IoLaser Scope Review Planning

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DUNE CALCI Laser WG meeting
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CALCI Scope Review

- The scope review charge is here: https://docs.dunescience.org/cgi-bin/private/RetrieveFile?docid=17985&filename=CALCI_Charge.pdf&version=2

- The workshop is aimed at defining the overall scope for calibration and cryogenic instrumentation and provide a prioritization across systems.

- It is not a design review workshop but technical viability will be assessed.

- Scope review will be conducted remotely in May across several weeks, from May 11 to May 29th.

- A detailed agenda and list of review committee members will be circulated soon.

Review Committee Charge I

1. Does the system have a well-justified role in safeguarding the far detectors and facilitating their operation, and if so, what is the minimum amount of system scope needed to carry out this role? (Cryogenic Instrumentation only)

2. Does the system have a well-justified role in facilitating the analysis of far detector data, and if so, what is the minimum amount of system scope required to fulfill this role?

3. Have all technical issues related to the feasibility of the system (including those raised in the previous workshops) been resolved?

4. Are there any risks to overall detector performance associated with the implementation of the system, and if so, is there a plan in place for mitigating these risks?

5. Is there a credible plan in place for demonstrating system performance in ProtoDUNE-II?

6. Does the functionality of the system justify its overall cost?

Review Committee Charge II

- **Review Committee Charge – Part II:** Based on their evaluations of the individual systems, the review committees are asked to classify each of the proposed systems in terms of the following categorizations:

1. Essential – Experiment should not be run without this system in place.

2. Highly-desirable – Strong justification for including this system but not viewed as absolutely necessary.

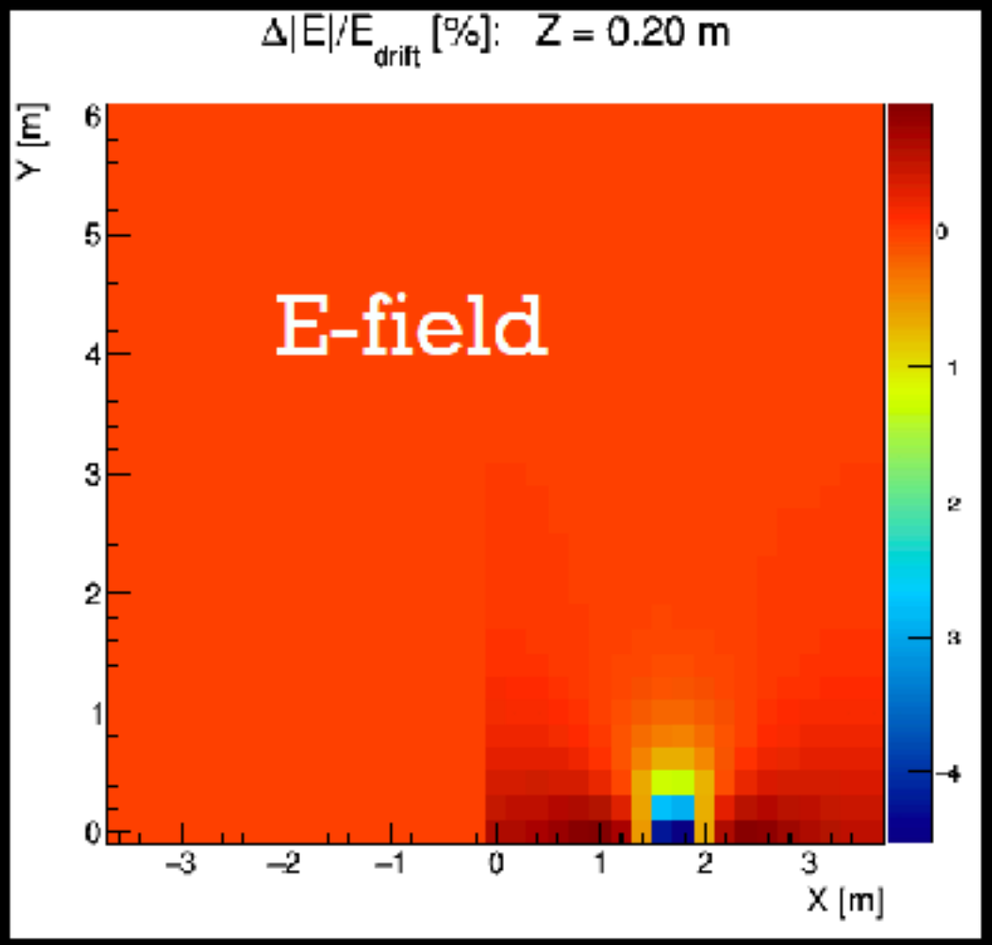
3. Advantageous – Good arguments exist for why this system might be useful but not fully justified in terms of its contribution to overall detector performance.

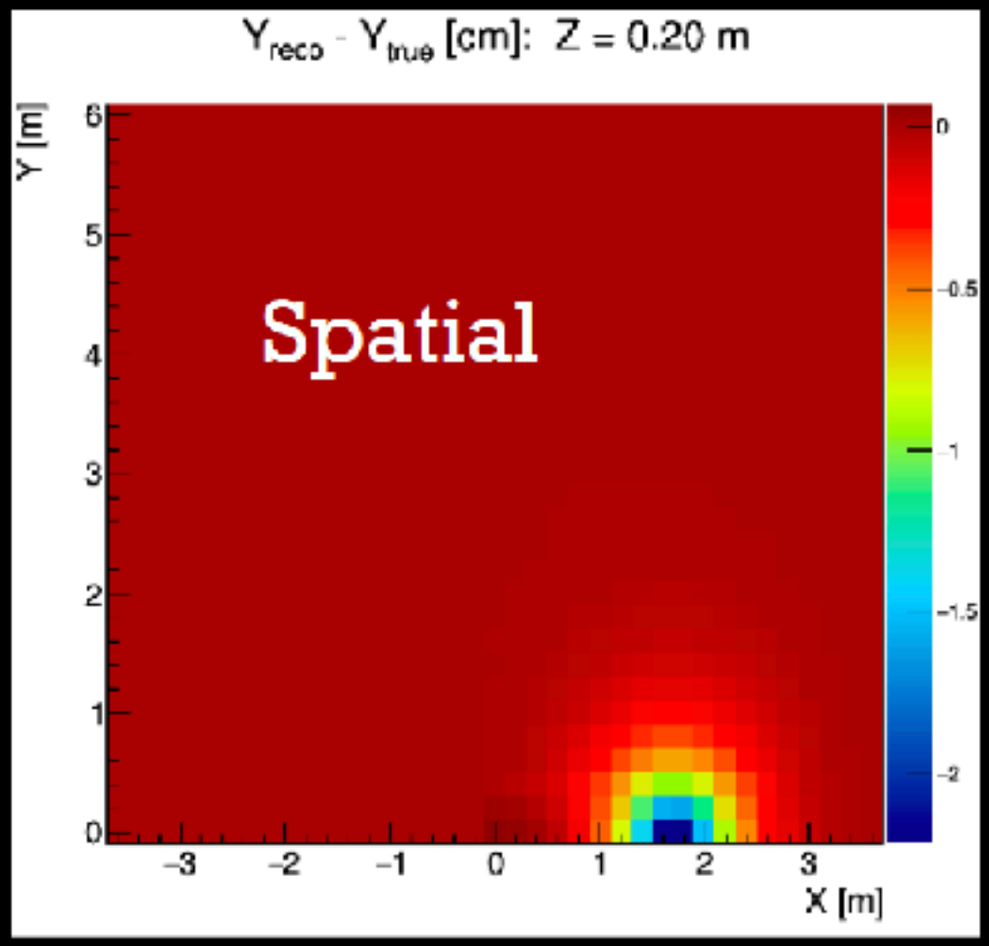
4. Debatable – System could potentially be useful but not fully supportable based on current arguments.

1. Does the system have a well-justified role in safeguarding the far detectors and facilitating their operation, and if so, what is the minimum amount of system scope needed to carry out this role? (Cryogenic Instrumentation only)

- Although this one says cryogenic instrumentation only, I think from operations perspective Laser holds a lot of value. The ability to shine a laser at a given part of the detector and check response is very useful in general.
- Some specific examples include: diagnosing detector issues such as field cage resistor failures (see next slide); misalignment; stability monitoring.
- However, it is hard to define a minimum scope for laser driven by this. So, we won't emphasize on this but will note these as part of the general motivation for the system. No new studies will be planned in this direction except for reminding what we learnt previously.

E-field distortions: Field Cage Resistor Failure (SP)





- Single FC resistor failure in ProtoDUNE-SP geometry
- Up to 4% effect on total E-field and up to 2 cm offset in the Y-direction
- Effect is not completely local, but strongest in the ~1 m^3 volume around the defect
- Impact on dQ/dx = 1-2%

B. Yu, M. Mooney

2. Does the system have a well-justified role in facilitating the analysis of far detector data, and if so, what is the minimum amount of system scope required to fulfill this role?

Answering this question will require more work

- What detector parameters will laser help us measure? e.g. E-field, drift velocity, lifetime (?)
- Show connection between these parameters to high-level physics e.g. energy scale/resolution.
- Motivate sources of expected E-field distortions since measuring E-field is the primary motivation for the laser system.
- How important are these parameters for physics? Demonstrate the impact of these parameters on high level physics.
- Can these parameters be measured in other ways e.g. cosmic rays? If so, how long would it take? If too long, what is the impact on timescale of planned physics results for DUNE?

1. Does the system have a well-justified role in facilitating the analysis of far detector data, and if so, what is the minimum amount of system scope required to fulfill this role?

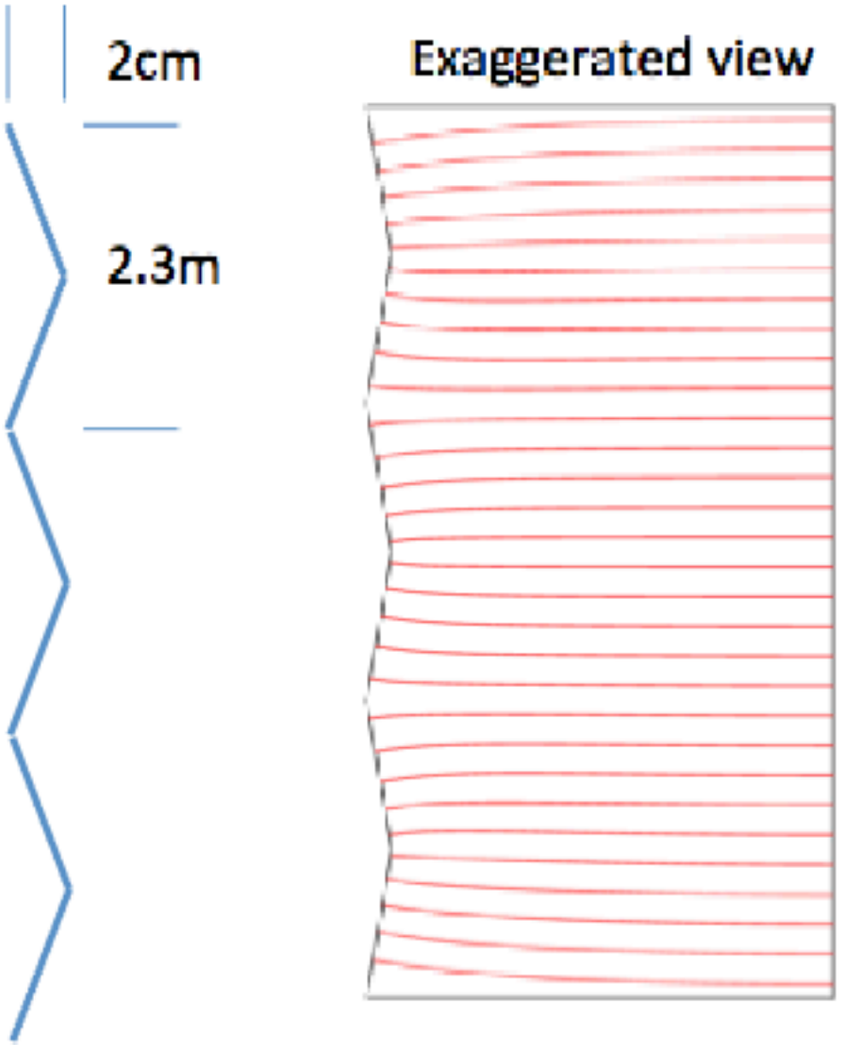
— **These two points always gets us**
— need to have well motivated assumptions that go into the estimating the expected E-field distortions e.g. range of CPA tilts, is 2 cm reasonable?
— Other ways of measuring parameters especially with cosmic rays. We need to fold in ProtoDUNE experience here and make projections for the FD. Consult with the DUNE calibration physics WG here for input.

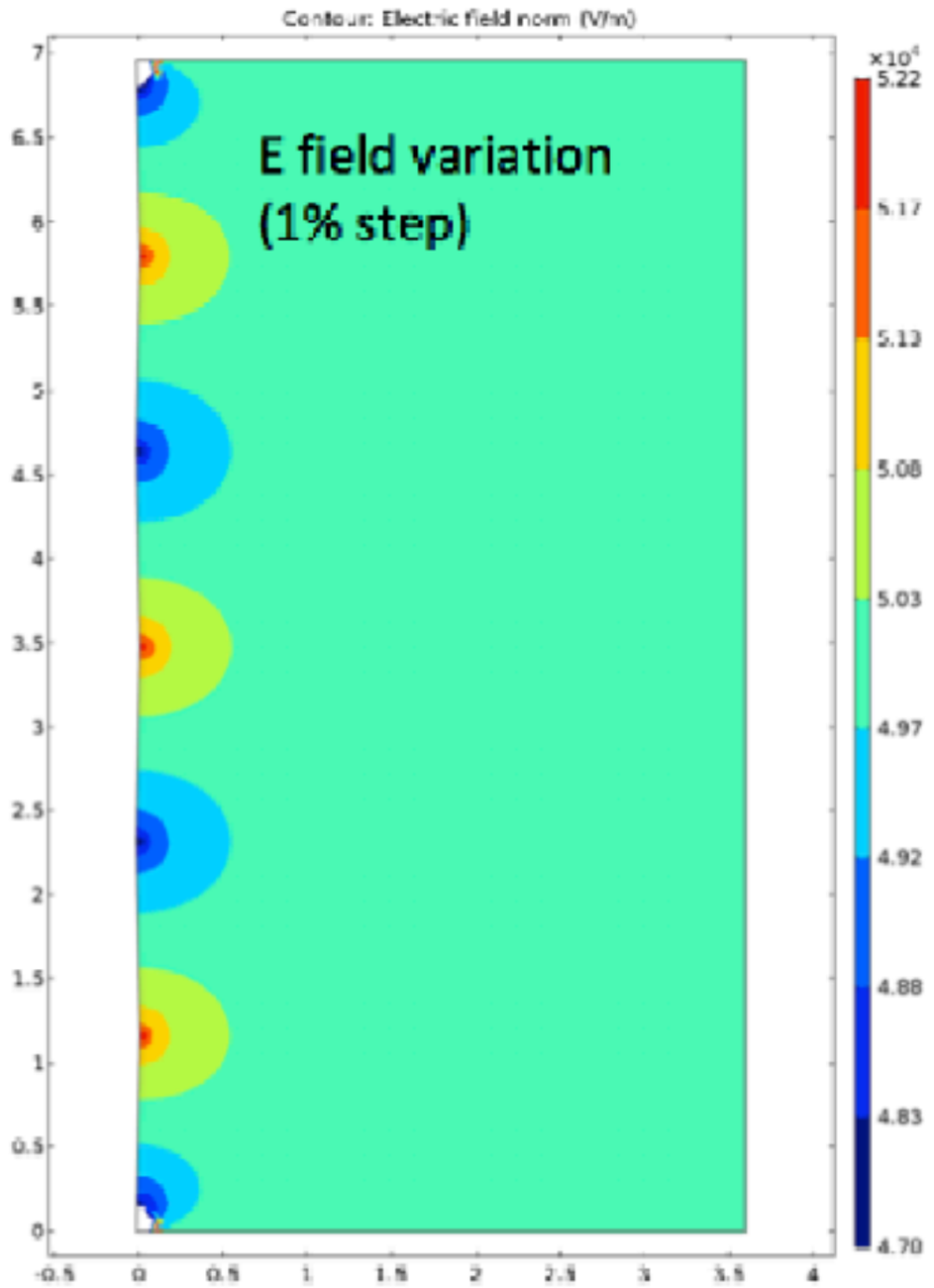
- Motivate sources of expected E-field distortions since measuring E-field is the primary motivation for the laser system.

- Can these parameters be measured in other ways e.g. cosmic rays? If so, how long would it take? If too long, what is the impact on timescale of planned physics results for DUNE?

E-field distortions: CPA position tilts (SP)

B. Yu





- Assuming 2 cm CPA position tilts results in few % effect on E-field

2. Does the system have a well-justified role in facilitating the analysis of far detector data, and if so, what is the minimum amount of system scope required to fulfill this role?

This part of the question also requires more work

- Justify the laser system requirements more thoroughly
  - Precision 1%
  - Coverage > 75%
  - Granularity 30x30x30 cm^3
- The coverage is what drives the scope of the laser system (quantity and distribution of lasers across the detector)
- Need a strategy to address this repeated comment: “Distortions are higher at detector boundaries, why not just scan those regions?”

2. Does the system have a well-justified role in facilitating the analysis of far detector data, and if so, what is the minimum amount of system scope required to fulfill this role?

- Related:
  - FC penetration to achieve >75% coverage for baseline laser
    - Also relevant when discussing risks to the detector
- Are baseline (central) 12 lasers enough or endwall lasers needed? If so, why?
- Do you really need crossing tracks? (also motivates the alternative endwall lasers)
- Can one laser serve two periscopes? (also is relevant when discussing technical viability)

3. Have all technical issues related to the feasibility of the system (including those raised in the previous workshops) been resolved?

- This is where we need to show the technical progress w.r.t. the design work for both baseline and alternative laser systems
  - Focus on implementation of the periscope retraction as that was the biggest ask from the review committee last time
- Can the design provide necessary pointing accuracy, intensity control?
- Alignment procedures and related design accommodations e.g. cameras
- Imaging capability both from above and below the FC.
- Is it technically feasible to use 1 laser for 2 central ports?
- Can the operation be automated enough to provide the necessary number of tracks? Will DAQ cope with the rate/data volume?
- Noise (laser, motors, encoders), grounding (building vs detector), major electrical interfaces (power load per laser)
- Arrangement of the laser system outside the cryostat, installation interfaces/ considerations leading to design accommodations (e.g. segmentation). Understanding of overall technical constraints (e.g. proximity of laser head from HV and feedthrough)?

4. Are there any risks to overall detector performance associated with the implementation of the system, and if so, is there a plan in place for mitigating these risks?

- Here are the risks and planned mitigations for the laser system
- FC penetration a risk to HV
  - Mitigation: periscope retraction into the design; integration of cameras into laser to confirm FC clearance; working closely with HV group to evaluate impact on E-field at each stage; mitigated all technical interferences w.r.t. penetration.
- Laser periscope will be long, needs design accommodation to ensure periscope straightness e.g. port aligners, cameras and inclinometers on periscopes; allowing additional clearance around periscopes instead of being snug
- Laser on PDS
  - PDS confirmed this is not an issue for SiPMs; U. Of Bern PDS studies promising in this direction
  - Will avoid directly hitting PDS — need mechanical and software controls to avoid this; no interlock needed?
  - Stray/reflected light from laser not an issue for PDS
- Electrical Noise from laser and system components; ensuring proper grounding

5. Is there a credible plan in place for demonstrating system performance in ProtoDUNE-II?

- Yes! We can show our plans for protoDUNE here
- We are already developing designs specific to ProtoDUNE; already short-listed desirable ports for laser
- Need to understand DAQ, slow controls and top-of-the cryostat and rack interfaces
- FC penetration plan for protoDUNE-2
- List of what we plan to test in protoDUNE: design validation, mechanical deployment, **FC penetration and retraction**, operational experience, electrical interfaces, grounding, DAQ/SC interfaces, crossing tracks, and physics analysis
- Show schedule here and where development is happening LANL, LIP, KSU etc.

6. Does the functionality of the system justify its overall cost?

- uB/SBND estimate per laser system is ~$130k, with retraction aspect implemented this cost will increase by $20k to $30k.
- Value engineering is also being done to reduce cost e.g. using steel instead of torlon on the chimney side; replace torlon with Peek where possible; vendor choices also being revised to see if costs can be reduced between US vs European vendors (largely used by Bern)
- We already have some costs developed for this, we will update them based on the design changes/improvements being implemented and present them.

Plan for coming weeks

- Next week, I plan to ask for similar presentations from PE Laser and LBLS.
- For all systems, we understand the major questions by now both technically and physics-wise, so we should target work in the coming weeks towards addressing these questions and prepare answers.
    - We understand any lab work is not possible due to COVID-19 restrictions and if some answers rely on lab work we should make a note of that
    - Eric suggested drafting a 1 page summary for the review committee on aspects that will depend on lab work for CALCI and the committee will make assessment/deliberations assuming the tests are successful
- A schedule leading to the scope review to ensure preparedness will be presented at the consortium meeting next week, stay tuned for that