Exploring the Potential of Short-Baseline Physics at Fermilab

GEFAN
Grupo de Estudos em Física e Astrofísica de Neutrinos

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UNICAMP

06/19/2018

New Perspectives

Phys.Rev. D97 (2018) no.9, 095026

Arxiv: hep-pheno/1802.02133

FAPESP

Fermilab
50 Years of Discovery

Short-Baseline may hide lots of New Physics!

Near Detec-
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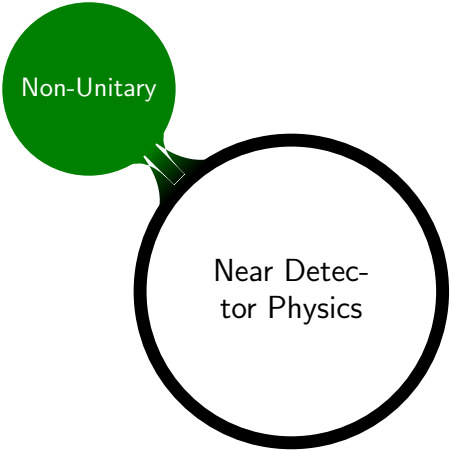

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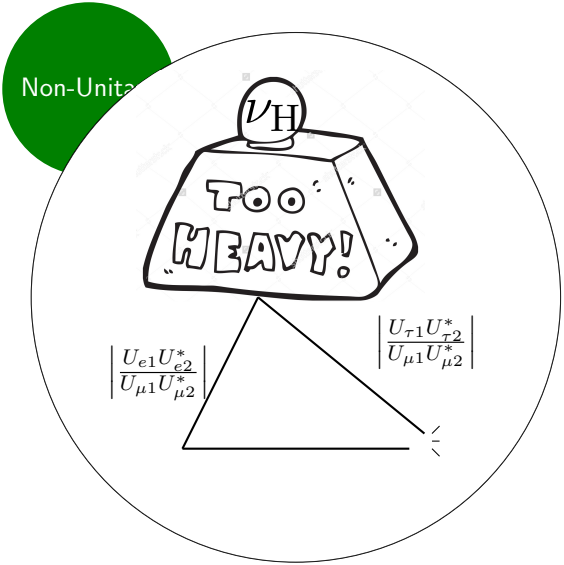

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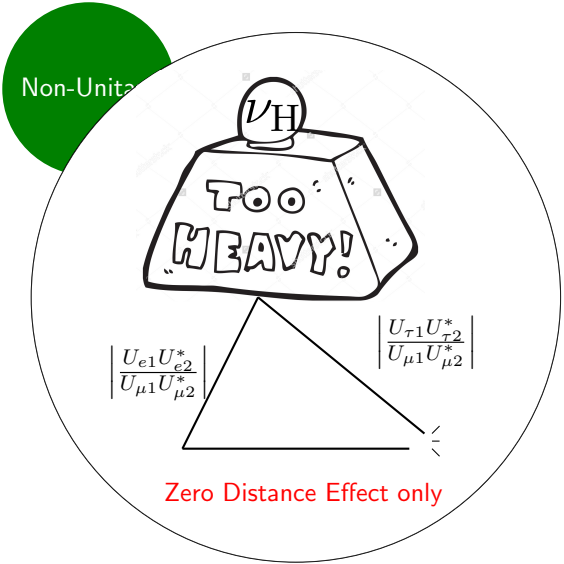

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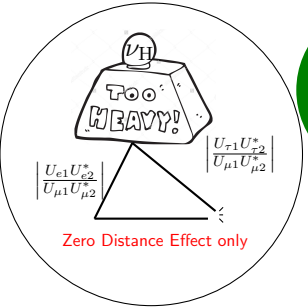

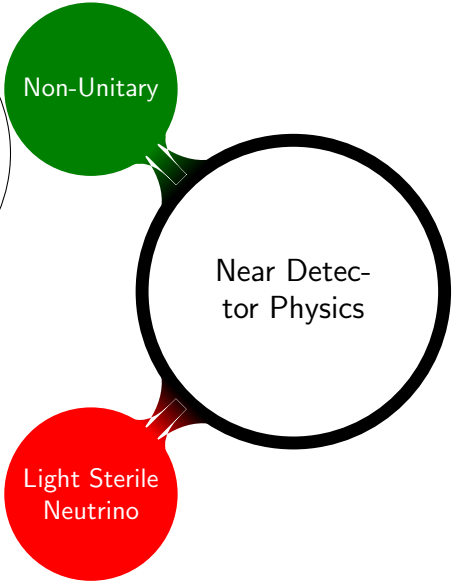

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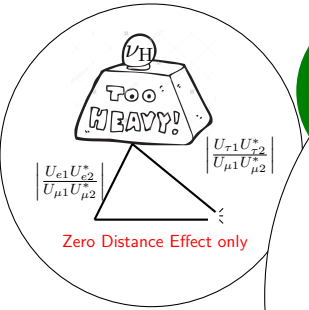

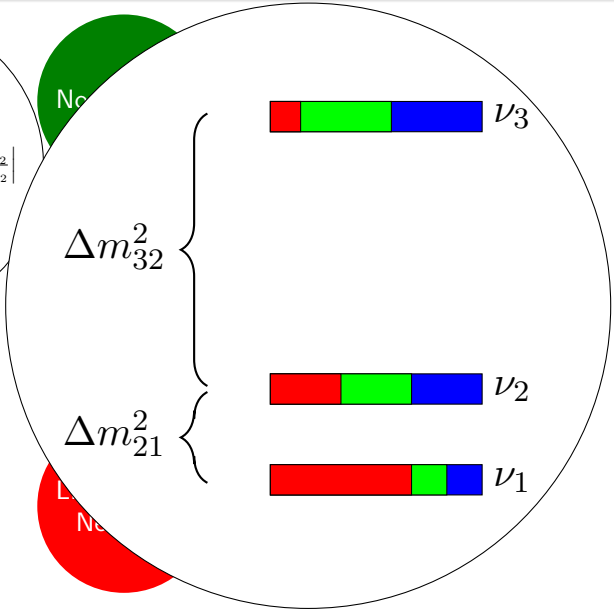

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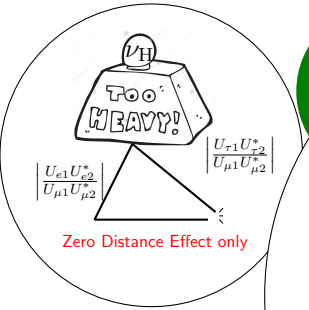

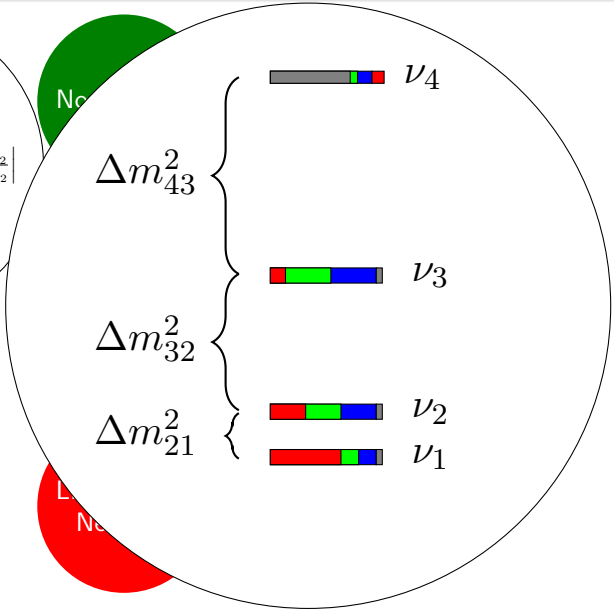

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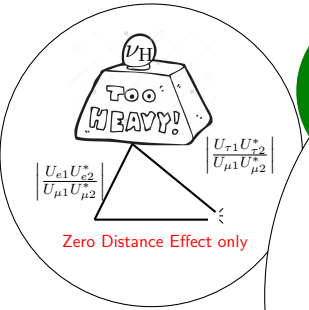

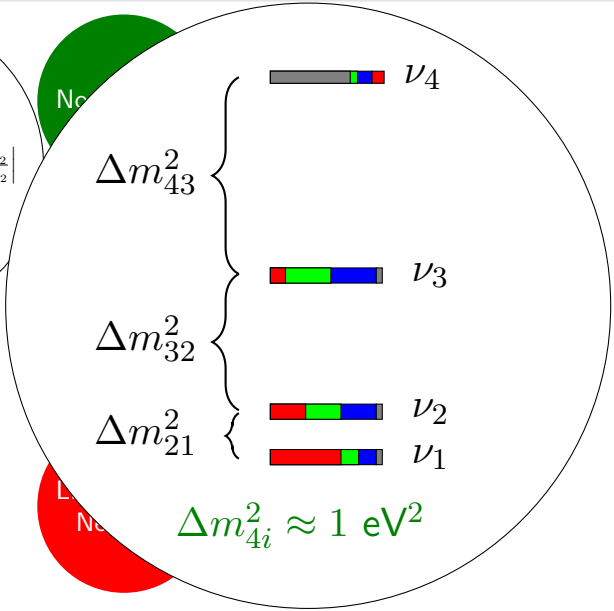

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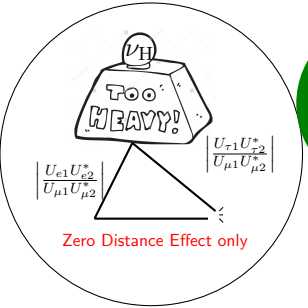

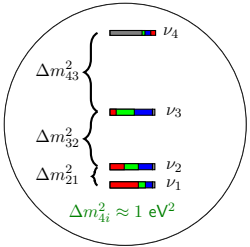

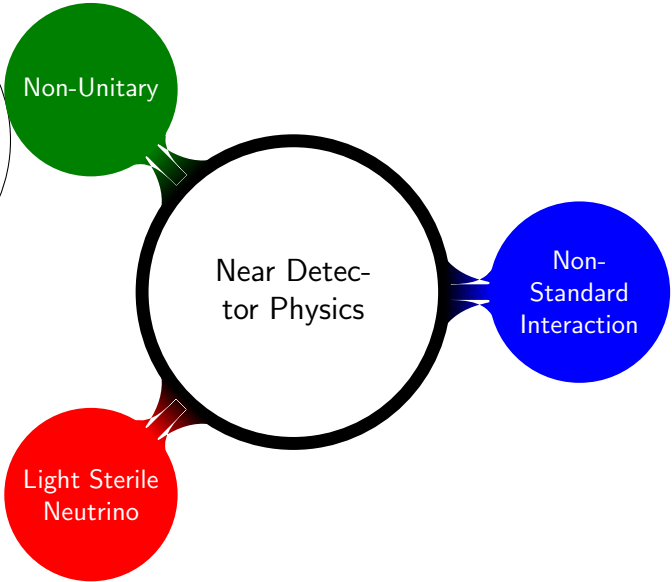

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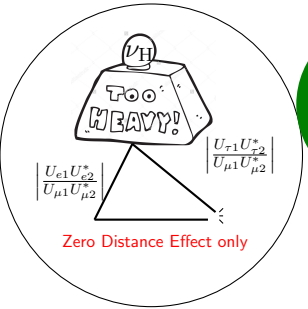

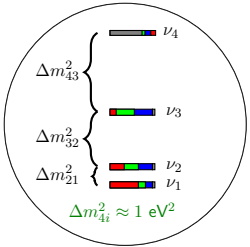

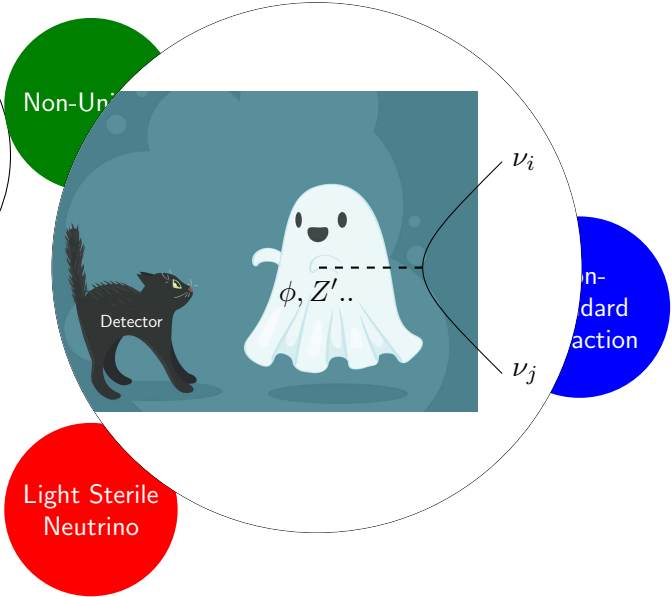

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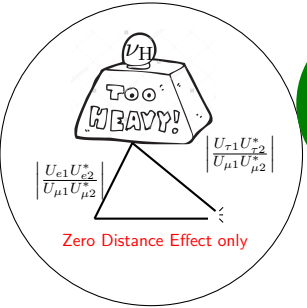
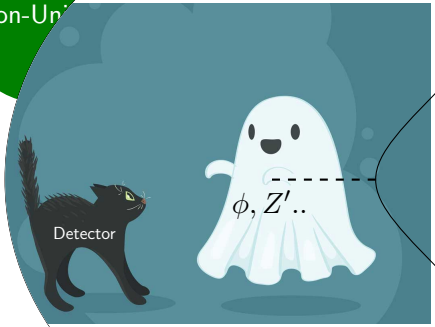


Non-Uni



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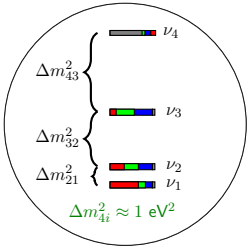
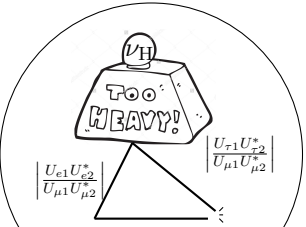
dard
action

Source/Detector NSI only

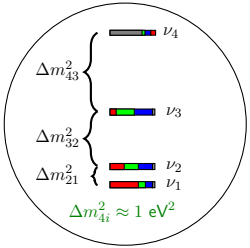


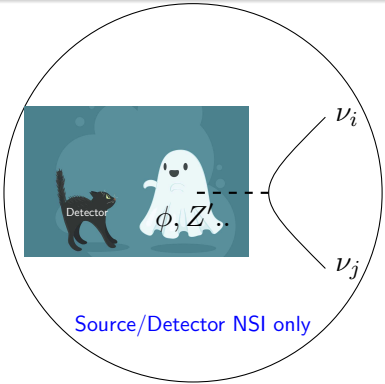
Light Sterile Neutrino

New physics change ν_e spectrum



Zero Distance Effect only





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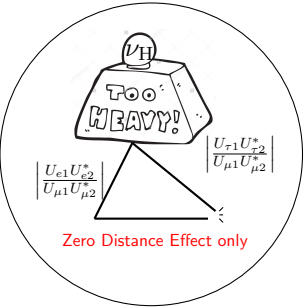
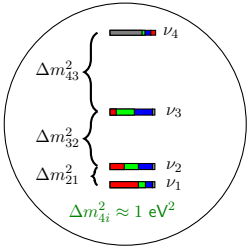
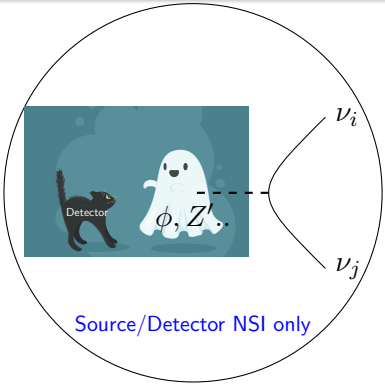




$\approx$



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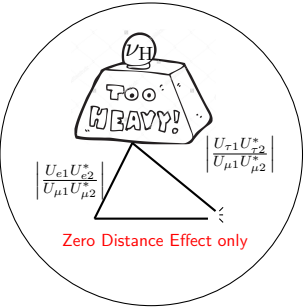

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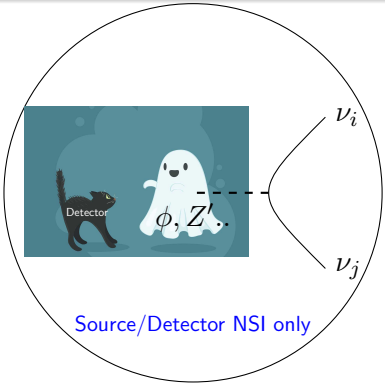
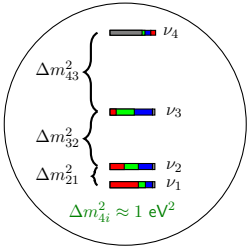
$$L = 0 \to N_e \propto \phi_{\nu_e} + |\alpha_{21}|^2 \phi_{\nu_\mu}$$





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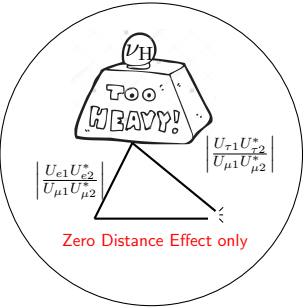

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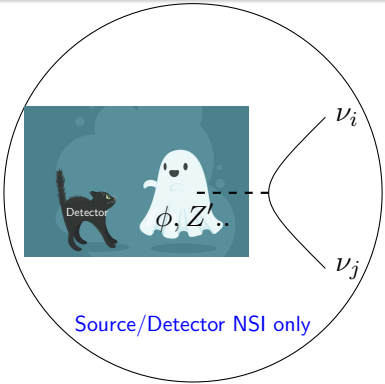

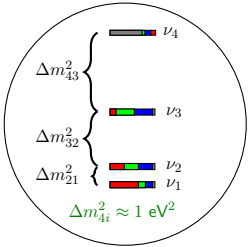

$$P(\nu_\mu \to \nu_e) = 1 - \sin^2 2\theta_{\mu e} \sin \frac{\Delta m^2_{41} L}{4E}$$

We can put better constrain to new physics!

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LBNF beam with: protoDUNE and ICARUS as ND

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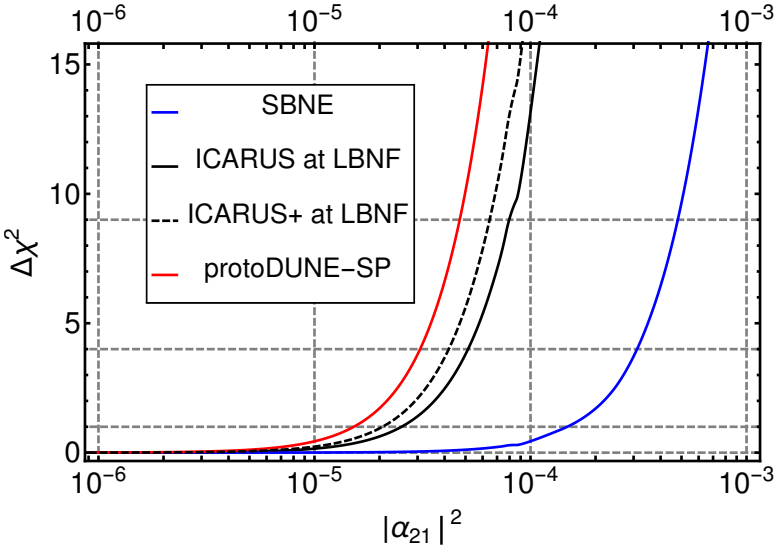

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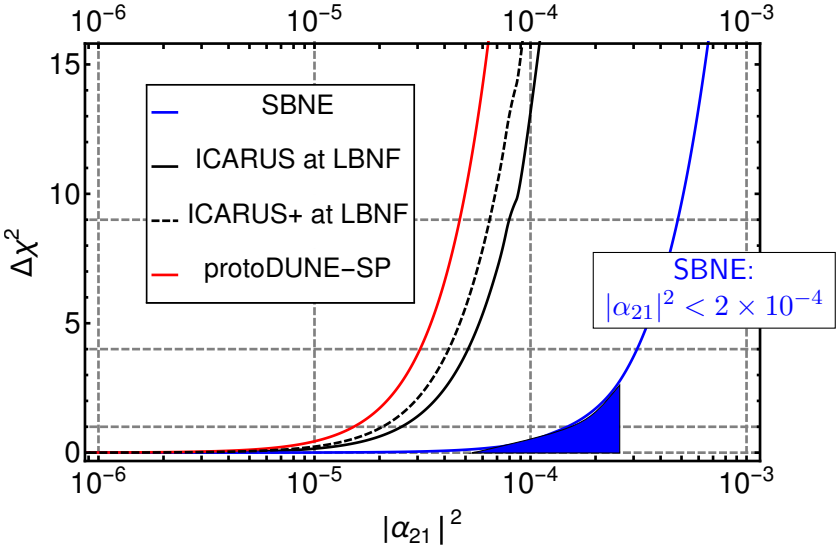

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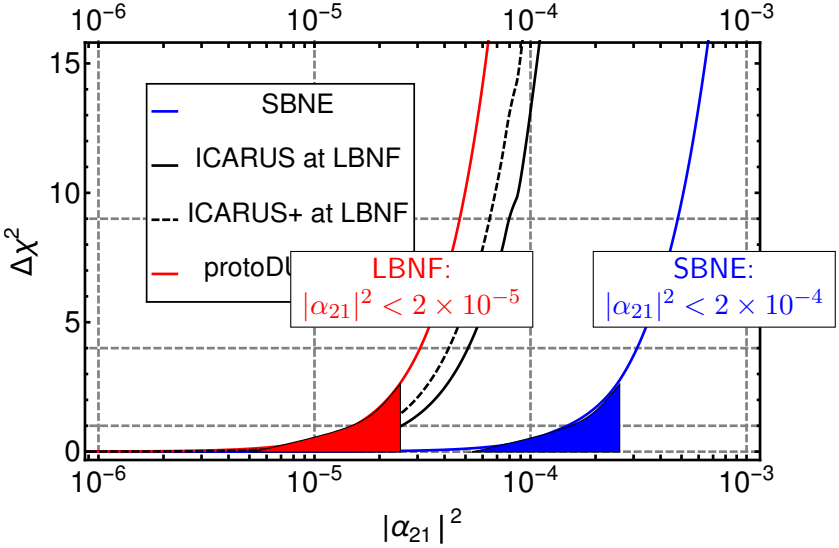

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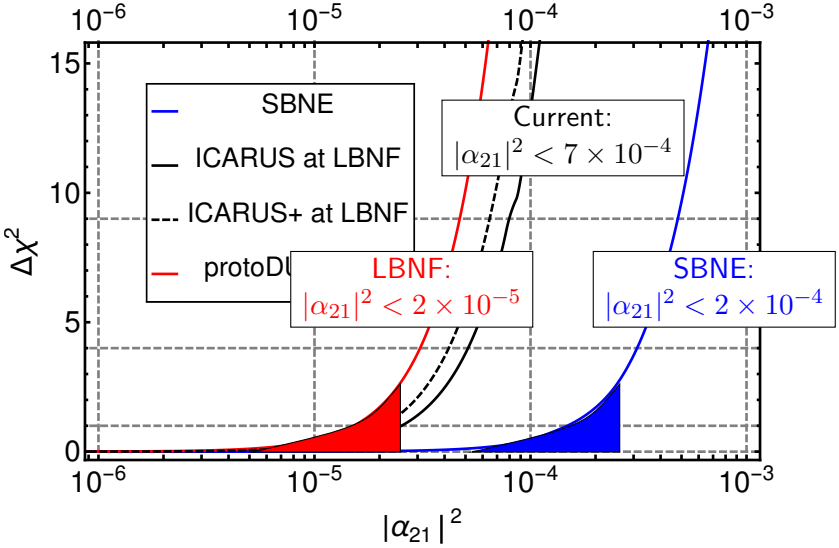

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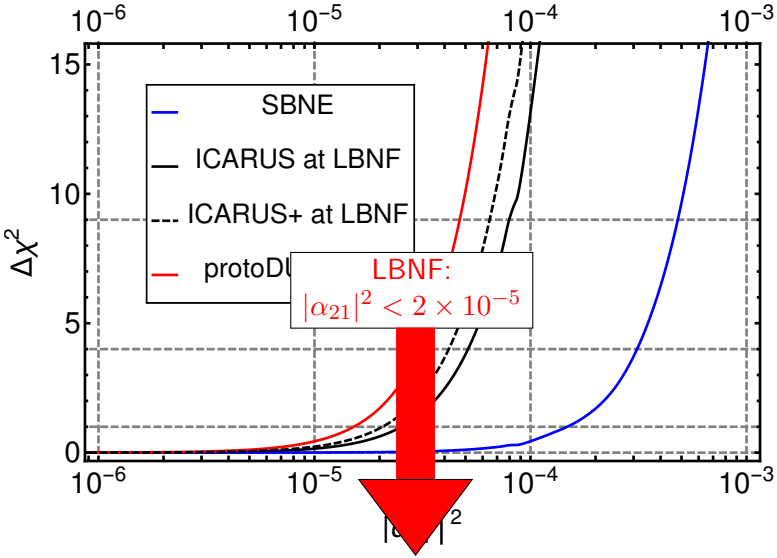

Can we really reach this level?

We need to know the expected flux precisely!

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Thus, we need to know the expected flux:

We need good production simulation and measurement (μ, hadron)

We parametrized our lack of knowledge

Let's parametrize our lack of knowledge to see its impact:

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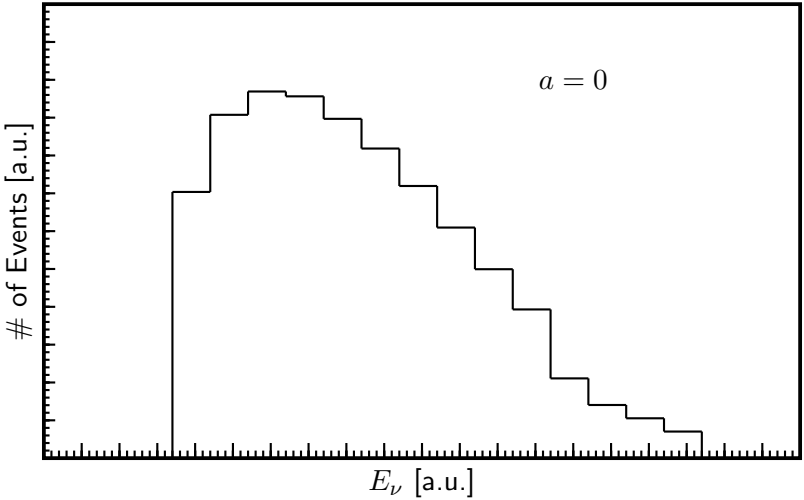

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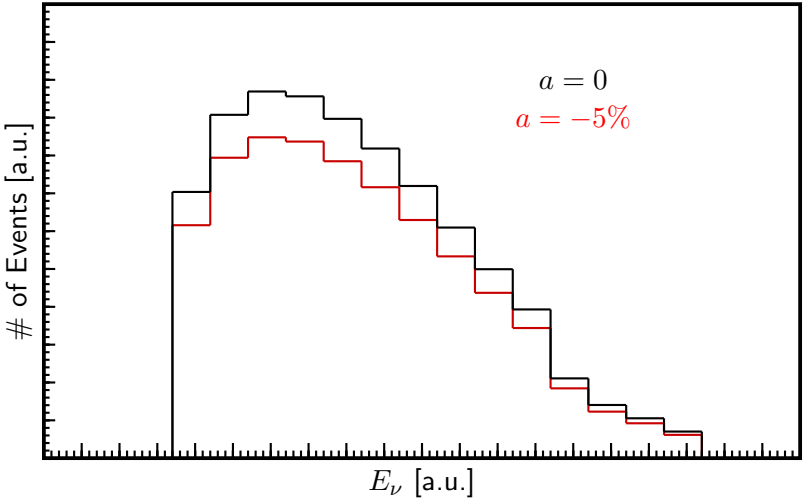

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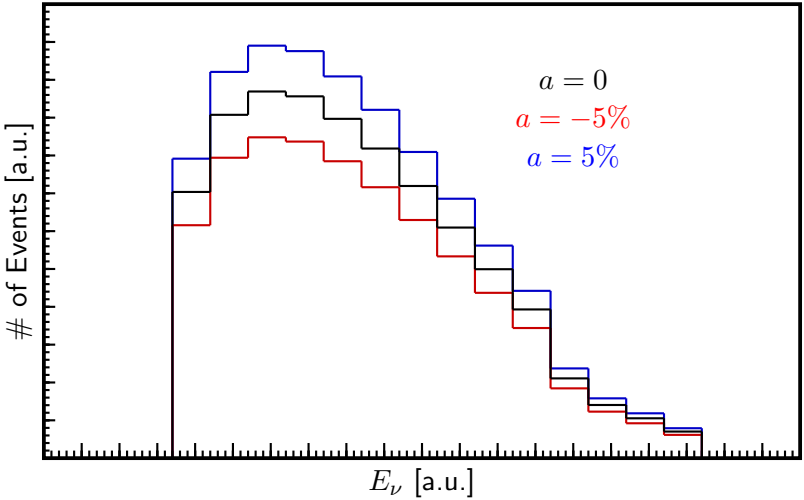

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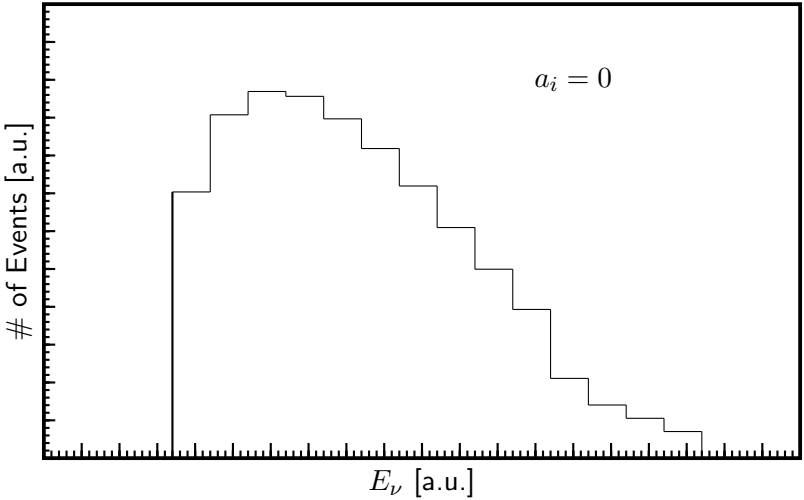

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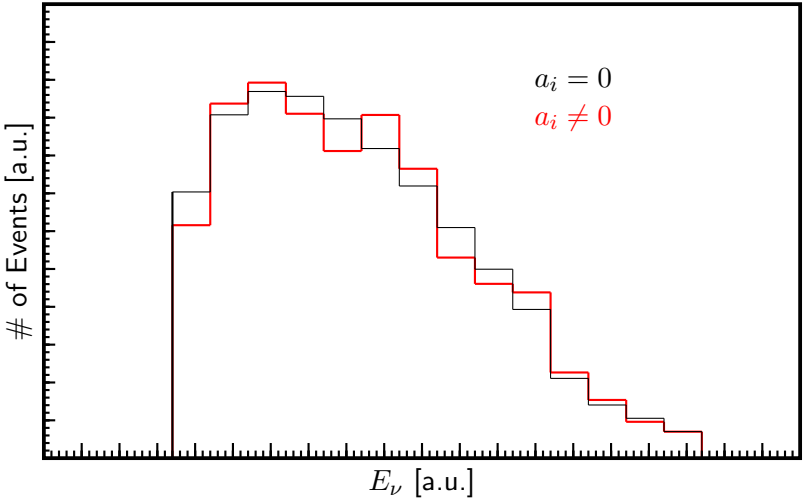

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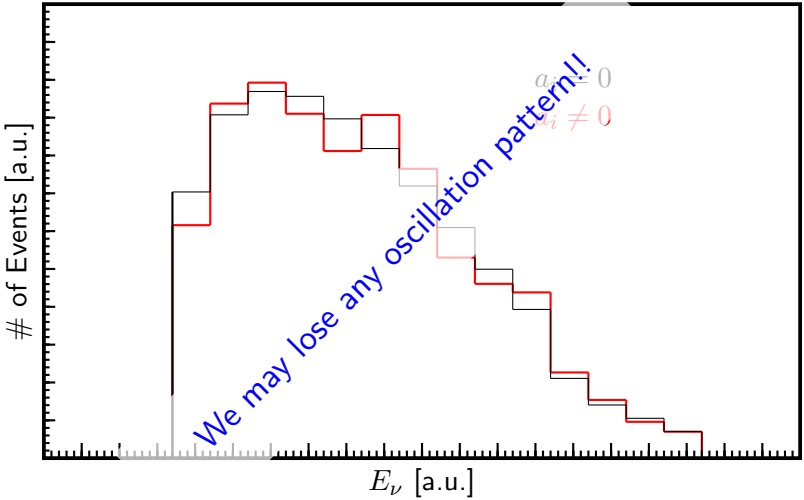

σ_s the real parameter here

A bit of math....

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$$\chi^2 = \sum_{i=1}^{N_{\rm bin}} \left(\frac{N_i^{\rm exp} - (1-a-a_i)N_i^{\rm th} - (1-b-b_i)N_i^{\rm bg}}{\sqrt{N_i^{\rm exp}}} \right)^2 + \chi^2_{\rm SYS}\,,$$

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We minimize over a, b, a_i, b_i

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A bit of math....

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We minimize over a, b, a_i, b_i

$\sigma_{sa} = \sigma_{sb} = \sigma_s$ Spectrum error

We need $\sigma_s \sim O(1)\%$

What we got (for $|\alpha_{21}^2|$):

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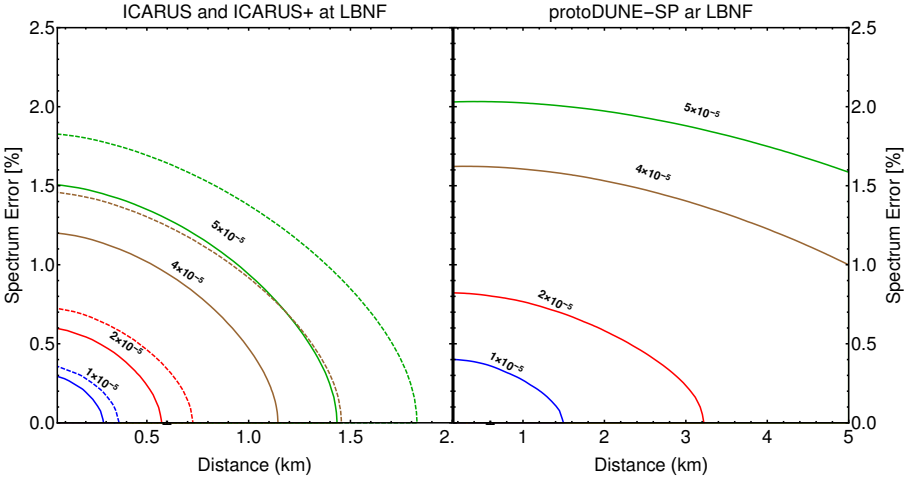
What we got (for $|\alpha^2_{21}|$):



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Spectrum error (σ_s)

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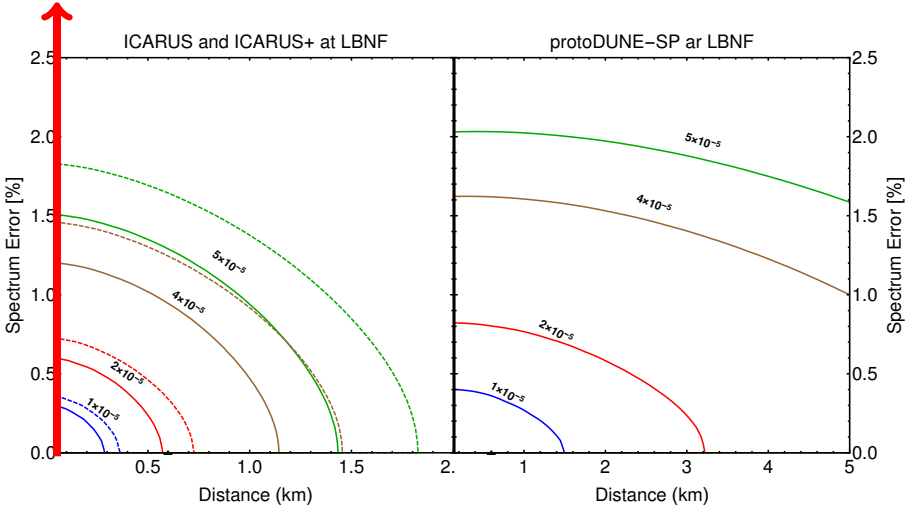

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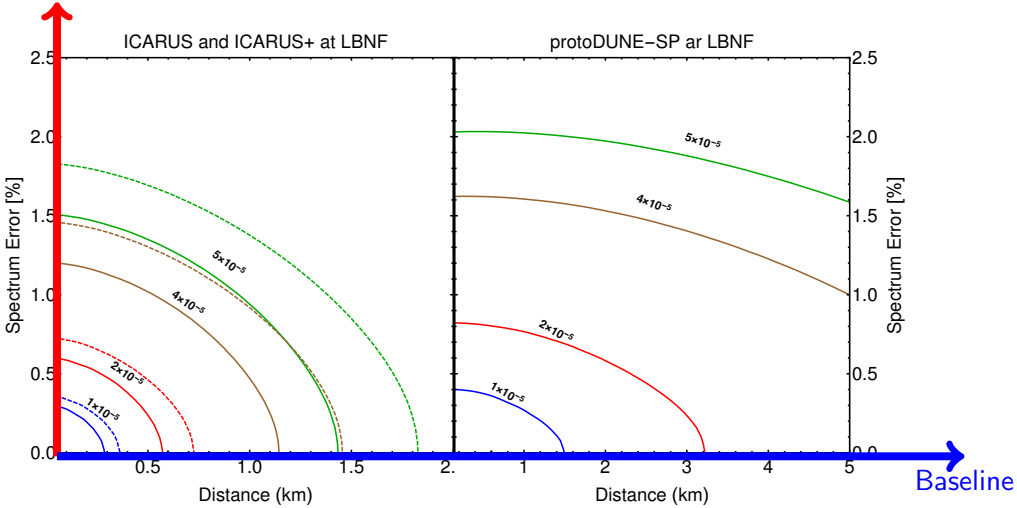

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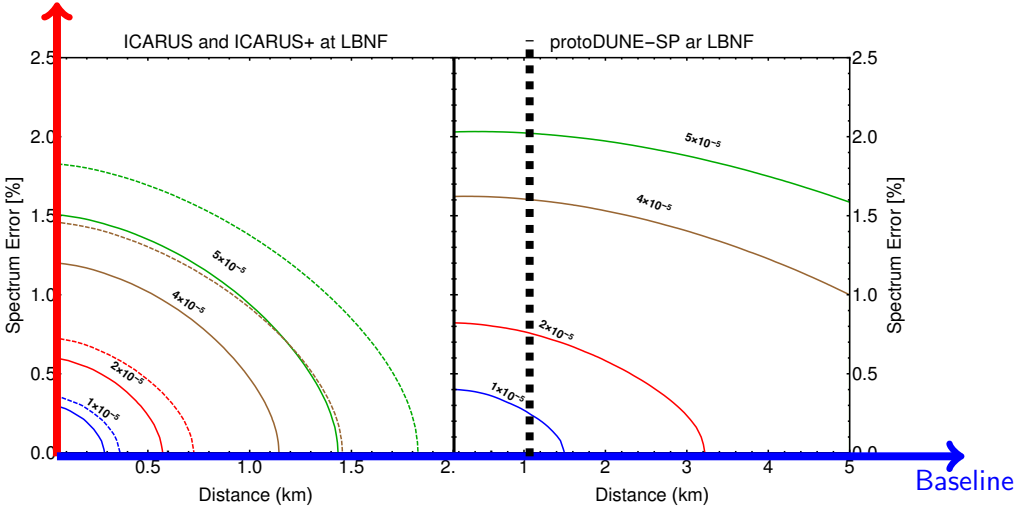

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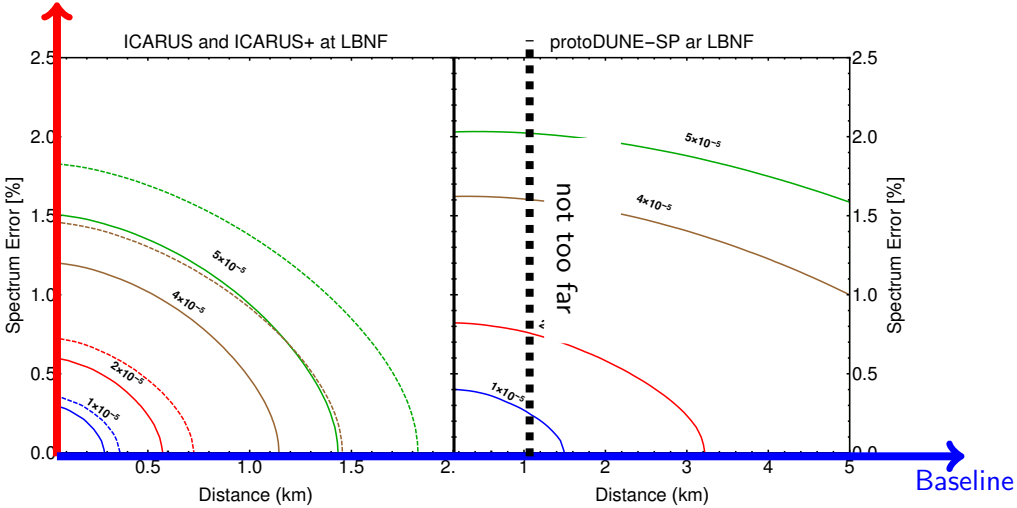

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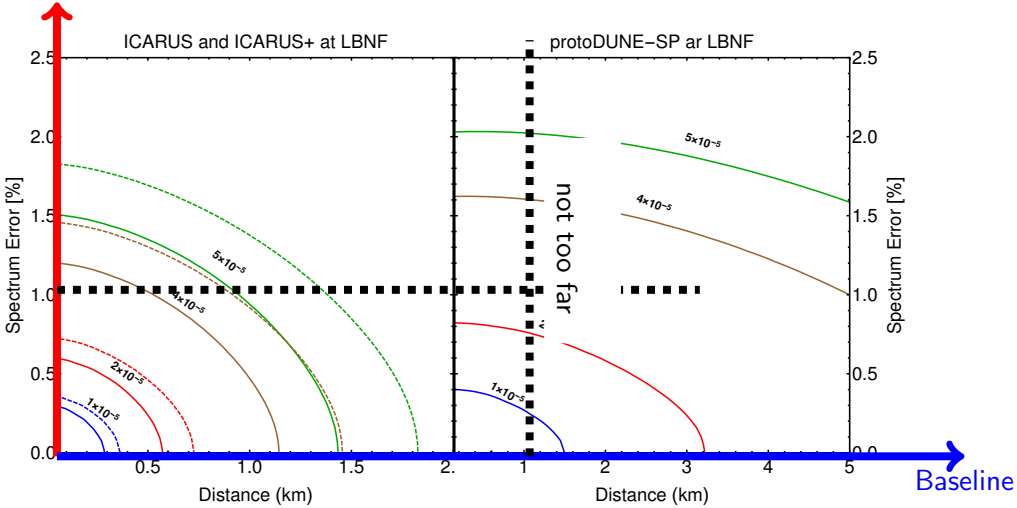

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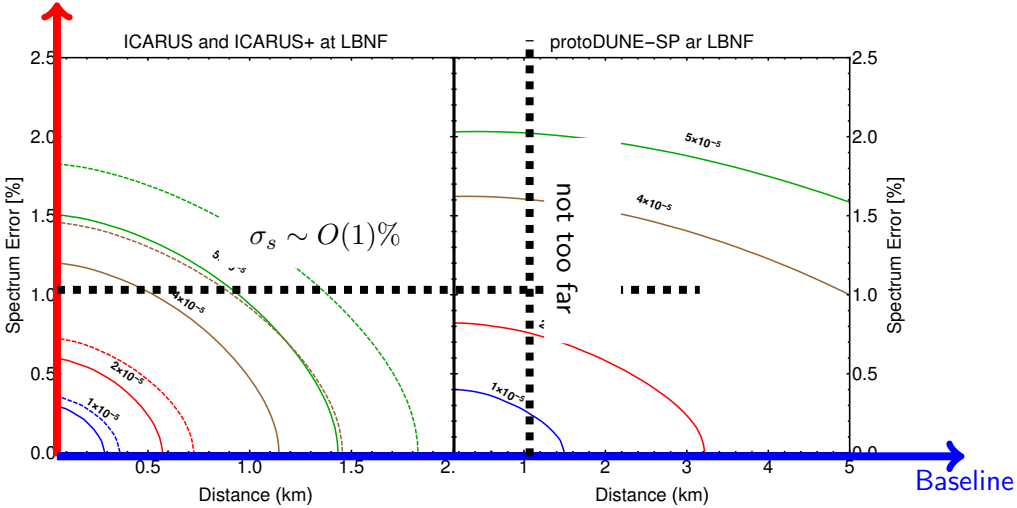
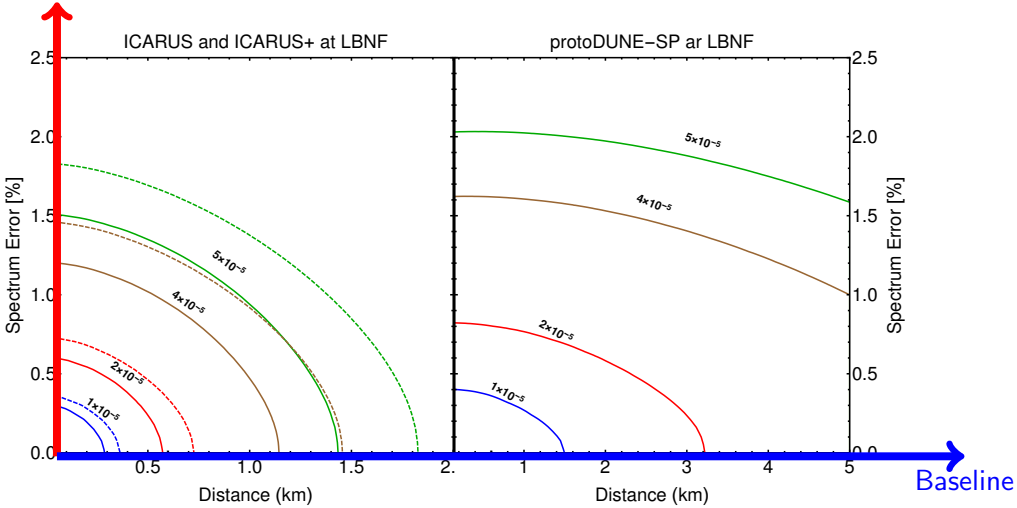


σ_s defines maximum resolution

Spectrum error (σ_s)

What we got (for $|\alpha_{21}^2$:



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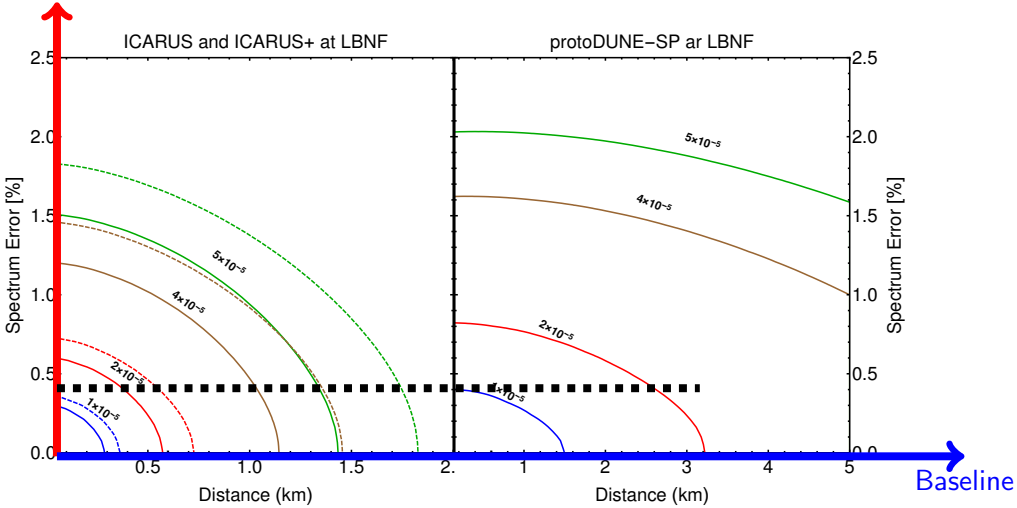

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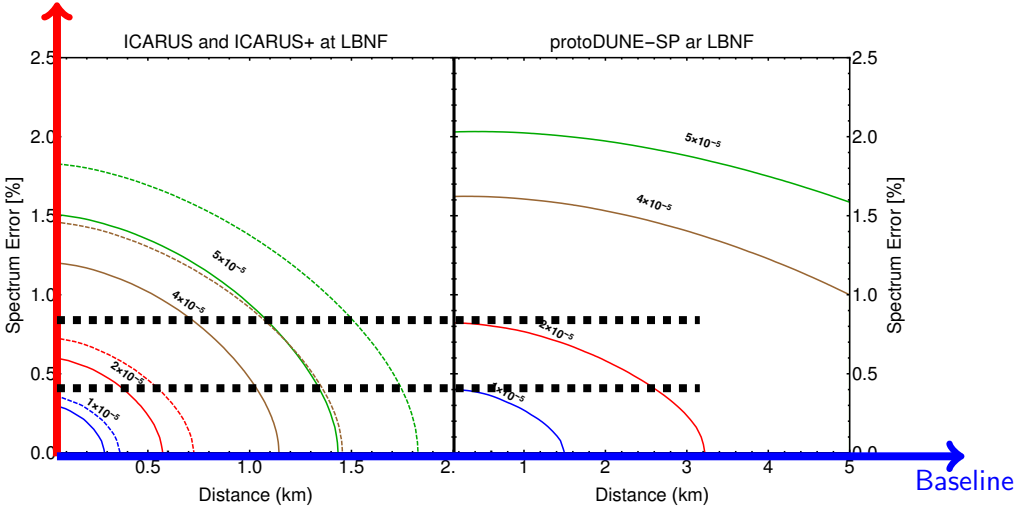

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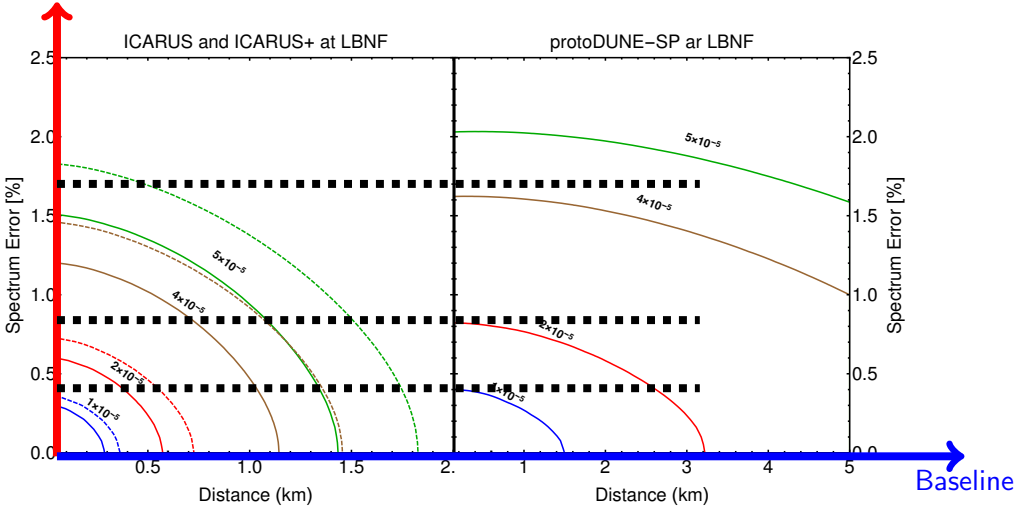

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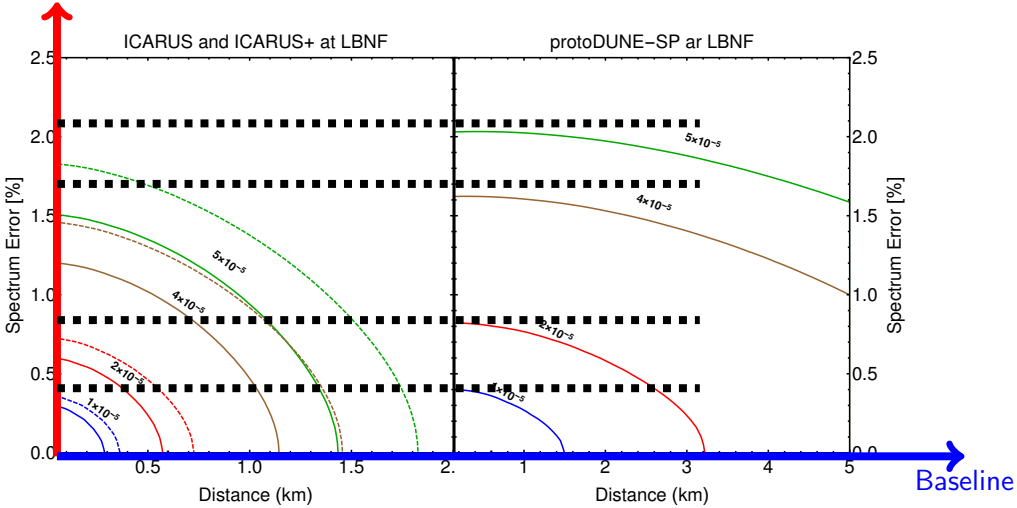
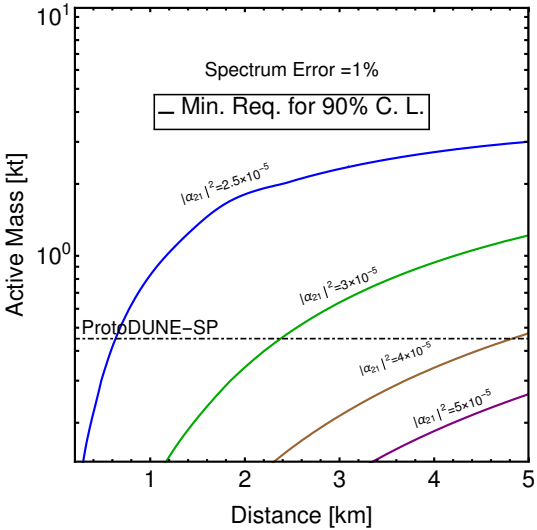


Setting a σ_s goal, we can get minimum requirements



We can probe sterile neutrinos too!

similar for sterile neutrino!

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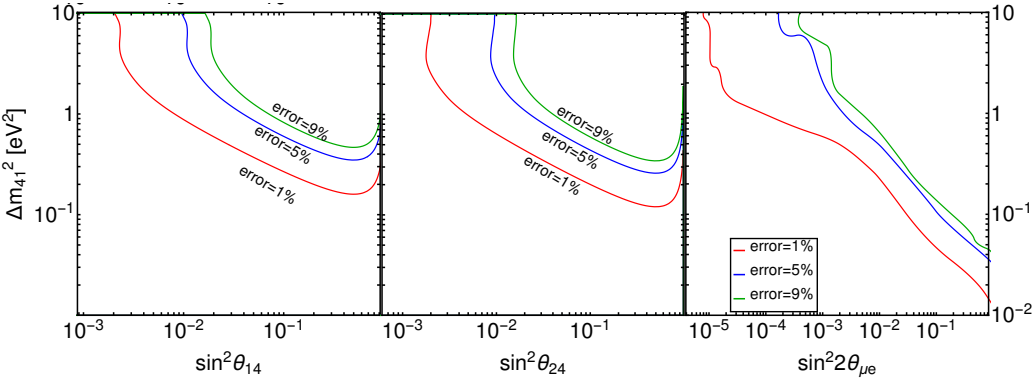

New physics can be probed if $\sigma_s \sim O(1)\%$

Conclusion:

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SBN can slightly improve NSI/Non-unitary

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Similar for sterile neutrino

Thanks for the supporters

Thanks

G. V. Stenico for SBN codes

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Generalitat Valenciana

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