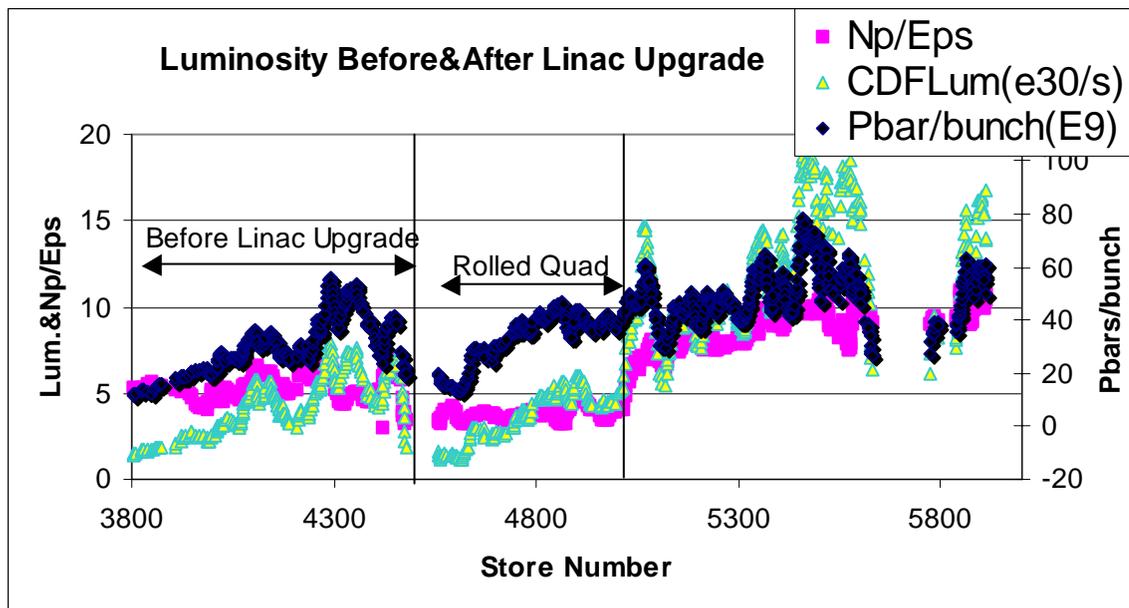
600 MeV H⁻ Injection System

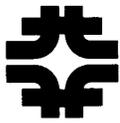




First Upgrade to 400 MeV

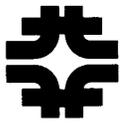
- Upgrade to 400 MeV in '93 increased Booster intensity
 - From 2.5 to 4.2×10^{12} for pbar production (factor of 1.68)
 - From 3.4 to 5.5×10^{12} maximum (factor of 1.62)
 - Approximately then as $\beta\gamma^2$ (factor of 1.72)
- Tevatron max and record Luminosities increased by 2.5





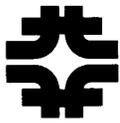
600 MeV Afterburner Impact on Run 2

- Collider Luminosity depends on projects now underway
 - Recycler as storage ring, pbar cooler, receiver of used pbars
 - Slip-stacking to create more pbars
 - Tevatron electron lenses to ease beam-beam tune-shift limit
- In all cases the Afterburner will produce
 - more pbars and
 - brighter proton bunches
- These are useful if
 - the accumulator can handle more pbars
 - The electron lenses raise the tune shift limit
- The Afterburner may be required to reach this new limit
 - Since there are many more bunches in the Tevatron, Fewer Booster bunches get coalesced to make a Tevatron bunch (7 vs 11)
- NUMI, CKM, and BooNE are also helped by more protons



Summary

- Technology- Copy of Linac 93 Upgrade
- Cost – 23M\$, much going towards Proton Driver
 - 20MeV/1M\$ in '93 -> Today 20MeV/1.5M\$
 - requires new debuncher and buncher sections
 - New 600 MeV injection girder
- Civil Construction – Almost None
- Duration of Construction – 1.5 to 2 Years
- Less Impact on Scheduled Operations
 - MH2 allows switch between 400 and 600 MeV
- Raises transverse and longitudinal space charge limits
- More protons, more pbars, brighter bunches for Run 2
 - Another factor of 2.5 in Luminosity? $\beta^2\gamma^3$ scaling?



References

- 1-GeV Linac Upgrade Study at Fermilab,
M. Popovic, et al., FERMILAB-Pub-98/266
- Present, Near Future and Future Performance of the Fermilab
Linac, M. Popovic, FERMILAB-Pub-96/046
- A Linac Afterburner to Supercharge the Fermilab Booster,
C. Ankenbrandt, J. MacLachlan, M. Popovic, Fermilab,
and R. P. Johnson, IIT, July, 2001, FERMLAB-Pub-??