DELPHI week, April 2002
Presented by: S. Ask

The single photon analysis, Neutrino interactions beyond the SM

$$e^+e^- \to \not{X} + \gamma$$

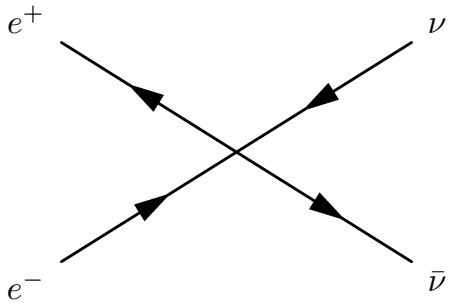
Theories with Non Standard (NS) interactions between neutrinos and matter have been suggested to explain the solar and atmospheric neutrino anomalies.

e.g.
Solar ν anomaly $\rightarrow$ non standard $\nu_\tau - e$ interactions
Solar ν anomaly $\rightarrow$ non standard flavor changing interactions
...

Present non standard $\nu - e$ coupling constrains,
$\nu_e - e$, loose
$\nu_\mu - e$, severe
$\nu_\tau - e$, not existing

Non Standard neutrino interactions with electrons can be studied through the single photon event process
$e^+e^- \rightarrow \nu\bar{\nu}\gamma$
(Z. Berezhiani, A. Rossi, hep-ph/0111137)

The fundamental theory acts on a mass scale
larger than Λ ($\gg \sqrt{s}$)
$\Rightarrow$ The low energy limit can be used to describe it



Low energy limit
(Point like interaction)

$$\mathcal{L}_{eff} = -2\sqrt{2}G_F(\bar{\nu}\gamma_\mu P_L \nu)[\epsilon_{\alpha,R}(\bar{e}\gamma_\mu P_R e) + \epsilon_{\alpha,L}(\bar{e}\gamma_\mu P_L e)]$$

$\epsilon_{\alpha,R}$ $\epsilon_{\alpha,L}$ $[\alpha = e, \mu, \tau]$
parameterize the strength of the new interactions
relative to the Fermi constant, G_F.

Relation between ϵ and Λ

$$2\sqrt{2}G_F\epsilon_{\alpha,R(L)} \equiv \frac{4\pi}{\Lambda^2}$$

$$\Rightarrow \qquad \sigma^{NS} = \sum_\alpha \sigma^{NS}_\alpha(\epsilon_{\alpha,L}, \epsilon_{\alpha,R})$$

$$\sigma^{Tot} = \sigma^{SM} + \sigma^{NS}$$

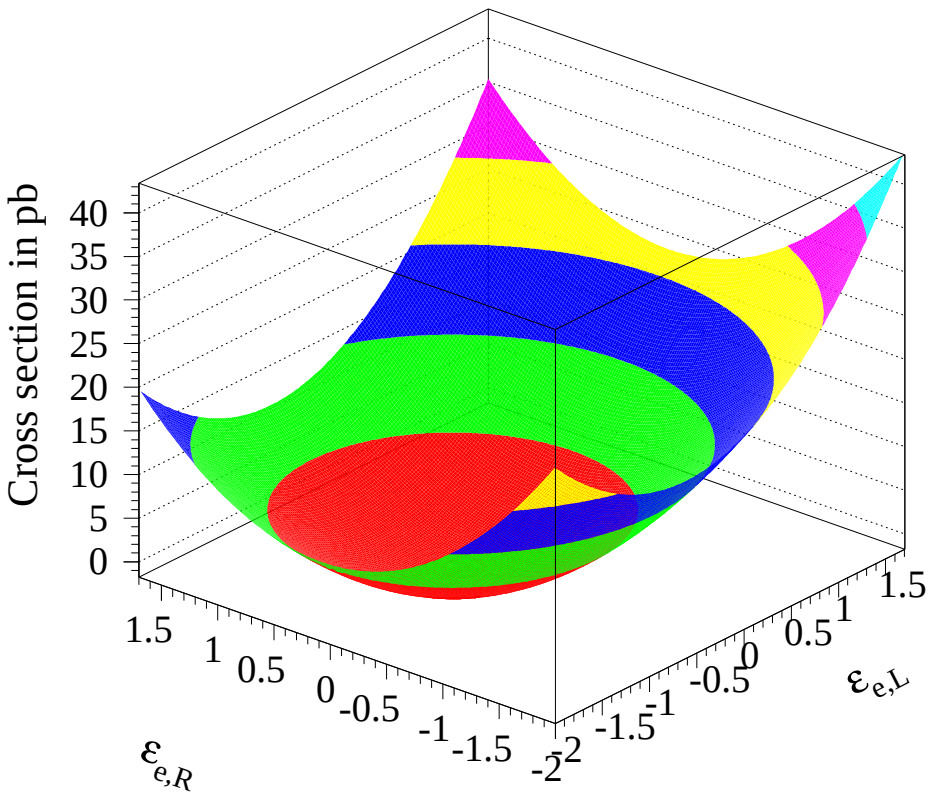
σ^{NS} contains,

1. Pure non standard neutrino interaction terms
2. Interference terms, between the SM and the non standard interactions

$\Downarrow$

σ^{NS} might be negative !

$$\sigma^{NS}(\epsilon_{e,L}, \epsilon_{e,R}, 0, 0, 0, 0)$$



The analysis was made for three different cases

$$e^+e^- \to \nu_e\bar{\nu}_e\gamma$$

Include interference terms with both t-channel W exchange and s-channel Z^0 exchange.

Can give both positive and negative single photon contributions.

$$e^+e^- \to \nu_\tau\bar{\nu}_\tau\gamma$$

Include interference terms with s-channel Z^0 exchange.

Can only give positive single photon contribution.

$$e^+e^- \to \nu_\alpha\bar{\nu}_\beta\gamma$$
$$(\alpha \neq \beta)$$

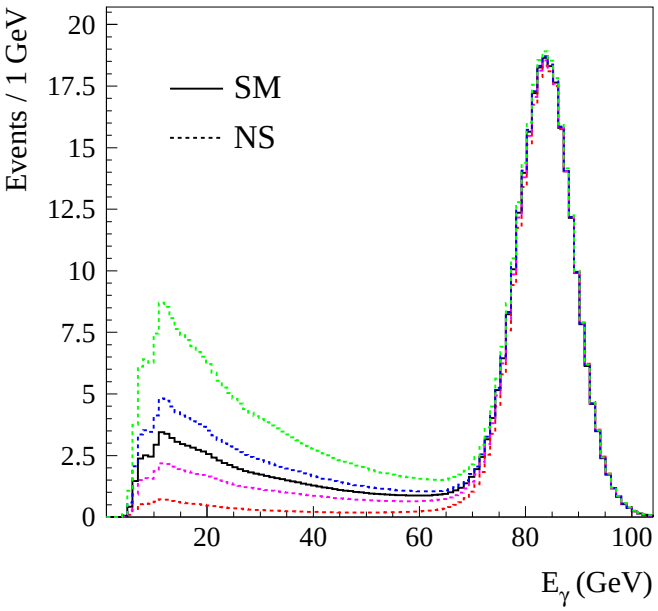
No interference with SM terms.

Can only give positive single photon contribution.

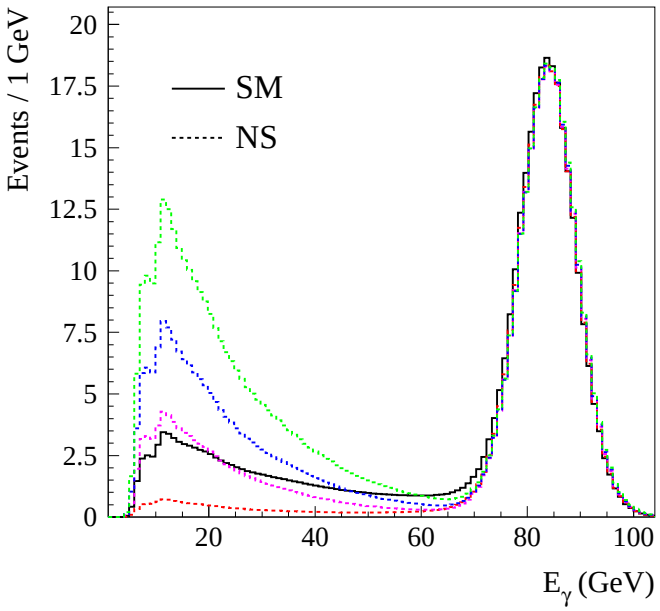
The E_γ distribution

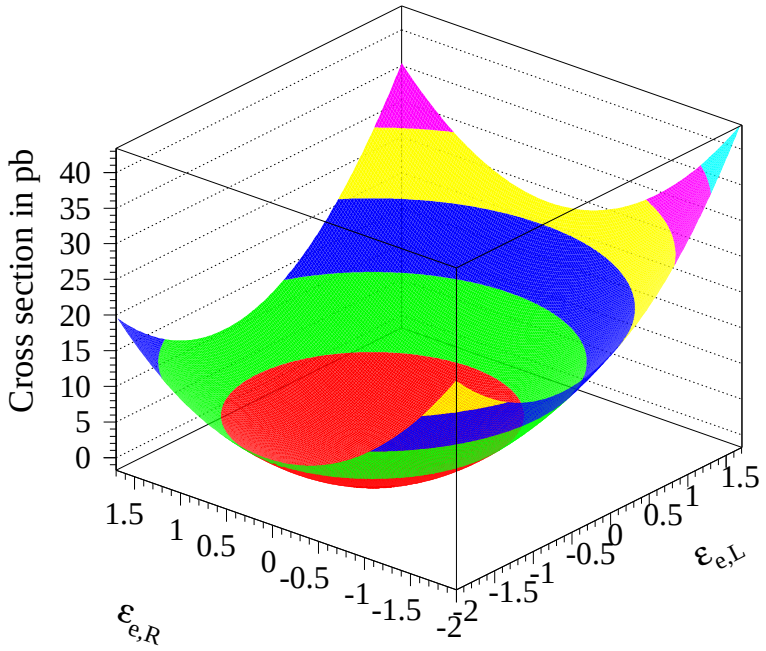
The signal would appear differently for different points in the $\epsilon_{e,L} - \epsilon_{e,R}$ plane.

increasing $\epsilon_{e,L}$



decreasing $\epsilon_{e,L}$

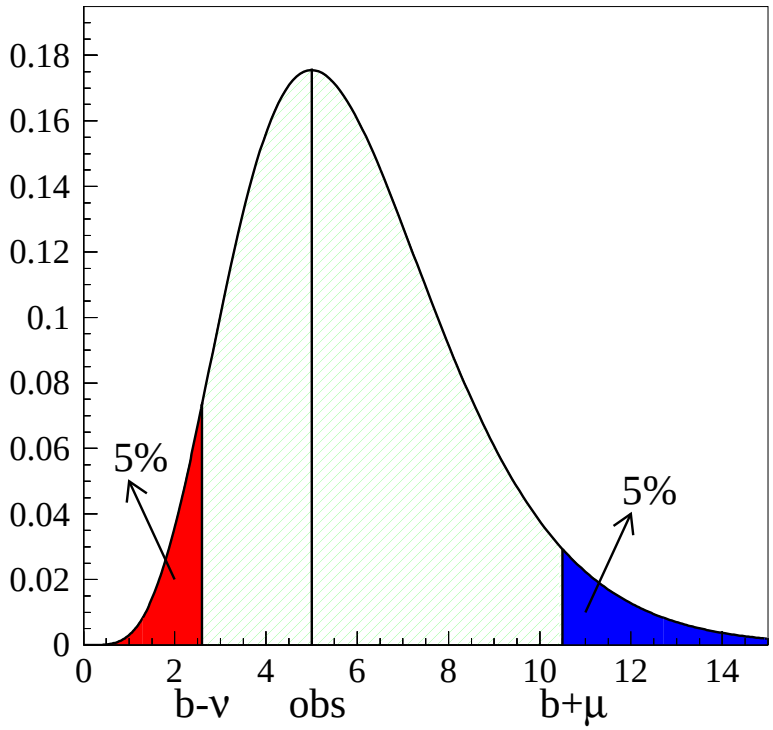




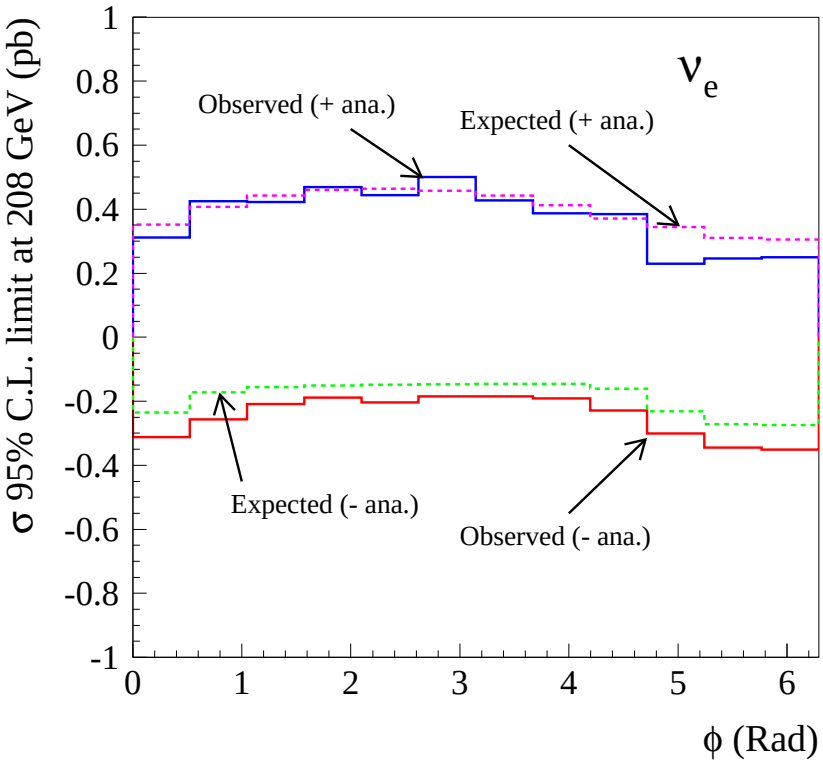
Two separate analysis

- σ_{95} computed for the positive part of the σ^{NS} contribution to the E_γ distribution.
  Used for $\sqrt{\epsilon_{e,L}^2 + \epsilon_{e,R}^2} \Rightarrow \sigma^{NS} \geq 0$.
- σ_{95} computed for the negative part of the σ^{NS} contribution to the E_γ distribution.
  Used for $\sqrt{\epsilon_{e,L}^2 + \epsilon_{e,R}^2} \Rightarrow \sigma^{NS} \leq 0$.

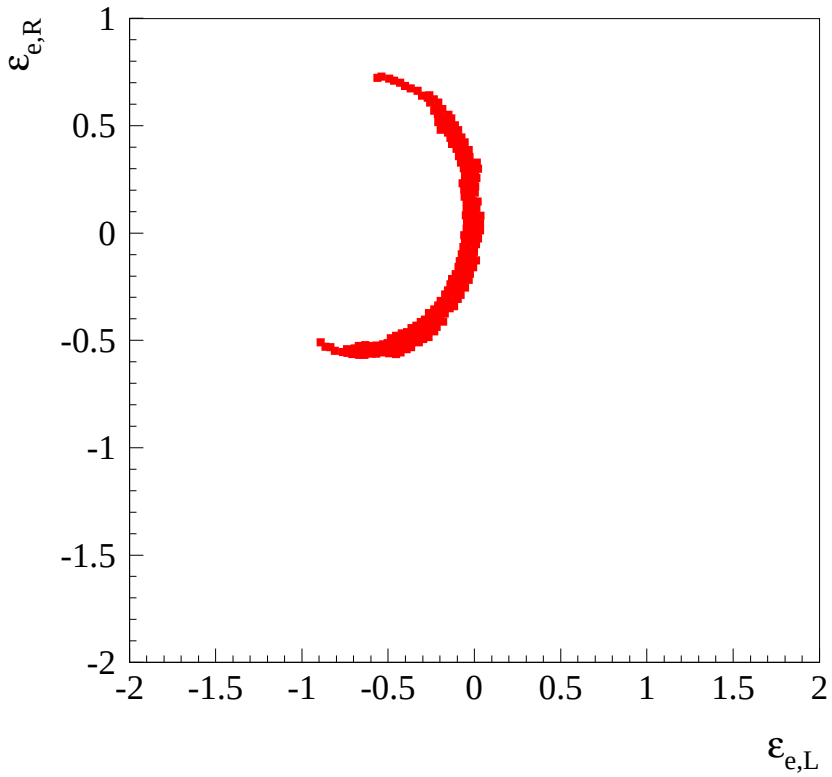
$$|N_{95}^-| \neq |N_{95}^+|$$



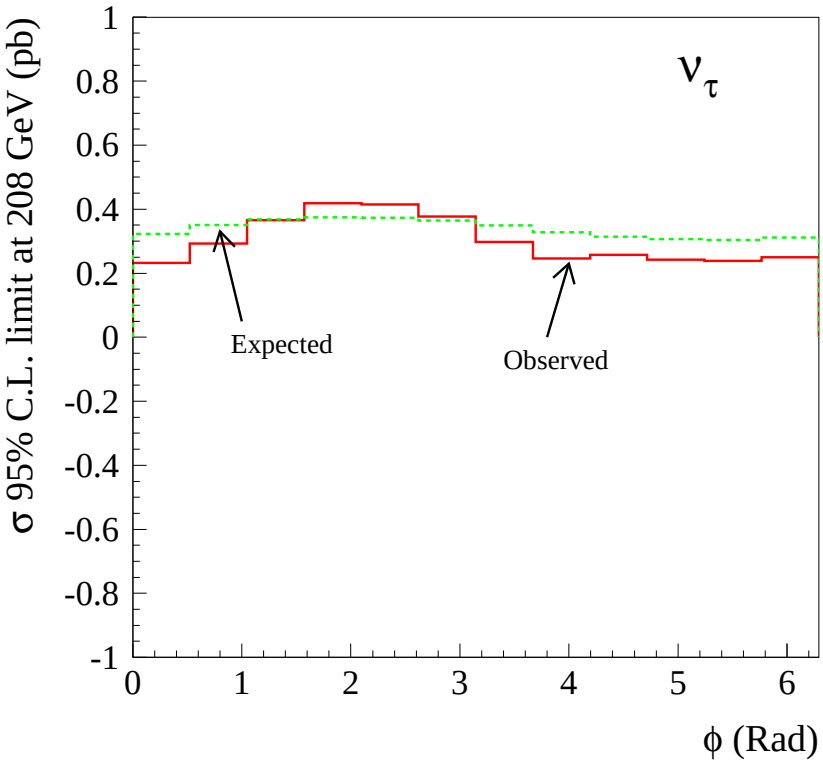
Cross section limit



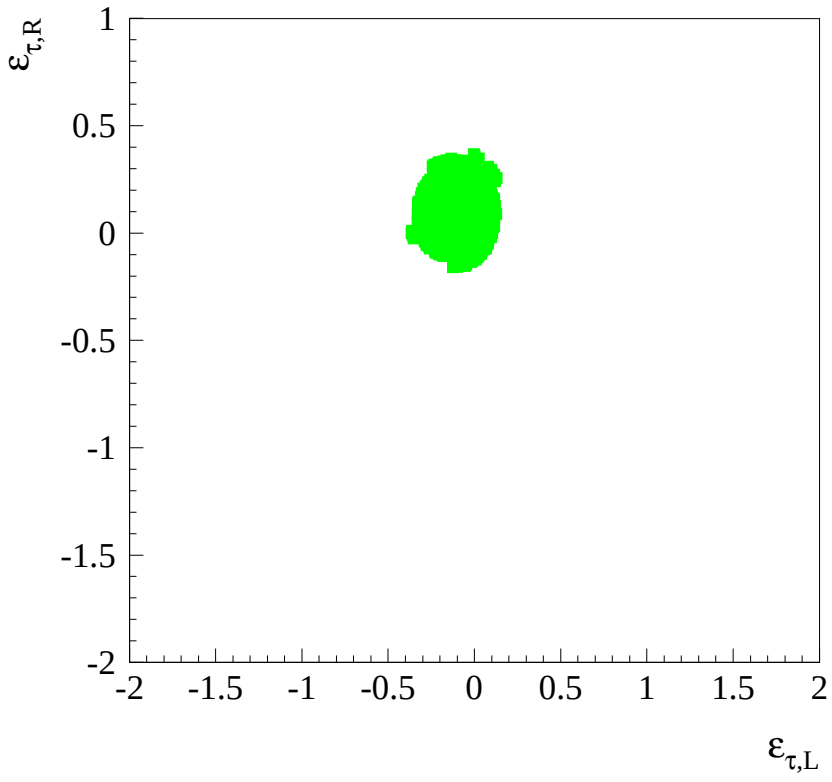
Not excluded $\epsilon_{e,L} - \epsilon_{e,R}$ region



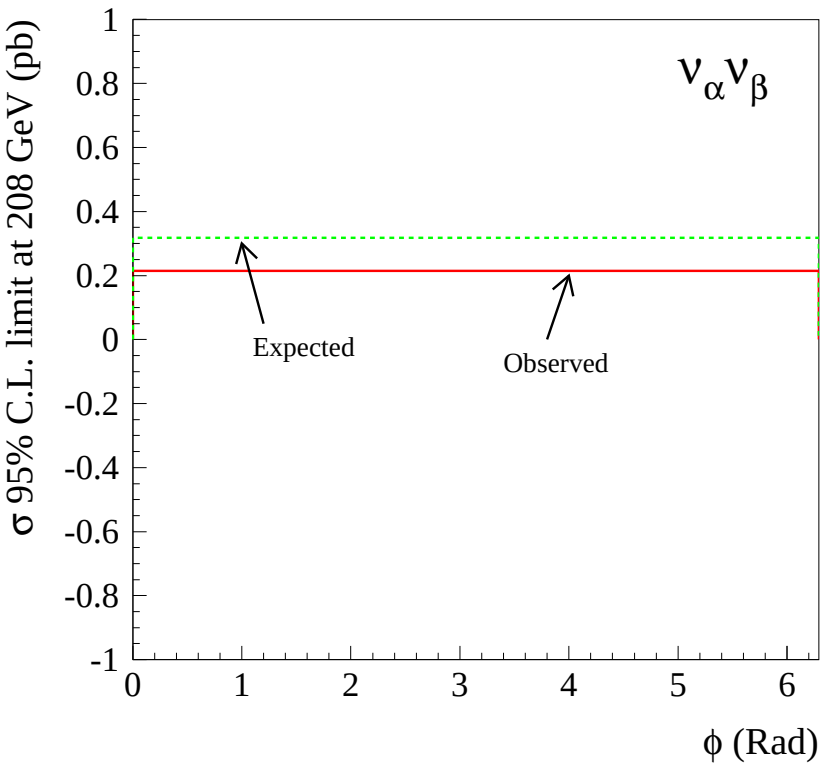
Cross section limit



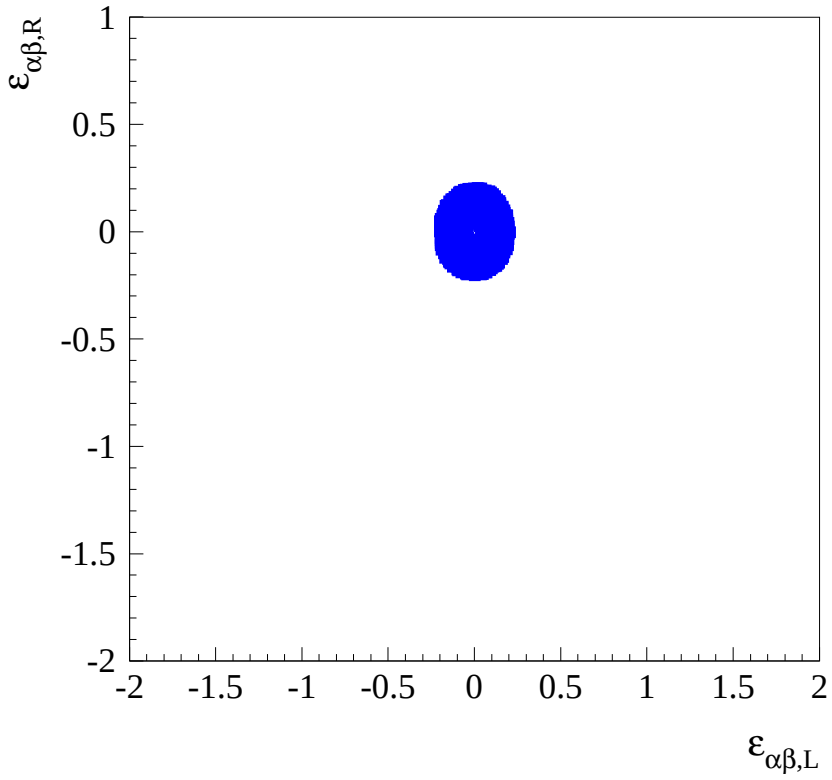
Not excluded $\epsilon_{\tau,L} - \epsilon_{\tau,R}$ region



Cross section limit



Not excluded $\epsilon_{\alpha\beta,L} - \epsilon_{\alpha\beta,R}$ region



A study of non standard neutrino interactions have been made.

The $\epsilon_L - \epsilon_R$ constrains have been significantly improved for all the three cases studied.

The results will be included in the single photon paper or in a separate paper.

A DELPHI note about this analysis will be written.