The CERN 1.18 m^3 Heavy Liquid Bubble Chamber

by

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Abstract: The CERN heavy liquid bubble chamber has been substantially modified and its volume has been increased from 0.5 m^3 to 1.18 m^3. The modification, which was suggested in order to achieve higher rates in the neutrino experiment, was completed in a relatively short time and the chamber has worked successfully. The design parameters and the results of the test runs are briefly reported.

Introduction.

The CERN heavy liquid bubble chamber, of which the design parameters were reported at the 1960 Berkeley Conference on Instrumentation[1)], devoted most of its operation to the search for neutrino interactions. It became apparent, in the course of the experiment, that a bigger bubble chamber could improve the experimental situation and the design of a modification of the 0.5 m^3 chamber to increase its volume of liquid above 1 m^3 was started in December 1963. Major components, like a new chamber body and additional magnet coils were ordered soon, so that, when the chamber stopped operation in a neutrino beam in June 1964, tests and assembly of

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1) C. A. Ramm and L. Resegotti, Proceedings of an International Conference on Instrumentation for High-Energy Physics, Berkeley, 1960, page 127 to 132.

the modified components could proceed without delay. The chamber was ready for operation and worked satisfactorily in February 1965.

Design.

Time considerations suggested to limit the modifications to the (3) magnet to the addition of 3 double pan-cakes, so increasing its power consumption to 4.5 MW. Therefore the magnet bore remained the same and the chamber I. D. could be increased very little. The larger volume is therefore due, in the first place, by an increase of the axial dimension (4) of the chamber, from membrane to window, up to 1.1 m (see fig. 1). On the chamber body (fig. 2) heat exchangers of improved design are mounted. The glass window clamping between chamber and safety tank is very similar to the one used previously, although all the new components are slightly (5) different.

The expansion system has been redesigned to increase the life of the components by limiting shocks and vibrations.

Illumination is obtained by 8 xenon flash tubes mounted in Pyrex (6) pipes axially at the periphery of the chamber. The input energy of 1 kJ per tube, at the repetition rate of the chamber, is available: this (7) demands an efficient cooling which is achieved by forced circulation of nitrogen along the tube.

Three 70 mm cameras are mounted on a pitch circle of 0.485 m radius; the centre of the lenses is at a distance of 2.207 m from the window side (8) in contact with the liquid; the film plates are parallel to the window to better than 0.3 mrad. Resolution on the film is limited to 50 μ by dispersion through the glass windows and the liquid and by the stop number of 32 necessary to cover the entire depth of field.

Thermistors are imbedded in the chamber walls at a distance of 1 mm from the liquid. Four thermostatic systems connected to the eight heat exchangers on the chamber, are driven by the thermistor signal and regulate the water temperature in the heat exchangers. (9)

Results.

The magnet has been operated at 4.5 MW and (with) a water temperature increase of approximately 35°C. A magnetization curve in the centre of the chamber is shown in fig. 3, ~~whilst the plot of the field on the axis at full current is shown in fig. 4.~~

The chamber has been operated with Freon 13B1 (CF_3Br) at a temperature of 29°C. The temperature is controlled to better than ± 0.2°C in the liquid.

Typical cycling time of 80 ms, from beginning of pressure drop to restoration of initial pressure, was found to be satisfactory, with a pressure drop from 23 to 9 kg/cm^2 abs. (vapor pressure of the liquid at 29°C is 19.6 kg/cm^2 abs.) and expansion somewhat faster than recompression. The maximum repetition rate achieved is one pulse in 1.7 s, limited by the compressor capacity.

Flash tubes were operated up to 1 kJ input energy; however, good pictures could be obtained with a set of light directive fins around the tube spaced 5 to 7 mm, film speed 21 DIN and 200 J per tube input energy. (10)

By observation of beam tracks, sensitivity and illumination could be shown to be adequate in all the volume of the chamber. A typical picture of test beam tracks is shown in fig. 5.
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Acknowledgments.

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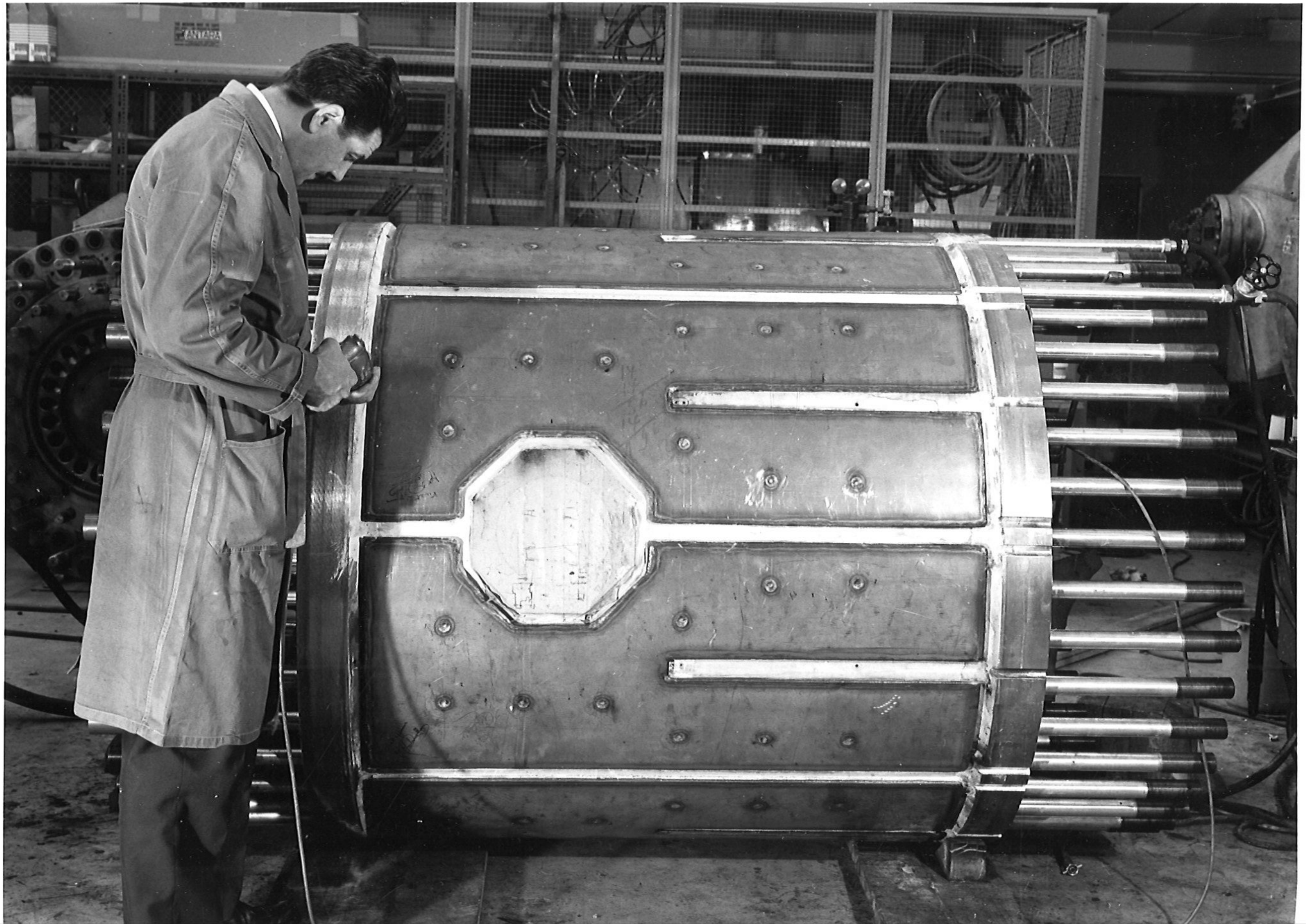


Figure captions.

fig. 1 - Vertical axial section in the magnet

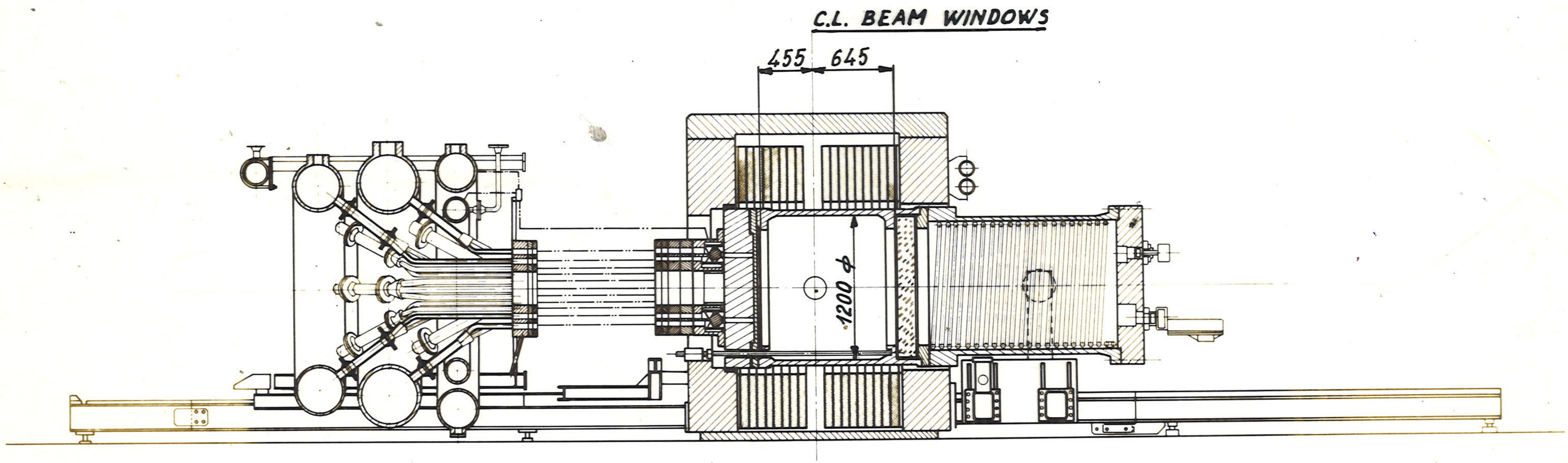
fig. 2 - Chamber body

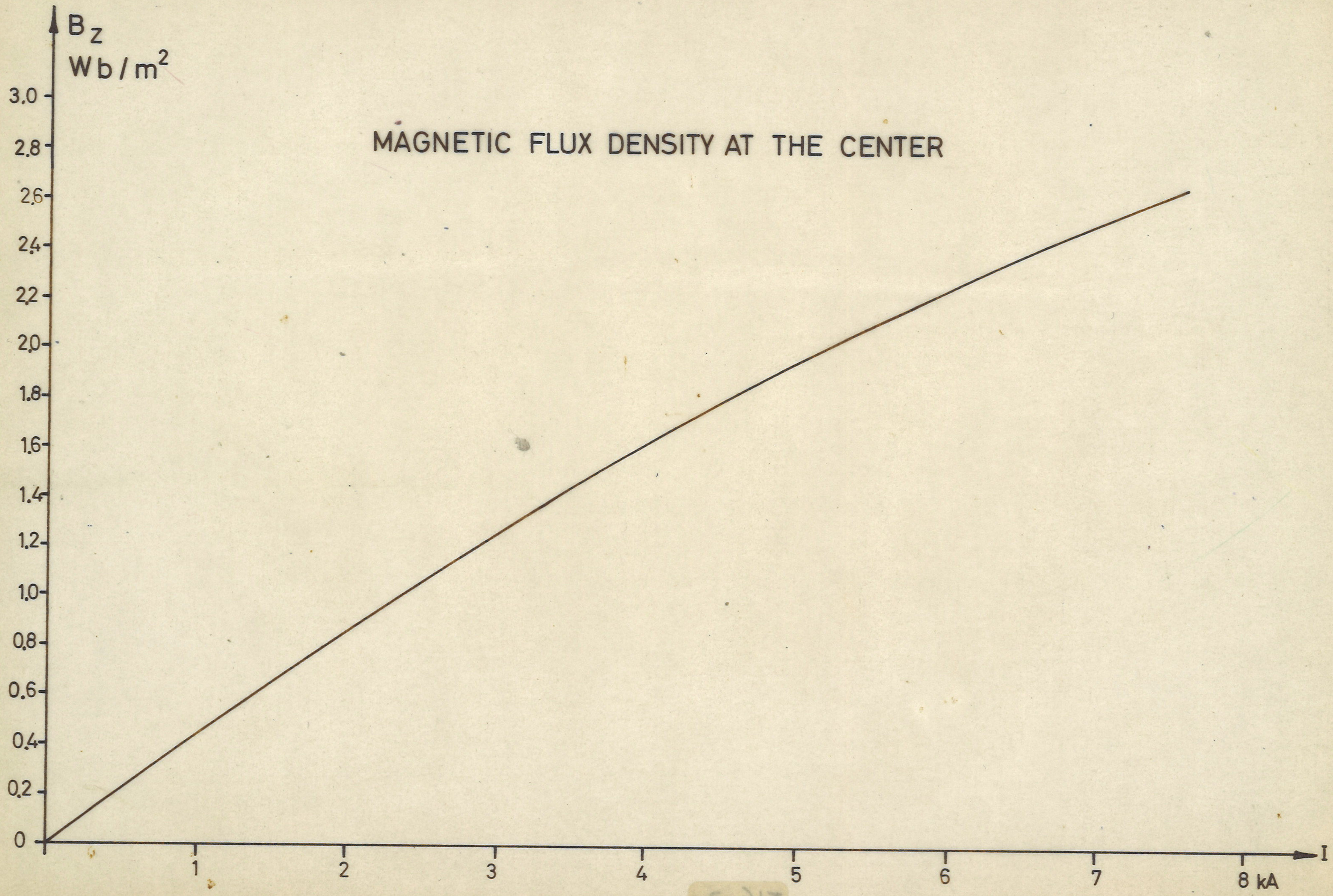
fig. 3 - Magnetization curve on the axis at 0.60 m from the glass window

~~fig. 4 - Magnetic field variation on the axis of the chamber at 7600 A~~

fig. ~~5~~ 4 - Test beam tracks through the chamber

Fig. 1




MAGNETIC FLUX DENSITY AT THE CENTER
B_Z
Wb/m^2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8 kA
I

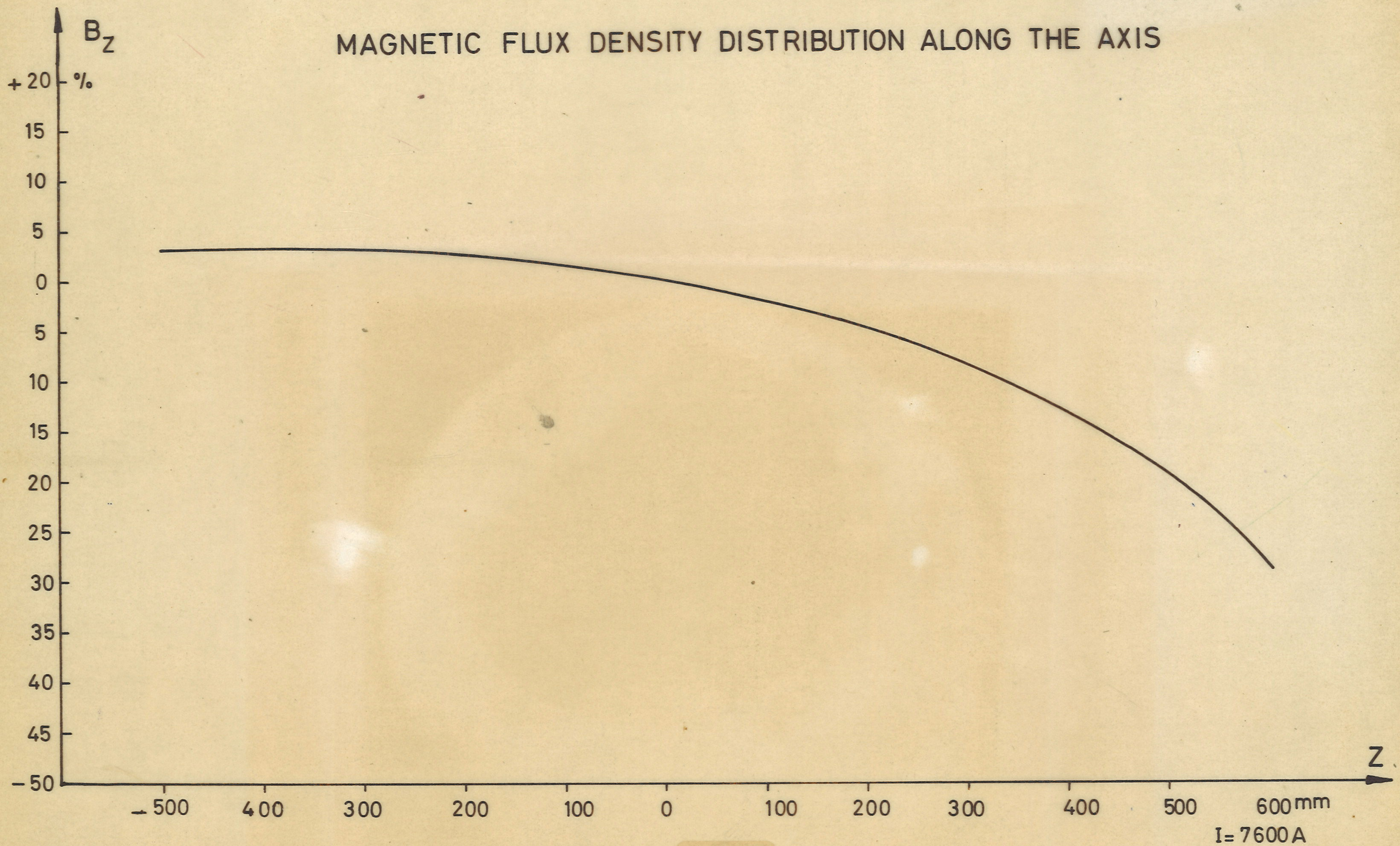

MAGNETIC FLUX DENSITY DISTRIBUTION ALONG THE AXIS
B_Z
%
+20
15
10
5
0
5
10
15
20
25
30
35
40
45
−50
Z
−500
400
300
200
100
0
100
200
300
400
500
600 mm
I = 7600 A

FIG. 4