Dual Phase Photon Detection (DPPD) System Consortium: Status and Plans

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LBNC Review
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DPPD membership & organization

- Charge: Plan and execute the construction, installation and commissioning of the Far Detector Dual-Phase Photon Detector System
- Institution members:

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USA	University of Iowa	Jane Nachtman	jane-nachtman@uiowa.edu
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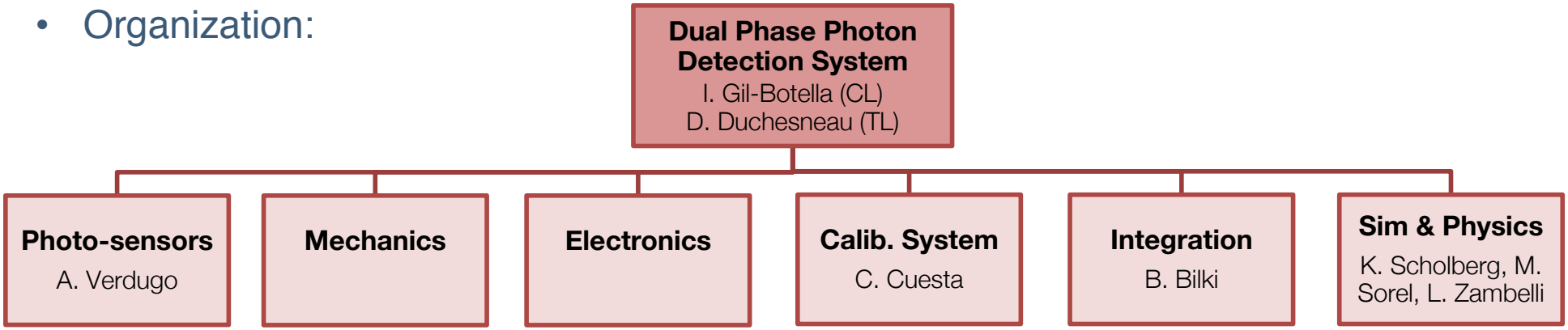
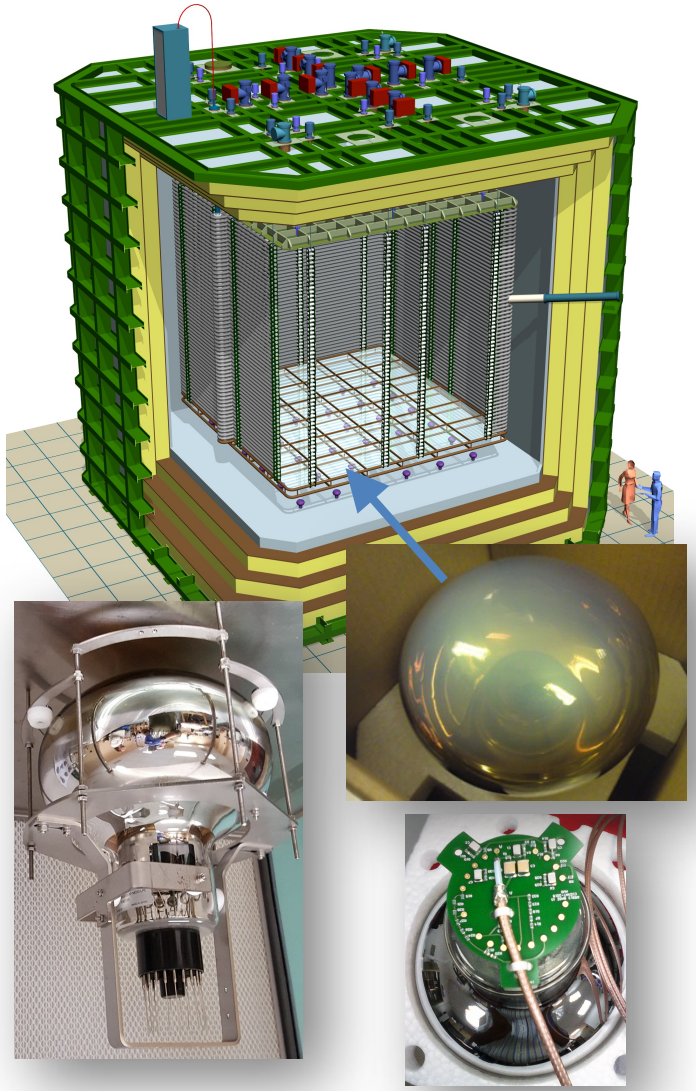
USA	University of Texas (Austin)	Karol Lang	lang@physics.utexas.edu

- Organization:



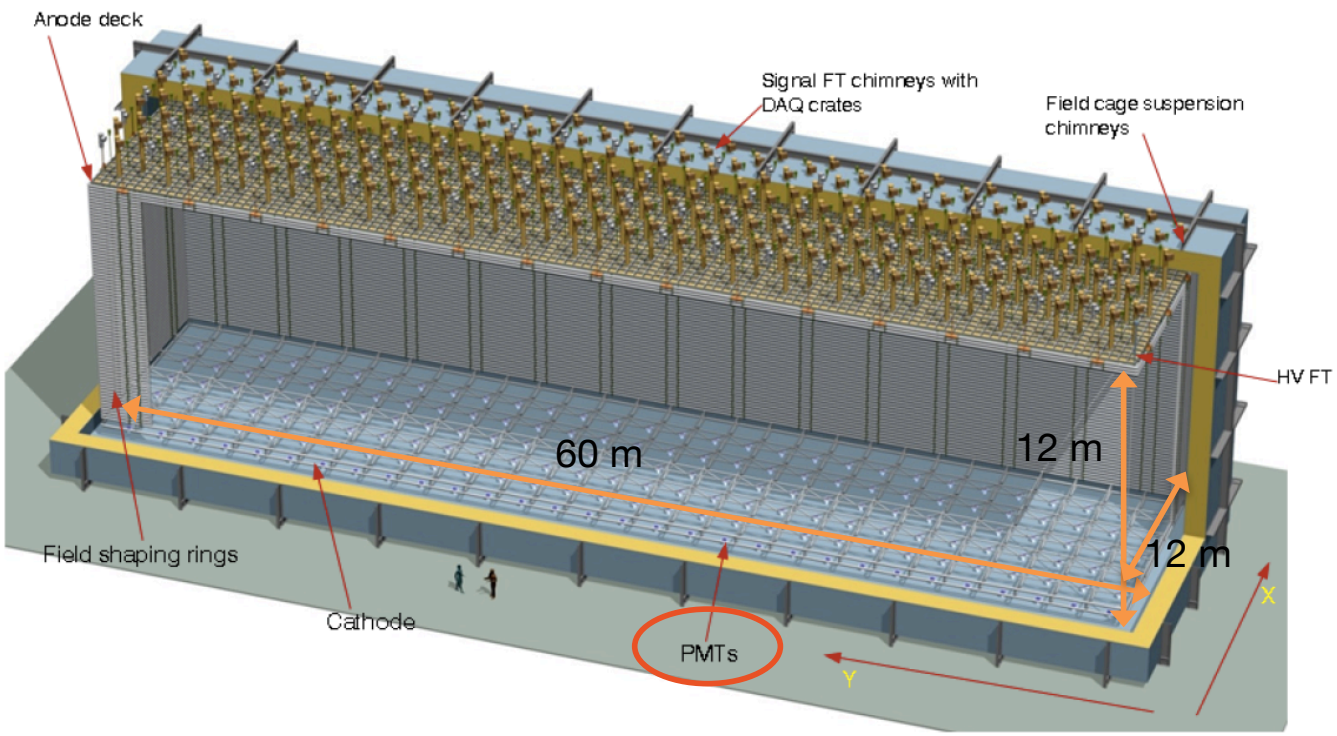
Current FD DPPD baseline design

- **Current design** is based on **protoDUNE-DP** Photon Detection system
  - 8” Hamamatsu R5912-02mod PMT of 14 dynodes at the bottom of the detector (below the cathode)
  - Wavelength-shifter: direct TPB coating on PMT
  - Light collectors being considered
  - PMT mechanical assembly similar to ProtoDUNE-DP
  - Voltage divider base + single HV-signal cable + splitter (external)
  - Light calibration system: light source and fiber system
  - DAQ system (external)



C. Cuesta et al. Photon detection system for ProtoDUNE dual phase JINST12 (2017) C12048

Dual-Phase DUNE Far Detector



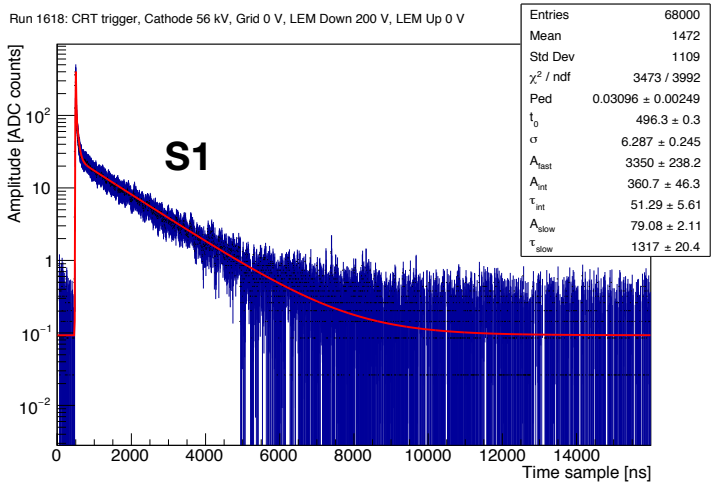
Goals of Photon Detector system:

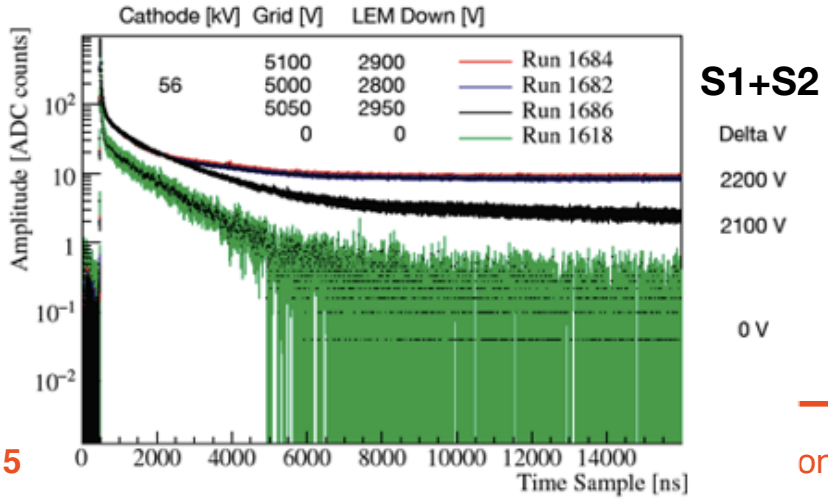
- trigger for non-beam events
- t_0 for beam and non-beam events
- explore other possibilities (PID, calorimetry, etc.)

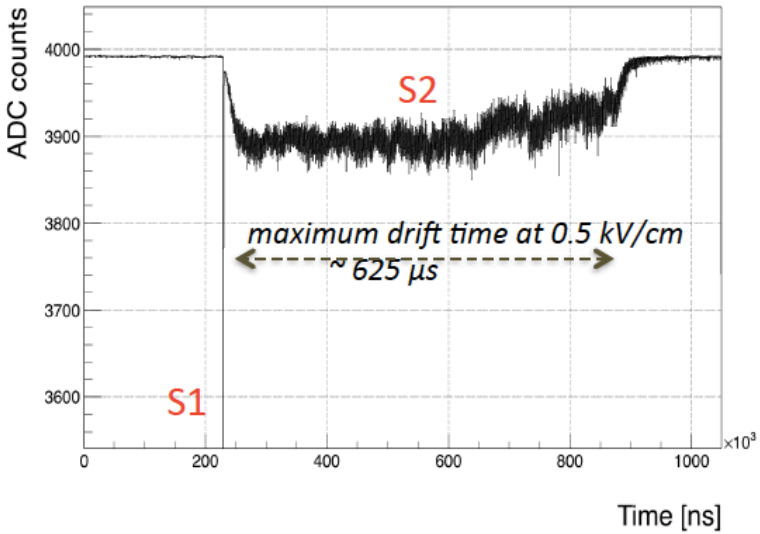
- DUNE Physics WG should define the physics **requirements** in terms of expected performance of the photon detection system
- Final design will be fixed based on **protoDUNE-DP data** & **DP FD MC simulations**

3x1x1 m^3 dual-phase demonstrator

- **Basic system tested** in dual-phase 3x1x1 m^3 prototype at CERN
- **Precious light data from 3x1x1 m^3** being analyzed







Interfaces

GROUP	INTERFACE COMPONENT	Doc-DB
DP Electronics	Readout electronics	6772
HV system	Cathode design	6799
Slow Control & Cryogenics instrumentation	Distribution of racks, power supplies definition, interlocks needs, RTD in cryostat, monitoring	6781
DAQ	Light data acquisition	6802 (TBD)
LBNF/cryostat	Penetrations, feedthroughs and fixation on the membrane	6979
Inst. and integration facility	Activities foreseen underground with the Underground Inst. Team	7006 & 7033
Calibration Task Force	PMT calibration system, control software, databases, data format	7060
Physics	Physics requirements	7087
Software	Implementation of geometry, simulation, reconstruction and analysis tools	7114

DPPD Strategy Document (DUNE-doc-6892)

Optimization and final DPPD design system will be driven by:

ProtoDUNE-DP data

- Fundamental step to understand the performance of the baseline photon detection system
- This will be used to tune MC simulations and extrapolate the performance to DUNE FD

Simulation studies

- Needed to optimize the photon system to meet the physics requirements
  - Light collection efficiency
  - Number of channels
  - Photosensor requirements
  - Dynamic range of readout electronics and timing resolution
  - Trigger strategy for non-beam events

DUNE Physics WG should define the physics requirements in terms of expected performance of the photon detection system

DPPD Strategy Document (Timeline)

- April 2018: Technical Proposal
  - Overview of current baseline design based on protoDUNE-DP design
  - Initial institutional expressions of interests for all components
  - High-level cost estimation
- April 2019 - Technical Design Report
  - Include full simulation of photon detection system & light propagation
  - Include input from protoDUNE-DP data
  - Detail specifications of all major systems
  - Identify possible issues/risks or needed optimizations
  - Define institutional responsibilities for all components
  - Provide system cost

Activities for 2018/2019

- DPPD activities during next 16 months will be focused on:

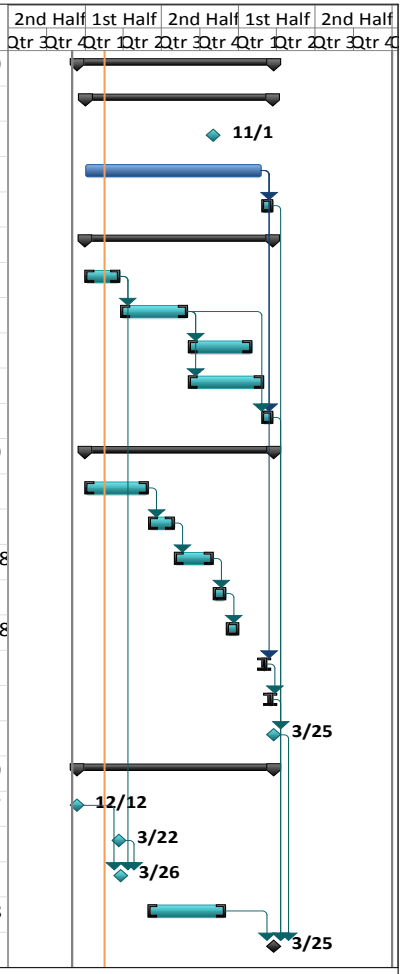
1. **Provide the design** of the photon detection system for the 10kt detector, including details about photosensors, mechanics, electronics, calibration
2. Demonstrate at which level the proposed photon system fulfills the **physics requirements**
3. **Production** and **assembly** planning including **quality control**
4. **Interfaces** with other systems
5. **Integration** and **installation** planning including **safety**

DPPD Decision Strategy

- By the end of 2018, the DPPD consortium will establish the detector performance required to meet the physics goals of DUNE.
- Prior to the TDR, the DPPD Consortium will **validate the baseline design** using both **simulation** and **ProtoDUNE data**.
- The Consortium will propose an alternative photon detection system or improvements to the baseline design if needed.

DPPD Schedule

ID	WBS	Task Name	Duration	Start	Finish
109	**6**	**Dual Phase Photon Detector Consortium**	**334 days**	**Tue 12/12/17**	**Mon 3/25/19**
110	**6.1**	**Photosensors**	**320 days**	**Mon 1/1/18**	**Fri 3/22/19**
111	6.1.1	ProtoDUNE Based Photosensor Design Complete	0 days	Thu 11/1/18	Thu 11/1/18
112	6.1.2	Installation and Commissioning of PD-DP	300 days	Mon 1/1/18	Fri 2/22/19
113	6.1.3	Modify Design as necessary based on protoDUNE-DP data	20 days	Mon 2/25/19	Fri 3/22/19
114	**6.2**	**PMT calibration system**	**320 days**	**Sun 12/31/17**	**Fri 3/22/19**
115	6.2.1	Define calibration requirements	61 days	Sun 12/31/17	Fri 3/23/18
116	6.2.2	System design	115 days	Mon 3/26/18	Fri 8/31/18
117	6.2.3	Selection of fibers, light source, and other elements	109 days	Mon 9/3/18	Thu 1/31/19
118	6.2.4	Production and testing plan	129 days	Mon 9/3/18	Thu 2/28/19
119	6.2.5	Revise the system in light of protoDUNE-DP data	20 days	Mon 2/25/19	Fri 3/22/19
120	**6.3**	**Simulation & Physics**	**320 days**	**Sun 12/31/17**	**Mon 3/25/19**
121	6.3.1	Develop Light Simulation Tools	109 days	Sun 12/31/17	Wed 5/30/18
122	6.3.2	First solution for full DP FD optical simulation in LArSoft	44 days	Thu 5/31/18	Tue 7/31/18
123	6.3.3	Develop Reconstruction and Background rejection algorithms	66 days	Wed 8/1/18	Wed 10/31/18
124	6.3.4	Simulation studies for rare events	22 days	Thu 11/1/18	Fri 11/30/18
125	6.3.5	Refine DP-PD FD design requirements	21 days	Mon 12/3/18	Mon 12/31/18
126	6.3.6	Tune light simulation based on protoDUNE data	10 days	Mon 2/25/19	Fri 3/8/19
127	6.3.7	Repeat Simulation studies	10 days	Mon 3/11/19	Fri 3/22/19
128	6.3.8	Validation of DUNE trigger strategy	0 days	Mon 3/25/19	Mon 3/25/19
129	**6.4**	**TP/TDR**	**334 days**	**Tue 12/12/17**	**Mon 3/25/19**
130	6.4.1	Complete Initial Pass of Interfaces	0 days	Tue 12/12/17	Tue 12/12/17
131	6.4.2	Complete Draft Production schedule and intial cost estimate	0 days	Thu 3/22/18	Thu 3/22/18
132	6.4.3	DP-PD Technical Proposal - Submit for Internal Review	0 days	Mon 3/26/18	Mon 3/26/18
133	6.4.4	Develop construction, QC, transportation, and installation plans	132 days	Wed 5/30/18	Thu 11/29/18
134	6.4.5	DP-PD TDR - Submit for Internal Review	0 days	Mon 3/25/19	Mon 3/25/19



Project: FD Int schedule
Date: Fri 2/16/18

Task		External Milestone		Manual Summary Rollup	
Split		Inactive Task		Manual Summary	
Milestone		Inactive Milestone		Start-only	
Summary		Inactive Summary		Finish-only	
Project Summary		Manual Task		Deadline	
External Tasks		Duration-only		Progress	

Key milestones

Simulation and Physics

- **Q3 2018:** Propose a solution for a full Dual Phase Far Detector optical simulation in LArSoft
- **Q4 2018:** Study the physics reach with the current DPPD performance and identify possible risks/issues
- **Q1 2019:** Tuning light simulation using protoDUNE-DP light data
- **Q2 2019:** Optimization of the DPPD performance to fulfil the physics requirements

Photosensors

- **Q1 2019:** Validation of PMTs & light readout electronics performance with protoDUNE-DP data
- **Q1 2019:** Modify design and LRO specifications as necessary based on protoDUNE-DP data

PMT calibration system

- **Q2 2018:** Initial design of the system for Technical Proposal
- **Q1 2019:** Review the proposed design in light of protoDUNE-DP calibration data

TP/TDR

- **Q2 2018:** DPPD Technical proposal
- **Q2 2018:** Initial WBS & high-level cost estimations
- **Q2 2019:** DPPD Technical Design Report

DPPD HIGH-LEVEL MILESTONES	2018				2019	
	Q1	Q2	Q3	Q4	Q1	Q2
Simulation & physics						
Understanding the DUNE physics requirements affecting the DPPD system						
Propose a solution for a full Dual Phase Far Detector optical simulation in LArSoft						
Study the physics reach with the current DPPD performance and identify possible risks/issues						
Tuning light simulation using protoDUNE-DP light data						
Optimization of the DPPD performance to fulfil the physics requirements						
Photosensors						
Validation of PMTs & light readout electronics performance with protoDUNE-DP data						
Final definition of readout electronics requirements						
PMT calibration system						
Initial design of the system for Technical Proposal						
Review the proposed design in light of protoDUNE-DP calibration data						
Mechanics						
PMT layout definition						
Review the proposed design in light of protoDUNE-DP operation						
Definition of the mechanical integration with cryostat						
Integration, installation & commissioning						
Safety requirements, integration facility design and definition of tests						
Underground installation plan						
Management & Organization						
Definition of milestones & activities						
Initial schedule & risks evaluation						
DPPD Technical proposal						
Initial WBS & high-level cost estimations						
Identification of risks						
DPPD Technical Design Report						
WBS and institutional responsibilities & cost						

Risks and main concerns

- Operation of **ProtoDUNE-DP** on the time scale needed for the TDR
- Development of **MC simulations** and needed **system performance studies** on time for TDR
- Propose an optimized system design on time for the TDR in case the DPPD baseline design does not fulfill the DUNE **physics requirements**
- Expanding the **consortium membership** and involvement
- Finding the needed **financial resources**