Fermilab U.S. DEPARTMENT OF ENERGY | Office of Science

Timeline for ArgonCube2x2 at Fermilab

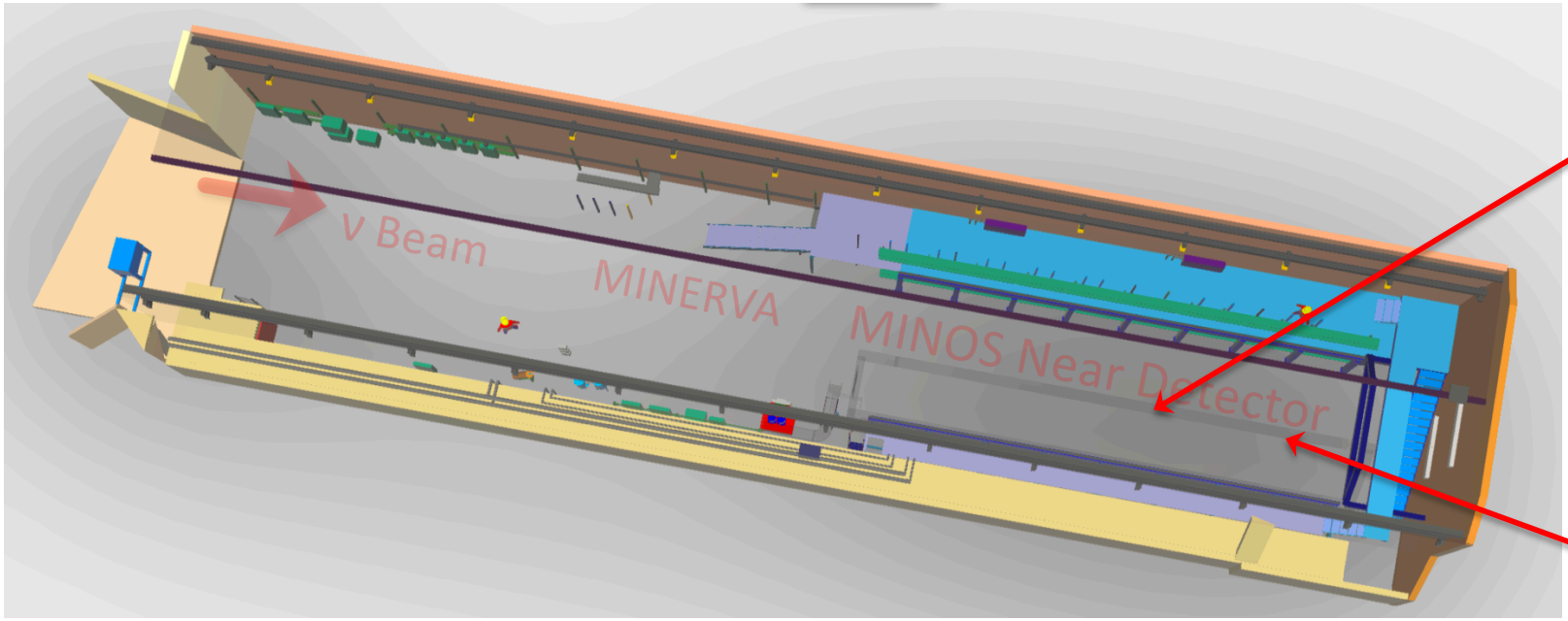
Ting Miao, Fermilab

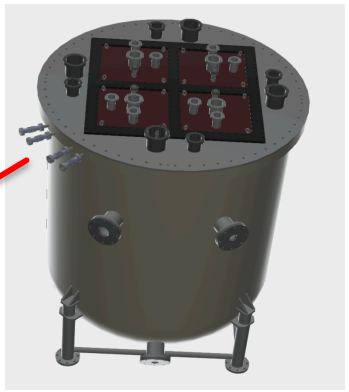
Near Detector Workshop 5-25-2019

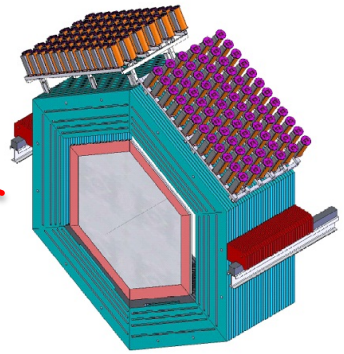
Scope of Works for 2x2 Test in MINOS

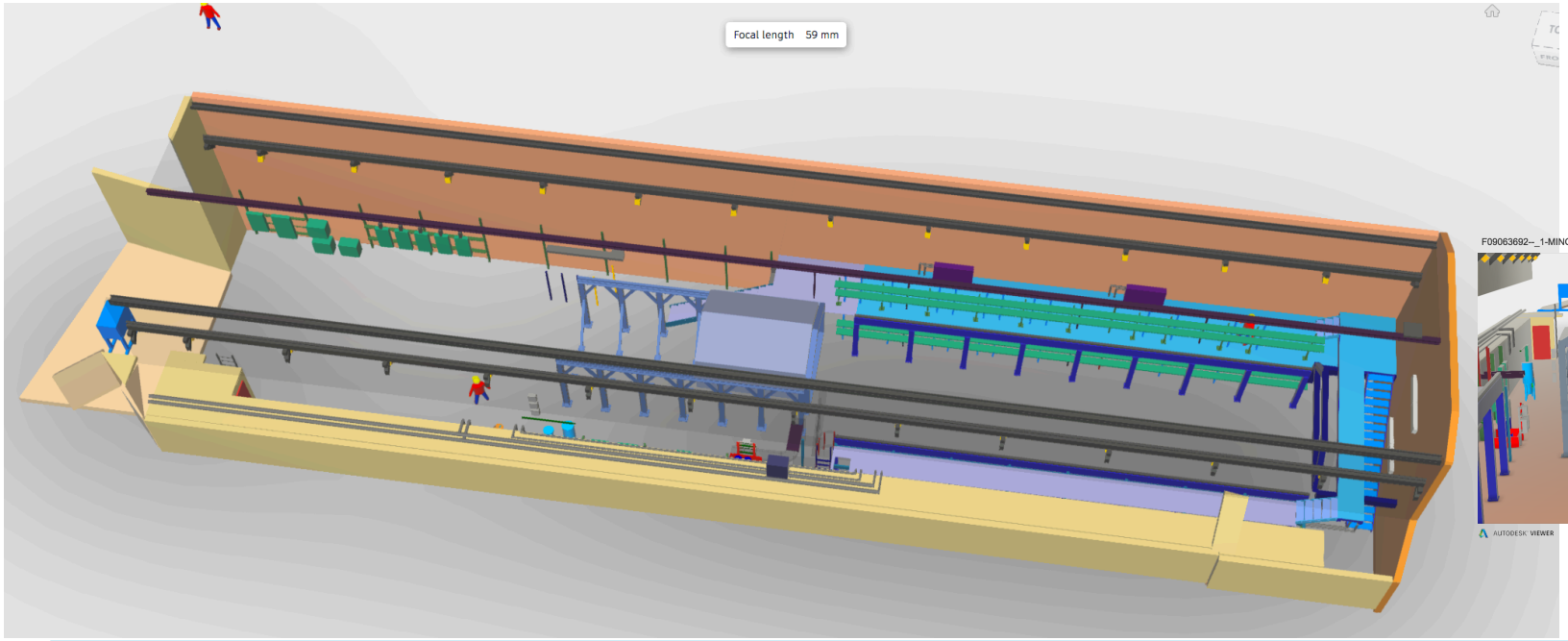
- Underground detector hall preparation
  - Minerva/Minos decommissioning and reconfiguration
  - 2x2 detector layout with support infrastructures
- Cooling and cryogenic infrastructures
  - LAr supply, cooling facility, purification and recirculation, control and monitoring
  - 2x2 cryostat vessel certification for use onsite at Fermilab
  - Cryostat venting, ODH mitigation and monitoring
- System integrations and safety design reviews
  - Interface of detector and cryo system
  - System integration of detector control and cryogenic control
  - System integration of readout and DAQ
  - Safety engineering design review (SEDR) for HV system
  - SEDR for front-end electronics
- Installation and commissioning

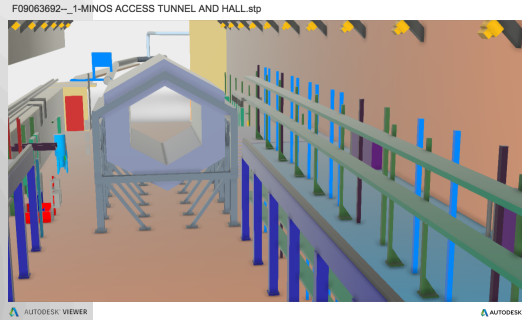
Detector Location





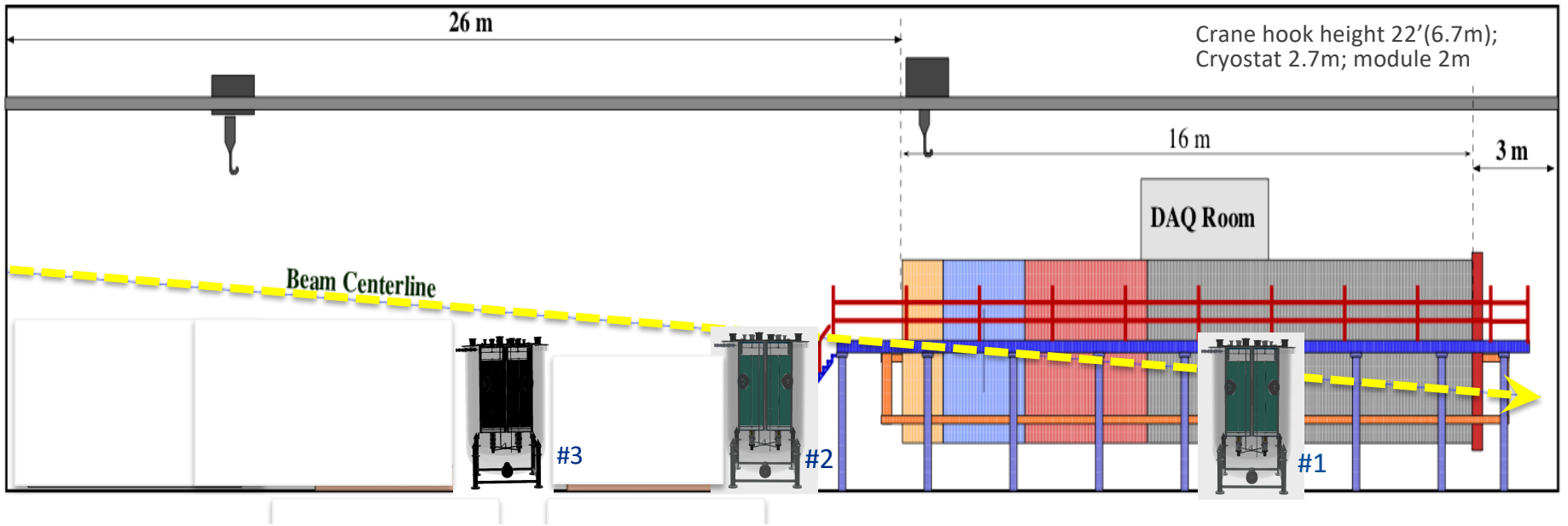






Fermilab

Detector Location and Configuration



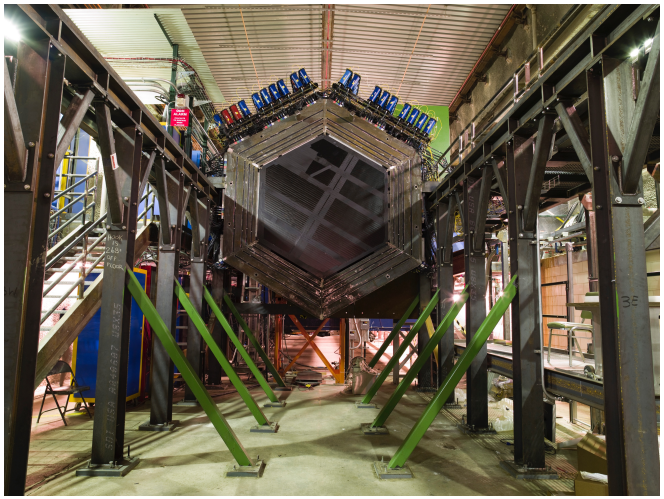
Best-wish detector configuration:

ArgonCube2x2 at position #1 (baseline)

+ Reconfigured Minerva modules (optional)

12 Minerva modules at upstream and 24 downstream

- Need to lower Minerva modules to match 2x2 height
- Add a new bookend to hold upstream modules
- Minerva/MINOS decommissioning plan is being finalized



Fermilab

New Facilities in MINOS to Support 2x2 Test

- Cooling Facility with Substantial Power
- LAr Supply, Storage Dewar, Cryostat Vessel Venting Line
- ODH Mitigation for a 6000L LAr System Underground
- Cryogenics and Control
- Support Platforms for 2x2 Vessel and Cryogenic Equipment
- Support for TPC Module Insertion and Extraction
- Support for TPC Module Assembly and Checkout (new)
- Power Panels, Relay Racks, Cable Trays, Networks etc.
- Computing and Control Room

The list grew a bit since March ArgonCube collaboration meeting

Cryogenic Concept for 2x2@MINOS

- Cryo-cooler cooling option is favored after comparing M&S cost, engineering labor and ODH mitigation impact to a long LN_2 line
  - LN_2 tank on surface+700ft vacuum jacketed pipe line +phase separator & condenser
- Need 5 of the 300W cryo-cooler units – total M&S cost $300K
- LAr recirculation and purification to be based on BERN system
  - Possibly new pressure relief device to work with existing MINOS venting line
  - Possibly new filter skid and purity monitor(s)
  - Same PLC control system implemented at Bern in May by Trevor Nichols
- Start to prepare safety and technical reviews
  - PFD available, P&ID in progress, equipment sizing and layout next
  - Engineering notes are being prepared

ODH Mitigation with 2x2 in MINOS Hall

- It is important for Fermilab to keep MINOS hall as ODH-0
  - Lowest oxygen deficiency hazard condition
  - Biggest concern is the accidental spill from the cryostat vessel
- Initial ODH mitigation recommendation:
  - Replace exhaust fan with two 5500CFM and connect them to backup generator
  - Integrate fan control into FIRUS notification system
  - Drop additional air duct to floor level to get closer to 2x2 vessel area
  - Install curtains around 2x2 vessel and its cryogenic devices
  - Instrument additional ODH monitoring sensors
- Cost is estimated to be around $150K + labor
  - Engineering note in preparation
  - Need to get green light from safety panel before implementation
  - Aim to get mitigation system installed before detector arrives

Detector and Readout System Integrations

- Detector and cryogenic interface
  - Coordinated through weekly 2x2 cryo meetings
- Detector control system to be designed and implemented by collaboration effort with Fermilab support
  - Looking helps to define DCS protocol
  - Looking helps on HV system control and monitoring
- Readout electronics includes new 2x2 electronics from BERN and existing Minerva electronics
  - Power budget, grounding schemes, clean AC power for TPC readout
  - Beam timing electronics and trigger electronics
  - DAQ and online computing, control room setup
- Linda Bagby to serve as electrical project engineer
  - To work with subsystem leaders and Fermilab OPS group
  - To organize safety engineering design reviews and ORCs

Schedule for 2x2 Test in MINOS

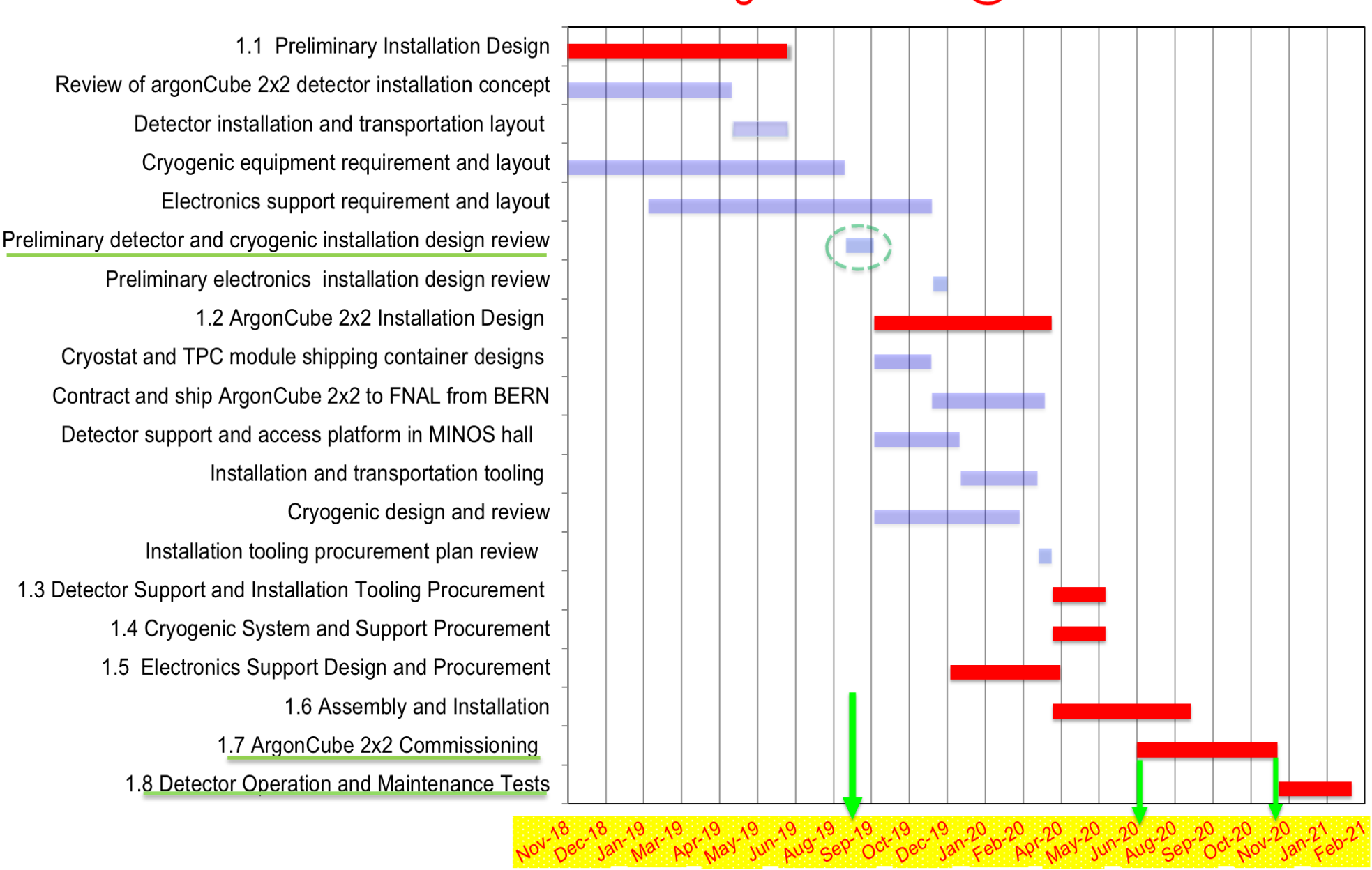
- WBS schedule file with cost and labor available in google drive
  - Decommissioning schedule of Minerva/MINOS also available
- WBS deliverables include cryogenic infrastructure, cryostat support, electronics integration, equipment procurement and fabrication, installation, commissioning and operation
- Schedule is built around the milestone that in March 2020 Bern delivers cryostat vessel, TPC modules, cryogenics, HV PS and feedthrough, electronics, detector control and readout
  - Installation to start in Spring 2020
  - Commissioning to start in Summer 2020
- It is an aggressive schedule as we are aiming for result in 2020
  - Doable with proper support and careful coordination

Schedule and Resource Summary

WBS Element	WBS Description	Lead Institutions	Start Date	Finish Date	FNAL Labor (type : working days)	M&S ($)
1	**ArgonCube 2x2 Installation in MINOS Hall**		10/25/18	2/4/21		
1.1	**Preliminary Installation Design**		10/25/18	6/20/19		
1.1.1	Review of argonCube 2x2 detector installation concept	BERN	10/25/18	4/23/19	Eng.Phys:70d + CryoE:125d + ME.FEA:10d	
1.1.2	Detector installation and transportation layout	FNAL	4/24/19	6/21/19	Eng.Phys:10d + Mech.Design:30d+ME:10d	
1.1.3	Cryogenic equipment requirement and layout	FNAL/BERN	10/25/18	8/20/19	CryoE:180d+ME.FEA:20d+ME:45d+ Mech.Design:70d+Eng.Phys:50d	
1.1.4	Electronics support requirement and layout	FNAL/BERN/LBNL/UTA	1/25/19	11/20/19	EE:95d+ComSP:40d +CryoE:10d+Mech.Design:5d	
1.1.5	*Preliminary detector and cryogenic installation design review*	FNAL/BERN	8/21/19	9/19/19	CryoE:5d+ME:5d+Mech.Design:5d+ EE:5d+ Eng.Phys:5d	
1.1.6	Preliminary electronics installation design review	FNAL/BERN/LBNL/UTA	11/21/19	12/6/19	EE:5d+Mech.Design:5d +CompSP:5d	
1.2	**ArgonCube 2x2 Installation Design**		9/20/19	3/25/20		
1.2.1	Cryostat and TPC module shipping container designs	BERN/FNAL	9/20/19	11/19/19	ME:5d+Mech.Design:5d+Eng.Phys.5d	
1.2.2	*Contract and ship ArgonCube 2x2 to FNAL from BERN*	BERN	*11/20/19*	*3/18/20*		
1.2.3	Detector support and access platform in MINOS hall		9/20/19	12/19/19	ME:30d+Mech.Design.30d+ CryoE:5d+Eng.Phys:10d	
1.2.4	Installation and transportation tooling		12/20/19	3/10/20	ME:25d+Mech.Design:50d + Eng.Phys:10d	
1.2.5	Cryogenic design and review		9/20/19	2/20/20	cryoE: 150d+ Mech.Design:65d +Eng.Phys:50d	
1.2.6	Review of installation tooling procurement plans	BERN/FNAL	3/11/20	3/25/20	Eng.Phys.5d	
1.3	**Detector Support and Installation Tooling Procurement**	FNAL	3/26/20	5/21/20	ME:5d+ Eng.Phys:5d	$20 K
1.4	**Cryogenic System and Support Procurement**	FNAL	3/26/20	5/21/20	Eng.Phys:10d	$300 K
1.5	**Electronics Support Design and Procurement**		12/9/19	4/3/20	EE:100d+CompSP:100d +ME.Process:40d	$70 K
1.6	**Assembly and Installation**		3/26/20	8/19/20	ME:30d+CryoE:55d+EE:45d+MT:160d+ ET:40d+CompSP:20d+Eng.Phys:50d+ ME.Process:10d	$110 K
1.7	**ArgonCube 2x2 Commissioning**		6/23/20	11/18/20	ME.Process:25d+CompSP:55d+CryoE:40d +ME:15d+EE:35d+Eng.Phys.60	$20 K
1.8	**Detector Operation and Maintenance Tests**		11/19/20	2/4/21	ME.Process:5d+CompSP:30d+CryoE:20d+ ME:10d+EE:10d+MT:30d+Eng.Phys.20d	$20 K

	Cryo Engineer + Eng. Physcist	Mech Engineer + Designer	Electrical Engineer	Mech Techs + Elec Techs	Computing Specialist
Technical support for WBS 1.1 to 1.2 Designs (2019+)	475d + 205d	255d+265d	105d		45d
Technical support for WBS 1.3 to 1.8 Installation & commissioning & test (2020)	185d + 175d	75d	190d	190d + 40d	205d

Schedule in Graphic



Schedule Risks

- Engineering resource limit from neutrino division
  - Competing with other projects for engineer's time
  - Seeking support from DUNE project office
- 20+8 weeks delivery time from CryoMech for 5 cryo-coolers
  - Need to make cooling option choice by end of the year
  - Also to checkout existing cooling water line in NUMI in order to reuse 2 coolers Alan has
- Detector hall preparation relays heavily on PPD team and FESS
  - Minerva/Minos decommissioning needs 100 man-day ME and 800 man-day MT
  - ODH mitigation system installation to be coordinated with FESS facility management
- Potential conflict with MAGIS-100 for MINOS shaft use
  - Need to transfer big items to underground before MAGIS-100 starts
- Potential fabrication delays of LArPix and TPC modules
  - To look infrastructure requirement for LArPix-TPC assembly at Fermilab
- Start to identify schedule risks from technical issues
  - Potential repair work needed for existing vent line - pressure test scheduled
  - Vessel safety review delay due to lack of manufacturer certification
    - Need full FEA to calculate pressure rating from material list and and repair records

Safety and Design Reviews

- Subsystems coming to Fermilab need safety reviews
  - Best to identify safety issues during the design stage
  - Document as much as possible of your design
- Will schedule safety engineering design review sooner than later
  - Could go together with performance and integration review to save time
- Cryo system design review to start in August
  - Covers ODH mitigation, pressure vessel qualification and venting, and cryogenics
  - MINOS cryogenic safety panel: Mike White (chair), Del Allspach, Alex Martinetz, Angela Aparicio
  - Additional reviewers for performance, system integration and value engineering
- Next two subsystems to be reviewed
  - SEDR for HV system: PS, splitter, cable, noise filter, feedthrough, TPC connection…
  - SEDR for front readout integration: LArPix, Arty-Z7 FPGA boards, cables, LVs, racks

Team for 2x2 Test in MINOS

- ArgonCube2x2 in MINOS is a Fermilab test experiment T-1563
- Project manager Ting Miao
  - Working with collaboration and neutrino division to complete management team
- Management team
  - Detector Hall Preparation and Underground Liaison: **Jim Kilmer** + **Steve Hahn** (FNAL)
  - Cryo Engineering and System Integration: **Min Jeong Kim** (FNAL)
  - Electrical Project Engineer for System Integration: **Linda Bagby** (FNAL)
  - Installation Support and Coordination: **Sai Kancharla** (FNAL) + **James Sinclair** (Bern)
  - TPC Installation and Integration: **Knut Skarpaas** (SLAC) + **James Sinclair** (Bern)
  - Detector and Cryogenic Controls: *Collaboration* + **Trevor Nichols** (FNAL)
  - Readout Electronics Integration &Trigger: **Dan Dwyer** (LBNL)+**Clarence Wret** (Rochester)
  - Online and DAQ: **Rochester + LBNL + FNAL** + *Collaboration*
  - Commissioning Coordination: **Igor Kreslo** (Bern)

Summary

- 2x2 in MINOS is to provide critical test of ArgonCube near detector concept
- We are aiming to have the detector installed and commissioned in 2020
- We are working to secure resources needed to carry out the plan
- Works already started for new infrastructures to support 2x2 test underground
- Need more Fermilab and collaboration supports

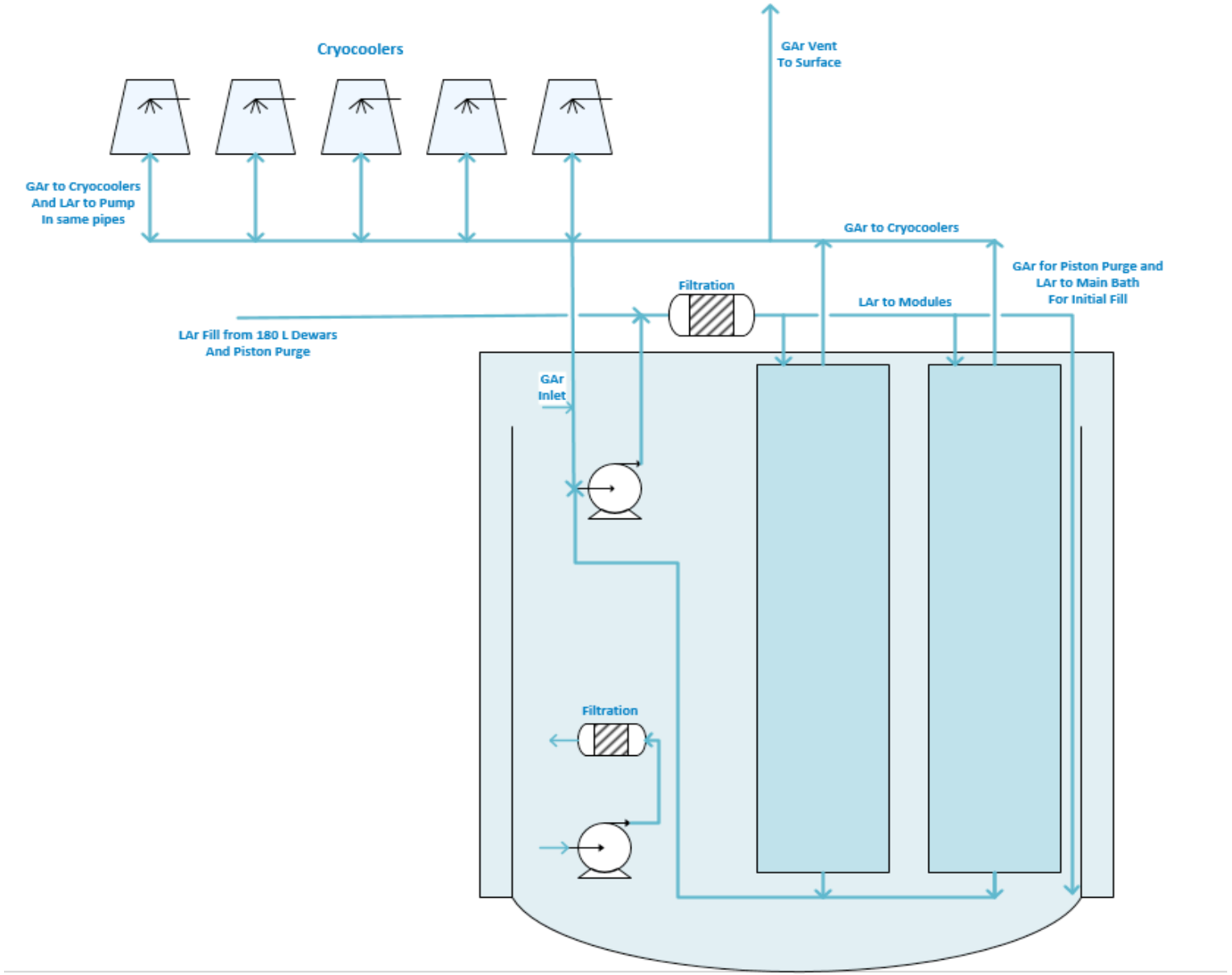
Backup Slides

Scope of Design Review of ArgonCube2x2 Cryogenics

May 2, 2019

- Topics to be reviewed:
  - ODH calculation and mitigation method
  - Cryostat cooling scheme
    - Cryostat cooler sizing and selection
    - Thermal analysis FEA
    - Module vacuum insulation
  - Cryogenic scheme: PFD,PID, equipment sizing and layout
    - LAr filling scheme
    - LAr re-circulation and purification
  - Cryostat venting line size calculation and layout
    - vessel pressure release scheme
    - LAr supply dewar
    - a new pipe to extent the helium piping to reach ArgonCube2x2 vessel
    - assuming 2x2 vessel at the very downstream end of the hall
  - Cryostat vacuum insulation scheme, certification as low-pressure vessel
    - FEA and pressure test procedure
  - Cryogenic control and monitoring
  - (Possibly) Equipment layout, procurement, cost
- List of documentation to be prepared
  - Design requirement signoff
  - ODH analysis and mitigation
  - Argon piping engineering note
  - Low pressure vessel engineering note
  - Cryogenics: PFD, P&ID, instrument sizing and layout
    - BERN July cryogenic test result and module design decision
  - PLC system for control and monitoring
  - Equipment layout
  - Failure Mode & Effect Analysis
  - What-if analysis
- Prerequisite documentation: design requirement and BERN's cryogenic system

Cooling Concept



Fermilab