CCLRC Technology

AIDA design study

Overload and cross-talk

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Overview

Block diagram - top-level

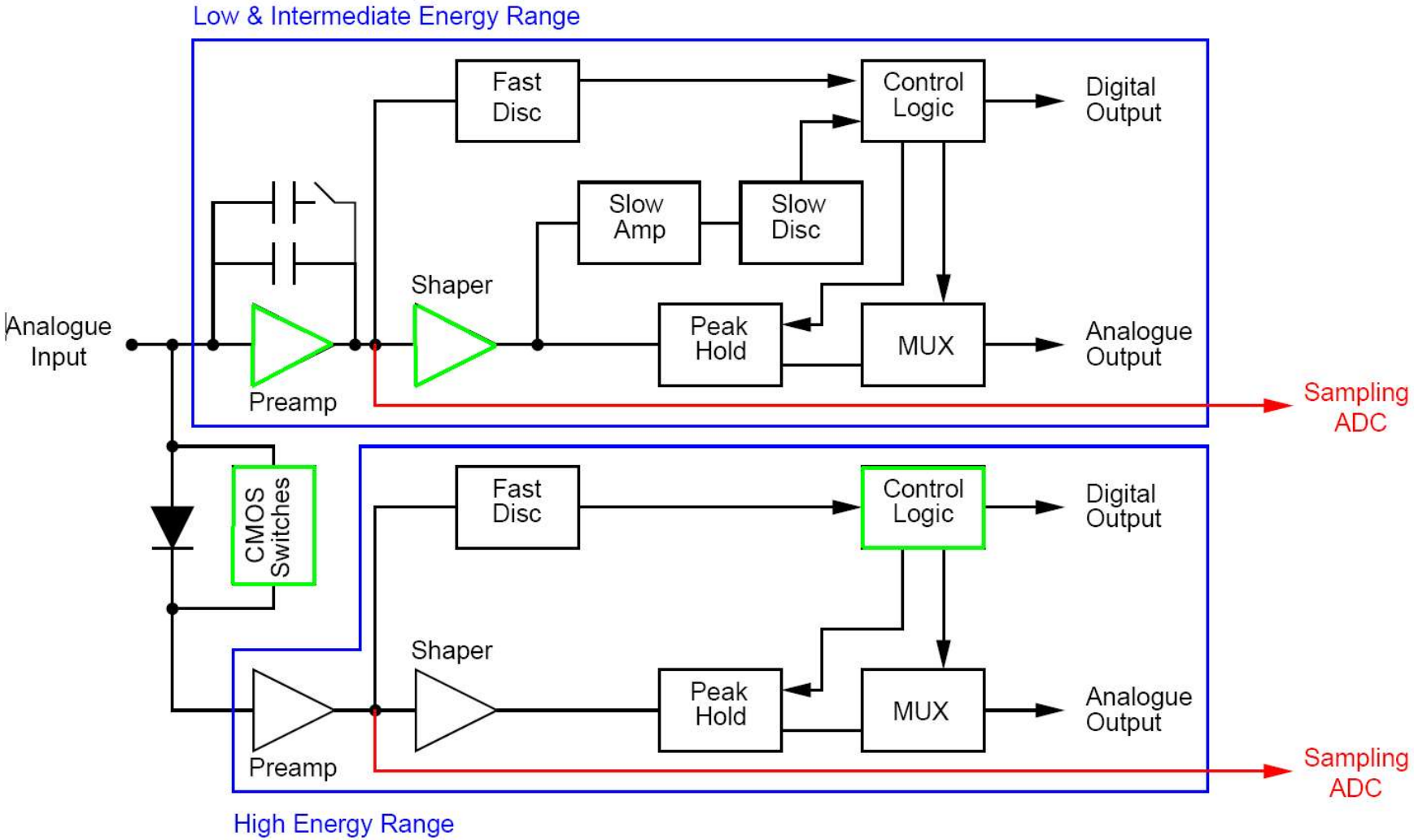
Overload recovery - the effect of fast reset

Timing of the link reset

Double-sided detector simulations

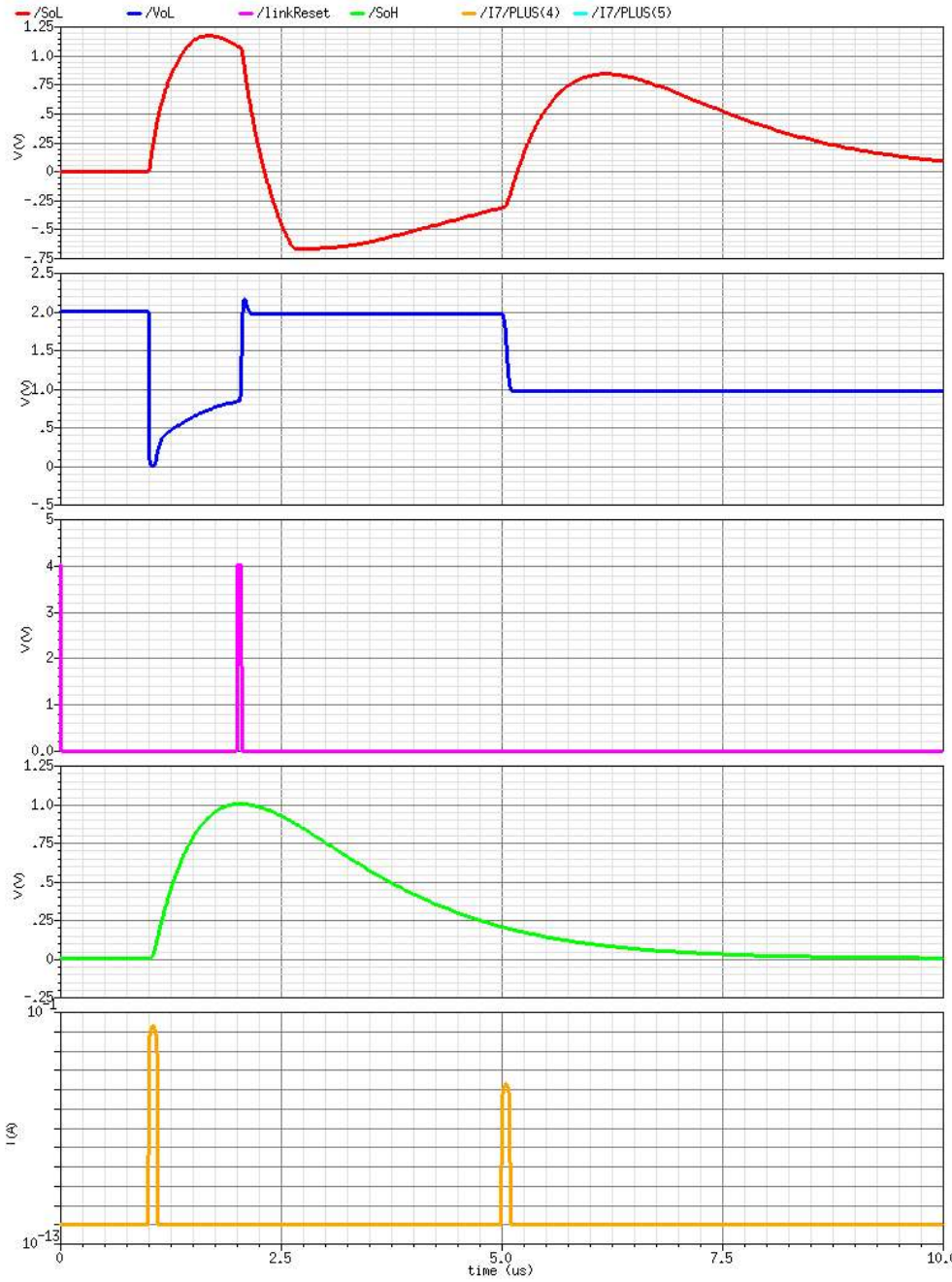
Cross-talk simulation

Conclusions



Fast overload recovery requires reset of low-energy pre-amp and shaper

Timing signals will be produced by the high-energy control logic.



Overload recovery simulation

Low-energy shaper output, no reset

Low-energy pre-amp output, no reset

Link reset

High-energy shaper output

Input current:

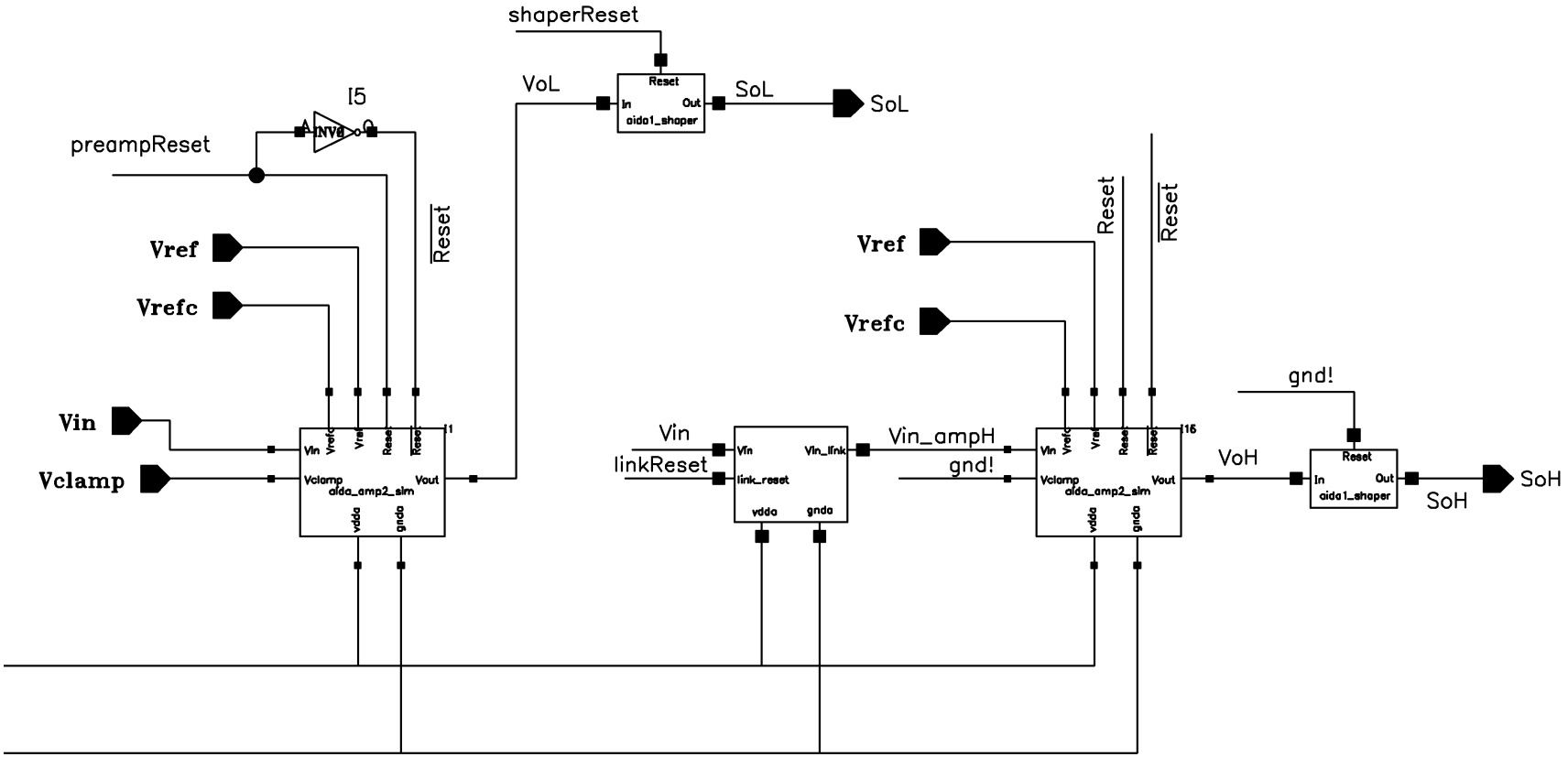
- 20mA peak, 1nC at t = 1 μs
- 20μA peak, 1pC at t = 5 μs

Analogue channel with additional resets

1 **Link reset**: disconnect link between low and high energy amplifiers

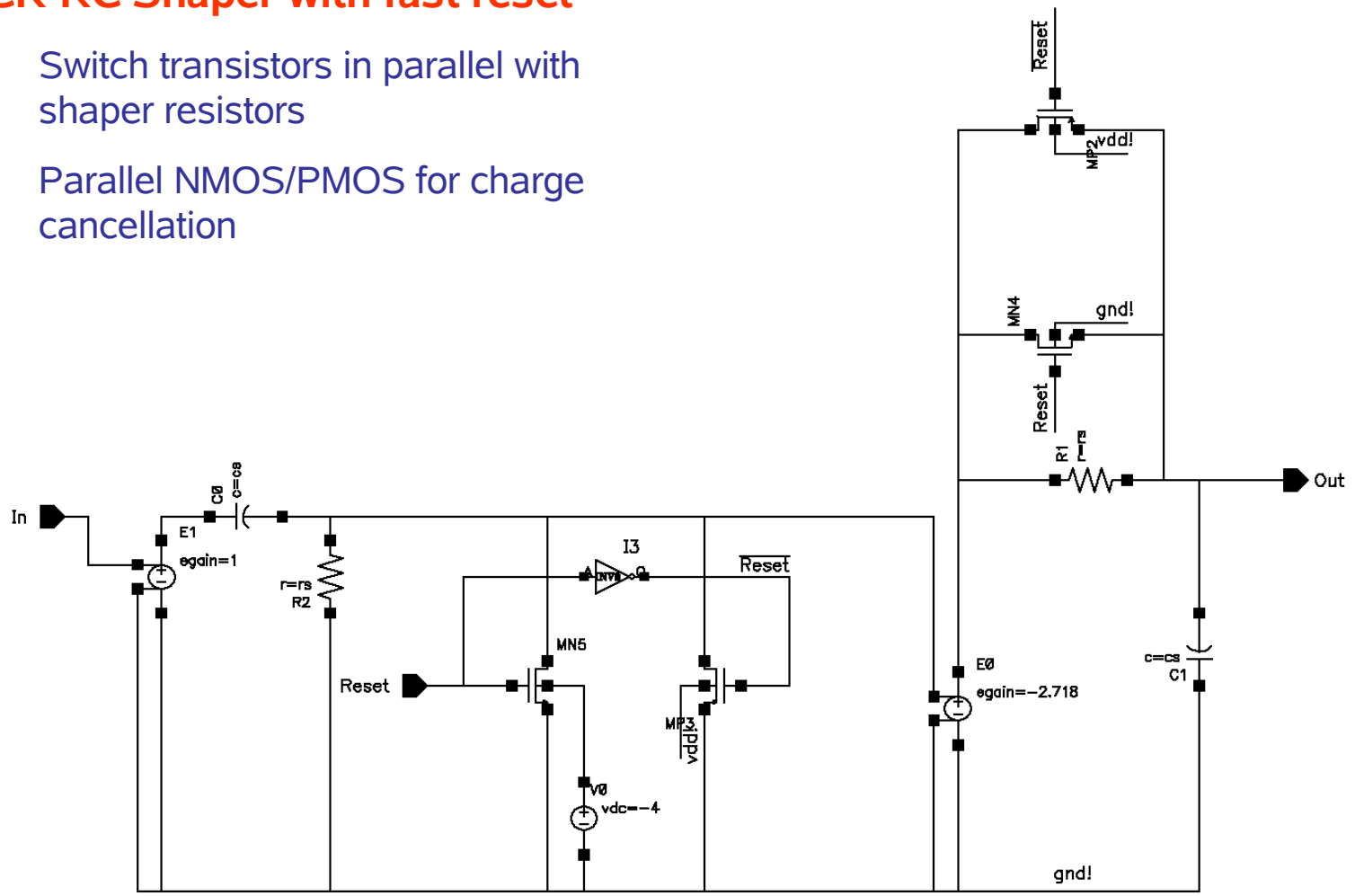
2 **Pre-amp reset**: fast discharge of feedback capacitor (~1µs)

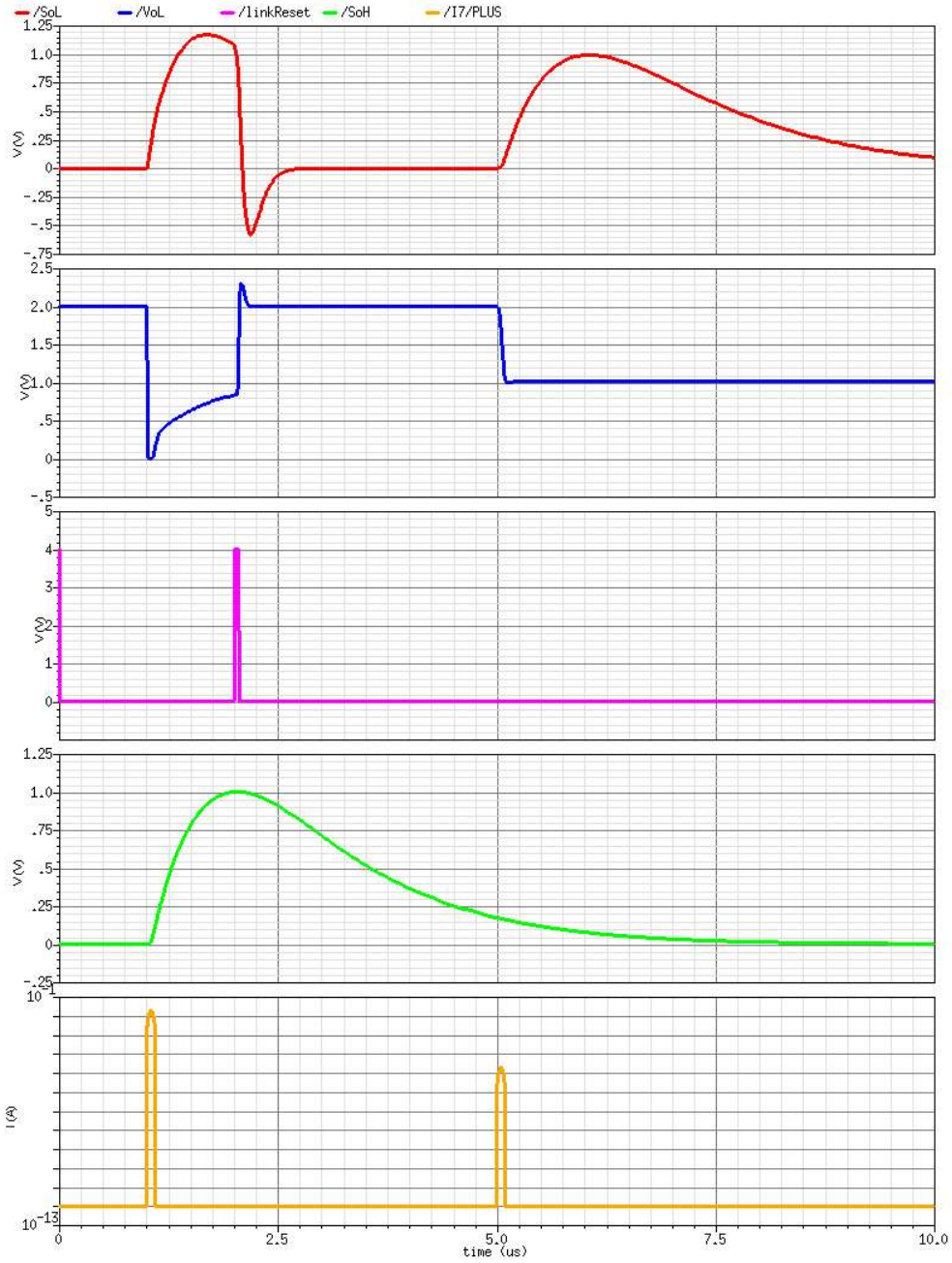
3 **Shaper reset**: transistors to short out shaper resistors (~2µs)



CR-RC Shaper with fast reset

- Switch transistors in parallel with shaper resistors
- Parallel NMOS/PMOS for charge cancellation





Overload recovery simulation

Low-energy shaper output, with reset

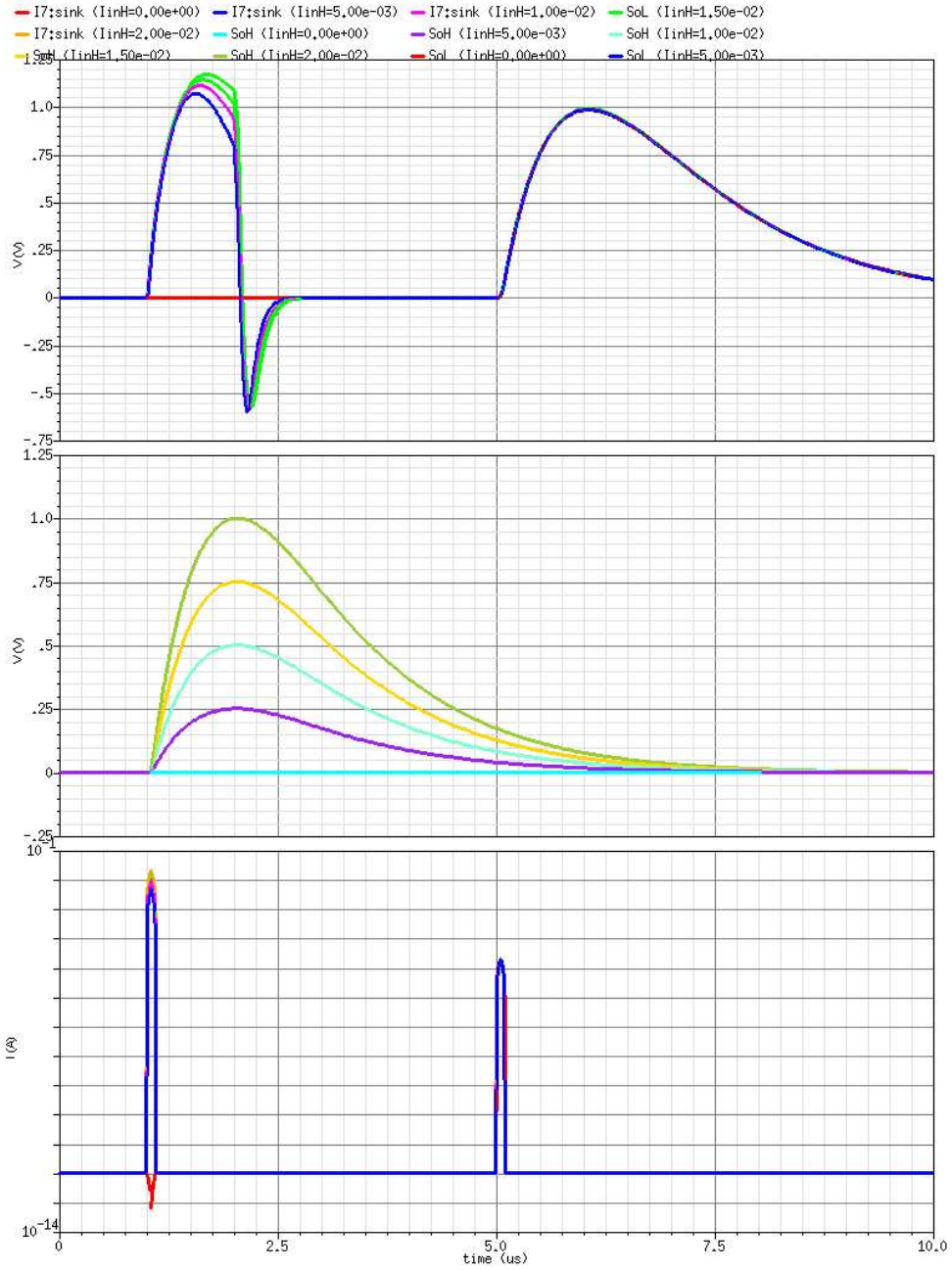
Low-energy pre-amp output, with reset

Link reset

High-energy shaper output

Input current

- 20mA peak, 1nC at t = 1 μs
- 20μA peak, 1pC at t = 5 μs



Overload recovery simulation: stepped current

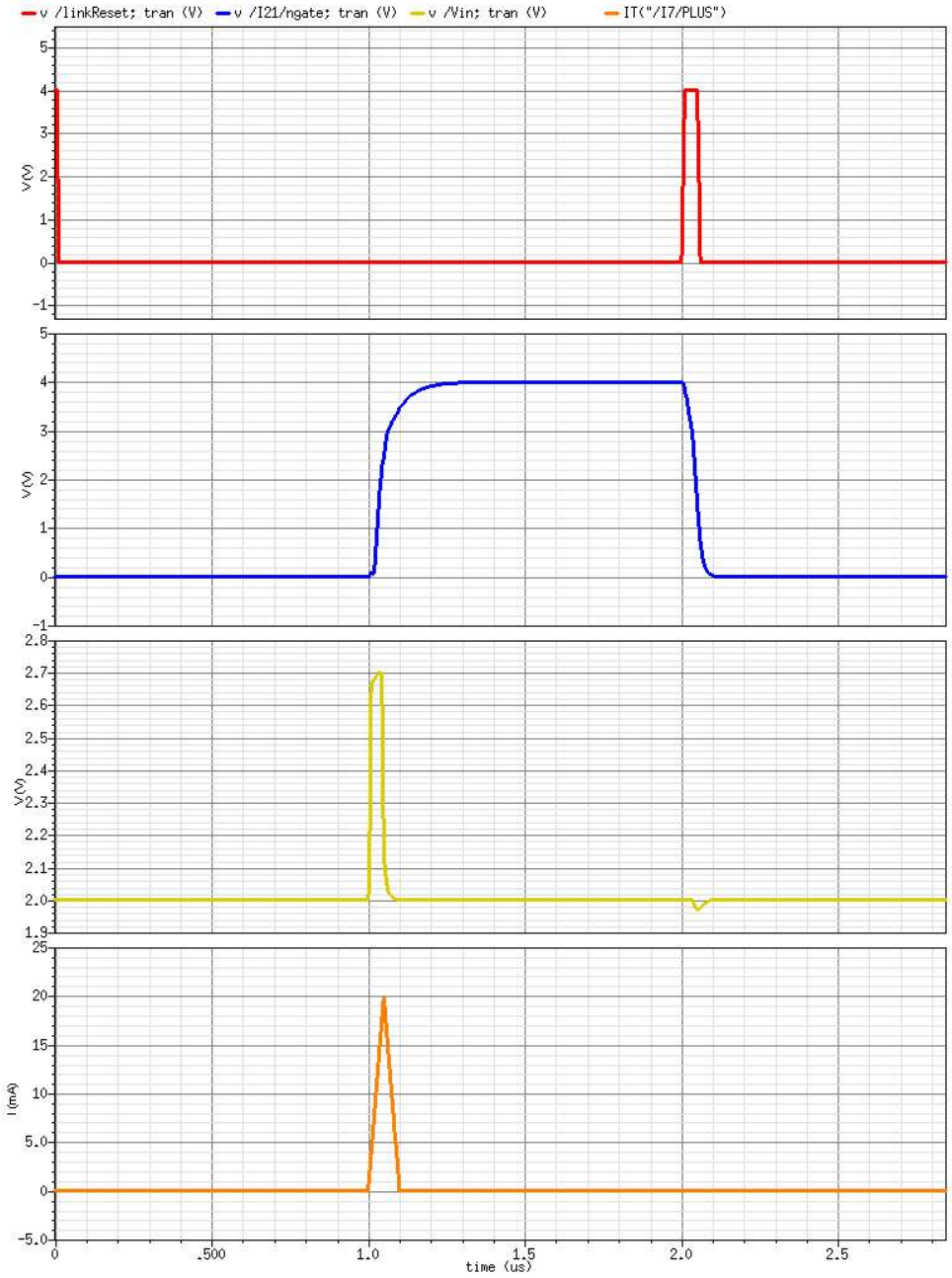
Low-energy shaper output, with reset

High-energy shaper output,

0-20GeV in 5GeV steps

Input current, 0-20mA at t = 1 μs,

followed by 20μA at t = 5 μs



Timing of link reset

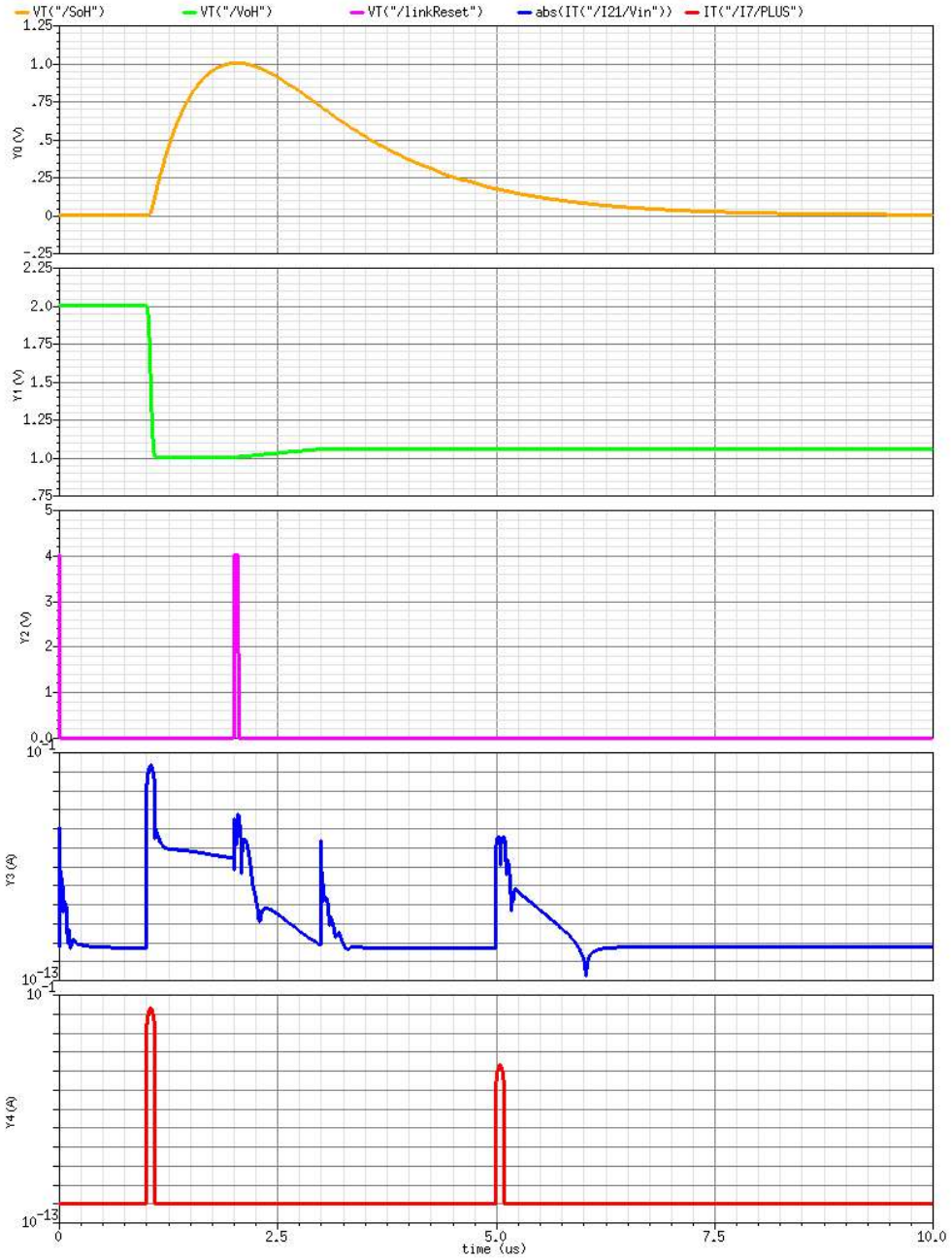
link reset

link gate control (NMOS switch)

Amplifier input voltage

Input current, 20mA at t = 1µs,

Timing of link reset



High-energy shaper output

High-energy pre-amp output

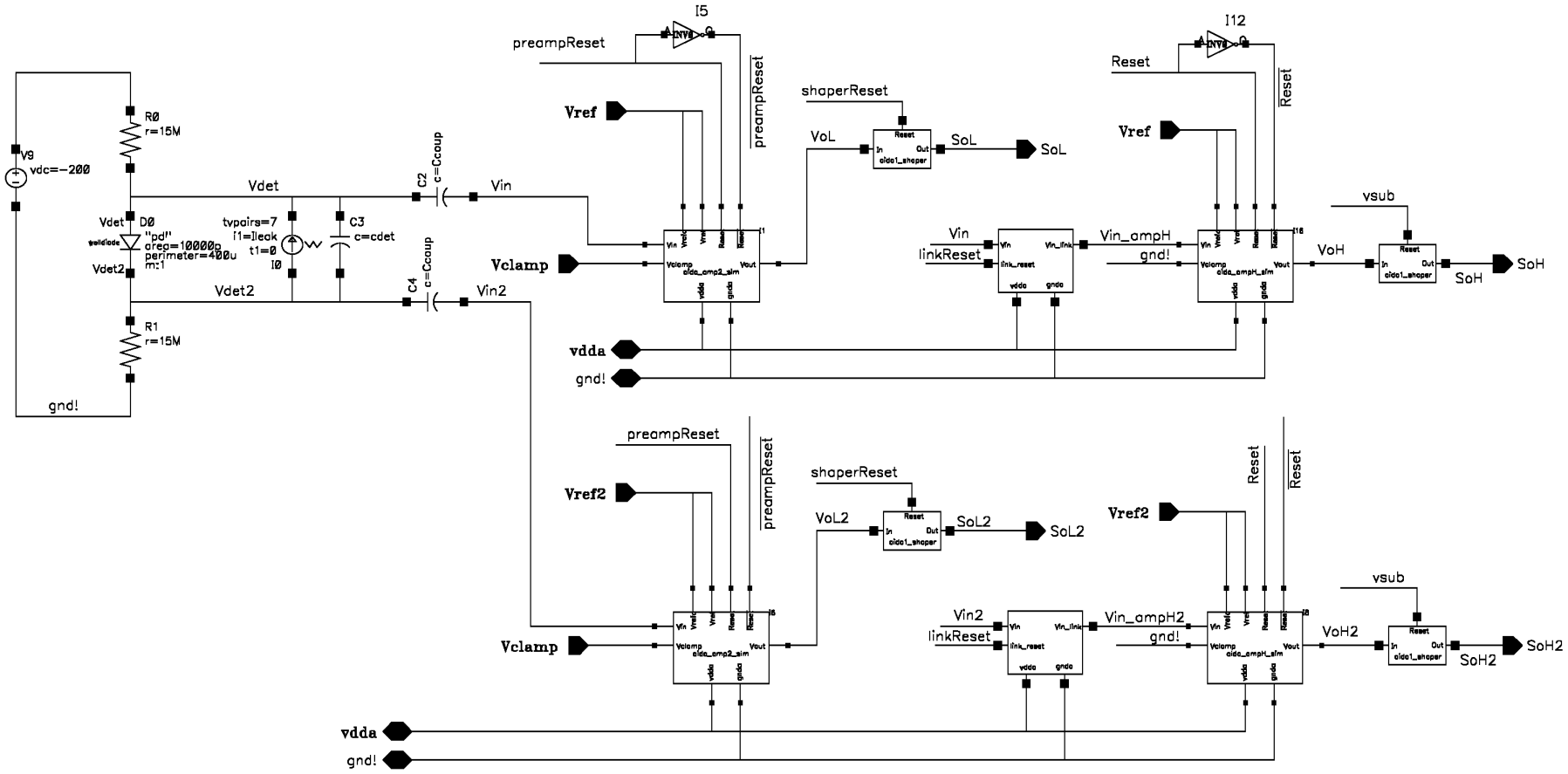
Link reset

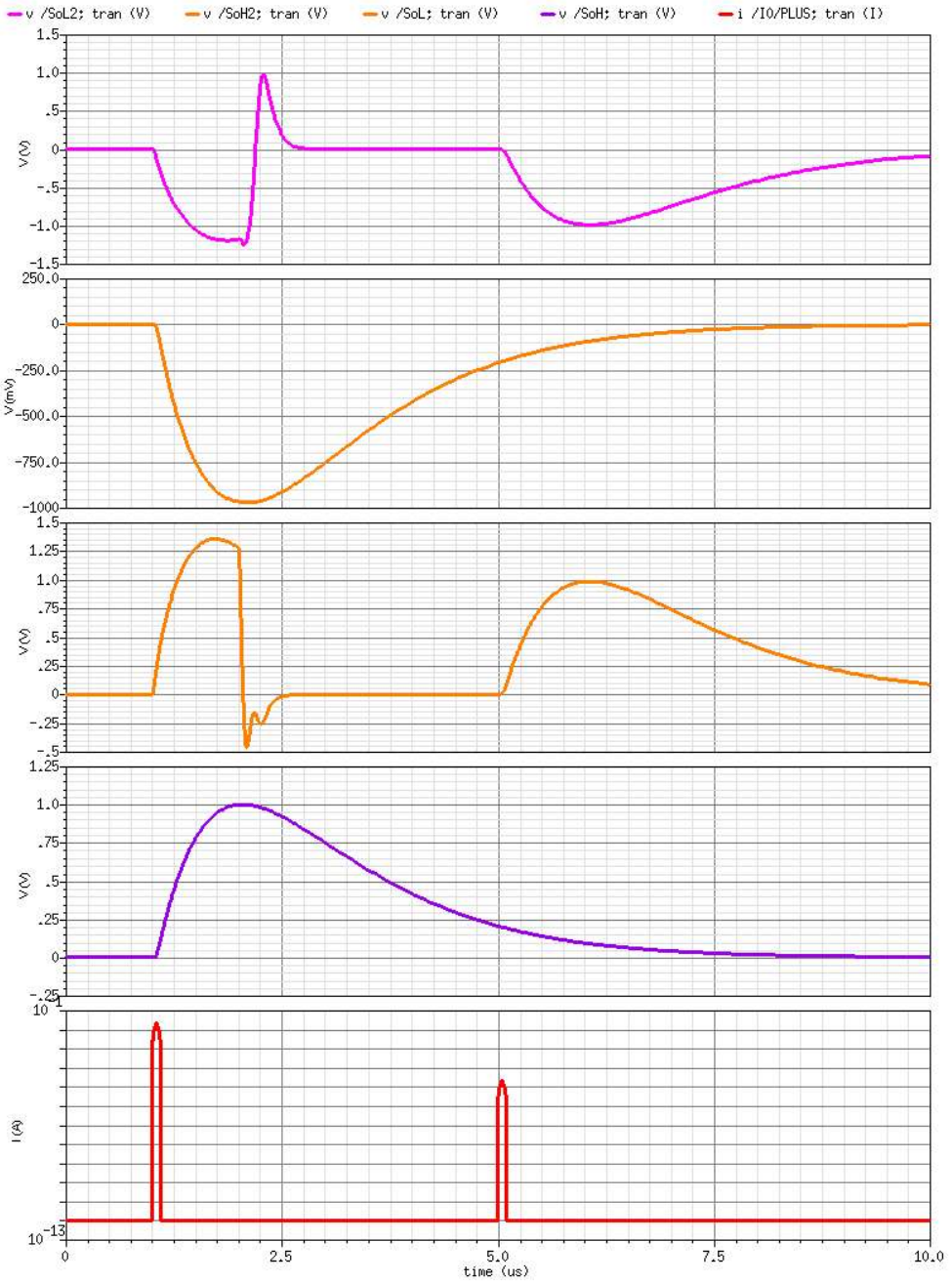
Link current

Input current

Double-sided amplifier simulations

- 15M bias resistors, 22nF coupling
- Separate bias for amplifiers, for optimum dynamic range
- Reversed polarity for diode link and comparator





Double-sided simulation

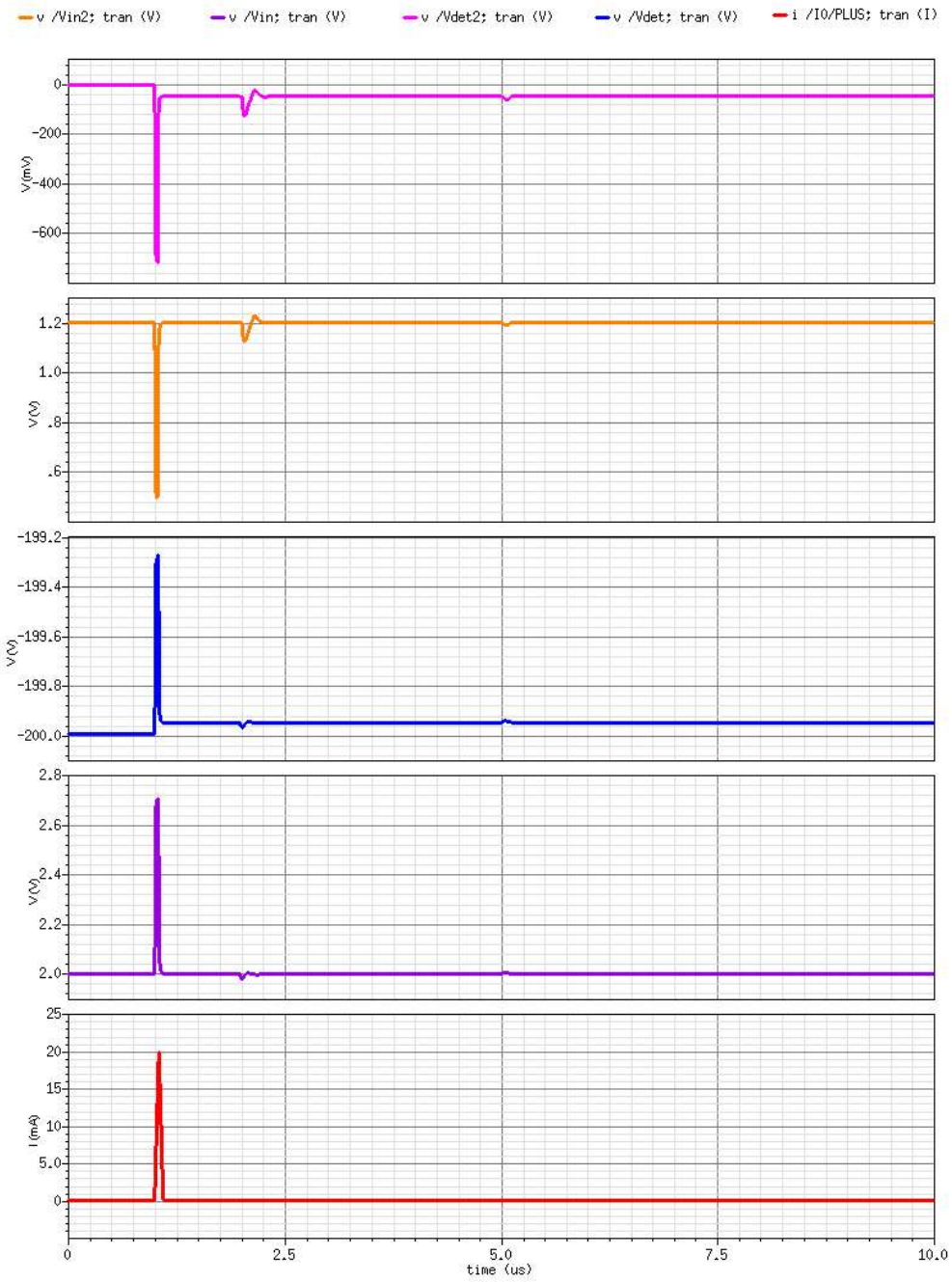
Low-energy shaper, n+ side

High-energy shaper, n+ side

Low-energy shaper, p+ side

High-energy shaper, p+ side

Input current: 20mA and 20µA



Double-sided simulation:

Detector voltage, n+ side :

700mV spike, with 50mV step

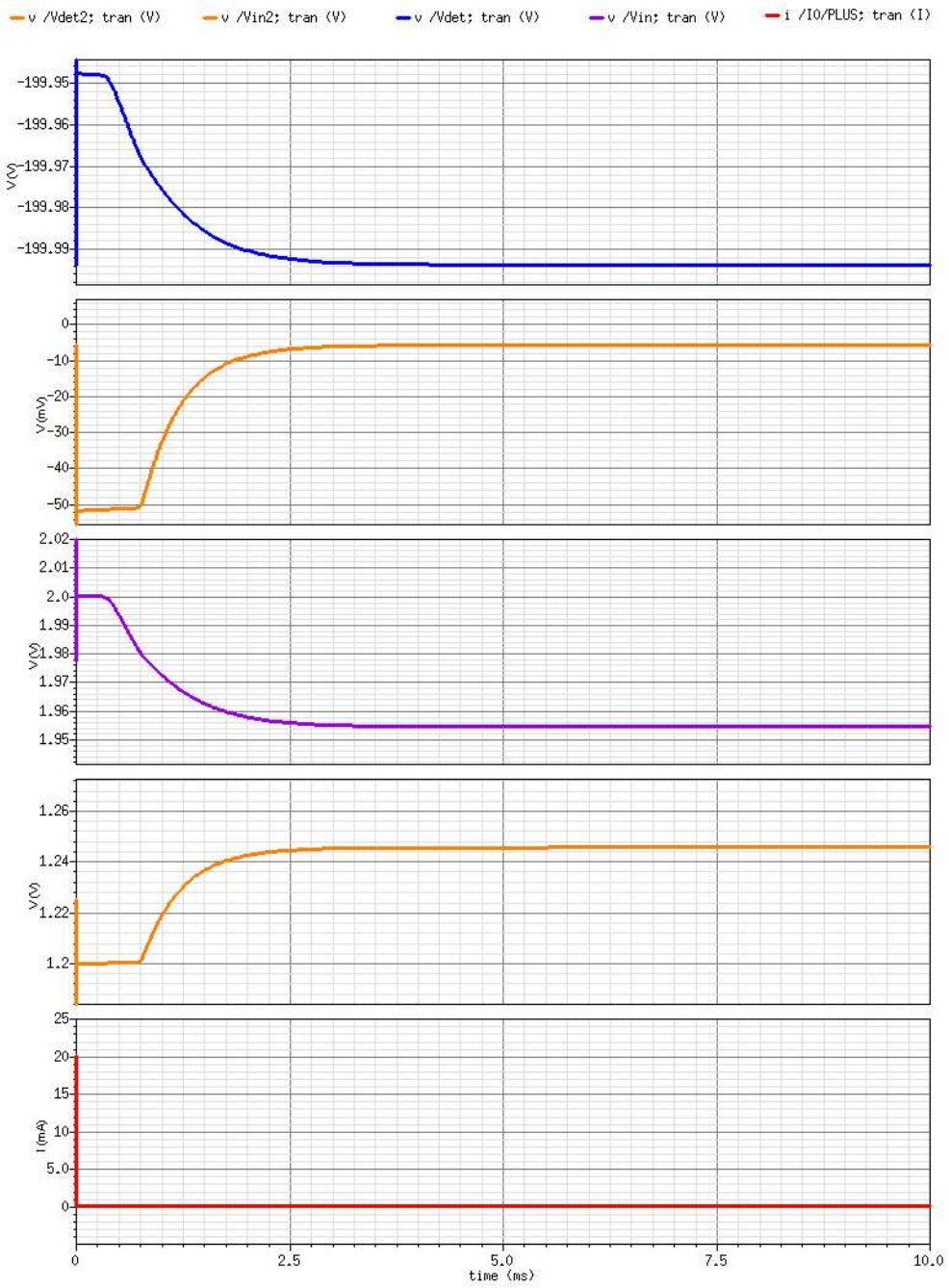
Pre-amp input, n+ side

Detector voltage, p+ side :

700mV spike, with 45mV step

Pre-amp input, p+ side

Input current: 20mA



Double-sided simulation over 10ms

Warning: Simulator convergence problems, results unreliable

Detector voltage, p+ side :

recovery from 50mV step

Detector voltage, n+ side

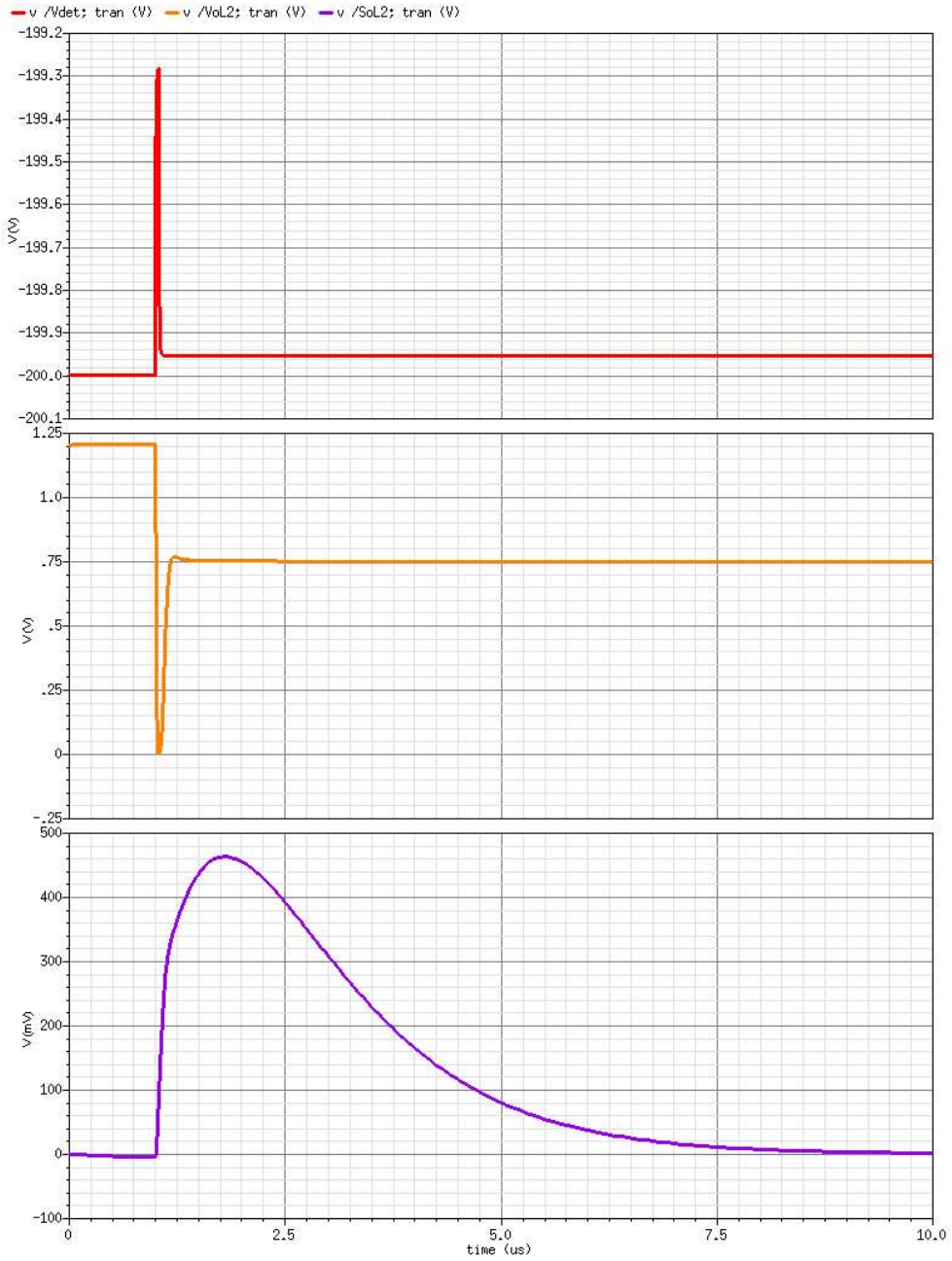
recovery from 45mV step

Pre-amp input, p+ side

Pre-amp input, n+ side

Input current: 20mA

Cross-talk simulation



Detector voltage, p+ side :

700mV spike, with 50mV step

Low-energy pre-amp output:

10pF coupling to detector voltage

Low-energy shaper output

No output on the high-energy channel

Conclusions

- Fast overload recovery is possible (a few μs)
- Extra reset pulses needed for pre-amp and shaper
- n+ read-out requires adjustment of amplifier operating point, with reverse polarity for diode and comparator
- Cross-talk effect matches earlier calculation ($\Delta V \sim 50mV$); initial voltage spike does not affect the shaper peak value