

Meeting focus: Feedthrough discussion for radioactive sources and Alignment studies with Cosmics with plans for physics week.

Indico link: <https://indico.fnal.gov/event/15236/>

Attendees: Sowjanya, Kendall, Josh Klein, Juergen, Bo Yu, Chuck Lane, Byron Roe, Jack Fowler, Jennifer Heigh, Alberto, Eric James, Vitaly, and possibly others.

Talk 1: DUNE Physics Week Planning:

Reminder to register for the DUNE Physics week which is planned for November 14 to 17. A list of topics are proposed by Task Force leaders for the physics week and a point person appointed for each topic.

Current list of topics:

1. Cosmic ray muon studies (Rates, Spatial/angular distributions, alignment studies etc.) – T. Junk
2. Space charge from cosmics and other ionization sources – M. Mooney
3. Drift field distortions from other sources (alignment, resistor failure etc.) – B. Yu
4. Radioactive source studies and low energy events – Kate, Juergen
5. Physics with Laser – TBA
6. Physics requirements and calibration needs (TF & LBL conveners, most probably joint session)

Collaborators are welcome to add a new topic or join any of the existing efforts. Send email to Sowjanya and Kendall with your interests.

Josh Klein: It would be good to have discussion about cosmic ray tracker (CRT) in terms of what is needed and what can be done. More specifically, what would be the pixel size for the tracker? 1 foot wide?

Juergen: This could go as part of Tom's studies; discuss in terms of alignment as well. For example, is external information useful for alignment with cosmics?

Surprise discussion: Multi-purpose cryostat port special gate valve envisioned (Jack Fowler):

To accommodate multiple devices in one port, a special gate valve design is being pursued. Jack showed one such gate valve from a manufacturer. Gate valves are nice and ensure safety. If one doesn't want a port, put a flange and seal it. It makes it easy and safe for people to work on gate valve of a port. One will have to follow special protocols for open ports, the longer we leave it open, risks for contamination of argon.

Discussion:

Juergen: In the cryostat drawings so far, lots of I-beams. Is support located between I-beams?

Jack: Yes, ports are b/n I-beams. Orient valves to be parallel to beams. Every feedthrough will also have a side flange (CF63) to route cable and such. A 10 mm purge port will also be there on each FT to pull gas out of the FT. Flanges will be at room temperature about 2m away from the liquid.

Bo: Are bellows included to avoid contaminating the gas?

Jack: Don't see a need. If it's high vacuum and purge port, why need it?

Bo: If the device in the port is long and past the valve, gas gushes out in the time you try to change things.

Jack: I am assuming sealed and contained volume on the warm side. If one needs to open the port and stick a rod in, then that is different.

Sowjanya: This would be case for Radioactive source or Laser for example.

Jack: Anything not sealed must go through rigorous safety review.

Bo: If you have a laser system, flange is sealed on gate valve. But, as soon as you attempt to remove it, whole things will be open.

Jack: If you have bellows on top, then you need to design it. One needs to work with safety for any cold intrusion involved.

Bo: I was thinking alternatively, huge bellow to each object we want to extract, which serves many ports.

Jack: Can do that when not under Mezzanine (South-West side). Mezzanine covers some ports. Clearance around 2.3m.

Talk 2: Radioactive source Feedthrough discussion (Sowjanya Gollapinni)

Juergen presented a detailed talk on radioactive sources starting from choice of the source to needed feedthroughs. The main point of discussion given the FT counter proposal from the cryostat team, is where radioactive source FTs need to be located along drift for the ports above the TPC. For the electron lifetime requirements/measurements, half the drift is considered as the desired source of location. As an alternate proposal, the request was to have 4 dedicated FTs for radioactive sources at $Z=0$ where each FT is at half drift. A lot of discussion followed on these two points. Also, in terms of run plan, the general understanding was that the radioactive sources will be deployed only during commissioning, but Juergen's proposed run plan suggests deployment more often, at the very least once before a run period and once after the run period, assuming the detector is stable.

Discussion:

Juergen: ^{58}Ni - ^{252}Cf source is currently being considered as the reference design. Here ^{252}Cf acts as a moderator. The FT dimensions are basically decided by the choice of the moderator. ^{252}Cf allows to have a FT of size 20 cm. Other options such as AmLi or AmBe will require about 50cm FTs.

Sowjanya: Just to be clear, for the FTs on the TPC, the source will enter the cryostat but will be outside FC, right? And the source will be take up to 27 cm close to the cryostat to keep the same distance as the sources that are on the East/West of the cryostat.

Juergen: Yes. Per simulations, 20 cm is the safe distance for E-field.

Juergen: Using DoubleCHOOZ's fish line deployment system, one can also deploy other systems, Cameras, or laser possibly with this system. Extrapolating from DoubleCHOOZ, $\pm 2\text{mm}$ precision achieved over 7 m. So, we will have $\pm 4\text{mm}$ (or about 0.5 cm) over 14 m which is sufficient precision for DUNE.

Josh: For charge, where is MIP? One has to think about this in the context of DAQ zero suppression as it will shift the MIP.

Juergen: The DAQ zero suppression is implemented in LArSoft.

Josh: But, we don't know if it is implemented right.

Sowjanya: Your Z/X projection plot shows 1 to 2m spread in gammas. If we take the 20 FT scenario we got from Eric James, we have FTs on either side of the e.g. central APA at 40 cm distance. This means that the source will drift to the adjacent drift chamber which can complicate the situation.

Juergen: Right, I call this spill in and spill out. Could resolve it, but may as well have 1 port in that case. Charge itself, or detected light in photodetector can fluctuate (stochastic process).

Vitaly: Did you consider low neutron flux sources? Different gamma option.

Juergen: Not considered yet. Just neutron sources themselves.

Chuck: Short half-life within reactor produced.

Vitaly: Yes, remake every few days.

Bo: Did you consider Ar42 as a calibration source? One can use it in principle to get your electron lifetime correction.

Juergen: Yes. More as a rate monitor for detector stability and supernovae calibration.

Bo: Is it sufficient vs. the other sources?

Juergen: It could be done, yes, what you don't get there is response w.r.t. gammas. Only w.r.t. betas. Supernova neutrinos need to collect gammas too, both light and charge yield.

Tom: Using Ar42 will result in a bias since you won't get all the photons, only the high energy is detected.

Alberto: Not convinced that you need to deploy source at the middle of the drift. Easier to do it closer to

the wire planes, because HV on the field cage is smaller. With sources, don't want to do the lifetime, there are methods for that for purity. I see an advantage to have events close to wire planes for detector. Separate problem of e-lifetime, and resolution of detector for LE gamma. Advantage to APA proximity.

Juergen: If you use muons to measure electron lifetime, you need to know where the muons went, and E-field. With source, we know where we deployed it.

Alberto: Yes, we know where the source is, but we don't know where the gammas convert.

Juergen: We use simulation.

Alberto: Yes, but, a lot of simulation. Measure in a better way, the energy resolution for events close to wire planes, and then use other methods to understand electron lifetime. Deploy closer to APA.

Juergen: If you have issues with lifetime, then you are closing the avenue on it.

Juergen: 27 cm from FC is large safety factor. 15 cm is safe distance? Bo?

Bo: Don't recall. Depends on relationship to CPA. Mid-drift with insulating shell, it is maybe okay.

Sowjanya: Bo did some E-field simulations for Andrew/Jianming for purity monitors at the locations of the instrumentation ports that are on the East/West side of the cryostat outside the FC. I can send those simulations to Juergen. It seems like the ports are closer on the West side compared to the East side which resulted in large field value on the West side. One needs to take this difference into consideration.

Jack: The East/West difference may have been fixed now. It is 400 mm in from the inner wall or almost 688 mm.

Eric: Did anyone calculate how much the radioactive source get pushed by currents towards the FC if dropped 12 m? 12 m makes me nervous for the temperature rod. Worse on a string or a rod.

Juergen: Moderator is resistive material. Rope is also nylon/teflon coated resistive material.

Eric: what constrains it to a certain area?

Juergen: can determine how much it might swing. In previous experience, steady in x and y. This source will move more. Will need to cross check that in simulation. If there is a problem, then use tubes as alternate scheme with holes.

Tom: Even a small misalignment at the top can swing widely at the bottom.

Eric: Interesting discussion on close vs far for electron lifetime measurement. How many places to make the e-lifetime measurement?

Juergen: If close to APA, not much time difference b/n photons and charge hits. (Anti) correlated charge and light yield. If CRT, and purity monitor, can use this to get an additional handle on it. Each TPC might have differences.

Eric: What does the 4 in the top buy you?

Juergen: How uniform it is in between.

Eric: What is the behavior along length? Tilt in CPA plane? Or misalignment of one APA to another?

Eric: Function of Z position, 3 points?

Juergen: Only suggesting 4 more in the middle. Halfway through beam direction from some warping or misalignment of APA.

Bo: Don't see how you would use Radioactive source to determine misalignment APA, field cage?

Alberto: you have laser system for that.

Bo: Don't know if current PD are sensitive to the 3.5 MeV. If they can, Ar 42 is always there and we don't need to do more.

Alberto: How sure the source will work assuming thermalized neutrons?

Eric: will meet with Juergen next week in SD and will discuss this further.

[Juergen sent an email to the calibration TF list as a follow up response to some of the questions raised in the meeting. Be sure to read it!]

Talk 3: APA Alignment studies with muons & DUNE physics week plans (Tom Junk)

Tom presented interesting considerations/studies on alignment with muons. Both local and global alignment is discussed and specifically which distortions are difficult to measure with cosmics. An external pulsing method to test connectivity, geometry, and response was also discussed. Tom has also requested the production team to generate a 20k MUSUN events in a single 10 kt DUNE FD-SP module. Finally, a list of topics for Physics week is presented.

Discussion:

Byron: In addition to cosmics, you also have muons from atmospheric neutrinos and muons from neutrino interactions in the dirt. Muons from atmospheric neutrinos will be rare but muons from neutrinos interactions in the dirt when we have beam will be frequent.

Josh: If someone says energy scale, we need to know lifetime. What is dependence of energy scale on lifetime. Doing better than 1% on energy scale might mean we have to do 2 times as good on lifetime?

Tom: Uncertainties on lifetime dominated by systematics (from 35-ton), wouldn't expect scale.

Byron: when the chamber is empty, you can measure everything very accurately.

Josh/Tom: Yes, absolutely. That gives one measurement. But, the problem is when the detector is cold, it moves and we might mis-align in a way not predicted.

Sowjanya: In the physics list, in terms of Laser vs cosmics studies, alignment is one of the biggest piece. It would be good to prioritize this over the other items as it can also help us with the FT needs.

Tom: People may want lots of stuff to pick and choose from, but alignment we know how to do. The way I listed it, I prioritized alignment related work.

Sowjanya: Also, the last item, drift velocity calibration, how independent is this from the anode-cathode distance ? Is also very important since if absolute distance is highly correlated with drift velocity, then absolute distance can be measured independent of drift velocity using laser.

Sowjanya: What about recruitment for help?

Tom: Wallbank did a lot of this. Some people on ProtoDUNE (Leigh Whitehead) was working on cathode piercers.

Vitaly: Mike Wallbank is currently in transition and might or might not have time to participate. Will find out.