

shutdown of the Bevalac concentrated research on the properties of nuclear matter, especially dilepton production and studies of reaction dynamics using the new Equation Of State (EOS) Time Projection Chamber. The last experiment to be run was led by a collaboration from Japan, headed by Isao Tanihata, measuring the properties of radioactive beams near the proton drip line. Physics analysis of the large volume of data accumulated during this intensive year of running is now in full swing.

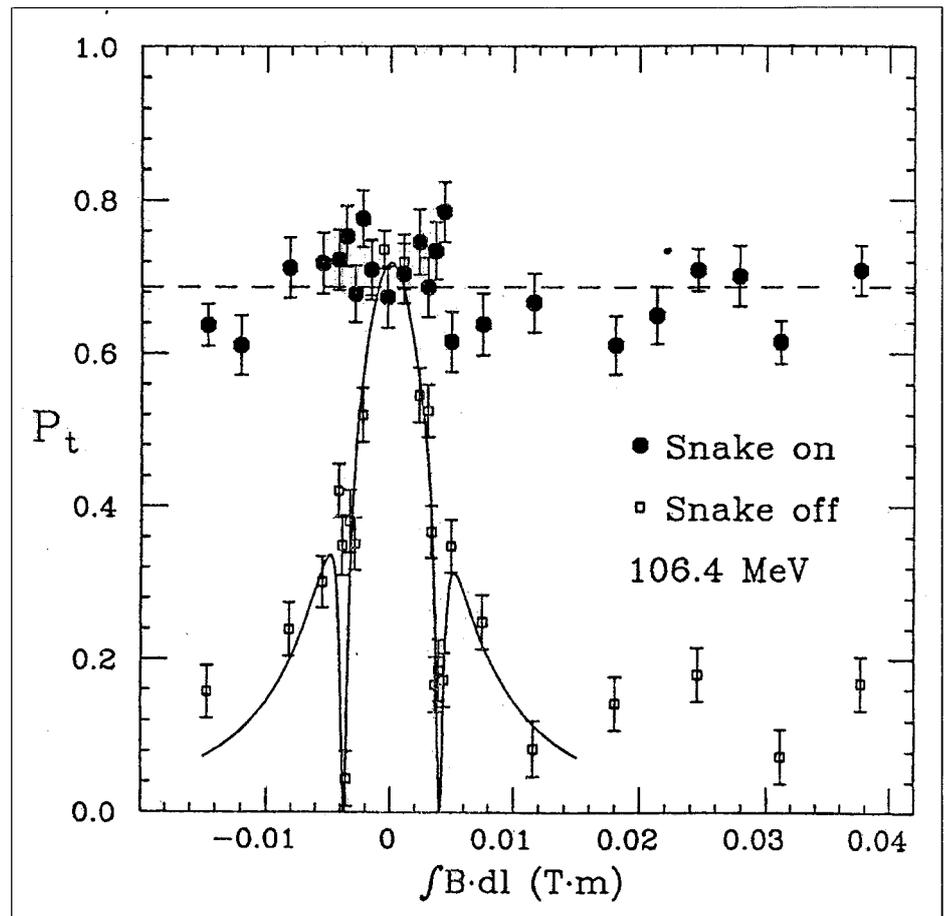
## MICHIGAN/INDIANA Siberian Snakes strike again

Siberian snakes are showing themselves to be even more deadly than expected in killing their prey, the depolarizing resonances which would make it very difficult to accelerate polarized protons to TeV energies at accelerators such as the Tevatron, UNK, LHC, and SSC.

The snake concept was proposed in the mid-1970s by Siberians Yaroslav Derbenev and Anatoly Kondratenko at Novosibirsk, but the snakes lay almost dormant until Owen Chamberlain, Ernest Courant, Alan Krisch, and the late Kent Terwilliger organized the 1985 Superconducting Supercollider (SSC) polarized beam workshop in Ann Arbor, which highlighted the need to test the concept.

The idea is to rotate the spin through  $180^\circ$  on each turn in the ring. With such successive spin flips, the depolarizing effects seen in one turn should be cancelled by an equal and opposite perturbation on the subsequent turn.

The new Cooler Ring at the Indiana



*'Siberian Snakes' save spin. The total transverse proton beam polarization at the Indiana Cooler Ring plotted against the imperfection magnetic field integral with the Siberian snake device on (circles) and off (squares). The solid line is a fit to the imperfection depolarizing resonance peak and radiofrequency resonance dips; the dashed line is a constant fit to the snake-on data.*

University Cyclotron Facility then seemed an excellent test site for these eager but untested serpents. The Michigan/Indiana/Brookhaven team led by Krisch constructed the world's first snake and found that it could easily overcome its initial enemy, the imperfection depolarizing resonances caused by ring magnet imperfections (January/February 1990, page 20). In the next few years the growing team of "herpetologists" showed that Siberian snakes could overcome all kinds of depolarizing resonances, including the intrinsic kind (caused by the vertical betatron oscillations which keep the beam focused) and the synchrotron resonances (caused by synchrotron oscillations in energy).

The team also discovered a new type of snake that was inadvertently built into the cooling section. This so-called type-3 snake rotates the spin around the vertical direction. A full type-1 snake (such as the team's superconducting solenoid magnet) rotates the spin by  $180^\circ$  around the beam direction; a type-2 snake rotates the spin around the radial direction.

Despite this display of serpentine power, the snake experts still questioned the ability of a Siberian snake to overcome all depolarization problems at TeV energies. At very high energies, the depolarizing resonances may become so strong that they are even wider than their normal 523 MeV separation, and

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# People and things

*In March, Jiro Kondo (centre), President of the Science Council of Japan, visited CERN, where he was shown the muon spectrometer of the new Chorus neutrino experiment by Klaus Winter (left) and Shigeki Aoki of Kobe. (Photo CERN HI22.3.93)*

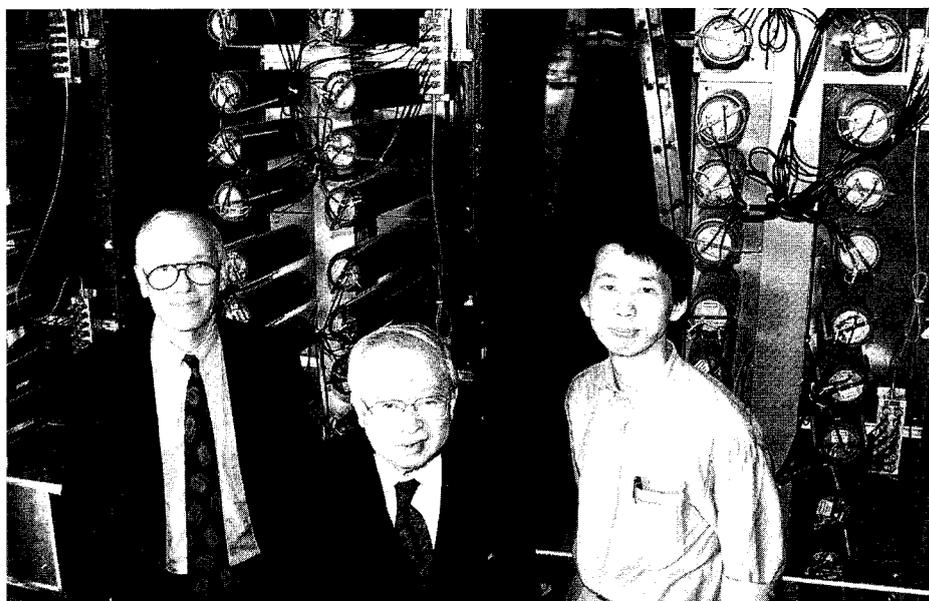
would then overlap.

The snake team decided to study overlapping depolarizing resonances by building a 25 kV radiofrequency solenoid magnet to create an depolarizing resonance in the Indiana Cooler Ring. This new resonance was then forced to overlap with the nearby imperfection depolarizing resonance by varying the solenoid's frequency. The experimenters found a sharp destructive interference between the two overlapping resonances; while this still cannot be calculated theoretically, such effects are well known in physics. Fortunately the Siberian snake was powerful enough to overcome completely both overlapping resonances and all their interference effects, keeping the beam fully polarized.

The potency of these serpents is being closely followed at accelerator laboratories around the world.

Meanwhile, Krisch and his colleagues assembled the SPIN Collaboration to encourage the use of Siberian snakes at TeV accelerators. This Collaboration (Michigan/Indiana/Fermilab/North Carolina/IHEP-Protvino/JINR-Dubna/Moscow/INR-Troitsk/KEK/Kyoto) contains about 40 accelerator experts, 40 spin experimenters and one theorist. The SSC's 20 TeV lattices could include more than 50 empty straight sections, typically 20 metres long, for subsequent installation of many Siberian snakes.

For Fermilab, SPIN produced a 146-page report - Accelerating Polarized Protons to 150 GeV in the Fermilab Main Injector- and has just started work for a similar report on the possibilities for accelerating and storing polarized protons in the Tevatron Collider.



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## On people

*CERN Director General Carlo Rubbia, together with François Gros, Director of the Institut Pasteur in Paris, and distinguished Belgian chemist Ilya Prigogine, will advise European Commissioner for Research and Educational Policies Antonio Ruberti on new directions for European Community research policy. Carlo Rubbia's special concern will be the internationalization of research and the development of major world-scale projects.*

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## US awards

*Prominent astrophysicist David N. Schramm of Chicago has been awarded the 1993 Julius Edgar Lilienfeld Prize of the American Physical Society. As well as recognizing contributions to physics, the prize is awarded for skills in presenting science. Schramm's citation reads 'For his manifold contributions*

*to nuclear astrophysics and his ability to communicate the joy and excitement of science to a diversity of audiences.'*

*Recent American Institute of Physics awards included the Compton Award to Victor Weisskopf, doyen of the world particle physics community, recognizing his 'leadership throughout the world in advancing science, promoting peace and seeking solutions to world problems'. The citation underlined his roles as CERN Director General from 1961-65 and as founder of the US High Energy Physics Advisory Panel (HEPAP) as well as his contributions as teacher and author. In the 1930s, Weisskopf worked with Schrödinger, Heisenberg, Bohr and Pauli before moving to the US in 1937.*

*The American Institute of Physics Science Writing Prize has gone to author and science historian David Cassidy for his book 'Uncertainty, The Life And Science of Werner Heisenberg' (W.H. Freeman, 1991).*