WP9: JRA1 - PASPAG

Phoswich scintillator assemblies:
Application to the Simultaneous detection of PArticle and Gamma radiation

Coordinator: Olof.Tengblad@csic.es Deputy: Franco.Camera@mi.infn.it

PASPAG studies of particles and gamma rays with phoswich scintillators allowing for simultaneous detection using the same detector array. PASPAG will also develop applications of detection systems for medical & homeland security.

Keywords:
Scintillators, Phoswich, New-materials, Digital-electronics, DAQ, Gamma & Particle Detection, Secondary Electron Emission materials

Budget: ***400.000 €***

The aim of: PASPAG

Using the R&D and KnowHow of the PARIS and CALIFA collaborations the PASPAG aims for

- **Simultaneous detection of Gamma and Particle Radiation** by the use of **new scintillator materials** combined with the **phoswich** technique.
- **Digital electronic** and DAQ with **improved throughput and more effective storage** will be developed.
- R&D on new **Secondary Electron Emission (SEE)** materials will be performed in order to develop **thin detectors for Low-Energy beam**.
- **The JRA aims for cost effective, reduced systems in size and complexity that can be used at several facilities.**

Task 1: Novel Scintillator Materials (INFN)

A wide range of promising new scintillators are becoming commercially available, such as CeBr3, CLYC and GAGG. Others, such as GYGAG:Ce, CLLB and CLLC will be available in the near future.

Subtask 1.1(**CNRS**, INFN, UniWarsaw):

Characterising these materials and exploring their combination with different photosensors in order to identify their usefulness in basic research and societal applications.

Subtask 1.2 (**USC**, CSIC, IFIN-HH):

We will construct an 'imager' using scintillators with one or two transparent windows. The system will be optimised in terms of choice of photosensor and geometry. Algorithms will be designed and tested to determine the position resolution.

Deliverable:

- D9.1: Report on Scintillator Materials (Month 24) report on the performance of various scintillators for nuclear-physics applications in terms of response to gamma rays, thermal and fast neutrons;
- D9.2: Prototype Imager (Month 42) prototype 'imager'.

Task 2: Phoswich detectors (IFJ PAN)

Phoswich detectors use two different scintillators which are optically coupled. Typically, the scintillators are chosen so that the light output of the two materials has very different timing properties so that the energy deposited in the two parts of the phoswich can be extracted.

Subtask 2.1(**CSIC**, USC, TUD, UoY):

Explore the optimum coupling to high-performing photosensors including ultra-bright PMTs and solid-state replacements such as silicon drift detectors (SDD) and silicon photomultipliers (SiPM).

Subtask 2.2 (**IFJ-PAN**, CTH, TUM):

To separate the different components in the light emission. Reduce the data by digital preprocessing at the frontend. Optimised algorithms improve performance and throughput. Dedicated in-beam tests at facilities in Krakow, Orsay and Warsaw.

Deliverable:

- D9.3: Report on Phoswich Assemblies (Month 42); i.e. report on the construction and evaluation of various prototype phoswich designs.

Task 3: Hybrid arrays and their applications (UoY)

Hybrid arrays; highly segmented assemblies of different scintillator materials combined uwith different photosensors in the same detector package, e.g., position sensitivity achieved with SiPMs on one side and a PMT on the other to obtain the best energy or timing resolution.

Subtask 3.1 (**UoY**, CSIC, USC):

Exploit the Compton camera technique to construct hybrid detector systems (phoswich) with layers of different scintillators and semiconductors boasting high timing and energy resolutions in order to improve SPECT imaging by removing physical collimation.

Subtask 3.2 (**CSIC**, CTH, USC, TUD, UoY):

Applications in the area of homeland security, where the illicit movement of fissile material are of particular concern. We will use the phoswich technique in combination with digital pulse identification to build segmented detectors that can be carried by drones.

Subtask 3.3 (**GSI**, Univ. Rzeszow, UCO):

New scintillator materials are of interest in nuclear structure applications with radioactive beams. Excellent timing and energy resolution is needed in order to discriminate rare events from dominant background. A test setup, combining particle-tracking detectors with high-resolution scintillators, will be realised and employed at GSI.

Deliverable:

D9.4: Report on Hybrid Arrays (Month 48)

Task1 –Novel Scintillator Material

Material Characterization

- Treatment
- Test set-up
- Optical absorption/emission spectra

Sensor – combinations

- SiPM (time) combined APD (energy)
- CCDD position sensitivity
- Gain stabilization

System integration

Task2 – Phoswich

Electronics

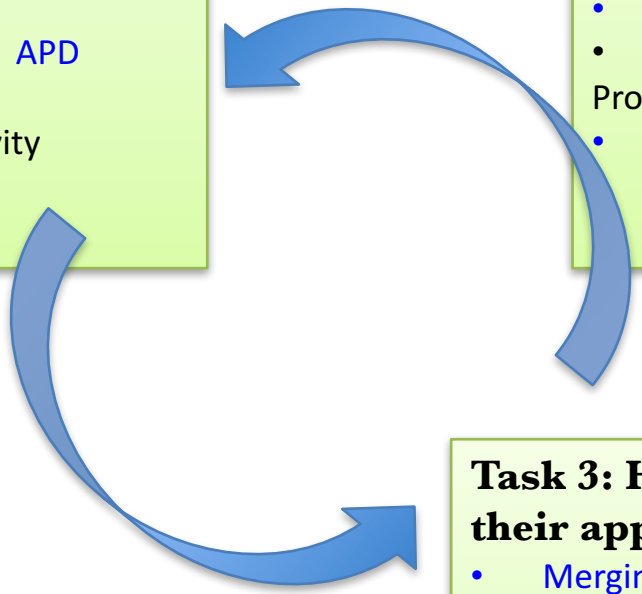
- Fast scintillators
- 10x more data → Deadtime free
- Combining different Light output
- Front end integration
- Table top

Process- handling

- Data reduction

p, γ, n, separation

Isotope identification



Task 3: Hybrid arrays and their applications

- Merging of PW prototypes
- Different segmentations
- Tracking clustering
- Cosmic particle in space
- Home land security
- Biological imaging

SUMMARY

Milestones & Deliverables

Impacts of the joint research activity

PASPAG JRA will broaden the physics case of gamma-ray spectroscopy by developing phoswich scintillators for detection of particles and gamma rays allowing for simultaneous detection of both with the same detector array.

MS9.1	Crystal characterisation	Month 12	Report
MS9.2	Scintillator readout Test-bench	Month 18	Test-bench
MS9.3	Hybrid readout	Month 24	Prototype test report
MS9.4	Data processing	Month 24	Test beam report
MS9.5	Imaging using Segmented	Month 36	Prototype

D9.1	Scintillator Materials	Month 36	R & DEM	PU
D9.2	Phoswich Assemblies	Month 42	DEM	PU
D9.3	Hybrid arrays	Month 48	R	PU

Work Package JRA1 - PASPAG	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
MS9.1: Crystal characterisation				M												
MS9.2: Scintillator readout Test-bench						M										
MS9.3: Hybrid readout								M								
MS9.4: Data processing								M								
MS9.5: Imaging using Segmented detector												M				
D9.1: Scintillator Materials												D				
D9.2: Phoswich Assemblies														D		
D9.3: Hybrid arrays																D

Partners

Work package number	9		**Start Date or Starting Event**		1	
Work package title	JRA1 – PASPAG: Phoswich scintillator assemblies: Application to the Simultaneous detection of PArticle and Gamma radiation					
Participant number	**25**	2	5	8	9	10
Short name of participant	**CSIC**	INFN	CNRS	IFJ PAN	UNIWARSAW	IFIN-HH
Person-months per participant:	36	36	36	36	12	6
Participant number	26	29				
Short name of participant	USC	UoY				
Person-months per participant:	36	48				

The associated partners involved in PASPAG activities are:
CTH, Univ. Rzeszow, TUM, TUD and UCO

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C)Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on	(F) Indirect Costs / €	(G) Special unit costs covering direct & indirect costs/€	(H) Total estimated eligible costs/€	(I) Reimbursement rate (%)	(J) Max grant/€ (H*I)	(K) Requested grant / €
CSIC	ES	40	40	0	0	0	20	0	100	100%	100	100
IFJ PAN	PL	40	4	0	0	0	11	0	55	100%	55	55
INFN	IT	40	4	0	0	0	11	0	55	100%	55	55
IFIN-HH/ELI-NI	RO	0	12	0	0	0	3	0	15	100%	15	15
IPNO	FR	0	20	0	0	0	5	0	25	100%	25	25
SLCJ	PL	0	12	0	0	0	3	0	15	100%	15	15
GSI	DE	0	18	0	0	0	4,5	0	22,5	100%	22,5	22,5
USC	ES	40	4	0	0	0	11	0	55	100%	55	55
U.York	UK	40	6	0	0	0	11,5	0	57,5	100%	57,5	57,5
PASPAG-JRA		200	120	0	0	0	80	0	400	9	400	400

PASPAG

Contact: Olof.Tengblad@csic.es & Franco.Camera@mi.infn.it

Participants: **Budget**: ***400.000 €***
(200 k€ is personnel)

France	**CNRS**	
	IPNO Orsay	**G. Hull**
	IPHC	**O. Dorvaux**
Italia	**INFN**	**F. Camera**
Poland	**IFJ PAN**	**Maria Kmiecik**
	SLCJ	**P. Napiorkowski**
Romania	**IFIN-HH**	**C. Mihai**
Spain	**CSIC**	**O. Tengblad**
	USC	**H. Alvarez Pol**
UK	**U. York**	**D. Jenkins**
Associates:		
Germany	TU Munich	R. Gernhäuser
	TU Darmstadt	T. Kröll
	GSI	P.Boutachkov
	UC Cologne	J.Jolie
Poland	Rzeszow UniTechnology,	M. Cholewa
Sweden	CTH	T. Nilsson

➔ 15 partners from 8 EU countries