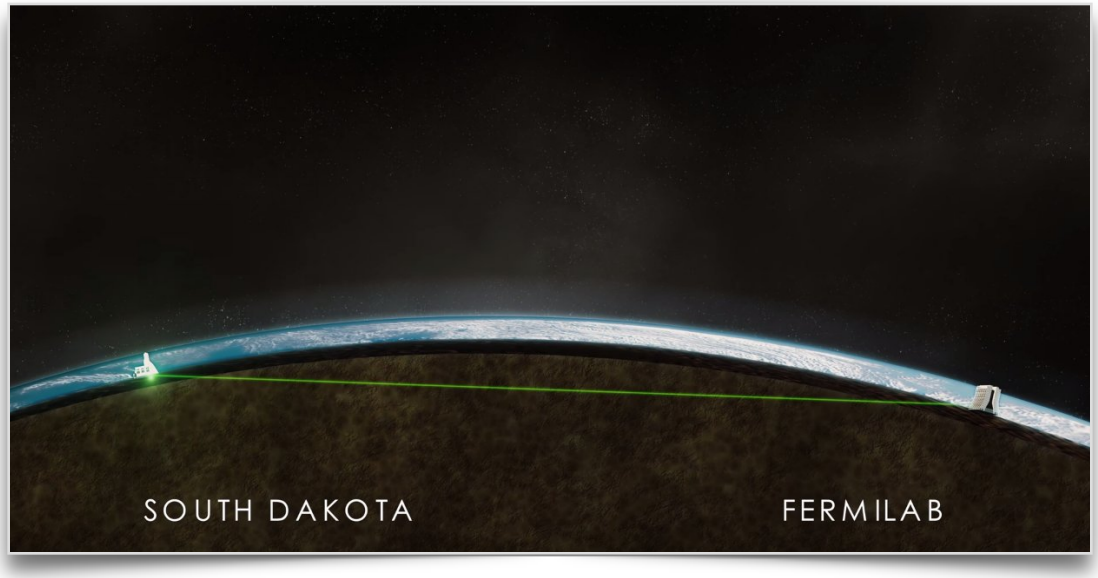

ProtoDUNE-SP Installation Planning

Flavio Cavanna
LBNC Meeting - CERN
June 22-24, 2017

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Outline

- 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#1readiness 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 Prevessin July 17
- Clean Room **partition** (SAS / Jura side) clean by July 18
- Cold Box commissioned by August 4

Operations phases:

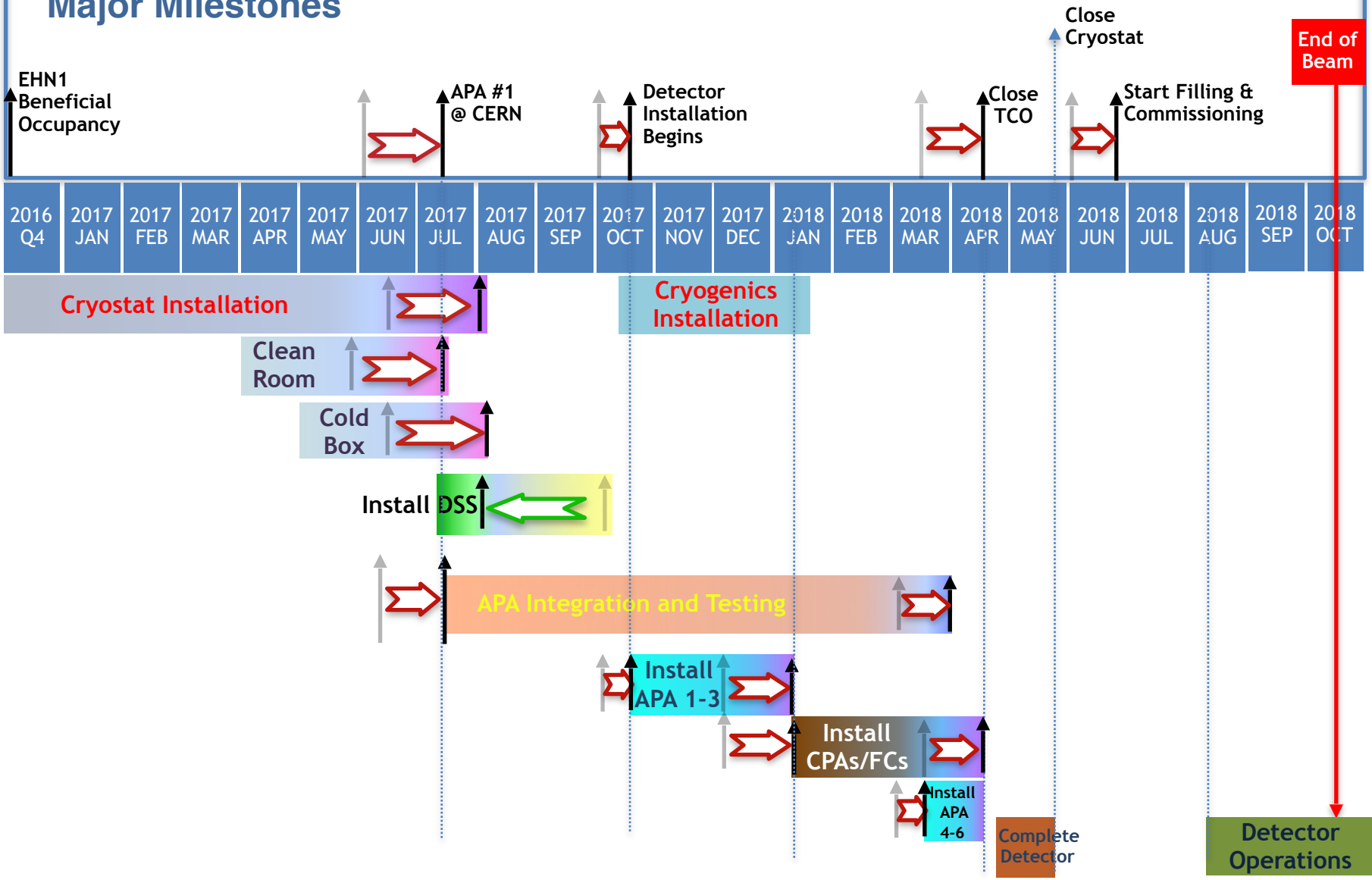
- APA#1 check-in & PDS integration: July 19 – Aug 4
- CE integration, warm & cold testing in Cold Box: Aug 7 – Oct 6
- APA#1 roll into cryostat: October 9-11

Response to 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.

Look ahead

Major Milestones



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Risks

- 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]

Organizational updates

	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)

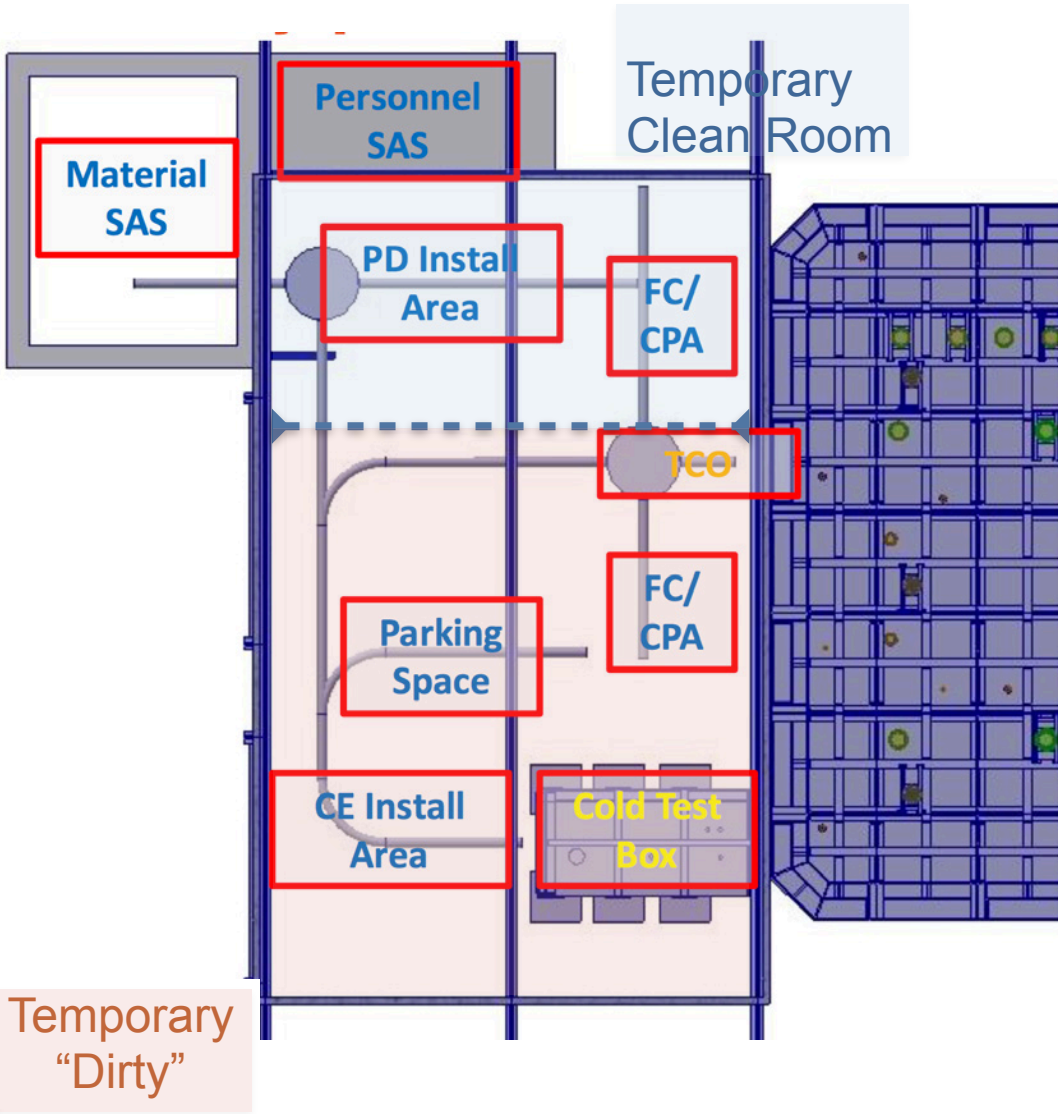
International

- 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**

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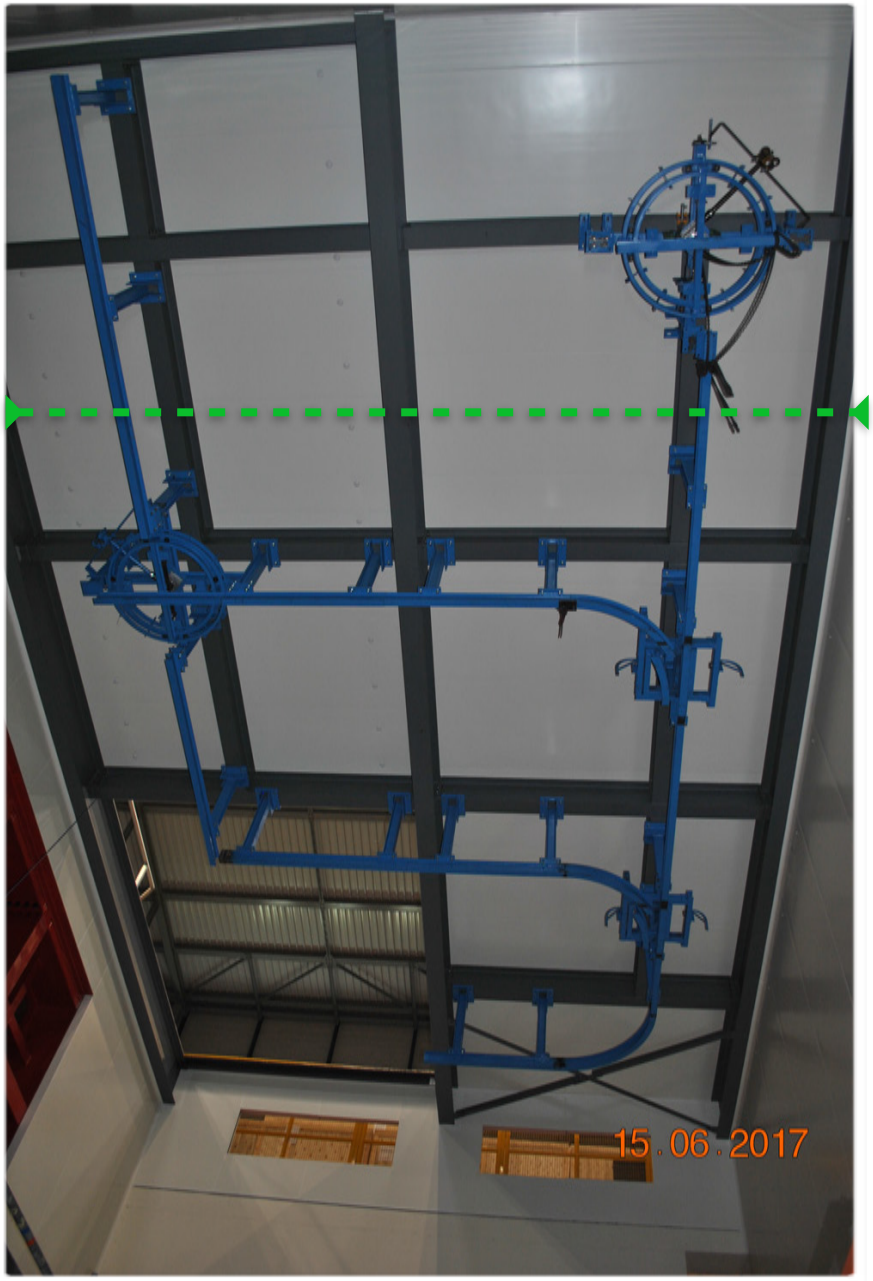
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ProtoDUNE-SP Instrumentation

-*Beam Instrumentation:*

-**H4 beam line model including concrete shielding**: substantial reduction of background particle rate at TPC front

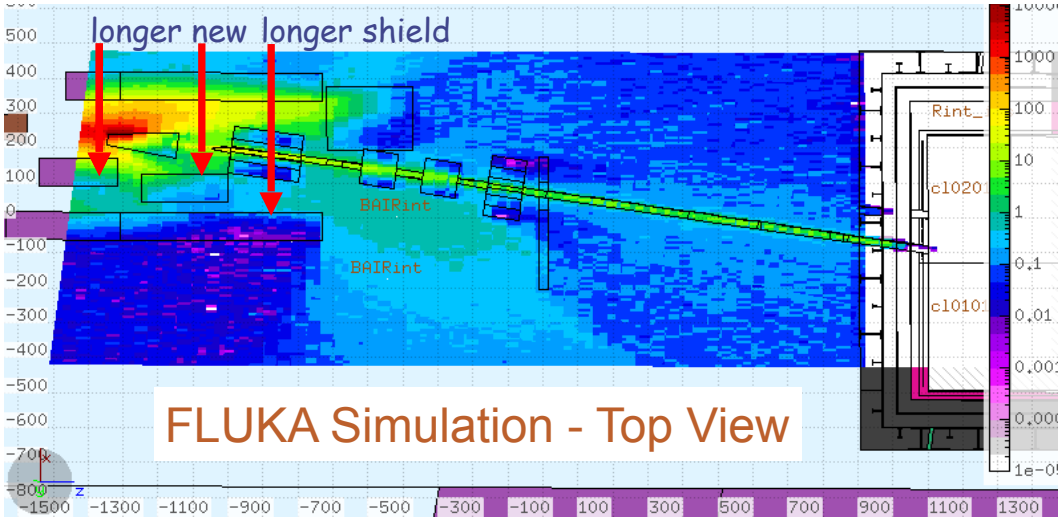
-Precise **field map calculation for H4 magnets**, important for the muon background calculations

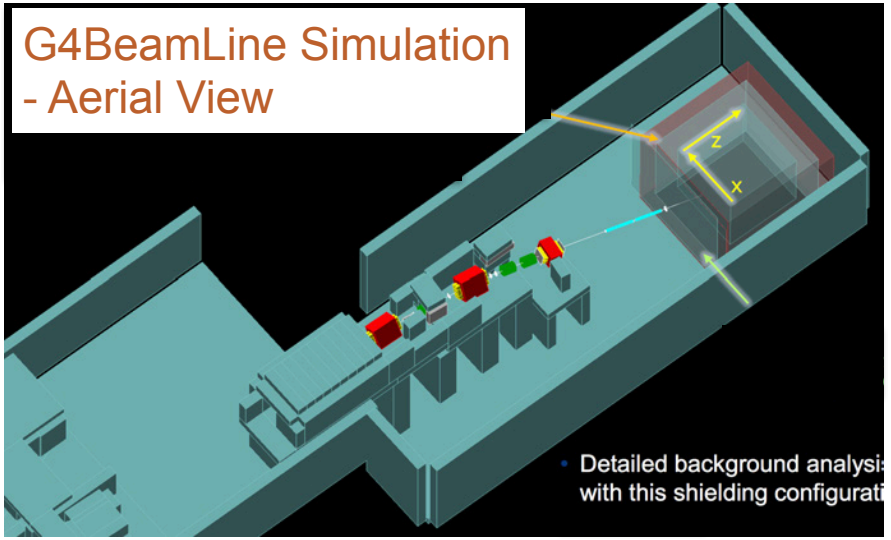
-Exact **bending magnet geometry** completed.

-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, succesfully Tested in LAr

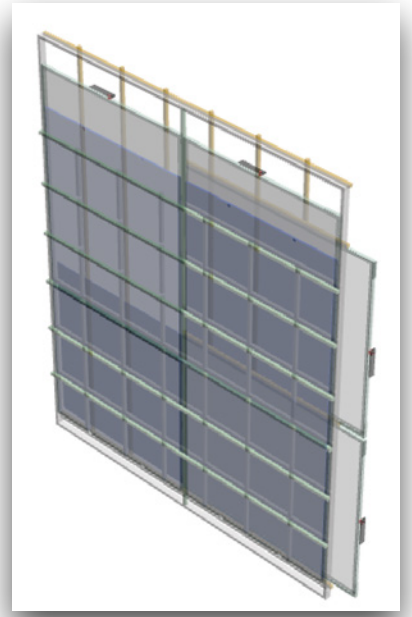
- **Video Camera**: improving design and lighting with LED

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

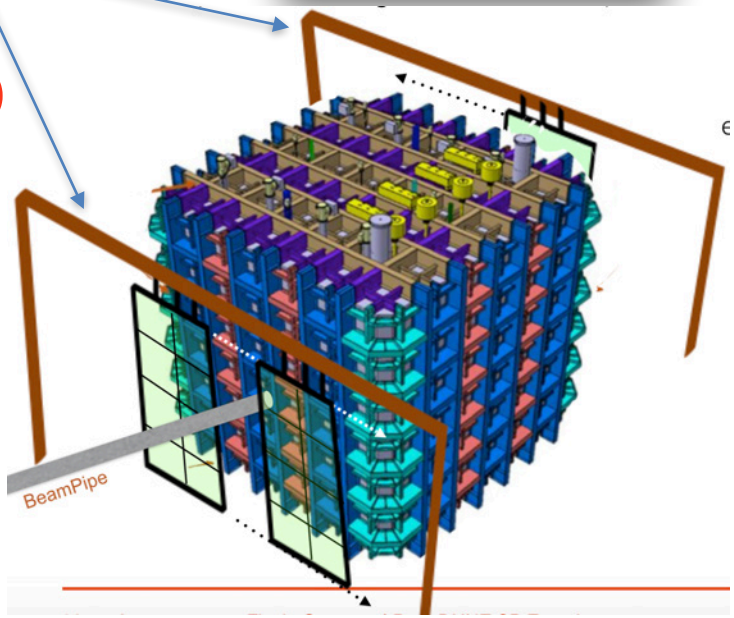
- **SlowCtrl/DCS** rack layout at EHN1 completely finalized.

-*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



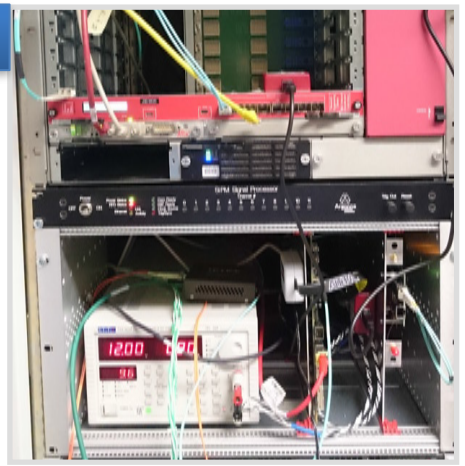
- All **electronics components** tested, few modifications needed. Integration with main system under study.

DAQ

- 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

Vertical Slice Test

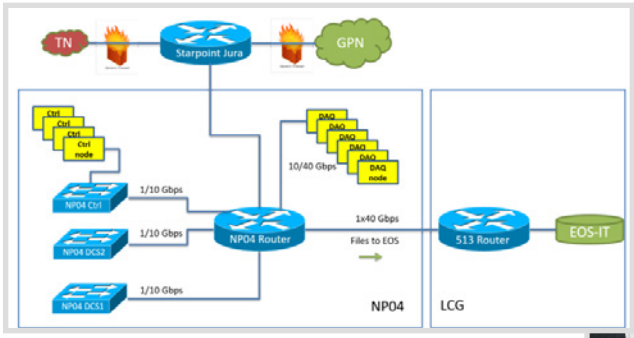


RCEs

SSP

Timing System

Network



Racks

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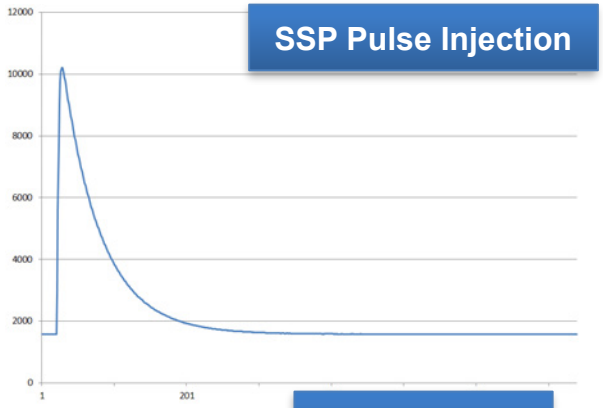
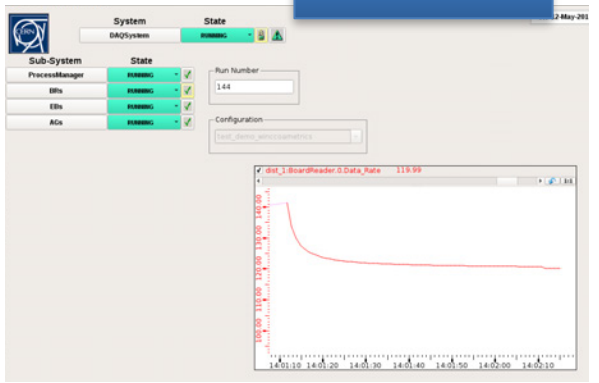
DAQ

- **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

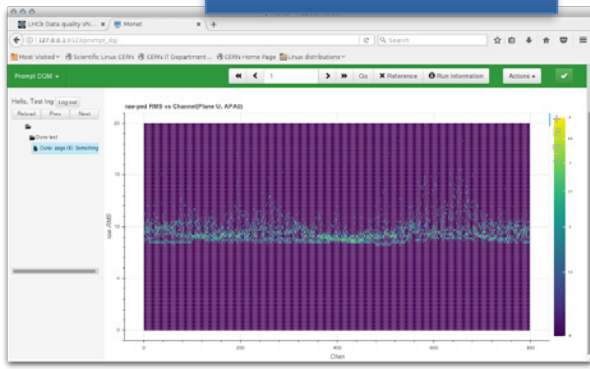
SSP Pulse Injection



Run Control



Online Monitoring



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Data Quality Monitoring and P3S

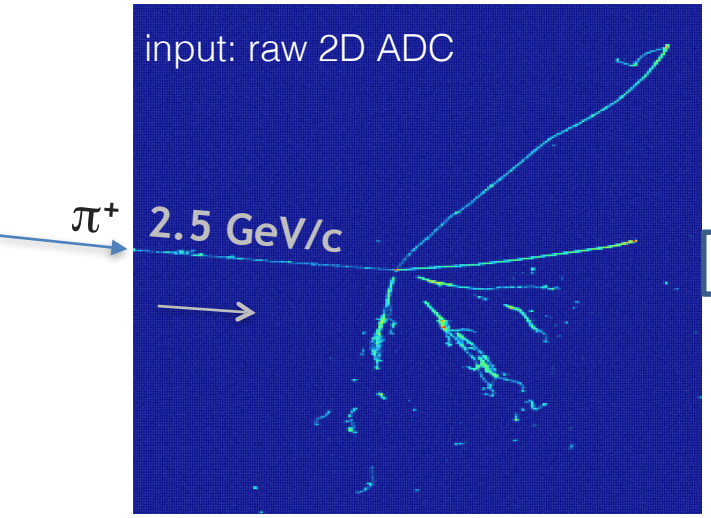
- DQM more relaxed time to result (up to an hour) wrt OnLine Monitoring, allowing for more sophisticated/time-consuming algorithms to be run
- low bandwidth (only a small fraction of data is processed)
- can use data which is not part of the DAQ stream e.g. the Beam Instrumentation data
- **DQM: types 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

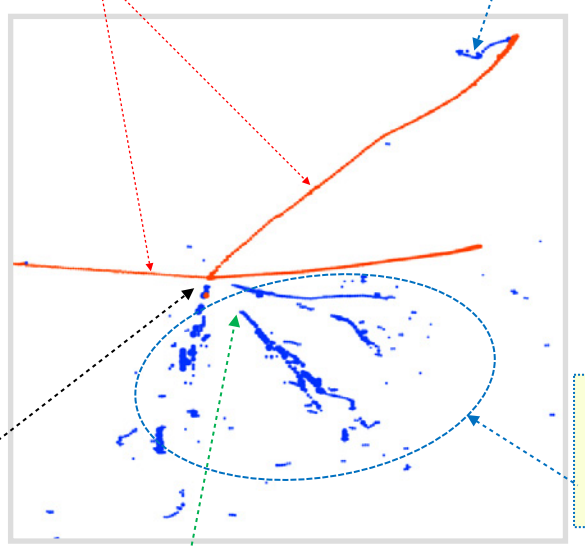
- P3S: computing platform for DQM & Prompt Processing —> Serving data and visual products to the user

Data Reconstruction and Analysis

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





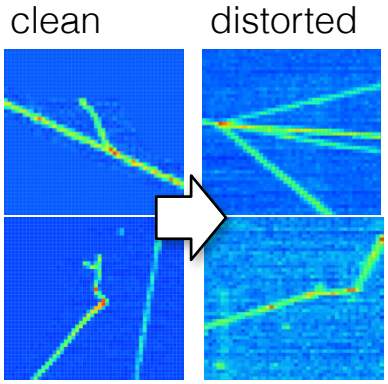
1. EM selection: done
➡ labeling with CNN

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)

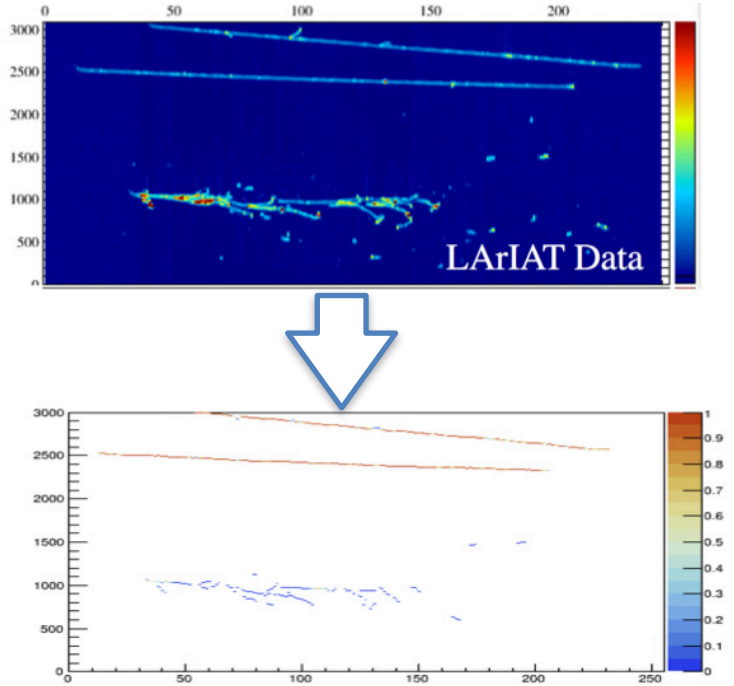
CNN based EM/track separation



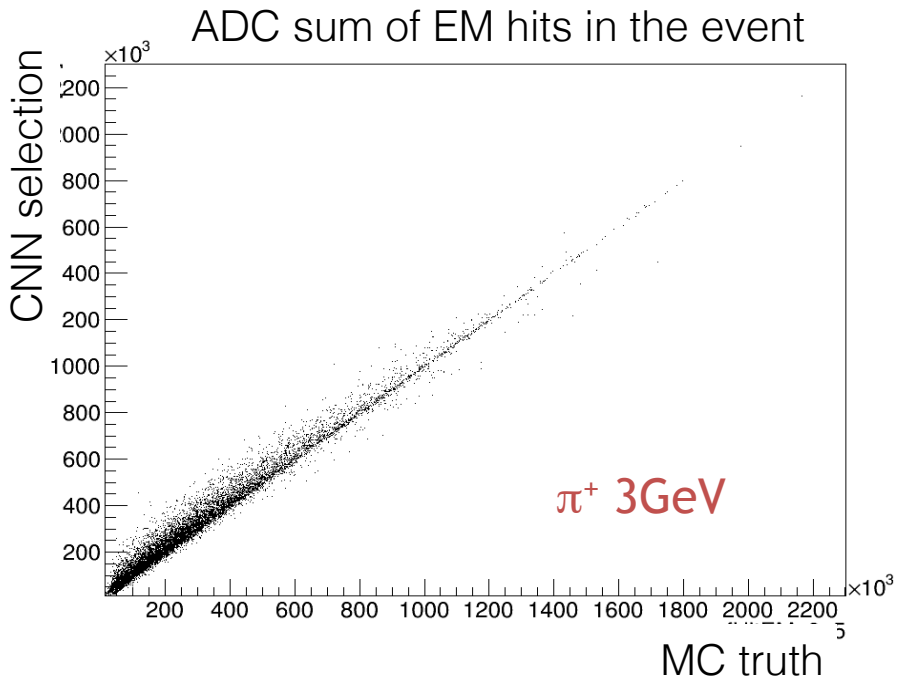
- validation and improvements with using the LArIAT data sample
- tests on distortions and noise patterns: no major deterioration

- integration with PMA: done (included in MCC9)
- integration with Pandora: started (towards applications in DUNE FD)

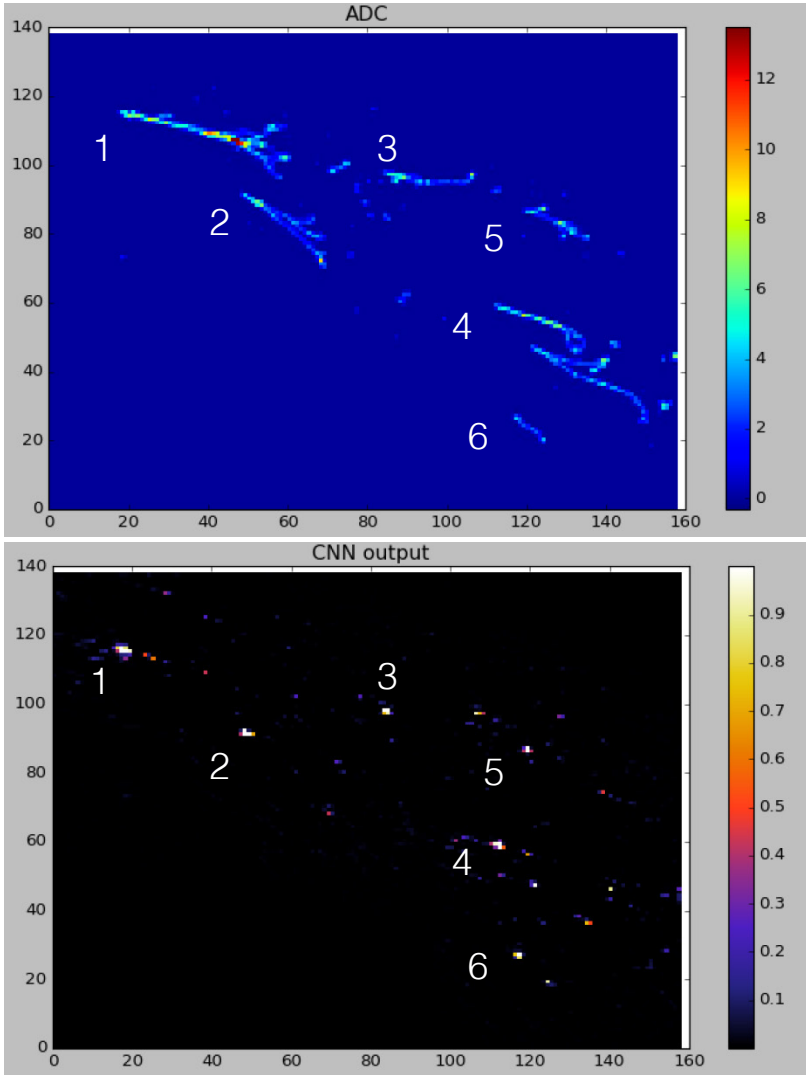
- Michel electron localization and reconstruction
  → now using MCC9's large statistics



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



CNN based EM cascade reco



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

Conclusion

- 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*
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- M. Potekhin, B. Viren *and the DQM/P3S Team*
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