

ProtoDUNE-SP Installation Planning

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LBNC Meeting - CERN
June 22-24, 2017

- Months of intense activity and progress on Detector Integration, Test and Installation at CERN
- Summer / APA#1 at CERN: Schedule update
- Major Milestones (6 month plan) - Response to LBNC Recommendations: look ahead
- Risk (Installation Section) and Risk mitigation
- Recommendations from Internal Reviews and forthcoming Reviews
- Organizational updates (ProtoDUNE-SP Collaborators at CERN for Detector ITI)
- ProtoDUNE-SP On-Site:
 - Cryo-Instrumentation, Beam Instrumentation, Muon Tagger
 - DAQ
 - Data Quality Monitoring
 - Data Reconstruction and Analysis
- Summary

- All ProtoDUNE-SP activities ongoing
- Fast pace and progress from:
 - *remote (US and UK) construction of all detector components*
 - *cryostat assembly at CERN and EHN1 experimental site completion*
 - *readiness for detector Integration and Installation at CERN (ITI)*
 - *readiness for detector Testing - DAQ Vertical Slice*

This is the time when all these streams of intense activity from different groups come all together in one: coordination and tuning is complex and crucial for success

- Updates on Construction:
 - ▶ **weekly reports in docdb#1776**
- Activity at CERN:
 - ▶ **weekly ITI meetings on Indico** <https://indico.fnal.gov/categoryDisplay.py?categId=623>
 - ▶ **series of DAQ Milestone Weeks**

Summer / APA#1 Schedule

- Just updated to reflect CERN Facility and PSL APA#1 readiness dates
- Current version much more robust with respect to external events
- There is some safety margin built in

Key critical dates:

- APA#1 flies from ORD July 11th, received at Preveessin **July 17**
- Clean Room **partition** (SAS / Jura side) clean by **July 18**
- Cold Box commissioned by **August 4**

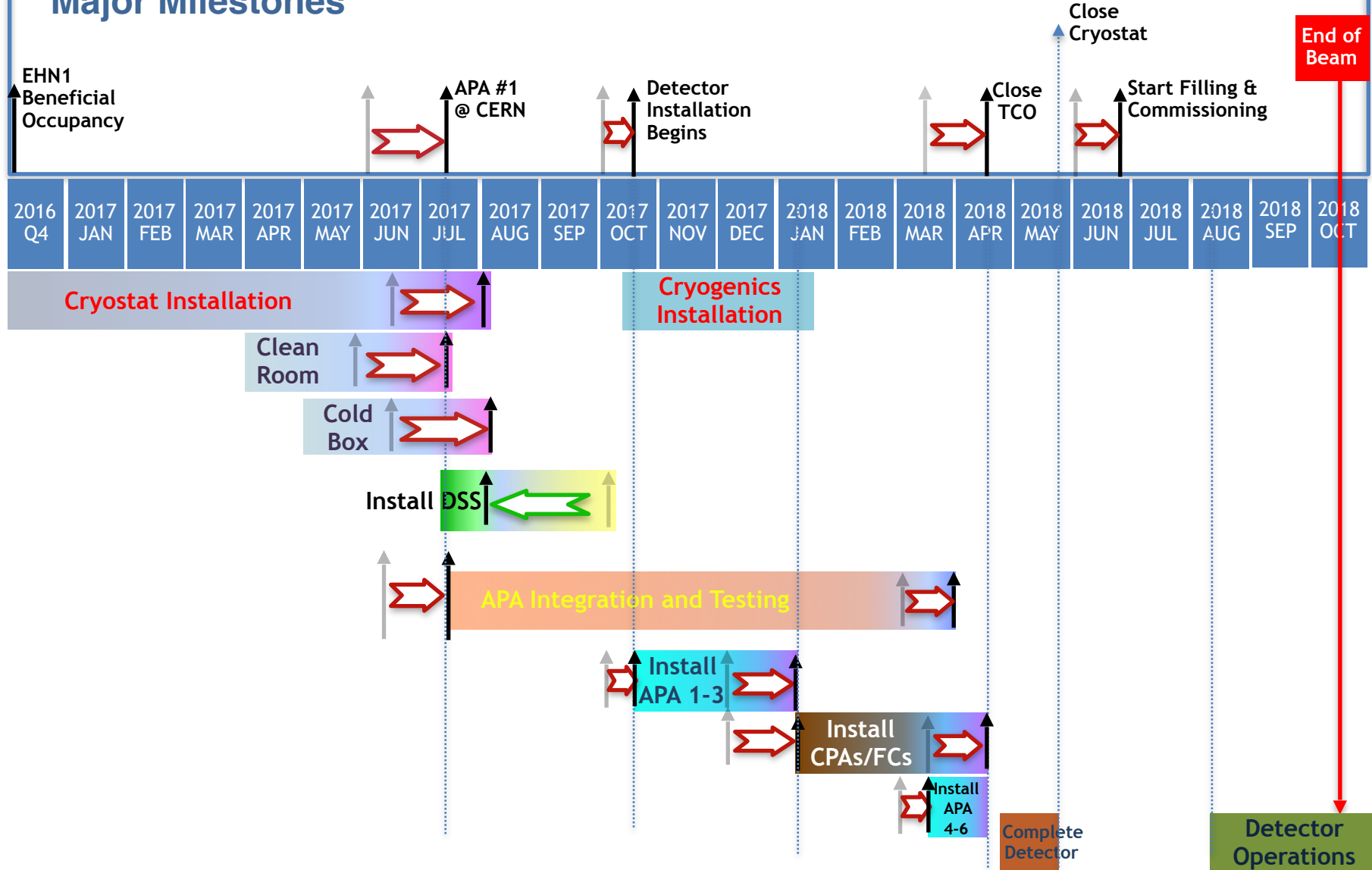
Operations phases:

- APA#1 check-in & PDS integration: **July 19 – Aug 4**
- CE integration, warm & cold testing in Cold Box: **Aug 7 – Oct 6**
- APA#1 roll into cryostat: **October 9-11**

LBNC Recommendations

Item Description	Due Date	Close Date	Status	Actions
It would be useful for DUNE and LBNF to develop a 6-month look ahead mechanism to anticipate important developments or activities that would benefit from interaction with the LBNC. •Recent examples are the SPSC Q&A responses and preparations for the DOE status review	24-Jun-17		in process	As a first step, we are attempting to incorporate relevant information into the LBNC plenary presentations.

Major Milestones



- As of February, Installation Phase: 11 Risk registers had been identified
 - DocDB#2814
- Update June 2017 (11 Risk registers) :
 - Open: 3 (preparation for Installation)
 - Installation phase “technically” not started yet
 - Realized : 1 (schedule delays) -
 - Mitigation Strategy in place
 - Closed : 0

Recommendations and forthcoming appointments

- Recommendations from Cryo-Instrumentation Review, Beam Instrumentation (Apr. 17)
 - Recommendations reviewed and being incorporated
 - Action items being addressed; documentation by system managers in progress
 - Engineering Design and/or Production underway
- **Forthcoming Reviews:**
 - *Electrical/Grounding QC Review* [Sept.'17]
 - *Muon Tagger Review* [Dec. '17]
 - *Reconstruction SW and Analysis Review* [Fall '17]
 - *Operation Readiness Review* [Mar. '17]

	Institutions	protoDUNE Collaborators	permanent at CERN	extended stay at CERN
from US	29	87	19	22
from EU + CERN	10	29	14	6
from Latin America	3	7	3	3
all in all	42	123	36	31

US Institutions

FNAL
Duke U
U Minnesota
Boston U
Yale U
Stony Brook U
LBNL
ANL
Michigan State U
BNL
Rochester U
Virginia Tech
U of Chicago
PSL (Wisconsin)
U of Hawaii
UC Irvine
Colorado State U
Huston U
W&M College
SLAC
U of Pennsylvania
CALTECH
Louisiana St U
UC Davis
U of Texas Arlington
U of Tennessee
Syracuse U
PNNL
Kansas State U

EU + CERN

CERN
NIKHEF (NL)
U of Birmingham (UK)
U of Liverpool (UK)
U of Warwick (UK)
Oxford U (UK)
U of Bristol (UK)
U of Manchester
NCBJ Cracow (PL)
IFIG Valencia (SP)

International

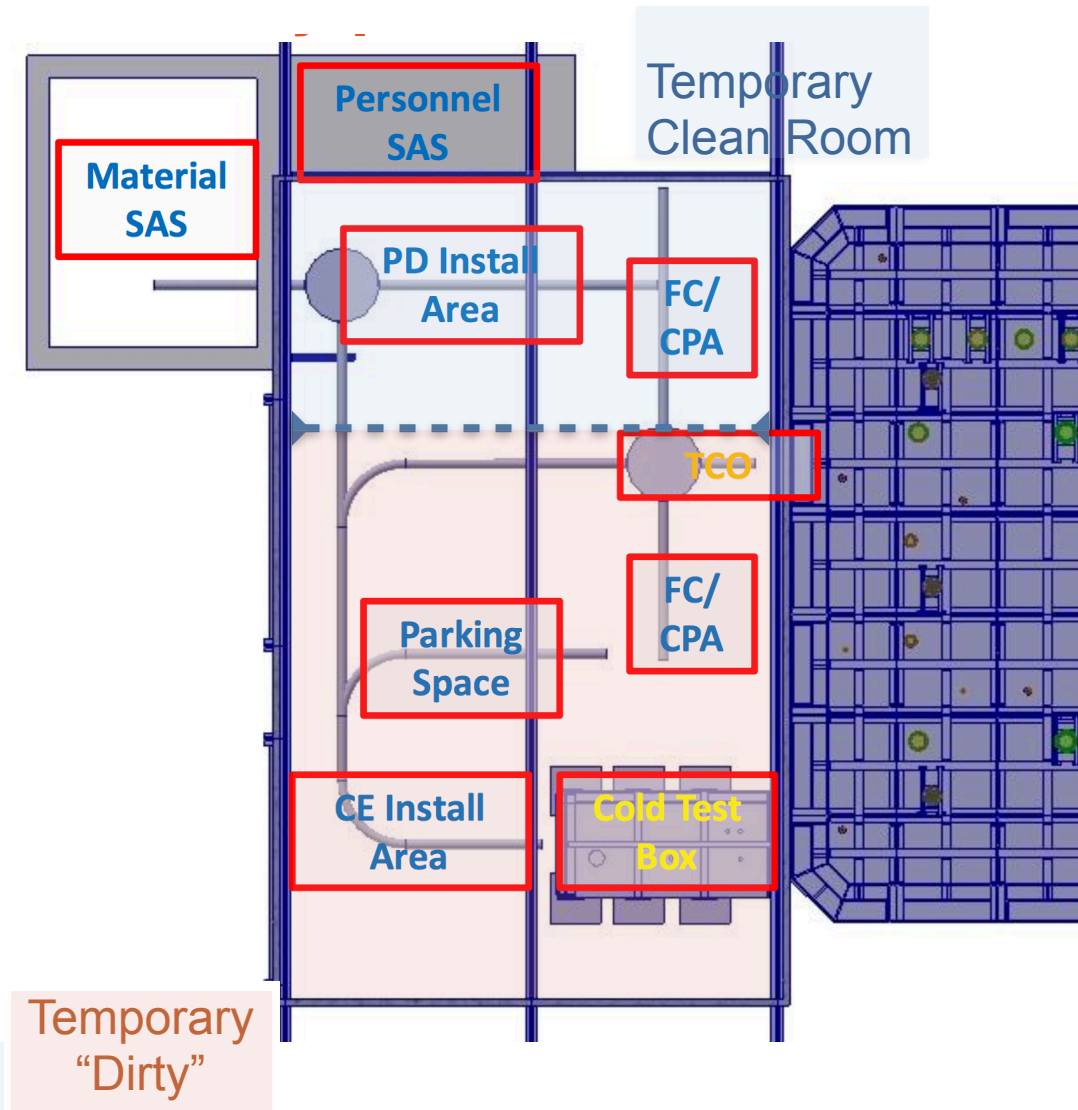
UNICAMP (BR)
UFABC (BR)
UAN (Colombia)

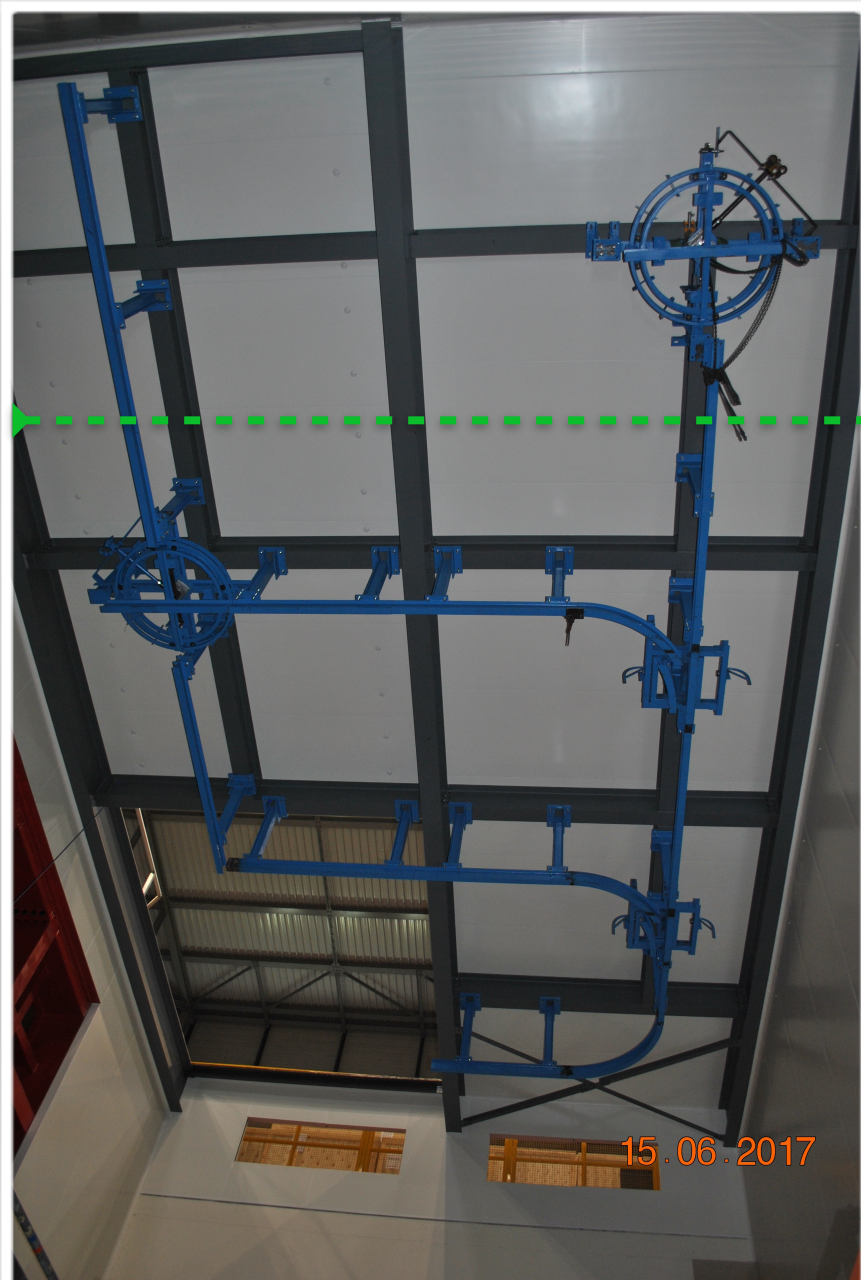
ProtoDUNE-SP On-Site, Instrumentation and preparation for Data Analysis

Clean Room partition, operations in July

- In the second half of July begin APA1 integration
- Other activities in the same period:
 - Cryostat construction completion & checkout
 - DSS installation
 - Cryostat cleaning
 - Cold Box brought into the C.R., completed, connected and commissioned

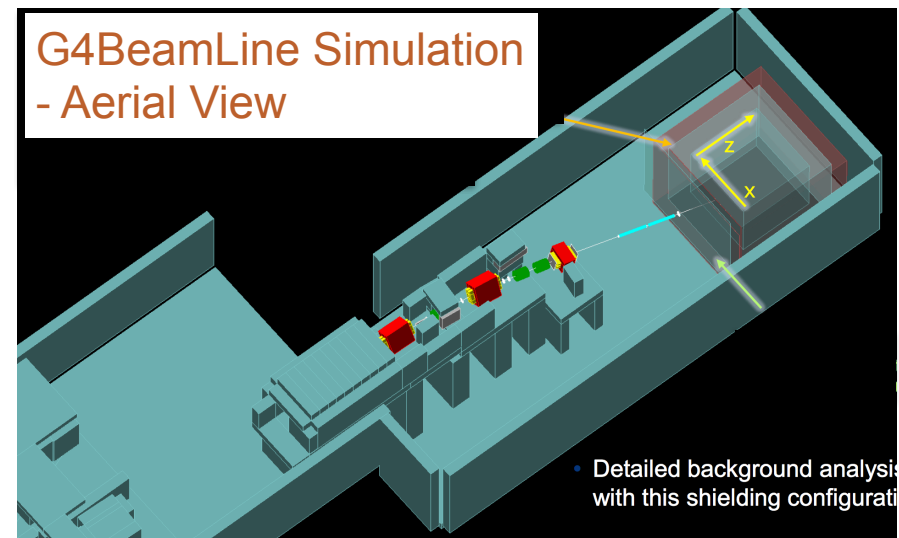
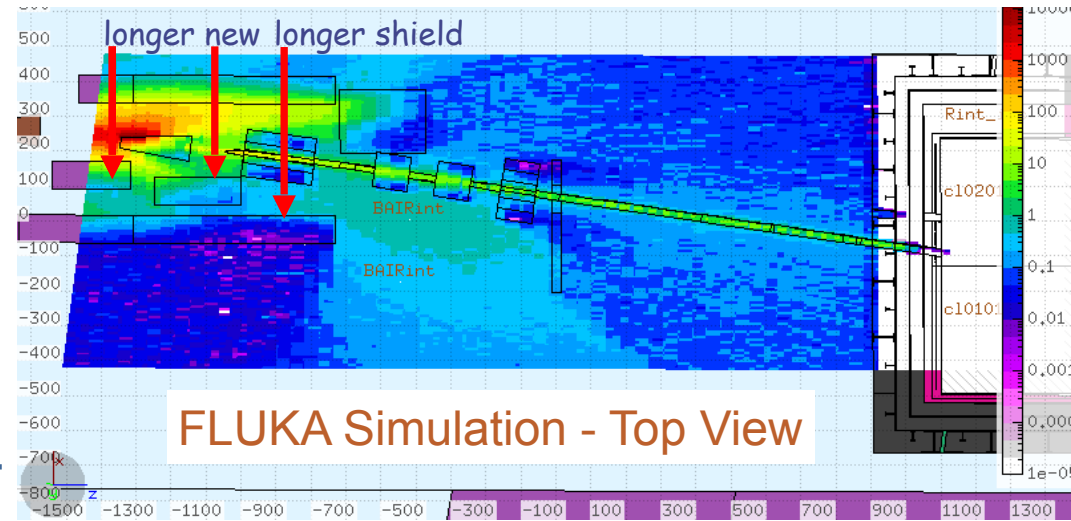
- **Clean Room partition (dash line) decouples the two sequences, allows work in parallel**





-Beam Instrumentation:

- **H4 beam line model including concrete shielding:** substantial reduction of background particle rate at TPC front
- Precise **field map calculation for H4 magnets**, important for the muon background calculations
- Exact **bending magnet geometry** completed.
- Optimization of **beam pipe geometry** and dimensions
- Final H4 **beam position** decision taken by ProtoDUNE-SP (NP04) Collaboration
- Implementation of **LAPPD ToF Counters in H4 beam line.**



- Cryo-Instrumentation:

- **T-gradient monitor:** design completed for the two different T-grad monitors (Hawaii and Valencia).

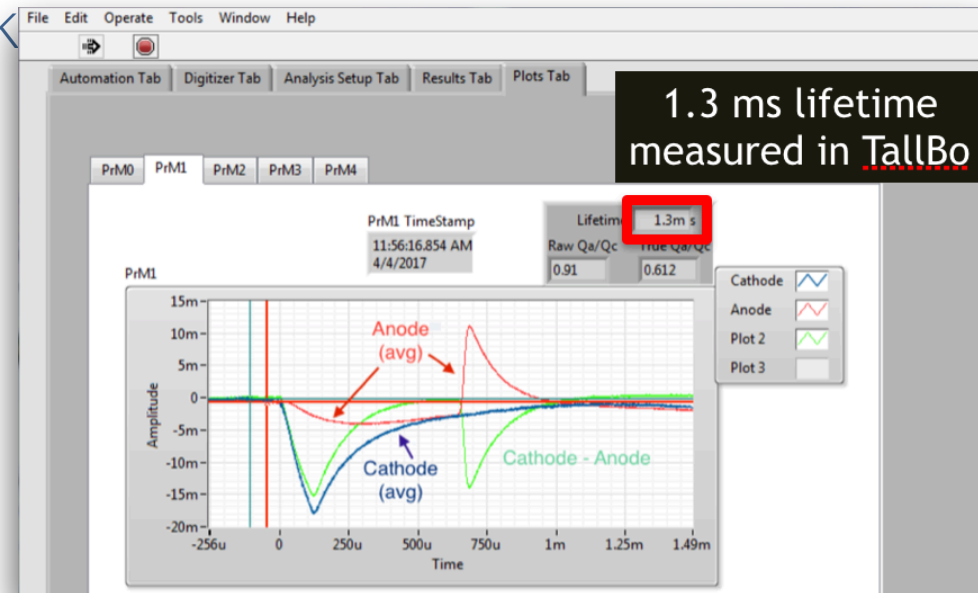
- Prototype Tests in LAr on-going: Excellent resolution -
RMS of the offset between sensors ~2-3 mK

- **Purity Monitors:** detectors built & ready,
successfully Tested in LAr

- **Video Camera:**
improving design and lighting with LED

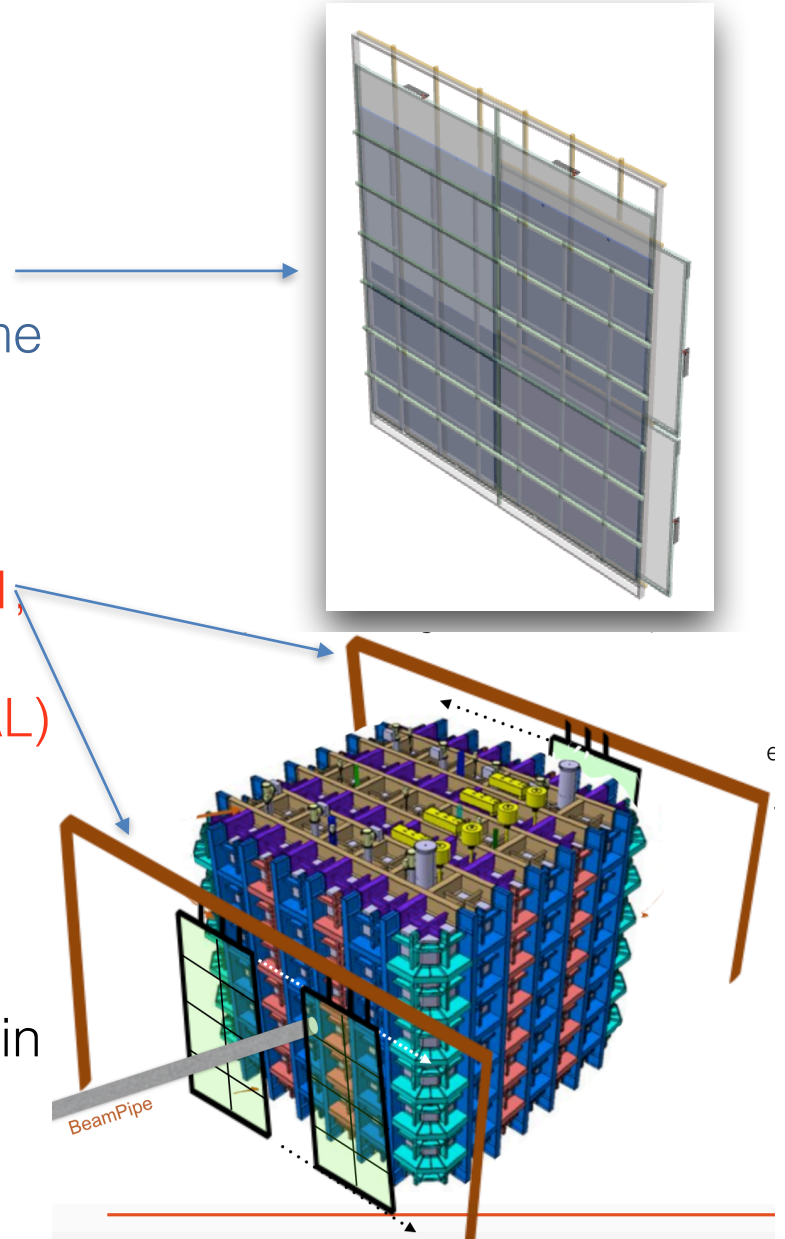
- **Gas Analysers:**
proposed solutions for gas analysis

- **SlowCtrl/DCS** rack layout at EHN1 completely finalized.



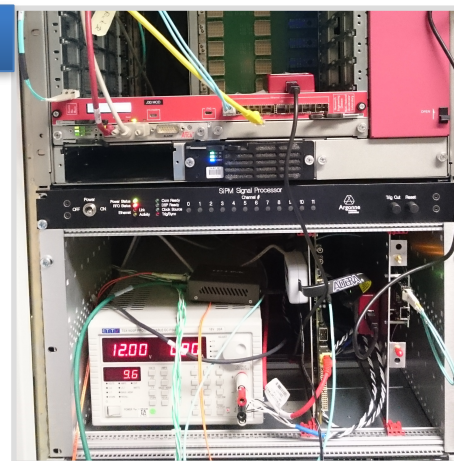
- External Instrumentation (CRT System):

- **Muon tagging paddles: “CRT module”** formed by 4 paddles in a mechanical frame
 - 6 or 8 modules → 24 or 32 NIM trigger output.
- Mechanical **holding structures at EHN1** upstream and downstream the Cryostat: Conceptual Design to be developed (FNAL) and developed with Neutrino Platform at CERN
- All **electronics components** tested, few modifications needed. Integration with main system under study.



Vertical Slice Test

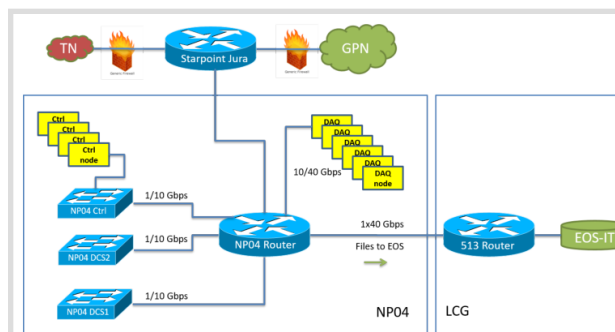
- Most on-site work directed towards Cold Box testing
- In parallel, working towards final system: storage, trigger, ToF integration
- Progress managed tracked with a series of Milestone Weeks
 - MW4 next week
 - Finalisation before cold box testing
- **Integrating on Vertical Slice test**
- Almost finished move to EHN1
 - Network and power installed
 - Racks installed
 - Initial computers installed
 - Expect operational this week
- Support infrastructure
 - Logbook, wiki, software repositories, etc
 - Working closely with CERN IT



RCEs

SSP

Timing System

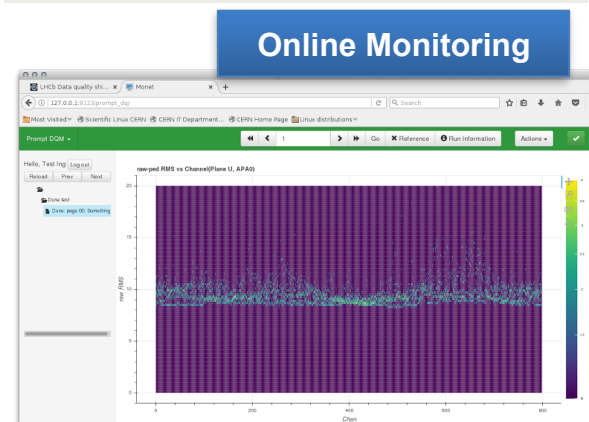
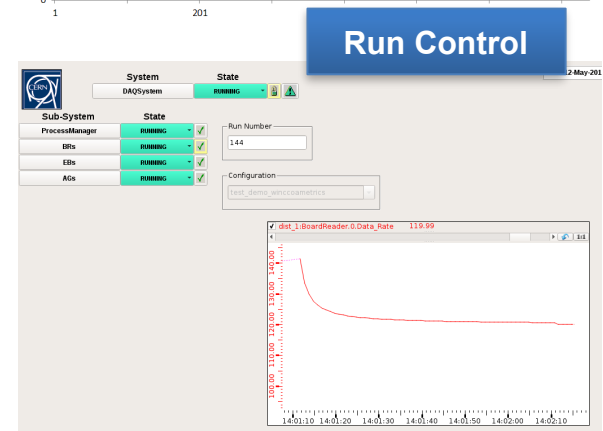
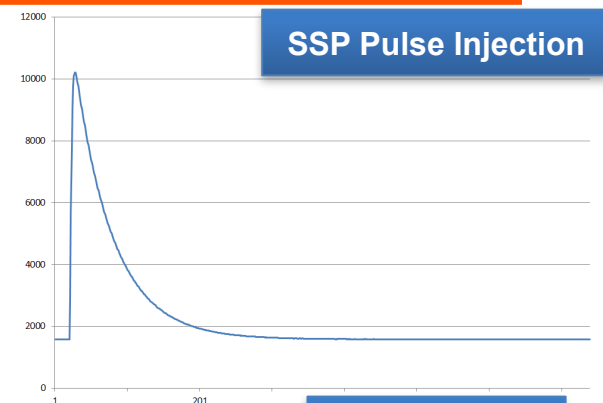


Network



Racks

- **Timing system tests**
 - Can time to clock and (fake) triggers
 - With RCEs, SSPs
 - Control and readout SW integrating with artDAQ
 - WIB integration underway
 - Delivery to CERN expected next week
- **SSP readout working**
- **FELIX integrated and working in loopback mode**
- **Awaiting ProtoDUNE WIB**
- **Run Control (JCOP) advancing well**
 - Will be ready for Cold Box
- **Online Monitoring showing first plots (sim)**
 - Integrating with artDAQ



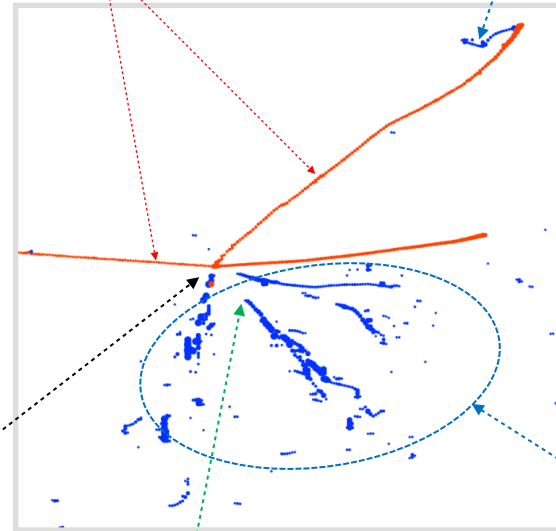
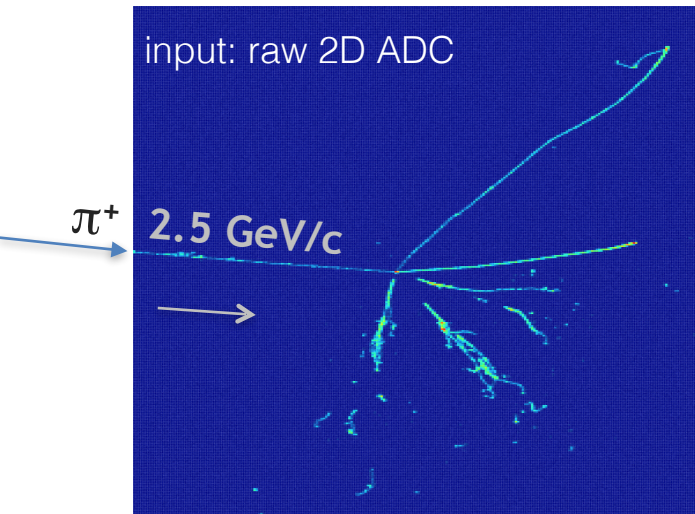
- DQM more relaxed time to result (up to an hour) wrt OnLine Monitoring, allowing for more sophisticated/time-consuming algorithms to be run
- low bandwidth (only a small fraction of data is processed)
- can use data which is not part of the DAQ stream e.g. the Beam Instrumentation data
- **DQM: types of processing:**
 - “ADC”: a summary of ADC-level data e.g. mean/RMS values
 - “FFT”: a summary of the ADC-level data in frequency space.
 - “SIG”: a summary of the data after signal processing. It includes:
 - “stuck code” mitigation
 - coherent noise removal
 - noise subtraction and filtering
 - deconvolution of the response function
 - “VIS”: visualization, including 2D event display, before and after “SIG”
 - “BI”: merging of the Beam Instrumentation data, basic validation of the trigger vis-a-vis the TPC data
- P3S: computing platform for DQM & Prompt Processing → Serving data and visual products to the user

3. hadron tracks reconstruction: **done**

→ once EM separated by CNN, track reco with standard algorithms w/ increased efficiency

2. Michel selection: **advanced**

→ labeling with CNN



1. EM selection: **done**

→ labeling with CNN

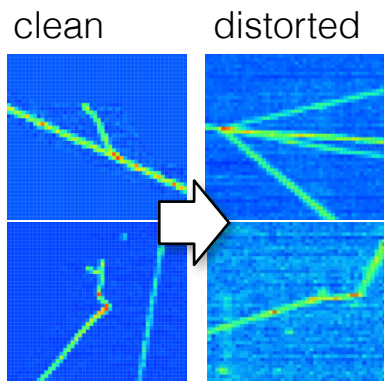
4. interaction vertex:

- π events similar to ν events
- **TO DO**: process in vtx labeled with CNN

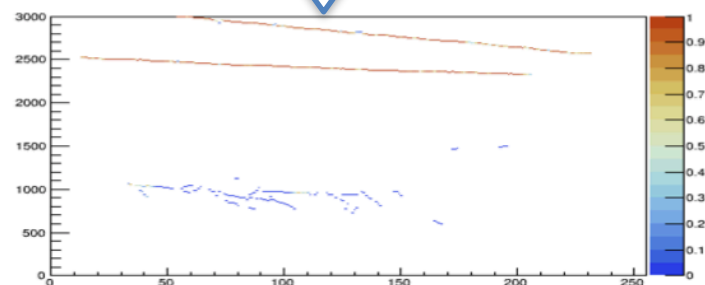
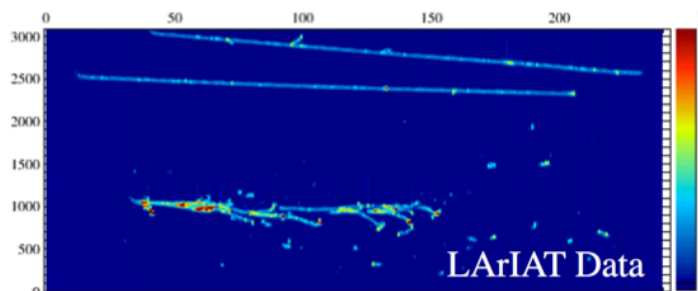
5. EM cascade start finding: **work started**

- most significant for e/γ separation and ν_e selection
 - EM shower displacement from the vertex
 - 1m.i.p. vs 2m.i.p. dE/dx in the initial part

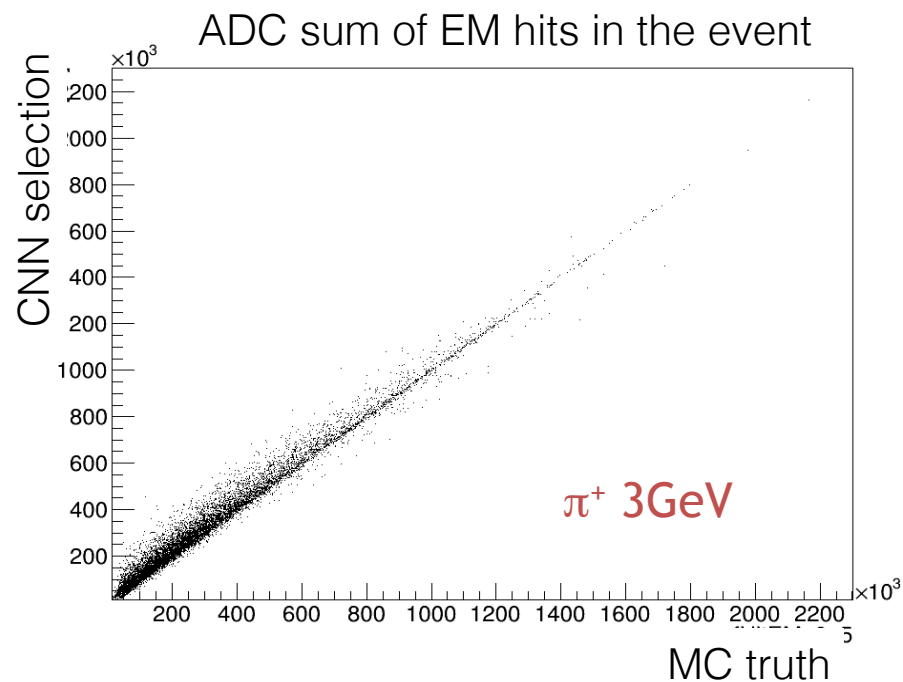
Feature Labeling with CNN
(Convolutional Neural Network)

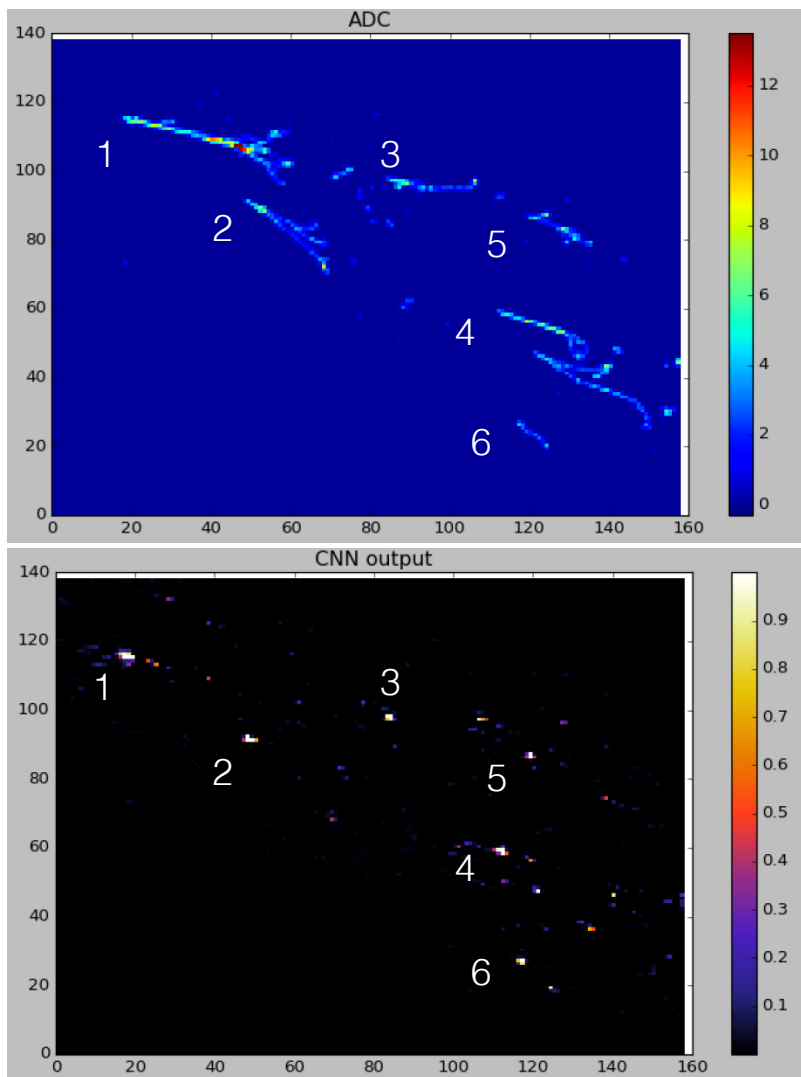


- validation and improvements with using the LArIAT data sample
- tests on distortions and noise patterns: no major deterioration
- integration with PMA: done (included in MCC9)
- integration with Pandora: started (towards applications in DUNE FD)
- Michel electron localization and reconstruction
→ now using MCC9's large statistics



shower-like hits (Blue-CNN) and track-like (red)





EM cascade start (γ conversion) finding
Target application:

- π^0 reconstruction: hard problem in LArTPC data
- support e/gamma separation

ALL TASKS:

- students from many institutes collaborate
- working together with the Dual-Phase team
 - ▶ tools for e/gamma separation
 - ▶ tools for Michel electron reconstruction
 - ▶ aim: validate on ProtoDUNE's real data

- preliminary results, first attempts of the training
- prominent, high-value blobs indicate γ conversions

- A detailed plan of activity has been put in place for detector integration, test & assembly at CERN, based on improved integration and coordination with Neutrino Platform team
 - Functional DUNE Working Groups are addressing the major tasks and have extended and qualified participation and key activity coordinators are on the ground at CERN.
 - At this point in time, the protoDUNE-SP installation plan remains on schedule for being ready for beam data in July-August 2018.
 - ***Next months at CERN:***
 - fast transitioning from facility preparation to actual detector assembly, test and installation **organized in a complex set of parallel activities.**
 - this challenge anticipates even more intense effort and full dedication from the ProtoDUNE-SP team.
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Thank you for the contributions to the preparation of this report:

- R. Acciarri *and the Integration-Test-Installation Team*
- S. Pordes, A. Cervera *and the Cryo-Instrumentation Team*
- P. Sala, J. Paley *and the Beam-Instrumentation Team*
- E. Blucher, C. Mariani *and the Muon Tagger Team*
- G. Lehman, K. Hennessy *and the DAQ Team*
- M. Potekhin *and the DQM/P3S Team*
- R. Sulej, D. Stefan *and the Data Reco/Analysis Team*

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