DUNE Near Detector Storage Estimates
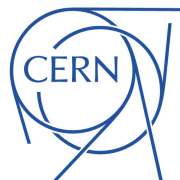
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LBNF/DUNE-US NS Storage and Assembly Planning Workshop

8 August 2021

Overview

- The following slides contain our best current estimates for ND subsystem storage needs

  - These are likely to evolve over time as design maturity increases

  - Many near detector systems are not yet at the preliminary design stage

- The ND Installation plan contains some estimated dates, but these have not yet been optimized / resource leveled

  - Storage start/end times have not yet been precisely determined

  - However, most components will need to arrive in advance of the beginning of installation, so to a first approximation, the following estimate is for simultaneous storage ~1-2 years in advance of the detector installation

    - We will refine this further as more installation plan details become available

ND-LAr Detector

- "standard HVAC" in this context refers more to limiting high humidity

  – Low temperatures are not a concern, but the effect of high temperatures has not yet been evaluated

Item Description	Current Status/Location	Type of Storage	Door Opening Size (ft)	Approx Weight (lb)	Approx Width (ft)	Approx Length (ft)	Approx Height (ft)	Sq Ft
NDLAr TPC in individual storage box, Units 1 - 10		Some temp control (standard HVAC)		2500 lbs (each)	5	11	5	550
NDLAr TPC in individual storage box, Units 10 - 20		Some temp control (standard HVAC)		2500 lbs (each)	5	11	5	550
NDLAr TPC in individual storage box, Units 20 - 30		Some temp control (standard HVAC)		2500 lbs (each)	5	11	5	550
NDLAr TPC in individual storage box, Units 30 - 40		Some temp control (standard HVAC)		2500 lbs (each)	5	11	5	550
NDLAr TPC Server Racks (7X)		Large temp swings		300 lbs (each)	2	4	7	392
ND-LAr TPC VME Crates (35X)		Large temp swings			1.5	1.7	2.4	214.2
NDLAR TPC I&I Fixturing		Outside		5000 lbs	6	20	4	480
Total		Some temp control (standard HVAC)						2200
Total		Large temp swings						606.2
Total		Outside						480

ND-LAr Cryostat Storage/Assembly Space

- 2200 sqft assembly area with some temperature control (standard HVAC)

- 6600 sqft uncontrolled storage near the above assembly area (green)

  – This could be tented/tarped outside space (cryostat components are painted/prepared similar to outdoor bridge/building components)

40m

20m

Assembly

Storage

Storage

Storage

Storage

Storage
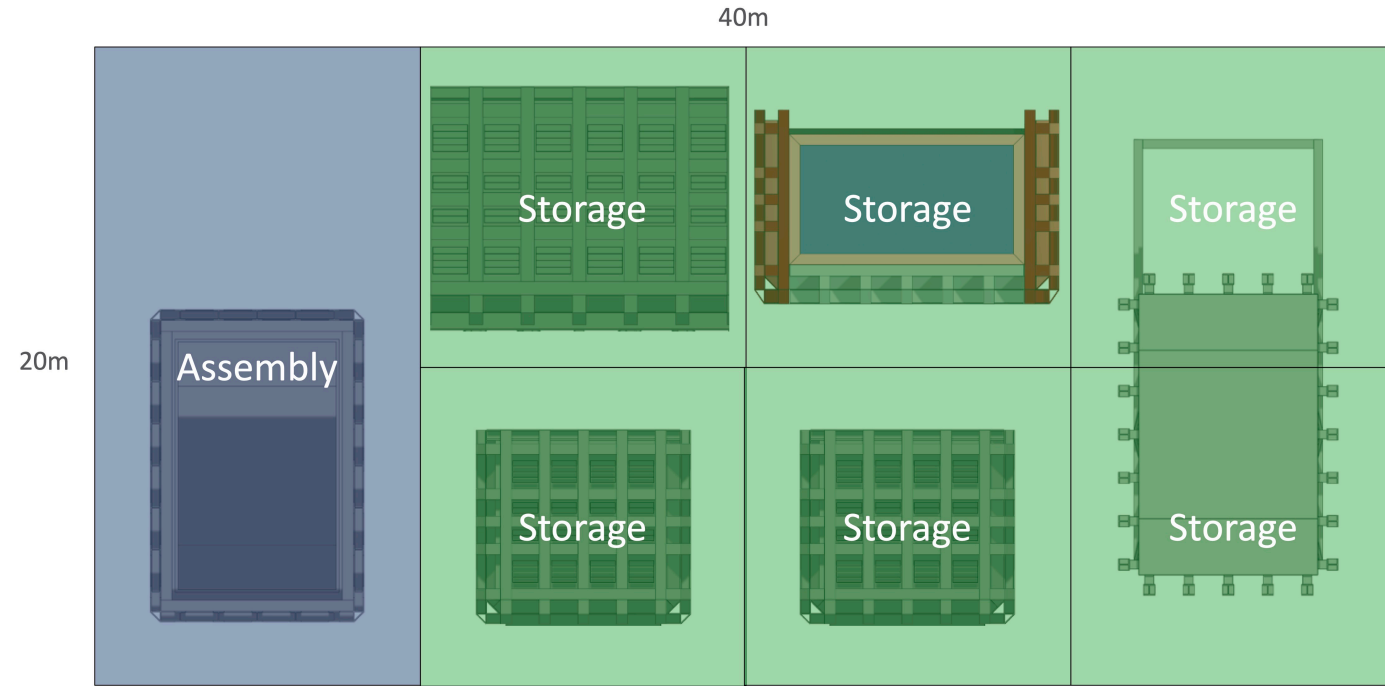
Storage

Note: Scale is Approximate

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PRISM Storage

- The current plan assumes that much of the system will be installed very early

  - Rails / grout

  - Rollers

  - Some energy chain components

- As the installation plan is optimized as a function of time, it may be possible to reuse some of this space if any later-arriving components can be identified

Item Description	Current Status/Location	Type of Storage	Door Opening Size (ft)	Approx Weight (lb)	Approx Width (ft)	Approx Length (ft)	Approx Height (ft)	Sq Ft
PRISM Energy Chain sets (2)		Large temp swings	8'	24000	4	52.5	2	210
PRISM Energy Chain Hardware		Large temp swings	8'	14000	8	60	3	480
PRISM Rollers (16)		Some temp control (standard HVAC)	8'	80000	5	8	2	640
PRISM Electrical Cabinets (2)		Some temp control (standard HVAC)	8'	4000	4	14	2	56
PRISM Rails (120)		Large temp swings	12'	228000	28	8	4	224
Epoxy Grout (300 buckets)		Large temp swings	4'	16500	20	20	8	400
PRISM Anchors (floor, wall, etc.)		Large temp swings	4'	8000	12	12	4	144
PRISM misc hardware		Large temp swings	4	2000	8	8	8	64
Total		Some temp control (standard HVAC)						696
Total		Large temp swings						1522

TMS Storage

- Stacks of steel plates will require large weight allowances

  - Exact stack configuration has not yet been specified

    - Depends on steel "stackability," movement capability, and floor weight capacity

  - Total required floor space has not yet been determined

Item Description	Current Status/Location	Type of Storage	Door Opening Size (ft)	Approx Weight (lb)	Approx Width (ft)	Approx Length (ft)	Approx Height (ft)	Sq Ft
TMS steel plates (40)		Large temp swings		4640 lbs (each)	10.5	16.5	15mm	173.25
TMS steel plates (80)		Large temp swings		2320 lbs (each)	5.25	16.5	15mm	86.625
TMS steel plates (60)		Large temp swings		12400 lbs (each)	10.5	16.5	40mm	173.25
TMS steel plates (120)		Large temp swings		6200 lbs (each)	5.25	16.5	40mm	86.625
Staging Area for TMS Steel		Large temp swings						0
TMS Detectors (150)		Some temp control (standard HVAC)		200 lbs (each)	6	10	20 mm	60
TMS Work area		Some temp control (standard HVAC)			20	20		400
Pre-assembly storage for support structure		Large temp swings			30	30		900
Total		Some temp control (standard HVAC)						460
Total		Large temp swings						1419.75

Cryogenics

- First 4 items may arrive as early as FY25
- Plan for the last 6 items is for arrival 3 months prior to installation

| Item Description	Current Status/Location	Type of Storage	Door Opening Size (ft)	Approx Weight (lb)	Approx Width (ft)	Approx Length (ft)	Approx Height (ft)	Sq Ft
ND Cryogenics - Circulation pump valve box	In service at CERN	Some temp control (standard HVAC)		4400	9.18	9.18	9.18	84.35
ND Cryogenics - Condenser pump valve box	In service at CERN	Some temp control (standard HVAC)		4400	9.18	9.18	9.18	84.35
ND Cryogenics - Lar Purification vessel	In service at CERN	Some temp control (standard HVAC)		8800	7.22	7.22	12.14	52.07
ND Cryogenics - LAr Regeneration Panel	In service at CERN	Some temp control (standard HVAC)		5500	8.53	9.51	8.53	81.12
ND Cryogenics - Shaft Argon Phase Separator	NEW	Some temp control (standard HVAC)		6600	4.89	4.89	6.56	23.91
ND Cryogenics - Shaft Nitrogen Phase Separator	NEW	Some temp control (standard HVAC)		6600	4.89	4.89	6.56	23.91
ND Cryogenics - LAR empty heater	NEW	Some temp control (standard HVAC)		2200	2.62	2.62	6.56	6.89
ND Cryogenics - LAr Phase Separator	NEW	Some temp control (standard HVAC)		13200	6.56	6.56	9.84	43.03
ND Cryogenics - LAr Condenser	NEW	Some temp control (standard HVAC)		13200	7.54	7.54	14.76	56.91
ND Cryogenics - LAr Purification Vessel	NEW	Some temp control (standard HVAC)		11000	6.56	6.56	14.10	43.03
Total		Some temp control (standard HVAC)						499.57

Summary

- Current estimate of each storage type is shown

    - Some modest additional storage of I&I equipment may be needed (TBD)

    - TMS floor space allocation needs to be further refined

- The plan for SAND is to have a functional test in late 2024 at FNAL/DAB

    - Current plan has SAND & LHe cryogenics remaining in DAB until installation begins (no additional storage needed)

    - If the DAB space is needed, more on-site storage will be needed for SAND

Subsystem		Storage Type	Sq ft
ND-LAr Detector		Some temp control (standard HVAC)	2200
ND-LAr Cryostat		Some temp control (standard HVAC)	2200
PRISM		Some temp control (standard HVAC)	696
TMS		Some temp control (standard HVAC)	460
Cryogenics		Some temp control (standard HVAC)	499.57
Total			**6056**
ND-LAr Detector		Large temp swings	606.2
ND-LAr Cryostat		Large temp swings	0
PRISM		Large temp swings	1522
TMS		Large temp swings	1419.75
Cryogenics		Large temp swings	0
Total			**3548**
ND-LAr Detector		Outside	480
ND-LAr Cryostat		Outside	6600
PRISM		Outside	0
TMS		Outside	0
Cryogenics		Outside	0
Total			**7080**

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Backup

ND-LAr Cryostat Storage/Assembly Space

- Finished wall subassembly approx. 10 x 10 m laid flat
  - Assume unassembled storage space = assembled storage space
  - PRISM frame is 20 x 10 m

- Assume assembly process takes up 20 x 10 m with space between weldments, fixtures, tools, personnel access

- Six storage bays, one assembly bay

- Assume all assemblies finished on surface before any are taken into cavern in order to minimize rental crane time

- Total estimate 800 m² [8600 ft²]
  - With 10 m perimeter for forklift / truck / crane access, 2400 m² [26,000 ft²]

- Possible size reduction options
  - Store assemblies upright (10 x 10 m becomes 5 x 10)
  - Stack weldments until ready to assemble (10 x 10 m becomes 5 x 10)
  - Lower assemblies into cavern as soon as completed
    - Requires just in time delivery of weldments for significant savings, otherwise storage space still taken up by unassembled weldments

40m

20m

Assembly

Storage Storage Storage

Storage Storage Storage

Note: Scale is Approximate
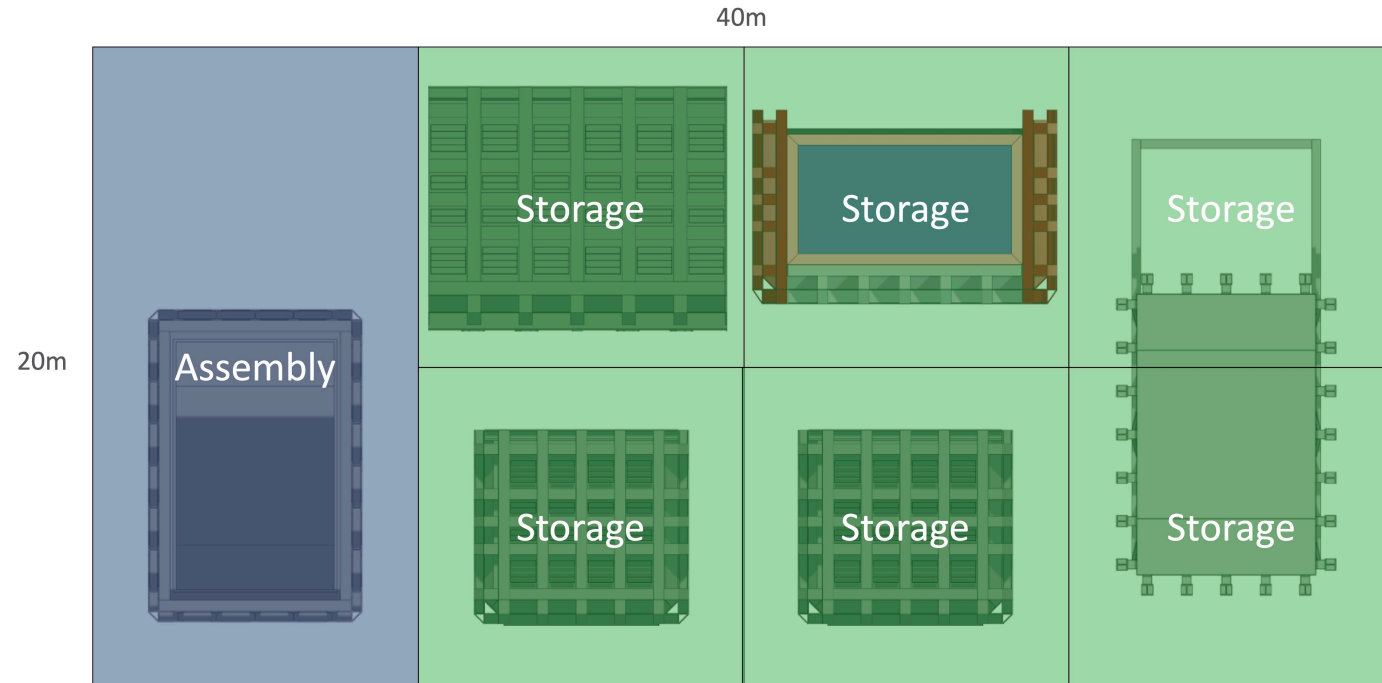
Summary:
- 2200 sqft assembly space
- 6600 sqft uncontrolled storage space near assembly
  - This could be tented/tarped outside space (structural steel painted with bridge coating)
- 1 year of storage / assembly prior to installation

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