ADDENDUM No. 13 - KR4708/TE
to
FRAMEWORK COLLABORATION AGREEMENT KN3083

BETWEEN: THE INSTITUTO NAZIONALE DI FISICA NUCLEARE ("INFN"), established at Rome, Italy,

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

Hereinafter each individually referred to as a "Party" and collectively as the "Parties".

CONSIDERING THAT:

The Parties have concluded Framework Collaboration Agreement KN3083 (the "Agreement") establishing the framework 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 provides that each Party's contribution to a specific collaboration and all related details shall be set out in an Addendum to the Agreement;

That the Parties have identified the project set out below, which shall be covered by the provisions of this Addendum No. 13 KR4708/TE (the "Addendum");

INFN has been co-funded by Regione Lazio, within the POR FESR 2014-2020 European Commission Framework program, for setting up the LATINO Infrastructure at LNF,

THE PARTIES AGREE AS FOLLOWS:

1. Project

1.1 Under the terms of this Addendum, the Parties shall collaborate in the design and construction of systems for the field measurement of accelerator magnets (the "Project"). Both Parties have a strong strategic interest in developing tools for efficient, fast and reliable measurements of magnetic elements, including but not limited to those for the Large Hadron Collider (LHC) at CERN and for the LATINO Laboratory at INFN-LNF. The first element of this set of tools will be prepared at CERN for the INFN-LNF LATINO infrastructure. Design of the instrument will be conducted jointly at CERN and at INFN.

1.2 The Project comprises design and construction tasks related to the development of a novel modular rotating coil system, flexible enough to cope with a wide range of magnet geometries and test conditions. The design shall be inspired by existing state-of-the-art instruments and will aim to improve several aspects such as metrological accuracy and traceability, long-term maintainability and cost. In particular, software development shall focus on non-proprietary, open-ended infrastructure and tools to ensure longevity and reduce costs.

1.3 INFN shall execute its contribution to the Project through INFN-LNF.

1.4 Except as agreed in this Addendum, each Party shall bear the cost of its participation in the Project.

1.5 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.

2. Duration

The Project shall commence on 1 May 2020 and shall be completed no later than 30 April 2023. It is understood that this Addendum shall also cover any Project-related activities executed by the Parties prior to its entry into force.

3. Each Party's contribution

3.1 CERN shall provide the following contribution:

1) specification, design, purchase/manufacture and testing of analogue and digital electronic components, as well as mechanical supports;
2) development, validation and documentation of open-source software components on Windows and Linux platforms;
3) integration and metrological characterization of the measurement systems;
4) definition, execution and post processing of relevant magnetic test campaigns;
5) presentation of results;
6) necessary test bench infrastructure (lab floor space, electrical and cooling power) and technical support (mechatronic, geometrical survey and cabling);
7) training and supervision of a doctoral student on CERN premises appointed at CERN for the Project, and training and supervision of any visiting INFN staff.

3.2 INFN shall provide the following contribution:

1) mechanical and electrical design (CAD drawings, FE analysis, electrical layouts);
2) follow up of component production;
3) participation in the integration and metrological characterization of the rotating-coil systems on the CERN premises;
4) participation in the execution of magnetic test campaigns on the CERN premises;
5) a financial contribution to the Project that shall not exceed 370,000 (three hundred seventy thousand) Euros. INFN's financial contribution shall be subject to receipt of a correct invoice from CERN and acceptance of the relevant deliverable. Payment details are set out in Annex 3.

4. Deliverables and milestones

The Project shall comprise two Work Packages:

4.1 WP1) Standard Functionality Rotating Coil System

Design, construction, and testing of an initial version of the rotating coil system, based mainly upon off-the-shelf and commercially available components with simplified control and post-processing software. Two systems shall be built and tested at CERN: one of which will be shipped by CERN to INFN-LNF's premises, Frascati, Italy, at the end of WP1 (in accordance with Article 4.3 below) and become INFN property, while the other will remain at CERN and become CERN property. The full documentation of this system, including sample constructive drawings and electrical layouts, part lists and source code, shall be published according to an Open Access model to encourage dissemination. A technical description of the systems is set out in Annex 1.

4.2 WP2) Extended Functionality Rotating Coil System

Two final rotating coil systems, optimized for measurement performance, shall be obtained by suitably modifying each one of the first version (see deliverable WP1). These systems shall be based on a novel modular PCB coil shaft design, adaptable to a wide range of magnet bore diameters and lengths, and shall be mechanically compatible with selected (legacy) coil shafts available at INFN-LNF and CERN respectively. The technical description of the design is given in Annex 2. The detailed specifications, design and material costs of the final system shall be re-evaluated jointly, based on the experience acquired with the first system. The design shall firstly be implemented and tested on the CERN unit. Upon finalization of the design, the INFN unit shall be shipped by INFN back to CERN, Meyrin, Switzerland temporarily in order to be upgraded and tested.

WP	Milestones	Date	Deliverable CERN → INFN	Payment INFN → CERN
1	Start of project	05/2020	Signature of the Addendum by both Parties	200 kEUR
	Standard System design	07/2020	D1.1 Progress report	100 kEUR
	Construction	11/2020	D1.2 Standard rotating coil system (see Annex 1)	70 kEUR
	Test and characterization	03/2021	D1.3 Progress report	
2	Extended system design	07/2021	D2.1 Progress report	
	Construction	07/2022	D2.2 Progress report	
	Test and characterization	04/2023	D2.3 Extended rotating coil system (see Annex 2)	

4.3 Any shipment expenses, and any related shipment insurance in respect of the systems set out in Articles 4.1 and 4.2 shall be at INFN's cost.

4.4 It is recalled that by virtue of the 2004 "Protocol on the privileges and immunities of the European Organization for Nuclear Research", which has force of law in Italy, CERN is exempt from the payment of taxes and duties, including VAT and customs duties.

4.5 It is also recalled that by virtue of the same legal instrument, CERN's assets (including the GPU server) shall not be subject to any form of requisition, confiscation, expropriation or sequestration.

4.6 It is understood that the Parties contributions to this Project shall be performed on a best-efforts basis without any guarantees as to results or otherwise. In addition, any system produced in the course of the Project shall be accepted on an as-is basis.

5. Acceptance procedure

The relevant Party shall grant acceptance of a deliverable after the successful completion of the deliverable and of the respective WP, and the provision of the associated documentation, within two (2) months from the date of completion.

6. Resources

The following table lists all resources (personnel, equipment, material, infrastructure, travel, subsistence and services) required for the completion of the Project. In this table, FTE is defined as the entirety of the personnel over the Project lifetime. In addition, INFN provides financial contribution to the Project in the total amount of EUR 370 000 (three hundred seventy thousand euros).

The total equivalent contribution for each Party amounts to 486 k EUR.

Resources Provided		From Date	To Date
Provided by INFN:			
Senior scientist: Technician:	0.5 FTE (37 kEUR) 1.5 FTE (65 kEUR)	01.05.2020	30.04.2023
Financial contribution:	(370 kEUR)		
Travel and accommodation to/from CERN/INFN by CERN's and INFN's personnel	(14 kEUR)		
Provided by CERN:			
Engineer: Technician: Doctoral student:	0.5 FTE (116 kEUR) 0.5 FTE (111 kEUR) 3.0 FTE (122 kEUR)	01.05.2020	30.04.2023
Material and infrastructure:	137 kEUR		

7. Technical Coordinators

7.1 CERN and INFN shall each nominate a Technical Coordinator whose role shall be to co-ordinate the activities related to the performance of the work packages within the Project. The Technical Coordinators will also act as Safety Correspondents and will be responsible for safety matters.

7.2 The CERN Technical Coordinator shall grant acceptance of the deliverables in accordance with Article 5 above.

The Technical Coordinators and Safety Correspondents shall be:
For CERN: marco.buzio@cern.ch
For INFN: lucia.sabbatini@lnf.infn.it

Or such successor that may be designated in writing by the Parties.

8. Intellectual Property

In addition to the intellectual property provisions in Article 5 of the Agreement, title to all intellectual property developed in the execution of the Project shall be vested in CERN, which shall grant INFN a free, non-exclusive license for the use of such intellectual property in the execution of the latter's scientific program, for peaceful purposes only.

9. Experts

9.1 Both Parties shall grant access to their laboratories to personnel of each respective Party, with modalities to be agreed, for the execution of this Addendum.

9.2 Where CERN acts as a host Party, the INFN Experts may be appointed as Cooperation Associates pursuant to the conditions set out in Article 3 of the Agreement and the CERN Staff Rules and Regulations.

9.3 During the execution of the Addendum, CERN shall intervene, in agreement with INFN, with expert personnel (the "CERN Experts") to support the commissioning and exploitation of the delivered devices at INFN-LNF. In accordance with the table set out in Article 6, INFN shall cover the cost of the CERN Experts' duty travel, which will include transport, daily travel allowance and accommodation. Such reimbursement shall be made on the basis of an invoice describing the costs in detail, to be submitted to INFN within one month of the CERN Experts' duty travel.

10. Miscellaneous

10.1 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.

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

Thus, drawn up in two copies in the English language and signed by the authorized representatives of the Parties.

The Istituto Nazionale di Fisica Nucleare (INFN)

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Professor Antonio Zoccoli
Presidente

Signed on 20/05/2020

The European Organization for Nuclear Research (CERN)

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Dr Fabiola Gianotti
Director-General

Signed on 9th April 2020

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH — CERN

Annex 1
Deliverable D1.2: Standard Functionality Rotating Coil System

The prototype RC system shall include the following hardware components, that will be dimensioned and adapted to a range of magnets that will be tested at INFN-LNF and CERN:

- PCB bucked 5-coil array for high-precision absolute and compensated harmonic field measurements of multipole magnets (dipoles, quadrupole and sextupoles);
- non-magnetic rotating shaft to house the PCB coils, including ceramic ball bearings and suitable geometrical references for coil radius calibration and magnetic axis measurements;
- stepper motor unit with controller interface;
- optical angular encoder to parameterize the field measurement as a function of roll angle;
- tilt sensor to reference the measurement to gravity;
- slip ring (rotating contact) assembly for the acquisition of coil and tilt sensor signals;
- patch panel to make the appropriate series connection of the coils for harmonic compensation, and to route the desired combinations to the acquisition system;
- non-magnetic support structure suitable for precise and stable suspension and alignment of the rotating coil shaft inside the magnet to be tested;
- Windows PC for the control and acquisition of the instrument;
- multichannel ADC system for the simultaneous acquisition of analog sensor outputs (coils, tilt) and digital angular encoder signals;
- cabling and connectors;
- full technical drawings (mechanical drawings and circuital schemes).

The prototype RC system shall also include the following software components, the source code of which shall be released as open source:

- an application to control the motor and acquire/store sensor signals;
- set of routines for the post-processing of acquired data to deliver the following magnetic quantities: main field strength and phase angle; higher harmonic (error) components; transversal offset of the magnetic axis.

The best suited software platforms and operating system will be chosen in the course of the R&D program, and may in themselves be proprietary e.g. Microsoft Windows ®, LabView® or Matlab®.

Any necessary software licenses remain the responsibility of each Party.

The prototype RC system shall include the following services:

- geometrical and electromechanical qualification of all components;
- calibration of the effective area, width and rotation radius of the individual PCB coils, including written procedure for periodical recalibration;
- integration and test of the assembled system;
- metrological characterization of the assembled system, including cross-calibration with the reference field sources and instruments available at CERN, and a statistical assessment of the uncertainty of all measured quantities;
- training of INFN personnel on the use, calibration and maintenance of the instrument;
- full written documentation of hardware and software components, assembly, as well as testing, calibration and operation procedures.

Annex 2
Deliverable D2.3: Extended Functionality Rotating Coil System

The finished, full-fledged RC system shall be based upon and consist of a modification of the standard functional unit with the following components:

- a modular rotating shaft, apt to be fitted with PCB coil arrays of variable width for optimal measurement of magnets of different bore sizes;
- mechanical and electrical interfaces compatible with both the new modular coil shaft and legacy coil shafts available at INFN-LNF and CERN;
- two high-performance coil voltage integrators with programmable pre-amplifiers for the absolute and compensation acquisition channel, including the necessary PC interface components;
- application software (LabView/Matlab and/or C++) for the control and acquisition of the instrument;
- full documentation of the changes, including the parametric design of variable-sized PCB coil arrays.

The same services described in Annex 1 (qualification, calibration and training) shall apply to the finished version of the instrument.

Annex 3
Financial details

Payment details:

The payments within thirty (30) calendar days shall be made upon receipt by INFN of a correct invoice from CERN and acceptance of a corresponding deliverable. The list of deliverables and the schedule of payments is detailed in the following table:

Deliverable ref.	Description	Amount (EUR)	Date
Start of the Project	Signature of the Addendum by both Parties	200 000	May 2020
D1.1	Progress Report	100 000	July 2020
D1.2	D1.2 Standard rotating coil system	70 000	November 2020

Invoices shall be sent to:

Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Frascati
Via Enrico Fermi, 54
00044 FRASCATI (RM)
amministrazione.lab.naz.frascati@pec.infn.it
The invoice shall quote the CUP code: **CUP I12F18000040008**