Mlle Susan LEECH/Bib.SPS
Commissioning = 2 ex.

PS-DI/PA/EJN/nm

28th March, 1977

SPS COMMISSIONING REPORT NO. 52

Subject : First test of the SPS as a Storage Ring

Date of Experiment : 23rd March, 1977

Experimenters : G. Beetham, P.E. Faugeras, H.K. Kuhn, R. Lauckner, T. Linnecar, A. Millich, W. Mills, J.D. Pahud, J.C. Soulie, D. Thomas, S. van der Meer, E.J.N.Wilson.

-----ooOoo-----

Aim of Experiment

To prolong the 200 GeV intermediate flat top of the normal SPS, switching all systems into a coasting beam mode and to make preliminary measurements of beam lifetime with r.f. on and off in the context of using the SPS for colliding beams.

Machine Conditions

Injected intensity	: 10^{12} ppp
Cycle	: 200/400 GeV with Q = 26.6
Octupoles, chromaticity sextupoles, skew quadrupoles	: Operational settings then switched off during coasting.
Beam damper	: On
Vacuum pressure (mean)	: 4.5×10^{-8} Torr

Account of Experiment

Previous tests of switching the main power supplies to regulate from a current measurement at the end of the 200 GeV flat top and hold that current indefinitely, had proved successful. In this experiment we tried this for the first time with beam. At the press of a button the commands were sent out in mid pulse to execute this change in the power supply computer, to disable the injection kickers and beam dump, to switch off the correction elements and to either switch off or hold r.f. at low voltage appropriate to 200 GeV coasting.

After testing each of these actions individually they were linked together and the SPS repeatedly switched into coasting mode and back again. There proved to be quite sufficient time for one to decide that a pulse was a good one and send out the commands between transition and 200 GeV. Return to pulsing took only a few cycles.

Measurements of vacuum pressure taken during the run showed a pressure of 1 to 1.5×10^{-8} at all gauges except those in superperiod 5 where pumps had been switched off to allow pressure to rise to 20×10^{-8} to improve the sensitivity of the beam scanners. This high pressure region accounts for the bulk of the mean pressure. The BCT was used to sample beam current every 8.4 seconds.

Results

The figure shows (above) a 10^{12} proton pulse stored with r.f. on for 80 minutes before a slight instability of the power supply killed the beam. The lifetime, deduced from the slope of the logarithmic curve (below), is 103 minutes. An earlier and shorter coast of a beam with r.f. off gave a lifetime of 166 minutes once some initial losses had been cured.

Conclusions

The simple Coulomb scattering formula :

$$\theta_{rms}\ [\text{rad}] = \frac{14}{pc\ [\text{MeV}]}\ \beta\sqrt{\frac{x}{x_o}} \qquad (1)$$

where : $x = \Delta t c \beta \rho$
x_o = radiation length for N_2 (gm/cm^2)

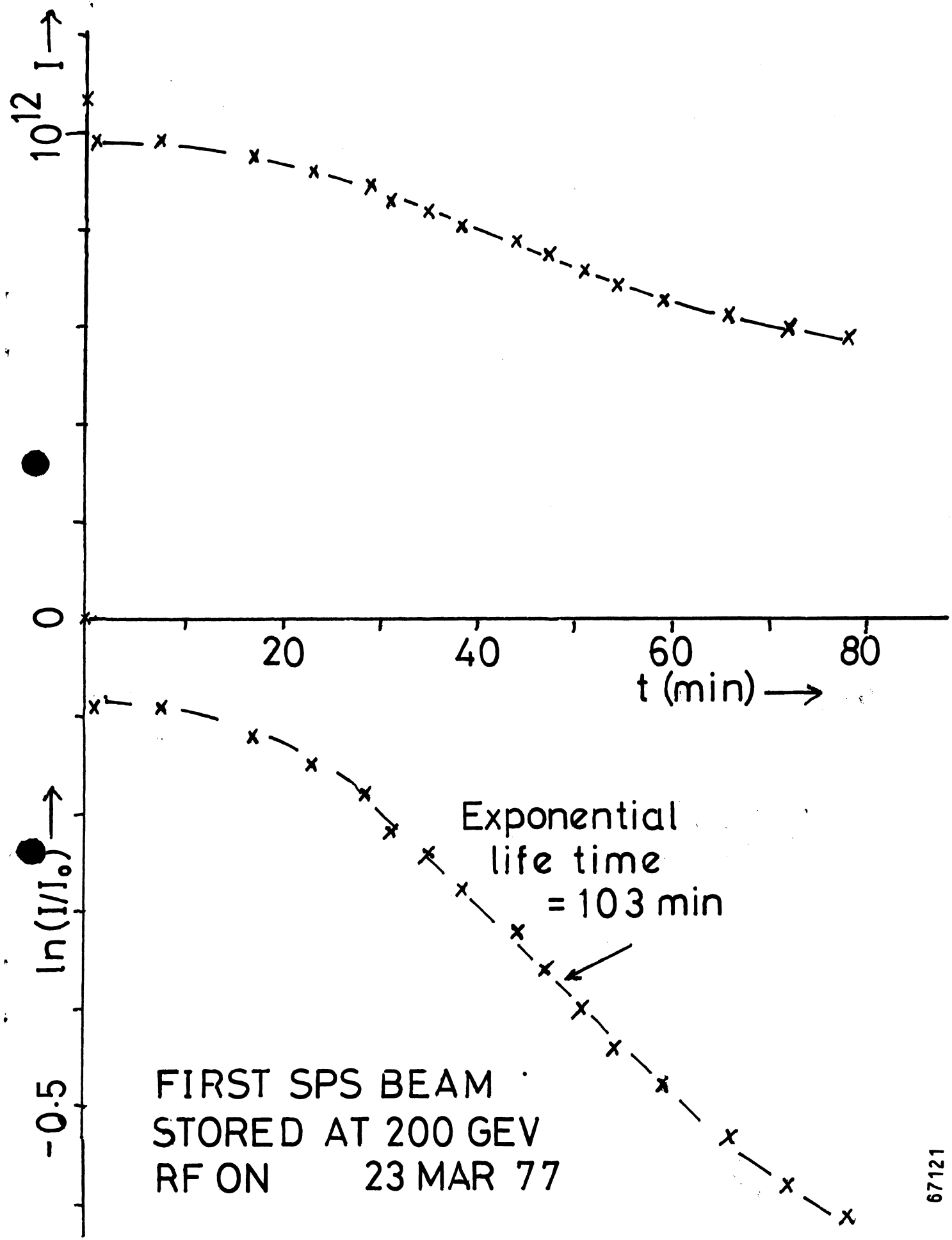
gives good agreement with experimental data if one assumes that the natural lifetime of the beam is just the time Δt in which θ_{rms} grows to be the angular acceptance of the accelerator in betatron space, $\sqrt{A/\beta}$, where A is taken to be 3π mm milliradians vertically.

This formula, though less rigorous than some and thought to be pessimistic, also fits NAL measurements at 8 GeV (Stiening) and at 100 GeV (Tolesthrup). For the conditions prevailing in the run it predicts 140 minutes for the SPS. At 280 GeV and for an average pressure of 10^{-8} torr it suggests a lifetime of about twelve hours may be attained.

No evidence of an electron induced instability of the debunched beam can be seen at this intensity. The fact that keeping the r.f. on does not reduce the lifetime drastically encourages us to hope that multiple crossing of fine resonances due to synchrotron oscillations may not be as destructive a mechanism as had been feared.

However, further experiments at higher energy, lower pressure and higher intensity will be needed before one can be confident of these early indications.

Reported by E. Wilson


10^{12} I →
0
20
40
60
80
t (min) →
ln(I/I$_o$) →
-0.5
Exponential
life time
= 103 min
FIRST SPS BEAM
STORED AT 200 GEV
RF ON 23 MAR 77
67121