[RIBF-ULIC-Symposium-005] The SHOGUN gamma-ray spectrometer

Report of Contributions

https://indico2.riken.jp/e/350

Contribution ID: **0** Type: **not specified**

The SHOGUN gamma-ray spectrometer

Friday 4 February 2011 10:25 (45 minutes)

Summary

I will introduce the SHOGUN gamma-ray spectrometer.

Primary author: Dr SCHEIT, Heiko (RIKEN Nishina Center)

Presenter: Dr SCHEIT, Heiko (RIKEN Nishina Center)

Session Classification: SHOGUN Introduction

Contribution ID: **2** Type: **not specified**

The PARIS project –status and next steps

Friday 4 February 2011 16:00 (45 minutes)

Summary

The PARIS (acronym for Photon Array for studies with Radioactive Ion and Stable beams) project aims at building an innovative gamma-array, playing the role of an energy-spin spectrometer, a calorimeter for high-energy photons and a medium-resolution γ-detector. The design of PARIS envisages a device using two shells: the most advanced scintillator technology, LaBr3(Ce) crystals, for the inner volume offering simultaneously high efficiency and relatively good energy resolution; and more conventional techniques, e.g. NaI crystals, for the outer shell.

In the talk the flag-ship physics cases driving the PARIS project will be reported, the status of the project will be presented and the most probably next steps will be discussed.

Primary author: Prof. MAJ, Adam (IFJ PAN)

Presenter: Prof. MAJ, Adam (IFJ PAN)

Session Classification: New and planned Arrays (1)

Contribution ID: **4** Type: **not specified**

Recent advancements in inorganic scintillator detectors

Friday 4 February 2011 13:30 (45 minutes)

Summary

The presentation will report on the last advancements in inorganic scintillator detectors. After discussing the basic concepts of scintillation in inorganic materials and their relations to scintillation performance, an overview of the current leading scintillators will be presented. Special emphasis will be given to scintillators that match the requirements for the next generation gamma-ray spectrometer for fast beams at the RIBF such as LaBr3:Ce3+ or the newly discovered halide scintillators such as CsBa2I5:Eu2+, BaBrI:Eu2+ and SrI2:Eu2+.

Primary author: Dr BIZARRI, gregory (Lawrence Berkeley National Laboratory)

Presenter: Dr BIZARRI, gregory (Lawrence Berkeley National Laboratory)

Session Classification: Recent Scintillator Developments

Contribution ID: **5** Type: **not specified**

Scintillator Materials for Gamma Ray Spectroscopy

Friday 4 February 2011 14:15 (45 minutes)

Summary

Over the past five years, our scintillator materials group has explored many new scintillators for gamma spectroscopy applications. This search and discovery program led us to our current work on the development and commercialization of two materials that offer high resolution gamma spectroscopy: Eu-doped Strontium Iodide single crystals (energy resolution, R = 2.8% at 662 keV), and Ce-doped Gadolinium Garnet transparent ceramics (R = 3.9% at 662 keV with APD readout). The discussions with RIKEN staff and international collaborators will allow us to further specify the relative importance of requirements related to energy resolution, timing, stopping power, radiation hardness, geometry, and mechanical properties, and compare the properties of scintillator materials to identify to most suitable candidate(s) for this application.

Primary author: Dr CHEREPY, Nerine (Lawrence Livermore National Laboratory)

Presenter: Dr CHEREPY, Nerine (Lawrence Livermore National Laboratory)

Session Classification: Recent Scintillator Developments

Contribution ID: **6** Type: **not specified**

Development of an 8 x 8 array of LaBr3(Ce) pixels for a gaseous Compton gamma-ray camera

Saturday 5 February 2011 10:00 (45 minutes)

Summary

For Mev and sub-MeV gamma-ray astronomy or medical imaging, we have developed an electron-tracking Compton camera (ETCC) consisting of a gaseous Time Projection Chamber (TPC) and a scintillator. The TPC measures the three-dimensional track and energy of a Compton recoil-electron, while the scintillator measures the energy and position of the scattered gamma ray. Therefore, the ETCC is able to reconstruct Compton scattering event-by-event.
Since the angular resolution of the camera depends on an energy resolution of the scintillator, we have adopted a LaBr3(Ce) that has an excellent energy resolution. We have developed an 8 x 8 array of the LaBr3(Ce) pixels with a pixel size of 5.8 mm x 5.8 mm x 15.0 mm (or 20.0 mm) in order to have position sensitivity for gamma rays. The array was coupled to an 8 x 8 multi-anode PMT (Hamamatsu H8500), and the pixel size was as the same as the anode size. The energy resolution of the array reached 5.2±0.6% (FWHM) at 662 keV. Using the LaBr3(Ce) arrays, the ETCC had an angular resolution of 4.2±0.3 degrees (FWHM) at 662 keV.

Primary author: Mr KUROSAWA, Shunsuke (Kyoto University)

Co-authors: Dr TAKADA, Atsushi (Kyoto University); Dr PARKER, D. Joseph (Kyoto University); Dr KUBO, Hidetoshi (Kyoto University); Mr UENO, Kazuki (RIKEN); Dr MIUCHI, Kentaro (Kyoto University); Mr NAKAMURA, Kiseki (Kyoto University); Mr TANIUE, Kojiro (Kyoto University); Mr HIGASHI, Naoki (Kyoto University); Mr IWAKI, Satoru (Kyoto University); Dr KABUKI, Shigeto (Kyoto University); Mr SAWANO, Tatsuya (Kyoto University); Dr TANIMORI, Toru (Kyoto University); Mr MATSUOKA, Yoshihiro (Kyoto University); Dr KISHIMOTO, Yuji (Kyoto University)

Presenter: Mr KUROSAWA, Shunsuke (Kyoto University)

Session Classification: New and planned Arrays (2)

Contribution ID: **7** Type: **not specified**

Opening

Friday 4 February 2011 10:00 (5 minutes)

Presenter: Dr SCHEIT, Heiko (RIKEN Nishina Center)

Contribution ID: **9** Type: **not specified**

In-beam isomer spectroscopy with LaBr3 crystal

Saturday 5 February 2011 14:00 (30 minutes)

Summary

Doppler broadening, which is one of the problems in in-beam gamma-ray spectroscopy in inverse kinematics, should be considered more seriously in the case where the gamma rays from short-lived isomer states with a lifetime of a few nanoseconds are detected. Decay points are distributed along the path of the particle, while such information is mandatory for complete correction of the energy spectrum for Doppler broadening effects. In this short talk, firstly an example (real data) of the energy spectrum obtained by detecting such retarded gamma rays (ground transition of the first excited 5/2+, 0.74 MeV state in 15C with a halflife of 2.61 ns) is shown. Secondly it will be shown how we can recover the energy resolution thorught identifying the decay points by using high timing resolution crystal like LaBr3, whose timing resolution is of the order of 0.2 ns. The second part is based on a Monte Carlo simulation study using GEANT code.

Primary author: Mr HWANG, Jongwon (Department of Physics and Astronomy, Seoul National University)

Presenter: Mr HWANG, Jongwon (Department of Physics and Astronomy, Seoul National University)

Session Classification: New and planned Arrays (3)

Contribution ID: **10** Type: **not specified**

Radiation Detection with Emerging Scintillators*

Friday 4 February 2011 15:00 (30 minutes)

Summary

The quest for new "super"scintillators, with significantly better energy and timing characteristics to replace the workhorse crystals of past decades is a work in progress. While the recent advent of LaBr3:Ce is a positive development, the high cost of growing large crystals of LaBr3 provides justification for continued R&D in this arena. We report here on our studies of three new scintillators for nuclear physics applications: (i) CeBr3, (ii) Cs2LiYCl6 (CLYC), and (iii) Cs2LiLaBr6 (CLLB). The crystals (~1 cm X ~1 cm) were coupled to Hamamatsu H6610 fast phototubes. Energy and time resolutions were measured with standard gamma calibration sources, using a multi-channel analyzer, as well as a CAMAC-based multi-parameter data acquisition system for extracting energy-gated parameters. A time resolution of 120 ps was obtained for two CeBr3 scintillators detecting back-to-back 511-keV positron annihilation photons. Electronic timing measurements were carried out with a 152Eu source, with excellent results obtained for the 1.4 ns half-life of the 2+ state of 152Sm populated in the decay sequence. Sub-nanosecond measurements are in progress. For the CLYC and CLLB detectors, in addition to energy and time resolution, the capability of these detectors in distinguishing between neutron and gamma signals through pulse shape discrimination was studied. Raw waveforms were captured, with subsequent digital signal processing. Following initial tests with a PuBe source, thermal neutron tests at our on-campus 1-MW research reactor facility are in progress. Fast neutron tests, as well as tests in coincidence with Ge detectors are also planned.

*Work supported by the U.S. Department of Energy.

Primary author: CHOWDHURY, P. (University of Massachusetts Lowell)

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Presenter: CHOWDHURY, P. (University of Massachusetts Lowell)

Session Classification: Recent Scintillator Developments

Contribution ID: **11** Type: **not specified**

Characterisation of LaBr3(Ce) Performance for PARIS

Friday 4 February 2011 16:45 (30 minutes)

Summary

The Photon Array for the study of Radioactive and Ion Stable beams (PARIS) is a worldwide collaboration, the aim of which is to construct the next generation gamma-ray calorimeter using high resolution LaBr3(Ce) scintillators. Consequently, a thorough investigation into the proposed detection methods was simulated and tested. This presentation will predominately focus on two methods; the response with novel SensL SiPMs and a unique LaBr3(Ce)/CsI(Na) phoswich set-up.

Initial investigations with a 4x4 SiPM array of 3.2mmpixels of the response of the sensitivity with various LEDs was conducted, to determine the spectral range of the detector (max = 520 nm). After observing excellent response with a green LED, the temperature response was subsequently tested between 2 and 30 C with a copper heat sink, where a linear dependence between temperature and energy resolution is presented. However, when the detector was coupled to a well-matched 1" CsI(Tl) scintillator and tested with a standard 137Cs calibration source, no resolution of the 662 keV photo-peak could be obtained due to a high amount of cross-talk and noise, when using all 16 pixels.

Due to the high cost of LaBr3(Ce), two layers of scintillators; 1"-2"of LaBr3(Ce) at the front (for timing purposes), followed by an outer layer acting as a high energy gamma-ray absorber, were tested. The study of the 1"x1"x2"LaBr3(Ce) and 1"x1"x6"CsI(Na) phoswich detector with a standard AmBe source was conducted to study the pulse shapes from neutron and gamma-ray sources, subsequently used to show that (n,gamma) discrimination was not possible without ToF methods. Consequently, an activated spectrum from a 241Am/9Be source was acquired where neutron activation due to excited states of Lanthanum and Bromine (140La, 80Br and 82Br) were found. The timing response of the phoswich was also measured and found to be appx. 690 ps when used in a start-stop set-up with BaF2, where an improvement of around 40 ps was achieved by optimising the timing loop. Pile-up measurements using hot and weak 57Co sources, revealed a threshold in the counting rate of appx. 800 kHz. An experimental set-up involving a proton beam to probe resonances in the 27Al(p,gamma)28Si reaction was also studied to observe the linearity of the detector at high energies, as well as test pulse shape techniques using several charge-to-digital (QDC) modules. These results are presented and commented upon.

Primary author: Dr ROBERTS, Oliver (University of Brighton)

Co-authors: Dr FINCK, Christian (IPHC Strasbourg); Dr JENKINS, David (University of York); Dr ROUSSEAU, Marc (IPHC Strasbourg); Dr DORVAUX, Olivier (IPHC Strasbourg); Dr JOSHI, Pankaj (University of York)

Presenter: Dr ROBERTS, Oliver (University of Brighton)

Session Classification: New and planned Arrays (1)

Contribution ID: **12** Type: **not specified**

NaI(Tl) array for in-beam gamma-ray spectroscopy -DALI2-

Friday 4 February 2011 11:30 (30 minutes)

Summary

We have developed the NaI(Tl) array (DALI2) for high efficient measurements in in-beam gamma-ray spectroscopy experiments performed at RI Beam Factory. The design policies of DALI2 are to have high efficiency and high angular resolution by using 160-186 NaI(Tl) detectors, which enable to have a large solid angle and an averaged angular resolution of 9 degree.
The efficiency and energy resolution are obtained to be about 20% and 10%(FWHM) for 1 MeV gamma ray emitted from moving nuclei with beta~0.6, respectively.
By using DALI2, we have performed various experiments such as Coulex, (p,p'), and removal reaction at RIPS and BigRIPS beam line.
I will present the details of DALI2 and the experimental results.

Primary author: Dr TAKEUCHI, Satoshi (RIKEN Nishina Center)

Presenter: Dr TAKEUCHI, Satoshi (RIKEN Nishina Center)

Session Classification: SHOGUN Introduction

Contribution ID: **13** Type: **not specified**

Dipole Response of Exotic Nuclei and Neutron Skin – Possible Experiments for a next generation LaBr3(Ce) scintillator based setup at RIBF

Saturday 5 February 2011 15:35 (35 minutes)

Summary

In the last years the study of the giant resonance response, in particular the pygmy dipole state in neutron rich nuclei as produced in radioactive beams has provided the first interesting experimental results. Such experiments requires high efficiency and well designed arrays. Future experiments in this field will benefit from the availability of higher beam intensity and improved experimental set ups.

One of the techniques which can be used in these studies is the virtual photon scattering technique followed by gamma decay.

This technique was used to study the Pygmy Dipole Resonance (PDR) in 68Ni with an experiment at GSI using the FRS and the RISING setup.

New experiments to investigate further the properties of the pygmy dipole resonance are expected to be made. The objective of future measurements is to use more exotic beams, get a more detailed information on the isovector nature and on the fine structure of the PDR (above and below the particle emission threshold). For this a new, high gamma-efficient and high resolution gamma ray detection array combined with beam tracking is essential.

For detection of high energy gamma-rays after virtual photon scattering at bombarding energies of around 250 MeV/nucleon the SHOGUN array combined with BigRIPS-ZDS for beam identification meets these requirements. It has to be noted that this approach is complementary to the neutron break up technique, which will be employed in the future SAMURAI setup at RIKEN.

We present plans for future gamma decay experiments of the PDR in radioactive neutron rich nuclei. The particular cases we are interested in concern the nuclei along the Ni and Zr -chain, which are expected to be good key cases to study the nature and properties of the dipole response in neutron rich nuclei. In fact, these studies are natural follow ups of the previous work for 68Ni for which the comparison with theory deduces an estimate of the size of neutron skin.

Primary author: Dr WIELAND, Oliver (INFN sezione di Milano)

Co-authors: COLO, Gianluca (University of Milan and INFN sezione di Milano); LEONI, Silvia (University of Milan and INFN sezione di Milano)

Presenter: Dr WIELAND, Oliver (INFN sezione di Milano)

Session Classification: Physics Opportunities, New Ideas, Discussion

Contribution ID: **14** Type: **not specified**

CAESAR-A high-efficiency scintillator array for gamma-ray spectroscopy

Saturday 5 February 2011 10:45 (45 minutes)

Summary

The CAESium iodide ARray consists of 192 CsI(Na) scintillation detectors totaling 290kg of active material. This device is designed for in-beam gamma-ray spectroscopy utilizing fast beams of rare isotopes at NSCL/MSU. For 1MeV gamma rays the full-energy-peak efficiency is 35% and an energy resolution better than 10% FWHM after event-by-event Doppler reconstruction of the gamma rays emitted by nuclei moving with velocities of v/c ~ 0.3-0.4 was achieved. The spectral quality of CAESAR will be presented. Furthermore results obtained with LaBr detectors in test measurements will be shown.

Primary author: Dr WEISSHAAR, Dirk W (NSCL/MSU)

Presenters: Dr MACCHIAVELLI, Augusto (Nuclear Science Division - Lawrence Berkeley National Laboratory); Dr WEISSHAAR, Dirk W (NSCL/MSU)

Session Classification: New and planned Arrays (2)

Contribution ID: **15** Type: **not specified**

R&D on large volume LaBr3:Ce detectors

Saturday 5 February 2011 14:30 (35 minutes)

Summary

The availability of large volume LaBr3:Ce detectors has generated, in the scientific community addressing nuclear structure problems with experiments using scintillator, a large interest. Indeed, its properties make it the best scintillation crystal for -detection and -spectroscopy and a possible alternative or complementary system to HPGe array.
The group of Milano has been conducting since 2007 an R&D activity on these detectors. The activity is focused to the construction of an array of large volume 3.5"x 8"LaBr3:Ce detectors for -spectroscopy in nuclear structure experiments. Inside this project the following activities are carried out:

- Linearity, energy and time resolution for different PMTs
- Response to high energy gamma rays measured up to 15.1 MeV
- Internal radioactivity measurement
- Pulse Shape Analysis (PSA) for linearity correction
- Pulse Shape Analysis (PSA) for particle identification measurements
- Digital/Analogical board development
- Position Sensitivity and gamma imaging in a continuous crystal
- GEANT simulations and scintillation light tracking

A summary of these activities and an overview of the results will be presented.

Primary author: Prof. CAMERA, Franco (Università di Milano and INFN sect. of Milano)

Co-authors: Prof. BRACCO, Angela (Università di Milano); Dr MILLION, Benedicte (INFN sect. of Milano); Mr BOIANO, Ciro (INFN sect. of Milano); Dr BLASI, Nives (INFN sect. of Milano); Dr WIELAND, Oliver (INFN sect. of Milano); Dr BRAMBILLA, Sergio (INFN sect. of Milano); Dr RIBOLDI, Stefano (Università di Milano)

Presenter: Prof. CAMERA, Franco (Università di Milano and INFN sect. of Milano)

Session Classification: New and planned Arrays (3)

Contribution ID: **16** Type: **not specified**

Lifetime Measurements with SHOGUN

Saturday 5 February 2011 16:45 (25 minutes)

Summary

In present in-beam gamma-ray experiments with high-resolution Ge-spectrometers at intermediate energies, the lifetime of excited states can be obtained employing a plunger and the recoil distance Doppler shift method. For next-generation Ge-spectrometer such as AGATA or GRETINA, the increased energy resolution permits a detailed study of the observed lineshapes depending on the lifetime of an excited state. In my talk I will demonstrate that the envisaged energy resolution of the SHOGUN spectrometer of three percent is sufficient for many cases to be sensitive for lifetime measurements.

Primary author: Dr DOORNENBAL, Pieter (RIKEN)

Presenter: Dr DOORNENBAL, Pieter (RIKEN)

Session Classification: Physics Opportunities, New Ideas, Discussion

Contribution ID: **17** Type: **not specified**

Status of SHOGUN Spectrometer Simulations

Friday 4 February 2011 11:10 (20 minutes)

Summary

A simulation toolkit based on the frameworks ROOT and GEANT4 has been developed for the SHOGUN spectrometer. The toolkit is designated for the simulation of fast in-beam gamma-ray spectroscopy experiments and includes important details as atomic background, target energy-loss, and the lifetimes of excited states. Different SHOGUN configurations can be tested in order to find the optimum configuration for an envisaged experiment. In my presentation I will give an overview of the simulation status and discuss issues that need to be addressed.

Primary author: Dr DOORNENBAL, Pieter (RIKEN)

Presenter: Dr DOORNENBAL, Pieter (RIKEN)

Session Classification: SHOGUN Introduction

Contribution ID: **18** Type: **not specified**

Probing two-nucleon correlations using knockout reactions & possible use of the SHOGUN

Saturday 5 February 2011 17:10 (25 minutes)

Summary

Reactions involving the direct and sudden removal of a pair of like or unlike nucleons from a fast projectile beam are suggested as sensitive probes for two-nucleon correlations. Coupled with reaction and structure theories, the measured two-nucleon removal cross sections and momentum distributions would give quantitative evaluations of the correlated many-body wave functions. The physics cases and the possible use of SHOGUN in accompany with other detection systems for such measurement will be discussed.

Primary author: Dr LEE, Jenny (RIKEN)

Presenter: Dr LEE, Jenny (RIKEN)

Session Classification: Physics Opportunities, New Ideas, Discussion

Contribution ID: **19** Type: **not specified**

CALIFA a calorimeter for the R3B/FAIR experiment

Saturday 5 February 2011 09:00 (45 minutes)

Summary

CALIFA (CALorimeter of In Flight emitted pArticles) is a gamma and light charged particle detector, based on scintillation crystals, that will surround the target of the R3B experiment at FAIR. CALIFA has to act as total absorption gamma calorimeter and spectrometer, as well as identifier of charged particles emitted from reaction residues when operating in coincidence with the R3B tracking target recoil detector. This versatility is its most challenging requirement, demanding a huge dynamic range. Moreover, its granularity should be adapted to the relativistic energies that will be used in the experiment. The conceptual design and technical solutions proposed for the construction of CALIFA will be presented here.

Primary author: CORTINA, Dolores (Universidad de Santiagio de Compostela)

Presenter: CORTINA, Dolores (Universidad de Santiagio de Compostela)

Session Classification: Lola special

Contribution ID: **20** Type: **not specified**

Neutron Capture Study and LaBr3 spectrometer

Saturday 5 February 2011 11:30 (45 minutes)

Summary

First, current neutron capture study in the field of nuclear engineering is reviewed. A LaBr3 spectrometer is expected to be a powerful tool for determining neutron capture cross sections. In order to design a next generation spectrometer, performances of a LaBr3 detector to high energy gamma rays were studied, and the performance of 4pai type LaBr3 spectrometer were simulated. These results will be presented.

Primary author: Dr HARADA, Hideo (Japan Atomic Energy Agency)

Presenter: Dr HARADA, Hideo (Japan Atomic Energy Agency)

Session Classification: New and planned Arrays (2)

Contribution ID: **23** Type: **not specified**

Gamma-ray spectroscopy of hypernuclei with Hyperball-J at J-PARC

Saturday 5 February 2011 13:15 (45 minutes)

Summary

A new Ge detector array dedicated to gamma-ray spectroscopy of hypernuclei with a strangeness degree of freedom has nearly been constructed. This array, aka Hyperball-J, will be installed as soon as this fall at the K1.8 beam line of J-PARC for the gamma-ray spectroscopy of light lambda hypernuclei such as 4He-lambda and 19F-lambda in its inaugural run. Hyperball-J has some features that are unconventional in Ge arrays for gamma-ray spectroscopy of non-strange nuclei. In this presentation, physics that can be accessed via the hypernuclar spectroscopy will be discussed together with description of Hyperball-J. Also a possible use of high resolution and high efficiency scintillators for detecting lambda inter-shell transitions of lambda hypernuclei in the sd-shell will be mentioned.

Primary author: Dr KOIKE, takeshi (Tohoku University)

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Presenter: Dr KOIKE, takeshi (Tohoku University)

Session Classification: New and planned Arrays (3)

Contribution ID: **24** Type: **not specified**

Short Introduction of the RIBF

Friday 4 February 2011 10:05 (20 minutes)

Presenter: Dr SAKURAI, Hiroyoshi (RIKEN Nishina Center for Accelerator-Based Science)

Contribution ID: **25** Type: **not specified**

Possible use of SHOGUN spectrometer for the studies of hyperdeformed nuclei

Saturday 5 February 2011 17:35 (25 minutes)

Summary

I would like to discuss a possible use of SHOGUN spectrometer combining with Ge detectors in order to search for hyperdeformed nuclei.

Primary author: Dr IDEGUCHI, Eiji (CNS, University of Tokyo)

Presenter: Dr IDEGUCHI, Eiji (CNS, University of Tokyo)

Session Classification: Physics Opportunities, New Ideas, Discussion

Contribution ID: **26** Type: **not specified**

Potential isomeric-decay spectroscopy with Ge-LaBr3 hybrid array

Saturday 5 February 2011 16:10 (35 minutes)

Primary author: Dr WATANABE, Hiroshi (RIKEN)

Presenter: Dr WATANABE, Hiroshi (RIKEN)

Session Classification: Physics Opportunities, New Ideas, Discussion

Contribution ID: **27** Type: **not specified**

Open Discussion

Saturday 5 February 2011 18:00 (30 minutes)

Session Classification: Physics Opportunities, New Ideas, Discussion

Contribution ID: **28** Type: **not specified**

Closing

Saturday 5 February 2011 18:30 (5 minutes)

Presenter: Dr SCHEIT, Heiko (RIKEN Nishina Center)