Muon Lifetime Experiment Checkout Procedure

01/19/2005

A guide to a quick and interesting way to setup the experiment

The Hypothesis

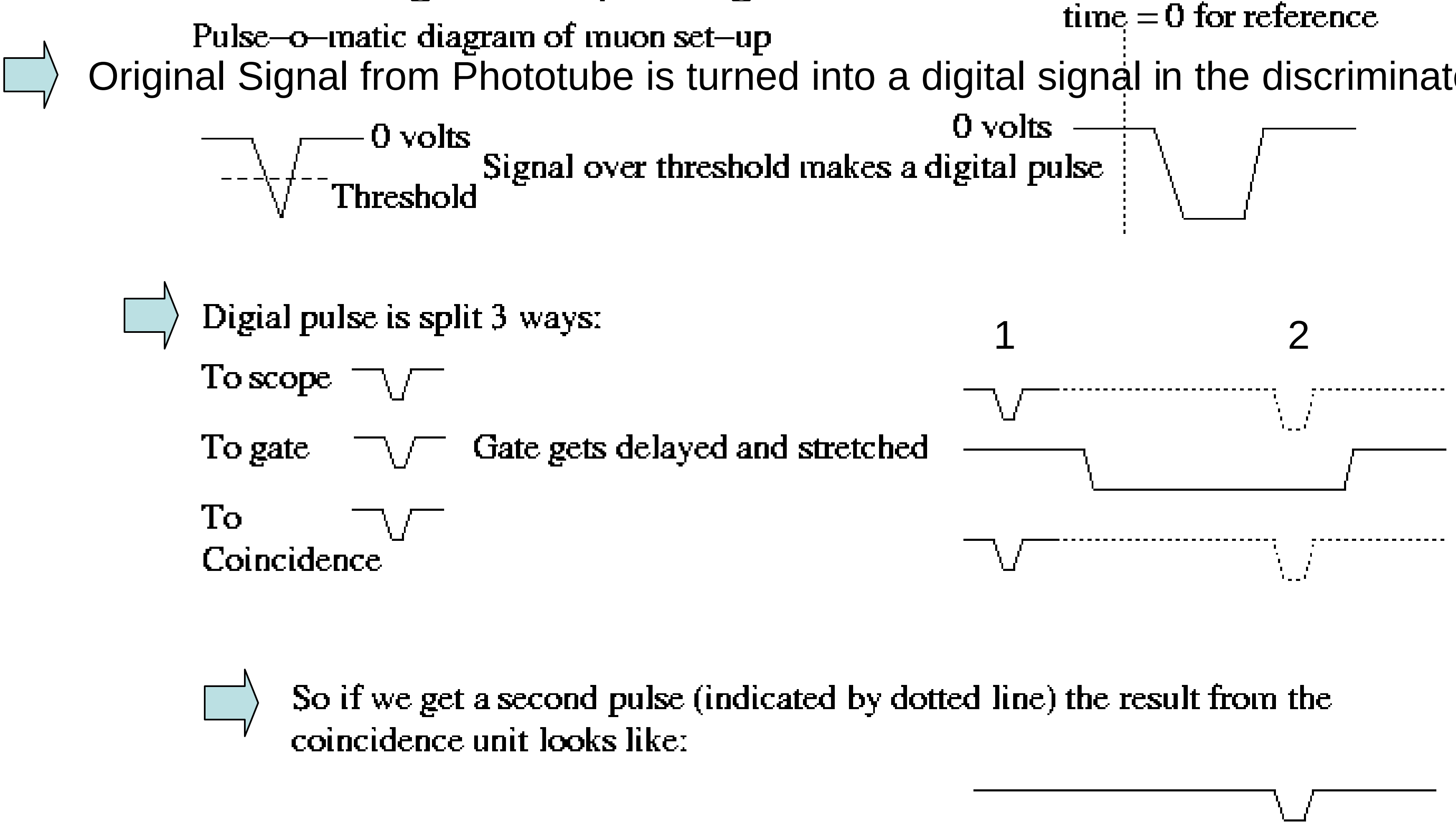
- Random noise in a coincidence experiment with 2 counters can be quantified

$$Rate_{Coincidences}^{Random} = Rate_1 \, Rate_2 \, (Width_1 + Width_2)$$

- The sum of the widths of the logic pulses represents the total amount of time over which a coincidence works. (sometimes called the resolving time)
- Imagine the rate of the first counter times this sum of widths as the probability that the coincidence window is open.
- The rate of the second counter times this probability gives you the rate of the accidental coincidences.
- Example: The probability of getting tails on a coin is about ½. If we flip the coin once every 3 seconds, the rate (on average!) we can expect to see tails is: (1/3s)(1/2)= a tail every 6 seconds.

This should work for a single counter too!

- In the muon experiment, we are taking a signal, delaying it, stretching it and putting it in coincidence with itself



The pulse labeled “1” acts like the first counter, the pulse labeled “2” acts like the second counter, and the total width is essentially the stretched width.

Prove it!

- 3 parameters can be varied:

1) The High Voltage on the tube (do not exceed 1600V)
2) The threshold on the discriminator
3) The width of the stretch (Don't change the discriminator width!)

- If the muon experiment is in the "standard set up"

1) The High voltage is 1300V
2) The Discriminator threshold is set to 45mV (reads as 0.450 V on a DVM for easier DVM-ing)
3) The width of the stretch is ~20 microseconds (note: this width must be returned to its original value before data taking starts.
4) There are about 800 single counts/min and 2-10 coincidences/minute (Average is about 6/minute)

What it looks like

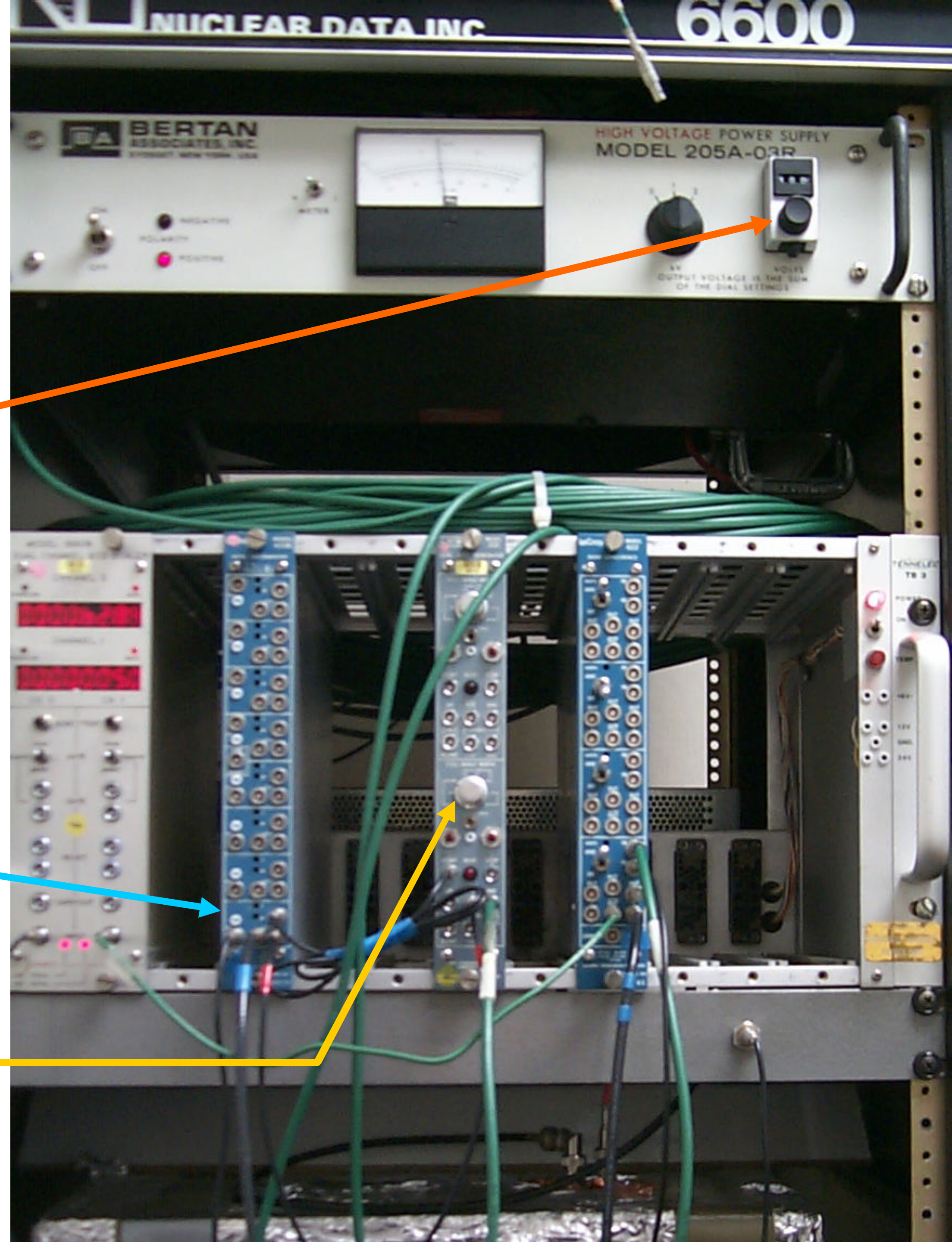
Set High Voltage Here

Counts single pulses

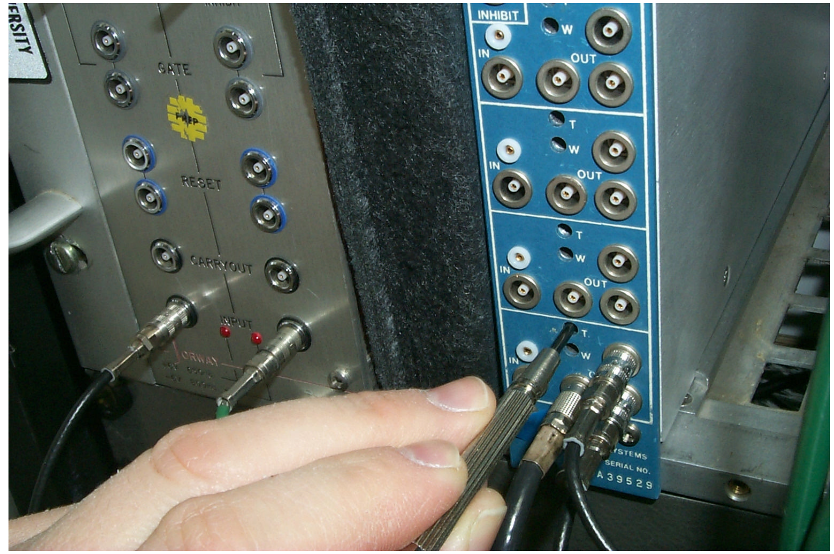
Counts Coincidences

Discriminator (Set Threshold here)

Stretcher (Set total Width here)



Setting Threshold with a tiny screwdriver



Measuring Threshold with a DVM

Use the knob on the right (reads 300 now) for HV

Suggested Proceedure

- Record the initial setup conditions
- Calculate the expected number of accidental coincidences you expect in a minute with this setup

$$Rate_{Coincidences}^{Random} = Rate_{Single}^{2}(Width_{Stretched})$$

- For the “Standard” setup, this is about (1/5) minute
- Turn the knob on the stretcher a couple clicks clockwise or until you notice a substantial increase in the number of coincidences (2 clicks is about a factor of 100)
- Record data for different conditions, varying the 3 parameters from the previous page. Take enough data with enough conditions to verify or refute the above equation
- You’ll notice that coincidences may remain very stable over a large range of conditions. That’s probably signal. I.e.

$$Rate_{Coincidences} = Rate_{Coincidences}^{Random} + Rate_{Coincidences}^{Signal}$$

- Is the “standard” setup still a good choice?