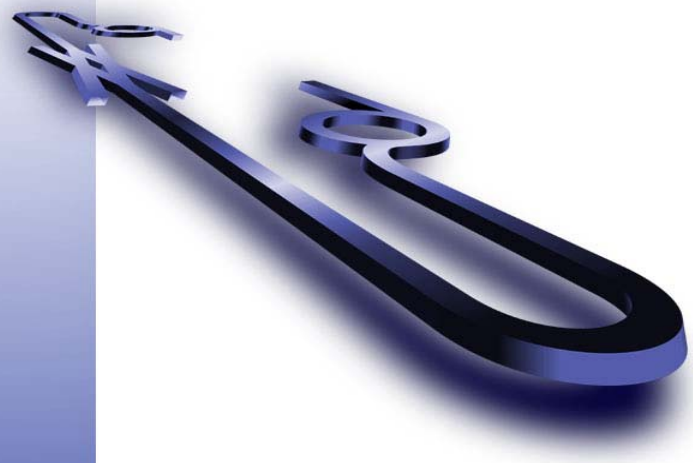

Acquisition of Diamond Ionization Signal Bunch-by-Bunch

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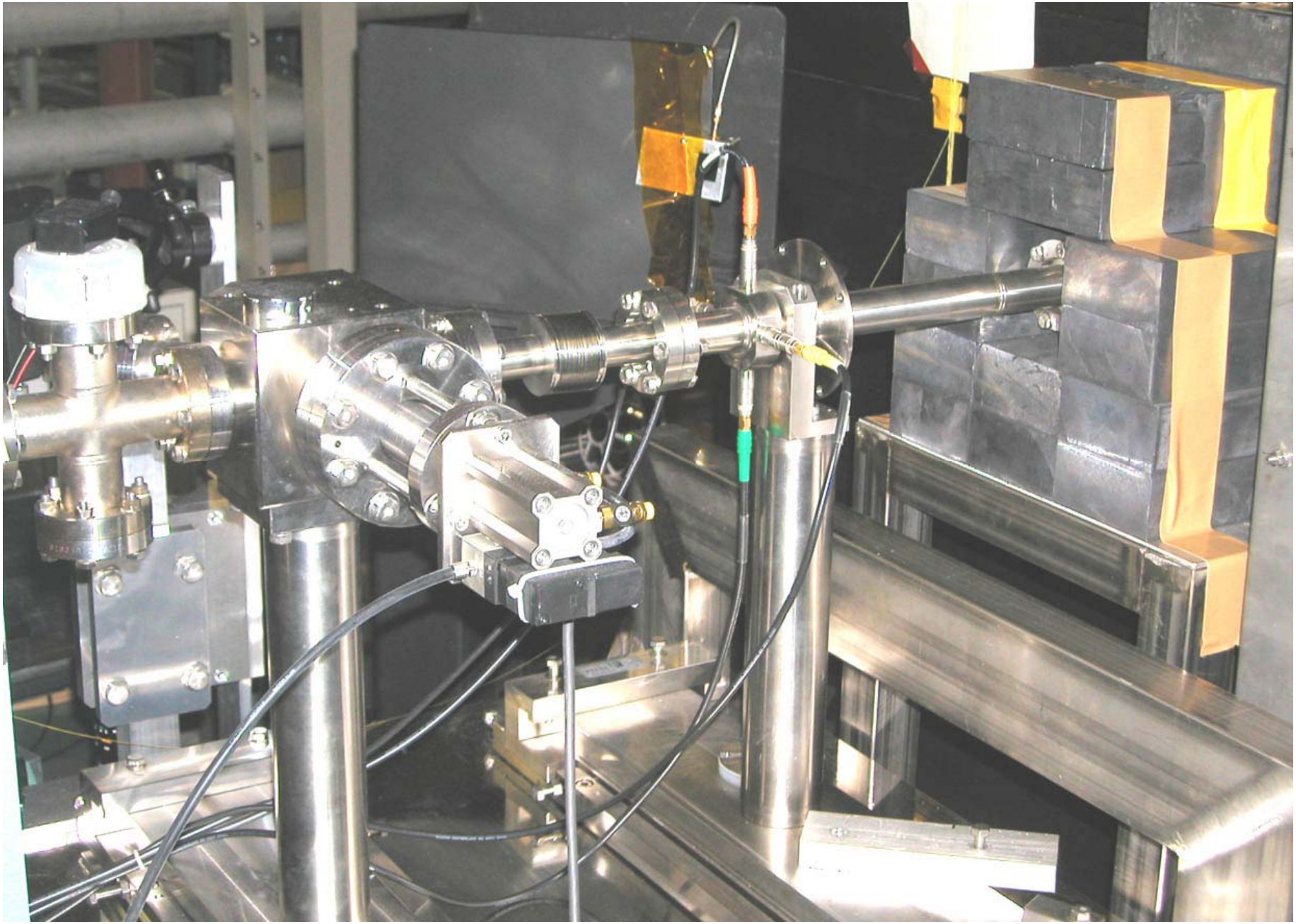
SLAC
June 17, 2004

Bunch-by-Bunch Forward Calorimeter

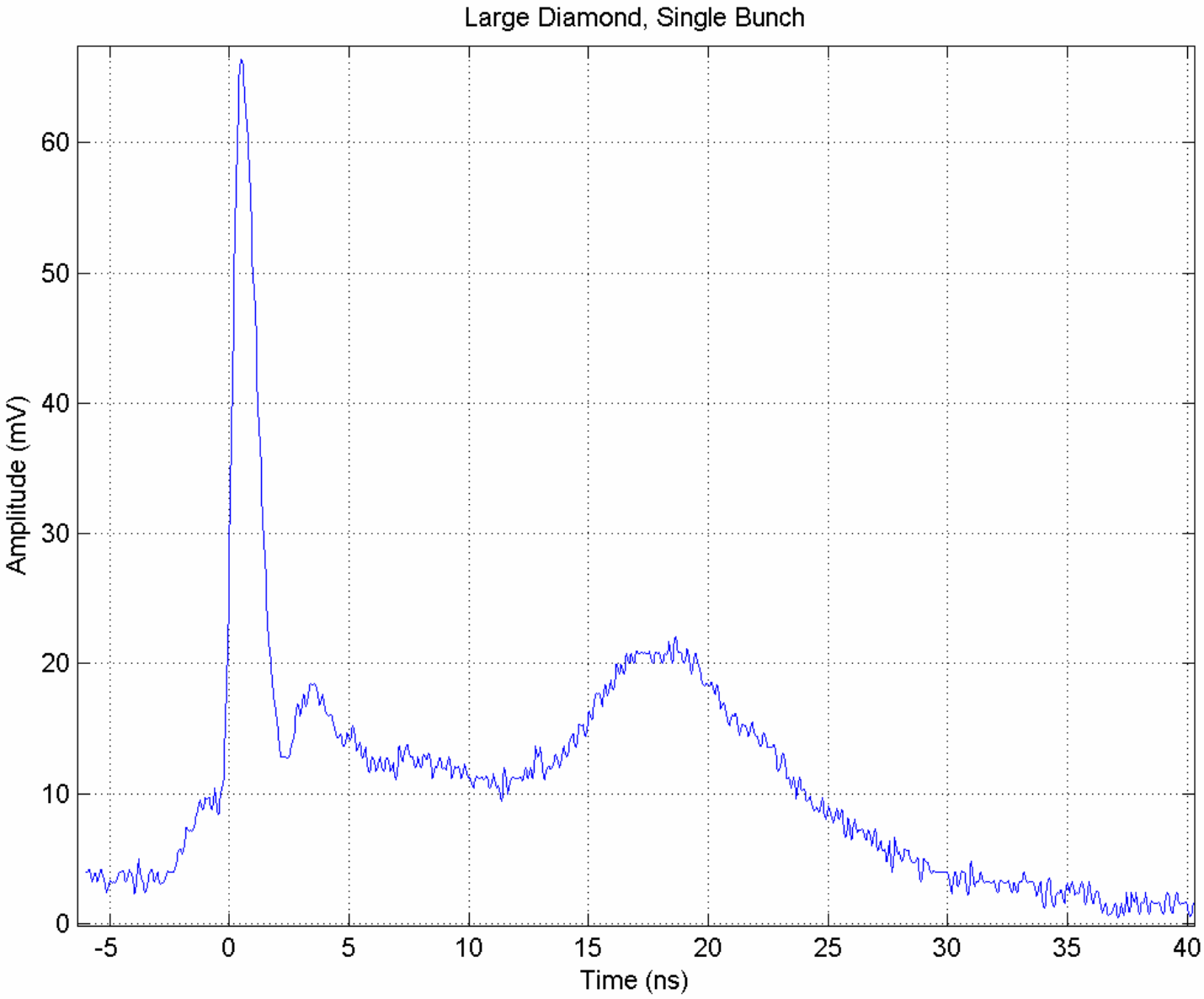
- Supersymmetry search requires bunch-by-bunch veto of energetic forward e.
- Large pile-up background of low-energy e's.
- Warm LC needs forward EM calorimeter which can cleanly separate 1.4 ns bunches in forward calorimeter
- Is sampling calorimeter with diamond readout fast enough?
- Check it out at KEK/ATF
- Single bunch / multibunch extracted beam
  - 20 bunch extraction at 2.8 ns bunch spacing

Large Diamond

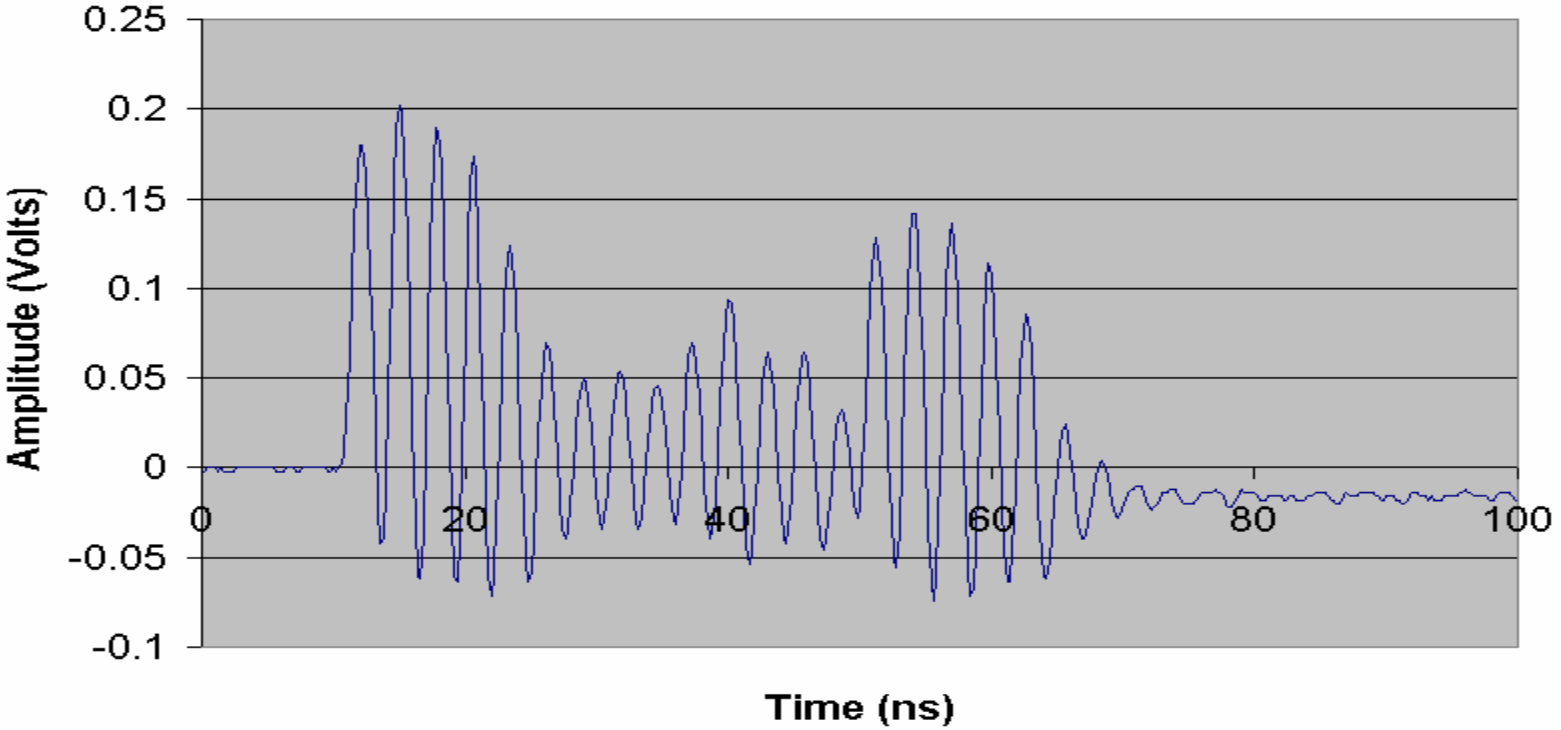
Beamline



Single Bunch, Large Diamond



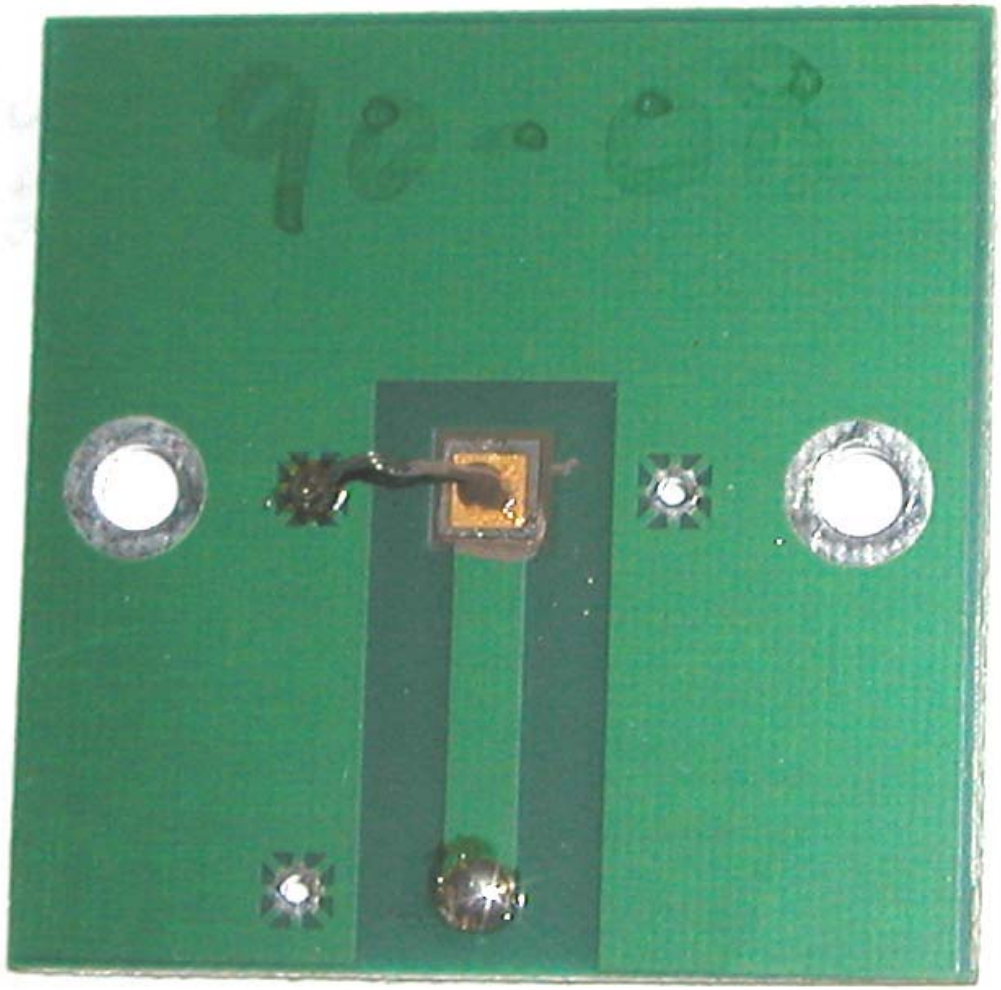
Multibunch



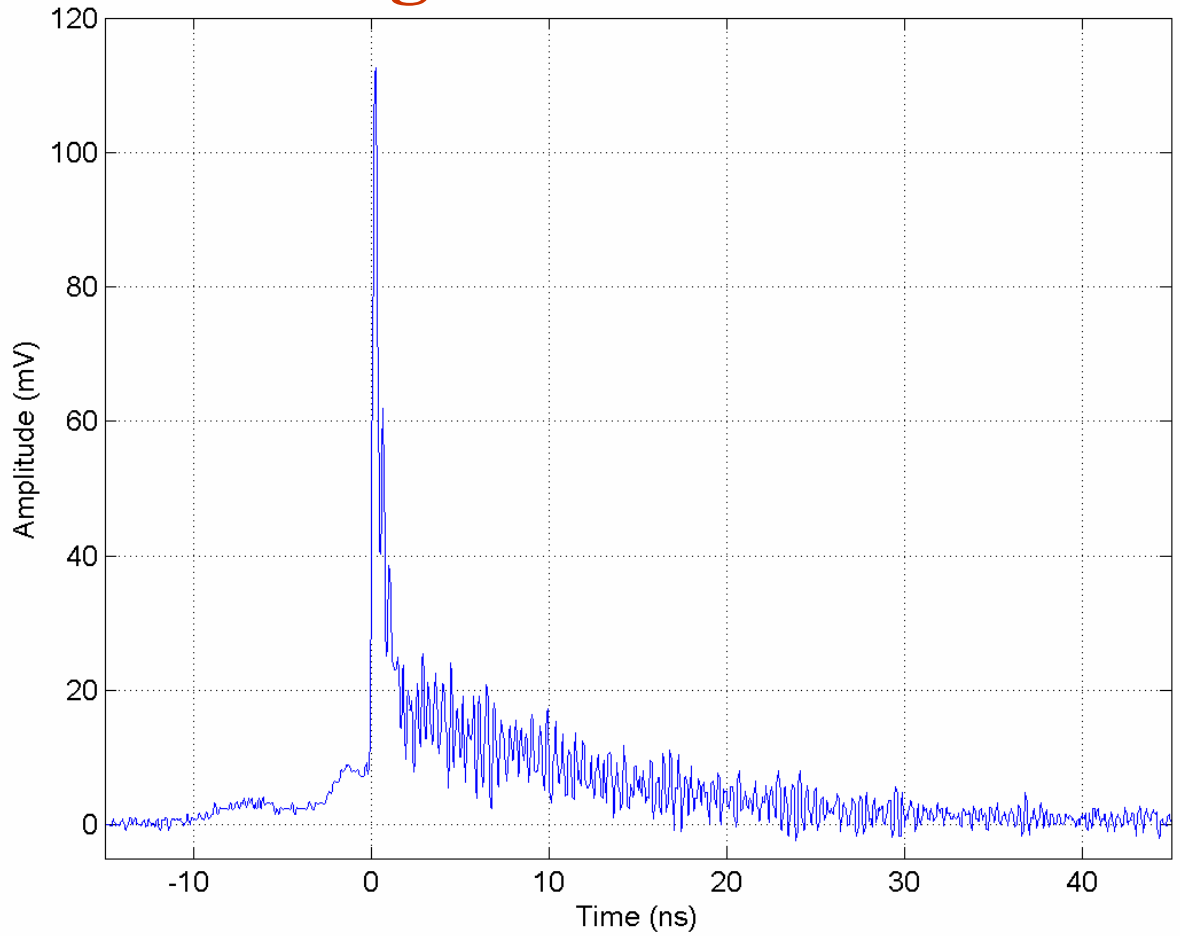
- ~20 bunches hitting scanning wire
  - Head and tail hitting wire more than center of train
- 2.8 nS bunch spacing
- 25mm x 10 mm diamond
  - High capacitance, significant inductance in wiring
- Limited by capacitance, inductance, 500 MHz Amplifier.

Small Diamond

- Small Sample
- 10 x10mm diamond film
- Electrode 9mm x 9mm
- Low capacitance ~ 10pF
- Low inductance
- Courtesy Y. Sugimoto (KEK)



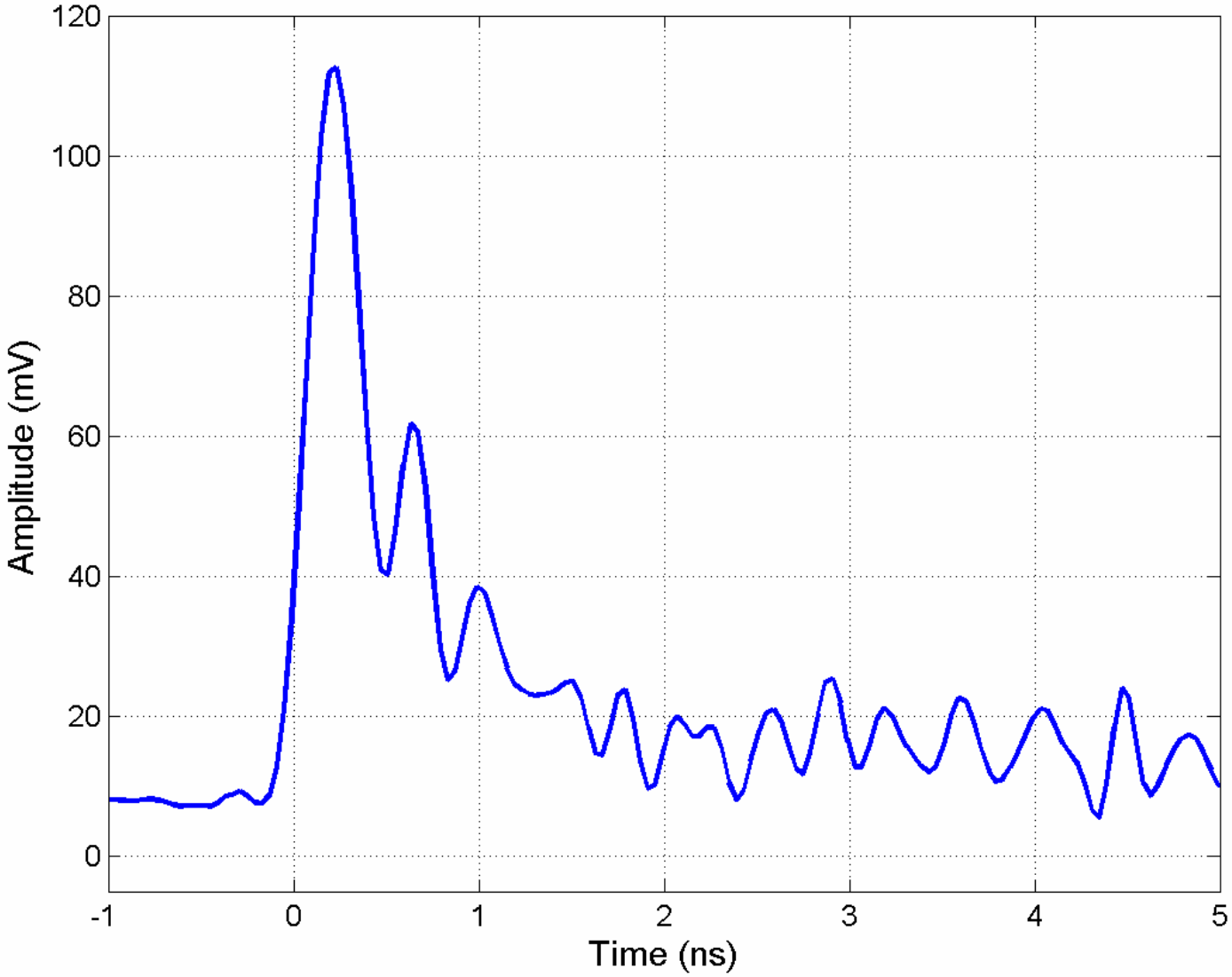
Single Bunch



- Bias 700 V
- Digitized on Tek 694 scope
- 10 G samples/sec
- 3 GHz bandwidth

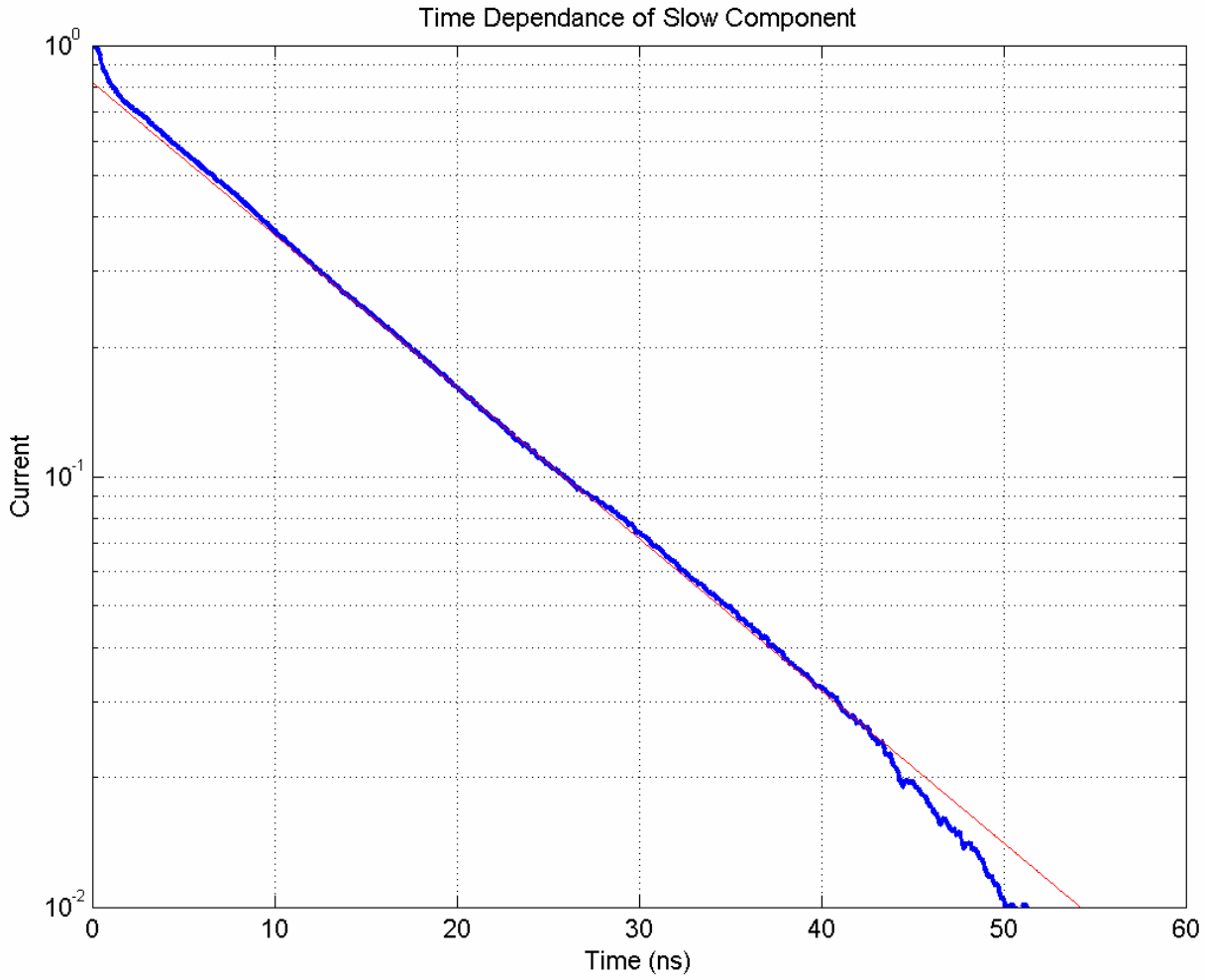
- Two stages of pre-pulse
  - ionization in cable?
- Fast central pulse
- Slow tail (~12 ns)
  - Trap/release?

Fast Peak



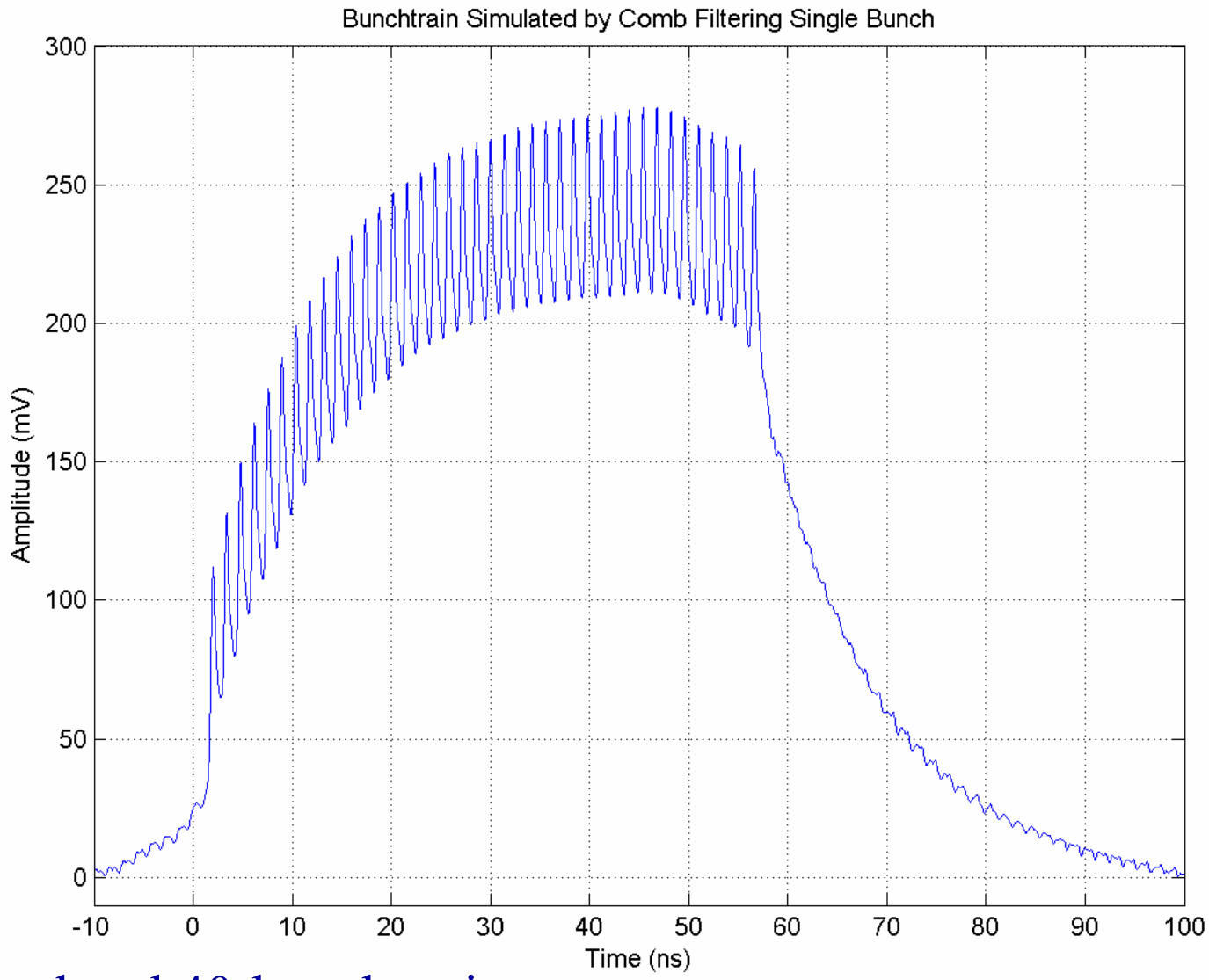
- Full width half max ~ 500 ps
- Consistent with 10 pF x 50 Ω
- Ringing @ 2 GHz may be from contact wire loop inductance

Fast / Slow Component



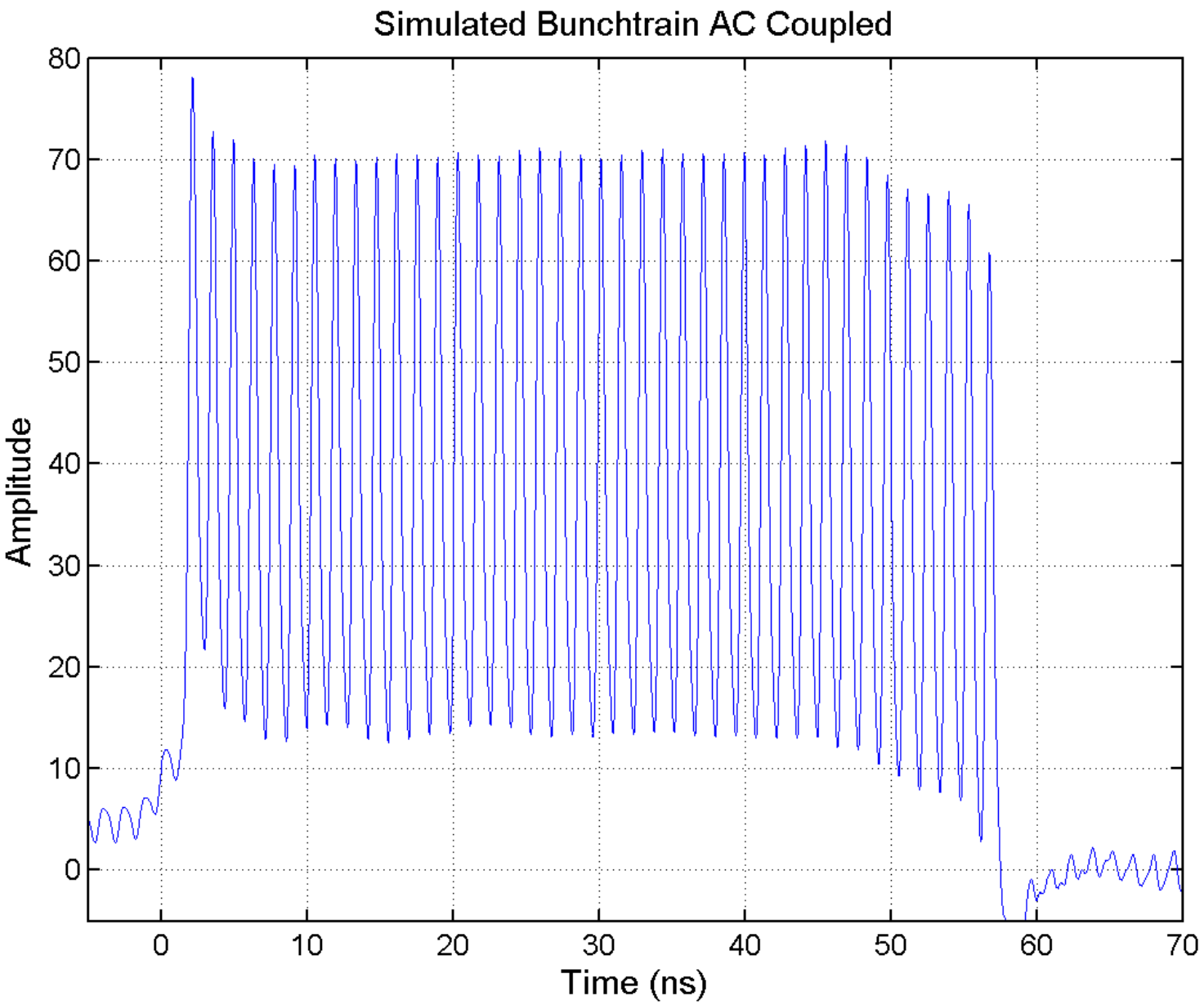
- $\tau_{fast} = 0.5$ ns
- $\tau_{slow} = 12.2$ ns

Bunchtrain



- Simulated 40-bunch train
- Convolution of Single bunch response with 1.4 ns comb filter

Bunchtrain, AC Coupled



Diamond Calorimetry Results

- Pulse has a fast component
- It may have a slow component
  - Or we may be seeing backscatter, etc.
- If there is a slow component,
  - Is it due to trapping?
- Then might use higher quality material (low trapping)
  - In thin layers (100 microns) for speed.
- Readout at lower impedance for speed.
- Even if slow tail is fundamental, an appropriate high-pass filter cleanly selects fast component.

Conclusion

- Diamond sampling calorimeter appears to meet needs
- Silicon may still be better
  - Ease of fab
  - May be sufficiently rad-hard
  - May be fast enough