



ECLOUD STUDIES AT TEVATRON

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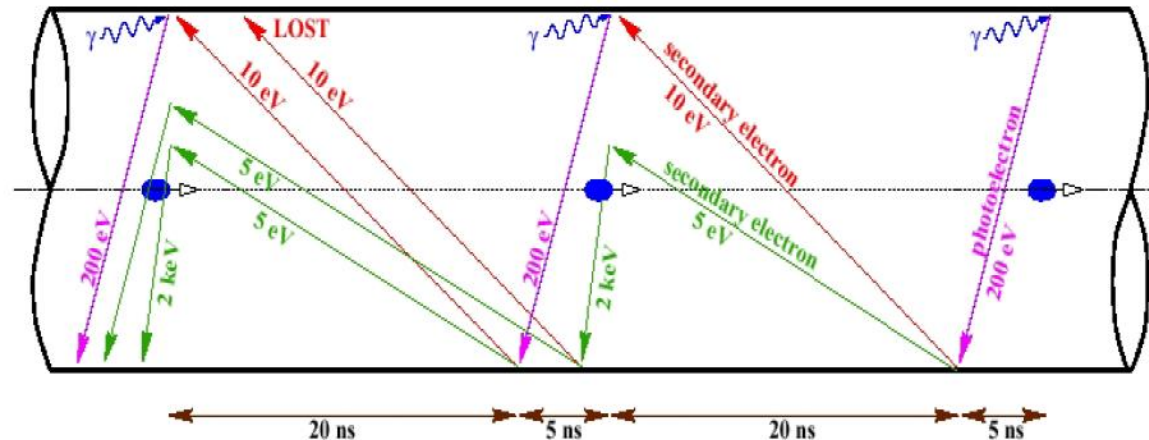
Tevatron Accelerator Studies Workshop



Electron Cloud Buildup



$\tau_{\text{bunch}} < 1/f_e < s_{\text{bunch}}$
(LHC, SPS-25 ns)



- Short bunch:

- Initial electron produced by photos, beam loss, ionization, etc.
- Density of the electron increased by generating secondary electrons.
- Exponential growth of electron density happens with appropriate beam conditions.
- Electron cloud saturated by its space charge effect.



Effects of Electron Cloud



- Vacuum instabilities:
 - Fast vacuum jumps of several order of magnitude
- Beam instabilities
- Beam losses
- Heat loading
- Noise on beam instruments



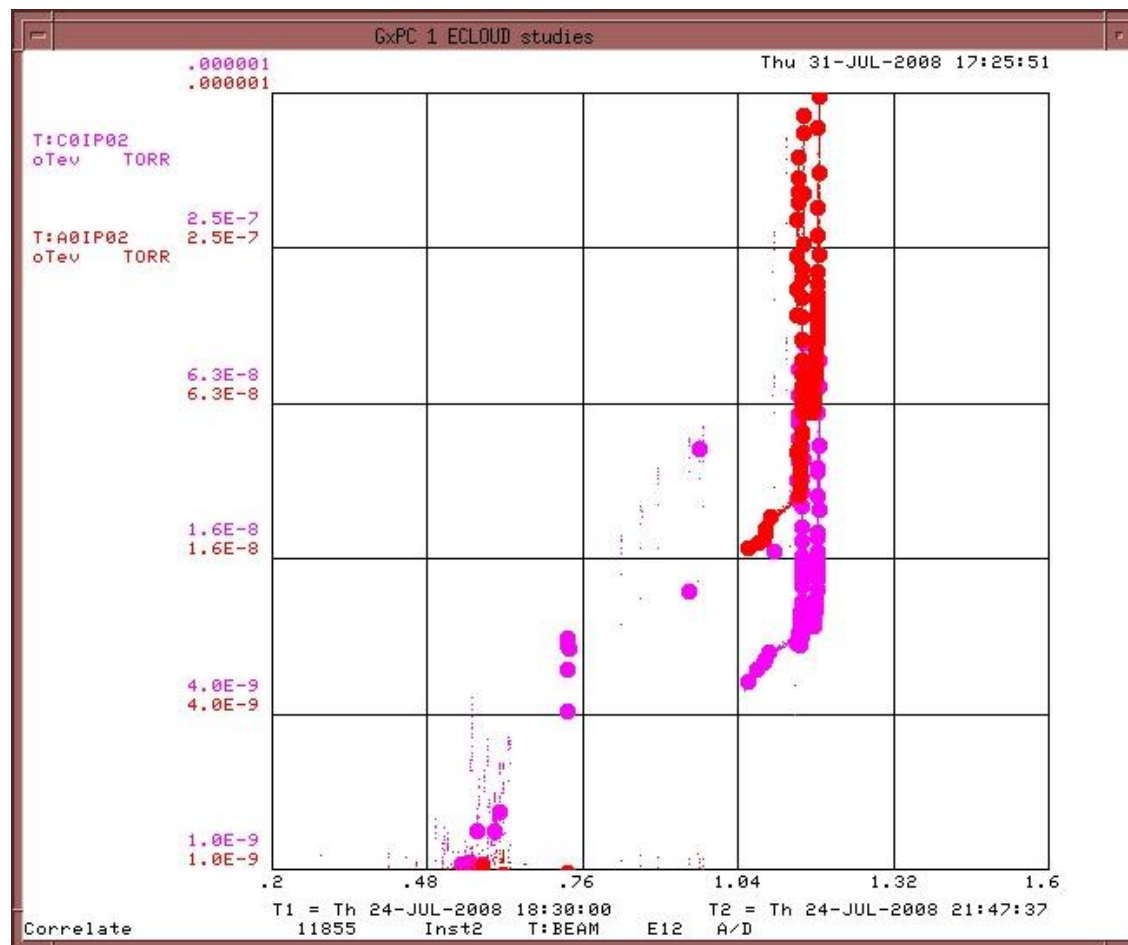
Studies at Tevatron



- Started from Dec. 2002, not a problem for Tevatron.
- Intensive studies carried out since May, 2005 when proton driver and MI upgrade purposed.
- Objectives:
 - Benchmark the simulation code;
 - Measure the electron cloud and energy distribution (since beam is stored in Tevatron while MI in constantly cycling);
 - Studies if Tevatron run as 800GeV fix target or 150GeV stretcher ring;
- Observation:
 - Vacuum jumps (especially in MI-type magnets);
 - Emittance growth;
 - Threshold of $2 \sim 4 \times 10^{10}$ /bunch for a 30-bunch train;
 - Varies with orbit (maybe the wakefield effect);



Vacuum vs. IBEAM



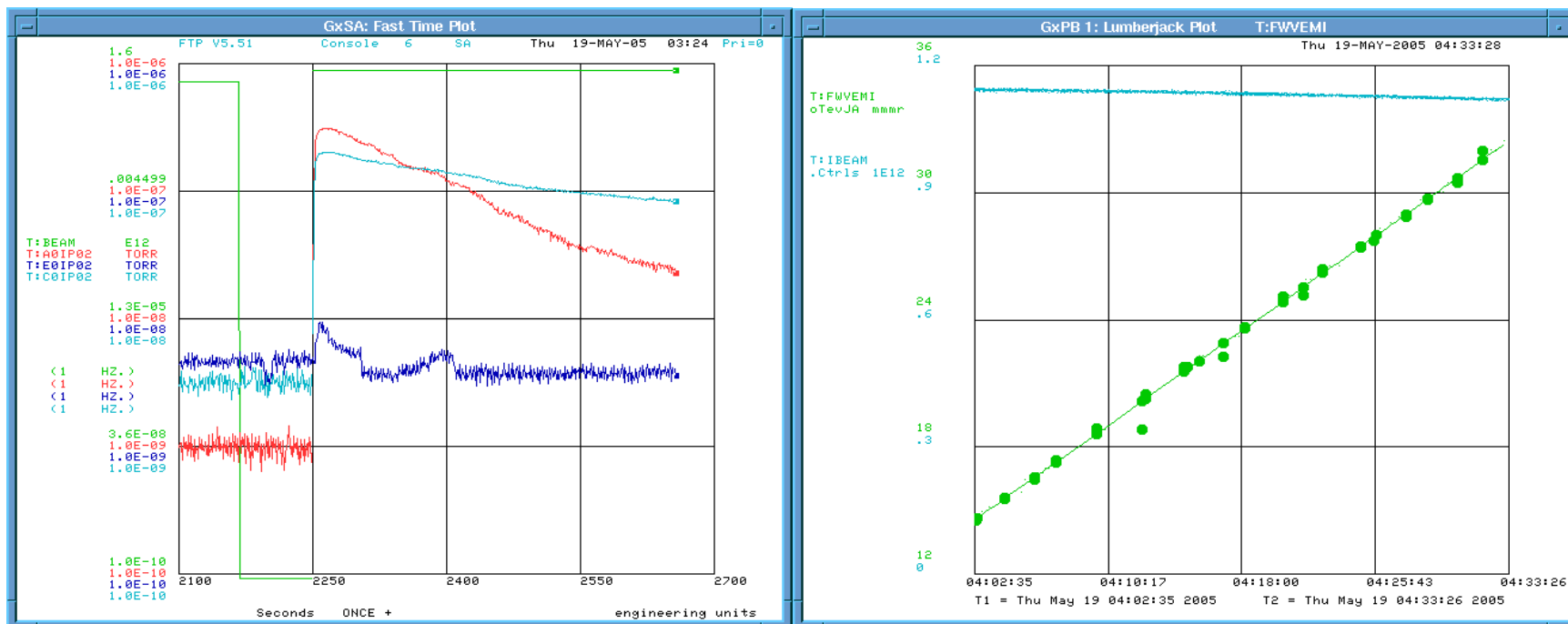


Observations



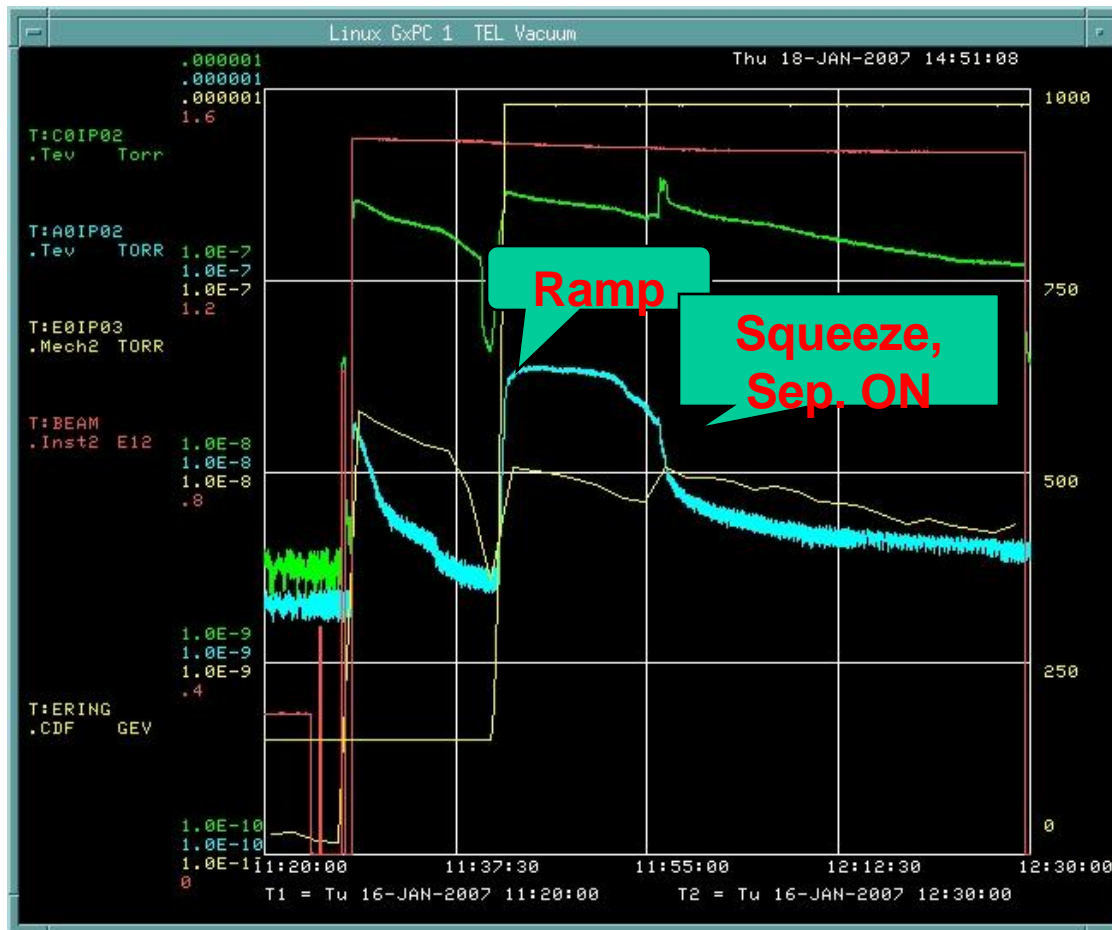
Tevatron 150GeV, 116e10/30bunches

Beam lifetime 24.4hrs
Emittance growth $34.8\pi/\text{hr}$





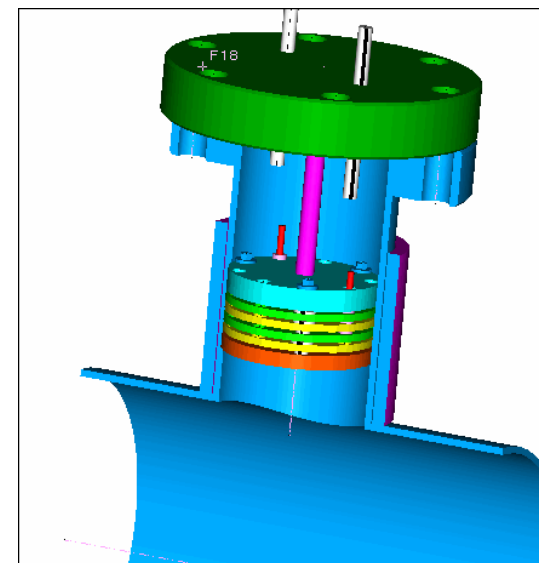
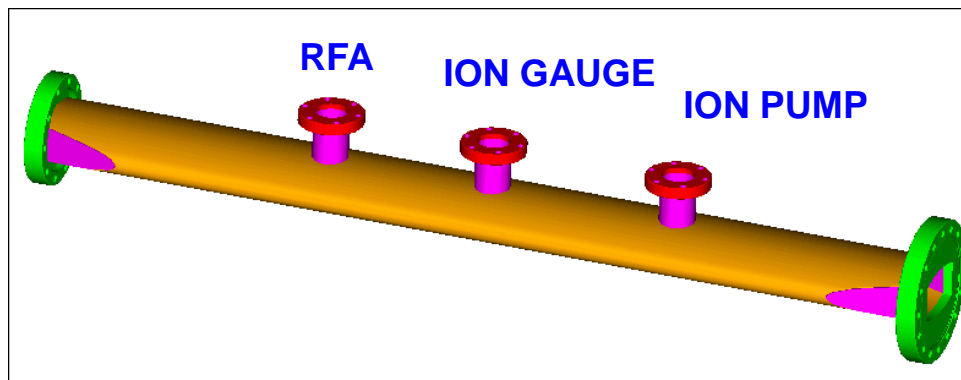
Vacuum Pressure Rise



Jan. 16, 2007

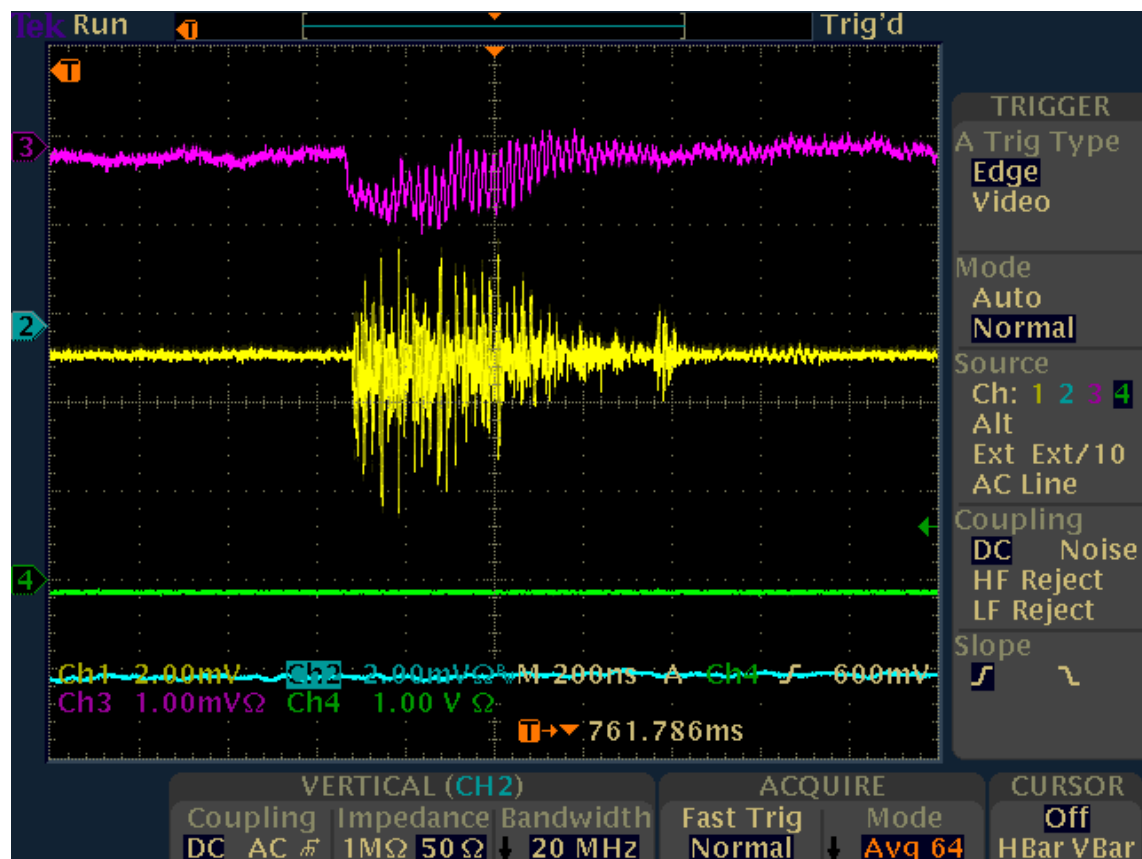


RFA Testing Beam Pipe in Tevatron and MI





RFA signal





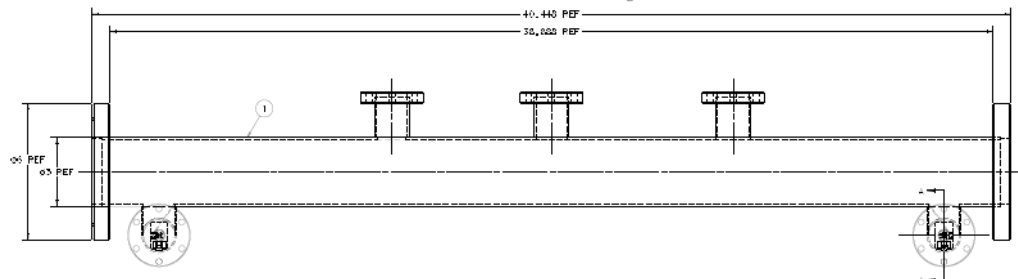
Instrumentations



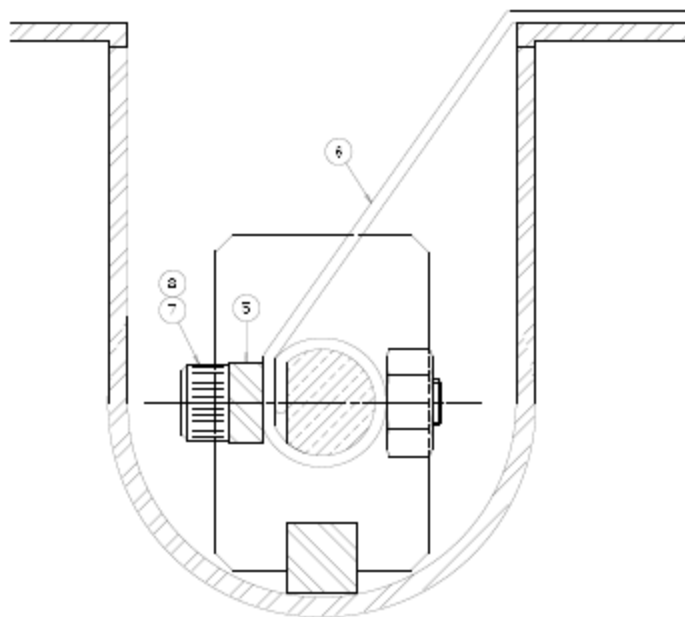
- Installed @Tevatron:
 - Argonne RFA on MI type vacuum chamber;
 - No amplification;
 - Long cable;
 - Bunch beam signal dominates;
- New improved RFAs were designed and made at Fermilab with higher efficiency include amplifier on detector;
- New cables needed;
- Need develop bunch by bunch tune, emittance and position measurements;
- ECLLOUD measurements using microwave (which is done successfully at MI but not fully understand, probably can be tested using TEL);



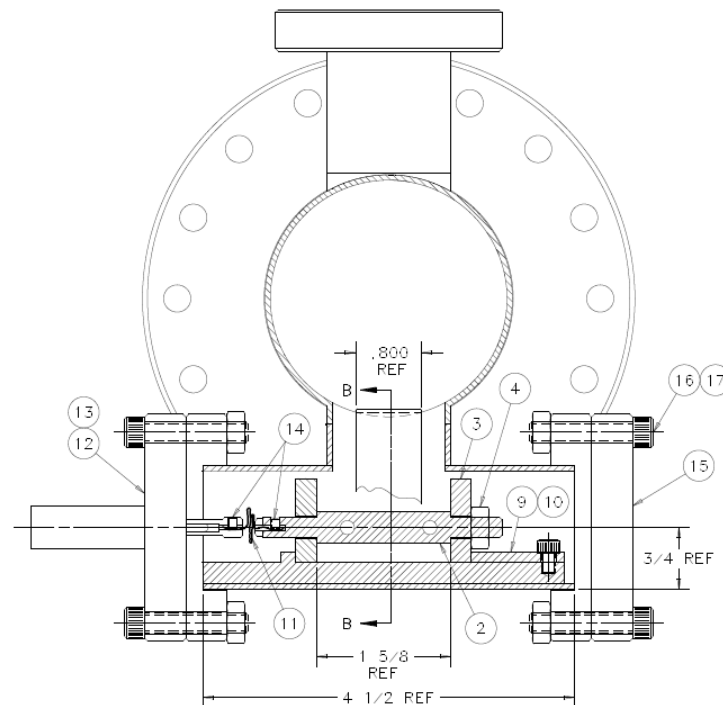
Preliminary Design



Kapton Insulation
S.S. strip w. or w/o NEG coating



VIEW B-B
SCALE 4:1



SECTION A-A
SCALE FULL



Clearing Electrode



- Pros:
 - Can suppress Ecloud efficiently;
 - Easy to install in magnets than the coating;
 - No beam scrubbing time needed;
 - Can be used as to improve vacuum (like Tevatron SNEG);
 - Can measure Ecloud density in magnets;
 - Cross check with microwave measurements;
- Cons:
 - Impedance ?
 - Longevities?



Injection of more bunches



- Successfully injected 50 bunches without changes made to Tevatron; possibly 80 bunches could be injected.
- But the bunch intensity limited by linac.
- Maybe the slip stacked Mi beam can be injected in the future.



Your valuable inputs are appreciated!

THANKS!