ND DAQ Update

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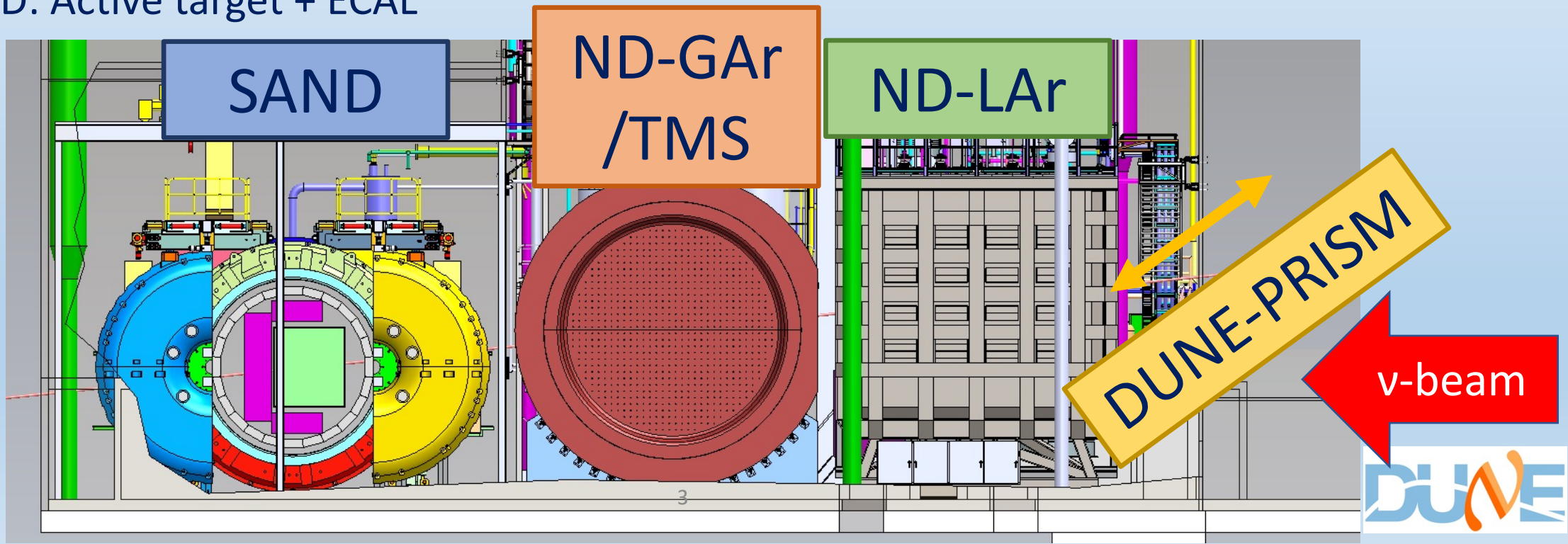
Introduction

- ND DAQ part of joint ND/FD DAQ consortium since early this year
- 2 ND specific groups were formed to tackle ND specific DAQ aspects: ND Upstream DAQ (NDUSDAQ) and ND Data Selection (NDDS)
- Aim to reuse FD infrastructure and contribute to joint development as much as possible
- ND made up of several different consortia/proto-consortia so we must set interface standards and provide framework for them to all hook into soon so as to prevent fragmentation

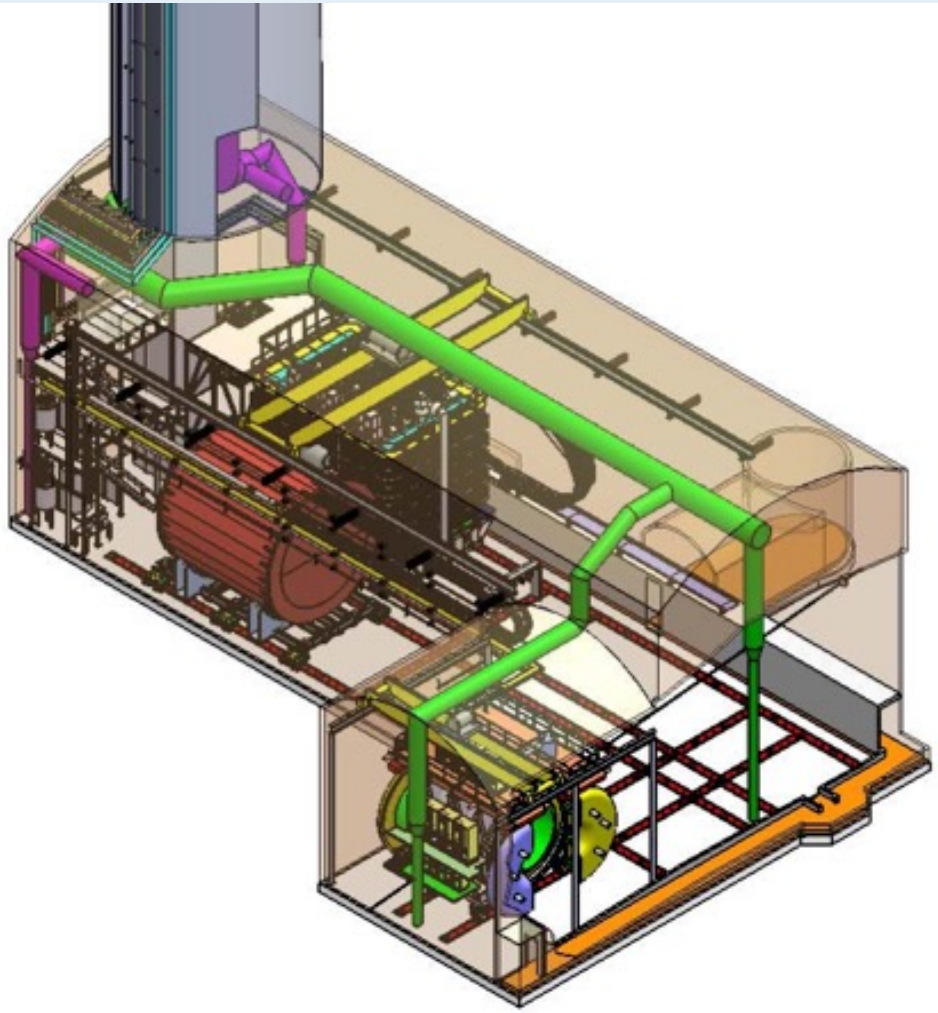
What detectors do we need to read out?

- 3 components: 2 of which (ND-LAr, ND-GAr/TMS) move off-axis giving different flux
  - ND-LAr: Liquid Argon TPC with charge + light systems + potential upstream veto
  - ND-GAr: High Pressure gas TPC + ECAL + potential cosmic ray tagger
  - TMS: Scintillator panel tracker present initially before ND-GAr
  - SAND: Active target + ECAL

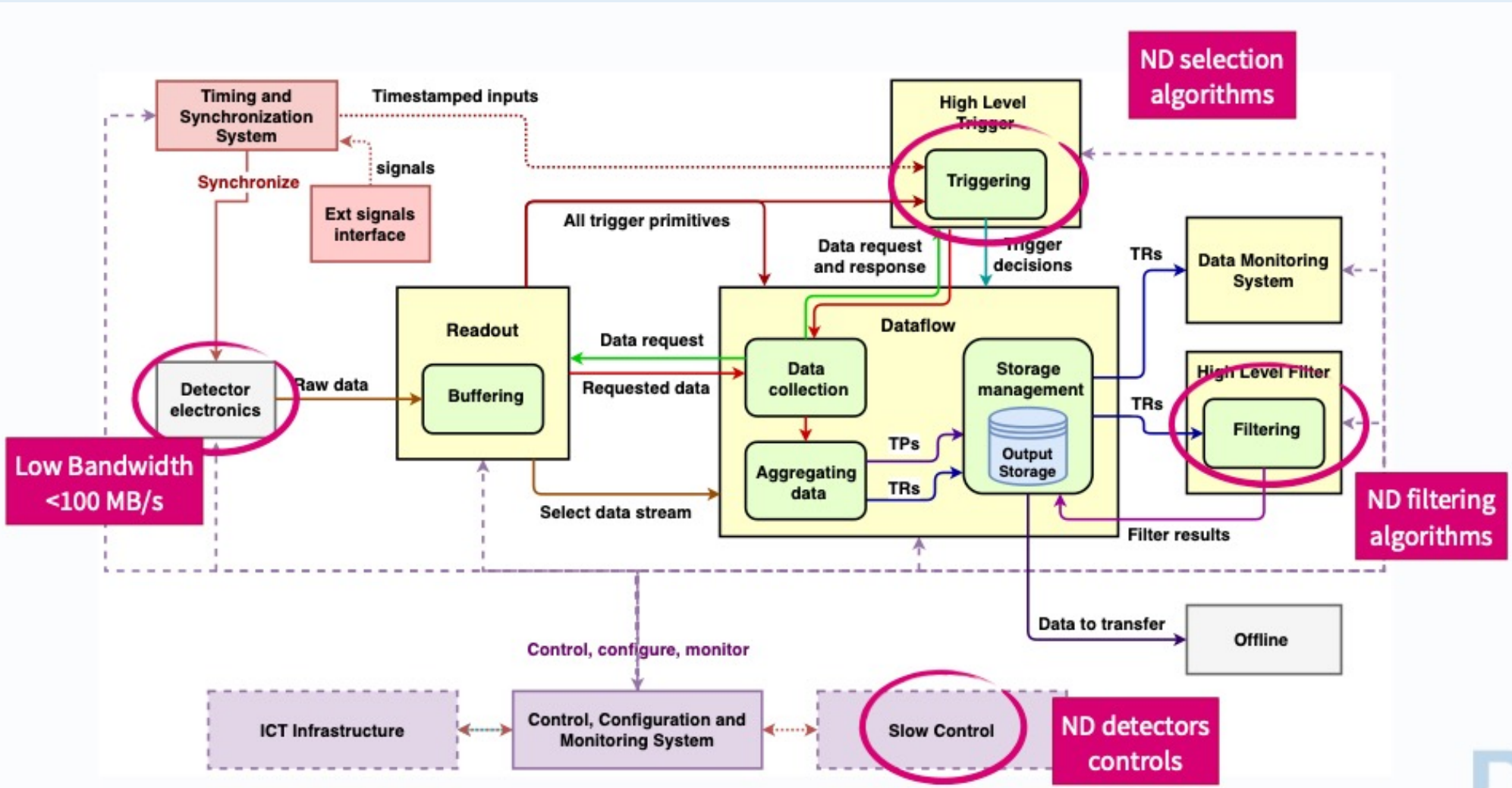


ND specific DAQ challenges

- Data rate from many ND subsystems is much lower than FD
  - Necessitates development of specific ‘low bandwidth readout unit’ (LBRU)
- Different combination of detectors and subsystems will need its own data selection algorithms
- We must implement a timing system for the ND
- We must make sure control, configuration and monitoring is sufficient for ND



Structure of the DAQ



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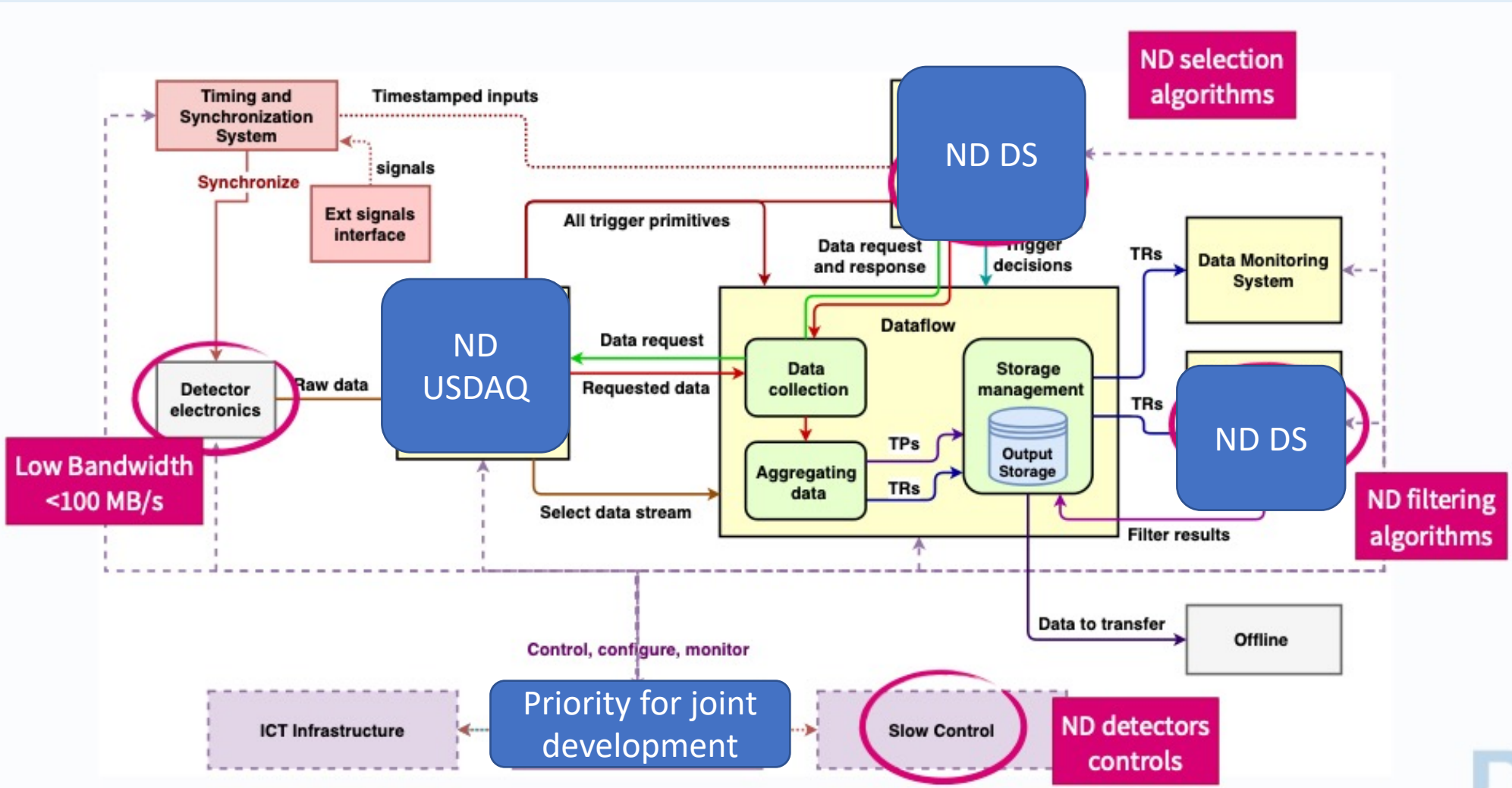
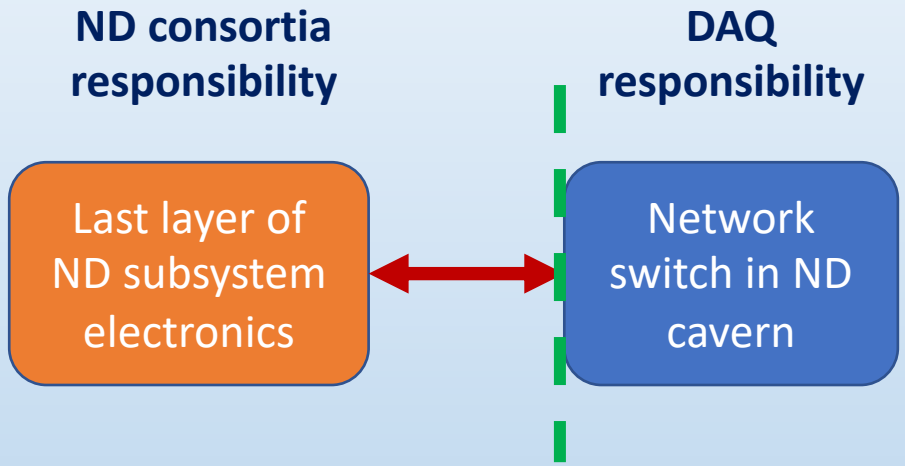


First steps – External interfaces

- Define interfaces with external groups
- Early contacts have agreed on data transmission protocol (TCP) and point of responsibility handover with most ND subdetectors
- Establishing what each subdetector's last layer before the DAQ is (e.g. FPGA vs CPU) and whether there are constraints from commercial hardware is key to this



First steps – Low Bandwidth Readout Unit

- LBRU's job is to read in data coming in from subdetectors at much lower bandwidth than FD
- 'Low bandwidth' means low enough that standard TCP/IP into off the shelf server will be sufficient
- One input handler for all low bandwidth subdetectors will improve long-term maintainability, decreasing UK expert shifter burden during operation

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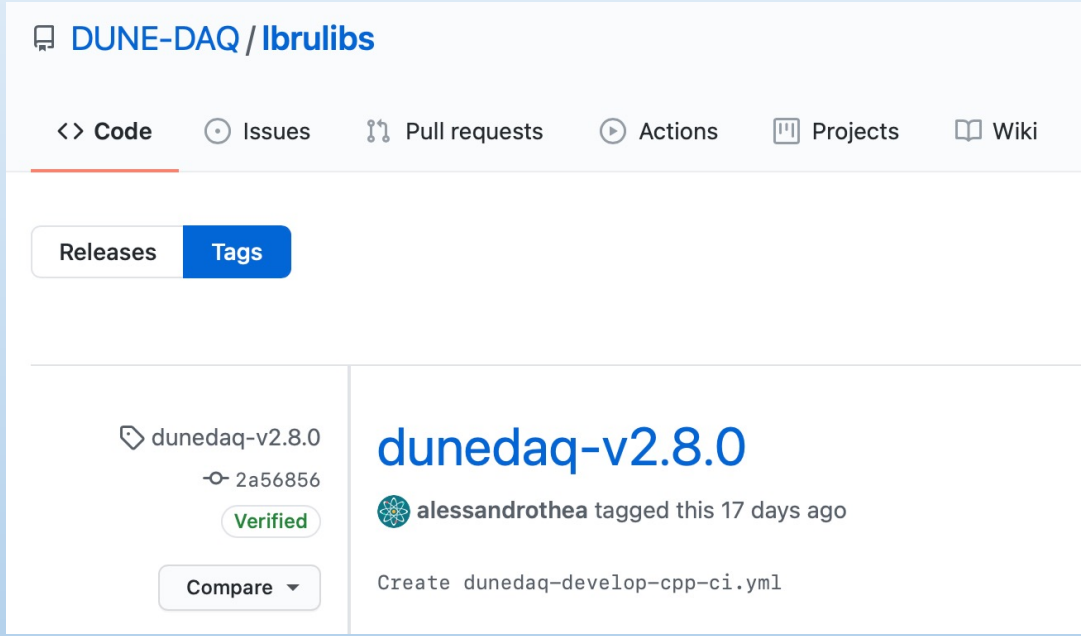
First steps – Low Bandwidth Readout Unit

- DAQ 2.8 software release contains first ND specific packages
- LBRUlibs code in this release accepts data from ND-LAr charge PACMAN controller cards
- Reuses FD development for reading in non-time ordered data
  - Folly concurrent skip-list buffer for those following in detail
- Having a dedicated ND-LAr contact (Peter Madigan) proved very helpful so we will try to repeat this structure for other subdetectors



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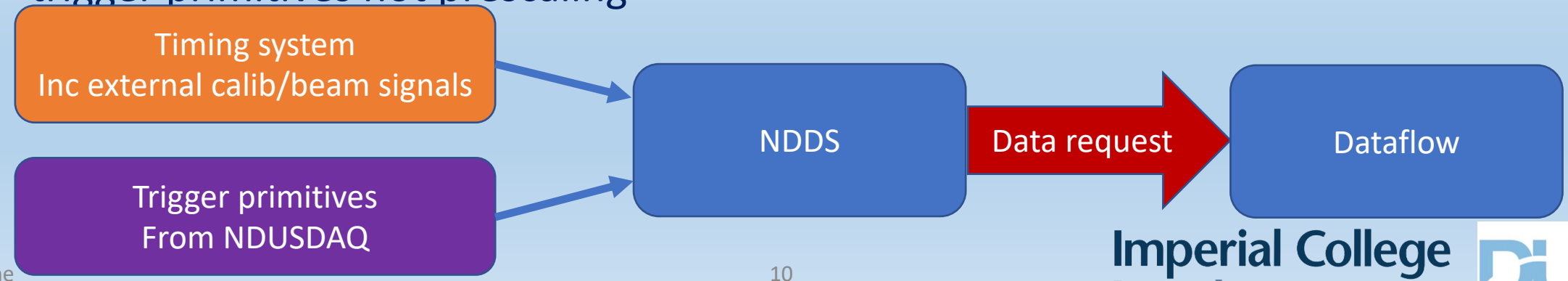
First steps – Data selection

- ND is much smaller so not anticipating supernova triggering
- Triggers fall into 3 categories:
  - Beam
  - Controlled calibration e.g. laser pulse
  - Uncontrolled calibration e.g. cosmics
- Beam and controlled calibration handled by generating request for a known time window
- Current 2.8 software release code is able to generate a fixed time window data request that is correctly passed to NDUSDAQ
- Alex Booth also contributing to FD DS: Adding operational monitoring, fake heartbeat module for testing and implementation of trigger algorithms that use trigger primitives not prescaling

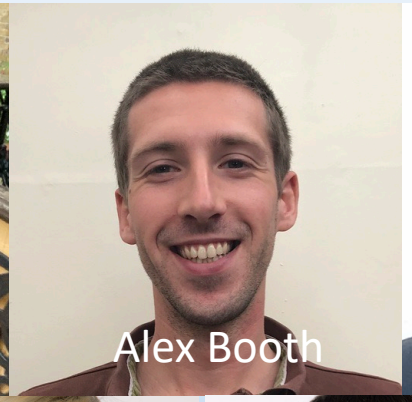


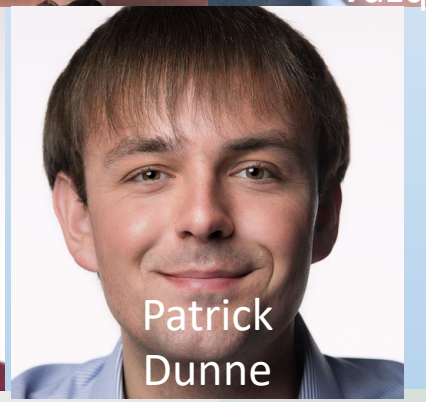
Next steps

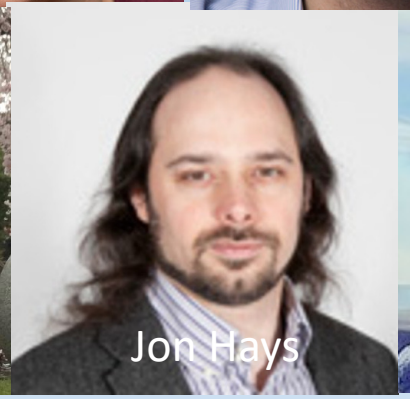
- Two focusses for NDUSDAQ
    1. Bringing more subsystems into lbrulibs: ND-GAr TPC + ND-LAr light readout are next on the list. Actively looking for effort in the detector groups to assist with this
    2. Testing: Several fellows have funding to build test stands in the UK
- NDDS aiming for configurable time window data requests soon (mostly done but not quite in time for 2.8) as well as studying how best to reuse FD work in uncontrolled calibration
- Both groups aiming to make development more robust e.g. improving testing with unit tests and moving to continuous integration

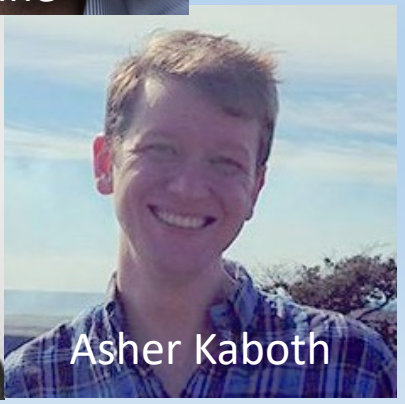
Communications and group structure

- Currently have members at: Imperial, Royal Holloway and Queen Mary
  - Most non-faculty effort is through university scholarship and fellowships (Dunne, Cremonesi)
  - 2 more incoming fellows (Duffy, Pickering)
- NDUSDAQ and NDDS currently sharing meetings/slack
- Meetings every Tuesday at 1000 BST
- Slack channel: #daq-nd-upstream
- Email list: DUNE-DAQ-ND-UPSTREAM-SUBGROUP@fnal.gov









Summary

- ND DAQ groups formed as part of overall DAQ consortium at start of year to tackle ND specific DAQ challenges while leveraging work already done for FD
- Interface specification and requirement setting in progress with ND consortia
- First ND specific component (the LBRU) has a prototype version in the latest DAQ software release 2.8.0 able to read in data from ND-LAr charge electronics
- More features/subdetectors and robust development coming soon