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The CERN 25 GeV Proton Synchrotron

The backbone of CERN celebrated its 60th Anniversary

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Summary

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Milestones in Physics (20)

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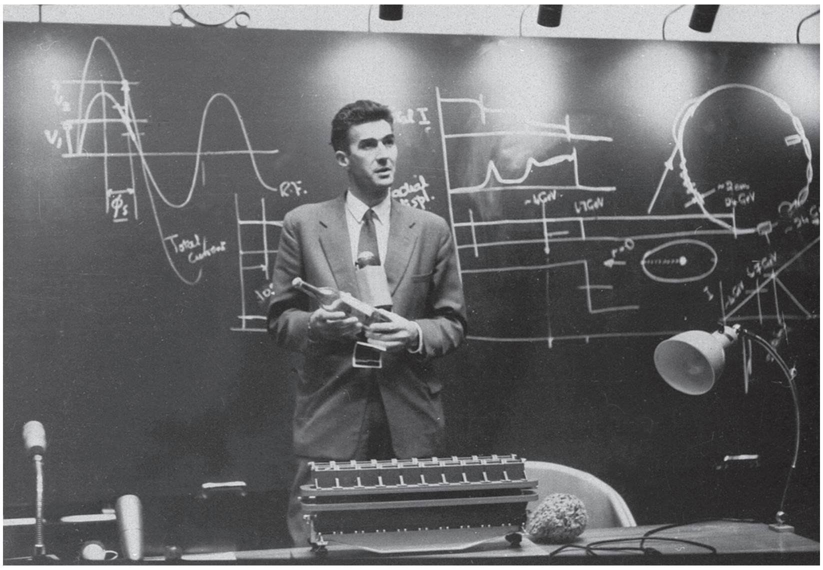

John Adams, leader of the construction team, during the celebration of the first acceleration of particles in the Proton Synchrotron (PS) to 24 GeV in 1959 (CERN-HI-5901881-1). More on the PS's 60th anniversary on p. 32. Picture: © CERN

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On 24 November 1959 the first proton beam was accelerated to 24 GeV. This event 60 years ago was duly celebrated in a colloquium at CERN in November 2019. This article summarizes the conception, design, construction and evolution of this unique physics instrument, which became the tireless workhorse and the unflagging backbone of the accelerator-based research programme of CERN [1, 2].

From the idea to decision

After World War II common action was considered a prerequisite for re-establishing Europe's science position as for example suggested in a declaration by Louis de Broglie at the "Conference Européenne de la Culture" at Lausanne in 1949. Isisdor Rabi's declaration at the General Conference of UNESCO in 1950 at Florence lent American support to this idea to pool European resources for nuclear research. Pierre Auger, a physicist active in cosmic ray research, assembled a Group of Experts in 1951 which finally proposed the construction of two accelerators: a very ambitious one which could not be "easily overtaken elsewhere" and a more conventional one for early operation. Obviously, the first one had to be a synchrotron and for the second one a synchro-cyclotron was chosen. After the first meeting of government representatives at the end of 1951, a convention was agreed provisionally establishing CERN in a second meeting in February 1952.

After ratification of this provisional convention, the CERN Council decided in its first meeting in May 1952 to establish four study groups. One of them, led by Odd Dahl, was formed for the Proton Synchrotron (PS). This Group presented already in June a first proposal for the construction of a 10 to 15 GeV proton synchrotron obtained from scaling up the 3 GeV weak-focusing Cosmotron at Brookhaven (BNL), which had reached 1 GeV. Three members of the study group, Dahl, Goward and Widerøe, visited Brookhaven in August and were acquainted there with a new idea, the Alternating-Gradient (AG) or "strong" focusing principle of particle beams which held the potential to substantially reduce the size of the vacuum chamber und hence the magnets producing the guide field. Odd Dahl presented two options to the 3rd Council meeting in October: a 10 GeV weak-focusing (estimated magnet weight 6000 t) and a 30 GeV strong-focusing synchrotron (700 t) with identical cost within the error margins. Council boldly entrusted the group with a study of the 2nd option, strongly advocated by O. Dahl, though in untried and new, risky territory. The site of Geneva was selected at the same Council meeting. In June 1953, a referendum against this choice was successfully passed in the Canton and Republic of Geneva and the final CERN convention was signed by the then twelve member states.

A more detailed study discovered serious beam stability problems brought about by sensitivity to inevitable magnet misalignments and field inhomogeneities enhanced by the too strong magnet field gradient in the combined-function magnets which provide the dipole guide field and the focusing quadrupole field gradient. A concerted theoretical effort leading to a number of parameter iterations and friendly help from colleagues from Brookhaven provided understanding and a satisfactory parameter set so that the 7th Council meeting in October 1953 could take the decision to aim at a strong-focusing synchrotron which would reach 25 GeV with a magnetic dipole field of 12 kG.

Construction of the PS

The preliminary design of the main components had started in institutes spread all over Europe, in Bergen, Paris, Heidelberg and Harwell. However, the design team reached its efficiency only until its transfer to Geneva in the course of 1954. John B. Adams became the project leader after resignation of O. Dahl and the final parameters were adopted in December 1954.

The strong-focusing magnet lattice with 2π 100 m orbit length contained 100 combined-function magnet units of 4.4 m nominal length with a field index n = 288 and a total steel mass of 3400 t. The magnet unit was assembled from 10 blocks consisting of 1.5 mm thick steel sheets glued together.

Each magnet was equipped with pole-face windings to correct i) for the remanent field at the injection energy of 50 MeV where the field level is as low as 140 G and ii) for saturation effects at high fields. Sixteen out of the twenty 3 m long straight section were reserved for the accelerating cavities and the eighty 1.6 m long short straight sections housed auxiliary magnets as quadrupole correction lenses, sextupole and octupole lenses. The width of the vacuum chamber in the main units was 14 cm and its height is 7 cm.

The rise time was set to 1.0 to 1.2 s and the pulse rate

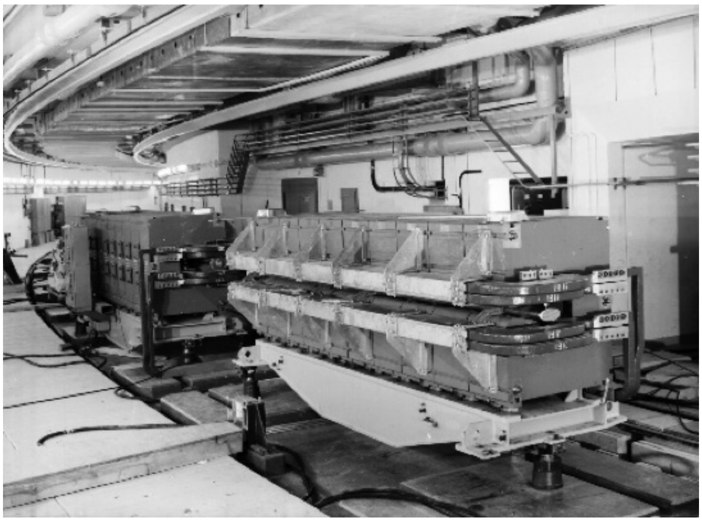

Figure 1: The first magnets in the PS tunnel [3].

10 to 12 per min depending on the final energy of 25 resp. 28 GeV corresponding to a maximum magnetic field of 12 resp. 14 kG. The maximum required peak electrical power of 32 MW was provided by a motor-generator set with a flywheel as energy storage. Sixteen ferrite-loaded accelerating cavities tune-able between 3 to 10 MHz supplied 54 keV per turn.

Civil engineering had started in May 1954 even before the ratification of the convention in September. Exploration of the subsoil showed that the machine could be based on a concrete ring-shaped beam of 2 × 2 m^2 cross-section supported by pillars founded on the competent deeper molasse rock under the moraine. The PS tunnel building was finished by mid-1957 and the magnet installation was complete in June 1959 (Fig. 1).

Running-in and first operation

Despite the choice of a hitherto unknown technology and an inexperienced team the running-in took a surprisingly short time. The first turn of a proton beam at 50 MeV was obtained in middle of September 1959 and, after the RF system was complete in October, the acceleration tests started. A few GeV were quickly reached and the beam reached a kinetic energy of 24 GeV on 24 November after a modification of the low-level RF control system. The pulse intensity was 3 × 10^{10} protons, beyond the design intensity of 10^{10}. By the way, the sister accelerator at BNL in Brookhaven, the Alternating-Gradient Synchrotron (AGS) developed in friendly competition with the PS, started operation in summer 1960 after having reached 31 GeV in July.

The next years saw an intense effort to better understand the accelerator, improvement of the beam observation, an increase of the available RF voltage and expansion of the experimental facilities. The main power supply was modified in 1960 to provide a flat top so that two bursts from the internal targets could be produced in the same acceleration cycle: a short one (hundreds of ms) for the bubble chambers and a long one (up to 400 ms) for counter experiments.

After a first neutrino experiment had failed in 1961, a unique neutrino beam was constructed based two novel technologies: a fast-ejected beam (Fig. 2) produced by fast kicker magnet and a pulsed magnetic horn for efficient focusing of the parent mesons and, therefore, of the neutrinos produced in the reaction $p \rightarrow$ external target $\rightarrow \pi \rightarrow \mu\nu_{\mu}$. However, the experiment taking data in 1963/1964 came too late to compete with BNL where the discovery of the existence of at least two neutrinos was made in 1962, which understandably led to some deception.

Figure 2: Fast-extracted proton beam in PS 1963 [4].

Although fast extraction was also used later for the short spill needed for the bubble chambers and, therefore, mitigated somewhat the radiation damage brought about by the use of internal targets, the development of the so-called slow extraction serving external targets and already proposed in 1961 was intensified. In this extraction mode, the beam is slowly "peeled" at top energy during the so-called flat top by means of a non-linear resonance with a thin electrostatic septum magnet deflecting the beam out of the vacuum chamber. The first tests took place in 1964 and the refinement of this technique continued over the years beyond the elimination of the internal targets in 1980 and is still in use.

Consolidation and operation as injector

By end of 1965, 10^{12} protons per pulse had been reached and the protons were shared between nine experiments by means of four internal targets, one slow-extraction and a fast extraction. However, new demands for the PS were coming up: operating as injector for the Intersecting Storage Rings (ISR), a new neutrino beam line for the new heavy liquid bubble chamber Gargamelle, and feeding protons to the planned West Hall earmarked to house the large hydrogen bubble chamber BEBC and the Omega experiment. Hence, a comprehensive and long-term improvement programme was decided by the CERN Council in December 1965, where also the ISR programme was approved.

A new, performing main magnet power supply was foreseen and came in operation in 1968, which provided e.g. two flat tops at different energies in the same magnet cycle. The injection energy was raised to 800 MeV by interleaving between the 50 MeV linear accelerator (Linac 1), a fast-cycling four-ring synchrotron, the PS Booster (PSB), which became operational in 1972 and boosted indeed the number of protons in the PS pulse to 5 × 10^{12} and, in consequence, the neutrino flux to Gargamelle by a factor three, which was essential for the discovery of the neutral currents by this experiment.

The increasing intensity and the inevitable losses implied and implies a relentless effort to replace radiation damaged and ageing components: e.g., all vacuum seals made from organic material were replaced by 1972. Magnets had to be replaced from 1967 onwards and the damaged units became spares after having been refurbished with new coils; all pole-face windings very exposed to radiation by their position close to the vacuum chamber were completely replaced by 1979; the ageing original Linac 1 was superseded by Linac 2 of CERN design authorised in 1973 and coming on line in 1978.

For the ISR, a new fast-extraction system and new beam lines were constructed and beam was delivered to the ISR from late 1970 onwards. The 450 GeV Super Proton Synchrotron (SPS), approved in 1971 and entering the scene in 1975, required a novel extraction technique, called somewhat obscurely Continuous Transfer (CT), to cope with its circumference of 11 times the one of the PS. Each PS pulse was cut into five beamlets in betatron phase space prior to extraction by means of a combination of a fast kicker, fast beam bumpers, and a thin septum in order to fill with two PS pulses 10/11th of the SPS circumference by boxcar stacking. Obviously, this crude cutting of the beam resulted in intolerable particle losses with increasing intensity and had to make way for the novel and much more efficient Multi-Turn Ejection (MTE) commissioned in 2008 (see section "New challenges").

Antiparticles enter the scene

After failing to discover the J/Ψ and the Υ in the ISR for lack of performing 4π detectors in the early 70's, the attention of CERN turned to two new projects having a substantial impact on the PS: i) conversion of the SPS into an proton-antiproton collider in the medium term; ii) construction of a Large Electron Positron collider (LEP).

Since the antiproton phase space density was crucial for the luminosity of the SPS collider and this density was too low in the secondary beam created by the primary proton beam hitting the target, it was imperative to increase this density by beam cooling both in the transverse and longitudinal phase space. This was performed in the new large-acceptance Antiproton Accumulator (AA), accumulating secondary antiprotons at 3.5 GeV/c for hours and simultaneously increasing the 6-dimensional phase space density of the accumulated coasting beam by means of stochastic cooling which had been pioneered in the ISR. In order to increase the rate of antiproton production by a factor 10, a second ring, the Antiproton Collector (AC), was installed in 1987 around the AA, the latter being in operation since 1980. Stochastic cooling also in the AC increased this phase space density by up to 4×10^9 before the beam was extracted to the AA, where the beam was accumulated over hours or days continuing cooling until transfer.

The PS provided every 2.4 s a primary beam of up to 1.4×10^{13} 25 GeV protons per pulse, which had to be grouped in one quarter of the PS circumference to match the circumference of the AA. This challenge ushered in a new chapter in treating bunched beams in longitudinal phase space. This RF technique reached its culmination in the complex manipulation of the PS bunches to prepare the beam for LHC (see section "New challenges"). After a number of trials, a two-step process was adopted taking place on the flat top of the PS cycle at ejection energy where initially the proton bunches occupy 20 equidistant positions around the circumference. In the first step, each group of 10 consecutive bunches are merged into five bunches which produces a beam filling half of the circumference. In the second step, the distance between the bunches is progressively halved yielding a beam in a quarter of the circumference as required.

Since the momentum of the accumulated antiproton beam was too low for direct injection into the SPS, the beam was injected into the PS and accelerated to 26 GeV/c before transfer to the SPS. Weak pilot bunches of antiprotons taken from the stack in the AA were used to check the correct functioning of the whole chain from AA to SPS in order to avoid the loss of the whole stack painstakingly collected over some 24 hours. Even with this precaution, the cliff-hanging operation created daily anxiety for the PS team and their clients in the SPS.

The PS was thus a key player in the successful SPS proton-antiproton programme pursued from 1980 onwards and terminated in 1991, which established the existence of the heavy bosons $W^{\pm}$ and Z^0. However, this programme had not been the only user of antiprotons. The strong interest in low-energy physics with antiprotons had led to the construction of a small Low-Energy Antiproton storage Ring (LEAR), which provided from 1982 to 1996 a constant flux of antiprotons over spill times of several hours after filling of the ring. A single bunch, of usually 10^9 antiprotons, was skimmed off the AA stack and, after deceleration in the PS to 609 MeV/c, transferred to LEAR where it could be either decelerated to as low as 100 MeV/c (5.3 MeV kinetic energy) or accelerated up to 2000 MeV/c. For most of the experiments, ultra-slow extraction provided a continuous spill until the next fill. In order to simplify the costly operation involving four accelerators (AC, AA, PS, LEAR), the AA was dismantled in 1997 and the AC was converted into the 3.5 GeV/c Antiproton Decelerator (AD) now in operation since 2000 providing decelerated antiprotons down to 100 MeV/c (5.3 MeV). In order to increase the antiproton flux at lowest energy by decelerating the particles from AD even further to down to 100 keV, the Extra Low ENergy Antiproton (ELENA) ring is under commissioning. It has only 30 m circumference and is fitted inside the AD. To eliminate the blow-up of the beam during deceleration, stochastic and electron cooling are used in the AD, whereas the latter cooling technique suffices for ELENA.

Studies for the long-term LEP project started in 1975 and they had shown that the electrons and positrons could be accelerated in the two existing synchrotrons PS and SPS without fundamental modifications. This was an overwhelming argument to choose a site in close vicinity to the existing CERN site when the project was authorized in 1981. Hence, the PS had to shoulder this additional task, which implied the construction of a 600 MeV lepton Linac and of a small accumulation ring sequentially providing electron and positrons to the PS, and the addition of injection and extraction systems. The acceleration to 3.5 GeV within 1.2 s of two consecutive pulses of positrons followed by two pulses of electrons was accomplished by the existing 10 MHz RF system tuned to 3.8 MHz, but two new cavities operating at 114 MHz were installed to prepare the PS bunches for proper injection into the SPS and trapping by its 200 MHz RF system. Since the PS ring is composed of combined-function magnets, the horizontal betatron oscillations would be excited by the synchrotron radiation at higher energies whereas the energy oscillations would be strongly damped. Hence, the damping of the horizontal oscillations had to be established by the addition of two short so-called Robinson gradient wiggler magnets each consisting of four blocks of a total magnetic length of 46 cm so that they could be easily housed in the existing straight sections. In order to limit the synchrotron radiation induced gas desorption from the vacuum chamber, a vacuum improvement programme was carried out in the mid-80s. All 100 magnets received a new vacuum chamber made out of vacuum-fired stainless steel and the total pumping capacity was substantially augmented reaching 80 × 200 l/s and 40 × 400 l/s yielding a static pressure of 1×10^{-6} Pascal in static conditions. After these modifications, the PS beam was ready for the first injection tests of LEP in 1988 and the new challenge of regular operation of LEP between 1989 and 2000.

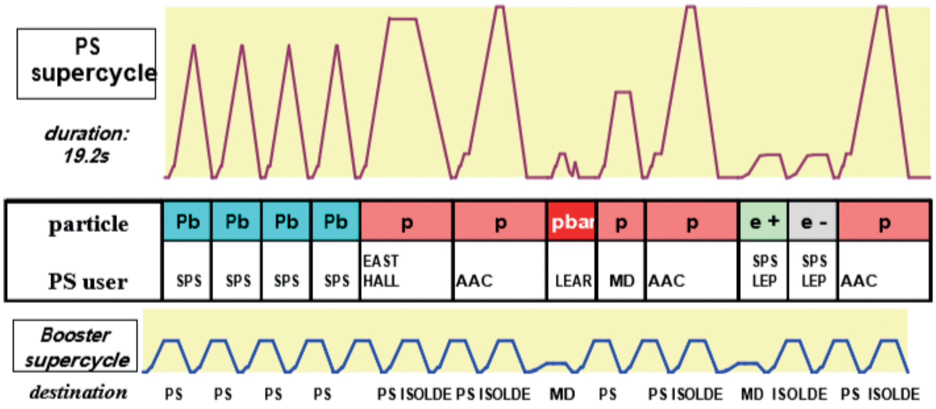

Figure 3: Typical PS super-cycle in 1995 of 19.2 s. The upper graph shows the PS magnetic field and the lower graph the field of the PSB as a function of time [5].

The versatile particle factory

The backbone of the operation of the PS was, of course, the flexible, continuously upgraded beam instrumentation and control system, which handled the timing and the sequencing. The first computer was installed in 1967 to assist the operators and the PS was proud of a memory upgrade to 16 k words (sic) in 1968. By 1981, a network of computers has taken over not only the monitoring and operation of the main ring but also of the injectors and AA. The whole dispatching of the beams was computer-driven. The various cycles providing very different beams had become the substructure of a super-cycle. The super-cycles were composed on the basis of the agreed schedule with the users and, once established, could be executed at will with high precision and reproducibility without tedious retuning. As illustration of the astonishing PS versatility, Fig. 3 gives an example of such a 19.2 s long super-cycle used in fall 1995 which was an especially demanding year with 6800 h operation. Nevertheless, the availability for SPS and LEP was 92%. The shown super-cycle was composed of four cycles delivering 3.5 GeV/c/u Pb beams to the SPS for fixed-target physics; a 24 GeV proton beam for similar experiments in the East Hall; 25 GeV protons for antiproton production for AC; deceleration of 3.5 GeV/c antiprotons for LEAR; protons for machine development; 3.5 GeV positrons and electrons for LEP via SPS, and a 2nd cycle for the AC. The PSB super-cycle reveals that the PSB was providing a 1 GeV proton beam for a nuclear physics programme (ISOLDE) in its spare time when not needed for the PS. Obviously, when the PS celebrated its 40th anniversary in 1999, it had become the heart of a vast system of accelerators serving a large physics community and executing multiple tasks not dreamt of in 1953 when the decision for its construction was made.

New challenges

In the 1990s and early 2000s, the PS faced two major challenges: the request for even higher intensity beams on one side, and the request for very dense ("high brightness", defined as the intensity divided by the transverse emittances) beams for the Large Hadron Collider (LHC), approved in 1994 and constructed at CERN 1998 – 2008 in the former LEP tunnel.

The request for higher beam intensity was mainly pushed by the neutrino appearance experiments installed in the INFN Gran Sasso Laboratory in Italy and deserved by the CERN neutrino beam named CERN Neutrinos to Gran Sasso (CNGS), operating between 2006 – 2012. In order to deliver a sufficiently high neutrino flux to the experiment, a maximum proton beam intensity was required culminating in an intensity record of 3.5 × 10^{13} reached in 2004.

With the quest for higher and higher intensities, the beam loss brought about by the extraction using the continuous transfer technique became unacceptably high and a new extraction mode was devised: the Multi-Turn Extraction (MTE). It consists in a resonant extraction process based on beam splitting in the horizontal phase space. Non-linear elements (sextupoles and octupoles) are used to excite a fourth-order resonance (Fig. 4). By a controlled adiabatic crossing of this resonance, the beam is split into four islands and one core, with essentially no particles in between. The beam is then extracted in two consecutive 5-PS turn long pulses towards the SPS to uniformly fill 10/11th of the SPS circumference.

The other, very different new client for beams from the PS was the LHC. The LHC requires beams with a high proton density ("brightness"), as well as a certain time structure which the PS generates using its different RF systems. A whole variety of beam types for the LHC can be produced by the injector complex, underlining its flexibility. The main type of beam used by the LHC is the beam with 25 ns bunch spacing. For this beam, the PSB produces six bunches at 1.4 GeV energy, which are then transferred in two extractions (4 + 2 bunches) to the PS. In the PS the beam is accelerated to a top energy of 26 GeV and at the same time the bunches are longitudinally split at an intermediate and final energy. This scheme employs consecutively the RF harmonics 7, 21, 42 and 84, which leads to a 12-fold splitting of each bunch. The resulting number of bunches produced from the six bunches coming from the PSB is hence 72. The

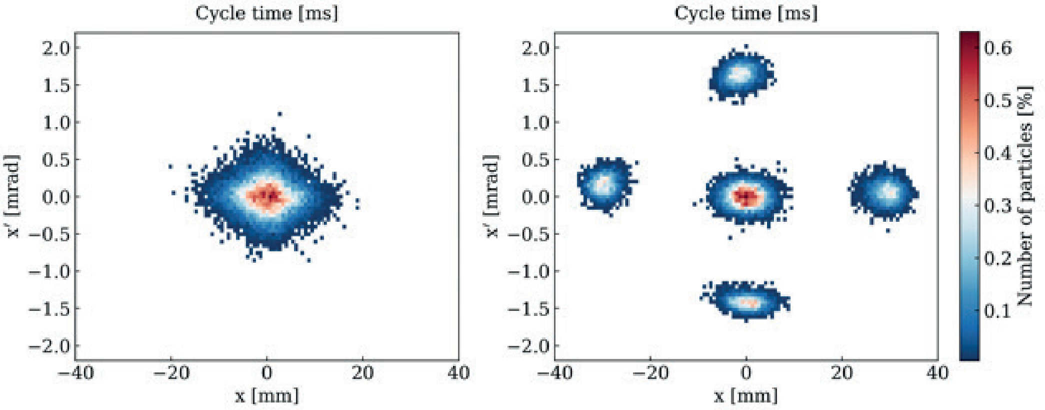

Figure 4: Principle of multiturn extraction. The uniform beam distribution (left) is split in horizontal transverse phase space into four beamlets and a core (right) which are then consecutively extracted with essentially vanishing beam loss [6].

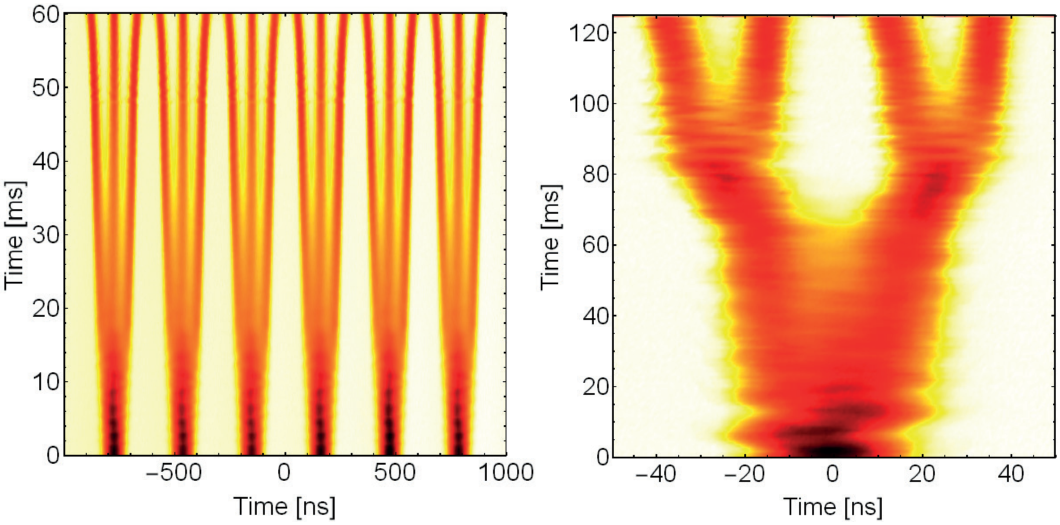

Figure 5: Evolution of the longitudinal structure of the LHC 25 ns beam in the PS as a result of the bunch splitting at 2.5 GeV and 26 GeV. The position of the bunches along the circumference is plotted horizontally and the time increases along the vertical axis. See for example [7, 8].

evolution of the bunch distribution as a function of time as a result of complex RF manipulations is shown in figure 5. In a first step triple splitting of each bunch coming from the PS Booster is performed at 2.5 GeV (left figure); in a second step, two consecutive double splittings are performed at 26 GeV, yielding 72 bunches to be injected into the SPS.

A word on ions

After the ISR runs with deuterons and alphas supplied by the PS in the 1970s, the demand increased at CERN for heavier ions to be delivered as a primary beam to the SPS North experimental hall. The installation of a new ECR (Electron Cyclotron Source) along with a dedicated RFQ and a number of upgrades in the PS enabled delivery of a total of around 2 × 10^9 oxygen ions per SPS shot to a variety of experiments in 1986. One year later, up to 9 × 10^9 sulphur ions were accelerated at CERN to a world-record energy of 6.4 TeV (200 GeV/u). The success of the oxygen and sulphur runs in the SPS pushed the users to request heavier ions. Since this was out of reach of CERN's Linac 1, a new ion injector chain was constructed in collaboration with Czech, French, German, Indian and Italian institutes consisting of a new ECR source and a new Linac ("Linac 3") based on a novel compact, high-gradient Interdigital H-type structure suggested and built by GSI. Linac 3 injected ions first into the PS Booster, where they were pre-accelerated before being injected into the PS. During this transfer, the charge state of the ions was progressively increased by stripping, first at the exit of Linac 3 to an intermediate charge state (Pb^{53+}), followed by full stripping in the PS-SPS transfer line. Between 1995 and 2002 the PS complex delivered lead ions to the SPS, followed by an Indium run in 2003. While the intensities and brightness delivered was sufficient for the fixed-target program, the upcoming LHC ion program requested intensities orders of magnitudes beyond what could be delivered by this injection scheme. This led to the decision to convert the low-energy ion ring (LEAR) to and ion accumulator and cooler, called Low Energy Ion Ring (LEIR), operating as buffer between the fast-cycling linac and the slow cycling PS. The PSB stopped injecting ions into the PS in 2004, and LEIR operation started in 2005, injecting into the PS, where the new Pb ion beam was commissioned in 2006. In this configuration, the PS is today delivering Pb ion beams for the LHC ion program as well as for the fixed target ion program.

Upgrades and future

While the injector complex is delivering beams to the LHC well within and beyond the original specifications, the High-Luminosity LHC program (HL-LHC) is aiming at beam parameters well out of reach of the present injectors. Figure 6 shows the beam emittance versus beam intensity, indicating the values presently achieved and the one requested by the HL-LHC program. In order to enable the injector chain to deliver high-brightness beams in the High-Luminosity LHC era, CERN has put in place the LHC Injectors Upgrade (LIU) project. This project comprises the replacement of CERN's proton Linac (Linac 2) by a new H^- Linac (Linac 4) with an increased injection energy in the PSB, the increase of the top energy of the PSB from 1.4 GeV to 2.0 GeV and upgrades of the PS and SPS synchrotrons [9, 10].

The upgrade program of the PS focuses on issues both in the transverse and longitudinal plane. In the transverse plane, the direct space-charge tune spread pushes the beam on betatron resonances causing beam loss and transverse emittance blow up. The upgrade of the injection energy to 2 GeV will help to overcome this limitation. The transverse damper was also upgraded to cope with transverse instabilities and to reduce injection errors. Concerning the

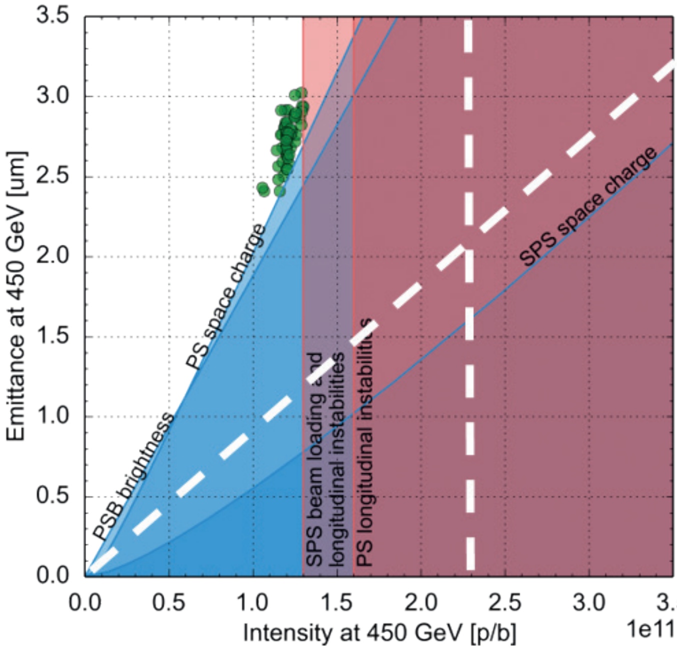

Figure 6: Bunch emittance versus intensity for LHC beam at SPS extraction. The green circles are measured data before LIU upgrade, the intersection of the dashed white lines is the target to be reached for the HL-LHC era. The main limitations to be overcome are space charge effects and instabilities in the injector synchrotrons. See for example [11, 12].

longitudinal plane, coupled bunch instabilities appearing after the transition energy would limit the maximum intensity per bunch well below the 2.6 × 10^{11} p+ per bunch of the future HL-LHC type beam if no countermeasures were taken. A new dedicated longitudinal damper, based on a Finemet® cavity and a new low-level RF have been installed to stabilise the beam. The electronics of the 1-turn delay feedback was also renovated with a new digital system for the main accelerating cavities. The high-frequency cavities are being equipped with additional multi-harmonic feedbacks. Beyond these main upgrade items, new hardware items are being constructed, as for example beam instrumentation, RF components and beam dumps.

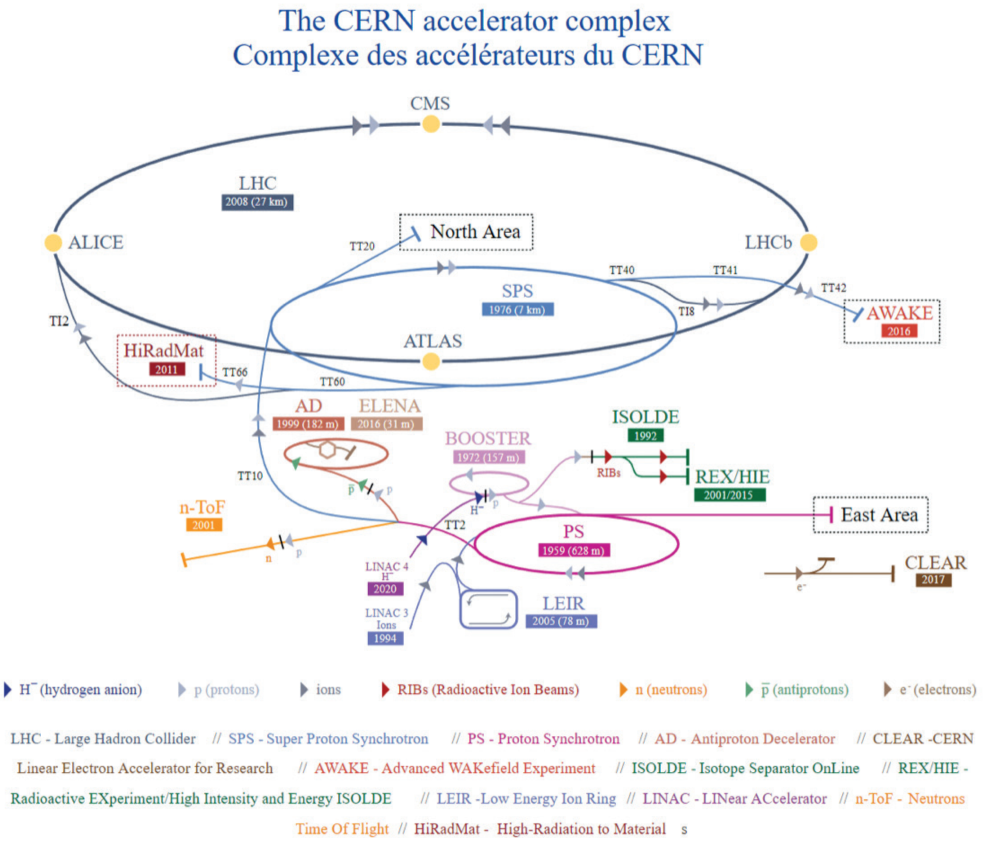

Figure 7: An overview on the various accelerators and experiments at CERN. The years of their start of operation as well as their circumferences (where appropriate) are also shown.

Summary

Sixty years after its commissioning the PS, one of the two oldest synchrotrons still in operation, is today the hub for CERN's entire physics program as shown in Fig. 7. Accelerating protons and heavy ions for the fixed target physics and the LHC, the PS keeps on evolving and ramping up its performance, exceeding by orders of magnitude the original specifications. Multiple consolidation and upgrade programs have been performed over the years, culminating in the presently ongoing LIU project. During the upcoming run 3 of the LHC, the whole injector chain will ramp up its performance in order to satisfy the needs of the upgraded High-Luminosity LHC. For the foreseeable future, the PS will remain the heart of CERN's accelerator complex serving both CERN's collider and fixed-target physics program.

Klaus Hanke (*1968) promovierte 1997 in Physik an der Universität Hamburg / DESY. Ab 1998 Beschleunigerphysiker am CERN. Arbeitsgebiete Betrieb der Linacs und Hadronquellen, RFQ Entwicklung und Strahldynamik, Studie einer Neutrino Factory, Verantwortlich für den Betrieb des PS Booster (PSB), Mitarbeit am Linac 4 Projekt, Verantwortlich für den Betrieb des Isotopenseparators ISOLDE. Derzeit verantwortlich für den Betrieb des CERN Proton Synchrotrons (PS) und Projektleiter im Rahmen des LHC Injectors Upgrade (LIU) Projektes.

Kurt Hübner (*1937) promovierte in technischer Physik an der Technischen Hochschule Wien. Ab 1964 Mitglied der Division für Beschleunigerforschung im CERN. Arbeit am Speicherringmodel für die ISR (CESAR), an den Intersecting Storage Rings (ISR), der LEP-Injektorkette und der CLIC-Studie. Forschungsaufenthalte im Budkerinstitut Novosibirsk, SLAC und DESY. Leiter der CERN PS-Division 1991-1993, Direktor für Beschleuniger 1994 bis Mitte 2001. Fellow der Europäischen Physikalischen Gesellschaft.

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