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A SURVEY OF INNER ZONE PROTONS

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Abstract

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This report presents detailed data from a survey of trapped protons made by Relay I. Six energy channels from 1.1 to 63 MeV are analyzed to determine the stationary distribution of trapped protons as of January 1, 1963. This data is presented as the observed flux of locally mirroring particles plotted as a function of $/B/$ on each shell of force, and in the form of contour maps in B, L space. Although interpretation is reserved for a companion paper, it is believed that this data will be useful reference material for scientists investigating the trapped radiation.

A. L. ...

I. Introduction

The State University of Iowa - University of California detectors aboard Relay I have been used before to make selected studies of the trapped radiation in the interior of the magnetosphere. A broad survey of radiation intensities, including electrons of energy greater than 0.45 MeV and protons from 1.1 to 63 MeV, emphasizing spatial dependence, radiation damage effects on satellite solar cells, and geomagnetic storm-time effects, was distributed in a NASA report [McIlwain, Fillius, Valerio, and Dave, 1964]. McIlwain exhibited the effects of the major magnetic storm of September, 1963 on the protons counted by a 34 MeV threshold omnidirectional scintillation detector [McIlwain, 1964]. Fillius and McIlwain used the array of eight energy selective proton channels to demonstrate the spatial dependence of the energy spectrum and to indicate the intensities encountered [Fillius and McIlwain, 1964].

The present report is a detailed presentation of data from a survey of protons in six energy ranges from 1.1 to 63 MeV. This report is a supplement to a more interpretive paper to be published by Fillius [Fillius, 1965]. Because it was desired to make the complete set of data available, and because its bulk was too great to be included in the companion paper, the collection is presented in this separate report. It is believed that this data will be found useful by other experimenters for detailed comparison with their work, for theoreticians who want more than a superficial knowledge of experimental results, and, in general, by anyone who wishes to refer to the trapped proton intensities within the inner zone.

II. Instrumentation

This report deals with two of the four SUI/UCSD instruments on Relay I. Using pulse height discrimination, these detectors generate six energy bands of data on the trapped proton fluxes. Table I summarizes their characteristics. Previous reports have described the design and calibration of these instruments quite thoroughly [Fillius, 1963; Fillius and McIlwain, 1964; McIlwain et al, 1964]. These references can be consulted for a more detailed review of the instrumentation.

The output of the detector is digital, with digital telemetry and data handling. The discriminators and scalers are linear for the counting rates experienced by these detectors and a redundant readout in the telemetry frame guards against transmission errors. The linear amplifiers have a temperature coefficient which causes the discrimination levels to change by as much as 20% in the operating temperature range of -5 to +30° C. The data presented here has been compensated for this change by calculating, for the observed spectrum, the counting rate that would have been observed at the calibration temperature. Furthermore, radiation damage caused the gain of detector B to drop to 50% of its initial value in the period from April 10 to May 10, 1963. This data has been recovered by a similar correction. A complete description of this correction is given by Fillius [1965]. The temperature correction to the B detector data rarely amounts to as much as 40% and is generally less than 20%. That to the C detector data is rarely more than 30% and generally less than 15%. The radiation damage correction to detector B increases from zero to

as much as a factor of ten at the highest. These changes have proved themselves valid by reducing the scatter in the points, and, furthermore, the data recovered by the damage correction has made it possible to perform operations on the computer which, without it, had to be done by hand. It may be noted that previously published data [McIlwain, et al, 1964; Fillius and McIlwain, 1964] does not include the temperature correction to detector C or the additional detector B data gained by the damage correction.

III. Data Reduction

The complex data analysis program used for this survey was developed by McIlwain [McIlwain, 1963] for Explorer XV data. The method will be reviewed here as it has been applied to Relay I.

The raw satellite data consists of counting rates for the several detectors versus time. The position of the satellite as a function of time is provided by NASA and added to the data. Position is calculated in magnetic coordinates, or B, L space. [McIlwain, 1961]. From this is obtained the counting rates versus B and L. Next a computer program interpolates the data to selected magnetic shells [L = 2.0, 2.05, 2.1, etc.] wherever the orbit crosses them and data are usable. The interpolated data are grouped according to L value and sorted in order of B. With adequate data, one can then plot the counting rates as a function of B for any selected L. Usually there is a strong B dependence.

As each crossing of a magnetic shell occurs at a different time, the time dependence has so far been left out. For proton data it is typically quite small. When the time dependence is steady and not a function of B,

one can fit the flux on a line of force with the function,

$$\ln_e \Phi = \ln_e \left(\frac{1}{G} \right) + A_1 + A_2 t + A_3 \left(\frac{B}{B_0} \right) + A_4 \left(\frac{B}{B_0} \right)^2 + \dots + A_N \left(\frac{B}{B_0} \right)^{N-2} \quad (1)$$

where

$B_0 = \frac{.3116}{L^3}$ is the value of the magnetic field at the equator for that L,

$3 \leq N \leq 8$ is selected by the computer or by the programmer for the best fit.

G is the geometric factor in cm^2 - ster for the detector.

t is numbered in days and fractions of a day, beginning with 1 on January 1, 1963.

One sees that the given function can produce a strong B dependence and a weak t dependence as required. Good fits are obtained with this function without cross terms or higher powers in time.

Satisfactory coefficients $A_1, \dots, A_N$ have been obtained on a grid of L values for each of the six data channels of this survey. These coefficients are listed in Tables 2 through 7, along with the limits of B (in gauss) over which the fit is satisfactory and the number of data points on the line of force. The last column gives 100 times the rms difference between the logarithm of the data and the logarithm of the fit. In the approximation of a good fit this is just the rms error in per cent. This measure of quality ranges from 5 to 75 %, and is typically between 10 and 25%.

During a stable or slowly changing epoch a counting rate at time t can be projected to a reference time t_{ref} by multiplying by $\exp(A_2(t - t_{\text{ref}}))$. The result is the intensity that would presumably have been measured at the reference time. The figures accompanying this paper represent such presumed intensities, projected to January 1, 1963. Data in the three ranges of detector B were taken during the interval from December 14, 1962 to May 10, 1963; in the three ranges of detector C, from December 14, 1962 to September 22, 1963.

Figures 1 through 21 exhibit $\log \Phi$ vs $\log B$ measured in the six energy ranges of detectors B and C. The next three figures, Figures 22 - 24, show the sum of the detector C channels, or the flux of protons from 18.2 to 63 MeV. The points represent the individual measurement projected to day 1, and the line is the analytical fit according to equation (1).

All of the information from an individual channel can be displayed by a map of intensity contours. Figures 25 through 31 are contour maps in B, L space for the seven energy ranges named above. Although the former plots are more accurate, contour maps are convenient and make a pleasing summary of a set of data.

IV. Summary

Over 6000 data points have been presented which show the fluxes of trapped protons in the inner radiation zone. Discussion of the data will be made in a separate paper [Fillius, 1965]. It is hoped that distribution of this data will supplement other experimental work, and will stimulate theoretical studies of the origin, transport, and loss of these particles.

Acknowledgment

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Table ISummary of Detector Characteristics

Detector B

Sensor: Silicon surface-barrier diode with depletion depth
of 25 mg/cm².

Geometric factor: .0136 cm²-ster (directional).

Shielding: 8.5 gm/cm² brass in sides and back. 1.115 mg/cm²
(air equivalent) nickel light shield over look cone.

Electronic discrimination levels:

B α	=	0.87	MeV
B β	=	1.41	MeV
B γ	=	2.11	MeV
B δ	=	3.84	MeV

Proton energy ranges:

Range one: 1.1 to 1.6 MeV and
7.1 to 14 MeV

Range two: 1.6 to 2.25 MeV and
4.75 to 7.1 MeV

Range three: 2.25 to 4.7 MeV

Detector C

Sensors: Two silicon Li-drift diodes with active depths of
107 and 132 mg/cm², operated in coincidence.

Geometric factor: 0.22 cm² ster (directional).

Table I (Continued)

Electronic discrimination levels:

C1 α	=	0.75	MeV
C1 β	=	1.71	MeV
C1 γ	=	2.84	MeV
C2 α	=	1.14	MeV
C2 β	=	2.04	MeV
C2 γ	=	3.53	MeV

Proton Energy Ranges:

Range one:	18.2 to 25 MeV
Range two:	25 to 35 MeV
Range three:	35 to 63 MeV

Directionality

These detectors are mounted perpendicular to the satellite spin axis and are gated by a magnetometer to record data only when they point within ± 10 degrees of the plane perpendicular to the local magnetic field vector. Thus they measure $j_{\perp}$, the flux of locally mirroring particles.

TABLE 2 1.1 TO 14 MEV PROTONS

L	BMN	BMX	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	N	RMS
1.5	.10	.20	11.6582800	-0	-4.0635220	.2950260	-0	-0	-0	-0	-0	7 5.4
1.6	.08	.23	35.8079400	-0	-74.7808600	82.4972800	-46.5561300	12.9346100	-1.4074120	-0	-0	16 10.7
1.7	.07	.23	19.1000500	.0009004	-20.4352700	16.1119200	-7.3456670	1.7426390	-1.1673900	-0	-0	16 8.1
1.8	.06	.23	15.5548900	.0002643	-8.2263050	2.5557890	-3.026881	-0	-0	-0	-0	18 9.6
1.9	.05	.22	15.0070500	.0015174	-6.5427110	1.6956190	-1.647541	-0	-0	-0	-0	27 7.7
2.0	.04	.21	14.4767000	.0045160	-5.2990520	1.1730630	-0.980400	-0	-0	-0	-0	38 7.3
2.1	.03	.21	16.1838800	.0020190	-8.2367300	3.3151030	-7.793776	.0963539	-0.048545	-0	-0	42 5.9
2.2	.03	.21	16.5321300	.0020329	-8.2829380	3.1400140	-6.544800	.0684164	-0.028211	-0	-0	48 5.8
2.3	.03	.28	16.0865100	.0020970	-7.0064430	2.2676300	-3.982481	.0349287	-0.012073	-0	-0	51 8.4
2.4	.03	.28	15.5399100	.0026470	-5.9621920	1.7436280	-2.221119	.0209292	-0.006304	-0	-0	54 10.2
2.5	.03	.29	15.2792100	.0028744	-5.3004260	1.4271100	-2.039458	.0142715	-0.0033880	-0	-0	60 10.3
2.6	.03	.20	13.8347300	.0018612	-3.4891630	.6776554	-0.629868	.0021517	-0	-0	-0	61 11.2
2.7	.04	.22	15.0687900	.0009437	-4.5599780	1.0647950	-1.281342	.0074639	-0.001679	-0	-0	66 11.2
2.8	.04	.21	17.2443100	.0003762	-5.8026860	1.3078970	-1.463451	.0078552	-0.001624	-0	-0	57 21.7
2.9	.04	.24	13.2640700	.0005477	-2.7341500	.4720224	-0.416744	.0017696	-0.000291	-0	-0	53 9.8
3.0	.04	.24	12.9305900	.0002248	-2.4331510	.3965054	-0.333284	.0013597	-0.000216	-0	-0	43 9.3
3.1	.04	.25	9.1532710	.0003249	-4.624939	.0238457	-0.005213	-0	-0	-0	-0	37 8.5
3.2	.04	.24	8.2265660	-0	-2.203311	.0034380	-0	-0	-0	-0	-0	36 11.3
3.3	.04	.24	7.3978680	-0	-1.038430	.0002531	-0	-0	-0	-0	-0	27 34.7
3.4	.05	.24	6.8390540	-0	-0.752574	-0	-0	-0	-0	-0	-0	20 30.3
3.5	.05	.30	6.4095180	-0	-0.781935	-0	-0	-0	-0	-0	-0	23 27.6
3.6	.05	.26	5.8561310	-0	-0.680025	-0.001437	-0	-0	-0	-0	-0	20 45.3
3.7	.05	.26	5.2430680	-0	-0.313821	-0.006436	-0	-0	-0	-0	-0	18 58.9
3.8	.05	.12	4.5995740	-0	-0.182007	-0	-0	-0	-0	-0	-0	20 62.7
3.9	.05	.11	4.0471550	-0	-0.011601	-0	-0	-0	-0	-0	-0	19 67.3
4.0	.05	.09	3.7010570	-0	-0.033989	-0	-0	-0	-0	-0	-0	18 71.1
4.1	.05	.08	4.2664950	-0	-0.0904359	-0	-0	-0	-0	-0	-0	17 68.4
4.2	.05	.29	3.2889300	-0	-0.350940	.0001093	-0	-0	-0	-0	-0	19 64.9

TABLE 3 1.6 TO 7.1 MEV PROTONS

L	BMN	BMX	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	N	RMS
1.5	.10	.22	10.5428500	-0	-3.0688050	-0	-0	-0	-0	-0	-0	9 23.4
1.6	.08	.23	36.9233700	.0043508	-77.1469700	83.1371200	-45.6908500	12.3814800	-1.3196480	-0	-0	15 10.5
1.7	.07	.23	11.2449600	-0	.2078288	-4.3942450	2.1227820	-.3041325	-0	-0	-0	16 15.9
1.8	.06	.23	15.5863500	.0028247	-8.4748080	2.6676580	-.3164716	-0	-0	-0	-0	18 13.6
1.9	.05	.22	14.8767800	-.0006612	-6.8101790	1.8398700	-.1845511	-0	-0	-0	-0	27 11.0
2.0	.04	.21	14.0408500	-.0002171	-5.2701650	1.4776130	-.0989961	-0	-0	-0	-0	38 9.8
2.1	.03	.21	13.6473500	-.0007179	-4.4566230	.8679136	-.0631783	-0	-0	-0	-0	42 7.8
2.2	.03	.21	15.5517500	-.0013353	-7.5997450	2.7675590	-.5655090	.0598016	-.0025714	-0	-0	48 6.4
2.3	.03	.28	14.9710700	-.0015203	-6.3993520	1.9712950	-.3292901	.0276083	-.0009222	-0	-0	51 9.4
2.4	.03	.28	14.5559900	-.0017712	-5.7150850	1.6101930	-.2406252	.0177668	-.0005178	-0	-0	51 10.2
2.5	.03	.29	14.2622200	-.0019230	-5.0511310	1.2387340	-.1568914	.0097437	-.0002412	-0	-0	56 8.9
2.6	.03	.20	13.1594800	-.0007147	-3.7880840	.7224352	-.0632694	.0020100	-0	-0	-0	51 12.0
2.7	.04	.21	12.5648000	-.0000511	-3.1374940	.5172966	-.0384145	.0010133	-0	-0	-0	53 11.6
2.8	.04	.21	17.2031800	.0007859	-6.8108610	1.6047440	-.1879814	.0106522	-.0002340	-0	-0	45 12.5
2.9	.04	.22	12.4913200	.0019125	-2.8392740	.4131045	-.0260275	.0005714	-0	-0	-0	36 15.2
3.0	.04	.22	12.6997200	.0014857	-2.7936560	.3852723	-.0228945	.0004739	-0	-0	-0	28 16.1
3.1	.04	.25	6.5738880	-0	-.1585077	-0	-0	-0	-0	-0	-0	22 20.5
3.2	.04	.24	6.2511540	-0	-.1325682	-0	-0	-0	-0	-0	-0	23 22.4
3.3	.05	.24	5.7716520	-0	-.1041656	-0	-0	-0	-0	-0	-0	19 24.9
3.4	.05	.24	4.9016750	-0	-.0454015	-.0011382	-0	-0	-0	-0	-0	16 26.8
3.5	.05	.25	4.4574680	-0	-.0537307	-0	-0	-0	-0	-0	-0	20 46.5
3.6	.05	.25	4.1721680	-0	-.0659510	-0	-0	-0	-0	-0	-0	14 62.8
3.7	.05	.12	4.0672430	-0	-.0653543	-0	-0	-0	-0	-0	-0	14 61.6
3.8	.05	.12	2.9197630	-0	-.0074525	-0	-0	-0	-0	-0	-0	18 71.4
3.9	.05	.11	2.4382730	-0	.0000488	-0	-0	-0	-0	-0	-0	18 69.6
4.0	.05	.28	2.0446340	-0	-.0181530	-0	-0	-0	-0	-0	-0	14 69.1
4.1	.05	.28	1.8722030	-0	-.0215710	-0	-0	-0	-0	-0	-0	12 70.0
4.2	.05	.29	1.3180370	-0	-.0132529	-0	-0	-0	-0	-0	-0	

TABLE 4 2.25 TO 4.7 MEV PROTONS

L	BMN	BMX	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	N	RMS
1.5	.10	.22	9.9040480	-0	-2.9120660	-0	-0	-0	-0	-0	9	26.7
1.6	.08	.23	16.3282900	-0	-13.4555100	6.0788420	-1.0368100	-0	-0	-0	-0	15 20.4
1.7	.07	.23	20.1631000	-0	-17.3207700	7.0108750	-0.9822686	-0	-0	-0	-0	16 24.9
1.8	.06	.23	17.1763800	-0	-11.1843800	3.7758890	-0.4514030	-0	-0	-0	-0	18 19.0
1.9	.05	.22	14.3962000	-0	-6.7516690	1.8369300	-0.1852364	-0	-0	-0	-0	27 11.6
2.0	.04	.21	13.2287000	.0015741	-4.9719260	1.0776170	-0.0885237	-0	-0	-0	-0	39 12.0
2.1	.03	.21	12.8552900	.0006450	-4.2776070	.8220975	-0.0591745	-0	-0	-0	-0	42 9.3
2.2	.03	.21	13.6164700	.0000473	-5.4710230	1.4304060	-0.1773227	.0080251	-0	-0	-0	48 9.6
2.3	.03	.22	15.7077400	.0004589	-9.4184020	4.0788830	-1.0053530	.1362941	-.0093610	.0002493	50	10.5
2.4	.03	.21	15.9658100	.0006573	-9.5613430	3.9275710	-.8972405	.1123597	-.0071764	.0001805	50	10.8
2.5	.03	.29	11.9034000	.0005543	-3.6149810	.6696126	-.0544286	.0014846	-0	-0	-0	56 11.8
2.6	.03	.20	11.6427800	.0007706	-3.5955800	.6841598	-.0593454	.0018542	-0	-0	-0	51 15.3
2.7	.04	.21	11.3036700	.0014346	-3.2491810	.5620647	-.0441086	.0012429	-0	-0	-0	54 13.8
2.8	.04	.21	8.8939410	-0	-1.4651980	.1452113	-.0051605	-0	-0	-0	-0	46 25.8
2.9	.04	.22	7.7306670	-0	-.9844201	.0808824	-.0024764	-0	-0	-0	-0	36 26.9
3.0	.04	.22	8.0688600	-0	-1.1556810	.0964732	-.0027787	-0	-0	-0	-0	29 24.7
3.1	.04	.13	5.4278520	-0	-.2344463	-0	-0	-0	-0	-0	-0	19 24.7
3.2	.04	.24	4.5441580	-0	-.1318399	-0	-0	-0	-0	-0	-0	23 28.5
3.3	.05	.24	3.8189720	-0	-.0986965	-0	-0	-0	-0	-0	-0	19 29.8
3.4	.05	.24	3.2226480	-0	-.0871034	-0	-0	-0	-0	-0	-0	16 41.3
3.5	.05	.25	2.6164030	-0	-.0802174	-0	-0	-0	-0	-0	-0	19 57.1
3.6	.05	.25	2.2118950	-0	-.0628416	-0	-0	-0	-0	-0	-0	16 71.6
3.7	.05	.12	1.7286760	-0	-.0337218	-0	-0	-0	-0	-0	-0	14 56.9
3.8	.05	.12	1.4321420	-0	-.0262435	-0	-0	-0	-0	-0	-0	18 60.8
3.9	.05	.11	1.1667130	-0	-.0151207	-0	-0	-0	-0	-0	-0	18 77.3

TABLE 5 18.2 TO 25 MEV PROTONS

L	BMN	BMX	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	N	RMS
1.3	.14	.20	15.8884100	-.0006014	-9.4411690	-0	-0	-0	-0	-0	-0	11 14.2
1.4	.13	.22	44.2170500	-.0030533	-71.2245200	45.3188500	-10.2203000	-0	-0	-0	-0	24 15.1
1.5	.09	.23	23.7005000	-.0023621	-26.9895900	14.0833400	-2.7327540	-0	-0	-0	-0	30 15.8
1.6	.08	.24	44.1594200	-.0041770	-92.2339700	93.8274500	-49.0659400	12.7873500	-1.3201970	-0	-0	38 10.8
1.7	.06	.24	15.8696300	-.0011602	-11.4196300	4.1710400	-.5664800	-0	-0	-0	-0	45 12.7
1.8	.05	.23	20.8353800	-.0004001	-26.4460800	19.3024700	-7.4511230	1.4399310	-.1101860	-0	-0	48 12.6
1.9	.05	.24	11.6251500	-.0002598	-6.1116010	1.6709340	-.1654887	-0	-0	-0	-0	66 14.0
2.0	.04	.25	10.4375800	-.0005865	-4.7492870	1.1634430	-.1028861	-0	-0	-0	-0	90 12.6
2.1	.03	.26	10.4258000	-.0002375	-5.2636250	1.5181310	-.1949160	.0084708	-0	-0	-0	106 15.7
2.2	.03	.28	9.5170660	-.0006003	-4.3134470	1.1324020	-.1330999	.0053629	-0	-0	-0	146 13.8
2.3	.03	.28	8.1546280	.0001225	-3.1700220	.7229578	-.0760918	.0027924	-0	-0	-0	162 19.7
2.4	.03	.28	7.0326820	-.0008836	-2.3805630	.4752252	-.0431096	.0013383	-0	-0	-0	164 21.5
2.5	.03	.29	4.9575040	-.0016423	-.9619683	.1029726	-.0043162	-0	-0	-0	-0	173 26.1
2.6	.03	.30	2.8452590	-.0003892	-.2125737	-0	-0	-0	-0	-0	-0	167 33.4
2.7	.03	.28	1.9540890	-.0007630	-.1414619	-0	-0	-0	-0	-0	-0	167 44.3
2.8	.03	.28	.9755268	-.0007618	-.0688191	-0	-0	-0	-0	-0	-0	110 54.5
2.9	.03	.21	-.1850345	.0004638	-.0106418	-0	-0	-0	-0	-0	-0	65 45.9
3.0	.04	.21	-.6825705	.0009982	-.0134183	-0	-0	-0	-0	-0	-0	25 39.5

TABLE 6 25 TO 35 MEV PROTONS

L	BMN	BMX	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	N	RMS
1.6	.08	.24	8.0221080	-.0006074	5.0248340	-9.1147680	4.0774380	-.6042224	-0	-0	37	9.9
1.7	.06	.24	13.9620900	.0002514	-10.1130800	3.6773820	-.4977730	-0	-0	-0	45	14.0
1.8	.05	.23	11.7686400	.0008132	-7.3270580	2.2763270	-.2583201	-0	-0	-0	44	14.6
1.9	.05	.24	9.9469850	.0012174	-5.3242060	1.4353770	-.1395492	-0	-0	-0	59	14.8
2.0	.04	.25	9.9003000	.0010664	-5.6410430	1.7855080	-.2542363	.0122408	-0	-0	80	15.2
2.1	.03	.26	11.3467400	.0014431	-8.4634710	3.5479840	-.7647769	.0813939	-.0034437	-0	91	13.7
2.2	.03	.23	8.9186590	.0007538	-4.4106810	1.1896720	-.1462802	.0063613	-0	-0	127	17.4
2.3	.03	.27	7.9511350	.0005376	-3.4872920	.8198835	-.0855337	.0030315	-0	-0	139	20.7
2.4	.03	.20	6.4831420	.0009097	-2.5772740	.5526946	-.0530208	.0017349	-0	-0	141	24.3
2.5	.03	.29	4.3003440	.0010197	-1.0253120	.1136218	-.0047648	-0	-0	-0	151	31.4
2.6	.03	.20	3.1117840	-.0005469	-.4732603	.0168934	-0	-0	-0	-0	147	37.4
2.7	.03	.26	1.2797600	.0016163	-.1736106	-0	-0	-0	-0	-0	137	49.4
2.8	.03	.10	.0829587	.0008991	-.0641442	-0	-0	-0	-0	-0	80	59.0
2.9	.03	.17	-.2250829	.0013297	-.1030687	-0	-0	-0	-0	-0	26	51.2

TABLE 7 35 TO 63 MEV PROTONS

L	BMN	BMX	A(1)	A(2)	A(3)	A(4)	A(5)	A(6)	A(7)	A(8)	N	RMS
1.8	.05	.23	10.3396500	-.0003308	-6.8858710	2.3154030	-.2758983	-0	-0	-0	-0	44 23.4
1.9	.05	.24	8.4352300	-.0001479	-4.9150510	1.4710840	-.1547764	-0	-0	-0	-0	59 20.1
2.0	.04	.25	8.0709220	.0007800	-4.4680360	1.1772180	-.1060265	-0	-0	-0	-0	79 19.9
2.1	.03	.26	8.0241180	-.0001189	-3.9468210	.8797388	-.0670586	-0	-0	-0	-0	89 26.6
2.2	.03	.27	7.5207700	.0001800	-3.4239520	.6692296	-.0437430	-0	-0	-0	-0	126 25.8
2.3	.03	.27	6.3867810	.0006308	-2.5871340	.4401495	-.0249583	-0	-0	-0	-0	137 33.2
2.4	.03	.27	5.3389960	-.0005407	-1.8318750	.2588822	-.0123537	-0	-0	-0	-0	134 33.4
2.5	.03	.28	4.1338650	-.0011154	-1.2806070	.1571931	-.0064725	-0	-0	-0	-0	144 44.5
2.6	.03	.28	1.3903660	-.0003072	-.1407362	-0	-0	-0	-0	-0	-0	123 61.1
2.7	.03	.22	4.588950	.0002999	-.0693819	-0	-0	-0	-0	-0	-0	82 61.7
2.8	.03	.07	-.3357471	.0001383	.0259355	-0	-0	-0	-0	-0	-0	38 59.9
2.9	.04	.17	-1.0660410	.0047092	-.0012526	-0	-0	-0	-0	-0	-0	11 49.0

FIGURE CAPTIONS

Figure
Nos.

- 1 - 4 Protons 1.1 to 14 MeV. The flux of mirroring particles
vs B for 28 lines of force from
$$L = 1.5 \text{ to } L = 4.2,$$

on January 1, 1963.
- 5 - 8 Protons 1.6 to 7.1 MeV. The flux of mirroring particles
vs B for 28 lines of force from
$$L = 1.5 \text{ to } L = 4.2,$$

on January 1, 1963.
- 9 - 12 Protons 2.25 to 4.7 MeV. The flux of mirroring particles
vs B for 25 lines of force from
$$L = 1.5 \text{ to } L = 3.9,$$

on January 1, 1963.
- 13 - 15 Protons 18.2 to 25 MeV. The flux of mirroring particles
vs B for 18 lines of force from
$$L = 1.3 \text{ to } L = 3.0,$$

on January 1, 1963.
- 16 - 18 Protons 25 to 35 MeV. The flux of mirroring particles
vs B for 14 lines of force from
$$L = 1.6 \text{ to } L = 2.9,$$

on January 1, 1963.

FIGURE CAPTIONS
(Continued)

Figure
Nos.

- 19 - 21 Protons 35 to 63 MeV. The flux of mirroring particles
vs B for 12 lines of force from
 $L = 1.8$ to $L = 2.9$,
on January 1, 1963.
- 22 - 24 Protons 18.2 to 63 MeV. The flux of mirroring particles
vs B for 12 lines of force from
 $L = 1.8$ to $L = 2.9$,
on January 1, 1963.
- 25 - 31 Contour maps in B, L space for the flux of trapped protons.

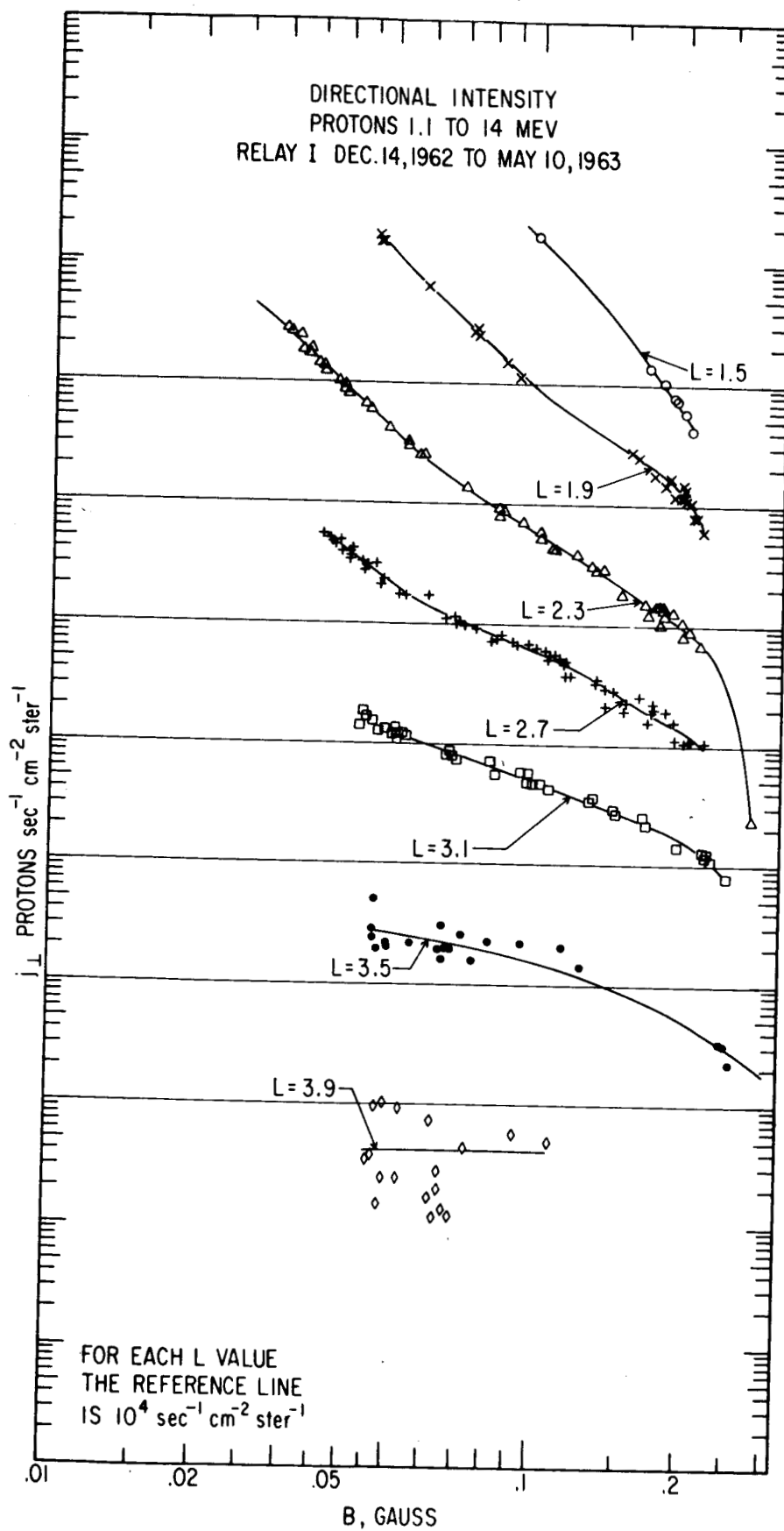


Figure 1

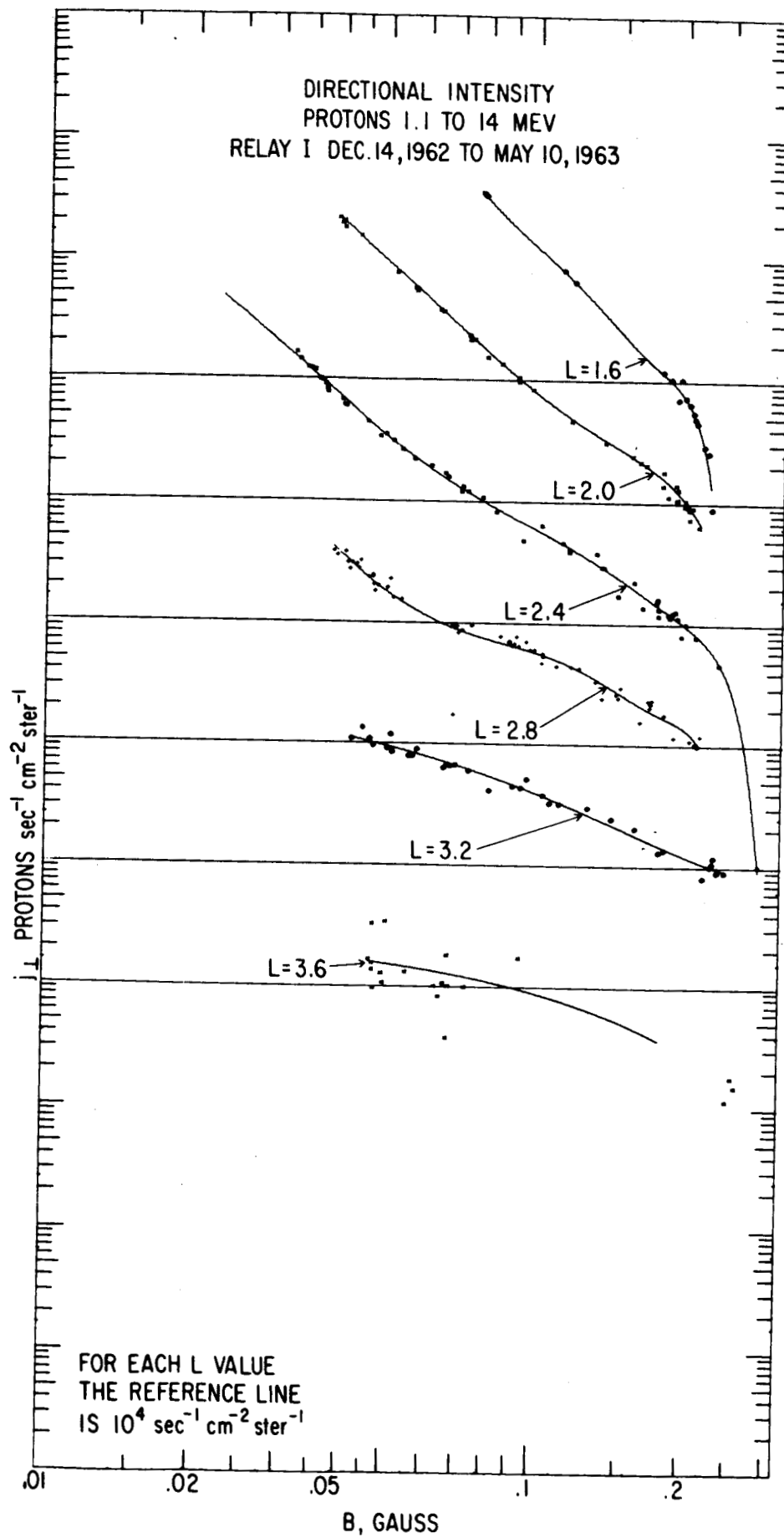


Figure 2

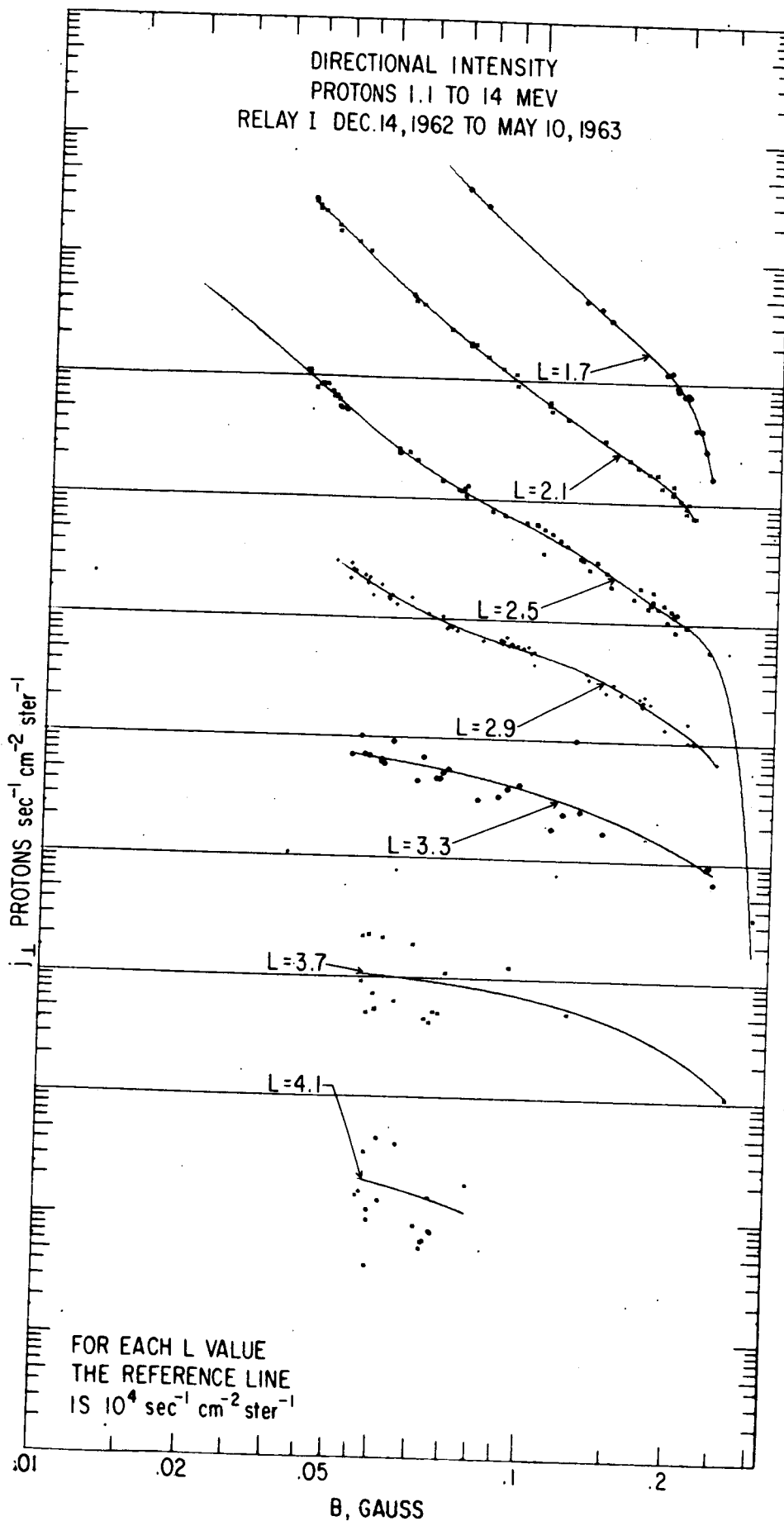


Figure 3

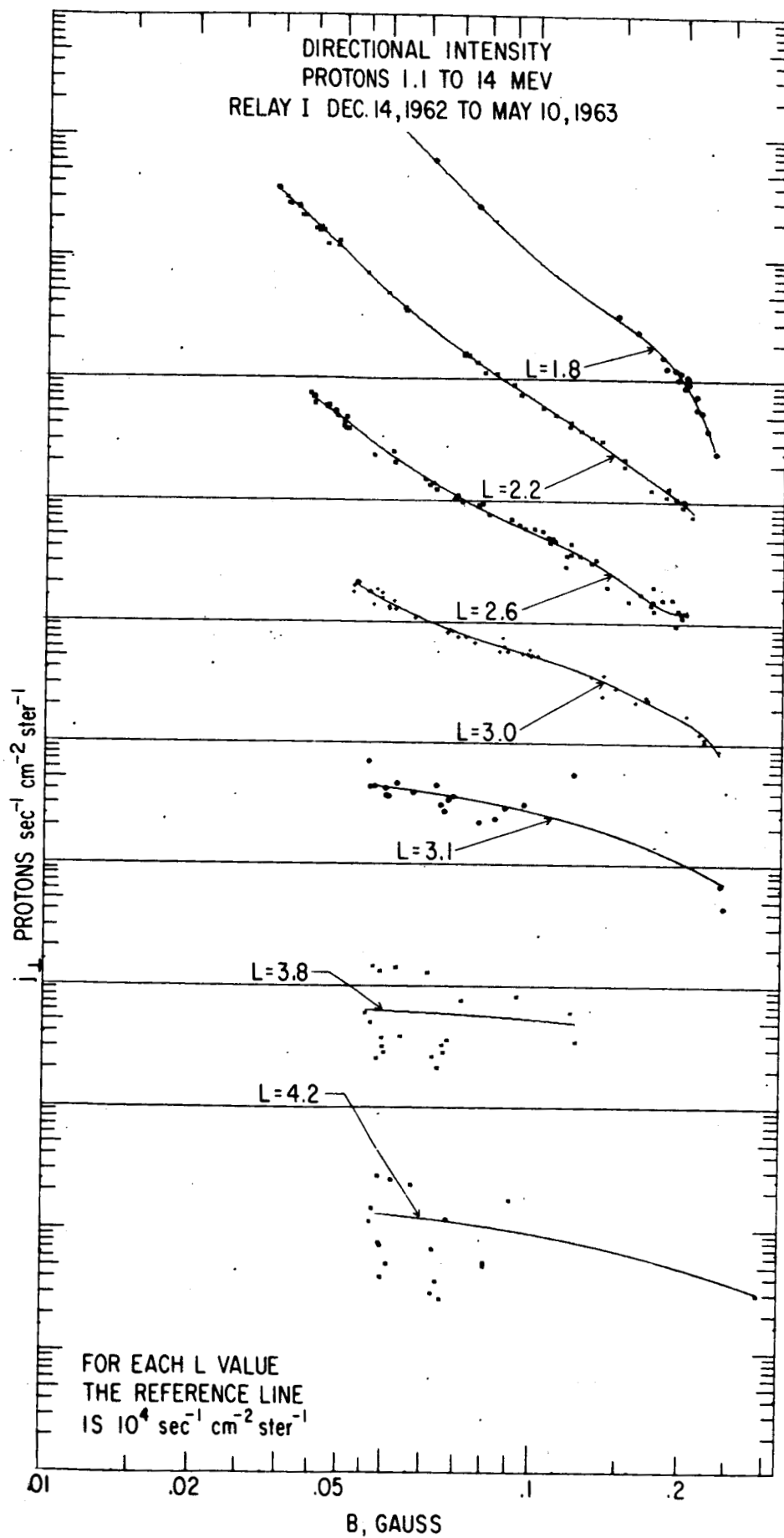


Figure 4

DIRECTIONAL INTENSITY
 PROTONS 1.6 TO 7.1 MEV
 RELAY I DEC. 14, 1962 TO MAY 10, 1963

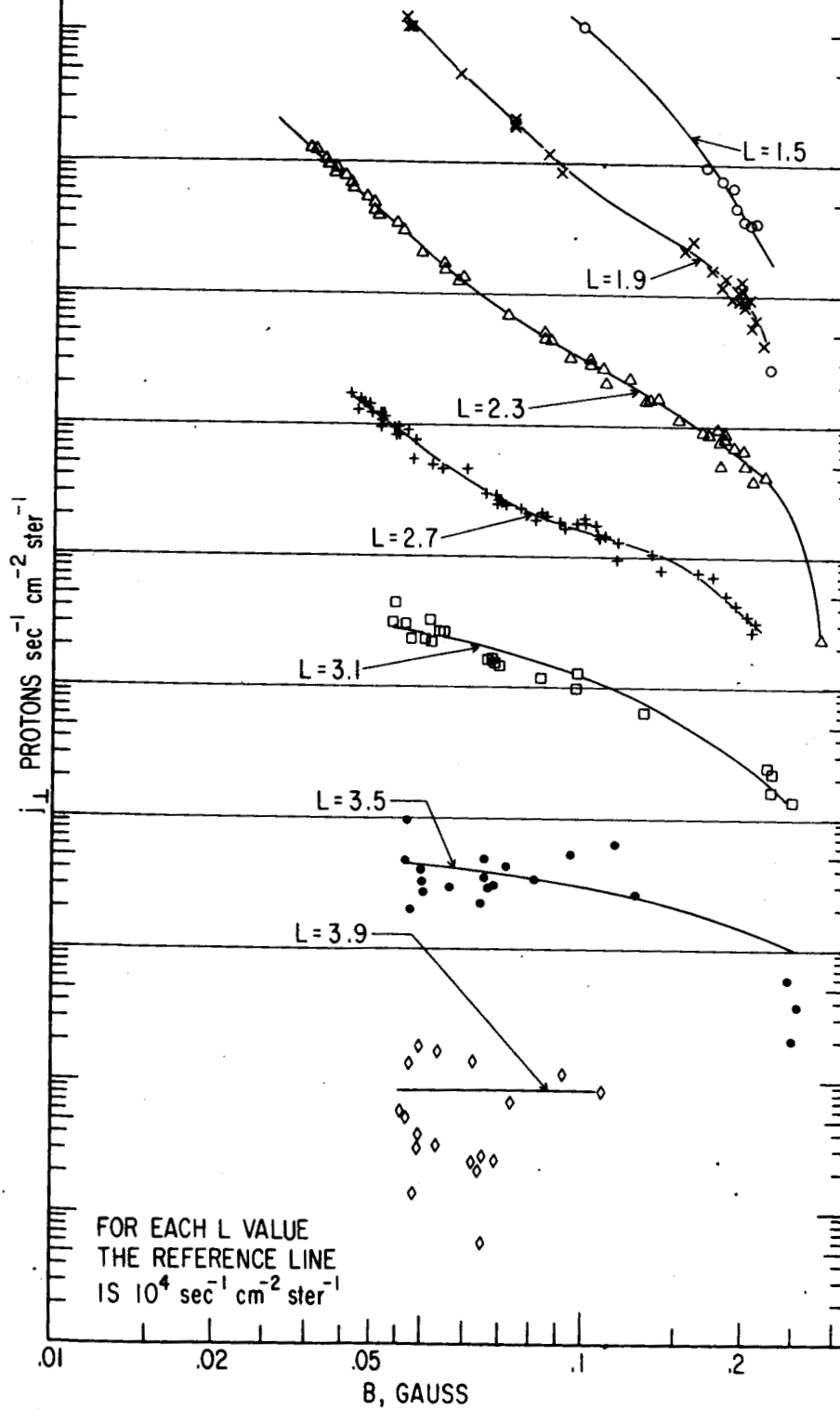


Figure 5

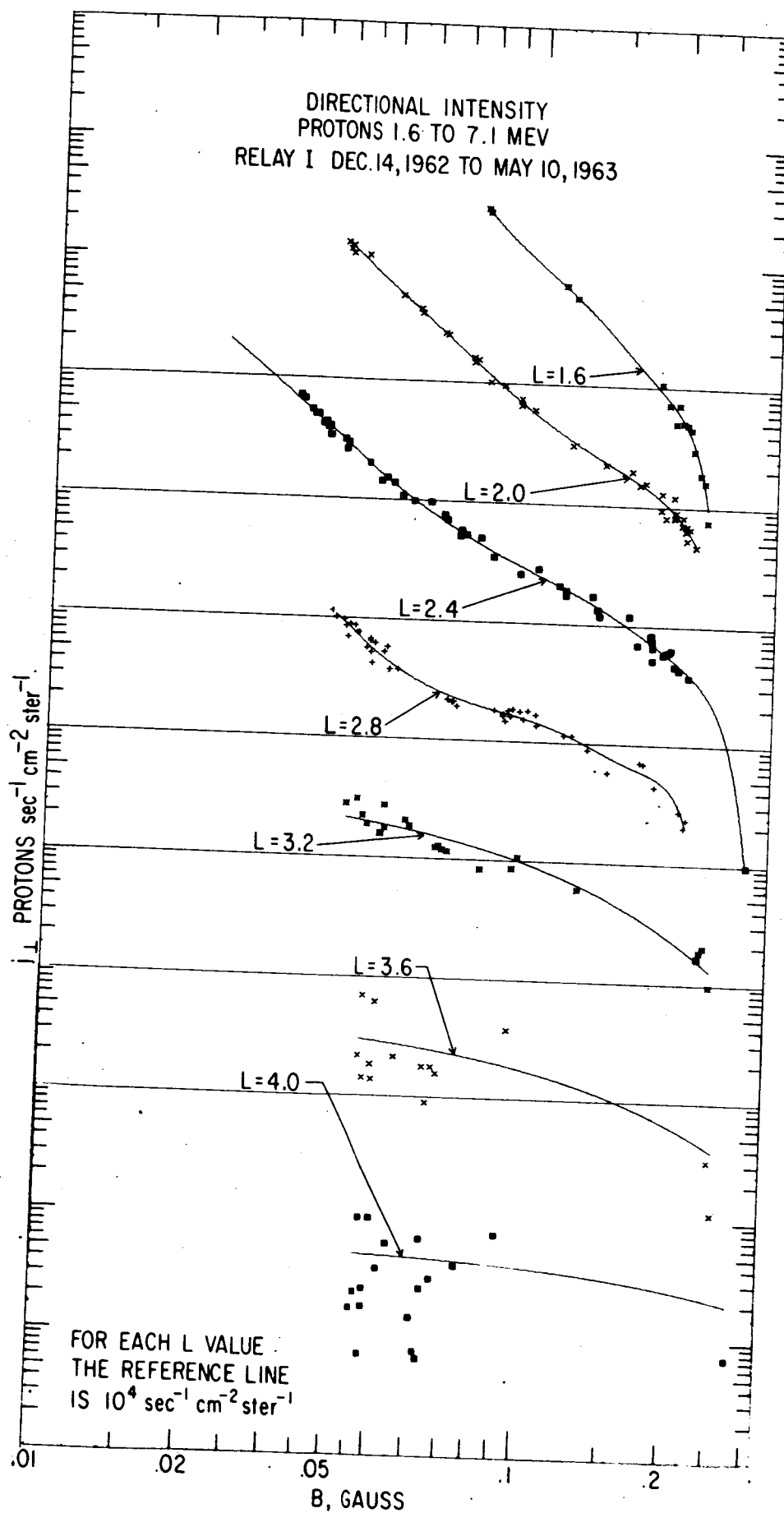


Figure 6

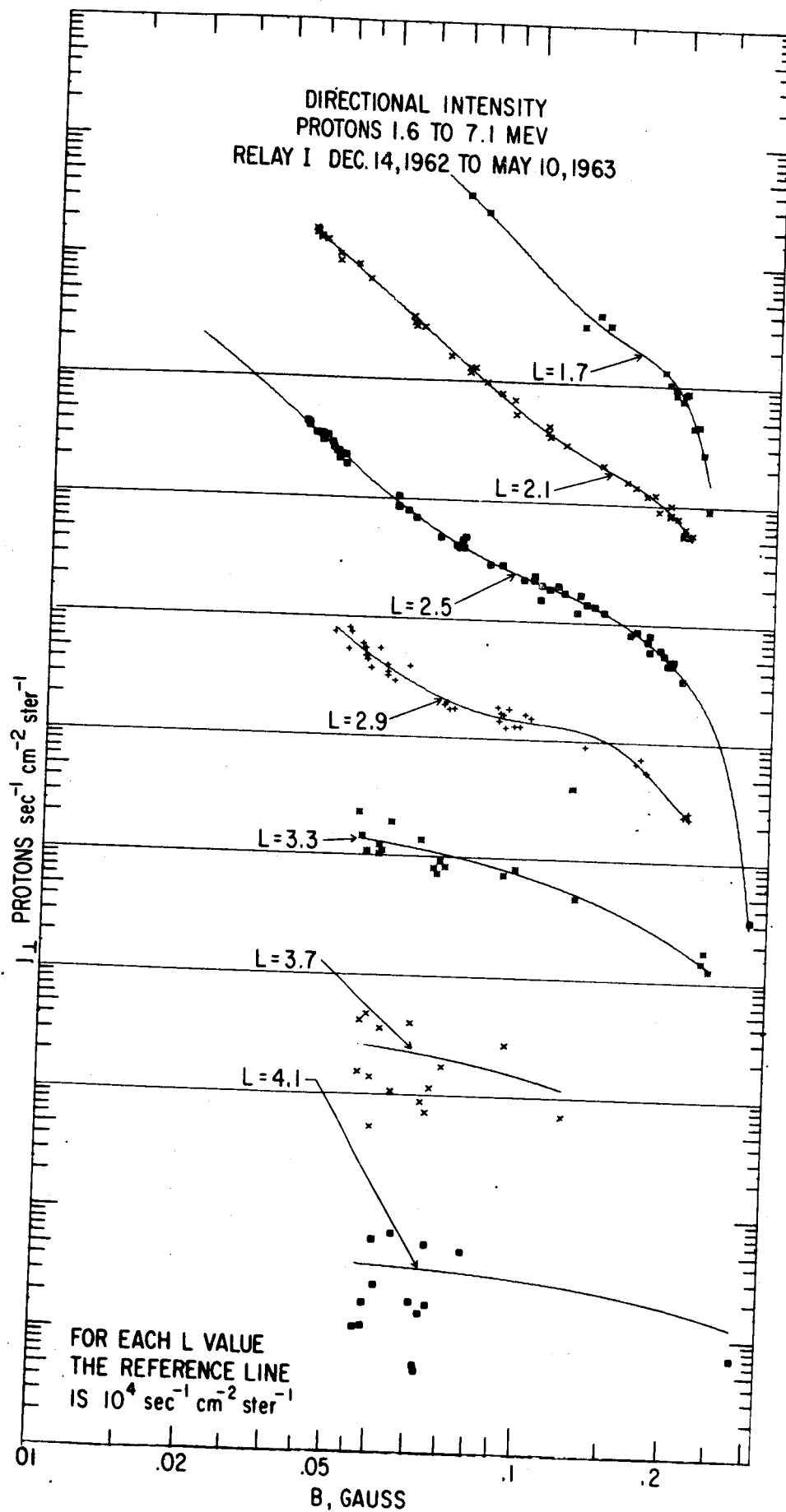


Figure 7

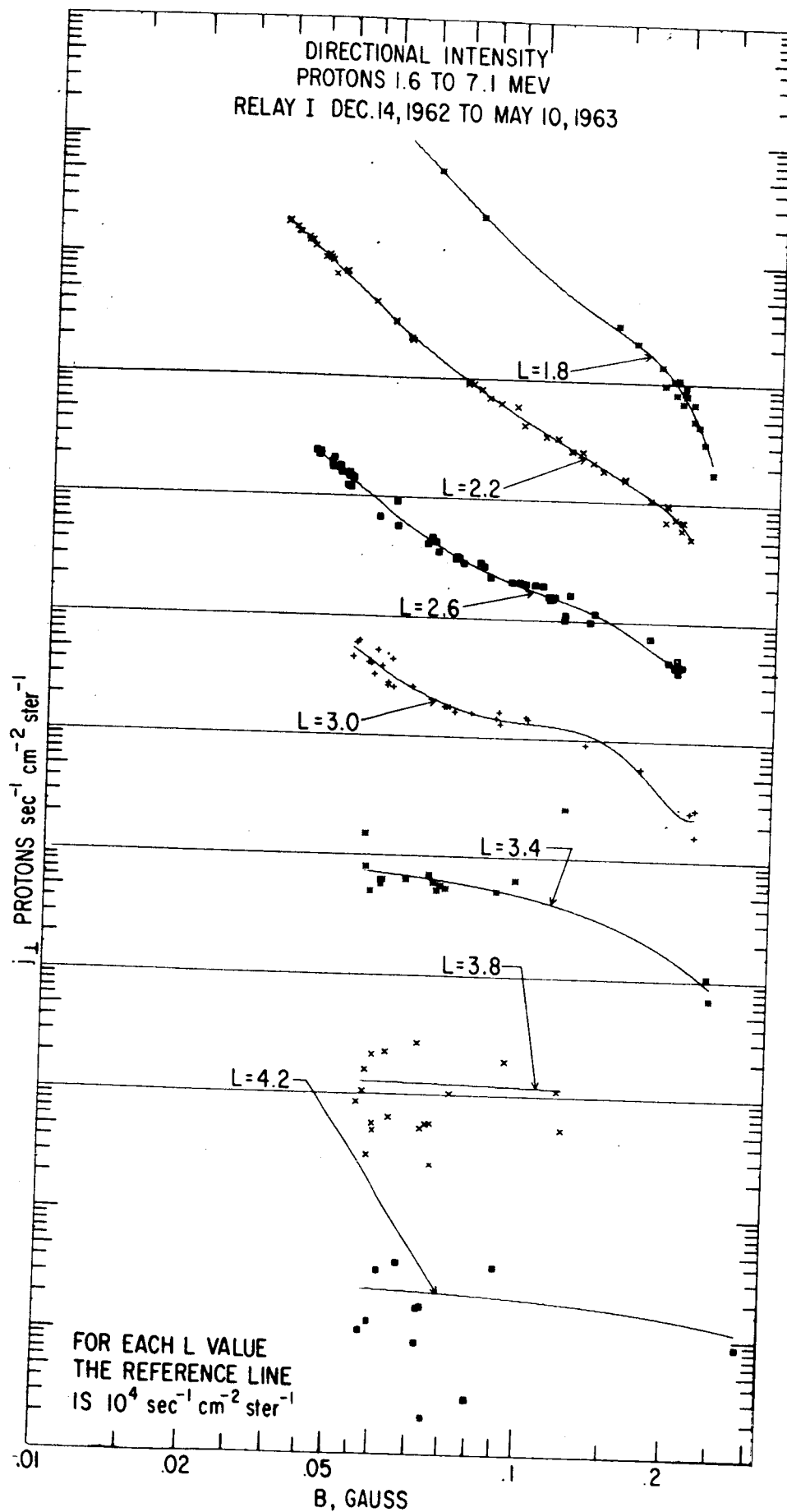


Figure 8

DIRECTIONAL INTENSITY
PROTONS 2.25 TO 4.7 MEV
RELAY I DEC.14,1962 TO MAY 10,1963

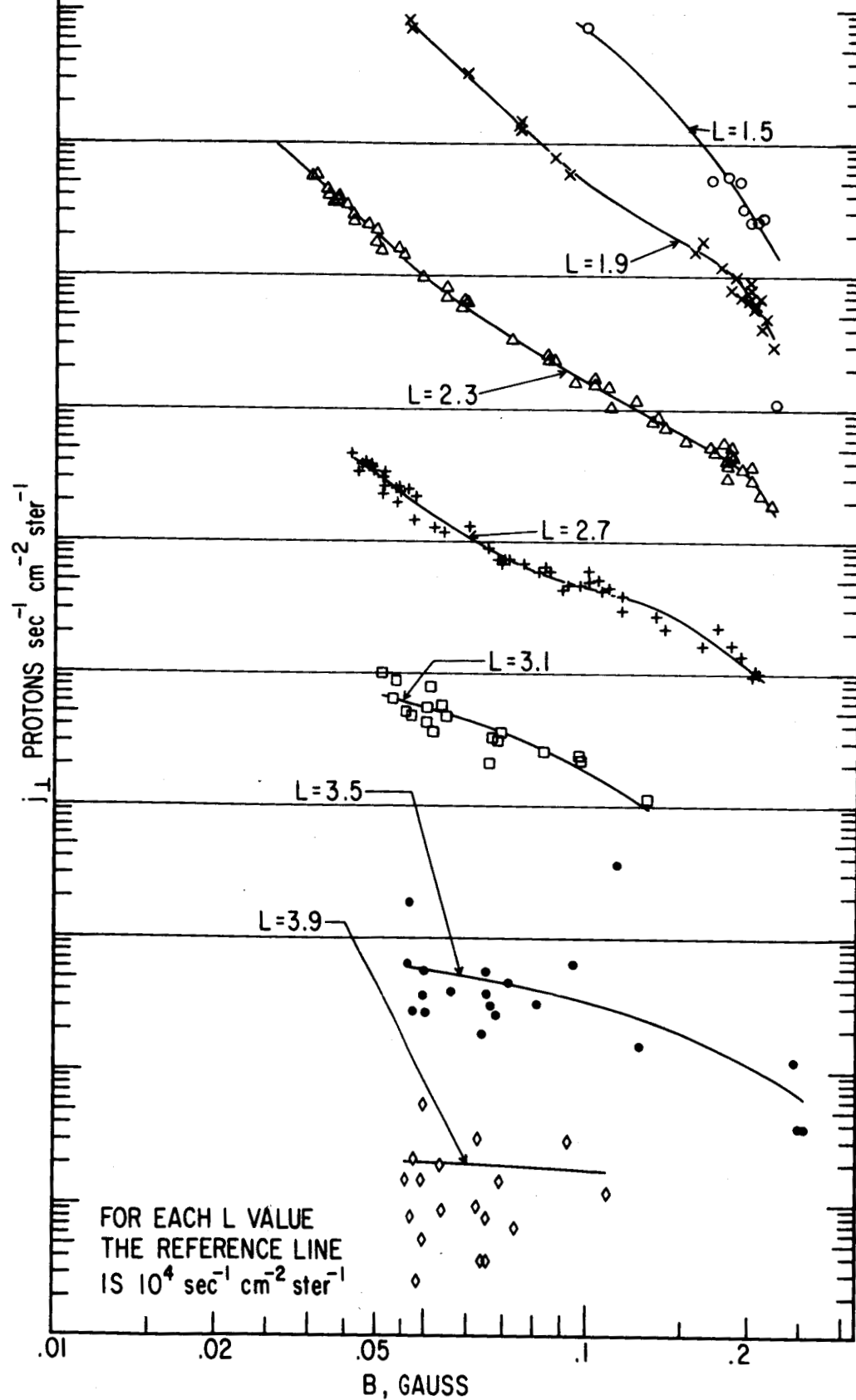


Figure 9

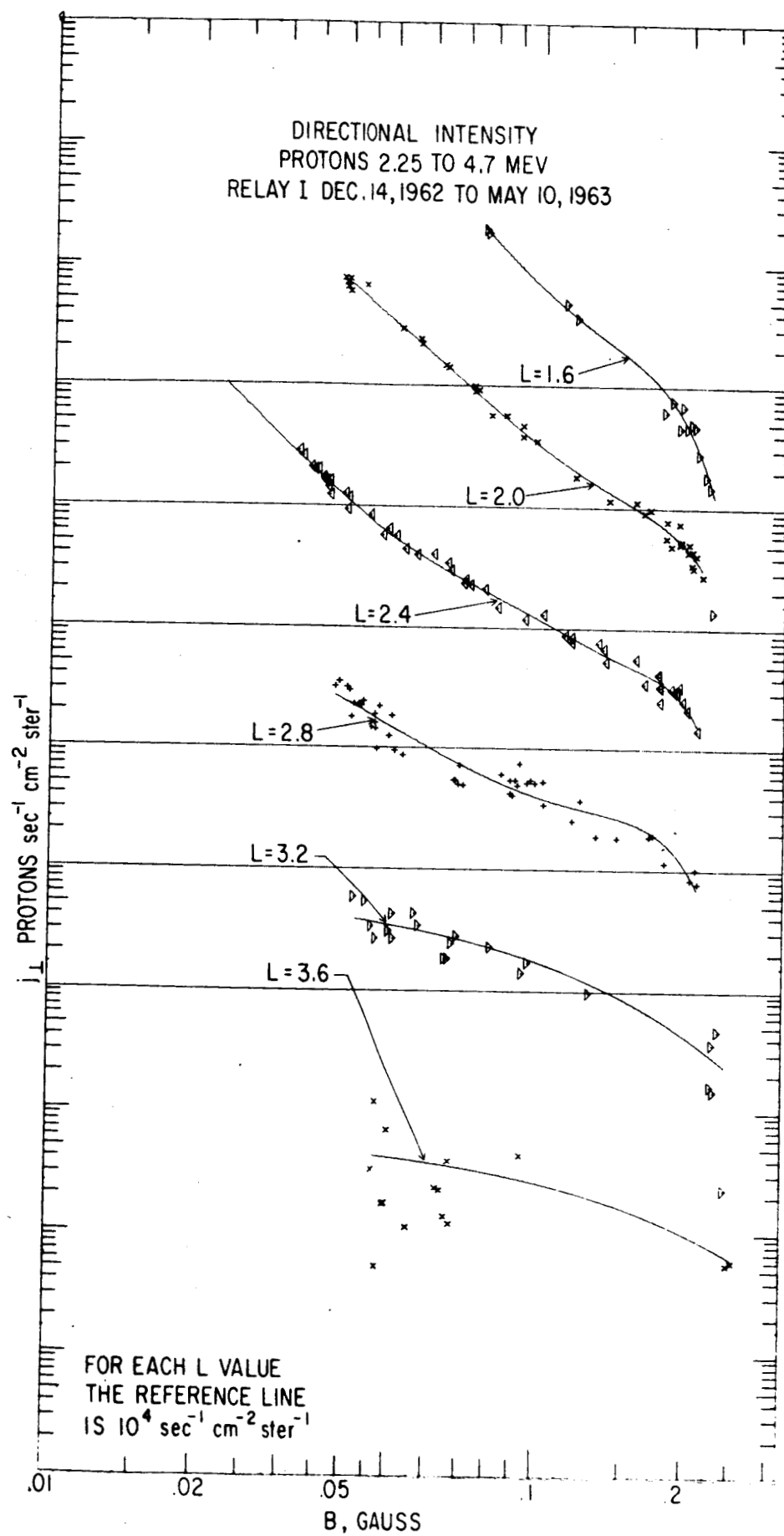


Figure 10

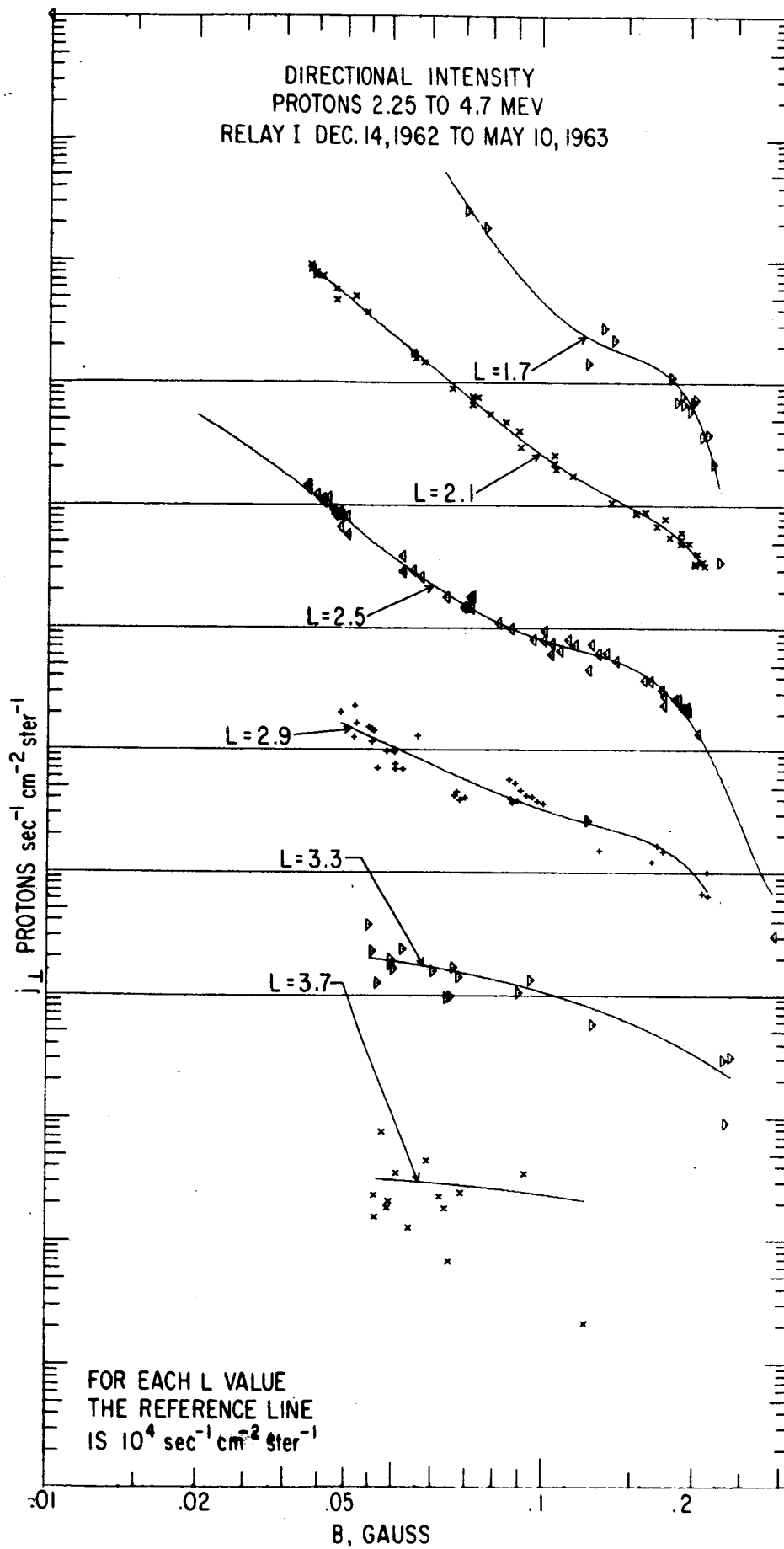


Figure 11

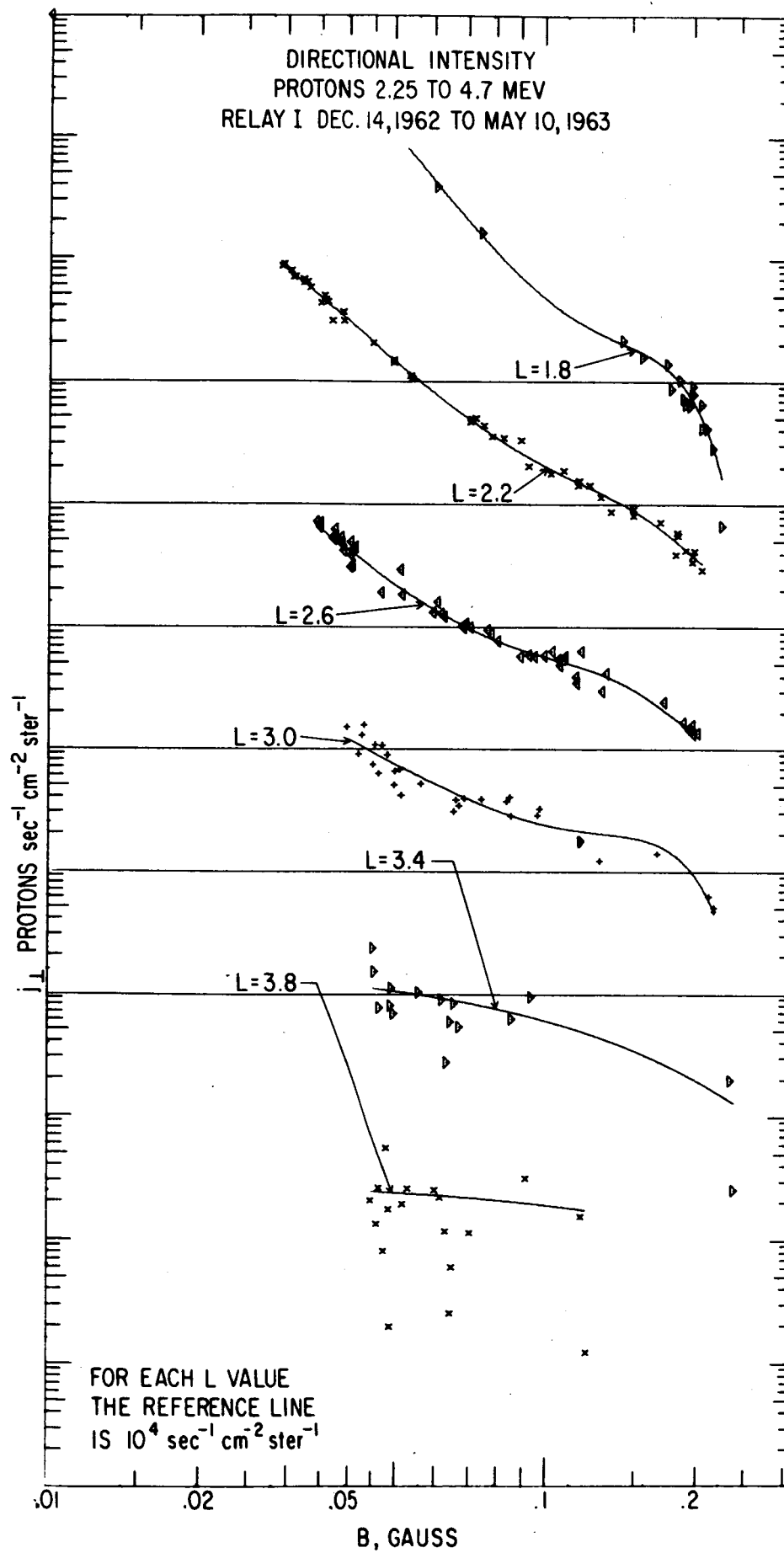


Figure 12

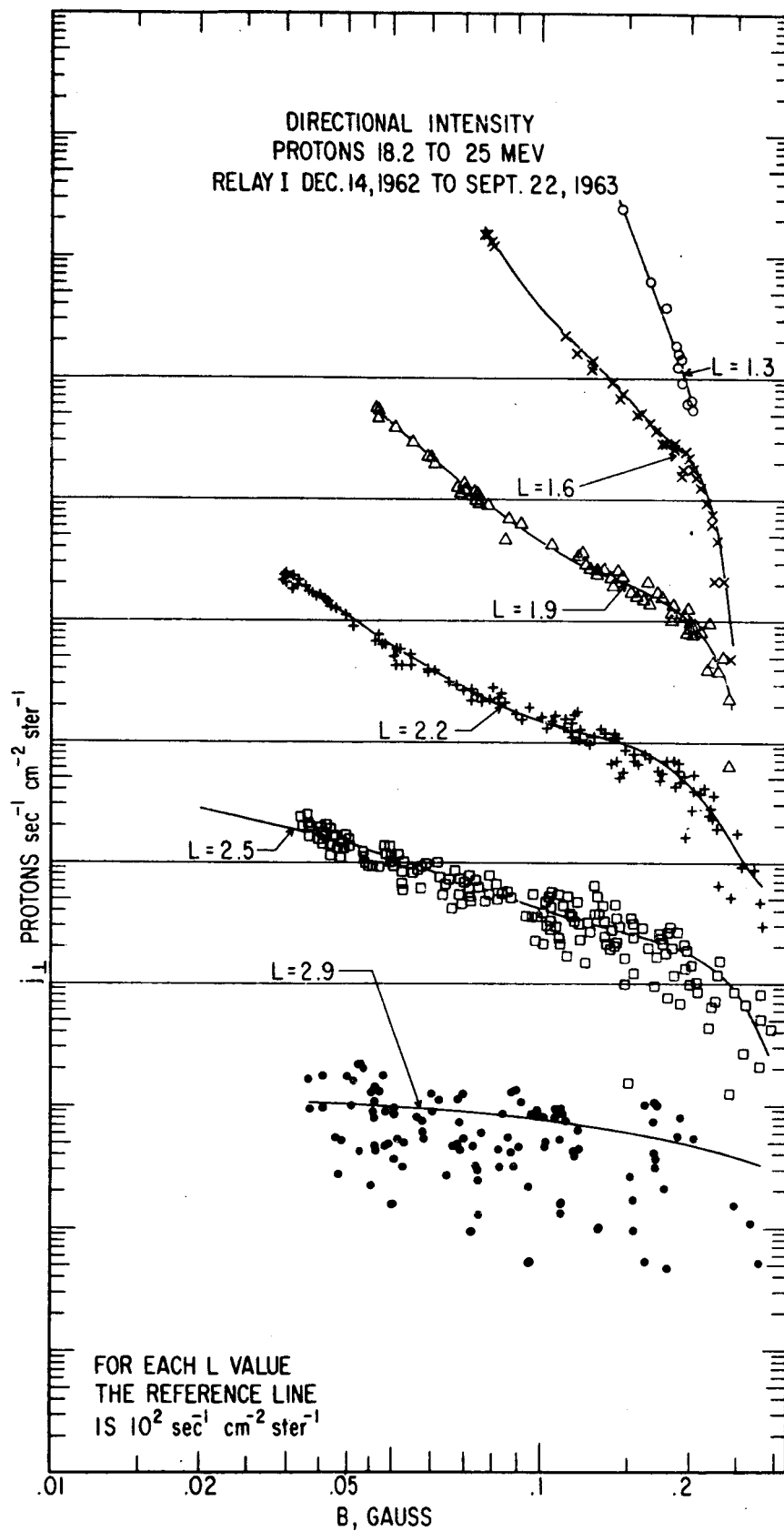


Figure 13

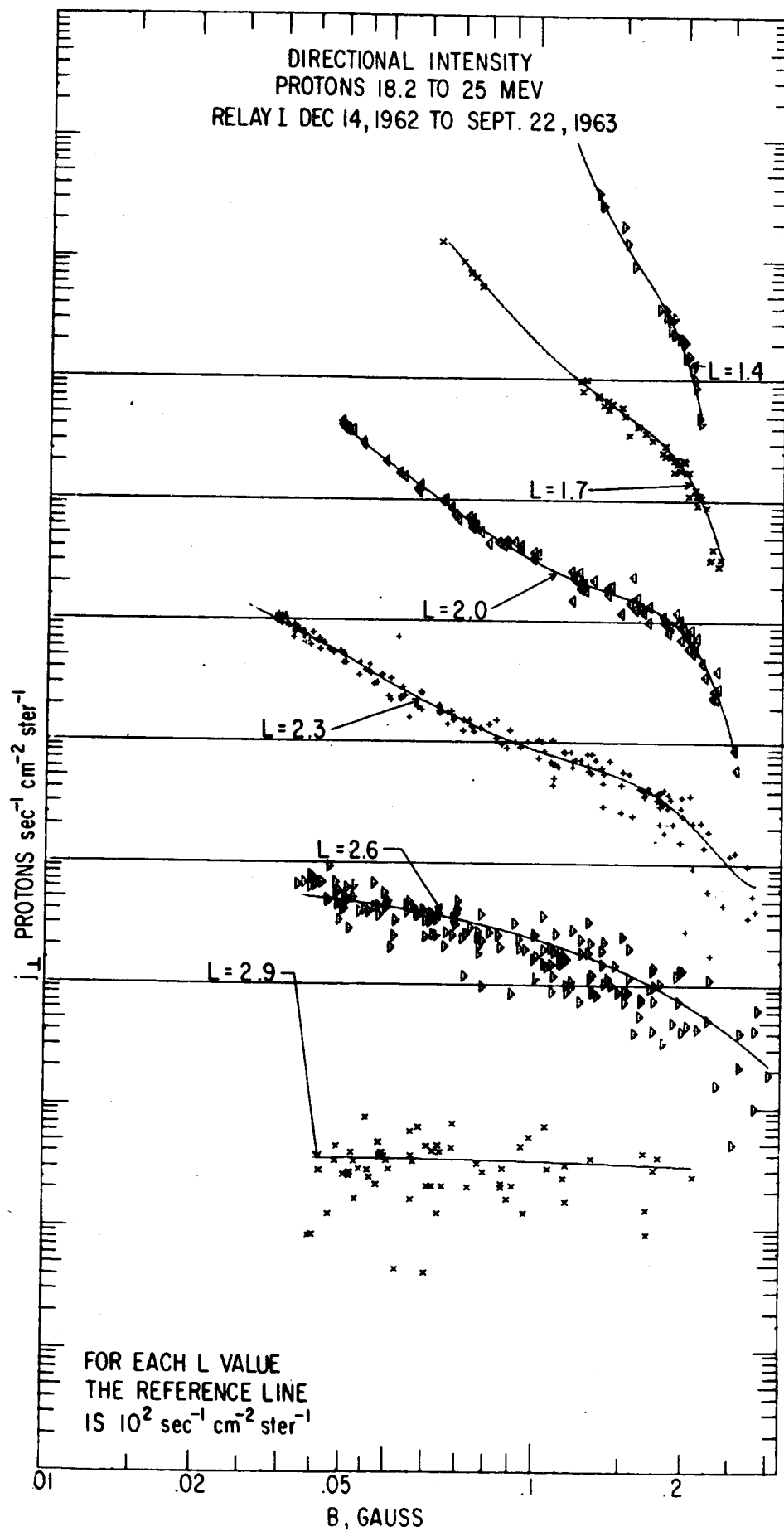


Figure 14

DIRECTIONAL INTENSITY
 PROTONS 18.2 TO 25 MEV
 RELAY I DEC. 14, 1962 TO SEPT. 22, 1963

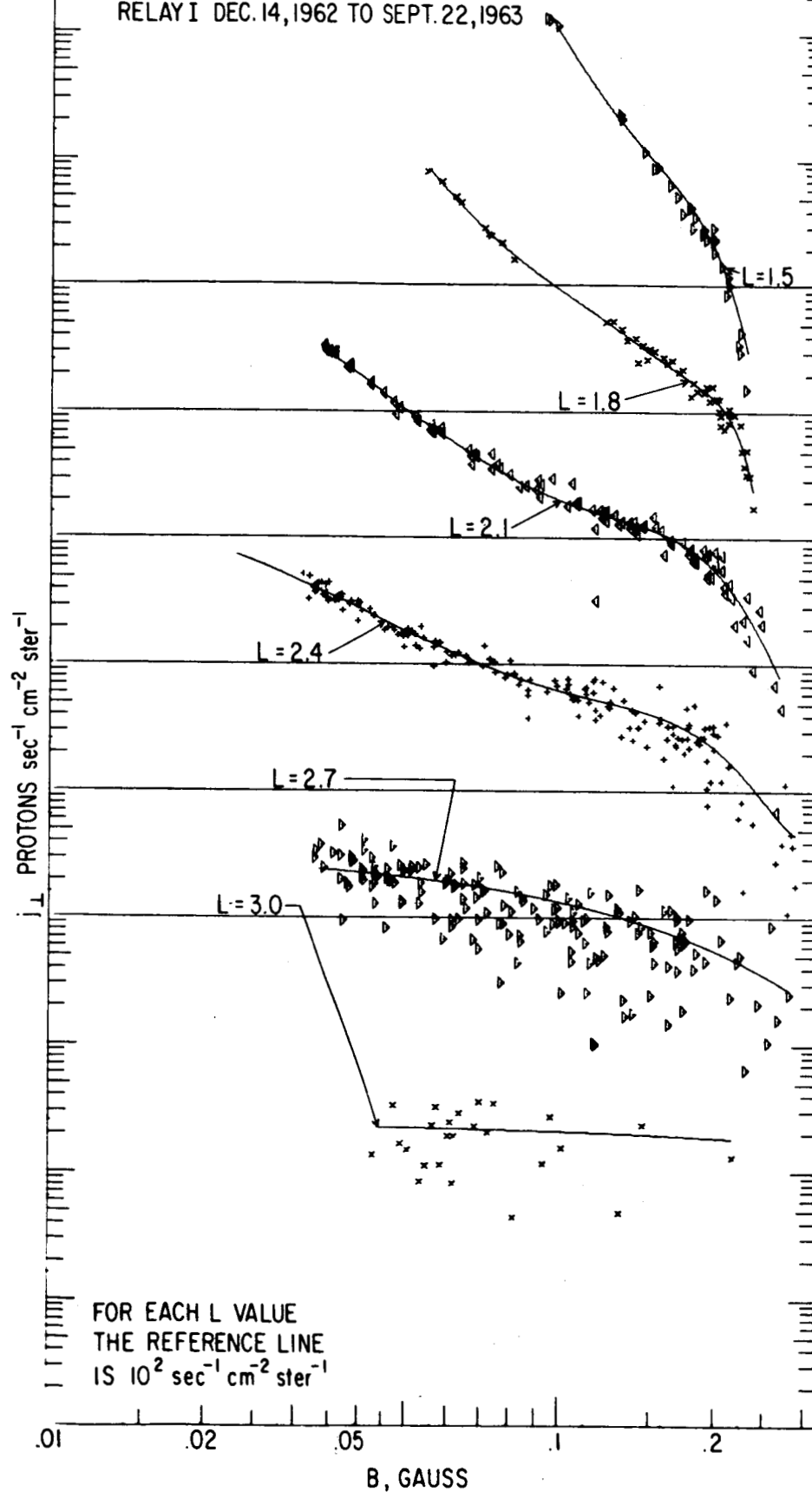


Figure 15

DIRECTIONAL INTENSITY
 PROTONS 25 TO 35 MEV
 RELAY I DEC. 14, 1962 TO SEPT. 22, 1963

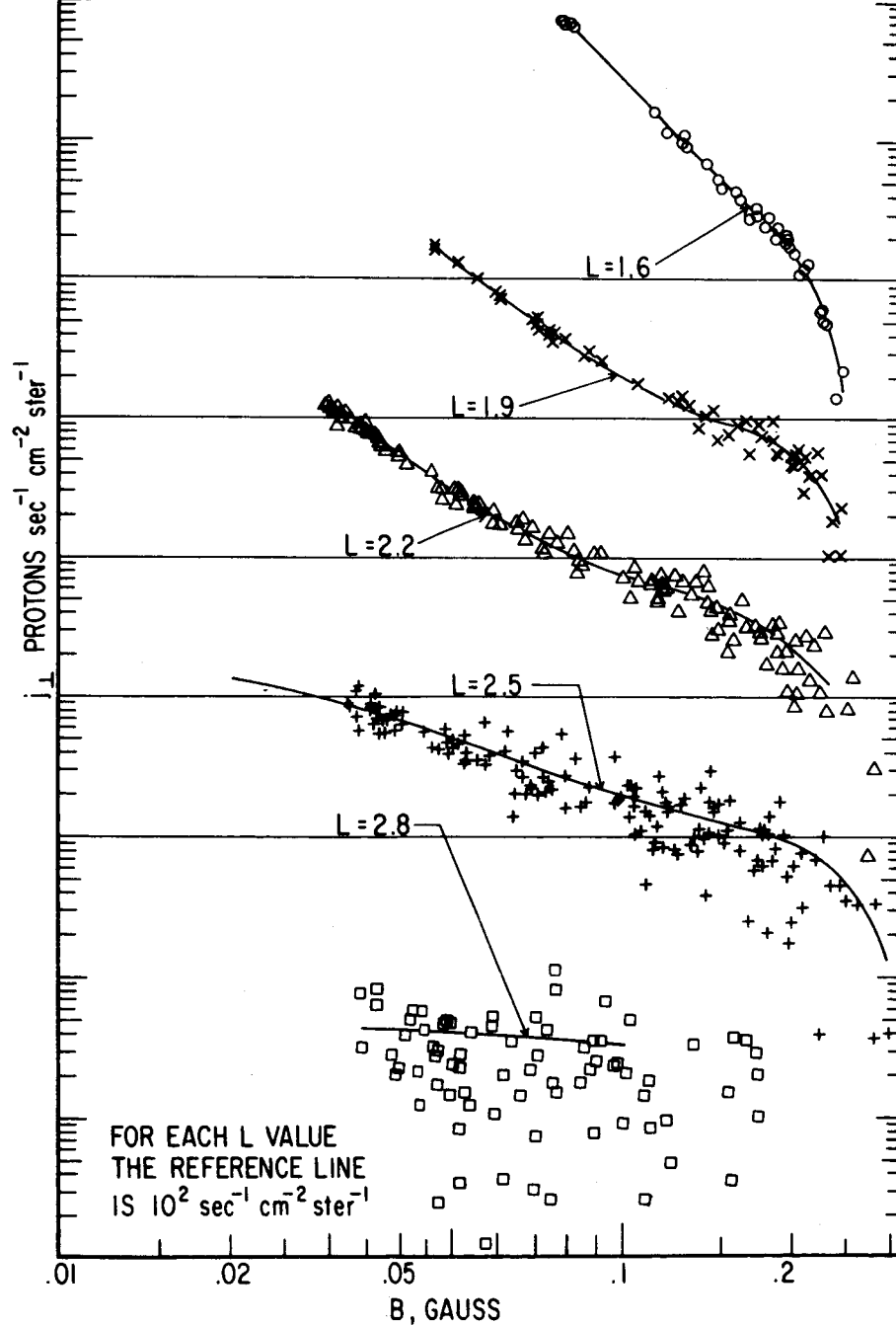


Figure 16

DIRECTIONAL INTENSITY
 PROTONS 25 TO 35 MEV
 RELAY I DEC. 14, 1962 TO SEPT. 22, 1963

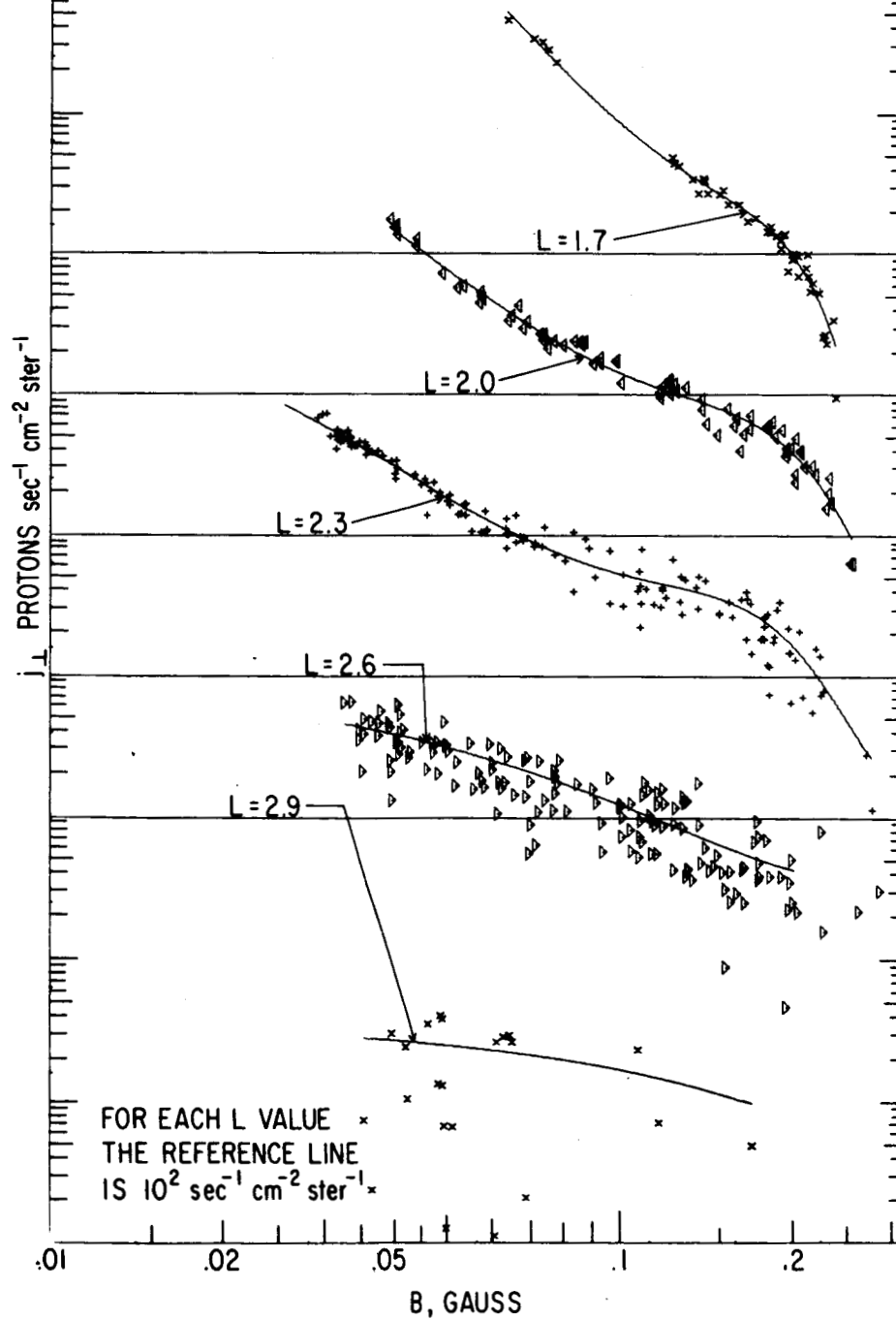


Figure 17

DIRECTIONAL INTENSITY
 PROTONS 25 TO 35 MEV
 RELAY I DEC 14, 1962 TO SEPT. 22, 1963

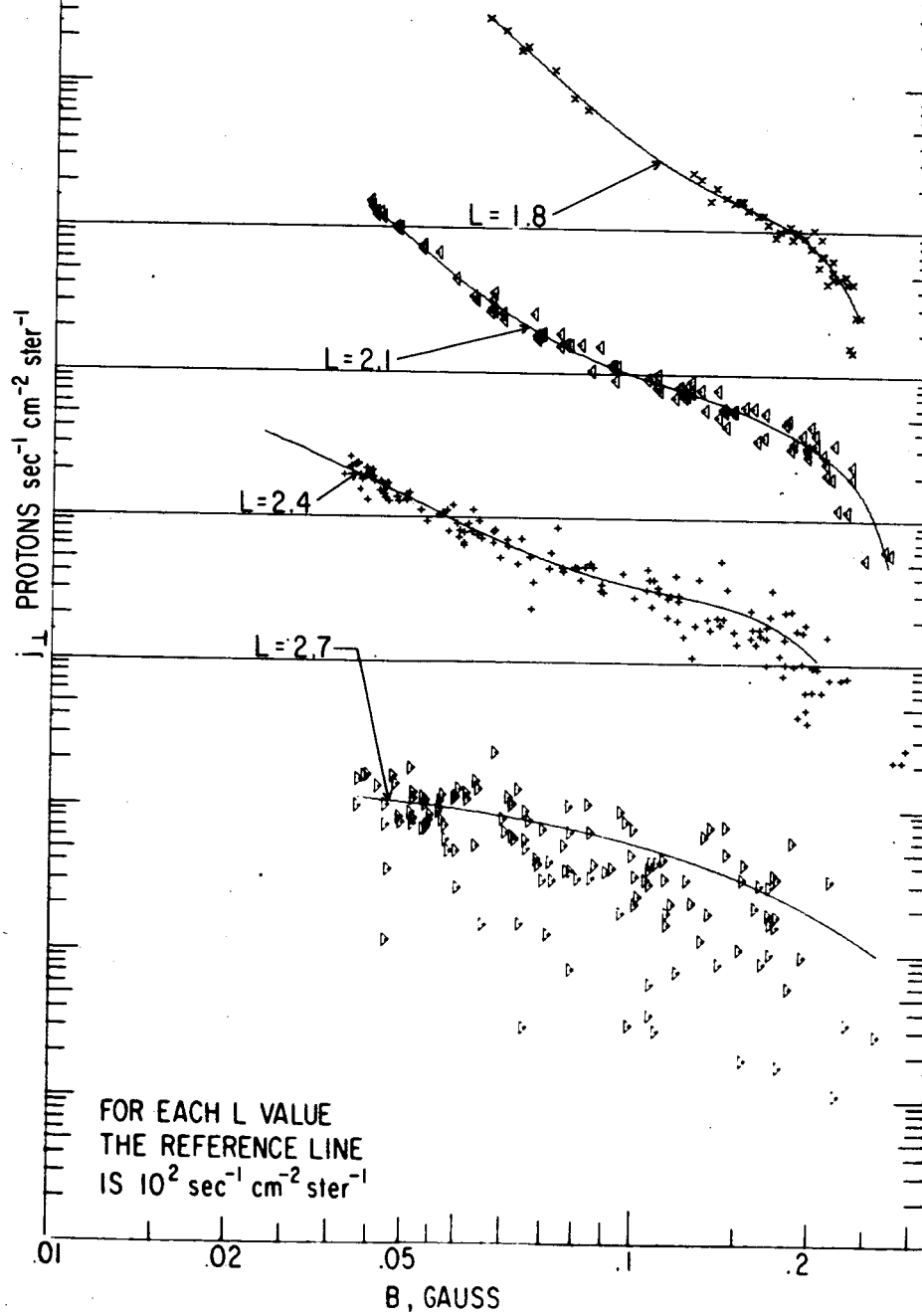


Figure 18

DIRECTIONAL INTENSITY
 PROTONS 35 TO 65 MEV
 RELAY I DEC. 14, 1962 TO SEPT. 22, 1963

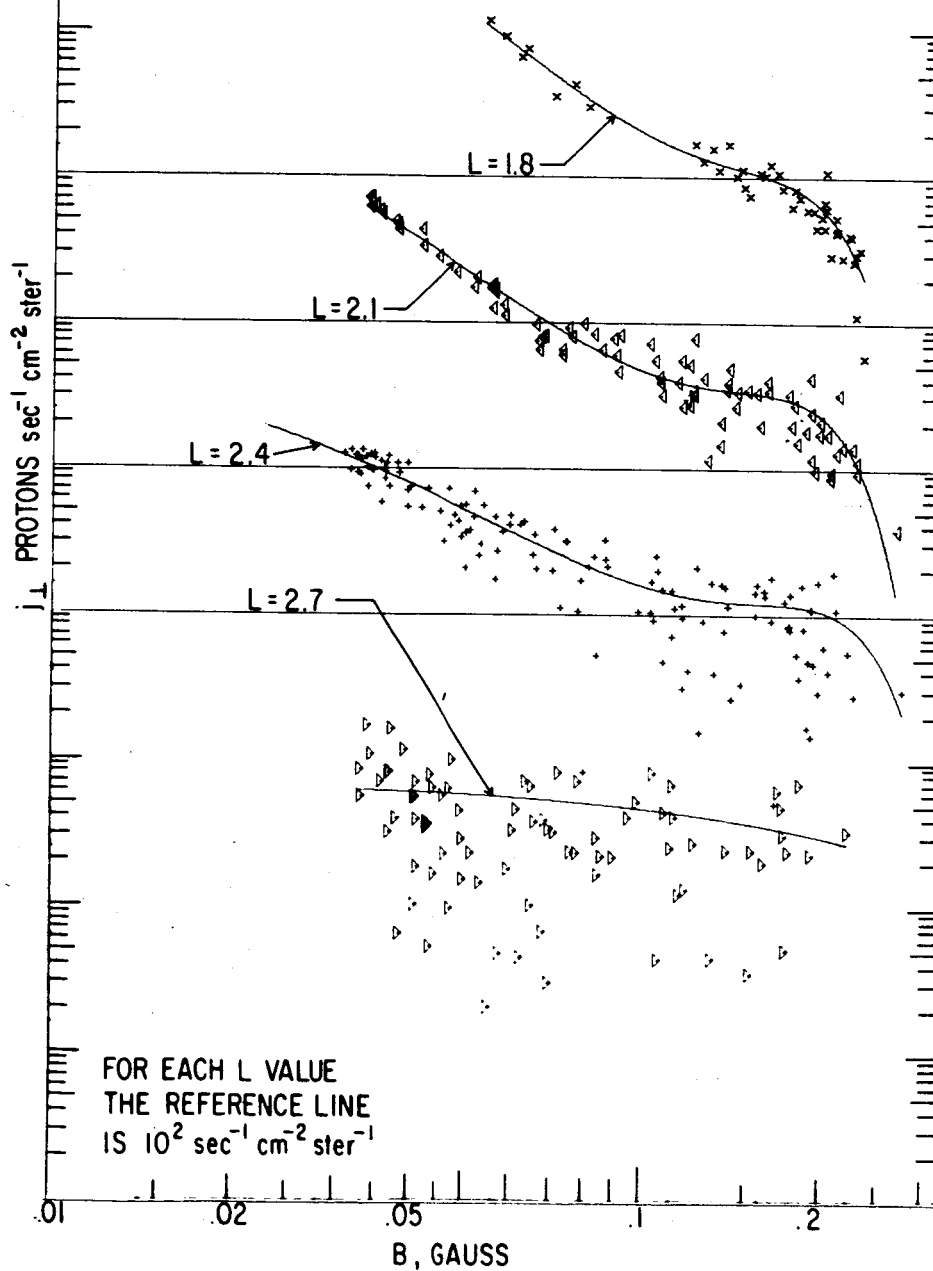


Figure 19

DIRECTIONAL INTENSITY
 PROTONS 35 TO 63 MEV
 RELAY I DEC.14,1962 TO SEPT.22,1963

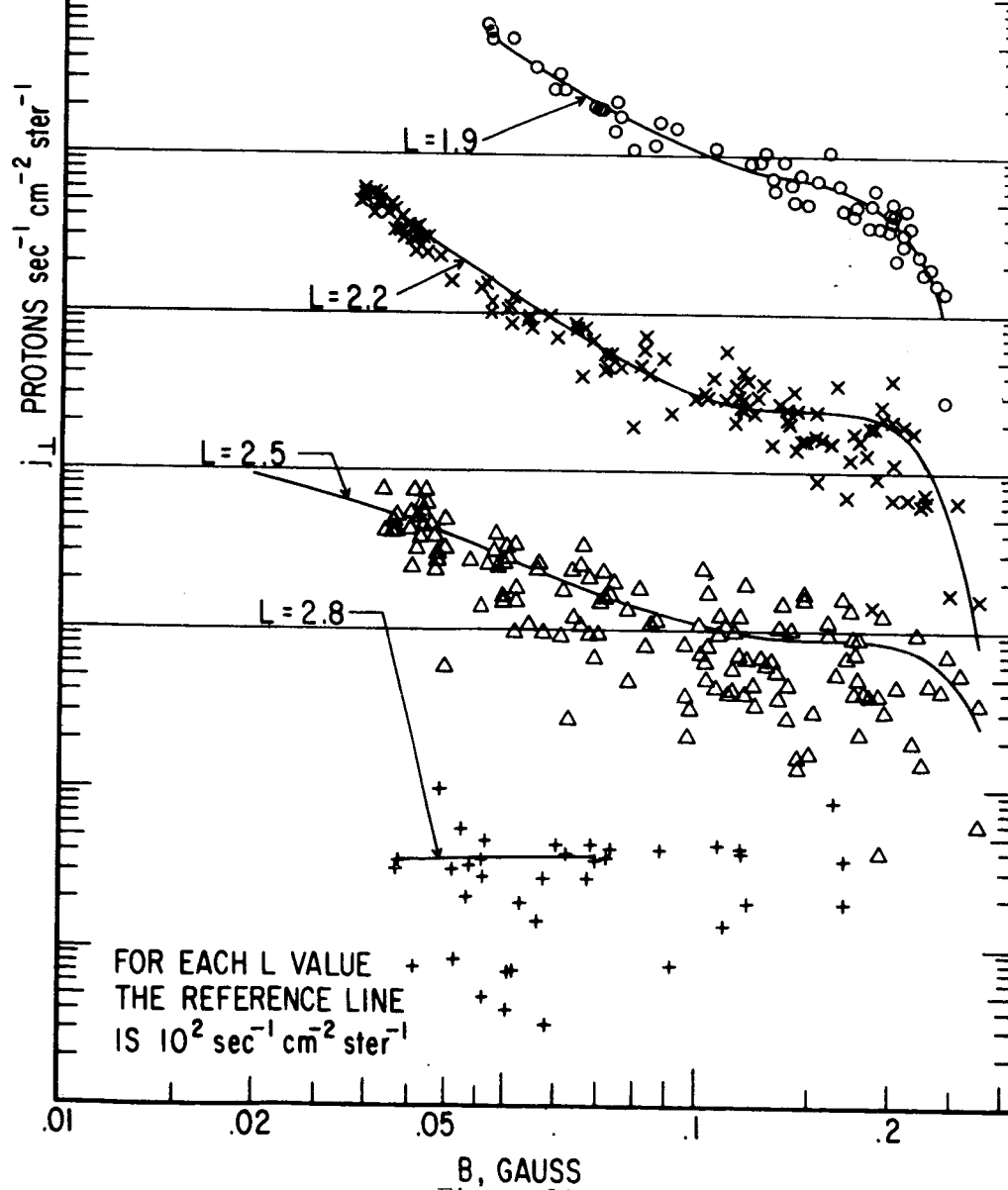


Figure 20

DIRECTIONAL INTENSITY
PROTONS 35 TO 63 MEV
RELAY I DEC. 14, 1962 TO SEPT 22, 1963

$j_{\perp}$ PROTONS $\text{sec}^{-1} \text{cm}^{-2} \text{ster}^{-1}$

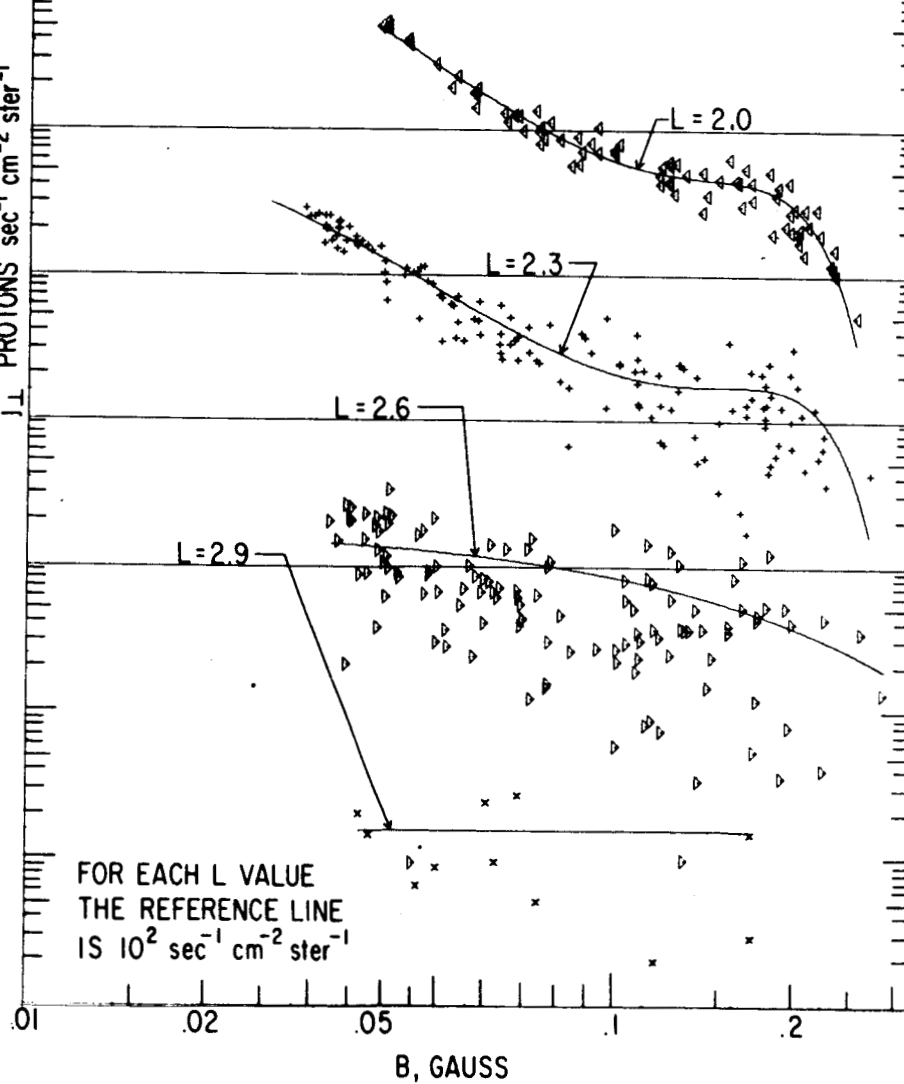


Figure 21

DIRECTIONAL INTENSITY
 PROTONS 18.2 TO 63 MEV
 RELAY I DEC. 14, 1962 TO SEPT. 22, 1963

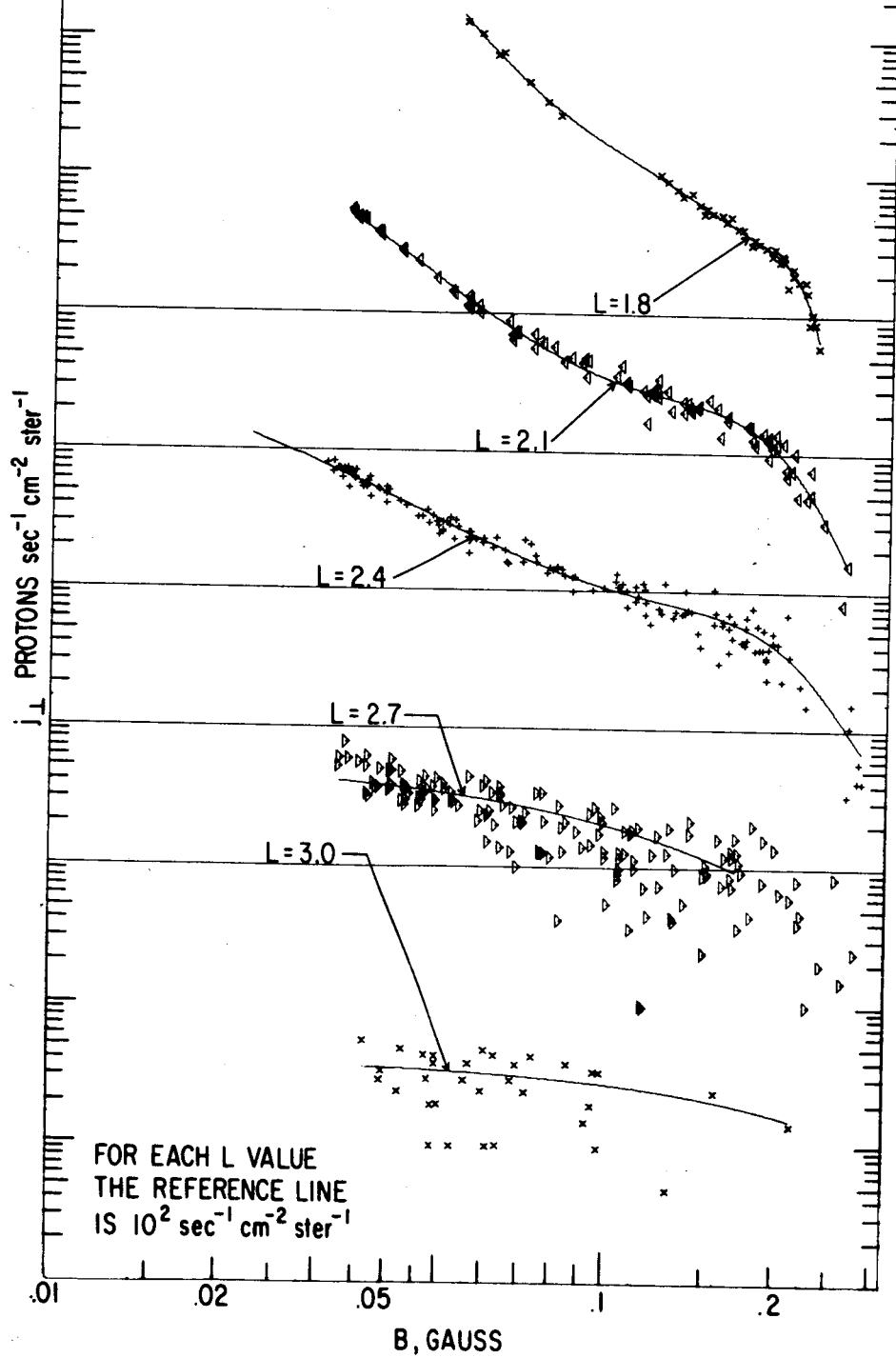


Figure 22

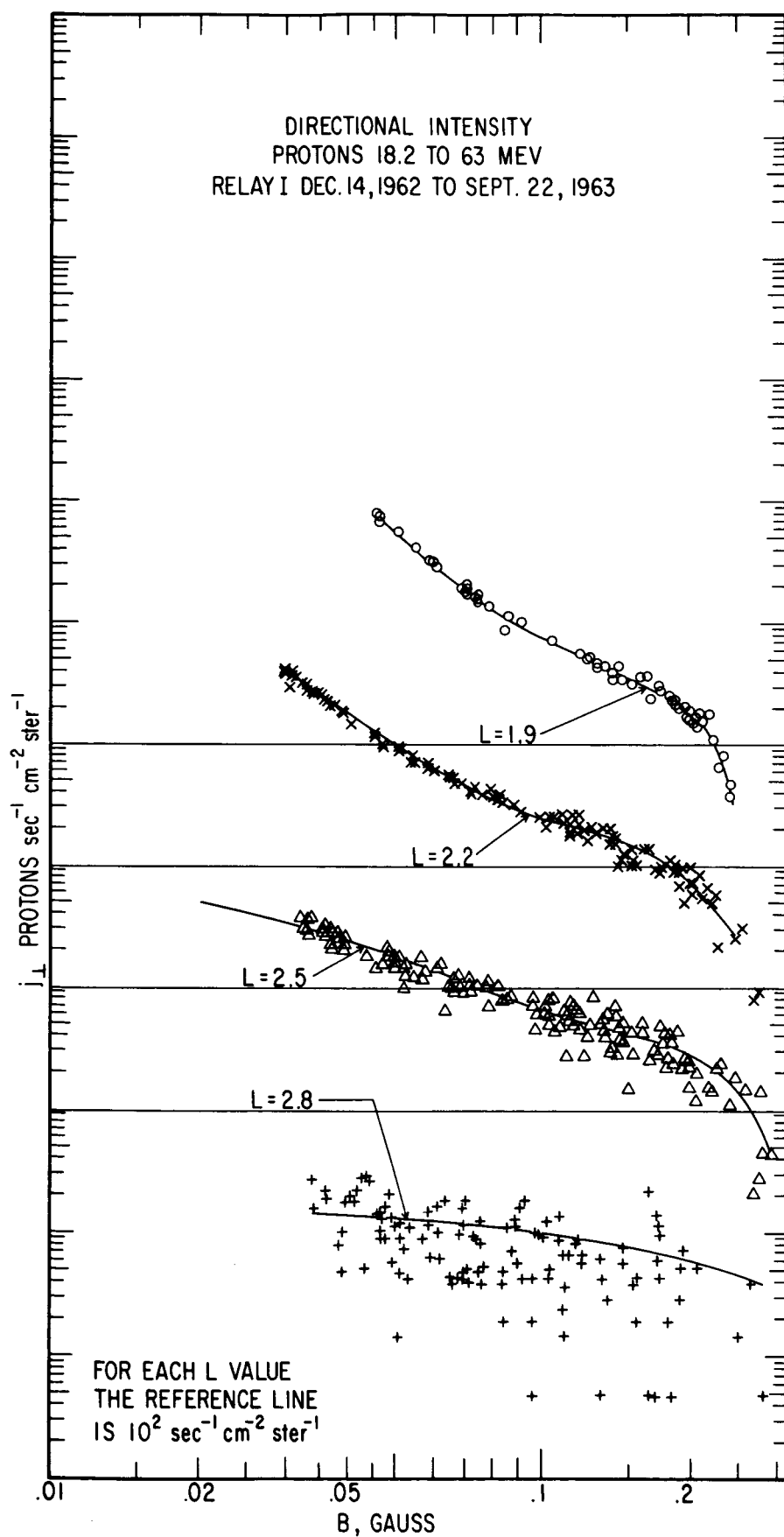


Figure 23

DIRECTIONAL INTENSITY
 PROTONS 18.2 TO 63 MEV
 RELAY I DEC. 14, 1962 TO SEPT. 22, 1963

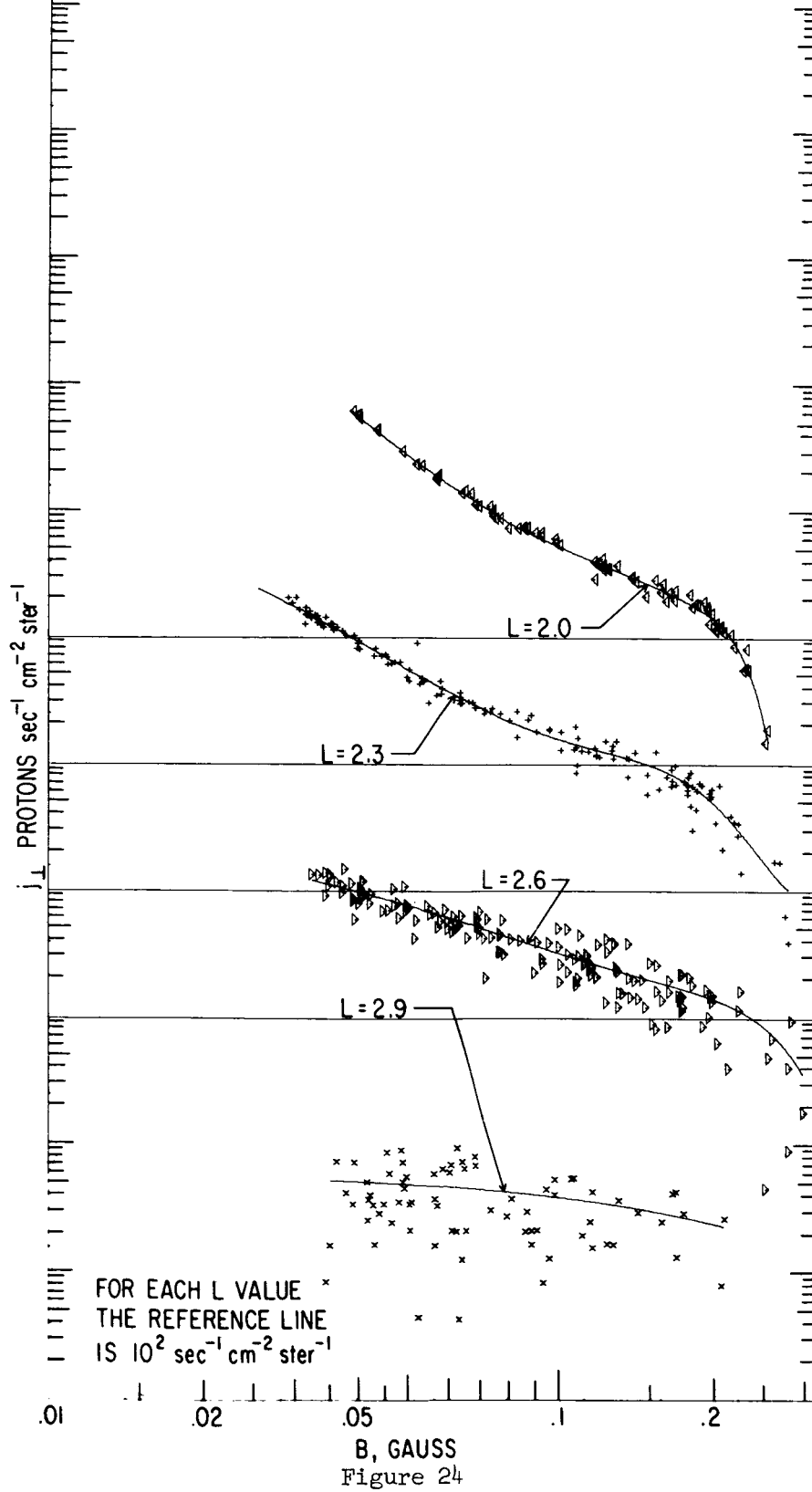


Figure 24

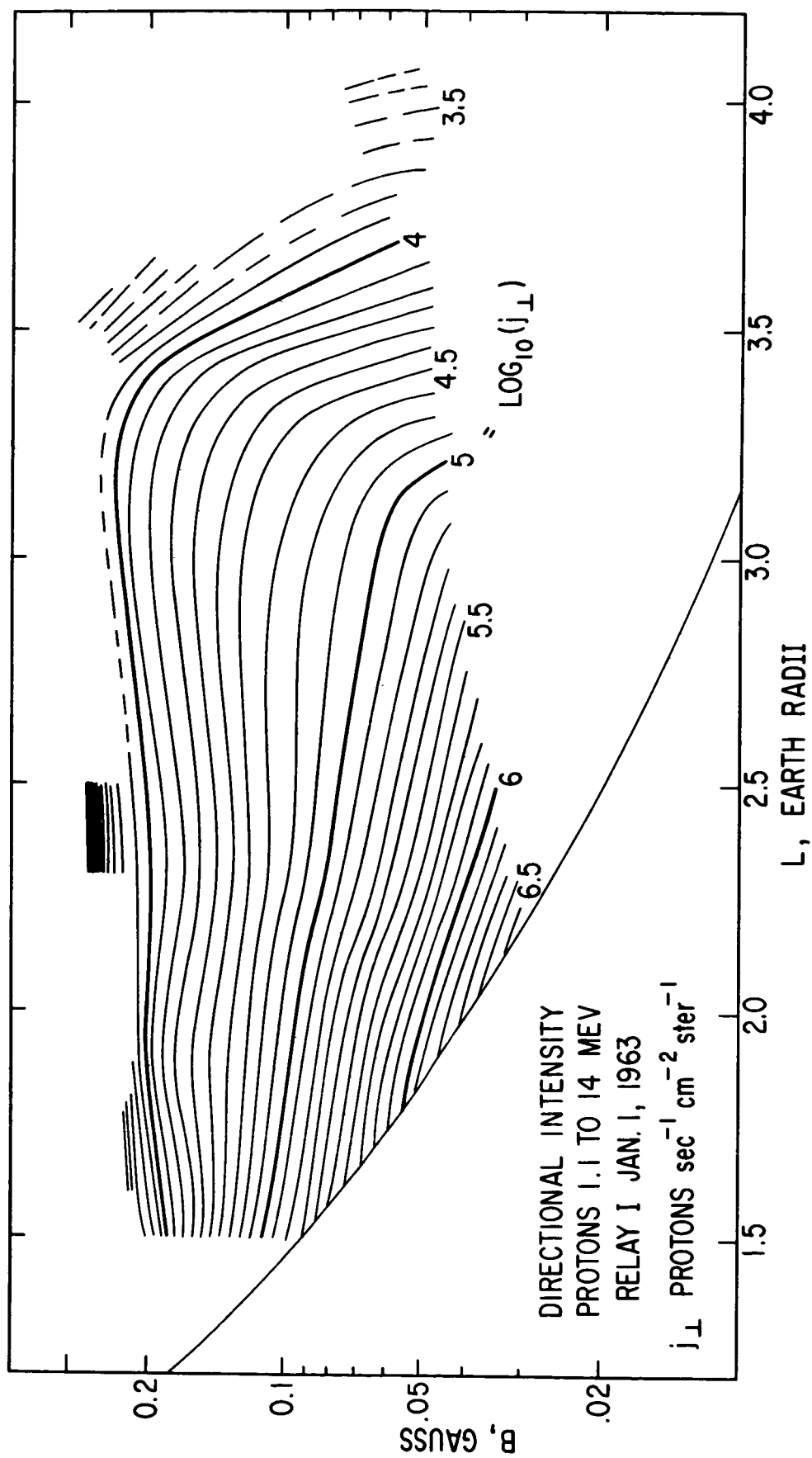


Figure 25

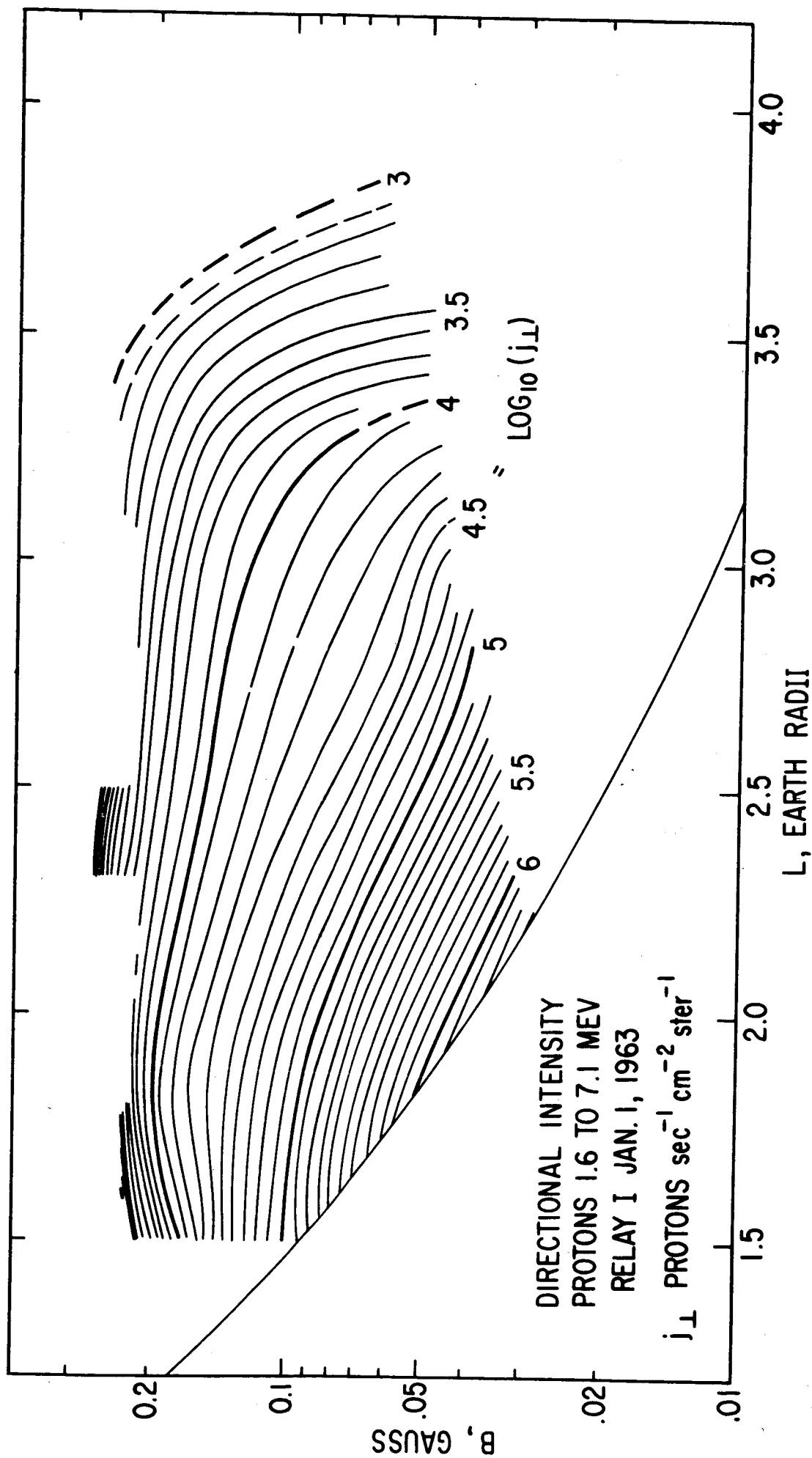


Figure 26

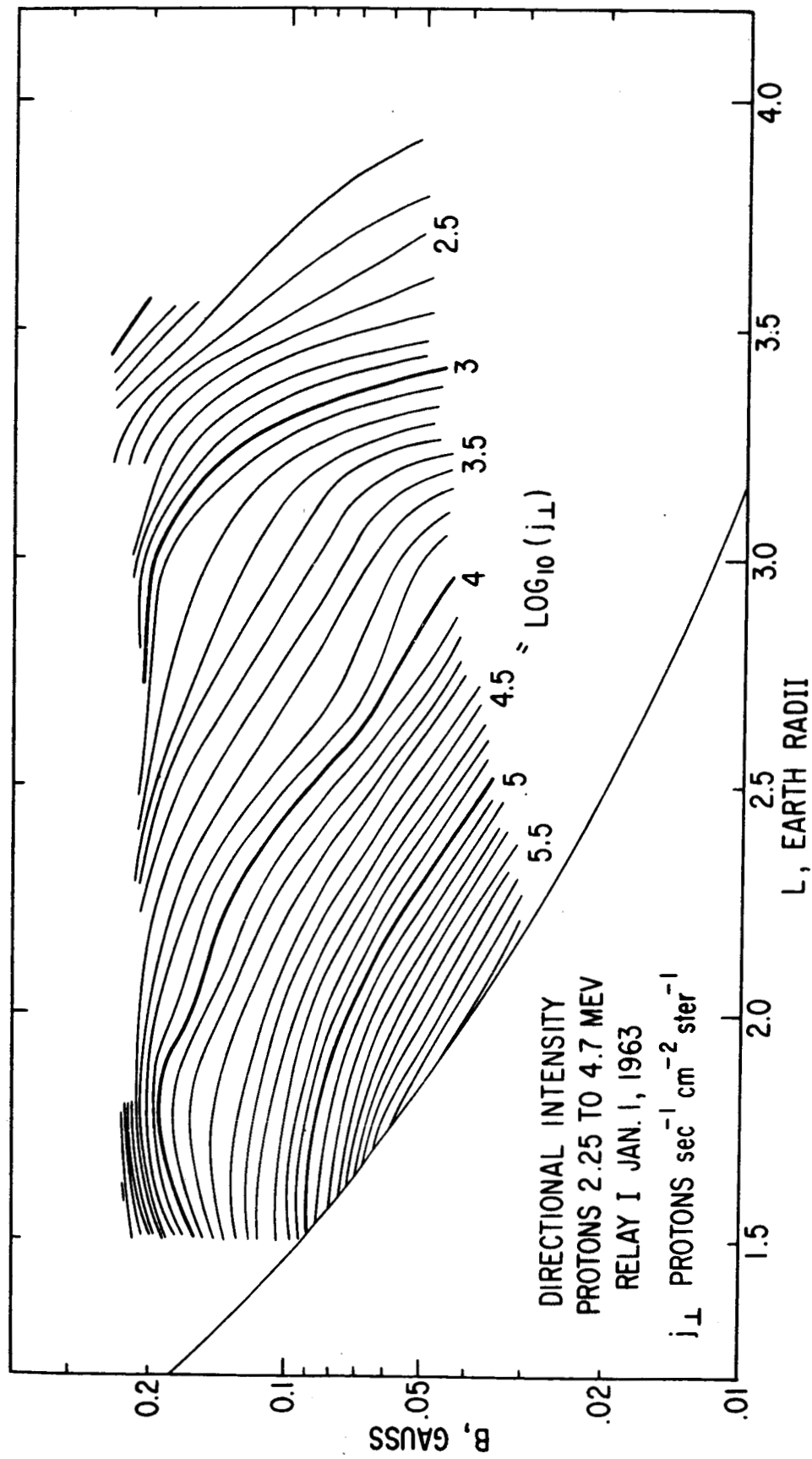


Figure 27

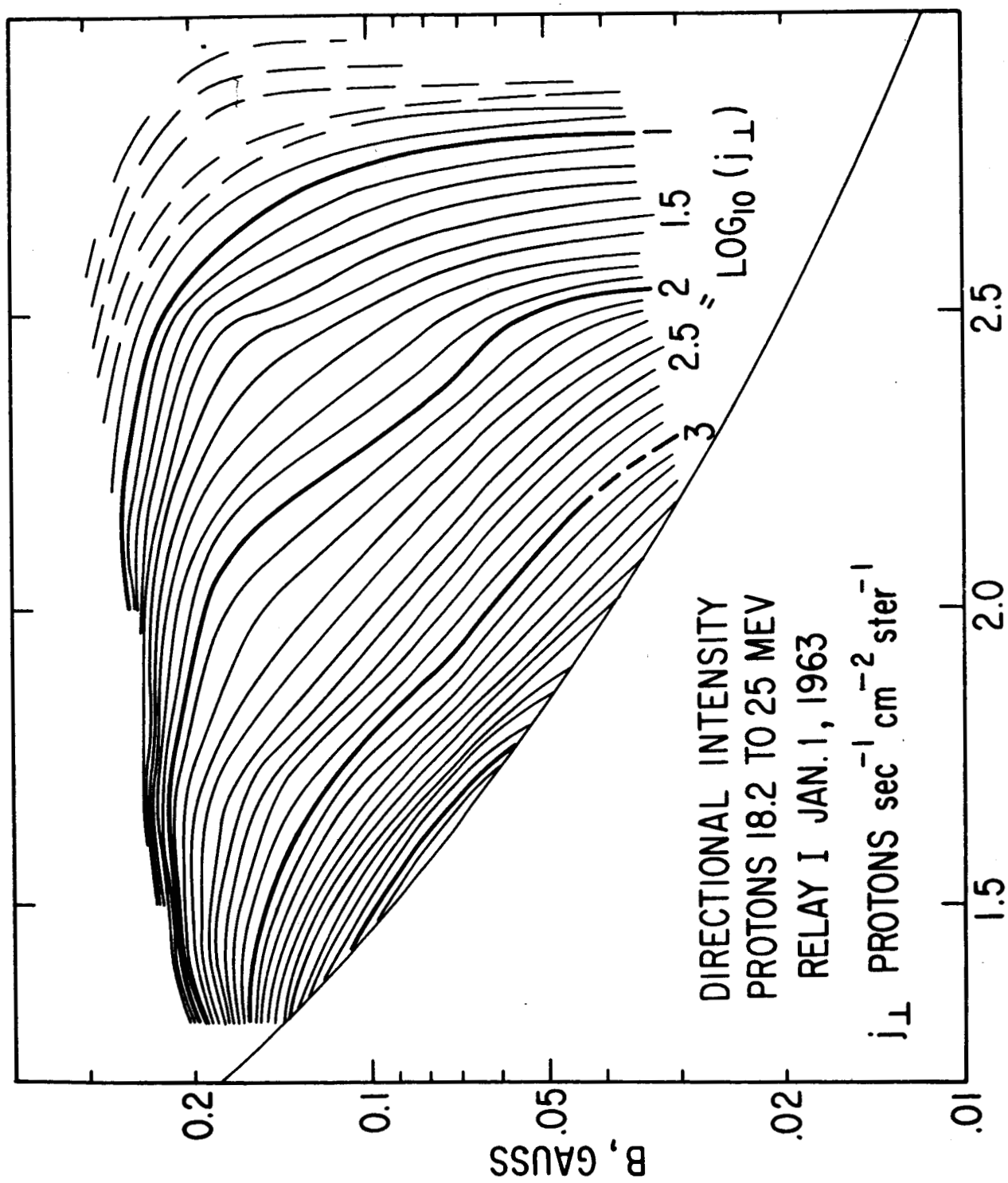
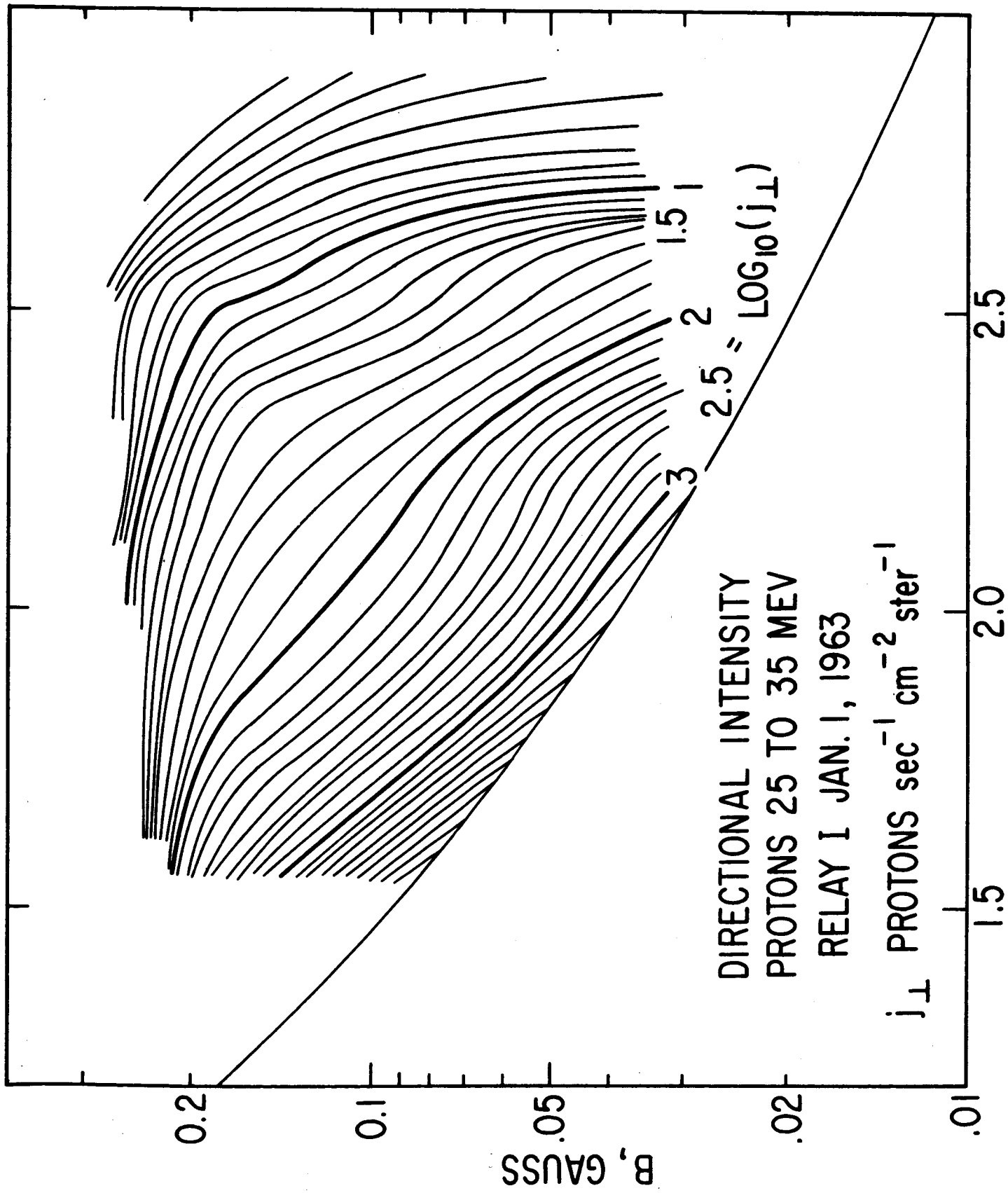


Figure 28



L, EARTH RADII

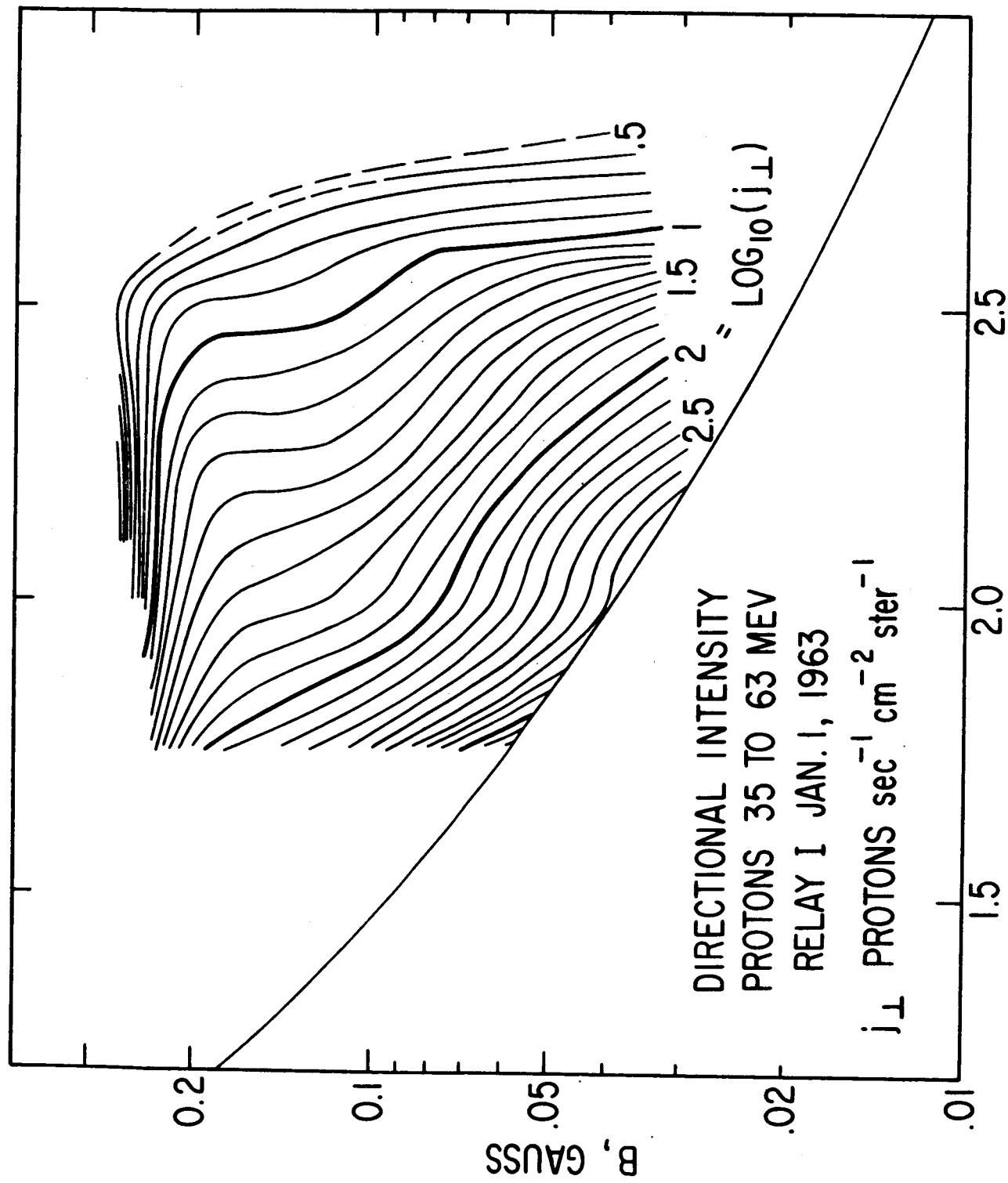


Figure 30

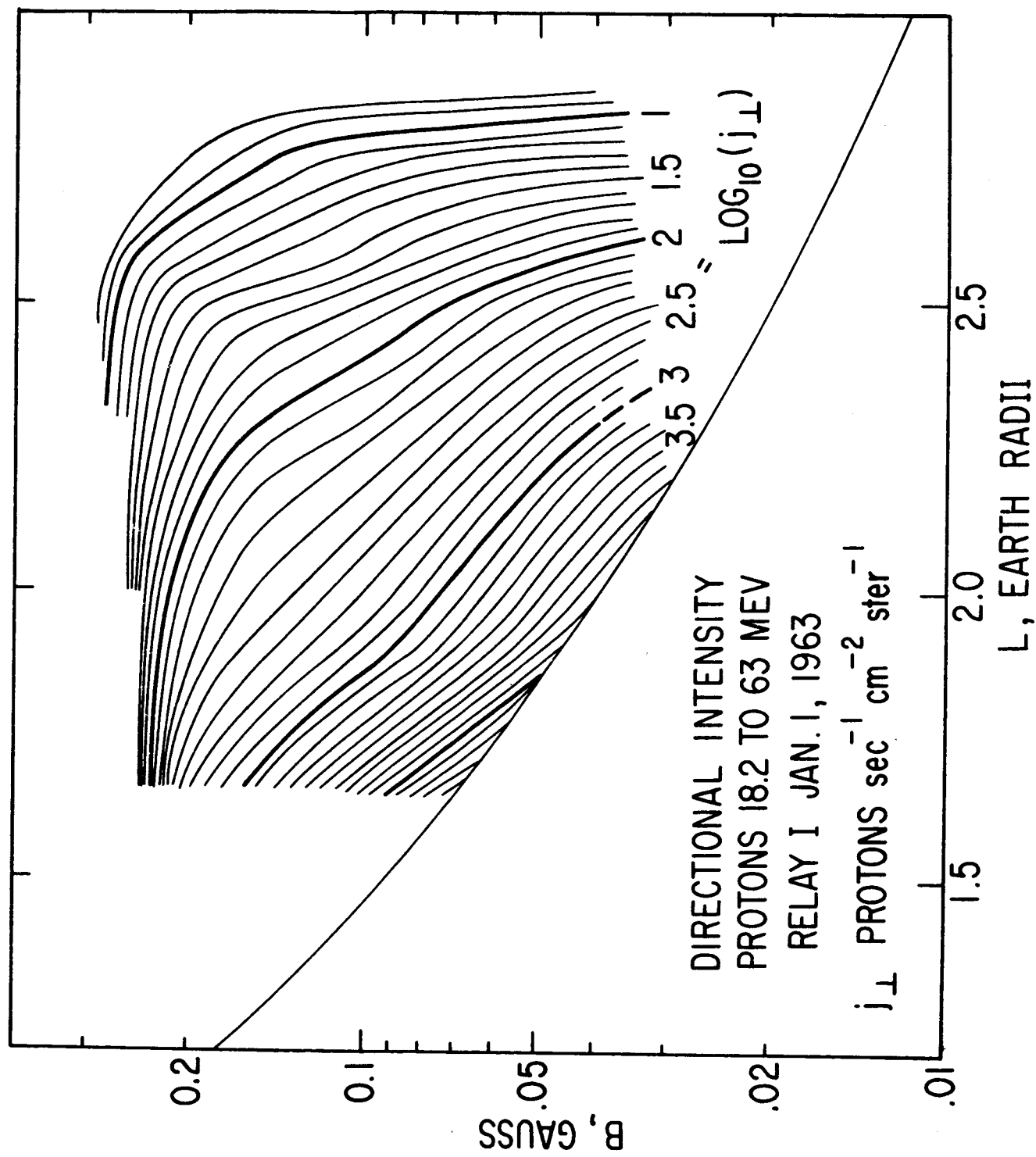


Figure 31