



PARIS

PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

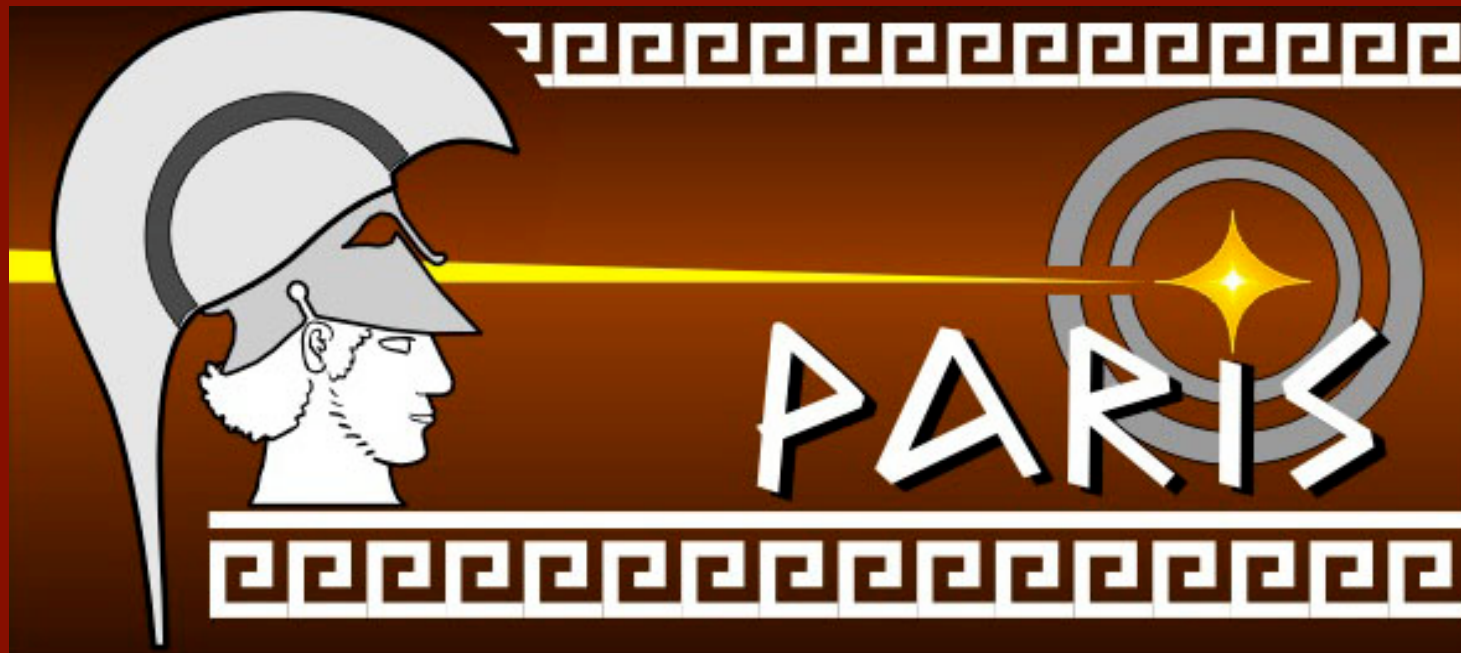
[www.paris.w.pl](http://www.paris.w.pl)

J.P Wieleczko

GANIL

(On behalf of PARIS collaboration)

# PARIS project



*Detector System for Nuclear Physics with RI beams. WS 02/15 2008*



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PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS



Letter of Intent for SPIRAL 2

**Title: High-energy  $\gamma$ -rays as a probe of hot nuclei and reaction mechanisms**

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PARIS

# PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

## PHYSICS CASES

NUCLEAR SHAPES

**a) Jacobi shape transitions**

$^{120}\text{Cd}$ ,  $^{98}\text{Mo}$ ,  $^{71}\text{Zn}$

(A. Maj, J. Dudek et al.)

**b) Studies of shape phase diagrams of hot nuclei – GDR differential methods**

$^{186-193}\text{Os}$ ,  $^{190-197}\text{Pt}$

(A. Maj, I. Mazumdar et al.)

**c) Hot GDR studies in neutron rich nuclei**

$128 < A < 144$

(D.R. Chakrabarty, M. Kmiecik et al.)

**d) Isospin mixing at finite temperature**

$^{68}\text{Se}$ ,  $^{80}\text{Zr}$ ,  $^{84}\text{Mo}$ ,  $^{96}\text{Cd}$ ,  $^{112}\text{Ba}$

(M. Kicińska-Habior et al.)

**e) Onset of the multifragmentation and the GDR**

$120 < A < 140$ ,  $180 < A < 200$

(J.P. Wieleczko, D. Santonocito et al.)

**f) Reaction dynamics by means of  $\gamma$ -ray measurements**

$^{214-222}\text{Ra}$ ,  $^{118-226}\text{Th}$ ,  $^{229-234}\text{U}$

(Ch. Schmitt, O. Dorvaux et al.)

**g) Heavy ion radiative capture**

$^{24}\text{Mg}$ ,  $^{28}\text{Si}$

(S. Courtin, D.G. Jenkins et al.)

ISOSPIN SYMMETRY

REACTION MECHANISMS

High efficiency calorimeter for high energy  $\gamma$ -rays

+

$\gamma$ -multiplicity filter + RFD or VAMOS

$\gamma$ -multiplicity filter

$\gamma$ -multiplicity filter + RFD or VAMOS

$\gamma$ -multiplicity filter

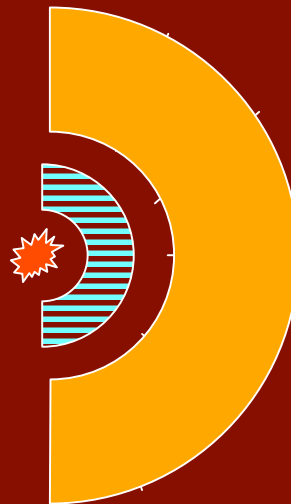
INDRA

$\gamma$ -multiplicity filter + RFD or VAMOS or CORSET-like

LISE or RFD

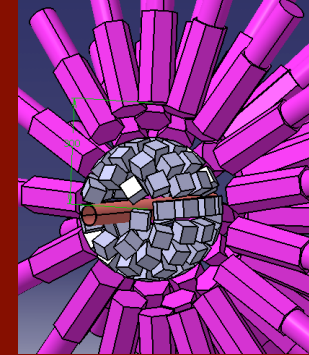
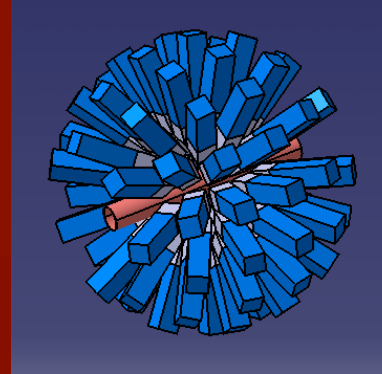
According to the request shared by the above physics cases,  
the present proposal is intended to develop  
a **versatile  $\gamma$ -calorimeter**  
for high-energy (4-50 MeV) photons and  
for multiplicity/sum-energy of low energy (100 keV – 2 MeV)  $\gamma$ -transitions

- ✓ Large angular acceptance ( $4\pi$  or  $2\pi$ )
- ✓ Modular (in order to couple with other detectors)
- ✓ High granularity
- ✓ Energy resolution: 2–3%
- ✓ Time resolution: < 1 ns
- ✓ Energy range 100 keV–50 MeV
- ✓ High efficiency for gamma rays: (>25% at 1.3 MeV, ~5% at 20 MeV)



## Various geometries are explored

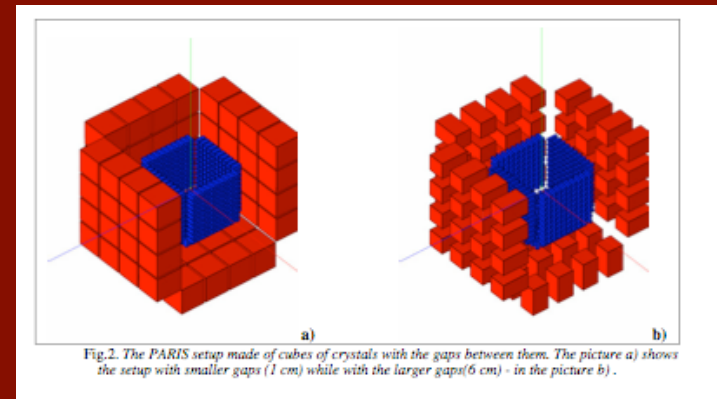
Spherical Option (Strasbourg, York)  
Cubic Option (Krakow, Debrecen)



## From GEANT4 simulations (Lyon)

size of the individual modules (50mm)  
10 deg aperture at 15 cm

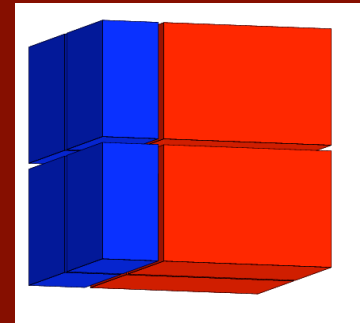
Segmentation : about 200 modules



Elementary modules : LaBr3 (5cm thick)+ CsI(Na) 15 cm thick)  
From Saint-Gobain

high light output, good energy resolution, high efficiency, short decay time

**R&D Phase** : Phoswich concept, Mechanical stability, n- $\gamma$  discrimination, PSA





## Crystal comparison



	BGO	NaI(Tl)	CsI(Tl)	LSO	LaBr <sub>3</sub> (Ce)	LaCl <sub>3</sub> (Ce)	LuYSiO (Ce)
Density (g/cm <sup>2</sup> )	7.13	3.67	4.51	7.4	5.29	3.79	7.1
Hygroscopic	no	very	slightly	no	yes	yes	no
Wavelength of emission (nm)	480	415	540	420	380	350	420
Decay Time Fast (ns)	300	250	600	40	16	28	41
Slow component (ns)	no	1000	~3000	no	no	no	180
Energy Resolution (% for 662 keV)	12 (16.07)	(7.37)	6	10	2.8 (3.6)	3.8 (4.65)	8
Light yield (photon/keV)	9	38	54	26	63	49	32

Courtesy O. Dorvaux

**A formal PARIS collaboration was established** (see [www.paris.w.pl](http://www.paris.w.pl))

**Management:**

**Project Leader:** A. Maj (Krakow)

**Deputies:** D. Jenkins (York), J.A. Scarpacci (Orsay), J.P. Wieleczo (GANIL)

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W. Catford (Surrey, UK)  
D. Chakrabarty (BARC, India)  
Z. Dombardi (ATOMKI, H)  
S. Courtin (Strasbourg, F)  
J. Gerl (GSI, D)  
D. Jenkins (York, UK) - deputy chairman  
S. Leoni (Milan, I)  
A. Maj (Krakow, PL)  
J.A. Scarpacci (Orsay, F)  
Ch. Schmidt (Lyon, F)  
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**Working groups and their coordinators:**

***GEANT4 simulations:***

O. Stezowski (Lyon)

***Calorimeter scenarios:***

D. Jenkins (York)

***Mechanical design:***

S. Courtin (Strasbourg)

***Detectors and electronics:***

O. Dorvaux (Strasbourg), F. Camera (Milan)

***Theory and Physics cases:***

C. Schmitt (Lyon), I. Mazumdar (Mumbai)

***Connections to other detectors:***

M. Rousseau (Strasbourg)

## **The PARIS collaboration (status on 26.11.2007)**

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**38 institutions from 16 countries  
≈ 100 physicists, engineers and  
PhD students**