Line-field terahertz computed tomography of continuously rotating object

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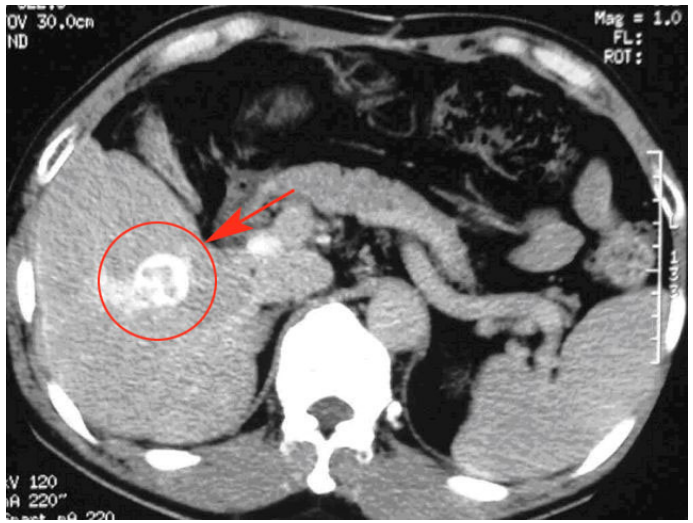
TST2012@Prague (2012.6.19)

X-ray Computed Tomography (X-ray CT)



Utility:
Nondestructive inspection
Medical imaging

Advantage:
High penetration

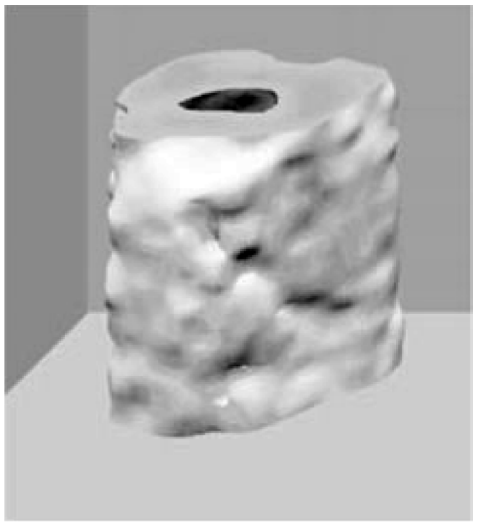
Disadvantages:
Hazardous ionizing effect
Too high penetration
Monochrome image
→Difficult to analyze chemical components

THz CT

THz radiation

Moderate penetration in opaque soft materials, insensitivity to optical scattering, low photon energy, and good beam coherence
Spectral images for material characterization

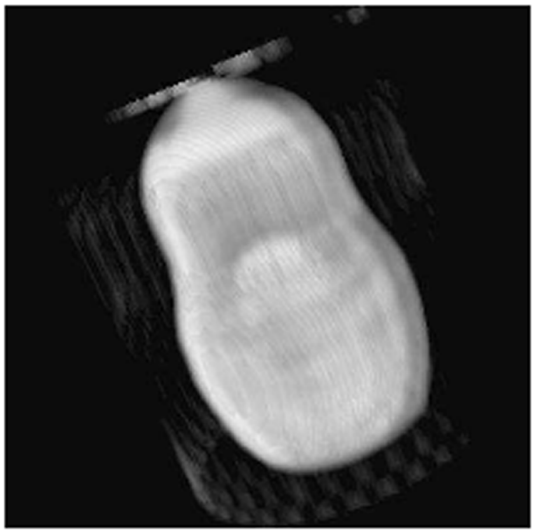
Optical photograph



THz CT image

*Ref) Ferguson, OL **27**, 1312 (2002).*

Optical photograph

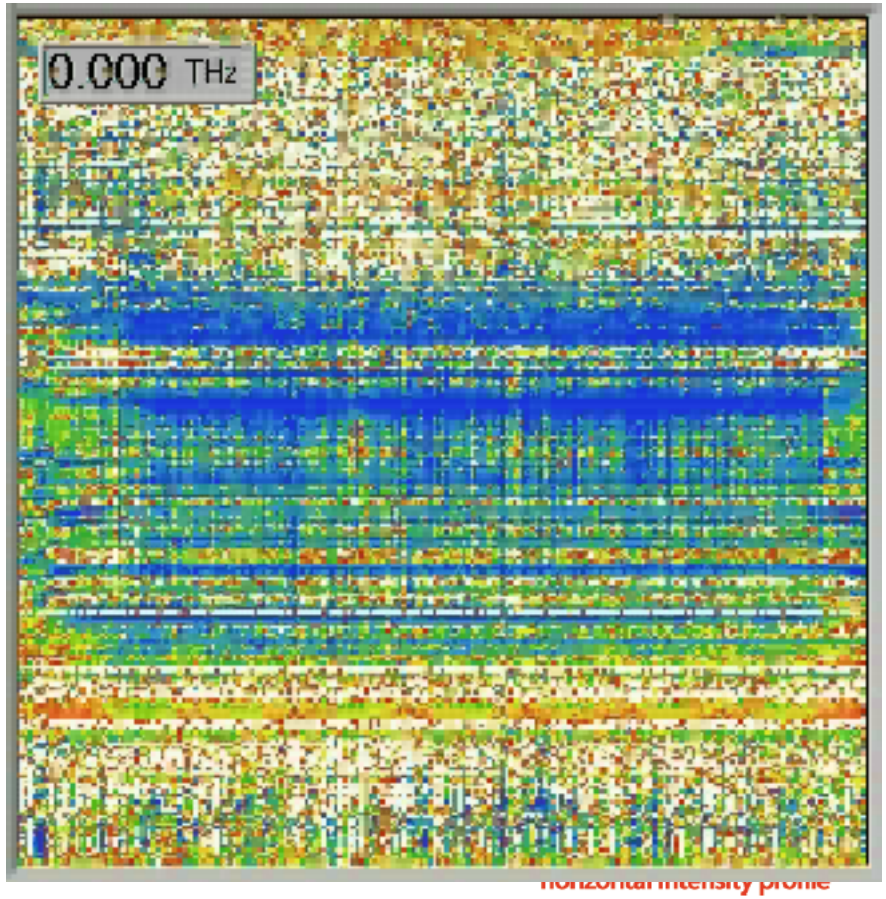


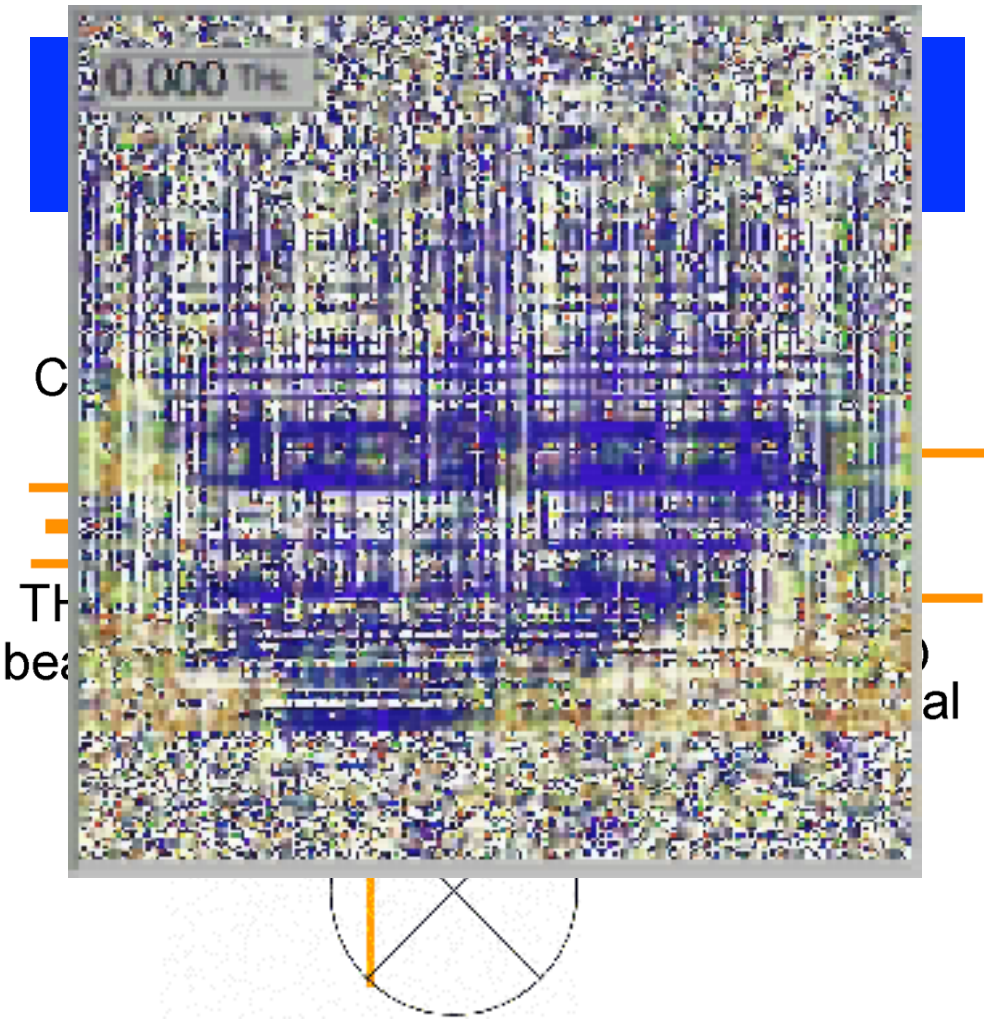
THz CT image

*Ref) Recur, OpEx **19**, 5105 (2011).*

Rapid THz color scanner equipped with real-time line scanning of THz beam

*Ref) Yasui, OpEx **16**, 1208 (2008); Schirmer, Biomed. OpEx **1**, 354 (2010) .*





*Ref) Shan, OL **25**, 426 (2000)*

Present talk

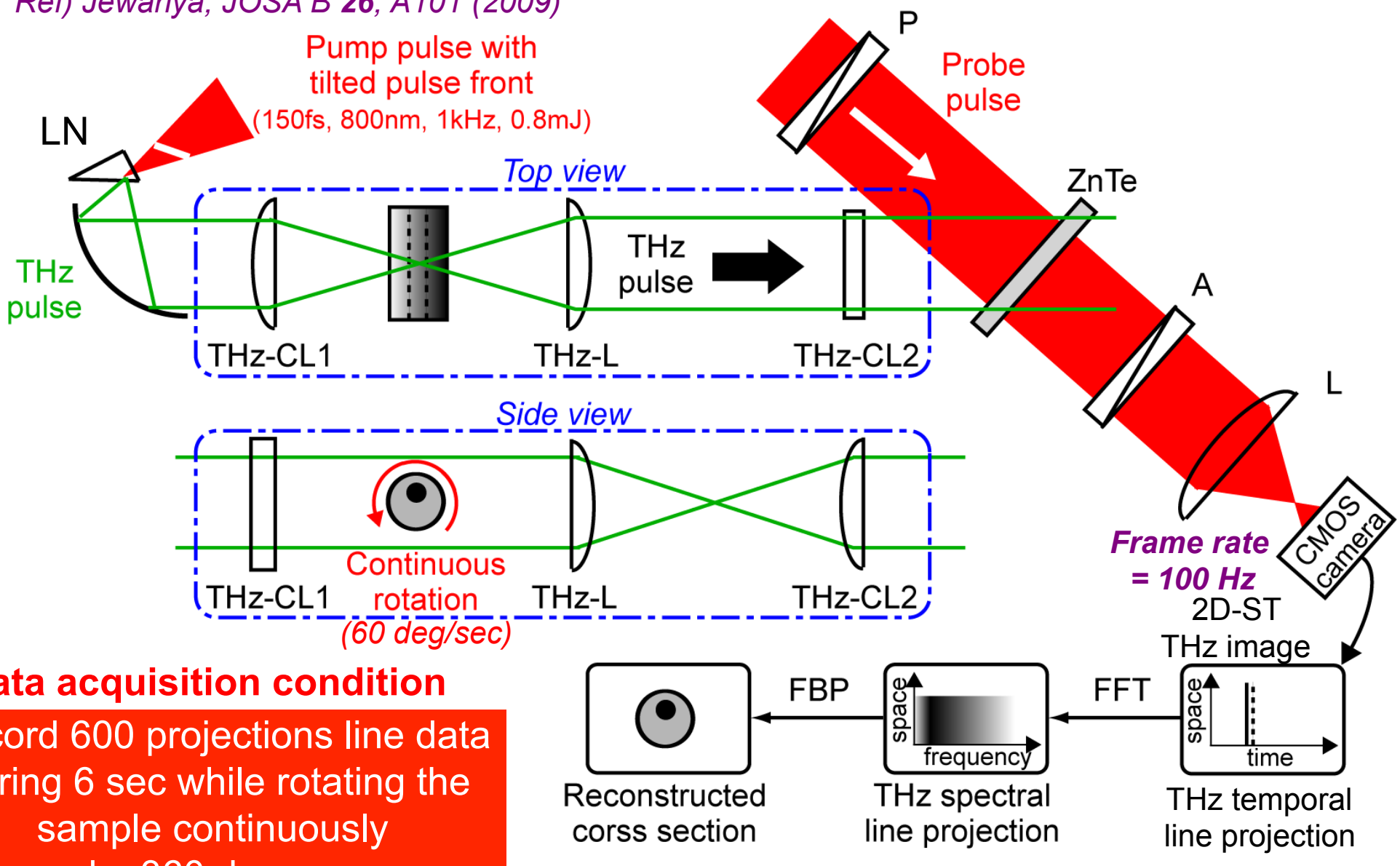
THz color line projection in real time without any mechanical scanning

Significant increase of image acquisition rate in THz CT

- Fast THz CT system based on real-time line projection of THz beam
- Apply it for continuously rotating sample

Experimental setup

*Ref) Jewariya, JOSA B **26**, A101 (2009)*

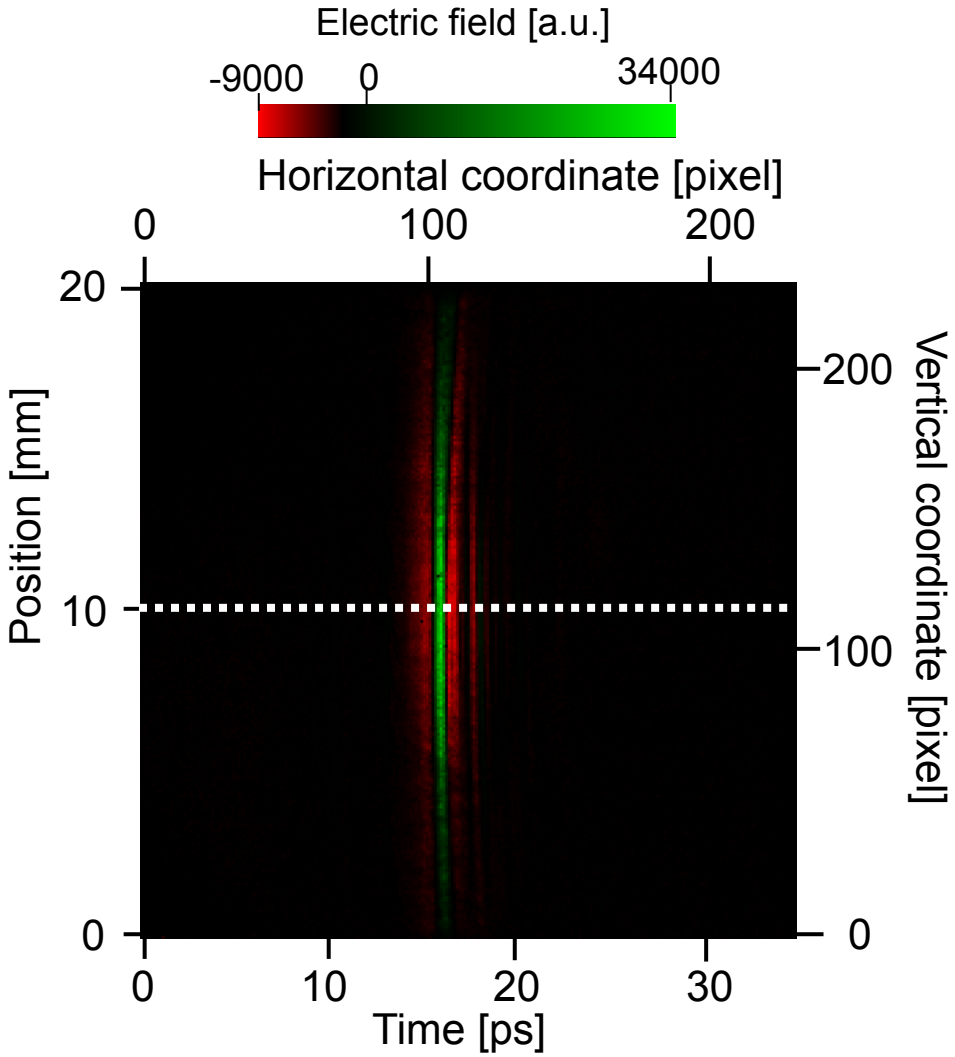


Data acquisition condition

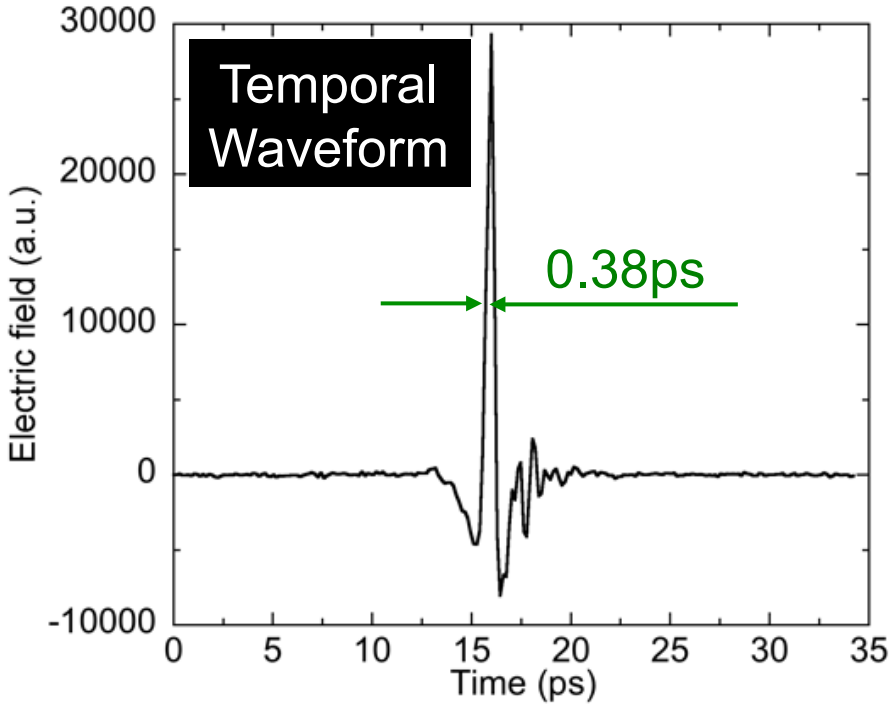
Record 600 projections line data during 6 sec while rotating the sample continuously by 360 degree

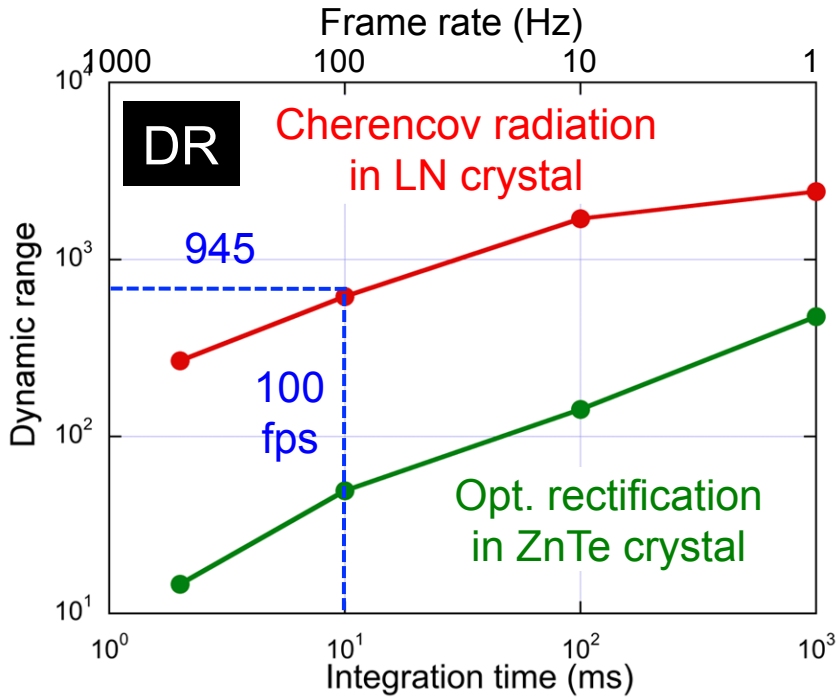
FBP: filtered back-projection

Time characteristics



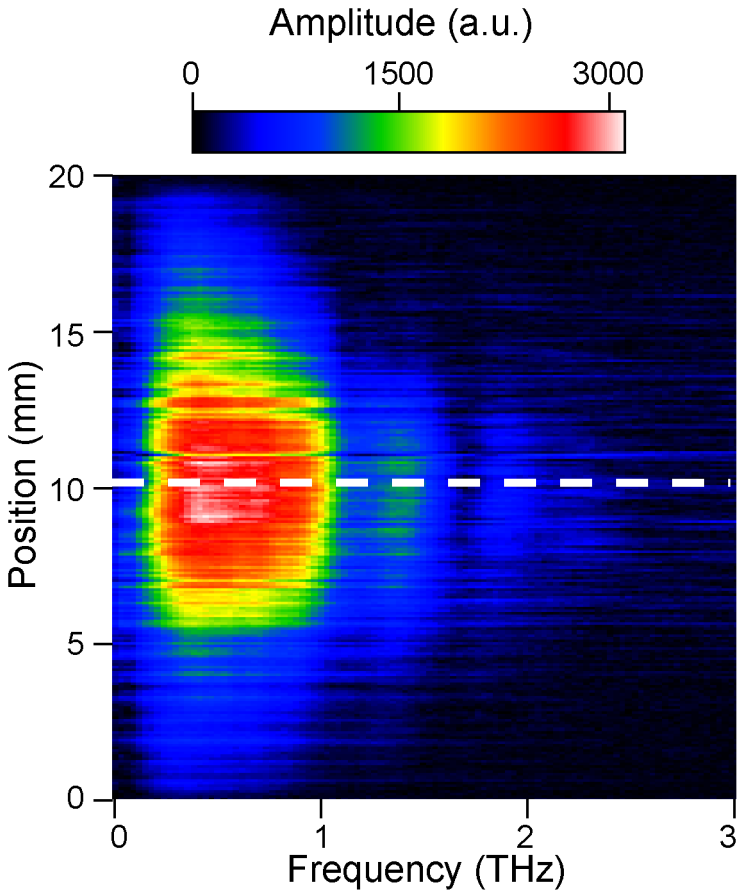
Temporal line projection data (without sample)



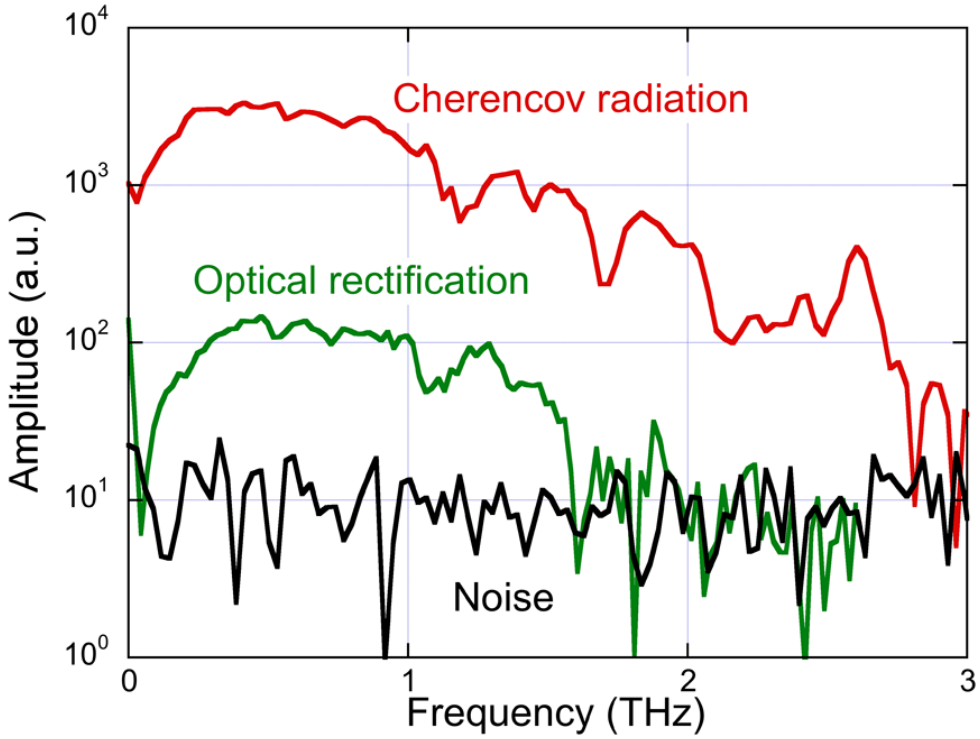


Spectral characteristics

Line projection data of spectral amplitude



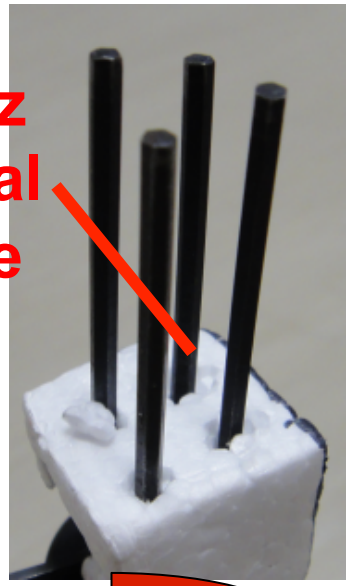
Comparison of amplitude spectrum



Spectral bandwidth = 3THz, Spectral resolution = 27GHz

Result (1): Four metallic bars (ϕ=2 mm)

Sample photograph



THz focal line

Continuous rotating (360degree@6sec)

Weak Signal Strong

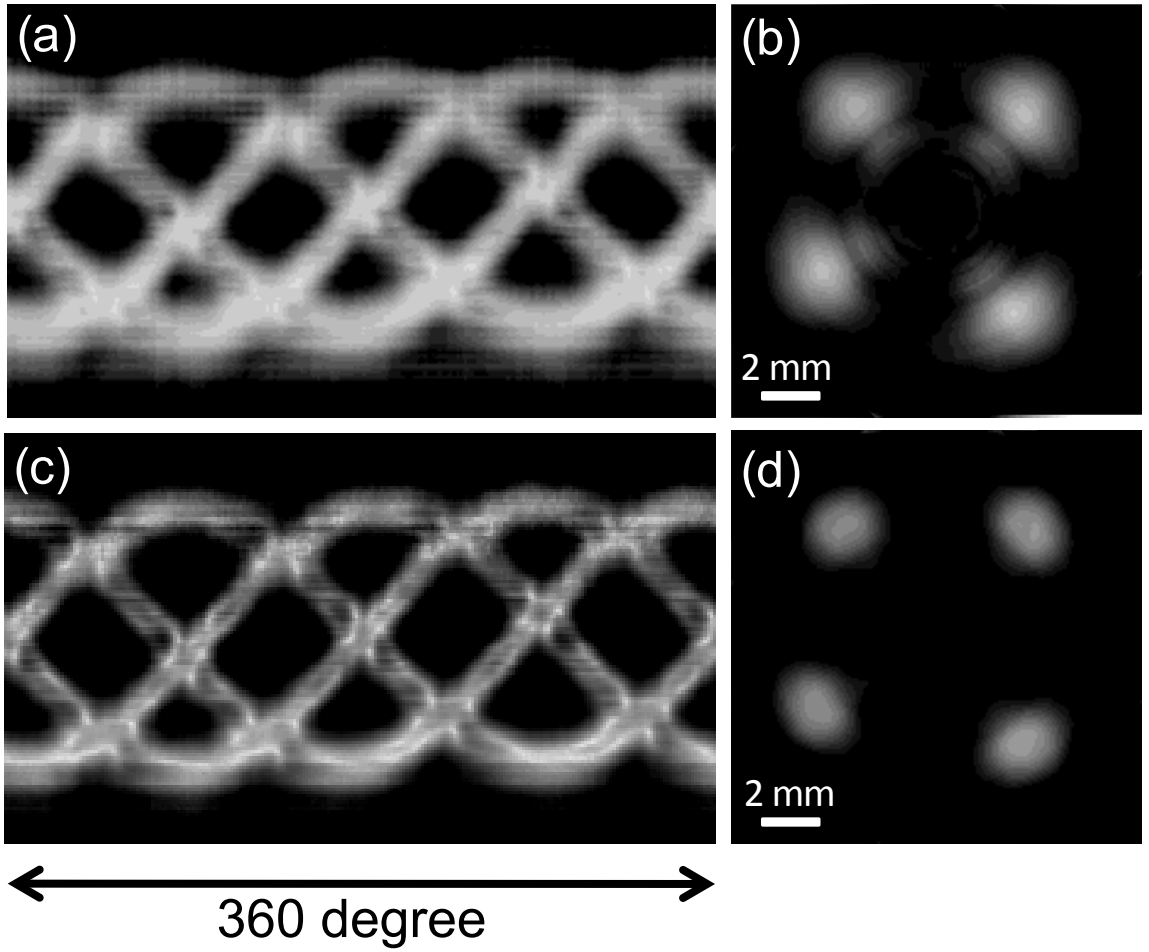
Sinogram

Reconstructed cross-section

$E_{p\text{-}p}$

20 mm

Spectral Amp. at 0.6 THz



Result (2): Teflon cylinder (ϕ=10 mm) drilled with off-axis cylindrical hole (ϕ=2 mm)

Sample

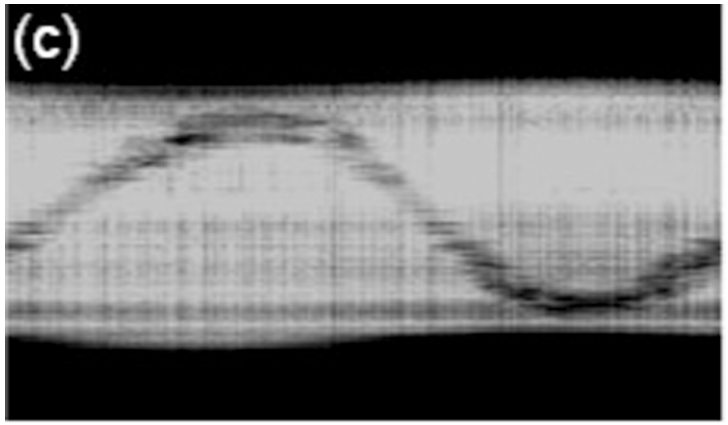
n=1.45, α=2cm^{-1}

Continuous rotating (360degree@6sec)

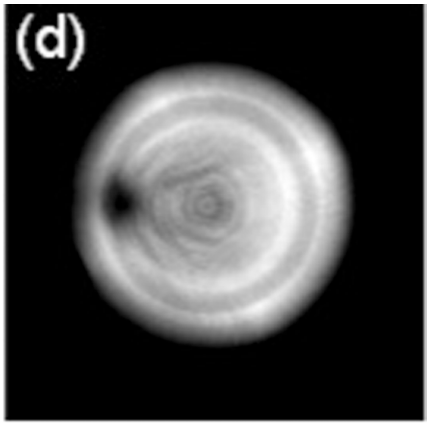
Weak Signal Strong

E_{p-p}

Sinogram



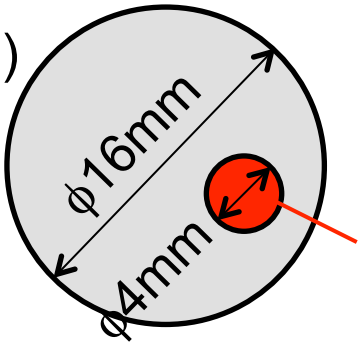
Reconstructed cross-section



Result (3): Powder sample (30% lactose and 70% PE) filled in off-axis hole of foam cylinder

Foam
(n=1.15,
α=0.1cm^{-1})

Sample

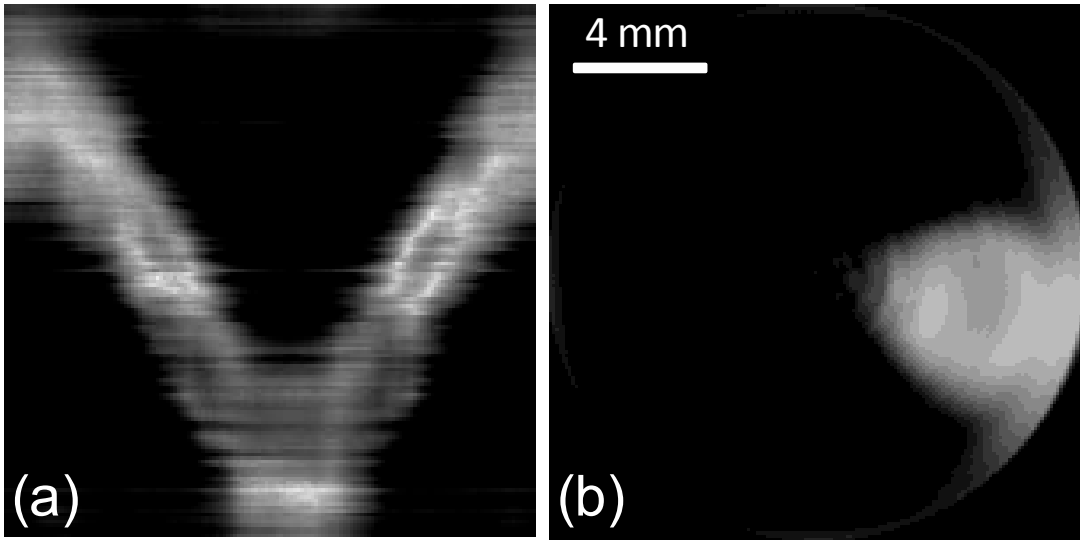


Powder sample

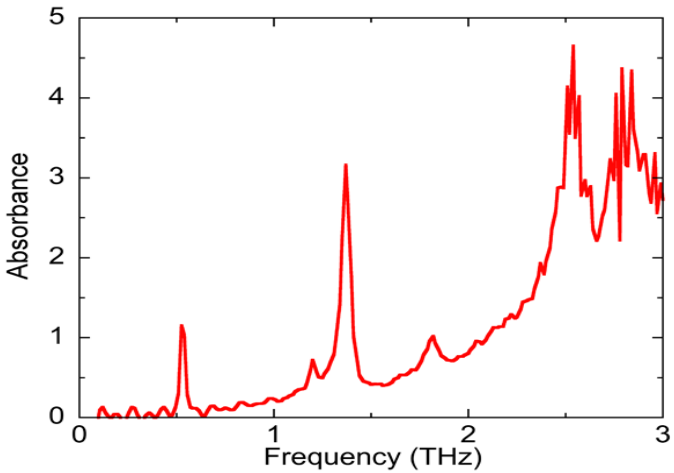
Weak Signal Strong

Sinogram

Reconstructed cross-section



Absorption spectrum of lactose powder



Spect. amp. at 0.53 THz

Summary

(1) THz CT equipped with real-time line projection at a frame rate of 100 Hz

(2) Measurement of continuously rotating object at a speed of 60 deg/sec