DUNE Computing Requests for 2024

Computing Contributions Board Meeting

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Basics of the resource model

- Keep raw data on disk for 1 year, on tape to end of expt.
  - For protoDUNE – 1 copy each at CERN/FNAL
  - For DUNE 1 copy at FNAL, 1 copy at other institutions
- Reconstruct full sample every year (protoDUNE for 4 years, DUNE to end of expt.)
- Do new simulation campaigns each year
- Keep simulation and reconstructed data on disk for *2* years (always have 2 versions)
  - One copy in Americas, one in Europe where possible (model assumes 1.5 copies)
  - No need to stage from tape until it ages out
- One copy of reconstruction/simulation -> tape as it can be redone if necessary.

- **CPU estimates** are based on measurements from ProtoDUNE data and existing simulations **ND estimates have large uncertainties**.

Updates to the model

- **Delayed ProtoDUNE II operations** until Spring 2024
- With the **successful large-scale FD simulation campaigns**, we have considerably better understanding of both our processing time expectations and our simulation needs
- not all of that additional information has been included in the model just yet (minor tweaks)
- new estimates for FD processing time based upon multithreaded processing and subsequent smaller memory footprint
- updated files sizes for reconstruction and simulation output – no longer estimate based upon retention of the raw waveforms in data or all rawdigits in the simulation
- still working on understanding the GPU requirements for 2x2 and ND-LAr and how those estimates can be translated
- We are **transitioning from MWC to HEPScore23 (HS23)** as the metric for CPU resources

Proposed divisions between nations/labs

		FNAL:	CERN	Global
Disk				
	Raw	0.50	0.50	0.00
	Sim:	0.40	0.10	0.50
	Reco-Data:	0.40	0.10	0.50
	Test:	0.50	0.50	0.00
Tape				
	Raw:	0.50	0.50	0.00
	Rest"	1.00	0.00	0.00
CPU				
	All:	0.40	0.10	0.50

Global here means non-CERN, non-FNAL. Includes other US national labs

Table 2: Proposed division between FNAL/CERN/Global for storage and CPU in the near term, until ~2028, when FD replaces ProtoDUNE as the primary source of experimental data. The tape division is not yet finalized as we work on integration of Global tape archives. In the long run, Global sites are expected to take over some of the tape provision currently provided by CERN.

Projected Disk Needs
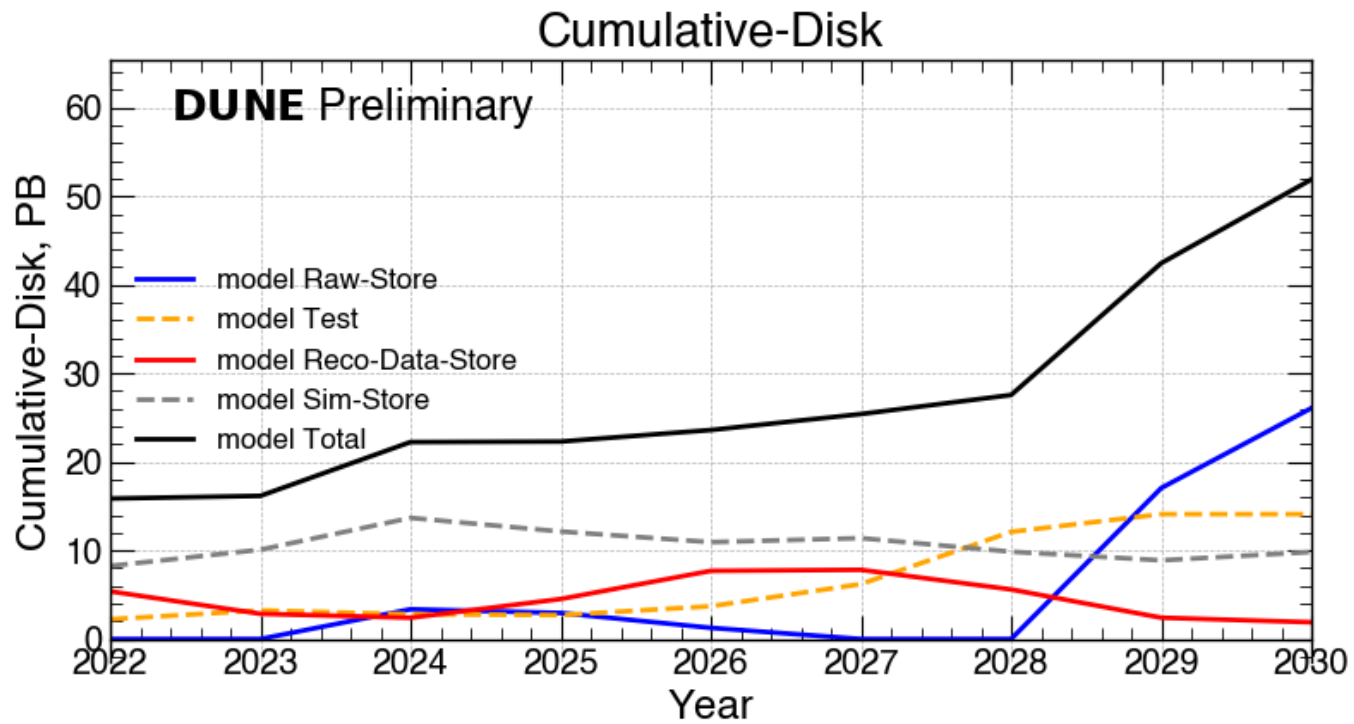
Summary of allocation/use as of February 1

Country	Allocated (TB)	used (TB)	account lim (TB)	rse usage (TB)	percent used
CERN	4020	2121	3000	1957	53
CZ	1126	561	1000	561	50
ES	720	192	1000	192	27
FNAL	9830	7009	9830	12239	71
FR	537	180	500	180	33
IN	750	0	0	0	0
IT	300	0	300	0	0
NL	1899	551	1750	556	29
UK	4303	3250	3950	3149	76
US	850	14	850	2	2
Total	24334	13877	22180	18836	57

Table 5: Disk allocations and usage across countries at the end of 2023. These numbers are derived from usage reports, rucio reports and from cross-checks with individual sites on 2024-02-01. The percentages are Used/Allocation.

Data from Physical disk reports and Rucio
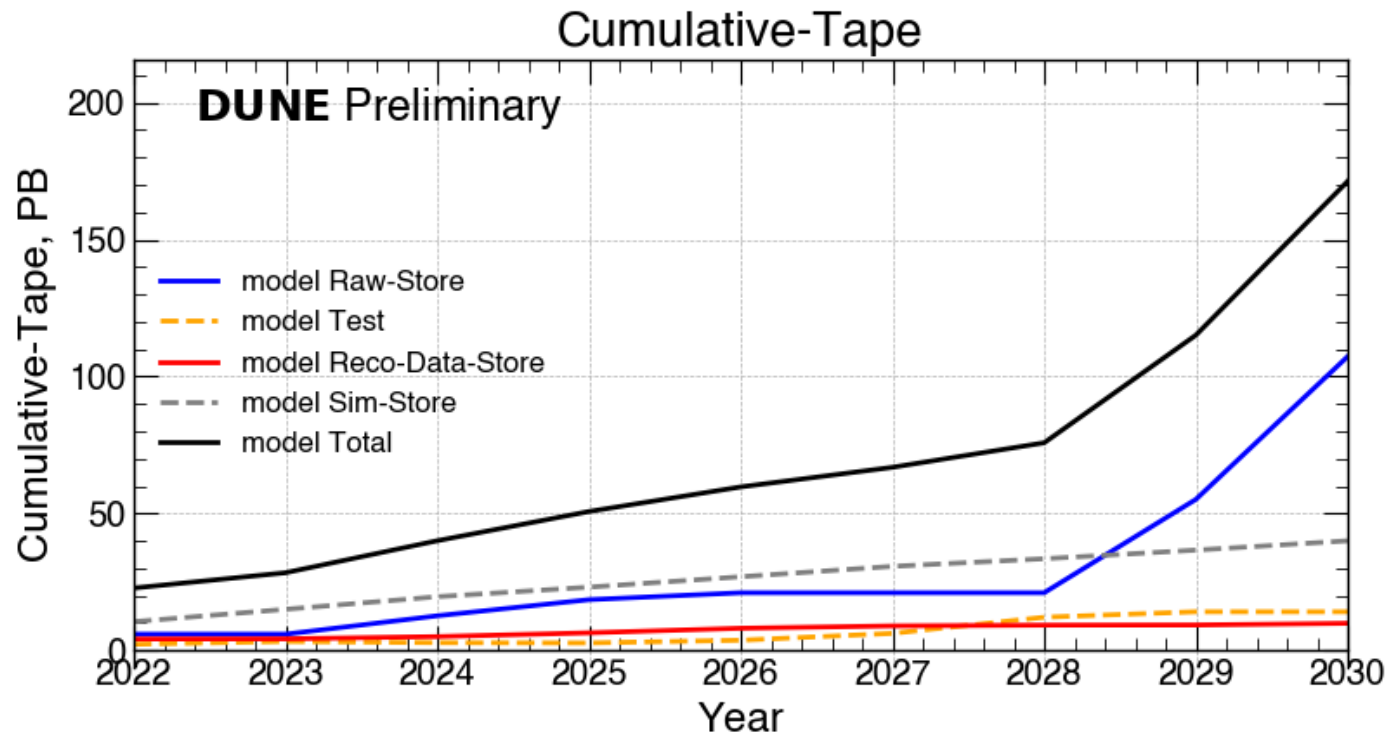Rucio allocations and physical sizes – TiB vs TB in some cases?

Disk requests from the model

Cumulative-Disk	2022	2023	2024	2025	2026	2027	2028	2029	2030
Raw-Store(PB)	0.0	0.0	3.4	2.9	1.3	0.0	0.0	17.1	26.1
Test(PB)	2.2	3.2	2.8	2.7	3.7	6.2	12.1	14.1	14.1
Reco-Data-Store(PB)	5.4	2.8	2.4	4.5	7.7	7.8	5.6	2.4	1.9
Sim-Store(PB)	8.2	10.1	13.7	12.1	10.9	11.4	9.9	8.9	9.8
Total(PB)	15.9	16.2	22.2	22.3	23.6	25.4	27.6	42.4	51.

Cumulative-Disk	2022	2023	2024	2025	2026	2027	2028	2029	2030
Global(PB)	6.8	6.5	8.0	8.3	9.3	9.6	7.7	15.5	15.8
FNAL(PB)	6.6	6.8	9.5	9.5	9.9	10.8	12.2	26.9	36.1
CERN(PB)	2.5	2.9	4.7	4.5	4.3	5.0	7.6	0.0	0.0
Total(PB)	15.9	16.2	22.2	22.3	23.6	25.4	27.6	42.4	51.

Figure 1: Cumulative Disk needs in PB. Includes data lifetimes. The top table shows the source of the data while the bottom table shows the proposed split using the fractions from Table 2 and a modified version which reflects the disk already in place at FNAL and CERN, thus reducing the Global request.

Projected Tape Needs

Cumulative-Tape

DUNE Preliminary

- model Raw-Store
- model Test
- model Reco-Data-Store
- model Sim-Store
- model Total

We anticipate needing 40.0 PB of tape (an increase of 7 PB from 2023) to accommodate the ProtoDUNE run 2 data and increased simulation.

# Numbers for tape needs

Cumulative-Tape	2022	2023	2024	2025	2026	2027	2028	2029	2030
Raw-Store(PB)	5.9	5.9	12.6	18.5	21.0	21.0	21.0	55.1	107.3
Test(PB)	2.2	3.2	2.8	2.7	3.7	6.2	12.1	14.1	14.1
Reco-Data-Store(PB)	4.2	4.2	5.0	6.4	8.1	8.9	9.2	9.3	9.9
Sim-Store(PB)	10.5	15.0	19.6	23.1	26.9	30.7	33.5	36.6	40.0
Total(PB)	22.8	28.3	40.0	50.7	59.7	66.8	75.8	115.1	171.

Cumulative-Tape	2022	2023	2024	2025	2026	2027	2028	2029	2030
Global(PB)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.8	58.8
FNAL(PB)	18.7	23.8	32.3	40.1	47.3	53.2	59.2	57.6	85.6
CERN(PB)	4.1	4.6	7.7	10.6	12.4	13.6	16.6	13.8	26.8
Total(PB)	22.8	28.3	40.0	50.7	59.7	66.8	75.8	115.1	171.

Figure 2: Cumulative Tape needs from the model in PB, includes data lifetimes. The top table shows the origin of the data while the bottom table shows the proposed split. Global contributions are set low in 2024 and grow thereafter as more tape archives are integrated. The exact division between FNAL, CERN and Global once DUNE starts taking FD data in 2029 is not yet defined.

Projected CPU needs updated to HS23
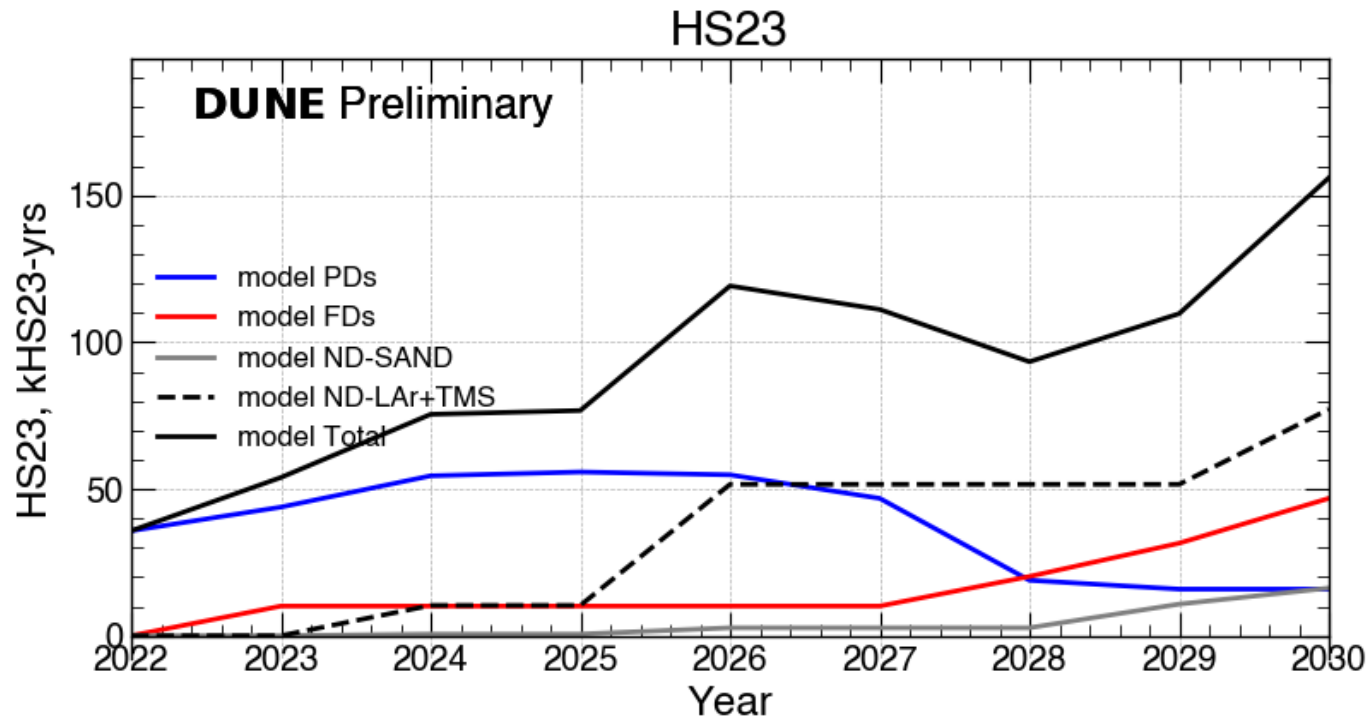
CPU needs in cores
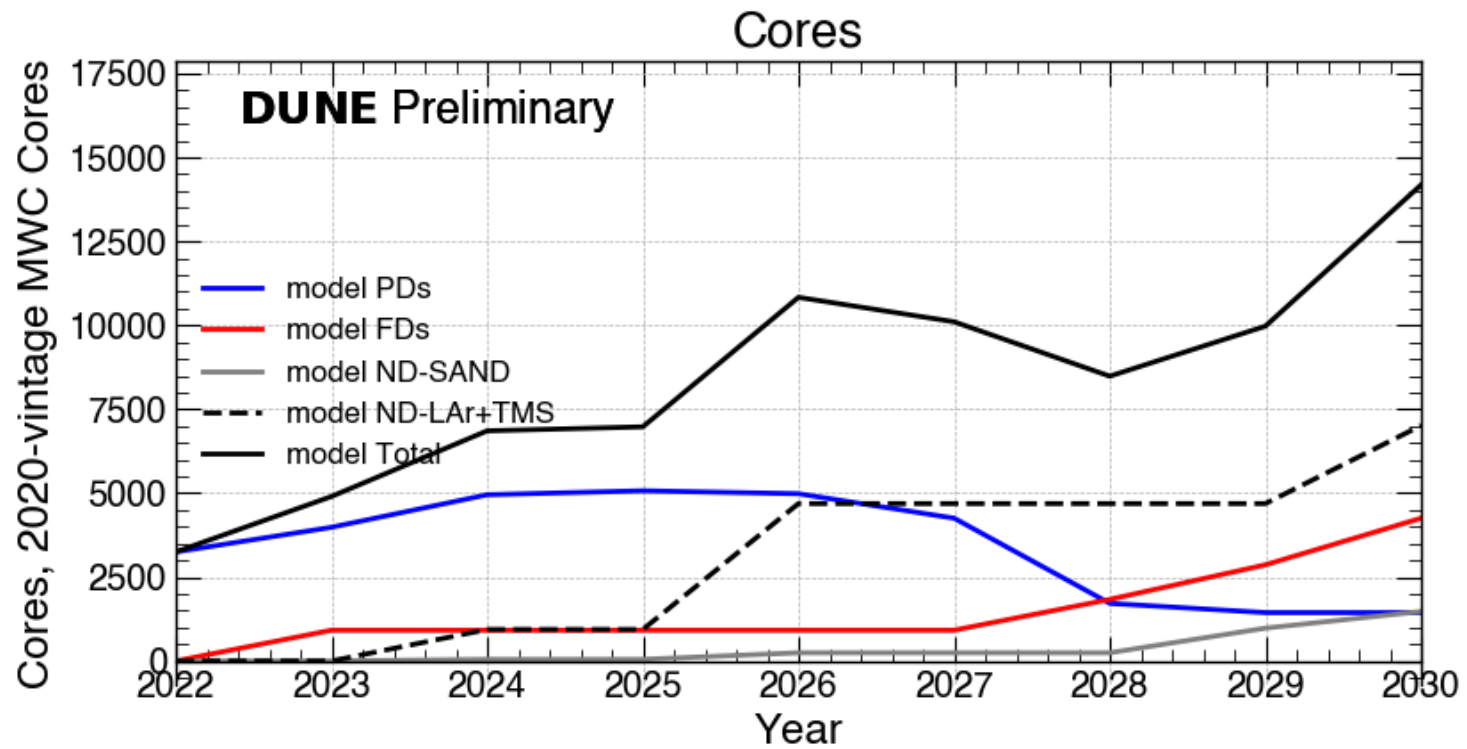
Actual CPU usage in 2023

Site	Production	Analysis	NoMARS	MARS	Total
BR	0.296	0.102	0.398	0.000	0.398
CA	0.085	0.156	0.241	0.000	0.241
CERN	0.627	0.921	1.548	0.000	1.548
CH	0.030	0.003	0.033	0.000	0.033
CZ	0.562	0.530	1.092	0.000	1.092
ES	0.218	0.281	0.499	0.000	0.499
FR	0.384	0.270	0.654	0.000	0.654
IN	0.060	0.368	0.428	0.000	0.428
IT	0.000	0.083	0.083	0.000	0.083
NL	1.215	0.975	2.190	0.000	2.190
RU	0.052	0.217	0.270	0.000	0.270
UK	3.158	4.373	7.531	0.001	7.532
US FNAL	1.718	21.346	23.063	8.265	31.328
US OSG	2.364	0.955	3.319	0.001	3.320
undefined	0.007	0.097	0.104	0.000	0.104
Total	10.778	30.676	41.454	8.267	49.721

Table 8: CPU utilization in kHS23-Years for calendar 2023 divided by use case. Production includes official reconstruction and simulation. Analysis is user analysis of data. MARS is beamline simulations performed at Fermilab. NoMARS sums just Production and Analysis.

Summary of DRAFT request for 2024

		Disk (PB)	Tape(PB)	CPU (kHS23-years)	CPU (Core-years)
Model		22.2	40.0	75.4	6856
Request					
	FNAL	9.5	32.3	30.2	2742
	CERN	4.7	7.7	7.5	686
	Global	8.0	–	37.7	3428
Total		22.2	40.0	75.4	6856

Table 4: Requests for 2024. The disk requests reflect the different data types and the proposed splits from Table 2. They do not include the normal headroom of 5-10%. Tape pledges reflect the dominant use of CERN and FNAL for archival storage of data. CPU pledges are in units of kHS23-years with Core-years provided for comparison to 2023.

- Disk request includes existing FNAL and CERN contributions
- Tape request reduced to 100 TB from Global sites for testing, will increase in later years.
- CPU request is no-longer memory-weighted, assumes data taking in 2024.

The longer term

- We are still doing R+D on Near Detector Computing and optimizing Far Detector codes.

- As a result, CPU estimates are difficult

- But storage is largely driven by raw data. This shows estimated raw data per year

- Cumulative needs on the next slide.
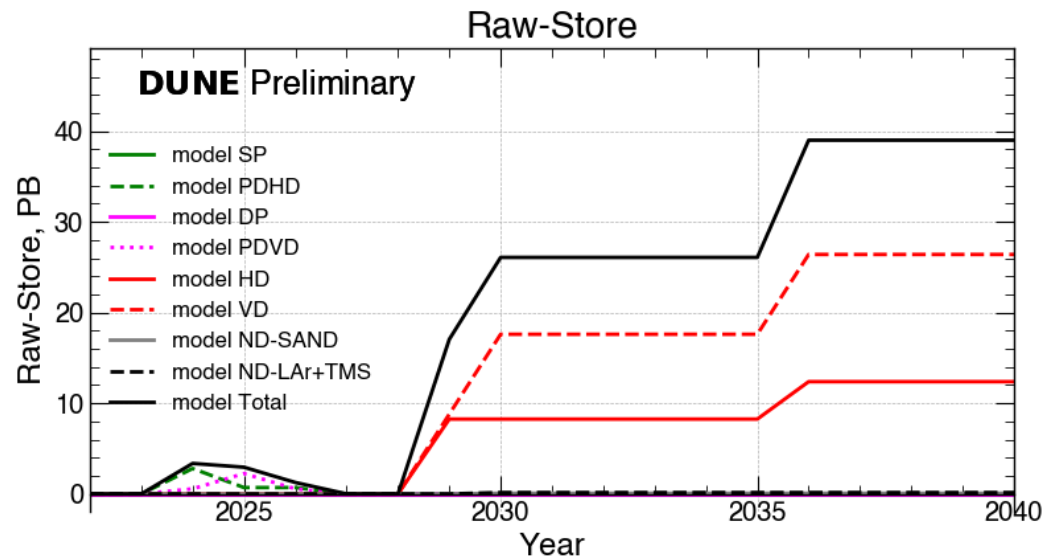
Cumulative storage projections

- These are rough estimates
- Include a 3rd detector added in 2036
- With testing/calibration of that detector causing a short-term blip in maximum disk needs