Introduction to the Fermilab Scientific Program

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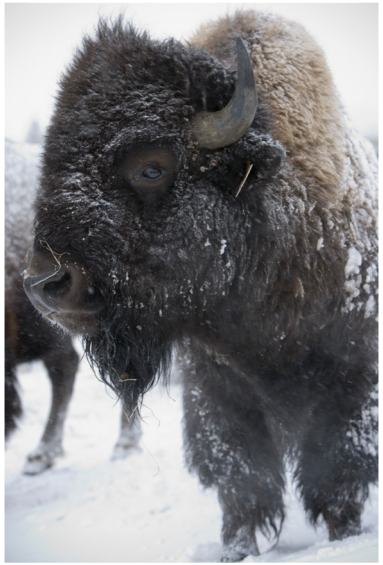
Fermilab

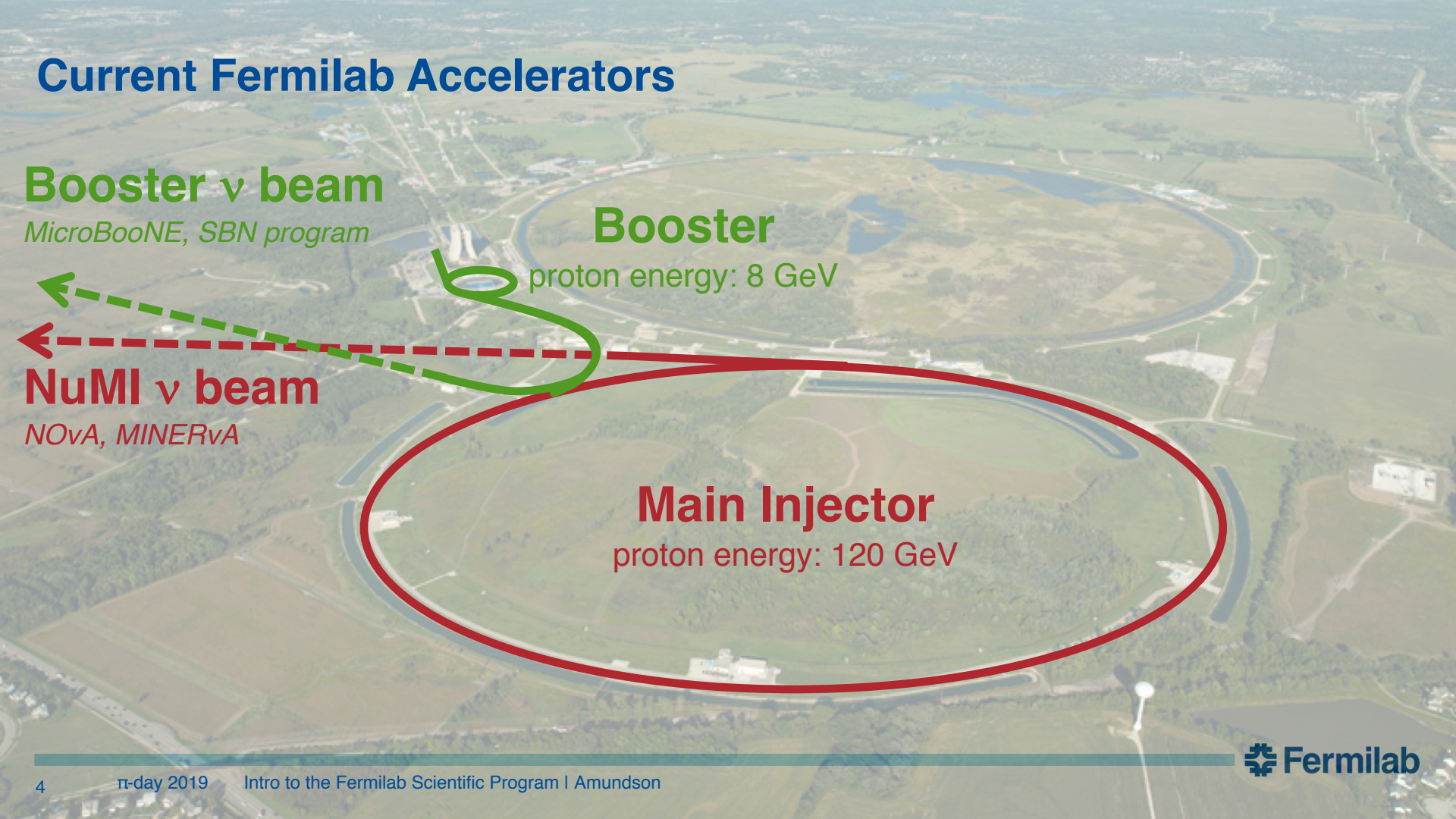
- America's laboratory for particle physics and accelerators
- About 1,800 staff at $550M/yr
- 6,800 acres for federal land including restored prairie
- 4,000 scientists from across the U.S. and 53 countries use Fermilab's facilities



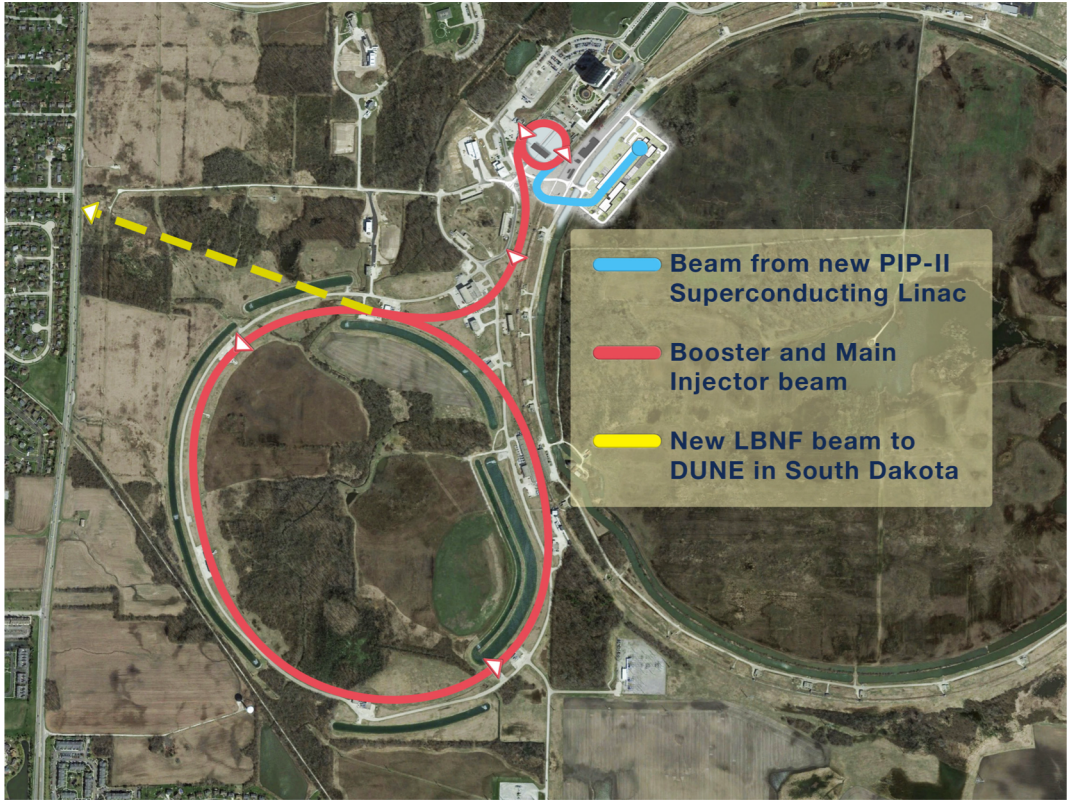
Fermilab Program Driven by the P5 Report

- Particle Physics Project Prioritization Panel (P5)
  - A strategic plan for U.S. particle physics maximizing
    - opportunities for breakthrough science
  - Explicit prioritization, hard choices made within realistic budget scenarios
- Plan:
  - Continue U.S. commitment and leading roles in the LHC
  - Build a neutrino program at Fermilab that will attract the world community
  - Continue U.S. leading efforts in dark matter, dark energy and cosmic microwave background
  - Pursue the Fermilab-based muon program
  - Invest in the accelerator and detector technologies that we will need in the future

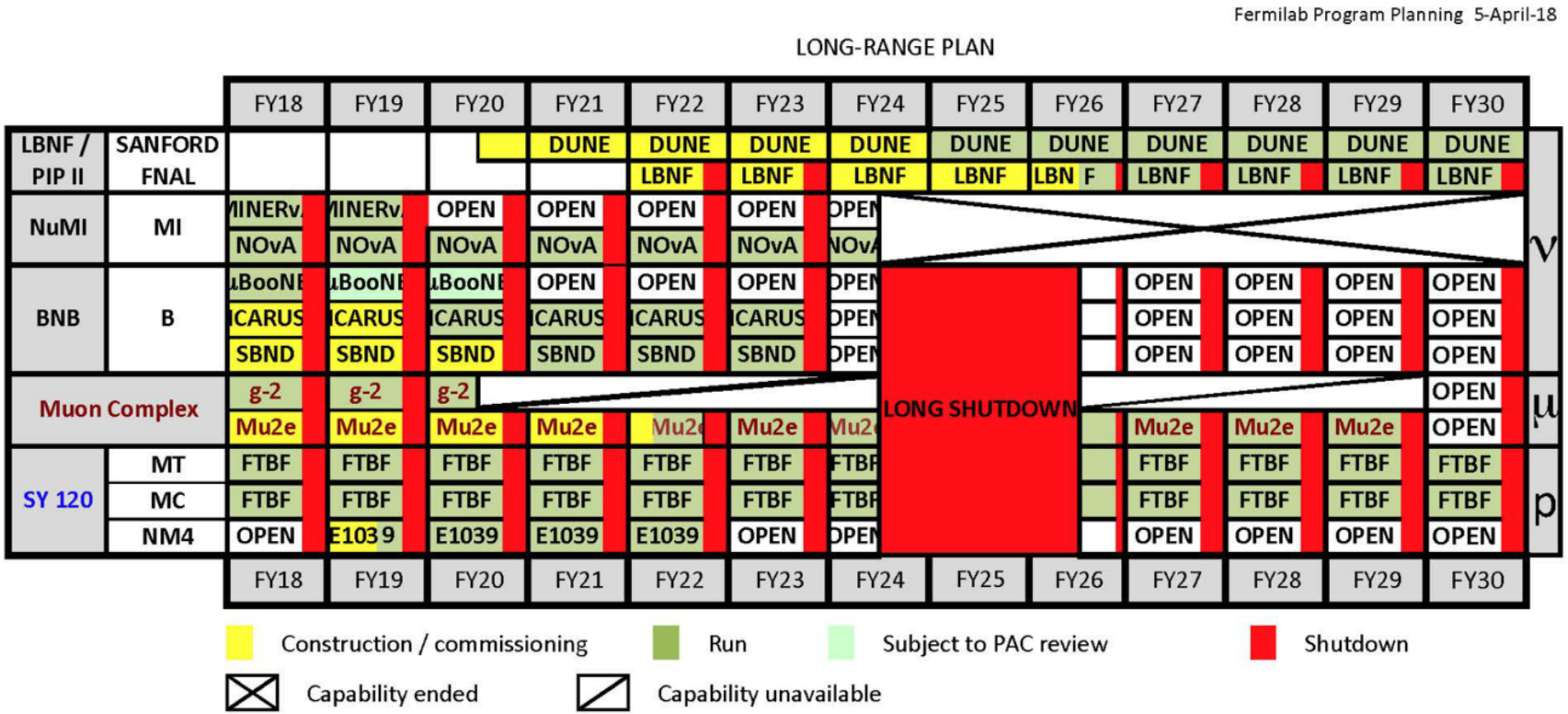
Current Fermilab Accelerators



Proton Improvement Plan-II (PIP-II)



Experiments Utilizing the Fermilab Accelerator Complex



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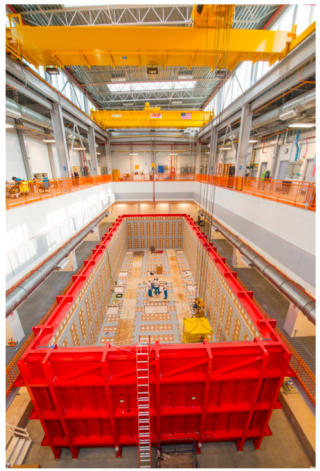
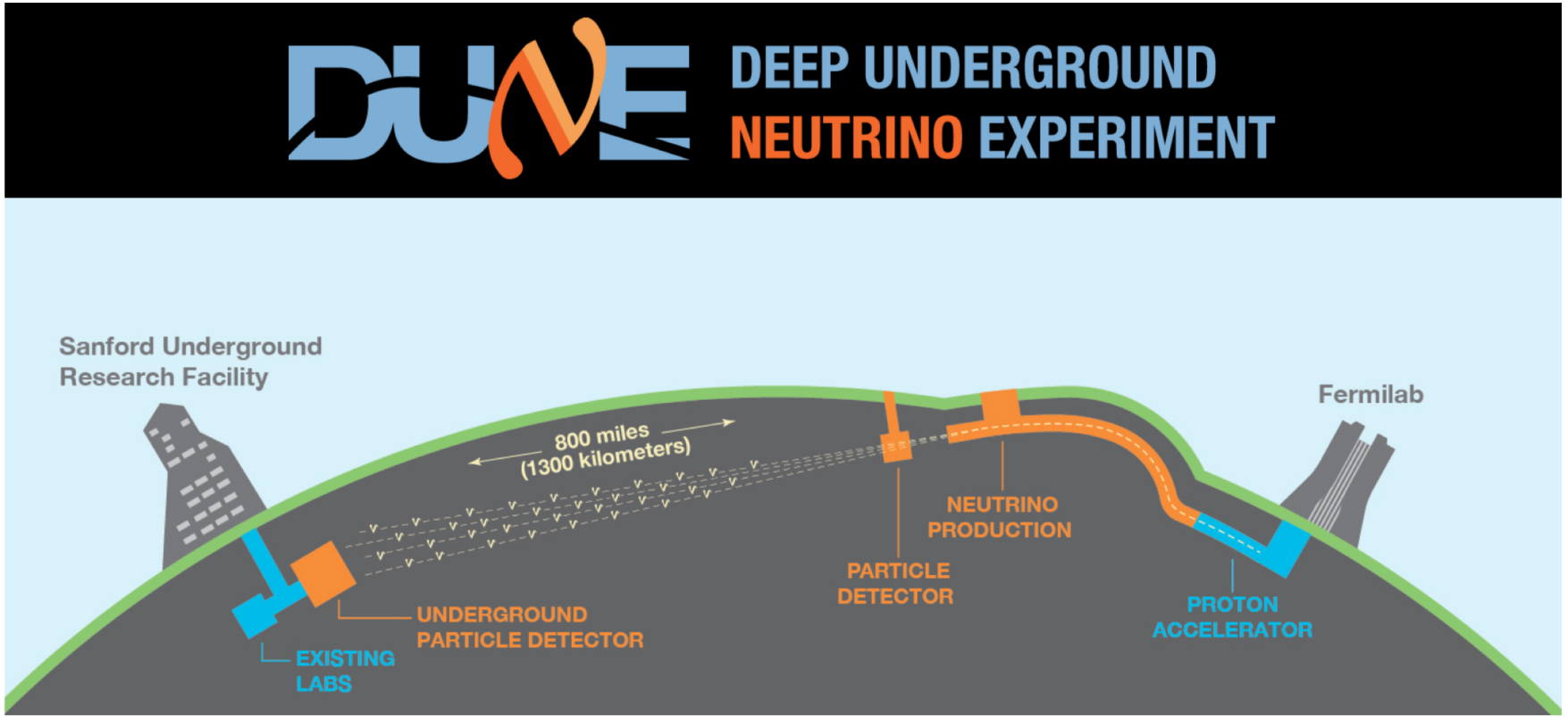
Neutrino Experiments

- Current/recent
  - MINERvA
  - MicroBooNE
  - NOvA
- New/Upcoming
  - ICARUS
  - SBND



Fermilab's Future Flagship



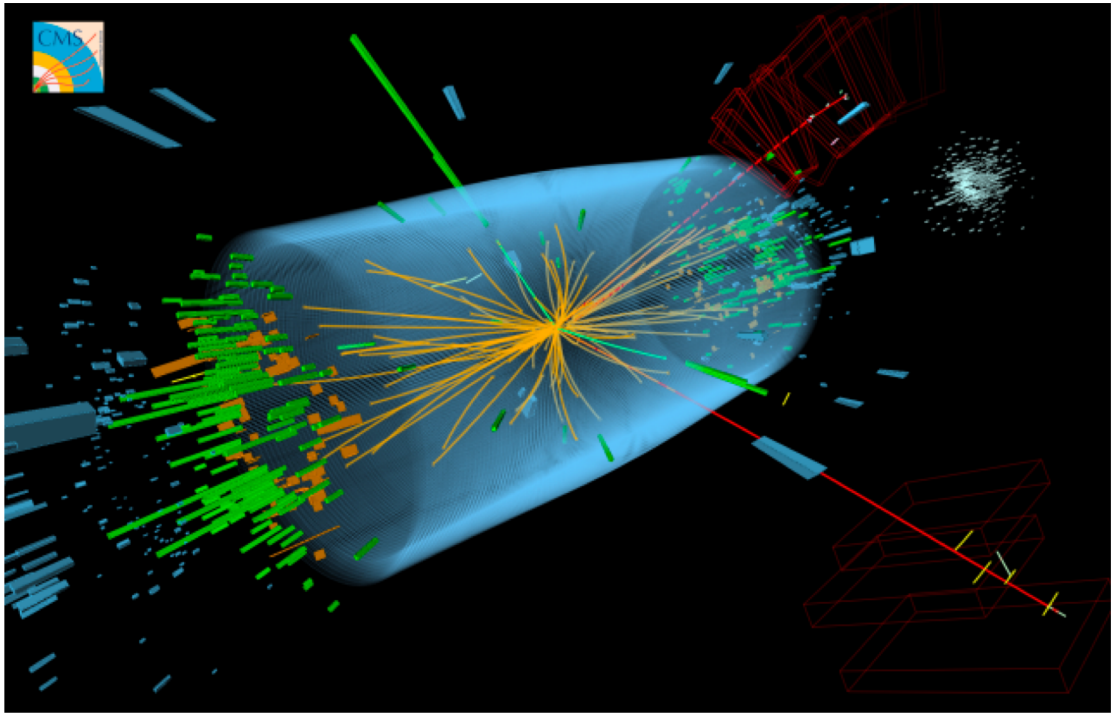
Muon Experiments

- Measure muon's magnetic moment to 140 parts per billion accuracy
- Last experiment at Brookhaven indicated >3σ discrepancy
- Fermilab goal is >5σ discrepancy
- Data set larger than BNL already on tape

- Endeavoring to discover a rare muon interaction implying new physics
- Will achieve unprecedented sensitivity (7×10^{-17}) - a factor of 10,000 better than world's best
- Full construction underway

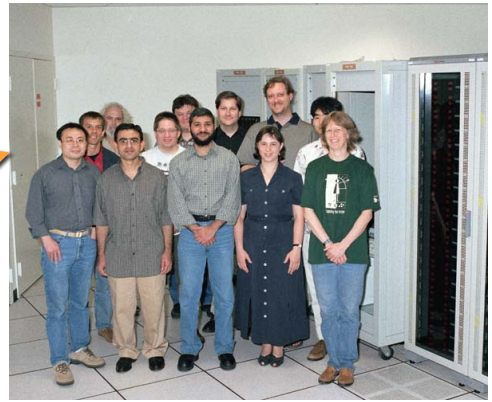
Fermilab is the U.S. CMS National Lab

- CMS T1 Facility
- LHC Physics Center
- Remote Operations Center



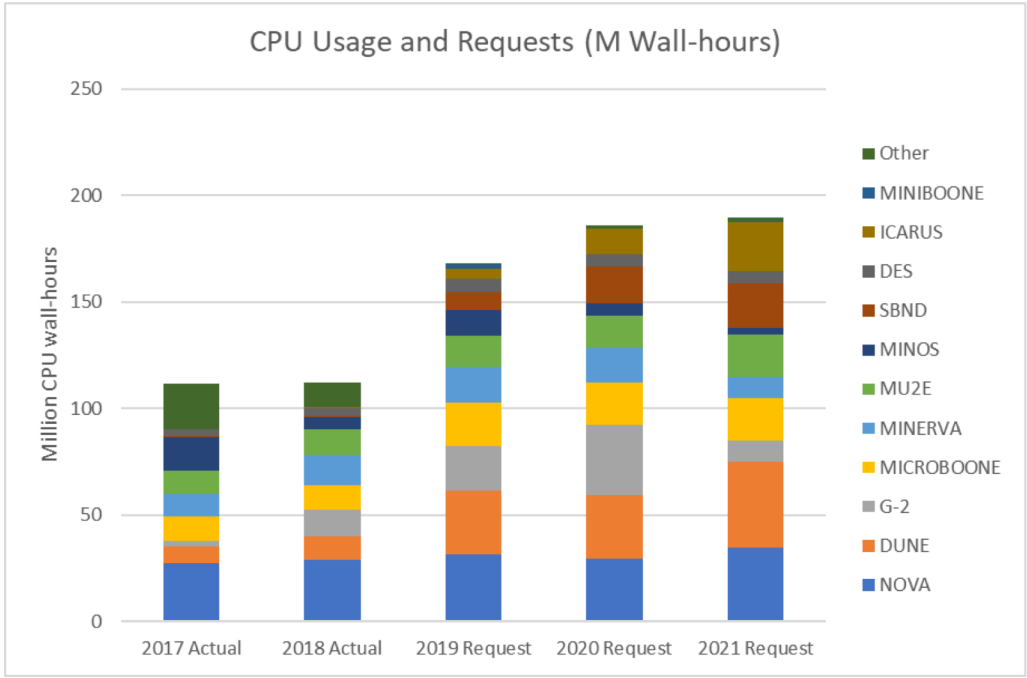
We have been working on CMS for a long time

2001



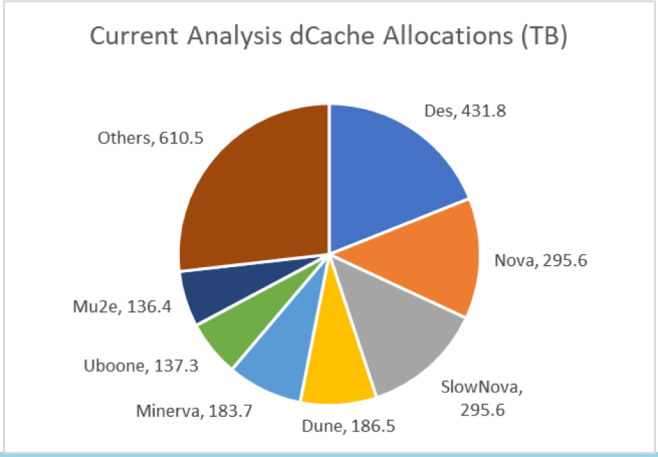
Supporting Fermilab Experiments: CPU

- Note: CMS not included
  - CMS computing is separately funded



Supporting Fermilab Experiments: Analysis / Persistent Disk

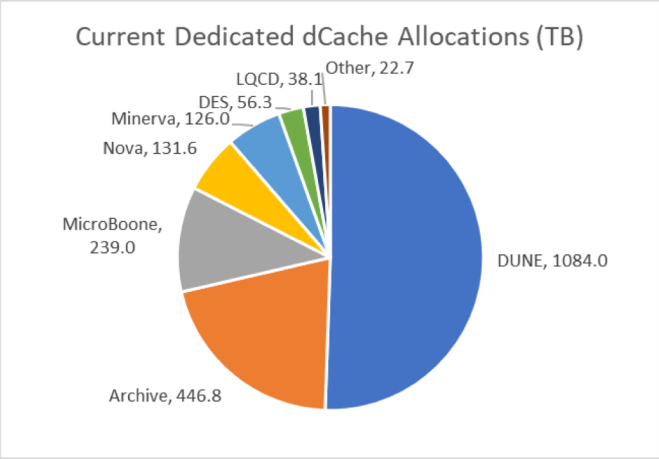
- Note: CMS not included
- This is disk space that is permanently resident but with no backup
  - Allocated via SCPMT / SPPM process
  - Management under experiment control
  - 2.3 PB split across 32 experiment/project users



Experiment	2019 Request	2020 Request	2021 Request
DES	400	500	500
DUNE	400	400	800
ICARUS	100	150	200
MicroBoone	300	300	300
Mu2e	150	200	300
g-2	150	300	300
Nova	450	450	450
SBND	100	125	150
Minerva	250	250	250
Others	450	450	450
TOTAL	2,750	3,125	3,700

Supporting Fermilab Experiments: Dedicated Disk

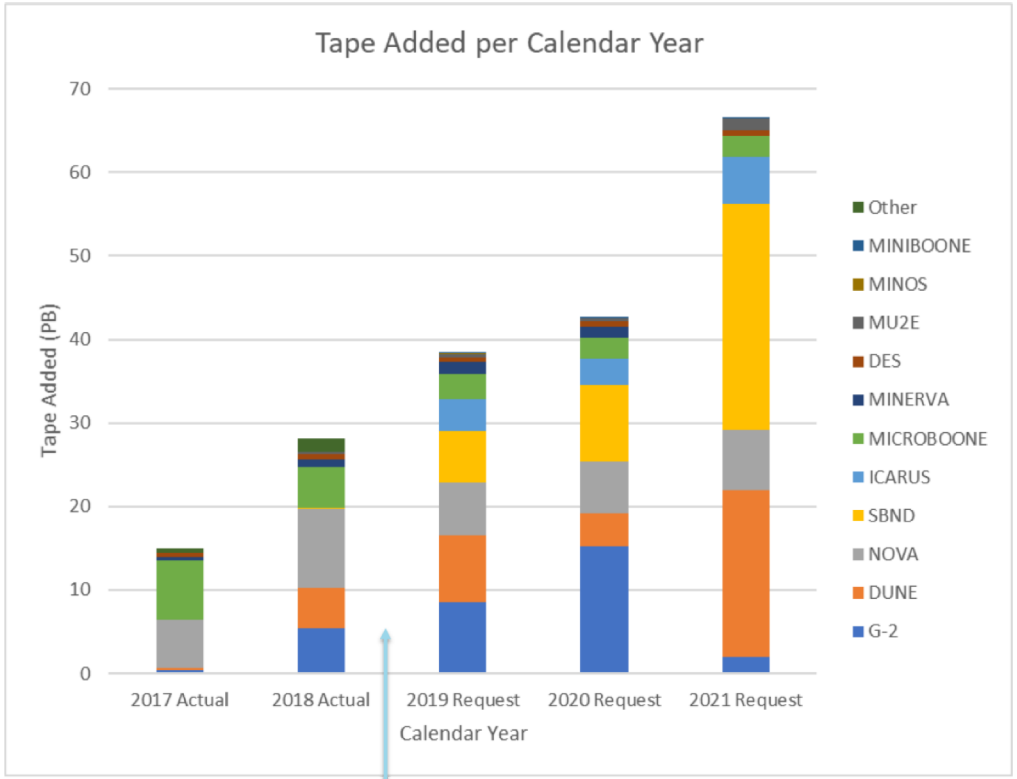
- Note: CMS not included
- This is “tape backed” disk space that is dedicated to a specific experiment
  - Allocated via SCPMT / SPPM process
  - Typically for raw data ingest or pre-staging
  - 2.1 PB split across 13 functions



Experiment	2019 Request	2020 Request	2021 Request
DUNE	1,100	1,100	1,500
MicroBoone	?	?	?
Mu2e	0	0	60
Nova	132	132	132
SBND	2	2	2
Minerva	126	126	125
Others	132	132	132
TOTAL	1,234	1,234	1,694

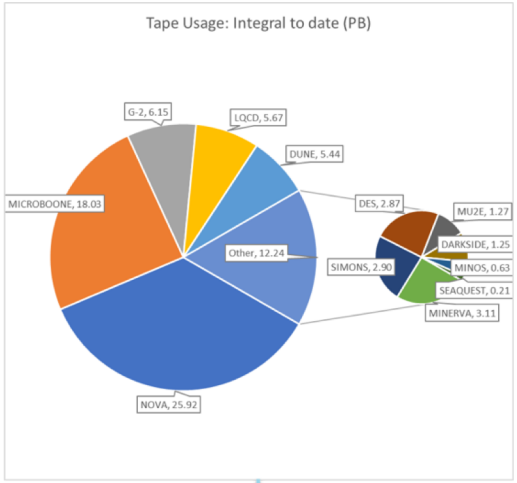
Supporting Fermilab Experiments: CPU

- Note: CMS not included



For reference, the net tape usage to date:

Experiment	Net to date (PB)
NOVA	25.92
MICROBOONE	18.03
G-2	6.15
LQCD	5.67
DUNE	5.44
MINERVA	3.11
SIMONS	2.90
DES	2.87
MU2E	1.27
DARKSIDE	1.25
MINOS	0.63
SEAQUEST	0.21
Other	0.81
TOTAL Public	74.25



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Scientific *Computing* Program at Fermilab

- Support of the accelerator-based particle physics experiments is the primary mission of the Scientific Computing Division
- … but it is not the entire mission
- Other topics include
  - Particle Theory
    - Lattice QCD
  - Accelerator Physics
    - Computational accelerator physics
      - Especially collective effects and HPC
  - Cosmology
    - Computing support for cosmological experiments
      - DES (ending), LSST (beginning)
  - Artificial Intelligence
    - Mostly machine learning applications
  - Quantum Computing
    - Now in its own organization, but with continuing SCD contributions

Conclusions

- The Fermilab Scientific Program has many components
  - Fermilab accelerator-based physics
    - Neutrinos
    - Muons
  - CERN accelerator-based physics
    - CMS
  - Cosmological experiments
- The Fermilab accelerator complex is expanding
- DUNE will be our flagship experiment
- Program includes many smaller computational physics topics
- The Scientific Computing Division supports them all