ISR/BT/BWM/EEK 4th March, 1971

ISR RUNNING-IN

SCRAPER TARGET TESTS - RING 1

Run 29 (26. 2. 71) 15 GeV, 4 bunches

1) Single shot injections were brought out to <+ 10 mm> with the ramp generator, and beam position and emittance measured.

C.O. error	- vertical	+ 6.2 mm
	- radial	< - 8.5 mm >
Emittance	- vertical	$0.81\pi \times 10^{-6}$ rad.m
	- radial	$2.66\pi \times 10^{-6}$ rad.m

2) Kicker screen shadow position was measured as :
Radial steps 693 ≡ - 12.3 mm (α_p = 1.49 m)
or < - 15.4 mm >
which is within ~ 0.5 mm of previous determinations.

3) Single shot injection, beam brought to < + 10 mm > with ramp generator and dump block moved downwards from central position:

Dump position		Beam current
	0	14.9 mA
	- 6 mm	14.8
	- 8 mm	14.7
	- 9 mm	14.3
	- 9.9 mm	13.8

The dump block was then moved back to:

- 8 mm

and left in that position for the remainder of Run 29 (and the beginning of Run 30).

The 13.8 mA beam was scraped continously radially (in around 5 secs) and the I4 background count went up from ~ 10^3 to a peak > 10^5 during the scraping.

4) ST programmed operation with stacking was then set up to :

Vertical steps 113 (100) 213 (18.2mm sweep)
Radial steps 700 (60) 760 (5 mm sweep)

A 4-bunch stack was made with programmed ST operation and with kicker screen open. Saturation occurred at ~ 700 mA (normal stacking orbit) and injection was stopped. The kicker screen was then closed and the circulating beam current dropped from 695.8 to 695.7 mA. This 0.1 mA loss is, of course, completely harmless for the screen.

Next, a stack was made with moving kicker screen but without ST, stacking 5 mm further out than normally. Saturation was reached at ~ 945 mA and stacking stopped. The ST was then brought in manually at a radial step position of 700, which reduced the circulating current from 944,2 mA to 932.6 mA. This 11.6 mA loss came from the ~ 0.5 mm radial region between the kicker screen and the tip of the ST.

A few more stacks were made with moving kicker screen and programmed ST, stacking even further out by up to ~ 20 mm more than the normal radius. One such 4-bunch stack saturated at 1.2691 A. Some of these stacks were dumped by continuous scraping, recording beam current against radial ST position on an X - Y recorder. Figure 1 gives an example of such a profile.

5) The tests under 4) above showed that programmed ST operation apparently worked as expected. However, we wanted to measure how efficient the ST is in protecting the kicker screen. For this we observed the pulses from the ionisation chamber mounted near the inflector. This was calibrated by stacking to saturation with ST and moving screen, adding one more pulse with ST and with screen open, and then closing the screen manually to intercept the tail of the stack. A loss of ~ 15 mA gave a signal of 70 V on the

oscilloscope. Then continuing stacking into a saturated stack with ST and moving screen the pulse amplitude was observed for various strokes of the ST radially. There was always a detectable signal corresponding in time to the screen closing and usually one associated with the ST moving into the beam. The strokes given below are measured with respect to the outer surface of the screen shadow at α_p = 1.49 m.

Radial stroke of ST	Pulse amplitude from "screen" signal
+ 0.5 → + 4.5 mm	1.2 V
+ 0.5 → + 2.5	4
+ 1 → + 3	4
+ 1 → + 6	0.5
- 0.5 → + 4.5	0.3
- 0.5 → + 3.5	1.5
- 0.5 → + 2.5	1.5

From the above figures one can note the following :

(a) There is a correlation between stroke and beam current intercepted by the screen, though not a very clear one.

(b) Even in the worst case above (4V) the current intercepted is only ~ 0.85 mA, but even in the best case (0.3 V) there is still 0.064 mA cut by the screen.

(c) Since the radial displacement per injection cycle due to RF phase displacement is less than 1 mm, it is surprising that an ST stroke of 5 mm fails to eliminate completely the loss on the screen.

It should be emphasised that this loss is completely negligible from a practical point of view, but vulgar curiosity (scientific method) requires that we find out the reason for it. One possibility is that an instability develops near the scraped tail of the stack in the time between the ST being withdrawn and the kicker screen closing.

However, this would hardly explain a further observation made, namely that a small signal (~ 0.1 V), coincident with screen closing, was observed even for the first few pulses of a new stack, where the lower edge was still a long way from the inner edge of the screen.

6) Conclusions: The programmed ST operation works satisfactorily and gives full protection to the kicker screen during repetitive stacking. (It was used with 20 bunches during Run 30). There are still some unreliable features in the control electronics which lead to occasional logical errors, but with this exception the ST performs essentially as expected.

The residual small beam loss on the screen is very small but unexplained. Further systematic tests will be made to find out where and how it occurs.

In all future ISR runs the dump block should be off-centered whenever possible, in order to reduce the general irradiation of the ring and to concentrate beam loss on the dump. For 4-bunch operation in Ring 1, -8 mm appeared to be a good position, though with the 20-bunch operation of Run 30, it was necessary to use -6 mm because of the increased vertical beam size. These positions may have to be changed for other operating conditions and, in any case, are not necessarily suitable for achieving low background conditions.

B. W. Montague
B. de Raad

Distribution

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RUN 29 (26.2.71)

Radial ST scan.

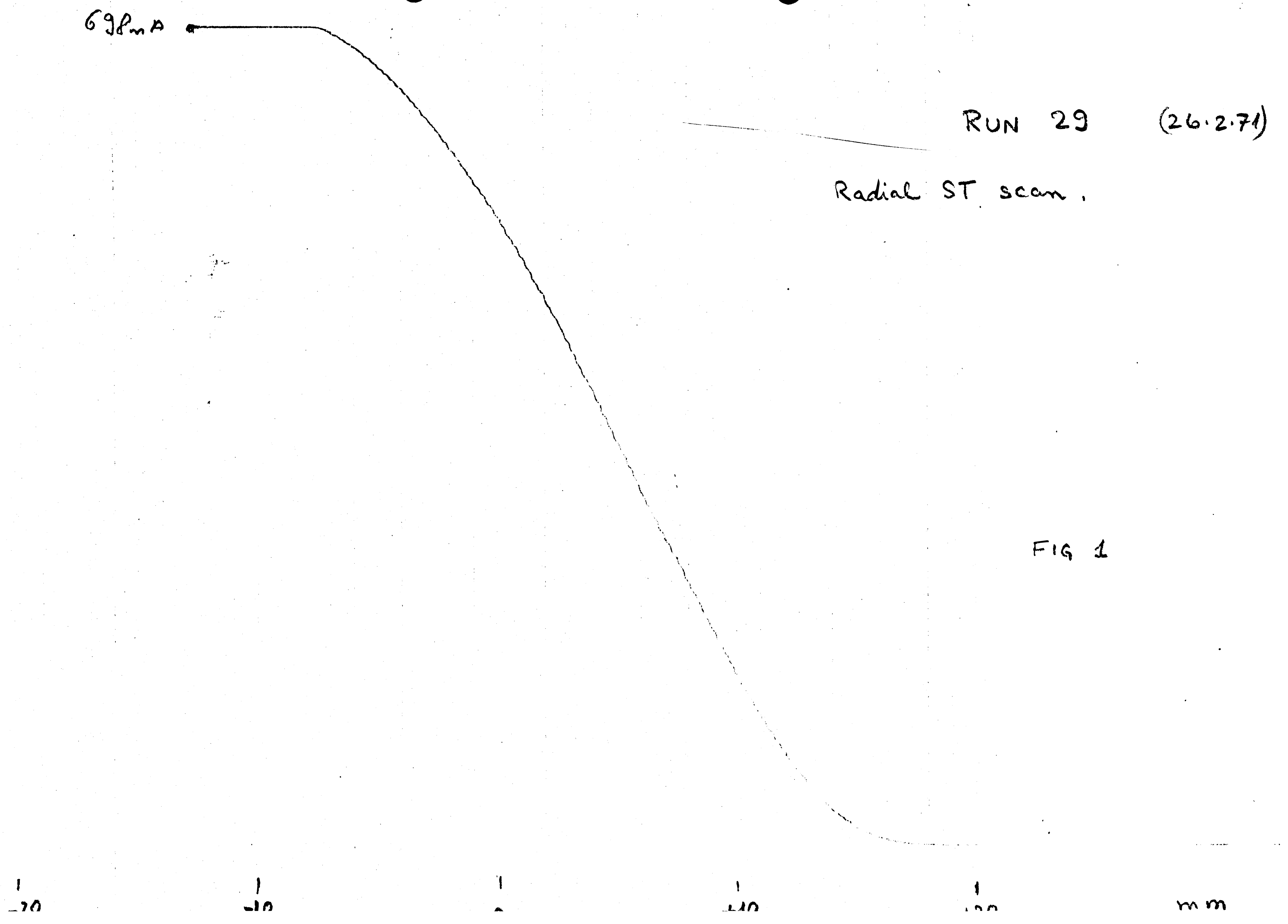

FIG 1