Purity & Radio-purity WG

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Scope

- Purity
- Radiological Purity
  - Argon
  - Detector Materials
- Cleanliness
- Simulations

Purity

- Determine required chemical purity of the argon
  - electronegative species that affect charge transport, impact light propagation, or adversely affect detector operations such as high voltage application
- Requirements must be assessed in con junction with the relevant physics, simulations and installation Working Groups
- This group provides interface, co-ordinates, and conducts measurements of purity and material outgassing where necessary
- This group provides input to develop appropriate techniques for achieving, maintaining, and assuring requirements are met on timescales compatible with the project schedule

Radiological Purity of Ar and Detector Materials

- Determine the requirements on tolerable levels of radiological contamination in the detector target and construction materials
- Potential to cause backgrounds in the experiment:
  - ^{238}U, ^{235}U, ^{232}Th, ^{60}Co, ^{40}K, ^{39}Ar, ^{222}Rn
- This group will assess feasibility of a ^{39}Ar-depleted target
- Liaise with relevant WGss to define materials for radio-assay, aid procurement of samples, and allocate and schedule the assays at facilities available to the project.
- The group reports assay results, and works with the Simulations and Physics Groups to determine impact on science
- Determine suitability of use for materials

Cleanliness

- Set requirements on tolerable levels of dust and other foreign materials in the detector that may induce backgrounds
  - …radioactive decay, electrical discharges, mechanical obstructions
- Assessment of impact from radon decay and radon plate-out, radio-activity within dust particulates, particulate mass and size distributions
- Translate requirements to ambient cleanliness levels covering dust fall-out and carry-in rates, cleanroom class requirements and protocols, air handling infrastructure
- Extends to assembly, installation, and integration of all detector components and the detector itself on-site
- Group will work with the Installation and Integration WG to develop cleanliness protocols, and techniques for quality control and assurance of cleanliness levels throughout the project

Simulations

- **Ongoing efforts (to our knowledge):**
- Graduate student Jason Stock and Juergen (**SDSM&T**):
  35t detector response (both reconstructed charge and light) for Co-60, 5 MeV alpha's from radon and its daughters, 0.5 MeV electrons (-> Ar-39)
- Graduate student Gleb Sinev (**Duke**):
  Ar-39 PD Simulation and Reconstruction
- Neil Spooner's group (**Sheffield**) interested

- **Still to do:**
- Write and commit external LArSoft generators for isotopes of interest
- Full FD simulations
- Compare 35t real data with simulation of e.g. Ar-39
- Get more people involved!

Radio-assay Resources

- Boulby Underground Laboratory
  - Canberra BEGe 5030, SAGe (well-type) GSW275, Ortec (p-type) GEMXX-95, BEGe 2825
  - Heavy LZ use, but some capacity may be made available
  - Managed by Ghag through DMUK
- ICP-MS at UCL
  - Agilent 7900 ICP-MS with HF capability, H2 reaction cell, KED
  - Microwave digestion and ashing ovens
  - Class 1000 cleanroom
  - Dedicated to LZ assays
- SURF/BHUC
  - Wide capability with high sensitivity instruments
  - Heavy LZ use, but diverse range of resources

Radio-assay Resources

- LNGS
  - HPGe
  - ICP-MS (with laser ablation)
  - Availability of resources ??
- Radon Emanation
  - Requirements need to be determined; low throughput
- Neutron Activation Analysis (NAA)
  - MITR
  - UC-Davis
- Glow-Discharge Mass Spectrometry
  - Commercial availability

Purity Resources

- **MTS at Fermilab/PAB** (Stephen Pordes, Brian Rebel, Ewa Skup) for material compatibility tests with liquid argon
- **Purification system** expert Terry Tope (and his team) at **Fermilab**
- **35t purity monitoring** expert Alan Hahn at **Fermilab** (+ potentially Juergen/**SDSM&T** who helped in phase 1)

- Ar-39 measurement in test dewar by Victor Gehman at **LBL**

- (and anyone who we might not be aware of yet)
- -> get more people involved!

Cleanliness Resources

- **Defining onsite and offsite cleanliness protocols for assembly, shipping & installation as well as required temporary cleanliness facilities:**
- **UCL, SDSM&T, LBL and UC Davis** expertise on cleanliness (dark matter + reactor neutrinos + solar neutrinos + neutrinoless double beta decay experiments) + anyone who we might not be aware of yet
- **Particulate counters** in clean areas to monitor airborne dust and inspection of **control swipe samples**
- **Monitor radon level** in critical areas (SDSM&T/Luke)
- **Optical dust count on witness plates** (automated microscopic dust assay at SDSM&T/Bai+Juergen)
- **gamma-spectroscopic assay** of large dust samples (LBL/SURF)
- **ICPMS isotopic analysis of dust** (started at SDSM&T) & other radio-assay methods available at other institutions
- Get more people involved!

Logistics

- Regular Meetings Slot: proposal for **Wednesday 10 am MT** (5 pm UK)
- Immediate tasks to finalise charge, determine resources
- Create WBS structure:
  - Purity
  - Radio-purity
    - LAr
    - Materials
  - Cleanliness
  - Simulations
- Mailing List: ***DUNE-FD-PURITY@LISTSERV.FNAL.GOV***