Summary
CERN ND Workshop

DUNE Monthly Collaboration Call

8-Dec-2017

Kam-Biu Luk, **Alfons Weber**
Steven Manly, Mike Kordosky

Science & Technology Facilities Council
Rutherford Appleton Laboratory

UNIVERSITY OF OXFORD

Charge

- Make progress on unsettled issues
  - Details in DUNE-doc-5831
- No decisions, but define questions for technologies to be judge
- ND WS and design group agreed summary and outcome
  - Details in DUNE-doc-6263

Timeline

1	Target date	Milestone	Type	Tier	Original date	Complete
40	Jan-17	Launch of expressions of interest in ND Concept Study	ND	2	Jan-17	Feb-17
44	Mar-17	ND Concept Study workshop	ND	2	Mar-17	Mar-17
50	May-17	Define two/three ND concept options for further study	ND	2	May-17	May-17
56	Jun-17	ND Concept Study workshop	ND	2	Jul-17	Jun-17
69	Nov-17	ND Concept Study workshop (CERN)	ND	4	Nov-17	
73	Nov-17	Document criteria/physics processes for ND tracker choice	ND	3	Nov-17	
74	Nov-17	Document criteria for comparison of magnet options	ND	3	Nov-17	
77	Dec-17	Report on cost implications/technical risks of Solenoid option	ND	3	Dec-17	
85	Jan-18	Status report on ND tracker studies - define next steps	ND	3	Jan-18	
86	Jan-18	Recommendattion on whether to purse PRISM concept	ND	2	Jan-18	
87	Jan-18	Report on scientific arguments for magnet to EC	ND	3	Jan-18	
89	Feb-18	Decision on ND Magnet	ND	2	Feb-18	
91	Mar-18	Report on comparison of tracker options and recommendation	ND	3	Mar-18	
92	Mar-18	Report on benefits of PRISM concept and recommendation	ND	3	Mar-18	
93	Mar-18	Report on benefits of 3-D scintillater as part of MPT and recommendation	ND	3	Mar-18	
94	Mar-18	ND Concept Study workshop	ND	4	Mar-18	
97	Apr-18	Decision on PRISM concept	ND	2	Apr-18	
98	Apr-18	Decision on 3-D scintillator	ND	2	Apr-18	
99	Apr-18	Decision on ND Tracker technology	ND	2	Apr-18	
101	May-18	Decision on the conceptual design of the near detector systems	ND	1	Dec-17	
104	Jun-18	Start of ND EoI process	ND	2	Jan-18	
124	Apr-19	Draft of CDR for Near Detector	ND	2	Sep-18	
130	Aug-19	Review of Near Detector CDR	ND	1	Aug-19	
135	Apr-20	TDR for Near Detector	ND	1	Apr-20	
136	Jun-20	LBNC Review of Near Detector TDR	ND	1	Jun-20	
137	Aug-20	CD-3 and LBNC Reviews for near site and Near Detector	ND	1	Aug-20	

Concepts under study

- LAr TPC with pixel readout
  - Augmented by muon system (MPT or otherwise)

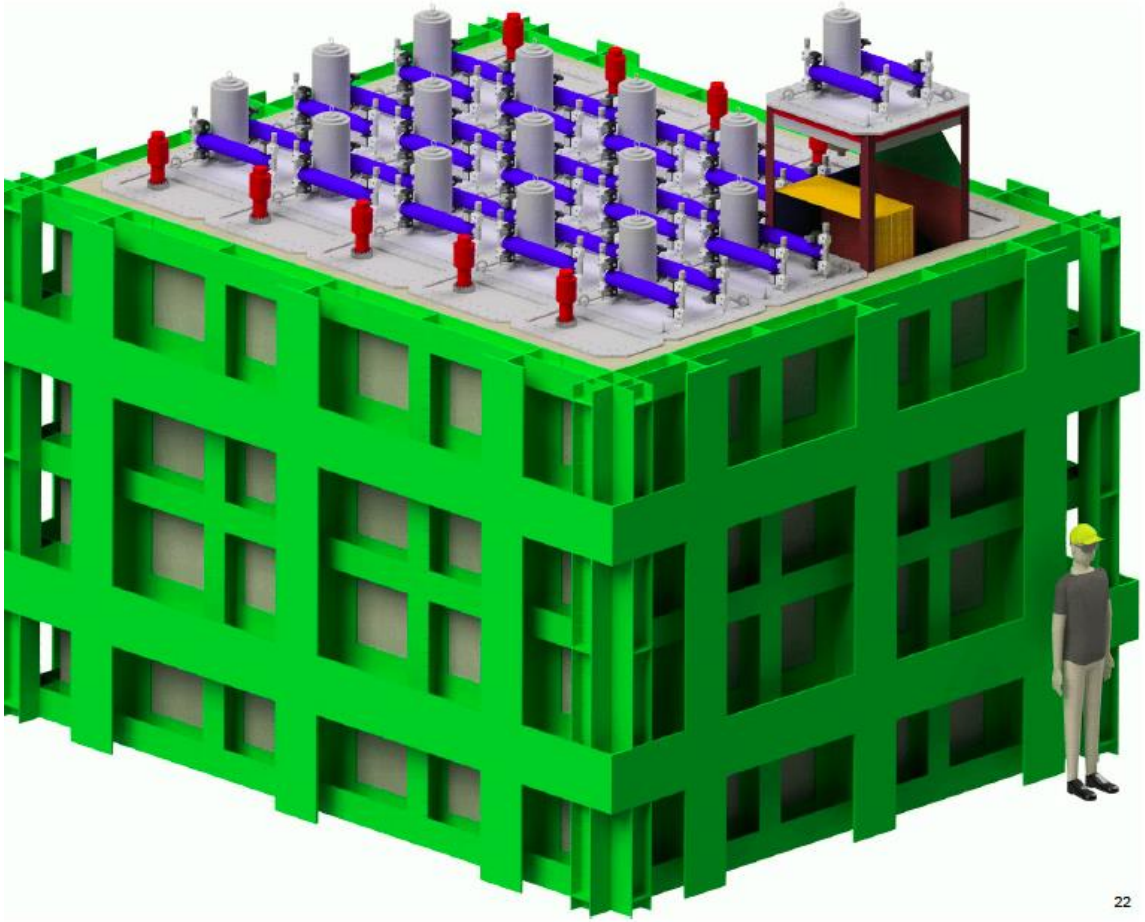
- Multi-purpose tracker (MPT)
  - HP TPC or straw tube tracker
  - Traditional Dipole or KLOE superconducting solenoid
  - Possibly augmented with 3D scintillator

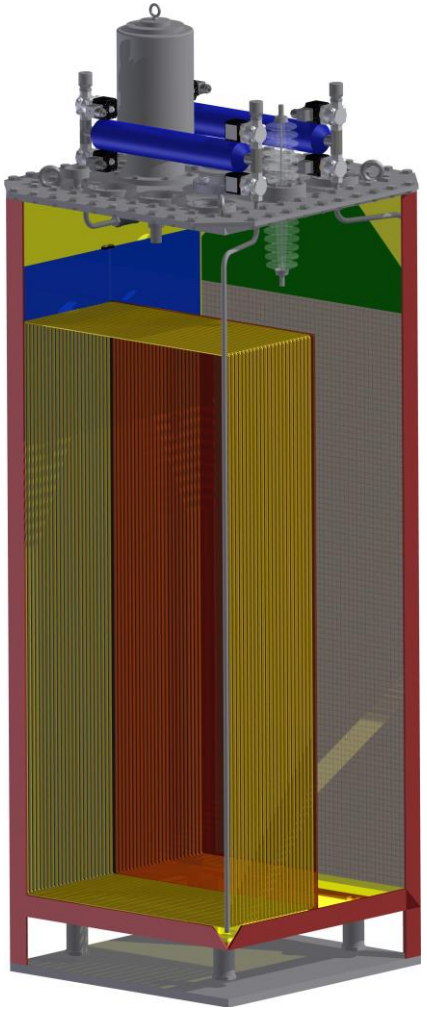
- DUNEPRISM
  - Movable detectors (off-axis 0~30 m)

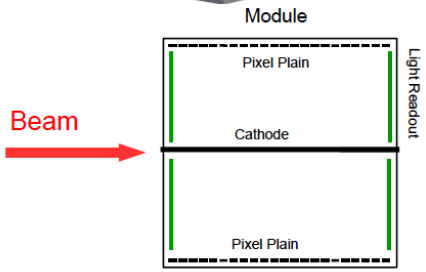
Key Reactions

- Neutrino-electron elastic scattering
  - Theoretically well understood
  - Total flux and energy spectrum (stat limited)
- Coherent pion
  - Beam divergence
- Low-ν method
  - Flux shape
- CC-Inclusive (electron/muon)
  - The signal
- NC and CC pi0 production
  - The BG

ArgonCube Concept
(4x5x3 m^3)





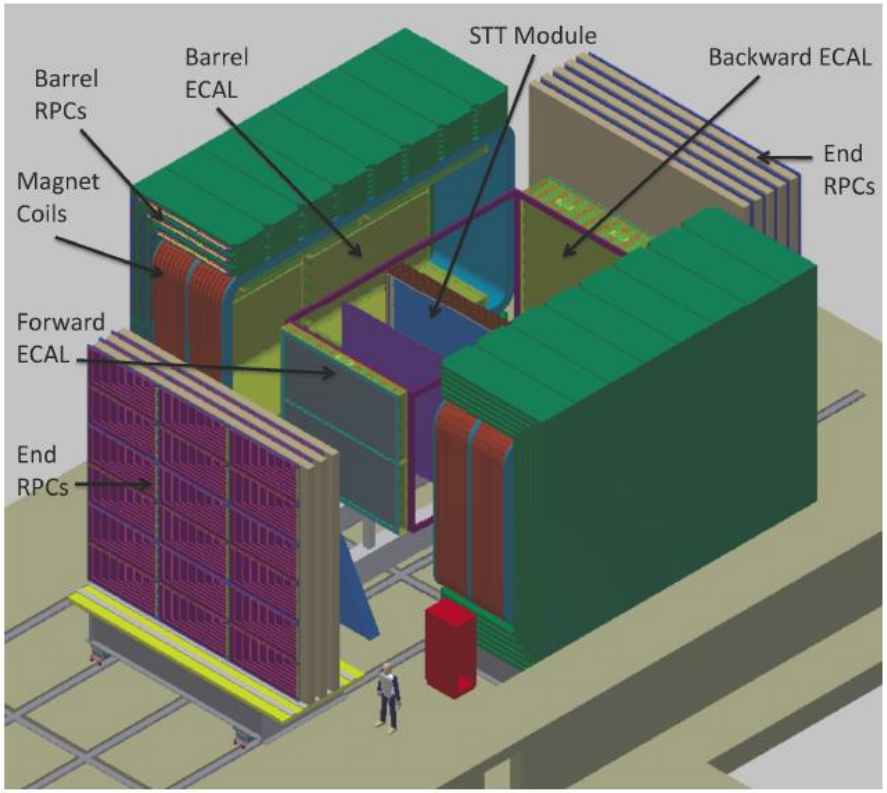


LAr Detector

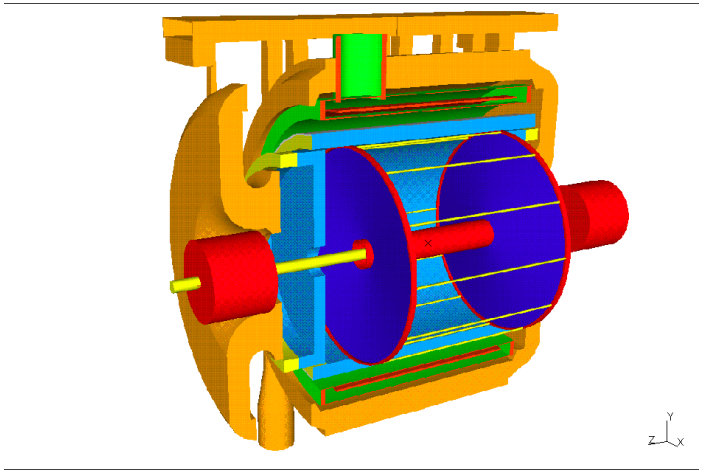
- Functionally similar to FD, but adapted to high rate environment
- Purpose
  - Study selection and detector effects in LAr
  - Related neutrino to visible energy on Ar
  - Maybe have High statistics neutrino electron scattering
- Questions
  - What is the cost?
  - Can it handle the high rate?
  - Demonstrate that the pixel readout works!
  - Is a side and downstream muon systems needed?

Magnet Choice

ND280-like dipole



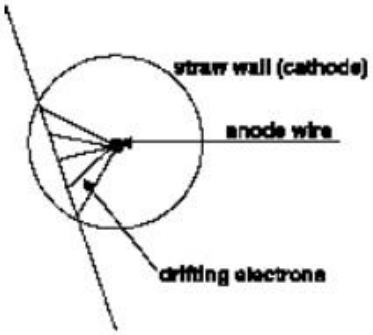
KLOE SC solenoid

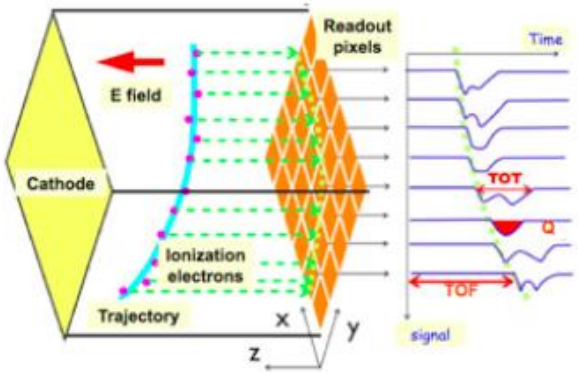


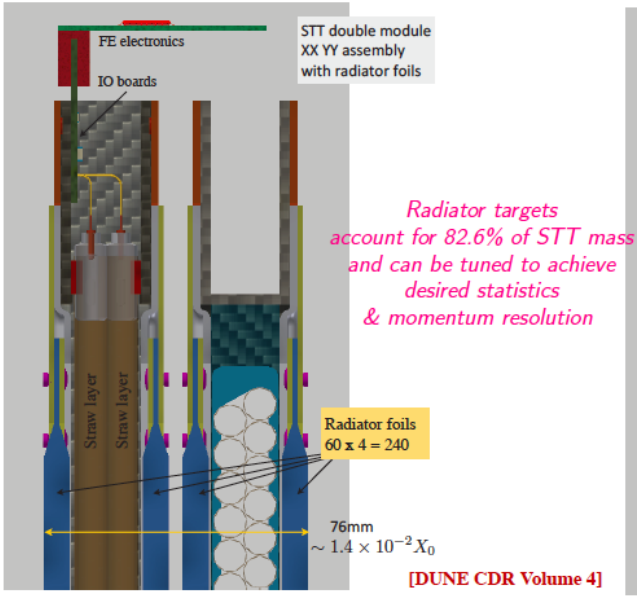
Magnet Question

- KLOE magnet is solenoid and has smaller volume
- Can one do the physics?
- Questions
  - statistics in different channels
- key performance figures
  - Muon momentum/angular resolution as a function of E,FV
  - Electron energy/angular resolution (E,FV)
  - Pi0 energy resolution and efficiency in neutrino interactions
  - Muon acceptance angle/energy for LAr (and resulting uncertainties)
  - Background rate in ECAL and FV

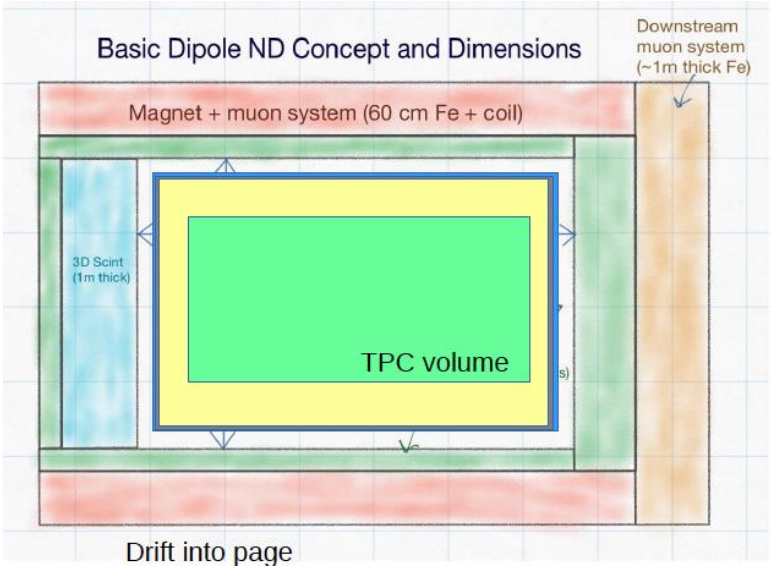
Tracker Technology







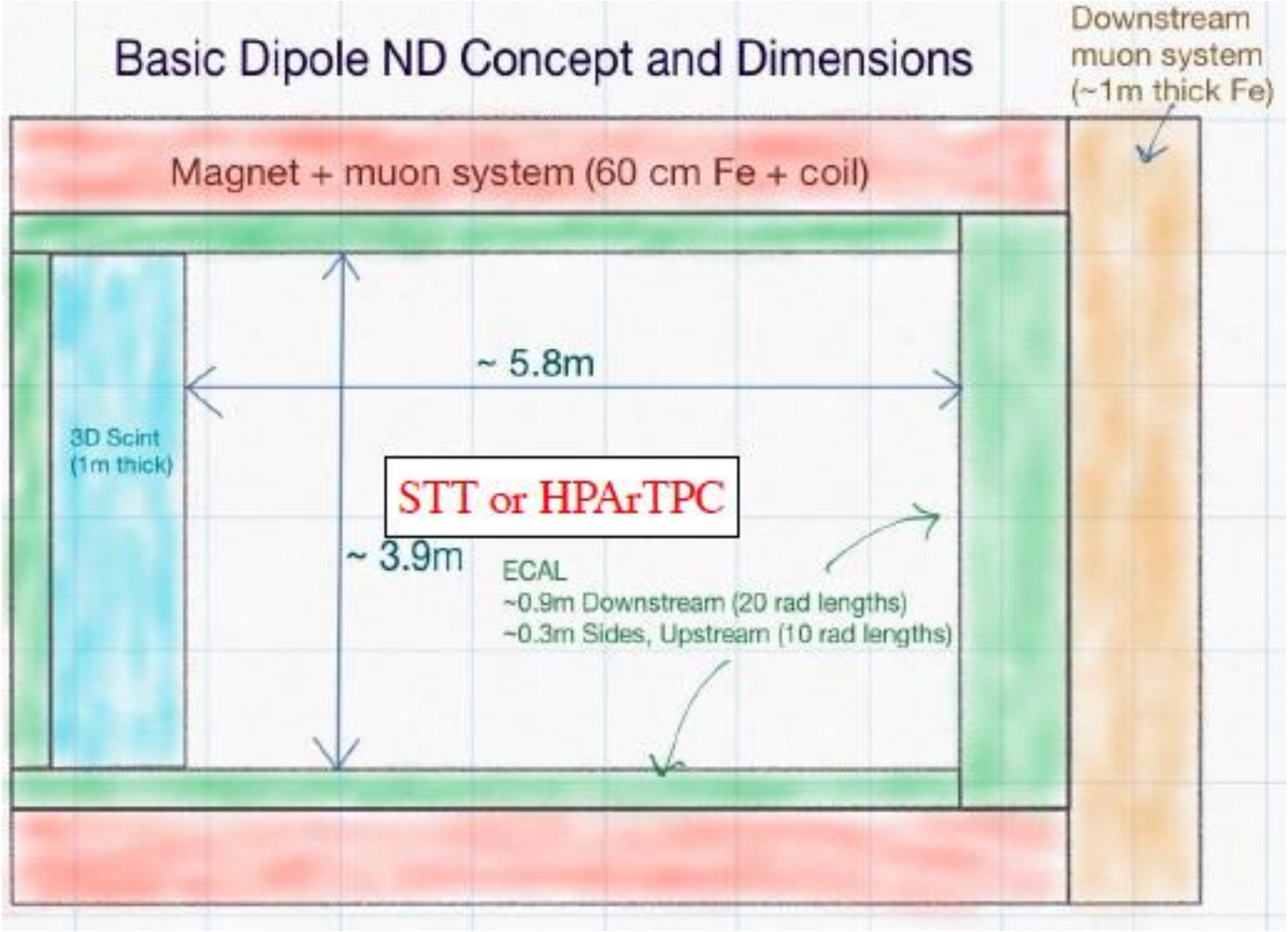
Radiator targets account for 82.6% of STT mass and can be tuned to achieve desired statistics & momentum resolution



Tracker Questions

- What is the tracking efficiency as a function of track angle, especially when the track is along the wire in the case of the STT?
- What is the energy threshold for detecting protons/pions and how important is this to reduce systematics?
- Momentum/angular resolution of all particles;
- Pi0 energy resolution and efficiency in neutrino interactions (overlays, multiple interactions & background from rock);
- What are the uncertainties in energy scale for e/mu?
- What are the uncertainties in angular resolution?
- What are the key performance parameters for the ECAL to detect NC pi0?
- Can neutrons be detected in the tracker?
- What is the expected performance for key channels (see appendix A) including yields?

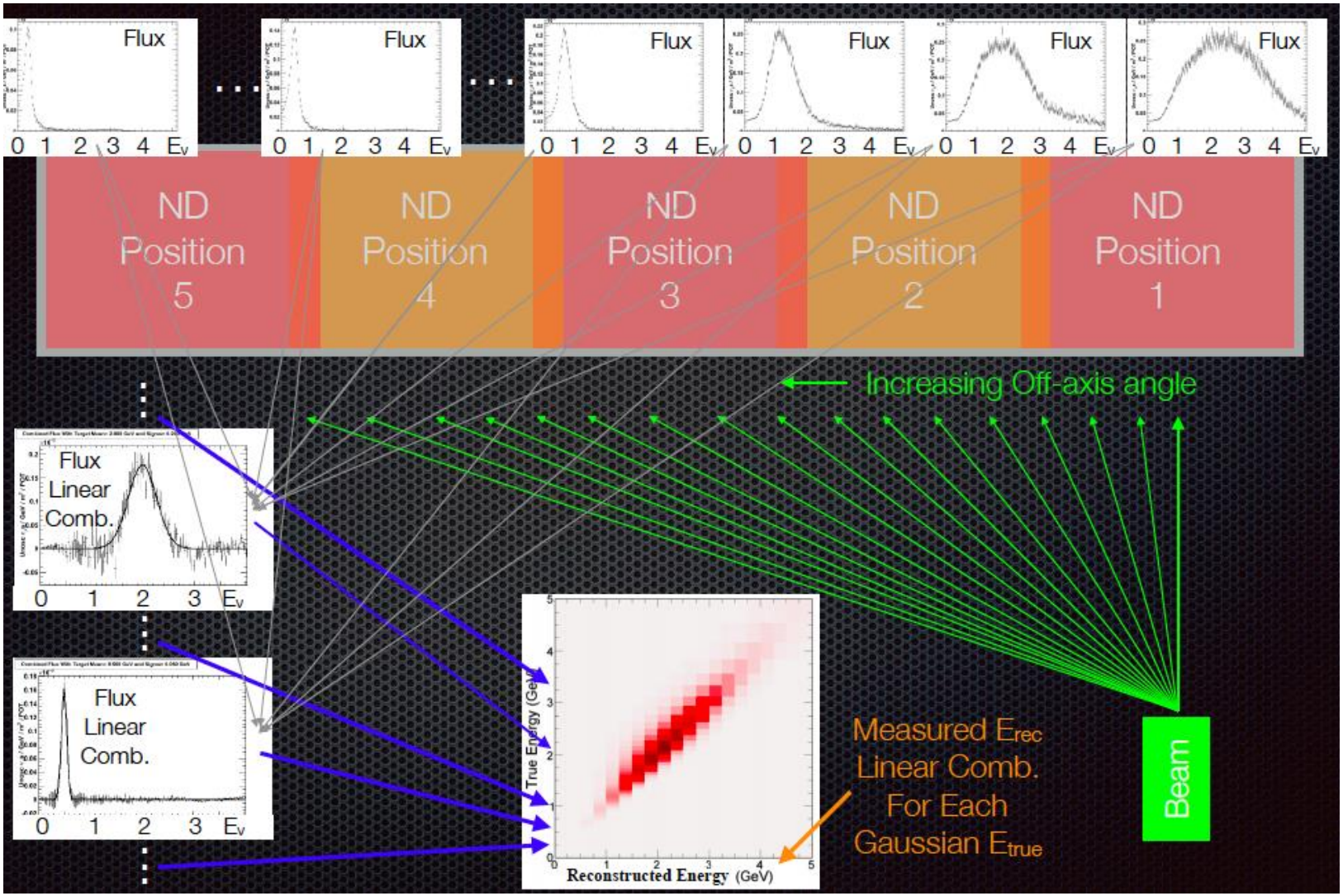
3D Scintillator Tracker



3DST Questions

- What are the angular/energy resolutions of the 3DST for photons, muons and electrons?
- How well can it do neutrino-electron elastic scattering?
- How big does the 3DST target have to be to do reasonably well with Pi0 topologies and neutrons?
- Can it do something with neutron counting/angles?
- Does it have to be in the magnetic field?
- What is the complementary physics relative to the other trackers that can be addressed with the 3DST?

DUNEPRISM Concept



DUNEPRISM Questions

- How well can PRISM address the beam-related systematic issues in the oscillation analysis?
- How can it help to decouple the beam-related systematic uncertainties from those coming from cross section and energy scale?
- How does it improve CP sensitivity? A full study to address this would be the best, but maybe a few case studies are adequate.

Next Steps

- Questions and action items have been defined and agreed
  - See DUNE-doc-6263

- First round of answers in January collaboration meeting

Upgrade Idea

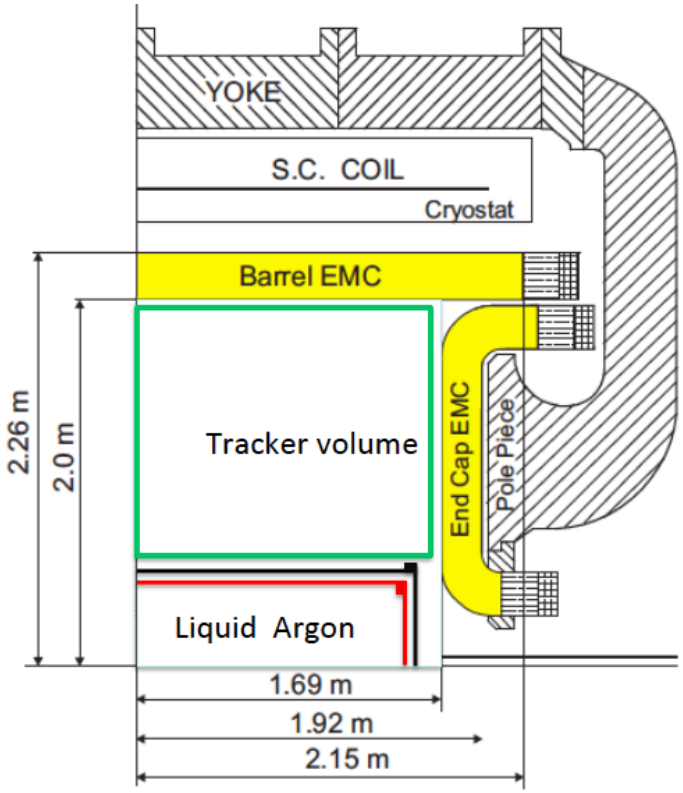
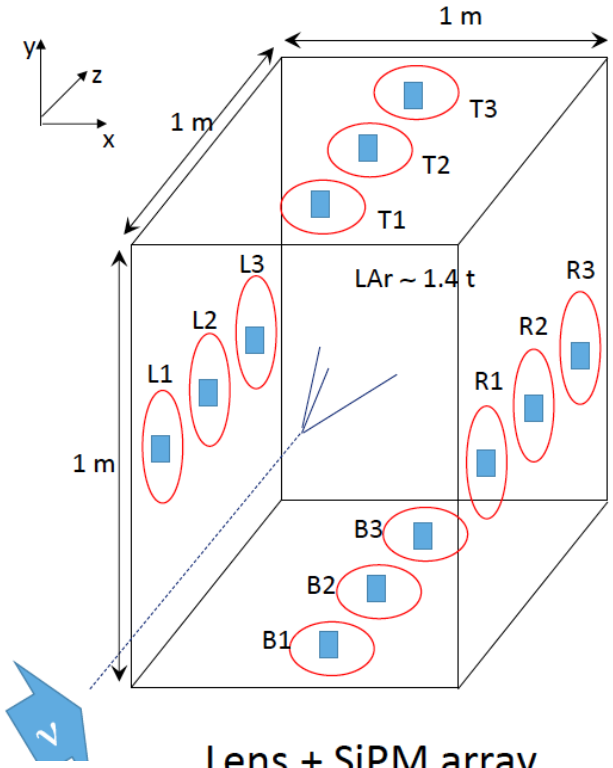
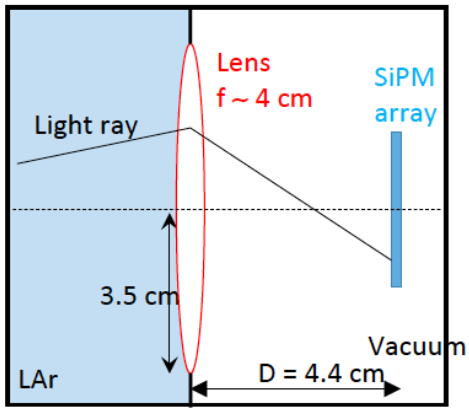


Figure 1: Schematic view of the KLOE detector



Lens + SiPM array



Summary

- DUNE ND design effort making progress

- Compressed timescale to get to CD2 for facility in 2019
  - Need a TDR

- Agreed next steps and timescales
  - Action items identified and assigned

- But
  - Open questions remain
  - Only partially groups in place to built and finance detectors

Backup

Agreed Action Items (I)

Magnet

1. The INFN team with help of Mike Kordosky to provide answers for KLOE magnet with STT using the tools prescribed by Near Detector Concept Study. A docDB document should be made available by Jan 15th at the latest.
2. The HPGArTPC team with Alan Bross in charge to provide answers for KLOE magnet with HPGArTPC using the tools prescribed by Near Detector Concept Study. A docDB document should be made available by Jan 15th at the latest.

Agreed Action Items (II)

Tracker

1. The STT team with Sanjib Mishra and Roberto Petti in charge should provide a document summarizing the initial answers to these questions and the agreed list of physics processes (see appendix) for the STT in a dipole before the January collaboration meeting in 2018, and should prepare a docDB document detailing the final answers to these questions and the physics processes by March.
2. The HPGArTPC team with Alan Bross in charge should provide answers to these questions and the agreed list of physics processes (see appendix) for the HPGArTPC in a dipole detailed in the CDR but with an optimized aspect ratio before the January collaboration meeting in 2018, and should prepare another document detailing the final answers to these questions and physics processes by March.

Agreed Action Items (III)

3DST

1. The 3DST team with Cheng Kee Jung in charge will provide a document answering these questions. A document summarizing the initial answers to these questions should be circulated before the January collaboration meeting, and a docDB document should be made available by 15 March 2018 at the latest.

DUNEPRISM

1. The DUNEPRISM team with Mike Wilking in charge should provide a document answering these questions by 15 January 2018.

LAr

1. The LAr Group with James Sinclair in charge should document answers to the above questions, especially 1-3 and documents them in a docDB document before the March workshop in 2018.