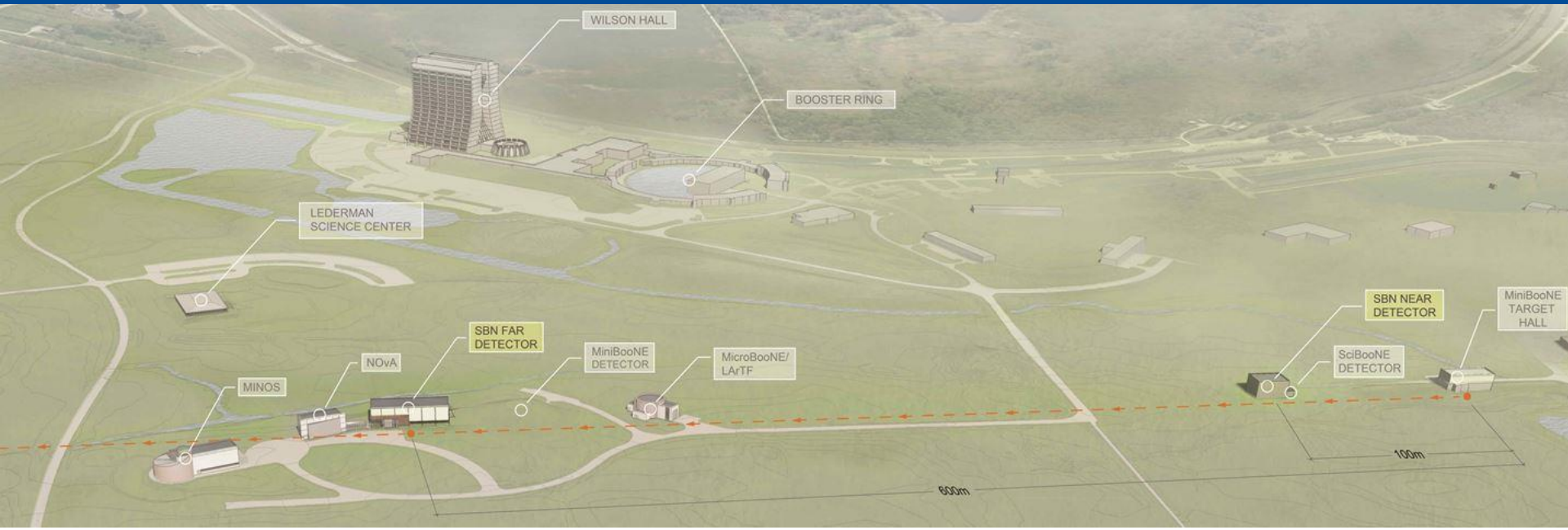



# SBN Infrastructure Overview

Catherine James

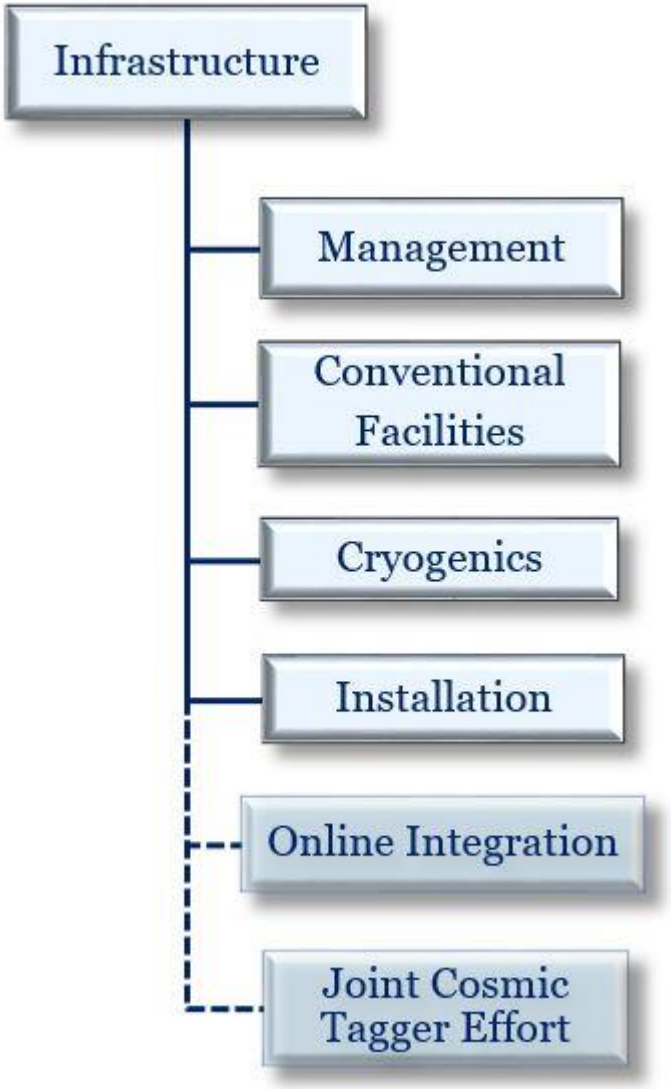
Director's Progress Review of SBN

15-17 December 2015

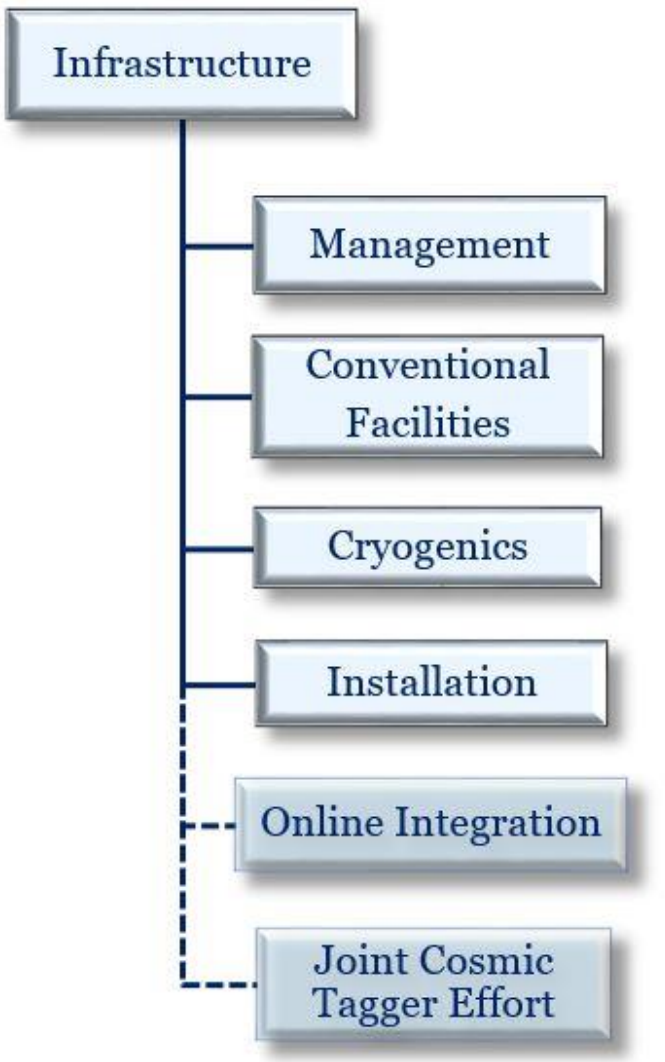
# Outline

- Overview of Infrastructure
- About each topic
  - Requirements
  - Scope
  - Resources
  - Cost & Schedule Summary
  - Present status

  - Introduce the Breakout talks



# Overview




Provide the Infrastructure elements to support two new detectors on the Booster beamline

Provide two new enclosures

Provide two cryogenics systems

Install the **Far Detector**
Acquire and install Overburden

Common Online elements; in early discussions

A recently formed Task Force will help refine the requirements for detectors and overburden

# Overview - Infrastructure Funding Source Matrix

| | DOE GPP | DOE OPS | DOE R&D | NSF | CERN | INFN |
|---|---|---|---|---|---|---|
| Civil Construction | 100% | | | | | |
| ICARUS Cryogenics | | ~45% | | | ~45% | ~10% |
| SBND Cryogenics | | | ~50% | | ~50% | |
| ICARUS Overburden | | 100% | | | | |
| SBND Overburden | | 100% | | | | |
| Cosmic Ray Tagger | | tbd | | ? | 25%* | 25%* |
| ICARUS DAQ | | tbd | | | tbd | >50% |
| Common Online | | tbd | | | tbd | |
| Integration and Installation | | >50% | | | tbd | tbd |

blue – portion has a cost estimate; red, not costed

* - $1.2M CHF in WA104 agreement, estimate need at least 2 times this (core cost)

tbd – expect contribution but fraction not determined

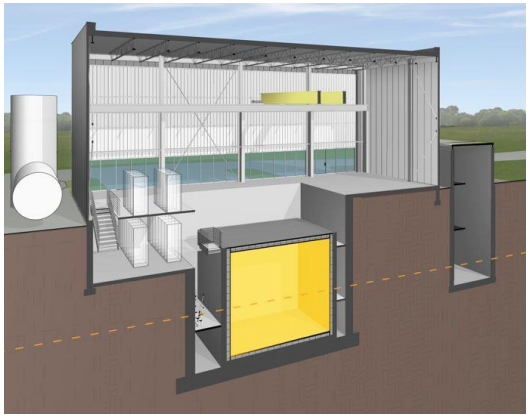
? – possible grant proposal

# Conventional Facilities

# Conventional Facilities - Requirements

- Provide buildings which meet the needs of the respective detectors

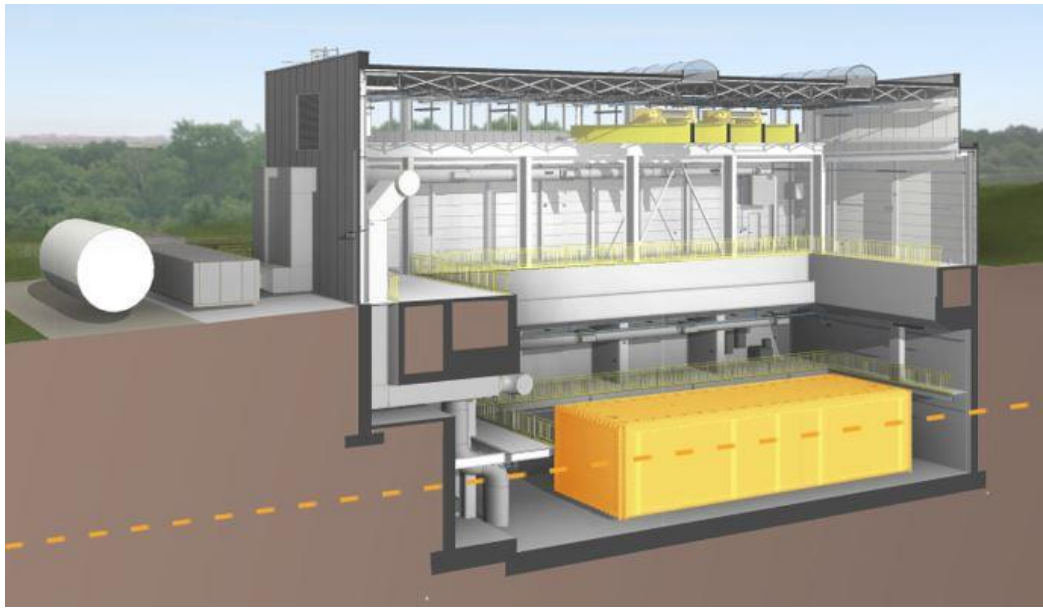
  Designs are complete, and both buildings are now under contract



The collaborations provided input to the design process for their respective buildings

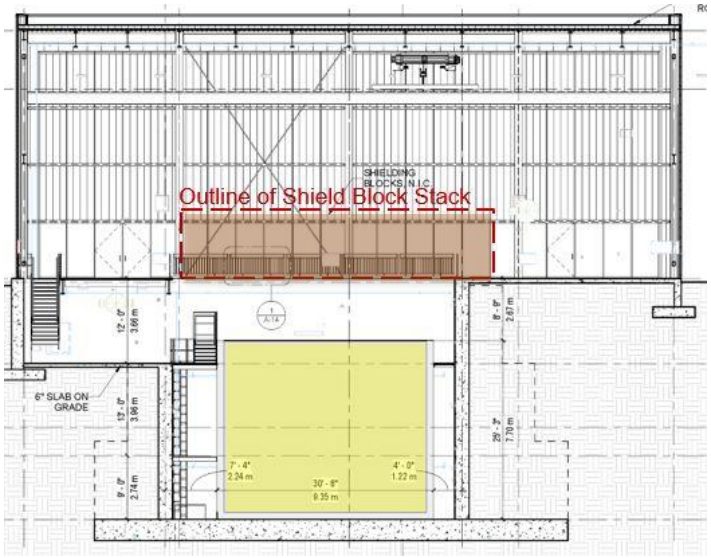
Cryogenics team provided preliminary ODH analyses

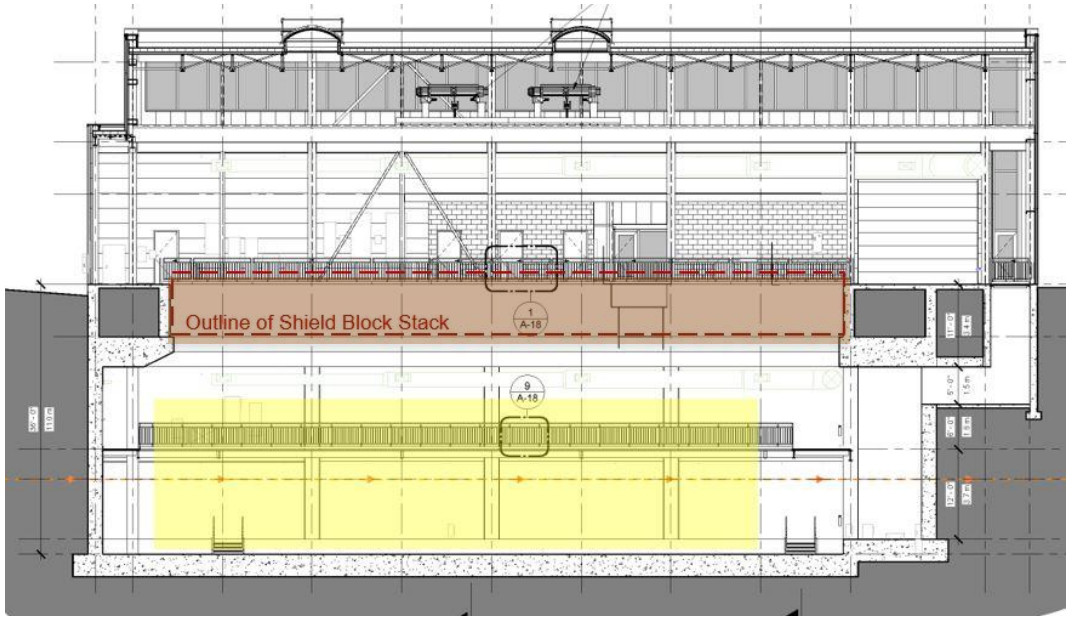
Both buildings reviewed at the 60% and 90% design level, by committees composed of people both internal and external to the collaborations



# Conventional Facilities - Requirements

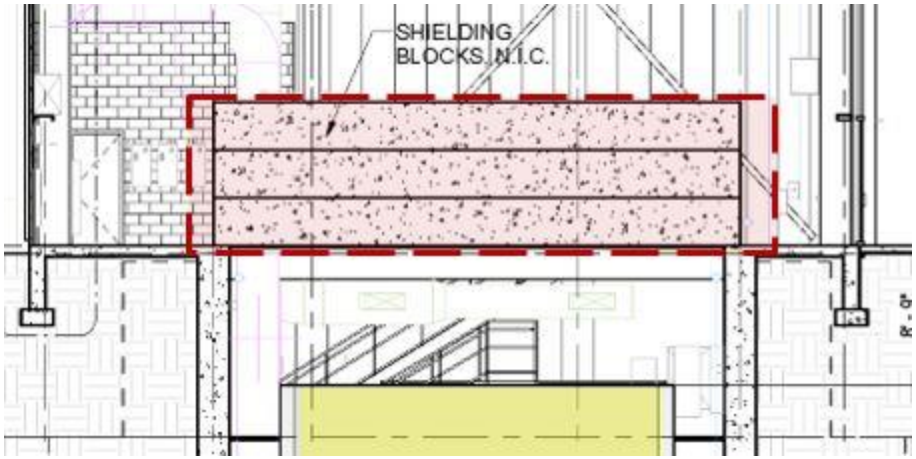
- Both buildings designed to support ~3m concrete overburden



# Overburden

- Basic Plan – 3 layers, each ~1m
- Base layer
  - Engineered bridge beams
  - Not standard shield blocks
  - Must be ordered/purchased
  - Estimate
    - $622k for ICARUS
    - $217k for SBND
    - OPS funding (not GPP)
- Middle and upper layers
  - Existing shield blocks on the Fermilab site
  - Identified, but must be “mined”
    - Cost contributions to be negotiated within the Lab
- Install all layers
  - Estimate $70k for ICARUS and $30k for SBND

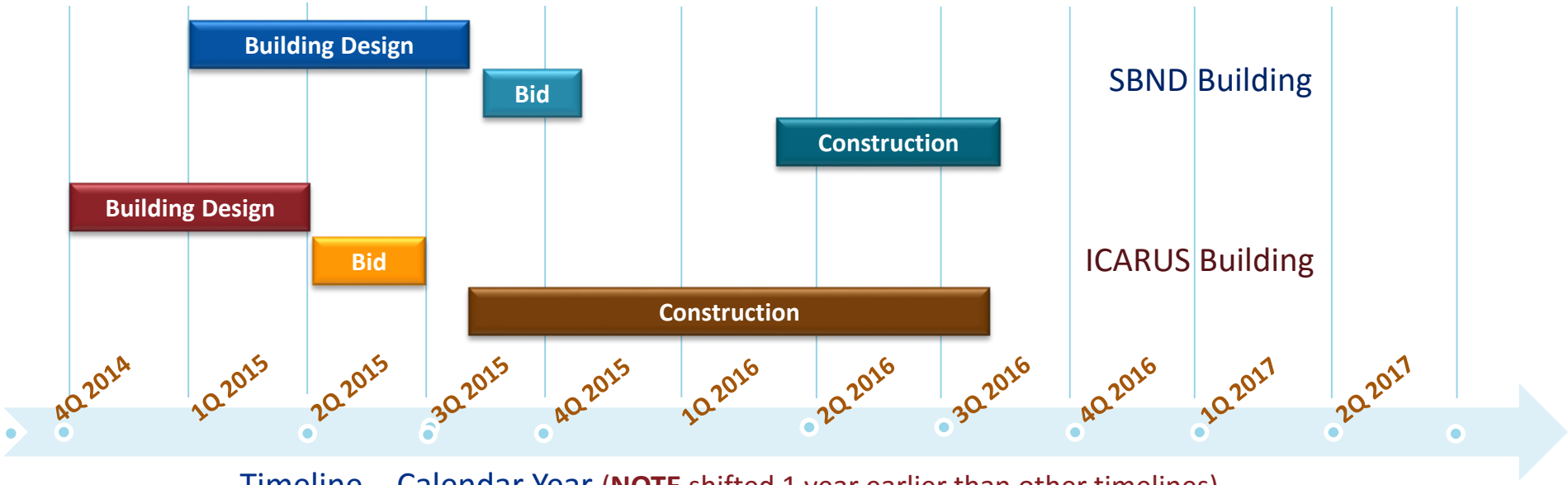



***Jim Kilmer** has more details in his Breakout talk*

# Conventional Facilities – Cost & Schedule

## Contract Costs, $k, fully burdened

| Task | WBS | Funding | Estimate |
|---|---|---|---|
| Near Detector Building | 4.2.1 | GPP | $5,350 |
| Far Detector Building | 4.2.2 | GPP | $9,800 |
| Site Development | 4.2.3 | GPP | $2,200 |




Timeline – Calendar Year (**NOTE** shifted 1 year earlier than other timelines)

# Conventional Facilities - Resources

- Fermilab Facilities & Engineering Services
  - SBN Manager – Steve Dixon
  - Construction Coordinator – Josh Kenny
  - Procurement – Tom Powers

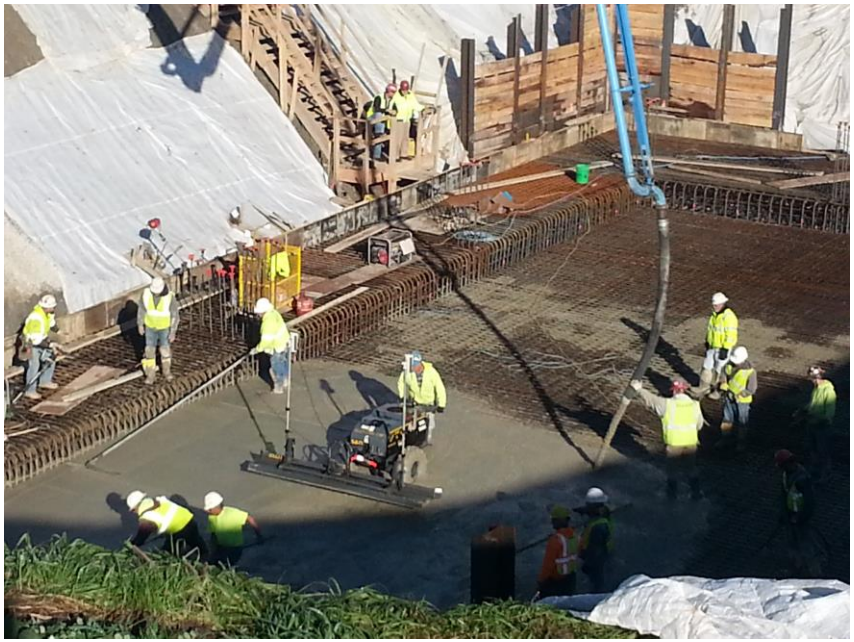
- Weekly meetings with the contractors

## Summary

- More material in Steve Dixon's breakout presentation

- Tour ?

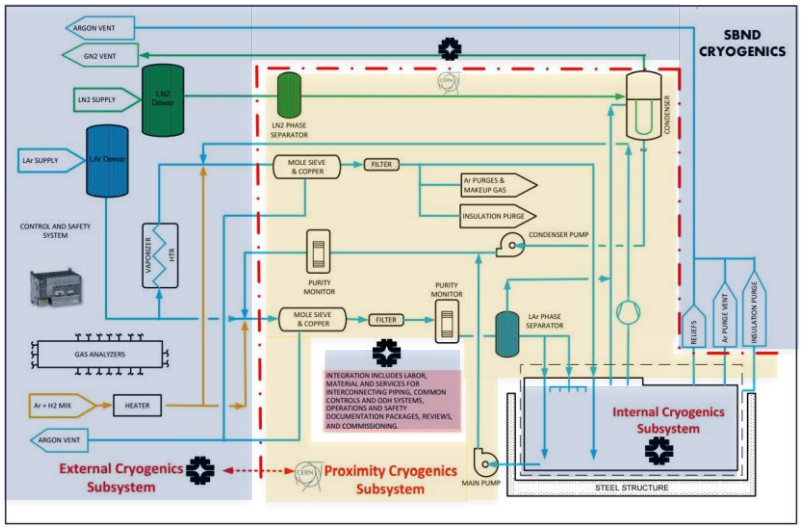
*~90 trucks of concrete poured on a single day*

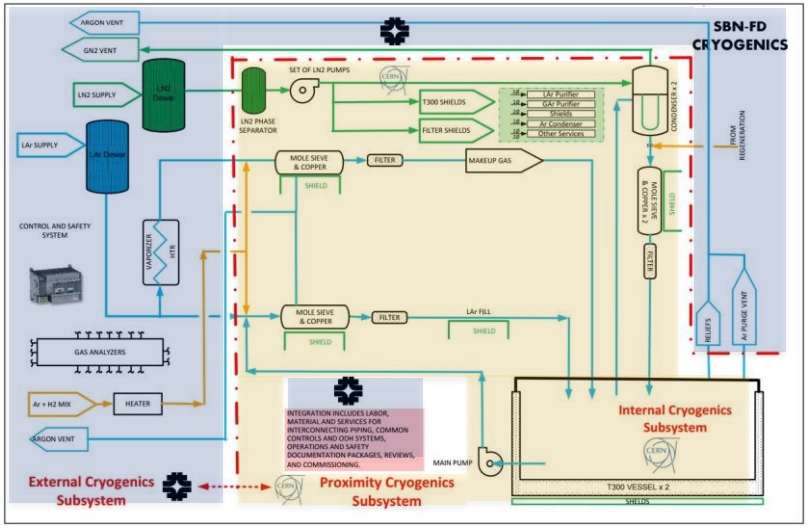


*more photos on the SBN SharePoint site – Civil Construction*

# Cryogenics

# Cryogenics - Scope of Work




Systems are partitioned

- External : nitrogen and argon supply
  - Fermilab scope, both detectors
- Proximity : Argon circulation & filtering, cooling
  - CERN scope, both detectors
- Internal : inside the cryostat
  - ICARUS – CERN scope
  - SBND – Fermilab scope
- Integration : Controls and ODH systems; safety documentation; interface documents
  - Fermilab scope

- Stated scope covers all phases
  - Design, Construction, Installation

# Cryogenics - Requirements

Keep the cryostats cold and keep the argon pure

- parameters are specified for cooling capacity, flow rates, surface temperatures, minimum purity goals, and more

- full list of cryogenics requirements are in Barry Norris's Breakout presentation

Requirements for **SBND** Cryogenics - Cryogenics

| Required Parameter for Cryogenics | Value |
|---|---|
| LAr purity in cryostat | 3 ms electron lifetime (100 ppt O2 equivalent) |
| Nitrogen contamination | Less than 2 ppm (to coincide with T600) |
| Design Pressure | 345 mbarg (~5 psig) |
| Operating gas pressure | 70 mbar (~1 psig) with +/- 5% (~0.05 psig) |
| GAr Piston purge rate of rise | 1.2 m/hr |
| Membrane cool-down rate | From manufacturer (most likely < 10-15 K/hr) |
| TPCs cool-down rate | < 40 K/hr<br>< 10 K/m (vertically) |
| Mechanical load on TPC | The LAr or the gas jet pressure shall not apply a mechanical load to the TPC greater than 200 Pascal |
| Nominal LAr purification flow rate (filling/ops) | 1 volume change/day 7.9 $m^3$/hr = 35 gpm. Less circulation flow is allowed , e.g. 10 gpm, is rationale is verified. Similar to 1 change per 8 days for T600 |
| All surfaces in the ullage during operations | < 100 K |
| Convective currents inside cryostat | < 10 cm/s |
| GAr purge within insulation (From LBNF) | 1 volume change/day of the open space between insulation panels |
| Condenser cooling power | Based on fill with LAr (~25 kW) |
| Grounding and noise requirement | Electrical isolation from cryostat. Approval by SBND committee supervising detector and building grounding |

Requirements for **SBN FD** Cryogenics - Cryogenics

| Required Parameter for Cryogenics | Value |
|---|---|
| LAr purity in cryostat | **15** ms electron lifetime (to replicate Icarus performance) |
| Nitrogen contamination | Less than 2 ppm |
| Design Pressure | **350** mbarg (~**5** psig) |
| Operating gas pressure | **150** mbar (~**2** psig) with +/- 5% (~0.1 psig) |
| | |
| | |
| TPCs max gradients | < **70** K<br>< **50** K (vertically) |
| Mechanical load on TPC | no load on the TPC |
| Nominal LAr purification flow rate (filling/ops) | 1 volume change/week **2** $m^3$/hr/T300 module ≈ **9** gpm. |
| All surfaces in the ullage during operations | ≈ 87 K except for the cables inside the chimneys |
| Convective currents inside cryostat | < **20** cm/s |
| GAr purge within insulation (From LBNF) | **0.5** volume change/day of the open space between insulation panels |
| Condenser cooling power | ~**2** kW / gas recirculation unit |
| Grounding and noise requirement | Electrical isolation from cryostat. Approval by SBN-FD committee supervising detector and building grounding |

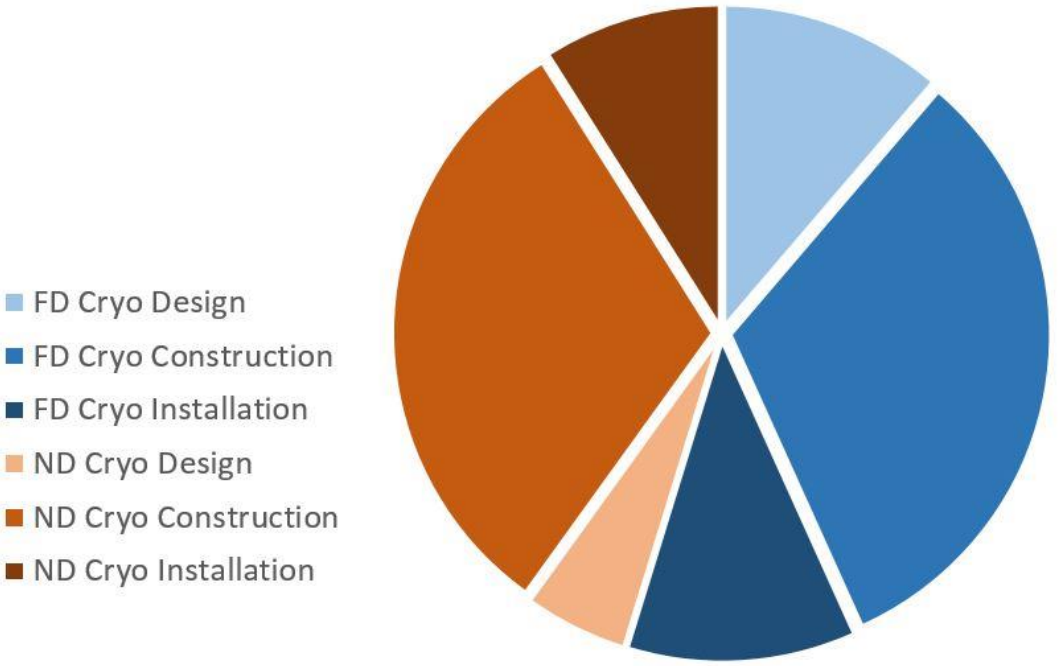
# Cryogenics - Cost

| Task | WBS | DOE Funds | Estimate $k |
|---|---|---|---|
| Mgmt | 4.3.1 | OPS | $221 |
| Cryogenics Conceptual Design | 4.3.2.1 | OPS | $52 |
| FD Cryogenics Design | 4.3.3.1 & 4.3.3.2 | OPS | $499 |
| FD Cryogenics Construction | 4.3.3.3 | OPS | $1,419 |
| FD Cryogenics Installation | 4.3.3.4 | OPS | $510 |
| ND Cryogenics Design | 4.3.2.2 & 4.3.2.3 | R&D | $230 |
| ND Cryogenics Construction | 4.3.2.4 | R&D | $1,379 |
| ND Cryogenics Installation | 4.3.2.5 | R&D | $397 |

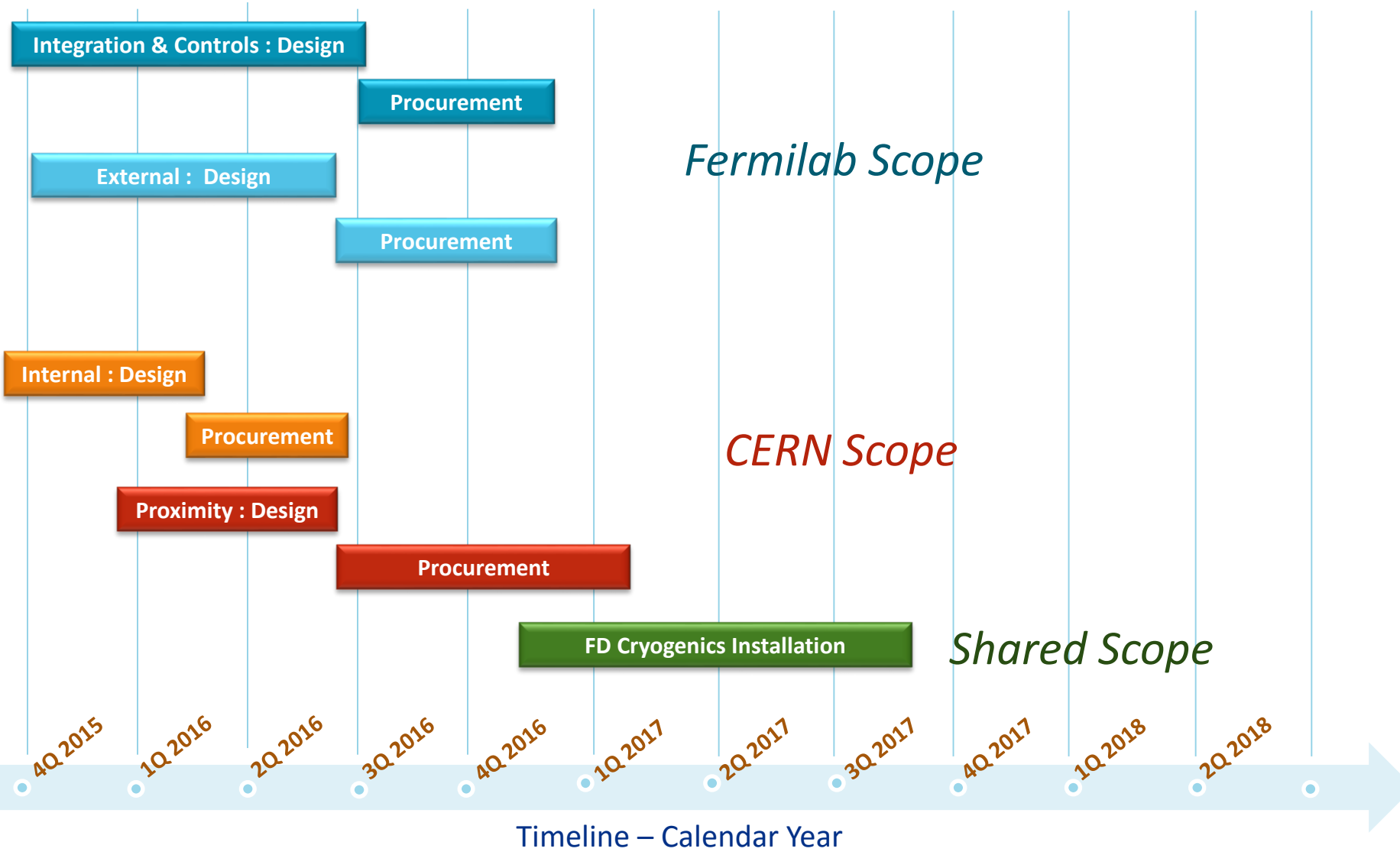
$4.7M DOE funds

FD is 55% of total
ND is 45% of total

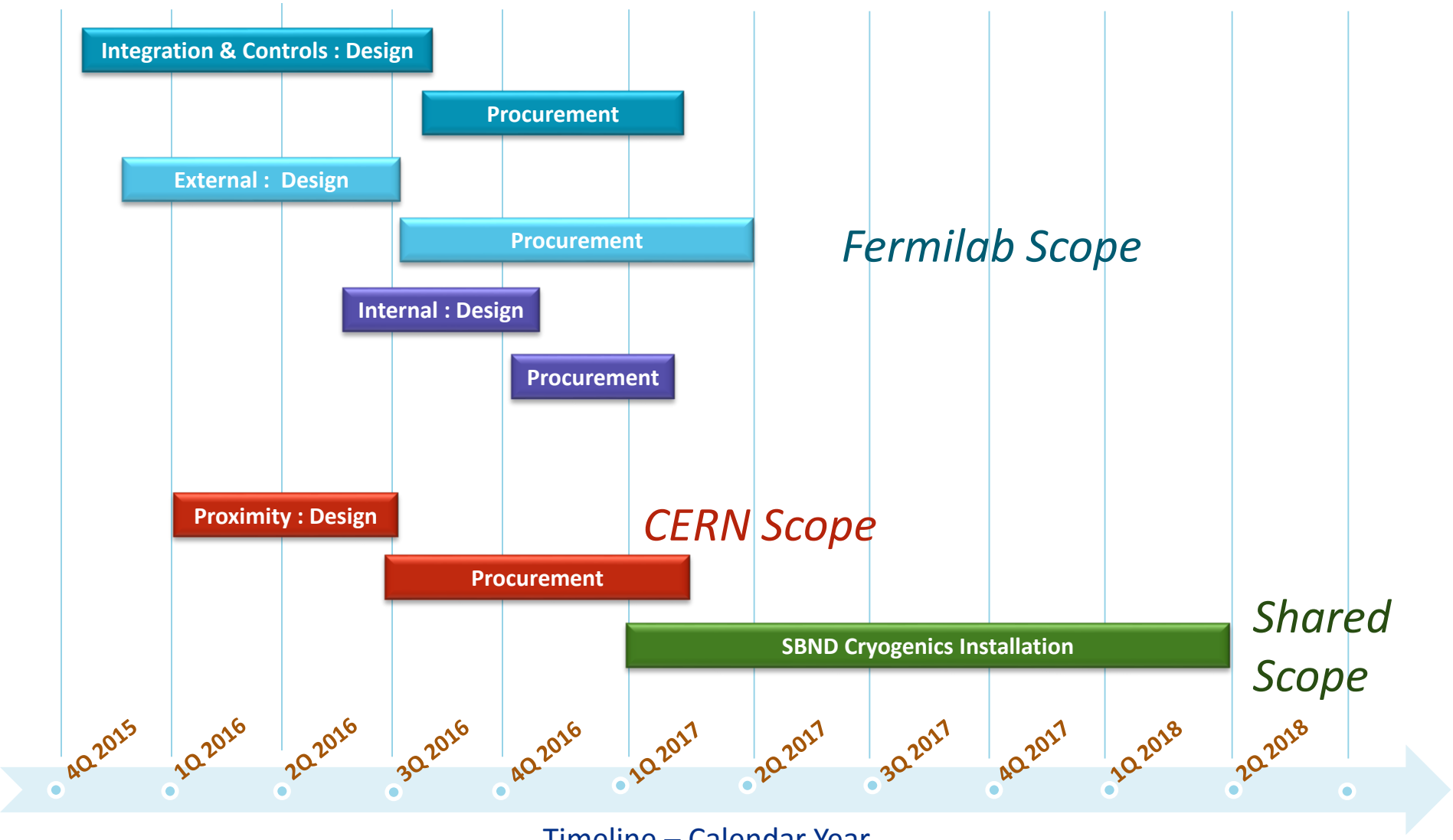
*Design is 21% of the FD total cost*
*Design is 11% of the ND total cost*



# Cryogenics – Schedule for ICARUS



# Cryogenics – Schedule for SBND



# Cryogenics - Resources

- Managers – Mike Dinnon, Mike Geynisman
- Fermilab: Barry Norris, Roza Doubnik, Min Jeong Kim, David Montanari, Mike Zuckerbrot
- CERN: Johan Bremer, Michel Chalifour & group

*Designers – costs to develop CAD models of the detectors and cryogenics in their buildings is contained in the Installation-Integration tasks under each detector WBS*

## Technical Assessment

- the first Independent Technical Assessment of the Cryogenics was held at CERN in October
- the report was just recently posted – See Program Review page
  - no formal responses yet

# Cryogenics – Summary

- Over the past 6+ months, this CERN+Fermilab group has made much progress
  - logical layout of the systems – the P&ID, Piping and Instrumentation Diagrams
  - P&ID in turn used to define the Scope
  - these in turn supply the content for the Work Package Agreements and the documents which define the interfaces between CERN and Fermilab components

MORE in their Breakout presentations

# ICARUS Installation

# ICARUS Installation – Scope of Work

- Installation of ICARUS
  - Fermilab scope in collaboration with INFN and CERN
- Detector Readout installation
  - ICARUS Collaboration, with assistance from Fermilab technical staff as needed
- Cryogenics installation
  - part of the Cryogenics WBS
- Cosmic Tagger installation
  - scope TBD
- Overburden installation
  - Fermilab scope

# ICARUS Installation - Requirements

- Be ready to receive the ICARUS detector and install into the SBN-FD Building by the close of calendar 2016
- Complete the ICARUS detector installation and be ready for data-taking in calendar 2017

**Many details**

- interfaces between the cryostats, cryogenics, detectors, detector readout & DAQ
- items being shipped, in how many shipments, their handling requirements (weight, size)
- assembly order (warm cryostat structure, insulation, cold cryostats) and assembly tooling (lifts, rigging fixtures)
- Detector readout support needs
  - grounding, networks, racks, power

Collaboration with the ICARUS Collaboration and CERN colleagues is vital to success!

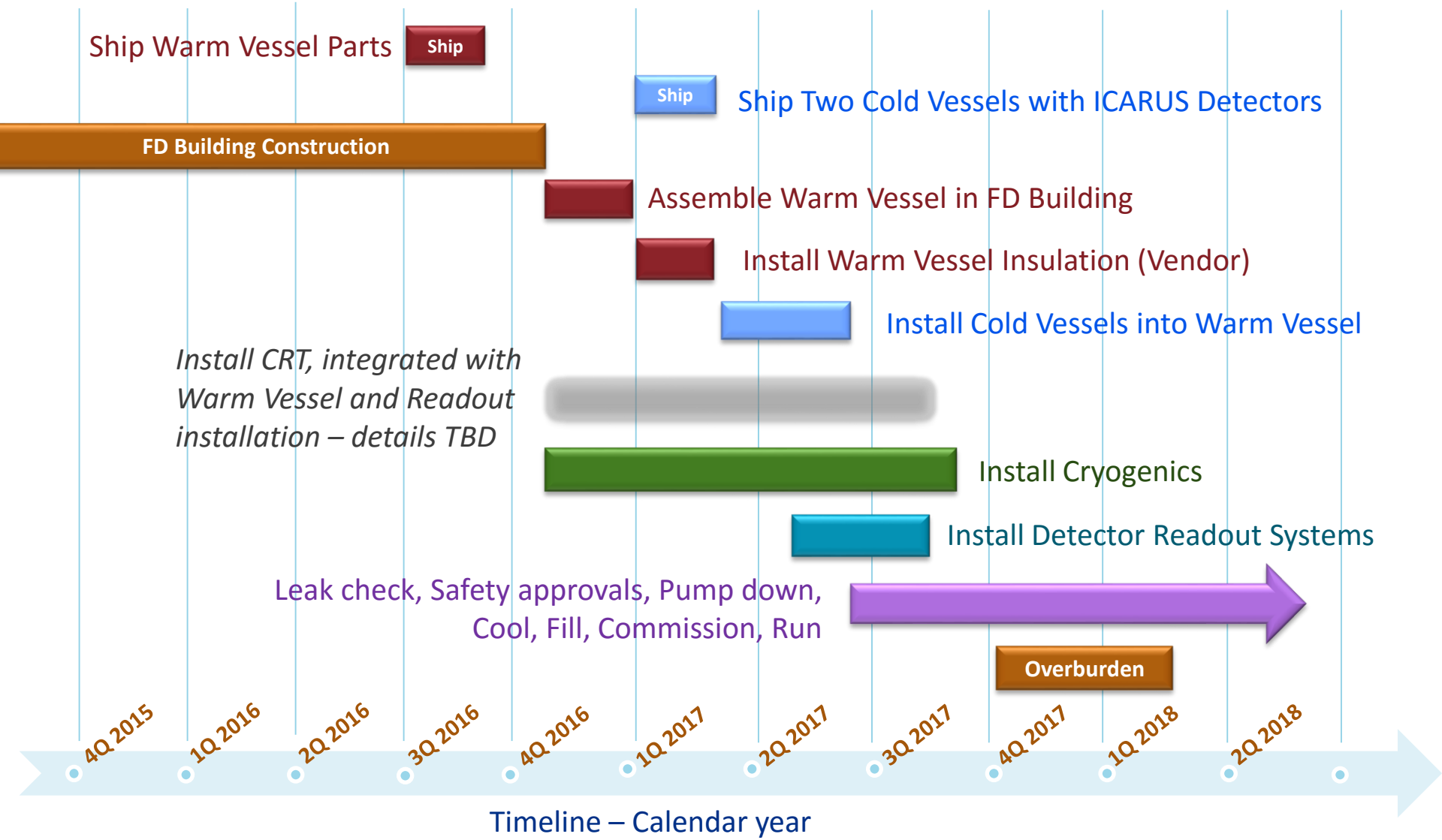
# ICARUS Installation - Resources

- The Fermilab team is organized starting November 2015
  - Manager : Fernanda Garcia
  - team to date : Andy Stefanik, Jim Kilmer, Linda Bagby, Justin Tillman
  - expect to recruit more

- They are coming up to speed quickly
  - Joint Breakout session presentation provides a look at the startup effort

- One outcome after the Cosmic Tagger Task Force has concluded is expected to be the determination of collaboration contributions towards the design, fabrication & integration of a Cosmic Tagger system for ICARUS

# ICARUS Installation – Provisional Plan



# ICARUS Installation – DOE Costs

- Since the local team has just started, the Technical Coordinator (myself) has made a Top down estimate and entered this into the Program schedule as Planning Packages

Costs, $k, fully burdened, $2.2 M

| Task | WBS | Funding | Estimate |
|---|---|---|---|
| Management | 4.4.1.1 | OPS | $524 |
| Installation Planning | 4.4.1.2 | OPS | $535 |
| Installation of T600 at FNAL | 4.4.1.3 | OPS | $1,142 |

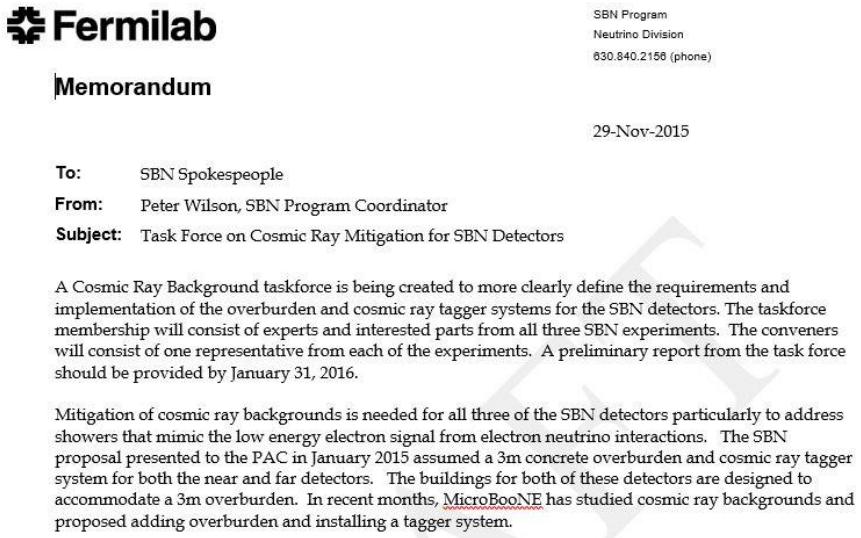
- The Installation manager and team will develop a bottoms up estimate as they work out the details of their plan

# Early Planning Stages

# Joint Cosmic Tagger Effort

- Cosmic Tagging detector
  - ICARUS : general agreement on the main requirements of coverage and layers, but less development on details (readout hardware; timing resolution)
  - a Task Force is recently formed, chaired by Bob Wilson and Roxanne Guenette, to provide requirements for all detectors and optimal implementation for each
  - Breakout presentation

common solutions may save design costs and streamline construction



Fermilab

SBN Program
Neutrino Division
630.840.2156 (phone)

**Memorandum**

29-Nov-2015

**To:** SBN Spokespeople
**From:** Peter Wilson, SBN Program Coordinator
**Subject:** Task Force on Cosmic Ray Mitigation for SBN Detectors

A Cosmic Ray Background taskforce is being created to more clearly define the requirements and implementation of the overburden and cosmic ray tagger systems for the SBN detectors. The taskforce membership will consist of experts and interested parts from all three SBN experiments. The conveners will consist of one representative from each of the experiments. A preliminary report from the task force should be provided by January 31, 2016.

Mitigation of cosmic ray backgrounds is needed for all three of the SBN detectors particularly to address showers that mimic the low energy electron signal from electron neutrino interactions. The SBN proposal presented to the PAC in January 2015 assumed a 3m concrete overburden and cosmic ray tagger system for both the near and far detectors. The buildings for both of these detectors are designed to accommodate a 3m overburden. In recent months, MicroBooNE has studied cosmic ray backgrounds and proposed adding overburden and installing a tagger system.

# Online Integration

- Details of the scope and requirements of this item are under discussion
  - if the SBN detectors have similar requirements for some portions of their online systems, then there is motivation to devise common solutions
  - recent DUNE-SBN workshop

Breakout presentation by Wes Ketchum

| Data Size Comparison | SBND | MicroBooNE | ICARUS |
|---|---|---|---|
| Number of TPCs | 2 | 1 | 4 |
| TPC Channels (total) | 11,500 | 8,256 | 53,000 |
| PMT Channels | 100 | 36 | 400 |
| CRT Channels | 4,000 | *1600 (under design)* | *under design* |
| TPC Digitization | 2 MHz, 12b | 2 MHz, 12b | 2.5 MHz, 12b |
| PMT Digitization | ~1 GHz | 64 MHz | ~1 GHz |
| TPC drift/readout period | 1.3 ms / 3.8 ms | 2.3 ms / 4.8 ms | 1.0 ms / 1.6 ms |
| Uncompressed data size (per event, TPC only) | 220 MB | 150 MB | 330 MB |
| Compression factor (Hardware + Software) | 5 | 5 | 4*2 |
| Total data size (per event, TPC only) | 45 MB | 30 MB | 40 MB |

# Summary

- Conventional Facilities
  - under construction; will be ready for their detectors
- Cryogenics
  - has laid the ground for a successful joint Fermilab-CERN venture
- ICARUS
  - will arrive in about 1 year, and we will be ready for it

The Integration team is prepared to meet all challenges