WP9-JRA1 PASPAG
1st Annual meeting 25.04.2017

http://www.iem.cfmac.csic.es/departamentos/nuclear/WEB-PASPAG/webstyle1/

Time		Activity		Convener	Institute
13:30:00		Welcome		Giulia HULL	IPN Orsay
13:35:00		ENSAR2 & PASPAG		Olof TENGBLAD	CSIC Madrid
13:55:00		Activity IPN		Giulia HULL	IPN Orsay
14:15:00		Activity IFJ PAN		Maria KMIECIK	IFJ PAN Krakow
14:35:00		Activity USC		Hector Alvarez Pol	USC Santiago
14:55:00		Activity York		Jamie BROWN	Univ. York
15:15:00		Activity SLCJ		Paweł J. NAPIORKOWSKI	SLCJ Univ Warsaw
15:35:00		Activity TUM		Roman GERNHÄUSER	TUM Munich
15:55:00		COFFEE			
16:15:00		COFFEE			
16:30:00		Discussion		Everyone	
		Discussion		Everyone	
		Discussion		Everyone	
		Discussion		Everyone	
17:45:00		Summary		Olof TENGBLAD	
18:00:00		END			

PRESENT at the meeting

Olof TENGBLAD		CSIC Madrid	ES
Hector Alvarez Pol		USC Santiago	ES
Roman GERNHÄUSER		TUM Munich	DE
Giulia HULL		IPN Orsay	FR
Iolanda MATEA		IPN Orsay	FR
Maria KMIECIK		IFJ PAN Krakow	PL
Adam MAJ		IFJ PAN Krakow	PL
Pawel KULESSA		IFJ PAN Krakow	PL
Paweł J. NAPIORKOWSKI		SLCJ Univ Warsaw	PL
Jamie Brown		Univ. York	UK

Questions to ENSAR2 Management:

- **Acknowledgement**

This work was supported by the H2020-INFRAIA-2014–2015 Grant Agreement 654002 – ENSAR2-PASPAG

- **Move money between personnel – travel – equipment → in principal OK send info to ENSAR**
- **Travel expenses of associates. → Letter from FISCO**
- **Deliverables: reports or hardware? → Photos of prototypes, delays leads to new amandments to contract agreement troublesome adminstration should be avoided**
- **Online reporting? → Only FISCO do this**

AGENDA

1. ENSAR2 & PASPAG management
2. 1st year Activity of the participants
3. Discuss the future of the TASKs:
    1. Novel Scintillator Materials (INFN)
    2. Phoswich detectors (IFJ PAN)
    3. Hybrid arrays and their applications (UoY)
4. GANAS archive?

PASPAG - Partners

Participation per Partner			
Partner number and short name			**WP9 effort**
2 - INFN	**IT**		18.00
5 - CNRS	**FR**	IPNO & IPHC	0.10
6 - GSI	**PL**		0.10
8 - IFJ PAN	**PL**		18.00
9 - UNIWARSAW	**PL**		0.10
10 - IFIN-HH	**RO**		6.00
25 - CSIC	**ES**	IEM	18.00
26 - USC	**ES**		15.00
29 - UoY	**UK**		6.00
	Total		81.30

PASPAG- Associates

Scintillator activity: CTH, TUM, TUD
SEE activity (GSI): UCO & Univ. Rzeszow

PASPAG- Deliverables

Deliverable Number [14]	Deliverable Title	Lead beneficiary	Type [15]	Dissemination [16]	Due Date (in months) [17]
D9.1	Report: present status of New Scintillator Materials and their basic characterisation (energy & time response)	25 - CSIC	Report	Public	12
D9.2	Report: Sensor characterization and Base design of hybrid detectors	25 - CSIC	Report	Public	18
D9.3	Report: Scintillator response to gamma and particle radiation	25 - CSIC	Report	Public	24
D9.4	Report: Digital pre-processing at frontend	25 - CSIC	Report	Public	30
D9.5	Report: Design Phoswich Assemblies for homeland security	25 - CSIC	Report		36
D9.6	Report: Summary of test results	25 - CSIC	Report	Public	48

convener

INFN
IPNO

Uni YORK

USC-CTH

TUM-CTH

Krakow-York-IEM

IEM

D9.1 - STATUS OF NEW SCINTILLATOR MATERIALS AND THEIR BASIC CHARACTERIZATION
25.01.2017 Data from Task 1 by G. Hull & F. Camera prepared by O. Tengblad

Milestones

Schedule of relevant Milestones

Milestone number [18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of
MS30	Crystal characterisation	25 - CSIC	12	Report
MS31	Scintillator readout Test-bench	25 - CSIC	18	Report
MS32	Hybrid readout	25 - CSIC	24	R
MS33	Data processing	25 - CSIC	24	Report
MS34	Imaging using segmented detector	25 - CSIC	36	Report

convener

INFN
IPNO

USC

Uni YORK-Krakow

TUM Warsaw

INFN
IFIN-HH

M3.0 - CRYSTAL CHARACTERIZATION
20.02.2017 Data from Task 1 by G. Hull & F. Camera, prepared by O. Tengblad

Task1: Novel scintillator materials IPNO & INFN

New crystals for PASPAG

- $Cs_2LiLaBr_6$:Ce → CLLB

Elpasolite, same family as the CLYC (Li based)

- Neutron – Gamma pulse shape and pulse height discrimination
- High efficiency for gamma rays and neutron

	Light Yield (ph/MeV)	Decay Constant (ns)	Wavelength of emission (nm)	ΔE/E @ 662 keV (%)	Propor.
CLLB $Cs_2LiLaBr_6$:Ce	60,000	55, ≥270	410	2.9	Good
CLYC Cs_2LiYCl_6:Ce	20,000	50, ~1000	390	3.9	Good

Two optics procured from Saint Gobain:

- ⌀1” x 1” delivered in 01/2017
- ⌀2” x 2” delivered in 03/2017

Novel scintillator materials IPNO & INFN

New crystals for PASPAG

$LaBr_3$:Ce, Sr – co-doped $LaBr_3$:Ce

- Co-doping is claimed to stabilize the growing process, thus possibly increasing the production rate with a consequent lowering of the price
- The co-doping process increases the light output and the crystal response proportionality and thus the energy resolution
- The co-doping process increases the α-γ PSD

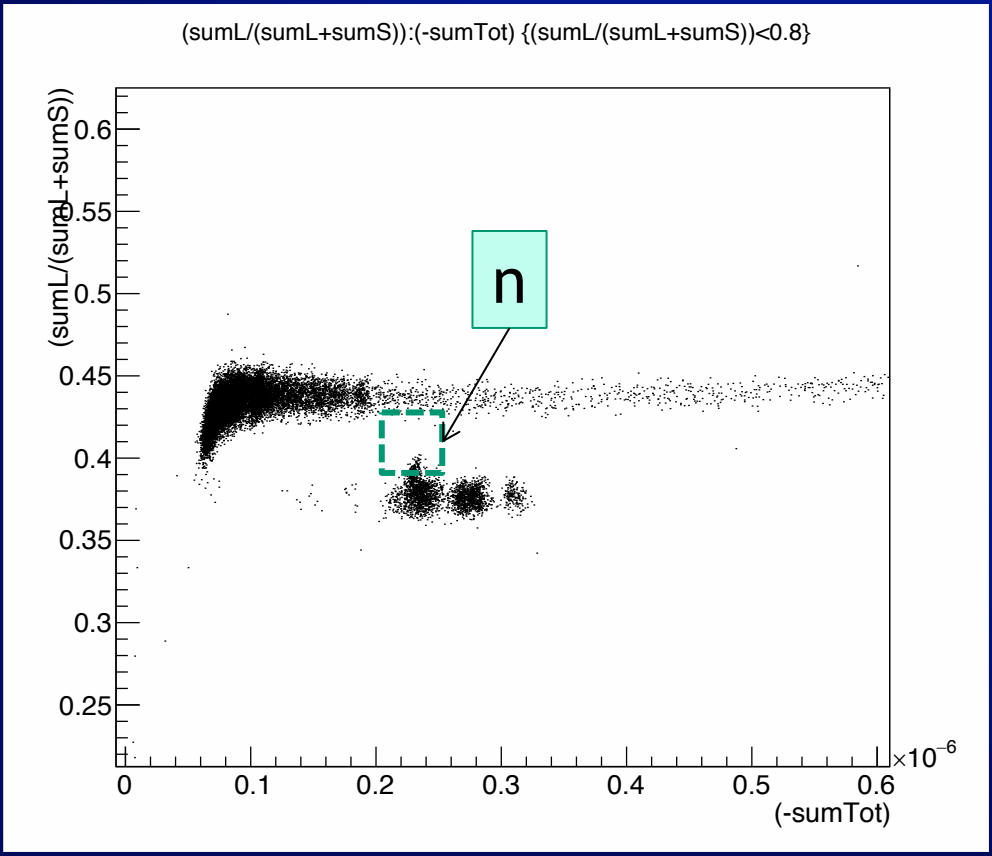
	Light Yield (ph/MeV)	Decay Constant (ns)	Wavelength of emission (nm)	ΔE/E @ 662 keV (%)	Propor.
$LaBr_3$:Ce,Sr	?	17-18, 60-2500	390	2.7 As good as 2%	Good

One optic procured from Saint Gobain (the first ever quoted):

- ⦸ 1” x 1” expected in late Q2, early Q3 2017

1”x1” CLLB - first results

Thermal neutrons from moderated ^{252}Cf source
PMT R6231-100 + Digital Oscilloscope



sumS between [-100, 300] ns
sumL between [400, 2000]

Need a stronger source and/or more thermalisation

Funding

20k€ in three years

⦸ 1” x 1” CLLB	2500 €
⦸ 2” x 2” CLLB	4950 €
⦸ 1” x 1” LaBr3:Ce,Sr	6250 €

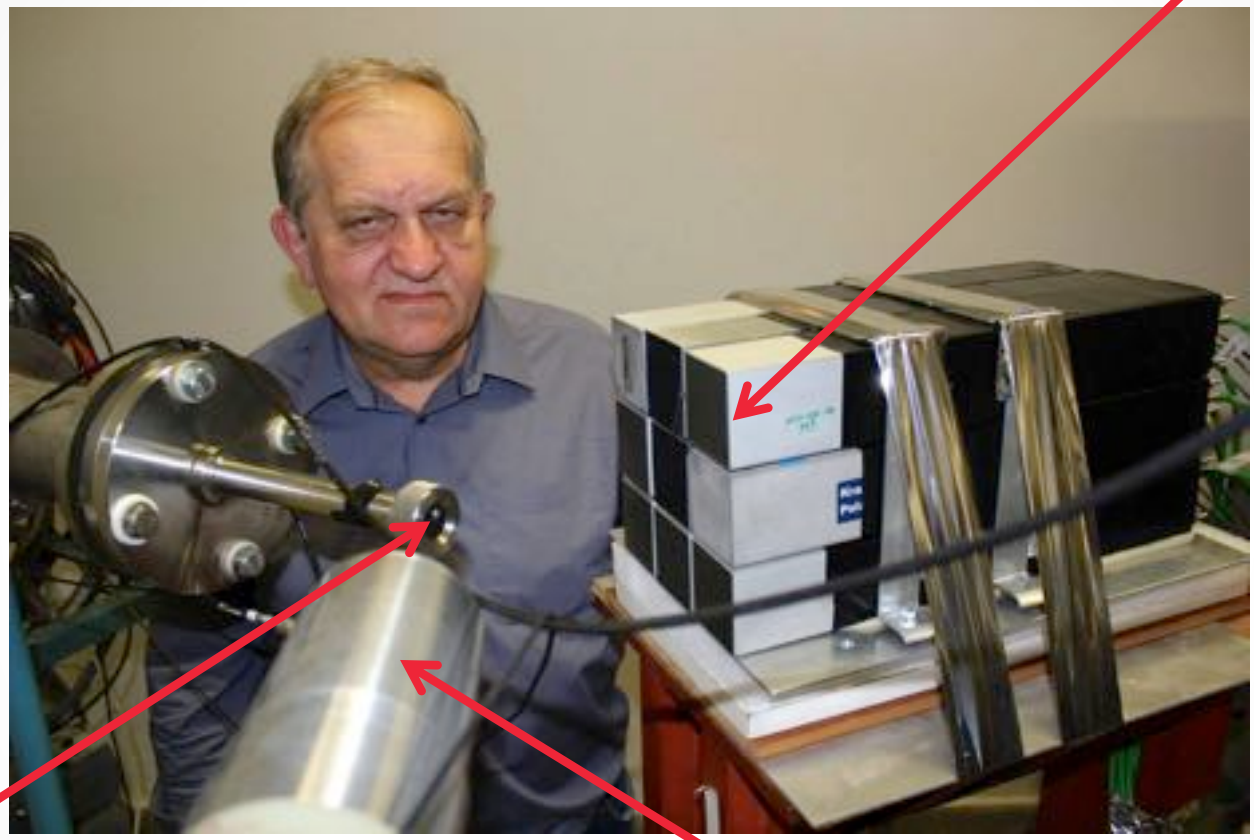
Task 1&2: Phoswich detectors (IFJ PAN)

M. Kmiecik, A. Maj,
P. Kulessa, M.Ciemała, M. Jastrząb,
P. Napiorkowski, S. Brambilla, S. Kihel

Performed actions:
Measurement of the response of $CeBr_3$+NaI:Tl and $LaBr_3$+NaI:Tl phoswiches to high-energy γ rays

Planned actions:
- Testing response of the phoswiches and minicluster to protons
- Experiment prepared together with the Califa detectors, for July 2017 in Krakow

PARIS cluster; 4 LaBr/NaI & 5 CeBr/NaI phoswiches



Target for p,gamma reaction

HPGe for monitoring

Verification of novel readout for PARIS detectors, based on SiPM arrays (SENSL J-Series) together partner *Univ. York*

Measurement setup:
Oscilloscope 12-bit Lecroy HDO6104
Sampling frequency: 2.5 GS/s
Energy pulse polarization: positive
SiPM J-series, bias voltage positive: +29.5V.

Task:2&3 Phoswich detector *readout with GHz sampling* using the FEBEX platform

1st PASPAG Meeting, Paris 2017

R3B @ FAIR

CEPA Readout

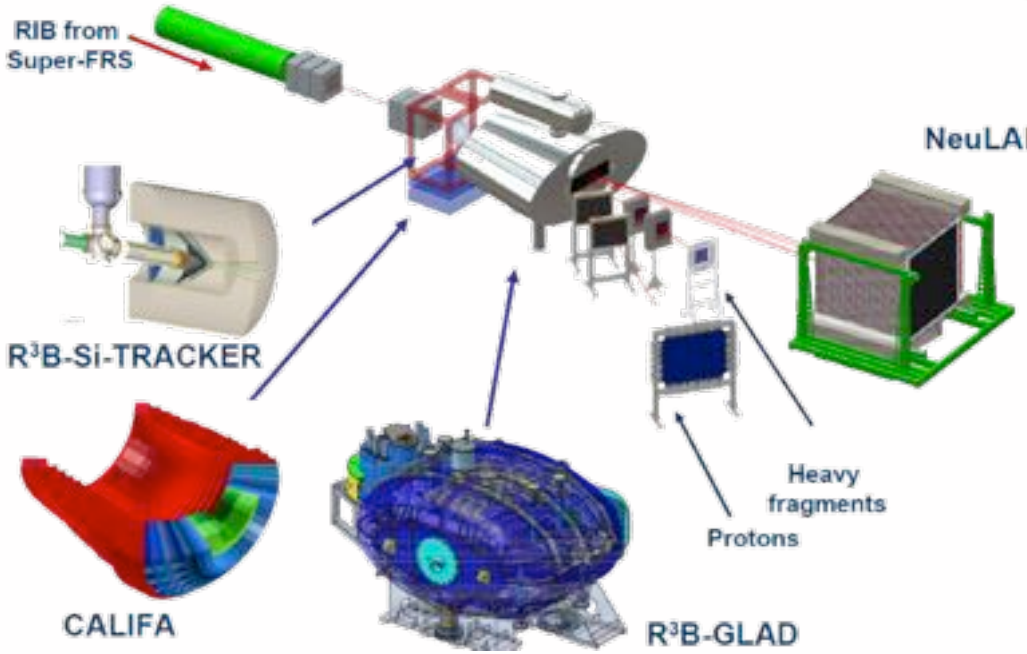
Basic Concept using DRS4

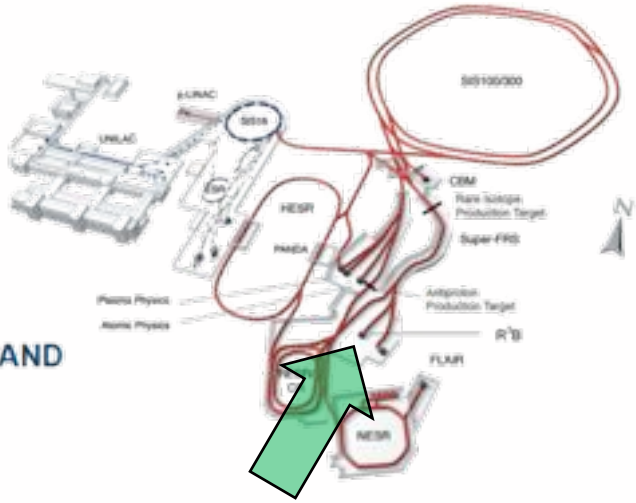
First Prototype

R³B @ FAIR

Reactions with **R**elativistic **R**adioactive **B**eams

- Investigation of exotic nuclei in inverse kinematics
- Kinematically complete measurements





CALIFA Structural Design

Barrel:

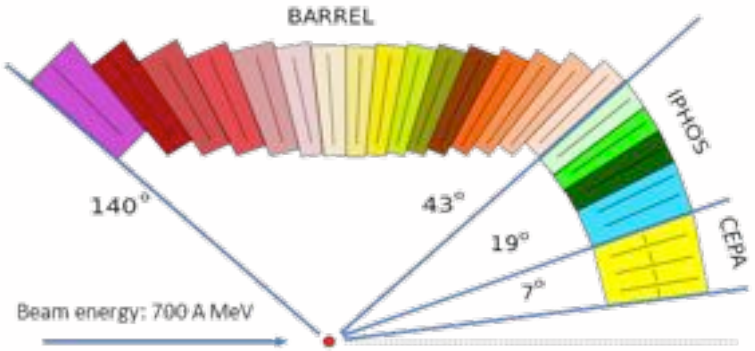
- 1952 CsI(Tl) scintillation crystals (0,7 μs + 3,3 μs)
- LAAPD readout
- Direct energy measurement of stopped protons up to ~300 MeV

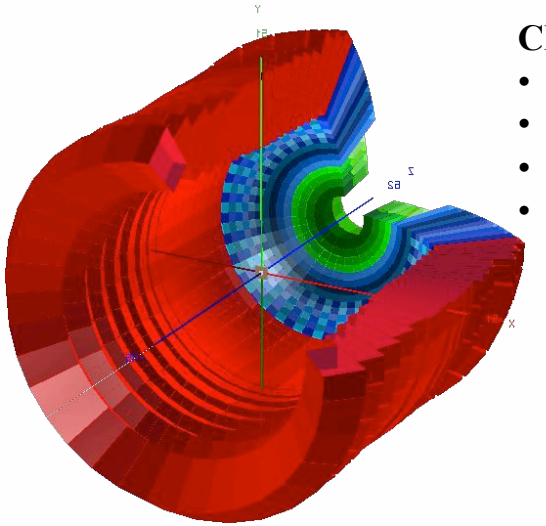
iPhos:

- 512 CsI(Tl) crystals
- LAAPD readout
- Full energy reconstruction of punched through protons by PID

CEPA:

- 96 $LaBr_3$ (16 ns) + $LaCl_3$ (28 ns)
- Phoswich detectors + PMT/SiPM readout





CEPA:

- largest rate
- small Doppler broadening
- highest energies
- beam line opening

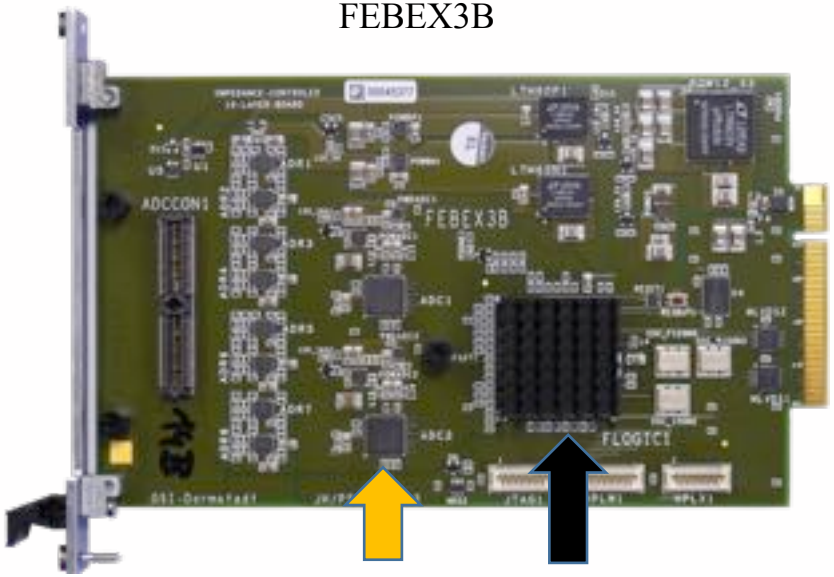
Task:2&3 → CALIFA Readout
Phoswich detector *readout with GHz sampling* using the FEBEX

Barrel

iPhos

CEPA

FEBEX3B

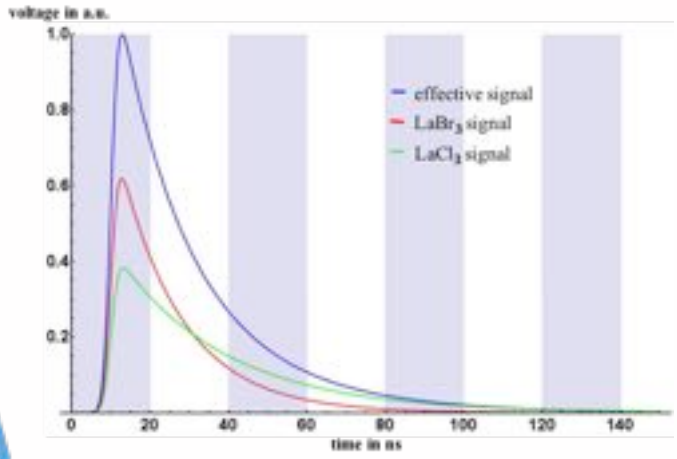


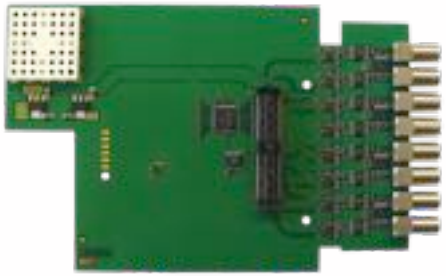
50 MHz ADC

Pulse Shape Analysis

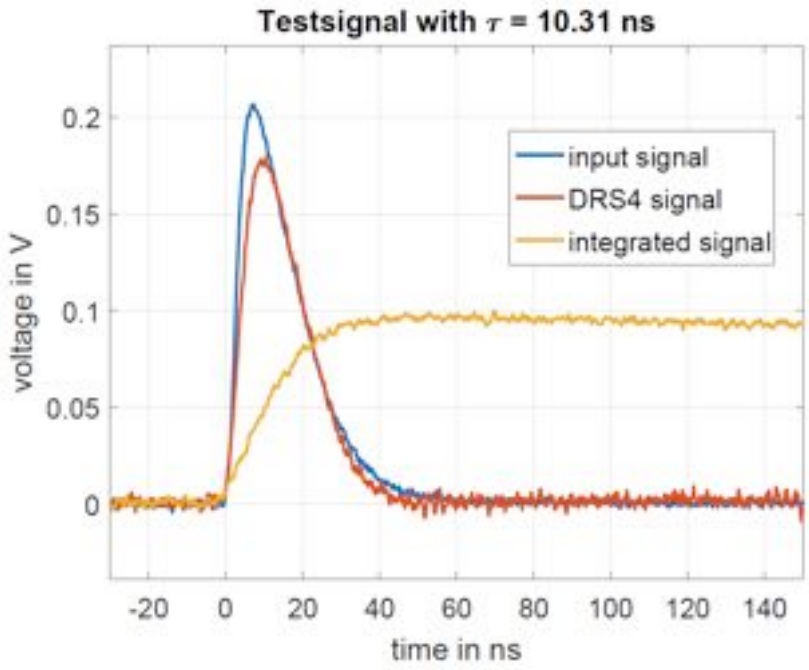
FEBEX3B:
50 MHz sampling frequency

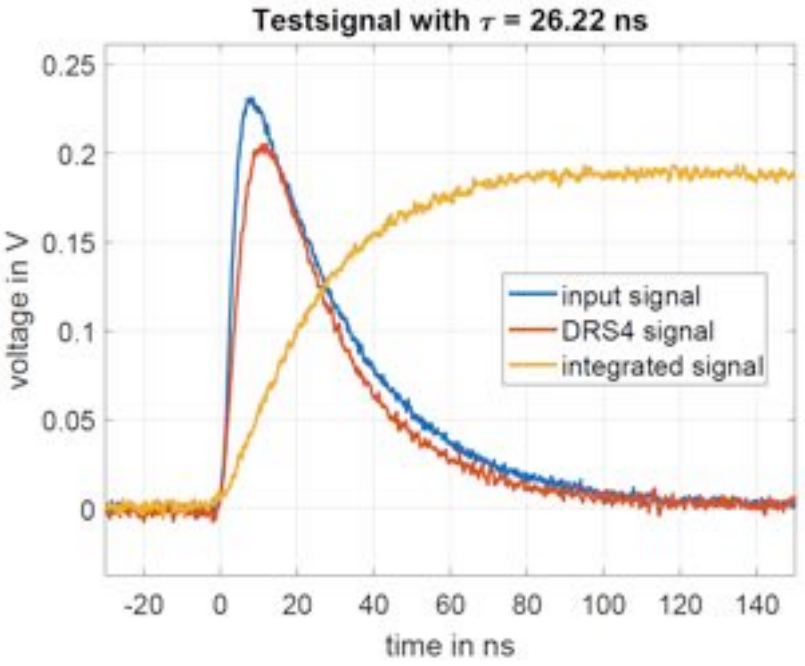
Add-on board:
1 GHz sampling frequency





Add-on Board Fast Signals

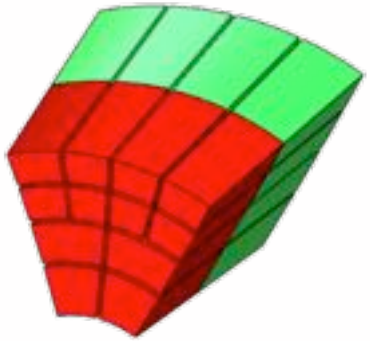




Felix Stark Master Thesis TUM

Summary / Outlook

- **high-frequency signals preprocessed with only small deformation**
- **integrated signals used as trigger for DRS4 readout**



- **finish DRS4 firmware for full readout (Clock synch, timing…..)**
- **optimization of component values for usage of available range**
- **next revision of the DRS add-on board**
- **test experiment with 235 MeV protons in July 2017 in Krakow**

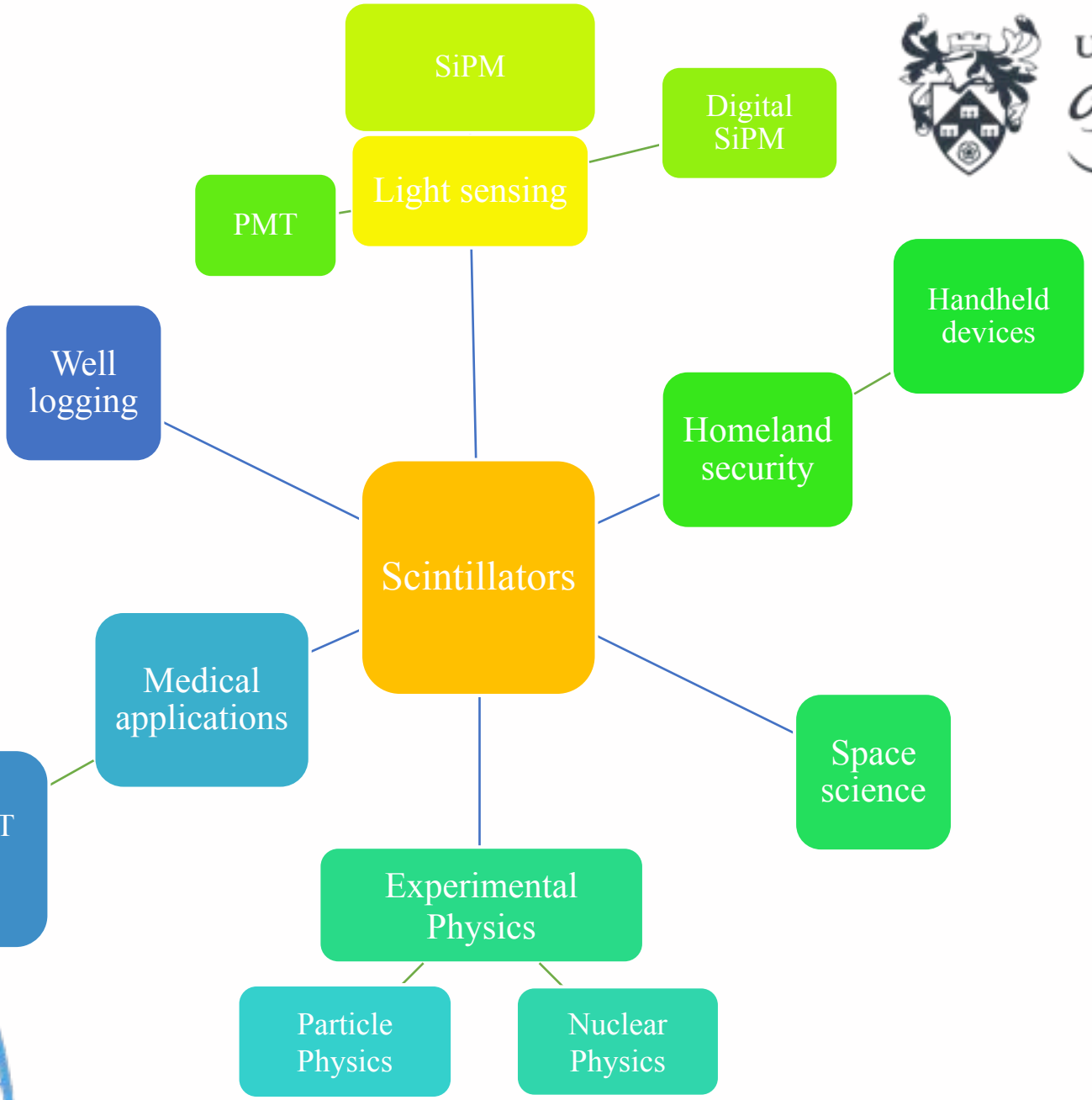
The Team

CALIFA @ Technical University of Munich (TUM)
Felix Stark, Roman Gernhäuser, Benjamin Heiss, Philipp Klenze, Patrick Remmels and the CALIFA working group

UNIVERSITY of York

Task 3: Hybrid arrays and their applications (UoY)

Jamie Brown


SiPM
Digital SiPM
Light sensing
PMT
Well logging
Handheld devices
Homeland security
Scintillators
Medical applications
PET/SPECT Imaging
Space science
Experimental Physics
Particle Physics
Nuclear Physics

Application: Nuclear Security handheld devices

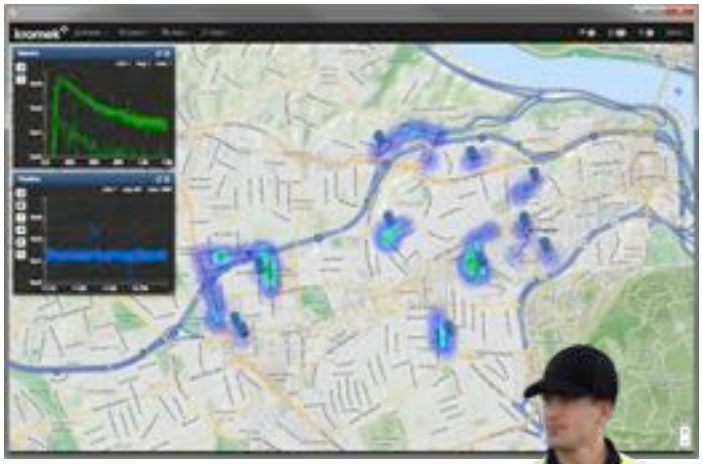
CsI coupled to SiPM

Prototype detector in collaboration with Kromek

http://www.evproducts.com/sigma.html

Kromek D3S handheld device

CsI coupled to SiPM



Several thousand sold in US

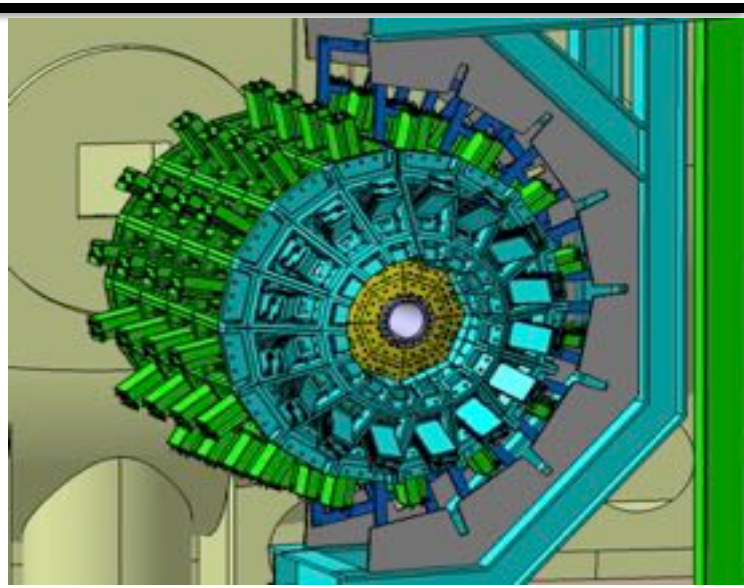
- **Fruitful collaboration with Kromek and other industry partners**
  - **Looking at applications for homeland security and medical imaging**
- **Common interest in scintillator detectors coupled to SiPM**
- **Commercially successful detector solution**
- **Projects on hygroscopic crystals coupled to SiPM**
  - **high-resolution performance**
  - **Wrapping, optical coupling and signal processing optimization**
  - **Pulse shape analysis using digital electronics**
  - **Position reconstruction and resolution**
- **Digital SiPM very promising solution for position sensitive measurements and very fast signals**
- **Detector developments for nuclear technology are very attractive for undergraduate student projects and several students are engaged in our research**

USC CONTRIBUTION TO PASPAG

H. Alvarez-Pol, D. Cortina, J. Benlliure, D. Gonzalez
Departamento de Física de Particulas, IGFAE, USC.

FIRST ANNUAL PASPAG MEETING
CNRS – Délégation Paris Michel-Ange
PARIS – 25/04/2017

USC in PASPAG



USC team for PASPAG

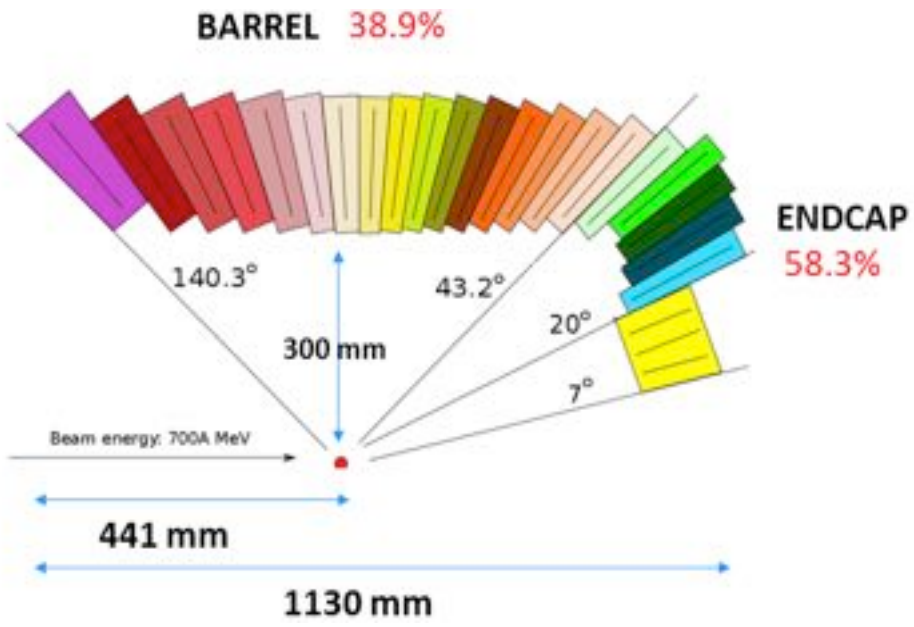
- 3 Proffesors.
- 4 PhD students.
- 1 Engineer.
- Looking for a Post-Doc!

Participation driven by our interest in the R^3B (Reaction with Relativistic Radioactive Beams) experiment and, particularly, in the design and evaluation of the detector CALIFA.

CALIFA calorimeter & spectrometer:

Photo Peak Eff.	40% (up to $E\gamma$=15 MeV projectile frame)
Calorimeter for HE LCP	200-700 MeV in lab system
$\Delta E/E$	~5-6% (FWHM at $E\gamma$=1 MeV) , ~ 3% forward
LCP resolution	~2% (stopped particles), ~ 5% (punch through)

CALIFA design parameters



	Barrel	Endcap	
		iPhos	CEPA
Scintillator	CsI(Tl)	CsI(Tl)	LaBr/LaCl
Geometries	11	16	6
Length (cm)	15-22	22	7/8
Polar cov.	43-140º	20-43º	7-20º
Read-out	LAAPD	LAAPD	PM/SiPM
Det. units	1952	480	96
Ele. channels	1952	960	96
Weight (Kg)	~1500	~550	~50
Volume (cm^3)	285.000	90.000	11.000

Within PASPAG, contribute to the CALIFA Forward Endcap:

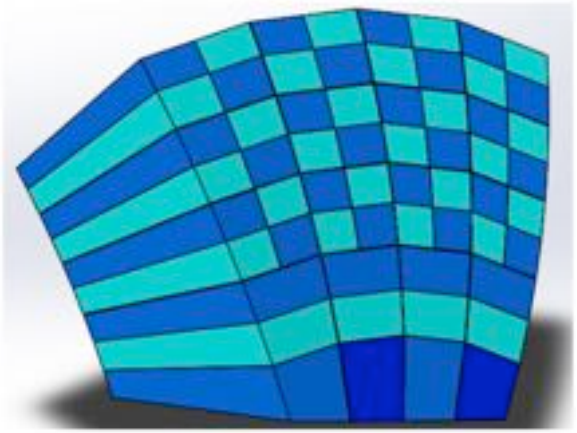
I. **iPhos**: verification of the LAAPD coupling and performances for the new geometries.

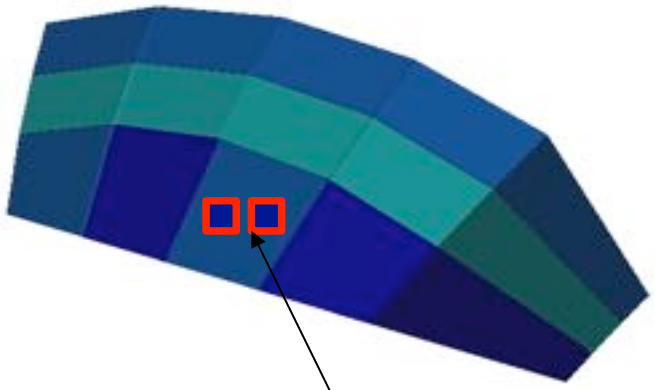
II. **Tests of new phoswich detectors** based on CsI(Tl).

USC Working plan I: coupling new geometries

Iphos issues

New design: → crystals with different geometries...
→ are the Hamamatsu S8664-1010-2 LAAPDs well suited??





ACTIONS:
- Construction of an iPhos sector prototype.
- Response / Light collection tests.

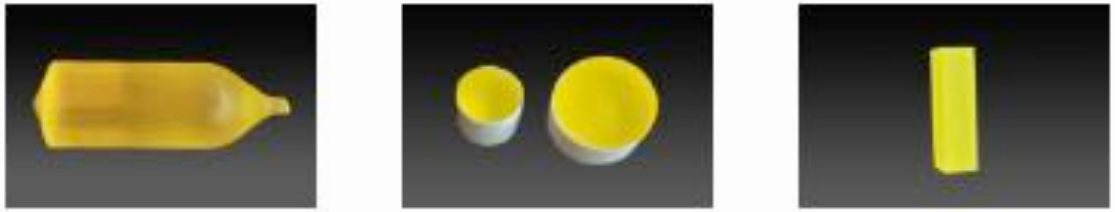
Related with:
- TASK 1 Novel scintillators.
- TASK 3 Hybrid arrays.

USC Working plan II: test new phoswichs

Iphos issues

New scintillator available GAGG:(Ce)

Density	6.63 g/cm3
Ene. resol.	5.1 % @ 662keV
Peak emm.	520 nm
Decay time	87 ns (90%) 255 ns (10%)
Hygroscopic	**no**



- Test the response with LAAPDs.
- Study possibilities for Phoswich GAGG-CsI(Tl).

ACTIONS:
- Purchase of GAGG samples (EPIC/AMCRYS):
  1x1x1 cm / 1x1x5 cm / 1x1x10 cm
- Coupled to LAAPDs.
- Construction of phoswich prototypes.

Related with:
- TASK 1 Novel scintillators.
- TASK 2 Phoswich detectors.