Data Collection and Analysis at the ATLAS Detector

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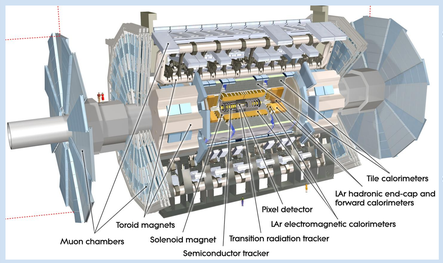
Savannah Thais, Yale University and the ATLAS Collaboration

The Large Hadron Collider

- 17 mile proton-proton collider
- 1000 million collisions per second

- 4 large particle detectors
- Largest physics collaboration in history, ~10000 scientists

The ATLAS Detector

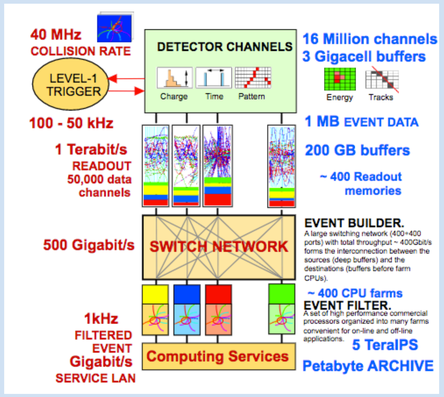


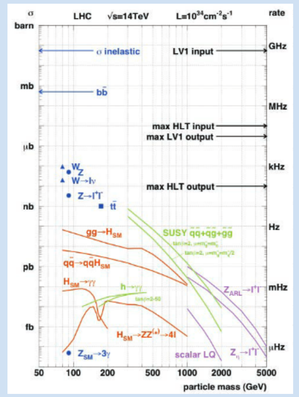
- 46m x 25m, 7000 tons, 3000 km of cables
- Protons collide within detector
- Inner detector for tracking
- Calorimeters for energy measurements
- Magnet system for momentum/charge
- Muon spectrometer outside detector

Physics Measurements

- Precision measurements of standard model properties (couplings etc)
- Searches for new physics: supersymmetry, dark matter, black holes, CP violation, etc)

Data Acquisition

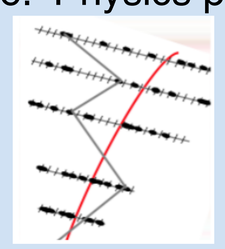


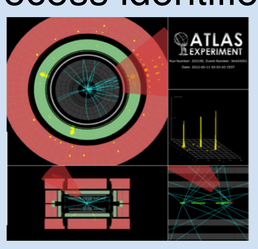


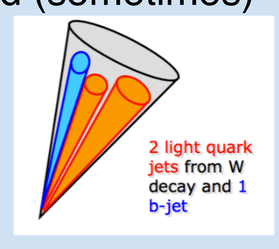
- 40 million events/second * 1.5 MB/event = 60 TB of data produced every second!
- Interesting physics happens only ~$1/10^{11}$
- 3 layer online trigger system selects which events to write out to storage

Data Reconstruction

1. Spacepoints formed from pixel hits
2. Tracks reconstructed from spacepoints with primary and z vertex searches
3. Clusters formed from calorimeter deposits using anti-kt algorithm
4. Jets reconstructed with cone PR
5. Tracks and clusters matched to reconstruct different particle types
6. Physics process identified (sometimes)

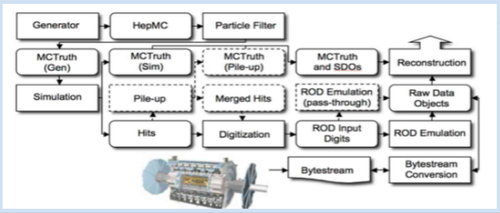






Simulations

- To select events for an analysis, need to know what the events should look like
- Quantum events are MC simulated and propagated through detector electronics



- FastSim vs FullSim: detector in 1 step vs several

Completing a Physics Analysis

Common analysis goal: **maximize sig/bkg ratio**

1. Model/simulate the process + backgrounds
2. Apply known corrections to simulations
3. Develop efficient signal selection tool
4. Compare sims to data in a control region
5. Adjust data to match sims in CR
6. Apply selection tool to entire distribution, get final results (excess, measurement, etc)

Continued Improvements

MUCH work being done to apply machine learning techniques to ATLAS data:

- Complex classification algs for selection
- Image processing for reconstruction/ID
- Adversarial learning for simulations