980nm VCSEL
Performance in extreme temperatures

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Supporters

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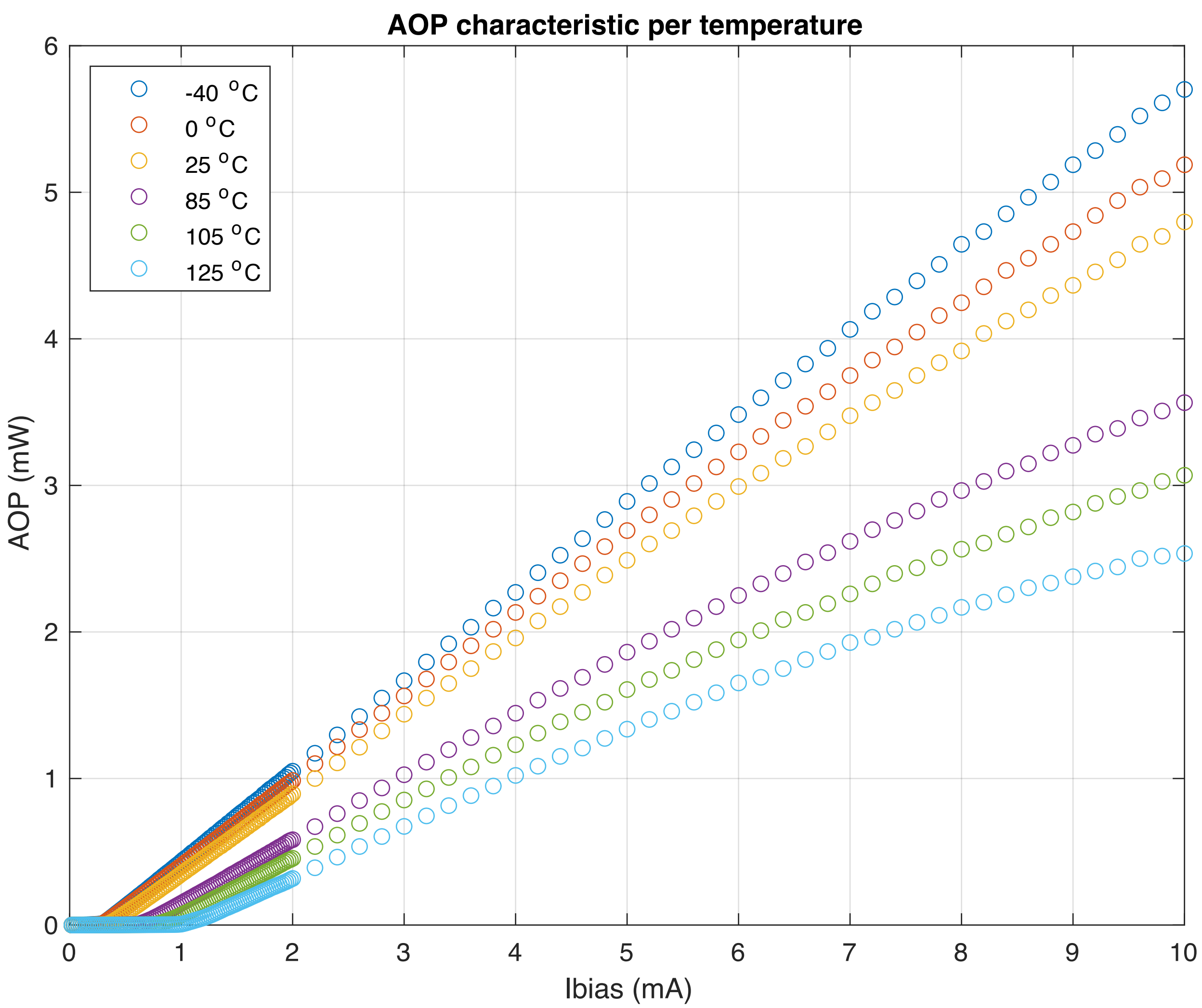
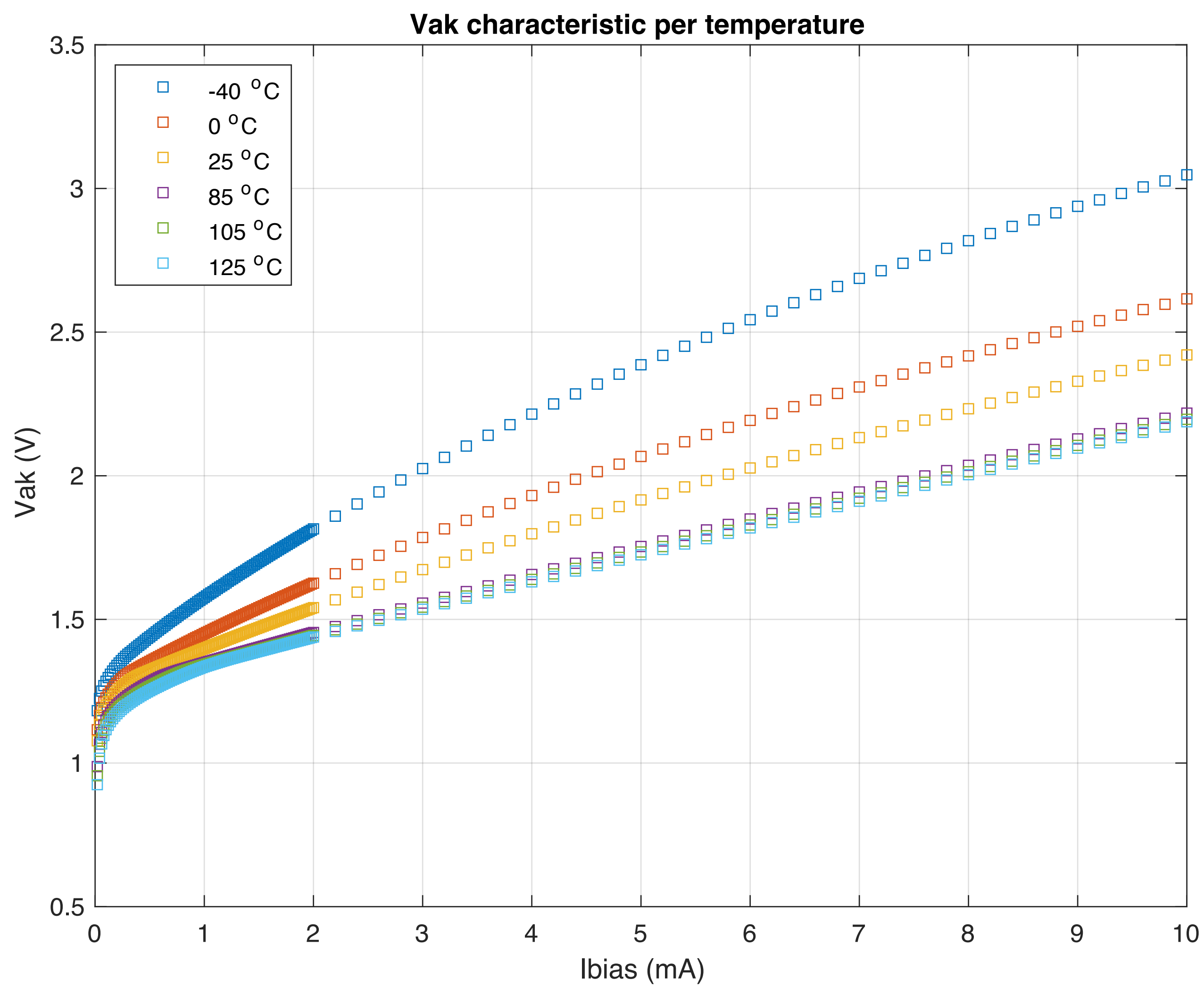
Introduction

- A TRUMPF 980nm VCSEL was characterized in LIV and RIN, according to the methodology reported in [1] and tested for 50 Gb/s PAM4, 25Gb/s NRZ and 10Gb/s NRZ real-time transmissions using the same test-setup reported in [2]
- The results will demonstrate the best performance results reported in the 802.3cz TF until now of real-time transmissions experiments across extreme temperatures (-40ºC to +125ºC backside temperature)
- The results will also demonstrate the superior speed and signal integrity (i.e. linearity) of the 980nm VCSELs compared to 850nm VCSELs, which allow to reduce the transceiver complexity:
  - No TX FFE is needed in any temperature: lower injected current peaks, lower TX power consumption and relative cost
  - Reduced number of taps in the RX equalizer (in some rates, the equalizer can be eliminated even in extreme temperatures): lower RX power consumption and relative cost
- The results will also demonstrate the superior RIN performance of the 980nm VCSELs compared to 850nm VCSELs, making posible to improve link budget for 50 Gb/s
- Note about the assembly:
  - The devices were assembled in an existing PCB that makes the transition from coaxial interface of the test equipment to the VCSEL, being this PCB not optimally redesigned for such devices
  - Because of that, the electrical connection was affected by extra electrical parasitics that affected the signal integrity in the experiments and also the observation of the optical signal from the device
  - Despite it, the results presented in the following slides allow to see a superior performance of 980nm devices compared to the one reported in [2]

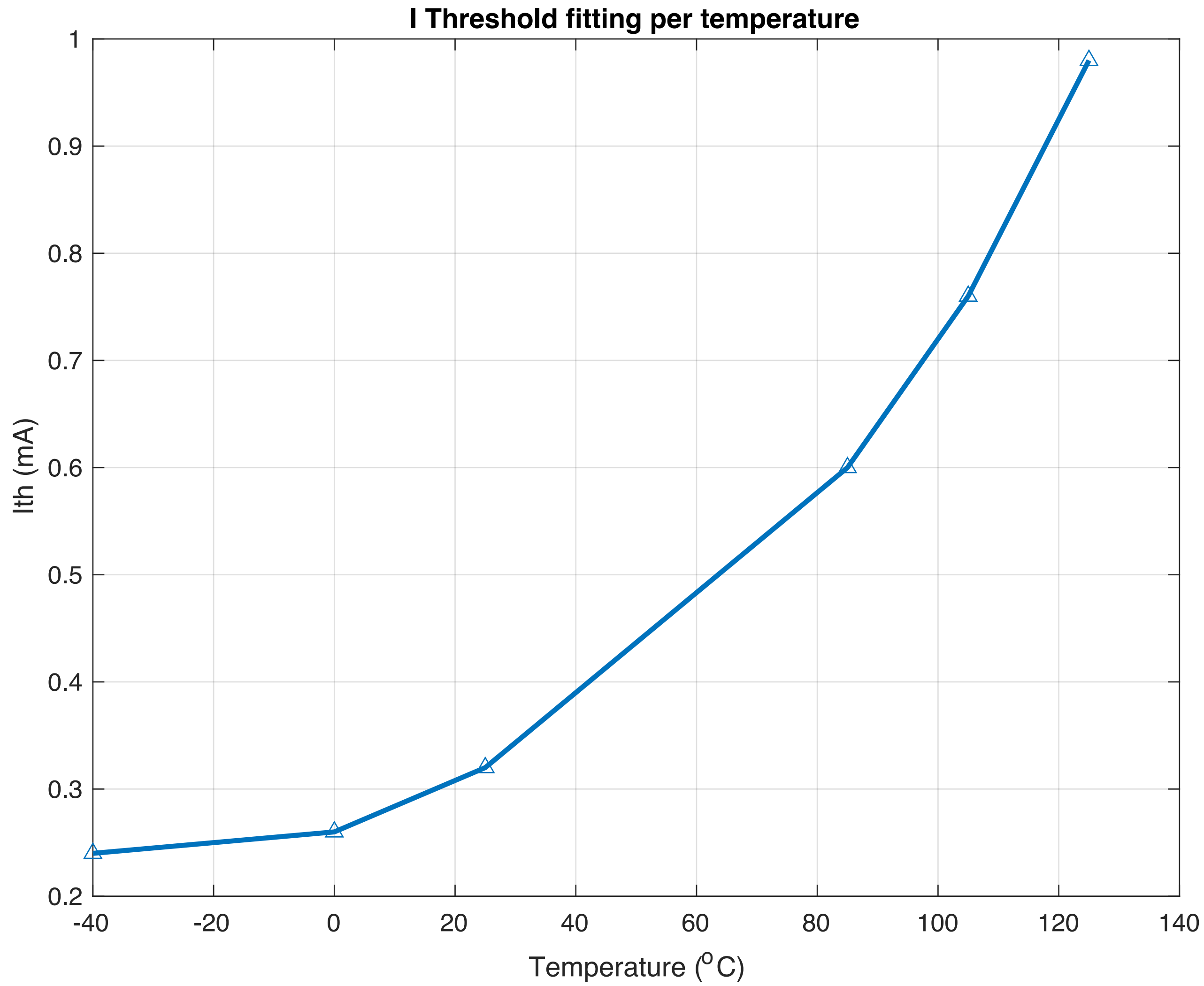
LIV and RIN characterizations

L-I-V characteristic

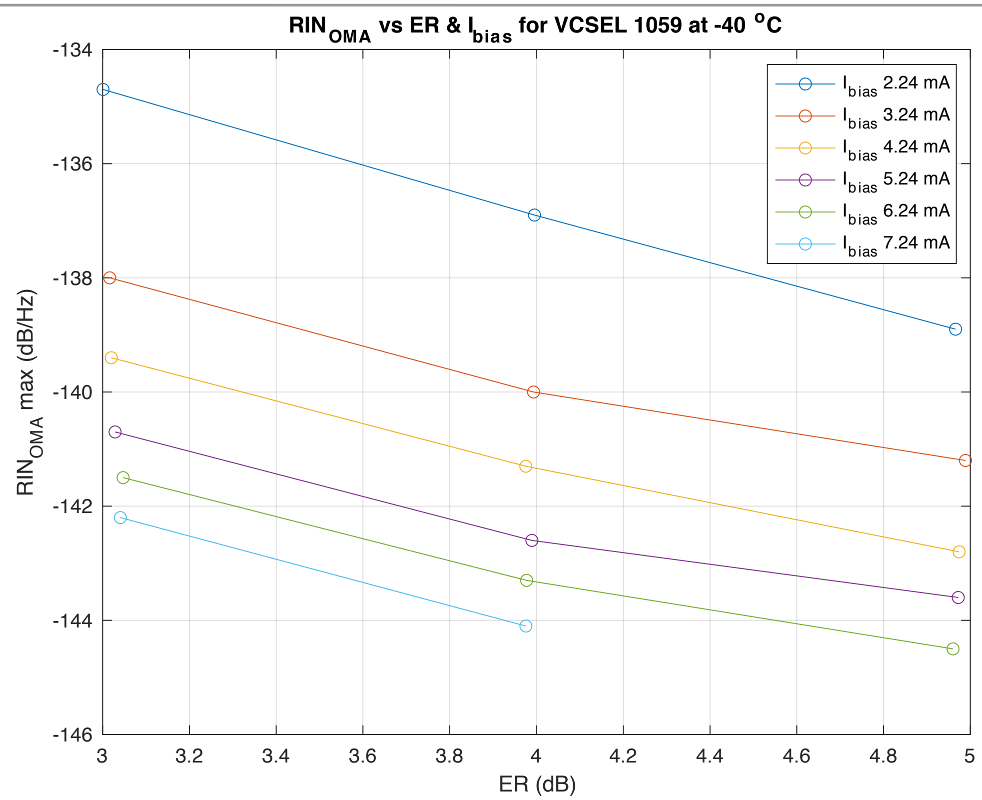


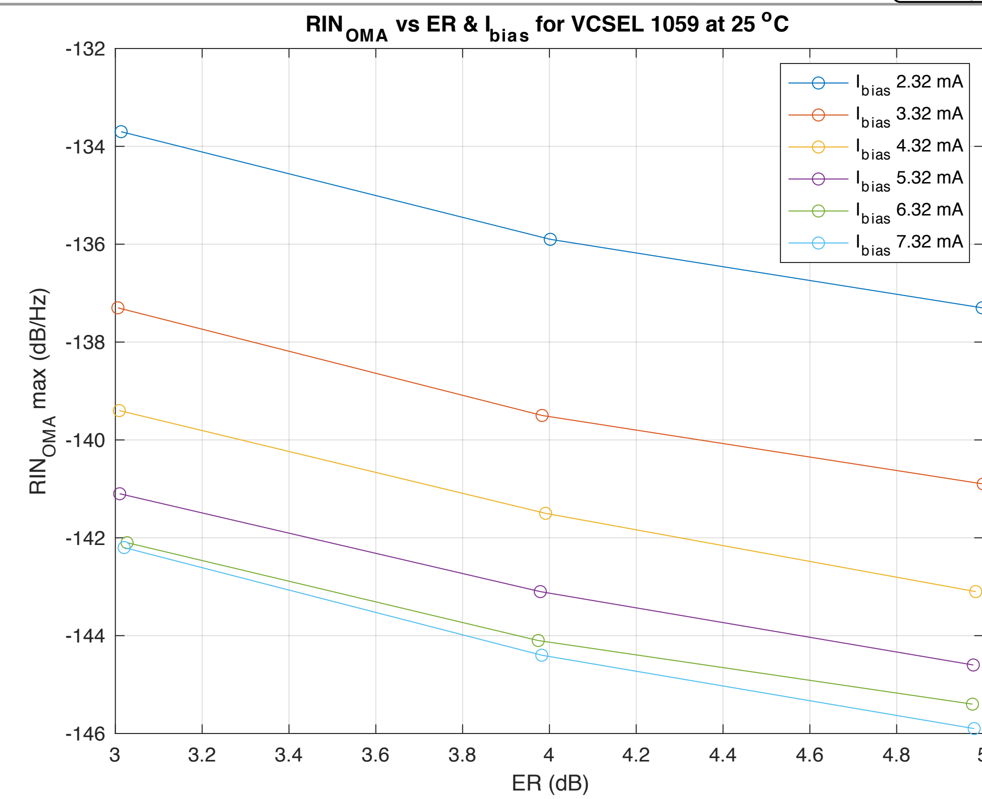


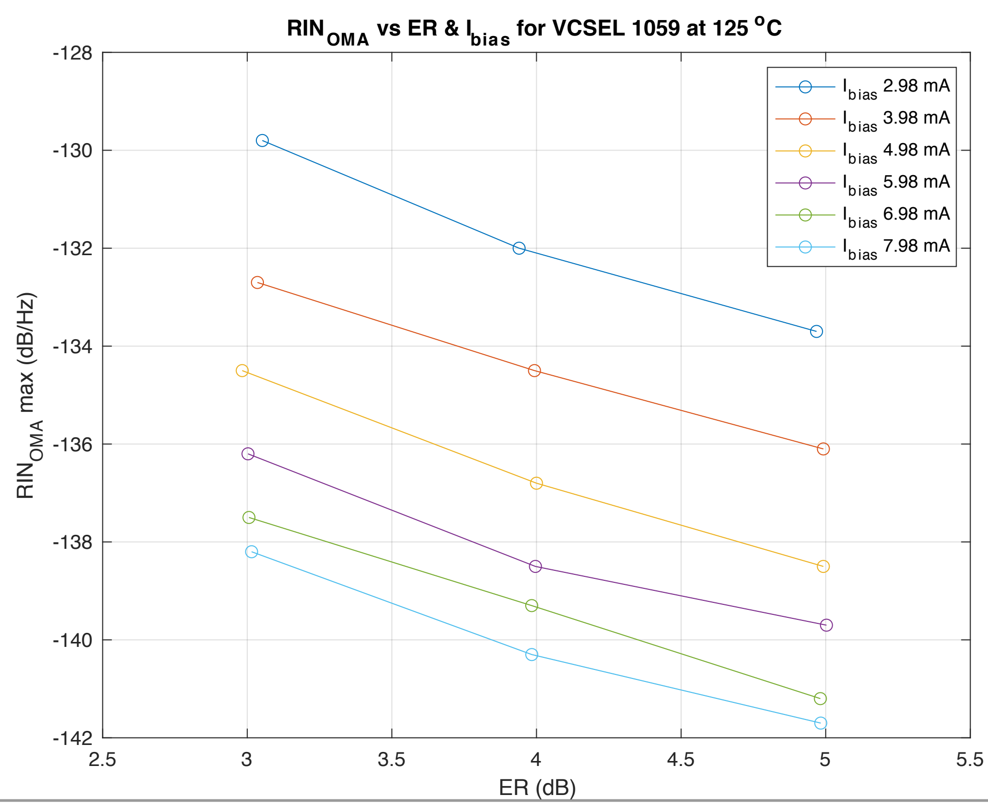
Threshold current characteristic

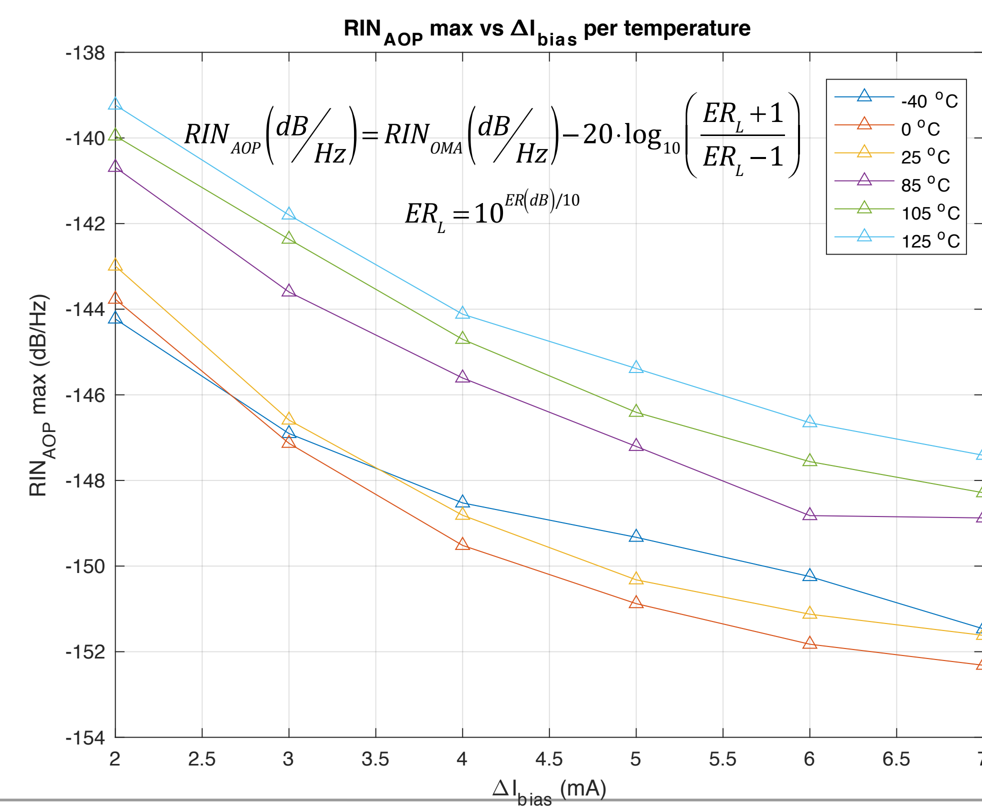


Relative intensity noise (RIN_{OMA})



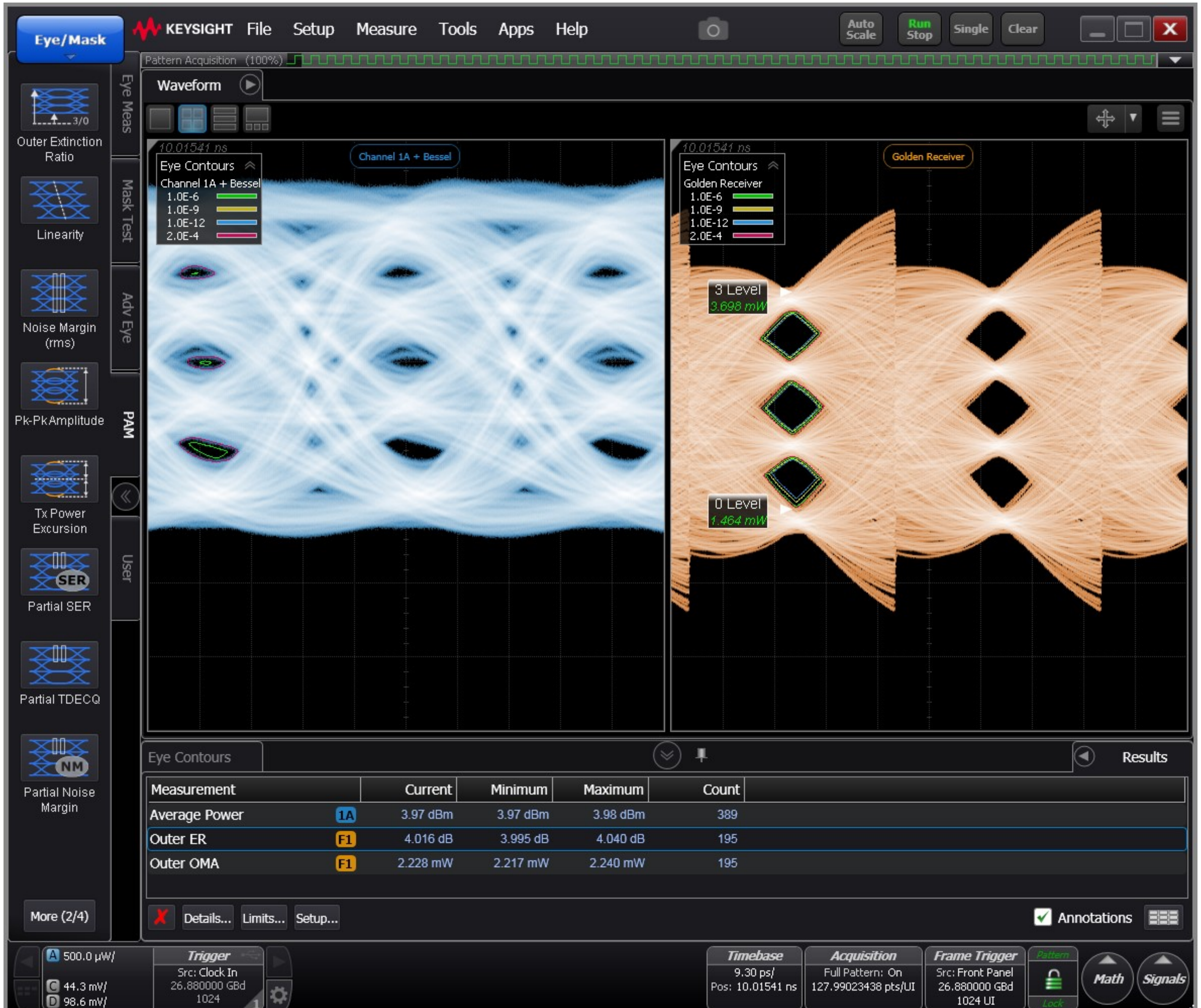






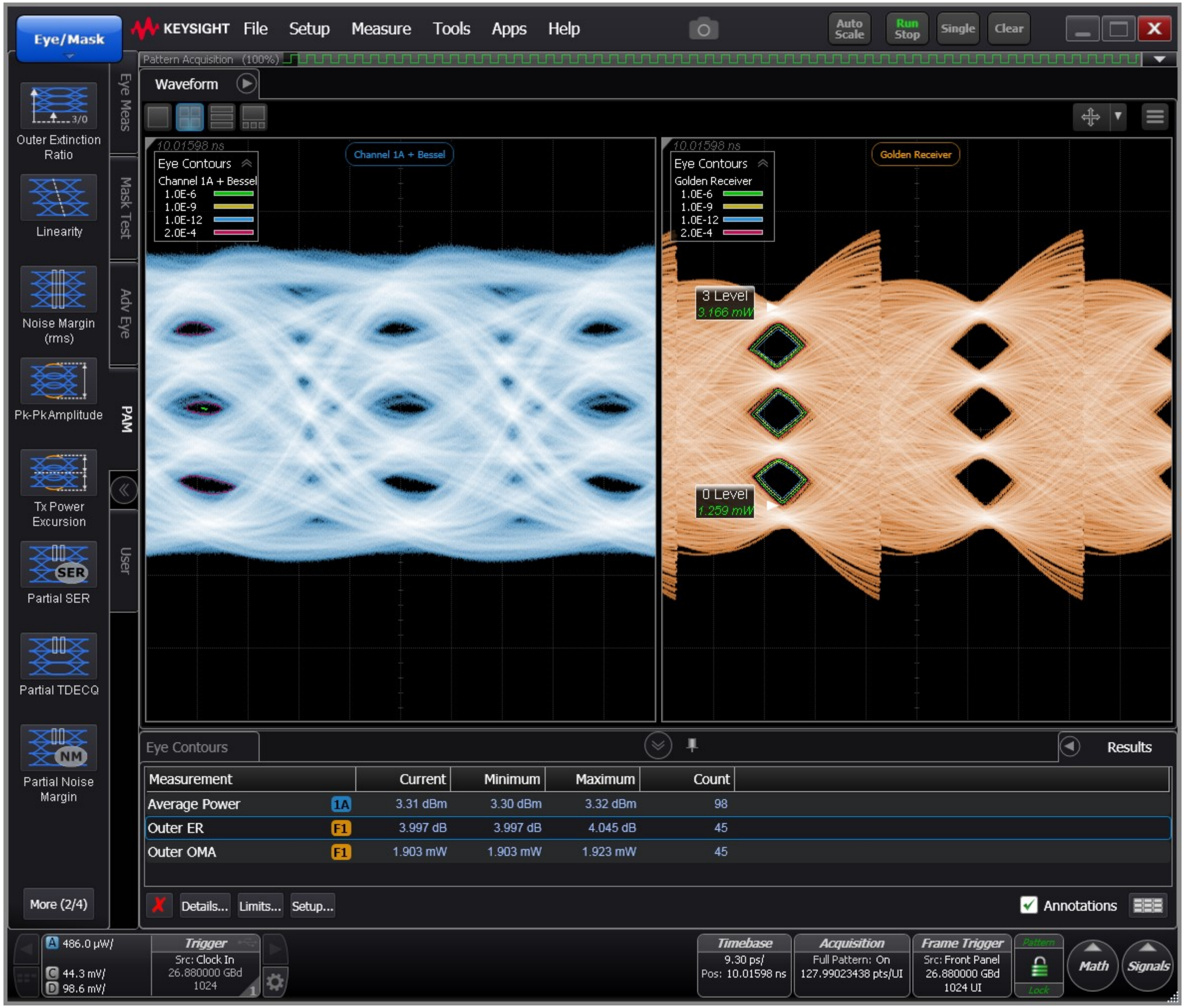
Real-time performance at 25ºC

25ºC, 53.76 Gb/s PAM4, Ibias 7mA, ER 4 dB

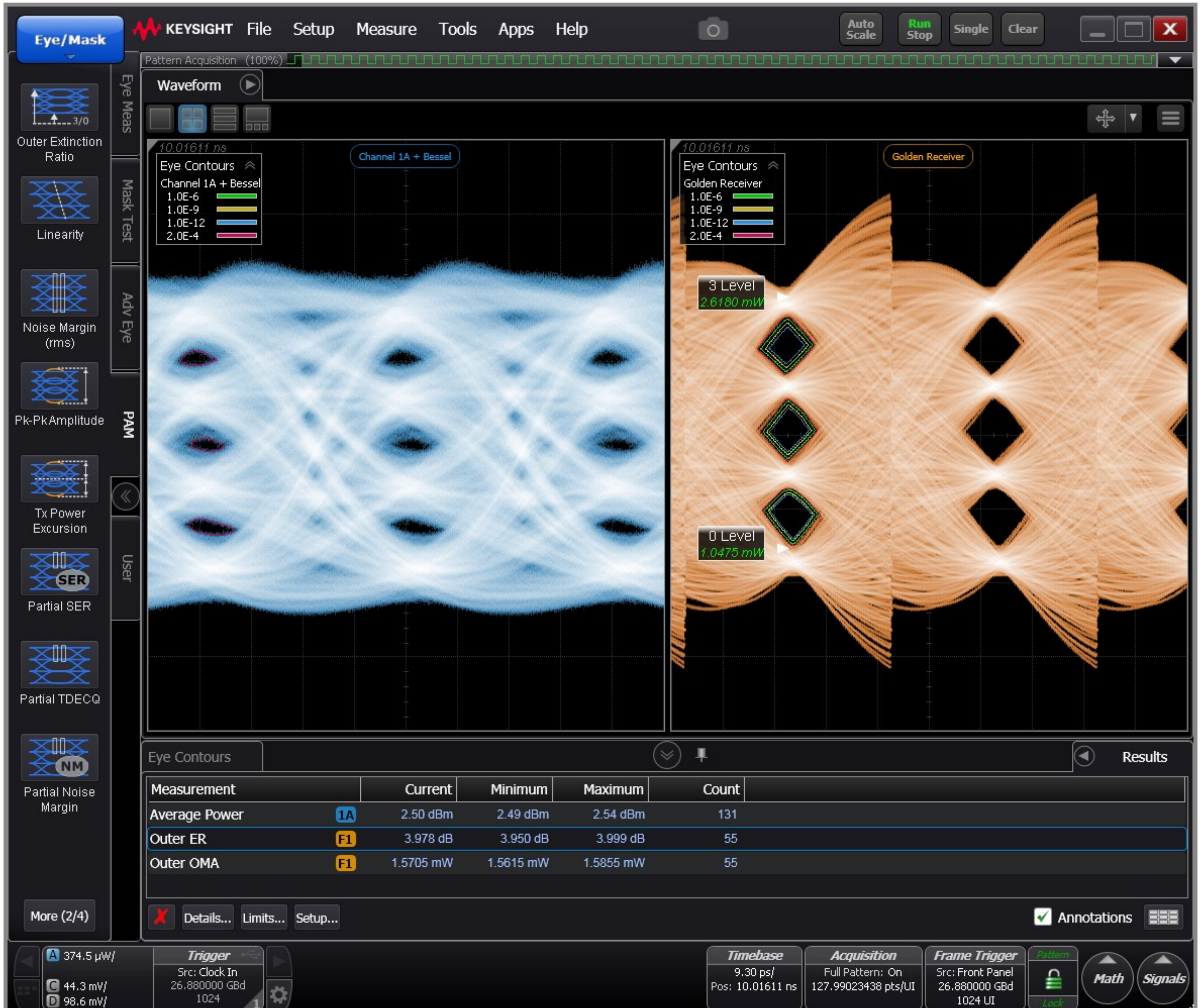


Measurement		Current	Minimum	Maximum	Count
Average Power	1A	3.97 dBm	3.97 dBm	3.98 dBm	389
Outer ER	F1	4.016 dB	3.995 dB	4.040 dB	195
Outer OMA	F1	2.228 mW	2.217 mW	2.240 mW	195

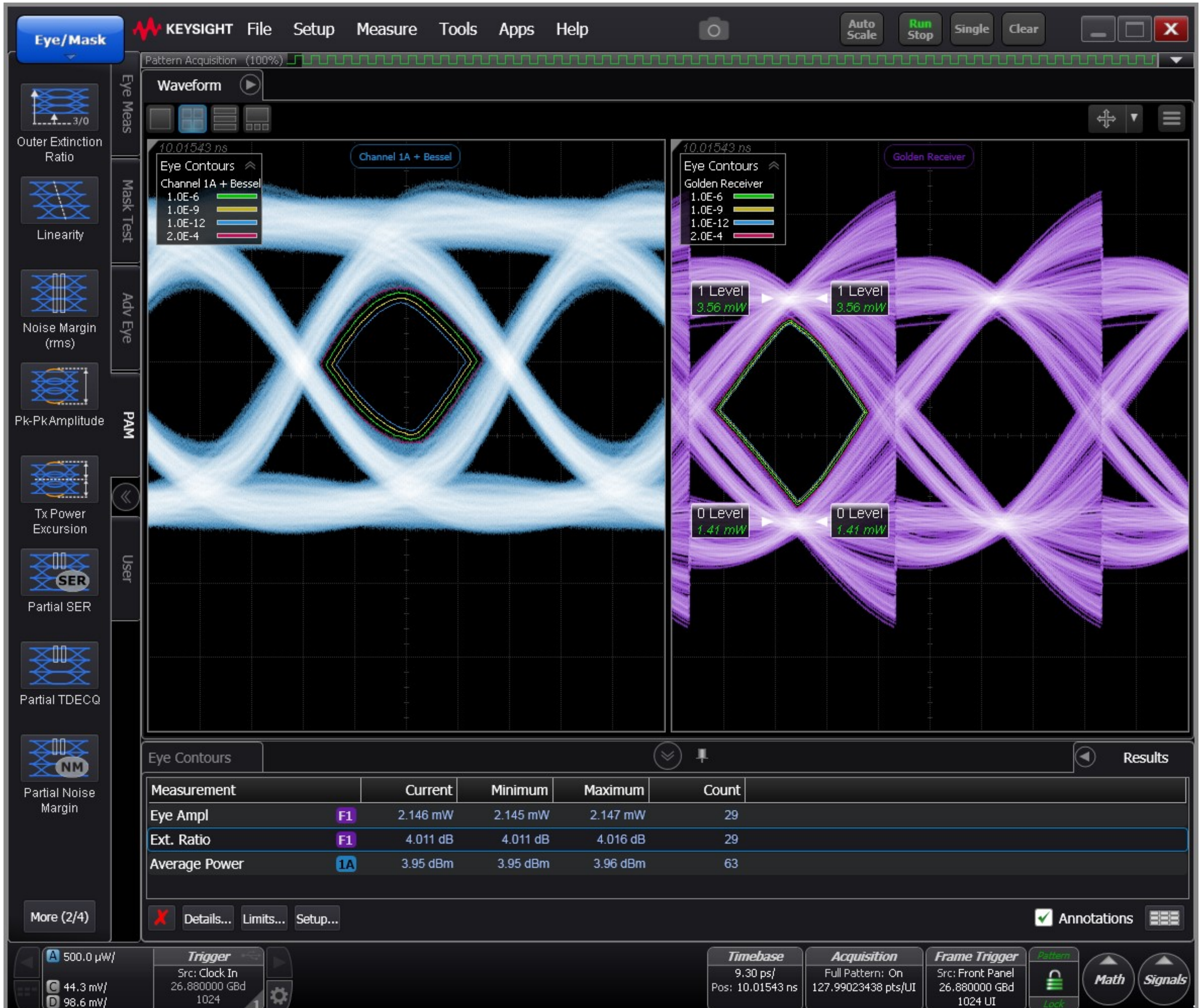
25ºC, 53.76 Gb/s PAM4, Ibias 6mA, ER 4 dB



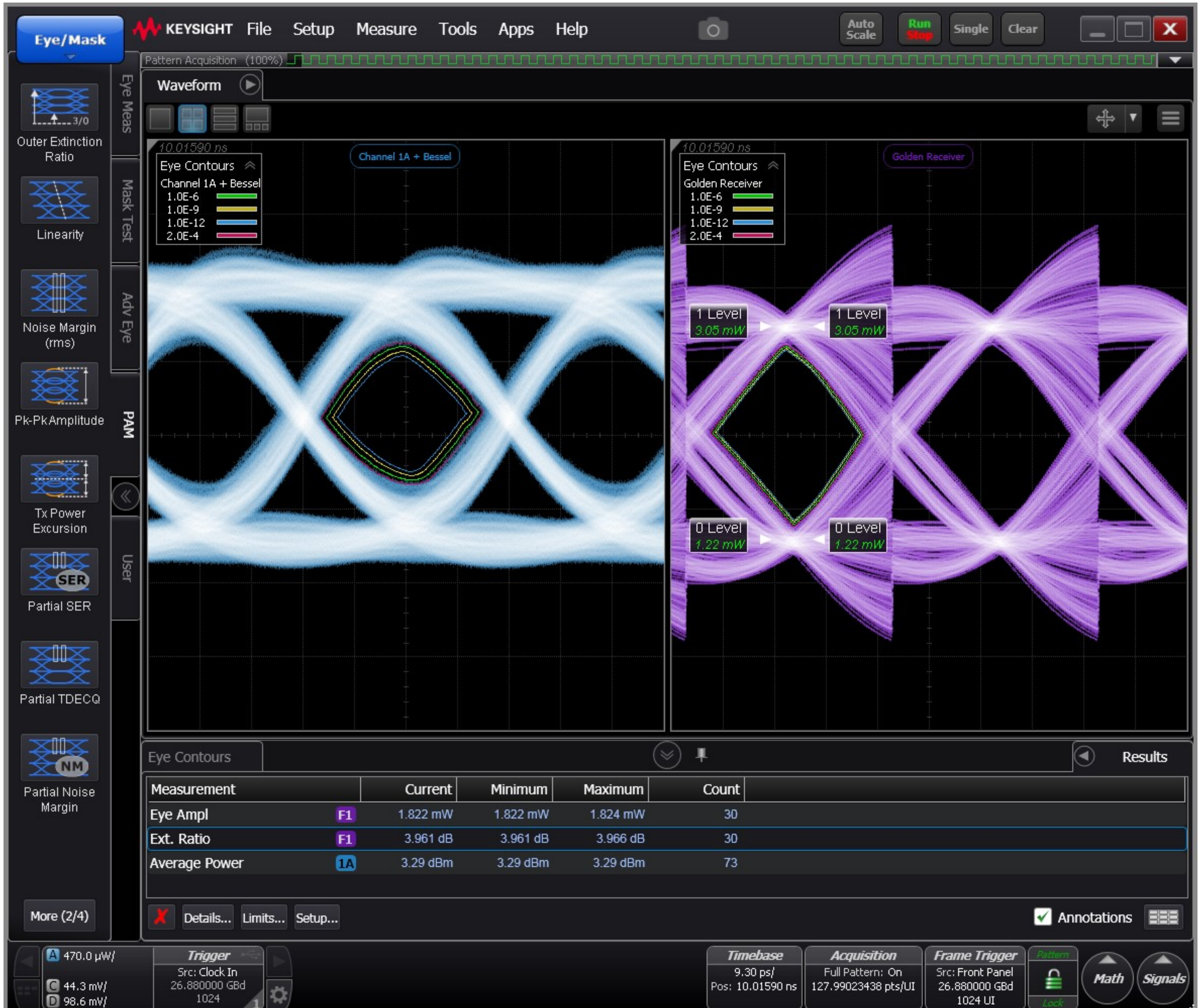
25ºC, 53.76 Gb/s PAM4, Ibias 5mA, ER 4 dB



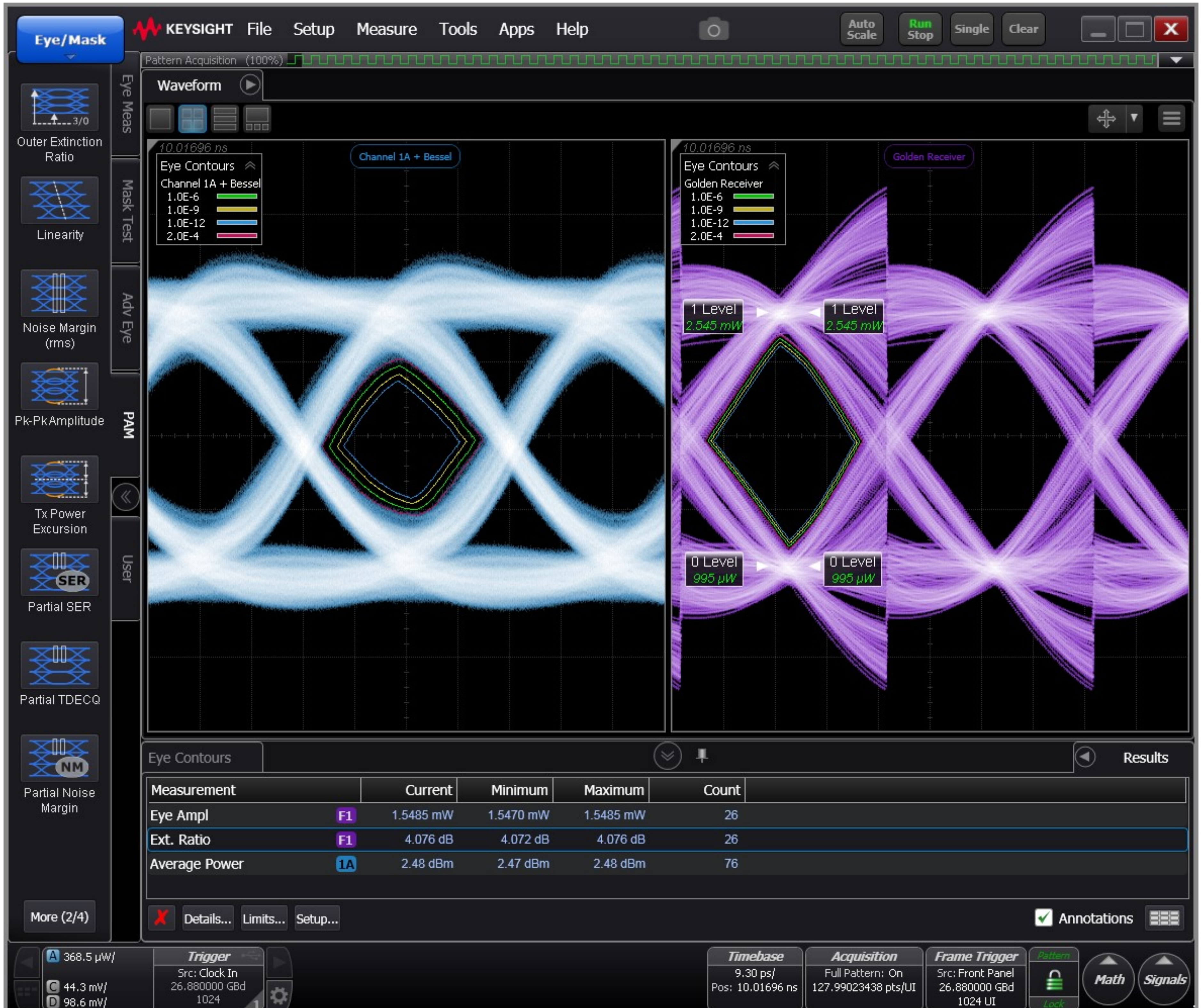
25ºC, 26.88 Gb/s NRZ, Ibias 7mA, ER 4 dB



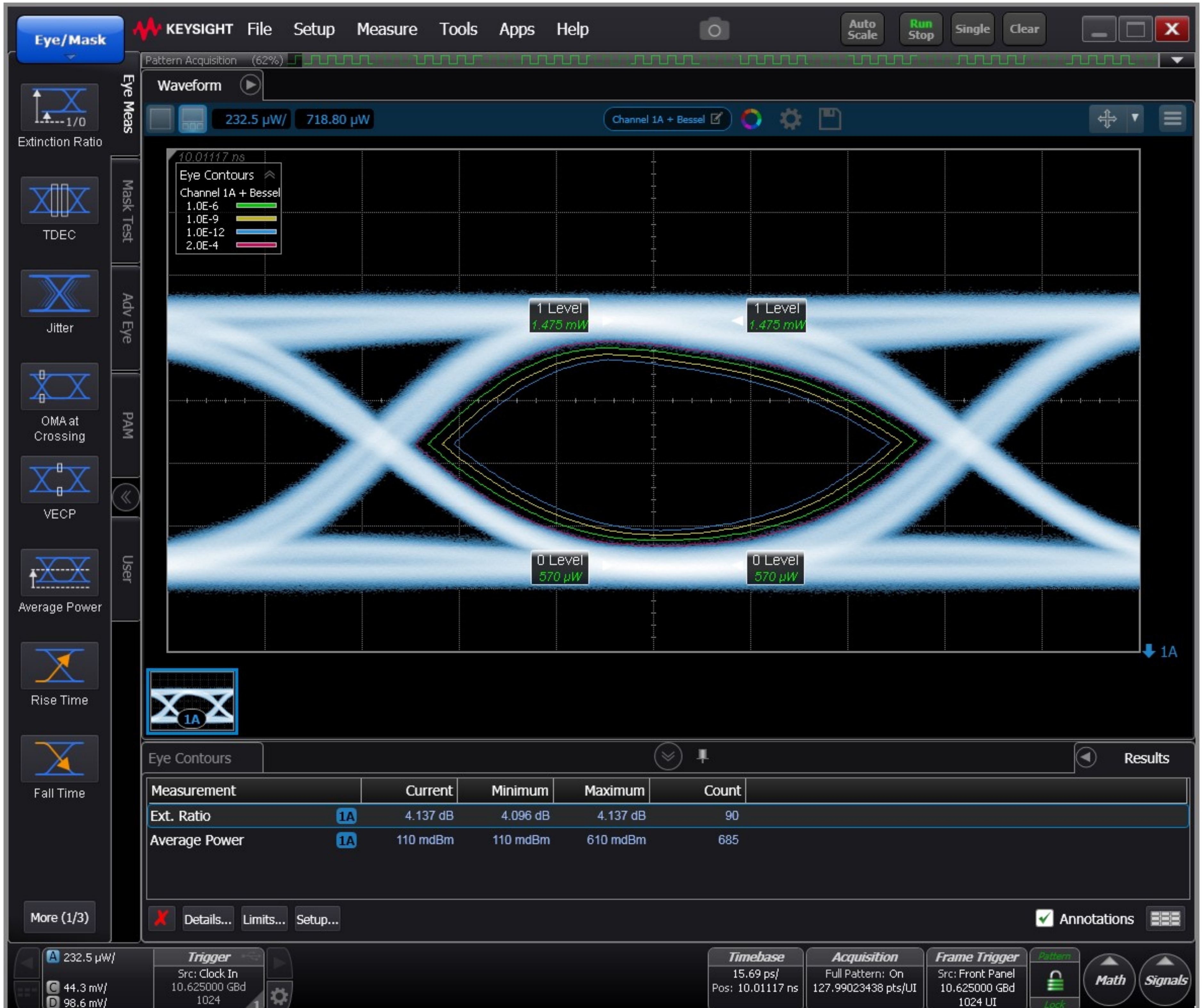
25ºC, 26.88 Gb/s NRZ, Ibias 6mA, ER 4 dB



25ºC, 26.88 Gb/s NRZ, Ibias 5mA, ER 4 dB

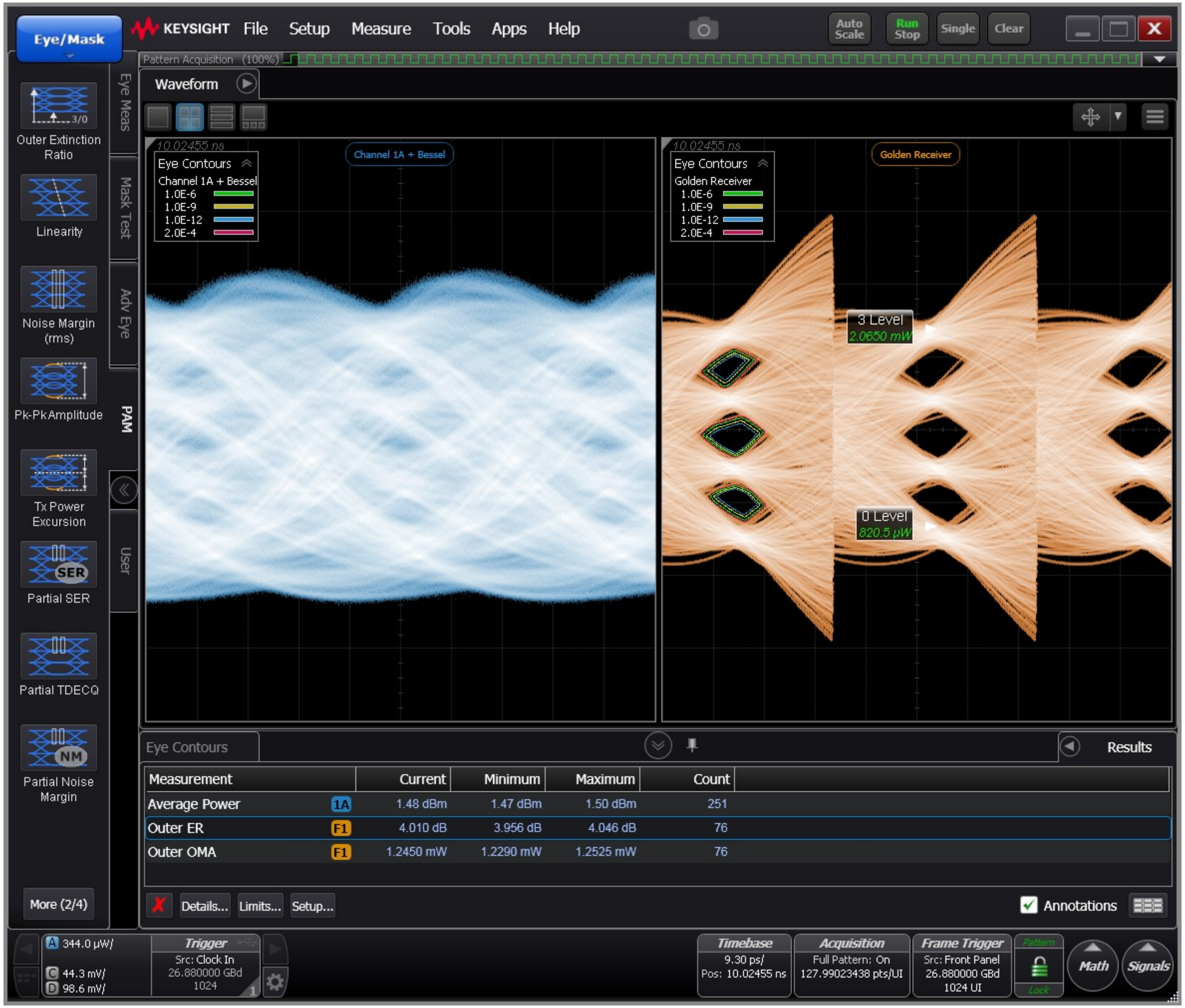


25ºC, 10.625 Gb/s NRZ, Ibias 3mA, ER 4 dB



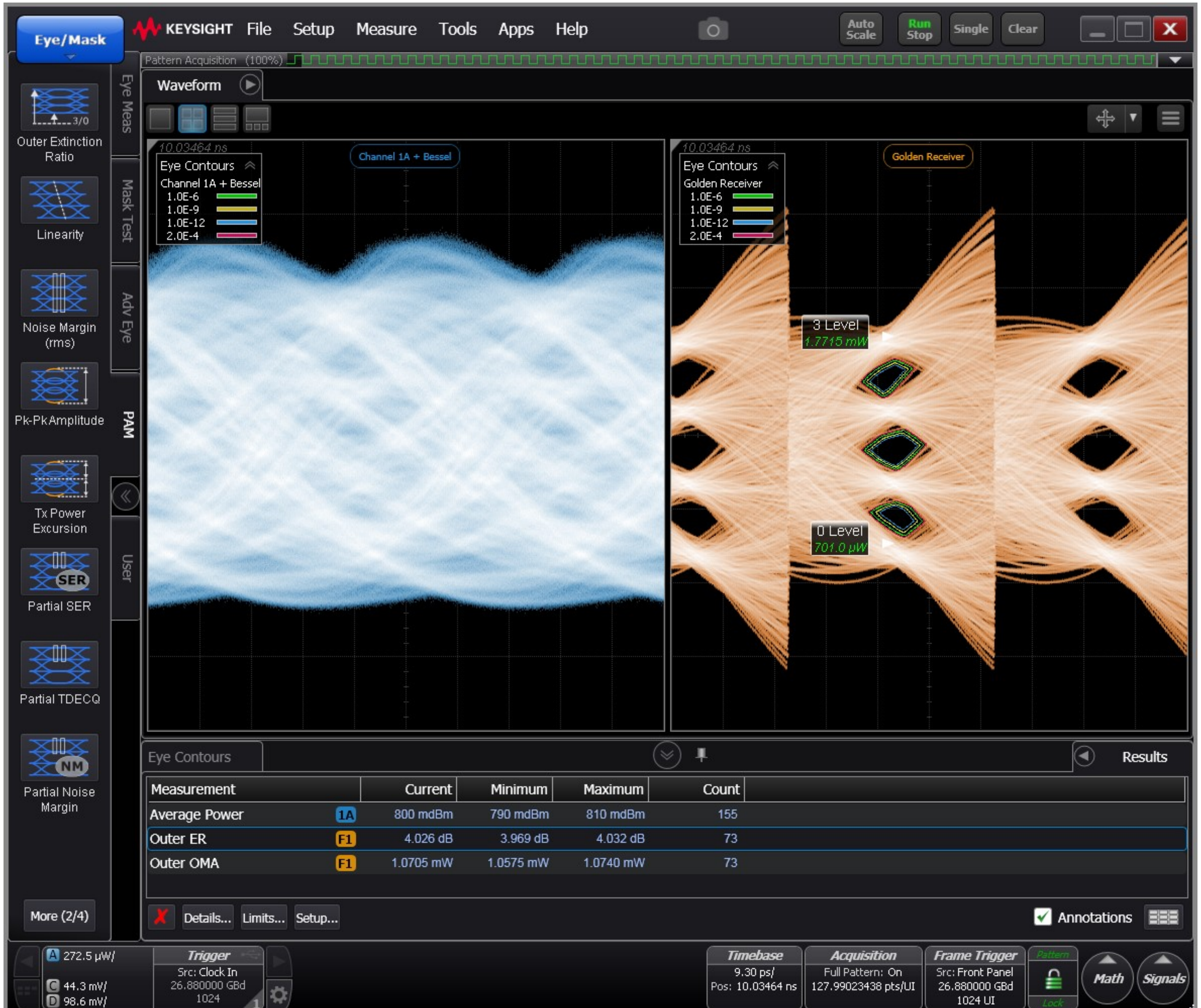
Real-time performance at 125ºC

125°C, 53.76 Gb/s PAM4, Ibias 7mA, ER 4 dB

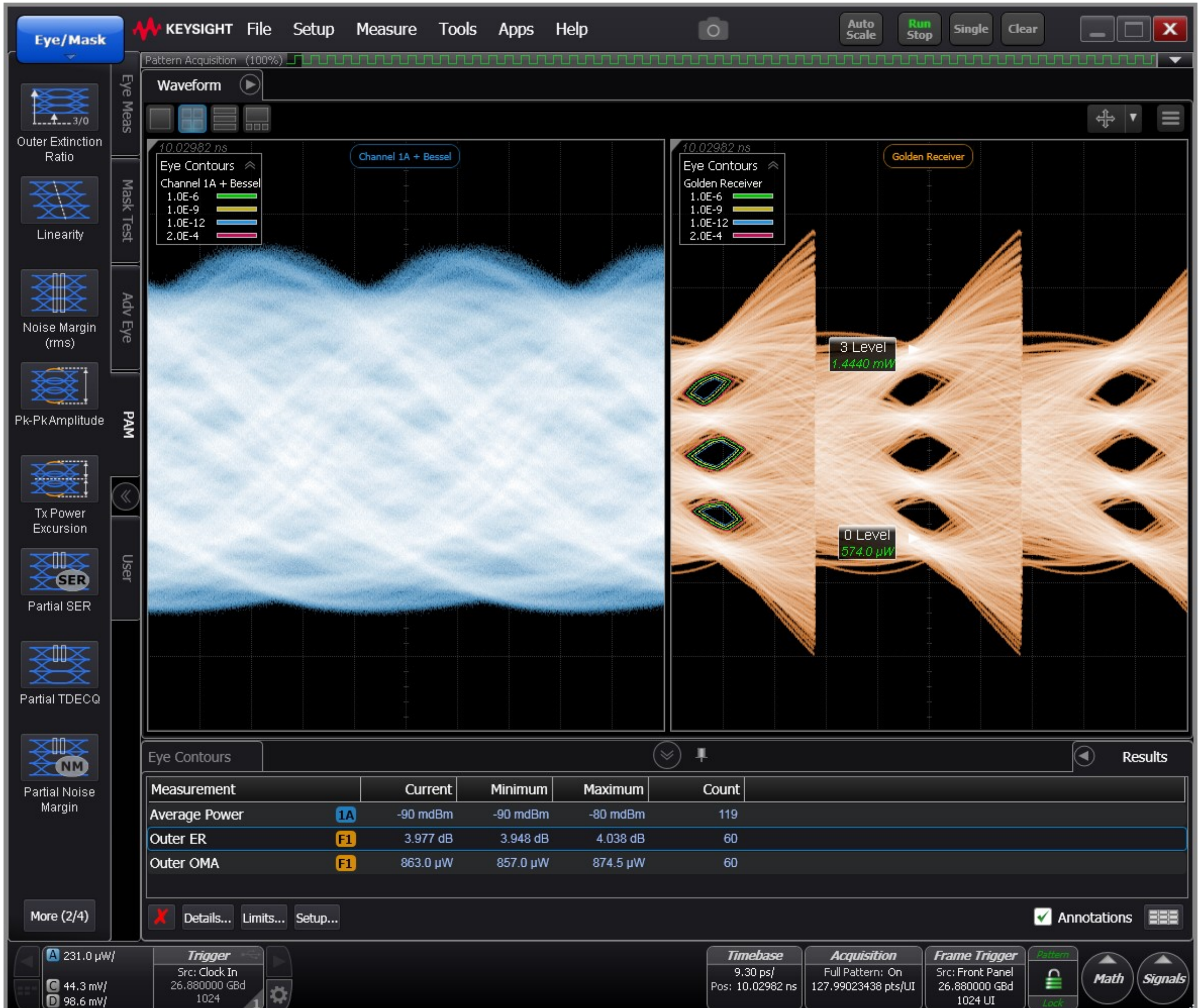


Measurement		Current	Minimum	Maximum	Count
Average Power	1A	1.48 dBm	1.47 dBm	1.50 dBm	251
Outer ER	F1	4.010 dB	3.956 dB	4.046 dB	76
Outer OMA	F1	1.2450 mW	1.2290 mW	1.2525 mW	76

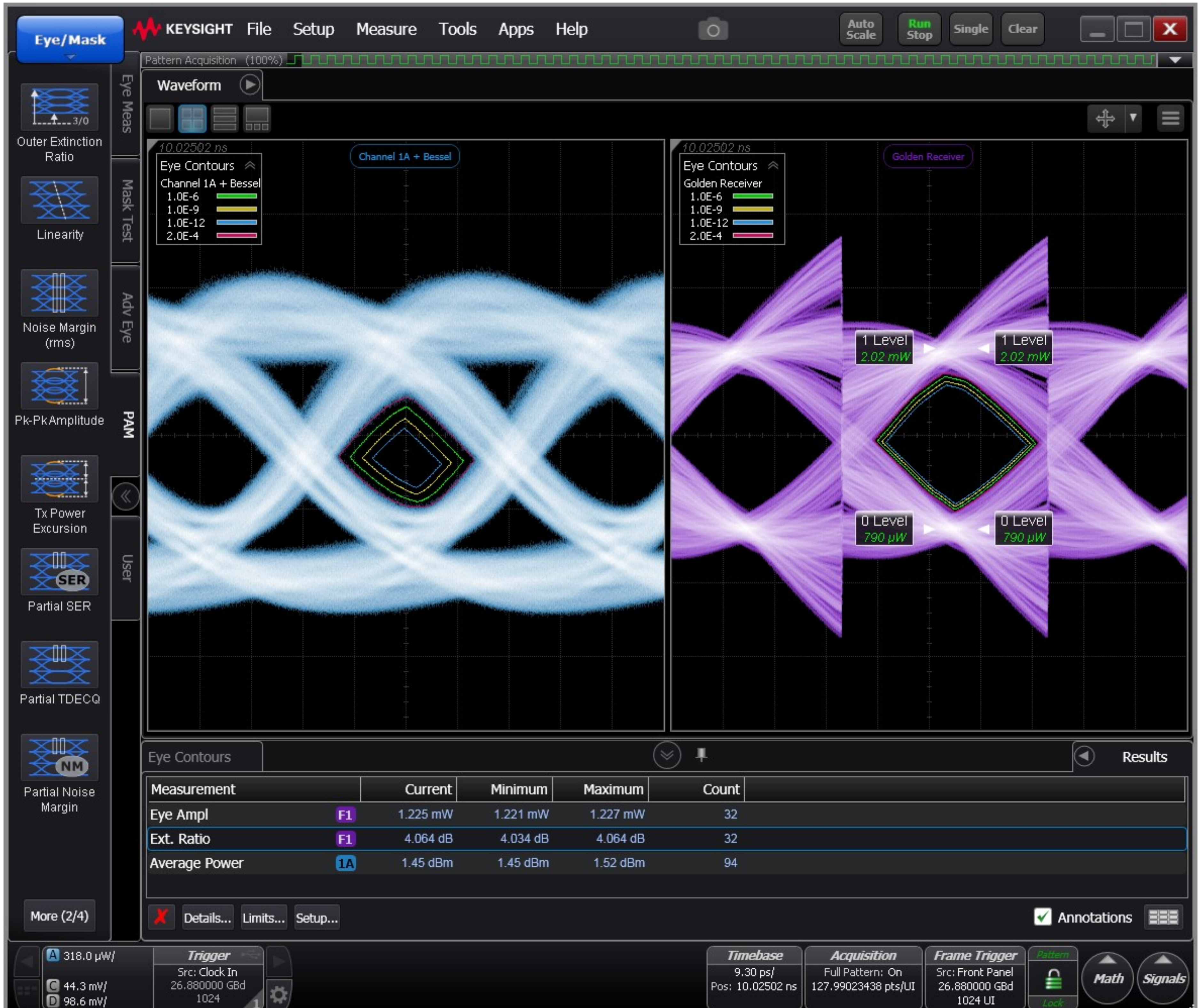
125°C, 53.76 Gb/s PAM4, Ibias 6mA, ER 4 dB



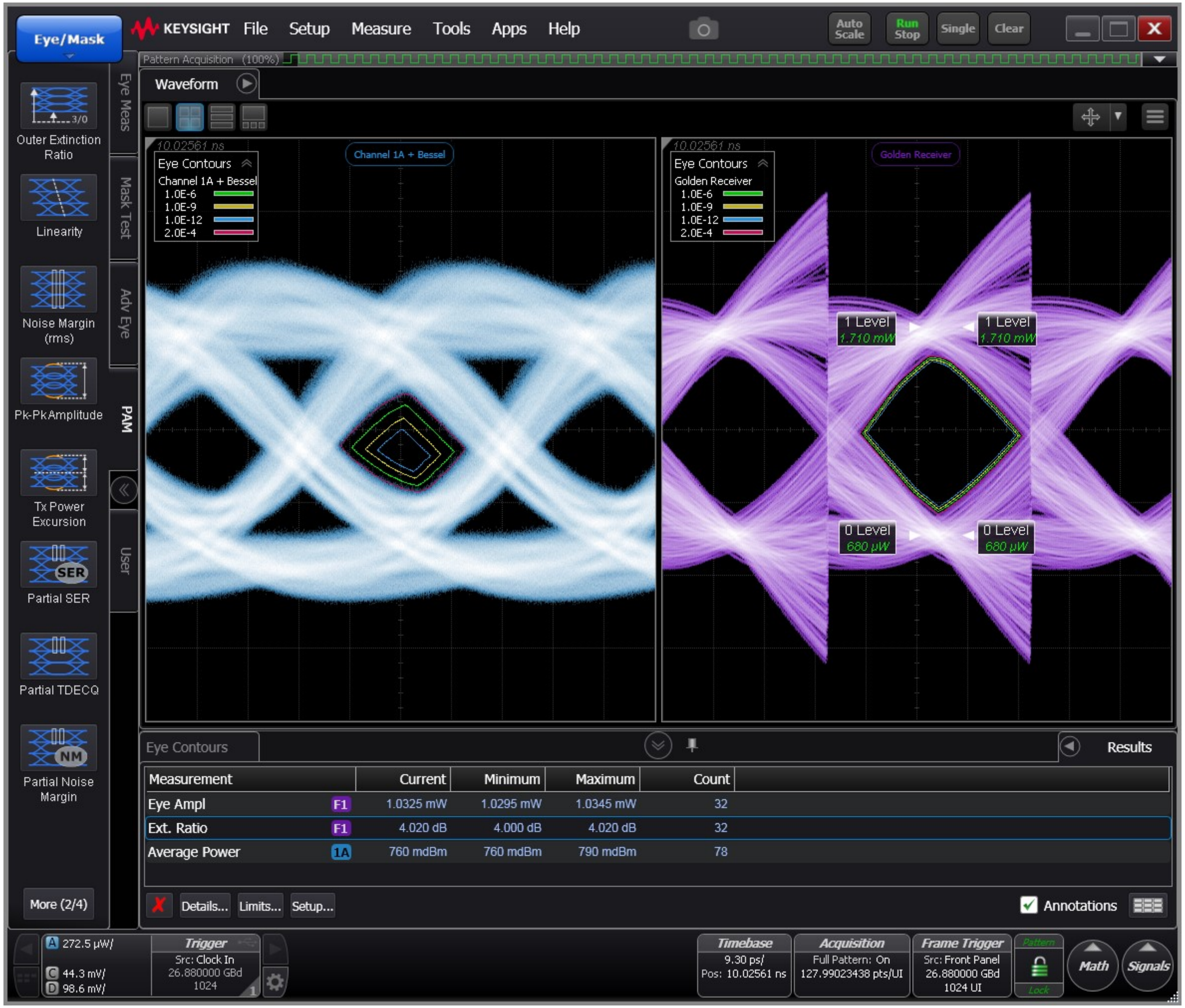
125°C, 53.76 Gb/s PAM4, Ibias 5mA, ER 4 dB



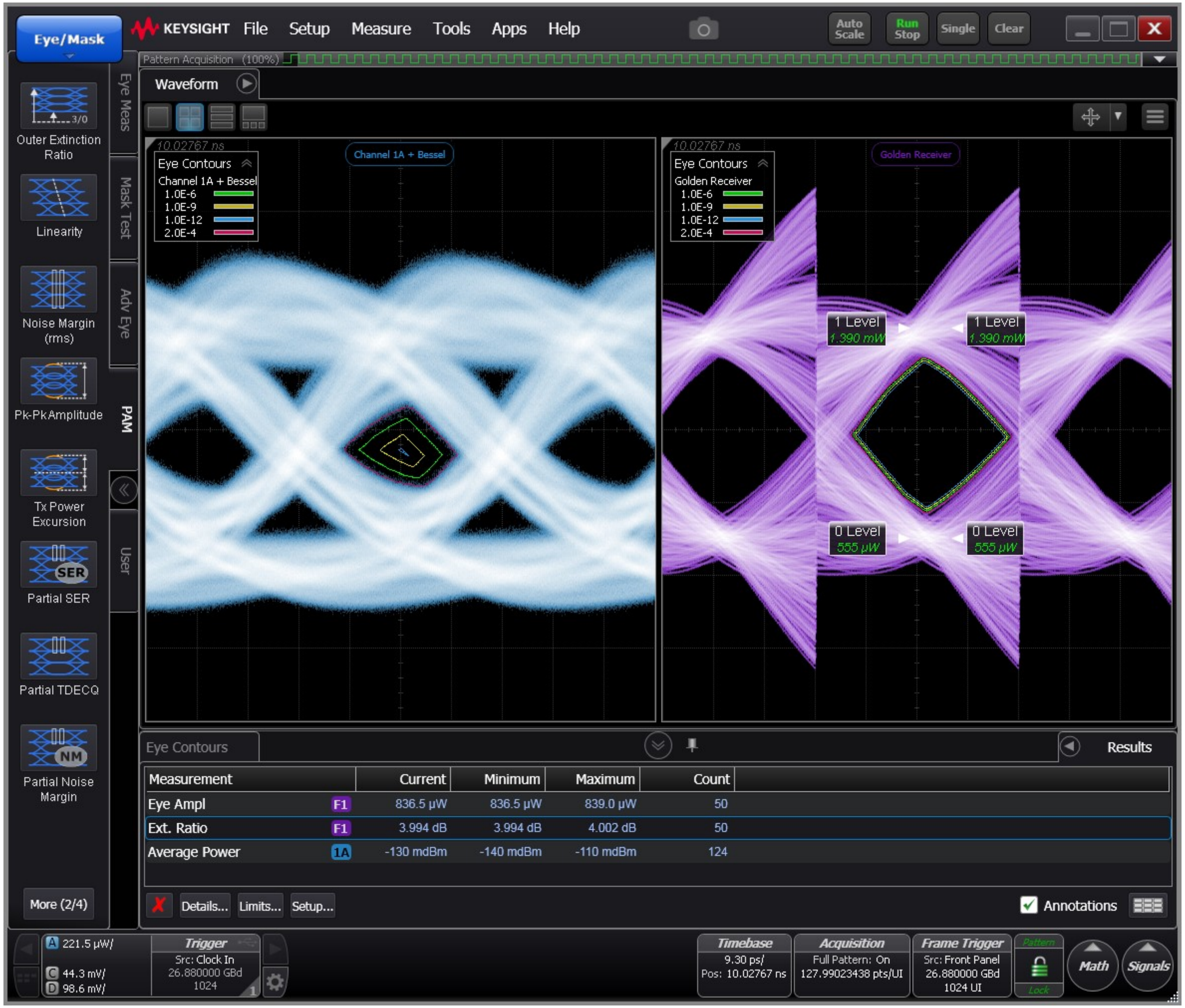
125°C, 26.88 Gb/s NRZ, Ibias 7mA, ER 4 dB



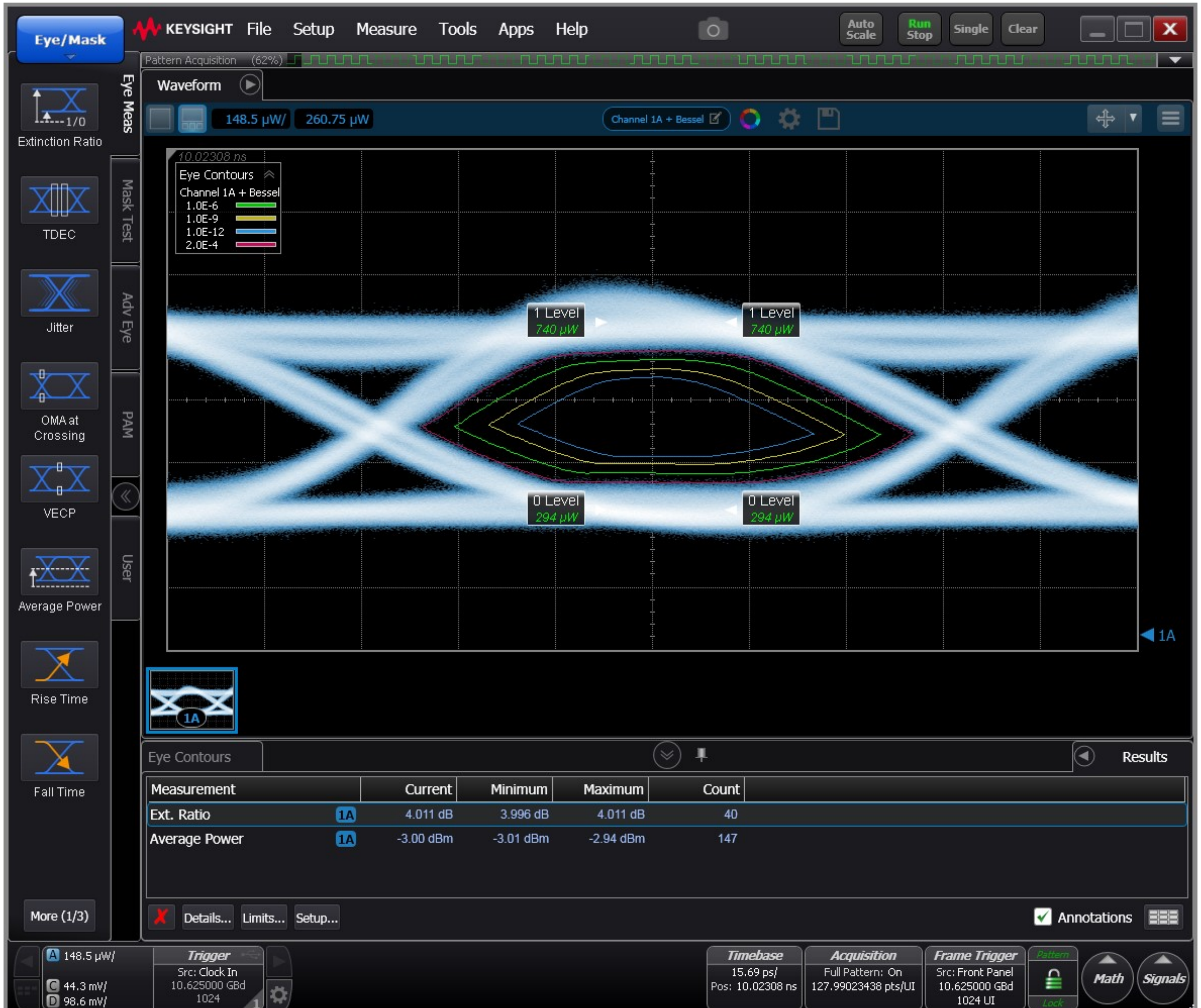
125ºC, 26.88 Gb/s NRZ, Ibias 6mA, ER 4 dB



125°C, 26.88 Gb/s NRZ, Ibias 5mA, ER 4 dB

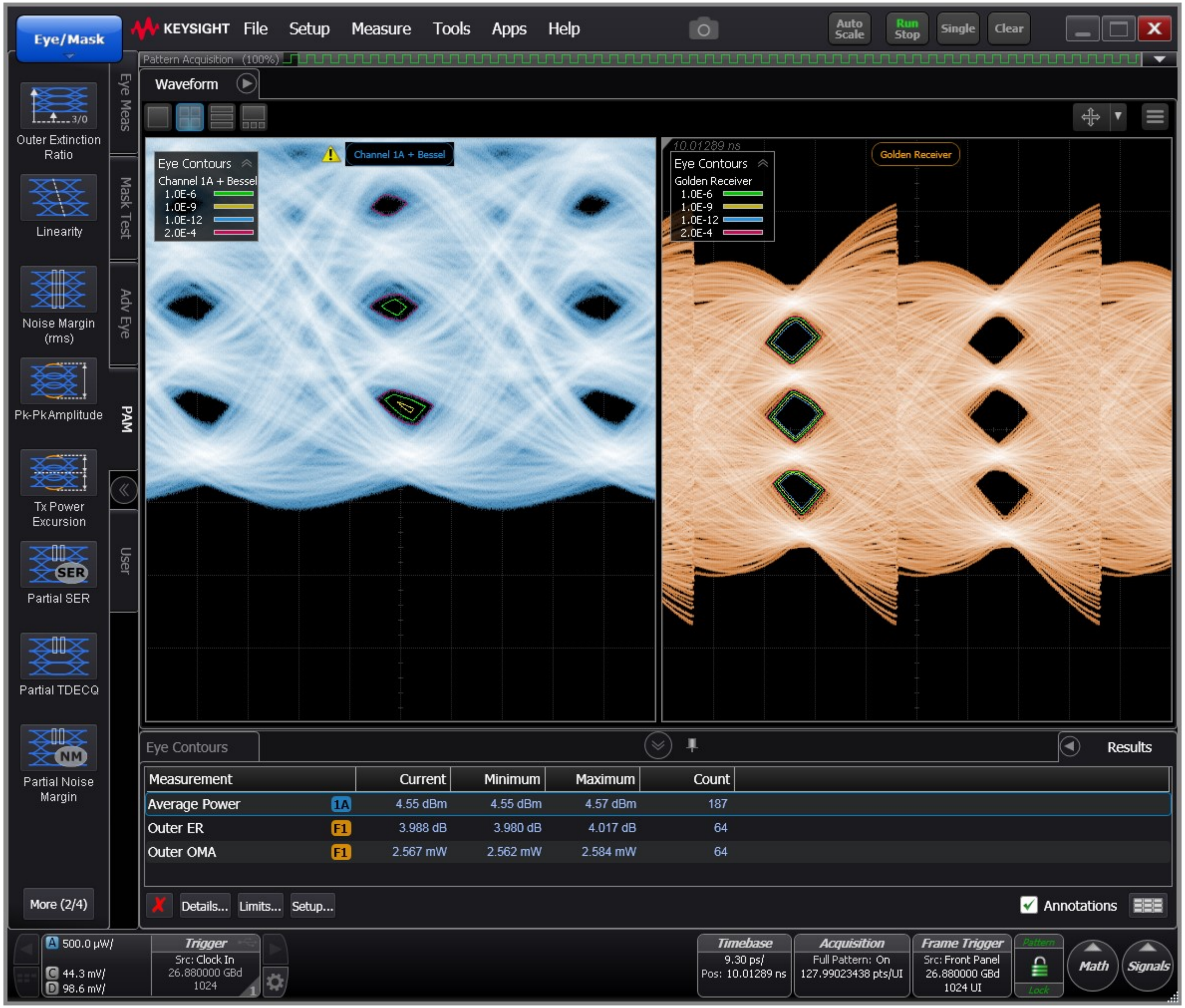


125ºC, 10.625 Gb/s NRZ, Ibias 3mA, ER 4 dB

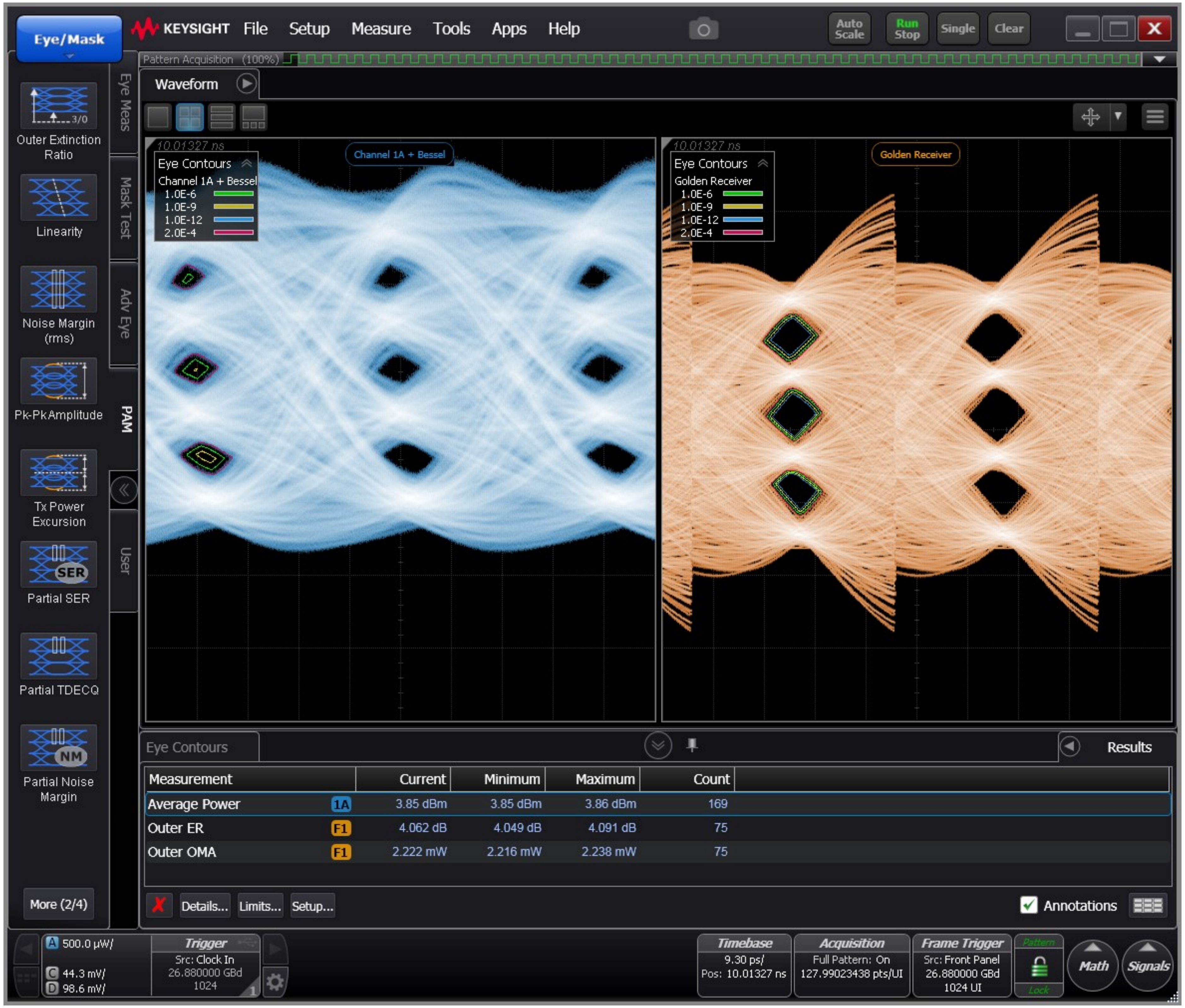


Real-time performance at -40ºC

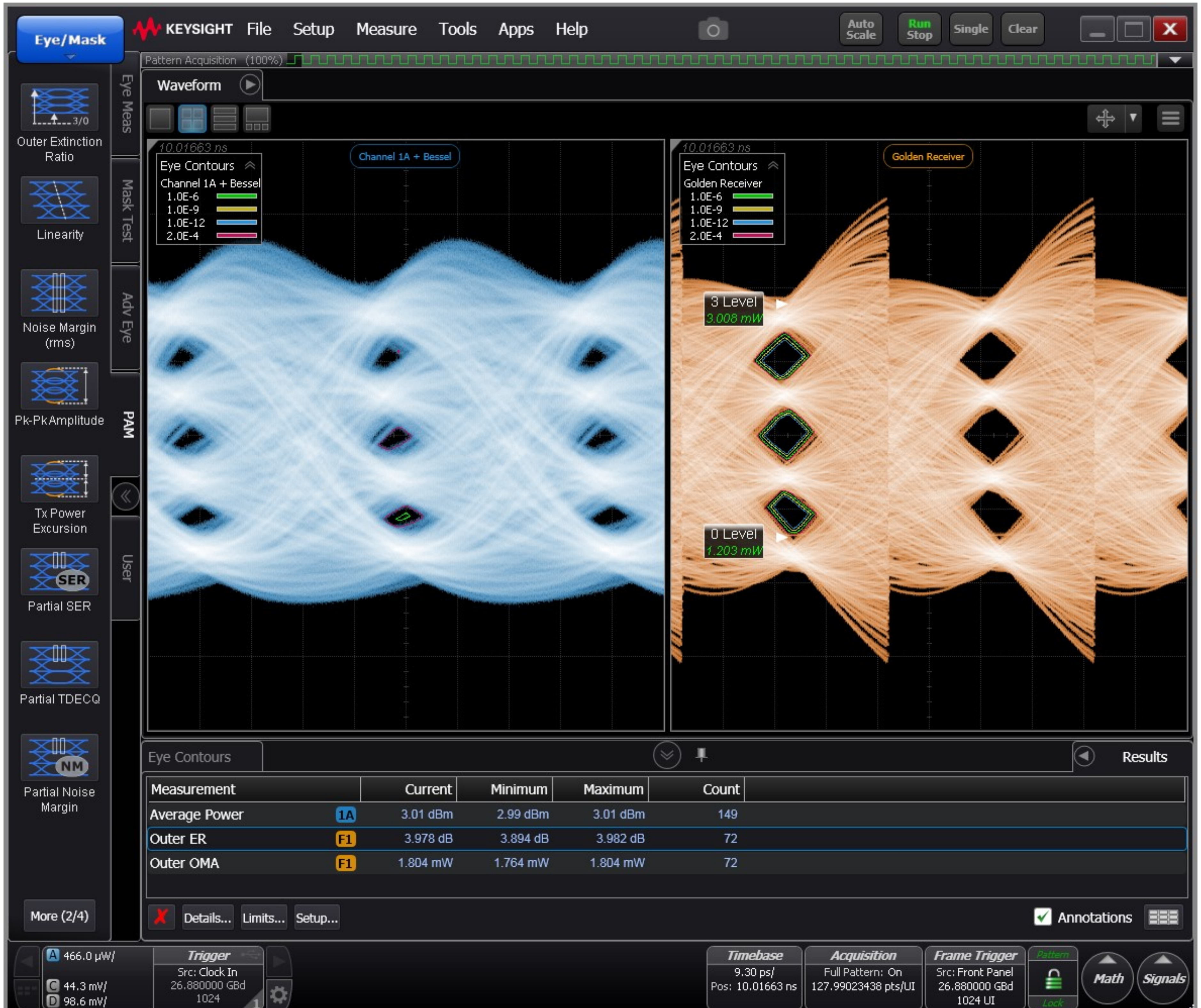
-40ºC, 53.76 Gb/s PAM4, Ibias 7mA, ER 4 dB



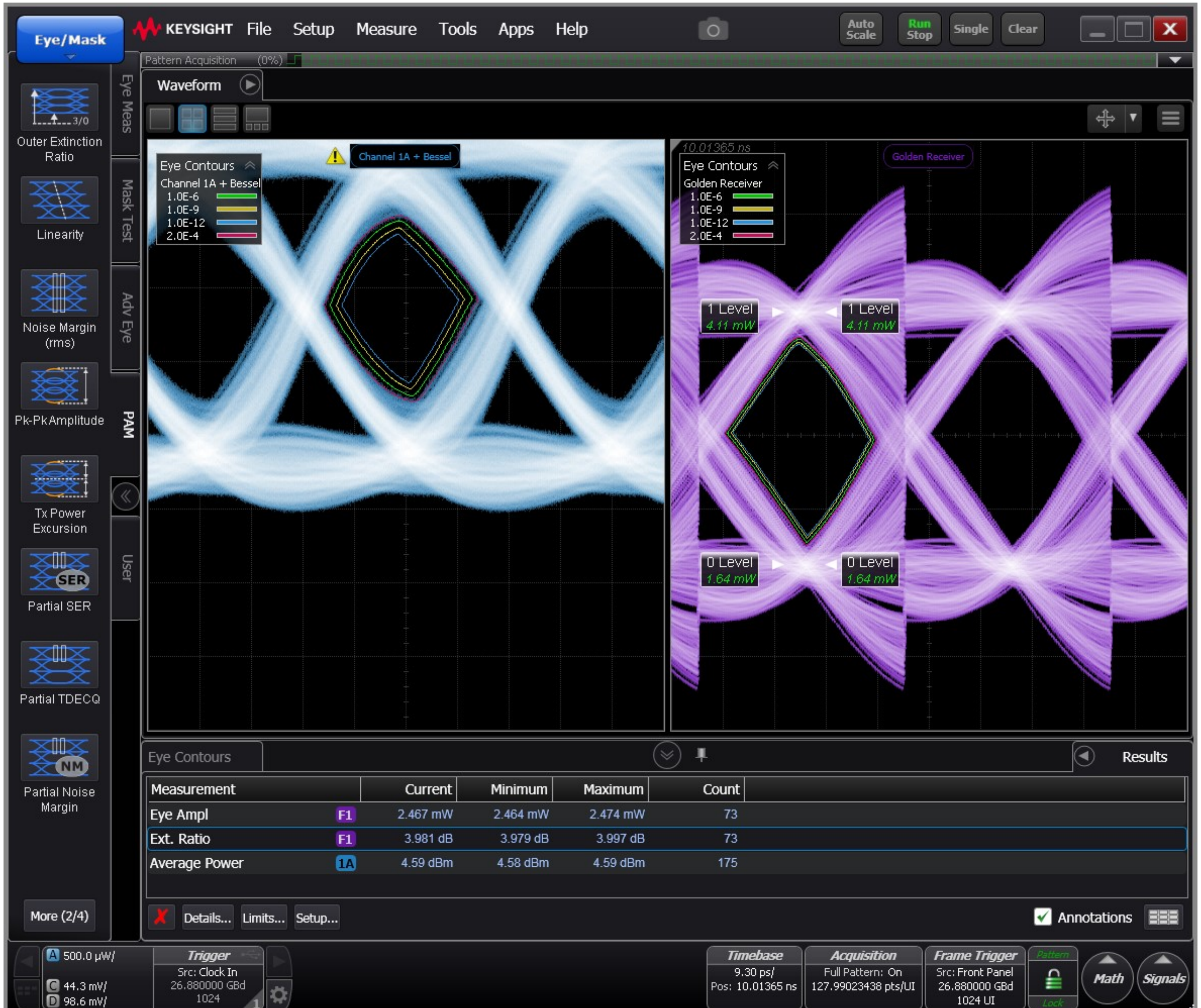
-40ºC, 53.76 Gb/s PAM4, Ibias 6mA, ER 4 dB



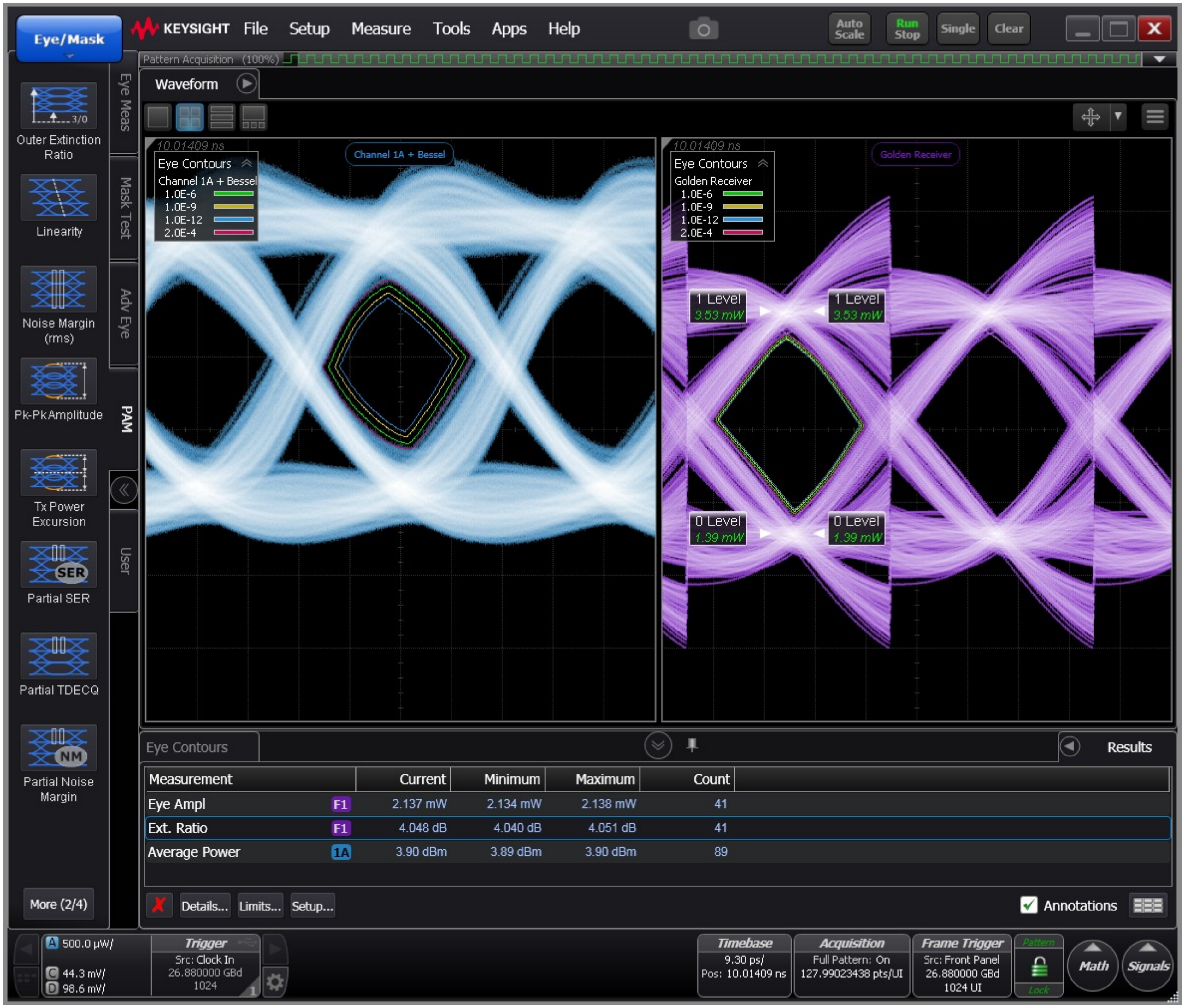
-40ºC, 53.76 Gb/s PAM4, Ibias 5mA, ER 4 dB



-40ºC, 26.88 Gb/s NRZ, Ibias 7mA, ER 4 dB

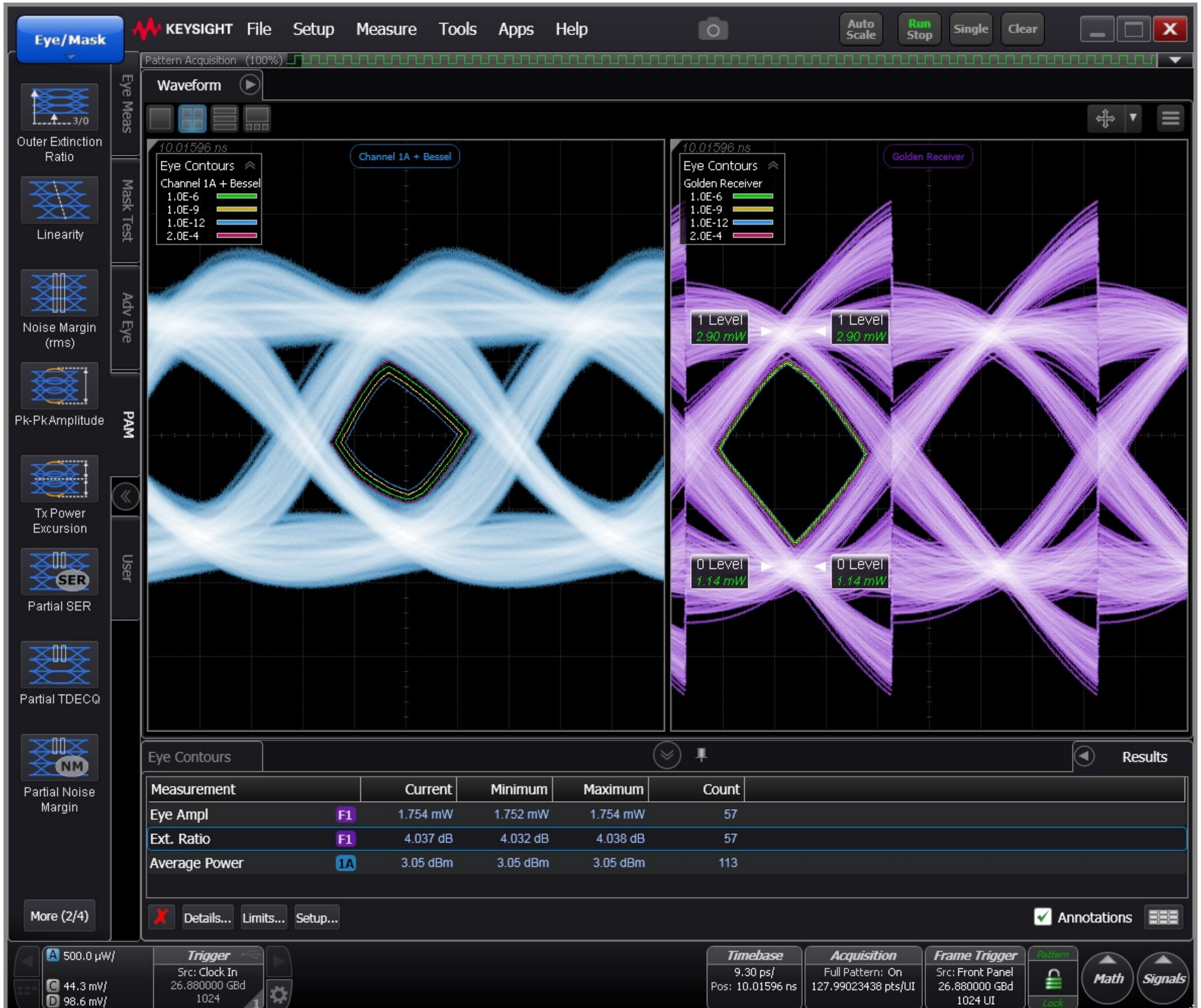


-40ºC, 26.88 Gb/s NRZ, Ibias 6mA, ER 4 dB

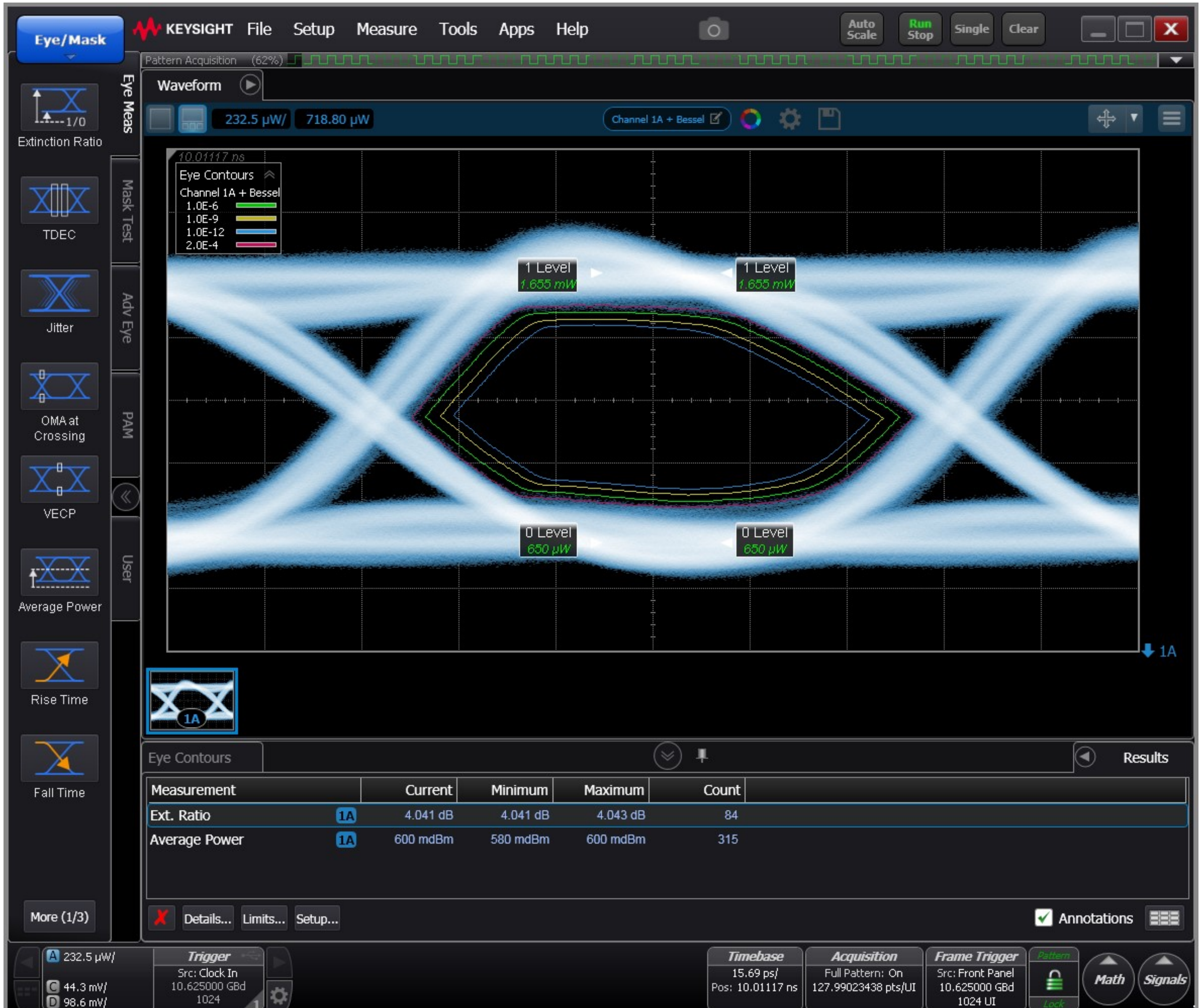


Measurement		Current	Minimum	Maximum	Count
Eye Ampl	F1	2.137 mW	2.134 mW	2.138 mW	41
Ext. Ratio	F1	4.048 dB	4.040 dB	4.051 dB	41
Average Power	1A	3.90 dBm	3.89 dBm	3.90 dBm	89

-40ºC, 26.88 Gb/s NRZ, Ibias 5mA, ER 4 dB



-40ºC, 10.625 Gb/s NRZ, Ibias 3mA, ER 4 dB



Conclusions

- A TRUMPF 980nm VCSEL was tested using 50 Gb/s PAM4, 25Gb/s NRZ and 10Gb/s NRZ real-time transmissions across extreme temperatures (from -40 to 125ºC backside temperature)
- The results demonstrate the superior speed and signal integrity of the 980nm VCSELs compared to 850nm VCSELs, which allow to reduce the transceiver complexity, power consumption and relative cost
- The results also demonstrate the superior RIN performance of the 980nm VCSELs compared to 850nm VCSELs, making posible to improve link budget for 50 Gb/s
- The reported results, together with the superior reliability and lower production cost, make the wavelength 980nm the right choice to meet the specific requirement of the 802.3cz project

References

- [1] R. Pérez-Aranda, “Test methods for VCSEL characterization,” July 2020, [Online], Available: https://www.ieee802.org/3/cz/public/jul_2020/perezaranda_OMEGA_01b_0720_VCSEL_test_methods.pdf

- [2] R. Pérez-Aranda, “50 Gb/s demonstration in extreme temperatures using 850nm VCSELs,” May 2021, [Online], Available: https://www.ieee802.org/3/cz/public/11_may_2021/perezaranda_3cz_01a_110521_50Gbps_850nm_demo.pdf

Thank you!