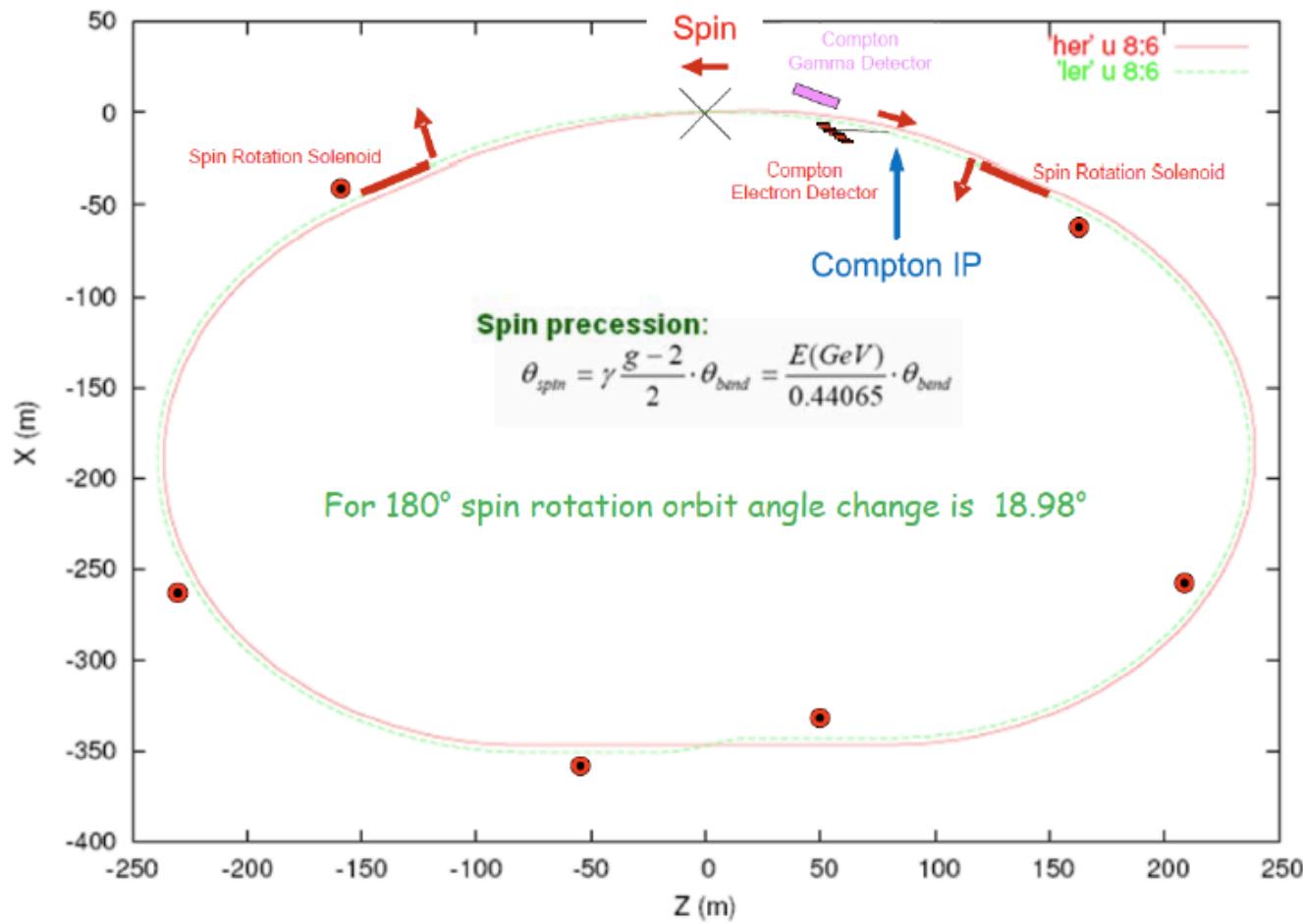


Compton backscattering polarimeter and energy measurement

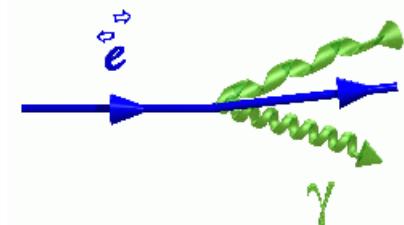
Presented by D. Moricciani
INFN - Roma "Tor Vergata"

Spin dynamics at SuperB

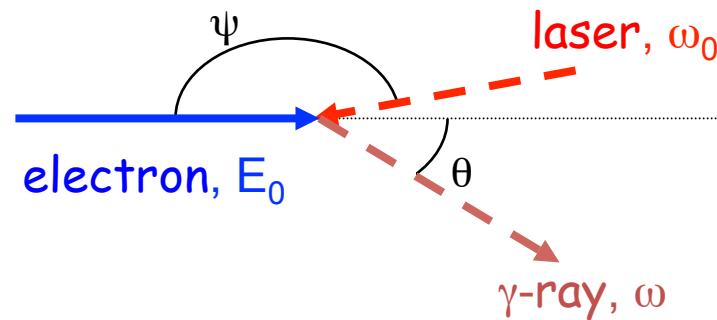
Interaction Region



- The electron beam LER ($E=4.18 \text{ GeV}$) is polarized
- The Compton Backscattering (CBS) technique could be used to measure both: Longitudinal Polarization and Energy



CBS kinematics (2 body)



$$\omega(\theta, \psi) = \frac{\omega_0 (1 - \beta \cos \psi)}{1 - \beta \cos \theta + \frac{\omega_0}{E} [1 - \cos (\psi - \theta)]}$$

head-on collision ($\psi = \pi$) +
electron high energy ($\gamma \gg 1$)

$$\omega(\theta) \simeq \frac{4 \gamma^2 \omega_0}{1 + 4 \gamma \frac{\omega_0}{m_e} + \gamma^2 \theta^2}$$

backward scattering ($\theta = 0$)
i.e. Compton Edge

$$\omega^{\max} = \frac{4 \gamma^2 \omega_0}{1 + 4 \gamma \frac{\omega_0}{m_e}}$$

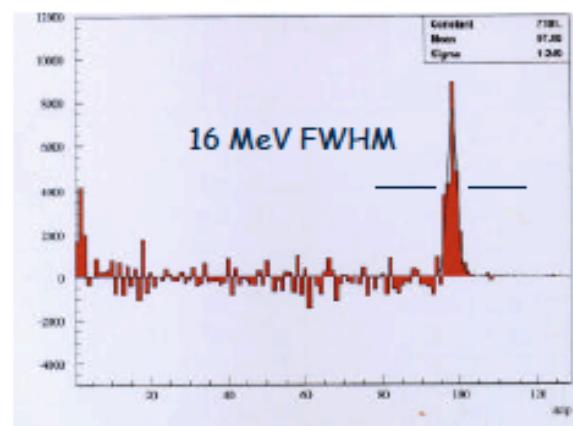
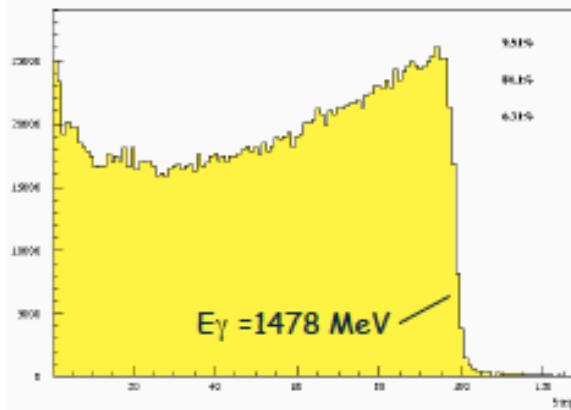
Main Characteristics of the CBS beam

- The energy spectrum follow the Klein-Nishina differential cross section
- The Compton Edge identify the kinematical case of a head-on collision ($\psi=\pi$) and backward ($\theta=0$) scattering
- In this condition is not possible transfer angular momentum between incoming polarized photon and outgoing electron i.e. the outgoing photon has the same polarization of the incoming one

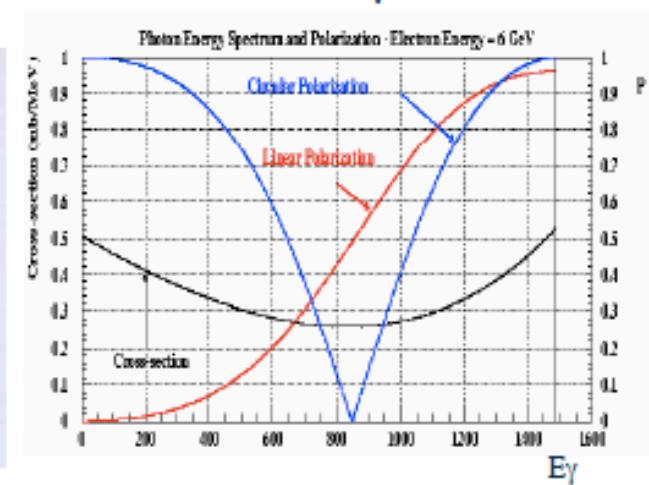
Graal $\bar{\gamma}$ beam characteristics

- Energy Resolution: we use an internal tagging made of 128 silicon μ -strips which provide a resolution of 16 MeV (FWHM)
- Polarization: since we use polarized laser light against relativistic electrons \rightarrow the produced $\bar{\gamma}$ beam is polarized

Tagged spectrum

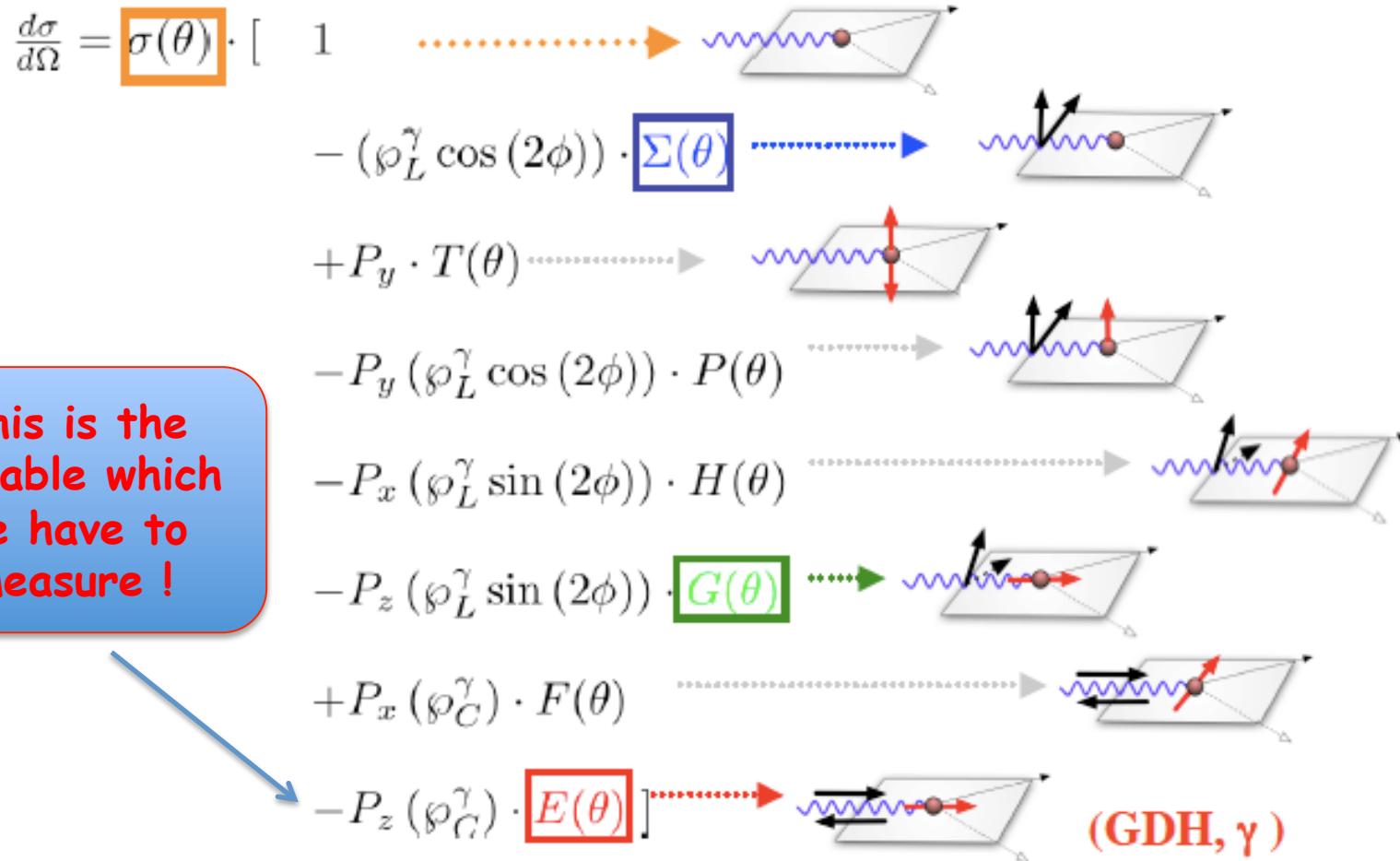


High degree of linear
and circular polarization



Polarization Measurement

Polarization observables of $\vec{\gamma}\vec{e} \rightarrow \gamma e$



$E(\theta)$ asymmetry for the CBS

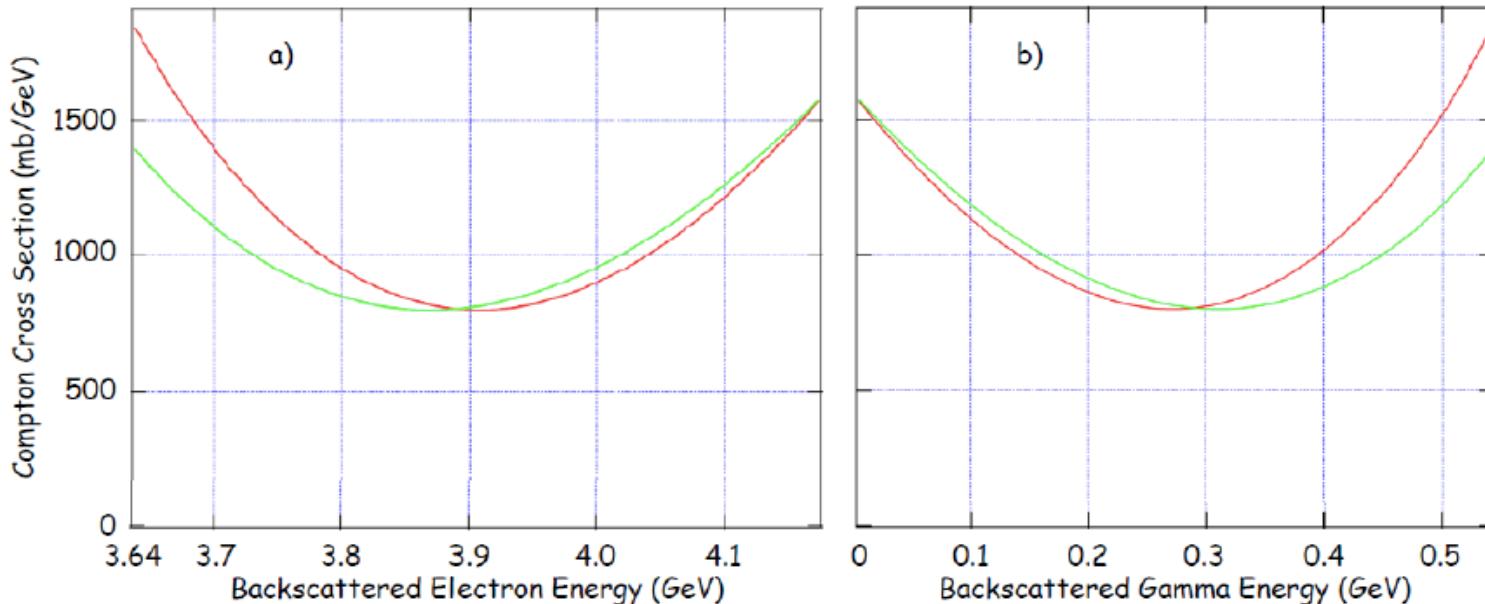


Figure 16.7: Compton cross section for scattering of 532 nm photons with a 4.18 GeV electron beam a) electron energy (b) Gamma energy. The $J_z = 3/2$ ($J_z = 1/2$) cross section for electron and photon spins aligned (anti-aligned) is shown in red/darker line (green/lighter line).

The longitudinal polarization of the electron beam is given by:

$$P_{\text{long}} = \frac{N_{3/2} - N_{1/2}}{N_{3/2} + N_{1/2}}$$

Energy measurements

The Compton Edge is also useful for measure the LER beam energy

- Measuring ω^{\max} we know the energy of the energy of the beam $E_0 = \gamma m_e$

$$\omega^{\max} = \frac{4 \gamma^2 \omega_0}{1 + 4 \gamma \frac{\omega_0}{m_e}}$$

- We can measure the γ -ray ω^{\max} by high resolution detector like Ge or
- We can measure the recoil electron energy $E_{\text{rec}} = E_0 - \omega^{\max}$ using the same magnet of SuperB like magnetic spectrometer

VEPP-4M Performance

Review of beam energy measurements at VEPP-4M collider
KEDR/VEPP-4M \star

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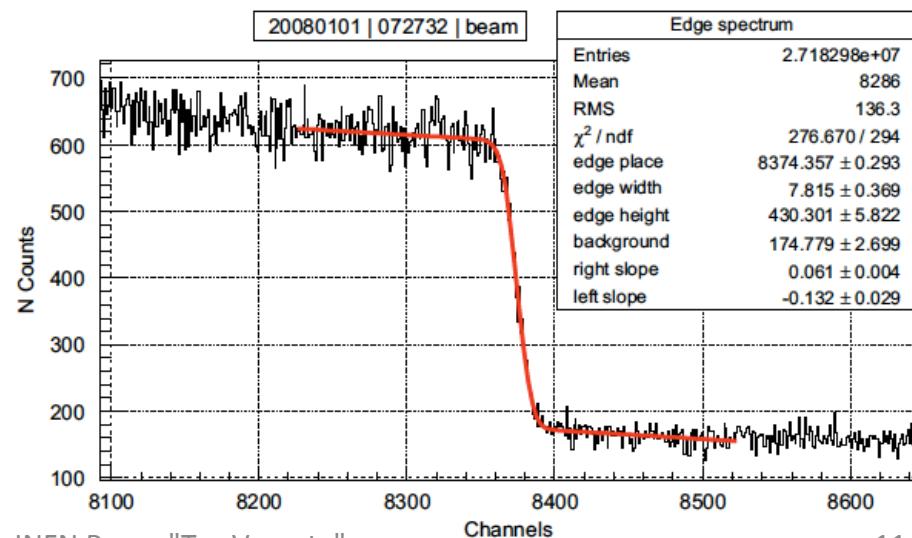
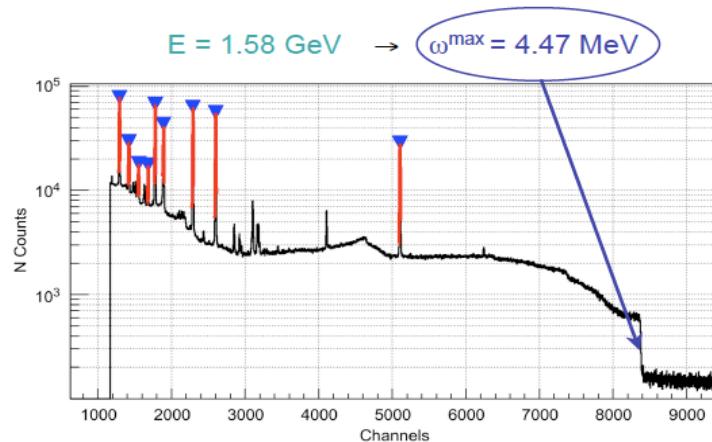
Keywords:
Beam energy measurement
Energy calibration
Depolarization technique
Compton scattering

$$\lambda_0 = 10 \text{ } \mu\text{m}$$

ABSTRACT

An accurate knowledge of the colliding beam energies is essential for the current experiments with the KEDR detector at the VEPP-4M collider. Now the experimental activity is focused on the measurements of τ lepton mass and parameters of narrow resonances of the ψ -family in the c.m. energy range of 3.0–4.0 GeV. Two complementary approaches are used for the beam energy measurements. The resonant spin depolarization technique (RD) provides an accuracy about 1–3 keV for the instantaneous beam energy value, but requires a special regime of the collider. Between calibrations the interpolation procedure is used providing the accuracy of 6–10 keV for the J/ψ , $\psi(2s)$ and 15–30 keV for the τ lepton mass determination experiments.

Another approach allows to calculate beam energy via the maximum energy of backscattering laser photons. The Compton BackScattering (CBS) monitor allows continuous on-line monitoring of the beam energy with accuracy about 150 keV, which is critical during the τ lepton mass measurement. The statistical error for a 1 h period is about 100 keV, the present systematic error is 50–70 keV.



Graal Performance

PRL 104, 241601 (2010)

PHYSICAL REVIEW LETTERS

week ending
18 JUNE 2010

Limits on Light-Speed Anisotropies from Compton Scattering of High-Energy Electrons

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The possibility of anisotropies in the speed of light relative to the limiting speed of electrons is considered. The absence of sidereal variations in the energy of Compton-edge photons at the European Synchrotron Radiation Facility's GRAAL facility constrains such anisotropies representing the first nonthreshold collision-kinematics study of Lorentz violation. When interpreted within the minimal standard-model extension, this result yields the two-sided limit of 1.6×10^{-14} at 95% confidence level on a combination of the parity-violating photon and electron coefficients $(\tilde{\kappa}_{o+})^{YZ}$, $(\tilde{\kappa}_{o+})^{ZX}$, c_{TX} , and c_{TY} . This new constraint provides an improvement over previous bounds by 1 order of magnitude.

$$\omega^{\max} = \frac{4 \gamma^2 \omega_0}{1 + 4 \gamma \frac{\omega_0}{m_e}}$$

$$\beta^2 = (1 - 1/\gamma^2)$$

$$\Delta\beta/\beta \leq 1.6 \times 10^{-14}$$

$$E_o = 6.03 \text{ GeV}$$

$$\Delta E/E = 1.4 \times 10^{-6}$$

$$\Delta E = 8.4 \text{ keV}$$

SuperB case

- CO₂ laser will produce a Compton Edge of 31.1 MeV, could be a problem for absolute energy calibration
- We can use the M1 level of ¹²C at 15.1 MeV.
This level could be excited only by using a linear polarized photon
- In this case we need a laser with $\lambda_0 \geq 21.9 \mu\text{m}$

Terahertz Laser R&D

JOURNAL OF APPLIED PHYSICS

VOLUME 95, NUMBER 11

1 JUNE 2004

Widely tunable terahertz-wave generation in an organic crystal and its spectroscopic application

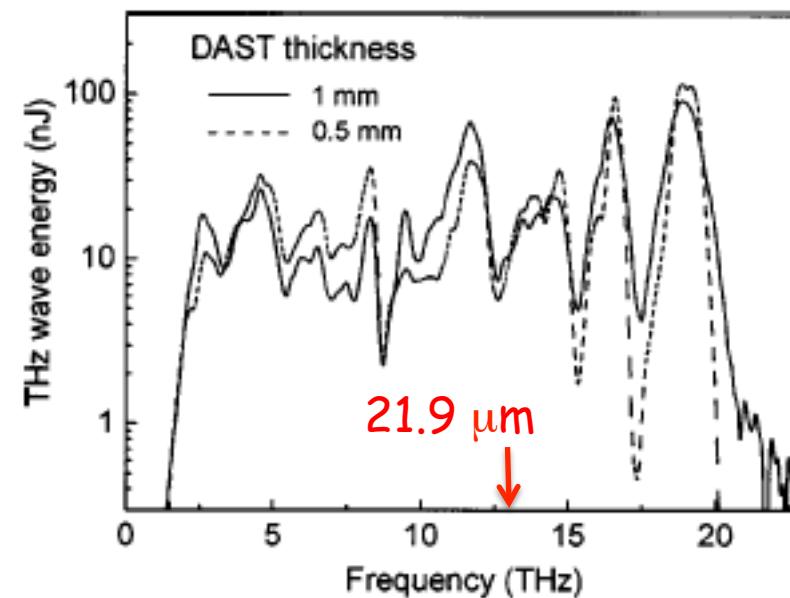
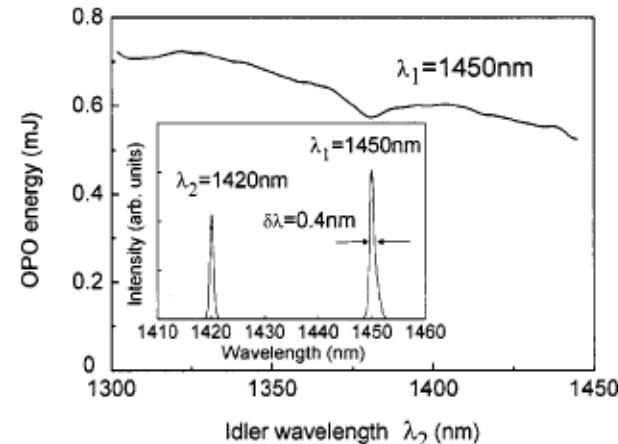
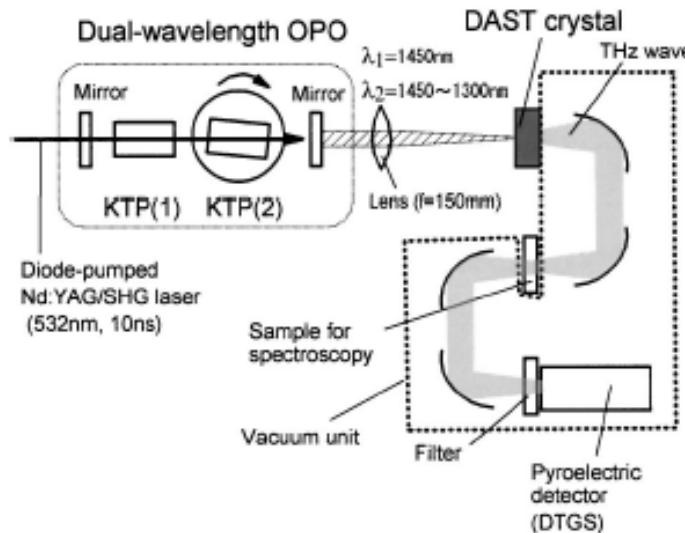
T. Taniuchi,^{a)} S. Okada, and H. Nakanishi

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(Received 22 October 2003; accepted 2 March 2004)

Terahertz (THz)-wave generation using difference-frequency mixing in an organic 4-N, N-dimethylamino-4'-N'-methyl-stilbazolium tosylate (DAST) crystal was investigated theoretically and experimentally. We developed a dual-wavelength optical parametric oscillator (OPO) with two KTiOPO₄ crystals as the input light source. This oscillator has a tunable range from 1300–1450 nm and is pumped by a diode-pumped, frequency-doubled, Q-switched Nd:YAG laser with a pulse duration of 10 ns. Widely tunable THz waves ranging from 2 to 20 THz were generated from DAST crystals with 0.5- and 1-mm thickness using the OPO. THz output energies of 82 nJ (peak power of 10.3 W) at 11.6 THz and 110 nJ (peak power of 13.8 W) at 19 THz were obtained with a 1-mm-thick DAST crystal. Using a tunable THz-wave system consisting of the THz source and a pyroelectric detector, THz spectroscopic data for a polytetrafluoroethylene sheet were obtained and were comparable to data obtained from a conventional far-infrared spectrometer.

© 2004 American Institute of Physics. [DOI: 10.1063/1.1713045]



R&D from 2004 → ...



TeraKit - DODS

NEW



Specifications	TeraKit-D	TeraKit-O	TeraKit-DS
THz generator	DAST	OH1	DSTMS
Spectral range	0.3 – 11 THz	0.1 – 3 THz	0.1 – 11 THz
Best phase matchable wavelength	1300 – 1600 nm	1200 – 1460 nm	1300 – 1700 nm
Requirements	External femtosecond laser source		

- An external CO₂ pulsed laser is always needed
- This laser with two NL optical system could provide the energy measurements for both LER and HER rings

Application

Explosive Detection
Bio Agent
Mail Inspection
Identify of Pharmaceutical Drugs

Conclusion

- Polarization and Energy measurements seems feasible with "standard" technique
- Accuracy and systematic (misalignment, laser line, electron beam emittance, etc) are under study
- Cost of the overall system needs also to be valuated
- ...
- Thank you for the attention