SSCL-N-799
Sept. 1992

# The Effect of Small Changes in Higher Multipole Moment Systematic Errors on the SSC Dynamic Aperture

T. Garavaglia, and S. K. Kauffmann

*Superconducting Super Collider Laboratory,**
*2550 Beckleymeade Avenue, Dallas, TX 75237*

Tracking experience using SSCTRK [1] has indicated that arc random errors have a greater effect on the dynamic aperture than do arc systematic errors. Since the ten-million turn dynamic aperture of the Collider is small $\sim$ 3.5 mm, it is to be expected that small additions of very high-order systematic multipole moments will little affect it. As there may be difficulty in measuring the tolerances specified for systematic $B_5$ and $B_7$ in the present design for the SSC dipole magnets, a tracking study has been performed to determine the effect on the dynamic aperture of using readily measurable values for these systematic errors. The presently specified values are $Bsys_5 = Bsys_7 = .005$, while the readily measurable values are $Bsys_5 = Bsys_7 = .02$.

We have used SSCTRK to track 64 particles, 16 seeds and 4 grid points, for $10^5$ turns using the benchmark values and the expected measurable values. The Palmer [2] method has been used to extrapolate the $10^5$ turns particle-loss data to estimate the long-term, $10^7$ turns, Collider dynamic aperture. With this method,the statistical uncertainty in the predicted rms radius of the Collider long-term dynamic aperture is $\sim$ .2 mm. The effect we have found on the Collider dynamic aperture resulting from these high-order

* Operated by the Universities Research Association, Inc. for the U.S. Department of Energy under Contract No. DE-AC35-89ER40486.

Moments.tex

systematic multipole changes is within these statistical uncertainties. We conclude that these changes would have no significant effect on the long-term Collider dynamic aperture.

The present results where obtained using SSCTRK on the FSU Cray YMP computer. In Fig.1a we show the particle-loss data for the benchmark run (RUN181S). For this case the Palmer method gives a long-term dynamic aperture of 3.6 mm ±.2 mm. Fig. 2a gives the same data for the case when $Bsys_5 = Bsys_7 = .02$ (RUN181T). The Palmer prediction for this case is a long-term dynamic aperture of 3.8 mm ±.2 mm. Thus, the change in the dynamic aperture is within the statistical uncertainty. In Fig. 3a, we show the results for the case when the systematic errors in the skew multipoles $Asys_5$, $Asys_6$, and $Asys_7$, as well as the values $Bsys_5$ and $Bsys_7$, are changed from the benchmark value of .005 to .02. For this case (RUN181U), the Palmer extrapolated long-term dynamic aperture is 3.8 mm ±.2 mm. This result is also within the statistical uncertainty. The results for the particles not yet lost for the three cases considered are shown in Fig. 1b, Fig. 2b, and Fig. 3b, respectively.

## REFERENCES


[1] D. Ritson, in *Nonlinear Problems in Future Particle Accelerators,* edited by W. Scandale and G. Turchetti (World Scientific, Singapore, 1991) p. 304.

[1] R. Palmer and S. K. Kauffmann, in *SSCL-N-771,* edited by H. T. Edwards (SSCL, August,1991) Appendix 6.

## FIGURES

FIG. 1a. The particles lost data for the benchmark case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.005$.

FIG. 2a. The particles lost data for the case with $Bsys_5 = Bsys_7 = 0.02$, and $Asys_5 = Asys_6 = Asys_7 = 0.005$.

FIG. 3a. The particles lost data for the case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.02$.

FIG. 1b. The particles not lost data for the benchmark case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.005$.

FIG. 2b. The particles not lost data for the case with $Bsys_5 = Bsys_7 = 0.02$, and $Asys_5 = Asys_6 = Asys_7 = 0.005$.

FIG. 3b. The particles not lost data for the case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.02$.

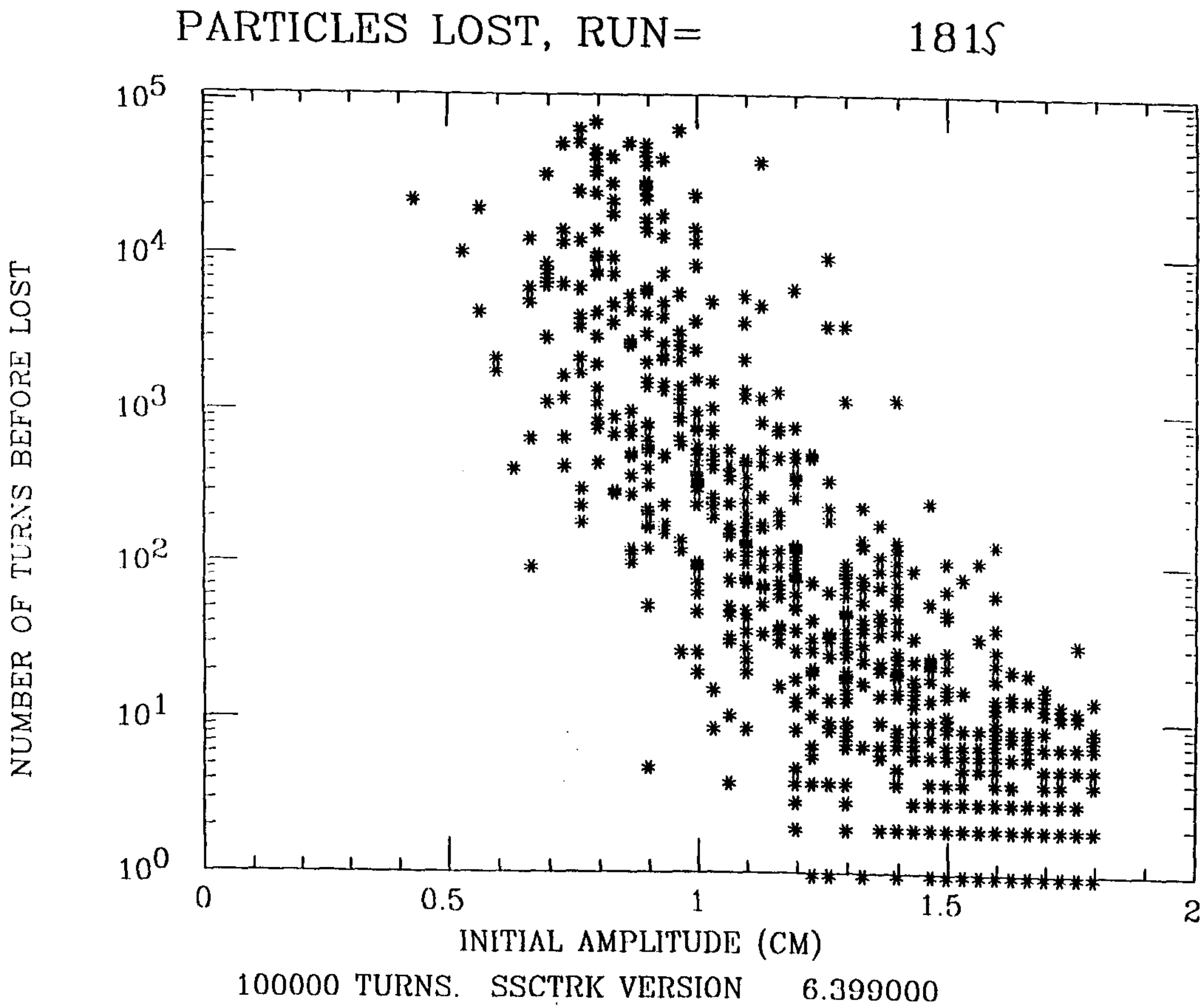


FIG. 1a. The particles lost data for the benchmark case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.005$.

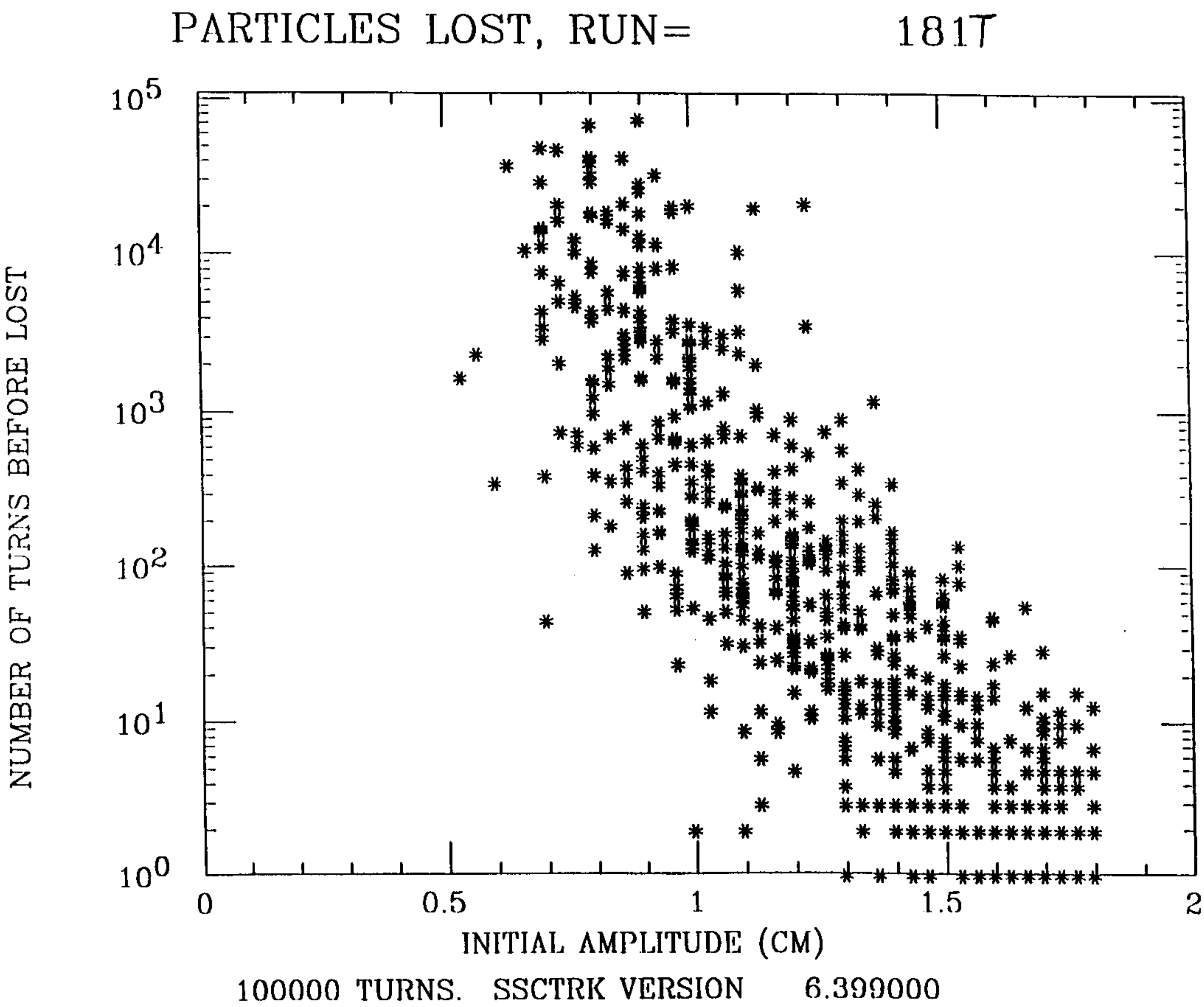


FIG. 2a. The particles lost data for the case with $Bsys_5 = Bsys_7 = 0.02$, and $Asys_5 = Asys_6 = Asys_7 = 0.005$.

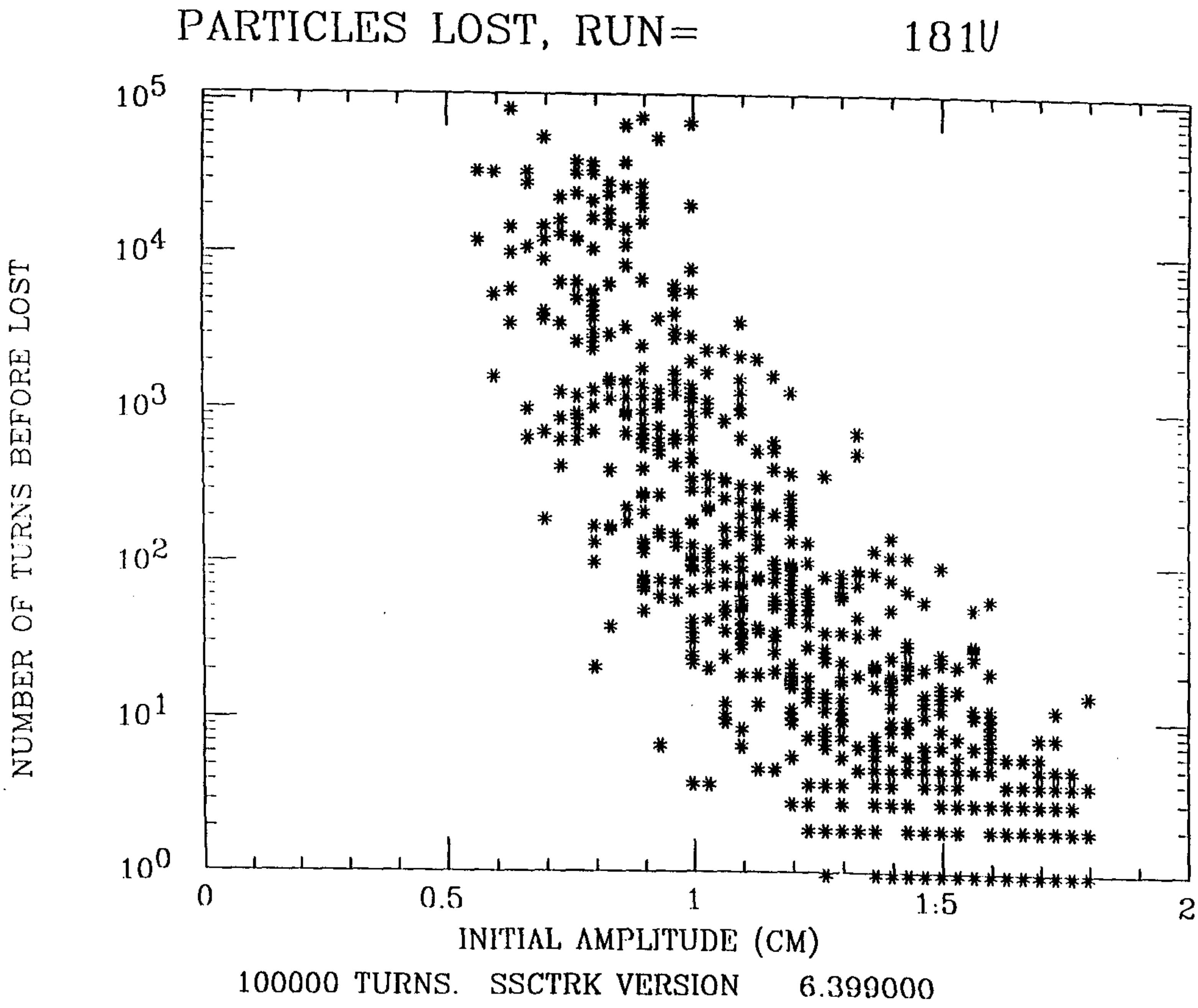


FIG. 3a. The particles lost data for the case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.02$.

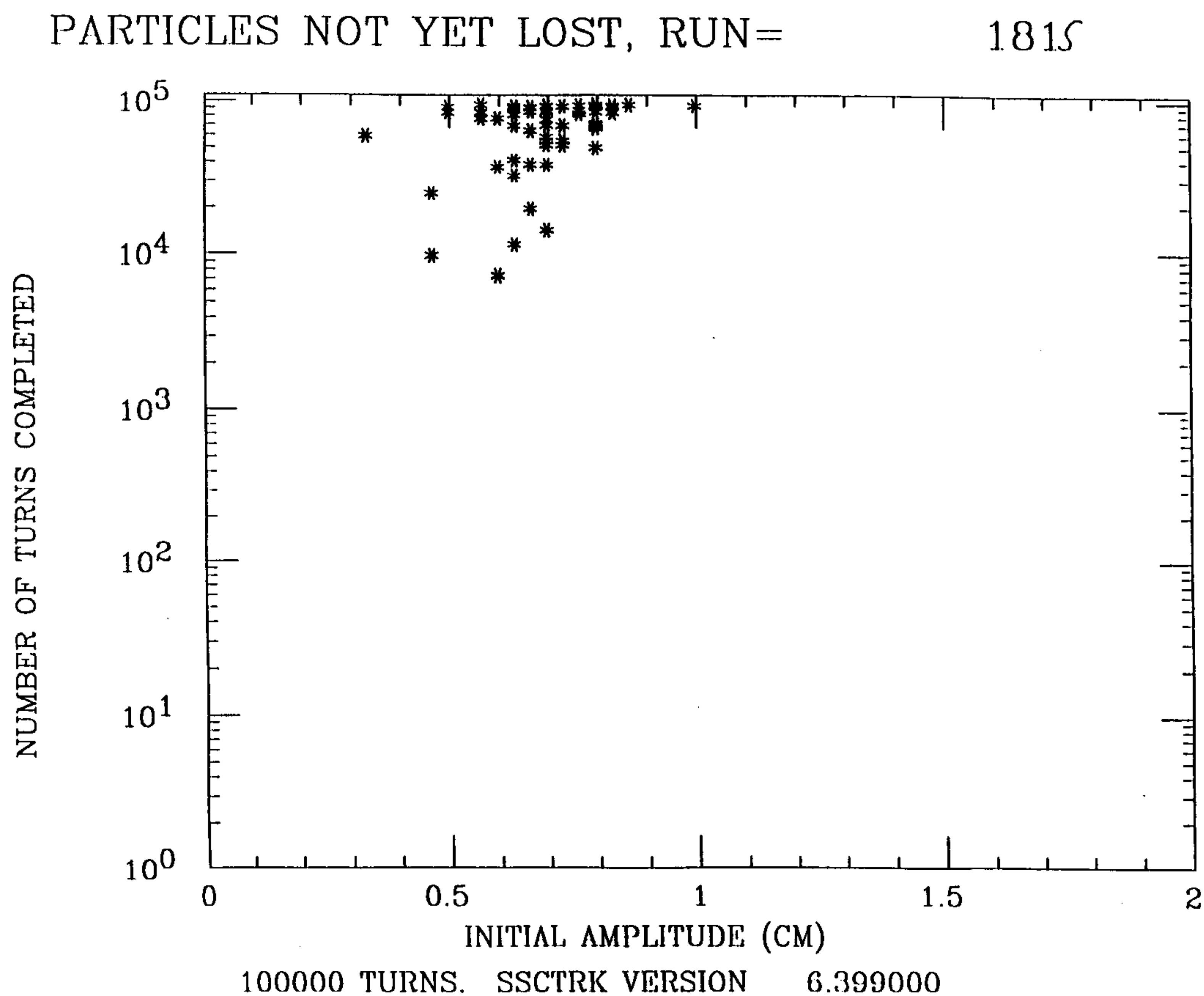


FIG. 1b. The particles not lost data for the benchmark case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.005$.

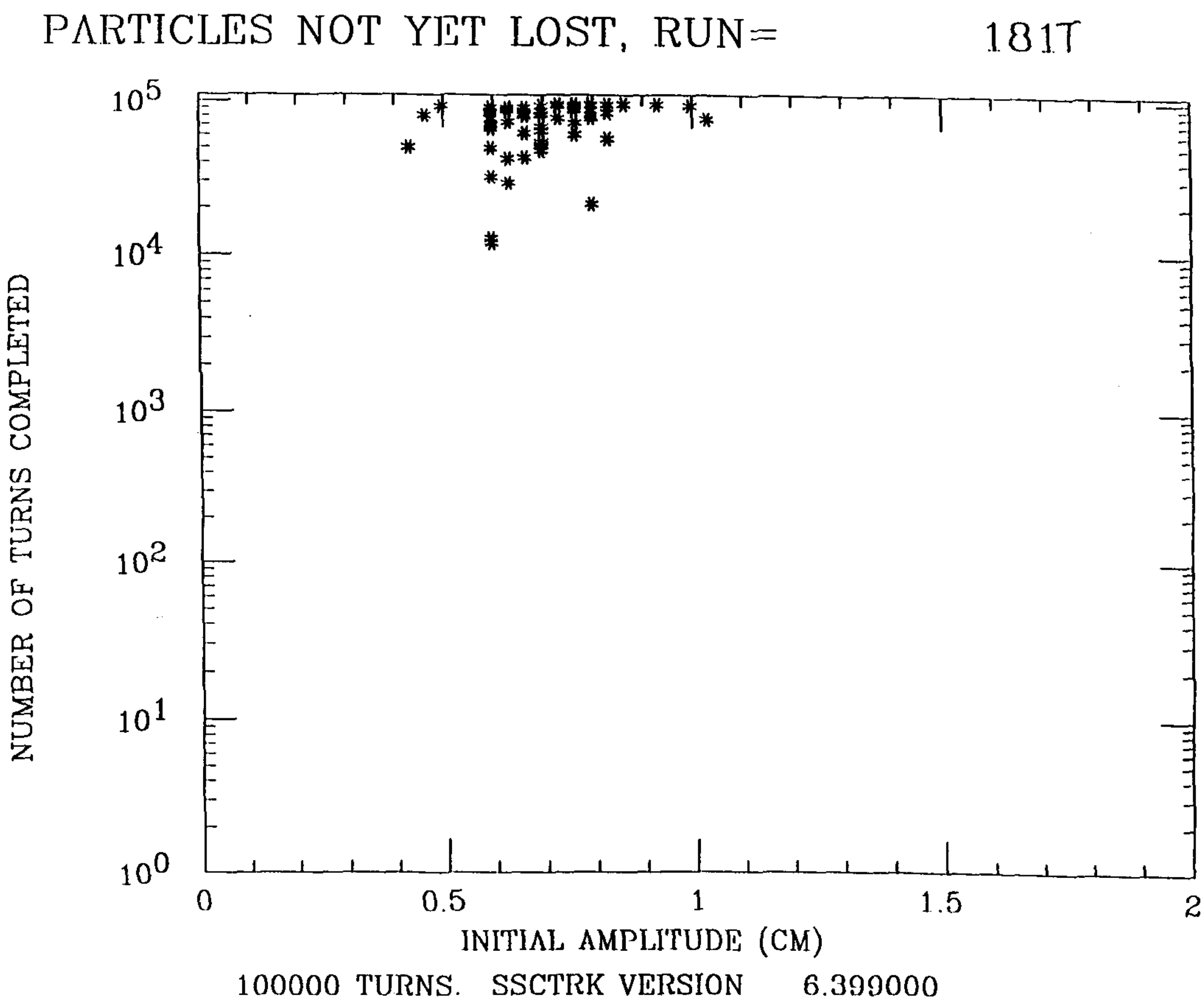


FIG. 2b. The particles not lost data for the case with $Bsys_5 = Bsys_7 = 0.02$, and $Asys_5 = Asys_6 = Asys_7 = 0.005$.

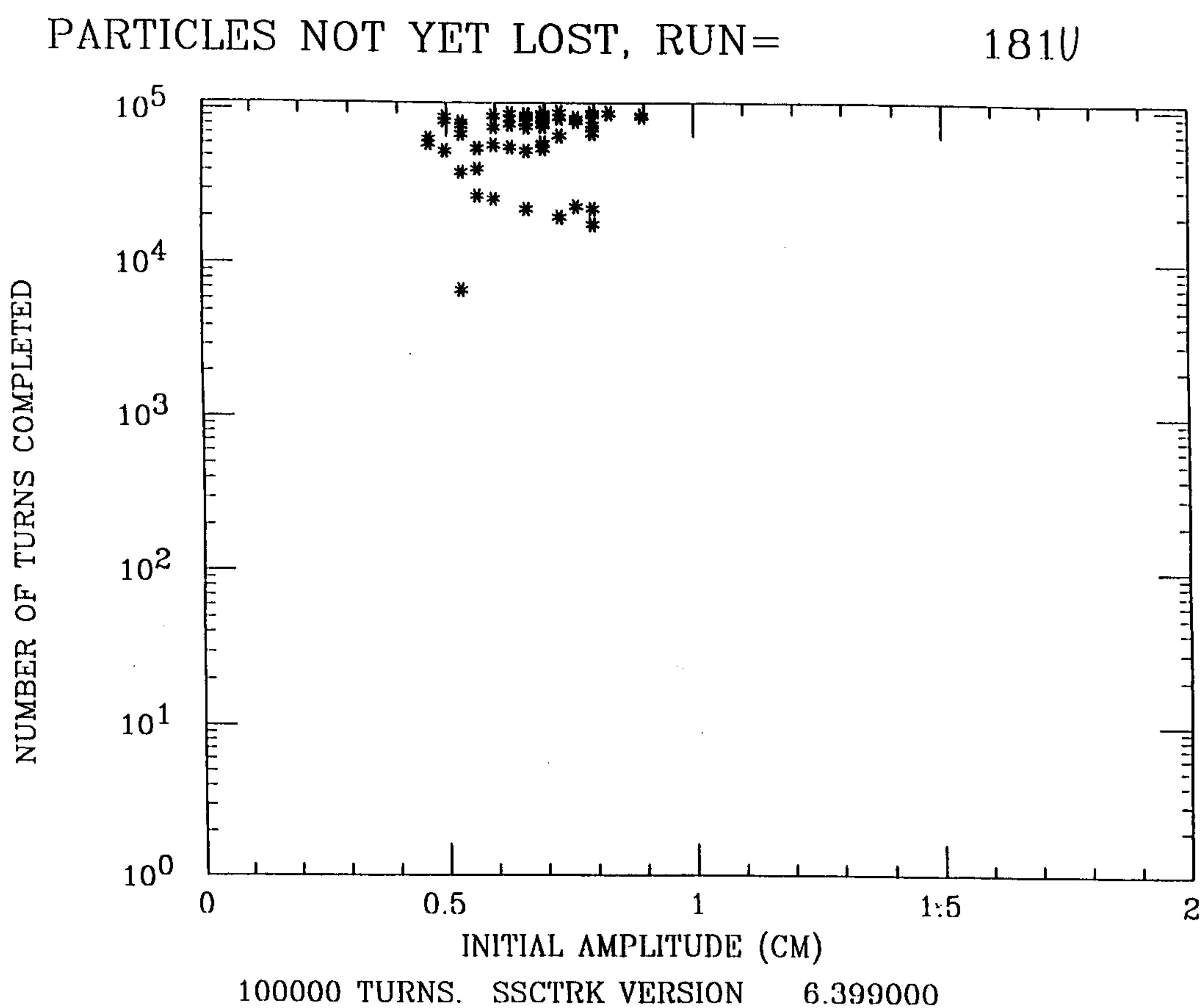


FIG. 3b. The particles not lost data for the case with $Bsys_5 = Bsys_7 = Asys_5 = Asys_6 = Asys_7 = 0.02$.