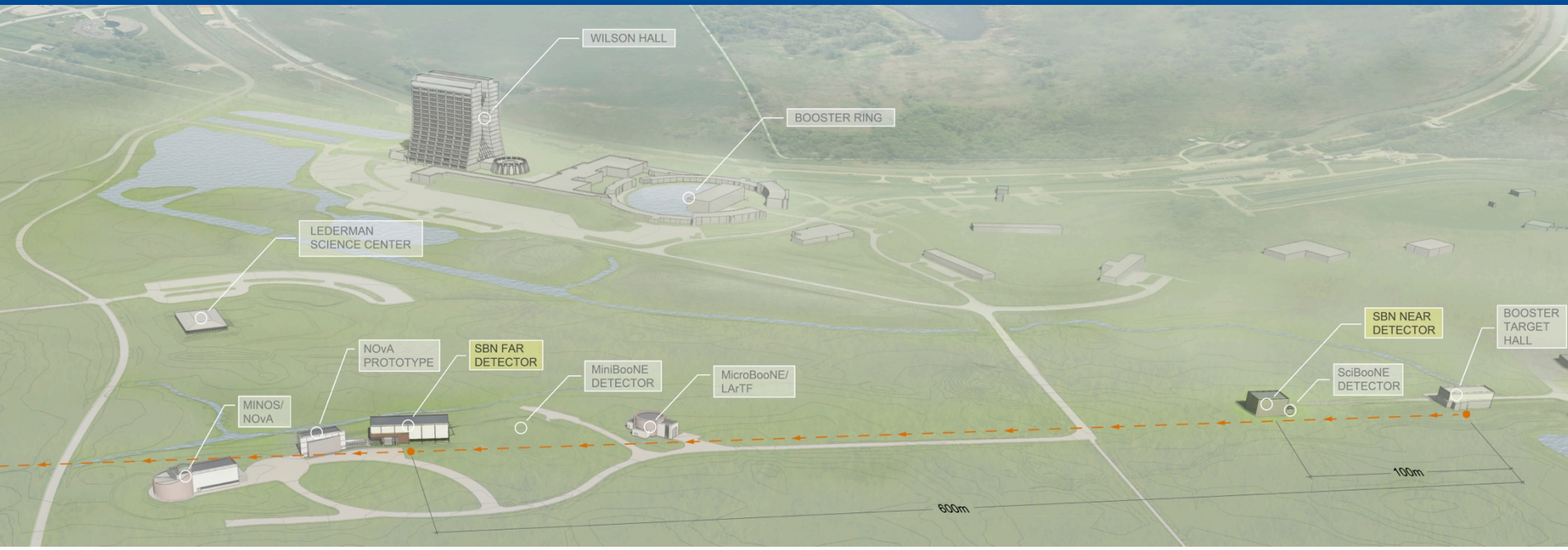


SBN Joint Working Groups

SBN Oversight Board Meeting

Fermilab, September 13th 2019

Ornella Palamara

SBN Joint Working Groups

- SBN DAQ and Data Pre-Processing *[conveners: B. Badgett, A. Fava, W. Ketchum, S. Ventura]*
  - *Scope*: Identify areas of common effort on **trigger, data acquisition and data pre-processing**, and coordinate activities in those areas.

- SBN Slow Controls *[conveners: S. Gollapinni, Geoff Savage (New! Replacing A. Fava)]*

Thanks to A. Fava for her contributions to the group and welcome Geoff!

  - *Scope*: Develop a **control system** based on **hardware and software interfaces** as much as possible identical for the two detectors.

- SBN Cosmic Ray Tagger *(conveners: U. Kose, I. Kreslo, M. Betacourt)*
  - *Scope*: Review the **CRT production status and the installation plans for the two detectors**, develop common CRT **DAQ and data output format** (together with the SBN DAQ WG), develop **common CRT monitoring.**

SBN Joint Working Groups

- SBN Data Management *(convener: W. Ketchum)*
  - *Scope:* Review computing resources and needs for SBND and ICARUS, and define a **model for SBN computing**. Collaborate with the Fermilab Scientific Computing Division to develop an **implementation of the SBN computing** strategy.

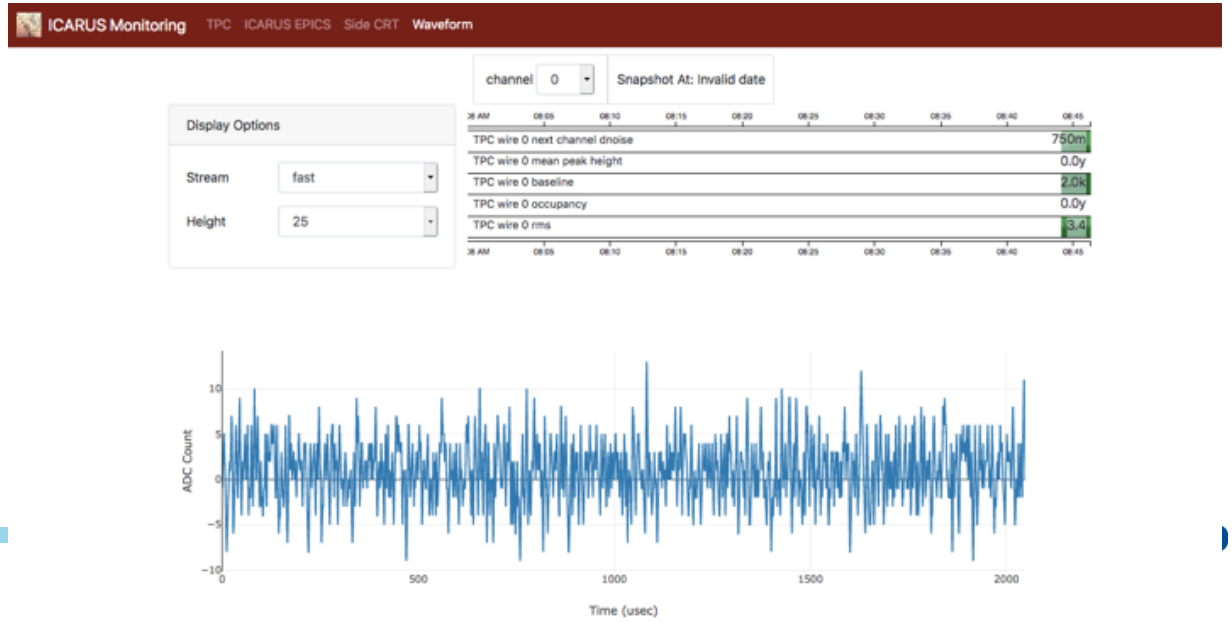
- SBN Analysis *(conveners: D. Gibin, O. Palamara)*
  - *Scope:* Implement a **multi-detector simulation**, the **reconstruction** algorithms/tools and the **analysis tools for the SBN oscillation analysis**.

SBN DAQ and Data Pre-processing WG

- **TPC DAQ** developed independently by ICARUS and SBND, but with continuous exchange of information.
- **PMT DAQ** development at test-stands (DZero Assembly Building & FD VST)
  - operated at near maximum bandwidth of the CONET-2 links (80 MB/s), detailed time synchronization tests.
- **CRT DAQ**
  - readout strategy defined as continuous collection of data stream and respond to requests for data within a window around a trigger time
  - development of *BoardReader* software in progress.
- Run configurations managed through *FHiCL* files, and stored in an online unstructured database.

SBN DAQ and Data Pre-processing WG

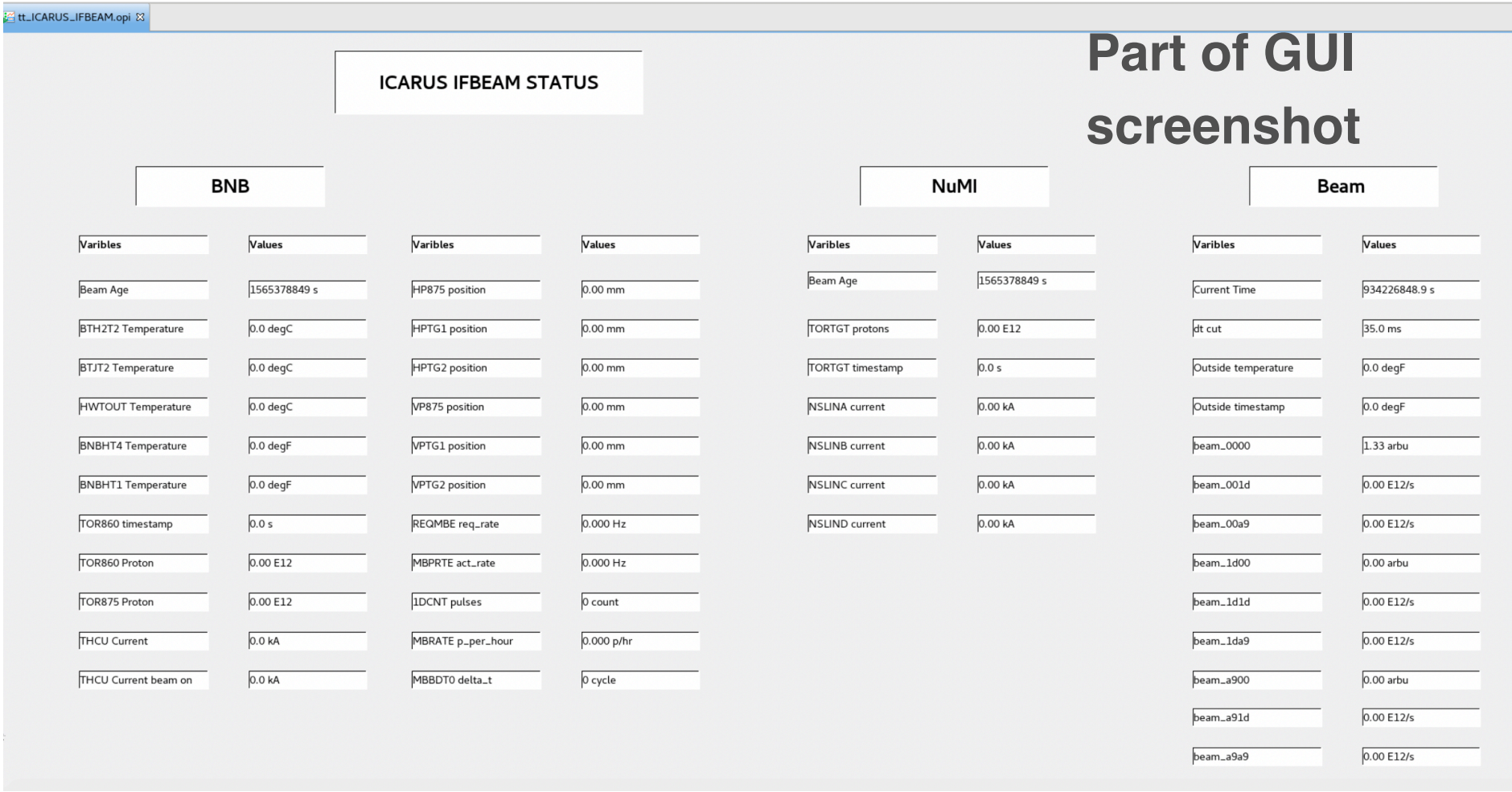
- Run control interface developed.
- Trigger inhibit mechanism based on DAQ backpressure being adapted from ProtoDUNE SP.
- Online monitoring:
  - display of TPC waveforms, pedestal and rms per channel;
  - tools being cloned for PMT waveform display;
  - early purity measurement being integrated.



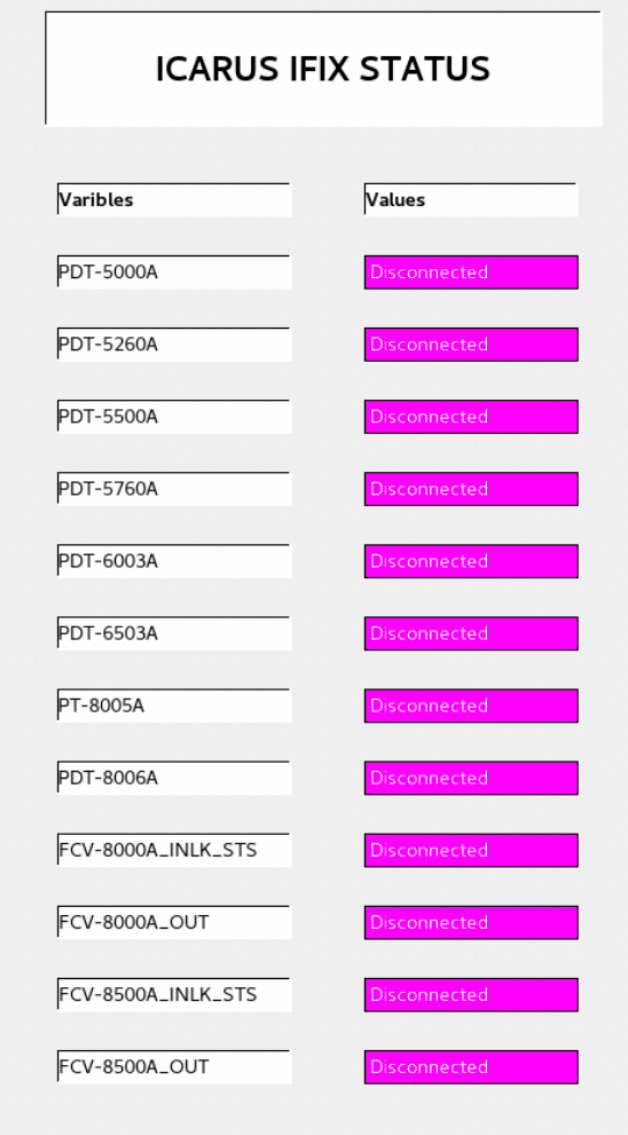
SBN Slow Controls WG

- Recent progress (current primary focus on ICARUS given the timeline)
  - **Beam** to EPICS interface now available
  - IFIX (**Cryogenics**) to EPICS interface now available — updating with new variables for ICARUS in discussions with Cryo experts
  - Test stand at DAB (for power supply testing)
  - LAr level meters and temperature sensors installed in ICARUS, power and programming underway

ICARUS Beam Status GUI



ICARUS IFIX (Cryogenics) Interface

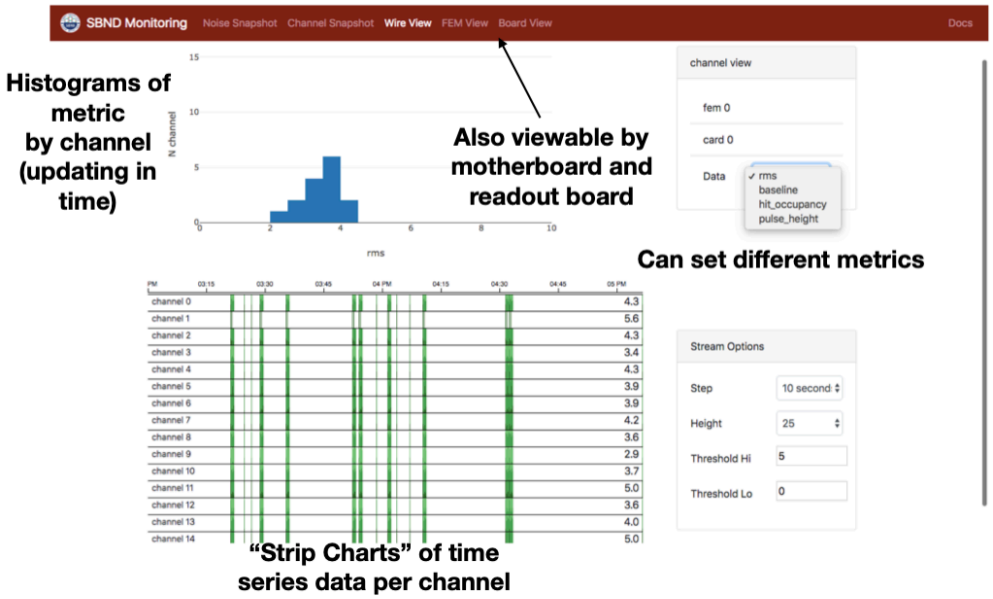


A mini-GUI based on 12 variables provided by ICARUS. — resolving some mapping issues currently

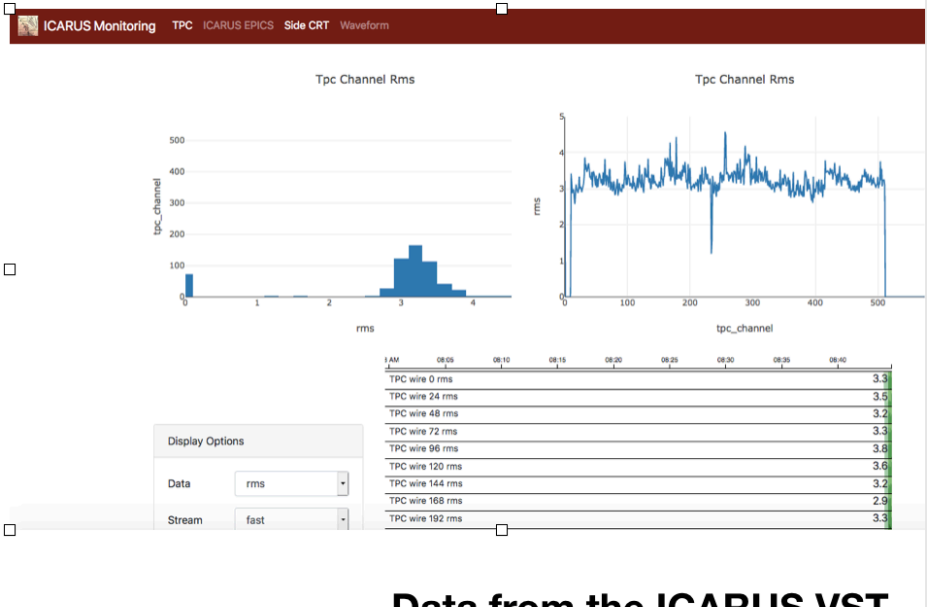
SBN Online Monitoring

- Online monitoring infrastructure is in place for SBN
  - Replicated the setup from SBND to ICARUS
- Adding detailed information for data quality from the different subsystems PMT, TPC and CRT

SBND Online Monitoring



ICARUS Online Monitoring



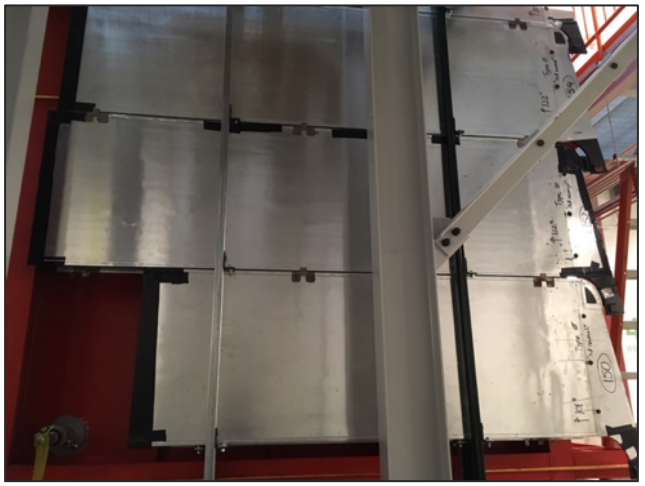
Online monitoring developed at the SBND VST

Data from the ICARUS VST

SBN Cosmic Ray Tagger WG

- Near Detector CRT system:
  - Following changes in the cryostat dimension, the installation of CRT modules revised
  - Bottom CRT system will be installed in October

North wall (FD)



- Far Detector CRT system:
  - Bottom CRT installed and tested
  - North CRT wall installed to be commissioned soon

Bottom CRT (FD)

SBN Cosmic Ray Tagger WG

- Common **artDAQ CRT framework** in progress and to be tested on test-stands in US & EU
- Common **CRT data output** defined (in collaboration with the SBN DAQ Working Group)
- Development of **CRT Database** in progress
- Common **CRT online monitoring** under development

SBN Data Management

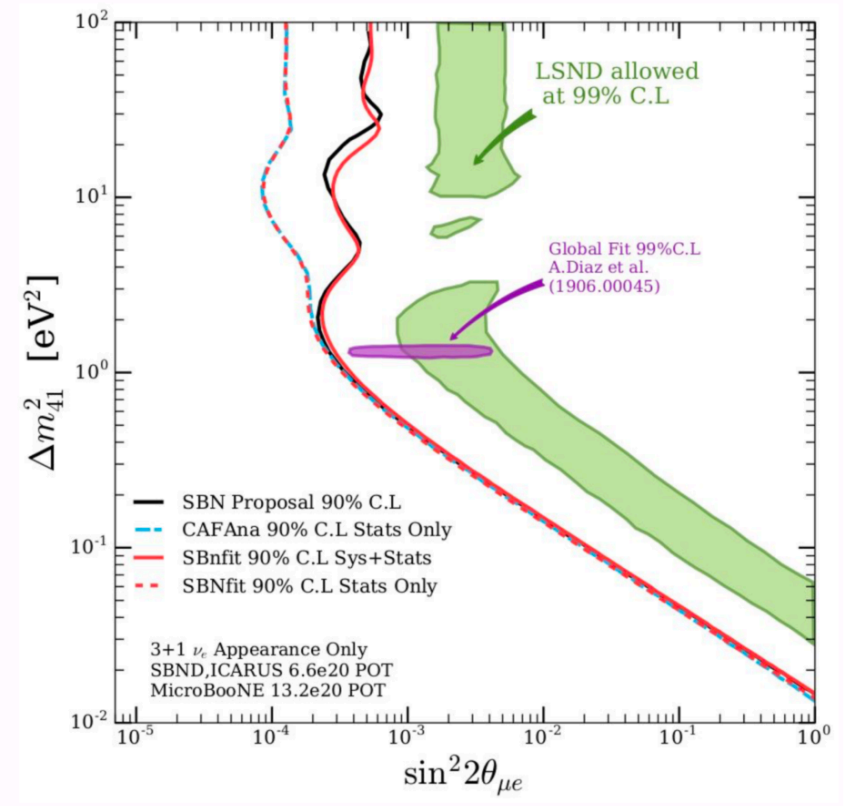
- Recent direct efforts have focused on ICARUS given first data coming soon
  - Organized meeting this summer with Fermilab and CNAF experts to arrange for remote data replica storage and production jobs integrated with FNAL-centered toolkits, building off of experience with CDF
  - Evaluating data file sizes and forming strategies for appropriate data file tiers
  - Working with SBN online to implement online data management schemes and integrate to offline data production
    - Outlining requirements and testing plans for creation of multiple file streams in the online system
    - Integrating online and offline data formats to avoid unnecessary duplication
- Supporting efforts to allow far and near detector collaborators to work together
  - e.g. data accessibility for SBN analysis workshop

SBN Analysis WG

- Work toward **updating the projections of expected physics capabilities of the SBN program** using full simulation and reconstruction
  - Generating MC samples in the different detectors with the current software packages.
  - Include updated reconstruction efficiencies, performances, systematic effect and background rejection from a full MC simulation of the detectors.
- SBN Analysis Group wiki page
  https://cdcvs.fnal.gov/redmine/projects/sbn-analysis-group/wiki
- The **internal organizational structure** with sub-groups working on specific reconstruction and analysis topics is working well.

Last SBN Analysis Workshop (Oxford March 2019)

- Three fitters (SBNfit, CAFAna, VALOR) incorporated into the SBN analysis
- A lot of effort by several people in preparing the samples, emulating proposal-era conditions on the event samples, running the oscillation sensitivities.



Next SBN Analysis Workshop

September 16-20 2019 at Fermilab

Pivoting from truth-level proposal era to full reconstruction

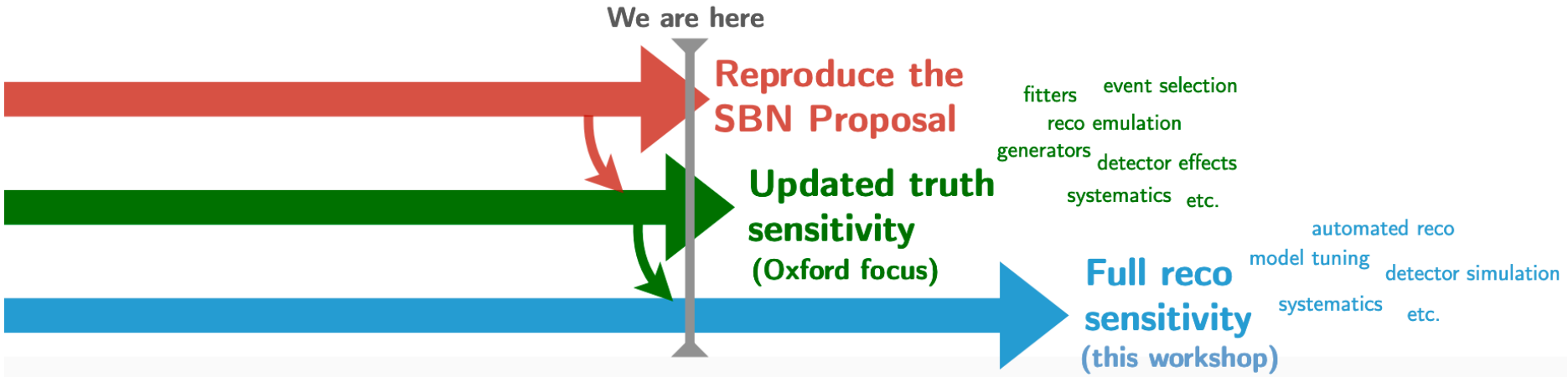
- 50 participants, with 40 local at Fermilab
- Indico page https://indico.fnal.gov/event/21554/
- Agenda:

16	17	18	19	20
09:00 Workshop Introduction and WG goals presentation 14:00 Working time	08:45 SBND Assembly Review: Day 1 09:00 Working Group update and Discussion time 14:00 Working time	09:00 SBND Assembly Review: Day 2 09:00 Working Group update and Discussion time 14:00 Working time	09:00 Working Group update and Discussion time 14:00 Working time	09:00 Workshop closeout

- Tutorials in advance of the workshop on Monday, September 9. Very well attended.
  - LArSoft
  - SBNCode
  - CAFAna

September 2019 SBN Analysis Workshop - Goals

- Transition from truth variables to as much as possible **reconstructed quantities** for the event selection and measurement
- Verifying the **sensitivity reach** at the present stage of our code
- Start discussing for the introduction of **detector-related systematics** and for a cross calibration within the different detectors
  - Define a list of the dominant systematics
  - Energy resolution for different particles, post-calibration
  - Efficiency (correlations) for different event topologies
  - Status/differences in optical systems/simulation/reco

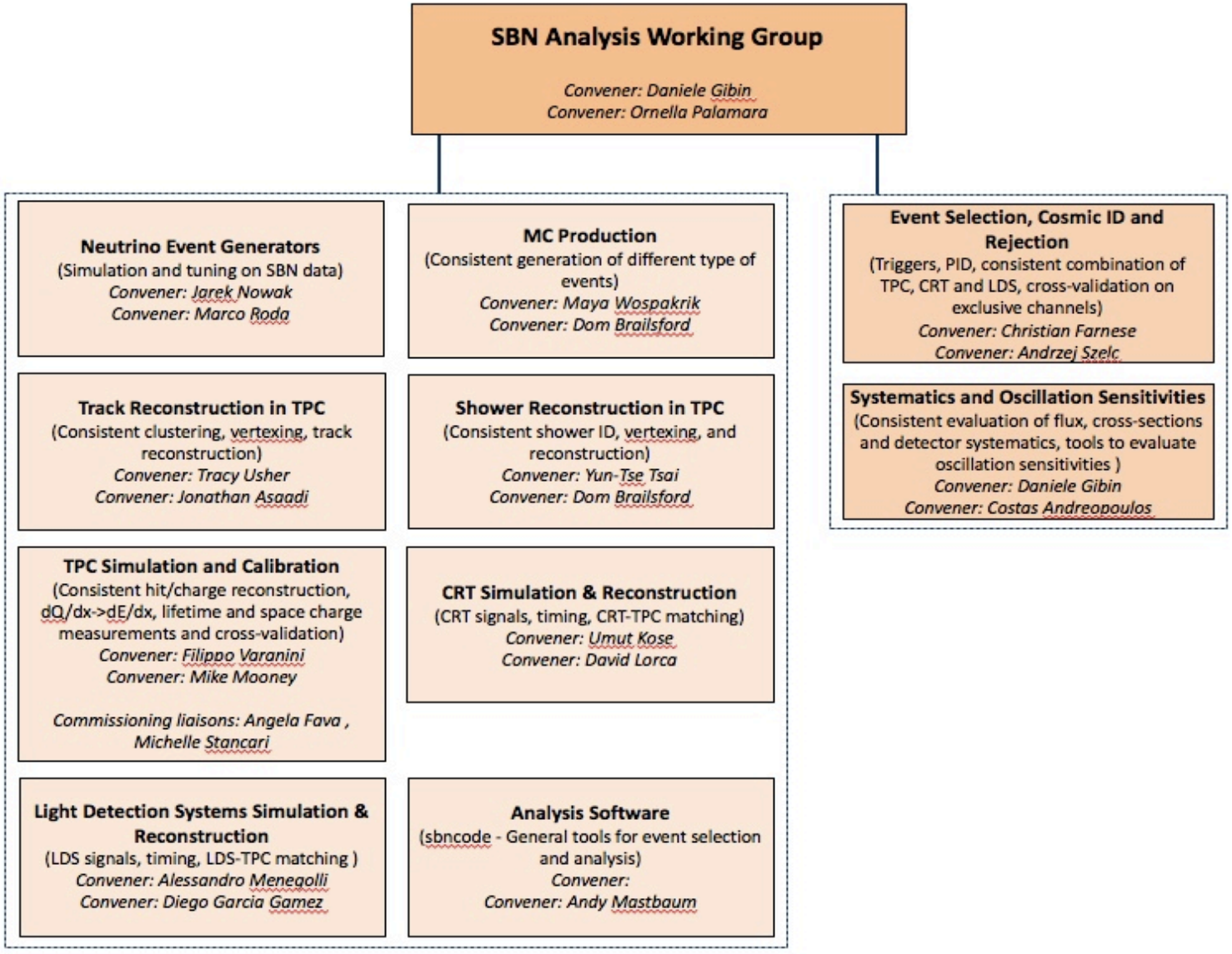


September 2019 SBN Analysis Workshop

- Three Working Groups
  - Oscillation Sensitivities
    - Oscillation sensitivity with reconstructed input, fake data tests, fitter development
  - Detector Systematics
    - Main systematics, estimate impact on sensitivities
  - Event Selection (with TPC + CRT + light)
    - Development of multi-subsystem algorithms, evaluation of efficiency and background rejection, impact on sensitivities

Overflow

SBN Oscillation Analysis Group Organizational Chart



SBN Analysis Group

- **Oscillation Analysis**: proceed in three (parallel) intermediate steps
  - I. Consistency check - **reproduce the SBN proposal-era oscillation sensitivities** with 3 new oscillation fitting frameworks, using truth-level information and the same inputs for beam, reconstruction efficiencies, backgrounds and systematic uncertainties.
  - II. Update the oscillation sensitivities - still using truth-level information, and exploiting **updated inputs** for efficiencies/backgrounds and systematic effects (accounting for the available/developed SBN event reconstruction and recent results from other LAr experiments).
  - III. Oscillation physics sensitivity results based on full event simulation and full event reconstruction.

Oscillation Sensitivities - Milestones and Timeline

M.1: Reproduce the SBN proposal oscillation sensitivity for both ν_e appearance and ν_μ disappearance (**Mid March 2019**).

M.2: Revise the proposal assumptions using more realistic estimate of efficiency and backgrounds, implementing a truth-level based sensitivity study for both appearance and disappearance channels (**Summer 2019**).

M.3: Produce an end-to-end analysis of ν_μ disappearance with as complete as possible event selection and reconstruction (**End of 2019**).

M.4: Produce an end-to-end analysis of ν_e appearance with as complete as possible event selection and reconstruction (**Spring 2020**).

M.5: Final, complete, reconstruction & systematics included appearance and disappearance sensitivities (**by end of 2020**)

Notes on SBN Computing

- Detailed computing estimates are prepared and presented yearly to Fermilab SCD to allow for resource planning

- SBN computing needs will be very significant over the coming years. There are a mixture of similar and unique challenges:
  - ICARUS
    - Large size leads to large data volumes and high memory requirements for computing
    - Collected data will be dominated by cosmic-induced activity → storage will be dominated by cosmics, not neutrino data or simulation
  - SBND
    - Though smaller, it sees a much higher neutrino rate which will be comparable to the cosmic-induced rate → comparable simulation samples will be extremely challenging

- Engaging with institutions beyond Fermilab to help support storage and computing requirements

SBN Computing estimates

- ICARUS
  - Expecting to collect ~1.8 PB of data during early commissioning period
    - Most data can be able to be retired after detector fully commissioned
  - In normal running, expect to collect ~2.2 PB data per year and utilize 2M CPU hours per year for immediate reconstruction of data events
  - Anticipate being able to support one major simulation and reconstruction campaign per year
- SBND
  - Estimates preliminary, but also expecting to collect ~ 2PB of data per year
  - Challenge to develop strategies for producing the simulation to support the physics program
    - Particularly the high-stats cross section physics program