



SBND Detector

Ting Miao

Director's Progress Review of SBN

15-17 December 2015

Outline



- SBND Introduction
- Detector subsystem progress and schedules
- Overall schedule, reviews and management
- Cost and resources
- Summary

Details are in 7 breakout talks on SBND

SBND Introduction



- SBND = Short-Baseline Near Detector
- A near detector in the three-detector SBN program
- A FNAL experiment T-1053 of 26 collaboration institutes

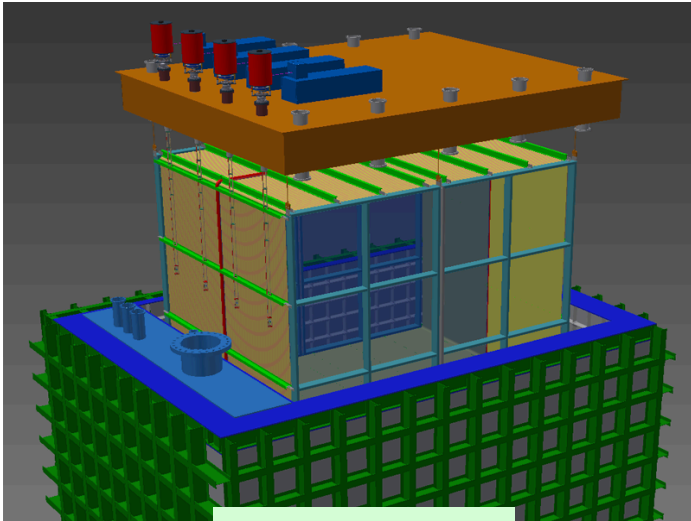


SBND Logo

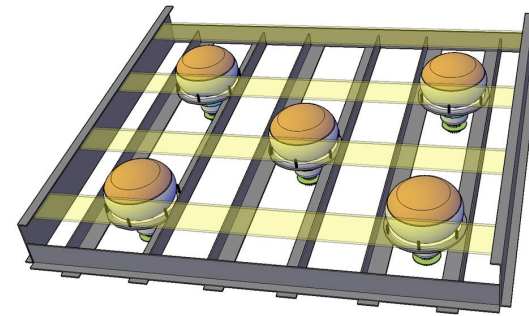


People Power

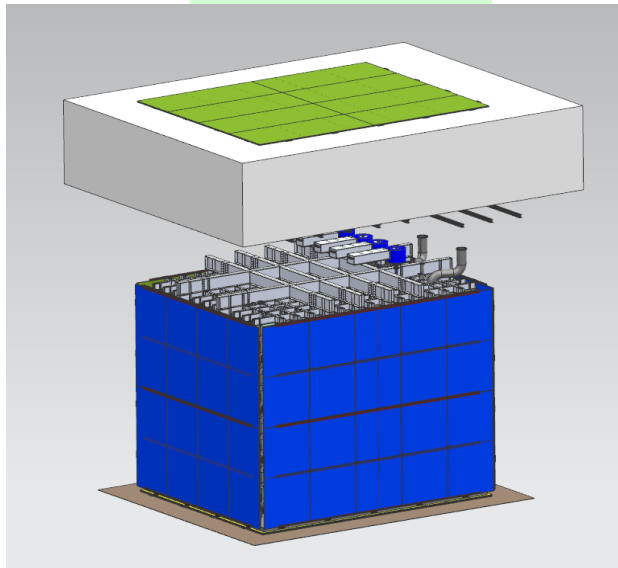
Major Component of SBND



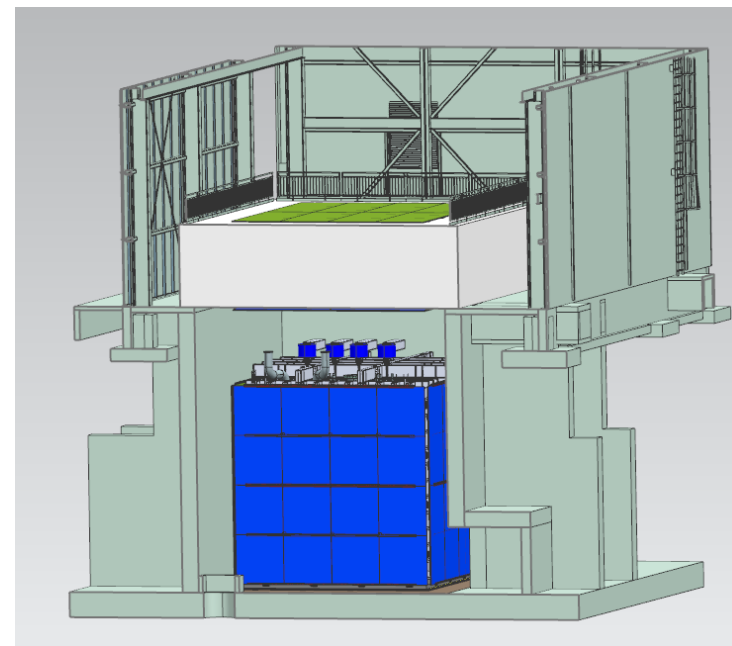
TPC, Cryostat



Light Detector



Cosmic Ray Tagger



Building

Key SBND Detector Specifications



- TPC:
 - 4m (H) x 4m (W) x 5m (L) and 112 ton active LAr volume
 - One Cathode Plane Assemblies (CPA) in the middle
 - Four 4m(H) x 2.5m (L) Anode wire Plane Assemblies (APAs)
 - APA has 3 wire planes with 3mm pitch and spacing: vertical (y) and $\pm 60^\circ$ (U&V)
 - Cold electronics to have 10:1 S/N ratio and noise level below 800-electron
- 112 PMTs to be mounted behind APA wire planes
 - 8" Hamamatsu R5912-02mod with TPB coating
 - 15 photo-electron/MeV light yield, 5ns timing resolution or better
- Cryostat uses stainless steel membrane design from GTT
- Cosmic ray tagger has 4π solid angle coverage around TPC
- DAQ is based on uBooNE design and uses PMTs to tag BNB events

SBND WBS and L2 Managers



- Technical coordinator - Ting Miao (FNAL)
- Subsystems and L2 managers

Preliminary integration design - Joe Howell (FNAL)

TPC construction - Kostas Mavrokoridis (Liverpool)

PMT light detector - Richard Van De Water (LANL)

Cosmic ray tagger and laser calibration - Igor Kreslo (Bern)

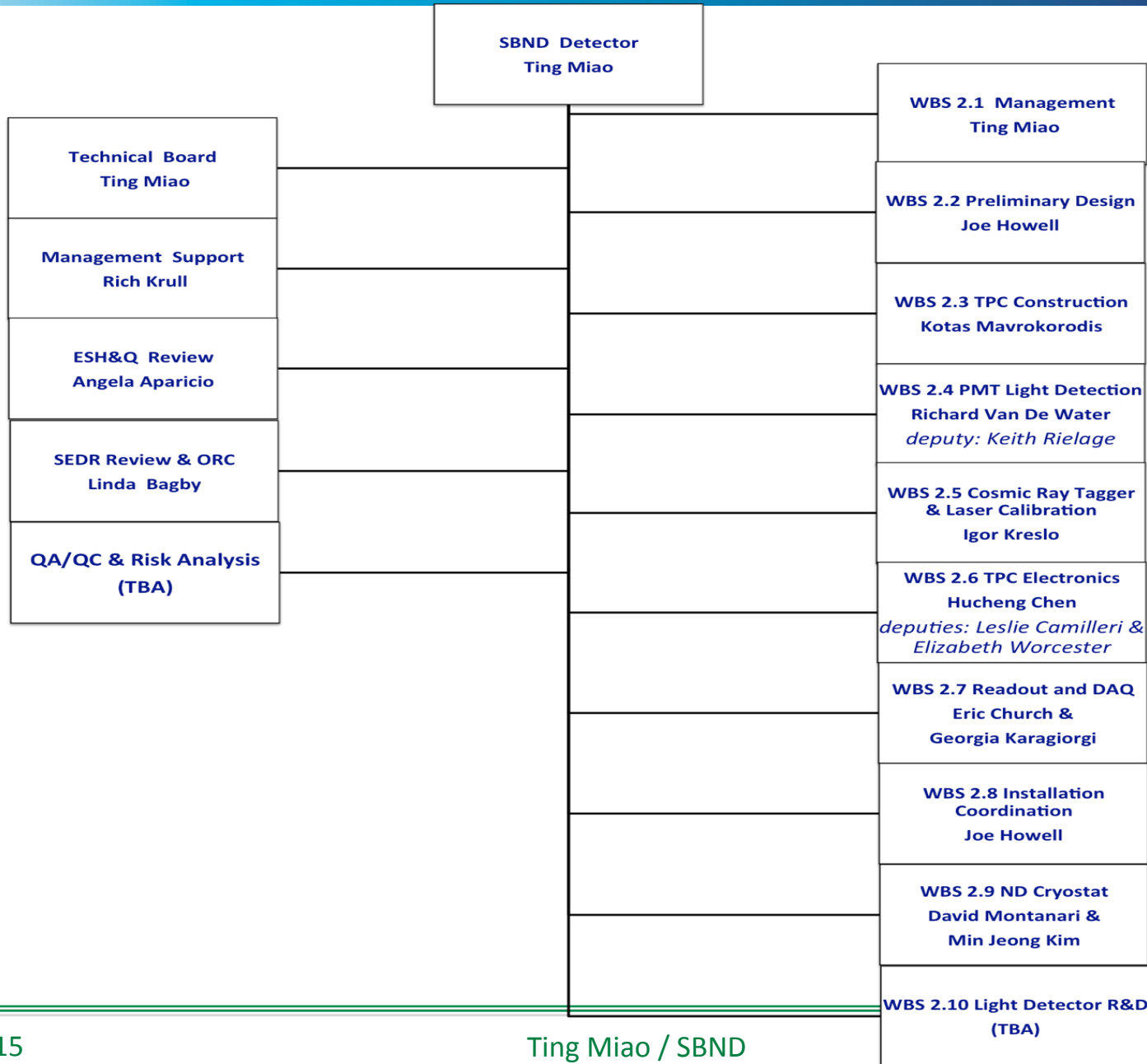
TPC electronics - Hucheng Chen (BNL)

Readout and DAQ - Eric Church (PNNL) & Georgia Karagiorgi (Manchester)

Cryostat - David Montanari → Min Jeong Kim (FNAL)

Installation coordination - Joe Howell (FNAL)

SBND Detector Team – L2 managers



SBND Status



- TPC in final design stage and fabrication to start early Spring
- TPC electronics made significant progress for cold ASIC revision, feed-through, Nevis boards and cold-warm interface designs
 - Aiming for prototype cold ASIC chip submission in Feb 2016
- Cosmic ray tagger is ready for final design reviews
 - Review scheduled for early Feb 2016
- Cryostat is finishing up top lid layout for detector feed-through
 - Aiming to start GTT contract in March 2016
- PMT system design started in October 2015
 - Preliminary design stage for PMT mounting and readout
- Readout/DAQ are focusing on integration issues
 - Common clock, trigger, grounding
- Preliminary integration design is finishing up
 - Special SBND cryostat integration meeting this Friday

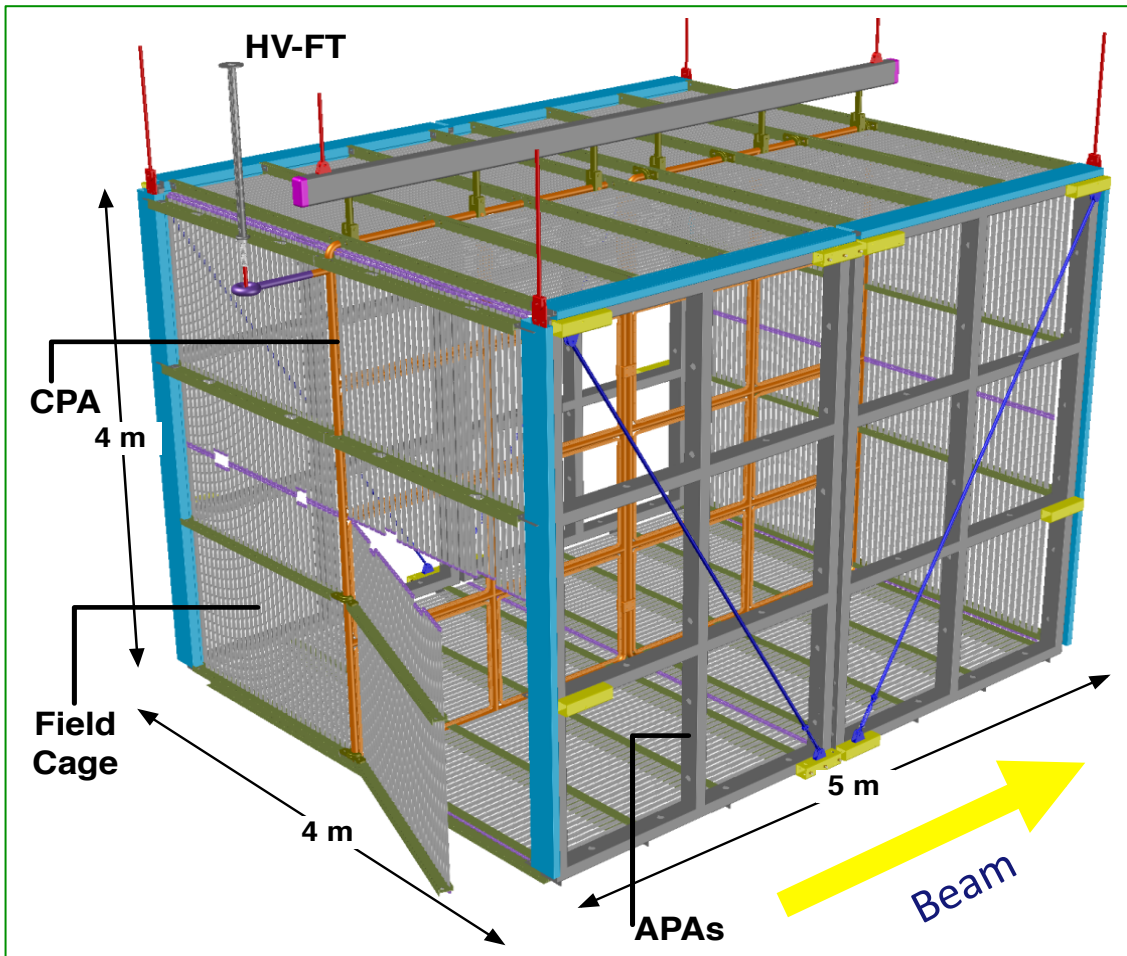
Detector Subsystem Status and Schedules

TPC Construction - WBS 2.3

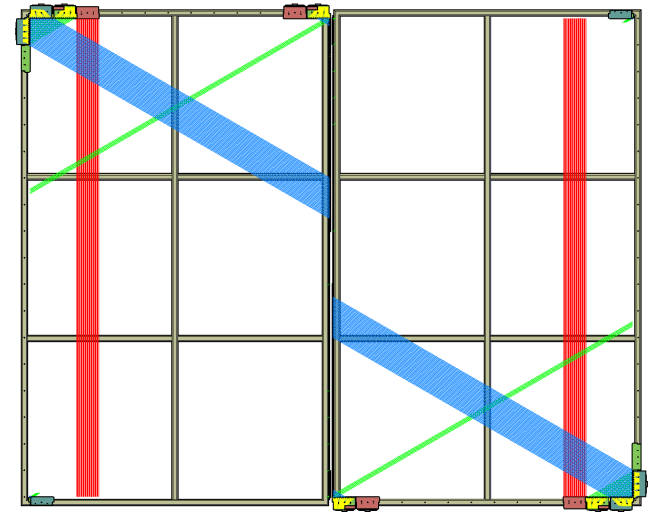


- Funded by US NSF & UK STFC (Science and Technology Facilities Council)
- L2 Manager - Kostas Mavrokoridis of Liverpool
- WBS covers design, fabrication and assembly
- Key TPC components
 - Anode Plane Assemblies (APAs)
 - Cathode Plane Assembly (CPA)
 - Field Cages
 - HV Feed-through
 - Integration and Assembly tooling and procedures

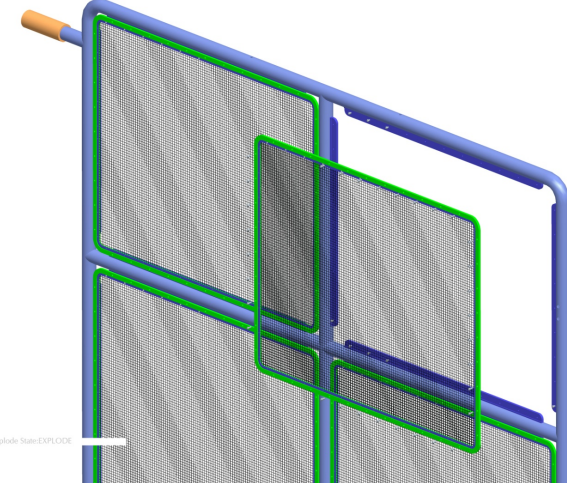
SBND TPC Component



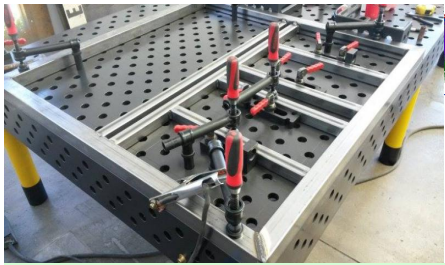
APA wire planes



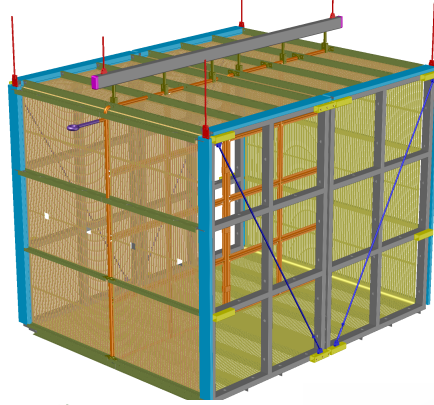
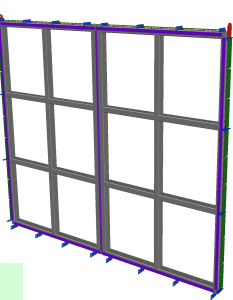
CPA SS frame and wire mesh



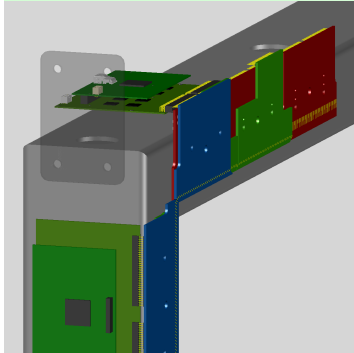
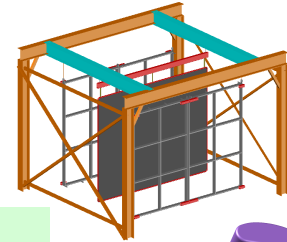
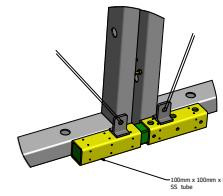
TPC Participating Institutions



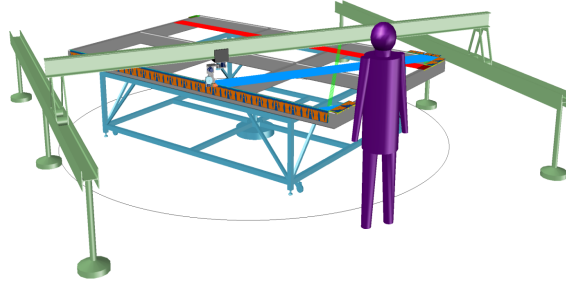
APA Frames - *Sheffield*



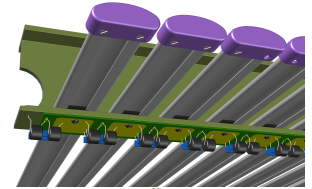
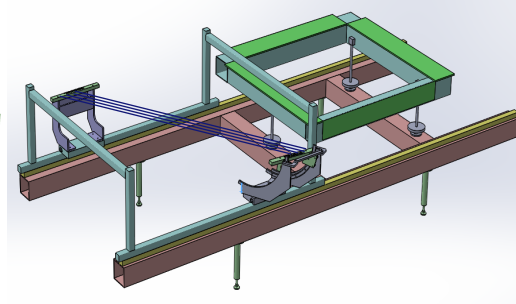
TPC Assembly
- *Chicago/FNAL*



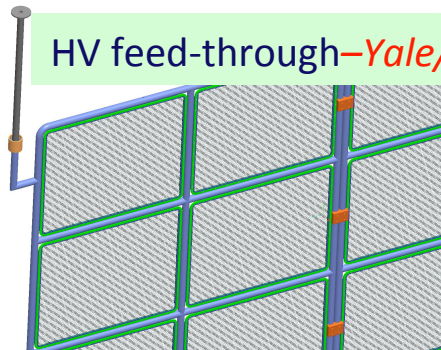
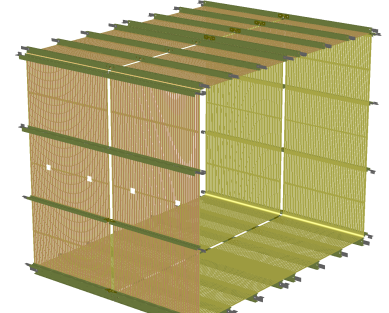
Geometry boards - *Yale/BNL*



Wire Winding - *Manchester/Syracuse/Yale*



Field Cages - *Yale/BNL*



HV feed-through - *Yale/UCL*

CPA - *Liverpool*



Cold Test - *Lancaster*

TPC Component Deliverables



Deliverables	Institution in Charge
Four APA Frames	University of Sheffield
APA Geometry boards	Yale University
Winding two APAs	University of Manchester
Winding two APAs	Syracuse University
CPAs	University of Liverpool
HV Feed-through	UCL (50%) and Yale (50%)
Field Cage	Yale University
QA/APA cold tests	Lancaster University
Integration and Assembly	Chicago University

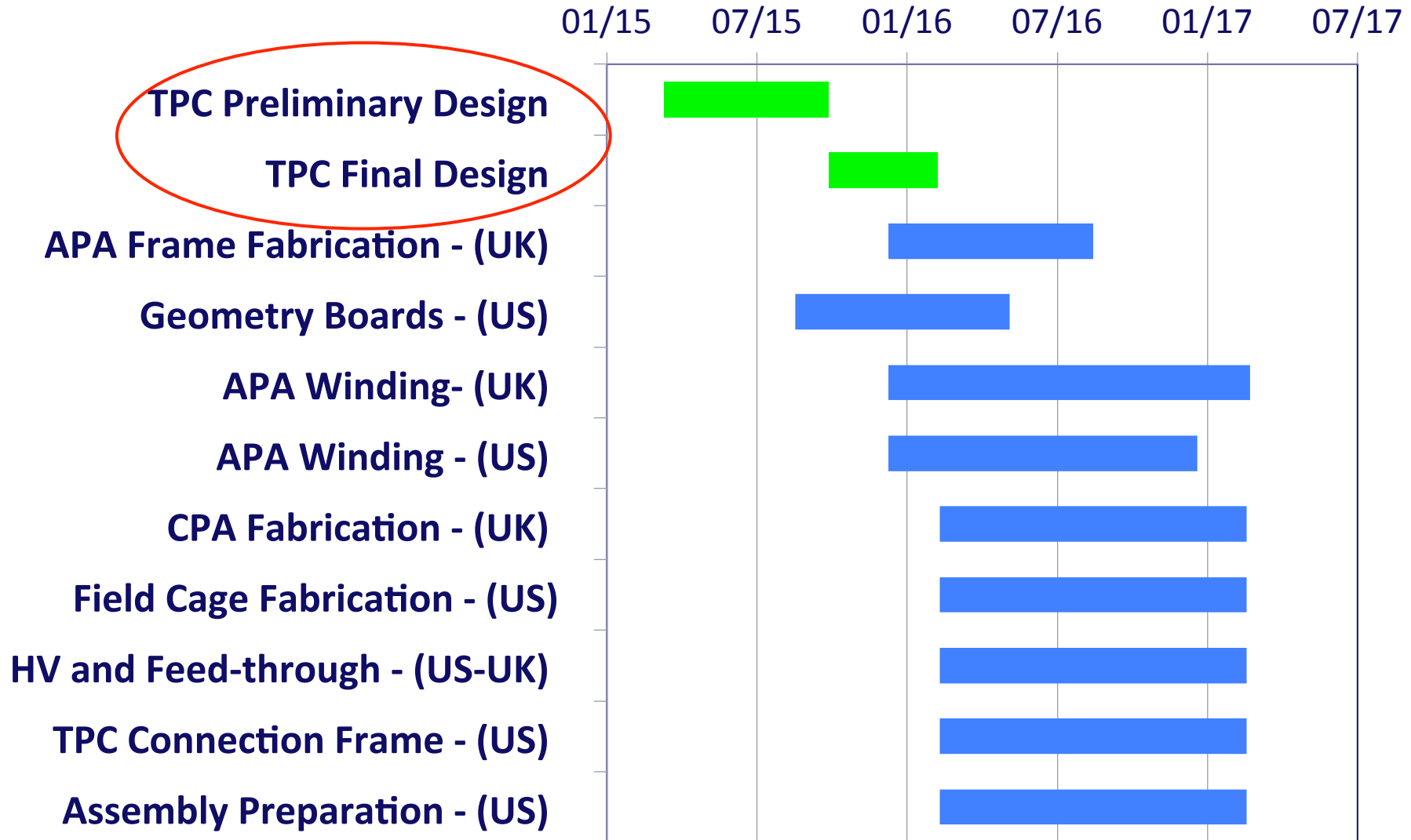
Work Package Agreement draft is being reviewed by NSF/STFC PIs

TPC Effort Coordination



- TPC design, fabrication, assembly and installation are true international collaborative effort
 - US-NSF and UK-STFC universities leading the effort
 - TPC experts of BNL, FNAL, PSL and UK from MicroBooNE, LBNE/DUNE, ICARUS
 - Fermilab provides interface/integration and management supports
- Three very productive design workshops this year
 - February at BNL on conceptual design
 - July at Liverpool on preliminary design
 - December at Yale on final design
- TPC component fabrication to start early Spring 2016

TPC L3 Tasks



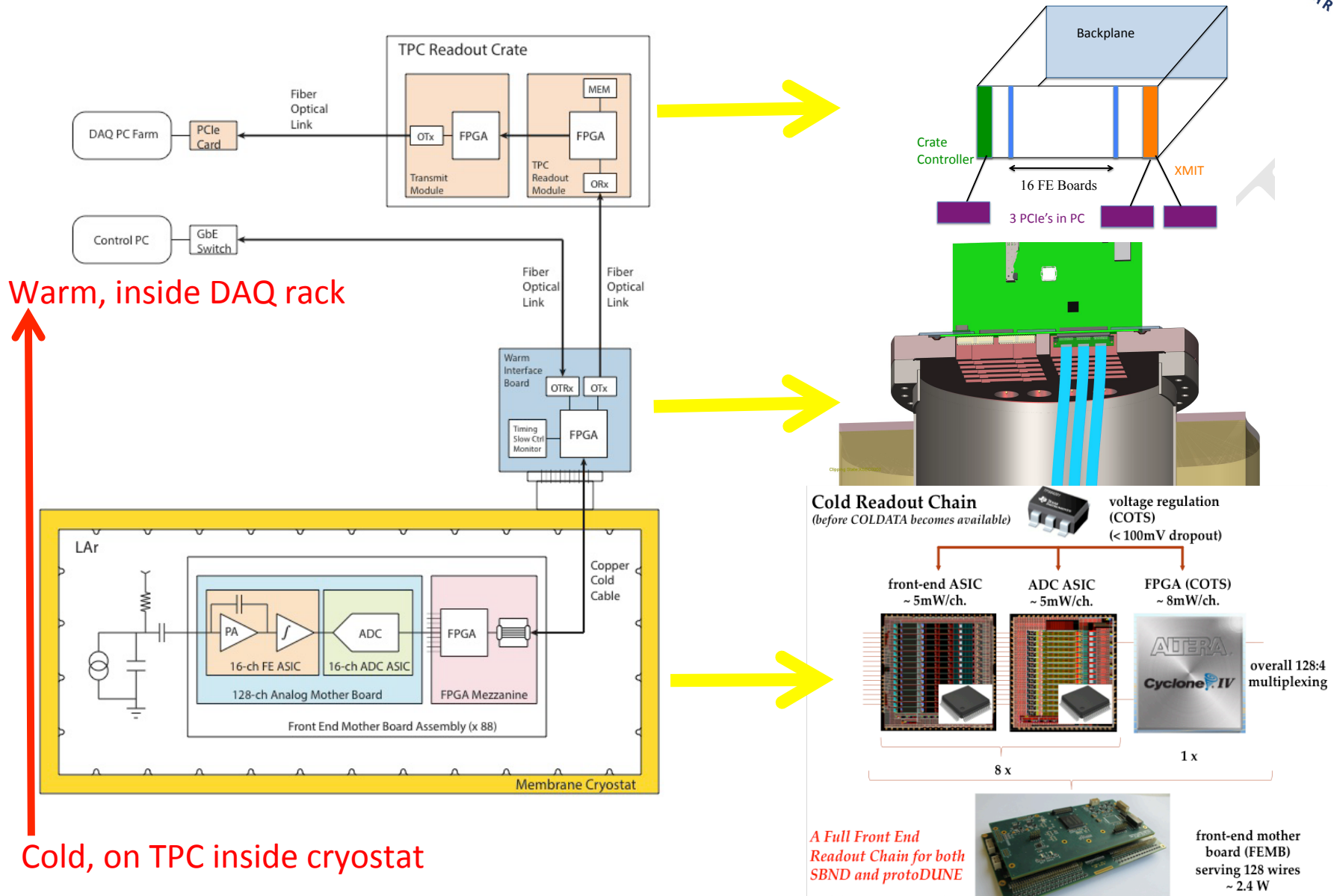
All TPC components to arrive Fermilab by 3/2017

TPC Electronics - WBS 2.6



- TPC electronics system includes
 - Cold electronics: front-end & ADC ASICs, FPGA data transfer
 - Cold cables and signal feed-through
 - Warm back-end readout based on Nevis system
 - Cold-warm interface electronics
- Fermilab R&D fund covers cold electronics (FNAL→BNL) and NSF for Nevis warm electronics (Columbia U.)
- L2 Manager - Hucheng Chen of BNL
 - Deputy L2 on Nevis electronics - Leslie Camilleri of Columbia
 - Deputy L2 on installation& integration-Elizabeth Worcester of BNL

TPC Electronics Components

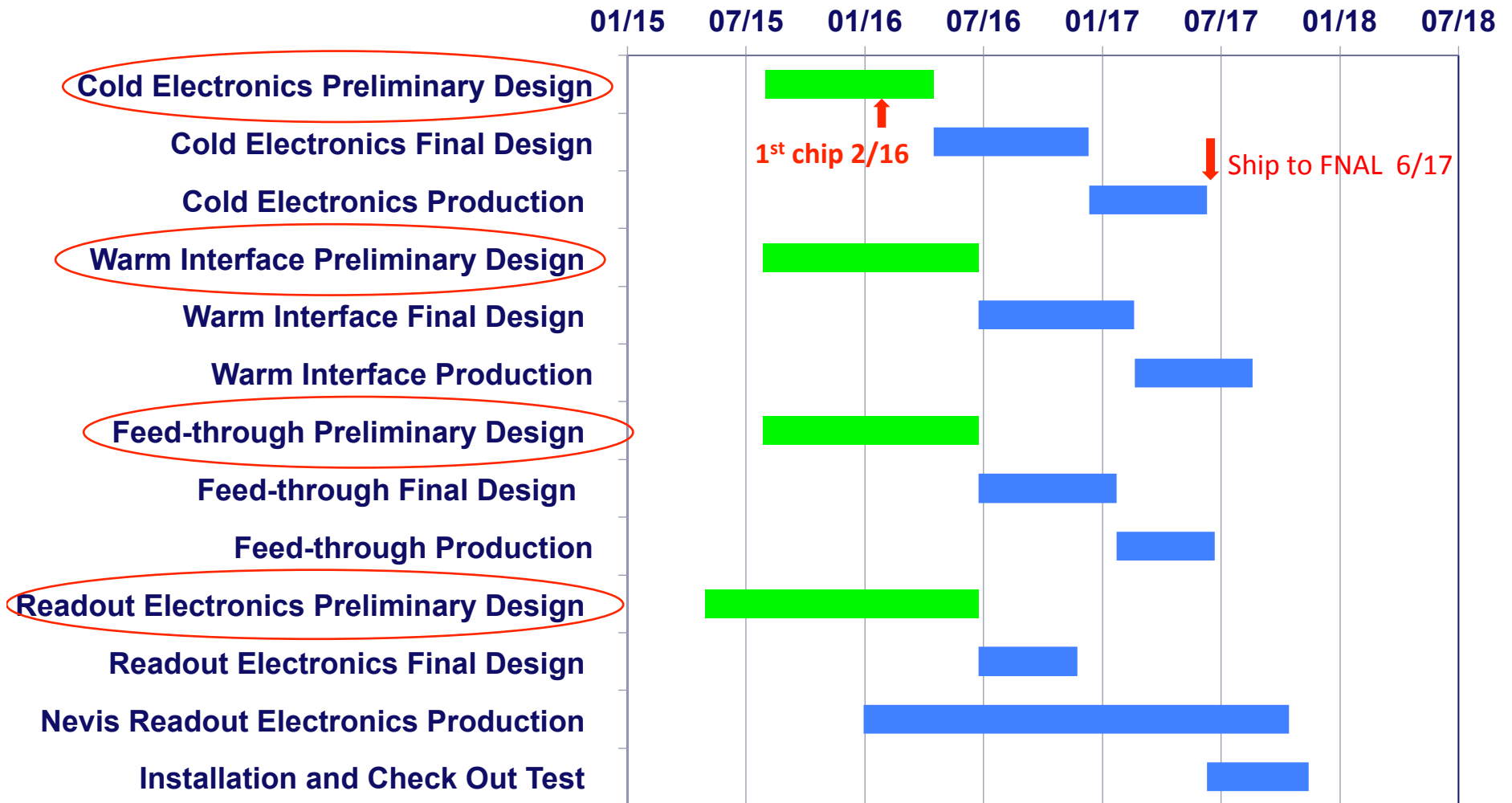


Cold ASIC Revision for SBND & DUNE



- Cold ASIC design is jointly supported by SBND and DUNE
 - Design being carried out by BNL ASIC design group
- Based on 35T test result, a list of changes was identified and prioritized by SBND/DUNE
 - See Hucheng's breakout talk for detail
- 3 rounds of design, chip submission and test are needed
 - 6-month duration for each round
 - This is one of the key schedule driver of SBND
 - Two EE graduate students was added to alleviate schedule risk
- 1st ASIC revision submission in February 2016
 - A technical review is scheduled at BNL for the week of Jan 18

TPC Electronics L3 Tasks



Readout and DAQ - WBS 2.7

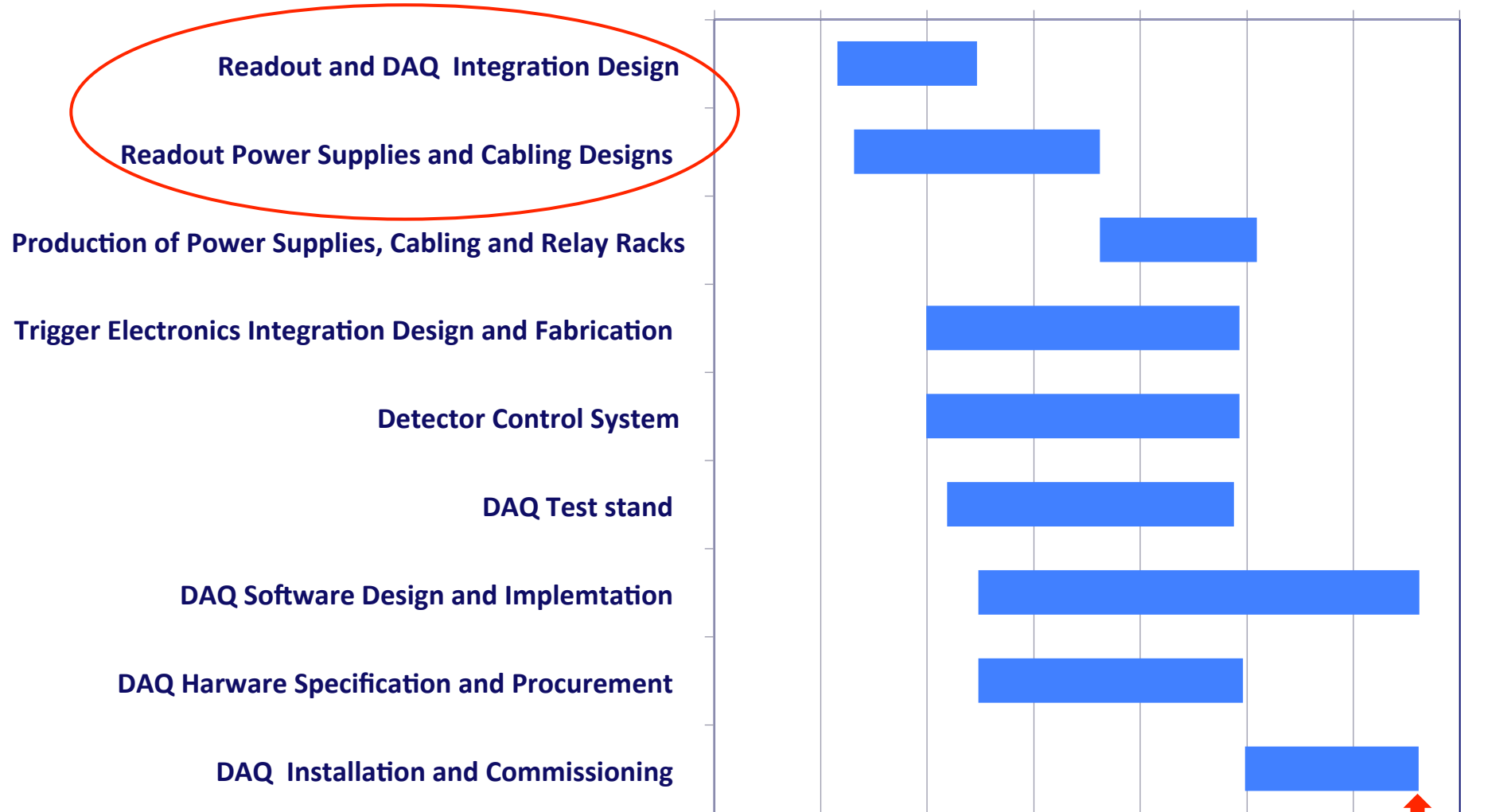


- The WBS covers electronic infrastructure and DAQ hardware/software tasks
 - A place to integrate all detector system readout electronics
- Co-L2: Eric Church (PNNL) and Georgia Karagiogi (Manchester)
 - Both with extensive experiences from MicroBooNE
- Readout and DAQ design is based on MicroBooNE system
 - TPC readout is Nevis PCIe design
 - Software to be base on artDAQ - support from FNAL SCD
- Working on integration issues with PMT and Cosmic Ray Tagger readouts – common clock and trigger designs
 - Detail in Eric's breakout talk

Readout and DAQ L3 Tasks



01/15 07/15 01/16 07/16 01/17 07/17 01/18 07/18



DAQ ready for TPC Checkout - 5/18

PMT Light Detector - WBS 2.4

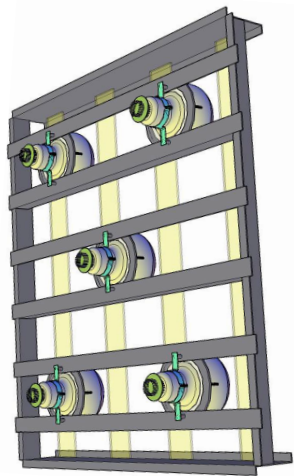


- L2 - Richard Van der Water with Deputy Keith Rielage (LANL)
- PMT system is fully funded by LDRD of LANL
 - PMT tubes, wavelength shifting PTB coating treatment and testing
 - Cold cabling and feed-through
 - Front-end and readout electronics
- Total 112 PMTs are to be mounted behind TPC wire planes
 - 8” cryogenic PMT (R5912-02mod) the same as ICARUS and MicroBooNE
 - 15 photo-electrons per MeV expected → quite large light yield
- Commercial readout electronics is being explored for ~ns resolution and large dynamic range
 - CANE 1730: 500 MHz and 14 bits, 16 channel/board, ~\$1000/channel
 - Argonne SSP is also being considered

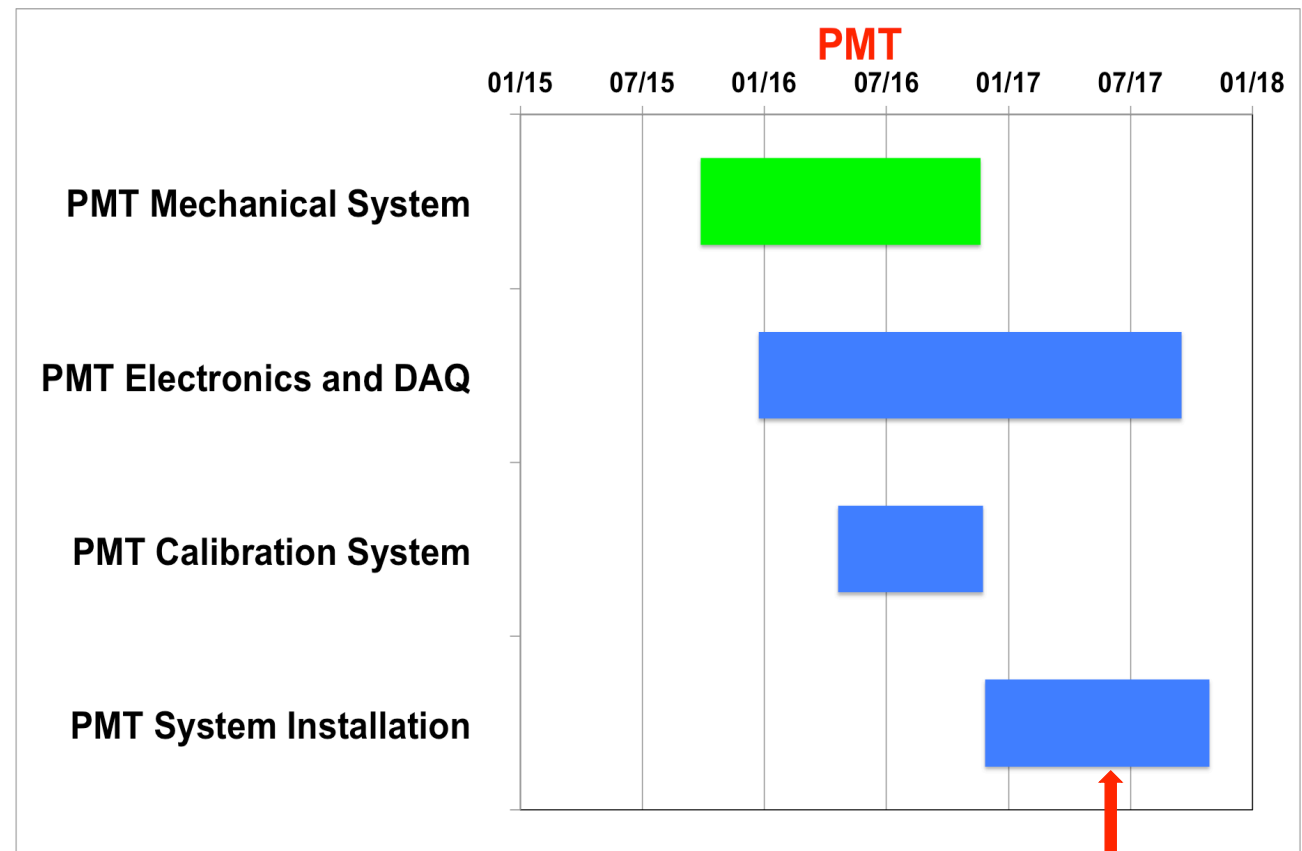
PMT L3 Tasks and Schedule



- Work started Oct 2015 when LRDR fund arrived
 - Working with ICARUS on TPB coating, HV base, QA testing and readout
 - Working also on PMT mounting design and DAQ integration (clock and trigger)



X24



PMT installation at DAB 5/17

Cosmic Ray Tagger and Laser Calibration - WBS 2.5

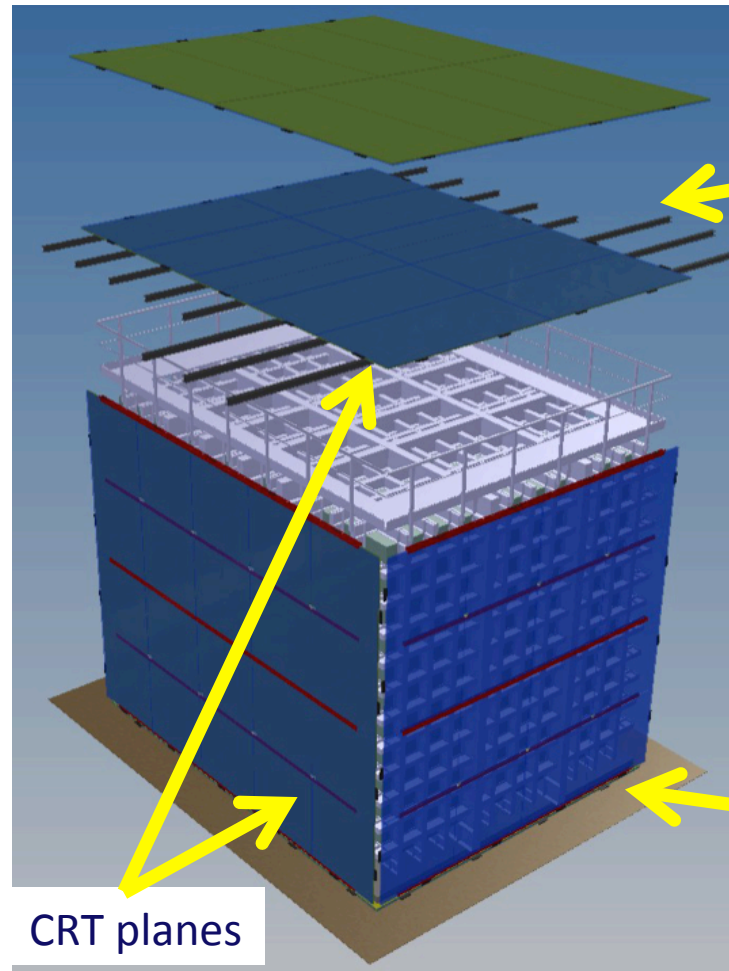


- Both cosmic ray tagger and laser calibration systems are funded by CH-NSF through University of Bern
- L2 manager - Igor Kreslo (Bern)
- Both systems are well advanced in designs and prototyping
 - See Igor's breakout talk for the very impressive progress
- CRT technical design note is posted - SBN docDB 681
 - Plastic scintillator (Uniplast Inc.) modules, optical fiber and siPM
 - Front-end electronics and readout
 - Prototype testing, production and installation
 - And Safety Engineering Design (SEDR) documentation
- CRT readout design is with safety review committee (Linda Bagby)
- CRT module production readiness review is scheduled for Feb, 2016

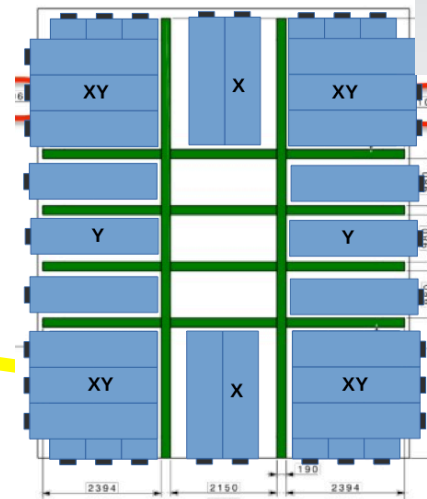
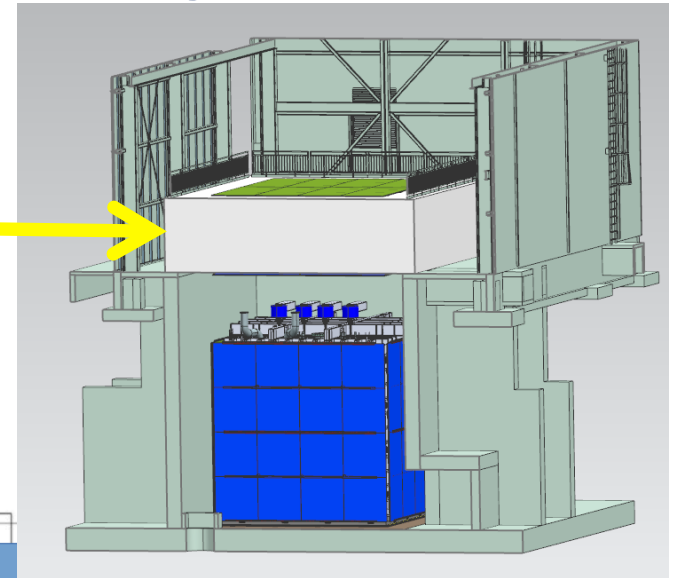
Cosmic Ray Tagger – SBND on surface



- 7 scintillator planes with scintillator models staged in x-y to tag cosmic background in TPC → 94% muon flux coverage

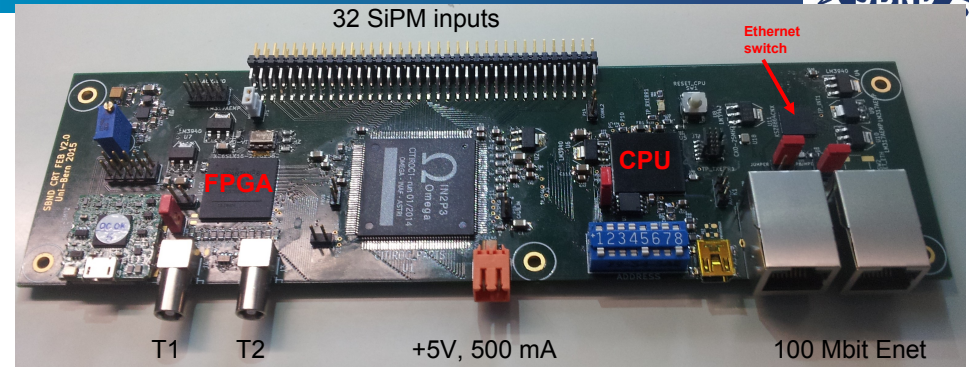
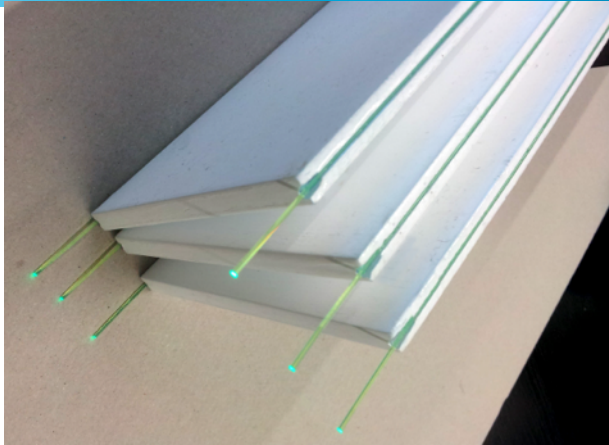
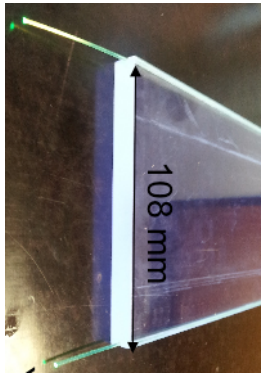


Overburden



Working with cryostat and installation teams to finalize scintillator module sizes and mounting design

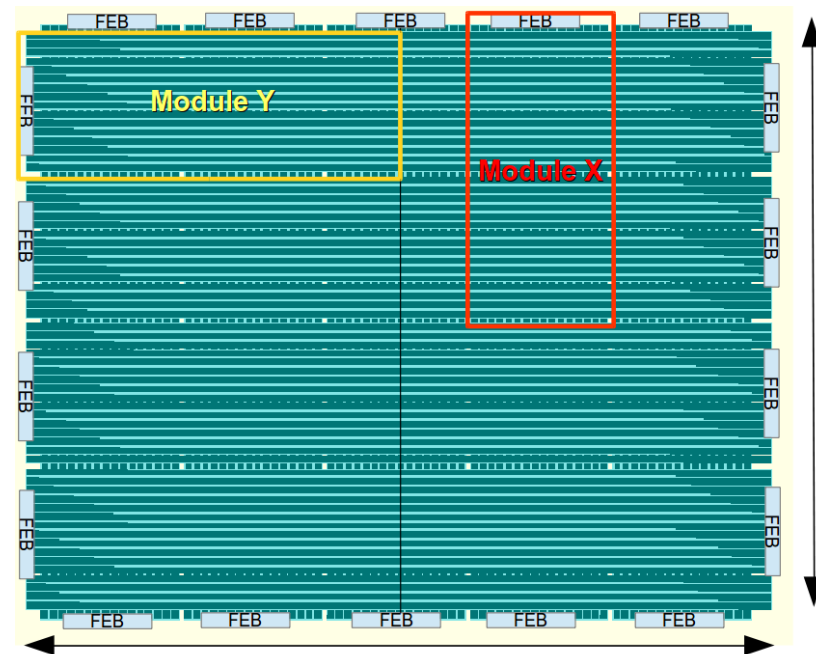
Cosmic Ray Tagger Prototyping



CRT front-end

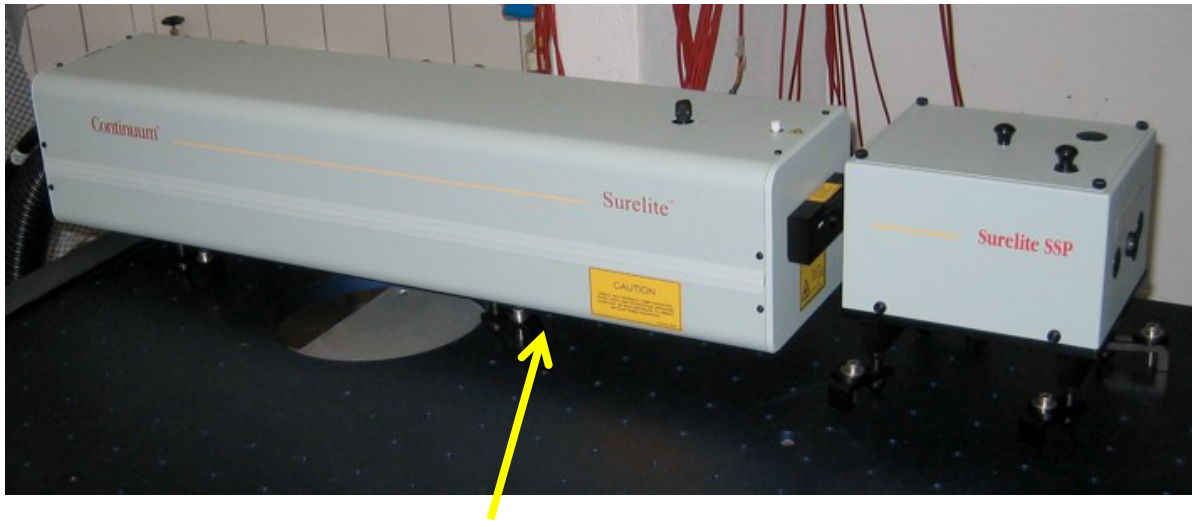


CRT Scintillator Module

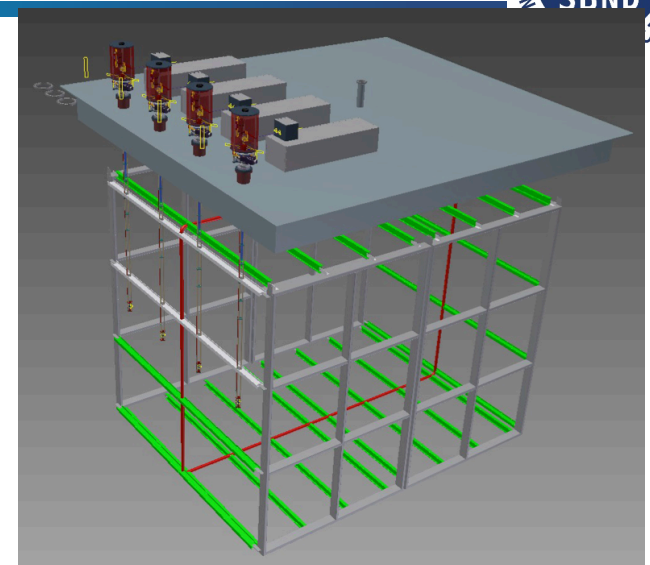


CRT Plane with x-y layers

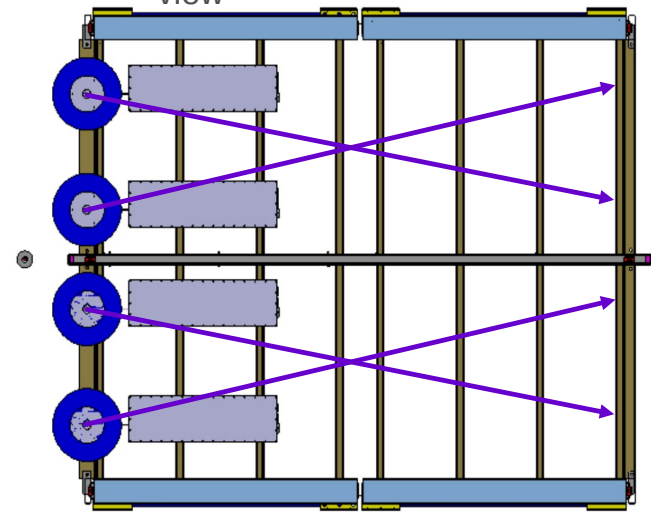
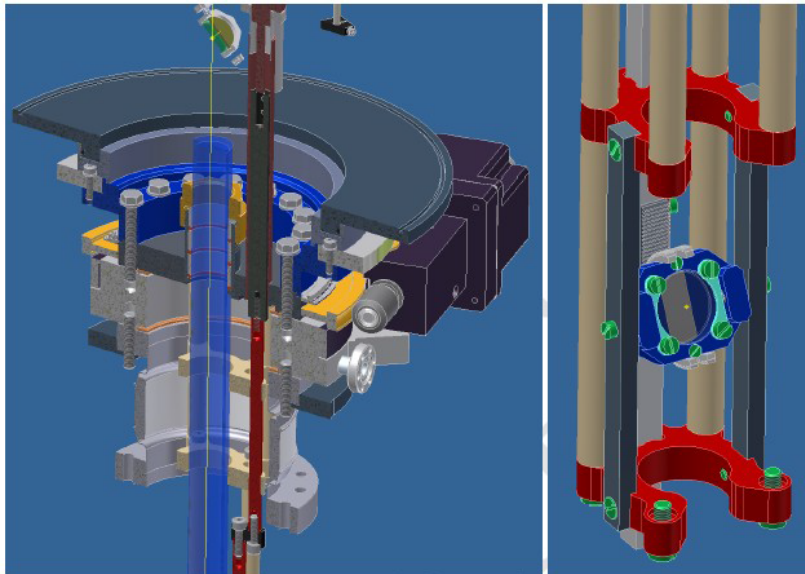
Laser Calibration System



Four laser heads already arrived at FNAL



TPC cage top view

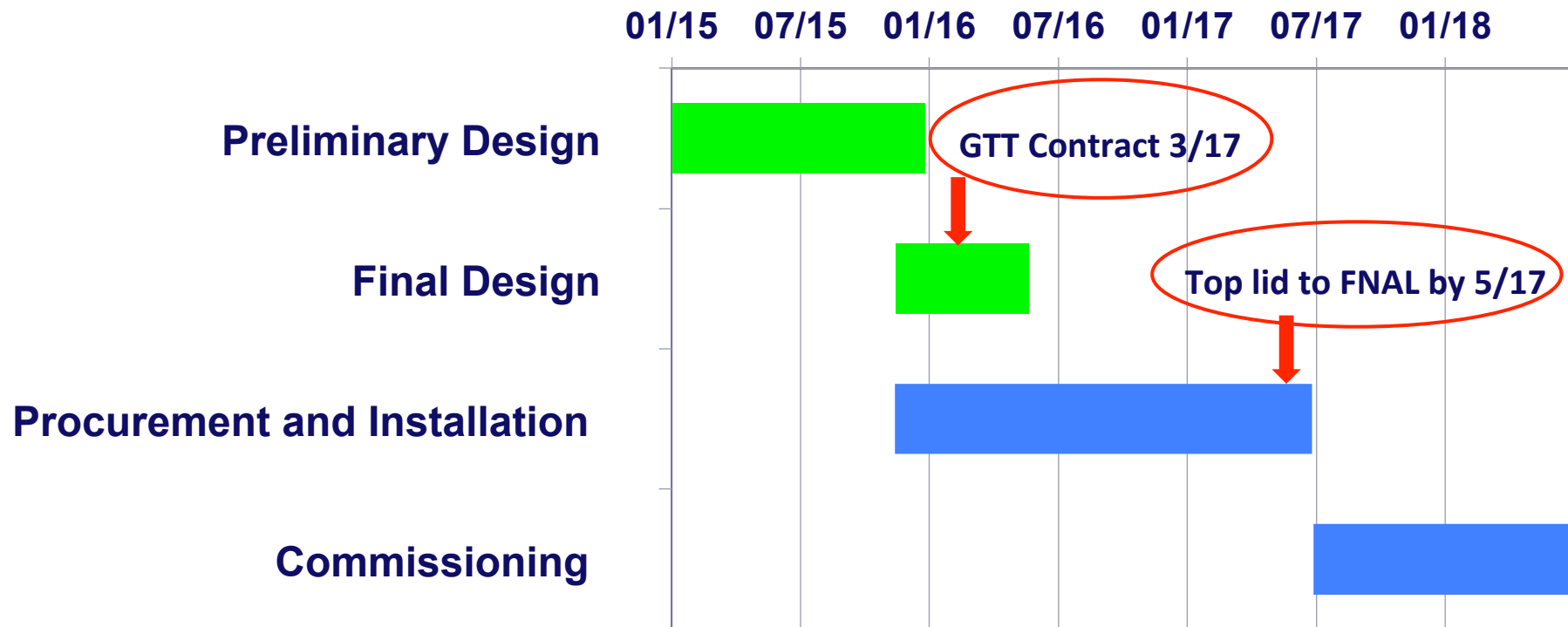


2-crossing laser lines per TPC

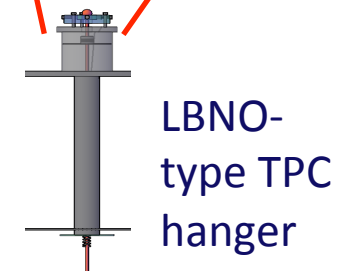
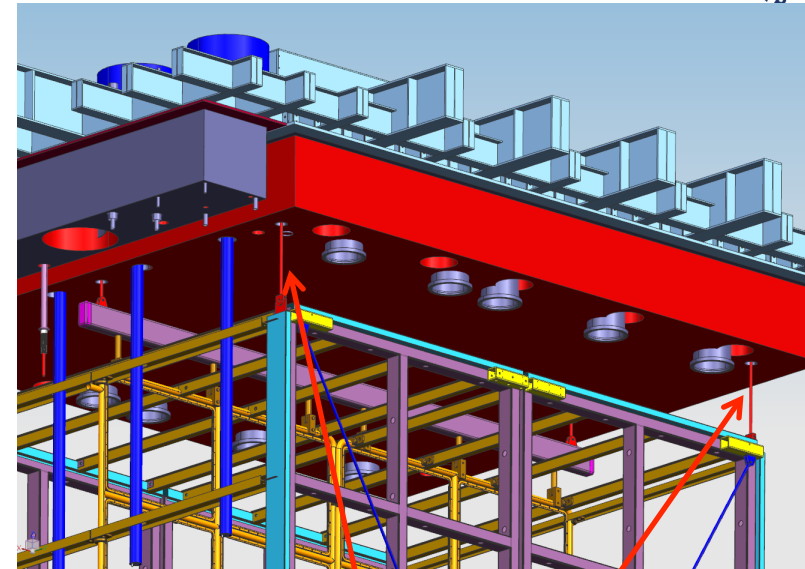
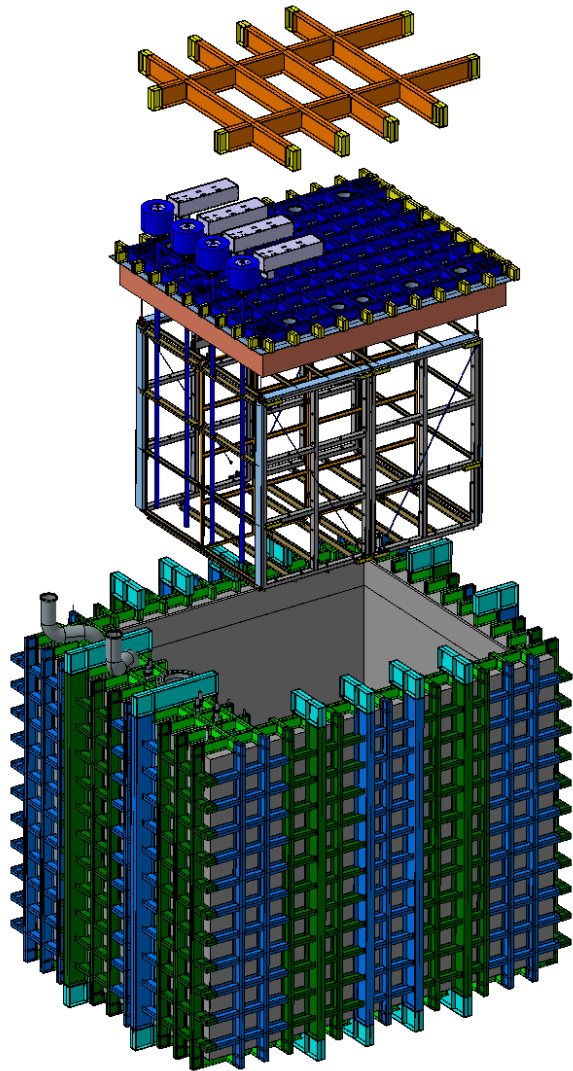
Near Detector Cryostat - WBS 2.9



- Joint effort of CERN and FNAL for design and installation
- GTT of France to fabrication the steel membrane cryostat
- Now finalizing detector feed-through design on cryostat top which is to support TPC assembly at DAB



Cryostat – Detector Interface



Key interface issue: feed-through and TPC support

Integration and Installation - WBS 2.2 & 2.8

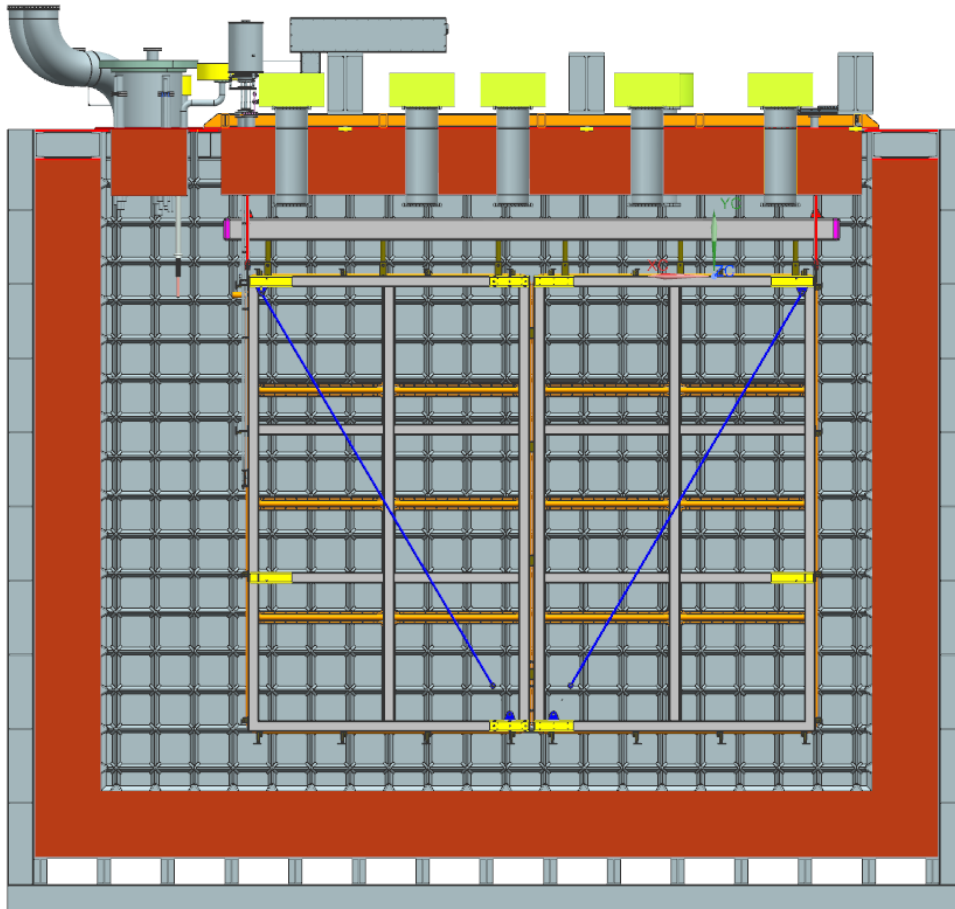


- WBS includes integration and installation design, assembly facility setup and detector transfer & installation
- A place to integrate all subsystems
 - Active detector, building, cryostat, cryogenics, cabling, grounding...
- L2 manager Joel Howell (FNAL)
 - Extensive experience of LBNE TPC installation design
- Preliminary design (WBS 2.2) is near completion
- Current focus is finalizing detector component integration and cryostat/cryogenics-detector interface

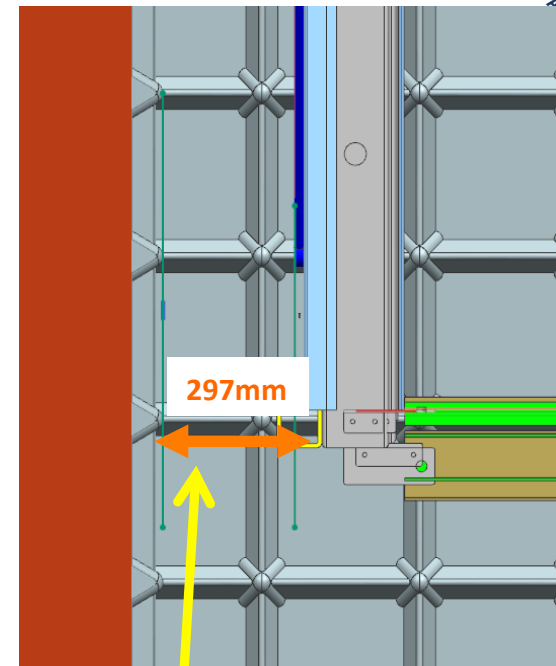
Detector Integration



All 3D models of cryostat, cryogenics, TPC, CRT, Laser, PMT and building comes to FNAL



24 detector + 22 cryogenics feed-through ports



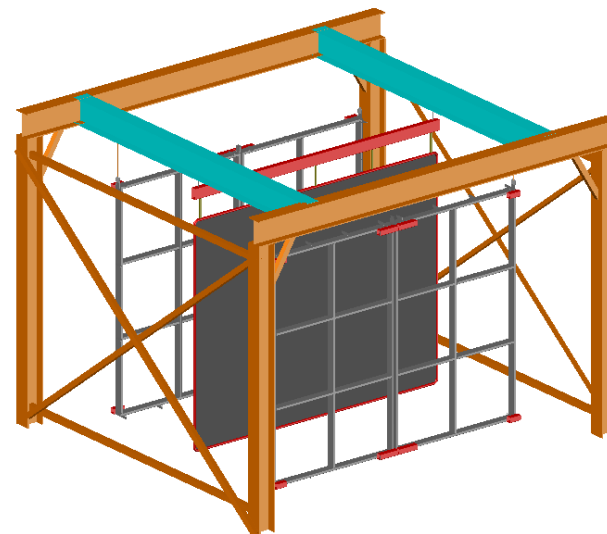
290mm

PMT Installation

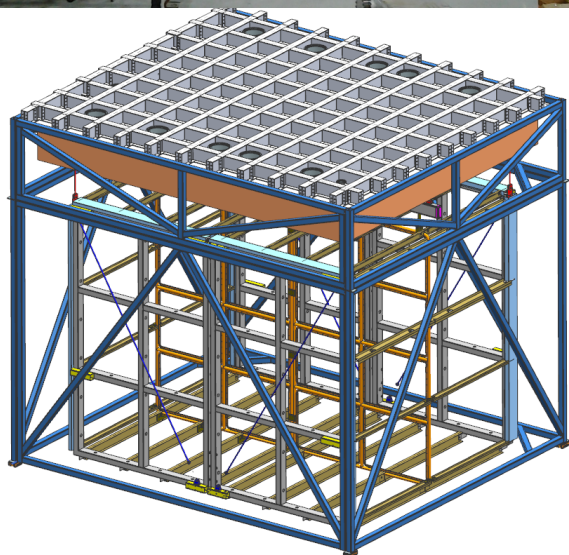
Detector Assembly at DAB



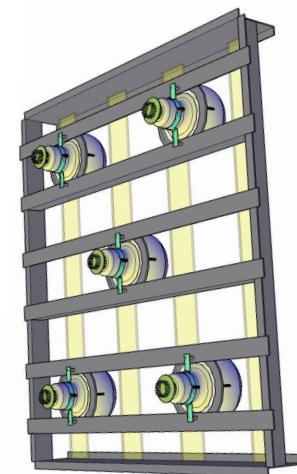
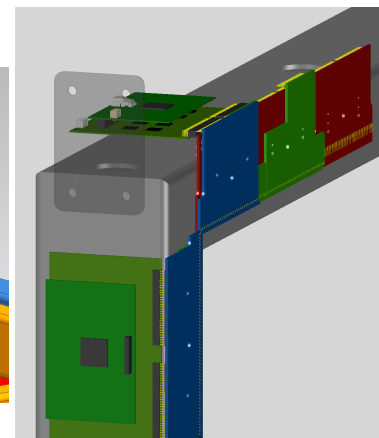
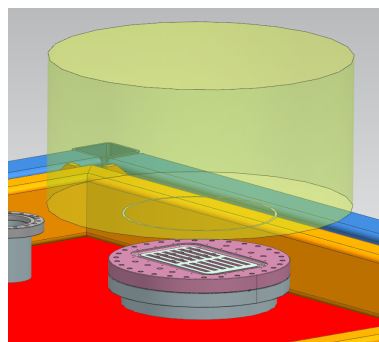
DAB Clean Tent



#1 - TPC assembly

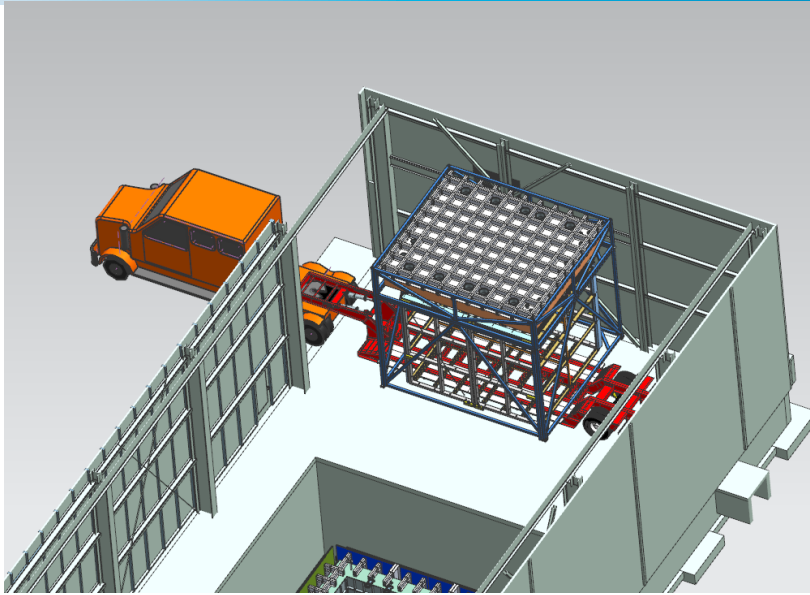


#2 - TPC-Cryostat Connection

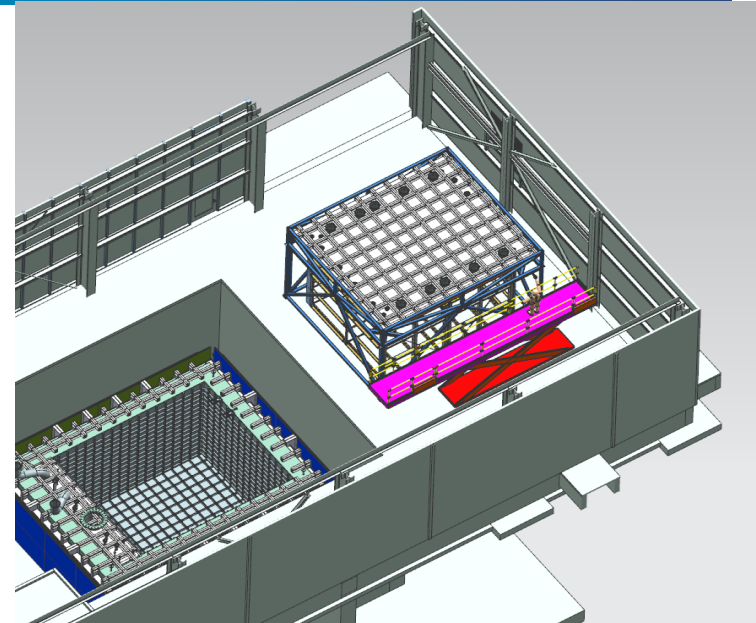


#3 - Feed through, Electronics and PMT

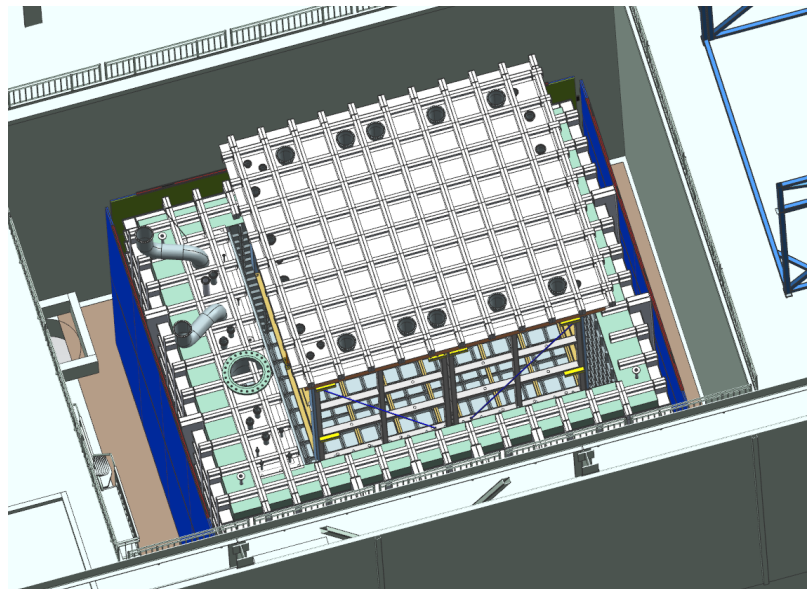
Detector Transfer and Installation



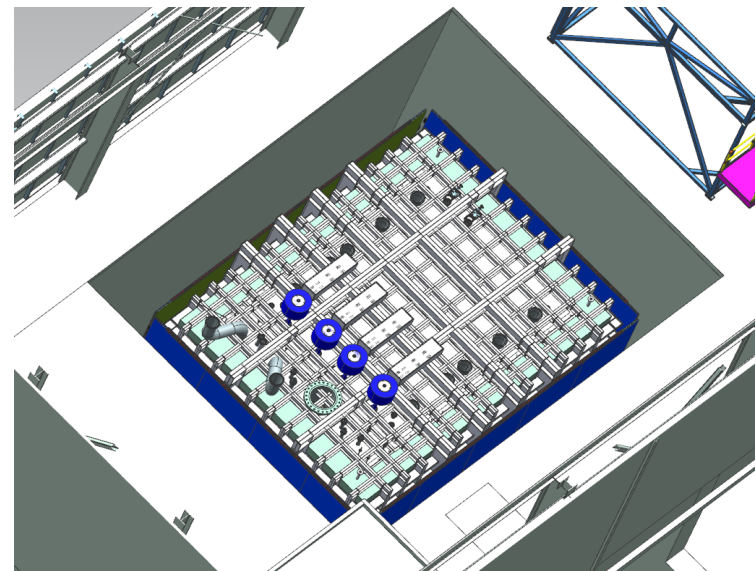
#1



#2

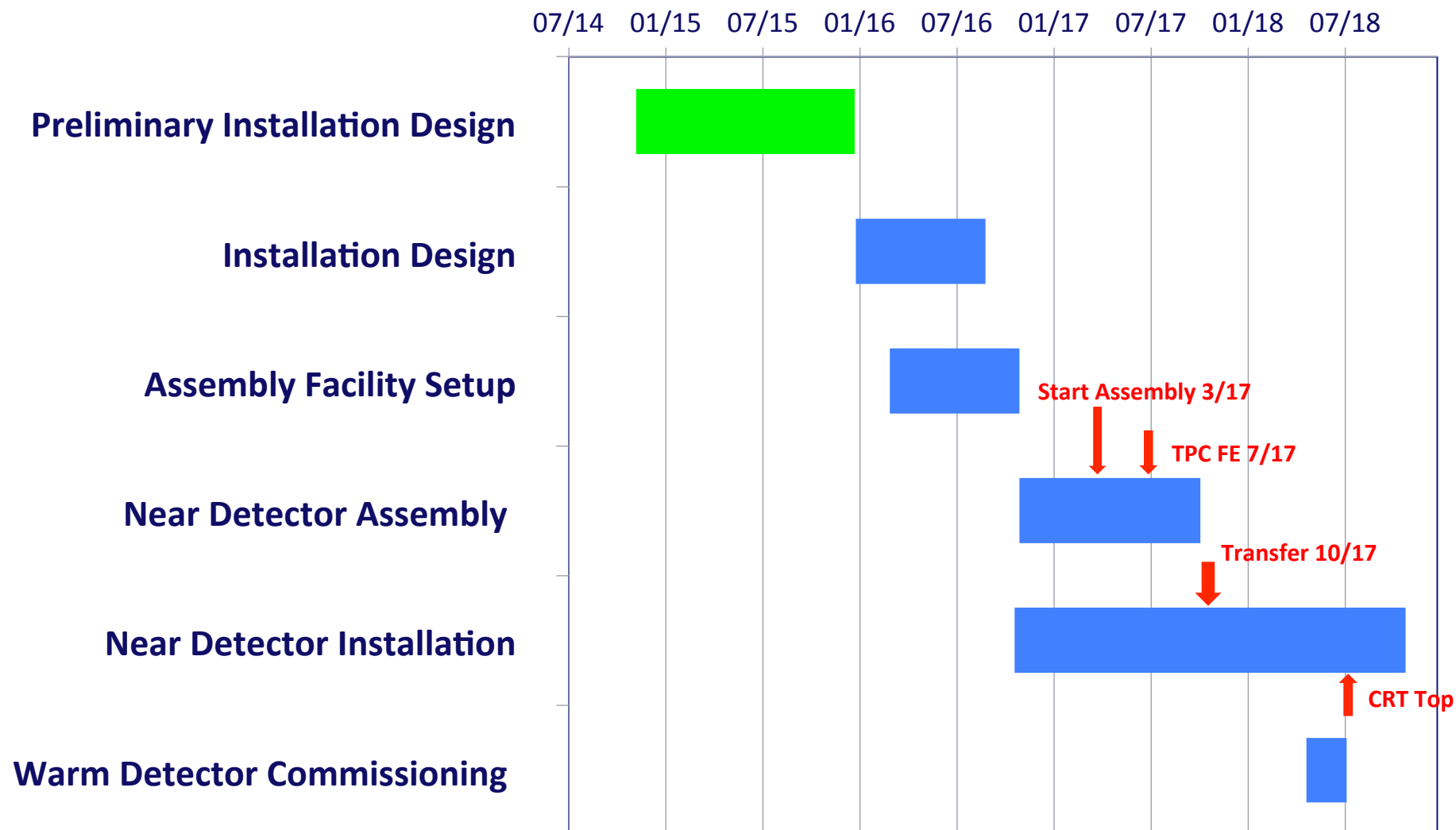


#3

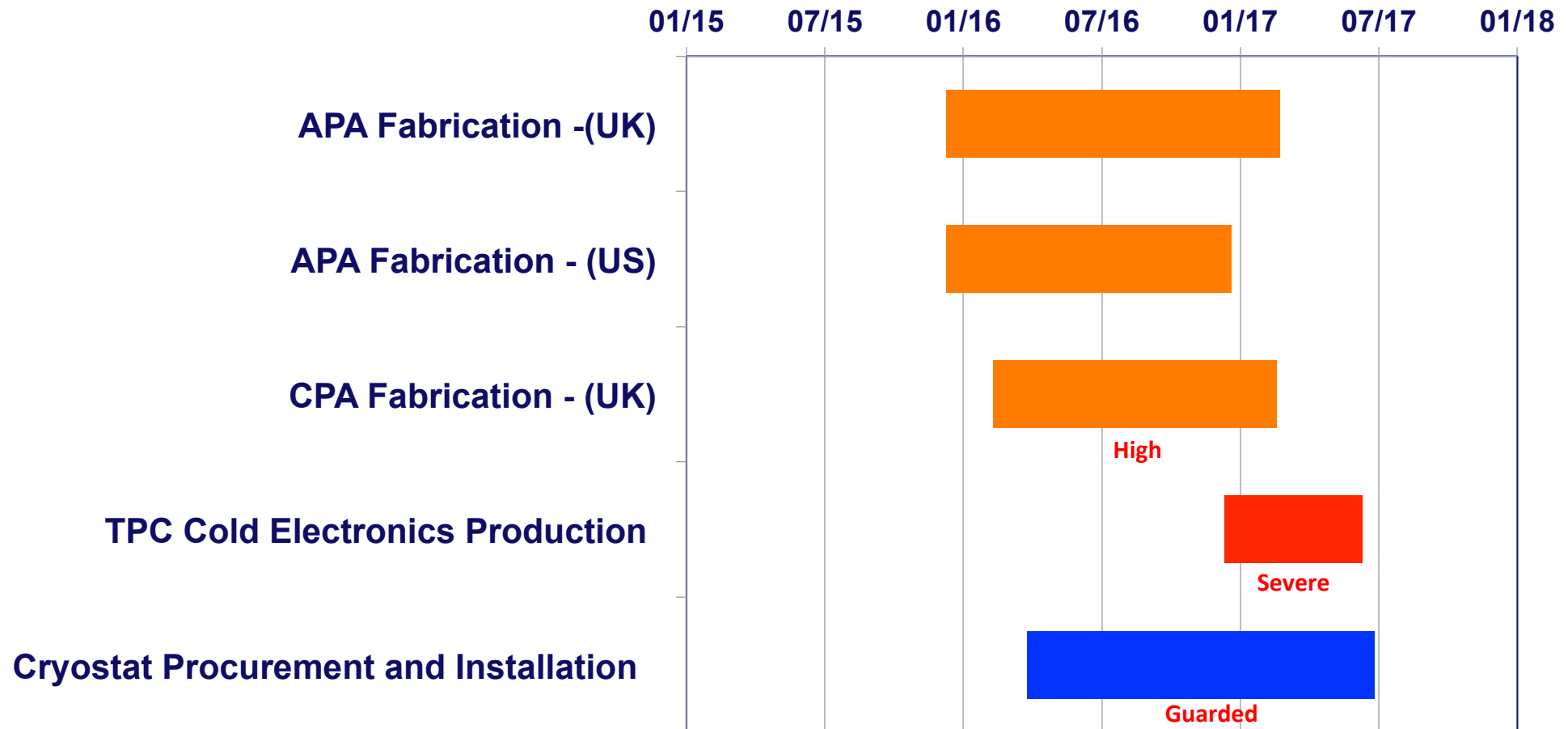


#4

Installation Schedule



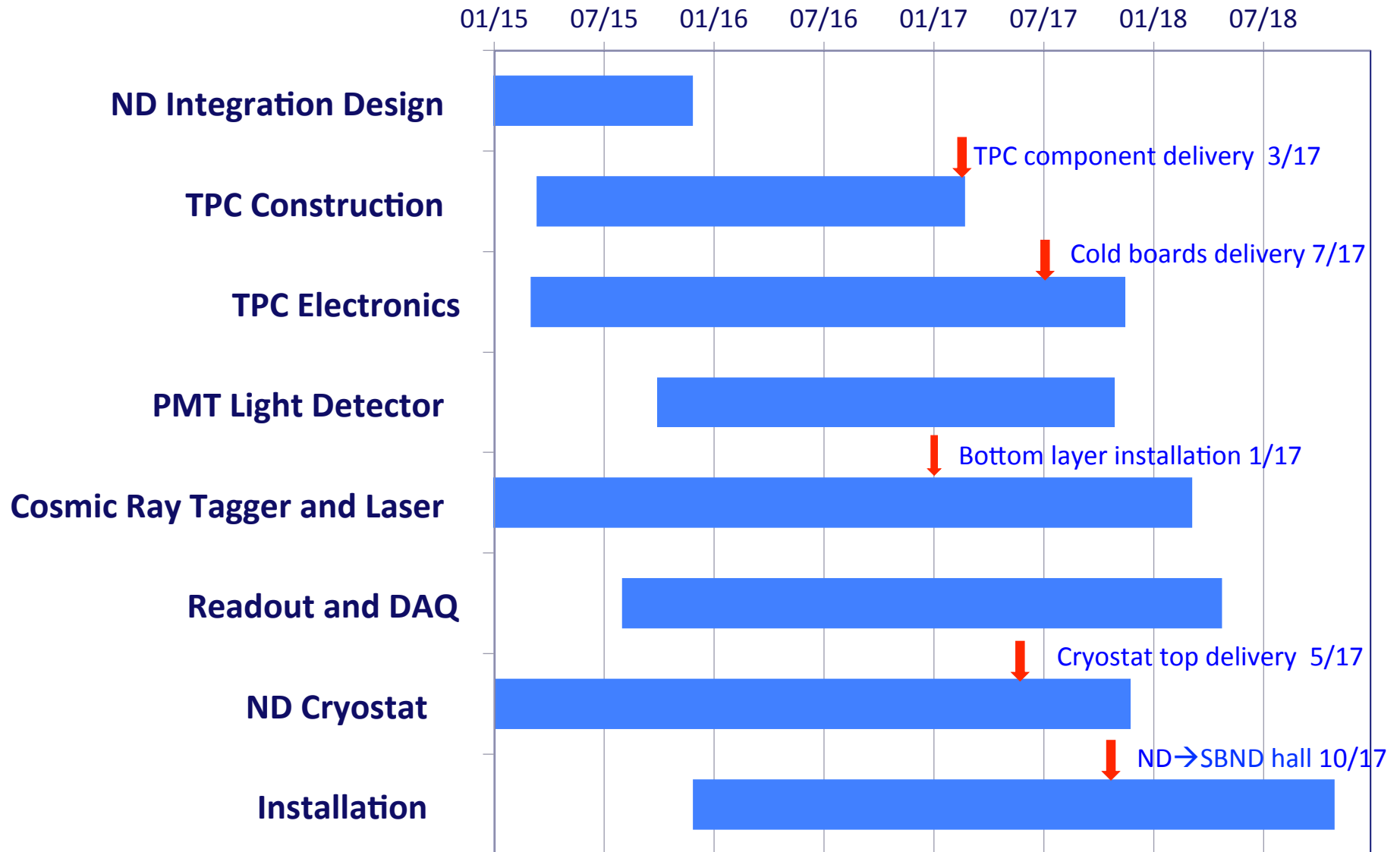
Schedule-driving Tasks



- TPC component deliveries drive the start time of ND assembly
- Cold Electronic board delivery drives the completion of assembly
- Cryostat top delivery drives the start of cabling at DAB and ND transportation

Overall Schedule, Reviews and Management

SBND Overall Schedule



SBND Key Milestone Dates



WBS	Task Name	Milestone Date
2.3.2.12	Completion of TPC Final Design and Production Readiness Review	02/12/16
2.3.5.12	Completion of Delivery UK APAs to Fermilab - (UK)	03/03/17
2.3.6.14	Completion of Delivery US APAs to Fermilab - (US)	12/28/16
2.3.7.8	Completion of Delivery CPAs to Fermilab - (UK)	02/27/17
2.3.8.9	Completion of Delivery HV Supply and Feed Through	02/27/17
2.3.9.8	Completion of Delivery Field Cage to Fermilab - (US)	02/27/17
2.3.11.9	Completion of Delivery TPC Assembly Tooling to Fermilab - (US)	02/27/17
2.4.3.4	Completion of PMT Detector Installation Readiness Review	12/02/16
2.5.1.4.6	Approval for Laser Calibration System Installation	11/10/16
2.5.2.2.14	CRT Ready for Production	01/29/16
2.5.2.5.11	Approval for CRT Installation	06/30/16
2.6.1.1.5	FE ASIC and ADC ASIC Design Ready for 1st Prototype Submission	01/28/16
2.6.1.2.30	Cold Electronics Production Readiness and Safety Review	12/19/16
2.6.2.3.9	Warm Interface Electronics Production Shipment	08/31/17
2.6.4.2.9	TPC Nevis readout production readiness review	12/01/16
2.8.3.3	TPC Component Arrived at Fermilab for Assembly	03/03/17
2.8.3.10	Completion of TPC Component Assembly	04/07/17
2.8.3.11	Cryostat Top Delivery to Fermilab for TPC Installation	04/07/17
2.8.3.30	Completion of ND Transportation to ND Building	10/20/17
2.8.4.19	Completion of Detection Insertion into Cryostat	01/12/18
2.8.4.32	Completion of Cosmic Ray Tagger Installation	11/15/18
2.8.5.7	Near Detector Ready for Commissioning	07/25/18

SBND Reviews and Documentation



- Subsystems are writing TDR-like technical notes as living documentations
- TPC preliminary design note - SBN docDB 613
 - <http://sbn-docdb.fnal.gov:8080/cgi-bin/ShowDocument?docid=613>
- TPC construction and readout independent review held at Sept 28-29
 - http://sbn-nd.fnal.gov/project/TPC_Review_Sept28.html
 - Committee recommendation is positive
- Cosmic ray tagger technical report - SBN docDB 685
 - Design review is scheduled to be during the February collaboration meeting
- Technical and safety reviews are built into schedule files (SBN docDB 246)

SBND Management



- Technical board
 - Technical, value engineering, schedule discussions/decisions
- Weekly meetings for interface and integration
 - Run by installation L2 (Joe Howell)
- Monthly schedule turnaround and progress report
 - Managed by project control Rich Krull
- Baseline schedule and change control process
 - BOE, contingency analysis guideline documentations in docDB
- Safety engineering design reviews and ORCs
 - Committee by Linda Bagby

Cost and Resources

SBND Funding Sources



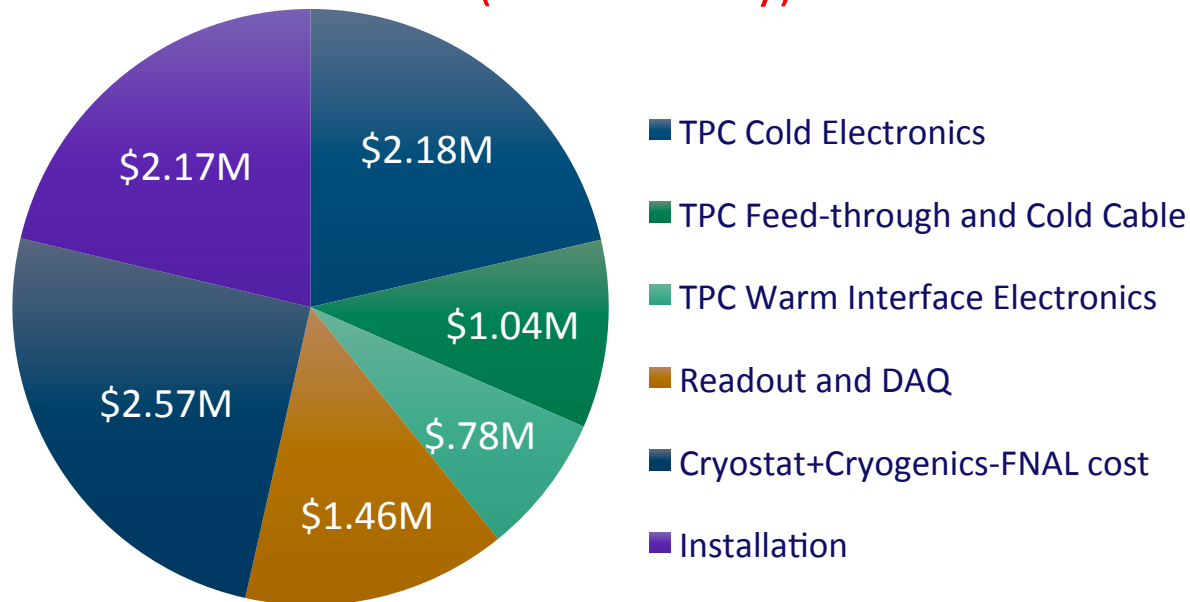
WBS	Tasks	Funding Sources	Note
2.1	Program Management	FNAL -R&D	
2.2	Preliminary Detector Design	FNAL -R&D	
2.3	TPC Construction	US-NSF & UK-STFC	WPA
2.4	PMT Light Detector	LANL - LDRD	WPA
2.5	Cosmic Ray Tagger and Laser Calibration	CH -NSF	WPA
2.6	TPC Electronics	FNAL-R&D and US-NSF	SOWs & WPA
2.7	Readout and DAQ	FNAL - R&D	
2.8	Installation Coordination	FNAL - R&D	
2.9	Near Detector Cryostat	CERN & FNAL-R&D	WPA
4.3.2	Near Detector Cryogenic Systems	FNAL-R&D & CERN	WPA

- 5 work package agreements (WPA) are being discussed for deliverables and responsibilities
- 2 statement of works (SOWs) in effects for collaboration works paid by FNAL

SBND Baseline Cost Estimate



FNAL contribution to SBND detector - \$10.2M (Baseline only)



WBS	Baseline Cost
TPC Cold Electronics	\$2.18M
TPC Feed-through and Cold Cable	\$1.04M
TPC Warm Interface Electronics	\$0.78M
Readout and DAQ	\$1.46M
Cryostat+Cryogenics-FNAL	\$2.57M
Installation	\$2.17M

SBND FNAL Labor Estimate



Technical labor estimated for SBND Installation, Readout & DAQ and Cryostat

Labor Type	WBS Tasks	FTE-Year	Task Duration
Senior Mech. Engineer	Manager of 2.2 & 2.8 Installation	1.5	FY15-FY18
Mech. Engineer	Installation design -2.2 & 2.8	0.85	FY15-FY17
Mech. Designer	Installation design - 2.2 & 2.8	1	FY15-FY17
Cryo Engineer	Cryostat - 2.9	1	FY15-FY18
Mech. Technician	Assembly and installation -2.8 & 2.7	3	FY17-FY18
Alignment & survey	Assembly and installation -2.8	0.46	FY17-FY18
Electronics Engineer	2.2 and 2.7-readout	1	FY15-FY18
Comp.Serv. Spec.	2.7 DAQ	1	FY16-FY18
Computing programmer	2.7 DAQ	1.5	FY16-FY18

SBND Detector Summary



- Design works are progressing really well
- Production and fabrication phase to start in Spring 2016
- Final assembly and installation to start in 2017
- Critical path tasks are being identified and mitigation methods are being developed
- Baseline cost of FNAL contribution is within funding profile
- SBND detector is aiming to be operational in 2018

Backup slides

SBND L3 Tasks and Managers



SBND Detector	WBS Managers	Deputy Manager
SBND Program Management	Ting Miao	
Preliminary Detector Design	Joe Howell	
TPC Construction	Kostas Mavrokoridis	
TPC Preliminary design	Bo Yu	
TPC Final Design	Peter Sutcliffe/Bo Yu	
APA frame construction - UK	Trevor Gamble & Nicola McConkey	
APA geometry board production --US	Bo Yu	Serhan Tufanli
APA construction -UK	Stefan Soldner-Rembold	Jaroslav Nowak
APA construction -US	Mitch Soderberg	Serhan Tufanli
CPA construction -UK	Peter Sutcliffe & David Payne	
HV supply and feed through construction -UK&US	Anna Holin & Bonnie Fleming	
Field cage construction -- US	Bo Yu	Serhan Tufanli
TPC connection frame construction -US	Rich Northrup & Dave Schmitz & Bo Yu	
TPC Assembly Preparations-US	Rich Northrup & Dave Schmitz & Bo Yu	
PMT Light Detector	Richard Van De Water	Keith Rieladge
PMT Mechanical System	Jan Boissevain	
PMT Electronics & DAQ		
PMT Calibration System		
PMT System Installation		
Cosmic-ray Tagger and Laser Calibration	Igor Kreslo	
Laser Calibration System	Michele Weber	
Adaptation of the MicroBooNE Laser Calibration to SBND Cryostat	Roger Haenni	
Fabrication of Components of Laser Calibration System	Roger Haenni	
Assembly and Test of Laser Calibration System at Bern	David Lorca	
Laser Calibration System Delivery to Fermilab	Roger Haenni	
Laser Calibration Installation	Bryce Littlejohn	
Cosmic-ray Tagger Detector	Igor Kreslo	
Preparation of Requirement Documents	Pascal Lutz	
Preliminary Design and Tests	David Lorca	
Production of Module #0 and Tests	Roger Haenni	
Mass Production of Planes #1 - #7	Roger Haenni	
Modules Delivery to Fermilab	Martin Auger	
Installation of CRT Modules at the Detector	Bryce Littlejohn	
CRT Commissioning	Wesley Ketchum	

40SBN/2	SBND Detector	WBS Managers	Deputy Manager
2.6	TPC Electronics	HuCheng Chen	Leslie Camileri /Elizabeth Worcester
2.6.1	TPC Front-end Cold Electronics	Hucheng Chen	
2.6.2	TPC Warm Interface Electronics	Jack Fried	
2.6.3	TPC readout signal feedthrough	Bo Yu	
2.6.4	Nevis TPC Readout	Leslie Camileri	
2.6.5	TPC Electronics Installation	Elizabeth Worcester	
2.7	Readout and DAQ	Eric Church/Georgia Karagiorgi	
2.7.1	ND readout and DAQ integration design	Georgia Karagiorgi / Eric Church	
2.7.2	ND readout power supply, rack and cabling design	Linda Bagby	
2.7.3	Production of power supply, rack and cables	Linda Bagby	
2.7.4	DAQ Trigger electronics design and fabrication	Georgia Karagiorgia	
2.7.5	Detector control system	Sowjanya Gollappini	
2.7.6	DAQ teststand	Bill Badgett/Jonathan Asaadi	
2.7.7	DAQ software design and implementation	Eric Church	
2.7.8	DAQ hardware specification and procurement	Wesley Ketchum	
2.7.9	DAQ installation and commissioning	Georgia Karagiorgi/ Eric Church	
2.8	Installation Coordination	Joe Howell	
2.8.1	Near Detector Installation Design	Joe Howell	
2.8.2	Near Detector Assembly Facility Setup	Jim Kilmer	
2.8.3	Near Detector Assembly		
2.8.4	Near Detector Installation	Joe Howell	
2.8.5	Warm detector commissioning		
2.9	Near Detector Cryostat	David Montanari	
2.9.1	Preliminary Design of Near Detector Cryostat	David Montanari	
2.9.2	Final Design of Near Detector Cryostat	Dimitar Miladenov	
2.9.3	Procurement and Installation of Near Detector Cryostat	Mazio Nessi	
2.9.4	Commissioning Cool-down of Near Detector Cryostat		

List of FE/ADC ASIC Revision



FE and ADC ASIC chips revision based on 35T test result

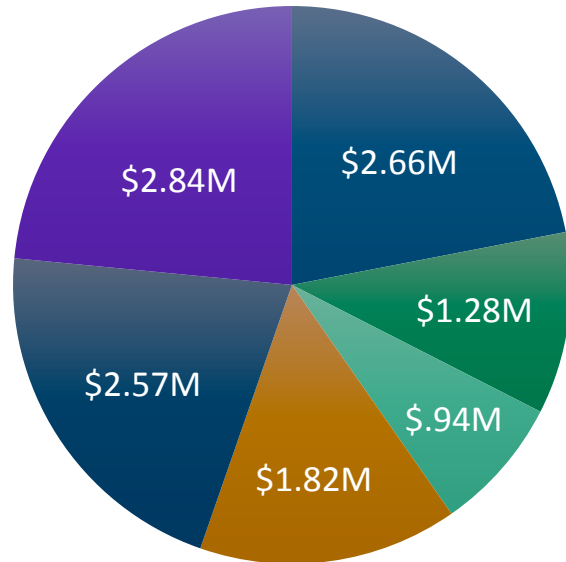
- *Implement the power on default configuration*
- *Improve the input protection*
- *Improve the ADC DNL/INL performance*
- *Implement user friendly interface*
- *Implement compatible SPI interface between FE ASIC and ADC ASIC*
- *Implement compatible interface to COLDATA ASIC*
- *Implement ADC_CONV input and ADC_BUSY output*
- *Implement read back of internal serial configuration registers*

See Hucheng Chen's breakout session talk for detail

FNAL Cost With Contingency

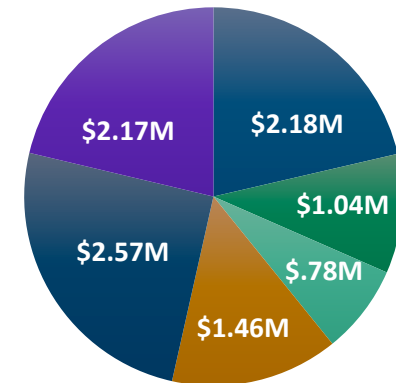


FNAL contribution to SBND detector - \$12.1M
(Baseline+ contingency)



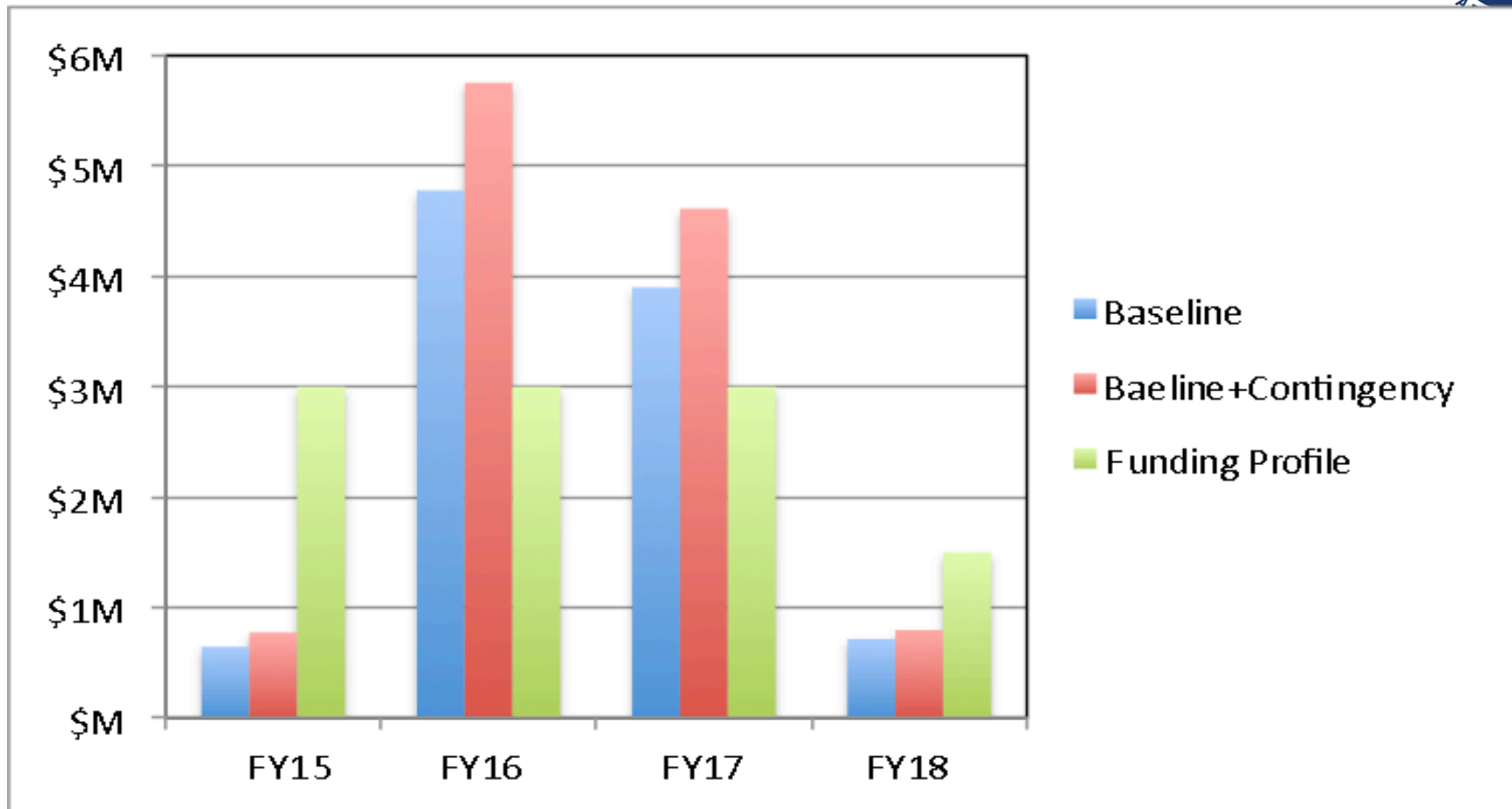
- TPC Cold Electronics
- TPC Feed-through and Cold Cable
- TPC Warm Interface Electronics
- Readout and DAQ
- Cryostat+Cryogenics-FNAL cost
- Installation

\$10.2M
(Baseline only)



	Baseline	Base+cont.
TPC Cold Electronics	\$2.18M	\$2.66M
TPC Feed-through and Cold Cable	\$1.04M	\$1.28M
TPC Warm Interface Electronics	\$0.78M	\$0.94M
Readout and DAQ	\$1.46M	\$1.82M
Cryostat+Cryogenics-FNAL	\$2.57M	\$2.57M
Installation	\$2.17M	\$2.84M

FNAL Cost vs. Funding Profile



	FY15	FY16	FY17	FY18	FY19	Total
Baseline	\$0.644M	\$4.778M	\$3.899M	\$0.715M	\$0.151M	\$10.2M
Baeline+Contingency	\$0.774M	\$5.753M	\$4.614M	\$0.796M	\$0.17M	\$12.1M
Funding Profile	\$3M	\$3M	\$3M	\$1.5M		\$10.5M