SPS/RF/TL/bs

11th June, 1976

SPS COMMISSIONING REPORT No. 10

RF Team Report on the Run of 3rd/4th June 1976

RF-Team

a) Measurements on 80 GeV cycle and 200 GeV cycle

The run started with a measurement of the capture efficiency under the conditions used during the earlier part of the evening when transverse measurements were undertaken.

Inj. Freq.	199.927 MHz
Phase lock on	5 turns after injection
Radial loop on	3 mSecs after phase lock
RF voltage (1 cavity)	1000 kV at injection
Beam intensity	∿ 2 x 10^{12} ppp.

The capture efficiency was measured before the front porch by steering the beam radially towards the wall until lost. This was done over 40 mSecs to avoid spill out. The capture efficiency measured varied between 70 % and 90 % from cycle to cycle. A typical result is shown in Photos 1 and 2. Photo 1 gives the BCT signal, Photo 2 the detected wide band signal. The majority of beam is lost at 240 mSecs when pushed to the wall, the remainder is lost during the front porch at 410 mSecs.

The debunching of the beam both at 200 MHz and 9,5 MHz was then studied by switching off the RF and observing the 9,5 MHz and 200 MHz components (wideband P.U. signal) on the injected beam. The form of the decay of the signal varied from cycle to cycle. A first zero was always present in the response, but subsequent zeros due to multiple overlaps of the bunches did not always take place. The envelope of the decay curve however remained more or less constant. Typical results (with zeros) are given in photos 3 and 4.

Decay time 9,5 MHz to 1st zero = 21 mSecs
200 MHz " " " = 1,2 mSecs.

It can be seen that the ratio is not exactly 21 as expected. The 200 MHz decay indicates a $\frac{DP}{P} = \pm 3{,}3 \times 10^{-4}$.

Having measured the debunching time and observed the form of the decay, the 2 RF cavities were switched on and by counterphasing an attempt was made to reduce the effective RF voltage to zero. Careful adjustment of amplitude and phase allowed an indicated voltage 30 kV to be achieved. Some time was spent adjusting the conditions whilst observing the debunching but at no stage was it possible to obtain the same situation as without RF.

The beam was then captured by switching the RF on to full voltage some time after injection and immediately closing the phase loop. A measure of the capture efficiency using the method outlined before indicated ∿ 80 % of the beam captured and this was approximately independent of the time of capture after injection. However, it was necessary to capture ∿ 120 mSecs after to have a residual 9,5 MHz structure < 1 % of the original value. Trying the capture before this always gave a much greater structure even around the zeros of the debunching curve.

A programme was now added to the counterphasing loop so that after the RF switch on at 100 mSecs the effective voltage rose approximately parabolically to the maximum in a time of ∿ 5 mSecs. The minimum RF voltage was ∿ 100 kV rising to ∿ 2 MV. Photo 5 shows the programme superimposed on the total effective RF voltage as seen by probes in the cavities, and beneath this is seen the wideband pick up signal. At capture there is a small "transient" on the wideband signal but after 1,5 mSecs the signal rises smoothly to a maximum. Photo 6 shows the BCT and detected wideband signals during acceleration. Unlike previous occasion there is now a loss at transition. This can perhaps be explained by an increase in emittance at capture. Some of the particles could now be forced into a transverse resonance near transition when the bunches alter radically in shape. The bunch decay can just be seen at injection and the subsequent adiabatic capture is clearly visible ∿ 100 mSecs later.

A measurement was made of the capture efficiency under these conditions. The result (which was very stable from cycle to cycle) is shown in photos 7 and 8. Both show radial position signal and the BCT signal. In both the dump is at 250 mSecs (start of photo INJ + 130). The first photo shows the beam dumped with no radial steering, the 2nd the effect of radial steering. It can be seen that the capture efficiency under these very stable conditions and with a beam intensity of ∿ 1,5 - 2 x 10^{12} ppp is of the order of 100 %.

RF experiments stopped at this point and the change to the 200 GeV cycle was made. Later in the day when the Q's had been optimised for the 200 GeV cycle photos were taken of the BCT and the pk det wideband signal (photo 9). It can be seen that the loss at transition has now disappeared. In comparison with the 80 GeV cycle where there was loss at transition the tuning of the machine was now different and the rate of which transition was crossed had increased by a factor of 2,5 x. Again the debunching and capture are visible on the wideband pick up signal.

b) Conclusions

1) Under the present conditions it is necessary to allow a debunching time of the order of 100 mSecs to have less than 1 % residual 9,5 MHz structure.

2) With a beam intensity of 1 - 2 x 10^{12} ppp and with stable operating conditions it is possible to achieve a capture efficiency approaching 100 %.

T. Linnecar

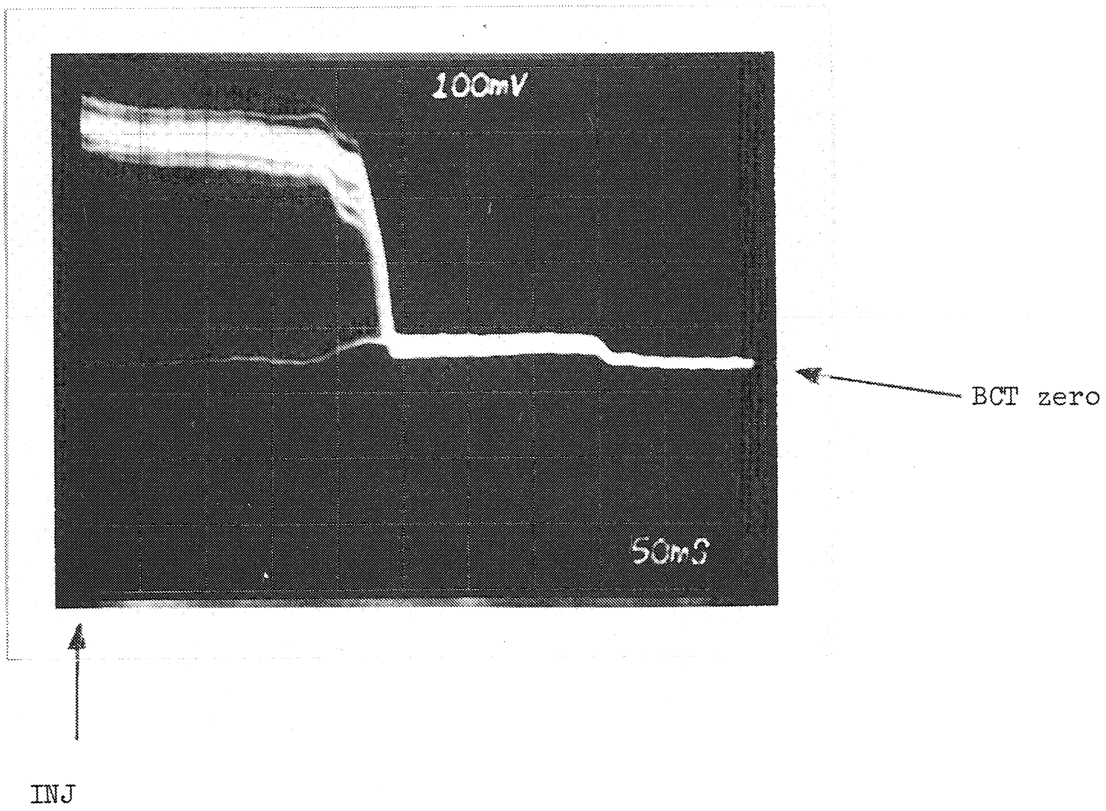


Photo 1. BCT signal showing measurement of capture efficiency under initial conditions.

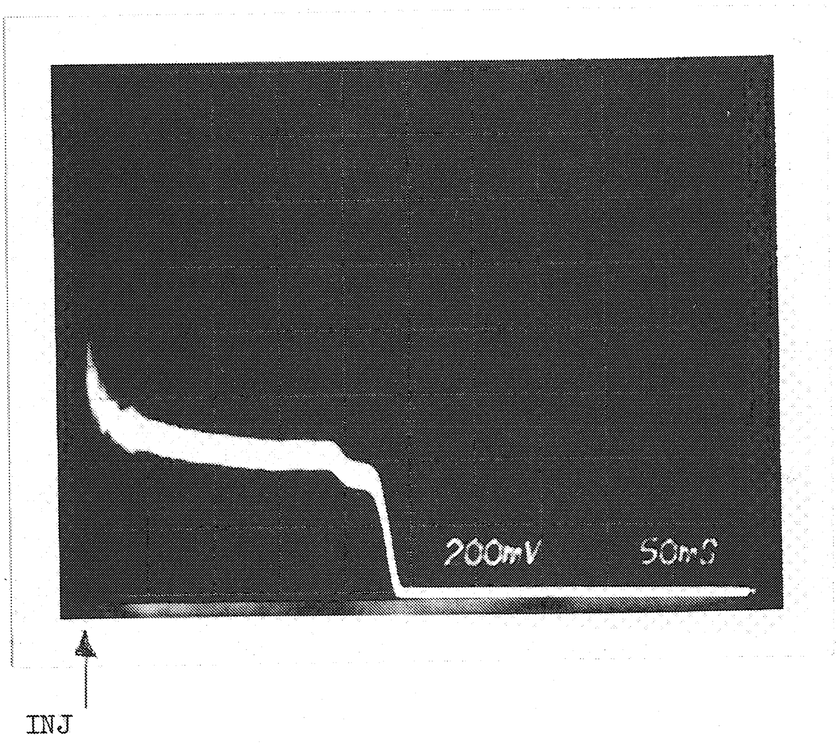


Photo 2. Detected wideband P.U. signal corresponding to photo above.

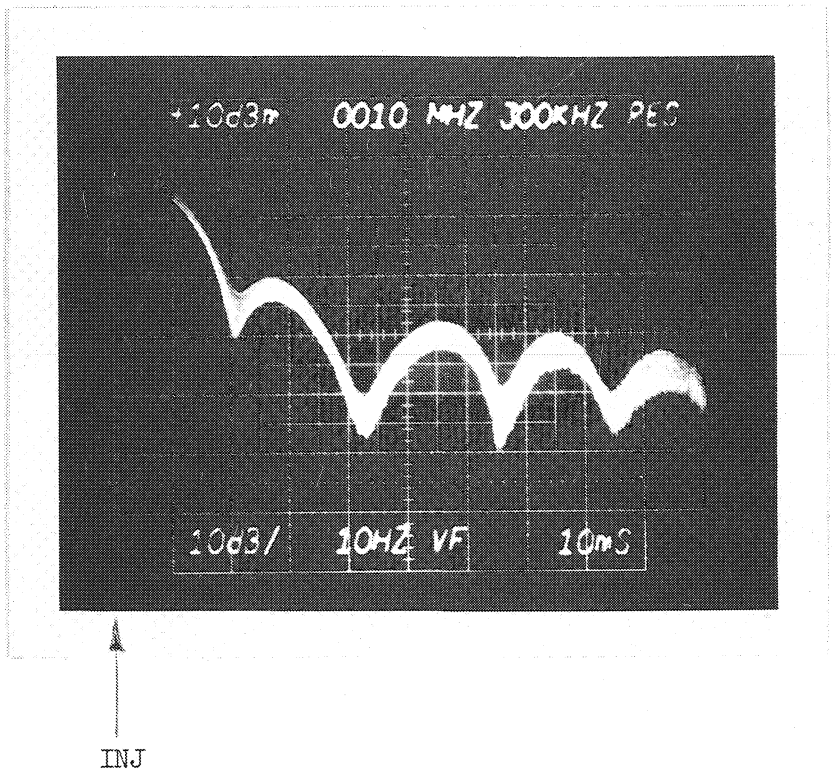


Photo 3. Debunching at 9,5 MHz

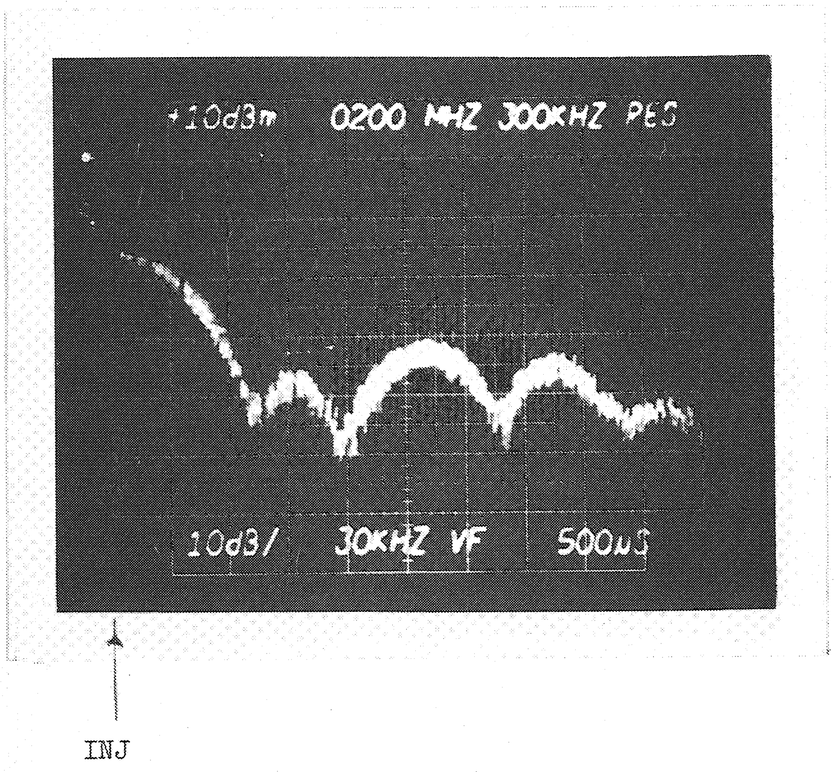
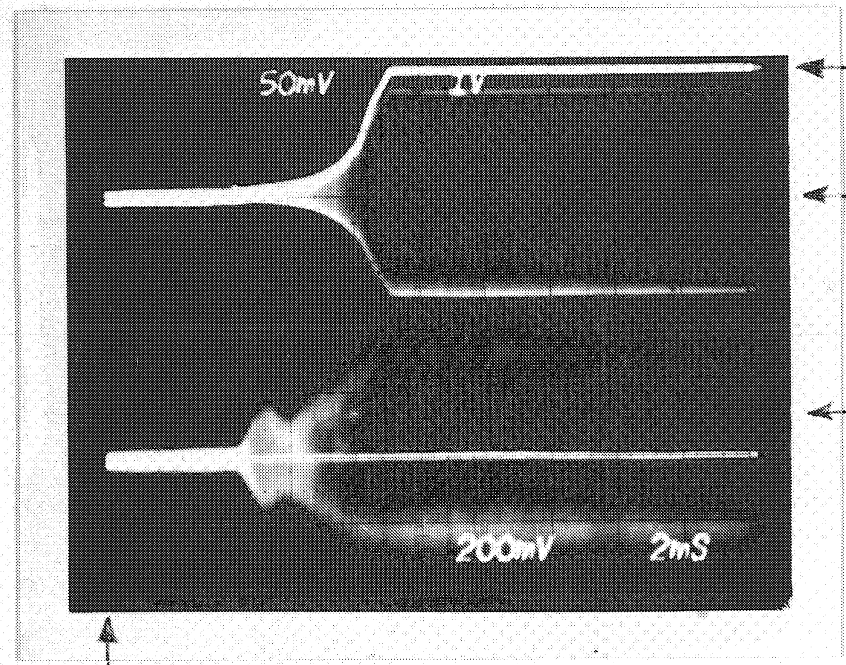


Photo 4. Debunching at 200 MHz



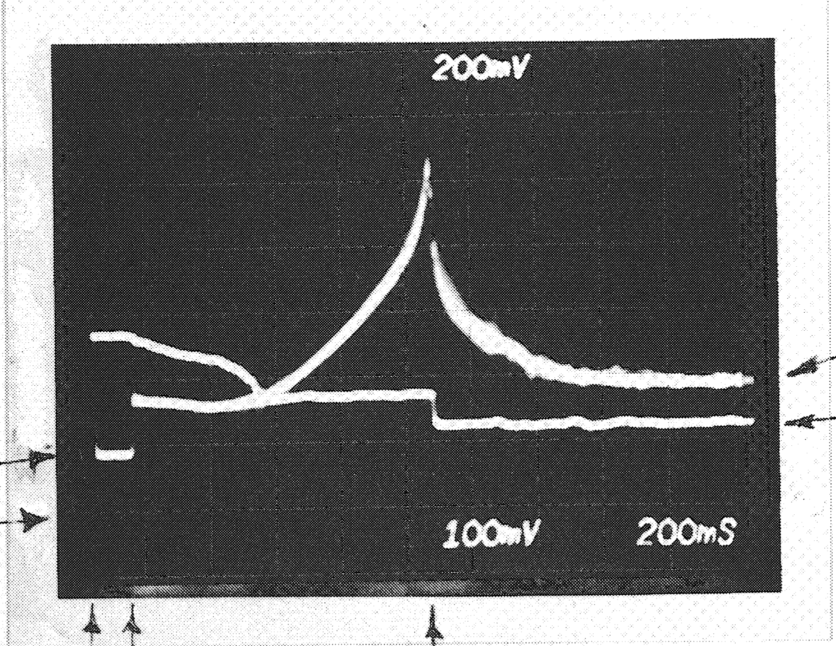
Function applied (IV)

Resultant effective voltage (200 mV) (10,7 MHz Σ amp)

Wideband PU signal (50 mV)

INJ + 120

Photo 5. Adiabatic capture



Wideband PU (200 mV)

BCT (100 mV)

(N.B. curves cross)

0 Wideband P.U.

0 BCT

INJ (DEBUNCHING)

CAPTURE

TRANSITION

Photo 6. Acceleration after adiabatic capture

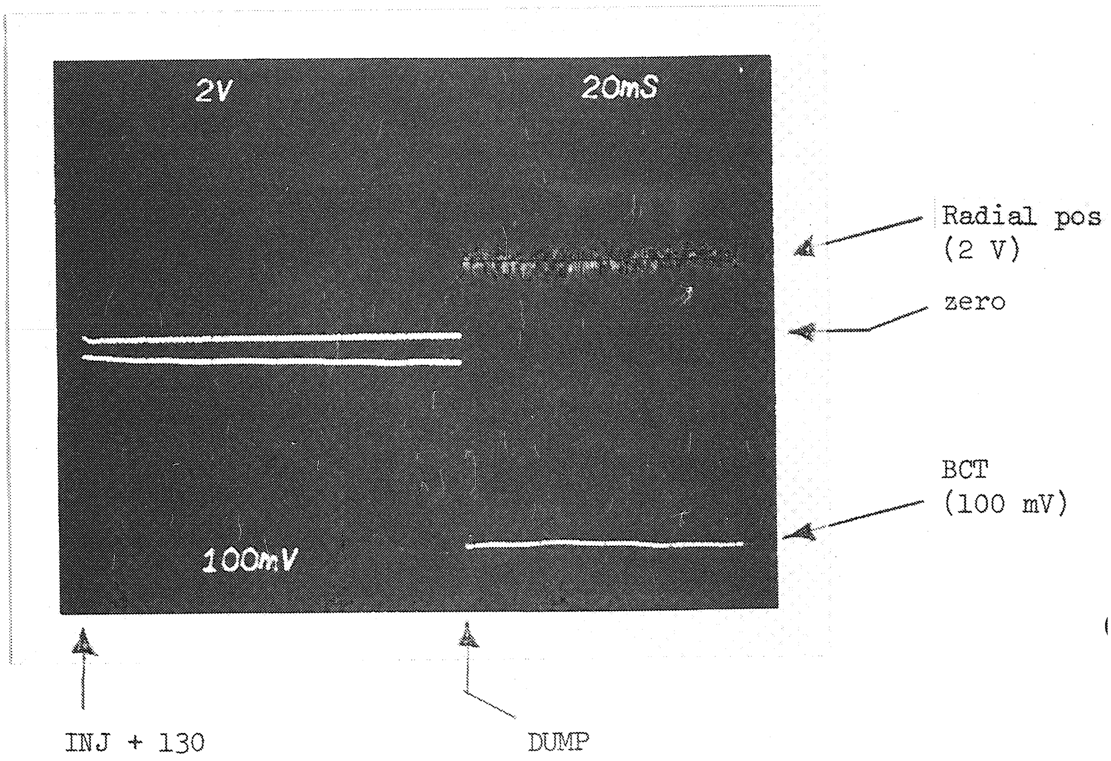


Photo 7. Measurement capture efficiency - adiabatic capture. No radial steering.

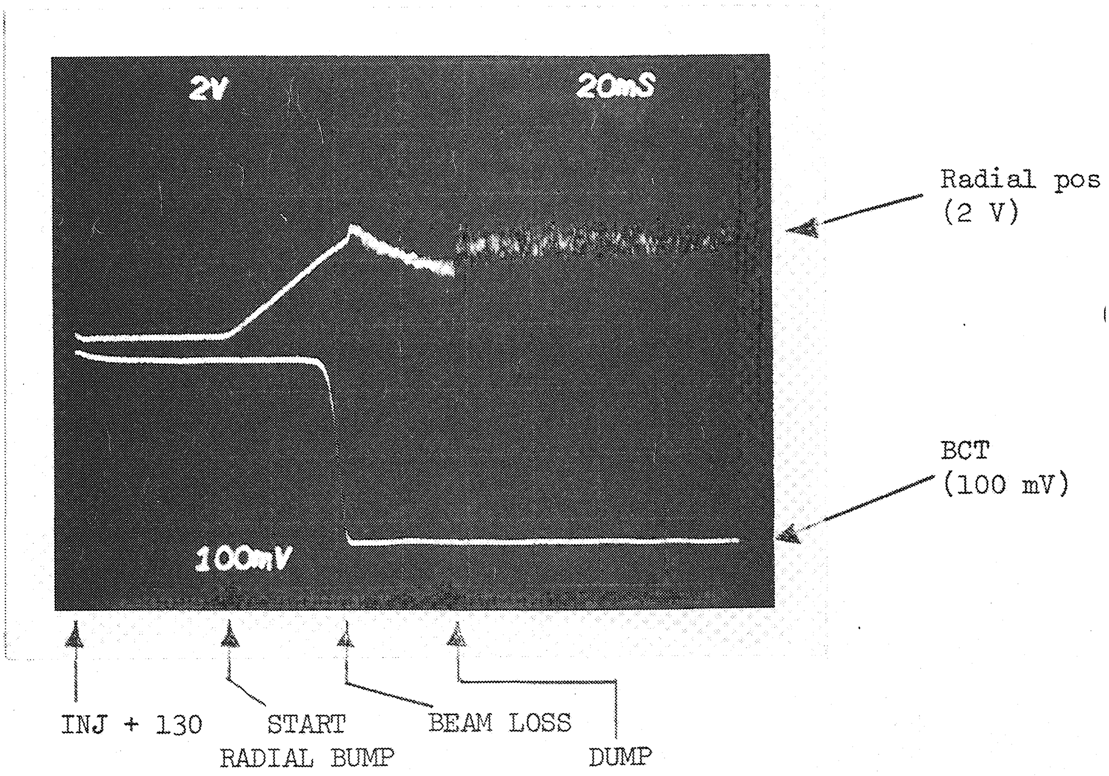


Photo 8. As above, with radial steering

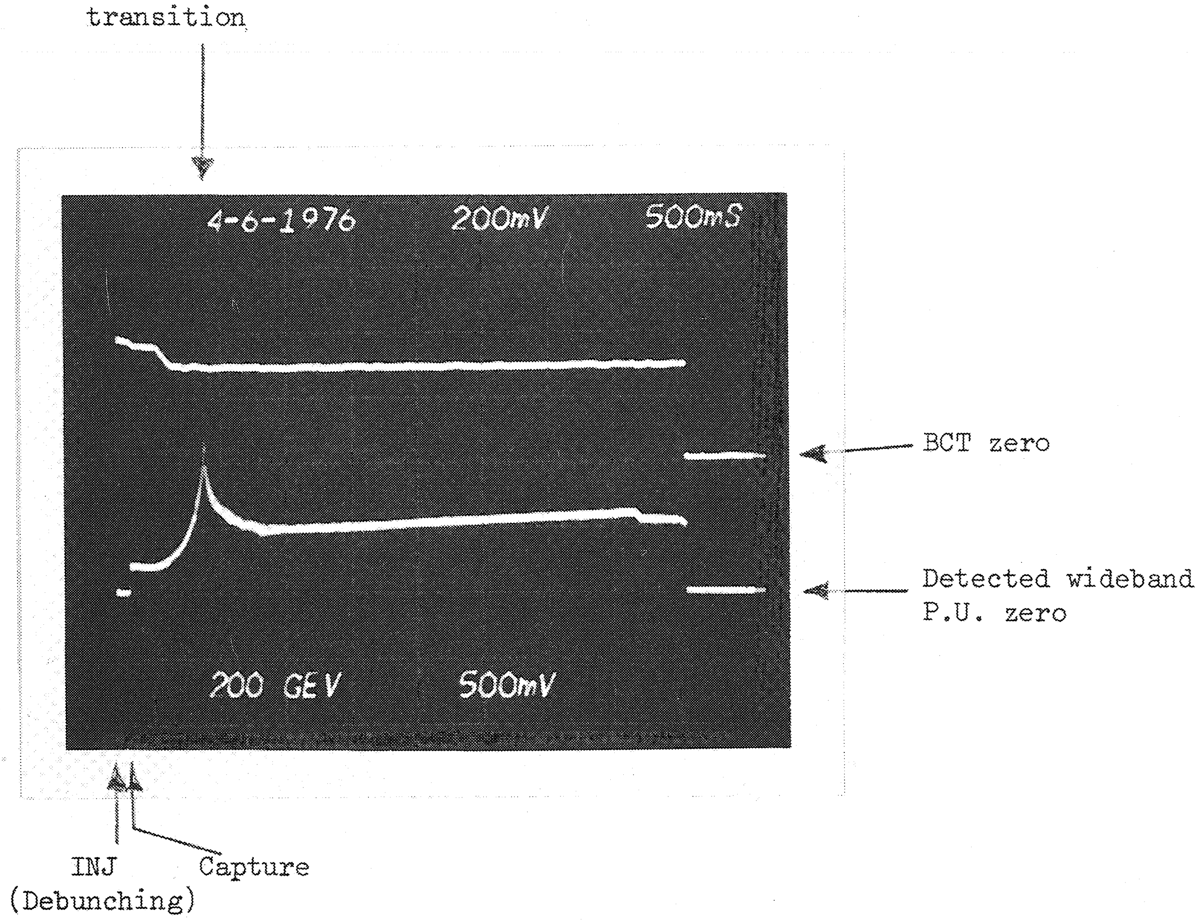


Photo 9. 200 GeV cycle. BCT and wideband P.U. signals.