ADDENDUM No. 4 KExxx

to

FRAMEWORK COLLABORATION AGREEMENT KNxxx

between

THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH (CERN)

and

UNIVERSITY OF MANCHESTER (the "University")

concerning

Collaboration in the construction of DF devices in the framework of the High Luminosity upgrade for the LHC at CERN

CONSIDERING:

- Framework Collaboration Agreement KNxxx (the "Agreement") concluded between CERN and the University (individually the "Party" and collectively the "Parties") defining the framework applicable to collaboration between them in areas of mutual interest, including but not limited to the domains of particle and accelerator physics;

- Article 2.1 of the Agreement which provides that the scope, each Party's contribution and all other details of each specific Project shall be laid down in Addenda to the Agreement;

- That the Parties have identified the Project set out below, which shall be covered by the provisions of this Addendum No.4 KExxx (the "Addendum"). This Addendum shall be subject to the provisions of the Agreement, it being understood that in case of divergence the provisions of this Addendum shall prevail,

THE PARTIES AGREE AS FOLLOWS:

Article 1

Scope

1.1 Under the terms of this Addendum, the Parties shall collaborate in the construction of a total of nine DF electrical connection devices, (four DFX and five DFM), required for the High Luminosity upgrade of the LHC (the "Project"). The technical description and the identification of the work-packages are detailed in Annex 1.

1.2 This Addendum defines the Project between the Parties and shall form an integral part of, and be subject to, the Agreement. In case of conflict between the terms of this Addendum and the terms of the Agreement, the terms of this Addendum shall prevail.

1.3 Except as agreed otherwise by the Parties, each Party shall bear the cost of its participation in the Project.

Article 2

Duration

Subject to the continued validity of the Agreement, this Addendum shall enter into force on 1 April 2020 and shall remain valid until 31 December 2025 (inclusive), or, failing completion of the Project by that date, on such later date as the Parties may agree. It is understood that this Addendum shall also cover any work relating to the Project executed by the Parties prior to the entry into force of this Addendum.

Article 3

Scope of the University's contribution

3.1 The work to be performed by the University as its contribution to the Project is set out in the list given hereunder (the "Deliverables"), and shall be defined in detail between the Parties before the start of each task. The work will be executed under the coordination of the University by the following institutes: UNIVERSITY OF SOUTHAMPTON. Add statement to the fact that "University" in the following text refers to University of Southampton.

The University shall provide the following:

a) A Quality Plan covering the activities included in this Addendum according to the HL-LHC Quality Plan (the "Quality Plan"):

https://edms.cern.ch/document/1513591/2.0.

b) The production of execution drawings;

c) The construction of four DFX devices;

d) The construction of five DFM devices;

e) The documentation relating to the full life cycle of the Deliverables covered by this Addendum as requested in the Quality Plan for review and acceptance, in accordance with the milestones defined in Annex 1. Such documentation and records shall be made available in either French or English; and

f) All tooling agreed during the Steering Committee meetings to be delivered to CERN by University as necessary for the maintenance and repair at CERN of each Deliverable over the HL-LHC operational life.

g) Delivery of components to CERN.

3.2 The specifications of the Deliverables and of the University's contribution are further detailed in Annex 1.

A detailed agreement on the organisation of the shipment of the Deliverables to CERN and the associated formalities shall be established during the execution of the Project work, on the occasion of the first meeting of the Steering Committee.

3.3 Upon discussion between the Parties it may be decided that University shall also contribute to the Project through experts (the "University Experts"). During their stay at CERN, the University Experts shall be appointed as Associated Members of the Personnel pursuant to Article 3 of the Agreement. Subject to the University Experts' continued employment by University, throughout their stay at CERN, CERN may pay a subsistence allowance to the University Experts in accordance with, and subject to, the limitations set out in its Staff Rules and Regulations.

3.4 To the extent that the University contracts with third parties in the execution of the Project, University shall:

a) Inform CERN in due time of its selection of industry partners (shall CERN be involved in the approval process ?);

b) Ensure that the provisions of its contracts with any industry partners are consistent with the provisions of this Addendum and the Agreement, including but not limited to the provisions dealing with intellectual property; and

c) Inform CERN as to the terms of any contracts with its industry partners.

d) CERN shall notify visits and have access to the industrial site

3.5 Where the University considers that it would be necessary for experts who do not qualify for association with CERN as per Article 4 of the Agreement to come to the CERN site in the execution of the Project (as may in particular be the case for the employees of any industry partners referenced above), the University shall so notify CERN three months ahead of the intended date of arrival of such experts at CERN. CERN shall facilitate the granting to such experts of a (non-personnel) status that will allow University to execute its contribution effectively.

Article 4

CERN's contribution

CERN shall be responsible for the overall co-ordination of the installation of the Deliverables at CERN's premises (LHC tunnel).

CERN shall contribute to the Project by providing:

- Office facilities, laboratories, equipment, materials and services on the CERN site as required for the execution of the University's contribution;
- The technical specifications of the Deliverables, as summarized in Annex 1 of this Addendum;
- Technical support, i.e. assistance, for the manufacturing, assembly and testing activities performed at the University or in industry;

- An interface specification, summarizing the interfaces with other relevant accelerator components;
- CERN shall make a financial contribution in an amount of 825 000 GBP (eight-hundred twenty-five thousand pounds sterling);
- CERN shall contribute in specific components or materials, special tooling and travel required for the Deliverables and as agreed by the Parties in the Steering Committee meetings materials for a value of 1 350 000 GBP (one million three-hundred fifty thousand pounds sterling);
- CERN shall contribute with personnel for the start of the production and follow-up. This manpower effort has an equivalent value of 270 000 GBP (two-hundred seventy thousand pounds sterling). In case of needs that may arise during the execution of the work, CERN reserves the right to increase the manpower effort to an equivalent value of 400 000 GBP (four-hundred thousand pounds sterling);
- Training to the University Experts on the application of the Quality Plan and on the tools for the management of the documents and records linked to the Deliverables.

CERN shall define the acceptance criteria for the production of the Deliverables, to be agreed by the Parties in the Steering Committee meetings. The acceptance criteria that CERN shall apply will be based on four steps:

- Approval of conformity with requirements during production at the University or in industry;
- Approval of conformity with requirements of pre-assembly at the University or in industry;
- Approval of conformity with requirements upon final assembly at CERN;
- Approval of safety conformity in accordance with Article 5, below.

Conformity with requirements will be analysed during the Production Readiness Reviews (the "PRRs"). Production shall not start before the validation of the PRRs.

Article 5

Safety documentation

CERN shall provide the specific safety requirements that the Deliverables must comply with. The University shall provide the safety documentation/certification as agreed with CERN to establish the conformity of the Deliverables with CERN's safety rules.

Article 6

Acceptance procedure for Deliverables

The CERN Technical Coordinator shall grant acceptance of the Deliverables in two phases:

6.1 Phase 1:

The University shall arrange for shipping of the Deliverables (with adequate packaging and related insurance) to CERN at its cost.

CERN shall approve shipment of each Deliverable to CERN, not later than one (1) month from approval of all documents and records linked to the lifecycle of the Deliverables including non-conformities.

6.2 Phase 2:

CERN shall grant final acceptance of each Deliverable within six (6) months from the date of delivery to CERN, and following successful completion of acceptance tests at CERN. Shall we add provisional acceptance after reception - within 1 month ?

After shipment to CERN, in the event of non-acceptance of a Deliverable, because of a defect of the series production unit concerned, the Parties shall establish a protocol either for repairing such

series production unit at CERN's premises by the University Experts with support by CERN, or for returning such Deliverables to the University for repair.

Non-conformities shall be treated in accordance with the CERN Quality Plan.

The Deliverables shall eventually be integrated in the LHC and shall become CERN property upon the issuance of the final acceptance certificate.

The University shall intervene and repair any possible hidden defect that is caused by the non-compliant execution of the quality procedures forming part of the University's scope of delivery and that may be discovered within two (2) years from the issue of the final acceptance certificate.

Article 7

Technical Coordination

For the purpose of the technical co-ordination of this Project, CERN's representative shall be:

- Paul Cruikshank – HL-LHC DF Project leader
- Yann Leclercq – HL-LHC DF Project Engineer (?)

And University's representative shall be:

- Yifeng Yang – Southampton DF construction leader

or such successors as each Party may designate and communicate to the other Party.

All documentation shall be sent to Amalia Ballarino (WP6a Leader) and Paul Cruikshank (Deputy WP6a Leader).

The Technical Coordinators shall liaise with each other at regular intervals in order to define the detailed work packages and time schedules, to monitor the execution of the Project and to ensure corrective actions in case any difficulty arises in the execution of a Party's contribution.

Article 8

Intellectual property

8.1 Deliverables, and any related documentation, provided by University under this Addendum shall be deemed to include a perpetual and irrevocable intellectual property license for their free and unlimited use, including for their repair, reproduction, modification and replacement by CERN, or by any third party designated by CERN, within the scope of CERN's scientific program.

8.2 The provisions in this Article 8 shall apply in addition to the intellectual property provisions in Article 5 of the Agreement.

Article 9

Confidentiality

9.1 Except as expressly authorised by, and subject to any obligations under this Addendum, each Party agrees to keep confidential and not to disclose to any third party any information, document or other material which is designated as confidential or which should reasonably be understood to be confidential. Each Party shall limit the circle of recipients of such confidential information on a need-to-know basis and shall ensure that the recipients are aware of and comply with the obligations as defined in this Article.

9.2 The obligation of confidentiality applies in particular to the information contained in the documentation provided by University with each Deliverable.

9.3 Notwithstanding the above, no confidentiality obligation shall apply to such information, document or other material which:

- The receiving Party demonstrates was in the public domain prior to its communication by the disclosing Party;
- Became part of the public domain after such communication but not through any fault of the receiving Party;
- Has been lawfully received by the receiving Party from a third party without any confidentiality obligation; or
- Has been developed by the receiving Party independently and outside the scope of this Agreement.

Article 10

Termination

10.1 In the event of a substantial breach by University of its obligations under this Addendum, CERN may terminate this Addendum in whole or in part if no corrective action satisfactory to CERN is taken within two (2) months of the issue of a letter of notice by CERN to University.

10.2 In the event of a substantial breach by CERN of its obligations under this Addendum, University may terminate this Addendum in whole or in part if no corrective action satisfactory to University is taken within two (2) months of the issue of a letter of notice by University.

Article 11

Miscellaneous

11.1 The University shall grant access to CERN personnel or third-party personnel mandated by CERN, and, where so required, subject to the establishment of non-disclosure agreements and with modalities to be agreed, to its own premises and to the premises of industrial partners involved in the execution of the work under this Addendum.

11.2 Subject to the continued validity of the Agreement, this Addendum shall remain in force for as long as necessary to give effect to the Parties' respective rights and obligations under this Addendum.

11.3 This Addendum may be amended by written agreement by the Parties.

Done in two (2) copies in the English language.

The European Organization
for Nuclear Research (CERN)

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xxx

On:……2019

University of Manchester

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xxx

On:…….2019

For Information

University of Southampton

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On:…….2019

ANNEX 1: REQUIREMENTS MILESTONES DELIVERABLES

Introduction

The following provides a description of the DF (X or M) electrical connection devices for the HL LHC. It describes the scope of the supply, limits of responsibility, main technologies, technical requirements and deliverables.

Description

The DF cryostats house the electrical connections of the MgB_2 cables of the superconducting (SC) Link to the Nb-Ti cables of the HL-LHC magnets, ensuring cryogenic cooling and routing of instrumentation needed for monitoring and protection of cables and splices.

Two types of devices are required for HL LHC. The DFX, connecting the about 80 m long SC link to the high luminosity triplets, its corrector magnets and the D1 beam recombination dipole, and the DFM, connecting the about 130 m long SC link to the D2 beam separation dipole and its correctors. The superconductors in the DFX will carry about 120 kA, whereas those in the DFM will carry about 30 kA.

Eight DF devices are needed plus two spares (one per type) to power the four high luminosity insertions of ATLAS and CMS. The DFX spare is supplied under agreement KN *****, while the DFM spare is part of this agreement. The following figure shows a view of a DFX.

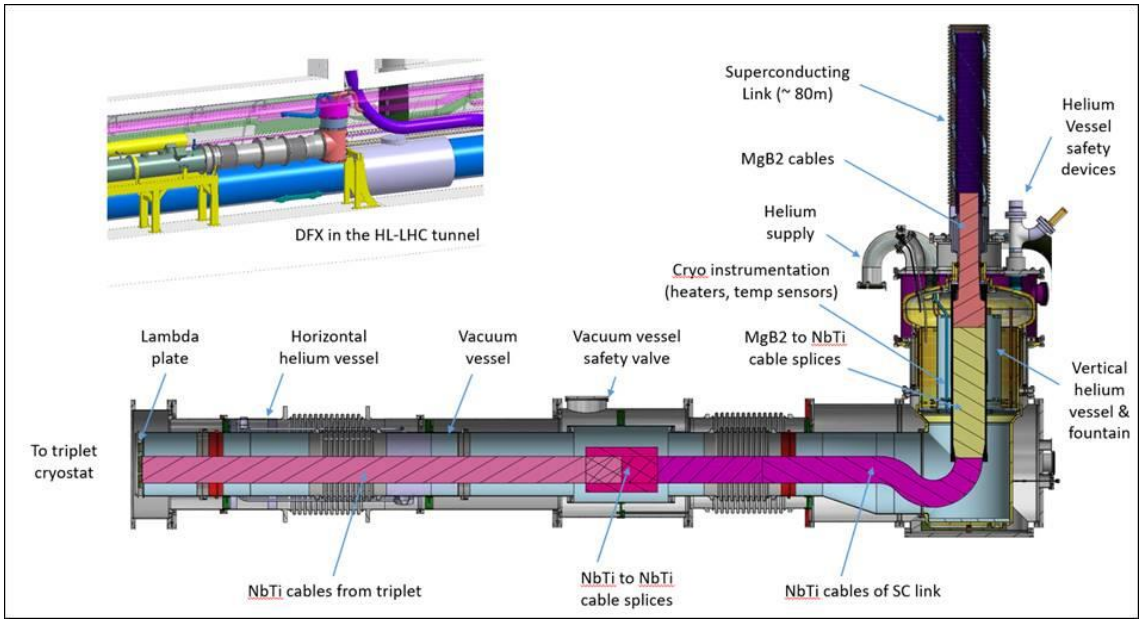

Figure 1.DFX integrated preliminary design (from plug, left side, to SC link, right side).

Work sharing between CERN and the in-kind collaboration institute

CERN is in charge of the supply of some specific components (e.g. lambda plugs, cryogenic and electrical instrumentation, superconducting cables, equipment for performing the splices) while the collaborating institute is in charge of the manufacture, assembly and qualification testing, and the supply to CERN of the qualified DF devices with all the relevant QA/QC documentation. The collaborating institute, being in charge of the industrial follow-up, will have to make the needed qualified resources available for this activity.

Technical requirements and technologies

Each cryostat device is composed of an inner helium pressure vessel integrated in an outer vacuum insulated vessel with connections to the SC Link and magnet cryostat at either side. Thermal insulation of the helium vessel, containing the splices, and operating in saturated 4.5 K helium, is ensured by an optimally designed low heat in-leaks supporting system with multilayer insulation (MLI). The devices shall be equipped with electrical and cryogenic instrumentation for cryogenic operation and control (electrical heaters, temperature and level gauges, pressure gauges) and voltage taps for monitoring and protection, with instrumentation wiring to be routed out to ambient via leak-tight feedthroughs. All welded and sealing solutions comply with specified levels of leak-tightness. Appropriate manufacturing procedures (in particular choice of materials, machining and welding) and manufacturing quality control (e.g. X-rays, helium mass spectrometry) are required. Cryogenic and vacuum vessels shall be in austenitic grade stainless steels and mechanical supporting systems in low thermal conductivity materials. To limit materials' activation in the environment of the LHC tunnel, the austenitic stainless steel shall have a cobalt content lower than 0.1%. Certificates of raw materials shall be approved by CERN prior to start the manufacturing of the components. Thermal contraction compensating elements like bellows and flexible hoses are needed. They are critical elements and shall be supplied by qualified specialized manufacturers.

Construction norms and regulations

The construction of the pressure vessels will have to be compliant with pressure vessel regulations (Pressure Equipment Directive 2014/68/EC PED). The devices shall be constructed and qualified conforming to EN or ISO norms and standards and shall be CE marked.

Assembly of the devices

The cryostat devices shall be assembled in a clean facility equipped with all necessary services and infrastructure. The assembly will entail precise mechanical fitting, TIG welding (manual and orbital) on thin-walled sheet metal work, assembly of pressure and insulation vacuum leak-tight feed-through, mounting of cryogenic instrumentation and routing of electrical circuitry, assembly of superinsulation blankets and thermal insulating supporting systems. The assembly shall be made by qualified personnel. In particular welders shall be qualified according to EN standards.

QC and qualification testing

The cryostat devices shall be manufactured and qualified prior to shipment to CERN in accordance with the CERN HL-LHC QA Plan. Qualifications shall include QC mechanical checks and measurements (metrology) of single components and sub-assemblies. The devices shall be pre-assembled and qualified via acceptance tests. These will include welds visual inspections and 100% X rays, pressure tests according to PED, and LN2 thermal shocking of the cryogenic envelopes. Electrical instrumentation circuits shall be checked for continuity and electrical insulation. The leak-tightness shall be verified by helium mass spectrometry. The personnel employed for tests shall be qualified according to EN standards. After qualification, the devices will be disassembled, conditioned for final assembly and prepared for shipment to CERN.

Typical profile of industrial suppliers

The construction of the DF devices shall be ensured by one main supplier having a proven experience in the assembly of similar size devices and having relevant experience with sheet metal work for stainless steel pressure vessels according to categories II or III of the Pressure Equipment Directive. The main supplier shall manage in house at least the following activities:

- Overall project management, including preparation of the required production and QA documentation (manufacturing and assembly drawings, assembly procedures, QC protocols, etc.);
- Assembly in a clean and dedicated area, well separated from other manufacturing activities which may hinder the required level of cleanliness;
- QC and final acceptance testing.

Schedule for series production

The manufacture and shipping to CERN of the series of 9 DF units shall take place in the period 2021-2023 with a first unit shipped for qualification at CERN by March 2021, followed by regular supplies. The manufacture of components, especially for the long lead items, should be started in 2020.

Prototype DFX

Qualification of the manufacturing capabilities shall be ensured through the construction of a prototype of a DFX supplied to CERN by November 2020 (under agreement KN ****).

Work Package	Deliverable Number	Deliverable Name	Complete by	Type

4	D4.01	Report on constructin and proposed improvements to DFX/DFM design features/considerations and functional specifications	29/1/20	Report
4	D4.02	Final technical report on the detailed design of DFX with full specification drawings of all parts and subassemblies ready for procurement	26/3/21	Report and drawings
4	D4.03	Final technical report on the detailed design of DFM with full specification drawings of all parts and subassemblies ready for procurement	24/9/21	Report and drawings
4	D4.04	Four DFX cryomodules dispatched after tests and received by CERN		Hardware
4		D4.04a: DFX unit 1	16/12/21	
4		D4.04b: DFX unit 2	26/2/22	
4		D4.04c: DFX unit 3	29/4/22	
4		D4.04d: DFX unit 4	29/4/22	
4	D4.05	Five DFM cryomodules dispatched after tests and received by CERN		Hardware
4		D4.05a: DFM unit 1	30/6/22	
4		D4.05b: DFM unit 2	30/8/22	
4		D4.05c: DFM unit 3	7/10/22	
4		D4.05d: DFM unit 4	11/1/23	
4		D4.05e: DFM unit 5	14/3/23	
4	D4.06	Technical report on production and qualification of DFX series units	31/7/22	Report
4	D4.07	Technical report on production and qualification of DFM series units	31/5/23	Report

ANNEX 2: CERN Financial contribution and payments details

The total CERN contribution shall not exceed 825 000 GBP.

The payments shall be set upon CERN's acceptance of a deliverable and receipt of a correct invoice. The list of deliverables and the schedule of payments is detailed in the following table:

To be re-worked out to take into account the new schedule.

Deliverable	Description	Amount (GBP)	Date
D1.1	Start of the project and supply of the first series production DFM unit and related documentation	105 000	31 May 2021
D1.2	Supply of one series production DFX unit and related documentation	90 000	31 May 2021
D1.3	Supply of two series production DFM units and related documentation	180 000	31 May 2022
D1.4	Supply of two series production DFX units and related documentation	180 000	31 Sep. 2022
D1.5	Supply of two series production DFM units and related documentation	180 000	31 Dec. 2022
D1.6	Supply of one series production DFX units and related documentation	90 000	31 Mar. 2023

ANNEX 3: Project Management

For the University:

Yifeng Yang, Southampton DF construction leader, Y.Yang@soton.ac.uk

For CERN:

Lucio Rossi, HL-LHC Project Leader, Lucio.Rossi@cern.ch

Amalia Ballarino, HL-LHC WP6A Leader Amalia.Ballarino@cern.ch

Paul Cruikshank, HL-LHC WP6A Deputy Leader, Paul.Cruikshank@cern.ch

All technical documents shall be sent to:

Paul Cruikshank

TE Department

CH-1211 Geneva 23

E-mail: Paul.Cruikshank@cern.ch

Tel: +41 22 767 3254

All commercial or contractual documents shall be sent to:

CERN — IPT Department

Procurement Service

CH-1211 GENEVA 23.

Invoices shall be sent to:

CERN — FAP Department

Accounts Payable

CH- 1211 GENEVA 23.