# Cold Electronics Integration Plan

## Contribution to the Integration/Installation workshop

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DUNE Integration and Installation Workshop

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# Content

- Reminder: deliverables from the CE consortium
- What we need to do at the integration facility
- What we need at the integration facility (from the facility, from other consortia)
- When ?

- I am not claiming that we know the entire sequence, this is how we understand it, and most important it contains our requirements in terms of time for testing / services from other consortia and the integration facility
- Our ideas for timeline may be different from official plan
  - We think that the APA availability drives the dates for the integration facility, we will be ready

# Cold Electronics Deliverables

- Inside the cryostat
  - FEMBs will have already been installed on the APAs
  - Cables are connected to the APAs / SHV boards, tested, ready for routing through the cryostat penetrations
  - Cable trays
- At the boundary between cold and warm
  - Cryostat penetrations with strain reliefs
  - Cold flanges
- Outside the cryostat
  - Chimneys, warm interface crates
  - Electronic racks
  - Warm cables

# Work at the integration facility

- The main goal of the CE consortium at the integration facility is the installation of the front end motherboards on the APAs and the test in a cold box that everything is working properly
- Other activities
  - Repackage (and store) components to meet the requirements for transport into the mine
  - Suggest to install all crates and modules into the racks for CE, PD, CISC, and some DAQ (possibly clock distribution) at the integration facility to reduce the number of shipments to the mine

# Work plan(i)

- Receive front end mother boards from test sites and perform a quick warm reception test (10 minutes per FEMB, 1/2 day to get all the FEMBs for an APA)
- APA consortium does wire inspections, wire tension measurements, mounts CR boards on APA (1 day ?)
- Install FEMBs on the APA perform fast test using local power/readout, connect pigtails to the FEMBs (1 day total)
- Insert and test photon detectors (1 day)
- Move the APA into the cold box and connect pigtails from FEMBs to fixed cables attached to the chimney and the warm interface crate, perform very fast test prior to closing the cold box using DAQ readout through the WIC (1 day)

# Work plan(ii)

- Cool down (24 h)
- Perform all tests at low temperature (including turning on/off photon detector, bias voltage on the wires, 1 day)
- Warm up (24 h)
- Remove the APA from the cold box, detach pigtails from cables fixed to WIC, detach pigtails from the cold boxes (1 day)
- If shipment within a few days, pack the APA for shipment, otherwise store in controlled environment

- I.e. 8 days for getting one APA out of the integration facility, 3 days spent in the cold box, if running at full speed
- To avoid bottlenecks require at least 3 cold boxes (might be better to have a spare one in case of problems). Also require 5 work stations where the APA are measured, CE and PD installed (+ spare)

# Work plan(iii)

- Required integration speed is only 2 APAs per week
- More relaxed requirements on number of stations (3+1 spare) and cold boxes (2+1 spare), reduce number of people working at the integration facility

# What we need at the integration facility (i)

- Laboratory space
  - Station for warm testing of FEMBs
  - Station for cold testing of FEMBs that fail during integration or installation (we will provide our CTS, will require way of refilling LN2 dewar)
  - Space for small electronic workshop
  - Storage space for tools / equipment (dry air cabinets)
  - ESD protection everywhere in this laboratory
  - 40 $m^2$ total (this included storage space in the replies to the questionnaire sent by Marvin Marshak)
  - No special requirement on cleanliness

# What we need at the integration facility (ii)

- Storage space
  - Would like to store 2-3 months worth of equipment
  - Estimate this is 200 $m^2$
  - Estimate based on number of chimneys plus fully populated racks for 3 months, doubled to take into account cables and trays
  - Would prefer to have some temperature / humidity control in storage space (T>10 $^oC$, dewpoint safely below this value), air conditioning for summer probably not needed
  - If this is a loading area, will need to pack properly things stored to avoid collecting dust
- Area for packing / unpacking
  - Will be dirtier than the laboratory, should not share the same space
  - Estimate this is 100 $m^2$
  - People will be working in this room, prefer to have temperature around 20 $^oC$, dewpoint safely below this value)
    - I am used to wear a sweater in Winter…. Some people like it warmer
    - Air conditioning for summer

# What we need at the integration facility (iii)

- 3-6 working stations for APA/PD/CE integration
- 2-4 cold boxes, each already equipped with its cryostat penetration, fully populated warm interface crate and DAQ connection
- DAQ system (and slow controls, detector safety system) to handle the cold boxes
- Connection to FNAL for data storage / analysis
- Based on protoDUNE experience (to be checked) will have significant LN2 needs (refill dewar every 2-3 days ?)

# Personnel at the integration facility

- Expect to have 10-12 people from CE consortium working at the integration facility plus 2 shifts of 10 people from the CE consortium working at SURF. Additional management team of 2 people.
- Not all the people will be full time resident, expect mixture 2/3 resident + 1/3 non-resident
- Expect 40 people total in the Rapid City / SURF area, should assume that at least 10-15 will want to work at a desk at any time
- Assume that at least 1 meeting room for 20-30 people will be available, possibly plan for another pair of small rooms (5-10 people)

# When do we want access ?

- According to optimistic timeline
  - First DUNE prototype APA available in Fall 2019, will be sent to CERN for tests in protoDUNE cold box with new FEMBs
  - First three production APAs to arrive in Spring 2021, will be sent to CERN for 2nd protoDUNE run in late 2021 + 2022
  - Ideally we could start receiving APAs at the integration facility already in April / May 2021
  - This would relax the integration timeline, but also require significant storage space for APAs (either before or after integration)
  - Anticipate access to integration facility to prepare setuo to 2nd half of 2020 ?