Longitudinal Bunch Density Study

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What I'm trying to demonstrate

- Demonstrate that I can change the bunch distribution with a phase modulation.
- Demonstrate I can stop bunch oscillations.
- Does not show that
  - I have damped the oscillations.
  - I have made the beam more stable with this the new bunch shape.

Care and Feeding ...

- It is well known that the injected beam has coherent motion (dancing bunches)
- Is this “unstable”. **NO!** It is persistent motion and does not grow. e.g. An oscillating pendulum will never be called unstable.
- The experiment will show that the oscillation stops. BUT
  - Is it due to beam loss? i.e. stuff that is oscillating at fs= 87.47Hz is lost leaving behind stuff that doesn't oscillate?
  - Does shape really matter? (because we are not unstable)

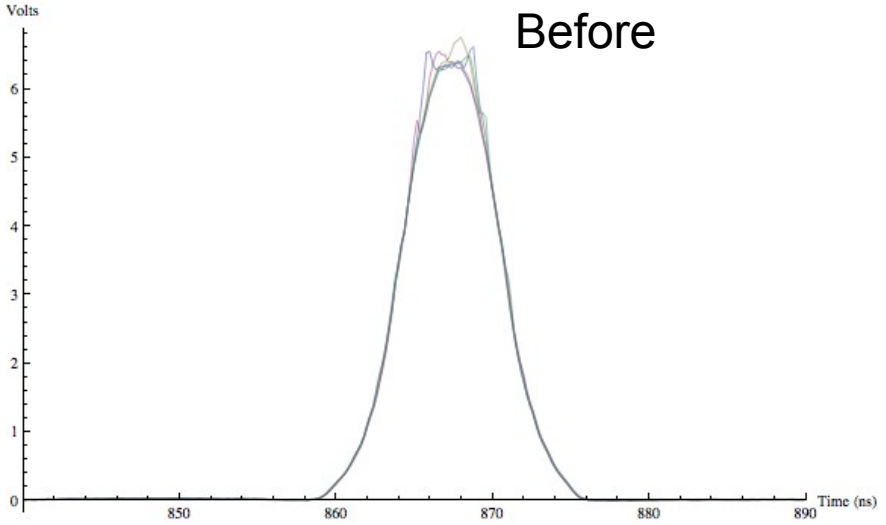
Method

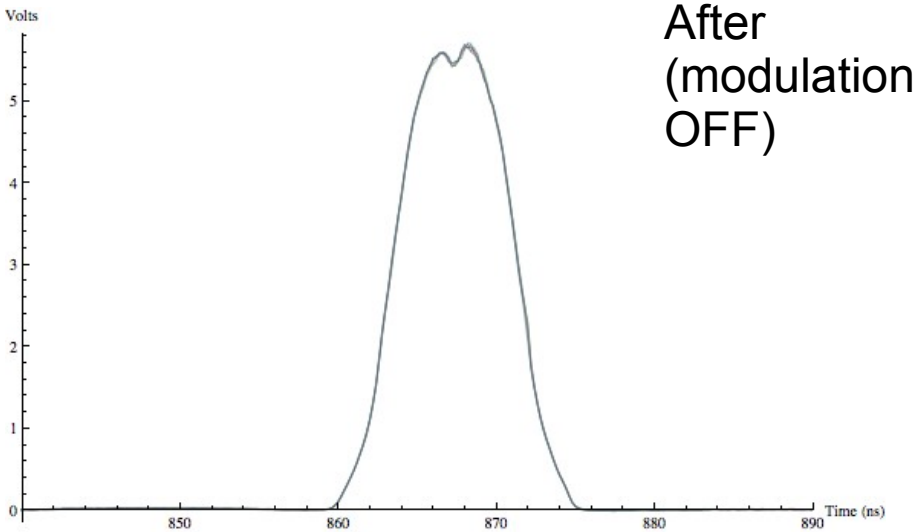
- Change the distribution with phase modulation of the RF
  - Use the current phase modulation source used for chromaticity tracking.
- What is different is that we will modulate at the synchrotron frequency rather than at 23Hz for CT.
  - The measured synchrotron frequency is 87.47Hz at 150GeV.

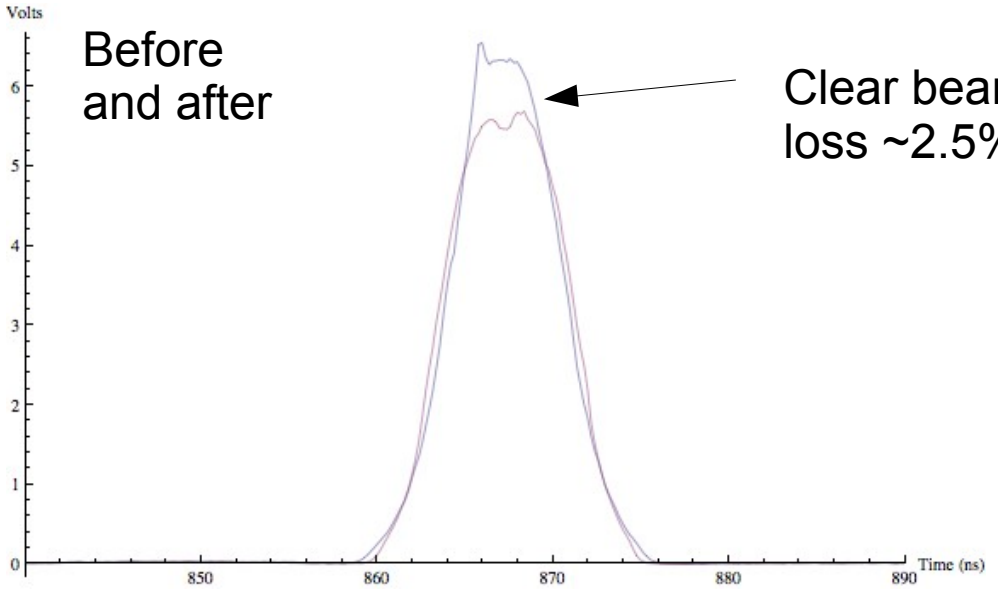
Method (cont'd)

- Inject 2 coalesced bunches before final protons.
- Take SBD picture before modulation.
- Take picture after modulation.
- Compare before and after.
- Control experiment
  - Use dampers to damp the oscillations.

3 deg peak phase mod at fs=87.47Hz







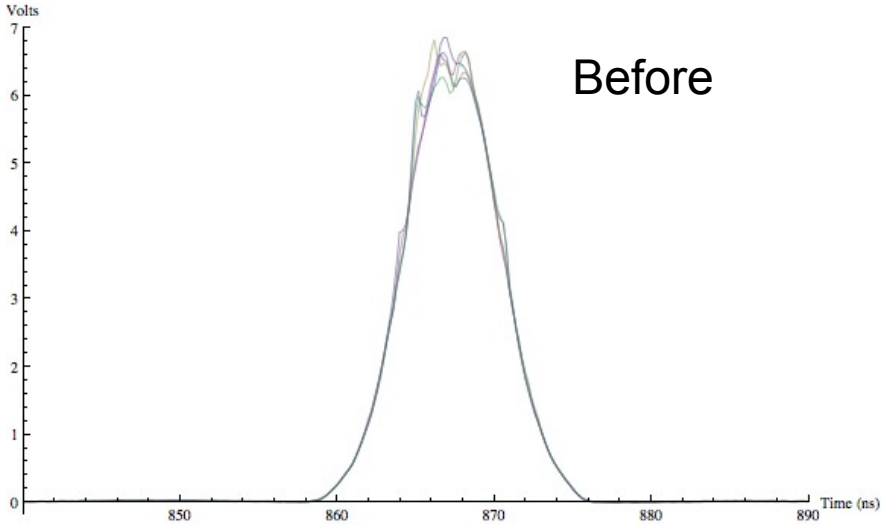
Note: 5 slices (1 s apart) superimposed.

Did I just kick out the stuff that oscillates at 87.47Hz?

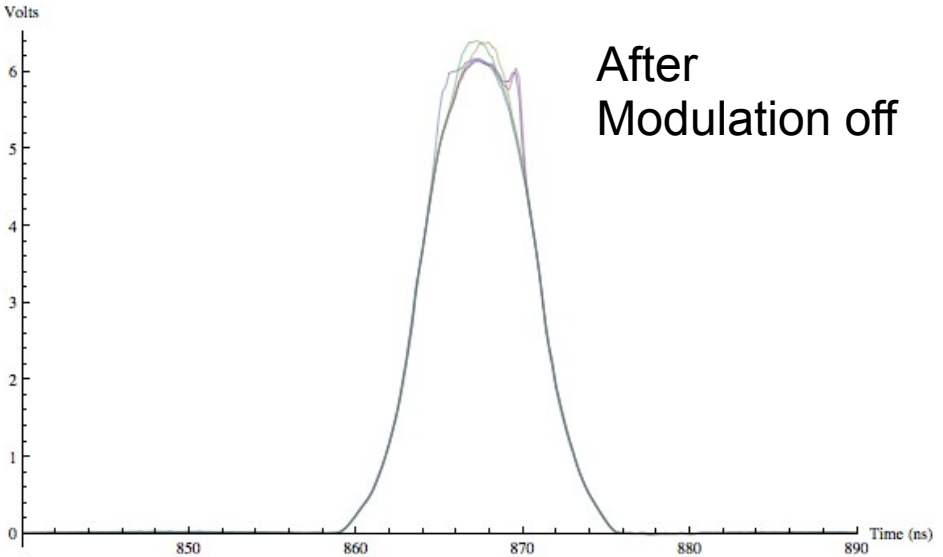
Divot is as Alexy had predicted.

Same effect with bunch 2.

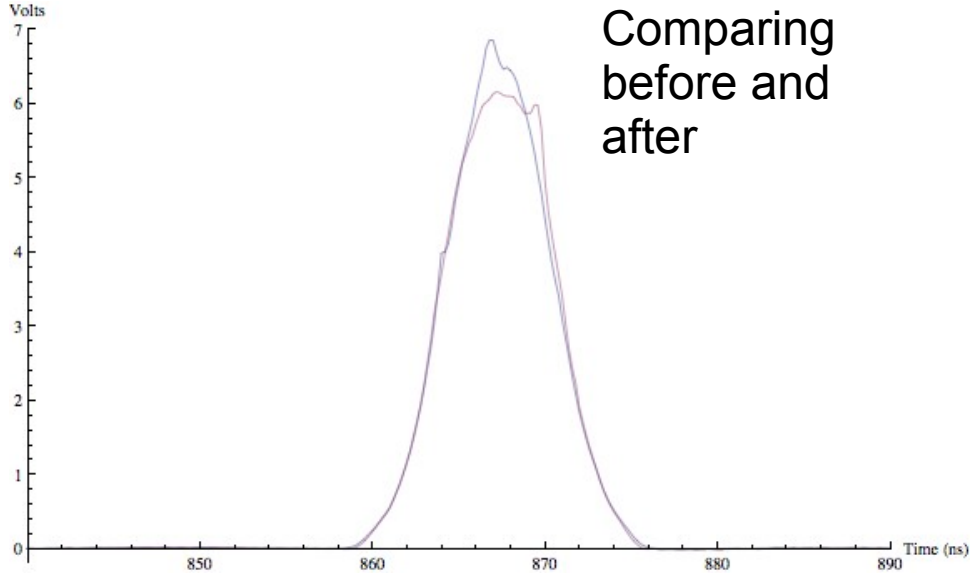
1 deg phase mod at 87.47Hz



Before



After
Modulation off

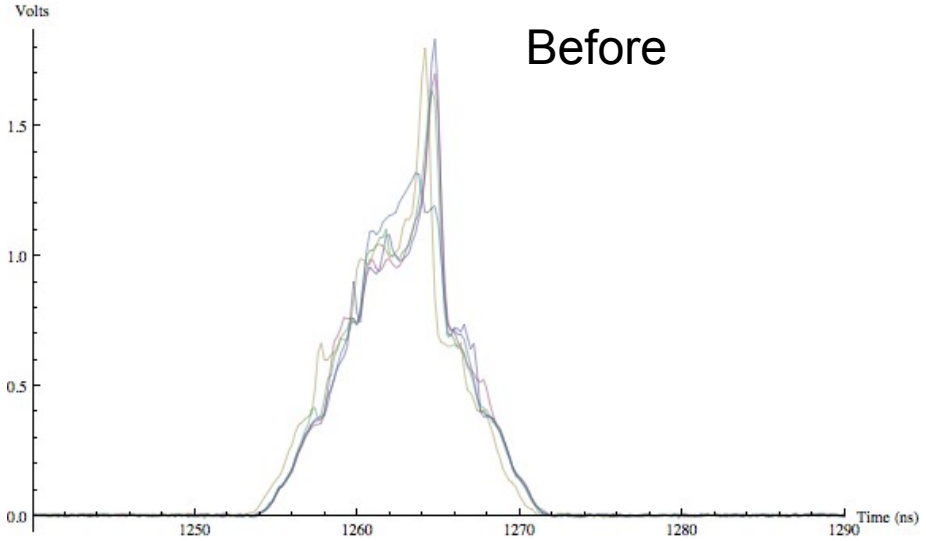


Comparing before and after

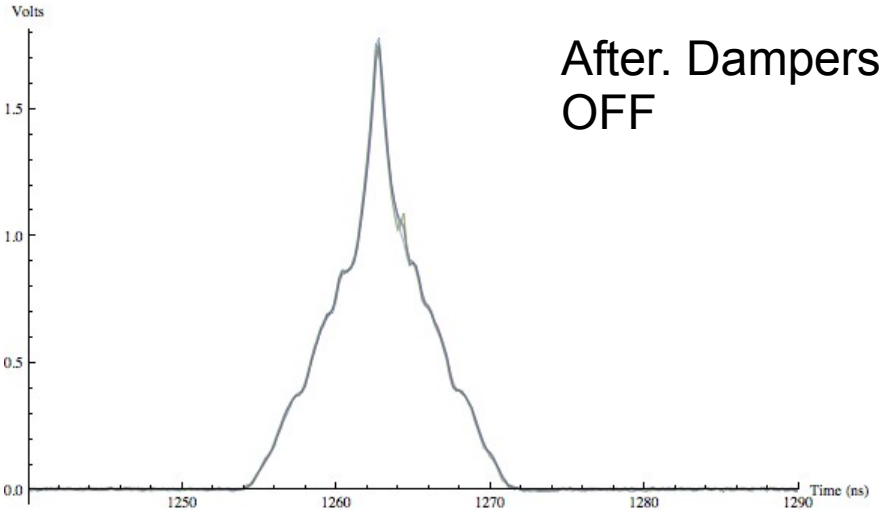
Clearly there is still some oscillation after phase mod is turned off.

Beam loss is smaller ~0.75%

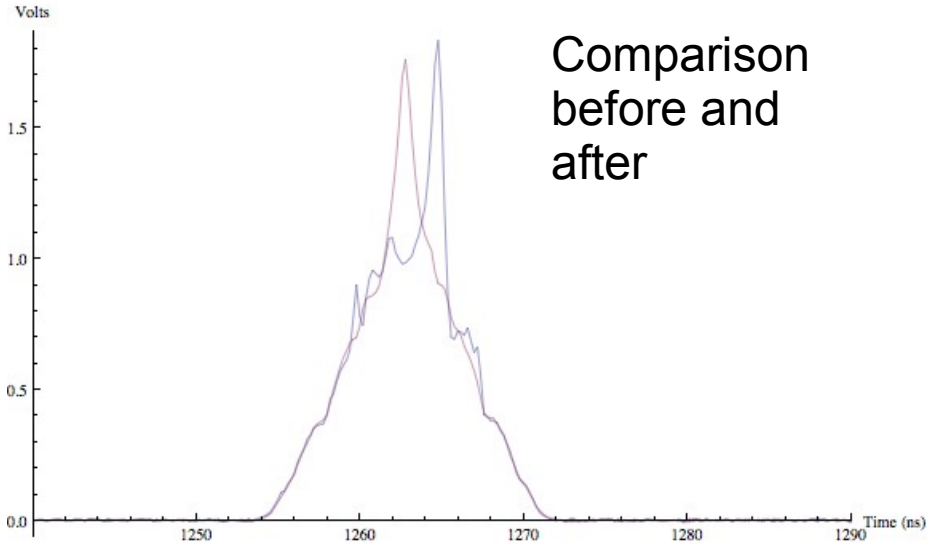
Dampers



Before



After. Dampers OFF



Comparison before and after

Note: crappy coalesced beam.

Triangle distribution is “stable” after dampers were turned off.

This will be redone with tuned up beam.

Conclusion

- Experiment says that I can change the bunch shape.
- Clearly the oscillation stops
  - Experiment shows that it has been stopped or reduced by damping(?) or by some other means, e.g. like beam loss.
  - Shape does not seem to be the determinant because once oscillation stops. **IT STOPS!**
  - This experiment does NOT show that the beam is more stable or unstable with new distributions.
- A more definitive experiment is to see if the new bunch shape increases the instability threshold.
- Perturb the beam a little to see if it is in a stable equilibrium.
- Measure the growth rate for different shapes with anti-damping.