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OPERATION IN A VACUUM OF A PLASTIC SCINTILLATOR RANGE SPECTROMETER

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ABSTRACT

The arrangement in a vacuum of a plastic scintillator range spectrometer and the optimization of the involved physical parameters, are discussed.

1. - INTRODUCTION

The measurement of charged pions in coincidence with charged particles detected in a large solid angle [1], required the solution of some specific problems concerning the environment where the experimental set-up had to operate.

The environment under discussion is the large vacuum chamber NAUTILUS, available at GANIL. The large solid angle multidetector [2], employed in the experiment [1], covers the inner side of the movable door of the NAUTILUS. Therefore, we were obliged to put the pion detector inside the vacuum chamber.

The employed charged pion detector is made up of a 10 elements range telescope of plastic scintillators, similar to that described in [3], that has easily worked in the air.

The problems were mostly given by the heat dissipation of electronic components and by the outgassing of some materials.

The description of the set-up, adopted in order to pass these problems and to ensure the best mechanical as well as electrical stability, constitutes the topic of the present work.

2. - CHOICE OF COMPONENTS

The employed photomultiplier was a 9954B EMI [4]. It was chosen, because its photocatode (bialkali) has a sensibility centred at about 400 μm, that is also the maximum of the NE102A emission spectrum, as shown in [5].

Preliminary tests, performed in a testing vacuum chamber, pointed-out the inopportunity to put the potential chain divider (PM base) in a vacuum, because of the thermic drift. In particular we observed that the current absorption, as well as the output signal, were stable just for one hour. So, on these conditions, it was not well-founded to plan a long time run.

The adoption of "cooled housings" (where the heat-transfer is provided by the circulation of cooling fluids), was rejected for two reasons: the overall dimension and the most expense cost (about quadruple cost).

The adopted solution was to place the bases in air, leaving the other parts of the system inside the vacuum chamber. The feeding to the photomultipliers was supplied by means of a "pin-to-pin" connection between the bases and the photomultipliers.

The PM base 4244 [6], available at CERN was adopted for its good stability. Some appropriate mechanical and electrical modifications, shown in fig. 1, were performed.

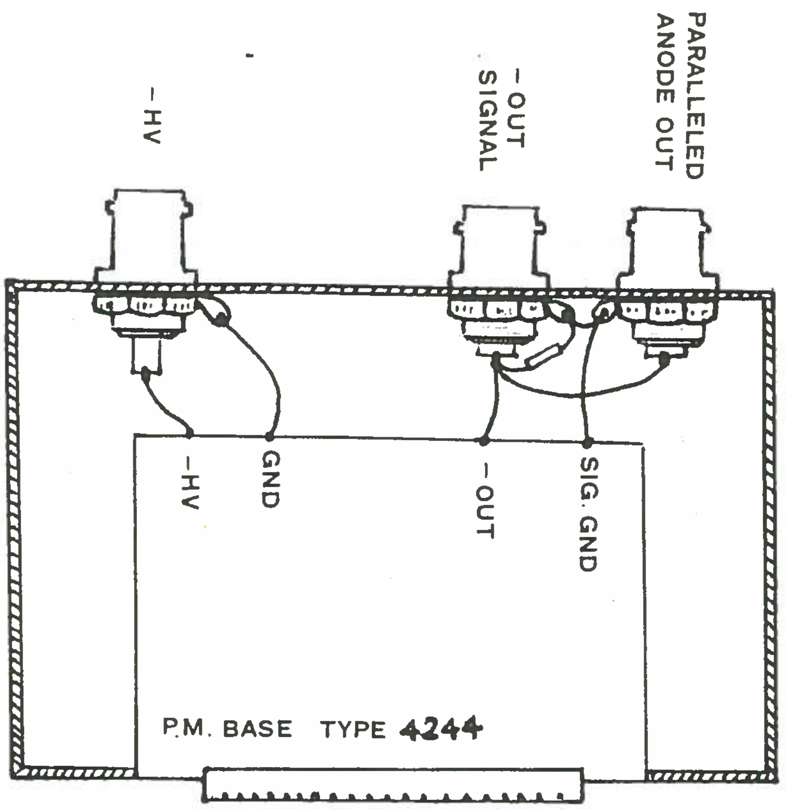


FIG. 1 - Photomultiplier divider in its final assemblage.

The next trial pertained to the choice of the other materials taking into account first and foremost their outgassing rates. Therefore we utilized aluminum for mechanical structures (telescope frame and PM housing) and teflon for the inner parts of the housings (socket and internal frame of PM).

Special care was taken for the choice of the cable type to connect PM and bases, because of the great number of involved cables and the distance (about 2 m) between the PMs and the external bases. The most convenient solution consisted in making use of ten sets (everyone composed by 15 cables) of RG62 cables, without external coating. Every set was contained in a not very clinging rilsan sheating. The choice of RG62 cable (that is not the best from the electrical point of view) is justified because the air trapped between the wire and the dielectric can escape easily.

3. - LAY-OUT OF THE SYSTEM

The system, in its final arrangement including the mechanical frame [7], is shown in fig. 2. It can be considered as constituted by three parts: 1) the detectors (in a vacuum); 2) the interconnecting cables (in a vacuum); 3) the bases (in air).

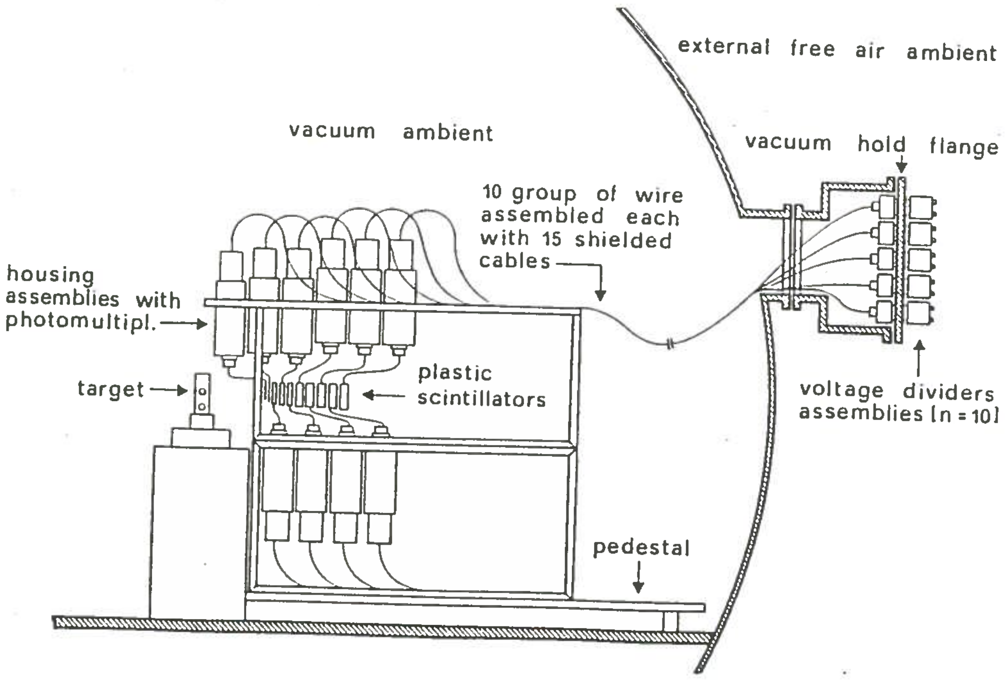


FIG. 2 - System configuration.

The connection between the bases and the inner part of the NAUTILUS was realized by means of an eltalon flange, in which the ten sets of pins were inserted (fig. 4). Every set strictly followed the standard pins' disposition of photomultipliers (19 pins).

The external look of the PM bases in its final assembly is also shown in fig. 4. External trimmers connected by a 10 cm BNC cable to the parallel anode output are also visible. Their function consists in the optimization of the pulse form at the beginning of the electronic chain, as a function of the cable lenght.

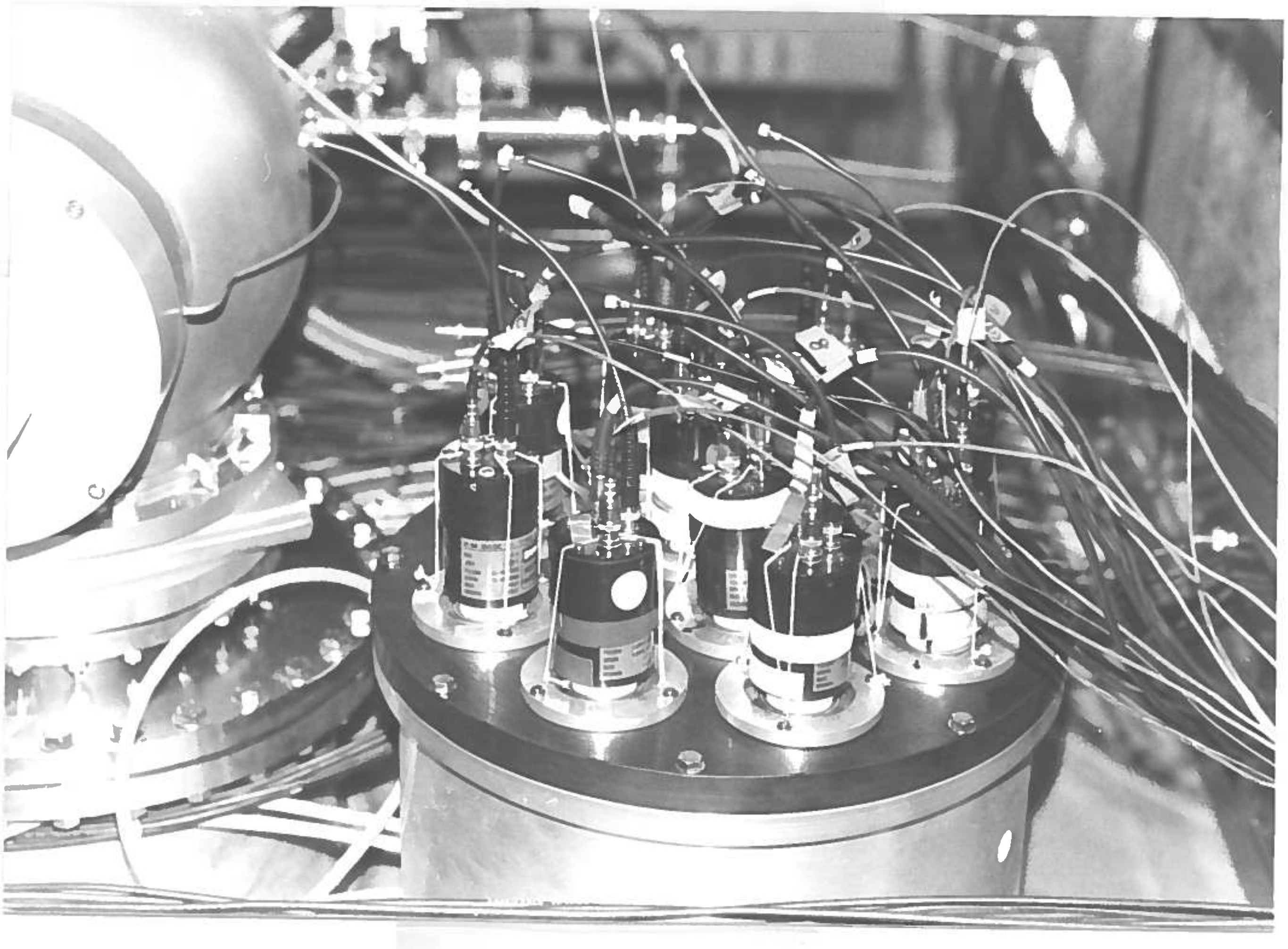
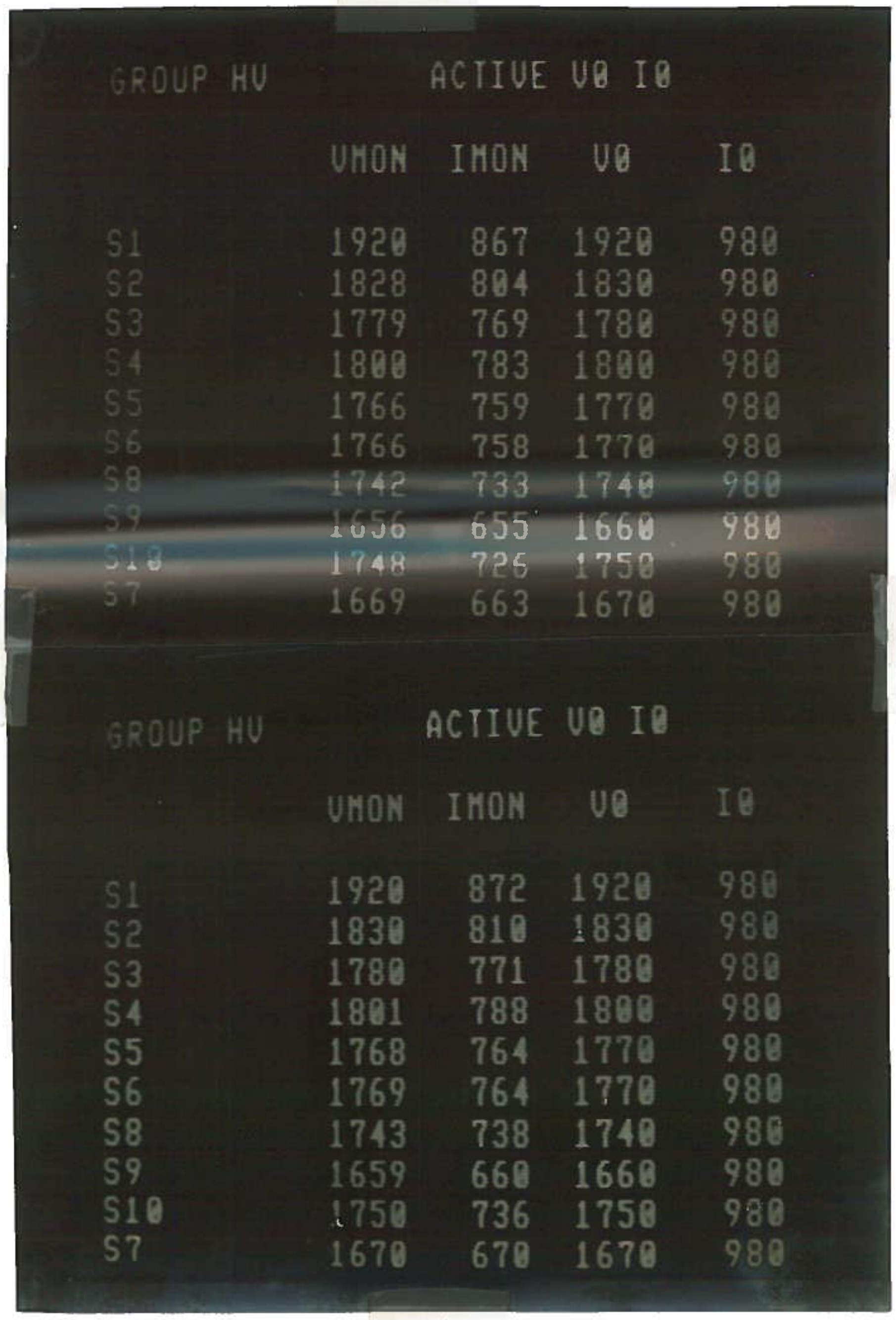


FIG. 4 - Photomultiplier assembly view during the preliminary test.

4. - PERFORMANCE CHECK

The results, obtained during the preliminar simulation tests, were also verified during the experiment [1].

The experimental apparatus was in operation for about 10 consecutive days at a pressure of 10 E-6 mbar. Throught this period the electrical stability was excellent: the feeding parameters, visualized on the monitor at a given time and 24 h later, are reported in fig. 5.



GROUP HV ACTIVE V0 I0

	VMON	IMON	V0	I0
S1	1920	867	1920	980
S2	1828	804	1830	980
S3	1779	769	1780	980
S4	1800	783	1800	980
S5	1766	759	1770	980
S6	1766	758	1770	980
S8	1742	733	1740	980
S9	1656	655	1660	980
S10	1748	726	1750	980
S7	1669	663	1670	980

GROUP HV ACTIVE V0 I0

	VMON	IMON	V0	I0
S1	1920	872	1920	980
S2	1830	810	1830	980
S3	1780	771	1780	980
S4	1801	788	1800	980
S5	1768	764	1770	980
S6	1769	764	1770	980
S8	1743	738	1740	980
S9	1659	660	1660	980
S10	1750	736	1750	980
S7	1670	670	1670	980

FIG. 5 - Monitored data of electrical parameters visualized at two different time (24 h).

A typical pulse form, obtained during the run (i.e. with beam on), is shown in fig. 6. The pulse amplitude is between -0.8 V and -1.2 V and the total ripple is smaller than 30 mV.

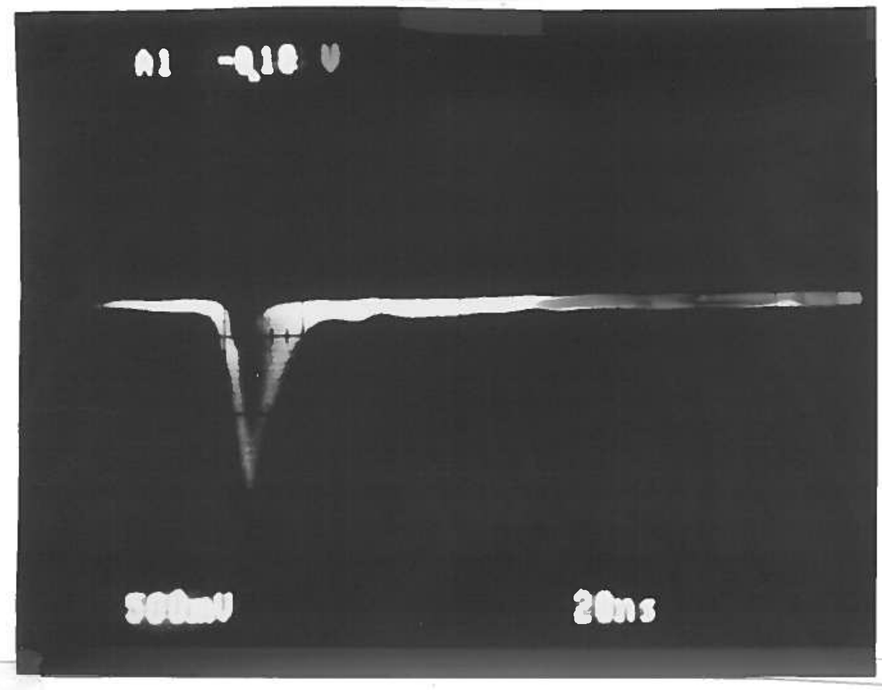


FIG. 6 - Typical pulse form.

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[2] G. Bizard et al., Nucl. Instr. and Meth. A 244(1986) 483
[3] J. Julien, Proc. Third Int. Conf. On Nuclear Reaction Mechanism,
[4] Thorn EMI Bury Street Ruislip Middlesex HH 41 TA ENGLAND
[5] NUCLEAR ENTERPRICE LIMITED BATH ROAD, BEENHAM, READING RG7 5PR, ENGLAND
[6] FI-M-ST 83 | 243 lf GSE 124-3 MAGASINS CERN
[7] Mechanical frame was designed by C. Rapicavoli I.N.F.N. - Sezione di Catania.