

# SBN Program Status

Cat James – SBN Program Deputy Coordinator

SBN Oversight Board

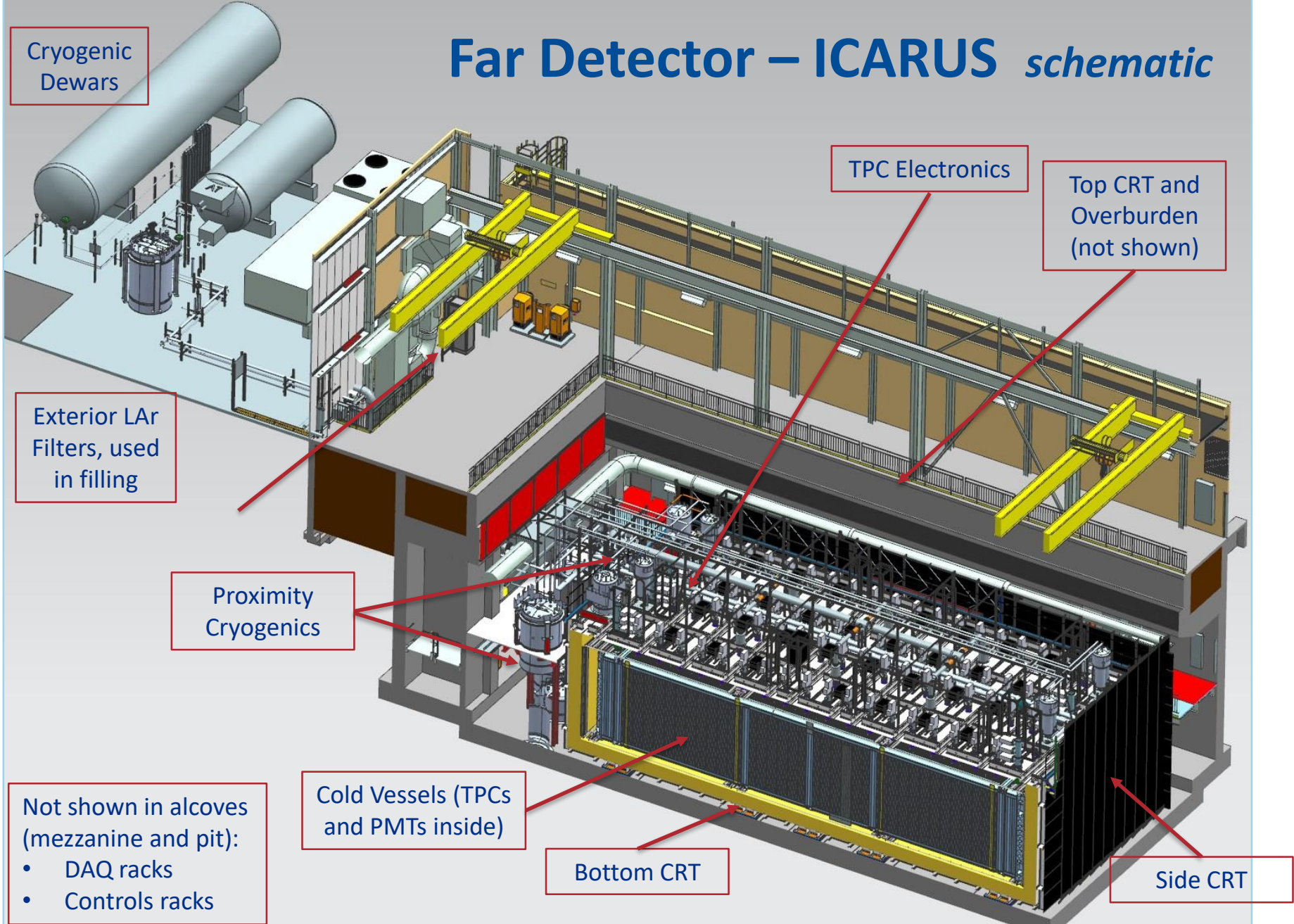
14 June 2019

# Outline

- Far Detector technical progress
- Near Detector technical progress
- Transition to Operations
- Safety & Work Planning



# Far Detector – ICARUS *schematic*



# Far Detector - today

South side

Detector readout feed-through  
Chimneys - 4 rows  
With readout installed (detail on later slide)

Cold cryostat safety relief  
and vent piping to exterior

Walkway decking

Argon gas condenser valve box

Cold Shield valve box

Liquid Argon lines  
from pumps to cryostats

Temporary scaffolding

Structure for support of cabling and  
argon gas circulation piping

Beam  
Direction

North side



# Far Detector - cryogenics

*Liquid argon purification filter  
One for each cryostat*

*Outer shell of the valve box is removed,  
showing the filter media cartridges below*

*Side CRT modules, north wall*



Mezzanine Level



Pit Level

*Liquid argon pump valve box  
(one for each cryostat)*

*Another very large valve box is outside  
- holds a large volume of argon filter  
media. Used at FD only during filling  
It will be moved to ND afterward, to  
become its main filtering unit*



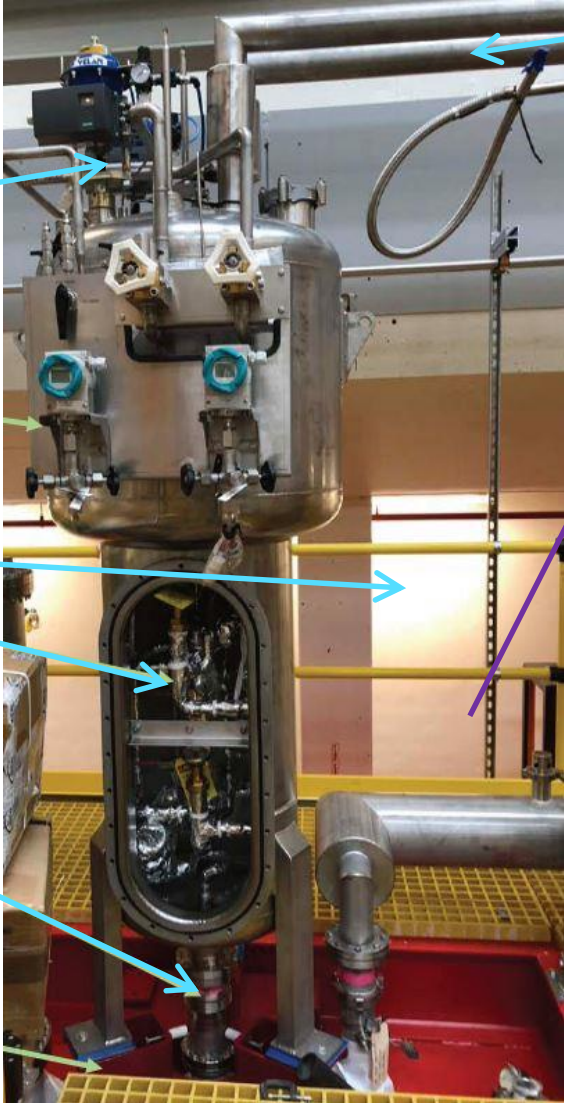
# Far Detector - cryogenics

Argon gas condenser valve box

Argon ullage gas from chimneys

Filter medium cartridge

Liquid argon return to cryostat



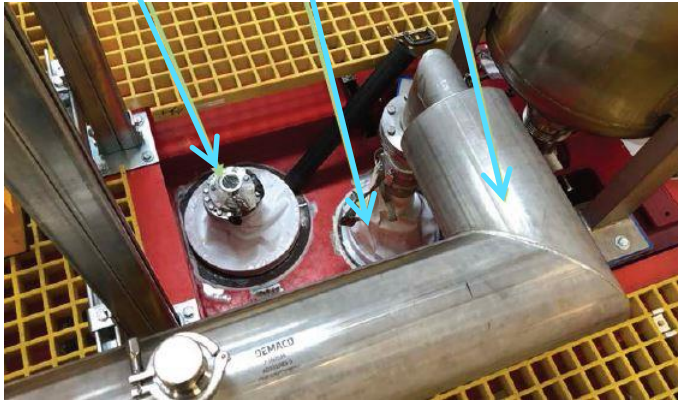
LN2 refrigerant

Standing here, looking down

Chimney for TPC Drift HV

Liquid argon from pumps, input to cryostat

"boots" Flexible gas-tight seal



# Far Detector Cryogenics Installation Progress

- Proximity Piping
  - Cern's contractor, Demaco, expects to be finished in one week; remaining effort focused on piping pressure and leak tests, including of the long argon supply lines
- External Piping
  - Installation of argon and nitrogen vent lines, and LN2 supply lines, has proceeded in parallel with Demaco work, as their connecting interface piping was put into place
  - *filling filter* in place and connected (outdoors)
  - *warm gas system* for collection of ullage gas and delivery to Condenser valve boxes – fabrication is ongoing, installation starting this month
- Controls system
  - Wiring between instruments and the Controls PLC is ongoing
  - Air lines for pneumatic valves, and tubing for delivery of samples to the gas analyzer, also ongoing
  - Instrumentation for vacuum installed and operating



Vacuum operation started Monday this week, and is proceeding well.

All remaining cryogenics installation work on track for completion in July.

Following completion of hardware installation is a period for check-out of the controls instrumentation and programming, performed as a joint effort by CERN & Fermilab

# Far Detector Readout Installation Progress

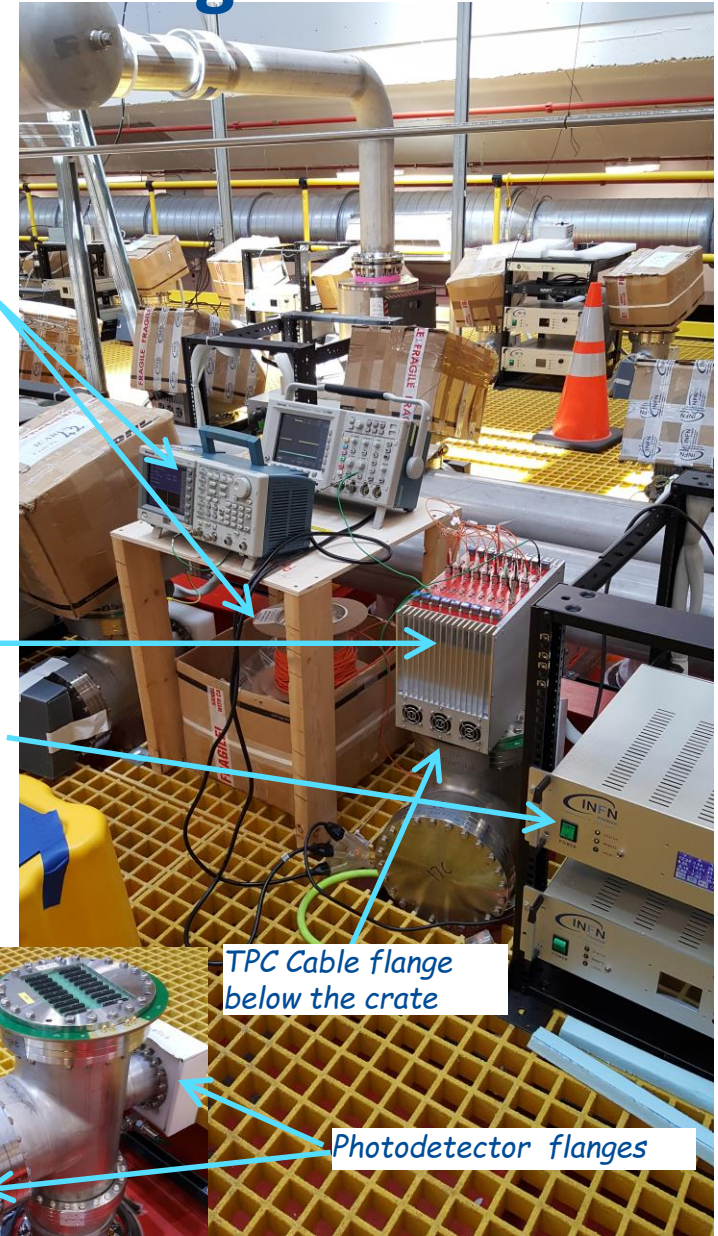
- TPC and PMT cable flanges were installed in March shortly after the previous OB meeting (inset)
- TPC digitizer crates and electronics followed in two phases, in April (outer rows) and May (inner rows)
  - A scaffold, required by the cryogenics installation, was installed down the centerline and blocked access to the inner rows of chimneys until May
- A mobile testing station is used to check both TPC and PMT connections and perform noise studies
  - Scopes used for both TPC and PMT
  - TPC vertical slice in addition has connection all the way to DAQ server via fiber (orange spool)
- Cabling and DAQ servers installation are the major remaining steps
  - Some cables are already at Fermilab, others in procurement or delivery; all expected here by end of July
  - DAQ servers are procured but not yet delivered; server racks are identified
  - A Technical Meeting tomorrow will focus on detailed plans for the remaining installation activities

*Vertical slice readout testing*

*TPC wire signal digitizers & power supplies*

*TPC Cable flange below the crate*

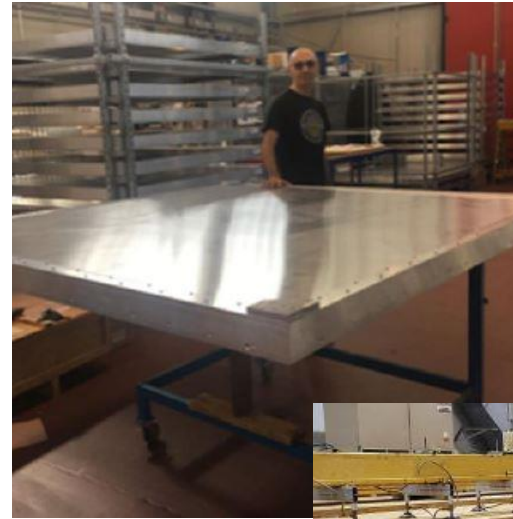
*Photodetector flanges*





# Far Detector Cosmic Ray Tagger Progress

- Top CRT
  - panels are in production at Frascati
  - First 25 on their way to CERN
  - Two of these will come to Fermilab this summer, and placed on the North wall
- Side CRT
  - North wall installed
  - Portion of long sides will be installed this summer
  - SiPM readout board, customized to fit MINOS module, in production at CSU
- Bottom CRT in place



*Top CRT panels*



*MINOS modules test stand at Fermilab*

*Most of the CRT installation will occur after cold commissioning and filling is completed, and the cryogenics has entered stable operations*



*SiPM readout*

# Far Detector Commissioning

- Cryogenics and vessels commissioning
  - Weekly Cryogenics Working Group, weekly meetings
    - discuss and agree on procedures for vessels qualification, for vacuum process, cool-down procedure, liquid argon filling procedure
      - In multi-step procedures agree on the conditions to reach before moving to a following step; discuss what conditions require falling back to a previous step; discuss what instrumentation is needed so you know what the conditions are
      - Develop hazard analyses for each of the commissioning stages, e.g. personnel access to the building
    - Status
      - Cold vessels low-pressure Engineering Note completed and signed by the Director
      - Cold vessels vacuum Engineering Note completed and signed by the Director
      - Performed pneumatic pressure test on both vessels April 17, 18
  - Cool-down and liquid argon filling
    - Argon procurement contract signed; funds are obligated
    - Hardware installation complete in July, followed by Controls checkout procedure ~ 2 weeks
    - Fermilab safety review of all documentation, results of Controls checkout, visual inspection; after these steps Operations Readiness Clearance is signed by Division head
    - CERN requires personnel be present at Fermilab at the start of cool-down and following this the filling with liquid argon. At present, scheduling of people presents the main constraints on the start of cold commissioning
- Detector and Readout Commissioning
  - Schedule details to be discussed at technical meeting tomorrow



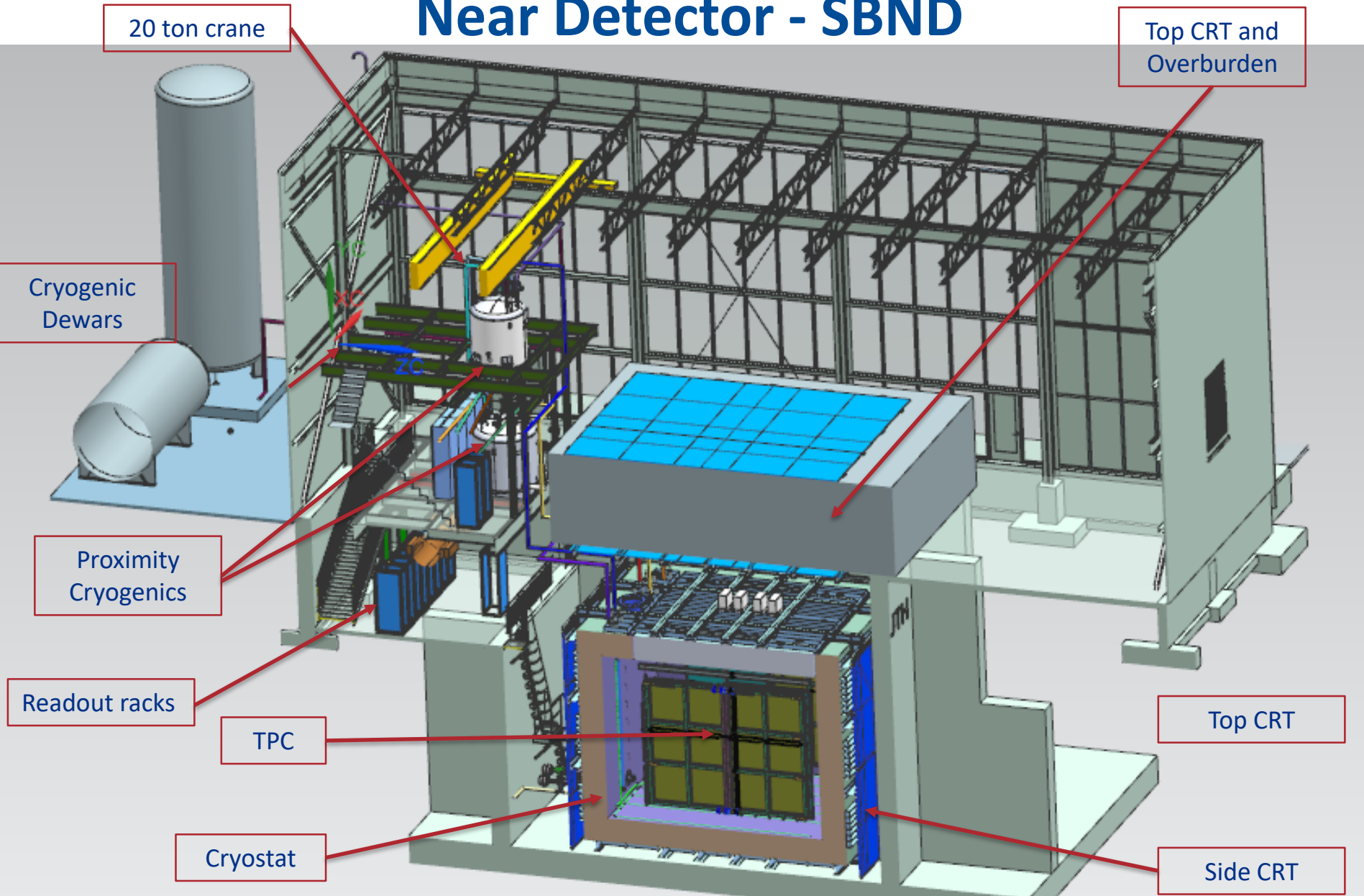
# Far Detector Milestones to I-1 Ready to Fill

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	<i>21-Jun-2019</i>		
1 <sup>st</sup> 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	<i>Early August</i>		
<b>I1: ICARUS detectors ready to fill with LAr</b>	<b>P. Wilson</b>	<b>30-May-2019*</b>	<b>11-Jul-2019</b>		

\* 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



# Near Detector TPC progress

All major TPC components received at Fermilab

- CPAs, APAs, and field cage were received at DAB
- The first set of APAs was
  - Unpacked
  - Moved into clean tent
  - Removed from transport frame
  - Lifted onto alignment table for QC, alignment and coupling



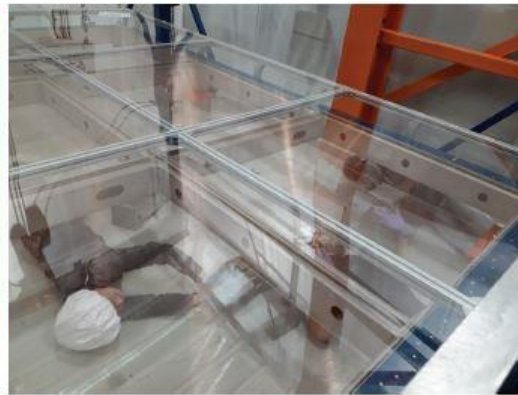
APA unloading at DAB



Truck arrival with first APA  
Field cage crates arriving at DAB



Moving the first APA into the clean tent



Installing protective covers



Leading the DAB team: Nicola McConkey and Joseph Zennamo



# Near Detector TPC progress

## Cathode Assembly

- Cathode frames were removed from traveler base, assembled and put in upright position
- The CPA will be installed first in the Assembly Transport Frame (atf)
- Once the CPA is in the atf, we will install CPA reflector foils
- We are currently setting up our facility at DAB to cool down the frames and install the foils into mesh frames



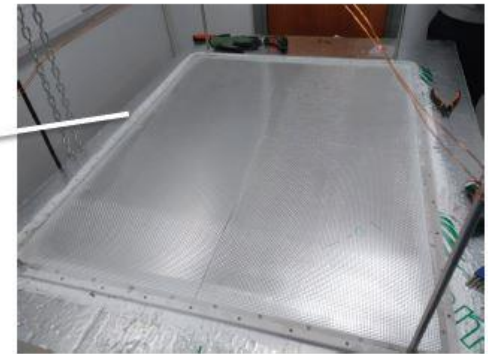
*CPA on traveller*



*Assembled CPA being moved into the clean room*



*Final CPA assembly upright in clean tent*

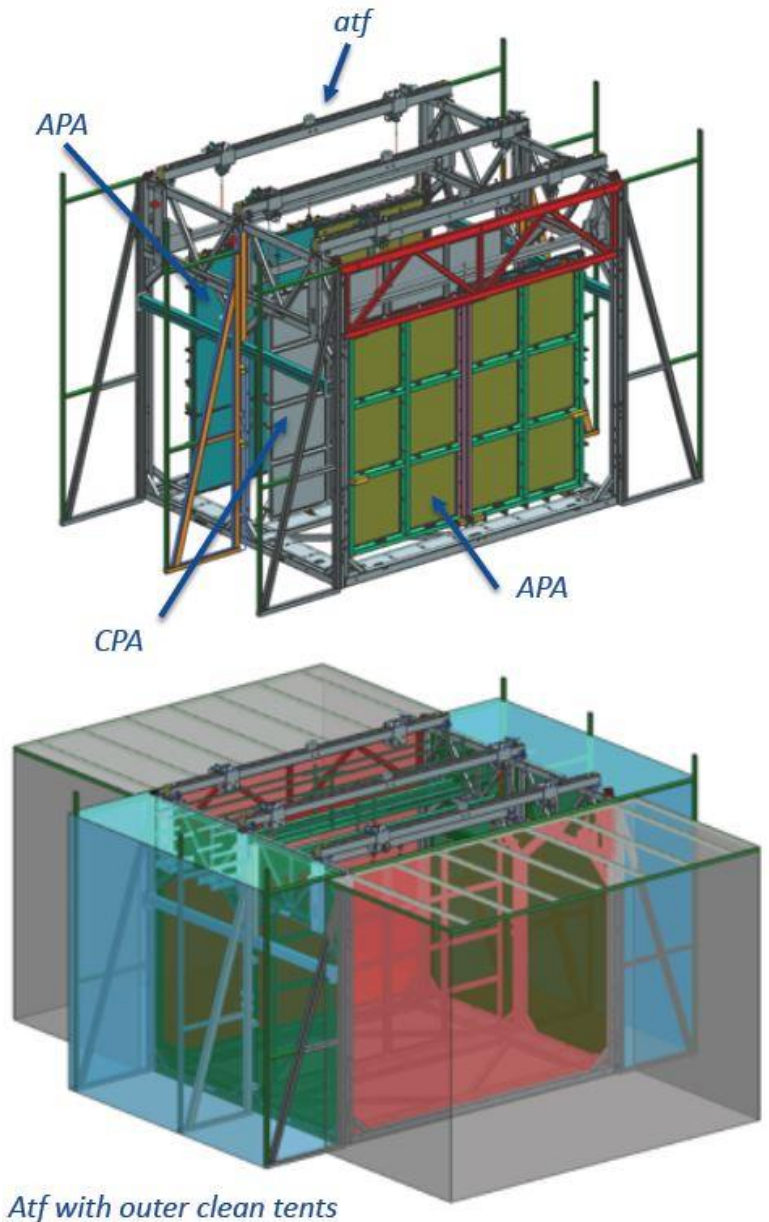


*Mesh frame with reflector foil to be installed in CPA*



# Near Detector TPC progress

- Assembly Transport Frame (atf)
  - The atf holds the TPC components in place for assembly
    - CPA in the center, APAs on each side, field cage between
    - Followed by cold electronics and photon detection
    - Clean room tents surround the atf during detector assembly
  - All takes place at DAB, on Fermilab site
    - atf parts are being fabricated offsite; arrive here next week
    - TPC assembly begins end of June
  - atf also used for *transport*
    - The entire atf with the assembled detector will be moved from DAB to the ND Building, when the cryostat is installed at the building



# Near Detector Cold Electronics progress

- Electronics production is concluding at BNL
  - Half of production FEMBs and all cold cables delivered to Fermilab on 05/29!
- A reception checkout test bench is ready at Fermilab
- Completed final mechanical and installation check out on APA at FNAL
- CE is being integrated into DAB test stand for DAQ development
- A Nevis integration test is scheduled in the week of June 10<sup>th</sup>

SBND CE		Production Status
Cold Front-end Electronics	Top FEMB	60 pcs FEMB passed QA/QC test by 05/23 50 pcs FEMB arrived Fermilab on 05/29 Reception test is scheduled
	Side FEMB	Post-assembly screening test is ongoing QA/QC test starts on 05/28
	Side AM adapter	50 pcs assembled, inspected, and packaged
Cold Cables	Data Cable	11 pcs (>10%) passed LN2 test on 04/30 105 pcs arrived Fermilab on 05/29
	Power Cable	11 pcs (>10%) passed LN2 test on 04/30 98 pcs arrived Fermilab on 05/29
Signal Feed-through	Flange	In factory for welding ports
	Flange Board	Assembled, passed continuity test
	WIE Crate	Received and inspected
	Front panel	Drawings of WIB and PTC panel checked, sent for quote
	HV Filter Board	Assembled, checkout test is scheduled
Warm Interface Electronics	WIB (1B)	7 pcs are available for debugging and test purpose The rest WIBs delivered on 05/30, QA/QC test is planned
	PTC (1D)	Assembled and tested
	PTB	Assembled and inspected
	MBB	Assembled and tested. Boxes ordered.



3 CTS for FEMB QA/QC test at BNL



Cold cables ready to ship

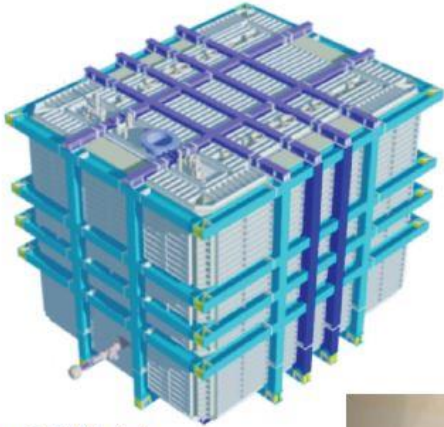


50 pcs Top FEMBs



# Near Detector Cryostat

## Cryostat construction at CERN



*SBND Cryostat Model*



### Building 185

- I-beam structures for the base and two long walls welded and bolted together
- I-beam structure of the short walls under construction



*Fabrication status on May 28th*



# Near Detector Cryogenics

- Focus of Demaco work shifted to ND between May 13 and May 31
  - Three valve boxes set in place May 10
  - Installed ~ 2/3 of the proximity piping before returning to FD to complete installation there
  - Demaco has other commitments and needs to move it's workers to jobs elsewhere; CERN is discussing when they can return to complete the ND proximity installation
- Fermilab portions of the cryogenics are in procurement and pre-assembly stages



# Near Detector status

## Other sub-system updates

### Photon Detection Systems

- PMTs are being tested at LANL in the CCM experiment
- Lightbar and ARAPUCA teams finalizing design and planning production of R&D light systems

### HV Feedthrough

- First feedthrough tested at CERN, further testing at Yale this summer
- Production of two additional feedthroughs over the coming months

### Warm electronics

- Warm electronics production at NEVIS progressing well. Expecting to send components to FNAL and start readout rack installation in the fall.

### CRT

- CRT module production for bottom and sides complete.
- Top CRT module production ongoing at Bern

### Laser

- Laser systems production ongoing at Bern

### Membrane Cryostat

- Contract between CERN and GTT is in place



# Near Detector Schedule Overview

## DAB

- June: atf assembly
- Summer: Installation of CPA, APA, reflector foils, cold electronics, field cage into the atf
- Fall: Completion of TPC assembly (**S1 Milestone**)
- End of 2019: Installation of PDS system onto APAs (just prior to TPC move from DAB to ND building)

## ND building

- May/June: Cryogenics valve box & piping installation
- September: Start of warm cryostat installation; start of rack installation
- End of 2019: Start of membrane cryostat installation

## Early 2020: Move of TPC from DAB to ND building

(we will close in on the exact move date once the membrane cryostat schedule is known precisely)

*We expect the December 2019 SBN Director's Review will focus on Near Detector technical progress and schedule*



# Near Detector Milestones to S-1 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	10-Jun-2019		
50% of motherboards delivered to Fermilab	H. Chen	15-May-2019	22-May-2019		
APAs and CPAs installed in atf	J. Zennamo	15-Jun-2019	27-Aug-2019	a	
Field cage assembly complete	J. Zennamo	15-Jul-2019	4-Oct-2019	a	
Cold electronics installed and tested	H. Chen	23-Aug-2019	11-Nov-2019	a	
<b>S1: TPC ready to move to SBN ND</b>	<b>A. Schukraft</b>	<b>30-Aug-2019</b>	<b>14-Nov-2019</b>	b	

- a) The atf is arriving later than originally planned. We are working on parallelizing some of the installation efforts into the atf such that we can gain time back in the schedule.
- b) The actual move of the TPC to the ND building is dependent on the completion of the membrane cryostat. Even with the current forecast date of S1, the TPC assembly is not on the critical path.



# Near Detector 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		
Warm vessel installation complete	M. Nessi	15-Jul-2019	4-Oct-2019		
TPC Transport to ND building complete	N. McConkey, J. Zennamo	15-Sept-2019	30-Jan-2020		
Cryostat material arrives at Fermilab	M. Nessi	1-Oct-2019	12-Nov-2019		
Cryostat top plug is ready to attach to atf	M. Nessi	1-Nov-2019	16-Jan-2020		
Membrane Cryostat Completed	A. Soha	1-Mar-2020	22-Jan-2020		
Plug welded to cryostat	A. Soha, N. McConkey, J. Zennamo	15-Apr-2020	11-May-2020		
Cryogenic operation approved	M. Geynisman	1-Jul-2020	30-Jun-2020		
<b>S2: SBND detector is ready to fill with liquid Argon</b>	<b>A. Schukraft</b>	<b>15-Jul-2020</b>	<b>30-Jun-2020</b>		



# SBN - Transition to Operations

- Transition to Operations Team created early this year
  - Kick-off meeting in February
    - Presentations on the organization of experiment operations at Fermilab including support model and example of the MicroBooNE operations organization
  - May meetings
    - Data Management at Fermilab
    - Control Room – ROC West facility; Online Monitoring and Slow Controls
- Operations Readiness Review
  - Generally held before an experiment begins taking beam
  - Fermilab is planning to hold one for the Far Detector in fall 2019
    - coincide with start of neutrino beam to the far detector.
  - Expect a 2<sup>nd</sup> review focused on the Near Detector in 2020

# SBN - ES&H & Work Planning

Everyone plans to work safely

- Yet there were incidents in May

Work Planning is important

- SBN has a formalized process

- Written description of task
- Presentation in a weekly planning meeting
  - Keep work flowing efficiently; utilize the technical teams effectively; keep concurrent tasks from interfering with one another
- Task proceeds after approval
- Daily planning meeting (8am at FD) reviewing all approved tasks in progress
  - For FD installation, this process has been in place for some months *and it works*
  - ND assembly work is ramping up, and adopts the same Work Planning process

In addition

- Safety walk-throughs of SBN work areas, rotating among them each week
- House-keeping walk-throughs at work areas, 2-3 times per week

## ES&H

- Two incidents this week under investigation:
  - Unsafe use of power cords – removal of ground pins
    - Cords were discovered by ES&H personnel during inspection of
    - Cords were not connected to any equipment when found
    - Investigation in progress by Angela Aparicio
  - Two Rad HEPA Vacuum Cleaners were checked out from the Rad Tech for use during concrete drilling in SBN FD building
    - These should not have been brought to SBN
    - No evidence of contamination. Returned to Rad Techs
    - HPI initiated by Angela Aparicio





# Conclusion

- Far Detector
  - Final stages of installation
  - Beginning of commissioning with vacuum operations
  - Cool-down and filling within a few months
- Near Detector
  - Major TPC detector components delivered to Fermilab
  - TPC assembly in progress
  - Cryostat construction ongoing at CERN
  - Cryogenics installation at ND building started
- Management
  - Operational Readiness and Director's reviews before the end of the year

