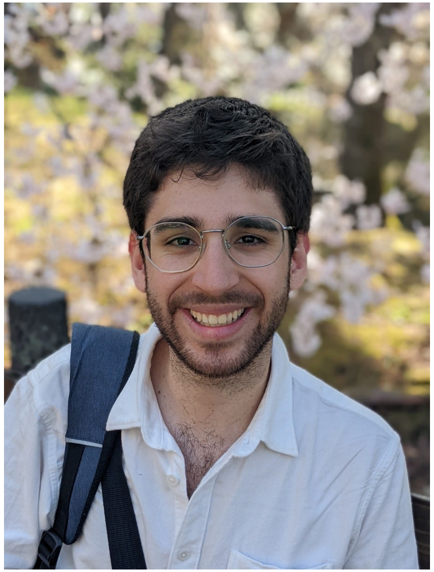
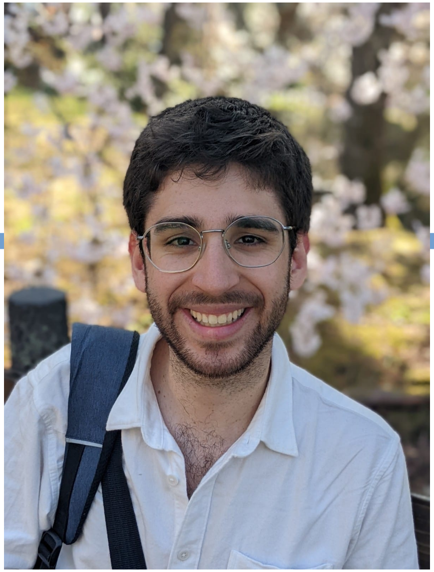
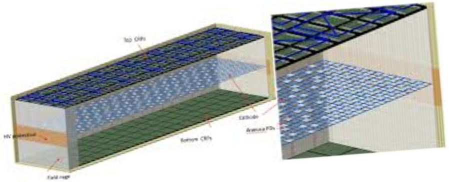
Recent progress on DUNE’s solar parameter sensitivity at LAPP



Andrés López Moreno (Me)
Luis Manzanillas
Maël Martin

Recent progress on DUNE’s solar parameter sensitivity at LAPP

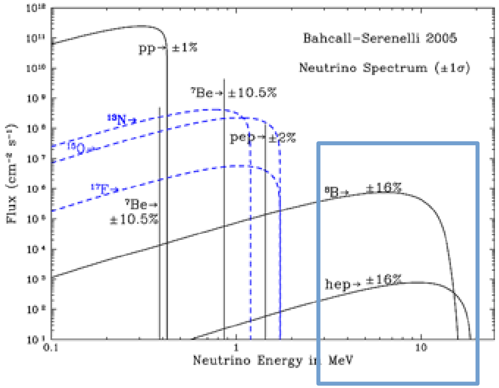




Andrés López Moreno

Solar fit

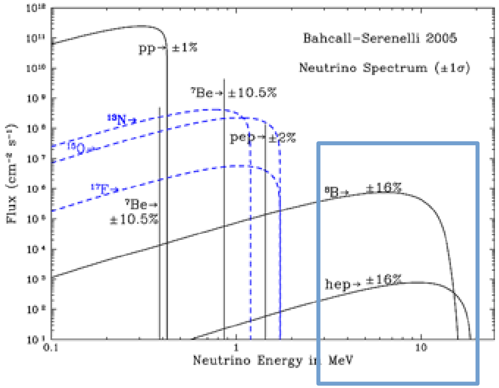
New Solar Opacities, Abundances, Helioseismology, and Neutrino Fluxes, ApJ, 621, L85 (2005)



Neutrino fluxes from solar model (AGSS09)

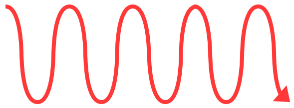
Solar fit

New Solar Opacities, Abundances, Helioseismology, and Neutrino Fluxes, ApJ, 621, L85 (2005)



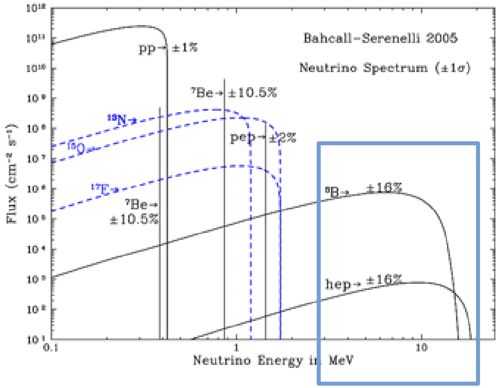
Neutrino fluxes from solar model (AGSS09)

$P_{ee}(\theta_{12}, \theta_{13}, \Delta m^2_{21})$



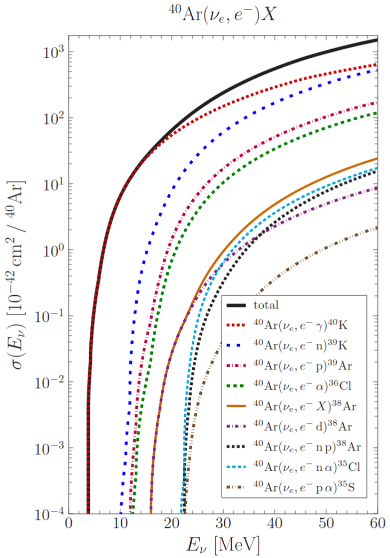
Solar fit

New Solar Opacities, Abundances, Helioseismology, and Neutrino Fluxes, ApJ, 621, L85 (2005)



Neutrino fluxes from solar model (AGSS09)

$P_{ee}(\theta_{12}, \theta_{13}, \Delta m^2_{21})$



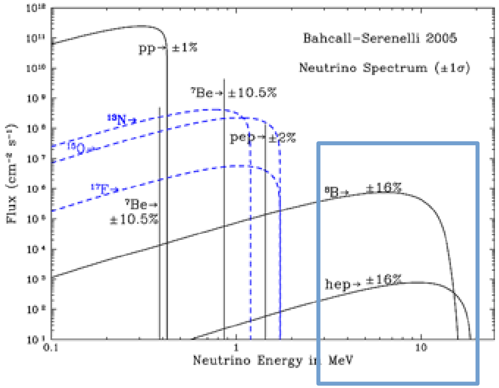
Nuclear de-excitations in low-energy charged-current ve scattering on 40 Ar PRC, 103 (2021)

E_{true} **spectrum**

Cross sections from MARLEY

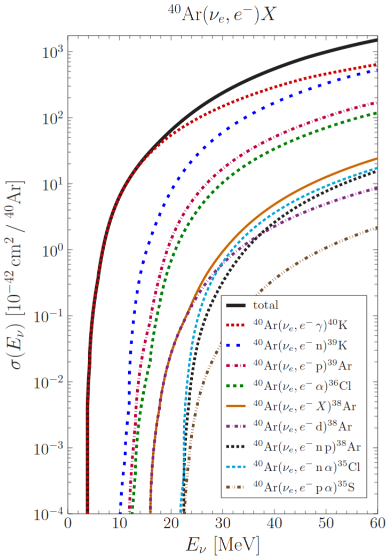
Solar fit

New Solar Opacities, Abundances, Helioseismology, and Neutrino Fluxes, ApJ, 621, L85 (2005)



Neutrino fluxes from solar model (AGSS09)

$P_{ee}(\theta_{12}, \theta_{13}, \Delta m^2_{21})$



Nuclear de-excitations in low-energy charged-current ve scattering on 40 Ar PRC, 103 (2021)

Cross sections from MARLEY

E_{true} spectrum

Response matrices (generated by Maël)

Binned E_{reco} spectrum

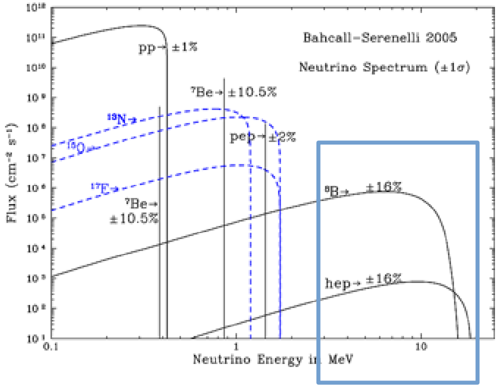
(normalised to match Maël's calculations)

Laboratoire d'Annecy de Physique des Particules

DEEP UNDERGROUND NEUTRINO EXPERIMENT

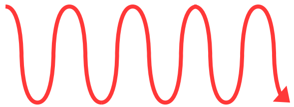
Solar fit

New Solar Opacities, Abundances, Helioseismology, and Neutrino Fluxes, ApJ, 621, L85 (2005)

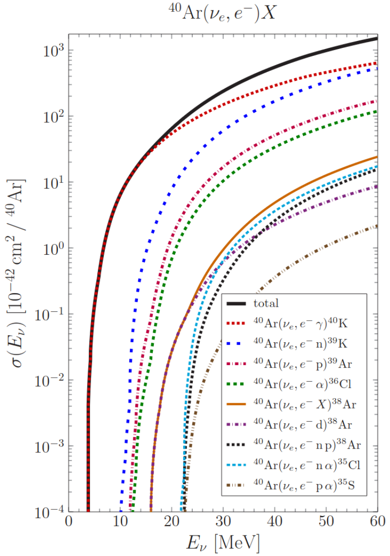


Neutrino fluxes from solar model (AGSS09)

$P_{ee}(\theta_{12}, \theta_{13}, \Delta m^2_{21})$



VARY PARAMETERS



Nuclear de-excitations in low-energy charged-current ve scattering on 40 Ar PRC, 103 (2021)

Cross sections from MARLEY

E_{true} spectrum

Response matrices (generated by Maël)

Binned E_{reco} spectrum

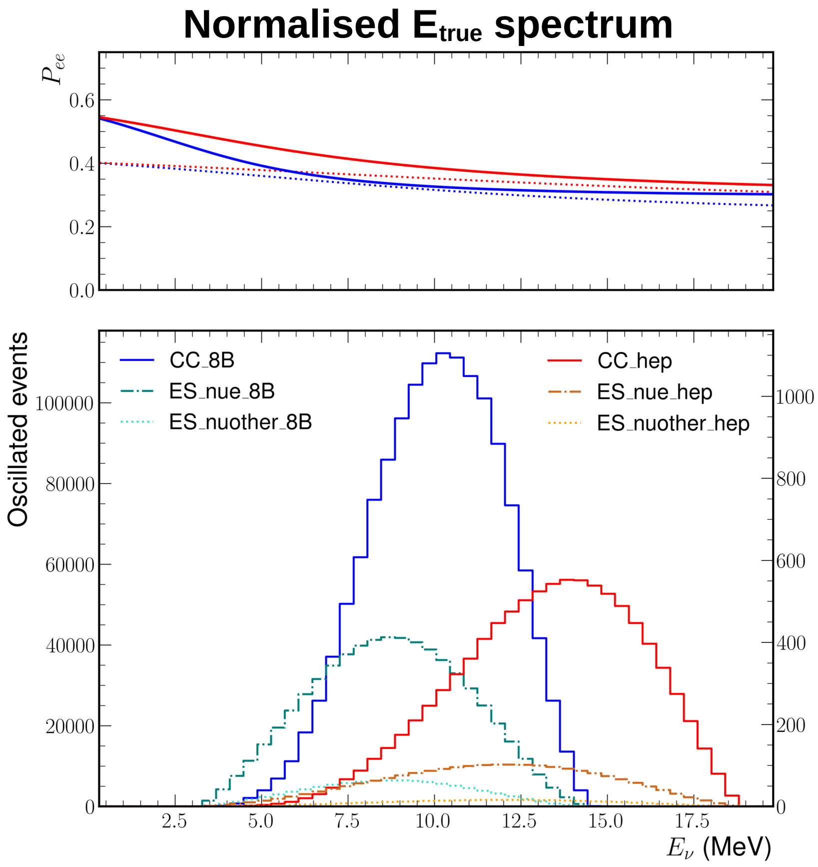
(normalised to match Maël's calculations)

COMPARE TO (FAKE) DATA

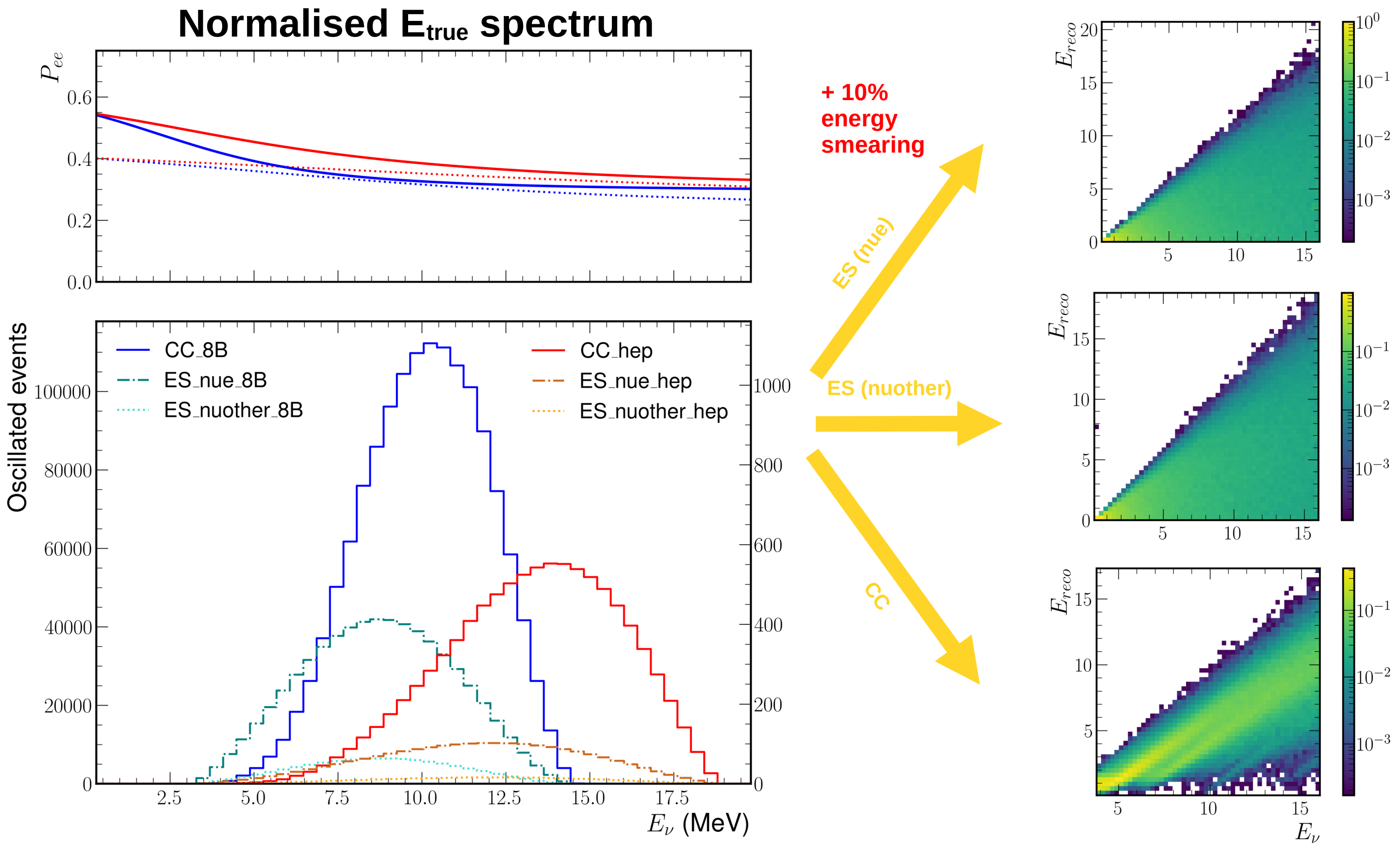
Laboratoire d'Annecy de Physique des Particules

DEEP UNDERGROUND NEUTRINO EXPERIMENT

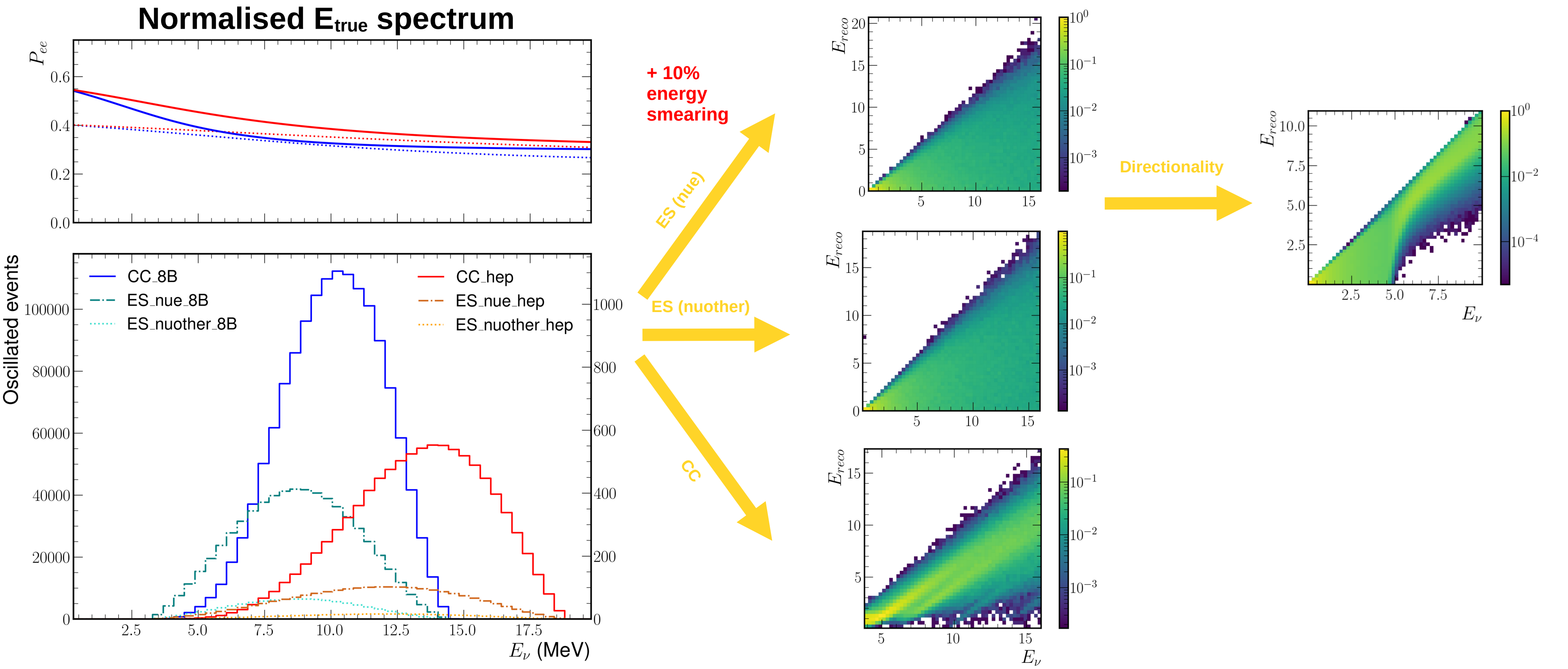
Solar event rates



Solar event rates

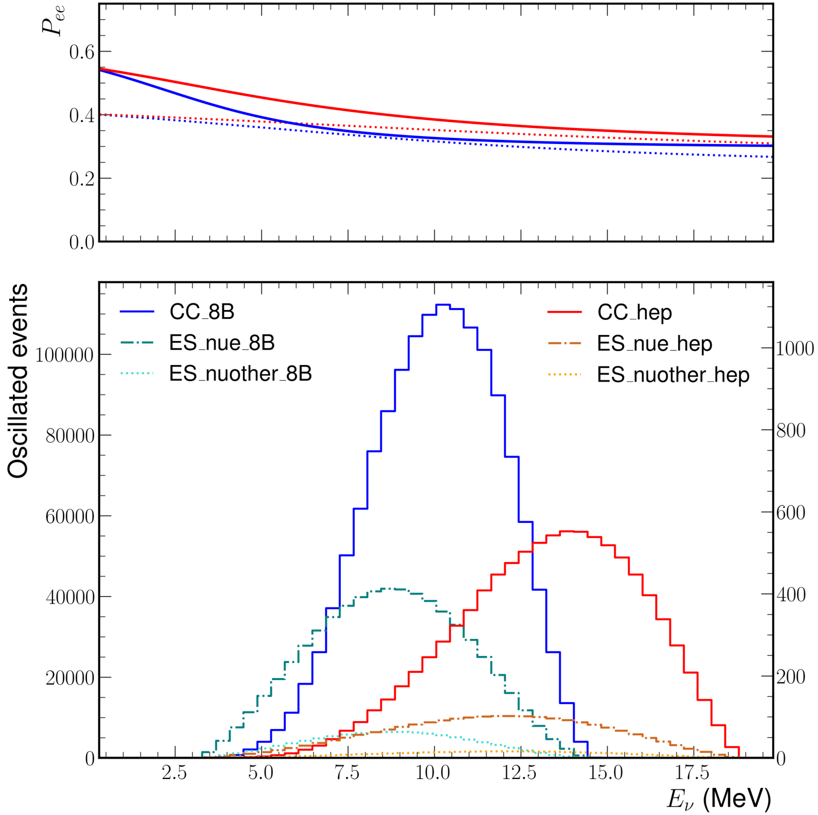


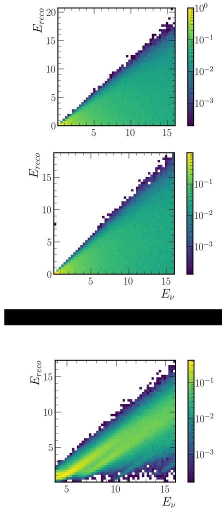
Solar event rates



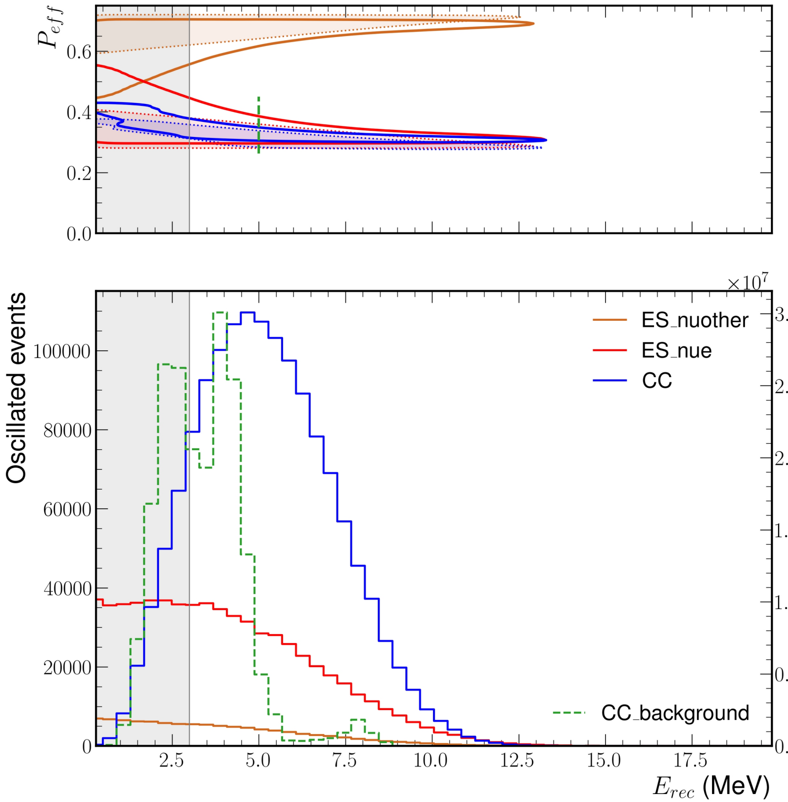
Solar event rates

Normalised E_{true} spectrum



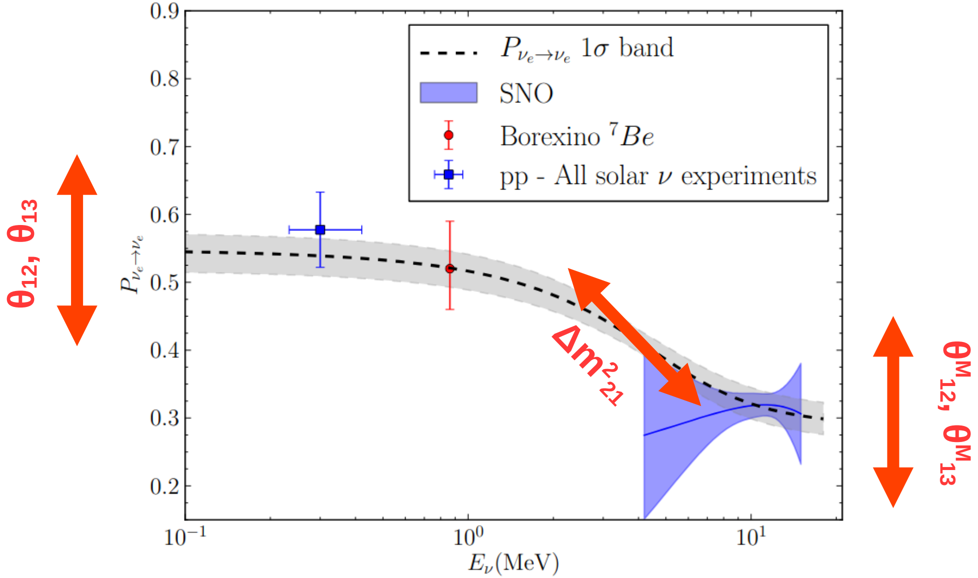


Reconstructed event rates



Sensitivity

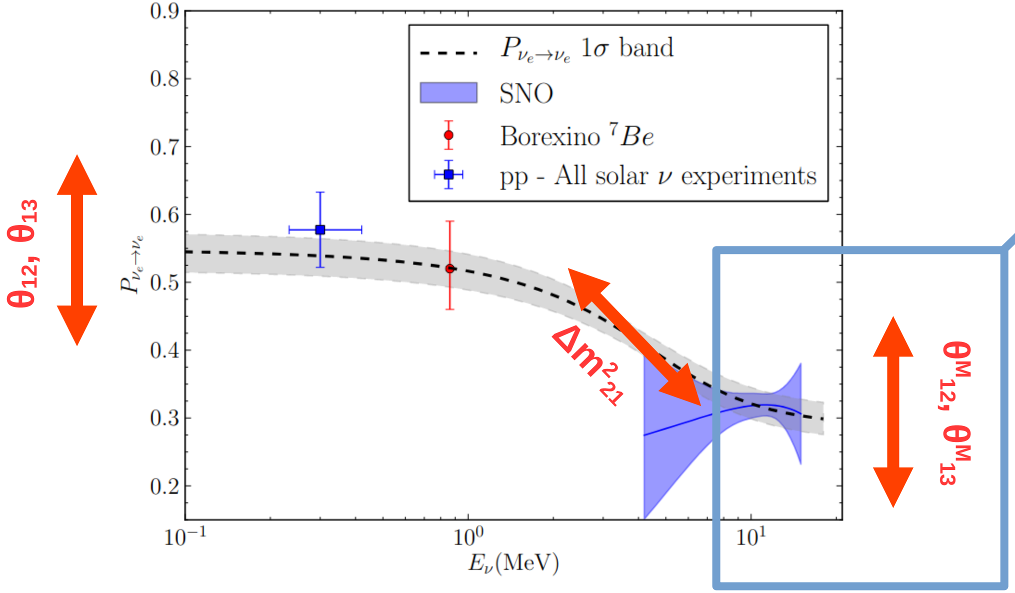
Combined Analysis of all Three Phases of Solar Neutrino Data from the Sudbury Neutrino Observatory PRC, 88 (2013)



Andrés López Moreno

Sensitivity

Combined Analysis of all Three Phases of Solar Neutrino Data from the Sudbury Neutrino Observatory PRC, 88 (2013)



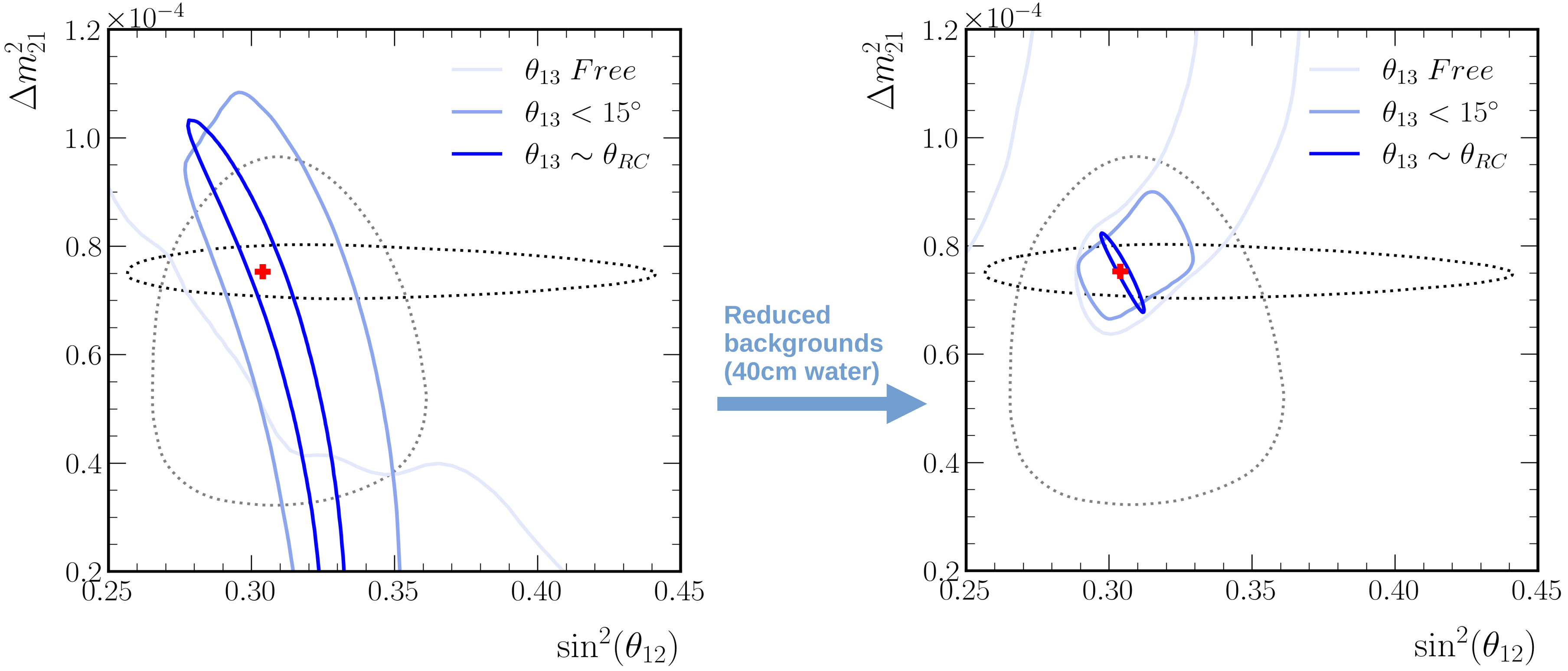
Unable to separate θ_{13} without measuring the vacuum regime.

Consider 3 scenarios:

- **Free θ_{13}**
- **$\theta_{13} < 15^o$**
- **θ_{13} as given by the PDG's global reactor measurement (~ 2 flavour fit)**

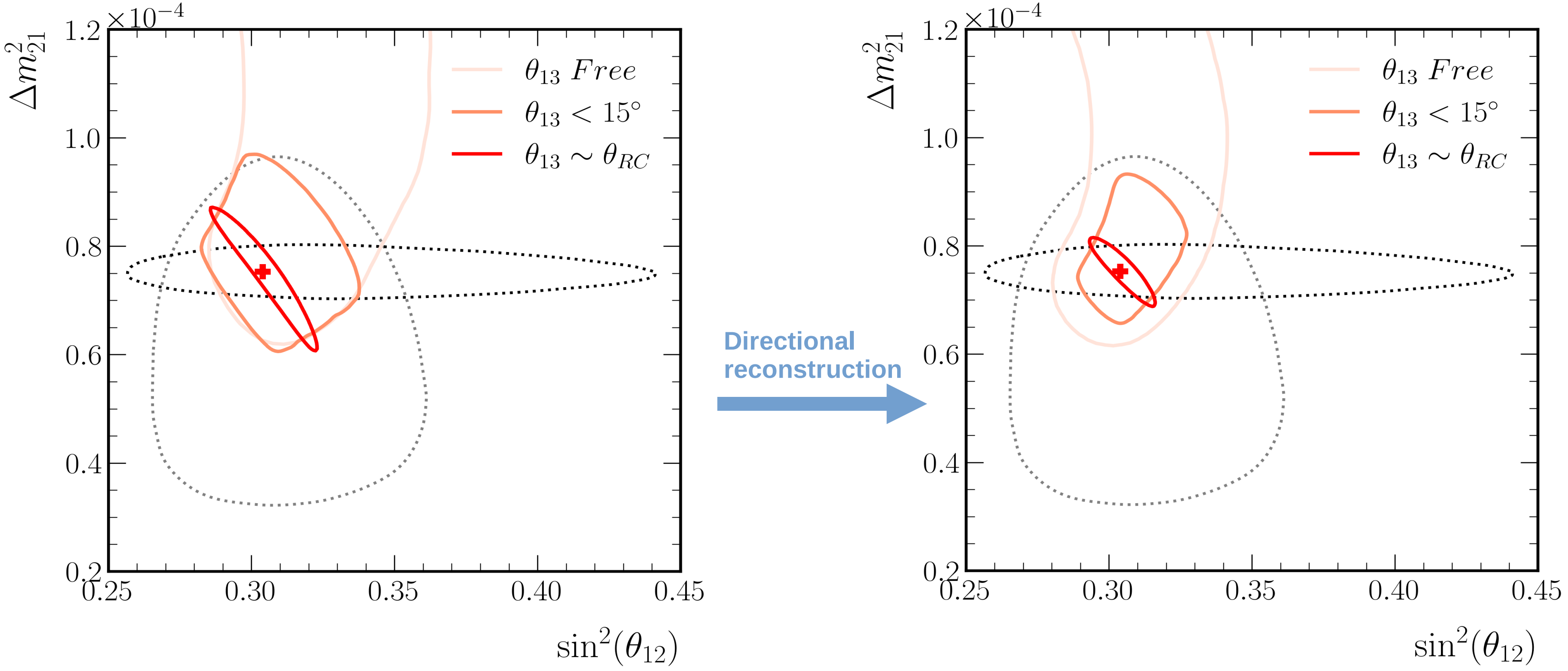
Sensitivity

CC only: 95% credible regions



Sensitivity

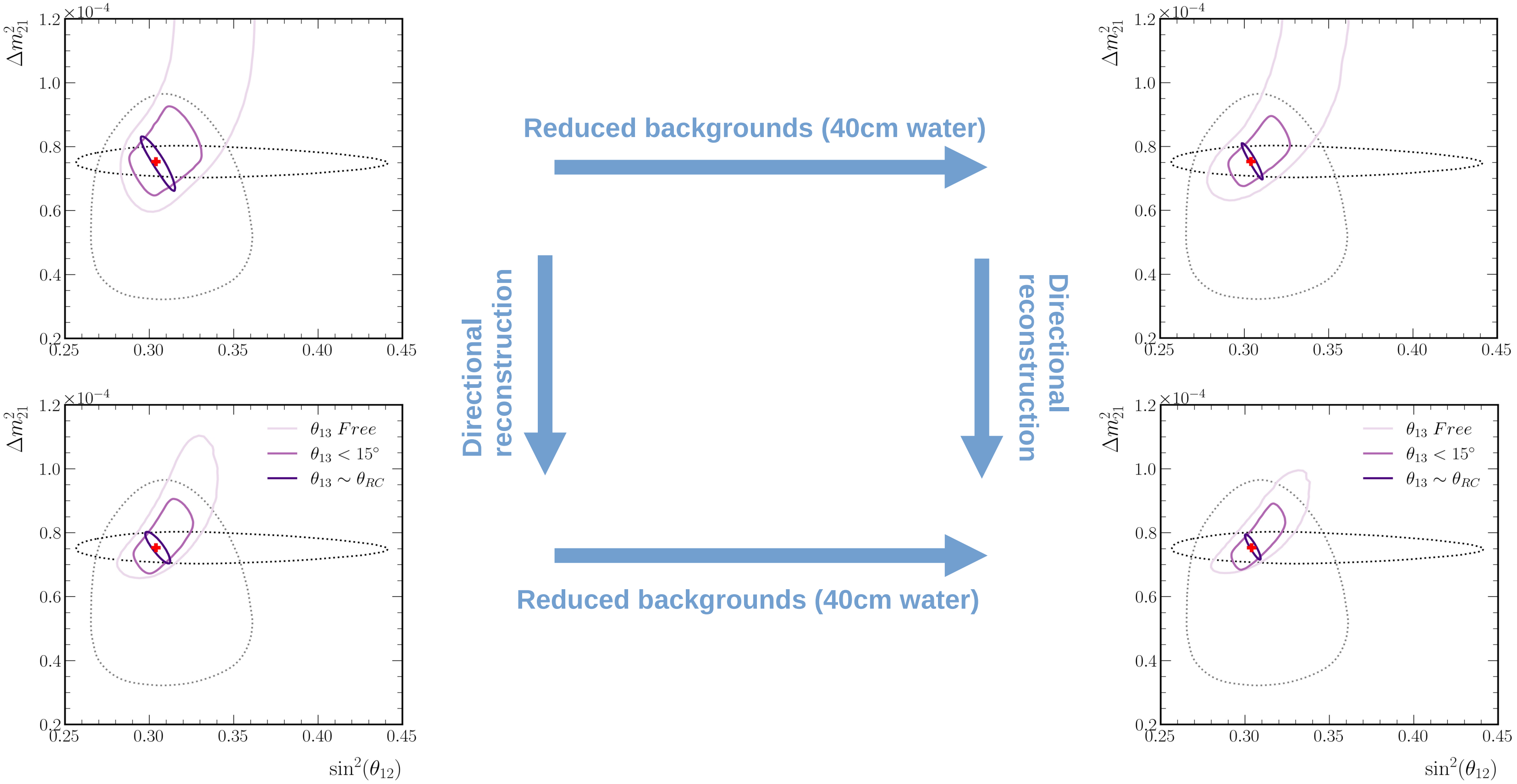
ES only: 95% credible regions



Andrés López Moreno

Sensitivity

Combined channels:
95% credible regions



Conclusions

- DUNE should be able to perform excellent measurements of the solar neutrino parameters when combining the ES and CC channels, given we achieve a threshold of E_{reco} ~ 3MeV

- Although the CC channel has larger statistics, the cross section vanishes at E_{true} < 4.7 MeV, obscuring the region of highest sensitivity

- As things stand, our sensitivity is driven by the ES channel, which can be boosted by using scattering angle information

- For the CC channel to be useful, we need to reduce the neutron background from radioactive decays in the surrounding rock

Many thanks

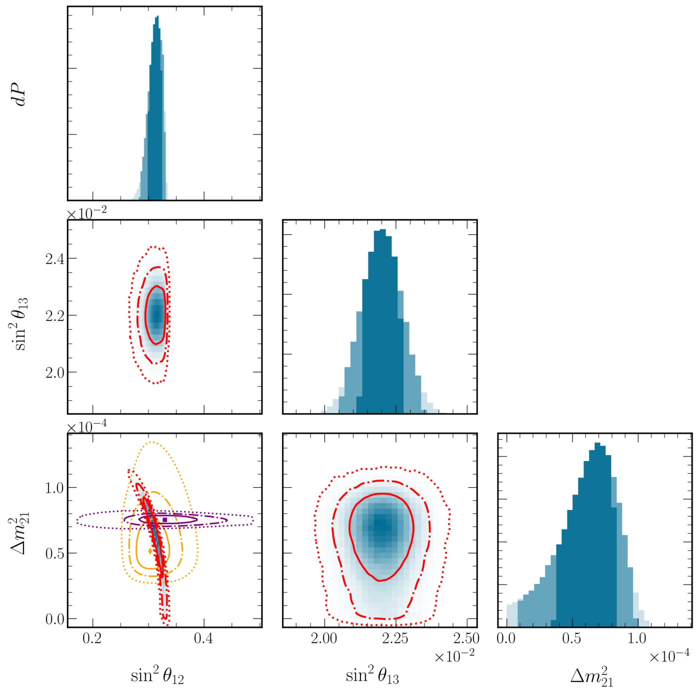
PS:All this work was done using an MCMC fitter I wrote in Julia, and it is available at https://github.com/AlopezMoreno/DUNE_SolarOscFitter.

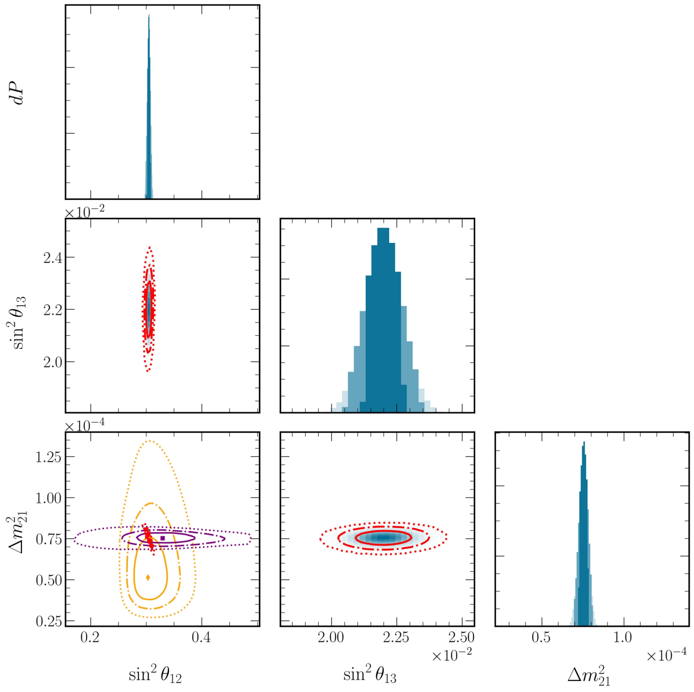
It is easy to use and should allow you to generate similar contours to the ones I showed. It is still a work in progress

Backups

Corner plots

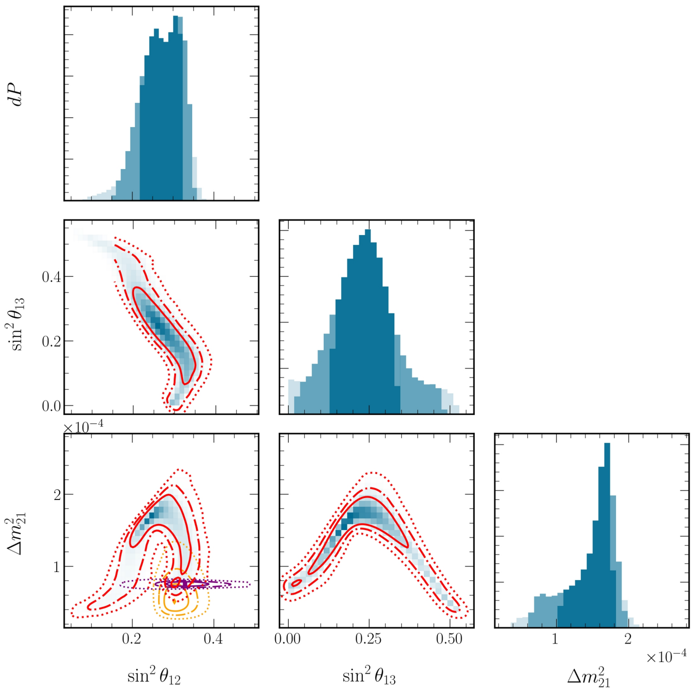
CC only: RC, with and without backgrounds

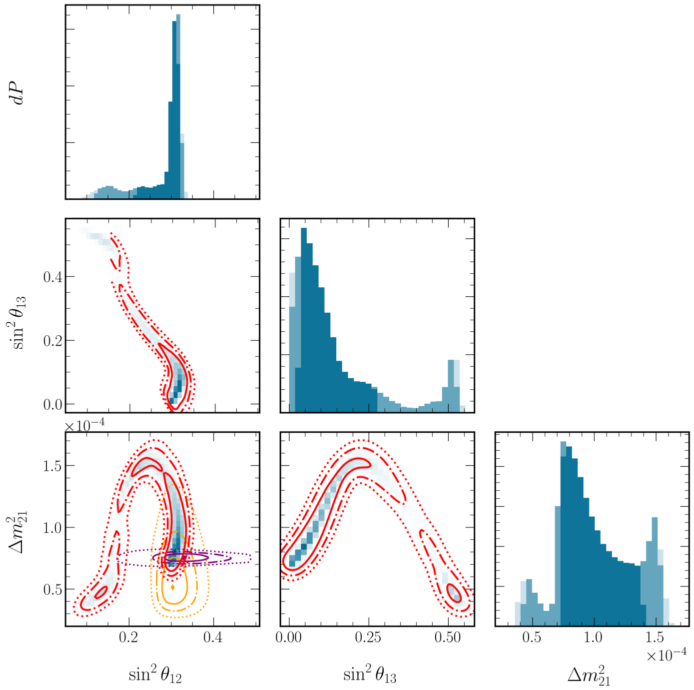




Corner plots

ES only: free, without and with directional reconstruction

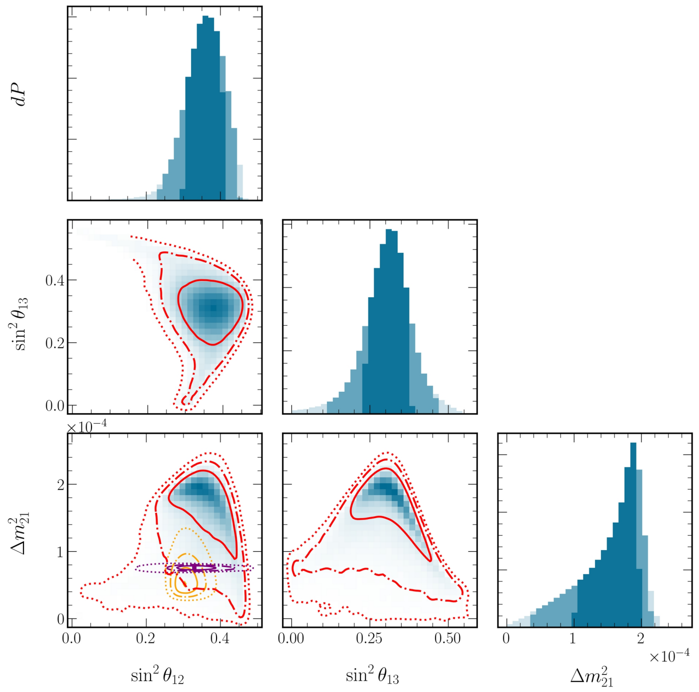


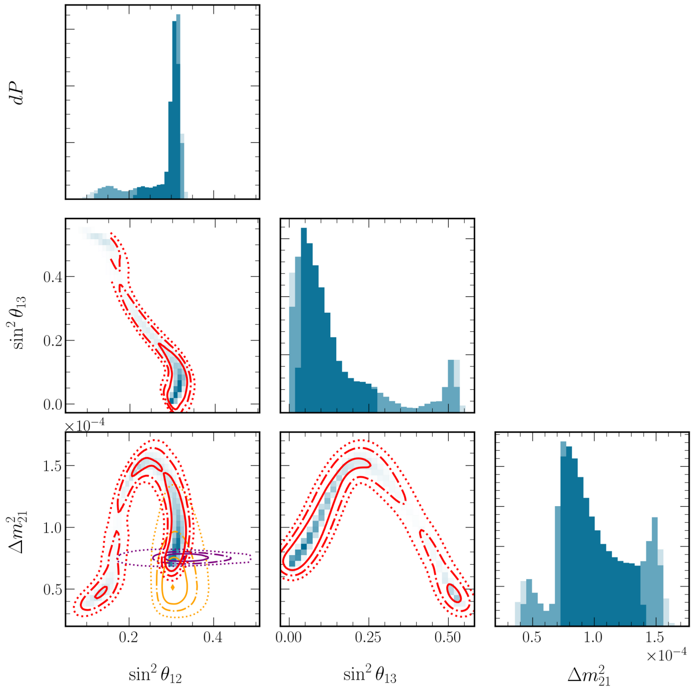


Andrés López Moreno

Corner plots

Contributions to the combined fit with directional reco: CC (left) and ES (right)





Corner plots

Combined fit with directional reco (left), ES contribution (right):