

Another 200 MeV Upgrade

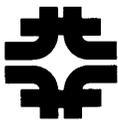
Linac Afterburner in Booster Tunnel

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R. P. Johnson, IIT

Snowmass 2001, July 13, 2001

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



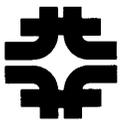
The 23M\$ Afterburner

- 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)

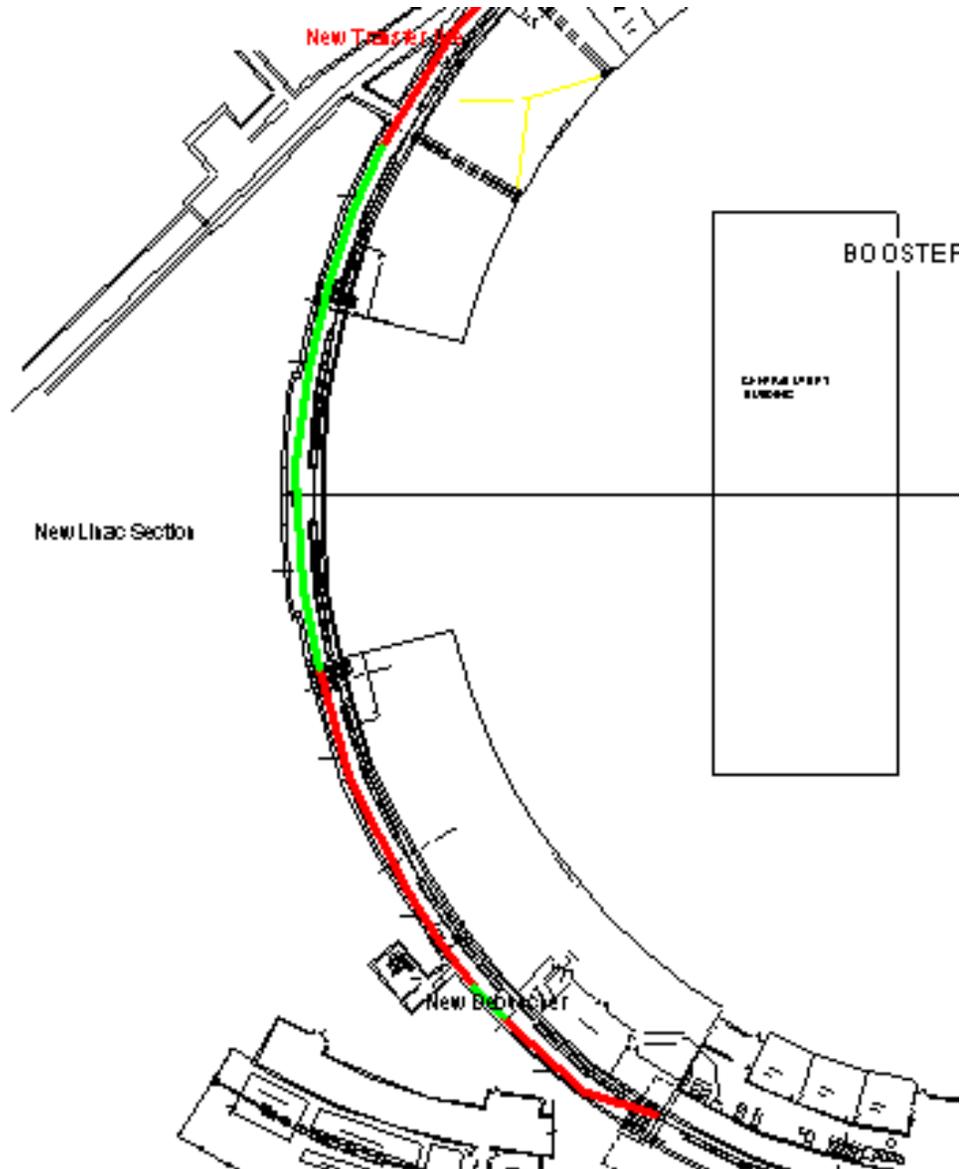


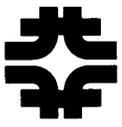
Linac Booster Complex



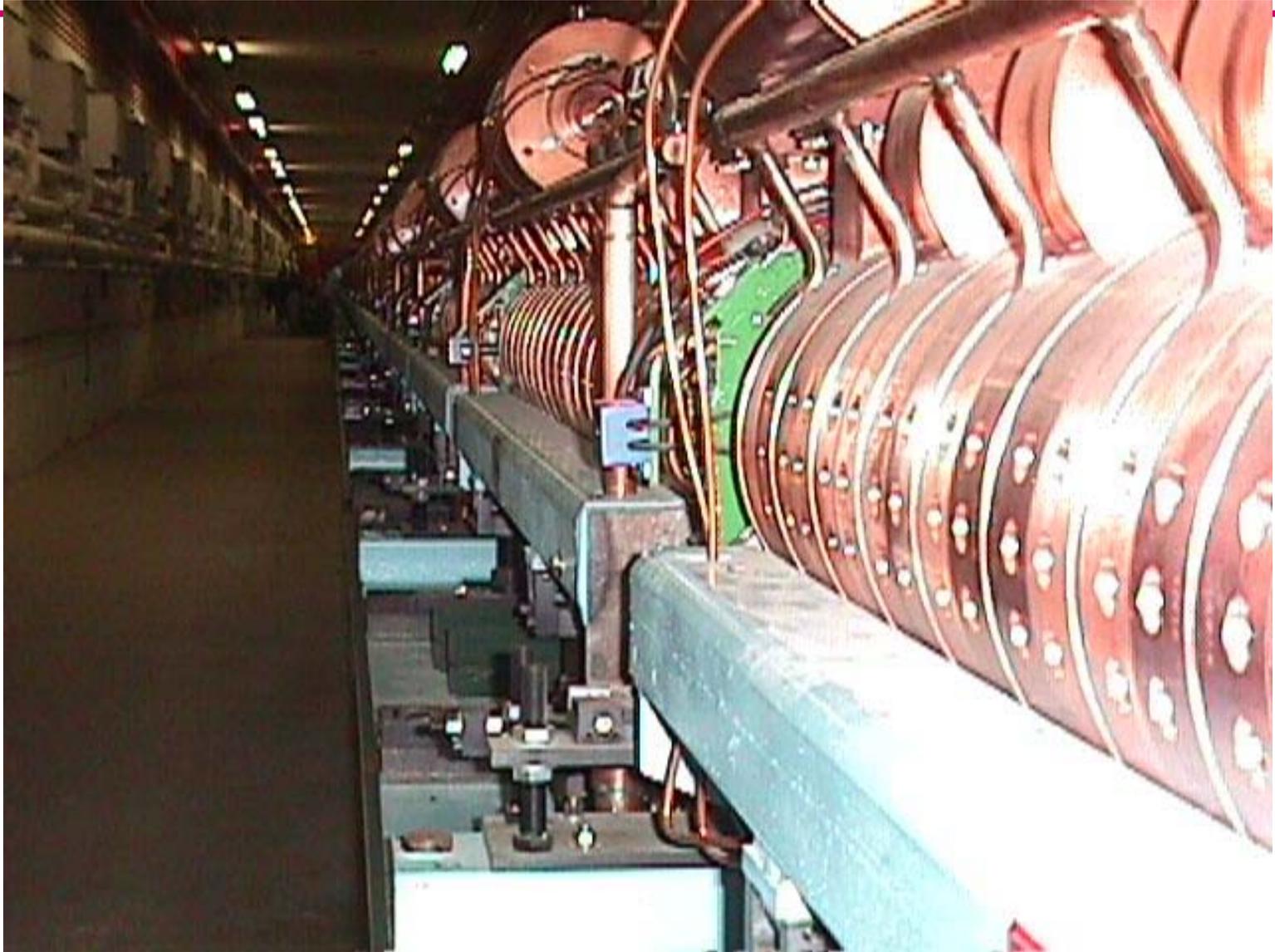


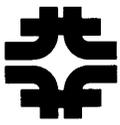
Booster Ring Drawing





Modules

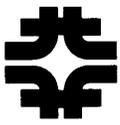




Booster Tunnel

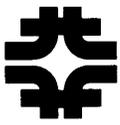


94 inches From Wall to Girder



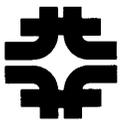
Booster East Tower



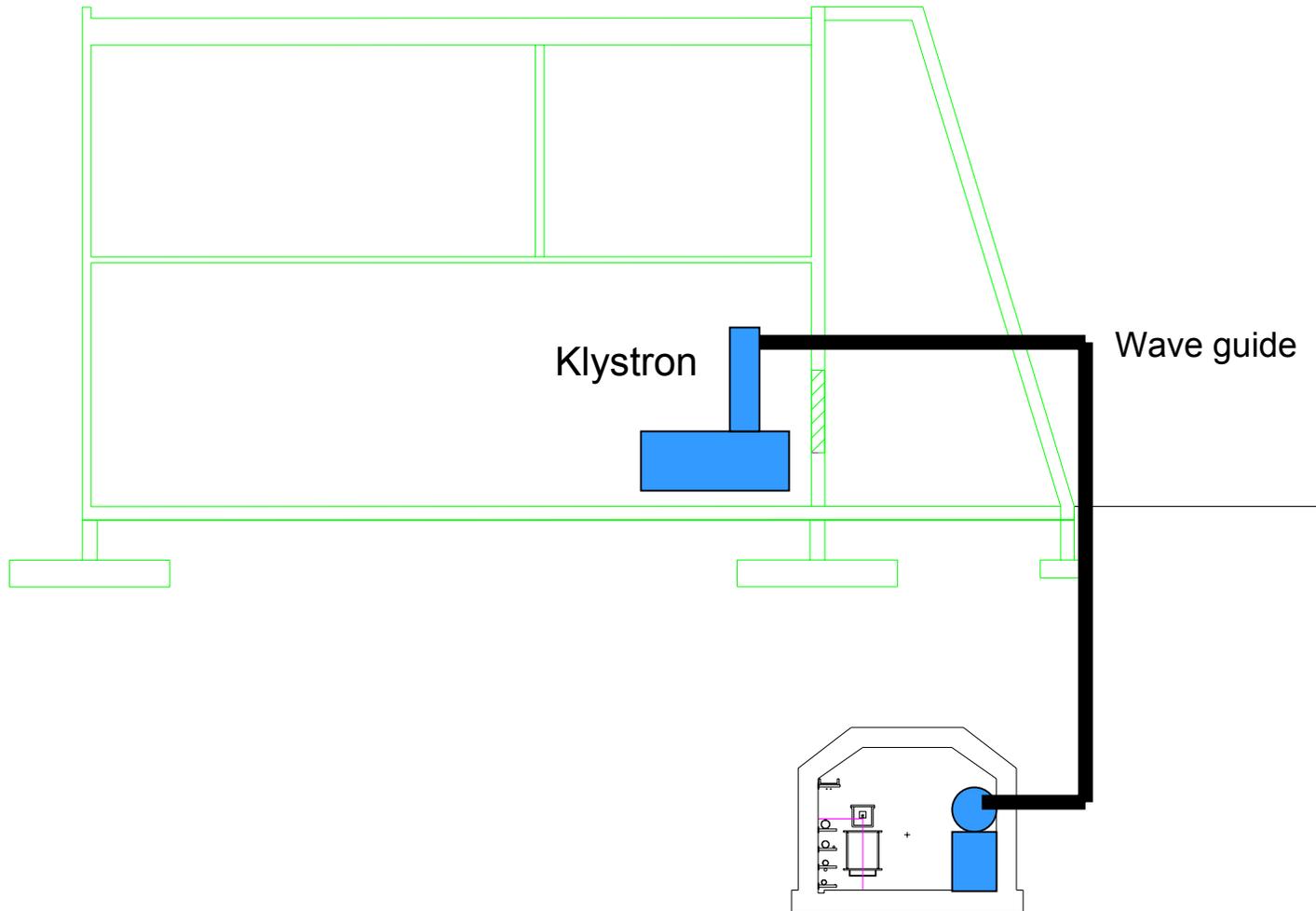


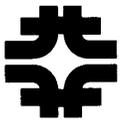
Booster East Gallery



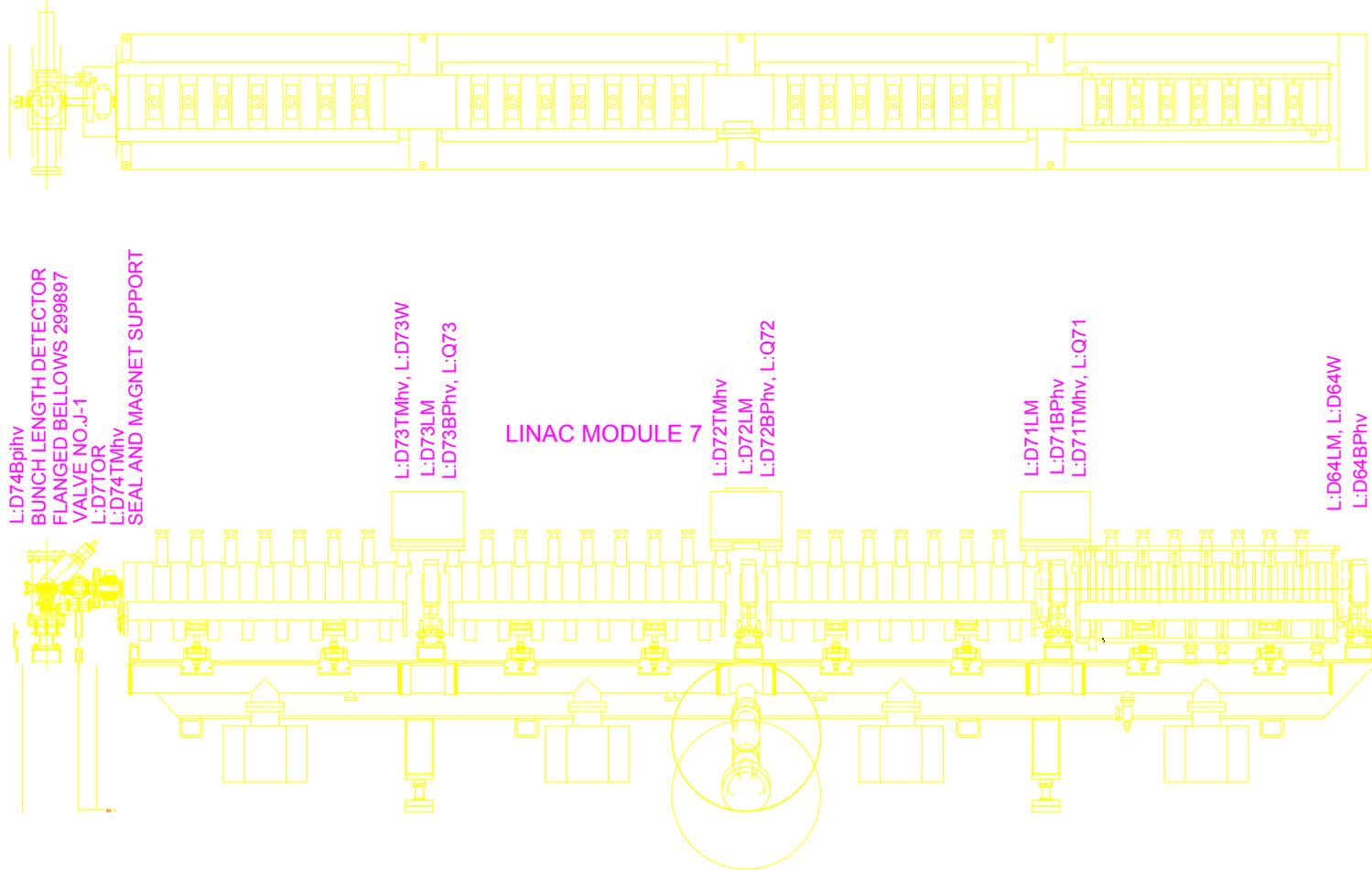


Booster Tower & Tunnel

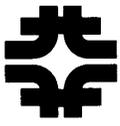




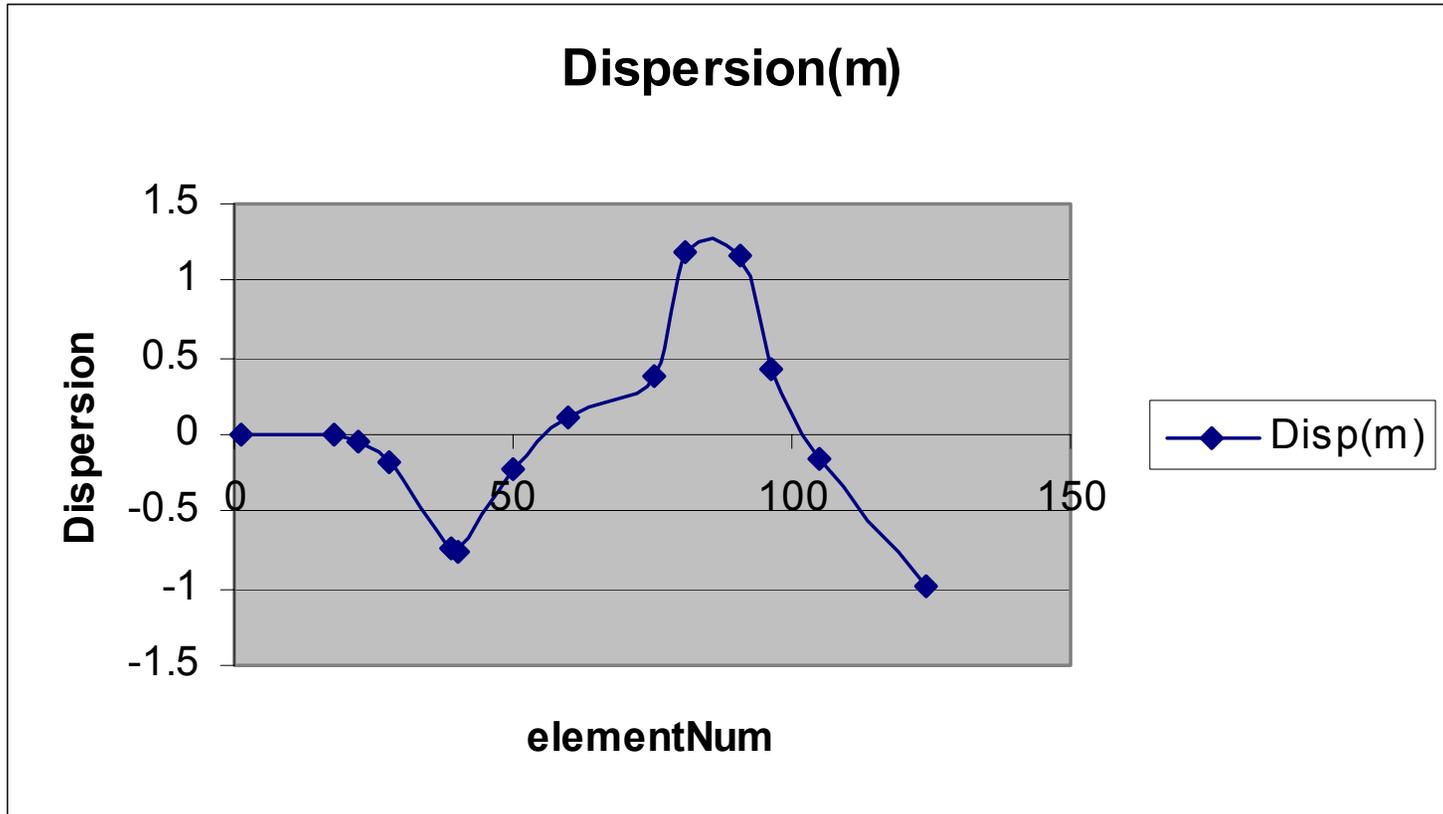
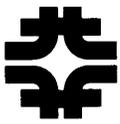
Linac Accelerating Module

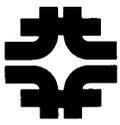


Cavity width is 12 inches/Girder width is 32 inches

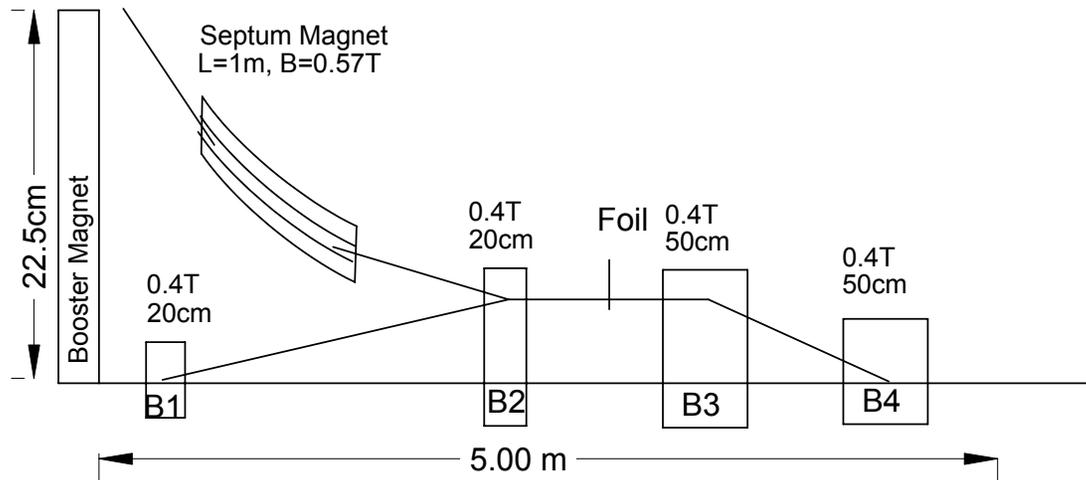


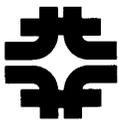
Trace3D Output for 400 to 600 MeV





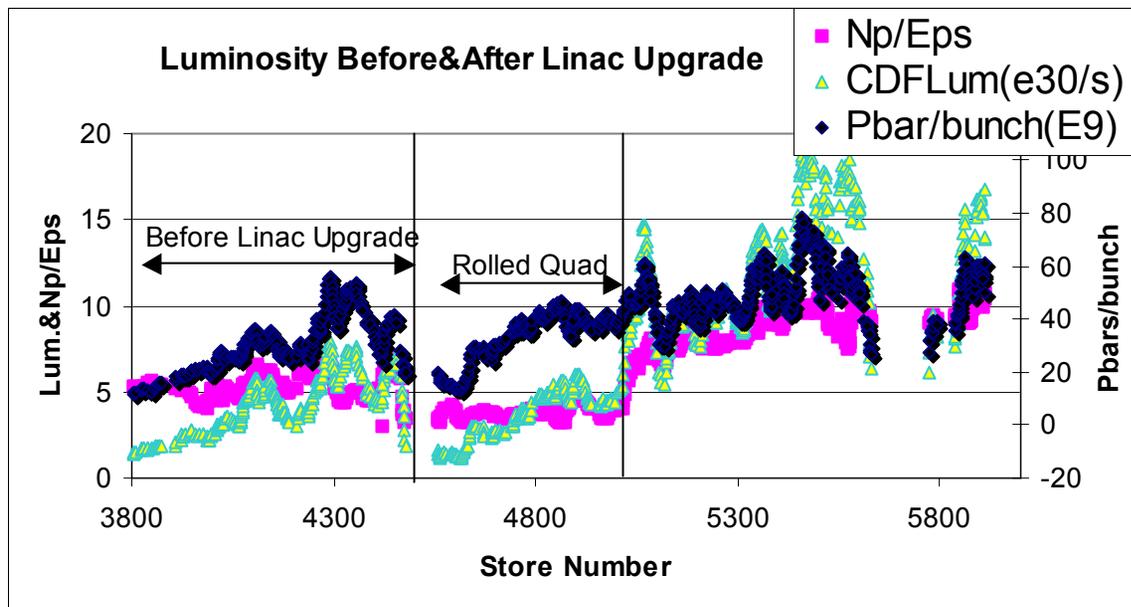
600 MeV H⁻ Injection System

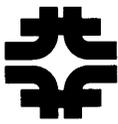




First Upgrade to 400 MeV

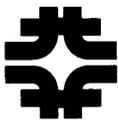
- Upgrade to 400 MeV in '93 increased Booster intensity
 - From 2.5 to 4.2×10^{12} for pbar production (factor of 1.68)
 - From 3.4 to 5.5×10^{12} maximum (factor of 1.62)
 - Approximately then as $\beta\gamma^2$ (factor of 1.72)
- Tevatron max and record Luminosities increased by 2.5





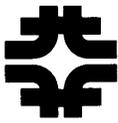
600 MeV Afterburner Impact on Run 2

- 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 (3 vs 7)
- 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,
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- 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-??