

Inside Story

Super Proton Synchrotron turns 40

The workhorse of CERN's accelerator complex continues to drive discoveries.

The Super Proton Synchrotron (SPS) was approved by CERN Council in December 1970. By mid-May 1976 a beam circulated for the first time, although it took another month to get the radio-frequency system to operate correctly. The first beam was accelerated to 300 GeV on 17 June (the SPS was originally approved as a lower energy machine called the 300 GeV Project), which happened to be the day of the Council meeting. John Adams formally asked the Council for permission to accelerate the beam further to 400 GeV, and 10 minutes later we were there!

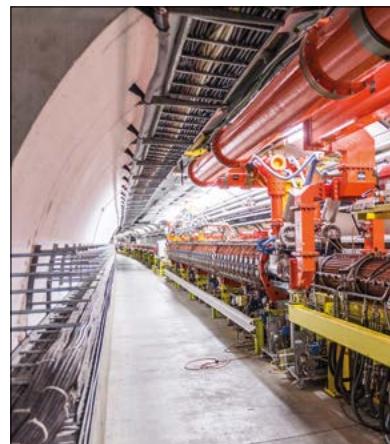
The approval of the SPS was a long process that began in the early 1960s. Initially it was supposed to be a completely new laboratory located in the south of France, but there was deadlock in the Council when it was realised that the additional infrastructure would add considerable extra cost to the project. Adams broke the deadlock when he proposed to build the machine deep underground across the road from the Meyrin site.

Even during the construction of the SPS, events were taking place elsewhere at CERN that would prove to be pivotal in turning CERN into the world's greatest particle-physics laboratory. The first was the demonstration of stochastic cooling, already proposed in 1968 by Simon van der Meer as a method of increasing the density of particle beams in the Intersecting Storage Rings. The second was the discovery of weak neutral currents at the Gargamelle bubble chamber fed with a neutrino beam from the smaller Proton Synchrotron (PS). The existence of neutral currents had been predicted by the nascent electroweak theory, which also predicted the existence of two vector bosons with a rough estimate of their masses.

Carlo Rubbia was the first to realise that the SPS could be converted into a storage ring with a sufficient energy to create these W and Z bosons. Since the SPS was a single ring, he proposed that the protons were collided with



Left: The occasion of the first beam accelerated in the Super Proton Synchrotron on 17 June 1976, showing (back row, left to right): Claudio Aramatea, machine operator; H P Kindermann, radio-frequency system; Bas de Raad, beam transport; Michael Crowley-Milling, who built the control system; and the present author Lyn Evans, then a junior physicist. Front row: Simon van der Meer (left) and J D Pahud, who were responsible for the SPS power supplies. Right: Inside the 7 km-circumference SPS tunnel.



Initially it was planned to site the 300 GeV Project in the south of France.

the counter-rotating antiprotons produced by the PS and then stored in a special ring where they could be cooled using stochastic cooling. Once a sufficient number of antiprotons had been accumulated and cooled, they would be transferred to the SPS and accelerated, together with protons, to the maximum energy that the SPS could muster (initially 270 GeV). In 1978, work started on building the Antiproton Accumulator and to convert the SPS into a part-time storage ring. In 1983 the first W and Z particles were observed, winning Rubbia and van der Meer the Nobel prize the following year.

Although the SPS is not a superconducting machine, the proton-antiproton collider was also an essential step towards the design of the LHC, for instance by elucidating the

physics of bunched-beam hadron colliders. The SPS has proven to be an extremely versatile machine, mainly because of the quality of its design and construction. It has provided particle beams, protons and heavy ions to fixed-target experiments for 40 years, including a neutrino beam for the detectors in the Gran Sasso laboratory 800 km away. The SPS has also served as the injector to LEP, where it accelerated electrons and positrons to 22 GeV, and today it accelerates protons to its maximum energy of 450 GeV for injection into the LHC. Yet thanks to the care with which it has been maintained, the core of the machine is still the same as it was 40 years ago.

The SPS, together with the PS, continues to be the workhorse of CERN today. It serves thousands of users, both for the LHC experiments and the fixed-target community, in addition to providing test beams for high-energy physics and also for a new plasma wake-field experiment called AWAKE. Thank you SPS. We look forward to another 40 years!

● Lyn Evans, former LHC-project leader and director of the Linear Collider collaboration.