ND CDR update

M. Kordosky, S. Manly
ND general meeting
January 23, 2019

First we work on the TDR

- ND executive summary in TDR – target 20 pages, may have to go longer
  - SM+MK+experts
- Physics volume of TDR – oscillation sensitivity, ND role in sensitivity studies, 4-5 pages
  - C. Marshall + SM+MK
- Physics volume of TDR – appendix on physics relevant detail of ND role in sensitivity studies – length?
  - C. Marshall, need help here
- Physics volume of TDR – BSM physics
  - BSM working group, happening
- Physics volume of TDR – SM physics (electroweak, QCD, Xsections)
  - Ignored to date, xsec and modeling text probably useable, this chapter needs effort and someone to be point person

And THEN we can turn to the CDR!

Overall multi-purpose detector – Alan Bross, Hiro Tanaka
MPD magnet – Alan Bross
LArTPC/ArgonCube – James Sinclair
HPgTPC – Jen Raaf
ECAL – Eldwan Brianne
3DST – Davide Sgalaberna
ND facilities – Farshid Feyzi
Stay tuned, more help needed …

From A. Bross – DUNE ND general meeting, Dec. 19 2018

LBNC meeting: Comments

- The strength of what we propose was appreciated, but the scale raised many concerns and questions
- The thrust of the questions pertained to what was really needed (minimum?) to reach CPV goals (P5 mandate – 50% coverage at 5σ). Some provocative:
  - Do you really need near detector(s)?
  - What if you only get LAr?
  - What if you only get LAr + MPD (no DUNE-PRISM)?
  - What does an active scintillator target add to the CPV reach?
- **Connection between detector performance spec and physics achievables (quantifiable)**
  - This is being stressed for the Far Detector
- In the CDR, they would like to see a table where each component of the facility (including the width of the Hall), is enumerate in such a way that its impact on the CP Violation ultimate systematic uncertainty can easily be understood

VERY scary, shows need to make basic case in CDR and exec summary of TDR

Not directly the point of that part of the ND complex, It's all about developing confidence in our modeling and controlling systematics, not reasonable to look at this way.

Scary, shows lack of appreciation of how hard it will be to control systematics and overconfidence in N to F similarity, must address in CDR and exec summary of TDR

Easy to understand why they want this. However it trivializes the problem and is not reasonable to do with any confidence. The point of the different parts to the ND complex is to provide the input needed to improve and gain confidence in our modeling so that we can end up with smaller systematic errors.
This is a very heavy lift. Perhaps can argue with examples and limiting cases (this systematic goes away)?
Ideas/studies encouraged!

ND shopping list

- ❑ Liquid argon detector
- ❑ Muon spectrometer
- ❑ HPgTPC+ECAL in magnet
- ❑ ND hall, with no/medium/large transverse movement
- ❑ 3DST in magnet

Mass
Same nucleus as FD
Similar to FD

Must have if no MPD

Low threshold
Excellent acceptance
Same nucleus as FF

Neutrons
A dependence in systematics
Connect to plastic data

Breaks xsec*flux degeneracy
Sensitive to some modeling issues

Better modeling of FD flux
Extract some sensitivity from 2nd oscillation max?

ND concept study preferred option

Hall Size	Minimal (0 m off-axis)	Medium (24? m off-axis)	Ideal (33 m off-axis)
Liquid argon detector			
Muon spectrometer			
HPgTPC & ECAL In magnet			
3DST in magnet			

In larger hall but not part of DUNE-PRISM movement

DUNE ND Evaluation Sheet (Group evaluation/discussion)

	HPTPC	STT	HPTPC+3DST	Importance beyond LAr
Photon conversion in tracker (help understand backgrounds and pizeros)		Radiators degrade performance		1
Fast timing (pileup & neutrons)	Gas R&D needed for neutrons, pileup not an issue			4
Sign selected low Pmu included in flux constraint				5
Larger angular acceptance (good Pmu) in flux constraint				5
Acceptance/eff even over 4 pi	Only tracker with full 4pi acceptance			5
High stats when LAr off axis	120k numu CC per month			3
neutrino-electron scattering with different systematics				3: LAr will do it, then monitor with numuCC in on-axis detector
low-nu flux determination with sample independent of LAr CCQE				1
Sign separate pions for xsec				5
High stats connection to plastic data				3
nu-Ar xsec measurement with different systematics				5
CC coherent-pi measurement (specified CC)	8k events/yr	Wrong target nucleus, select by low vertex activity (require more than one straw)		2
sensitivity to low energy protons		Require more than one straw for measurement		5
potential to usefully measure scattering on hydrogen	w/H2 in TPC	requires stat subtraction (model dependent, several unsuccessful attempts on T2K & MINERvA)	2 methods (direct fill and stat subtraction)	2: usefulness to OA assessment requires extra work
potential to usefully measure scattering on other nuclear targets				2: xsec, not OA
potential to measure NC pizeros	Rely on ECAL			2: why needed in tracker in addition to LAr?
ability to tag neutrons				3
ability to tag neutrons from Argon				4
ability to measure primary neutron energy				4
transverse variables on Argon				2: possibly more important for xsec than for OA
measuring multiplicity		assume on argon		5: low momentum particles w/high multiplicity not seen well in LAr
energy scale				5
calibrations				5
control sample		Requires subtraction for argon		4: All have sidebands. Control sample for what?
e+/- sign selection				5
electron identification				5

	can't do	low
	bad	
	neutral	
	good	
	excellent	high

From end of 4th ND workshop:

Reminder that the concept study consensus formed around the HPgTPC+3DST combination.

We did not set out to find the optimal money-limited detector in addition to the LAr.

Cheapest option worth discussing

Hall Size	Minimal (0 m off-axis)	Medium (24? m off-axis)	Ideal (33 m off-axis)
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ND Concept study

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Cheapest option worth considering

These different options are quite different in cost and in the level and specifics of input for systematic error control.

Timing of knowledge of hall construction cost is very late in the game for informing these decisions!

How do we choose one plus one alternative?

ND Concept study

For the TDR:

- ND role in sensitivity studies
  - Mainly LAr
  - Big effort, well underway
- Must make case for ND and need to have powerful complex to have best chance to minimize systematic errors
- Must do without knowledge of cost of ND hall
- Must show some studies and some thinking about ND (only) physics

For the CDR:

- Must make the case for one option and one alternative
- Must try to be quantitative as requested to justify parts while making case against trivialized treatment of very complex problem
- Must give detailed design, show how it fits with facilities, physics performance