UseCase.0053 (1.0)

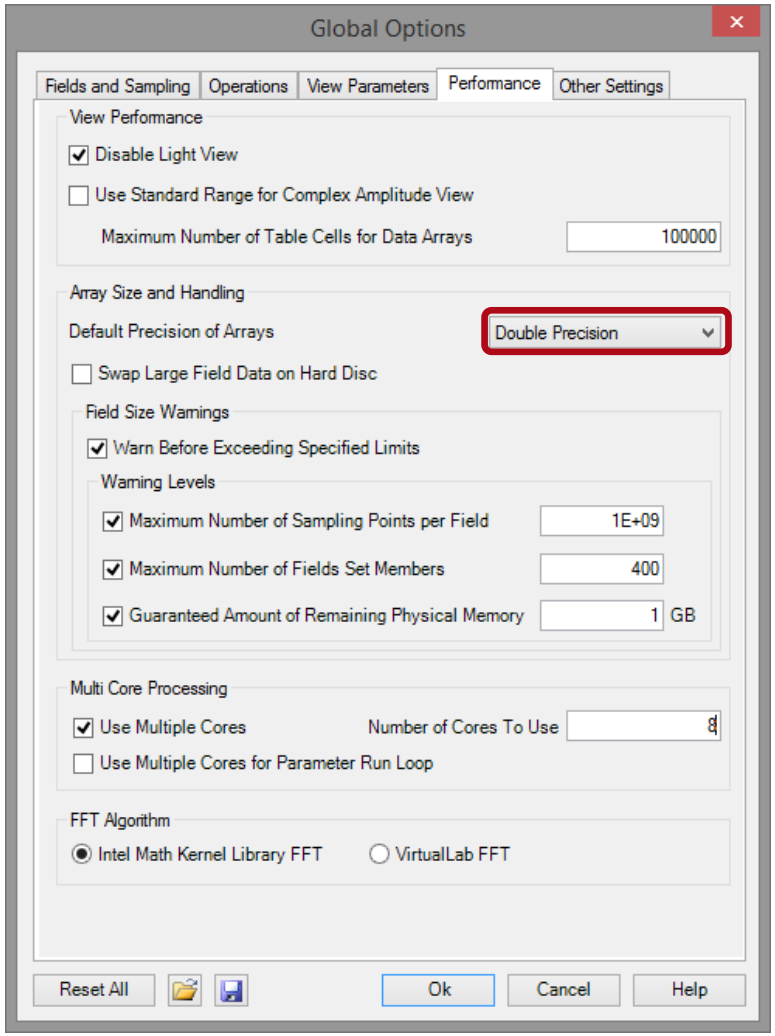
Pulse Simulation – Temporal Dispersion

Keywords: pulse, bandwidth handling, temporal dispersion

Description

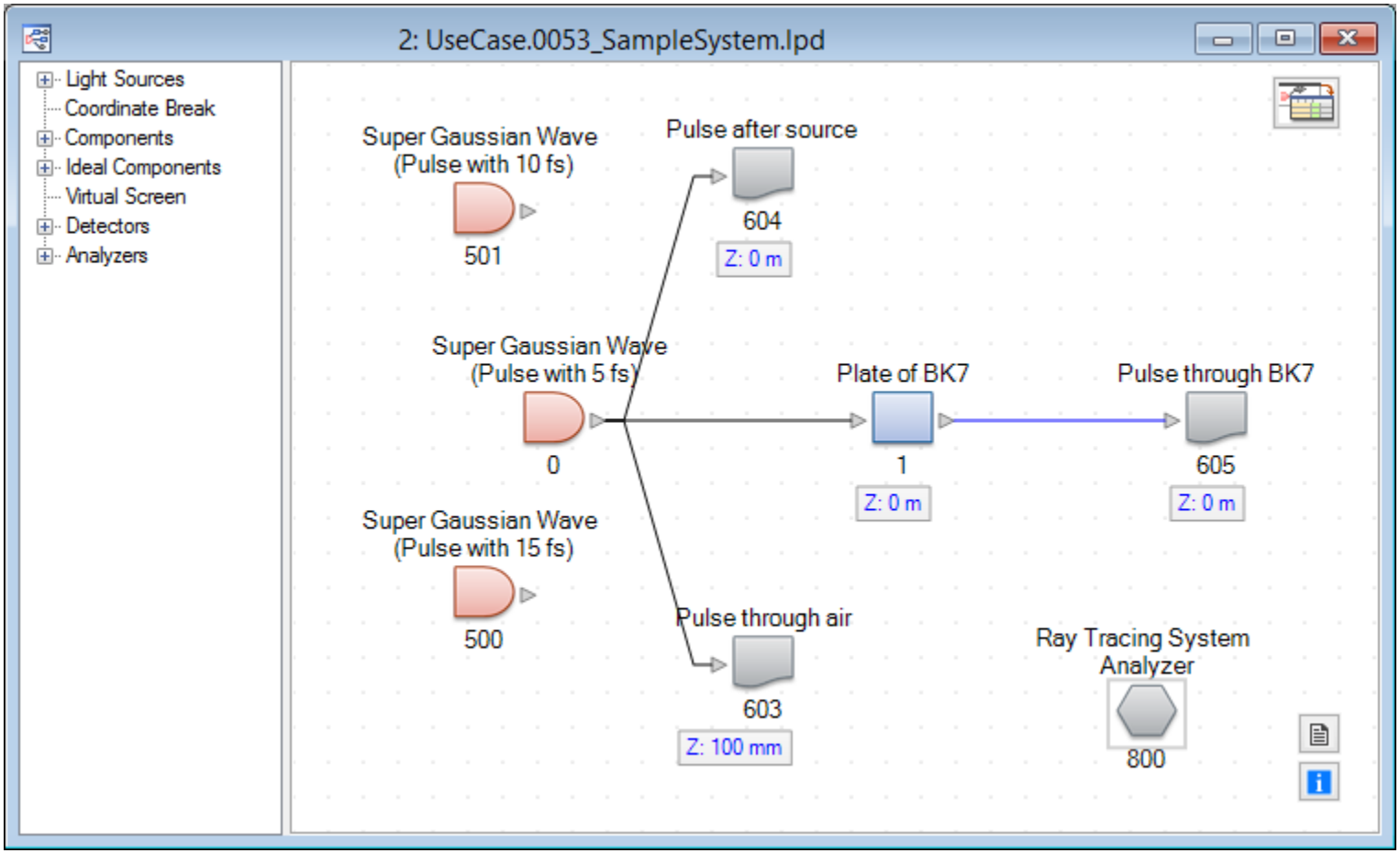
- The use case demonstrates the effect of material dispersion on pulse propagation.
- Specifically it presents the modeling of a pulse through 100 mm in BK7 vs Air.
- The central wavelength of the pulse is 800 nm.
- Different pulse lengths are evaluated: 5, 10, 15 fs.
- Goal:
  - Show effect on pulse by temporal dispersion
  - Different ways for visualization of pulses
  - Smart sampling handling within spectral domain

Important Reminder!



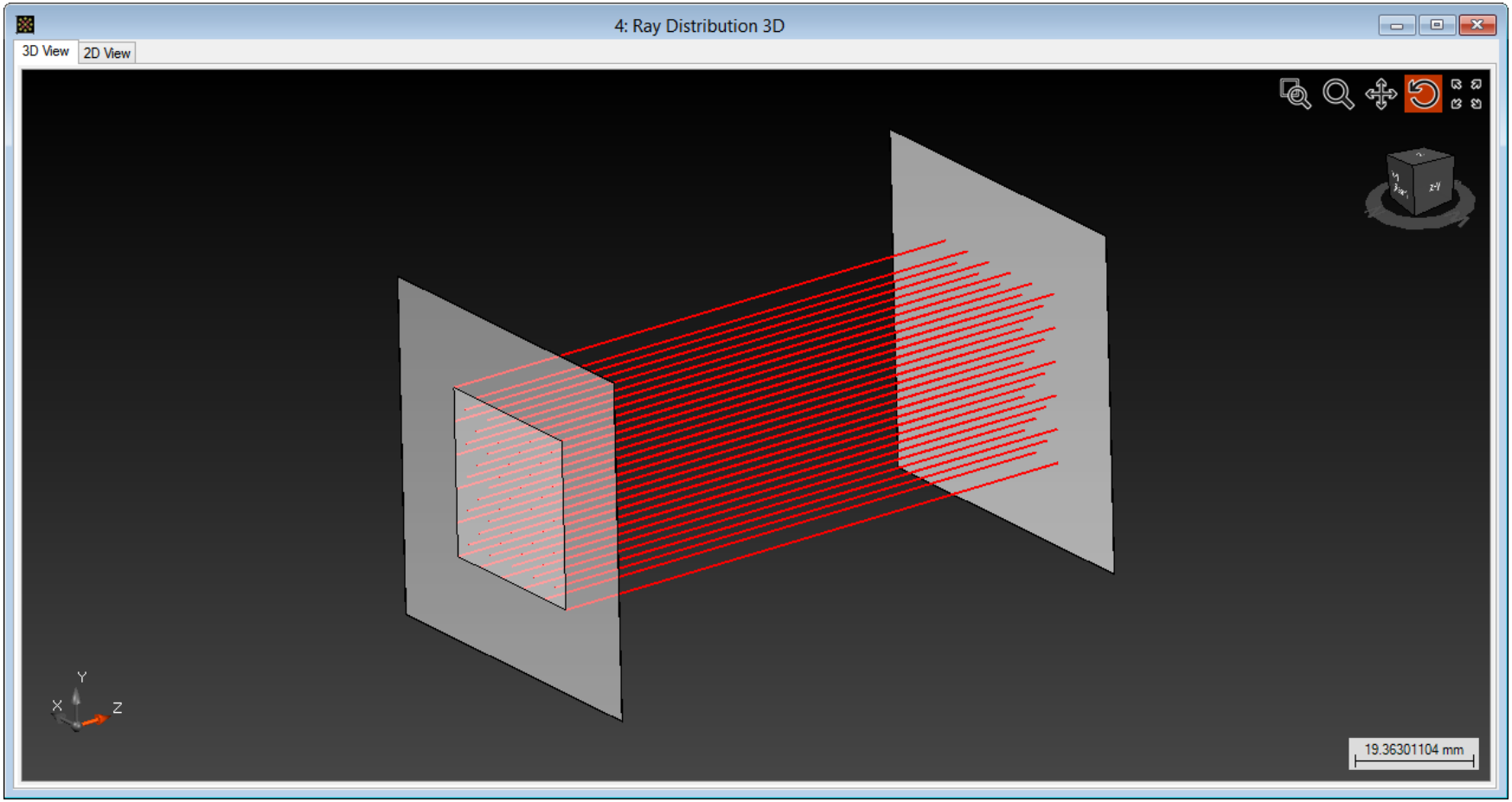
- Make sure, that for pulse modeling you have chosen Double Precision BEFORE pulse specification!
- The global options can be edited by the menu item “Global Options” in the file menu.

Sample System

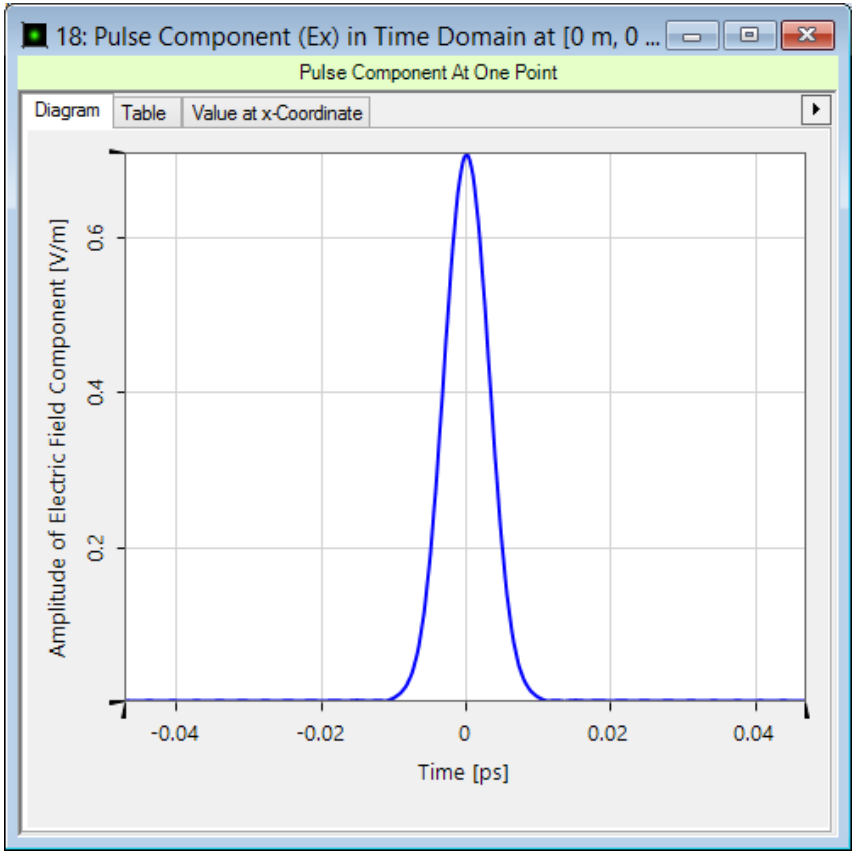


Filename: UseCase.0053_SampleSystem.lpd

Sample System (3D View with Rays)

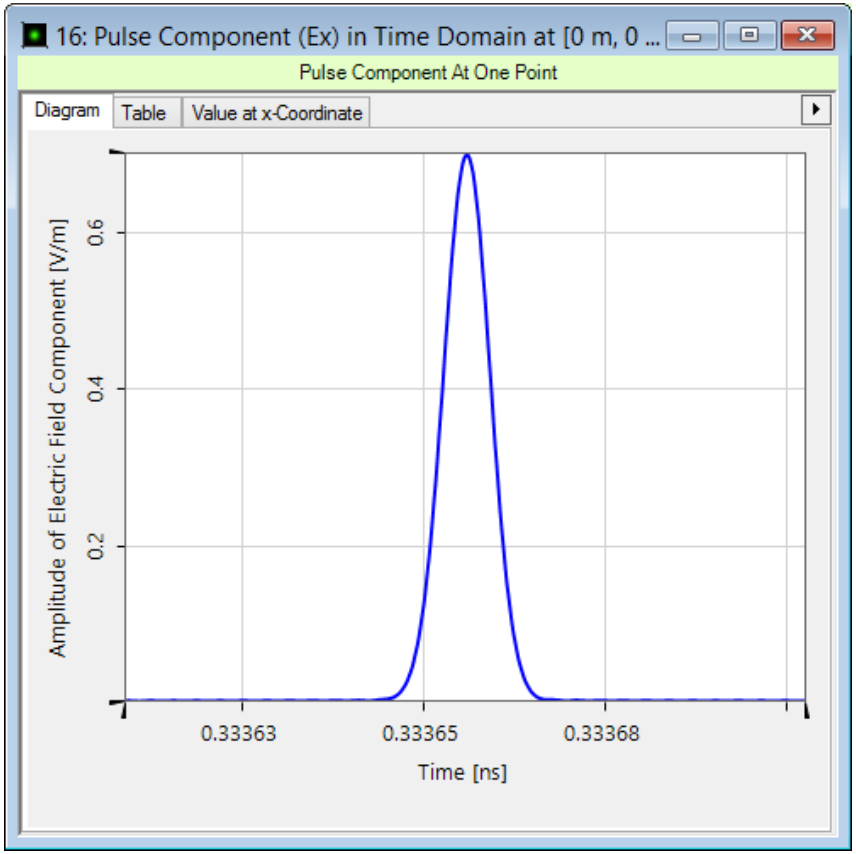


Result Simulation 5 fs Pulse After Source



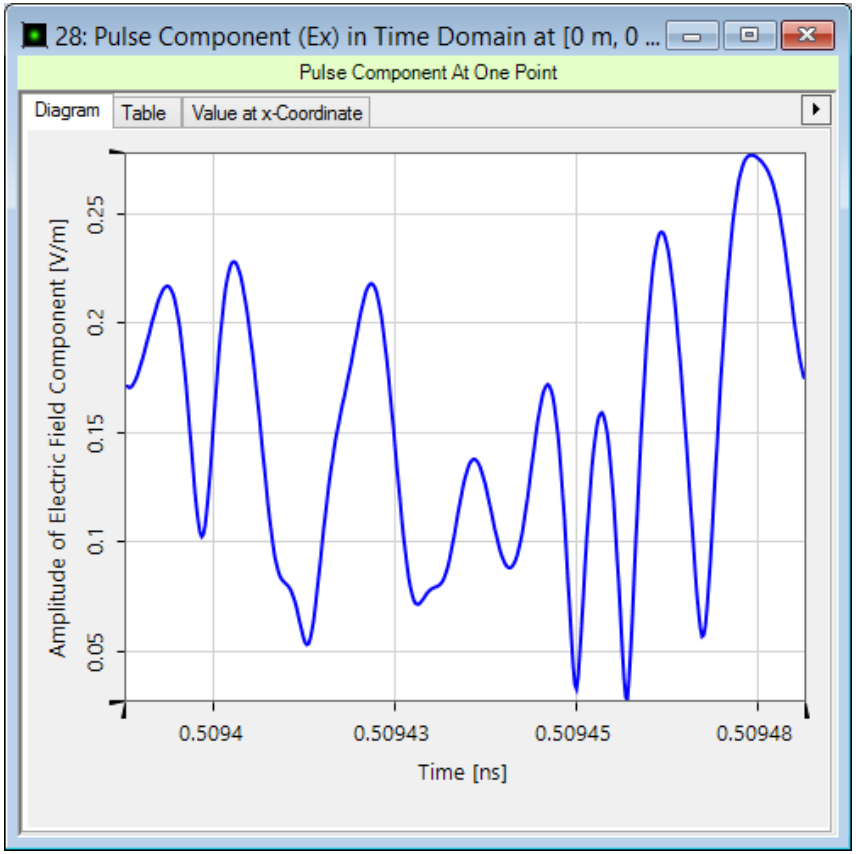
- The pulse (1D) is located centered around the time of **0 s**.
- The pulse duration is **5.2239 fs** (measured by FWHM detector).
- The time window of the pulse is as large as necessary. The information displayed is numerically correct.

Result Simulation 5 fs Pulse in 100 mm Air



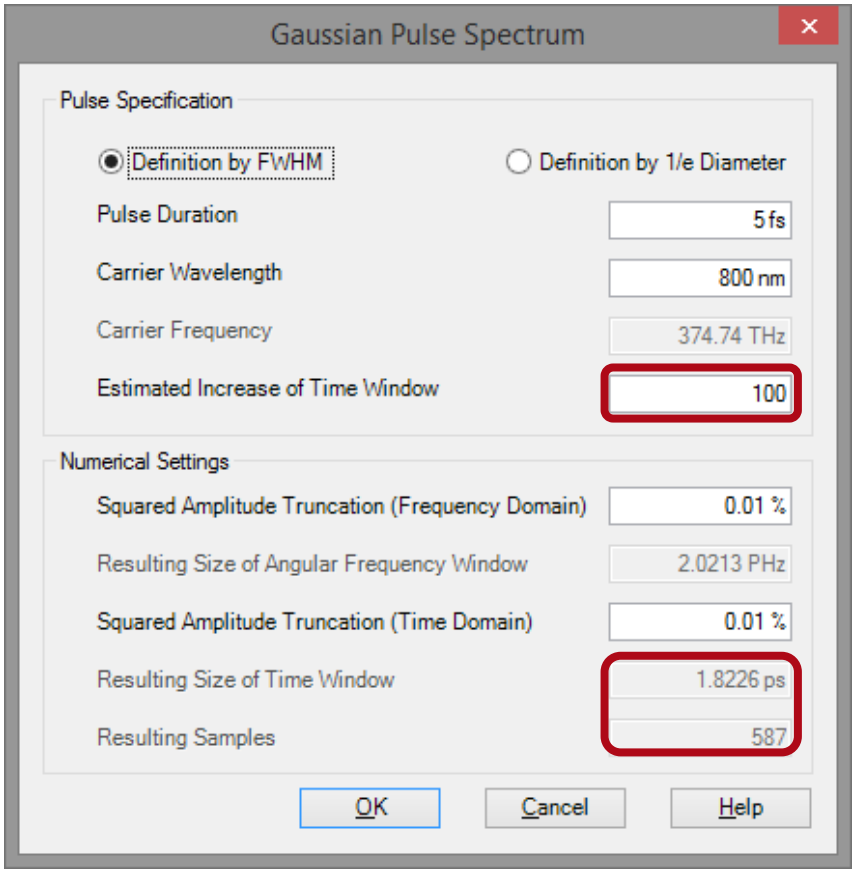
- The pulse (1D) is located centered around the time of **333.66 ps**.
- The pulse duration is **5.3376 fs** (measured by FWHM detector).
- The time window of the pulse is as large as necessary. The information displayed is numerically correct.

Result Simulation 5 fs Pulse in 100 mm BK7



- The pulse (1D) is located centered around the time of **509.43 ps**.
- The pulse duration measurement makes no sense.
- The time window of the pulse is too small. The information displayed is numerically not correct.

Initial Time Window Size?

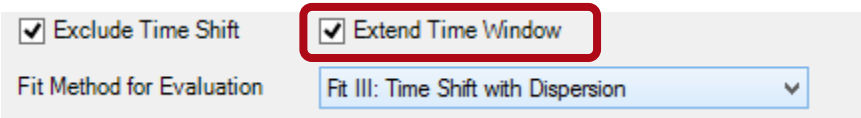


- In this example the resulting pulse has a size of several ps (we will see that soon).
- Preparation in the initial time window would require more than 550 harmonic fields!

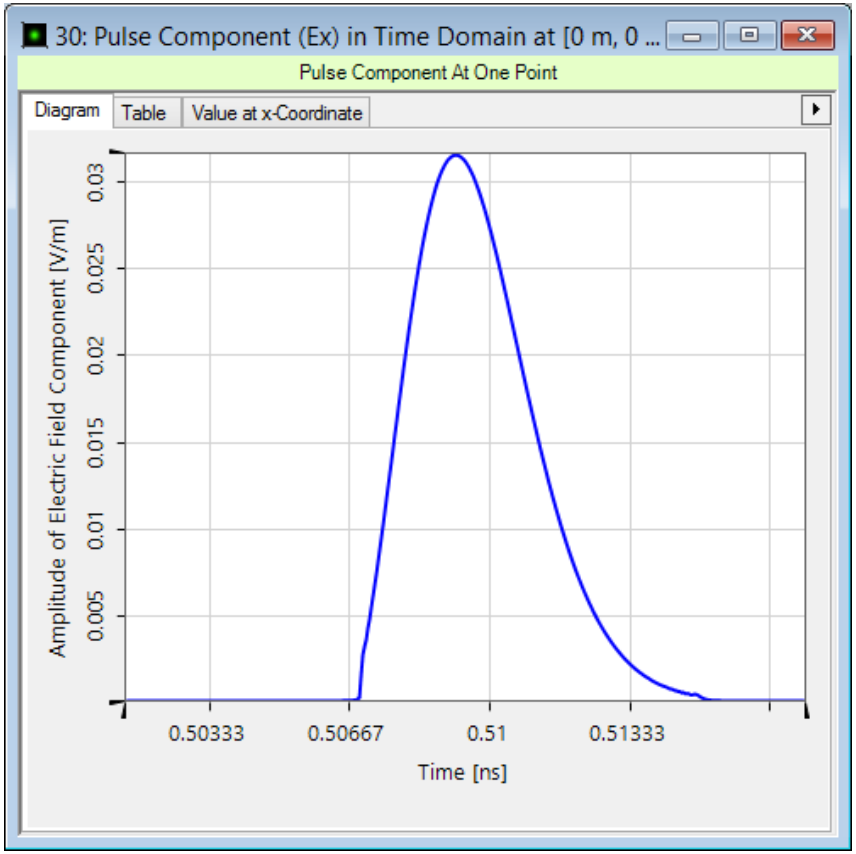
Not practical for fast simulation!

Smart Inclusion of Material Dispersion

- VirtualLab offers a smart solution to this problem.
- The pulse evaluation detector provides the change of phase due to material dispersion: phase residual
- That can be calculated for an arbitrarily fine frequency sampling.
- Smart processing allows increase of time window in order to house pulse without increase of initial time window.
- This option can be enabled by selecting extend time window option within the pulse evaluation detector.

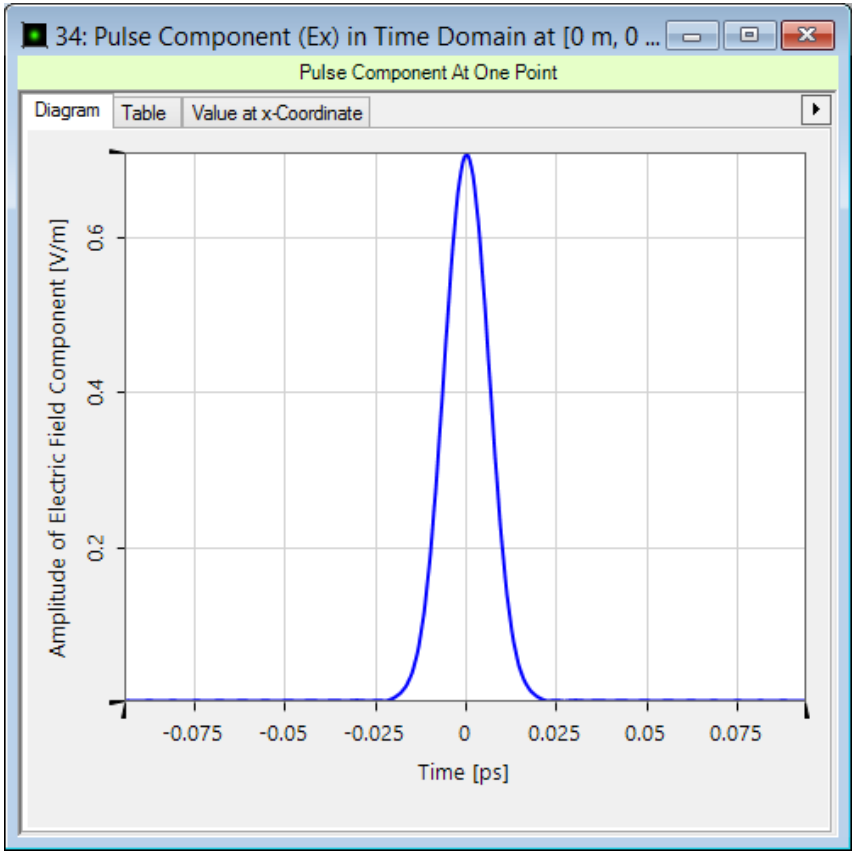


Result Simulation 5 fs Pulse in 100 mm BK7



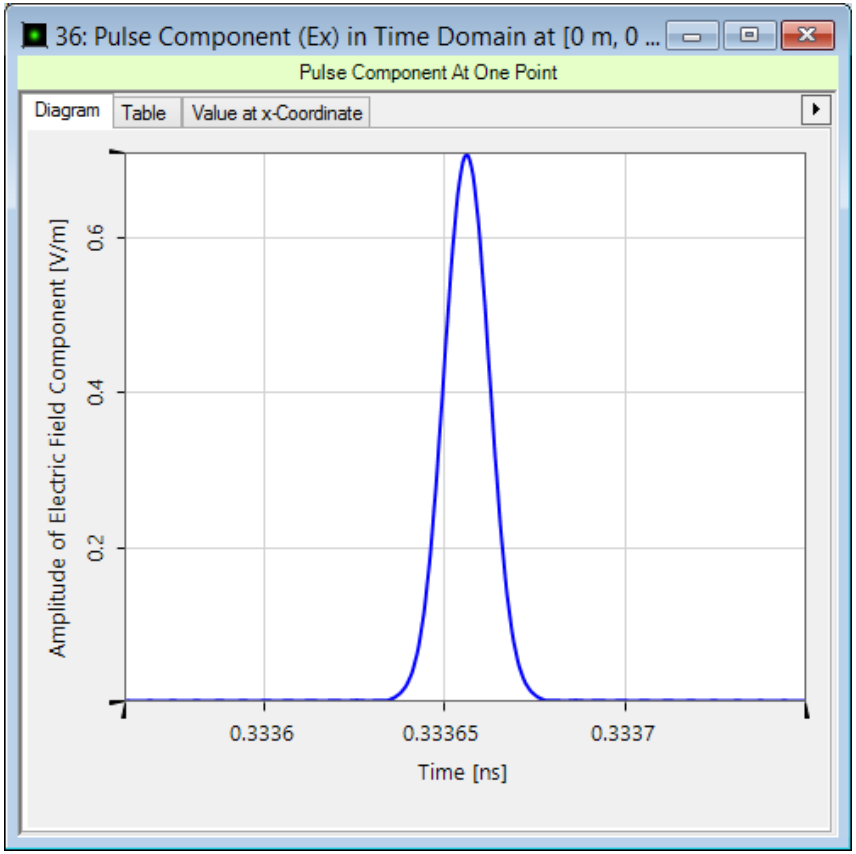
- By applying the VirtualLab algorithm to automatically enlarge the time window, the pulse can be reconstructed, without using more frequency samples as before.
- The pulse duration is **2.3721 ps** (measured by FWHM detector).

Result Simulation 10 fs Pulse After Source



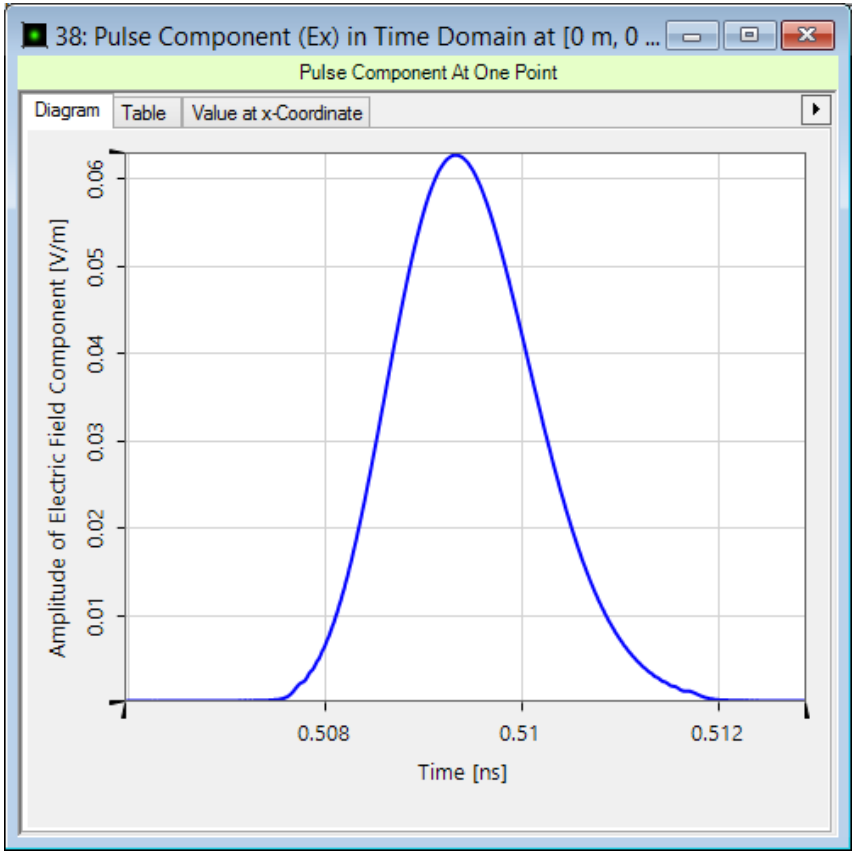
- The pulse (1D) is located centered around the time of **0 s**.
- The pulse duration is **10.448 fs** (measured by FWHM detector).

Result Simulation 10 fs Pulse in 100 mm Air



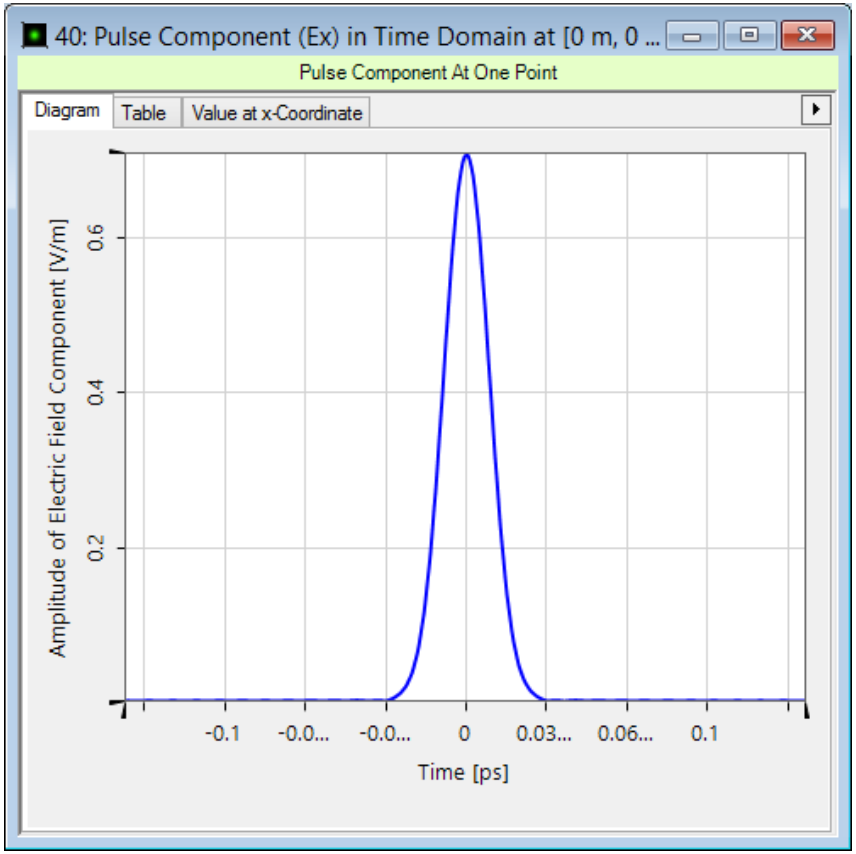
- The pulse (1D) is located centered around the time of **333.66 ps**.
- The pulse duration is **10.462 fs** (measured by FWHM detector).

Result Simulation 10 fs Pulse in 100 mm BK7



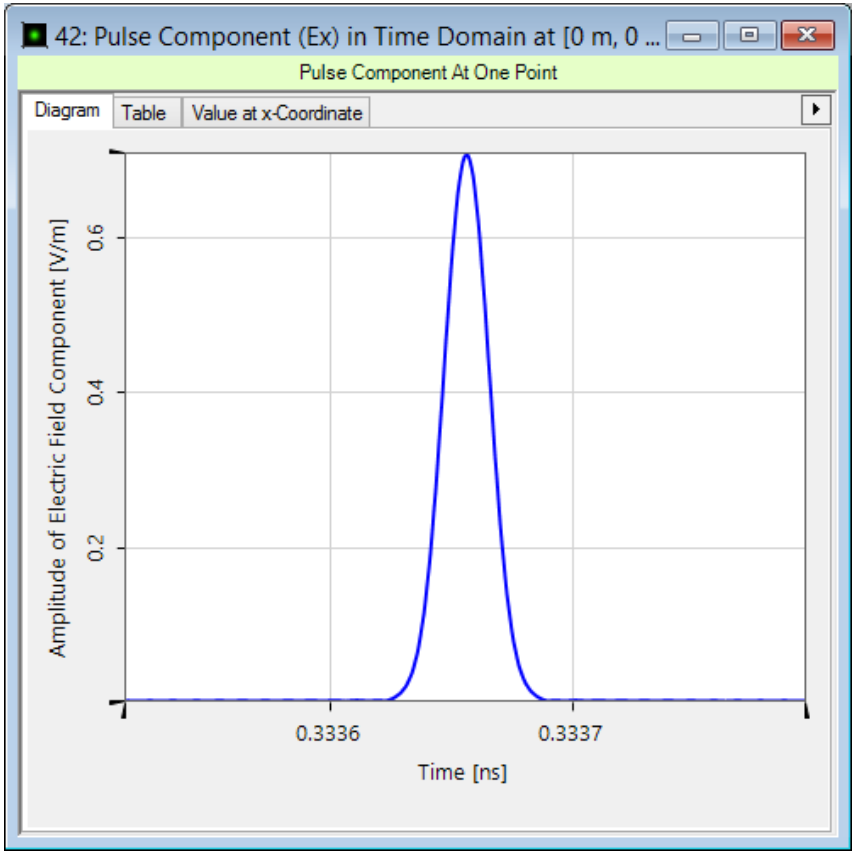
- The pulse (1D) is located centered around the time of **509.33 ps**.
- The pulse duration is **1.1962 fs** (measured by FWHM detector).
- These values can be calculated efficiently by using the algorithm to include the material dispersion smart

Result Simulation 15 fs Pulse After Source



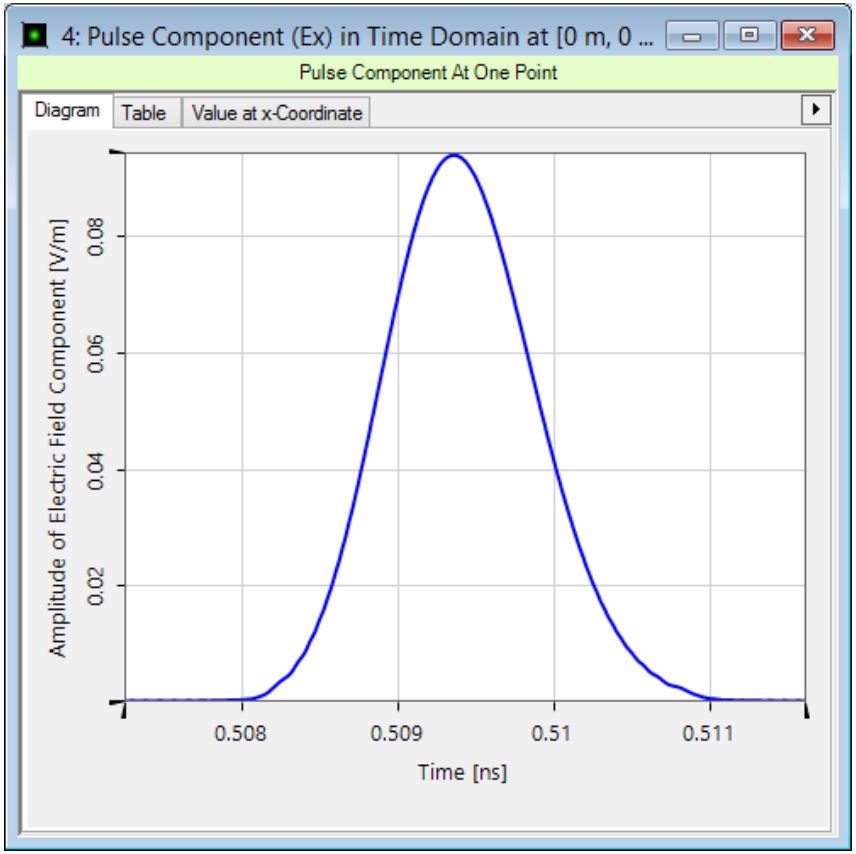
- The pulse (1D) is located centered around the time of **0 s**.
- The pulse duration is **15.672 fs** (measured by FWHM detector).

Result Simulation 15 fs Pulse in 100 mm Air



- The pulse (1D) is located centered around the time of **333.66 ps**.
- The pulse duration is **15.676 fs** (measured by FWHM detector).

Result Simulation 15 fs Pulse in 100 mm BK7



- The pulse (1D) is located centered around the time of **509.43 ps**.
- The pulse duration is **800.83 fs** (measured by FWHM detector).
- These values can be calculated efficiently by using the algorithm to include the material dispersion smart

Summary

- VirtualLab enables the evaluation of pulses using the pulse evaluation detector.
- Material dispersion is included within the simulation of pulses using VirtualLab.
- Temporal dispersion leads to extension of the time window of the propagated pulse. This would typically result in an oversampling in frequency domain.
- With the smart sampling techniques of VirtualLab it is not necessary to trace significantly more frequencies, but to use the optical path length information of the system for a smart interpolation technique.