The protoDUNE program

The protoDUNE program at CERN was created to advance the design of the extremely large 4x10kt Liquid Argon Time Projection Chambers (LArTPC) of the DUNE experiment to be built in the next decade.

- Both Single- and Dual-Phase TPC designs will be tested in protoDUNE (only the single-phase protoDUNE-SP is covered here)
- Test-beam facility created in the extension of the CERN North Area Hall, with a tertiary beam from the SPS to provide various particle types
- Validation of the detector design with full size structural components
- Demonstrate the long-term operational stability of the detectors ahead of the construction of the first 10kt Far Detector module
- An opportunity for detector characterization and evaluation of reconstruction techniques in controlled test-beam conditions
- Beam and cosmic ray triggers, data taking to commence in late summer of 2018 with beam time through November of this year

protoDUNE-SP parameters

- External Cryostat dimensions ~11x11x11m³
- TPC channel count: 15,360
- Digitization frequency: 2MHz
- Nominal readout window: 5ms
- Nominal beam trigger rate: 25Hz
- Single readout size: 230MB
- Lossless compression factor: 4
- Post-compression peak data rate: 1.4GB/s
- Nominal 20Gbps bandwidth to central storage

Online Monitoring vs ”Prompt Processing”

<table>
<thead>
<tr>
<th></th>
<th>Online Monitor</th>
<th>Prompt Processing</th>
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<tbody>
<tr>
<td>Strong coupling to DAQ</td>
<td>No coupling to DAQ</td>
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<tr>
<td>Some fraction of full data rate</td>
<td>~1% of full data rate</td>
<td>Scalable CPU resources</td>
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<tr>
<td>Fixed/limited amount of CPU</td>
<td></td>
<td>Facility Hardware</td>
</tr>
<tr>
<td>Dedicated Hardware</td>
<td>Facility Hardware</td>
<td></td>
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<tr>
<td>DAQ network</td>
<td>Facility Network</td>
<td></td>
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<tr>
<td>Immediate (sec)</td>
<td>Prompt (min)</td>
<td></td>
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<tr>
<td>User access strictly controlled</td>
<td>More relaxed access for DUNE</td>
<td>Software can be tested/updated at any time with no impact on data taking</td>
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<tr>
<td>Workflow Mgt: artDAQ</td>
<td>p3s Graph-based DAG mgt</td>
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<tr>
<td>Software testing and updates tightly controlled</td>
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The ”protoDUNE prompt processing system”: p3s

The protoDUNE-SP prompt processing system is used for Data Quality Monitoring, running a variety of applications on a fraction of the data already recorded on disk, with a turnaround time of O(10min). This is done to ascertain the performance of the apparatus and to provide actionable information to the operators.

- Leveraging standard, well established components and frameworks e.g. Apache, Django and its companion packages, JSON, JavaScript
- Straightforward deployment
- Clients (operators via web browsers as well as automated clients) interface with the system via HTTP
- Services deployed on CERN OpenStack VMs in 2017 and have been running continuously, tested in two separate Data Challenges in 2017-2018
- DQM applications are now being finalized in preparation for the protoDUNE-SP commissioning in July-August 2018 such as track-based estimation of the Argon purity, data preparation (corrections for the ADC response and noise filtering) and the Event Display before/after the preparation, hit distribution, ADC/FFT distribution in various aggregation groups