

MEMORANDUM OF UNDERSTANDING

between

The European Organization for Nuclear Research (CERN)

and

The Fermi National Accelerator Laboratory (Fermilab)

under

Addendum II to Accelerator Protocol III

**between the European Organization for Nuclear Research
and the Department of Energy of the United States of America
for Participation by the U.S. Department of Energy in the
High-Luminosity Large Hadron Collider Accelerator Upgrade**

concerning

Methodical Accelerator Design Single-Particle Dynamics Code ("MAD X")

THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH ("CERN"), an Intergovernmental Organization having its seat at Geneva, Switzerland,

and THE FERMI NATIONAL ACCELERATOR LABORATORY ("Fermilab"),

(hereinafter collectively referred to as the "Participants"):

CONSIDERING:

That CERN and the U.S. Department of Energy ("DOE") agreed to collaborate under the Co-Operation Agreement Concerning Scientific and Technical Co-Operation in Nuclear and Particle Physics signed May 7, 2015 (the "2015 Co-Operation Agreement"), and under Accelerator Protocol III thereto signed December 18, 2015 ("Accelerator Protocol III") on the Large Hadron Collider ("LHC") accelerator consolidation plan and the LHC accelerator upgrade program;

That CERN and DOE concluded Addendum II to Accelerator Protocol III of May 2, 2017 ("Addendum II") establishing a framework on participation by DOE, the U.S. funding agency, and U.S. universities, national laboratories, and other organizations (hereinafter collectively referred to as the "U.S. Participating Organizations") in the High-Luminosity LHC ("HL-LHC") accelerator upgrade program being carried out under the auspices of CERN;

That planned activities for the HL-LHC accelerator upgrade program include the design, research and development, prototyping, and construction of technologically advanced accelerator components in order to enable an increase of the LHC accelerator's integrated luminosity by a factor of ten;

That Article 3.2 of Addendum II provides that final responsibilities and detailed delivery schedules for the planned HL-LHC accelerator upgrade activities shall be specified in Memoranda of Understanding ("MOUs") concluded between DOE and/or its national laboratories, on the one hand, and CERN, on the other hand, in accordance with Article 3 of Accelerator Protocol III;

That Fermilab, a DOE national laboratory managed and operated by Fermi Research Alliance LLC, is one of the U.S. Participating Organizations carrying out activities for the HL-LHC accelerator upgrade;

That the Participants desire to collaborate in research and development efforts concerning the space charge module of the Methodical Accelerator Design Single-Particle Dynamics Code ("MAD-X") software, in particular for the purposes of CERN's LHC Injector Upgrade; and

That this MOU defines each Participant's contribution to the collaboration,

HAVE REACHED THE FOLLOWING UNDERSTANDING:

Section 1 Purpose

- 1.1 The purpose of this MOU is to define the modalities of collaboration between the Participants in research and development efforts concerning the space charge module of MAD-X (hereinafter referred to as the "Collaboration"). The Collaboration is expected to cover the period of March 1, 2021 through August 31, 2021, it being understood that its total duration is not intended to exceed six (6) months and that it is subject to, in particular, ongoing review by the Participants of health and safety restrictions.

The aim of the Collaboration includes, inter alia, ensuring that changes in size and intensity of the beam can be accounted for, in particular for the Low Energy Ion Ring and the Booster at CERN. Capabilities of the space charge module in MAD-X are planned to be complementary to those of existing codes, and can possibly be extended to obtain accurate results with reduced computing time.

- 1.2 Except as otherwise specified in this MOU or otherwise in writing by the Participants, each Participant is responsible for the costs it incurs in participating in the activities identified in this MOU.

Section 2

Contributions by the Participants

- 2.1 Fermilab intends to contribute to the Collaboration by making available two (2) specialised full-time Fermilab staff members, in addition to office facilities, equipment, materials and services on its site as required for the execution of the Collaboration.
- 2.2. CERN intends to contribute to the Collaboration by making available one (1) specialised full-time CERN staff member ("CERN Expert") who is to be granted the status of a Visiting Scientist at Fermilab.
- 2.3 The Collaboration is planned to be coordinated by Fermilab and supervised by the Associate Head of Fermilab's Accelerator Division. In accordance with Article 10.4 of Addendum II, the CERN Expert is expected to comply with applicable Fermilab rules with regard to admission to and use of the premises, and to execute all documents required by Fermilab acknowledging and agreeing to comply with such applicable rules.

Section 3

Financial and Other Modalities

- 3.1 For such period(s) as the CERN Expert visits Fermilab to undertake the planned scope of activities under this MOU:
 - (a) Fermilab intends to cover the costs of the CERN Expert's car, accommodation, and standard daily subsistence;
 - (b) CERN intends to cover the payment of salary, as well as financial and social benefits of the CERN Expert, in accordance with his employment contract and CERN's Staff Rules and Regulations. The CERN Expert plans to remain enrolled in the CERN Health Insurance Scheme and the CERN Pensions Scheme, to which CERN intends to continue to contribute at levels in accordance with applicable rules, regulations, and procedures of CERN; and
 - (c) CERN intends to cover the transport of the CERN Expert to and from Fermilab at the commencement and end of the Collaboration, whereas Fermilab intends to cover the cost of any additional travel undertaken by the CERN Expert in the execution of the Collaboration under this MOU.

Section 4

Intellectual Property

The protection and allocation of intellectual property, and the treatment of business-confidential information, for the activities performed under this MOU are governed by the Annex to the 2015 Co-Operation Agreement and Article 5 of Accelerator Protocol III.

Section 5

Commencement, Modification and Discontinuation

- 5.1 Cooperative activities under this MOU may commence upon signature and may continue until completion of all activities under this MOU is confirmed by mutual written decision of the Participants, unless earlier discontinued in accordance with paragraph 5.3 of this Section.
- 5.2 The Participants may modify this MOU at any time by mutual written decision so long as the 2015 Co-operation Agreement, Accelerator Protocol III, and Addendum II remain in force.
- 5.3 The Participants may discontinue cooperative activities under this MOU at any time by mutual written decision. Alternatively, a Participant that wishes to discontinue its participation in the activities under this MOU is expected to provide at least six (6) months advance written notice to the other Participant.

Section 6

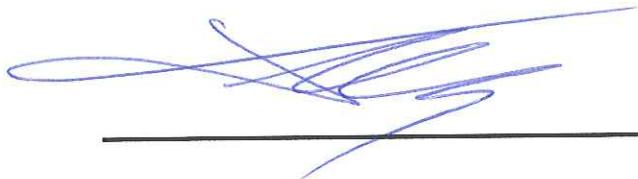
Final Provisions

This MOU is subject to and governed by the terms of Addendum II, Accelerator Protocol III and the 2015 Co-operation Agreement. This MOU does not create any legally binding obligations between the Participants. Each Participant's participation in the activities contemplated by this MOU is subject to the availability of appropriated funds, personnel, and other resources.

Signed in duplicate in the English language.


**FOR THE EUROPEAN
ORGANIZATION FOR NUCLEAR
RESEARCH:**

**FOR THE FERMI
NATIONAL ACCELERATOR
LABORATORY:**



Frédérick Bordry

Director for Accelerators
and Technology



Nigel Lockyer

Director

Date: 16th September 2020

Date: SEPTEMBER 21, 2020

Place: CERN, Geneva

Place: BATAVIA, IL