



# Neutrino Generator Tools Workshop Overview

Laura Fields, NDNN 2021

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# A Workshop Talk About a Workshop!

**The Neutrino Generator Tools Workshop was held at Fermilab last January, shortly before the world shut down.**

**It was jointly organized by me, Minerba Betancourt, and Kevin McFarland**

**Attended by experiments, theorists, and generator authors (GENIE, NuWro, NEUT, and GiBuu)**

## Generator Tools Workshop

8-10 January 2020  
Fermilab  
US/Central timezone

Overview

Timetable

Registration

Participant List

Lodging

Support

Fermilab Statement of  
Community Standards

The goal of this workshop is bring together to neutrino experimentalists, theorists, and event generator developers to agree on a plan for implementing several tools aimed at providing easier access by experiments to various generators and easing the process of getting new models into generators. This follows earlier discussions on these topics, most recently at the ECT\* workshop in Trento Italy on "Testing and Improving Models of Neutrino Nucleus Interactions in Generators" held in June 2019.

The topics of the workshop will be:

1. A common input format for flux and geometry
2. A common generator output format
3. A common flux and geometry driver
4. Separation of hard scattering from FSI in generators
5. A model interface for adding models to each generators

<https://indico.fnal.gov/event/22294/>

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# Organization of This Talk

I'll give a general overview of the workshop, then Minerba and Luke will take over and talk about the resulting workplan in more detail, including progress since the workshop

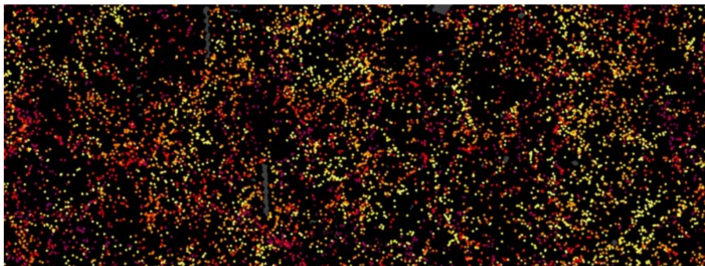


See also the talk by Chris Backhouse later today on the GENIE Event Library Generator Interface

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# Earlier Workshops!

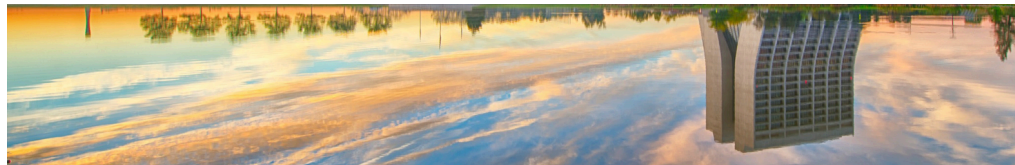
TESTING AND IMPROVING  
MODELS OF NEUTRINO NUCLEUS  
INTERACTIONS IN GENERATORS



03 June 2019 — 07 June 2019

**ECT\* - Villa Tambosi**

Strada delle Tabarelle, 286  
Trento - Italy



## Generators as "Platforms"

Gabriel Perdue // @gnperdue

Fermi National Accelerator Laboratory // @Fermilab  
ECT, Trento, July 2018

The Neutrino Generator Tools workshop at Fermilab aimed to push forward ideas discussed earlier at summer workshops held in Trento, Italy

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# Conclusions from Trento

- Needs for increasing sophistication in generators have been clear for a long time, but increasingly urgent with T2K and NOvA data, and design studies for DUNE and Hyper-K.
- Experiments would benefit from faster access to new theoretical models.
- Experiments would benefit from using a generator framework to more effectively “share” each other’s work.
- The model at hadron colliders uses factorization of components to allow many groups to develop independently, but still results in an integrated product.
  - This model is not perfect, but it has some advantages over ours.
  - We have different “factorization” in neutrino interaction models, but can still use the concept
- Key Trento conclusion: pursue separation of components of generators

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# Ideas for Separable Components

1. An accord on a common event format for all generators
2. Support FSI in a “second stage”, separate from initial scattering
3. Common flux and geometry driver
4. Universal theory “API” in generators
5. More speculative/difficult ideas
  - Separation of initial state and hard scattering
  - Common reweighting engines
  - Common tuning infrastructure or project for models

**Focus of the Fermilab workshop was on Items 1-4**

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# Structure of Workshop

- Reports from GENIE, NEUT, NuWro, GiBUU
- Topics (with significant discussion time)
  - Flux and geometry
  - Event format
  - Factorizing FSI from hard scattering
  - Theory API
- Summary and development of a work plan



**Generator authors were asked to address:**

- **Give an overview of your flux/geometry driver functionality and input format**
- **Review the output formats of your generator**
- **Are there any structural problems that would be needed to solved to use a common flux/ geometry driver**
- **Are ISI and FSI done at separate stages in your generator. If not, why not? How difficult, mechanically, would this factorization be?**

**Special thanks to Cheryl Patrick, Jeremy Wolcott, and Clarence Wret who wrote excellent summaries**

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# Goals of the Workshop

## Next steps

- Documentation
  - We will use the discussions and summaries at the meeting as a springboard for writing an outcomes document from this workshop.
  - That document will include a first draft of a work plan based on discussions here.
    - That plan can be refined (offline) in the document when it is circulated for review. Don't be shy in helping to improve the output of this meeting.
- First work towards realizing the plan
  - We hope to leave with a set of action items for interested individuals and generators developers.
- Collaboration
  - As that work progresses, we will want to stay in touch. Remote, periodic meetings on focused topics seem desirable.
  - When ready and needed, another global meeting like this one.

**We actually did  
(almost all) of this —  
take that COVID!**

**Tentatively planning  
another 'global' (and  
virtual) workshop this  
summer**



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# Documentation

## Summary of Workshop on Common Neutrino Event Generator Tools

Josh Barrow<sup>1</sup>, Minerba Betancourt<sup>2</sup>, Linda Cremonesi<sup>3</sup>, Steve Dytman<sup>4</sup>,  
Laura Fields<sup>2</sup>, Hugh Gallagher<sup>5</sup>, Steven Gardiner<sup>2</sup>, Walter Giele<sup>2</sup>, Robert  
Hatcher<sup>2</sup>, Joshua Isaacson<sup>2</sup>, Teppei Katori<sup>6</sup>, Pedro Machado<sup>2</sup>, Kendall  
Mahn<sup>7</sup>, Kevin McFarland<sup>8</sup>, Vishvas Pandey<sup>9</sup>, Afroditi Papadopoulou<sup>10</sup>,  
Cheryl Patrick<sup>11</sup>, Gil Paz<sup>12</sup>, Luke Pickering<sup>7</sup>, Noemi Rocco<sup>2,13</sup>, Jan  
Sobczyk<sup>14</sup>, Jeremy Wolcott<sup>5</sup>, and Clarence Wret<sup>8</sup>

[arXiv:2008.06566](https://arxiv.org/abs/2008.06566)

- The workshop is documented in a white paper on the arXiv
- Many thanks to all who contributed to it
- It includes:
  - A summary of the workshop talks + discussion
  - A workplan

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# Working groups

- A key part of the work plan was the formation of working groups to push forward the common generator interfaces discussed at the workshop
- The workshop organizers charged three working groups
  - Theory Interface
    - This was absorbed into the joint theory-experiment working group at Fermilab, led by Minerba Betancourt, Josh Isaacson, and Steven Gardiner
  - Output format + Separation of Primary + Final State Interactions
    - New group led by Josh Isaacson and Clarence Wret
  - Flux + Geometry Driver
    - New group led by Luke Pickering, Hugh Gallagher and Yoshinari Hayato
- The workshop organizers continue to have periodic meetings with the working group leaders

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# Final Notes

- Minerba and Luke will tell you more about the activities of the working groups, but a few more organizational details
  - We are planning a follow-up virtual workshop in the summer to see progress from the working groups and plan next steps
    - All are welcome
  - A key question will be support
    - Right now this is being done by proponents in their 'free time'
    - Also the possibility of a multi-institution proposal
  - If you are interested in getting involved, contact the relevant working group leaders. The workshop organizers are also more than happy to talk with you