

LHP: Lattice Hadron Physics (VA)

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1 Research objectives

The input of the research groups involved and the European Lattice QCD/Hadron Physics (LHP) community as a whole is needed to enable the full exploitation of the potential of the major Hadron Physics infrastructures in Europe and beyond.

Calculations in support of the experimental infrastructures offering transnational access will be carried out in the fields of

- nucleon and nuclear structure,
- hadronic matrix elements for electroweak physics,
- advanced hadron spectroscopy,
- QCD under extreme conditions.

These have direct applications for the physics programmes at CERN (in particular ALICE, AMBER, LHCb, NA62 and TOTEM), MAMI and MESA, ELSA, PSI, INFN-LNF (KLOE-2 and KAONNIS), JLab (CLAS12, glueX etc.) and planned experiments at FAIR (CBM and spectroscopy experiments) and BNL (ePIC/EIC).

A major aim of this proposal is to strengthen the interaction between the Lattice QCD, phenomenology and the experimental communities, with clear benefits to the TA infrastructures. A dedicated LHP effort to support the research at European Hadron Physics infrastructures also requires some degree of organization within the LHP community itself.

The planned activities involve

- Identification of novel observables amenable to Lattice QCD methods through discussion with other scientists working with/at the TA infrastructures and with other theorists.
- Coordination of the existing national sub-grids Latfor Data Grid (LDG, continental Europe) and UK Lattice Field Theory (UKLFT) of the International Lattice Data Grid (ILDG) for the storage and curation of gauge ensembles according to the FAIR principles. The LHP community generates huge sets of Monte Carlo data (tens of PBytes in Europe), using high performance computers (HPC) and data handling is a major issue.
- Linking European lattice hadron physics research groups to broader expertise in hadron phenomenology, contributing to the organization of cross-activity workshops, including EINN at Cyprus, and impromptu workshops (also with other VA and TA) to react timely to new developments.

- Contribute to training activities, in particular LaVA (Lattice Virtual Academy) as part of Virtual Platform at ECT* and Related facilities (VIPER) and Lattice Practices training events.
- Three focussed topical workshops, encouraging information exchange on new methods, new software and new results.
- Staff and student exchanges within the activity and with TA sites (in particular CERN and Mainz).
- Organization of yearly town meetings of EuroLFT, which is a new organizational structure to give the lattice field theory community a voice in view of EuroHPC, AI Gigafactories, to liaise with supercomputer centres, storage element providers etc.
- Benchmarking of common LQCD kernels on different HPC architectures and analysis of emerging architectures.
- Discussion and evaluation of future research directions, writing a white paper.

2 Connection to Transnational Access infrastructures (TAs) and / or Virtual Access projects (VAs)

Lattice calculations give indispensable information about non-perturbative aspects of QCD and are needed for a large number of experiments at the TAs (see above). There are LHP groups in Mainz and at CERN with whom exchanges will take place. Close links exist to ECT* who host VIPER/LaVA. We anticipate some of the activities (training events, workshops and town meetings) to be carried out at TA infrastructures. A number of links exist to other VAs, however, without a list of approved VAs, these are hard to elaborate on.

3 Budget Request

We anticipate that some meetings will take place at TAs, in particular at CERN, ECT* and Mainz, which allows us to save some money. Nevertheless, organizing the proposed workshops, training events and town meetings, supporting cross-community workshops, research visits and secondments, direct (total) costs of €160000 (200000) will be needed. While the proposed activity has close connections to a large number of TAs, being a supporting theory activity, a large proportion of the travel will take place between and to/from the LHP VA partners.

The own contribution will be in terms of person-hours contributing to the effort.

4 Participating institutions

Universität Bern, University of Cambridge, University of Cyprus, Trinity College Dublin, University of Edinburgh, INFN Firenze, Forschungszentrum Jülich, CSIC/Universidad Autónoma de Madrid, Johannes Gutenberg Universität Mainz, Syddansk Universitet Odense, Universität Regensburg.