# Tests of the radiation hardness of scintillators in a high energy proton-proton collider environment

Joshua Kunkle[a,*], Alberto Belloni[a], Jeff Calderon[a], Pawel De Barbaro[f], Sarah C. Eno[a], Kenichi Hatakeyama[d], Geng-Yuan Jeng[a], Julie Schnurr[a], Yao Yao[a], Sung Woo Youn[b]

[a] *Dept. Physics, U. Maryland, College Park MD 30742 USA*
[b] *Institute for Basic Science, Center for Axion and Precision Physics Research, IBS Center for Axion and Precision Physics Research Room 4315, Department of Physics, Natural Science Building (E6-2), KAIST, 291 Daehak-ro, Yuseong-gu, Daejeon 305-701, South Korea*
[c] *Fermi National Accelerator Laboratory, Batavia, IL, USA*
[d] *Baylor University, Waco, Texas, USA*
[e] *The University of Iowa, Iowa City, IA, USA*
[f] *The University of Rochester, Rochester, NY, USA*

**Abstract**

Radiation damage to the attenuation length and light output of scintillating materials may depend not just on the deposited energy, but also on the dose rate and the type and energy of the interacting particle. We present the results of measurements of the damage to several different types of scintillating material irradiated in the CMS collision hall at the Large Hadron Collider. The materials received a dose of xxx over a person of xxx months. The light output was measured at several intermediate doses.

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

## 1. Introduction

Radiation damage to the attenuation length and light output of scintillating materials may depend not just on the deposited energy (dose), but also on the dose rate and the type and energy of the interacting particle. We present the

*Corresponding author
*Email address:* jkunkle@cern.ch (Joshua Kunkle)

results of measurements of the damage to several different types of scintillating material irradiated in the CMS collision hall at the Large Hadron Collider (LHC) during its operation at a center-of-mass energy of 13 TeV during 2015. The materials received a dose of xxx over a person of xxx months. Their light output was measured at several intermediate doses. Irradiation in the collision hall of a running high energy proton-proton collider allows access to very low dose rates that would not be affordable at reactors, electron linacs, and $^{60}$Co sources, with a particle type and energy spectrum most appropriate for those designing detectors for hadron colliders.

In-situ tests are of particular interest, as several experiments have found unexpected large radiation damage in operation compared to expectations based on irradiations using reactors, linacs and $^{60}Co$ sources. In the CDF experiment, scintillators placed close to the beam line received much larger damage than expected [1]. During the running of the LHC from its commissioning in 2009 through 2012, the CMS detector was exposed to an integrated luminosity of 25 fb$^{-1}$. Parts of the CMS endcap calorimeter are estimated to have received doses of 0.1 to 0.2 Mrad [2]. Studies of the radiation hardness of scintillator tiles prior to installation in the detector, using an electron linac and $^{60}$Co sources, indicated an exponential reduction in light output with accumulated dose, with a exponential constant of around 7 Mrad [3, 4]. However, although the dose received by the CMS tiles was small compared to this number, significant light loss was observed [5].

However, experiments using scintillator at HERA saw damage consistent with expectations.

One possible explanation is dose rate effects.

Another possible explanation is damage that is dependent on particle type and energy.

## 2. Tile designs

## 3. Radiation parameters

## 4. Measurement techniques

## 5. Results

## 6. Conclusions

We presented results on radiation damage to scintillating materials in

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