ISR-ES/KP/lp 11.8.1975

ISR PERFORMANCE REPORT

RUN 614 - 4 July 1975 Ring 1 26 GeV/c - FP line

Test of high precision "LUMS"

Aim

To make measurements of vertical beam displacements given by a new version of the program "LUMS" written by R. Keyser. A correction for hysteresis in the H-magnets following the model of T. Taylor[1] is included and verification of setting precision to ± 1 DAC pulse ($\Delta I = 0.03\%$ of I_{max}) is required. Measurements of beam position were made with the intersection scrapers of I7.

Conclusions

The new program is able to make beam displacements for luminosity calibrations with greatly improved precision. The program gives displacements which are 1.27% too large but as expected this is now a linear error[2]. Its origin is not known. The scatter of the measured points about a straight line fit is only ± 9 microns (rms value). This value includes the error in the scraper measurements but can be used to make an estimate of expected precision in luminosity calibrations. With this new program it should be possible to limit the error introduced into luminosity calibrations by beam displacement errors to less than 0.5%.

Measurements and Discussion

The hysteresis correction routine in "LUMS" assumes that all H power supplies have been brought to their found values from + 100%. This ensures that all magnets have a maximum field error of + 5 gauss

...

due to hysteresis. Operationally this requires the following method of setting the closed orbit, XSET (FULL, ISR, H) which takes the H-magnets to maximum field, followed by XINC (OF = CO26, R1, H).

To check the operation of the program a set of displacements were made in intersection 7, as in a normal luminosity calibration 0 → +4 mm, 0 → -4 mm and 0. The beam positions were measured with the intersection scrapers using control program PROB. The working line FP 26 was checked beforehand and single pulses on central orbit were used.

The measured positions are given in Table I and the results displayed graphically in figure 1. The straight line of Fig. 1 is a least squares fit to the data and has a slope of +1.27% which is in reasonable agreement with what was expected[2)]. The rms scatter of the measured points from the fitted line is ± 9 microns, coming mainly from the spread of the three points at Z = 0. It should be noted that this is close to the limit of what can be achieved with existing hardware. One pulse on the DAC corresponds to ± 0.03% of I_{max} or 3 microns in terms of beam displacement at 26 GeV/c. With four magnets a mean error of ± 6 microns must therefore be expected. A setting precision of ± 0.03% of I_{max} is inside the power supply specifications but is consistently achieved in practice.

An estimate of the effects of the remaining, hopefully random, errors has been made by assuming a correction of - 1.25% to the displacements and calculating the error on the area of a gaussian curve of σ = 1 mm ($h_{eff} \sim$ 3.5 mm) with the points of this particular measurement. The result is an error in the area of the curve (proportional to a luminosity monitor constant) of 0.2%. This will increase to 0.4% if the 1.25% correction is in error by ± 0.25.

Further measurements should be made to establish the validity of the 1.25% correction particularly at other energies.

K. M. Potter

TABLE 1

LUMS POSITION	SCRAPER MEAS.	
Z_{SET} (mm)	Z_{MEAS} (mm)	$Z_N - Z_S$ (mm)
0	1.440	1.440
1	2.443	1.443
2	3.461	1.461
3	4.467	1.467
4	5.492	1.492
0	1.454	1.454
-1	0.424	1.424
-2		
-3	-1.601	1.399
-4	-2.617	1.383
0	1.419	1.419

References :

1) *Internal Report "More on the Radial Field Magnet System" - T.M. Taylor - 13.11.72*

2) *ISR Perf. Report "Precision of Vertical Bumps" - K. Potter - 31.7.74*

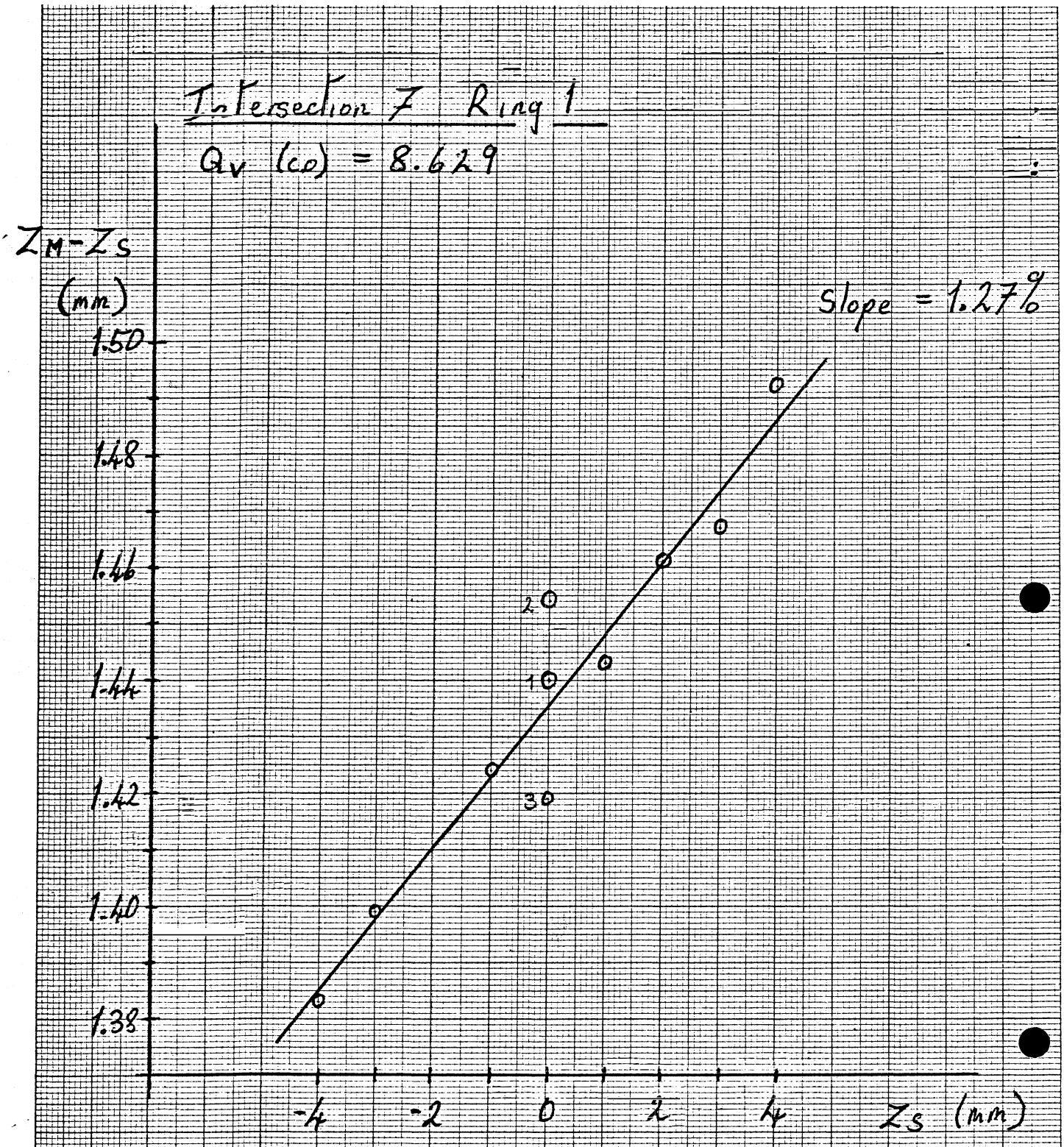

Figure 1 : Difference between measured and required displacement