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Automated distributed computing for Project 8

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on the behalf of the Project 8 collaboration
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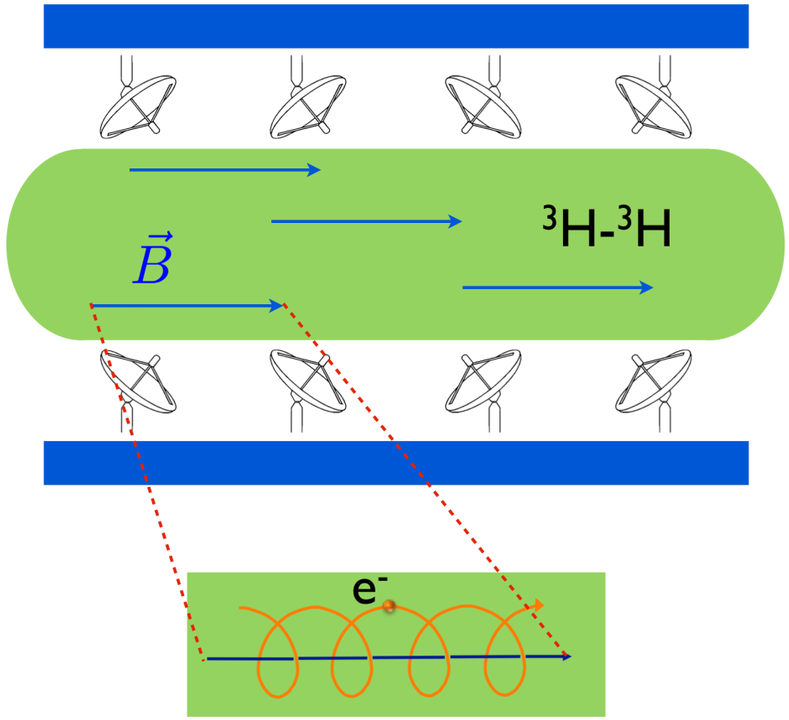
U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

Project 8 high-level overview

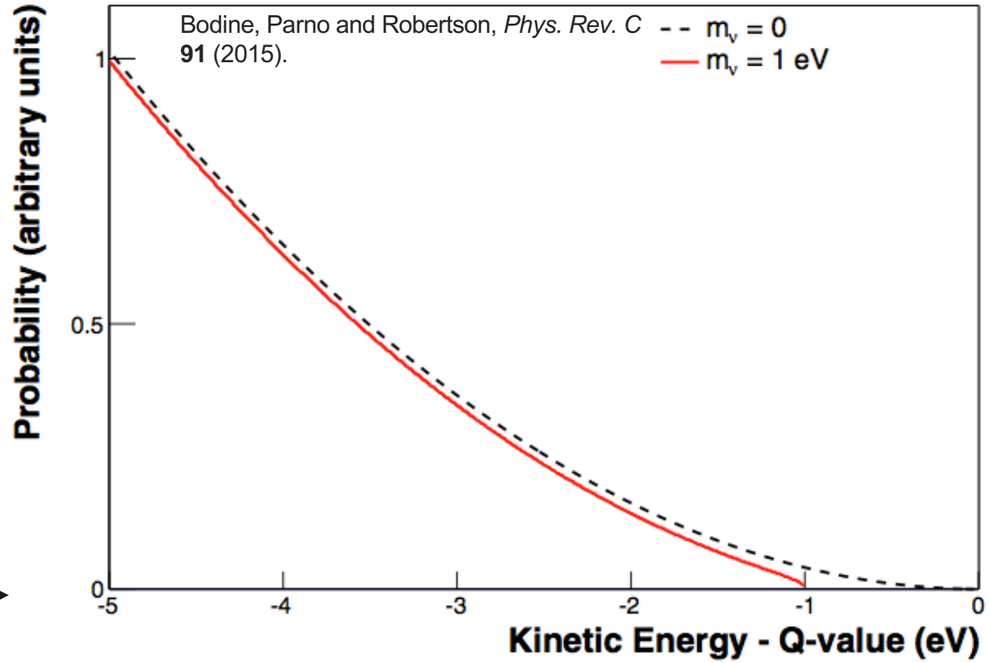
- The goal of the Project 8 experiment is to measure the absolute neutrino mass using tritium beta decays. The approach taken by the Project 8 collaboration is to make this measurement using a new method of electron spectroscopy, Cyclotron Radiation Emission Spectroscopy (CRES)

Cyclotron Radiation Emission Spectroscopy
(measure frequency of radiation from magnetically trapped electrons)



Invert *f(E)*

Tritium β-decay electron endpoint



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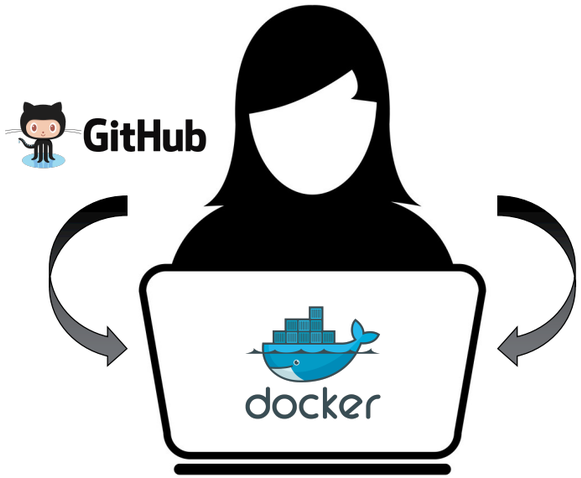
Computing Requirements

- The current data rates are modest, however, they are expected to increase significantly in the later experimental phase:
  - Phase I & II (now): ~0.5PB
  - Phase III (FY2021): 10-20PB
  - Phase IV (FY2025-2030): Potentially ExaBytes without triggering and data reduction
- Processed data is currently distributed to a select number of sites.
- Research for reducing the anticipated data volume is ongoing
- Close coordination between online and offline computing will be critical in the later phases of the experiment.

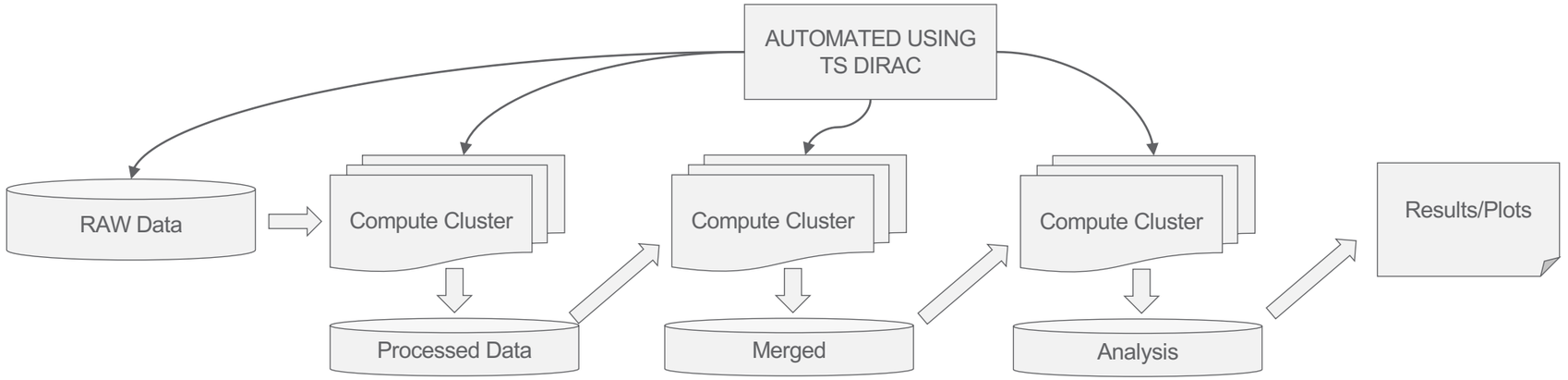
Designing a flexible Infrastructure

- The core computing services are hosted and managed at the Pacific Northwest National Laboratory (PNNL) using ***Kubernetes***.
- Individual containers are used to instantiate ***DIRAC*** services, agent, and databases and other core grid services.
- ***Docker*** containers are also used to build new instances of the development and production environment.
  - This provides maximal flexibility and satisfies the collaborations specific OS and libraries requirements.
  - Production containers are then converted to a ***Singularity*** image. Computation jobs are performed on the PNNL HPC cluster using a dedicated DIRAC agent mapped to the desired singularity image.



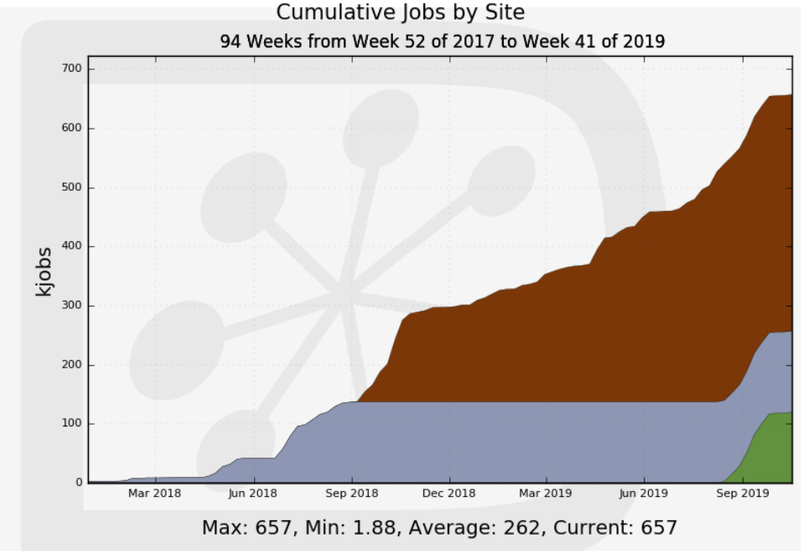
Distributed computing and automating workflows

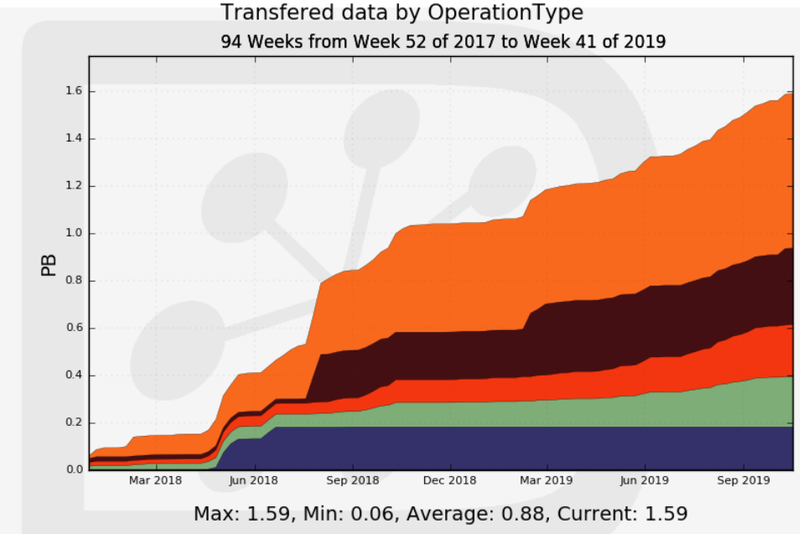
- Project 8 has adopted DIRAC (Distributed Infrastructure with Remote Agent Control) INTERWARE as it's distributed computing workflow because it provides a complete solution and includes automation features.
- These automated features are critical for smaller scale experiments such as Project 8.
- The raw data is produced at the University of Washington and transferred to PNNL using a dedicated DIRAC agent.
- The files are registered to the DIRAC File Catalog with well defined metadata in order to trigger the raw data processing workflow. Once a data production run is finished, all raw processed files are automatically merged and analyzed.



Computing usage to date

- The majority of the computing used by the production system has been to process and analyze the data.
  - Over 650,000 jobs have already been executed
  - Nearly 2PB of data have been moved.
- We expect an increase in computational usage in order to preform simulation studies for phase III and beyond.
- We are currently re-evaluating the offline computing in preparation for phase III





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Thank you

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