Time Telescope for Photonic Interconnects

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The time lens has been extensively studied and engineered to achieve the temporal characterization and manipulation of the optical waveforms [2], however, the residual temporal chirp it always imparts may be detrimental to quantum networks [3]. In this talk, we present the concept of a general two-time-lens temporal imaging system satisfying the telescoping condition. We find the conditions for loss minimization and show how an erecting time telescope creates a real chirpless image of a temporal object. We also present the idea of making single photons identical by such a time telescope which is of high importance in recent quantum technologies. The development of quantum networks requires the construction of interconnects between "slow parts" such as quantum memories and "fast" parts such as communication lines. The use of chirpless temporal imaging is inevitable in such interconnects for noiseless temporal stretching/compressing of arbitrary (non-Gaussian in general) waveforms where the fragile features of the quantum fields have to be preserved.

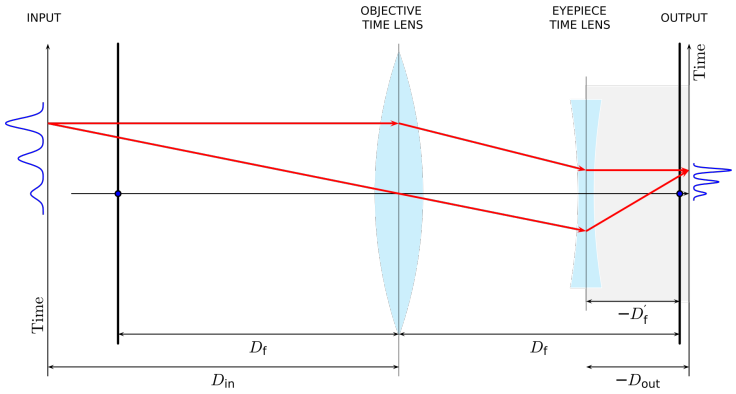

Figure 1: Erecting compressing time telescope

The objective time lens has a focal GDD $D_f > 0$, while the eyepiece time lens has a focal GDD $D_{f'} < 0$, where the condition $D_f > D_{f'}$ is satisfied. The time rays (red lines) show transformations of individual frequency components in the imaging system: vertical position corresponds to time while the direction of the time ray corresponds to frequency [?]. The grey area shows a dispersive medium with a negative GDD, resulting in the creation of a real image at the output. This element is not possible in the spatial domain because negative diffraction does not exist while negative dispersion does. We have considered two examples of the application of such a time telescope to distinguishable photons produced by SPDC and single emitters such as quantum dots and shown that in both cases the photons can be made perfectly indistinguishable by means of an erecting time telescope.

References

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