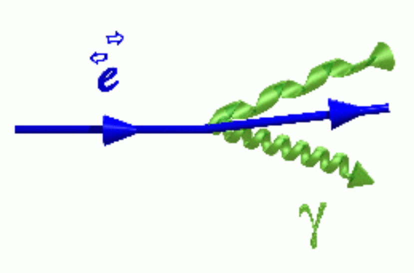
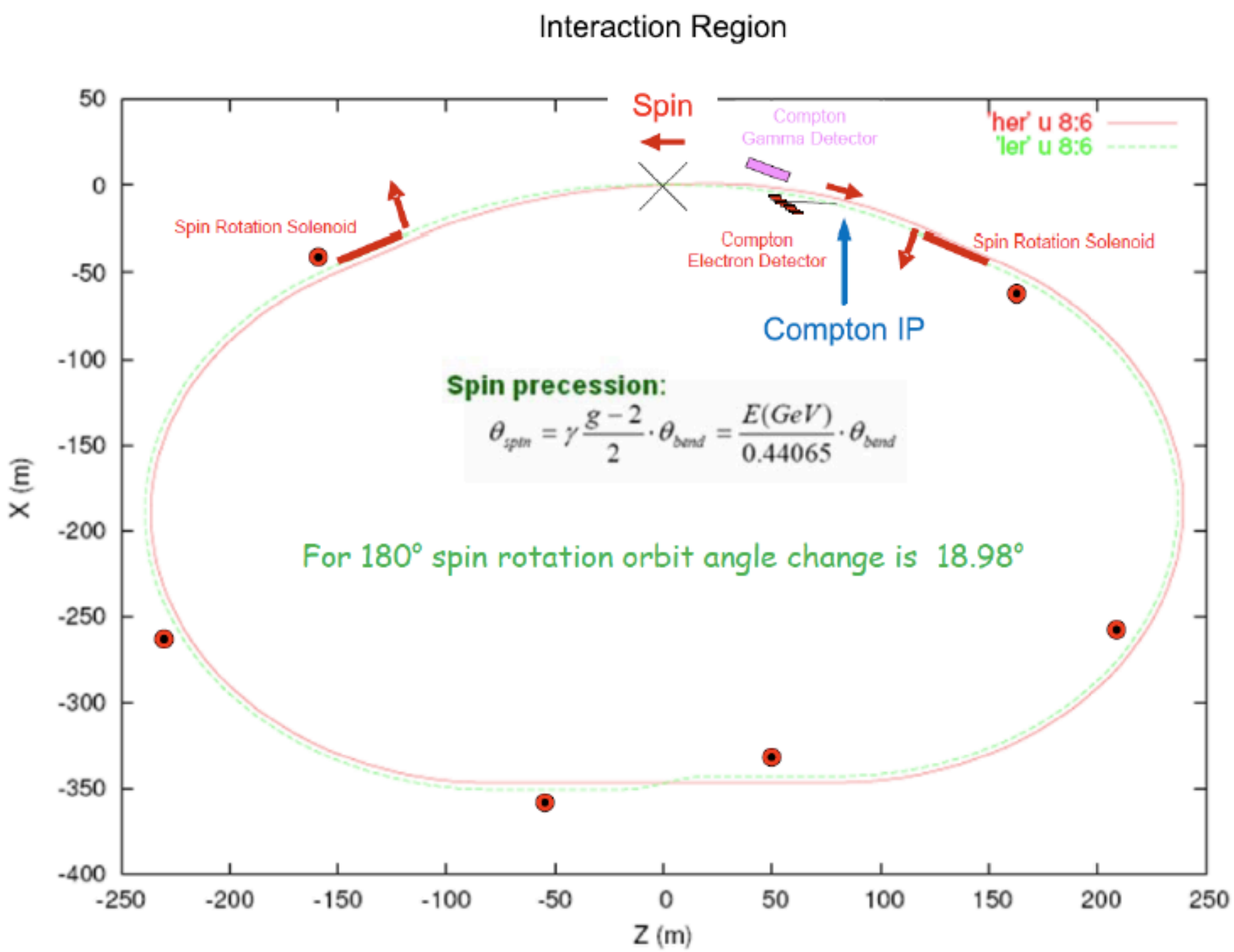
SuperB : Polarimetro

- Si pensa di usare la tecnica della retrodiffusione Compton (CBS)
- Descrizione della tecnica della CBS



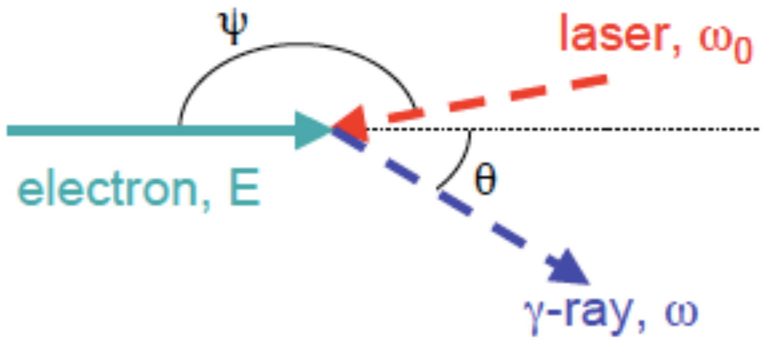
- Caratteristiche della CBS utili per la misura della polarizzazione e dell'energia del fascio di e^- (LER) della SuperB

Dinamica di Spin alla SuperB



- Solo il fascio degli elettroni LER è polarizzato.
- La sua energia è di 4.18 GeV.
- Si vuole misurare la polarizzazione longitudinale.
- La tecnica del CBS è molto promettente

Cinematica del CBS



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

Collisione testa-testa ($\psi=\pi$)
Diffusione all'indietro ($\theta=0$)
Alta energia (γ>>1)

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

me >> $\gamma\omega_o$

$$\boxed{\omega^{max} \simeq 4\gamma^2\omega_0}$$

Caratteriste Peculiari del CBS

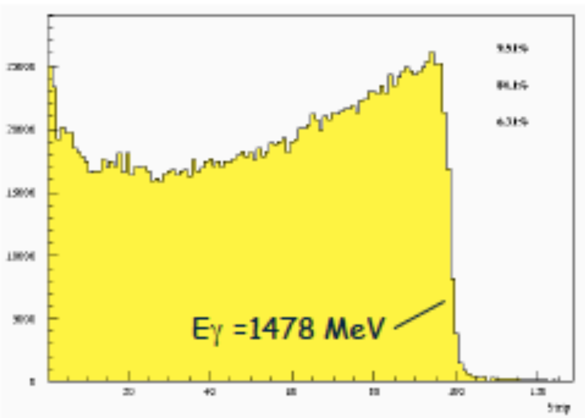
- Lo spettro in energia dei fotoni diffusi è essenzialmente "piatto" (sezione d'urto differenziale di Klein-Nishina)
- Presenta un "Compton-Edge" che identifica il caso cinematico di urto testa-testa e diffusione a 180°
- In questa condizione cinematica non è possibile trasferire momento angolare tra il fotone (laser) incidente e l'elettrone diffuso e quindi il fotone diffuso mantiene la stessa polarizzazione del fotone incidente.

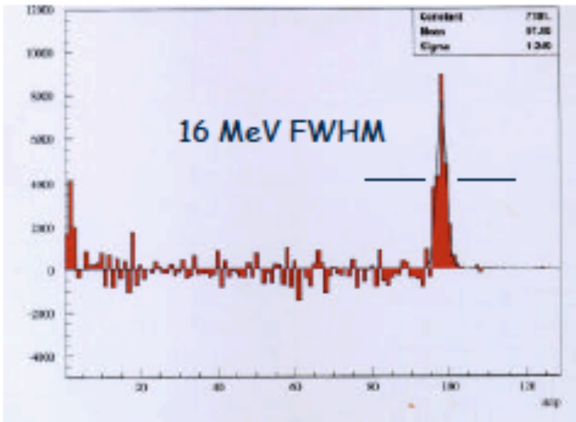
Graal $\vec{\gamma}$ beam characteristics

- Energy Resolution: we use an internal tagging made of 128 silicon μ-strips which provide a resolution of 16 MeV (FWHM)

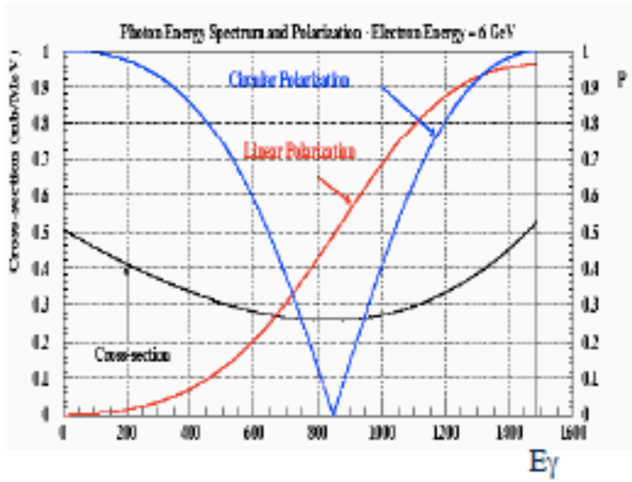
- Polarization: since we use polarized laser light against relativistic electrons ⟹ the produced $\vec{\gamma}$ beam is polarized

Tagged spectrum



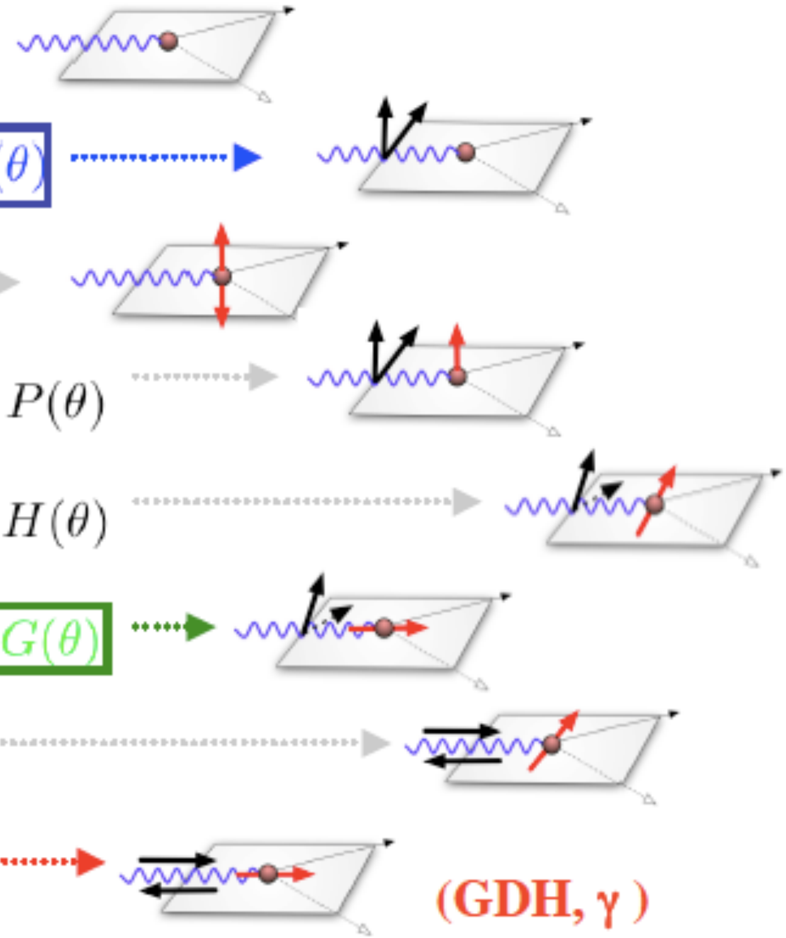


High degree of linear and circular polarization



$\vec{\gamma} + \vec{N} \rightarrow \pi + N$ (simile a $\vec{\gamma}\vec{e} \rightarrow \gamma e$)

$$
\begin{aligned}
\frac{d\sigma}{d\Omega} = \sigma(\theta) \cdot [\ & 1 \\
& - (\wp_L^\gamma \cos(2\phi)) \cdot \Sigma(\theta) \\
& + P_y \cdot T(\theta) \\
& - P_y (\wp_L^\gamma \cos(2\phi)) \cdot P(\theta) \\
& - P_x (\wp_L^\gamma \sin(2\phi)) \cdot H(\theta) \\
& - P_z (\wp_L^\gamma \sin(2\phi)) \cdot G(\theta) \\
& + P_x (\wp_C^\gamma) \cdot F(\theta) \\
& - P_z (\wp_C^\gamma) \cdot E(\theta)\ ]
\end{aligned}
$$



Questo è quello che vogliamo misurare

E(θ) nel caso del CBS

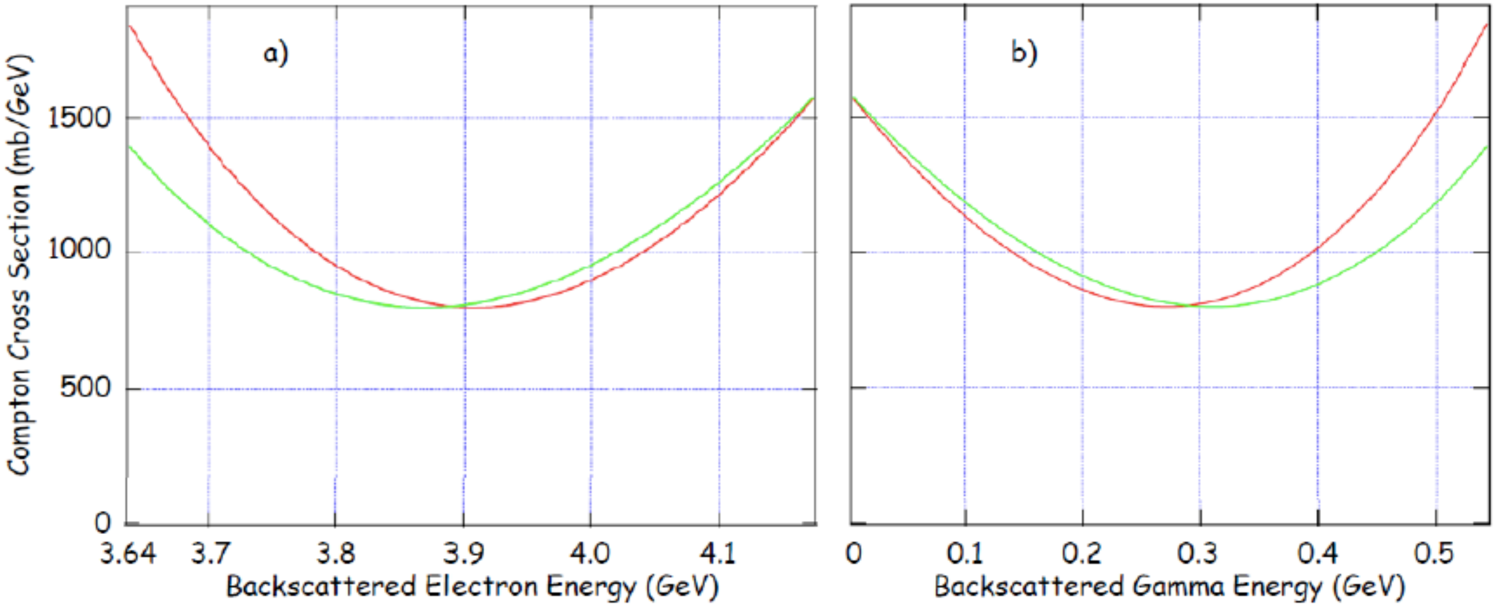


Figure 16.7: Compton cross section for scattering of 532 nm photons with a 4.18 GeV electron beam a) electron energy (b) Gamma energy. The $J_z = 3/2$ ($J_z = 1/2$) cross section for electron and photon spins aligned (anti-aligned) is shown in red/darker line (green/lighter line).

La polarizzazione longitudinale del fascio di elettroni è :

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

ω_o ottimale ?

- Se l'energia del fotone diffuso fosse compresa tra 1 e 5 MeV. Potremmo misurare il Compton Edge con grande precisione grazie ad un rivelatore al Germanio.
- Grazie ad una calibrazione assoluta fatta con delle sorgenti radioattive potremmo determinare l'energia del fascio LER con precisione dell'ordine di ~100 KeV. Questa tecnica è attualmente utilizzata a VEPP-4M con un laser CO_2 (~10 μm)

VEPP-4M Performance

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

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A R T I C L E I N F O

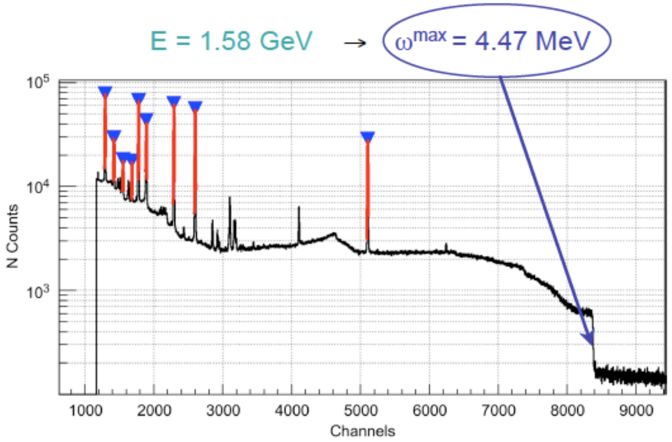
Available online 23 August 2008

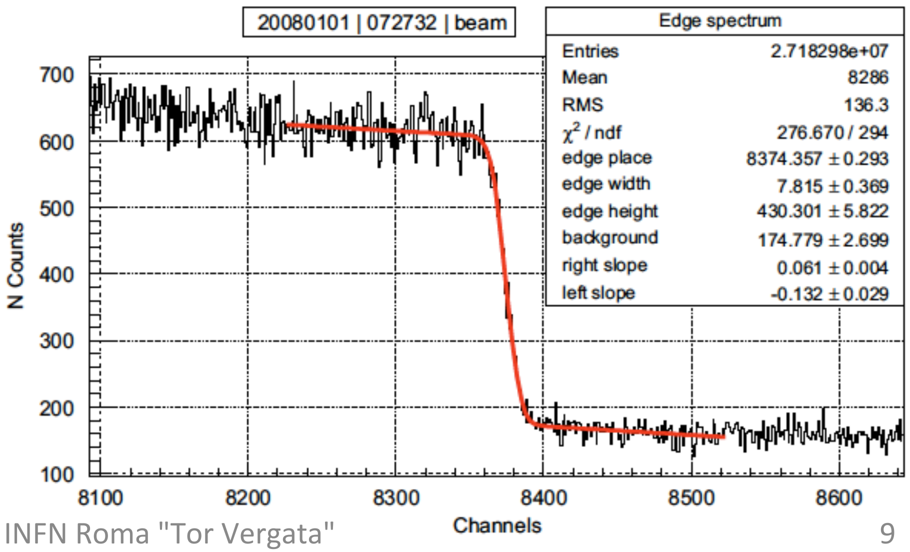
Keywords:
Beam energy measurement
Energy calibration
Depolarization technique
Compton scattering

A B S T R A C T

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, ψ(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.





Lo stesso laser alla SuperB produrrebbe un Compton Edge di 31.1 MeV

Laser FIR commerciali

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GAS SENSORS, ANALYTICAL INSTRUMENTS & LASERS

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Home > Lasers > FIR Series Lasers

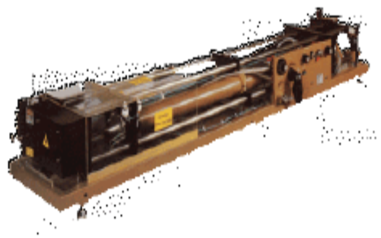
FIR (TeraHertz) series Optically Pumped Far Infrared Lasers from Edinburgh Instruments

A choice of FIR lasers from Edinburgh Instruments to meet applications requiring coherent radiation in the range of 40 microns to 1.22 mm (0.25 to 7.5 THz). Invar bar stabilised

295 FIR : single output, 150mW output (using a pump CO_2 laser such as PL5), 500mW (using a pump source as PL6) at 118.8 and 184.3 microns, isotopic fills

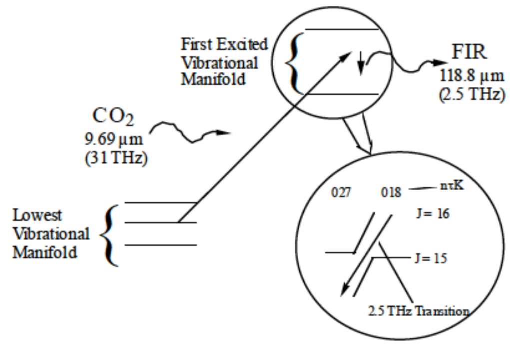
395 FIR : Dual FIR output ; utilises single pump CO_2 source (e.g. PL5, PL5-S, PL6)

FIRL 100 : Has both the pump CO_2 source and FIR laser housed in an integrated structure ; FIR output at 118.8 micron is guaranteed at 150mW. The lasers and coupling optics are mounted within a 5 bar invar rod frame for excellent thermal and mechanical stability. The CO_2 section provides 80 lines between 9.1 and 10.9 microns and features a flowing gas single discharge tube giving more than 50w on the strongest lines. Mode performance is ($M^2 < 1.25$) is assured by internal profiling of the tube and the use of highest quality optics. The resonator design is based on the proven PL5 laser with diffraction grating, two ZnSe Brewster windows and peizo ceramic mounted ZnSe output coupler.



The FIRL 100 Far Infra Red laser gas a 1.5m long pyrex waveguide of 36mm diameter. The pump beam is input via a Brewster window and input coupling with central aperture. FIR radiation is extracted via a unique, customised dichroic output mirror with wideband transmission.

Methanol (CH_3OH)



Con un laser a 118.5 μm si ottiene un fascio γ con un "Compton Edge" pari a 2.8 MeV.
Questa tecnica ci consentirebbe di misurare l'energia del fascio di elettroni con una risoluzione di circa lo 100 KeV.

Sorgenti di Calibrazione ~ 2.8 MeV

Decay Radiation Results http://www.nndc.bnl.gov/nudat2/dec_searchi.jsp

Results:

Dataset #1:

Author: JOHN A. CAMERON AND BALRAJ SINGH Citation:Nuclear Data Sheets 102, 293 (2004)

Parent Nucleus	Parent E(level)	Parent Jπ	Parent $T_{1/2}$	Decay Mode	GS-GS Q-value (keV)	Daughter Nucleus		
$^{40}_{17}Cl$	0	2-	1.35 m *2*	β^-: 100 %	7480 *30*	$^{40}_{18}Ar$	Decay Scheme	ENSDF file

Gamma and X-ray radiation:

Energy (keV)	Intensity (%)	Dose (MeV/Bq-s)
2220.0 *2*	7.0 % *10*	0.155 *23*
2457.7 *4*	4.7 % *8*	0.115 *21*
2524.1 *2*	2.0 % *3*	0.051 *7*
2621.7 *2*	14.7 % *15*	0.38 *4*
2840.1 *3*	28 % *4*	0.78 *12*
3101.7 *4*	11.3 % *17*	0.35 *5*

Se volessimo fare meglio ?

Dovremmo taggare gli elettroni diffusi nel CBS

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.

ΔE = 8.4 KeV con
E_{beam}= 6 GeV

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

Richieste Finanziarie Roma2

- Missioni Interne : 3 K€ contatti con CA
- Missione Estere : 7.5 K€ = 3.5 test beam a Mainz + 4 K€ contatti con SLAC
- Consumo : 10 K€ per studio prototipi (possibile test a DAΦNE serve ottica per laser CO_2 (CE=0.46 MeV) e DAQ HPGe)

- Sezioni Coinvolte : Roma2 e Cagliari