

SBN Analysis Working Group

SBN Collaboration Meeting
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Coordinating Analysis Plans across the SBN detectors

- Close coordination is required, for successful oscillation analysis
 - Formalizing joint activities into a *single analysis management structure* for the SBN program. Data from the different detectors must be analyzed side-by-side
 - The adoption of a common reconstruction and analysis framework is crucial for the joint analysis of the SBN experiments
 - Teams of experts from each detector. The teams work very closely in working groups organized by topics (signal processing, noise characterization, calibration, reconstruction...)
 - Maximize synergies and mutual cross checks

SBN Analysis Group – a coordinated effort



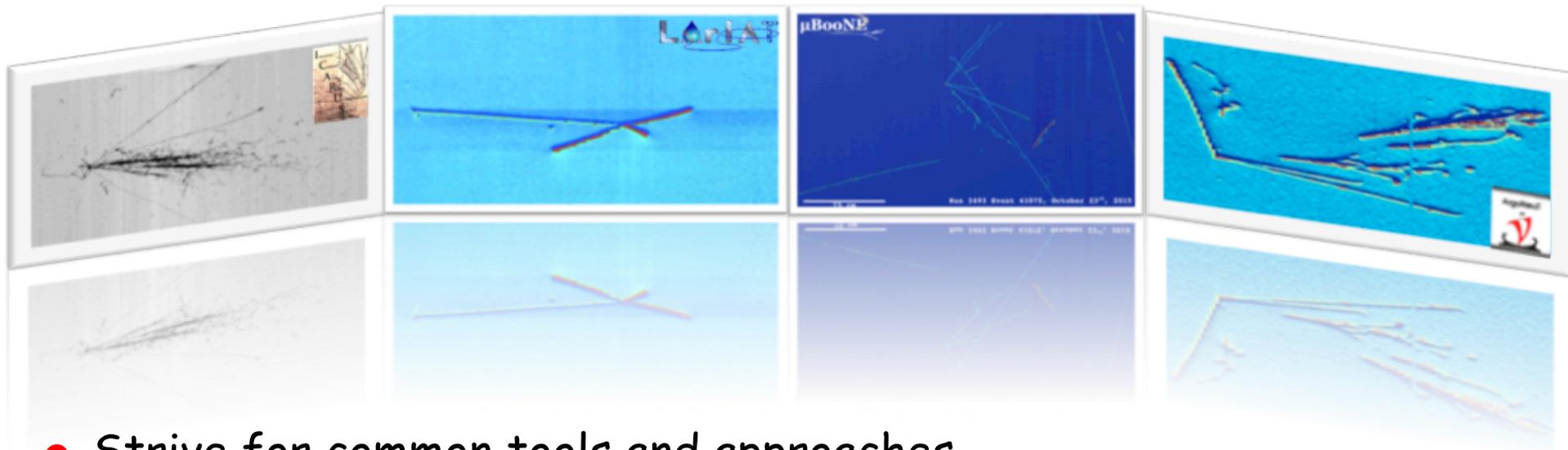
- Joint SBN Oscillation Analysis group formed in September 2016 convened by D. Gibin and O. Palamara
- Aim: explore how the combined physics analysis **sterile neutrino oscillation searches** can be most effectively performed.
- The group includes collaborators from SBN interested in contributing to the oscillation analysis, and Fermilab computing and beam experts.
- The group has defined the strategy for a **common simulation, reconstruction and analysis framework**.

SBN Analysis Group Goals

- Implement a **multi detector simulation, reconstruction and analysis model** within the **common framework (LArSoft)**.
- Implement a **common analysis scheme** in preparation for real data
 - Data from the different detectors must be analyzed side-by-side together with the analysis/mitigation of all systematic effects
- Update projections of **expected physics capabilities** of the SBN program, including
 - reconstruction efficiencies
 - performances and systematic effects
 - background rejection from a full MC simulation of the detectors
- Develop **new analysis methods and tools** to perform sensitivity analyses
 - combining appearance and disappearance channels, and
 - exploiting different models and exclusive topology measurements.

SBN Analysis Group - Reconstruction Strategy

- SBN software tools are all incorporated in common LarSoft framework
- Maximize synergies and capitalize on what has already been developed for LAr TPC signal processing and event reconstruction by previous experiments (ICARUS, ArgoNeuT, LArIAT, MicroBooNE)



- Strive for common tools and approaches
- Common final analysis data structures built from common elements

SBN Analysis Group – Organization/Status/Milestones

- **Bi-weekly meetings of the SBN Analysis Working Group**
- **SBN Analysis Workshops** to facilitate discussion and side-by-side practical work of SBN collaborators
 - **I Workshop - Fermilab Oct. 23-27 2017** (21 participants)
 - Successfully generated **BNB neutrino events** in SBND and ICARUS detectors in the common framework.
 - Focus on **TPC charge reconstruction**: hit, clusters, track reconstruction, neutrino interaction vertex and calorimetric reconstruction.
 - Comparison of **reconstruction performances** in the two detectors.

- **II Workshop – Padova (Italy) March 19-23 2018** (32 participants)
 - Further progress in comparing **vertex and shower reconstruction** in the TPC in the two detectors
 - Use and compare different existing **e.m. shower reconstruction** algorithms
 - Develop **exclusive neutrino event selections** tools based on TPC information
 - Verify geometry and simulation of **Cosmic Ray Tagger**. Develop tools for the reconstruction of CRT signals
 - Develop tools for the reconstruction of **Photon Detection Systems** signals.
 - First use of the **sbncode** for SBND and ICARUS event simulations/reconstruction/analysis

SBN Analysis Group – Organization and Status

- The common workshops were organized into parallel sessions of subgroups of experts from the two detectors focusing on specific items and periodic common sessions for general discussions
- The “work-together” scheme of the workshops is very effective to discuss and progress in the preparation of the necessary tools, share ideas and find common solutions.
- **Next milestones:** reproduce SBN proposal sensitivities through the **sbncode** framework, calculate sensitivities including event selections and reconstructions.

Requests from PAC

- O.P. presentation "SBN Analysis Working Group Report" (SBN-doc-7555)
- PAC Official Report from the meeting not yet available
- The PAC required for
 - a plan for presenting oscillation analysis sensitivity updates that use the current LarSoft framework
 - a more detailed and comprehensive SBN computing/data plan with the physics/calibration/other data requirements mapped into computing requirements through an event model.

Other PAC questions

- *Who are the key people/groups playing big roles in the analysis efforts?*
 - *Need org chart showing the groups and names and what they are doing.*
- *You need Monte Carlo productions several times data statistics + multiple systematics samples. Are you prepared and is Fermilab able to provide what you need?*

- How to organize to best and timely answer these questions?
- Start from the structure of subgroups already implemented during past workshop, more clearly identifying tasks and people to report on progresses

II SBN Analysis Workshop Padova March, 19-23 2018

Working groups:

(A) Light – Verify simulation and develop reconstruction. Prepare the objects to be used for trigger studies and other studies for event classification and reconstruction through light.

(B) CRT – Verify simulation and geometry. CRT reconstruction. Tools to exploit the CRT information.

(C) Different neutrino event selections – Develop tools, identify places where reconstruction improvements are needed.

(D) Shower reconstruction – Try different existing reconstruction algorithms. Identify places where reconstruction improvements are needed.

(E) SBN Oscillation Analysis frameworks – I) Reproduce SBN proposal sensitivities. II) Calculate sensitivities including event selections and reconstructions.

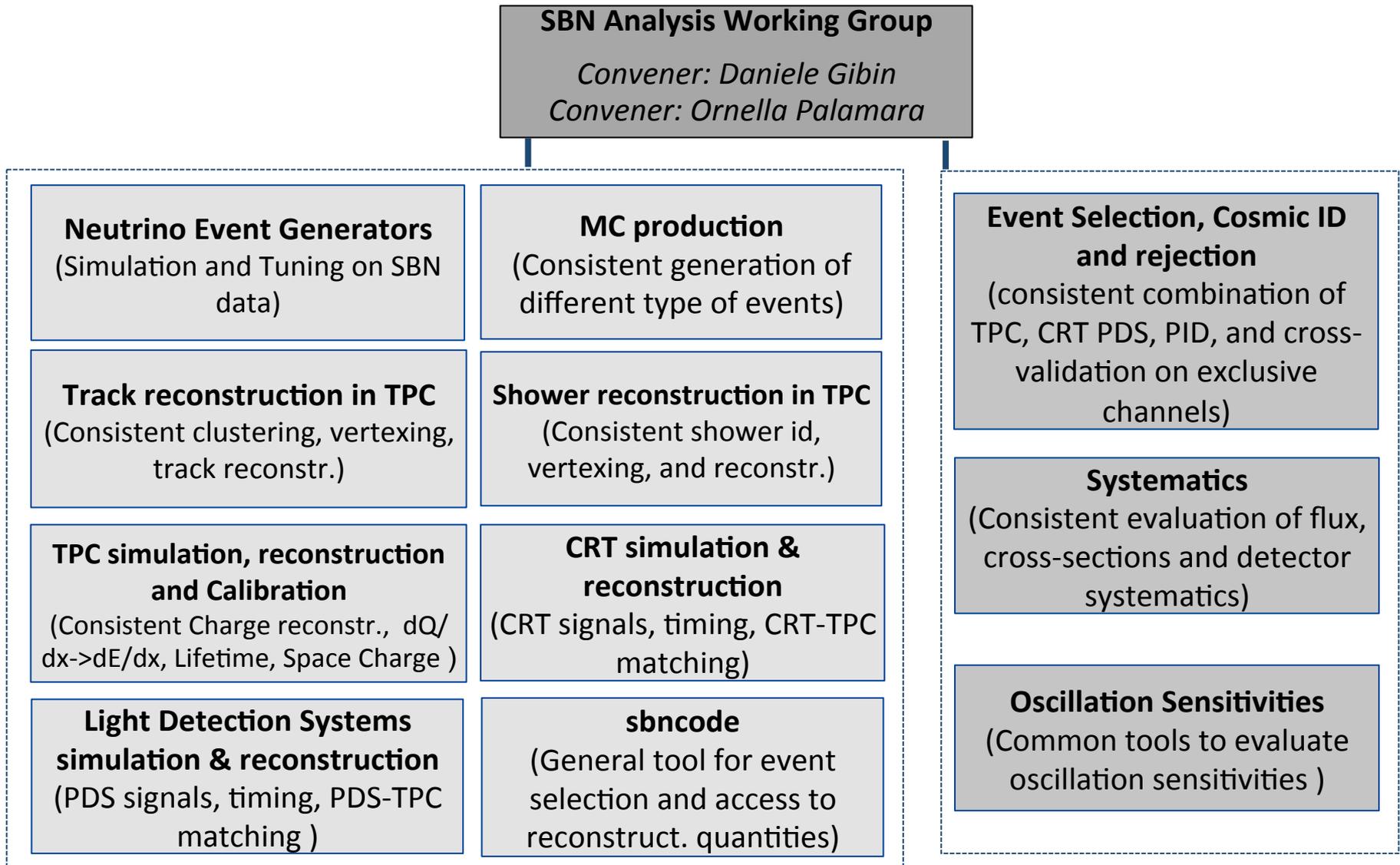
If needed (F) Hit finding/track Reconstruction/Calorimetry/PID – Refine studies done at the I SBN Analysis Workshop in October.

Tasks, goals and mission of the group

- The success of SBN program requires a coherent oscillation analysis of data collected at different distances, adopting for the different detectors as similar as possible reconstruction and simulation tools
- Experts from both detectors are already collaborating on the different items within the SBN analysis group
- Within the group it has been discussed and proposed to set up a more formal organization in subgroups focusing on the different elements, following closely the structure successfully tested during the two common workshops
- The mission of each subgroup includes:
 - ensuring the closest commonality in simulation reconstruction and analysis between the two detectors
 - developing suitable procedures to cross-calibrate and cross-check the efficiencies and backgrounds in the near and far
 - checking that the difference between the detector structure and the running condition are properly understood and handled
- Each subgroup should be driven under the responsibility of two experts, one per detector, periodically reporting to the group on the progress

Proposal for SBN Oscillation Analysis Group Organizational Chart

Replicating the structure of subgroups during the workshops



Conclusions

- The “work-together” scheme, in particular during the workshops was very effective and produced significant progress in many simulation/reconstruction items
- Common analysis frame `sbncode` allowing easy access to physical reconstruction on the two detector has been made available
- **Next milestones:** reproduce SBN proposal sensitivities through the `sbncode` framework, calculate sensitivities including event selections and reconstructions, also matching PAC requests.