Measuring Interbunch Extinction in the AGS Test Beam for RSVP Experiments

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KOPIO Microbunch requirements

- **Microbunch width, σ_{rms} < ~200 ps.**
- **Microbunch separation, Δ_t = 40 ns.**
- **Extinction (defined as flux integral between microbunches/flux in microbunch)**

  ε < ~10^{-3}.
- **(Sometimes quoted as rate out/rate in must be R < ~10^{-5}).**

Status of Studies

Took test beam data in June 2002 with a photon telescope designed to look at photons from secondary π^0 decays from ~10^{12} protons per spill.

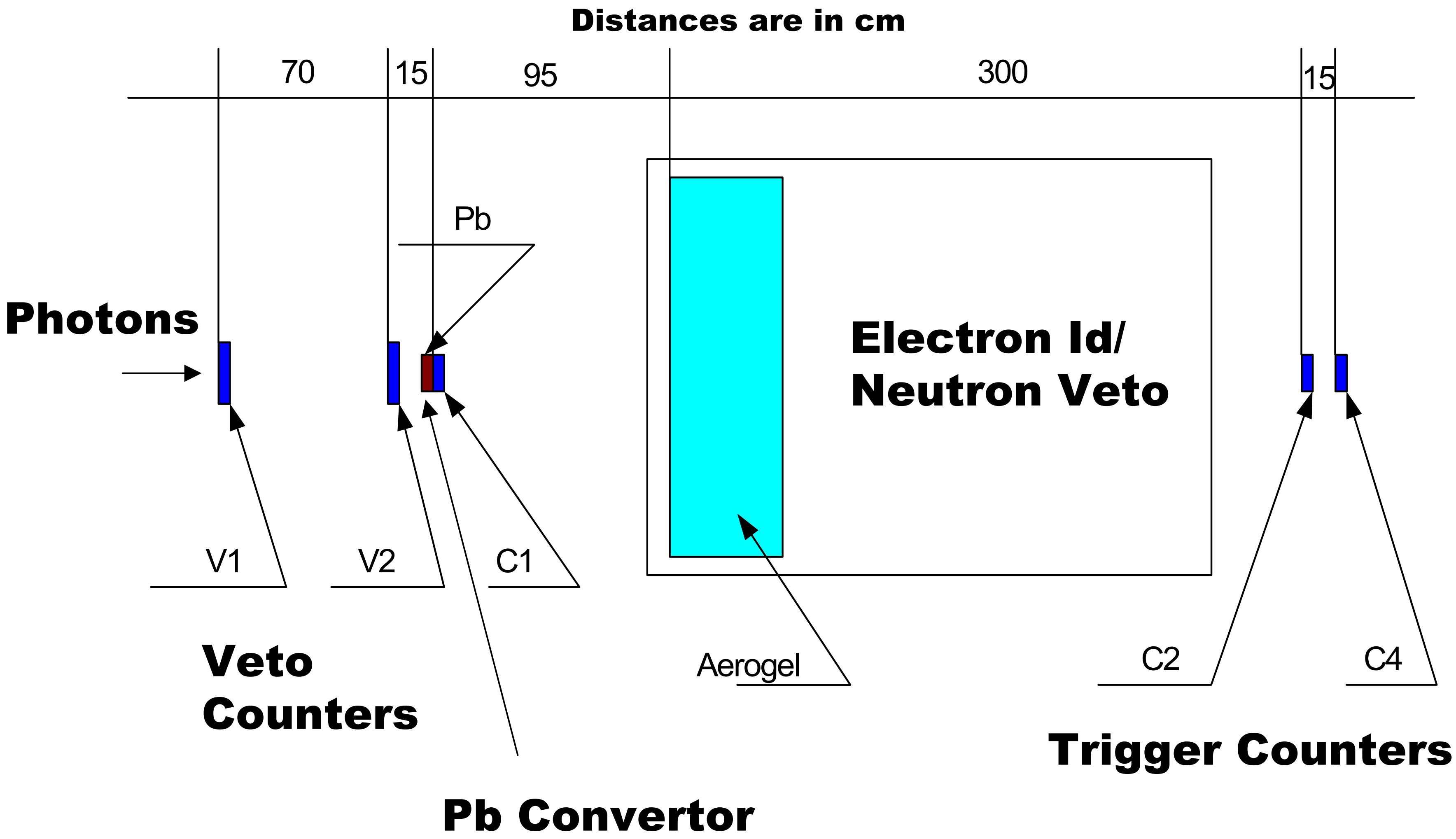
Measured microbunch width and structure.

Observed events between microbunches at the rate of ~1.5% of the On-Peak Rate.

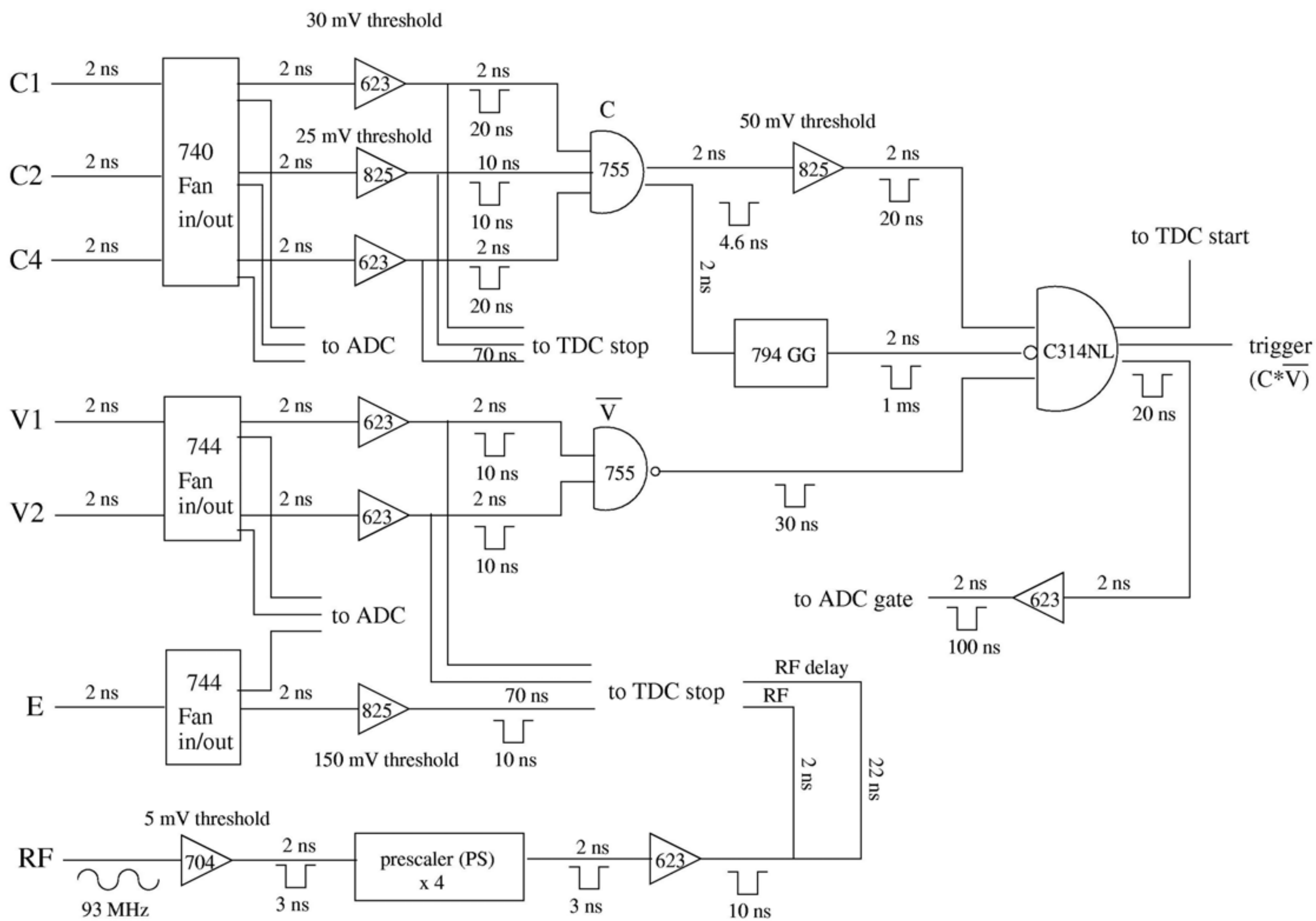
Need to understand whether these interbunch events are reflecting beam structure or are an artifact of the equipment/method.

RF Microbunch Test

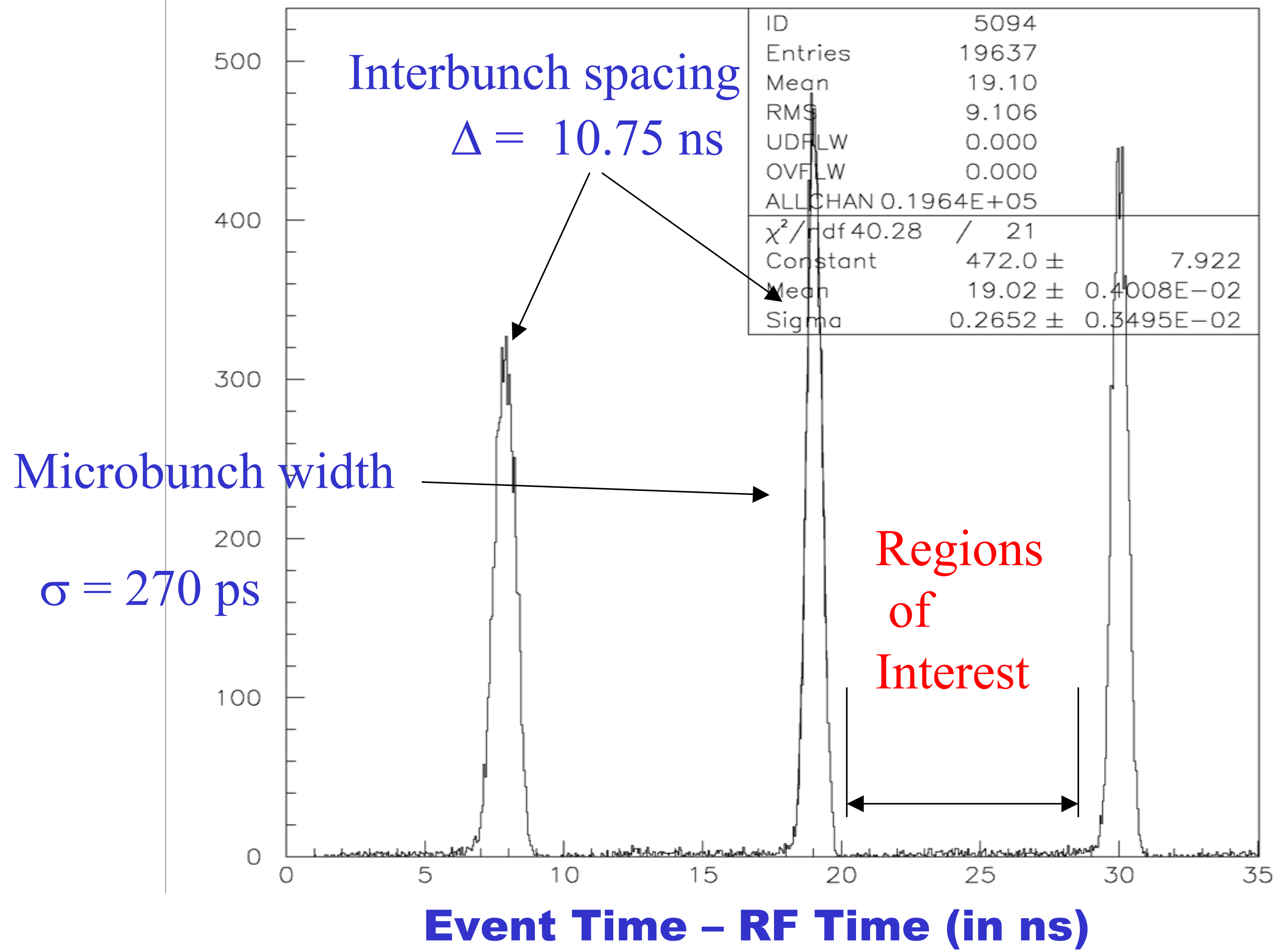
Telescope Schematic

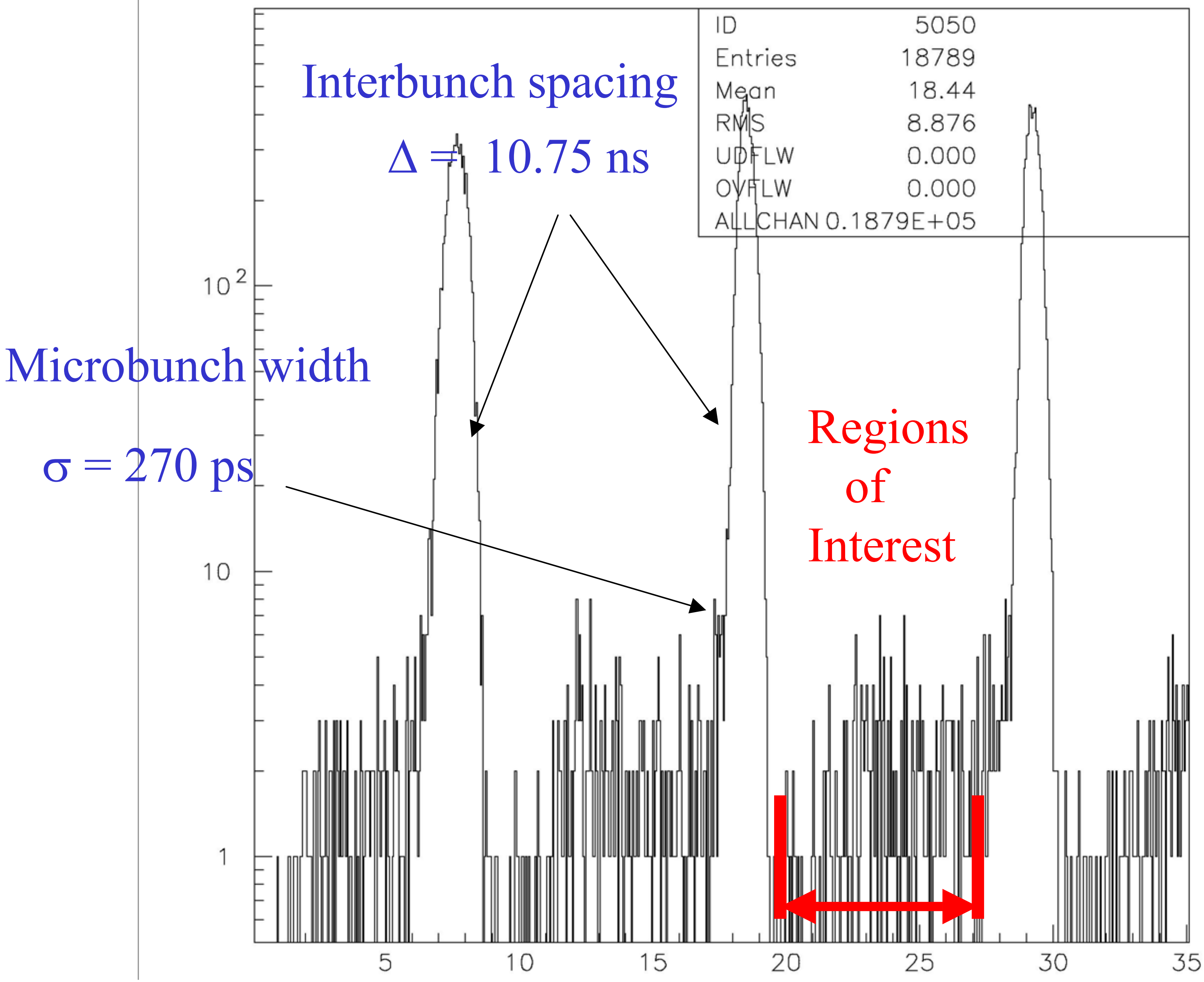


Trigger Logic



2002 Test Beam Results: 93 MHz cavity





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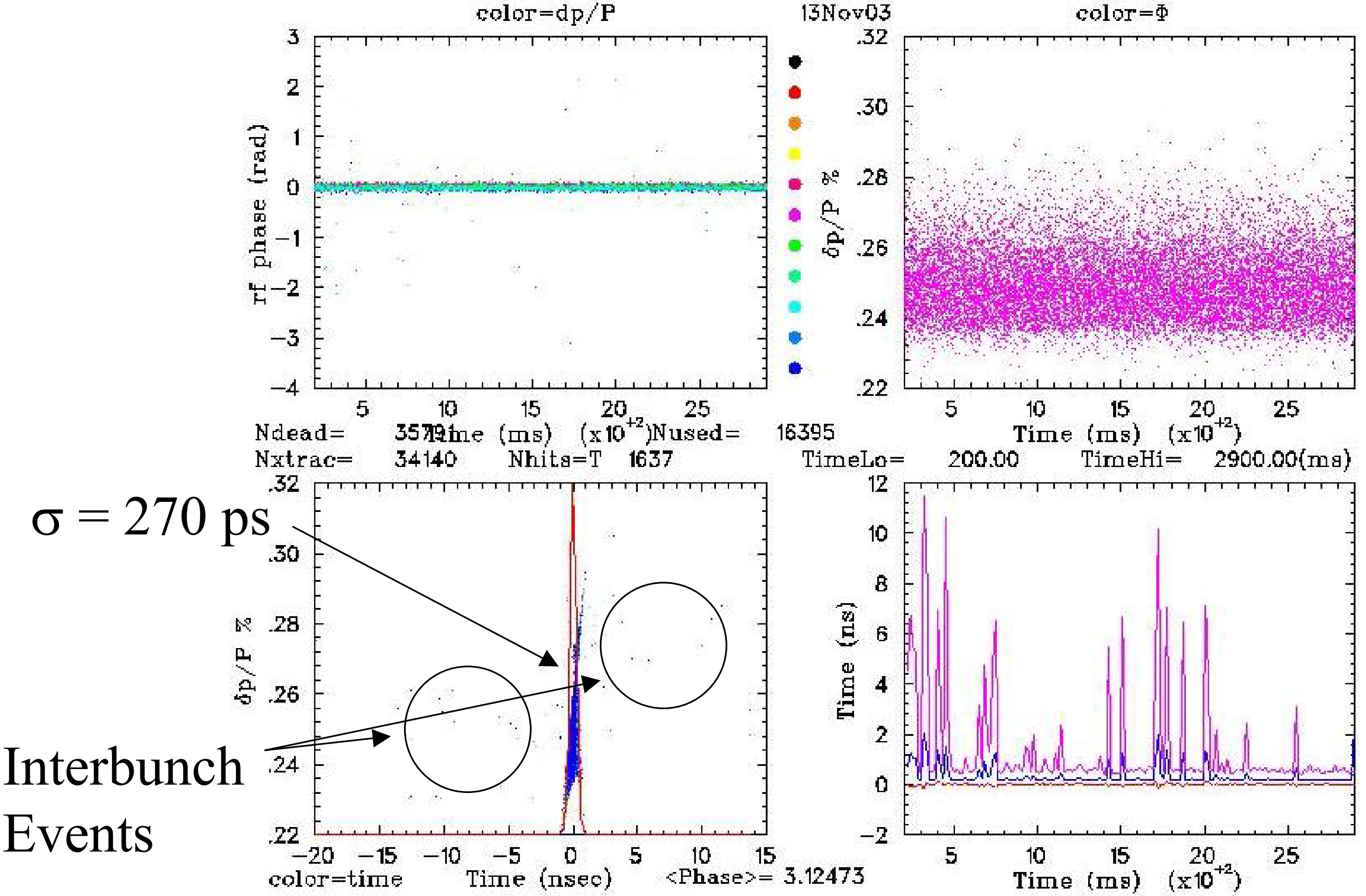


Microbunch width in ns **Time in spill, in milliseconds**

Output of SLEXPLOT, analysis routine for microbunch simulation
For 25 MHz cavity at 150 kV, 100 MHz cavity at 150 kV.

Statement of the Problem

How can we measure an interbunch event rate that is ~5 orders of magnitude below the peak rate?

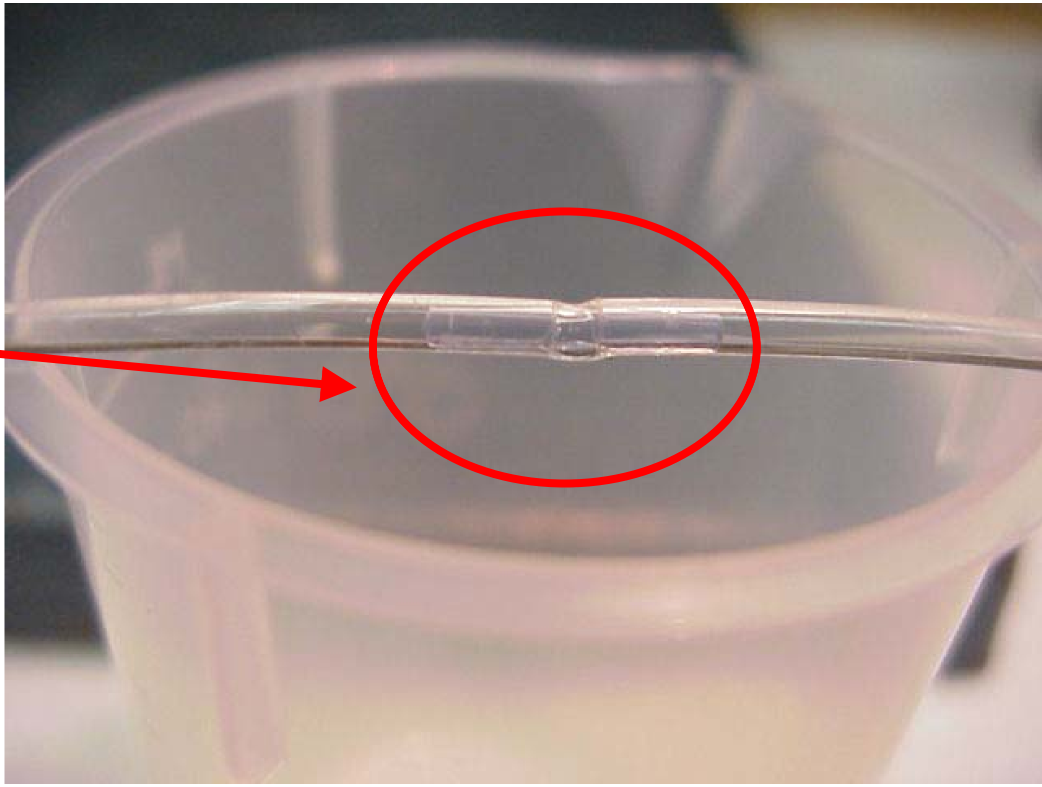
- Have low accidental/background rate!!!
    * high thresholds
    * multiple coincidences
    * measure the primary beam
    * good timing

Detector must be insensitive to cosmic rays, yet capable of measuring a single proton.

KOPIO Approach to a solution

Plan A:

Scintillating fiber
1 mm diameter
10 mm length
Aligned with beam
Double-ended readout

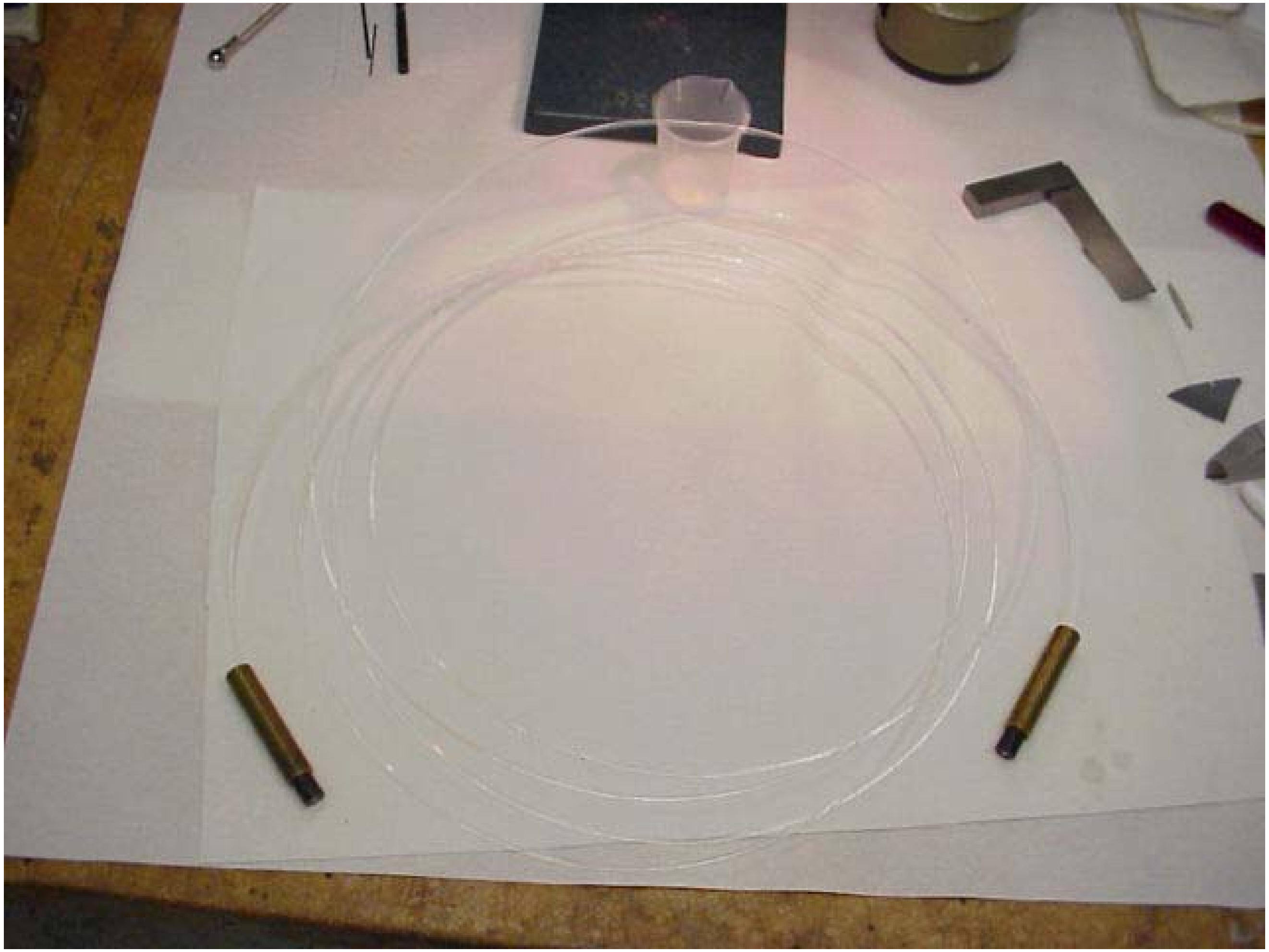


Signal level ~100 p.e.
Cosmic ray rate ~ 1/day

Keep out of the core of the primary beam!

Plan A (continued)

Mount the Sci-Fi inside a 2mm ϕ clear fiber to transmit the light to the two PMTs.



Detector Readiness

We have measured the PMT gain, and seen single photoelectron level response in the tubes.

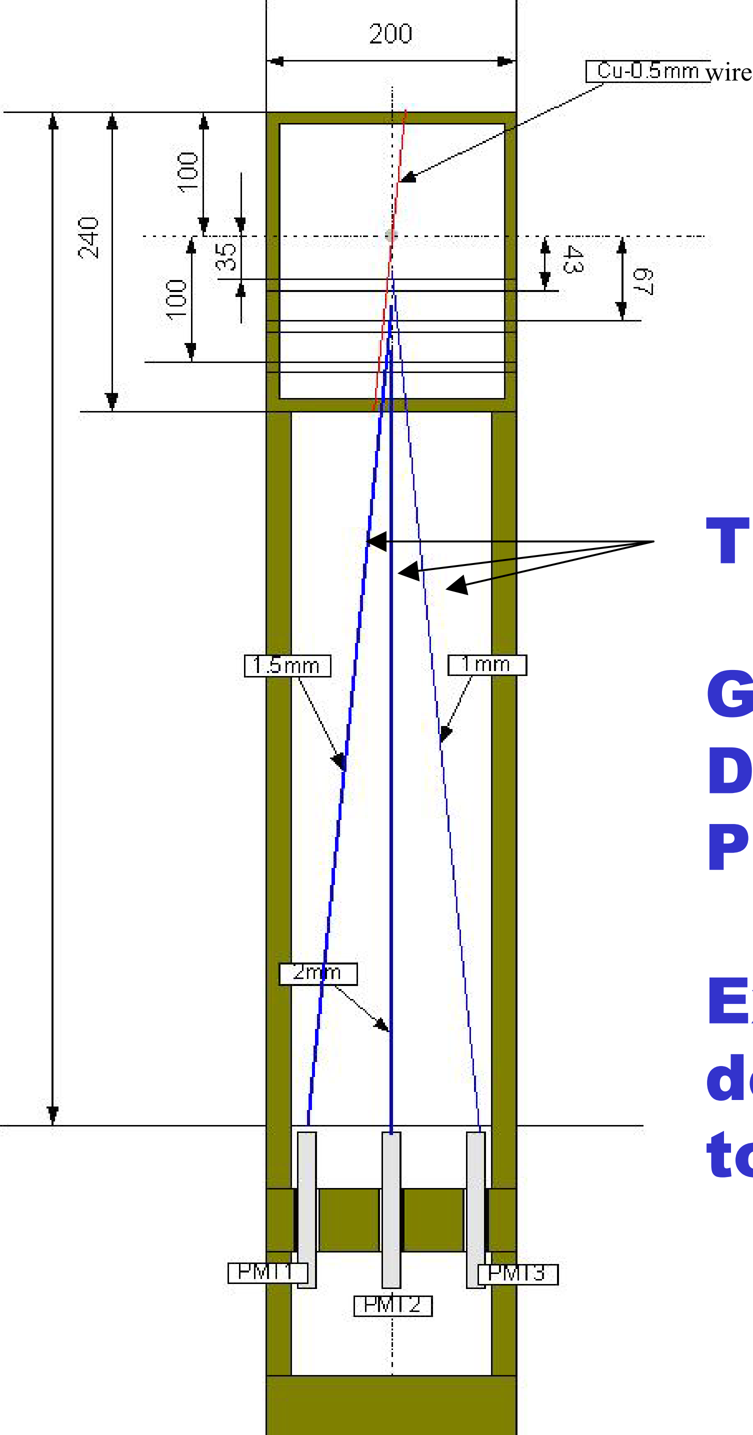
The trigger rate for cosmic rays with a discriminator threshold of ~2 p.e. is 1/day.

We have a scannable table that can move the fiber up and down, into and out of the beam, in order to adjust the rate of triggers.

We have a portable data acquisition system with ADCs, TDCs, and Scalers, in a VME crate and a LabView driver.

Plan B

- Is the time structure of the beam core the same as the time structure of the beam halo? **Backgrounds from beam scattering off residual gas can give late tails from stragglers that preferentially populate the halo!!!**
- Is the time structure of the beam intensity dependent? **Simulations say it should be!!!**
- What we would really like is a device that can measure the primary beam structure (especially extinction) in the core of the beam.
- Plan B attempts this by using a very thin wire target and observing the secondaries with 3 glass rod Cherenkov counters in coincidence. **Now we are looking at secondaries again…**



Plan B Detector

(all dimensions are in mm)

Target interacts ~10^{-4} of beam.

Glass fiber Cherenkov detectors
Diameters: 1.0, 1.5 and 2.0 mm
Pathlength through fiber: ~1 cm

Expect small solid angle of detector to reduce trigger rate to manageable level.

Run Plan for 2004

Set up for test beam running in the D-line at the end of RHIC running, ~ 15 June 2004.

Funding for ~15 consecutive shifts of running.

Ambitious program to study microbunch width effects as well as extinction. Lots of set-up and debugging time needed.

Max beam current ~1TPPP, (10^{12} protons per spill).

Expect data rate of 10 kHz – 100 kHz.

Look at extinction from 4.5 MHz cavity and 93 MHz.

This will probably be the beginning of a long study…