DUNE Far Detector assessment of computational fluid dynamics calculations concerning the DUNE far detector cryostat.

Scheduled date: December 15, 2015, 10:00-12:00 CST.
Location: ReadyTalk.

As part of the preparations for the LBNF CD3A review, Erik Voirin of Fermilab performed calculations of fluid and thermal properties of the liquid argon in the DUNE Far Detector for two pumping schemes using computational fluid dynamics (CFD) methods.

It would be very useful for the DUNE Far Detector to produce an informed conclusion on the results of Erik's calculation, both to produce a better definition of the DUNE detector for the benefit of various physics and detector working groups and task forces, and to generate a list of any issues of concern for DUNE that could benefit from further CFD studies in the future.

We appreciate your willingness to participate in this exercise, which will be led by the convener of the DUNE Far Detector Cryogenics and Civil Interfaces Working Group, Milind Diwan.

Please consider the following questions:

1) Have the CFD calculations addressed key scientific and engineering requirements concerning the cryogenic systems?
2) Are the parameters and boundary conditions used for the calculations consistent with the envisioned operation of the DUNE detectors?
3) Are further calculations needed for adequate consideration of various stages of the cryogenics process: A) purge, B) cool-down, C) fill, D) operation, and E) equipment installation.
4) Are the assumptions regarding heat flux into all liquid surfaces, gas/liquid interface, and gas/feedthrough interface based on adequate modeling ?
5) Is there sufficient modeling of gas pressure at various interfaces during the various stages of the cryogenic process ?
6) Is there enough information from the calculations to guide final design for the DUNE Far Detector and its interfaces with conventional facilities and the cryogenics system?

We would appreciate you discussing these questions among yourselves after a presentation by Erik, and then sending a summary in a findings/comments/recommendations format by e-mail to Milind (diwan@bnl.gov) by Friday, December 18, 2015.

Milind Diwan
Tim Bolton
Jim Stewart

Participants: Erik Voirin (FNAL), Brian Rebel (FNAL), Bruce Baller (FNAL), Ben Carls (FNAL), Igor Kreslo (Bern), Craig Thorn(BNL), Keith Rielage (LANL), Christopher Mauger (LANL), Stephen Gent (South Dakota State), Gregory Michna (South Dakota State).

Erik's presentation will be open to the DUNE collaboration and LBNF project team.

Main material for the review:

(1) *LBNF Liquid Argon CFD Simulations - Temperature, Velocity, and Impurity field*, Erik Voirin, DocDB- 581.

Abstract: We perform several 3D fluid simulations of the LBNF cryostat using ANSYS CFX, a commercial Computational Fluid Dynamics (CFD) code. We calculate the Temperature, Velocity, and Impurity Distribution for the case when 4 pumps are on, circulating 103 gpm each, and discharging all to one location on the opposite end of the cryostat as the suction openings. We also calculate the same results with only 1 pump operational. A simulation for the positive Ion distribution with an 8 mm/s ion drift, and 1 pump operational will be added to the document once completed.

(2) LBNF Cryostat Condensation Prevention Simulation, Erik Voirin, DocDB- 519.

Abstract: We perform CFD simulations of the ventilation and air space around the LBNF cryostat to check methods of preventing condensation on the outer walls of the cryostat, which will condense water if the surface temperature drops below the 48F dew point. Several methods of fans and ductwork are tested for conceptual plausibility. The best method can be simulated in further detail.

Other materials:

DocDB-112: LBNF Science and Engineering requirements and parameters. Sheet related to Cryogenics/Cryostat high level requirements.

DocDB-251: LBNF Cryostat and Cryogenics parameters.

DocDB-602: The LBNF Cryogenics Infrastructure at the Far Site. CDR Annex 3D.