Skeleton of the field analysis FSD

1. Data processing (Matt): run the data through ndlar_flow; get the pedestal, larpix operating voltage and the geometry
2. Analyzing the hits:
    a. Detector contour:
        i. From hits directly
        ii. From track ends
            1. Charge clustering
            2. Determine a cluster is track-like
            3. Find the track ends
            4. Determine what is considered as the vicinity of the detector boundary
        iii. Cathode from the crossing tracks
    b. “Cosmic muon” straightness
        i. Identify tracks (largely overlap with 2/a/ii)
            1. One and only one external trigger per TPC
                a. Will the light detectors from both tpcs trigger together?
                b. How the trigger is forwarded to the pacmans
            2. Charge clustering
            3. Fit a line
            4. Remove non-track like objects
        ii. Calculate straightness (How the b./i./4. interfering this part)
            1. Average distance from hits to the line
                a. Very short timeline to implement, delay is mostly just in running it (if plots, ~1 week, if just numbers,~2 hours)
            2. Accumulative angular changes
            3. Second axis of the PCA fit
    c. Survey the full detector volume with the anode-to-anode (AA) tracks
        i. Identify the AA tracks (largely overlap with 2/a/ii)
            1. Timeline depends on what “identify” means - see comment
        ii. Calculate the residuals with respect to the detector positions

AJ’s Code

Can do already (turnaround depends entirely on computational time)

Will be able to do (Estimated Timeline)

Might be able to do, not sure

Brooke’s Code

Can Do Already

Will be able to do (Estimated Timeline)

DeMario’s Code/(AJ and Brooke can also do this as a result)

Can do already

Should already be doing this, not 100% sure

Hiro's comments, Yifan's comments, AJ's & Brooke's comments:
Hello Everyone: Thanks for stating the discussion.

> I guess it's not easy to answer how many tracks are enough, so I will try to provide some insight through another angle. I think the rate of the cosmic activities per volume should be similar in FSD as in a single 2x2 module. Given most of them are through going tracks, we should be able to put similar quality of analysis with similar period of data taking. I checked that M0-3 took roughly 3-7 days of cosmic data, which fits with what Saba proposed (3 days of data taking with nominal conditions). I think more cosmic data is always safer, but we can probably live with it. Also there are a few readout setup/adjustment data taking campaign (as mentioned in the run plan meeting) that should also be useful for this work.

It would be useful to be more specific here both in terms of numbers and configurations of the track beyond the rough time in which we expect to take data.

For example, do we need anode/cathode crossing tracks? anode-cathode-anode crossing tracks? Do we have any spatial requirements (i.e. is it important to have certain types of tracks in every part of the volume, or is it okay just to have roughly vertical tracks that presumably will eventually populate the whole volume with track segments)?

A targeted number of tracks or some other metric that can be monitored would also be useful in case data taking rates, etc. turn out to be different than expected,

For example, even we run for two weeks, if we find that we have a small fraction of a particular track topology that we need, there would be a case to continue to take data. Conversely, if after several hours, we find we have more than what we need of every category, we wouldn't make the case for more and the running can move to some other goal.

Beyond the kind and number of cosmic tracks we need, is there any utility in these studies for variations in operational parameters (field, charge readout settings, light readout settings, etc.)?

> 1 - when we say "identifying" tracks, is that an actual step in terms of labelling things/saving information or is just in terms of the processing step where I don't need to save any label information?

I think whether you store the "identified" tracks and the associated hits depends on if you want to have a checkpoint there. You can save the displacement on the hit-level, or make plots directly. It just a matter how likely you would change something intermediately. I would at least store the hit level of distortion.

> 2 - not sure what "accumulative angular changes" means? I'm assuming this is related to changes in theta_xyz in each slice (which I am already doing) but I wasn't very sure. (I don't think I'm saving it for the entire length of one track at

> the moment but it wouldn't be very hard to implement, maybe a week at most ignoring computational time)

For example for coulomb scattering, the overall scattering angle is more random as opposed to electric field introduced lensing which causes potentially systematic bends for tracks

I think the question is what are we actually measuring as opposed to why are we measuring it. Do we need to record the change differentially across the length of the track, or is it sufficient to have the overall deflection at the end of the track vs. the beginning.

> 3 - not really sure what the second axis of a PCA fit would be since I'm not doing a PCA fit on any of my own code right now beyond the part i borrowed from DeMario. (I'm not even sure what the difference between the first/second axis of a PCA fit would be...maybe I should just spend time on my own looking this up though)

This depends on how you would define tracks. Also this is just one proposal to evaluate straightness, not the only one.

> 4 - residuals with respect to the detector positions: is "detector positions" the positions of the hits? (I assume yes but wanted to be sure)

If we want to show the correction, then it is the position of hits. During the workshop, we briefly mentioned the nuances of the basis of true detector positions and reconstructed detector positions. I think this work is mostly to demonstrate the scale of the distortion, so yes it doesn't matter that much which basis. I mainly the distortion with respect to which area of the detector (for example O(1cm) distortion a few cm away from the cathode <<<<< make-up numbers)

I'm afraid I didn't follow this.

Hiro