



SBN Program Status and Path to Commissioning

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PAC Meeting

16 July 2018

Outline

- Introduction
 - SBN Program Scope
 - Scope of this talk
 - Focus on schedule
- T-600 far detector
 - Near term status
 - Outlook
 - Issues needing attention
- SBND near detector
 - Near term status
 - Outlook
 - Issues needing attention
- Summary of recent Director's Review
- SBN Program Organization
 - Near term activities
 - Outlook

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) – **construction**
- Install ICARUS detector – **on track since delivery of cold shields**
- Design, construct, and install infrastructure (e.g. cryogenics) – **on track**
- Design and construct SBND detector – **design complete, construction on track**
- Design and construct new membrane cryostat – **design pending agreements**
- Install SBND detector – **design in progress**

Operations Phase:

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

Definitions

- Pre-commissioning
 - Detector elements : done as installed and to the level that system read-outs are available
 - Cryogenic systems : leak-checking and controls exercised as available during installation
- Commissioning
 - Cryogenics : consuming cryogenics; cooling, filling, purifying
 - Detector : applying high voltage to drift and wires; detecting tracks (post-filling); collecting data
- Post-commissioning installations
 - Top CRT modules and shielding installed after detector/cryogenic performance is validated
- Operations/data taking : physics quality data after shielding is in place

Scope of this talk

- is *not* about commissioning and operations
- *is* about what needs to happen *before* we talk about commissioning and operations and when we expect to get there for each of the detectors
- Recent events :
 - February/March 2018 :
 - Investigated “cost to complete” and available funding for FY18 - 20
 - Concluded that we have a shortfall of ~\$4M in FY19 in order to maintain a technically driven schedule to complete installation of SBND before end of CY2020
 - Concern raised about the integrity of this conclusion due to continuing slippage of the schedule (significant delays in several key tasks)
 - Director’s Progress Review of SBN (June 26 – 28)
 - Focus on schedule
 - Main conclusion : subsystem schedules exist, but each detector lacks an integrated schedule with appropriate intermediate milestones

Key Milestones

- I-1 ICARUS vessels are ready to fill with LAr
- I-2 ICARUS detector is ready for commissioning (LAr pure and all electronics and readout installed)
- I-3 ICARUS detector ready for physics data (CRT and shielding installed)

- S-1 SBND TPC is ready to move to ND building
- S-2 SBND cryostat is ready to fill with LAr
- S-3 SBND detector is ready for commissioning (LAr pure and all electronics and readout installed)
- S-4 SBND detector ready for physics data (CRT and shielding installed)

Key Milestones

- I-1 ICARUS vessels are ready to fill with LAr
 - *One year ago we were hoping this would be taking place NOW*
- I-2 ICARUS detector is ready for commissioning (LAr pure and all electronics and readout installed)
- I-3 ICARUS detector ready for physics data (CRT and shielding installed)

- S-1 SBND TPC is ready to move to ND building
- S-2 SBND cryostat is ready to fill with LAr
- S-3 SBND detector is ready for commissioning (LAr pure and all electronics and readout installed)
- S-4 SBND detector ready for physics data (CRT and shielding installed)

A year goes by quickly ...

- **Detectors arrived at FNAL – end of July 2017**
 - Rigging contract delayed ...
 - Cranes for lifting undersized
 - Lifting plan delayed pending resolution of cranes and method
 - Work on vessels delayed ...
 - DOE “stop work” order pending resolution of detector ownership
 - Tasks included cold feet installation and door welding
 - Cold vessel installation couldn't proceed until cold shields installed
 - Original delivery expected in September 2017
 - 1st articles arrived in March 2018;
 - Final parts – end of April 2018
- Preparatory work has been accomplished!
- **Ready to install – end of July 2018**

Far Detector Progress

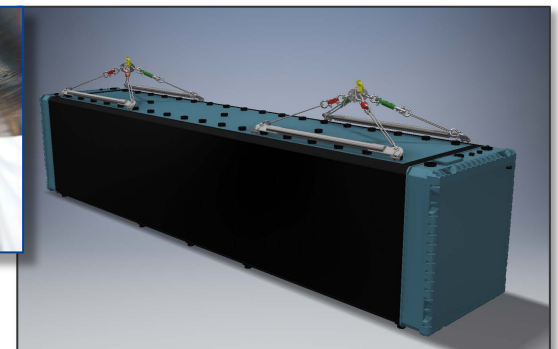
- Detector installation (CERN/FNAL/INFN)
 - Cranes upgraded from 30 Ton to 33 Ton
 - Vessel feet installed
 - LN2 cold shield installed in warm vessel, piping installation in progress
 - Cold vessel doors sealed and vacuum tests completed
 - Strain gauges being installed
 - Cold vessel rigging (Emmert Intl.) begins week of July 30
- Safety review preparation
 - Cold vessel engineering
 - Vacuum operation approved
 - Low pressure vessel documentation in progress
 - Need an agreed upon testing plan
 - Safety engineering design reviews for electronics in progress



Cold foot installation



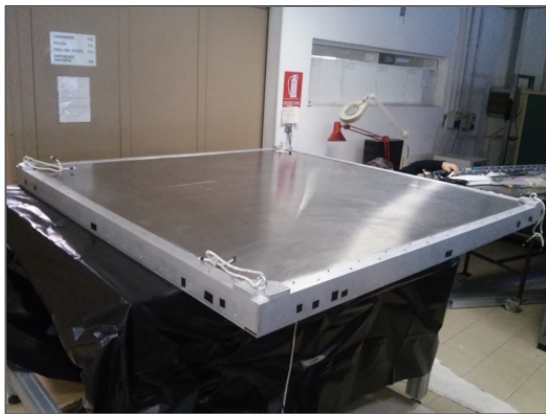
Vessel door welding and nut sealing



Rigging arrangement

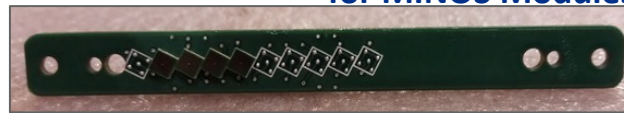
Far Detector Progress

- Cryogenics
 - Proximity cold cryogenics fabricated and delivered to CERN, will ship to Fermilab in time for installation (CERN)
 - External cryogenics in hand and partially installed (FNAL)
 - Controls cabinets ready, controls integration in progress (FNAL)
- Preparation of new detector components
 - TPC electronics testing passed 50% complete – 1 vessel (Padova)
 - Side CRT readout SiPM chosen for repurposed MINOS modules
 - starting final prototype (FNAL/CSU)
 - Top CRT ready for production assembly at Frascati (Bologna/CERN)



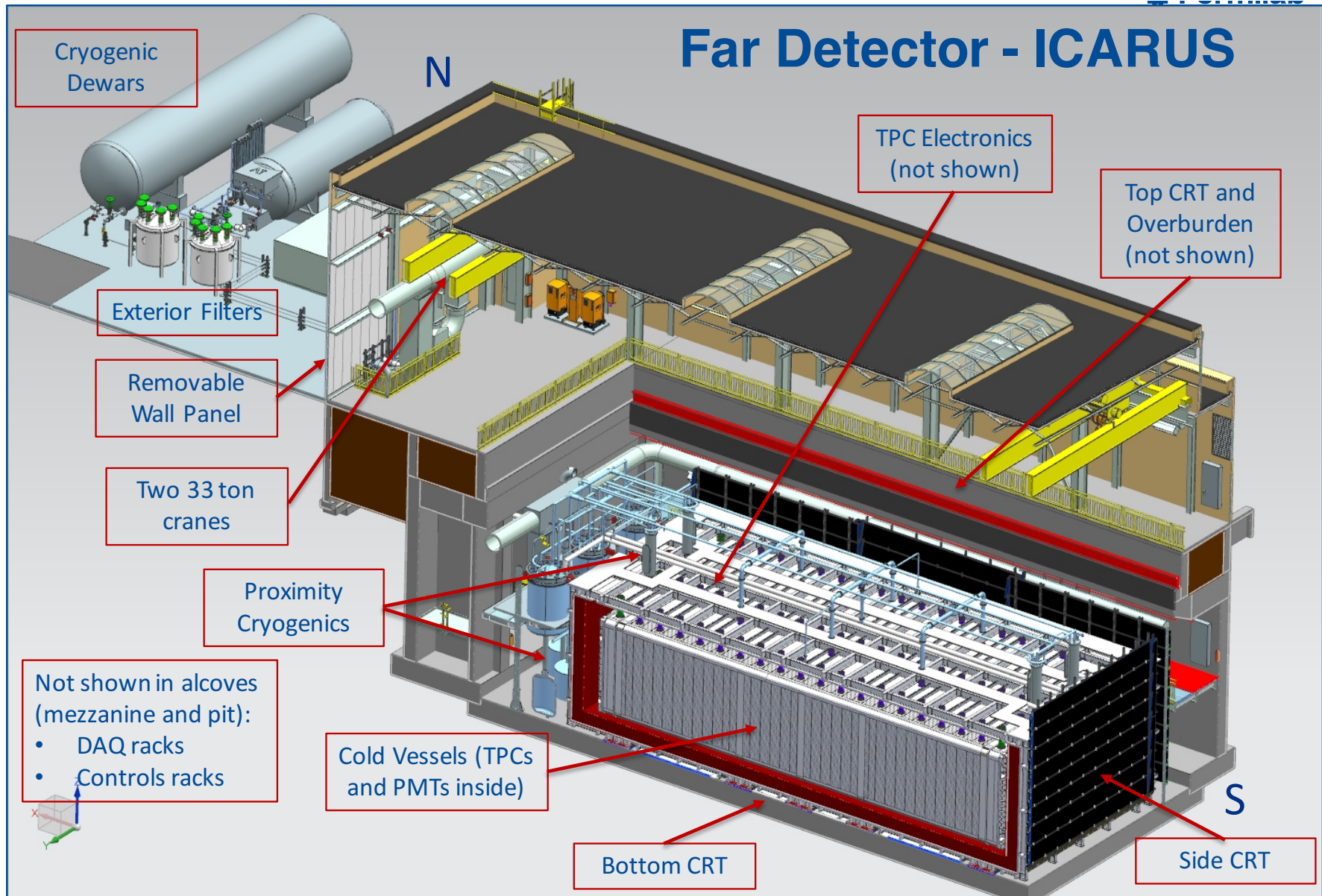
**PreProduction
CRT Module
@ Bologna**

**Prototype SiPM board
for MINOS Modules (Bottom and sides)**

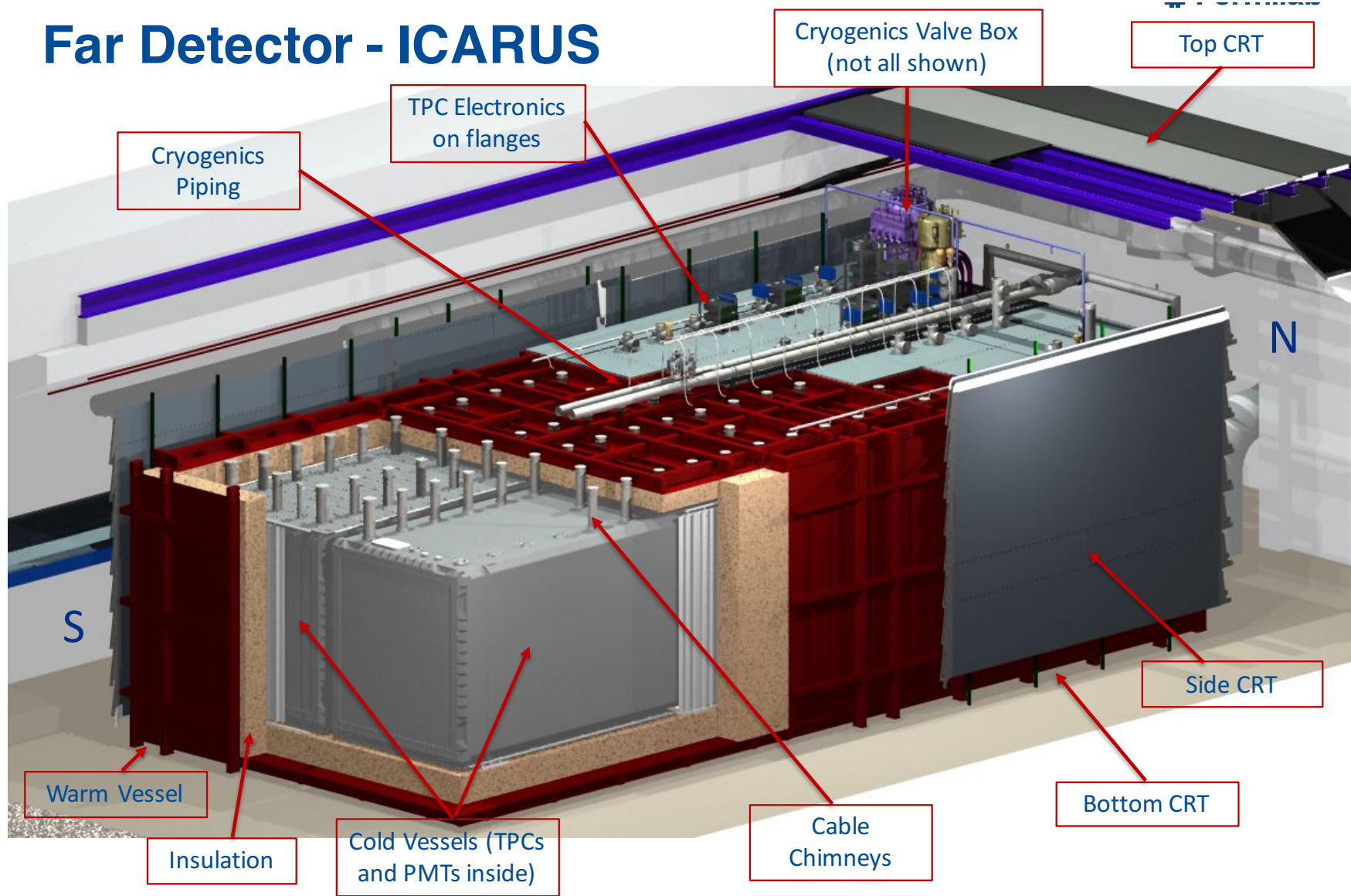


Post-rigging work : a six month outlook (Sept. – Feb.)

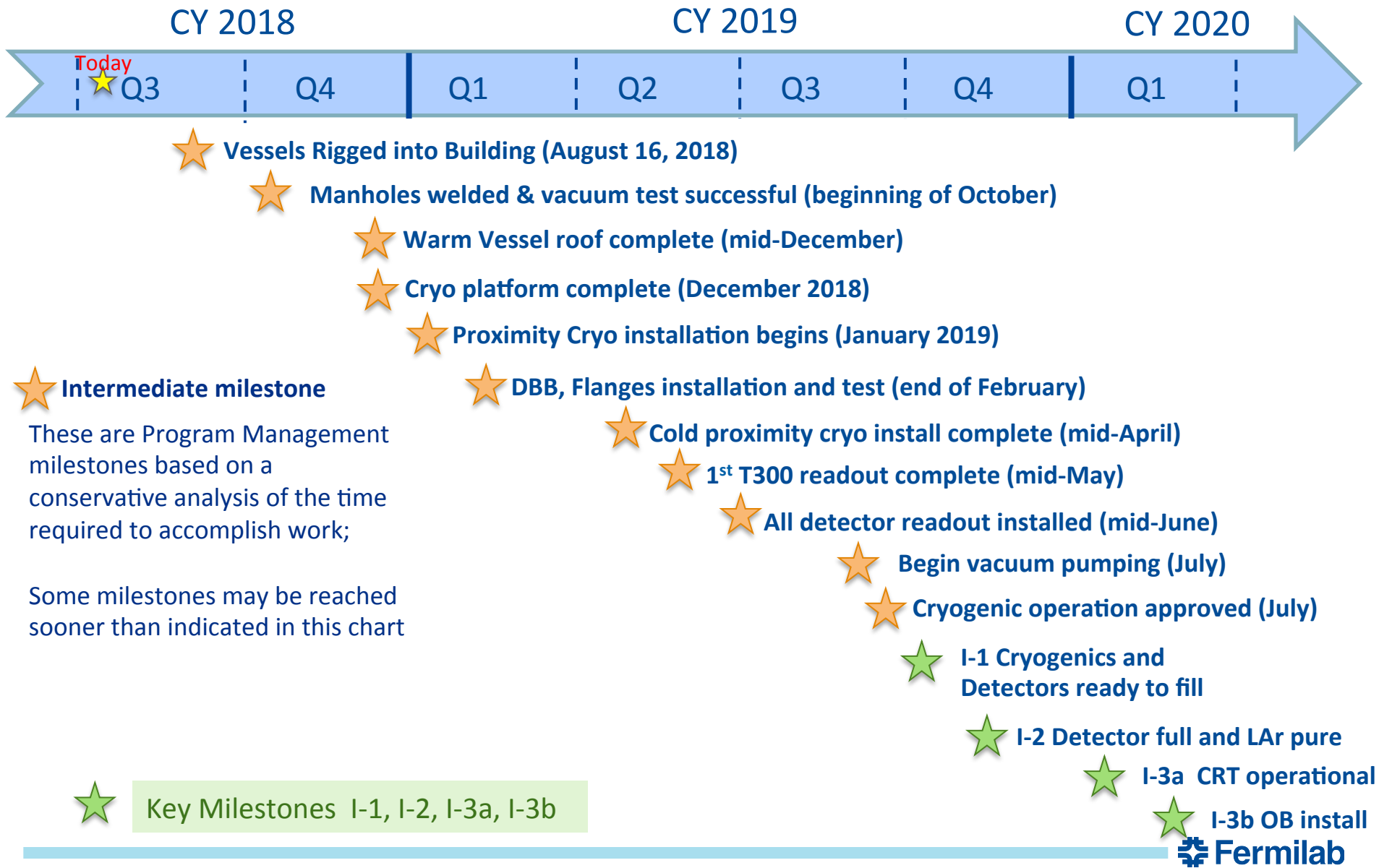
- Schedule and sequence for **detector readout** and **installation of cryogenics** and infrastructure (electrical) not yet fully defined : receiving high priority NOW
- Detector work – Phase 1
 - 1st task : Install chimneys (INFN + U.S. groups)
 - Number of people available will determine the duration
 - 6 to 8 teams of 2 (12 – 16 persons) predicts 4 week duration
 - INFN groups need 6 weeks advance notice; U.S. groups need travel support
 - 2nd task : install roof (technicians from CERN, INFN, GTT)
 - **4 - 5 week estimate**
 - 3rd task : install decking on top of detector
- Proximity cryogenics installation (Demaco and CERN)
 - Need platforms in place before starting; outside contractor – schedule still under discussion
 - Demaco needs three months notice in advance of start date
 - Can we even get started before January?
 - Duration of task is unknown; could be quite long if the PD-SP rate per valve box is not improved
- Detector work – Phase 2
 - Install crosses, TPC and PMT electronics, flanges, crates and power supplies



Far Detector - ICARUS



Intermediate Milestones



Issues needing attention

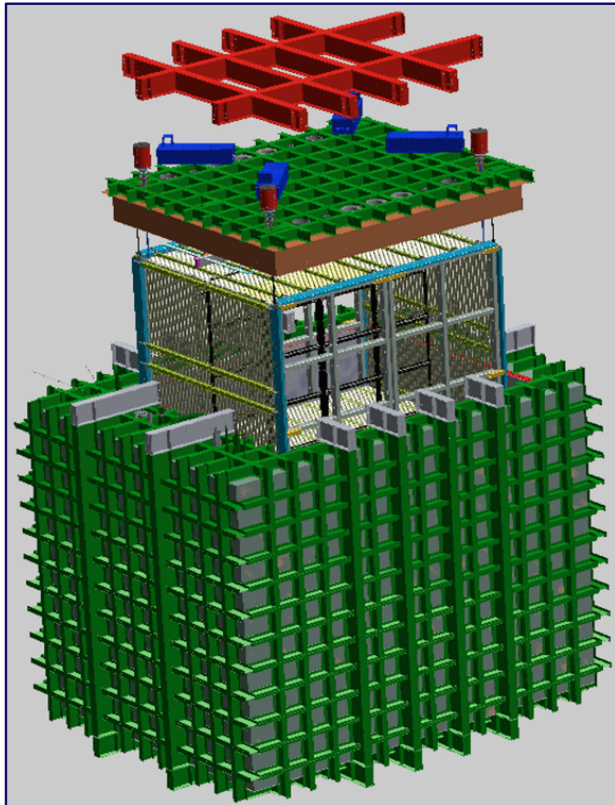
- Schedule planning
 - Understanding the full scope of work for each aspect of the remaining installations and all prerequisites for the jobs
 - Have initiated more rigorous job planning with written presentations for management and technical review prior to the start of the jobs
- Resource identification for all jobs
 - Time line for detector electronics installation will depend on the available resources
 - >96 chimneys/feed-throughs to be installed and checked out
 - 8 – 12 persons needed to do job in weeks; fewer imply months
 - Need to do vacuum checking at each stage since access to fix becomes impossible as more equipment gets installed

Key Milestones

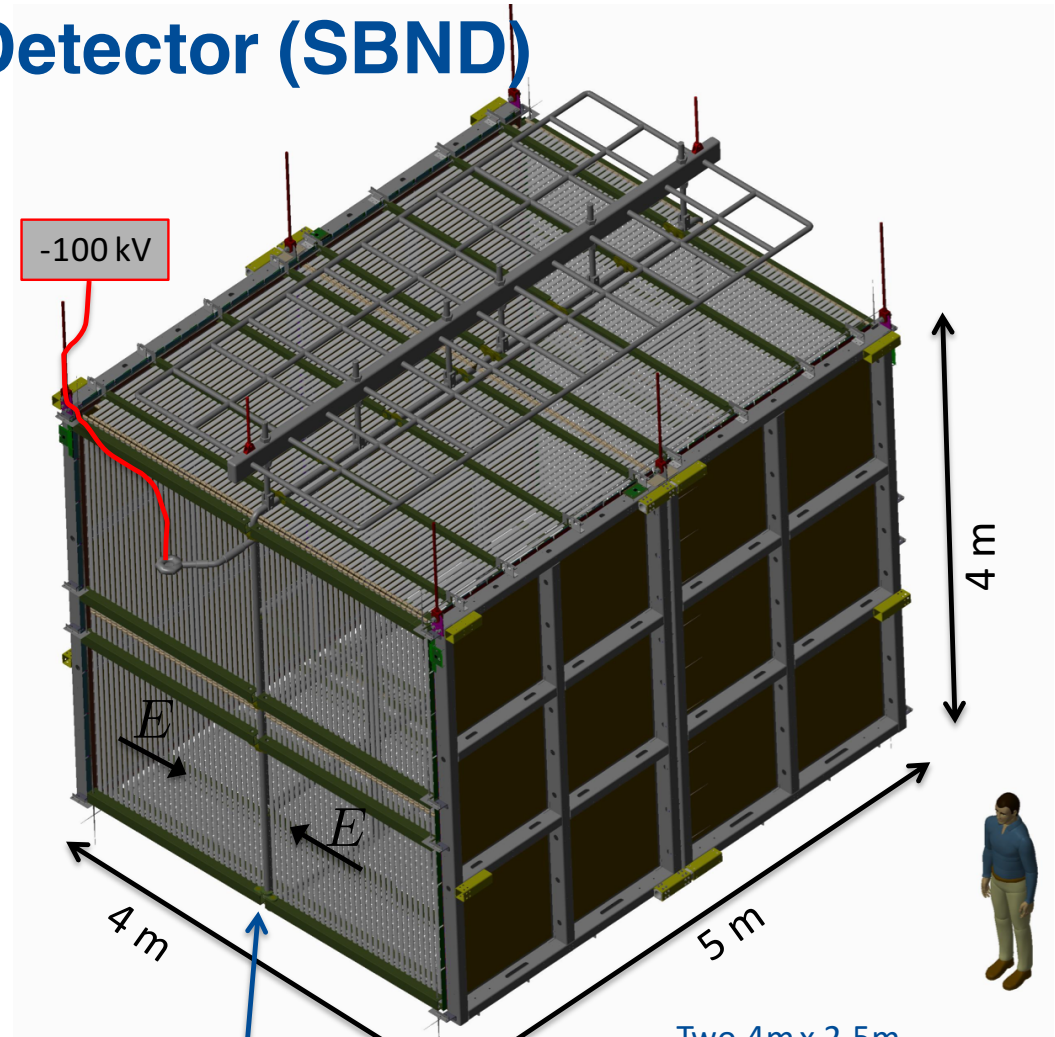
| Milestone | June 2018 |
|---|---|
| I-1 ICARUS vessels are ready to fill with LAr | Between May and August 2019 (depends on completion of cryo install) |
| I-2 ICARUS detector is ready for commissioning (LAr pure and all electronics and readout installed) | December 2019 (uses a conservative estimate for LAr delivery and fill time) |
| I-3 ICARUS detector ready for physics data (CRT and shielding installed) | March 2020 |
| | |

Short Baseline Near Detector (SBND)

New 112T LArTPC with many features in common with ProtoDUNE



Membrane cryostat constructed inside an outer warm steel structure

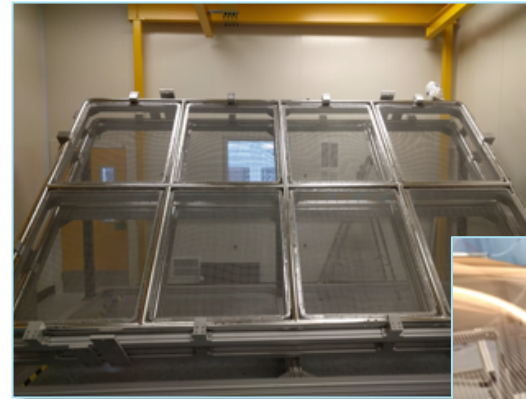


Central cathode with two 2m drift regions

Two 4m x 2.5m Anode Plane Assemblies (APAs) per side (drift region)

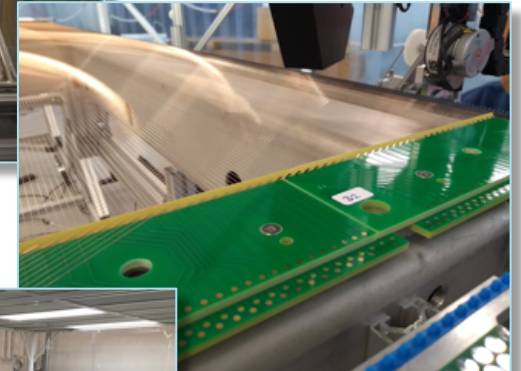
Near Detector Progress

- TPC Fabrication (UK/NSF)
 - Wire installation progressing on first two APAs at Yale and Daresbury labs.
 - Cathode plane shipped from Liverpool
 - Preparing field cage assembly at Yale
 - HV feedthrough tested at CERN (Yale)
- Other detector components
 - PMTs ready for installation, mounts in fabrication (LANL)
 - CRT panel production >70% complete (Bern)
 - Laser system in production (Bern)
- TPC Electronics (BNL, Columbia U)
 - Commercial off the shelf ADC chosen for cold operation – no lifetime problem found
 - Prototype Front-End Mother Boards (FEMB) tested
 - Vertical slice test w/LArIAT (FNAL test beam)

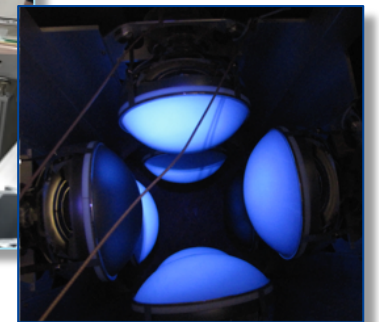


Cathode ready to ship @ Liverpool

APA frame wiring @ Yale & Daresbury



PMT test at LANL



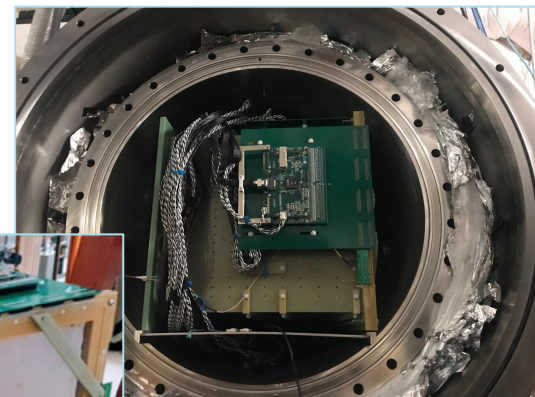
CRTs in SBND Building



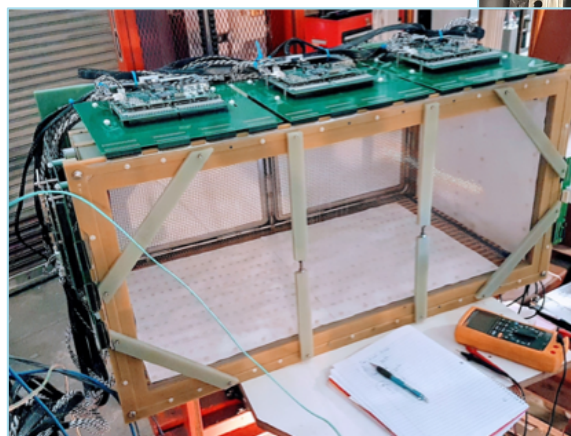
Near Detector Progress

- Detector Assembly (FNAL +)
 - Assembly facility prepared in the Dzero assembly building (DAB)
 - Mockup APA frames in hand to test assembly procedure (alignment)
- Cryogenics (CERN/FNAL)
 - Final proximity design in progress at Demaco
- Cryostat (CERN/FNAL/Bologna)
 - Ready for final design at CERN and GTT; insulation thickness now compatible with pDUNE
 - **Need SBN MOU to define the responsibilities between CERN, DOE (FNAL) and INFN**

Vertical Slice
with LArIAT



SBND FEMBs mounted



TPC inserted into Cryostat

Assembly tent
ready

Assembly at
Dzero



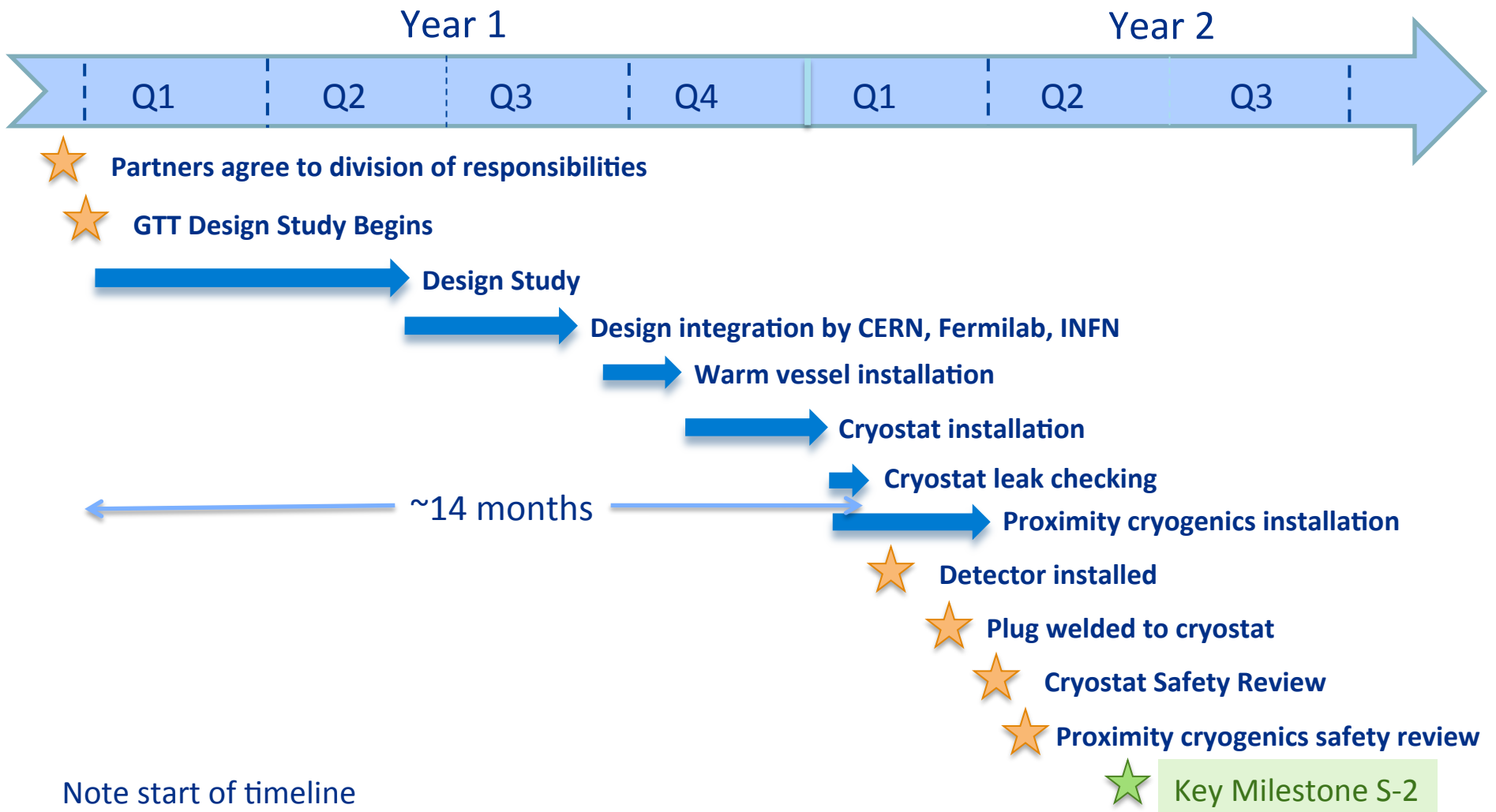
Gantries in
assembly tent



Key Milestones

| Milestone | June 2018 |
|---|---|
| S-1 SBND TPC is ready to move to ND building | August 2019 |
| S-2 SBND cryostat is ready to fill with LAr | Summer 2020 (if agreement were in place today) |
| S-3 SBND detector is ready for commissioning (LAr pure and all electronics and readout installed) | October 2020 |
| S-4 SBND detector ready for physics data (CRT and shielding installed) | December 2020 |

Key Milestone S2 depends on cryostat delivery



Note start of timeline driven by agreement on responsibilities

Main conclusions from schedule analysis

- Far Detector
 - Understanding scope and coordination of remaining activities is the key to efficient use of time
 - Development and review of cryogenic safety documentation must proceed in parallel with the system installation in order to not lose time awaiting approvals after installation is complete
- Near Detector
 - Resolution of the agreements necessary to proceed with the cryostat design are the highest priority
 - The cryostat is the critical path for completion of the Near Detector

SBN Program Organization

- Overall SBN experiment organization created
 - Outline agreed to by ICARUS and SBND collaborations in early 2018
 - Oversight board chaired by Steve Brice includes spokespeople of ICARUS and SBND and representatives of the largest financial contributors
 - Several joint working groups have started
 - Overall experiment number: **E-1100**
- Multilateral Agreement (“MOU”) between the major partners is in draft form
 - Reviewed by DOE legal; sent to all partners listed for review
 - Necessary to make the organization effective and to move forward on key deliverables (e.g. SBND cryostat)
- Oversight board held first meeting in May – setting up quarterly meetings
- Institutional Board being formulated
 - 1st meeting at September meetings of ICARUS, SBND and SBN
- Joint working groups:
 - Analysis, Online, Slow Control working groups already active
 - CRT Group formed
 - Next WGs in development: Cryostat and Cryogenics

Summary

- The past year :
 - The Program management team has concentrated on making progress towards the Key milestones that will get the detectors ready for commissioning.
 - There have been many hurdles and the team has navigated them well and are now on track to meeting the schedule presented here.
 - We have implemented a rigorous monitoring program for both cost to complete and milestone tracking.
 - Next review scheduled for ~late October will cover both cost and schedule

Backup

July 2017

From last month's DOE Briefing



ICARUS Milestones – 6 months

- July:
 - ICARUS T600 detectors arrive on-site
 - Rigging contract to install the T600 into the building out for bid
- August:
 - Final inspection and sealing of T600 cold vessels
- September:
 - Cold Shields delivered, installed, inspected (cryogenic piping)
 - Rigging contract awarded
- October:
 - T600 installed into the building and warm vessel
 - Begin Side CRT installation
- November:
 - Install readout chimneys and warm vessel insulated top
- December:
 - Begin cryogenics installation
 - Begin T600 readout installation

5 6/21/17 SBN Team I Plan - Next 6 Months



SBN



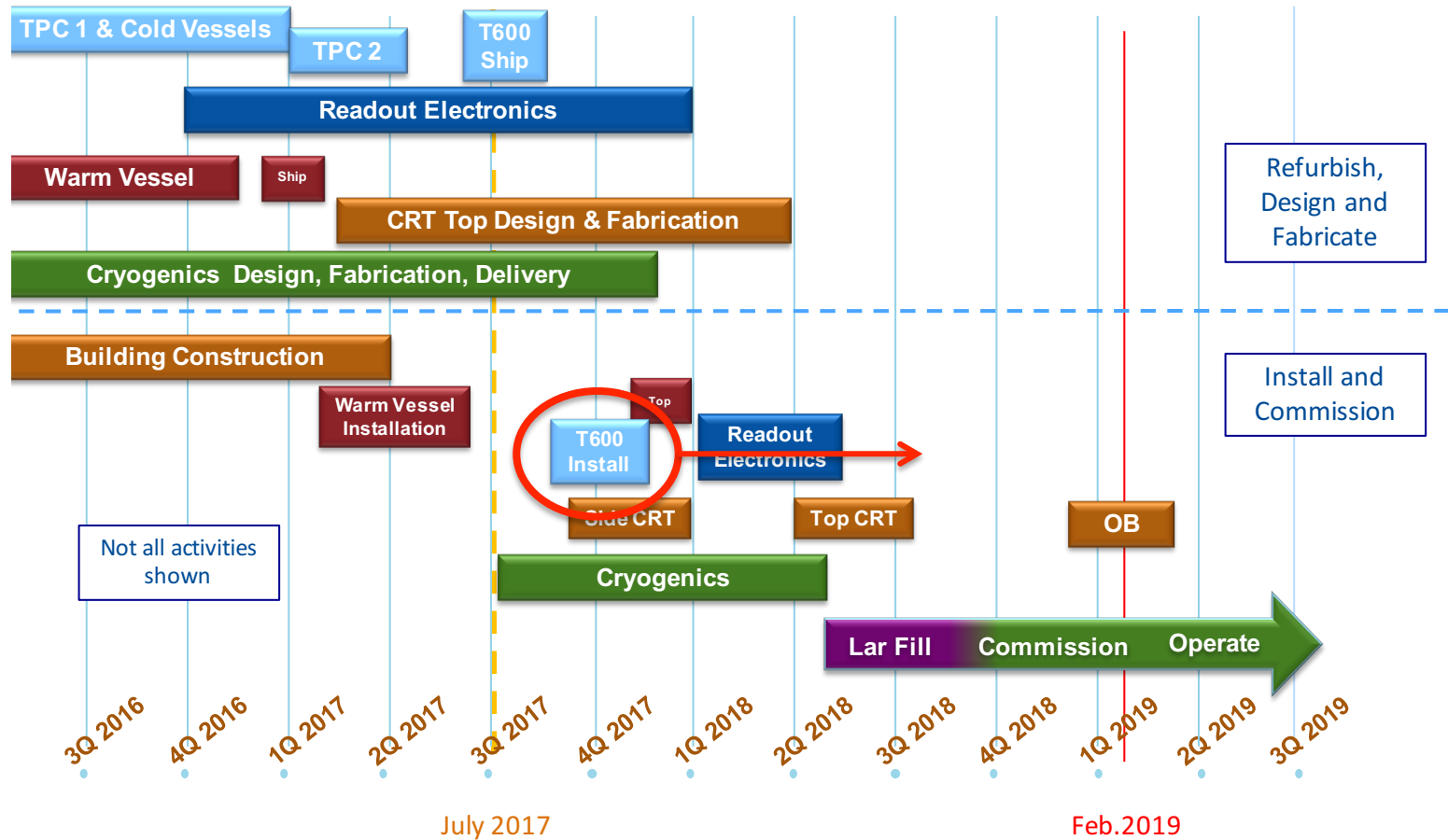
12 7/20/2017 WBS 4 Infrastructure | SBN PMG



26 July 16, 2018 G. Rameika | SBN Status - PAC Meeting

July 2017 PAC

Far Detector Timeline (Technically Driven)



Timeline – Calendar year

August 2017

Timeline updates

ICARUS Milestones – 6 months

- July:
 - ICARUS T600 detectors arrive on-site
 - Rigging contract to install the T600 into the building out for bid
- August:
 - Final inspection and sealing of T600 cold vessels
- September:
 - Cold Shields delivered, installed, inspected (cryogenic piping)
 - Rigging contract awarded
- October:
 - T600 installed into the building and warm vessel
 - Begin Side CRT installation
- November:
 - Install readout chimneys and warm vessel insulated top
- December:
 - Begin cryogenics installation
 - Begin T600 readout installation

By first week of September

Inspection/Repair – Sep/Oct
Doors welding & bolting – Oct/Nov

Cold shields delivery – Nov
Cold shields install – Nov/Dec

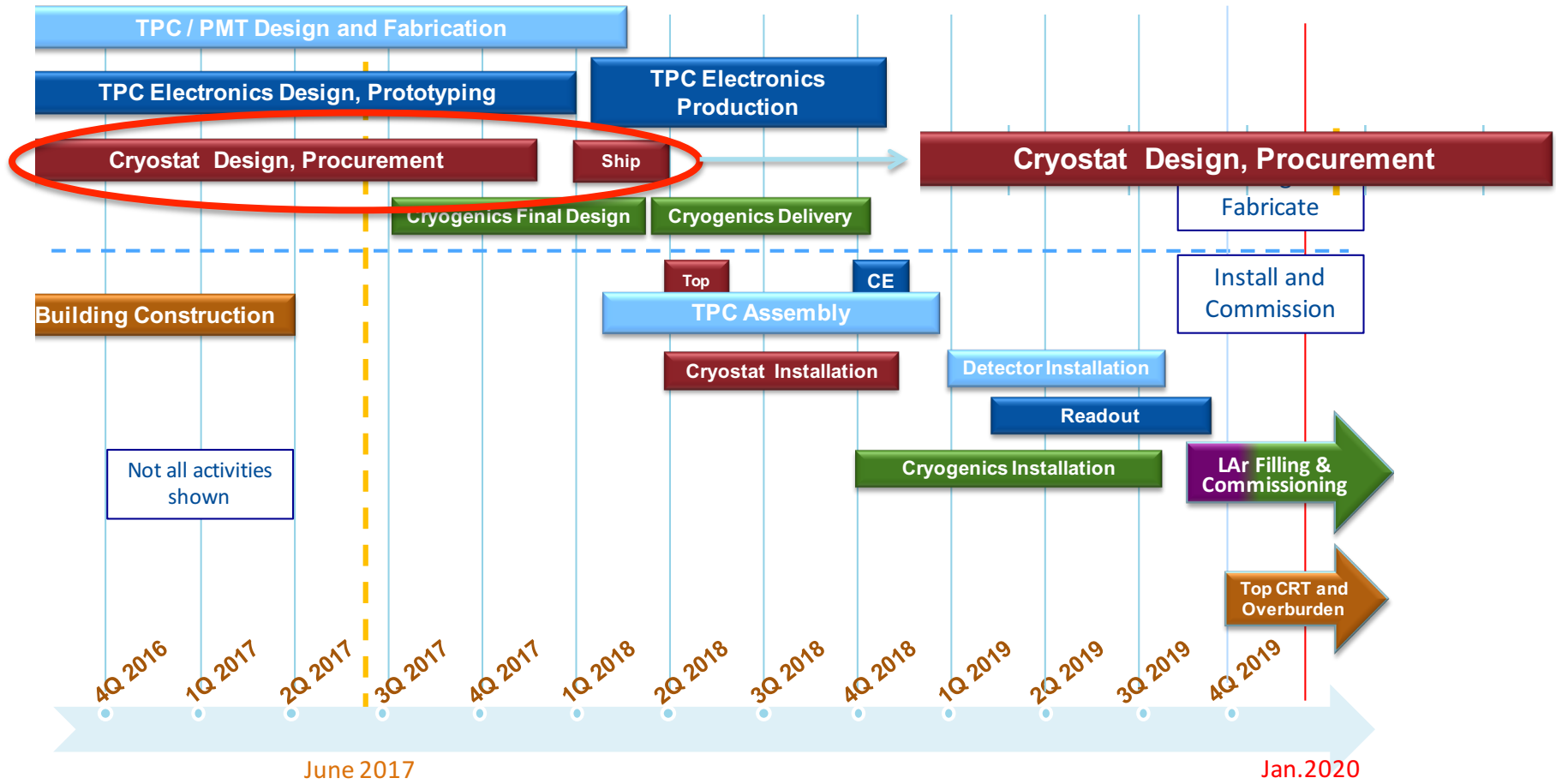
Unlikely before January 2018

Follows installation into building

5 6/21/17 SBN Team I Plan - Next 6 Months

Near Detector critical item

Near Detector Timeline (Technically Driven)



Milestone monitoring

- We have 11 intermediate milestones for the coming 12 month period, leading to I-1 “Ready to fill”
 - 5 owned by the detector
 - 6 owned by infrastructure
- Intermediate milestones have been assigned an owner who will monitor progress, update the forecast monthly and explain cause of any delays
- Forecasts can be compared to the baseline and float calculated

| Milestone to I-1 (ready to fill)* | Owner | July 2018 Forecast | July 2018 PM Baseline | Float (days) | Comment |
|---|-----------------|--------------------|-----------------------|--------------|--|
| Vessels rigged into building | P. Wilson | 16-Aug-18 | 16-Aug-18 | 0 | |
| Manholes welded and vacuum test successful | C. Montanari | 29-Sep-18 | 10-Oct-18 | 11 | |
| Warm vessel roof complete | C. James | 1-Nov-18 | 15-Nov-18 | 14 | |
| Cryo platform complete | C. James | tbd | 15-Dec-18 | | new terms of contract |
| Proximity cryo installation begins | B. Norris | 2-Jan-19 | 15-Jan-19 | 13 | need platform complete; holiday period may delay start |
| DBB, flanges installation complete and tested | A. Fava | 15-Feb-19 | 15-Feb-19 | 14 | two month duration from start |
| Cold proximity cryo install complete | B. Norris | 15-Apr-19 | 15-Apr-19 | 0 | 14 weeks after start |
| 1st T-300 readout installation complete | A. Fava | 01-Mar-19 | 15-Mar-19 | 14 | |
| All detector readout installed | A. Fava | 15-Apr-19 | 1-May-19 | 14 | |
| Begin vacuum pumping | C. Montanari | 15-May-19 | 15-Jul-19 | 61 | |
| *Cryogenic operation approved | B. Norris | 15-Jun-19 | 15-Jul-19 | 30 | minimum 2 months after cold proximity complete |

* critical intermediate milestone to reaching I-1

DRAFT