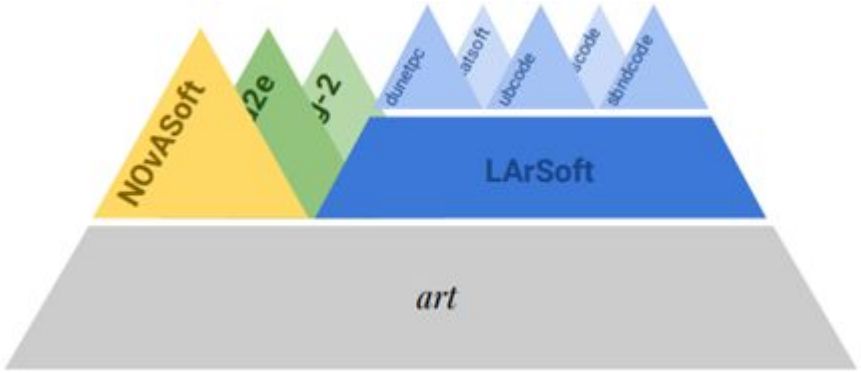
# Frameworks Workshop: NOvA



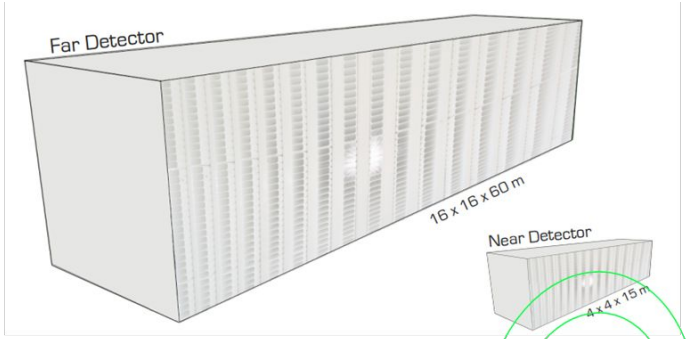

June 06, 2023

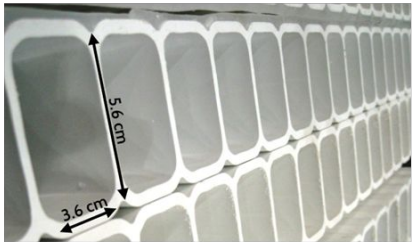
Alex Booth
NOvA art representative

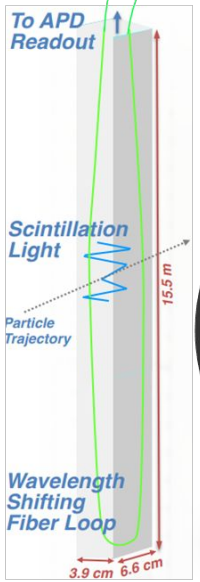
**Gavin Davies**
NOvA Computing Coordinator

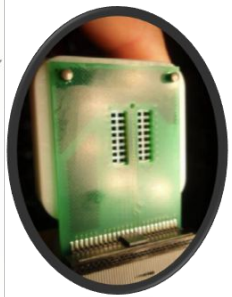
# NOvA

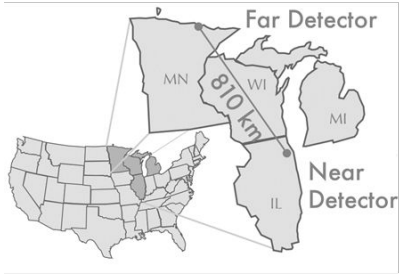
- ★ Long-baseline neutrino oscillation experiment
  - High power/high purity neutrino and antineutrino beams from Fermilab's NuMI facility
  - At 14 mrad off-axis, energy peaked at 2 GeV
  - 2 functionally identical detectors separated by 810 km
    - ND on-site at Fermilab
    - FD in Ash River, Minnesota
- ★ NOvA addresses many compelling questions surrounding the nature of neutrino mass
  - What is the Neutrino Mass Hierarchy?
  - Is there CP symmetry violation in neutrinos?
  - Is there more to it than 3 x 3 PMNS

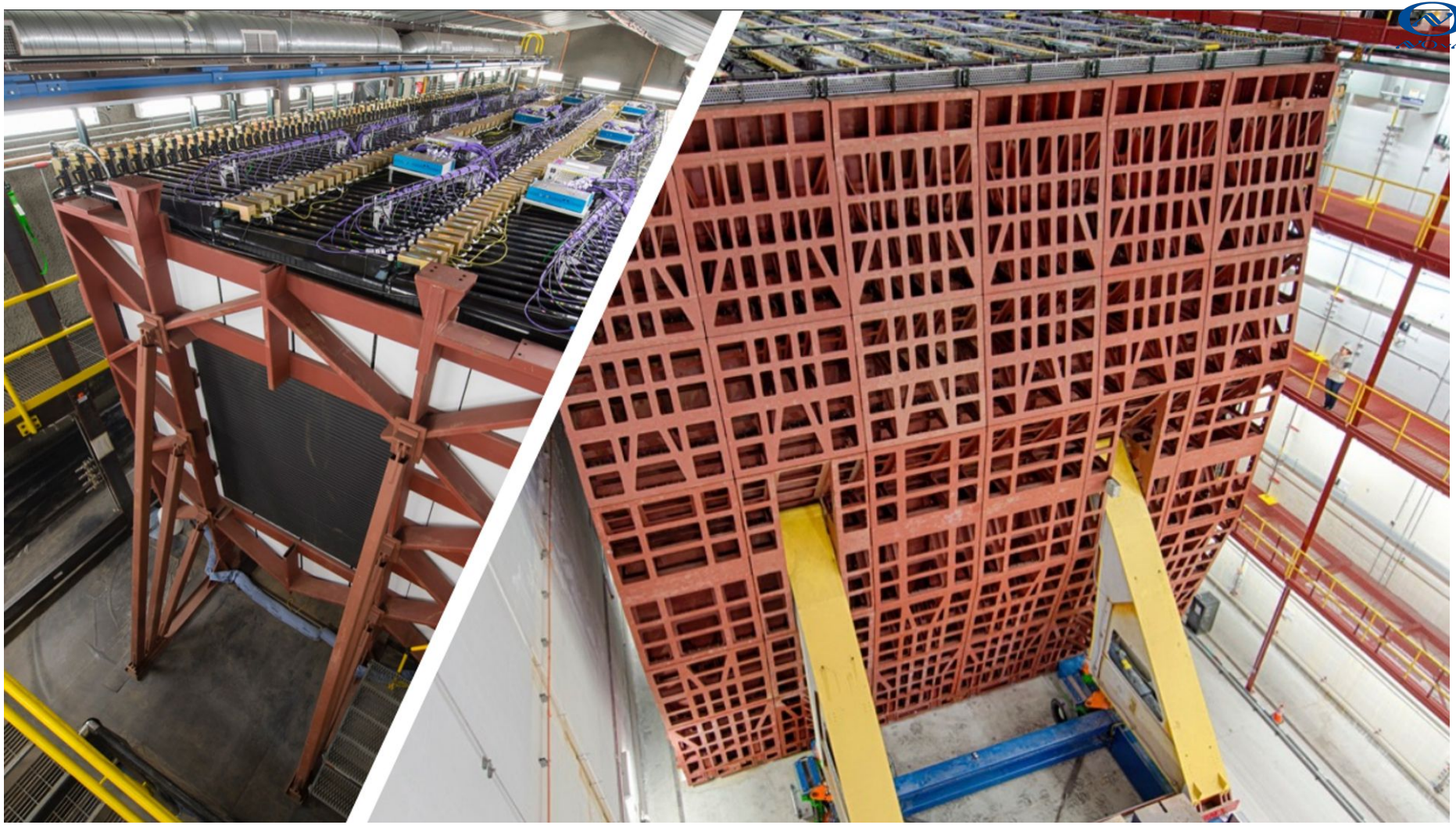


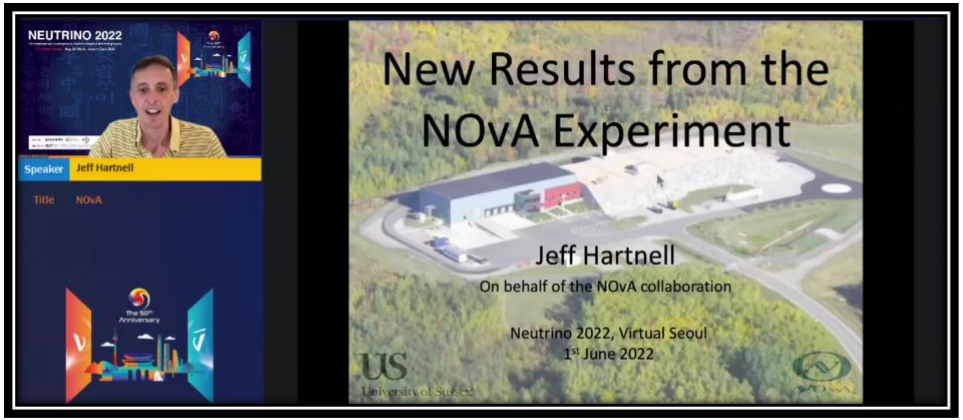




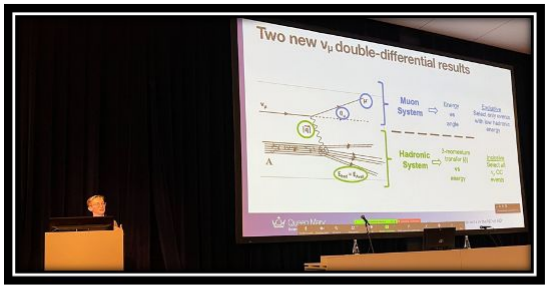
# NOvA

- ➔ Stage of Life
  - ◆ NOvA run is constrained by LBNF long shutdown
    - Our run has an anticipated end date of the end of 2026
- ➔ Total PhD count up to 60 now
- ➔ In terms of software development and upgrades a cost-benefit analysis is increasingly important. Absorbing large changes too painful.

# NOvA @ Neutrino 2022 and ICHEP 2022




J.Hartnell (Sussex): Neutrino 2022
"*New Results from the NOvA Experiment*"




L. Cremonesi (QMUL): ICHEP 2022
"*Neutrino scattering measurements at NOvA*"

https://agenda.infn.it/event/28874/contributions/169658/

G. Davies (U. Mississippi): ICHEP 2022
"*Measurement of Standard and Non-standard Oscillations at NOvA*"

https://agenda.infn.it/event/28874/contributions/169624/

Significant NOvA data-theory discrepancies in scattering measurements

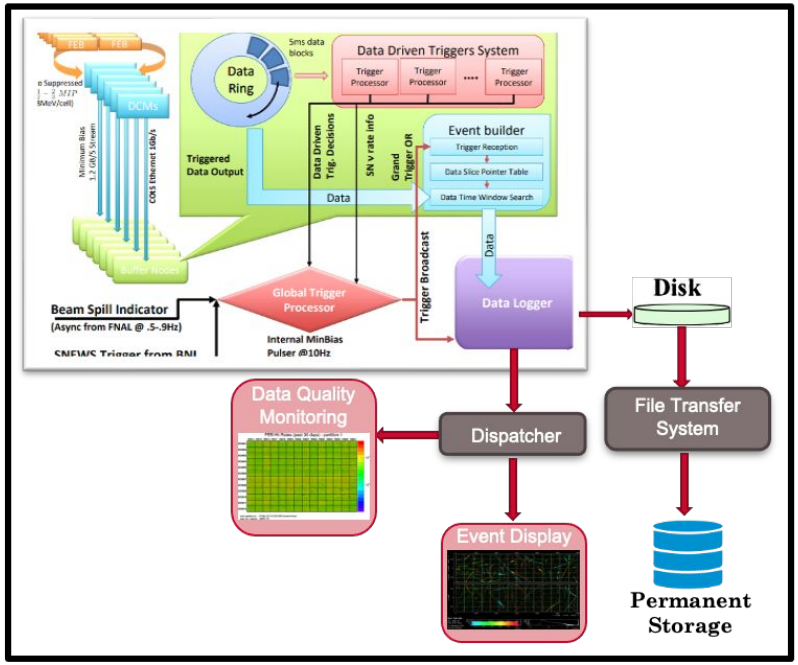
PMNS oscillation model holding up to increased scrutiny

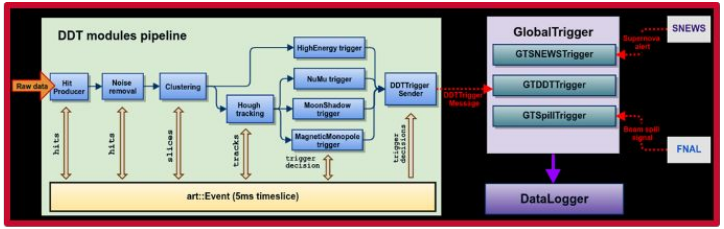
- No sign of sterile neutrino
- NSI do not improve description of data
- Good agreement with other PMNS measurements (T2K; reactors)

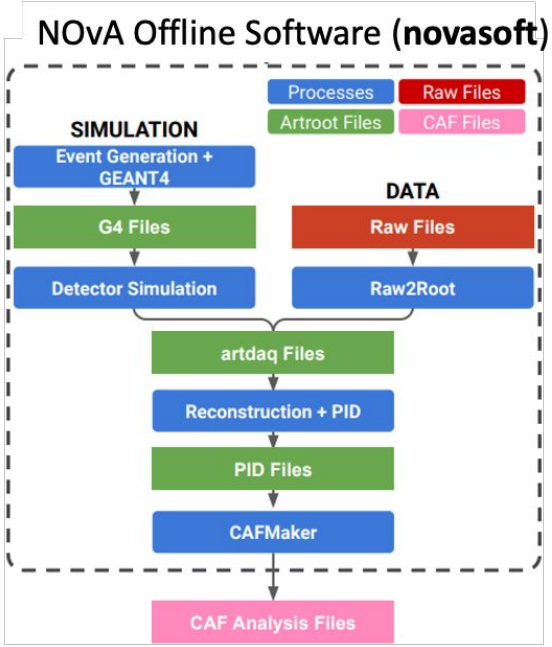
Plethora of new NOvA results around the corner!

- About 50% of expected data collection still to come

# NOvA Framework




NOvA ensemble is three main systems:

NOvA Data Acquisition (**novadaq**)
NOvA Data Driven Triggers (**novaddt**)
NOvA Offline Software (**novasoft**)

All built around **art** framework

# NOvA Offline Software

- *novasoft* **art** instance used for simulation, calibration, reconstruction, particle identification - hosted on github repository
  - `main` always builds. Individuals work on branches. Use of pull requests (PR) is mandatory.
  - Codeowners philosophy assign individuals to various parts of the codebase.
    - If a PR touches one's package a review from individuals(s) is requested in order to approve the PR.
- Novasoft builds handled by Software Release Tools (SRT) [1], unix based software management system (NOvA also supports a CMake / mrb build system).
  - Uses a "test release" philosophy; just have the one or two packages in working area.
  - GNUmakefiles handle building against full software stack and shared libraries.
    - Have to be careful about circular dependencies.
  - Partial, sparse clone for github cloning of repository in tandem with Git LFS.
- All release of novasoft hosted as an OSC CernVM File System (cvmfs) repository.
- External products (ROOT, art etc) access via Fermilab-developed Unix Product Support (UPS) and Unix Product Distribution (UPD).
  - Supports multiple versions of a product and build-types per version.

[1] J. Amundson, CHEP 2000: https://inspirehep.net/literature/538395

# User Feedback

➔ "The most annoying thing that I have personally encountered is not being able to create associations between the same type of product. Like, you can't have an association between two clusters with different labels".

➔ **Documentation, documentation, documentation.**

- Exit codes not explained.
- Workbook is very out of date.
- Best practises for, for example, using associations are not spelled out anywhere (difficult to find if they are).

# User Feedback

- ➔ **Example, examples, examples.**
- ➔ An updated "toy experiment" code base (which would go a long way to addressing the previous two bullets).

- ➔ The ability to dynamically reload a job fcl (which would also reload the configuration fcls) and *reprocess* an art event.
  - ◆ Would allow having an event display where a "job can be executed" and observe the change in reco (or truth) objects that are drawn.
- ➔ Streamlining data access patterns (through wrappers perhaps?). There are many layers of associations, handles etc, increases the threshold of entry.

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# Thank you!


http://novaexperiment.fnal.gov