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Measurements of DISTAGON Plates on ERASME S/M 1

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The DISTAGON plates are photographic plates with a test pattern of fiducial marks in order to study the distortions of the DISTAGON lenses of BEBC. These plates had been measured previously with LUCY. Details about the photographic arrangement of the DISTAGON plates and on some measurement results can be found in ERASME-NOTE 72-6 (1). The plates of lenses #4 and #7 which are currently installed in BEBC, were re-measured on ERASME S/M 1.

In order to introduce the glass plates into the film gate of the calibration channel, the plates were cut to smaller dimensions and glued into a metal frame which allowed a precise positioning of the plates within the film gate.

Parabola Fit to Fiducial Arms

As can be seen from figs. 2 and 3 of (1), the fiducial arms on the plates are slightly curved. The coordinates of the fiducial centre have therefore been calculated by fitting a parabola to the fiducial arms. The differences in position of the intersection point of the arms when using a straight line fit or a parabola fit to the fiducial arms is in the order of 2.7 microns for fiducials of the test pattern lying in the outer regions of the plates and about 1 micron for the camera based fiducials.

General features of the interactive programme to measure fiducial patterns will be described elsewhere.

Calibration of CRT

Currently, for measurements of events in film from the 2m HBC, the CRT of ERASME S/M 1 is calibrated over an area, which corresponds to 84.7 x 56.5 mm^2 in the film plane, using as calibration grid a copy of the LUCY calibration grid (see (1)) on a 4 mm thick glass plate. This area is too small to measure at least the same number of fiducials on the DISTAGON plates as measured earlier with LUCY. The question arises whether one can use the transformation coefficients of the "standard" calibration outside the calibrated region or whether the calibrated area has to be extended.

In order to answer this question, a set of fiducial marks with two more rows on the calibration grid was measured and transformed into undistorted space using the transformation coefficients of a "standard" calibration. It turns out that the deviations of the measured fiducial positions from the ideal grid positions are appreciably larger for fiducials outside than for fiducials within the calibrated area. The mean value of residuals of fiducials outside the calibrated region (row # 1 and # 13) is 4.3 microns (RMS value = 4.7 microns) compared to 1.3 microns for fiducials inside. The conclusion is that precision measurements should only be done within calibrated areas.

"Standard" and "extended" calibrations are compared with each other in the table below.

		"Standard" calibration	"Extended" calibration
Calibrated area		84.7 x 56.5 mm^2	84.7 x 67.8 mm^2
Number of equi-distant points used for calibration		176 11 rows x 16 columns	204 13 rows x 16 columns
Residuals after fit	Maximum	2.52 µm	2.64 µm
	Mean value	0.86 µm	0.99 µm
	RMS value	1.04 µm	1.18 µm

Both calibrations are equally good. The main contributions to the residuals are in the y-direction and are due to the digital-analog-converter (DAC) for the y-deflection-coil-driver, which is not as well adjusted as the DAC for the x-direction. (This fact is known for some time already.)

Measurements

The DISTAGON plates were measured 5 times each on 20 January 1973. The high voltage of the photomultipliers of the track detector were adjusted according to the average background density of the plates and the discriminator level could be set individually for each fiducial in order to adjust for a change in contrast and density.

Plate	Measurement time	Calibration date
4^{II}	10:42 - 10:57	20.1.73 9:07
7^{I}	17:18 - 17:20	20.1.73 16:00
4^{I}	17:33 - 17:39	20.1.73 16:00
7^{II}	17:48 - 17:52	20.1.73 16:00

Data reduction

The measurements, written as PDP-10 disk-files in HYDRA-block format, were dumped onto ½" magnetic tape and converted to CDC6000 format, so that the further data handling could be done on a CDC6000 machine.

ERASME S/M 1 was very stable during the period of measurements so that the measurements could be averaged without any further editing except for plate 4^{II}, where 6 fiducials with residuals larger than 7 microns were discarded (all the 6 fiducials are on the edge of the field of view). These averaged measurements can then be taken as input for the actual analysis programme for the lens distortion. The RMS scatter of the 4 camera based fiducials and the RMS scatter over all crosses and all measurements are given below.

RMS Scatter of Fiducials in Microns

Plate	Camera based fiducial				RMS scatter over all crosses and all measurements
	#1	#2	#3	#4	
7^{I}	.91	1.39	.91	.67	1.15
7^{II}	.63	.60	.50	1.15	1.70
4^{I}	.65	.38	1.43	.72	.69
4^{II}	.66	1.31	1.50	.86	1.36

As can be seen, the reproducibility of measurements is excellent (remember: 1 least count = 1.516 microns).

A further test is the comparison of distances between camera-based fiducials for the two positions I and II which should be equal. (In order to understand the following paragraph, the contents of ref. (1) should be known.)

It appears that the internal consistency for lens 7 is reasonable as it was already the case for the LUCY measurements (compare fig. 1b with fig. 8b of (1). On the other hand, the comparison for lens 4 exhibits differences when compared internally (fig. 1a) or with the microscope measurements (fig. 1c, 1e) which are probably due to the large variation of background density and contrast of the camera-based fiducials in these particular plates (see measurements in (1)). Therefore, the camera-based fiducials of plates 4^{I} and 4^{II} should be replaced by the corresponding microscope measurements (fig. 1d).

REFERENCE

/1/ D.M. Harmsen, On the accuracy of the CRT flying spot scanner LUCY, CERN/D.Ph.II/ERASME-NOTE 72-6 of 20.7.1972.

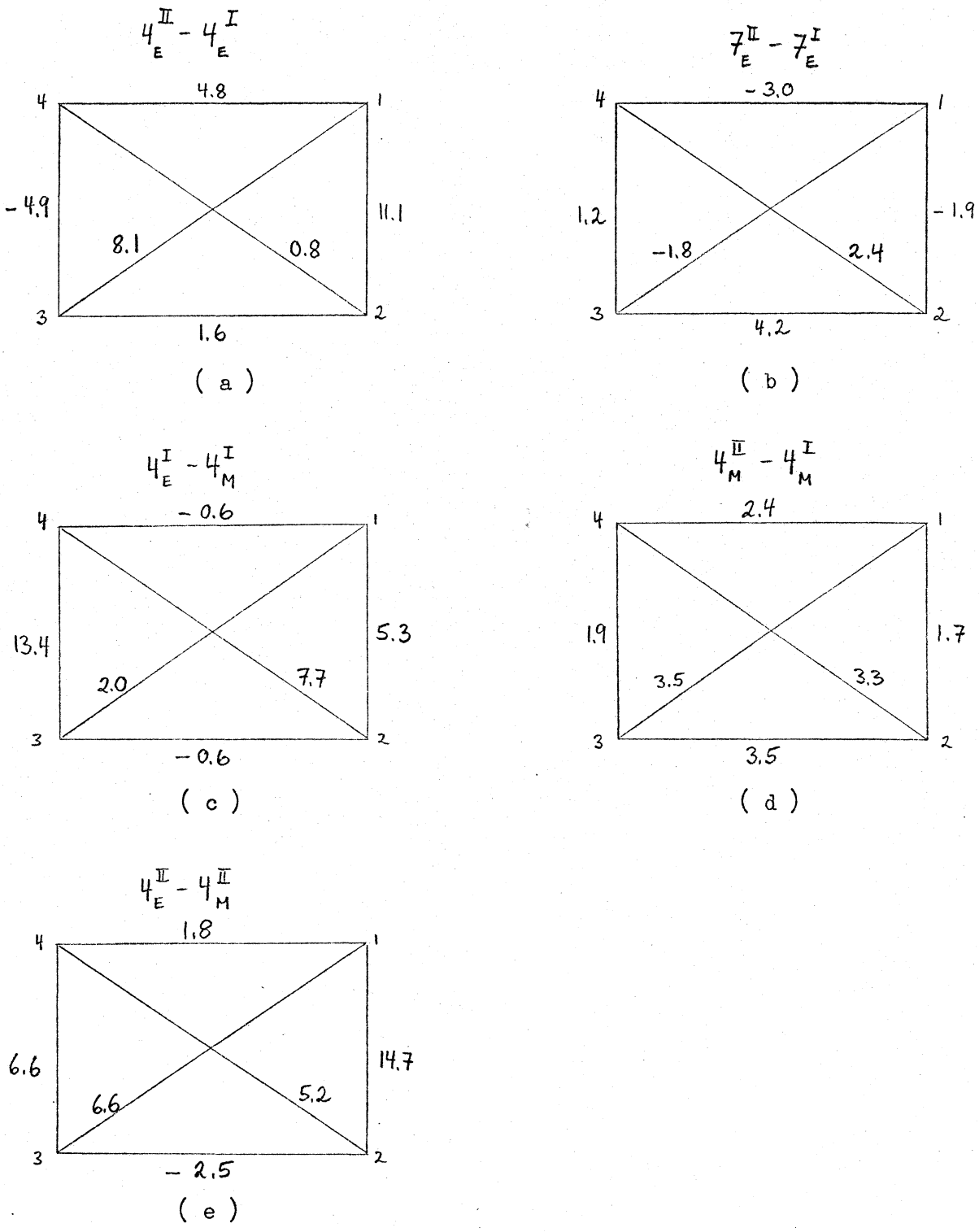

Fig. 1 Differences of distances in microns between camera based fiducials.