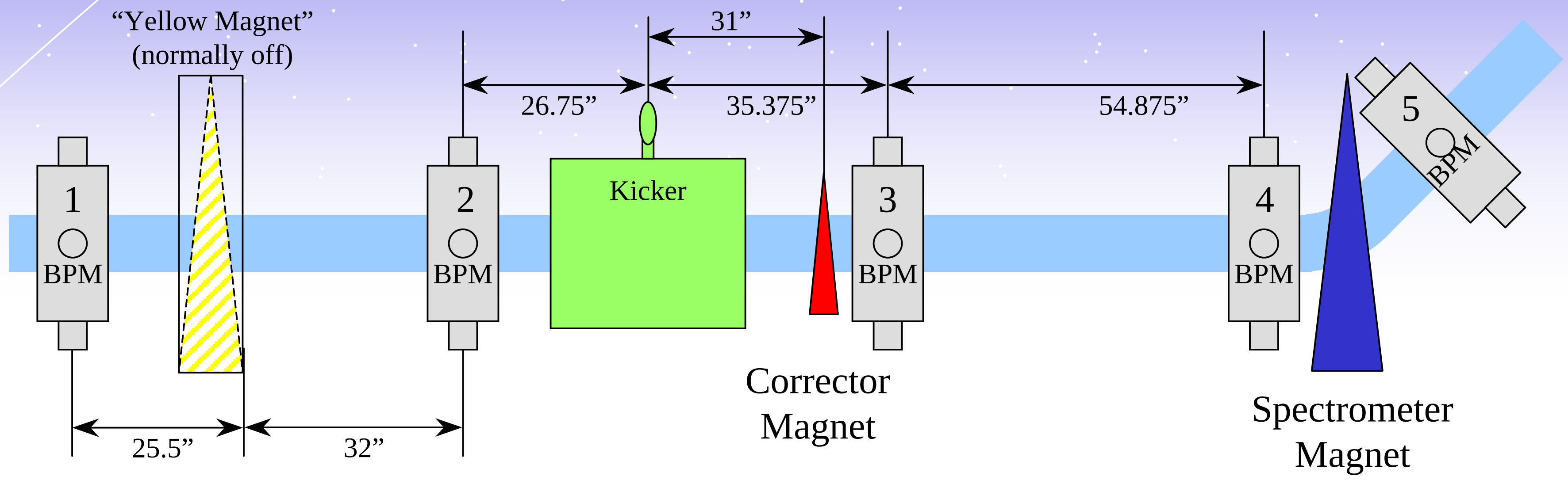
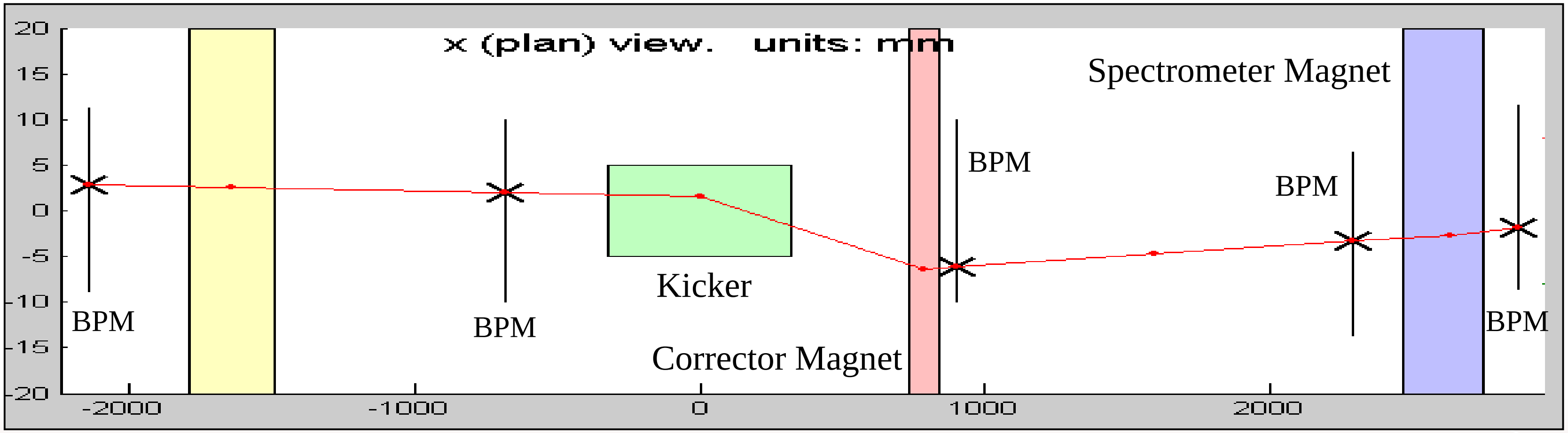
Damping Ring Kicker Tests at AØ

George Gollin
Department of Physics
University of Illinois at Urbana-Champaign

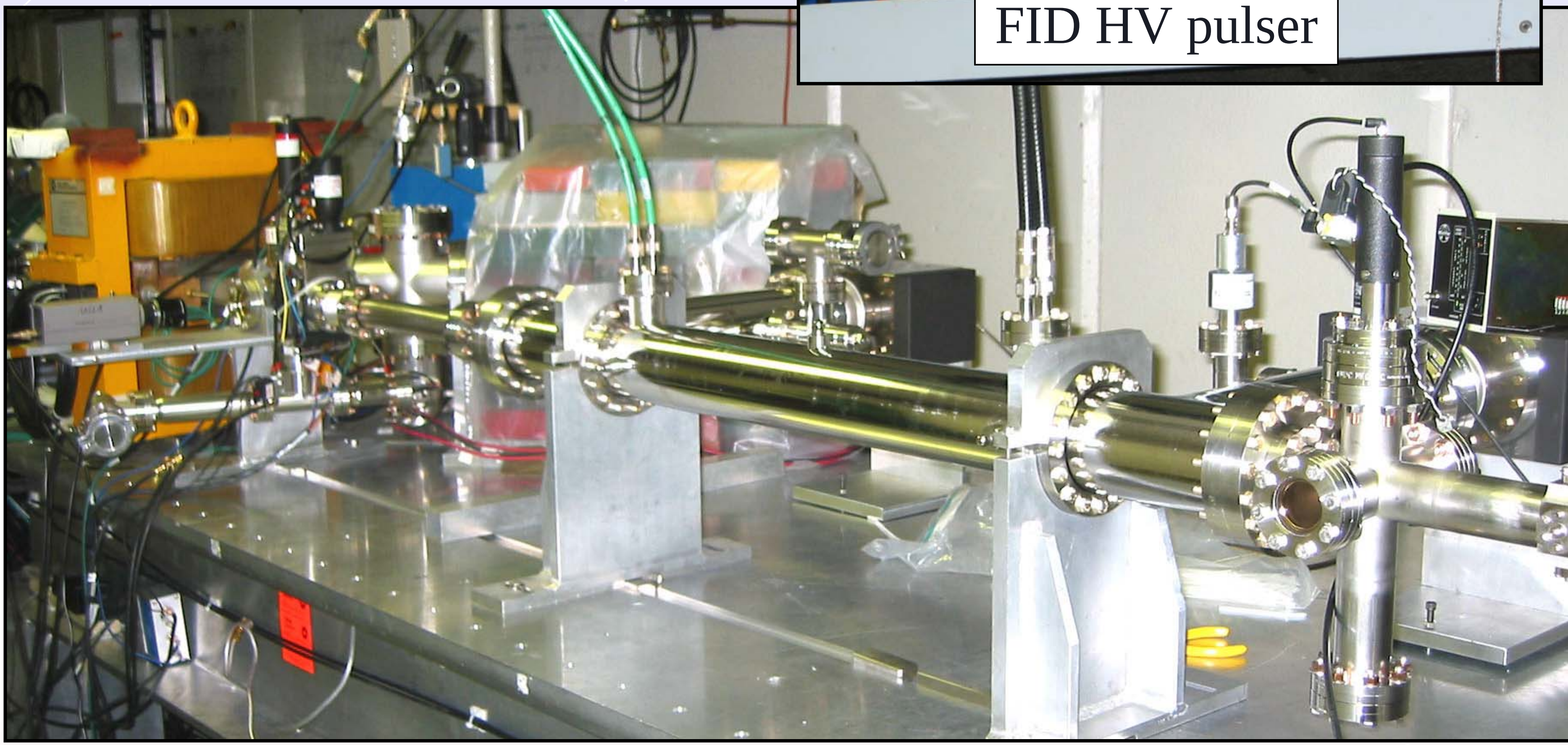
g-gollin@uiuc.edu
+1 217 333-4451

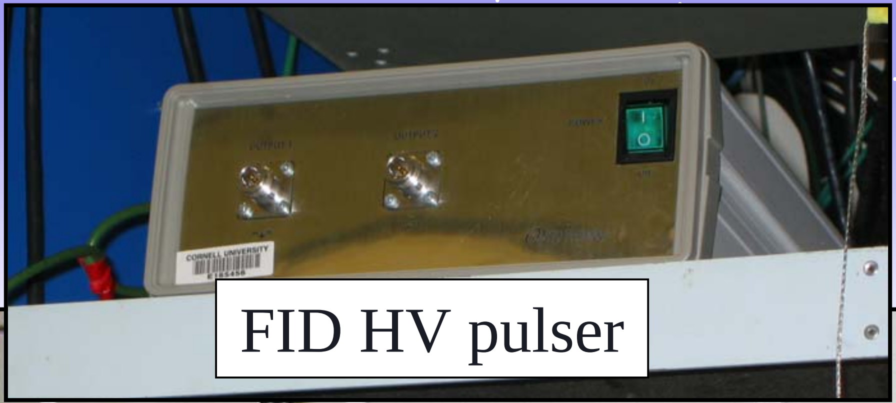
Kicker and AØ 16 MeV electron beam layout





Kicker installed at AØ





FID HV pulser

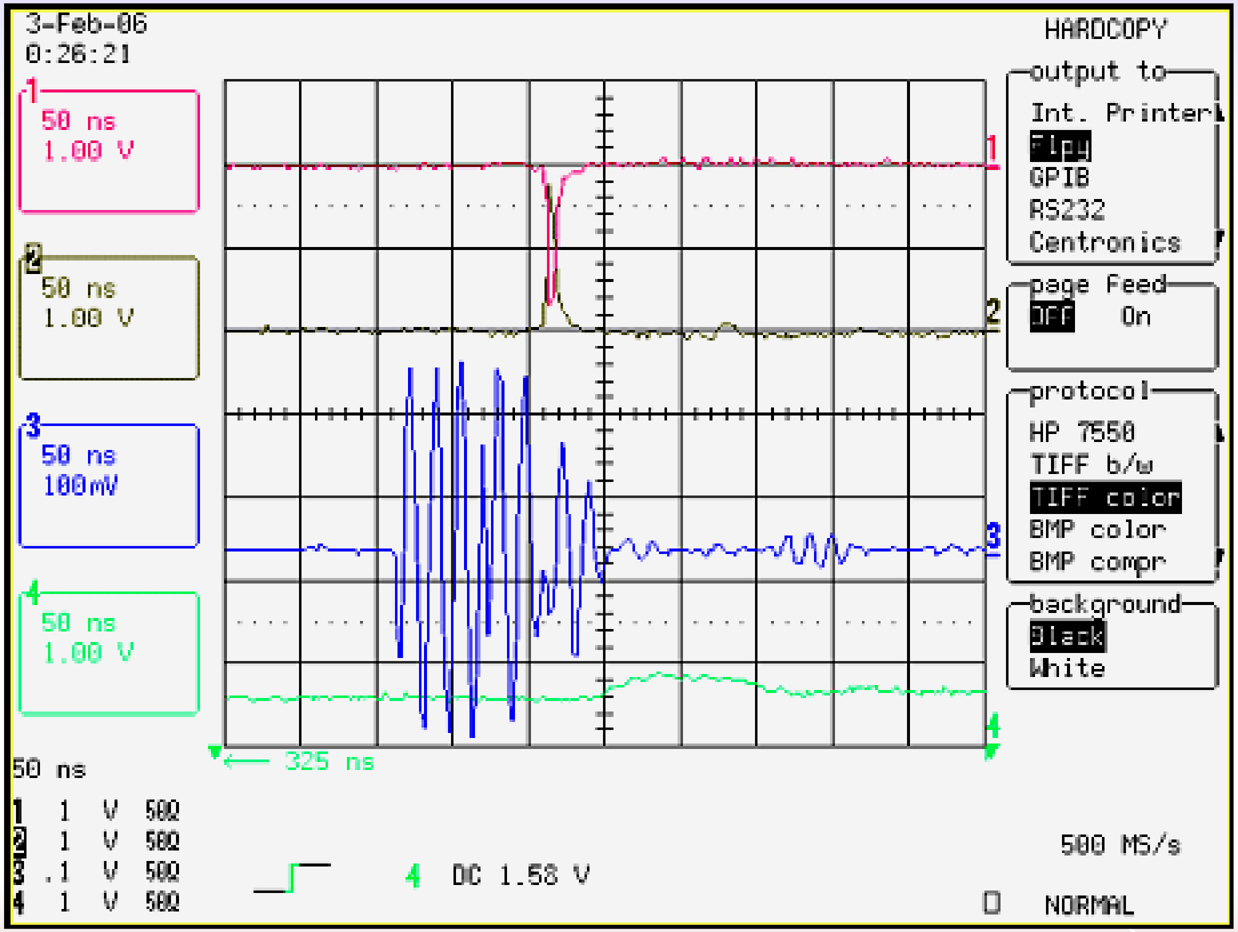
Data

BPM information read by DAQ, written directly to event data record.

±FID pulses digitized after leaving the kicker and passing through soft cables.

Phase detector signal mixed with 1.3 GHz RF, then digitized.

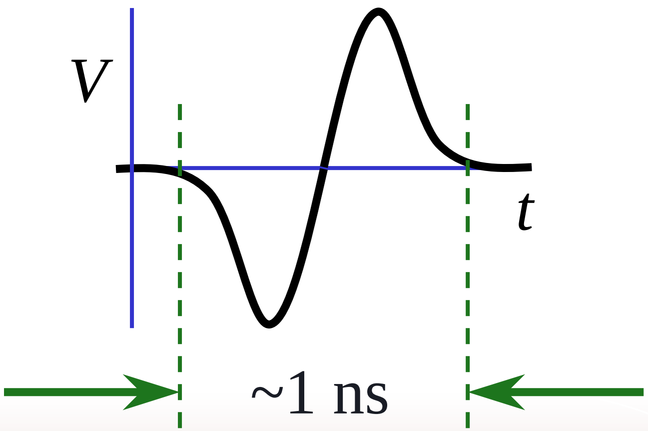
500 MHz scope data read, then written to event record.



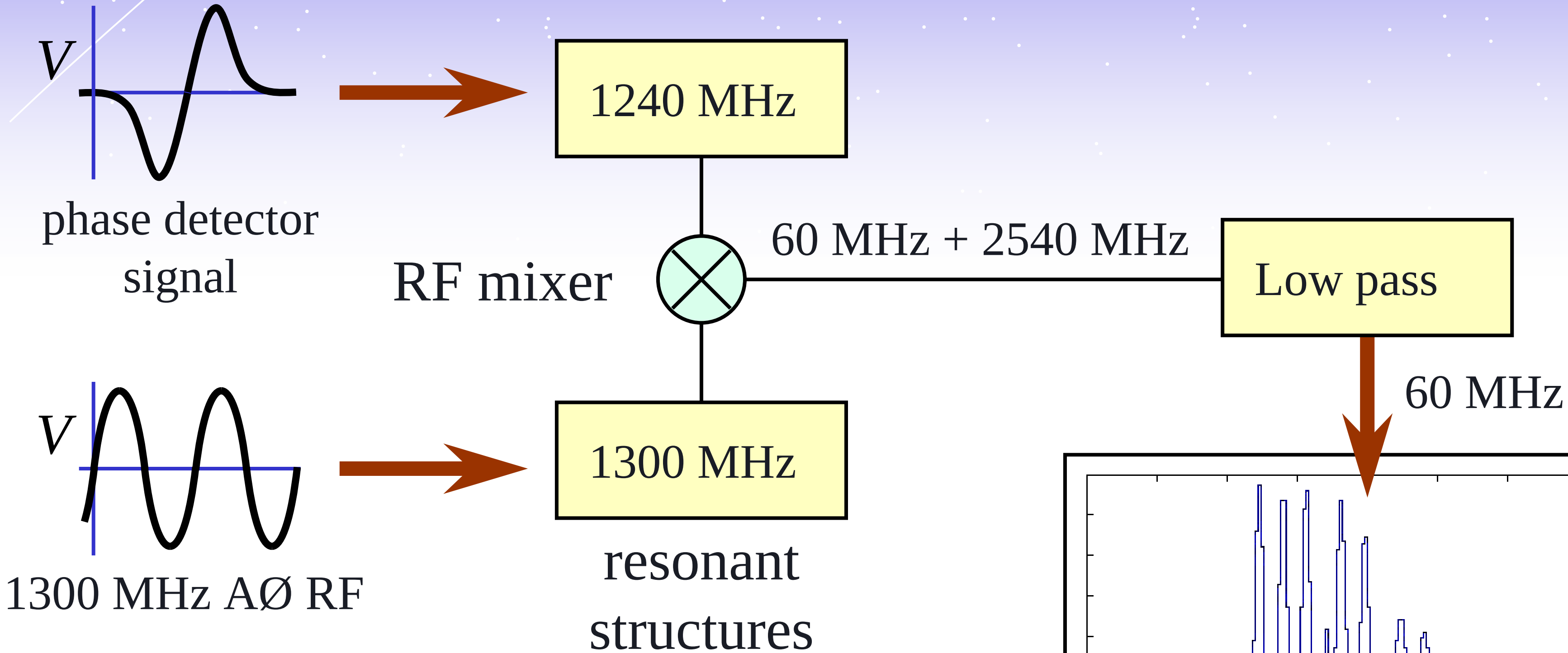
Phase detector: precision measurement of bunch arrival time

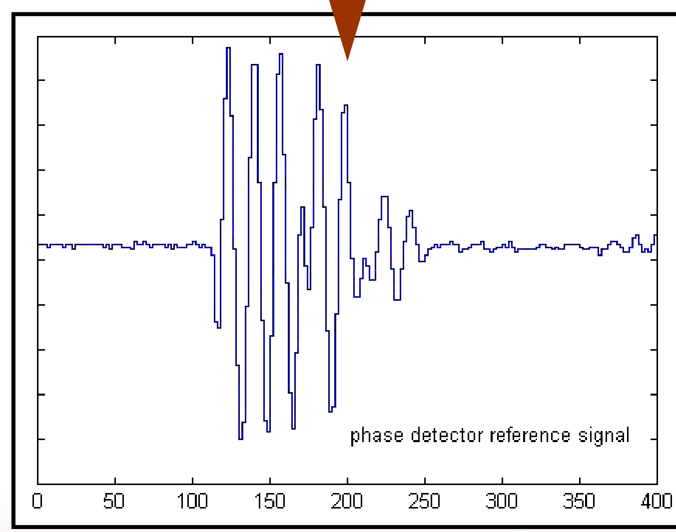
The device produces a very short bipolar signal when a bunch passes through it.

Dispersion in a coaxial cable broadens the signal to a full width of ~1 ns.



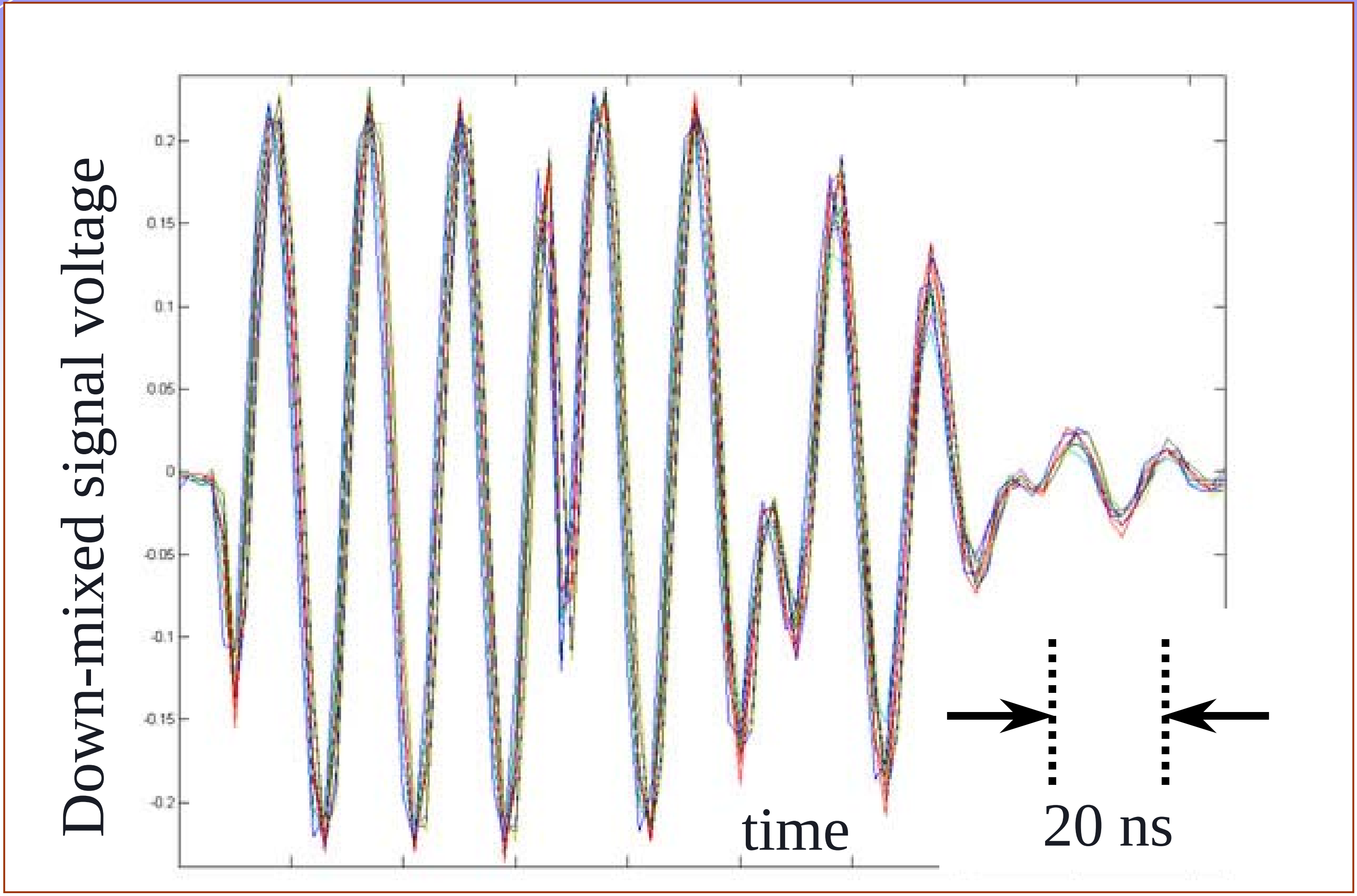
Phase detector signal path





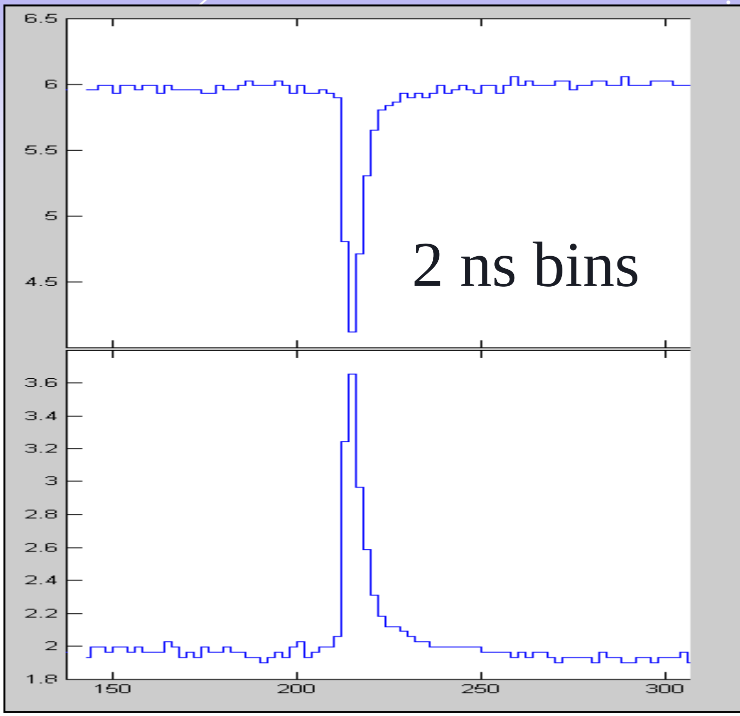
$\Delta\phi = 21.6°$ at 60 MHz (1 ns) maps into
$\Delta\phi = 21.6°$ at 1240 MHz (48.4 ps).

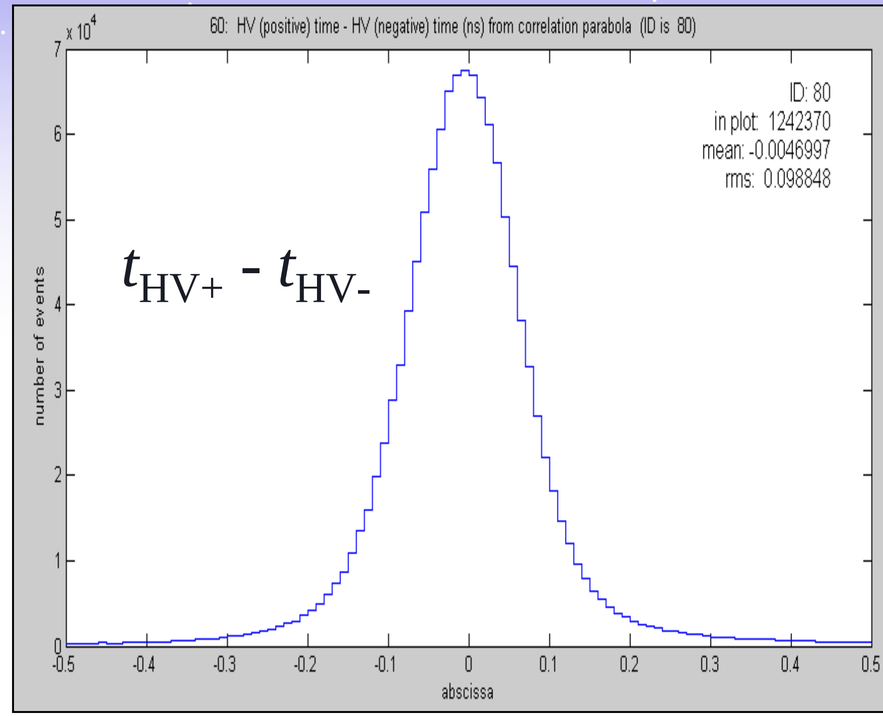
Phase detector AØ data



We can probably determine the relative start times for each of the displayed signals with a precision of ~60 ps. That maps into a bunch timing measurement accuracy of ~3 ps.

FID HV pulser data

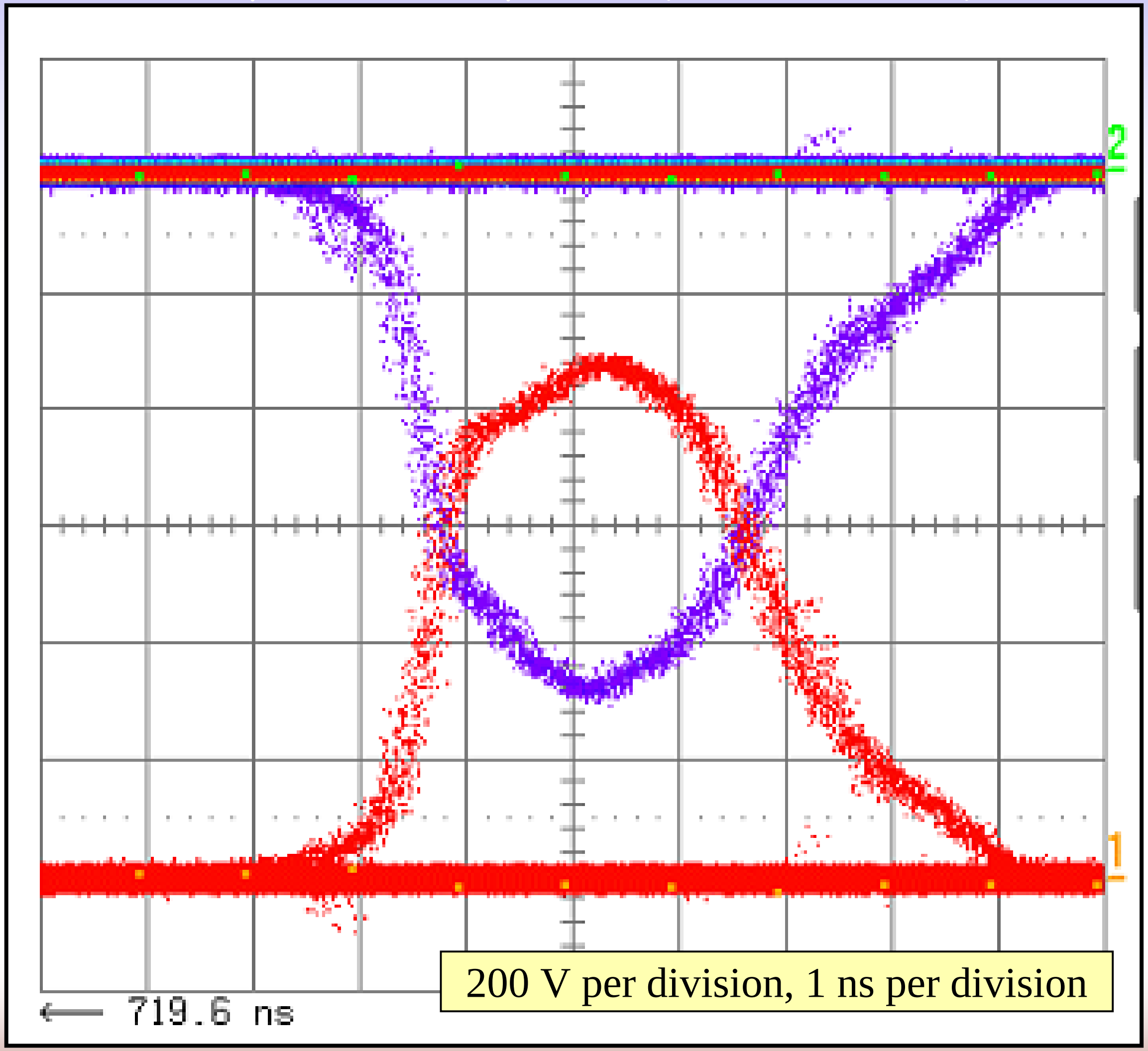




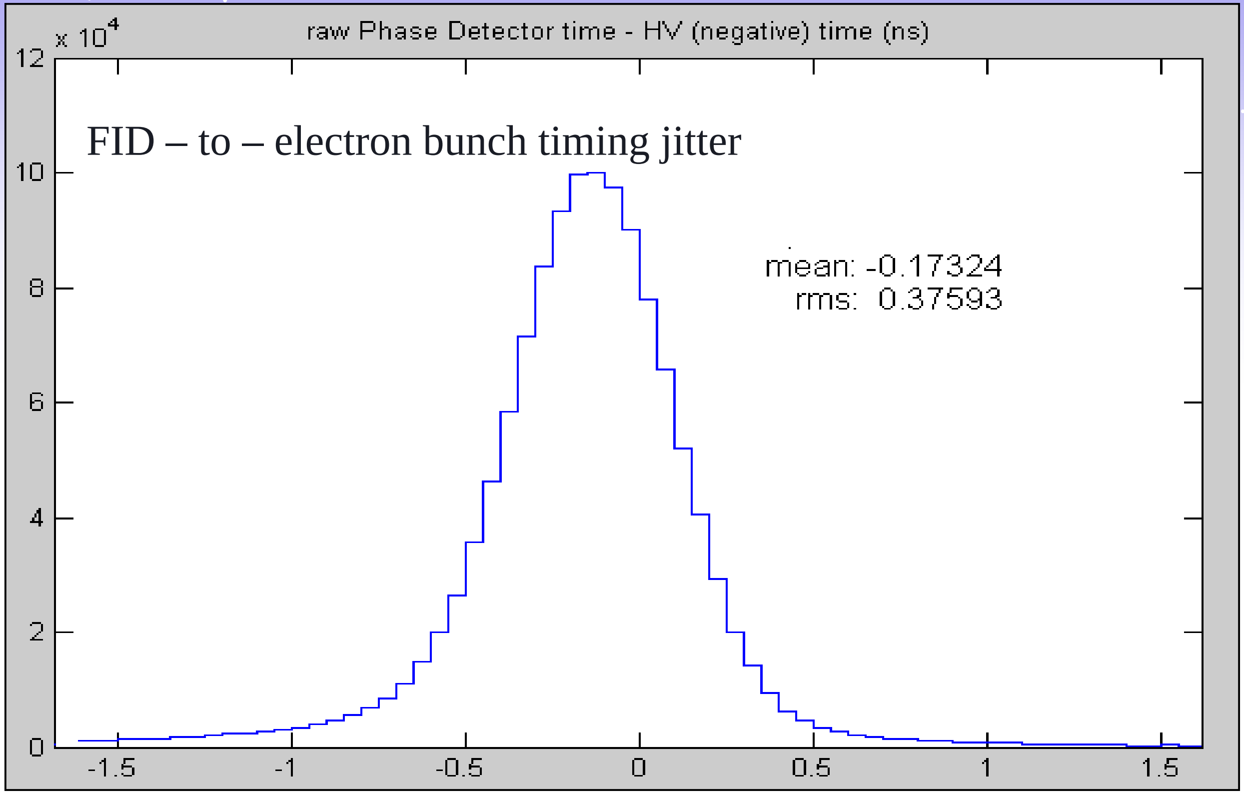
We can determine the relative times of the + and – kicker pulses with a precision of ~70 ps if all the jitter is due to resolution. (Even better if some jitter comes from the FID itself.)

FID HV pulse

±1 kV pulses, 1 ns per division.

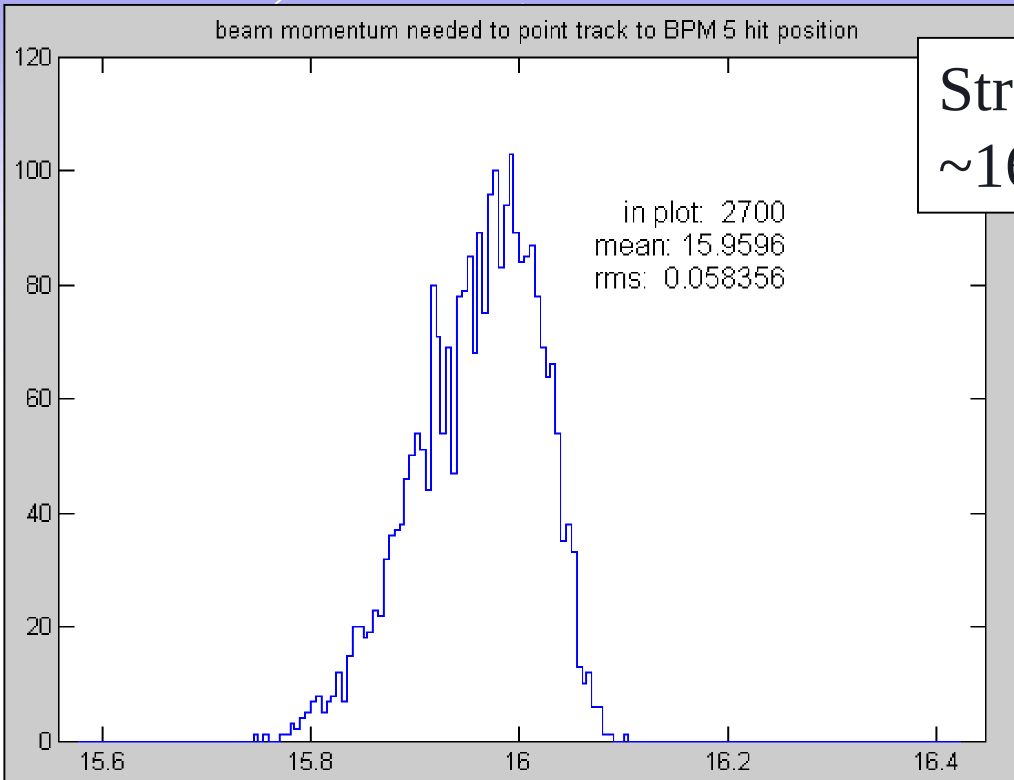


FID – to – electron bunch timing jitter

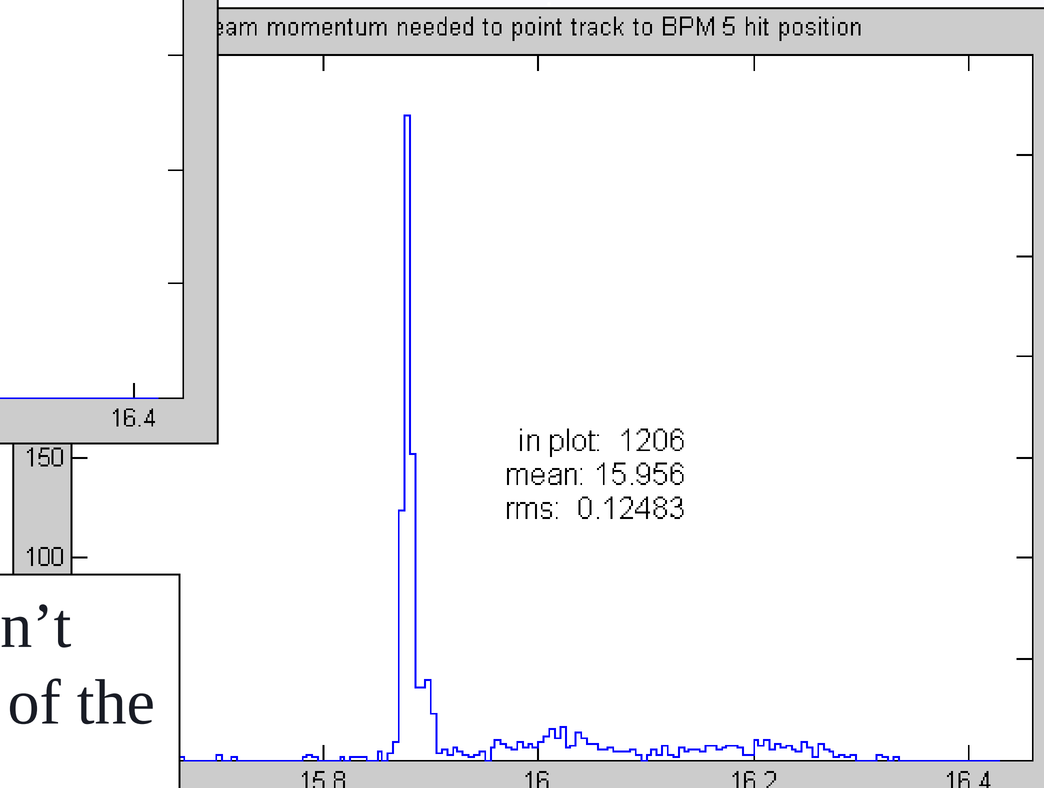


Jitter between raw phase detector signal and FID is ~375 ps. If all of this is due to bunch arrival time variations it corresponds to ~18 ps jitter in bunch arrival times. (Less if there are other sources of jitter such as the FID trigger circuitry.)

AØ beam momentum

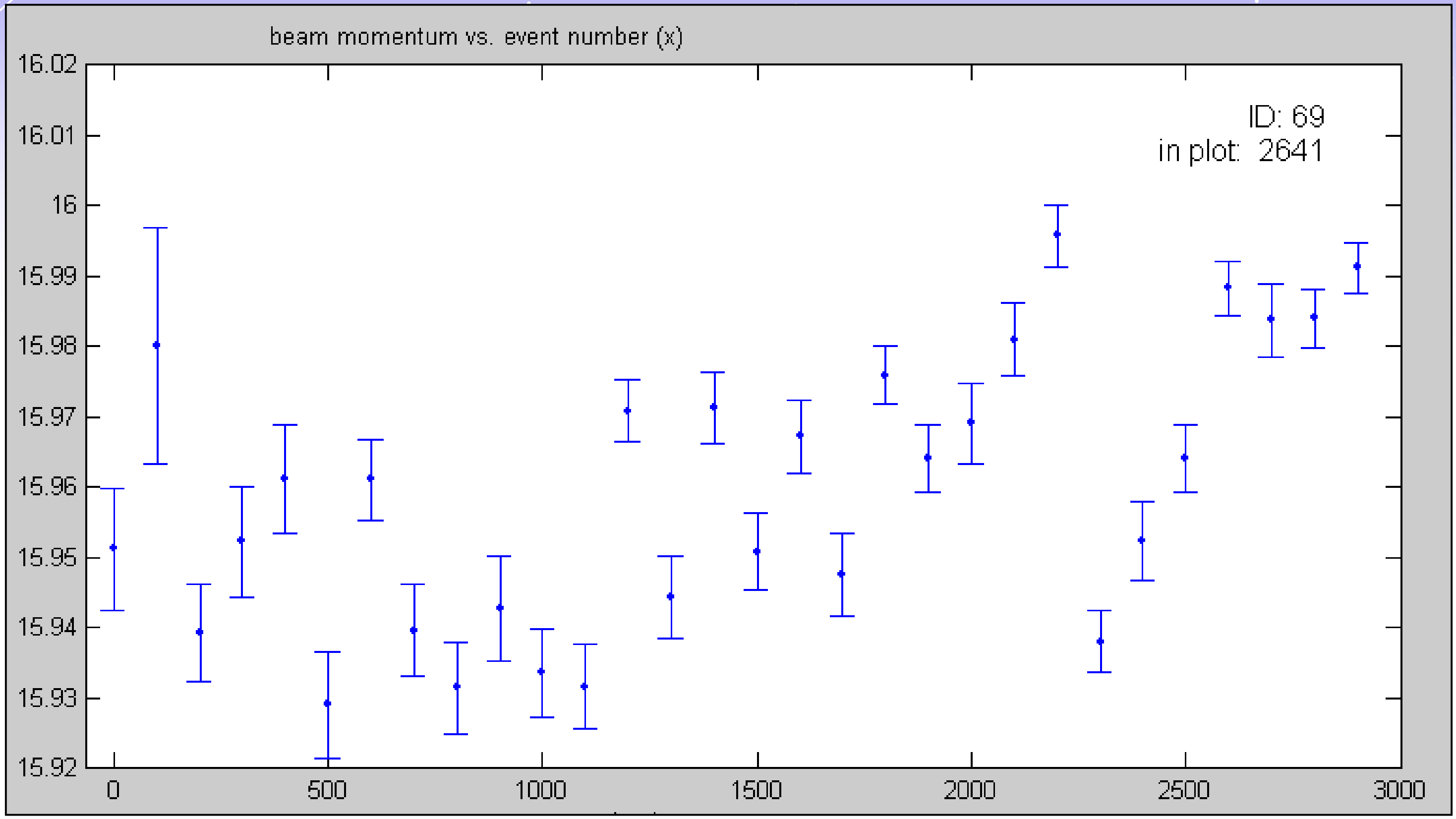


Straight-through run:
~16 MeV, 0.3% RMS width



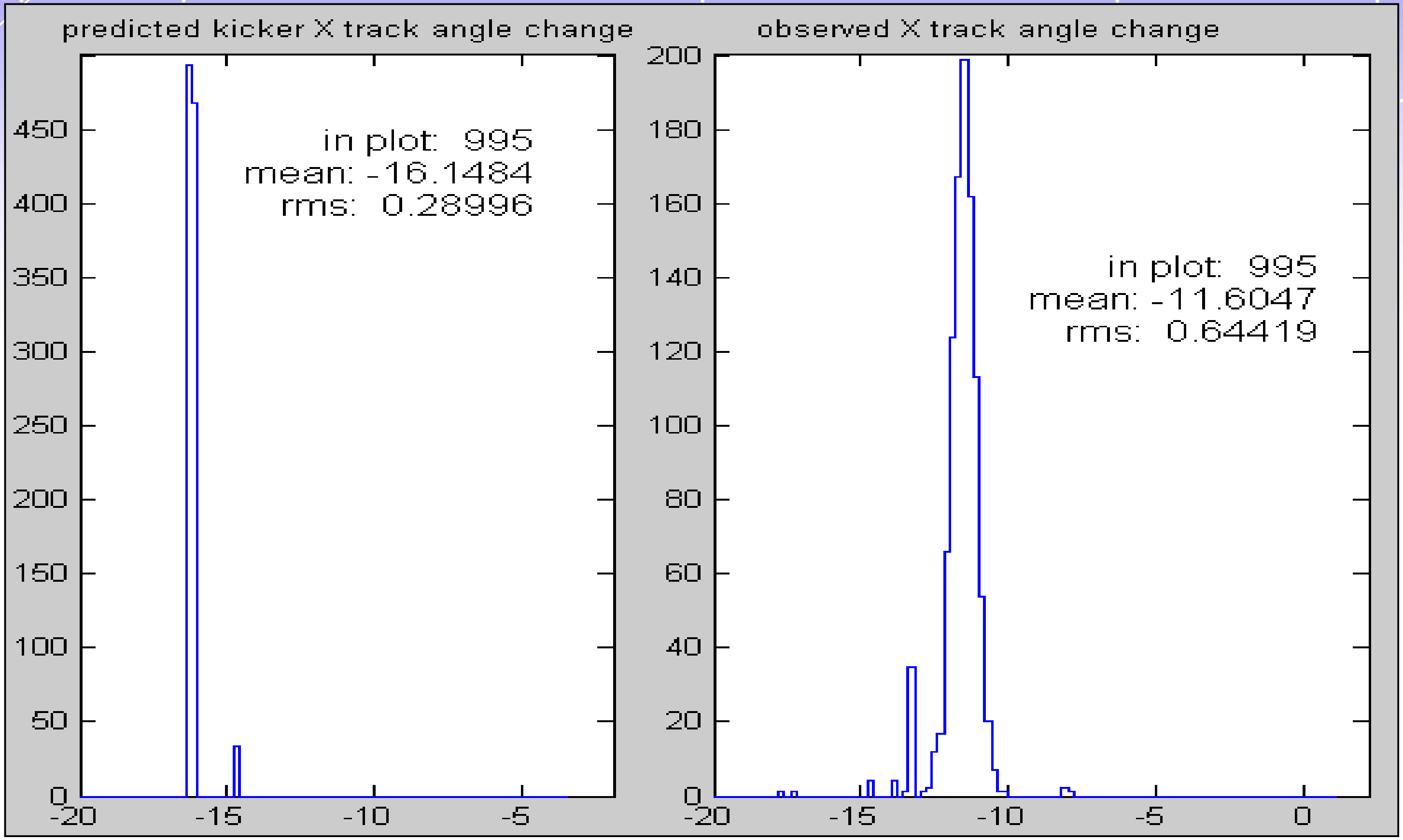
Everything on: we don't understand the origin of the anomalous tail yet.

AØ beam momentum



Straight-through run: average momentum per 100 events as a function of event number. It jumps around!

Predicted vs. measured kick (mrad)



We have some overall scale factors to work up, as well as a few details associated with the corrector magnet.

Why do this with a beam?

We can:

- test that the kicker really does what it is supposed to do, including problems from reflections and misterminations.
- test devices where the kick cannot be measured easily as a voltage on an oscilloscope (magnetic devices, RF devices,…
- study electrode geometries

AØ issues

- Low beam energy leads to sensitivity to small fringe fields
- Large kick angles are not characteristic of a 5 GeV beam, so geometrical issues will be different for the AØ and damping ring beams
- We need to understand kicker measurement sensitivities to the stability of AØ beam parameters better than we do at the present time.

Near-term plans

- Understand systematics of time measurements
- Fine-tune the AØ geometry used in event reconstruction
- Understand kicker measurement sensitivities to the stability of AØ beam parameters better than we do at the present time
- Map out FID timing and amplitude stability
- Begin modeling realistic electrode geometries
- Investigate possiblity of tests with other pulser technologies
- Investigate a reconfiguraion of AØ: redundant measurements; two phase detectors; higher precision BPMs; magnets with reduced fringe fields.
- etc.