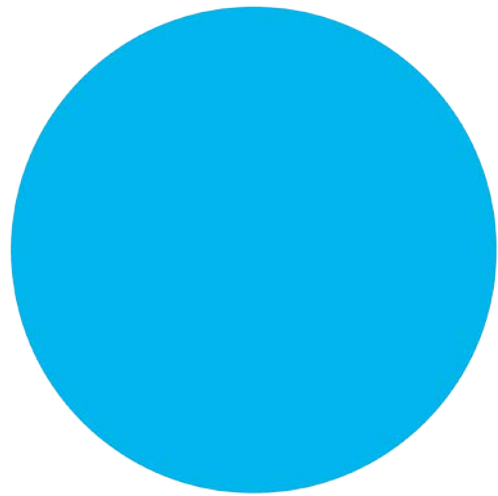


iXblue

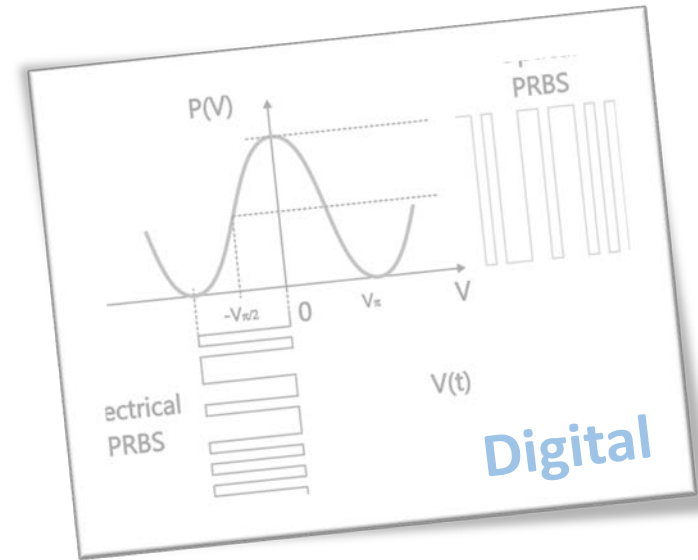
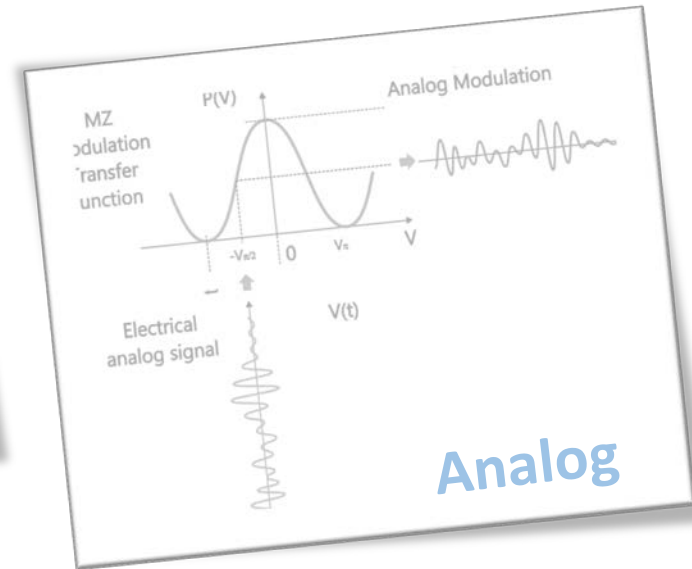
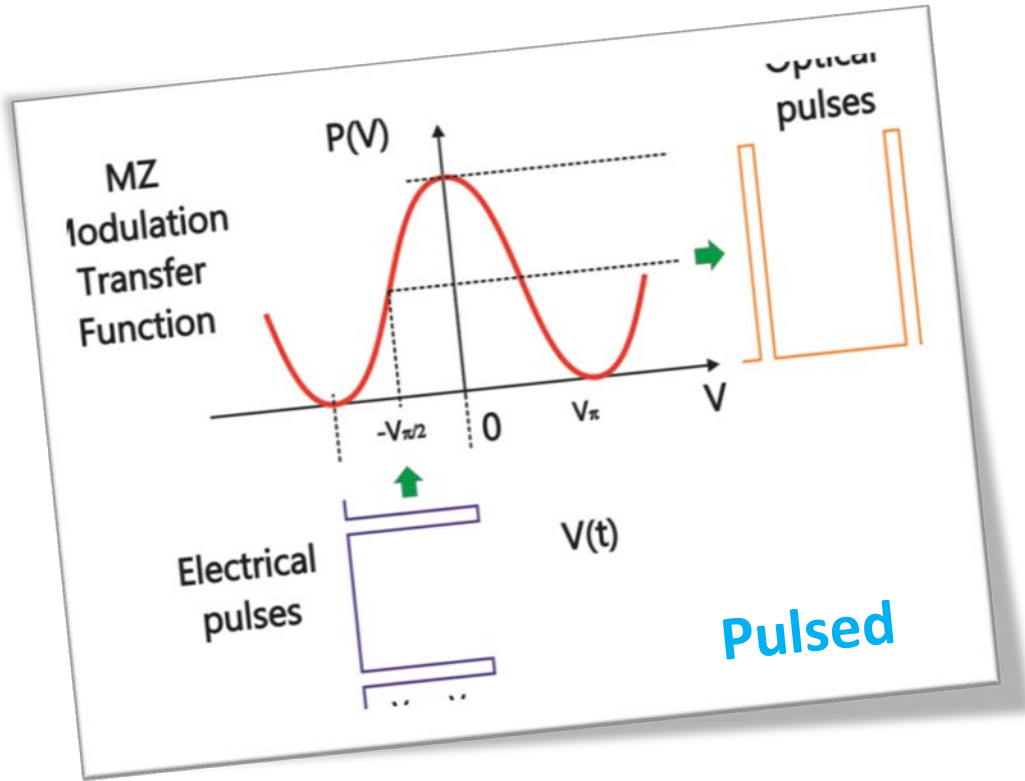
<http://www.photonics.ixblue.com>

contact.photonics@ixblue.com



Pulse Application using LiNbO_3 modulators and matching components

Main modulation formats of Mach-Zehnder Modulators (MZM) for Optical Pulse



iXblue Modulation Solution Components

iXBlue Photonics develops and produces:

- Pulsed optical LiNbO₃ modulators showing high extinction ratio and fast rise & fall time,
- high gain and Broadband GaAs MMIC pulsed driver amplifiers,
- Modulator Bias Controller (MBC) to lock the modulator at the minimum transmission.



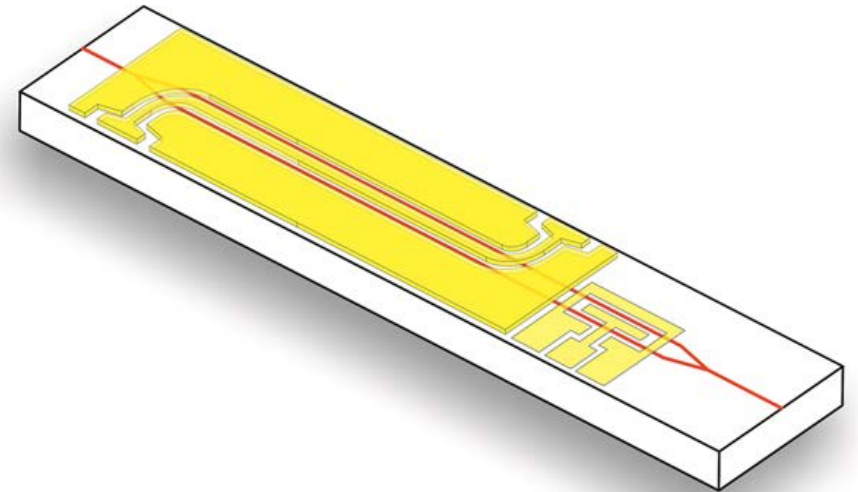
The Photline NIR-MX & NIR-MPX optical modulators series are dedicated to near infra red high performances pulsed laser applications.

Pulsed Optical Modulation

- Applications
 - Fiber lasers
 - Intense laser systems
- Requirements
 - Low loss
 - High extinction ratio
 - Short pulses
- Laser market
 - Rare earth doped pulsed fiber lasers at 1030 nm – 1070 nm Near-Infra-Red (NIR) wavelengths
 - LIDAR (Range-finding, Weather and Pollution monitoring)
 - material processing (Marking Welding Drilling)
- Scientific market
 - Plasma, laser confinement, fusion
 - Large laser systems instruments (Mega-Joule, LULI-CNRS, GSI,...)

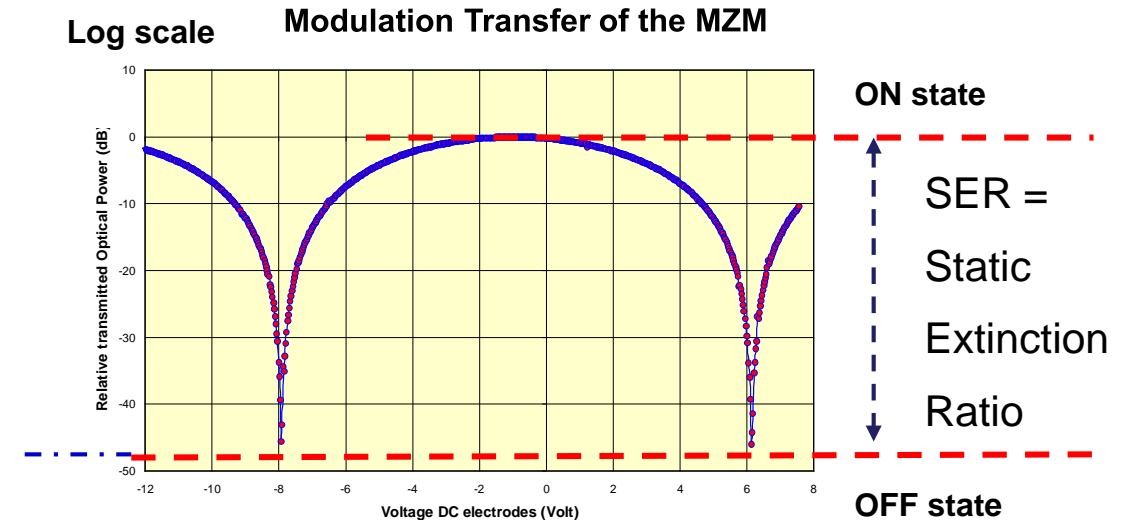
Lithium niobate Mach-Zehnder Modulators for pulsed applications

- High bandwidth up to 40 GHz.
- Rise/fall time as low as 10 ps.
- Chirp free : they do not induce phase distortion of the optical modulated signal.
- Relatively low optical loss (4 dB typ).
- Proven technology: numerous LiNbO_3 modulators are operating in the fiber optics laser systems, worldwide.
- High extinction ratio (larger than 30 dB, up to 40 dB) to ensure no degradation of the SNR in the cascade of optical amplification.
- High optical power handling in Continuous Wave (CW) regime (100 mW) and in pulse regime and up to 7 W peak power for pulses in the ns range (with duty cycle in the range of 1 -100kHz).



Extinction Ratio: Modulator Choice

- The **NIR-MX800-LN** is the reference modulator choice for high Extinction Ratio value at short infra red wavelength 780 nm, 795 nm, 850nm.
- The **NIR-MX-LN** is the best modulator choice for high Extinction Ratio value at near infra red wavelength 1030 nm, 1053 nm, 1060 nm, 1064 nm, 1080 nm.
- The **MXER-LN** is the best option for high Extinction Ratio in the C-band.
- Bandwidth of 12 GHz, equivalent rise time of 35 ps.
- Bandwidth of 18 GHz, equivalent rise time of 20 ps.
- Extinction ratio: > 30 dB, up to > 40 dB.



Photline MBC (Modulator Bias Controller)

- The MBC is a bias controller specially designed to stabilize the operating point of Mach-Zehnder modulators by monitoring the bias voltage applied on the DC port of the device.
- A Mach-Zehnder modulator is illuminated by a CW laser at the optical input port. The pulse signal is applied to the RF electrodes.
- At the output of the MZ modulator, a fiber coupler with a strong imbalance (10:90 or 1:99) allows to detect a small portion of the transmitted light with a monitoring photodiode.
- The signal is amplified and processed in order to control the stability of the operating point.
- Any deviation is compensated by a new value of the electrical bias voltage applied by the feedback loop in order to maintain the operating point at the desired position.

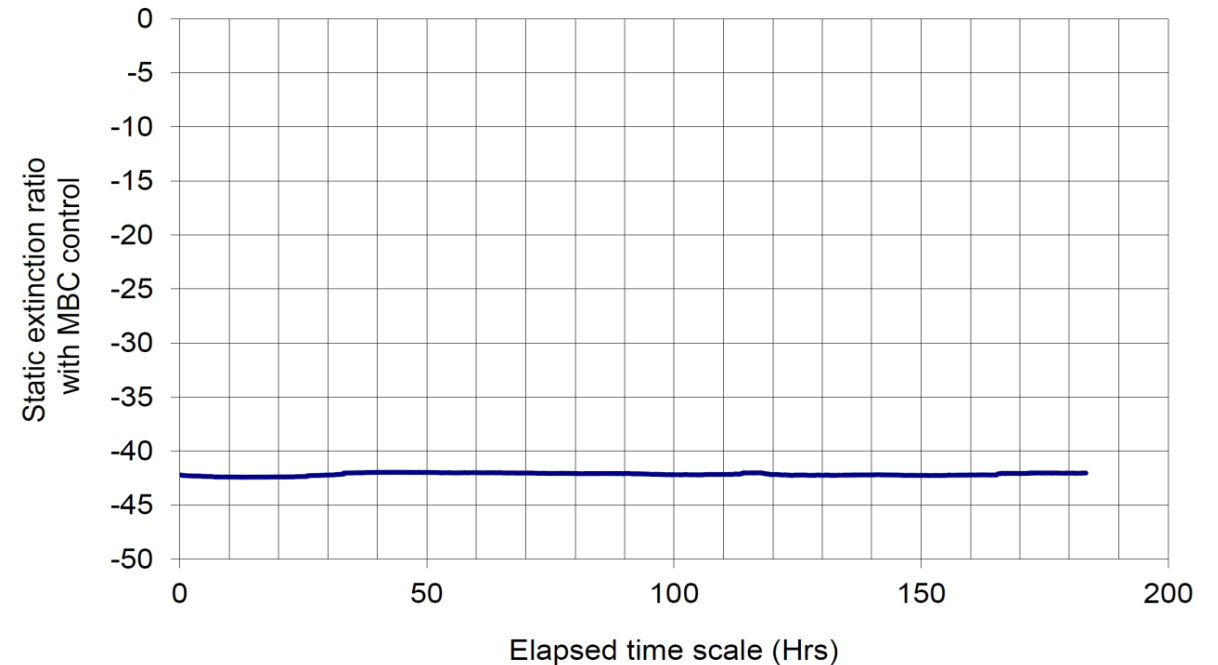
MBC is recommended for pulsed applications



MBC controllers lock any modulators at the MIN point of its transfer function.

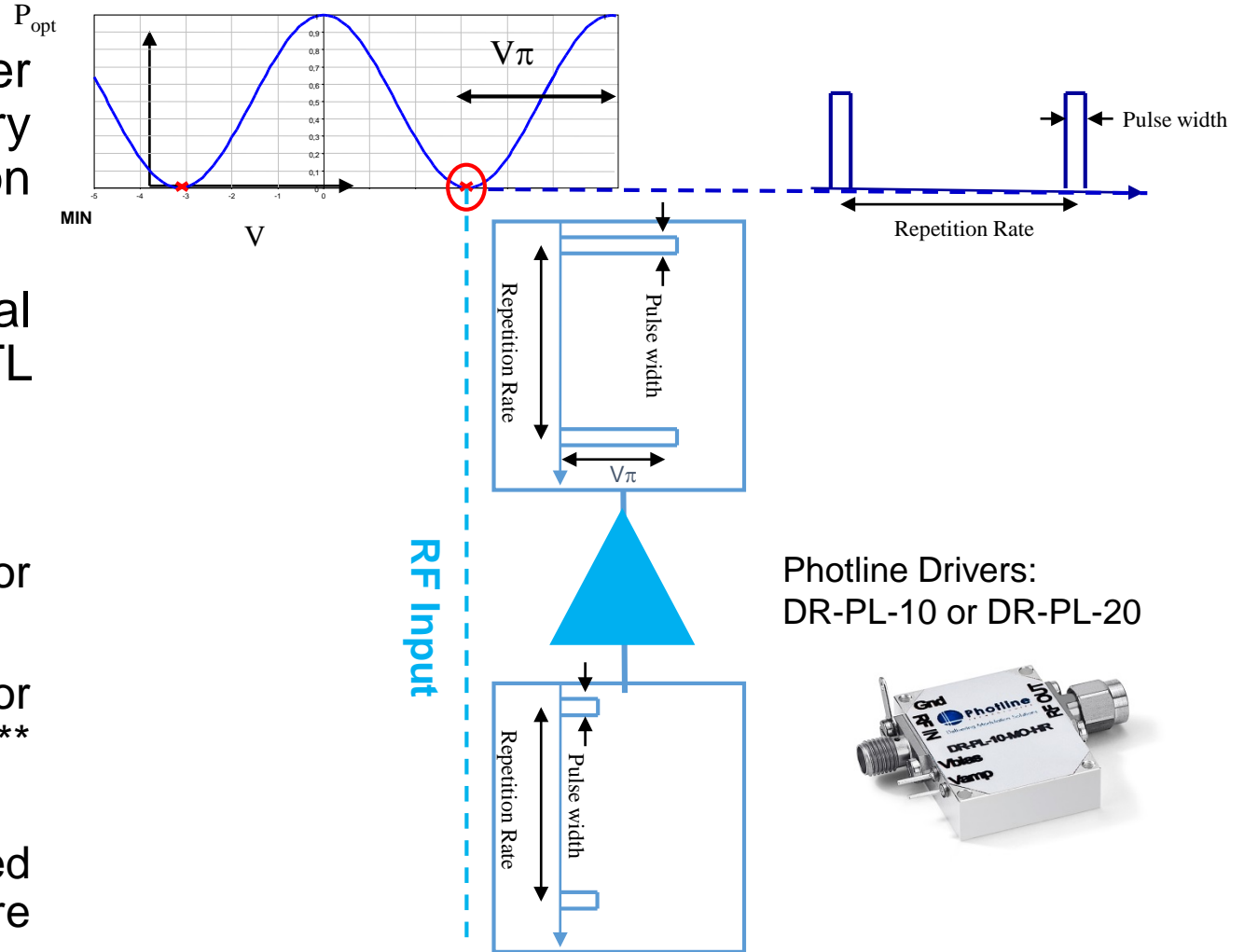
Photline MBC controls SER > 40 dB

- The Photline MBC (Modulator Bias Controller) fixes the modulator operating point at the extinction.
- When combined and controlled by the Photline Modulator Bias Controller (MBC), the Photline modulator shows a stable and high extinction ratio
- The modulator stabilized on the OFF state with a SER > 40dB can be monitored with a high stability over time.



DR-PL: RF driver amplifier

- The Photline **DR-PL** is a driver amplifier dedicated to pulse application, factory optimized to fit with end user repetition rate and pulse width.
- RF Driver boosts the electrical input signal (coming from Pulse generator or TTL signal).
- The Driver is recommended in order:
 - To reach $V\pi$ amplitude and get modulator ER,
 - To guarantee stabilized input modulator voltage whatever the FRR* and PW** generated from the Pulse generator.
 - To compensate pulse distortion involved by the modulator (and reach very square pulse shape).

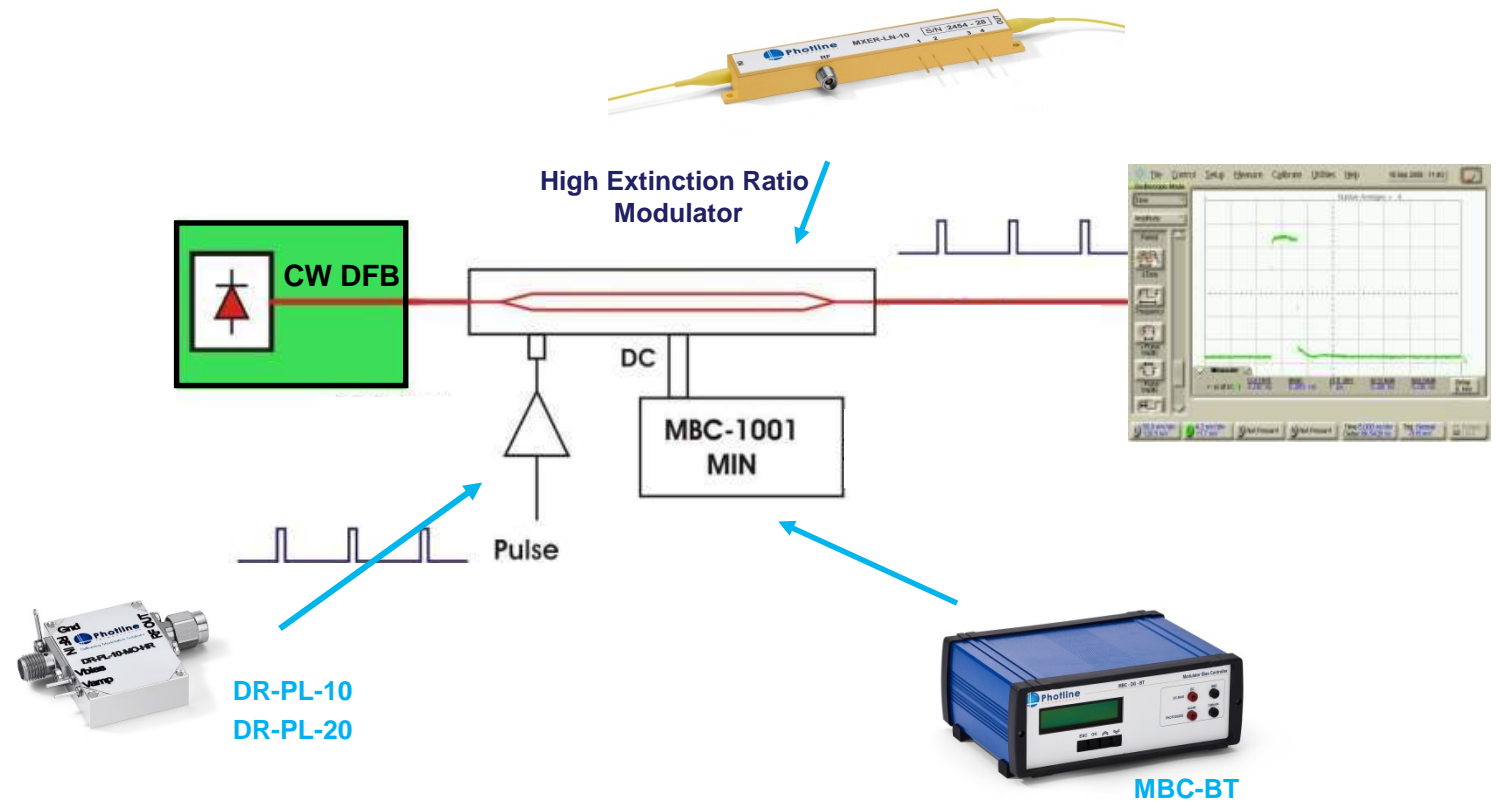


Photline Drivers:
DR-PL-10 or DR-PL-20



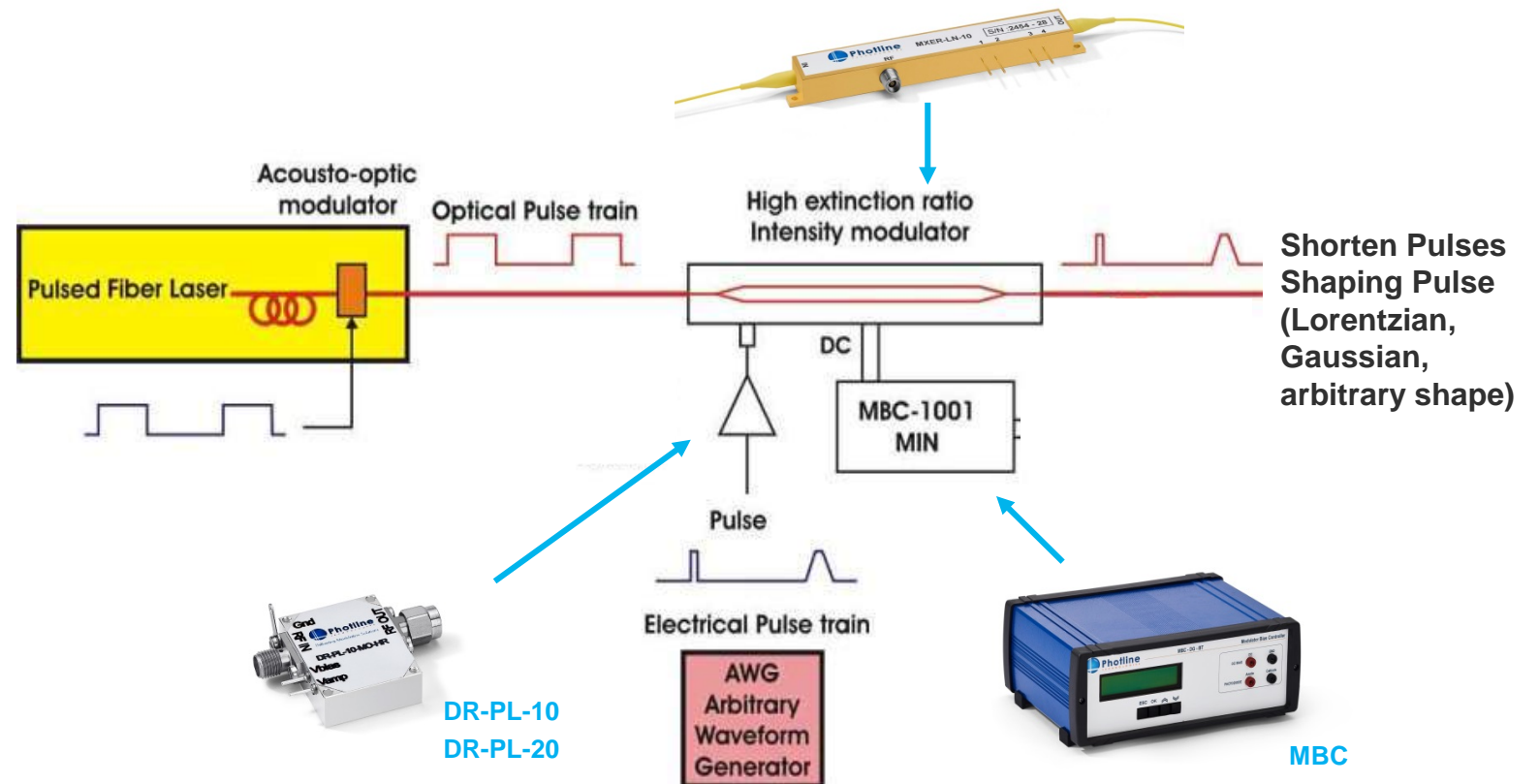
Pulse Generation – Set-up

- To generate pulses from an optical continuous wave laser
- To generate low rise / fall time with short pulses
- Application: industrial lasers



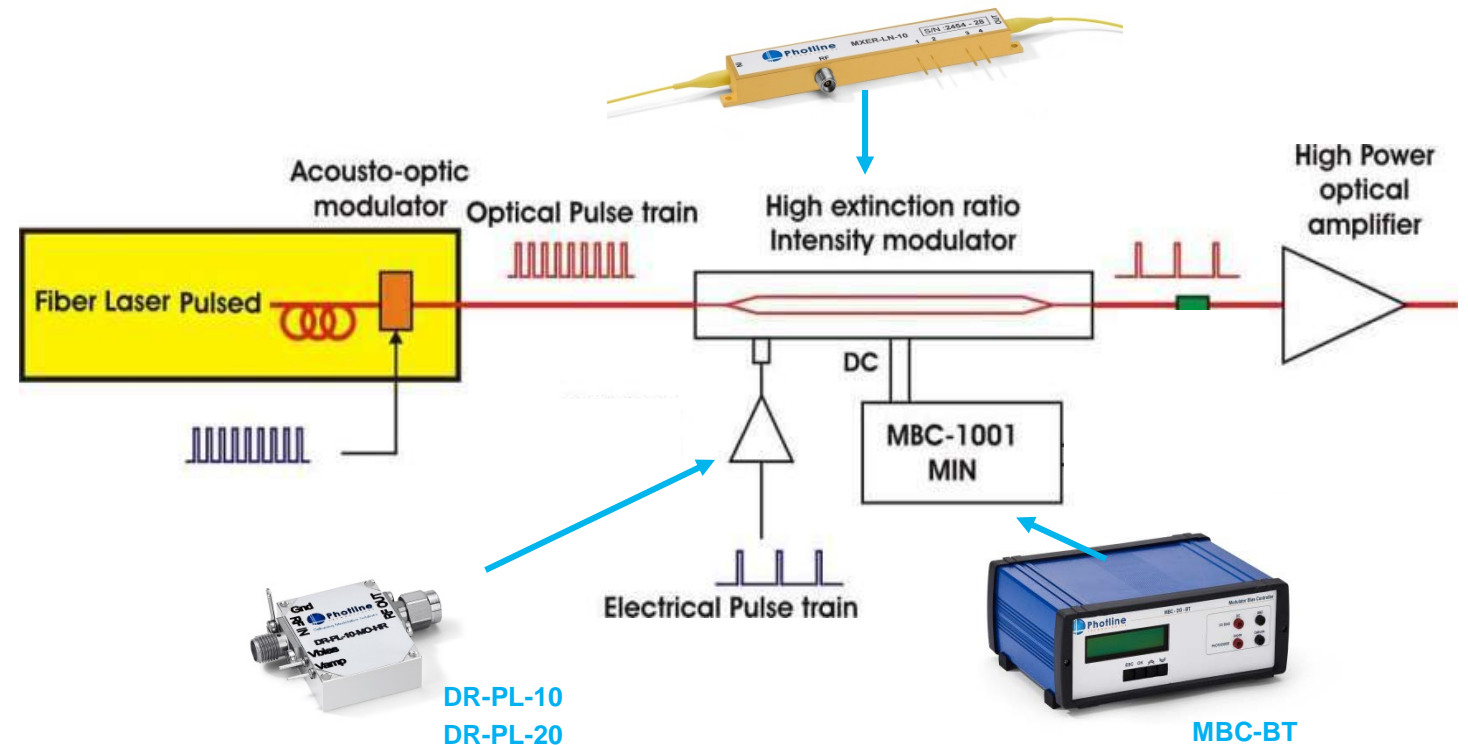
Pulse Shaping – Set-up

- To shorten pulses from an optical pulse train with low rise / fall times,
- To reshape pulses (Lorentzian, Gaussian, arbitrary shapes) from an optical pulse train,
- Application: industrial lasers



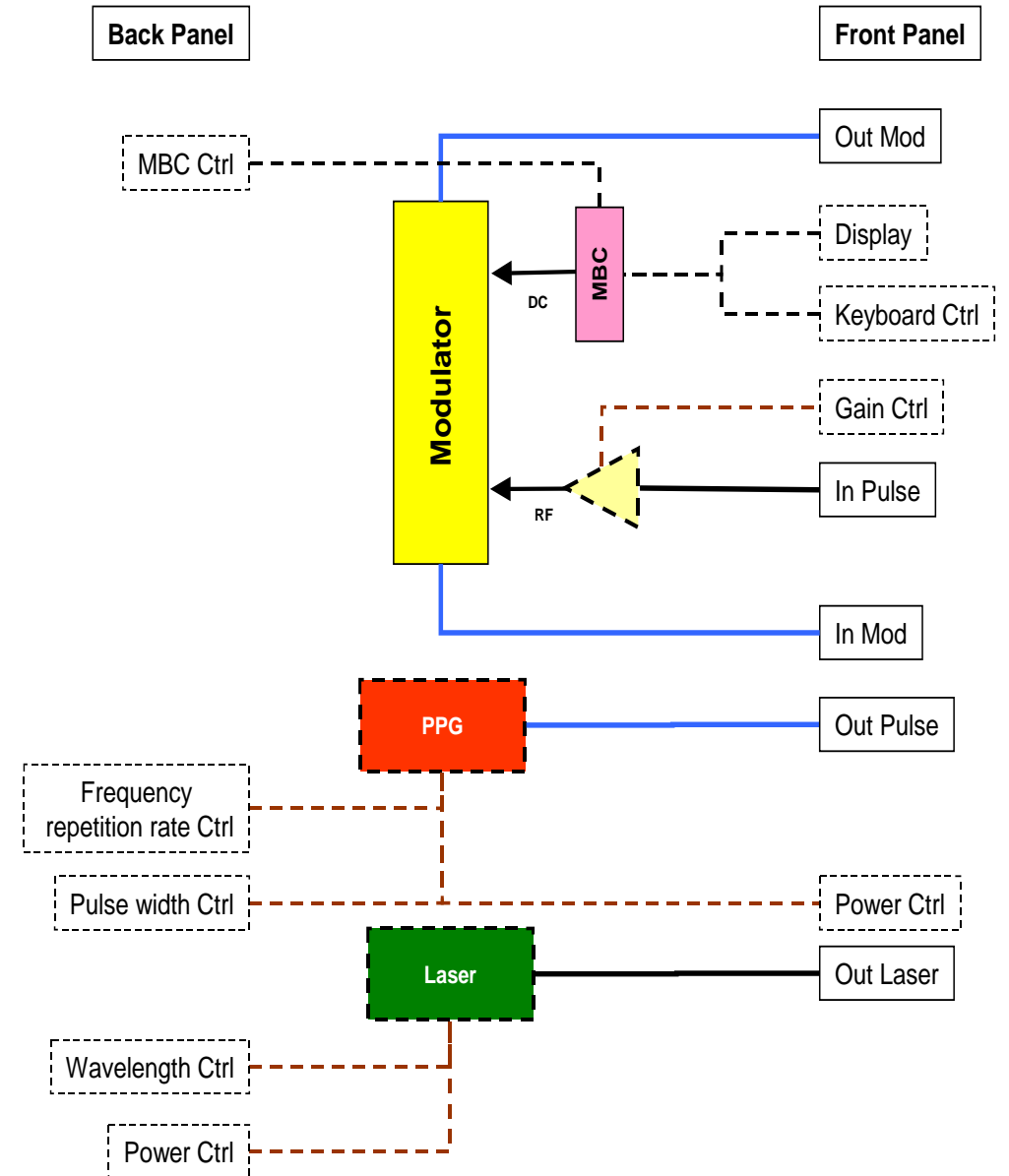
Pulse Picking – Set-up

- To select one pulse among a burst of optical pulses from a pulsed fiber laser
- High extinction ratio required when a cascade of optical amplifier is introduced at the output
- Application: industrial lasers

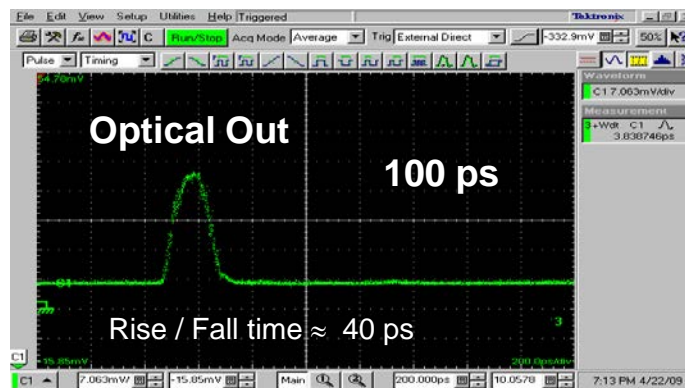
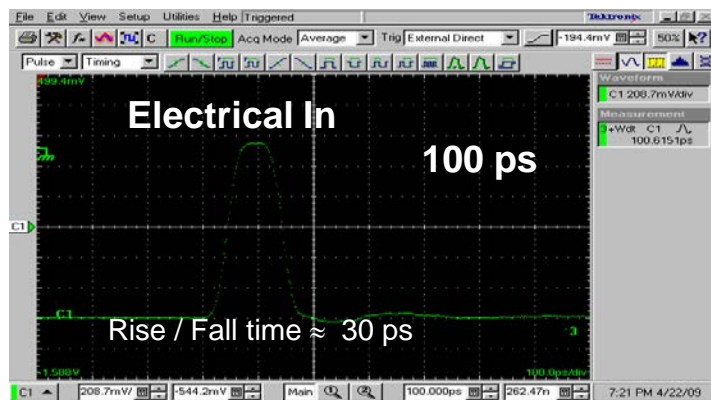
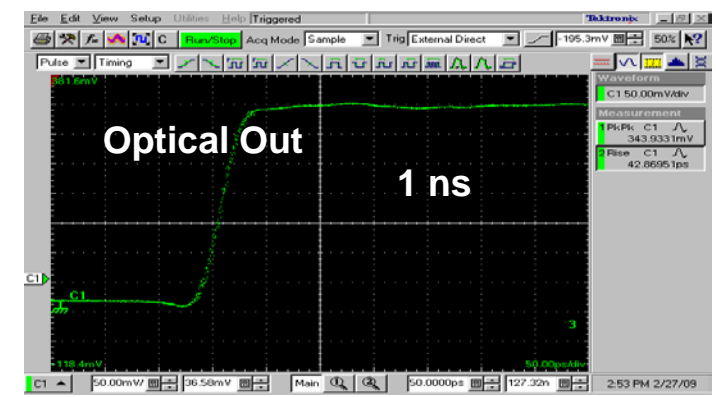
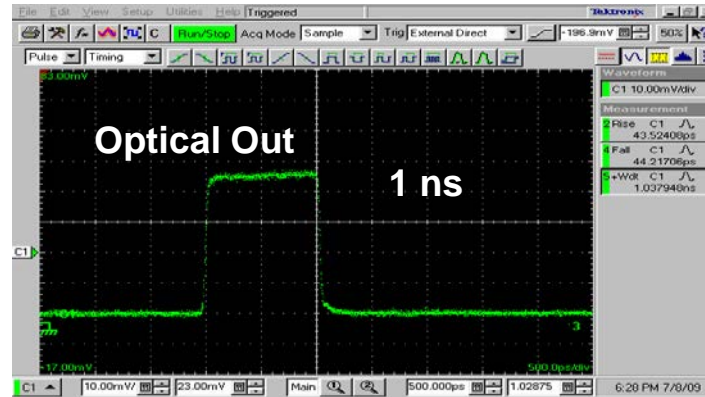
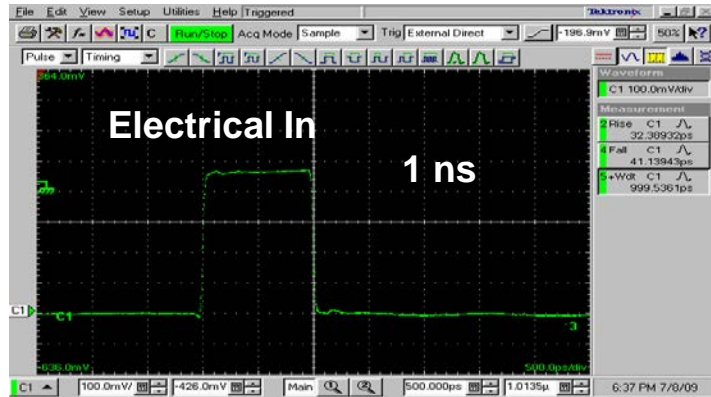


Turn-key Unit: The Pulse ModBox

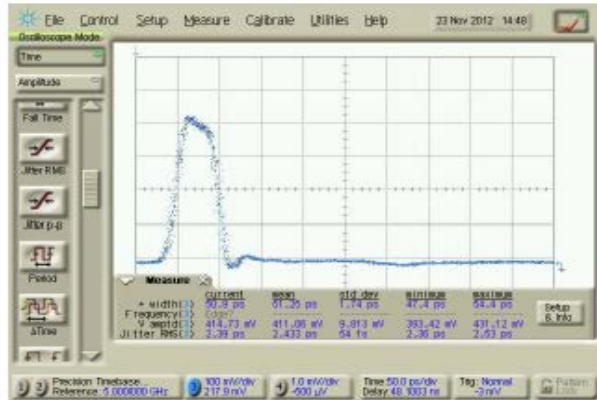
- The Pulse-ModBox integrates at least:
 - 1 × High Extinction Ratio modulator,
 - 1 × Pulse driver,
 - 1 × MBC (Min point).
- Option
 - 790 nm – 2200 nm,
 - Seed Laser,
 - Photodiode,
 - Pulse Generator (Square & Gaussian Shapes),
 - Arbitrary Generator,
 - Optical amplifiers,
 -



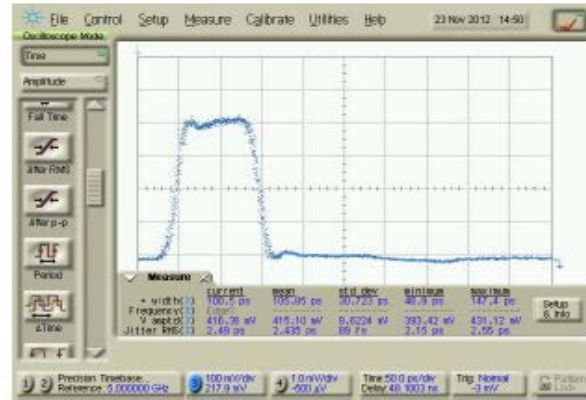
Optical Pulse Waveforms: Down to 100 ps optical pulse width – Square shape



Optical Pulse Waveforms: Down to 50 ps optical pulse width – Square shape



Pulsewidth = 50.9 ps
Jitter rms = 2.39 ps

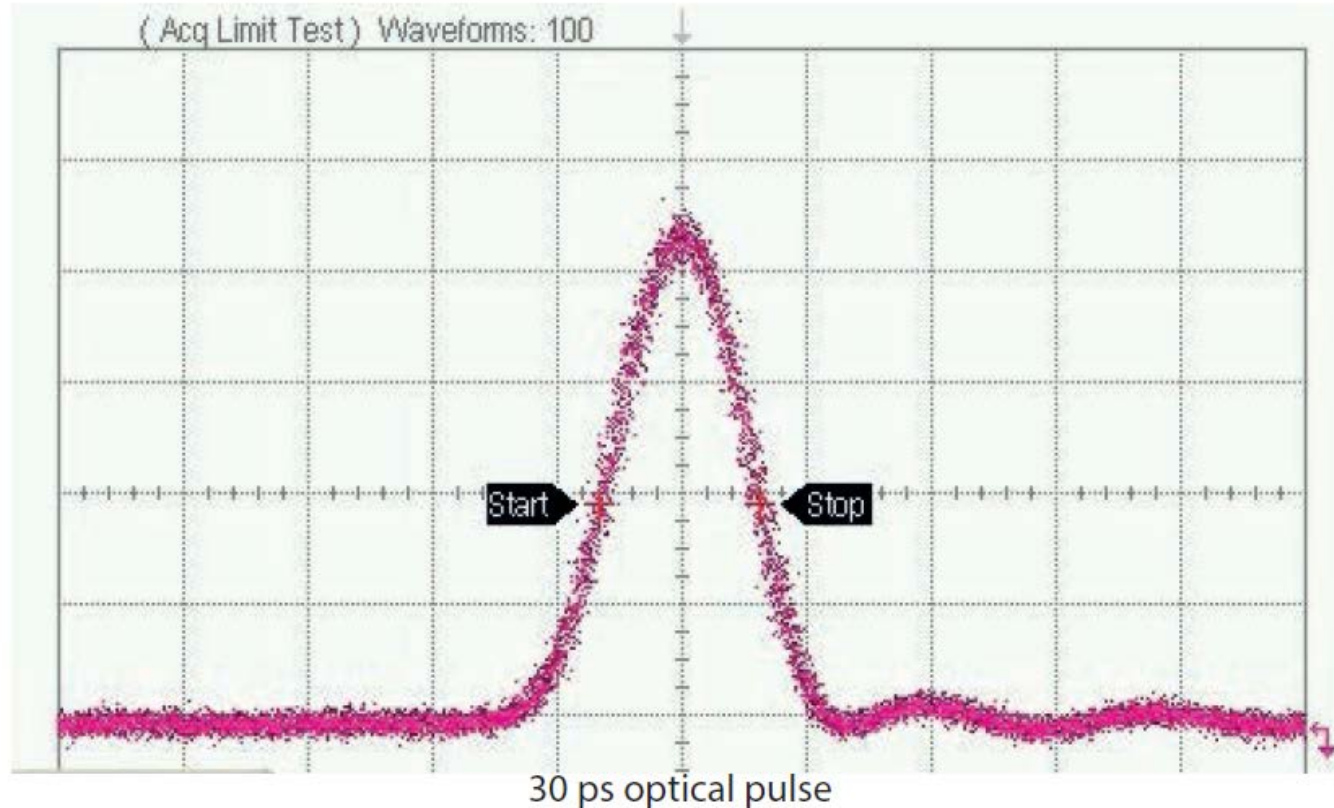


Pulsewidth = 100.5 ps
Jitter rms = 2.49 ps

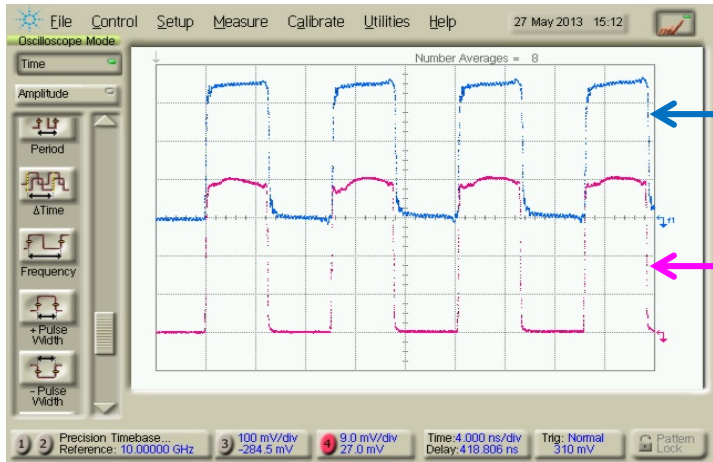


Pulsewidth = 120.6 ps
Jitter rms = 2.46 ps

Optical Pulse Waveforms: Down to 30 ps optical pulse width – Gaussian shape

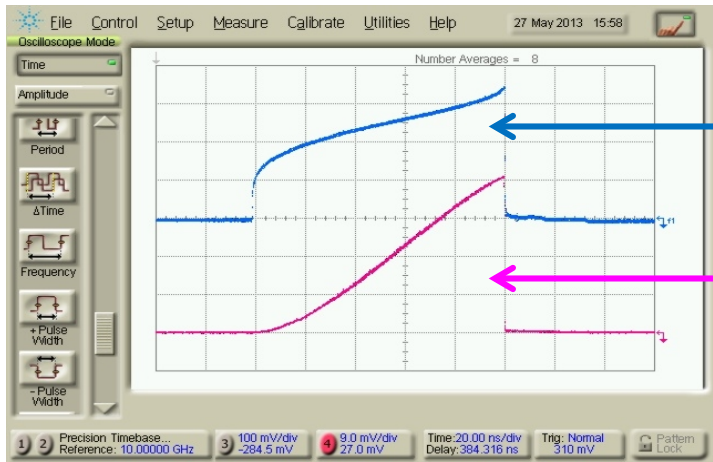
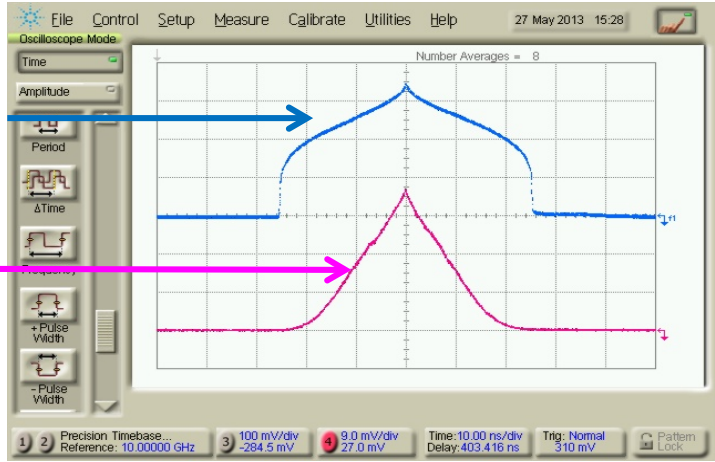


Optical Pulse Waveforms: Arbitrary Waveform from 125 ps



Electrical
Pulse AWG
output

Optical Pulse
ModBox output



Electrical
Pulse AWG
output

Optical Pulse
ModBox output

