Study of IBIS Waveform Time Offsets

How IBIS simulators handle offset and aligned IBIS waveform data

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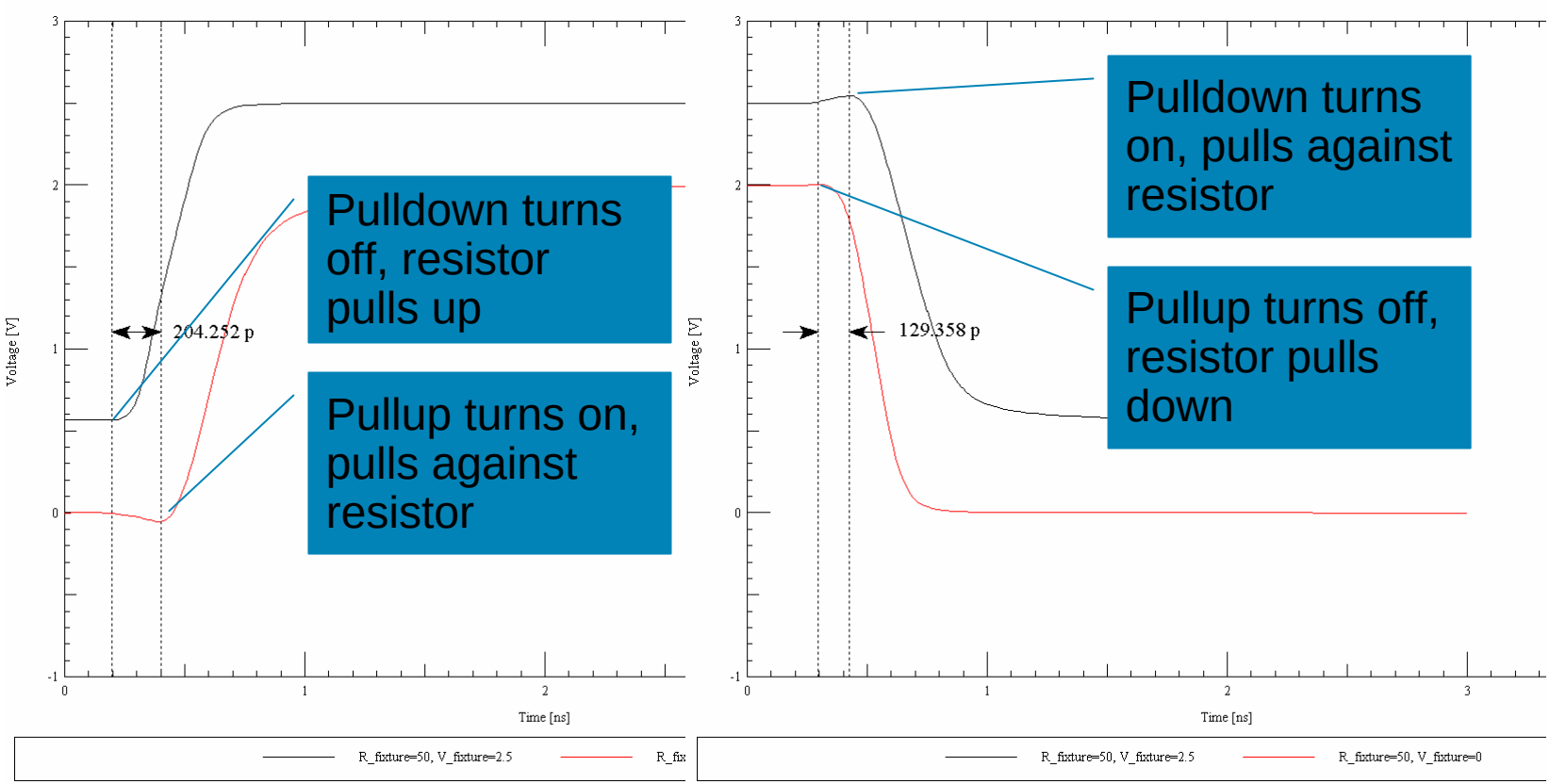
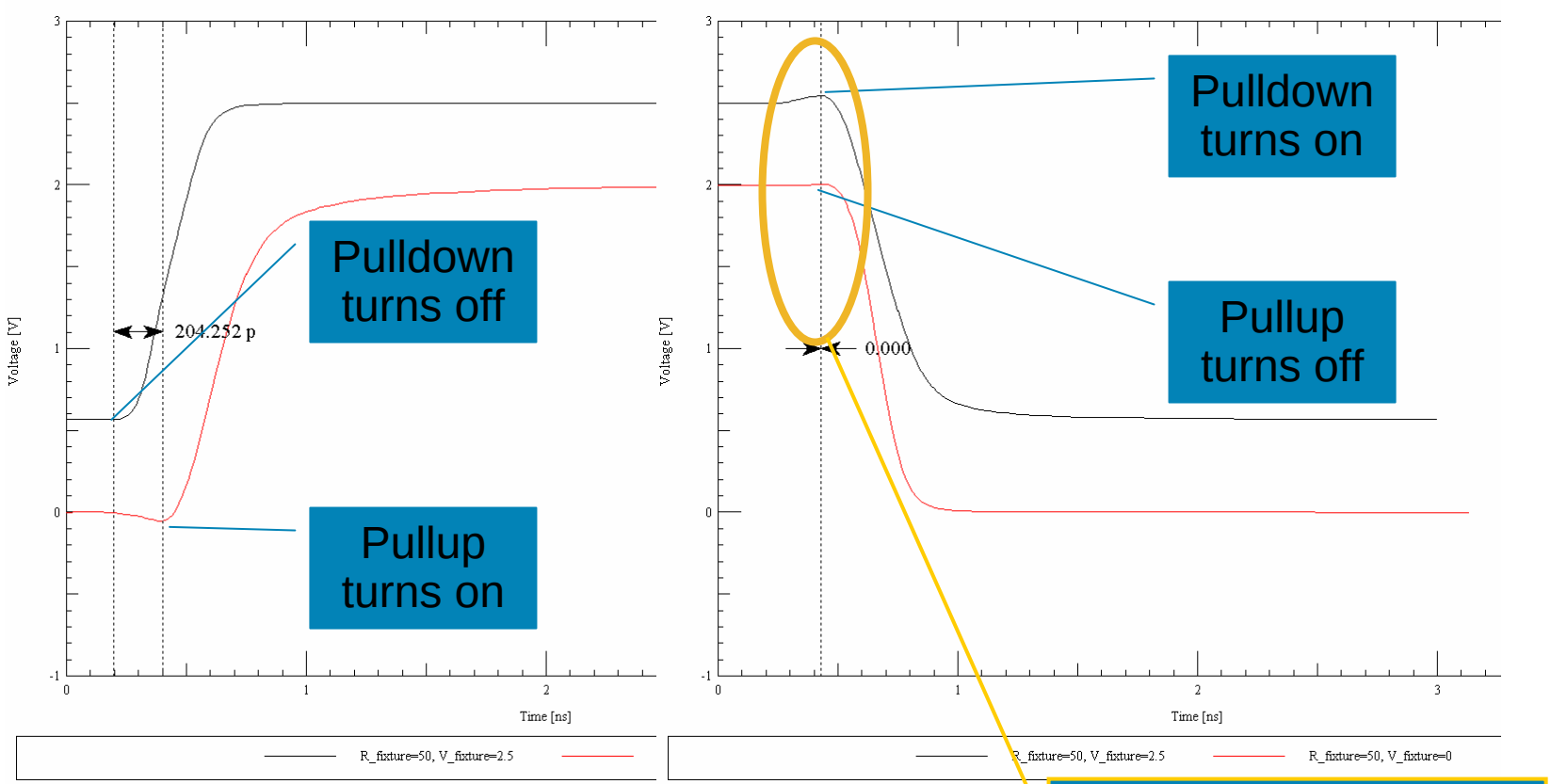
Background

- To change states a buffer must turn off one transistor and turn on the other.
- The turn-off usually precedes the turn-on, to avoid excessive “through current” while both are partially on.
- Simulators must mimic this time offset controlling the pullup and pulldown I/V elements.
- IBIS models do not directly convey this timing.
- Simulators examine IBIS waveforms for 2 fixtures (pulled up and pulled down) to “guess” the turn-on/turn-off timing.
- When waveforms have no offset, simulators must revert to some fallback mode, which is proprietary and likely to vary.

Offset IBIS Waveforms (normal)



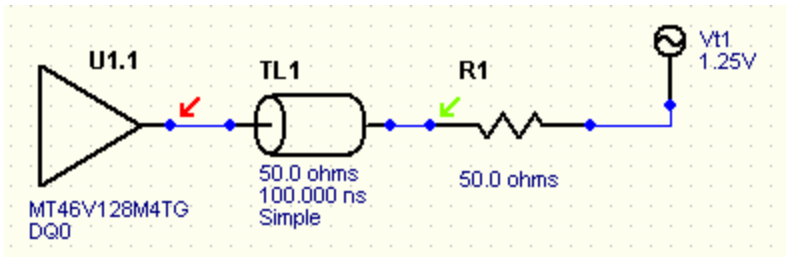
Aligned IBIS Waveform (abnormal)



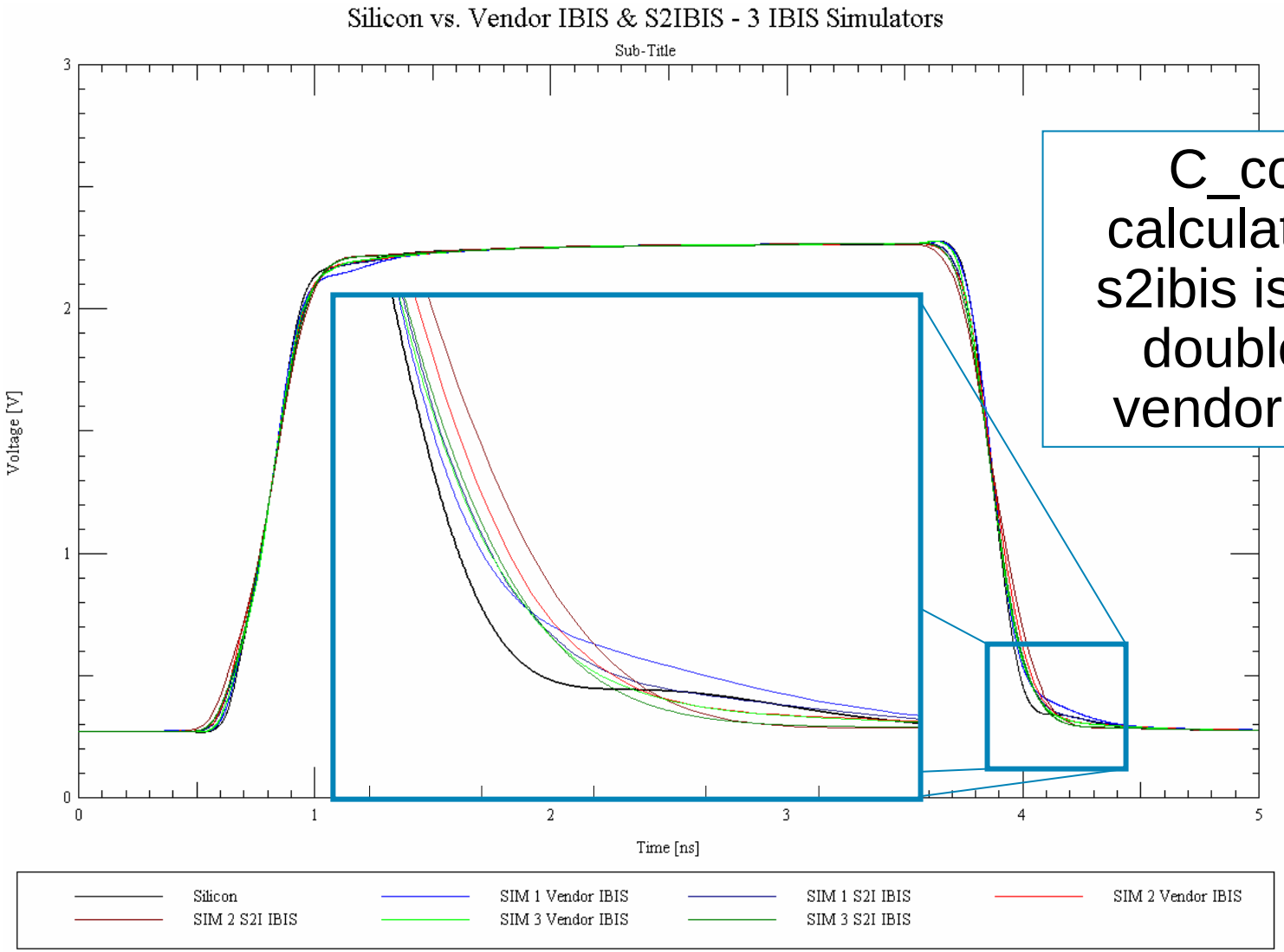
Note: waveform manually shifted

Simulation Test Circuit

- 2.5V 167MHz buffer
  - Vendor IBIS model, 0 ERRORs, 0 WARNINGs
  - Vendor silicon SPICE model
- Package R=70.4m L=5.3e-9 C=1.08e-12
- 50 ohm T-line terminated to mid-voltage VTT
- Tested with 3 IBIS simulators + Silicon SPICE
- Voltage measured at buffer pad
- Power/ground currents measured in 2 simulators
- Test cases:
  1. Buffer with normal waveforms
  2. Falling waveforms aligned
  3. No waveforms at all

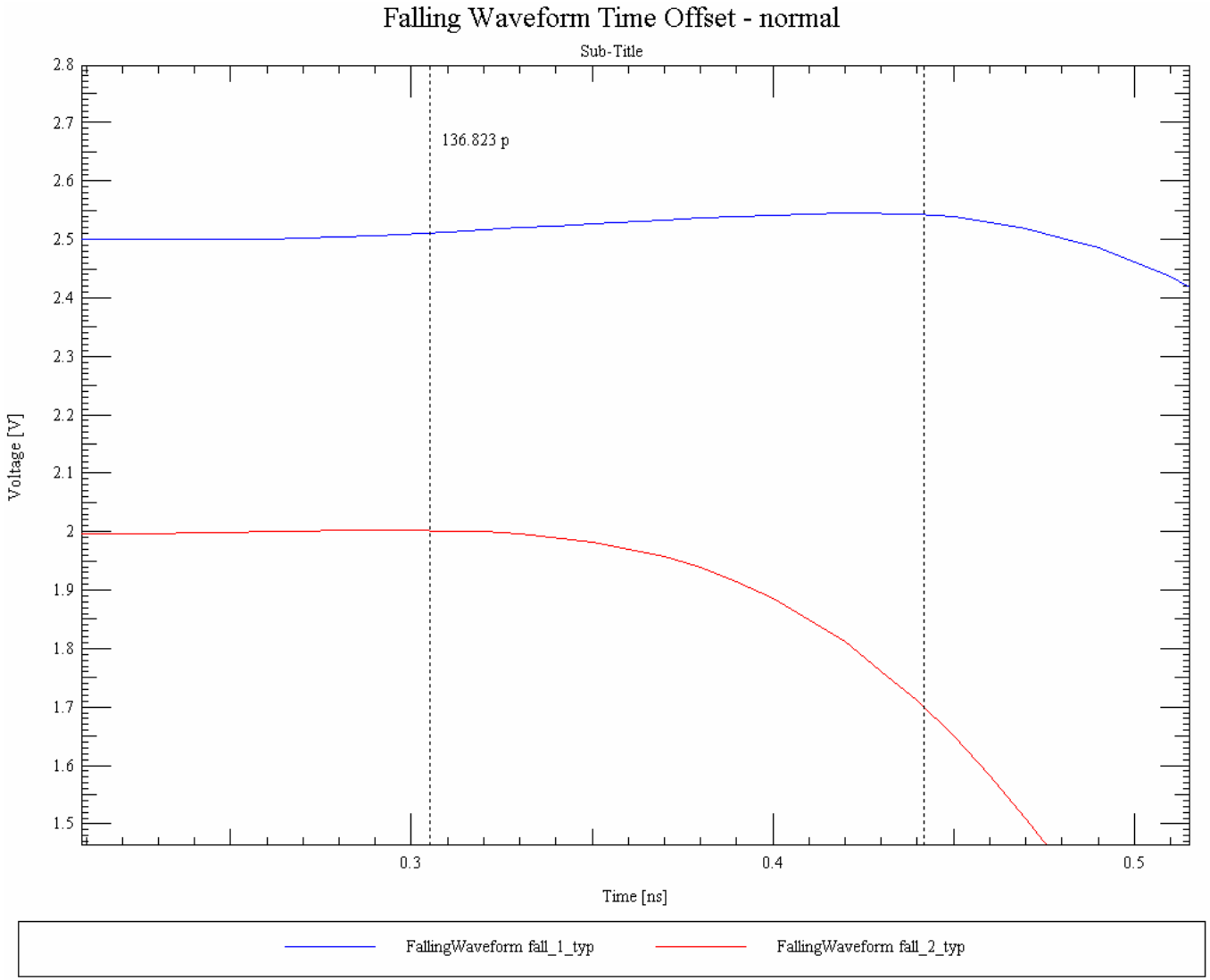


Baseline: Vendor IBIS, S2IBIS, and Silicon

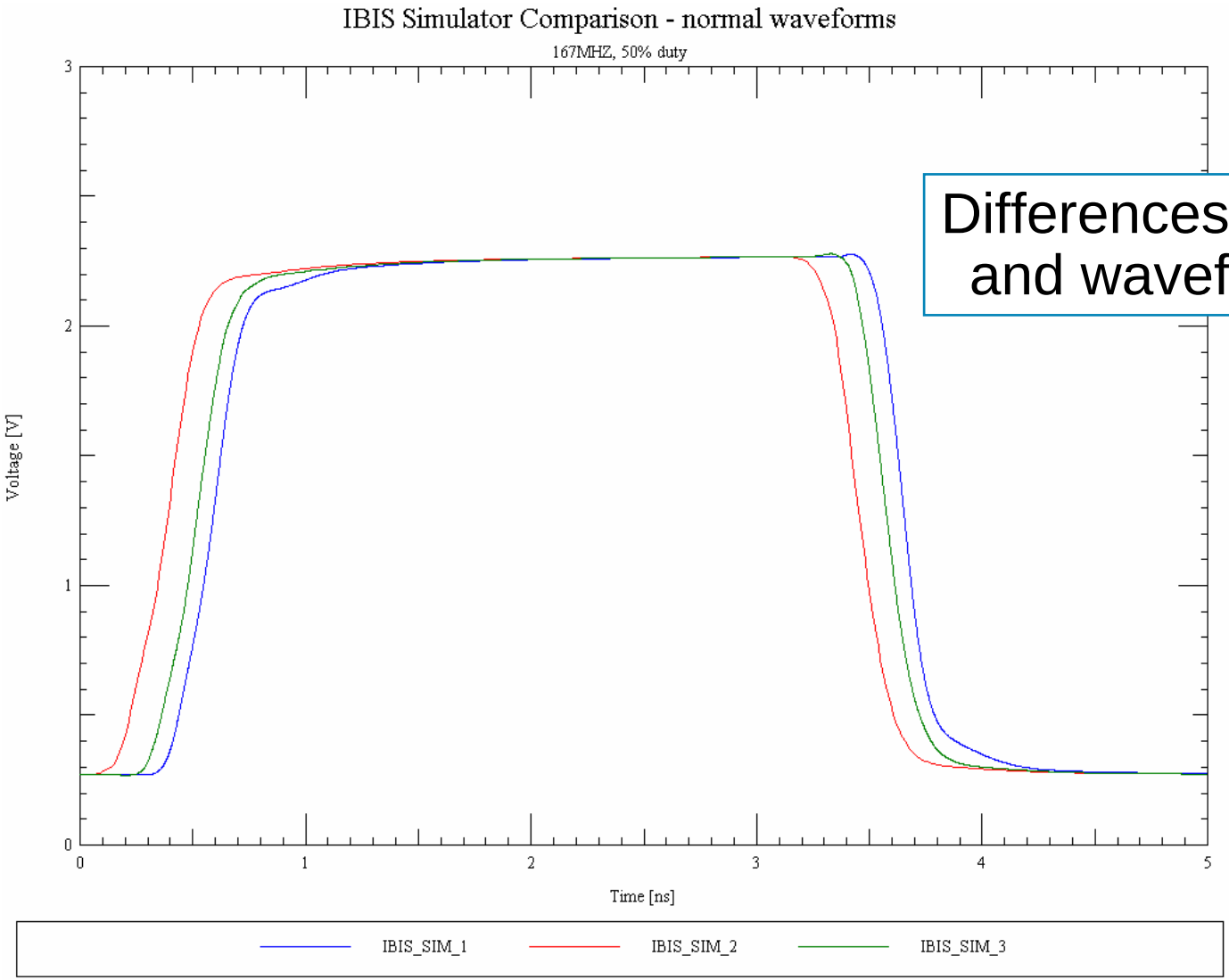


C_comp calculated for s2ibis is about double the vendor value

Vendor IBIS Fall Waves Offset (Normal)

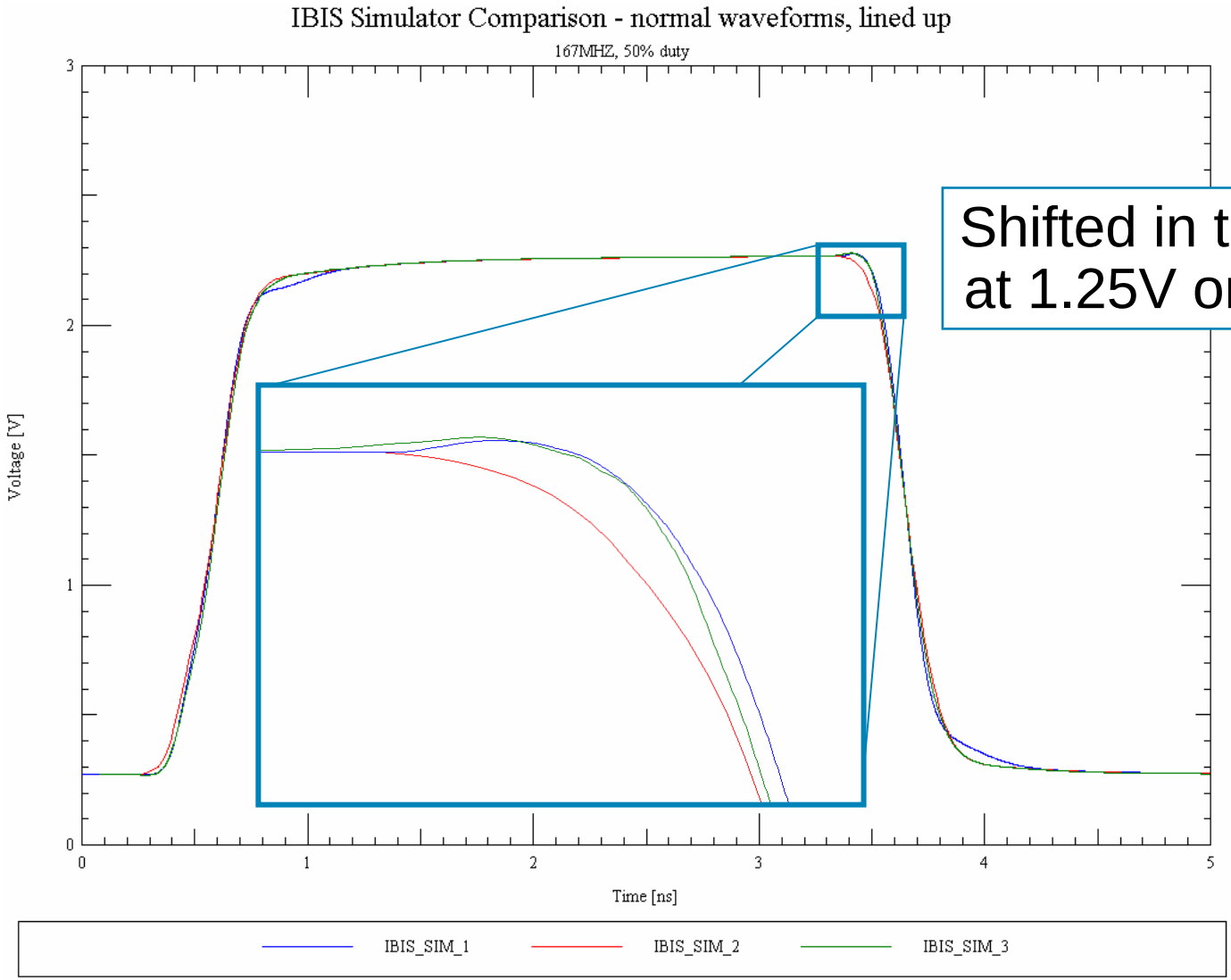


Vendor IBIS Waveform Case - 3 Simulators



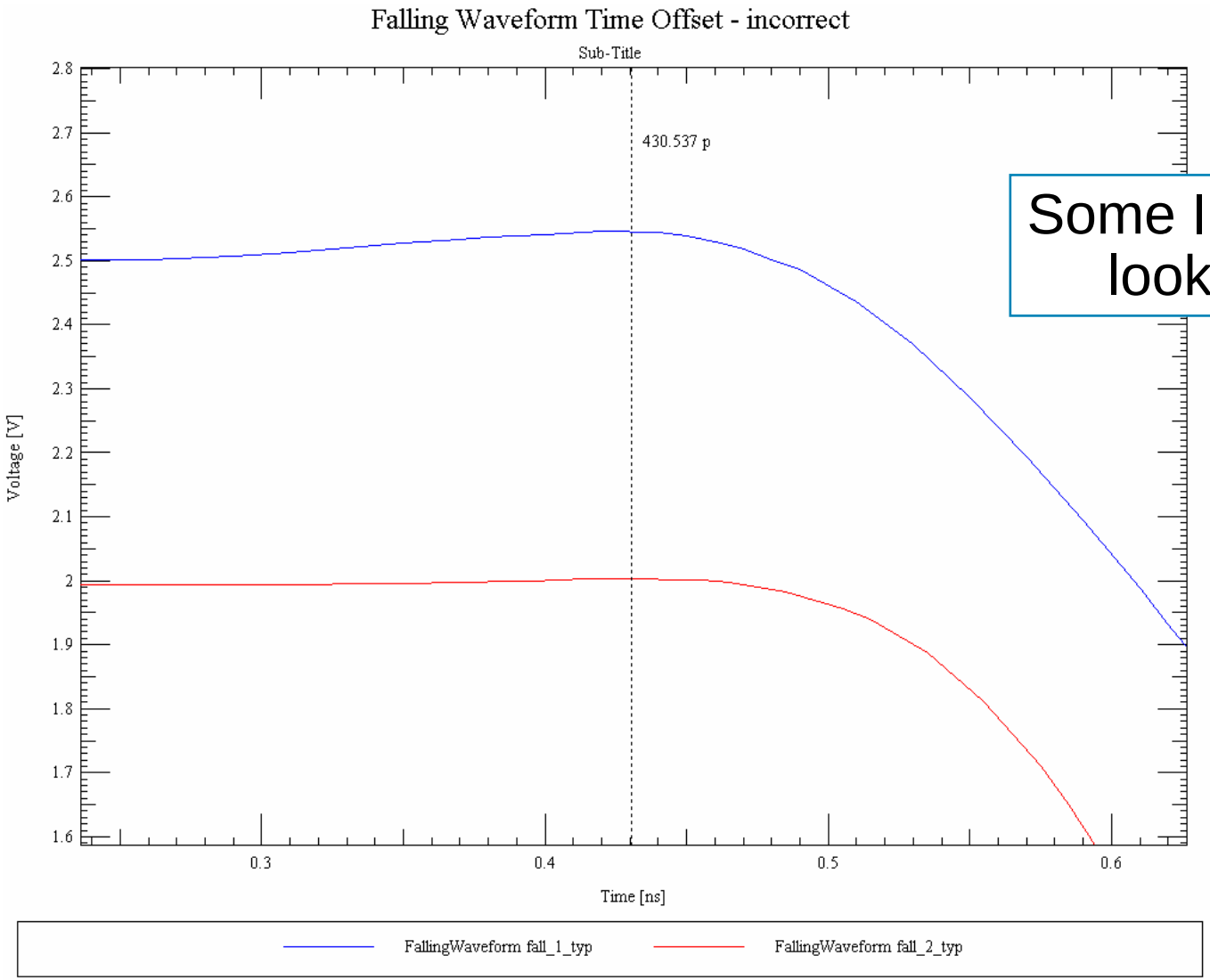
Differences in trigger time and waveform trimming

Vendor IBIS Waveform Case – Lined Up



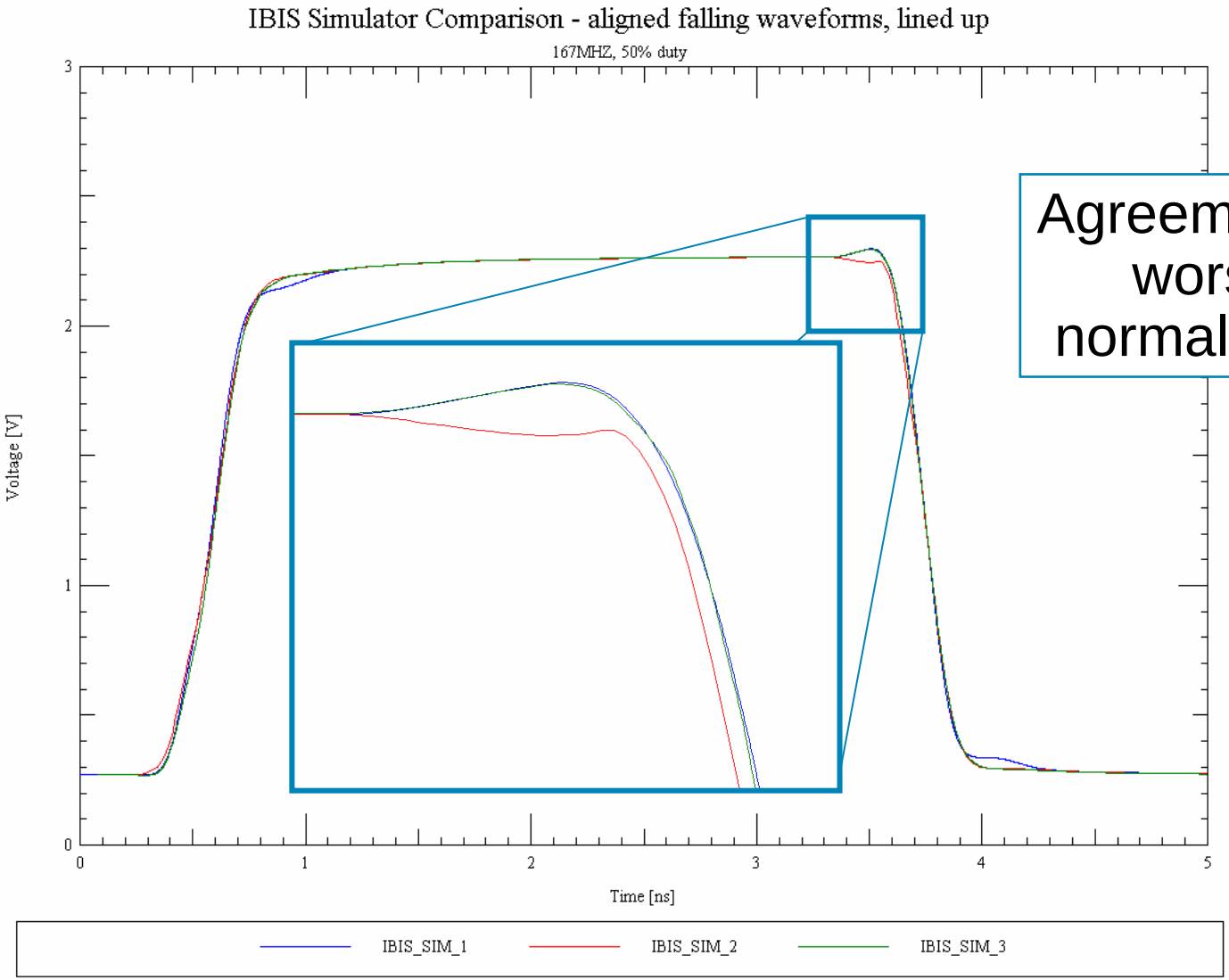
Shifted in time to line up at 1.25V on falling edge

IBIS Fall Waves Manually Aligned



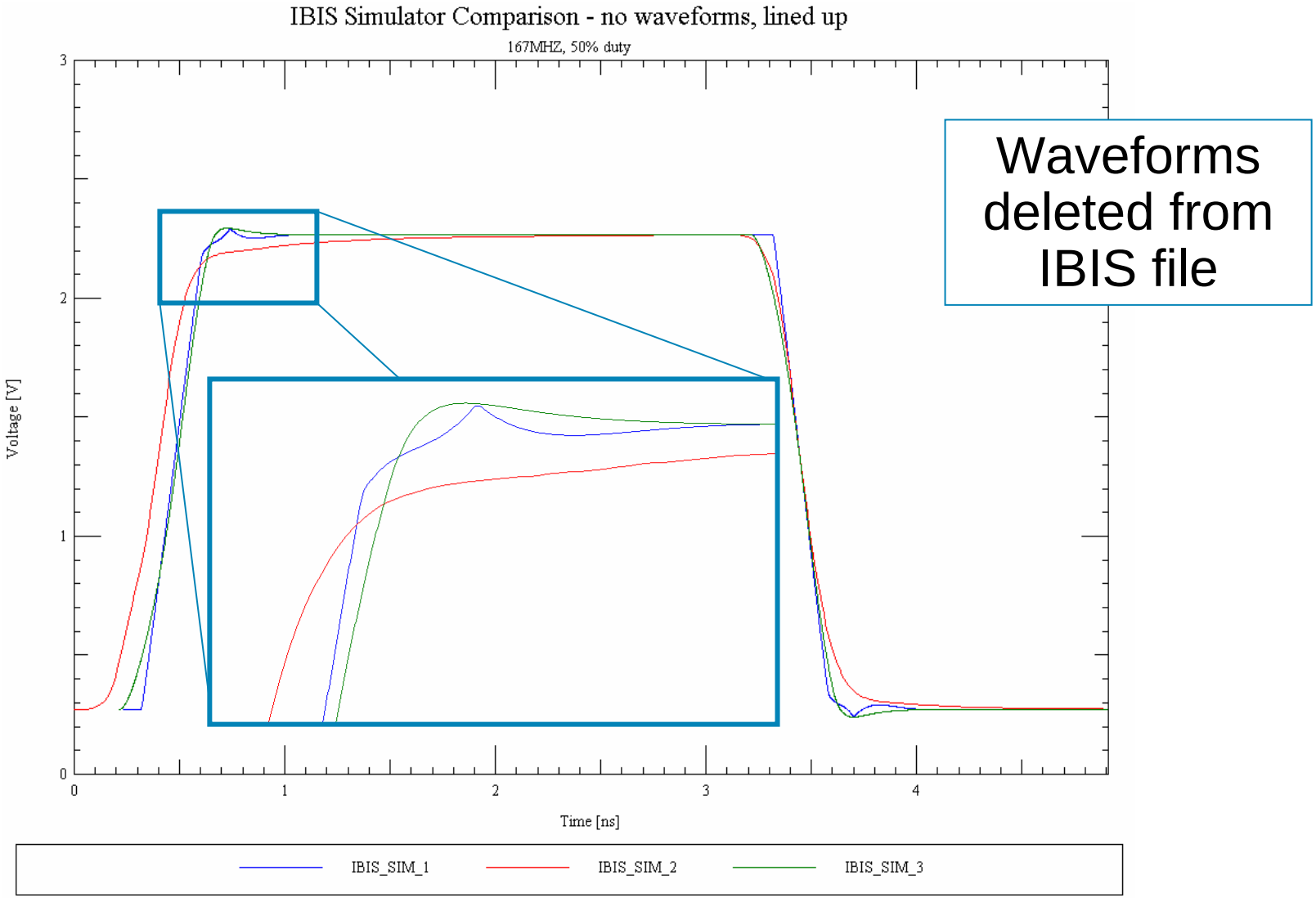
Some IBIS models look like this

Aligned IBIS Waveform Case – Lined Up



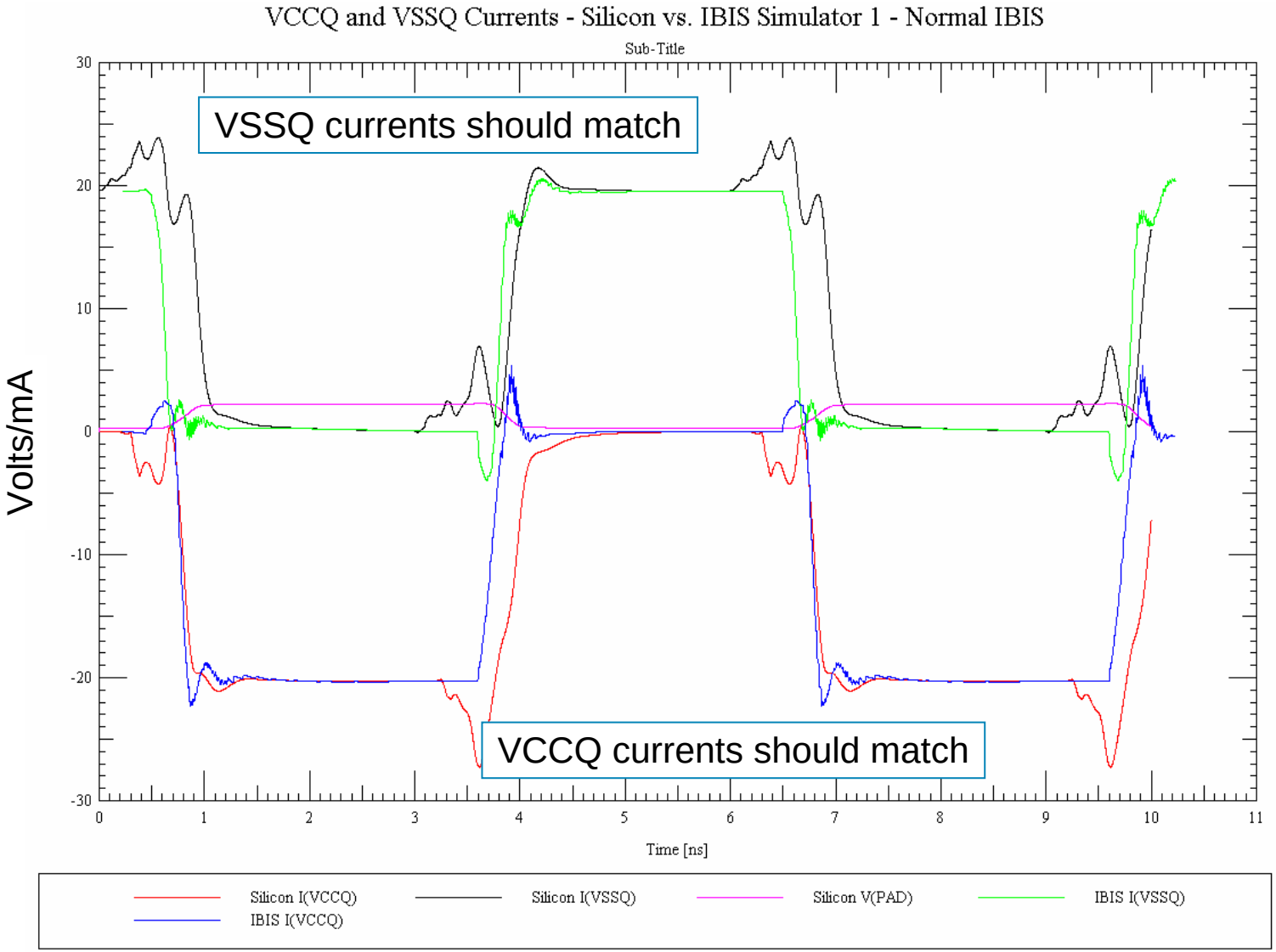
Agreement slightly worse than normal IBIS case

No IBIS Waveform Case – Lined Up

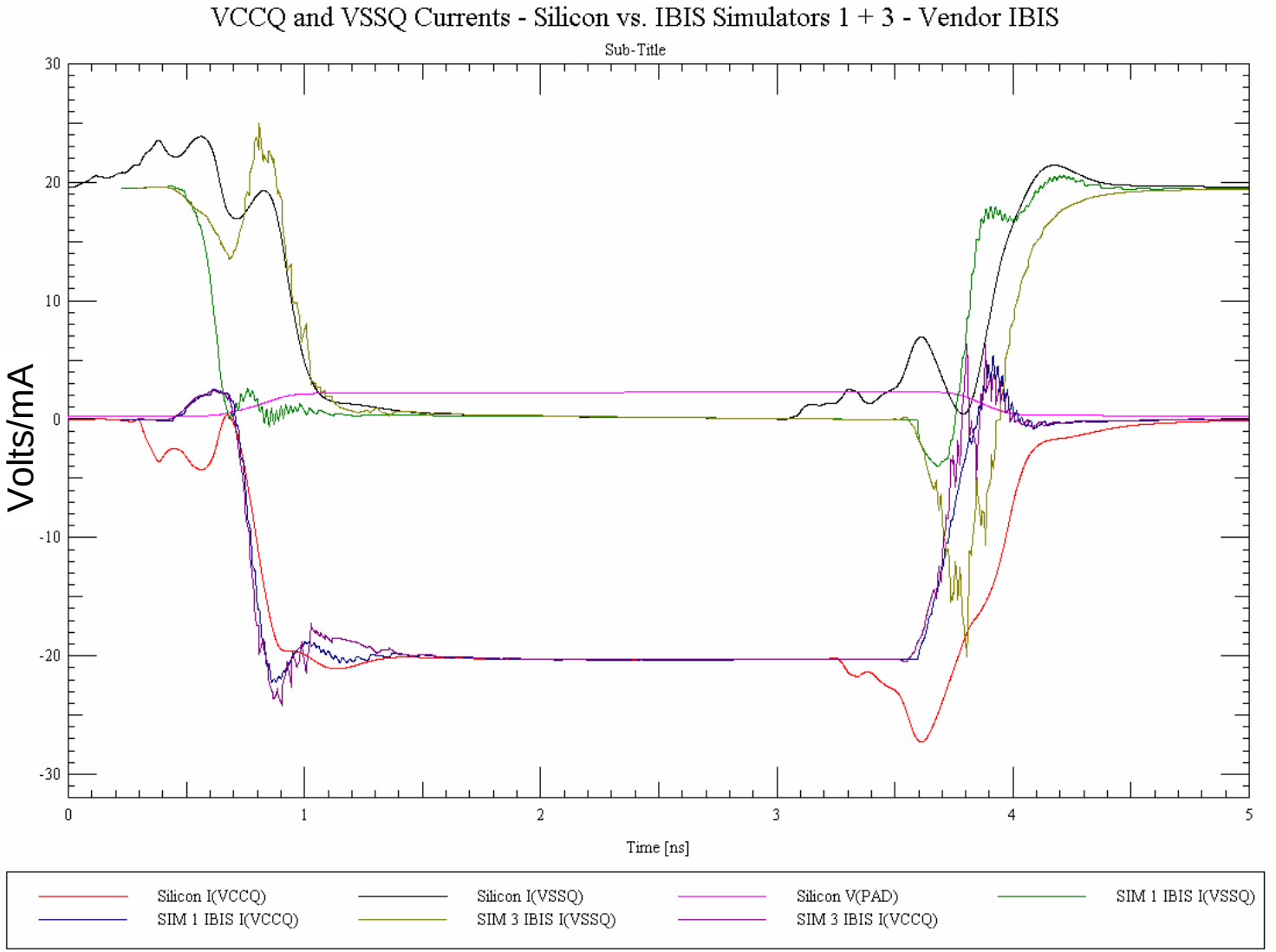


Waveforms deleted from IBIS file

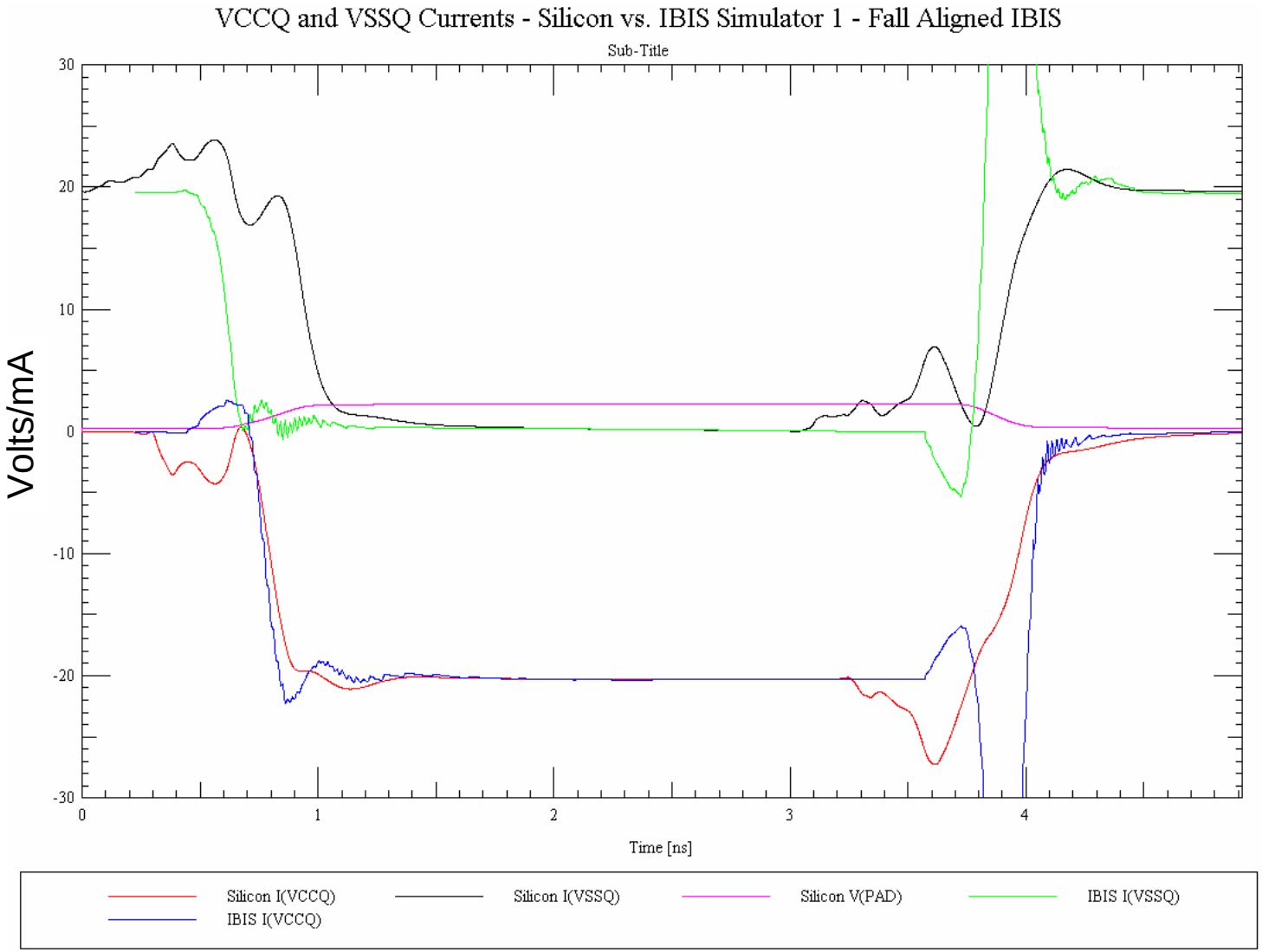
Normal IBIS Waveform Case - Currents



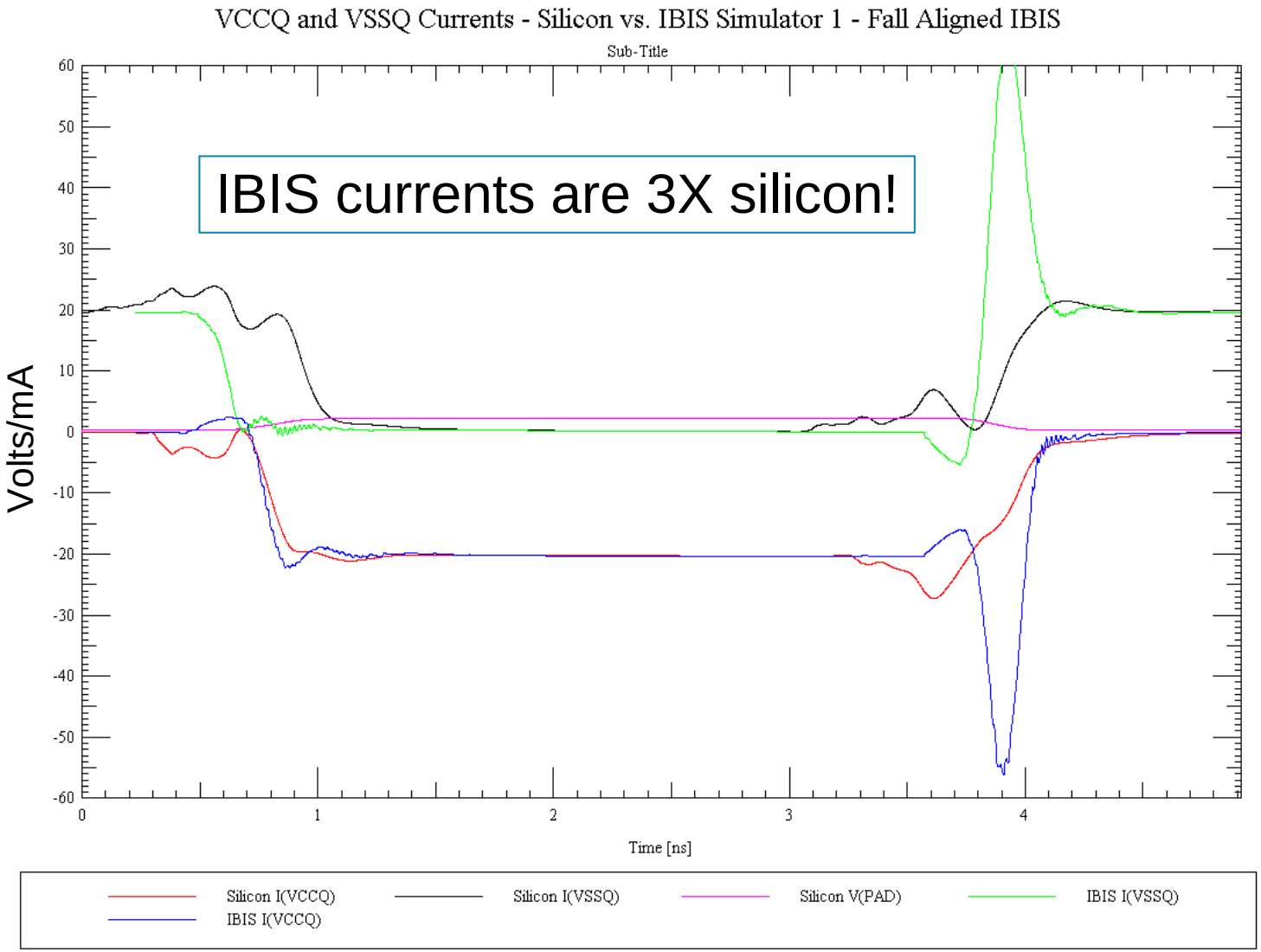
Normal IBIS Waveforms - 2 IBIS Simulators



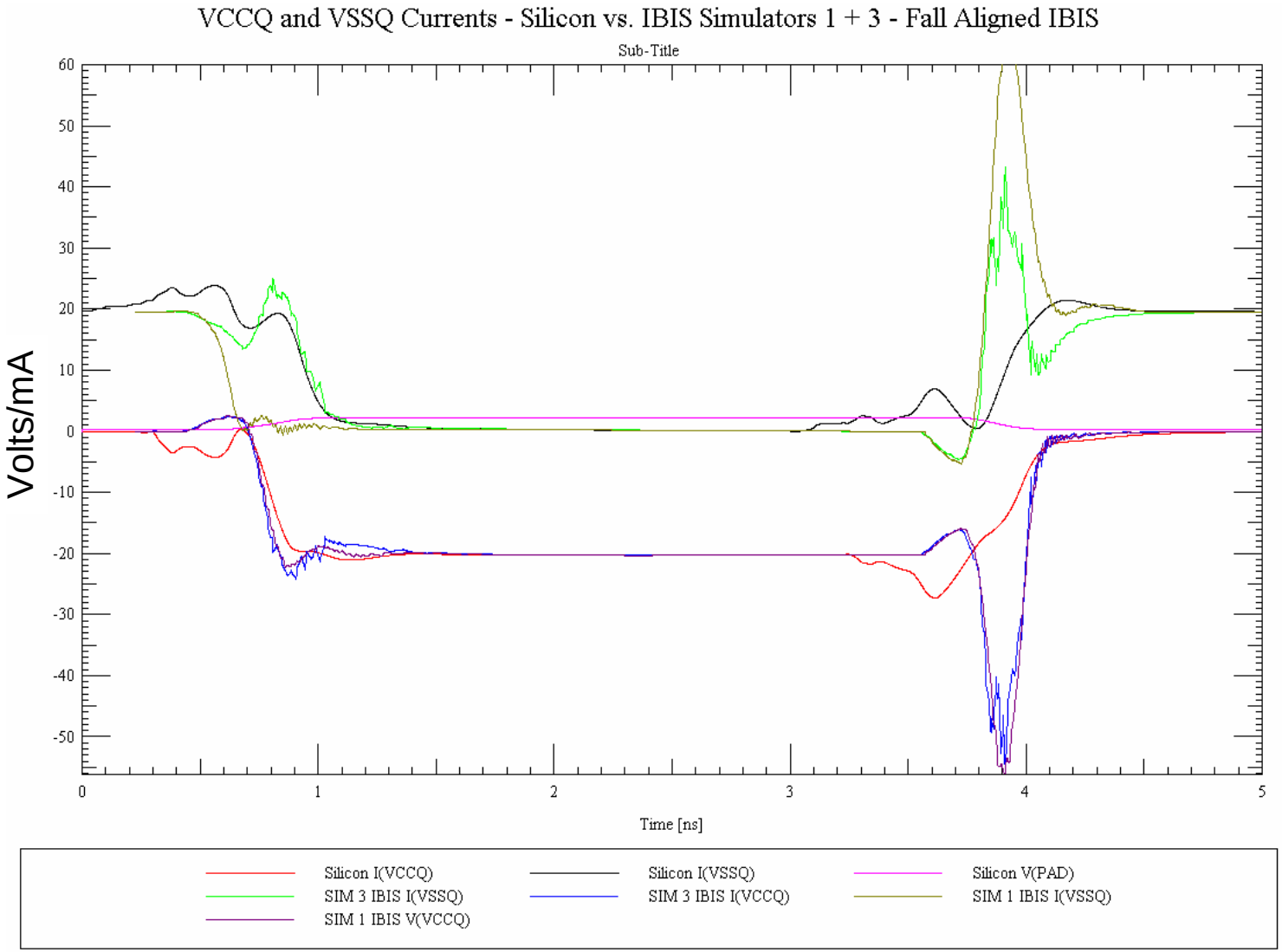
Aligned IBIS Waveform Case - Currents



Aligned IBIS Waveform Case - Currents



Aligned IBIS Waveforms – 2 IBIS Simulators



Conclusions

- IBIS simulators differ slightly in **voltage** simulation (*at least for one off-the-shelf IBIS model*).
- IBIS simulators differ in how they handle pullup/pulldown turn-on/turn-off timing, and therefore power/ground currents, even with **correctly timed** IBIS waveform data.
  - BIRD 95 has been accepted to address this.
  - Kumar was right.
- IBIS simulators differ even more in how they handle pullup/pulldown turn-on/turn-off timing when IBIS waveforms have **incorrect time offset**.
- In the latter case the voltage waveform difference between simulators becomes only slightly worse.