Automation and Job Management for LUX-ZEPLIN Simulations at NERSC

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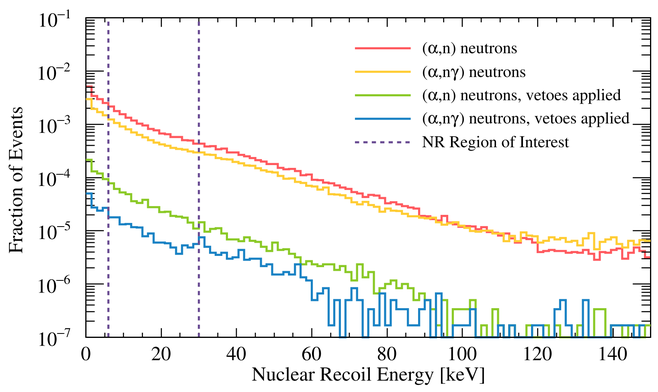
UCL

SIMS IN LZ

Detailed & high stats sims of radiogenic backgrounds is vital when looking for small signals

+ Complex decay chains require multiple sims per component
+ Secondary products from nuclear interactions with detector geometry
+ > 1000 combinations of components and decay sources simulated, up to 1000s of jobs each
+ High veto efficiency requires large stats to understand unvetoed backgrounds



Energy spectra of nuclear recoils by neutrons produced through (α,n) reactions in the PTFE material of the innermost lining of the LZ detector, as modelled by two different generators, before and after applying neutron vetoes. [1]

SOFTWARE CHAIN

BACCARAT

+ GEANT4-Based
+ Simulating radioactive decays & particle transport within detector geometry

LZLAMA

+ Custom code containing NEST model for Xe microphysics
+ Efficiently simulates production of observables from energy deposits

CONFIGURATION

+ Physics team specifies sims request on shared spreadsheet
+ Production details specified in configuration file
+ Suite of python tools automatically parse requirements and submit production request
+ Real-time monitoring of production progress and status

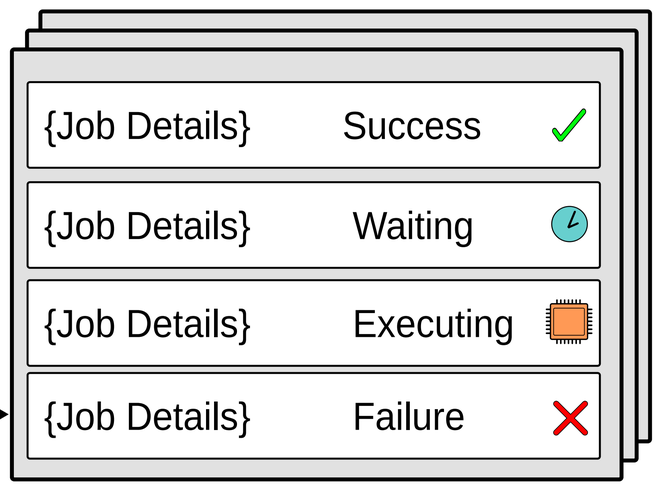
generate_ items
monitor_ items

.ini

PSQUARED

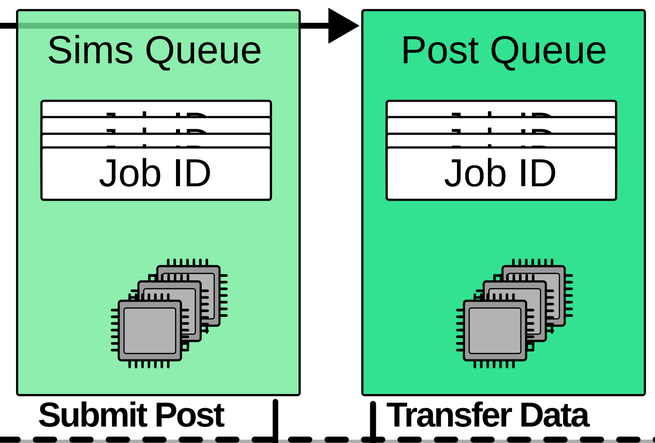
PSquared is the custom job management engine for LZ offline data processing - repurposed for sims production

+ RESTful API for item submission, management and monitoring
+ Postgres database keeps track of ongoing and historical jobs
+ Hierarchical job organization for multiple pipelines with minimal overhead
+ State-machine based architecture provides a robust system
+ CLI-based tools leverage the API to provide fine-grained control
+ Webapp-based visualization tools for high-level overviews



RABBITMQ

+ Integration with RabbitMQ for job allocation [2]
+ Productions can target specific queues and be assigned ad-hoc workers
+ Python-based runners register as RMQ consumers
+ Workers report status via PSquared's HTTP API
+ Queue utilization can be monitored in real-time through the RMQ webpage



+ On NERSC's Perlmutter: allocate worker processes with SLURM
+ Jobs are not specifically tied to SLURM requests:

The limited slots in the special LZ queue can quickly be taken off sims and assigned to data processing and vice-versa as necessary.

+ Register hooks to trigger actions upon job completion
+ For sims: trigger a "Post" job for each completed run
+ Responsible for data validation & transfer to CFS
+ Post workers run by lzdata user for correct file ownership

NERSC CFS

[1] D.S. Akerib et al. Simulations of Events for the LUX-ZEPLIN (LZ) Dark Matter Experiment doi : 10.48550
[2] RabbitMQ www.rabbitmq.com retrieved 2024/10/17

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