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MEASUREMENTS OF PULSE SHAPES OF NEUTRON BURSTS IN THE THERMAL AND SUBTHERMAL RANGE AT SINGLE ENERGIES

by

G. RICCOBONO, G. FRAYSSE and S. MENARDI

1968

Joint Nuclear Research Center
Ispra Establishment — Italy

Reactor Physics Department
Experimental Neutron Physics

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Joint Nuclear Research Center — Ispra Establishment (Italy)
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The experimental apparatus is described and its performances evaluated.

The results are given and discussed from the point of view that the moderator configurations studied should serve as sources of thermal and cold neutrons when coupled to a pulsed fast reactor.

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KEYWORDS

NEUTRONS
PULSES
MEV RANGE
NEUTRON BEAMS
MODERATORS
TEMPERATURE
LOW TEMPERATURE
NEUTRON SOURCES
FAST NEUTRONS

MEASUREMENTS OF PULSE SHAPES OF NEUTRON BURSTS IN THE THERMAL AND SUBTHERMAL RANGE AT SINGLE ENERGIES *)

1. INTRODUCTION

In a previous paper (1) were reported the relative yields of thermal and subthermal neutrons emitted by some moderator configurations following the injection of a fast neutron burst. Those measurements were performed in the course of the development of a thermal and of a cold neutron source to be used in connection with the pulsed fast reactor SORA. From the results of those measurements it appeared that the subthermal neutron yield could be noteceably increased by the addition to the moderator configuration (various containers filled with H_2O at room temperatures and at 77°K) of a Be reflector block placed in front of the neutron emitting surface (see ref. (1) for details).

However, due to the intended use of such pulsed sources, it has been stressed in various occasions (1, 2, 3) that the knowledge of the neutron population time behaviour at the energy of interest is of the outmost importance. As matter of fact the significant parameters of the instrumentation to be used with such source depend on the characteristics of the source itself (2). Therefore, as it has been anticipated in Ref. (1), neutron life time measurements have been performed for some configurations and for some energy values of particular interest for the problem at hand.

*) Manuscript received on August 14, 1968.

by increasing θ i.e. going towards longer wavelengths. This improvement in resolution is payed by a loss in reflectivity in fact $\mathcal{R}^{\theta}$ can be expressed in term of λ by $\mathcal{R}^{\lambda} = 2 d \cos\theta \ \mathcal{R}^{\theta}$ being now $\mathcal{R}^{\lambda}$ the band around λ, the Bragg wavelength, for which reflection is complete. Taking into account the decrease in flux at low wavelength (4Å) and the fact that our set up (see Fig. 1) had implied in order to go at angles $2\theta > 90°$ an increase of ℓ, with a further loss of intensity, as explained above, we would have arrived at a prohibitively low counting rate by using the zinc crystal for the 5 meV measurements. The use of the lead crystal for these measurements permitted to work with a barely possible counting rate and to perform the measurements at 5 meV with the same collimator and general assembling obtaining the same resolving time as in the 20 meVmeasurements done with the zinc crystal.

ELECTRONICS

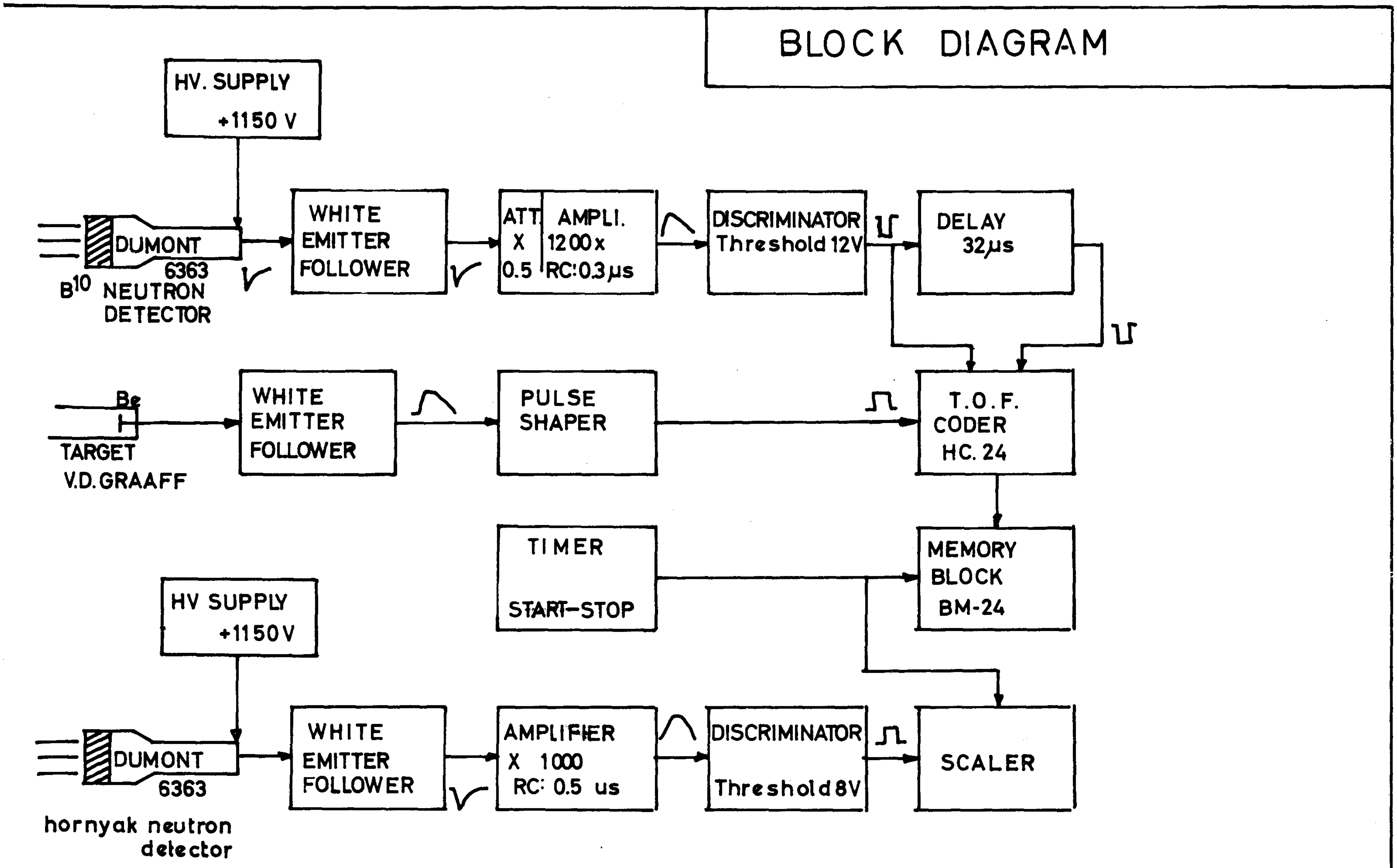
The counting chains used are shown in Fig. 2 where the significant parameters are also given. Pulses from the B^{10} loaded scintillator are fed, after having been conventionally amplified, formed and discriminated to a mod. HC 24 Intertechnique 1024 time coder. This model of time coder is subdivided in four subgroups containing 256 channels and also a built-in variable and independent time delay (not shown in the diagram) in each subgroups.

Only 256 channels of 4 μs width were used in the measurements at 20, 80 meV with a delay of 32 us. The accelerator deuteron pulse was 50 μs long with 2 μs rise and decay time, and a repetition rate of 800 pps.

The measurement at 5,20 meV with the lead crystal were done using two subgroups of the time coder. It is seen in the diagram that pulses to the second input were 32 μs externally delayed. This was done again in order to optimize the counting rate. In fact the two subgroups were set partially overlapping each other in order to work with the maximum repetition rate allowed by all other conditions, as explained before. The coder hoever rejects pulses which appear in coincidence at the two inputs. To avoid this coincidence the 32 μs delay was used. The data plots of Fig. 5, 6 are corrected for this delay. The accelerator frequency was 500 pps for these measurements being the pulse length still 50 μs as above. An Hornyac type fast neutron monitor was used for all measurements.

EXPERIMENTAL RESULTS

The raw data as obtained from the time of flight analyzer are plotted in Figs. 3, 4, 5, 6. In each figure is also schematically indicated the moderator source configuration (see Ref. 1 for details) and the temperature to which it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HV. SUPPLY
+1150 V
DUMONT
6363
B10 NEUTRON
DETECTOR
WHITE
EMITTER
FOLLOWER
ATT
X
0.5
AMPLI.
1200x
RC: 0.3 μs
DISCRIMINATOR
Threshold 12V
DELAY
32μs
Be
TARGET
V.D. GRAAFF
WHITE
EMITTER
FOLLOWER
PULSE
SHAPER
T.O.F.
CODER
HC. 24
TIMER
START-STOP
MEMORY
BLOCK
BM-24
HV SUPPLY
+1150V
DUMONT
6363
hornyak neutron
detector
WHITE
EMITTER
FOLLOWER
AMPLIFIER
X 1000
RC: 0.5 us
DISCRIMINATOR
Threshold 8V
SCALER

FIG.2

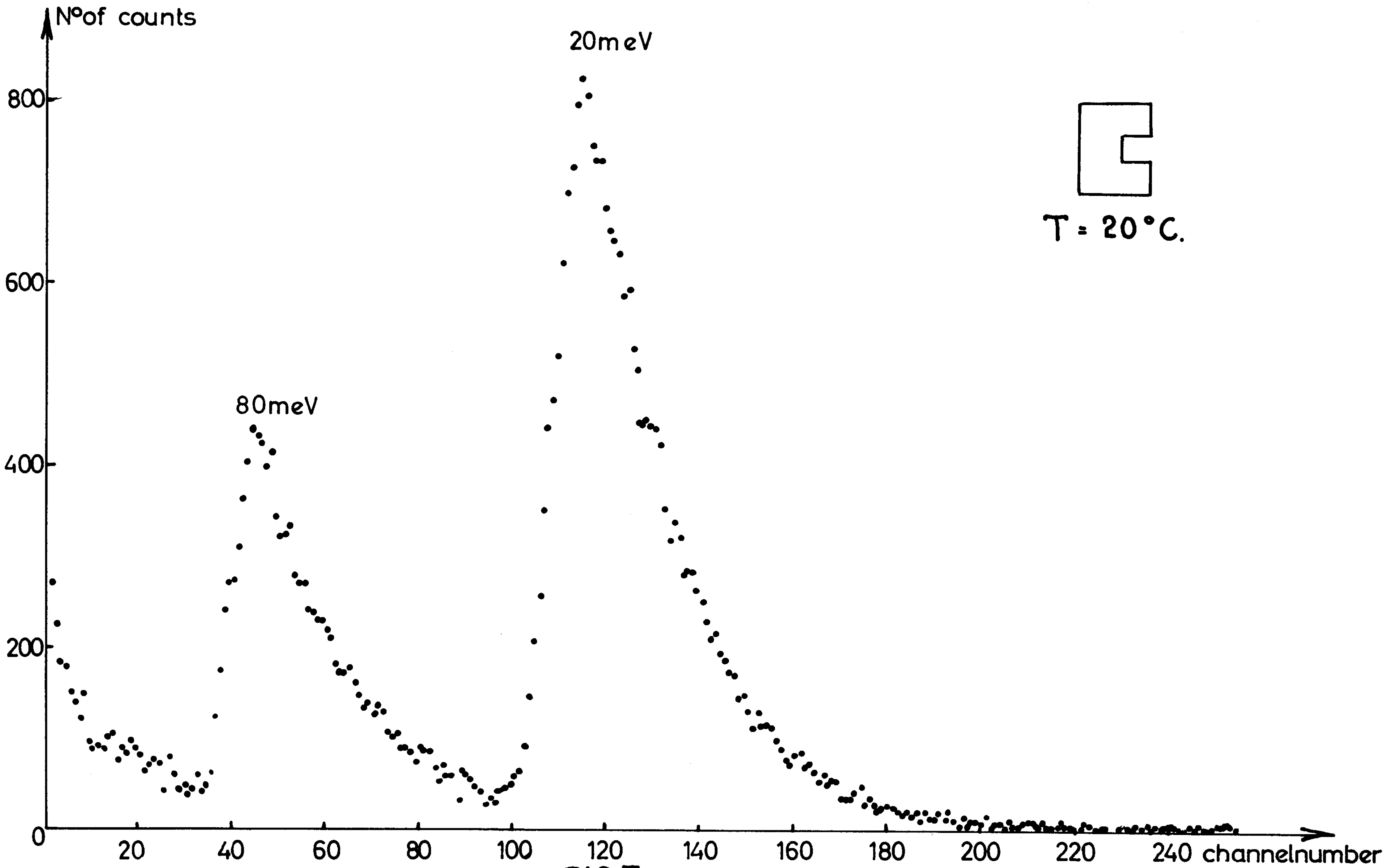
N°of counts
800
600
400
200
0
20
40
60
80
100
120
140
160
180
200
220
240 channelnumber
80meV
20meV
T = 20°C.

FIG. 3

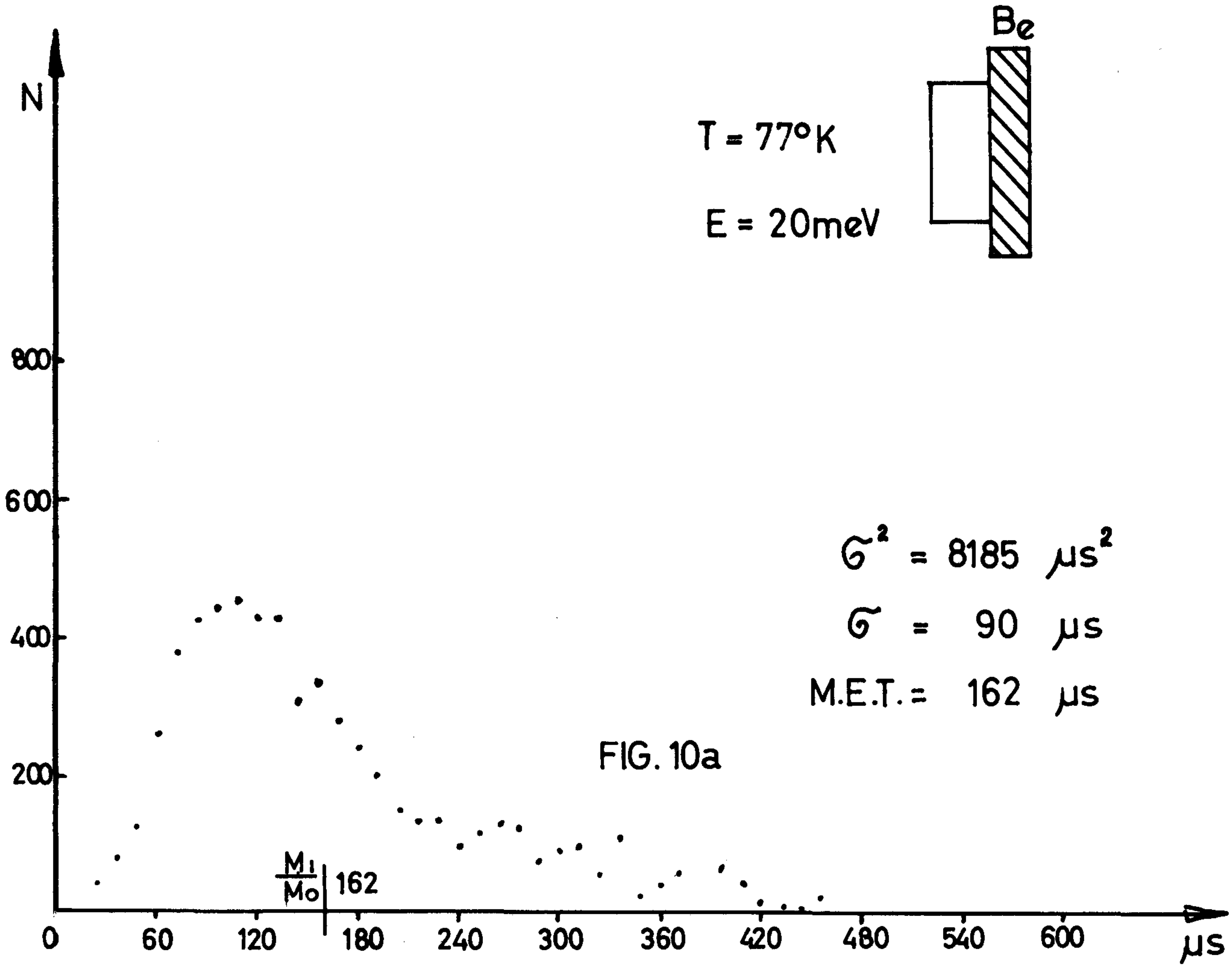

FIG. 10a

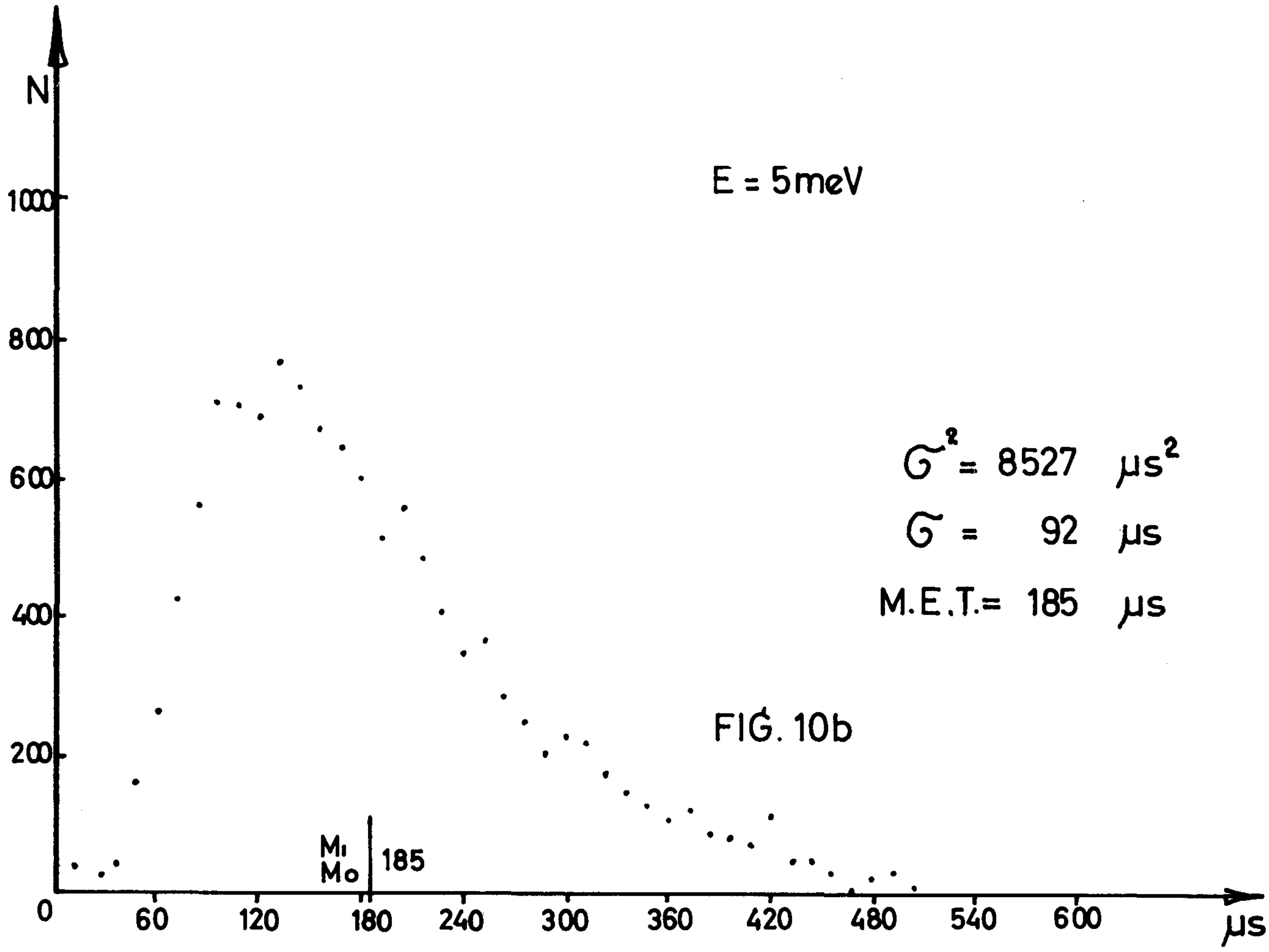

FIG. 10b

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To disseminate knowledge is to disseminate prosperity — I mean general prosperity and not individual riches — and with prosperity disappears the greater part of the evil which is our heritage from darker times.

Alfred Nobel

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