SPADIC – Self-triggered readout ASIC for CBM

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Outline

Concept

SPADIC

Self-triggered Pulse Amplification and Digitization ASIC

- readout of transition radiation detectors at CBM
- used for electron-pion separation (pulse shape)
- oscilloscope-like behaviour: record signal snapshots
- send out messages: signal + metadata

Features

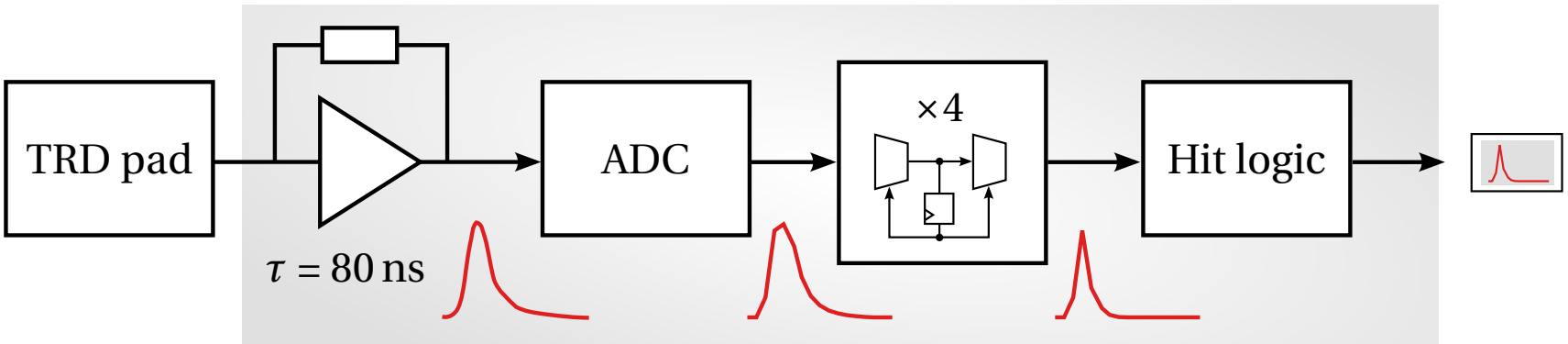
32 channels (2×16)

- charge sensitive amplifier + shaper ($\tau = 80\,\text{ns}$)
- 9 bit ADC (25 MHz sampling rate, effective res. ≈ 8 bit)
- 16 bit digital signal processing (IIR filter)
- hit detection and message building

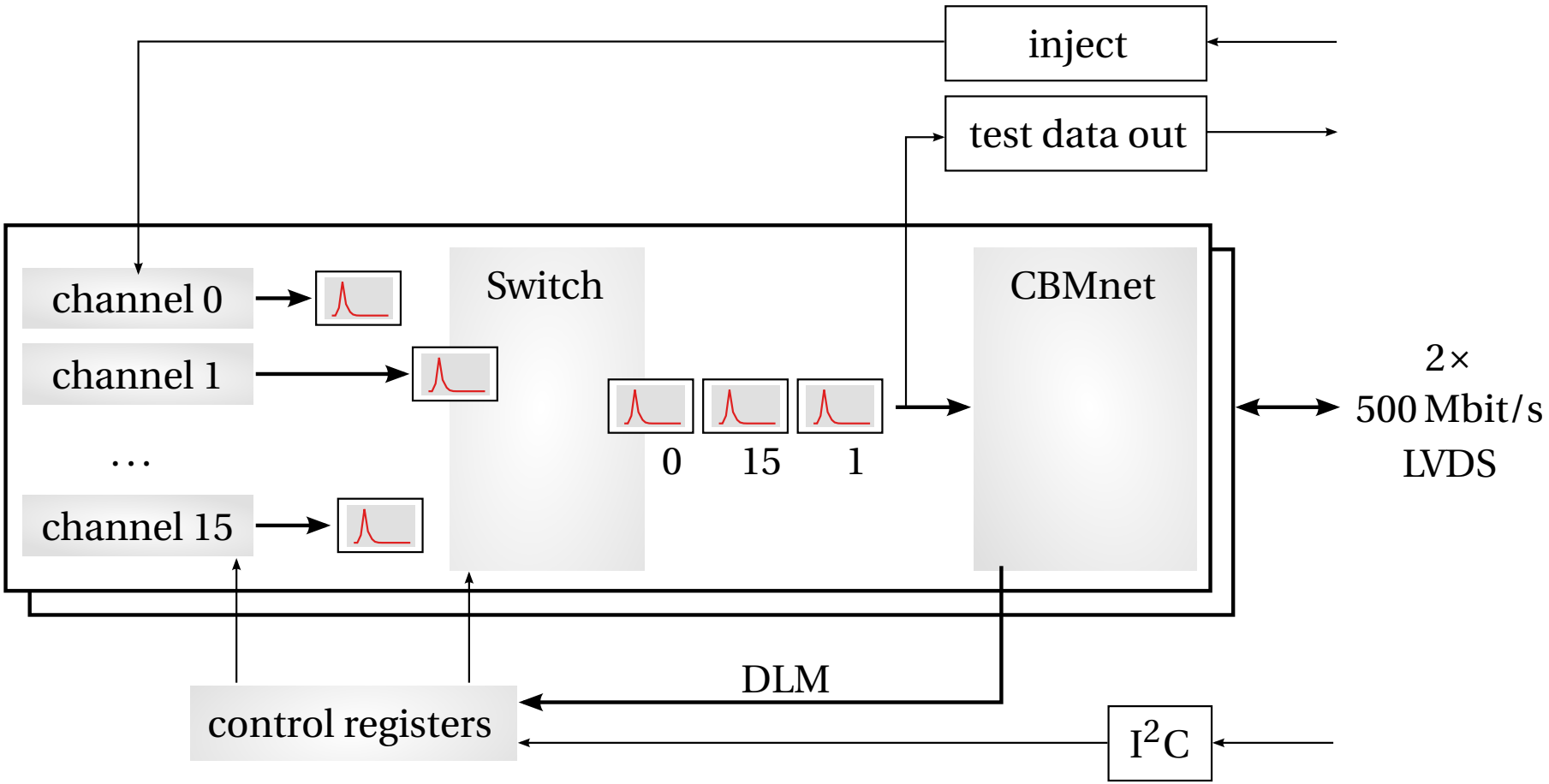
each 16 channel group

- time-sorted multiplexing of messages
- special message insertion (epoch markers, buffer overflows, ...)
- 500 Mbit/s serial data link *(CBMnet)*

Block diagram: single channel



Block diagram: channel groups

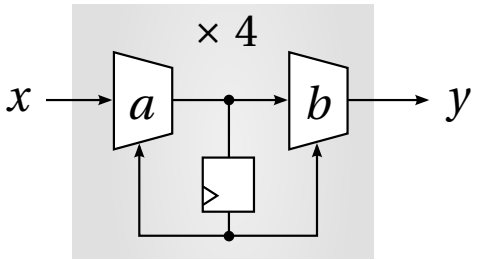


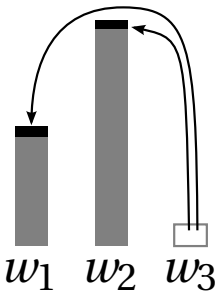
Signal processing

Goal

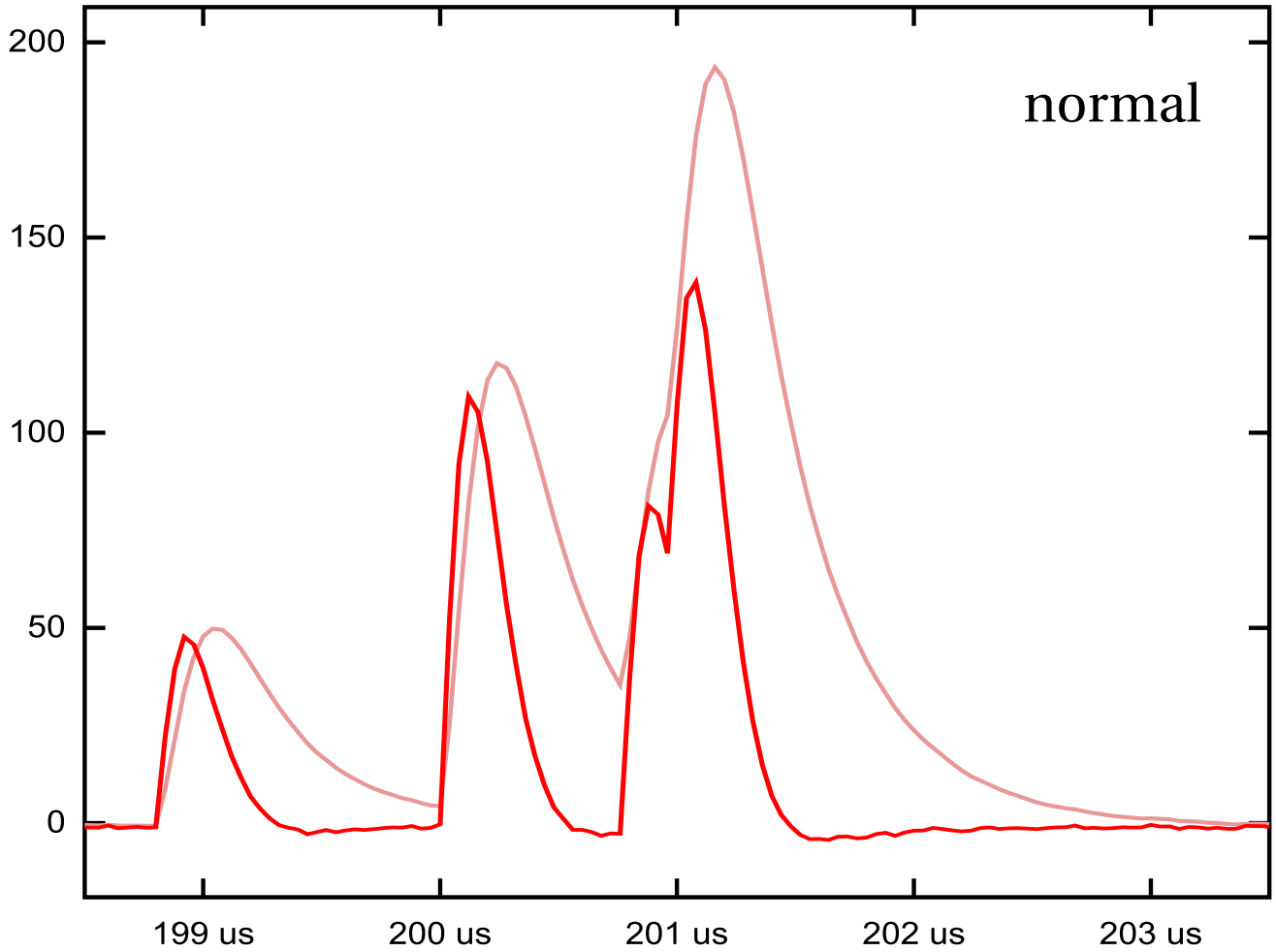
Tail cancellation → reduce pileup → help hit logic

- model signal as sum of exponential terms:
  $x_n \propto \sum w_i q_i^n$
- recursion: $y_n = x_n + b x_{n-1} + a y_{n-1}$
- each filter stage shifts relative weights:
  $w_i' = \frac{q_i + b}{q_i - a} w_i$

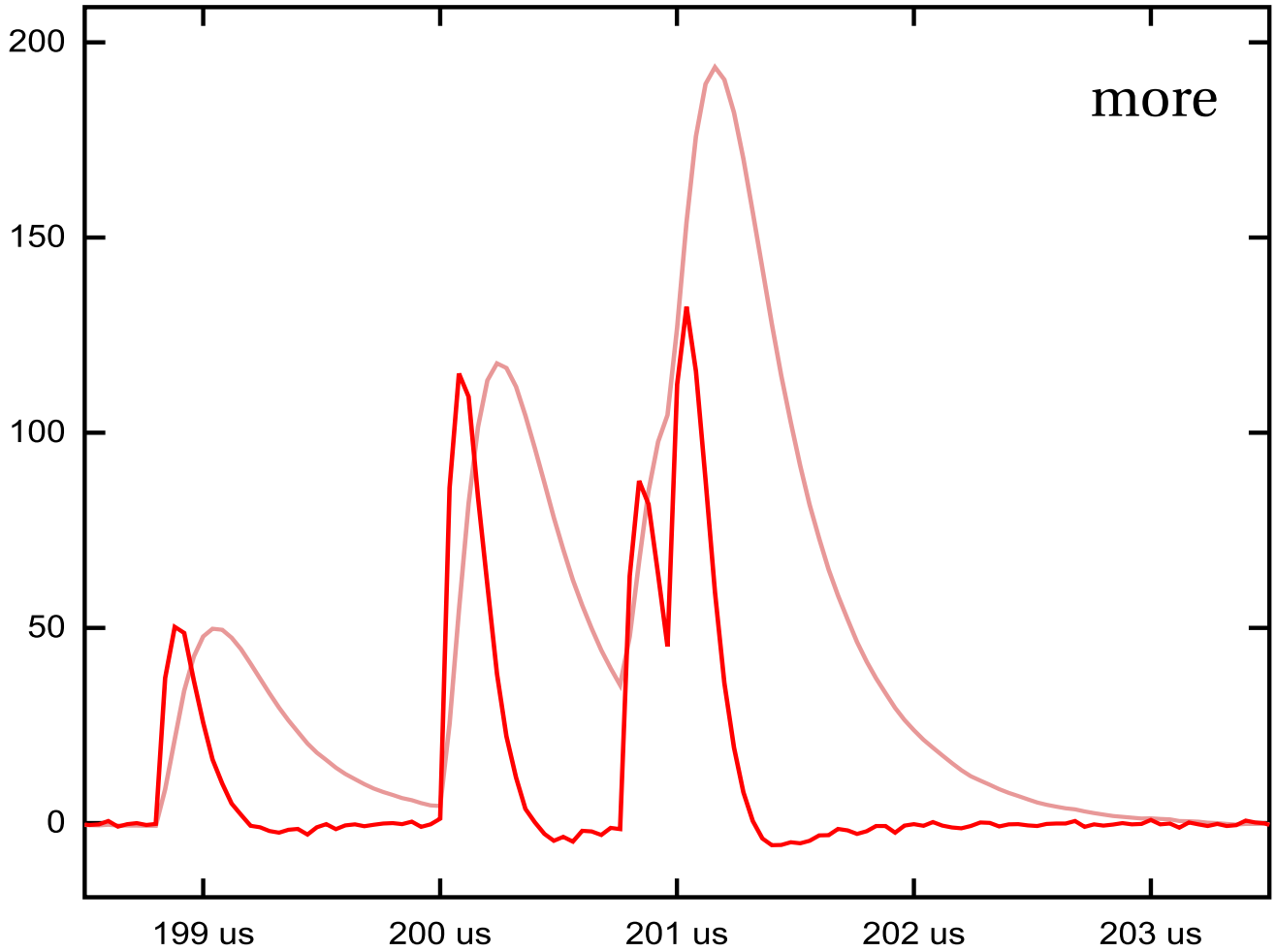




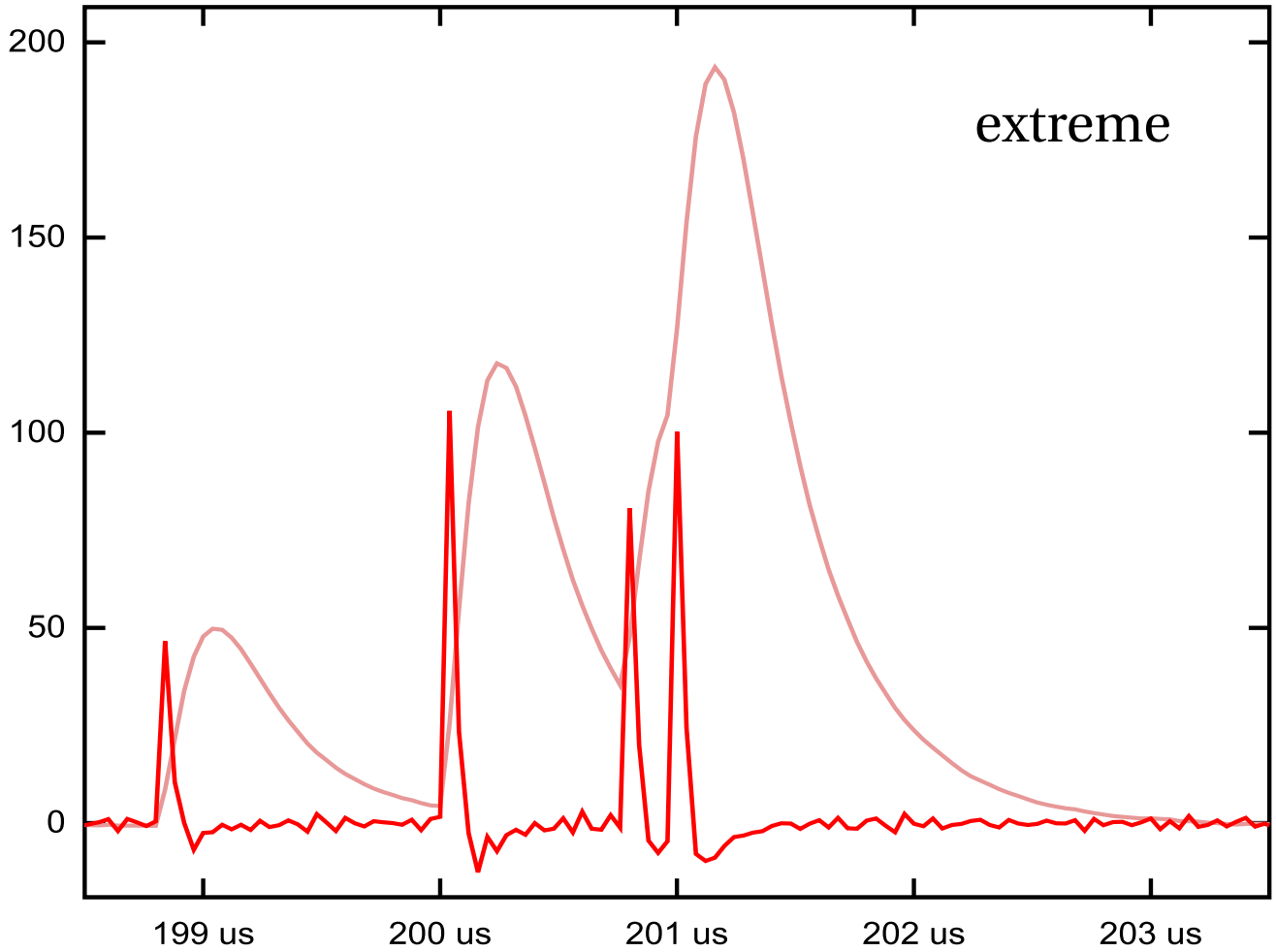
Signal processing: examples



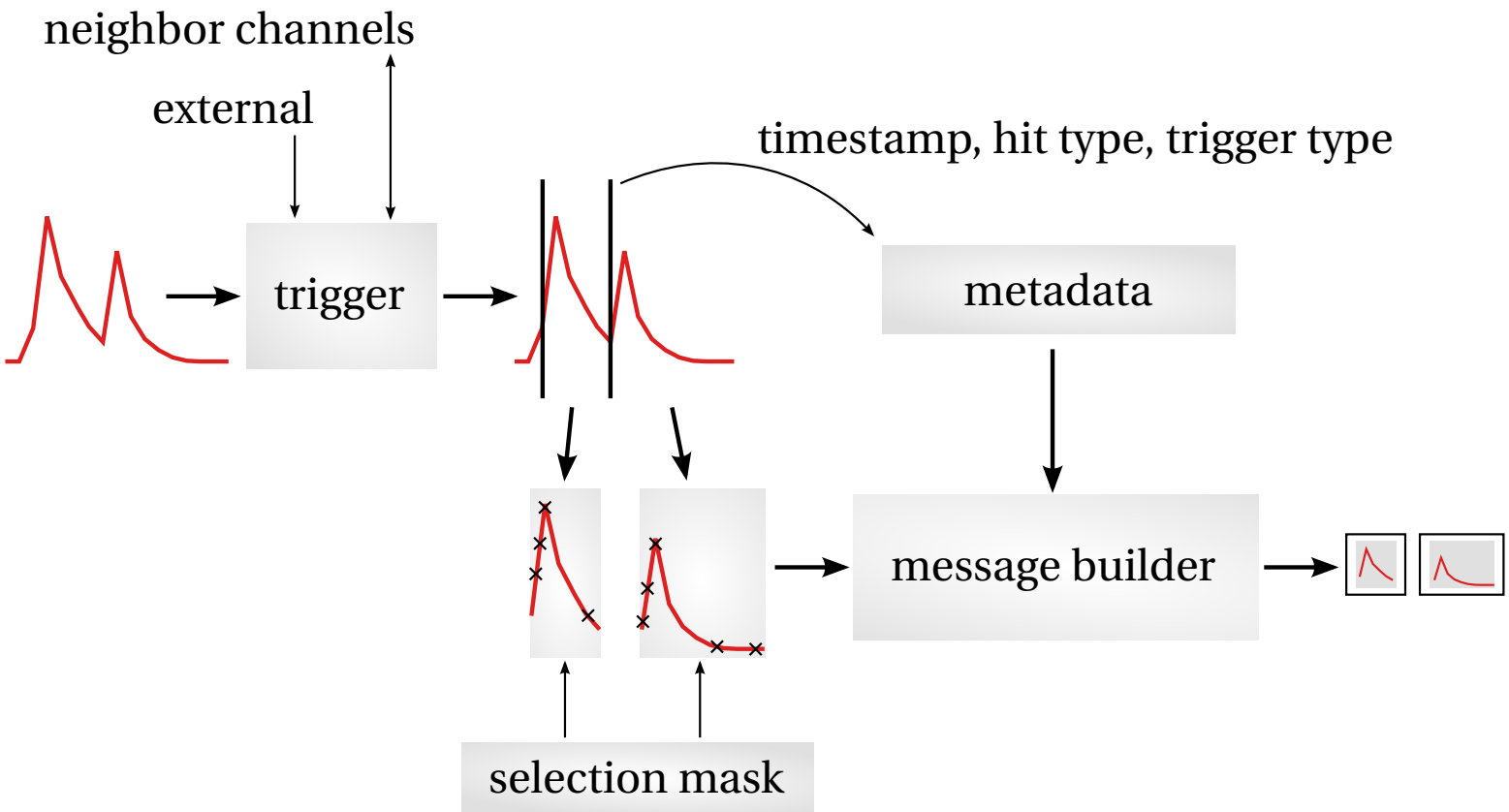
Signal processing: examples



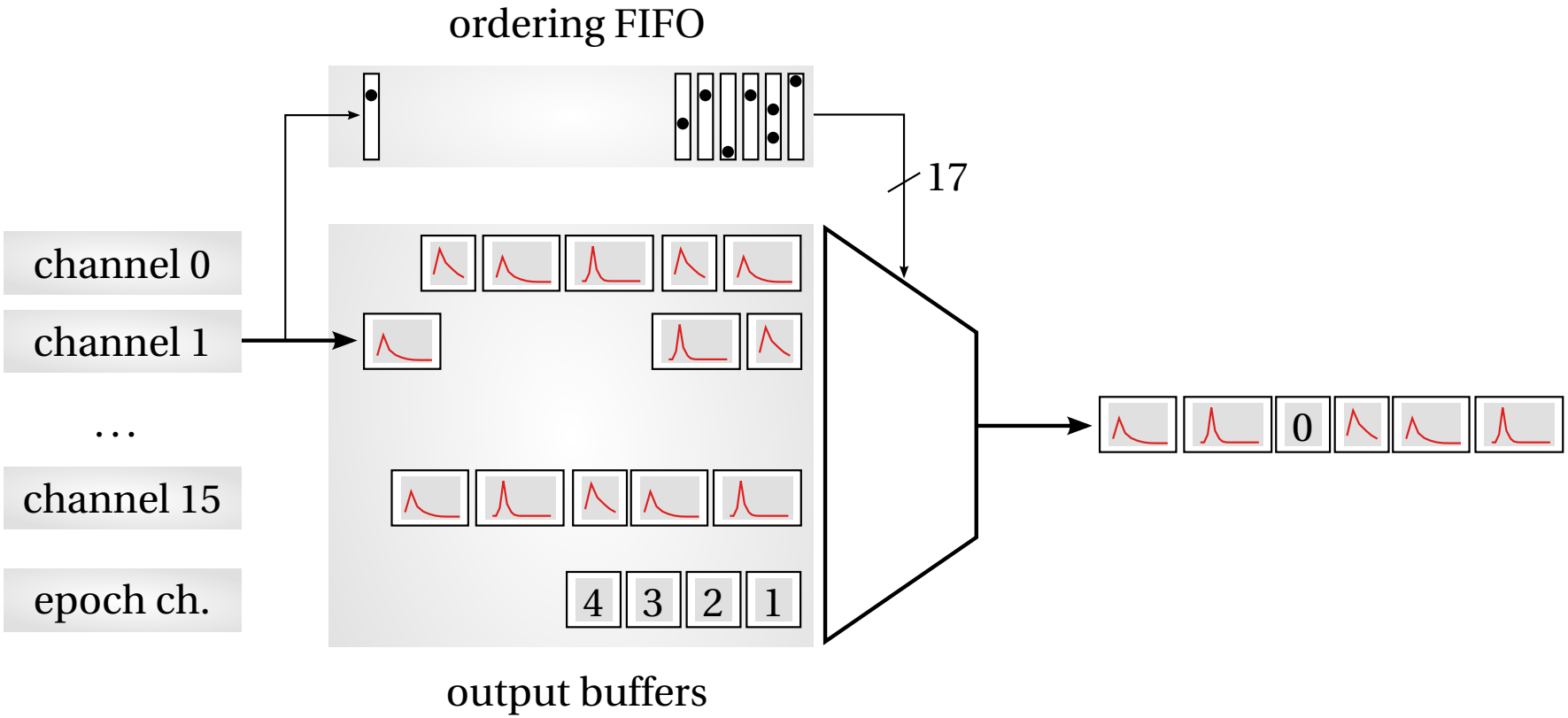
Signal processing: examples



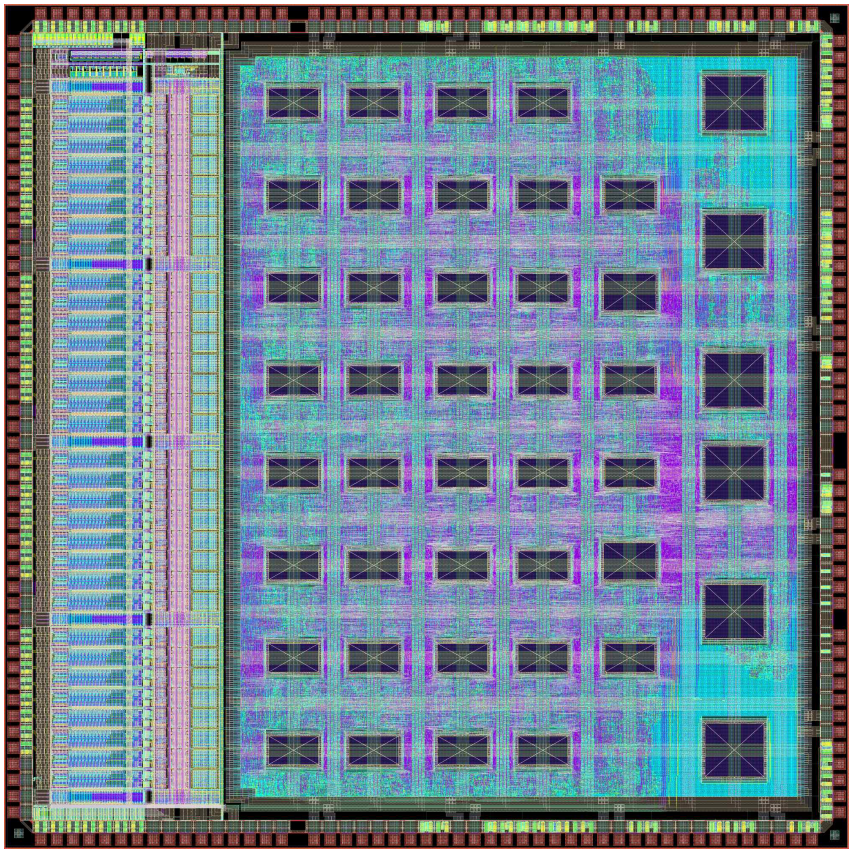
Hit logic


neighbor channels
external
timestamp, hit type, trigger type
trigger
metadata
message builder
selection mask

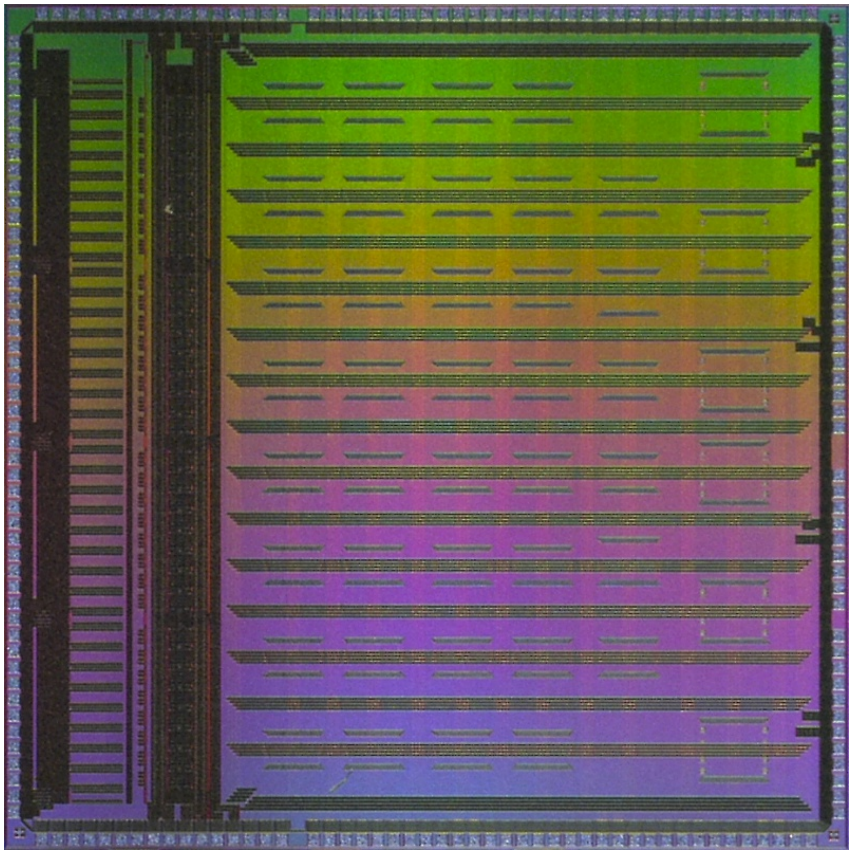
Ordering mechanism *(Switch)*



Layout + Photograph

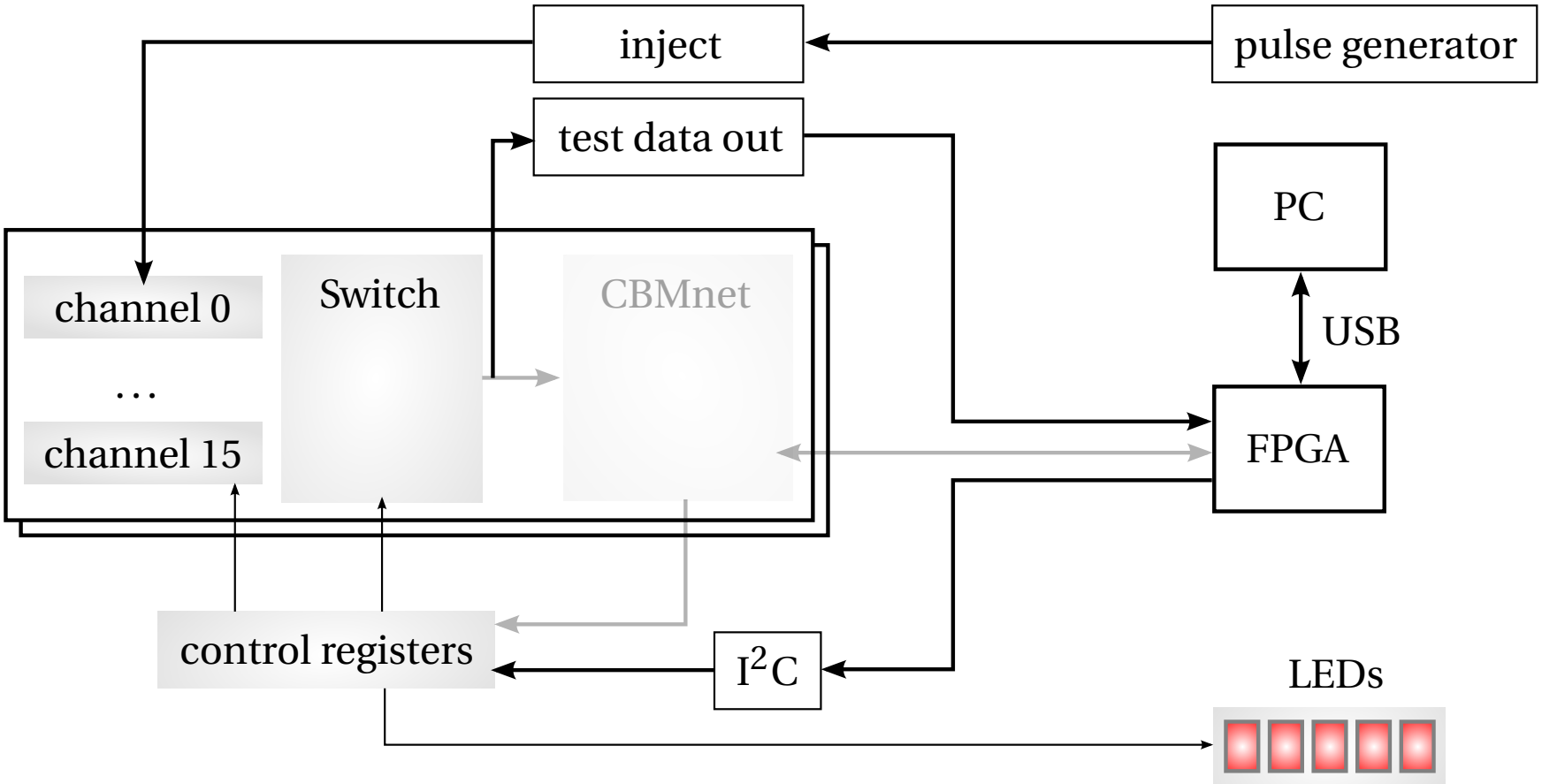


November 2011

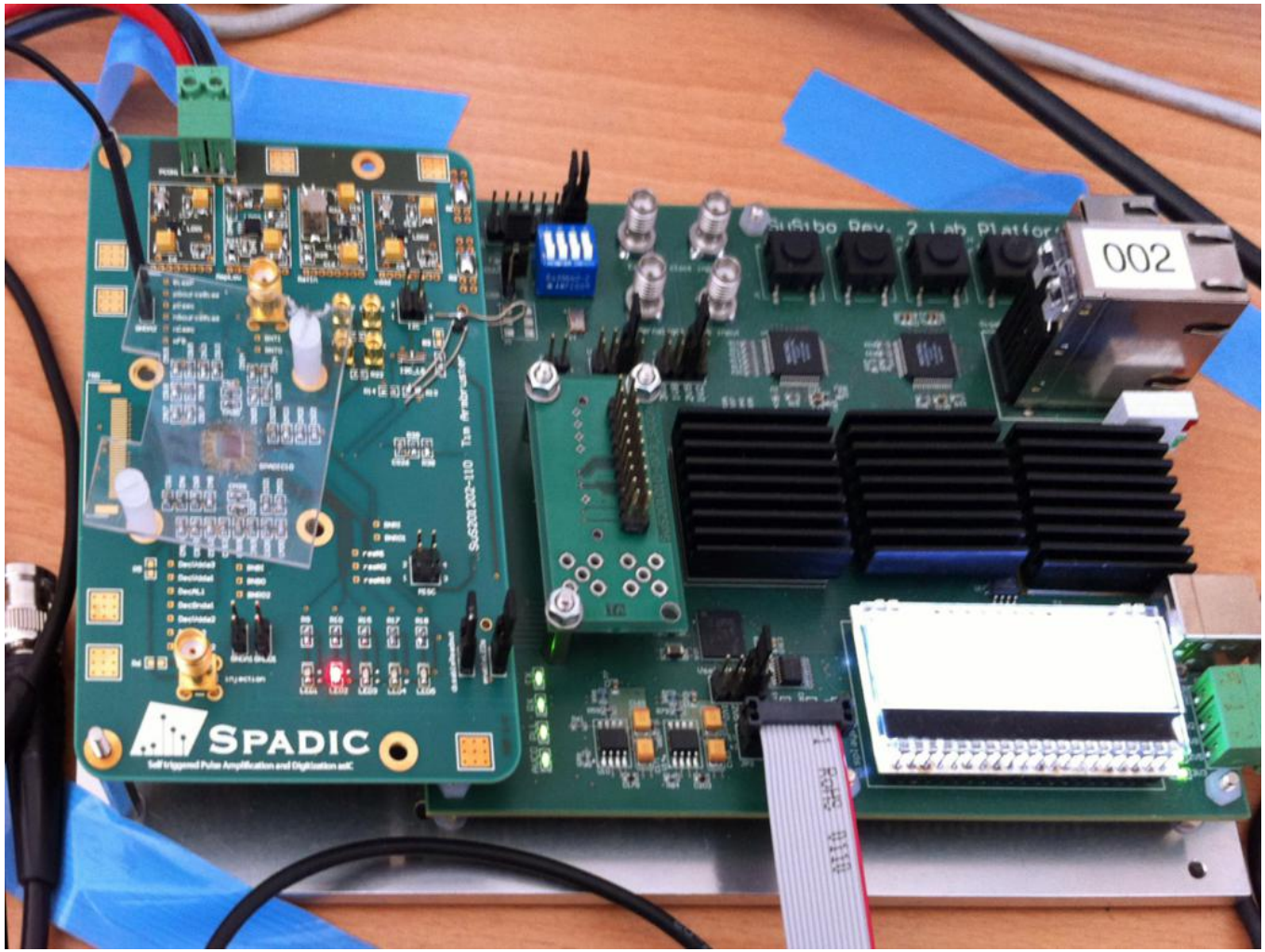


February 2012

Test setup (block diagram)



Test setup (photograph)



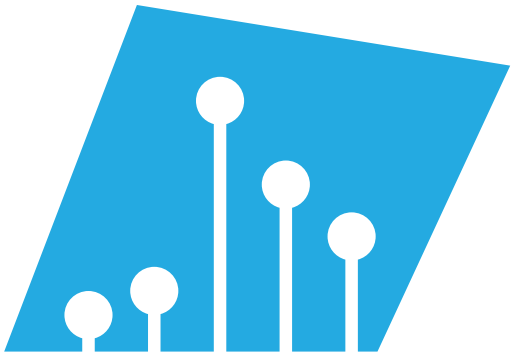
First results

many things already work:

- write register file over I^2C ✓
- turn status LEDs on/off :-) ✓
- set amplifier/ADC bias voltages (through RF) ✓
- get hit messages from channel 0 ✓

some things need to be done:

- (!) test CBMnet (FPGA firmware not ready)
- find epoch markers (should already be there . . .)
- test digital filter
- find correct bias voltages/digital configuration
- measure, characterize, write software/documentation, . . .



SPADIC

Self triggered Pulse Amplification and Digitization asIC

http://spadic.uni-hd.de