Minutes of the 6th Meeting of the LBNF/DUNE Resources Review Board (Fermilab, April 10-11, 2018)

Attendees:

R. Shellard (CBPF, Brazil)
R. Marcondes César (FAPESP, Brazil)
E. Elsen (CERN; remote)
M. Nessi (CERN)
A. Etienvre (CEA/IRFU, France)
P. Verdier (IN2P3, France)
F. Simon (Max Planck Institute, Germany; remote)
A. Masiero (INFN, Italy)
Y. Okada (KEK, Japan; remote)
M. Yamauchi (KEK, Japan)
M. Martinez (IFAE, Spain; remote)
A. Ereditato (Universität Bern, SNSF/SERI, Switzerland)
T. Medland (STFC, United Kingdom)
A. Patwa (DOE, United States)
M. Procario (DOE, United States; remote)
R. Ruchti (NSF, United States)

Fermilab: C. Keaty (*Secretariat*), N. Lockyer (*Director*), J. Lykken, A. Markovitz (*Chair*), E. McCluskey, L. Merminga, T. Meyer, C. Mossey, H. Ramamoorthi

DUNE: E. Blucher (University of Chicago), A. Dave (Fermilab), E. James (Fermilab), S. Soldner-Rembold (University of Manchester)

LBNC: D. MacFarlane (SLAC)
NCG: R. Rameika (Fermilab)

Apologies Received: I. Allekote (CNEA, Argentina), S. Bentvelsen (NIKHEF, Netherlands), F. León-Velarde Servetto (Concytec, Peru), M. Losada (UAN, Colombia), J. Tagüeña (Conacyt, Mexico)

Action Items

1. The next DUNE Resources Review Board (RRB) meeting will be on September 13-14, 2018 at Fermilab. Deliverables for the meeting:
    a. Reports from the Long Baseline Neutrino Committee (LBNC) and Neutrino Cost Group (NCG) on their evaluation of the DUNE Technical Proposals
    b. DUNE and LBNF provide updates on status of international contributions and timeline for agencies to enter into agreements
    c. DUNE provides updates on allocation of common funds and expectations for funding agencies
    d. DUNE report on Computing consortia
2. Also at its September 2018 meeting, the RRB will receive updates from the Projects and funding agencies/institutions on the status of international contributions and opportunities. The LBNC and NCG also will provide reports.
3. Additional information will be discussed regarding international agreements for DUNE, including the possibility of multilateral Memoranda of Understanding (MOUs),.

Introduction

A. Markovitz, RRB Chair, welcomed the members and participants to the Sixth Meeting of the RRB, and provided a summary of the day's agenda.

Director's Report, N. Lockyer

N. Lockyer, Fermilab Director, discussed the status of and support for DUNE, as well as the Long Baseline Neutrino Facility (LBNF) which will provide the infrastructure and beamline for DUNE, the Proton Improvement Plan-II (PIP-II) which will power the beam for LBNF/DUNE, and the current Short Baseline Neutrino (SBN) program at Fermilab.

The recently-enacted FY2018 U.S. budget shows strong support for High Energy Physics and LBNF/DUNE. FY2018 funding for the Department of Energy Office of High Energy Physics was at $908M, a 10% increase over the prior year. LBNF/DUNE was fully funded at $95M, and PIP-II was fully funded at $25M. The FY2018 budget also included $20M in funding for the Integrated Engineering Research Center building at Fermilab which will provide state-of-the-art laboratories, engineering, and technical spaces within a collaborative environment that will host scientists and engineers from around the world.

Since the November RRB meeting, senior leadership from the U.S. Department of Energy has visited Fermilab and expressed their support for LBNF/DUNE, including Secretary of Energy Rick Perry, Under Secretary for Science Paul Dabbar, and Under Secretary for Energy Mark Menezes. At the time of his visit, Secretary Perry stated: "As the nation's leading particle physics lab, Fermilab plays a vital role in bringing the national and international high-energy physics community together in pursuit of great discoveries. The Long-Baseline Neutrino Facility

and Deep Underground Neutrino Experiment, for instance, are a terrific example of continued U.S. leadership in this community."

N. Lockyer also described Fermilab's ongoing engagement with international partners since the November RRB meeting.

RRB Update, A. Markovitz

A. Markovitz detailed the RRB objectives. The RRB provides focused monitoring and oversight of DUNE, and also monitors the progress of LBNF, PIP-II, and SBN. The RRB will consider and approve, if appropriate, the Technical Design Reports (TDRs) for DUNE, following a recommendation from the Long-Baseline Neutrino Committee (LBNC) and the Neutrino Cost Group (NCG). In addition, the RRB monitors the international commitments secured by the DUNE collaboration in timeframes to support the experiment. The RRB also approves the DUNE common fund contributions as appropriate.

Since the last RRB meeting, the RRB charter was approved and is available on the DUNE RRB website: http://rrb.fnal.gov. Final minutes from the prior RRB meeting also are available on the RRB website. RRB meetings have been scheduled through 2019 as follows:

- September 13-14, 2018
- March 14-15, 2019
- September 19-20, 2019

A. Markovitz reiterated the objectives for the upcoming RRB meetings, as follows:

September 13-14, 2018

- Reports from LBNC and NCG on their evaluation of the DUNE Technical Proposals
- DUNE and LBNF provide updates on status of international contributions and timeline for agencies to enter into agreements
- DUNE provides updates on allocation of common funds and expectations for funding agencies
- DUNE report on Computing consortia

March 14-15, 2019

- Funding agencies confirm commitments identified on DUNE funding matrix, to be formalized following TDR approval
- DUNE presents common funds proposal and agreement language, to be finalized following TDR approval
- DUNE Computing consortia discussion, including expectations for funding agencies

September 19-20, 2019

- Reports from LBNC and NCG on their analysis of the TDRs for DUNE and their associated conclusions
- Presentation from LBNF on CD 2/3b elements for the far site, to be presented to DOE in October 2019
- RRB considers and, if appropriate, approves Technical Design Reports for DUNE consortia for the far site
- DUNE collaboration confirms deadline and expectations for funding agencies to enter into agreements to reflect scope of commitments as reflected in the TDRs; agreements would also include appendix on common funds

The DUNE Collaboration Resource Board (CRB) members are a key link between the work of the collaboration and the funding agency representatives on the RRB. The CRB members will help to ensure deliverables are articulated, the funding agency's agreement process is understood, and the commitment timeframes are met. Summer/fall 2019 is an important timeframe, with the consideration of the DUNE Technical Design Reports. Once construction begins, the CRB will work with the DUNE Resource Coordinator to provide financial assurances and review.

The RRB received an update on DUNE communications activities from the past six months. Members were encouraged to use relevant materials or language for their funding submissions as well as to amplify within their respective countries. Suggestions for future content were welcomed as well.

DUNE Status, E. Blucher

E. Blucher, DUNE co-spokesperson, discussed the progress of DUNE since the previous RRB meeting in November. The collaboration continues to grow. At present, the DUNE collaboration had 1,078 collaborators from 175 institutions in 31 nations. In addition, E. Blucher detailed progress in obtaining support across the globe from the countries/agencies supporting DUNE.

Earlier in the year, the collaboration elected Stefan Soldner-Rembold from the University of Manchester in the UK as the new DUNE co-spokesperson. His term began on April 1, replacing Mark Thomson who is now the Executive Chair of the UK Science and Technology Facilities Council (STFC).

E. Blucher described the many ongoing activities of the DUNE collaboration, including work on the ProtoDUNEs, the Far Detector, the Near Detector, physics studies, funding, and the Technical Design Reports.

With respect to DUNE management, the structures are defined in the collaboration governance document and DUNE management plan. In addition, the collaboration will be transitioning to a new Executive Board structure in May 2018. The restructured Executive Board will include the DUNE senior management team and representatives from each of the consortia. This change is

intended to improve communication, increase collaboration engagement and transparency in decision-making, and further formalize the management of the experiment.

E. Blucher described DUNE's strategic goals through 2019, including:

- Construction and operation of large-scale prototypes at the CERN neutrino platform
- Preparation of DUNE TDRs for LBNC review
- Enlarging the collaboration and defining the responsibilities for the far and near detectors
- Establishing a resource matrix for construction of DUNE, with funding for the TDR scope to be understood by 2019

Progress on the detector technologies was discussed, including the two liquid argon TPC technologies that are being pursued and prototyped: a single-phase and a dual-phase technology. The far detector strategy and the role of the ProtoDUNEs was detailed.

The collaboration is organized through nine consortia that were formed in August of 2017. These consortia, represented by leadership from around the globe, are making rapid progress with the following near term objectives:

- Constructing a detailed Work Breakdown Structure (WBS)
- Provisional mapping of institute interests to WBS deliverables
- Interface documentation
- Defining consortia strategy with milestones and a decision-making plan to reach TDR
- Drafting Technical Proposal content
- The next step would then be a Technical Proposal in May 2018 and a TDR in April 2019

E. Blucher discussed the status of DUNE's progress towards a responsibility matrix, based on institutional interests mapped onto the WBS. Additional opportunities for participation in DUNE were outlined, including opportunities for a presently undefined fourth detector module.

DUNE's strategy for the Near Detector (ND), to be located at Fermilab, also was discussed. The goal is to settle on a ND concept by May 2018, with a Conceptual Design Report in 2019 and TDR review in the summer of 2020. There is broad global participation in the ND concept study.

Current DUNE challenges and upcoming milestones were reviewed, leading to approval by the RRB of the TDRs for DUNE, including institutional responsibilities, in September 2019. Over the course of 2018, DUNE expects to complete, commission, and take data with the ProtoDUNEs, complete the technical proposals for the far detector and continue to work on the TDR, develop the Near Detector concept and begin work on the CDR, and make further progress on funding.

Status of the Neutrino Platform at CERN, M. Nessi

M. Nessi, CERN and University of Geneva, discussed the status of the neutrino platform at CERN. He detailed the history of this effort, which includes collaboration between CERN and the U.S.-based program, with large prototypes for DUNE built at CERN and significant

participation by CERN in the LBNF/DUNE hosted by Fermilab. As part of this collaboration, CERN constructed a large neutrino test area with charged beam capabilities. The new experimental area at CERN was completed in September 2016 and the two large prototype detectors are now under construction.

M. Nessi described the significant global participation in the ProtoDUNE effort at CERN, with delivery of materials from around the world. He also outlined the substantial progress in construction the detectors, including the significant R&D efforts entailed in the construction and the current status of the two detectors. With respect to the single-phase (SP) detector (NP04), the closing of the cryostat is expected to begin in May, with the cooling down and filling of liquid argon to follow. The SP detector is expected to take data in September. With respect to the dual-phase detector (NP02), a new technical board was established. The field cage for the DP detector is completed and installed, assembly is starting for the Charge Readout Planes (CRPs), and additional elements of the plan for the DP were discussed. Analyzing the lessons learned from ProtoDUNE will be a critical element for DUNE, including providing real information on the validity of the design and assembly.

In addition, the RRB received an update on the progress of other detectors being assembled at CERN or outside CERN. The work and R&D for the ProtoDUNE detectors also is benefitting the ongoing work on these other detectors.

Technical Coordinator Report, E. James

E. James, DUNE Technical Coordinator, spoke about the planned path forward for establishing a blueprint/Technical Design Report for the Far Detector.

The DUNE collaboration established nine consortia in the summer of 2017. These consortia will assume responsibility for the different detector subsystems and facilitate the process whereby collaborating institutions take on responsibility for specific deliverables. The leadership teams of the consortia have broad international representation.

The DUNE consortia have been focused on the following goals: validation of ProtoDUNE detector components and further refinement of sub-system technical designs, defining the consortia scope as documented in a global DUNE Work Breakdown Structure (WBS), developing a mapping between the interests of the consortia institutions and the detector sub-system/WBS deliverables, and producing a Technical Design Report for the proposed far detectors on the timescale of Spring 2019.

The Collaboration has defined a plan for the development and review of Technical Design Reports on an aggressive timescale consistent with collaboration requirements. DUNE management will work closely with the Long-Baseline Neutrino Committee (LBNC) and the Neutrino Cost Group (NCG) to define the documentation requirements and ensure a smooth review process. The next steps include the following:

- As an interim milestone towards producing the TDR, DUNE is in the process of writing a Technical Proposal, to be completed in May of 2018.

- The LBNC and NCG will review the TP, with a report expected by July 2018.
- The Collaboration expects to complete the Technical Design Reports for the Far Detector modules by the spring of 2019.
- The LBNC and NCG will review the TDRs, with a final report expected in August 2019.

E. James also discussed two areas required for DUNE integration that would comprise a common fund for DUNE: (1) a DUNE Technical Coordination organization and (2) common infrastructure items.

A strong DUNE Technical Coordination organization is required to ensure the overall integration of the detector elements and the successful execution of the project. Areas of responsibility for this Technical Coordination organization include:

- Project engineering and support
- Installation planning and execution for the Near and Far Detectors
- Operation of Far Detector Integration Test Facility
- Responsibility for common infrastructure associated with the detectors

With respect to funding the Technical Coordination, the following model was proposed. As host nation, the U.S. has some specific responsibilities that fall within the Technical Coordination effort such as the operation of facilities. At the same time, the creation of a truly international project with full buy-in from all of the partners requires broad-based support for Technical Coordination across the collaboration. To achieve this balance, the DUNE collaboration proposed to the RRB that required personnel resources for Technical Coordination are supported through both host nation and common collaboration resources.

The current projected needs for the Technical Coordination team was proposed to the RRB. With respect to the international support for Technical Coordination, the DUNE collaboration proposed to the RRB that a common fund for technical coordination should be established, funded by contributions spread evenly across all DUNE PhD scientists and collected as a per-PhD annual membership fee. In lieu of cash contributions, institutions and/or funding agencies could negotiate with DUNE management to provide in-kind contributions of specific personnel who would become members of the Technical Coordination organization.

A separate common fund was proposed for common infrastructure items. The proposal to the RRB was that the costs associated with these common infrastructure items be considered an additional element of the true capital cost associated with each of the different detector components being provided by the consortia. In this model, the M&S resources needed to support the acquisition of common detector infrastructure could come from a “tax” on the CORE value of capital contributions. In lieu of cash contributions, institutions and/or funding agencies could negotiate with DUNE management to provide specific pieces of the common infrastructure.

Funding agencies were asked to provide feedback on the two proposed common funds to support DUNE. Additional details regarding the anticipated level of contributions to each of the funds were presented in the following presentation.

Resource Coordinator Report, A. Dave

A. Dave, DUNE Resource Coordinator, presented additional details to the RRB on the proposed methodology for allocating and establishing a DUNE Common Fund, as well as a discussion of agreements on DUNE deliverables.

The Resource Coordinator chairs the Collaboration Resources Board (CRB). CRB members are those members of the DUNE collaboration who serve as the collaboration's contact for their respective country and/or funding agency. CRB members play an integral role in communicating with their institution/agency's RRB member to identify areas of interest in DUNE; determining their country/funding agency's timeline and processes for funding their interests; and ensuring the development and execution of an agreement specifying that agency/country's deliverables for DUNE.

The DUNE collaboration, working with the CRB, presented a proposed methodology for allocating common fund responsibilities for DUNE during the construction phase. E. James discussed the rationale for these two common funds in his previous talk. The methodology for allocation was proposed as follows:

- Technical Coordination common fund. The contributions from the DUNE participants for Technical Coordination would be assessed as follows:
  - Each funding agency/institution would contribute to DUNE Technical Coordination in proportion to the number of their scientific staff holding PhD or equivalent qualifications in the Collaboration. This would be an annual fee of approximately $10K U.S. starting in 2020 for a period of six years.
    - This contribution would be collected in cash (U.S.$) or "in-kind". The request to provide "in-kind" personnel to become a member of the technical coordination team would be reviewed by DUNE Management, Technical Board, CRB and endorsed by RRB.
- Common detector infrastructure common fund. The contributions from the DUNE participants for common detector infrastructure would be assessed as follows:
  - The common infrastructure needs for DUNE are anticipated to be at approximately 10-20% of the total CORE cost of the detector. Each funding agency's CORE contributions to the detector would be assessed a tax in the 10-20% range (fixed by the collaboration) to support the common detector infrastructure common fund. Contributions to this fund would start once the TDR for the detector is approved, and would be spread out over a period of five years.
    - Contributions would be collected in cash (U.S.$) or "in-kind". The request to provide "in-kind" specific pieces of common infrastructure would be reviewed by DUNE Management, Technical Board, CRB and endorsed by RRB.
- Future DUNE common funds. A. Dave also discussed that before detector operations commence, the DUNE collaboration will propose (1) a common fund for Maintenance and Operation of the DUNE detectors; and (2) a process for funding Computing, including in-kind contributions.

An overview of the years of applicability for each common fund was presented to the RRB for consideration.

At the next RRB, the collaboration will present additional details on the items proposed for the technical coordination and common detector infrastructure common funds. The collaboration also will discuss agreements regarding common funds. In the interim, DUNE management working with collaboration leadership (consortia and CRB) will be drafting a WBS which reflects the proposed deliverables from each funding agency/institution to DUNE. This completed WBS will be reflected in the TDR next year.

RRB members were asked to confirm that the identified Collaboration Resources Board for each funding agency/institution members were their appropriate points of contact with the DUNE collaboration and the interests being expressed for DUNE.

RRB members also were asked to consider the proposals for DUNE common funds and to communicate any input to the DUNE collaboration leadership or their CRB member. After receiving feedback, the proposed methods of allocation for a common fund will be presented at the RRB meeting in September.

Around the Table Discussion

RRB participants conveyed the status of activities and involvement in the Projects by their respective funding agencies/institutions.

Status of LBNF, C. Mossey

C. Mossey, Deputy Director for LBNF, provided an update on the progress of the LBNF project.

The project is working on reliability projects with a focus on the renovation of the Ross Shaft at the far site, located at the Sanford Underground Research Facility in South Dakota. This work was delayed in early January due to a safety incident; corrective actions are in progress. The civil construction contractor currently is working on work packaging and contracting strategy for all pre-excavation work for the far site conventional facilities. The final design for main excavation and buildings/site infrastructure for the far site conventional facilities will start in the near term.

An update also was provided on the design status for the cryogenic systems as well as the beamline. Beam optimization scope was added to the project with the assumption that additional partners will be identified to help with the improved components. In addition, the project is working to understand the requirements for the Near Detector, to be located at Fermilab, and implications on facilities. A timeline for decisions was discussed.

The project continues to have very strong support from the U.S. government. In the recently-enacted FY2018 budget, LBNF/DUNE was fully funded for that fiscal year at $95M. C. Mossey also discussed the path forward with the U.S. Department of Energy to baselining LBNF and

DUNE-US (the U.S. portion of DUNE). The project is planning to request CD-2 baselining in 2019, and the balance of the far site scope is expected to be reviewed for CD-3b approval at the same time as CD-2.

Project execution startup considerations were detailed, including procurement as well as a new organizational structure – a South Dakota Services Division – that is being stood up to support LBNF/DUNE requirements at the far site in South Dakota.

In addition, Fermilab has established a working group to address its responsibilities as the host for an international experiment. The focus is both on what support is necessary to ensure successful completion of LBNF and DUNE construction and on what support is necessary to support successful DUNE operations.

C. Mossey discussed the status of international in-kind contributions to LBNF, including CERN which is designing and building the first membrane cryostat, contributions from U.K./RAL, as well as participation and ongoing discussions with other international partners. Additional possibilities for international contributions to LBNF were also described, including items related to the beamline, cryostats, and liquid argon cryogenic systems.

Long Baseline Neutrino Committee Report, D. MacFarlane

D. MacFarlane, LBNC Chair, spoke regarding the committee's progress, status, and future plans. The LBNC provides an independent review of DUNE from a technical perspective, including a review of the TDRs. The Neutrino Cost Group (NCG) reviews cost and schedule associated with DUNE construction. Guidance for the LBNC and NGG's review of the TDRs was provided to the DUNE collaboration in January and is available on the RRB website.

In terms of organization and process, the LBNC presently is scheduled to meet three times in 2018 before the September 2018 RRB meeting. In between meetings, referee subgroups maintain regular contact with identified LBNF/DUNE points of contact. The LBNC prepares reports following each meeting, including recommendations to LBNF and DUNE. The LBNC intends to provide credible validation of the TDR and monitoring of the project for the RRB and sponsoring agencies. The committee is complemented by the NCG, an integral component of the validation process, focused on cost, risk, and schedule.

D. MacFarlane detailed the LBNC's input from recent reviews. In the view of the LBNC, this effort has come very far in a short time – including a vigorous, truly international science collaboration in DUNE; a further-strengthened LBNF organization; suitable management structures and oversight for the projects; a science strategy satisfying P5 requirements; successful completion of a DOE CD-3a review for LBNF far site construction; and an established ProtoDUNE organization to validate the DUNE engineering design.

Between May-July 2018, the LBNC will review the written Technical Proposal from DUNE. A similar process will take place a year later to review the TDRs. The LBNC's review will take place in close coordination with the NCG.

Discussion with Mike Procario, U.S. DOE

M. Procario, U.S. Department of Energy, provided his perspective on LBNF/DUNE. He discussed the DOE's Independent Project Review of LBNF/DUNE-US held in March 2018, as well as U.S. funding for DUNE in FY2018, which provided strong support for the Office of High Energy Physics and LBNF in particular.

The group discussed what the status of international contributions should be at the time of the DOE CD-2 review of LBNF and DUNE-US. Additional clarification will be shared with the RRB.

The group also discussed matters relating to international agreements, including the different types of agreements and the applicability of each. A. Patwa discussed the potential to add provisions to high level agreements which then allow details/specific responsibilities to be handled through Memoranda of Understanding (MOUs), signed by Fermilab and international partners. The possibility of multilateral agreements was discussed and will be explored. The group also discussed potential challenges with the international movement of materials for delivery to LBNF/DUNE in the U.S., and that agreements may provide some framework to better enable the work.

Closeout of Day One, N. Lockyer

N. Lockyer identified ongoing issues that are being considered by Fermilab and DOE, including visas for collaborators, import/export requirements, and international agreements. A discussion on a path for agreements including potentially MOUs will be provided at the next RRB meeting in September.

PIP-II: An International Accelerator Project, L. Merminga

L. Merminga, PIP-II Project Director, stated the mission of the PIP-II project: to deliver the world's most intense beam of neutrinos to the international LBNF/DUNE project, enable a broad physics research program and power new discoveries, for decades to come. The goals of the program are to deliver >1 MW of proton beam power from the Main Injector over the energy range of 60-120 GeV, at the start of LBNF operations; to support the ongoing 8 GeV program; to provide a platform for extension of beam power to LBNF to >2 MW; and to provide a platform for extension of capability to high duty factor/higher beam power and reliable beam operations.

PIP-II has a mature, validated technical design. In addition, the project has strong support in the U.S. including with the FY18 budget and initial funds for construction start. PIP-II successfully completed DOE reviews in December 2017. The next step for PIP-II is a CD-1 review and

approval by DOE, anticipated this upcoming summer. The project also has a new project management structure effective March 1, 2018, which was described to the RRB.

PIP-II is the first accelerator project in the U.S. with substantial international contributions. L. Merminga detailed areas of interest in PIP-II from international partners. Partners for PIP-II include: India/DAE, UK/STFC, Italy/INFN, and potentially France/CEA/IN2P3. Additional progress on international partnerships was discussed.

Neutrino Cost Group Discussion, G. Rameika

G. Rameika, the Chair of the Neutrino Cost Group, outlined the purpose and scope of the NCG, which was established since the prior RRB meeting. The purpose of the NCG is to review the cost, schedule, and associated risks for the DUNE experiment, and to provide reports and recommendations to the Fermilab Directorate and the RRB. This includes: (1) evaluating the reliability of the cost estimate for DUNE, (2) assessing the feasibility of the schedule for DUNE and the availability of the manpower necessary to execute the project, and (3) evaluating the project management structure and risk analysis for DUNE, along with the LBNC, including proposed levels of cost realism and schedule contingency. The NCG membership is being developed, and LBNC members will participate in reviews as appropriate. An initial focus is on establishing the methodology in preparation for the review of the TDRs in 2019.

As part of its activities, the NCG will establish a common methodology which can be used to value international contributions to DUNE. This would be a uniform way to assign a value of a capital investment, independent of widely ranging differences in actual costs for labor and materials in different regions of the world. The NCG's starting point is to consider the CORE costing methodology used by CERN in the construction and upgrades of the ATLAS and CMS detectors. Examples of issues to be resolved before finalizing the methodology were presented to the RRB. It was emphasized that CORE costs are not the real cost to deliver; for instance, they would not include R&D/small-scale prototyping or overheads, contingency, or escalation.

The NCG provided guidance to the DUNE collaboration in terms of developing cost estimates for each element of the Work Breakdown Structure; a summary of that guidance and expectations for the TDR was conveyed to the RRB.

The RRB was asked to provide input on the content presented, including the proposed approaches to establish a common methodology to value international contributions to DUNE.

Additional Discussion with Funding Agencies and Closeout, A. Markovitz

A. Markovitz reviewed the timeline and expectations for the RRB to meet the current objective of reviewing and, if appropriate, approving the TDR for the far detector in September 2019. Topics and deliverables for future RRB meetings through September 2019 were outlined.

There being no other business, A. Markovitz thanked the attendees and closed the meeting. The next RRB will be held on September 13-14, 2018 at Fermilab.

The RRB meeting was adjourned.