

ACCELERATOR STUDIES

EXPERIMENTAL TEST OF THE SIBERIAN SNAKE CONCEPT

A.D. Krisch, S.R. Mane*, R.S. Raymond, T. Roser, K.M. Terwilliger, J.A. Stewart
Randall Lab of Physics, University of Michigan
Ann Arbor, Michigan 48109

H.O. Meyer, R.E. Pollock, F. Sperisen, E.J. Stephenson
Indiana University Cyclotron Facility, Bloomington, Indiana 47405

E.D. Courant, S.Y. Lee, L.G. Ratner
Brookhaven National Laboratory, Upton, Long Island, New York 11973

We are interested in achieving a polarized proton capability at the 20 TeV Superconducting Super Collider. At the Ann Arbor SSC Accelerator Workshop in December 1983, we proposed that "Siberian Snakes" might allow the acceleration of polarized protons at SSC at a relatively small incremental cost. We then hosted a successful DPF sponsored Workshop on Polarized Beams at SSC at Ann Arbor, June 10-15, 1985 which produced a fairly detailed plan for adding polarization capability to SSC. In fall 1987 we submitted a request to the SSC/CDG to leave 50 10-meter long straight sections in the SSC lattice for the installation of Siberian Snakes.

We are now beginning an accelerator physics experiment at the Indiana University Cyclotron Facility (IUCF) proton cooler ring, which will be the first experimental test of the Siberian Snake concept for dealing with depolarizing resonances. If this test is successful, Siberian Snakes might be used to accelerate polarized beams to very high energies at facilities such as the 20 TeV SSC, the 800 GeV Tevatron and the 100-200 GeV RHIC.

The basic concept of the Siberian Snake, proposed around 1975 by Derbenev, Kondratenko, and Skrinsky, is to rotate the spin by 180° about a horizontal axis on each turn around the ring. This should result in any spin precession which occurs in one turn being exactly cancelled by the opposite precession in the next turn. This technique would eliminate the depolarizing resonances which are otherwise encountered during acceleration of polarized beams. The technique of correcting or jumping depolarizing resonances was first developed at the ZGS and is now used at the AGS, KEK, and Saturne to cross a moderate number of resonances (<50). However, it seems impractical for very high energy accelerators; at the SSC each 20 TeV ring would have about 36,000 depolarizing resonances!

If the Siberian Snake concept really works then future accelerators could have spin experiments with the very high energy polarized protons; thus we feel that a "proof of principle" experiment is quite important. An experimental verification of the Snake concept would greatly improve our ability to use Siberian Snakes to maintain polarization in high energy accelerators.

After reviewing all existing polarized proton facilities we concluded that the new Cooler Ring at IUCF is especially appropriate to test the Siberian Snake concept for the

following reasons:

- Its 6 m long straight sections allow the insertion of a type 1 Siberian Snake spin-rotator (superconducting solenoid).
- It could soon have polarized protons injected from the existing cyclotron polarized beam.
- The Cooler ring has both types of 1st order depolarizing resonances within its energy range:

$$\text{Imperfection:} \quad G\gamma = 2 \quad T = 108 \text{ MeV}$$

$$\text{Intrinsic:} \quad G\gamma = 13 + \nu_y = 2.135 \quad T = 179 \text{ MeV}$$

where $G = (g - 2)/2 = 1.79$ while g is proportional to the magnetic moment of the proton, $\gamma = E/m = 1 + T/m$, and ν_y is the vertical betatron tune. Both depolarizing resonances are expected to be rather strong and could provide a good test of the Siberian Snake concept.

We propose to carry out the set of studies summarized in the following table.

Step	Condition	Purpose	Time Requested	Hardware Required
4.1 a/b	Vertically p_{\uparrow} No Siberian Snake	Test polarimeter Check depolarizing resonances	8 shifts @ 100 MeV 5 shifts @ 170 MeV	2 Injection Kickers* 1 Power Supply CE-01 detector† Internal Target†
4.1 c	Unpolarized beam with Siberian Snake No acceleration	Test solenoid quadrupole configuration Measure ν_y	3×2 shifts	Supercond. sol.* Compen. quads.† Quad. power supplies†
4.1 d	Horizontally p_{\uparrow} Siberian Snake No acceleration	Test elimination of depolarizing resonances by Siberian Snake	8 + 11 shifts	Spin rotator in injection line†
4.1 e	Vertical p_{\uparrow} Siberian Snake Correction Dipoles	Test elimination of depolarizing resonances	8 shifts	Programmable correction dipoles†
4.2	Horizontal p_{\uparrow}	Study Snake Resonances	(15 shifts) Not now requested	Nothing New

Our proposal was approved in June 1987 with top priority and is now Exp. CE-05 at the IUCF Cooler Ring, which is shown in Fig. 1. We have constructed at Michigan two ferrite injection kicker magnets and one power supply. One kicker and its power supply

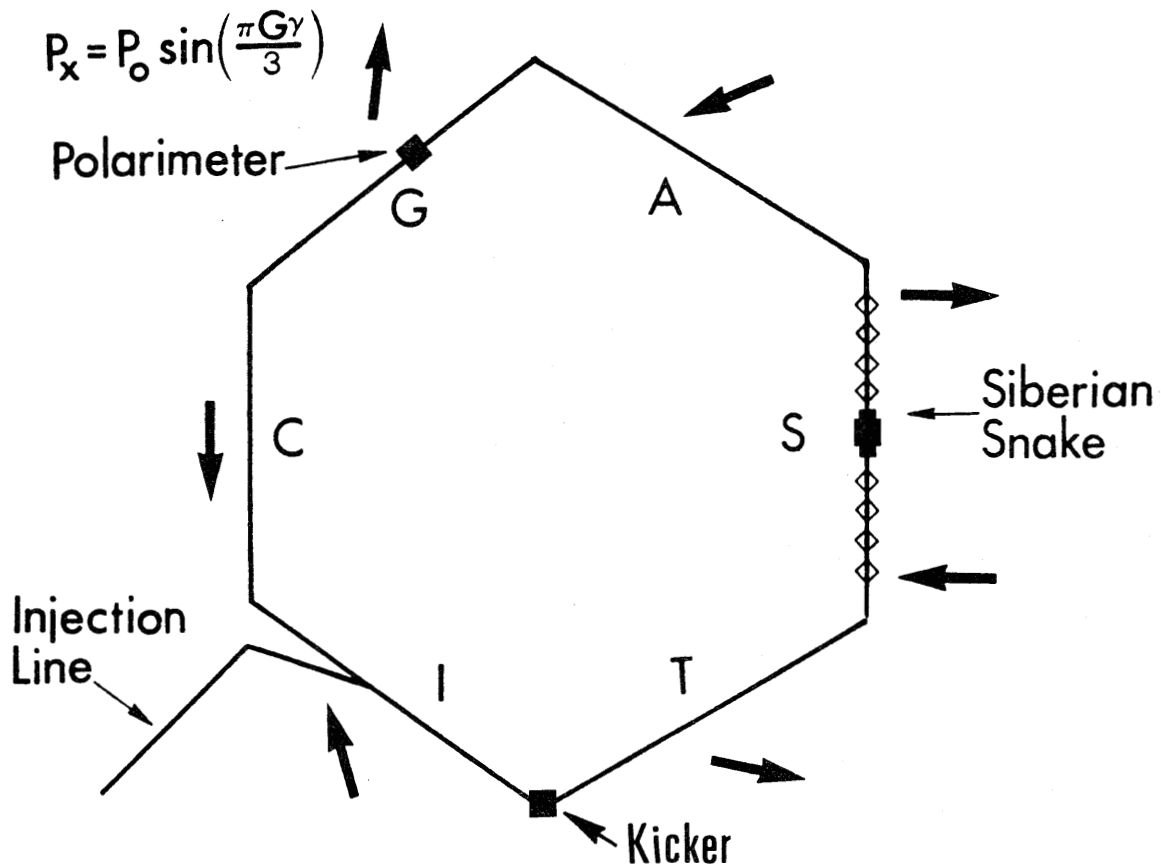


Figure 1. A schematic diagram of the Cooler ring showing the location of the kicker injection magnet, the CE-01 detectors to be used as a polarimeter, and the Siberian Snake magnet system. Also shown are arrows indicating the polarization direction for the horizontal plane experiment.

have just been installed in the Cooler ring and were successfully tested yielding a fall time of about 180 ns. Our first two runs are occurring in mid-March and early April 1988 and will respectively test the Indiana-constructed polarimeter and the injection of polarized protons into the Cooler ring using the new kicker. Our main data taking should begin in Summer-Fall of 1988 after the Siberian Snake itself has been installed.

*Present address: Fermilab, Batavia, IL 60510