

Addendum 1

CONCERNING THE SHORT BASELINE NEUTRINO PROGRAM

Under the

PROJECT ANNEX

TO THE IMPLEMENTING ARRANGEMENT

BETWEEN

THE DEPARTMENT OF ENERGY

OF THE UNITED STATES OF AMERICA

AND

THE MINISTRY OF EDUCATION, UNIVERSITIES AND

RESEARCH OF THE ITALIAN REPUBLIC

FOR COOPERATION

IN THE AREAS OF HIGH ENERGY,

ASTROPARTICLE AND NUCLEAR PHYSICS

CONCERNING NEUTRINO PHYSICS RESEARCH

The Department of Energy of the United States of America (DOE) and the Ministry of Education, Universities and Research of the Italian Republic (MIUR), hereinafter referred to as the "Parties":

ACTING pursuant to Section 6.B of the Project Annex Concerning Neutrino Physics Research of July 17, 2015 (the "Project Annex"), which the Parties entered into pursuant to Section 4 of the Implementing Arrangement between the Department of Energy of the United States of America and the Ministry of Education, Universities and Research of the Italian Republic for Cooperation in High Energy, Astroparticle, and Nuclear Physics Research and Related Fields and Technologies of July 17, 2015 (the "Implementing Arrangement"); and

DESIRING to augment the Project Annex with a description of the international Short Baseline Neutrino Program and an outline of the scope of their respective work and responsibilities associated with the international Short Baseline Neutrino Program,

Have agreed as follows:

Section 1 – Objective and Participants

- A. The objective of this Addendum 1 to the Project Annex is to describe the international Short Baseline Neutrino (SBN) Program hosted at DOE's Fermi National Accelerator Laboratory (Fermilab), and to define comprehensively the scope of work and responsibilities of the respective Parties in the SBN Program.
- B. The activities described in Section 3 of this Addendum 1 shall be performed by DOE's Fermilab for DOE, and MIUR's Istituto Nazionale di Fisica Nucleare (INFN) for MIUR, hereinafter individually referred to as "Participant" or collectively as the "Participants."

Section 2 – The Short Baseline Neutrino Program

- A. The SBN Program is directed to understanding the physics of neutrinos. This Program has three principal science goals, the first being of paramount importance:
 - a. Explore anomalous hints of new physics by measuring neutrino oscillations, particularly to learn about whether a new family of "sterile" neutrinos exists.
 - b. Study the interactions of neutrinos with argon nuclei to high precision.
 - c. Further develop the technologies, including those of liquid argon time projection chambers, required for the future international Long Baseline Neutrino Facility/Deep Underground Neutrino Experiment.
- B. The SBN Program is comprised of three experimental neutrino detectors. All three are located along the neutrino beamline of Fermilab's Booster Neutrino Beam, and all three are needed to achieve the science goals of the Program. The three experimental detectors are:
 - a. The Short Baseline Near Detector (hereinafter "SBND"): Located 110 meters from the beamed neutrino source, this detector will provide a measurement of the non-oscillated content of the neutrino beam.

- b. The MicroBooNE detector: Located 470 meters from the neutrino source, this detector is designed to measure excess electron neutrino events that could signal the existence of sterile neutrinos.
- c. The ICARUS T600 Detector: Located 600 meters from the neutrino source, it too will search for excess electron neutrino production. With the two different baseline distances, MicroBooNE and ICARUS T600 act synergistically to tighten constraints on the production of sterile neutrino.

Section 3 – Scope of Work in the SBN Program

- A. The INFN has adopted the following scope of work:
 - a. In collaboration with other members of the ICARUS collaborating institutions, contribution of the ICARUS T600 detector, which will become the SBN's far detector. This contribution includes:
 - i. The two ICARUS T600 detector modules including cold cryostats, time projection chambers photomultiplier tubes, cabling and feedthroughs;
 - ii. Readout electronics for ICARUS T600 photomultiplier tube and time projection chamber systems;
 - iii. Low voltage and high voltage power supplies; and
 - iv. Components of the ICARUS T600 cosmic ray tagger.
 - b. Contribution to the construction of the steel support structure for the SBND cryostat.
 - c. Additional support of the SBN far detector by providing:
 - i. A Technical Coordinator through the installation and commissioning period; and
 - ii. Scientist and technician support of installation and commissioning on-site at a level agreed to in relevant work packages.
 - d. Support of overall SBN operation by providing
 - i. Support for maintenance and repair of INFN-provided systems; and
 - ii. Support for scientists to take the institutional share of physics data-taking shifts as required for the efficient and safe operation of the detectors.
- B. Fermilab has adopted the following scope of work:
 - a. Provide facilities for the execution of the SBN Program, including:

- i. Accelerators and Booster Neutrino Beamline;
 - ii. Experimental halls including infrastructure such as AC power distribution, computer networking and building cranes;
 - iii. External cryogenic systems, cryogenic system integration, and process control systems;
 - iv. Concrete overburden for cosmic ray mitigation at each detector;
 - v. Data acquisition support hardware such as relays racks and rack protection systems; and
 - vi. Data storage, networking and data analysis computing systems.
 - b. Support the installation of the near and far detectors in their respective experimental halls. This support will include:
 - i. Providing an Installation Coordinator for each detector; and
 - ii. Providing certain specialized technical services such as crane operation and welding services.
 - c. Provide deliverables specific to each of the detectors, which include:
 - i. Components of the far detector Cosmic Ray Tagger system;
 - ii. Cold time projection chamber readout electronics for the SBND; and
 - iii. Assembly fixturing and facility for the SBND.
 - d. Support the commissioning and physics operation of the SBN detectors. This support will include:
 - i. Procurement of the liquid argon and liquid nitrogen necessary to fill and operate the detectors;
 - ii. Technical staff to operate the cryogenics systems;
 - iii. Physics control room facility, located in Fermilab's Wilson Hall, and online systems support personnel;
 - iv. Liaison person between the SBN Program and the technical operations at Fermilab.
 - e. Provide oversight of all activities in regard to Environment, Health and Safety; provide support for carrying out safety reviews and obtaining necessary Operational Readiness Clearances; and provide the necessary training for users to carry out the functions of installation, maintenance, and operation of the detectors.
- C. Additional information on planned scope of work, itemized list of deliverables, or other intended research and development, cooperative activities, or operations activities to be performed under this Addendum 1 may be exchanged and memorialized by and between the Parties and/or their Participants through non-binding written instruments such as letters of intent or memoranda of

understanding. Such instruments may cover, but are not limited to, specifications of equipment or personnel to be exchanged, definition of task responsibilities within a specific project, coordination, contributions, and adjustments of organizational structure as needed.

Section 4 – Exchange of Equipment and Ownership of Property

- A. Terms regarding the exchange of equipment are governed by Section 8 of the Implementing Arrangement, except as provided in paragraph B. of this Section.
- B. Notwithstanding Section 8 of the Implementing Arrangement, the ownership and use of the ICARUS T600 detector while on loan at Fermilab shall be governed by a separate loan agreement that entered into force on May 22, 2018 among DOE, MIUR and the European Organization for Nuclear Research (CERN).

Section 5 – SBN Program Joint Expenses

- A. Subject to section 8.4 of the Implementing Arrangement, both Parties shall provide funds for joint expenses such as, but not limited to, electrical power and other consumables that arise during the execution of the activities covered by this Addendum 1. Further specification of such expenses may be agreed upon by the Parties or their Participants at a later date, as needed.
- B. Annual budgets for such joint expenses shall be jointly determined by the Participants in consultation with both Parties.

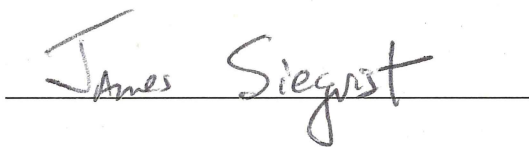
Section 6 – General Provisions

- A. This Addendum 1 is subject to the terms and conditions of the Project Annex, which is itself subject to the Implementing Arrangement.
- B. This Addendum 1 shall enter into force upon signature by the Parties, and remain in force so long as the Project Annex remains in force, unless earlier terminated by the Parties.
- C. This Addendum 1 may be terminated at any time by the written agreement of both Parties; or by either Party at its discretion, upon sixty (60) days advance notice in writing to the other Party. Notwithstanding termination of this Addendum 1, the terms and conditions of the ICARUS T600 detector loan shall be governed by the

loan agreement that entered into force on May 22, 2018 among DOE, MIUR and CERN. This Addendum 1 may be amended by written agreement of the Parties, provided the Project Annex remains in force.

DONE at Washington, D.C., in duplicate in the English language, this 28th day of June 2018.

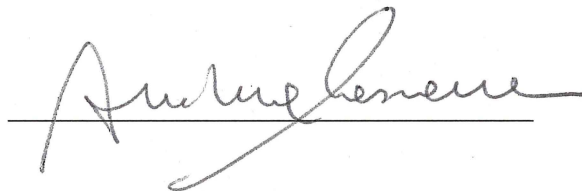
**FOR THE DEPARTMENT OF
ENERGY OF THE
UNITED STATES OF AMERICA:**

A handwritten signature in dark ink, reading "James Siegrist", written over a horizontal line.

James Siegrist

**Associate Director of Science
for High Energy Physics**

**FOR THE MINISTRY OF
EDUCATION, UNIVERSITIES AND
RESEARCH OF THE
ITALIAN REPUBLIC:**

A handwritten signature in dark ink, reading "Andrea Cascone", written over a horizontal line.

Andrea Cascone

**First Counsellor
Embassy of Italy in the
United States of America**