TRIUMF Experiment E614
Technical Note #65.4

One dimension TEC at B=2T

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The one dimension TEC has been proposed in TN-65 (03 May 2002) as a permanent part of E614 spectrometer to measure event by event muon helix and muon polarization therefore after a fringe field. A muon helix at $B = 2T$ has period $\simeq 56cm$ and radius $R(mm) \simeq 5 \cdot 10^{-2} \cdot \theta(mr)$, where θ is a small polar angle of muon helix. For example, crucial value of $\theta = 14mr$ will provide $1 - P_\mu = 1 - cos\theta \simeq 10^{-4}$. The corresponding helix has $R \simeq 0.7mm$. Examples of muon trajectory from TN-28 shown in Fig.1.

Idea is to put an one dimension TEC in center of empty E614 magnet to measure an one projection of a muon helix. Length of the TEC can be selected as an compromise between muon scattering by TEC foil and gas, and an accuracy of helix parameters measurement. TEC with mylar input window of $25\mu m$ and gas length of $300mm$ has been selected. Draft estimation of scattering angle θ_0 gives $\theta^{rms}_{space} \simeq 15mr$. This is a scattering angle of a surface muon after $25\mu m$ mylar foil and $300mm$ of DME gas at $p = 60torr$. The TEC covers more than a half period of a muon helix. The proposed TEC sketch presented in Fig.2. The TEC has a cross section of $40 \times 80mm^2$ and length of $300mm$ and covers a beam with divergence of $\theta < 100mr$ according to pessimistic estimations. Figs.3-12 demonstrate drift electrons behavior in the TEC and space resolution. Drift velocity along electric field $E = 164V/cm$ is $V_d = 250ns/mm$ at $p = 40torr$, and $V_d = 244ns/\mu m$ at $p = 60torr$.

The proposed TEC could be used as a tool for direct measurement and optimization of P_μ inside E614 magnet after fringe field. This is the tool for direct alignment of beam and magnetic field axis. This is tool also for direct investigation an influence of beam parameters on P_μ value. Unfortunately the tool can be used alone only (without E614 detector).

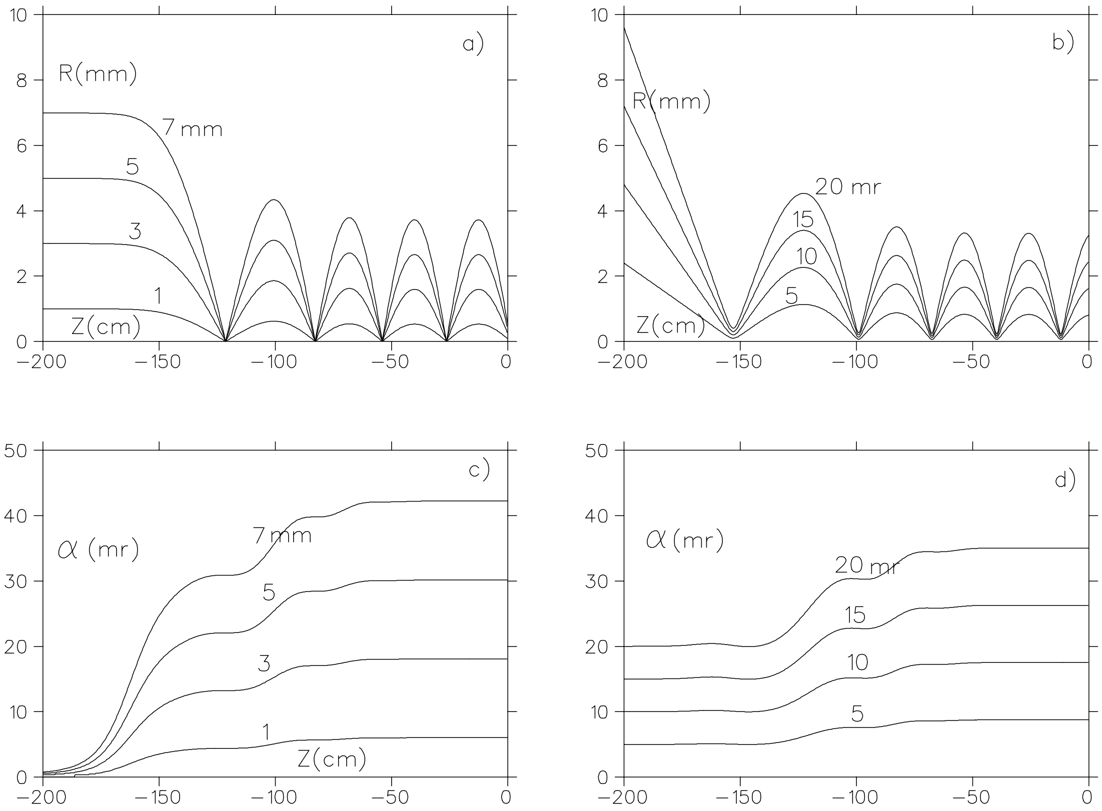

Figure 1: Fig.2 from TN-28: Jaap Doornbos "Injection of Muon Beam into Solenoid". Figs. a), b) demonstrate $R(z)$ transformation of a surface muon trajectory at different original trajectory parameters before E614 magnet.

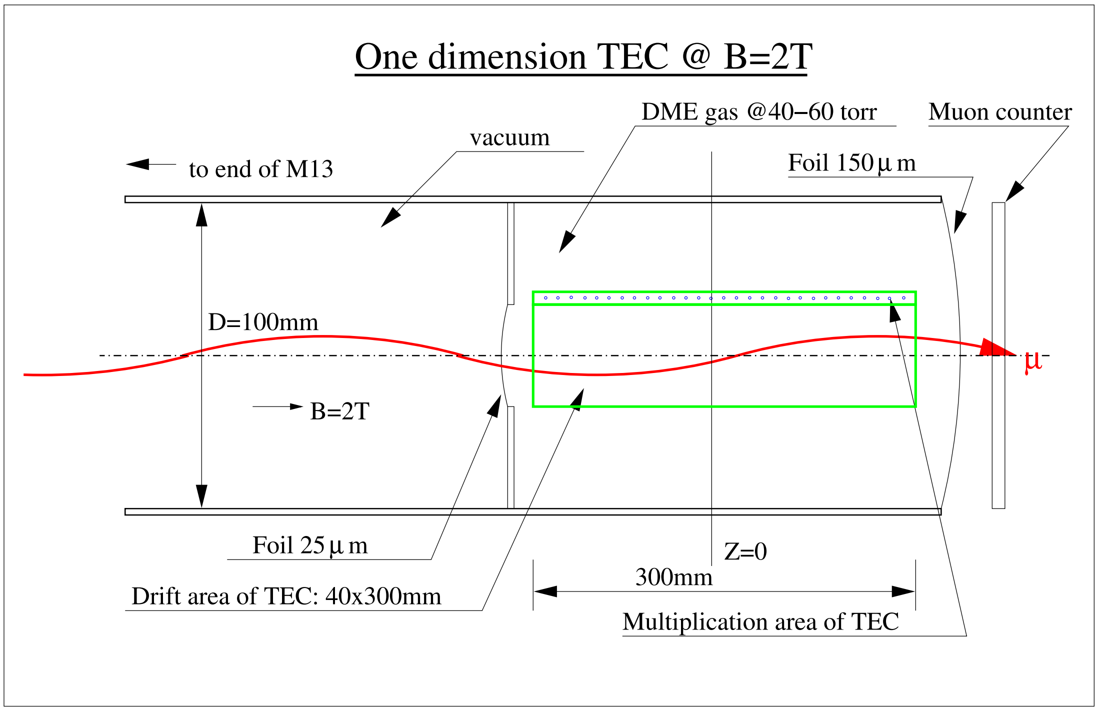

Figure 2: Sketch of the proposed one dimension TEC. The TEC placed along Z-axis of magnet with TEC center at $Z = 0$ and can be rotated on any angle around Z-axis. The TEC placed into empty magnet. Length of sense wires is $\simeq 8cm$ because Lorentz angle as one can see in Figs.5, 6.

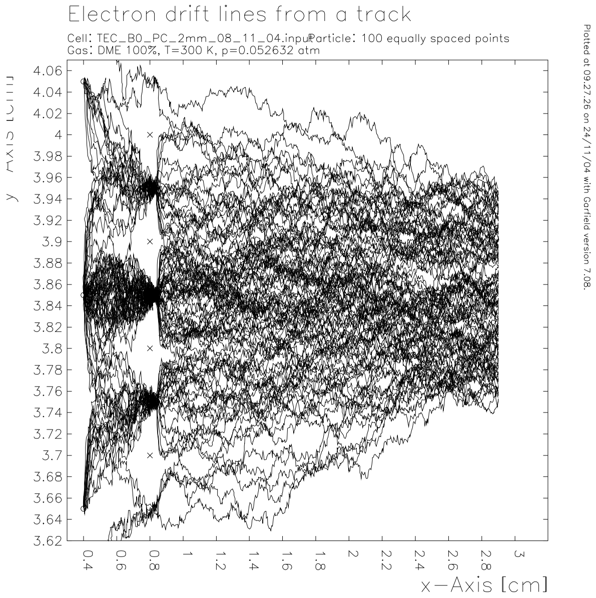

Figure 3: Projection in XY-plane of electron drift lines from a $2mm$ track going in XY-plane along Y-axis at $X = 2.9cm$ and covering one cell with sense wire at $Y = 3.85cm$. DME gas at $p = 40torr$ and $B = 2T$. One can see an electron leakage to nearest wires.

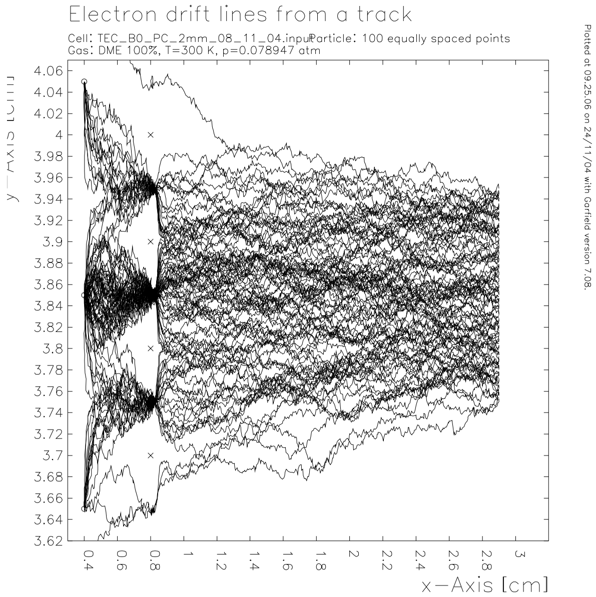

Figure 4: Projection in XY-plane of electron drift lines from a $2mm$ track going in XY-plane along Y-axis at $X = 2.9cm$ and covering one cell with sense wire at $Y = 3.85cm$. DME gas at $p = 60torr$ and $B = 2T$. One can see that an electron leakage to nearest wires is slightly less than at $p = 40torr$.

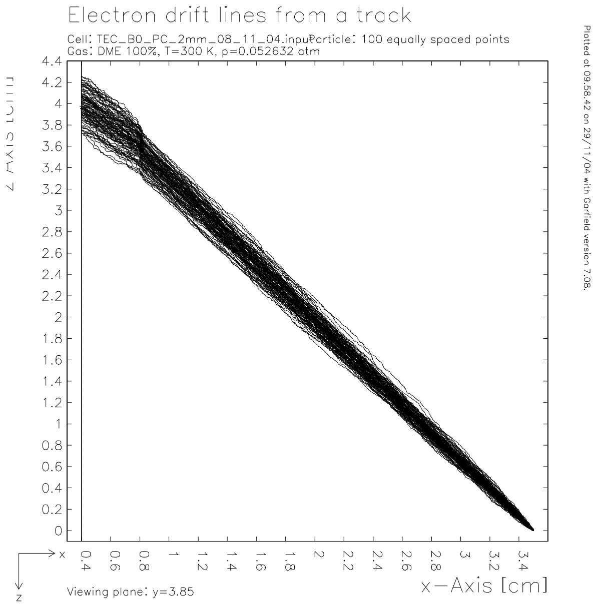

Figure 5: Projection in XZ-plane of electron drift lines from a $2mm$ track going in XY-plane along Y-axis at $X = 3.5cm$ and covering one cell with sense wire along $X = 0.4cm$ at $Y = 3.85cm$. DME gas at $p = 40torr$ and $B = 2T$. Drift lines go to the sense wire under a Lorentz angle $\theta_L \simeq 53^\circ$. One can see lines spread along the sense wire because a diffusion.

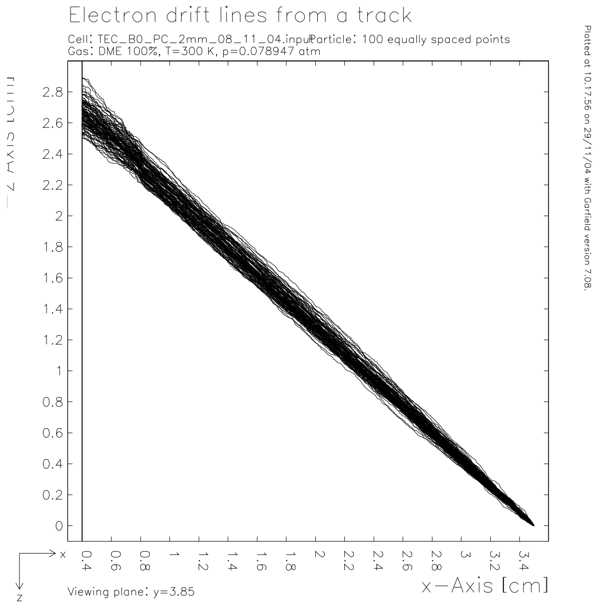

Figure 6: Projection in XZ-plane of electron drift lines from a $2mm$ track going in XY-plane along Y-axis at $X = 3.5cm$ and covering one cell with sense wire along $X = 0.4cm$ at $Y = 3.85cm$. DME gas at $p = 60torr$ and $B = 2T$. Drift lines go to the sense wire under a Lorentz angle $\theta_L \simeq 41^\circ$. One can see lines spread along the sense wire because a diffusion.

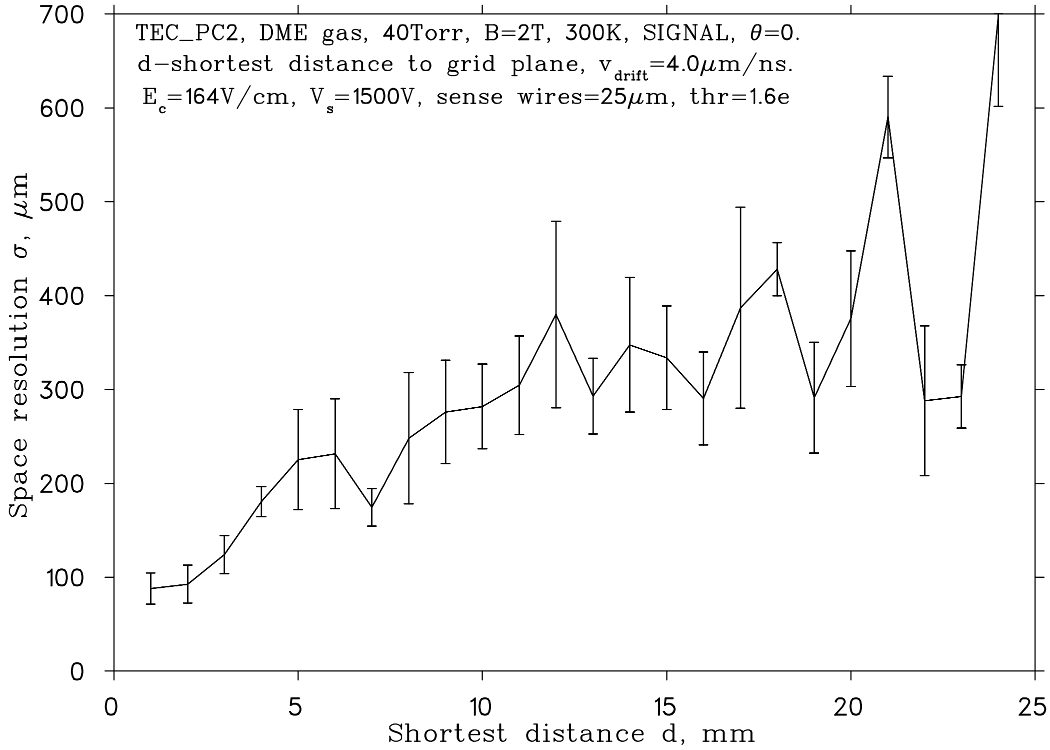

Figure 7: TEC space resolution for surface muons. DME gas at $B = 2T$ and $p = 40torr$.

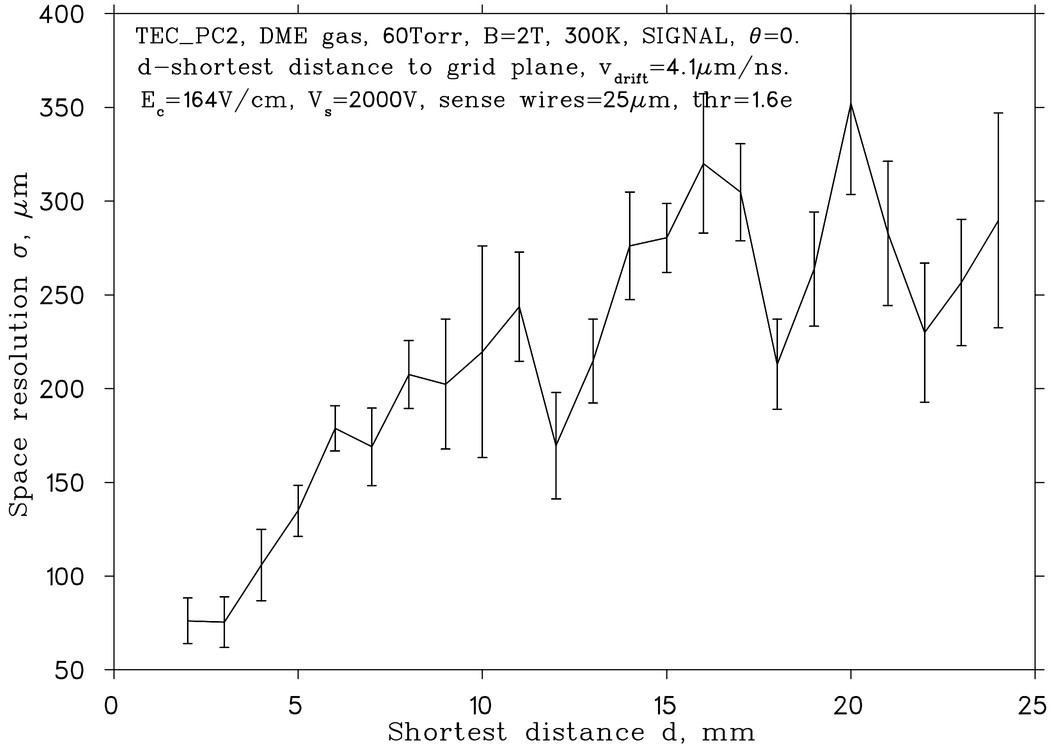

Figure 8: TEC space resolution for surface muons. DME gas at $B = 2T$ and $p = 60torr$.

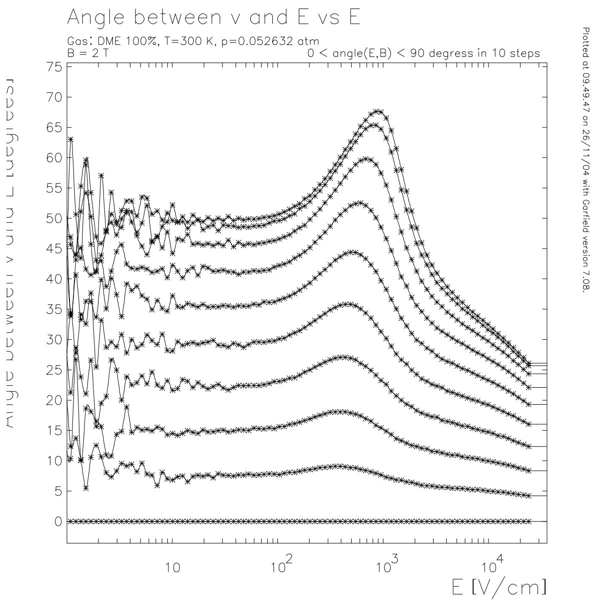

Figure 9: Lorentz drift angle in DME gas at $p = 40torr$. Electric field in drift part of the TEC is $E \simeq 164V/cm$.

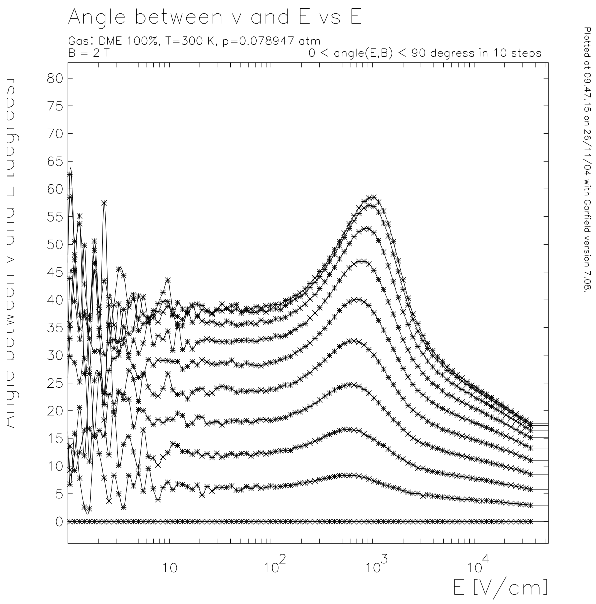

Figure 10: Lorentz drift angle in DME gas at $p = 60torr$. Electric field in drift part of the TEC is $E \simeq 164V/cm$.

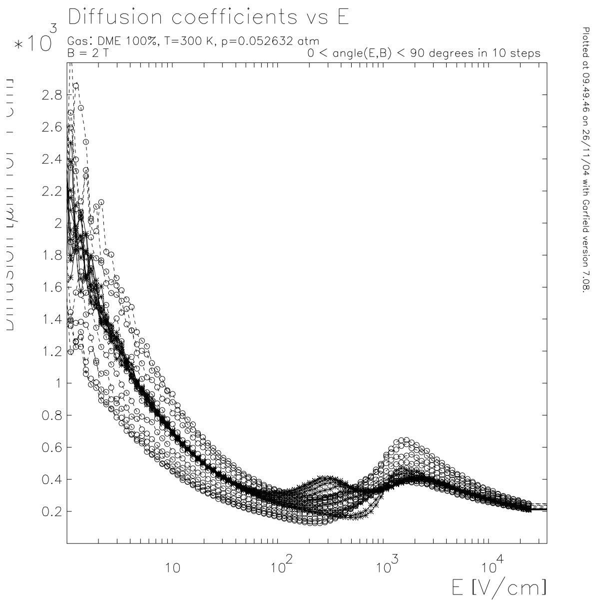

Figure 11: Diffusion of drift electrons in DME gas at $B = 2T$ and $p = 40torr$. Vertical axis is a diffusion coefficient in $\mu m/1cm$. Electric field in drift part of the TEC is $E \simeq 164V/cm$. Longitudinal and transverse diffusion coefficients are presented in the Fig. at different angles between $\vec{E}$ and $\vec{B}$.

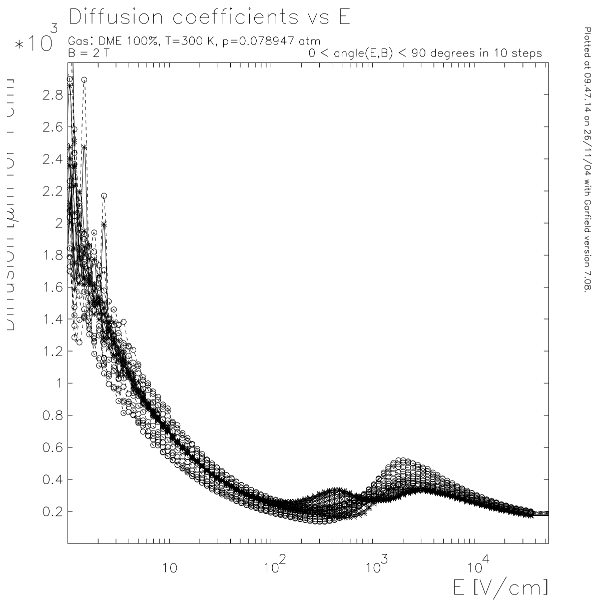

Figure 12: Diffusion of drift electrons in DME gas at $B = 2T$ and $p = 60torr$. Vertical axis is a diffusion coefficient in $\mu m/1cm$. Electric field in drift part of the TEC is $E \simeq 164V/cm$. Longitudinal and transverse diffusion coefficients are presented in the Fig. at different angles between $\vec{E}$ and $\vec{B}$.