SBN Joint Working Groups Update

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Georgia Karagiorgi, Columbia University

SBN Oversight Board Meeting, December 9th, 2022

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: 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, Chris Backhouse → Giuseppe Cerati]*
  - ➢ *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 Data Pre-processing WG

- ICARUS and SBND at stage where dedicated online meetings for each experiment is necessary;
  - ➢ ICARUS DAQ leaders Antoni Aduszkiewicz and Laura Pasqualini
  - ➢ SBND DAQ leaders Daisy Kalra and Bill Badgett
- Continued coordination on common topics and DAQ expertise
  - ➢ Recent ICARUS DAQ workshop with contribution and participation from SBND https://indico.fnal.gov/event/56801/
  - ➢ Shared efforts on DAQ releases and DAQ and online software maintenance;
- ICARUS DAQ developments:
  - ➢ DAQ updates to be ready for Run 2, including increasing reliability of DAQ, updates for new information from trigger board and better POT accounting;
  - ➢ Current continued developments on TPC firmware-based compression and bottom CRT readout.
- SBND DAQ developments:
  - ➢ Preparation and planning for data from commissioning!
  - ➢ Testing and development/updates on TPC (SBND-specific), PMT (some SBN-shared, some SBND-specific), and CRT (SBN-shared) readout software;

- Goal: establish controlling/monitoring system for important devices;
- Workflow:
  - ➤ Build input/output controller (IOC) apps. Use the EPICS Channel Access protocols to access process variables (PVs);
- Make Graphical User Interface (GUI), monitoring webpage for easy access to PVs and PVs' time evolution and connect to the database servers : archiving history of PVs.
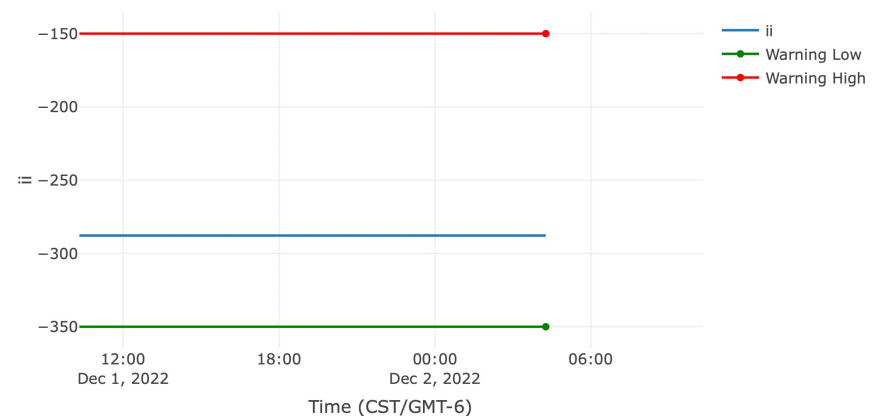
Example Monitoring webpage

Example GUI Page

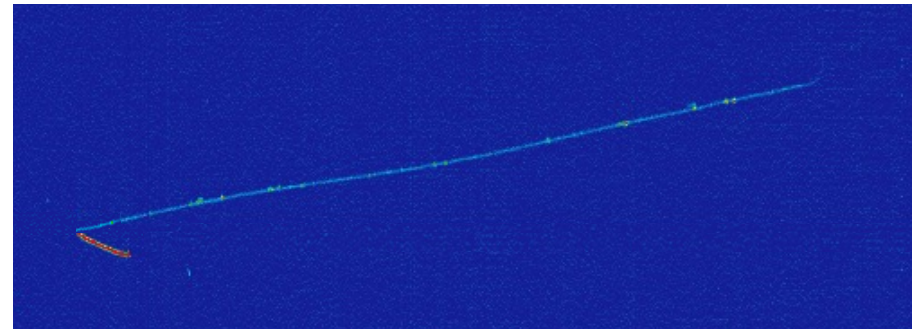*SBN Oversight Board - Dec 9 2022*

- Time based CRT – PMT matching ongoing (with beam and off-beam data): synchronized with Global Trigger signal;
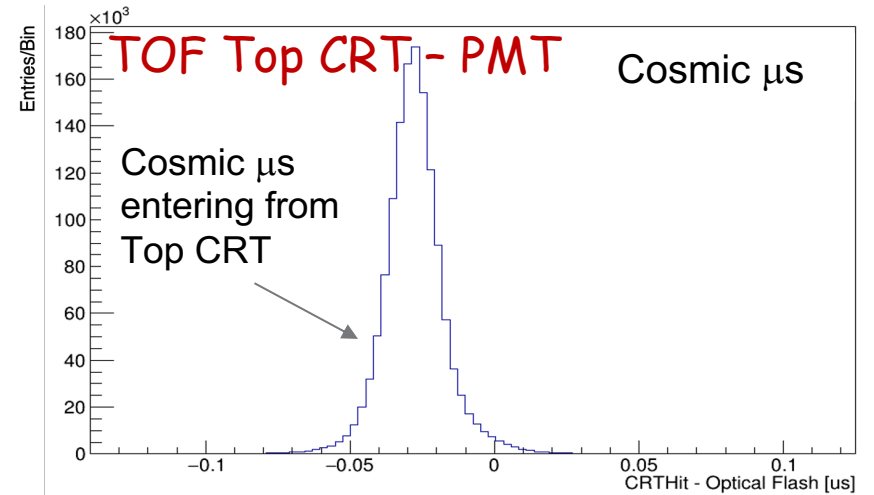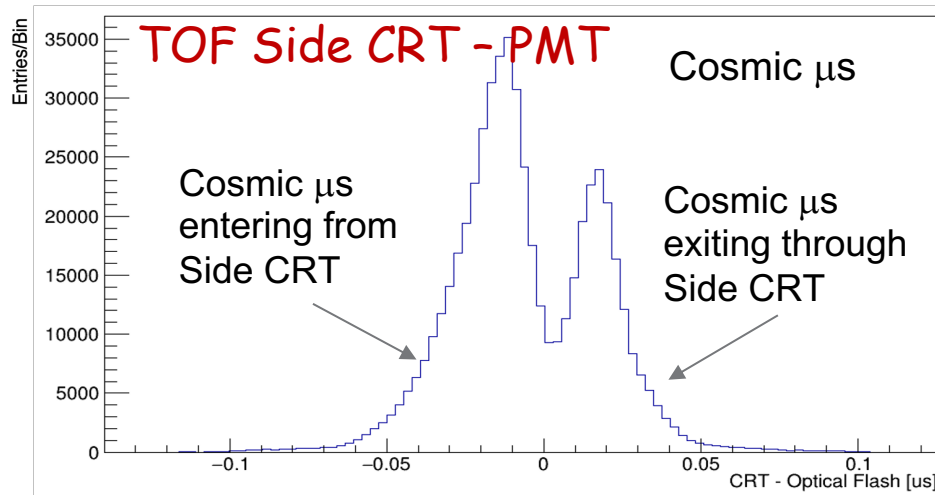
- The event selection based on CRT hit – Optical Flash time difference is under study, without TPC reconstruction;

- Neutrino event with optical flash not associated with any CRT hit

SBN Analysis Infrastructure group WG – Updates

- New co-convener of SBN Analysis Infrastructure: Giuseppe Cerati of FNAL;

- New co-convener of Production and Data Management working group: Ivan Caro Terrazas of CSU

  - Huge thanks to Maya Wospakrik for previous leadership!

- Major activity over last months: preparation of production release SBN2022B

  - Major goal to support ICARUS stage 0 data reconstruction (signal processing and hit finding) in 'keep-up processing' that runs promptly on data collected from detector;

  - <u>Significant</u> other updates in simulation, high-level reconstruction, calibration, and analysis framework

- Production release created in November – final patches being prepared now coincident with ICARUS Run 2 beginning

  - Currently developing production plan and what's needed for final simulation release

SBN Analysis Infrastructure WG – Computing planning

- Fermilab Computing Resource Scrutiny Group (FCRSG) annual review planned for early February

- Following feedback from previous years and from recent Fermilab-wide computing prioritization issues, we are being asked to prepare a 5-year computing plan

- Have started to collect inputs and feedback on that plan now

  - 15 Nov meeting devoted to discussion on computing/data management planning https://sbn-docdb.fnal.gov/cgi-bin/sso/DisplayMeeting?sessionid=15280

  - 29 Nov meeting devoted to discussion of implementation of Machine Learning workflows, including at dedicated HPC centers https://sbn-docdb.fnal.gov/cgi-bin/sso/DisplayMeeting?sessionid=15410

  - Discussion on developing multithreaded algorithms in LArSoft: https://sbn-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=28239

- Will share overall plan and collect further feedback early in the new year

SBN Analysis Infrastructure WG – tools for cosmics and ν

- Cosmic rays remain a significant and important background to model correctly for assessment of impact on neutrino reconstruction:

  ➢ Significant progress on tools for cosmic removal: a) light-track matching utilities in SBN code; b) CRT/PMT timing in ICARUS and development of timing-related filters;

- We have had detailed discussion of cosmic modeling, including data-driven models using data collected out-of-time with the beam (https://sbn-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=27733 , : https://sbn-docdb.fnal.gov/cgi-bin/sso/DisplayMeeting?sessionid=15189

- Working toward a coherent and effective approach to cosmic modeling, which will be critical for the SBN.

- SBN has encouraged the move of LArSoft to use the updated GENIE v3.2 as a default for ν event generator;

- Need to coordinate base interaction model to use for simulation:

  ➢ Proposal from ICARUS event selection group to use 'DUNE' interaction model presented to SBN Analysis Meeting: https://sbn-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=28096;

  ➢ Hoping to converge promptly to allow for inclusion in next productions campaigns.

SBN Analysis Group – Update

- Joint activities have been slowing down in the present year, as could be expected from co-conveners' priorities/commitments (naturally) shifting within their respective collaborations (some roles have also been unfilled);

- Progress on joint efforts and interactions between SBND and ICARUS experts in various subgroups has stalled, leading to divergent efforts (although independent SBND/ICARUS developments are progressing well);

- **We need to ensure joint WG efforts are revitalized and that joint coordination of (at least a subset of) joint activities resumes ASAP!**

- A Reorganization of working groups is going forward:
  - ➢ Identify activities which require highest priority;
  - ➢ Identify new co-conveners;

SBN Analysis Group – Present Organization

SBN Analysis Working Group

Convener: Daniele Gibin
Convener: Georgia Karagiorgi

Neutrino Event Generators
(Simulation of ν interactions and Tuning on SBN data)

Convener: Marco Roda

TPC Reconstruction
(track/shower and vertex reconstruction)

Convener: Yun-Tse Tsai, Tracy Usher
Convener: Dom Brailsford

TPC Simulation and Calibration
(Simulation/reconstruction of charge, dE/dx, Lifetime, Space Charge, including calibration procedure)

Convener: Filippo Varanini
Convener: Mike Mooney

Photo Detection Systems (PDS) Simulation & Reconstruction
(PDS signals, timing, PDS-TPC matching)

Convener: Alessandro Menegolli
Convener: Diego Garcia Gomez

CRT Simulation & Reconstruction
(CRT signals, timing, CRT-TPC matching)

Convener: TBD
Convener: TBD

Event Selection, Cosmic ID, and Rejection
(exploiting the information from TPC, CRT PDS, Triggers, PID, including cross-validation on exclusive channels)

Convener: Christian Farnese
Convener: TBD

Systematics and Oscillation Sensitivities
(Evaluation of flux, cross-sections and detector systematics, Common tools to search for ν oscillations and evaluate oscillation sensitivities)

Convener: Daniele Gibin
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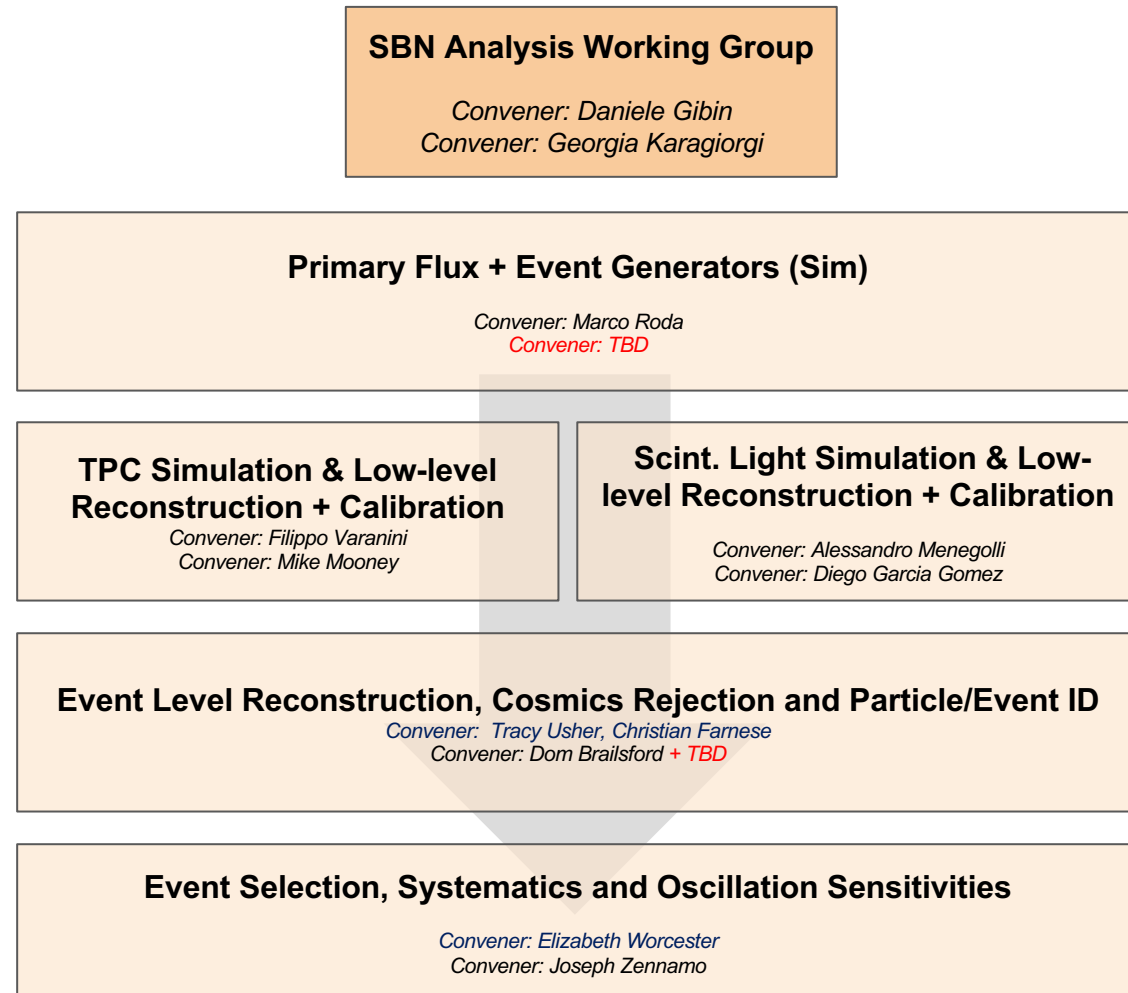
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SBN Analysis Group – Proposed Organization structure

Notes:

New organizational structure mirrors "end-to-end analysis" flow and needs.

Reduces the overall number of WGs, making it less management-heavy.

Has been discussed with ICARUS and SBND leadership

SBN Analysis Working Group

Convener: Daniele Gibin
Convener: Georgia Karagiorgi

Primary Flux + Event Generators (Sim)

Convener: Marco Roda
Convener: TBD

TPC Simulation & Low-level Reconstruction + Calibration
Convener: Filippo Varanini
Convener: Mike Mooney

Scint. Light Simulation & Low-level Reconstruction + Calibration

Convener: Alessandro Menegolli
Convener: Diego Garcia Gomez

Event Level Reconstruction, Cosmics Rejection and Particle/Event ID
Convener: Tracy Usher, Christian Farnese
Convener: Dom Brailsford + TBD

Event Selection, Systematics and Oscillation Sensitivities

Convener: Elizabeth Worcester
Convener: Joseph Zennamo

SBN Analysis Group – Proposed Organizational structure

ν Event Generator Joint WG now expanded to include flux simulation, and could also include, in its scope, Beyond Standard Model (BSM) event generators.

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TPC Sim & Calibration and TPC reconstruction merged into a single WG, and refocused on low-level reconstruction.

Analogous for Scintillation light Detection Systems WG (the same as the existing one).

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SBN Analysis Group – Proposed Organizational structure

Merges higher-level reconstruction (flash matching, particle/event ID, kinematics reconstruction, etc.) and event-level calibration with event selection. Also combines cosmic rejection (making use of CRT information) in lieu of CRT Joint WG.

Includes joint exploitation of TPC, light, CRT for beam event identification and cosmic ray rejection.

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Event selection is inherently linked with systematics consideration and oscillation fits. Since the fitter tools/frameworks are well developed, and what is lacking is inputs from event selection and systematics, this allows joining of forces to revitalize efforts on both fronts.

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- The SBN Analysis Group is composed of members of two very active and strong collaborations, and represents a group of motivated, resourceful, skilled, and highly creative scientists, with diverse interests;

- We should **allow and enable people to apply their creativity and interests**, while supporting and guiding them to **do this in an organized (effective and efficient) way**, in order to achieve the best possible science;

- We need to ensure we keep computing needs manageable/viable, optimize physics analysis performance, and use available peoplepower and other resources as efficiently and wisely as possible and avoid "reinventing the wheel" situations.