

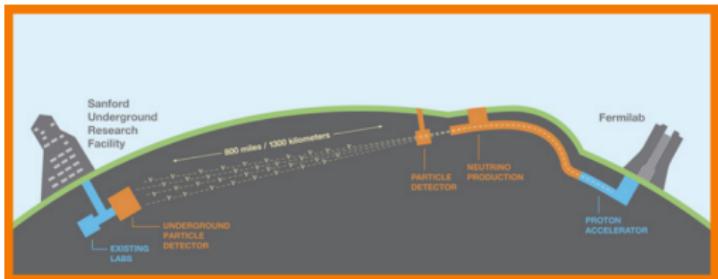


The DUNE experiment PRISM method for data-driven predictions

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Deep Underground Neutrino Experiment



The crucial goal is:

to study neutrino oscillations in
the three flavour paradigm of SM

The DUNE advantages:

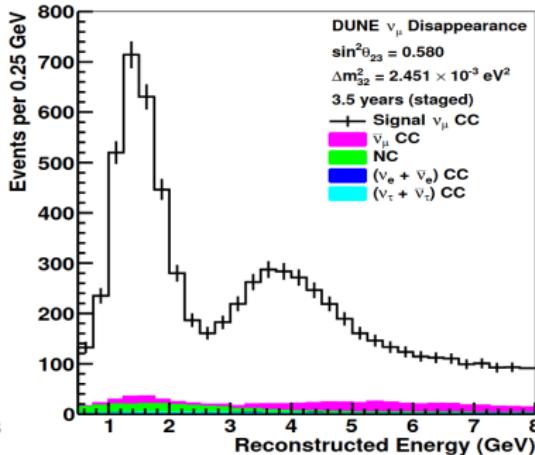
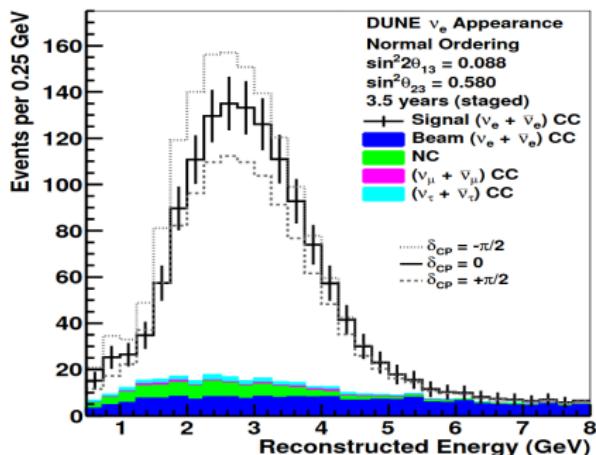
- two regimes: FHC, RHC
- a long baseline: ~ 1300 km
- energy range: 0.5 – 8 GeV
- a on-axis peak ~ 2.5 GeV
- fiducial mass: 40 kt
- 1.2 MW neutrino beam
- 1.1×10^{21} POT/year



high statistics:

10^8 ν_μ CC events/year
on the ND axis

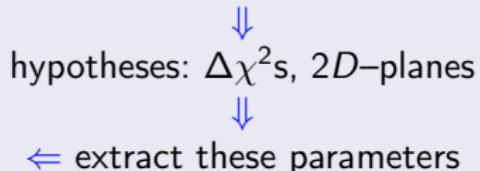
Oscillation parameters (Spectra observed at the FD)



Unknown parameters of oscillation:

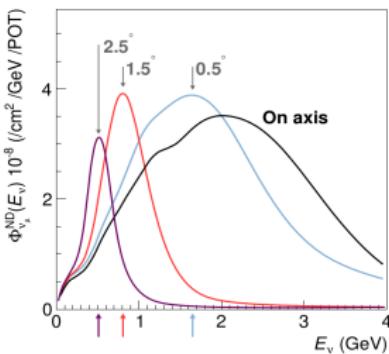
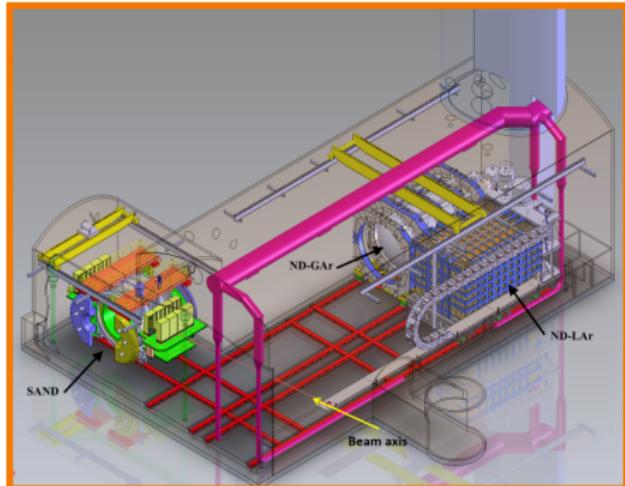
- a mass hierarchy: the sign of Δm_{32}^2
- CP-violation: the phase of δ_{CP}
 - the octant of θ_{23} angle

neutrino oscillation analysis



Any biases in these spectra can lead to wrong parameter values

The near detector complex of DUNE



Types of uncertainties:

- interaction
- detector
- flux

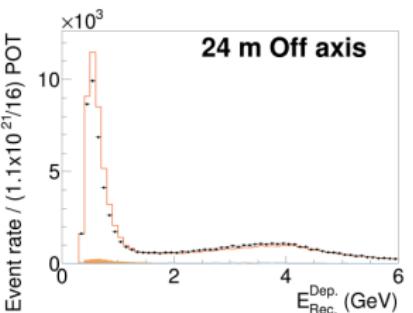
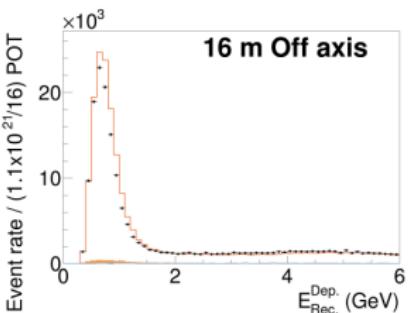
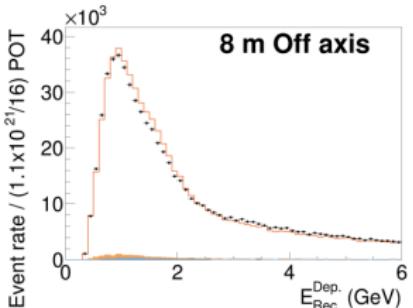
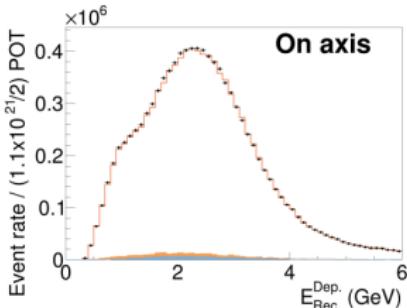
The wealth of the ND:

- ND LArTPC similar to FD one: to reduce systematic uncertainties connected with detector and nuclear effects
- movable LArTPC and GarTPC: to measure precisely ND spectra to predict FD spectra
- a solution to the problem of neutrino interaction modelling: to find biases in on-axis spectra by comparing to off-axis ones
- to predict wrong sign bkg in the RHC regime



to unfold exactly oscillation parameters

Reconstructed neutrino energy (Spectra observed at the ND)



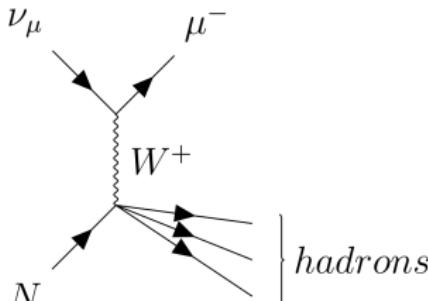
$$E_{\nu_\mu}^{\text{rec}} = E_{\mu}^{\text{true}} + E_p^{\text{dep}} + E_{\pi^\pm}^{\text{dep}} + E_{\pi^0}^{\text{dep}} + E_{\text{other}}^{\text{dep}} + \varepsilon,$$

– missing energy, misidentified particles

DUNE PRISM:

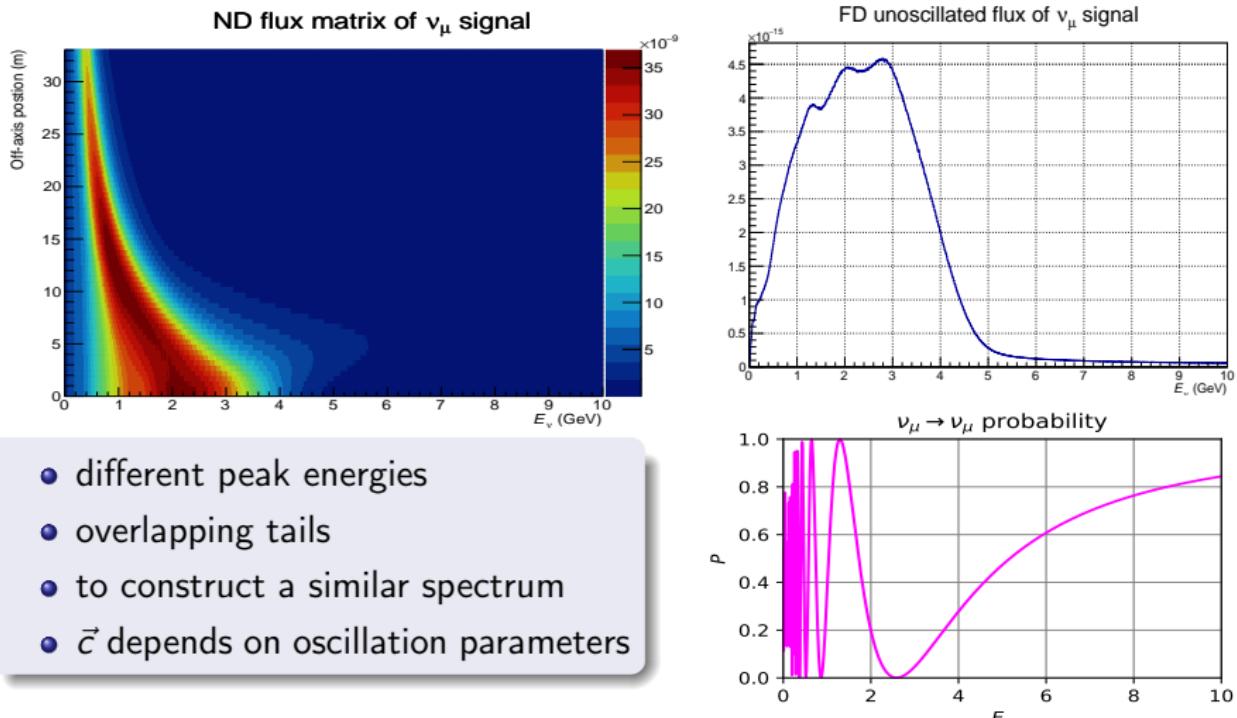
- Precision
- Reaction-
- Independent
- Spectrum
- Measurement

Neutrino interaction modelling

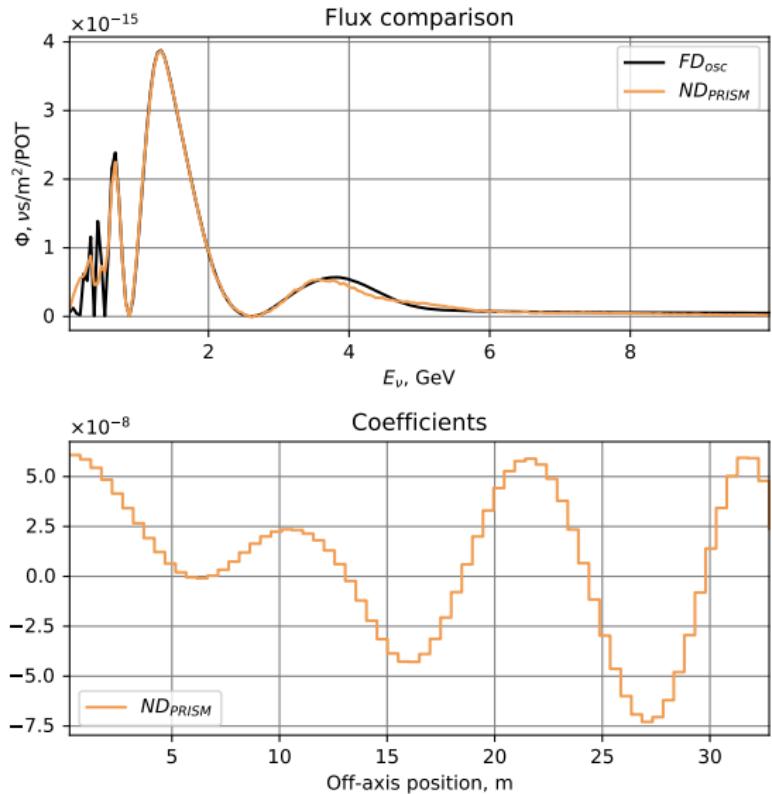


The linear combination of off-axis spectra: FHC regime (1)

$$\text{ND matrix} \cdot \vec{c} \text{ (osc. params)} = \vec{F} \text{ unosc} \cdot \vec{P}(\nu_\mu \rightarrow \nu_\mu) \Rightarrow \vec{c} \text{ (osc. params)}$$



The linear combination of off-axis spectra: FHC regime (2)



- FD_{osc} – an oscillated flux in the FD

- ND_{PRISM} – a predicted flux with ND off-axis measurements

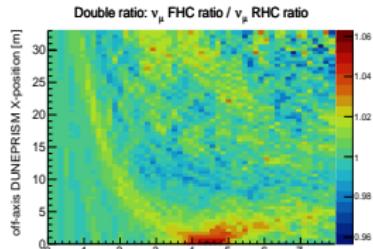
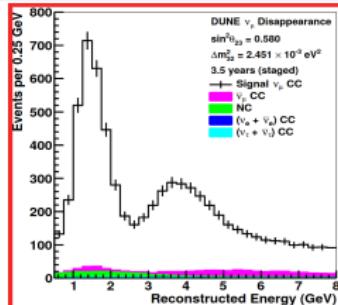
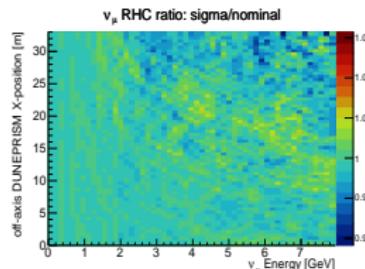
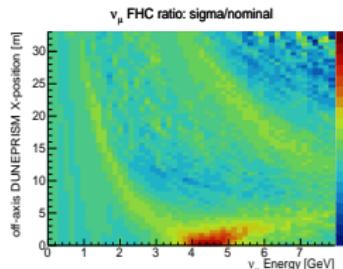


There is a powerful technique to find and control some systematic uncertainties



- this technique is sensitive to flux uncertainties:
 - hadron production
 - focusing
 - alignment

Study of a wrong sign background in the RHC mode



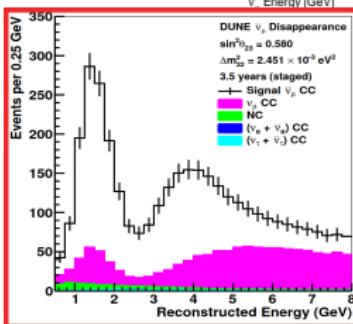
A horn current shift:

- a nominal flux: 300 kA
- a shifted flux: 303 kA

the PRISM method:

- predicted ν_μ background in the RHC
- linear combination of ν_μ signal in the FHC

- x – focusing uncertainties
- ? – hadron production
- ? – math these fluxes



Thank you
for your attention !

