Research report
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Detection of THz wavefront

The basic experimental setup of THz wavefront analysis is shown in Fig.1.

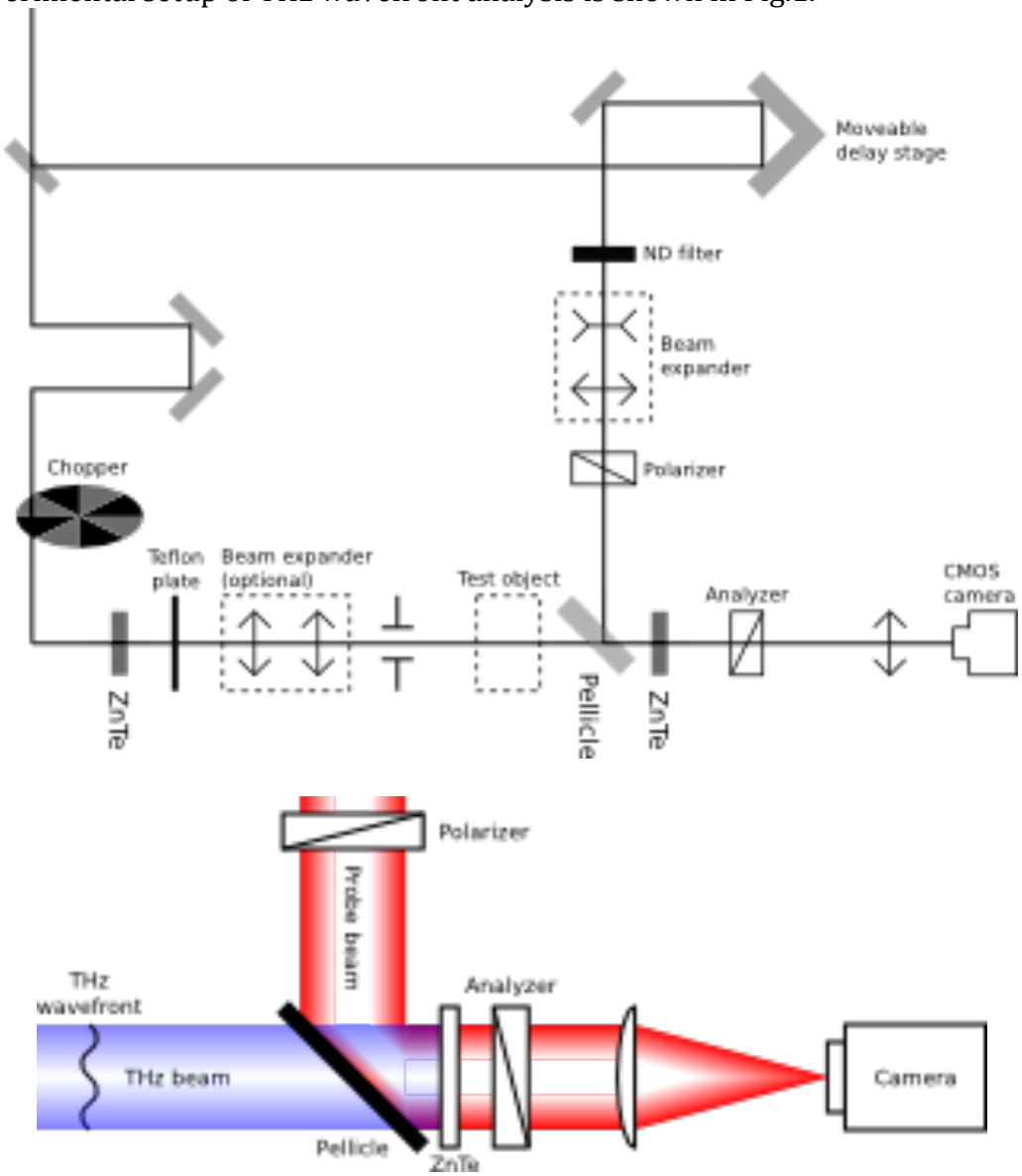

Fig. 1. Setup for THz wavefront analysis

Some images of the detected beam profile due to several conditions has been presented in previous report. Currently, I tried to focus on the analysis of only certain condition: planar wave and sphererical wave formed by the introduction of lens.

For planar wave, detection was conducted directly to beam profile of THz beam without any test object. After a THz lens introduced into test object position with three different distances measured from sensing ZnTe: 80 mm, 115 mm, and 150 mm (Fig. 2). Then we tried to analyze these results in frequency domain by transforming the temporal data using FFT. But the results can not be displayed here because of some technical problems (very long calculation due to a huge number of data).

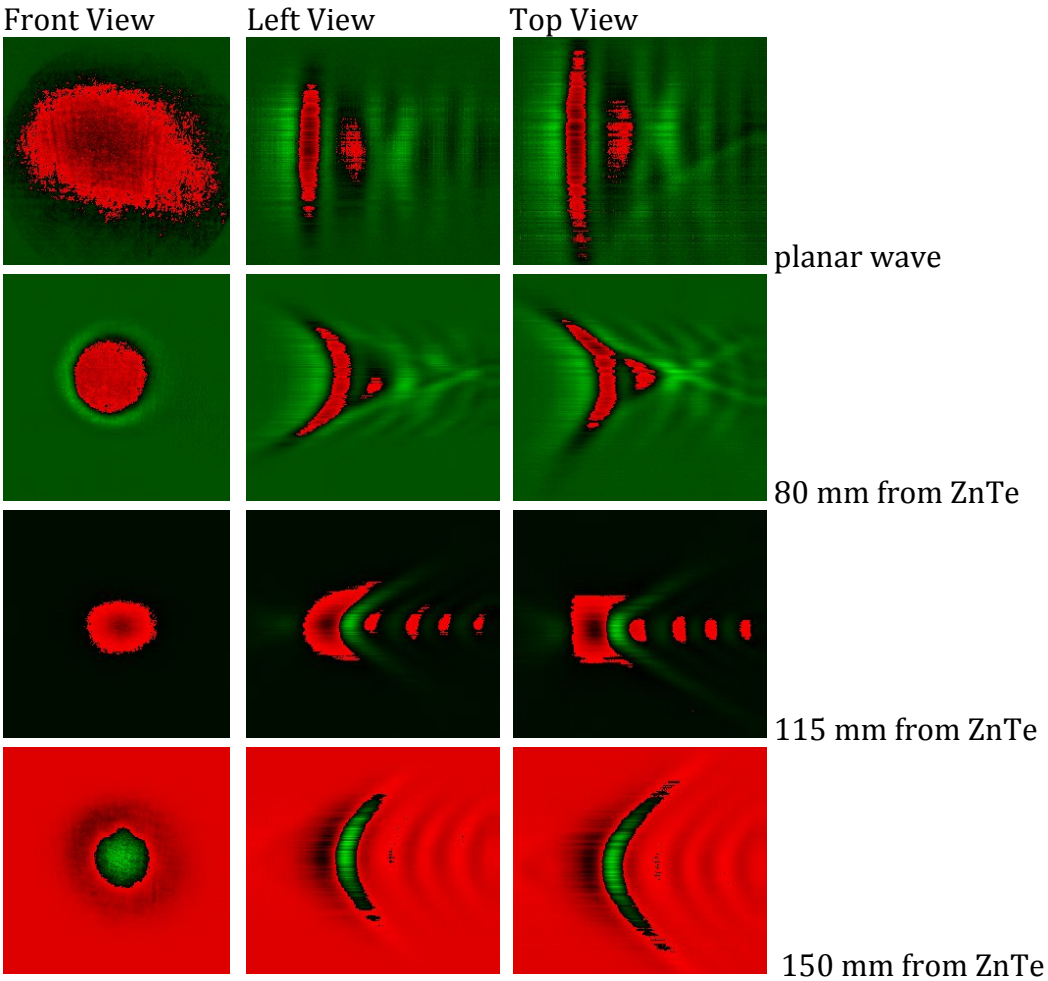

Fig. 8. Image on CMOS camera with different lens distances from ZnTe

For the next experiment, certain condition change should be considered to get sufficient data and to provide better condition for data analysis. The movement of delay stage determines the frequency resolution after FFT. The distance of 1 mm resulted in a time window of 6.67 ps, which equaled to resolution of 0.15 THz. With the sampling number of 260, the time interval was 26 fs and provided a frequency range of 38 THz. The frequency resolution and frequency range did not satisfy the sufficient conditions for spectral analysis for THz beam. Typically, the frequency range of THz beam is between 0.1 to 2 THz.

I considered to increase the frequency resolution by 10 times (0.015 THz) and decrease the frequency range by 10 times (4 THz). Therefore, the time window and the time interval should equal to 66.67 ps and 256 fs, respectively. Due to it, the movement of delay stage should be 10 mm and the sampling number should be 260. If the movement of delay stage is kept like current condition, the THz profile generated by ZnTe crystal due to EO sampling mechanism will not change (just the change of temporal range/frequency range). The SNR will also get better because of longer acquisition time. In order to get an identical beam profile, the total acquisition time should be equal. Therefore, the movement speed of delay stage should be increase by 10 times. Table 1 shows the summary of these condition change.

Table 1. Comparison of experiment conditions

Condition 1	Condition 2	
S = 1 mm	S = 10 mm	
T = 6.67 ps	T = 66.67 ps	
ΔF= 0.15 THz	Δf = 0.015 THz	
N = 260	N = 260	
ΔT = 26 fs	ΔT = 256 fs	
F = 38 THz	F = 4 THz	
V = 40 pulse/s	V = 40 pulse/s	V = 400 pulse/s
t total = 26 s	t total = 260 s	t total = 26 s
t frame = 100 us	t frame = 1 s	t frame = 100 us