Memorandum of Understanding

on the Spanish Participation

in the Hyper-Kamiokande Experiment

between

The University of Tokyo,
The High Energy Accelerator Research Organization

and

The Ministry of Science and Innovation of the Kingdom of Spain

Preamble

The Hyper-Kamiokande experiment includes the construction of the Hyper-Kamiokande detector in Hida, Japan, and the upgrade of the existing high-intensity proton accelerator along with the near detector suite at Japan Proton Accelerator Complex (hereinafter referred to as "J-PARC") in Tokai, Japan, aiming at precise measurements of neutrino oscillations, the discovery of proton decay, and observation of supernova neutrinos.

In February 2020, the first-year construction budget was approved by the Japanese Diet, and therefore the Hyper-Kamiokande project officially started. The Hyper-Kamiokande Collaboration (hereinafter referred to as "Collaboration"), currently consisting of about 500 people from 95 institutes in 20 countries, has been formed to build, commission, operate, maintain, and analyze and publish the data. The host institutes are the University of Tokyo (hereinafter referred to as "U Tokyo") for the far detector part of the experiment, and the High Energy Accelerator Research Organization (hereinafter referred to as "KEK"), handling mainly the neutrino beam and related facilities. The beginning of data-taking is currently scheduled for 2027.

The Hyper-Kamiokande experiment is described in detail in the Hyper-Kamiokande Design Report[1] . It is understood by the Collaboration, that the responsibilities for the construction and operation of the Hyper-Kamiokande experiment will be shared by U Tokyo and KEK as host institutes (hereinafter referred to as "Hosts") and all the participating institutes of the Collaboration.

Spain has been participating in the Hyper-Kamiokande experiment since its inception, and has the will to participate significantly in the experiment in its operation and future developments.

The Ministry of Science and Innovation of the Kingdom of Spain (hereinafter referred to as "MCIN") is responsible for the implementation of the national policy in science, technology and innovation, and of the participation of the Spanish research institutions, groups and companies in the scientific and technological activities and developments conducted at international research and development institutions.

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[1] K. Abe et al., "Hyper-Kamiokande Design Report," arXiv:1805.04163 [physics.ins-det], https://arxiv.org/abs/1805.04163.

Aiming to promote the Spanish institutes' participation in the construction and physics exploitation of the Hyper-Kamiokande experiment, and the interest of its host Institutes in the participation of Spain in the endeavor, MCIN, U Tokyo and KEK have reached the following understanding based on the principle of mutual benefit:

1: Signatories of this Memorandum of Understanding

The Ministry of Science and Innovation of the Kingdom of Spain, the University of Tokyo and the High Energy Accelerator Research Organization are hereinafter referred to as the "Signatories".

2: Purpose of this Memorandum of Understanding

The purpose of this Memorandum of Understanding (hereinafter referred to as "MoU") is to set out the conditions under which the Signatories intend to collaborate in the construction and physics exploitation of the Hyper-Kamiokande experiment.

This MoU is not legally binding and does not enforce any legal obligation, but the Signatories recognize that the success of the collaboration depends on the participation of all the Signatories, as well as the Spanish institutes provided in Annex I (hereinafter referred to as "Spanish Institutes") in the construction and exploitation of the Hyper-Kamiokande experiment.

This MoU is not subject to International Laws.

3: Organization and Implementation

The Signatories will coordinate the cooperation under this MoU within the framework of the participation in the Hyper-Kamiokande Financial Forum or the Funding Oversight Panel of the Hyper- Kamiokande Experiment.

The Signatories will promote the funding of the participants in the Hyper-Kamiokande experiment under this MoU in accordance with their respective procedures and based on availability of their respective budget.

Any communication derived from this MoU shall be agreed upon by Signatories.

4: Collaboration activities and compromises of the Signatories

U Tokyo will construct and operate the Hyper-Kamiokande far detector in cooperation with other participating institutes of the Collaboration.

KEK will upgrade the J-PARC accelerator and neutrino beamline, improve the facilities and equipment of the near detectors, and operate them in cooperation with other participating institutes of the Collaboration.

U Tokyo and KEK will install and operate the computer system necessary for data recording, distribution, and data analysis in cooperation with other participating institutes of the Collaboration. The sharing of the operating expenses among the participating institutes of the Collaboration will be defined separately.

The Hosts have the will to provide appropriate infrastructure for the detector and services for the Collaboration within their resources. The Hosts will try to fulfill, as much as possible, the personal and professional needs of visitors from the Spanish Institutes, including access to the host facilities within the context of the regulations in force at the host sites.

MCIN is committed to participate significantly in the construction and exploitation of the Hyper-Kamiokande experiment, by encouraging and supporting in a proportionate manner, the involvement of the Spanish Institutes. The specific contributions by the Spanish Institutes will be defined in an independent document, separated from this MoU.

MCIN will make their best effort to promote the funding to ensure the participation and the successful collaboration of the Spanish Institutes within the Hyper-Kamiokande experiment, in the whole experiment life. A list of the potential collaboration from the Spanish Institutes in the construction of the experiment is listed in Annex II, subject to the corresponding budget availability.

MCIN will encourage the Spanish Institutes to join the operational phase of the Hyper-Kamiokande experiment and to participate in the scientific exploitation of the data acquired. Any personnel, students and property of the Spanish Institutes located at the Hosts for the purposes of this MoU shall comply with the relevant regulations in force at the host site.

5: Intellectual Property and Information

Management of any intellectual property and information shall be subject to the general rules established for the Collaboration. Notwithstanding foregoing, when intellectual properties are jointly born by the personnel and/or the students of the Spanish Institutes and the Hosts, or born by the personnel and/or the students of the Spanish Institutes

using the Hosts' facilities or equipment, the treatment of the rights for the properties shall be discussed between the said participants.

The use of research outcomes and their intellectual property rights from cooperation activities under this MoU shall be agreed upon on a case-by-case basis by the participants of such cooperation activities, in accordance with international practice and the principles of equal rights and responsibilities, and sharing of research outcomes.

The automatic treatment of personal data that may be needed during this MoU will follow the national legislations.

The Signatories agree on observing and adopting the security actions to ensure the integrity of data obtained in the projects, avoiding its alteration, lost, modification or non-authorized access, following the legislation on data protection. Moreover, the signatories agree upon the destruction or returning back all the personal and/or confidential data obtained during this action.

6. Modification of the MoU

This MoU, as well as its Annexes, may be modified as deemed necessary by written unanimous consent of Signatories.

7. Other Matters

Any dispute or difference arising from the interpretation, application and execution of the provisions of the MoU shall be settled through friendly consultation between the Signatories, and with the assistance of one or more independent experts if necessary.

8: Duration and end of application

This MoU will begin from the date of the final signature affixed below by the three Signatories.

This MoU will be effective until December 31, 2026. This MoU may be extended thereafter annually, at any time, by mutual written agreement of the Signatories.

Either Signatory may discontinue the application of this MoU by written notice to the other Signatories at least one year in advance of discontinuation.

This is the signature page of the Memorandum of Understanding on the Spanish Participation in the Hyper-Kamiokande Experiment between The University of Tokyo, The High Energy Accelerator Research Organization and The Ministry of Science and Innovation of the Kingdom of Spain.

For the University of Tokyo

Date: 08/17/2022

Place: Tokyo, Japan

T. Fujii

Prof. FUJII Teruo
President of the University of Tokyo

This is the signature page of the Memorandum of Understanding on the Spanish Participation in the Hyper-Kamiokande Experiment between The University of Tokyo, The High Energy Accelerator Research Organization and The Ministry of Science and Innovation of the Kingdom of Spain.

For High Energy Accelerator Research Organization (KEK)

Date: Aug. 18, 2022

Place: Tsukuba

M. Yamauchi

Prof. YAMAUCHI Masanori
Director General of KEK

This is the signature page of the Memorandum of Understanding on the Spanish Participation in the Hyper-Kamiokande Experiment between The University of Tokyo, The High Energy Accelerator Research Organization and The Ministry of Science and Innovation of the Kingdom of Spain.

For the Spanish Ministry of Science and Innovation

Date: Aug. 25, 2022

Place: Madrid (SPAIN)

Prof. Raquel Yotti Álvarez
Secretary General for Research

Annexes to the Memorandum of Understanding on the Spanish Participation in the Hyper-Kamiokande Experiment

Each Annex attached to this MoU is considered as an integral part of it. Additional annexes may be added to this MoU by mutual written decision of the Signatories.

Annex I: List of Spanish Institutes that are currently members of the Hyper-Kamiokande Collaboration, and their principal investigators.

Annex II: List of potential collaborations from the Spanish Institutes.

ANNEX I: List of Spanish Institutes that are currently members of the Hyper-Kamiokande Collaboration, and their principal investigators.

- Center of Astroparticles and High Energy Physics (CAPA), University of Zaragoza, represented by S. Cebrian.
- Donostia International Physics Center (DIPC), represented by J.J. Gomez-Cadenas.
- Institute of High Energy Physics (IFAE), represented by T. Lux.
- Laboratorio Subterraneo de Canfranc (LSC), represented by C. Peña-Garay.
- University Autonoma Madrid (UAM), represented by L. Labarga.
- University of Girona (UdG), represented by P. Maimi.
- University of Oviedo (UO), represented by F.J. de Cos Juez.
- Universitat Politecnica de Valencia (UPV), represented by F.J. Mora Mas.
- University of Santiago de Compostela (USC), represented by J.A. Hernando-Morata.

Annex II: List of potential collaborations from the Spanish Institutes

The potential collaborations, listed below, will be based on the accredited expertise of the Spanish Institutes involved, and according to the Hyper-Kamiokande Collaboration organization.

POTENTIAL COLLABORATIONS FROM SPAIN	PLANNING DATE	SPANISH INSTITUTIONS PARTICIPATING IN THE HK COLLABORATION
1. Study and Design of Inner Detector (ID) 20"-photomultiplier tube (PMT) covers	By Apr 2023	UdG, UAM, LSC, DIPC
2. Procurement and delivery of 20,400 ID 20"- PMT covers to Kamioka, Hida, Japan. It will imply the development, production, quality assurance, assembly, temporary storage and final transportation to Japan	By Dec 2025-Sep 2026	LSC, CAPA, DIPC, UAM, UdG
3. Assembly and installation of the PMT + cover units (shared activities with Japan); consisting of the production of PMT bands, construction and operation of assembling lines, and installation to the water tank	Dec 2025-Dec 2026	LSC, CAPA, DIPC, UAM, UdG
4. Design and construction of the full Hyper-Kamiokande cavern ventilation system, including procurement, transportation, installation, commissioning, and future maintenance of the system.	By Apr 2025 (blower/ chiller) By Dec 2026 (ducts)	LSC

5. Design and construction of the Hyper-Kamiokande geomagnetic compensation system, including procurement, transportation, installation, commissioning, and future maintenance of the system.	By Nov 2025	UO
6. Contribution to the design and construction of the Hyper-Kamiokande electronics components and their mechanical parts, including the development, procurement, fabrication, transportation, and assembly of the data processing modules (DPMs). Contribution to procurement and assembly of the combined power and fiber optic cable. Contribution to installation, commissioning, and future maintenance of assembled electronics pressure vessels in the water tank.	By Feb-Nov 2025 (DPMs), By Mar 2025 (cable), Dec 2025-Dec 2026 (installation)	UPV
7. Contribution to the production of the Nickel-Californium and Americium-Beryllium-BGO calibration sources, including their design, installation, commissioning, and future maintenance.	By Dec 2026	USC

8. Contribution to Machine Learning software for analysis of HK, developing ML algorithms for the event reconstruction (particle identification, energy reconstruction, timing information). Reconstruction and Data Analysis with AI techniques.	By Dec 2026	DIPC, UO, IFAE, UAM, USC
9. Contribution to the transfer of the ND280 near detector from T2K to HK following the ND280 upgrade and the continuation of the TPCs and magnets. Contribution to the design studies, hardware contributions and integration of new subdetectors in the existing ND280 for HK.	By Dec 2026	IFAE
10. Contribution to the Water Cherenkov Test Experiment (WCTE) and the Intermediate Water Cherenkov Detector (IWCD), including design studies, hardware contributions and integration.	By Dec 2026	DIPC, LSC, USC, UdG

The planning dates for the potential collaborations listed above should accommodate the construction schedule of the Hyper-Kamiokande experiment which is already fixed.