DUNE ND-SAND PDR: KLOE Components to SAND
(https://indico.fnal.gov/event/64578/)
Questions and Answers

This document aims to capture questions and answers during the preliminary design review of the DUNE ND KLOE Components to SAND held on July 22-23, 2024

1. Is the MoU with INFN that spells out the SAND contributions public? If so, may we see it to provide background information.
SAND team: The MOU is public. We post it on the Indico page.
2. Is there anything being reviewed at this PDR that is part of the LBNF/DUNE TPC? If so, what?
SAND team: This PDR is about Near Detectors and related only. Parts in common with the Far Detector are related to DAQ infrastructure, timing, computing models, beam, simulations and slow control interfaces. Obviously, these parts have to be consistent throughout the entire DUNE program.

There are no items here related to the TPC of LBNF/DUNE, since SAND needed are arranged within the DOE-INFN MoU.

3. Is there or will there be a resource loaded schedule for SAND work at Fermilab?
SAND team: A resource loaded schedule will be developed in the coming months to be included in the PDR. INFN resources to be employed at FNAL have been already identified for ECAL/Magnet/Yoke mounting. Resources from FNAL have been partially identified (crane/infrastructure/engineering supervision etc.). There are discussions with Fermilab for additional resources as the schedule is developed in further details.

4. Is there anything like a critical path for ECAL/Magnet to be ready for the current planned installation start in the ND hall?
SAND team: The present schedule for ECAL and the Magnet contains a significant amount of contingency (more than 1.5 years) and already includes significant testing of components. Risks for installation readiness are related to severe accidents due to transport. These are mitigated by appropriately engineering the transport and through the choice of highest reliability carriers.

5. Somewhat related to the question above, it's not possible to understand if you have schedule float to the September 2028 date. Or are ECAL and magnet not the drivers and tracker and GRAIN driving the schedule?
SAND team: The KLOE-to-SAND schedule ends at mid.2028 to be followed by the installation and integration (I&I) schedule. The ECAL/MAGNET are the main initial components driving the installation process. Schedule after Sept.2028 is in C. Montanari's presentation.

6. One of the charge questions relates to technical personnel needed at Fermilab. This is not adequately addressed in the material posted so far. Please elaborate on this. Do you have a spreadsheet by person type of what is needed when, by fiscal year? The usual thing you would get from a resource loaded schedule.

SAND team:
technical personnel at FNAL in 2028 (6 months) will be:
INFN personnel and INFN contractors:
- 2 technicians from external company with experience in the ECAL and Magnet dismounting at LNF.
- 2-4 INFN technicians from the same team that participated to the ECAL dismounting operations at LNF
- technicians from the company contracted to dismount at LNF and reassembly at FNAL the yoke
FNAL related personnel:
- crane driver and FNAL services for onsite transport (as needed)
additional FNAL personnel (engineering). Time to be defined in the resource loaded schedule.
- FNAL safety officer
- FNAL ELO (Experiment Liaison Officer)
- FNAL personnel for supervision (1 or 2 persons) technical coordination (1 person) and ORCs (operation readiness clearance) as needed.
- FNAL engineers to validate projects and installation (as needed).

7. Do the ECAL signal/HV cables that are planned for reuse satisfy current Fermilab EHS standards?

SAND team:
Yes, we already checked that they are CE and FNAL EHS compliant. The documentation is currently in Italian.This is an extract of the safety characteristics of the cables:

4 Caratteristiche termiche e di sicurezza

- i cavi in oggetto devono essere costruiti con materiali in grado di mantenere le specifiche richieste per un periodo di almeno dieci anni, senza perdite dovute all'invecchiamento
- debbono poter operare in un intervallo di temperatura da 15°C a 35°C senza alterare le caratteristiche elettriche sopra descritte per ciascun cavo
- dal punto di vista della sicurezza devono avere requisiti sufficienti per operare in ambienti classificati:

- resistenza alla propagazione del fuoco	normativa	CEI 20-22/iii &IEC 332.3C
- bassa emissione di fumi: densitá fumi	CEI 20-37/III	≤ 1.5
	ASTM E 662	Ds ≤ 250
- conduttività fumi		≤ 100 µS/cm
- bassa emissione di gas tossici	sec. CEI 20-37/II	≤ 2
- bassa corrosione fumi "contenuto HCl"	sec. CEI 20-37/I & IEC 754.1	≤ 0.3%
	sec. VDE 0472/813	pH > 4

- devono essere zero alogeni secondo specifiche CERN

8. In general, what level of Fermilab EHS review has been done so far related specifically to the ECAL and Magnet. Usually in a PDR this kind of activity would at least be referenced. And SAND more generally, if that information is available.
SAND team:
There have not been formal Fermilab EHS reviews of ECAL and Magnet subcomponents. Fermilab engineers are analyzing designs and discussing action items with involved people from SAND Consortium to conform to Fermilab protocols. There have already been visits at INFN LNF from Fermilab personnel to witness the uninstallation activities of ECAL modules and more are planned before and during testing and uninstallation of the Magnet. The review process will follow the same scheme as the ones applied to other detectors (ICARUS, SBND, 2x2, …).

9. How many ECAL PMTs are known to be dead? How comfortable is the 150 number of spares? Is there an agreed threshold for the number of working PMTs prior to installation in the ND hall? 95% 98% ??%
SAND team:
Few tens of PMTs were substituted for infancy defects (year 1998-2000). During KLOE runs (2001-2018) O(0.2%) were substituted for malfunction. We expect that 150 spares (3%) would be a very comfortable number to cope with the whole DUNE phase-I and phase-II runs, including refurbishment of modules.
The agreed threshold prior to ND installation at the moment is 100%.

10. Please try to expand on the transportation plans for the ECAL from LNF to Fermilab. Orally during the relevant presentation or point us to documents. What are the milestones for "pre-ship" review or reviews for the ECAL?
SAND team:
ECAL modules will be rewrapped, re-glued (if needed), mechanically verified

(dimensions and mechanical stability) and individually tested with cosmic rays at LNF. The pre-ship requirements are the full functionality of each module, and dimensional and mechanical fitness. Everything will be documented and used as a reference for the functional tests to be carried on at Fermilab, before installation. Tests at Fermilab are in principle solely intended to verify that no damage occurred during transport.

11. Where do the ECAL modules go at Fermilab? Have you verified that this location has the appropriate temperature control, cranes etc?
SAND team:
We have clear requirements for the storage and test areas:
- barrel storage area ~50 m^2 and crane 5 tons
- endcap storage area ~60 m^2 and crane 15-20 tons
Test area should be 50-100 m^2 depending on the parallelization of operations; with crane 15-20 tons. The temperature should be within +/- 10 degrees.
There are some locations at Fermilab with the required characteristics of surface, crane coverage and cleanliness (for example at IERC and CDF assembly building).
A specific area has not been assigned by Fermilab; this will happen when we get closer to the shipping date.

12. Do you do complete cosmic tests of all ECAL modules at Fermilab? Who is doing this and how have you estimated the duration that is in the schedule shown? Is there a QA/QC document that covers what will be done at LNF and Fermilab?
SAND team:
Actually the schedule has plenty of contingency in operations at LNF under the supervision of INFN personnel. At FNAL the operation are still under evaluation (see below).
At LNF we need:
- 1 week per barrel module for refurbishment
- 4-5 days of full data taking (whole module and all cells exposed to cosmic rays) +1-2 days for PMT mounting/dismounting, module handling => 1 week per barrel module for test
Parallelizing the refurbishment and test operations, and processing two modules at the same time => 12-14 effective weeks for barrel
2 technicians (refurbishment) + 2 physicists (test) needed for the whole period.
Including the endcap modules => 24-28 weeks in total.
The schedule takes into account completion of preparation of cosmic ray test stand, learning phase for refurbishment operations, testing FEE prototypes, not full speed testing of the modules and a robust contingency.
At FNAL the operation should take at most 24-28 weeks in total, as at LNF.
It could be shortened depending on the ECAL shipment with or without PMTs.
The risk option must be evaluated wrt PMTs shipped separately. This evaluation can be done after the test of a relevant part of ECAL modules considering the risk of (A) vs (B) options, with:

(A) dismounting, re-mounting, dismounting PMTs at LNF and then shipment, remounting PMTs and test at FNAL
(B) dismounting and re-mounting PMTs at LNF and then shipment and test at FNALI.
With option (B) => 5 days per module
=> total ECAL barrel+endcap = 5 days x 24 modules /2 (2 modules at the same time) x 2 (including endcap) = 120 days =>17-18 weeks in total
We have the old KLOE note describing the main procedure to asses ECAL module performance with cosmic rays: KN154 (seeTDR draft and http://www.lnf.infn.it/kloe/kdocs/getfile.php?doc_fname=kn154.ps)

13. Do you need to make ANY modifications to the tooling used for the successful disassembly of the ECAL for reassembly in the ND hall? Are there any additions needed to the tooling?
SAND team:
The mechanical tools are the same used for the dismounting. The extraction and rotation tool for barrel is going to be slightly modified/improved. No additional tools are foreseen. Possible small improvement/modification of endcap mechanical tools will be evaluated a posteriori after Endcap dismounting operation.

14. Will all of the ECAL modules be on one ship?
We will choose the best option in terms of damage risk minimization according to the commissioned transport engineering study.
We are also considering the possibility of shipping ECAL modules by airplane as alternative option.

15. What is the status of doing a trial, instrumented shipment relevant to the ECAL? When might this happen?
SAND team:
The bureaucracy of the procedure has been already tested with the shipment of 150 spare PMTs. At the moment we do not plan to make a trial shipment.

16. When do you plan to decide among the FEE options?
SAND team:
According to our plans by summer 2025 at latest. It is not critical, we have ample contingency margins in the procurement phase.

17. Is there an interface document that spells out the civil infrastructure needs for the magnet in the ND hall and the associated legacy and new-build equipment to operate the magnet?
SAND team:
An interface document has been produced about three years ago. It has been integrated in the NSCF (Near Site Conventional Facilities) interface document and is part of the definitive project for the ND building.

18. It would be good to indicate that you are aware of Fermilab electrical EHS requirements including for legacy items.

SAND team:

We will indicate that electrical EHS requirements will be respected by all SAND electrical and electronic components. All electrical and electronic components will be newly procured or rebuilt (magnet power supply and quench protection system) following the requirements of the relevant FESHM (Fermilab Environment, Safety and Health Manual) chapters. There are no legacy items requiring special consideration with the only exception of the magnet coil.

19. Can you fully test the magnet in the DO assembly hall? Assuming this is the initial location at Fermilab.

SAND team:

Testing of the magnet at Fermilab will be limited to the requirement of verifying that no damage occurred during transport. To this purpose, the maximal set of tests is: visual inspection, vacuum tightness test of the cryostat, pressure test of the cooling circuit, continuity check of the solenoid, cooling at LHe temperature, test of the SC coil with minimal current without installation of yoke. Magnet will be tested at LNF following the same procedure to be used at Fermilab. At LNF, where the yoke is installed, a current of about 1kA will be reached, while at Fermilab, where the yoke will not be installed, the current will be limited to 10% of the nominal value. We verified that these tests can be done at DAB, but, to minimize the cost, other locations are being considered that are already equipped with the required cryogenic and safety infrastructures.

20. The magnet is roughly 30 years old. Oxford made many superconducting magnets. Out of curiosity, is there any information on long-term degradation of Oxford magnet components? Yes, I know most were unique.

SAND team:

No information on long term degradation by Oxford Instruments is available. Below a list of considerations on the subject:

- All the wearable components will undergo thorough maintenance service.
- About the coil it is worth to note that during its operation at LNF the magnet did experience very few full thermal cycles from 300 K, since it has been kept always cooled during the years, with the exception of the yearly 5 days winter shutdown for the maintenance of the refrigerator, during which the magnet did not exceed 100 K.
- The KLOE magnet has never suffered a quench, which is a sign of absence of an aging training effect.
- The KLOE magnet has been operated below 2660 A (to optimize the KLOE performance for low momenta tracks), below the operating design current of 2902 A
- The KLOE magnet underwent during the whole operation period only a limited number of energizing and de-energizing cycles.

21. Please elaborate here on during one of the talks on what has been done related to customs and export/import regulations. Do I understand correctly that you plan to subcontract end-to-end shipping of both the ECAL and magnet to a firm, including having them deal with duties, etc?
SAND team:
Yes, the idea is to have a general contractor to deal with mechanical engineering, interface with transportation companies, shipping permits and bureaucracy. There is some past experience at LNF about this procedure, already followed for the shipping of other experiment detectors.

22. There is a nice summary table in the magnet dismantling and transport talk about “Design Studies”. Can you point us to documents/drawings? Can you give us some sense of the level of review accomplished so far for the various fixtures/tooling? Does the DUNE review office get involved or not?
SAND team:
We have already the design and final executive drawings. They will be available as soon as possible on edms (upon availability of A. Saputi presently on vacation).
The DUNE Review Office is not going to be involved, as far as we know.

23. The LBNF/DUNE Review Office review plan calls for a list of required documents. Are these available and where can they be found?
SAND team:
The updated TDR has been uploaded in the Indico page of the PDR. It contains many of the requested documents/information.
The physics requirements are under re-evaluation of the ND group.
The schematics for the ECAL electronics are only partially available (see TDR) since the definition of the FE electronics is still not complete (see presentation by Antonio Di Domenico).
Most of the required documentation, schematics, and drawings are available on a dedicated repository on EDMS (reference person A. Saputi).
Link to EDMS:
https://edms.cern.ch/ui/#!master/navigator/document?P:100233194:101210940:subDocs
For the grounding issue see answer to question 26.
Part lists related to legacy equipment and instrumentation will be provided together with generic specifications to find equivalent part lists.
The remaining documentation is in preparation.

24. It is assumed that the performance of the ECAL will be the same as what was measured in KLOE. For this to be true the calibration will need to be equally precise in DUNE, but the experimental environment is quite different. Please provide the studies showing how the calorimeter will be calibrated and that the expected

precision can be achieved. It seems likely that large samples of Bhabha events are not going to be available.

SAND team:

We are well aware of that. In KLOE we exploited the huge Bhabha and e+e- => gamma gamma processes for fast calibration check/correction during the runs, while the basic calibration and cell inter-calibration (but the absolute energy scale) was performed with MIPs (minimum ionizing particles) from cosmic rays. In SAND we are studying the best solution to inter-calibrate ECAL cells using (i) cosmic rays, (ii) punch-through muons, pions and (iii) particles from other processes reconstructed with the tracker. For the absolute energy scale we are going to exploit pi0->gamma gamma, K0S=> 2 pi0 decays, and electrons from neutrino interactions.
Reconstruction techniques developed in KLOE and suitable also in SAND will be exploited. Note that a dedicated working group has been set to study the calibration issues (see also the TDR Section on ECAL calibration).
In general we are going to calibrate ECAL using a several step process.
1. Cell-by-cell response equalization and time offset alignment with MIPs;
2. Setting the absolute energy scale, at cluster level, with photons from pi0 decays and electrons from beam events;
3. Timing alignment with other SAND sub-detectors by using muons, pions, and electrons from events with reconstructed vertices in the inner tracker.
We expect on average ~150 neutrino interactions per spill at the maximum beam power. Most of the muons produced in these interactions will also be exploited for calibration purposes. The study with MC simulation is in progress.

25. The support of the mechanical structure inside a superconducting magnet is normally minimal to minimize the resulting heat leak. Often manufacturers will provide temporary supports for use in transportation. Were such temporary bracing members needed in the initial transport? Have there been calculations showing that no additional bracing is needed for the ocean transport?

SAND team:

The vessel structure of the KLOE magnet has been over-designed in consideration of the need to support the barrel ECAL (85 tons). Therefore no braces have been used by OXFORD for the transport from England to Frascati, through the Atlantic Ocean and the Mediterranean Sea. We will confirm the calculation once the details of the transport will be settled.

26. One of the documents required for the preliminary design report is a grounding and shielding plan. Is this available? The HV breakout boxes planned short all the grounds together in a module and connect this to the rack ground. Has the impact of the resulting ground loops been evaluated?

SAND team:

The scheme of the grounding of the KLOE experiment shown in the figure below has been discussed with FNAL engineers in order to assess compliance with FNAL rules and adapt to local conditions.

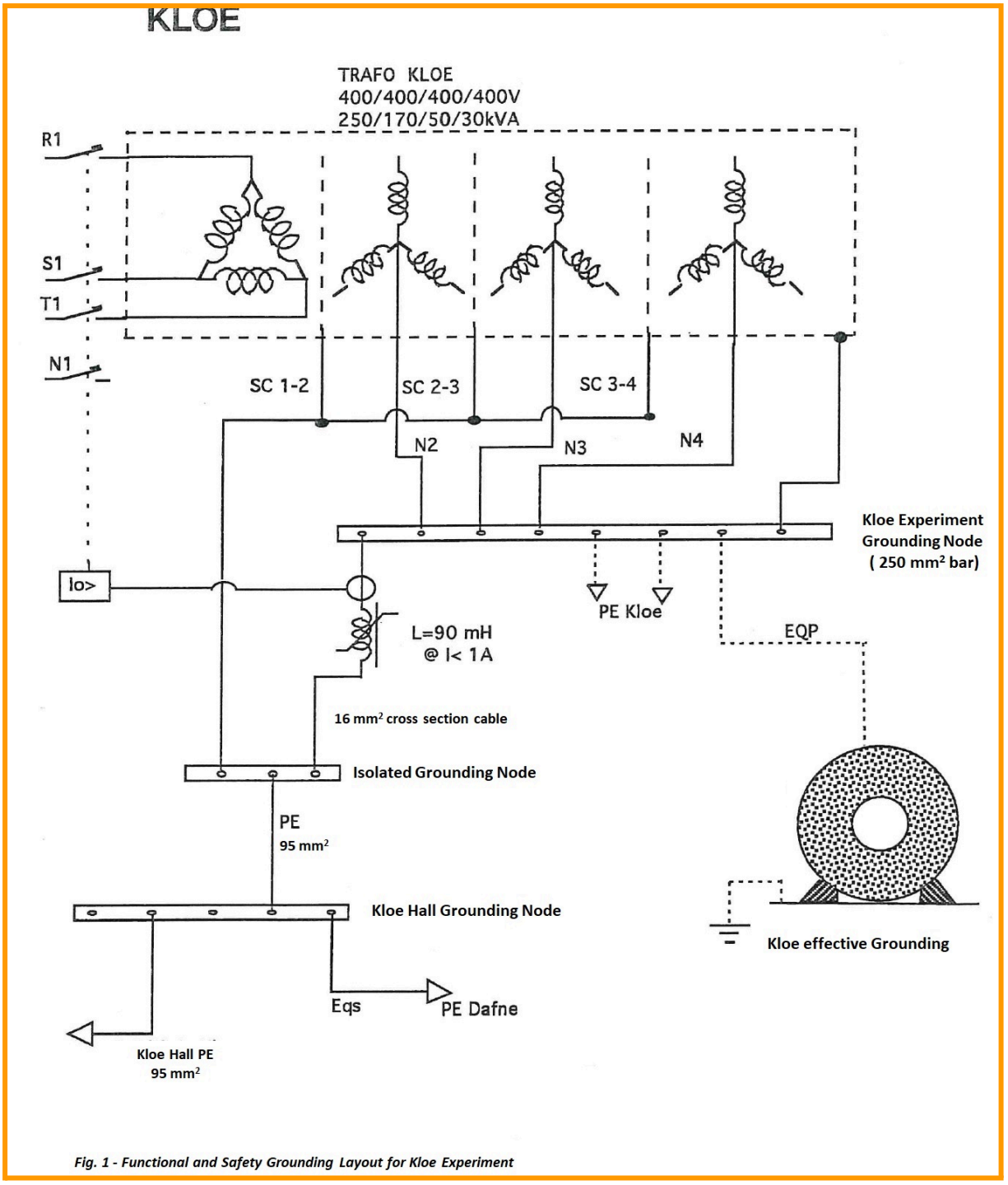

Fig. 1 - Functional and Safety Grounding Layout for Kloe Experiment

27. Are interface drawings available to show that adequate space exists for the magnet in the hall and for the internal detectors?

SAND team:

Yes. These are part of the work performed with the I&I team. Requirements and interface drawings have been integrated in the I&I specifications and are available on edms (see for example https://edms.cern.ch/project/CERN-0000231814 and https://edms.cern.ch/project/CERN-0000216390). The drawings will be inserted in the TDR chapter related to integration and installation, but they still need to be

reviewed after changes following the removal of SAND from Project.

28. Are requirements documents available to define the cryogenics requirements and the power requirements?

SAND team:

The guaranteed cryogenic power requested from the refrigerator was:

Current leads	0.6 g/s
4 K Radiation and conduction	55 W
70 K Radiation and conduction	530 W

Test by Oxford Instrument in Frascati measured:

Current leads	0.2 g/s
4 K Radiation and conduction	27.8 W
70 K Radiation and conduction	62.6 W

(reference in TDR)

29. Is there a resource loaded logically linked schedule for the work to be performed not at FNAL?

SAND team:

Not yet. An estimate of the required resources has been performed, but it has not been detailed into a schedule.

In all the activities in Italy so far we have never experienced a limitation due to lack of personpower. We will nevertheless implement a resource loaded schedule both for the work in Italy and at FNAL, which will be inserted in the TDR.

30. Are there a list of milestones agreed upon with all funding agencies that will allow the US/LBNF-DUNE project to monitor progress on the Magnet and ECAL scope?

SAND team:

Not yet. The general requirement on this subject is contained in the DOE-MUR MoU, that, at Section 2 point D-2 states that "*the SAND installation schedule is planned to be coordinated with Fermilab and the DUNE Program*". In any case, milestones can only be meaningfully defined once the installation sequence in the ND hall is formally agreed within DUNE, and when the spaces and logistics at FNAL will be defined.

31. Are the existing procedures posted and have the FNAL safety organizations reviewed them to verify that they would be acceptable at FNAL?

SAND team:

For the time being the dismantling procedures are reviewed by the LNF safety office. We are totally open to share those procedures with FNAL. To this end we are in contact with a FNAL engineer who has already visited the KLOE site at LNF during the dismantling operation of the barrel modules.

32. Has the documentation for the tooling used or to be used at Frascati to dismantle the ECAL and the magnet been reviewed by FNAL to verify that the US safety requirements are met?
SAND team:
The tooling used to dismantle the ECAL and the Magnet is being certified by third parties according to CE rules and will be accompanied by technical specifications according to ASME standards. This documentation is the starting point for the validation by FNAL safety office.

33. Additional information on where and how the magnet will be tested cold and at field upon arrival at FNAL should be presented.
SAND team:
The location of the test at Fermilab has not been assigned, yet. Two possibilities have been considered, one at D0 Assembly building (more expensive option, as it requires installation of safety equipment) and one at IARC (already provided with most of the necessary infrastructure). The testing procedure, as described earlier, has been discussed and agreed with Fermilab experts. It was also agreed that at a field 10% of the nominal, installation of the yoke was not necessary, and a restricted no-go area around the magnet was sufficient for personnel safety.

34. How is the packaging for the ECAL modules engineered? What shock is expected and how is the packaging designed to absorb this?
SAND team:
The engineering of the packaging for the ECAL modules will start at the beginning of 2025. We plan each module of the barrel to travel on a steel support inside its own box. Dampers could be designed depending on the amplitude and the frequency of vibration expected, which strongly depend on the transportation mean (ship or plane).

35. The temperature stability requirement for storage is pm 10C but the temperature variation during shipping can easily exceed this. Do you need to environmentally control the shipping containers?
SAND team:
Yes. For ECAL we need controlled temperature containers and temperature logs and periodic check points.

36. The temperature variations in shipping can easily cause condensation. Is this an issue?
SAND team:
For ECAL temperature and environmental conditions will be controlled during shipping. Boxes will be sealed.

37. Is there a QC plan with clear pass fail criteria for acceptance testing at FNAL? Can this be posted?

SAND team:

Each ECAL channel will be tested for reproducing the performances measured at LNF using cosmic rays and the same test procedure.

The details of this plan will be provided after completion of the testing procedures studied and implemented at LNF before shipment.

38. Is there a project Near Detector risk register? Are the risks presented all the risks that have been evaluated?

SAND team:

A comprehensive risk analysis has not been performed, yet. The risk analysis of the magnet transport has been reported in the distributed documentation. How to integrate SAND in the Near Detector risk register is still to be discussed and agreed between the ND-US project and SAND's Consortium.

39. An extended engineering note is to be prepared to request an exception to the FESHM ES&H requirements. The schedule needs to be updated to include the preparation of this document and its internal review and the FNAL safety review.

SAND team:

Yes. Preparation of this document will happen in parallel with the definition and execution of the magnet test at LNF, carried on in consultancy with Fermilab experts. A dedicated line in the schedule will be added.

40. Please provide additional details related to shipping to clarify the plans for customs and permitting. Will the Oxford magnet properly packaged and on a truck fit under a US bridge?

SAND team:

We will provide customs and permit documentation as soon as we get it. Most of US bridge are below 14' which would not let the magnet through. A detailed trip plan is needed to find a suitable route avoiding bridges. A possible solution would be to put the vessel with the axis perpendicular to the ground, to reduce height from 5.8 m to 4.4 m. We will confirm with OXFORD and with our independent calculation based on construction drawings that this solution does not harm the components inside the vessel.

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