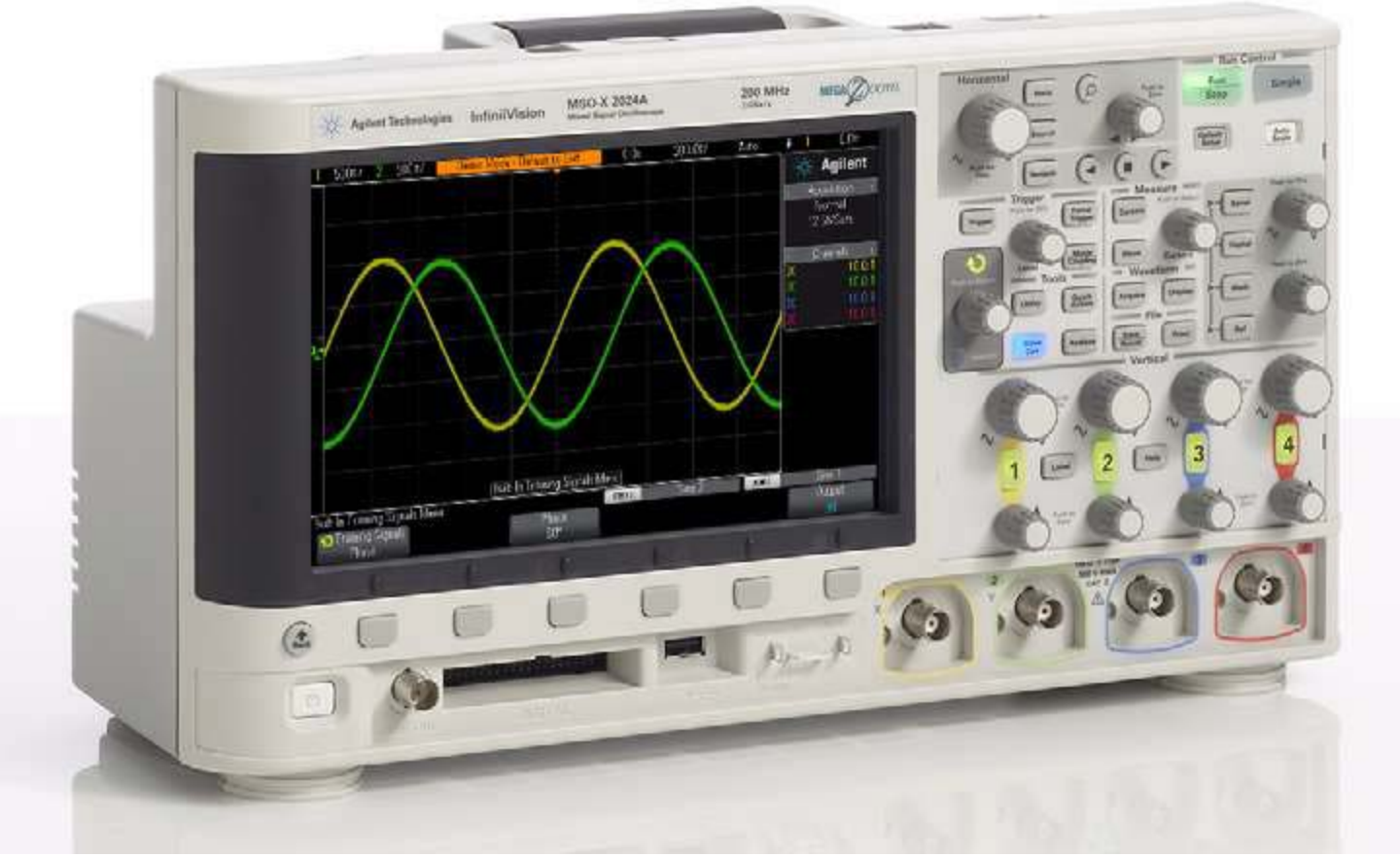
# Signal processing

Lecture: Hans-Jürgen Wollersheim

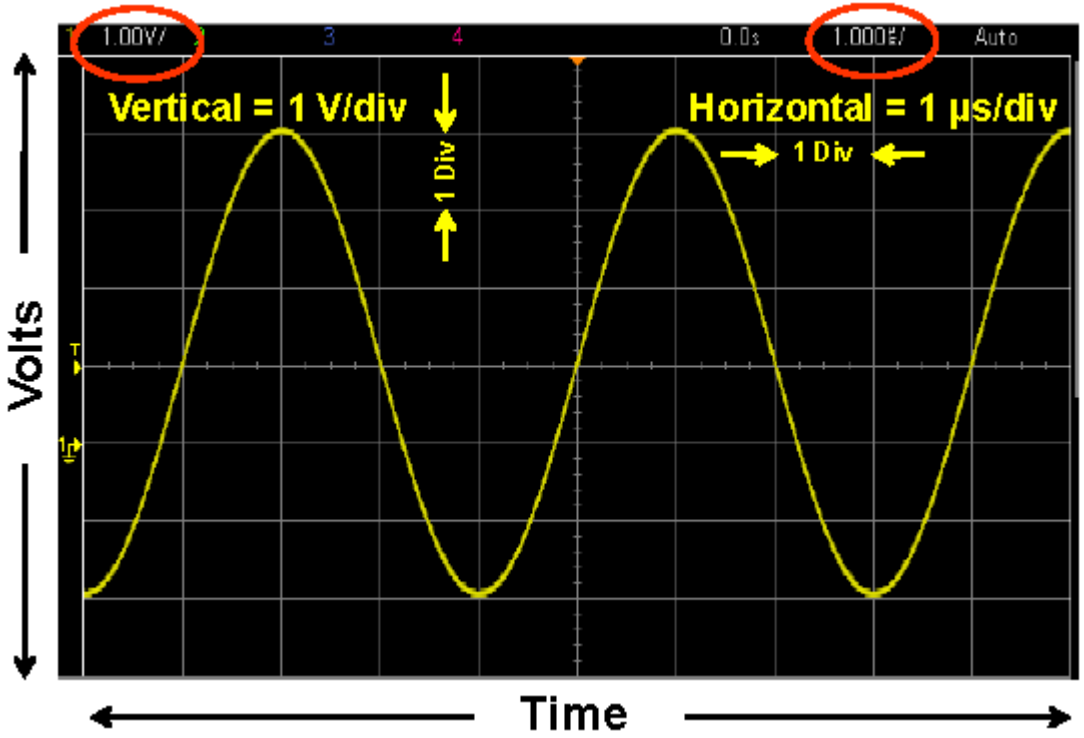
e-mail: h.j.wollersheim@gsi.de

- Working with an oscilloscope
- Signal processing

# Digital Oscilloscope

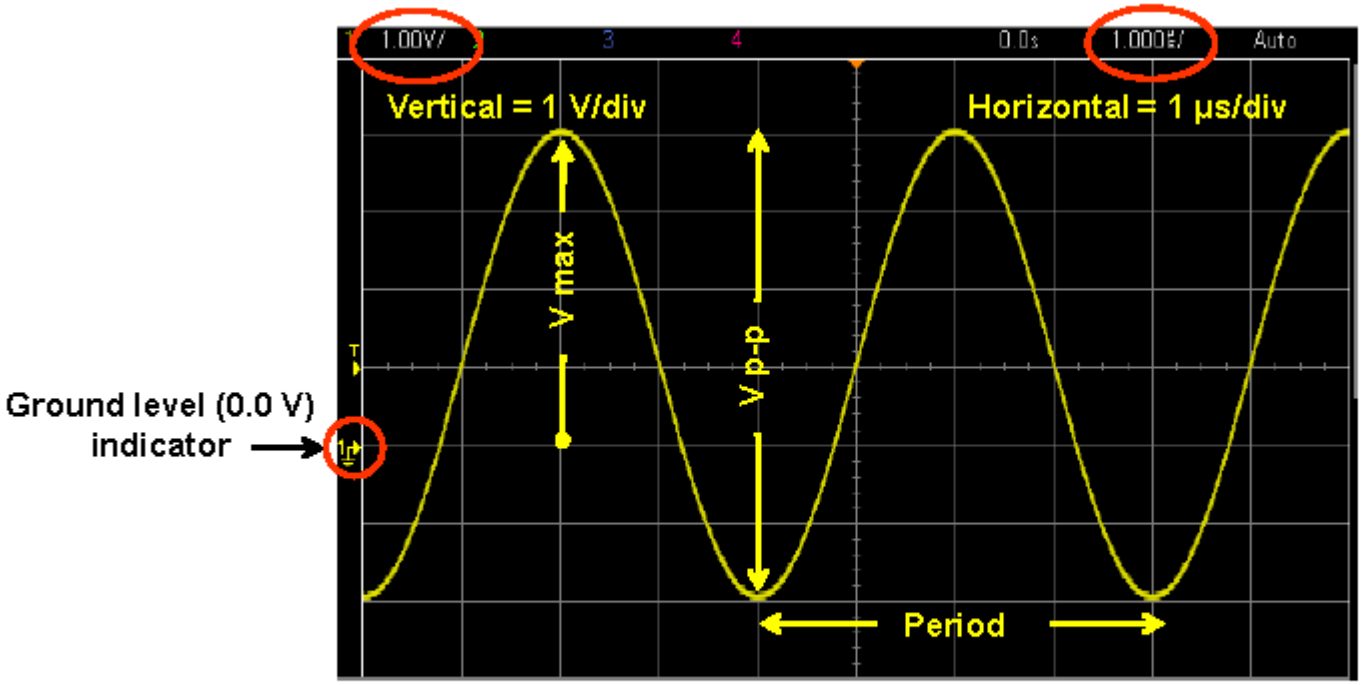


# Understanding the Scope's Display



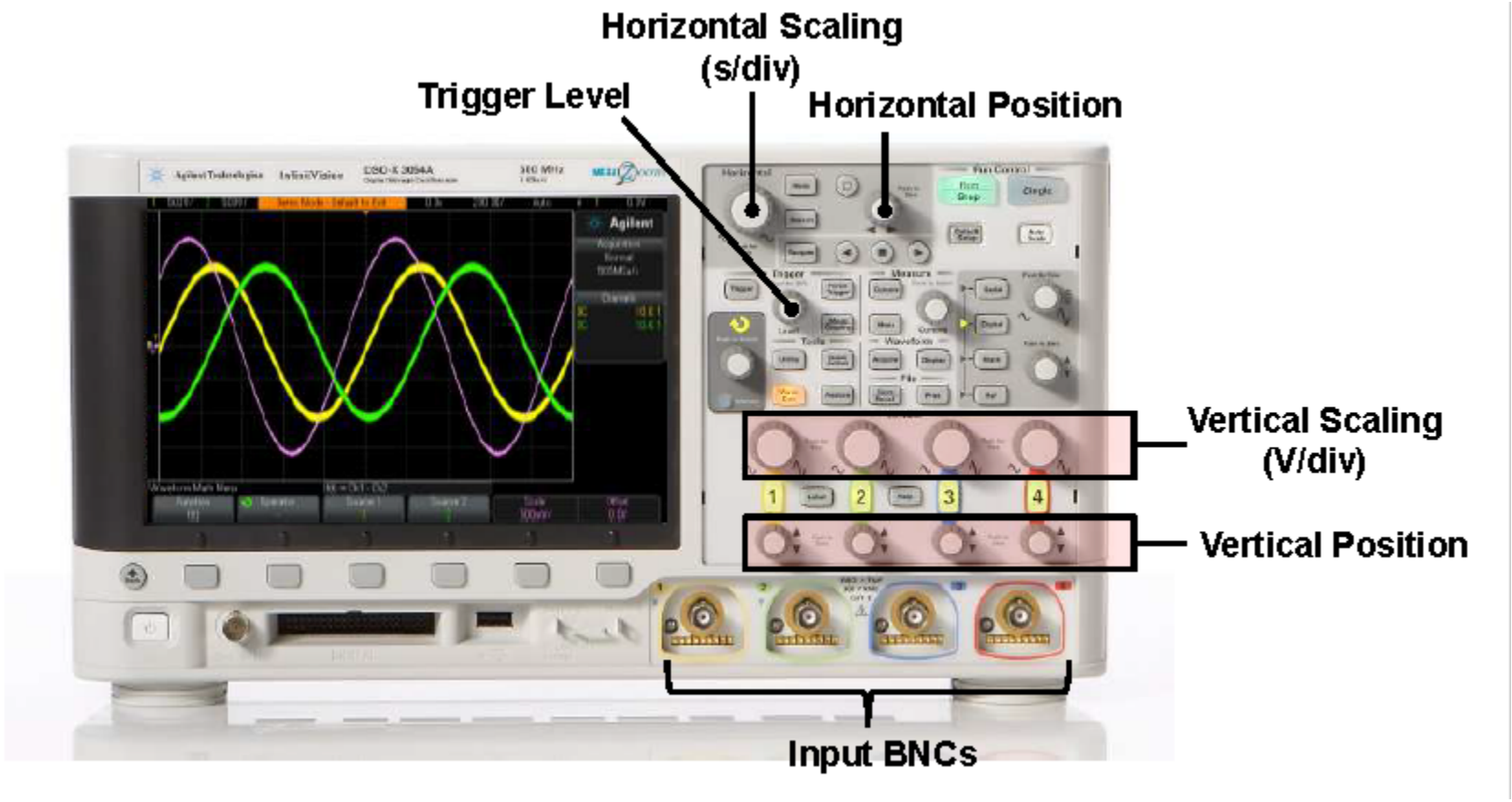
# Making Measurements – by visual estimation

***The most common measurement technique***




- Period (T) = 4 divisions x 1 µs/div = 4 µs, Freq = 1/T = 250 kHz.
- V p-p = 6 divisions x 1 V/div = 6 V p-p
- V max = +4 divisions x 1 V/div = +4 V, V min = ?

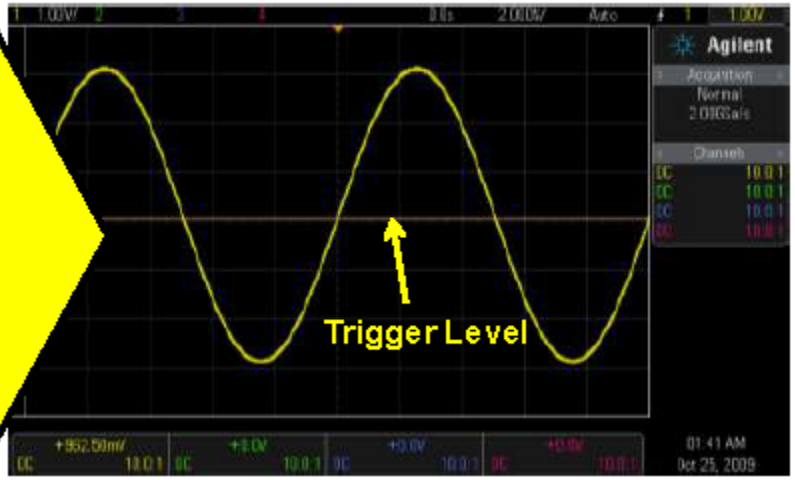
# Primary Oscilloscope Setup Controls



# Properly Scaling the Waveform

**Initial Setup Condition (example)**


**Optimum Setup Condition**



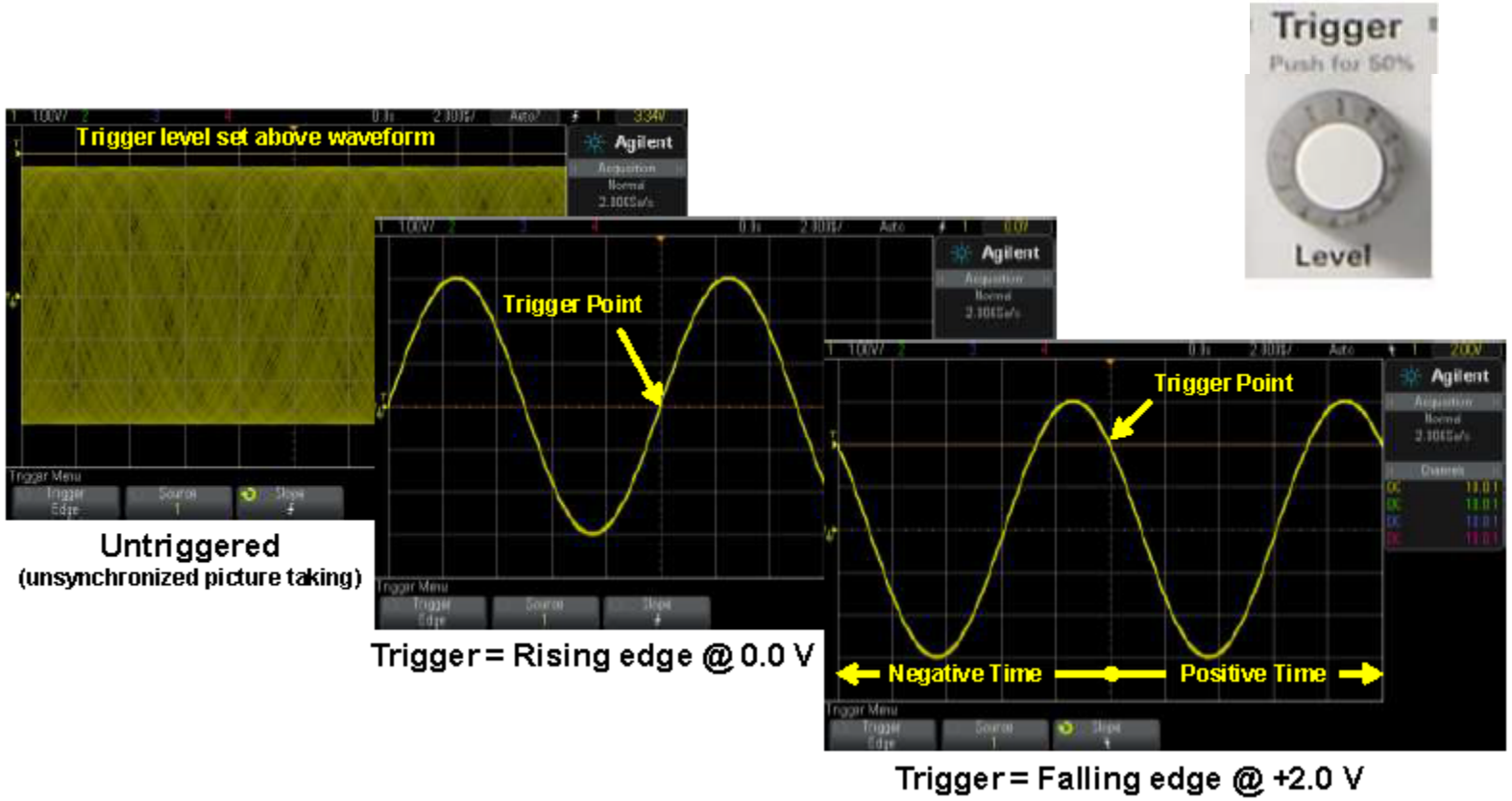
# Understanding Oscilloscope Triggering

***Triggering is often the least understood function of a scope, but is one of the most important capabilities that you should understand.***

- Think of oscilloscope "triggering" as "synchronized picture taking".
- One waveform "picture" consists of many consecutive digitized samples.
- "Picture Taking" must be synchronized to a unique point on the waveform that repeats.
- Most common oscilloscope triggering is based on synchronizing acquisitions (picture taking) on a rising or falling edge of a signal at a specific voltage level.

**A photo finish horse race is analogous to oscilloscope triggering**

# Trigger Examples

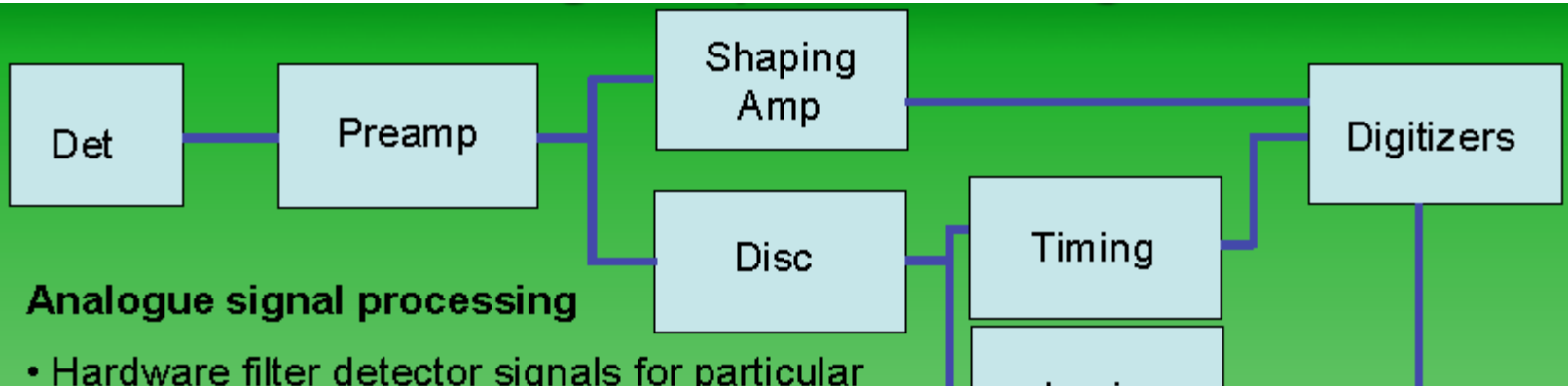



Untriggered
(unsynchronized picture taking)

Trigger = Rising edge @ 0.0 V

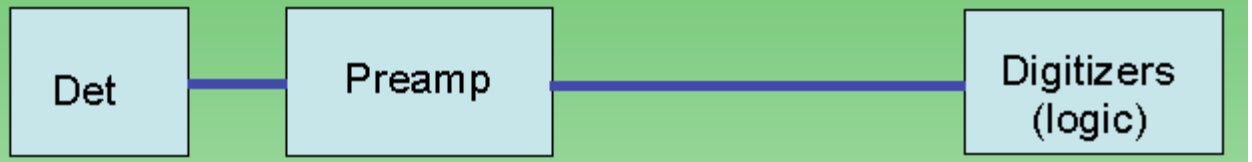
Trigger = Falling edge @ +2.0 V

# Signal processing




**Analogue signal processing**

- Hardware filter detector signals for particular qualities (energy resolution, timing, etc)
- Excellent resolution, but some information is discarded




**Digital signal processing**

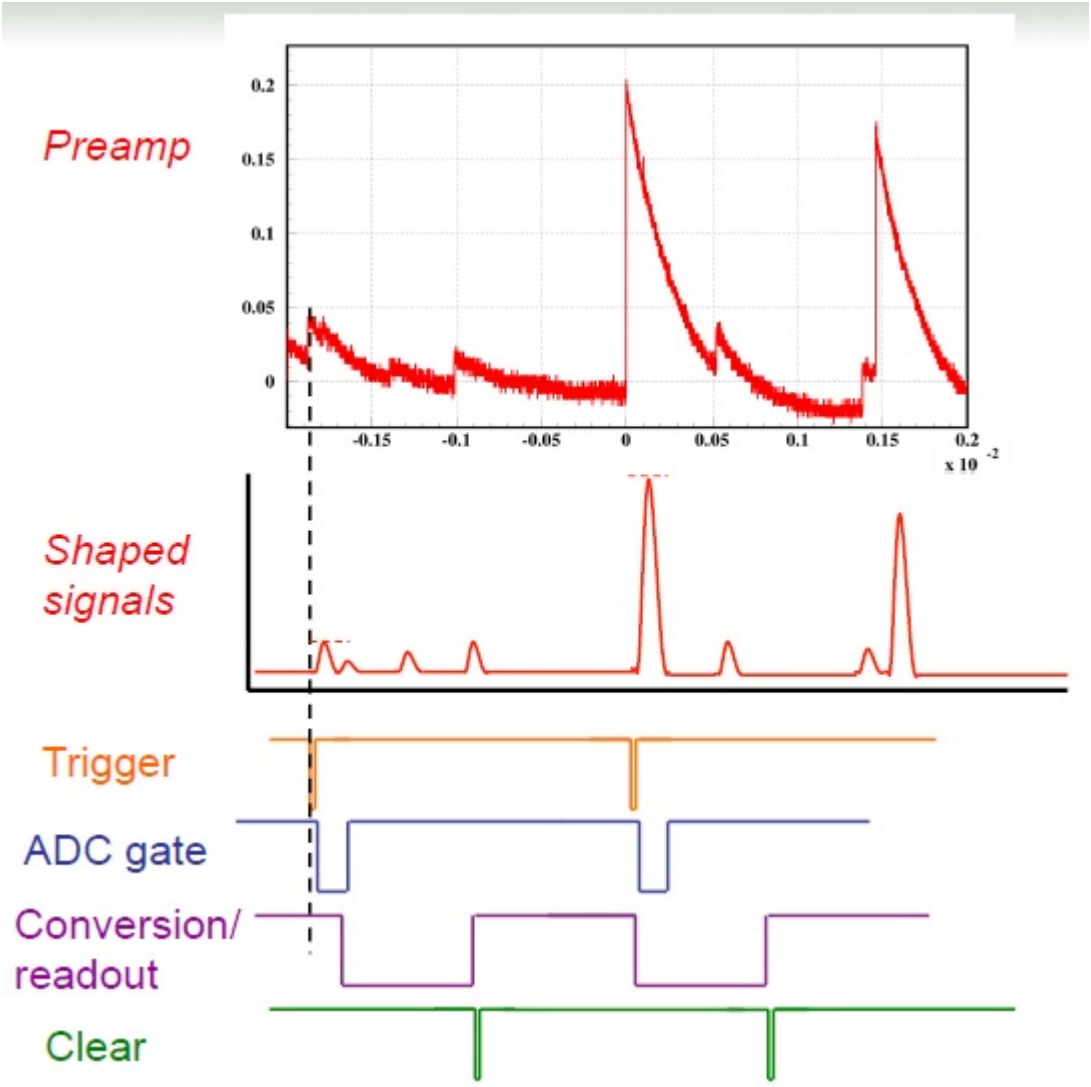
- Process (and sometimes store) a digital approximation of the trace from a detector/preamp
- All information encoded in the preamp trace can be processed (software)
- Single data stream can be multiplied and each stream processed independently

# Shaping amplifier

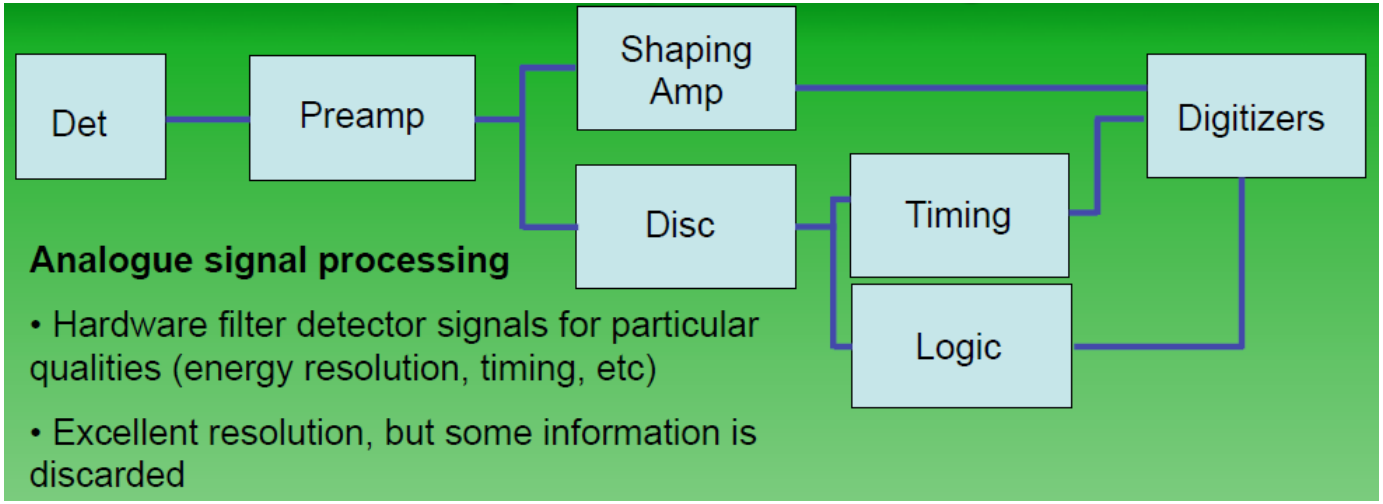
Shape pulses to:

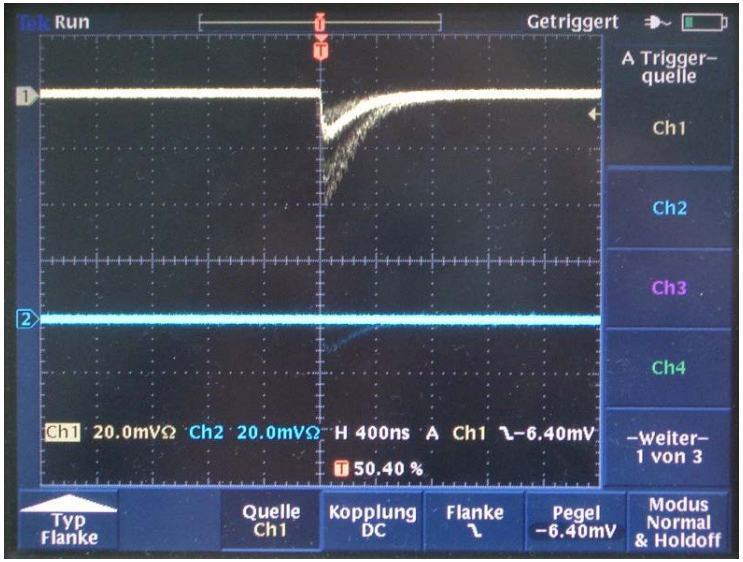
- Improve signal to noise
- Reduce pileup effects

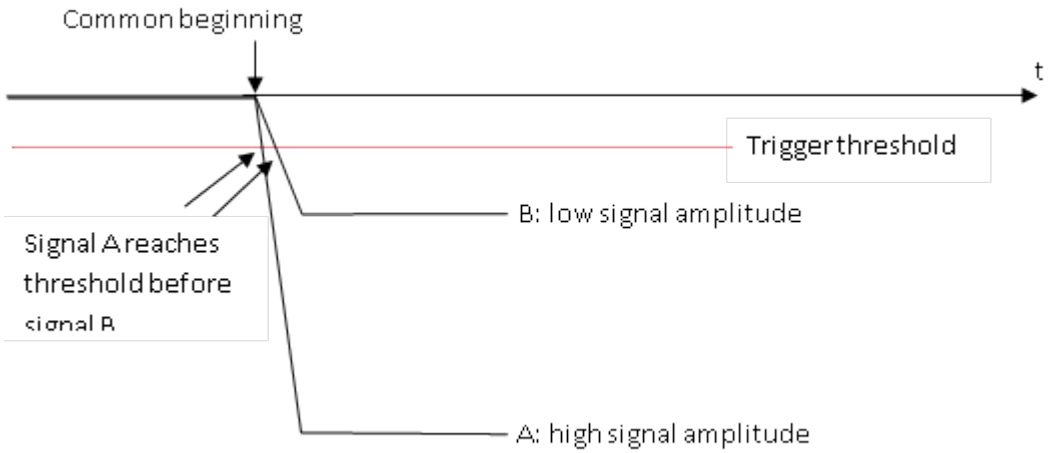
- Keep signal height information
- Lose shape information



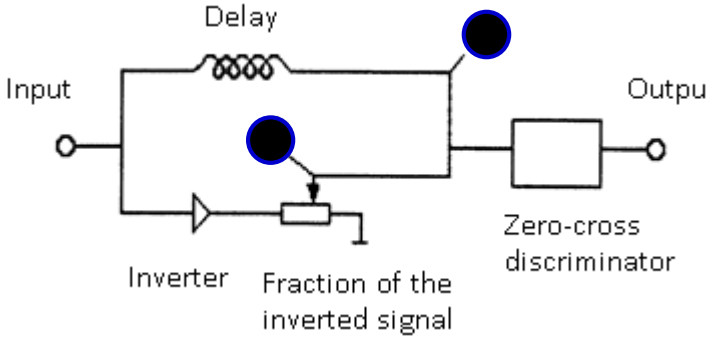
# Signal processing



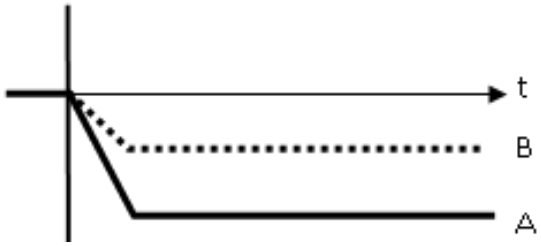



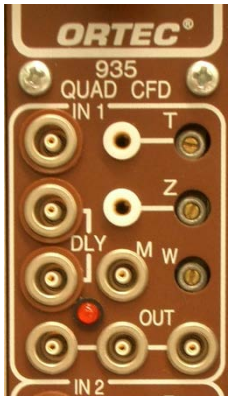



# Constant Fraction Discriminator




Input signals

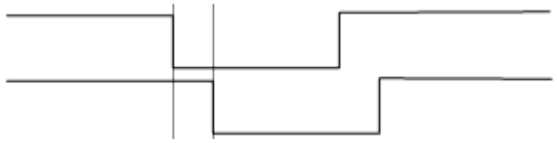


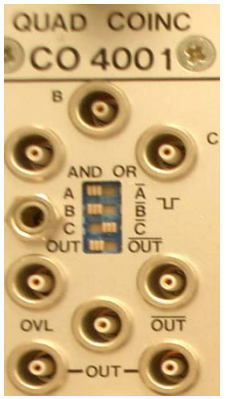



# The coincidence unit

detector 1:

detector 2:

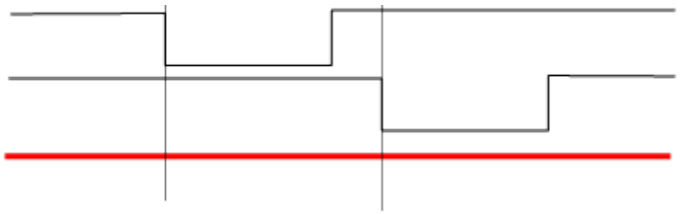


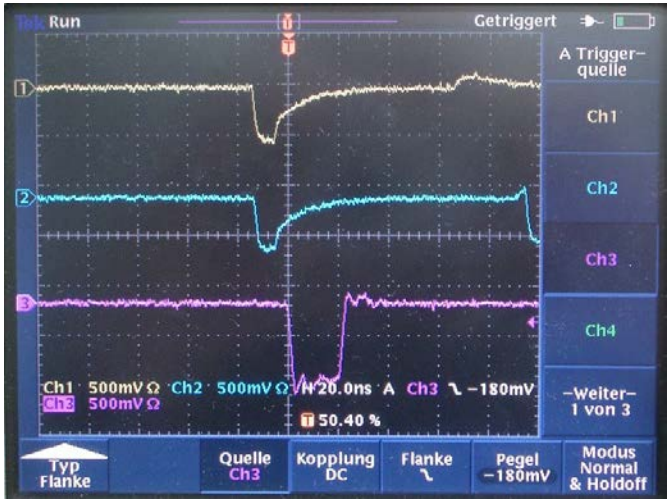



detector 1:

detector 2:

(detector 1) AND (detector 2):





# Coincidence electronic