INTRODUCTION

PURPOSE OF WORKSHOP

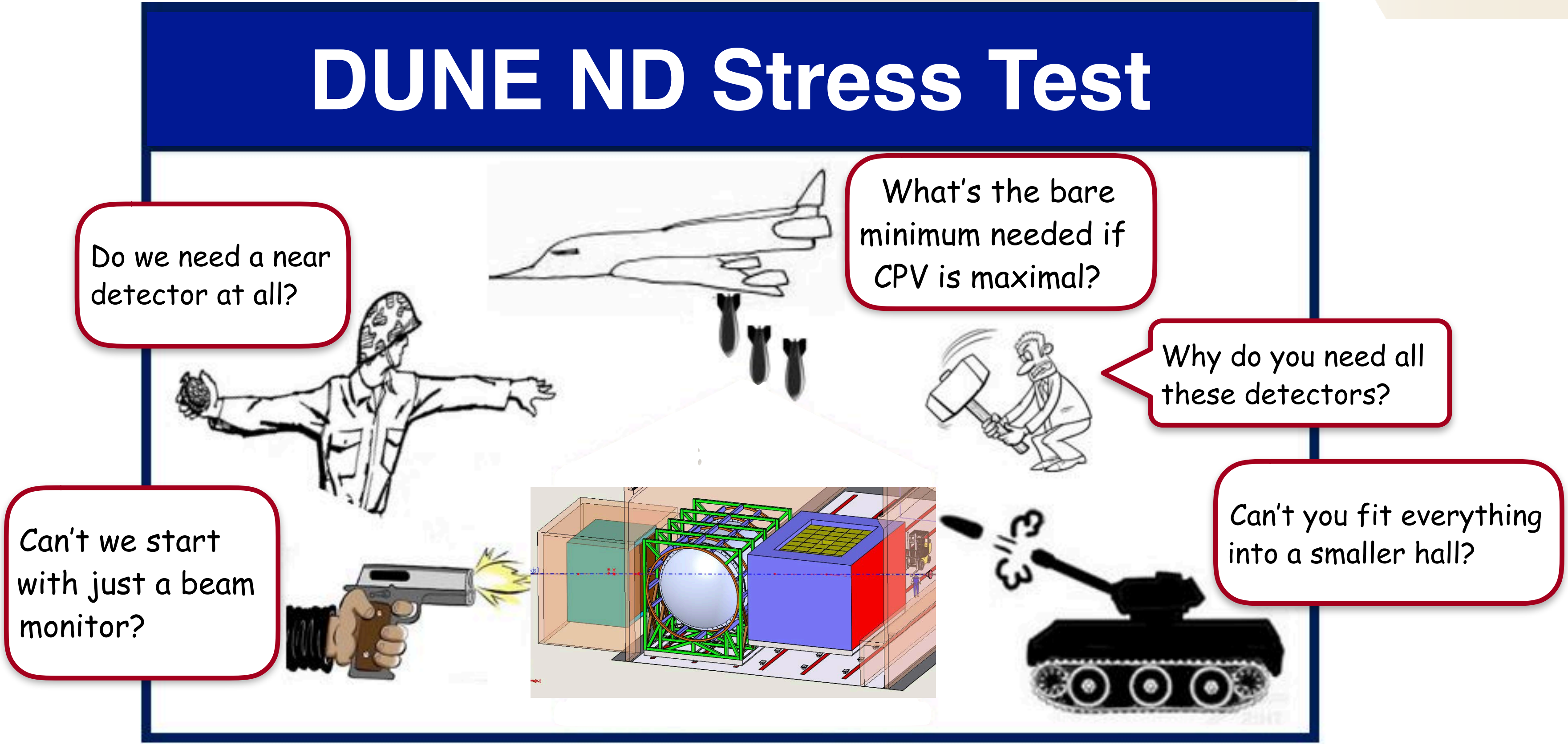
- Why are we having a workshop?
  - We just had several days of extensive discussions . . .
  - What more do we have to discuss?
- The most urgent upcoming event is the LBNC ND review (4 June)
  - Preparation for this is the focus of this workshop
- There are other important things to discuss:
  - Related “strategic” issues
    - The LBNC ND review is just the first step in additional reviews as we move to CDR → TDR →
  - Many important discussions in CM cut off due to time

OVERVIEW:

- What's going on?
- LBNC ND review
- Descoping/Staging
- Requirements
- Workshop Agenda

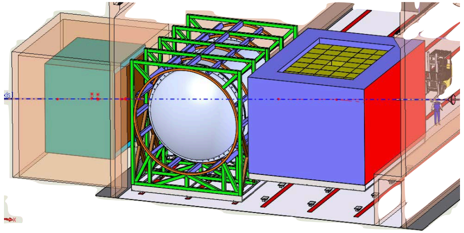

Bank Stress Test
BANK
Falling housing prices
Rising unemployment
Economic Recession
Global market instability
Falling share prices

OVER THE LAST FEW MONTHS:



HOW IT FEELS:

Warning: spoiler on next slide



Not much has changed to our design
That is good news . . . .
We have the right concept

But the stress test continues . . .

LBNC NEAR DETECTOR REVIEW

COMMITTEE MEMBERS:

- Scott Oser† (chair)
- Ties Behnke
- Patrick Huber†
- Eric Kajfasz
- Dean Karlen
- Naba Mondal†
- Ex officio:
  - Beate Heinemann†
  - Hugh Montgomery† (LBNC Chair)

† = LBNC member

LBNC ND REVIEW GOALS:

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- DUNE should provide the ND review committee with an “existence proof” for a plausible and achievable ND design that will meet the requirements set in the physics TDR.
  - This need not be an optimized design, but enough to permit sign-off on the physics TDR.
- The review committee will advise the LBNC on whether the ND concept is feasible and appropriate.
- The review committee will provide early constructive feedback to DUNE, as DUNE prepares to complete the ND CDR later this year.

REVIEW AGENDA:

0800-0900	Executive Session	
0900-1000	DUNE near detector Requirements and Reference Design Overview	40+20 (Tanaka)
1000-1015	Break	
1015-1100	Long-baseline physics analysis status overview	30+15 (Worcester)
1100-1145	Near detector sample constraints on differential cross-section on Ar	30+15 (Wilkinson)
1145-1215	Neutrino-electron elastic & direct flux constraint	20+10 (Marshall)
1230-1315	Executive session over lunch	
1315-1400	DUNE-PRISM capability for determining energy response in a model-independent way	30+15 (Wilking)
	Short subsystem talks	
1400-1430	LAr	30+10 (Sinclair)
1430-1445	Break	
1445-1515	MPD	30+15 (Bross)
1515-1545	3DST-S	30+15 (Manly)
1545-1645	Executive session	
1645-1715	Close out	

PREPARATIONS

- Presentation material to be submitted to the committee morning of 2 June
- We received a very detailed set of comments from the ND committee yesterday
- We will discuss the response to the most significant of these questions in this workshop
  - This has changed somewhat the focus of the workshop and some of the agenda will be fluid
  - Steve will present the major questions in the next talk
  - We will formulate initial responses and iterate through the workshop

DESCOPING/STAGING

OTHER ISSUES:

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- Not strictly part of the LNBC review but related:
- Descoping:
  - Reduction in scope of detector systems
  - What is the best way to do this if necessary?
  - When do we hit the bone?
- Staging:
  - Building/deploying detectors over an extended time
  - What would this sequence look like?
- Both discussions should be driven by the physics requirements

REQUIREMENTS

PHYSICS REQUIREMENTS:

- Example from far detector

Unique integer ID (per subsystem)	Name	Label	Primary Text	Value	Value (LaTeX)	Goal	Rationale (full)	Validation (full)	Rationale (brief)	Validation (brief)	Note
(REQUIRED)	**Descriptive name of the specification (max 100 characters including spaces) (REQUIRED)**	**Unique label for use in LaTex processing (max 40 characters including hyphens) (REQUIRED; won't show in TDR table)**	**Full text of the req/specification. Example: The DAQ shall provide (REQUIRED)**	**Specification value: number plus units (as needed) (REQUIRED)**	**Specification value: number plus units (as needed) (REQUIRED)**	**Number plus units (as needed) (Eric wasn't sure it's needed)**	**State what drives and/or supports this specification. (REQUIRED)**	Include, simulations, impact of ProtoDUNE test on specification, other experiments, etc. (REQUIRED)	**Max 120 characters (REQUIRED)**	**Max 120 characters (REQUIRED)**	**Additional notes about this requirement/ spec (OPTIONAL; this will not show in TDR table)**
1	Minimum drift field	min-drift-field	The drift field in the TPC shall be greater than 250 V/cm, with a goal of 500 V/cm.	>250 V/cm (goal 500 V/cm)	$>$\, \SI{250}{ V/cm}	$>\,\SI{500}{ V/cm}$	Limits impacts of electron-ion recombination (on particle ID via dE/dx versus range), reduces effect of finite electron lifetime on S/N ratio (with implications on tracking and calorimetry), and limits electron diffusion and to a lower degree space charge effects.			ProtoDUNE will demonstrate if the present HVS design allows reaching the nominal electric field in the drift volume. Initial data taking will be with the maximum obtainable electric field setting, but additional studies at lower fields to study the effect on particle ID will also be targeted. Detector simulation will take advantage of the experimental data collected with ProtoDUNE. Additional runs collected at lower field settings will allow for more fine tuning of the models. Reduces impacts of e^--Ar recombination, e^- lifetime, e^- diffusion and space charge.ProtoDUNE	MicroBooNE is demonstating that a field of 270 V/cm can be a viable operating point in terms of particle ID. Early simulation results shown at the January collaboration meeting suggest that detector performace would degrade below 200 V/cm. The previous comments apply in case of "infinite" electron lifetime. Degradation of detector performance (e.g. low Signal-to-Noise ratio) associated with finite electron lifetime is enhanced at lower electric field settings.

TOWARDS REQUIREMENTS DUNE ND

SLAC

- In the end, everything should be motivated by its physics impact
- However, it is impractical to do a sensitivity study for every requirement, particularly technical ones
- Propose a hierarchy of requirements:
  - **Overarching (O):**
    - State the role/purpose of ND in the experiment
    - No reference to individual subsystems or particular implementations
  - **Capabilities (C):**
    - Measurements that the ND must make to deliver overarching requirements (e.g. ν-e flux measurement)
    - Refers to subsystems that perform these measurements but not particular implementation
  - **Performance (P):**
    - Detector performance (efficiencies, resolutions, etc.) that are needed to deliver the capabilities.
    - Refers to specific subsystems and refers to particular implementation as needed
  - **Technical (T):**
    - Parameters/other properties (pixel pitch, granularity, magnetic field, etc.) specific to detectors needed to deliver required performance.
- Requirements interact in "nearest neighbor" fashion
  - e.g. Performance requirements are driven by Capabilities, and drive the technical requirements

OVERARCHING REQUIREMENTS (I):

- **O0: Predict the neutrino spectrum at the FD** The ND must provide a prediction for the energy spectrum of ν_μ, $\bar{\nu}_\mu$, ν_e and $\bar{\nu}_e$ at the FD. The prediction must be provided as a function of the oscillation parameters and systematic uncertainties must be small enough to achieve the required CP coverage. **This is the primary requirement of the DUNE ND.**
- **O0.1: Measure interactions on argon** The ND must measure neutrino interactions on argon to reduce uncertainties due to nuclear modeling. The ND must be able to determine the neutrino flavor and measure the full kinematic range of the interactions that will be seen at the FD.
- **O0.2: Measure the neutrino energy** The ND must be able to reconstruct the neutrino energy in CC events and control for any biases in energy scale or resolution, keeping them small enough to achieve the required CP coverage. These measurements must also be transferable to the FD.
- **O0.3: Constrain the cross-section model** The ND must measure neutrino cross-sections in order to constrain the cross-section model used in the oscillation analysis. In particular, cross-section mis-modeling that causes incorrect FD predictions as a function of neutrino flavor and true or reconstructed energy must be constrained well enough to achieve the required CP coverage.

OVERARCHING REQUIRMENTS (II)

- **O0.4: Measure neutrino fluxes** The ND must measure neutrino fluxes as a function of flavor and neutrino energy. This allows for neutrino cross-section measurements to be made and constrains the beam model and the extrapolation of neutrino energy spectra from the ND to the FD.
- **O0.5: Obtain data with different fluxes** The ND must measure neutrino interactions in different beam fluxes (especially ones with different mean energies) to disentangle flux and cross-sections, verify the beam model, and guard against systematic uncertainties on the neutrino energy reconstruction.
- **O0.6: Monitor the neutrino beam** The ND must monitor the neutrino beam energy spectrum with sufficient statistics to be sensitive to intentional or accidental changes in the beam on short timescales. The precise requirement will be informed by the run plan as well as experience from previous experiments.

TOWARDS THE CDR

- The overarching requirements are a starting point
- We need to work to through the rest
  - May be challenging due to the multiple subsystems, but each subsystems needs this in any case.

AGENDA

WORKSHOP AGENDA:

Saturday:

- Introductory discussions
  - Status of Reference Design
  - Preparations for the LBNC ND meeting
- ArgonCube workshop

SUNDAY

- Session V: Subsystem overviews
  - MPD: HPgTPC
  - MPD: Magnet
  - 3DST-S
  - DUNE-PRISM
- Session VI: MPD Calorimetry
  - CALICE for DUNE ND
  - Discussions
- Session VII: Staging/descoping
  - LAr:
  - MPD
  - 3DST-S
  - DUNE-PRISM
- Discussion
- ND Software
  - LAr plans
  - GAr plans
  - Software integration discussion

MONDAY

- Session IX: LBNC talks (I)
  - DUNE ND requirements/overview
  - Long Baseline Physics overview
- Session X: LBNC talks (II)
  - LAr
  - MPD
  - 3DST-S
  - DUNE-PRISM
- Session XI: Closeout