SBN Joint Working Groups Update

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Georgia Karagiorgi, Columbia University

SBN Oversight Board Meeting, March 10, 2023

SBN Joint Working Groups

- **SBN DAQ and Data Pre-Processing** [conveners: Bill Badgett, Angela Fava, Wes Ketchum]
  - Goal: Develop common tools for **trigger, data acquisition and data pre-processing**, and coordinate activities in those areas.
- **SBN Slow Controls** [convener: Geoff Savage, Sungbin Oh]
  - Goal: Develop **control systems** based on **hardware and software interfaces** as much as possible identical for the two detectors.
- **SBN Cosmic Ray Tagger** [conveners: Laura Patrizii, Minerba Betancourt]
  - Goal: Review the **CRT production status and the installation plans** for the two detectors, develop common CRT **DAQ and monitoring.**
- **SBN Analysis Infrastructure** [conveners: Giuseppe Cerati, Steven Gardiner] (change in leadership in Jan. 2023)
  - Goal: Coordinate and address **data and software infrastructure** and **computing resource needs** across the SBN
- **SBN Analysis Trigger** [conveners: Angela Fava, Michelle Stancari]
  - Goal: Share and discuss strategies for cross-checking trigger efficiencies independently measured by the two detectors
- **SBN Analysis** [conveners: Daniele Gibin, Georgia Karagiorgi]
  - Goal: Take care of all the aspects of the multi-detector physics analysis for **SBN sterile neutrino oscillation searches**

SBN DAQ and Pre-Processing [Wes Ketchum, Angela Fava, William Badgett]

Main Activities:

- **Recent common online activities:**
  - Testing/improving PMT readout and DAQ software
    - Generalization of software to apply to SBND; corresponding testing in ICARUS successful
    - Improvements in configuration for baseline stability/application to trigger thresholds in ICARUS
  - Online-to-offline file transfer
    - SBND has test instance of file transfer working, building off of ICARUS (and previous SBND Vertical Slice Test) work
  - Control room setup
    - SBND planning for control room setup; conversation with ICARUS experts
- Large number of DAQ and online activities moving along in parallel
  - Each experiment has been having dedicated meetings as SBND commissioning preparations have demanded more time
  - ***Still maintaining shared software infrastructure and expertise across SBN!***

SBN Slow Controls [Sungbin Oh, Varuna Meddage, Tingjun Yang, William Badgett, Geoff Savage]

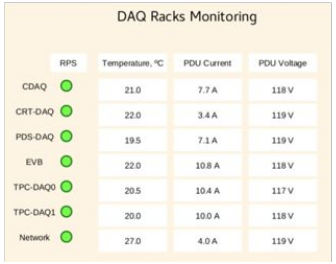
Main Activities (SBND):

- **Ongoing efforts to establish control/monitoring system for critical devices involve:**
  - Building input/output controller (IOC) cards
    - Using EPICS Channel Access protocols to access “process variables” (PVs) – quantities to be monitored or controlled
  - Making Graphical User Interface (GUI) for convenient access to “PVs”
  - Connecting to the database servers: archiving history of PVs
  - Building monitoring webpage: providing easy access to history of PVs

Example PVs - TPC Drift HV

Read & Write	Read PV	Write PV
Current limit	sbnd_drift_hv/curr	sbnd_drift_hv/set_curr
Voltage setting	sbnd_drift_hv/meas_volt	sbnd_drift_hv/set_volt
Average number of recording	sbnd_drift_hv/aver	sbnd_drift_hv/set_aver

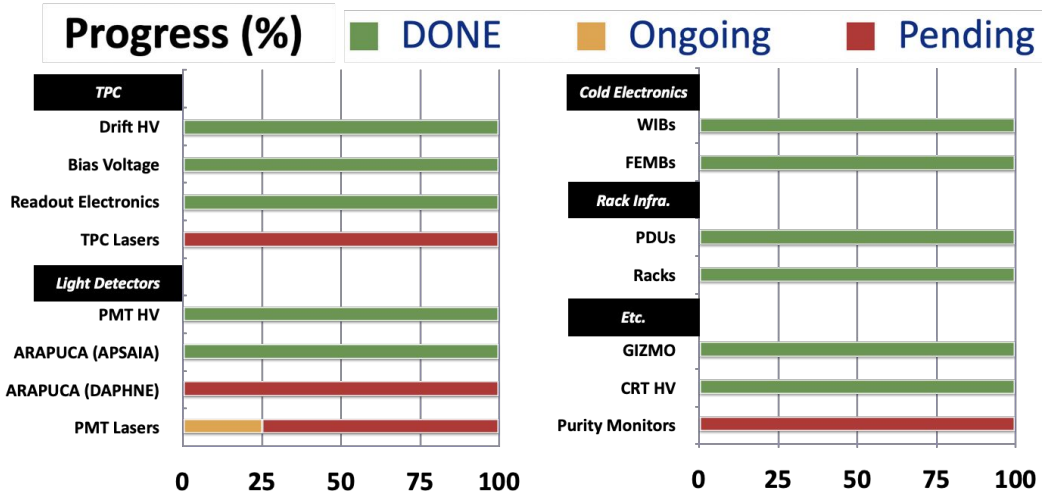
Example GUI Page



SBN Slow Controls [Sungbin Oh, Varuna Meddage, Tingjun Yang, William Badgett, Geoff Savage]

Main Activities (SBND):

- **Major updates:**
  - Set up two new VME crates for photon detection system (PDS) readout
  - Enabled simultaneous access to cold electronics from both the DAQ and the Slow Controls
- **Status:**
  - Making good progress
  - Missing tasks are awaiting for hardware
  - Have sufficient person power to perform remaining tasks

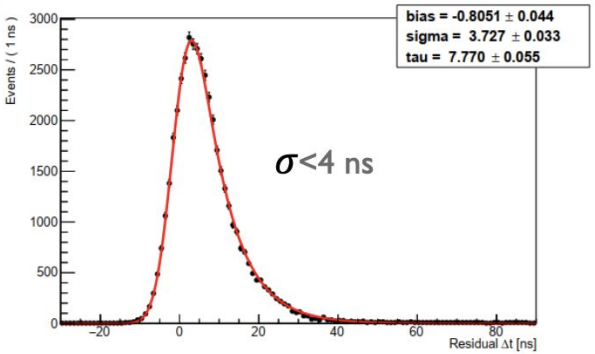


SBN Cosmic Ray Tracker [Laura Patrizii, Minerba Betancourt]

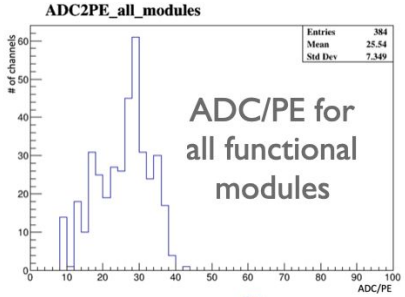
ICARUS CRT – status and updates

- Making progress with data analysis using CRT-PMT, CRT-TPC matching and testing bottom CRT with ICARUS data taken DAQ
- **CRT – PMT matches**
  - Out-of-Beam data: 88% of flashes matched with CRT (statistics of 2 M PMT flashes)
  - In-Beam data: 68% (61%) of flashes matched with CRT for BNB (NuMI) (run 8552 June-July 2022)
  - Time Resolution: <4 ns for Top CRT-PMT; <5 ns for Side CRT-PMT if space-time trajectory constrained by two hits in different CRT planes
- **Improving side CRT hit reconstruction**
  - Improved for incomplete hits (missing signal from one scintillator end)
- **CRT-TPC matching algorithm**
  - Being evaluated using cathode crossing tracks
- **Bottom CRT**
  - Half of the modules integrated in the general DAQ, testing is being finalized

Top CRT- PMT matching: time resolution



Fit model : exponential decay (LAr light emisssion) ⊗ gaussian (CRT+PMT resolutions)

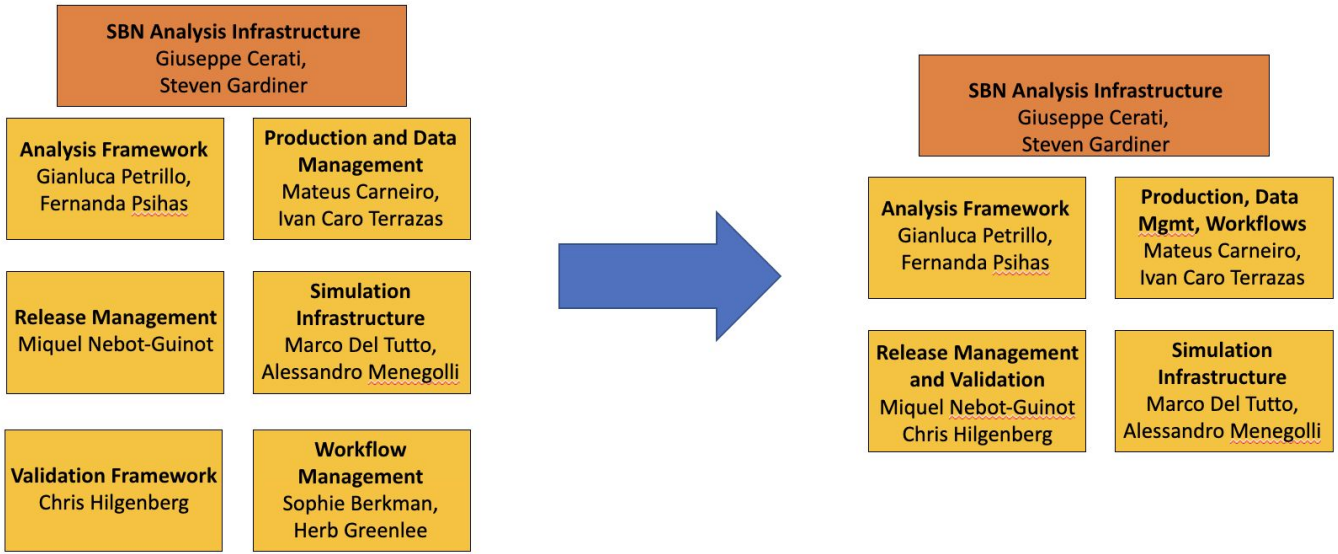


Fermilab

SBN Analysis Infrastructure [Steven Gardiner, Giuseppe Cerati]

Group restructure

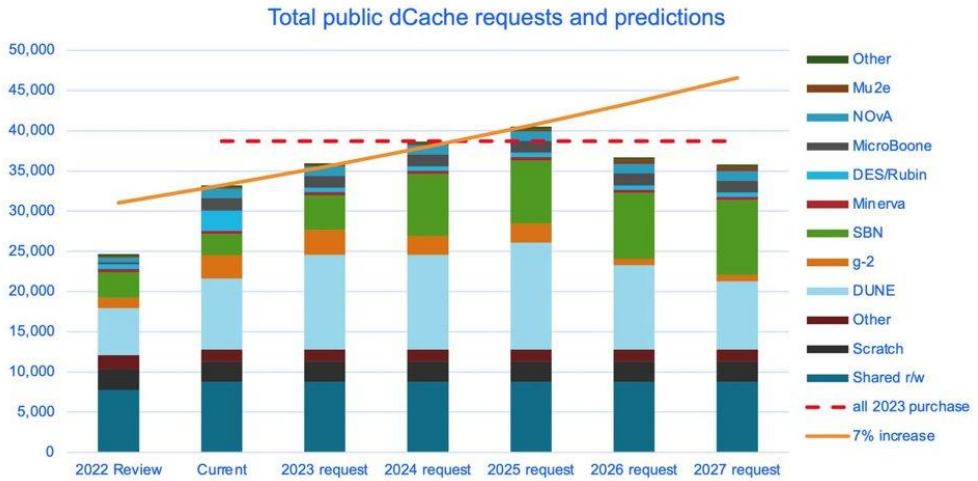
- **New co-convener**: Steven Gardiner (FNAL), replacing Wes Ketchum
- **Consolidation of subgroups**; updates to group charges in progress
- **Updated effort requests** to be shared soon with SBND/ICARUS leadership (more resources needed!)



SBN Analysis Infrastructure [Steven Gardiner, Giuseppe Cerati]

SBN presentation to Fermilab Computing Resource Scrutiny Group (FCRSG)

- **Annual review process** designed to Understand Fermilab computing needs/ strategy
- This year's **agenda**: https://indico.fnal.gov/event/57596/
- SBN resource requests (CPU, disk, etc.) appeared to be **well received**
  - Our computing footprint is noticeable but not dominant
  - Example: dCache disk requests from experiments (SBN in green)
- Official recommendations from reviewers will be available in 1-2 months



SBN Analysis Infrastructure [Steven Gardiner, Giuseppe Cerati]

Neutrino interaction model

Much recent discussion about choice of interaction simulation for near-term SBN production

Many configurations of the GENIE neutrino event generator are available

Consensus reached between GENIE authors, experts from SBND, ICARUS, and DUNE

Requires minor physics enhancements in new GENIE release (v3.4), expected very soon; LArSoft integration will proceed quickly thereafter

TABLE I: Complete list of models used for the `G18_10a_02_11a` tune in GENIE v3 [5].

Simulation domain	Model
Nuclear model	Local Fermi Gas [14]
QEL and 2p2h	Valencia [13, 15]
QEL Charm	Kovalenko [16]
QEL $\Delta S = 1$	Pais [17]
RES	Berger-Sehgal [18]
SIS/DIS	Bodek-Yang [19]
DIS $\Delta S = 1$	Aivazis-Tung-Olness [20]
Coherent π production	Berger-Sehgal [18]
Hadronization	AGKY [21]
FSI	INTRANUKE hA [22]

SBN Analysis Infrastructure [Steven Gardiner, Giuseppe Cerati]

Towards MC production

- **SBND+ICARUS are still finalizing their requirements for a new production release**
  - E.g., SBND is interested in 2D drift simulation and deconvolution (likely willing to wait for these)

- **A staged approach (ICARUS first, then SBND) is on the table**

- **Simulation consistency between experiments is being re-evaluated** (key for correlating effects in multi-detector analyses)
  - Generator: Consensus GENIE v3.4 model set will be consistent
  - Geant4: different LArSoft interface, legacy (ICARUS) vs. new refactored (SBND)
    - Physics is almost certainly not the same in the two implementations
    - Legacy has no support for updates to Geant4 physics and computing improvements
    - Transitioning to new version may also help mitigate high memory usage for ICARUS
  - Detector response: 2D drift simulation not available in SBND yet
  - Optical simulation: lookup (ICARUS) vs. parameterized (SBND) approaches

SBN Analysis Trigger [Michelle Stancari, Angela Fava]

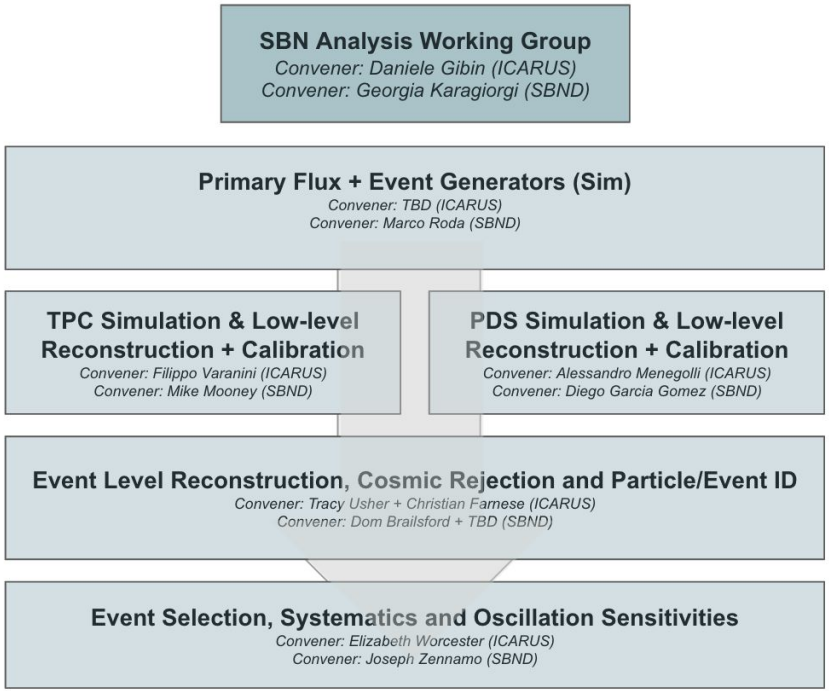
Main Activities:

- **Mini-workshop on White Rabbit network implementation/usage in SBND and ICARUS**
  - Meetings on Mar. 10 and Mar. 17, and possibly a third meeting the following week
  - Presentations from SBND and ICARUS experts on current status, issues, and topics for common discussion
  - D. Torretta and W. Badgett coordinating technical report draft, as basis for possible internal note or publication
- Intend to keep momentum going with additional, similar mini-workshops on other topics

SBN Analysis WG [Daniele Gibin, Georgia Karagiorgi]

Main Activities:

- **Presentation to the Fermilab PAC in Jan. 2023**
  - Well received; no recommendations
- **Group restructuring**
  - Pursued in an effort to consolidate/ strengthen core efforts
  - Finalized after discussions with SBND and ICARUS leadership, and SBN Analysis/Analysis Infrastructure Conveners
  - Several key positions have been filled/replaced; 2 remain to be filled
  - Revisited subgroup charges, to help better define interfaces, to be finalized soon
- **Updates to SBN IB meeting in Feb. 2023**
  - Useful input/feedback

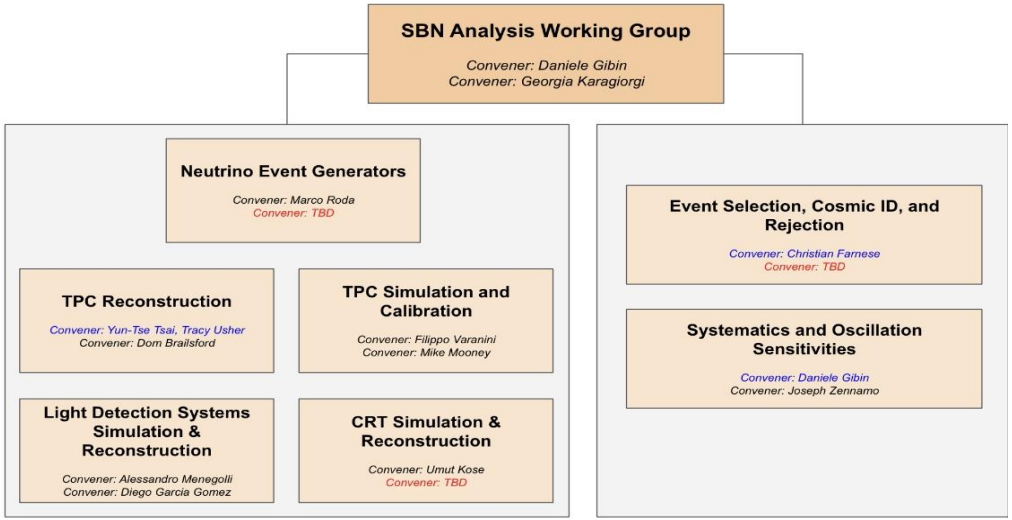


SBN Analysis WG [Daniele Gibin, Georgia Karagiorgi]

- **With SBN Oscillation WG activities revitalized, ongoing discussions on SBN analysis strategy**
  - Considering first SBN joint result on muon neutrino disappearance, targeted for Neutrino 2024
  - Primary concern is production timelines
- **SBN Analysis Workshop**
  - In lieu of three separate Reconstruction, Calibration, and Detector Systematics/Overlays workshops
  - Scope includes SBN Analysis **priorities identified** among SBN Analysis/Analysis Infrastructure Conveners, and in consultation with SBND/ICARUS physics conveners:
    - Getting 2D drift simulation and deconvolution integrated in both SBND and ICARUS, and calibrated
    - Understanding where SBND+ICARUS simulation and reconstruction diverge, re-benchmarking reconstruction performance, and working on fix/convergence
    - Developing methods to assess full systematic envelope, with a primary focus on detector systematics
    - Informing/developing our first SBN resets strategy, e.g. POT needed, exclusive or multi-channel search, etc.
  - Timescale: Early summer. In discussion with conveners and consulting SBND commissioning leaders to identify best time (minimizing impact on SBND commissioning, allowing sufficient time for necessary samples from production, etc.) Location: Fermilab, or US (non-Chicagoland).

Backup

SBN Analysis WG [Daniele Gibin, Georgia Karagiorgi]



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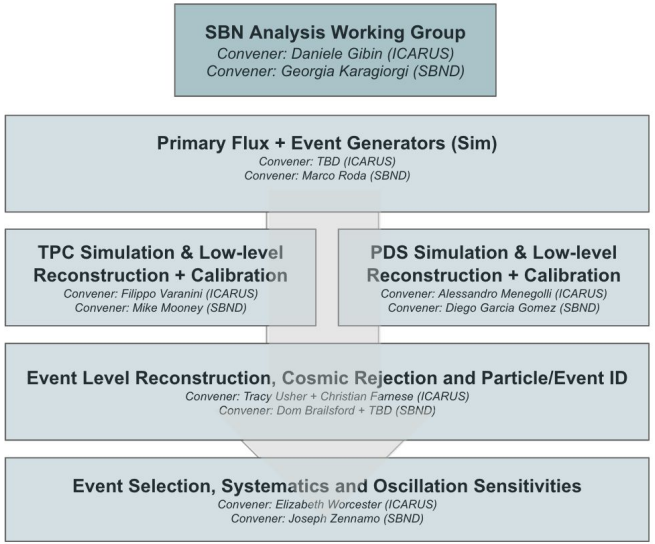

as of Jan. 2023