# Letter of Intent

Acronym: CHARMED

Project Title: Charm Hadron Apparatus for Research on Magnetic and Electric Dipole Moments

Project Leader(s): Massimiliano Ferro-Luzzi (CERN), Nicola Neri (INFN Milano), Fernando Martínez Vidal (IFIC Valencia)

## 1. Research Objectives

The CHARMED project proposes a flagship hadron physics program at the LHC, focused on delivering the first measurement of the magnetic (MDM) and electric (EDM) dipole moments of charm baryons, primarily Λc+ and Ξc+ baryons. These observables are powerful probes of physics beyond the Standard Model, offering sensitivity to new sources of CP violation and testing predictions from non-perturbative QCD calculations in the heavy-quark sector.

The experiment uses a dual bent-crystal system: the first crystal deflects protons from the beam halo onto a fixed target, producing high-energy charm baryons; the second crystal channels a fraction of these baryons, inducing spin precession through intense electromagnetic fields. The spin orientation is determined from the angular distributions of the decay products in polarisation-sensitive channels, reconstructed with a dedicated spectrometer featuring a high-granularity silicon tracker and a Ring Imaging Cherenkov (RICH) detector.
A proof-of-principle experiment (TWOCRYST) is currently taking data in 2025. The full CHARMED setup is designed for implementation in LHC Run 4, with expected MDM precision at the 10% level and EDM sensitivity at the $10^{-16}$ e·cm scale in about two years of data taking. In addition to MDM and EDM measurements, CHARMED will enable studies of charm baryon production mechanisms, spin dynamics in QCD in the very forward region and with large values of Feynman-$x$.

## 2. Connection to Transnational Access Infrastructures (TAs) and/or Virtual Access Projects (VAs)

CHARMED provides access to an emerging facility for unique hadron physics measurements using concurrent fixed-target collisions. It will operate at CERN's Insertion Region 3 (IR3), integrating with existing beam collimation infrastructure. This location enables access to high-intensity beam halo particles without interfering with LHC operations.

Connections to research infrastructures include:
- Transnational Access (TA): on-site access to IR3 at CERN, including hardware

infrastructure (bent crystals, target system, detectors), software environments, beam instrumentation, and collimation systems. Support includes scientific and technical assistance, users' training
- Virtual Access (VA): A comprehensive cloud-based suite will be developed, including Monte Carlo simulation and reconstruction tools, charm baryon multi-hadronic decay modelling and advanced analysis frameworks. These services will enable remote data processing, validation, and collaborative interpretation.

The project is fully aligned with goals of INFRASERV and builds on previous Horizon-supported initiatives in hadron physics and detector R&D, e.g. ERC Consolidator Grant SELDOM G.A. 771642 and H2020 - ATTRACT Instant project.

## 3. Estimated Budget Request

Total estimated budget request: €400,000

Breakdown:
- Detector components and beamline integration: €80,000
- Travelling and organization of workshops: €20,000
- CERN doctoral student fellowship: €150,000
- CERN postDoc fellowship: €150,000

Additional technical support, infrastructure, and in-kind contributions are expected from CERN and partner institutions.

## 4. Participating and Partner Institutions

Lead Institutions:

- CERN (Switzerland)
- INFN Sezione di Milano & Università degli Studi di Milano (Italy)
- IFIC – Universitat de València-CSIC (Spain)

Prospective Partners:
- IJCLab (France), University of Bonn (Germany), INFN Sections (Firenze, Genova, Padova, Pisa)

The CHARMED project brings together a diverse European consortium with expertise in high-precision measurements, detector technology, theoretical interpretation, and beam operations with bent crystals, offering training and collaborative access opportunities to the wider hadron physics community. A structured program of training and users' support is integral to CHARMED: - Ad hoc technical training for users during installation, operation, and analysis phases; - Open courses and workshops on simulation, detector interfacing, and

polarisation measurements; - Data stewardship training, aligned with FAIR principles and EOSC workflows.