DUNE

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BNL

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Acknowledgements

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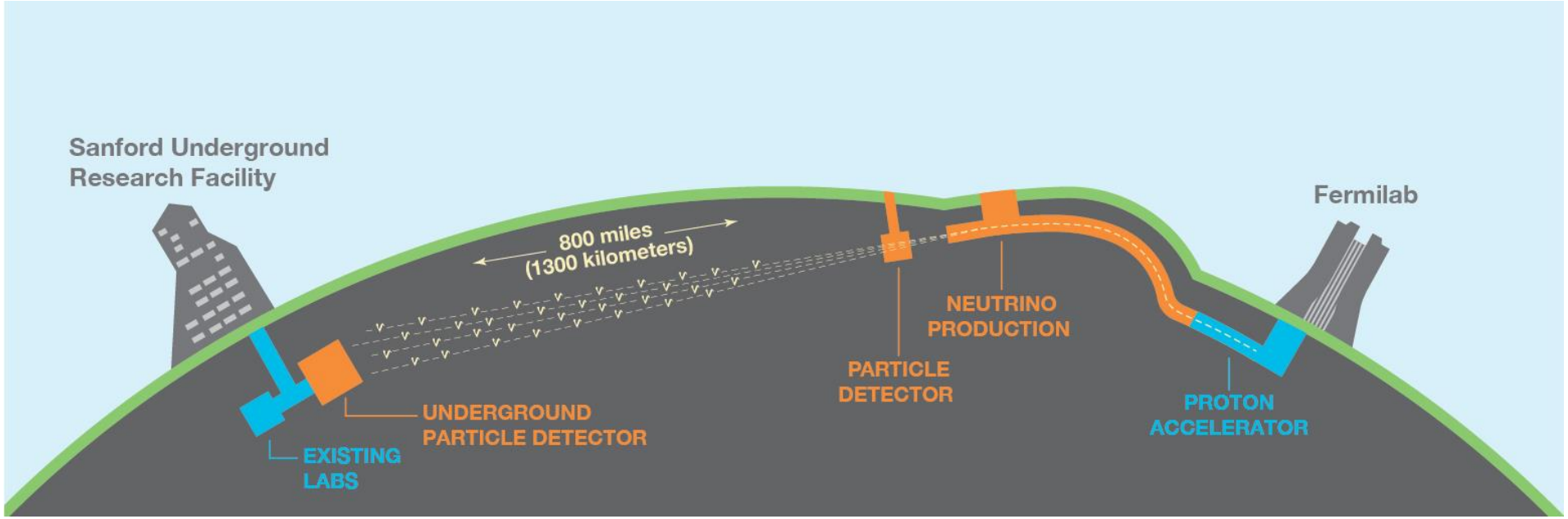
Mistakes are mine.

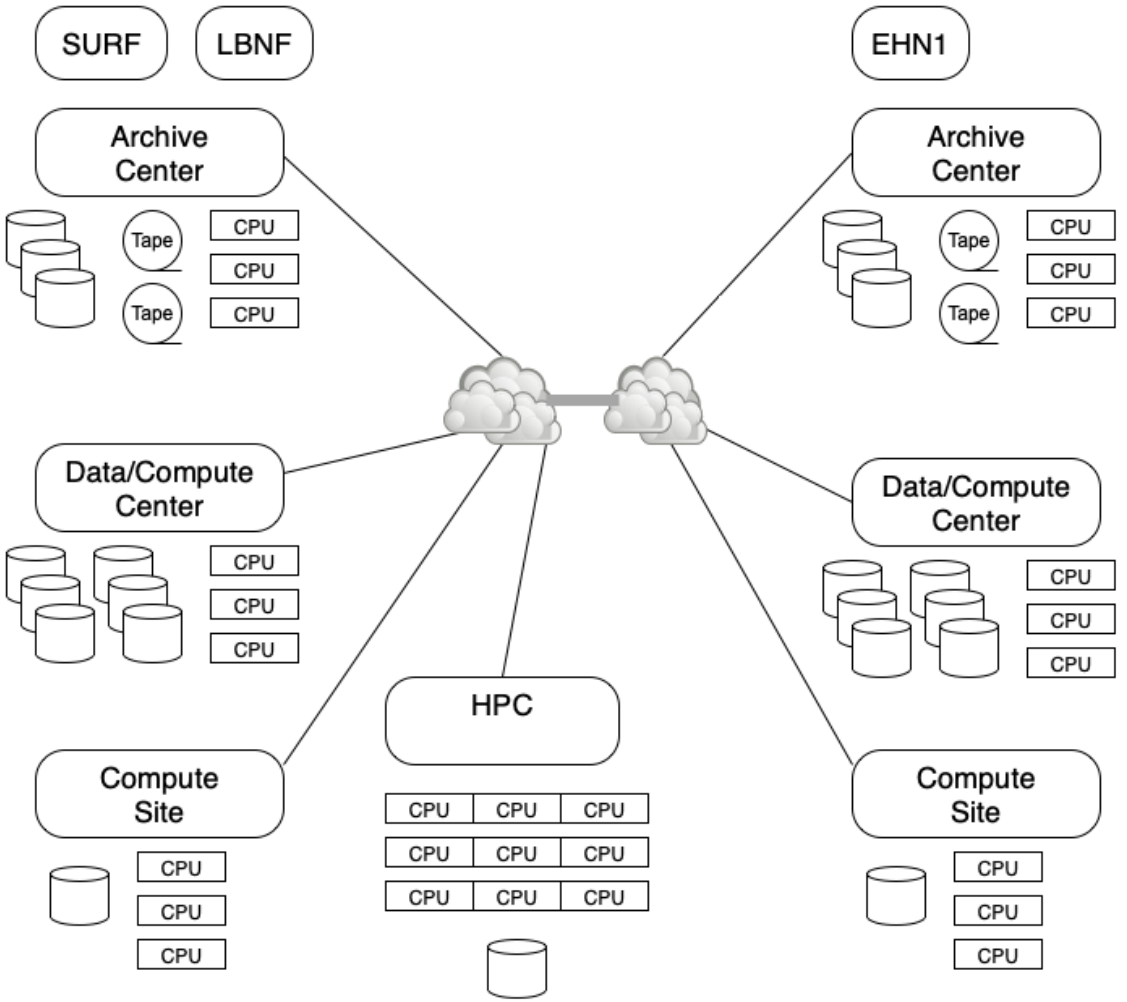
Quick reminder about DUNE



- neutrino experiment studying neutrino oscillation parameter (mass ordering, matter vs antimatter asymmetry, unitarity), proton decay, supernova neutrinos, and more.
- four very large LAr TPC (17 kT) at 4850 ft underground in Lead, SD (Homestake Mine)
- near detector onsite at Fermilab being designed (3 sub-detectors, two that move)
- two prototypes at CERN - (ProtoDUNE II Horizontal Drift - ProtoDUNE II Vertical Drift)

DUNE Computing Resource Model

- less “tiered” than current WLCG model —> flatter model proposed by HSF DOMA working group
  - take advantage of existing WLCG sites that can add DUNE access
  - require reasonable minimum size - storage elements
  - allow for CPU only sites with **data streaming**
- collaborating institutions (or groups of institutions) provide significant disk resources (~1PB chunks)
- plan to use common tools for most services
- participation in the HSF process important to provide and integrate new solutions

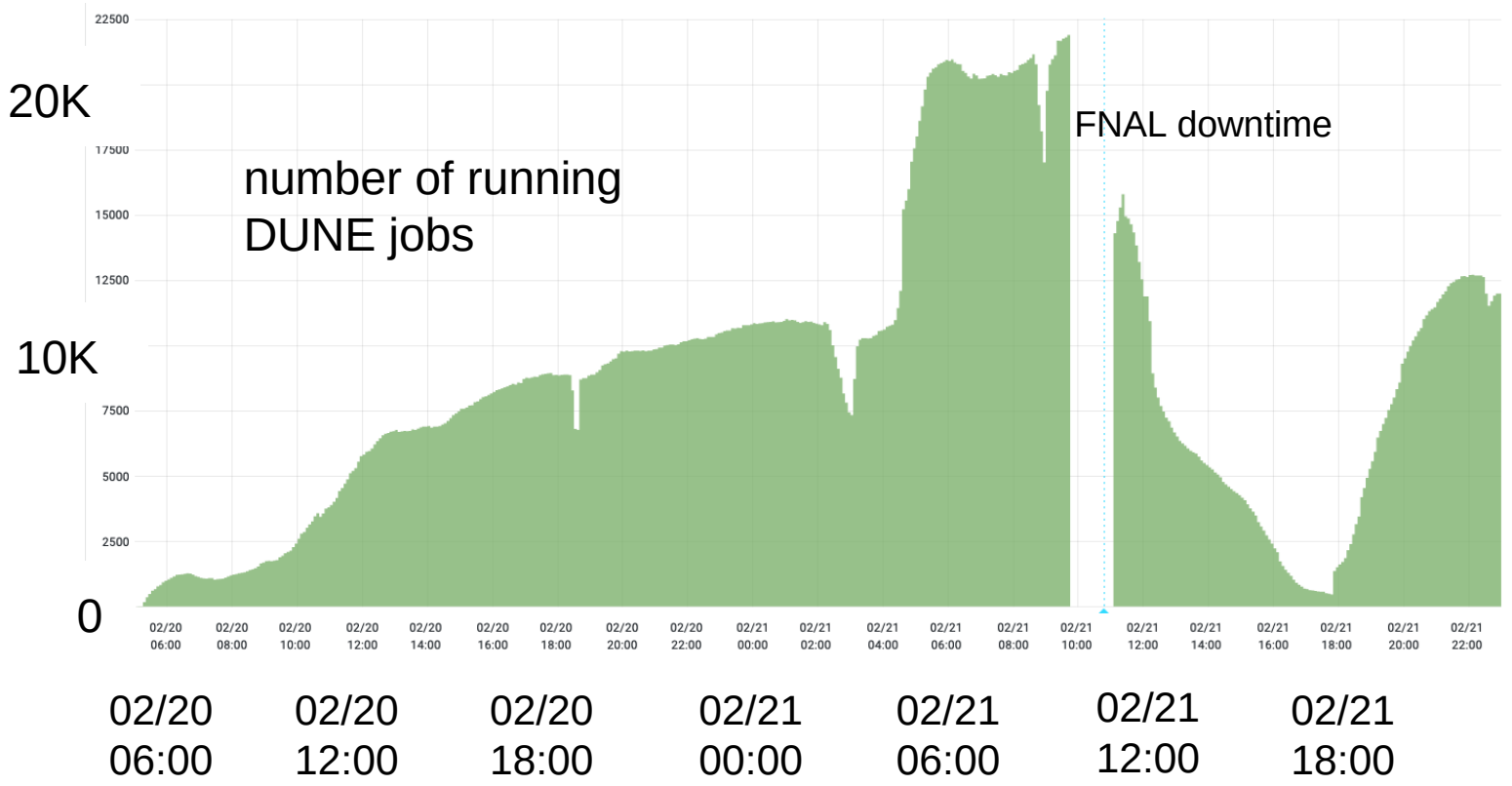


Initial Test Plans

- Test 1 - “FD” Raw Data to archival storage
  - Simulate the archival of 25% of the raw data rate from the Far Detector
    - translates to 1 GB/s from SURF (BNL as stand-in) to FNAL
    - replicate that “FD” raw data to archival storage facilities around the world
    - replicate the “FD” raw data to disk storage elements around the world for prompt access from compute elements
- Test 2 - “FD” Raw Data keep up processing
  - Maintain continuous processing workload at distributed sites commensurate with 25% “FD” raw data rate (1 GB/s)
    - Utilize compute resources across sites in Europe and North America
    - Match the locality of jobs with locality of data at nearby RSEs
- Test 3 - SuperNova Raw Data rapid transfer & processing
  - 3.5 GB/s SURF (BNL) to FNAL to NERSC

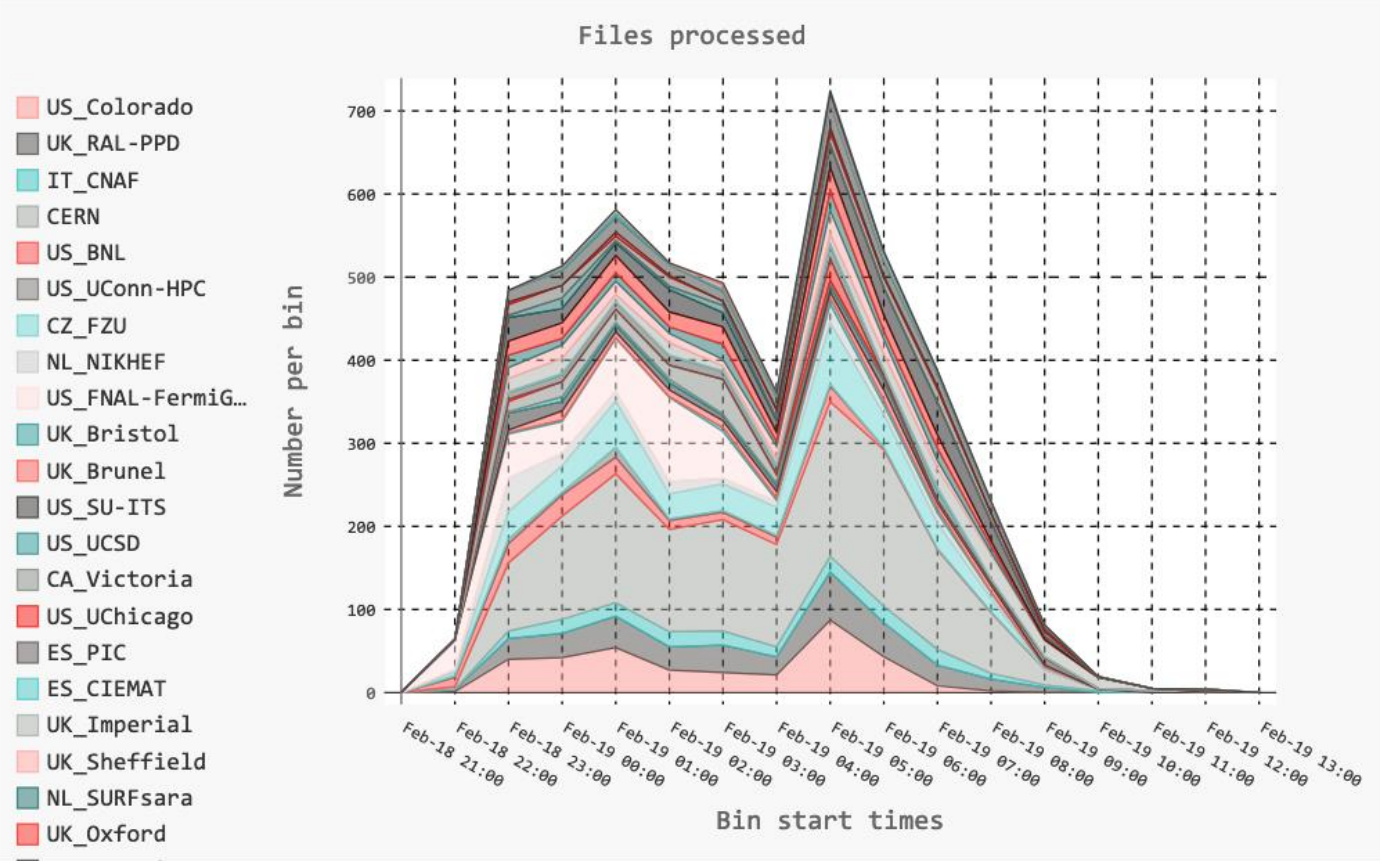
Keep up processing scale testing

- Used FD1-HD FD2-VD MC step 2 full reconstruction production processing using justIN
  - More I/O intensive than normal keep up processing will be – 1 GB/file (input)– 2 GB output (up to 4 files – 1 big 3 small – VD MC)



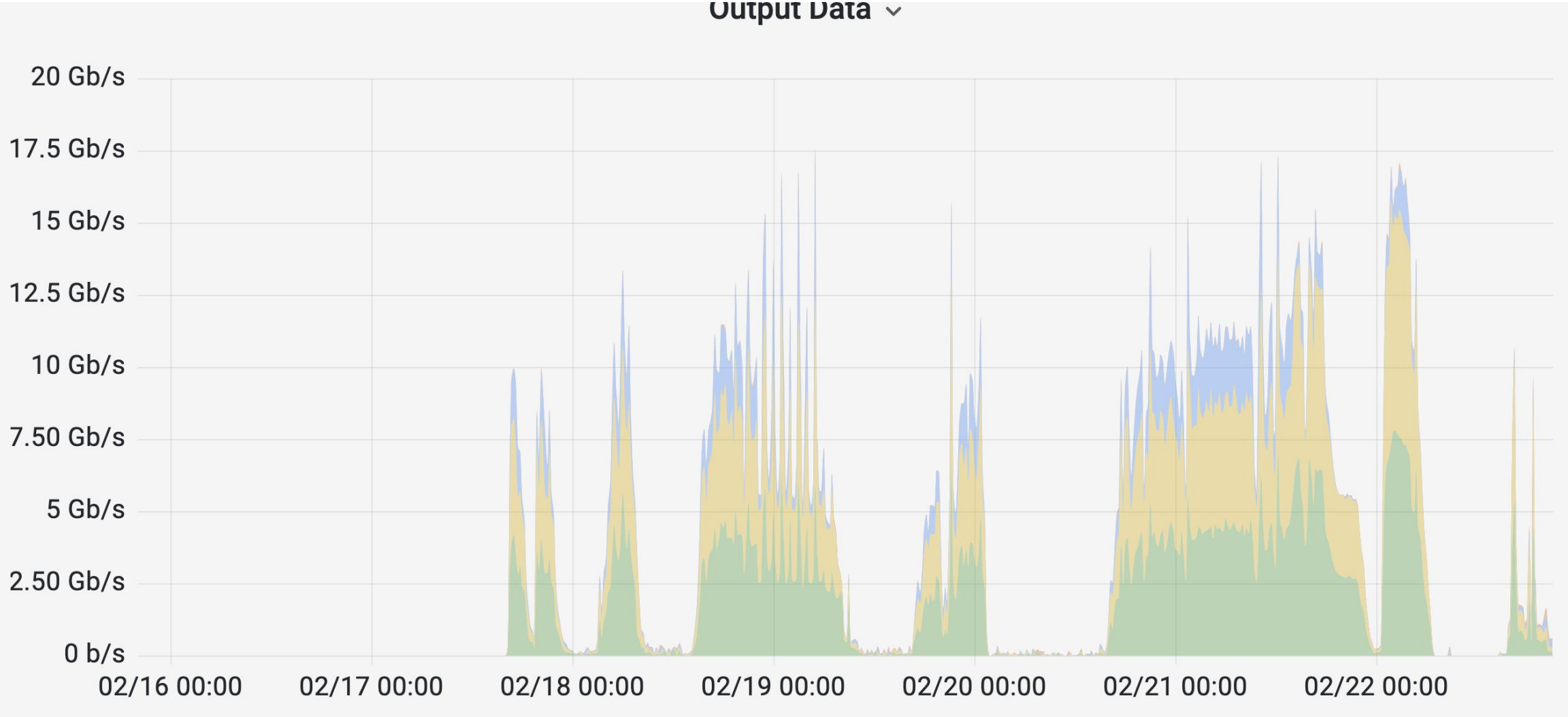
- ~3k jobs running simultaneously to keep up with ProtoDUNE data taking starting this June 2024.

Example justIN workflow task



File processing rate across different Compute sites in US, Canada and Europe

Data streaming from PIC to European sites



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Lessons learned / next steps

- Rucio/MetaCat scale to 16k jobs
  - FNAL DB admins had to increase # Rucio DB connections to 500 (not a preferred solution long term)
- JustIN schedd at RAL need lots of memory and disk space
  - Increased to RAM 60 GB, disk 250 GB
- multiple schedd VM's at RAL
  - Retested during subsequent dress rehearsal – will scale up more if needed
- Needed to tune File Transfer Service configuration settings for better throughput of output files back to FNAL
  - some channels clogged with slow transfers - due to WLCG Data Challenge 24 (DC24) interference - Tuning complete
- Using lessons learned from DC24 – April-24 - ran another dress rehearsal in preparation protoDUNE HD data taking next month
  - Found a bug in Rucio upload.

Conclusions

- Were not able to run the SNB or DC running tests at rate desired because we were occupied with the keep up processing test
- Discovered important limitations and weaknesses in our current setup for keep up processing.
  - Initial Rucio mis-configuration – lead to many TPC transfers using xrootd instead of davs. (many timeouts at RAL)
  - DC24 extremely helpful as a stress test for our processing system. DUNE used MC production reconstruction (reco2) as part of the DC24 activity.
  - Already applying lessons learned immediately improve our workflow system justIN
  - Identified services that need to be hardened.
- Recently ran another dress rehearsal (April 24) ahead protoDUNE HD data taking this summer, using information and changes made because of our DC24 activities
  - Found a bug in Rucio upload.