HORIZON 2020

RESEARCH INFRASTRUCTURES

H2020-INFRAIA-2014-2015

INFRAIA-1-2014-2015 INTEGRATING AND OPENING EXISTING NATIONAL AND REGIONAL RESEARCH INFRASTRUCTURES OF EUROPEAN INTEREST

ENSAR2

EUROPEAN NUCLEAR SCIENCE AND APPLICATION RESEARCH 2

GRANT AGREEMENT NUMBER: 654002

M3.0 - CRYSTAL CHARACTERIZATION

Version: V1
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Date: 16.02.2017

PROJECT AND DELIVERABLE INFORMATION SHEET

ENSAR2 Project Ref. №	654002
Project Title	European Nuclear Science and Application Research 2
Project Web Site	http://www.ensarfp7.eu/
Milestone ID	M3.0
Deliverable Nature	Report
Deliverable Level*	PU
Contractual Date of Delivery	Month 12
Actual Date of Delivery	Month 12
EC Project Officer	

* The dissemination level are indicated as follows: PU – Public, PP – Restricted to other participants (including the Commission Services), RE – Restricted to a group specified by the consortium (including the Commission Services). CO – Confidential, only for members of the consortium (including the Commission Services).

DOCUMENT CONTROL SHEET

Document	Title: Status of New Scintillator Materials and their basic characterization	
	ID: M3.0	
	Version 1	
	Available at: http://www.ensarfp7.eu/	
	Software Tool: Microsoft Word for Mac	
	File: PASPAG-M3_0.docx	
Authorship	Written by:	O. Tengblad
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	Reviewed by:	
	Approved by:	

DOCUMENT STATUS SHEET

Version	Date	Status	Comments
		For internal review	
		For internal review	
		Submitted on EC Participant Portal	
		Final version	

Document Keywords

Keywords	Scintillator materials, CeBr, CLLB, CLLBC, CLYC, LaBr,

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This milestone has been prepared by Work Package 9 (PASPAG - Phoswich scintillator assemblies: Application to the Simultaneous detection of Particle and Gamma radiation) of the Project in accordance with the Consortium Agreement and the Grant Agreement n°654002. It solely reflects the opinion of the parties to such agreements on a collective basis in the context of the Project and to the extent foreseen in such agreements.

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REFERENCES AND APPLICABLE DOCUMENTS

[1]

LIST OF ACRONYMS AND ABBREVIATIONS

$LaBr_3$:Ce	A transparent scintillator material that offers the best energy resolution obtained so far.
$CeBr_3$	An alternative to LaBr, not exhibiting the internal radiation of La
CLYC	Cs_2LiYC_6:Ce crystal belonging to the elpasolite scintillator family
CLLB	$Cs_2LiLaBr_6$(Ce)) scintillator material sensitive to gamma and neutron radiation
CLLBC	$Cs_2LiLa(Br6)_{90\%}(Cl6)_{10\%}$ elpasolite crystal with excellent neutron and gamma radiation response

Executive Summary

In this JRA, we exploit novel scintillator materials and explore new techniques and concepts such as phoswich detectors and segmented or hybrid scintillators. We focus on developing the capability to simultaneously detect high-energy gamma rays, neutrons and charged particles. The emphasis is on a modular approach both in the scintillator crystals and photosensors as well as in the electronics where improved throughput and effective data processing will allow for compact scalable devices.

Introduction

The performances of new scintillator materials, and their possible use as detectors, are not well known and thus require specific characterization. The results of such studies are of particular interest not only for the researchers but especially for the producers of these materials in order to be able to make and sell detectors that can be commonly used in applications and not only for use by specialists of the field.

We identify here a number of new promising scintillator materials that recently have become commercially available, ie. materials that we are planning to further investigate in more detail during the PASPAG project.

This milestone is related to the deliverable D9.1 of Task 1 Novel Scintillator Materials. The work presented has mainly been performed by the participating groups of INFN (F. Camera) and CNRS (G. Hull) with some inputs from the rest of the collaboration.

Section 1 Crystal characterization

Some materials are completely new and most of these can only be obtained in small sized crystals, for these materials only basic characterization can be made like; energy resolution for low energy standard gamma sources. Other materials, however, have been on the market for some years, but can first now be obtained as bigger sized crystals and these crystals are now available for more advanced studies as useful detectors.

In the continuation we list the material and the investigation we plan to perform;

Existing materials that were bought in 2016;

$CeBr_3$ can now be obtained in large volumes (e.g. 3”x3”). These crystals should be studied for homogeneity, efficiency for high energy (10-100 MeV) gamma rays, internal activity, dead-time in high intensity flux.

$LaBr_3$:Ce These crystals are now available in very large volumes. The position sensitivity properties of a 3” x 3” in $LaBr_3$:Ce crystal will be studied for its possible use for doppler correction when detecting gamma rays emitted in flight. The response function of large volume detectors (e.g. crystals of 9 cm of diameter and 20 cm of length) has been measured for high and low energy gamma-rays (up to 40 MeV)

The elpasolite scintillator family http://prod.sandia.gov/techlib/access-control.cgi/2012/129951.pdf, are materials sensitive both to gamma and neutron radiation due to the content of Lithium.

Cs_2LiYC_6:Ce or CLYC maximum size 2"x2" could be obtained 2016, we expect larger volume ^{7}Li enriched CLYC scintillator (3" diameter - 3" height) to be available in late 2017.

CLYC-7 with 99% of ^{7}Li The fast neutron detection efficiency will be studied, cylindrical crystal 1"x1".

CLYC-6 with 95% of ^{6}LI The fast neutron detection efficiency will be studied, cylindrical crystal 1"x1".

Material expected to be available in 2017;

$Cs_2LiLaBr_6$(Ce) or CLLB

These crystals are expected to have an excellent energy resolution, good efficiency for thermal neutrons and a good neutron-gamma radiation response

CLLB, cylindrical crystal (1" x 1") was obtained by the collaboration early 2017

$Cs_2LiLa(Br6)_{90\%}(Cl6)_{10\%}$ or CLLBC

These crystals are expected to have a good energy resolution (comparable to that of LaBr3), efficiency for fast neutrons and a good neutron and gamma radiation response.

CLLBC cylindrical crystal (1" x 1") are expected to be available to us late 2017

Co-Doped $LaBr_3$:Ce cylindrical crystal (1" x 1") have been announced to be commercially available and therefore will be ordered in 2017.

It is reported that by co-doping the LaBr:Ce with any of Li+, Na+, Mg2+, Ca2+, Sr2+, and Ba2+ , one can tailor the response for different activity http://aip.scitation.org/doi/10.1063/1.4810848 ; eg. The energy resolution of LaBr3:Ce improves with Na, Ca, and Sr co-doping. The proportionality improves with Ca, Sr, and Ba co-doping.

Conclusion

A search for new scintillator materials has been performed. Some new materials have been identified as promising candidates for future gamma, neutron, and particle detectors. The features of these materials will be further investigated within the PASPAG project. Some results have already been reported in the deliverable D9.1.