Introduction: MPD Workshop

Near Detector Design Group

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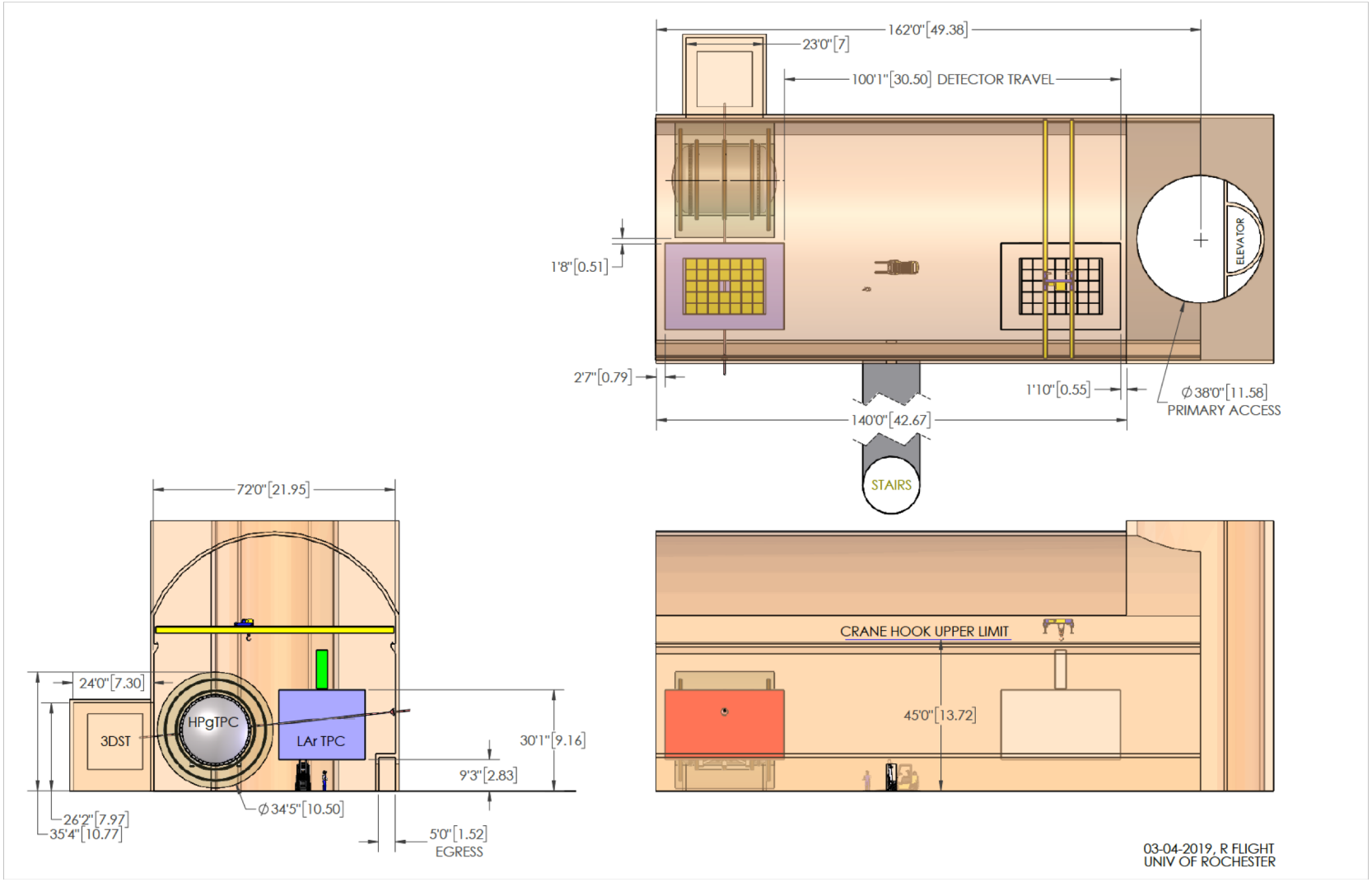
Executive Board Near Detector Recommendations

- A near detector suite consisting of a LArTPC (not in a magnetic field), a Multi-Purpose Detector (MPD) consisting of a HPgTPC, an ECAL, and 3D Scintillator Tracker (3DST) in a magnet.
  - The concept has now evolved with the NDDG proposing a stand-alone 3DST in a separate magnet, fixed on-axis.
- The design of a mobile LAr detector that can make measurements at one or more off-axis positions should go forward (DUNE-PRISM). Also study option of moving MPD
  - The Engineering integration group is assuming both LAr & MPD move
- The experimental floor area should be at least 42.5m x 17m and the hook height must be at least 13m, measured from the floor. The minimum lateral dimension of hall needs further study, and will ultimately be settled in EFIG.

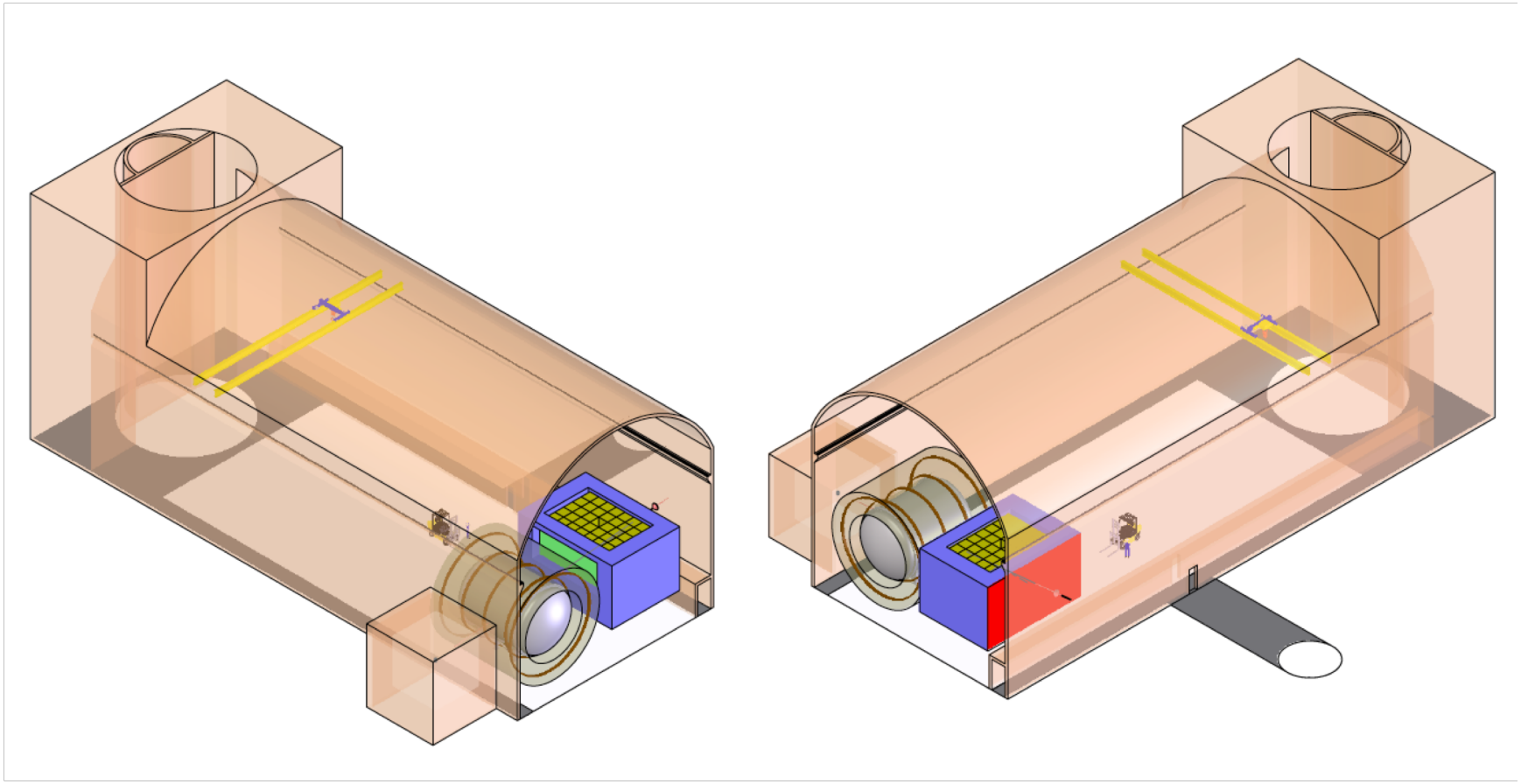
Current concept details

- **Prong 1: State-of-the-art Ar detectors:**
  - LAr - non-magnetized
    - **5 x 7 array of 1x1x3 m^3 modules: ~75t fiducial target mass**
    - Pixelated (raw 3D data) readout, Optically segmented modules
  - **Multi-purpose Detector (MPD) (Focus of this meeting)**
    - High-Pressure (10ATM) gas TPC (HPgTPC)
      - **1t fiducial target mass**
    - In ~0.5T field (magnetic spectrometer)
    - Surrounded by high-performance ECAL and muon tagger
- **Prong 2: DUNE-PRISM**
  - Move LAr and MPD off axis
- **Prong 3: Stand-alone 3-dimensional scintillator (CH) tracker (3DST)**
  - **4t fiducial target mass**
  - Magnetized, with external tracking and ECAL
  - Fixed on axis

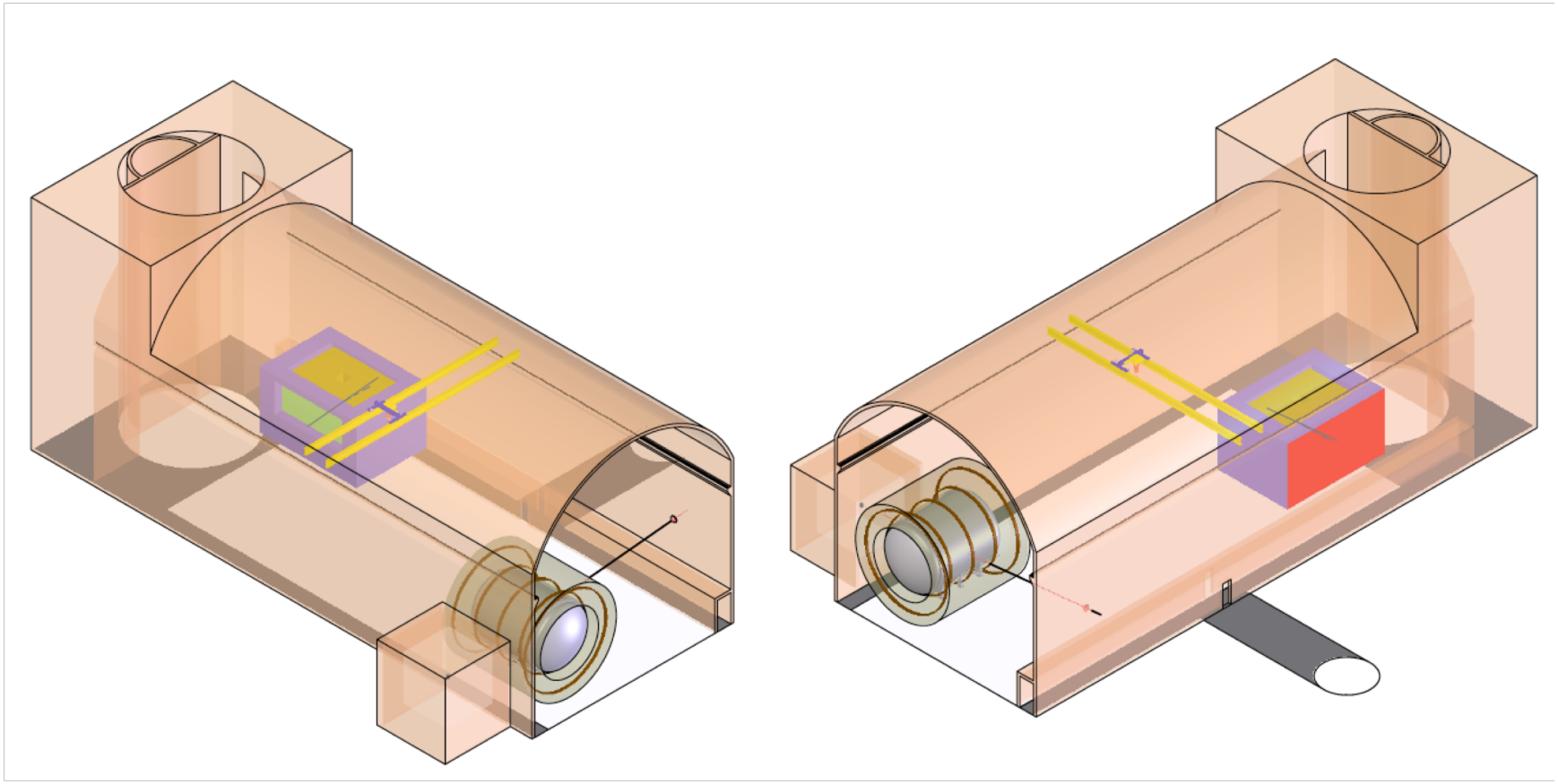
Current overarching concept



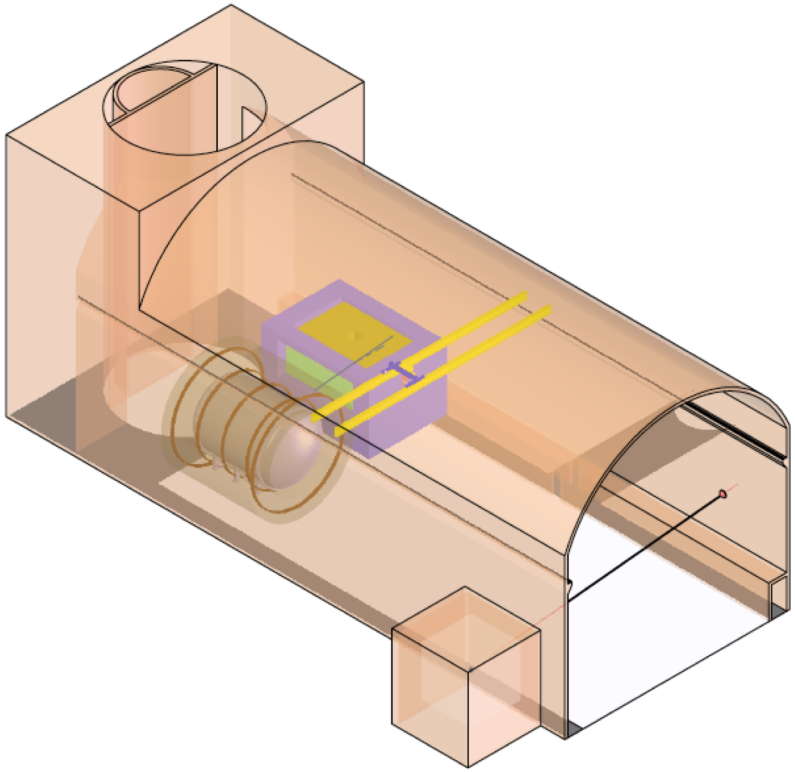
Hall layout: isometric, on-axis

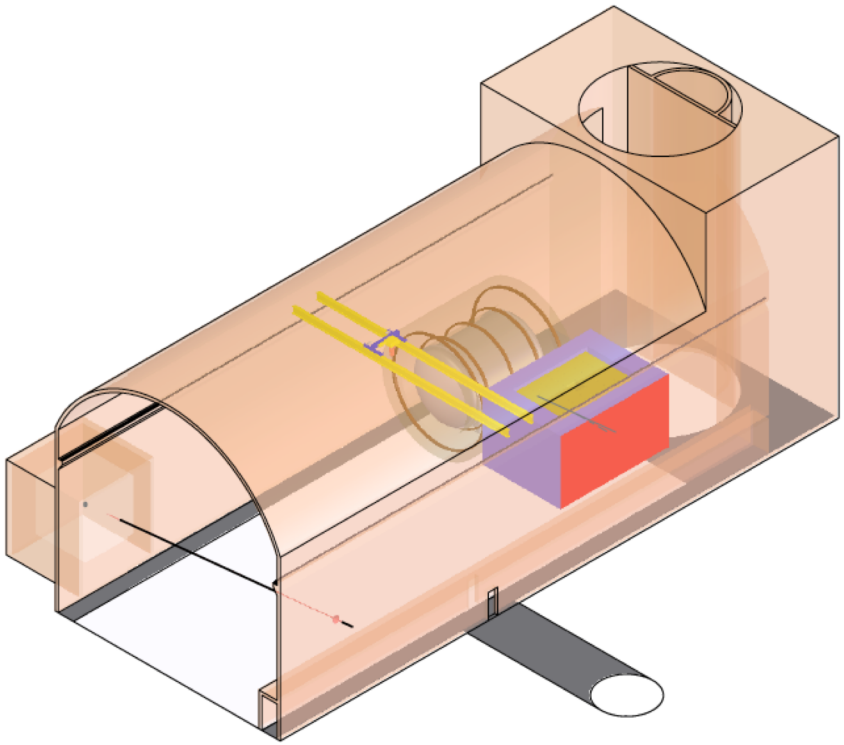


LAr off-axis



LAr + MPD off axis





Focus of this meeting

- MPD Components:
  - ECAL
  - Magnet
  - Photon detection
  - Muon tagger

Agenda

Monday, March 18, 2019

09:00 - 09:30	Welcome	
	09:00	**Welcome** *10′*
	09:10	**Meeting overview and goals** *20′* Speaker: Mr. Hirohisa Tanaka
09:30 - 11:00	KLOE	
	09:30	**Detector configuration** *20′* Speaker: Prof. Sergio Bertolucci (University of Bologna)
	09:50	**Simulation results** *20′* Speaker: Mr. Matteo Tenti (INFN - CNAF)
	10:10	**Ongoing Activities and discussion** *40′*
11:00 - 11:35	Coffee and tour of KLOE	
11:35 - 12:35	Newly built magnet	
	11:35	**SC Helmholtz coil design** *20′* Speaker: Prof. Alan Bross (Fermilab)
	11:55	**Magnet concepts** *20′* Speaker: Pasquale Fabbricatore
	12:15	**NC magnet option** *20′* Speaker: Mr. Sanjay Malhotra (BARC)
12:35 - 13:35	Newly built magnet II: Discussion	
13:35 - 15:05	LUNCH *1h30′*	
15:05 - 17:00	ECAL	
	15:05	**Neutron reconstruction in the ECAL** *40′* Speaker: Dr. Chris Marshall (Lawrence Berkeley National Laboratory)
	15:45	**CALICE-style ECAL** *30′* Speaker: Eldwan Brianne (DESY)
	16:15	**Downstream ECAL** *15′* Speakers: Prof. BIPUL BHUYAN (IIT Guwahati), Maharnab Bhattacharya
	16:30	**KLOE ECAL for MPD** *30′*
17:00 - 17:20	Coffee	
17:20 - 18:50	ECAL II	
	17:20	**ECAL readout electronics: VMM3** *20′* Speaker: Brian Kirby
	17:40	**Discussion** *1h10′*
18:50 - 20:50	Dinner	

Tuesday, March 19, 2019

09:00 - 10:40	Photon Detection	
	09:00	**SiPM development at FBK-Italy** *20′* Speaker: Alessandro Montanari (INFN - Bologna)
	09:20	**Photon detection in the HPgTPC** *20′* Speaker: Prof. Alan Bross (Fermilab)
	09:40	**Photo-detector options for CALICE ECAL** *30′* Speaker: Prof. Lucia Masetti (Johannes Gutenberg University Mainz)
	10:10	**Photo-detector options for KLOE ECAL** *30′*
10:40 - 11:00	Coffee	
11:00 - 12:30	Muon system	
	11:00	**Muon system requirements** *30′*
	11:30	**Technology options** *30′*
	12:00	**Discussion** *30′*
12:30 - 13:30	General discussion and close-out	
13:30 - 15:00	Lunch	
15:00 - 16:00	General discussion and close-out	

- Thanks to our hosts at INFN Frascati!
  - Gabriele Sirri
  - Maria Cristina D'Amato

MPD ECAL

- The ECAL for the MPD will have a number of components
  - Barrel upstream
  - Barrel downstream
  - End caps
- Each functional part is likely to have inner/outer sections
  - HPgTPC pressure vessel design will impact design considerations for the barrel inner/outer.
- The required dynamic range (granularity?) for the barrel downstream will be greater than that for the barrel upstream
- Ample opportunity for collaboration and potential for repurposing an existing detector

Magnet

- A newly built magnet is needed for the MPD
- A superconducting (SC) approach is favored
  - but both SC and Normal Conducting (NC) are being explored
- Superconducting
  - Helmholtz coil design
  - Current concept now has 3 coils to provide main field and 2 coils to contain stray field
- Normal Conduction
  - BARC has evaluated the old LBNE (UA1-style magnet) design, but now optimizing for current HPgTPC + ECAL concept

Photon detection

- Photon detectors (primarily SiPMs) are used extensively in the MPD (and LAr detector)
  - Could also be part of the muon tagger too, if scintillator strips are used there
- Again, ample opportunity for collaboration
- Engaging industrial sources for the SiPMs at an early stage will be extremely advantageous

MPD Muon tagger

- Little work has been done on the muon tagger
- In order to reduce backgrounds from neutrino interactions in non-active material, the design approach is to minimize materials used in the MPD muon tagger
  - Design studies needed to determine what is needed beyond the HPgTPC's PID and the ECAL's signal

Looking forward

- 3/2019: Executive summary of ND design in the far detector TDR
- End 2019: Conceptual Design Report with detailed design concept
- 2020: Technical Design Report
- LBNC:
  - 12/2018: ND design concept LBNC for first time.
    - “provide an abbreviated description, but with sufficient detail to be reviewed, in mid-2019”
    - “It will be important to clearly articulate the physics impact of the different components”
  - 4/2019: LBNC meeting update on ND status towards June meeting
  - 6/2019: LBNC meeting focused on ND design

Conclusions

- The Near Detector is a critical component of DUNE
  - It drives the capabilities of the experiment with respect to the flagship long baseline neutrino oscillation measurements
  - A complete design of the ND is needed to fully define the experiment
- International (non-US) and US interests/roles are starting to come together
- A very rapid timetable is set to converge on the design and assess cost and capability
  - There is a lot of work to do both in developing the design and studying its impact on the physics
  - A coherent and focused effort following the Executive Board recommendations is essential