

Liquid scintillator tiles for high radiation environments

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Abstract

Future experiments in high energy and nuclear physics may require large, inexpensive calorimetry that can operate to doses of 50 Mrad or more. We present the results of a study of a scintillator tile based on EJ-309 liquid scintillator using cosmic rays, test beam, and ⁶⁰Co irradiations.

Keywords: organic scintillator, liquid scintillator,, radiation hardness, calorimetry

1. Introduction

Sampling calorimeters using plastic scintillator tiles with wave length shifting fibers, such as the CDF plug calorimeter [?], are popular due to their suitable performance at a reasonable cost. Plastic scintillator is available commercially
5 from companies like Kuraray, St. Gobain, and Eljen. When irradiated, however, the performance of plastic scintillator deteriorates; light self-absorption (yellowing) increases and light output decreases. The resulting damage has been studied for most common plastics[1], [2], [3], [4],[5],[6],[7],[8]. Generally,

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the light output decreases with exponentially with dose, with an decay constant
on order of a few Mrad. Future high energy and nuclear experiments, however,
may have to operate in environments that will deliver doses of tens of Mrad. In
this paper, we present the design and optimization of a liquid scintillator tile,
based on EJ-309 liquid scintillator, that can operate in thie kind of environment.

2. Tile design

Our tile is based on EJ-309 scintillator, from Eljen Technology, and is based on naphthalene with wavelength shifting additives. It has a light output that is 75% of anthracene, a wavelength of maximum emission of 424 nm, a refractive index of 1.57 and a flash point of 144°C. It's low flash point is important for its suitability for a collider environment.

The design of tile to hold the liquid needs to consider light collection efficiency, light collection uniformity, and cost. The container should not leak and there should not be interactions between the container and its contents that degrade the light output over time. Figure 1 shows the mechanical constructure.

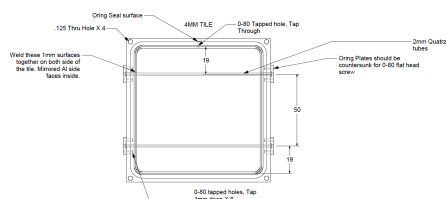


Figure 1: Mechanical design of a liquid scintillator tile.

3. Tile Simulation

25 We use the GEANT4 package

4. Test beam results

5. Light yield dependence on tile parameters and comparison with simulation

6. Radiation hardness tests

30 Performance of the tile under irradiation in a proton-proton collision environment will be the subject of a future paper.

7. Conclusions

8. Acknowledgements

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