

Current Status and Future Plans of the Pulsed Neutron Source

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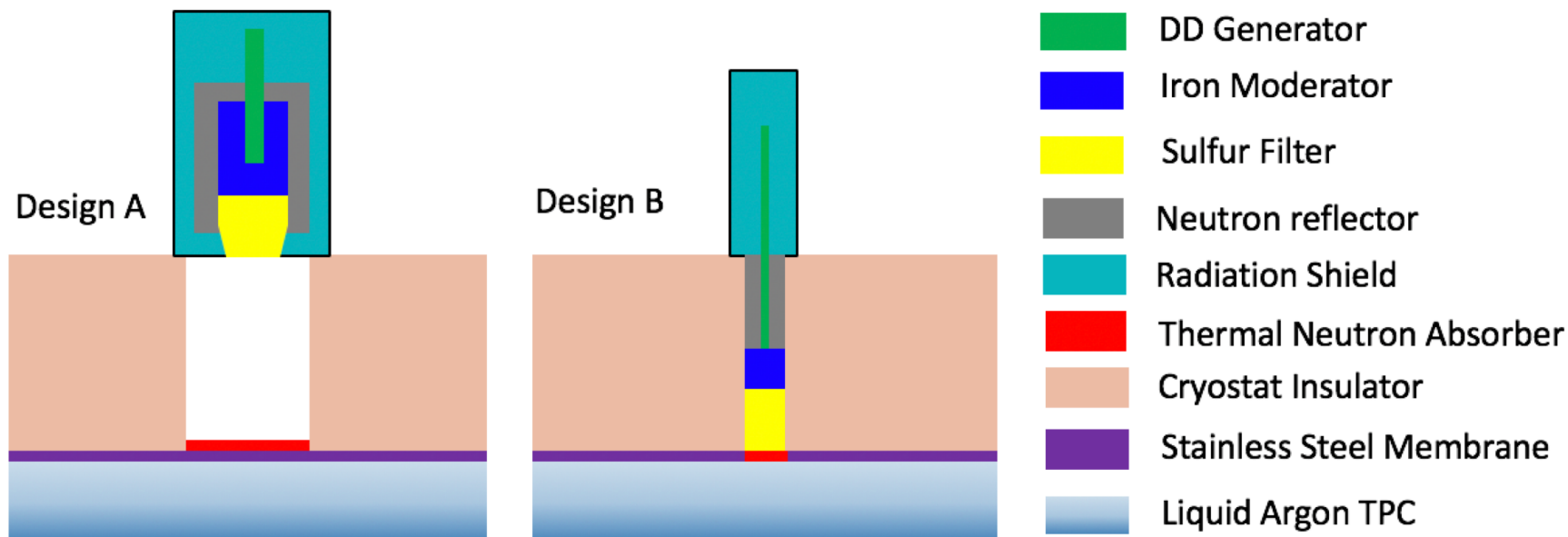
Calibration Consortium Meeting
01/18/2019

Neutron Source Working Group

- We have recently formed a Pulsed Neutron Source Working Group under the Calibration Consortium
- **UC Davis:** Robert Svoboda, Jingbo Wang
- **University of Pittsburgh:** Donna Naples
- **Boston University:** Chris Grant
- **MSU:** Kendall Mahn
- **University of Iowa:** Paul Debbins, Jane Nachtman, Yasar Onel
- **LIP (Portugal):** Jose Maneira, Sofia Andringa

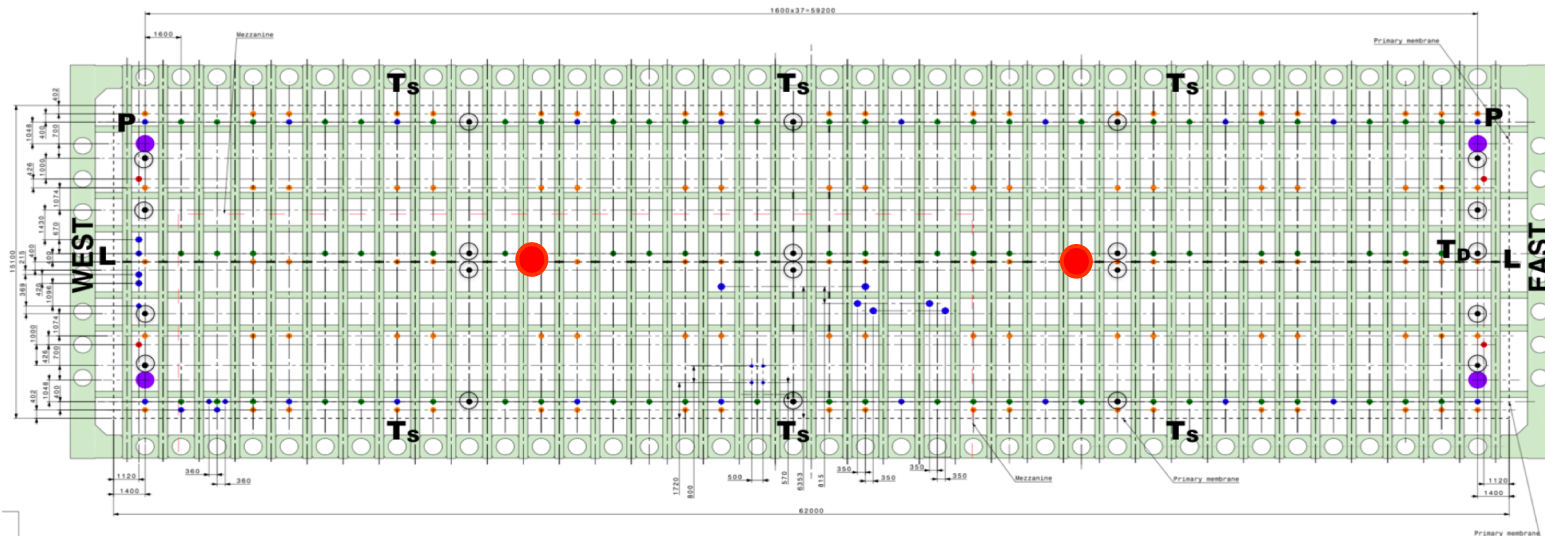
Design Options for DUNE-FD

- Primary design (Design A): Neutron source above the cryostat insulation; need to remove a part of the form insulation
- Alternative design (Design B): DD generator inside the cryostat feedthrough ports; need more shielding study
- Final option depends on the cryostat design



Location of Deployment

- In ProtoDUNE-SP, we can place the neutron source on top of (or inside) the unused manhole (~ 80 cm diameter)
- For DUNE-FD, the best strategy is to deploy two neutron sources at the red spots. However, we were told that the cryostat design had been finalized. Is it too late to make a request for the neutron source deployment?



Status of Simulation

- Feasibility studies completed in Geant4 simulation
- Final goal is to incorporate the Pulsed Neutron Source geometry into the LArSoft DUNE-FD simulation and run reconstruction to understand the detector response
- Simulation tasks (UCD, LIP, U Iowa, U Pittsburgh):
 - Neutron moderator optimization in Geant4
 - Radiation shield design in Geant4
 - Reconstruction tuning for low energy gammas in LArSoft
 - Validation of neutron cross-sections in LArSoft
 - Neutron capture identification in LArSoft
 - Photodetector response simulation & reconstruction in LArSoft
 - Validation of calibration capabilities: electron life time, energy deposition, field non-uniformity

Neutron Source Prototyping

- We are working on the MRI proposal (led by K. Mahn) to request funding for building the first neutron source prototype
- UCD and LIP will design the neutron moderator
- U Iowa will design the radiation shield
- BU will design and assemble the neutron monitoring system
- MSU will purchase a DD generator and assemble the neutron source
- Moderator test (UCD), material activation test (UCD, BU, LIP), neutron scattering experiment (UCD, BU, LIP)

TDR Studies

- Simulation studies
 - Neutron moderator and radiation shield optimization
 - Neutron capture identification in LArSoft
 - Connection to detector response

- Mechanical design
 - DD generator installation
 - Neutron energy moderator
 - Radiation shield

Beyond TDR

- Possible tests:
 - Moderator test at UC Berkley High Flux Neutron Source
 - Neutron scattering experiment at Los Alamos (proposal due in March 2019, the paper of the previous experiment ACED will be published in a month)
- Physics studies:
 - Update the neutron cross-section library and improve the neutron transport modeling in liquid argon
 - Develop reconstruction and identification algorithms for neutron capture using LArSoft
 - Study the impact on energy reconstruction in oscillation physics
 - Study the impact on supernova neutrino measurement
- Purchase a DD generator and build a prototype
- First operation at ProtoDUNE-SP detector at CERN

Time Line

- Before spring 2019: TDR simulation studies
- Summer 2019 to spring 2020:
 - Purchase a DD generator
 - Optimize the design (moderator and shield)
 - Assemble the neutron monitor
- Fall 2019- Spring 2020:
 - Perform neutron scattering experiment at LANL
 - Perform neutron moderator test at UC Berkley
- Spring 2020-Fall 2020:
 - Build the source at UC Davis
 - Set up test area at MSU
- Fall 2020-Spring 2021: Assembly and test at MSU
- Summer/Fall 2021-Summer 2021: Test at ProtoDUNE-SP

Summary

- We formed a neutron source working group
- Studies can go parallel among different institutions within the WG
- We defined a task list for TDR and beyond TDR. Will coordinate with other groups
- We Aiming at building a prototype and testing it at ProtoDUNE in 2021

