Recent Reviews

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DUNE-PRISM Engineering Meeting

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Recent Reviews

- On July 7-9, we had (internal to DUNE) a Near Detector Conceptual Design Review
  - https://indico.fnal.gov/event/43949/timetable/
  - DUNE collaborators were asked to assess whether we were at a 30% Conceptual Design level
- On July 14-16, we had an Independent Project Review (IPR)
  - DOE-led review of steps toward CD-2 readiness, conducted by external (non-neutrino) reviewers
- On the next few slides are some highlights of the findings, comments, and recommendations relevant to DUNE-PRISM are given from both of the reviews
- After that are a few slides on some of the details we presented
  - Some further refinement may be needed, so we can discuss these today

DUNE CDR Review Highlights

- Findings
  - The PRISM concept has been endorsed by the collaboration and LBNC as required to meet the goal of 3-sigma observation of maximal CPV in the first three years of operation.
  - The technical needs of PRISM are met by commercial rollers and energy chain devices.
- Comments
  - The plans for other automatic interlocks for power supplies etc. for all three detector systems seem to be less well developed than those for personnel safety.
  - It was stated that there is ample space in the energy chains for all pipes and cables. The project should consider sizing these channels with enough spare capacity to accommodate possible future detector needs and upgrades.
  - The cryostat structure is very sensitive to differences in the stiffness of the floor support structure. Also the cryostat could provide highly non-uniform load to the floor support structure.
  - An alternative and more cost effective moving option, not just the rails and rollers could explored.
- Recommendations
  - We suggest to consider with particular care the impact of the deformation of the cryostat to the load of PRISM

IPR Closeout Highlights

- Findings
  - Lateral movement by 30m of the ND-LArTPC and TMS is provided by the Precision Reaction-Independent Spectrum Measurement (PRISM) system.
  - There are currently no KPPs related to PRISM.
- Comments
  - The installation sequence requires SAND to be the first ND detector installed and thus it has the potential to become the ND critical path during installation.
  - The risk registry is incomplete and needs to be expanded to capture all risk exposure, including non-DOE risks.
  - De-scoping of the Near Detector due to budgetary pressures should be avoided given the relevance of the ND for the ultimate physics program. A close interaction between the NSCF and the ND should be maintained to understand and quantify the implications of any change in conventional facilities and beamline on the environmental parameters of the ND hall and the detector.
- Recommendations
  - Develop a strategy to document the Day-1 detector configuration before CD-2
  - Define KPPs for the PRISM system before end of FY2020
  - Develop and maintain a table of parameters for the ND, by early 2021.
  - Update, complete, and actively manage the risk register by the end of FY2020.

Key Requirements and Specifications

ND-O4	Obtain measurements with different fluxes		The ND must verify that model predictions are robust with different neutrino fluxes.		
ND-M7	Take measurements with off-axis fluxes with spectra spanning region of interest	0.5-3.0 GeV	The ND must be able to move off the beam axis to take data with different neutrino spectra.	ND-LAr, ND-GAr, DUNE-PRISM	ND-O4

- ND-C4.1: The detectors must move up to 30.5 m off-axis to cover the full FD ν_e & ν_μ energy spectra (0.5 – 3.0 GeV)
- ND-C4.5: To minimize systematic uncertainties due to changes in beam conditions over time, these measurements should be made over a yearly beam run
- ND-C4.4: To minimize downtime, the detectors should be capable of moving between any 2 positions within 8 hours
  - ND-T5.9: Movement system must have a maximum speed of at least 10 cm/min
  - ND-T5.10: Detectors have < 1 hour to prepare for, and recover from, a movement
- ND-C4.3 → T5.5: The detector performance is expected to vary at the 10 cm scale (50 cm drift distance), which sets the required granularity of achievable detector positions
  - ND-T5.6: The placement precision requirement is ±3 cm
  - ND-T5.7: Position monitoring requirement is ±1 cm (goal: ±1 mm)

Summary Costs

- **Support Frames** are in individual detector BOEs — **N/A**
  - ND-LAr support frame is in cryostat BOE (131.02.03.03.02)
  - Spectrometer frame is in muon spectrometer BOE (131.02.03.04)
  - SAND frame needs to be reconfigured -> SAND cost, not US scope
- **Floor Rails** are in PRISM BOE
  - Rails for all three detectors (LAr, Spectrometer, SAND) plus installation is in PRISM BOE (131.02.03.08.02) — **$ 1,071,882**
- **Movement System** (rollers, control interface, safety system, position sensor, hardware)
  - ND-LAr movement system plus common tooling is in PRISM BOE (131.02.03.08.02) — **$ 970,235**
  - Spectrometer movement system is in I&I BOE (131.04.02.02) — **$ 921,915**
  - SAND Movement system -> SAND cost, not US scope — **N/A**
- **Energy Chains**
  - LAr and spectrometer chain procurements plus pre-assembly are in PRISM BOE (131.02.03.08.02) — **$ 379,883**
  - Energy chain cavern wall mounts, assembly, installation are in I&I BOE (131.04.02.02) — **N/A**

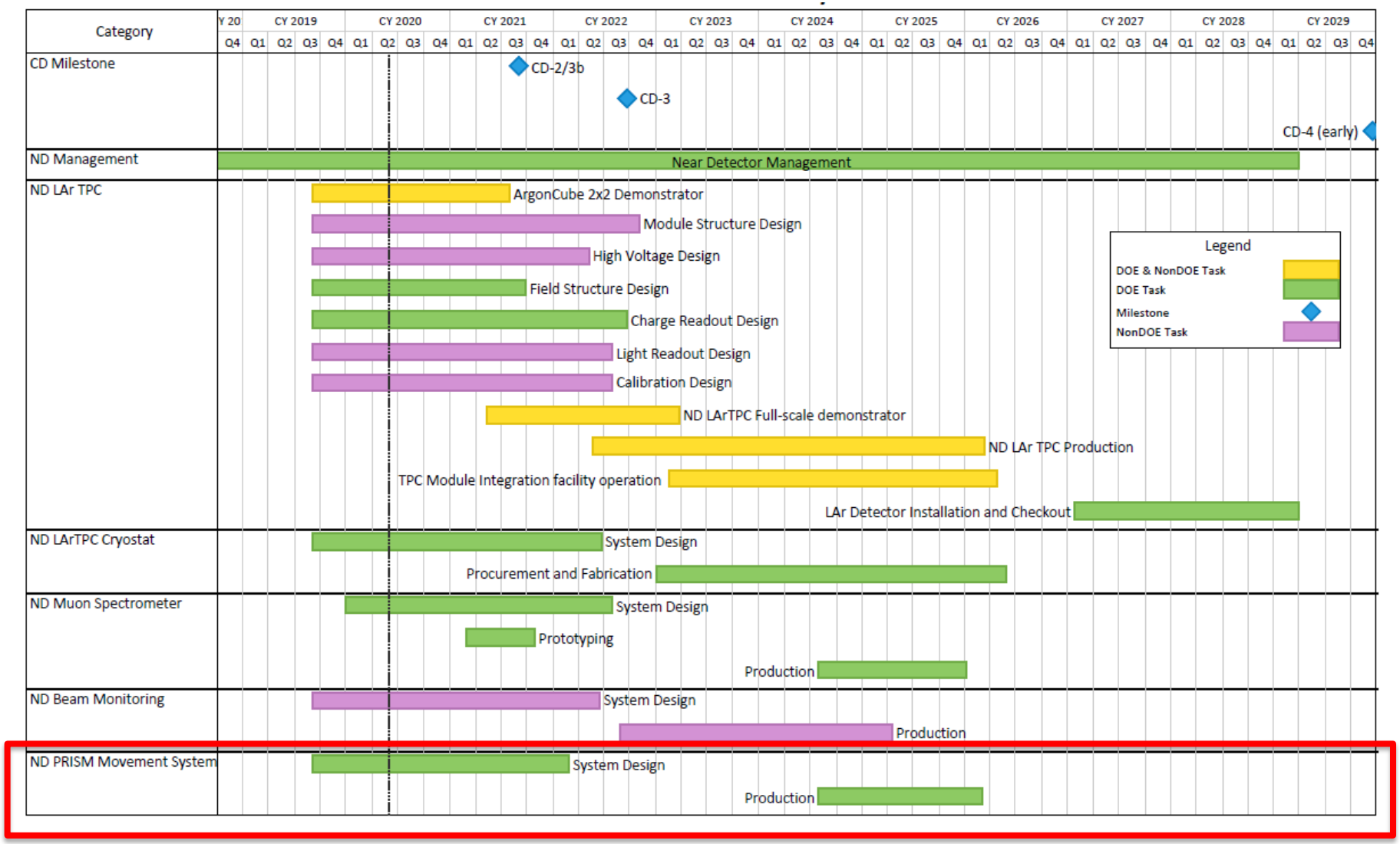
Total PRISM Cost: $ 3,343,915

PRISM Material Budget in 131.02.03.08.02

Primary Column	Supplier	Unit Cost or Rate/hr	QTY	Total Cost	Quote Year	Estimate Type	Note
FABRICATION OR PROCUREMENT - COST ESTIMATE SHEET							
131.02.03.08.02 PRISM MATERIAL COST	**TOTAL COST:**			**$2,422,000**	year: 2020		
Estimate Quality:							
Quote Attached	91%						
Engineering Estimate	9%						
Material or Procurement Total Cost				**$2,292,400**			
MOVEMENT SYSTEM (ND-LAr)				***$970,235***			
Hilman Rollers MR200E-20005		$130,070	6	$780,420	2020	Quote Attached	
Control System		$105,295	1	$105,295	2020	Quote Attached	see quote above, only includes control interface, safety PLC and operational control system part of Stonybrook scope
Position Sensor		$10,000	1	$10,000	2020	Engineering Estimate	use laser diodes (e.g. Pinpoint Laser System)
Hilman Bolts and Hardware		$31	200	$6,224	2020	Quote Attached	200 M36 bolts 200 mm long, $31.12 per bolt
Hilman Safety Systems		$20,000	1	$20,000	2020	Engineering Estimate	e.g. proximity sensors, flashing lights
Miscellaneous Tooling		$48,296	1	$48,296	2020	Engineering Estimate	50,000 plus rounding
HILMAN FLOOR RAILS (ND-LAr, Spectrometer, SAND)				**$1,028,682**			
Track System		$335,294	3	$1,005,882	2020	Quote Attached	3 track systems for all three detectors
Hilman Epoxy Grout		$76	300	$22,800	2020	Quote Attached	500 sqft coverage needed for one detectors, one pail = 6 sqft, anchors part of facility scope
ENERGY CHAIN (ND-LAr, Spectrometer)				***$293,483***			
IGUS Chain		$195,656	1.5	$293,483	2020	Quote Attached	MPD chains are stock items, less costly (hence factor 1.5)
Vendor Labor or Fabrication Labor Total Cost				**$129,600**			
FLOOR RAILS INSTALLATION				***$43,200***			
Hillman Roller Installation Trade Labor		$43,200	1	$43,200	2020	Engineering Estimate	$135/hr Trades Tech, 1 month and 2 technicians, 160 hrs per month, peak labor in addition to I&I technicians
ENERGY CHAIN ASSEMBLY				**$86,400**			rock anchors and mounts are part of installation BOE
Energy Chains Installation Trade Labor		$86,400	1	$86,400	2020	Engineering Estimate	$135/hr Trades Tech, 2 months and 2 technicians, 160 hrs per month, peak labor in addition to I&I technicians

Summary schedule

- **System Design**
  - Started: Q3 2019
  - Ends: Q2 2022
- **CD-3**
  - End of Q3 2022
- **Procurement and Fabrication**
  - Starts: Q3 2024
  - Ends: Q1 2026



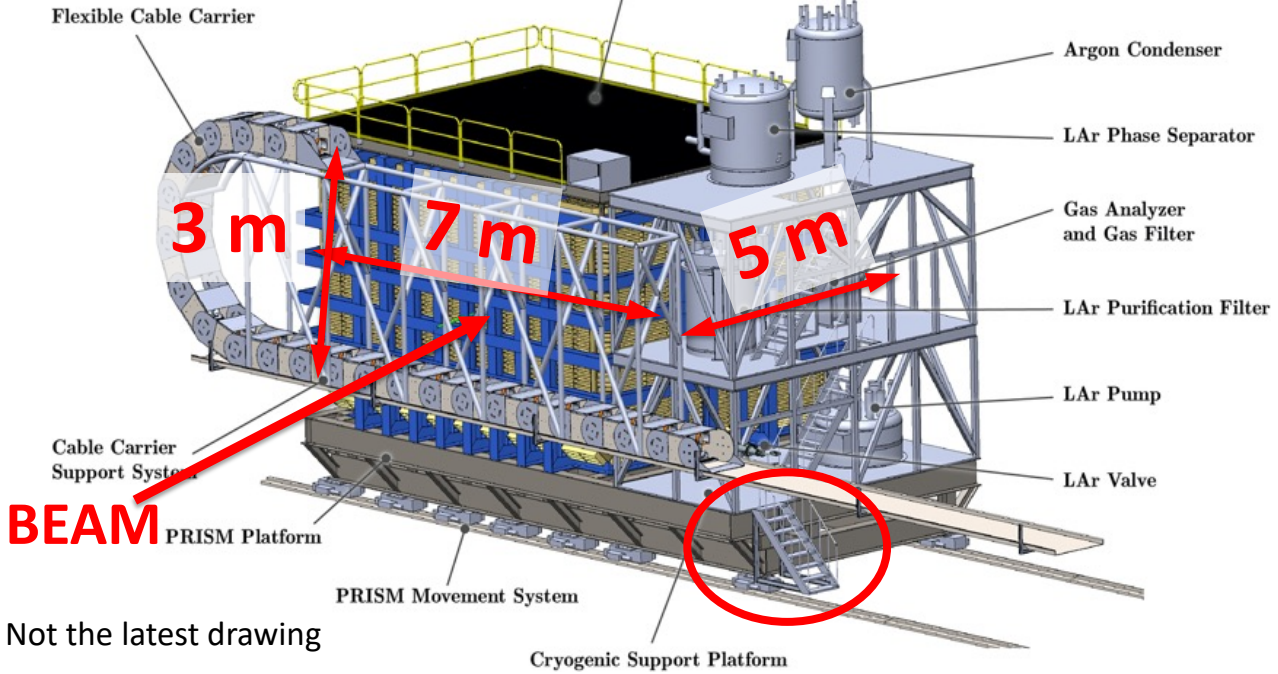
Preliminary Risk Analysis

RI-ID	Risk Rank	Title	Risk Mitigations	Prob.
RT-131-ND-018	1 (Low)	Beam Monitor detector delayed	Limit near detector to on-axis operation (no PRISM) until beam monitor is in operation.	20.00%
RT-131-NI-039	1 (Low)	Near Detector PRISM movement system design cannot reach performance requirements	- Design reviews - Prototyping	5.00%

- System consists of standard commercial parts ➔ Low risk design

Off-Axis Travel Distance

- We should stay vigilant in protecting the off-axis travel distance
- If we lose off-axis range, we lose access to rapidly changing oscillation features at low energy
  - Very high information content region



Not the latest drawing