Report on test methodologies from the February 11th and 12th lab work

Objective: Test the tests

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Proposal to have an open laboratory prior to the February interim meeting

- **Proposed procedures must be validated on several devices**
- **Follow up and refinement of “Raleigh” modifications through subsequent serial PMD teleconferences**
- **Test beds built during between Jan 18th and Feb 11th**
- **A “Public” lab (open to anyone)**
- **A “Private” lab (those who signed up were given 3 hours of private use on the test beds)**
- **Eight participants**

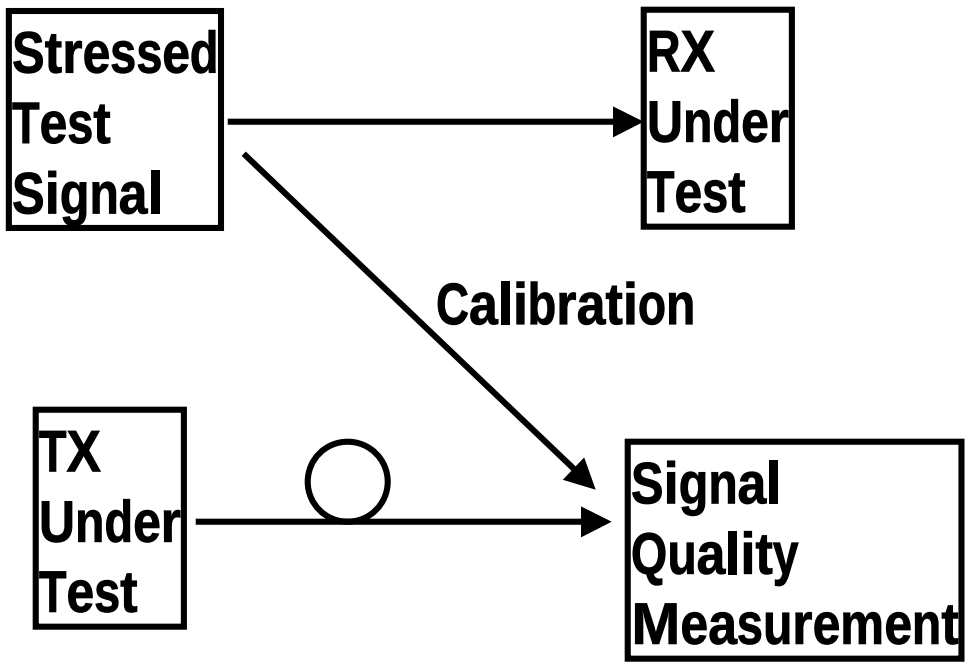
Some results from the January meeting in Raleigh

- New proposals for stressed eye receiver testing
- New proposals for transmitter jitter testing
- Report on root causes for difficulties in performing jitter bathtub stressed receiver test measurements
    - Verification needed on “real” devices

Test system overview

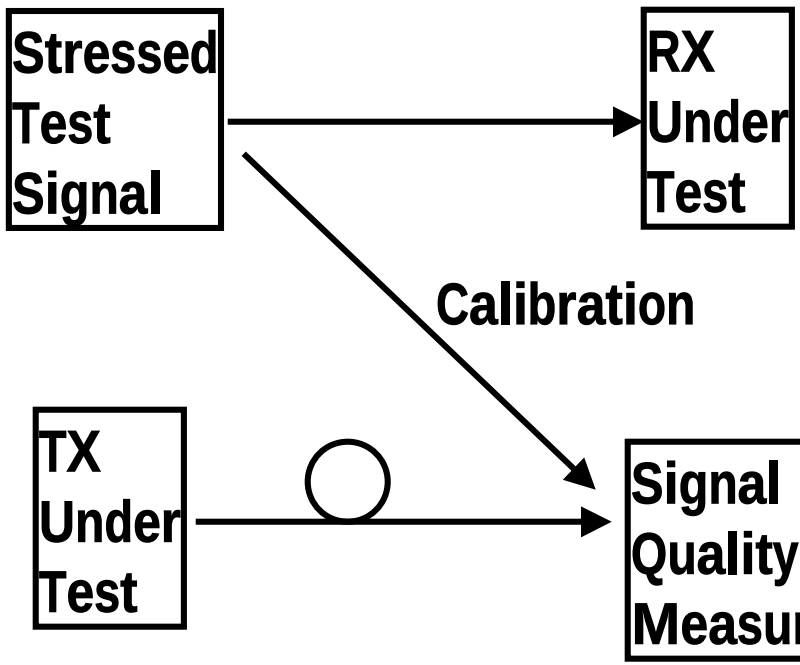
- **Transmitter test bed:**
  - **Jitter bathtub measurement**
  - **Transmitter Dispersion Penalty (TDP) measurement**
- **Receiver test bed:**
  - **“Old” stressed eye**
  - **“Simplified” Stress**

D4.1 vs D4.0: What hasn't Changed:



D4.1 vs D4.0: Two Major Changes:

"Simplified" Stress:
Additive Amplitude ISI



Replace Jitter BT With Eye Mask +TDP

Contract Between TX and RX

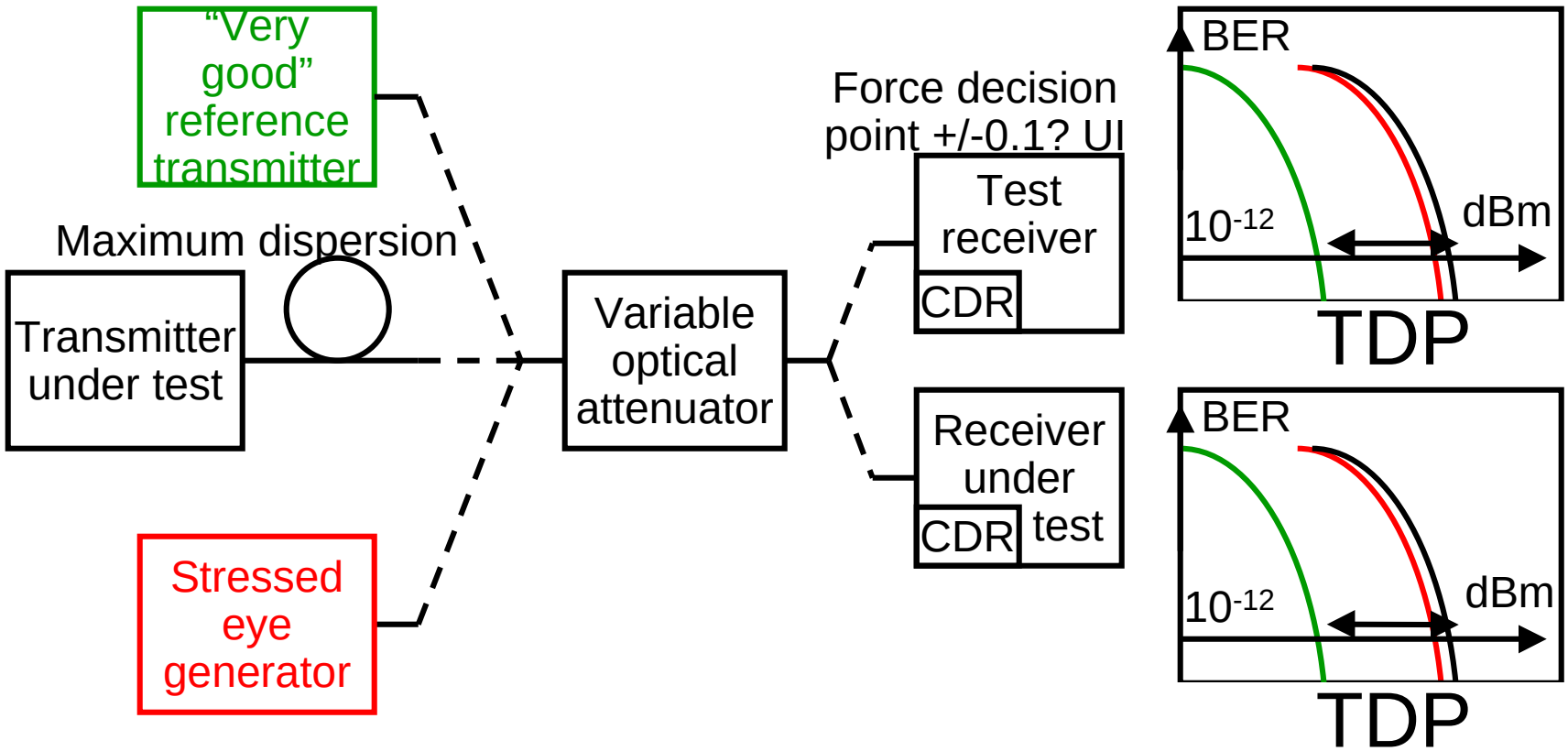
Bathtub jitter

TX must produce less jitter than stressed eye

RX must successfully receive stressed eye

- **TDP methodology**
- **TX must produce a smaller sensitivity penalty than stressed eye**
- **RX must successfully receive stressed eye**

Matrix of measured Penalties



Three transmitters

Two receivers

	Receiver	
Transmitter	Test Rx	Rx U.T.
V.good ref.	cal. for TDP	Inform. sens.
Tx U.T.	TDP	
Stressed eye	cal.for str.sens.	Norm. sens.

from Raleigh, NC, January 2002 Matrix of measured Penalties

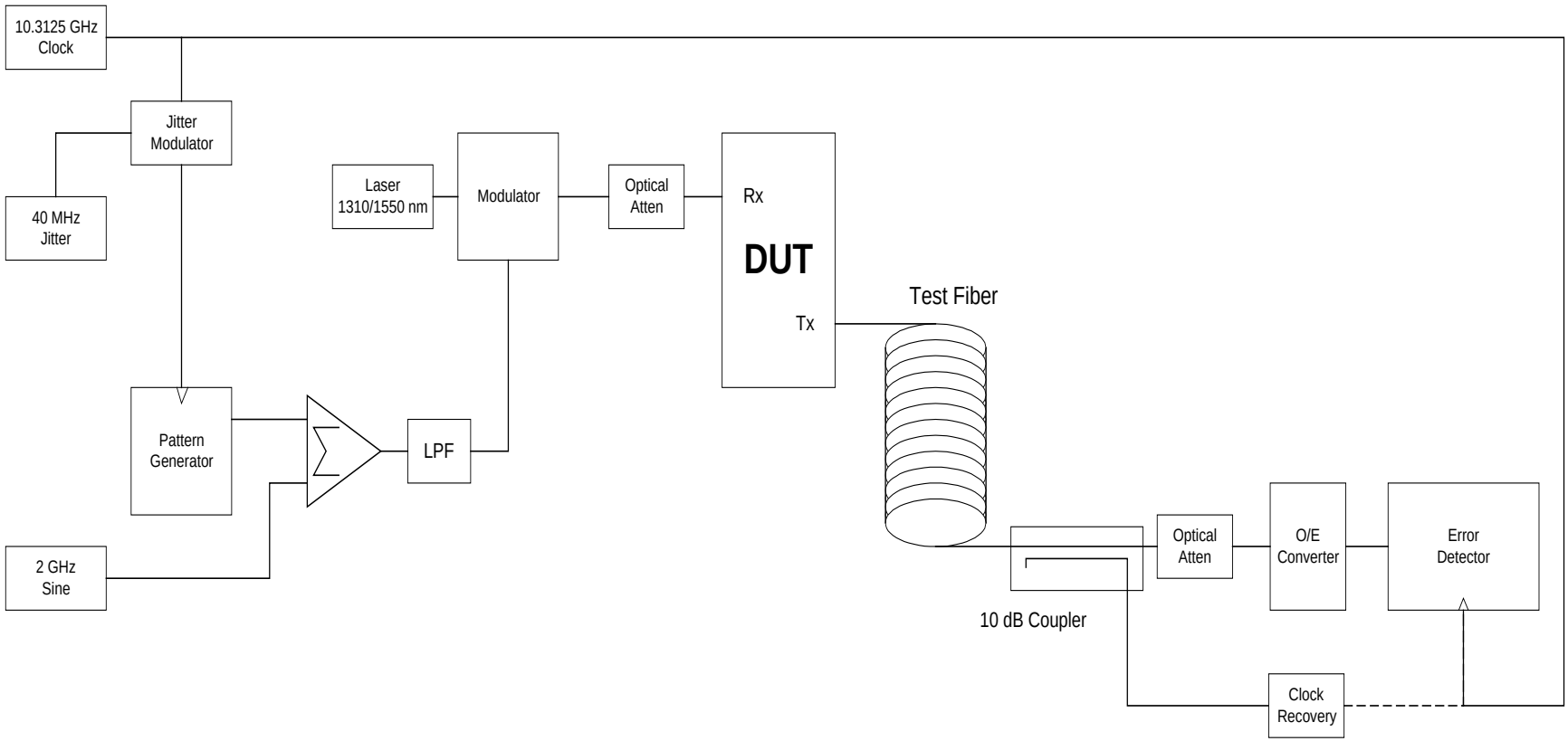
Effect of Test Equipment non-ideality

Jitter Bathtub method

- **Tend to over-estimate jitter of TX**
- **Tend to over-estimate jitter in stressed RX test signal**
- **These two effects tend to partially cancel out**
- **But, not all test equipment has equal non-ideality**
- **How does jitter combine?**

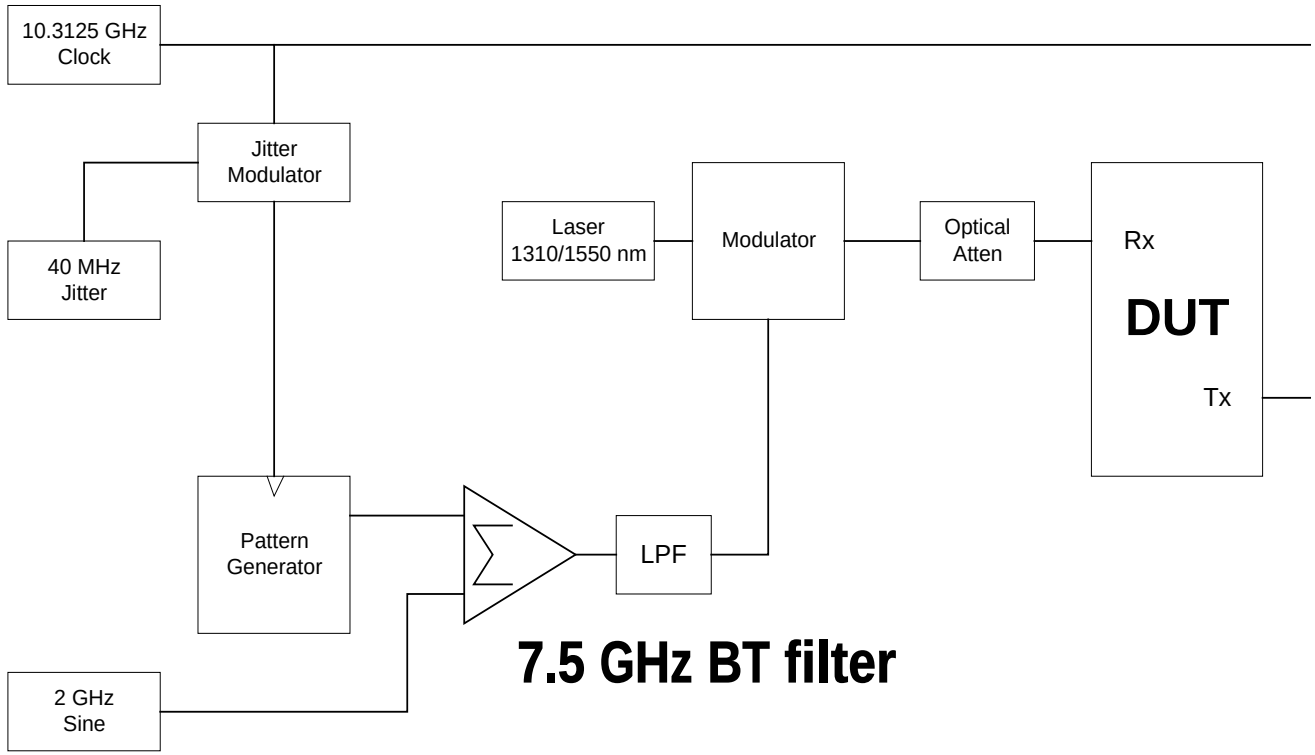
- **TDP method**
- **Substitutional method:**
  - **first order compensation for jitter in measurement RX**
- **But what about differences between reference RX?**

Test System Block Diagram



Receiver Test

- **Unstressed**
- **Simplified Stress**
- **PRBS31**



Original Stress vs Simplified Stress

Original Stress:

Emphasis on LPF

Added RJ

- **Hard to Adjust Filter**
- **Need BT measurement to Calibrate**
- **Non-ideal Frequency Response:**
  - **larger pattern dependence**
  - **larger Sigma, smaller W**

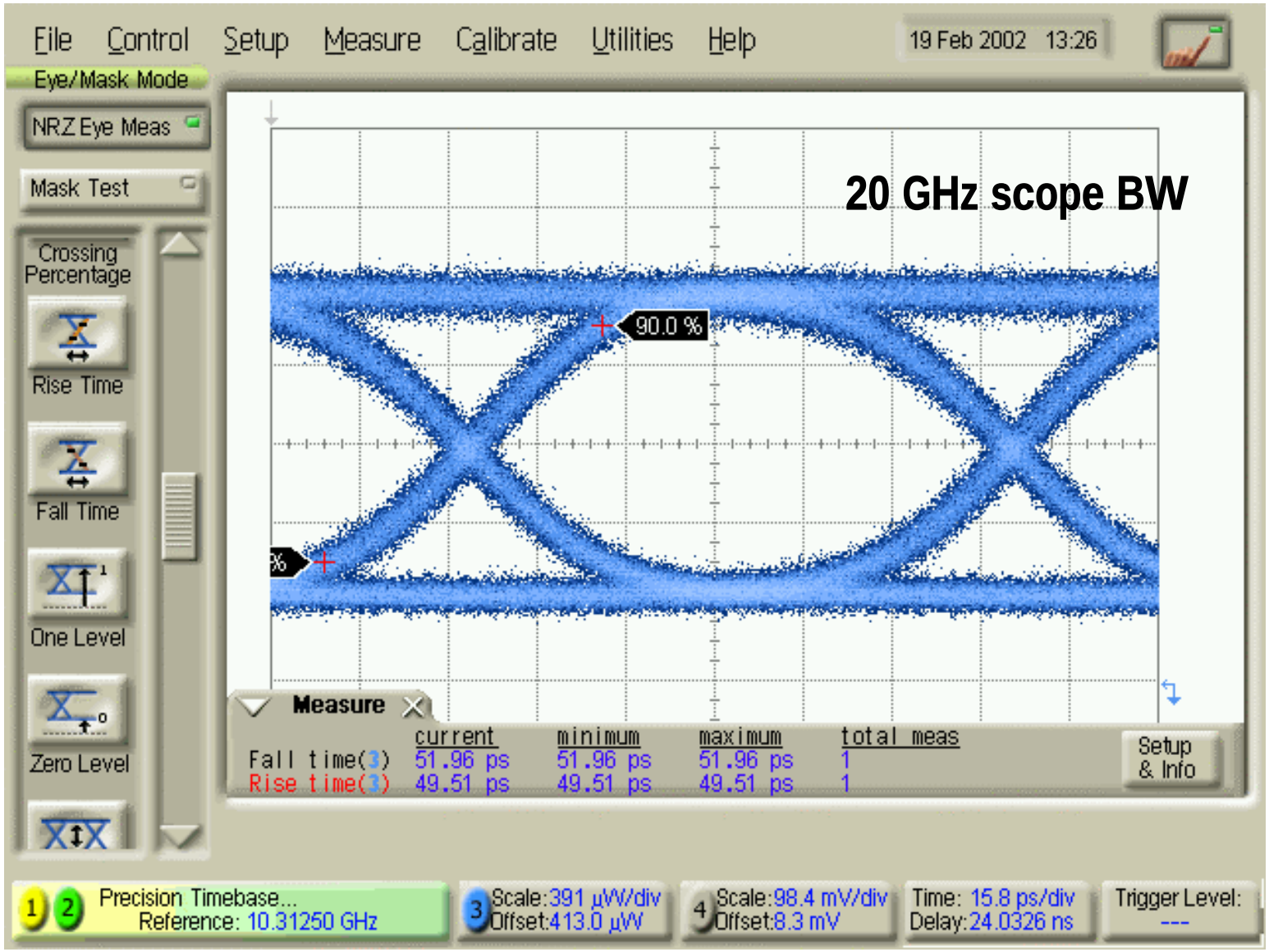
Simplified Stress:

Additive Amplitude ISI

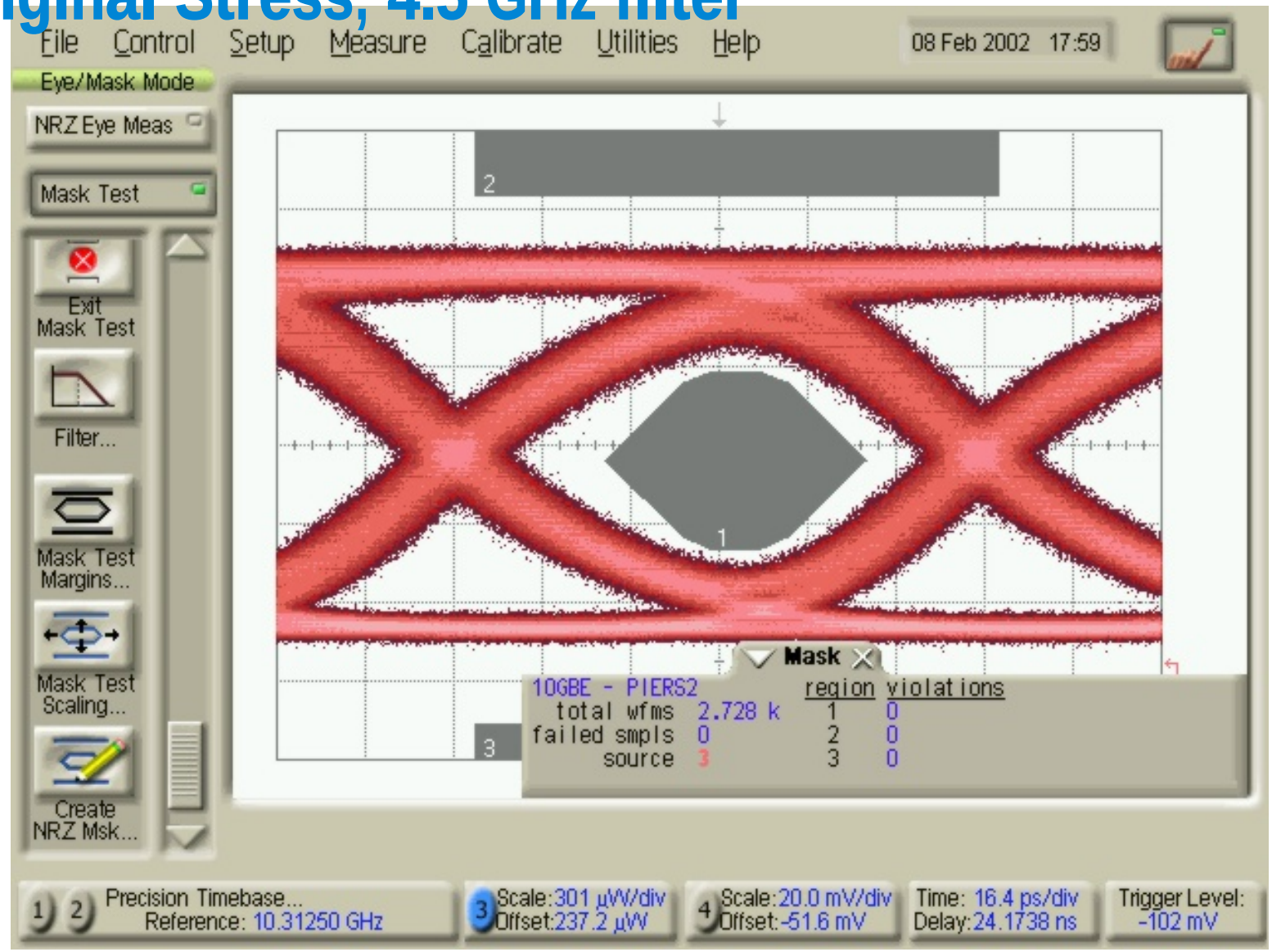
Sinusoidal Jitter

- **Easier to Adjust ISI, SJ**
- **Measure with Oscilloscope**
- **More ideal frequency response**
- **Smaller pattern dependence**
- **W larger, Sigma is smaller**

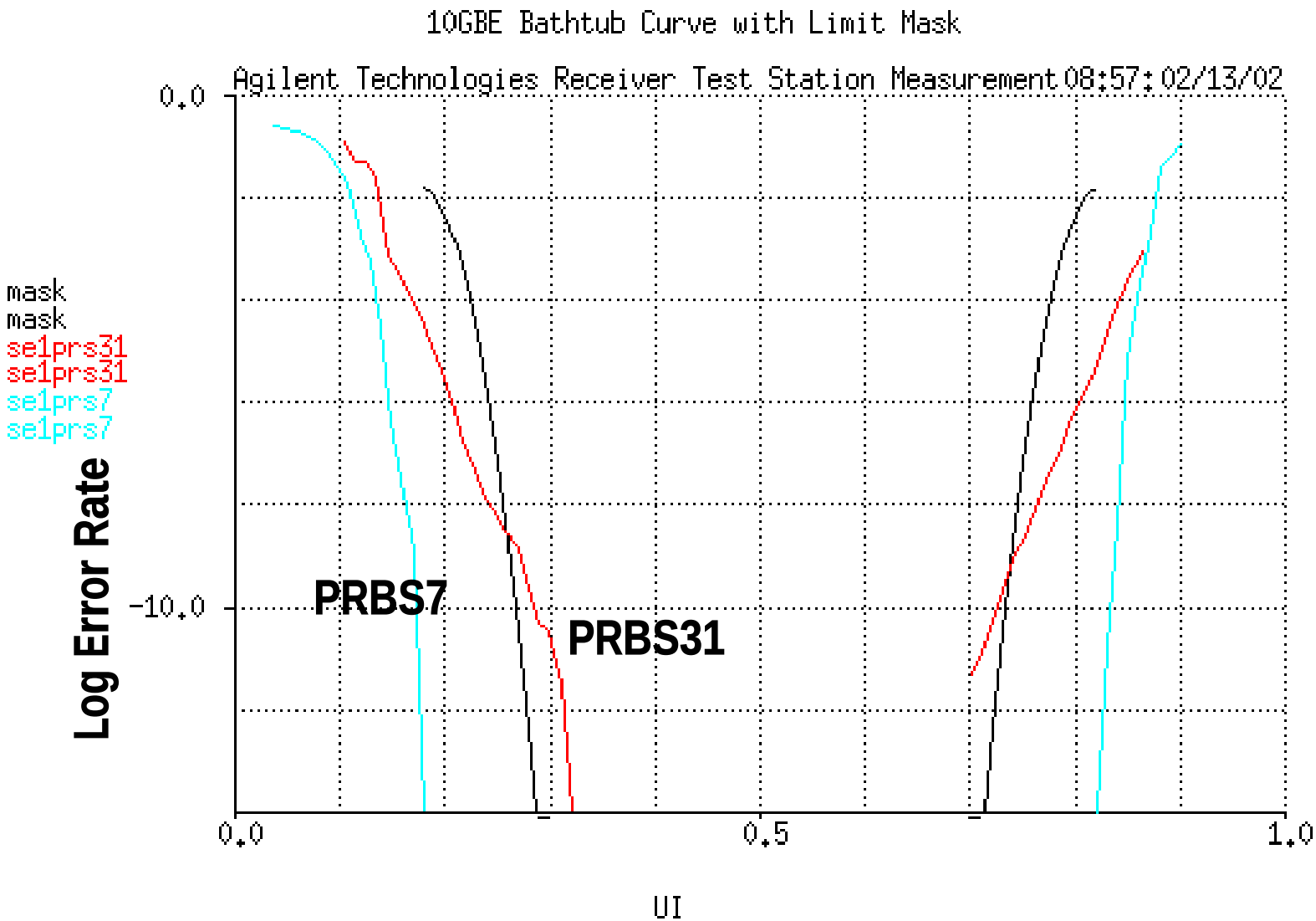
Clean signal- 7.5 GHz BT filter



Original Stress; 4.5 GHz filter

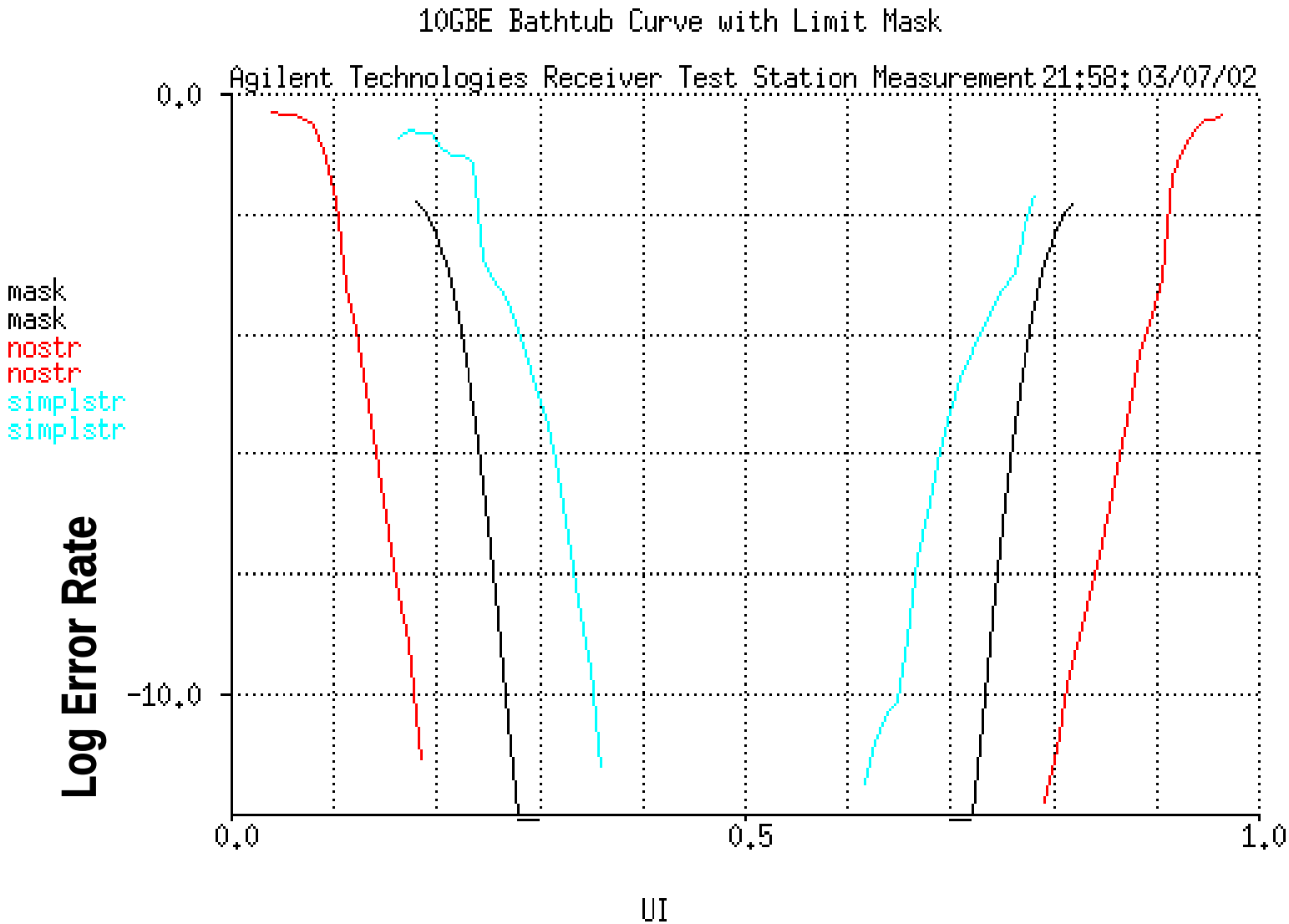


Original stress-Pattern dependence

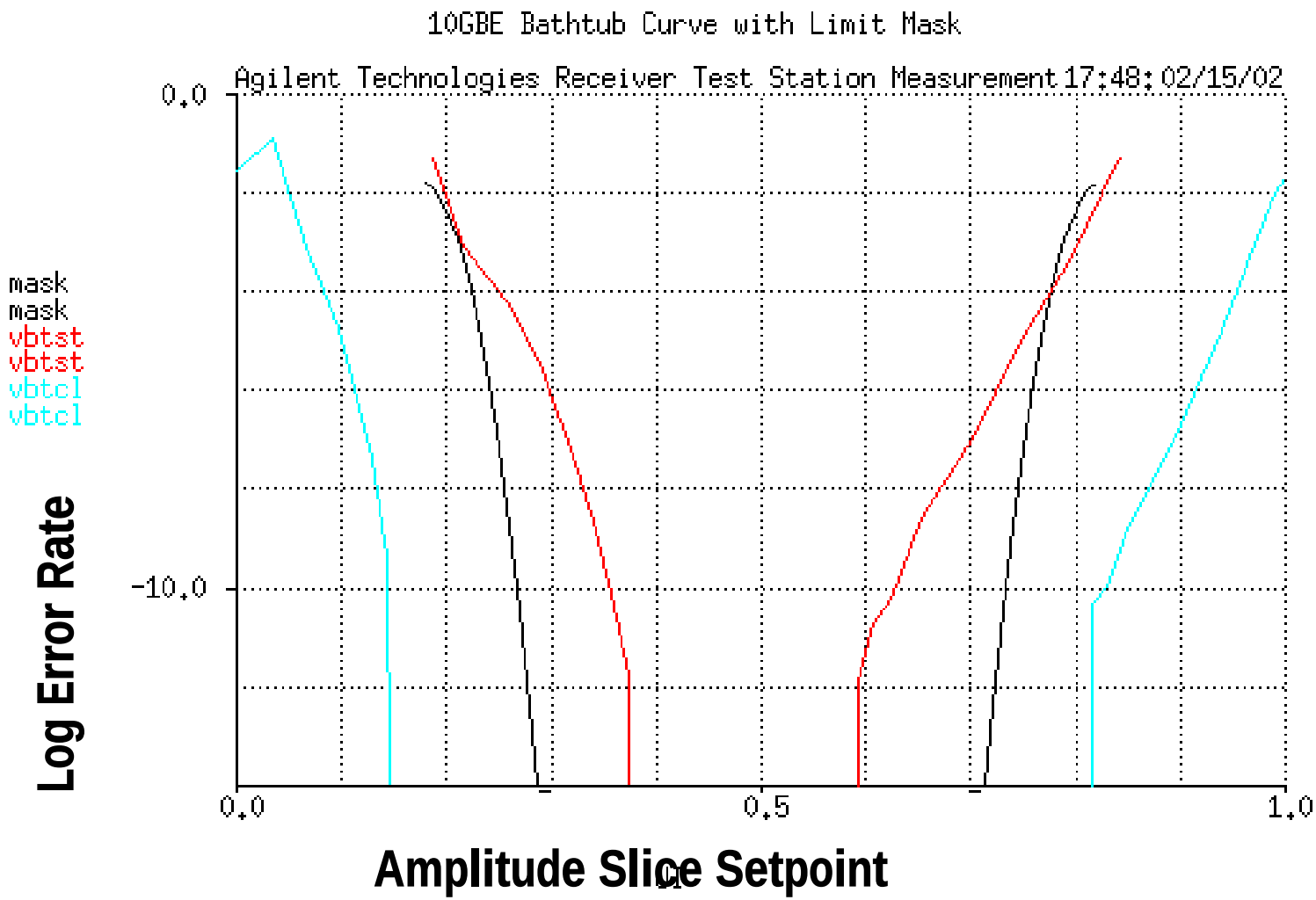


Simplified Stress- 7.5 BT filter

PRBS 31 – Nostress vs Simplified Stress

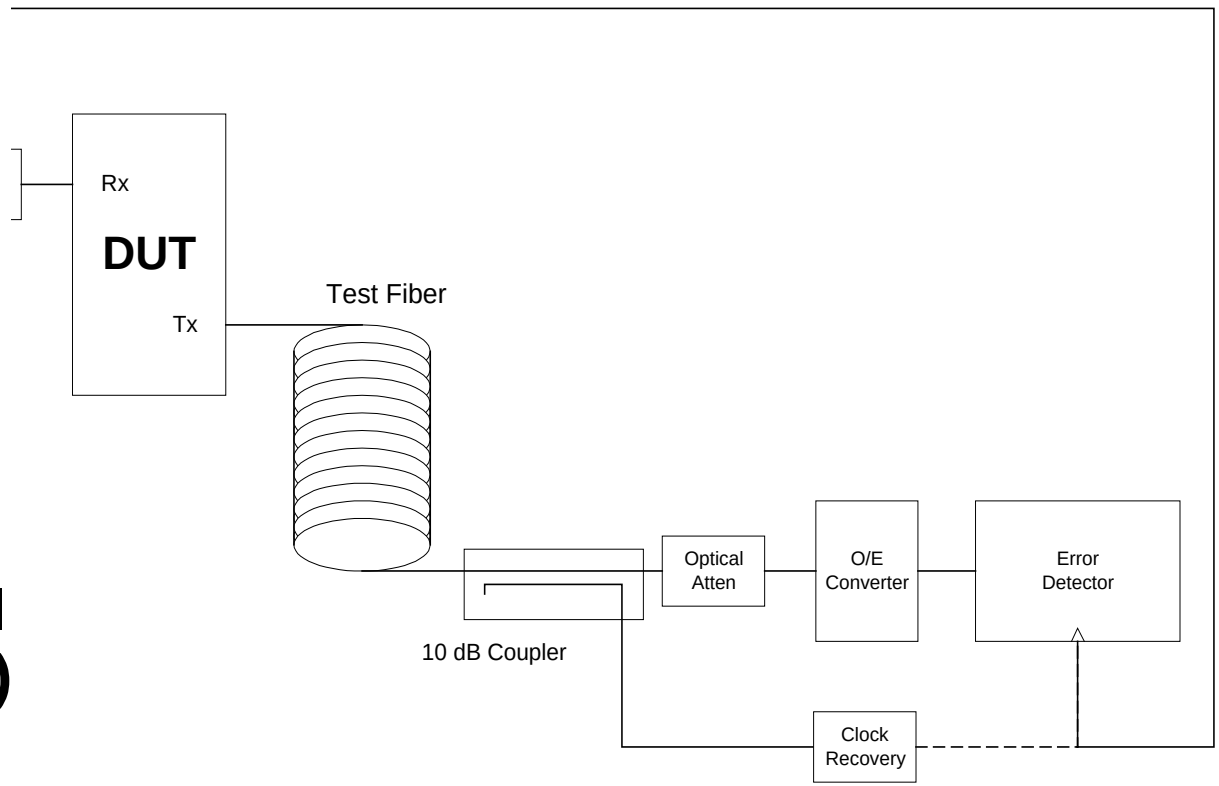


PRBS 31 – Nostress vs Simplified Stress Vertical “Q” Plot



Transmitter Test

- **Eye Mask**
- **Bathtub Jitter**
- **TDP (+- 0.1 UI decision point)**
- **PRBS31**



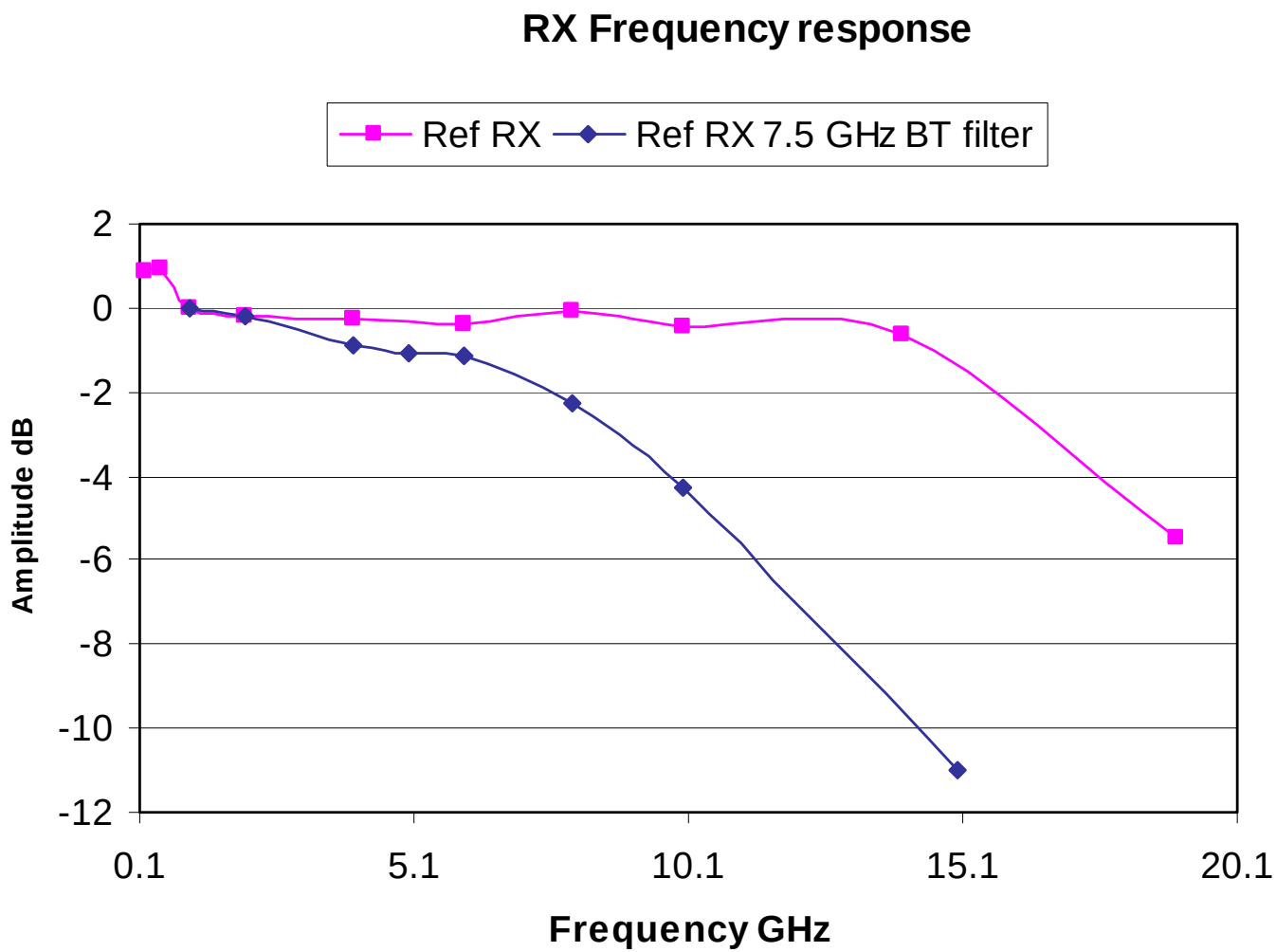
Bathtub Curve vs TDP

Bathtub Jitter Measurement

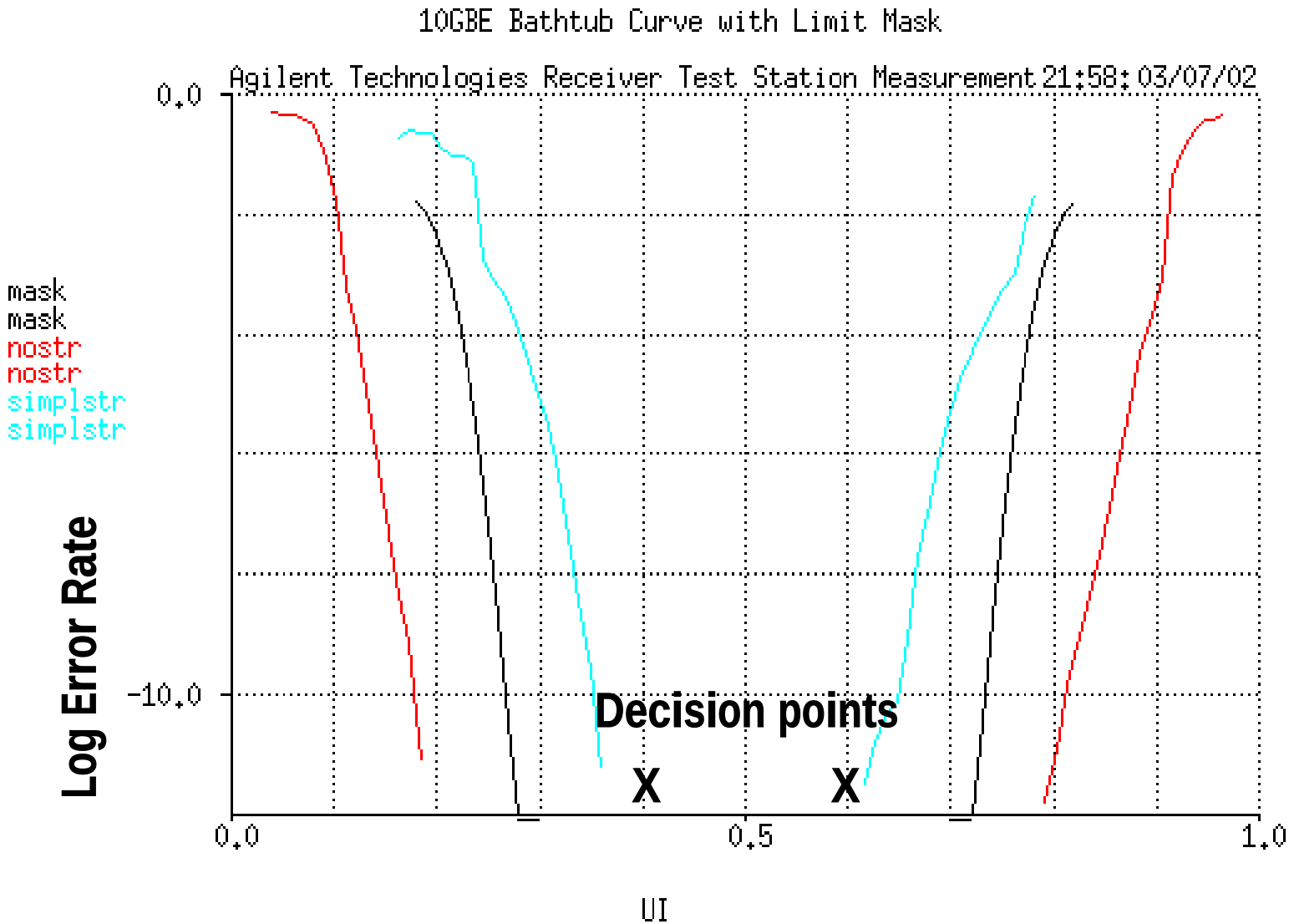
- **Tests Low and High Probability Jitter**
- **Does not test Vertical Eye Closure**
    - **Left to eye mask**

TDP

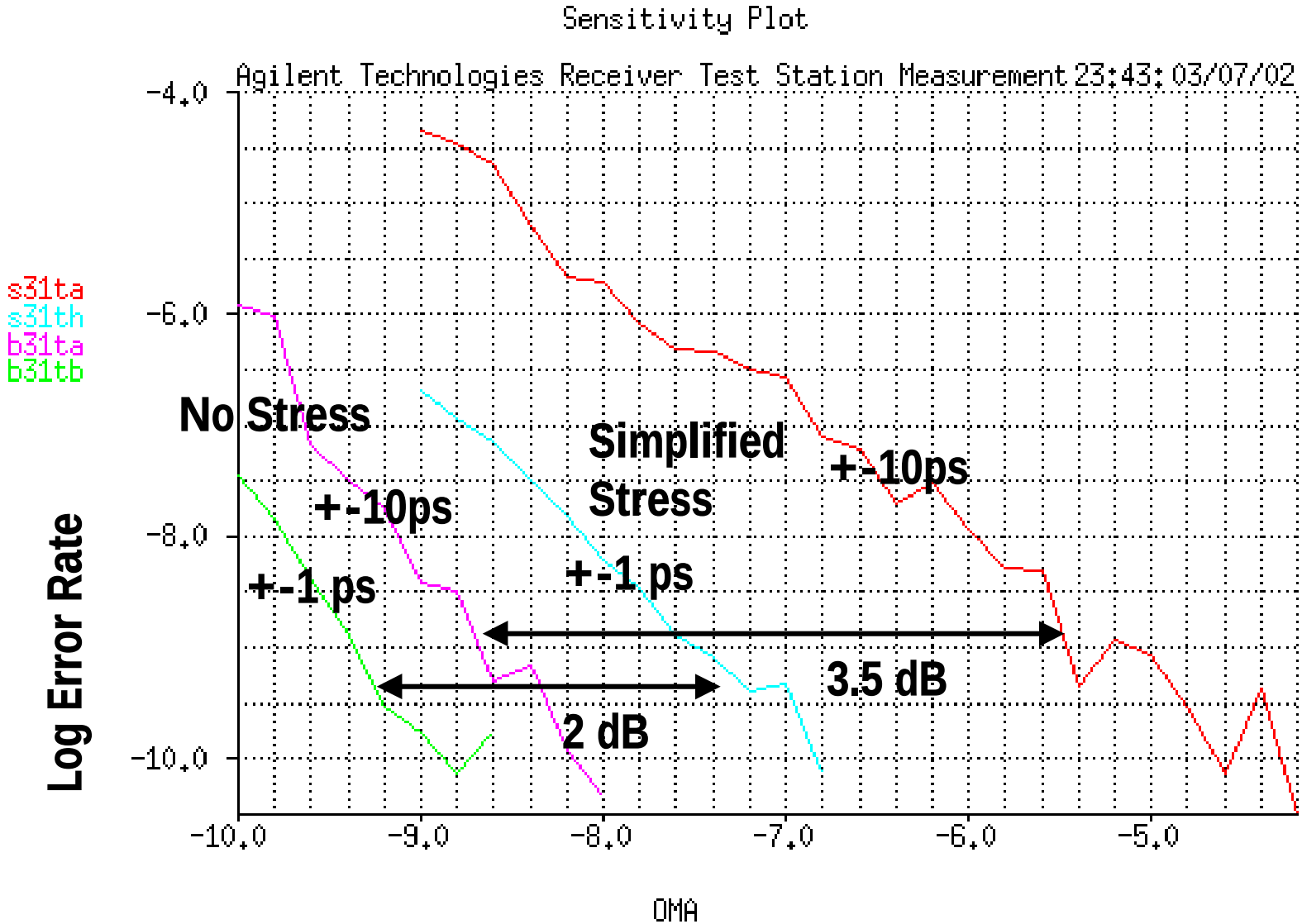
- **Classical TDP tests Vertical Eye Closure**
- **TDP with Offset sampling point tests Vertical Eye Closure and Jitter**
- **Sensitivity to Jitter depends on choice of Sampling Point Offset**


RX Frequency response
Ref RX
Ref RX 7.5 GHz BT filter
2
0
-2
-4
-6
-8
-10
-12
Amplitude dB
0.1
5.1
10.1
15.1
20.1
Frequency GHz

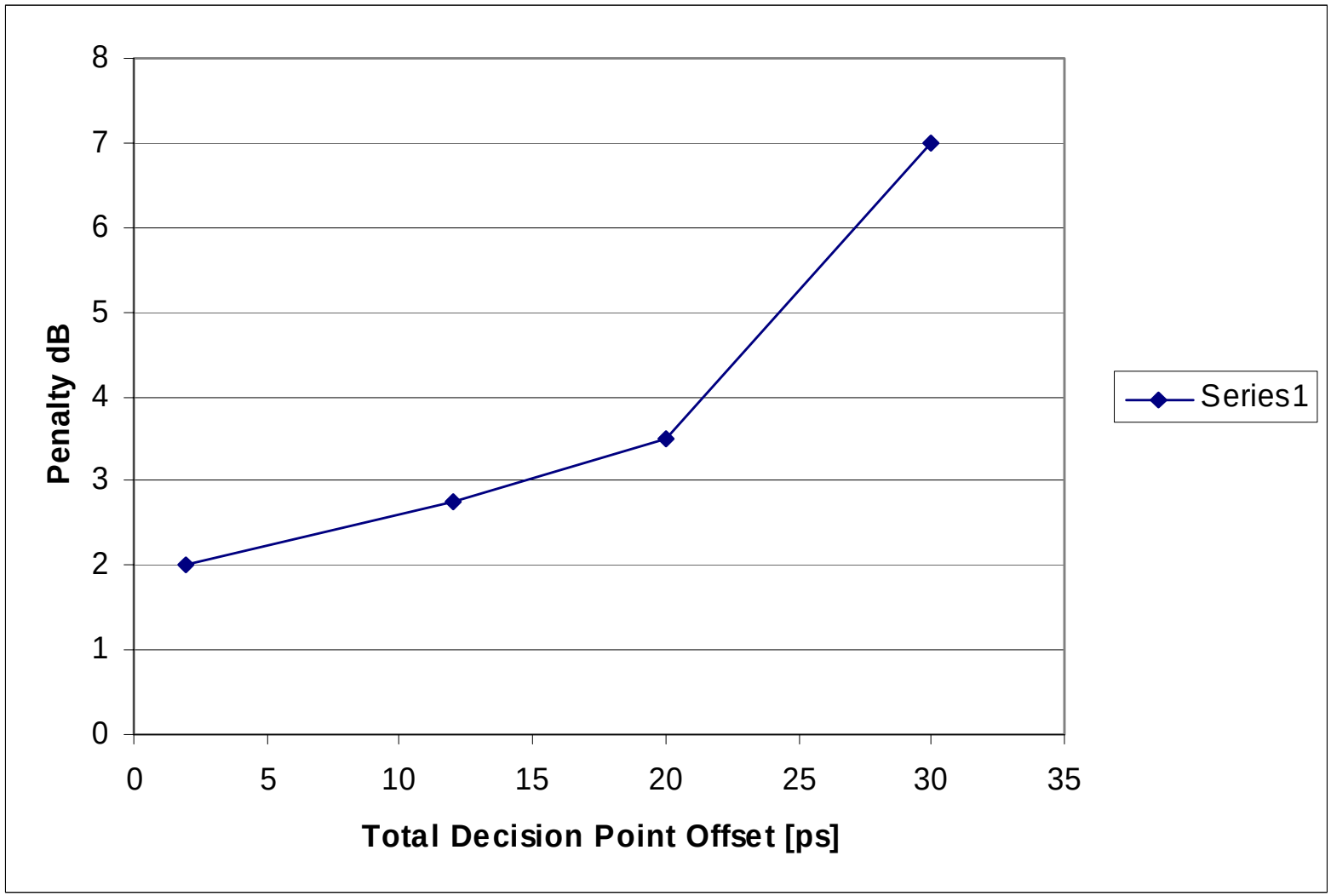
TDP Meas and BT measurement on Simpl stress



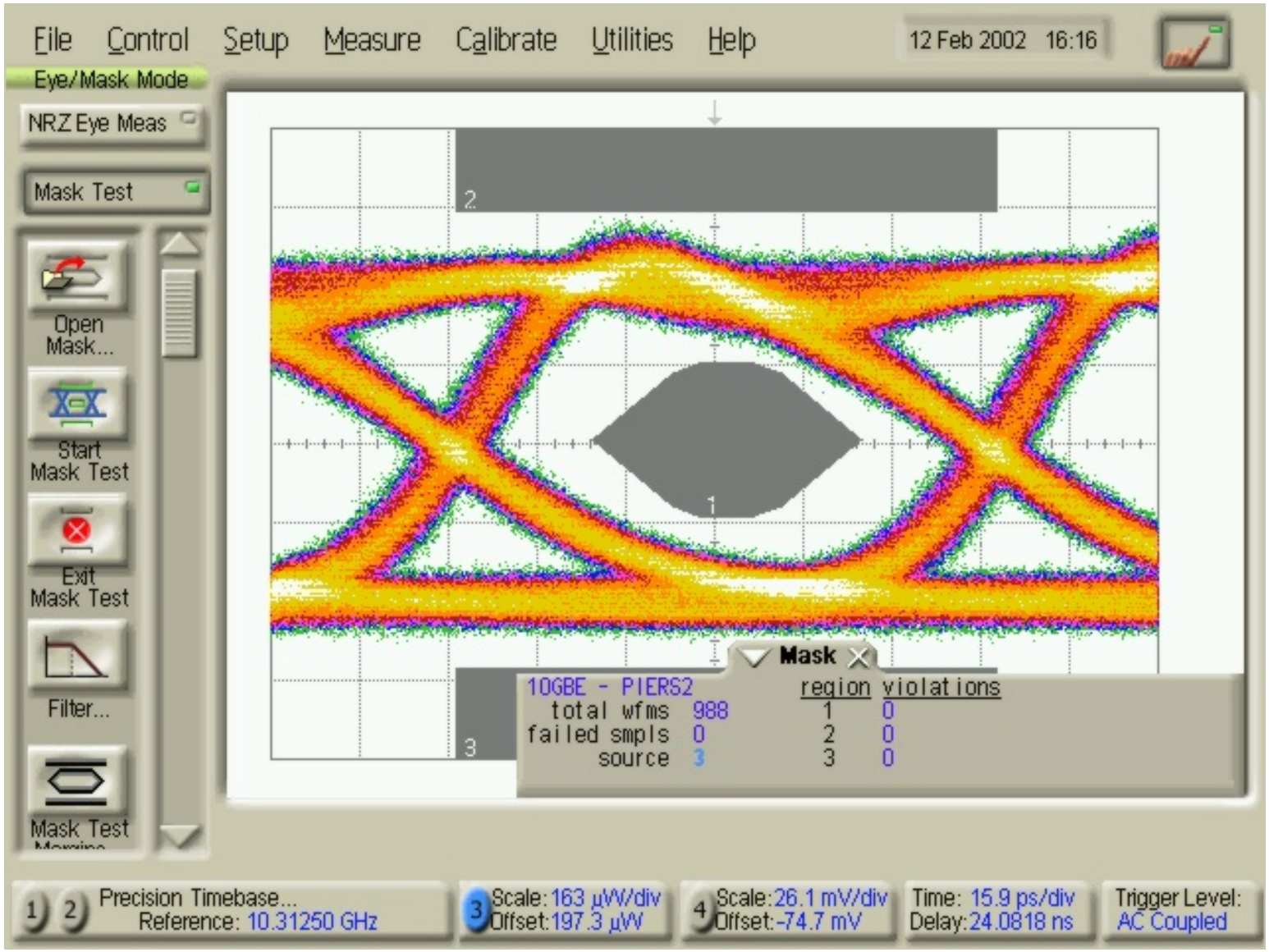
Reference RX penalties; 7.5 GHz RX BT filter



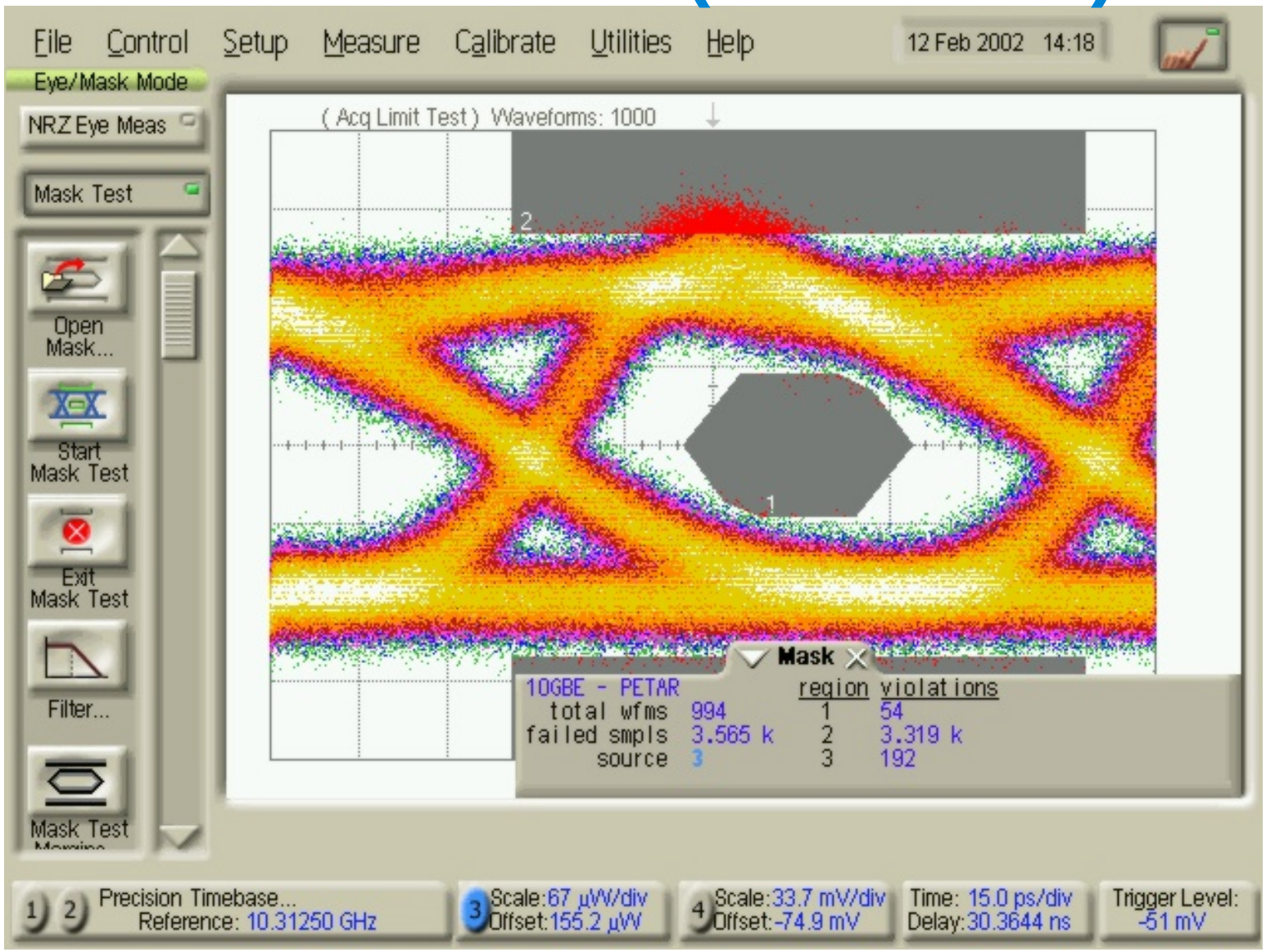
Effect of Decision Point Offset- ref RX



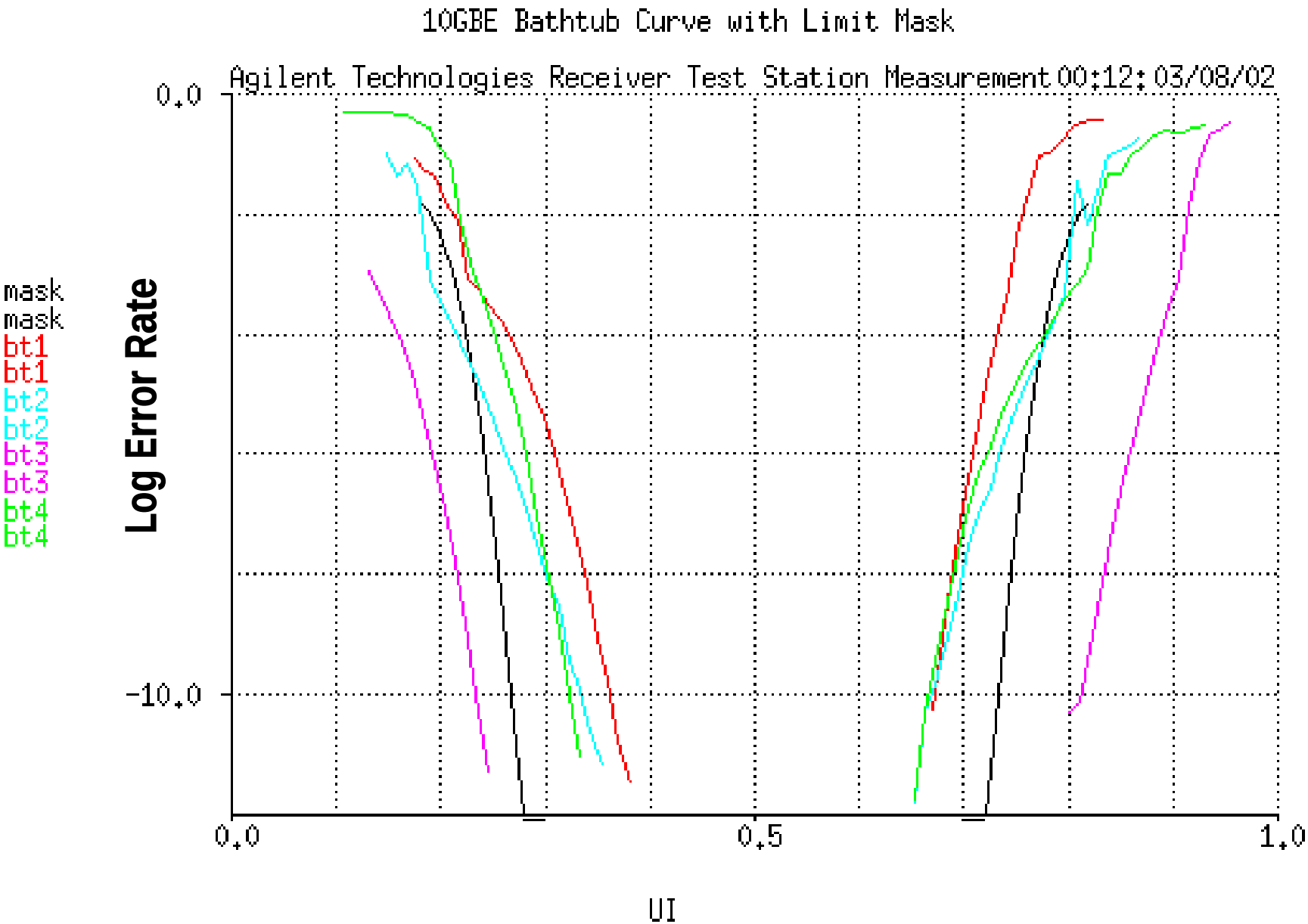
Direct Tx No Fiber (Pier's Mask)



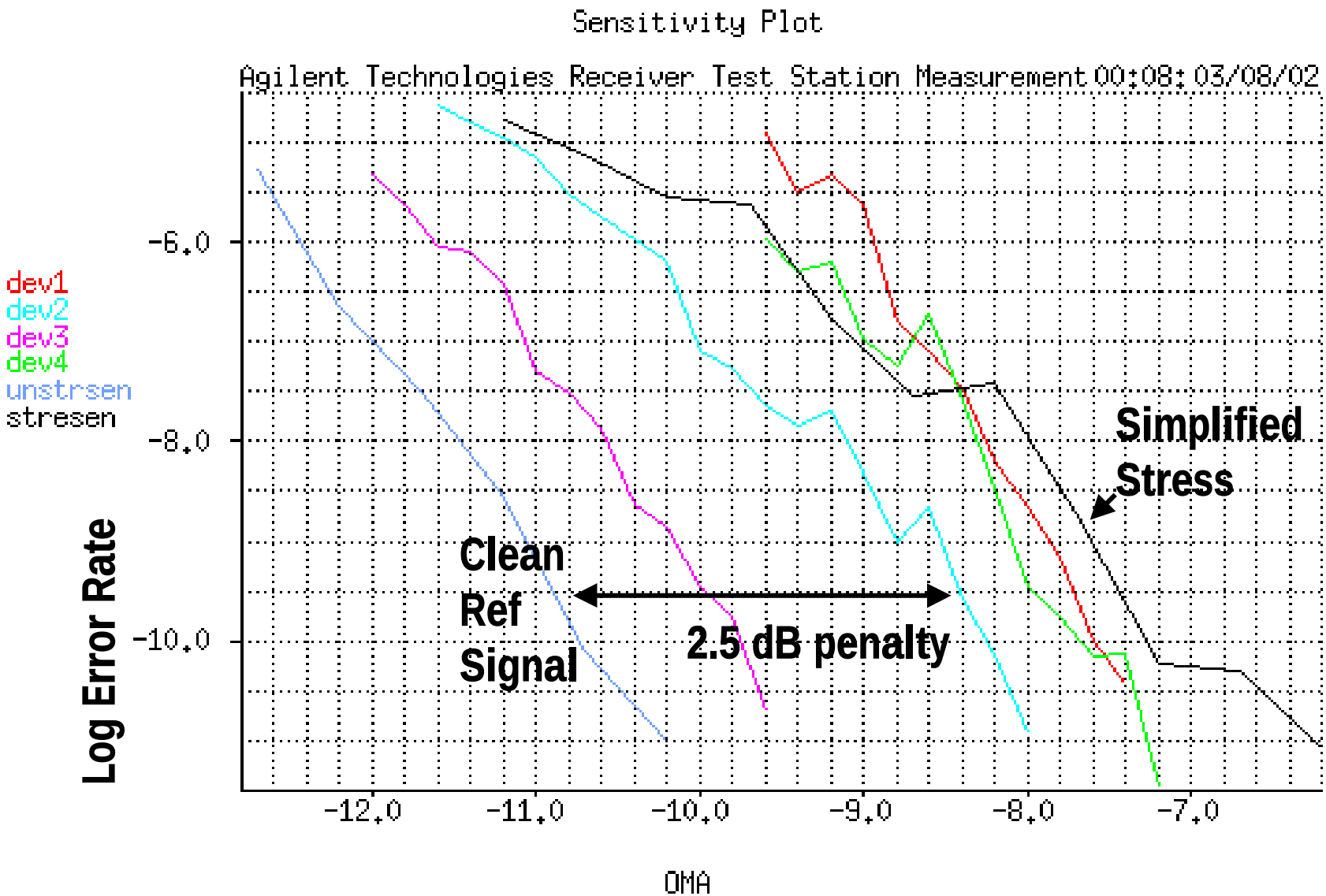
Direct Laser Tx With Fiber (Petar's Mask)



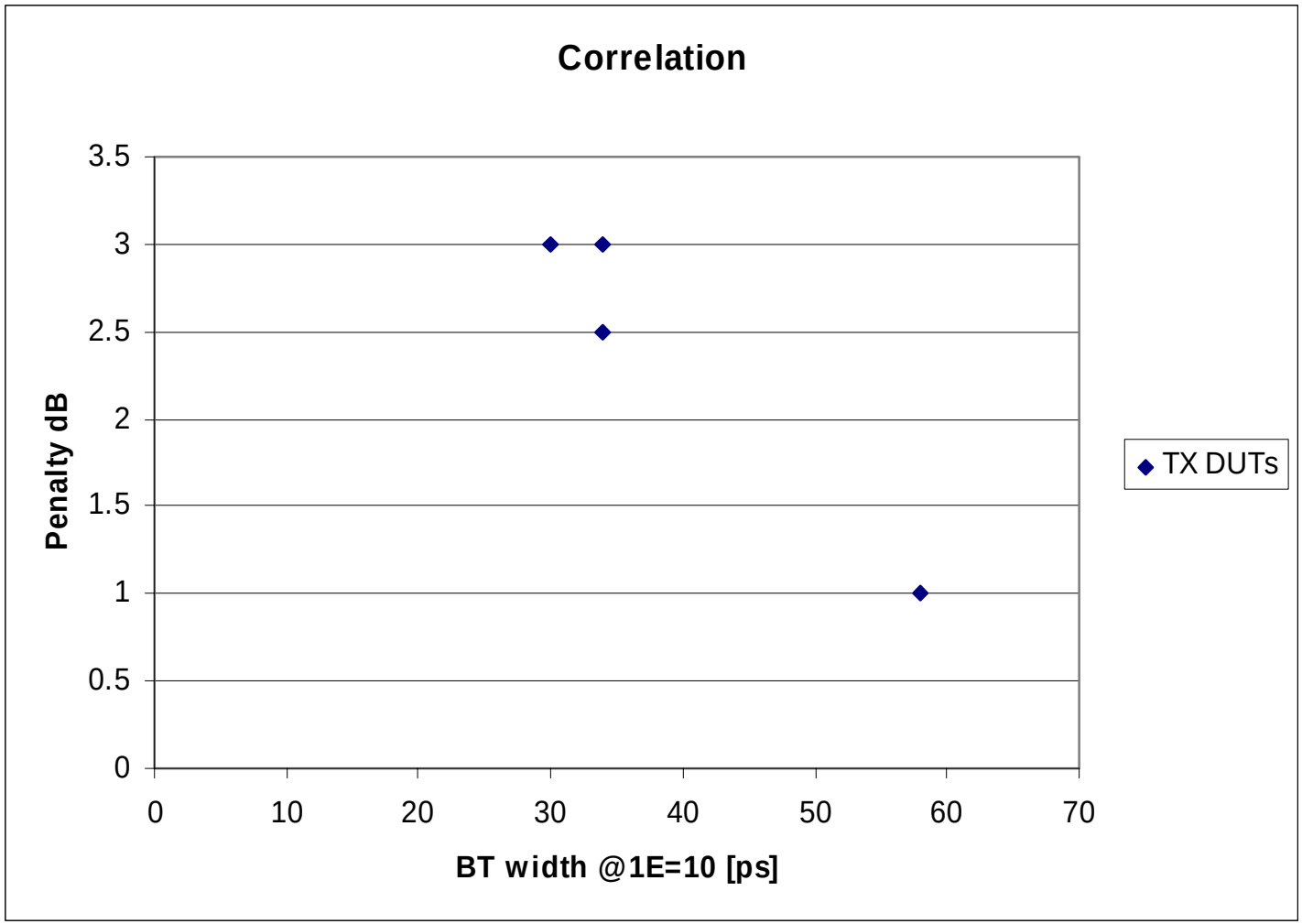
Tx Test; PRBS31; No Stress; “10 km” fiber



TDP +- 0.1 UI; TX through Fiber



TDP correlation to BT curves

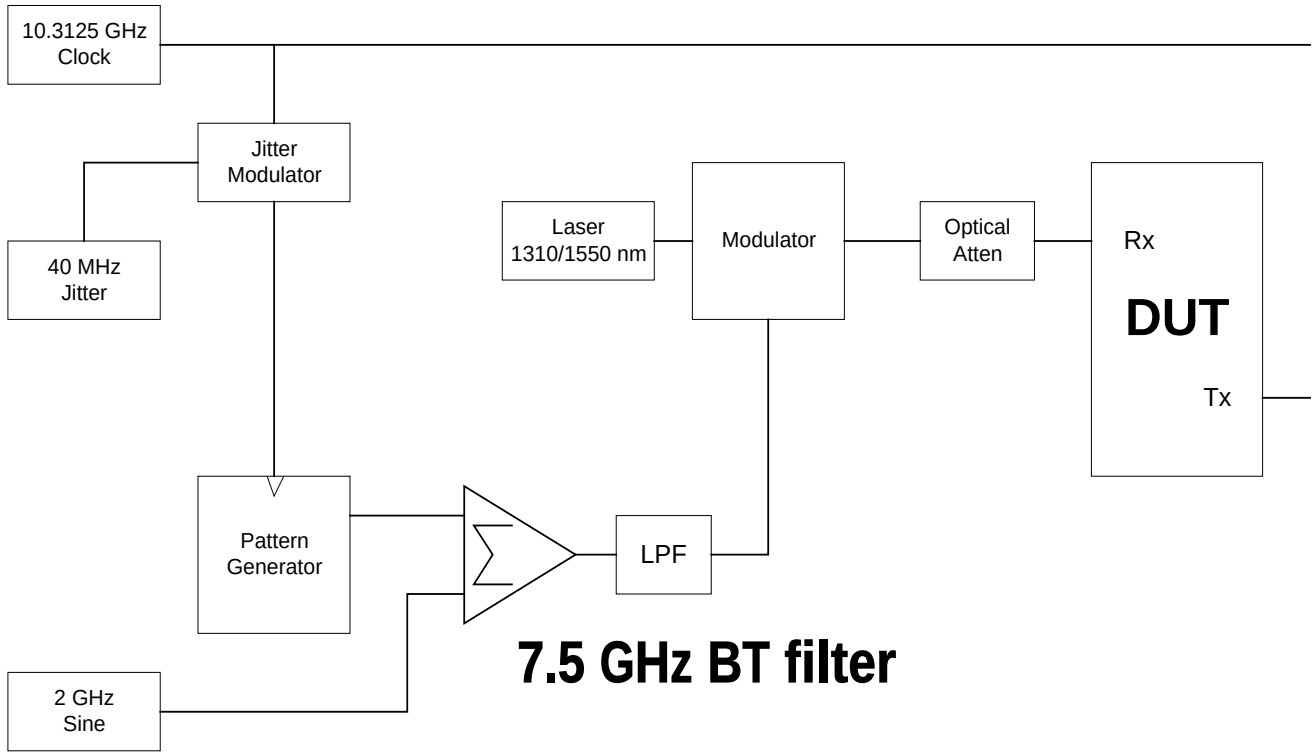


TDP Table- TX results

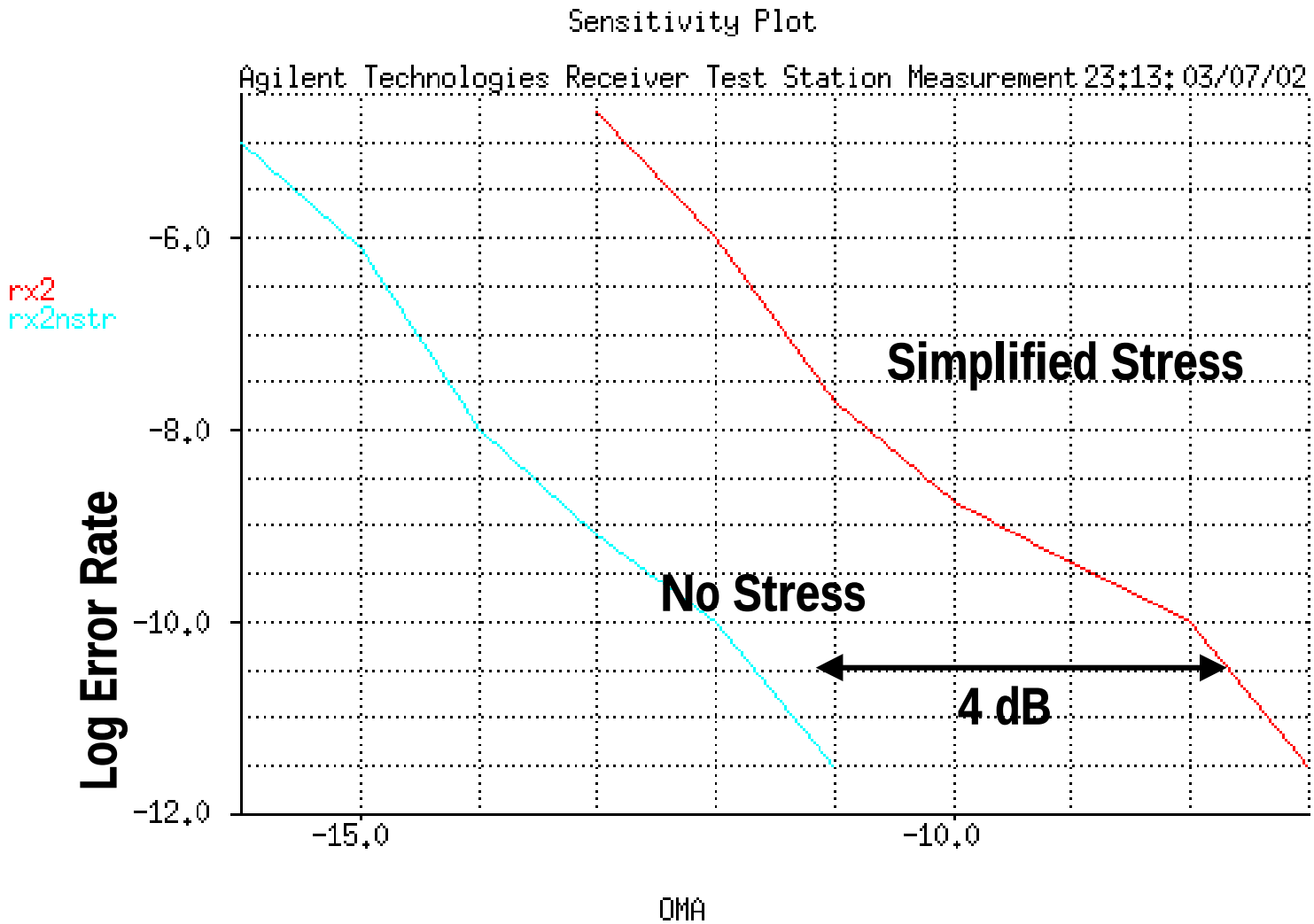
	Reference RX + / - 0.1 UI	RX DUT
Clean Source	calibration	
TX DUT	1 to 3 dB penalty	
Stressed Eye	3.5 dB penalty	

Receiver Test

- **Unstressed**
- **Simplified Stress**
- **PRBS31**

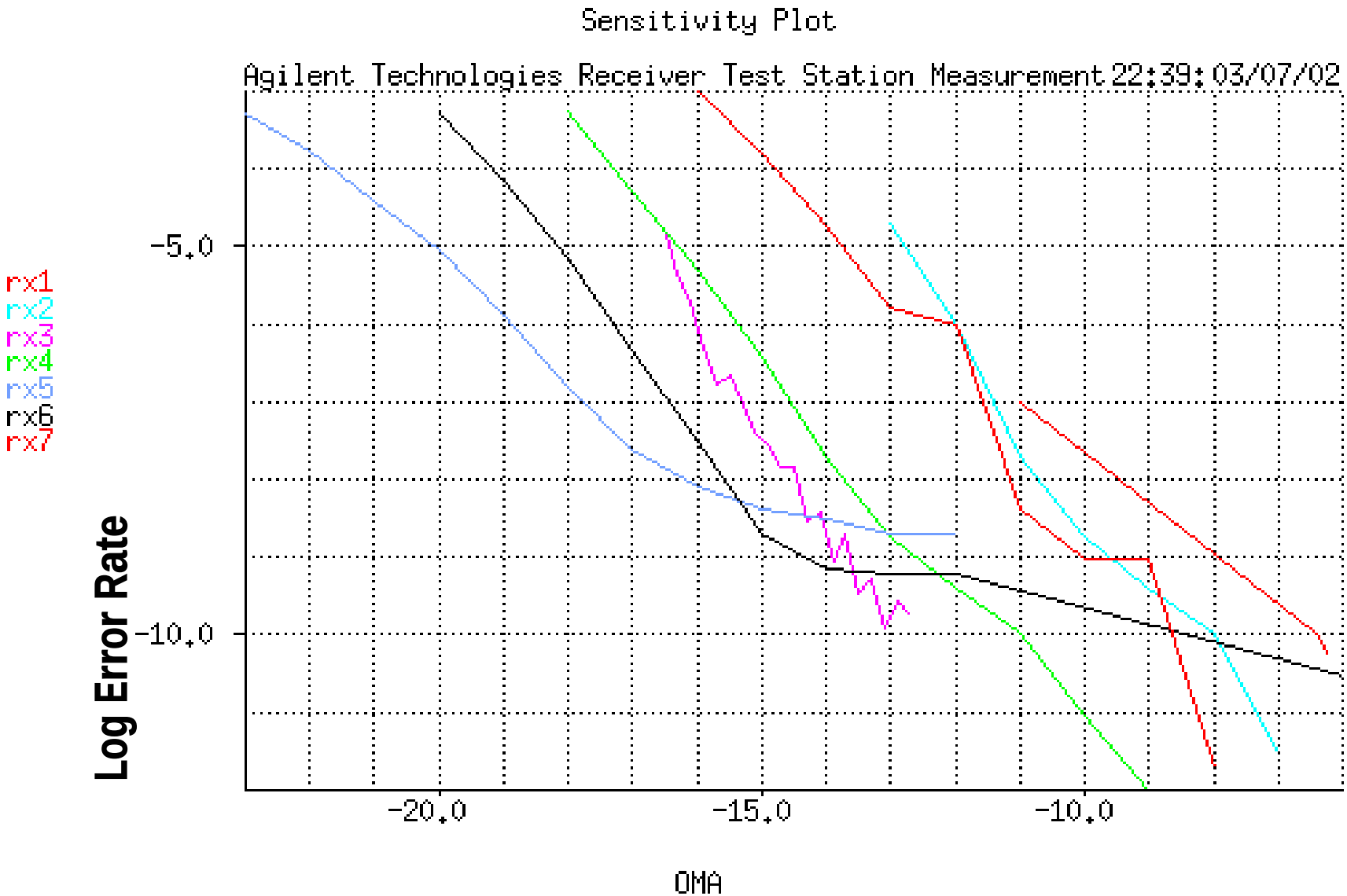


Rx BER vs OMA – Simplified Stress vs Nostress



SJ ~.25UI

Rx Sensitivity with Simplified Stress



TDP Table

	Reference RX + / - 0.1 UI	RX DUT
Clean Source	calibration	Nominal sensitivity -18 to –11 dBm
TX DUT	1 to 3 dB penalty	
Stressed Eye	3.5 dB penalty	3.5-7 dB penalty OMA=-11 to –5 dBm

Summary

- Simplified Stress BT curves qualitatively similar to actual DML TX curves
- TDP measured with +-0.1 UI decision point offset correlates with BT curve
- All TX DUTs measured smaller penalties than simplified stress
- Simplified stress induced moderate to large power penalties in RX DUTs
- Simplified Stress / TDP methodology seems to be workable using optimized test Receiver