Titolo
DUNE experiment for neutrino studies

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Fundamental Physics

Problems

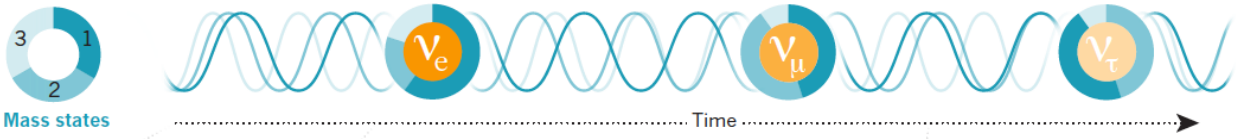
A possible solution:
specific studies with neutrinos

History of neutrinos was not so simple…

Although neutrinos are very abundant:

- Until 1998 nobody knew that neutrinos have masses and they could oscillate among them
- How do they oscillate?
- Mass states and Flavour states

LS, Rev. in Phys. 1 (2016) 90



A neutrino with flavor α can be expressed as a combination of mass states:

$$|\nu_\alpha >= \sum_{I=1}^{3} U_{\alpha i} |\nu_i >$$

Бруно Понтекорво

Pontecorvo, 1957

Standard Neutrino Oscillations

The recent Neutrino History

1998

1rst Annus Mirabilis

Oscillations :
- Observation by *SuperK* atm
- Reactor exclusion by *Chooz*

2002

2nd A. M.

3 x 3 matrix :
- Solar by *SNO*
- Reactor by *KAMLAND*

2012

3rd A. M.

θ_{13}:
- Reactor by *Daya Bay*, *RENO*, *Double Chooz*,
- *T2K* beam

20- ?

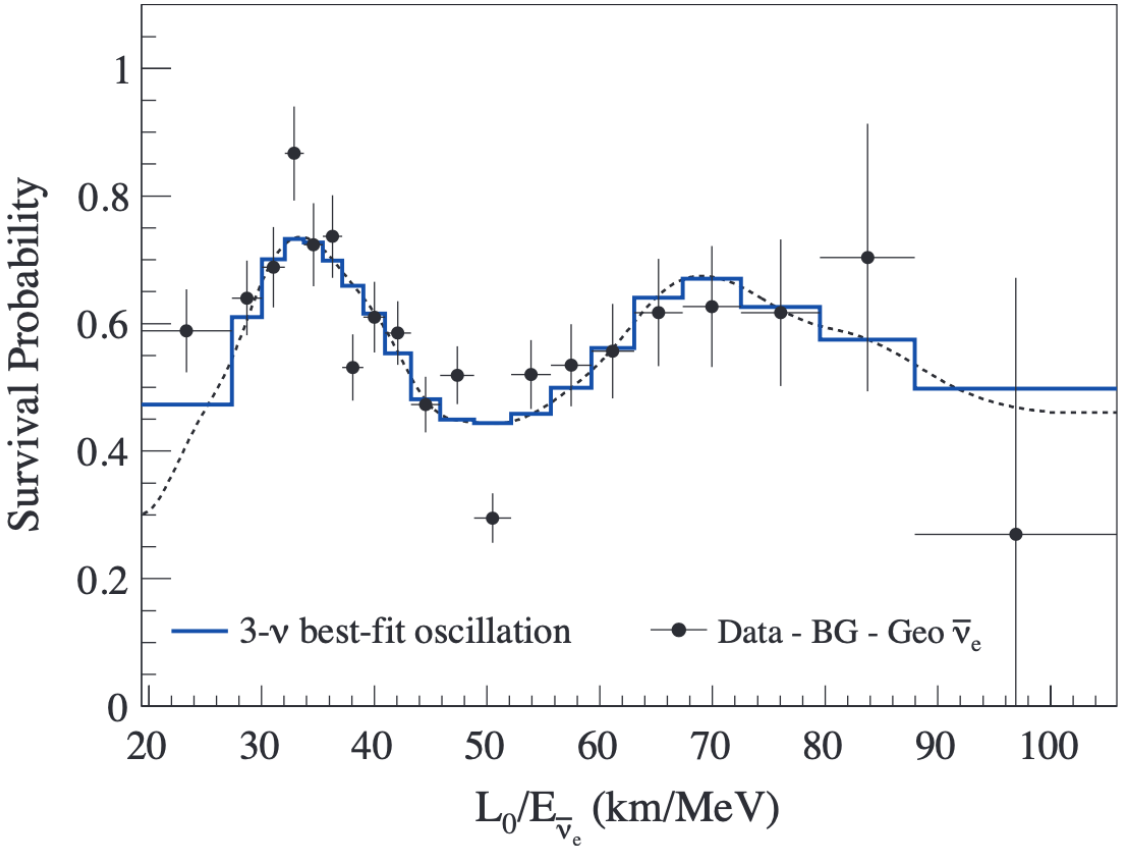
4th A. M. ?

- Hints for Mass Hierachy by *NOvA/T2K*
- CPV by *T2K*

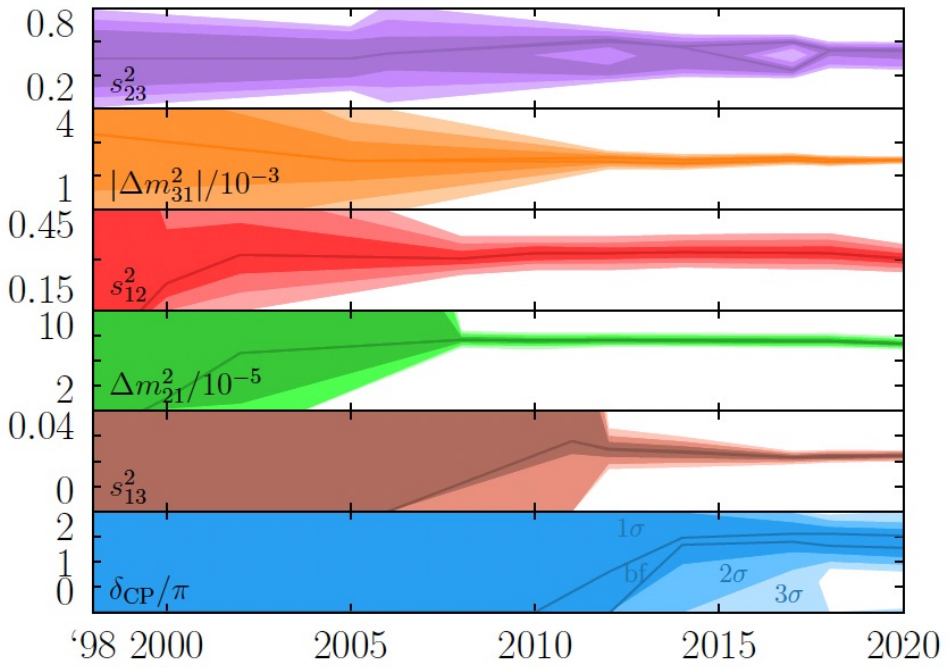
≥ 20- ? → δ_{CP} ?

Is it really true? Yes! They oscillate

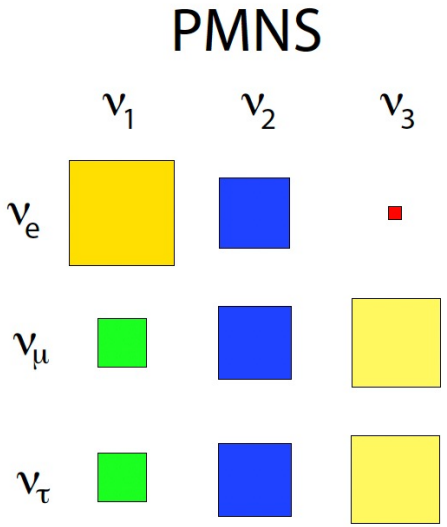
Survival probability of reactor antineutrino-electron (KAMLAND exp. 2013)



Impressive progress since 1998



	θ_{23}	θ_{13}	θ_{12}	δ
Leptons	$\sim 45°$	$8.5°$	$34°$	?
Quarks	$2.4°$	$0.20°$	$13°$	$69°$



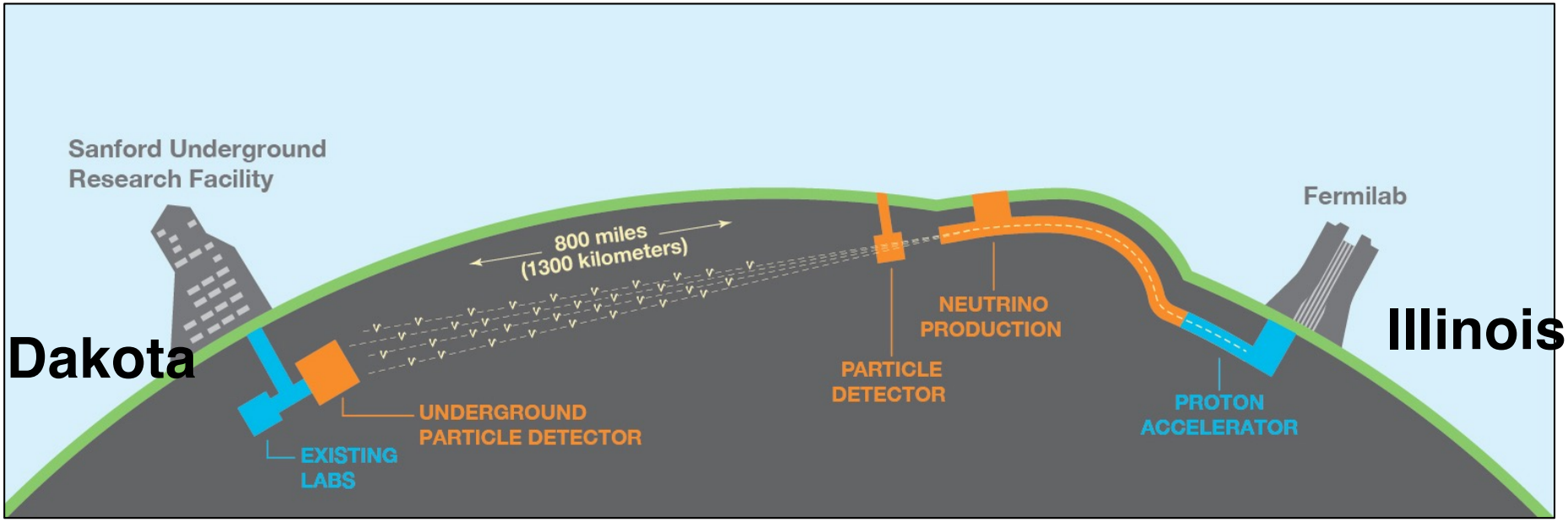
arXiv:1212.6374v2

The source of all joys and torments comes from this matrix

(together with the smallness of the cross-section)

Long-Baseline Neutrino Facility (LBNF) and Deep Underground Neutrino Experiment (DUNE)

S. Dakota

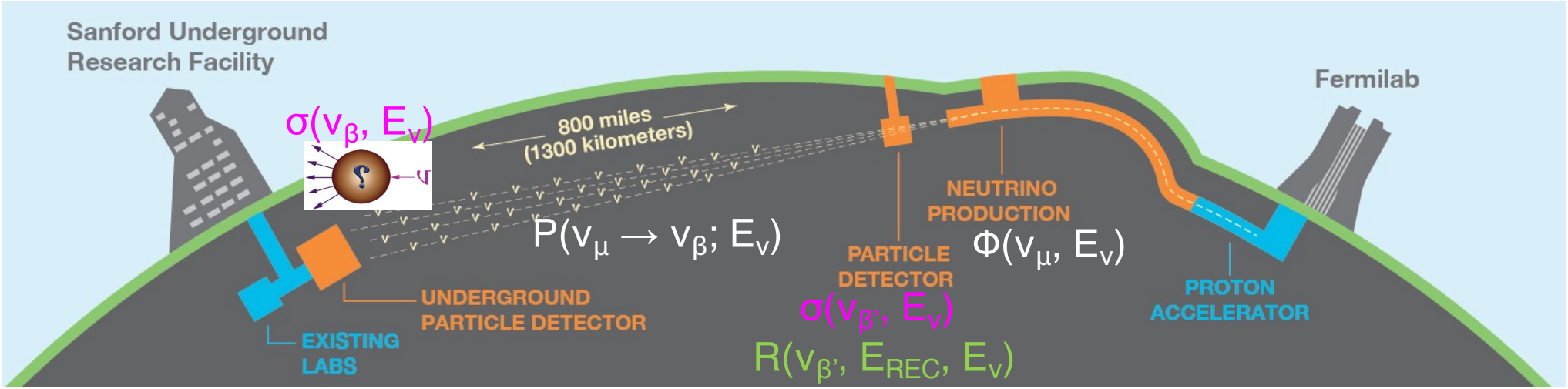


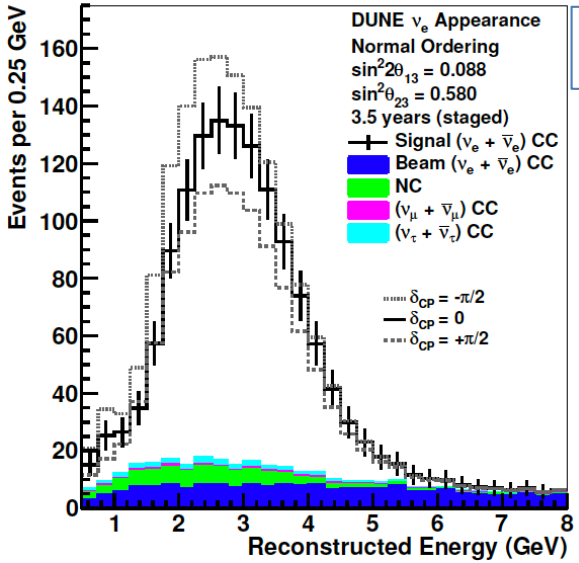
Illinois

The DUNE Experimental Design

- DUNE TDR (Vol I,III,IV https://iopscience.iop.org/journal/1748-0221/page/extraproc95, Vol II arxiv:2002.03005 for Physics)
- ND CDR (arXiv:2103.13910, Instrument 5 (2021) 4, 31)

Dune at work





ν_e appearance from ν_μ beam after 3.5 years (staged)

Need maximal control of prediction under PMNS parameters:
fluxes, cross-sections, detector responses

To maximize deconvolution of intrinsic degeneracies perform single measurements for as many as possible sources of systematics effects ☞ Near Detector complex

DUNE: Why, What, How?

Why DUNE?
What to measure?
How to measure it?

DUNE: best detector ever to access **all the neutrinos parameters in a single experiment**

DUNE will measure missing parameters of the 3 ν picture, with high precision the others, and sensitivity to SNB and BSM

With artificial beam from 1.2 to 2.4 MW proton beam and multi-kton Liquid-Argon detectors

Facts

- Possible activities for theses on every subject
  - hardware, electronics, DAQ,
  - software, Monte Carlo simulation, phenomenology

- Concurrence: HyperKamiokande, JUNO

- DUNE is an international Collaboration:
  Over 1700 scientists, from more than 209 Institutions, 38 countries plus CERN

Not exclusive list of theses

- Electromagnetic Calorimeter refurbishing test-modules (test of electronic signals for 4880 mesh-photomultipliers)
- Tracker design and test of prototype (drift chamber) in SAND-DUNE
- Reconstruction of neutrino interaction in Liquid Argon and a light tracker (end-to-end simulation and Kalman reconstruction)
- Electron identification from neutrino interactions in ECAL
- Neutron identification from neutrino interactions
- Cross-section measurements in Liquid Argon
- Sterile neutrinos with the ND-SAND detector in DUNE
- Beyond Standard Model in short-baseline neutrino beam

Contacts

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