

JARA-FAME

Jülich Aachen Research Alliance for

Forces and Matter Experiments

Annual Report 2013

Forschungszentrum Jülich

RWTH Aachen

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JARA-FAME
Jülich Aachen Research Alliance for Forces and Matter Experiments
Annual Report 2013

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JARA-FAME Highlights 2013

JARA-FAME Launched

On 17 January 2013, an event was held to officially mark the foundation of the new JARA-FAME (Forces and Matter Experiments).

JARA-FAME is concerned with basic physical research in the field of nuclear and particle physics, and aims to investigate and improve our understanding of matter-antimatter asymmetry in the universe. This asymmetry ultimately holds the key to our existence.

FAME will initially rest on two pillars: For one, it will host the new JEDI project (Jülich Electric Dipole Moment Investigation), which will be coordinated, planned and implemented by both JARA partners. Its second pillar is the AMS experiment in operation on the International Space Station (ISS), in which Aachen is already actively involved. Under JARA, Jülich will play a leading role in strengthening AMS and linking it to the PANDA experiment at FAIR (Facility for Antiproton and Ion Research). JARA-FAME also includes theoretical work that will support experiments with model predictions and aid interpretation of the results. The new section will focus on the interdisciplinary topics of detector development and data processing.

The directors of the new section are Prof. Dr. Rudolf Maier from the Nuclear Physics Institute at Forschungszentrum Jülich and Prof. Dr. Achim Stahl from the Institute of Physics (IIB) at RWTH Aachen University.

Dr. Wolfgang Schroeder from Corporate Development at Forschungszentrum Jülich is the managing director.



Figure 1: (from the left) Prof. Sebastian M. Schmidt, Member of the Board of Directors Forschungszentrum Jülich, Dr. Wolfgang Schroeder, Prof. Rudolf Maier, Prof. Stefan Schael, Prof. Samuel C. C. Ting, Prof. Hans Ströher, Prof. Henning Gast, Prof. Ulf Meißner und Prof. Achim Stahl.

Nobel Laureate Prof. Samuel C. C.

Ting from Massachusetts Institute of Technology was guest speaker at the event, providing the some 250 guests with insights into the AMS experiment on the International Space Station (ISS).

Prof. Ting also announced that JARA-FAME would be more closely involved in the AMS experiment in the future.

Commissioning of the 2 MeV Electron Cooler at COSY

Andreas Lehrach, FZ Jülich

In a dedicated shutdown the new 2 MeV electron cooler has been installed at the Cooler Synchrotron COSY in autumn last year. The system has been built in close collaboration with the Budker Institute of Nuclear Physics in Novosibirsk (Russia). Dr. V. Kamerdzhev is the coordinator for this project at Jülich. The layout of the whole system is shown in Figure 2. In a high-voltage tank a DC electron beam with up to 1 A current and 2 MeV kinetic energy is produced, guided via a transport line to the cooling section, where it interacts with the circulating COSY beam, and guided back to the high-voltage tank to recover its kinetic energy. The principle of Electron cooling is based on a heat exchange of a "cool" electron beam with "hot" hadron beam by Coulomb interaction.

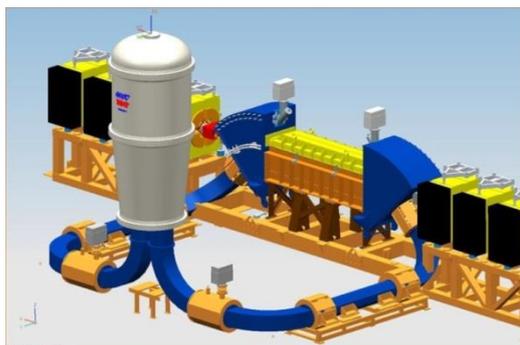


Figure 2: Layout of the new 2 MeV electron cooler at COSY. It consists of a high-voltage tank filled with up to 10 bar inert gas (Sulfur hexafluoride), electron transport line and cooling section.

In Figure 3 a picture of the cooling section of the electron cooler taken after installation inside the COSY tunnel is shown.



Figure 3: Cooling section of the new 2 MeV electron cooler after installation inside the COSY tunnel.

Up to now electron beams up to a current of 340 mA have been produced. Acceleration voltages of 1.4 MV could be reached and electron cooling at 908 kV / 340 mA (1.8 GeV p) could be established. First Electron cooling was achieved for 108 protons at a kinetic energy of 200 MeV at the end of last year. Figure 4 shows the first transverse beam profiles of the COSY beam before and after electron cooling.

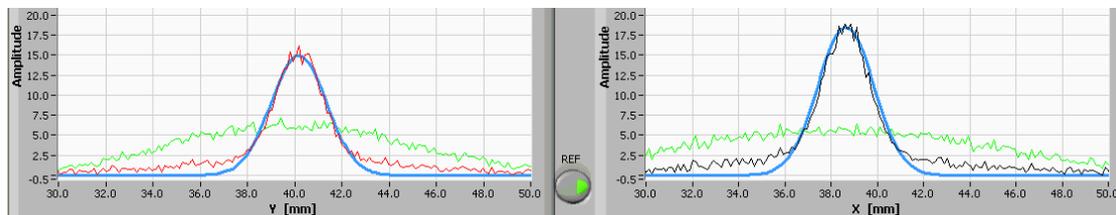


Figure 4: Transverse beam profiles of the COSY beam before and after electron cooling with a 109 kV electron beam of 200 mA. Green line shows the initial beam profile, the red line (left plot) the vertical beam profile after cooling and the black line (right plot) the horizontal beam profile after cooling. In blue a Gauss function has been fitted to the cooled beam profiles.

Technical developments for this electron cooler are important steps towards the 4.5(8) MV electron cooler planned for the High-Energy Storage Ring (HESR) of the International Facility for Antiproton and Ion Research (FAIR) at GSI in Darmstadt. The HESR electron cooler layout will strongly benefit from the experiences of the high-energy electron cooler operation at COSY. The measurement of beam cooling forces and other features of magnetized electron cooling at high energies are essential for the planned HESR electron cooler. For the startup phase of the FAIR this 2 MV electron cooler is well suited for beam cooling and accumulation at HESR injection energy.

Spin Coherence time measurements at COSY

Jörg Pretz, RWTH Aachen

The electric dipole moment (edm) of charged particles can be measured by looking at their spin motion in storage rings. One important prerequisite for these kinds of measurements is a long spin coherence time (SCT) of the particle beam. Without any special effort, spins initially placed in one direction in the horizontal plane decohere within a few milliseconds. This is due to the fact that particles deviate slightly in momentum ($\Delta p/p \approx 10^{-4}$) and the spin precession frequency is momentum dependent. Turning on the accelerator RF cavities has the effect that the particle momentum oscillates around the reference particle momentum and the SCT increases to few seconds, still orders of magnitude too short for EDM measurements. Because the revolution frequency is fixed by the RF cavity frequency, particles with different path lengths necessarily differ in velocity, which implies decoherence. Different path lengths can be compensated by adding appropriate sextupole magnet settings in COSY. This leads to an increase in the SCT. Figure 5 shows the horizontal polarization as function of time for two different sextupole magnet settings, leading to a spin coherence time of 20s initially and 400s, never reached in an accelerator before, for an optimized setting.

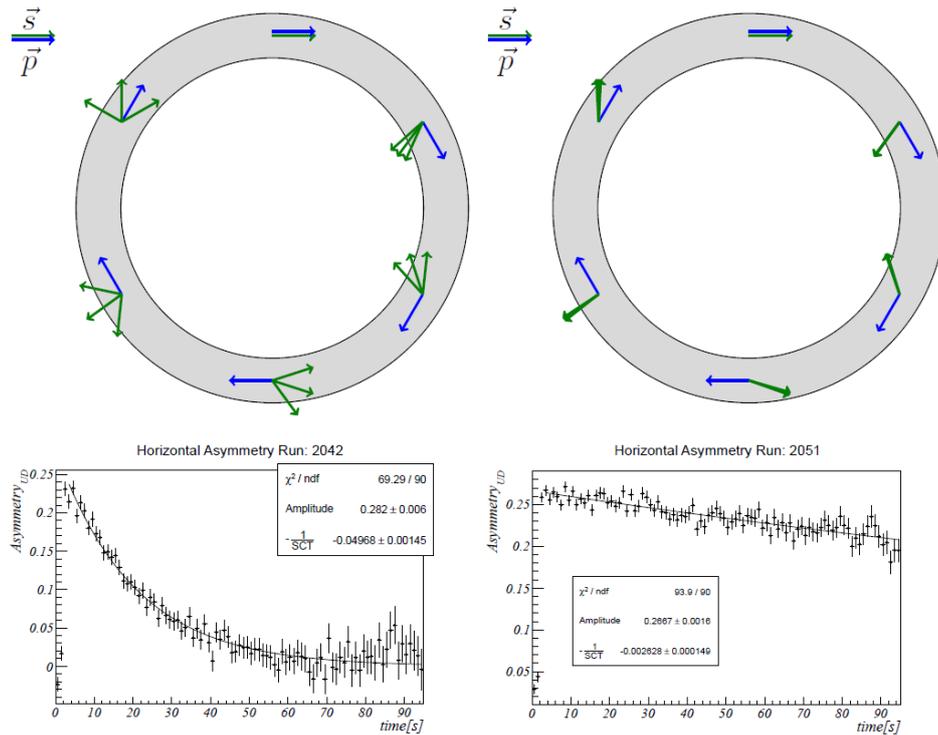


Figure 5: The horizontal polarization as function of time for two different sextupole magnet settings, leading to a spin coherence time of 20s initially and 400s

Alpha Magnetic Spectrometer

Henning Gast, RWTH Aachen

The Alpha Magnetic Spectrometer (AMS-02) is a general-purpose high-energy particle physics detector that was installed on the ISS in May 2011 (Fig. 6). Its goal is a measurement of charged cosmic rays with unprecedented precision. The AMS detector consists of a permanent magnet, nine planes of precision silicon tracker, a transition radiation detector, four planes of time of flight counters, an array of anti-coincidence counters, a ring imaging Cherenkov detector, and an electromagnetic calorimeter. AMS operates continuously on the ISS and is monitored and controlled around-the-clock from the ground.

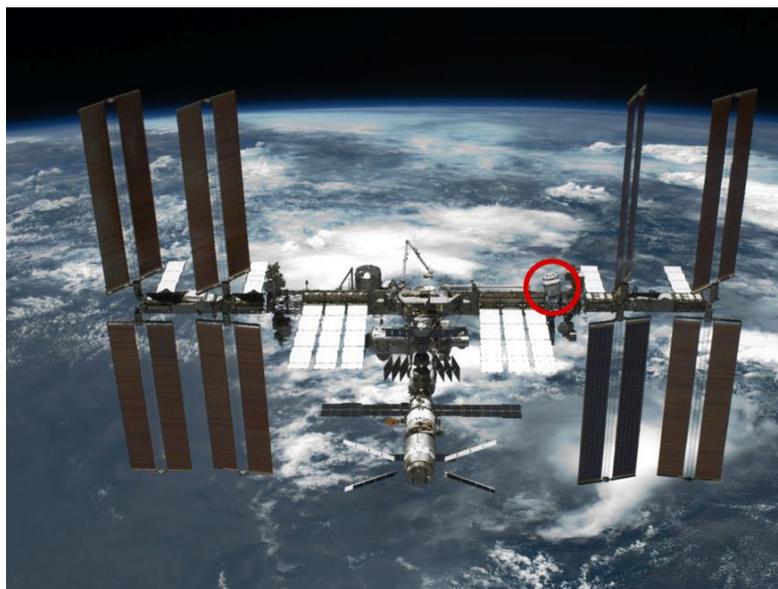
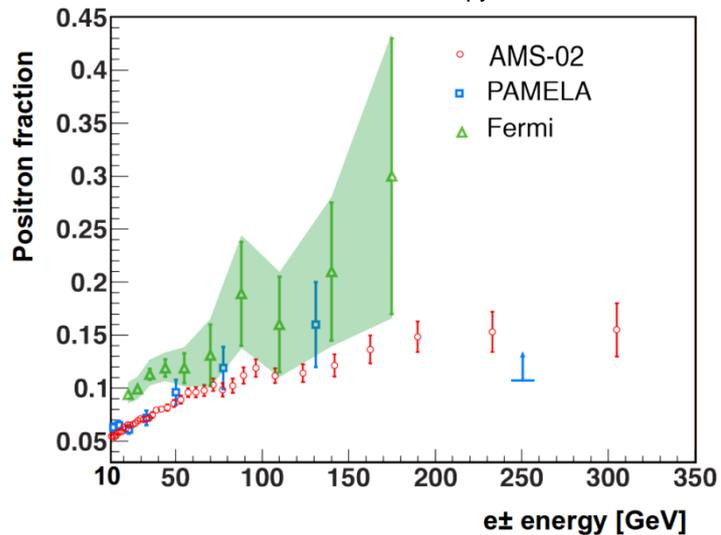


Figure 6: The AMS experiment on the International Space Station ISS (marked by the red circle). Credit: NASA.

In 2013, the AMS Collaboration published its first paper in Physical Review Letters. It deals with a measurement of the positron fraction, i.e. the ratio of positrons to the sum of electrons and positrons, in primary cosmic rays in the energy range from 0.5 to 350 GeV based on 6.8×10^6 positron and electron events. This energy range extends considerably beyond the range covered by earlier experiments. According to generic models for cosmic-ray production and propagation, positrons are produced as secondaries in the interactions of primary cosmic rays (mostly protons and Helium nuclei) with interstellar matter, and a positron fraction gradually declining with energy is predicted as a result. The very accurate data from AMS (Fig. 7) now show that the positron fraction is steadily increasing from 10 to ~250 GeV, but, from 20 to 250 GeV, the slope decreases by an order of magnitude. The positron fraction spectrum shows no fine structure, and the positron to electron ratio shows no observable anisotropy. This result has already triggered a considerable amount of theoretical work, with models proposed in explanation ranging from new astrophysical sources of positrons such as pulsars to the annihilation of dark matter particles.

Figure 7: The cosmic-ray positron fraction measured by AMS, as a function of particle energy. The small error bars on the individual points demonstrate the precision of the measurement compared to earlier results of satellite-based experiments (PAMELA and Fermi). The AMS measurement explores a previously uncharted energy range.



AMS has recorded more than 50 billion individual particle crossings until now, corresponding to an average counting rate of around 500 particles per second. The resulting data volume is enormous and amounts to 60 terabytes. The computing power required to analyze these data has been provided by the Jülich Supercomputing Centre (JSC) in the context of JARA-FAME. In particular, the complete reconstruction of the data used for the first publication of the AMS Collaboration has been performed on the JUROPA cluster.

JEDI Collaboration

Achim Stahl, RWTH Aachen

Within the JEDI collaboration we are developing a new type of storage ring to search for electric dipole moments of the proton and light ions. Such a ring will need strong electric fields to create a measurable effect on the spin of the particles. This field is generated in electrostatic deflectors that are used at the same time to define the orbit of the beam. It is essential to reach the highest possible fields. On the one hand the high fields increase the sensitivity of the experiment on the other hand they reduce the size of the storage ring and reduce its costs.

When funding became available in the second half of 2013 we started to set up the infrastructure to develop these deflectors. We installed a clean room of sufficient size (5m x 5m) in the Physikzentrum. In parallel we developed a test chamber with ultra-high vacuum and a corresponding high voltage system. The chamber will be used to test prototypes of a scale up to 20 % of the final size.

During 2013 we developed the plans and ordered most of the parts. By now everything is installed and ready for the first tests.

Novel Design of an RF Wien Filter

Dirk Heberling, RWTH Aachen

A classical Wien Filter generates an orthogonal electromagnetic field by using two subsystems; one to generate an electric field and another to generate a magnetic field. Without any assumptions, such separation implies that the fields are static. Most of the publications related to the design and realization of Wien Filters are restricted to the DC case only. Now, for the search for electric dipole moment (EDM), an RF Wien Filter at 1MHz is required with high accuracy. The proposed solution is to generate a dynamic electric field and to let its spatial variation to generate the temporal variation of the magnetic field. The structure must support the TEM mode at very low frequency. The concept of 'parallel plates' waveguide is chosen (figure 8). From theory, an orthogonal electromagnetic field is expected. Feeding the parallel plates with an RF signal (figure 9) would generate high frequency current distribution of the surface of the plates. The variation of such current distribution is responsible for the generation of the electromagnetic field. The electric field is assumed to be in the x-direction, the magnetic field is assumed to be in the y-direction and the z-direction is the direction of propagation which is also the direction of the particles' beam. For the RF Wien Filter, what is of remarkable importance is the ration between the x-component of the electric field and the y-component of the magnetic field. For deuterium particles, this ratio must be equal to 173 Ω . This value can be controlled by changing the value if the load resistance (figure 10). At 1MHz, it is safe to assume that a TEM mode is able to propagate because

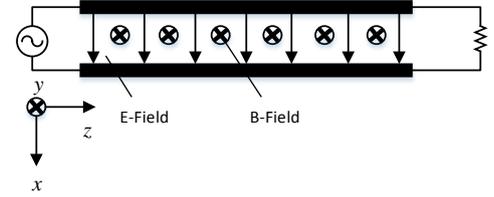


Figure 8: Schematic of the proposed RF Wien Filter

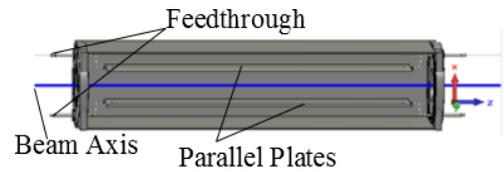


Figure 9: Computational Model of the proposed RF Wien Filter

the cut-off frequency of the TEM is 0 Hz. For a pure TEM case, the solution reads: $H_y(x, z) = H_0 e^{-\beta_z z}$, $E_x(x, z) = \frac{\beta_z}{\omega \epsilon} H_0 e^{-\beta_z z}$ and $E_z(x, z) = 0$. In reality, fringe fields appear very strongly at the edges.

The target is to minimize the fringe fields represented as a distortion function for the electric and magnetic fields: $h(E_{\perp}) = h(E_y, E_z)$ and $g(H_{\perp}) = g(H_x, H_z)$. A simple demonstration of the concept is shown in figures 11 - 12. These can be thought as cost functions and that must be kept as small

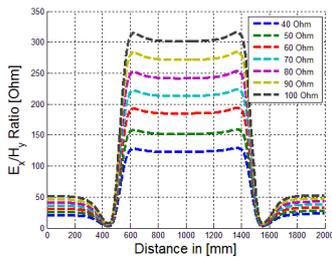


Figure 10: Variation of the wave impedance as a function of the load resistance

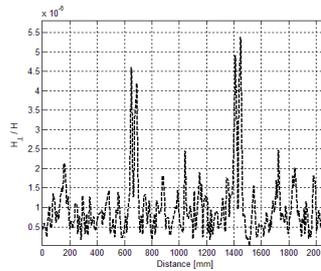


Figure 11: Accuracy indicator of the H-field

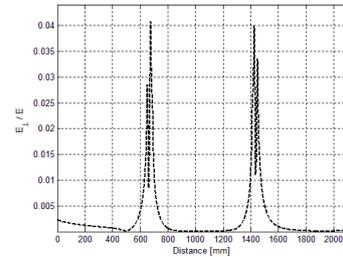


Figure 12: Accuracy indicator of the E-field

JARA-FAME Institutes

I. Physikalisches Institut B , RWTH Aachen

Prof. Stefan Schael, Prof. Henning Gast

Supercomputing Center, Forschungszentrum Jülich

Prof. Thomas Lippert

The combined effort of the I. Physics Institute of RWTH Aachen and of the Jülich Supercomputing Centre builds one of the leading research groups in the Alpha Magnetic Spectrometer (AMS) Project on the International Space Station. AMS, is a general purpose high energy particle physics detector. After a construction period of 15 years it was installed on the International Space Station, ISS, on 19 May 2011 to conduct a unique long duration mission (20 years) of fundamental physics research in space. The main scientific focus is the search for anti matter and dark matter. The work of 25 scientists and PhD students is coordinated by Prof. Dr. S. Schael with significant external funding by the German Space Agency DLR.

III. Physikalisches Institut B , RWTH Aachen

Prof. Achim Stahl

The institute of experimental particle physics is active in the development of particle detectors, Experiments in Collider Physics (LHC at CERN) and Neutrino Physics (DoubleChooz, T2K, IceCube, JUNO, LENA). Recently, the search for CP-violation with the JEDI collaboration was started as a new activity.

Within JARA-FAME the group of Prof. Stahl focuses on the development of the electrostatic deflectors of the JEDI storage ring.

Prof. Jörg Pretz

The group of Prof. Pretz is working on various aspects of the storage ring EDM project, covering simulations of spin dynamics in accelerators, hardware development for a first charged particle EDM experiment at COSY, beam instrumentation, polarimetry and analysis.

Prof. Sebastian M. Schmidt

Sebastian M. Schmidt is member of the board of directors of FZJ and active in research on theoretical physics. His focus in JARA-FAME is the education of students by organizing a laboratory course on spin physics.

Institut für Hochfrequenztechnik, RWTH Aachen

Prof. Dirk Heberling

The Institute of High Frequency Technology (IHF) is concerned with the simulation, design, fabrication and most importantly measurement of microwave components. Topics range from antennas, waveguides, resonators, RF coils, radar cross section measurements, metamaterials and many more. In terms of simulation methods, various simulations systems exists with different computational methods including the finite integration methods (CST Suite), the finite element/volume method (Comsol) and method of moments (FEKO). The IHF is also equipped with Small GPU cluster for faster simulations. The labs at IHF, are fully equipped with many devices including for instance, network analyzers covering very high frequencies up to 110 GHz. One of the most remarkable research facilities at IHF, is an anechoic chamber for antenna measurements (the best in German universities).

Institut für Hochspannungstechnik , RWTH Aachen

Prof. Armin Schnettler

The main research focus of the IFHT are models, components and systems for a sustainable future energy supply. New systems and methods are developed and existing ones are evaluated and improved. Important tools of the research are mathematical simulations which have to be verified with experimental investigations. The close cooperation with industry provides a high degree of practical application.

The scientific staff around 50 PhD students at IFHT is organized in four departments whose research concentrates on materials and components of sustainable systems. The Department Insulation Systems and Diagnosis develops new insulation materials and procedures for their assessment. The Department Power System Technologies further develops components and assets for electric grids. The departments Sustainable Distribution Systems and Sustainable Transmission Systems model and assess energy supply systems from a systemic perspective.

Institut für Theoretische Teilchenphysik und Kosmologie, RWTH Aachen

Prof. Werner Bernreuther

The research of my group and myself is devoted to theoretical investigations of models for fundamental particles and interactions. Our main focus is predictions for high-energy reactions, in particular reactions that apply to the Large Hadron Collider, within the Standard Model of particle physics and extensions thereof. In particular, we investigate effects of non-standard CP-violating interactions in high-energy processes, but also on low-energy observables such as electric dipole moments of leptons and hadrons.

Institut für Kernphysik, IKP-1, Forschungszentrum Jülich

Prof. Jim Ritman

The IKP-1 research group is mainly involved in experimental studies of hadron structure. One group of activities is connected to experiments at the COSY facility at Jülich. This includes the assembly and operation of the extracted beam COSY-TOF experiment, for which recently a large-scale ultra light Straw Tube Tracker was constructed, which is operated in vacuum. This has been used to measure e.g. the proton-Lambda spin resolved scattering length to investigate SU(3)_F symmetry at the interaction level. In addition to this the Institute has a major role in operating and data evaluation from the internal WASA-at-COSY experiment. The interests here mostly revolve about studies of fundamental symmetry in the decay of eta mesons. The other major pillar of activities is connected to preparation for the PANDA experiment, which will measure proton-antiproton annihilation in the charmonium mass range at the FAIR complex currently under construction. The main activities here are connected to detector development and simulation/computing. The detector developments are connected to charged particle tracking devices, such as silicon pixel and silicon strip devices, thick semiconducting energy detectors and large-volume gaseous tracking detectors. The computing activities are connected to detector simulations, data readout as well as GPU/FPGA based tracking acceleration.

Institut für Kernphysik, IKP-2, Forschungszentrum Jülich

Prof. Hans Ströher

IKP-2 is one of the two experimental institutes of IKP of FZJ. In the past it has been pursuing hadron physics with (polarized) proton and deuteron beams at COSY, exploiting the ANKE, PAX and WASA detection systems at internal target positions. More recently the group has put its focus on precision studies with polarized stored beams; in particular it is heavily involved in the JEDI-project.

Institut für Kernphysik, IKP-3, Forschungszentrum Jülich

Prof. Ulf-G. Meißner

In the IKP-3/IAS-4 group, we have done considerable progress in the calculation of the electric dipole moments (EDMs) of nucleons and light nuclei, combining methods from effective fields theories with lattice simulation data, if available. We have also been granted sizeable amounts for two different projects on JUQUEEN that intend to calculate the proton and neutron EDM at physical quark masses based on very different approaches (imaginary theta-angle and Lüscher flow method).

These studies are of course pertinent to the EDM storage ring project at FZ Jülich.

We also investigated the traces of R-parity violating supersymmetry effects in selected hadron decays and studied the effect of quark mass variations on the rate of light element synthesis in the Big Bang.

Institut für Kernphysik, IKP-4, Forschungszentrum Jülich

Prof. Rudolf Maier and Prof. Andreas Lehrach

IKP-4 is operating the Cooler Synchrotron COSY and leading laboratory for design, construction and commissioning of the High-Energy Storage Ring HESR at FAIR (HESR Consortium: (HIM Mainz, GSI/FAIR, ICPE-CA Bucharest, FZJ/ZEA). COSY will be operated in the next funding period to test accelerator and detector components for HESR and FAIR as well as for R&D work and a precursor experiment for a first direct charged-particle EDM measurement in a storage ring. In addition a design study for a dedicated high-precision EDM storage ring will be performed together with partners (IKP-2, RWTH Aachen, Ferrara Università degli Studi di Ferrara Italy, Ivane Javakhishvili Tbilisi State University Georgia, Krakow Uniwersytet Jagiellonski w Krakowie Poland, Grenoble Centre National de la Recherche Scientifique France).

Scientific Results

EDM Theory

Varying the light quark mass: Impact on the nuclear force and big bang nucleosynthesis

Berengut J. C., Epelbaum E., Flambaum V. V., Hanhart C., Meißner U.-G., Nebreda J., Pelaez J. R.

Physical Review D **87** (8), 085018 (2013)

The quark mass dependences of light-element binding energies and nuclear scattering lengths are derived using chiral perturbation theory in combination with nonperturbative methods. In particular, we present new, improved values for the quark mass dependence of meson resonances that enter the nuclear force. A detailed analysis of the theoretical uncertainties arising in this determination is presented. As an application, we derive from a comparison of observed and calculated primordial deuterium and helium abundances a stringent limit on the variation of the light quark mass, $\delta m_q/m_q = 0.02 \pm 0.04$. Inclusion of the neutron lifetime modification, under the assumption of a variation of the Higgs vacuum expectation value that translates into changing quark, electron, and weak gauge boson masses, leads to a stronger limit, $|\delta m_q/m_q| < 0.009$.

DOI: 10.1103/PhysRevD.87.085018

The electric dipole moment of the deuteron from the QCD θ -term

Bsaisou J., Hanhart C., Liebig S., Meißner U.-G., Nogga A., Wirzba A.

European Physical Journal A **49** (31), (2013)

The two-nucleon contributions to the electric dipole moment (EDM) of the deuteron, induced by the QCD theta-term, are calculated in the framework of effective field theory up-to-and-including next-to-next-to-leading order. In particular we find for the difference of the deuteron EDM and the sum of proton and neutron EDM induced by the QCD theta-term a value of $(-5.4 \pm 3.9) \langle \theta \rangle \times 10^{-4} e \text{ fm}$. The by far dominant uncertainty comes from the CP- and isospin-violating π NN coupling constant.

DOI: 10.1140/epja/i2013-13031-x

Improving the hadron physics of non-standard-model decays: Example bounds on r-parity violation

Daub J. T., Dreiner H. K., Hanhart C., Kubis B., Meißner U.-G.

Journal of High Energy Physics 1301, 179 (2013)

Using the example of selected decays driven by R-parity-violating supersymmetric operators, we demonstrate how strong final-state interactions can be controlled quantitatively with high precision, thus allowing for a more accurate extraction of effective parameters from data. In our examples we focus on the lepton-flavor-violating decays $\tau \rightarrow \mu \pi^+ \pi^-$. In R-parity violation these can arise due to the product of two couplings. We find bounds that are an order of magnitude stronger than previous ones.

EDM Experiment

Sparc experiments at the high-energy storage ring

Stohlker T., Litvinov Y. A., Bagnoud V., Bechstedt U., Dimopoulou C., Dolinskii A., Geppert C., Hagmann S., Katayama T., Kuhl T., et al.

Physica Scripta **T156**, 014085 (2013)

The physics program of the SPARC collaboration at the Facility for Antiproton and Ion Research (FAIR) focuses on the study of collision phenomena in strong and even extreme electromagnetic fields and on the fundamental interactions between electrons and heavy nuclei up to bare uranium. Here we give a short overview on the challenging physics opportunities of the high-energy storage ring at FAIR for future experiments with heavy-ion beams at relativistic energies with particular emphasis on the basic beam properties to be expected.

DOI 10.1088/0031-8949/2013/T156/014085

Polarization of a stored beam by spin-filtering

Augustyniak W., Barion L., Barsov S., Bechstedt U., Benati P., Bertelli S., Carassiti V., Chiladze D., Ciullo G., Contalbrigo M., et al.

Physics Letters B **718** (1), 64-69 (2012)

The PAX Collaboration has successfully performed a spin-filtering experiment with protons at the COSY-ring. The measurement allowed the determination of the spin-dependent polarizing cross section, that compares well with the theoretical prediction from the nucleon-nucleon potential. The test confirms that spin-filtering can be adopted as a method to polarize a stored beam and that the present interpretation of the mechanism in terms of the proton-proton interaction is correct. The outcome of the experiment is of utmost importance in view of the possible application of the method to polarize a beam of stored antiprotons. (C) 2012 Elsevier B.V. All rights reserved.

DOI 10.1016/j.physletb.2012.10.030

Synchrotron oscillation effects on an rf-solenoid spin resonance

Benati P., Chiladze D., Dietrich J., Gaisser M., Gebel R., Guidoboni G., Hejny V., Kacharava A., Kamerdzhev V., Kulessa P., et al.

Physical Review Special Topics-Accelerators and Beams **15**, 124202 (2012)

New measurements are reported for the time dependence of the vertical polarization of a 0.97 GeV/c deuteron beam circulating in a storage ring and perturbed by an rf solenoid. The storage ring is the cooler synchrotron (COSY) located at the Forschungszentrum Jülich. The beam polarization was measured continuously using a 1.5 cm thick carbon target located at the edge of the circulating deuteron beam and the scintillators of the EDDA detector. An rf solenoid mounted on the ring was used to generate fields at and near the frequency of the 1 - G gamma spin resonance. Measurements were made of the vertical beam polarization as a function of time with the operation of the rf solenoid in either fixed or continuously variable frequency mode. Using rf-solenoid strengths as large as 2.66×10^{-5} revolutions/turn, slow oscillations (similar to 1 Hz) were observed in the vertical beam polarization. When the circulating beam was continuously electron cooled, these oscillations completely reversed the polarization and showed no sign of diminishing in amplitude. But for the uncooled beam, the oscillation amplitude was damped to nearly zero within a few seconds. A simple spin-tracking model without the details of the COSY ring lattice was successful in reproducing these oscillations and demonstrating the sensitivity of the damping to the magnitude of the synchrotron motion of the beam particles. The model demonstrates that the characteristic features of measurements made in the presence of large synchrotron oscillations are distinct from the features of such measurements when made off resonance. These data were collected in preparation for a study of the spin coherence time, a beam property that needs to become long to enable a search for an electric dipole moment using a storage ring.

DOI: 10.1103/PhysRevSTAB.15.124202

Measurement of permanent electric dipole moments of charged hadrons in storage rings

Pretz J., Collaboration J.

Hyperfine Interactions 214 (1-3), 111-117 (2013)

Permanent Electric Dipole Moments (EDMs) of elementary particles violate two fundamental symmetries: time reversal invariance (T) and parity (P). Assuming the *CPT* theorem this implies *CP* violation. The *CP* violation of the Standard Model is orders of magnitude too small to be observed experimentally in EDMs in the foreseeable future. It is also way too small to explain the asymmetry in abundance of matter and anti-matter in our universe. Hence, other mechanisms of violation outside the realm of the Standard Model are searched for and could result in measurable EDMs. Up to now most of the EDM measurements were done with neutral particles. With new techniques it is now possible to perform dedicated EDM experiments with charged hadrons at storage rings where polarized particles are exposed to an electric field. If an EDM exists the spin vector will experience a torque resulting in change of the original spin direction which can be determined with the help of a polarimeter. Although the principle of the measurement is simple, the smallness of the expected effect makes this a challenging experiment requiring new developments in various experimental areas. Complementary efforts to measure EDMs of proton, deuteron and light nuclei are pursued at Brookhaven National Laboratory and at Forschungszentrum Julich with an ultimate goal to reach a sensitivity of 10^{-29} e·cm.

DOI 10.1007/s10751-013-0799-4

AMS

First result from the alpha magnetic spectrometer on the international space station: Precision measurement of the positron fraction in primary cosmic rays of 0.5-350 GeV

Aguilar M., Alberti G., Alpat B., Alvino A., Ambrosi G., Andeen K., Anderhub H., Arruda L., Azzarello P., Bachlechner A., et al.

Physical Review Letters 110, 141102 (2013)

A precision measurement by the Alpha Magnetic Spectrometer on the International Space Station of the positron fraction in primary cosmic rays in the energy range from 0.5 to 350 GeV based on 6.8×10^6 positron and electron events is presented. The very accurate data show that the positron fraction is steadily increasing from 10 to similar to 250 GeV, but, from 20 to 250 GeV, the slope decreases by an order of magnitude. The positron fraction spectrum shows no fine structure, and the positron to electron ratio shows no observable anisotropy. Together, these features show the existence of new physical phenomena.

DOI: 10.1103/PhysRevLett.110.141102

Top quark spin correlations and polarization at the LHC: Standard model predictions and effects of anomalous top chromo moments

Bernreuther W., Si Z. G.

Physics Letters B 725 (1-3), 115-122 (2013)

A number of top-spin observables are computed within the Standard Model (SM), at next-to-leading order in the strong and weak gauge couplings for hadronic top-quark anti-quark ($t \bar{t}$) production and decay at the LHC for center-of-mass energies 7 and 8 TeV. For dileptonic final states we consider the azimuthal angle correlation, the helicity correlation, and the opening angle distribution; for lepton plus jets final states we determine distributions and asymmetries that trace a longitudinal and transverse polarization, respectively, of the t and \bar{t} samples. The QCD-induced transverse polarization of the top quarks leads to an asymmetry of about 8% that should be detectable with existing data. In addition, we investigate the effects of a non-zero chromo-magnetic and chromo-electric dipole moment of the top quark on these and other top-spin observables and associated asymmetries. These observables allow to disentangle the contributions from the real and imaginary parts of these moments. (C) 2013 Elsevier B.V. All rights reserved.

DOI 10.1016/j.physletb.2013.06.051

Higgs CP properties using the τ decay modes at the ILC

Berge S., Bernreuther W., Spiesberger H.

Physics Letters B 727 (4-5), 488-495 (2013)

We investigate the prospects of determining the CP nature of the 126 GeV neutral spin-0 Higgs-boson H , discovered at the LHC, at a future linear collider. We consider the production of h by the Higgsstrahlung process and its subsequent decays to tau leptons. We investigate how precisely a possible pseudoscalar component of h can be detected by the measurement of a suitably defined angular distribution, if all major decay modes of the tau lepton are used. From our numerical simulations, we estimate the expected precision to the scalar-pseudoscalar mixing angle, including estimates of the background and of measurement uncertainties, to be 2.8 degree for Higgs-boson production at a center-of-mass energy of 250 GeV and for a collider with integrated luminosity of 1 inverse attobarn.

DOI 10.1016/j.physletb.2013.11.006

WASA-at-COSY Experiment

Search for a dark photon in the $\pi^0 \rightarrow e^+ e^- \gamma$ decay

Adlarson P., Augustyniak W., Bardan W., et al.

Physics Letters B 726 (1-3), 187-193 (2013)

The identification of charged particles based on energy losses in straw tube detectors has been simulated. The response of a new front-end chip developed for the PANDA straw tube tracker was implemented in the simulations and corrections for track distance to sense wire were included. Separation power for p-K, p-pi and K-pi pairs obtained using the time-over-threshold technique was compared with the one based on the measurement of collected charge.

DOI: 10.1016/j.physletb.2013.08.055

Isospin decomposition of the basic double-pionic fusion in the region of the ABC effect

Adlarson P., Augustyniak W., Bardan W., et al.

Physics Letters B 721 (4-5), 229-236 (2013)

Exclusive and kinematically complete high-statistics measurements of the basic double-pionic fusion reactions $pn \rightarrow d \pi(0)\pi(0)$, $pn \rightarrow d \pi(+)\pi(-)$ and $pp \rightarrow d \pi(+)\pi(0)$ have been carried out simultaneously over the energy region of the ABC effect using the WASA detector setup at COSY. Whereas the isoscalar reaction part given by the $d \pi(0)\pi(0)$ channel exhibits the ABC effect, i.e. a low-mass enhancement in the pi-pi-invariant mass distribution, as well as the associated resonance structure in the total cross section, the isovector part given by the $d \pi(+)\pi(0)$ channel shows a smooth behavior consistent with the conventional t-channel Delta Delta process. The $d \pi(+)\pi(-)$ data are very well reproduced by combining the data for isovector and isoscalar contributions, if the kinematical consequences of the isospin violation due to different masses for charged and neutral pions are taken into account.

DOI: 10.1016/j.physletb.2013.03.019

Search for η -mesic ${}^4\text{He}$ with the WASA-at-COSY detector

Adlarson P., Augustyniak W., Bardan W., et al.

Physical Review C 87 (3), 035204 (2013)

An exclusive measurement of the excitation function for the $dd \rightarrow ({}^3\text{He})\pi(-)$ reaction was performed at the Cooler Synchrotron COSY-Julich with the WASA-at-COSY detection system. The data were taken during a slow acceleration of the beam from 2.185 to 2.400 GeV/c crossing the kinematic threshold for the eta-meson production in the $dd \rightarrow \text{He-4} \eta$ reaction at 2.336 GeV/c. The corresponding excess energy with respect to the He-4-eta system varied from -51.4 to 22 MeV. The integrated luminosity in the experiment was determined using the $dd \rightarrow ({}^3\text{He})n$ reaction. The shape of the excitation function for the $dd \rightarrow ({}^3\text{He})\pi(-)$ reaction was examined. No signal of the He-4-eta bound state was observed. An upper limit for the cross section for the bound state formation and decay in the process $dd \rightarrow (\text{He-4-eta})(\text{bound}) \rightarrow ({}^3\text{He})\pi(-)$ was determined on the 90% confidence level and it varies from 20 to 27 nb for the bound state width ranging from 5 to 35 MeV, respectively.

DOI: 10.1103/PhysRevC.87.035204

Overview Conferences, Awards and Offers

Conferences

- A. Lehrach, NuPECC Meeting Jülich, Mini-Workshop „Jülich Activities“, Accelerators COSY and HESR, 15. & 16. March 2013
- A. Lehrach, JEDI Kollaborationsmeeting, März 2013 und September 2013
- A. Lehrach, Festakt und Kolloquium zu „20 Jahre COSY Betrieb“ 6. Sep. 2013, Jülich
- A. Lehrach, Vollversammlung Komitee für Beschleunigerphysik, Darmstadt, Lab Report COSY, 28.-29.11.2013
- Andreas Lehrach, KHuK Jahrestagung 2013, Physikzentrum Bad Honnef, Bericht zu COSY, 5.-6. Dezember 2012
- Ulf-G. Meißner, „Hadrons and nuclei: Mass without Higgs,“ plenary talk, Symposium „Ursprung der Masse“, DPG Tagung, Dresden, März 2013
- Ulf-G. Meißner, „A lecture on Effective Field Theories,“ invited lecture, First Workshop and School on Particle Physics Phenomenology, Lake Bazaleti, Georgia, September 2013
- Ulf-G. Meißner, „Life on earth -- an accident?“, plenary talk, The Seventh International Symposium on Chiral Symmetry in Hadrons and Nuclei (CHIRAL 13), Beihang University, Beijing, China, Oktober 2013
- J. Pretz, JEDI Kollaborationsmeeting, März 2013 und September 2013
- J. Pretz, „Electric Dipole Moments - Probes of fundamental symmetries“, Kolloquium RWTH Aachen, June 10, 2013
- J. Pretz, „Measurement of Electric Dipole Moments in Storage Rings“, 2013 PSI - September 8 - August 12, 2013
- J. Pretz, „Electric Dipole Moments - Probes of fundamental symmetries“, Particle & Astrophysics Colloquium Heidelberg, December 3, 2013.
- J. Ritman, Physics Potential with Baryonic final states at PANDA, Plenary talk NSTAR Conference, Peniscola, Spain: May 2013
- J. Ritman, Antiproton Annihilation at Darmstadt – PANDA, Colloquium, GSI Darmstadt, Germany: July 2013
- J. Ritman, Detector Development at Jülich for hadronic and precision physics, Colloquium KVI-Groningen, The Netherlands: July 2013
- J. Ritman, The PANDA Experiment: A Facility to Map out Exotic Charmed Hadrons, Plenary talk HADRON Conference, Nara, Japan: November 2013
- S. Schael, „First results from the AMS Experiment on the ISS“, S. Schael, Kolloquium University Mainz, May 2013
- S. Schael, „First results from the AMS Experiment on the ISS“, Kolloquium University Siegen, June 2013
- S. Schael, „First results from the AMS Experiment on the ISS“, Kolloquium DESY Hamburg and DESY Zeuthen November, June 2013
- S. Schael, „First results from the AMS Experiment on the ISS“, Kolloquium University Heidelberg, June 2013
- S. Schael, „Precision measurements of the electron spectrum and the positron spectrum with AMS“, ICRC 2013, Rio de Janeiro, Brazil, July 2013
- Stefan Schael, „First results from the AMS Experiment on the ISS“, Kolloquium EPF Lausanne, October 2013

H. Gast, "Cosmic-ray research with AMS-02 on the International Space Station", Ferrara International School Niccolò Cabeo 2013, Ferrara, May, 20-24 2013

H. Gast, "Cosmic-ray research with AMS-02 on the International Space Station", 9th Patras Workshop on Axions, WIMPs and WISPs, Mainz, 24-28 June 2013

H. Gast, "Identification of cosmic-ray positrons with the transition radiation detector of the AMS experiment on the International Space Station", ICRC 2013, Rio de Janeiro, Brazil, July 2013

H. Gast, "Cosmic-ray research with AMS-02 on the International Space Station", Origin of Mass 2013, Odense, 5-22 August 2013

H. Gast, Data Driven Science: "Data Management, Analytics and Visualization", 2nd Annual CHANGES Workshop, Chicago, 10-12 September 2013

H. Gast, „First results from the AMS Experiment on the ISS“, Kolloquium HU Berlin and DESY Zeuthen, December 2013

H. Stockhorst et al., Paper Contribution to the Invited Talk TUAM1HA02 at the COOL13 Conference, Müren, Switzerland, STOCHASTIC COOLING OF A POLARIZED PROTON BEAM AT COSY, 10th – 14th June, 2013.

H. Ströher, JARA-Fame Inauguration, Jülich (The Fate of Antimatter), Jan. 17, 2013

H. Ströher, FZ Jülich Führungskräfte-seminar 2013, Vaals (NL) (Präzisionsphysik im Rahmen von JARA-Fame), June 24, 2013

H. Ströher, ICNPF 2013, Crete (JEDI – The Jülich Electric Dipole Moment Investigations in Storage Rings), Aug. 28 – Sept. 5, 2013

Awards and Offers

Andreas Lehrach: Professor for Physics of Particle Accelerators at RWTH (since 07/2013)

Jim Ritman: Elected Spokesperson of the PANDA Collaboration