PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

Adam Maj
IFJ PAN Kraków

Projekt kalorymetru gamma nowej generacji

http://paris.ifj.edu.pl

Plan referatu

- Wstęp
- Idea projektu PARIS
- Tematyka fizyczna
- Organizacja kolaboracji PARIS
- Symulacje GEANT4
- Wstępne projekty techniczne
- Testy detektorów $LaBr_3$
- Plany na przyszłość
- Podsumowanie

Wstęp

Kilka otwartych zagadnień w fizyce struktury jądra atomowego

• Jakie są granice istnienia jąder? Ile protonów może być w jądrze?
• Jakie są nowe formy kolektywnych wzbudzeń jądra?
• Jaka jest sekwencja poziomów kwantowych w jądrach dalekich od doliny stabilności?
• Czy halo neutronowe, znane w lekkich jądrach, przekształca się w skórkę neutronową w ciężkich jądrach?
• Czy dynamiczne symetrie (np. superdeformacja, hiperdeformacja), znane w jądrach bliskich stabilności występują również w jądrach egzotycznych?

Te i inne pytanie mogą być zaadresowane za pomocą intensywnych wiązek radioaktywnych, produkowanych np. w powstającym akceleratorze **SPIRAL2 w GANIL**, (np. w reakcjach fuzji wiązka neutrono-nadmiarowa może wnieść ok. 15 $\hbar$ więcej krętu do jądra złożonego)
z wykorzystaniem **wysoce wydajnych detektorów**:

• rozproszonej wiązki i ciężkich jonów
• cząstek naładowanych: *FAZIA, GASPARD, …*
• neutronów: *Neutron detektor*
• promieniowania gamma: *AGATA,* ***nowe układy detektorów scyntylacyjnych***

Detektory promieniowania gamma

Typ	Zalety	Wady	Układ
Ge	2 keV @ 1 MeV	Δt>10 ns, niska wydajność dla wysokich energii (chyba że AGATA)	EUROBALL, EXOGAM, EAGLE, AGATA
NaI	ΔE≈5%	Δt>3 ns	JANOSIK
BGO	ΔE≈10%, wysoka wydajność	Δt>3 ns	EB Innerball
BaF2	ΔE≈10%	Δt≈1 ns	HECTOR, Chateu de Crystal, Medea
LaBr3 Firma Saint Gobain	Δt<250 ps, ΔE<3%	Wysoka cena	?

Idea projektu PARIS

4-5-6th October, 2005 „Future prospects for high resolution gamma spectroscopy at GANIL" - Convenors : Bob Wadsworth and Wolfram Korten

WG „Collective modes in continuum" – convenors: Silvia Leoni & Adam Maj

GANIL
SAC open session
October 19th, 2006

Letter of Intent for SPIRAL 2

Title: High-energy γ-rays as a probe of hot nuclei and reaction mechanisms

Spokesperson(s) *(max. 3 names, laboratory, e-mail - please underline among them one corresponding spokesperson):*

Adam Maj, IFJ PAN Krakow, Adam.Maj@ifj.edu.pl
Jean-Antoine Scarpaci, IPN Orsay, scarpaci@ipno.in2p3.fr (
David Jenkins, University of York (UK), dj4@york.ac.uk

GANIL contact person

Jean-Pierre Wieleczko, GANIL, wieleczko@ganil.fr

Aim:
to design and build efficient gamma calorimeter *PARIS*

Założenia projektu PARIS:

Zaprojektowanie i zbudowanie
kalorymetru gamma o wysokiej wydajności,
składającego się z 2 powłok dla celów spektroskopii gamma
w szerokim zakresie energii

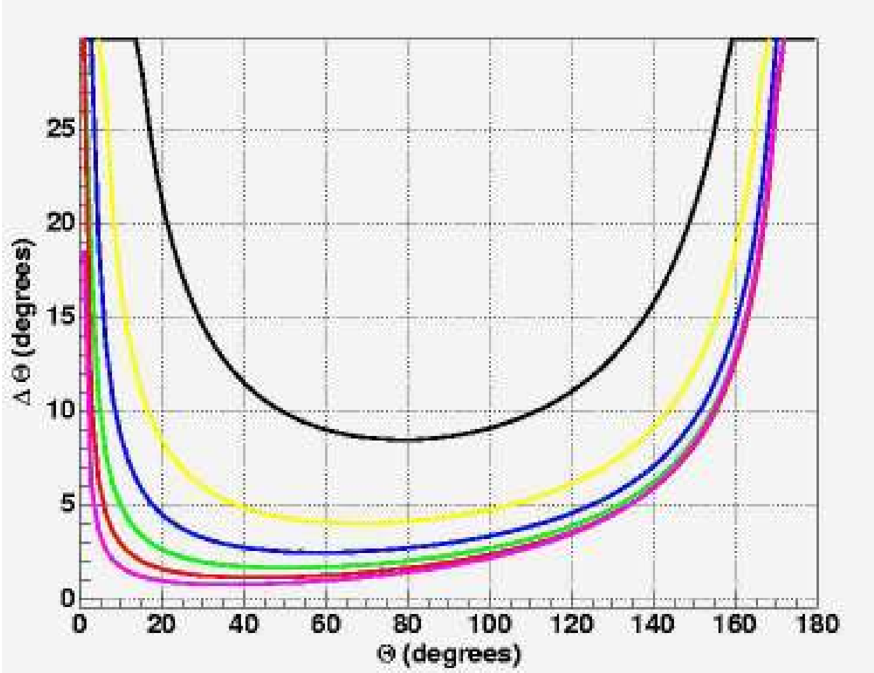
Wewnętrzna sfera, wykonana z nowych kryształów scyntylacyjnych LaBr3(Ce), powinna mieć dużą granulacje. Będzie użyta do pomiar krotności gamma, sumarycznej energii, sub-nanosekundowych czasów życia, jak i pomiarów spektroskopowych w zakresie energii 1-10 MeV.

Zewnętrzna sfera, wykonana z konwencjonalnych kryształów scyntlacyjcych: BaF2 lub CsI; albo z istnięjących detektorów: HECTOR, Chatea de Crystal. Może mięć niższą granulacje. Będzie użyta do pomiarów wysokoenergetycznych kwantó gamma (3-40 MeV). Może też stanowić aktywną osłonę wewnętrznej sfery.

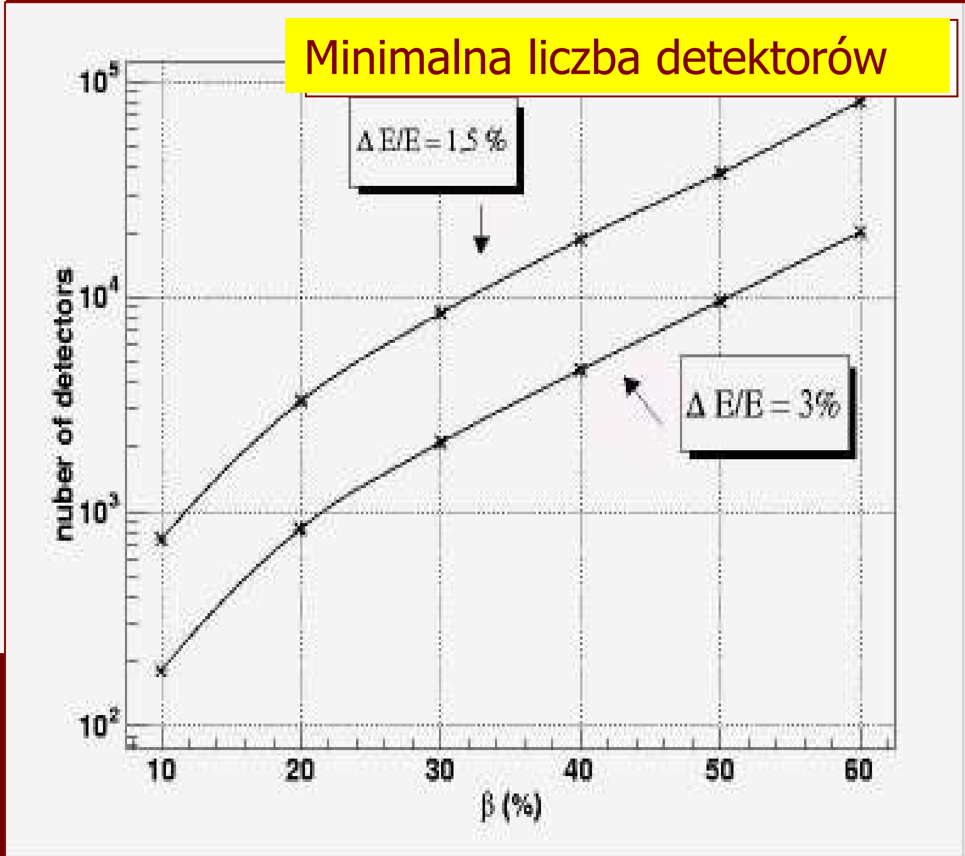
Układ powinien być modularny i kompatybilny z innymi detektorami: AGATA, EXOGAM2, GASPARD, Neutr. Det, INDRA/FAZIA

Poszerzenie dopplerowskie a granulacja układu detekcyjnego

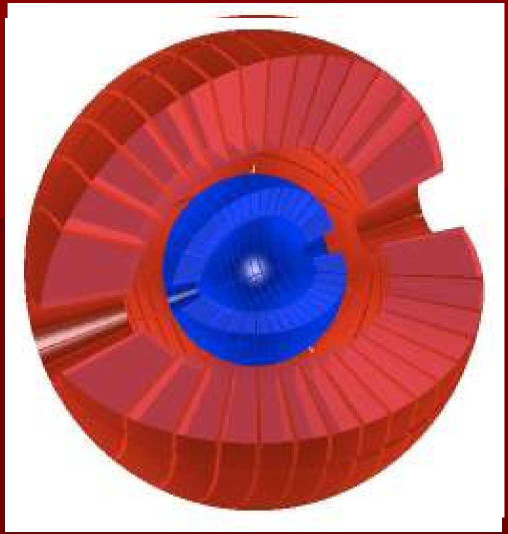
Max. rozwarcie det. dla poszerzenia dopplerowkiego = 3%
dla v/c=10, 20, 30, 40, 50, 60%



Minimalna liczba detektorów



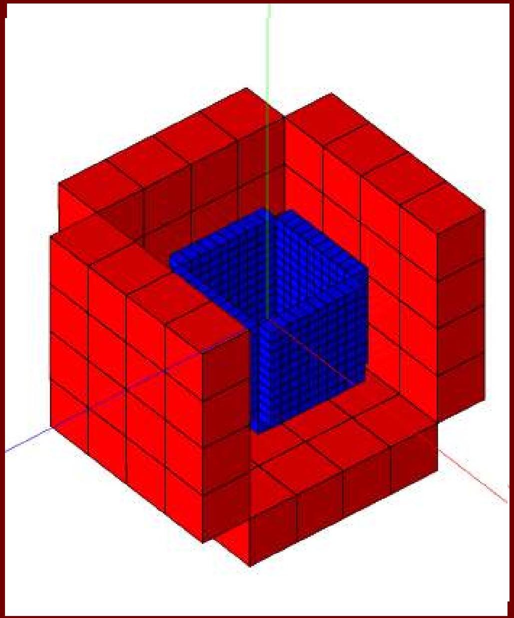
POSSIBLE GEOMETRIES of PARIS



SPHERICAL (e.g. same as AGATA modules):

+ : easy reconstruction, good line shape, compability with other spherical detectors,..

- : Limited to one distance, high cost of a segment,…

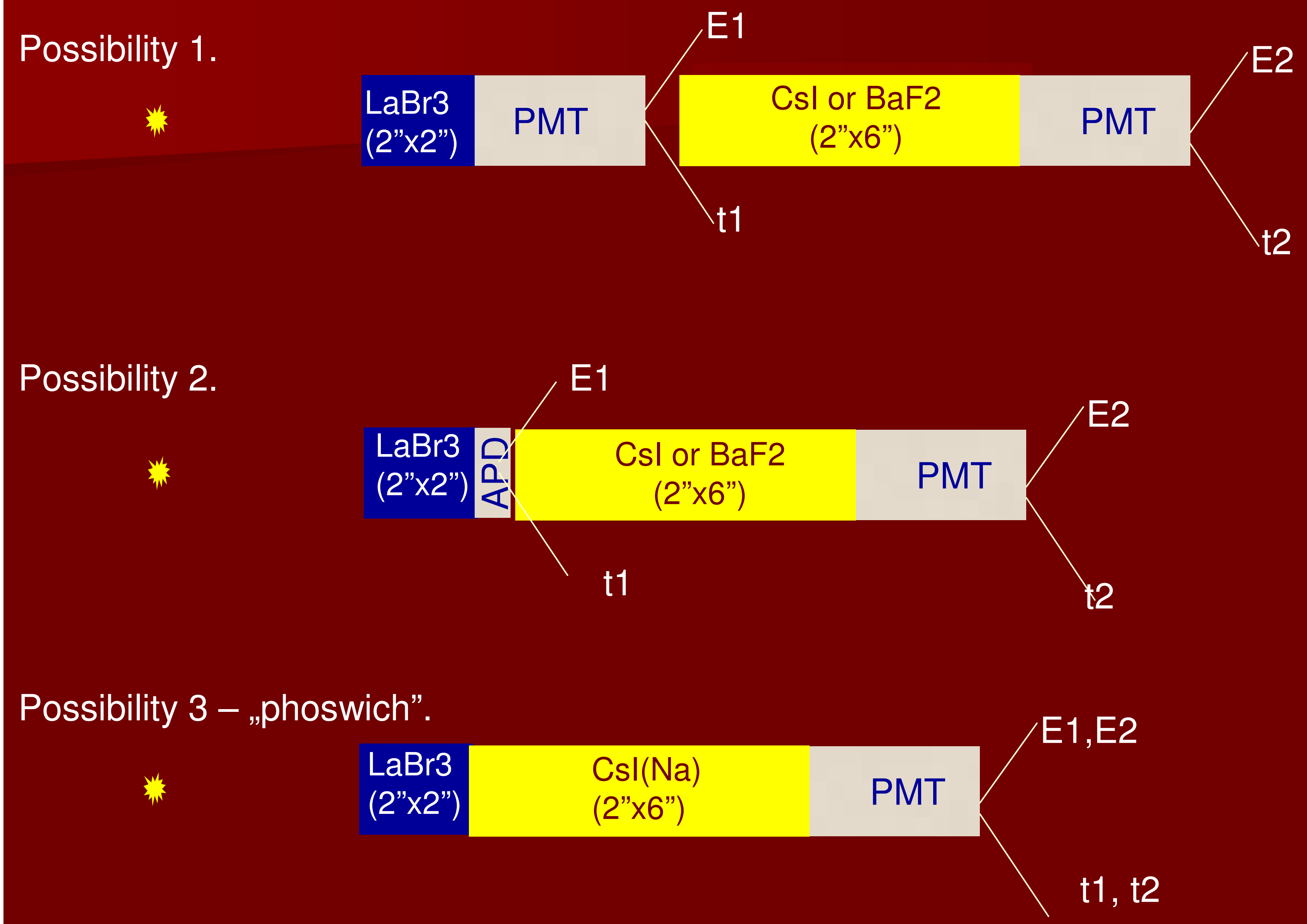


CUBIC (offering variable geometry):

+ : adjustable to different distances, compatibility with many detectors, lower cost for a segment, easier mechanical support,

- : More complicated reconstruction, worse line shape, …

3 POSSIBILITIES FOR A „GAMMA-TELESCOPE” ELEMENT



Tematyka fizyczna

PARIS — PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

a) **Jacobi shape transitions*** (A. Maj, J. Dudek et al.) *^{120}Cd, ^{98}Mo, ^{71}Zn*

b) **Shape phase diagrams – GDR differential methods** (A. Maj, I. Mazumdar et al.) *$^{186-193}Os$, $^{190-197}Pt$*

c) **Hot GDR studies in neutron rich nuclei** (D.R. Chakrabarty, M. Kmiecik et al.) *$128<A<144$*

d) **Isospin mixing at finite temperature** (M. Kicińska-Habior et al.) *^{68}Se, ^{80}Zr, ^{84}Mo, ^{96}Cd, ^{112}Ba*

e) **Onset of the multifragmentation** (J.P. Wieleczko, D. Santonocito et al.) *$120<A<140$, $180<A<200$*

f) **Reaction dynamics** (Ch. Schmitt, O. Dorvaux et al.) *$^{214-222}Ra$, $^{118-226}Th$, $^{229-234}U$*

g) **Heavy ion radiative capture*** (S. Courtin, D.G. Jenkins et al.) *^{24}Mg, ^{28}Si*

h) **Multiple Coulex of SD bands** (P. Napiorkowski, F. Azaiez, A. Maj et al.) *$36<A<50$*

i) **Relativistic Coulex (case for FAIR or RIKEN)** (P. Bednarczyk et al.) *$40<A<90$*

j) **Nuclear astrophysics (p,γ)** (S. Harissopulos al.) **e.g.** *^{90}Zr*

k) **Shell structure at intermediate energies (SISSI/LISE)** (Z. Dombradi et al.) *$20<A<40$*

l) **Shell structure at low energies (separator part of S^3)*** (F. Azaiez, S. Franchoo et al.) *$30<A<150$*

m) **Nuclear Moments measurements (G. Georgiev, D. Balabanski et al.)**

*) Key experiments

Jacobi shape transition:
Theoretical shapes of rotating gravitating body

Colin MacLaurin (1742) shows that, as the angular momentum increases, the Earth will become more flat. The shape is an ellipsoid with two equal axes, rotating around the short axis. The ellipsoid becomes a disc with an ever increasing radius.

Carl Gustav Jacob Jacobi (1834):

At certain angular velocity *gravitating mass rotating synchronously* may change abruptly the shape from MacLaurins oblate shape to elongated triaxial (Jacobi bifurcation).

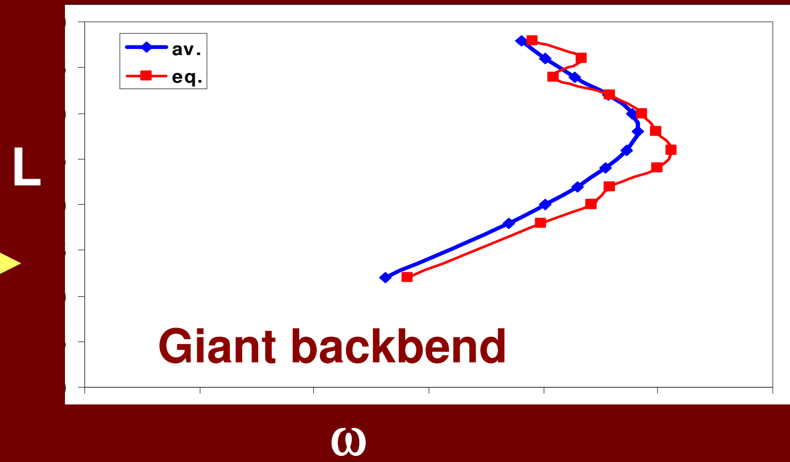
Based on talk by Prof.. Etienne Ghys of the Unité de Mathématiques Pures et Appliquées de l'E.N.S. de Lyon
www.josleys.com/show_gallery.php?galid=313

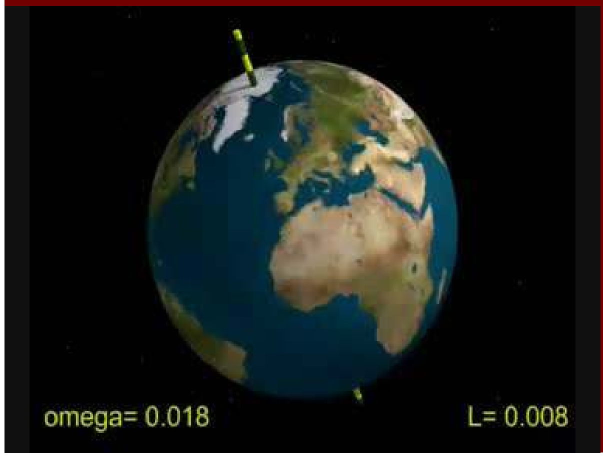
Henri Poincare (1885):

Described how the path of the Jacobi ellipsoids encounters multiple bifurcation points – elongated triaxial may change rapidly to a pear shape

McLaurin path

Jacobi path





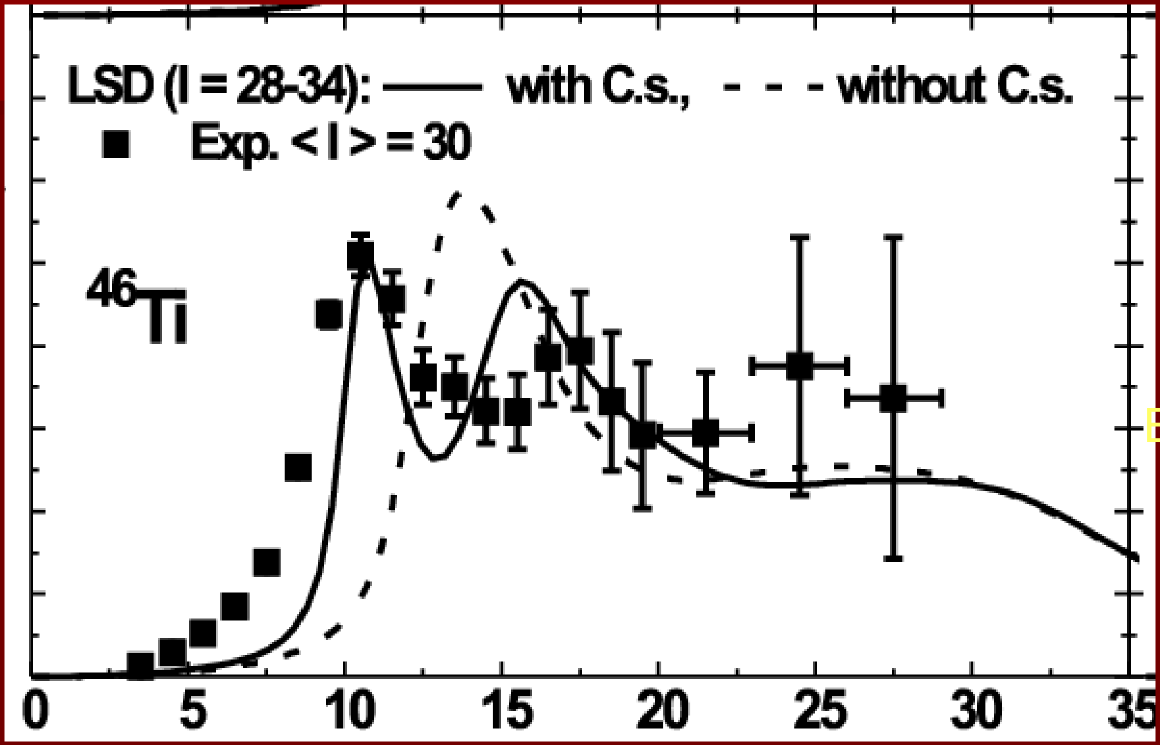
Poincare path

- **R. Beringer, W.K. Knox, *Phys. Rev.* 121 (1961) 1195:**
  Similar phenomenon might be expected in nuclei at highest spins
- **S. Cohen, F. Plasil, W.J. Swiatecki, *Ann. Phys. (N.Y.)* 82 (1974) 557:**
  Rotating liquid drop model
- **K. Pomorski, J. Dudek, *Phys. Rev.* C67 (2003) 044316:**
  LSD (Lublin-Strasbourg Drop) Model

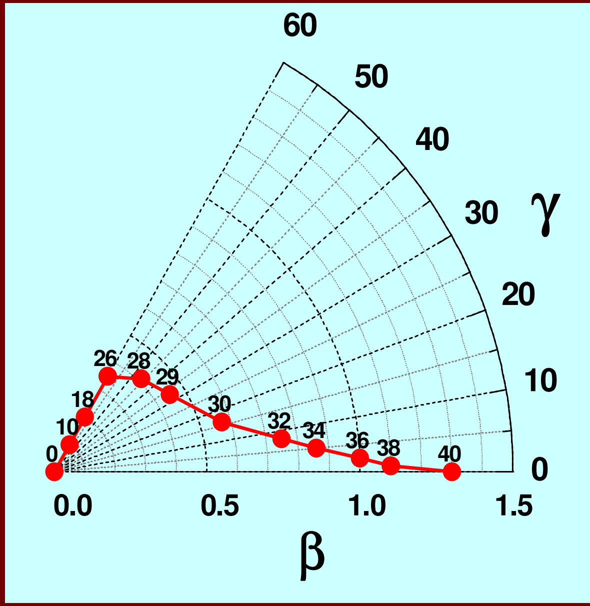
- **M. Kicińska-Habior *et al.*, *Phys.Lett.* B308 (1993) 225:**
  ***Seattle exp.* - Possible signature of the Jacobi shape transition for ^{45}Sc in the inclusive GDR spectrum**
- **A. Maj et al, *Nucl. Phys.* A687 (2001) 192:**
  ***NBI exp.* – Possible signatures of the Jacobi shape transition for ^{46}Ti in the multiplicity gated GDR spectra and angular distributions**
- **D. Ward *et al.*, *Phys.Rev.* C66 (2002) 024312-1:**
  Giant backbend of the E2 quasicontinuum bump
- **M. Riley, Zakopane 2008:**
  Oblate to prolate transition in N~90 nuclei for $I>60\hbar$

A. Maj et al, Nucl. Phys. A731 (2004) 319
M. Kmiecik et al., Acta Phys. Pol. B36, (2005) 1169

EUROBALL IV exp: Evidence for the Jacobi shape transition and (for the first time) for the Coriolis splitting in ^{46}Ti

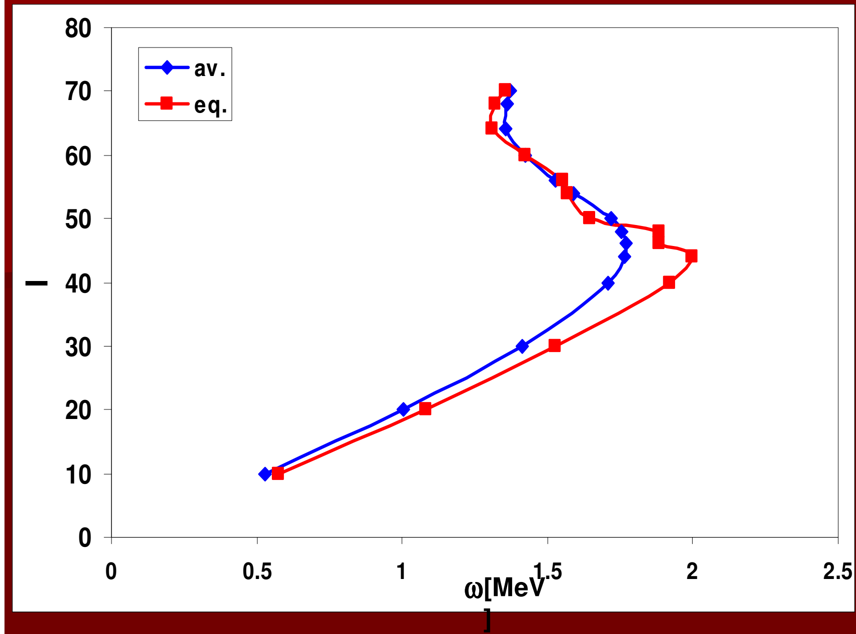


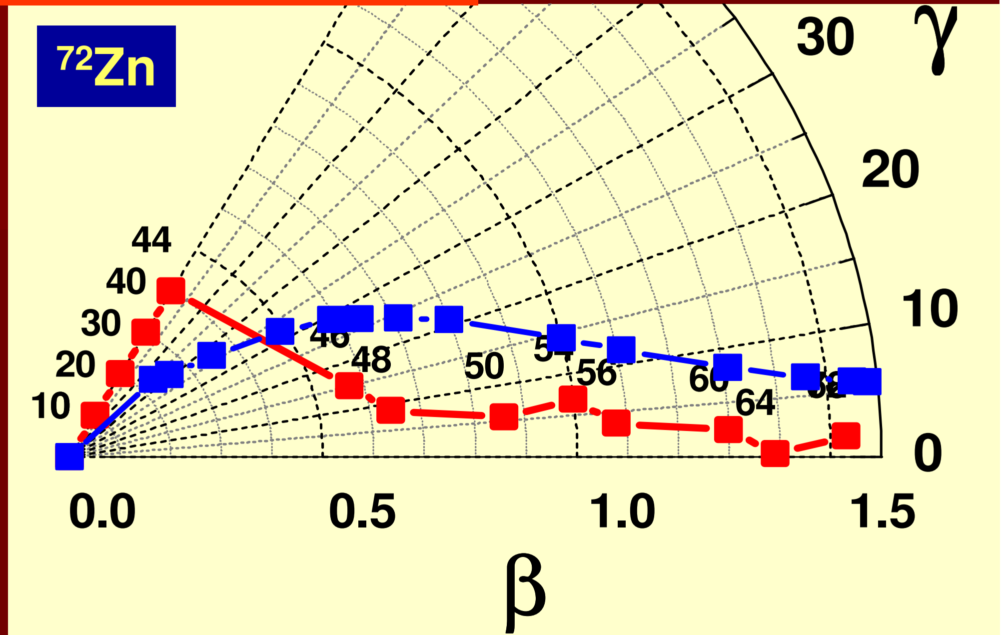
Evolution of equilibrium shape

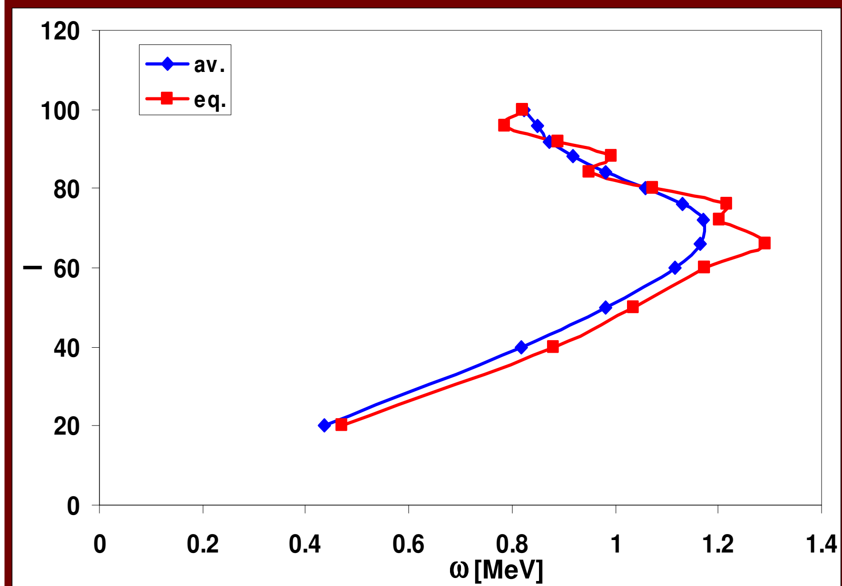


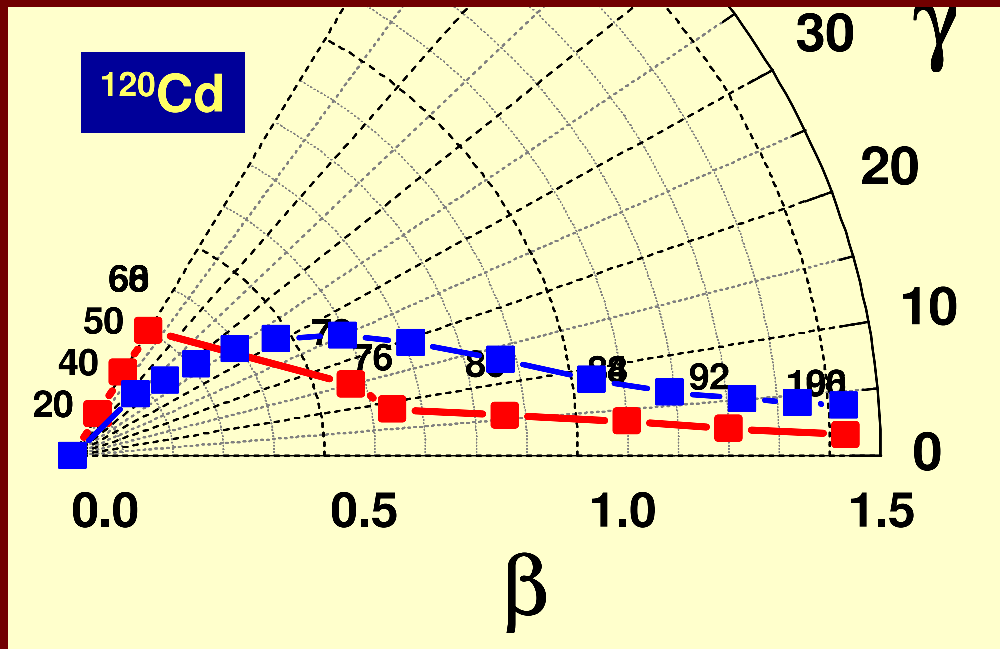
Calculations: LSD model and thermal shape fluctuactions

Predictions based on LSD (Dudek&Pomorski) model

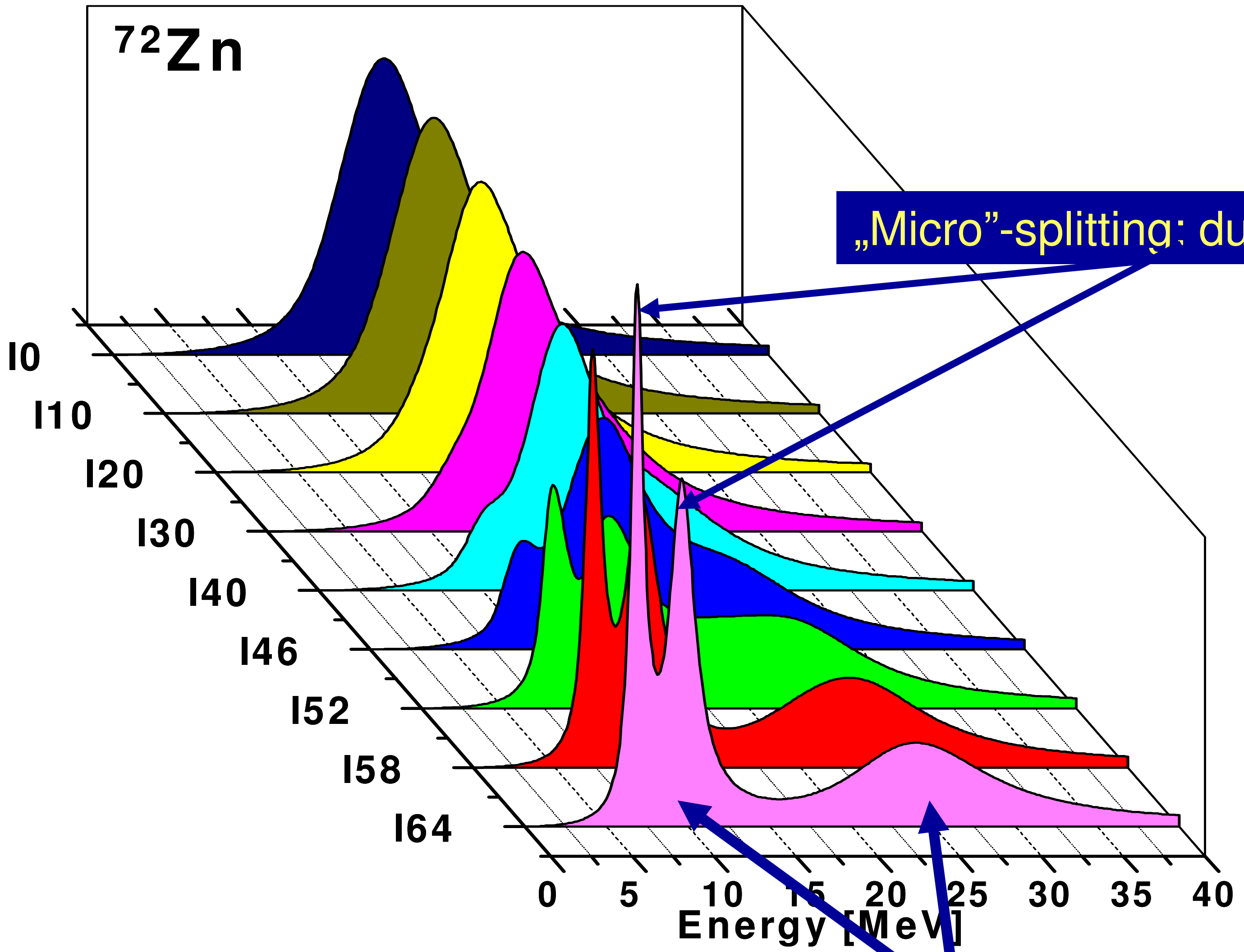








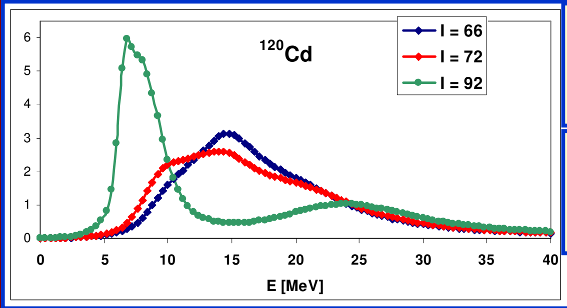
Spin evolution of the GDR line shape



„Micro”-splitting: due to Coriolis effect

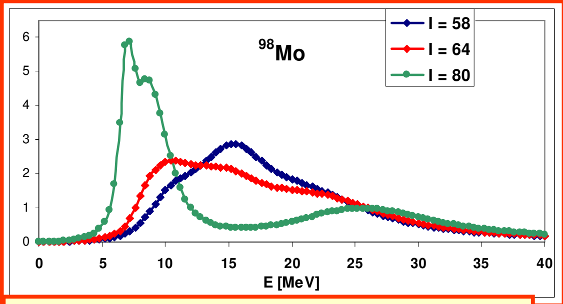
„Macro”-splitting: due to very elongated shape

Summary of the experimental programme for GANIL



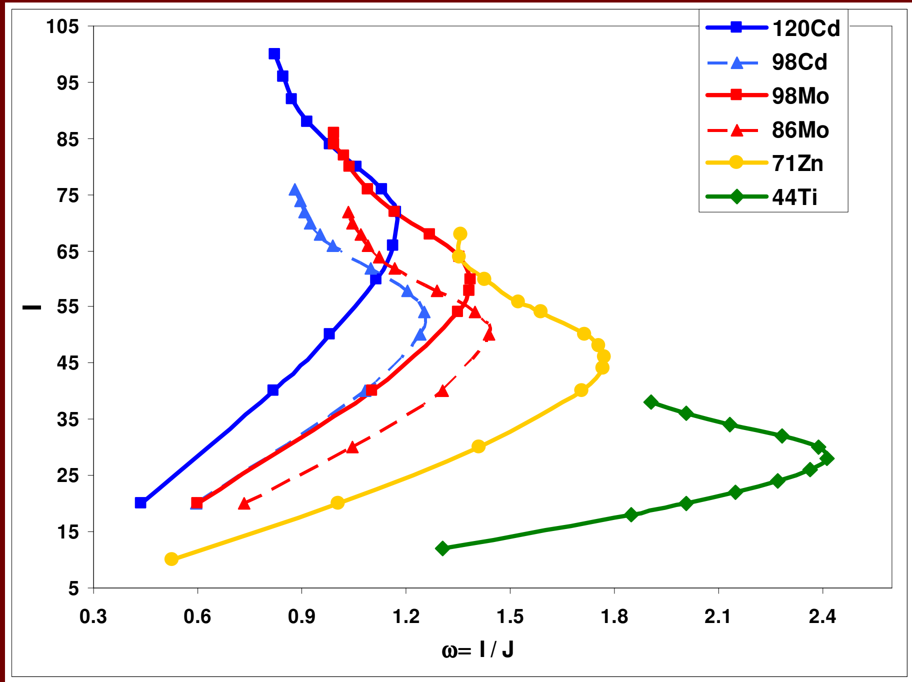
$^{94}_{36}Kr + ^{26}_{12}Mg \rightarrow ^{120}_{48}Cd$;
10^{10} pps
E_b = 900MeV, I_{max} = 100 ħ, E* = 190 MeV

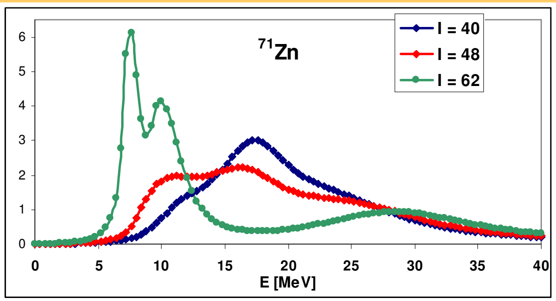
$^{40}_{20}Ca + ^{58}_{28}Ni \rightarrow ^{98}_{48}Cd$;
stable
E_b = 250MeV, I_{max} = 78 ħ, E* = 120 MeV



$^{68}_{28}Ni + ^{30}_{14}Si \rightarrow ^{98}_{42}Mo$;
10^{8} pps
E_b = 500MeV, I_{max} = 85 ħ, E* = 150 MeV

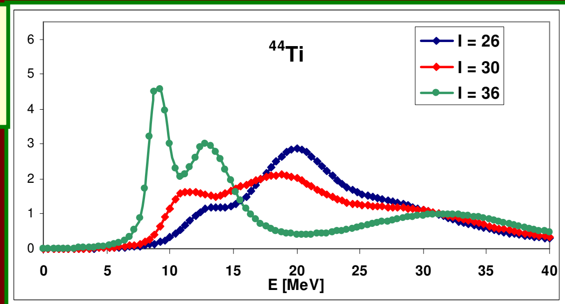
$^{58}_{28}Ni + ^{28}_{14}Si \rightarrow ^{86}_{42}Mo$;
stable
E_b = 400MeV, I_{max} = 68 ħ, E* = 110 MeV





$^{23}_{10}Ne + ^{48}_{20}Ca \rightarrow ^{71}_{30}Zn$;
10^{6} pps
E_b = 220MeV, I_{max} = 70 ħ, E* = 160 MeV

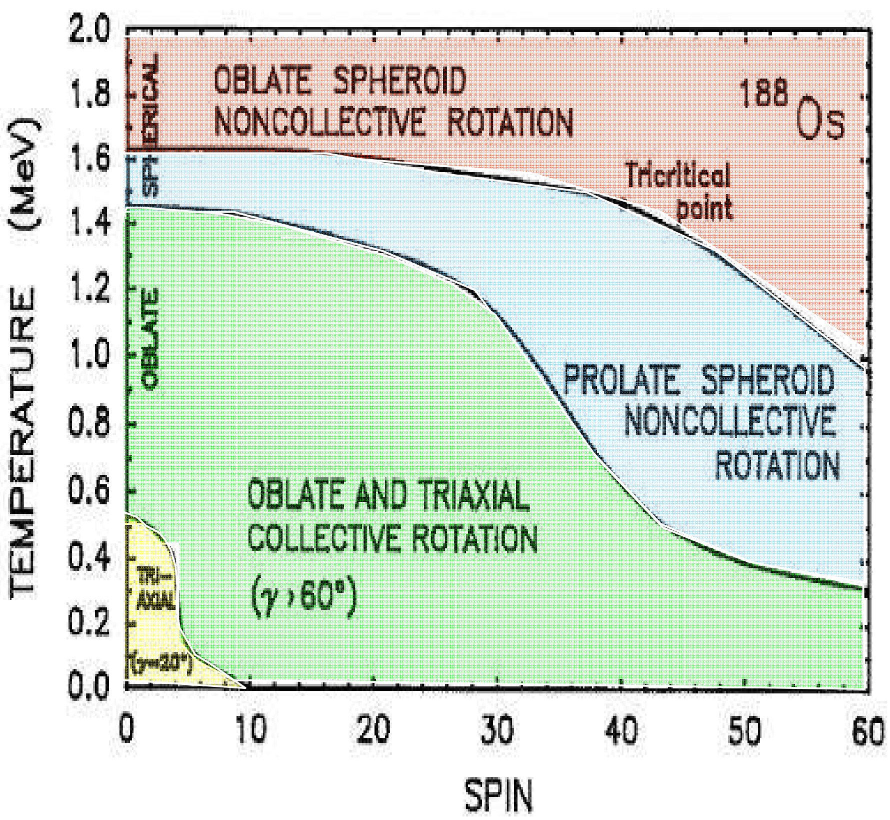
$^{12}_{6}C + ^{32}_{16}S \rightarrow ^{44}_{22}Ti$
stable
E_b = 170MeV, I_{max} = 38 ħ, E* = 130 MeV



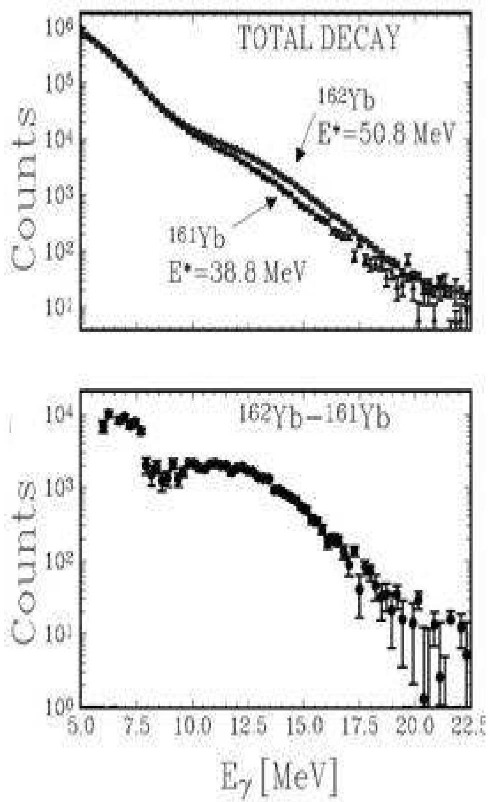
Studies of shape phase diagrams of hot nuclei – GDR differential methods

I. Mazumdar, A. Maj et al..

A.L. Goodman, *Nucl. Phys.* **A687** (2001) 206c



A. Maj et al., *Phys. Lett.* **291B**, (1992) 385



$^{138-145}Xe + {}^{48}Ti \rightarrow {}^{186-193}Os$

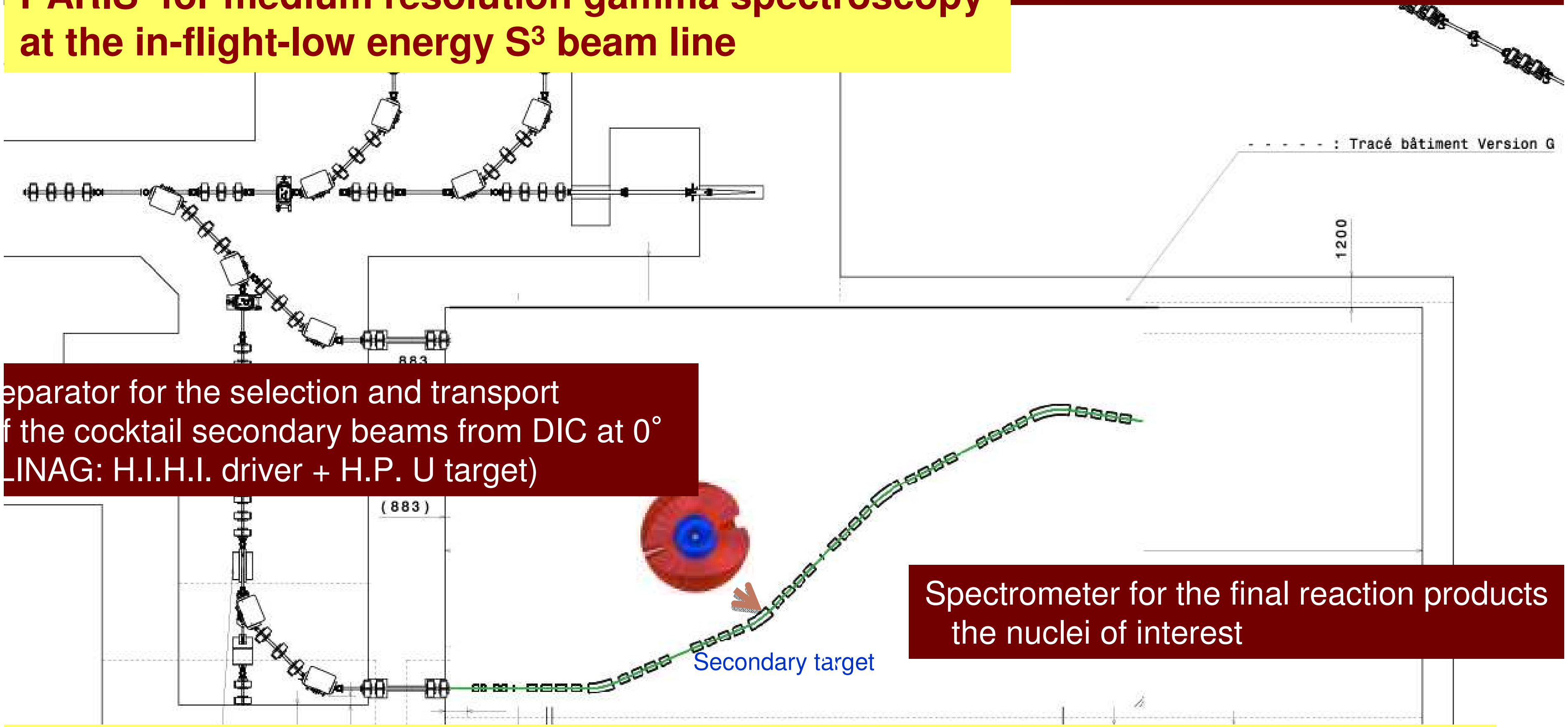
$^{138-145}Xe + {}^{52}Cr \rightarrow {}^{190-197}Pt$

I. Mazumdar et al., *Nucl. Phys.* **A731** (2004)146

Shell structure at low energies (separator part of S³)

F. Azaiez, S. Franchoo, et al.

PARIS for medium resolution gamma spectroscopy at the in-flight-low energy S³ beam line



eparator for the selection and transport
f the cocktail secondary beams from DIC at 0°
LINAG: H.I.H.I. driver + H.P. U target)

Spectrometer for the final reaction products
the nuclei of interest

- **Molecular states in neutron rich nuclei : Inelastic scattering and radiative capture.**
- **Shell structure evolution in neutron rich nuclei : Coulex, inelastic scattering and DIC.**
- **N/Z dependance of the nuclear collective modes- soft modes in hot nuclei**

Physics Case	Recoil mass	v/c [%]	E_γ range [MeV]	$\Delta E_\gamma/E_\gamma$ [%]	$\Delta E_{sum}/E_{sum}$ [%]	ΔM_γ	Ω coverage	ΔT [ns]	Ancillaries	Comments
Jacobi transition	40-150	<10	0.1-30	4	<5	4	2π-4π	<1	AGATA HI det.	High eff. Beam rej.
Shape Phase Diagram	160-180	<10	0.1-30	6	<5	4	2π-4π	<1	HI det.	High eff. Differential method Beam rej.
Hot GDR in n-rich nuclei	120-140	<11	0.1-30	6	<8	4	2π-4π	<1	HI det.	Beam re.
Isospin mixing	60-100	<7	5-30	6	-	-	4π	<1	HI det.	High eff. Beam rej.
Reaction dynamics	160-220	<7	0.1-25	6-8	<8	4	2π	<1	n-det. FF det.	Complex coupling
Collectivity vs. multi-fragmentation	120-200	<8	5-30	5	-	-	2π	<1	LCP det. HI det.	Complex coupling
Radiative capture	20-30	<3	1-30	<4	5	-	4π	<1	HI det.	High eff.
Multiple Coulex	40-60	<7	2-6	5	-	-	2π	<5	AGATA CD det.	Complex coupling
Astrophysics	16-90	0.1	0.1-6	6	5	-	4π	<1	Outer PARIS shell as active shield	High eff. Back-ground
Shell structure at intermediate energies (SISSI/LISE)	16-40	20-40	0.5-4	3	-	-	3π	<<1	SPEG or VAMOS	High eff. Low I_{beam} γ–γ coinc
Shell structure at low energies (separator part of S^3)	30-150	10-15	0.3-3	3	-	-	3π	<<1	Spectrometer part of S^3	High eff. Low I_{beam} γ–γ coinc
Relativistic Coulex	40-60	50-60	1-4	4	-	1	Forward 3π	<<1	AGATA HI analyzer	Ang. Distr. Lorentz boost

<β> ≈ 10%; ΔM/M<4 → **Granularity: 200-800**

ΔT: <1 ns; ΔEγ/Eγ: < 3%; high efficiency up to 15 MeV → **$LaBr_3$ scintillators**

Organizacja kolaboracji PARIS

The PARIS collaboration (status on 31.12.2008)

IFJ PAN Kraków (Poland): P. Bednarczyk, M. Kmiecik, B. Fornal, J. Grębosz, A. Maj, W. Męczynski, K. Mazurek, S. Myalski, J. Styczeń, M. Ziębliński, M. Ciemała, A. Czermak. R. Wolski, M. Chelstowska
IPN Orsay (France): F. Azaiez, J.A. Scarpaci, S. Franchoo. I. Stefan
CSNSM Orsay (France): G. Georgiev, A. Lefebvre-Schuhl, R. Lozeva
University of York (UK): D.G. Jenkins, M.A. Bentley, B.R . Fulton, R. Wadsworth, O. Roberts
IPN Lyon (France): Ch. Schmidt, O. Stezowski, N. Redon
IPHC Strasbourg (France): O. Dorvaux, S. Courtin, C. Beck, D. Curien, B. Gall, F. Haas, D. Lebhertz, M. Rousseau, M.-D. Salsac, L. Stuttgé, J. Dudek
GANIL Caen (France): J.P. Wieleczko, S. Grevy, A. Chbihi, G. Verde, J. Frankland, M. Płoszajczak, A. Navin, G. De France, M. Lewitowicz
LPC-ENSI Caen (France): O. Lopez, E. Vient
Warsaw University (Poland): M. Kicińska-Habior, J. Srebrny, M. Palacz, P. Napiórkowski, K. Hadyńska
IPJ Swierk, Otwock (Poland): M. Moszyński
BARC Mumbai (India): D.R. Chakrabarty, V.M. Datar, S. Kumar, E.T. Mirgule, A. Mitra, P.C. Rout
TIFR Mumbai (India): I. Mazumdar, V. Nanal, R.G. Pillay
University of Delhi, New Delhi (India): S.K. Mandal
University of Surrey, Guildford (UK): Z. Podolyak, P.R. Regan, P. Stevenson
GSI Darmstadt (Germany): M. Górska, J. Gerl, S. Pietri
University of Oslo (Norway): S. Siem
Oak Ridge (US): N. Schunck
ATOMKI Debrecen (Hungary): Z. Dombradi, D. Sohler, A. Krasznahorkay, G. Kalinka, J.Gal, J.Molnar
INRNE, Bulgarian Academy of Sciences, Sofia (Bulgaria): D. Balabanski,
University of Sofia (Bulgaria): S. Lalkovski, K. Gladnishki, P. Detistov
NBI Copenhagen (Denmark): B. Herskind, G. Sletten
UMCS Lublin (Poland): K. Pomorski
HMI Berlin (Germany): H.J. Krappe
LBNL, Berkeley, CA (US): P. Fallon, M.-A. Deleplanque, F. Stephens, I-Y. Lee
iThemba LABS (RSA): R. Bark, P. Papka, J. Lawrie
DSM/Dapnia CEA Saclay (France): C. Simenel
INFN-LNS, Catania (Italy): D. Santonocito
Institute of Nuclear Physics, NCSR "Demokritos", Athens (Greece): S. Harissopulos, A. Lagoyannis, T. Konstantinopoulos
Istanbul University, Instambul (Turkey): M.N. Erduran, M.Bostan, A. Tutay, M. Yalcinkaya, I. Yigitoglu,E. Ince, E. Sahin
Nigde University, Nigde (Turkey): S. Erturk
Erciyes University, Kayseri (Turkey): **I**.. Boztosun
Ankara University, Ankara (Turkey): A. Ataç-Nyberg
Kocaeli University, Kocaeli (Turkey): T. Güray
Flerov Laboratory of Nuclear Reactions, JINR, Dubna, Russia: A. Fomichev, S. Krupko, V. Gorshkov.
Uppsala University, (Sweden): H. Mach
KVI, Groningen, (The Netherlands)*:* M. Harakeh
INFN and University Milano (Italy): S Brambilla, F. Camera, S. Leoni, O. Wieland.
LPSC Grenoble(France): G. Simpson
The Weizmann Institute Rehovot (Israel): M. Haas
INFN Napoli (Italy): D. Pierroutsakou
STFC Daresbury (UK): J. SImpson, J. Strachan, A. Smith, M. Labiche
RIKEN, Tokyo (JP): P. Doornenball

40 institutions from 17 countries
≈ 100 physicists, engineers and PhD students

IFJ PAN Kraków (Poland):
P. Bednarczyk, M. Chełstowska, M. Ciemała, A. Czermak, B. Fornal, J. Grębosz, M. Kmiecik, A. Maj, K. Mazurek, S. Myalski, W. Męczyński, J. Styczeń, R. Wolski, M. Ziębliński

Warsaw University (Poland):
M. Kicińska-Habior, J. Srebrny, M. Palacz, P. Napiórkowski, K. Hadyńska

IPJ Swierk, Otwock (Poland):
M. Moszyński

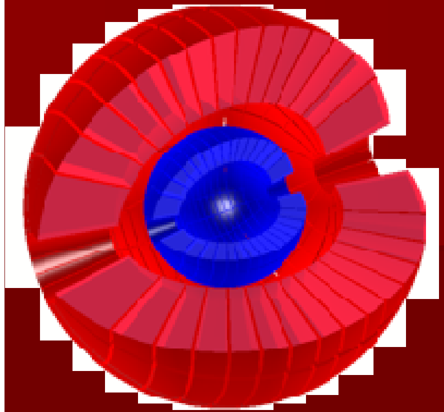
PARIS Management board
A. Maj - project spokesman;
D.G. Jenkins, J.P. Wieleczko, J.A. Scarpaci - deputies

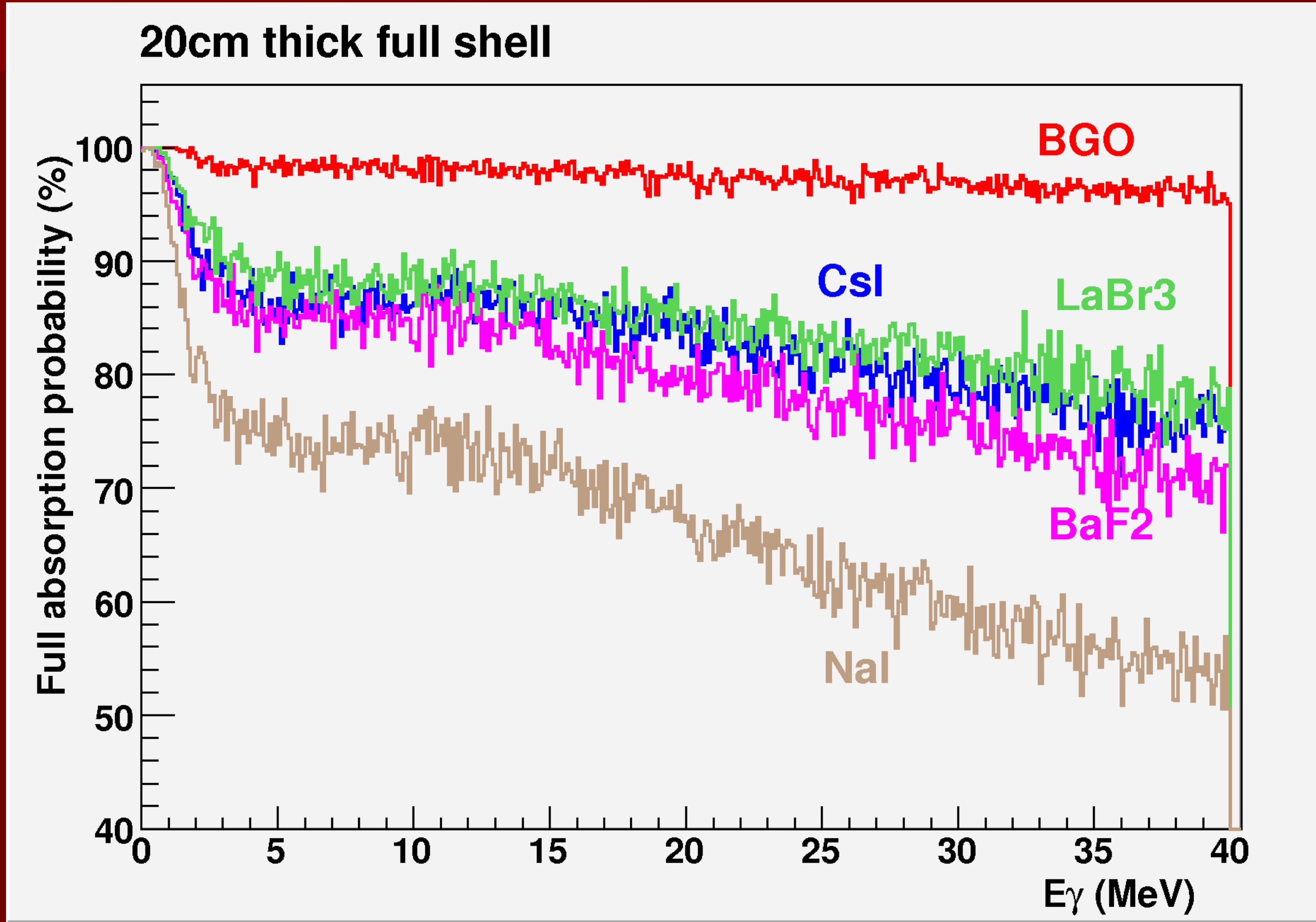
PARIS Steering *(Advisory)* Committee
F. Azaiez (F) -chairman, D. Balabanski (BG), W. Catford (UK), D. Chakrabarty (India), Z. Dombradi (H), S. Courtin (F), J. Gerl (D), D. Jenkins (UK) - deputy chairman, S. Leoni (I), A. Maj (PL), J.A. Scarpaci (F), Ch. Schmidt (F), J.P. Wieleczko (F)

Active working groups

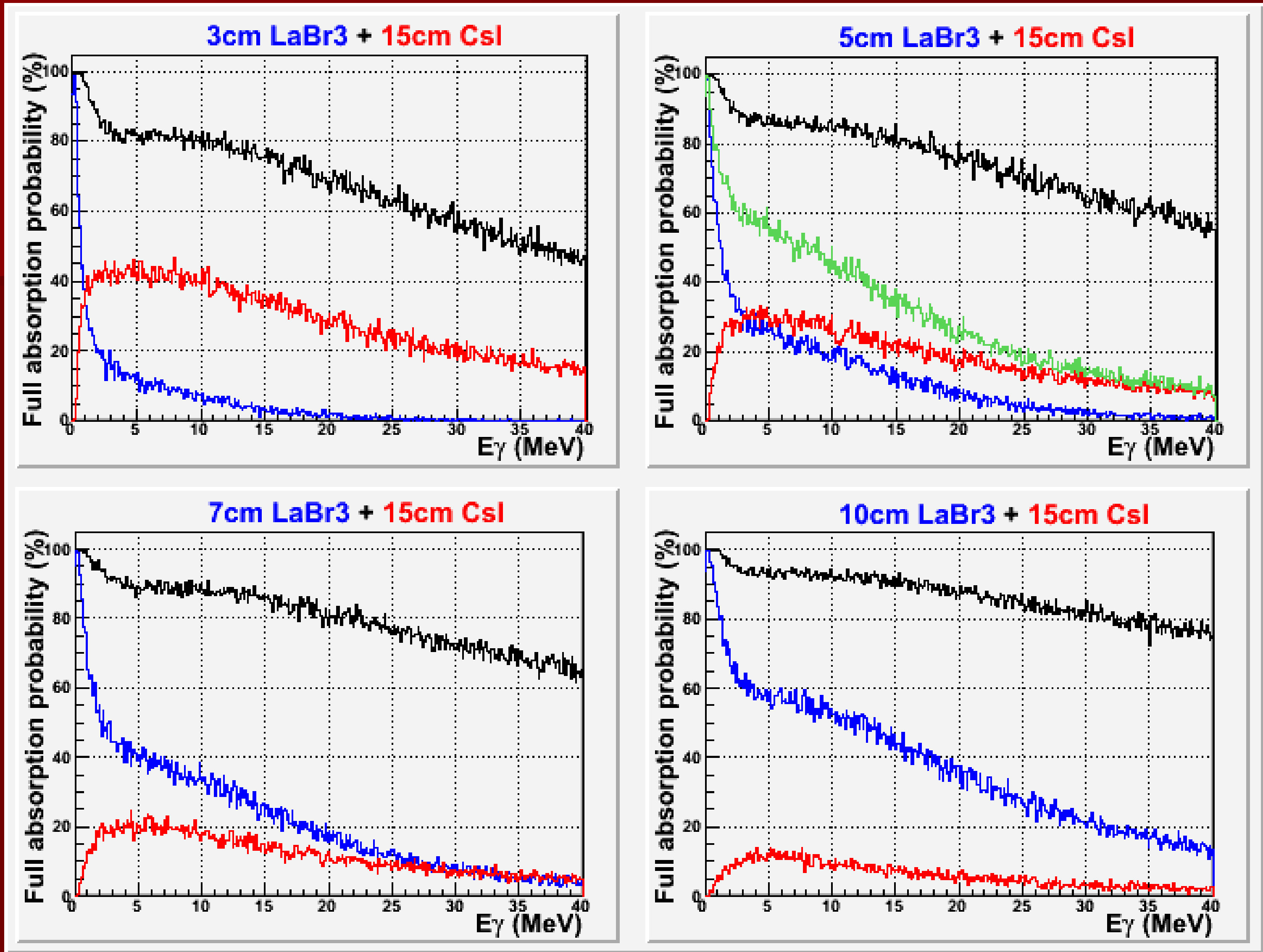
1. Simulations (O. Stezowski et al.)
2. PARIS mechanical design scenarios (S. Courtin, D. Jenkins et al.)
3. Physics cases and theory background (Ch. Schmitt et al.)
4. Detectors (O. Dorvaux, J. Pouthas et al.)
5. Financial issues (J.P. Wieleczko et al.)
6. PARIS in FP7 projects (A. Maj, F. Azaiez et al.)
7. Electronics (P. Bednarczyk et al.)
8. PARIS-GASPARD synergy (J.A. Scarpaci et al.)

Symulacje GEANT4

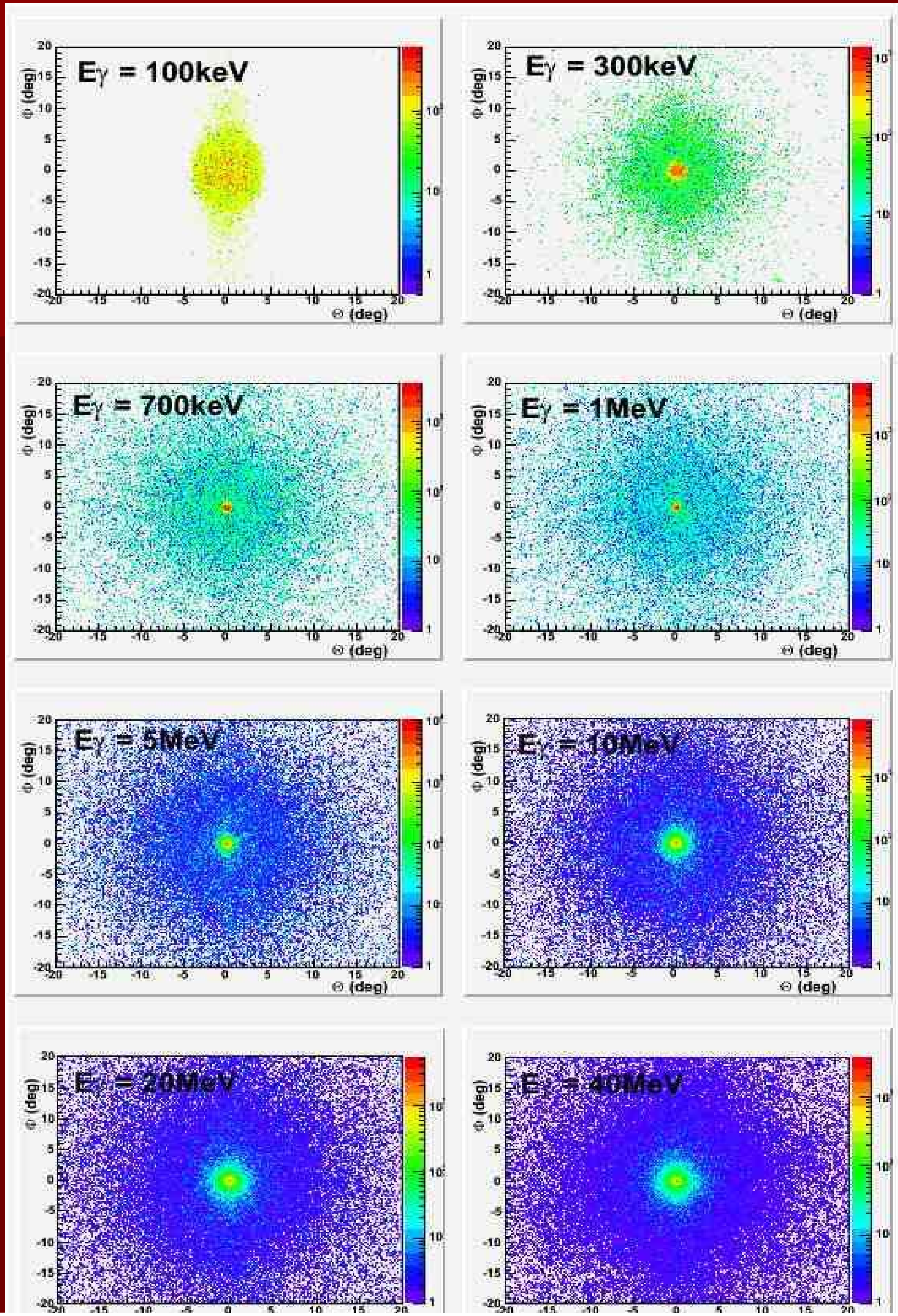




Full absorption probability for full shells (20cm radius) made of different scintillators

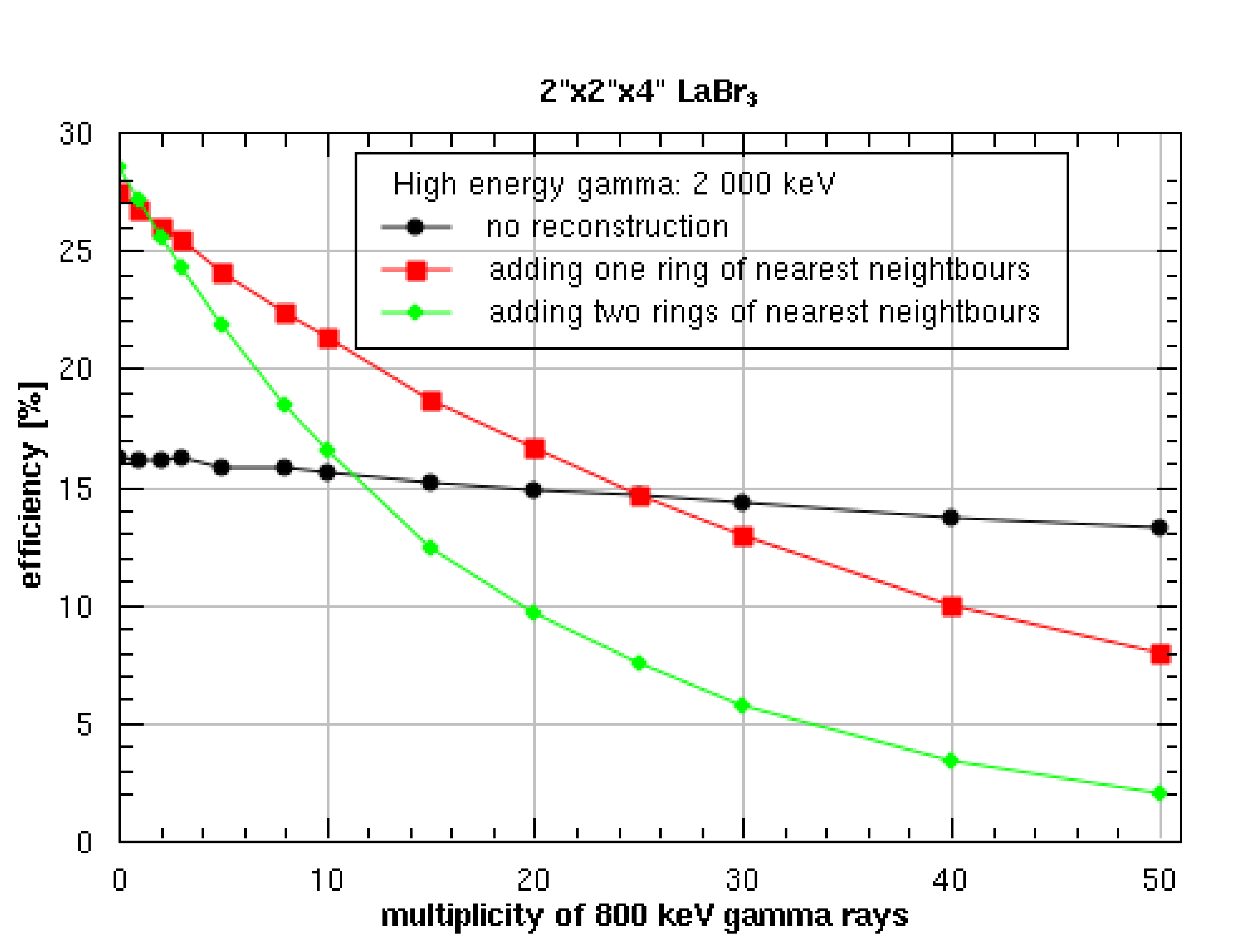


Full absorption efficiency for different 'ideal' configurations

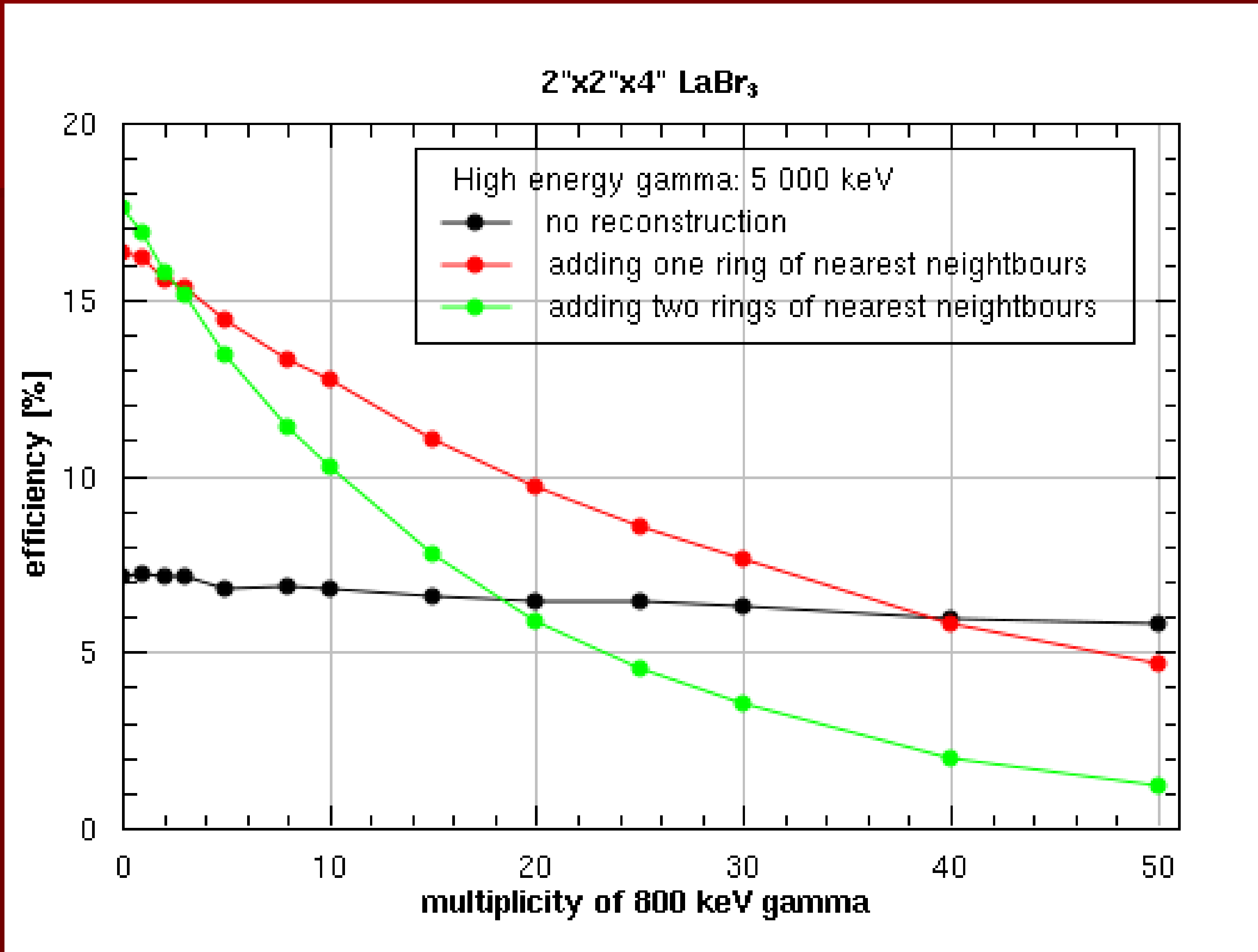


Rozmiary poprzeczne „pęku” w det. LaBr3 dla różnych energii kwantu gamma

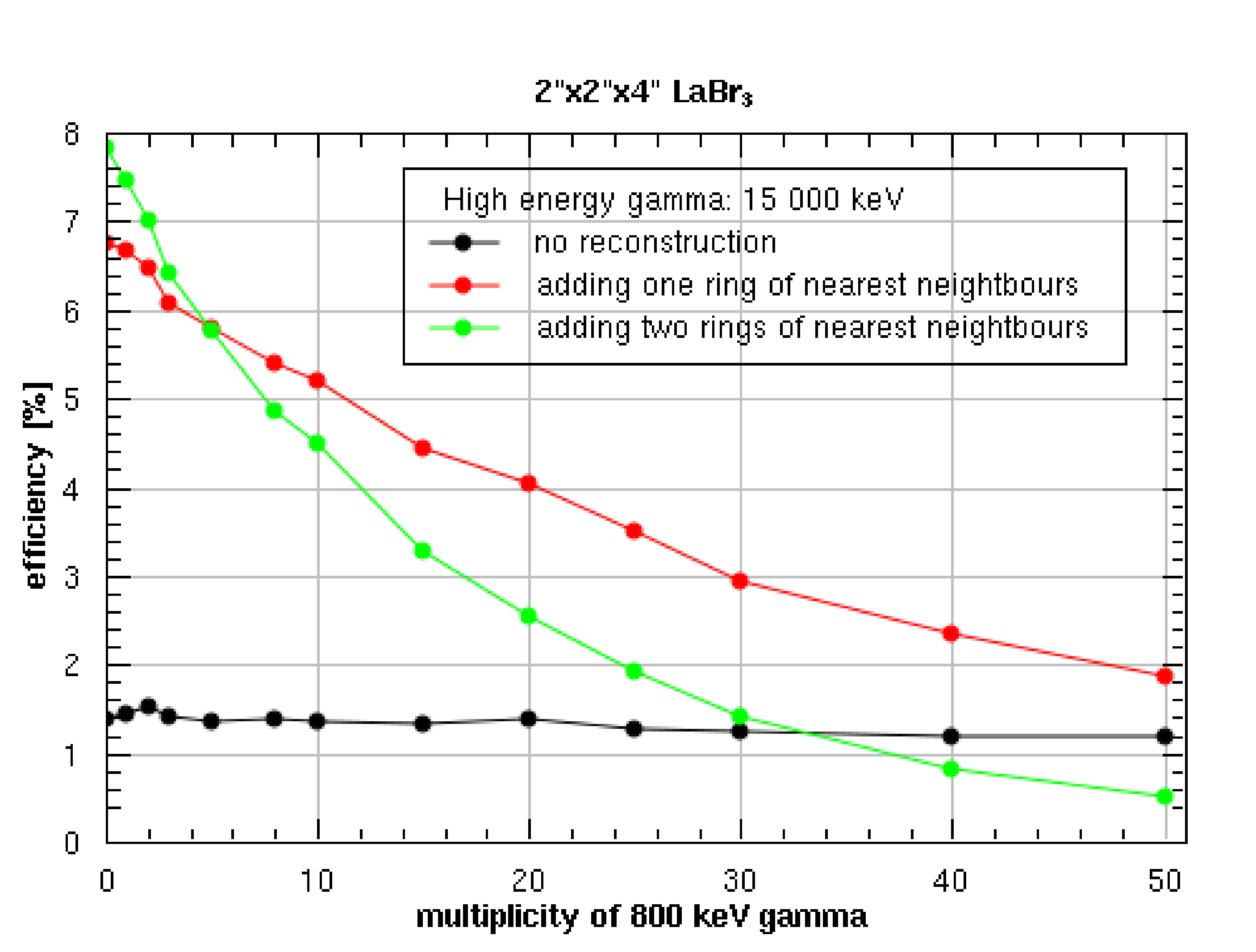
Rekonstrukcja wysokoenergetycznego (2 MeV) fotonu przy obecności wielu niskoenergetycznych (800 keV) kwantów gamma



Rekonstrukcja wysokoenergetycznego (5 MeV) fotonu przy obecności wielu niskoenergetycznych (800 keV) kwantów gamma



Rekonstrukcja wysokoenergetycznego (15 MeV) fotonu przy obecności wielu niskoenergetycznych (800 keV) kwantów gamma



Konkluzje z symulacji:

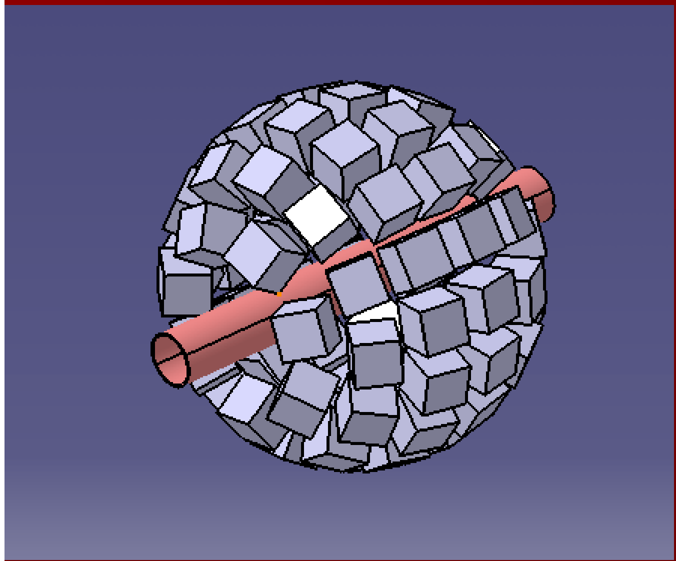
Idea układu składającego się z 2 sfer wydaje się być możliwa do zrealizowania pod warunkami:

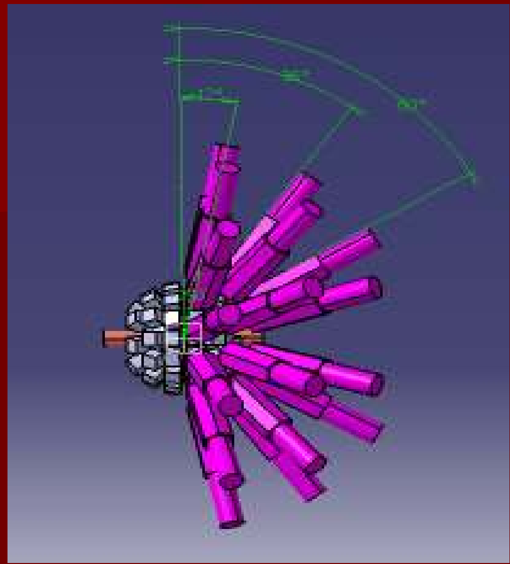
a) Wewnętrzna sfera nie może być za bardzo absorbująca (<10 cm LaBr3).
b) Poprzeczne rozmiary detektora powinny być 2-5 cm,
c) Granulacje (dla eksperymentó z v/c <15%) 200-800

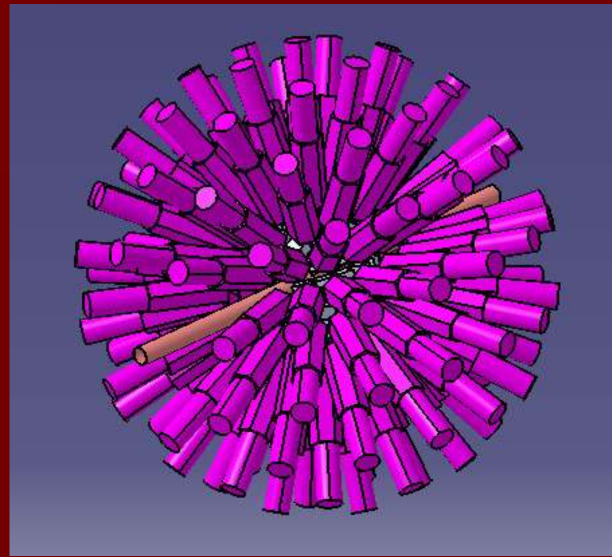
Zarówno geometria sferyczna jak i kubiczna wydają się być dobrymi rozwiązaniami.

Wstępne projekty techniczne

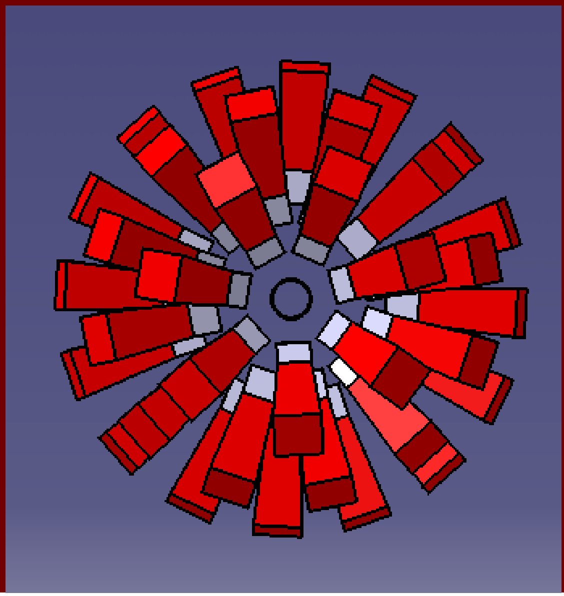
Geometria sferyczna

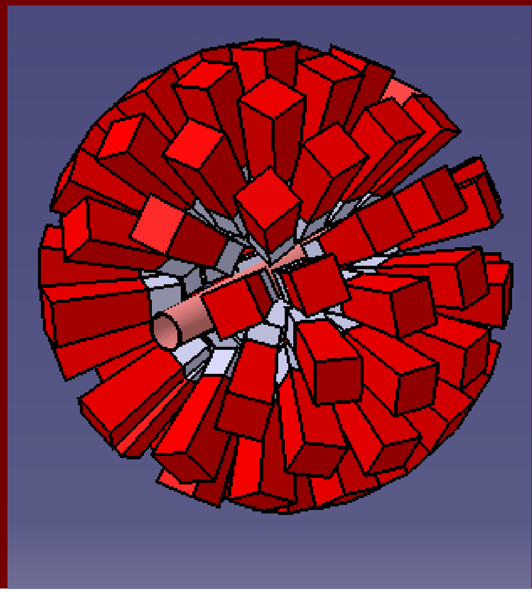


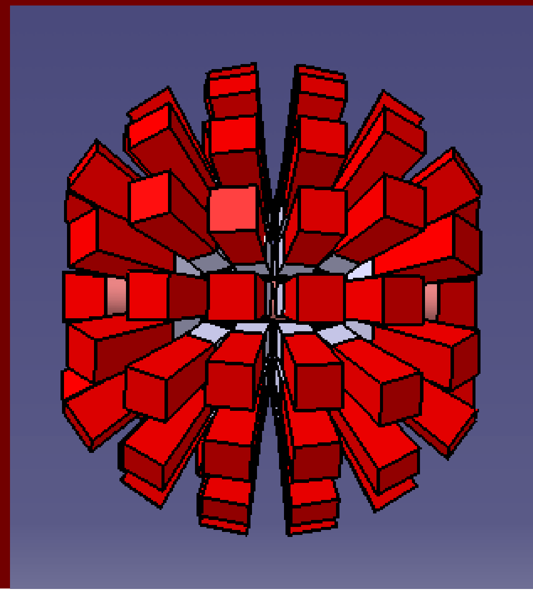


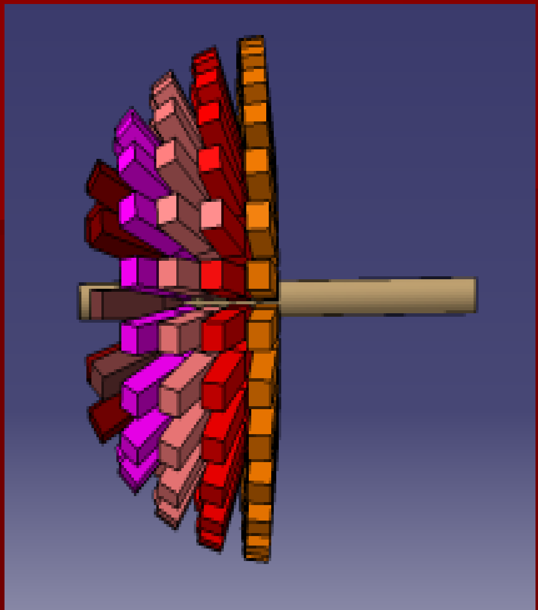


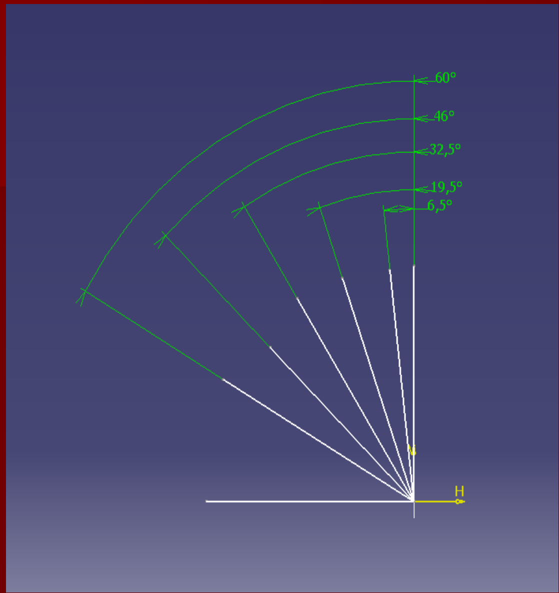
70 elements

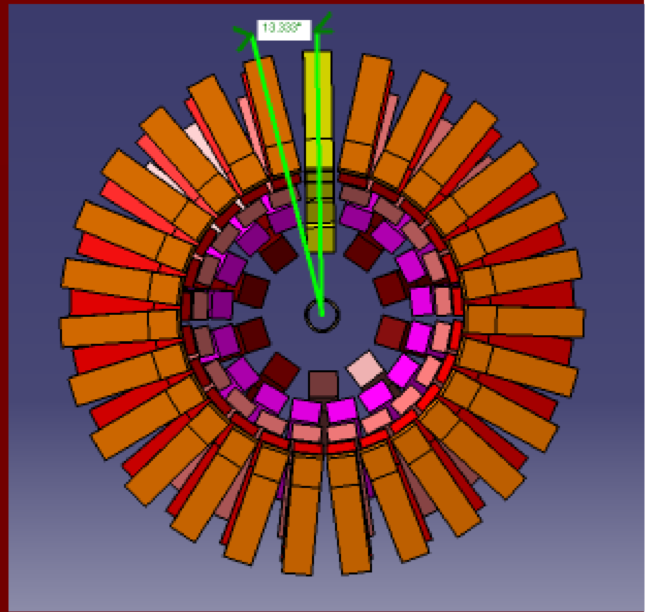




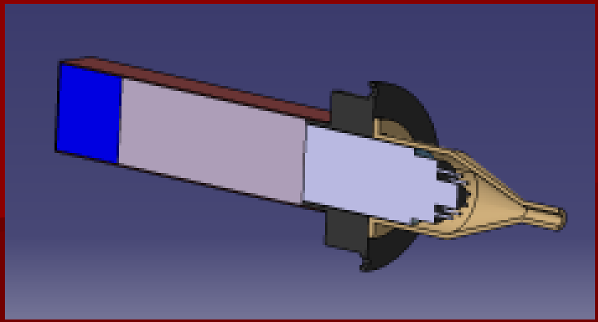


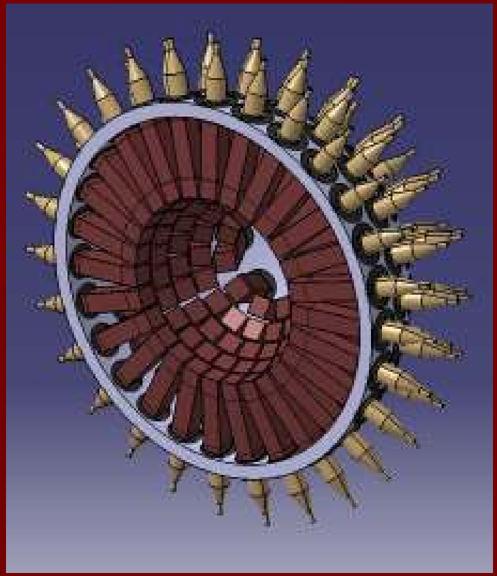




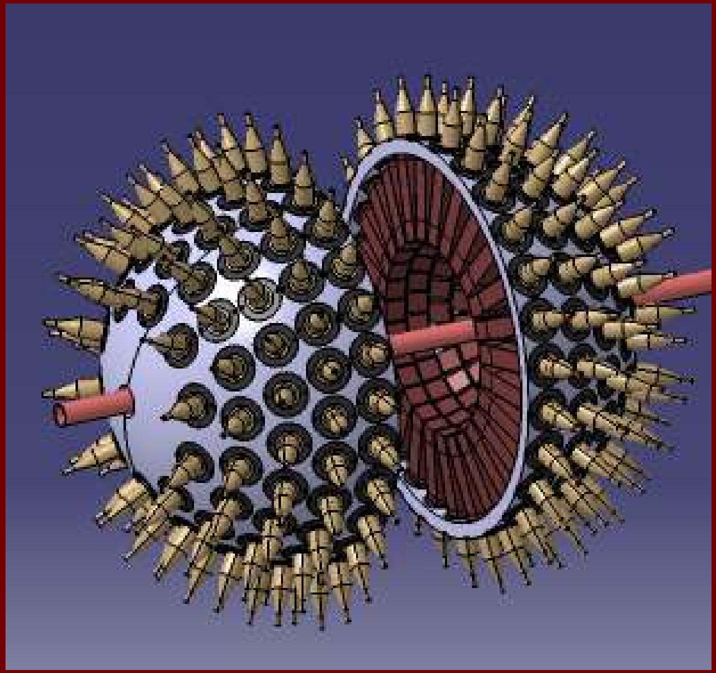


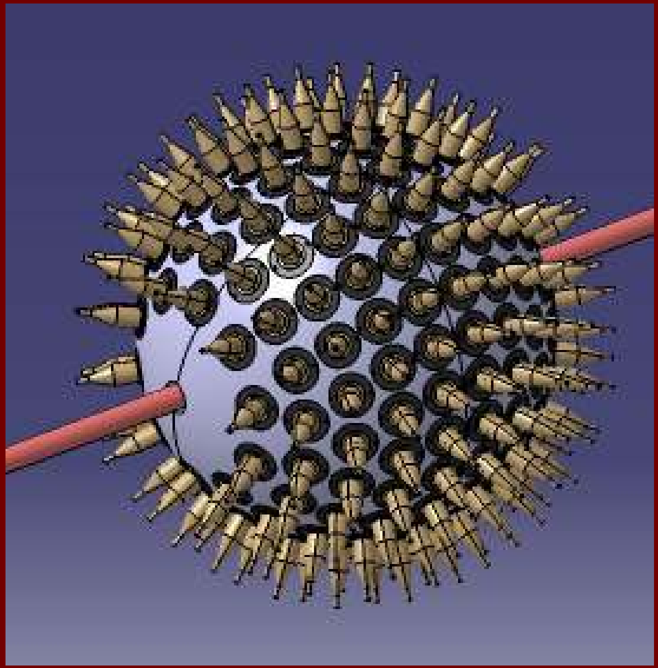
200 elements



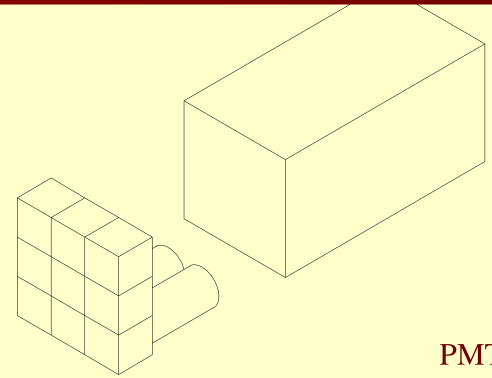


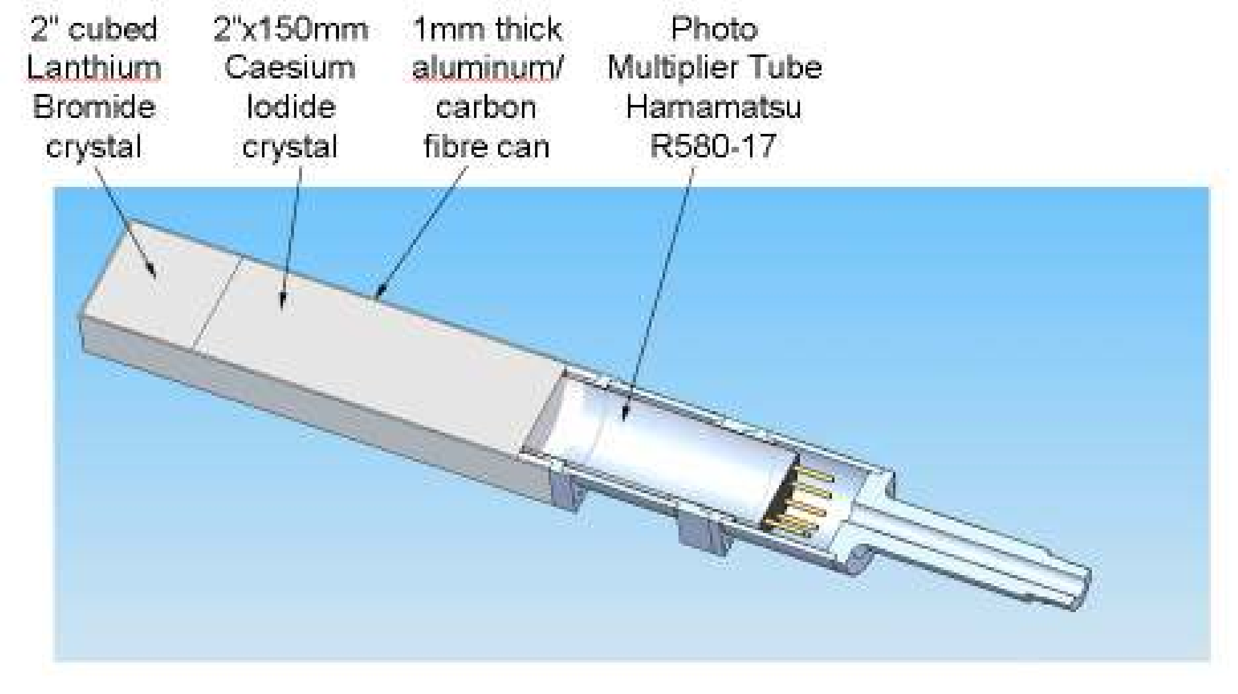
200 elements

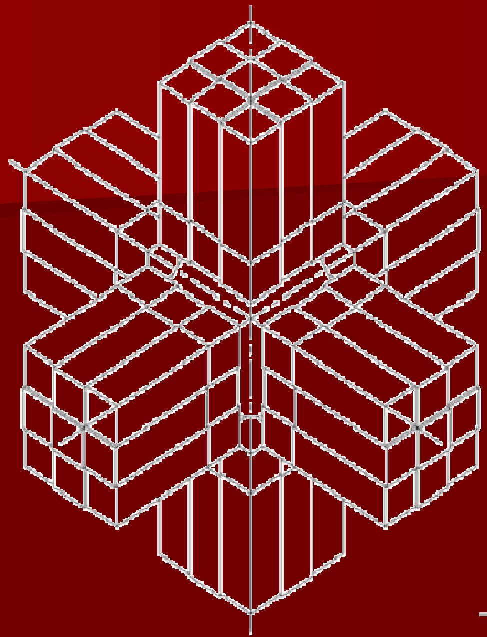




Geometria kubiczna

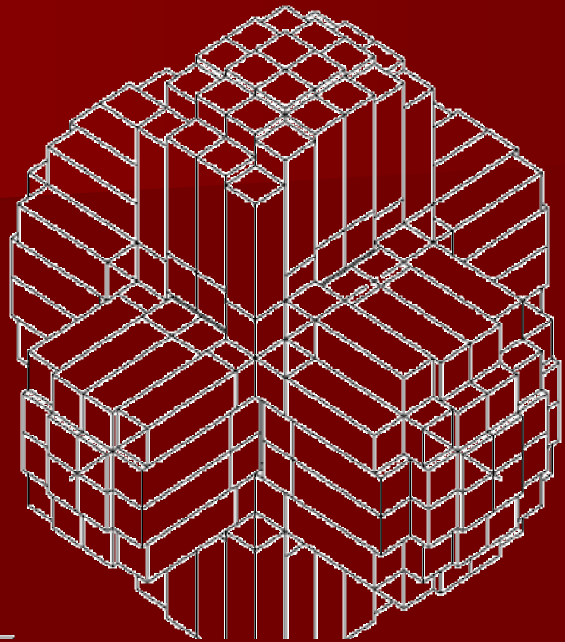






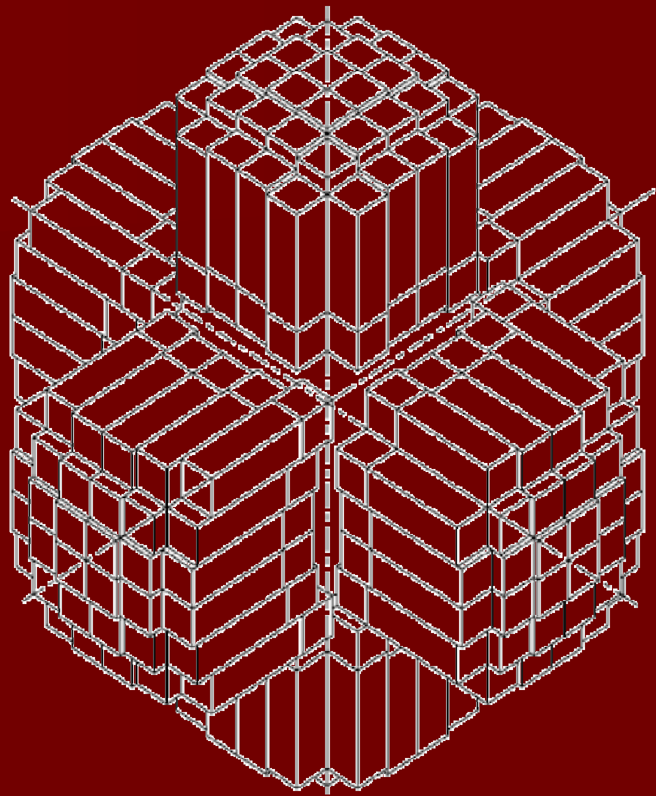
R100

54 elements



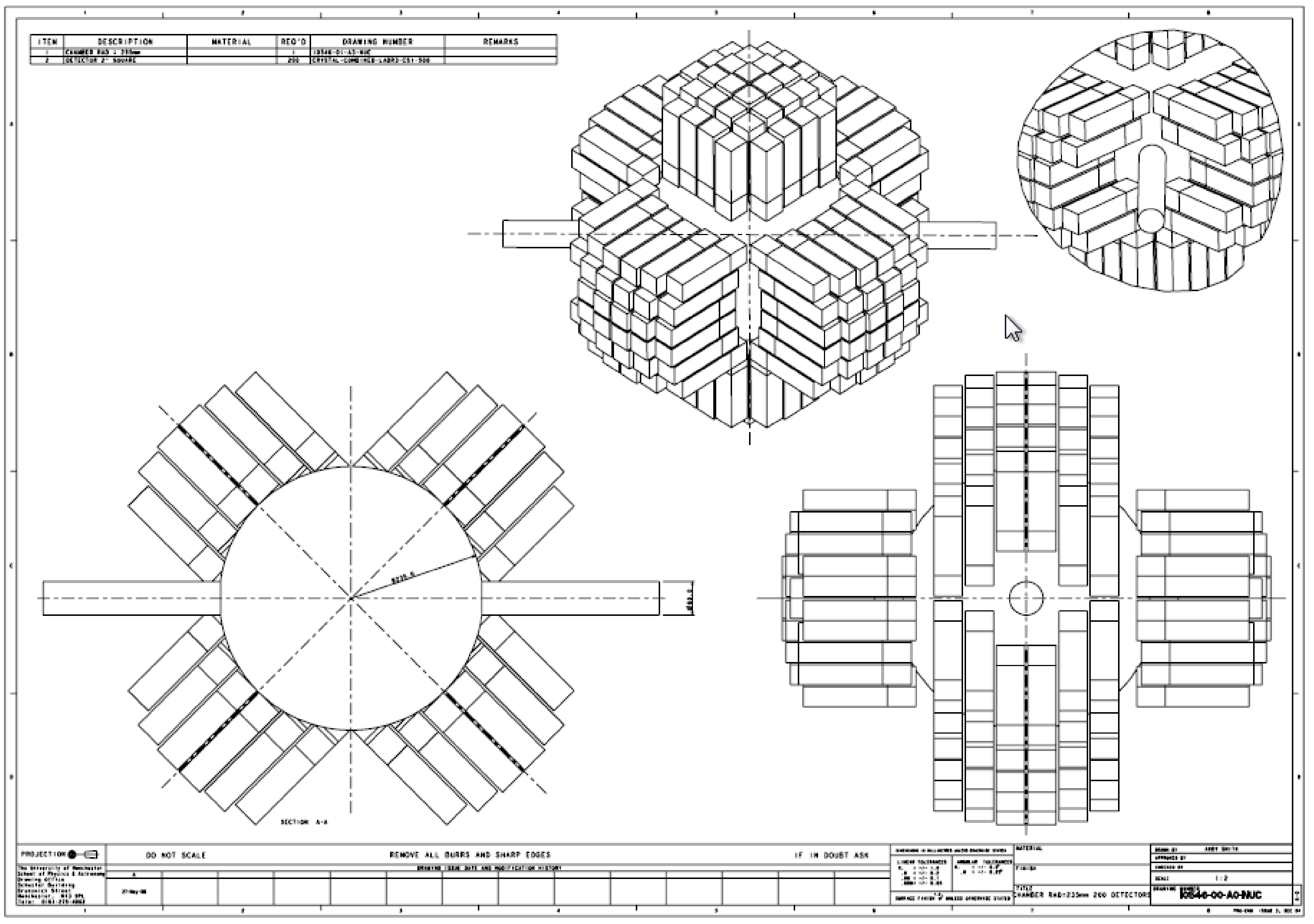
R150

144 elements

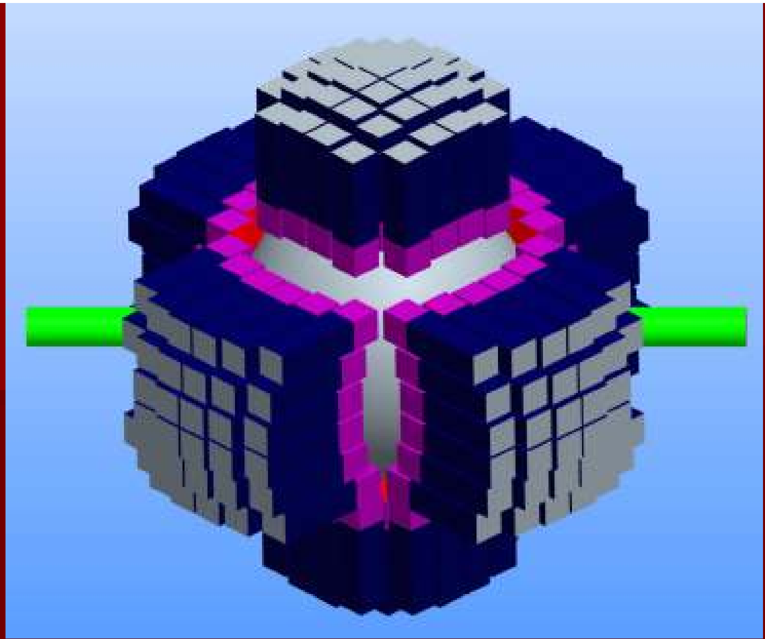


R200

200 elements

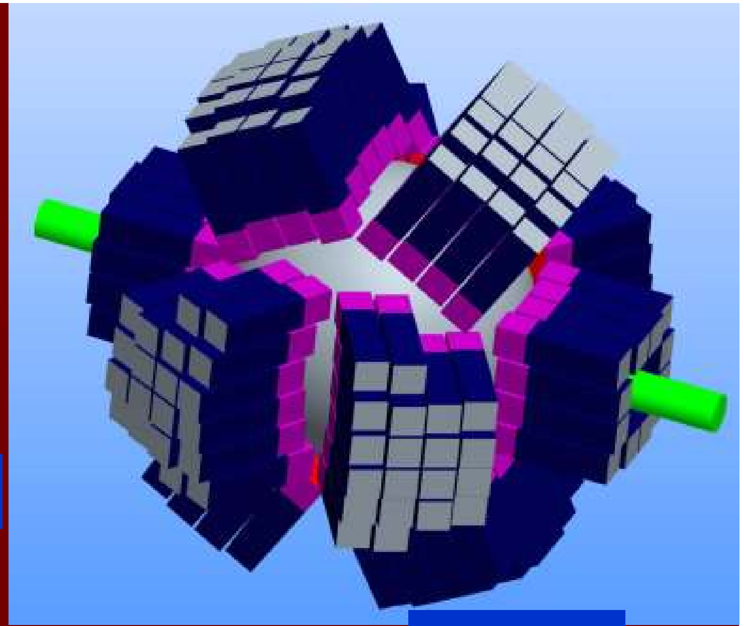


ITEM
DESCRIPTION
MATERIAL
REQ'D
DRAWING NUMBER
REMARKS
SECTION A-A
PROJECTION
DO NOT SCALE
REMOVE ALL BURRS AND SHARP EDGES
IF IN DOUBT ASK
DRAWING ISSUE DATE AND MODIFICATION HISTORY
LINEAR TOLERANCES
MATERIAL
FINISH
TITLE
SCALE 1:2
-00-A0-NUC

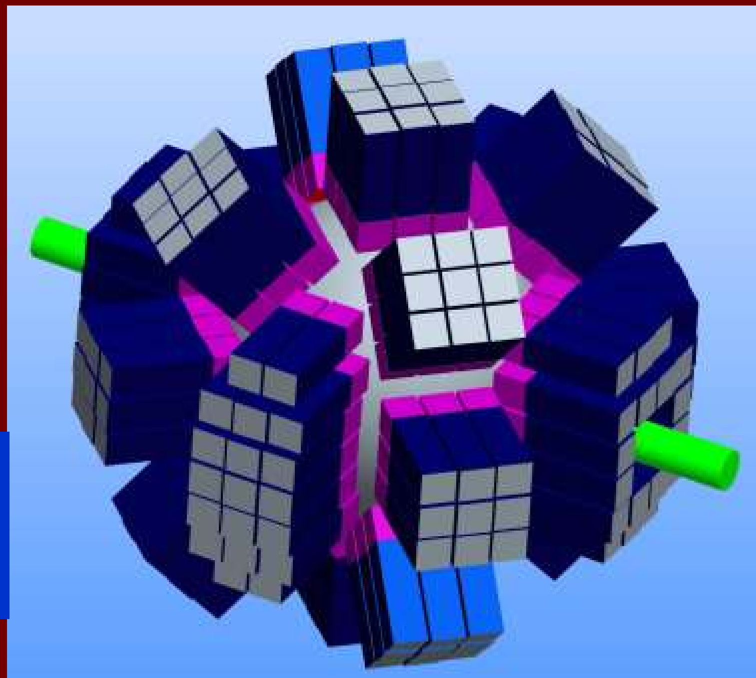


Cube
6 faces

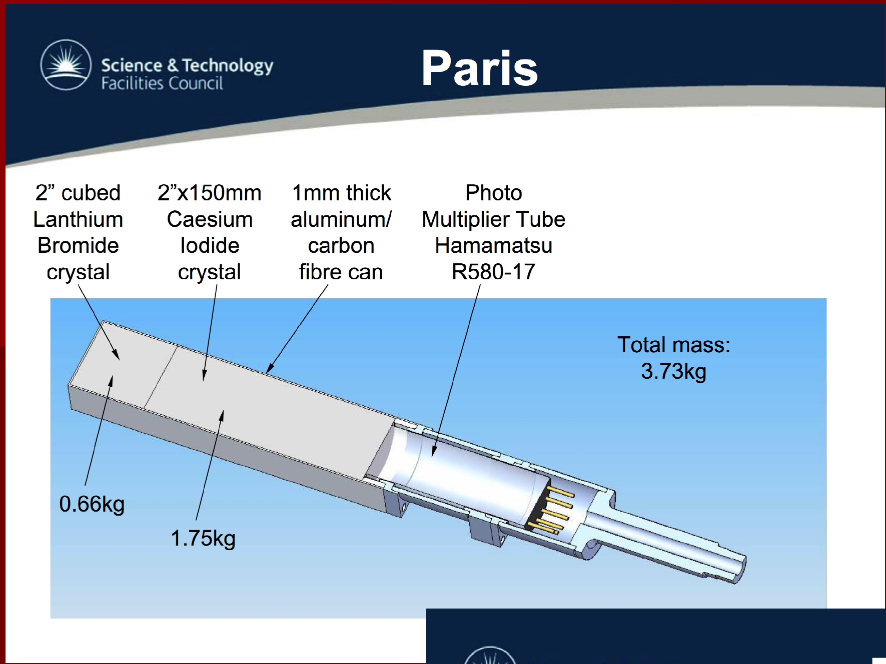
200 elements

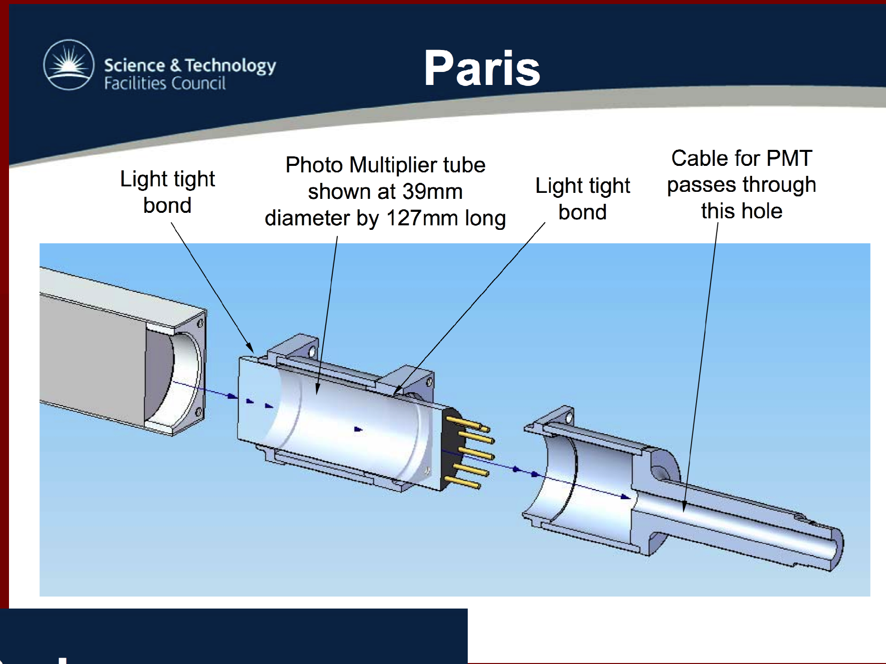


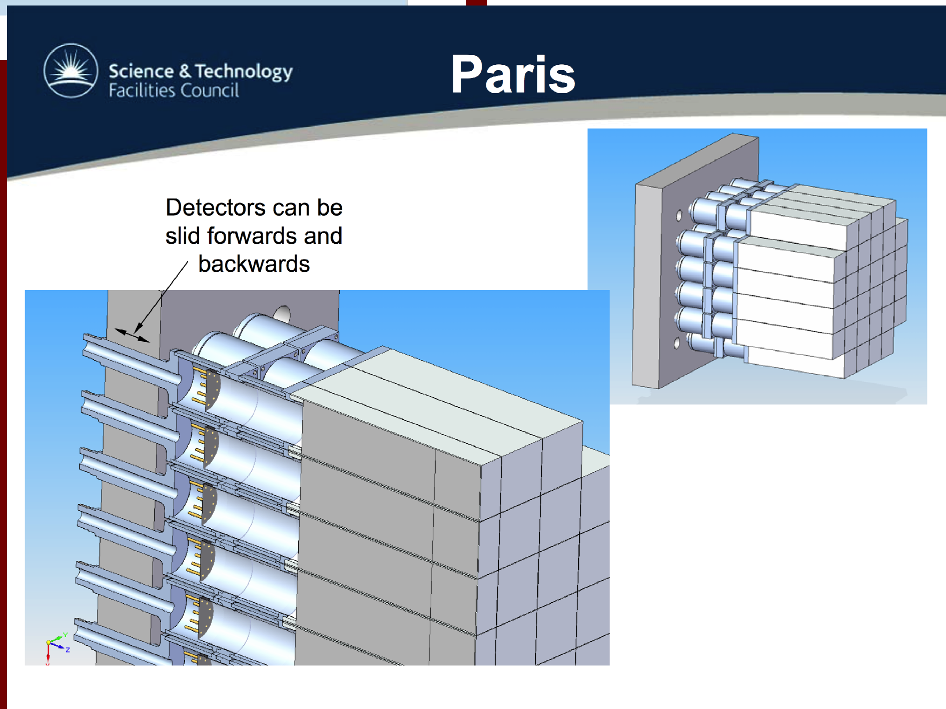
Decagon
10 faces

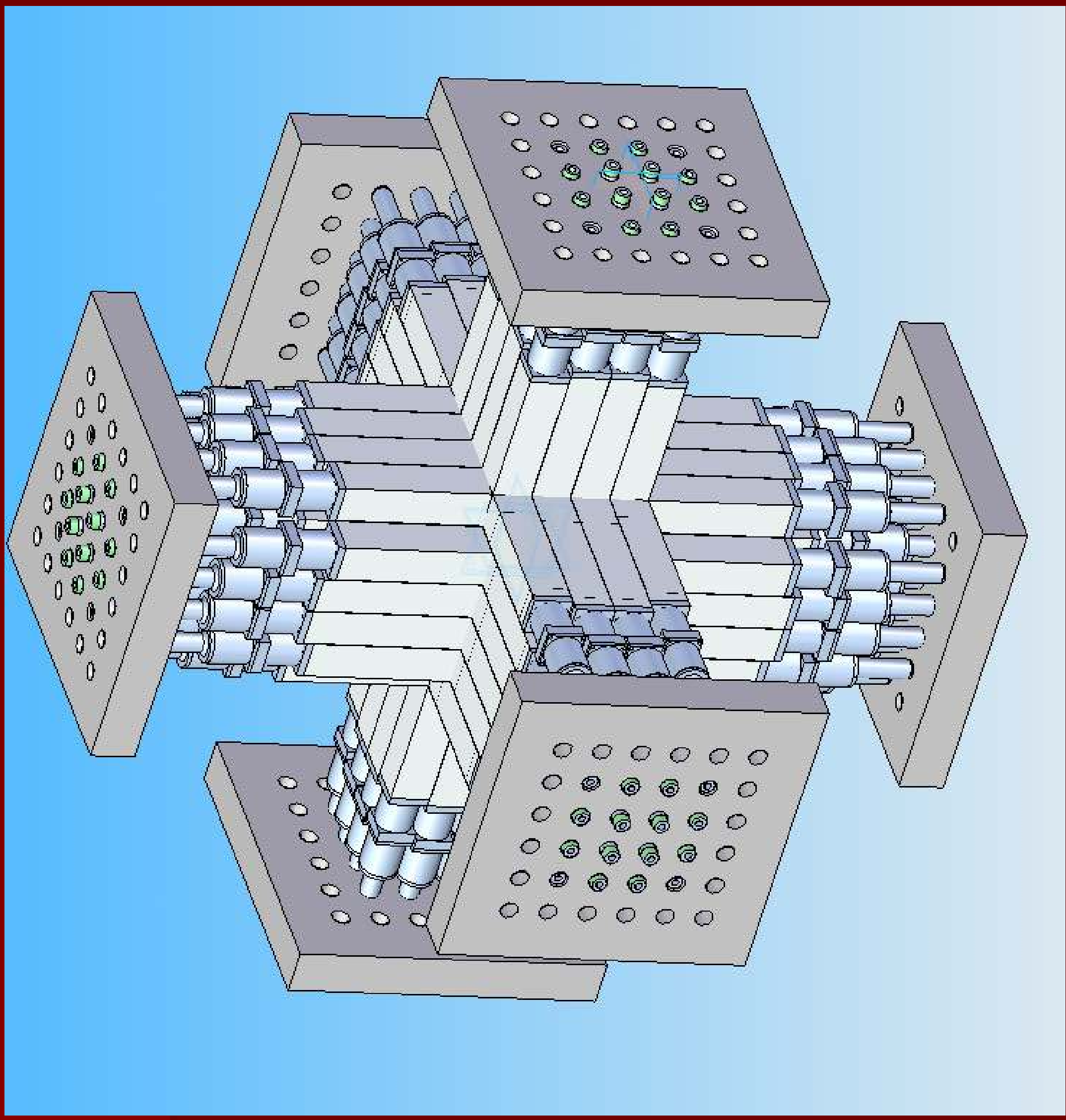


Octadegon
18 faces


Science & Technology Facilities Council
Paris
2" cubed Lanthium Bromide crystal
2"x150mm Caesium Iodide crystal
1mm thick aluminum/ carbon fibre can
Photo Multiplier Tube Hamamatsu R580-17
Total mass: 3.73kg
0.66kg
1.75kg


Science & Technology Facilities Council
Paris
Light tight bond
Photo Multiplier tube shown at 39mm diameter by 127mm long
Light tight bond
Cable for PMT passes through this hole

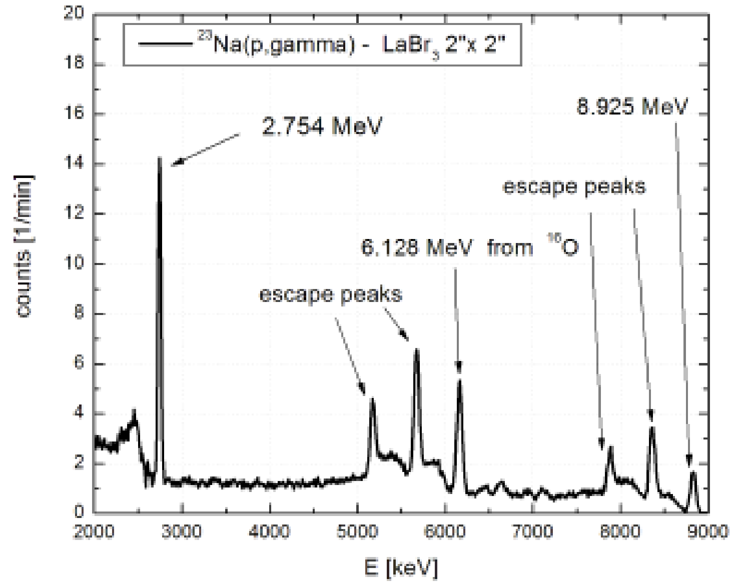

Science & Technology Facilities Council
Paris
Detectors can be slid forwards and backwards



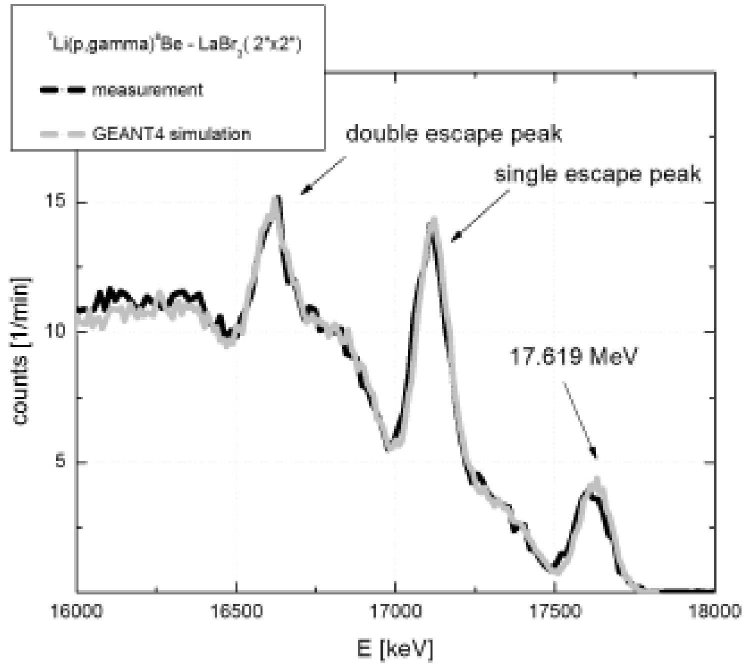
Testy detektorów $LaBr_3$

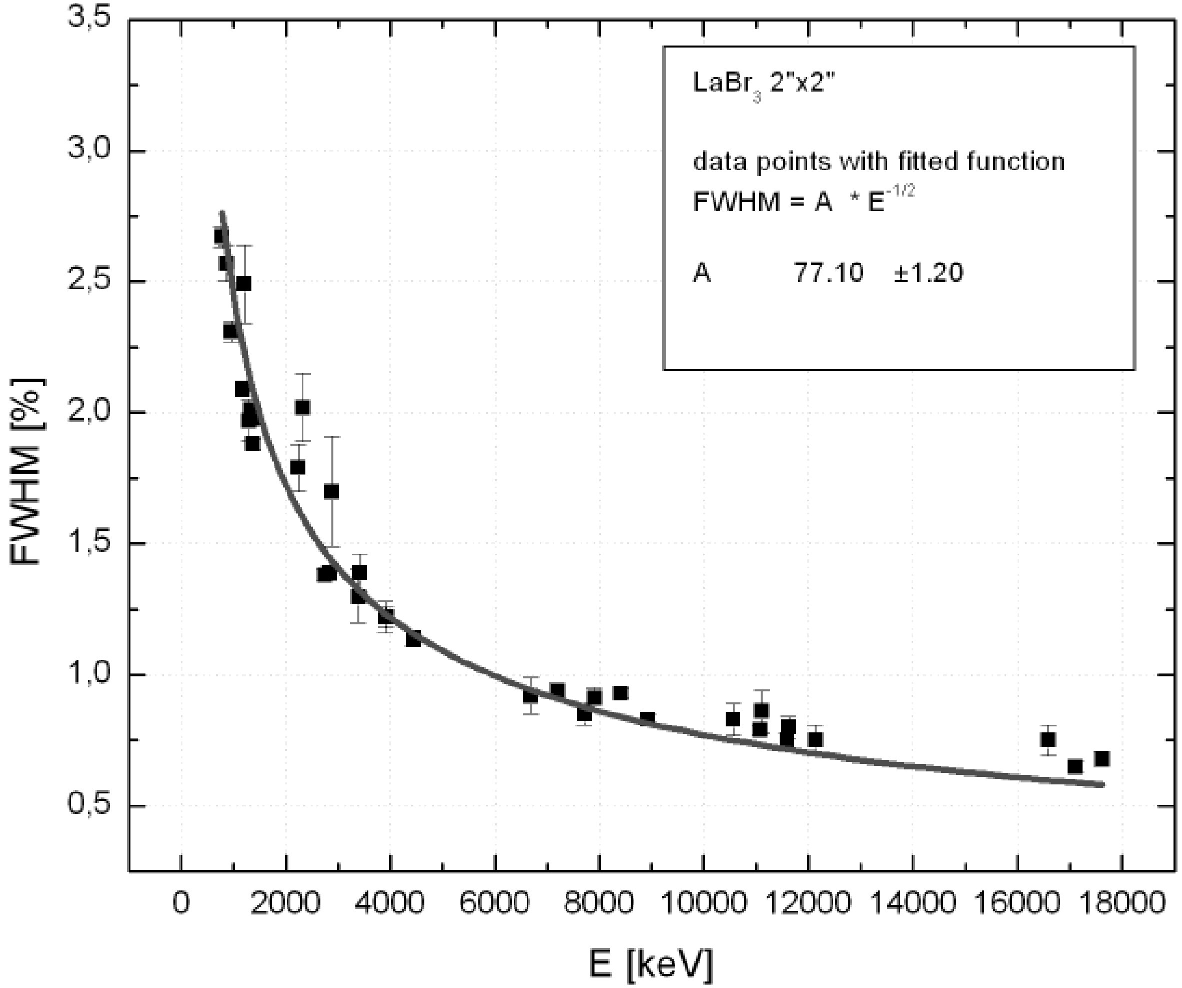
PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

M. Ciemała et al. – Debrecen experiment, to be published in NIM



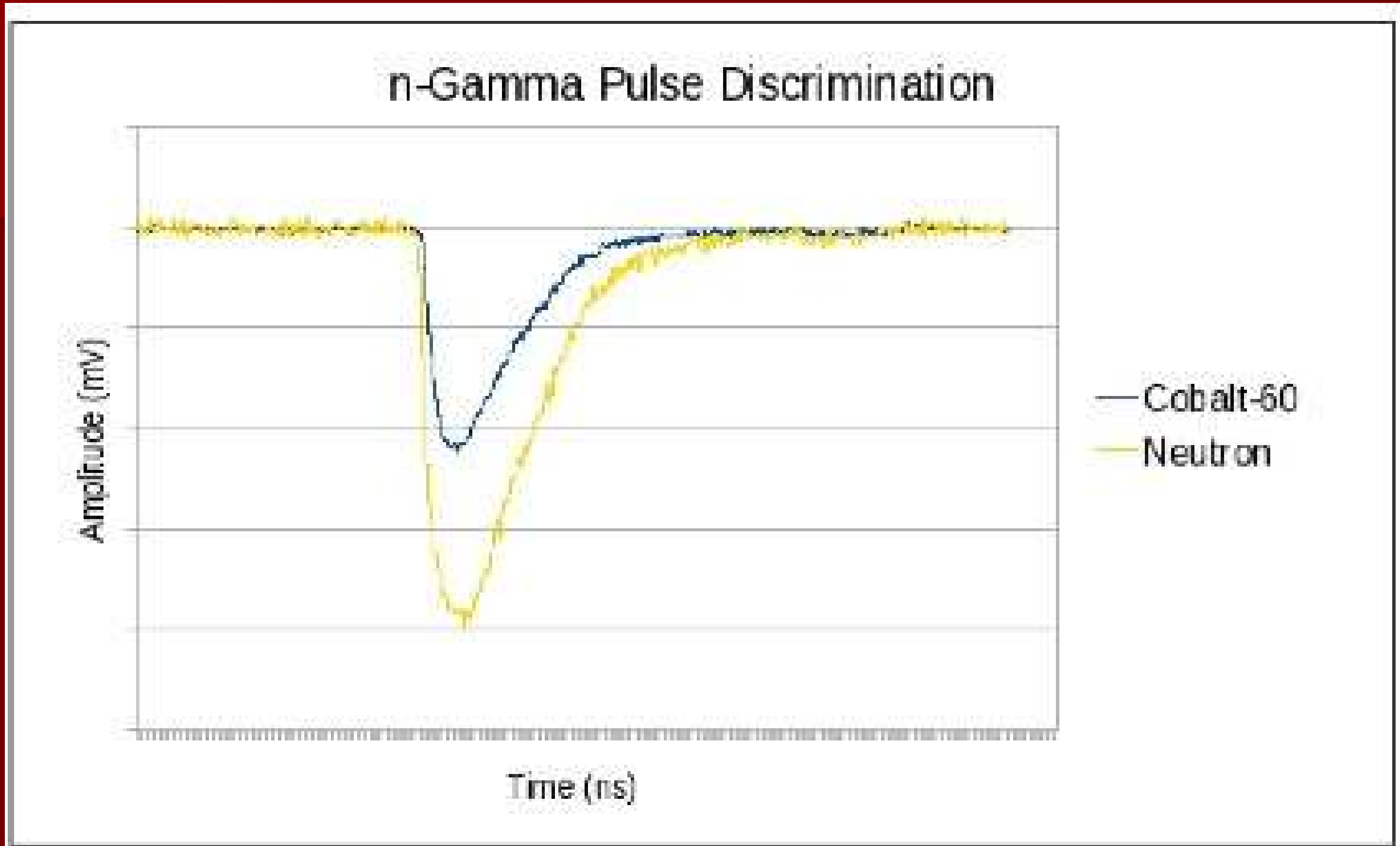
Cylindrical LaBr3 2″x2″





LaBr3 2"x2"
data points with fitted function
FWHM = A * E-1/2
A 77.10 ±1.20
FWHM [%]
3,5
3,0
2,5
2,0
1,5
1,0
0,5
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
E [keV]

O. Roberts et al., York test exp.



Wiele innych testów – Świerk (Moszynski), Mediolan (Camera), Bukareszt (Balabanski)

Plany na przyszłość

Minutes of the meeting of the Scientific Advisory Committee of SPIRAL2 held in Giens on Tuesday June 10, 2008

PARIS

SAC is satisfied with the progress made the PARIS detector.

The PARIS collaboration seems to be very well organised and working efficiently on the various aspects of the detector design. Some tests have been made of prototype components and different configurations for the detector are being discussed.

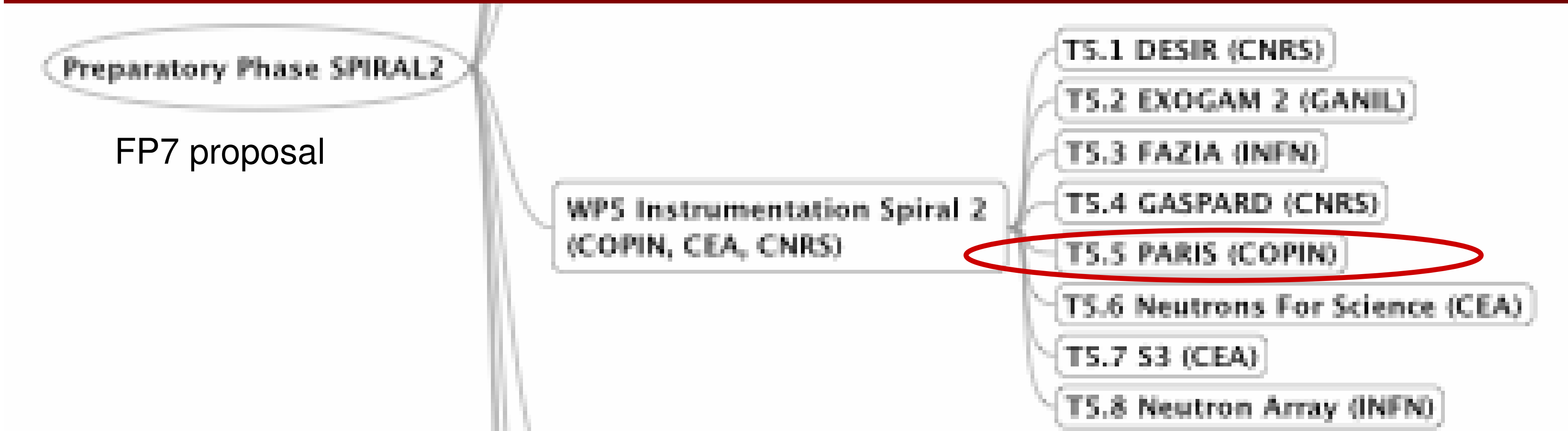
It is important at this stage to coordinate the efforts and look for synergies with GASPARD.

It is very strongly advised to come with a preliminary technical design of PARIS in which the synergies with other detectors for SPIRAL2 are clearly incorporated.

SAC would like to have this together with the report on activities for the next SAC meeting planned for the end of January.

PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

PARIS in the FP7 SPIRAL2 Preparatory Phase project



Main goals: Design and construct PARIS prototype
Sign MoU between partners of PARIS collaboration

~200 kEuro

Frame for common preparation with **EXOGAM2 (+Agata Demonstrator**).

Also possibility for synergy with **Neutron Array and GASPARD**

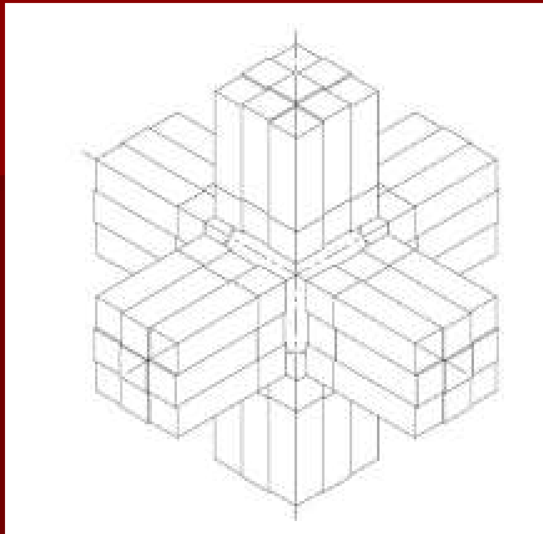
Discussion are going on with **VAMOS** group

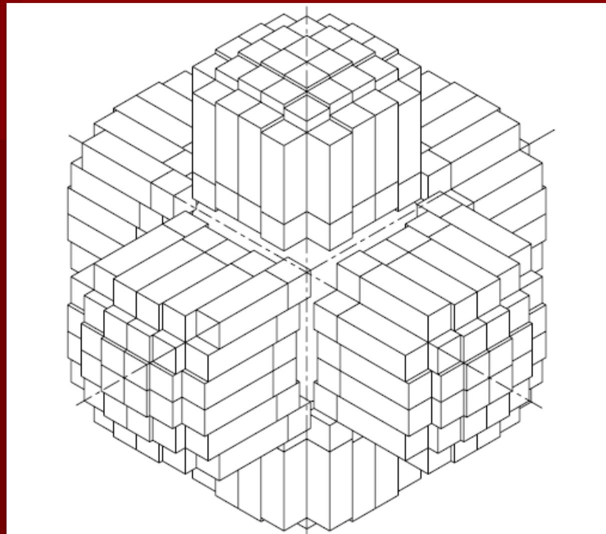
Następne kroki

- Rozwinięcie i uściślenie tematyki naukowej
- Testy detektorów LaBr3 (pojedynczych i Phoswich, cylindrycznych i kubicznych) – m.in. w SLCJ Warszawa (zaakceptowany projekt: Hadyńska & Ciemała)
- Testy odpowiedzi na neutrony: York, Paryż
- Zbudowanie i testy prototypu PARISa *(w ramach FP7 SP2PP)*
- Realistyczne symulacje
- Sfinalizowanie końcowego projektu PARISa
- Podpisanie MoU pomiędzy partnerami kolaboracji PARIS
- Znalezienie pieniędzy na zbudowanie PARISa:

1. Demonstrator: 1π
2. Pozostałe 3π

Cost estimate for some possible scenarios of PARIS





a) Low granularity (Demonstrator ?):

54 phoswitches
LaBr3: 2”x2”x2”
CsI(Na): 2”x2”x6”
(15 cm from target)

54*14 k€ = **0.75 M€**
+ cost of 216 channel electronic

b) Medium granularity:

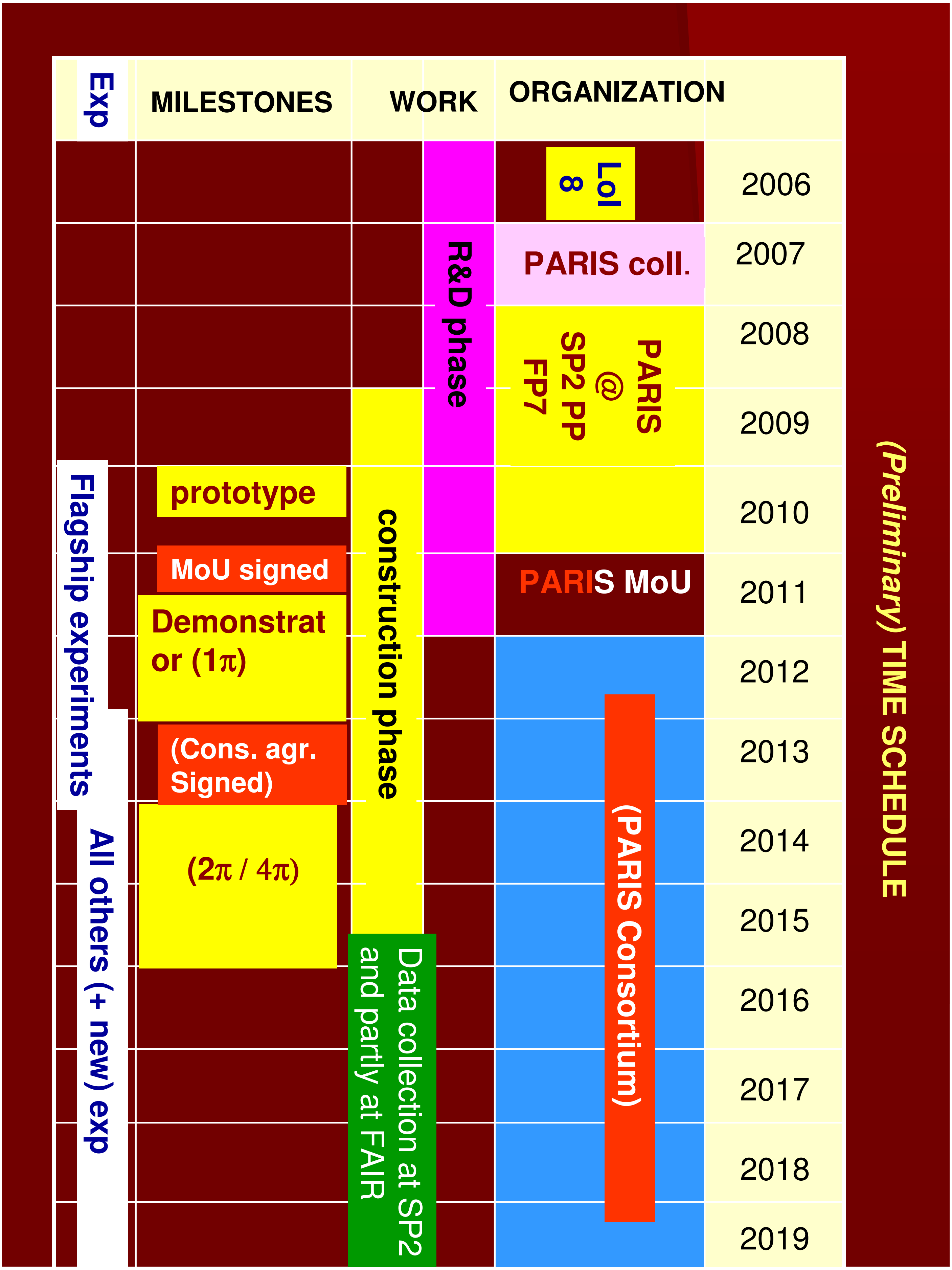
200 phoswitches
LaBr3: 2”x2”x2”
CsI(Na): 2”x2”x6”
(20 cm from target)

200*14 k€ = **2.8 M€**
+ cost of 800 channel electronic

c) High granularity:

800 phoswitches
LaBr3: 1”x1”x2”
CsI(Na): 1”12”x6”
(20 cm from target)

800*6 k€ = **4.8 M€**
+ cost of 3200 channel electronic



(Preliminary) TIME SCHEDULE
Exp
MILESTONES
WORK
ORGANIZATION
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
LoI 8
PARIS coll.
PARIS @ SP2 PP FP7
PARIS MoU
(PARIS Consortium)
R&D phase
construction phase
Data collection at SP2 and partly at FAIR
prototype
MoU signed
Demonstrator (1π)
(Cons. agr. Signed)
(2π / 4π)
Flagship experiments
All others (+ new) exp

Oprócz SPIRAL2 rozważa się wykorzystanie układu PARIS (lub jego części) gdzie indziej: M.in. w FAIR (exp. DESPEC), a także
w SLCJ Warszawa i w IFJ PAN Kraków.

Obecne finansowanie:
- FP7 SP2PP
- PROVA (francuski grant ANR)
- Umowa polsko-francuska LEA COPIGAL

Planowane jest wystąpienie:
- do MNiSW (SPUB) - Polska
- do podobnych agencji finansujących badania w Bułgarii, Wielkiej Brytanii i Turcji

Podsumowanie

- Zaproponowano opracowanie i skonstruowanie kalorymetru gamma PARIS do badań egzotycznych jąder na wiązkach radioaktywnych SPIRAL2

- Wiodącą rolę w projekcie PARIS odgrywa Polska

- Projekt PARIS rozwija się dobrze: utworzono kolaboracje, zaproponowano obszerny projekt naukowy, przeprowadzono symulacje GEANT4, zaproponowano wstępne projekty konstrukcyjne, rozpoczęto testy detektorów

- Zamówiono dedykowane detektory z firmy Saint Gobain

PHOTON ARRAY FOR STUDIES WITH RADIOACTIVE ION AND STABLE BEAMS

Zainteresowani przyłączeniem się do kolaboracji PARIS będą mile widziani !

Adam.Maj@ifj.edu.pl

Thanks to:

M. Kmiecik, M. Ciemała, P. Bednarczyk, K. Mazurek – *Kraków*
J.P. Wieleczko - *GANIL*
D. Jenkins, O. Roberts –*York*
O. Stezowski, C. Schmitt – *Lyon*
F. Azaiez, S. Franchoo, J. Pouthas, A. Scarpaci – *Orsay*
S. Courtine, O. Dorvaux, J. Dudek – *Strasbourg*
F. Camera, S. Leoni, S. Brambilla, A. Bracco – *Milano*
M. Kicińska-Habior, P. Napiórkowski – *Warszawa*
M. Csatlos, Z. Dombradi – *Debrecen*
I. Mazumdar, D.R. Chakrabarty – *Mumbai*
S. Harissopoulos – *Athens*
J. Strachan– *Daresbury*
A. Smith *- Manchester*

And to
- *FP7 SP2PP project*
- *Saint Gobain*
- *French ANR project*
- *Polish MNiSW Grant*

Adam.Maj@ifj.edu.pl

http://paris.ifj.edu.pl