Soliton Research at the Lightwave Communication Systems Laboratory

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University of Kansas
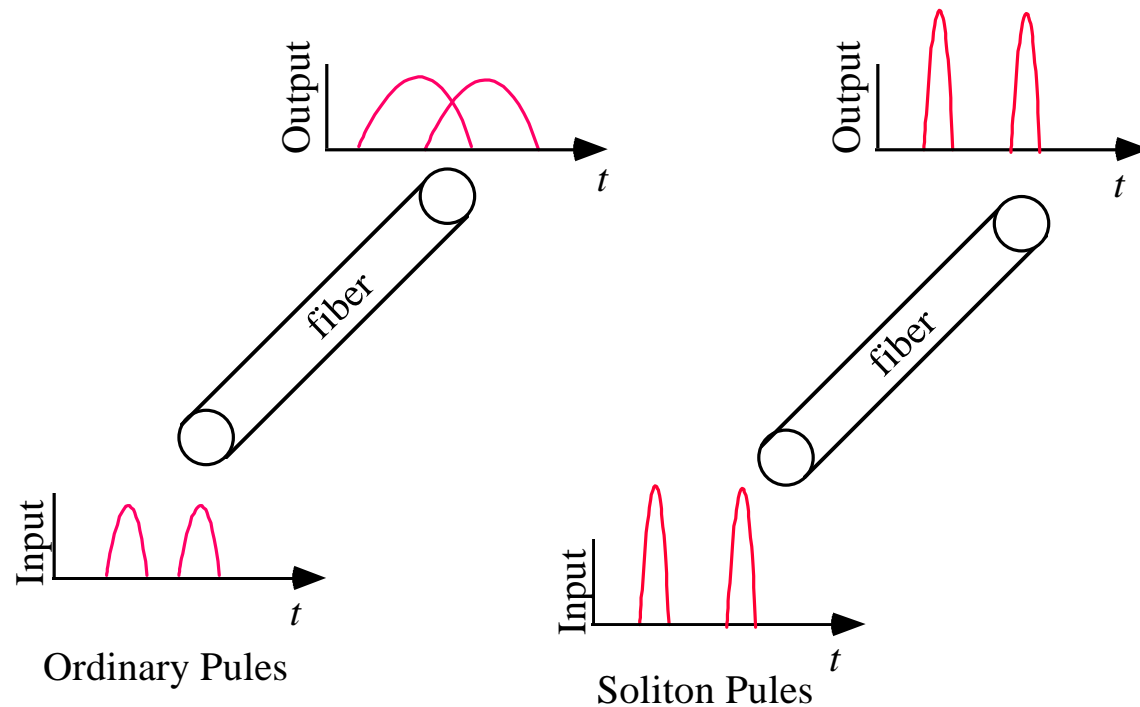
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Telecommunication
Technology Center
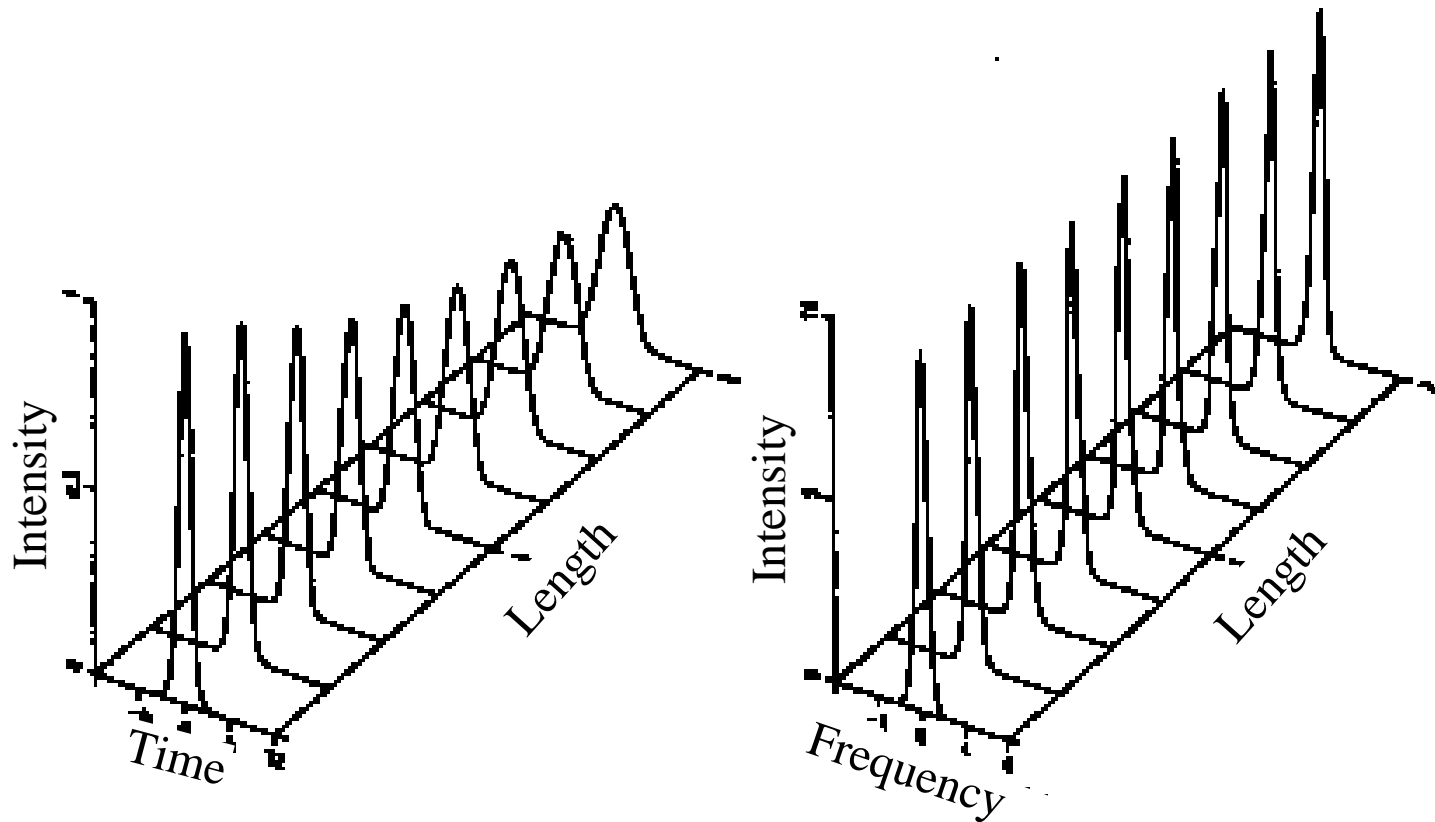
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Summary

- **Introduction to optical solitons**
- **The KU soliton generator**
- **The KU recirculating loop**
- **Preliminary soliton transmission results**
- **Summary and suggestion for future work**

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Optical Solitons

An optical soliton is a short, high-amplitude an optical pulse that does not spread as it propagates

Ordinary Pules

Soliton Pules

Information and
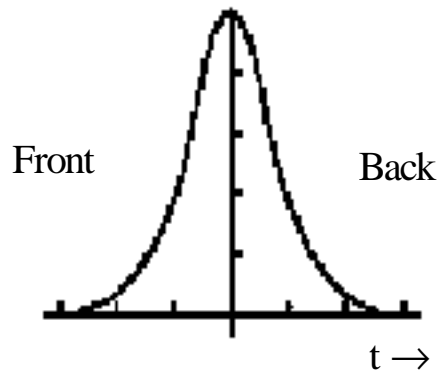Telecommunication
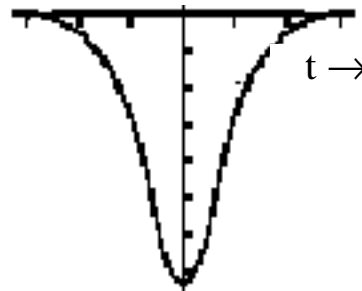Technology Center

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Linear, Dispersive Fiber

Kerr Effect and Chirp

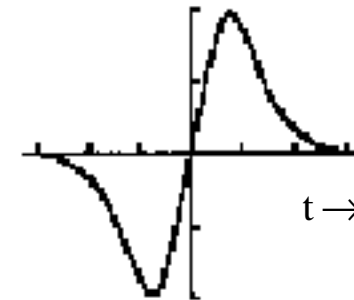Amplitude Profile

Kerr Phase

Instantaneous Frequency

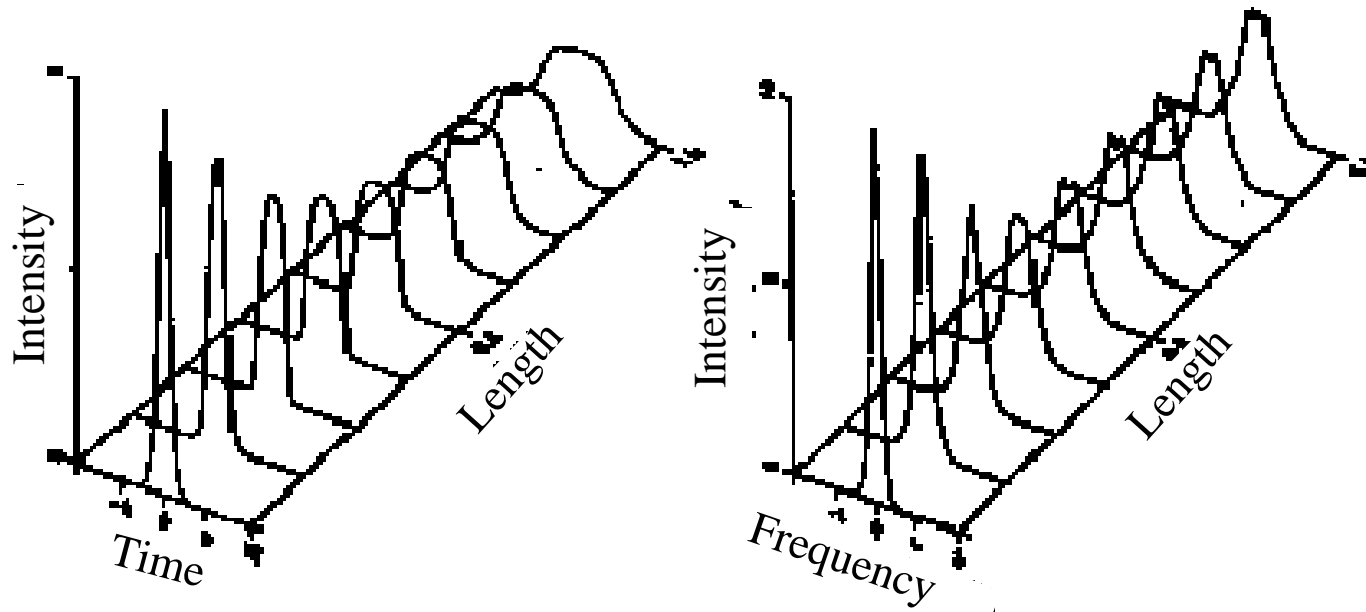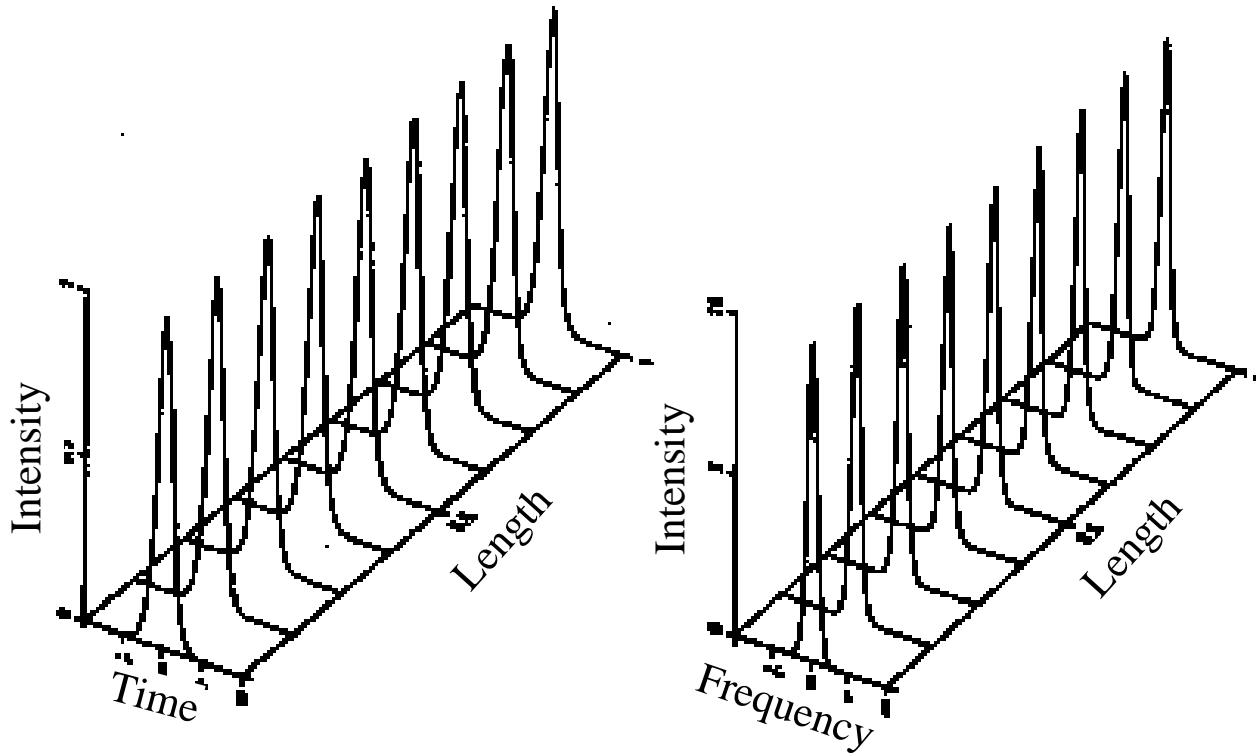Front

Back

t →

t →

t →

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Nonlinear, Nondispersive fiber
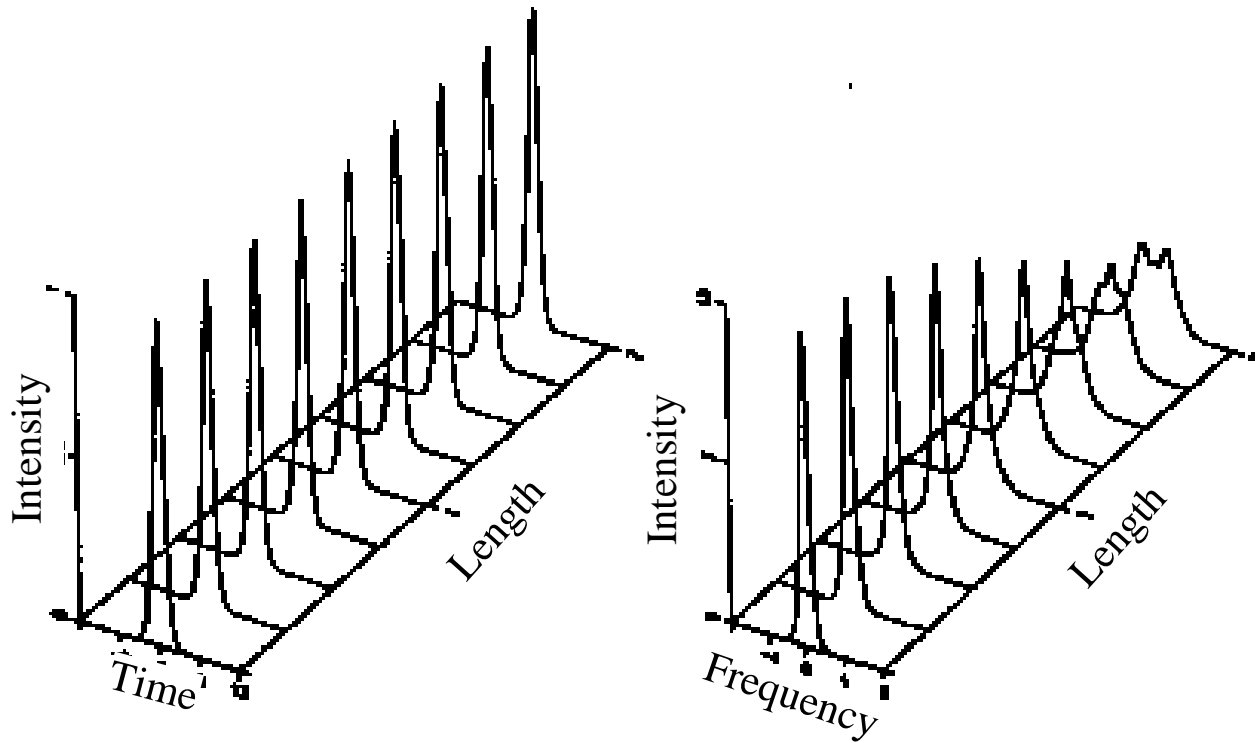
Nonlinear Fiber with Positive Dispersion

Fundamental Soliton

Soliton-based optical fiber transmission
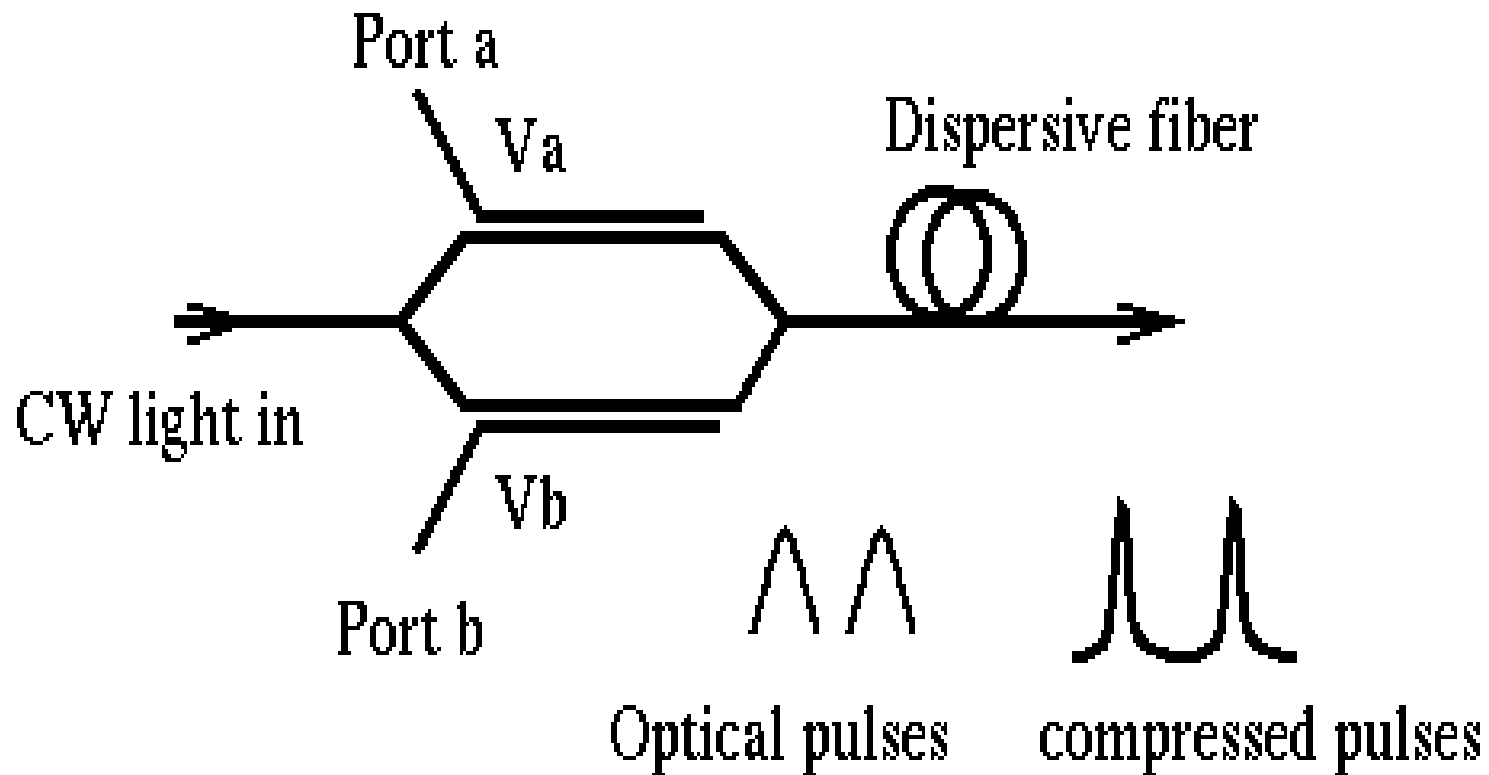
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soliton1.ps
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PostScript printer, but not to
other types of printers.

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Achieved error free distances in single-channel and WDM

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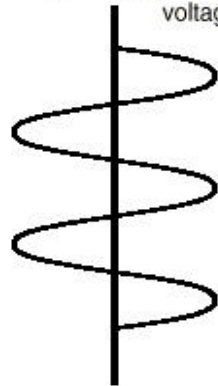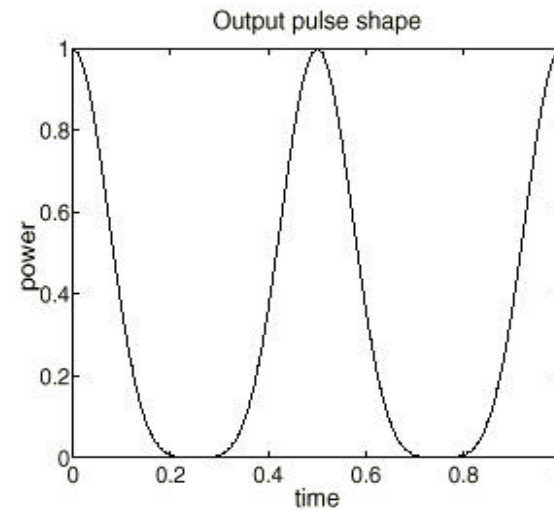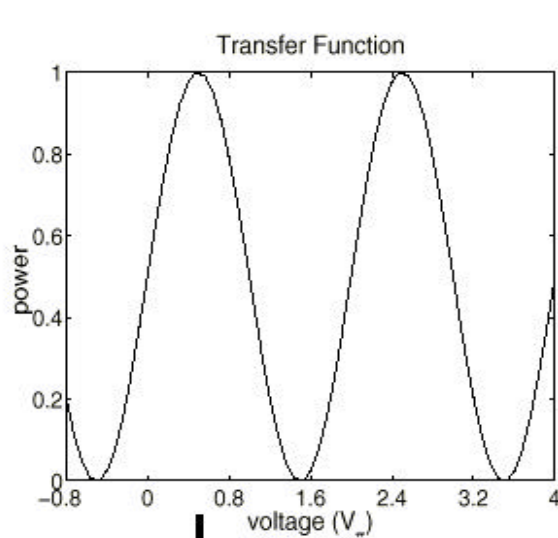Lightwave Laboratory

Three Types of Soliton Generators

1. Soliton laser based on mode-locking

2. Electroabsorption Modulator-based soliton generators

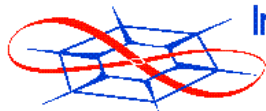3. $LiNbO_3$ Mach-Zehnder Modulator-based soliton generators

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Mach-Zehnder Soliton Generator

Port a
Va
Dispersive fiber
CW light in
Vb
Port b
Optical pulses   compressed pulses

Amplitude Modulation

Transfer Function

Output pulse shape

Sinusoidal voltage

Pulse Compression
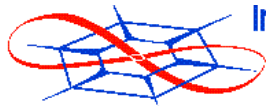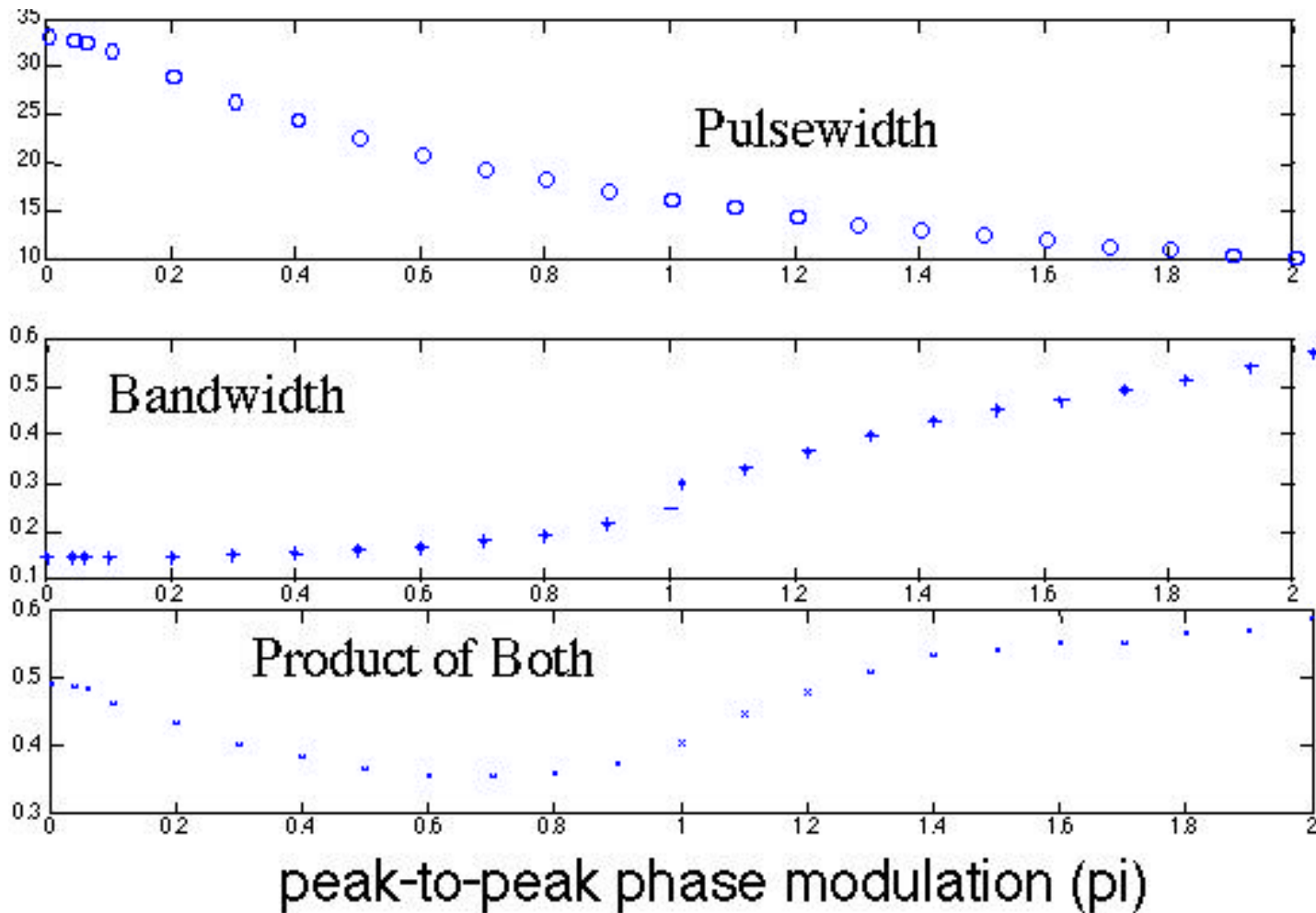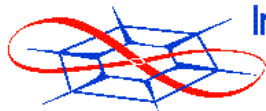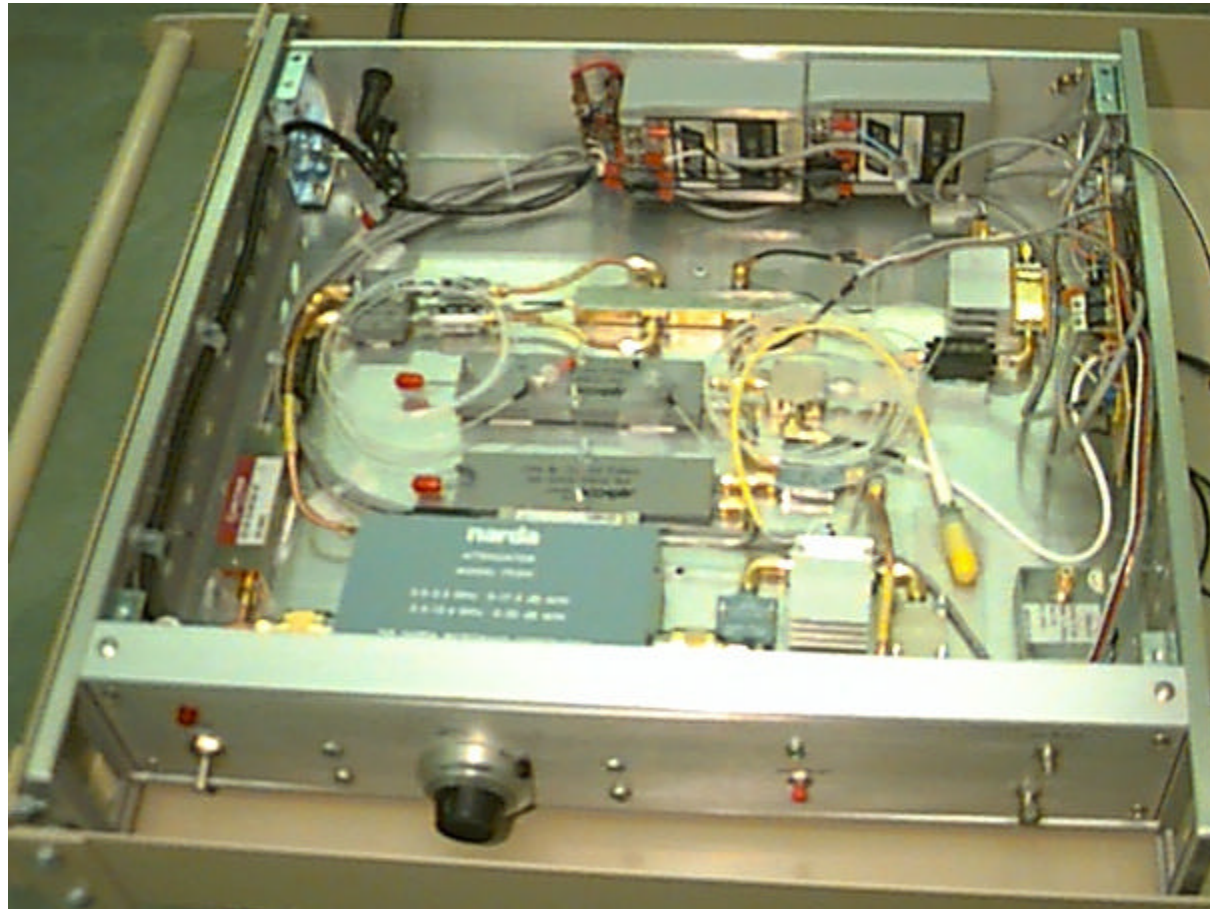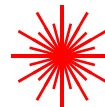
Structure and Operation

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other types of printers.

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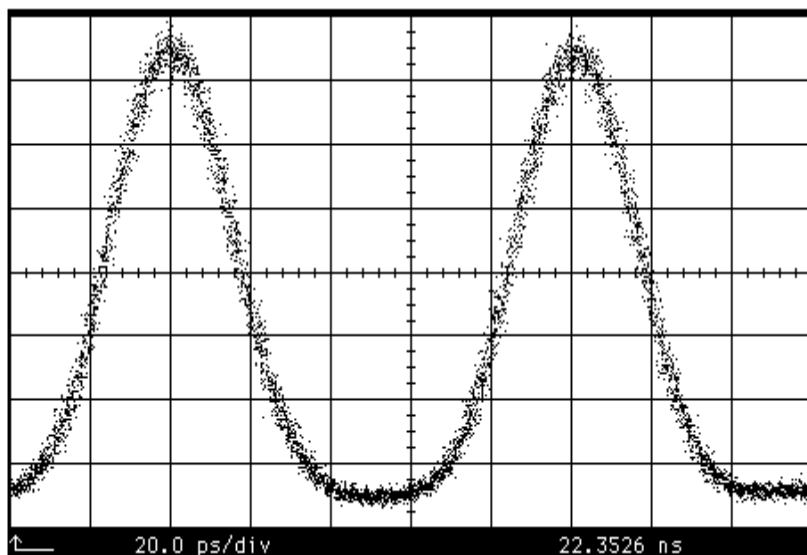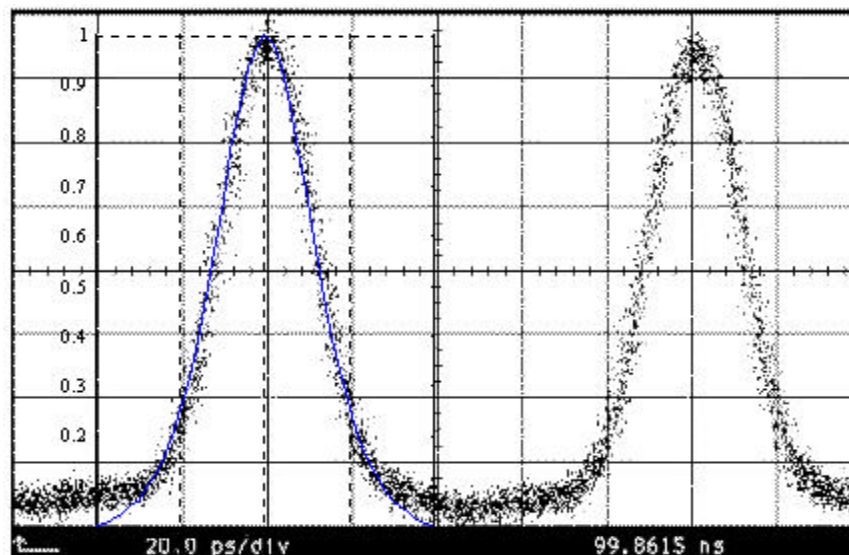Technology Center

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KU Soliton Generator

Mearsured Pulse Compression

Uncompressed pulses

Compressed pulses

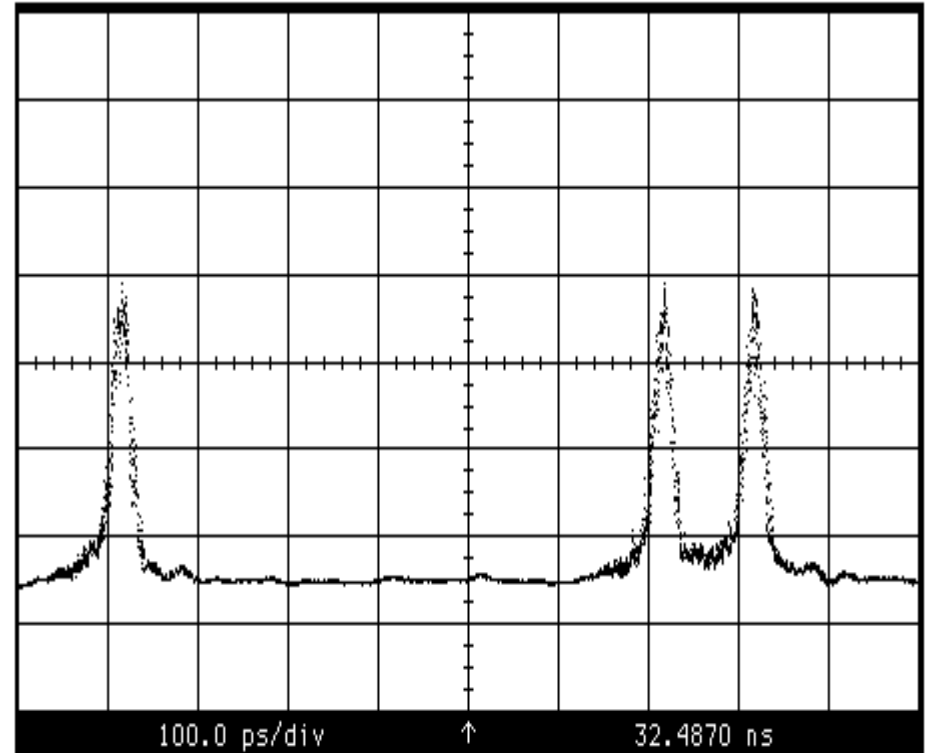
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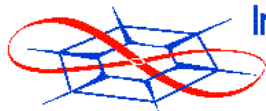Lightwave Laboratory
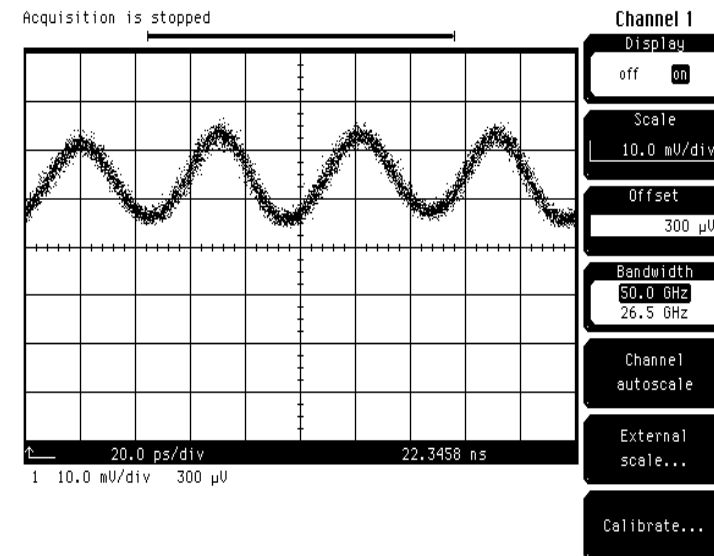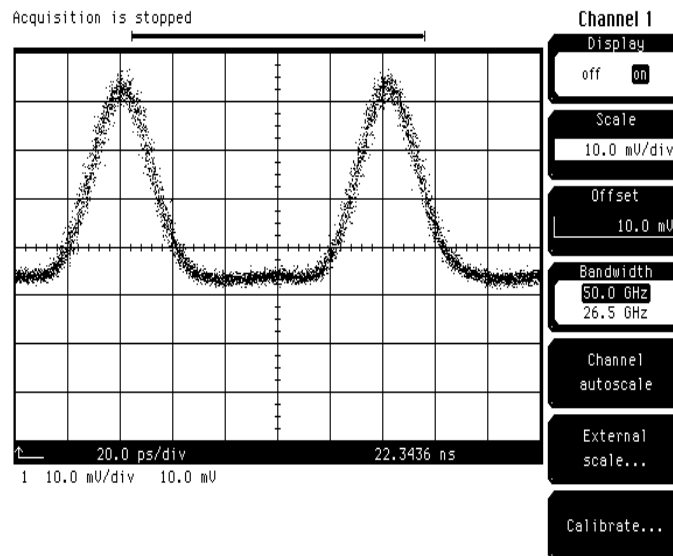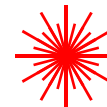
Soliton Source: Output
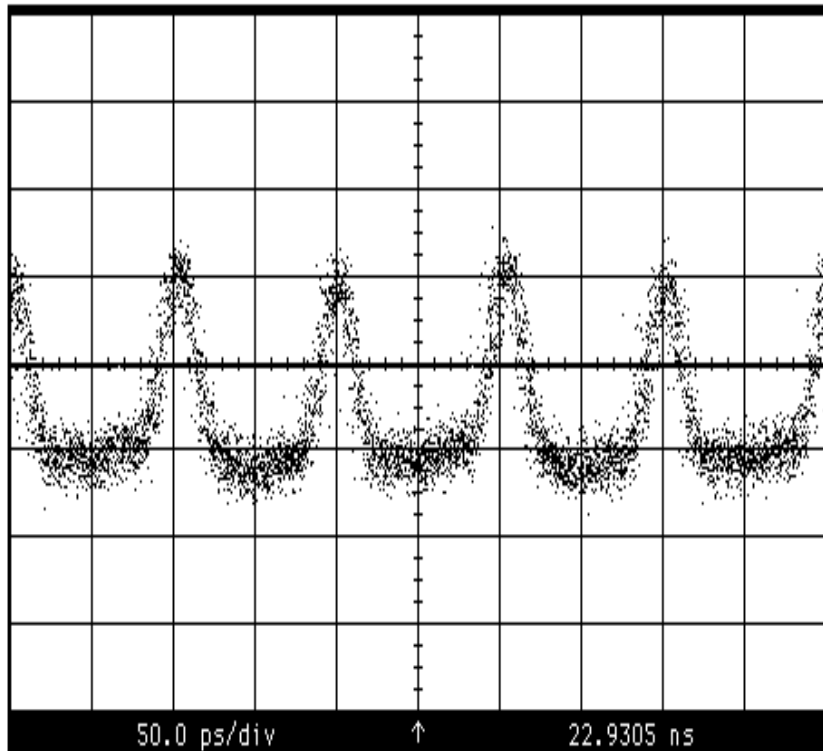
Soliton Train

Data Encoded Soliton Sequence

20GHz Time/polarization Division Multiplexed Soliton Train

PM fiber

Polarization of Incident Light

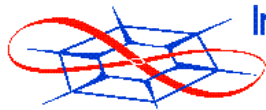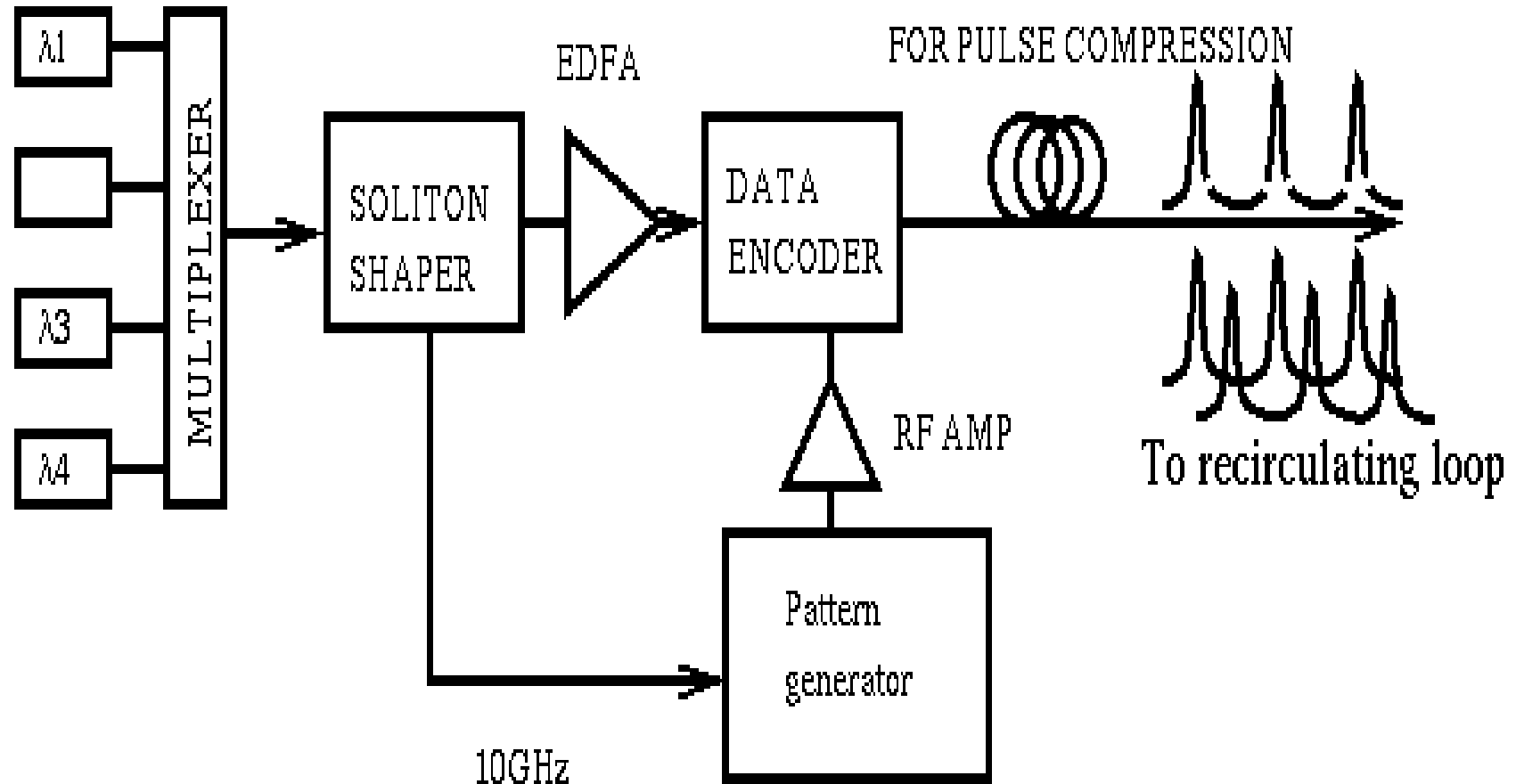# Soliton Generator For WDM

LASERS

λ1

λ3

λ4

MULTIPLEXER

SOLITON SHAPER

EDFA

DATA ENCODER

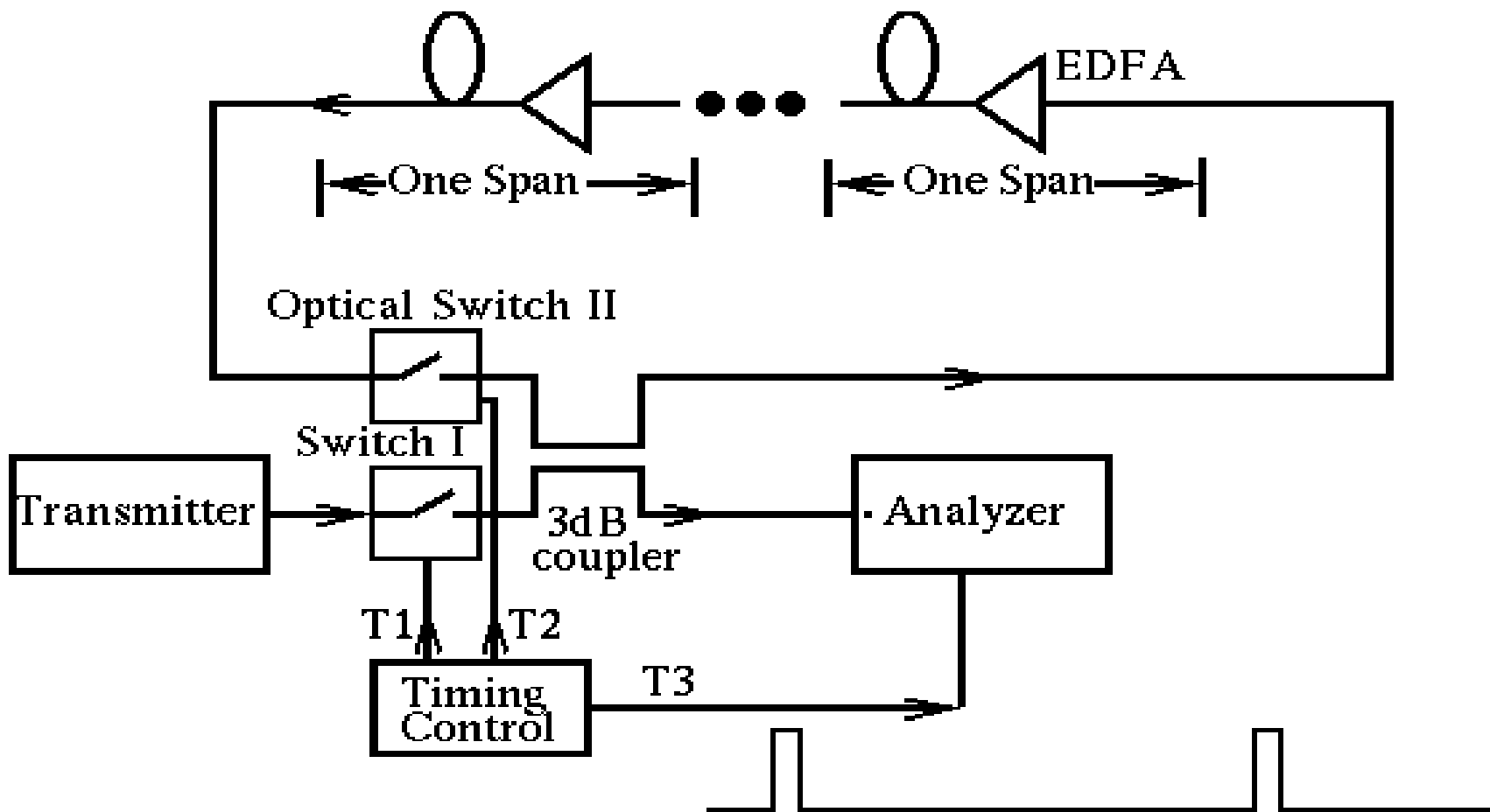STANDARD FIBER FOR PULSE COMPRESSION

RF AMP

Pattern generator

10GHz

To recirculating loop

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Recirculating Loop

Optical Switch II

Switch I

Transmitter

3dB coupler

Analyzer

T1   T2

Timing Control

T3

EDFA

One Span

One Span

KU Recirculating Loop Testset

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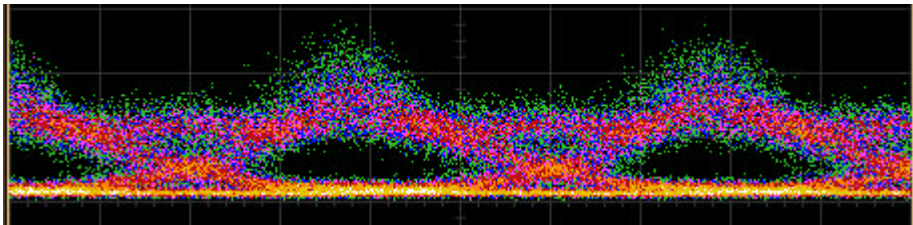
Lightwave Laboratory
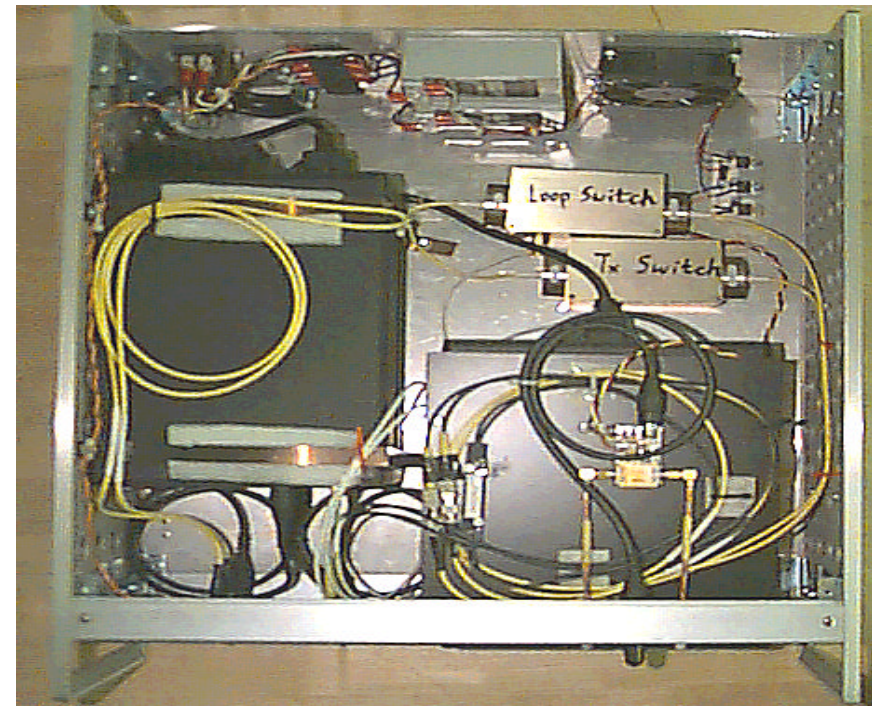
OC48 Rate Transmission Emulation
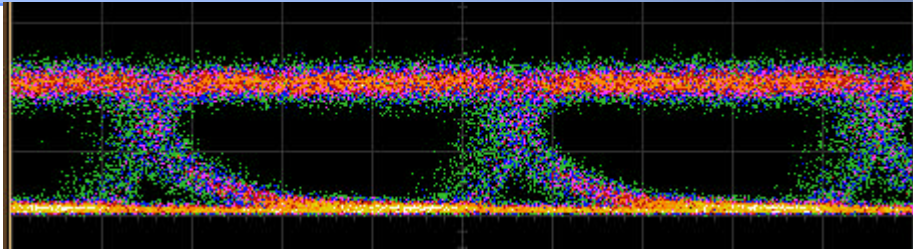
Standard Fiber
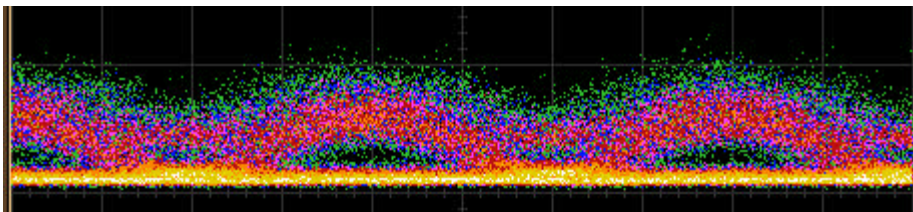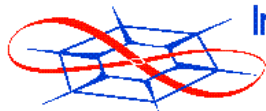
75 km: Error Free

600 km: Error Free
(BER$<2*10^{-13}$)
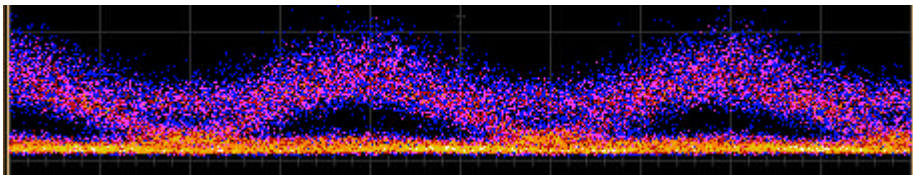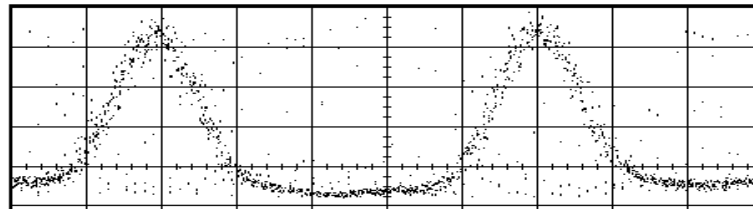
1050 km: BER$=2*10^{-10}$

1350 km: BER$=3*10^{-7}$

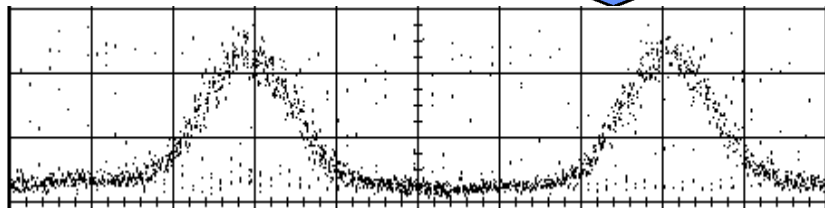Information and
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Measured, Near-Soliton Characteristics

Transmitter
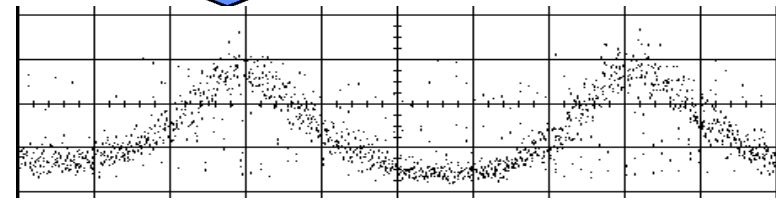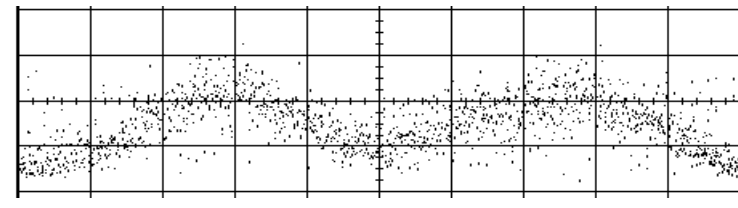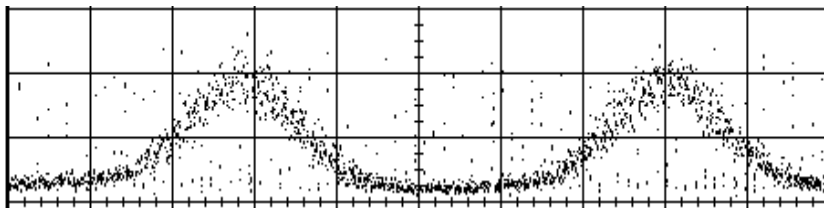
20 ps/div

4*35 km *High Power*   *Low Power*

6*35 km

Launch power: 8 dBm   -2.5 dBm

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Future Work

1. Long-distance 10 Gb/s or time/polarization-division-multiplexed soliton transmission in alternating positive and negative dispersion fiber links.

2. 10 Gb/s or 20 Gb/s WDM transmission in dispersion-compensated standard fiber link with long amplifier spans.

3. Experimental demonstration of soliton control for all-optical networks.

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