SMART:
a SiPM Multichannel Asic for high Resolution Cherenkov Telescopes

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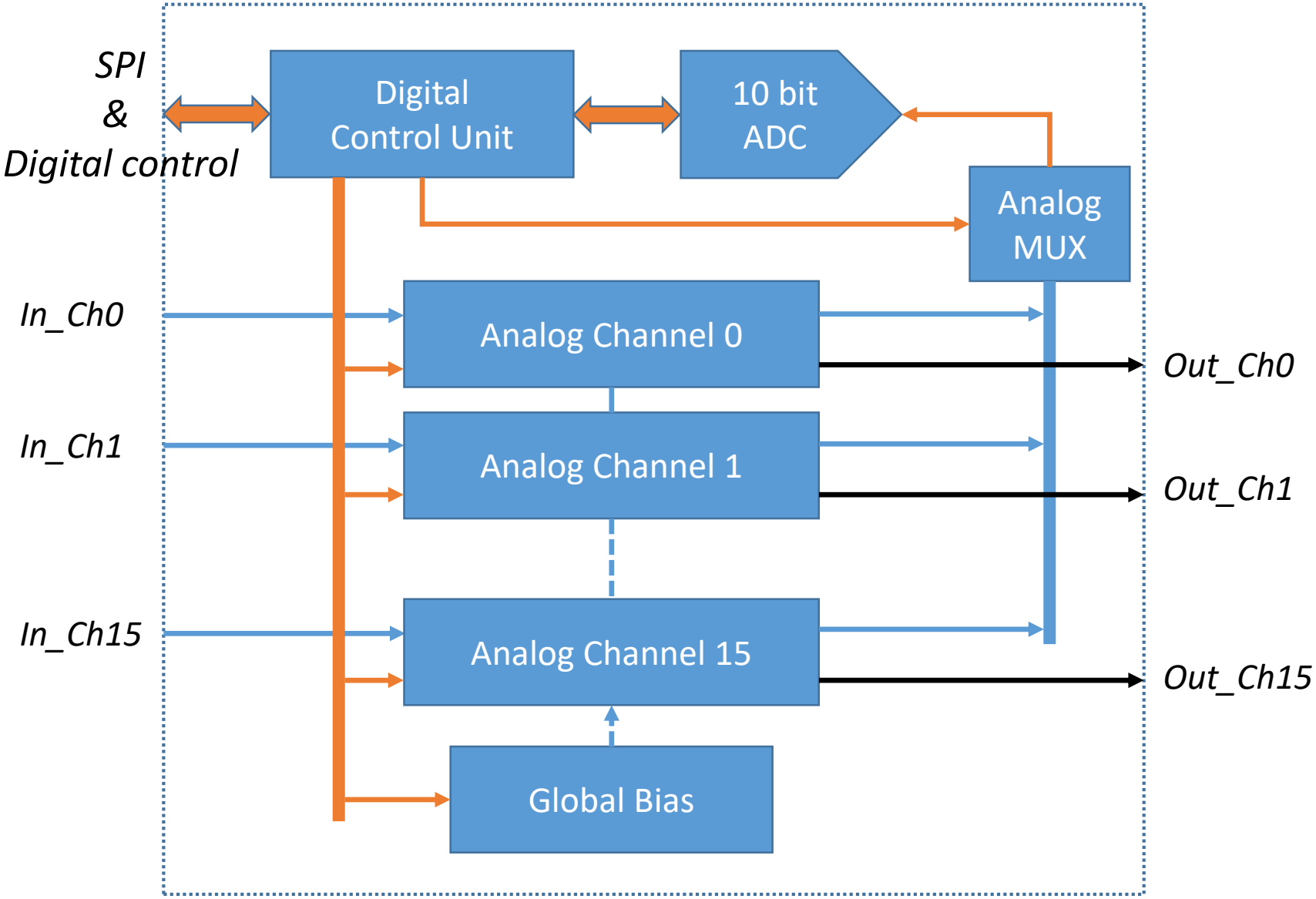
INFN – Section of Bari

Outline

1. ASIC & channel architectures
2. Channel simulations
3. SMART specifications
4. Measurements
5. Future perspectives

SMART Architecture



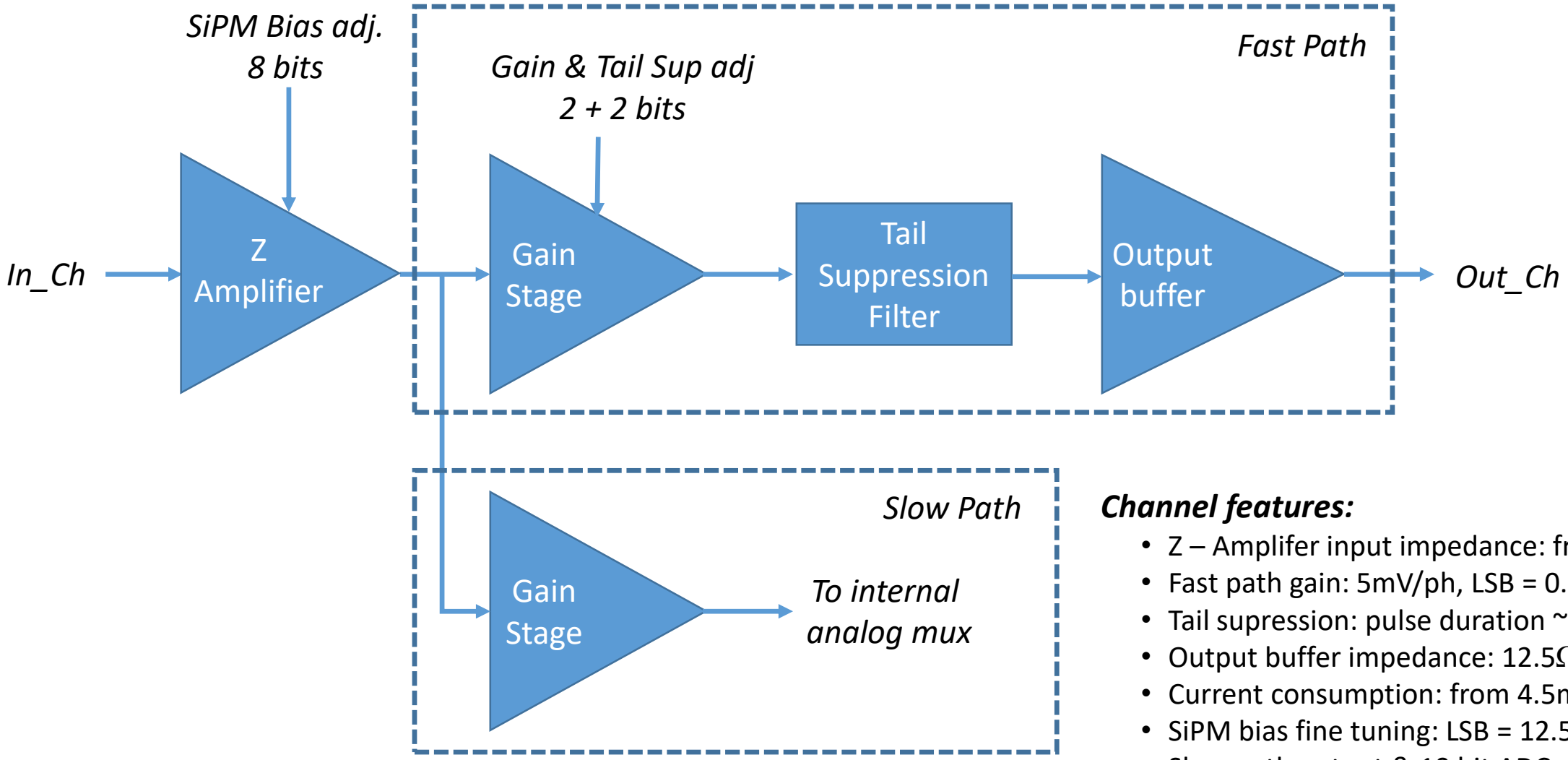
Analog Section:

- 16 Front-end channels:
  - Direct output: designed for photon-counting
  - Internal output: SiPM mean current measurement
- Global Bias: temperature and power supply independent
- 10 bit 1MHz SAR ADC for channel internal output conversion

Digital Section:

- Control Unit:
  - 1MHz SPI LVDS link
  - Channel & Global bias adj. bits
  - ADC control

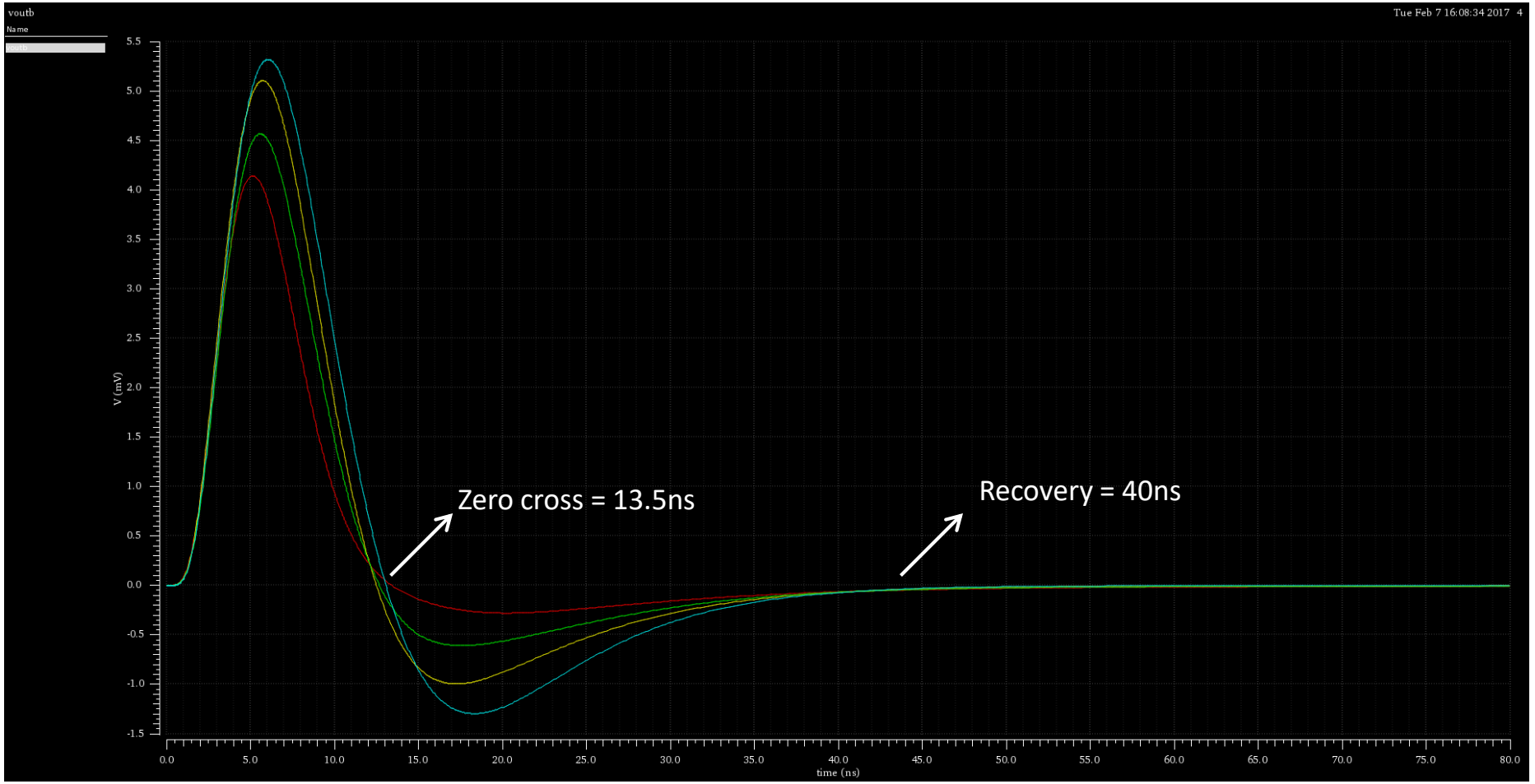
Channel Architecture



Channel features:

- Z – Amplifer input impedance: from 12.5Ω to 50Ω
- Fast path gain: 5mV/ph, LSB = 0.5 mV
- Tail supression: pulse duration ~ 10ns, LSB = 0.5ns
- Output buffer impedance: 12.5Ω
- Current consumption: from 4.5mA to 6mA
- SiPM bias fine tuning: LSB = 12.5mV
- Slow path output & 10 bit ADC: LSB = 2MHz

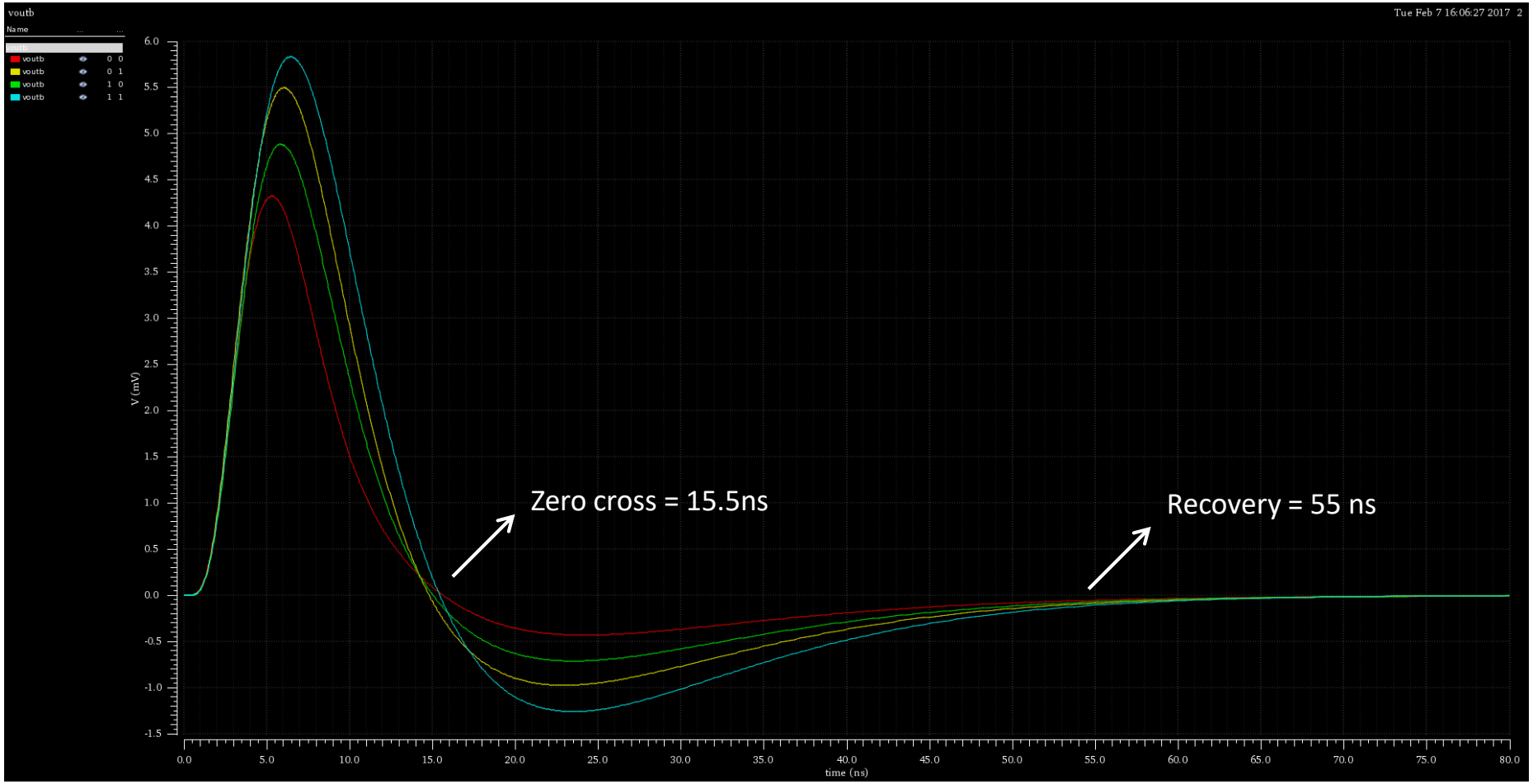
Transient simulation: single pulse



Typical simulation for different gain settings: input signal 1ph (150fC), fast suppression

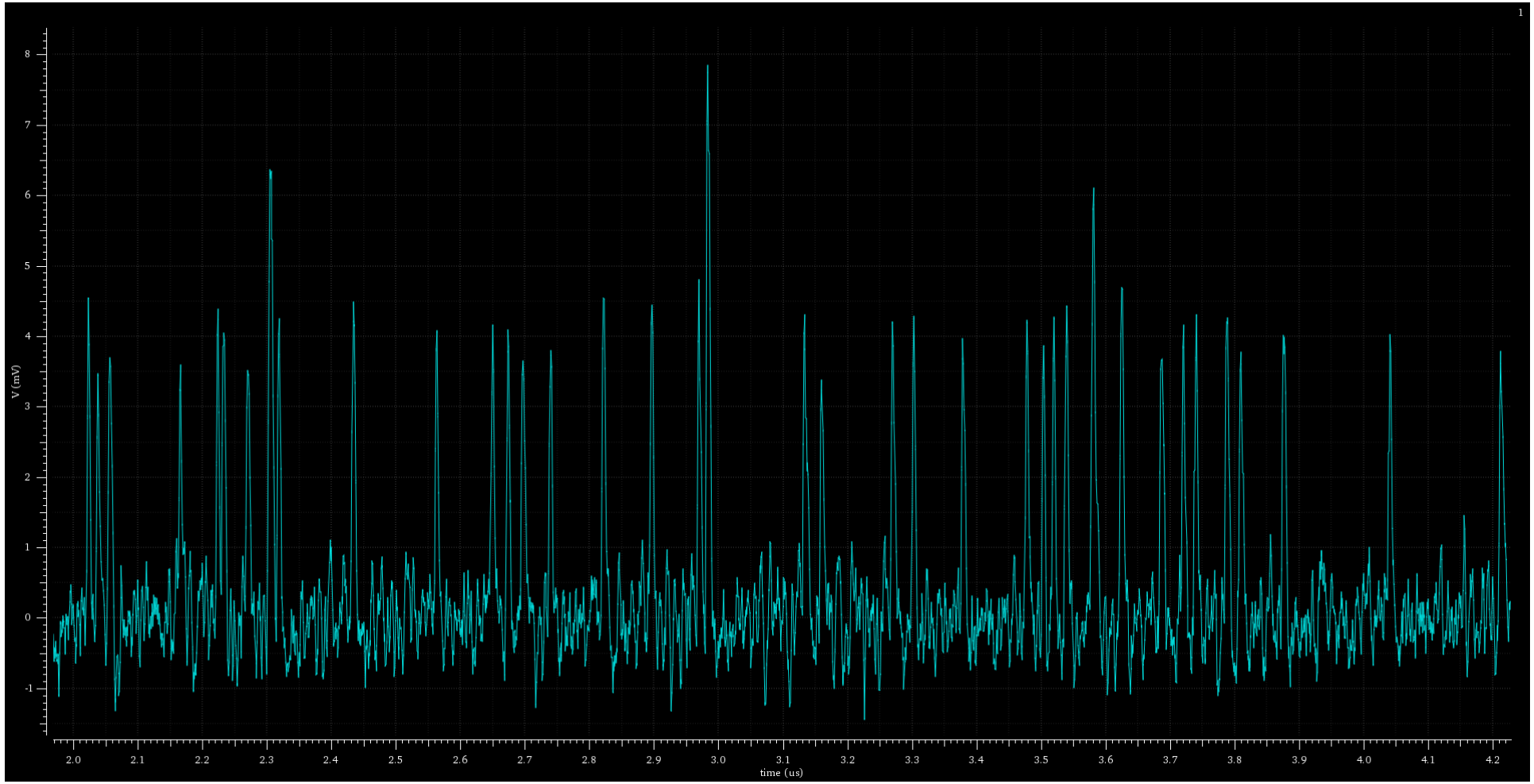
- For all the simulations an FBK 6x6mm2 SiPM has been used

Transient simulation: single pulse



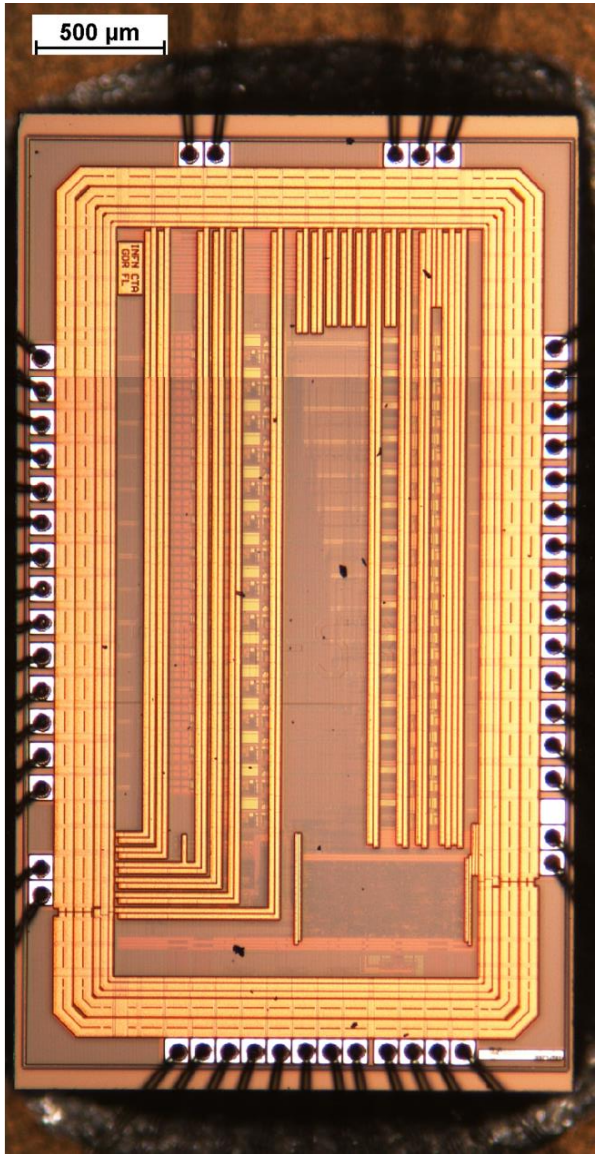
Typical simulation for different gain settings: input signal 1ph (150fC), slow suppression

Noise Transient Simulation



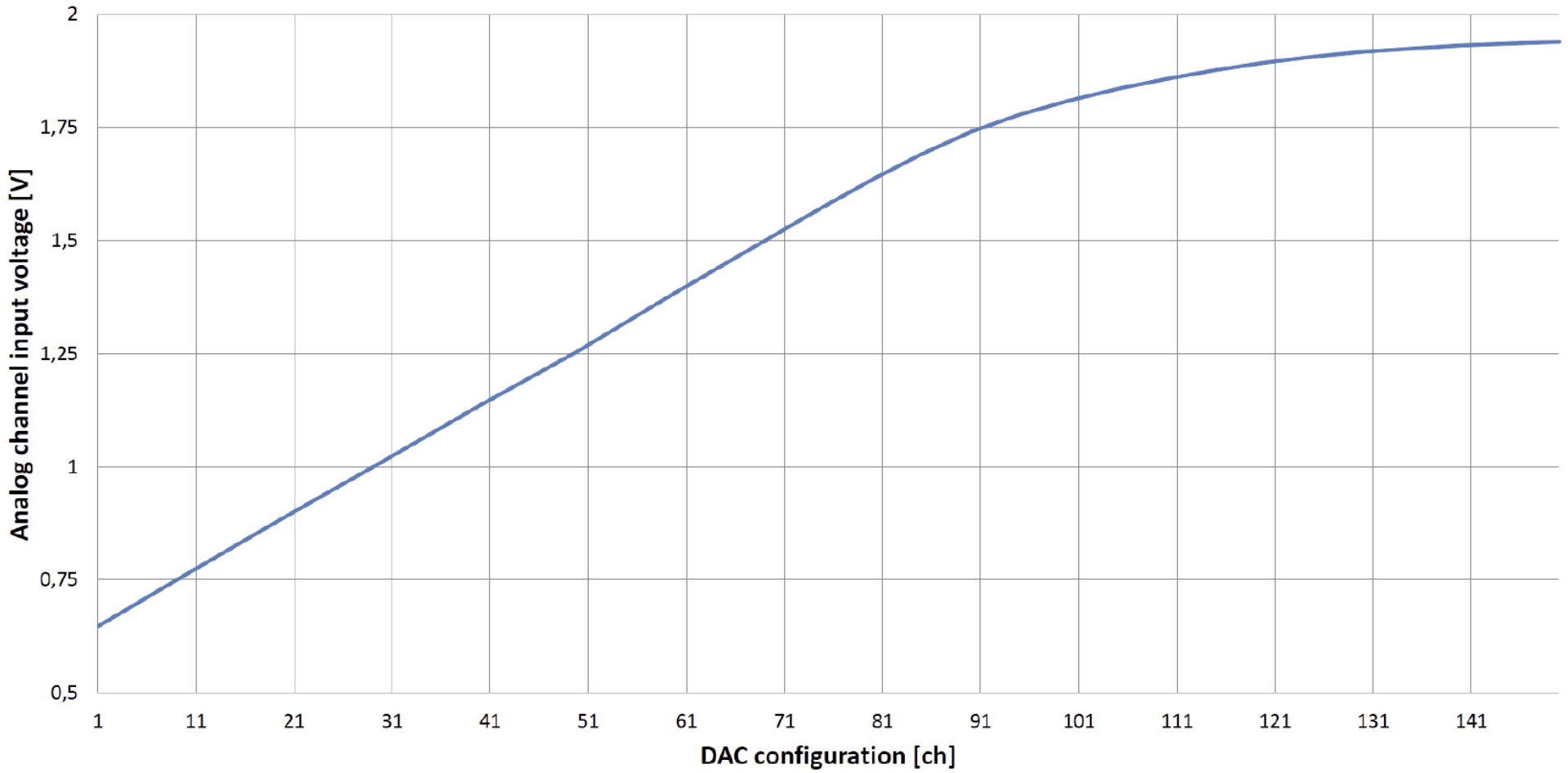
Dark Rate 20MHz

SMART Specifications



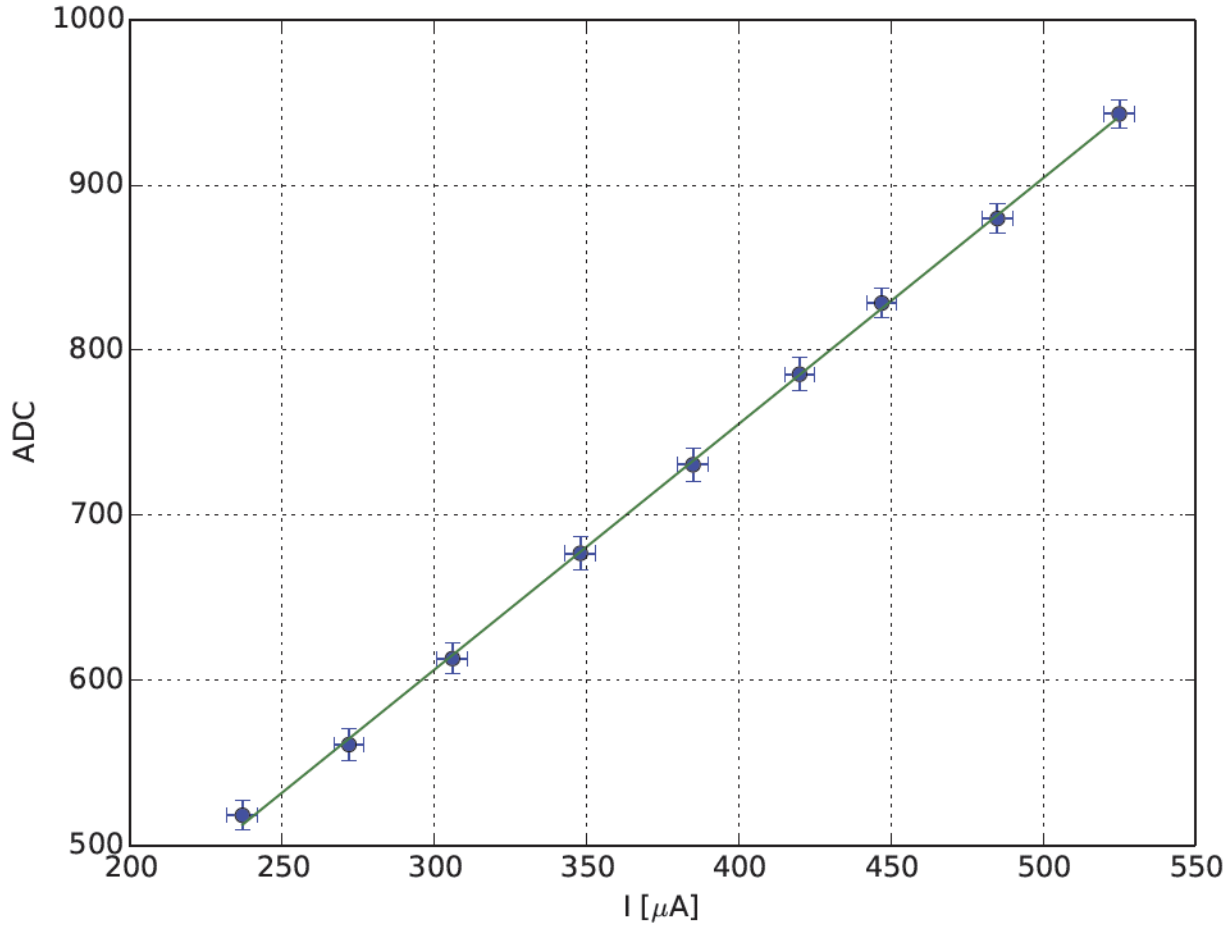
- Dimensions: 2.1 x 3.9 mm^2
- Technology node: 0.35um SiGe
- 16 analog channels
- Digital control and readout: LVDS SPI 1Mbps
- 6 global configuration bits + 8 local bits for each channel
- Chip power consumption: from 290mW to 420mW
- 64 pin CQFP package

SMART measurements: SiPM bias adjust



Analog channel input vs DAC control: LSB = 12.5mV, if DAC value = 0 the channel is off

SMART measurements: SiPM mean current

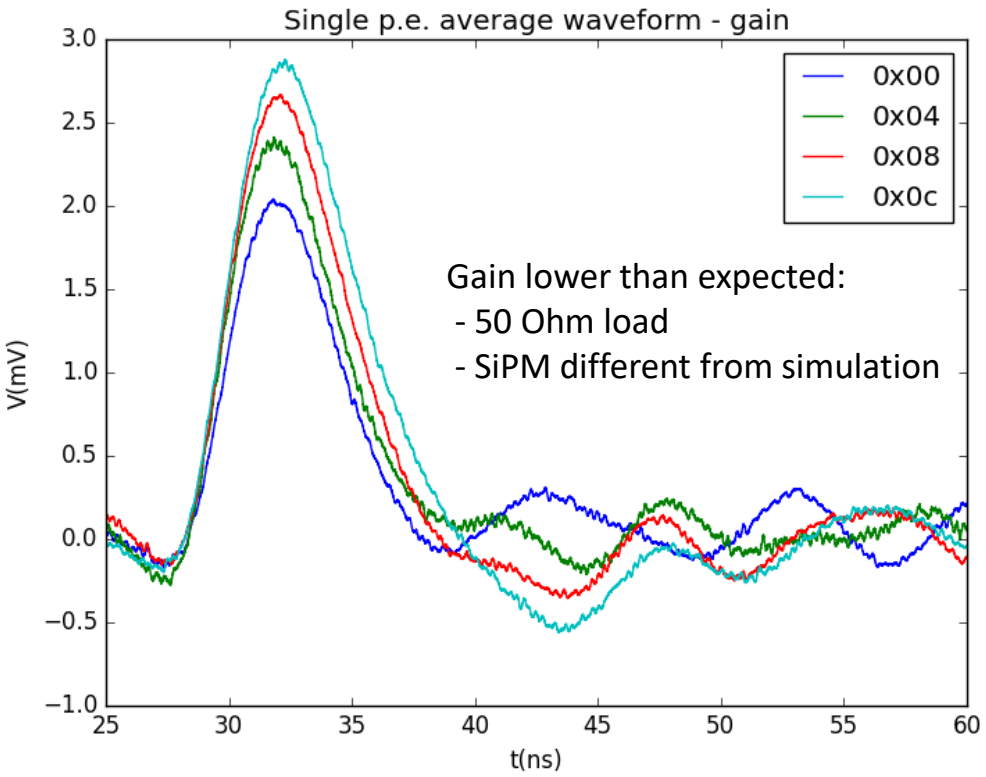


Setup:

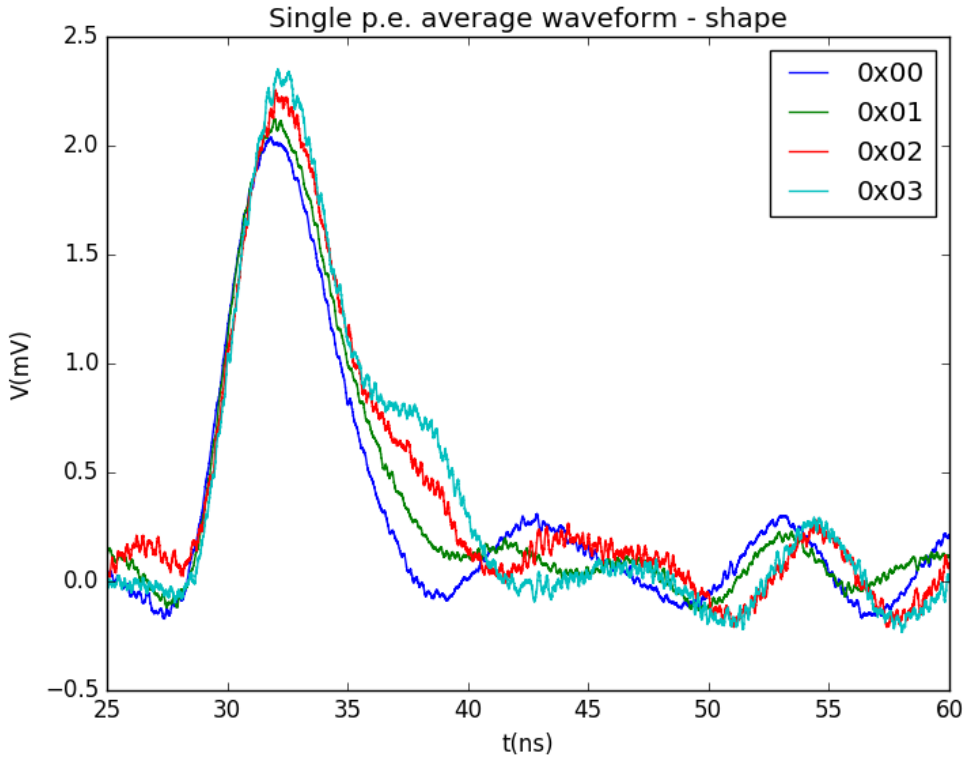
- FBK 6x6mm^2 NUV-HD3 SiPM
- Continuous wave laser
- Pico-amperometer power supply for SiPM bias

SMART slow monitoring output vs SiPM DC current for different CW laser light intensity, the measured sensitivity is 1.5*ADC_ch/µA* => LSB = 670 nA .

SMART measurements: output pulses



Single p.e for different gain adj.: Gain ≈ 2-3 mV/p.e.



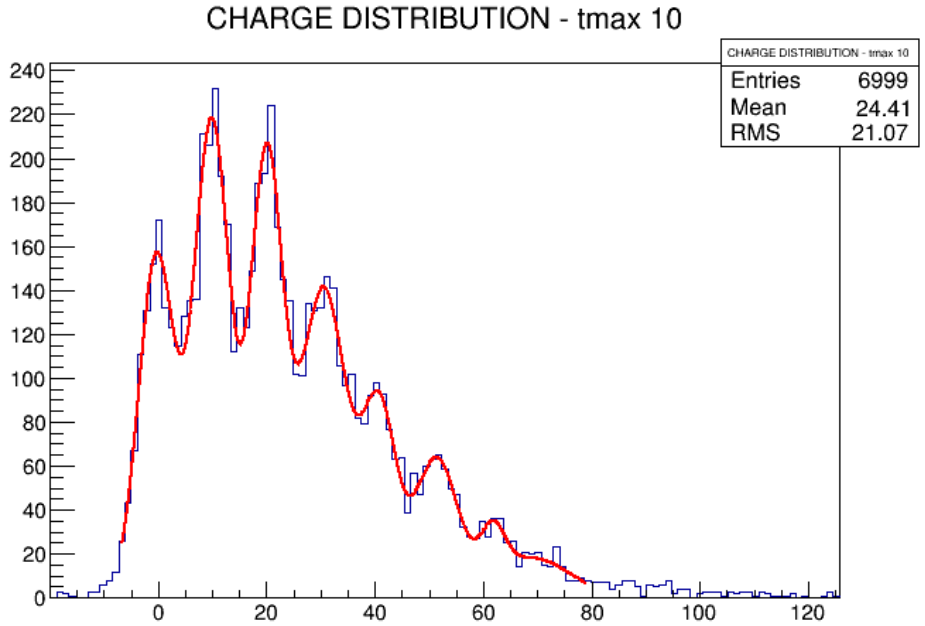
Single p.e for different shaping adj.: LSB ≈ 0.8ns

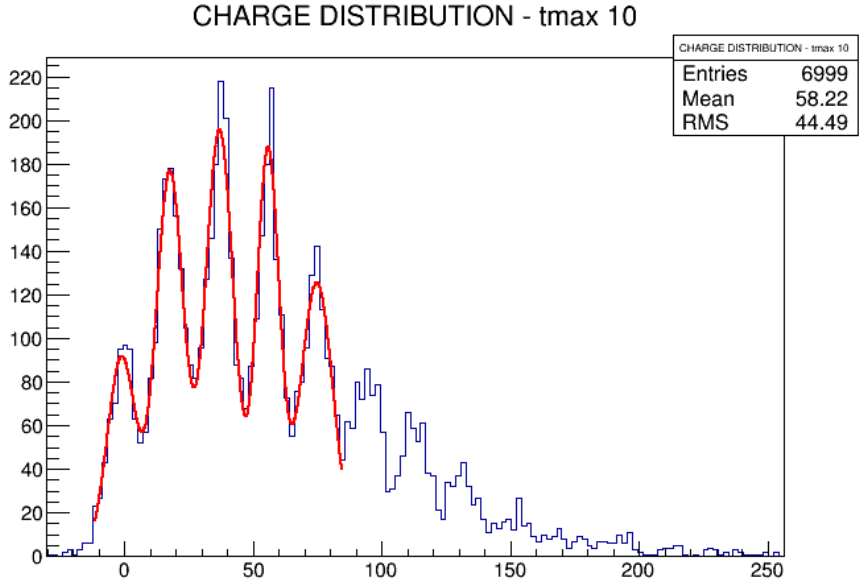
Setup:

- 4x4 NUV-HD3 matrix
- Vbias = 33V (Over Voltage = 6V)
- All channels active; light only on channel 7; channel 7 read.
- 50ps FWHM laser pulser

SMART measurements: Charge Finger Plots

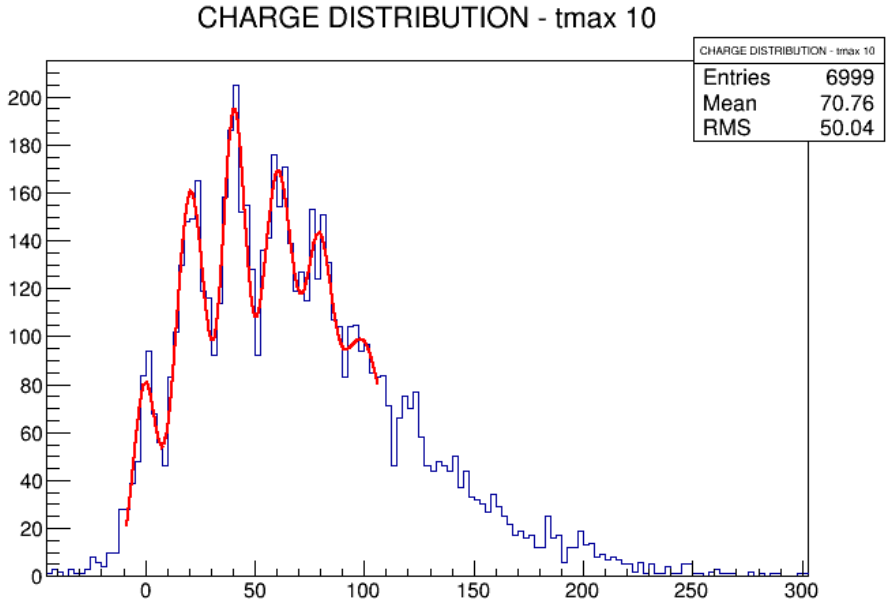
Highest Input Z
Lowest gain
Fastest Shaping

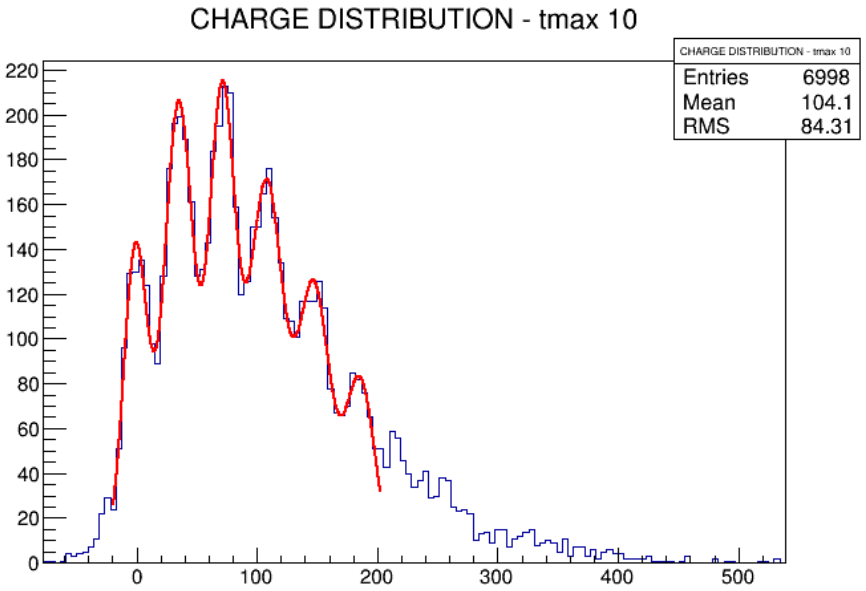




Lowest Input Z
Lowest gain
Fastest Shaping

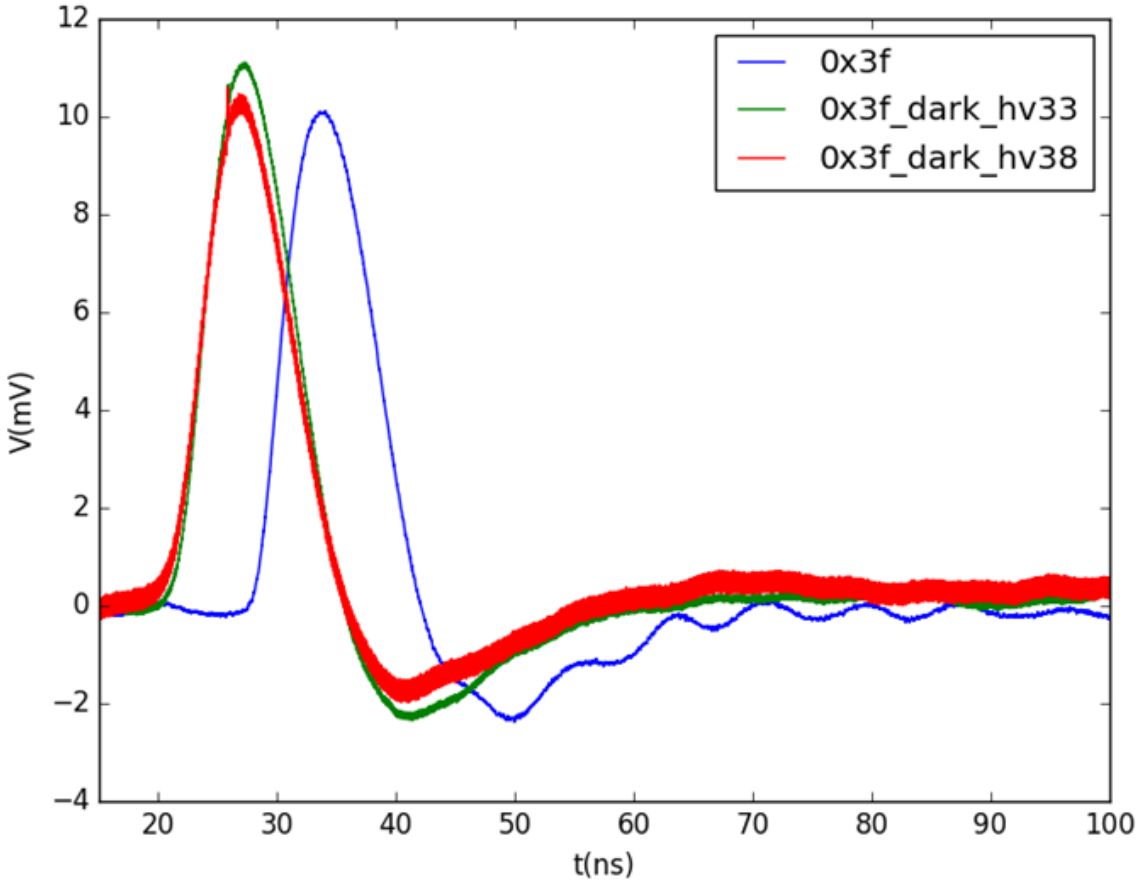
Highest Input Z
Highest gain
Slowest Shaping





Lowest Input Z
Highest gain
Slowest Shaping

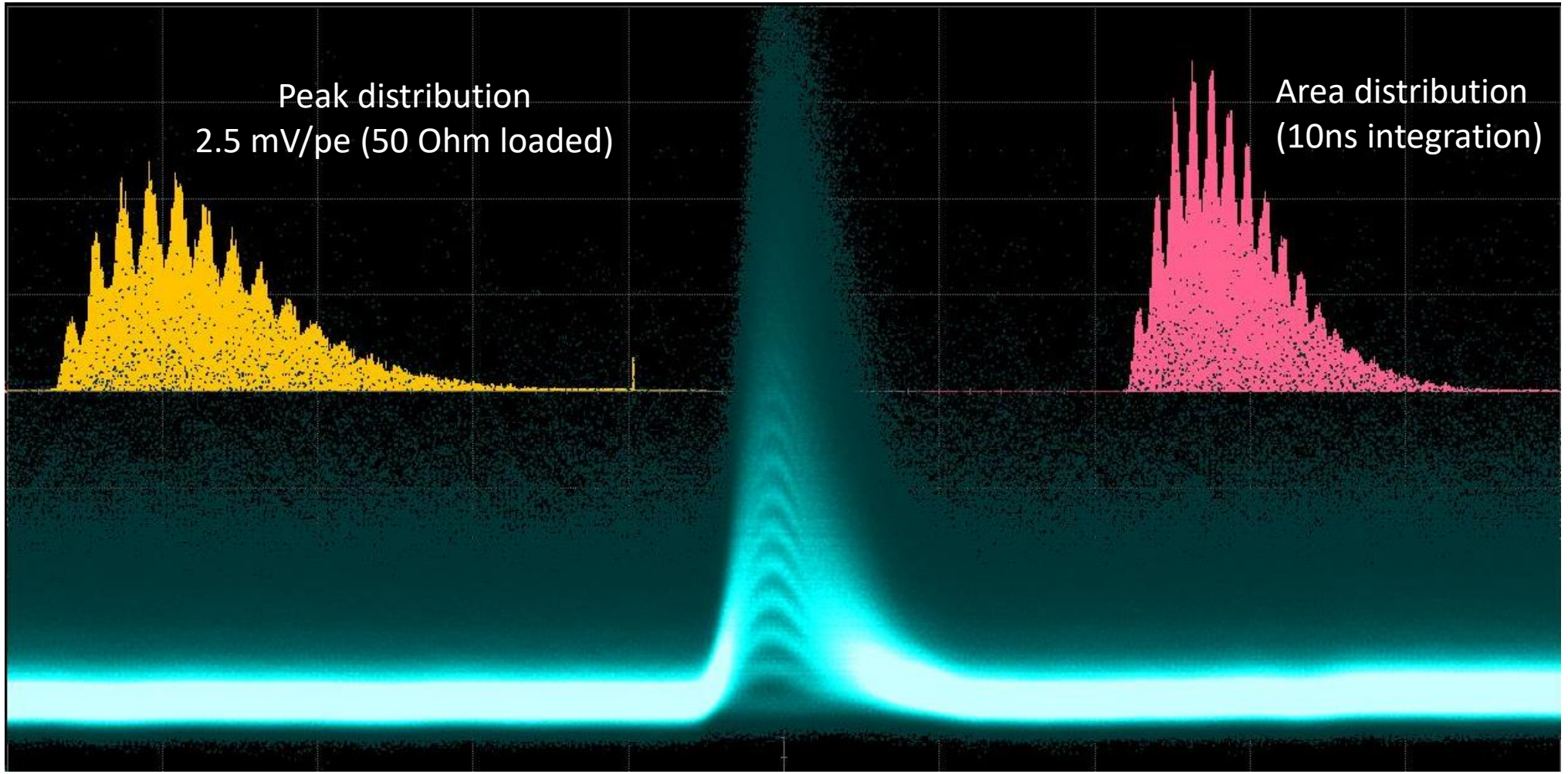
SMART measurements: dark pulses



Comparison between laser & dark pulses, a ripple is present:

- Laser trigger very noisy
- PCB parasitic feedback source of oscillations

SMART measurements



FBK HD3 single SiPM connected to one ASIC channel (no matrix), 50ps FWHM laser pulser
Oscilloscope settings: horizontal axis 10ns/div, vertical axis 10mV/div

Future perspectives

- Further characterization: xtalk, all SiPMs of the matrix lighted
- SMART & TARGET characterization
- New PCB design
- Second version of SMART?