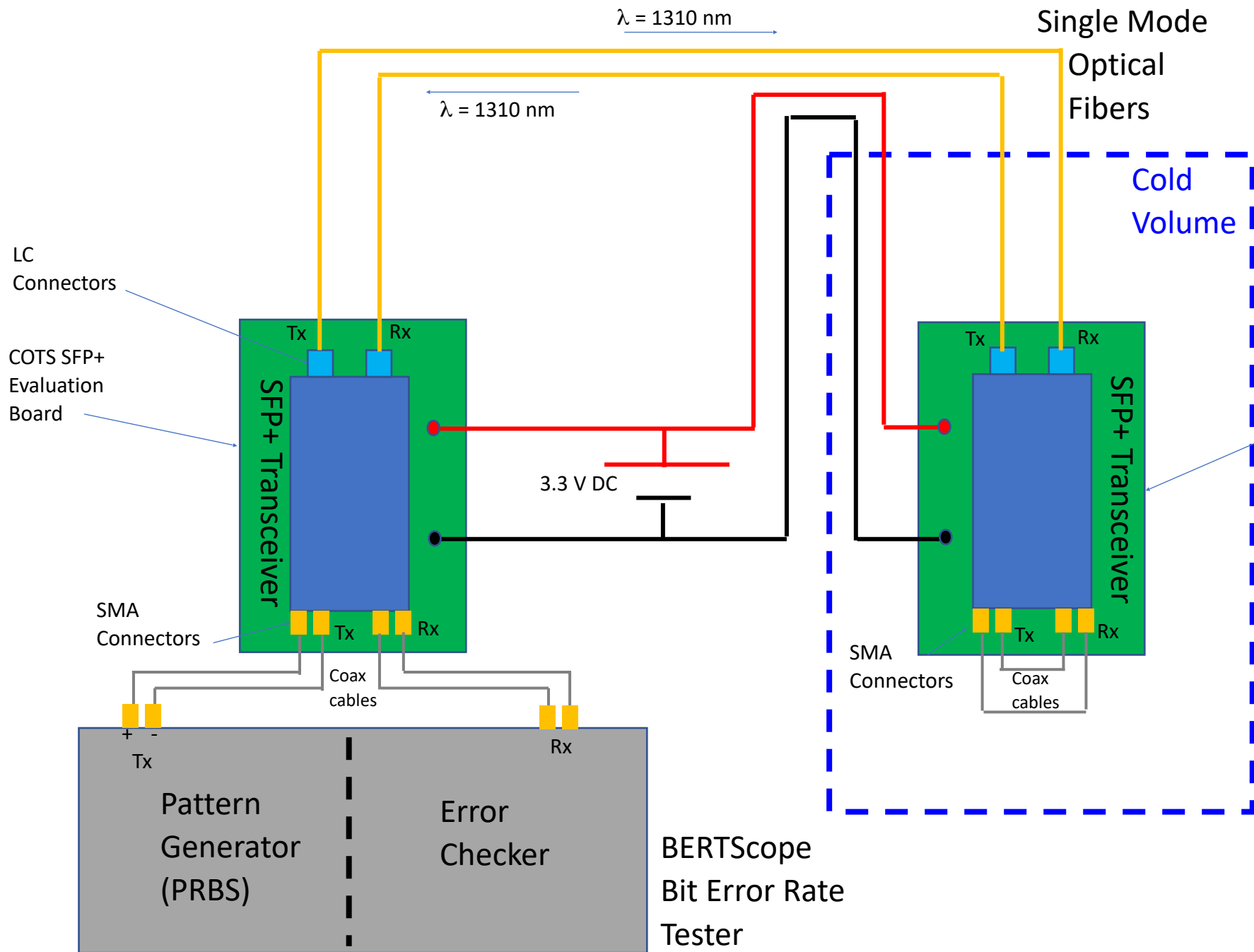


Optical Link and Component Testing

Alan G. Prosser

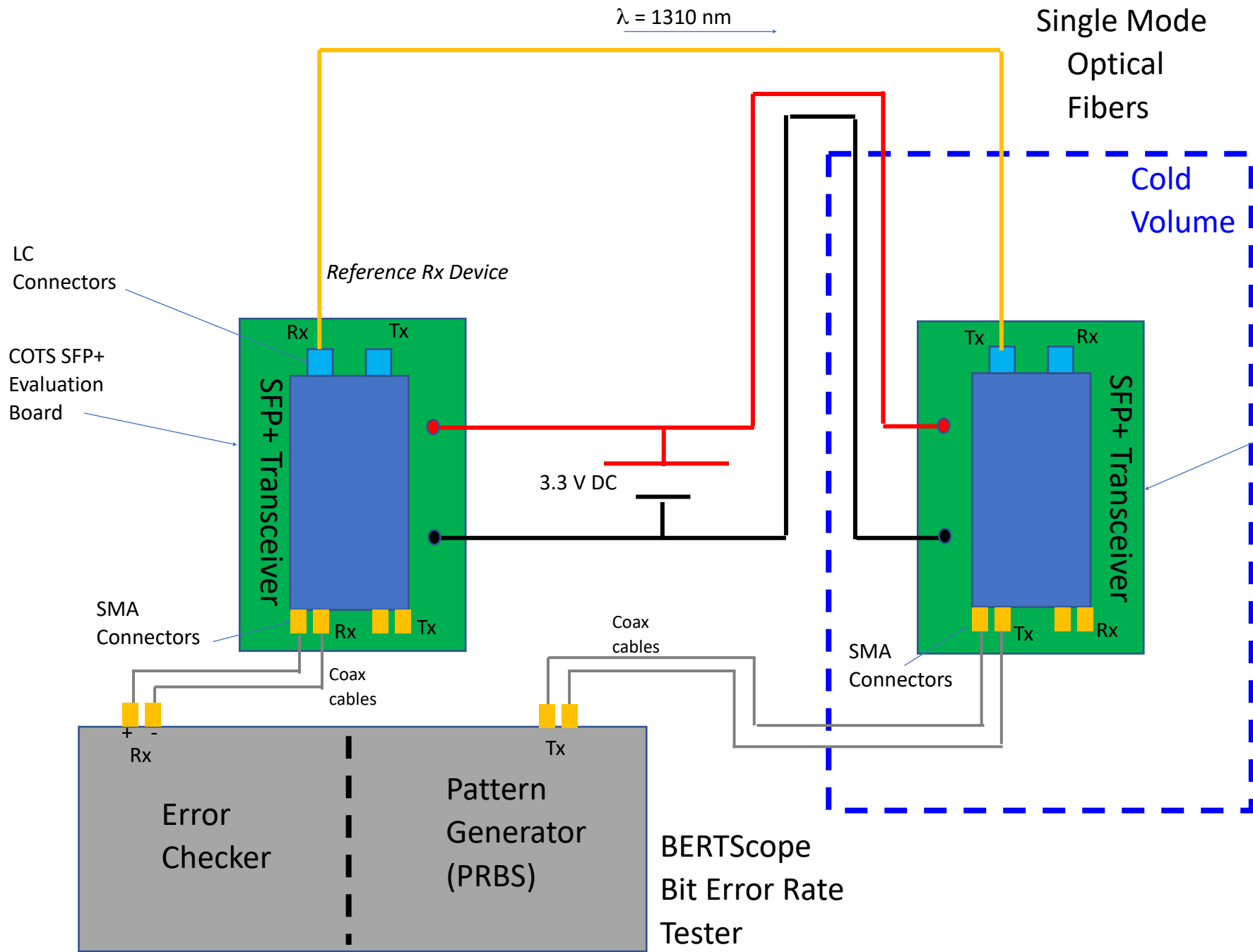
Feb. 3, 2021



In this configuration, the bit error rate performance of the system including the Device Under Test (DUT) within the cold volume can be measured.

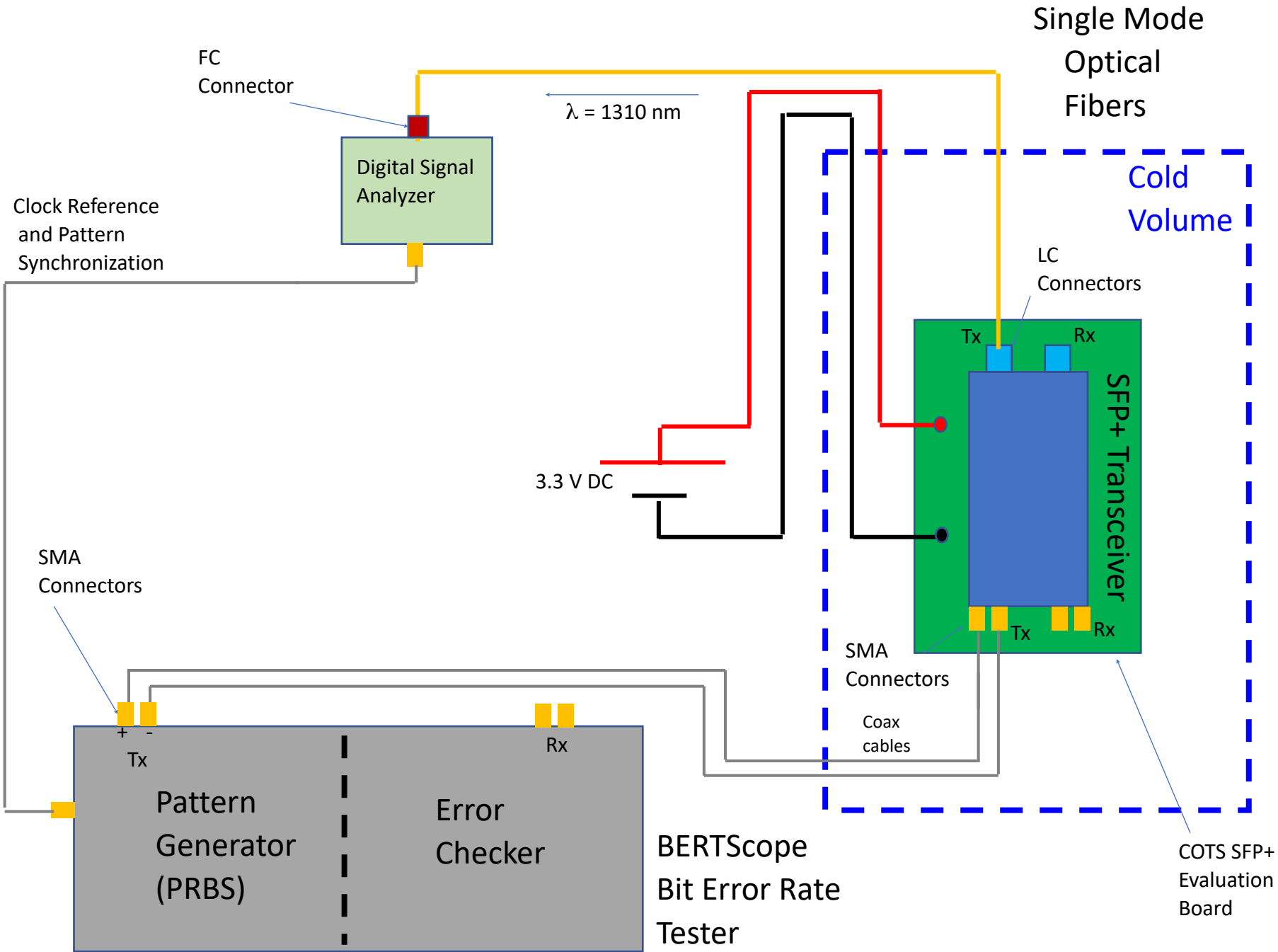
This approach has the drawback that the outgoing signal quality is dependent on the conversion properties of the receiver channel of the DUT.

It has the advantage of minimizing the external connections.



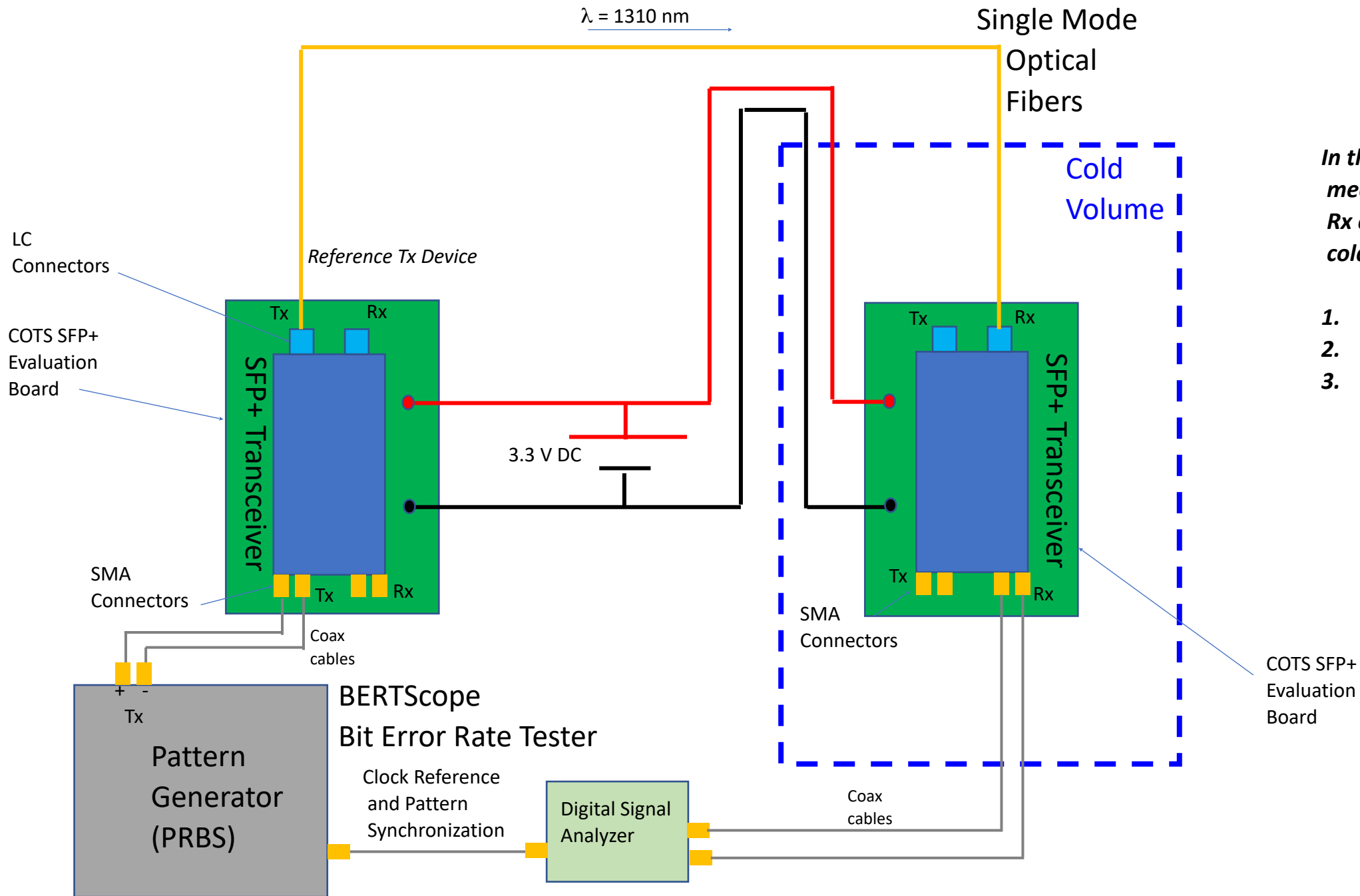
In this configuration, the bit error rate performance of the uplink including the Device Under Test (DUT) within the cold volume can be measured.

This approach more faithfully represents an upstream link



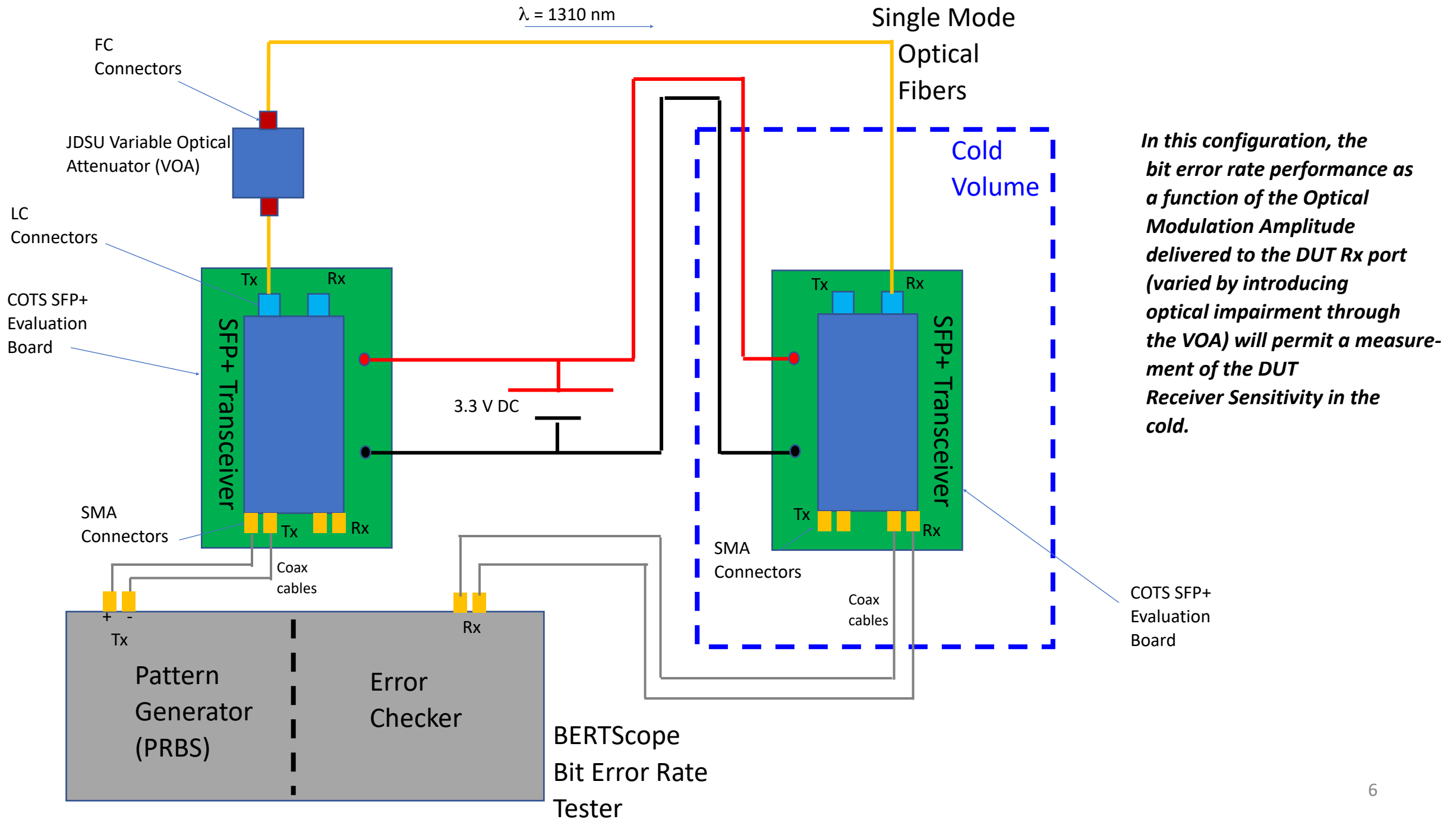
In this configuration, measurements of the DUT Tx optical signal can be obtained including:

- 1. OMA**
- 2. Extinction Ratio**
- 3. Eye Height**
- 4. Rise and Fall Times**
- 5. Deterministic Jitter**
- 6. Total Jitter**

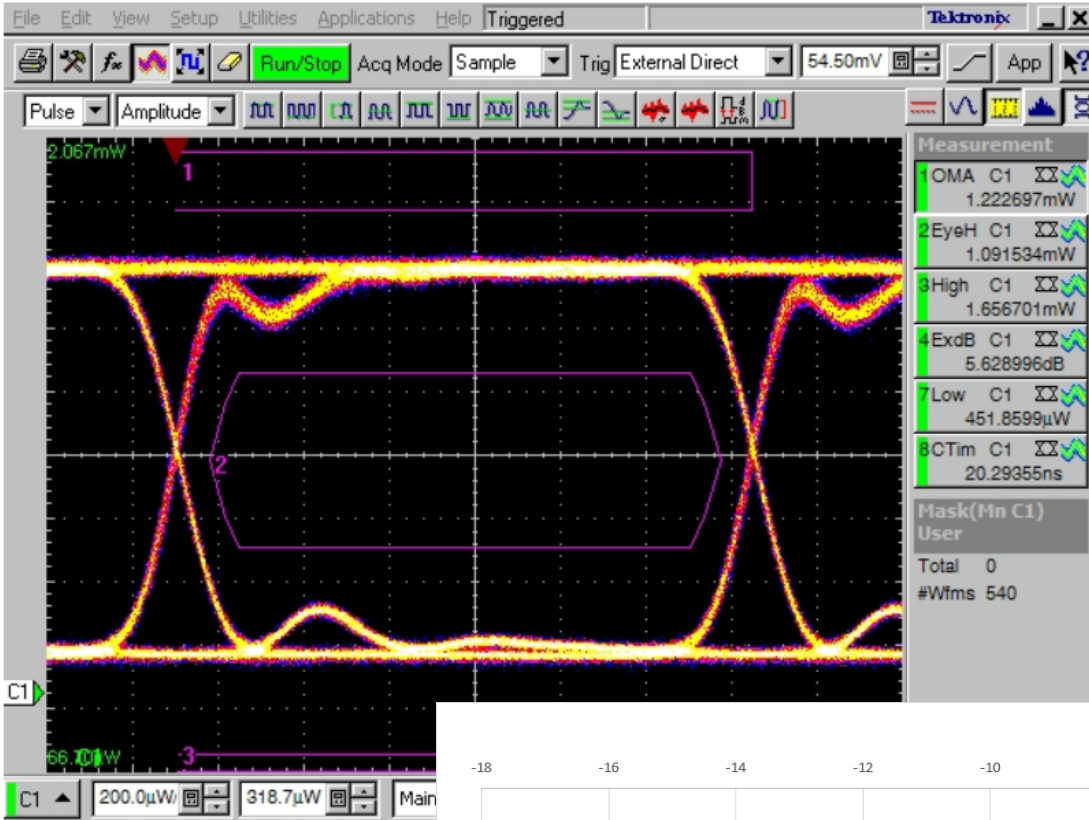


In this configuration, measurements of the DUT Rx channel eye in the cold can be made including:

- 1. Rise and fall times**
- 2. Eye amplitude**
- 3. Deterministic and total jitter**



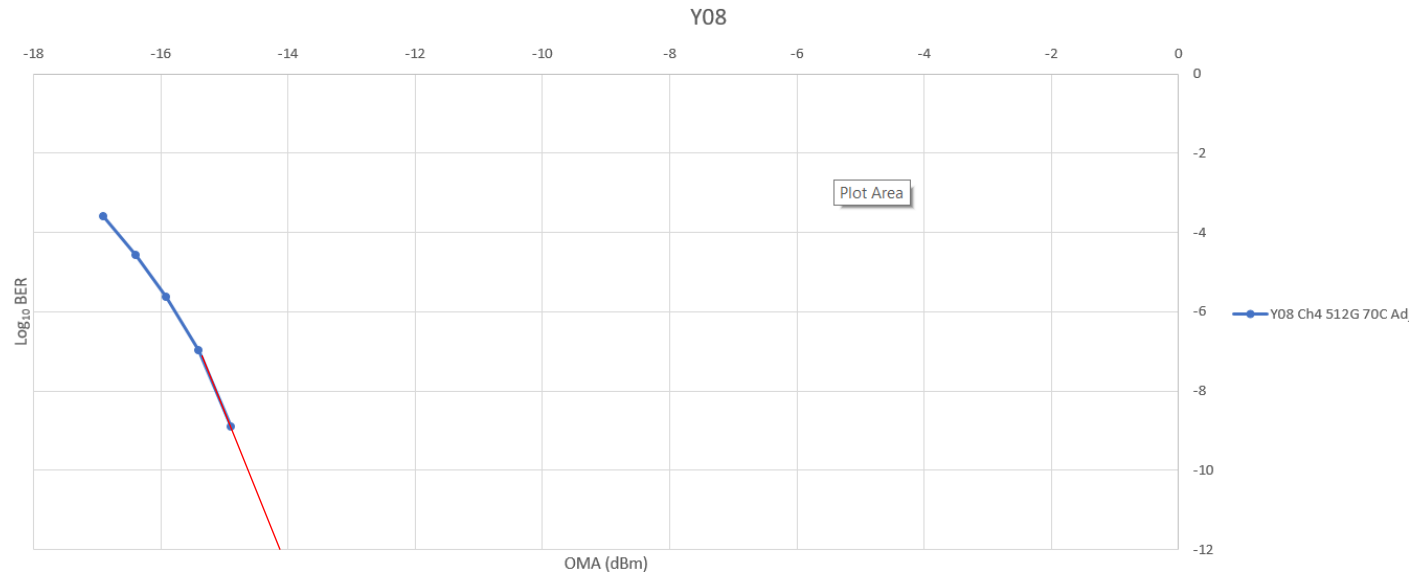
Eye Pattern Measurements (Optical and Electrical)



Jitter Composition Measurements (Optical and Electrical)



Rx Sensitivity Measurements



The characteristics of the transmitter optical eye (Optical Modulation Amplitude, Eye Opening, Extinction Ratio, Rise and Fall Times, Deterministic Jitter Transfer, Total Jitter Transfer) are valuable measures by which we can see what might be degrading (if anything) in the cold. There are specs on these values from the vendors (usually designed to be compliant with some transmission specification such as IEEE802.?) and, if the devices remain with those specs, you can be confident that other components (outside the cold) will operate compatibly with them. Of course, if they don't remain within specs, I doubt any commercial vendor will be concerned as liquid argon temperatures lie outside the range of their operating environment.

Once we have determined that devices seem to operate satisfactorily on a short time scale, as noted by others, reliability testing will be warranted.

On the other hand, if the devices do not operate satisfactorily, then it might be necessary to understand what specifically has failed or degraded. Is it the laser diode, is it the laser diode driver, is the optical alignment impaired in some way? This is a much more difficult path but if optical transmission of this sort is desired, it might be worth pursuing. The Versatile Link and Versatile Link Plus projects (led by CERN for ATLAS and CMS optical links) has done just this and identified and designed custom miniature multichannel transmitters and receivers able to operate in high radiation and magnetic field environments. Perhaps a program of that sort is in the future for DUNE as well.