MEMORANDUM OF UNDERSTANDING

between

The Fermi National Accelerator Laboratory (Fermilab)

and

The European Organization for Nuclear Research (CERN)

under

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

for

U.S. Contributions to the
High-Luminosity Large Hadron Collider Project

THE FERMI NATIONAL ACCELERATOR LABORATORY ("Fermilab"),

and

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

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

CONSIDERING:

That the U.S. Department of Energy ("DOE") and CERN 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 DOE and CERN 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 Project ("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 Fermilab has been assigned by DOE to be the U.S. host laboratory with the responsibility to execute the U.S. HL-LHC Accelerator Upgrade Project ("U.S. HL-LHC AUP");

That the Participants desire to collaborate in the production of superconducting quadrupole focusing magnets ("Q1 and Q3") and dressed radiofrequency dipole ("RFD") crab cavities, which are required for the HL-LHC accelerator upgrade and which are planned to be delivered by the U.S. Participating Organizations, by way of Fermilab, through the U.S. HL-LHC AUP as part of their contributions to the upgrade;

That the Participants concluded a MOU for Contributions to Superconducting Quadrupole Focusing Magnets on January 17, 2019 to define CERN's planned supply to Fermilab of stainless steel sheets and end-domes, in order to permit Fermilab to assemble, align, fabricate and test the Q1 and Q3 Cold Masses, for integration into Cryostat Assemblies; and

That this MOU defines Fermilab's planned supply to CERN of Q1 and Q3 Cryo-assemblies and RFD crab cavities for the HL-LHC accelerator upgrade, as well as the delivery schedule, relevant documentation and the supply or exchange of components between the Participants,

HAVE REACHED THE FOLLOWING UNDERSTANDING:

Section 1
Scope and Funding

1.1. The purpose of this MOU is to define the planned U.S. contributions to CERN for the HL-LHC accelerator upgrade that are provided through the U.S. HL-LHC AUP, which is managed and executed by Fermilab with planned activities undertaken by a consortium of U.S. Participating Organizations. The scope of the U.S. contribution is the production and delivery to CERN of the following accelerator components (collectively referred to as the "Accelerator Components"):

(a) Q1 and Q3 Cryo-assemblies: total of ten (10) units; and
(b) Dressed RFD Crab Cavities: total of ten (10) units.

Annex 1 of this MOU includes a detailed description of the aforementioned Accelerator Components. It is understood that no elements of commissioning or installation of the Accelerator Components at CERN are foreseen as part of the scope of the U.S. contribution to the HL-LHC accelerator upgrade.

1.2 Fermilab expects to receive funding from DOE for the U.S. HL-LHC AUP at a total project cost, established following standard DOE accounting practice, of $242,720,000 (which includes contingency and overhead costs). Funds for the U.S. HL-LHC AUP are planned to be disbursed annually between U.S. fiscal years (FYs) 2016 and 2024 in accordance with the disbursement schedule for DOE funding that is documented in the Project Execution Plan (Fermilab reference document: US-HiLumi-Docdb-1341, dated December 21, 2020). The schedule for all activities and deliveries described in this MOU and its Annexes are planned to be contingent on the full and timely availability of funds for the U.S. HL-LHC AUP.

1.3 The duration of the U.S. HL-LHC AUP is planned to be from FYs 2016 through 2028, where, in accordance with the schedule of the U.S. HL-LHC AUP, all deliveries of Accelerator Components by Fermilab to CERN are planned to be completed by FY 2025. As of the commencement date of this MOU, project completion of the U.S. HL-LHC AUP, to be designated by a Critical Decision-4 approval by DOE, is planned for FY 2028.

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

1.5 In case Fermilab is not able to meet the delivery schedule for the Accelerator Components (as set out in Paragraph 1.15 of Annex 1) and subject to the financial constraints of the U.S. HL-LHC AUP specified in Paragraph 1.2, Fermilab is expected to provide:

(a) Six (6) Cryo-assemblies fully assembled and horizontally tested;
(b) Three (3) Q1 and Q3 Cold Masses built with vertically tested magnets; and
(c) Completed coils and remaining components for one (1) additional Q1 and Q3 Cold Mass.

Fermilab is also expected to provide a total of eight (8) Dressed RFD Crab Cavities plus components for two (2) additional Dressed RFD Crab Cavities as further described in Annex 1 of this MOU.

Section 2
Contributions by Fermilab

2.1 Fermilab plans to provide the following deliverables to CERN through its execution of the U.S. HL-LHC AUP:

(a) A quality plan covering the activities included in this MOU according to CERN's HL-LHC Quality Plan (the "HL-LHC Quality Plan"), as specified in CERN's Electronic Document Management System (EDMS) electronic system: https://edms.cern.ch/document/1513591/2.0.

(b) Full sharing of data, technical information, and lessons learned from the construction of prototype Nb_3Sn low-β 4.2-meter length quadrupole (MQXFA) magnets, Q1 and Q3 Cryo-assemblies, and Dressed RFD Crab Cavities.

(c) The construction of Accelerator Components in accordance with Section 1 and Annex 1 of this MOU.

(d) Documentation providing the specification for production of the Accelerator Components, including the associated manufacturing drawings and assembly procedures.

(e) Documentation providing the record for production of each Accelerator Component.

(f) Documentation providing results of performance evaluation tests for each Accelerator Component, and the determinations of their acceptance that are performed in accordance with Section 4 and Annex 3 of this MOU.

(g) All necessary tooling, the details and disposition of which is to be mutually determined in writing between the Participants, for the maintenance and repair at CERN of each series production of the Accelerator Components over the HL-LHC operational life.

2.2 The Participants plan to exchange parts and components, as specified in Annex 4 of this MOU, to achieve the objectives for the U.S. HL-LHC AUP.

Section 3
Contributions by CERN

In its capacity as the host organization of the HL-LHC accelerator upgrade, CERN plans to execute the upgrade at CERN and to provide Fermilab the contributions specified in Annex 2 of this MOU. In addition, CERN intends to provide specific safety-related requirements to ensure operational compliance of each Accelerator Component.

Section 4
Delivery and Acceptance Procedures

4.1 While the overall responsibility for the execution of this MOU is shared between the Participants, each Participant intends to remain exclusively responsible for the proper performance of its activities.

4.2 Delivery and acceptance procedures are detailed in a document entitled "Acceptance Plans" that has been prepared by U.S. HL-LHC AUP (Fermilab reference document: US-HiLumi-doc-1148 and US-HiLumi-doc-1744), of which the key elements are summarized in Annex 3 of this MOU.

Section 5
Technical Co-ordinators

In accordance with Article 4.1 of Accelerator Protocol III, for an area of activity in the HL-LHC accelerator upgrade, each Participant has designated a Technical Coordinator, whose contact details are provided in Annex 6.

Section 6
Financial Procedures

5.1 For the implementation of this MOU, CERN intends to establish dedicated budget codes, subject to applicable rules, guidelines and procedures at CERN. CERN intends to maintain accurate records of all financial transactions in accordance with such budget codes. Payment details are specified in Annex 5 of this MOU.

5.2 The budget codes are planned to be used to track material, equipment and personnel invoicing and costs connected to activities performed under this MOU.

Section 7
Schedules and Milestones

Details related to the planned schedules and milestones are specified in Annexes 1, 2, and 4 of this MOU. The Technical Co-ordinators, referred to in Section 5 and Annex 6 of this MOU, intend to monitor and track the progress of each activity to ensure schedules and milestones are met and to prepare regular reports to their respective leadership.

Section 8
Organization and Coordination

8.1 For the purpose of undertaking the planned scope of activities under this MOU, the Participants plan to create a Steering Committee comprised of at least two (2) qualified representatives from each Participant. Each Participant's representative may be assisted, in an advisory capacity only, by a specialist of his or her choice (such as, but not limited to, the Technical Co-ordinator referred to in Section 5 and Annex 6 of this MOU), subject to prior written notification to the other Participant.

8.2 The planned roles and responsibilities of the Steering Committee include, but are not limited to, the following:

(a) Monitor the implementation of this MOU to ensure consistency with the guidelines and requirements specified in Annex 1 of this MOU and, as appropriate and upon guidance from the Technical Co-ordinators, recommend solutions to the Participants in the event of difficulties in the execution of activities;

(b) Propose any modification to this MOU which it may deem necessary for technical and/or financial matters for the Participants' mutual written decision in accordance with Section 10.2 of this MOU; and

(c) Act as a body to facilitate the Participants' amicable resolution of any differences or disputes that may arise during the implementation of this MOU.

8.3. The Steering Committee intends to meet at least once a year or, if needed, more frequently upon a written request of either Participant. Meetings may be conducted by remote electronic participation.

8.4 The planned Fermilab and CERN representatives on the Steering Committee are, respectively:

(a) Dr. Alexander Romanenko, Chief Technology Officer, Fermilab
(b) Dr. Giorgio Apollinari, U.S.-HL-LHC AUP Project Manager, Fermilab
(c) Dr. Michael Lamont, Director for Accelerators and Technology, CERN
(d) Dr. Oliver Bruning, HL-LHC Project Leader, CERN

8.5. Each Participant may designate successor(s) to its Steering Committee representatives upon prior written notification to the other Participant.

8.6. For the purpose of undertaking the planned scope of activities under this MOU, the contact persons for each Participant are:

(a) Fermilab: Dr. Giorgio Apollinari, U.S. HL-LHC AUP Project Manager
(b) CERN: Dr. Oliver Bruning, HL-LHC Project Leader

8.7. Each Participant may designate a successor to its contact person upon prior written notification to the other Participant.

Section 9
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 10
Commencement, Modification and Discontinuation

10.1 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 10.3 of this Section.

10.2 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.

10.3 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, and to discuss its intention to discontinue during a Steering Committee meeting scheduled in accordance with Section 8.3 of this MOU as soon as feasible following such notice.

Section 11
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 FERMI NATIONAL ACCELERATOR LABORATORY:	FOR THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH:
Nigel Lockyer Director	Fabiola Gianotti Director-General
Date: MARCH 26, 2021	Date: MARCH 23, 2021
Place: BATAVIA, IL	Place: GENEVA (CH)

ANNEXES

Annex 1: Fermilab Contributions
Annex 2: CERN Contributions
Annex 3: Delivery and Acceptance Procedures
Annex 4: Exchange of Parts
Annex 5: Payment Details
Annex 6: Technical Co-ordinators

ANNEX 1: FERMILAB CONTRIBUTIONS

1.1 DOE designated to Fermilab in April 2016 the responsibility to host, manage, and, in consortium with U.S. Participating Organizations, execute the U.S. HL-LHC AUP in accordance with DOE Order 413.3.B regarding program and project management for the acquisition of capital assets. The U.S. HL-LHC AUP was established to provide in-kind contributions of beam-line deliverables to the HL-LHC accelerator upgrade program at CERN.

1.2 DOE approved the project baseline of the U.S. HL-LHC AUP, designated by a DOE Critical Decision-2, on February 11, 2019, and the Project Execution Plan was approved by DOE on December 21, 2020 (Fermilab reference document: US-HiLumi-doc-1341, dated December 21, 2020)

1.3 The objectives of the U.S. HL-LHC AUP include the delivery to CERN of Accelerator Components specified in Section 1.1 of this MOU.

1.4 In the scenario specified in Section 1.5 of this MOU, Fermilab is expected to prioritize assembled coils in the delivery of parts to CERN. In order to allow for the assembly of coils for all ten (10) Cryo-assemblies, Fermilab plans to provide:

(a) Six (6) Cryo-assemblies fully assembled and horizontally tested;
(b) Three (3) Q1 and Q3 Cold Masses built with vertically tested magnets; and
(c) Completed coils and remaining components for one (1) additional Q1 and Q3 Cold Mass.

Components for two (2) additional Dressed RFD Crab Cavities plan to include:

(a) Two (2) un-processed and un-tested bare RFD Crab Cavities;
(b) Un-processed and un-tested higher order mode and pick-up ancillaries for two (2) RFD Crab Cavities; and
(c) Helium Vessel Parts and Magnetic Shield parts for two (2) RFD Crab Cavities.

1.5 Fermilab plans to provide documentation for the production of the Q1 and Q3 Cryo-assemblies and Dressed RFD Crab Cavities, including the manufacturing drawings and the assembly procedures.

1.6 Fermilab plans to provide documentation for the results of performance evaluation tests of each Q1 and Q3 Cryo-assembly and Dressed RFD Crab Cavity.

1.7 Fermilab plans to deliver all necessary tooling, as determined by the Participants, for the maintenance and repair at CERN of each series production Q1 and Q3 Cryo-assembly or Dressed RFD Crab Cavity over the HL-LHC operational life. The tooling provided by Fermilab to CERN is expected, at the minimum, to include:

(a) Cryo-assembly Tooling;
(b) one (1) set of Winding Mandrel for Coils;
(c) one (1) set of Reaction and Impregnation Tooling; and
(d) one (1) set of Bladders for Magnet Assembly/Disassembly.

1.8 Fermilab and other U.S. Participating Organizations in the U.S. HL-LHC AUP are expected to abide by the HL-LHC Quality Plan (CERN reference document: EDMS #1513591).

1.9 Any contracts between Fermilab or other U.S. Participating Organizations in the U.S. HL-LHC AUP and third parties for the execution of the scope of this MOU are expected to:

(a) Ensure that the provisions of its contracts with any industry partner are consistent with the provisions of this MOU, the 2015 Co-operation Agreement, Accelerator Protocol III, and Addendum II, including, but not limited to, provisions regarding intellectual property, ownership and shipment of deliverables, export control, liability and dispute settlement; and

(b) Ensure that relevant provisions of the HL-LHC Quality Plan are included/reflected in the provisions of its contracts with any industry partner.

1.10 In the event that Fermilab determines it would be necessary for expert(s) that are not affiliated with CERN but plan to visit the CERN site for the execution of Fermilab's or the U.S. Participating Organization's contribution of the U.S. HL-LHC AUP, as may in particular be the case for the employees of an industry partner, Fermilab intends to notify CERN two (2) months prior to the contemplated date of arrival of such expert(s) at CERN. Following such notification, CERN intends to grant such expert(s) a status that allows Fermilab or the U.S. Participating Organization, as applicable, to execute its contribution effectively.

1.11 Fermilab plans to comply with the provisions of the HL-LHC Quality Plan (CERN reference document: EDMS #1513591) during any testing and/or

production that is executed at its premises in the production of the Accelerator Components and in the execution of Fermilab's contribution to the HL-LHC accelerator upgrade.

1.12 Fermilab plans to comply with the Pressure Equipment CERN Safety Regulations, it being understood that such compliance is based on the provisions of (a) the document entitled "Memorandum: Conformity approach for Pressure Equipment for the High Luminosity LHC Project" (Fermilab reference document: US-HiLumi-doc-240, CERN reference document: EDMS #1698982), and (b) the Pressure Equipment Directive Compliance document (Fermilab reference document: US-HiLumi-doc-850, CERN reference document: EDMS #1891856). Additionally, for the RFD Crab Cavities, Fermilab plans to comply with the expectations set forth in the document entitled "Engineering Specification for Dressed Cavities" (CERN reference document: EDMS #1389669).

1.13 Fermilab plans to manufacture Accelerator Components for the U.S. HL-LHC AUP to meet:

(a) "Functional Requirement Specifications" provided by CERN (Annex 2);
(b) "Material Approvals" provided by CERN (Annex 2);
(c) "Acceptance Criteria" provided by CERN (Annex 2);
(d) "Interface Control Documents" provided by CERN (Annex 2); and
(e) "Engineering Specification for Dressed Cavities" [EDMS #1389669].

1.14 Inspection of the Accelerator Components upon delivery to CERN is expected to be carried out in accordance with Paragraphs 3.5, 3.6, and 3.7 of Annex 3 of this MOU.

1.15 The planned delivery dates of the Accelerator Components (hereinafter collectively referred to as the "Delivery Dates") are identified in the Project Execution Plan (Fermilab reference document: US-HiLumi-Docdb-1341, dated December 21, 2020) and in letters exchanged between the Participants (Fermilab and CERN reference documents: US-HiLumi-Docdb-2599 and EDMS #2301820, respectively, dated July 5, 2019; and Fermilab and CERN reference documents: US-HiLumi-Docdb-2599 and EDMS #2303166, respectively, dated December 16, 2019; and references therein), which are expected to be discussed by the Participants at regular Steering Committee meetings and updated as needed.

1.16 The Delivery Dates assume the successful execution of U.S. HL-LHC AUP activities, it being understood that if unforeseen elements or situations internal to the U.S. HL-LHC AUP efforts affect the Delivery Dates, Fermilab, on behalf

of the U.S HL-LHC AUP Project Management, intends to promptly communicate with the CERN Technical Co-ordinators, referred to in Section 5 and specified in Annex 6 of this MOU, to discuss any potential schedule delay and identify mutually acceptable solutions.

1.17 The Delivery Dates also depend, in several cases, on the timely exchange of parts and/or tooling between Fermilab and CERN as specified in Annex 4 of this MOU. If such exchanges are not executed according to these plans, Fermilab, on behalf of the U.S. HL-LHC AUP Project Management, intends to promptly communicate with the CERN Technical Co-ordinators to discuss any potential schedule delay and identify mutually acceptable solutions.

1.18 Documentation and reviews: the series construction of Accelerator Components is expected to follow the guidelines of the HL-LHC Quality Assurance Plan, in particular:

(a) Drawings are expected to be stored in the CERN Drawing Directory system;
(b) Assembly procedures are expected to be mutually determined between Fermilab and CERN, and stored in the CERN EDMS system;
(c) MIPs are expected to be mutually determined between Fermilab and CERN, and stored in the CERN EDMS system;
(d) Manufacturing records are expected to be stored in the CERN Management and Test Folder (MTF) electronic system, it being understood that data is to be loaded at each main step of the production (coil fabrication, magnet assembly, cold mass assembly), and Microsoft Excel templates are to be mutually accepted for magnetic measurements data and power test data, and uploaded to the CERN MTF system;
(e) All texts are to be in the English language; and
(f) Appropriate Production Readiness Review is expected to take place prior to starting series production of Accelerator Components.

1.19 Fermilab's intended financial responsibility extends to any taxes, customs duties, and any other charges applicable to the importation of items shipped by CERN into the United States.

1.20 Fermilab's intended financial responsibility extends to relevant shipment and insurance costs necessary for export to CERN of any deliverable referred to in this Annex 1.

ANNEX 2: CERN CONTRIBUTIONS

2.1 All documents to be provided by CERN to Fermilab for the execution of the U.S. HL-LHC AUP reside in the CERN EDMS at CERN and the U.S. HL-LHC AUP Document Database, or US-HiLumi-doc, at Fermilab, and all are expected to be used by Fermilab for the execution of the scope of this MOU once they are approved by CERN, including those documents designated version 1.0 or higher in EDMS.

2.2 CERN intends to provide the following documentation to Fermilab:

(a) Functional Requirement Specifications:
1. MQXFA Functional Requirements Specification [US-HiLumi-doc-36, EDMS #1535430];
2. LMQXFA/B Functional Requirements Specification [US-HiLumi-doc-64, EDMS #1686197];
3. Requirements Specification for the Assembly of QQXF_SC [US-HiLumi-doc-246, EDMS #1828585];
4. Dressed RFD Functional Requirements Specification [US-HiLumi-doc-294, EDMS #1806220]; and
5. Engineering Specification for Dressed Cavities [EDMS #1389669], and the related specification drawings for the complete Dressed RFD Crab Cavity that are listed in the document's annexes.

(b) Material Approvals:
1. MQXFA Materials List [US-HiLumi-doc-96, EDMS #1786913];
2. LMQXFA/B Material List [US-HiLumi-doc-2890, EDMS #1868473]; and
3. Dressed RFD Crab Cavities Materials List [US-HiLumi-doc-668, EDMS #2001102].

(c) Acceptance Criteria:
1. Acceptance Criteria Part A: MQXFA Magnet [US-HiLumi-doc-1103, EDMS #2031083];
2. Acceptance Criteria Part B: LMQXFA Cold Mass and Cryo-assemblies Fabrication [US-HiLumi-doc-1127, EDMS #2323981];
3. Acceptance Criteria Part C: Cryo-assemblies Delivery [US-HiLumi-doc-1145, EDMS #1868479];
    i. Acceptance Criteria Part C: Cryo-assembly Delivery are to include sections on "First Article Acceptance Inspection at Delivery" and "Subsequent Articles Acceptance Inspection at Delivery", as specified in Paragraphs 3.5, 3.6 and 3.7 of Annex 3 of this MOU;
4. Acceptance Criteria Part A: Dressed RFD Cavities Fabrication [US-HiLumi-doc-1154, EDMS #2319856];

5. Acceptance Criteria Part B: Dressed RFD Cavities Delivery [US-HiLumi-doc-2896, EDMS #2339758];
    i. Acceptance Criteria Part B: Dressed RFD Cavities Delivery are to include sections on "First Article Acceptance Inspection at Delivery" and "Subsequent Articles Acceptance Inspection at Delivery", as specified in Paragraphs 3.5, 3.6 and 3.7 of Annex 3 of this MOU.

(d) Interface Control Documents:

1. Q1 and Q3 Interface Control Document [US-HiLumi-doc-375, EDMS #1868472]; and
2. RFD Interface Control Document [US-HiLumi-doc-647, EDMS #2319638]

2.3 It is understood that certain documents listed in Paragraph 2.2 of this Annex still need to be finalized by the Participants after the signature of this MoU. Should delays in their finalization affect the Delivery Dates referred to in Paragraph 1.15 of Annex 1 of this MOU, Fermilab, on behalf of the U.S. HL-LHC AUP management, intends to communicate with the CERN HL-LHC Project Leader at the earliest possible date to discuss any potential schedule delay and identify mutually acceptable solutions.

2.4 CERN plans to provide, as necessary, training to any individuals undertaking activities contemplated under this MOU, in particular on applying the HL-LHC Quality Plan and the necessary tools for the management of the documents and records that are linked to the Accelerator Components.

ANNEX 3: DELIVERY AND ACCEPTANCE PROCEDURES

For the purpose of this MOU, key elements of the delivery and acceptance procedures for the Accelerator Components, as detailed in a document entitled "Acceptance Plans" that has been prepared by U.S. HL-LHC AUP (Fermilab reference document: US-HiLumi-doc-1148 and US-HiLumi-doc-1744), are as follows:

3.1 After the fabrication and associated technical tests for the Accelerator Components are completed, a U.S. HL-LHC AUP Review Board (hereinafter referred to as the "Board") is expected to be convened to review the manufacturing and test data, and subsequently verify whether the elements meet the acceptance criteria specified in Annex 2 of this MOU (hereinafter referred to as "Acceptance Criteria"). After its review, the Board is expected to issue a formal recommendation for acceptance to the U.S. HL-LHC AUP Office at Fermilab. The Board's recommendation is expected to include any exceptions, restrictions on use, and the basis of the evaluation. In all cases, the Board is expected to provide a recommendation to the U.S. HL-LHC-AUP Office regarding the disposition of the cryo-assembly.

3.2 The U.S. HL-LHC AUP Project Manager is expected to review and send the Board's recommendation report with any additional comments to the official CERN Technical Co-ordinator, referred to in Section 5 and specified in Annex 6 of this MOU, for the Accelerator Component under consideration.

3.3 CERN's HL-LHC Project Leader is expected to evaluate the aforementioned information specified in Paragraph 3.2 of this Annex and, if acceptable, to issue a notification to the U.S. HL-LHC AUP Project Manager that the relevant Accelerator Components may be shipped. As part of the evaluation, the HL-LHC Project Leader is expected to have access to all the manufacturing data specified in the mutually accepted document entitled "Manufacturing and Inspection Plans" (MIPs), which resides in CERN's EDMS and MTF electronic systems, as well as any additional information that the CERN HL-LHC Project Leader may request from Fermilab.

3.4 Subject to the outcome of the evaluation specified in Paragraph 3.3 of this Annex, Fermilab intends to, at its expense, accept the risk of full replacement cost during shipment of each Accelerator Component if needed.

3.5 Upon delivery of the Accelerator Components by Fermilab to CERN, or to any other site(s) indicated by CERN's HL-LHC Project Leader, the Participants intend to follow mutually accepted procedures to verify that no damage to the delivered Accelerator Components has resulted from the transportation process. To this end, the first delivered Accelerator Component to be shipped

under a mutually determined method of shipment is planned to be inspected in accordance with a "First Article Acceptance Inspection at Delivery" provision specified in the Acceptance Criteria and under procedures described in Paragraph 3.6 of this Annex in order to fully verify no damages resulted from the shipment. The remaining delivered Accelerator Components, shipped by the same shipping method as the first, are planned to be inspected in accordance with the "Subsequent Articles Acceptance Inspections at Delivery" provision specified in the Acceptance Criteria and under procedures described in Paragraph 3.7 of this Annex, in order to effectuate transfer of ownership under Article 6.2 of Addendum II.

3.6 Procedures for the "First Article Acceptance Inspection at Delivery" are planned to be conducted at the receiving site, at CERN's expense, following the procedure mutually determined by the Participants for the acceptance of the Accelerator Component in question (or a similar procedure suitably adapted and mutually determined between U.S. HL-LHC AUP and HL-LHC management) as described in the Acceptance Criteria. A representative of the U.S. HL-LHC AUP Project is expected to share with CERN the information and the detailed procedure of the test, it being understood that the representative intends to approve and witness any activity performed on the item, including any inspections, in accordance with the Acceptance Criteria. Such representative should also have the authority to stop any activity deemed not appropriate. The receiving site is expected to provide personnel and equipment to conduct such inspections. All inspection data should be made available to the Participants. Upon a successful completion of the inspection, CERN's HL-LHC Project Leader is expected to issue the formal acceptance, attested in writing, of the Accelerator Component(s) to the U.S. HL-LHC AUP Project Manager within five (5) months from the date of delivery of the Accelerator Component(s). Such formal acceptance is intended to represent the transfer of ownership of and all risks related to the delivered Accelerator Component(s) from the U.S. HL-LHC AUP to CERN as of its date of issuance in accordance with Article 6.2 of Addendum II.

3.7 Procedures for "Subsequent Articles Acceptance Inspections at Delivery", described in the Acceptance Criteria, are planned to include visual and mechanical inspections. Such inspections are expected to be performed at CERN's expense under the responsibility of the representative of the CERN HL-LHC Project at the receiving site. All inspection data should be made available to the Participants. Upon a successful completion of the inspection, CERN's HL-LHC Project Leader is expected to issue the formal acceptance, attested in writing, of the Accelerator Component(s) to the U.S. HL-LHC AUP Project Manager within two (2) months from the date of delivery of the Accelerator Component(s). Such formal acceptance is intended to represent the

transfer of ownership of and all risks related to the delivered Accelerator Component(s) from the U.S. HL-LHC AUP to CERN as of its date of issuance in accordance with Article 6.2 of Addendum II.

3.8 In the event of non-acceptance of an Accelerator Component after shipment, the Participants intend to mutually determine a process either for a) the repair of such deliverables with the involvement of U.S. HL-LHC AUP personnel or b) returning such deliverables to Fermilab for subsequent repair or replacement. Except as otherwise specified in writing by the Participants, the U.S. HL-LHC AUP is expected to be responsible for the costs of any such activities, subject to availability of funds, prior to project completion, which is designated by a Critical Decision-4 approval by DOE.

3.9 After project completion of the U.S. HL-LHC AUP, or in case of insufficient availability of funds, Fermilab plans to intervene to the extent possible and furnish critical tooling as appropriate to repair any defect that may be caused by a failure to comply with applicable quality procedures that form part of the U.S. HL-LHC AUP scope of deliverables as set forth in this MOU within two (2) years of acceptance by CERN of an Accelerator Component.

ANNEX 4: EXCHANGE OF PARTS

4.1 The Participants understand that it is in their interest to exchange parts and/or tooling to ensure better efficiency and quality uniformity of the activities that are contemplated under this MOU and the final deliverables of Accelerator Components to CERN.

4.2 The list of parts and tooling planned to be exchanged, the Participant responsible for each individual part, and the schedule for the delivery of said parts and tooling are specified in the Fermilab and CERN reference documents entitled "US-HiLumi-doc-844" and EDMS #1825173, respectively, which are expected to be discussed by the Participants at regular Steering Committee meetings and updated as needed.

4.3 The timely exchange of parts and tooling between Fermilab and CERN underlies the Delivery Dates described in Paragraph 1.15 of Annex 1 of this MOU. In the event that the exchange cannot be executed according to principal delivery dates specified in Paragraph 4.2 of this Annex, Fermilab, on behalf of the U.S. HL-LHC AUP management, intends to communicate with the CERN Technical Co-ordinators, referred to in Section 5 and specified in Annex 6 of this MOU, at the earliest possible date to discuss any potential schedule delay and identify mutually acceptable solutions.

4.4 Each Participant intends to be responsible for its respective parts as specified in the documents identified in Paragraph 4.2 of this Annex, including any matters related design, procurement, and/or fabrication of Accelerator Components.

4.5 To facilitate the exchange of parts, each Participant intends to provide to the other Participant technical documentation related to the exchanged parts, including drawings, inspection, and/or material documentation.

4.6 Each Participant intends, at its own cost, to arrange for shipment to the receiving Participant of any material or parts for which it is responsible in accordance with the document entitled "US-HiLumi-doc-884" or EDMS #1825173, and to insure such material or parts for its replacement value.

4.7 In respect of the parts and tooling specified in the document entitled "US-HiLumi-doc-884" or EDMS #1825173, the receiving Participant is expected to be responsible for any taxes, custom duties and any other charges applicable to importation of the exchanged parts into its territory.

4.8 The exchange of parts is intended to reflect a financial balance in the exchange, it being understood that any imbalances may be discussed and validated by the Steering Committee and, in such an event and at the Participants' discretion, may be addressed by exchange of payment between the Participants in accordance with Annex 4 of this MOU.

ANNEX 5: PAYMENT DETAILS

5.1 Any payment intended to address a financial imbalance generated by the exchange of parts described in Annex 4 is to be invoiced at cost to the Participant planning to make such payment. In application of CERN's exemption from taxes and customs duties for the procurement of supplies, the amount(s) to be invoiced by CERN are to be net, firm and exclude such taxes and customs duties.

5.2 Any taxes, customs duties and any other charges applicable to importation of the material or exchange parts into the U.S. is to be at the expense of Fermilab.

5.3 Invoices, if necessary, are to be issued upon acceptance by the receiving Participant of the material concerned. Invoices are to include a breakdown of costs.

5.4 For Fermilab, invoices are to be submitted to Fermilab Accounts Payables Office at APinvoices@fnal.gov. All costs are to reflect actual costs incurred.

5.5 Payments are to be made by bank transfer within thirty (30) days from receipt of the invoice into the account specified in the invoice. CERN plans to report such payments using the dedicated budget codes established in accordance with Section 6 of this MOU.

ANNEX 6: TECHNICAL CO-ORDINATORS

The Technical Co-ordinators for activities under this MOU are:

For Fermilab:

Q1 and Q3 Magnets:	Dr. Giorgio Ambrosio
Q1 and Q3 Cryo-assemblies:	Dr. Sandor Feher
RFD Crab Cavities:	Dr. Leonardo Ristori
Quality Assurance Coordinator:	Dr. Jamie Blowers
Safety Coordinator:	Dr. Tom Page

For CERN:

Q1 and Q3 Magnets and Cryo-assemblies:	Dr. Ezio Todesco
RFD Crab Cavities:	Dr. Rama Calaga
Quality Assurance Coordinator:	Dr. Hector Garcia Gavela
Safety Coordinator:	Dr. T. Otto