Interim Observations on Multimode Optical Channels

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Measurement Technique

- **Instruments:**
  - HP 3Gig BERT
  - 850nm VCSEL (15μm diameter, high NA oxide laser)
  - Optical bench, 2mm ball lens to couple to fiber
  - 10GHz optical receiver
  - Agilent 83480 Digital Communications Analyzer
  - Randomly selected fibers per table of next viewgraph

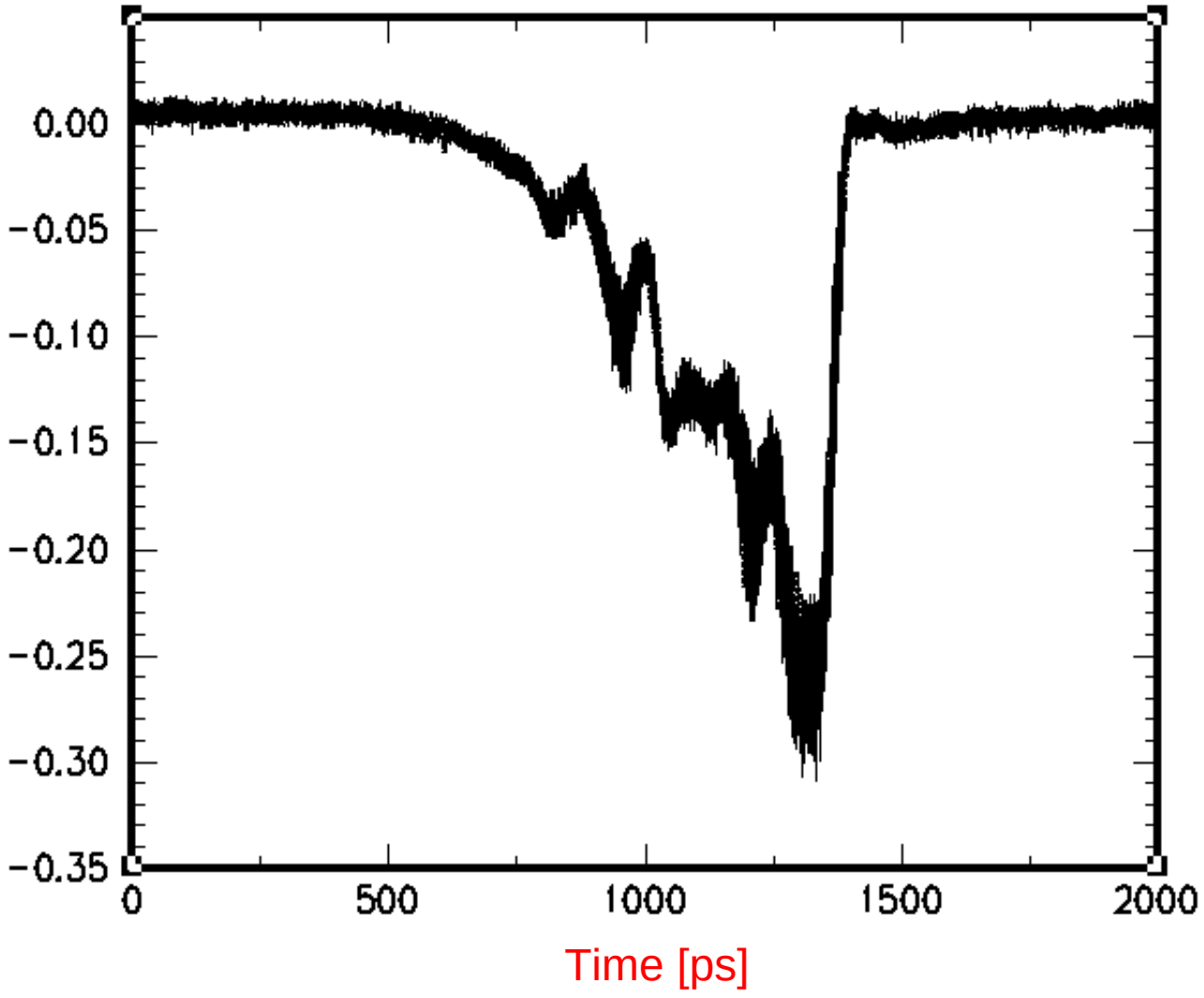
- **We collected 20 samples of impulse responses and periodic signals for each fiber using a 32 bit pseudoran-dom sequence**

Measured Fibers

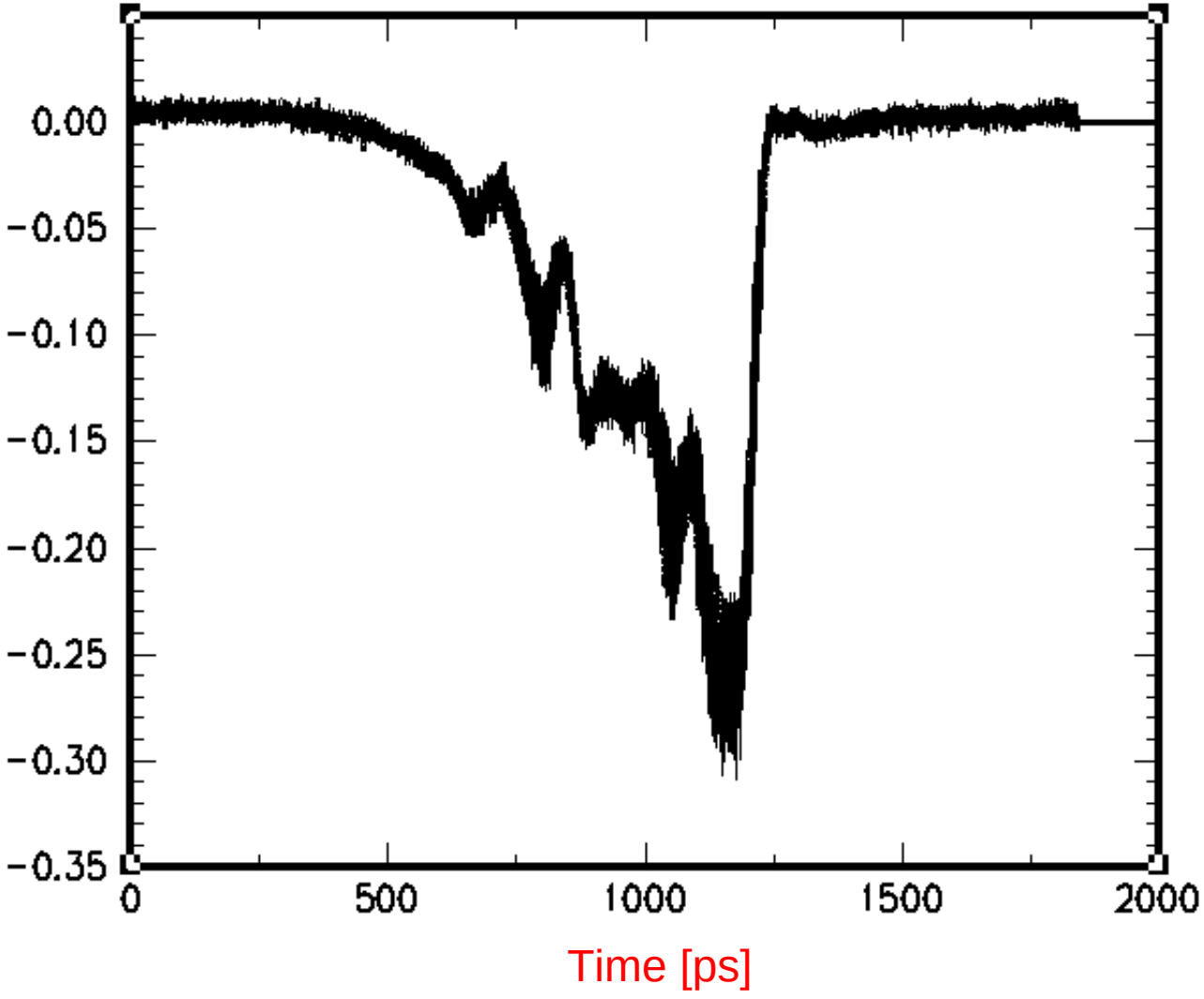
FIBER	CORE DIAMETER[mm]	LENGTH[m]	MANUFACTURER
F0	62.5	270	Fujikura
F1	50.0	1152	Corning
F2	62.5	2234	Corning
F3	50.0	2247	Corning
F4	62.5	1151	Corning
F5	50.0	540	Corning

NOTE: All measurements were done at 850nm

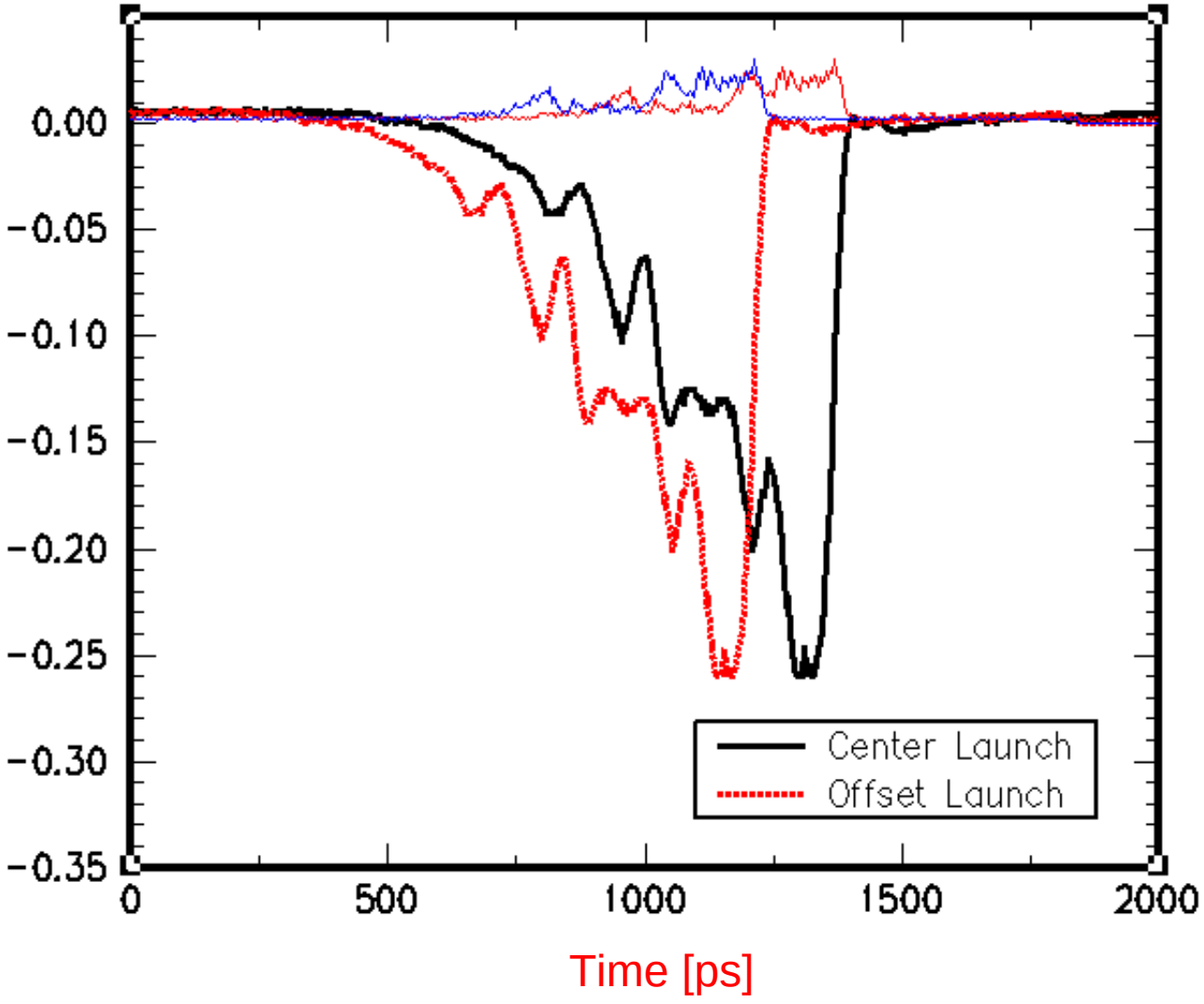
Overlap of 20 Samples of Impulse Response
Fiber F0 - Center Launch



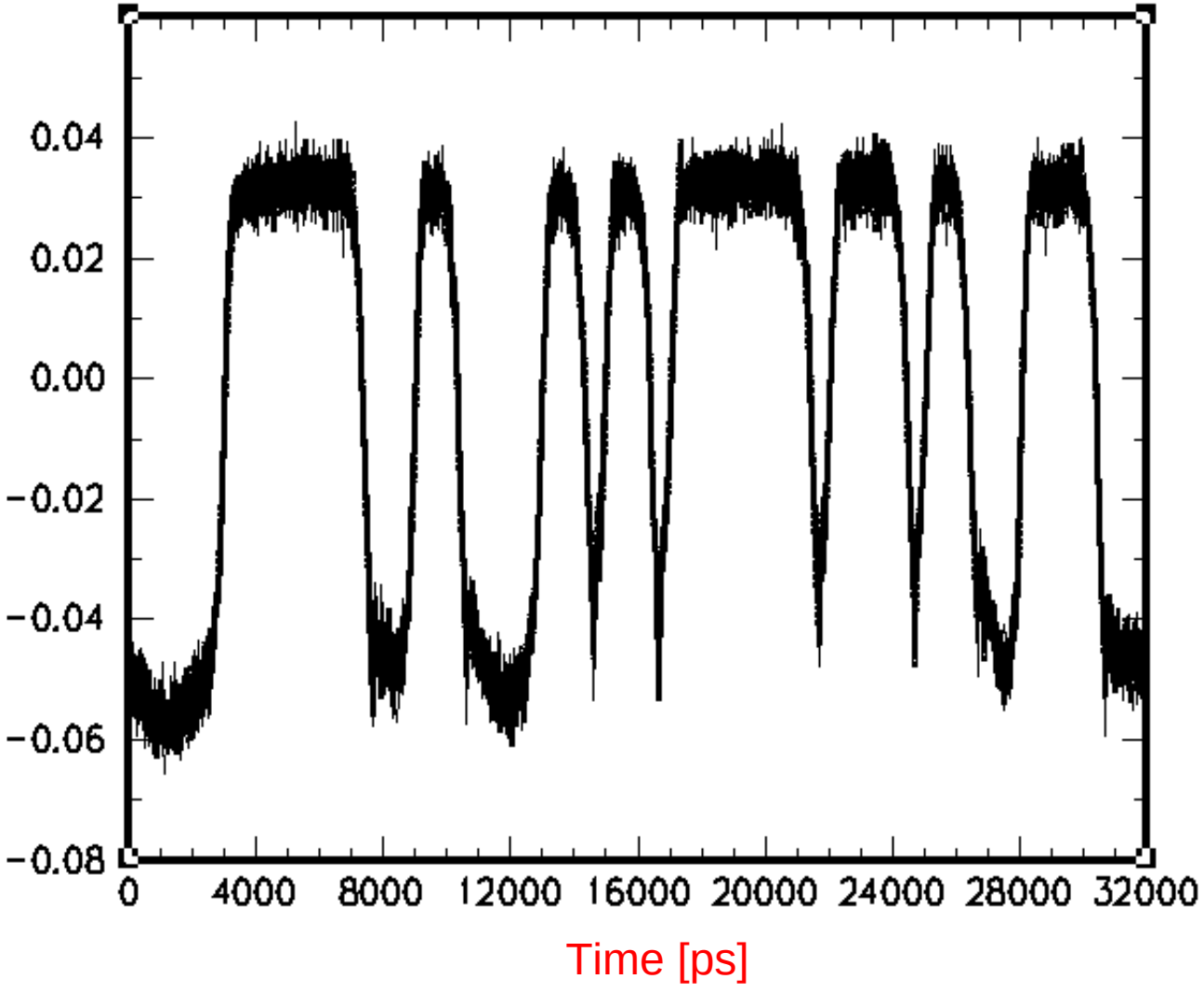
Overlap of 20 Samples of Impulse Response Fiber F0 - 5μm Offset Launch



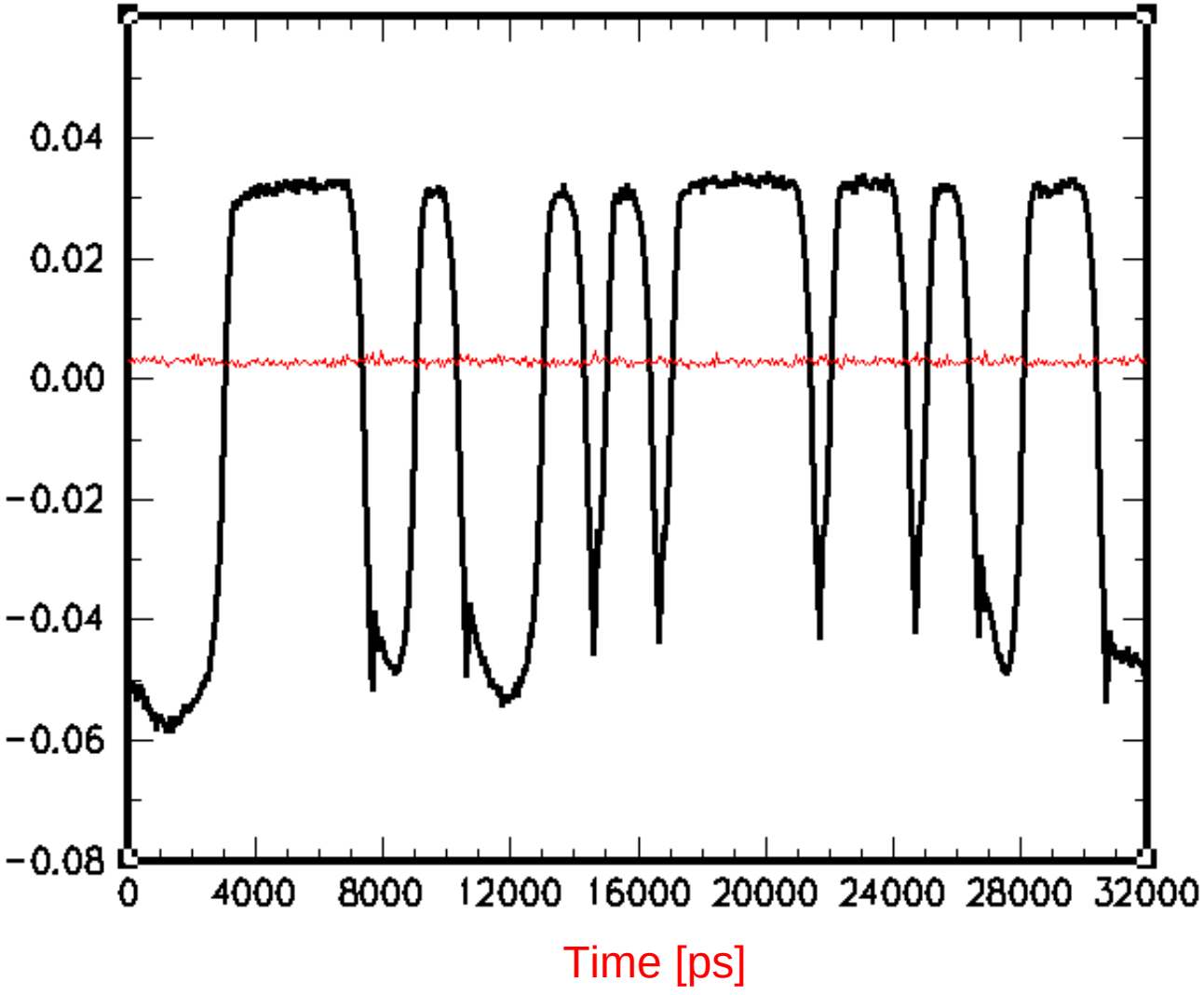
Average Impulse Response and Noise Standard Deviation Fiber F0 - Center and 5μm Offset Launches



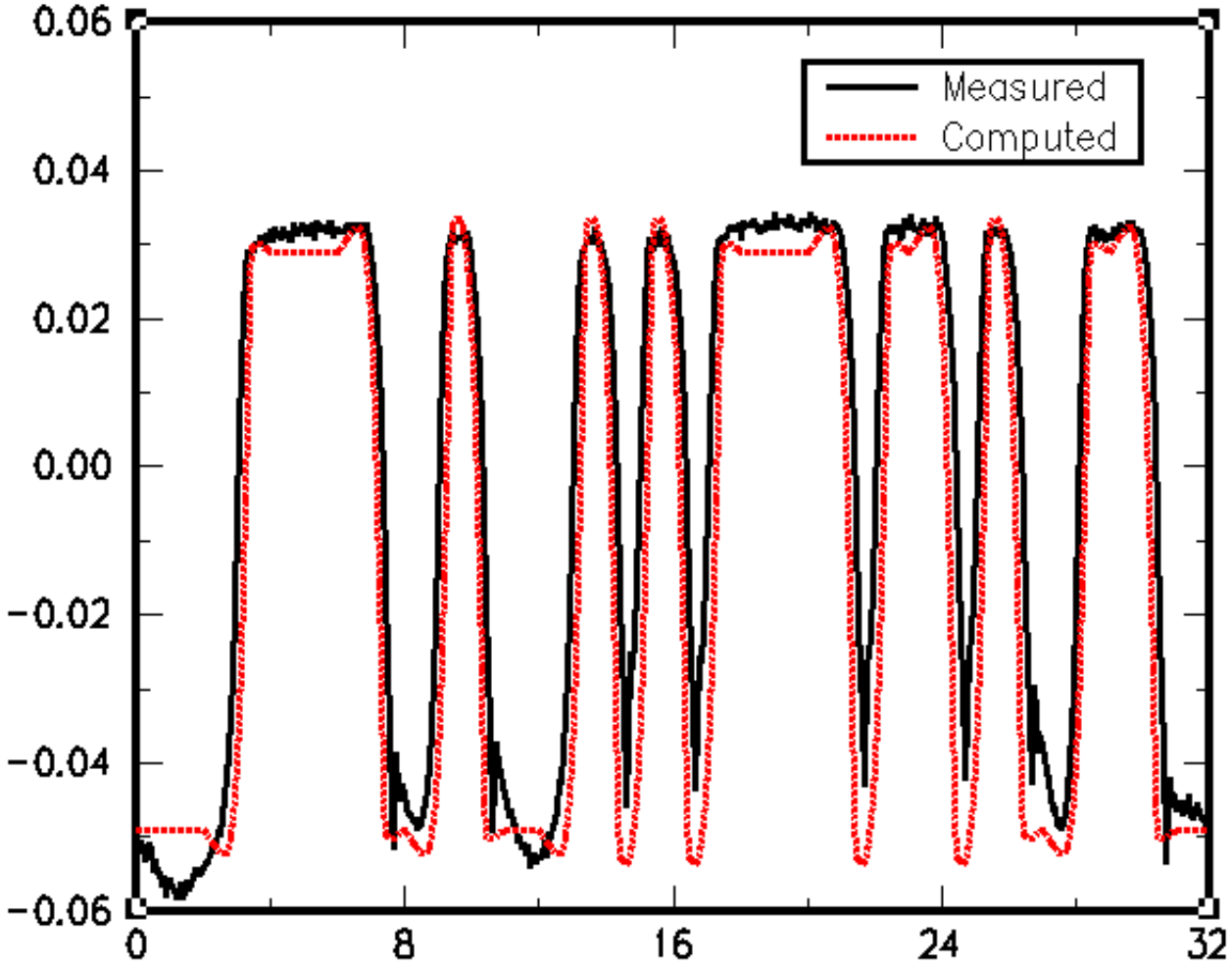
Overlap of 20 Samples of Received Signal
Fiber F0 - Center Launch



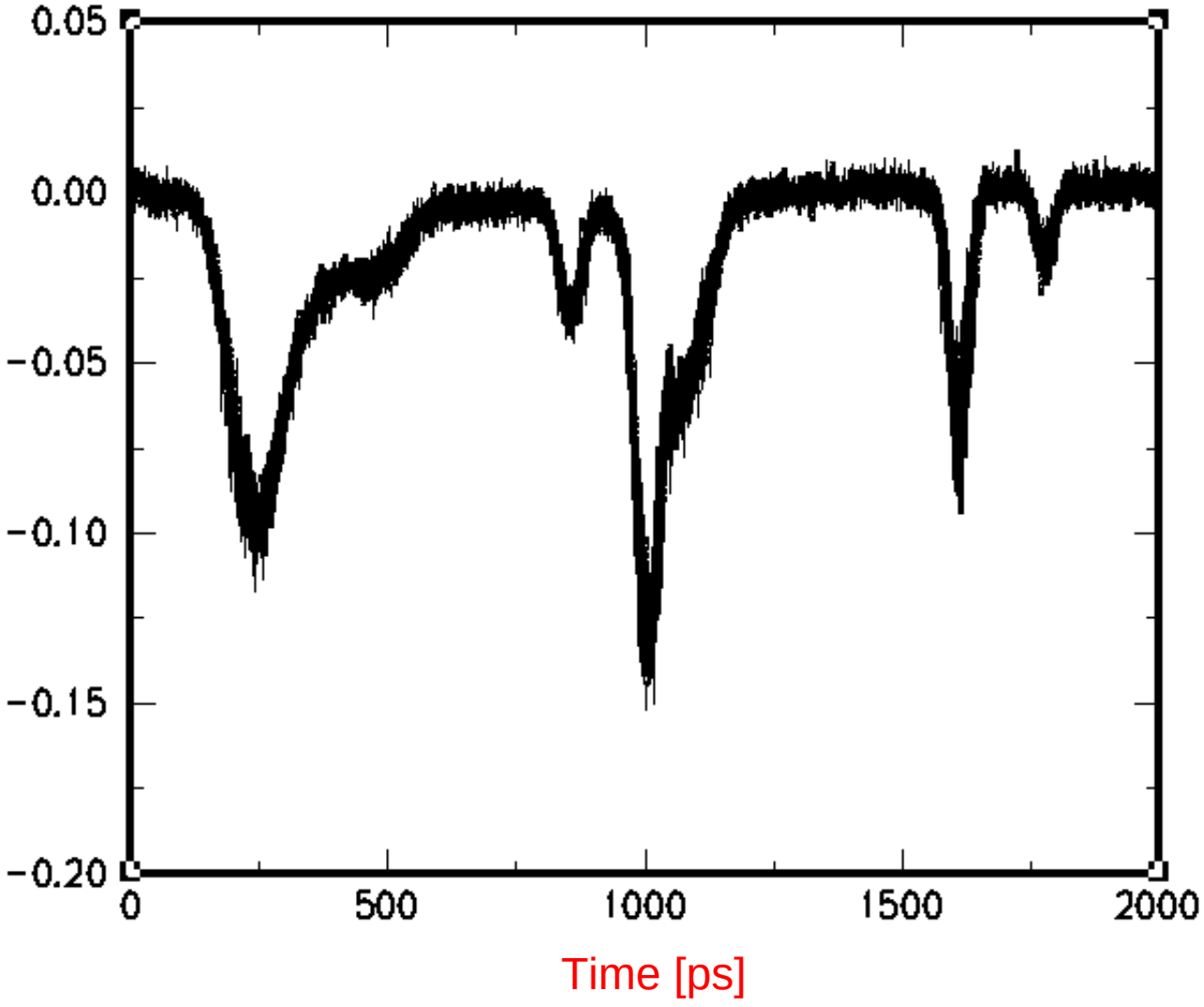
Average Received Signal and Standard Deviation
Fiber F0 - Center Launch



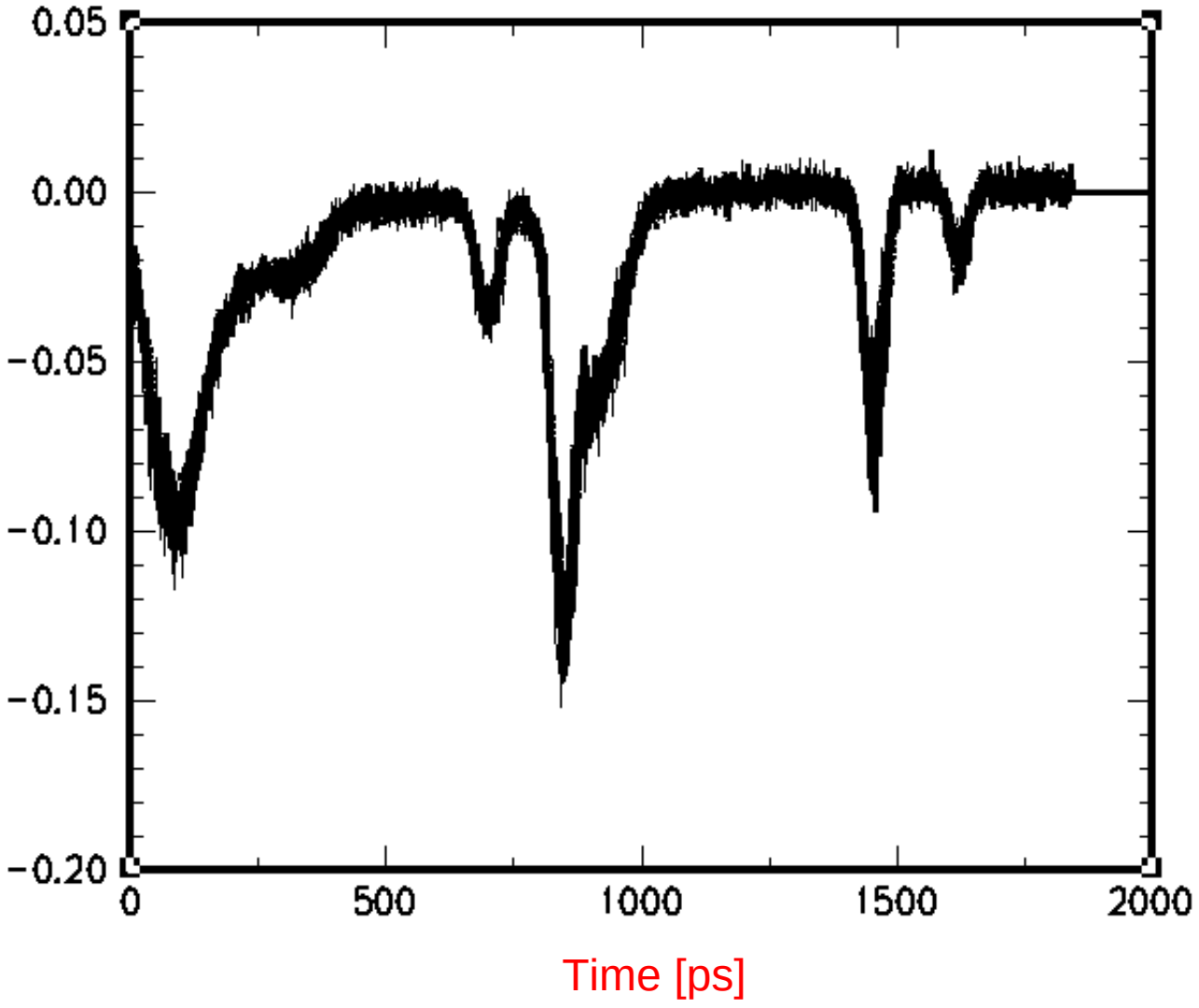
Best Fit of Computed and Measured Signals
Fiber F0 - Center Launch



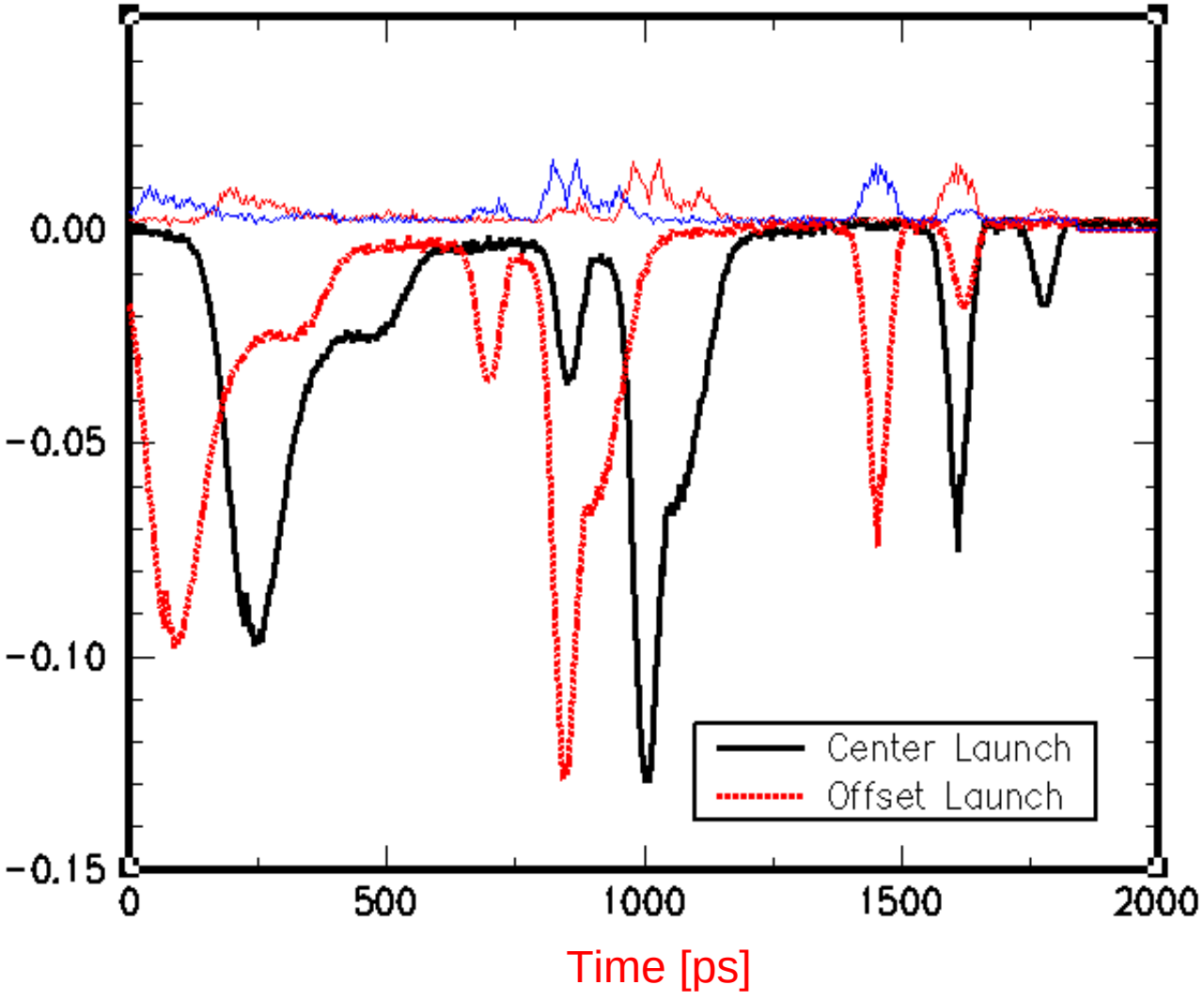
Overlap of 20 Samples of Impulse Response
Fiber F1 - Center Launch



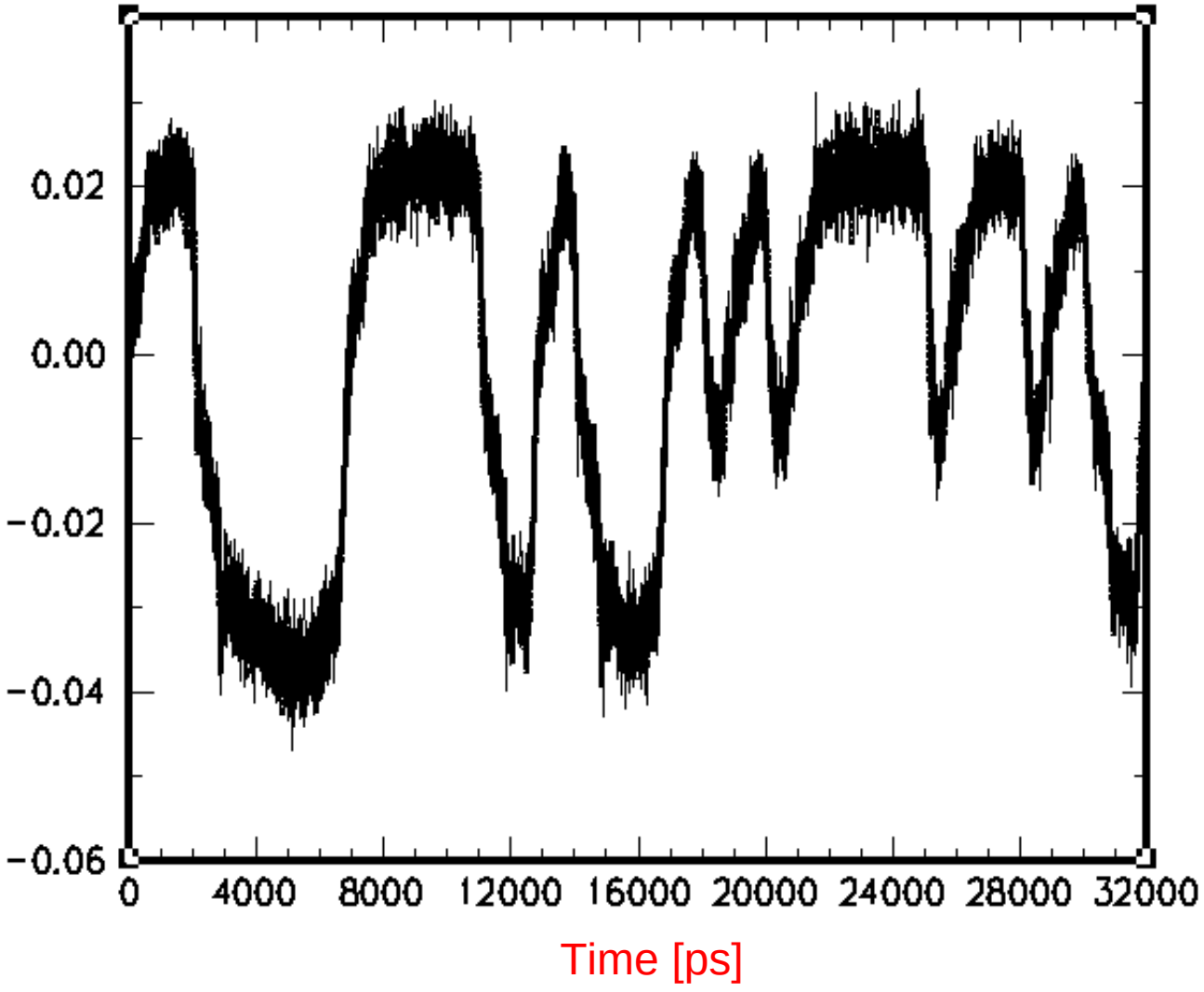
Overlap of 20 Samples of Impulse Response
Fiber F1 - 5μm Offset Launch



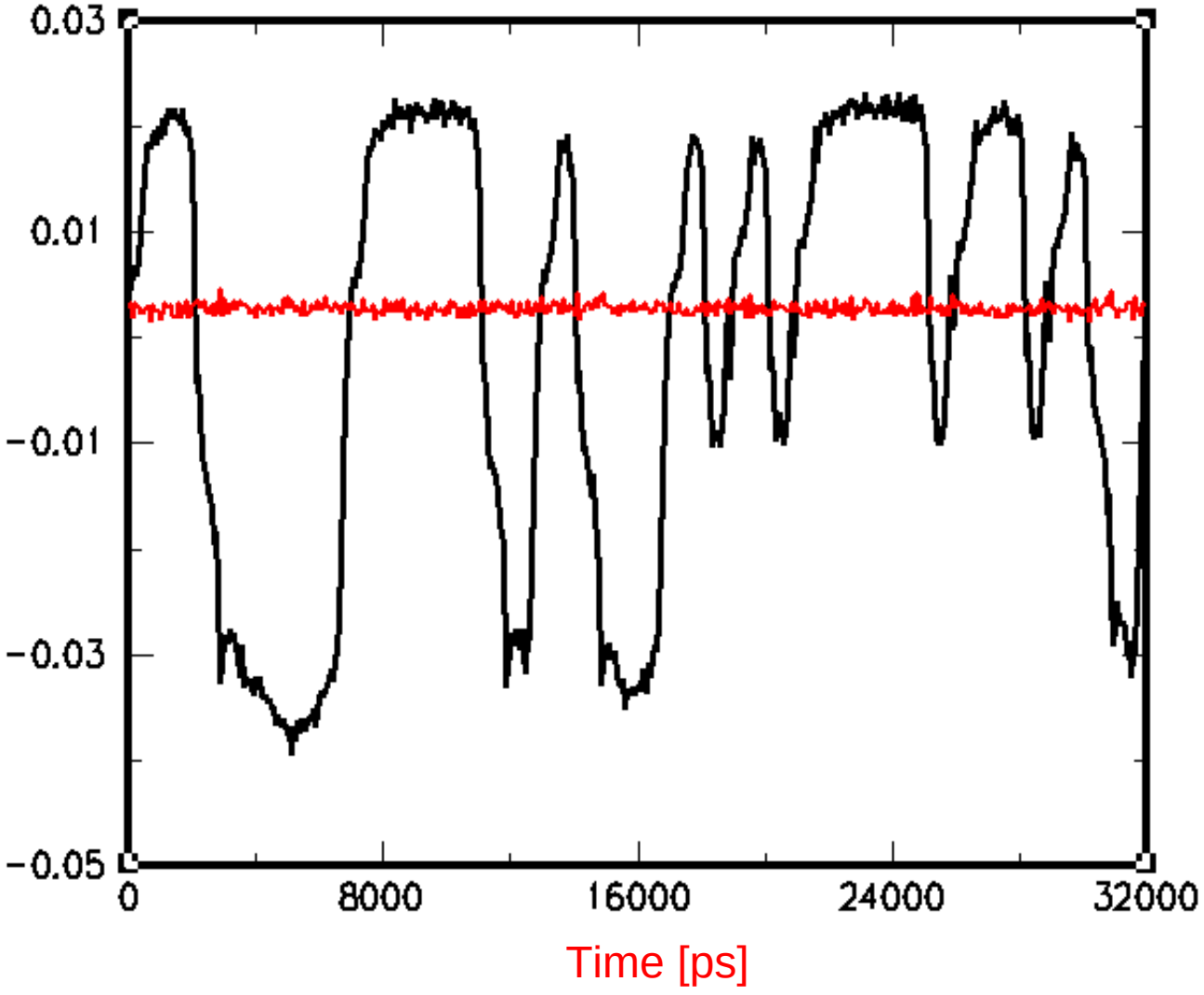
Average Impulse Response and Noise Standard Deviation Fiber F1 - Center and 5μm Offset Launches



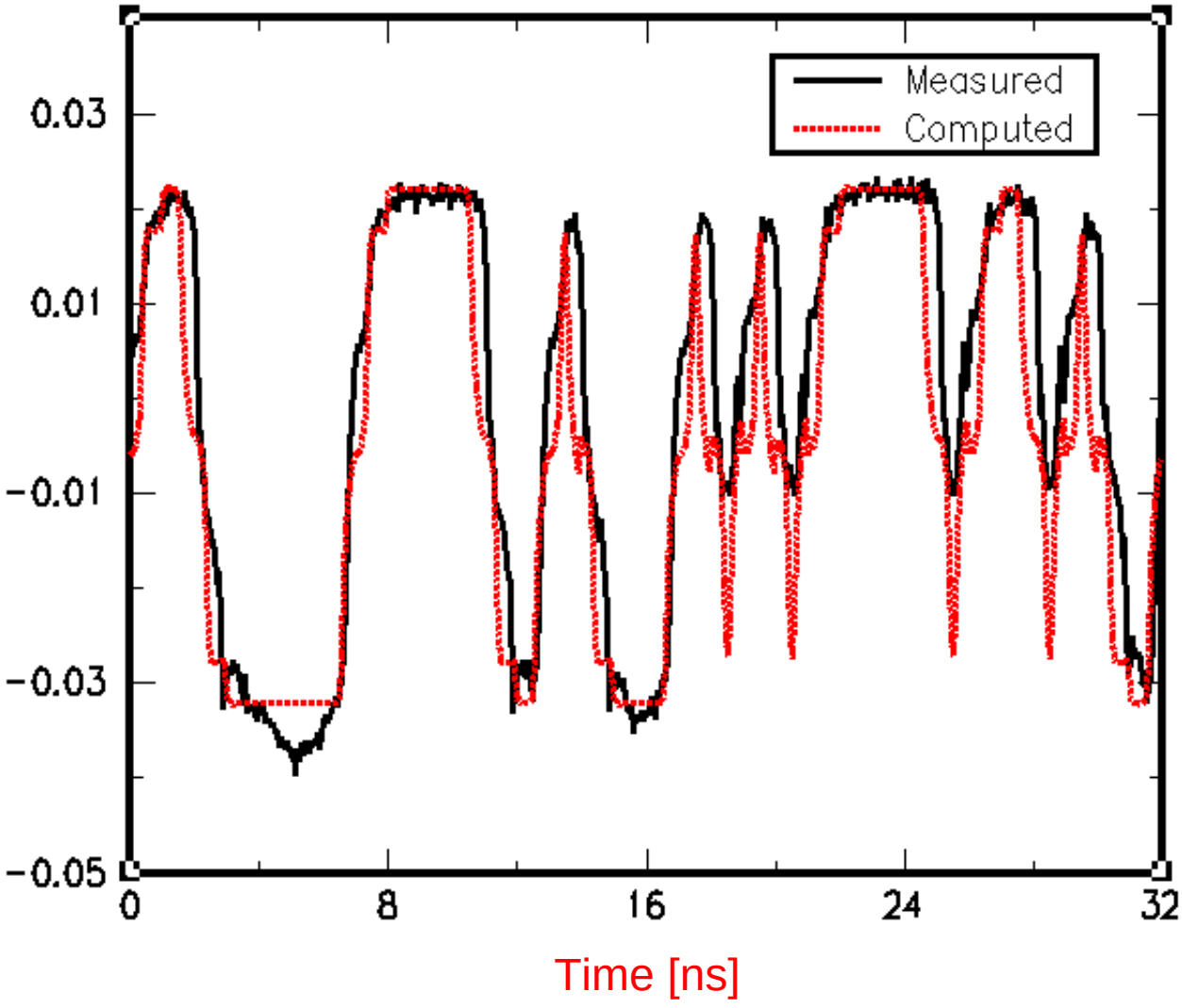
Overlap of 20 Samples of Received Signal
Fiber F1 - Center Launch



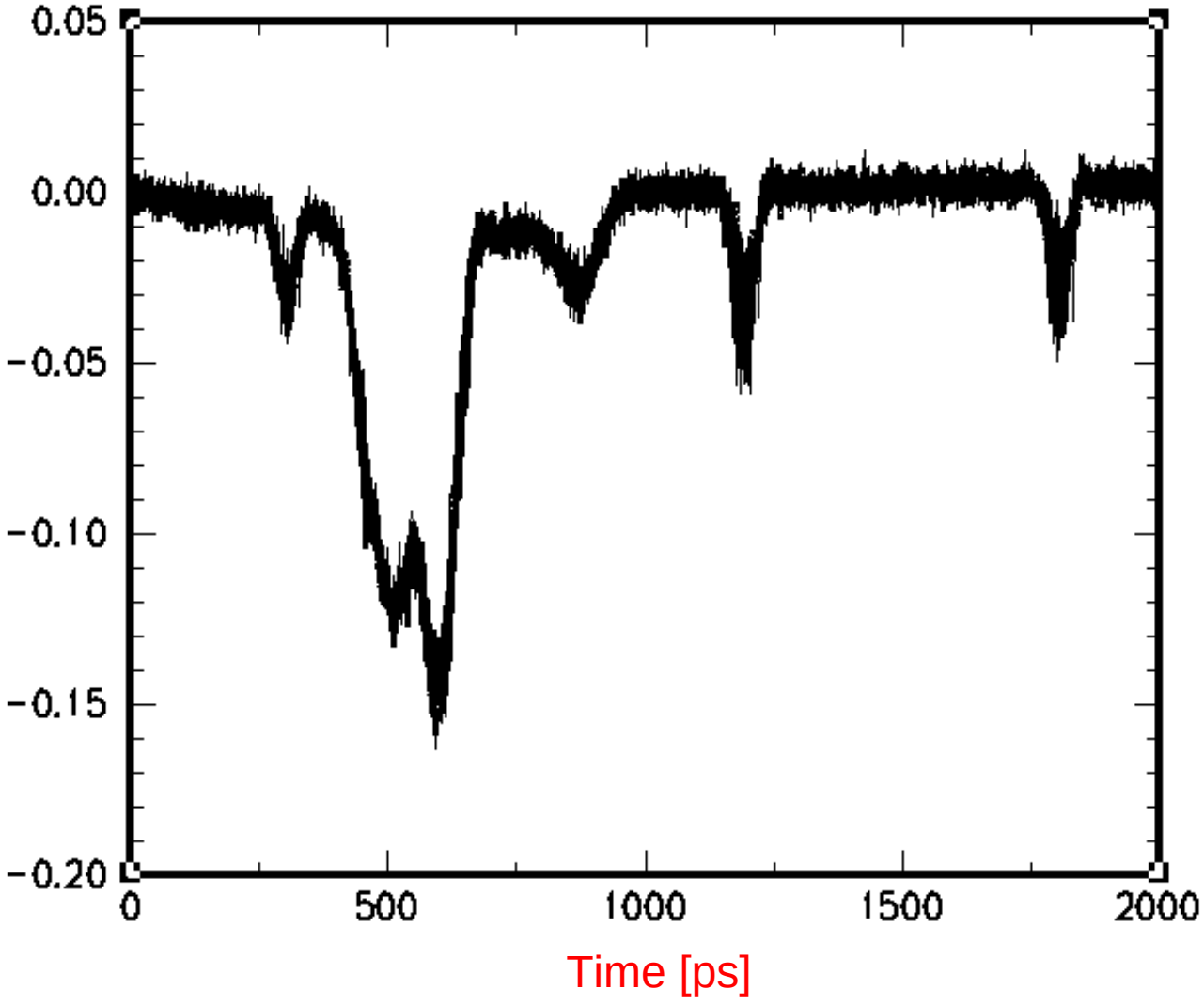
Average Received Signal and Standard Deviation
Fiber F1 - Center Launch



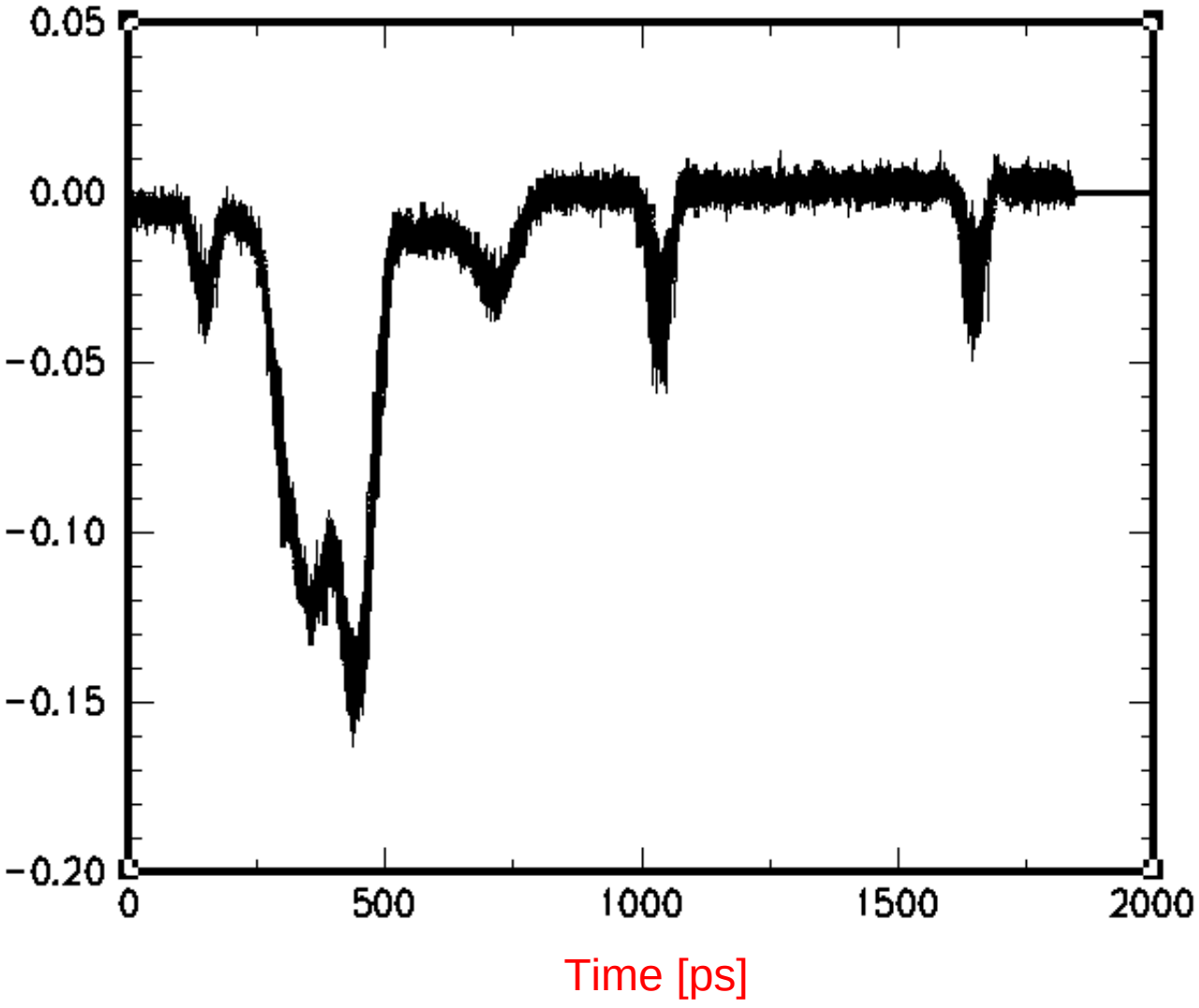
Best Fit of Computed and Measured Signals
Fiber F1 - Center Launch



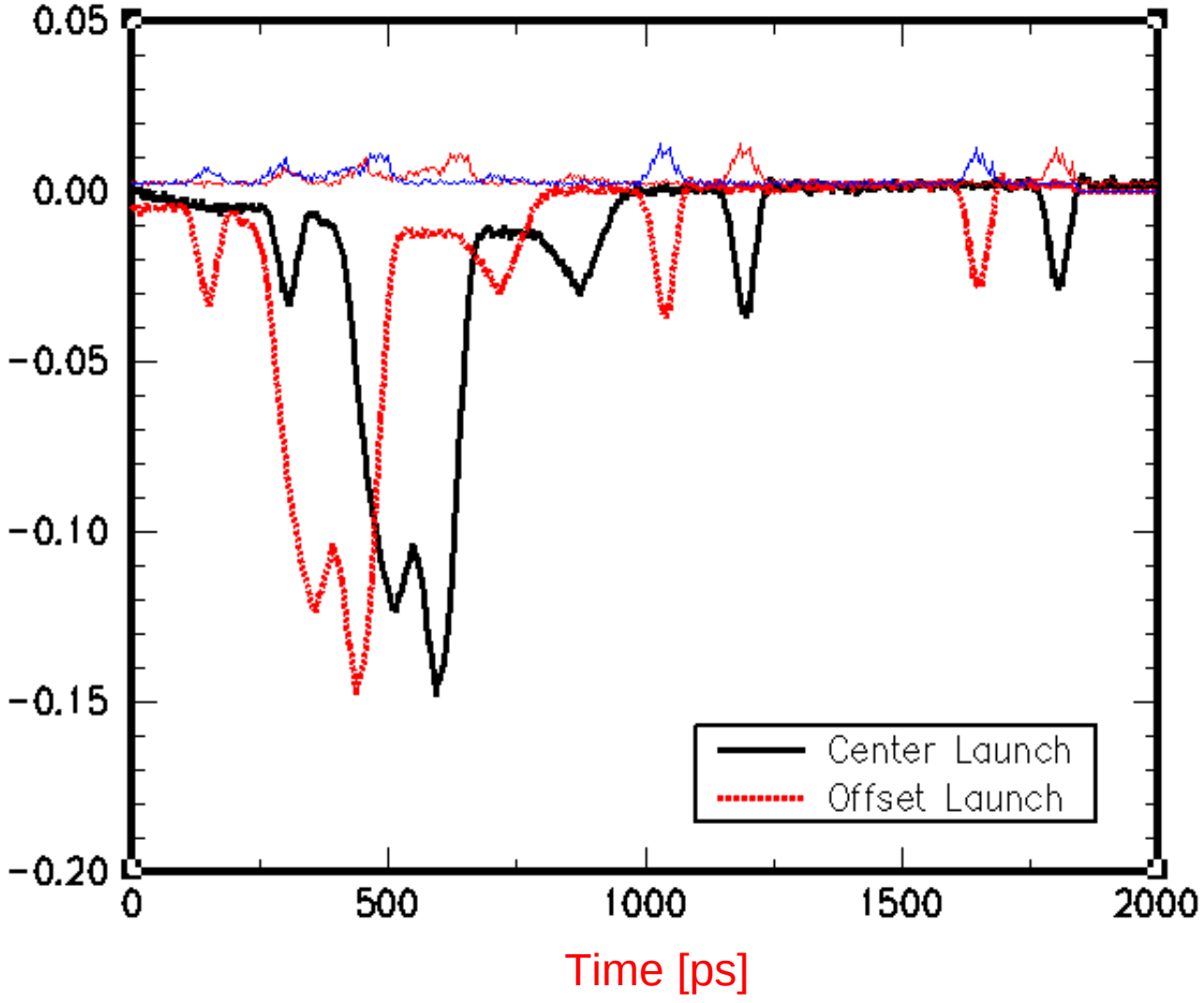
Overlap of 20 Samples of Impulse Response
Fiber F4 - Center Launch



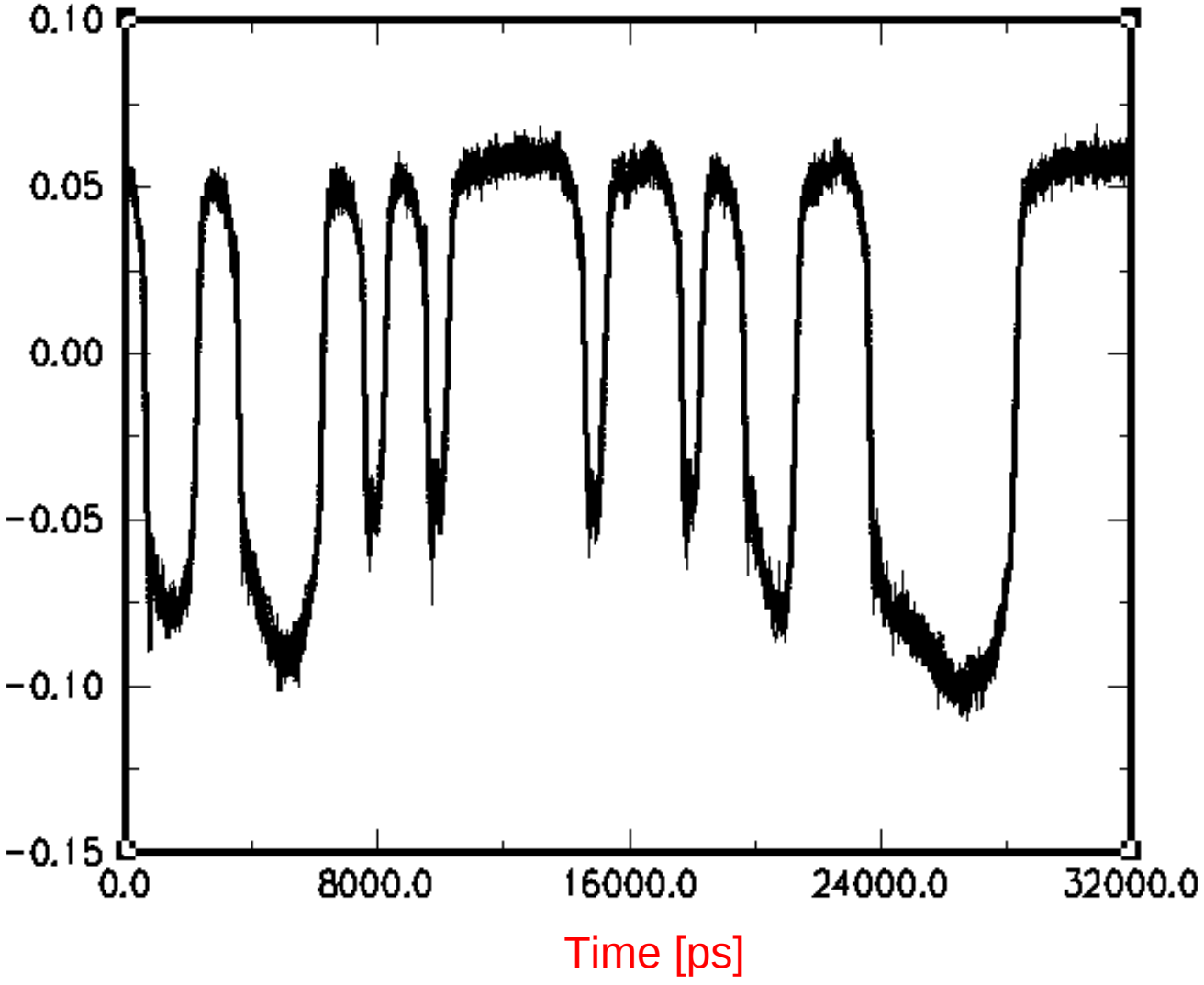
Overlap of 20 Samples of Impulse Response
Fiber F4 - 5μm Offset Launch



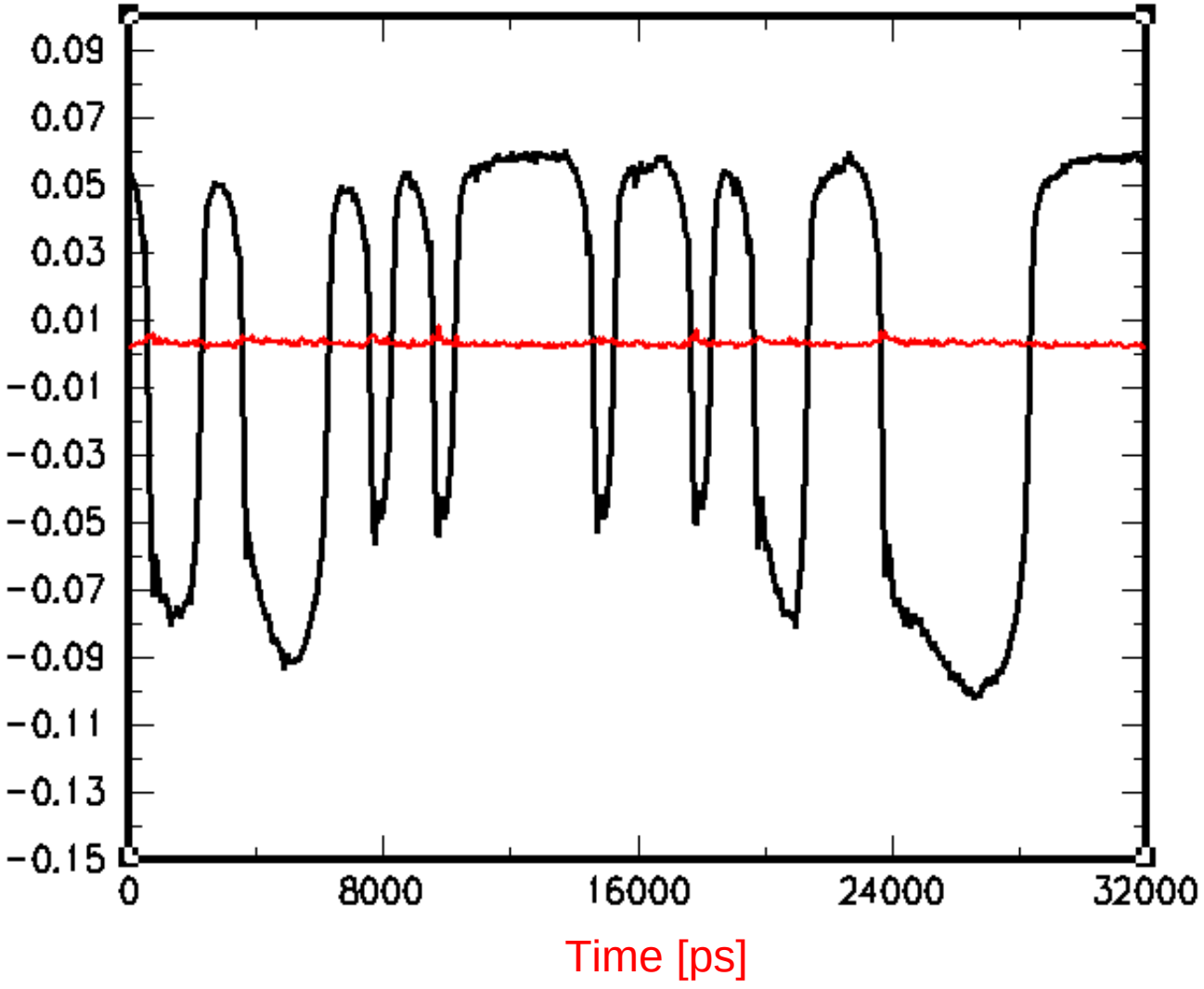
Average Impulse Response and Noise Standard Deviation Fiber F4 - Center and 5μm Offset Launches



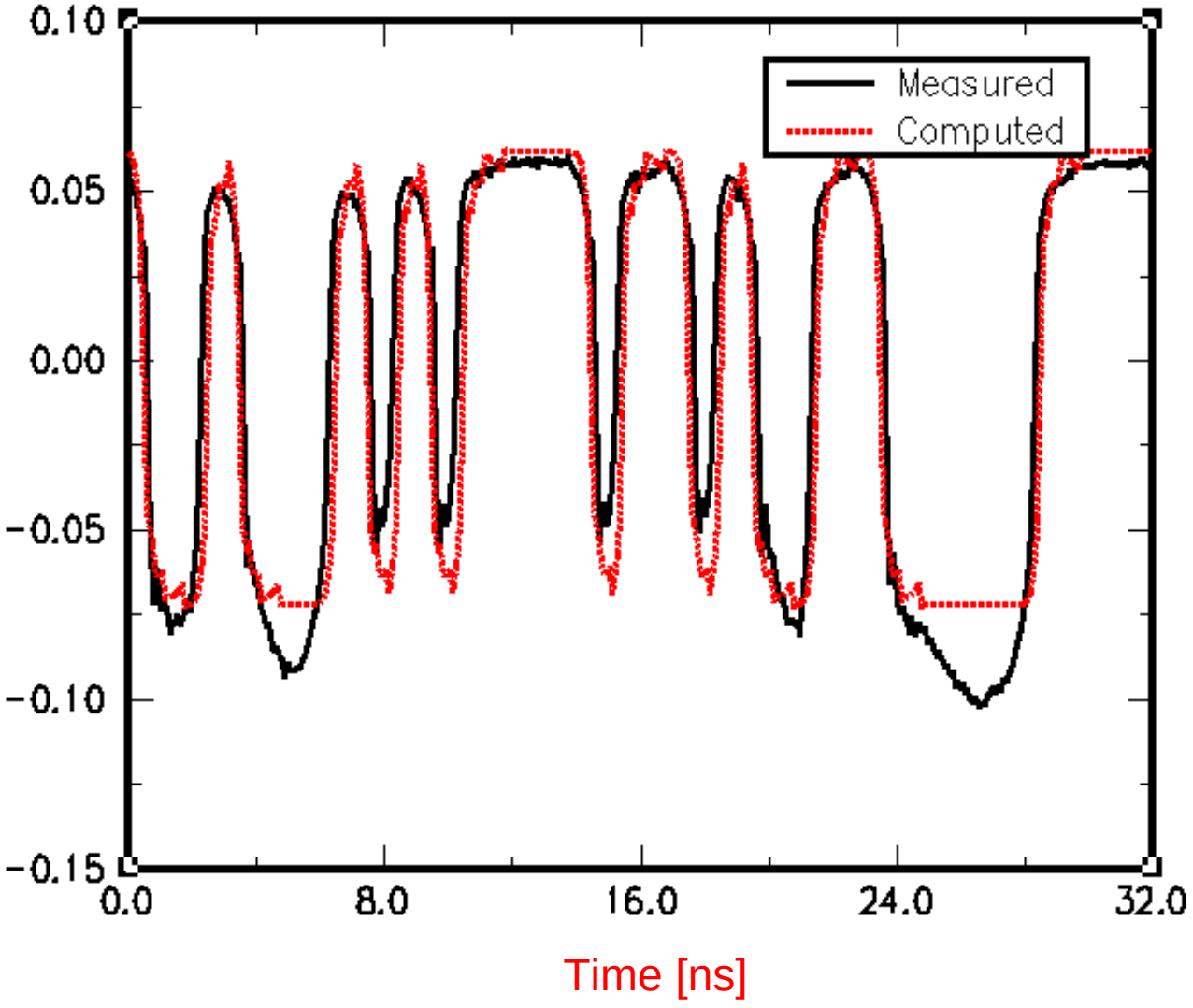
Overlap of 20 Samples of Received Signal
Fiber F4 - Center Launch



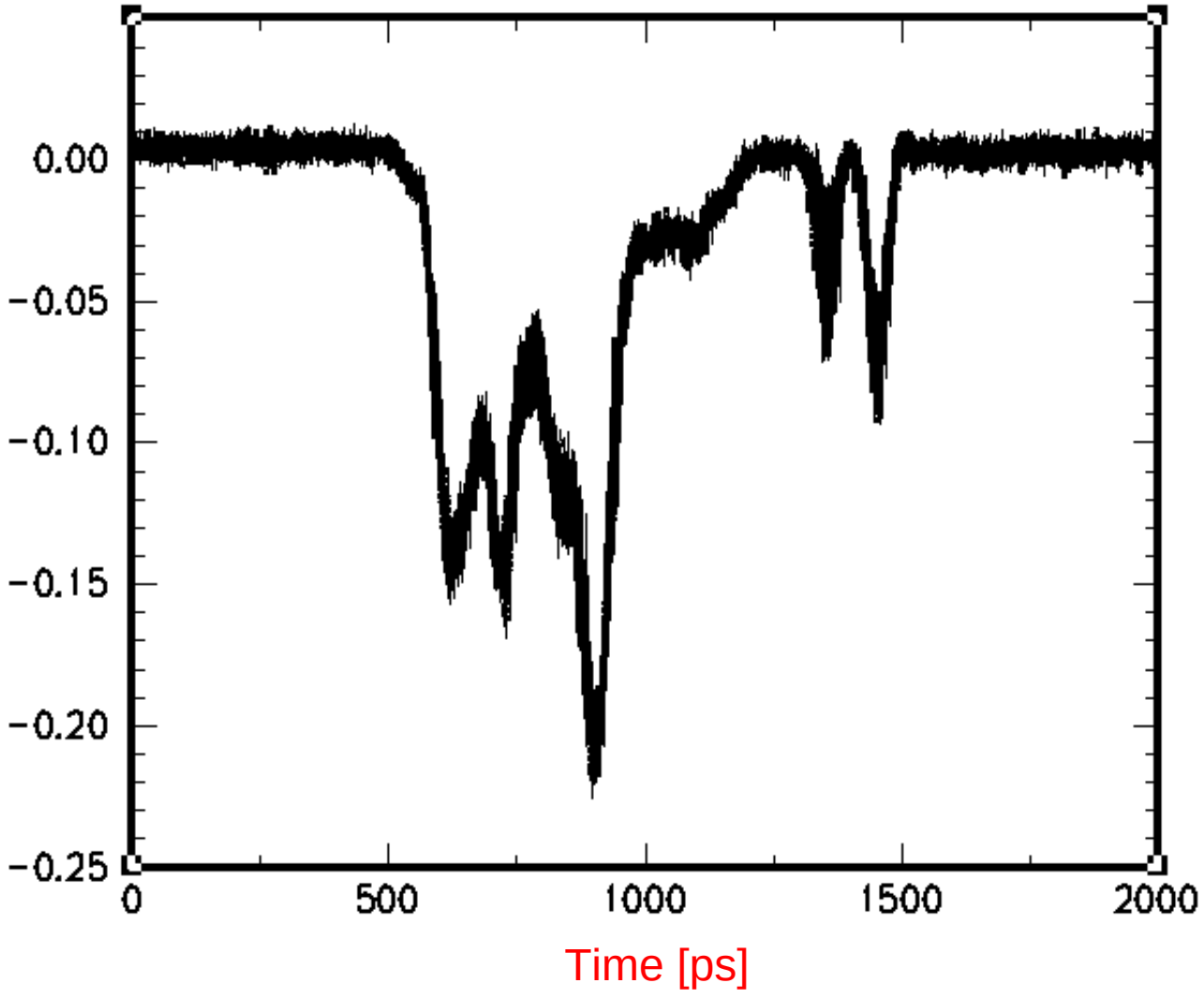
Average Received Signal and Standard Deviation
Fiber F4 - Center Launch



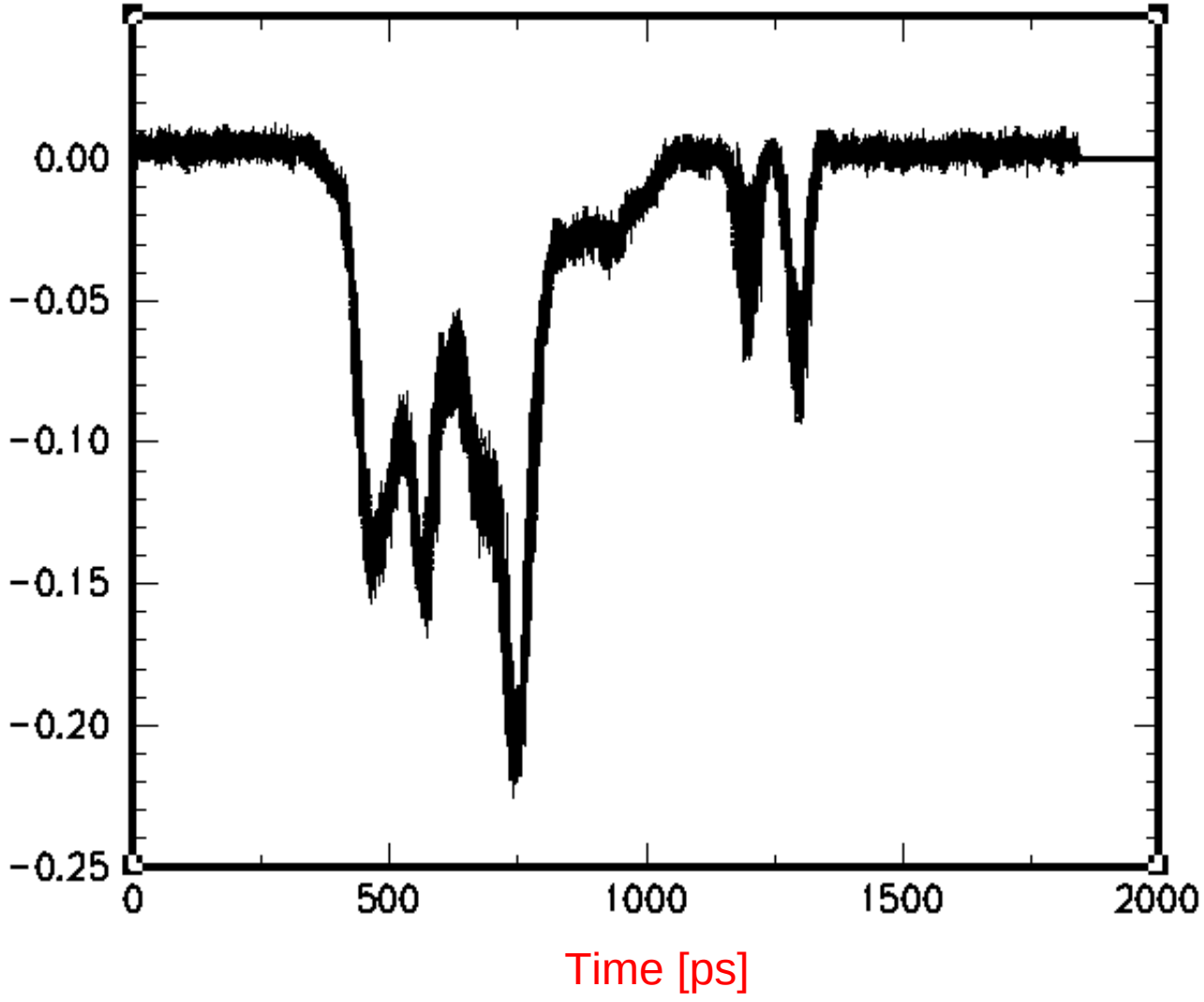
Best Fit of Computed and Measured Signals
Fiber F4 - Center Launch



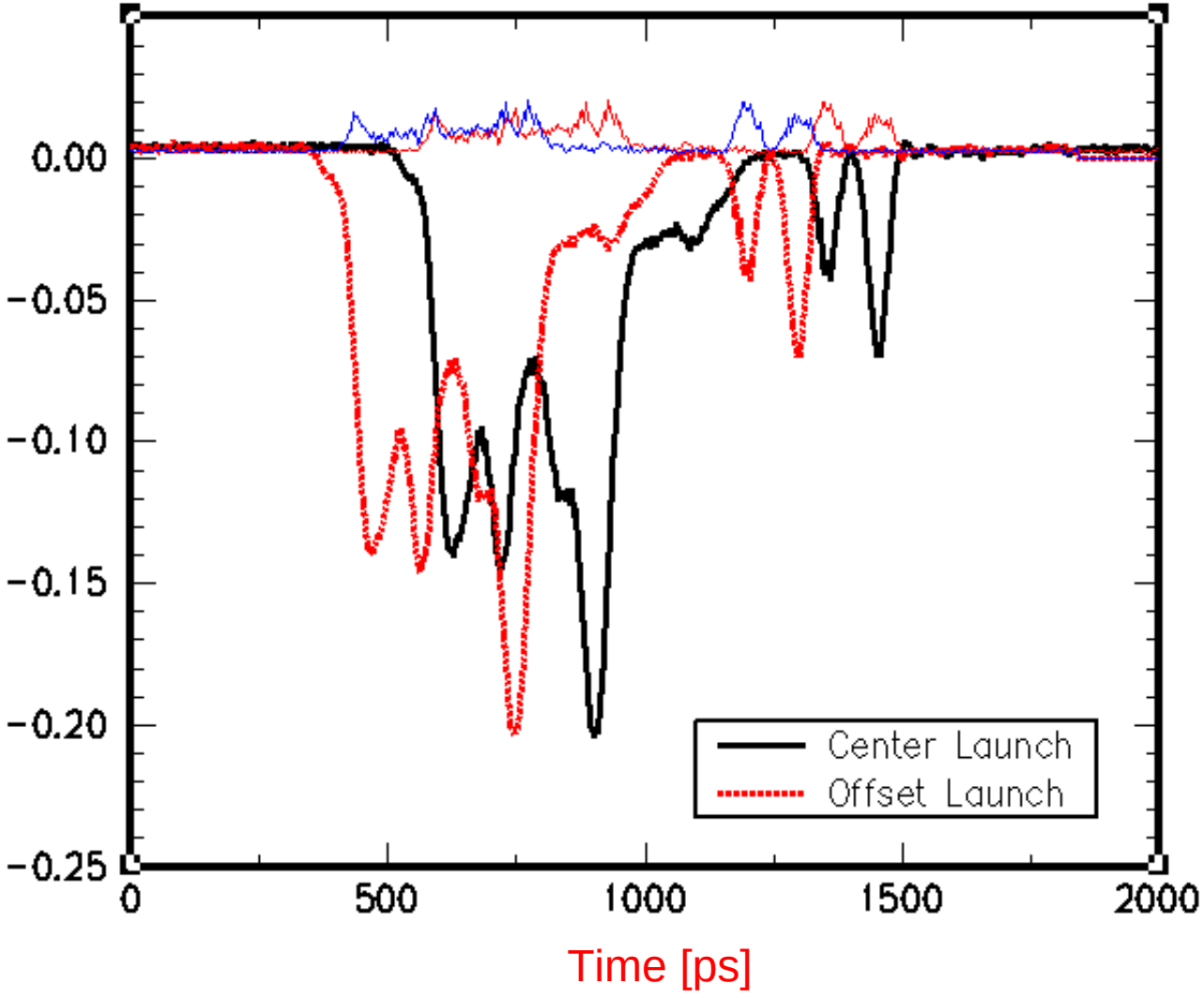
Overlap of 20 Samples of Impulse Response
Fiber F5 - Center Launch



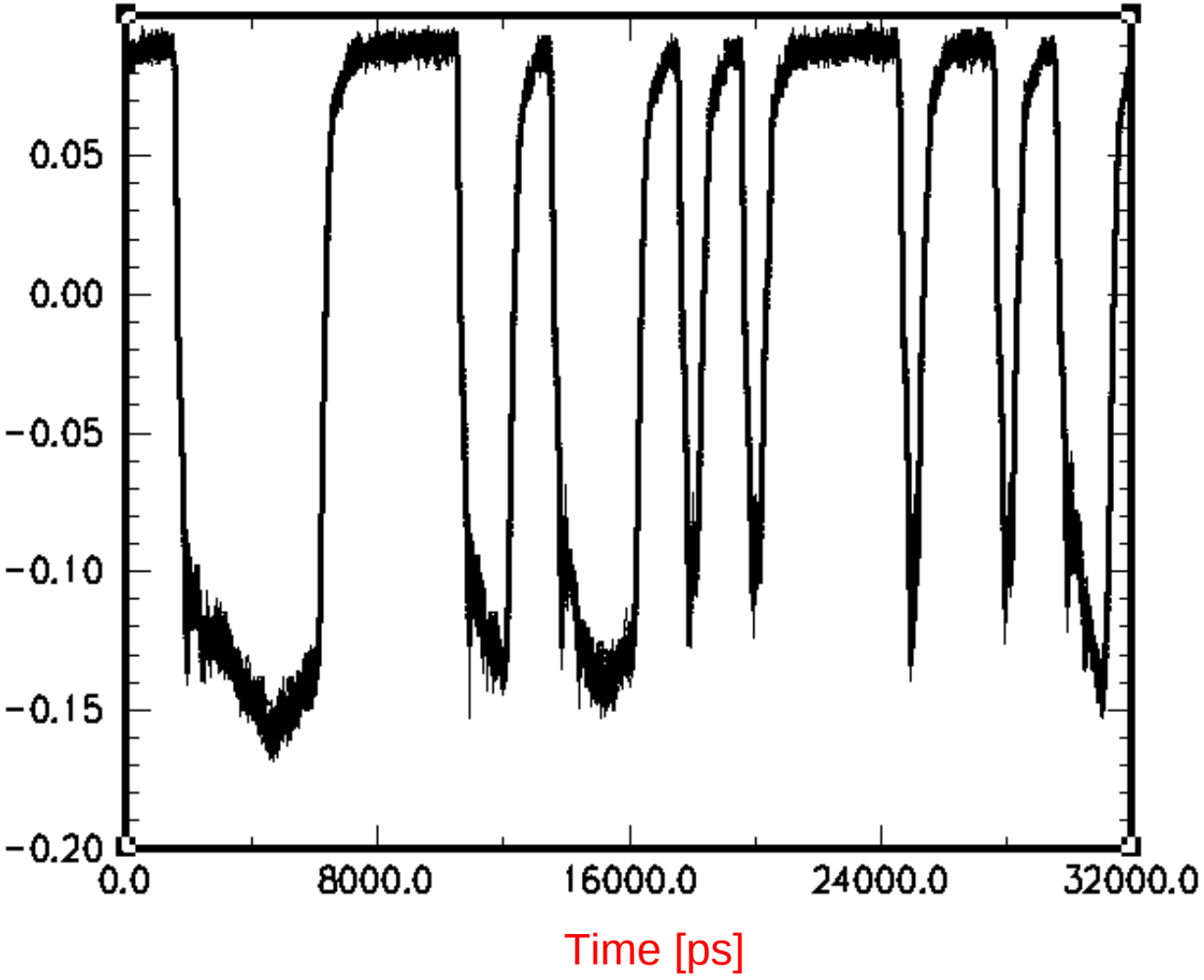
Overlap of 20 Samples of Impulse Response
Fiber F5 - 5μm Offset Launch



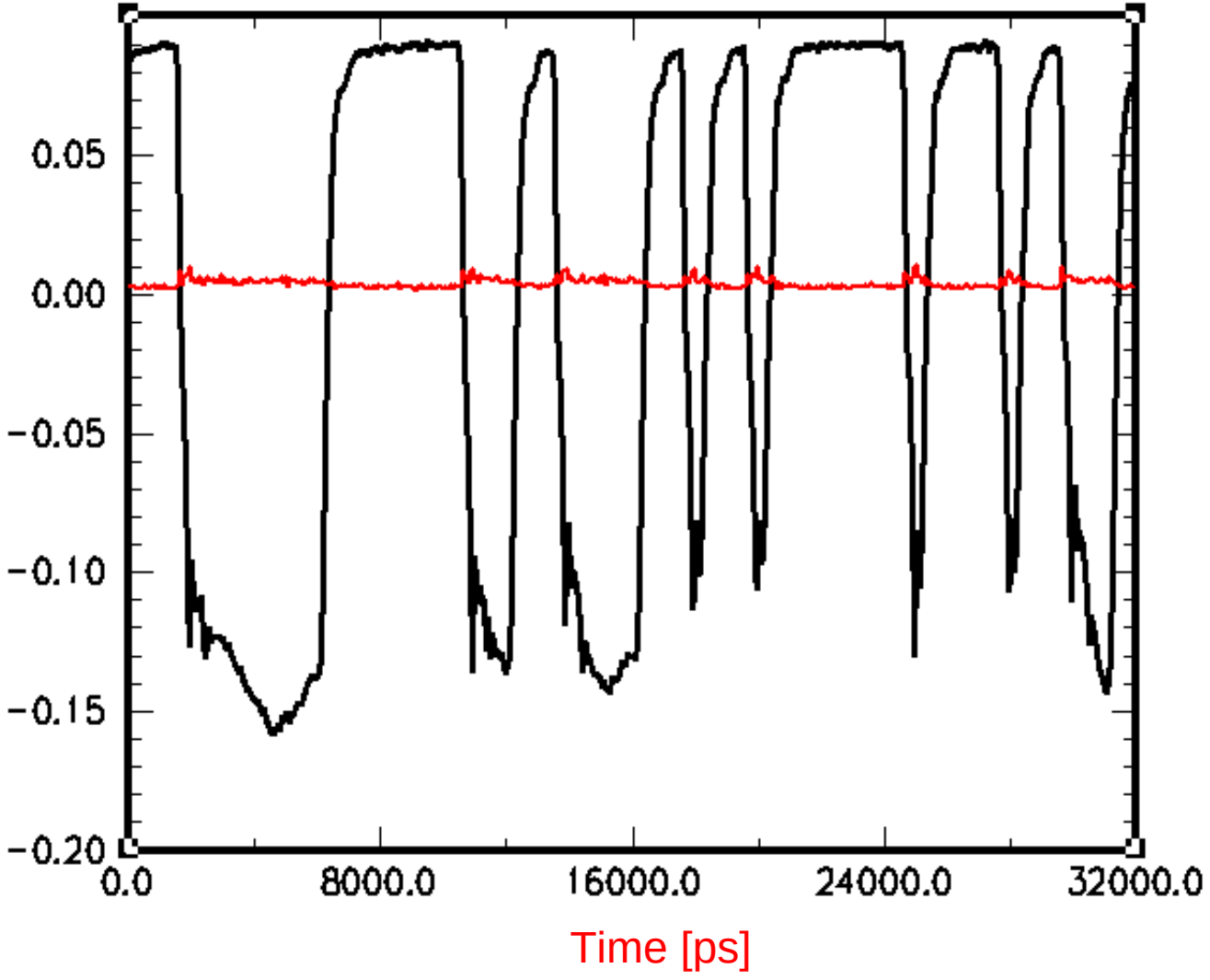
Average Impulse Response and Noise Standard Deviation Fiber F5 - Center and 5μm Offset Launches



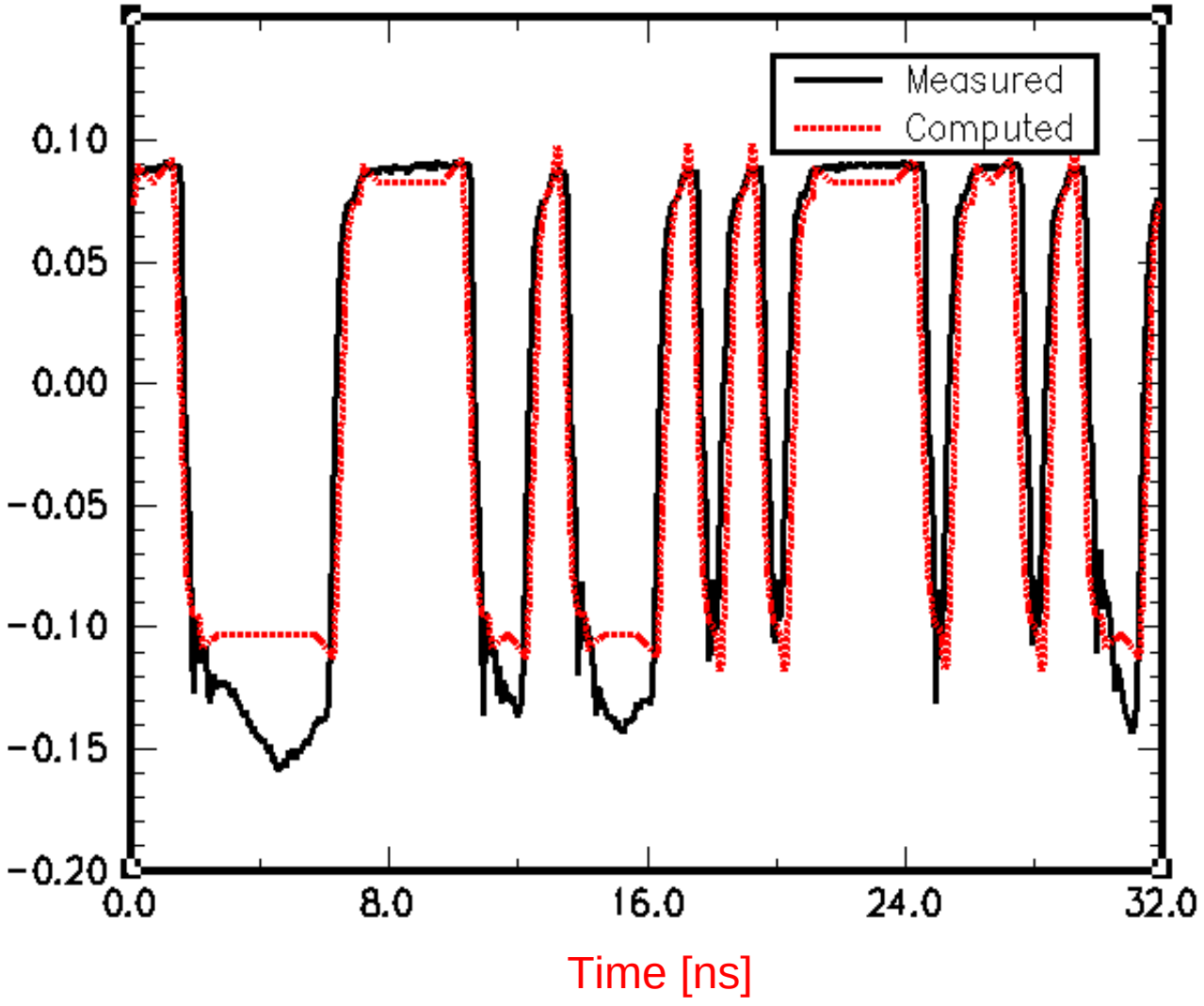
Overlap of 20 Samples of Received Signal
Fiber F5 - Center Launch



Average Received Signal and Standard Deviation
Fiber F5 - Center Launch



Best Fit of Computed and Measured Signals
Fiber F5 - Center Launch



Conclusions

- **Although the interleaved sampling of the 83480 DCA cannot identify the precise time dependence of the channel response for time constants smaller than ~50μs, it can still capture its magnitude**
- **In these measurements, any non-stationarity of the channel response would be indistinguishable from random noise**
- **There is no evidence of significant non-stationarity in the observations reported here**
- **Long-term time-dependence is possible, but it would not be a problem for an adaptive equalizer**
- **Very fast time changes of the channel response with a quick return to the original shape are still possible, since the slow sampling could miss them**
- **However this seems to be an unlikely possibility**
- **Mismatch between measured and computed responses is under investigation (at this point we cannot rule out a calculation error)**

Future Work

- **Identify channel nonlinearity, if any**
- **Measurements at higher data rates, up to 10Gb/s**
- **Measurements at 1310 and 1550nm**
- **Collect a more complete fiber database**