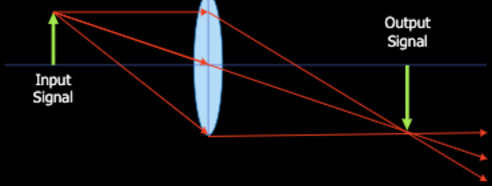
We use lenses every day to focus and magnify light in space: they're in our cameras, our telescopes, and our glasses. However, it is also possible to magnify light in time due to a duality between space and time and mathematical equivilencies between diffraction and dispersion.

TIME LENSING

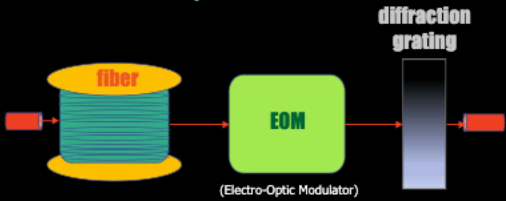
Spatial Lens vs Temporal Lens



Input signal diffracts at edge of lens

Lens introduces a quadratic phase shift (change in path length)

The output signal is magnified relative to the distance it traveled before and after the lens



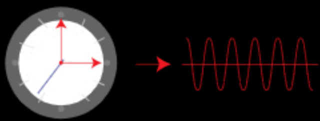
The input signal is chirped and dispersed as it travels through an optical fiber. This dispersion is equivilent to diffraction at the edge of the lens

An EOM introduces a time dependent quadratic phase shift equivilent to that introduced by the spatial lens

The output signal is magnified relative to the length of the dispersive medium (fiber) and the size of the diffraction grating

How does time lensing work?

The time lens maps an input signal from the time domain to the frequency domain. The output pulse is identical to the input pulse except for a change in time scale.



Resolution of two photons without and with a time lens. The time lens makes it possible to distinguish both photons individually when they are otherwise indistinguishable to a measuring apparatus.

Why is time lensing important?

Better Microscopy

Improved Spectroscopy

Faster Data Processing and Communications