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AIR TRAFFIC CONTROL RADAR DATA ANALYSIS AND BIRD MOVEMENTS DETECTION

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Summary

This paper discusses the problem of the analysis of the ATC radar echoes and the possibility of detecting bird's movements, by implementing an appropriate logical function.
The approach looks promising and some additional advantages may be expected in terms of system performances. Moreover, it is suggested that this problem should be duly considered in the specification of the ATC radar meteo channel.

Foreword

This document discusses the analysis of the ATC radar data not caused by aircrafts, the problems involved in their classification aimed to the detection of the bird's movements, and the possible use of such information.

General

Bird's detection by radar is a well known phenomenon, and a wide bibliography is available on the subject. Normally the data are collected with the cooperation of ornythologists and involving a noticeable number of observers. We want examine whether it is possible to implement a permanent function of radar data analysis and reconnaissance.

At the radar output (digital or video) we found, besides the signals caused by aircrafts, other signals, caused by

- surface traffic (terrestrial and marine)
- meteo phenomena
- sea clutter
- other airbone targets (birs, insects and smokes)
- anomalous propagation

In order to characterize the radar environment and to analyze a few simple cases, AAAVTAG and Selenia of Italy have jointly developped an experimental work.

Data collection description

Two different types of sensor have been used: an en route radar (Poggio Lecceta) whose digital signals (plots) have been recorded on disk at the Regional Control Center (CRAV) of Ciampino, and a terminal area radar (Fiumicino) whose video signals have been recorded in TV raster format. The main parametres of the radars are indicated in the appendix A.

The digital data have been processed, obtaining several types of diagrams; the most significant are the position at parametric intervals [XY (nT)] and the coordinate versus scan time [X (T) or Y (T)]. The first diagram show the position of the signals every n antenna scans. This graphical artifice makes easier to recognize the movement, because at such time intervals the steady state component of the motion prevails on the statistical component. A real time approach would require slow tracking techniques, with some arrangements for the signals distributed over several radar cells.

For these elaborations we have used only omogeneous cases, i.e. charactherized by a single type of sources.

The video signals have been used as a reference either for the digital presentation, either for the visual observation in order to identify the sources. During this phase the Roman Section for the Birds Protection (SRoPU) has actively collaborated, providing information about position, time, quantity and type of flocks. It has been therefore possible to identify on the terminal radar screen the signals caused by birds. It has not been possible to obtain similar identifications on the en route radar due to the distance between the visual observers positions and the area covered by the radar and probably interested by the phenomenon.

Figures 1 thru 6 show the diagram derived from surface traffic (terrestrial and marine) and meteo echoes.

Figures 7 thru 10 show the raw video of the terminal area; it is evident the evolution of the signal that has been positively identified as flock of starlings (sturnus vulgaris) moving toward the breeding area, thanks to the cooperation of the SRoPU. For such a signal the digital translation is similar to that of a meteo nucleus; a more concentrated flock appears more like to a marine target.

Analysis of the results

The analysis of these sample of environment lead us to the following considerations:

1) The different sources are characterized by evolution profiles (in space and time) quite typical, and they are active when certain measurable parametres assume well defined values (pressure, wind, temperature, sea state and similar).

2) The absolute speed is slow (if compared to the air traffic); the spatial distribution of the signals fluctuates more from scan to scan. The processing and display technique used in ATC, which has been optimized for the aircrafts, makes very difficult to recognize the evolution profiles, particularly when different types of sources are active in the same time and area.

3) The sources height is concentrated at medium and low levels, where the radar sensitivity gradient reaches high values. Rven if the sign is favourable (the sensitivity increases toward the levels more interesting for safety) the module is too large.

4) The analysis of the signals needs times longer than the air traffic, it tolerates slower rates, and, by memorizing the previous situations (short and long terms) it allows quick reconnaissance or even prediction for certain types of sources.

Possible applications

This picture allows us to make the following hypotheses about the signal processing:

a) data processing

An automatic analysis function, fed by the primary extractor accumulates results and, in a later stage, supplies the extractor with information useful to reduce the processing load of the same extractor. The typical case is the ground traffic, where the automatic function is able, in the long run, to supply the matrix of all the possible coordinates. The automatic function therefore, besides to supply the inforamtion about the sources to the control center, increases the actual load capabality of the system and its available sensitivity. The final configuration foreseen the automatic function embedded in the extractor, due to the amount of integration with it and with the radar; as an interim solution it can be implemented on separated machine working in parallel with the extractor.

The availability of the doppler measurement, expected at short terms, will increase the analysis capabilities.

We must emphasize that the above is applicable either to the en route, either to the terminal area radars. For these, normally sited inside the airport area, the increase of acceptable load offered by the automatic function is extremely important because it allows to watch the close in zone.
It is foreseen that the surveillance of local birds movements will be available, possibly with a suitable integration with the airport surface movement radar system.

b) Effect on the radar configuration

The problems that we have discussed so far have an high degree of commonality with the processing of the metereological signals in the Air Traffic Control Radars. If we exclude some peculiar problems of normalization and level quantization, the analysis and the reconnaissance of meteo echoes require the same processing that we have envisaged in our case. It is therefore logical to imagine a dedicated receiving channel that encompasses also the meteo function, and is handled by the automatic reconnaissance function. In this case it is possible to perform also sensitivity tests, changing the radar parameters on a scan to scan basis. The automatic function is therefore strongly powered, and it may resolve a number of ambiguities that cannot be resolved at plot level, or at least using more time.

A few words about the use of the signals

When the sensor is equipped with the automatic function, a map of signals, where only airbone sources are present with ambiguity not exceeding two, is available. This map may be transmitted using low speed channels, and it may include also information about the radar setting, and therefore on the expected coverage. This type of message may use the same transmission medium, and probably the same gestional structure of the system telediagnostic. In the Control Center the maps can be composed together (a mosaic is probably sufficient), correlated with the meteo information, and therefore cleared from the remaining ambiguities. The image synthesized in this way, having resolved all the reconnaissance problems, is an essential support tool for an human operator.

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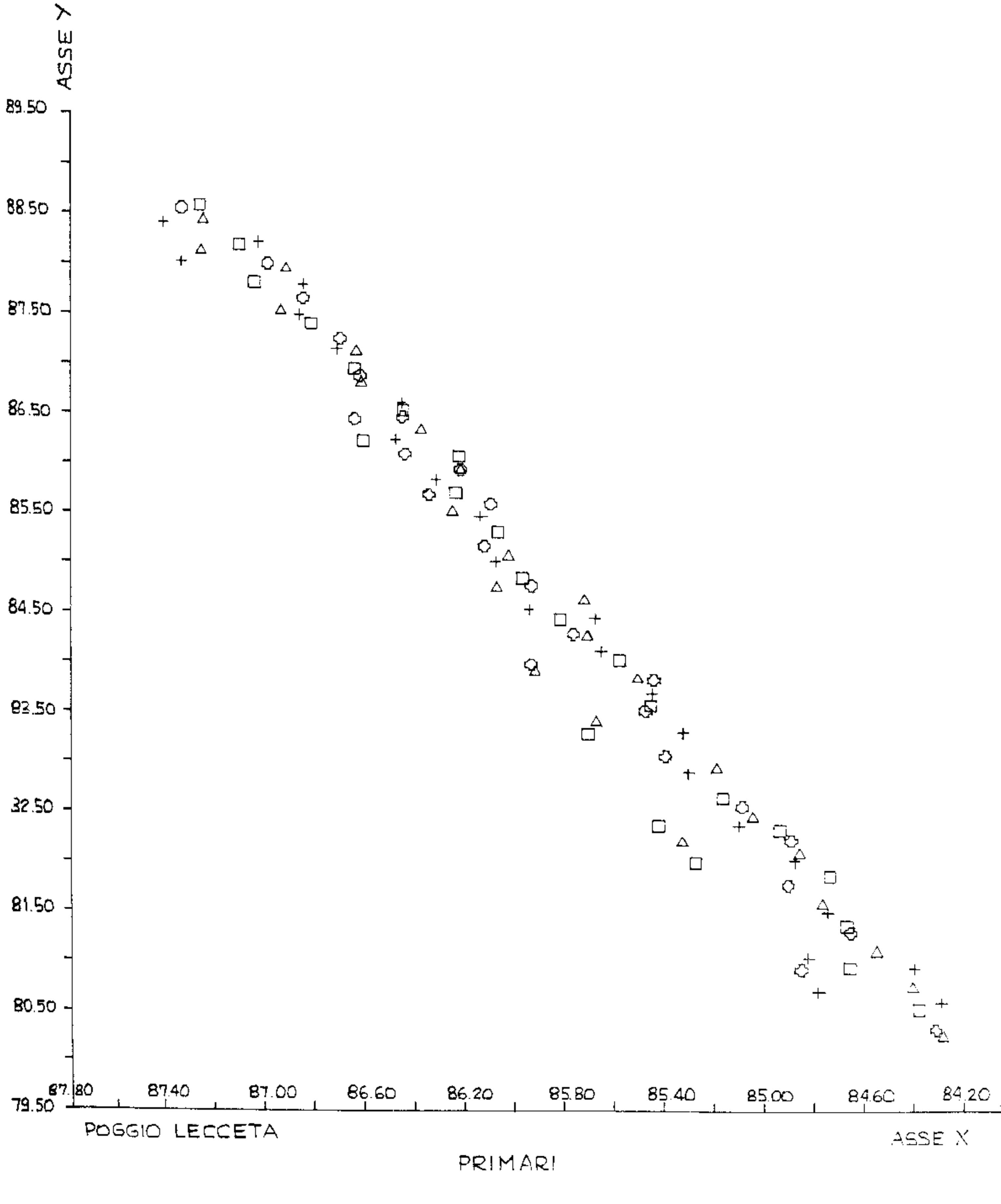
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87.40
87.00
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POGGIO LECCETA
ASSE X
PRIMARI

FIG. 1

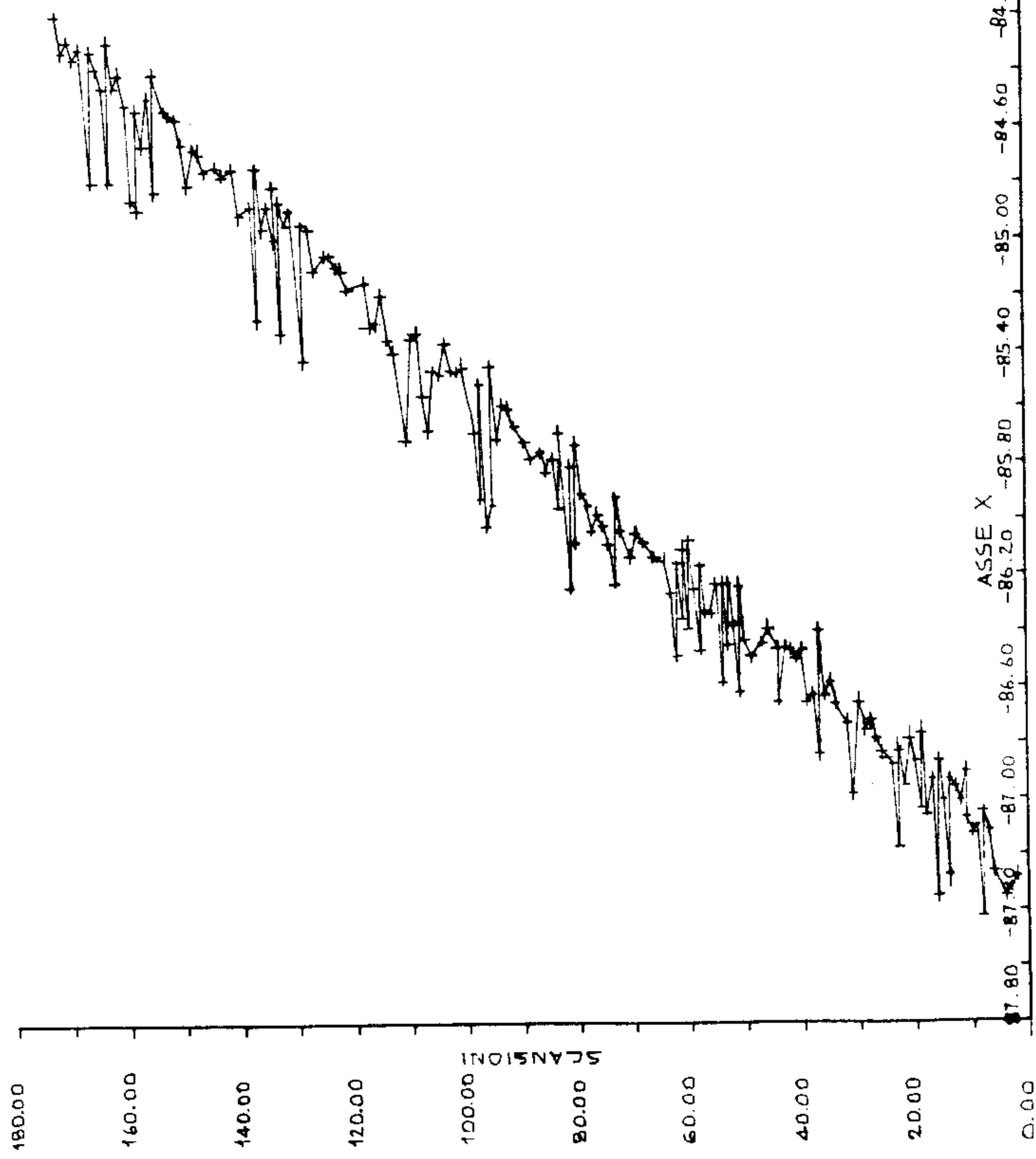
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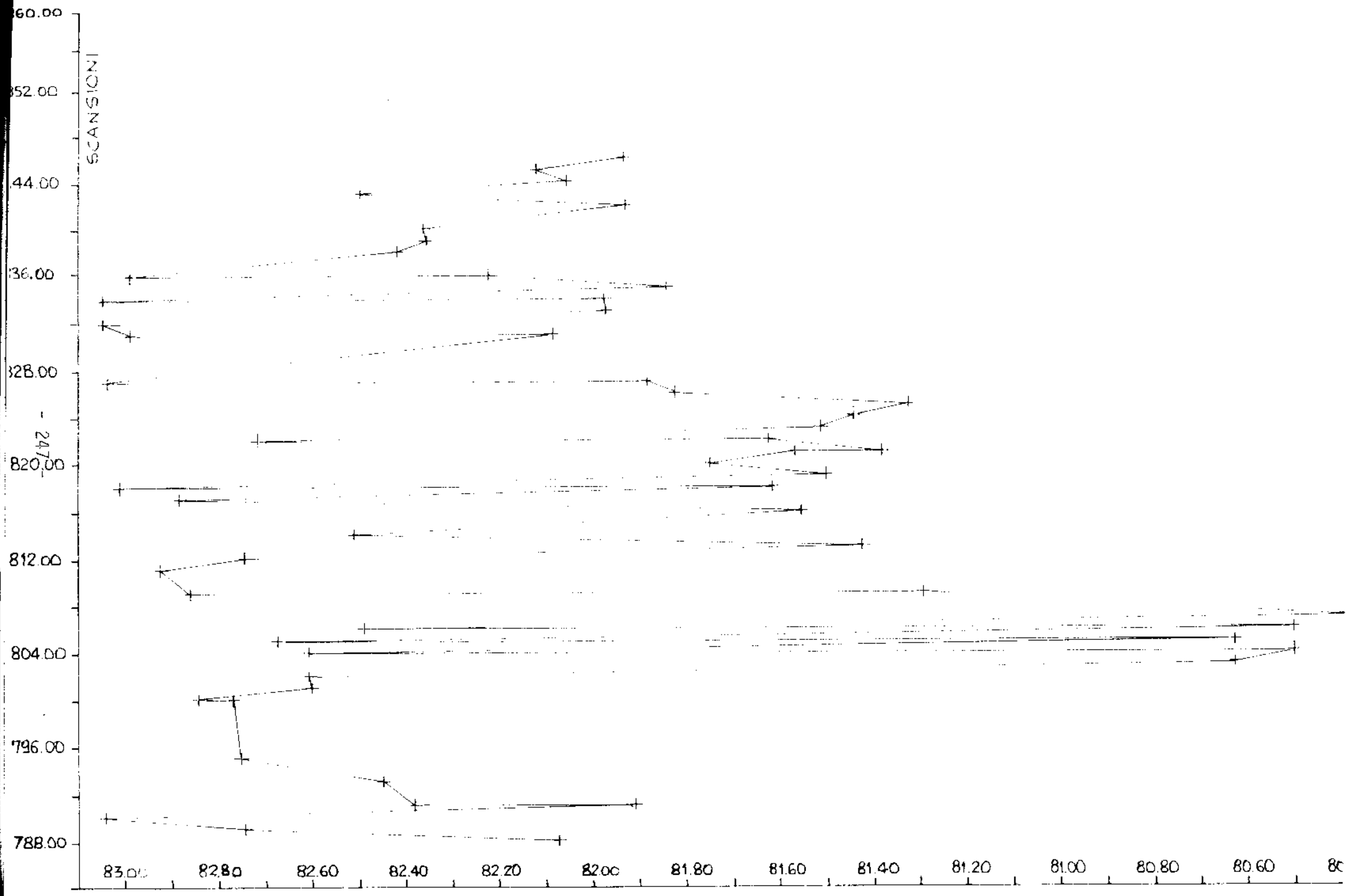
FIG. 2

- 247 -



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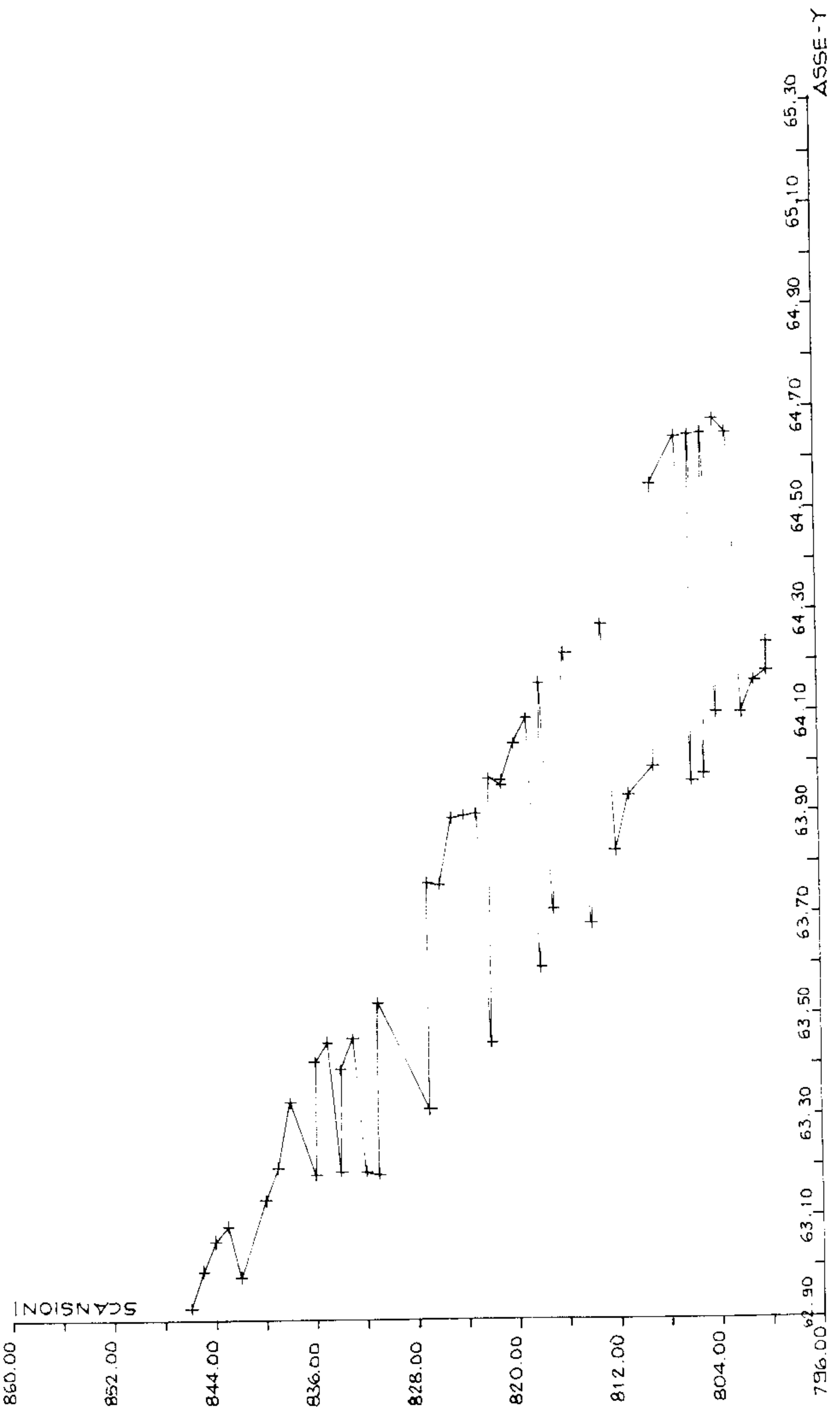
ASSE - X

FIG.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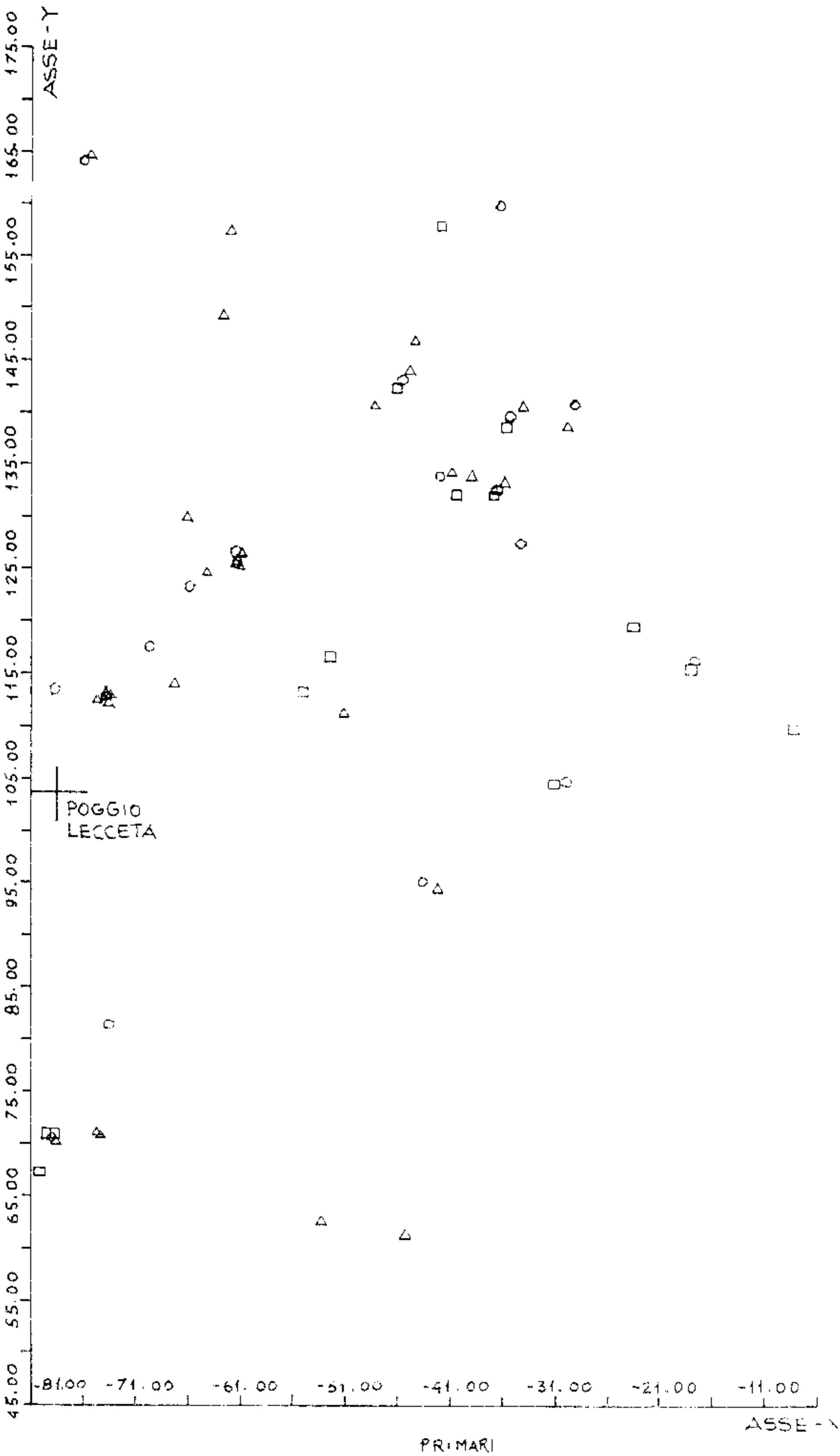
ASSE-Y

FIG. 4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POGGIO
LECCETA
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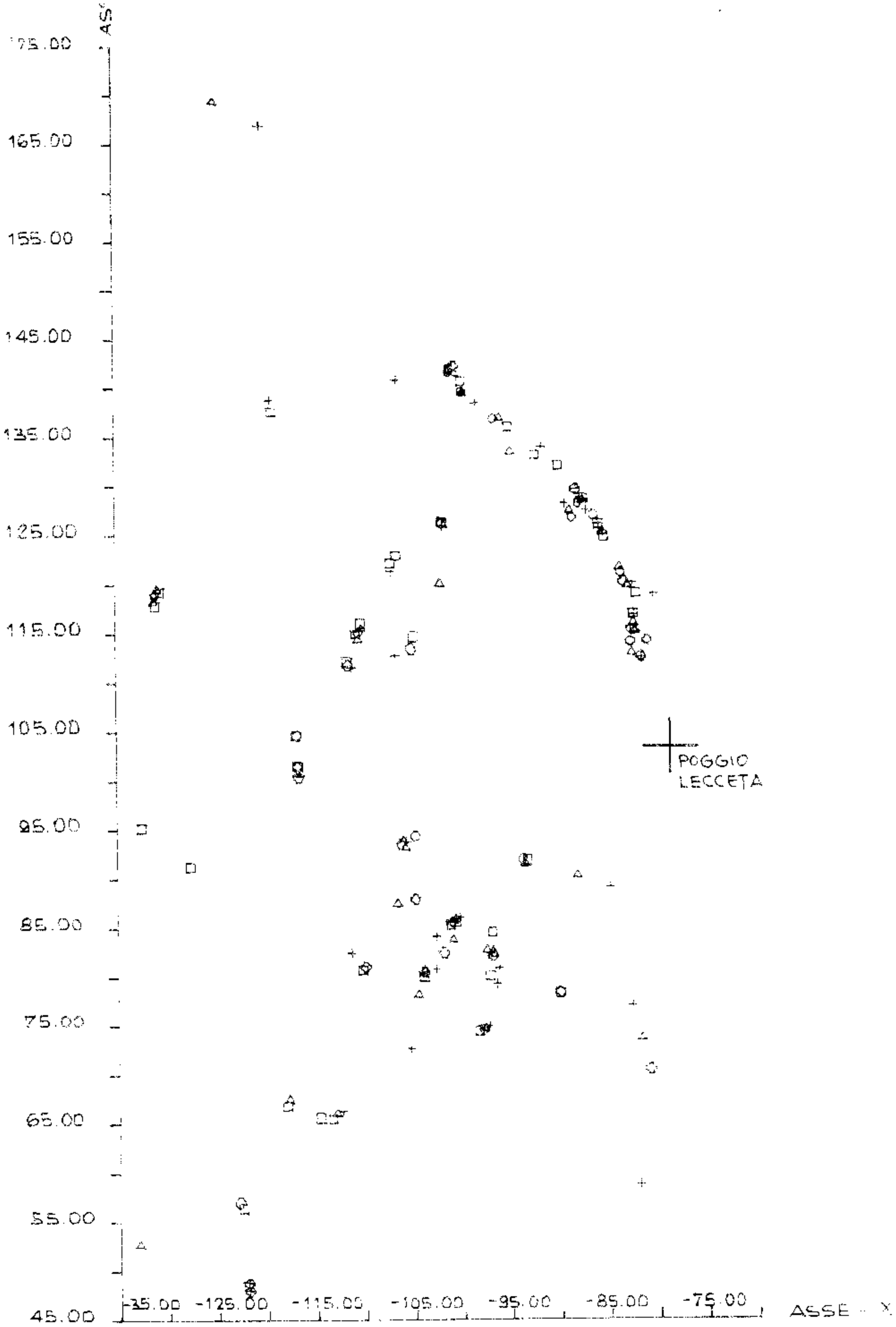
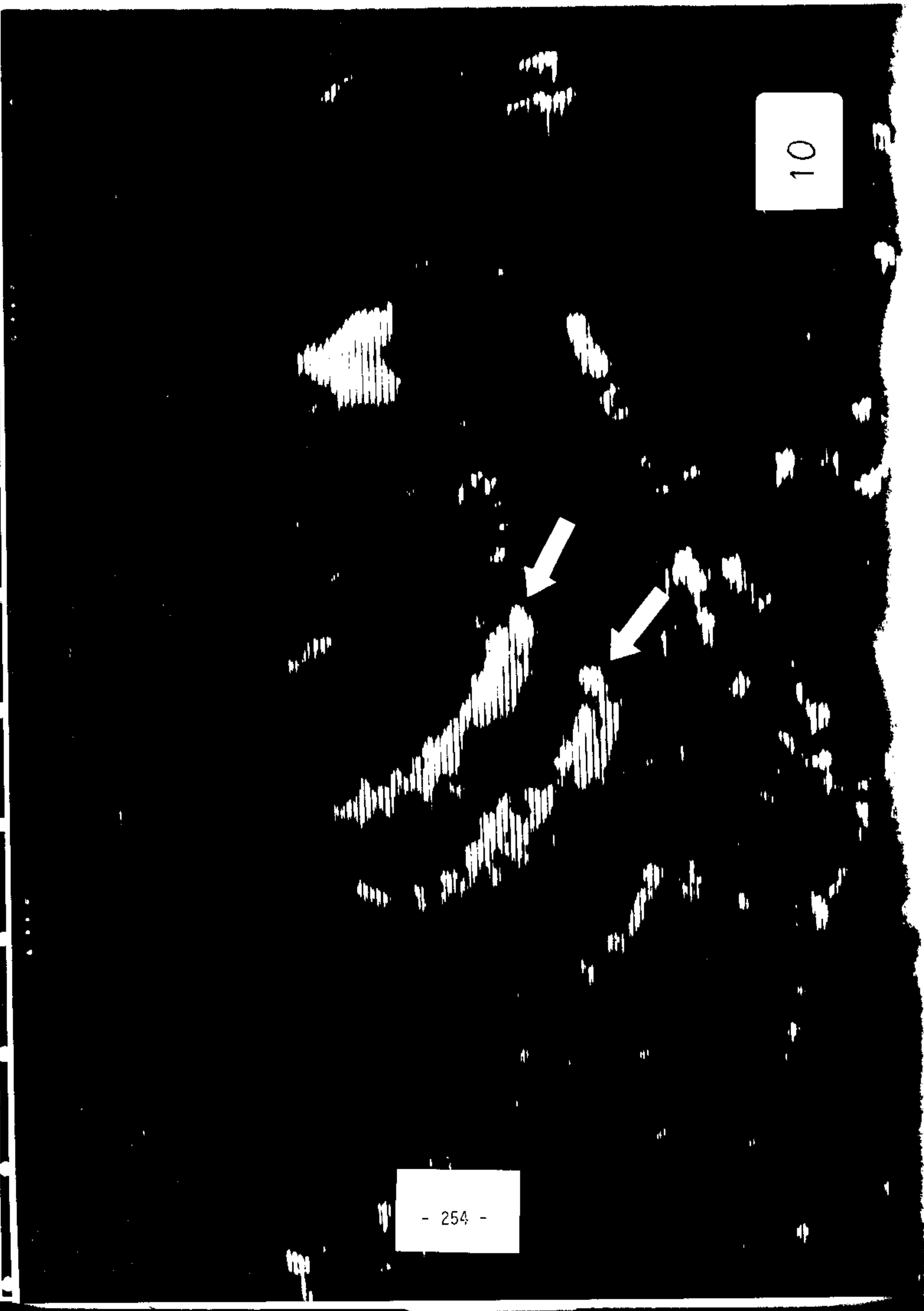
ASSE -
PRIMARI

FIG. 5



PRIMARI

FIG. 6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