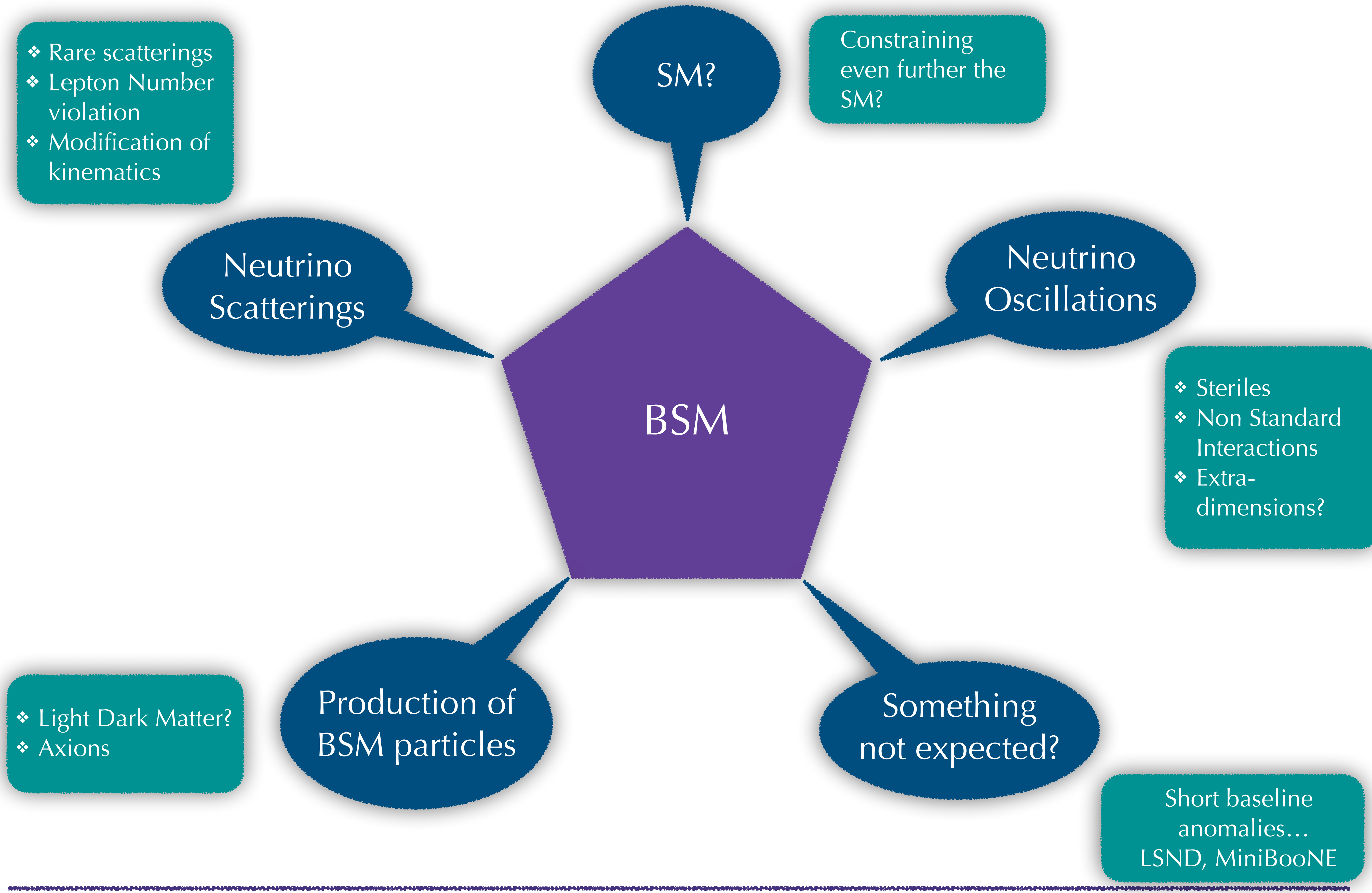
BSM Physics with nuSTORM

Yuber F. Perez-Gonzalez

Exploring the Physics Opportunities of nuSTORM
April 6th, 2023

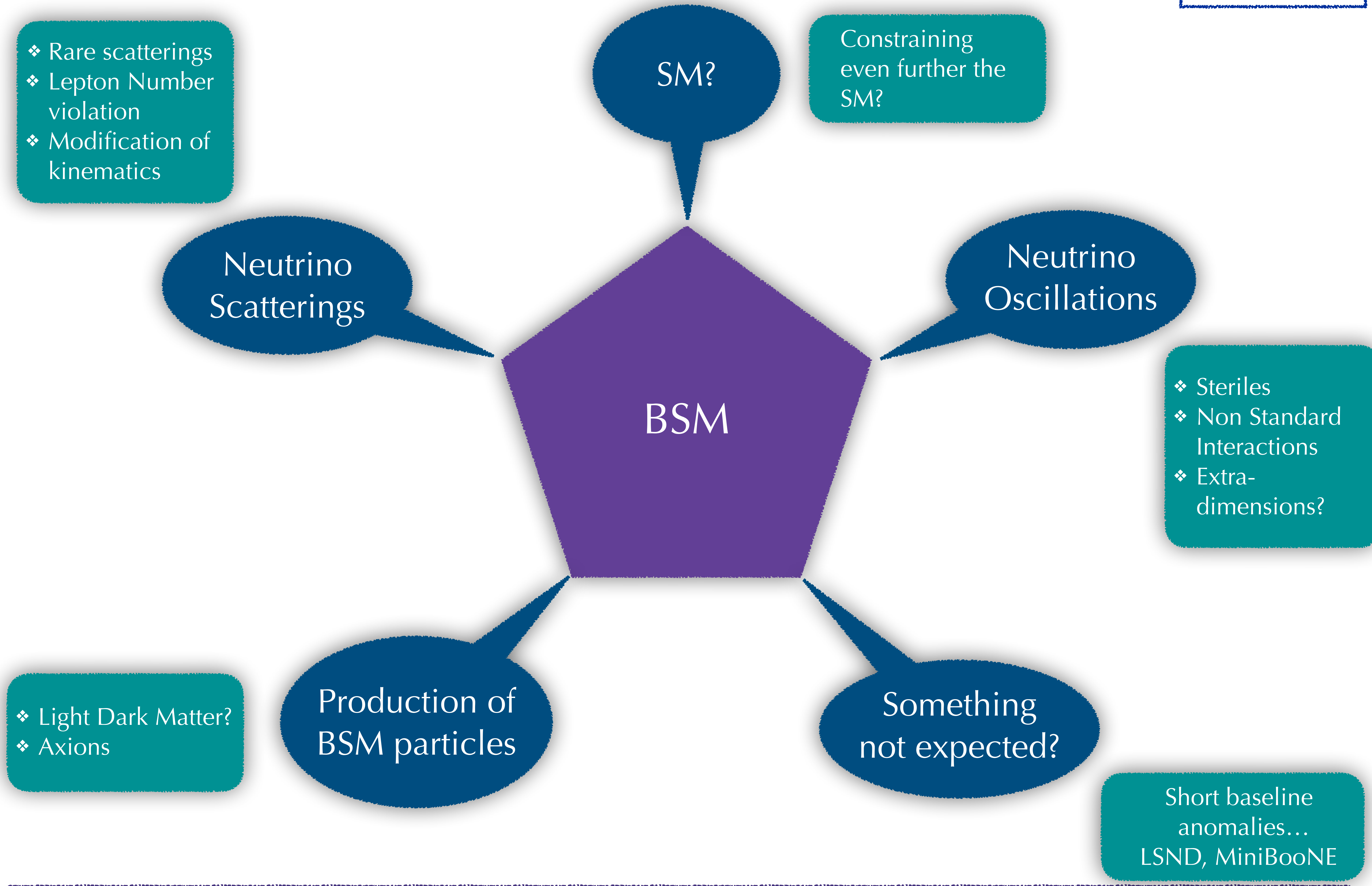
Durham University

IP3


Rare scatterings
Lepton Number violation
Modification of kinematics
SM?
Constraining even further the SM?
Neutrino Scatterings
Neutrino Oscillations
BSM
Steriles
Non Standard Interactions
Extra-dimensions?
Light Dark Matter?
Axions
Production of BSM particles
Something not expected?
Short baseline anomalies…
LSND, MiniBooNE

What nuSTORM could do?

More questions than answers



What nuSTORM could do?

More questions than answers

- Highly segmented detectors capable of precision operation at high event rate. Detectors with inherent 3D tracking (or very precise timing) capability over 4π are required.
- Excellent muon and electron ID capability.
- Excellent energy resolution.
- A magnetized detector for charge identification. In addition, reconstruction via spectrometry can be applied to event reconstruction as opposed to being done via calorimetry. This is particularly important for high-energy ($E_\nu \geq 10$ GeV) neutrino interactions where the outgoing muon's momentum must be measured via spectrometry.
- Excellent particle ID, ie, $p/\pi/K$ separation at momenta from a few hundred MeV/c to a few GeV/c.
- Neutron detection capability (with energy determination).
- A variety of nuclear targets to measure cross-sections as a function of the nuclear target mass number A.
- Micron-scale resolution for charm and tau identification or the capability to tag charm and taus in the final state via kinematics.

Bogacz et al. Snowmass 2203.08094

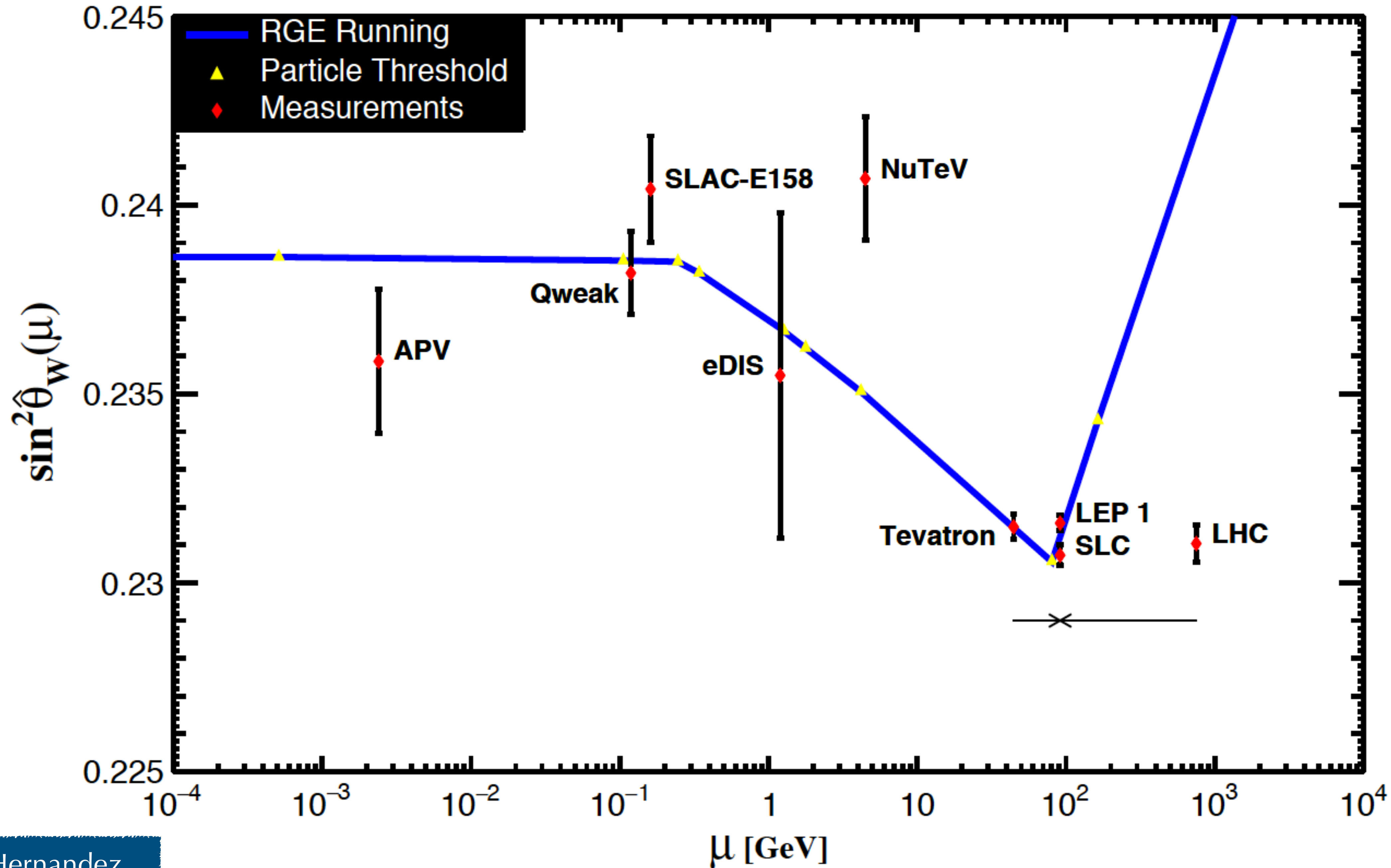
Let's start with some SM…

Weak mixing angle

Fermion Couplings

$$g_V^f = t_3^f - 2q_f \sin^2\theta_W$$
$$g_A^f = t_3^f$$

$$\overline{\text{MS}}: \quad \sin^2\theta_W(\mu) \equiv \frac{g'(\mu)^2}{g(\mu)^2 + g'(\mu)^2}$$



Erler, Ferro-Hernandez, JHEP 1803, 196

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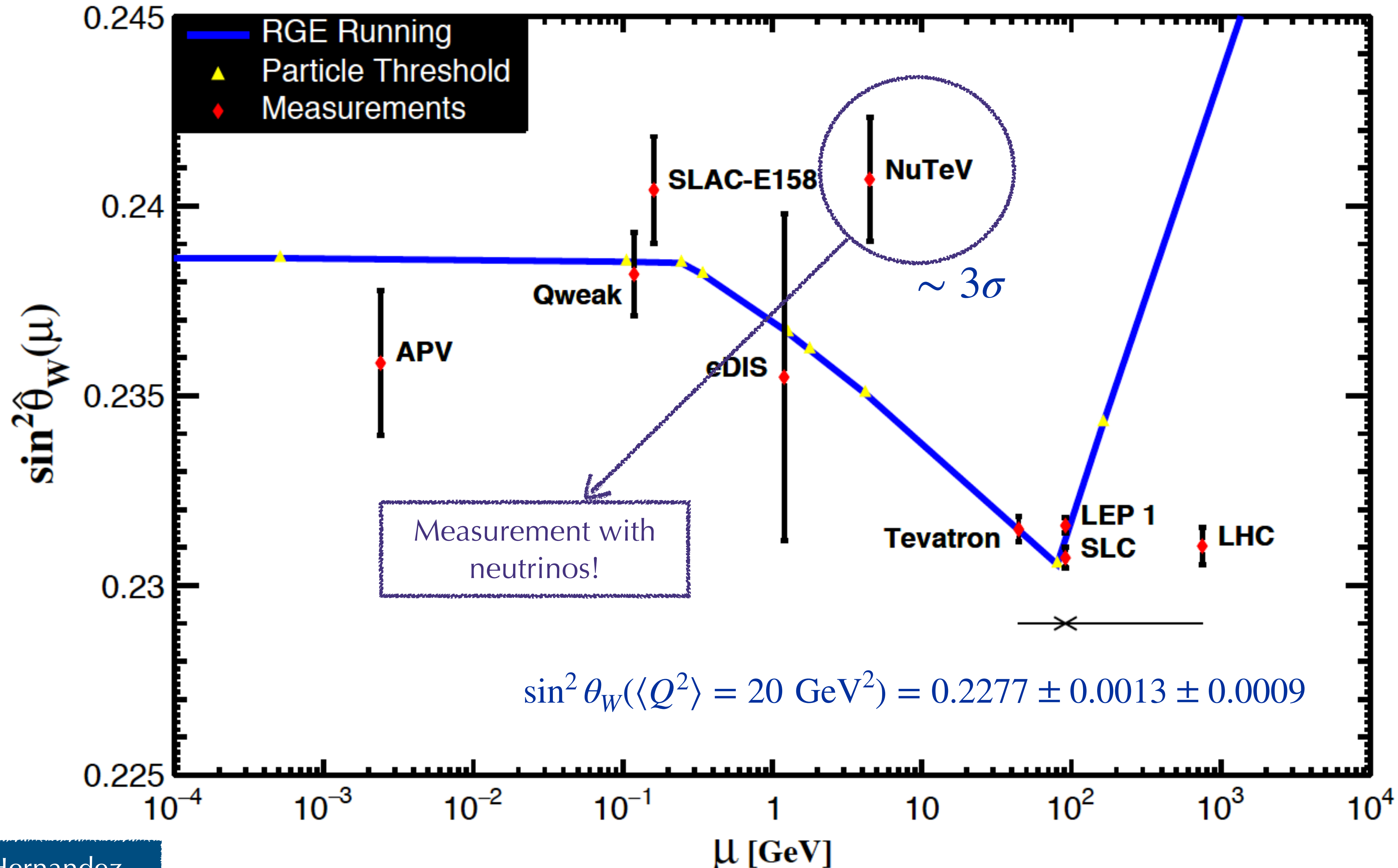
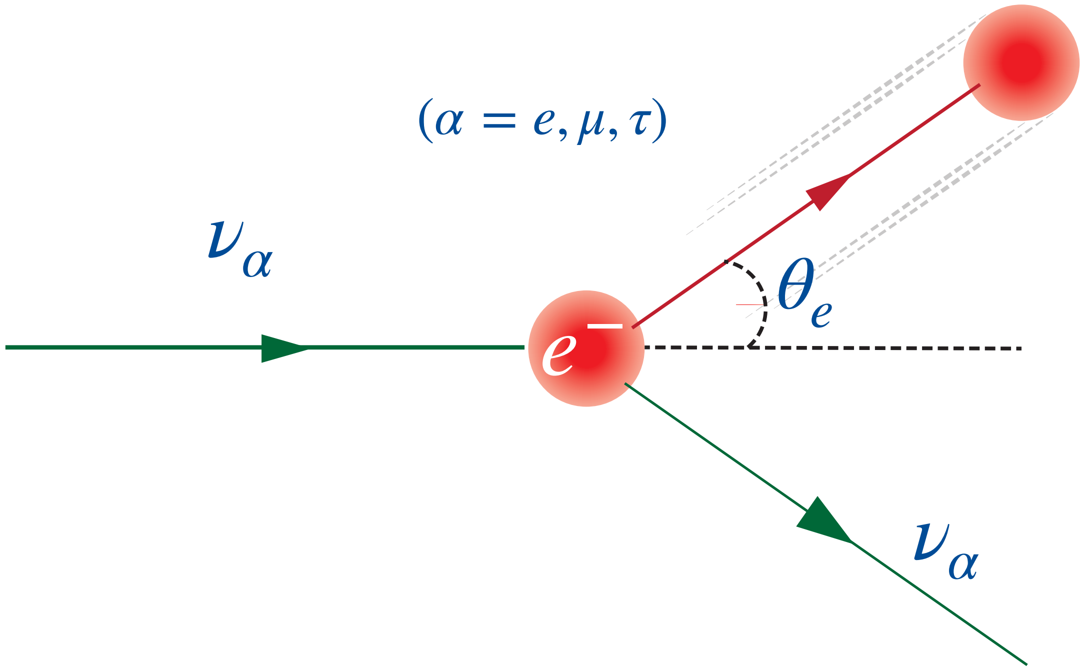


Erler, Ferro-Hernandez, JHEP 1803, 196

Neutrino-electron scattering

$$\frac{d\sigma}{dE_R} \propto g_1^2 + g_2^2 \left(1 - \frac{E_R}{E_\nu}\right)^2$$



For $\nu_\alpha e^- \to \nu_\alpha e^-$:

$$g_1 = g_V + g_A + 2\delta_{\alpha e}$$

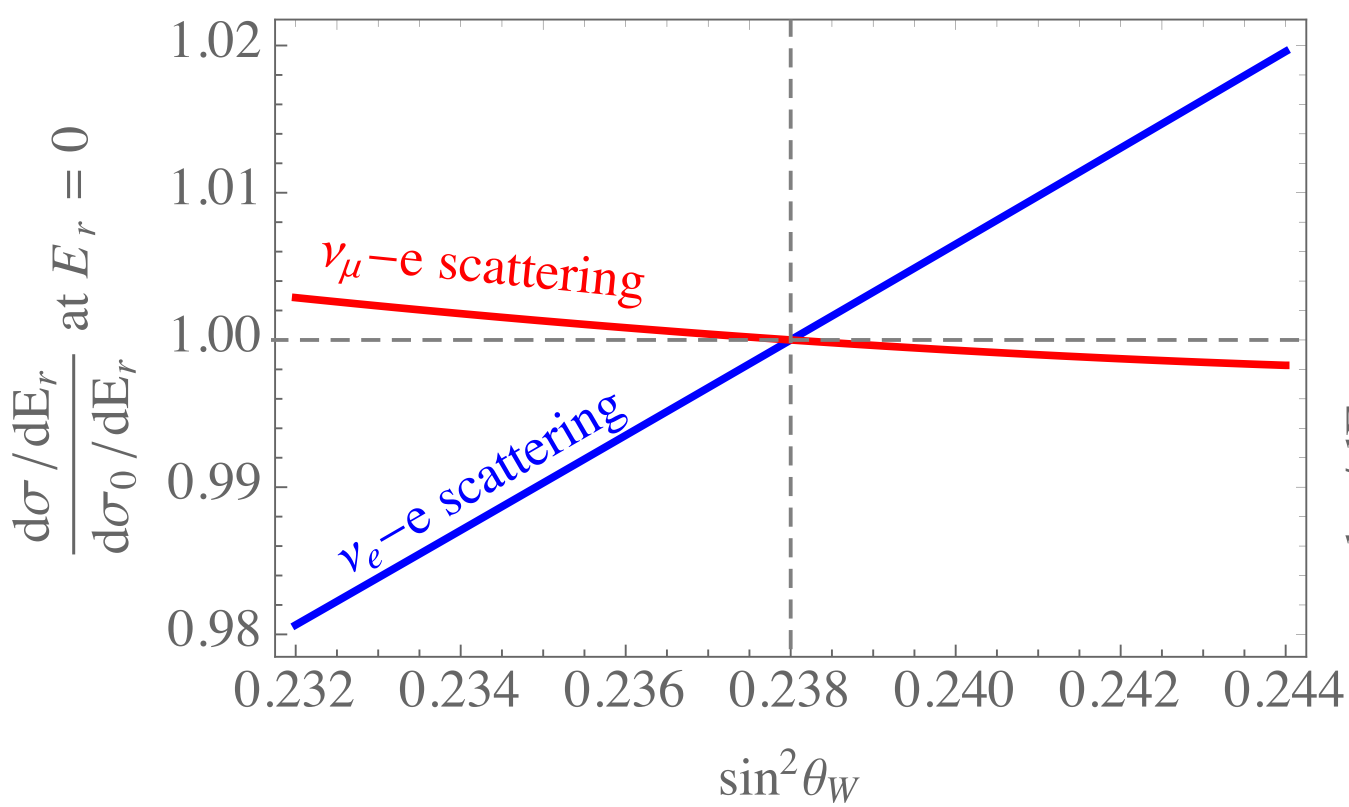
$$g_2 = g_V - g_A$$

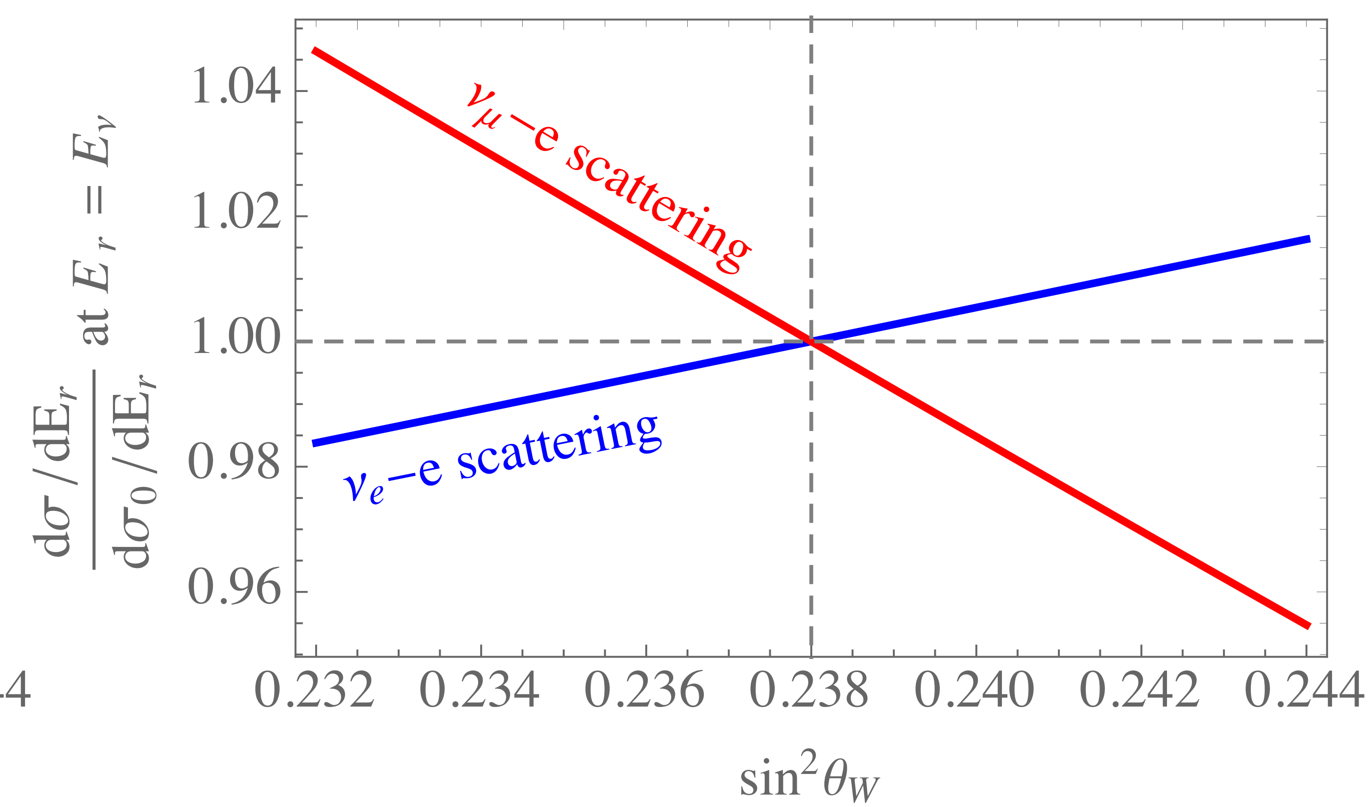
CC contribution

For $\overline{\nu_\alpha} e^- \to \overline{\nu_\alpha} e^-$:

$$g_2 \leftrightarrow g_1$$

In the SM: $g_A = -\frac{1}{2}, \quad g_V = -\frac{1}{2} + 2\sin^2\theta_W$





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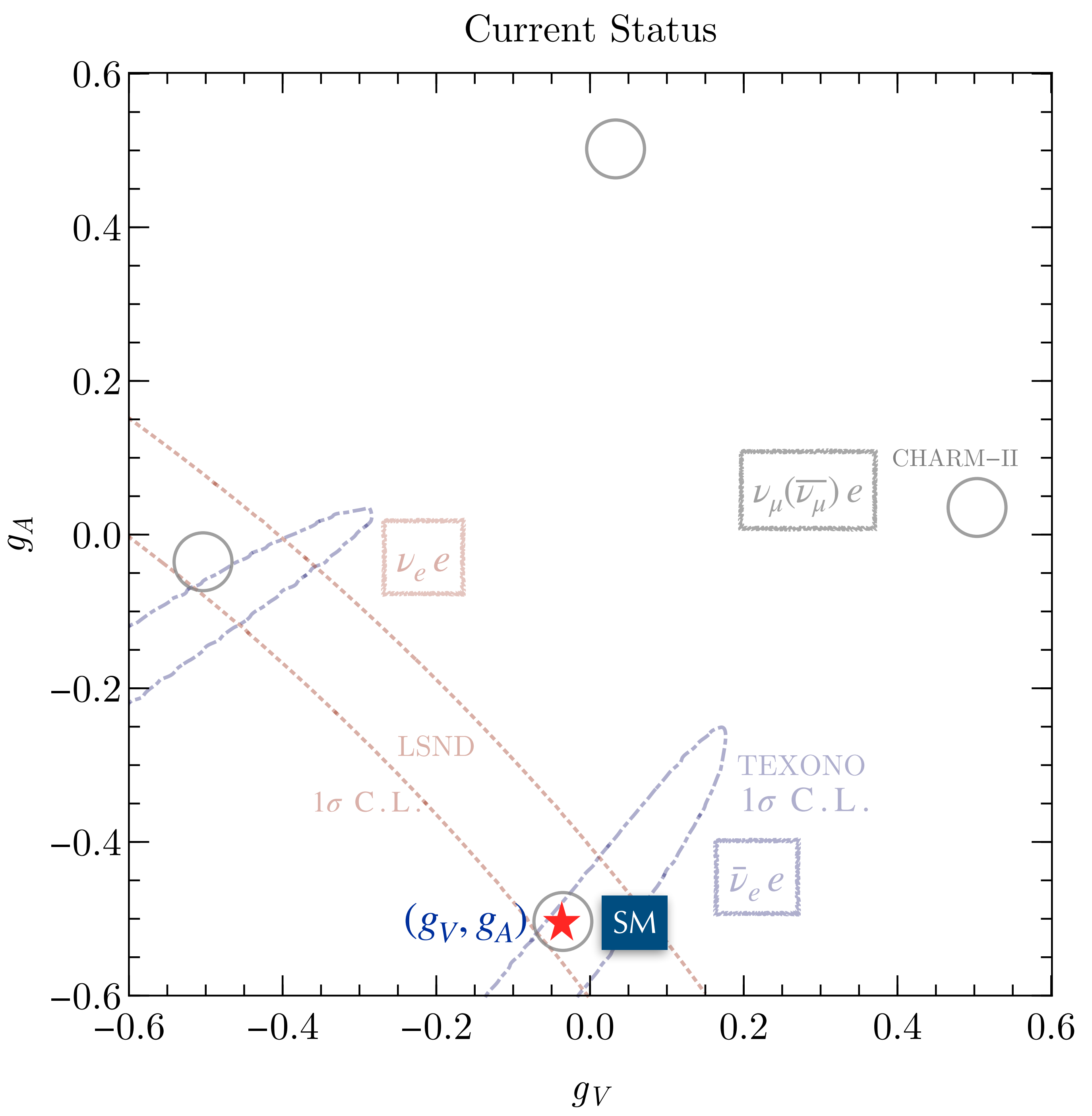
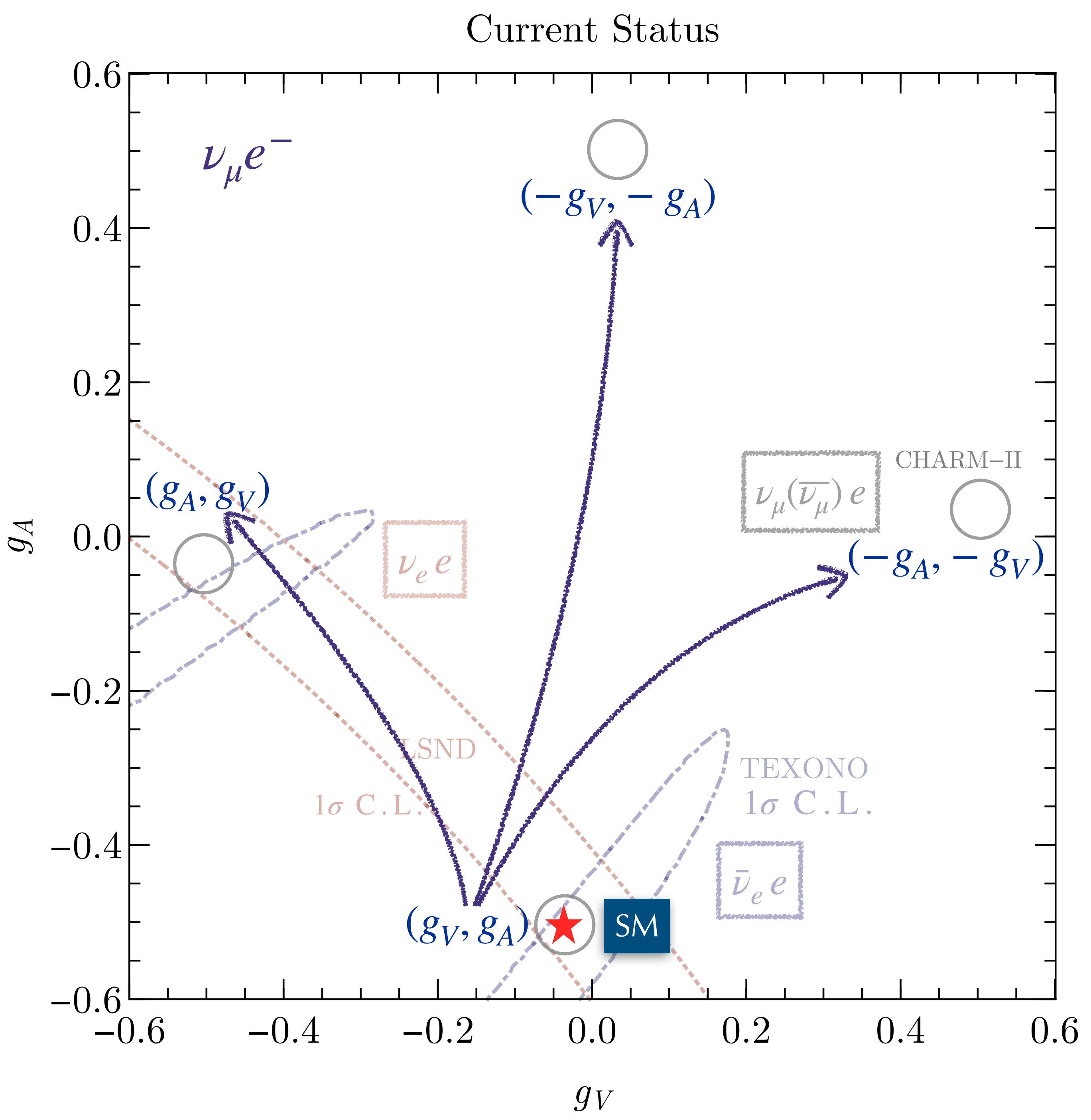


Model independent

Neutrino-electron scattering



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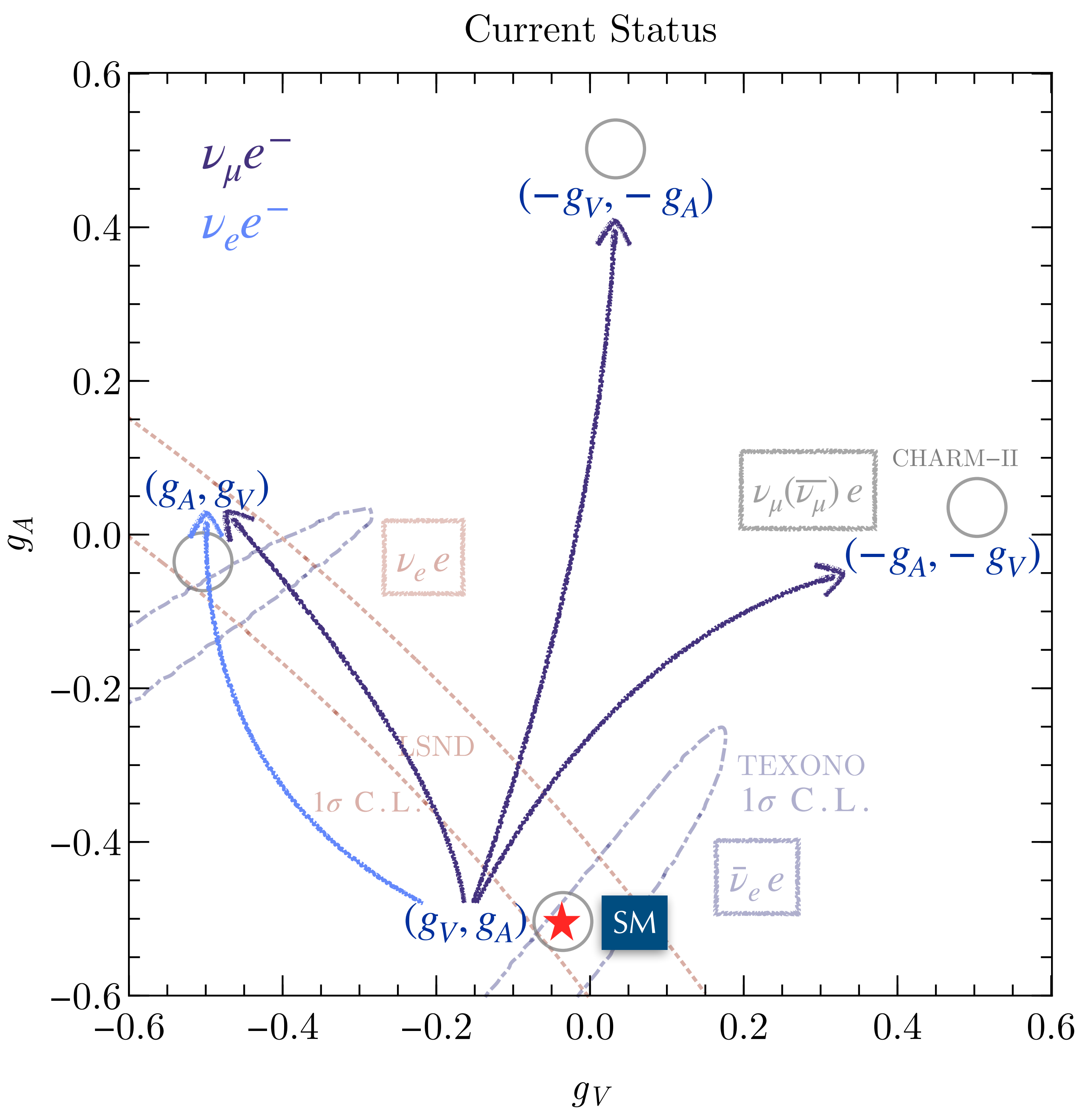

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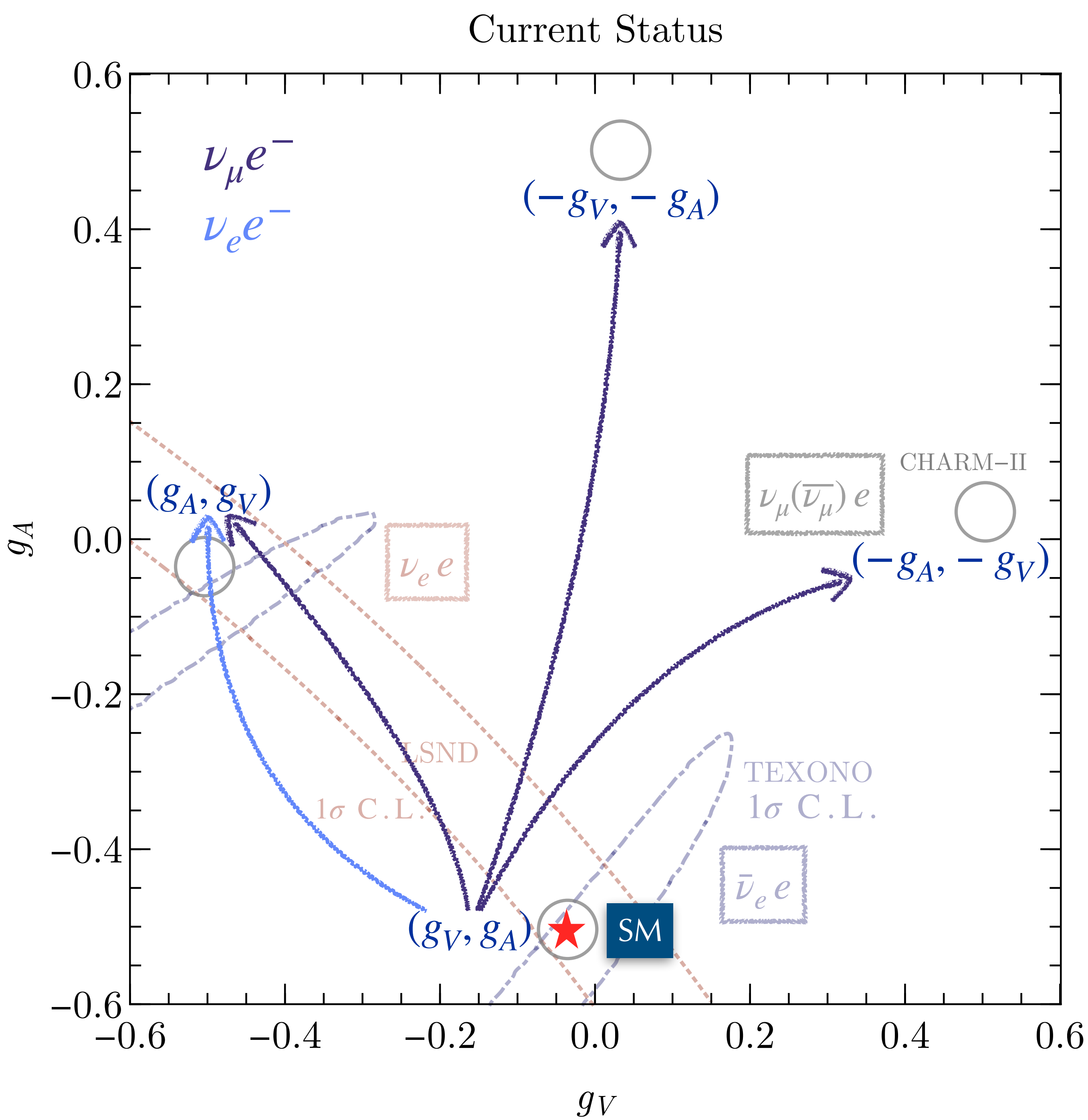
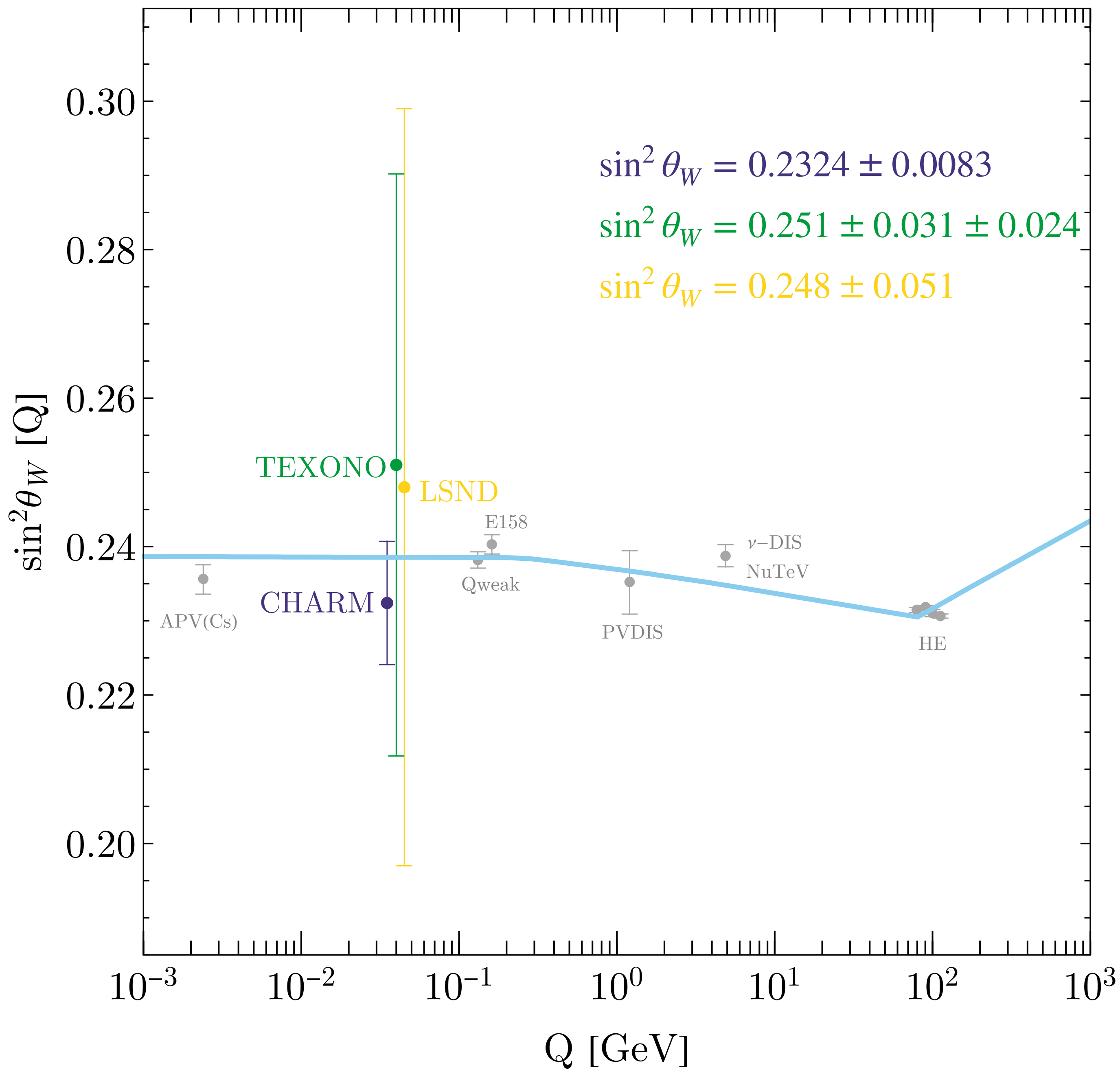


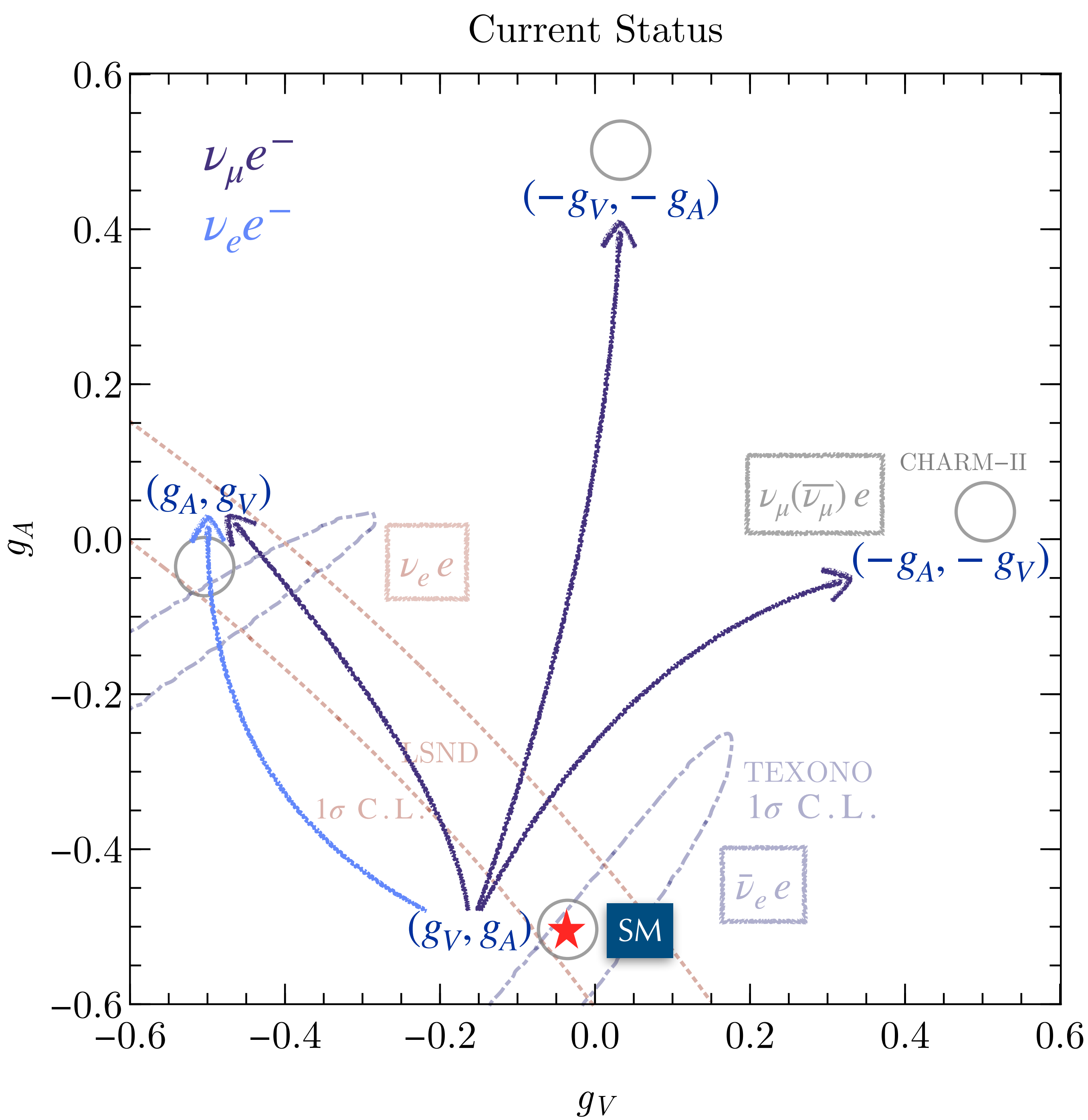


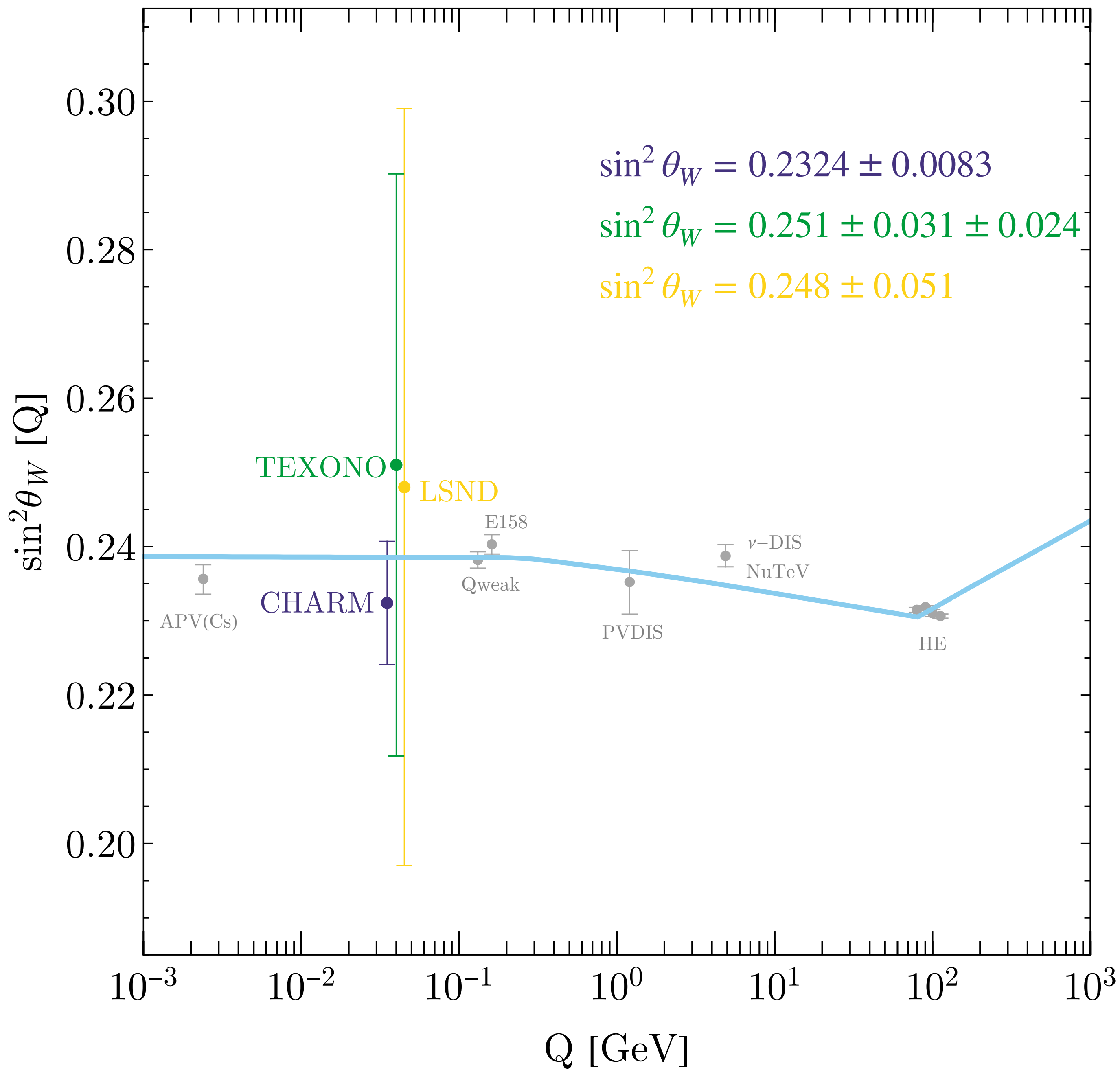
Model independent

Assuming the SM

Neutrino-electron scattering

What nuSTORM could do?

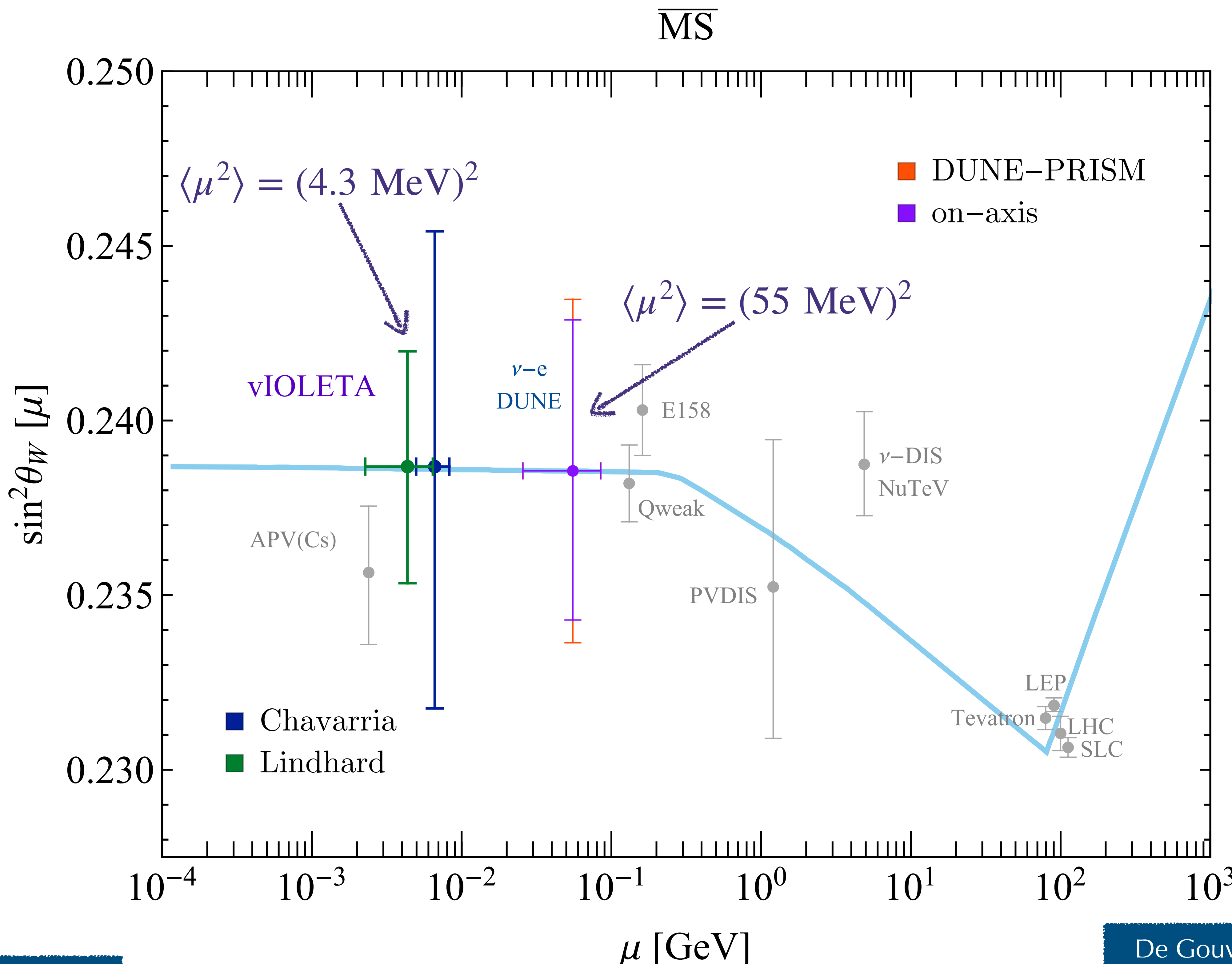




Model independent

Assuming the SM

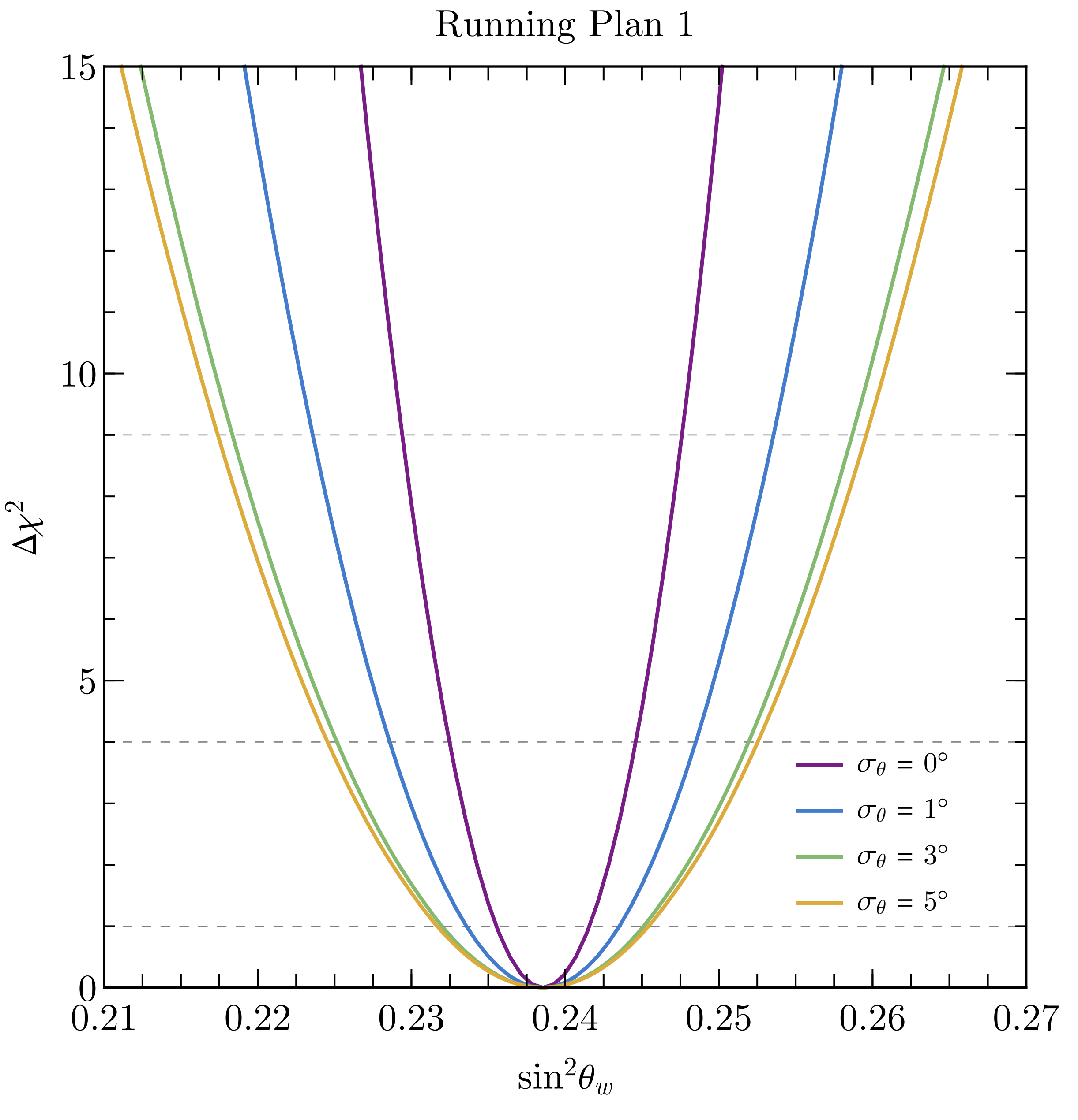
Measuring $\sin^2\theta_W$ with neutrino scatterings

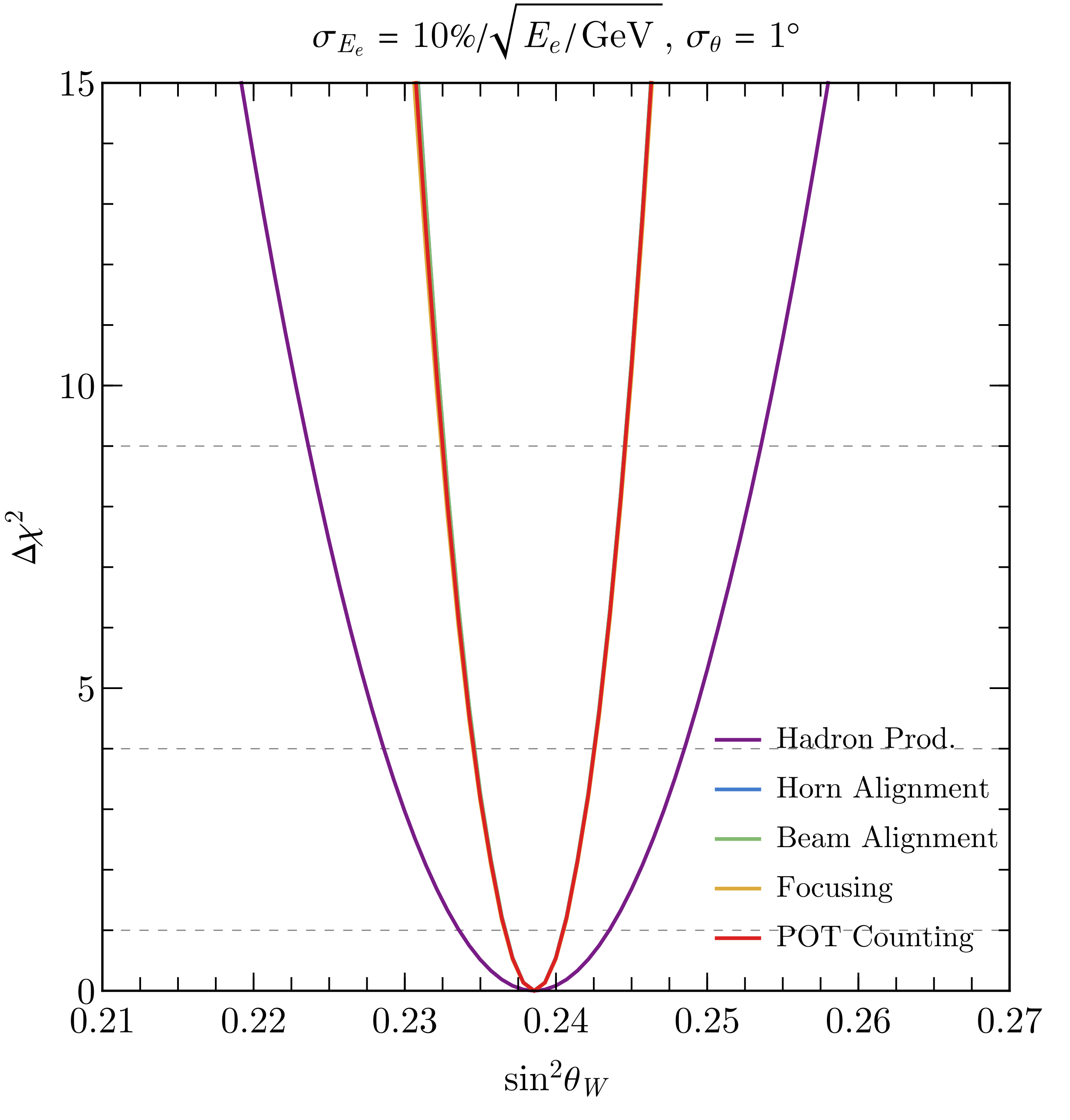


Fernandez-Morini et al
2009.10741

De Gouvêa, Machado, YFPG, Tabrizi
PRL125(2020) 5, 051803

Systematics — DUNE





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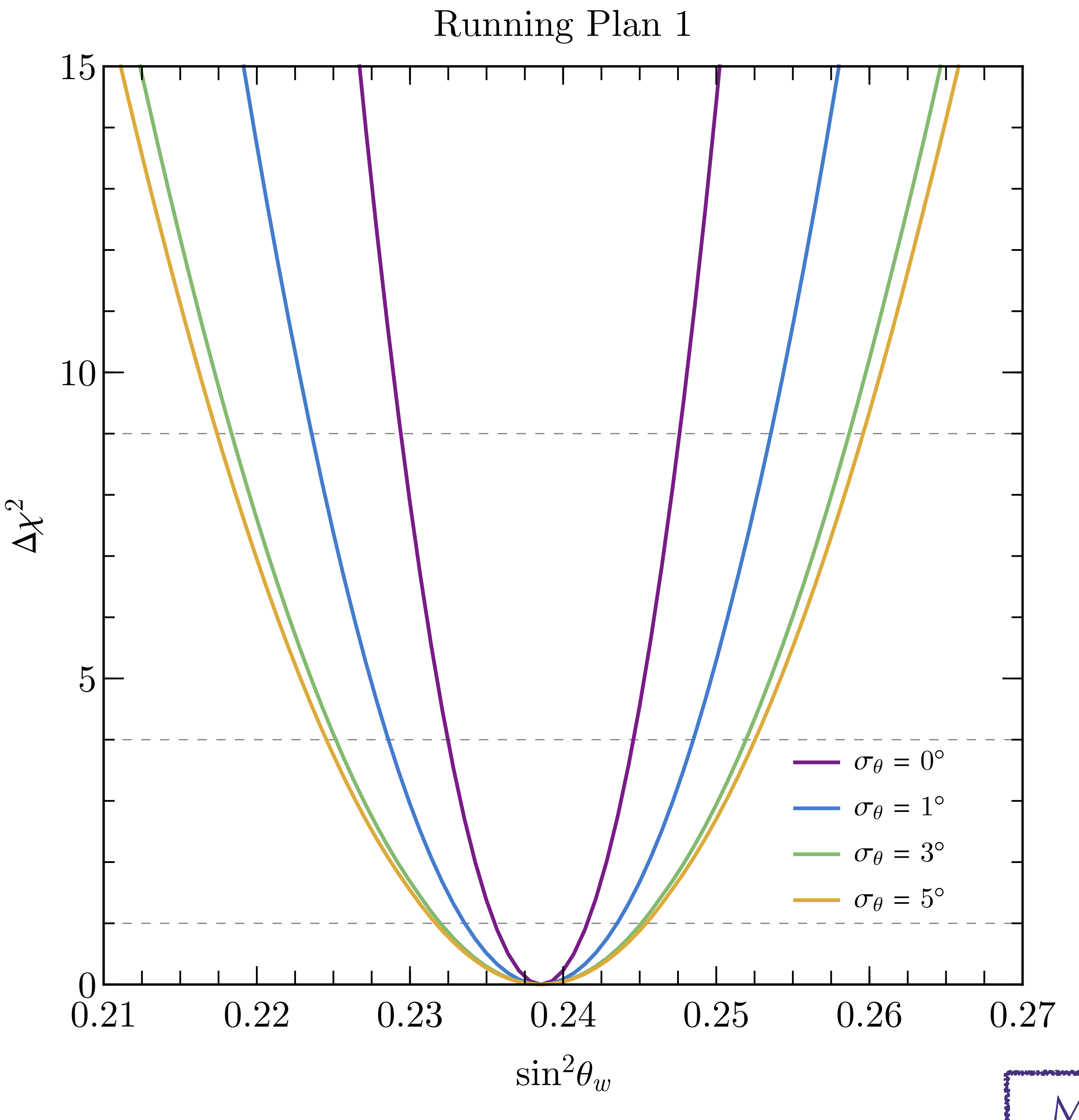

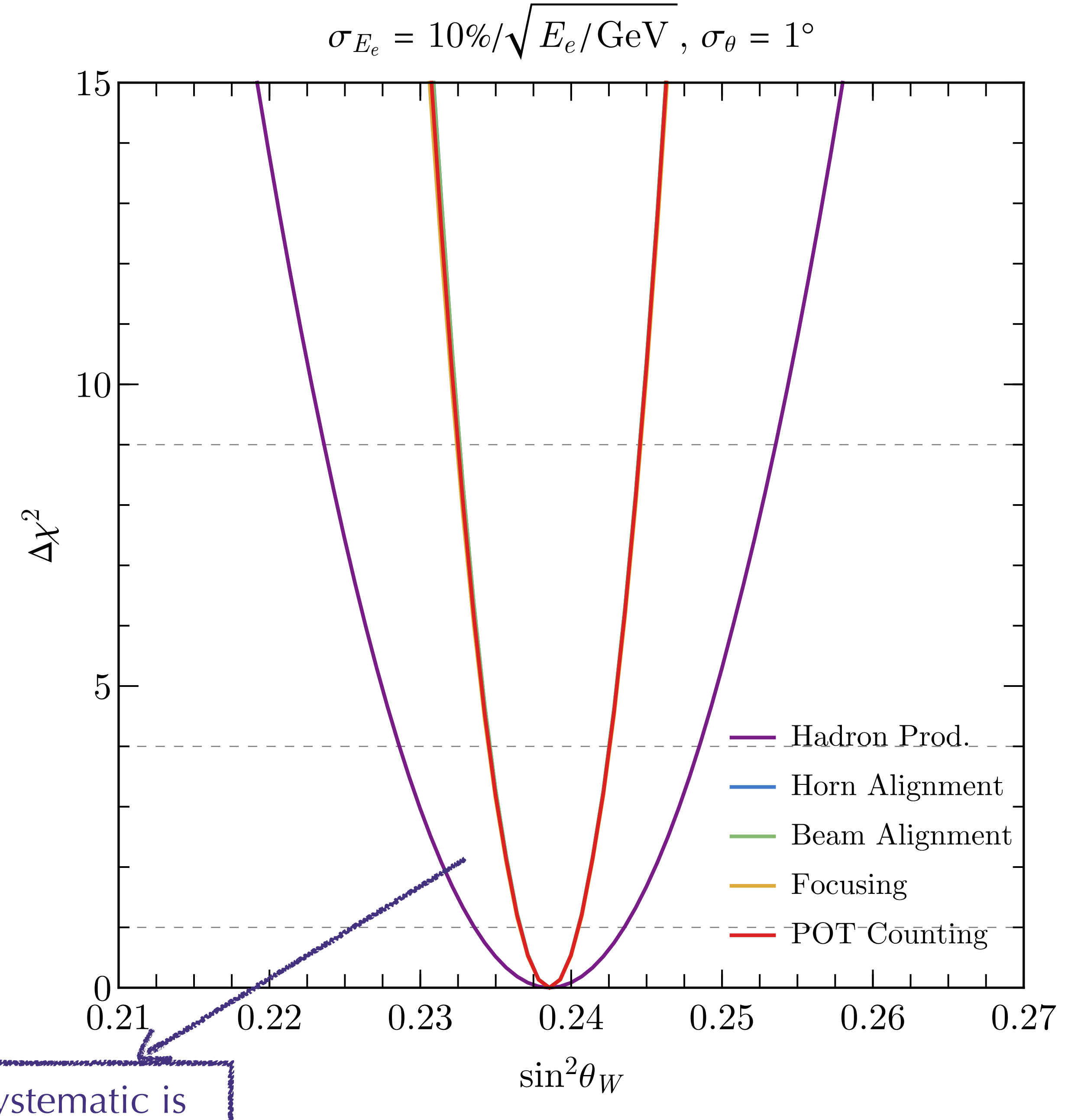

Main systematic is hadron production

Otherwise the measurement would be statistics limited

Trident Inelastic Scattering

M. A. Kozhushner et. al.1962
W. Czyz et al. 1964
Lovseth et al, 1971

Production of a charged lepton pair from the inelastic neutrino scattering in the Coulomb field of the nucleus

$$\nu_\alpha + \mathscr{H} \to \nu_{\alpha\,\mathrm{or}\,\kappa(\beta)} + \ell_\beta^- + \ell_\kappa^+ + \mathscr{H}$$

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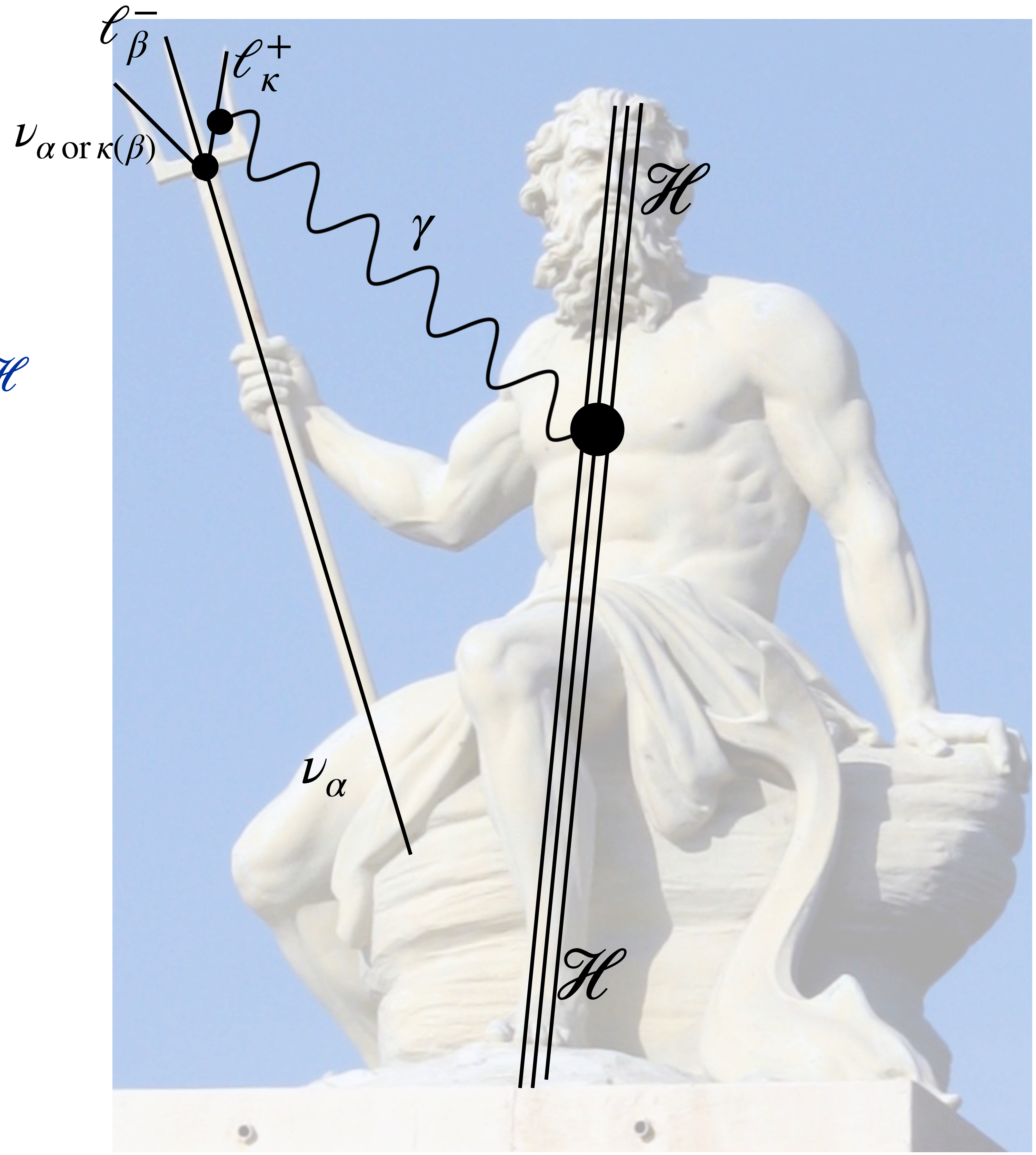

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$$\nu_\mu \rightarrow \nu_\mu \mu^+ \mu^-$$

CHARM II

PLB 245 (1990) 271

$$\frac{\sigma_{\text{CHARM II}}}{\sigma_{\text{SM}}} = 1.58 \pm 0.57$$

CCFR

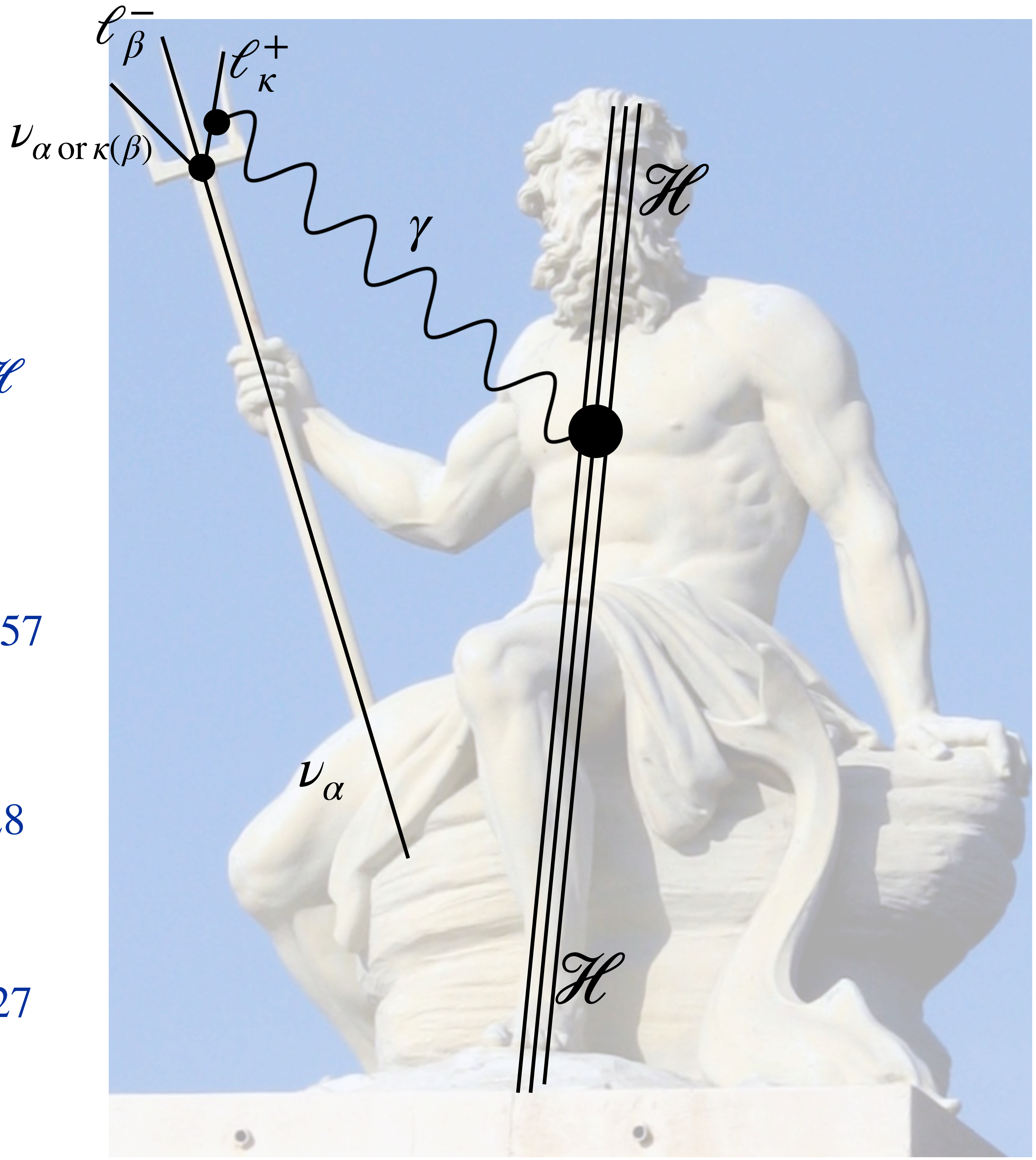
PRL 66 (1991) 3117

$$\frac{\sigma_{\text{CCFR}}}{\sigma_{\text{SM}}} = 0.82 \pm 0.28$$

NuTeV

Vancouver 1998, High energy physics, vol. 1

$$\frac{\sigma_{\text{NuTeV}}}{\sigma_{\text{SM}}} = 0.67 \pm 0.27$$



Neutrino trident scattering

Magill, Plestid , 1612.05642
Ballet et al., 1807.10973
Altmannshofer et al, 1912.06765

Relatively small cross section

$$\sigma_{\Psi} \approx 10^{-5}\sigma_{\text{CCQE}}$$

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(Anti)Neutrino	SM Contributions
$\overset{(-)}{\nu}_\mu \mathcal{H} \to \overset{(-)}{\nu}_\mu \mu^- \mu^+ \mathcal{H}$	CC + NC
$\overset{(-)}{\nu}_\mu \mathcal{H} \to \overset{(-)}{\nu}_e e^\pm \mu^\mp \mathcal{H}$	CC
$\overset{(-)}{\nu}_\mu \mathcal{H} \to \overset{(-)}{\nu}_\mu e^- e^+ \mathcal{H}$	NC
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$m_e, m_\mu \to 0$

$\sigma \sim g_V^2 + g_A^2 \qquad (\nu_\mu\ e^+ e^-)$

$\sigma \sim (g_V + 1)^2 + (g_A + 1)^2 \qquad (\nu_\mu\ \mu^+ \mu^-)$

$g_V \leftrightarrow g_A$ → In principle, invariant under this transformation

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Lepton masses break this symmetry

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Lepton masses break this symmetry

Backgrounds??

Ballet et al. 1807.10973 → Estimated efficiency from cuts

Rates

$$N_{\mathrm{X}}^{\psi} = \mathrm{Norm} \times \int dE_\nu \, \sigma_{\nu \mathrm{X}}(E_\nu) \frac{d\phi_\nu(E_\nu)}{dE_\nu} \epsilon(E_\nu)$$

Ballet et al., 1807.10973

Rates

Assuming a LAr ND for nuSTORM

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$$\text{Exposure [POT]} \times \frac{\text{Fiducial Detector Mass} \times {\rm N_A}}{m_{\rm T}} \left[\text{target particles}\right]$$

Ballet et al., 1807.10973

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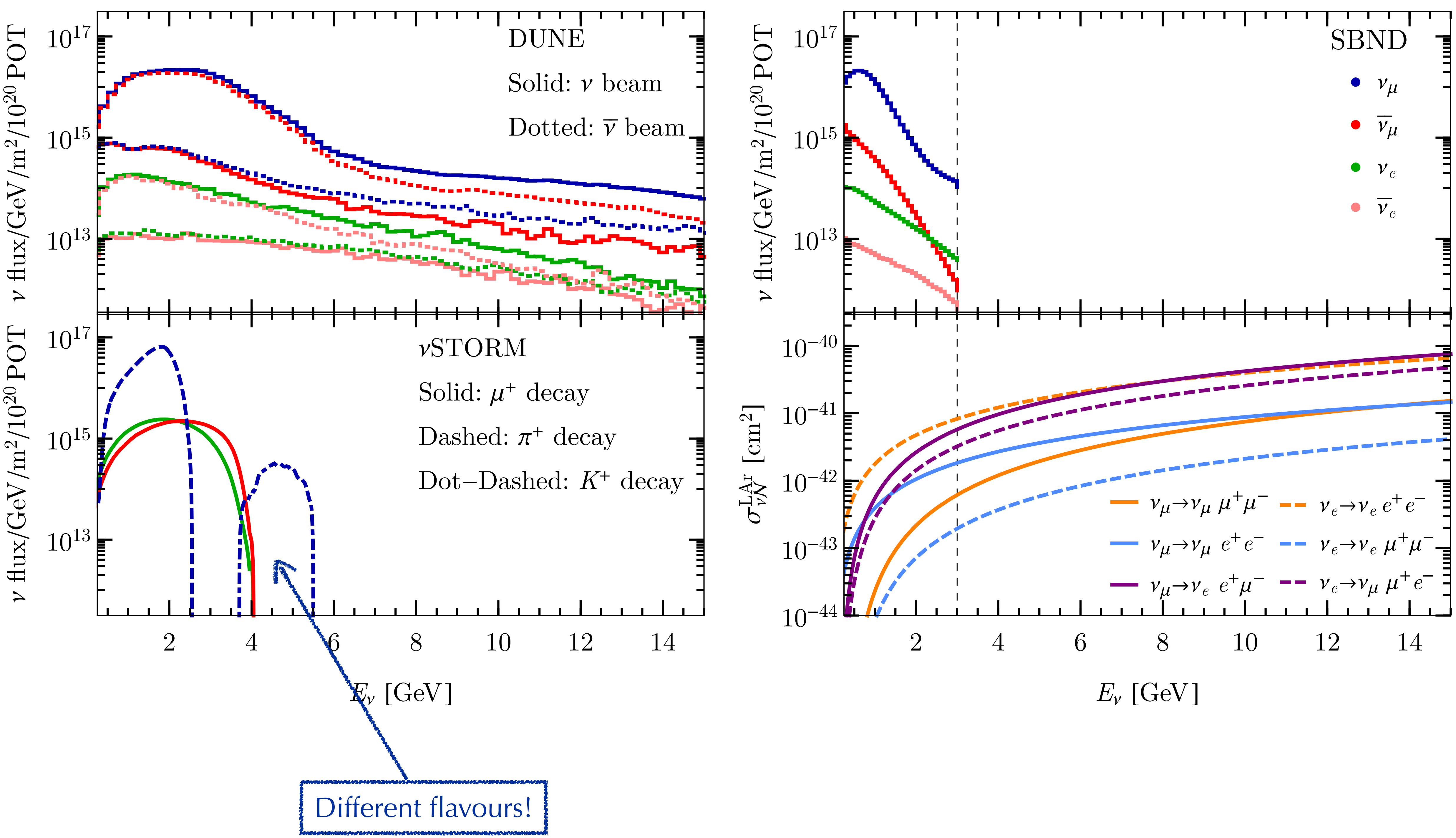
Experiment	Baseline (m)	Total Exposure (POT)	Fiducial Mass (t)	E_ν (GeV)
SBND	110	6.6×10^{20}	112	$0-3$
μBooNE	470	1.32×10^{21}	89	$0-3$
ICARUS	600	6.6×10^{20}	476	$0-3$
DUNE	574	$12.81\ (12.81) \times 10^{21}$	50	$0-40$
νSTORM	**50**	**10^{21}**	**100**	**$0-6$**

Ballet et al., 1807.10973

Exposure $= 10^{21}$ POT

Rates



DUNE
Solid: ν beam
Dotted: $\overline{\nu}$ beam
νSTORM
Solid: μ^+ decay
Dashed: π^+ decay
Dot−Dashed: K^+ decay
SBND
ν_μ
$\overline{\nu}_\mu$
ν_e
$\overline{\nu}_e$
ν flux/GeV/m^2/10^{20} POT
$\sigma^{\rm LAr}_{\nu N}$ [cm^2]
E_ν [GeV]
$\nu_\mu \to \nu_\mu\ \mu^+\mu^-$
$\nu_\mu \to \nu_\mu\ e^+e^-$
$\nu_\mu \to \nu_e\ e^+\mu^-$
$\nu_e \to \nu_e\ e^+e^-$
$\nu_e \to \nu_e\ \mu^+\mu^-$
$\nu_e \to \nu_\mu\ \mu^+e^-$
Different flavours!

Rates for current/future NDs

Exposure = 10^{21} POT

Channel	SBND	μBooNE	ICARUS	DUNE ND	νSTORM ND
Total $e^{\pm}\mu^{\mp}$	10	0.7	1	2993 (2307)	191
	1	0.1	0.1	391 (299)	23
Total e^+e^-	6	0.4	0.7	1007 (800)	114
	0.2	0.0	0.02	64 (49)	6
Total $\mu^+\mu^-$	0.4	0.0	0.0	286 (210)	11
	0.3	0.0	0.0	143 (108)	6

Not seen yet ($e^{\pm}\mu^{\mp}$)

Not seen yet (e^+e^-)

Large contributions of diffractive events

Compare order of magnitudes

Rates for current/future NDs

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Not seen yet (Total $e^{\pm}\mu^{\mp}$)

Not seen yet (Total $e^{+}e^{-}$)

Coherent (191)

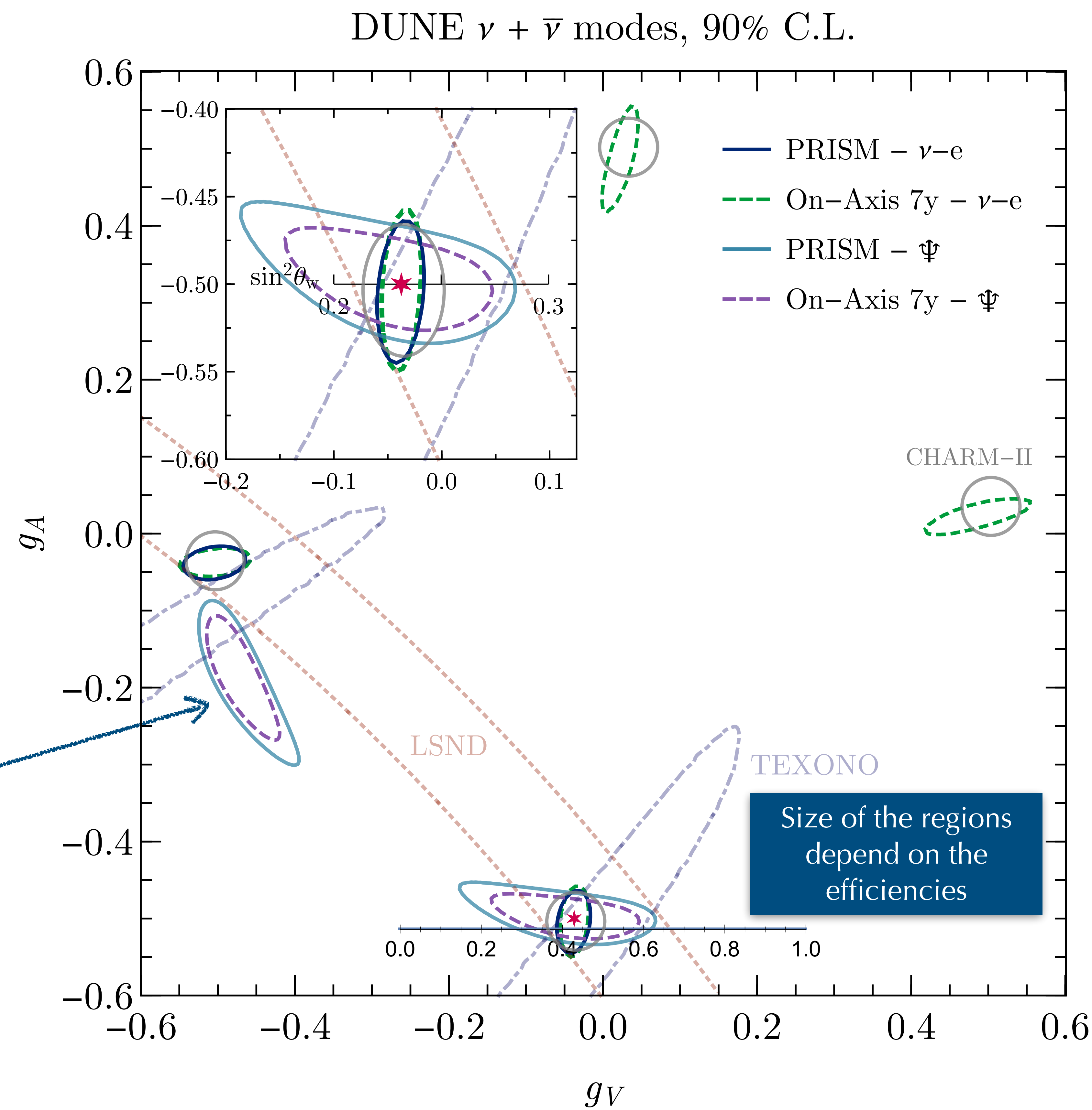
Diffractive (23)

Large contributions of diffractive events

Compare order of magnitudes

Measuring $g_A^{\nu e}$, $g_V^{\nu e}$

De Gouvêa, Machado, YFPG, Tabrizi
PRL125(2020) 5, 051803



Tridents can break the final degeneracy

Size of the regions depend on the efficiencies

BSM in tridents

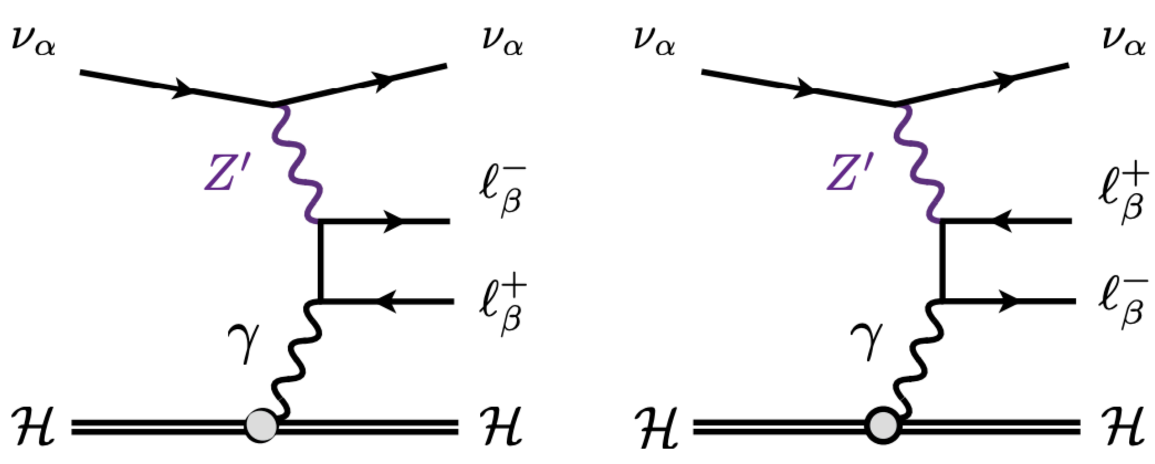
Let's consider a leptophilic Z'

Anomaly free scenarios: $L_\alpha - L_\beta$

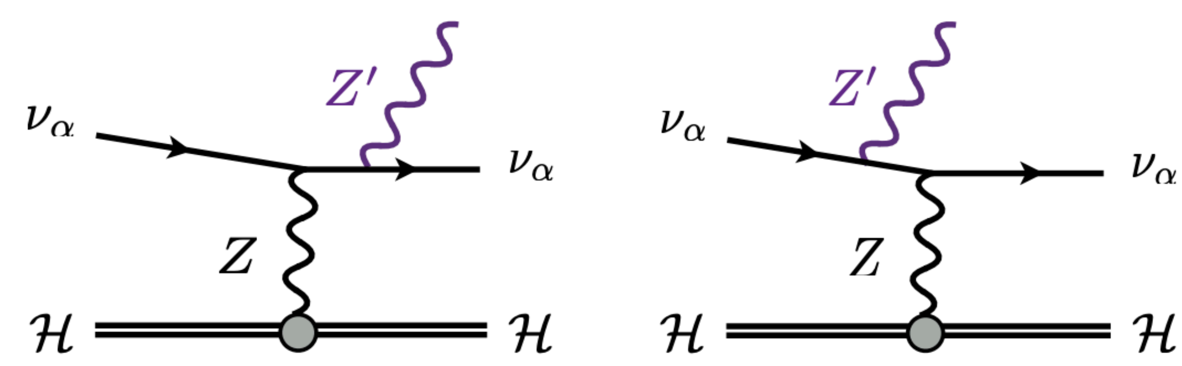
$$\alpha, \beta = \{e, \mu, \tau\}$$

$L_\mu - L_\alpha$ → Could solve $(g-2)_\mu$

- $\ell\ell\ell$ trident: $\mathcal{H} + \nu_\alpha \to \mathcal{H}' + \ell_\alpha^- + \ell_\beta^+ + \ell_\beta^-$
- $\nu\ell\ell$ trident: $\mathcal{H} + \nu_\alpha \to \mathcal{H} + \nu_\beta + \ell_\gamma^+ + \ell_\delta^-$
- $\nu\nu\ell$ trident: $\mathcal{H} + \nu_\alpha \to \mathcal{H}' + \ell_\alpha^- + \nu_\beta + \overline{\nu}_\beta$
- $\nu\nu\nu$ trident: $\mathcal{H} + \nu_\alpha \to \mathcal{H} + \nu_\alpha + \nu_\beta + \overline{\nu}_\beta$



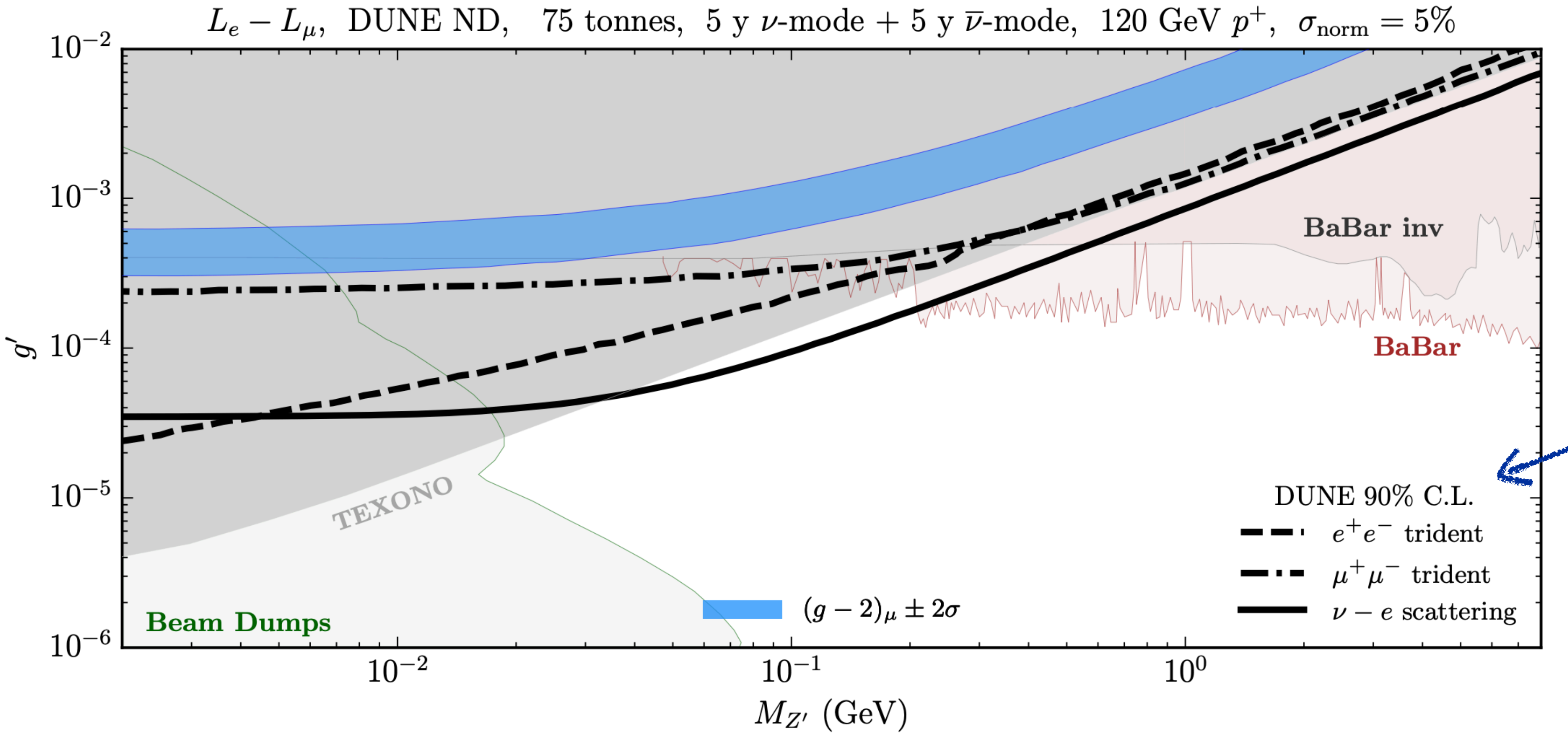
Bethe-Heitler



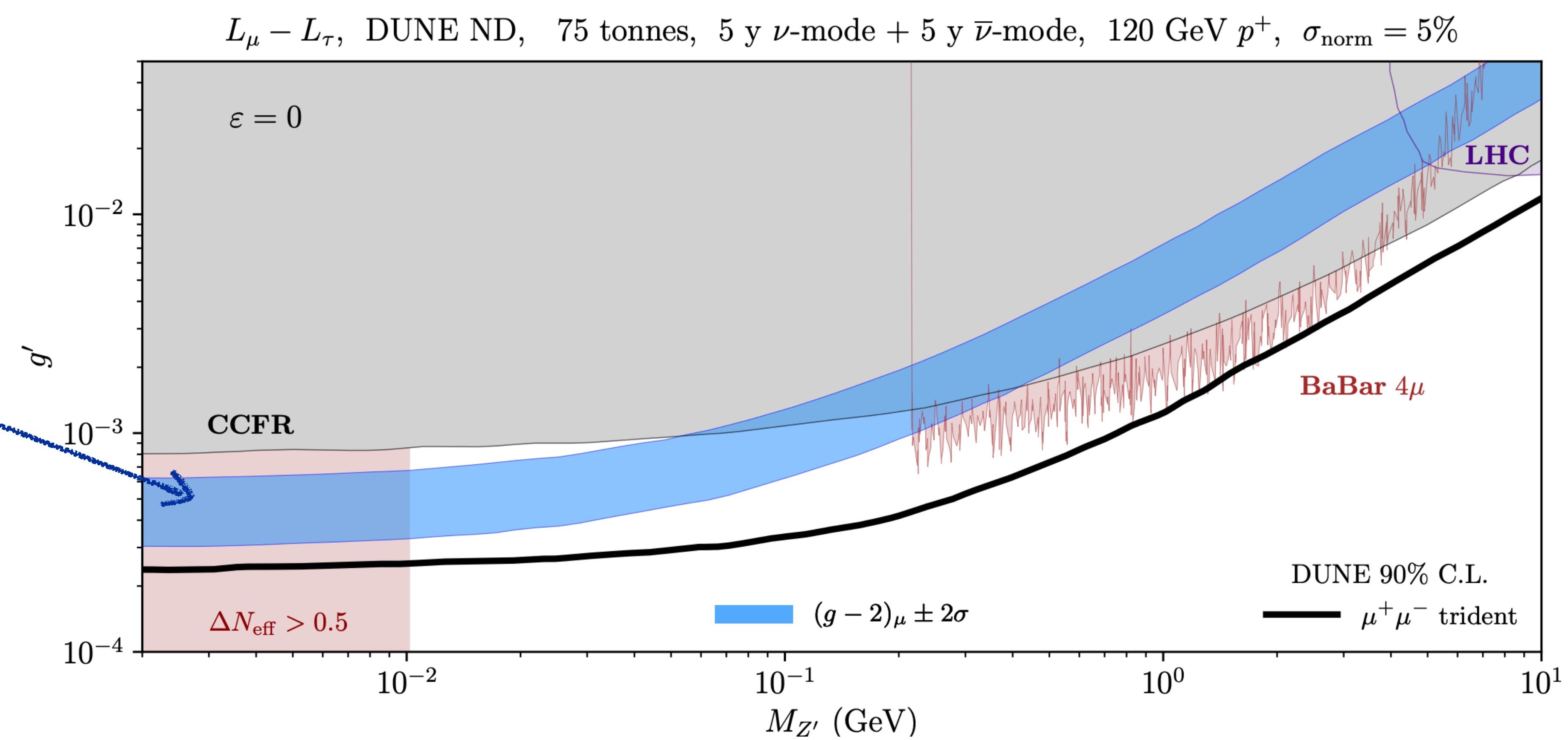
Dark-Bremsstrahlung

Ballet et al. 1902.08579

BSM in tridents



$\nu - e$ scattering can also me modified

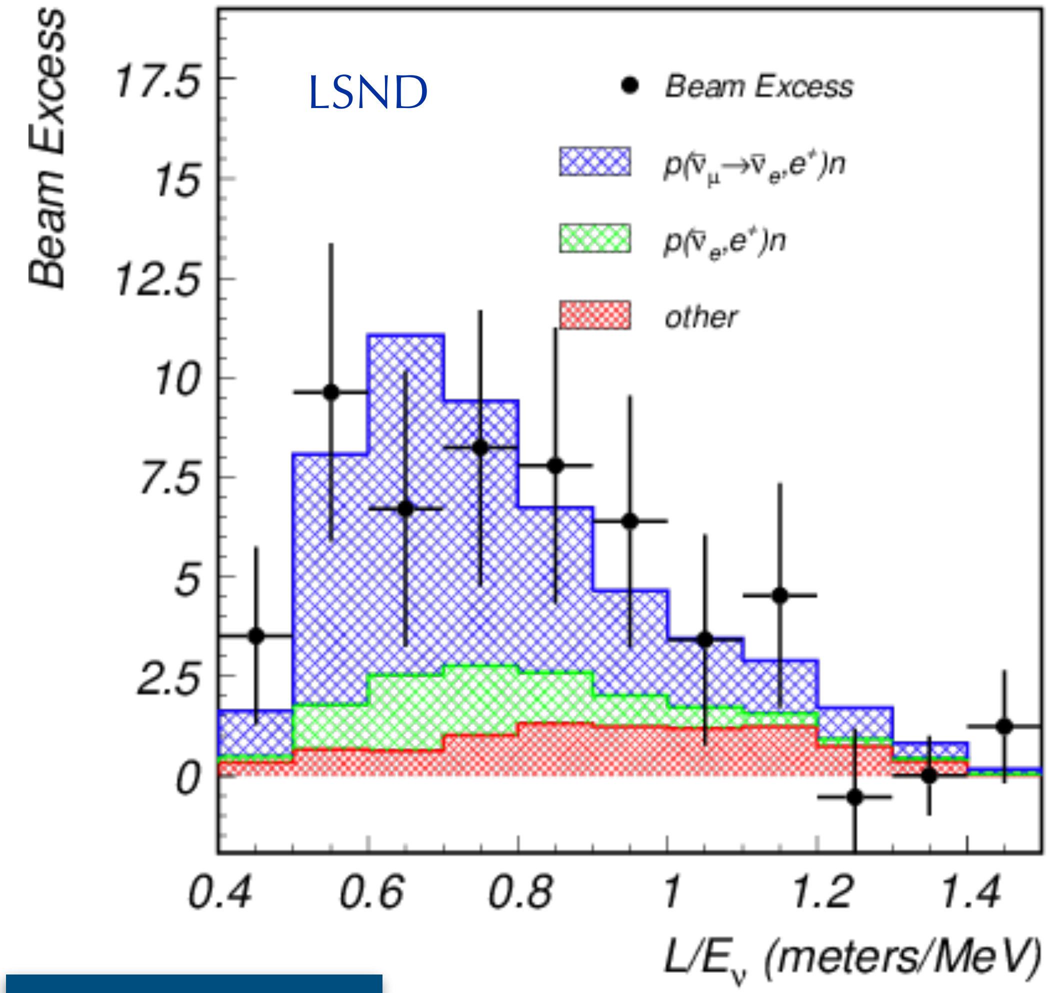


$(g-2)_\mu$ can fully be tested

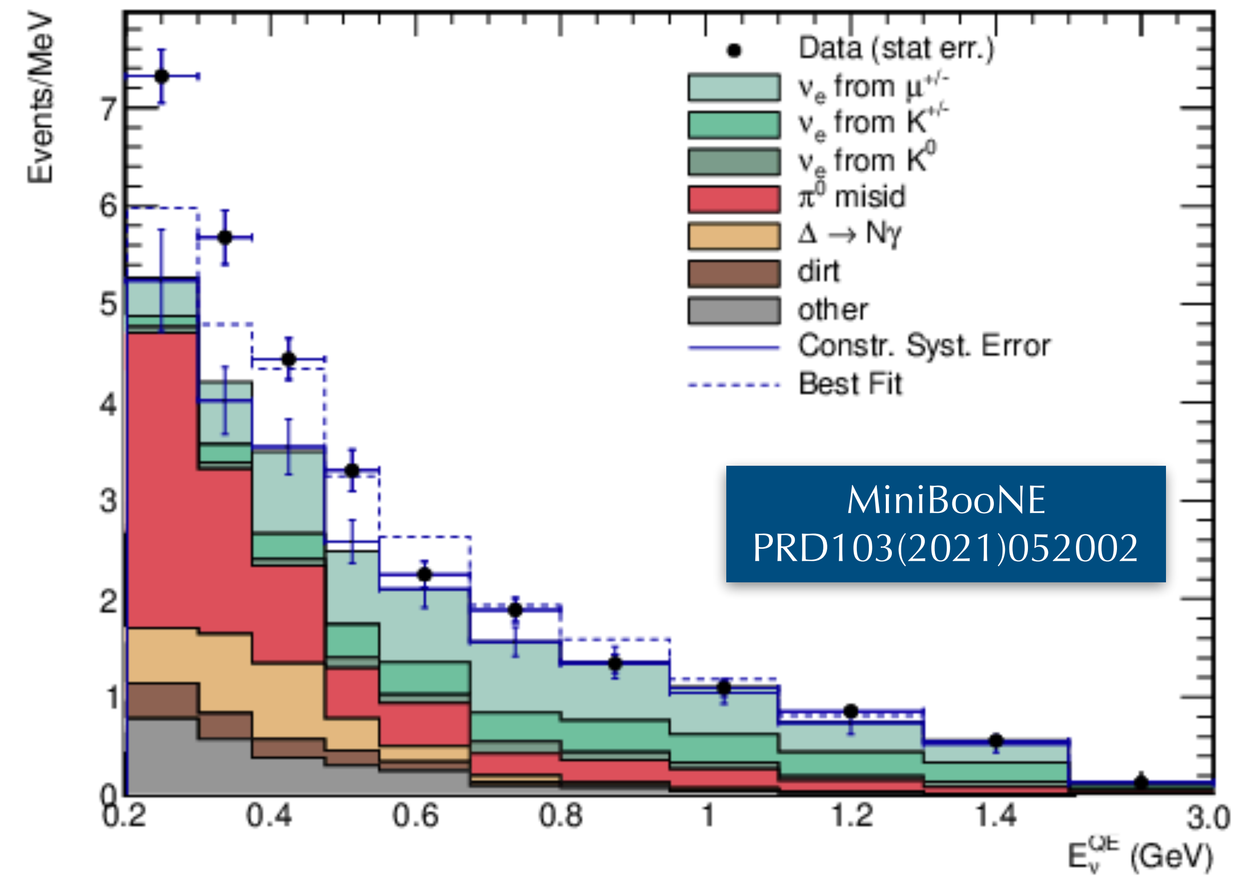
Ballet et al. 1902.08579

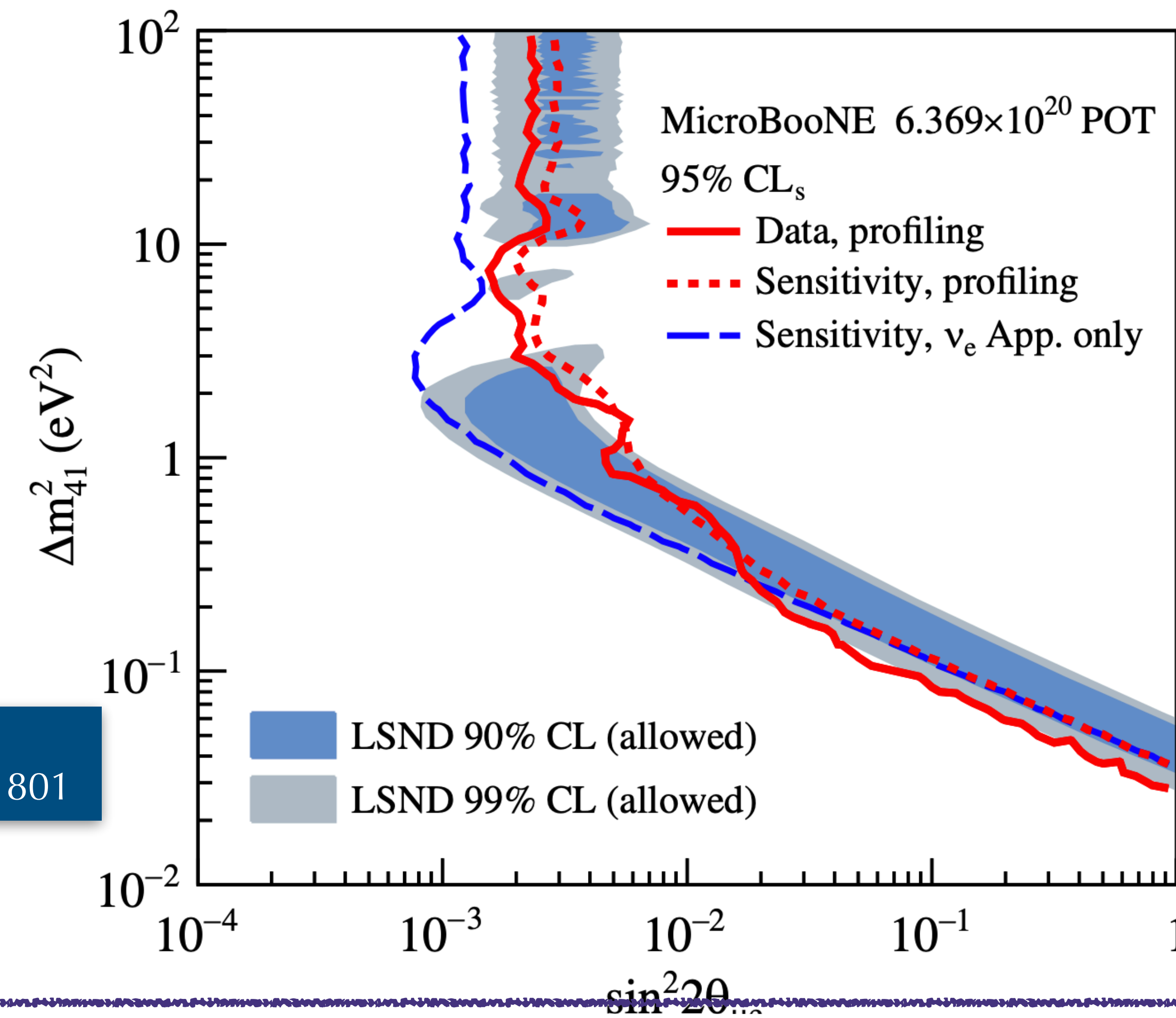
Steriles

eV sterile ⟶solution to LSND and MiniBooNE?



LSND
NPB66(1998)382





MicroBooNE
PRL130(2003)011801

eV sterile

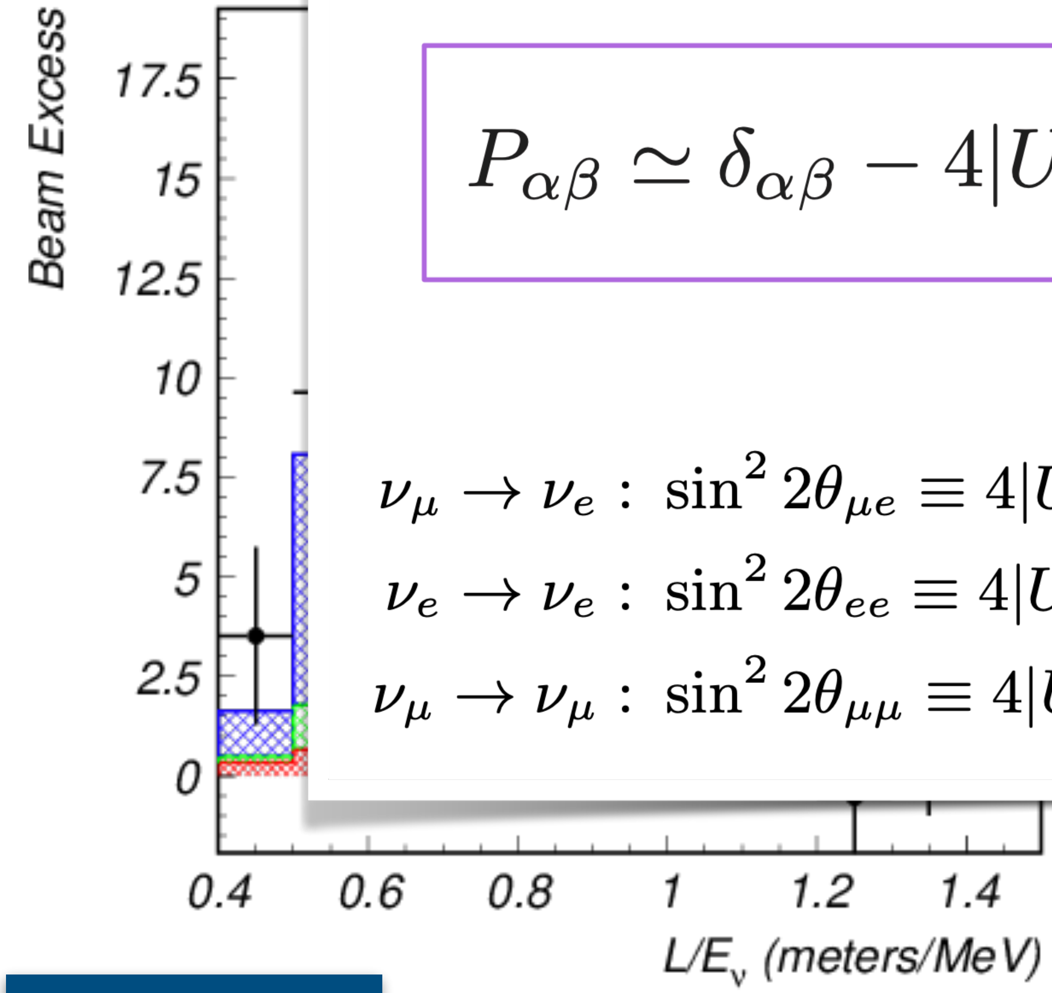
Oscillations via sterile neutrinos don't really work

$$P_{\alpha\beta} \simeq \delta_{\alpha\beta} - 4|U_{\alpha\beta}|^2(\delta_{\alpha\beta} - |U_{\alpha\beta}|^2)\sin^2\left(\frac{\Delta m^2_{41} L}{4E}\right)$$

$\nu_\mu \to \nu_e : \sin^2 2\theta_{\mu e} \equiv 4|U_{\mu 4}|^2|U_{e4}|^2$ → LSND, MiniBooNE, OPERA, …

$\nu_e \to \nu_e : \sin^2 2\theta_{ee} \equiv 4|U_{e4}|^2(1-|U_{e4}|^2)$ → Reactors, solar, Gallium, …

$\nu_\mu \to \nu_\mu : \sin^2 2\theta_{\mu\mu} \equiv 4|U_{\mu 4}|^2(1-|U_{\mu 4}|^2)$ → MiniBooNE, MINOS, IceCube, …



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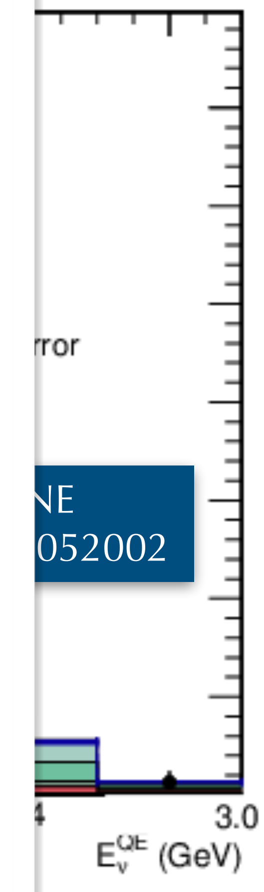
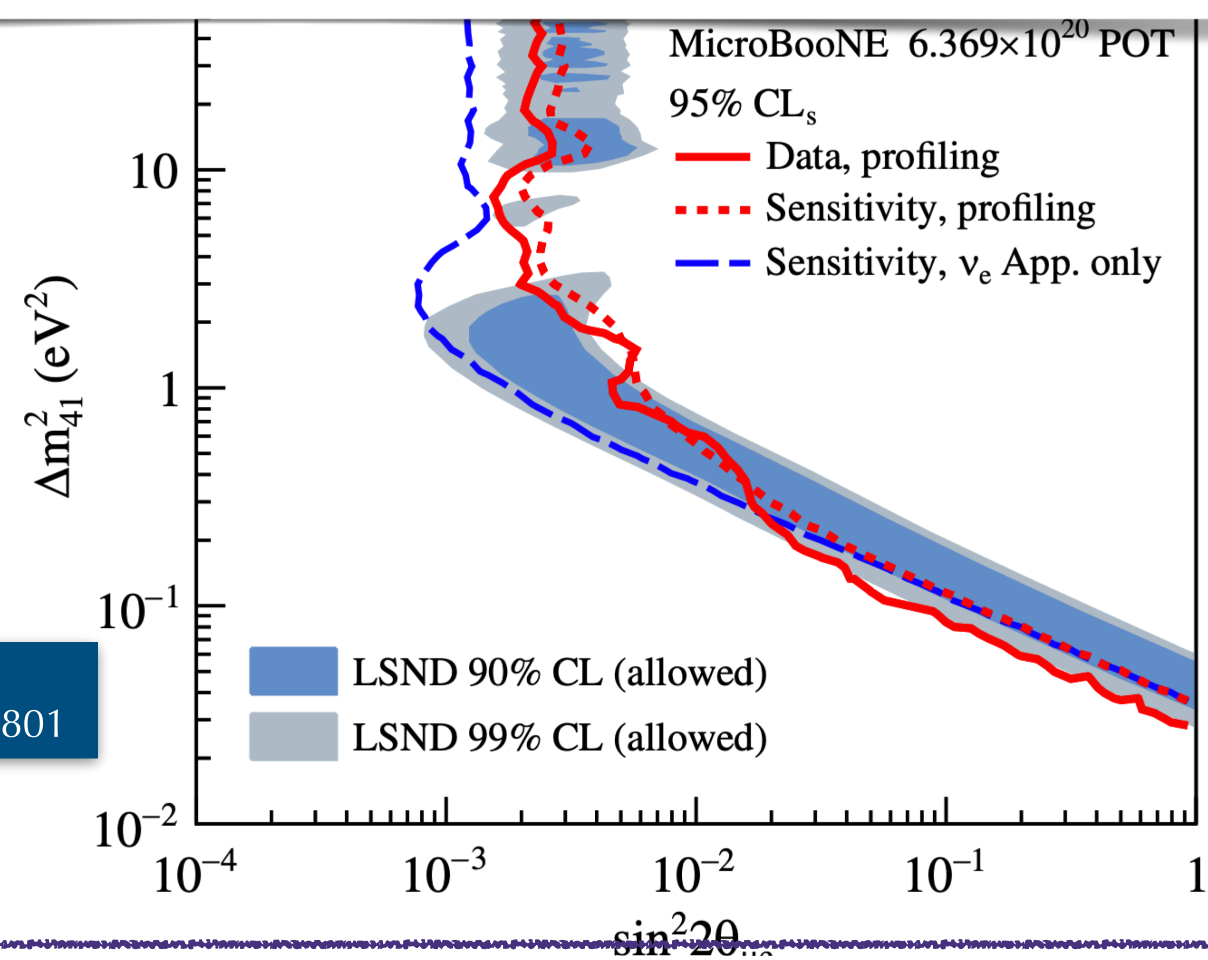
NPB66(1998)382



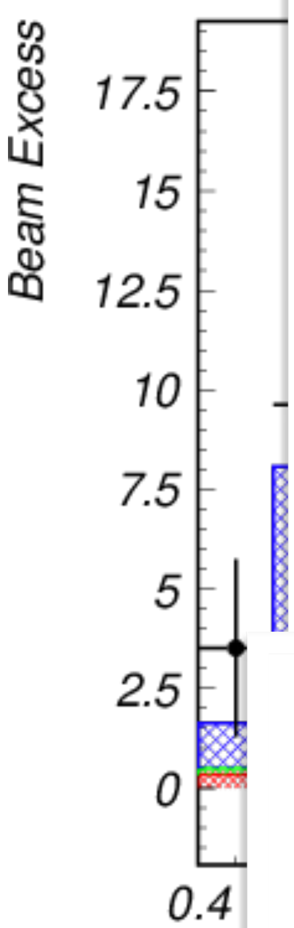


MicroBooNE
PRL130(2003)011801

Pedro Machado,
CERN colloquium

eV sterile

Oscillations via sterile neutrinos don't really work



LSND
NPB66(1998

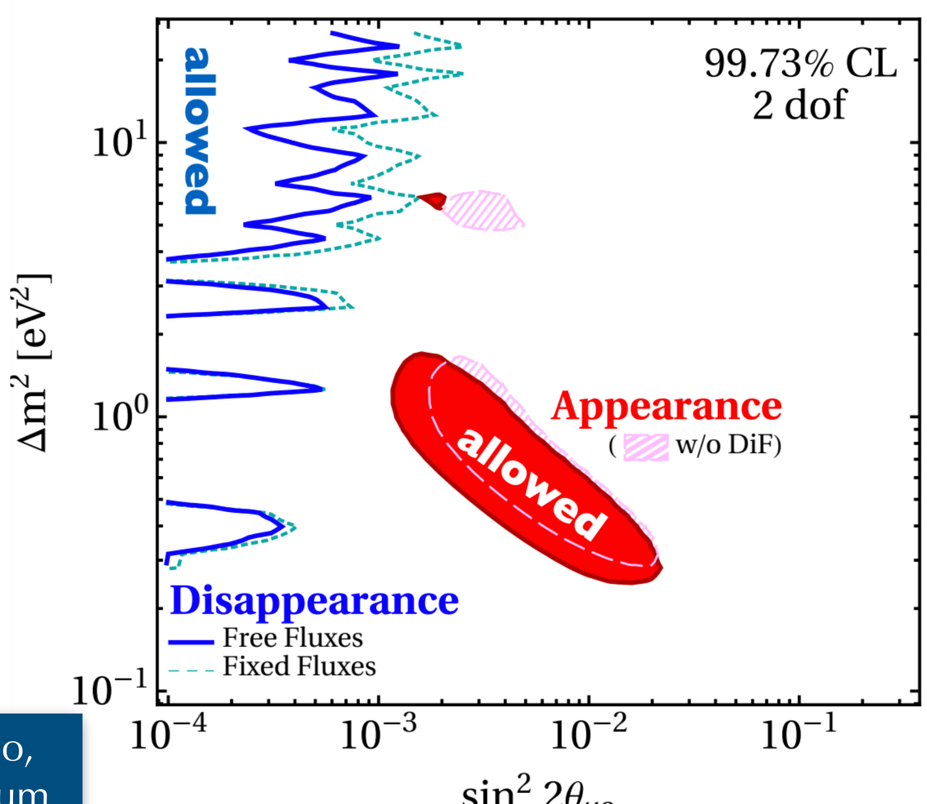
$$P_{\alpha\beta} \simeq \delta_{\alpha\beta} - 4|U_{\alpha\beta}|^2(\delta_{\alpha\beta} - |U_{\alpha\beta}|^2)\sin^2\left(\frac{\Delta m^2_{41} L}{4E}\right)$$

$\nu_\mu \to \nu_e$: $\sin^2 2\theta_{\mu e} \equiv 4|U_{\mu 4}|^2|U_{e4}|^2$ → LSND, MiniBooNE, OPERA, …

$\nu_e \to \nu_e$: $\sin^2 2\theta_{ee} \equiv 4|U_{e4}|^2(1-|U_{e4}|^2)$ → Reactors, solar, Gallium, …

NE
052002

Oscillations via sterile neutrinos don't really work



ν_μ to ν_e appearance

$\sin^2 2\theta_{\mu e} = 4\,|U_{e4}|^2|U_{\mu 4}|^2$

ν_e disappearance ν_μ disappearance

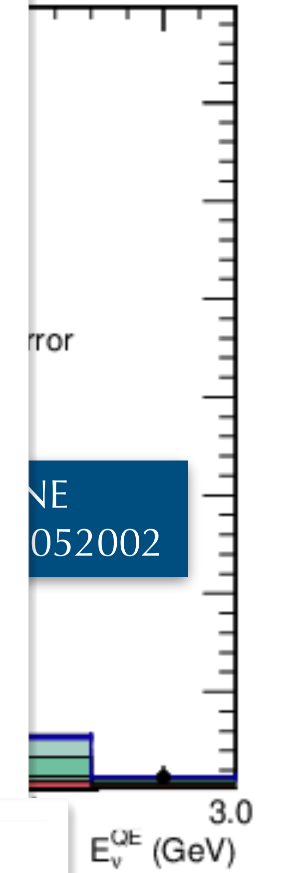
Data sets:
ν_e and ν_μ disappearance
vs.
ν_e appearance

4.7 σ tension
between DISAPP and APP data sets under eV sterile interpretation

Exercise: remove each experiment and see if agreement improves

Pedro Machado,
CERN colloquium

eV sterile



NE
052002

LSND
NPB66(1998

The SBN program will clarify this situation

Oscillations via sterile neutrinos don't really work

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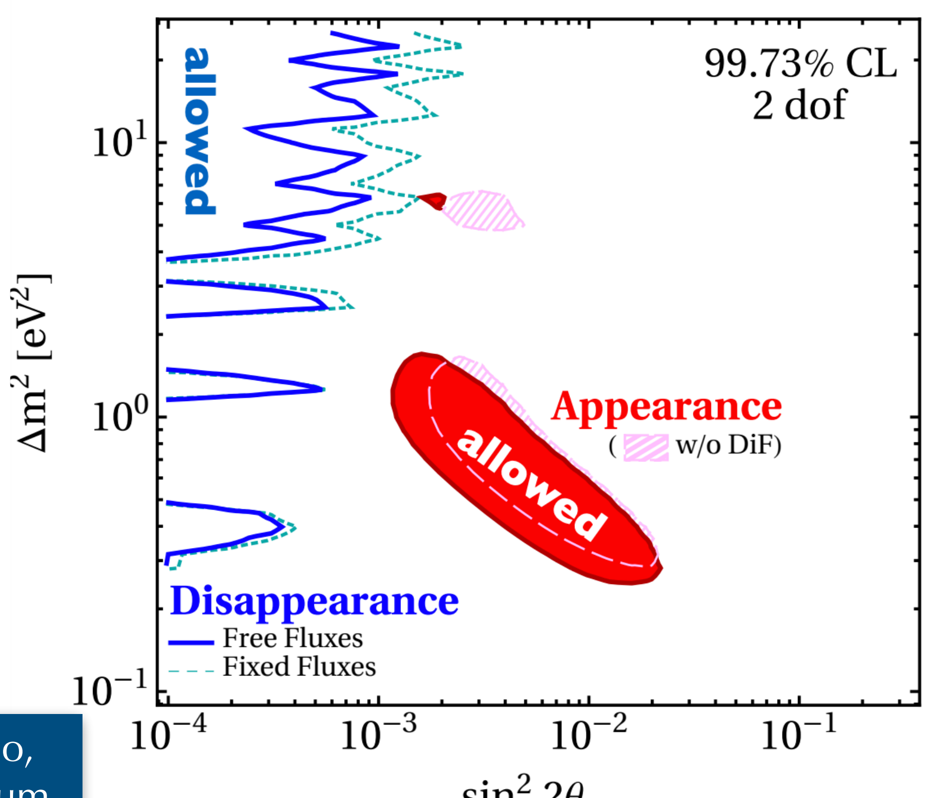

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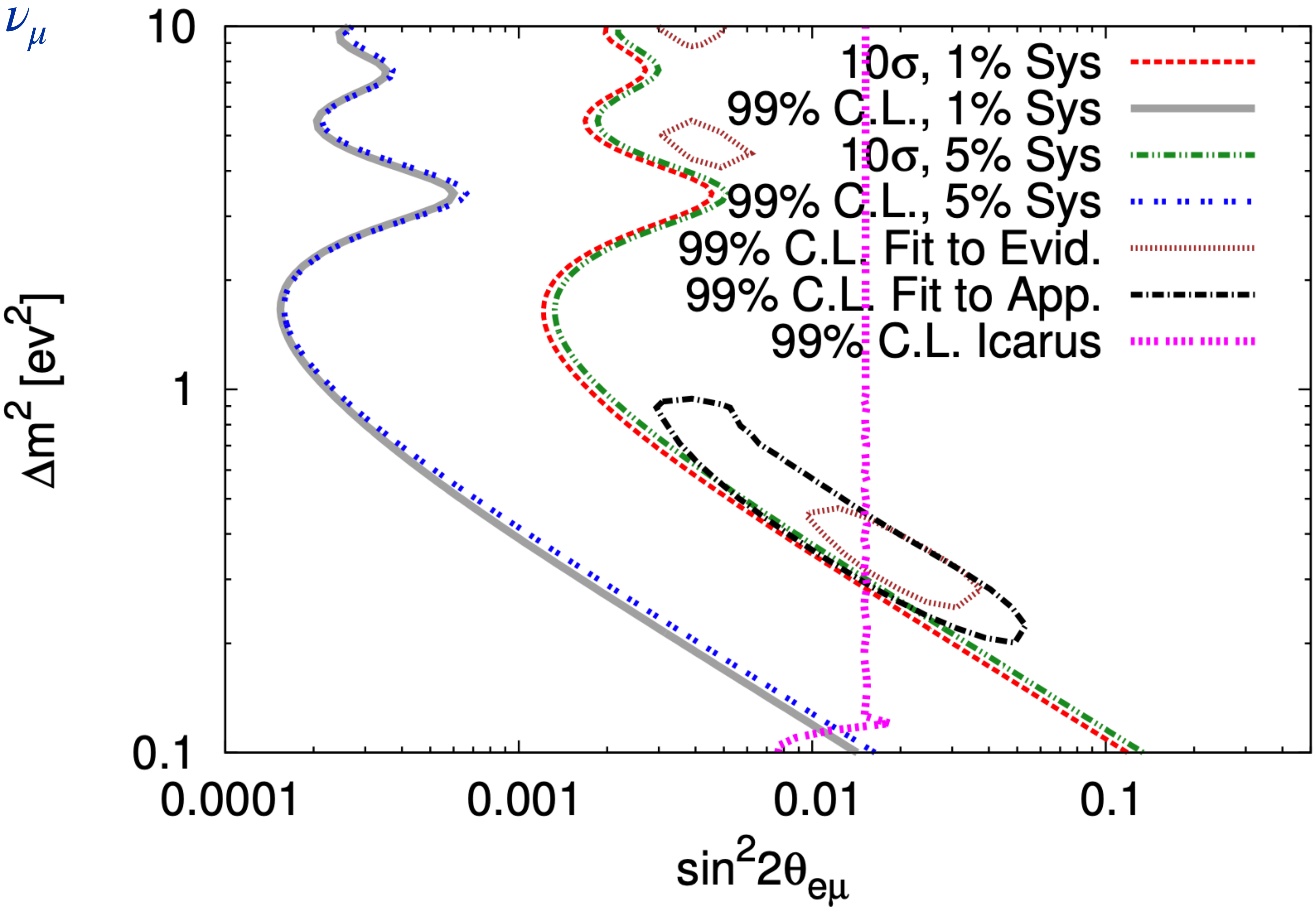
Pedro Machado,
CERN colloquium

What nuSTORM could do?

$\nu_e \longrightarrow \nu_\mu$



Adey et al. 1402.5250

Chakraborty et al. 2007.03321

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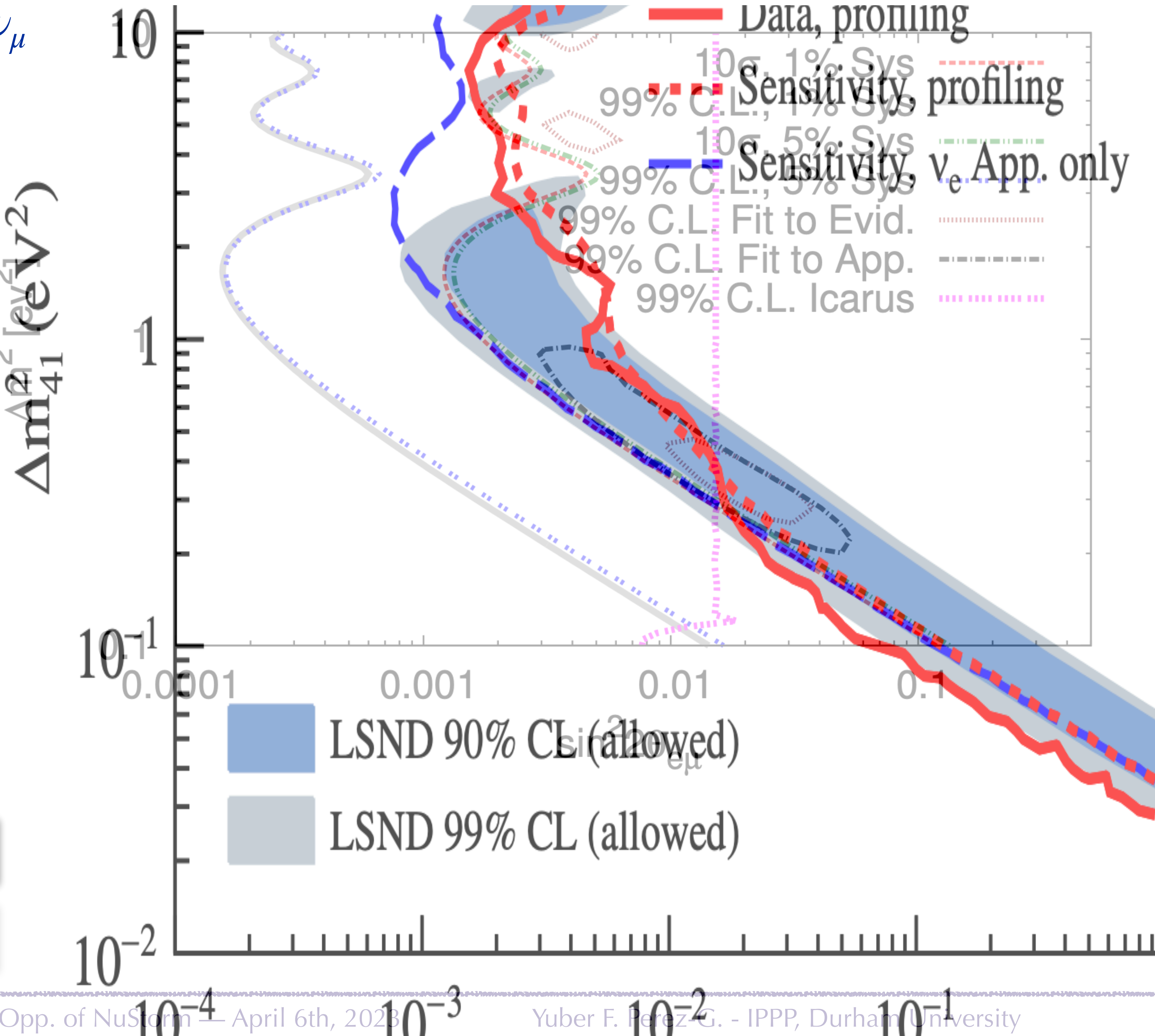

Adey et al.
1402.5250

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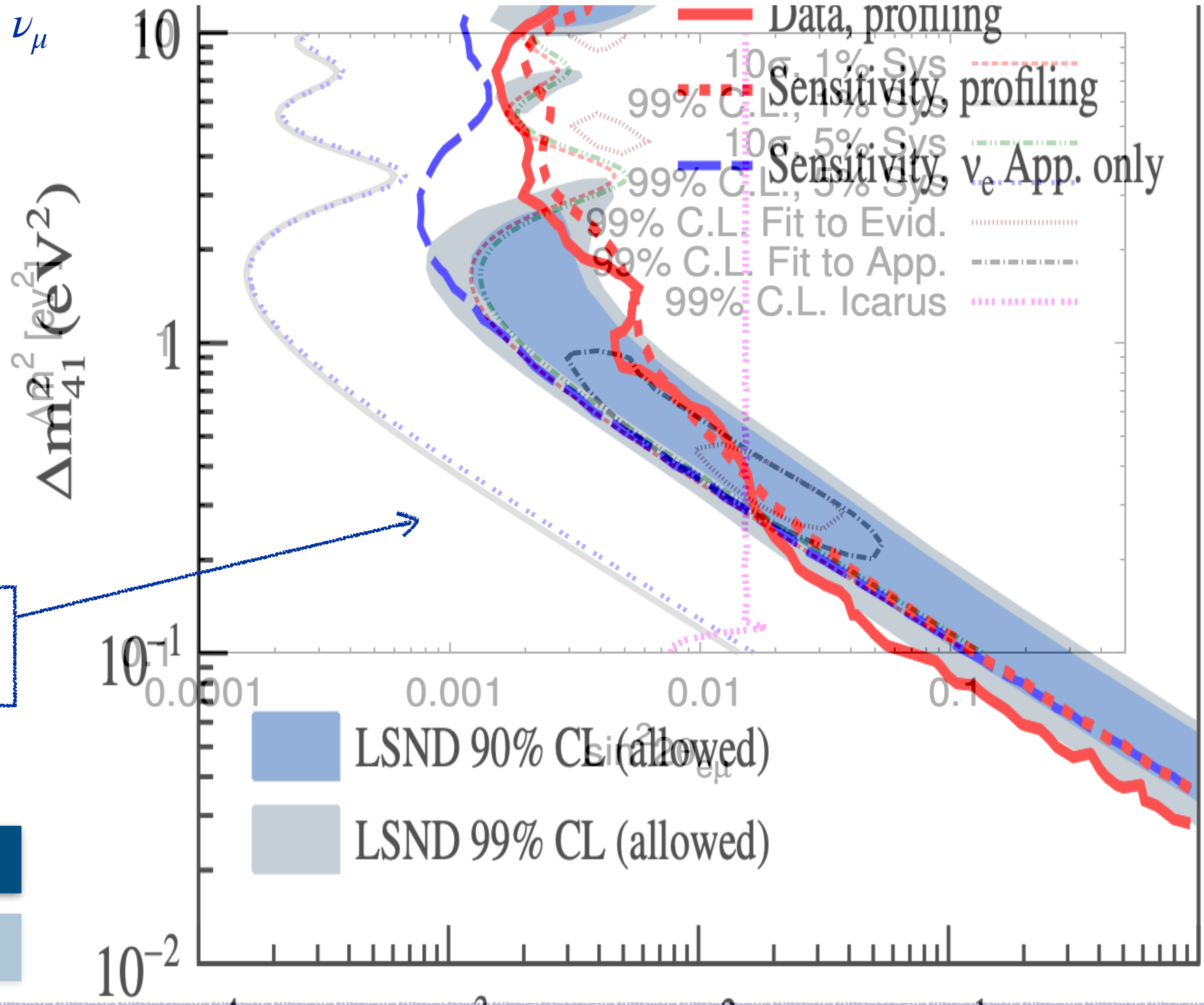

Full test of the sterile hypothesis for LSND

Adey et al. 1402.5250

Chakraborty et al. 2007.03321

What nuSTORM could do?

NF02 White Paper: arXiv:2203.07323.

SBL anomaly interpretations

Model landscape evolved significantly over the years.

Category	Model	Signature	Anomalies: LSND	MiniBooNE	Reactors	Sources	References
Flavor transitions Secs. 3.1.1-3.1.3, 3.1.5	(3+1) oscillations	oscillations	✓	✓	✓	✓	Reviews and global fits [93, 103, 105, 106]
	(3+1) w/ invisible sterile decay	oscillations w/ ν_4 invisible decay	✓	✓	✓	✓	[151, 155]
	(3+1) w/ sterile decay	$\nu_4 \to \phi \nu_e$	✓	✓	✓	✓	[159–162, 270]
Matter effects Secs. 3.1.4, 3.1.7	(3+1) w/ anomalous matter effects	$\nu_\mu \to \nu_e$ via matter effects	✓	✓	✗	✗	[143, 147, 271–273]
	(3+1) w/ quasi-sterile neutrinos	$\nu_\mu \to \nu_e$ w/ resonant ν_s matter effects	✓	✓	✓	✓	[148]
Flavor violation Sec. 3.1.6	Lepton-flavor-violating μ decays	$\mu^+ \to e^+ \nu_\alpha \overline{\nu_e}$	✓	✗	✗	✗	[174, 175, 274]
	neutrino-flavor-changing bremsstrahlung	$\nu_\mu A \to e \phi A$	✓	✓	✗	✗	[275]
Decays in flight Sec. 3.2.3	Transition magnetic mom., heavy ν decay	$N \to \nu \gamma$	✗	✓	✗	✗	[207]
	Dark sector heavy neutrino decay	$N \to \nu(X \to e^+e^-)$ or $N \to \nu(X \to \gamma\gamma)$	✗	✓	✗	✗	[208]
Neutrino Scattering Secs. 3.2.1, 3.2.2	neutrino-induced upscattering	$\nu A \to NA$, $N \to \nu e^+ e^-$ or $N \to \nu \gamma\gamma$	✓	✓	✗	✗	[205, 206, 209–216]
	neutrino dipole upscattering	$\nu A \to NA$, $N \to \nu \gamma$	✓	✓	✗	✗	[40, 185, 187, 188, 190, 193, 233, 276]
Dark Matter Scattering Sec. 3.2.4	dark particle-induced upscattering	γ or e^+e^-	✗	✓	✗	✗	[217]
	dark particle-induced inverse Primakoff	γ	✓	✓	✗	✗	[217]

Matheus Hostert, Community Summer Study Snowmass 2022

What nuSTORM could do?

NF02 White Paper: arXiv:2203.07323.

SBL anomaly interpretations

Category	Model	Signature	Anomalies: LSND	MiniBooNE	Reactors	Sources	References
							Reviews and global fits [93, 103, 105, 106]
							[151, 155]
							59–162, 270]
							[143, 147, 271–273]
							[148]
							174, 175, 274]
							[275]
							[207]
							[208]
							[205, 206, 209–216]
							40, 185, 187, 88, 190, 193, 233, 276]
							[217]
							[217]

Model landscape ev
significantly over the

Source	3+1 Oscillations	Anomalous matter effects	Lepton flavor violation	Decays in flight	Neutrino-induced upscattering	Dark-particle-induced upscattering
Reactor	DANSS upgrade, JUNO-TAO, NEOS II, Neutrino-4 upgrade, PROSPECT-II					
Radioactive Source	BEST-2, IsoDAR, THEIA, Jinping					
Atmospheric	IceCube upgrade, KM3NET, ORCA and ARCA, DUNE, Hyper-K, THEIA				IceCube upgrade, KM3NET, ORCA and ARCA, DUNE, Hyper-K, THEIA	
Pion/Kaon decay-at-rest	JSNS², COHERENT, CAPTAIN-Mills, IsoDAR, KPIPE		JSNS², COHERENT, CAPTAIN-Mills, IsoDAR, KPIPE, PIP2-BD			COHERENT, CAPTAIN-Mills, KPIPE, PIP2-BD
Beam Short Baseline	SBN			SBN		
Beam Long Baseline	DUNE, Hyper-K, ESSnuSB			DUNE, Hyper-K, ESSnuSB, FASERν, FLArE		
Muon decay-in-flight	νSTORM				νSTORM	
Beta Decay and Electron Capture	KATRIN/TRISTAN, Project-8, HUNTER, BeEST, DUNE-^{39}Ar, PTOLEMY, $2\nu\beta\beta$					

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Non-Standard Interactions

NC NSI

Modification of the neutrino propagation

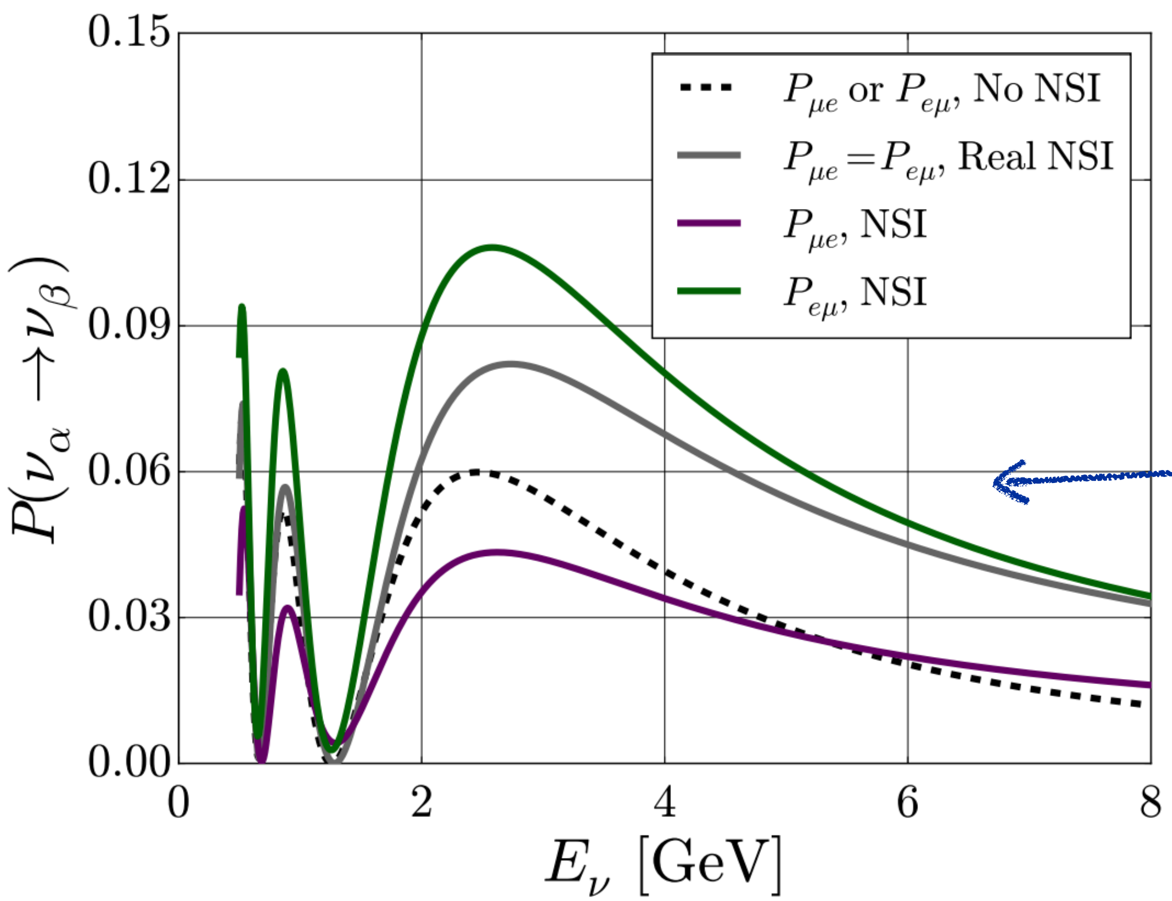
$$\mathcal{L}^{\rm NSI} = -2\sqrt{2}G_F(\bar{\nu}_\alpha\gamma_\rho\nu_\beta)(\epsilon_{\alpha\beta}^{f\tilde{f}L}\overline{f}_L\gamma^\rho\tilde{f}_L + \epsilon_{\alpha\beta}^{f\tilde{f}R}\overline{f}_R\gamma^\rho\tilde{f}_R) + h.c.,$$

Our Hamiltonian

$$H_{ij} = \frac{1}{2E_\nu}{\rm diag}\left\{0, \Delta m_{12}^2, \Delta m_{13}^2\right\} + V_{ij}$$

$$V_{ij} = U_{i\alpha}^\dagger V_{\alpha\beta}U_{\beta j},$$

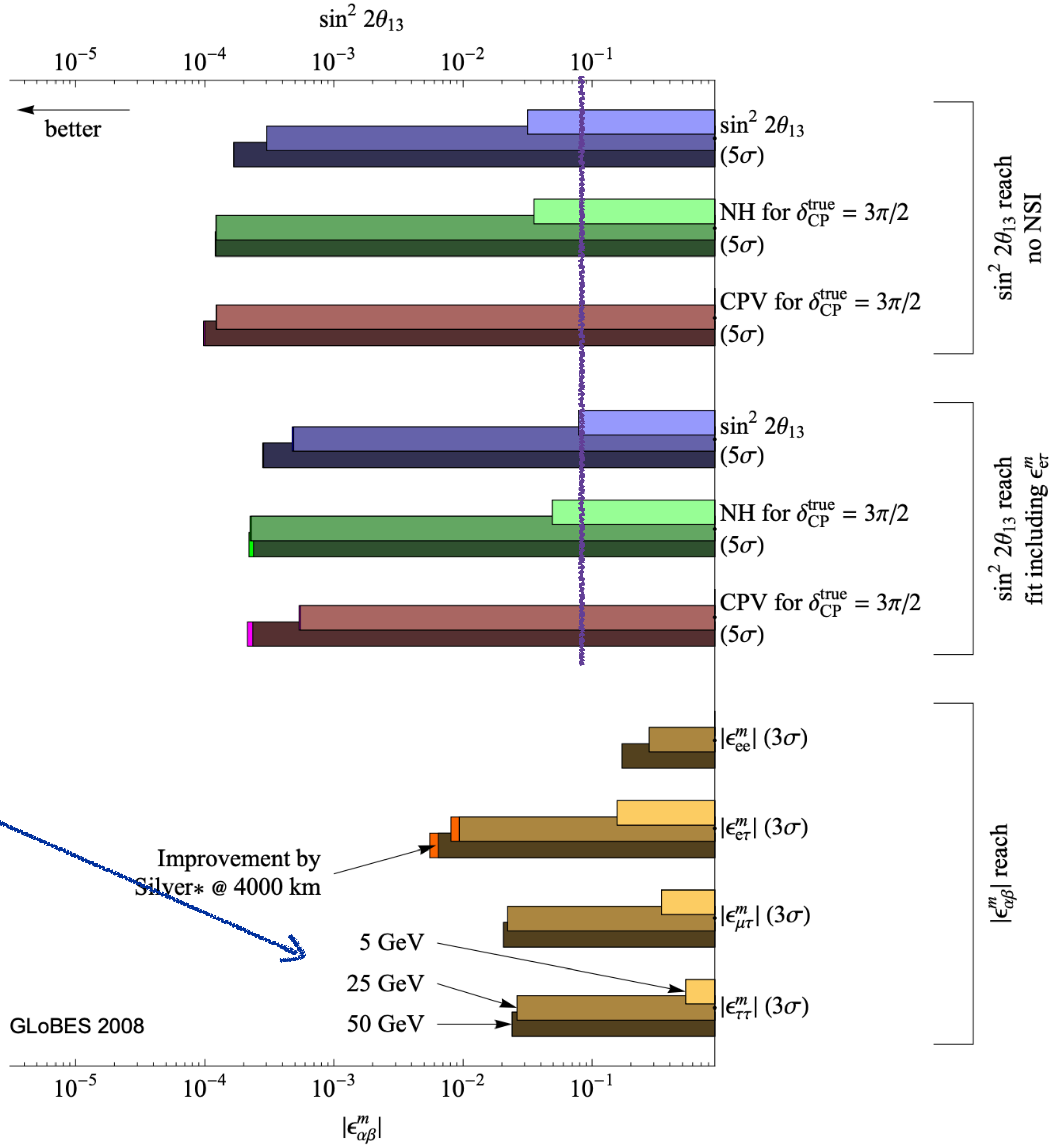
$$V_{\alpha\beta} = A\begin{pmatrix} 1+\epsilon_{ee} & \epsilon_{e\mu} & \epsilon_{e\tau} \\ \epsilon_{e\mu}^* & \epsilon_{\mu\mu} & \epsilon_{\mu\tau} \\ \epsilon_{e\tau}^* & \epsilon_{\mu\tau}^* & \epsilon_{\tau\tau}\end{pmatrix}$$



Probabilities for DUNE

$$\epsilon_{e\mu} = 0.1e^{i\pi/3},\ \epsilon_{e\tau} = 0.1e^{-i\pi/4},\ \epsilon_{\mu\tau} = 0.1$$

*At a Far Detector



Higher energy, better sensitivity

Kopp et al
0804.2261

Neutrino Self-Interactions

Neutrinos could interact among themselves

$$\mathcal{L} \supset g_{\alpha\beta}\phi\nu_\alpha\nu_\beta$$

UV completions?

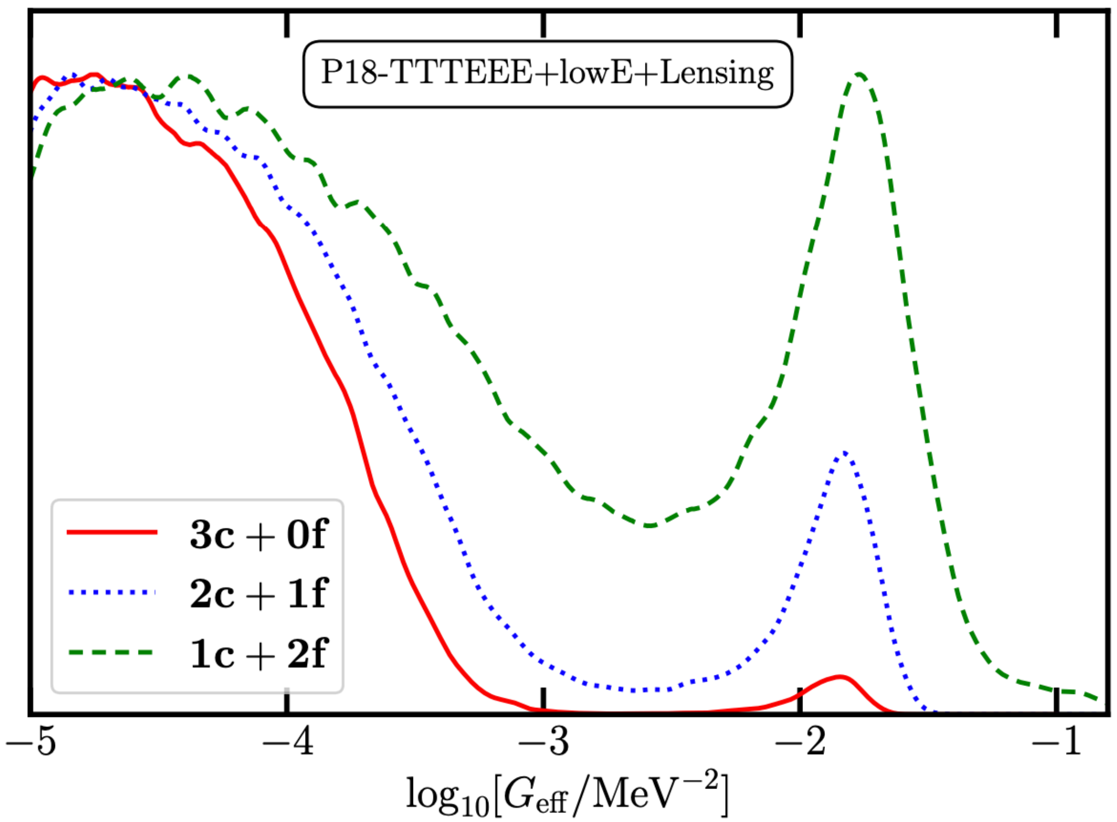
$$\mathcal{L} = \frac{1}{\Lambda^2}(LH)^2\phi$$

See snowmass: 2203.01955

Simplified approaches

Probes?

- ✳Cosmological
- ✳Astrophysical
- ✳Laboratory

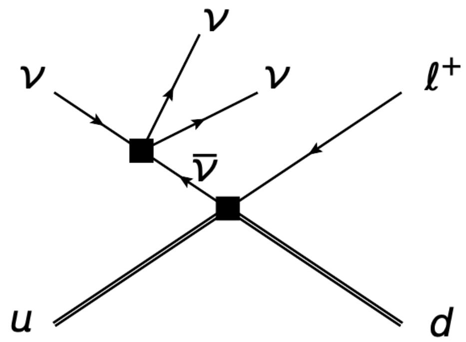


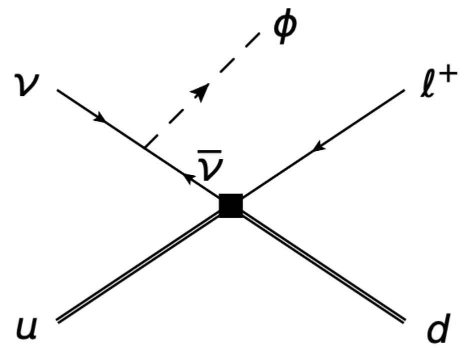
Das, Ghosh, JCAP 07 (2021) 038

✳Laboratory

Three body decays $m^- \to \ell_\alpha^- \nu_\beta \phi$

Scatterings

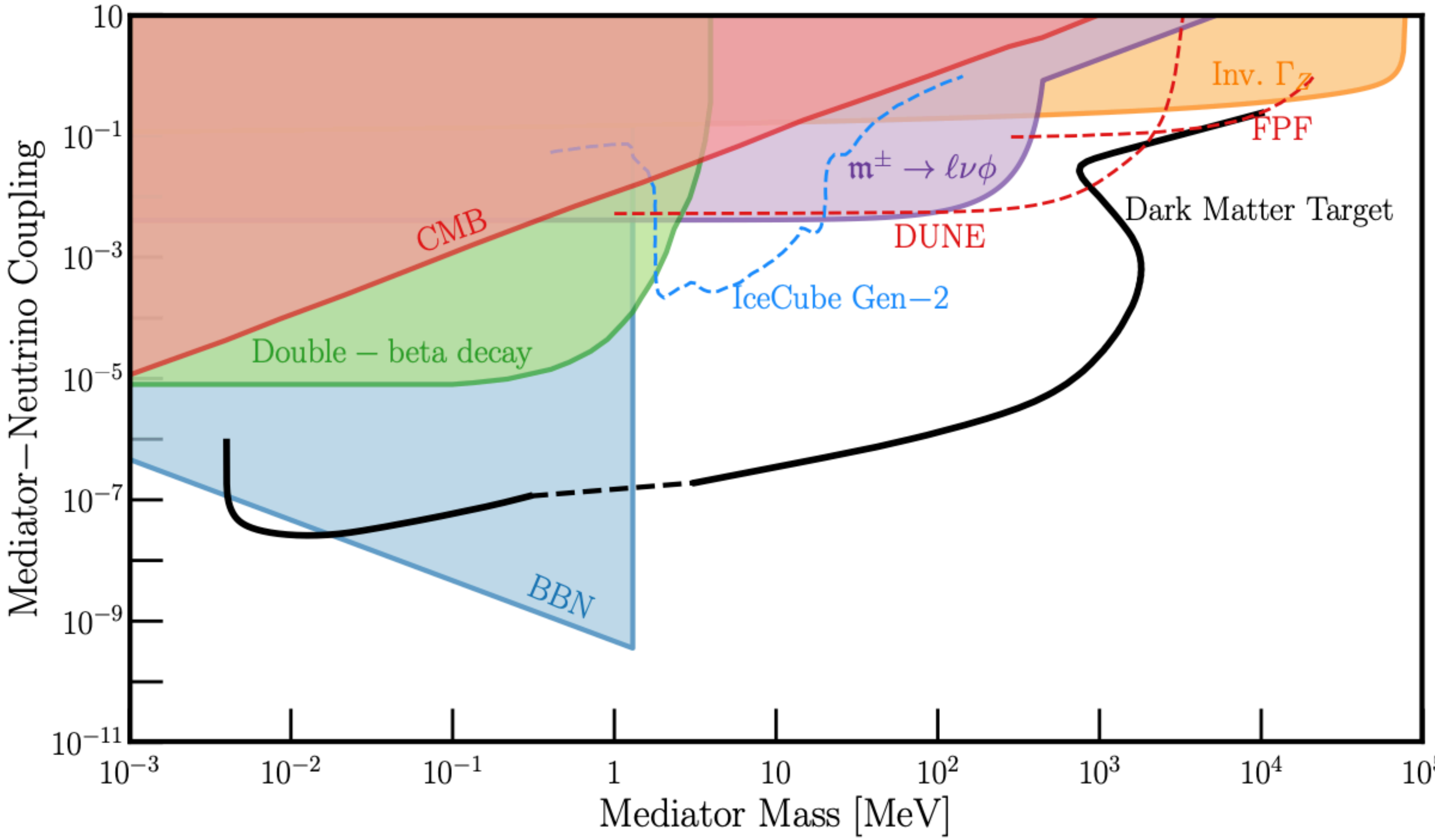




Produce non-standard components to the nuSTORM beam!

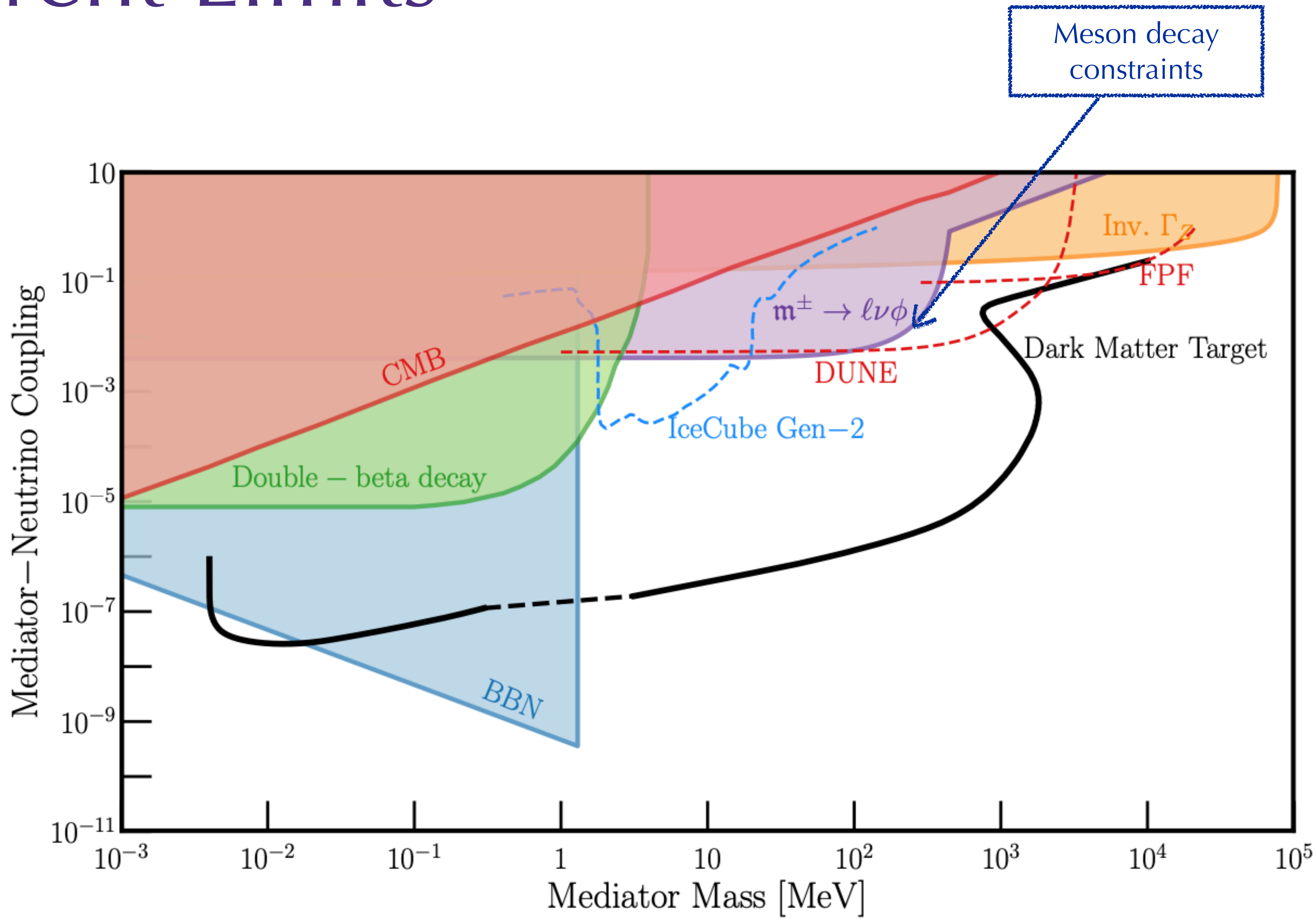
A "clean" environment is required

Current Limits



Snowmass: 2203.01955

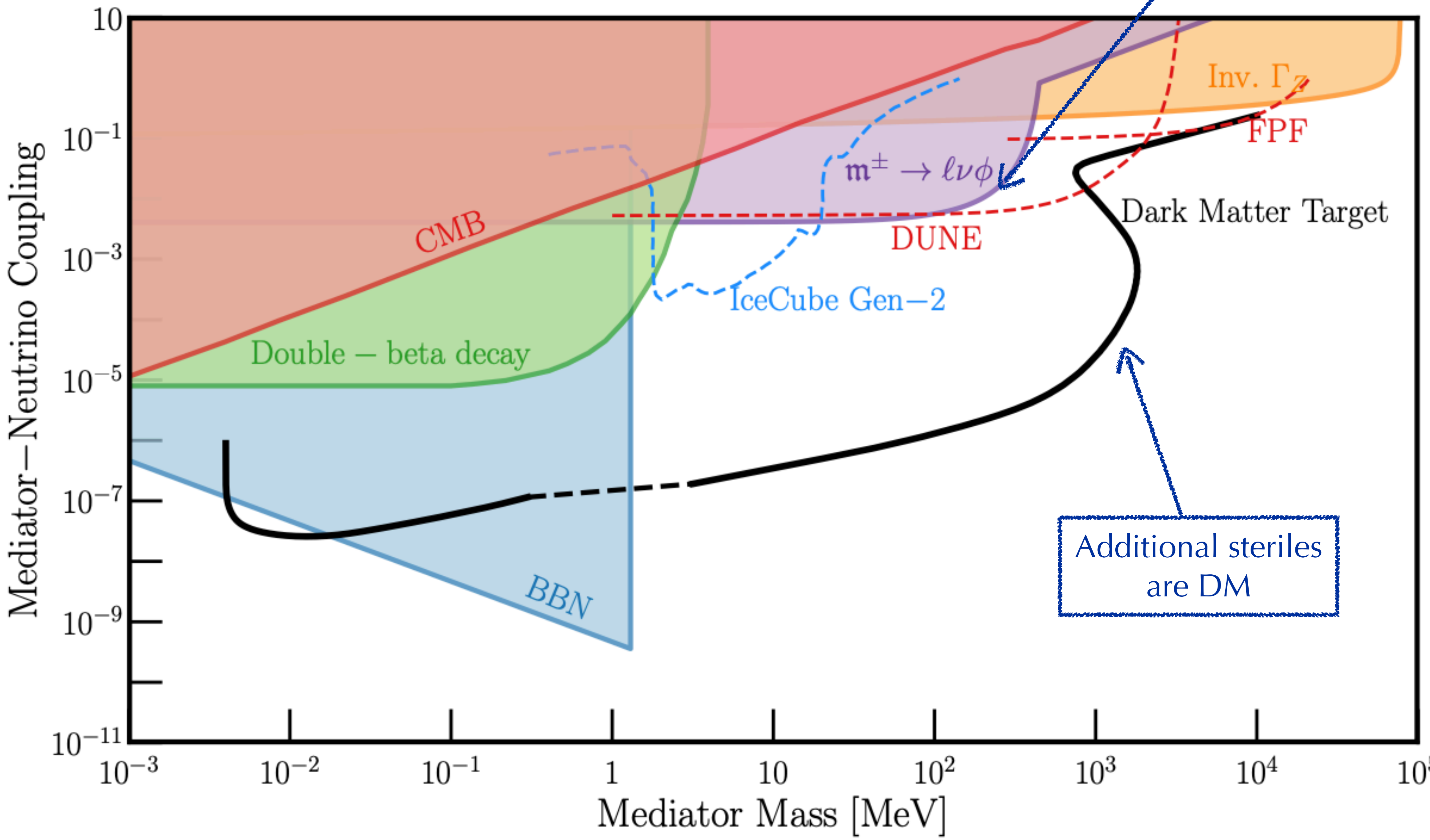
Current Limits



Snowmass: 2203.01955

Current Limits

Meson decay constraints



Additional steriles are DM

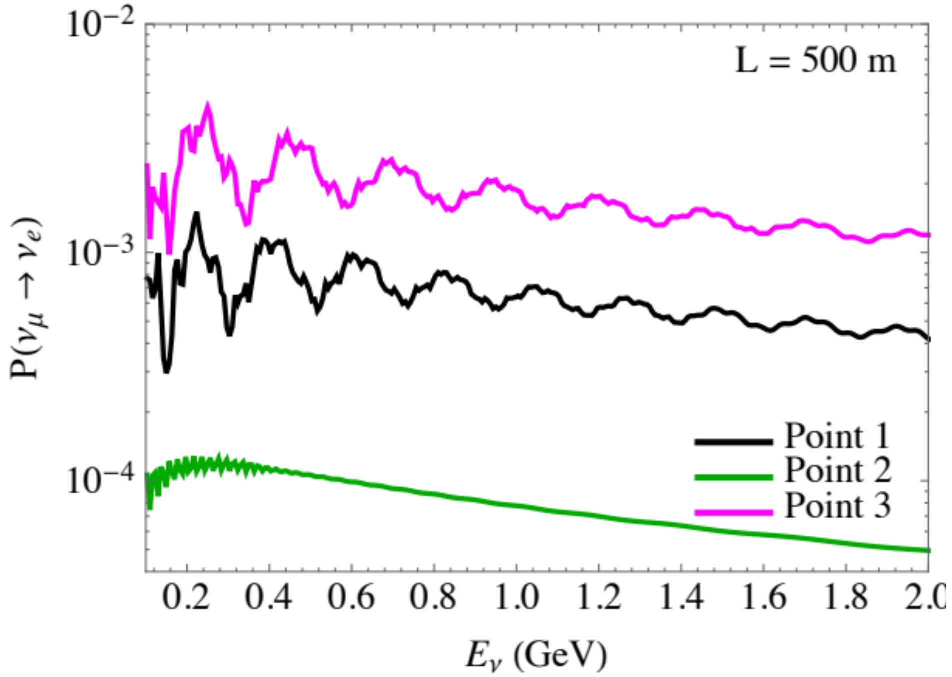
Snowmass: 2203.01955

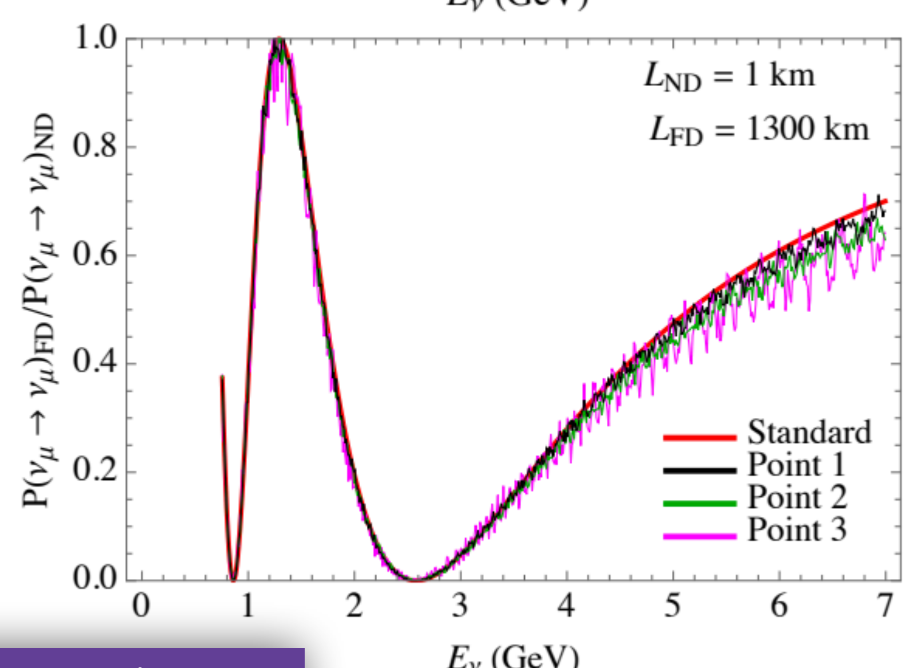
Large Extra Dimensions

Large Extra Dimensions

Weakness of Gravity might be the result of the existence of extra dimensions

$$M_4^2 = M_D^{2+n}(2\pi R)^n$$





$\{P_a, \nu_i\}$	$\frac{R}{\text{eV}^{-1}}$	$c_i R$	λ^i	$\frac{m_{i,0}^2}{\text{eV}^2}$	$\frac{m_{i,n'}^2}{\text{eV}^2}$	$\lvert W_i^{0n'}\rvert^2$
$\{P_1, \nu_1\}$	1.9	4.24	0.42	≈ 0	9.3	$9.0 \cdot 10^{-5}$
$\{P_1, \nu_2\}$	1.9	1.19	2.0	$7.6 \cdot 10^{-5}$	0.66	0.0196
$\{P_1, \nu_3\}$	1.9	−0.037	0.66	$2.5 \cdot 10^{-3}$	0.27	0.0169
$\{P_2, \nu_1\}$	6.4	−1.1	0.27	$2.5 \cdot 10^{-3}$	0.056	$5.9 \cdot 10^{-3}$
$\{P_2, \nu_2\}$	6.4	−1.2	0.25	$2.6 \cdot 10^{-3}$	0.066	$3.8 \cdot 10^{-3}$
$\{P_2, \nu_3\}$	6.4	3.2	1.1	≈ 0	0.64	0.01
$\{P_3, \nu_1\}$	1.8	0.43	0.42	$1.9 \cdot 10^{-4}$	0.37	$4.4 \cdot 10^{-3}$
$\{P_3, \nu_2\}$	1.8	1.0	2.4	$2.6 \cdot 10^{-4}$	0.65	0.0361
$\{P_3, \nu_3\}$	1.8	0.41	1.7	$2.7 \cdot 10^{-3}$	0.37	0.0576

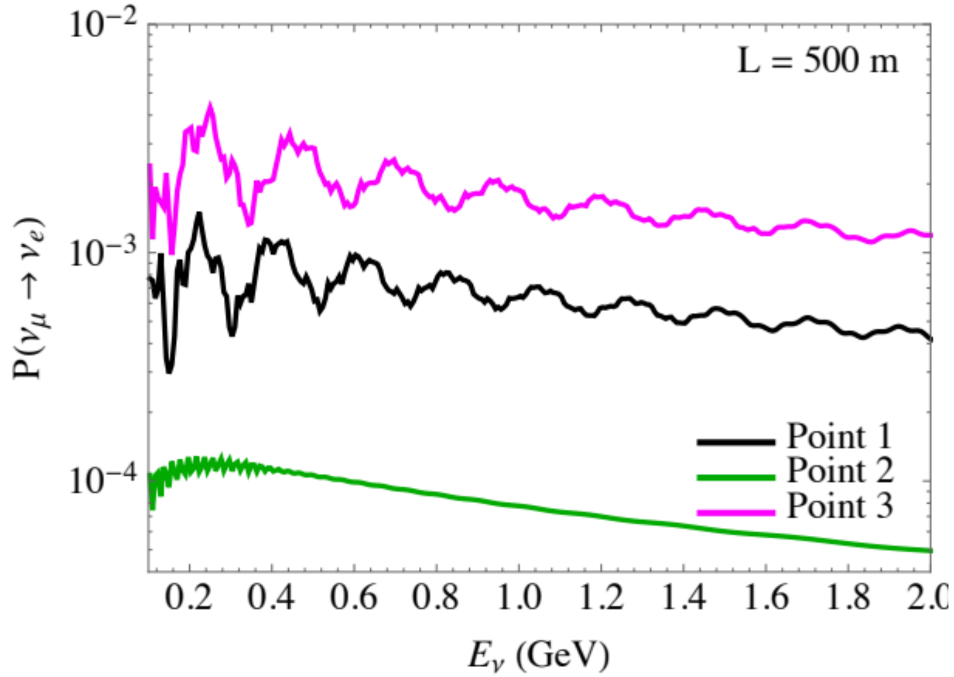
Maybe neutrino masses also "leak" through the extra dim?

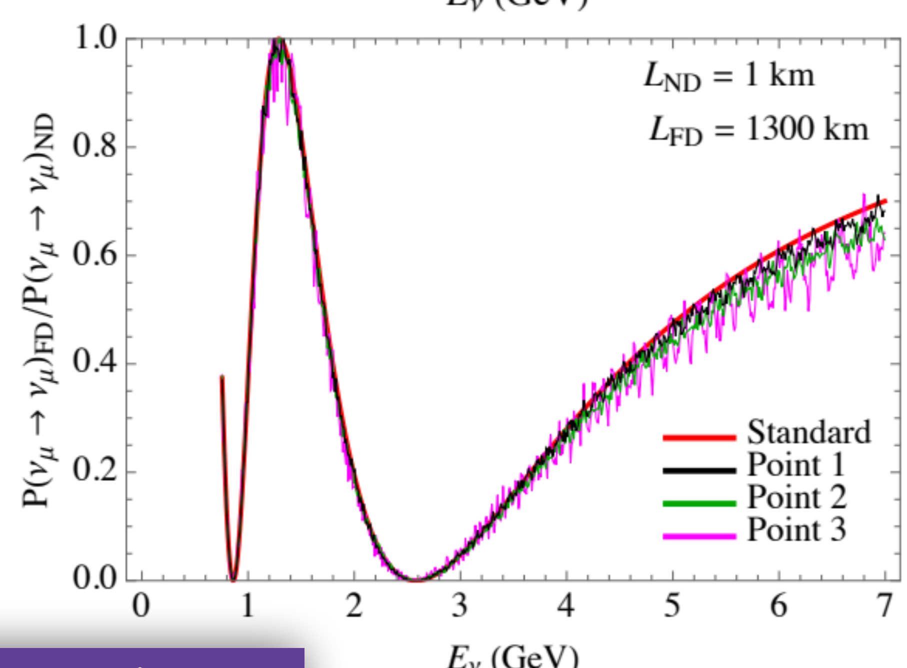
ADD model, hep-ph/9803315

Carena et al,1708.09548

Large Extra Dimensions

Weakness of Gravity might be the result of the existence of extra dimensions





Maybe neutrino masses also "leak" through the extra dim?

Volume of extra dims

$$M_4^2 = M_D^{2+n}(2\pi R)^n$$

Gravity that we "feel"

Actual gravity

$\{P_a, \nu_i\}$	$\frac{R}{\rm eV^{-1}}$	$c_i R$	λ^i	$\frac{m^2_{i,0}}{\rm eV^2}$	$\frac{m^2_{i,n'}}{\rm eV^2}$	$\lvert W_i^{0n'}\rvert^2$
$\{P_1, \nu_1\}$	1.9	4.24	0.42	≈ 0	9.3	$9.0 \cdot 10^{-5}$
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ADD model, hep-ph/9803315

Carena et al,1708.09548

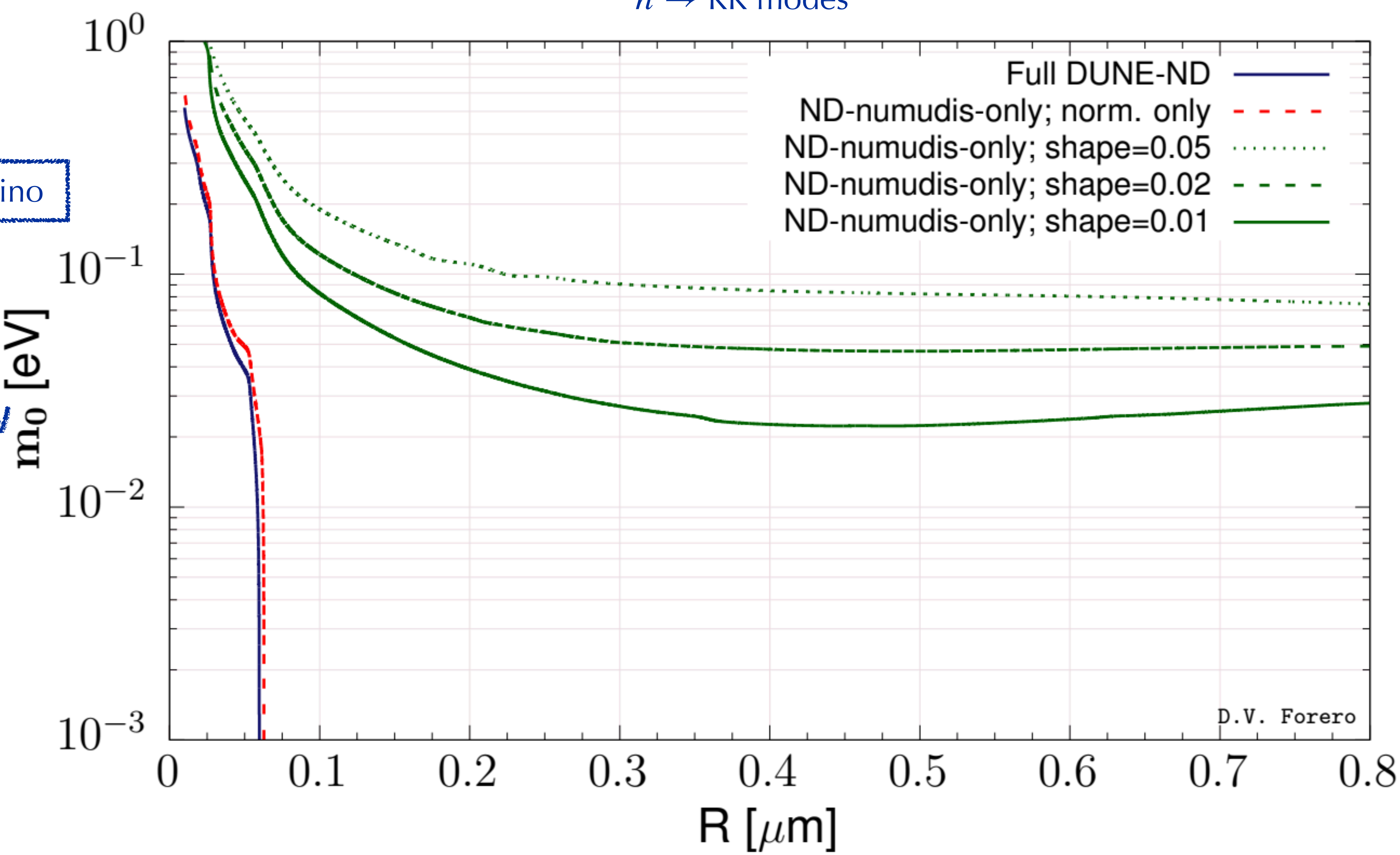
Large Extra Dimensions

Highly dependent on systematics!

$$\Delta m^2_{n1} = n^2/R^2 + 2m_0 n/R$$

$n \rightarrow$ KK modes

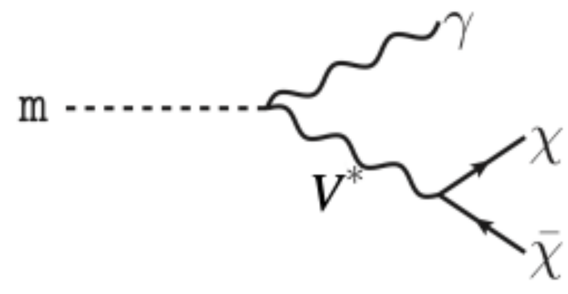
Lightest neutrino

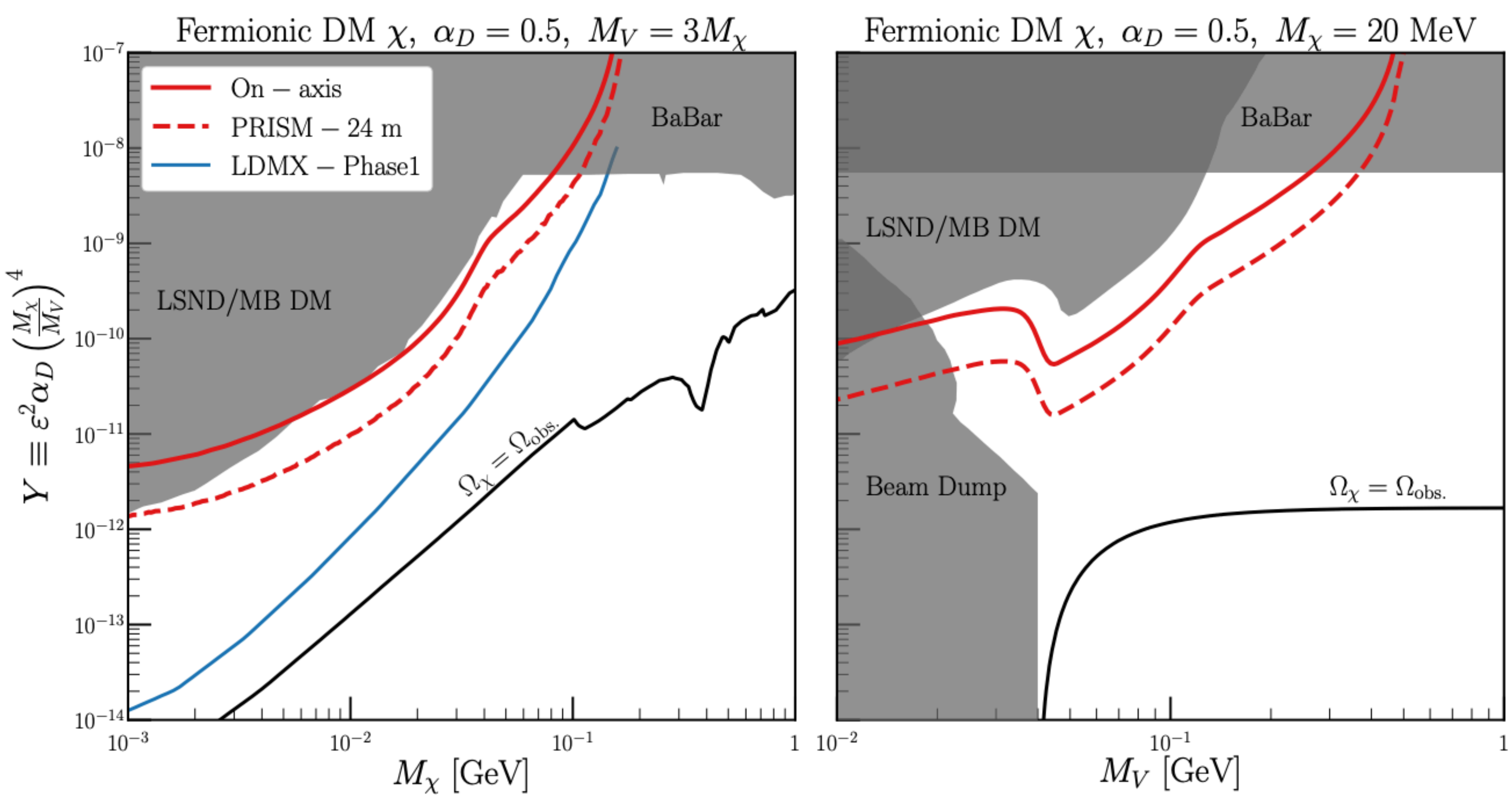


Again, having a "clean" flux would help here

Non-neutrino BSM

Light Dark Matter?





Additional channels?
What could nuSTORM do here?

Axions from the muon beam?

Conclusions

- Unique combination of flavours should help in constraining the $g_A^{\nu e}$, $g_V^{\nu e}$ SM couplings
- There is a vast landscape of BSM models trying to explain different phenomena, like the short baseline anomalies.
- Large flux, low backgrounds and low systematics make nuSTORM the best place to constrain many possible BSM models.
- Other ideias???

Thanks!