RQ 08 Department of Physics, Lund University

Division of Experimental High Energy Physics

2.1 General description (1-1,5 pages per division)

Organization and Administration of unit (incl significant changes the last 5 years):
The Division of Experimental High Energy Physics is lead by the Division Head (selected by the personnel of the Division for 3 years at a time, and appointed by the Institute Board), and the Deputy Head (appointed by the Division Head for 3 years at a time). The administration and economy are handled by an economist at the Division. Laboratory and computing infrastructure are taken care of by 3 engineers who also provide services to other Divisions and the Physics Department.

The Division has (Jan 2008) 5 professors (4/1 men/women), 3 lecturers (2/1), 1 researcher (1/0), 1 forskarassistent (1/0), 9 PhD students (5/4), 3 engineers (3/0), 1 programmer (1/0), 1 economist (0/1). There are 3 emeritus professors and 1 emeritus lecturer active in the Division.

The Division was formed by a merger of the Division of Elementary Particle Physics and the Heavy Ion Physics part of the Division of Cosmic and Subatomic Physics in 2003.

Special resources:
- CERN with its infrastructure (funded by Sweden's membership fee to CERN). http://public.web.cern.ch/Public/Welcome.html
- ATLAS and ALICE experiments at CERN (funded by VR[1] and KAW[2], investments ca 50 MSEK through Lund groups). http://atlas.ch/, http://aliceinfo.cern.ch/
- PHENIX experiment at Brookhaven National Laboratory (funded by VR and KAW, investments ca 9 MSEK through the Lund group). http://www.phenix.bnl.gov/
- H1 experiment at DESY (Lund activity funded by VR). http://www-h1.desy.de/
- Nordic Data Grid Facility NDGF (funded by Research Councils of SE, NO, DK, FI). http://www.ndgf.org/
- Swegrid (funded by VR and KAW), including a node at LUNARC (Lund University Center for Scientific and Technical Computing). www.swegrid.se, http://www.lunarc.lu.se/.

Local resources: 2 electronics laboratories, including an automatic chip testing facility, 1 gas detector laboratory, 1 local computer farm (being phased out).

General description of total research profile:
High Energy Physics investigates the basic constituents of matter, and the interactions between them. The present main research activities at the Division are to take part in the ALICE and ATLAS experiments at CERN's Large Hadron Collider (LHC), which will be ready for data taking in 2008. We also take part in the PHENIX experiment at Brookhaven, and H1 at DESY in Hamburg which are in data production or analysis stage. Research subjects are: collisions between heavy nuclei (ALICE and PHENIX), proton collisions at high energy (ATLAS), and structure of the proton using ep collisions (H1). The Division participates also in the EU-funded development of detectors for future linear e^+e^- colliders.

Modern High Energy Physics projects can not succeed without very substantial computational and data storage facilities. Our Division takes very active part in development of Grid

[1] VR = The Swedish Research Council ('Vetenskapsrådet')
[2] KAW = The Knut and Alice Wallenberg Foundation

technologies. Researchers from our Division co-initiated with colleagues from other groups in Nordic Universities the NorduGrid project.

Special multi- and interdisciplinary activities:
Grid development is application-driven research in information technology – *i.e.* in order to be able to process and analyze data from our experiments we need to develop Grid technology for distributed computing and storage. We are leading the development of ARC, Advanced Resource Connector, which is an original Nordic solution for Grid middleware, and which is recognized world-wide as one of the leading middleware technologies.

Development of detectors for High Energy Physics applications needs advanced research in electronics, data readout, material science, and material and gas chemistry. Many clinical applications (*e.g.* PET, radiation therapy) originate from advances in detector development for High Energy Physics experiments. Interdisciplinary activities with medicine could be started if resources allow.

Interactions within the department:
We cooperate with all the Divisions within Physics Department/Natural Sciences in undergraduate education (joint Master's level courses).

Our engineers are a resource for the Lund Laser Centre, UDIF, the Division of Mathematical Physics, and the Department of Physics (central operations).

We participate in the operation of the Department through the Institute Board and through various committees.

Relations between research and teaching:
Our research field advances rapidly, so it is mandatory to include fresh research material in courses on High Energy Physics and experimental methods – 20, or even 10 years old knowledge of particles, cosmology, detector technology or computing is hopelessly outdated.

Educational material is produced through hand-outs and compendiums, and we also aim at having the material web-based as much as possible.

Relations to and interactions with other departments:
Research and education at the Division of Theoretical High Energy Physics at the Department of Theoretical Physics is complementary to ours, and a close cooperation with them has shown to be very fruitful. Cooperation comprises joint research, post-graduate education (a joint graduate school funded by EU), and joint seminars.

The Division has taken initiatives for joint research and educational activities involving Experimental and Theoretical High Energy Physics, Astrophysics and Systemic Radiation Therapy.

The Division is interacting closely with LUNARC on Grid development and deployment.

Standing of the Division and of the department in a national/international context:
Our research is at the leading edge in Subatomic Physics. We participate in several international collaborations and perform our experiments at world-leading facilities. Our collaborators are highly-ranked universities, as can be seen from Fig. 1, and research institutes.

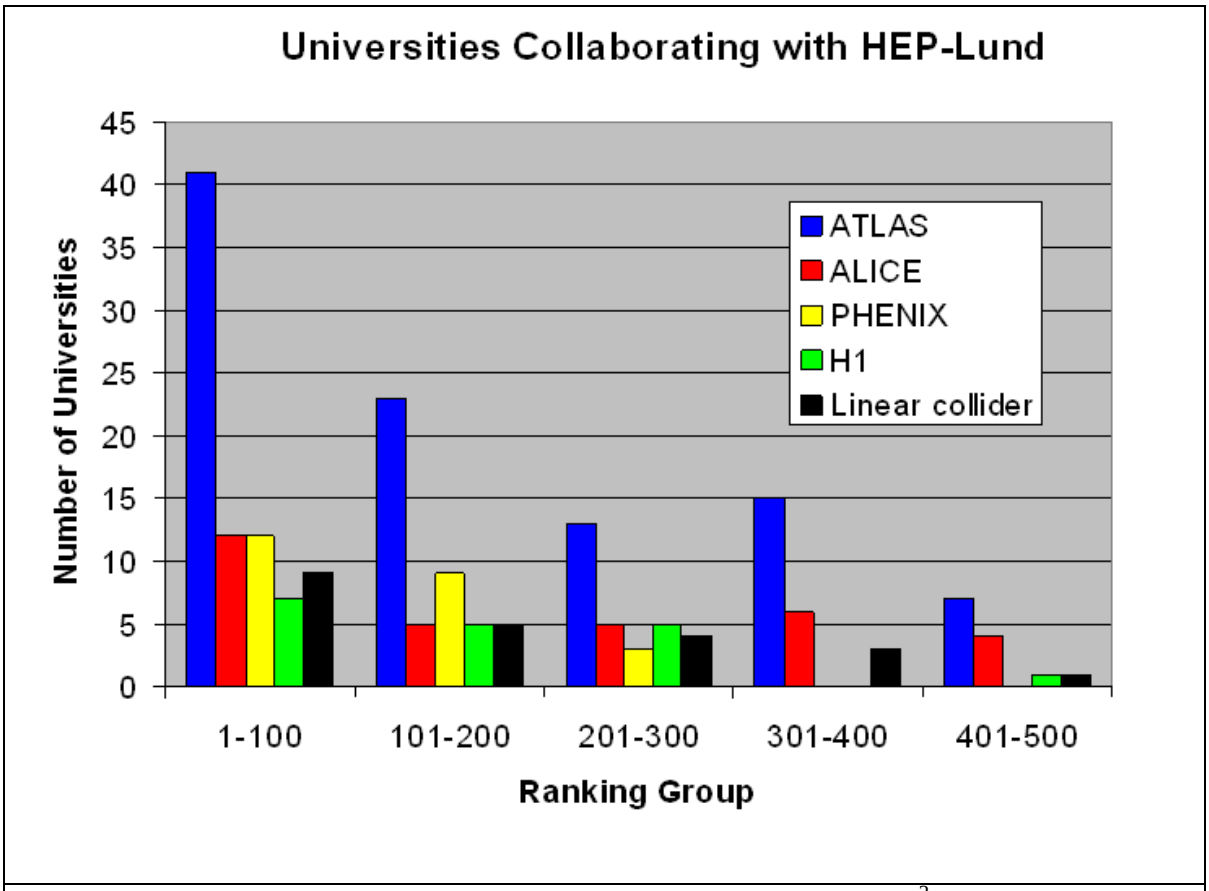

Figure 1. Universities collaborating with Lund-HEF sorted by ranking[3] and by experiment.

Lund is recognized world-wide for its research in High Energy Physics, which is proven by that several Lund researchers have or have had leading positions, *e.g.*: Deputy Spokespersons of ALICE (H.-Å. Gustafsson) and ATLAS (T. Åkesson), B-physics Coordinator in ATLAS (P. Eerola), Detector Project Leaders inside ATLAS (T. Åkesson, V. Hedberg), Chairman of ECFA (T. Åkesson), President of the CERN Council (T. Åkesson), Nordic research coordination (P. Eerola), Grid coordination (B. Kónya, O. Smirnova). Our graduate school (8 openings) together with the Theoretical Physics Department received over 60 applications world-wide, with a significant amount of highly-qualified applicants. We have also obtained outstanding evaluations and strong funding support from VR and the European Union.

At the national level, there are experimental High Energy Physics groups in Lund, Uppsala, Stockholm University and KTH. Lund covers the widest spectrum of High Energy Physics research: electron-proton collision physics, proton-proton collision physics, heavy ion physics, and Grid. Furthermore, we have close connections to the Theory Division involved in phenomenological High Energy Physics research.

Most of our senior researchers have started their careers in Lund through VR-funded researcher positions, which in our field typically receive a large number of international applicants. Many of our PhD students examined relatively recently have made successful careers in research (*e.g.* professor in Bergen, reader at Imperial College London, lecturer in Lund, staff researcher at Oak Ridge, staff researcher at U. of Texas, research associate in Oxford, research associate at NBI, CERN research staff, several CERN research fellows, DESY research fellow). Among the Universities involved in PHENIX Lund has produced the largest number of PhDs together with Stony Brook.

[3] 'Academic Ranking of World Universities 2006', http://ed.sjtu.edu.cn/ranking2006.htm

2.3 Description of the most successful research areas with strong national or international impact: (1-2 pages per division)

General
The research environment of the Division of High Energy Physics is fully part of the international collaborations for construction and research exploitation of the following facilities at different international accelerator laboratories:

- H1 experiment at HERA ep-collider at DESY. Status: data taking finished 2007, data analysis ongoing.
- PHENIX experiment at RHIC heavy-ion collider in Brookhaven. Status: data taking.
- ALICE experiment at LHC/heavy ions at CERN. Status: start data taking 2008-2009.
- ATLAS experiment at LHC/pp collider at CERN. Status: start data taking 2008.

In addition to these experimental collaborations in which Lund is partner, there are a number of other international collaborations:

- LHC and Beyond: This Joint Nordic Infrastructure project, coordinated from Lund, joins all the Nordic experimental High Energy Physics and Particle Phenomenology groups involved in LHC, to optimize the Nordic use of LHC and plan the experimental efforts beyond it. Funded by NordForsk. http://www.hep.lu.se/staff/eerola/LHCBeyond.htm
- The NorduGrid consortium: Grid computing development and deployment in the Nordic countries. http://www.nordugrid.org/
- NGiN: Innovative Tools and Services for NorduGrid. Funded by Nordunet3. http://www.nordugrid.org/ngin/
- KnowARC: Knowledge and know-how sharing through ARC grid middleware. Project technical coordination by Lund. Funded by EU. http://www.knowarc.eu/
- EUDET: Detector R&D in Europe for the next large particle accelerator project, the linear e^+e^- collider. http://www.eudet.org/

2.3.1. Research area 1: Particle Physics at the High-Energy Frontier.

Background:
High Energy Physics is the study of the fundamental constituents of matter and the forces that act upon them. This information is one of the basic pillars for our understanding of nature, the origin of the universe and the principles of physics.

Our Division has contributed in the near past in DELPHI and H1 experiments, which have confirmed the Standard Model to a high precision, and probed the interior of the nucleon. The current understanding of the innermost structure of the Universe will be boosted by a wealth of new experimental information, which we expect to obtain in the near future with colliding beams at the highest energies at the LHC. With the LHC, Particle Physics is about to enter a new territory, the TeV scale, where ground-breaking discoveries are expected. The exploration of this new territory will allow us to examine the very fabric of matter, space and time. The experimental information obtained from exploring the TeV scale will be indispensable, in particular, for deciphering the mechanism that gives rise to the breaking of the electroweak symmetry, and thus establishing the origin of the masses of particles. We also expect a deeper insight on whether space and time are embedded into a wider framework of supersymmetry, and whether the dark matter, which dominates the matter density of the Universe, consists of supersymmetric particles.

At the same time, it is also important to be involved in future collider projects to *e.g.* retain and renew detector development and technical competence, and to contribute to forming the next generation of experiments.

Project description:
ATLAS at LHC. ATLAS is a project which at the end of construction and is expected to start-up during 2008. It is generally accepted that when active, it will be the next major step forward for this research field giving new insight into the mechanism generating mass, and to physics beyond the Standard Model.

H1 at HERA. HERA is the only facility ever built to collide electrons against protons. The H1 experiment was one of the three experiments at HERA. HERA was closed down last year (2007), but the analysis of the data will continue during the coming years. The research at HERA is fundamental for the understanding of the interior of the nucleons.

Achievements:
The construction of the ATLAS detector is essentially finished. Lund researchers were part of initiating the ATLAS collaboration and setting up the organization of the collaboration, and participated in the central management. The Lund group initiated one of the ATLAS sub-detectors (the Transition Radiation Tracker, TRT) and led its development. Lund researchers are currently responsible for ATLAS shielding and luminosity monitoring, and take part in the ATLAS installation. Lund researchers also launched ATLAS preparations for B-physics.

Results from the HERA experiments have substantially increased the knowledge about the structure of matter and the properties of the strong force, which could not have been achieved at any other facility. The present picture as given by the HERA experiments will be valid for the coming decades. In H1, the Lund group was mainly involved in research concerning jets in deep inelastic scattering. Jet production has been used to test the theory of strong interactions through *e.g.* measurements of the strong coupling constant, direct measurement of the gluon density of the proton, and studies of the origin of diffractive processes.

National or international standing (substantiate your claims for the position)
That ATLAS at the LHC, together with its competitor CMS, will provide the world-leading high-energy research frontier is an undisputed fact that does not need any further explanation. Lund University standing in ATLAS is shown by the personal leadership positions held by Lund researchers: Detector Project Leaders (T. Åkesson, V. Hedberg), B-physics Coordinator (P. Eerola), Deputy Spokesperson (T. Åkesson). Lund University has a leading role in Nordic cooperation and collaboration on LHC physics: Coordination of Nordic Research and Training Network (P. Eerola), Coordination of Joint Nordic Infrastructure project (P. Eerola).

The standing of the Lund group within H1 is given by its hardware contributions but above all due to its many important results from physics analyses. Especially the contributions to low-x physics are indispensable for physics interpretations at LHC.

Specific actions/precautions needed to certain a successful development:
For a successful utilization of the substantial investments in the experiment it is essential to maintain the strong external financial support. Concerning human resources, the ATLAS research group in Lund is at the level of being sub-critical. At the moment, the group has no researchers at the junior or post-doc level, which is a serious and imminent risk factor for the exploitation of LHC data and for the renewal of the group at long term.

2.3.2 Research area 2: Matter at extreme conditions.

Background:
The theory of strong interactions, QCD, predicts that at sufficiently high energy density, nuclear matter will undergo a phase transition to a new state where the constituents, quarks and gluons form a system, often named the Quark Gluon Plasma (QGP). This new phase as well as the properties of the phase transition is the overall research goal. A similar state was present in the Universe at about 1 μs after the Big Bang. In today's Universe, particularly heavy neutron stars may also have similar core densities, however at low temperature.

The QGP is a unique laboratory to study bulk properties of quark matter as well as the fundamental interactions of coloured objects in a coloured medium. Thus it provides a test bench for the theory of the strong force of fundamental importance for our understanding of the basic laws of nature. The predictive power of QCD, whose parameters are determined on quite different grounds, can thus be tested in a situation which has had none or very little influence on the current theory. Likewise, mimicking the Big Bang in the laboratory following the expansion when protons and neutrons condense from the QGP, has fundamental interest for our understanding of the early Universe and the puzzle of *e.g.* net baryon excess in the observed Universe.

Project description:
At RHIC the Lund group is participating in the PHENIX experiment. Our main efforts on the hardware side have been to design, construct, install, operate and maintain the pad chambers, which are an essential part of the PHENIX tracking system, as well as its electronics.

At LHC the Lund group participates in the ALICE experiment. We have from the very beginning of ALICE participated in the planning of the readout concept for the TPC detector in ALICE. Among other things we have developed reliable test equipment and procedures for chip testing. Some 100 000 extremely advanced chips were tested in Lund by using an automatic robot system.

Achievements:
The most exciting result at RHIC is the observation that production of particles at high transverse momentum is strongly suppressed in heavy ion collisions at RHIC energies. Already, after the first minimal low luminosity experiment in year 2000, striking observations on so called Jet Quenching showed that something dramatically new was going on in central Au-Au collisions. High transverse momentum particles at these energies are the result of hard scattering between quark pairs, resulting in two high momentum quarks emitted back-to-back. These quarks fragment into two jets of hadrons. While the coloured quarks traverse the dense medium, it makes a big difference whether this medium consists of colourless hadrons or if its constituents are coloured quarks. In the latter case, the quark will lose a lot of its energy to the medium.

By studying the event topology one has observed a surprisingly large collective hydrodynamic flow. At RHIC energies the number of quarks in the hadrons appears to be the deciding factor of the flow. This indicates that quarks are the constituents that flow and that the hadrons are formed by recombination of quarks. Due to the small viscosity the partonic matter has been referred to as an almost perfect liquid. Evidently, this is in sharp contrast to most QGP predictions which suggested a "gas-like" state of freely moving quarks and gluons which only interacted very little with each other.

National or international standing (substantiate your claims for the position)
The Lund group, with its outstanding experience, is the only Swedish group in the field, and has contributed strongly to the development in general and to the two experiments in particular. The group is also one of few groups in the world, having direct access to both the PHENIX and ALICE detectors and the data recorded by those. The strong standing of the Lund group is manifested by leading positions in both experiments.

Specific actions/precautions needed to certain a successful development:
It is necessary, for a successful utilization of the substantial investments in the experiments, to maintain the strong external financial support. Concerning human resources, the age structure of the group is such that new faculty positions are needed in the coming years.

2.3.3. Research area 3: R&D on grid computing.

Background:
High Energy Physics experiments produce enormous volumes of data, both from the events registered in the detectors and from Monte Carlo simulations. Reliable data storage and efficient and rapid processing are necessary in order to achieve the research goals and study the new phenomena. Conventional computing facilities such as High-Performance Computing centres are not adequate anymore. In order to cope with the demands, physicists, led by CERN, invest a lot of efforts into enabling a new, distributed and scalable computing technology, the Grid. Grid is the new innovative technology that is revolutionizing the whole concept of computing and data storage by facilitating collaborative use of widely distributed networked computing and data storage resources.

Project description:
The Division of Experimental High Energy Physics established a dedicated team to work on Grid computing already in 2000, and since then initiated and participated in a number of international projects. The main goal of the research is to develop a Grid solution (so-called middleware) that suits the needs of HEP experiments. As a part of the NorduGrid Collaboration, our group develops one of the leading Grid middlewares, the Advanced Resource Connector (ARC), developed and distributed as Open Source software. ARC is a complete solution that enables a distributed computing and data storage facility composed of heterogeneous resources of different ownership. The project is supported by the EU (via the KnowARC project) and a number of other national and international projects and grants.

Achievements:
The ARC middleware is currently of a production status and is very successfully used by the ATLAS experiment and in the near future will be adapted for the ALICE experiment needs as well. Importantly, this solution is not limited to be used by the HEP applications; in fact, there are more non-HEP projects making use of ARC today. Through ARC, we prove the validity of the entire Grid concept, and demonstrate that it is indeed the solution for massive data processing; be it HEP or other areas. Lund leads the development activities of ARC.

National or international standing (substantiate your claims for the position)
ARC is one of very few Grid middlewares in the world, and is the only complete solution that is available for different operating systems and environments, being thus one of the major players in the area. ARC is used by the Swedish national Grid project (Swegrid) and a

substantial number of other national and international projects[4], including NDGF, which enables a distributed computing center for CERN and other research areas. The KnowARC project brings ARC in line with the latest technology developments. Lund provides the technical coordinator (B. Kónya) of NorduGrid and KnowARC, and the CERN coordinator of NDGF (O. Smirnova). ARC developers regularly contribute to international standardization efforts and provide members to a variety of relevant international bodies.

Specific actions/precautions needed to certain a successful development:
Further progress in the area of Grid research and development in Lund is dependent on a sustained commitment of the Division to accommodate these activities, and creation of possibilities to host sufficient number of developer positions. Cooperation with other departments is also essential: currently, there is a good cooperation with LUNARC, and we have actively searched for new partners within Lund University.

2.4 Description of most promising research areas or research directions in the division including areas you would like to see develop in the next 5-10 years and actions you consider necessary to allow this development.

Strategic planning
Time scales in particle physics are long, since experiments are large, complicated and expensive. After almost 20 years of planning and construction of LHC, we are now entering the exploitation phase in which we finally can analyze data and harvest research results. We expect that in the coming 5-10 years we will be much occupied with physics analysis.

Special actions taken for exploitation of LHC:

- graduate school 2006-2010,
- Grid development for data access,
- project for Nordic Joint Use of LHC.

For future directions beyond the LHC, there exist well-developed roadmaps for High Energy Physics both at the international[5] and national level[6], which we are using for our own internal planning. Main possible directions are LHC upgrade, and linear e^+e^- collider.

Special actions taken for future developments:

- participation in the EUDET project – development of TPC-GEM readout (also applicable to ALICE upgrade),
- project for Nordic Joint Use of LHC includes detector development for future accelerators and LHC upgrade,
- Grid – applications in other fields, co-operation within Lund University-LUNARC.

Visions
Thanks to our efforts in physics studies, detector construction and development of Grid, we have achieved a privileged position with an unlimited, direct access to unique data at LHC probing conditions similar to fractions of a second after the Big Bang. Our vision is to take a significant role in the analysis efforts of this exciting new data.

[4] For a list see www.nordugrid.org
[5] Particle Physics part of the ESFRI roadmap, "Towards a European Strategy for Particle Physics", http://council-strategygroup.web.cern.ch/council-strategygroup/Strategy_Brochure.pdf
[6] The Swedish National Strategy for Research Infrastructures (Research Council Reports 11:2007) http://www.vr.se/download/18.2f62b054117692ac43f8000446/Rapport+11.2007.pdf

Possibilities

- With relatively small local resources and investments we get access to world-class data.
- Our research is in line with the national and international strategies[5,6].
- High Energy Physics and Astronomy are typically fields with a high level of general interest and good exposure in media. Therefore, these fields can act as "flagships" for physics and natural sciences at large, contributing to positive public attitude and attracting students to physics at large.

Obstacles

- Economy within Lund University: research time goes wasted for applying for basic funding such as salaries of permanent academic staff such as lecturers and professors. This is also a risk factor which can at longer term lead to sub-critical groups, difficulties in future staff recruitment, and exodus of current researchers.
- Short-sighted requirements of scientific productivity can undermine fields such as ours with long time scales.

Also describe actions already taken to allow this development (recruitments, re-organization etc)

- Graduate school 2006-2010.
- For recruitments we need support from the Faculty.

2.5 List of publications which best represents the research activity

List the key publications that best describe or represents the present research in the department. These may be older than the 5 years primarily covered by RQ-08. For each publication, add three lines of text explaining why this publication is/has been important. If the publications are electronically available, include a link. If they are not available, please be prepared to submit them on demand.

These three publications represent three research areas of the Division of equal importance:

- Formation of dense partonic matter in relativistic nucleus-nucleus collisions at RHIC: Experimental evaluation by the PHENIX collaboration.
  By PHENIX Collaboration (K. Adcox *et al*.). Oct 2004. 127pp.
  Published in Nucl.Phys.A757:184-283,2005.
  e-Print: http://arxiv.org/abs/nucl-ex/0410003

  Summarizes the results obtained within the PHENIX experiment during the three first years of data taking. The results are examined with an emphasis of a new state of dense matter. We find that the state of matter created cannot be described by ordinary color neutral hadrons.

- Measurement and QCD analysis of the diffractive deep-inelastic scattering cross-section at HERA.
  By H1 Collaboration (A. Aktas *et al*.). Jun 2006. 60pp.
  Published in Eur.Phys.J.C48:715-748,2006.
  e-Print: http://arxiv/org/abs/hep-ex/0606004

  The paper presents a detailed analysis of the diffractive deep-inelastic scattering process ep → eXY, where Y is a proton or a low mass proton excitation carrying a fraction 1 - x_P > 0.95 of the incident proton longitudinal momentum and the squared four-momentum transfer at the proton vertex satisfies $|t|<1$ GeV^2.

- Precision electroweak measurements on the Z resonance.
  By ALEPH Collaboration and DELPHI Collaboration and L3 Collaboration and OPAL Collaboration and SLD Collaboration and LEP Electroweak Working Group and SLD Electroweak Group and SLD Heavy Flavour Group. SLAC-R-774, Sep 2005. 302pp.
  Published in Phys.Rept.427:257,2006.
  e-Print: http://arxiv.org/abs/hep-ex/0509008

  Summarizes the results on the final electroweak measurements performed with data taken at the Z resonance by the experiments operating at the electron–positron colliders SLC and LEP.

2.6 List of publications which best represents renewal of research activities

List the key publications which best describe the recent development and renewal of the research in the department. For each publication, add three lines of text explaining why this publication is/has been important. If the publications are electronically available, include a link. If they are not available, please be prepared to submit them on demand

These three publications represent three research areas of the Division of equal importance:

- ATLAS Detector and Physics Performance Technical Design Report (TDR).
  By ATLAS Collaboration. Editors P. Eerola and I. Hinchliffe.
  Vol I, CERN/LHCC/ 99–14, ATLAS TDR 14, May 1999.
  Vol II, CERN/LHCC/ 99–15, ATLAS TDR 15, May 1999.
  e-Print: http://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/TDR/access.html

  The purpose of this Detector and Physics Performance TDR is to document the expected overall physics performance of ATLAS. This TDR will serve both as a reference for the collaboration members and as an introduction to the ATLAS experiment and its rich physics potential for other physicists. Volume I is dedicated to describing the detector performance. Volume II describes the physics potential of ATLAS.

- ALICE Physics Performance Report (PPR).
  By ALICE Collaboration.
  Published in Journal of Physics G, Nuclear and Particle Physics Volume 32, 1295, 2006.
  e-Print: http://stacks.iop.org/0954-3899/32/1295

  This publication summarizes the collaboration efforts to study the physics performance of the ALICE detector. The results in the publication are based elaborate simulations using the full ALICE analysis chain. The publication gives a very good overview of the planned activities for the ALICE experiment once LHC starts operation.

- Advanced Resource Connector middleware for lightweight computational Grids.
  By M.Ellert *et al*. including B. Kónya (LU-HEP), J. Lindeman (LU-LUNARC), O. Smirnova (LU-HEP, corresponding author).
  Published in Future Generation Computer Systems 23 (2007) 219-240.

  The paper presents an in-depth view of the existing components of ARC, and discusses some of the new components, functionalities and enhancements currently under development. This paper also describes architectural and technical choices that have been made to ensure scalability, stability and high performance. The core components of ARC have already been thoroughly tested in demanding production environments, where it has been in use since 2002.

2.7 List of publications which cannot be defined as Scientific publications but are still important for understanding the scientific development.

For many scientific fields with a strong scientific publication tradition, this section may not be relevant. Then just leave this section empty. - Sometimes, non-scientific publications may have a strong influence on the scientific development. List publications which have had a strong influence on the scientific development. If the publications are electronically available, include a link. If they are not available, please be prepared to submit them on demand.

"Towards a European Strategy for Particle Physics",
http://council-strategygroup.web.cern.ch/council-strategygroup/Strategy_Brochure.pdf
prepared by the Strategy Group of the CERN Council 2005-2006, co-chaired by T. Åkesson.

R-ECFA study of particle physics in Europe. A survey of the field in Europe, country by country, illustrating in which areas the research effort in the field is spend. The survey was performed under the chairmanship of T. Åkesson.
http://doc.cern.ch//archive/electronic/cern/preprints/ecfa/ecfa-2006-342-rev2.pdf

2.8 List of important Scientific publications which are not yet included in the Lund University Publications (LUP) database (2003-2007) but which you still regard as essential.

None.

2.9 Additional sources of information

Evaluation of Subatomic Physics within the Faculty of Science at Lund University, J-J. Aubert, P. Minnhagen, D-O. Riska (appointed by the Swedish Research Council), 2001:
http://www.hep.lu.se/documents/Evaluation-2001.pdf

http://www.hep.lu.se/	Division homepage
http://www.hep.lu.se/Lund-HEP/	Homepage of the graduate school
http://www.hep.lu.se/staff/eerola/LHCBeyond.htm	LHC and Beyond: Joint Nordic Infrastructure project
http://atlas.ch/	ATLAS homepage
http://aliceinfo.cern.ch/	ALICE homepage
http://www-h1.desy.de/	H1 homepage
http://www.phenix.bnl.gov/	PHENIX homepage
http://www.eudet.org/	EUDET homepage
http://www.linearcollider.org/cms/	Linear collider homepage
http://www.swegrid.se/	Swegrid homepage
http://www.nordugrid.org/	NorduGrid homepage
http://www.knowarc.eu/	KnowARC homepage
http://www.ndgf.org/	NDGF homepage