ISR-BOM/AV/rh

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ISR PERFORMANCE REPORT

Run 1237 - Ring 1 - 26 GeV/c - 8 December 1981

Test of stacking possibility on the proposed double low-ß scheme

Purpose and conclusion

As the losses in I8 were high and the injection efficiency was low during the first test of the proposed double low-ß scheme[1], it was necessary to make a careful correction of the closed orbits and working line in order to estimate the possiblity of stacking with this scheme.

In this run, it was possible to obtain an injection efficiency of 90 % while the losses in SL7 were about 2 10^9 proton per injection, which is an acceptable starting condition for stacking. The closed orbits were corrected up to the radial position +38 mm with only one H-magnet and two CR-windings, the p-t-p amplitudes being 17 mm horizontal and 10 mm vertical at this position. The working line was adjusted to be that used for SL stacking and the PFW currents were such that only PFF1 saturated at 31 GeV.

The conclusion is that this scheme could be used for stacking under the same conditions as the SL scheme.

1. Set-up

The currents in the file 26DL, created during run 1228[1], were set except those in the AFM and SO sections: the only experimental magnet on was the SFM.

40 mA were asked from the PS because the losses at injection in SL7 were close to 10^{11} during the last run for 150 mA pulses.

BST and stopper 449 were set. Injection was adjusted with CINE on the previously measured injection orbit at -42.5 mm. As this was difficult, probably because a C-pulse was used here instead of a B-pulse as in run 1228, the main field was decreased from 76.517 % to 76.506 %. It was not possible, however, to obtain an accurate adjustment of the injection line, probably because the transfer betatron parameters in CINE were not good: the injection errors did not vent below 4 mm in the H-plane.

The adjustment of injection was kept so and the stopper 449 was removed: the subsequent losses in SL7 were about 10^9 at injection. When the BST was removed, 2 mA circulated after injection, which is not enough for a closed orbit measurement, even with the maximum gain of the PU's and with five bunches per pulse. It was then tried to move the girder and to change the kicker voltage, and finally 20 mA could be injected for 40 mA in the transfer line. About one hour was spent from the time the first pulse was asked to this step.

At the first trial of orbit correction (see procedure in Section 2), an injection check was made without using the stopper 449, the collimators having been positioned by POCO w.r.t. a wrong orbit, because the data base used was that of the bare machine. Under these conditions, the injected pulse could cross the collimator system and reach SL7 which quenched. The associated losses were 2 10^{11} in SL7 and 3 10^9 in SL5.

The time between quench and next injection was 56 min.

2. Closed orbit corrections

The procedure followed during run 1228 to obtain a circulating current implies that several orbit correctors are used. As it is preferable to have the minimum number of correctors, the following procedure was applied to obtain a corrected orbit:

- A closed orbit was measured (p-t-p amplitudes 20 mm horizontal and 7 mm vertical).
- COCO was run with the preset magnet option.
- Stopper 449 and the BST were set in order to adjust the injection, without any risk for SL7, on the closed orbit computed by COCO at its first iteration. The collimators were set w.r.t. this orbit.
- Stopper 449 was removed in order to check the losses in I8 at injection.
- The BST was removed and circulating protons were obtained.

This was done for both planes.

Finally, the horizontal closed orbit was measured at +35 mm and corrected. The resulting closed orbits are shown in Fig. 1. Proton losses appeared for radial positions beyond +38 mm.

3. Correction of the working line

This was made after closed orbit corrections. The first measurements were bad, so that $\Delta Q_V = -0.02$ was applied in order to reduce coupling. The line was corrected to obtain the line used for SL stacking and the final measurements are shown in Fig. 2.

The currents in the machine were copied in the file DL26 and are given in Table 1. The closed orbit measured at injection was copied in the file DLR1 and is shown in Fig. 3.

4. Losses at injection

As mentioned above, two points had to be checked in order to evaluate the definite possibility of stacking with the proposed double low-ß scheme:

4.1 Injection efficiency

- The maximum obtained with the machine current in file 26DL, created in run 1228[1)], was 50 %;
- after closed orbit corrections, the injection efficiency became 60 %;
- after the correction of the working line, 70 %;
- after the change of BT matching, 80 %. The losses in the machine before and after this change are shown in Fig. 4.a) and b). This measurement indicates that a good matching of the BT reduces the emittance of the beam.
- 90 % at the end of the experiment with the collimators positioned by "Find beam". Their positions as well as those computed by POCO are given in Table 2. The collimators were probably too close to the injected beam; indeed the losses on the collimators were somewhat "large" as is shown in Fig. 4.c). The intensity in the transfer line was 148 mA, and 133 mA remained after injection. The injection errors were 0.7 mm vertical and 2.5 mm horizontal.

4.2 Losses per injection in SL7 (calibration according to Ref. 2)

- 4 10^{10} when the first injection was obtained (40 mA in transfer line, 2 mA circulating). This level remained until the orbits were corrected.
- 10^{10} after the horizontal closed orbit correction and positioning of collimators by POCO.

- 8 10^9 after the vertical closed orbit correction and positioning of collimators by POCO.
- 1.5 10^9 after positioning the collimators 237 and 265 by "Find beam" and withdrawal by 2 mm.
- After the BT matching was rectified, the losses were 3 10^9 with the collimators set by POCO. They went down to 2 10^9 by positioning collimator 229 by "Find beam" and withdrawal by 2 mm, and to 1.3 10^9 by positioning collimator 237 in the same way.
- When 133 mA were circulating after injection, the losses in SL7 were about 2 10^9 which is the value obtained with the SL insertion alone.

5. AFM compensation

The compensation of the vertical kick created by the AFM was computed by INCO at the very beginning of the run. However, as the data base was not correct, it gave an enormous correction so that it was droped and injection was tried without this correction: indeed, the losses at injection did not appear in the vertical plane.

INCO was applied off-line with the good data base and it calculated the following increments:

For -100 % in the AFM current : +1.81 % for H817 and -2.90 % for H749B.

As only a 3-magnet bump is computed by INCO, this differs from the theoretical compensation increments computed for a 5-magnet bump for the SL case[3].

A. Verdier

References:

1. T. Risselada and A. Verdier, First test of a possible double low-β scheme for the ISR, Perf. Report ISR-BOM-OP/TR/AV/ml dated 28.10.1981, Run 1228.
2. L. Vos, Test of ion chamber to be used as local beam loss detector in the superconducting magnet to be installed in I8, Perf. Report dated 19.5.1980.
3. T. Risselada and A. Verdier, Compensation of the closed orbit perturbations due to the AFM with the SL insertion, Perf. Report ISR-BOM-OP/TR/AV/ml dated 16.11.1981, Run 1230.

TABLE 1

Currents in file DL26

(The associated working line and injection orbit are shown in Figs. 2 and 3, respectively)

```
/XOUT(IF=DL26,R1,ALL)     TIME:09H49M49S     DATE:81-12-10
 /LAST-RUN:1237   LAST-TIME:01H01M03S    LAST-DATE:81-12-09
/MA RUN R1/R2:1237/0
    1GEV     +26.5898     1DVM     +76.506     1WL     26DL
    1CF      +47.22
 /OT RUN R1/R2:1237/0
    1QT2     -23.46       1QT1     +13.84      1QT8     +0.42
    1QT3     -19.34       1QT5     +33.96      1QT6     -21.02
    1QT7     +40.94       1SLQ9    +82.93
 /FF RUN R1/R2:1237/0
    1FFF1    -56.59       1FFF2    -62.28      1FFF3    -40.84
    1FFF4    -35.52       1FFF5    -25.20      1FFF6    -17.90
    1FFF7    -12.84       1FFF8    -4.10       1FFF9    +9.47
    1FFF10   +18.33       1FFF11   +26.20      1FFF12   +40.60
    1FFD1    +59.28       1FFD2    -24.15      1FFD3    -33.40
    1FFD4    -32.35       1FFD5    -26.22      1FFD6    -28.71
    1FFD7    -26.27       1FFD8    -23.63      1FFD9    -20.43
    1FFD10   -10.38       1FFD11   -6.47       1FFD12   -2.22
/H RUN R1/R2:1237/0
    1H253    -27.86
/CR RUN R1/R2:1237/0
    1CR145   -4.00        1CR729   -14.09
/SQ RUN R1/R2:1237/0
 /QS RUN R1/R2:1237/0
/SL RUN R1/R2:1237/0
    1SLQ1    +74.176      1SLS1    +45.83      1SLQ3    +81.827
    1SLS3    +47.85       1SLD3    +24.85      1SLQ5    +73.500
    1SLS5    +47.95       1SLD5    -15.58      1SLQ7    +74.861
    1SLS7    +32.50       1SLD7    +9.38
 /LB RUN R1/R2:1237/0
    1LBQ1    +87.67       1LBQ3    -65.41      1LBQ5    +65.67
    1LBQ7    +53.27       1LBQ9    -68.63
/AFM RUN R1/R2:1237/0
 /T2 RUN R1/R2:1237/0
    QF337M   +76.982      QD338M   +78.177     VB303M   +75.450
    HB332    +41.472      QD346    +54.712     QF347    +21.420
    QD348    +45.007      QF349    +56.155     VB309    +57.062
    QD350    +55.034      QF351    +56.254     VH301M   +85.180
/T6 RUN R1/R2:1237/0
 /T1U RUN R1/R2:1237/0
/T1D RUN R1/R2:1237/0
 /EM RUN R1/R2:1237/0
/SFM RUN R1/R2:1237/0
    1TRIM    +20.464      SFM      -84.782     SCM1     +62.138
    LCM1     +64.448
 /TH RUN R1/R2:1237/0
    HB333    +15.425      HB334    +19.431     IK717    +56.03
 /TV RUN R1/R2:1237/0
    VB307    +38.602      VB308    +55.736
 / END OF DATA
```

TABLE 2

Collimator positions at the end of the MD (1 h)
for the currents in fil DL26 (see Table 1)

DEVICE	HORIZONTAL	VERTICAL	
FILE CKEE RING 1 RUN 1237 DATE 81-12-09 TIME 00H09M56S BY CKEE			
RADIAL COLLIMATOR 265	-47.8	+78.9	
RADIAL COLLIMATOR 253	-78.4	+78.1	
RADIAL COLLIMATOR 241	-64.5	+79.2	
RADIAL COLLIMATOR 237	-58.5	+78.9	
RADIAL COLLIMATOR 229	-78.4	+77.3	
VERT. COLLIMATOR 301			+10.8
VERT. COLLIMATOR 249		-9.4	+5.0

Positions computed by POCO for the orbit DLR1 (see Fig. 3).

DEVICE	HORIZONTAL	VERTICAL	
FILE CKEE RING 1 RUN 1232 DATE 81-12-09 TIME 00H50M07S BY CKEE			
RADIAL COLLIMATOR 265	-48.8	+79.0	
RADIAL COLLIMATOR 253	-65.3	+78.1	
RADIAL COLLIMATOR 241	-56.3	+79.2	
RADIAL COLLIMATOR 237	-50.2	+78.9	
RADIAL COLLIMATOR 229	-55.1	+77.3	
VERT. COLLIMATOR 301			+7.1
VERT. COLLIMATOR 249		-9.4	+5.0

Positions found by "Find beam" and withdrawal by 2 mm in the same conditions as above.

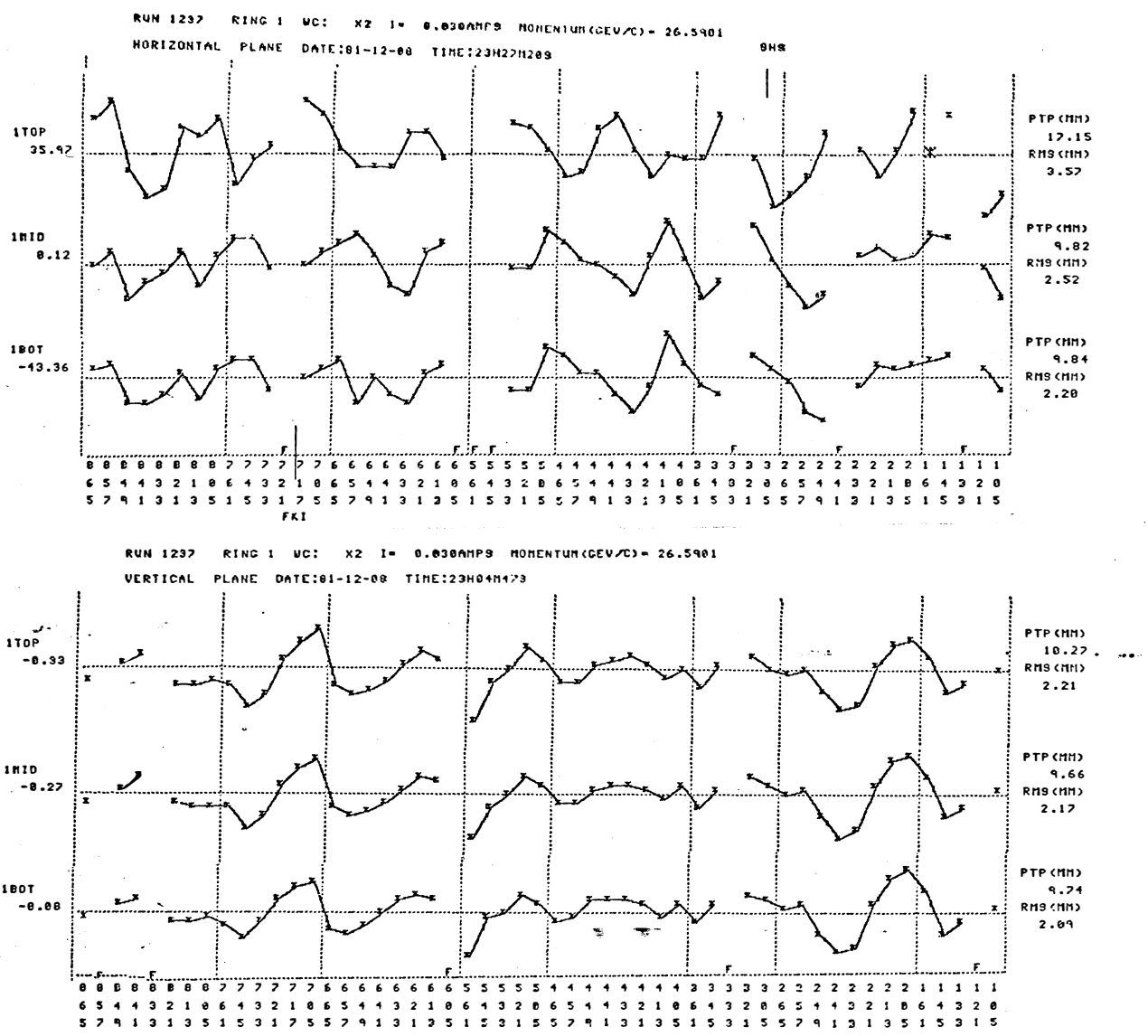


Fig. 1 Closed orbit distortions measured at the end of the MD.

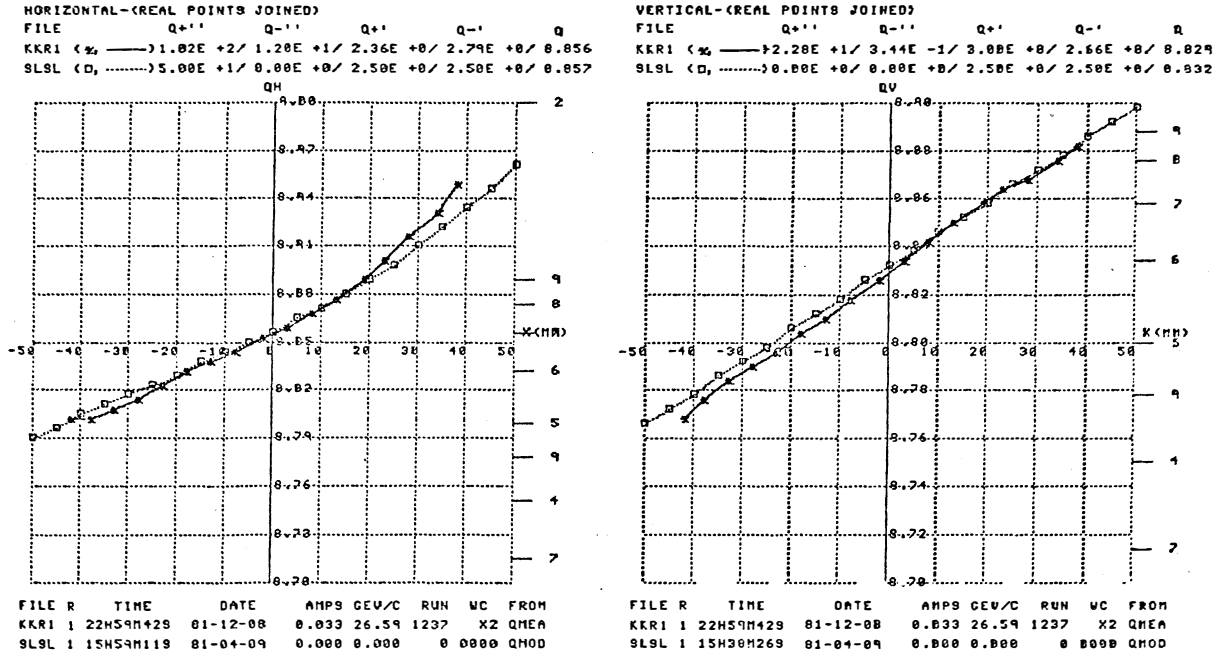
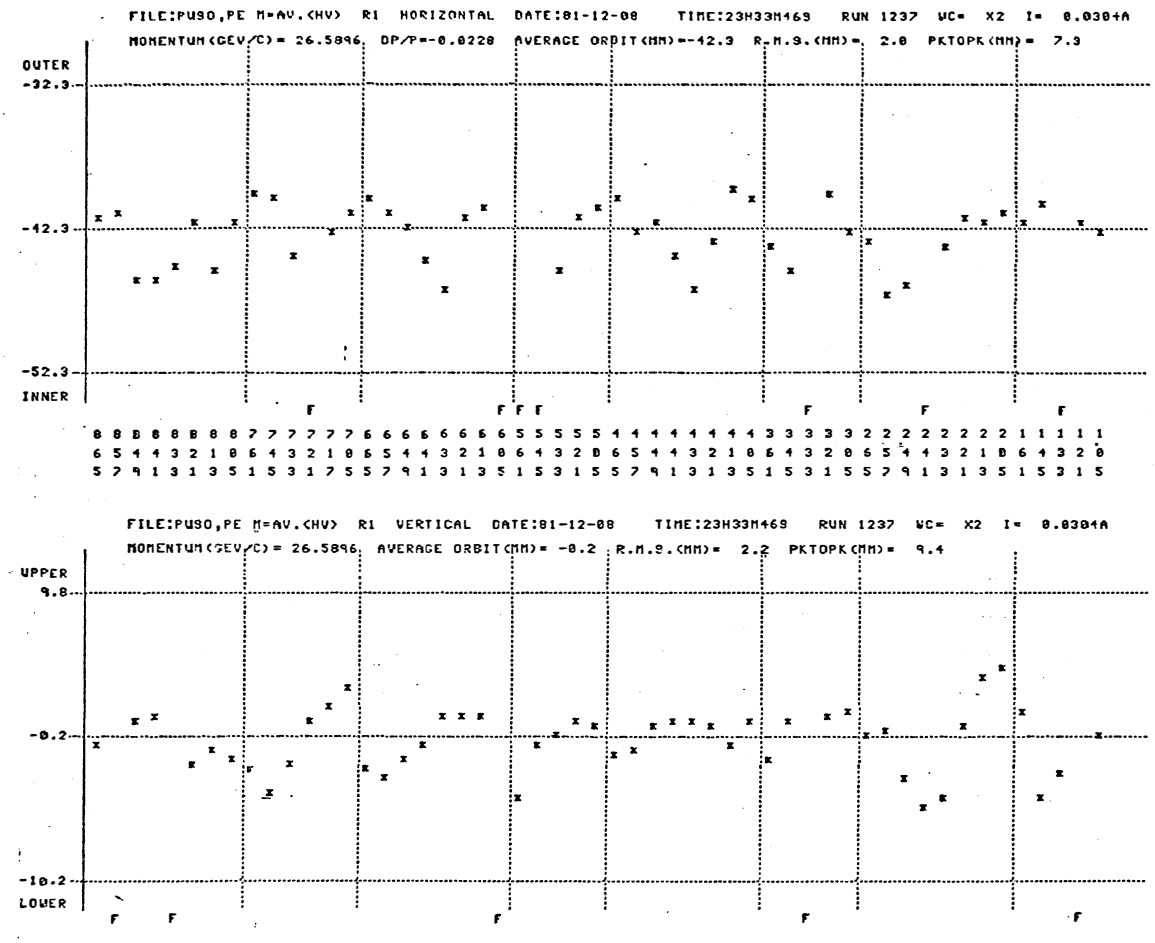
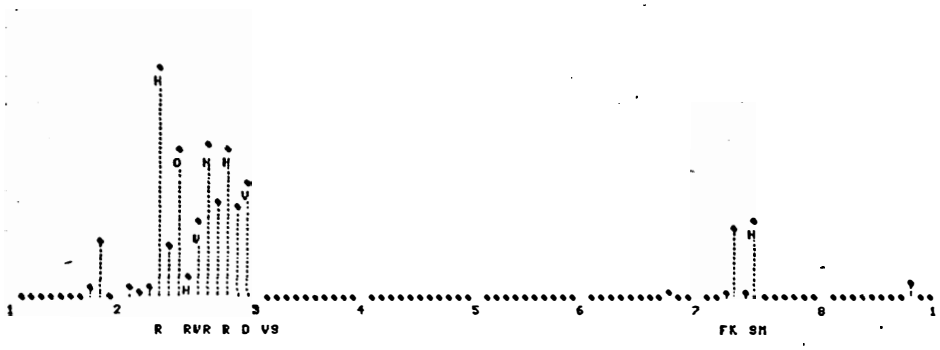


Fig. 2 Working line associated with the current file DL26, obtained at the end of the MD.

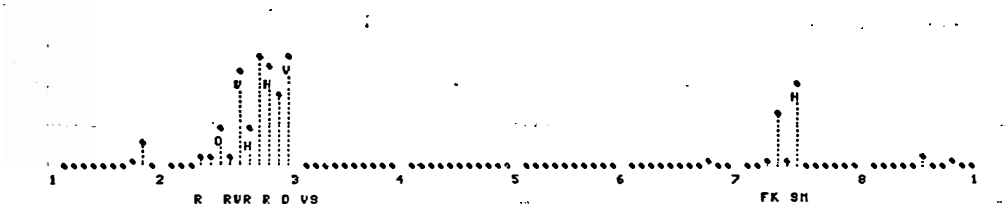


08	H	V	07	H	V	06	H	V	05	H	V	04	H	V	03	H	V	02	H	V	01	H	V
65	-35.5	-0.5	61	-34.6	-2.3	65	-36.1	-2.1	61	*FLT*	-4.2	65	-35.7	-1.3	61	-41.2	-1.6	65	-38.5	0.2	61	-40.5	1.8
57	-38.5	*FLT*	45	-36.5	-3.8	57	-41.1	-2.8	45	*FLT*	-0.4	57	-42.8	-0.8	45	-43.5	1.1	57	-47.6	9.6	45	-38.5	-4.1
49	-48.8	1.3	33	-54.5	-1.7	49	-45.2	-1.3	33	-56.2	0.2	49	-45.4	1.0	33	*FLT*	*FLT*	49	-50.7	-2.9	33	*FLT*	-2.5
41	-50.7	1.6	21	*FLT*	1.1	41	-47.9	-0.6	21	-39.7	1.3	41	-48.0	1.2	21	-37.2	1.5	41	*FLT*	-4.8	21	-38.3	*FLT*
33	-49.6	*FLT*	17	-45.4	2.2	33	-48.4	1.4	05	-33.8	0.7	33	-48.4	1.0	05	-34.4	1.7	33	-44.8	-4.2	21	-32.5	0.2
21	-45.8	-1.9	05	-35.3	3.6	21	-45.4	1.4				21	-46.3	0.7				21	-43.9	0.8			
13	-45.4	-0.9				13	-43.3	1.5				13	-41.6	-0.6				13	-44.1	4.3			
05	-39.5	-1.4				05	*FLT*	*FLT*				05	-40.7	1.3				05	-42.4	4.7			

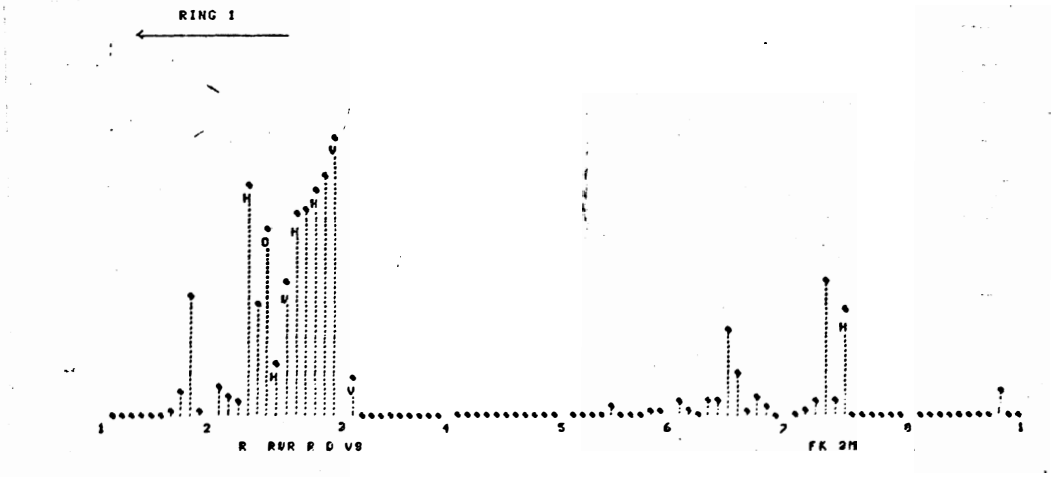
Fig. 3 Closed orbit distortions for the injection orbit. These measurements are copied in file DLR1.



a) losses with the BT matching of the FP machine.



b) losses with the BT matching for the DL machine (computation by V. Remondino) under the same machine conditions as in a).



c) losses with 148 mA injected and 133 mA circulating.

Same scale for all measurements.

Fig. 4 Multiturn losses at injection