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FAIR Joint Core Team (JCT)

FAIR JCT Communication Channels

What do we have

- On request the FAIR JCT gives status reports at experiment-collaboration meetings and at other national and international events (Helmholtz events, symposia, colloquia, industrial forums).

- Individual JCT meetings with the international experiment collaborations at least once a year.

- The FAIR Newsletter, internationally distributed 4 times a year.

What will be new

- The FAIR JCT established a new information meeting:

  FAIR Monthly

  It will be an approx. 2 hours forum, first held on March 20th, 2007 and set up as a video broadcast for those who are not present. For guests on site it will offer a platform for a bilateral exchange of information, for asking questions and launching short presentations. There will be discussions about problems and you will obtain a general "update" about the status of the FAIR project.

  FAIR Monthly will take place in the GSI Lecture Hall, always on Tuesdays, 14:00-16:00 pm. Please note the following dates:

  March 20
  April 24
  Mai 22
  June 19
  July 24
  August 21
  September 25
**FAIR Committees and Working Groups**

**IKAB-Meeting at GSI**

The IKAB (In-Kind Advisory Board) had its first meeting at GSI on January 08th, 2007. Dr. Horst Wenninger has been elected chairman of this board.

The IKAB delegates met with the FAIR Joint Core Team to learn about the latest FAIR project status and to discuss strategies for in-kind contributions. IKAB will monitor technical evaluation of potential in-kind contributions as an ongoing process up to the formation of FAIR GmbH. Pragmatic measures have been discussed which should allow converging towards concrete proposals for potential in-kind contributions of interest for partner countries and their respective industries. Emphasis will be given to direct contacts of delegates as link-persons between partner country institutes/industries, the FAIR management team and technical experts.

An industrial fair at GSI is scheduled for summer 2007 to bring together companies from FAIR partner countries. This might be a good opportunity to identify concrete interests for specific technologies and to prepare adequate in-kind contributions and work-package contracts. A concrete date will soon be fixed and communicated.

**STI-Meeting at GSI**

The STI (Working Group on Scientific and Technical Issues) met on January 09th, 2007. Related to the IKAB issues, STI discussed the tracing of ongoing projects. Another topic was the idea to use the CERN web-based "EDMS" (Engineering Database Management System) database. It shall be of assistance for a clear definition, description and administration of the FAIR work packages in order to ease bilateral negotiations with the partner countries. Moreover STI will support IKAB delegates in establishing links to industries and institutes in FAIR partner countries.

In order to comply with the 10% cost savings requested by CoRe-A (subgroup on Cost Review for accelerators) and TAC (Technical Advisory Committee), STI members clearly welcome efforts of the experts to improve the FAIR accelerator layout accordingly. A correspondent review by miniTAC (expert subgroups of TAC) and TAC, now under Chairman Roland Garoby, who succeeded Yanglai Cho, shall be completed in summer 2007.

As for experiments STI appreciates the progress of the experiment collaborations and will continue discussions on funding, detector R&D as well as on computing.
Meeting of the International Steering Committee at GSI

The delegates of the ISC numerousely met on February 26th, 2007 at GSI for discussing how to proceed with the preparations for the two large research infrastructure projects FAIR and XFEL.

The ISC considered the preparation of all legal documents, prepared by AFI and necessary for the foundation of the FAIR GmbH, as complete. ISC FAIR agreed to the recruitment of the Research Director and the Integration Director for the FAIR Joint Core Team for a 3 year period. The ISC also endorses the proposed strategy for an EU-FP7 application for the FAIR preparatory phase. If this application is successful, the personnel of the JCT could be amended by scientists from the FAIR MoU signatory countries and paid by corresponding EU funds.

The most important issue to be solved is the successful completion of the negotiations between the participating countries on their contributions to construction and operation of the FAIR facility. Dr. Diehl, German delegate from the Ministry of Research and Education (BMBF), asks the ISC delegates for a faster decision process in the ministries of their countries in order to assure a timely start of construction.
Joint FAIR project of INFN and GSI:
A curved superconducting dipole for SIS 300 of FAIR
Pascquale Fabbricatore, INFN, Section of Genova

Since beginning of the year 2006 the Italian National Institute of Nuclear Physics (INFN) has started a R&D program aiming at developing fast cycled superconducting dipoles for the FAIR SIS 300 synchrotron. The INFN activities are organized within the framework of a project called DISCO_RAP (Dipoli SuperConduttori Rapidamente Pulsati), involving the INFN Sections of Genova, Frascati and Milano-LASA.

On the basis of the preliminary studies done at INFN a Memorandum of Understanding has been signed by GSI and INFN, finalizing the development of a 4.5 T curved cosΘ-magnet, 3.8 m long with a bore of 100 mm, fully integrated in its horizontal cryostat. Difficult R&D work is necessary as this magnet will be designed to have two main characteristics: It is curved with a bending radius of about 67 m and it will be operated in fast ramp conditions (1 T/s).

The INFN scope of work also includes the conductor for this magnet. In order to avoid ac losses caused by the electromagnetic coupling between the superconducting strands, the conductor will have a core in the form of a flat stainless steel strip of thickness 25 µm. It will be placed between the two halves of the Rutherford cable. Such a cored conductor implies difficult winding operations, why the INFN R&D program includes the production of dummy cables for winding tests and construction of winding models. The tests are carried out at AS-G superconductors (see figures), with the equipment already used for the LHC dipole manufacturing.

Activities for the DISCO_RAP project are expected to be finished within the year 2009. The total research program costs are evaluated with 4.7 M€ plus 11 full time equivalent (FTE) physicists, engineers and technicians. GSI contributes to the funding of this program with 1 M€, while the main part is funded by INFN.
**FAIR Deal with India**

On February 7th, 2007, during an India/EU Ministerial Science Conference in New Delhi, the Indian Minister of Science and Technology, Prof. Kapil Sibal and the German Minister of Research and Education, Dr. Annette Schavan, signed a joint declaration for the Indian participation in the construction and operation of FAIR. It states an Indian contribution of at least 3% of the construction costs of approx. EUR 1.2 billion. This is a successful step towards the beginning of the construction work. Moreover India agreed to make "an appropriate contribution" to the operation costs of FAIR as well.

The declaration also associates the creation of a network of Indo-FAIR-centres in India. These centres will be the contact points for Indian and other FAIR scientists and will coordinate the Indian FAIR activities.

In front from left to right: Dr. T. Ramasami, Secretary to the Government of India, Department of Science and Technology, Dr. Annette Schavan, German Minister of Research and Education, Prof. Kapil Sibal, Indian Minister of Science and Technology and Janez Potočnik, Commissioner for Science and Research of the European Union
January 8\textsuperscript{th}, 2007, on initiative of Prof. Krzysztof Jan Kurzydlowski, undersecretary in the Polish Ministry of Science and Higher Education, an informational meeting in Warsaw was held in order to introduce the two international research projects FAIR and XFEL to the Polish industry and science community. Prof. Wolfgang Jacoby and Dr. Ingo Augustin from the FAIR Joint Core Team introduced the FAIR project with two interesting presentations, while Prof. Massimo Altarelli illustrated the new laser project XFEL.

The impressive attendance of Polish scientists and industry representatives in this event showed Poland's great interest in joining the international science community of FAIR and XFEL. At the moment Poland is in concrete discussion about their financial contribution to both projects. Dr. Jacek Gierlinski, Poland's representative in the International Steering Committees of FAIR and XFEL, leads a corresponding negotiating group within the Polish Ministry of Science and Higher Education. He gets support from Prof. Reinhard Kessler and Prof. Andrzej Warczak from the Jagiellonian University of Cracow as well as from Prof. Krystyna Jablonska, physicist from the Institute for Physics in Warsaw.

\textbf{FAIR welcomes Austria}

During the Meeting of the International Steering Committee (ISC) on February 26\textsuperscript{th}, 2007 at GSI, Dr. Daniel Weselka, Head of Division in the Austrian Ministry for Education, Science and Culture, signed the FAIR Memorandum of Understanding for Austria. As one of the observer countries in all important committees, Austria has already been involved in the initial and recent developments of the FAIR project and one of the largest experiment collaborations of FAIR has an Austrian spokesperson.

By now 14 countries declared their intention to contribute to the FAIR project.
Besides heavy ions, the FAIR program relies on an abundant supply of antiprotons, the anti-particle of the proton. They are produced in violent collisions of protons with some heavy target species like copper or tungsten. The art of collecting large stacks of antiprotons in a storage ring has been developed in the early 1980's at CERN for the source of the SPS Collider. It was crucial for first producing the $Z^0$ and $W^\pm$ bosons in 1983. Later on, these methods have been further improved in the course of the Tevatron program at FNAL. As for the FAIR antiproton source, which comprises the Noble prize-winning stochastic cooling technique invented by Simon van der Meer, all these developments can be utilized.

In order to bring experts and potential users together, a small discussion meeting on the 'FAIR-GSI Antiproton Source' took place at INFN Ferrara (Italy). It was organized by Paola F. Dalpiaz and E. Steffens and attended by about 20 physicists from Italy, Germany, Switzerland and the US. The support of this workshop by G. Fiorentini and the INFN Ferrara is gratefully acknowledged.

K. Gollwitzer described the steady improvement and impressive performance of the Fermilab source (FNAL). The interplay of the 150 GeV proton driver, the production target and the collector and accumulator rings with their powerful cooling systems and optimization is the key for the high performance achieved after 20 years of continuous efforts. P. Sievers (Geneva-GSI) presented the design principles of the pioneering CERN source. Its driver of 26 GeV is similar to that designated for FAIR (29 GeV). The result, a smaller number of produced antiprotons per proton, can partly be compensated by a higher proton current.

M. Steck (GSI) and B. Franzke (GSI) discussed the 'baseline design' of the FAIR source which may result in a stacking rate of about 40% of that of the present FNAL source. A staging concept allows for increasing the performance by e.g. upgrading the Linac, the SIS100 as proton driver and – most important – the beam cooling systems. This was illustrated by D. Krämer (FAIR JCT), who presented the scope and the boundaries of the FAIR project and who explained the potential development of the FAIR institutions and facilities of the core proposal. One extra, presented by Y. Shatunov from BINP Novosibirsk and not yet contained in the costbook, might be the HESR storage ring as a collider involving electron cooling for both, the p and p_bar beams at full energy. Here, the symmetric and the asymmetric collider options are under study, the latter being proposed for the PAX experiment (see article below).
The meeting provided the potential users with a clearer view of the rate of antiprotons to be expected with realization of the baseline design and verification of the underlying assumptions. It also showed possible upgrade routes and the need for close cooperation with labs having the required know-how. Cooperating with FNAL seems to be a promising option in view of the phasing out of their collider program and their excellent source. In addition, a strong support through the future p_bar users, including PANDA, PAX and FLAIR, is necessary. A meeting of the whole community is planned for spring 2007 at GSI in order to emphasize the need for a powerful p_bar source available at an early stage of the FAIR project.

For more information:

http://web.fe.infn.it/spinwiki/index.php/Workshops
The existing Experimental Storage Ring (ESR) at GSI will be succeeded by the New Experimental Storage Ring (NESR) of the FAIR facility. The higher bending power of the NESR magnets allows more efficient production of highly charged ions and rare isotope beams. Both secondary beam species, rare isotopes and antiprotons, will be pre-cooled in the collector ring (CR) which is equipped with a stochastic cooling system. Accumulation of antiprotons at 3 GeV will be performed by a dedicated stochastic cooling system in the accumulator ring RESR. Pre-cooled rare isotope beams at an energy of 740 MeV/u can be accumulated in the NESR by a combination of longitudinal rf (radio frequency) manipulations and electron cooling.

The NESR with a circumference of 222 m provides large space for the installation of experiments and devices in four 18 m long straight sections. The electron cooling system covering the whole energy range of ions from maximum energy down to 4 MeV/u will be installed in one straight section; the second one is used for the installation of an internal gas jet or pellet target and for associated detector systems. Compared with the today’s ESR, the higher cooling rates of the electron cooling system of the NESR and an increased target thickness will allow operation at luminosities up to $10^{29}$ cm$^{-2}$s$^{-1}$, depending on the ion beam intensity.

The third straight section will accommodate an electron target for ion-electron collision experiments with cooled ion beams at variable relative velocity between ions and electrons. The electron target is a device similar to the electron cooler: A longitudinal magnetic guiding field produces very cold electrons with energies up to 40 keV.

The fourth straight section is common with that of the storage ring for electrons (small ring, see figure below) of an energy up to 500 MeV. The rare isotope beam stored in the NESR will collide with this electron beam for studies of the scattering of electrons on exotic nuclei: The ion optical design and the layout of the interaction region have been finalized. 40 short ion bunches in the NESR will be matched to 8 counter-propagating electron bunches in the electron storage ring.

In a future option (experiment proposal “AIC”) it is considered to fill the smaller ring with low energy antiprotons. Collisions between coasting beams of rare isotopes and antiprotons will allow the determination of neutron and proton distribution inside the nucleus by the absorption of antiprotons. The straight section for collisions can also be used for experiments regarding the interaction of the ion beam with laser light injected along the straight section.

Besides the experimental installations, a variety of components are needed to support the different modes of operation. Electron cooling will be crucial for high beam quality over the whole energy range and for highest luminosity in collisions with the internal target or a counter-propagating beam. For accumulation of pre-cooled rare isotope beams a barrier bucket rf system is considered to increase the intensity of the stored beam by longitudinal stacking. Very short bunches of about 15 cm length for the collider mode will be generated with a high harmonic (h = 40) rf system. High sensitivity diagnostics devices for the monitoring of low intensity secondary beams and for precision mass measurements of unstable nuclei by Schottky noise detection are required. Detection of single highly charged ions has been demonstrated in the ESR and will be possible in the NESR, too.
An important mode of operation of the NESR will be the deceleration of ions. While the production of highly charged ions, rare isotopes and antiprotons require a high beam energy, the deceleration will allow experiments with slow secondary beams. They are advantageous with respect to resolution and precision. After having slowed down the particles in the NESR, the FLAIR facility is designed to further decelerate and finally trap them. Antiprotons for FLAIR will be decelerated in the NESR from the production energy of 3 GeV to a minimum energy of 30 MeV. Deceleration in the NESR covers the full energy range from the normal injection energy of 740 MeV/u to 4 MeV/u for ions. For short-lived isotopes it is important that the ramp rate of all magnetic elements is as fast as 1 T/s, covering a dynamical range of the magnetic field strength of a factor of 25. After accumulation in the RESR, the antiprotons will be shared between the low energy experiments installed in the FLAIR area and the high energy experiments in the HESR storage ring.

Fast cooling by the electron cooling system provides low beam emittance needed to efficiently decelerate the secondary beams. Slow and fast extraction of decelerated beams with a magnetic rigidity below 4 Tm can be chosen according to the experimental requirements.

Sketch of the NESR hall with the main accelerator components and the present design of the collision region. The four straight sections accommodate the electron cooler, the internal target, the collision region, and the electron target. The extraction line (top) will be used with decelerated beams for FLAIR.
The proton, just like the electron, carries intrinsic angular momentum, called *spin*. According to our present understanding, the electron constitutes a point-like particle bare of any internal structure, and its spin is just one of its intrinsic properties, besides the electric charge and other quantities. The proton, instead, possesses an internal substructure, i.e. it is composed of smaller components, called quarks and gluons (*Fig. 1*).

![Diagram of the proton structure](image)

*Fig. 1: Pictorial representation of the proton structure. Three valence quarks, two up (red), one down (blue) are bound together through the exchange of gluons. In addition, short-lived sea quark-antiquark pairs appear.*

The nucleons are quite complex systems with three valence quarks (two up and one down quark in the proton, two down and one up quark in the neutron), surrounded by a sea of short-lived quark-antiquark pairs, where strange quarks (s) also appear. The nucleon is bound together through the exchange of gluons. An open question is: *How can the proton spin be derived from the properties of its quark-gluon structure?* There are several sources of angular momentum in the proton that can contribute to its spin: the intrinsic spin-½ of the quarks, the spin-1 of the gluons and the orbital motion of these particles.

Since the past 40 years, the most successful tool to study the internal structure of the nucleon has been the Deep Inelastic Scattering (DIS). Here, a high-energy lepton beam, composed of muons, electrons or neutrinos, scatters off the individual quarks. High-precision experiments at CERN (SMC), SLAC (143 ...) and HERA (HERMES) successfully mapped out the helicity distributions of charged partons inside the proton, the longitudinal quark polarization in a longitudinally polarized proton. Presently, the helicity distribution of gluons is being measured in the COMPASS at CERN and in polarization experiments at RHIC.

However, the spin tomography of the proton would ever rest incomplete without the determination of transversity: the quark transverse polarization inside a transversely polarized proton. Transversity constitutes the last missing leading-twist piece of the QCD description of the partonic structure of the nucleon. As for non-relativistic quarks, helicity and transversity would coincide because of the commutation of rotations and Euclidean boosts. A longitudinally polarized proton could be converted into a transversely polarized proton at infinite momentum. However, because the internal motion of the quarks is relativistic, this is not correct and the
difference of the two structure functions just reflects the relativistic character of the quark motion in the nucleon.

In contrast to the un-polarized and the longitudinal quark distribution, transversity is a chiral-odd quantity. This property makes it difficult to measure transversity because chirality is preserved in hard QCD processes and in electroweak processes. Chirality also decouples from inclusive DIS. It may contribute to some single-spin observables, but, because of its chiral properties, this chirality is hence coupled to other unknown functions. The glorious story of DIS spin physics from SLAC via CERN to HERA and RHIC would have an end without exploration of the transversity properties of the proton.

An entirely new story regarding studies of the spin structure of the proton might begin with the availability of a polarized antiproton beam at FAIR in Darmstadt. A cornerstone of the hadronic physics program at FAIR is the collection, cooling, storing and acceleration of antiprotons in the 15 GeV High Energy Storage Ring (HESR). The PAX Collaboration has suggested to convert HESR into an asymmetrically polarized proton-polarized antiproton collider and to study double polarized antiproton-proton Drell-Yan reactions. They will be entirely dominated by the annihilation of valence quarks in the proton with the valence antiquarks in the antiproton. The measured double spin-asymmetry $A_{TT}$ will allow the first direct measurement of transversity. Yet, no other existing or planned facility will be able to directly measure the transversity in a competitive way.

While polarized protons are readily available, the principal issue is how to polarize antiprotons. The early attempts at LEAR to polarize antiprotons by hadronic scattering did not work. The production of polarized antiprotons by weak decay of anti-lambda hyperons, as it was done in the E704 experiment at Fermi National Accelerator Laboratory (FNAL), provided unusable low beam intensities.

![Fig. 2: Unpolarized antiprotons, stored in a ring, pass through a polarized hydrogen target. The spin-dependent antiproton-proton interaction acts as a filter, it selectively removes one spin state from the beam.](image)

Up to now, "spin filtering" (repeated passage of an antiproton beam through a polarized hydrogen target inside a storage ring) is the only viable method to produce polarized beams of antiprotons. The pilot experiment was carried out with protons at TSR, Heidelberg (FILTEX) in 1992.

Although the FILTEX experiment clearly demonstrated that the spin-filtering technique works, the interpretation of the result is not unanimous. Presently under discussion is in particular the contribution to the polarization build-up of the electrons of the polarized atoms in the target. In order to make spin filtering a practicable method for polarizing antiprotons, preparatory experiments with protons and antiprotons are required.
The PAX collaboration has therefore initiated a program, which comprises:

I. Depolarization measurements of a polarized proton beam, stored in COSY, passing through an un-polarized storage cell gas target (accepted proposal for COSY),

II. Spin-filtering tests with the proton beam of COSY and

III. Spin-filtering tests with antiprotons at AD of CERN (Fig 3).

The depolarization and spin-filtering experiments with protons at COSY will help to disentangle the hadronic and electromagnetic contributions to the polarization build-up.

In proton-proton scattering, many double-spin experiments have been carried out with polarized proton beams and targets. As, up to now, polarized antiproton beams have not been available, our present knowledge about the spin dependence of the antiproton-proton interaction is marginal. At present it is not possible to obtain a robust estimation of the polarization build-up of a stored antiproton beam. Hence, it is mandatory to carry out spin-filtering experiments at CERN, using stored antiprotons hitting an internally polarized Hydrogen target. The antiproton-decelerator (AD) of CERN is currently the only machine worldwide which provides the required experimental conditions to perform such spin-filtering experiments with antiprotons. A new era in the investigation of the nucleon structure - similar to the former introduction of the DIS studies - might be opened in the case that an experiment such as PAX at FAIR succeeded in providing a beam of polarized antiprotons.
FAIR Links

FAIR calendar:
http://www.gsi.de/gsitools/fair_e.shtml

FAIR in the Internet:
http://www.gsi.de/fair/index_e.html

How to reach the location:
http://www.gsi.de/informationen/users/verkehr/index_e.html

FAIR in 'Nuclear Physics News' :

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