OBELIX Note OX-CA/87-10

FIRST RESULTS ON THE TIME OF FLIGHT SYSTEM

G.Bonazzola, T.Bressani, S.Costa, A.Feliciello
S.Marcello, A.Masoni, I.Tricomi.

We give a short report about the status of the TOF tests.

In the OBELIX detector the time of flight system consists of two barrel of scintillator slabs coaxial with the $\overline{p}$ beam. It will allow to identify charged particles and to provide a fast triggering on $K^{\pm}$ and it will measure the time of light of $\overline{n}$ produced in the target. Therefore it's necessary to have good time resolution and localization properties. In the first decade of september 1987 we studied the performances of several scintillator slabs connected to different electronics by using a π beam at the PS facility at CERN.

The measurements were performed with the experimental layout shown in fig.1.

There were two thin strips (called toffino) of NE110 plastic scintillator (0.5X3.5X120cm^3) viewed by Lucite light guides of the same dimensions on both sides (125cm long). The light guides of one scntillator strip were connected by XP2020 PMs and the light guides of the other strip by RTC2982 PMs.

Then there was a long slab (3X10X300cm^3) of NE110 plastic scintillator (called toffone) viewed on both sides by two light guides (50cm long) coupled by XP2020 PMs for some tests and XP2262 PMs for other ones.

Another scintillator slab (toffone) (3X9X176cm^3) was connected to the PMs (XP2020) by a straight light guide (4X4X115cm^3) on one side and a bent light guide (4X4X215cm^3) on the other side.

The π beam was defined by two narrow scintillators (1X1X7cm^3) (J1,J2) crossed each other and by a larger one (0.5X10X20cm^3) (J3) behind the scintillator slabs.

This system also allowed to define precisely the position on the slabs.

The block diagram of the electronics is shown in fig.2. The trigger to the STATUS A and the gate to the ADCs were provided by a fivefold coincidence between these three detectors (J1,J2,J3) and the PMs of the left side and right side of the slab. The start pulse to the TDCs was provided by one of the narrow scintillator (J1) gated by the fivefold coincidence.

Data were collected by means of a LeCroy 3500M data acquisition System. It is not a powerful system (8 bit cpu) and allows to performe only simple online analysis, but its structure allows a straightforward interconnection with CAMAC. For a simple apparatus readout, it is possible to rely on its own hardware without any more interface system .

The maximum event rate was about 10 events per burst (50% of the actual trigger rate), data are written on floppy disk. The software was developed in Cagliari.

We performed an extensive study of the electronics associated to the scintillators, expeciallly about the discriminators, the mean timer and the PMs.

Four type of constant fraction discriminators (CFD) were available: ORTEC CFD (model 934) which was taken like reference discriminator for the measurements, CFD from Geneva University (GVA CFD: DPNC 953), CFD developed in the electronic laboratory of Torino INFN (INFN CFD: LE 243).

About the mean timer there were the LeCroy module (model 624), the INFN module (INFN MT: LE 244) and the GVA one (GVA MT: DPNC 953).

TOFFINO: TIME RESOLUTION MEASUREMENTS

The inner TOF barrel of OBELIX detector consists in two blocks of 15 strips, the PMs connected by light guides to these strips can be assembled only in the conical holes inside the two poles of the magnet because of the low magnetic field in this region.

If we want to use XP2020 PMs (8 cm diameter) we have to make long light guides, because the PMs diameter is too large and it's impossible to put them in a little cicumference.

For this reason we performed some measurements by using the RTC2982 PMs which are very small (3cm diameter, 13 cm long).

Both PMs provided 1250ps f.w.h.m. for the time resolution (see fig.3 a,b). An improvment can be achieved by using a thicker strip (1cm instead of 0.5cm).

Therefore we can use RTC2982 PMs which allow to use shorter light guides, of course we have to test their performances in the magnetic field.

We also performed a time of flight measurement by using the mean timer (LeCroy) of the thin strip (toffino) like start and the mean timer of the long slab like stop, the time of flight spectra are shown in fig.4, TOF means the software meantimer (TDCS+TDCD)/2 (fig.4 a,c) and MT means the hardware one (fig. 4 b,d).

We ascribe the bad resolution (1300ps f.w.h.m.) to the toffino performances.

TOFFONE: TIME AND SPATIAL RESOLUTION MEASUREMENTS

We performed a series of measurements by using different type of electronics (see tab. 1 for the scheme of the experimental program) in order to obtain the best time resolution for the long scintillator slab with straight light guides of both sides.

The results of the spatial and time resolution on central and edge position are shown in tab.3 e tab.2.

Some spectra of the best time resolutions are shown in fig.5 and in fig.6.

TOFFONE WITH BENT LIGHT GUIDES

We also tested the performances of a scintillator slab viewed on one side by a bent light guide (see fig. 7).

We need to use long bent light guides for the slabs of the outer barrel which are near the yoke of the magnet in order to take out the PMs in a region where the magnetic field is lower.

Because of the two curves of the guide the pulses from PMs are attenuated and this effect can worsen the performances of the detector, expecially time and spatial resolution.

In this measurement we used ORTEC CFD and XP2020 PMs.

The results are shown in fig. 8. The time resolution (TOF) in the central position was 600ps F.W.H.M. (fig. 8 a), it is worse than the resolution obtained by using straight light guides on both sides (500ps F.W.H.M.), the MT was 650ps F.W.H.M. (fig.8 b) and the spatial resolution was 1ns F.W.H.M. (fig.8 c).

PULSE ATTENUATON MEASUREMENTS IN MAGNETIC FIELD

During the month of july we performed some measurements at the OAFM in the South Hall at LEAR in order to study the behaviour of PMs in magnetic field.

We used a XP2020 PM and we put a sandwich made by an α source (^{241}Am) and a thin scintillator (NE110) on the top of the PM fixed by optical grease.

The pulse height was about 1.2 V (PM HV:-2200 V) when the magnetic field is switched off.

The maximum field (0.5 T) is obtained when the voltage is 2 V.

We performed only some measurements because it was not easy to fix the PMs at the magnet.

On the top of the poles the attenuation of the pulse height was about 80% , if we remove back the PM the attenuation decreases to 10% (see fig. 9 a,b).

On one side of the blue iron supports of the pole, the attenuation was 85% near the coil and 25% when the PM is removed about 50cm back (see fig. 9 c,d).

Inside the pole the attenuation was 27% (see fig. 9 e), it means the magnetic field is not zero, but it's still possible the PMs work well.

Under the pole the pulse height decreases about 58% (fig. 9 f), therefore we need to use long bent light guides to put the PMs out of the magnetic field.

In conclusions the conditions are not so bad and the PMs can give standard performances if we use light 70cm long for the outer barrel.

In order to improve the pulse attenuation we can use for the external shield of the PMs another type of iron (ARMCO) with higher magnetic permeability.

We plan to test the RTC2982 PM inside the conical holes of poles as soon as possible.

T11 - DRAWING OF DETECTOR INSTALLATION
(1 cm → 1 m scale)

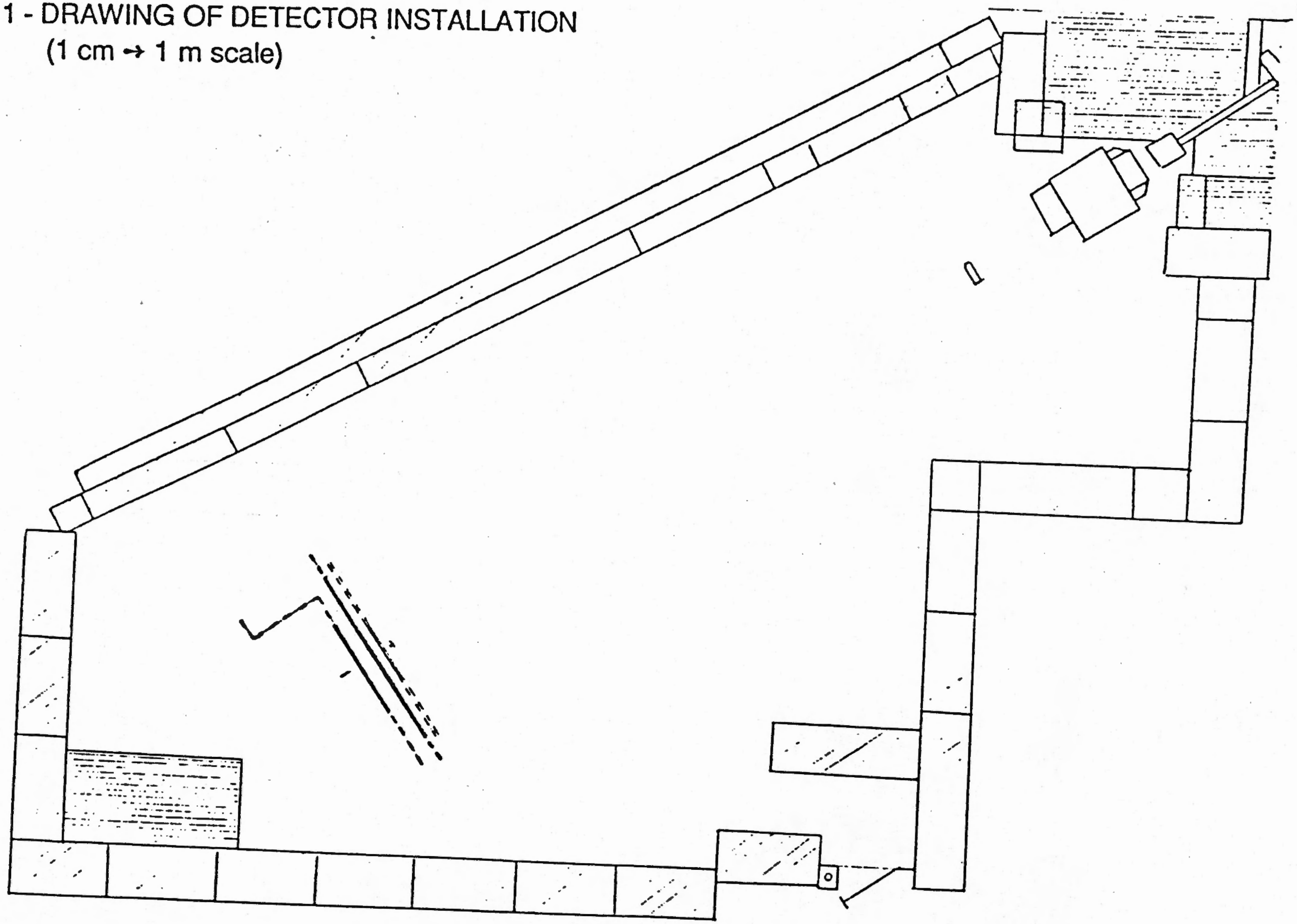


Fig. 1

OX-CA/87-10

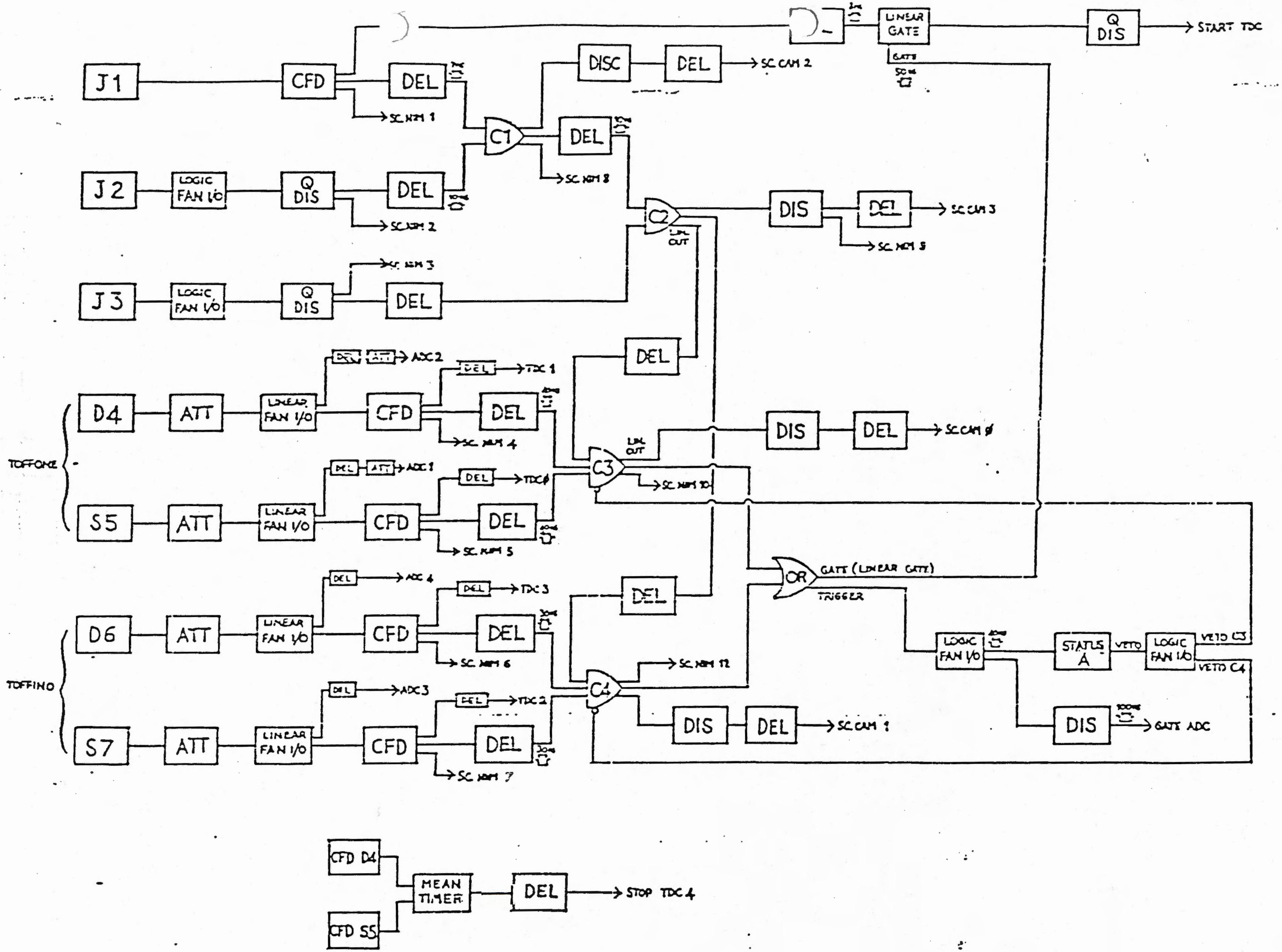
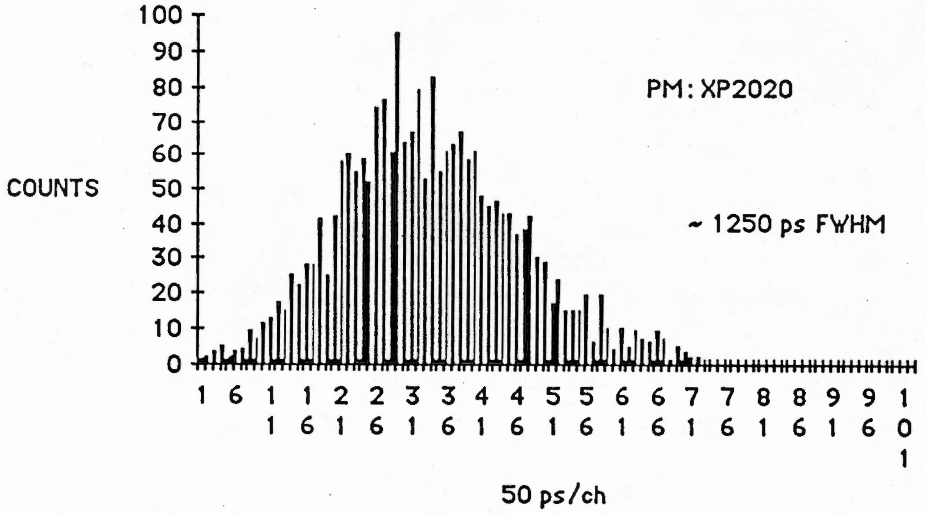


Fig. 2

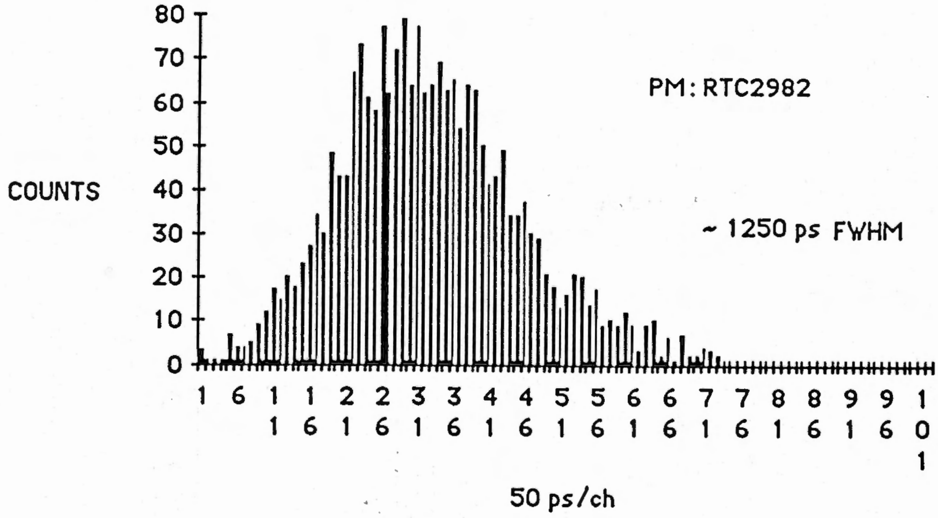
OX-CA/87-10

Toffino Time Resolution

TOF



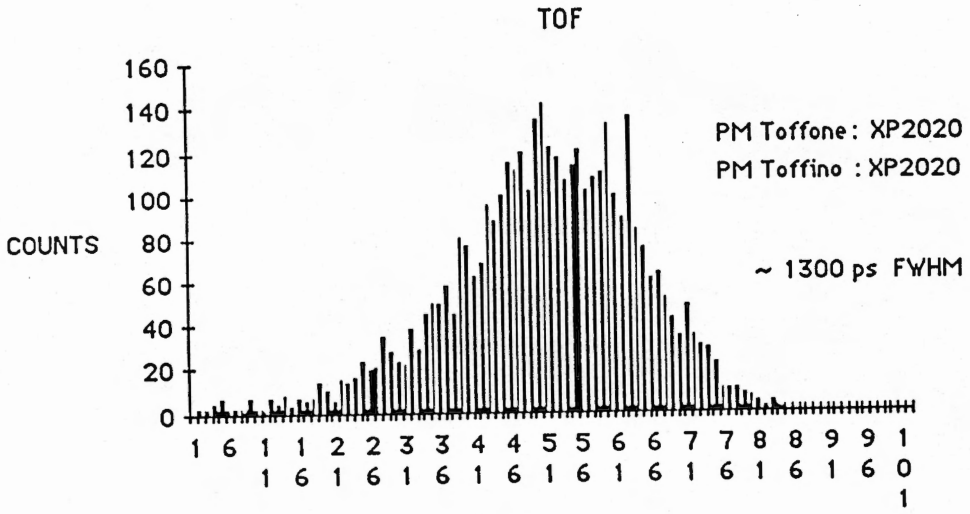
a)



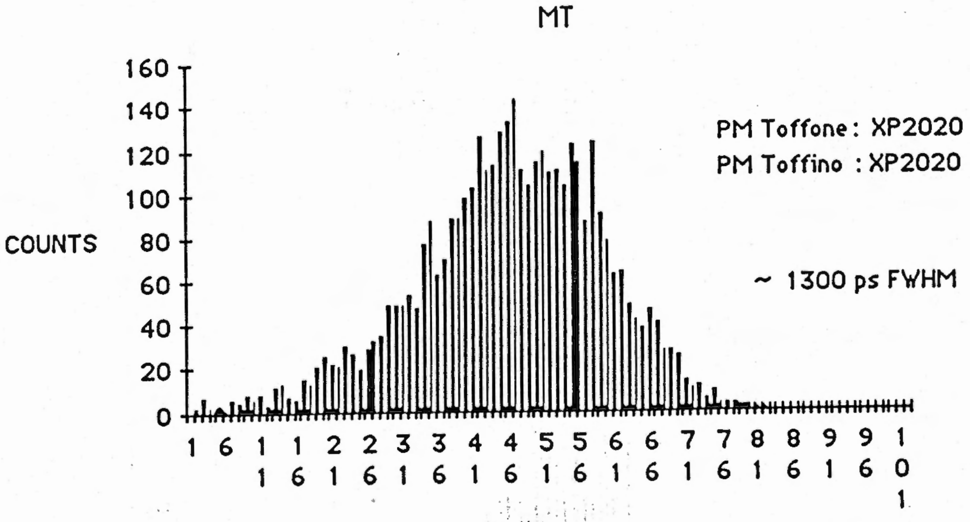
b)

Fig. 3

TIME OF FLIGHT MEASUREMENT
Start : Toffino / Stop : Toffone



a)



b)

Fig. 4

SETUP	PM	CFD	MT
1	Philips XP 2020	ORTEC mod.934	LeCroy mod. 624
2	Philips XP 2020	GVA DPNC 953	GVA DPNC 953
3	Philips XP 2020	INFN Le 243	INFN Le 244
4	Philips XP 2262	ORTEC mod.934	LeCroy mod. 624
5	Philips XP 2262	GVA DPNC 953	GVA DPNC 953

Tab. 1

TIME RESOLUTION
F.W.H.M. (ps)

	CENTER		EDGE	
SETUP	TOF	MT	TOF	MT
1	~ 550	~ 550	~ 700	~ 800
2	~ 650	~ 700	~ 650	~ 750
3	~ 650	~1100	~ 700	~ 850
4	~ 500	~ 500	~ 650	~ 750
5	~ 500	~ 550		

Tab. 2

SPATIAL RESOLUTION
F.W.H.M. (ps) (cm)

SETUP	CENTER	EDGE
1	~7.4 ~ 900	~9 ~ 1100
2	~9.4 ~1150	~8.2 ~1000
3	~8.2 ~1000	~9.8 ~1200
4	~7.4 ~ 900	~8.6 ~1050
5	~9 ~1100	

$v = 2 \frac{\Delta x}{\Delta t}$

$v = 16.4 \frac{cm}{ns}$

$\Delta x = \frac{v}{2} \Delta t$

Tab. 3

Toffone Time Resolution

TOF

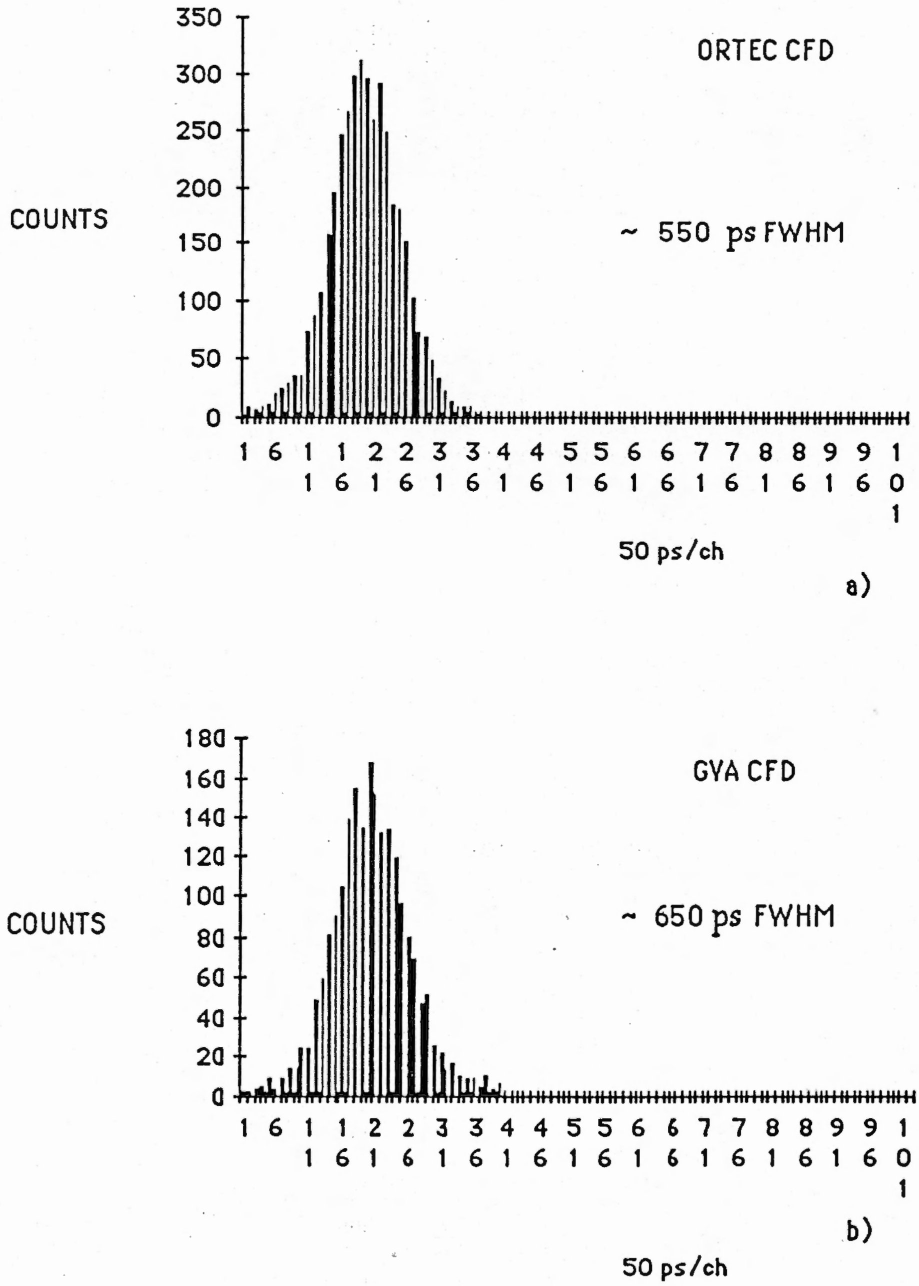
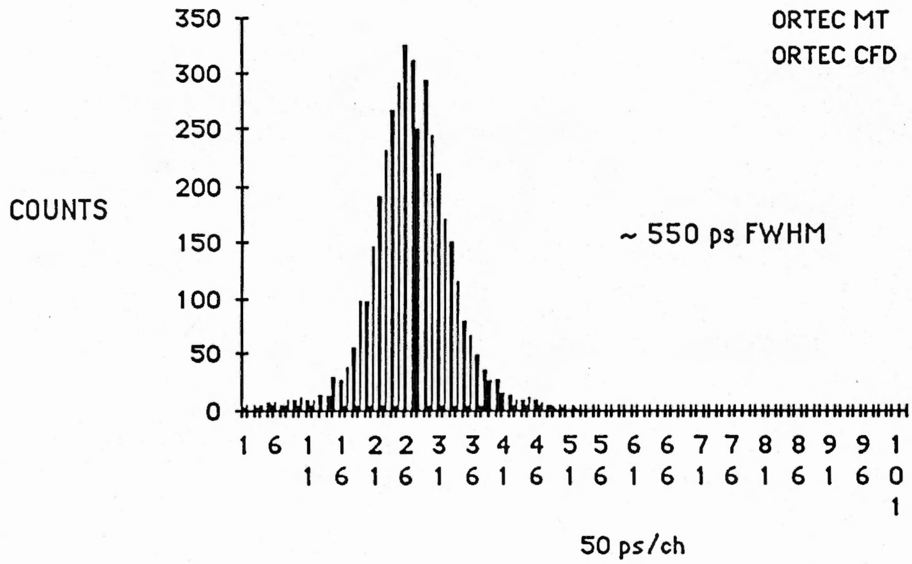


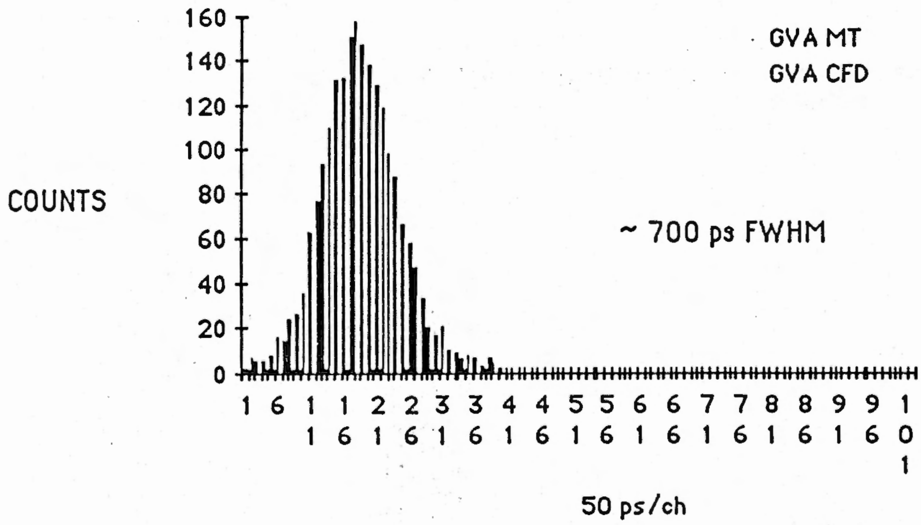
Fig. 5

Toffone Time Resolution

MT



a)



b)

Fig. 6

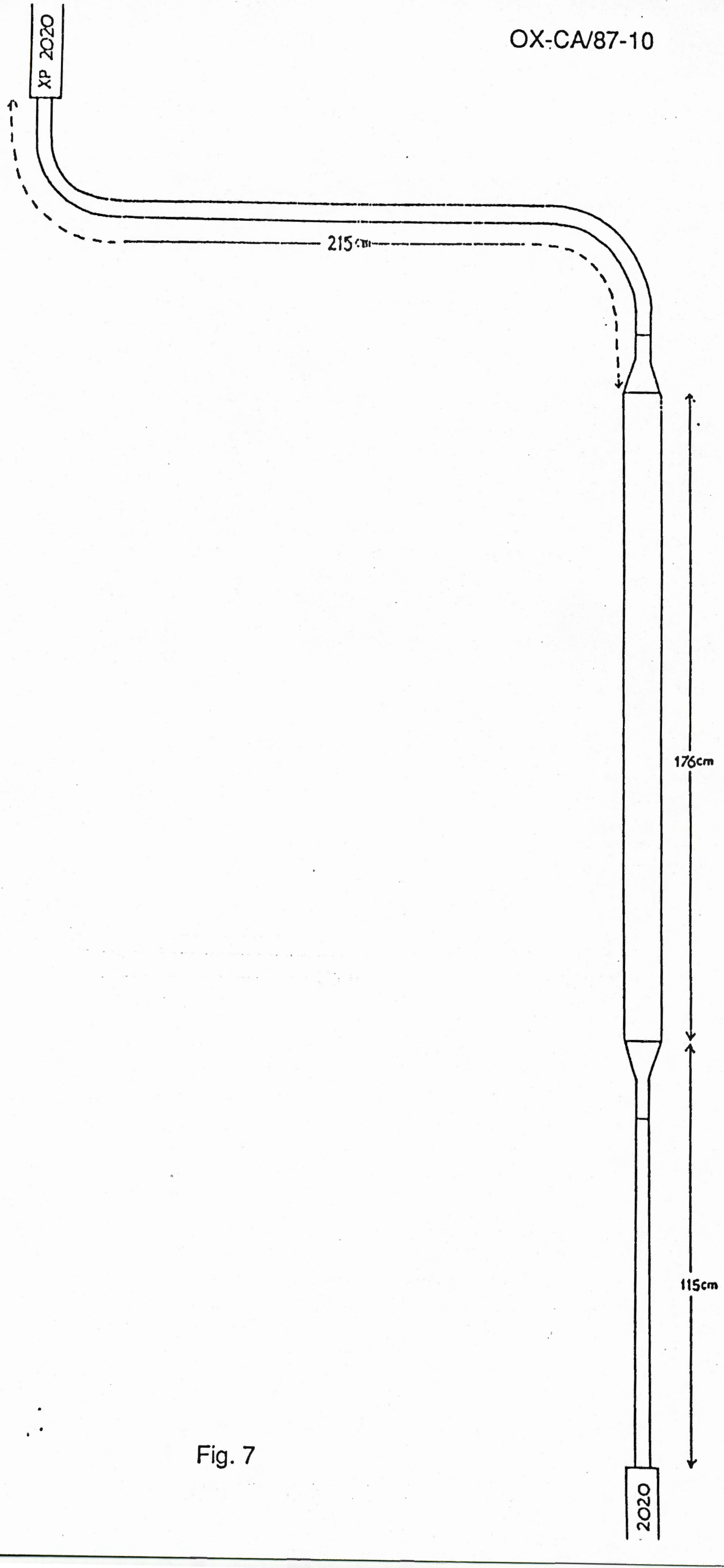


Fig. 7

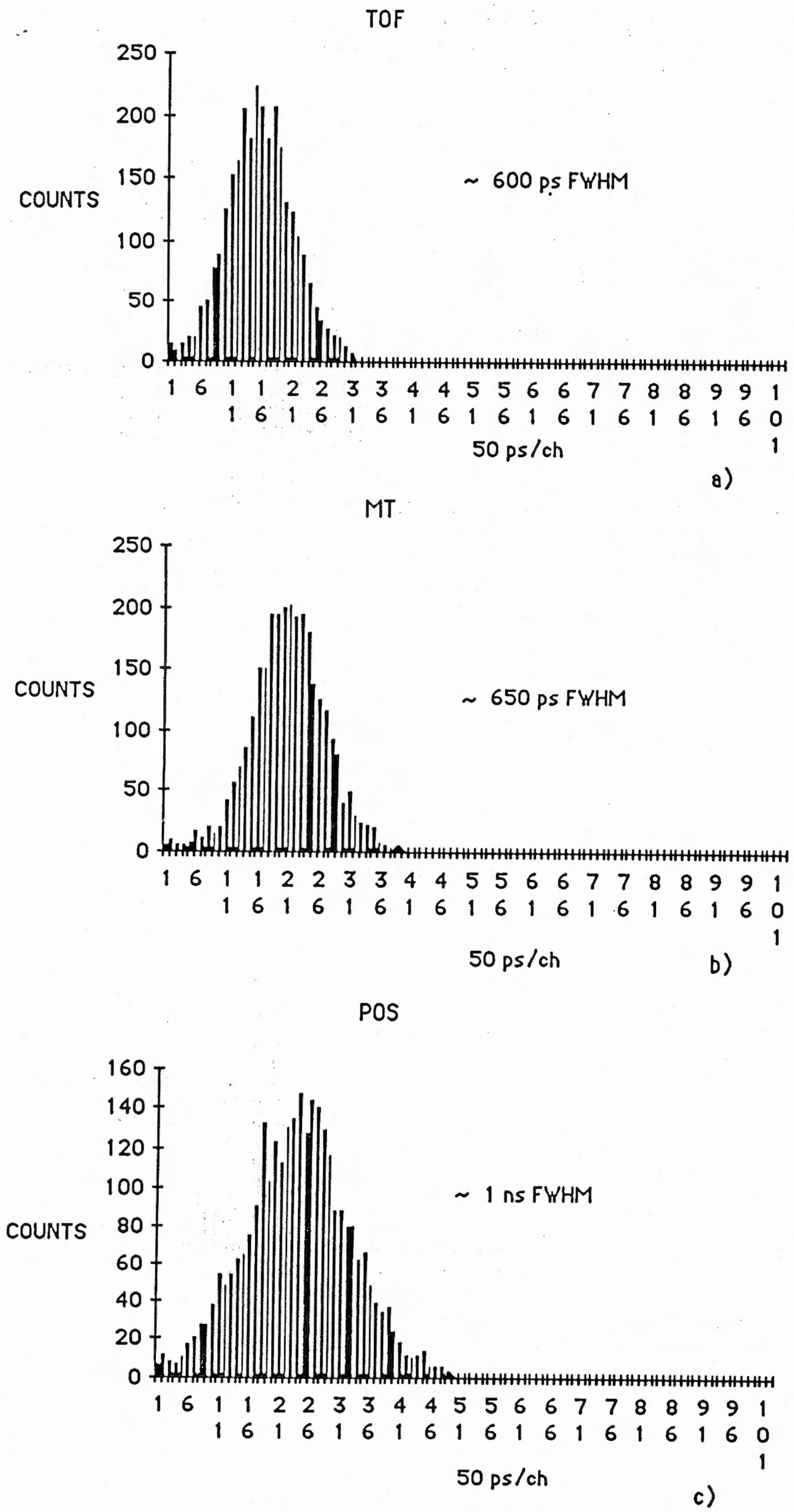

TOF
250
200
150
100
50
0
COUNTS
~ 600 ps FWHM
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101
50 ps/ch
a)
MT
250
200
150
100
50
0
COUNTS
~ 650 ps FWHM
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101
50 ps/ch
b)
POS
160
140
120
100
80
60
40
20
0
COUNTS
~ 1 ns FWHM
1 6 11 16 21 26 31 36 41 46 51 56 61 66 71 76 81 86 91 96 101
50 ps/ch
c)

Fig. 8

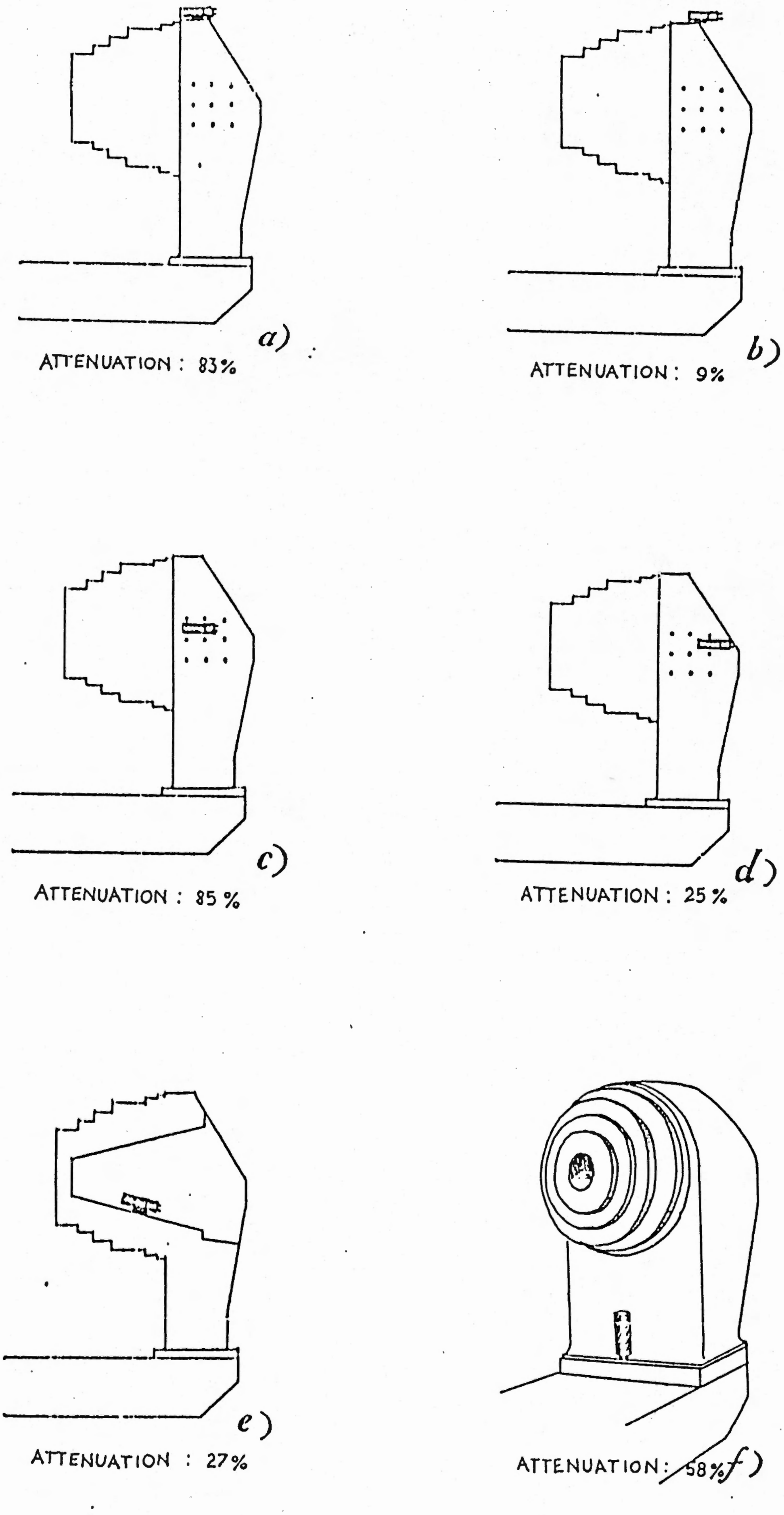

a)
ATTENUATION : 83%
b)
ATTENUATION : 9%
c)
ATTENUATION : 85 %
d)
ATTENUATION : 25 %
e)
ATTENUATION : 27%
f)
ATTENUATION : 58%

Fig. 9