

# NF01 Report Status

Snowmass

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# Three flavor oscillations

- ▶ Measuring the six oscillation parameters:  $\Delta m_{21}^2$ ,  $\Delta m_{31}^2$ ,  $\theta_{12}$ ,  $\theta_{13}$ ,  $\theta_{23}$ ,  $\delta_{\text{CP}}$ .
- ▶ What is needed to produce such neutrinos
  - ▶ Accelerator upgrades
- ▶ What is needed to detect such neutrinos
  - ▶ Energy & angular resolution
  - ▶ Particle identification
- ▶ Control systematics
  - ▶ Near detectors to measure flux and cross section
  - ▶ Connections of dedicated cross section measurements and calculations
  - ▶ Hadron production measurements for fluxes

# NF01 Scope: What It Isn't

- ▶ Neutrino mass generation, Majorana/Dirac, ... (NF05,TF11)
- ▶ New physics scenarios
  - ▶ Steriles (NF02)
  - ▶ Unitarity violation (NF03,TF11)
  - ▶ NSI (NF03,TF11)
  - ▶ ... (NF03,TF11)
- ▶ Reproduction of existing TDRs/CDRs
- ▶ Cross sections (NF06)
- ▶ Neutrino sources (NF04,NF09)
- ▶ Neutrino detectors (NF10)

# Strategy

- ▶ Organize experimental effort by facility
  - ▶ Show progress within facility
  - ▶ Continuity in systematics and accelerator progress
  - ▶ Facility contributions from the experiments (or us)
  - ▶ Roughly two pages for existing experiments, four pages for funded future experiments
- ▶ Also include:
  - ▶ Introduction
  - ▶ Theory overview
  - ▶ Theory inputs (cross sections, etc.)
  - ▶ Ancillary measurements
  - ▶ Possible upgrades
  - ▶ Other oscillation probes
  - ▶ Far future ideas

# Outline

## Contents

### 1 Introduction and Current Three-Flavor Status

- 1.1 Neutrino Oscillations in Particle Physics (Messier) . . . . .
- 1.2 Current Knowns and Known Unknowns in Neutrino Oscillations (Denton)
- 1.3 Neutrino oscillations and the Previous P5 (Tanaka) . . . . .

### 2 Three-Flavor Oscillation Theory (Denton)

- 2.1 Neutrino Oscillation Probabilities . . . . .
- 2.2 Matter Effect . . . . .
- 2.3 Role of Each Oscillation Parameter . . . . .
- 2.4 Neutrino Oscillation Sources . . . . .
  - 2.4.1 Solar . . . . .
  - 2.4.2 Reactor . . . . .
  - 2.4.3 Atmospheric . . . . .
  - 2.4.4 Accelerators . . . . .
- 2.5 Flavor Model Predictions . . . . .

### 3 Three-Flavor Neutrino Oscillation Facilities (current:2pg, future:4pg)

- 3.1 JUNO (Tanaka) . . . . .
- 3.2 Fermilab/SURF Program (Messier) . . . . .
- 3.3 J-PARC/Kamioka Program (Friend) . . . . .
- 3.4 South Pole (Taboada) . . . . .
- 3.5 KM3NeT (Coyle) . . . . .

### 4 Three Flavor Oscillation Supporting Program

- 4.1 Experiments (Friend) . . . . .
- 4.2 Theory (Denton) . . . . .

### 5 Possible Upgrades to Planned Experiments

- 5.1 Hyper-K (Friend) . . . . .
  - 5.1.1 ND . . . . .
  - 5.1.2 Detector in Korea . . . . .
  - 5.1.3 Accelerator Upgrades . . . . .
- 5.2 DUNE (Messier&Tanaka) . . . . .
  - 5.2.1 Realizing the P5 DUNE . . . . .
  - 5.2.2 Near detector . . . . .
  - 5.2.3 Third and Fourth Caverns . . . . .
  - 5.2.4 Accelerator Upgrades . . . . .

### 6 Other Oscillation Probes (Denton)

- 6.1 Galactic Supernova . . . . .
- 6.2 Astrophysical Neutrinos . . . . .

### 7 Possible Future Experiments (Tanaka)

- 7.1 ESSnuSB . . . . .
- 7.2 INO . . . . .
- 7.3 Neutrino Factory . . . . .
- 7.4 Beta beams . . . . .

### 8 Conclusions

# Community Input

in addition to right now

## Letters of Interest:

### 33 LoIs submitted to NF1

Nr	LOI PDF file	Date
1	<a href="#">CompF/SNOWMASS21-CompF2_CompF1-NF1_NF5-CF1_CF2-IF8_IF2_Monzani-085.pdf</a>	31/08/2020
2	<a href="#">CompF/SNOWMASS21-CompF3_CompF2-EF0_EF0-NF1_NF6_Kagan-129.pdf</a>	01/09/2020
3	<a href="#">CompF/SNOWMASS21-CompF3_CompF2-NF1_NF5-CF1_CF2-IF8_IF3_Monzani-084.pdf</a>	31/08/2020
4	<a href="#">NF/SNOWMASS21-NF1_NF0-205.pdf</a>	15/09/2020 <i>late</i>
5	<a href="#">NF/SNOWMASS21-NF1_NF0_DUNE-052.pdf</a>	30/08/2020
6	<a href="#">NF/SNOWMASS21-NF1_NF0_Ryan_Patterson-093.pdf</a>	31/08/2020
7	<a href="#">NF/SNOWMASS21-NF1_NF0_Tom_Stuttard-058.pdf</a>	31/08/2020
8	<a href="#">NF/SNOWMASS21-NF1_NF2_Dava_Bay-086.pdf</a>	08/08/2020
9	<a href="#">NF/SNOWMASS21-NF1_NF3-CompF3_CompF0_Aurisano-152.pdf</a>	31/08/2020
10	<a href="#">NF/SNOWMASS21-NF1_NF3-TF0_TF0_Peter_Denton-010.pdf</a>	18/08/2020
11	<a href="#">NF/SNOWMASS21-NF1_NF3_Jeremy_Wolcott-088.pdf</a>	31/08/2020
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24	<a href="#">NF/SNOWMASS21-NF2_NF1_Rosner-045.pdf</a>	30/08/2020
25	<a href="#">NF/SNOWMASS21-NF3_NF1-CF2_CF0-TF11_TF0_Pedro_Machado-203.pdf</a>	11/09/2020 <i>late</i>
26	<a href="#">NF/SNOWMASS21-NF3_NF1-CF7_CF0-TF11_TF8_Peter_Denton-023.pdf</a>	27/08/2020
27	<a href="#">NF/SNOWMASS21-NF3_NF1-EF9_EF0-RF4_RF6-CF1_CF3-TF11_TF9-AF5_AF0-195.pdf</a>	01/09/2020
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30	<a href="#">NF/SNOWMASS21-NF6_NF1-TF11_TF0_Kendall_Mahn-147.pdf</a>	31/08/2020
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32	<a href="#">NF/SNOWMASS21-NF6_NF1_Mayly_Sanchez-139.pdf</a>	31/08/2020
33	<a href="#">NF/SNOWMASS21-NF7_NF1-IF2_IF9_Adam_Bernstein-099.pdf</a>	31/08/2020

[snowmass21.org/neutrino/oscillations/start](https://snowmass21.org/neutrino/oscillations/start)