

# **Memorandum of Understanding**

for Chiral Belle: Leveraging New Physics through a Polarization Upgrade of the SuperKEKB  
Particle Collider

between

**Université Paris-Saclay (IJCLab)**

and

**University of Victoria (UVic)**

(Individually a “Party” and collectively the “Parties”)

## **Preamble**

The proposed technology development, Chiral Belle, is an international initiative that will open new research frontiers in the quest to understand nature at its most basic level. It does so by developing innovative technologies to upgrade Japan's SuperKEKB electron-positron collider with polarized beams and higher collision rates, thereby opening a unique world-leading program of precision physics. Production rates of different fundamental particle species in electron-positron annihilations will be measured with electron beams polarized with spins aligned in the beam direction (right-handed) and with spins aligned opposite the beam direction (left-handed). Differences in rates yield precision left-right asymmetries at 10GeV energy. This will be the only experiment globally to improve by large factors the precision of a set of fundamental parameters of Nature with a particular, and unique, focus on heavy flavoured fermions. These new measurements will uniquely probe the energy dependence of fundamental parameters of the Standard Model of particle physics and thereby be sensitive to New Physics, such as Dark Sectors. Chiral Belle requires: 1) upgrading the SuperKEKB infrastructure to significantly increase the rate of electron-positron collisions, referred to as increased luminosity; 2) a polarized electron source; 3) Compact spin rotator magnets to align the polarized electron spin directions at the collision point; and 4) a Compton polarimeter detector system to continuously monitor the magnitude of polarization with high precision. The upgrades will proceed in stages, with Stage 1 consisting of the required Research and Development (R&D) to realize Chiral Belle.

During Chiral Belle Stage 1, the KEK laboratory will start working on upgrading the SuperKEKB facility to have polarized electron beams and increased luminosity. Hiroshima University, in collaboration with KEK, will contribute to the design, development, and implementation of the polarized electron source and its associated beamline components. The Canadian team, consisting of members from University of Victoria, McGill University, St. Francis Xavier University, The University of British Columbia, and University of Manitoba, will lead the polarization upgrade component associated with R&D for the Compact spin rotator magnets and Compton polarimeter. The Compton polarimeter will also be the focus of the researchers at France's Laboratoire de Physique des 2 Infinis Irène Joliot Curie (IJCLab), located at the Université Paris-Saclay.

Together, these upgrades will enable the Belle II detector, which collects data produced in collisions in the SuperKEKB collider, to perform precision-frontier measurements of the weak interaction strength for all three generations of particles, and will push the frontiers of particle accelerator technologies and allow an array of exciting measurements uniquely sensitive to new physics, including probing the nature of dark matter. This Memorandum of Understanding ("MoU") addresses Stage 1 of the project ("Chiral Belle Stage 1"), which includes prototyping of spin rotator magnets, Compton detector and source development and the start on increasing SuperKEKB collision rates, and sets out the contributions to Chiral Belle Stage 1 by the Parties.

**NOW THEREFORE** the Parties agree as follows:

### **Article 1: Purpose of this MoU**

The purpose of this MoU is to set out the conditions under which the Parties intend to collaborate in the research. This MoU is not legally binding and the Parties recognize that the success of Chiral Belle Stage 1 depends on the Parties adhering to its provisions.

### **Article 2: Duration and Extension**

This MoU shall become effective at the date of last signature and it shall remain valid until a date not earlier than December 31, 2030. This MoU may be extended at any time by mutual agreement of the Parties. Each Party shall have the right to terminate its participation in Chiral Belle Stage 1 with or without cause by giving one-hundred, eighty (180) days prior written notice thereof to the other party ("Termination Notice"). Nothing in this MoU shall rescind the obligations that may have accrued or the rights and privileges of that Party up to the date specified in the Termination Notice.

### **Article 3: Obligations of the Parties**

In Chiral Belle Stage 1, the IJCLab will contribute to the design and development of the Compton polarimeter, which will be a key element to measure in real-time the beam polarization in the SuperKEKB ring required for the Chiral Belle project. They have requested funding from the Agence Nationale de la Recherche, which will cover hardware, contractual personnel and permanent staff salaries involved in the project, for the necessary prototyping of the Compton polarimeter. Further funding will be required for the procurement, assembly, and installation of the Compton polarimeter in SuperKEKB, which will take place in Stage 2. IJCLab's in-kind contributions to the project are valued at \$1,713,500 CAD, and the costs associated with this in-kind contribution are to be incurred between 1 November 2023 and 1 November 2030. IJCLab's contribution focuses on the photon detector and laser systems whereas the University of Manitoba contribution focuses on the electron detector system of the Compton polarimeter.

UVic will, as lead institution, lead the polarization upgrade component with the Canadian partners, including the design and engineering of the spin rotators, polarization source and Compton polarimeter development. As detailed magnet engineering solution proposals are developed, UVic will provide accelerator-modelling feedback, and will be involved in characterizing the spin rotator magnet prototype and Compton polarimeter detectors.

### **Article 4: Reporting**

IJCLab agrees to provide to UVic semi-annual reports detailing the progress of the luminosity upgrades, and a summary of IJCLab's financial contributions to the upgrades.

### **Article 5: Intellectual Property and Information**

Management of any intellectual property and information shall be subject to the general rules established for the Belle II Collaboration. Notwithstanding foregoing, when intellectual properties are jointly born by the personnel and/or the students of the Parties, or born by the personnel and/or the students of UVic using IJCLab's facilities or equipment, the treatment of the rights for the properties shall be discussed between the said participants. The Parties agree that the results of this work will be made publicly available.

### **Article 6: Amendments**

This MoU may be modified or amended as deemed necessary by written unanimous agreement of the Parties.

### **Article 7: Disputes**

The Parties agree that any dispute or difference arising out of the execution or interpretation of this MoU will be settled amicably if possible and with the assistance of one or more independent experts if necessary.

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**Université Paris-Saclay (IJCLab)**

**University of Victoria**

Date:

Date:

Place:

Place: Victoria, BC

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