Single photon production in νN interactions

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MiniBooNE result

6 x10^{20} POT

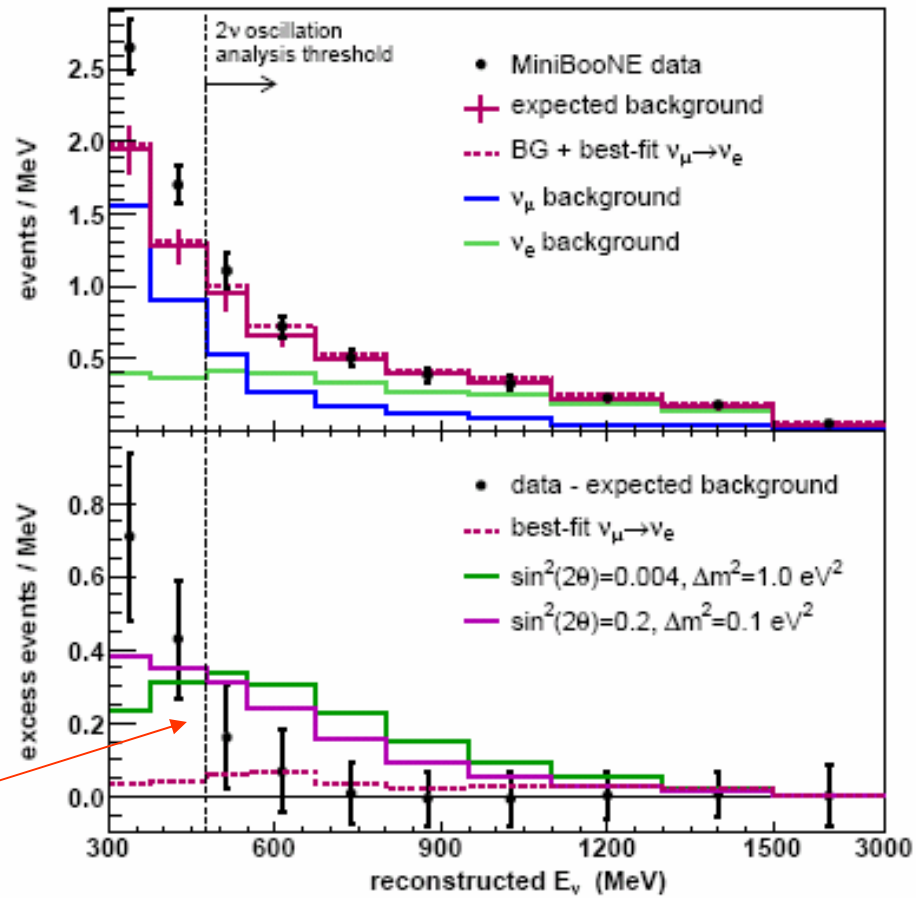
No ν_e excess in oscillation signal region E_ν > 475 MeV

however

96 ± 17 ± 20 events above background, for 300<E_ν^{QE}<475MeV

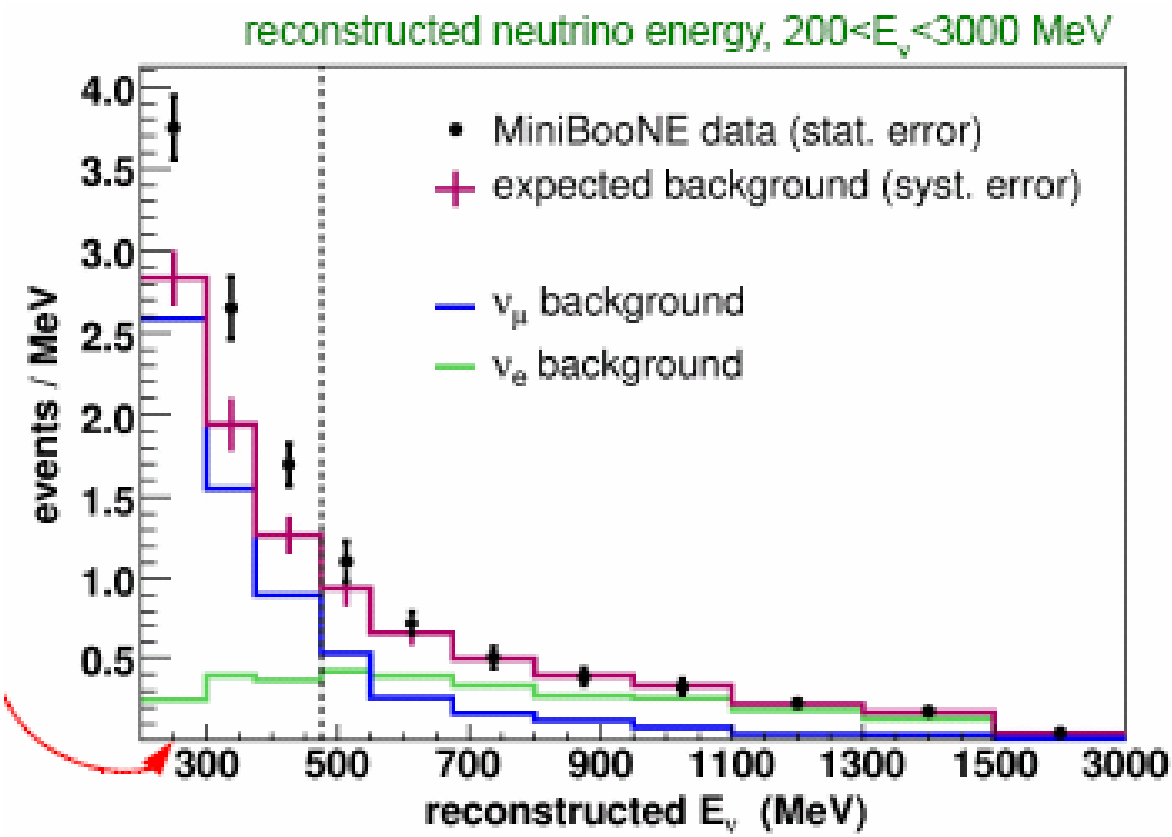
Deviation: 3.7σ

Background-subtracted



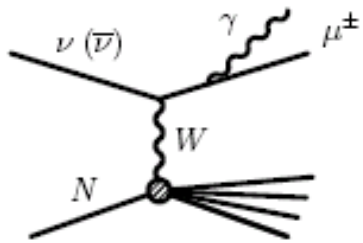
MiniBooNe low energy events

R.Tayloe, LP07



Possible non-oscillation explanations

1 $\nu + n \rightarrow \mu^- + p + \gamma$

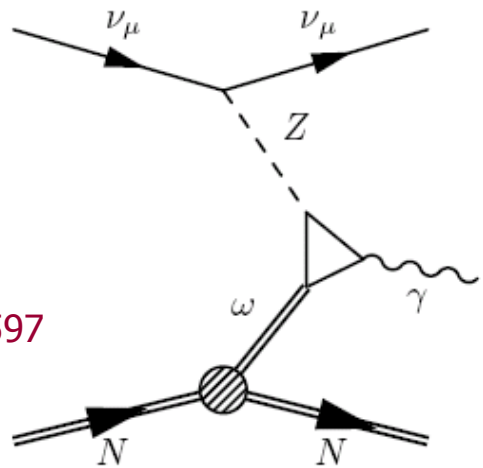


IB from muon
(if μ is below Cherenkov threshold)
suppressed through $\mu^- \rightarrow e^- \nu \nu$

2 Axial anomaly

Coupling between γ, Z and ω

$\sigma \sim 2.6\times10^{-41}(E_\nu/\text{GeV})^6(g_\omega/10)^4\ \text{cm}^2$



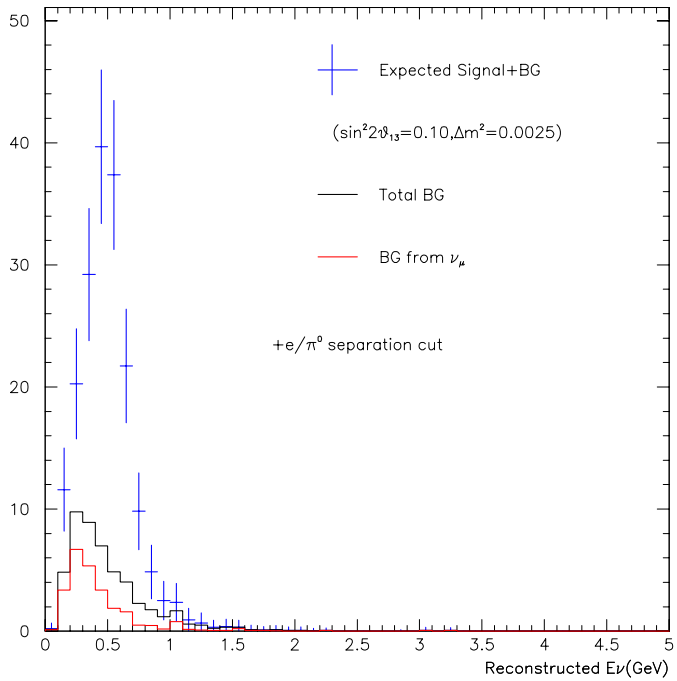
С.С.Герштейн, Ю.Я.Комаченко, М.Ю.Хлопов, ЯФ 33 (1981) 1597
J.Harvey, C.Hill, R.Hill, arXiv:0708.1281[hep-ph]

3 $\nu + p \rightarrow \nu + p + \gamma$

T2K

$$P(\nu_\mu \to \nu_e) \approx \sin^2 2\theta_{13} \sin^2 2\theta_{23} \sin^2[\frac{1.27\Delta m^2_{23} L}{E}]$$

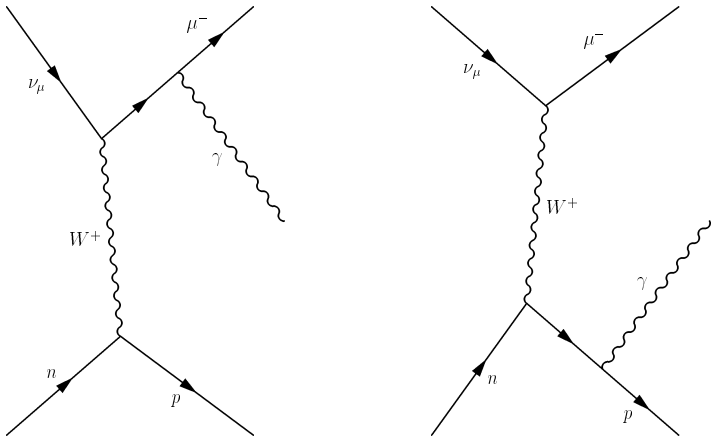
$$\delta(\sin^2 2\theta_{13}) \sim 5\times10^{-3} \Leftrightarrow P(\nu_\mu \to \nu_e) \sim 5\times10^{-3}$$



Single photon background?

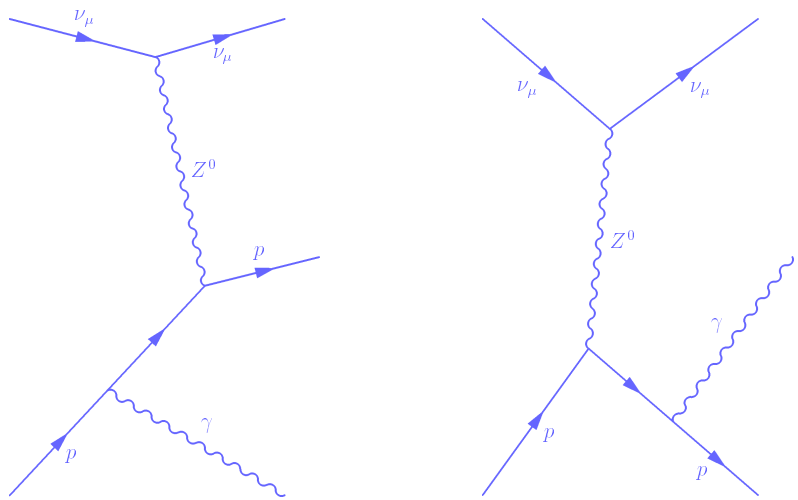
IB in CC and NC

V.Efrosinin, A.Khotjantsev and Yu.K.
preliminary



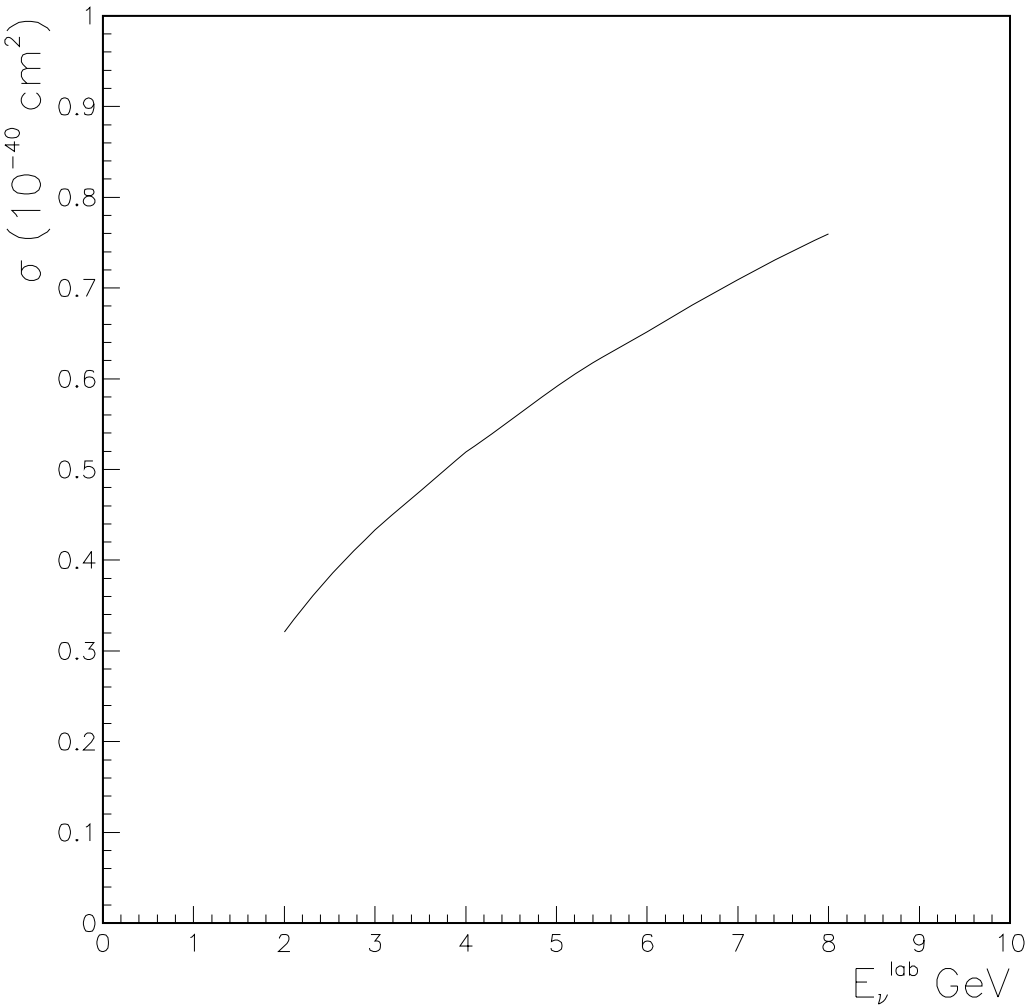
CC

NC



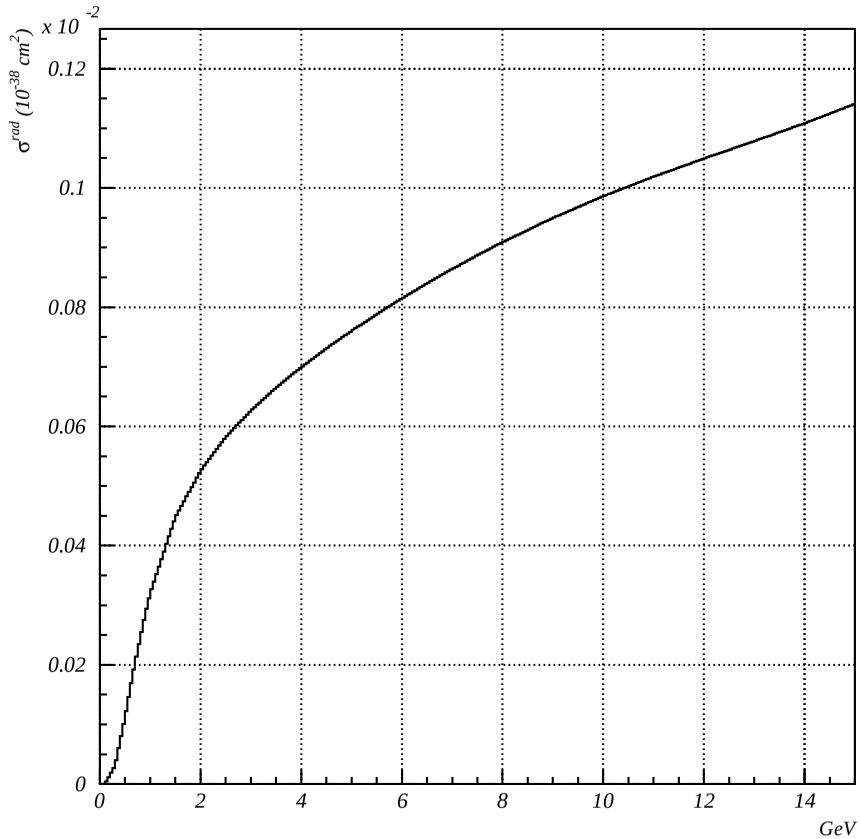
CC

$\sigma(\nu_\mu + n \rightarrow \mu^- + p + \gamma)$



NC

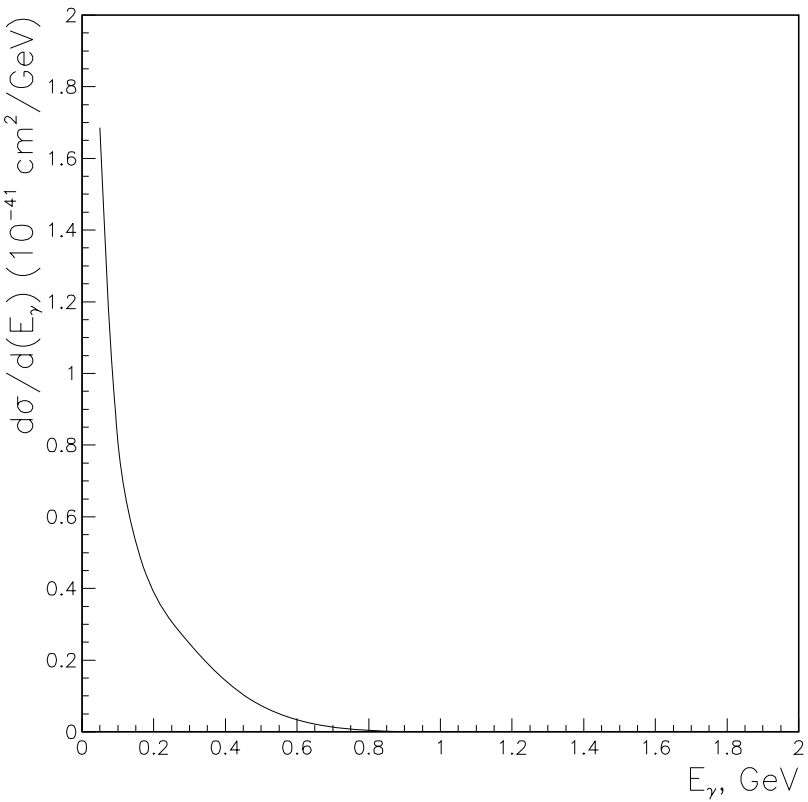
$\sigma(\nu_\mu + p \rightarrow \nu_\mu + p + \gamma)$



NC

E_ν = 1 GeV

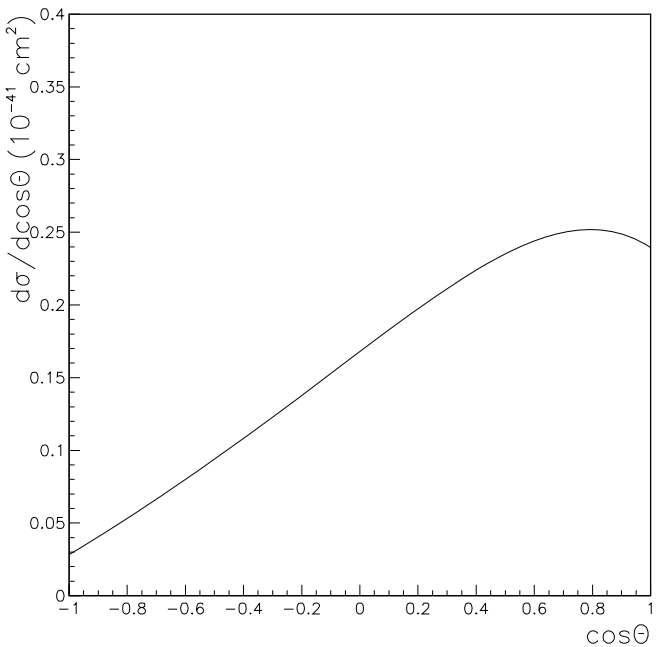
$\nu_\mu + p \rightarrow \nu_\mu + p + \gamma$



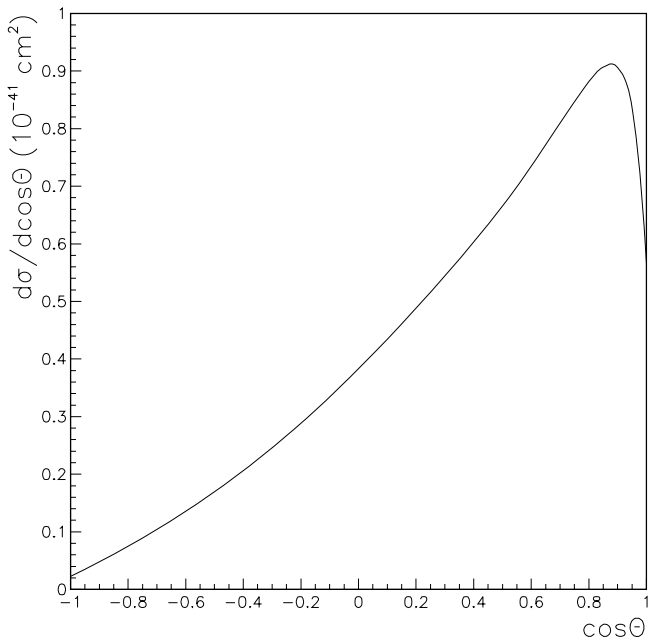
Angular distributions

$\nu_\mu + p \rightarrow \nu_\mu + p + \gamma$

1 GeV

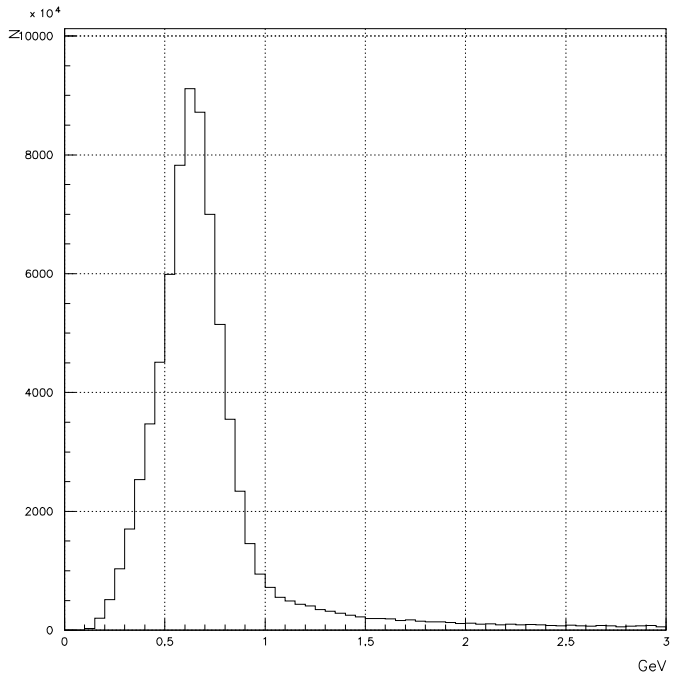


8 GeV

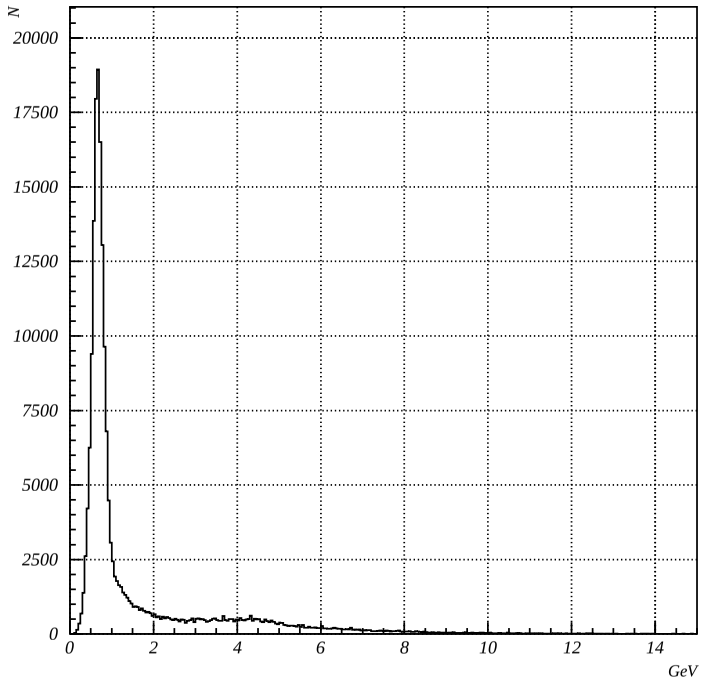


T2K spectra at SK

CCQE



NC IB



$\sigma(1\gamma)/\sigma(CCQE) \sim 4\times10^{-4}$
for signal range 0.3 – 1.0 GeV (ν_e appearance)
(not cuts on proton energy, photon energy > 10 MeV)

Photon production at $E_\nu \sim$ 1 GeV

(σ [10^{-38} cm^2])

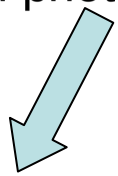
IB	
CC	**~2×10^{-3}**
NC	**~4×10^{-4}**
$\nu N \to \nu\Delta$ ($\Delta \to N\gamma$)	**~$\alpha\sigma$ ~ 0.01 → 1.5x10^{-3}**
DIS	**< 2×10^{-4}**
ω	**$2.6\times10^{-3}(g_\omega/10)^4$**
$\nu N \to \nu N\pi^0$	**~0.15 → ~10^{-3}**
CCQE	**~ 1**

T2K sensitivity: $P(\nu_\mu \to \nu_e)$ ~5×10^{-3}

Conclusion

Photon production in neutrino interactions - rare process

MiniBooNe: low energy excess – contribution from photons?



MicroBooNe proposal

T2K: - photon background through NC is below
expected sensitivity to $\nu_\mu \rightarrow \nu_e$
- photons from CC IB will be cut using Michel electrons
Other processes ?