Report on the SBN Program

Steve Brice

Fermilab Physics Advisory Committee Meeting

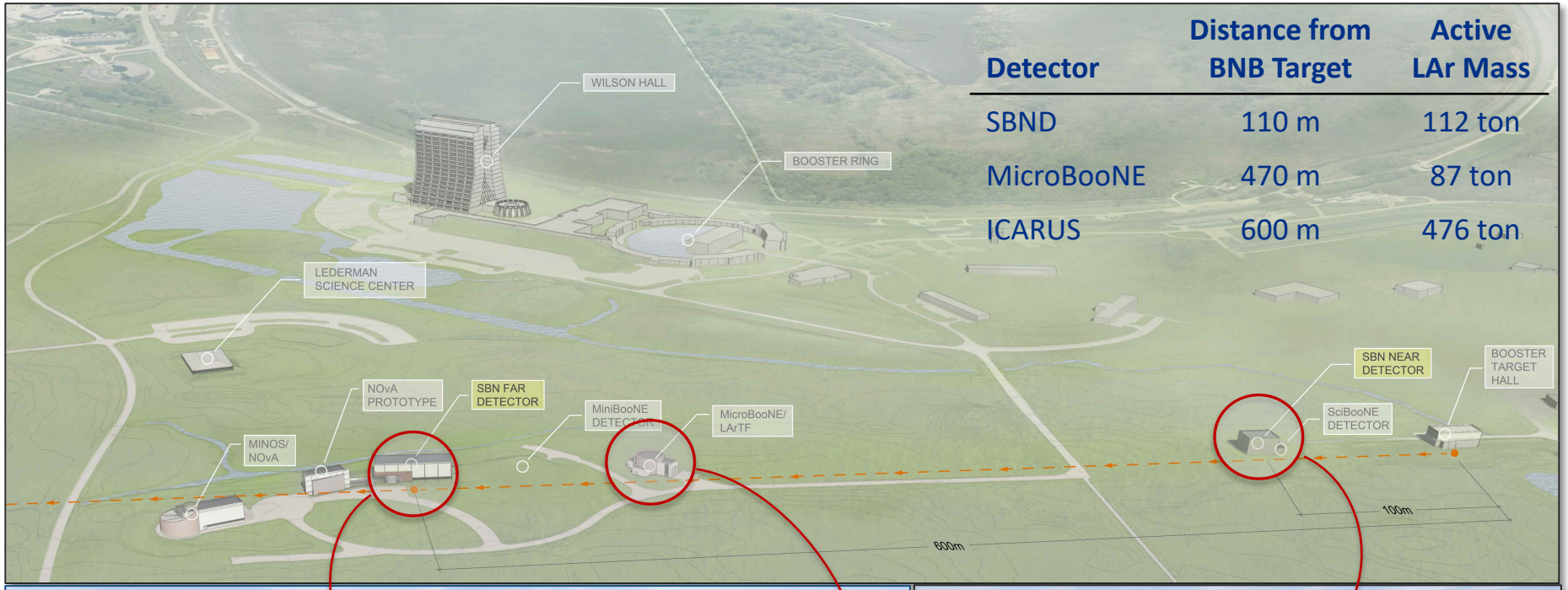
19 July 2019

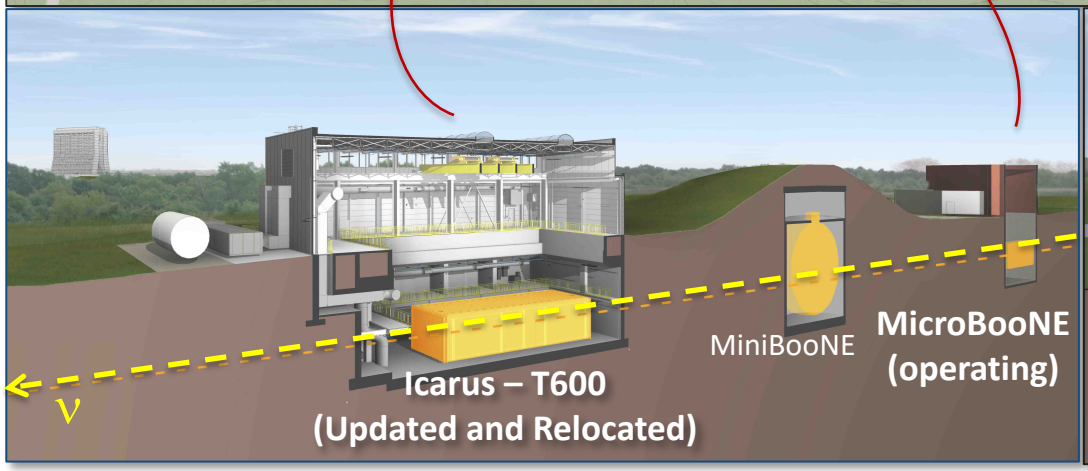
Outline

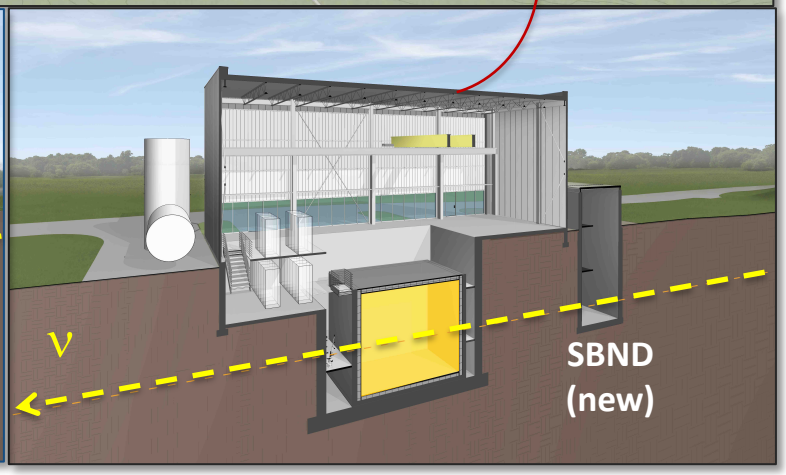
- **SBN Program Overview**
  - Location, Beamline, Physics
  - Trail Blazing for DUNE
- **Progress on the SBN Detectors**
  - Scope and Milestones
  - Far Detector (ICARUS T600) Progress
  - Near Detector (SBND) Progress
  - Additional DOE Funding
- **SBN Governance**
  - SBN Program Office
  - SBN Oversight Board
  - SBN Institutional Board
  - SBN Joint Working Groups
  - Multi-Institution MOU
- **Transition to Operations**
  - Transition to Operations Meetings
  - Operational Readiness Review

The Short Baseline Neutrino (SBN) Program

Detector	Distance from BNB Target	Active LAr Mass
SBND	110 m	112 ton
MicroBooNE	470 m	87 ton
ICARUS	600 m	476 ton

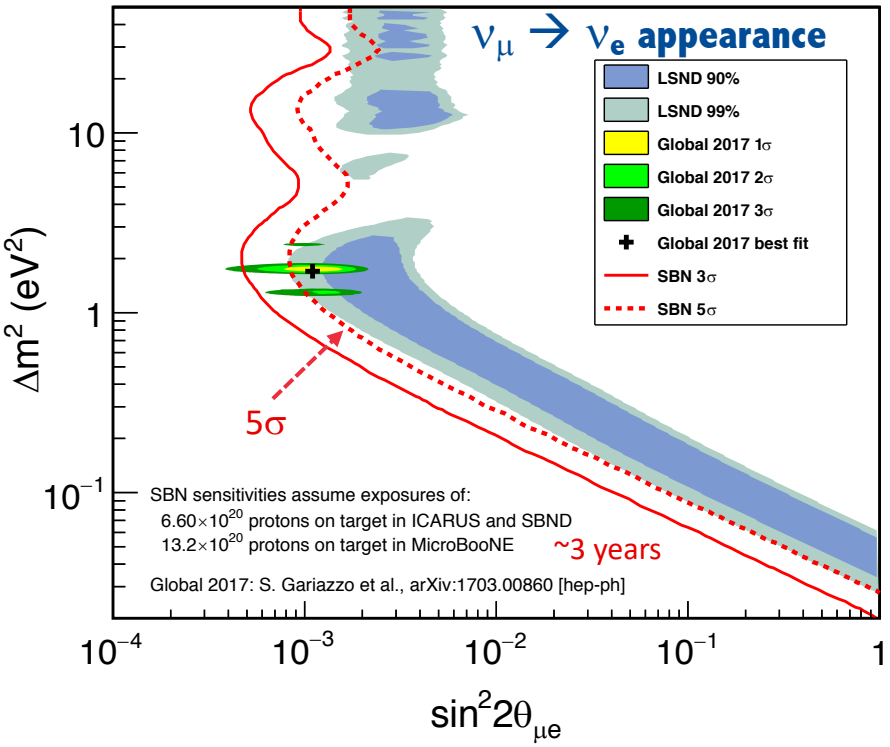


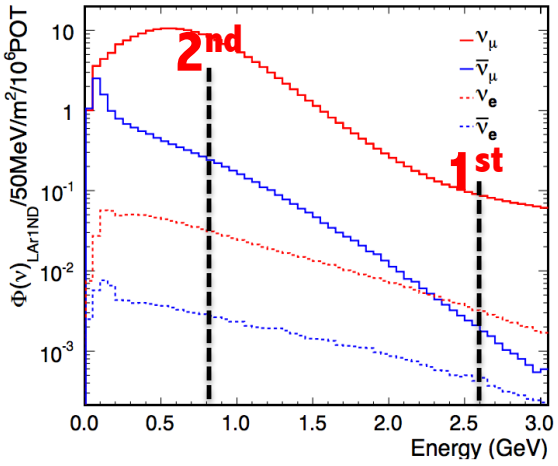


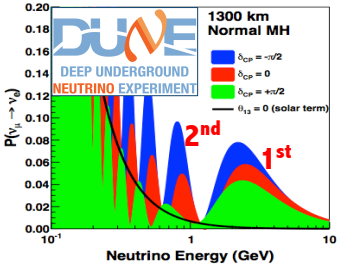


Program Goals

- **Neutrino oscillation measurements in both ν_e appearance and ν_μ disappearance channels**
  - 5σ coverage of LSND signal and best global fits
  - Requires near-far detector comparison
- **ν-argon cross-sections**
  - SBN will have world's largest dataset of ν-argon interactions for the foreseeable future
- **Technology development**
  - SBND development provides a next step beyond ProtoDUNE SP in path to DUNE (e.g. cryostat, cold electronics)
  - Transferable development of analysis tools
- **Collaboration and community building**
  - Direct experimental activity with LAr for the global community working toward DUNE.
  - International collaborative engineering teams on detectors and infrastructure (e.g. cryogenics)







SBN Fluxes

SBN Blazing a Trail for DUNE

- Physics
  - An SBN discovery of a sterile neutrino would reshape the DUNE physics program in a very exciting way
  - The neutrino-Argon cross-sections measured by SBN will be vital to a fast start to the analysis of DUNE
- Technology
  - SBND and the ProtoDUNEs provide a opportunity to iterate on the DUNE cryostat design
  - High Voltage development in MicroBooNE, the ProtoDUNEs, and SBND
  - Joint cold electronics development in the ProtoDUNEs and SBND
  - A full suite of LAr TPC algorithm development started in ICARUS, ArgoNeut, LArIAT, and MicroBooNE, will be perfected in the SBN Program, and ready for DUNE use (DAQ, data compression, reconstruction, particle ID,….)
  - Data from LAr detectors present very significant computing challenges - data volume and compression, algorithm speed, PID challenges and deep learning techniques,….
- Internationalization
  - SBN Multi-Institution MOU is a model for how we hope to form international DUNE agreements
  - ICARUS vessel three party (INFN, CERN, DOE) loan agreement
  - Established equivalency between CERN and FNAL for many safety training courses
  - Acceptance of EU codes for mechanical and cryogenics
- Community Development
  - Training the community that will deliver the DUNE physics
  - Students have theses on SBN whilst also doing work for DUNE
  - Comparable to how the Tevatron program (and others) gave the LHC program a running start

SBN Program Scope

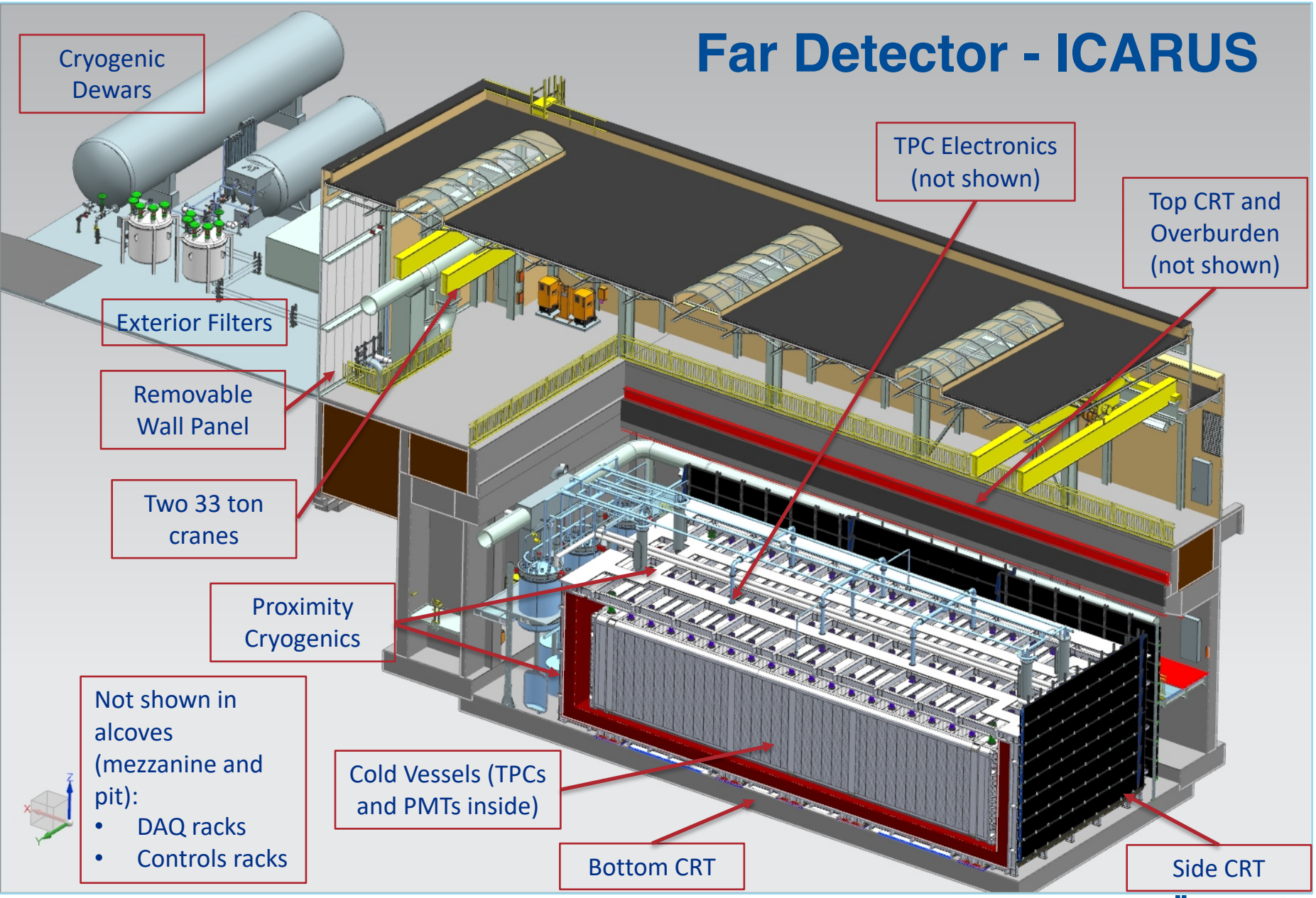
Construction Phase:

- Design and construct two buildings - complete
- Refurbish ICARUS T600 detector - complete
- Design and construct new ICARUS components (e.g. CRT) – final fabrication
- Install ICARUS detector – on track since arrival of cold shield
- Design, construct, and install infrastructure (eg cryogenics) – on schedule
- Design and construct SBND detector – in assembly phase
- Install SBND detector – TPC ready to move around the end of CY2019

Operations Phases:

- Transition to operations as each subsystem receives partial Operational Readiness Clearance (pORC)
- Two major transitions: pORCs to cold commission (LAr fill) ICARUS (fall CY 2019) and SBND (fall CY 2020)
- Two Operational Readiness Reviews
  - Phase 1 – Far Detector Only (Feb 2020)
  - Phase 2 – Near and Far Detectors (early 2021)

Far Detector - ICARUS



ICARUS T600 Contributions

	DOE	CERN	INFN
T600 Refurbishing including new PMTs, Cryostats		50%	50%
TPC Electronics			100%
T600 Transport to FNAL		100%	
Cosmic Ray Tagger	33%	33%	33%
Cryogenics	45%	45%	10%
DAQ	50%		50%
Integration and Installation	33%	33%	33%
Civil Construction	100%		
Overburden	100%		
Cryogen Purchase	100%		

All fractions are approximate (~10% level)

Key SBN Milestones - ICARUS

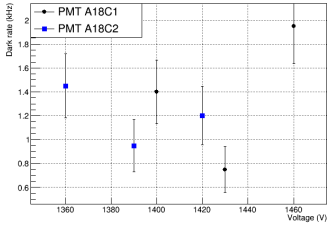
Milestone	Description	Baseline date
I-1	ICARUS detectors are ready to fill with liquid argon	May 2019
I-2	ICARUS detectors are filled with liquid argon and ready for detector commissioning (LAr purity adequate for physics has been achieved)	Nov 2019
I-3a	ICARUS detectors are ready for physics data - *CRT is operational*	Jan 2020
I-3b	ICARUS detectors are ready for physics data - *Shielding in place*	Feb 2020

Baseline dates for all four ICARUS milestones were set in March 2018.
See intermediate milestone slides later and in backup.

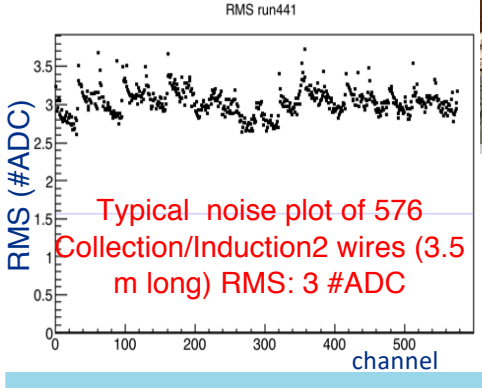
ICARUS Technical Progress

- Both cold vessels pressure tested, sealed and under vacuum
- Proximity Cryo system complete installation
- TPC readout electronics for all 54,000 wires installed and prelim. tested
  - inject test pulse at far end of chamber wires and read out signals on the other end

PMT & Laser System: All 360 PMTs tested in situ (2 w/ problems)

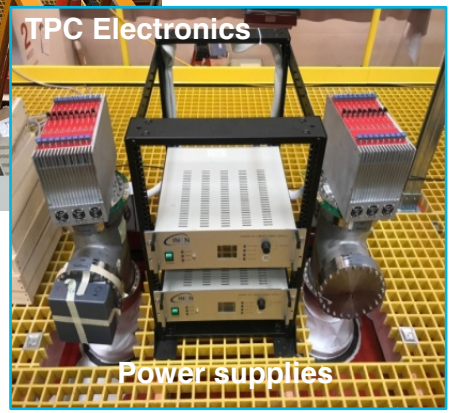


~1 kHz dark rate at gain 10^7, consistent with expectation.



Typical noise plot of 576 Collection/Induction2 wires (3.5 m long) RMS: 3 #ADC

ICARUS Trigger/DAQ
timing and sync. under development
- slice test performed w/ 1 server



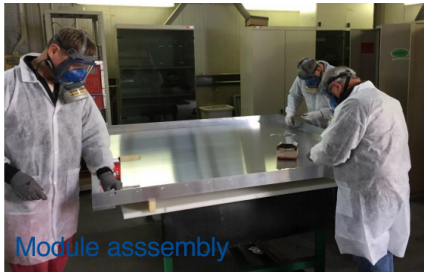
ICARUS Technical Progress

Cosmic Ray Tagger

Side +Bottom CRTs

Side CRT East, West, South installation fall 2019

Top CRTs – production facility at Frascati



Top CRTs

Top CRT module fabrication complete Sept. 2019 - installation after T-600 commissioning

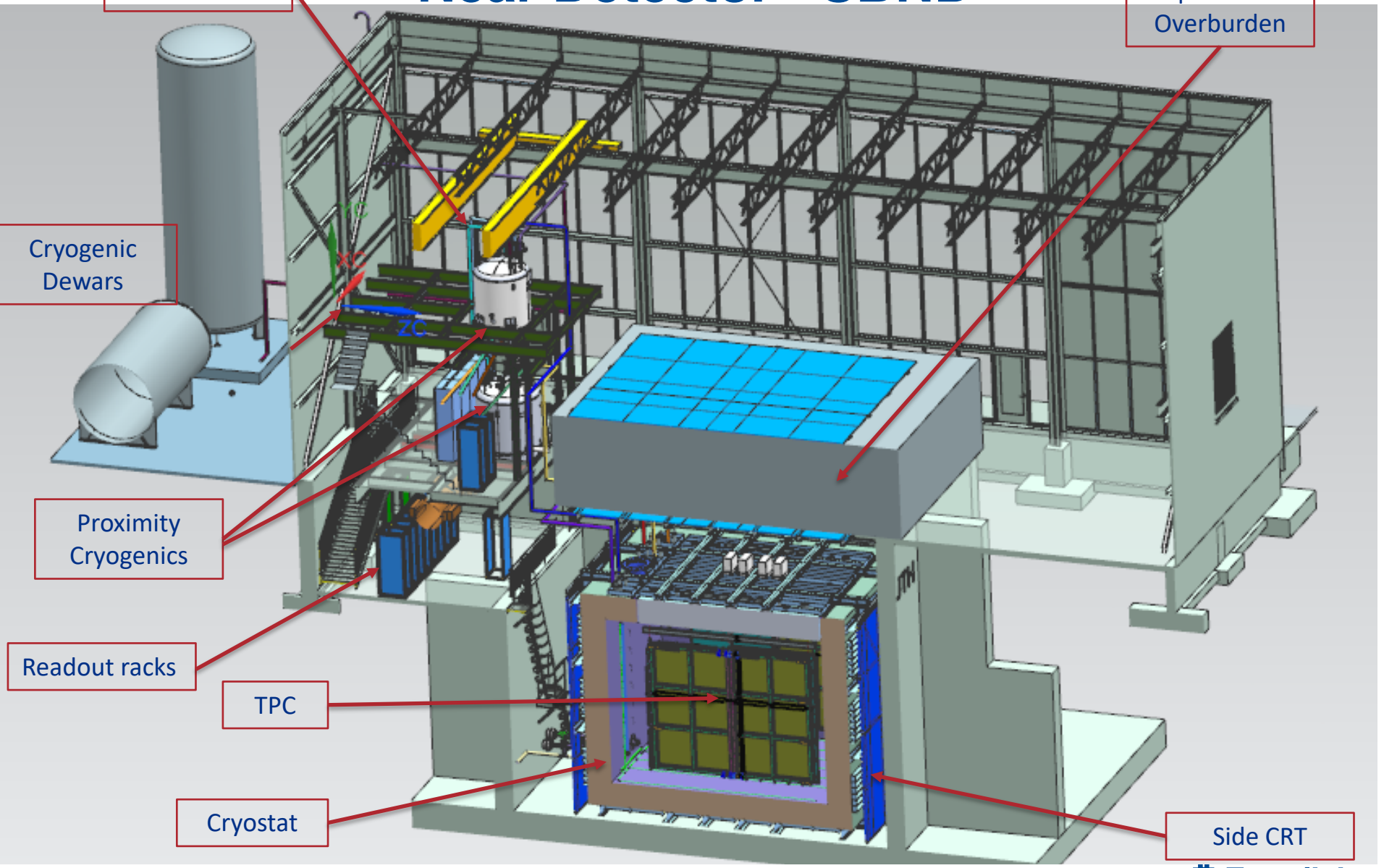
ICARUS cryo plant activation will start around the end of Sept. 2019 with the cold commissioning/LAr -> T600 detector activation, commissioning and calibration phases Nov. 2019

ICARUS Milestones to I-1 Ready to Fill

Intermediate Milestone	Owner	Baseline Date	Forecast Date		Actual Date
Vessels rigged into building	P. Wilson	16-Aug-2018		✓	16-Aug-2018
Manholes welded and vacuum test successful	C. Montanari	10-Oct-2018		✓	11-Oct-2018
Warm Vessel roof complete	C. James	15-Nov-2018		✓	31-Oct-2018
Cryo Platform complete	C. James	15-Dec-2018		✓	04-Oct-2018
Proximity cryogenics installation begins	B. Norris	15-Jan-2019		✓	28-Jan-2019
DBB & flanges installation complete and tested	A. Fava	15-Feb-2019		✓	15-Mar-2019
Cold proximity cryogenics installation complete	B. Norris	15-Apr-2019		✓	21-Jun-2019
1st T300 readout installation complete	A. Fava	15-Mar-2019		✓	11-Apr-2019
All detector readout installed	A. Fava	1-May-2019		✓	17-May-2019
Begin vacuum pumping	C. Montanari	15-Jul-2019		✓	10-Jun-2019
Cryogenic operation approved	B. Norris	15-Jul-2019	20-Sept-2019		
I1: ICARUS detectors ready to fill with LAr	**P. Wilson**	**30-May-2019***	**20-Sept-2019**		

* Baseline for I-1 was set in March 2018; the intermediate milestones were defined and baselined in the Program schedule afterward, in July 2018.

Near Detector - SBND



SBND Contributions

	DOE	US NSF	CERN	INFN	UK UKRI	Switzerland	LANL LDRD	Brazil
TPC Design and Fabrication		50%			50%			
TPC Electronics	85%	15%			X			
PMT System							100%	
Light detection (enhance.)		X			X			X
Calibration Laser						100%		
Cosmic Ray Tagger						100%		
Cryogenics	50%		50%					
Cryostat	X		X	X				
DAQ	100%							
Integration and Installation	90%	X			X		X	
Civil Construction	100%							
Overburden	100%							
Cryogen Purchase	100%							

All fractions are approximate (~10% level)
X = contribution but specific fraction tbd

Key SBN Milestones - SBND

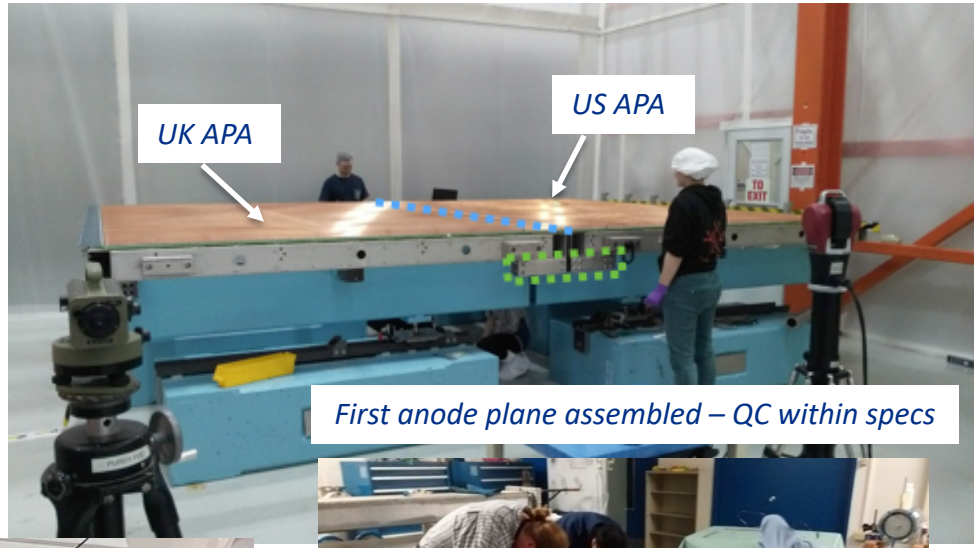
Milestone	Description	Baseline Date
S-1	SBND is ready for transport from Dzero Assembly Building to the SBN ND hall	Aug 2019
S-2	SBND detector is ready to fill with liquid argon	July 2020
S-3	SBND detector is filled with liquid argon and ready for detector commissioning (LAr purity adequate for physics has been achieved)	Feb 2021
S-4a	SBND detectors are ready for physics data - *CRT is operational*	March 2021
S-4b	SBND detectors are ready for physics data - *Shielding in place*	April 2021

Baseline dates for S-2 through S-4b were set in Nov 2018 after schedule re-plan including float relative to forecast dates.
See intermediate milestone slides later and in backup

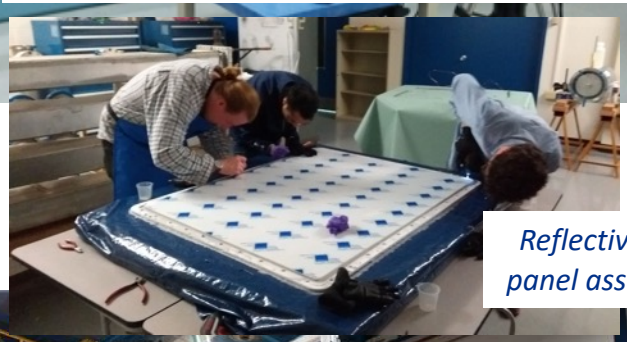
SBND Technical Progress

TPC Assembly at DAB

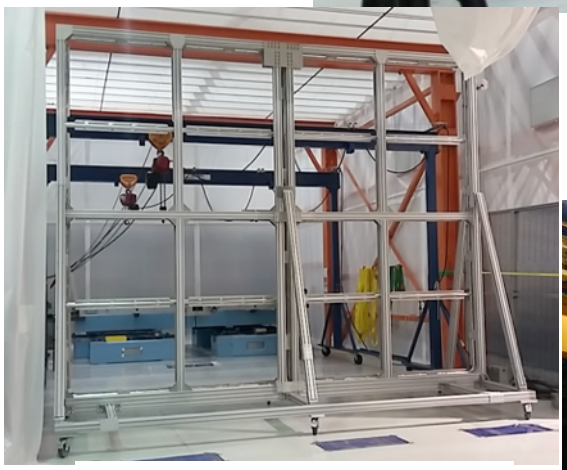
- Production of TPC components in UK & US complete
  - All major components delivered to FNAL
- Successful alignment, coupling and QC of the first of two anode planes
- Cathode frame & reflective foil panels assembled
- Electronics production (@BNL & Nevis) and light system production (@LANL) nearing completion
- TPC assembly transport frame under construction at DAB



First anode plane assembled – QC within specs



Reflective foil panel assembly



Cathode plane frame upright

Assembly transport frame

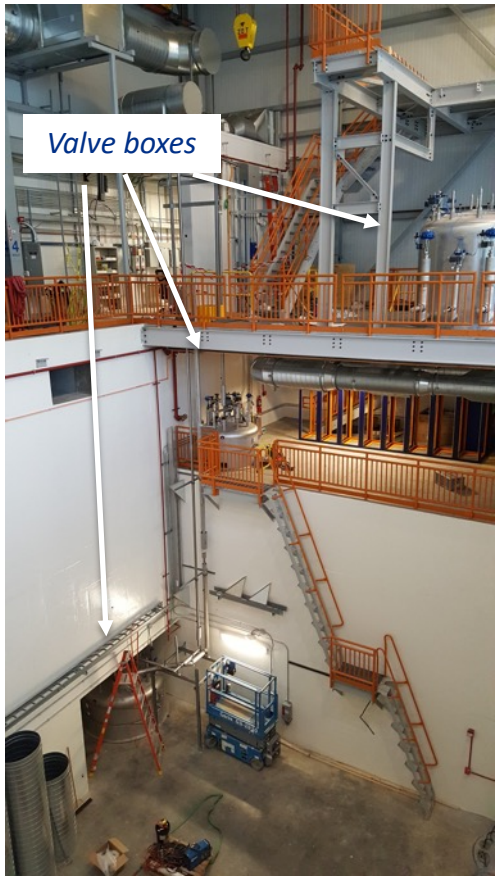
SBND Technical Progress

ND building installation

- Cryogenics platform, valve box and proximity cryogenics installation completing this month
- Warm cryostat fabrication at CERN completed
- Cosmic tagger modules fabricated @Bern delivered and tested

Valve box being craned into position

Warm cryostat structure construction at CERN



Cosmic tagger test installation

SBND Milestones to S-1 SBND ready to move

Intermediate Milestone	Owner	Baseline Date	Forecast Date (Schedule)		Actual Date
First set of APAs shipped to Fermilab	K. Mavrokoridis	24-Sept 2018		✓	4-Mar-2019
PO for COTS ADCs placed	H. Chen	10-Oct-2018		✓	30-Oct-2018
All TPC Components at Fermilab	K. Mavrokoridis	1-Mar-2019		✓	27-Mar-2019
Complete atf assembly at DAB	J. Zennamo	1-May-2019	26-Jul-2019	a	
50% of motherboards delivered to Fermilab	H. Chen	15-May-2019		✓	22-May-19
APAs and CPAs installed in atf	J. Zennamo	15-Jun-2019	27-Sep-2019		
Field cage assembly complete	J. Zennamo	15-Jul-2019	5-Nov-2019		
Cold electronics installed and tested	H. Chen	23-Aug-2019	13-Dec-2019		
S1: TPC ready to move to SBN ND	**A. Schukraft**	**30-Aug-2019**	**18-Dec-2019**	b	

a) The atf fabrication delay propagates through the rest of the schedule leading to S1.

b) The TPC won't be able to move before the cryostat is completed which is likely going to be around early 2020. Therefore, S1 does not delay S2 and subsequent milestones.

Technical Summary & Outlook

- Excellent technical progress for ICARUS
  - Both cold vessels pressure tested, sealed and under vacuum
  - Proximity Cryo system complete installation
  - TPC readout electronics for all 54,000 wires installed and prelim. Tested
  - PMT & Laser System: All 360 PMTs tested in situ (2 w/ problems)
  - On track to complete milestone I-1, ready to fill, in September
- Excellent technical progress for SBND
  - TPC components have all arrived at Fermilab
  - TPC electronics production nearing completion
  - TPC assembly process has started
  - Cryostat design and construction plan being completed
  - Milestone S-1, detector ready for transport, expected late 2019
- The biggest technical risks have all been retired:
  - ✓ Installation of ICARUS vessels
  - ✓ Pressure Testing of ICARUS vessels
  - ✓ Completion of SBND APA wire winding
  - ✓ Delivery of APAs to Fermilab
- Director's Review (SBND focused) planned for late Jan 2020

Additional Funding

- On January 29, Steve Brice, Tim Meyer and Peter Wilson visited DOE to brief them on the financial status of SBN
- After the briefing DOE has provided $3.9M in additional funds
- This allowed critical procurements to proceed unimpeded, for example:
  - LAr contract for the far detector
  - contribution to near detector cryostat design contract
  - near detector cold electronics

SBN Organization (E-1100)

- A set of organizational structures defined to…
  - oversee the completion of the ICARUS and SBND detectors,
  - develop plans and procedures for commissioning and operation
  - coordinate efforts toward combined physics analyses in the future.

1. SBN Program Office
2. SBN Oversight Board (SBN-OB)
3. SBN Institutional Board (SBN-IB)
   - SBND Collaboration
   - ICARUS Collaboration
   - Unaligned collaborators
4. SBN Joint Working Groups

SBN Program Office

- **Purpose:** Oversee construction on the SBN near and far detector buildings, install the far detector (ICARUS T600), design, construct, and install the near detector (SBND)

Program Support:
Program Coordinator – *Peter Wilson*
Deputy Coordinator – *Cat James*
Program Engineer – *Barry Norris*
Program Electrical Coordinator – *Linda Bagby*
Program Integration Engineer – *Andy Stefanik*
Logistics and Risk Manager – *Michael Dinnon*
Project Controls – *Ken Domann*
Financial Officer – *Molly Anderson*
Administrative Support – *Julie Saviano*
ES&H Coordinator – *Angela Aparicio*
CERN Safety Contact – *Olga Beltramello (CERN)*

Technical Coordinators:
SBND – *Anne Schukraft*

ICARUS – *Claudio Montanari,*
Angela Fava – deputy

Infrastructure – *Cat James*

SBN Oversight Board (SBN-OB)

- **Purpose:** The SBN-OB is internal to SBN and provides a key forum for cross-collaboration communication or agreement development on issues relevant to construction, commissioning, operations, data management, and analysis.
- **Membership:** The group consists of
  - ICARUS and SBND spokespersons
  - SBN collaborators selected to provide good representation of the international groups making major contributions to the ICARUS and SBND detectors,
    - Italy-INFN
    - US-DOE and NSF
    - UK-UKRI
    - Switzerland
    - CERN
  - As Host Lab, the initial Chair of the board is the head of Fermilab Neutrino Division
- **Timeline:**
  - Meetings held quarterly (Five so far - May 15, Sept 21, Nov 30 in 2018, Mar 8, Jun 14 in 2019)

SBN Oversight Board (SBN-OB)

- At the March 8 2019 SBN-OB meeting agreement was reached on a “Statement of Principles for Data Sharing, Analyzing, and Publication within the SBN Program”

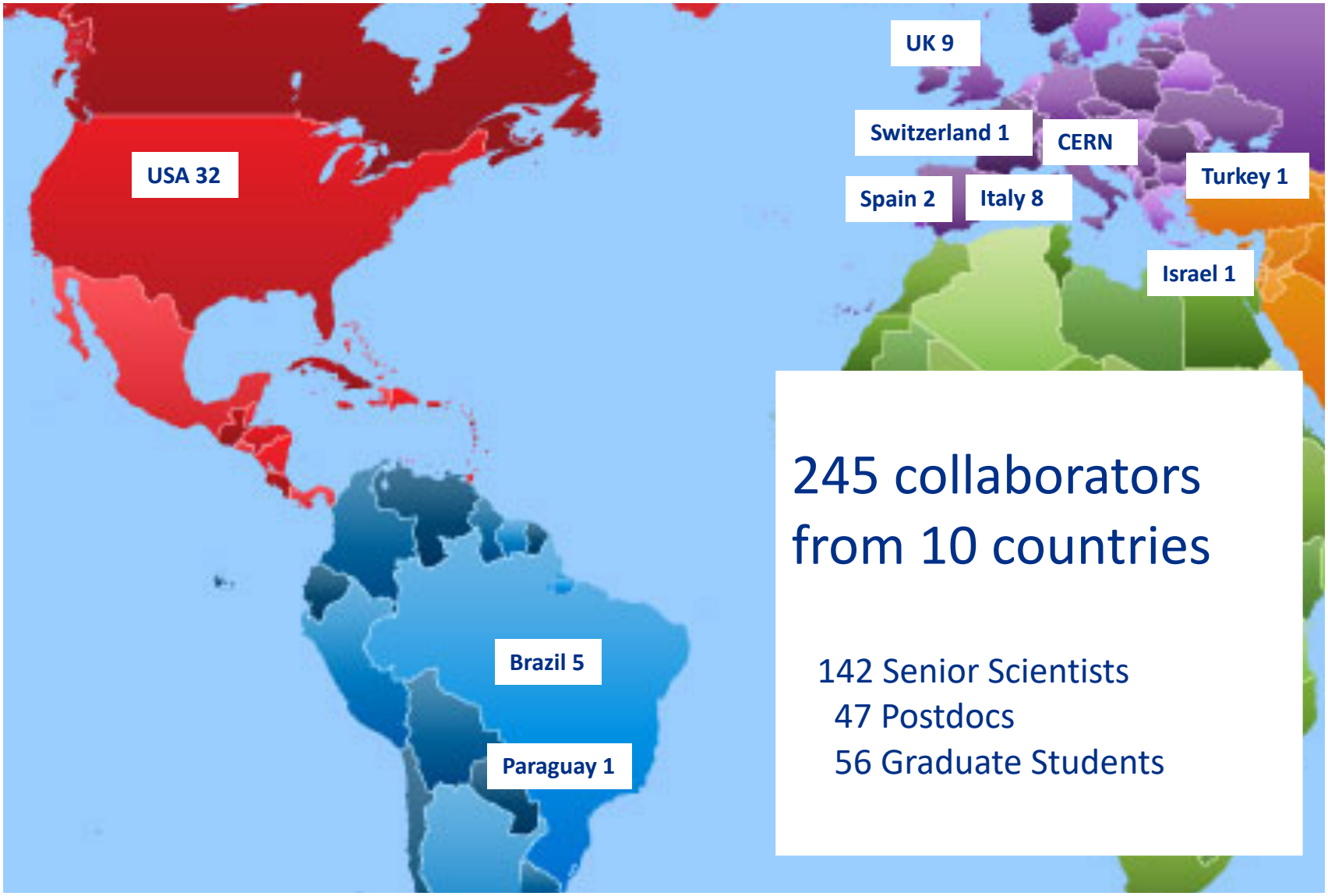
- The SBN-IB will now put together a set of rules and procedures based on these principles

- The SBN-OB has now moved on to consider
  - shared operations
  - the role of MicroBooNE in the SBN program

SBN Institutional Board (SBN-IB)

- **Purpose:** The SBN-IB provides a forum for program-wide communication on issues relevant to the Program. Procedures, policies, and bylaws covering joint aspects of operation, data sharing, data analysis, publications, etc. can be brought to this body for deliberation or developed from within the group. Agreements developed within the SBN-IB will need to return to the individual collaborations for final ratification.
- **Membership:** The SBN-IB will consist of one member from each institution participating in the SBN Program. Each institution's representative is selected by that institution and communicated to the IB chairperson who will maintain the official list of membership and mailing list. The chairperson will be elected by the members of the IB from within its membership.
- **Timeline:** Gina Rameika is serving as interim SBN-IB chair. The first meeting was Sept 22. Gina's first task is to run an election for SBN-IB chair. The SBN-IB signals the formal start of collaboration

SBN Collaborators and Institutions



245 collaborators
from 10 countries

142 Senior Scientists
47 Postdocs
56 Graduate Students

SBN Joint Working Groups

- **Purpose:** A set of SBN Joint Working Groups are needed to co-develop many key aspects of SBN operations and physics analysis. Several joint working groups already exist making extensive use of the experience running MicroBooNE and ICARUS
  - **SBN Analysis:** Explore how combined SBN physics analysis for sterile neutrino oscillation searches can be most effectively performed. Work focuses on implementing a three detector simulation, building reconstruction and analysis tools within a common framework, and developing an end-to-end common analysis scheme in preparation for real data exploitation.
  - **SBN DAQ and Data Pre-processing:** Prepare the infrastructure for the efficient collection of high quality data with ICARUS and SBND using common strategies whenever possible.
  - **SBN Slow Controls:** Compare Slow Controls needs and designs and identify common hardware and software solutions for ICARUS and SBND.
  - **SBN Cosmic Ray Tagger**: Work on the CRTs of both detectors including a common analysis of CRT data and bringing in experience from MicroBooNE.
  - **SBN Data Management:** Work on data storage, processing and distribution
  - **SBN Cryogenics:** Work on common approach to cryo for all detectors
  - New SBN Working Groups shall be set up as needed by the SBN-OB with the intent of spanning all detector subsystems
- **Membership:** Working Groups are open to all participants in the SBN Program. For each Working Group the SBN-OB identifies a set of conveners to lead the activities of the group and report progress to the SBN-OB and the collaborations.

SBN Multi-Institutional MOU

- A Memorandum of Understanding (MOU) for building of the SBN program is in draft form
- The expectation is that it will be signed by the parties contributing to building the SBN program
- Such a multi-institution document is unusual for the US DOE
- Blazes an important trail for future DUNE agreements

SBN Multi-Institutional MOU Opening

Memorandum of Understanding
for Collaboration in the
Short-Baseline Neutrino Program

between

The Fermi National Accelerator Laboratory, a United States Department of Energy National Laboratory, managed and operated by Fermi Research Alliance, in Batavia, Illinois (hereinafter referred to as “Fermilab”), as the Host Laboratory

on the one hand,

and

the Funding Agencies/Research Institutions and Universities participating in the Short-Baseline Neutrino Program at Fermilab

on the other hand

for the purpose

of collaboratively carrying out a jointly funded and supported physics research program at Fermilab. The Parties mentioned will individually be referred to as a “SBN Participant” and collectively as the “SBN Participants”

SBN Multi-Institutional MOU Preamble

Preamble

As recommended by the 2014 report of the Particle Physics Project Prioritization Panel and the European Strategy for Particle Physics Update 2013, Fermilab has developed an international Short-Baseline Neutrino Program ("SBN Program") to pave the way for substantial international involvement in the future Long-Baseline Neutrino Facility and the associated Deep Underground Neutrino Experiment ("LBNF/DUNE");

a) The SBN Participants wish to collaborate in the construction, operation, and physics data analysis using a set of liquid argon detectors for the SBN Program that will be deployed in the Fermilab Booster Neutrino Beamline (BNB);

a) This Memorandum of Understanding (hereafter referred to as "MOU") is a non-legally binding agreement that records contributions by SBN Participants to the SBN Program, it being understood that the SBN Participants recognize that the success of the SBN Program depends on all the SBN Participants adhering to its provisions.

Parties to the SBN MOU

- The Parties to the SBN MOU are the agencies, labs, and universities providing the resources to build the program
  - Fermi National Accelerator Laboratory (“Fermilab”);
  - The National Science Foundation of the United States ("NSF")*;
  - European Organization for Nuclear Research (“CERN”);
  - Istituto Nazionale di Fisica Nucleare ("INFN");
  - United Kingdom Research and Innovation (“UKRI”);
  - University of Bern, Switzerland ("Bern");
  - Los Alamos National Laboratory through its associated Laboratory Directed Research and Development program ("LANL");

  *NSF contributions will be listed, but the NSF will not be signing this MOU

- There are about 60 institutions in the SBN collaboration that will operate the detectors and analyze the data from them

Proposed Annexes to the SBN MOU

- **Annex 1:** Institutions Collaborating in the SBN Program and Names of Their Contact Persons
- **Annex 2:** SBN Collaboration Organization Structure
- **Annex 3:** SBN Program Governance
- **Annex 4:** SBN Cryogenics, SBND Cryostat, and ICARUS Cosmic Ray Tagger
- **Annex 5:** SBND Cosmic Ray Tagger
- **Annex 6:** Participation of SBN Participant in Each SBN Subproject for ICARUS and SBND
- **Annex 7:** Ownership of Equipment to the SBN Program
- **Annex 8:** Financial Guidelines for the SBN Program

Transition to Operations

- Jan 2019 SBN Program briefed DOE on the plan for the transition to operations
  - Addressed commissioning and operations plans for both detectors and associated support (e.g. cryogenics, online computing, data storage)

- Transition to Operations Team created
  - Angela Aparicio – Neutrino Division (ND) Safety Officer
  - Steve Brice – ND Representative
  - Angela Fava – Far Detector Deputy Technical Coordinator and Deputy Commissioning Coordinator
  - Cat James – Deputy Program Coordinator
  - Claudio Montanari – Far Detector Technical Coordinator and Commissioning Coordinator
  - Barry Norris – SBN Program Engineer and Head of ND Technical Support Dept
  - Dave Schmitz – SBND collaboration representative
  - Michelle Stancari – Near Detector Commissioning Coordinator
  - Peter Wilson – Program Coordinator, chair of TOT
  - Bob Wilson – ICARUS collaboration representative
  - Wes Ketchum - Scientific Computing Division representative

- SBN Transition to Operations meetings launched
  - Chaired by Peter Wilson and Steve Brice
  - Roughly monthly meetings (4 held so far)
  - Will culminate in an Operational Readiness Review (ORR)

Operational Readiness Review (ORR)

- ORR for “Phase 1- Far Detector Only” tentatively scheduled for early February 2020
  - Timed to correspond roughly to the point when the ICARUS HV is raised and stable and most systems are commissioned

- An Experiment Operations Plan (EOP) is developed and reviewed

- There will be an ORR for “Phase 2 – Far and Near Detector” when the SBND detector is ready (should be early CY2021)

Summary

- SBN construction and installation progressing well
  - Within a couple of months on milestones
  - DOE provided $3.9M additional to keep schedule on track
  - Director's Review planned for Jan 2020
- SBN Multi-Institutional MOU drafted and DOE review almost complete
  - Important trail blazing for DUNE
- SBN Governance structures in place and working.
  - Have agreement on "Statement of Principles for Data Sharing, Analyzing, and Publication within the SBN Program"
- SBN Transition to Operations planning for "Phase 1 – Far Detector Only" is underway
  - Operational Readiness Review expected Feb 2020

Backups

SBND Milestones to S-1 SBND ready to move

Intermediate Milestone	Owner	Baseline Date	Forecast Date (Schedule)		Actual Date
First set of APAs shipped to Fermilab	K. Mavrokoridis	24-Sept 2018		✓	4-Mar-2019
PO for COTS ADCs placed	H. Chen	10-Oct-2018		✓	30-Oct-2018
All TPC Components at Fermilab	K. Mavrokoridis	1-Mar-2019		✓	27-Mar-2019
Complete atf assembly at DAB	J. Zennamo	1-May-2019	26-Jul-2019	a	
50% of motherboards delivered to Fermilab	H. Chen	15-May-2019		✓	22-May-19
APAs and CPAs installed in atf	J. Zennamo	15-Jun-2019	27-Sep-2019		
Field cage assembly complete	J. Zennamo	15-Jul-2019	5-Nov-2019		
Cold electronics installed and tested	H. Chen	23-Aug-2019	13-Dec-2019		
S1: TPC ready to move to SBN ND	**A. Schukraft**	**30-Aug-2019**	**18-Dec-2019**	b	

a) The atf fabrication delay propagates through the rest of the schedule leading to S1.

b) The TPC won't be able to move before the cryostat is completed which is likely going to be around early 2020. Therefore, S1 does not delay S2 and subsequent milestones.

SBND Milestones to S-2 Ready to Fill

Intermediate Milestone	Owner	Baseline Date	Forecast Date		Actual Date
GTT Design Study Begins	M. Nessi	1-Feb-2019		✓	26-Apr-2019
Delivery of warm box steel	M. Nessi	15-Jun-2019	15-Aug-2019	a	
Warm vessel installation complete	M. Nessi	15-Jul-2019	4-Oct-2019	a	
TPC Transport to ND building complete	J. Zennamo	15-Sept-2019	30-Jan-2020		
Cryostat material arrives at Fermilab	M. Nessi	1-Oct-2019	12-Nov-2019	b	
Cryostat top plug is ready to attach to atf	M. Nessi	1-Nov-2019	23-Jan-2020	b	
Membrane Cryostat Completed	M. Kim	1-Mar-2020	22-Jan-2020	b	
Plug welded to cryostat	M. Kim, J. Zennamo	15-Apr-2020	11-May-2020	b	
Cryogenic operation approved	M. Geynisman	1-Jul-2020	5-Aug-2020	b	
S2: SBND detector is ready to fill with liquid Argon	**A. Schukraft**	**15-Jul-2020**	5-Aug-2020	b	

a) Warm cryostat schedule has been updated – added ~ 1 month to completion of S2.

b) Membrane cryostat and top cap schedule still subject to changes

SBND Milestones to S-3 Detector Filled

Intermediate Milestone	Owner	Baseline Date	Forecast Date		Actual Date
Laser system installation complete	I. Kreslo	1-Oct-2020	4-Jun-2020		
Detector checkout at 130-150 K complete	M. Stancari	15-Nov-2020	21-Dec-2020		
Vessels filled with LAr, ready for HV	M. Geynisman	21-Dec-2020	25-Jan-2021		
Drift HV operational	A. Schukraft	31-Jan-2021	8-Feb-2021		
PMTs operational	R. Van de Water	31-Jan-2021	1-Feb-2021		
Cryogenics commissioning complete	M. Geynisman	28-Feb-2021	22-Feb-2021		
Cosmic tracks are observed in the TPC	M. Stancari	28-Feb-2021	22-Feb-2021		
S3: SBND detector is filled with liquid argon and ready for physics commissioning (LAr purity adequate for physics has been achieved)	**A. Schukraft/M. Stancari**	**28-Feb-2021**	**22-Feb-2021**		

Note:

Accumulated ~1 months delay wrt previous forecast date through cryostat schedule update we implemented last month.

SBND Milestones to S-4a ready for physics data – CRT operational

Intermediate Milestone	Owner	Baseline Date	Forecast Date		Actual Date
Top CRT panels delivered to Fermilab	I. Kreslo	1-Jul-2019	10-Mar-2020	a	
Slow controls operational for all detector systems	S. Gollapinni	15-Sept-2020	8-Sep-2020		
DAQ operational with >5Hz output	W. Badgett	1-Nov-2020	7-Dec-2020		
Detector system timing synchronized with beam	W. Badgett	15-Nov-2020	12-Nov-2020		
Trigger system operational	W. Badgett	15-Jan-2021	1-Feb-2021		
Top CRT panels are installed and ORC'ed	I. Kreslo	31-Mar-2021	15-Mar-2021		
S4a: SBND detectors are ready for physics data – CRT is operational	**M. Stancari**	**31-Mar-2021**	**22-Mar-2021**		

a) Production of the top CRT modules has been delayed to reflect current SBN schedule and optimize load on the Bern workshop. There is no impact on the overall SBN schedule
(Installation is planned to start in Dec 2020).

Note:

Accumulated ~1 months delay wrt previous forecast date through cryostat schedule update we implemented last month.

SBND Milestones to S-4b ready for physics data – shielding in place

Intermediate Milestone	Owner	Baseline Date	Forecast Date		Actual Date
Shielding blocks in place	C. James	21-Apr-2021	9-Apr-2021		
CRT system complete and fully commissioned	I. Kreslo	30-Apr-2021	20-Apr-2021		
S4b: SBND detectors are ready for physics data – Shielding	**M. Stancari**	**30-Apr-2021**	**20-Apr-2021**		

Note:

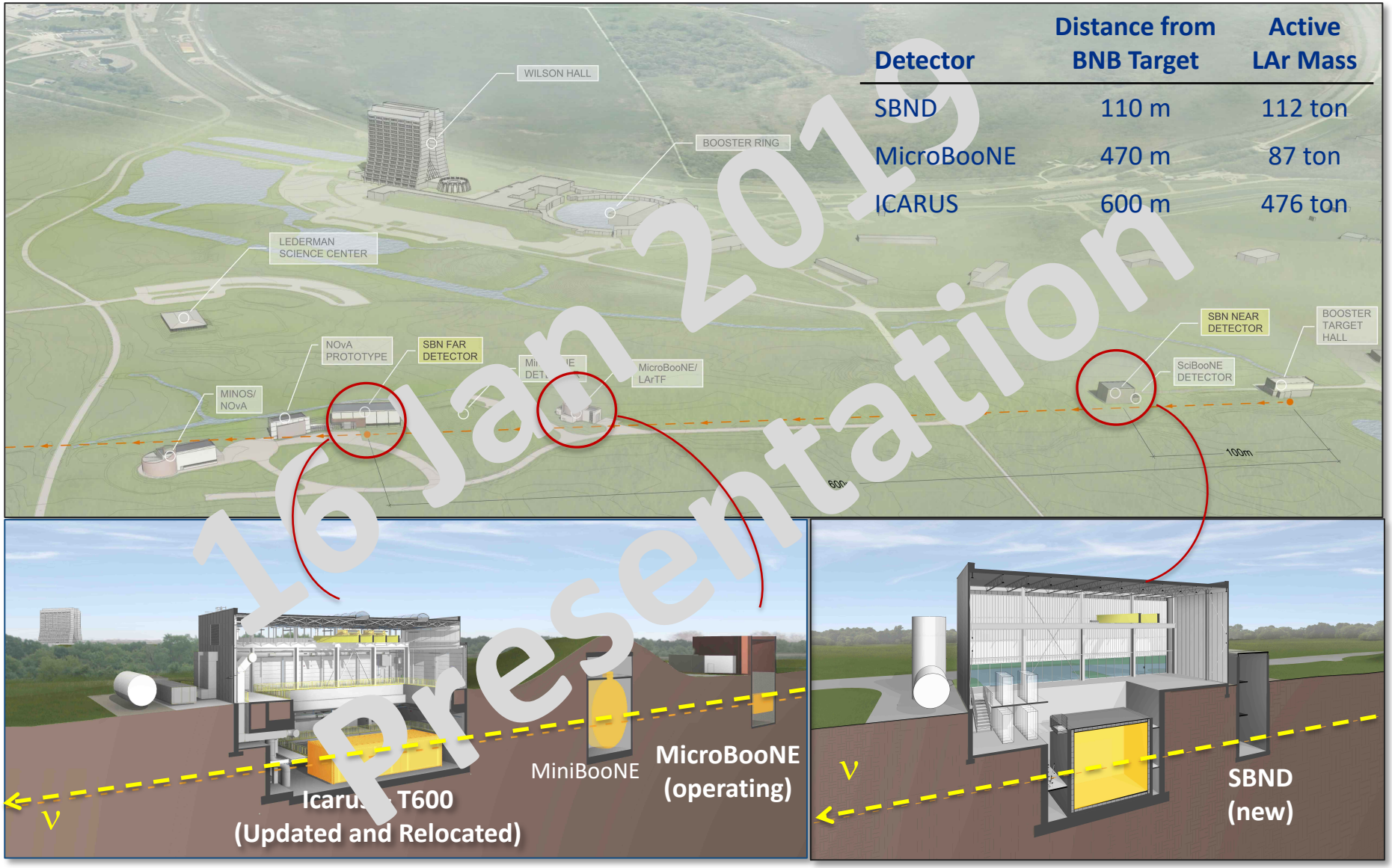
Accumulated ~1 months delay wrt previous forecast date through cryostat schedule update we implemented last month.

16 January PAC Presentation

Outline

- **SBN Program Overview**
  - Location, Beamline, Physics
  - Trail Blazing for DUNE
- **Progress on the SBN Detectors**
  - Scope and Milestones
  - Far Detector (ICARUS T600) Progress
  - Near Detector (SBND) Progress
  - SBN Director's Review (Dec 2018)
- **SBN Multi-Institution MOU**
  - Philosophy behind the MOU
  - Parties to the MOU
  - Annexes to the MOU
- **SBN Collaboration Governance**
  - SBN Program Office
  - SBN Oversight Board
  - SBN Institutional Board
  - SBN Joint Working Groups

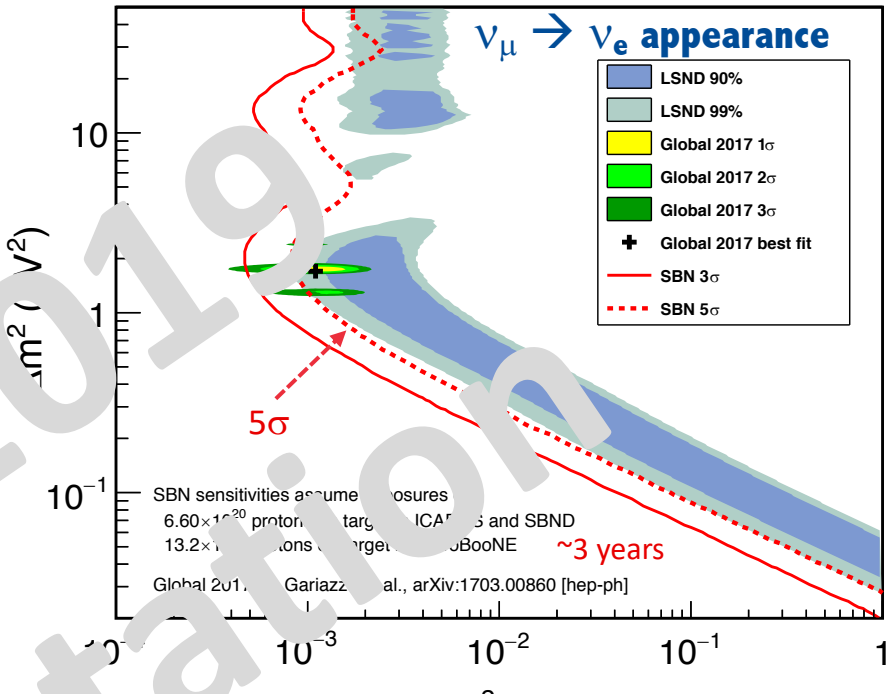
The Short Baseline Neutrino (SBN) Program

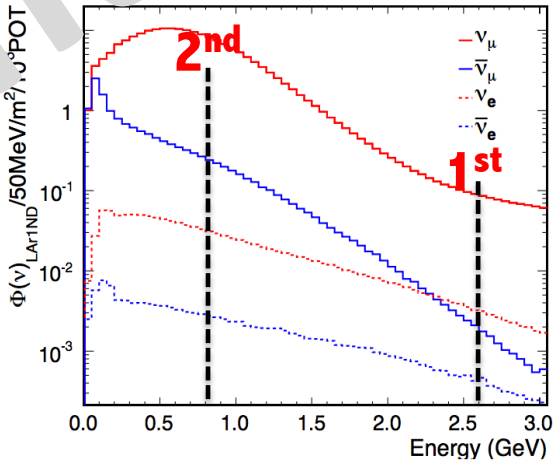


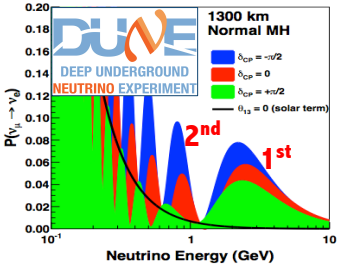
Detector	Distance from BNB Target	Active LAr Mass
SBND	110 m	112 ton
MicroBooNE	470 m	87 ton
ICARUS	600 m	476 ton

Program Goals

- **Neutrino oscillation measurements in both ν_e appearance and ν_μ disappearance channels**
  - 5σ coverage of LSND signal and best global fits
  - Requires near-far detector comparison
- **ν-argon cross-sections**
  - SBN will have world's largest dataset of ν-argon interactions for the foreseeable future
- **Technology development**
  - SBND development provides a next step beyond ProtoDUNE SP in path to DUNE (e.g. cold electronics)
  - Transferable development of analysis tools
- **Collaboration and community building**
  - Direct experimental activity with LAr for the global community working toward DUNE.
  - International collaborative engineering teams on detectors and infrastructure (e.g. cryogenics)







SBN Fluxes

SBN Blazing a Trail for DUNE

- Physics
  - An SBN discovery of a sterile neutrino would reshape the DUNE physics program in a very exciting way
- Technology
  - SBND and the ProtoDUNEs provide a opportunity to iterate on the DUNE cryostat design
  - High Voltage development in MicroBooNE, the ProtoDUNEs, and SBND
  - Joint cold electronics development in the ProtoDUNEs and SBND
  - A full suite of LAr TPC algorithm development started in ICARUS, ArgoNeut, LArIAT, and MicroBooNE, will be perfected in the SBN Program, and ready for DUNE use (DAQ, data compression, reconstruction, particle ID,….)
  - Data from LAr detectors present very significant computing challenges - data volume and compression, algorithm speed, PID challenges and deep learning techniques,….
- Internationalization
  - SBN Multi-Institution MOU is a model for how we hope to form international DUNE agreements
  - ICARUS vessel three party (INFN, CERN, DOE) loan agreement
  - Opportunity to switch to a review system where the international stakeholders jointly conduct the reviews
  - Established equivalency between CERN and FNAL for many safety training courses
  - Acceptance of EU codes for mechanical and cryogenics
- Community Development
  - Training the community that will deliver the DUNE physics
  - Students have theses on SBN whilst also doing work for DUNE
  - Comparable to how the Tevatron program (and others) gave the LHC program a running start

SBN Program Scope

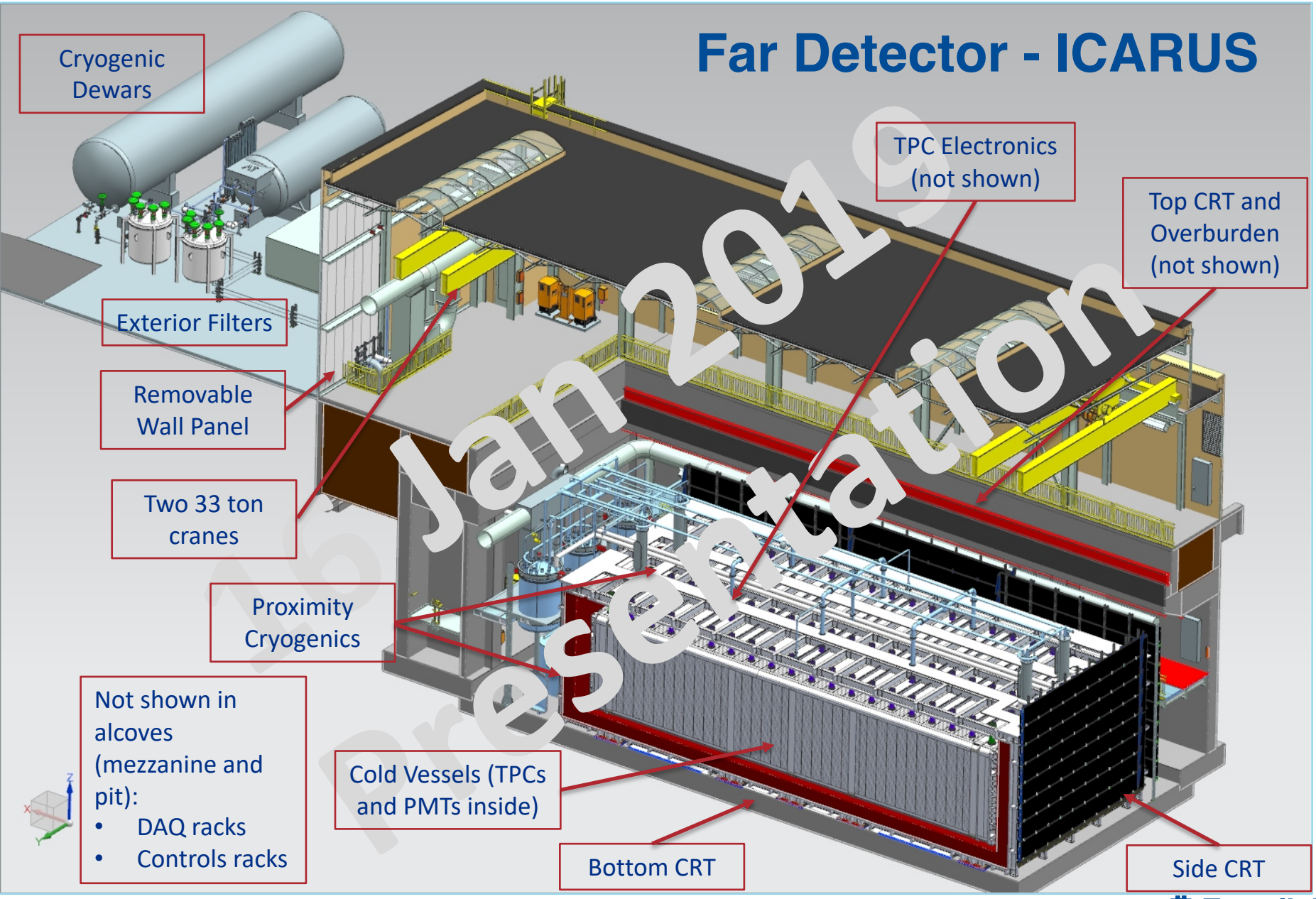
Construction Phase:

- Design and construct two buildings - complete
- Refurbish ICARUS T600 detector - complete
- Design and construct new ICARUS components (e.g. CRT) – final fabrication
- Install ICARUS detector – on track since arrival of cold shield
- Design, construct, and install infrastructure (eg cryogenics) – on schedule
- Design and construct SBND detector – moving to assembly phase
- Install SBND detector – preparing to start first installations in early CY2019

Operations Phase:

- Transition to operations as each system receives partial Operational Readiness Clearance (pORC)
- Two major transitions: pORCs to cold commission (LAr fill) ICARUS (mid-CY 2019) and SBND (mid-CY 2020)
- Commissioning, physics operations and physics analysis of ICARUS, MicroBooNE and SBND detectors

Far Detector - ICARUS



ICARUS T600 Contributions

	DOE	CERN	INFN
T600 Refurbishing including new PMTs, Cryostats		[illegible]%	[illegible]
TPC Electronics			100%
T600 Transport to FNAL		100%	
Cosmic Ray Tagger	[illegible]3%	33%	33.[illegible]
Cryogenics	45%	45%	[illegible]0%
DAQ	50%		50%
Int[illegible]on and Installation	[illegible]%	[illegible]%	33%
Civil Construction	10[illegible]%		
Overburden	100%		
Cryogen Purc[illegible]	100%		

All fractions are approximate (~10% level)

Key SBN Milestones - ICARUS

Milestone	Description	Baseline date
I-1	ICARUS detectors are ready to fill with liquid argon	May 2019
I-2	ICARUS detectors are filled with liquid argon and ready for detector commissioning (LAr purity adequate for physics has been achieved)	Nov 2019
I-3a	ICARUS detectors are ready for physics data - *CRT is operational*	Jan 2020
I-3b	ICARUS detectors are ready for physics data - *shielding in place*	Feb 2020

Baseline dates for all four ICARUS milestones were set in March 2018.
See intermediate milestone slides later and in backup.

Far Detector Installation

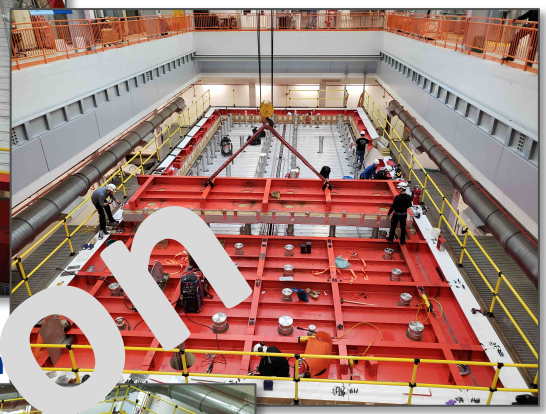
- Installation progress (CERN/FNAL/INFN):
  - ✓ Cold vessel vacuum tested
  - ✓ Cold vessels rigged into building (Emmert Intl.)
  - ✓ Cable chimneys installed, continuity tested and vac. tested
  - ✓ Top cold shield installed and tested
  - ✓ Cryogenics platform installed
  - ✓ Warm vessel roof installed
  - ✓ Proximity cryogenics delivered to Fermilab
  - – Installation of crosses and electronics feedthroughs in progress
  - – Proximity cryogenics installation starts Jan 28

Rigging the ICARUS Vessels

Far Detector Installation

- Installation progress (CERN/FNAL/INFN):
  - ✓ Cold vessel vacuum tested
  - ✓ Cold vessels rigged into building (Emmert Intl.)
  - ✓ Cable chimneys installed, continuity tested and vac. tested
  - ✓ Top cold shield installed and tested
  - ✓ Cryogenics platform installed
  - ✓ Warm vessel roof installed
  - ✓ Proximity cryogenics delivered to Fermilab
  - – Installation of crosses and electronics feedthroughs in progress
  - – Proximity cryogenics installation starts Jan 28

Chimneys and top cold shield



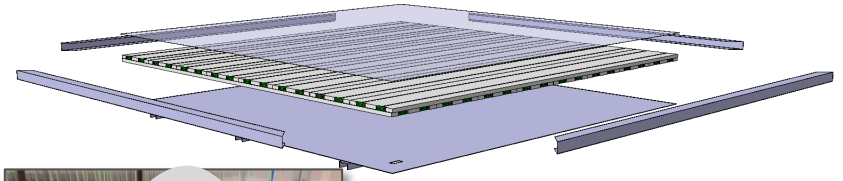
Warm vessel roof installation

Installing feedthrough crosses

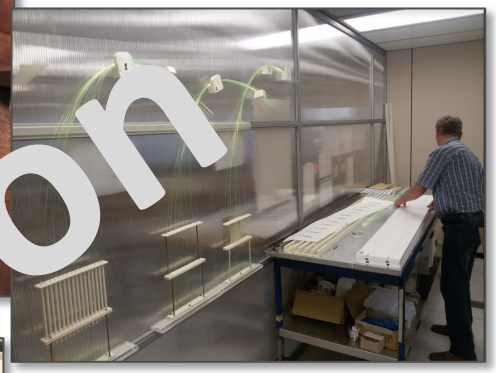
Proximity Cryogenics Delivery

Fermilab

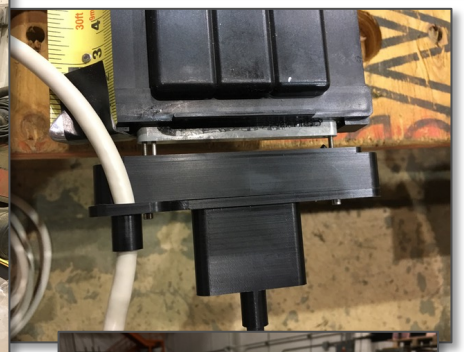
ICARUS Progress

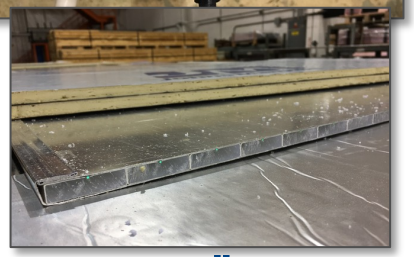


- TPC electronics production in final phase (INFN)
  - On track to complete delivery to FNAL by May
- Cosmic Ray Tagger (CRT)
  - Bottom modules installed in 2017 (Double Chooz spares courtesy of U. Chicago)
  - Top module production has started at Frascati (CERN/INFN)
    - First modules complete in January 2019
    - Complete assembly in summer 2019
  - Sides re-use MINOS far detector modules (FNAL/US), completing design of SiPM board
    - SiPMs ordered
    - Review of final prototype in January 2019
  - Common electronics for top, sides and SBND – designed by U. Bern, commercialized by CAEN
  - Common DAQ/event builder code



Top CRT Production in Frascati





Side CRT SiPM Board and module cutting @ Wideband lab

Fermilab

ICARUS Milestones to I-1 Ready to Fill

Intermediate Milestone	Owner	Baseline Date	Forecast Date		Actual Date
Vessels rigged into building	P. Wilson	16-Aug-2018		✓	16-Aug-2018
Manholes welded and vacuum test successful	C. Montanari	10-Oct-2018		✓	11-Oct-2018
Warm Vessel roof complete	C. James	15-Nov-2018		✓	31-Oct-2018
Cryo Platform complete	C. James	15-Dec-2018		✓	04-Oct-2018
Proximity cryogenics installation begins	Norris	15-Jan-2019	31-Jan-2019	a	
DBB & flanges installation complete and tested	A. Fava	15-Feb-2019	1-Feb-2019	b	
Cold proximity cryogenics installation complete	B. Norris	15-Apr-2019	23-Apr-2019	c	
1st T300 readout installation complete	A. Fava	15-Mar-2019	1-Apr-2019	d	
All detector readout installed	Fava	1-May-2019	31-May-2019	e	
Begin vacuum pumping	C. Montanari	15-Jul-2019	15-May-2019		
Cryogenic operation approved	B. Norris	15-Jul-2019	28-Jun-2019		
I1: ICARUS detectors ready to fill with LAr	**P. Wilson**	**30-May-2019**	**28-Jun-2019**	f	

Notes on milestones to I-1

a) Arrival of subcontractor delayed by CERN to ensure transport of equipment was completed in advance with schedule contingency

b) Delivery of last cross and PMT flanges from INFN/CERN completed by end of January

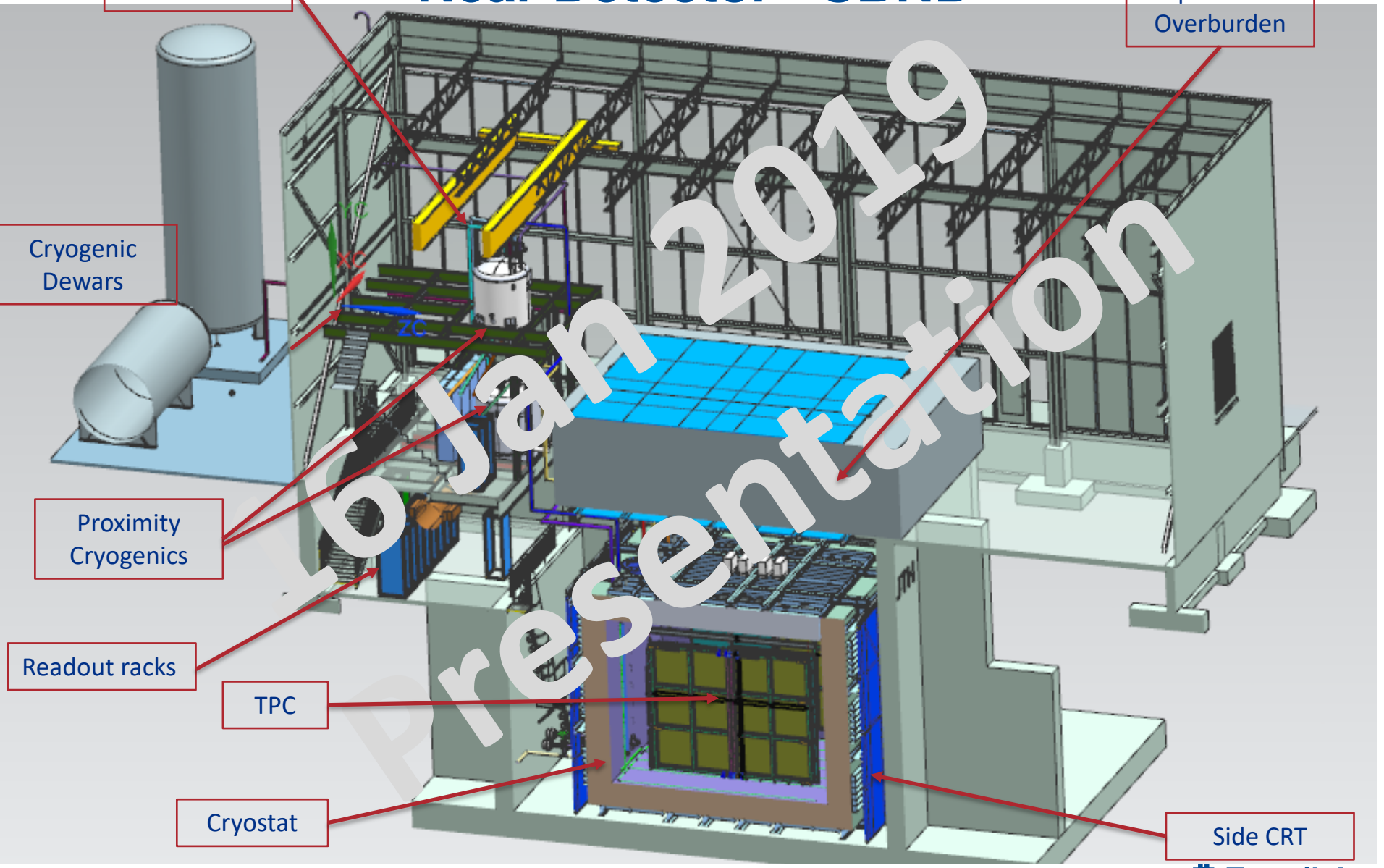
c) Start delayed by 2 weeks, see a) above

d) Added contingency in materials transport

e) Added contingency in materials transport

f) Baseline for I-1 set in March 2018 when delays in delivery of cold shields has not been completely realized. Detailed intermediate milestones were defined and baselined in July 2018

Near Detector - SBND



SBND Contributions

	DOE	US NSF	CERN	INFN	UK UKRI	Switzerland	LANL LDRD	Brazil
TPC Design and Fabrication		50%			50%			
TPC Electronics	85%	15%			X			
PMT System							100%	
Light detection (enhance.)		X			X			X
Calibration Laser						100%		
Cosmic Ray Tagger						100%		
Cryogenics	50%		50%					
Cryostat	X		X	X				
DAQ	100%							
Integration and Installation	90%				X		X	
Civil Construction	100%							
Overburden	100%							
Cryogen Purchase	100%							

All fractions are approximate (~10% level)
X = contribution but specific fraction tbd

Key SBN Milestones - SBND

Milestone	Description	Baseline Date
S-1	SBND is ready for transport from Dze[illegible] Assembly Building to the SBN ND hall	Aug 2019
S-2	SBND detector is ready to [illegible] with liquid argon	July 2020
S-3	SBND detector is filled with liquid argon and ready for detector commissioning (LAr purity adequate for physics has been achieved)	Feb 2021
S-4a	SBND detectors are ready for physics data - *CRT is operational*	March 2021
S-4b	SBND detectors are ready for physics data - *Shielding in place*	April 2021

Baseline dates for S-2 through S-4b were set in Nov 2018 after schedule re-plan including float relative to forecast dates.
See intermediate milestone slides later and in backup

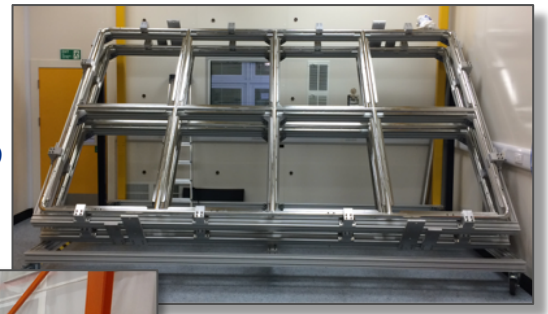
SBND TPC Progress

Joint responsibility of UK, US-NSF, FNAL

- UK: Cathode plane, two anode planes, HV feedthrough
- US-NSF: field cage, two anode planes, HV feedthrough
- FNAL: support integration and assembly

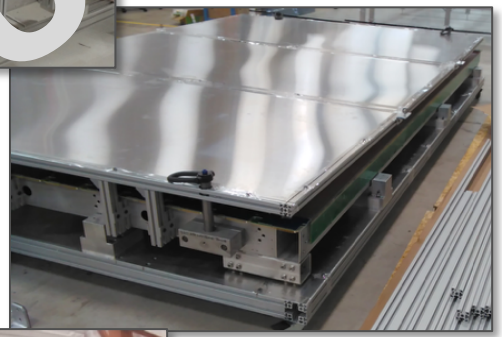
Recent Milestones:

- ✓ July 2018 Cathode delivered to FNAL
- ✓ Aug 2018 1st UK anode plane completed
- ✓ Aug 2018 1st US anode plane completed
- ✓ Sept 2018 Field cage completed
- ✓ Oct 2018 1st UK anode delivered to FNAL
- ✓ Sept 2018 Test of assembly fixture at FNAL
- ✓ Nov 2018 2nd US anode plane completed
- Dec 2018 US anodes shipped to FNAL
- Jan 2019 2nd UK anode delivered to FNAL

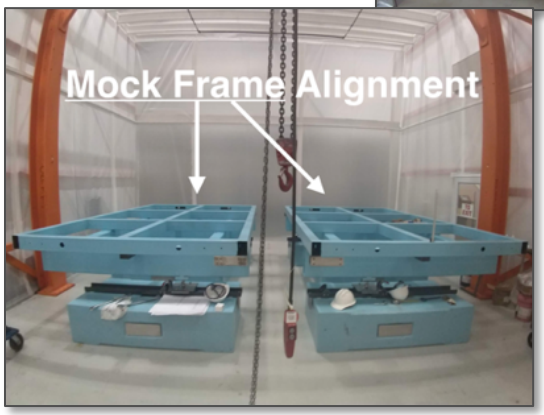


Cathode @ Liverpool

1st Manchester APA at FNAL in Dzero clean tent



Backed Anode Plane @ Yale

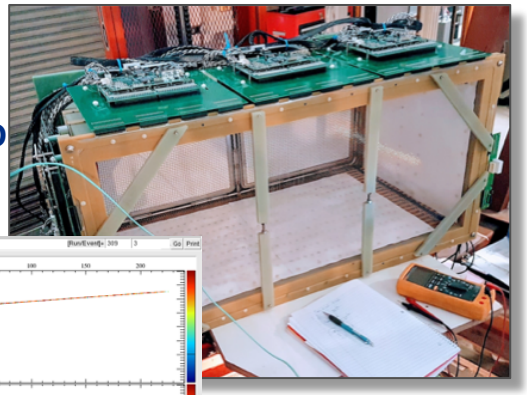


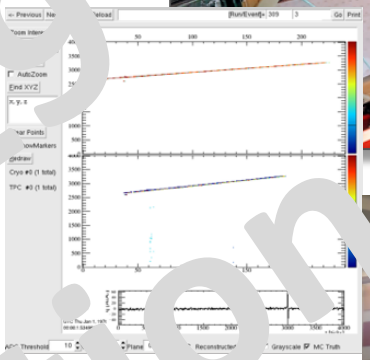
Assembly facility at Dzero Assembly building

SBND Progress

- TPC electronics (BNL, Columbia U.)
  - Using same FE ASIC as ProtoDUNE
  - Qualified commercial off the shelf ADC for cold operation – excellent lifetime
  - Vertical slice test of prototype electronics and DAQ w/LArIAT chamber in FNAL test beam
  - Incorporating lessons from ProtoDUNE into production design
  - Passed production readiness review on Nov 29
- PMT system components at LANL
  - Test of all PMTs in LAr late 2018
  - Mounting system and DAQ in hand
- CRT modules in production at Bern
  - Electronics designed by Bern (avail. from Caen)
  - Bottom and side modules at Fermilab
  - Top modules in production

VST - LArIAT TPC w/ SBND electronics

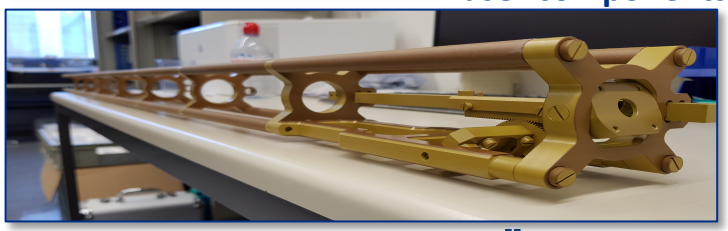




PMT test at LANL

Side CRT Modules at FNAL

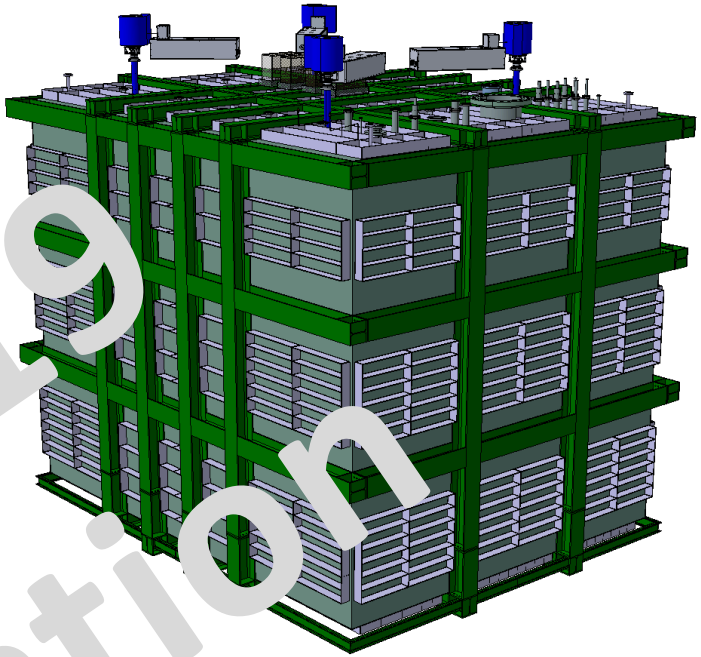
Laser components



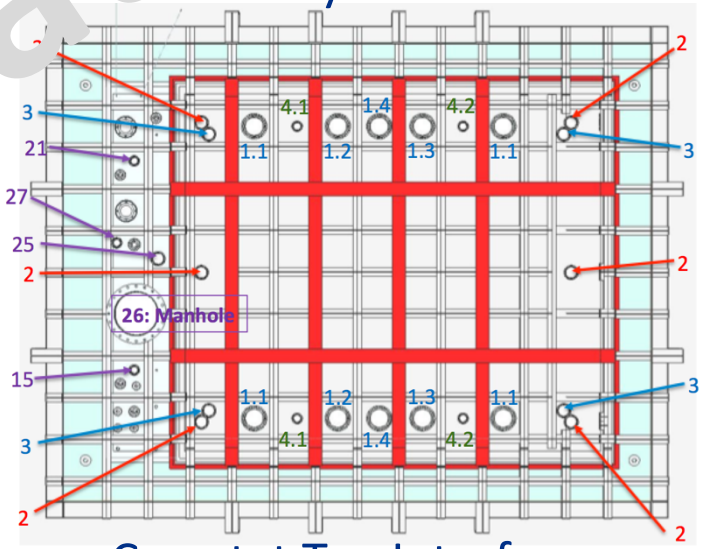
Fermilab

SBND Cryostat

- Joint responsibility of CERN, FNAL and INFN
- 3rd generation prototype for DUNE designed by CERN:
  - WA105 1x1x3 ➔ protoDUNEs ➔ SBND
  - Steel structure design updated to match LBNF/DUNE as closely as possible
- Status:
  - Final design of steel structure nearly complete
  - Ready to start final design study for membrane cryostat by GTT



SBND Cryostat Model



Cryostat Top Interfaces

SBND Milestones to S-1 SBND ready to move

Intermediate Milestone	Owner	Baseline Date	Forecast Date (Schedule)		Actual Date
First set of APAs shipped to Fermilab	K. Mavrokoridis	24-Sep-2018	28-Dec-2018	a	
PO for COTS ADCs placed	H. Chen	1-Oct-2018			3-Oct-2018
All TPC Components at Fermilab	K. Mavrokoridis	1-Mar-2019	26-Feb-2019		
Complete atf assembly at DAB	J. Zennamo	1-May-2019	Apr-2019		
50% of motherboards delivered to Fermilab	H. Chen	15-Apr-2019	5-Apr-2019		
APAs and CPAs installed in TPC	J. Zennamo	1-Jun-2019	23-May-2019		
Field cage assembly complete	J. Zennamo	15-Jul-2019	2-Jul-2019		
Cold electronics installed and tested	H. Chen	23-Aug-2019	8-Aug-2019		
S1: TPC ready to move to SBN ND	**A. Schukraft**	**30-Aug-2019**	**8-Aug-2019**		

a) US APA group decided to ship both their APAs together, delaying shipment of the first from September to December. This should have little to no impact on completion the final assembly

SBND Milestones to S-2 Ready to Fill

Intermediate Milestone	Owner	Ba[illegible]ne Date	F[illegible]recast Date		Actual Date
GTT Design Study Begins	M. Nessi	1-[illegible]-2019	1-Jan-2019		
Delivery of warm box steel	M. Nessi	15-Jun-2019	30-Apr-2[illegible]		
Warm vessel installation complete	M. [illegible]ssi	15-Jul-2019	29-[illegible]ay-[illegible]19		
TPC Transport to ND building [illegible]mpl[illegible]e	J. Zennamo	15-Sept-2[illegible]	[illegible]-Aug-2019		
Cryostat material arr[illegible]es at Ferm[illegible]h	M. Nessi	[illegible]ct-20[illegible]9	22-Aug-2019		
Cryostat top plug [illegible]ady to attacn to atf	M. Nessi	[illegible]-Nov-2019	23-Sept-2019		
Membrane C[illegible]stat Completed	M. Kim	1-Mar-2020	22-Jan-2020		
Plug welded to cryostat	[illegible] J. Zenna[illegible]o	15-Apr-2020	6-Mar-2020		
Cryogenic operation appr[illegible]d	M. Geynisman	1-Jul-2020	1-Jun-2020		
S2: SBND detector is r[illegible]dy [illegible] fill w[illegible] liquid Argon	**A. Schukraft**	**15-Jul-2020**	**1-Jun-2020**		

Technical Summary & Outlook

- Excellent technical progress for ICARUS
  - Installation remains on track since delivery of the cold shield components in April
    - Updated planning process is keeping it on track
  - Electronics readout delivery on track, installation starting (flanges)
  - Proximity cryogenics (near and far) delivered to Fermilab, ready to install in January
  - On track to complete milestone I-1, ready to fill, by June 2019
- Excellent technical progress for SBND
  - TPC components arriving at Fermilab
  - TPC electronics production underway
  - TPC assembly process has started
  - Cryostat design and construction plan being completed
  - On track to complete milestone S-1, detector ready for transport, by August 2019
- The biggest technical risks have been retired or are near retirement:
  - ✓ Installation of T600 vessels
  - ✓ Completion of SBND APA wire winding
  - Delivery of APAs to Fermilab

SBN Director's Review

- A Director's Review for SBN was held Dec 17-19 2018

- This review focused on the complete integrated schedule and the DOE High Energy Physics cost of the following program elements:
  - Construction and installation of the ICARUS detector systems;
  - Construction and installation of the SBND detector systems and cryostat;
  - Construction and installation of the necessary support infrastructure such as cryogenic systems, common DAQ and overburden;
  - Commissioning plan and transition to experimental operations plan.

- The focus of this review was the schedule forecast for completing installation, commissioning and transition to operations for ICARUS and SBND and the associated costs borne by the DOE office of High Energy Physics. Topics included schedule, US costs, management, ES&H, and technical readiness to execute the SBN program.

- Review web page

SBN Director's Review Closeout Exec. Summary

- The review committee was pleased with the progress made since the June 2018 review which focused primarily on schedule. The committee congratulates the team for the great progress in getting the far detector modules installed. Progress on the near detector components is also quite impressive.
- The committee's response to the Review Charge questions was nearly unanimously affirmative, with only a few minor caveats noted.
- Schedules for reaching each of the key milestones were presented. Most of the recommendations from the previous review have been addressed. The contributions from our international partners were particularly appreciated. The main conclusion of the review was that almost all subsystems are ontrack to meet the baseline schedule presented in June, resulting in the far detector being ready to fill in Summer 2019 and the near detector approximately one year later.
- The committee was satisfied with the Program's attention to ES&H.
- The committee reviewed outstanding risks, that if realized would impact the ability of the program to keep on schedule. The committee noted that a number of key risks have been retired.
- Two main areas of concern were identified. The first is the funding available for FY19 work. A request for additional funding of $3.9M was made to DOE in FY18. If this funding is not made available within FY19Q2, key procurements for both detectors will have to be delayed, resulting in corresponding delay of meeting milestones.
- The second area of concern remains the need to begin the final design of the near detector cryostat so that the schedule for the construction of the cryostat does not significantly delay achieving the milestones S2 and S3.
- The committee encourages the Program management team to continue to work with all program contributors to develop robust plans for commissioning, transition to operations and ultimately steady state operation of both the near and far detectors of the SBN Program.

SBN Multi-Institutional MOU

- A Memorandum of Understanding (MOU) for building of the SBN program is in draft form
- The expectation is that it will be signed by the parties contributing to building the SBN program
- Such a multi-institution document is unusual for the US DOE
- Blazes an important trail for future DUNE agreements

SBN Multi-Institutional MOU Opening

Memorandum of Understanding
for Collaboration in the
Short-Baseline Neutrino Program

between

The Fermi National Accelerator Laboratory, a United States Department of Energy National Laboratory, managed and operated by Fermi Research Alliance, in Batavia, Illinois (hereinafter referred to as “Fermilab”), as the Host Laboratory

on the one hand,

and

the Funding Agencies/Research Institutions and Universities participating in the Short-Baseline Neutrino Program at Fermilab

on the other hand

for the purpose

of collaboratively carrying out a jointly funded and supported physics research program at Fermilab. The Parties mentioned will individually be referred to as a “SBN Participant” and collectively as the “SBN Participants”

SBN Multi-Institutional MOU Preamble

Preamble

As recommended by the 2014 report of the Particle Physics Project Prioritization Panel and the European Strategy for Particle Physics Update 2013, Fermilab has developed an international Short-Baseline Neutrino Program ("SBN Program") to pave the way for substantial international involvement in the future Long-Baseline Neutrino Facility and the associated Deep Underground Neutrino Experiment ("LBNF/DUNE");

a) The SBN Participants wish to collaborate in the construction, operation, and physics data analysis using a set of liquid argon detectors for the SBN Program that will be deployed in the Fermilab Booster Neutrino Beamline (BNB);

a) This Memorandum of Understanding (hereafter referred to as "MOU") is a non-legally binding agreement that records contributions by SBN Participants to the SBN Program, it being understood that the SBN Participants recognize that the success of the SBN Program depends on all the SBN Participants adhering to its provisions.

Parties to the SBN MOU

- The Parties to the SBN MOU are the agencies, labs, and universities providing the resources to build the program
  - Fermi National Accelerator Laboratory (“Fermilab”);
  - The National Science Foundation of the United States ("NSF")*;
  - European Organization for Nuclear Research (“CERN”);
  - Istituto Nazionale di Fisica Nucleare ("INFN");
  - United Kingdom Research and Innovation (“UKRI”);
  - University of Bern, Switzerland ("Bern");
  - Los Alamos National Laboratory through its associated Laboratory Directed Research and Development program ("LANL");

*NSF contributions will be listed, but the NSF will not be signing this MOU

- There are about 60 institutions in the SBN collaboration that will operate the detectors and analyze the data from them

Proposed Annexes to the SBN MOU

- **Annex 1:** Institutions Collaborating in the SBN Program and Names of Their Contact Persons
- **Annex 2:** SBN Collaboration Organization Structure
- **Annex 3:** SBN Program Governance
- **Annex 4:** SBN Cryogenics, SBND Cryostat, and ICARUS Cosmic Ray Tagger
- **Annex 5:** SBND Cosmic Ray Tagger
- **Annex 6:** Participation of SBN Participant in Each SBN Subproject for ICARUS and SBND
- **Annex 7:** Ownership of Equipment to the SBN Program
- **Annex 8:** Financial Guidelines for the SBN Program

SBN Organization (E-1100)

- A set of organizational structures defined to…
  - oversee the completion of the ICARUS and SBND detectors,
  - develop plans and procedures for commissioning and operation
  - coordinate efforts toward combined physics analyses in the future.

1. SBN Program Office
2. SBN Oversight Board (SBN-OB)
3. SBN Institutional Board (SBN-IB)
   - SBND Collaboration
   - ICARUS Collaboration
   - Unaligned collaborators
4. SBN Joint Working Groups

SBN Program Office

- **Purpose:** Oversee construction on the SBN near and far detector buildings, install the far detector (ICARUS T600), design, construct, and install the near detector (SBND)

Program Support:
Program Coordinator – *Peter Wilson*
Deputy Coordinator – *Cat James*
Program Engineer – *Barry Norris*
Program Electrical Coordinator – *Linda Bagby*
Program Integration Engineer – *Andy Stefanik*
Logistics and Risk Manager – *Michael Dinnon*
Project Controls – *Ken Domann*
Financial Officer – *Molly Anderson*
Administrative Support – *Etta Johnson*
ES&H Coordinator – *Angela Aparicio*
CERN Safety Contact – *Olga Beltramello (CERN)*

Technical Coordinators:
SBND – *Brian Rebel*
Anne Schukraft - deputy

ICARUS – *Claudio Montanari,*
Angela Fava – deputy

Infrastructure – *Cat James*

SBN Oversight Board (SBN-OB)

- **Purpose:** The SBN-OB is internal to SBN and provides a key forum for cross-collaboration communication or agreement development on issues relevant to construction, commissioning, operations, data management, and analysis.
- **Membership:** The group consists of
  - ICARUS and SBND spokespersons
  - SBN collaborators selected to provide good representation of the international groups making major contributions to the ICARUS and SBND detectors,
    - Italy-INFN
    - US-DOE and NSF
    - UK-UKRI
    - Switzerland
    - CERN
  - As Host Lab, the initial Chair of the board is the head of Fermilab Neutrino Division
- **Timeline:**
  - Meetings held quarterly (May 15, Sept 21, Nov 30 in 2018)
  - Currently developing an agreement on data sharing, common analyses and publication

SBN Institutional Board (SBN-IB)

- **Purpose:** The SBN-IB provides a forum for program-wide communication on issues relevant to the Program. Procedures, policies, and bylaws covering joint aspects of operation, data sharing, data analysis, publications, etc. can be brought to this body for deliberation or developed from within the group. Agreements developed within the SBN-IB will need to return to the individual collaborations for final ratification.
- **Membership:** The SBN-IB will consist of one member from each institution participating in the SBN Program. Each institution's representative is selected by that institution and communicated to the IB chairperson who will maintain the official list of membership and mailing list. The chairperson will be elected by the members of the IB from within its membership.
- **Timeline:** Gina Rameika is serving as interim SBN-IB chair. The first meeting was Sept 22. Gina's first task is to run an election for SBN-IB chair. The SBN-IB signals the formal start of collaboration

SBN Collaborators and Institutions

SBN Joint Working Groups

- **Purpose:** A set of SBN Joint Working Groups are needed to co-develop many key aspects of SBN operations and physics analysis. Several joint working groups already exist making extensive use of the experience running MicroBooNE and ICARUS
  - **SBN Analysis:** Explore how combined SBN physics analysis for sterile neutrino oscillation searches can be most effectively performed. Work focuses on implementing a three detector simulation, building reconstruction and analysis tools within a common framework, and developing an end-to-end common analysis scheme in preparation for real data exploitation.
  - **SBN DAQ and Data Pre-processing:** Prepare the infrastructure for the efficient collection of high quality data with ICARUS and SBND using common strategies whenever possible.
  - **SBN Slow Controls:** Compare Slow Controls needs and designs and identify common hardware and software solutions for ICARUS and SBND.
  - **SBN Cosmic Ray Tagger**: Work on the CRTs of both detectors including a common analysis of CRT data and bringing in experience from MicroBooNE.
  - **SBN Offline computing:** Work on data storage, processing and distribution
  - New SBN Working Groups shall be set up as needed by the SBN-OB with the intent of spanning all detector subsystems
- **Membership:** The Working Groups are open to all participants in the SBN Program. For each Working Group the SBN-OB will identify a set of conveners to lead the activities of the group and report progress to the SBN-OB and the collaborations.

Summary

- SBN construction and installation now progressing well
  - There were some early delays
  - Now have loan agreement formed and ICARUS vessels rigged
  - Need to reach agreement on SBND cryostat

- SBN Multi-Institutional MOU drafted and being iterated
  - Important trail blazing for DUNE

- SBN Governance structures in place and working.