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**INFLUENCE OF MAGNETIC FIELDS ON THE RESPONSE OF  
ACRYLIC SCINTILLATORS**

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INFLUENCE OF MAGNETIC FIELDS ON THE RESPONSE  
OF ACRYLIC SCINTILLATORS

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We have measured the light output  $L$  of a type of commercially available acrylic scintillator as a function of the applied magnetic field  $B$  up to 2 KG.  $L$  is found to increase by about 7% at 2 KG and a change by 5% is already observed at 100 G.

1. - INTRODUCTION

The magnetic-field dependence of the light emission in organic scintillators is known(1) and it has been determined in the case of anthracene(2), NATON136(3) and NE235(4). Since the measured yield

and absolute value of the change are quite different for different materials, we had to find out the sensitivity to magnetic fields of the acrylic scintillators(5) we use as active medium in the hadron calorimeter of CDF(6). In fact, the CDF scintillator-iron calorimeter is assembled around a solenoidal magnet and is also used to partially return the magnetic flux. However, the energy calibration of all the calorimeter towers was determined in a test beam without any magnetic flux passing through. In order to carry the energy calibration from the test beam to the experiment, where the calorimeter is magnetized, we measure the d.c. current induced by a 1 mC  $^{137}\text{Cs}$  source that can be driven inside all the calorimeter towers.

To assess the true energy calibration, it is necessary to distinguish which fraction of the B-induced changes is due to L variations and which is due to the curling in the magnetic field of the Compton-electron produced by the  $^{137}\text{Cs}$   $\gamma$ 's. At the same time it is important to disentangle between the prompt scintillator fluorescence (in the experiment pulses are integrated over 400 ns) and the delayed one (that is accounted for in the d.c. current measurement).

## 2. - DESCRIPTION OF THE MEASUREMENTS AND RESULTS

Three complementary measurements have been performed:

a) First of all, to see if any field effect was noticeable, a  $10 \times 5 \times 1$  cm<sup>3</sup> scintillator was put in the uniform field of a dipole magnet. The scintillator was viewed (as in CDF) by a photomultiplier EMI

9954 via a 5 mm thick and 1 cm high WLS bar(7). The 2 mt long WLS bar, facing one  $10 \times 1 \text{ cm}^2$  scintillator side, was well extending out of the dipole. A point-like  $1 \text{ mC}^{60}\text{Co}$  source was put at a distance of a few millimetres in the centre of one of the  $10 \times 5 \text{ cm}^2$  faces of the scintillator. The PM current produced by the radioactive source was measured while changing the magnetic field value.

To disentangle between scintillator sensitivity to magnetic fields and the contribution due to changes of the Compton-electron trajectories in the magnet, this measurement was repeated with the scintillator tightly wrapped in a 5mm thick Pb foil. In fact, with no field Compton-electrons leaving the scintillator will not return. At increasing fields, Compton-electrons can return more to the scintillator if surrounded by air and should not with the Pb shielding.

Results are shown in fig.1. A strong increase of L vs. B is clearly

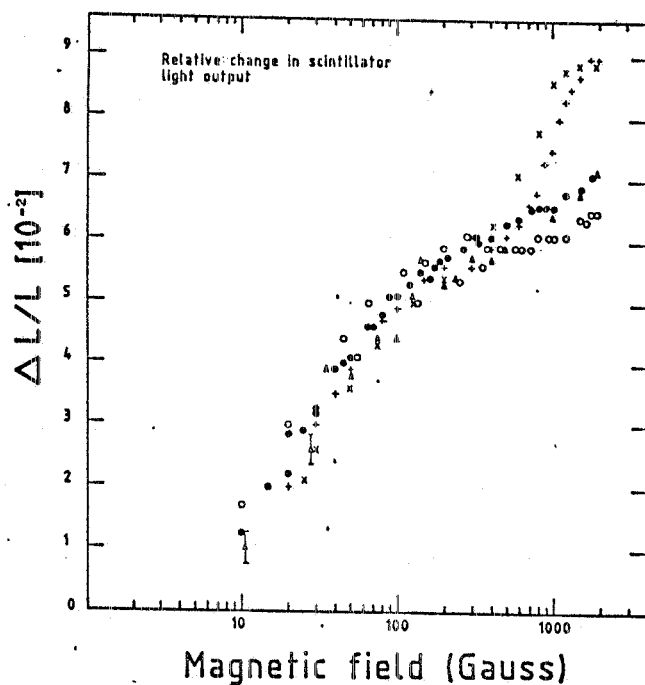


Fig. 1. Dependence of the scintillator light output on the applied magnetic field. x: WLS, no Pb, B//,  $^{60}\text{Co}$  as explained in the text. +: WLS, no Pb, B⊥,  $^{60}\text{Co}$ . o: WLS, Pb, B⊥,  $^{60}\text{Co}$ . •: no WLS, Pb, B⊥,  $^{60}\text{Co}$ . Δ: no WLS, no Pb, B//, 50 GeV  $\pi$ .

indicated. The comparison of data with (o) and without Pb (x indicate a measurement with B parallel to the irradiated face, + are data taken with B perpendicular) show that at about 500 G the curling of Compton-electrons is a not negligible effect (the bending radius, a few centimetres, becomes comparable to the scintillator size). These data also show that the L increase depends, as expected, on |B| only.

B) To see if the measured L increase is due to scintillator or to WLS changes, the above measurement, with Pb wrapping, was repeated by coupling the  $5 \times 1 \text{ cm}^2$  face of the scintillator to the PM with a  $5 \times 5 \text{ cm}^2$  PMMA bar, 2 mt long.

The result in fig.1 shows that the L increase is due to the scintillator only. The .5% difference observed at the highest field might be explained by the fact that the scintillator and the WLS give about the same signal when irradiated with a radioactive source. In this condition, since the the WLS volume was 10% of the total exposed volume, a 6.5% change of the scintillator light output becomes a 6% overall change. At smaller fields, this difference is hardly noticeable in the systematics.

C) To determine which fraction of the L increase is due to prompt fluorescence, the scintillator response [in the same configuration as in B)] was measured by exposing it to 50 Gev  $\uparrow$  in the X7 beam of the SPS. The counter was put inside a dipole magnet in the beamline. The PM charge generated upon passage of a single particle was integrated in a 400 ns wide gate, for several magnetic field values.

As shown in fig.1, the data reproduce exactly the points measured with the  $^{60}\text{Co}$   $\gamma$ -source, thus indicating a negligible delayed fluorescence contribution.

### 3. - CONCLUSIONS

The increase of the light output of acrylic scintillators has been measured as a function of B. The effect can be tracked with very little error by a d.c. measurement of the current induced by a radioactive  $\gamma$ -source.

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- 5) manufactured by Polivar, Pomezia, Italy. The scintillator base is PMMA to which is added 8% naphthalene, 1% butyl-PBD and 0.01% POPOP
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- 7) PMMA doped with 30mg/litre of Laser Dye 481, manufactured by Polivar.