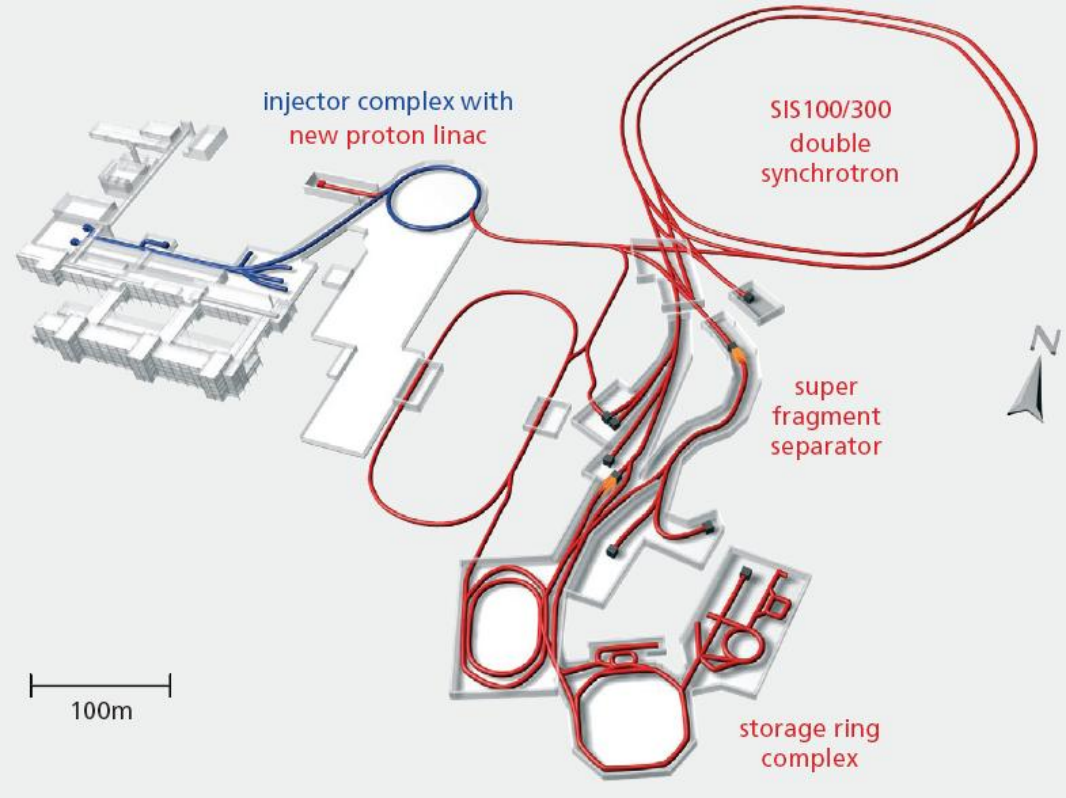
Science & Technology Facilities Council

AIDA : a 16-Channel Amplifier ASIC to Read Out the Advanced Implantation Detector Array for Experiments in Nuclear Decay Spectroscopy

Davide Braga

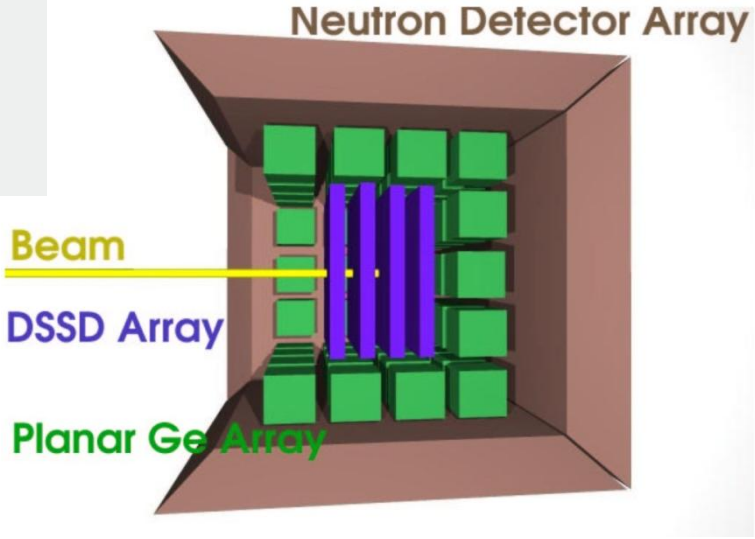
Stephen Thomas

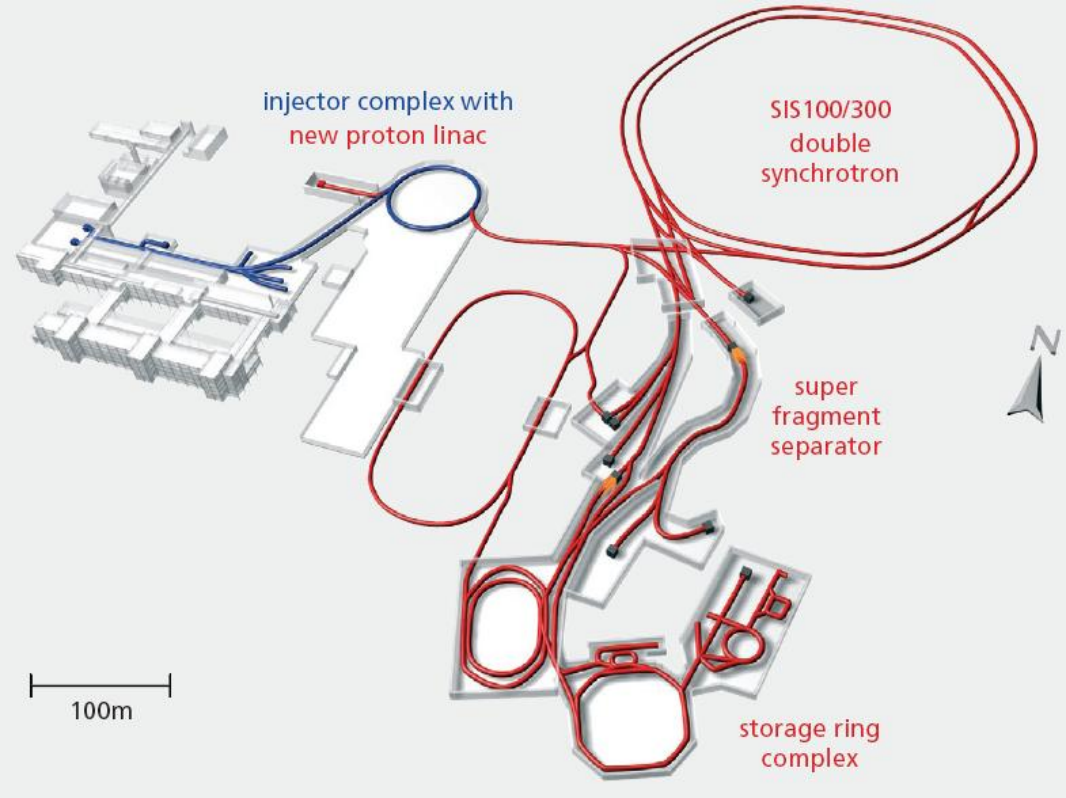
Rutherford Appleton Laboratory, STFC



FAIR, GSI
(Facility for Antiproton and Ion Research)

DESPEC
(DEcay SPECtroscopy)





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High Energy Implant:
≤ 20 GeV

Low-Energy Decay:
≥ 25 KeV

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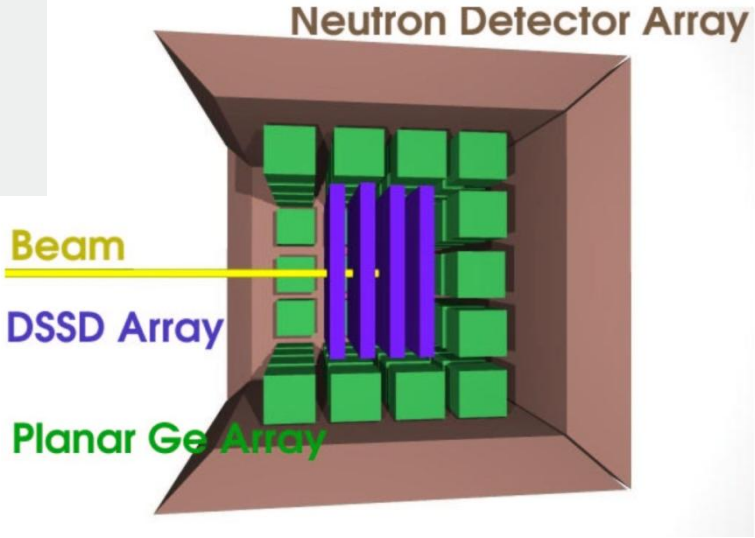


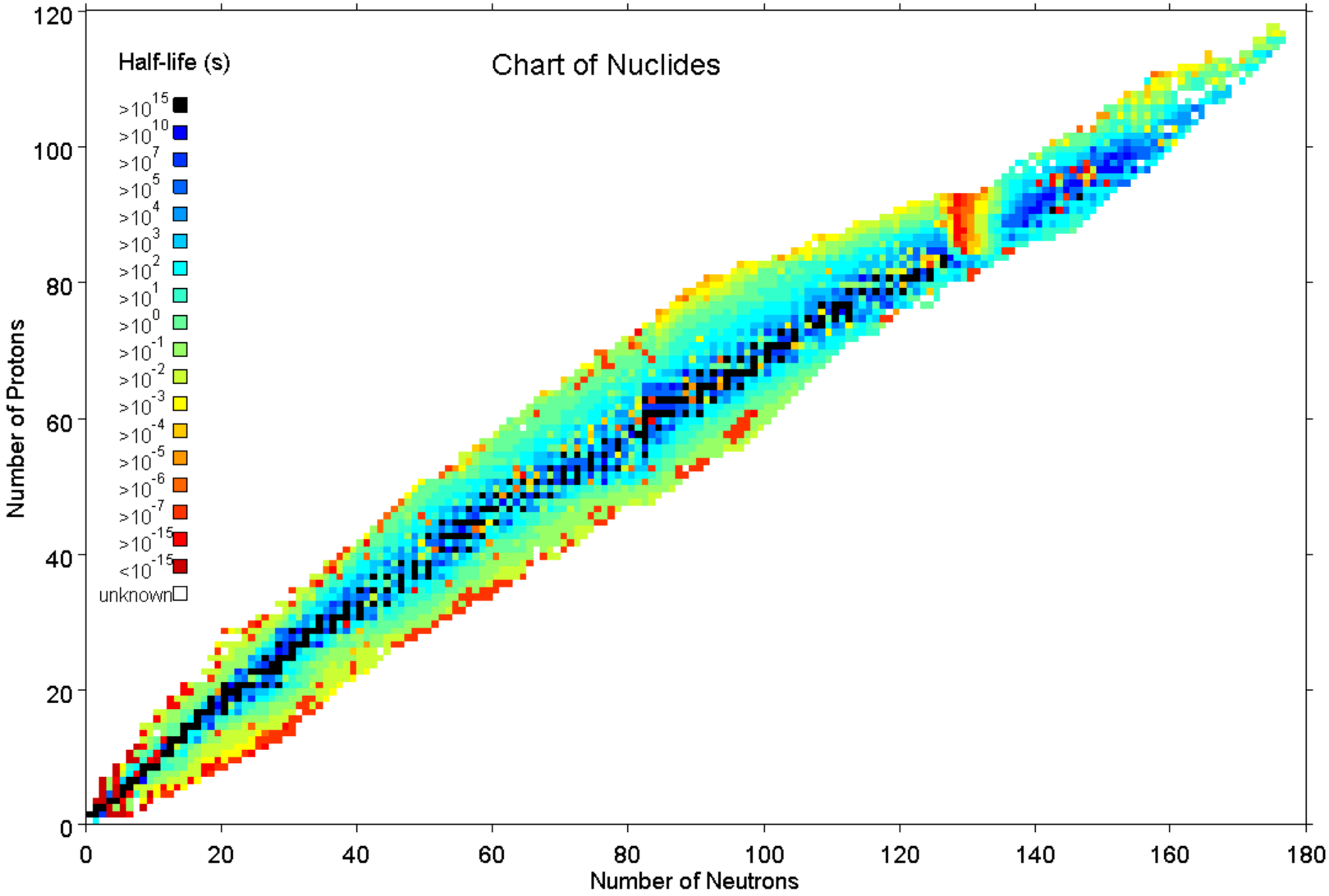
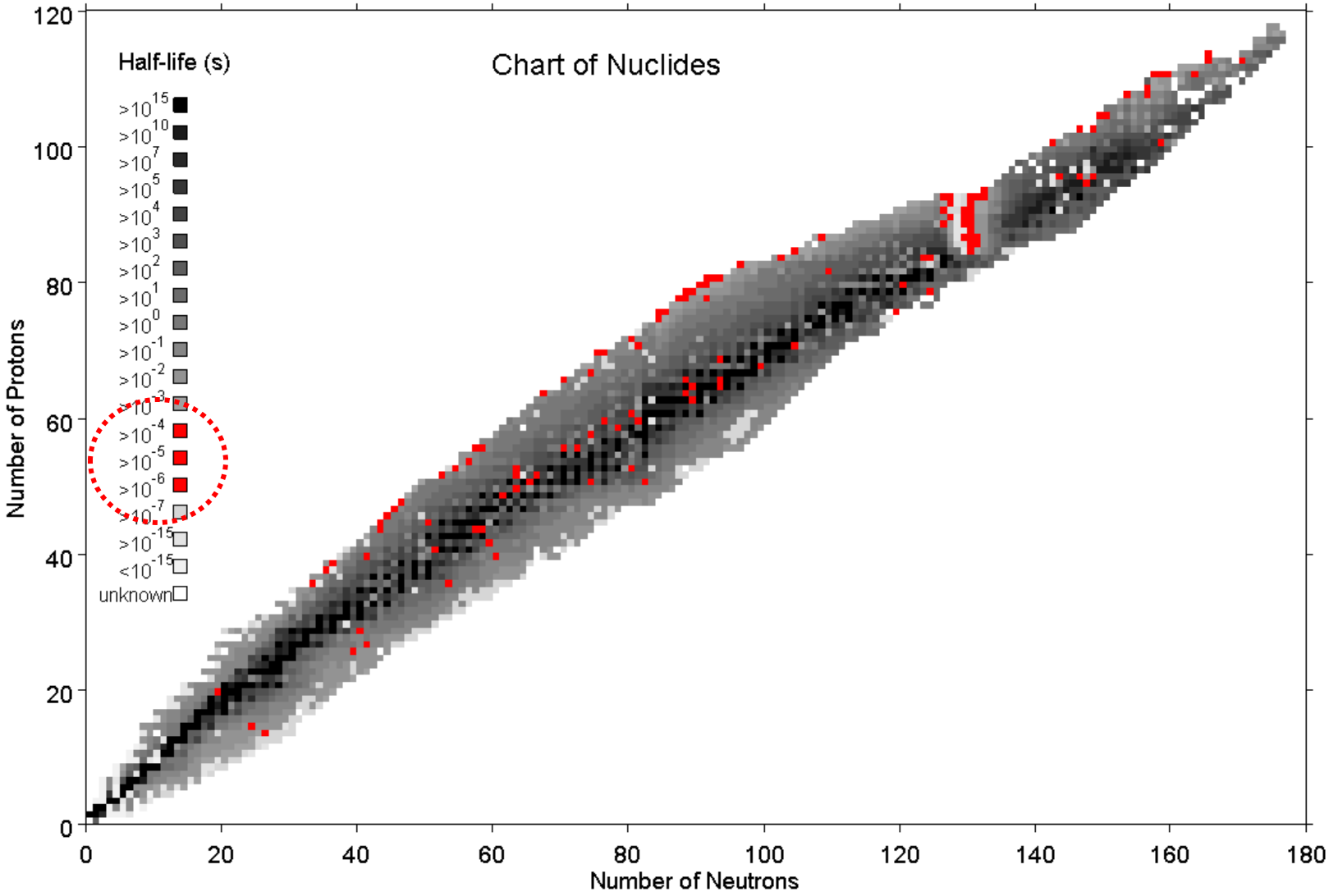


Chart of Nuclides
Half-life (s)
>10^15
>10^10
>10^7
>10^5
>10^4
>10^3
>10^2
>10^1
>10^0
>10^-1
>10^-2
>10^-3
>10^-4
>10^-5
>10^-6
>10^-7
>10^-15
<10^-15
unknown
Number of Protons
Number of Neutrons
0
20
40
60
80
100
120
140
160
180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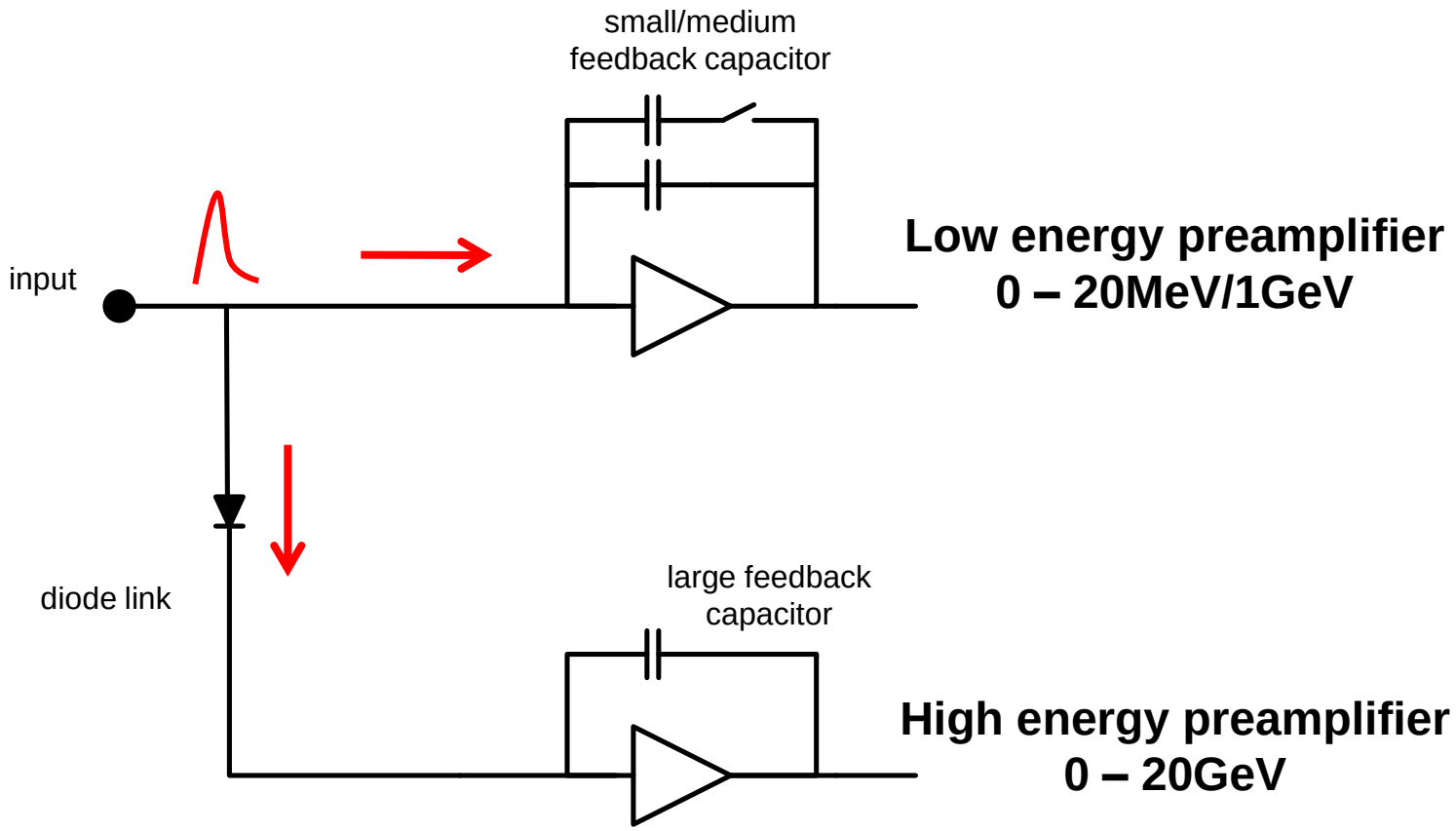
Specifications

- Input range: 20GeV → 25KeV (~10^6 :1)
- Short separation between high and low energies events (<10µs)
- Integral non linearity < 0.1%
- Autonomous overload detection and recovery
- Input referred noise 5KeV

Front end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feedback capacitor
input
Low energy preamplifier
0 – 20MeV/1GeV
diode link
large feedback
capacitor
High energy preamplifier
0 – 20GeV

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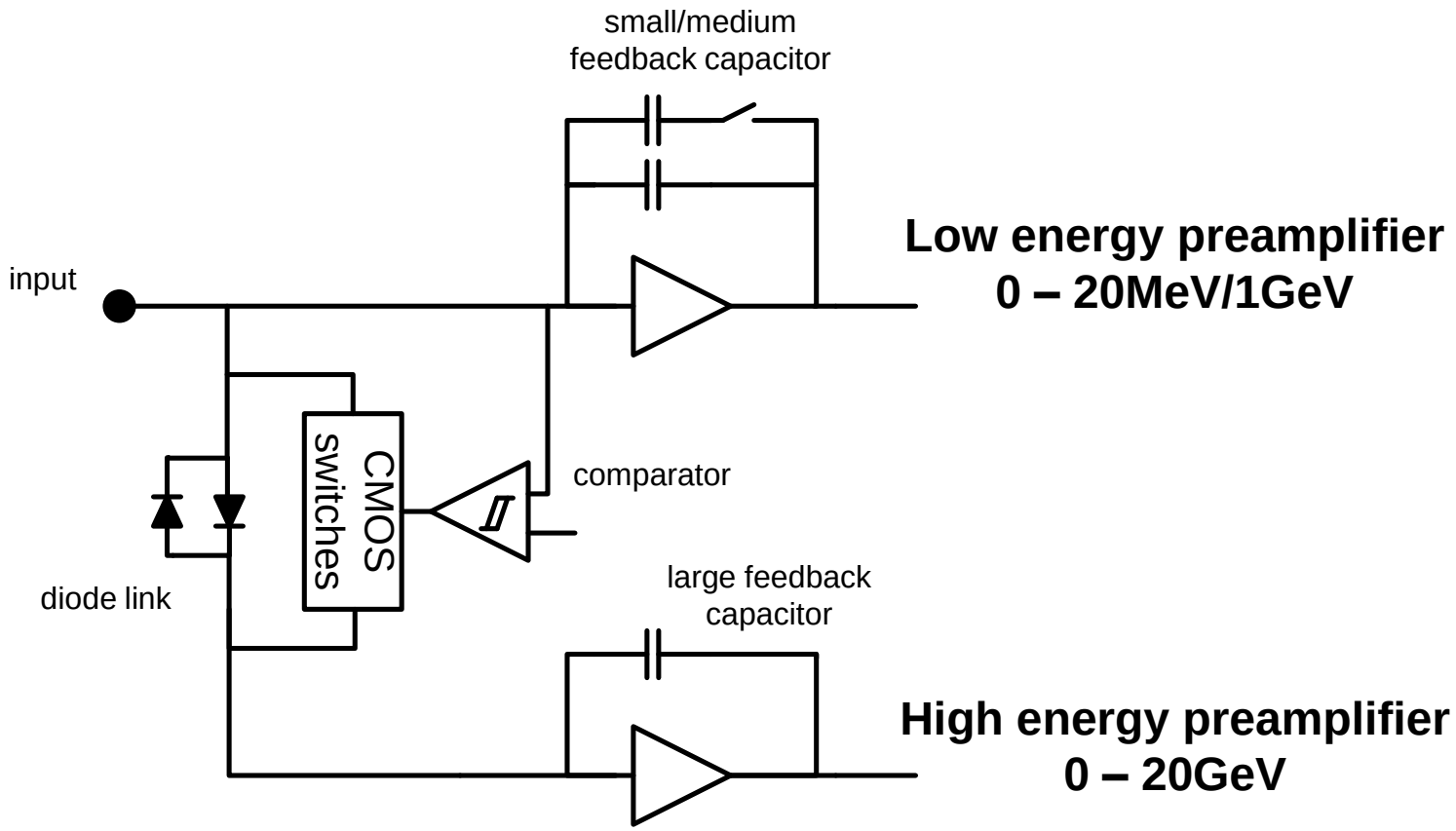
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Low energy preamplifier
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diode link
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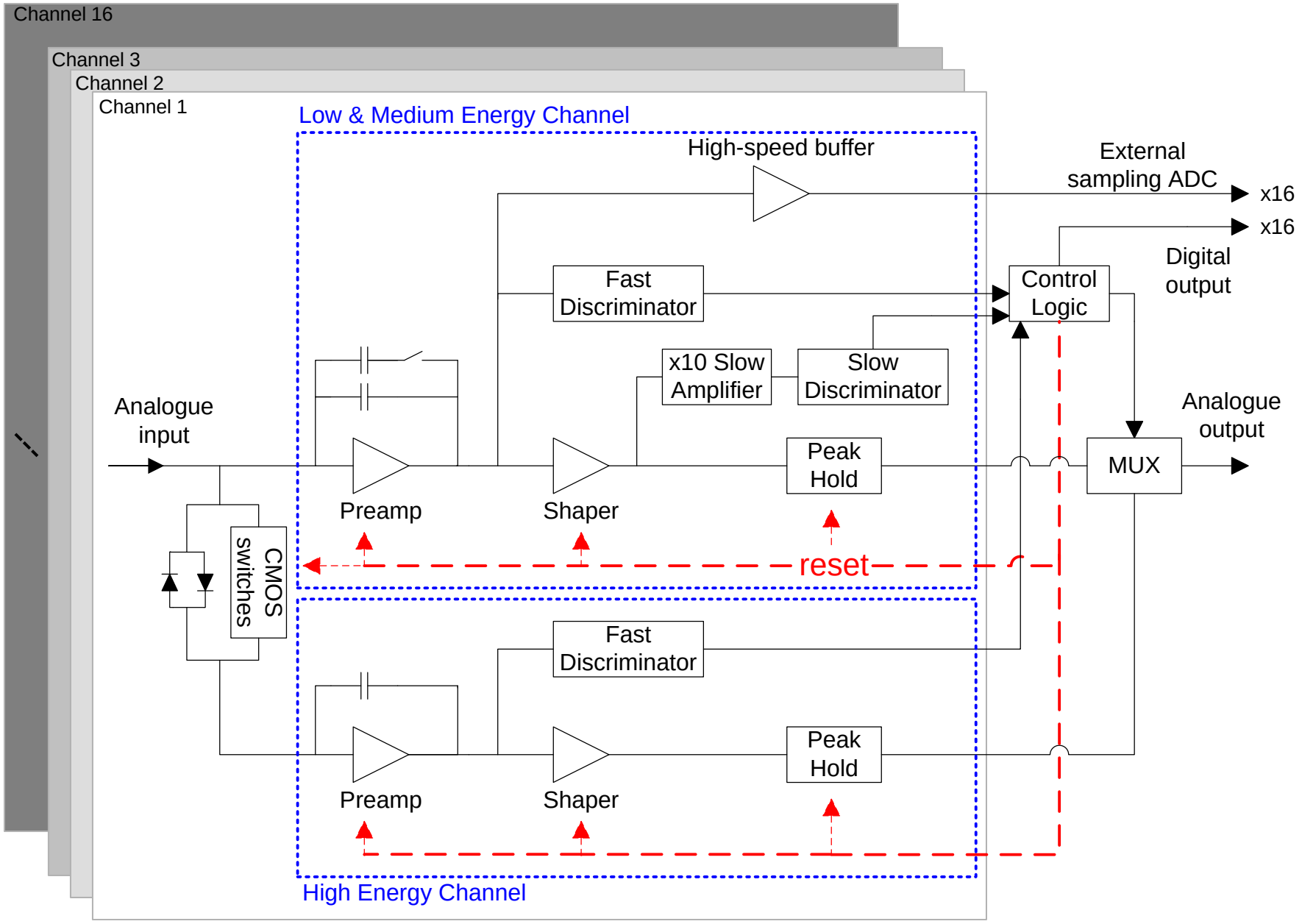
Channel 16
Channel 3
Channel 2
Channel 1
Low & Medium Energy Channel
High-speed buffer
External sampling ADC
x16
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Digital output
Fast Discriminator
Control Logic
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Slow Discriminator
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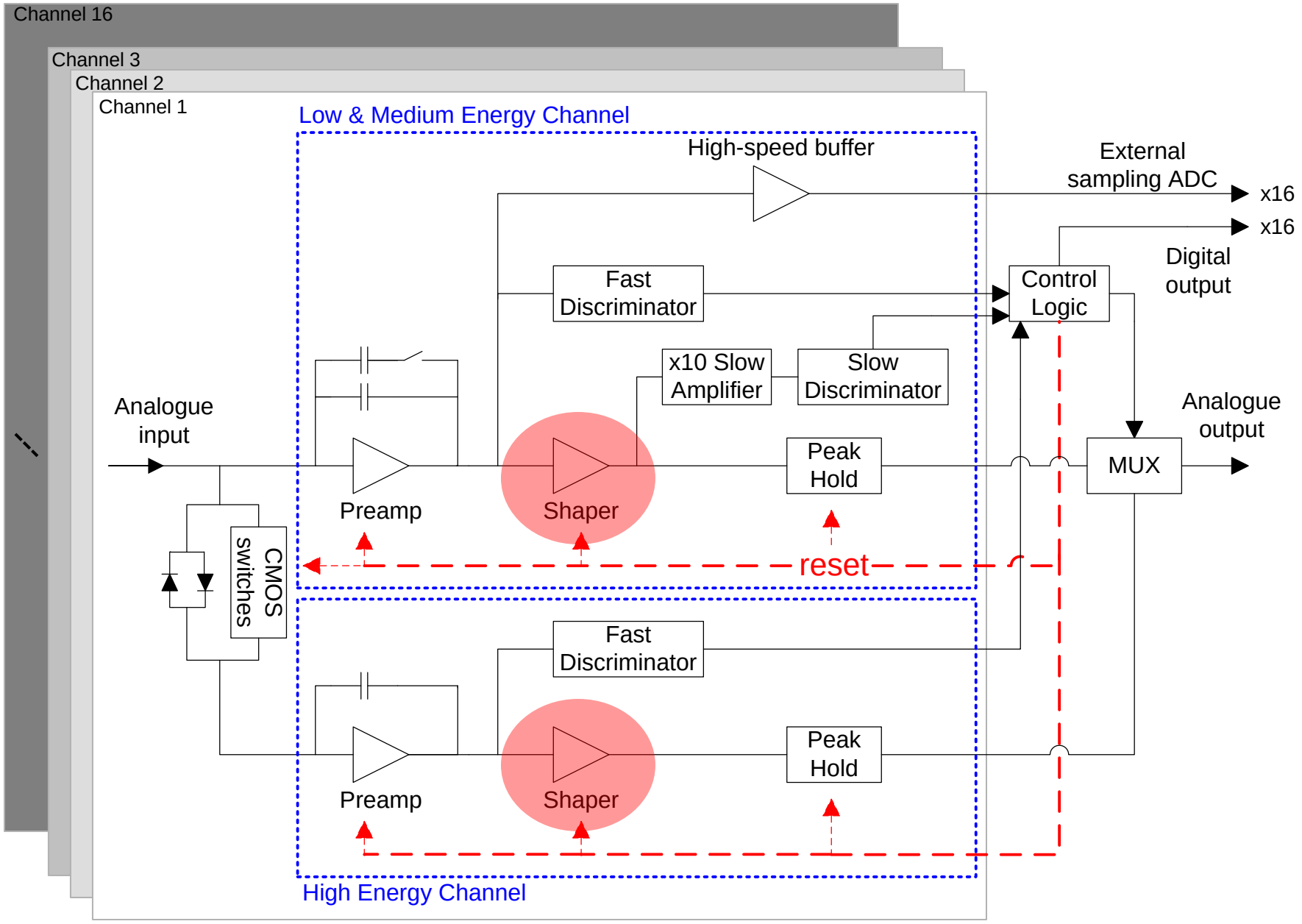
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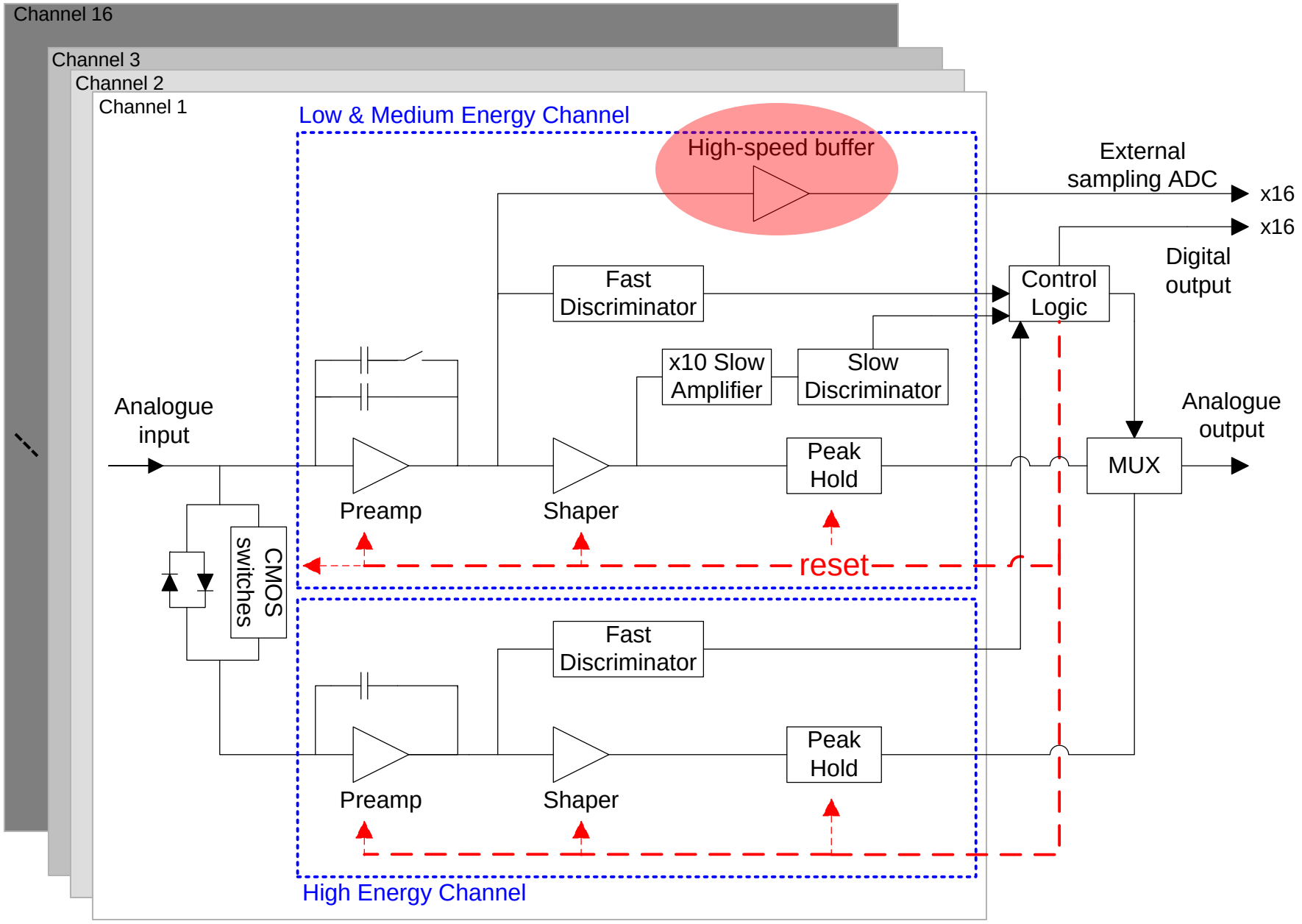
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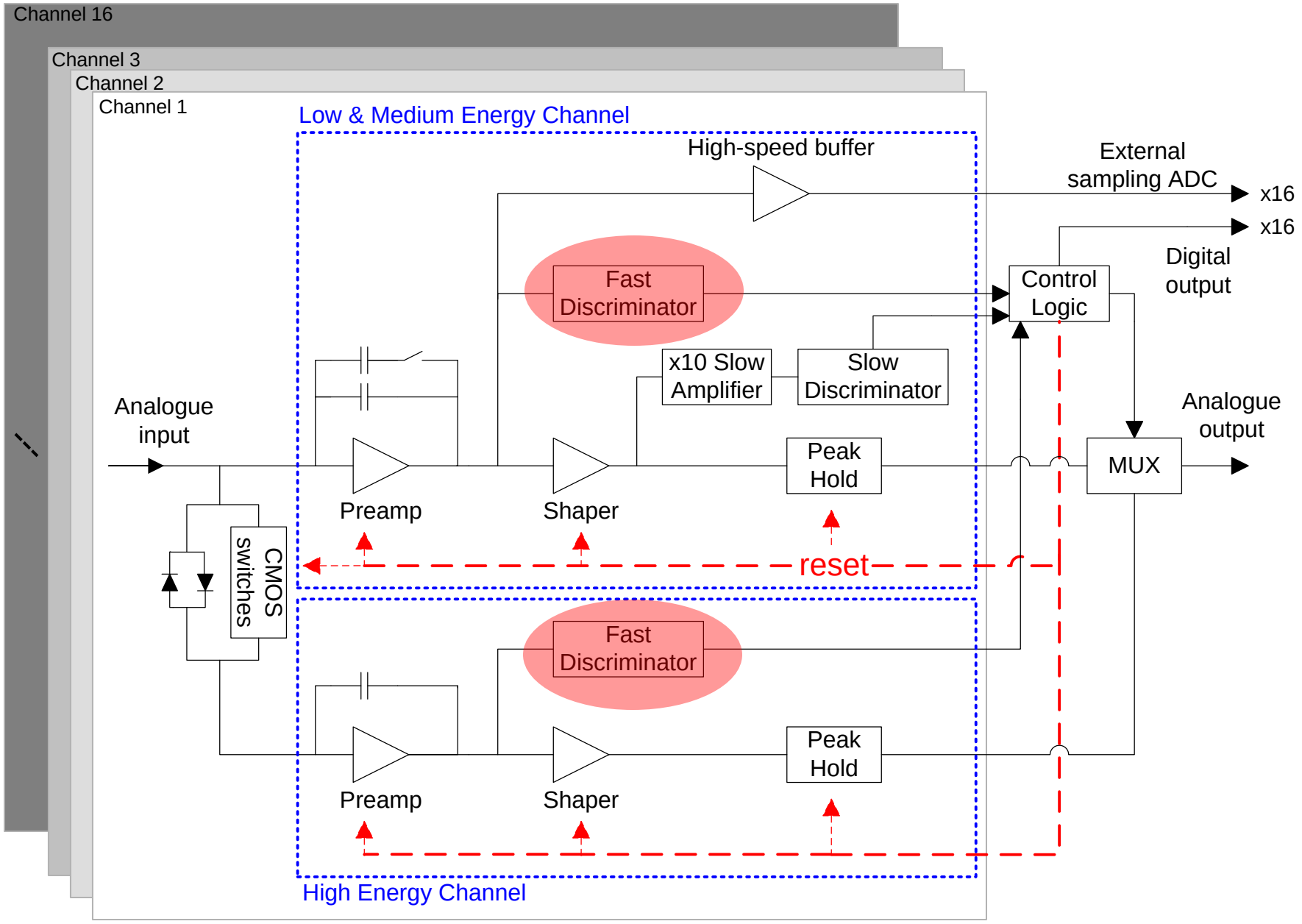
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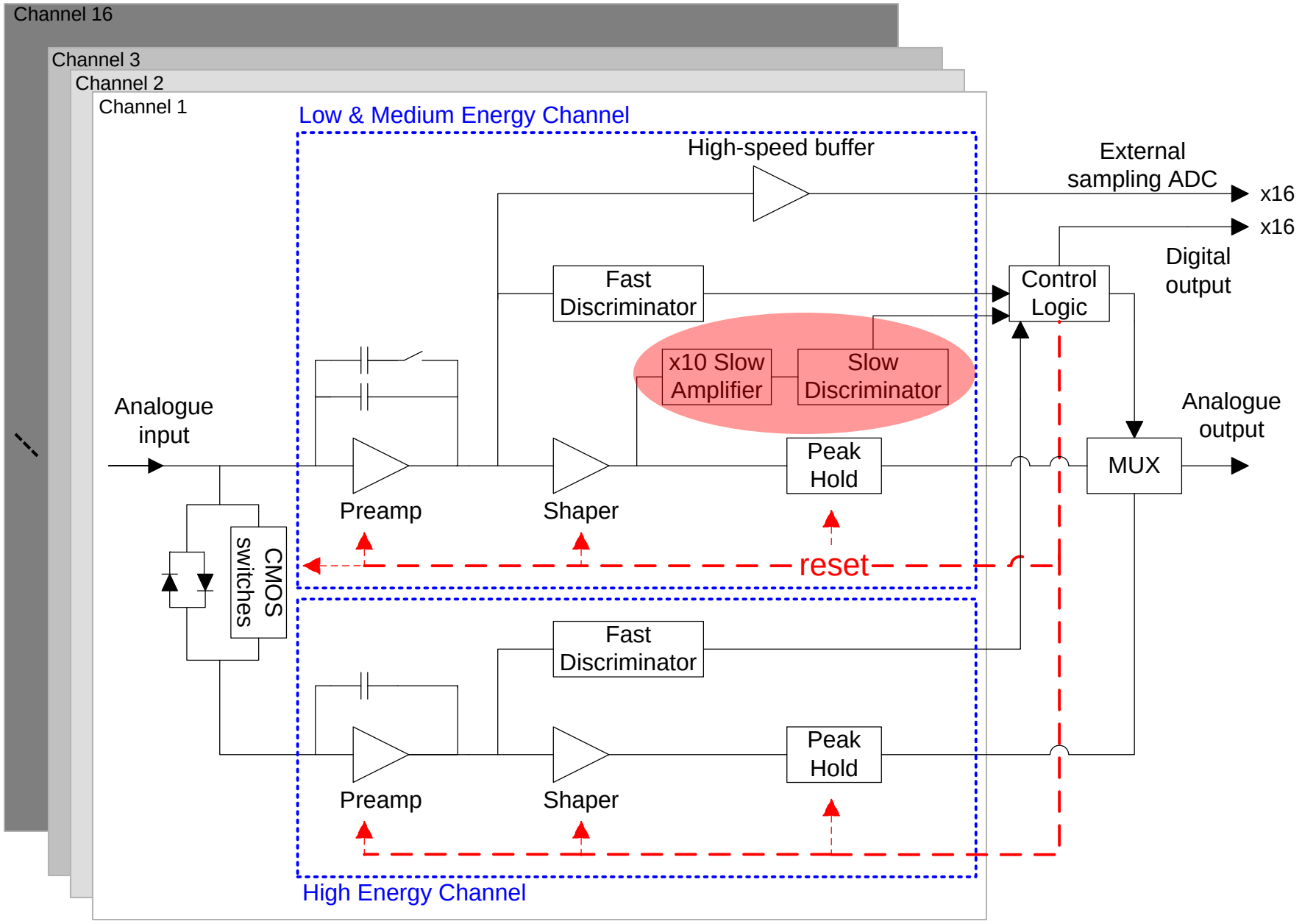
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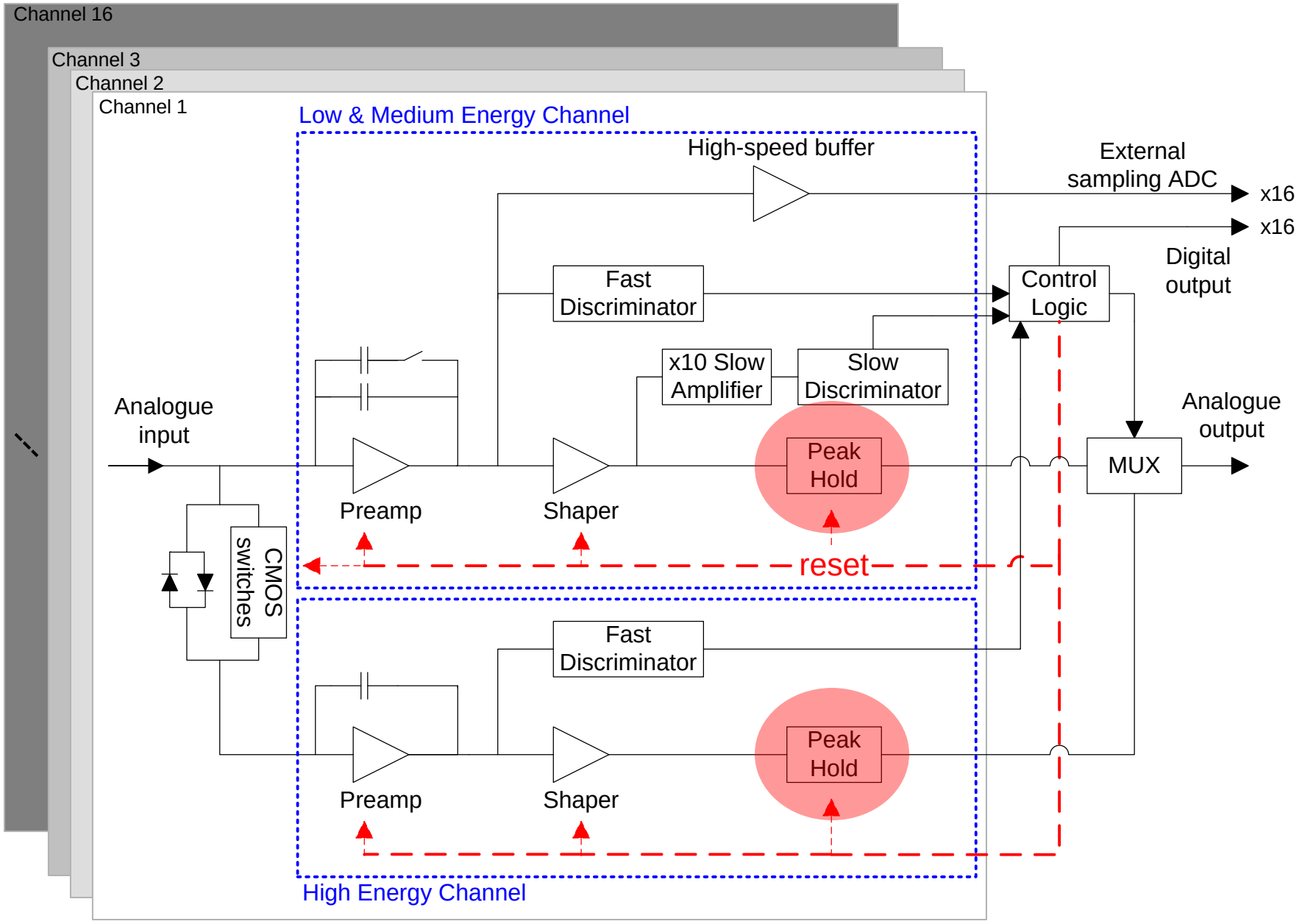
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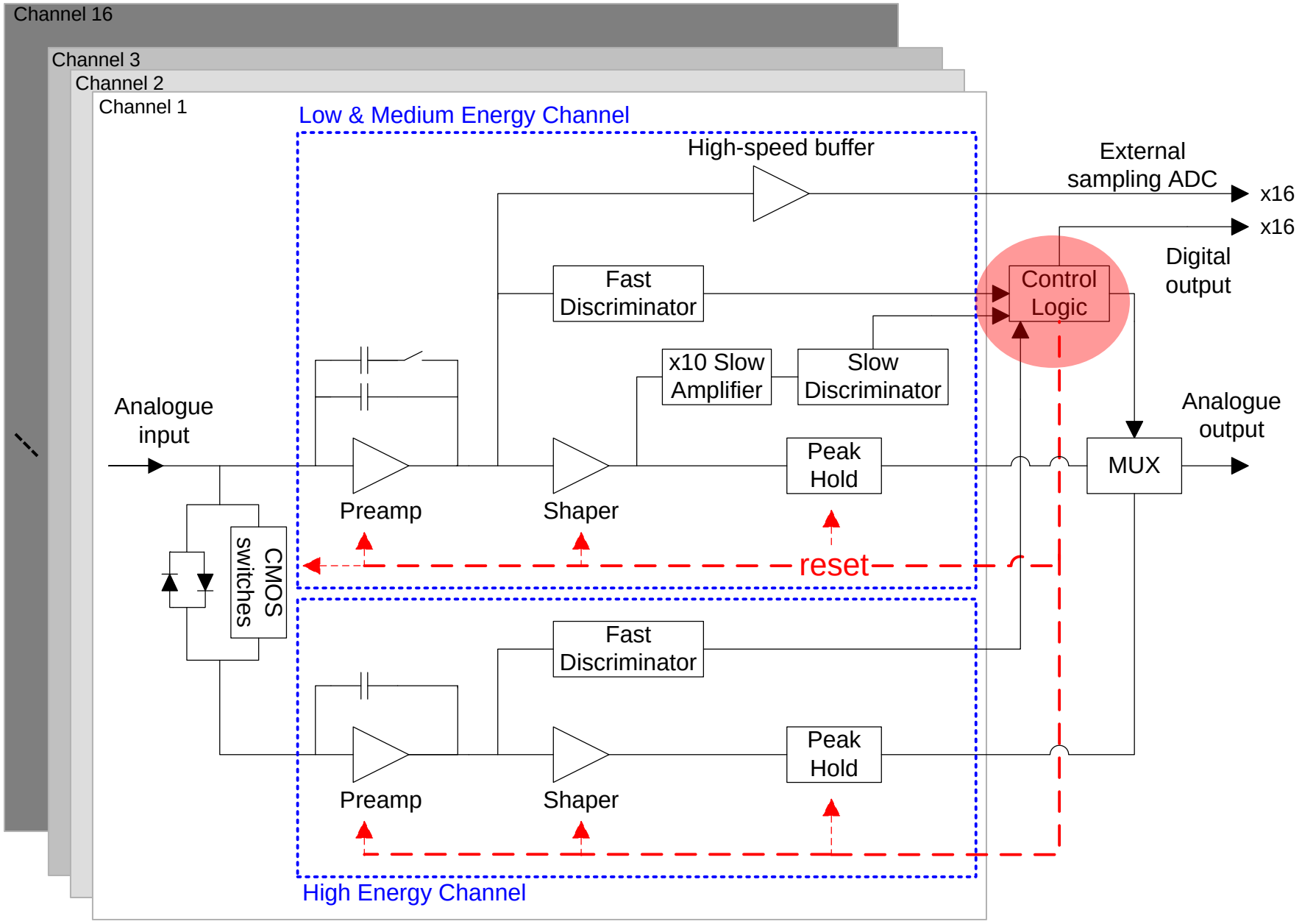
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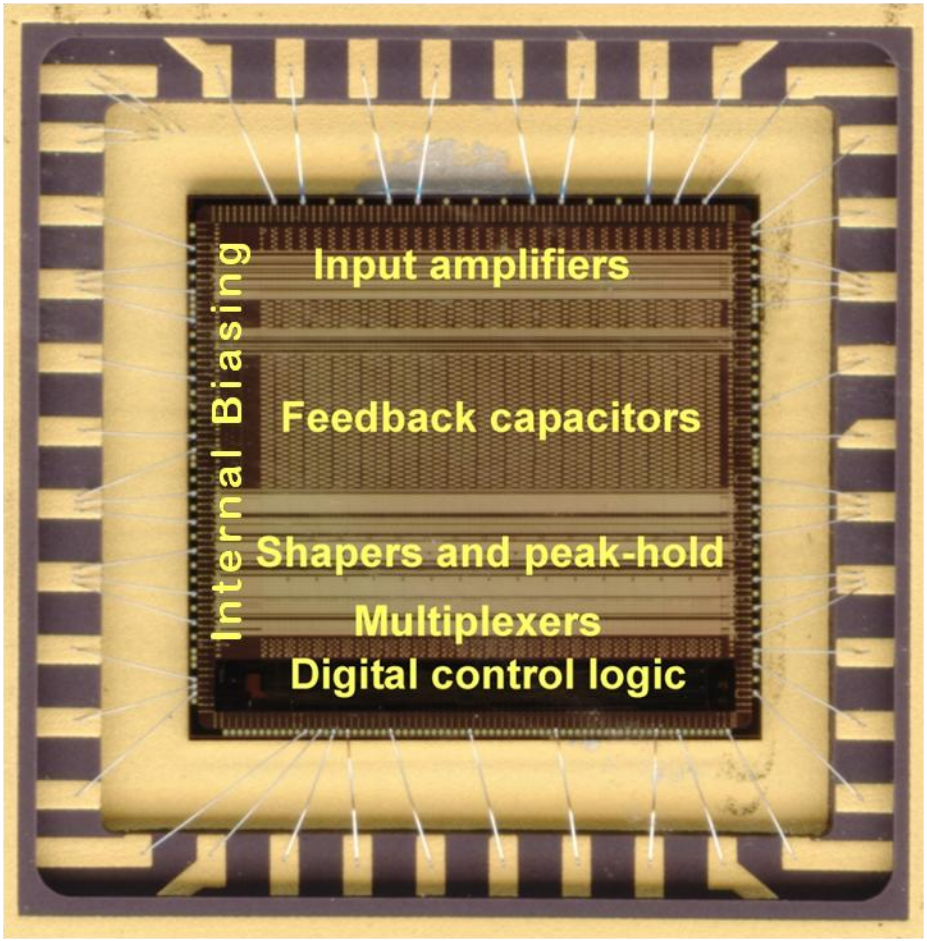
Layout

Front End



Back End

-Large feedback capacitors

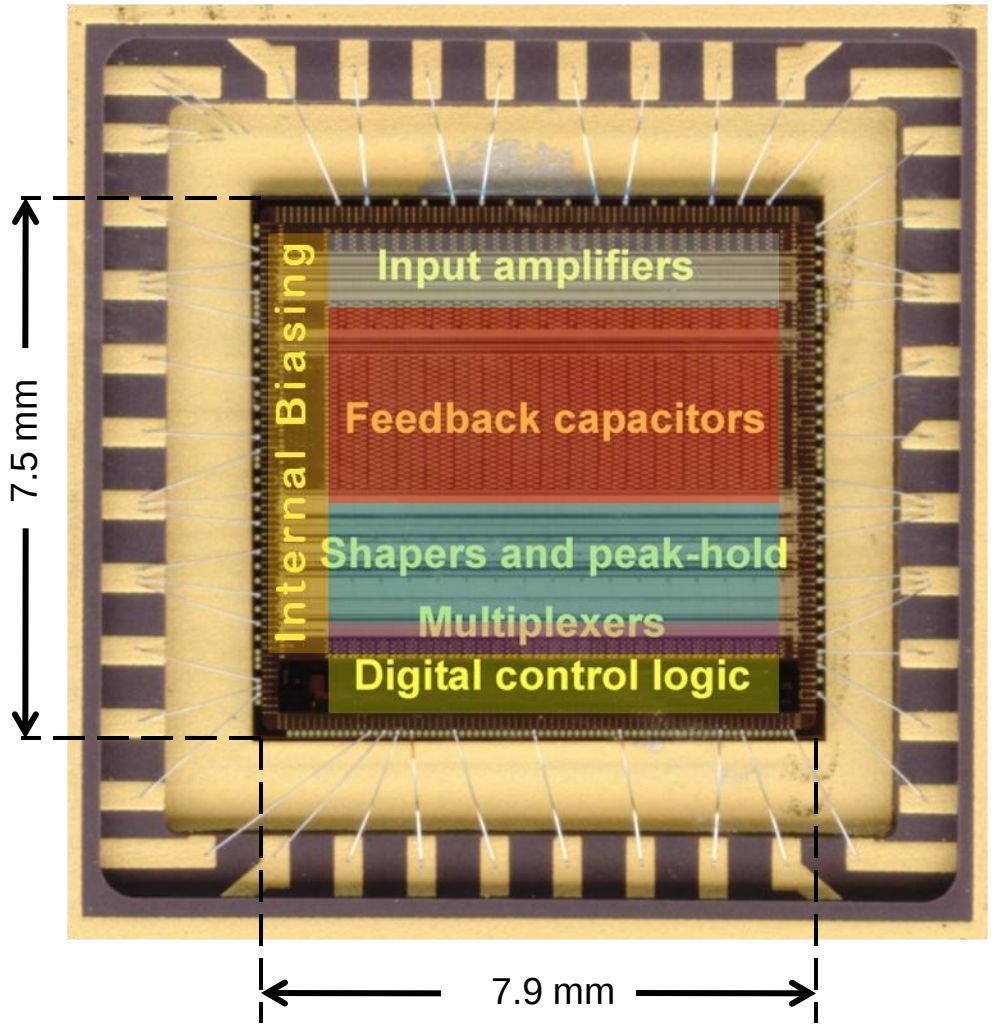
-Internal biasing

-Low-impedance power distribution:

-high number of PADs to gnd/vdd

-maximized metal coverage

Layout



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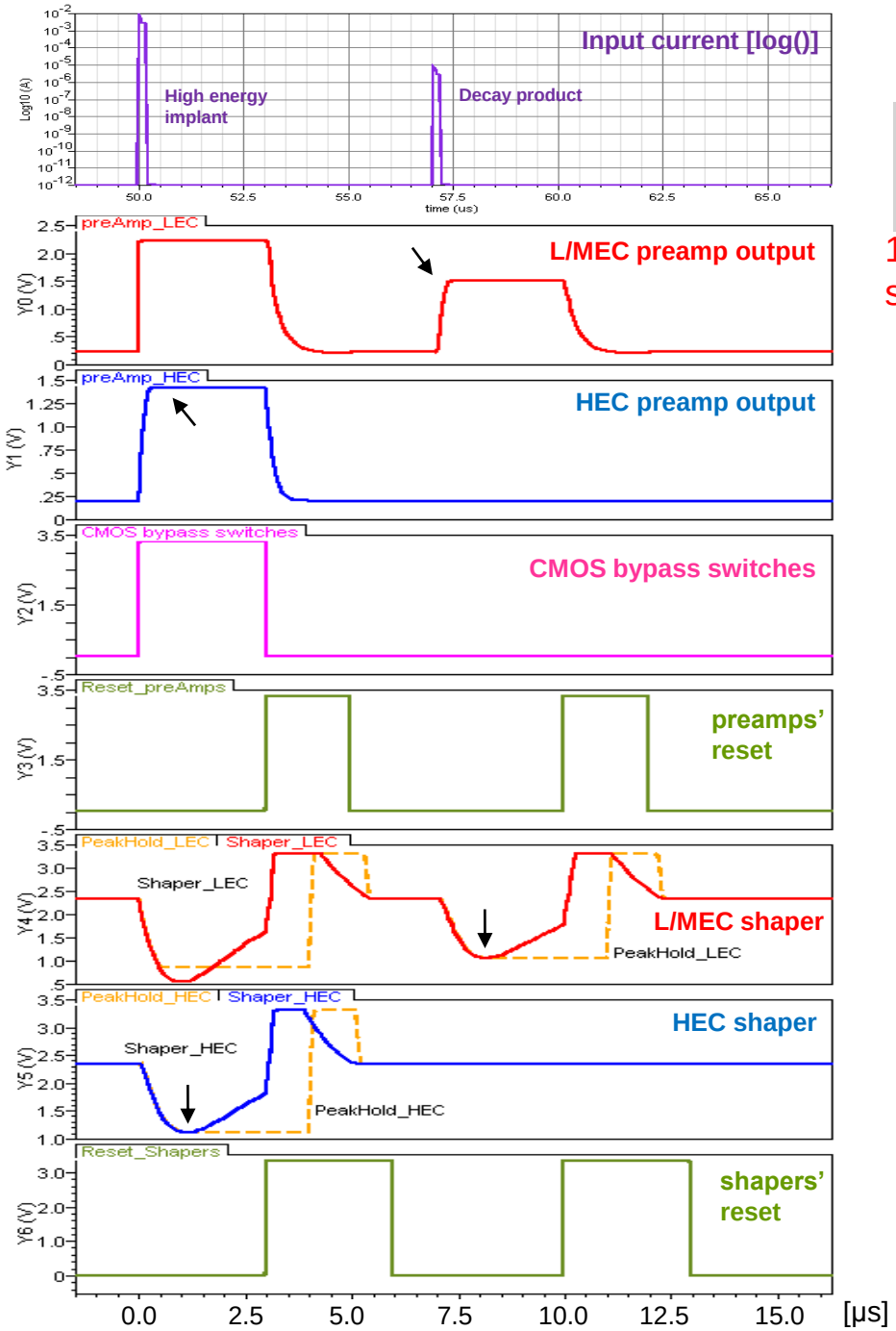

High-energy implant

1: LEC preamp saturates

3: HEC preamp integrates the input signal

2: CMOS bypass switches activate

5: preamplifiers (and CMOS switches) are reset

4: signal shaped, peak hold and read out

6: shapers are reset

Low-energy decay event

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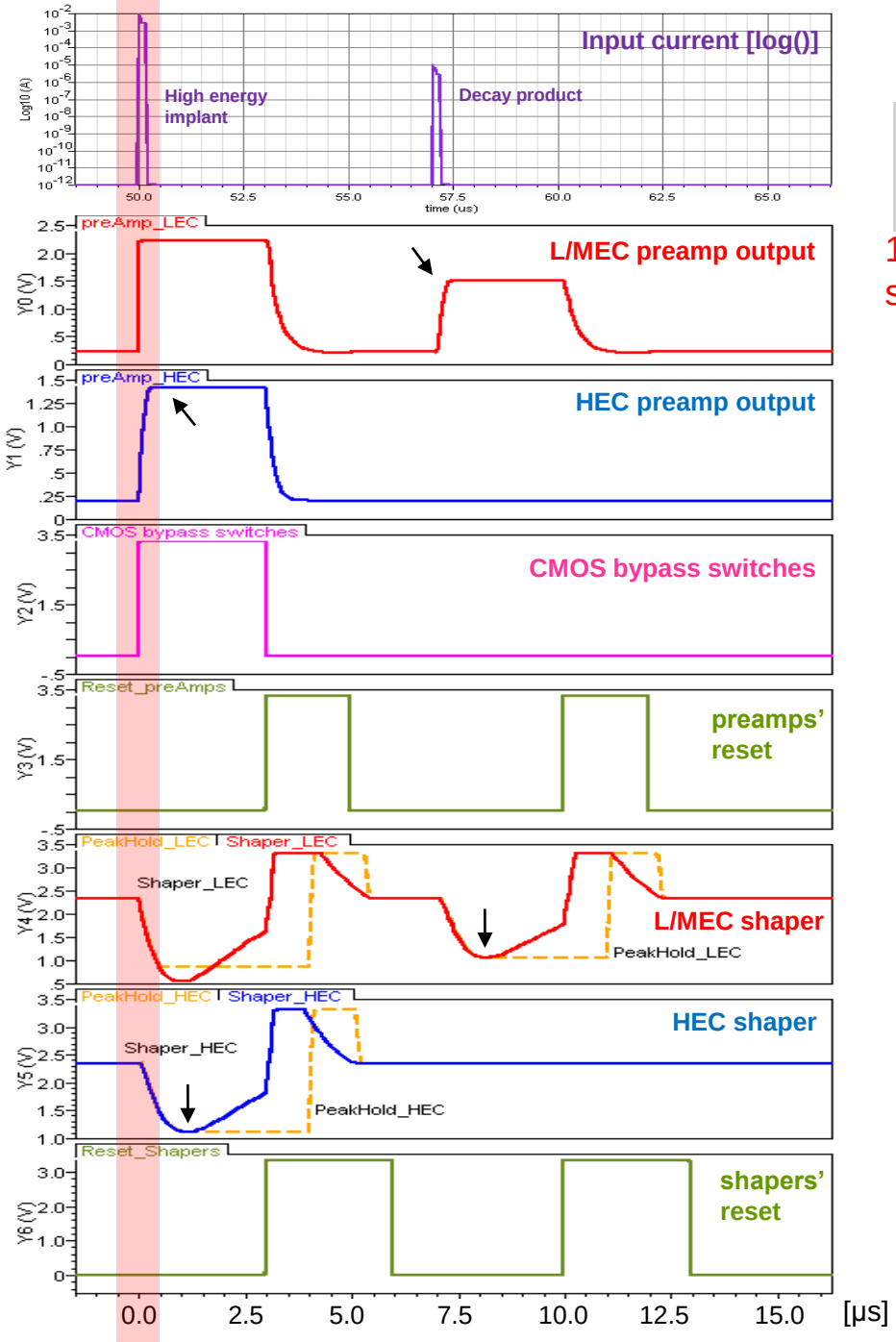

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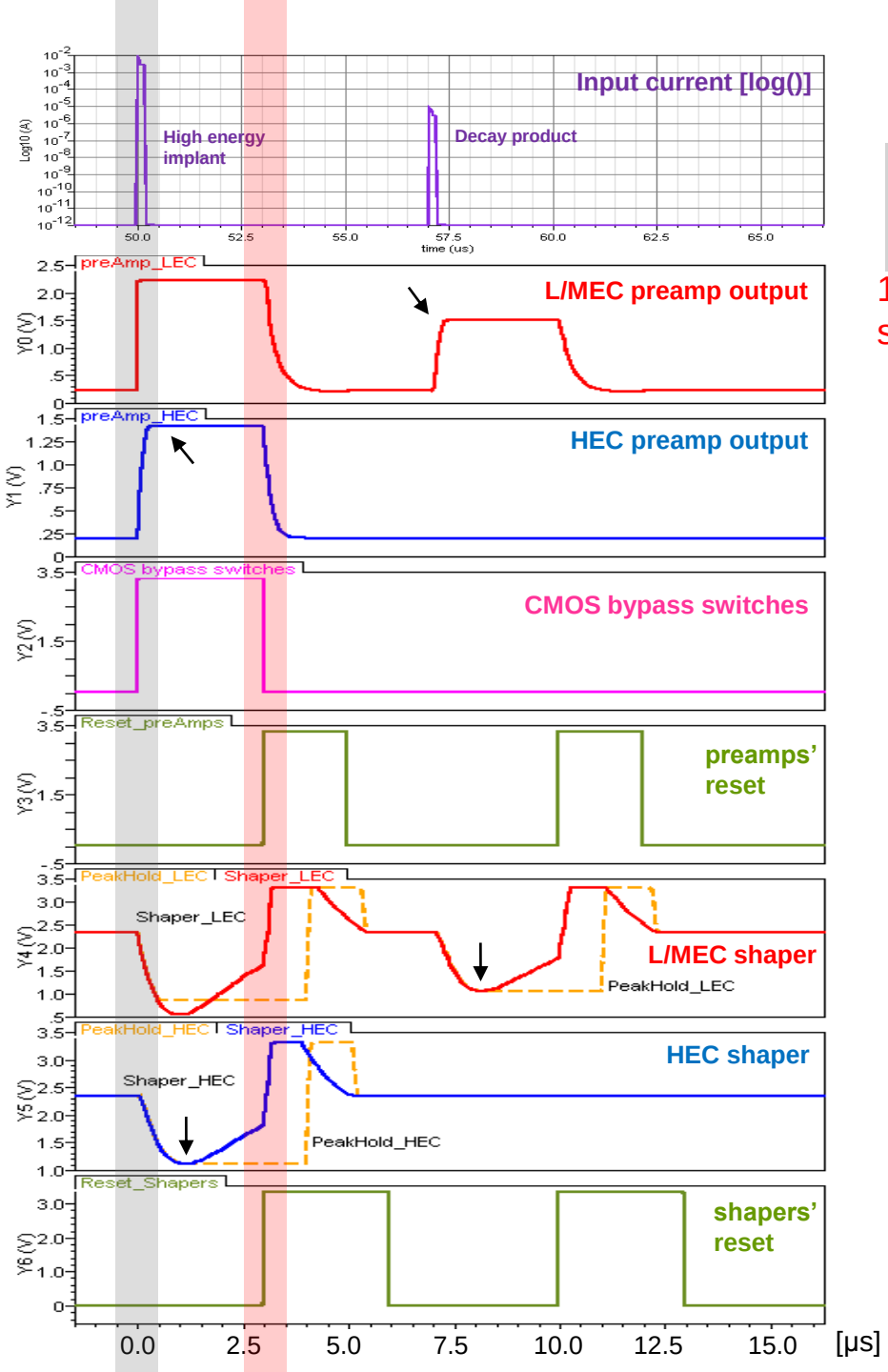

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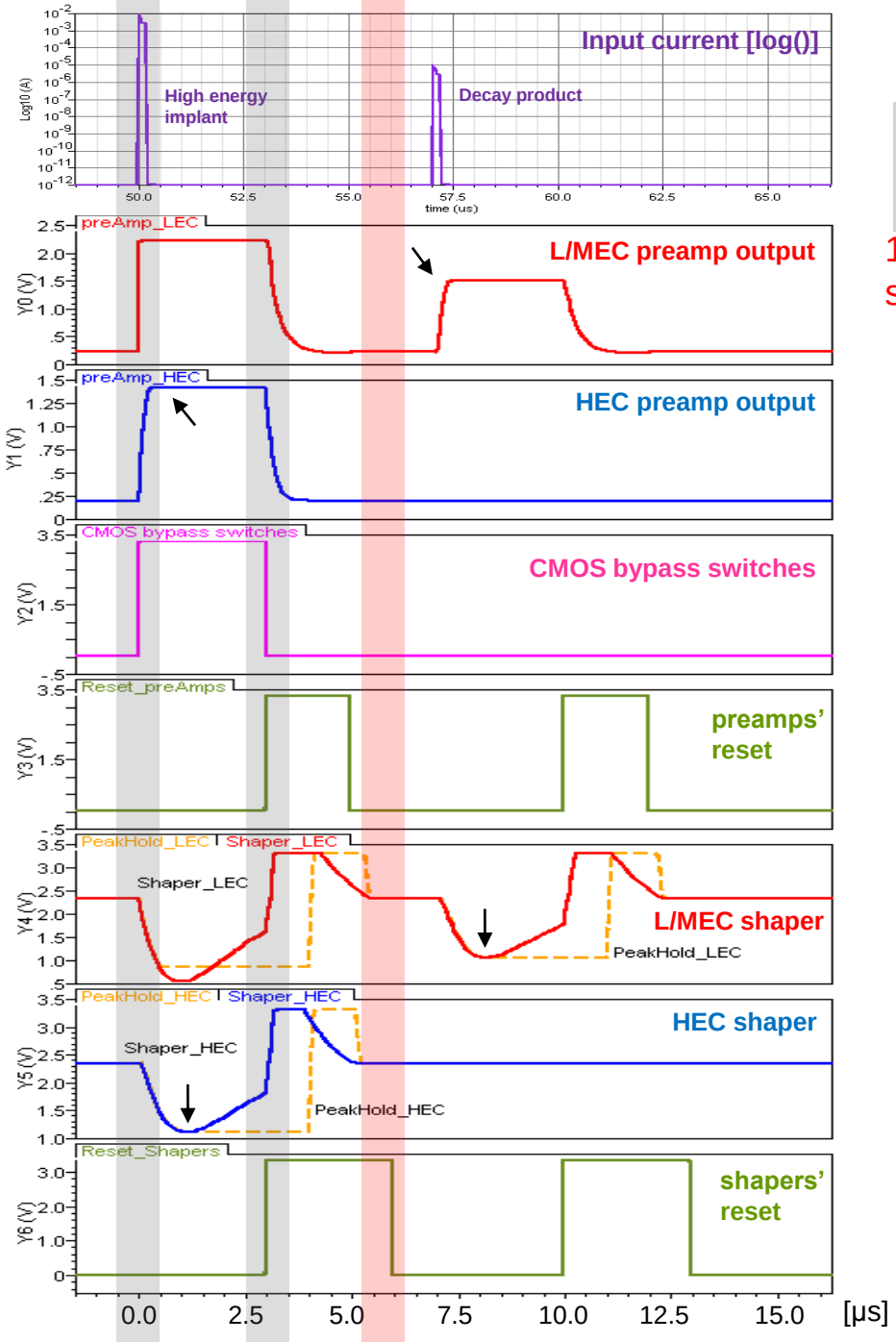

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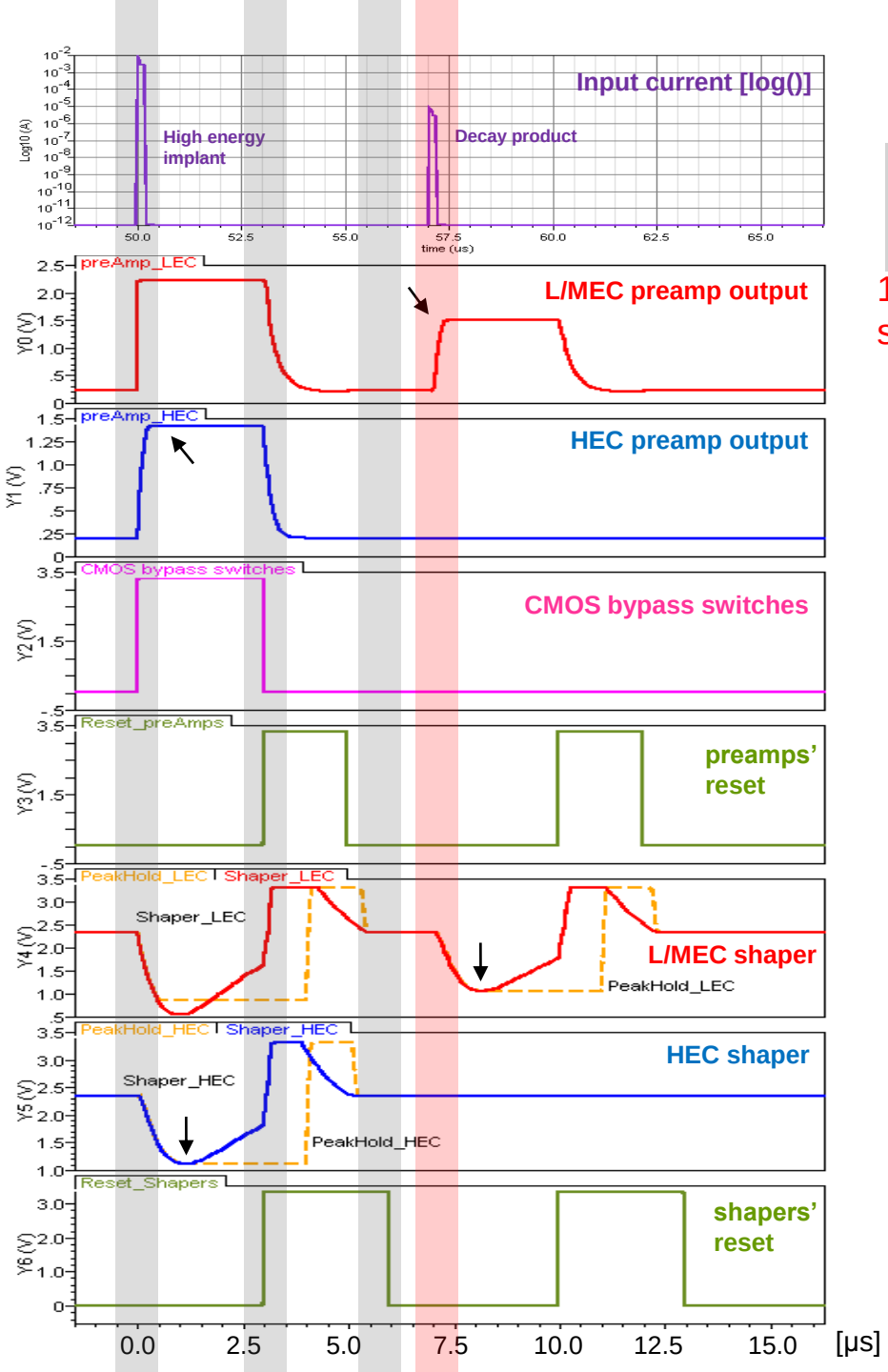

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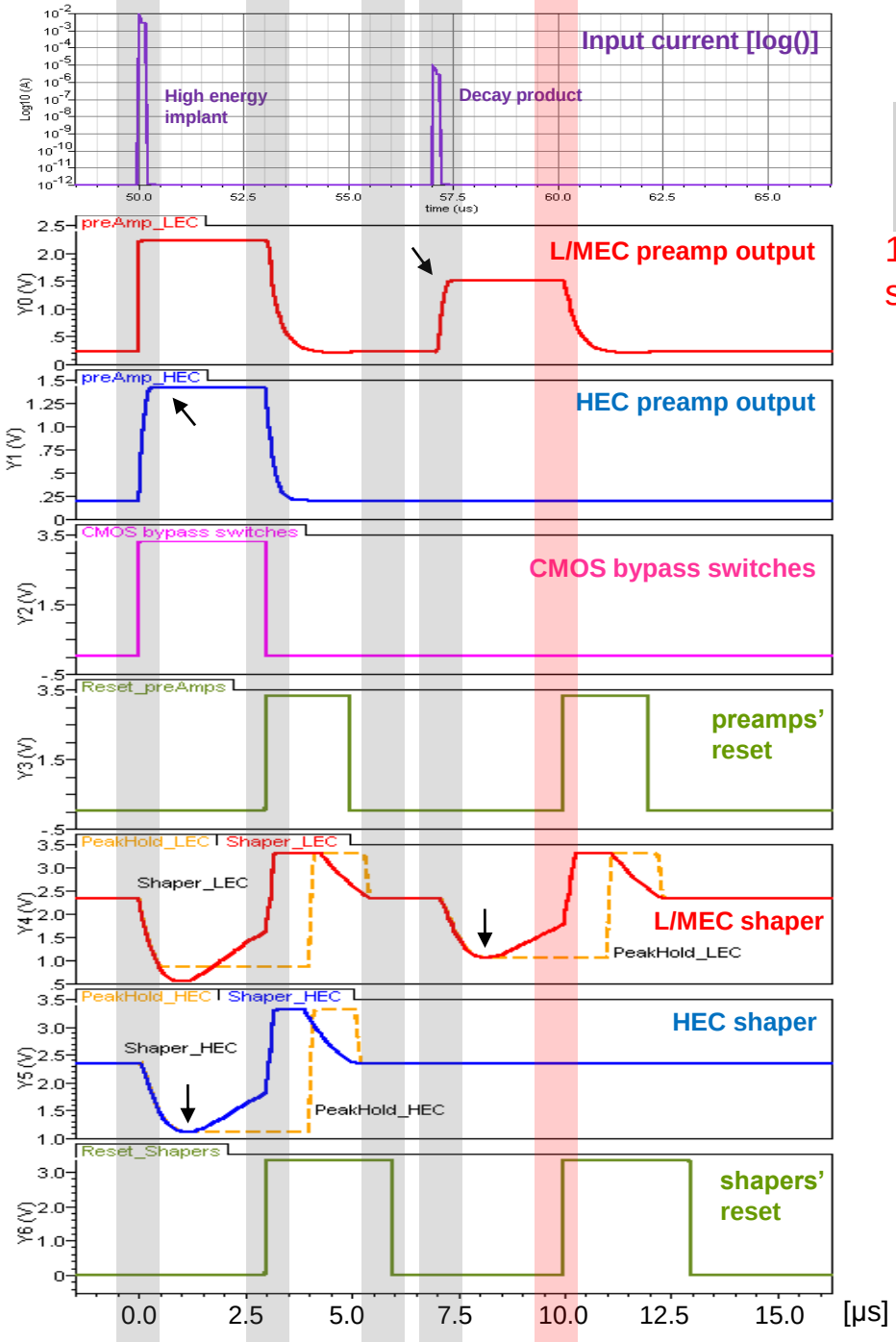

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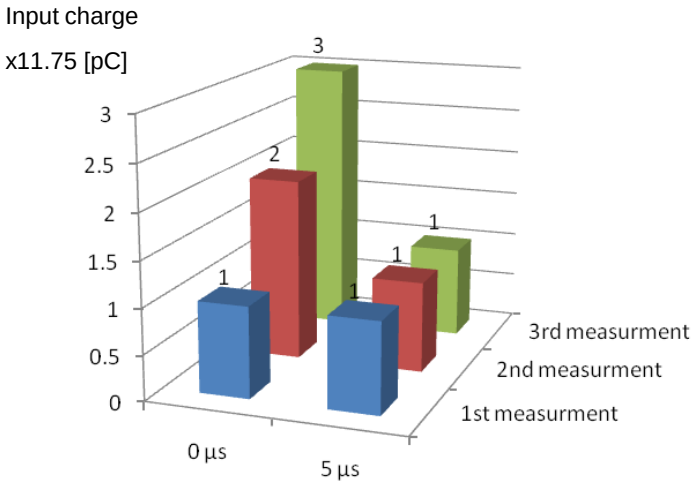
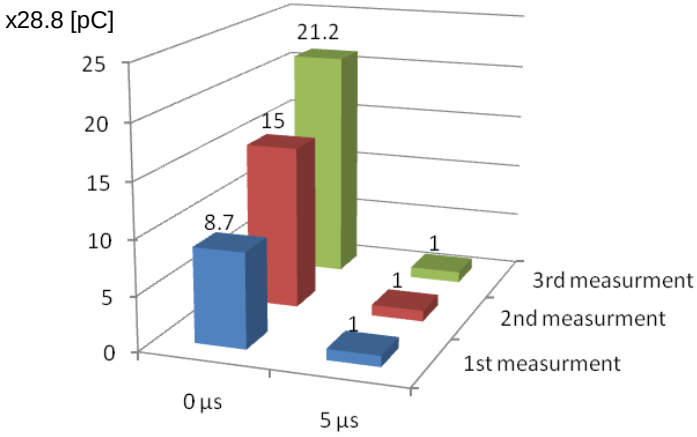
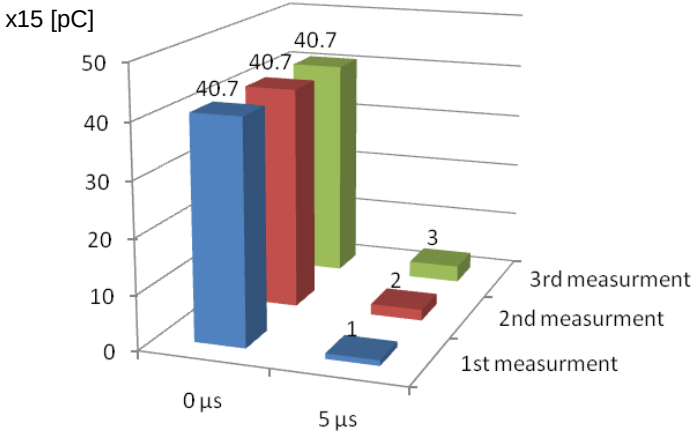
Test sets



1: variable Medium Energy (ME)
+
constant ME

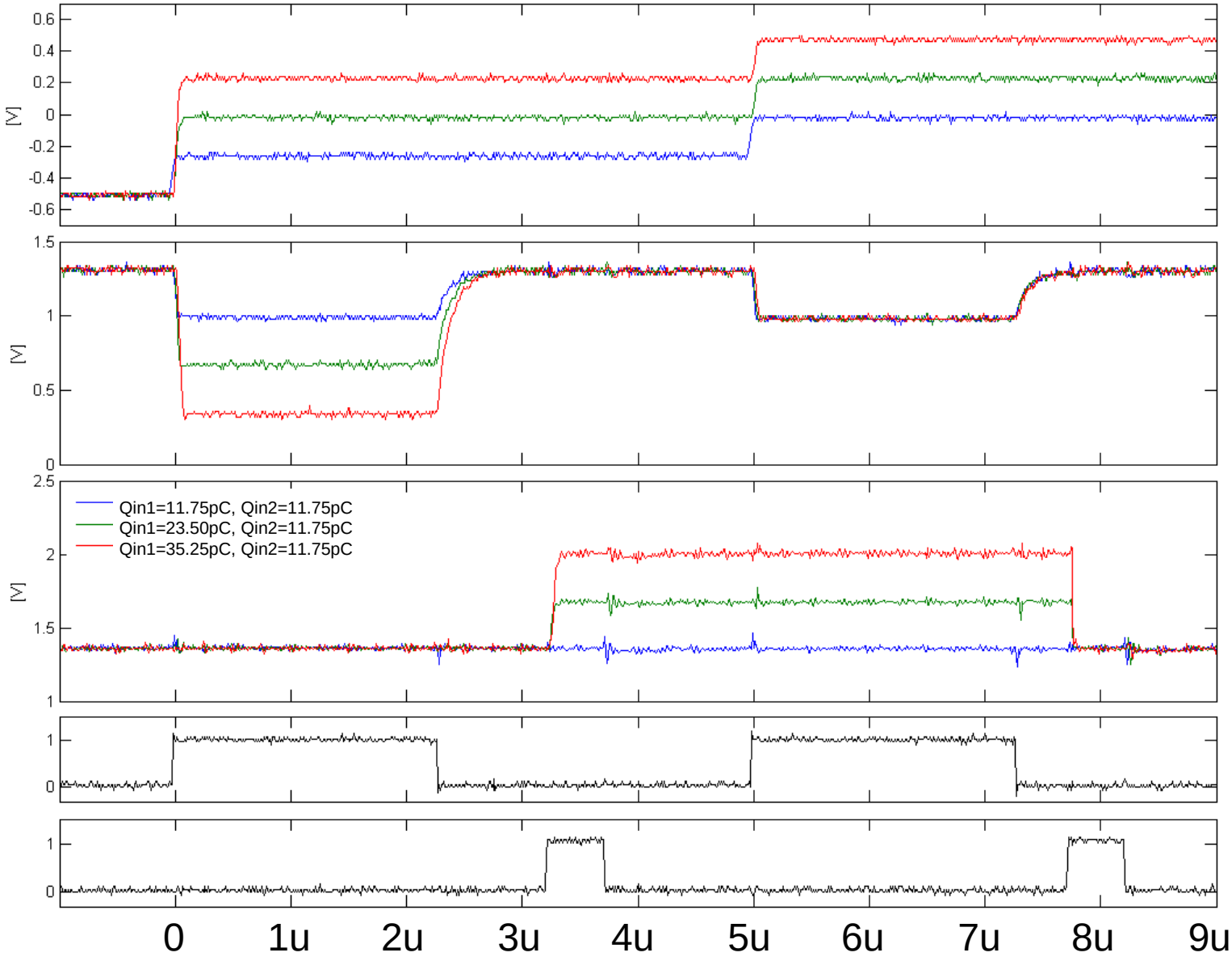


2: variable High Energy (HE)
+
constant ME



3: constant High Energy (HE)
+
variable ME

1: variable Medium Energy (ME) + constant ME



Input signals
(voltage step capacitive-coupled)

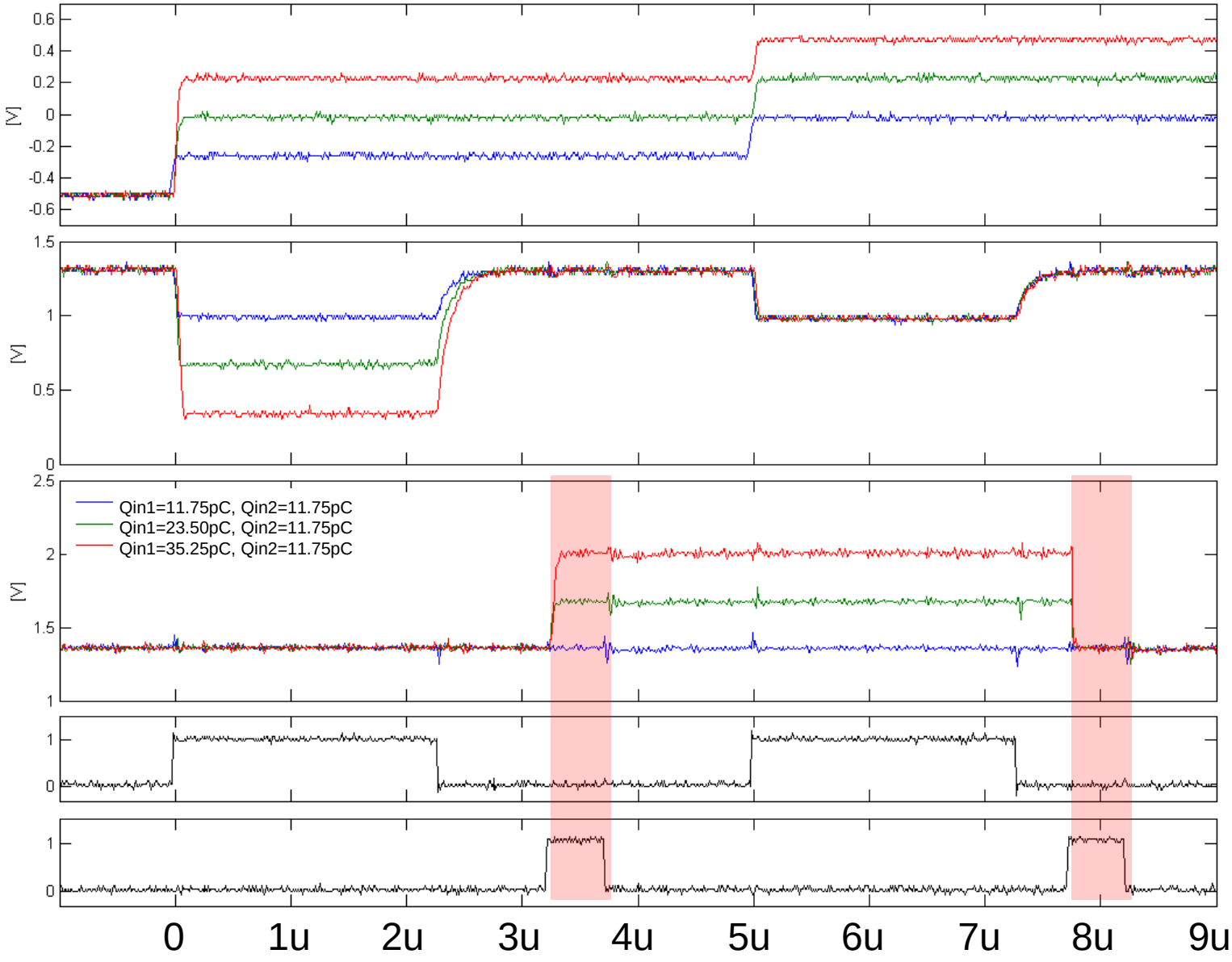
Preamp buffered output
(Low-Medium Energy Channel)

Analog output
(peak-hold multiplexed output)

Trigger output

“Data Ready”

1: variable Medium Energy (ME) + constant ME



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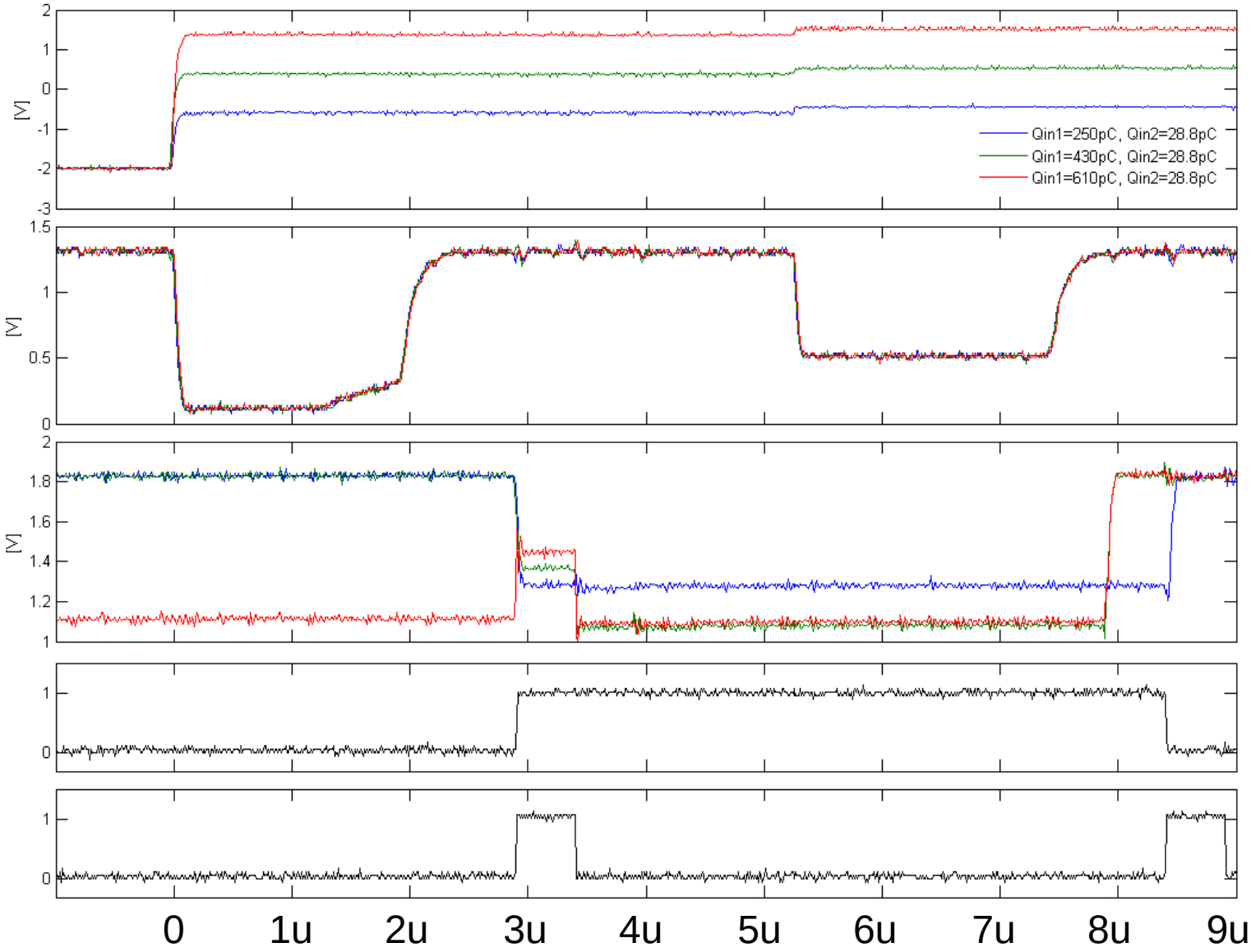

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“Range”
High = high-energy channel active

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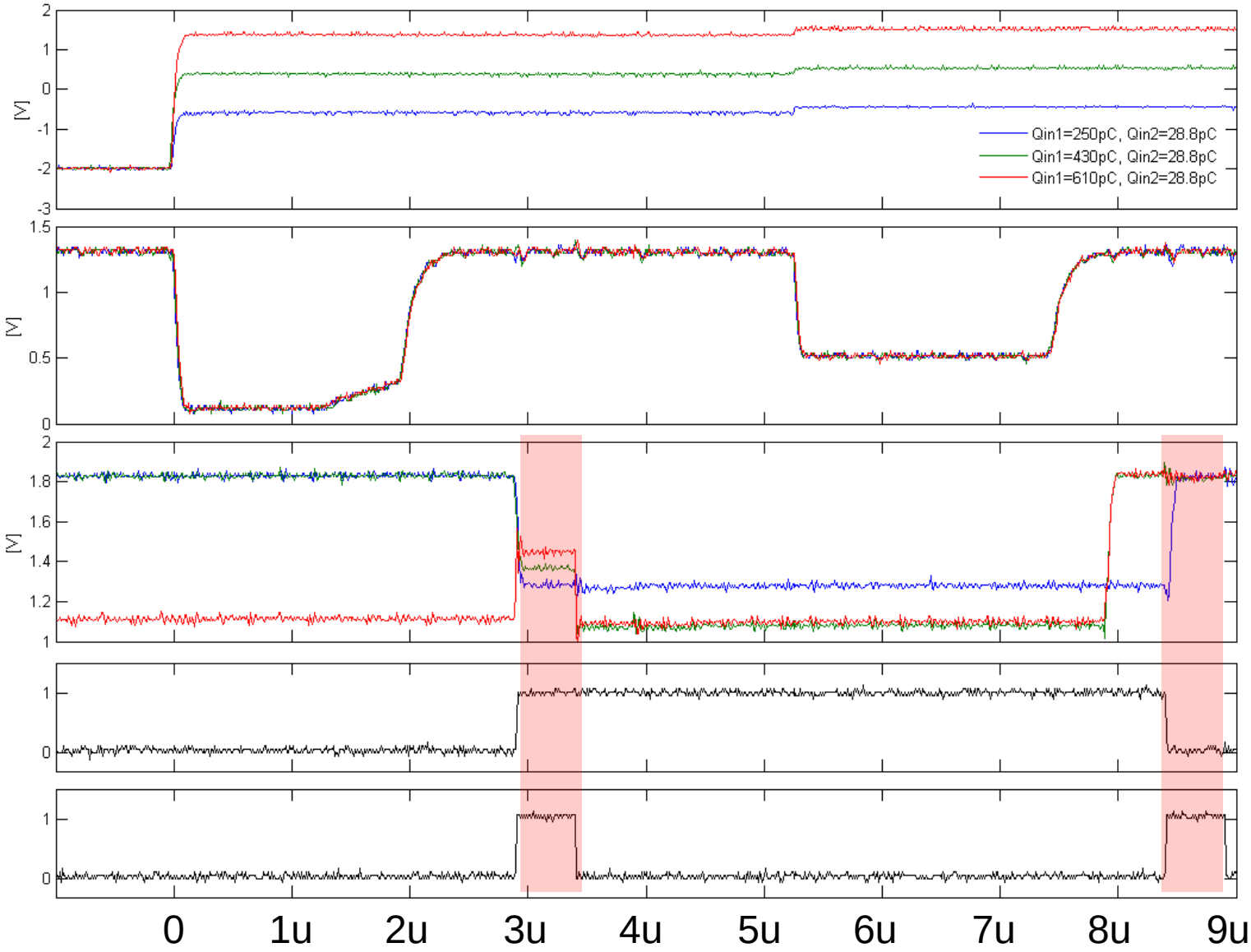

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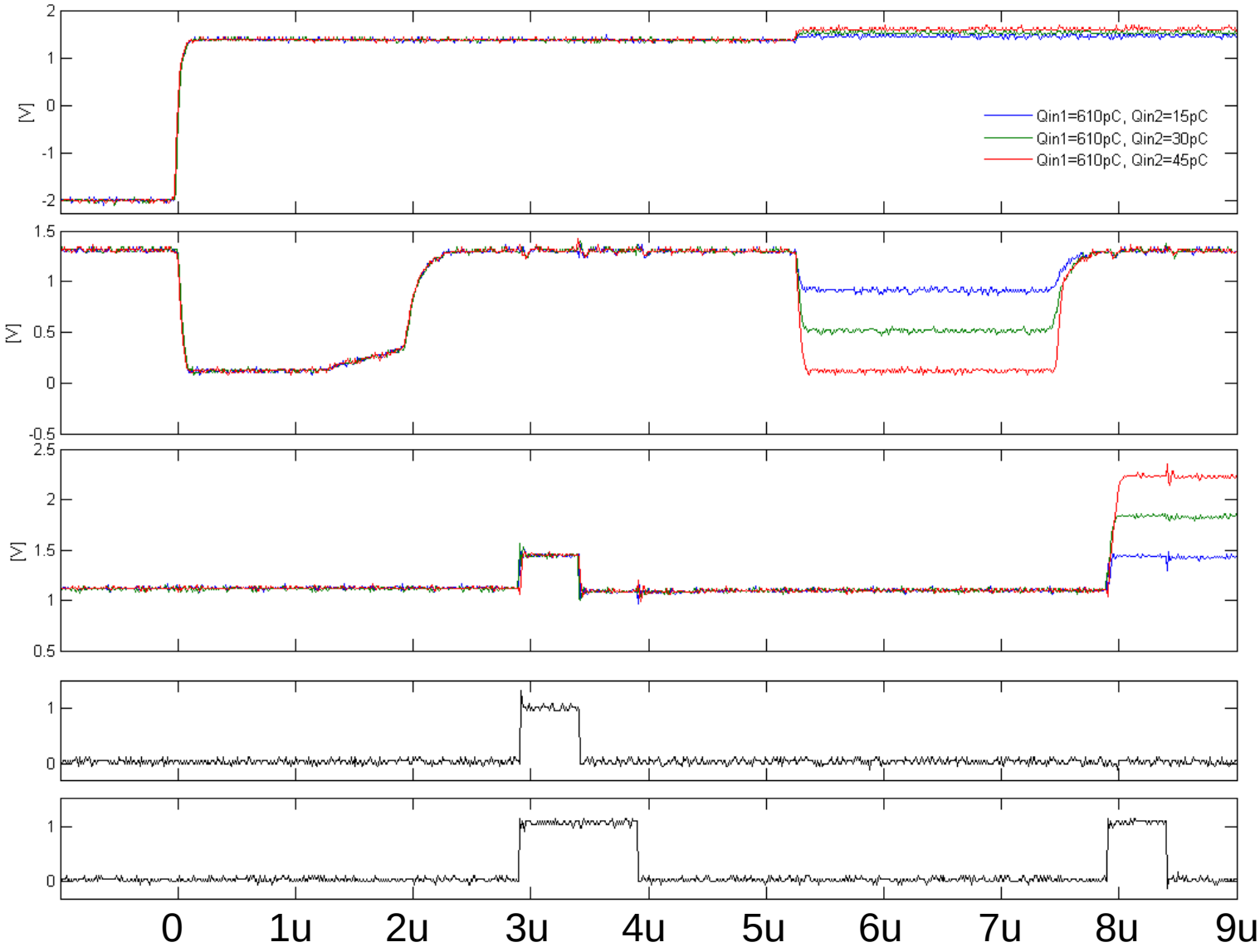

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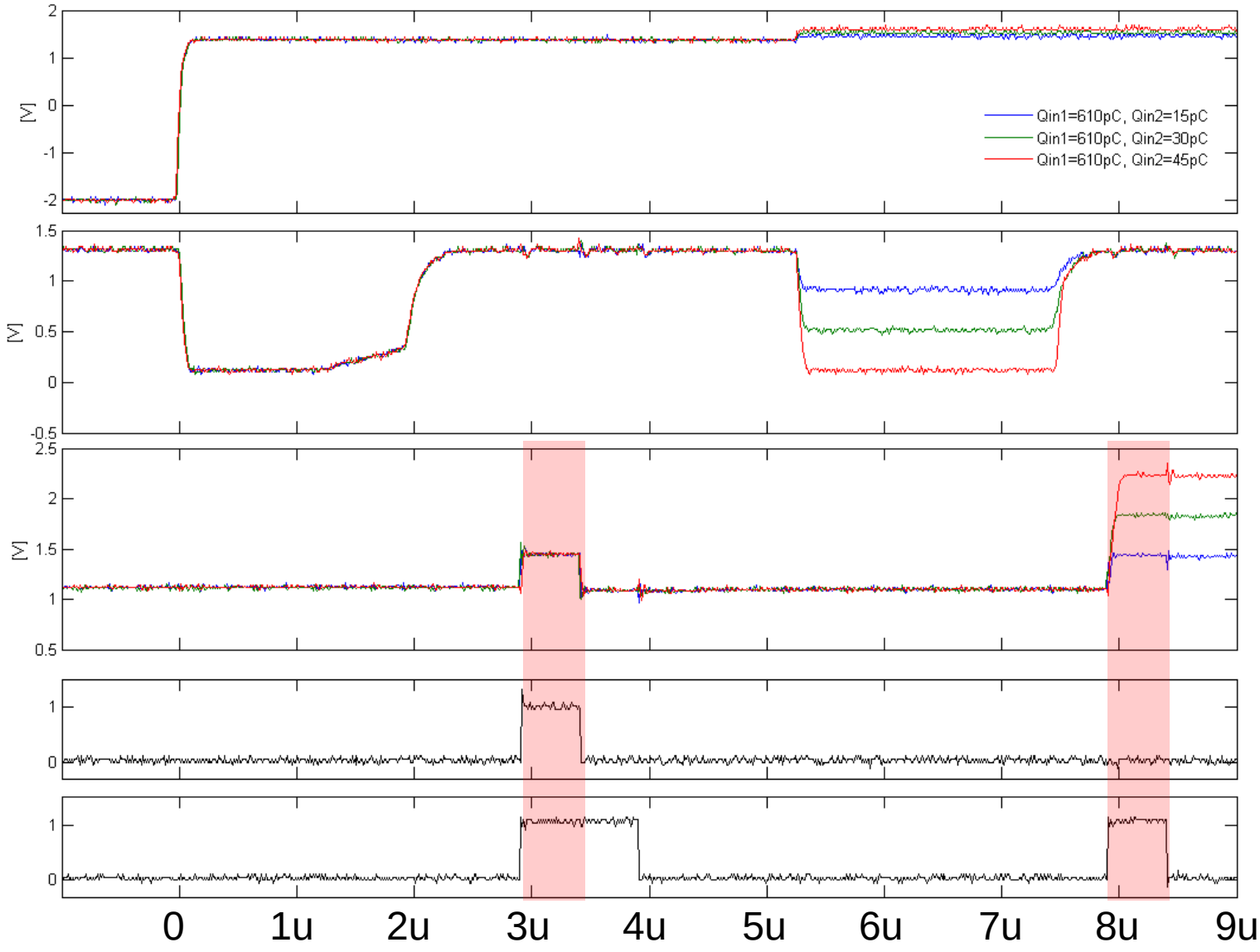

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Future development

-Support module, optimized for power supply distribution, shielding and decoupling, currently being manufactured;

-Once delivered, testing of analog performance and integration with data acquisition card (FPGA);

-Second and final iteration, with some minor adjustments and noise optimization, possibly on-chip calibration capacitors.

Acknowledgements

Thanks to:

- Thomas Davinson, *University of Edinburgh*
- Patrick Coleman-Smith, *STFC, Daresbury Laboratory*
- Ian Lazarus, *STFC, Daresbury Laboratory*