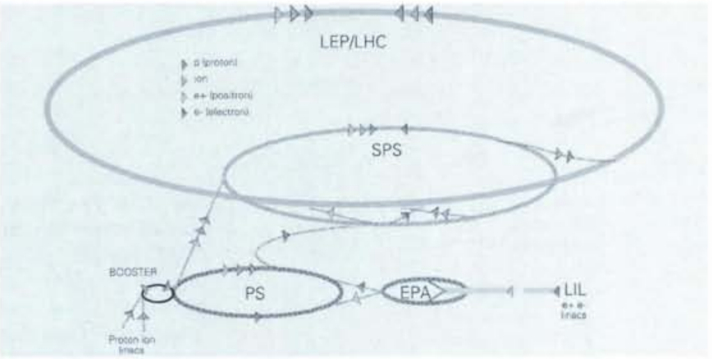


*Fig. 2 — The injector complex for the proposed LHC proton-proton collider that would be mounted above the existing LEP electron-positron collider.*

crease it to beyond $10^{34}$ cm$^{-2}$ s$^{-1}$ for specific purposes (the injector system is illustrated in Fig. 2).

**Complementary to SSC**

Important goals call for action everywhere and the United States has launched the construction of the SSC, a 40 TeV proton-proton collider with a circumference of 87 km, on a completely new site in Texas (the DoE approved US budget calls for $318 million to be spent in fiscal 1991). By exploiting important existing infrastructure, the LHC is in a position to be completed early enough to be competitive as its energy of 16 TeV is sufficient to cover the promising ground around the one TeV level. Moreover, the machine's higher luminosity would ensure an important complementarity, by compensating for the lower energy in making better use of infrequent collisions where the active constituents, quarks and gluons, take a large fraction of the energy of the protons they belong to. Indeed, CERN's $\bar{p}p$ collider remained competitive with Fermilab's Tevatron in the exploration of W and Z production despite its lower energy. It is only because this physics is well understood after eight years of detailed research that the CERN machine is now falling behind.

By the time SSC comes fully on stream with its higher energy as an overwhelming asset, one will still have the unique opportunity to collide LHC's protons against the LEP's electrons and positrons, thus continuing HERA's study of electron-proton collisions which starts shortly, but at three times the energy (1.7 GeV).

CERN's existing accelerator complex also accelerates heavy ions — a capability which will be extended to lead. The LHC could therefore be used to provide lead-lead collisions at 1312 TeV per nucleus — over 30 times the energy developed by RHIC, a new accelerator in the US. RHIC is set to receive funding for construction in the 1991 budget, and specific as opposed to broader, generic detector projects are now starting to be supported. Research is to focus on the quark-gluon plasma, a new state of matter which should have existed at high temperature and density during the first microseconds after the Big Bang. The corresponding phase transition of the vacuum will thus be achievable in the laboratory.

With electron-proton and lead-lead collisions, the physics potential of the LHC shows both versatility and complementarity in addition to its primary goal of shedding light on the puzzling aspect of the vacuum. The latter was also the motive for Newton to understand action at a distance, for Einstein to overthrow the ether, and for Dirac to propose antimatter. In each case, meeting properly the challenges inevitably heralded remarkable developments.

## John Stewart Bell

The prominent CERN theoretical physicist J.S. Bell died on 1 October of a stroke at 62 years of age. Though he left us far too soon, his contributions to quantum physics will remain as a lasting testimonial. He is universally known for the inequalities that go by his name. Reported in 1964, they showed that the specific probability correlations imposed by quantum mechanics could not be obtained from any set of preset values for hidden variables, and that any local realistic model was thus ruled out. Together they represent a major advance in the understanding of quantum mechanics starting from the famous paradox of Einstein, Podolsky and Rosen formulated in 1935. With characteristic modesty, he described the outcome of this advance into an intellectual territory where few dare to tread as a "dilemma".

In a convincing series of experiments, A. Aspect demonstrated in 1982 that the Bell inequalities are indeed violated by photon polarization correlations, and that the observations are in full agreement with quantum mechanics.

John Bell was born and educated in Belfast, Northern Ireland, graduating from Queen's University in Experimental Physics in 1948, and in Theoretical Physics a year later. His scientific career is rich with famous contributions other than his clarification of the deep and puzzling nature of the quantum state. His independent derivation of the CPT theorem was part of his thesis work in the mid-fifties under R. Peierls at the University of Birmingham, UK during a leave of absence from the UK Atomic Energy Authority, Harwell which he had joined in 1949. But for a leave of absence at the Stanford Linear Accelerator Center, California, USA in 1964, he worked in the CERN Theory Division from 1960. This period led to the discovery, in 1969, of the Adler-Bell-Jackiw anomaly pointing out a profound question in field theory. The effect of this anomaly, which spoils a symmetry at the quantum radiation level and challenges the renormalizability of the theory, has to be eliminated. The quark-lepton symmetry of the standard model responds to this demand.

Although a deep thinker in quantum physics, he fully understood those he called "why bother'ers" who merely use quantum mechanics as a tool to obtain physically meaningful results. His own work along such a line developing the violation of CP symmetry, completed in the mid-sixties, is a masterpiece. Other important contributions across a remarkably broad range of interests included work in accelerator physics, some of which he co-authored with his wife Mary, an accelerator engineer at CERN. His major achievements have been recognized by the Dirac Medal (1988) and the Heinemann Prize (1989).

John Bell was profound and much could be learnt from him. Yet his modesty, particularly with respect to the philosophical causes supported by some of his ideas, was impressive. As he himself said: "What I really wanted was a clean argument rather than to justify any particular conception of the world. From what I know of my own character, which is somewhat stubborn, I am often more concerned with the conduct of the debate and its logic than the actual truth". On his success with the inequalities: "Then people started doing the experiments: the results confirmed ordinary quantum mechanics and therefore disconfirmed Einstein's hopes. Then there was more and more publicity."

Despite the publicity, his approach to physics, epitomizing depth, modesty, rigour and imagination, stands as an enduring model: "What we deal with in physics are the simplest situations. We simplify questions to the limit in the hope of finding that the laws of simple things can be built up into the laws of complicated things."

**M. Jacob**
*Theory Division, CERN, Geneva*