



A New Generation of Coherent ULH Fiber-Optic Communication

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Outline

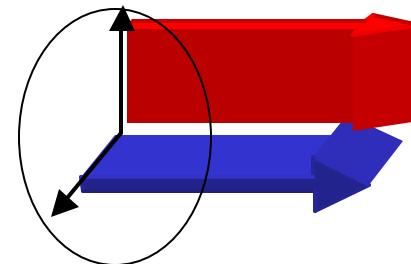
- Introduction
- Architecture
- Components
- Simulations
- Summary

Why Coherent Communication

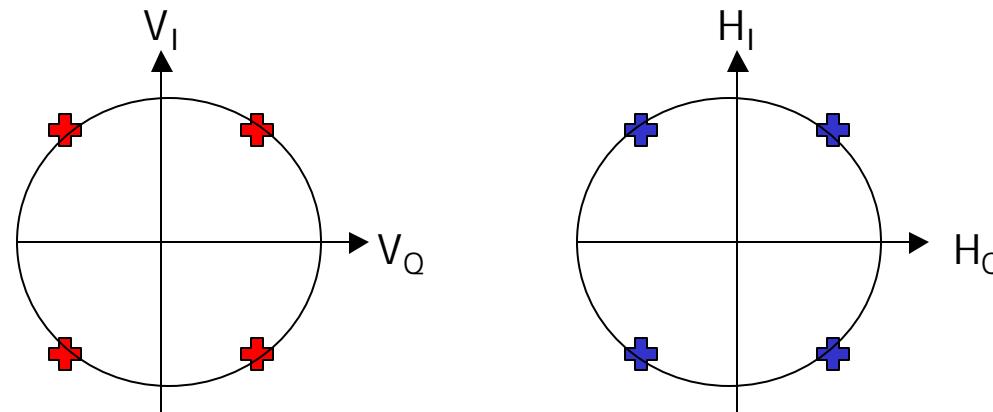
- Utilizes 10 G technology to achieve 40 G (20 G or 10 G) ULH systems
 - Operates on existing or new fiber plants
 - Facilitates flexible optical provisioning
- Requires less SNR
 - Longer reach
- Narrower spectrum for same data rate:
 - Robust to fiber impairments
 - Up to 1.6 bit/s/Hz
- Mitigates fiber nonlinear effects

Polarization Multiplexed QPSK Modulation

- Symbol transmitted in 2 orthogonal linear polarizations



- 2 bit/symbol QPSK in each polarization



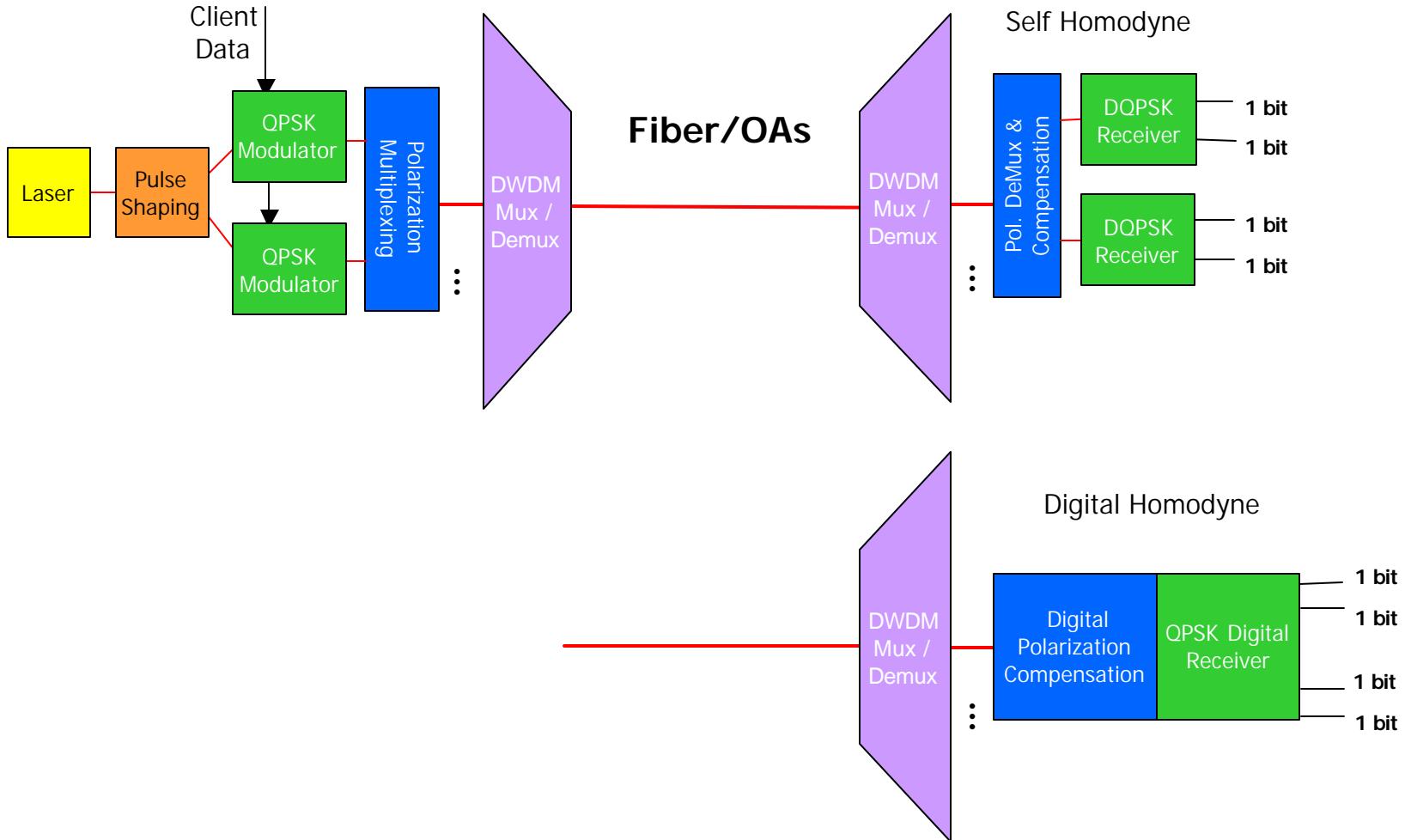
Total: 4 bits/symbol

4 bits/symbol - Narrower Spectrum

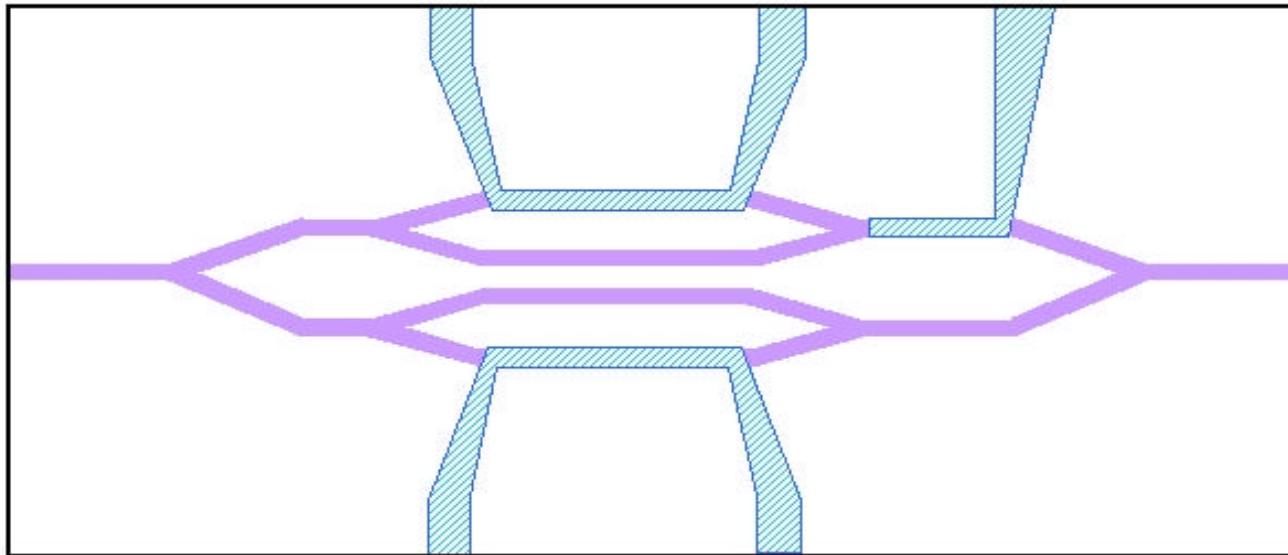
- Less exposure to fiber impairments:
 - Polarization mode dispersion
 - Residual chromatic dispersion, etc.
- Relaxed component requirements:
 - Reduced bandwidth



Coherent System Architectures



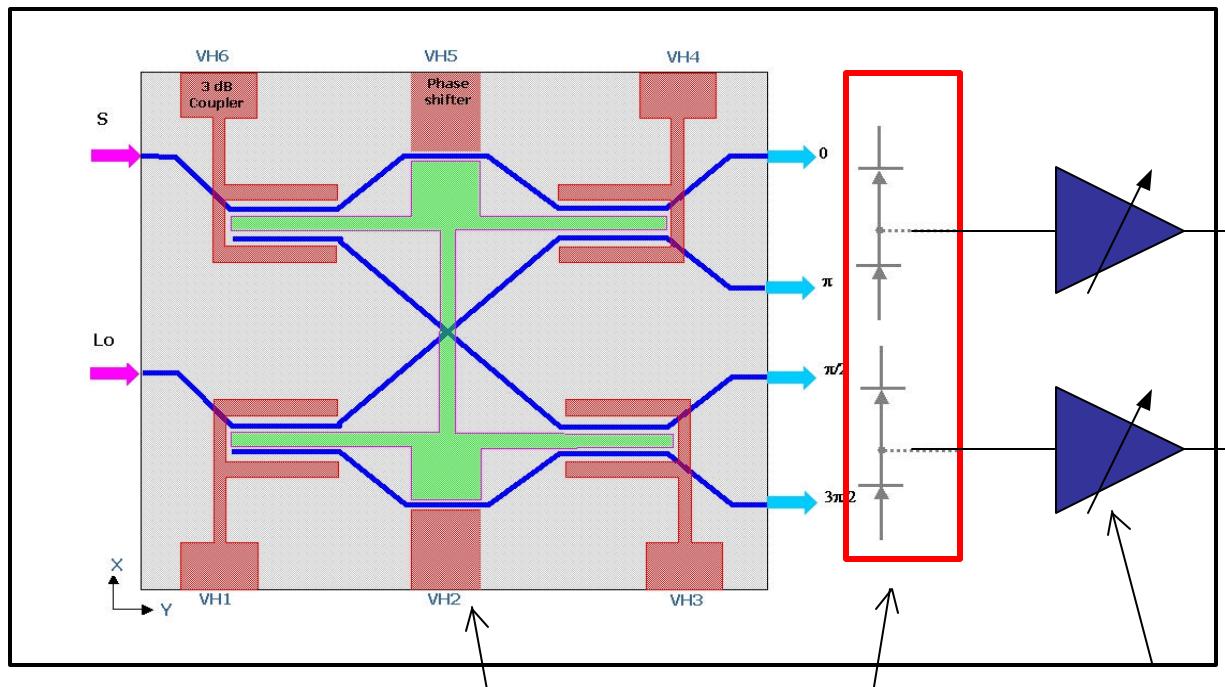
LiNbO₃ Integrated Quadrature Modulator



Features:

- Design optimized for 10 Gsymbol/s Quadrature Phase Shift Keying (QPSK) modulation (20 Gbit/s).
- Ti:LiNbO₃ diffused modulator technology.
- Dual Mach-Zehnder (MZ) configuration on single chip.
- Each MZ has 20Ghz bandwidth.
- 50 Ohm RF drive impedance.
- Separate external DC bias capability integrated on chip eliminates need for external bias "T".
- Additional DC bias input for quadrature phase difference between the two MZ arms.
- In package TEC and thermistor for temperature control and monitoring.

Integrated Single Polarization Quadrature Receiver



Balanced 90°
optical hybrid

Photo
detector
diode
array

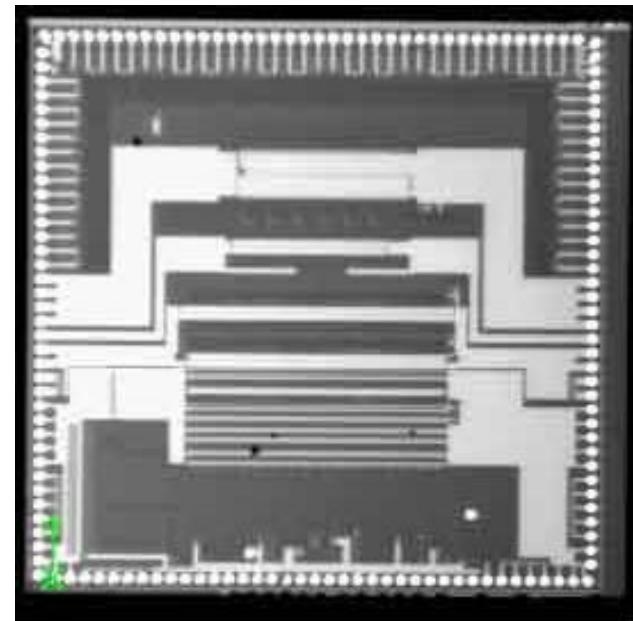
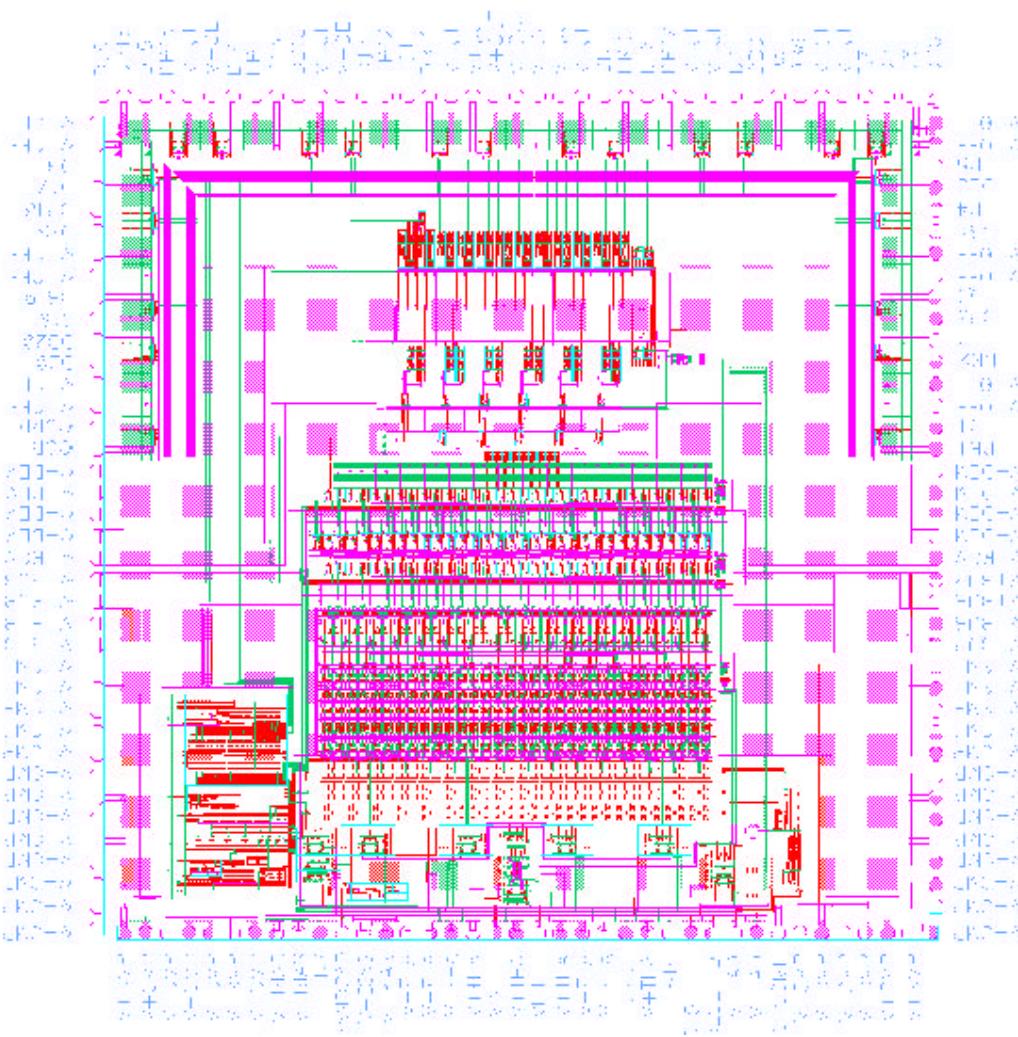
Trans-
impedance
amplifier

Optical Hybrid

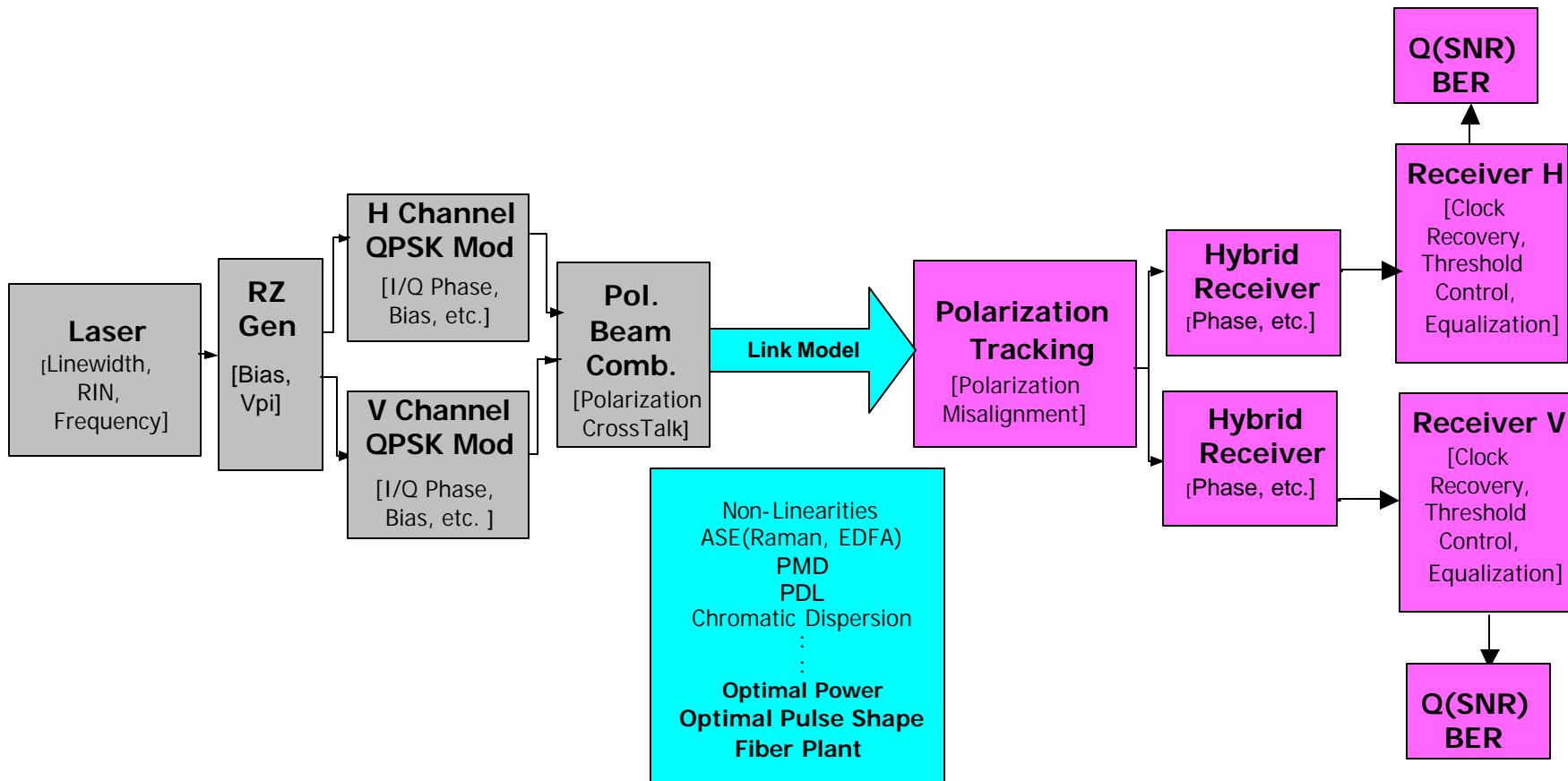


Produced at CeLight R&D Fab

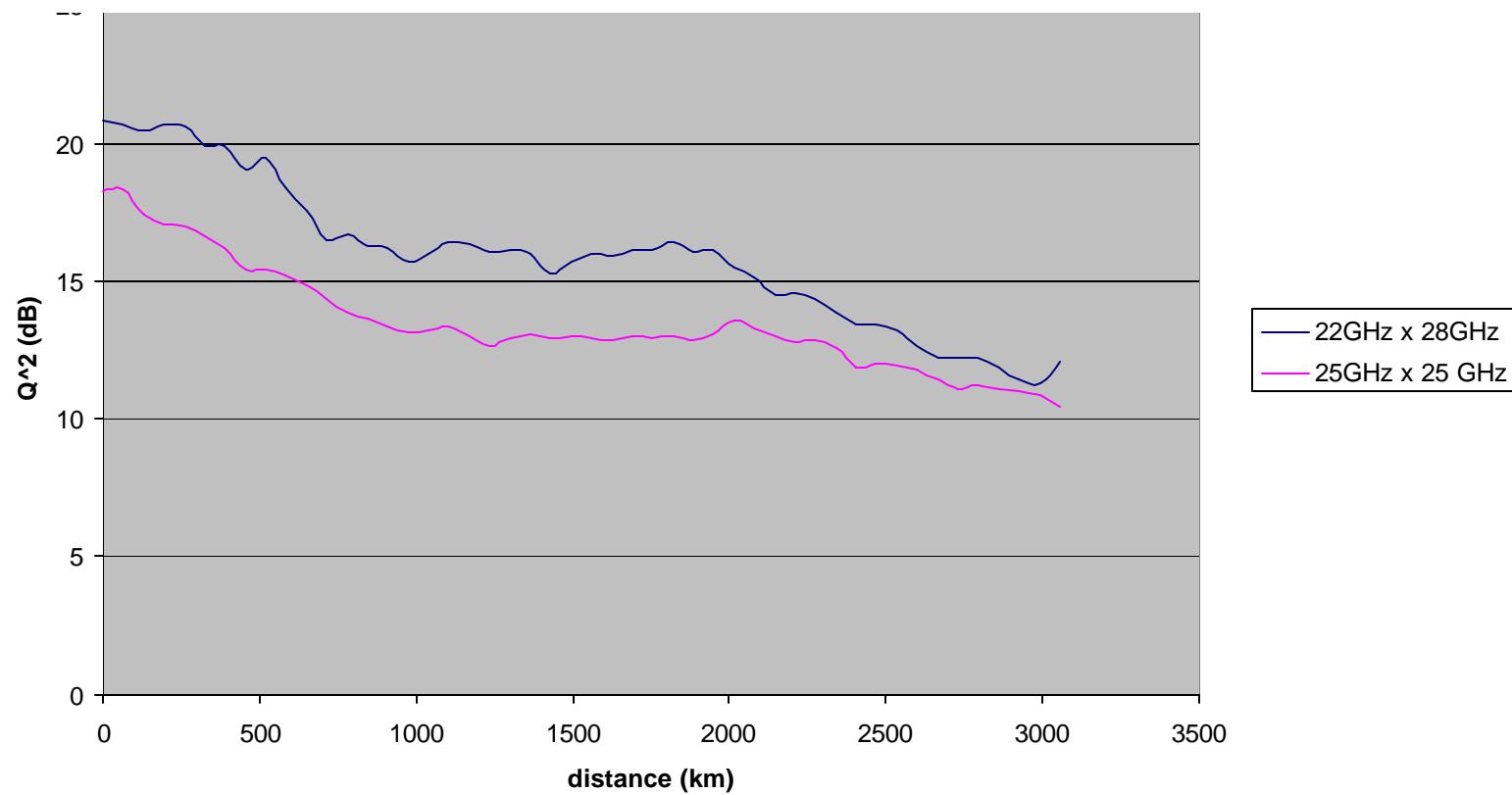
ADC Digital Receiver Front End Prototype



Coherent System Model

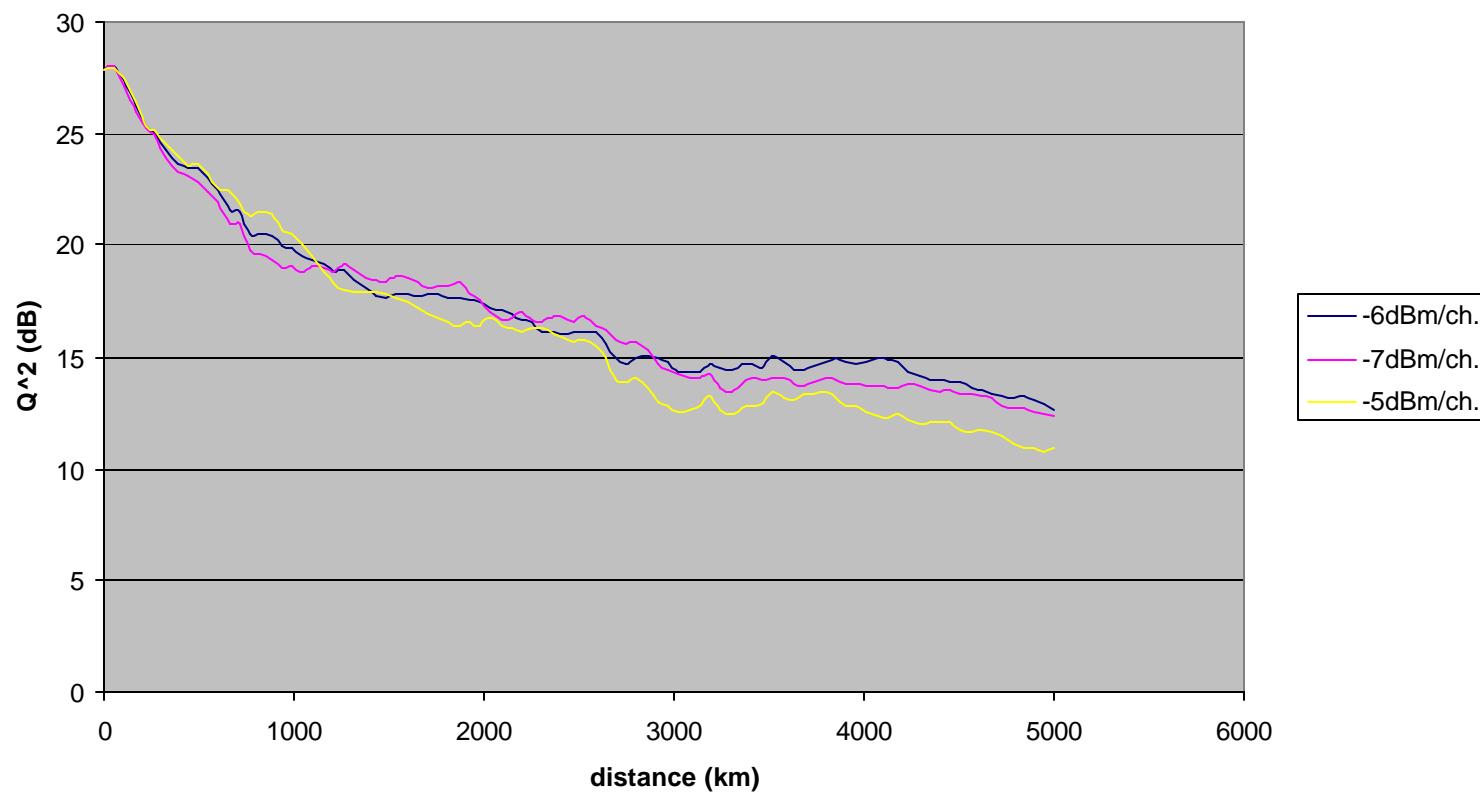


New Fiber Plant (Submarine) Simulation Results



- 2 Polarization DQPSK, 10.7 Gsymbols/s, 42.8 Gb/s
- 1.6 bit/s/Hz Spectral Efficiency
- 65 Km Amplifier Spacing

Existing Fiber Plant (Submarine) Simulation Results



- 1 Polarization DQPSK, 10.7 Gsymbols/s, 21.4 Gb/s
- 0.8 bit/s/Hz Spectral Efficiency
- 55 Km Amplifier Spacing

Summary

A New Generation of Coherent ULH Fiber-optic Communication

With the Benefits of:

- High Spectral Efficiency
- Long Distance
- Flexible Optical Provisioning
- Operation Over Existing or New Fiber Plants

40 G – Really !