# Timing Jitter in Optical Communication Systems

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**Abstract:** Timing jitter cubic growth limits the reach of high-speed optical communication systems. In this work we consider both linear and non-linear optical transmission systems and analyze the accumulation and mitigation of this unwanted effect.

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## 1. Introduction

High-speed optical transmission systems receivers have to deal with sequences of pulses representing the transmitted symbols. Reception requires a precise knowledge of the sequence timing, i.e. the temporal position of the pulses. However, clock recovery circuits do not respond to pulse-to-pulse timing jitter. Therefore, pulse-to-pulse timing jitter affects the decision process leading to symbol decision errors. In this work, we discuss the accumulation of timing jitter. We also show why the signal interaction with noise leads to timing jitter that grows cubically with the distance, in both linear and non-linear transmission systems, and analyze some steps that can be taken in order to control timing jitter.

## 2. Accumulation and Control of Timing Jitter

The cubic growth of timing jitter in non-linear transmission systems is a well-know phenomenon and was extensively studied in connection with soliton transmission systems, see for instance [1, 2]. More recently it was also showed that this cubic growth can also be seen in linear transmission system due to the nonlinear interaction between noise and signal at the photo-detector, see [3]. The control of timing jitter in soliton systems can be made by the use of synchronous modulators or by the use of sliding-filters. In linear systems, a technique that we analyze in this work is the pulse compression before photo-detection, in fact this technique virtually eliminate timing jitter in linear transmission systems. In figure 1, we present timing jitter as function of pulse width at the source output and before the photo-detector. As can be seen, shorter pulses after the source output leads to higher jitter values and shorter pulses before the photo-detector leads to smaller timing jitter, therefore pulse compression must be achieved during transmission or just before the photo-detector.

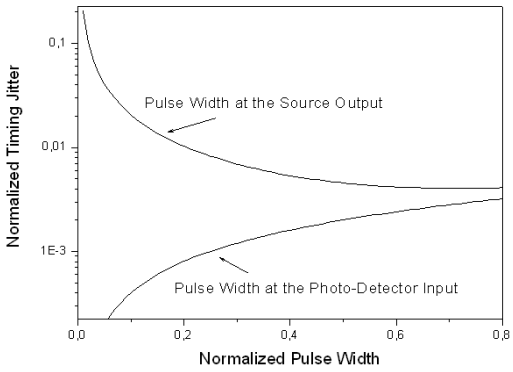


Figure 1. Timing jitter versus pulse width at the source output and at the photo-detector input.

## 3. References

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