HadronPhysics: Study of Strongly Interacting Matter

HadronPhysics deals with subatomic particles subject to strong nuclear force and modelled using the theory of quantum electrodynamics. It is a field that depends equally on theoretical research, carried out on some of the world's most powerful supercomputers, and experiments using particle accelerators. The EU-funded HadronPhysics project has improved transnational access to nine of Europe's research facilities, and is coordinating research into accelerator targets that will allow experimentalists to tackle new problems.

A STRONG FORCE IN PHYSICS RESEARCH

HadronPhysics deals with the study of strongly interacting subatomic particles (hadrons) such as protons and pions. Hadrons are described by quantum chromodynamics (QCD), the theory physicists use for the strong nuclear force – one of the four fundamental forces controlling the universe. Hadrons, which are composed of sub-particles known as quarks and gluons, can join together to form more complex systems such as atoms. Under extreme conditions of pressure and temperature, hadrons may also lose their identity and dissolve into a new state of matter similar to the primordial components of the early universe.

The HadronPhysics project is a huge initiative to unify and stimulate this field of research in Europe. Backed by more than 2 000 physicists from around 150 different institutions, it promotes access to nine Research Infrastructures (RIs), and covers seven Networking Activities and 12 Joint Research Activities (JRAs). Its overall effect will be to unite three previously separate communities of researchers: those who study hadrons by means of leptons, by means of hadrons or by means of high-energy beams of heavy ions.

The Transnational Access part of HadronPhysics covers seven European hadron physics laboratories and two supercomputer centres. A first call for proposals in mid-2004 resulted in 37 projects being selected to receive EU funding. Most research projects in this area involve more than one research facility, and all the facilities support multiple projects, so the level of collaboration is high.

The Networking Activities of HadronPhysics are aiding collaboration in both experimental and theoretical research. This is a field where close interaction between experimentalists and theoreticians is essential; three of the Networking Activities are in theoretical physics, and the other four relate to experimental work.

One of the three theory networks, HadronTh, is coordinating research in "non-perturbative" QCD models. Another, SIM, is mostly about relativistic heavy-ion experiments. The third, ComHP, concentrates on QCD lattice calculations using enormously powerful computers. All of these have produced an impressive volume of publications and international conference presentations.

DEVELOPING A BETTER DETECTOR

The remaining four networks deal mainly with experimental issues. CBMnet and DIMUONnet address the experimental aspects of the new hadronic physics which will be explored in heavy-ion collisions at CERN and GSI. EtaMesonNet is coordinating dedicated experiments on meson production and decay, and TRANSVERSITY combines data from COMPASS (CERN) and HERMES (DESY) to learn about spin proton structure.

The 12 Joint Research Activities of HadronPhysics fall into three categories. Eight JRAs are concerned with detector development, with close connections to a single JRA in data processing. Two JRAs are devoted to target technology, and the remaining one deals with improving tagged photon facilities at electron accelerators.

The detector development JRAs will provide the detector performance needed to support future experiments. The demands on the next generation of particle detectors are enormous: they must handle very high counting rates and particle densities, with higher resolution than today's technology, yet for some applications they must also respond top articles with extremely low energies.

EUROPEAN COMMISSION

The JRAs devoted to target development allow experimental facilities to make more observations in a given time and study new types of rare particle interactions. Laboratories all over the world are already making use of these developments.

STUDY OF STRONGLY INTERACTING MATTER IN SUMMARY

Project acronym: HadronPhysics
Funding scheme (FP6): Integrated Infrastructures Initiative (I3)
EU financial contribution: €17.4 million
EU project officer: Christian Kurrer
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Completion date: 31 December 2008
Project webpage: www.infn.it/eu/i3hp/wel.html
Coordinator: Carlo Guaraldo, Istituto Nazionale di Fisica Nucleare, Carlo.Guaraldo@lnf.infn.it
Partners: Istituto Nazionale di Fisica Nucleare (INFN), Frascati (IT), INFN, Bari (IT), INFN, Cagliari (IT), INFN, Catania (IT), INFN, Ferrara (IT), INFN, Genova (IT), INFN, LNF, Frascati (IT), INFN, Milano (IT), INFN, Pavia (IT), INFN, Rome 2 (IT), INFN, Torino (IT), INFN, Trieste (IT), Austrian Academy of Sciences (AT), Limburgs Universitair Centrum (BE), University of Cyprus (CY), Charles University in Prague (CZ), University of Helsinki (FI), Commissariat à l'Energie Atomique (DAPNIA, CEA/Saclay) (FR), Centre National de Recherche Scientifique (CNRS/SPM Palaiseau, CNRS/IN2P3 Orsay, CNRS/IN2P3 Lyon, CNRS/IN2P3 Clermont-Ferrand, CNRS/IN2P3 Grenoble, CNRS/IN2P3 Nantes) (FR), Deutsches Elektronen Synchrotron (DESY) (DE), DESY-HERMES (DE), DESYZeuthen (DE), Forschungszentrum Jülich GmbH (DE), Cooler Synchrotron (COSY0 (DE), NIC Supercomputing Facility (DE), FZJ, Universität Bielefeld (DE), Ruhr-University Bochum (DE), Rheinische Friedrich-Wilhelms-Universität (DE), Gesellschaft für Schwerionenforschung mbH (DE), Forschungszentrum Rossendorf (DE), Friedrich-Alexander-Universität Erlangen-Nürnberg (DE), Johann Wolfgang Goethe-Universität Frankfurt am Main (DE), Justus - Liebig – Universität (DE), Ruprecht-Karls-Universität Heidelberg (DE), Universität Mannheim (DE), Technische Universität München (DE), Westfälische Wilhelms-Universität Münster (DE), Universität Regensburg (DE), Eberhard Karls Universität Tübingen (DE), University of Mainz (DE). Max-Planck-Gesellschaft zur Förderung der Wissenschaften e.V. (DE), Max-Planck-Institut fur extraterrestrische Physik (DE), Konrad-Zuse-Zentrum für Informationstechnik Berlin, MTA KFKI Reszecske es Magfizikai Kutatointezet (HU), Politecnico di Milano (IT), Politecnico di Torino (IT), Rijksuniversiteit Groningen (NL), Vrije Universiteit Amsterdam (NL), Universitetet i Bergen (NO), Jagiellonian University (PL), University of Silesia, Institute of Physics (PL), The Andrzej Soltan Institute for Nuclear Studies (PL), Warsaw University (PL), Laboratório de Instrumentação e Física Experimental de Partículas (LIP) (PT), LIP, Coimbra (PT), LIP, Lisbon (PT), National Institute for Physics and Nuclear Engineering – "Horia Hulubei" (RO), Universitat de Barcelona (ES), Universidade de Santiago de Compostela (ES), Universitat de València, Estudi General (ES), Lund University (SE), Stockholms Universitet (SE), Uppsala Universitet (SE), The Svedberg Laboratory (SE), The University of Edinburgh (UK), University of Glasgow (UK), The University of Liverpool (UK)