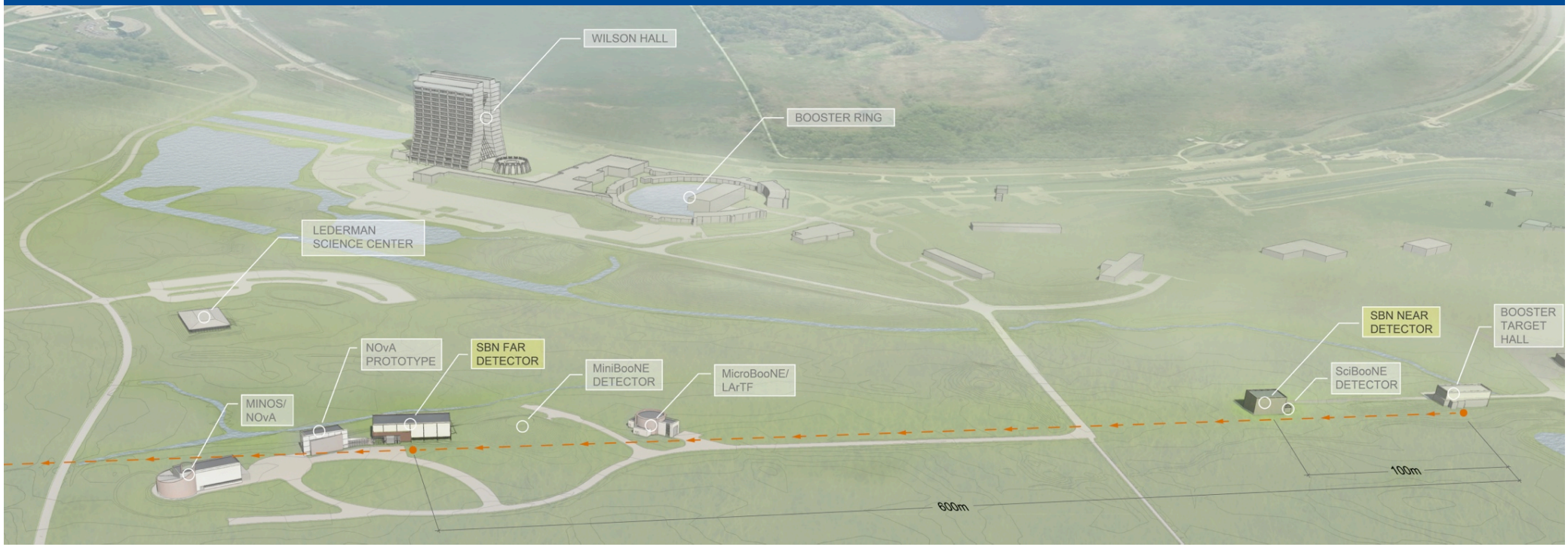


SBN Working Groups

SBN Oversight Board Meeting

March 12th, 2021

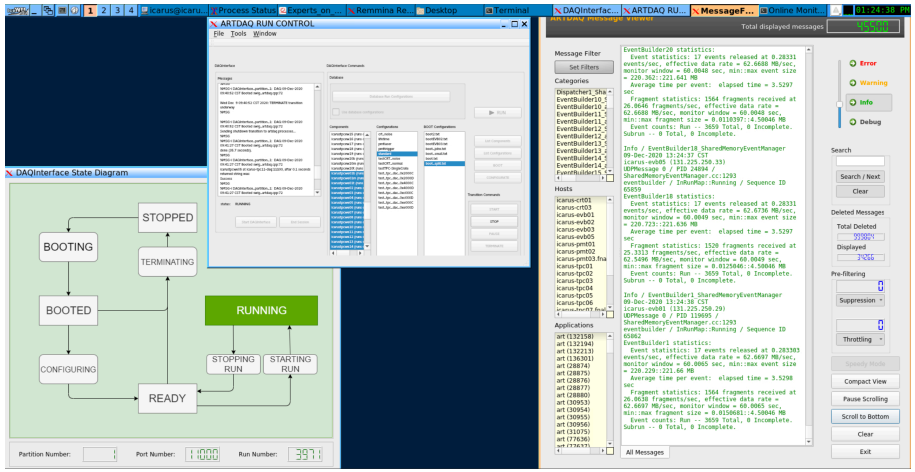
Ornella Palamara

SBN Working Groups

- SBN DAQ and Data Pre-Processing *[conveners: Bill Badgett, Angela Fava, Wes Ketchum, Yun-Tse Tsai]*
  - *Goal*: Develop common tools for **trigger, data acquisition and data pre-processing**, and coordinate activities in those areas.
- SBN Slow Controls *[convener: Geoff Savage]*
  - *Goal*: Develop **control systems** based on **hardware and software interfaces** as much as possible identical for the two detectors.
- SBN Cosmic Ray Tagger *[conveners: Umut Kose, Igor Kreslo, Minerba Betacourt]*
  - *Goal*: Review the **CRT production status and the installation plans** for the two detectors, develop common CRT **DAQ and monitoring.**
- SBN Analysis Infrastructure *[conveners: Wes Ketchum, Joseph Zennamo]*
  - *Goal:* Coordinate and address **data and software infrastructure** and **computing resource needs** across the SBN
- SBN Analysis *[conveners: Daniele Gibin, Ornella Palamara]*
  - *Goal:* Take care of all the aspects of the multi-detector physics analysis for **SBN sterile neutrino oscillation searches**

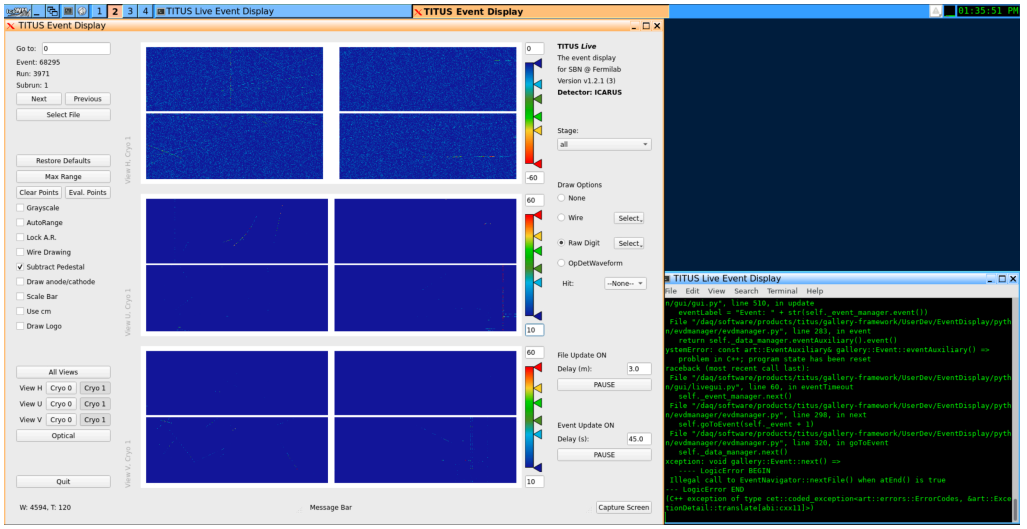
SBN DAQ and Data Pre-processing WG

- ICARUS Detector Commissioning
  - See ICARUS status update by Angela Fava
- SBN common efforts critical for ICARUS success
  - ex: Run Control, online monitoring being developed together with SBND collaborators



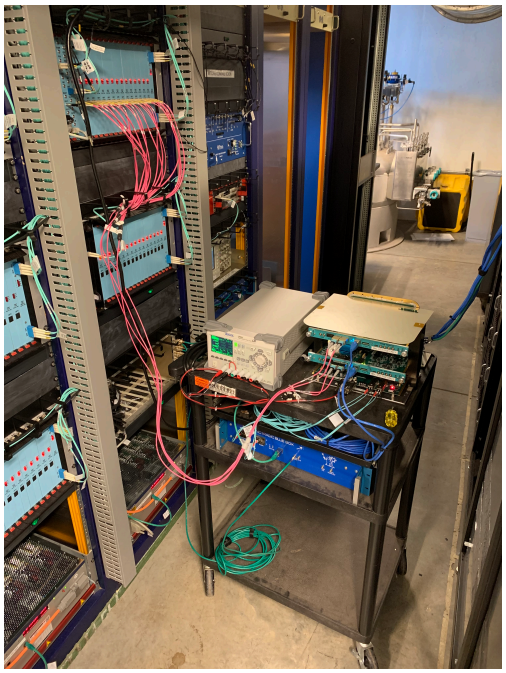
Run Control

Live Event Display



SBN DAQ and Data Pre-processing WG

- SBND developments
  - TPC readout reception tests at SBN-ND complete
  - Expect deliver of PMT readout electronics and power supplies in March from LANL
    - Preparing PMT electronics rack on SBN-ND mezzanine for their arrival
    - Configuring servers and installing server readout electronics for PMT DAQ
  - Integrating White Rabbit Timing System into DAQ readout
  - Designing detector top cables trays for all systems

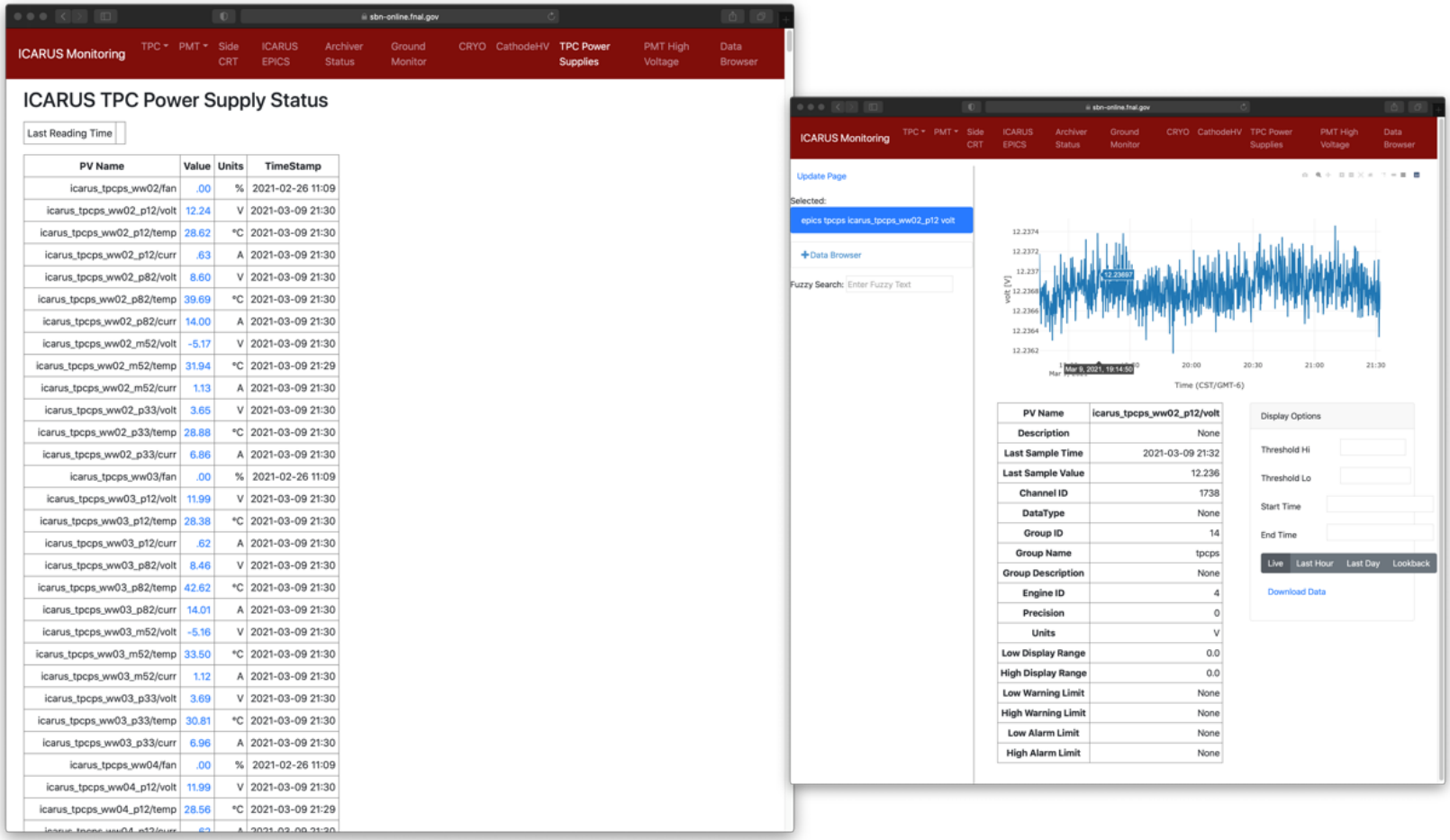


Test Stand
(ND building)

SBN Slow Controls WG

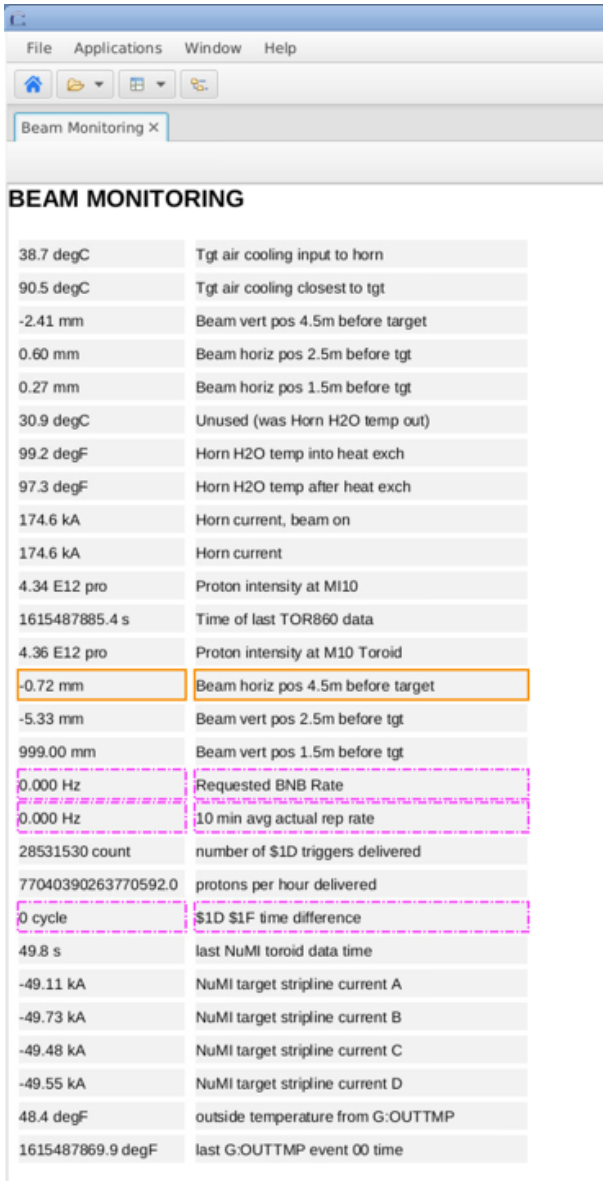
ICARUS

- Web-based displays expanded (common effort)
  - First pass for PMT and TPC web displays ready (the goal is to imitate protoDUNE monitoring)



SBN Slow Controls WG

- Beam Monitoring (common effort)

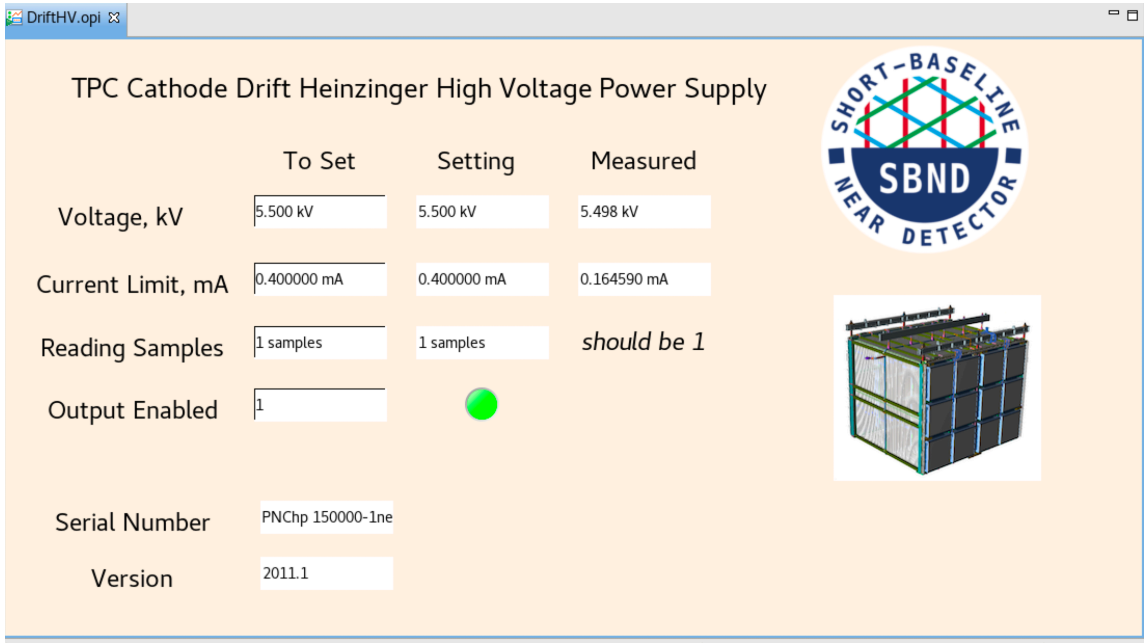


SBN Slow Controls WG

❑ SBND

- ❑ EPICS controller and Monitoring GUI has been written for cathode **drift High Voltage** power supply (Heinzinger)

Drift HV power supply Control



Power supply

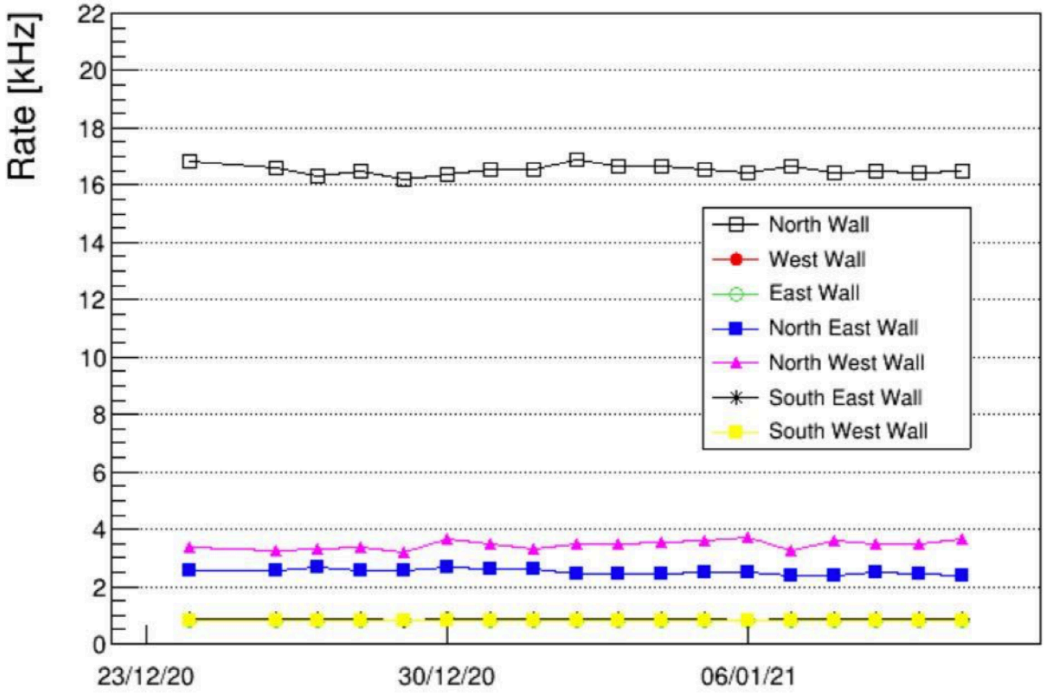
- Interface fully implemented, functional, tested
- Ready for reception tests of production SBND power drift power supply

SBN Cosmic Ray tagger WG

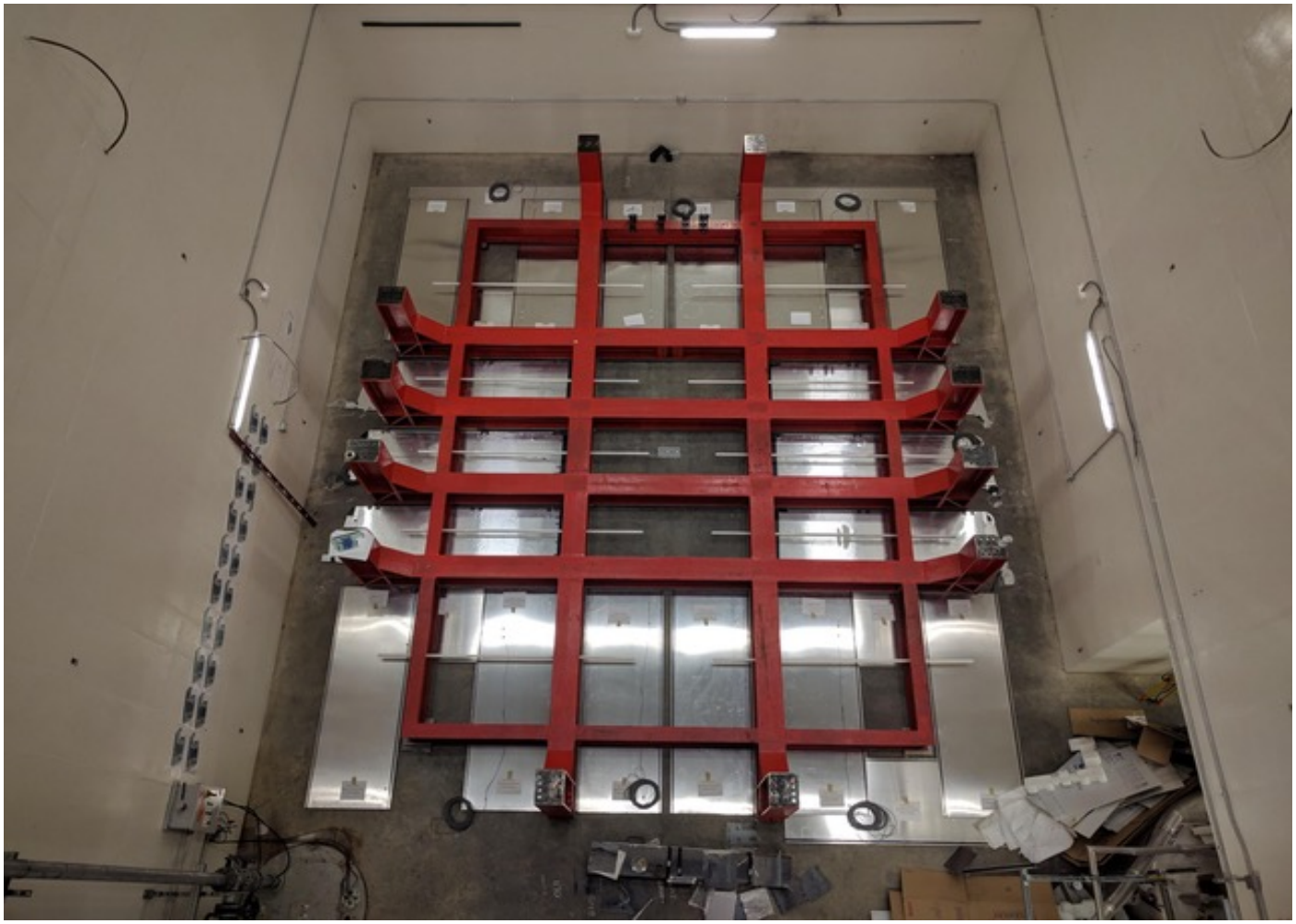
- ICARUS
  - Four sides of the ICARUS detector have been covered with the CRT modules
    - Last side (South) installed in February 2021
      - Electronics and cable installation in progress
  - Six CRT walls installed during the pandemic!
  - Top CRT:
    - All modules of the top CRT are in transit to FNAL
    - Vertical support structures are planned to be installed in February 2021
    - The work for the horizontal plane installation will begin once the supports are in place, currently expected in Summer 2021

SBN Cosmic Ray tagger WG

- Commissioning of the side CRT in progress
  - CRT data taking integrated to the standard DAQ
  - High rates in some CRT components (generally near the cryogenics), investigations ongoing



SBND: **CRT Bottom layer installed** (Sept. 2019)



SBN Analysis Infrastructure WG

When the SBN Analysis Infrastructure group was formed it was anticipated there would need sub-groups

After the production used for the PAC analyses it was clear what was needed to make progress

Roles

SBN Release Manager; Maintain high-quality releases of SBN-specific software packages

Validation Czar; Implementation and maintenance of an integrated validation platform to enable high performing and well-validated code.

Workflow Manager; Development and maintenance of standard workflows (conventional and HPC) within the SBN.

Groups

Analysis Framework Manager; Develop and maintain a framework capable of supporting complete analyses across the SBN physics program.

Simulation Infrastructure; Developing and maintaining the consistent configuration of neutrino production, neutrino and particle interactions, and detector modeling across the SBN.

Production and Data Management; Work with Fermilab SCD and SBN collaboration to maintain workflows & data-management and access

SBN Analysis Infrastructure WG

Recent Activities

Common Analysis Files

Small size files that could be used for complete analyses. They are modeled after files used by NOvA and DUNE. These files would be centrally produced by the SBN Production team.

Production Database

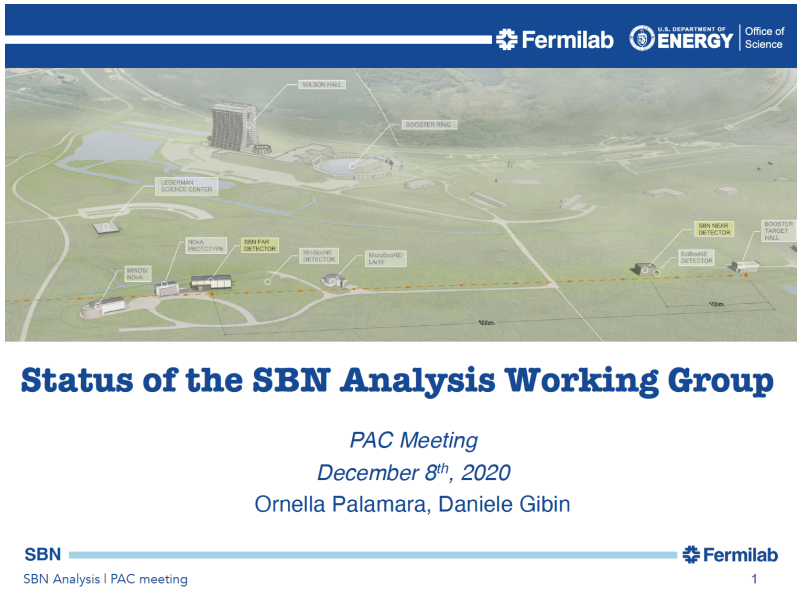
Building a database to accurately track production requests, their configurations, run tests of these requests, and automatically produce grid configurations for these requests. It would also automatically track the completeness of each request and list the location of files produced.

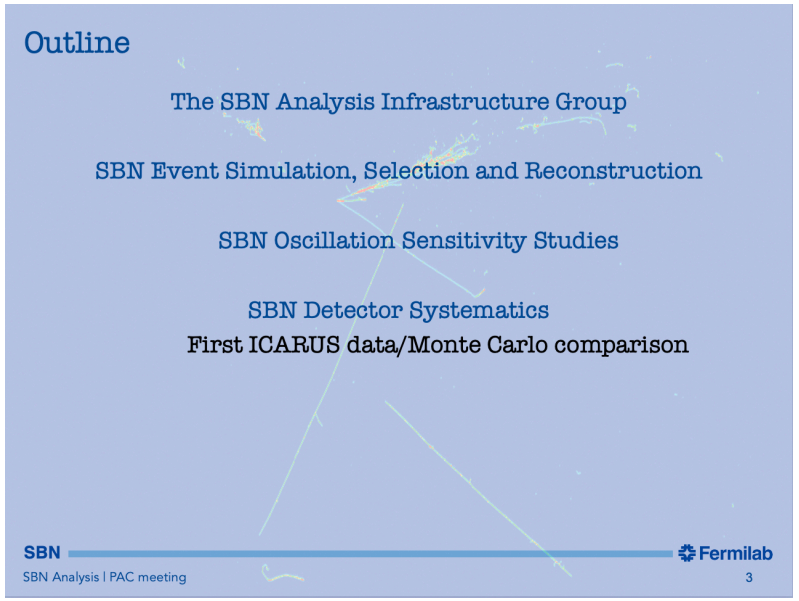
Studies into Reducing File Size

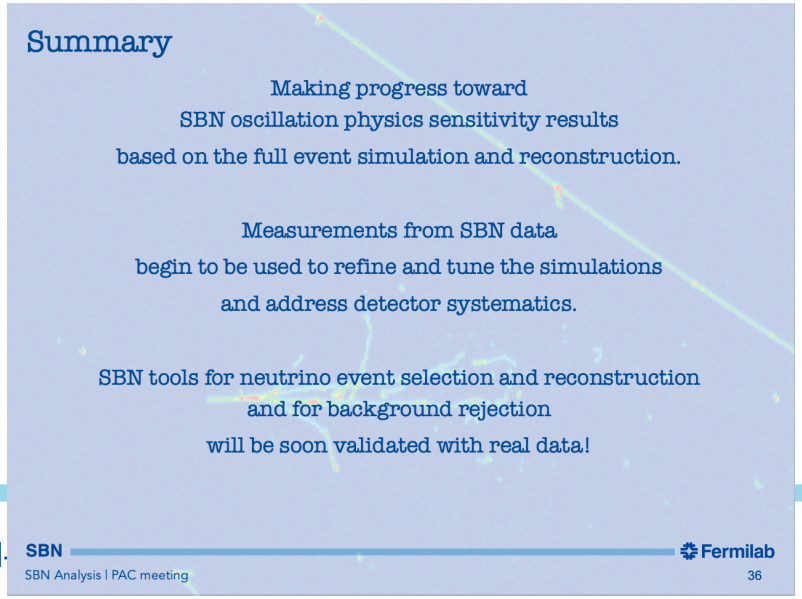
A major challenge to our computing structure is how to move around all the data and simulation files that we create. Studies have begun targeting the reduction of file sizes to help streamline production, reconstruction, and physics analyses.

SBN Analysis WG

"Status of the SBN Analysis Working Group" presented by O.P. at the Physics Advisory Committee (PAC) meeting on December 8th, 2020







SBN Analysis WG

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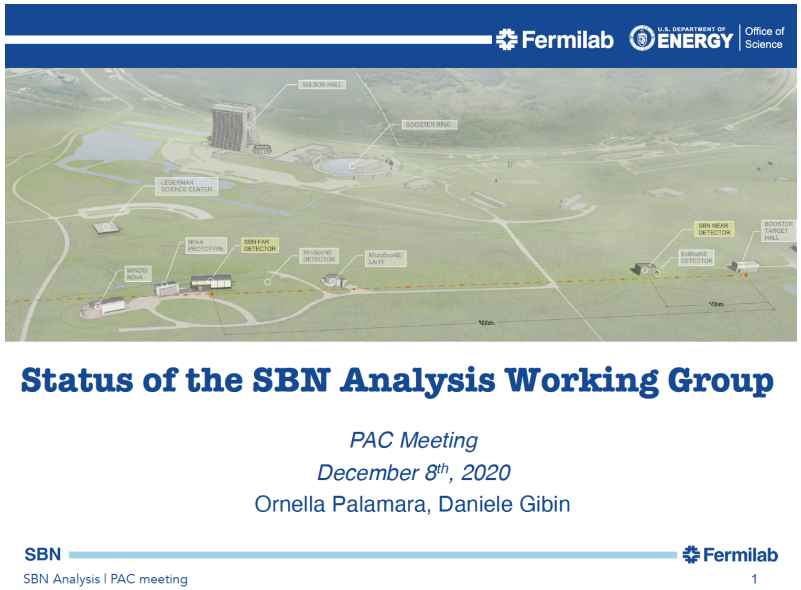

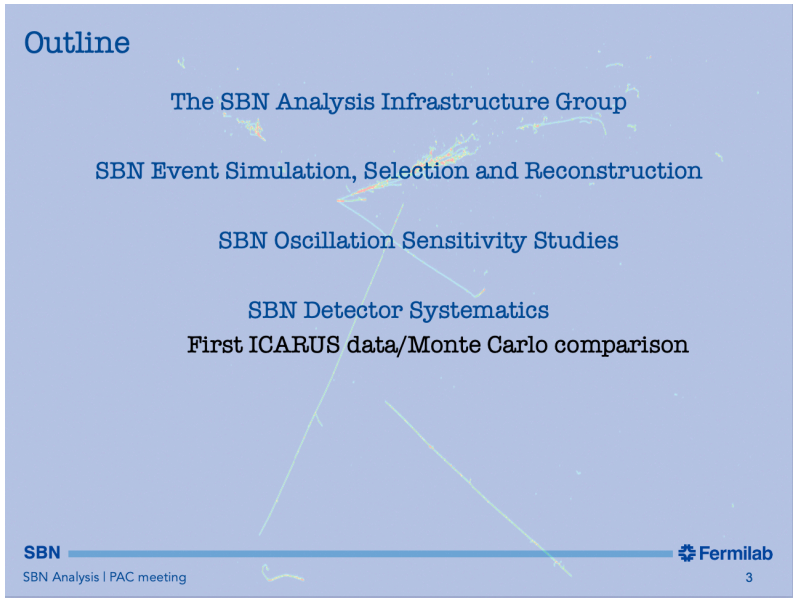

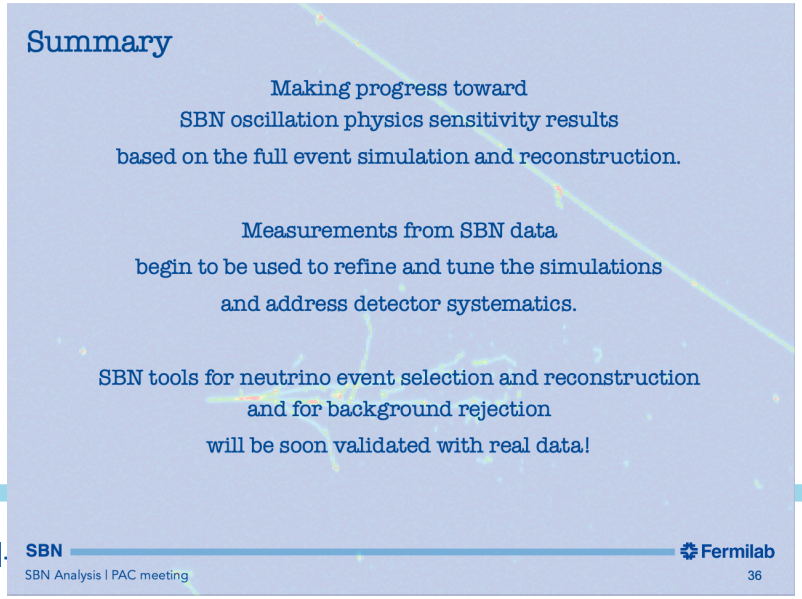

- Continuing to make progress
- Planning an SBN Analysis Workshop for mid-April

From the FNAL Director

Fermilab

Fermi National Accelerator Laboratory

Nigel Lockyer
Director

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January 21, 2021

Dr. Ornella Palamara
MS 220

Dear Ornella,

Thank you for your presentation on the "Status of the SBN analysis working group" at the meeting on December 8th for the Fermilab Physics Advisory Committee (PAC). The committee explicitly mentioned the appreciation of the excellent report at the meeting.

The status of the SBN working group was a very important topic at the meeting. Relevant excerpts from the PAC report are attached. The PAC notes, "The development of the common analysis framework is essential for reaching the core science goals of the SBN program". It also "reaffirms its strong support for this effort" and "commends the SBN analysis effort for incorporating the inputs from ProtoDUNE-SP and the first ICARUS data into simulations".

I take note of the PAC comments and findings and look forward to working with you to address the recommendations made by the committee in preparation for the next PAC meeting.

Sincerely,

Nigel S. Lockyer
Director of Fermilab

Excerpts from the December 2020 PAC report

Full Event reconstruction ICARUS data-MC comparison

From the Executive Summary:

The Short Baseline Neutrino (SBN) analysis working group presented an array of recent progress in simulation, selection, and reconstruction. Initial comparisons of simulation with ICARUS data were also shown. We encourage the continued development of common analysis tools across the SBN effort and look forward to seeing further progress in the future.

Findings:

The PAC heard an update from the SBN analysis working group. The overarching goal of this group is to enable accurate comparison between the event spectra measured in different detectors located at different distances along the beam line. This is achieved by building a set of common reconstruction tools for efficient selection of the neutrino events and for background rejection in both near and far detectors (SBND and ICARUS), and simulation and analysis tools to extract the physics from the comparison of data at the two detectors.

In calendar year 2020, despite the limitations imposed by the pandemic, the SBN analysis working group maintained regular meetings, organized two workshops on analysis and calorimetry, as well as tutorials on software tools. Additionally, it has put together a new working sub-group, SBN Analysis Infrastructure, tasked with coordinating the basic infrastructure and software organization across the detectors. Its goals include code sharing, a common analysis framework, large-scale event generation, and coordination of software package releases.

Excerpts from the December 2020 PAC report

Event Simulation, Selection and Reconstruction

The Event Simulation, Selection and Reconstruction sub-group achieved significant improvements in detector description and event reconstruction. Modeling of physical effects, such as electron diffusion constants, space charge distribution, and optical model, were all significantly improved. The committee notes that some of these improvements were made possible thanks to the availability of ProtoDUNE measurements. Progress is also reported in the TPC and photon detection system modeling, as well as in the ability of the cosmic ray tagger system to reject cosmic background and improve the muon neutrino selection. Efforts to combine these systems are also underway. Electron-neutrino selection efficiency, a key ingredient for sterile neutrino appearance searches, was reported to be improved significantly, although still not reaching the level assumed in the SBN proposal. Plans for further improvements are outlined.

Detector Modeling Combining TPC, PDS, CRT

Oscillation Sensitivities and detector systematics. ICARUS data-MC

The Oscillation Sensitivities sub-group updated estimates of the sterile neutrino sensitivities breaking out the contributions of several exclusive final-state topologies. The Detector Systematics working group carried out important initial comparisons of its Monte Carlo simulations with the first ICARUS data. The results allow to tune the space charge distribution, electron drift velocity, and electron diffusion in the model.

Excerpts from the December 2020 PAC report

Comments:

- The development of the common analysis framework is essential for reaching the core science goals of the SBN program, which relies on accurate comparisons between the event spectra in the SBND and ICARUS detectors. The PAC reaffirms its strong support for this effort.
- The PAC commends the SBN analysis effort for incorporating the inputs from ProtoDUNE-SP and the first ICARUS data into simulations of diffusion, space charge effects, and electron drift velocity.
- The PAC strongly encourages SBN to develop a scheme for incorporating the latest understanding of detector effects into modeling of projected oscillation sensitivity. This work involves close synergies among all working groups within SBN.
- The PAC encourages SBN to continue incorporating lessons learned on LArTPCs from MicroBooNE and ProtoDUNE.
- Given the large discrepancies in the predicted event rates reported by the collaboration when using different versions of GENIE, the PAC encourages the collaboration to quantify the impact of cross section uncertainties on the SBN physics program, particularly on the sterile neutrino search.
- SBN has been exploring the use of SciDAC resources, namely the HPC facilities at NERSC. It would be good to summarize the status of these efforts to date -- how much work it was to port the code, the resulting speedup, and the lessons learned.
- In some cases, there are three independent approaches to the same problem. While at the initial stage having redundancies is probably good, at some point it might lead to less than optimal efficiency. Accordingly, this should be periodically revisited.

Excerpts from the December 2020 PAC report

ICARUS to use common tools.
Running ICARUS is single detector mode

Recommendations:

- The PAC recommends the SBN analysis working group support the ICARUS collaboration in using the common tools developed in SBN to quantify the sensitivity of running ICARUS in the single-detector mode, as is planned in the current timeline, and to assess computing needs.

Utility of an overburden for the SBND and the ICARUS detectors

Request from the PAC (January 14th, 2021):

Thank you for the presentation at the PAC meeting of December 2020. In addition to the findings, comments, and recommendations you may find in the PAC Report, the PAC would like the joint SBN analysis working group to develop a study of effectiveness of the overburden for both the ICARUS and SBND detectors.

Results may be presented at a dedicated PAC meeting to be scheduled in the Spring 2021 (April or May). To facilitate the review, we very kindly ask you to submit a technical note summarizing the results at least two weeks before the meeting.

- SBND and ICARUS overburden studies and comparisons are in progress.
- See presentation on the status by Marco Del Tutto.