Summary and Review Against Charge

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DUNE DAQ Conceptual Design Review @ CERN
December 3-4, 2018

DEEP UNDERGROUND NEUTRINO EXPERIMENT

DUNE Conceptual Design Review

Charge

DAQ

3–4 December 2018

The committee is requested to review the DUNE DAQ System conceptual design and determine if it meets requirements of conceptual design as outlined in the DUNE Far Detector Design Review Plan (DocDB-9564).

30% basic deliverables (conceptual design)

- Design requirements in accordance with detector requirements;
- Design concept and approach to production;
- Preliminary engineering drawings, schematics, models and interface drawings;
- Preliminary interface documents;
- Preliminary engineering analyses and documentation, plan for further analyses;
- Preliminary installation and testing plans;
- Identification of applicable design codes and standards;
- Market survey and manufacturing concepts;
- Rough cost estimates and schedule.

Question 1

1. Are the requirements and technical constraints on the DAQ system, deriving from the DUNE FD top-level science requirements and DUNE FD operational regime, clearly documented and understood? Is the DAQ conceptual design compatible with these requirements?

- The DAQ Consortium has been part of a collaboration-wide effort to define the DUNE top-level requirements
  - DUNE top-level requirements are documented and managed by the Exec. Board and are being finalized with input from all consortia leadership, leading up to TDR
  - 15/30 requirements are relevant to the DAQ
- The DAQ has defined and documented additional DAQ top-level requirements
  - Design specifications (derived from requirements) are actively being developed
  - DAQ-level requirements and specifications are living, evolving numbers, also informed by ProtoDUNE (“reality”)
- The DAQ conceptual design presented in this review is driven by the need of meeting the DAQ top level requirements and constraints from DUNE-level requirements

Question 1

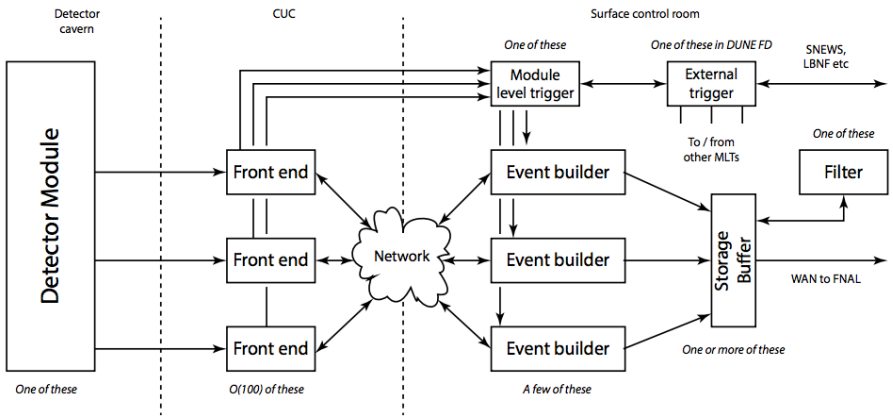
2. Is the envisioned conceptual design for the system technically sound, with evidence that it can form the basis for the detailed design phase?

- Presented Conceptual Design for DAQ for 1st SP TPC module
  - DAQ designed to support all four modules, SP and DP
  - Scope defined: fibers from detector → WAN network fibers to FNAL (to offline)
  - Slow control and safety is outside DAQ scope
  - Physical location, constraints defined (450kW, ~50 racks underground; 50kVA, 8 racks above ground)
- Design & Philosophy: partitionability and flexibility; reliability and remote operations; single scalable (performance and parameter) system; redundancy

Question 2

2. Is the envisioned conceptual design for the system technically sound, with evidence that it can form the basis for the detailed design phase?

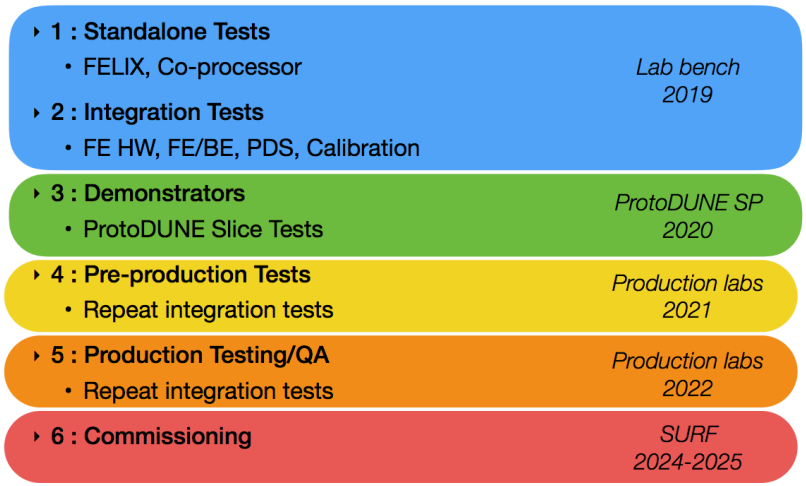
- Conceptual design for the most part makes use of available, proven, scalable technology, and benefits from ATLAS Felix development
- Front-end co-processor preliminary designs are progressing and a development plan has been laid out
- Further optimization of CPU/FPGA processing to understand processing/power performance
- Control/Configuration/Monitoring system choice must be specified
- ProtoDUNE demonstrates already many aspects of the design, and will form a platform for continual development and future demonstrations of design aspects, including vertical slice demonstration of final design

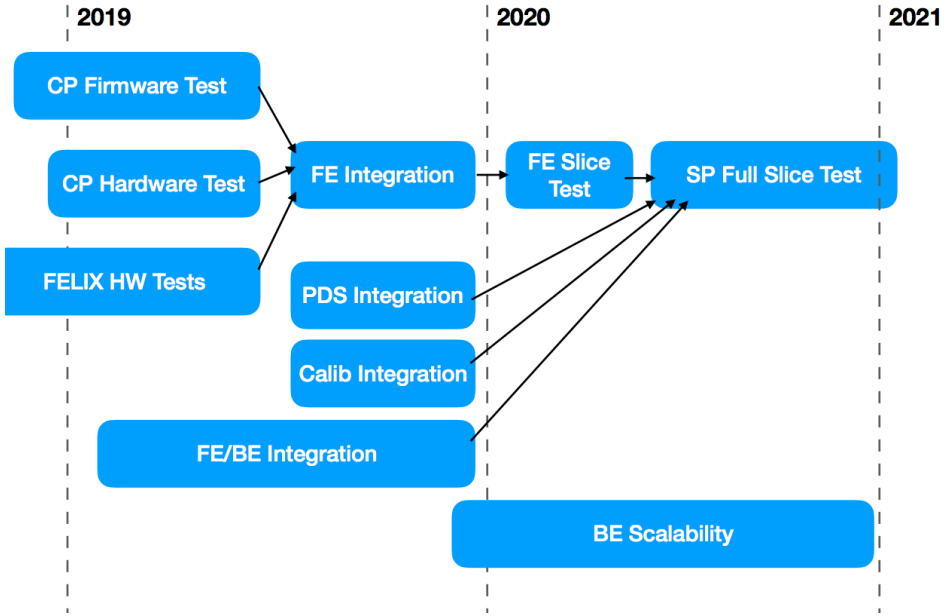


Question 3

3. Are the plans for R&D, including the use of ProtoDUNE-SP, well understood and documented?
   - To what extent has ProtoDUNE demonstrated system subcomponent performance?
   - Which additional tests are needed to demonstrate subcomponent performance?
   - Is there any evidence that any critical components may not be technically feasible?

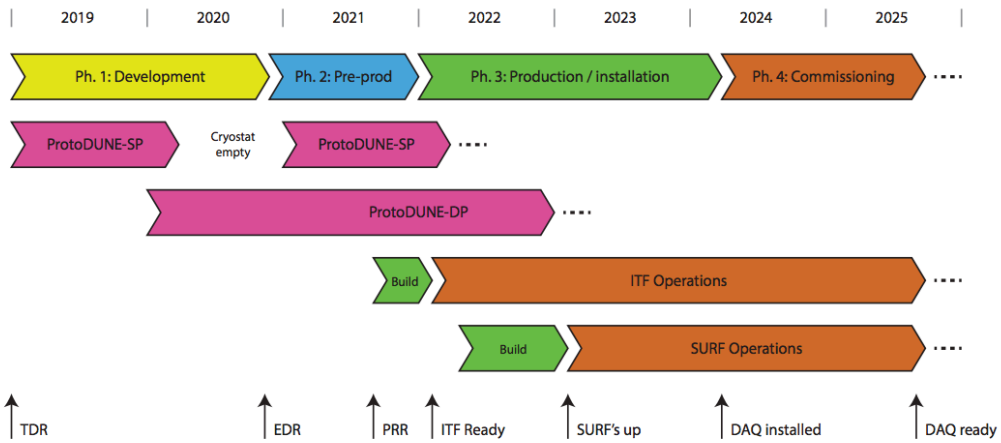
- Development plan is in place, and lessons learned from ProtoDUNE are used to inform development and design (e.g. need for partitioning and dynamic reconfiguration)





Question 4

4. Is an adequate project plan in place, capable of generating and demonstrating a detailed DAQ design on the required time scale?



- Project timeline has been developed (in more detail than shown here, with breakdown by subsystem)
- Schedule is aggressive, but critical milestones are in place
  - ProtoDUNE DAQ upgrade in Q1 of 2020
  - Engineering Design Review in Q4 of 2020
  - Pre-production Review by Q1 of 2022

Question 5

5. Are interfaces with detector components (e.g. slow control and detector front ends) and external data sources (e.g. accelerator, other detectors) well defined and documented?

- All hardware interfaces are defined and specified, including detector wide timing interface
  - PDS interfaces need follow-up
- Some will be revised following recent collaboration developments:
  - New Calibrations Consortium
  - Data Model Task Force document in preparation
- Control/configuration of front-end must be refined

- Interfaces defined in bilateral documents:
  - 6727-v2 SP Photons
  - 6742-v6 SP TPC
  - 7042-v0 Integration facility
  - 6988-v1 Facilities
  - 6802-v1 DP Photons
  - 6790-v1 Slow controls, calibration
  - 6736-v0 HV
  - 6778-v1 DP TPC
  - 7015-v1 Installation interfaces
- Single interface document for timing system: 11224-v1

Question 6

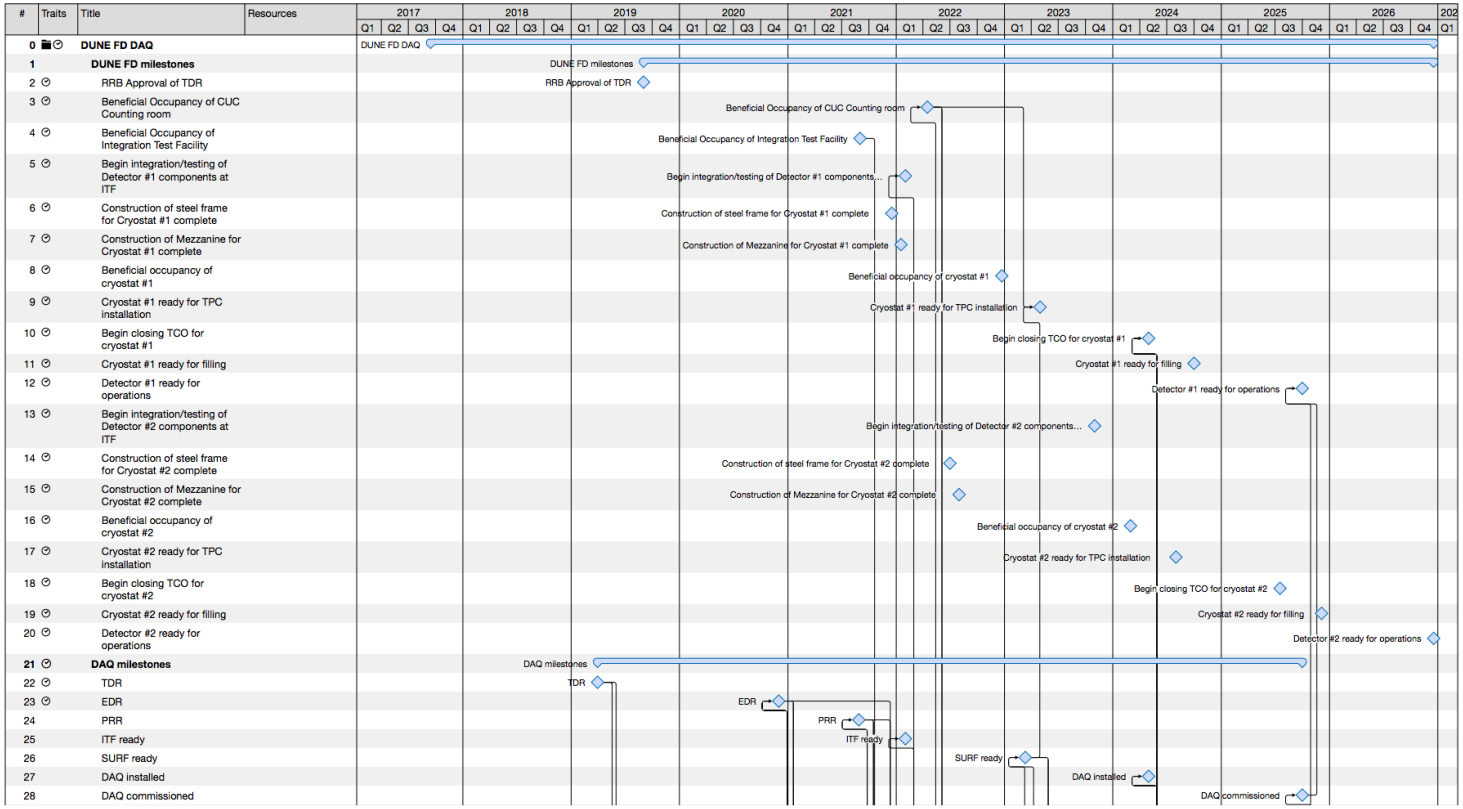
6. Are interfaces with the infrastructure (e.g. underground conventional facilities, utilities, networking, computing and detector safety system) well defined and documented? Is the interaction of DAQ with the DUNE FD grounding and shielding regime understood?

- Underground space, power constraints have been defined. Working closely with site engineering team to keep track of engineering design changes (CUC layout and outfitting)
- Rack infrastructure specified; DAQ hardware is all either COTS (servers, racks, routers) delivered straight to ITF, or Felix/co-processor
- Staged in ITF, ready to go underground at CUC BO
- Infrastructure (plumbing, power) installed by contractors starting at BO
- Hardware physically installed by consortium, configured and tested remotely
- Infrastructure for all four modules goes in at start, to allow us headroom to optimize system using initial modules

Question 7

7. Are the requirements on DAQ, and by DAQ, from and to the overall DUNE FD integration and commissioning plan understood? Does the DAQ project plan adequately address them?

- Integration facility interface yet to be documented
- DAQ schedule is integrated with ITF and detector site activities and installation



Question 8

8. Are the planned DAQ firmware and software design and development practices appropriate and adequate?

- Parts of system which require firmware and software design:
  - Front-end (Felix): fixed interface and functionality; benefits from data flow aspects demonstrated in ProtoDUNE
  - Co-Processor: in design stage; Dev board currently; FELIX daughter card is goal
  - Data Selection: algorithms under development; implementation to be specified
  - Back-end: artDAQ; benefits from ProtoDUNE demonstration
- Central DAQ repository exists (software); central firmware repository exists (CERN gitlab)

Question

9. Is there an online data selection strategy in place? Does it meet the DUNE science requirements? Are the requirements for data storage and transfer understood and documented?

- The Data Selection System conceptual design is in place (hierarchical, multi-level system)
- Data sources and volumes are well understood. To first order:
  - 5.4ms unbiased readout of whole detector for high energy trigger events or prescaled low energy trigger events (bias only at trigger level; prescale needed to meet 2 Hz trigger rate to Event Builder)
  - 100s of unbiased readout of whole detector for SNB trigger
  - Parallel trigger primitives stream read out (~200 MB/s, dominated by radiologicals)

Question

9. Is there an online data selection strategy in place? Does it meet the DUNE science requirements? Are the requirements for data storage and transfer understood and documented?

- Data rates expectations are motivated by physics assumptions and past/ongoing LArTPC operation experience; they are in continual iterations with physics and calibration groups
  - Within 30PB/yr (DUNE-level requirement) to offline for at least the first 10 kton module
- Biggest challenge: SNB trigger (and buffering)
  - Preliminary simulation studies indicate galactic coverage of >>90% while meeting fake SNB rate of 1/month
- Simulation results are being validated with ProtoDUNE data

Question

10. Are the requirements on DAQ from the FD calibration strategy clear and compatible with the DAQ conceptual design?

- New Calibrations Consortium
- Will continue to work together toward finalizing calibration interface as the experiment calibration strategy matures

Calibration

- Trigger for laser , neutron generator
  - Distributed through timing/synchronization system
- Fast feedback
  - Triggers from radioactive sources
  - Received through timing/synchronization system

Question

11. Have resource estimates and schedule been established at an appropriate level of detail?

- Project/DAQ milestones flowchart exists; includes subsystem-level detail
- Resource estimates are in place; peoplepower needs to be refined (additional resources on CCM, DQM must be sought out); awaiting feedback from NCG

Review Findings:
The committee should present its findings, comments and recommendations in a closeout meeting with DUNE Technical Coordination on December 4, 2018. The committee should provide a final written report by December 21, 2018.

Thank you for your time, effort, and feedback!