Meeting focus: Laser system option for DUNE. Options for various types of Laser. Physics motivations for laser.

Slides: https://indico.fnal.gov/getFile.py/access?contribId=4&resId=0&materialId=slides&confId=15242
After the talk, discussion on multiple TPC laser systems, usage, physics impact, pros and cons for DUNE.

Main points in the talk:

1. Cosmic rates are expected to be low in DUNE (40 to 45 stopping tracks per day; 200-500 crossing tracks per day; no muons at zenith angles > 75 degrees)
2. T2K photo calibration laser system discussed. In addition to redundancy, laser can help diagnose electronic issues (clock synchronization, HV problems etc.). Longevity/Degradation can be a concern. Can the T2K style system be extrapolated for DUNE? Can existing penetrations can be used for fiber optic cables?
3. The MicroBooNE/SBND style laser system is discussed. The minimal configuration for DUNE needs 16 additional penetrations on the cryostat. Steerable option poses an issue with sharing of ports with other systems.
4. The advantages and disadvantages of T2K and SBND systems is also discussed.

Summary of discussion during and following the talk (consider each bullet point as separate comments):

1. DUNE is underground, expected space charge is low, so field map is not a big concern. Need to quantify space charge underground and how precisely laser can address the map. Can laser address the field map to the precision that physics requires (1% currently on FV leading to 1% in drift velocity)?
2. Along the same lines, what are the timescales for field variation? Significant measurements with cosmics were slow from ICARUS, similar for DUNE.
3. General consensus that focusing on stability/debugging value of laser is useful. But, Separate field map from stability needs and show a clear case that laser helps us monitor stability.
4. Since we have a huge detector, with independent TPCs, need relative calibration information, with cross calibration from cosmics.
5. Cannot depend too much on what will be seen at MicroBooNE or other experiments, not sure able to demonstrate the laser even for MicroBooNE is a golden bullet and solves everything. We need information on bulk of field and need to have to have multiple systems.
6. Can laser help with deconvolution of field response for induction planes (a.k.a the dynamic induced charge where the charge spreads to near by wires). The answer is no since it is complicated by diffusion which results in a similar effect. Will require disentangling and is a difficult process.
7. What about uncertainties in the drift coordinate due to APA/CPA alignment? Thermal flexing? How well will we really understand alignment. Can laser help here? If so, to what precision?
8. Redundancy for each measurement is important since we are limited by cosmics. Need to understand penetration cost of now vs. later since the engineering costs for later can go very high (also uncertain to come up with specific costs now).
9. Can manholes that are located at the four corners of the cryostat be used for laser? These manholes are 800mm wide. Need to take into account any other space constraints.

Some concrete action items from the meeting:

1. Quantify the expected space charge in DUNE? How precisely can laser measure the E-field map?
2. Separate calibration of field map from stability. Survey on possible cases from stability perspective that laser can help with.
3. Understand and quantify APA/CPA mis-alignment or uncertainty in x-coordinate. How can laser help?

4. Cost is a factor in terms of having penetrations now or doing later (doing later depends how much of change will be needed in design and might go high based on engineering costs). Get some estimates of cost from Marzio and team.
5. Explore the possibility of using manholes or other spare ports for laser. Also explore if using 8 ports going beyond minimal makes sense?