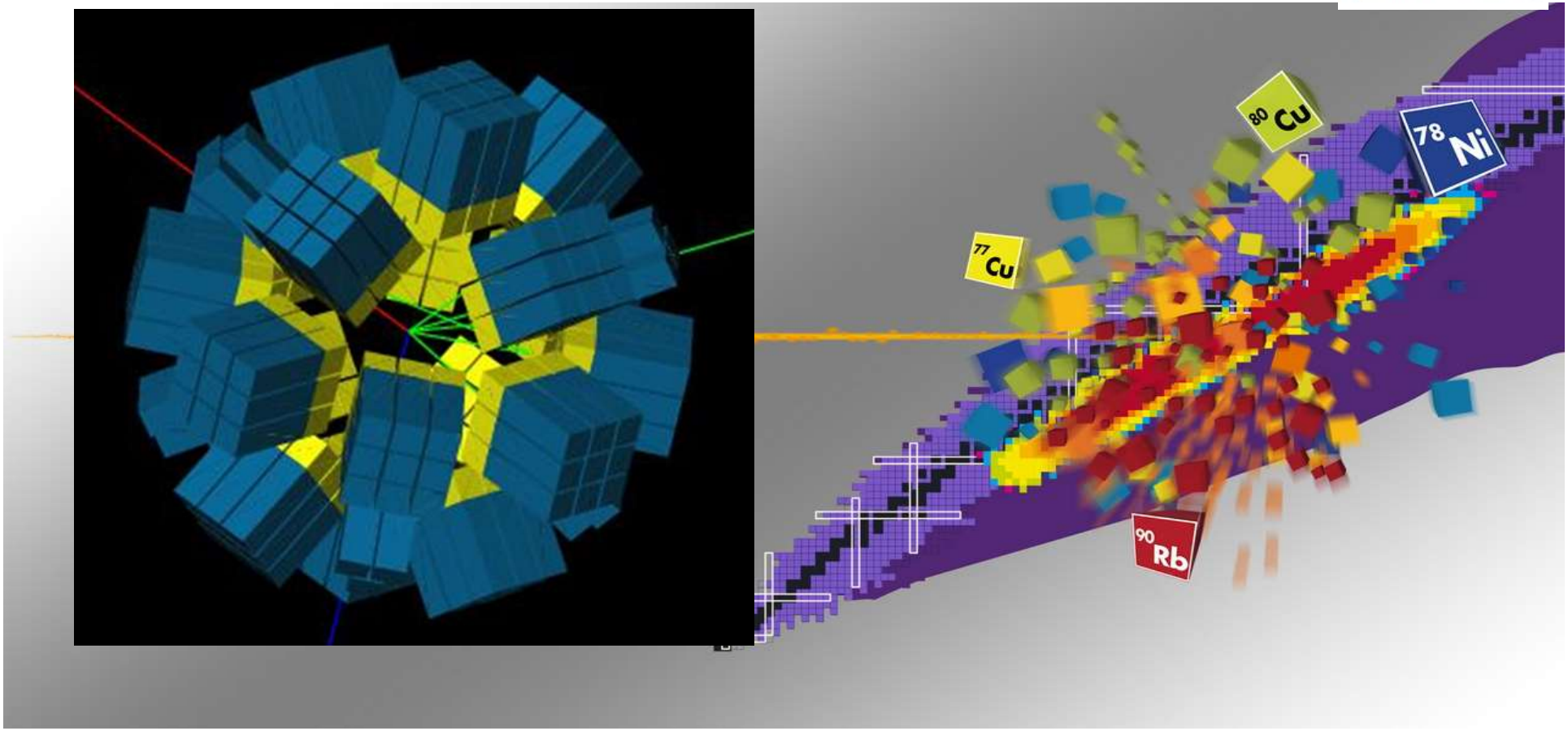
PARIS campaign(s) @ ALTO

Jonathan Wilson,
IPN Orsay



IN2P3 in PARIS Collaboratio

Two Institutes from France:

IN2P3 (IPN Orsay, IPN Lyon, IPHC Strasbourg)

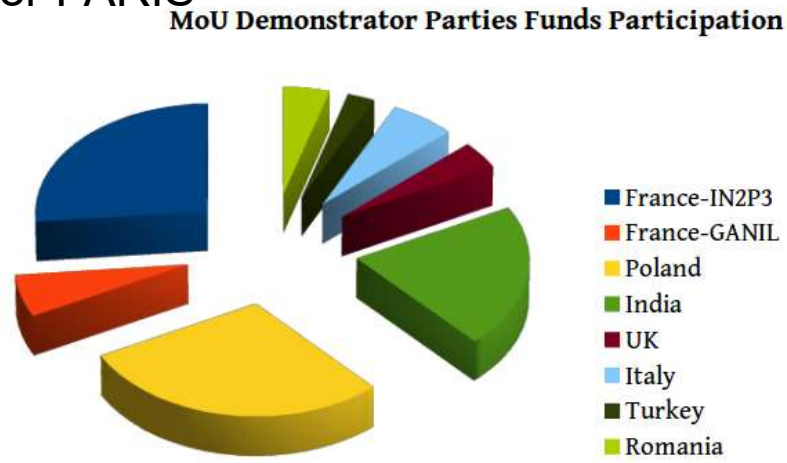
GANIL

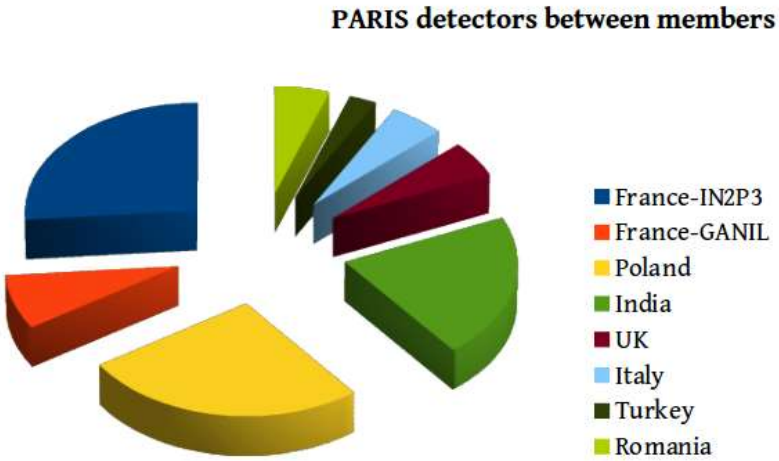
33 phoswichs (~4 clusters)

R&D on detector choice:

ANR PROVA (joint contribution of IN2P3 and GANIL)

→ triggered the phoswich choice for PARIS

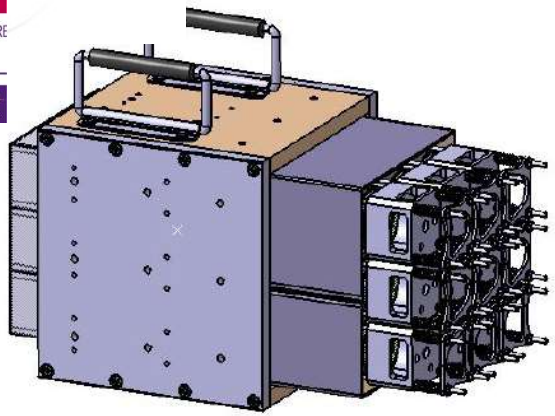




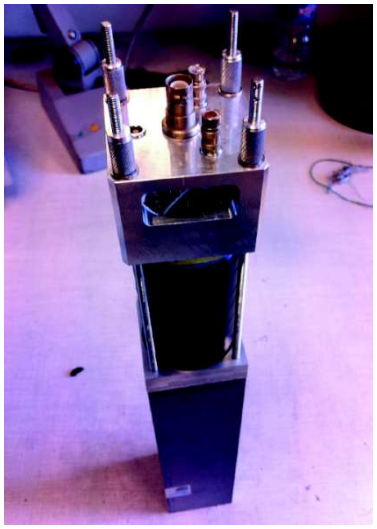
IN2P3 would like to contribute for one more cluster for the period 2018 - 20

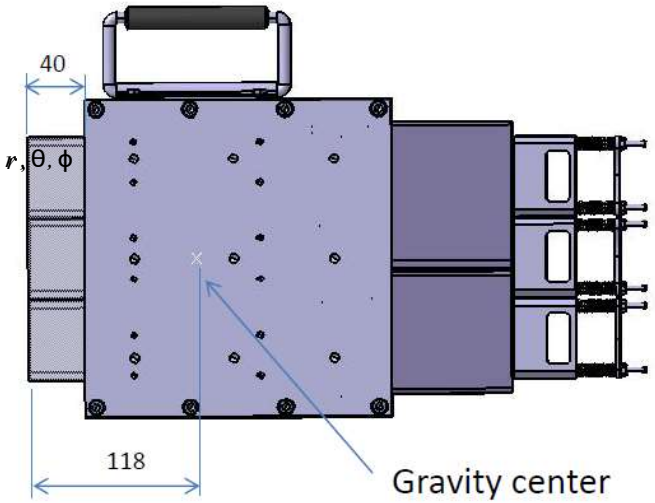
PARIS Mechanics

Design and Construction of Cluster Mechanics :



Weight 9 cristal labr3+na ~ 23 kg
Weight cluster ~ 11 kg
Total ~ 34 kg





Design for PARIS mainframe :

- hold 4 PARIS clusters around 90°
- possible variations in (r, θ, ϕ)
- compatibility with mechanics like: AGATA, BEDO/ALTO …
- start the design ~ first trimester of 2018

PAC-ALTO accepted experiments

2	M. Wiedeking 	**N-SI-83**	Coulomb Excitation of 14C	A*	12
3	P.J.Napiorkowski 	**N-SI-85**	Coulomb excitation of super-deformed band in 40Ca	A	18
4	M. Lebois 	**N-SI-86**	Prompt gamma and neutron emission for 238U fast neutron induced fission as a function of incident neutron energy	A	21
12	O. Kirsebom 	**N-SI-87**	A new probe of alpha-cluster structure in 12C	A-/B	18/0
13	E. Kozulin 	**N-SI-88**	Prompt γ-rays as a probe of nucleardynamics	A-	9
14	B. Blank	**N-SI-82**	Measurement of the super-allowed branching ratio of 10C	A*	36

PAC-ALTO accepted experiments

N-SI-107: Feeding of low-energy structures by GDR decay using coupled ν-ball and PARIS detectors, M. Kmeicik et al., Performed with PARIS/nuball 2018

PFG studies in 237Np, A. Oberstedt et al. Accepted 2017 (may run in 2019)

PFG studies in 233U, A. Oberstedt et al. Accepted 2018 (may run in 2019)

Beta decay to PDR states around N=50, I. Matea et al., will run in 2019

Experiments proposed and accepted for the PARIS@ALTO call

Experiment	Setup/Nb of daq ch	Cave	Daq	UBT
N-SI-83 (Wiedeking) : Coulex ^{14}C	PARIS(18) + LuSIA(96)	420	nGO	12
N-SI-85 (PJN) : Coulex ^{40}Ca	PARIS(18) + LuSIA(96) + ORGAM(15x2)	420	nGO	18
N-SI-87 (Kirsebom) : Alpha cluster ^{12}C	PARIS(18)	420	nGO	18
N-SI-88 (Kozulin) : CORSET	PARIS(18) + ORGAM(15x2) + CORSET(10)	420	nGO	9
N-SI-82 (Blank) : Super allowed BR ^{10}C	PARIS(18) + ORGAM(15)	420	Bdx(ORGAM) + nGO(PARIS)	36
N-SI-86 (Lebois) : ^{238}U prompt g and n	PARIS + LICORNE	410	FASTER	21

Outcome:

- Coulex of 14-C : finaly, the spokesperson (South Africa) went to US (I think) to do the experiment
- Coulex of 40-Ca : you and Matthieu were in contact with Pawel to see if he can do the experiment with Nu-Ball (will he go for Nu-Ball 2, for exemple ?)
- Alpha Cluster in 12 C : when I contacted Kirsebom, he didn't answer … So, for me, this is also a dead end. Maybe Sandrine will want to go and re-propose this type of experiments….
- Superallowed BR 10-C : performed, but without PARIS

- CORSET : experiment performed with ORGAM + PARIS (1 cluster + 1 det) + CORSET (slides attached)

- Lebois : well, this you know better than me, it is Liquiang thesis
(I don't remember very well, but I suppose that you have used PARIS for this type of physics for 2 experiments, right ?)

Prompt gamma and neutron emission for ^{238}U induced fission with fast neutrons at different energies (N-SI-36)

Courtesy of L. Qi

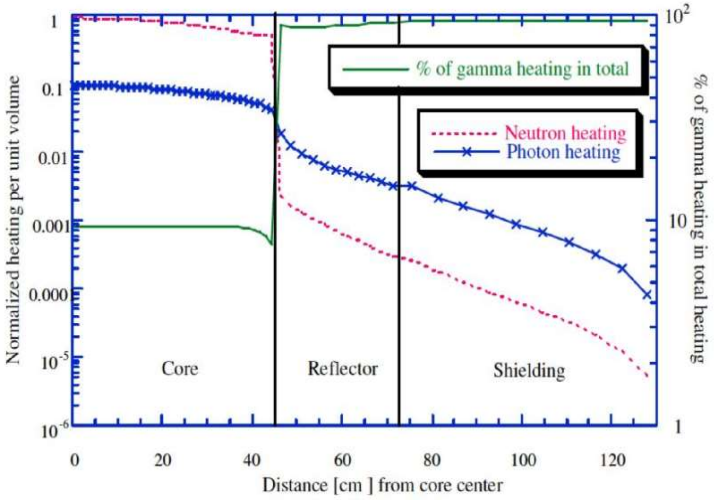
Two-fold motivation:

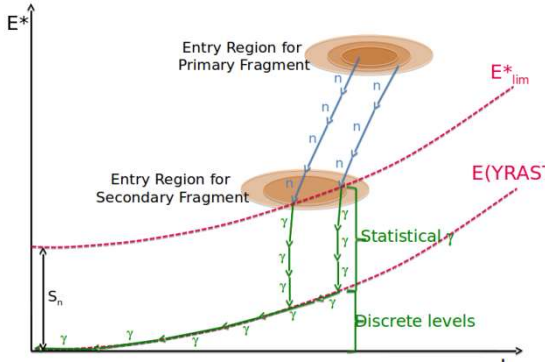
1. Reactor Physics

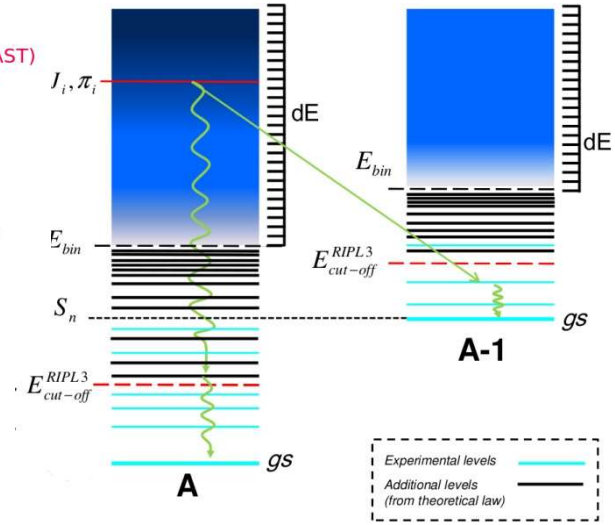
- 5% release in fission is done through PFG and γ-heating can be underestimated
- design of Gen. IV reactors: fast neutron reactors – nuclear data are scarce out of

2. Fundamental Physics

- understanding the fission process, like energy partition in fission or J generation of
- study of level density function, g-strength function, competition between n and γ
(needed for validation of different competing codes like GEF, FREYA, CGMF, FIFR



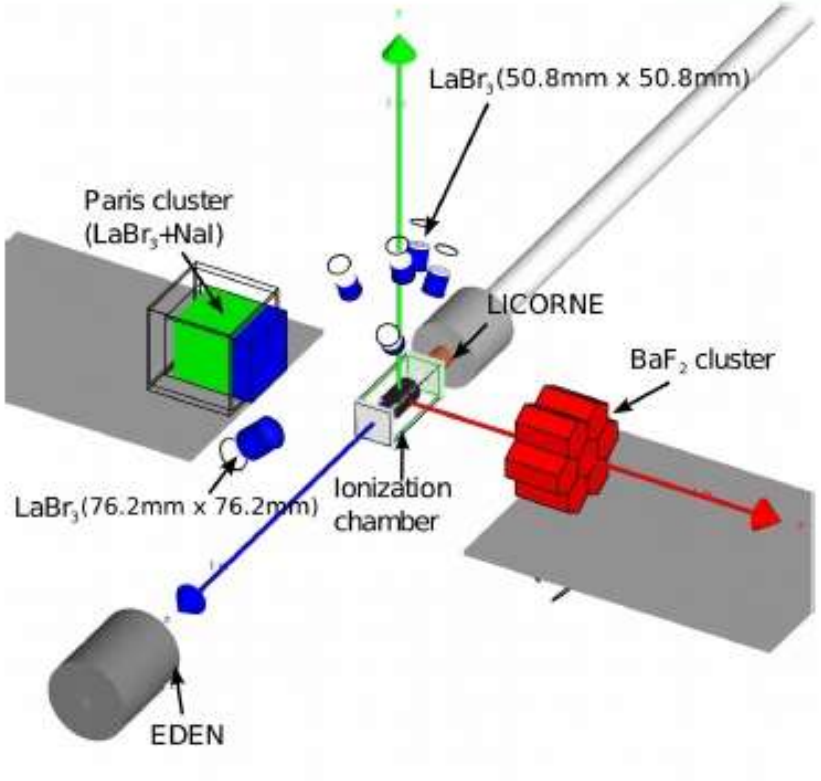




Prompt gamma and neutron emission for ^{238}U induced fission with fast neutrons at different energies (N.SI.36)

Courtesy of L. Qi

→ aiming at measuring spectral characteristics (M_{γ_p}, $E_{\gamma_p\ tot}$ and $\mathcal{M}_{ph}$) for different fissioning systems



→ ^{252}Cf source measurements (test data)

→ E_n = (1.9; 4.8) MeV – induced fission on ^{238}U

(→ also studied induced fission of fast n on ^{239}Pu)

Prompt gamma and neutron emission for ^{238}U induced fission with fast neutrons at different energies (N.SI.36)

Courtesy of L. Qi

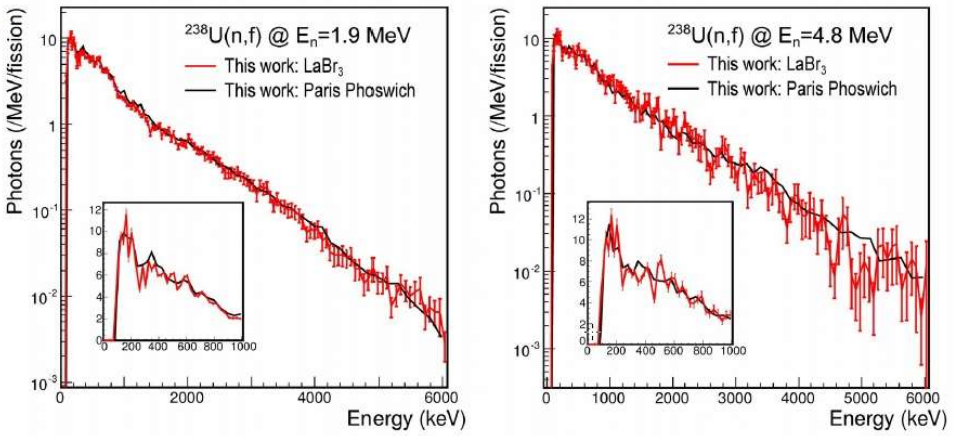


TABLE III. Summary of PFGS characteristics for the ^{238}U(n,f) reaction at two incident neutron energies.

	E_n(MeV)	$M_\gamma(/fission)$	$E_{\gamma,tot}(MeV)$	$\epsilon_\gamma(MeV)$
This work	1.9	6.54±0.19	5.25±0.20	0.80±0.04
	4.8	7.31±0.46	6.18±0.65	0.84±0.11
J-M.Laborie	1.7	7.05±0.20	5.92±0.24	0.84±0.03
et al. [7]	5.2	7.25±0.35	5.73±0.40	0.79±0.04
M.Lebois	2.4	7.62±0.25	5.78±0.29	0.77±0.03
et al. [8]	3.3	10.08±0.14	7.55±0.15	0.75±0.01

Conclusions:

→ low energy PFGS different for different energies : change in fragment population

→ softening of the HE part of PFGS suggests that the increased total excitation energy goes to the heavy fragments : hints on the excitation energy sharing mechanism ...

→ spectral characteristics stay constant with increased neutron energy : extra excitation energy is mainly evacuated by prompt neutron evaporation. As a consequence, the fast reactors in Generation-IV don't need significant changes in the modeling of gamma heating transportation

Statistical study of the prompt-fission γ-ray spectrum for 238U(n, f) in the fast-neutron regionL. Qi, M. Lebois, J. N. Wilson, et al. Phys. Rev. C 98, 014612 (2018)

Experimental Setup: CORSET

$^{32}S + ^{197}Au \rightarrow ^{229}Am^*$, $E^* \approx 43$ MeV

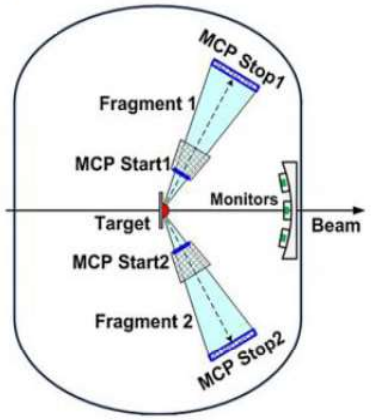
- CORSET:

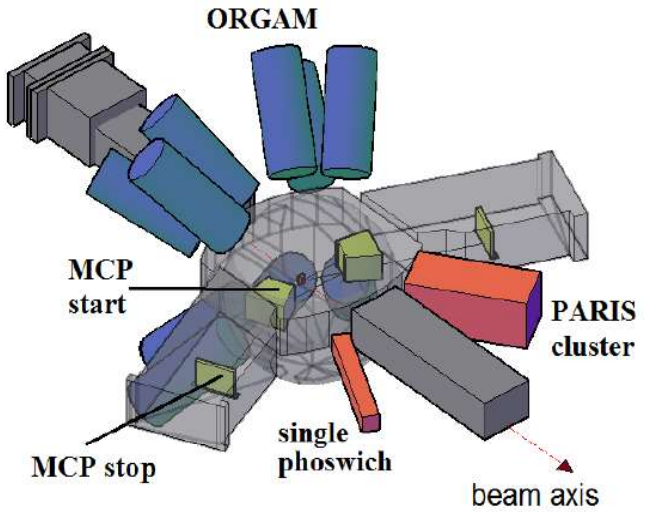
Measured parameters:

- ToF, X, Y

Extracted parameters :

- Velocity, energy, angles
- mass of fission fragments





Parameter	Value
The Coulomb barrier (in lab. sys)	167 MeV
Irradiation time	~4 days
Beam current	~90 nA
Collected statistics for fission fragments	274448
Excitation energy of the CN	~43 MeV

Courtesy of I.M. Harca

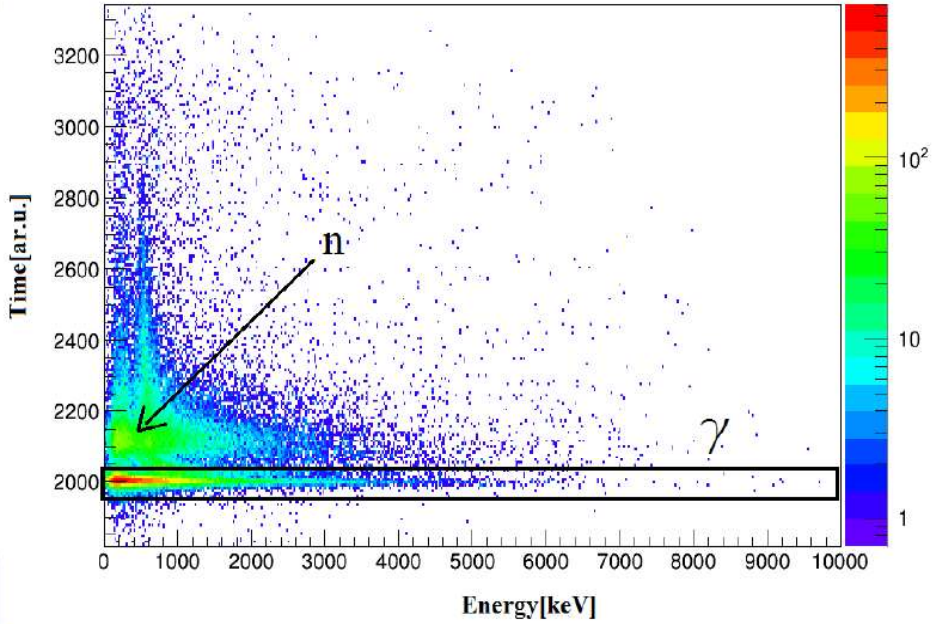
Experimental Setup: Coincident FF - γ-rays

- ORGAM: Prompt γ–rays coincident with FF
- PARIS: Prompt γ–rays (HE part) coincident with FF.

Parameter	ORGAM	PARIS
Number and type of Detectors	10 x Ge + BGO shielding	10 x LaBr3(Ce)-NaI(Tl) *(phoswich)*
Photo-peak Efficiency	~1%	~1%
Energy resolution	2.6(3.4)keV @121(1408)keV	62keV @1332keV
Dynamical range	$E_\gamma < 2.5MeV$	$E_\gamma < 15MeV$

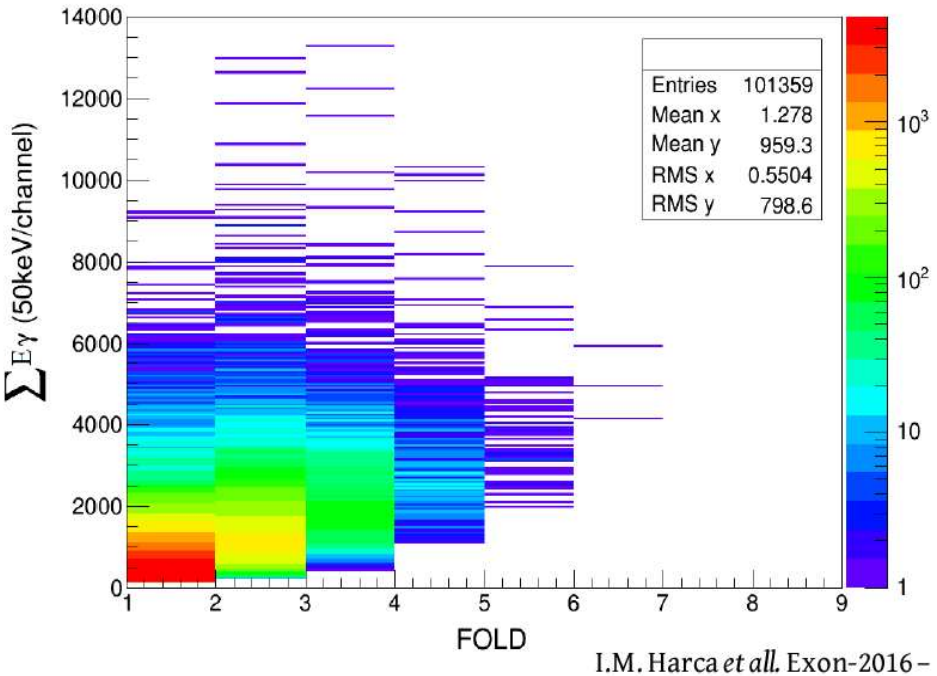
Courtesy of I.M. Harca

γ– Coincident with FF



- Good time resolution allowing discrimination of γ–rays against neutrons.
- Wide energy range.
- Able to accept high counting rate.

PARIS

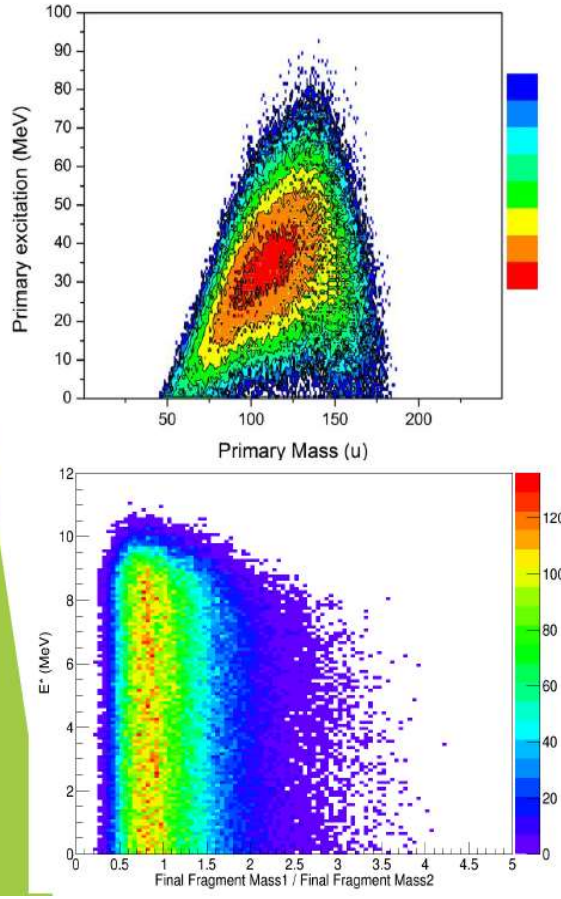


I.M. Harca *et all.* Exon-2016 – Proceedings Of The International Symposium (isbn: 9789813226555)

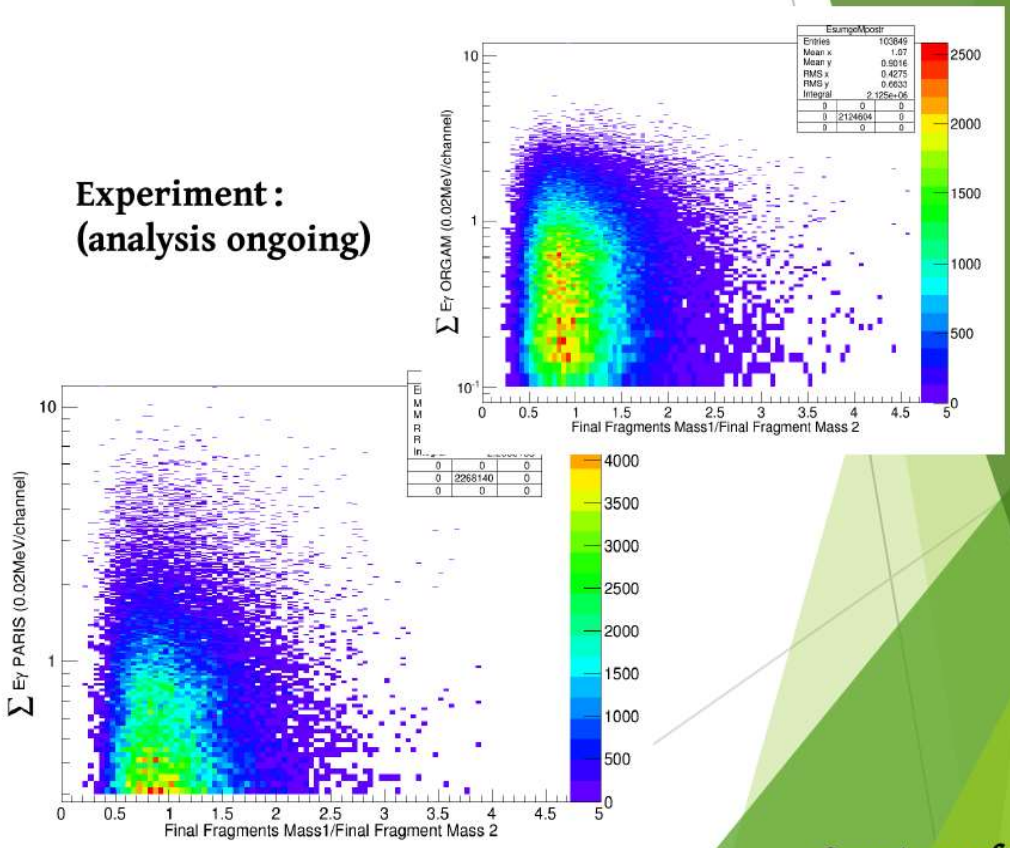
Courtesy of I.M. Harca

The excitation energy of Fission Fragments: From Primary Fragments to Final Fragments

Model :



Experiment :
(analysis ongoing)



Courtesy of I.M. Harca

Feeding of low-energy structures by GDR decay using coupled ν-ball and PARIS detectors

M. Kmiecik, M. Ciemała, A. Maj, B. Fornal, P. Bednarczyk, N. Cieplicka-Oryńczak, Ł. Iskra, K. Mazurek, M. Matejska-Minda, B. Wasilewska, et al. *IFJ PAN Kraków, Poland;*

F.C.L. Crespi, A. Bracco, F. Camera, S. Leoni, S. Ceruti et al. *INFN Milano and Milano University, Italy;*

J. Wilson, M. Lebois, I. Matea, D. Thisse et al., *IPN Orsay, France;*

P. Napiorkowski, M. Kicińska-Habior et al., *Warsaw University, Poland;*

O. Dorvaux, Ch. Schmitt, J. Dudek et al., *IPHC Strasbourg, France;*

I. Mazumdar, V. Nanal et al, *TIFR Mumbai, India;*

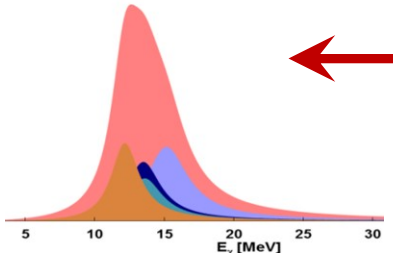
And the PARIS Collaboration

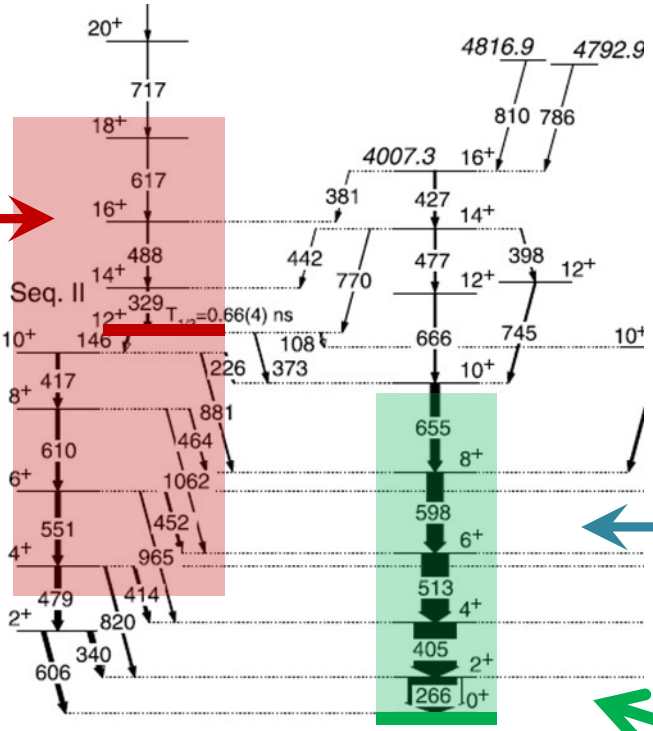
The idea

High-energy γ rays from ^{192}Pt* CN decay in 4n channel in coincidence with low-energy transitions in ^{188}Pt

How the deformation changes along the decay path?

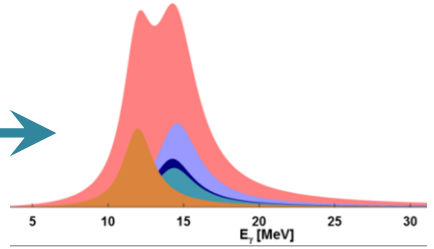
Gate on transitions



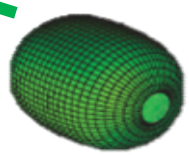


S. Mukhopadhyay et al., Phys. Lett. B 739, 462 (2014)

GDR strength functions for CN decaying to particular states of ^{188}Pt



β=0.16 and γ=−40° triaxial

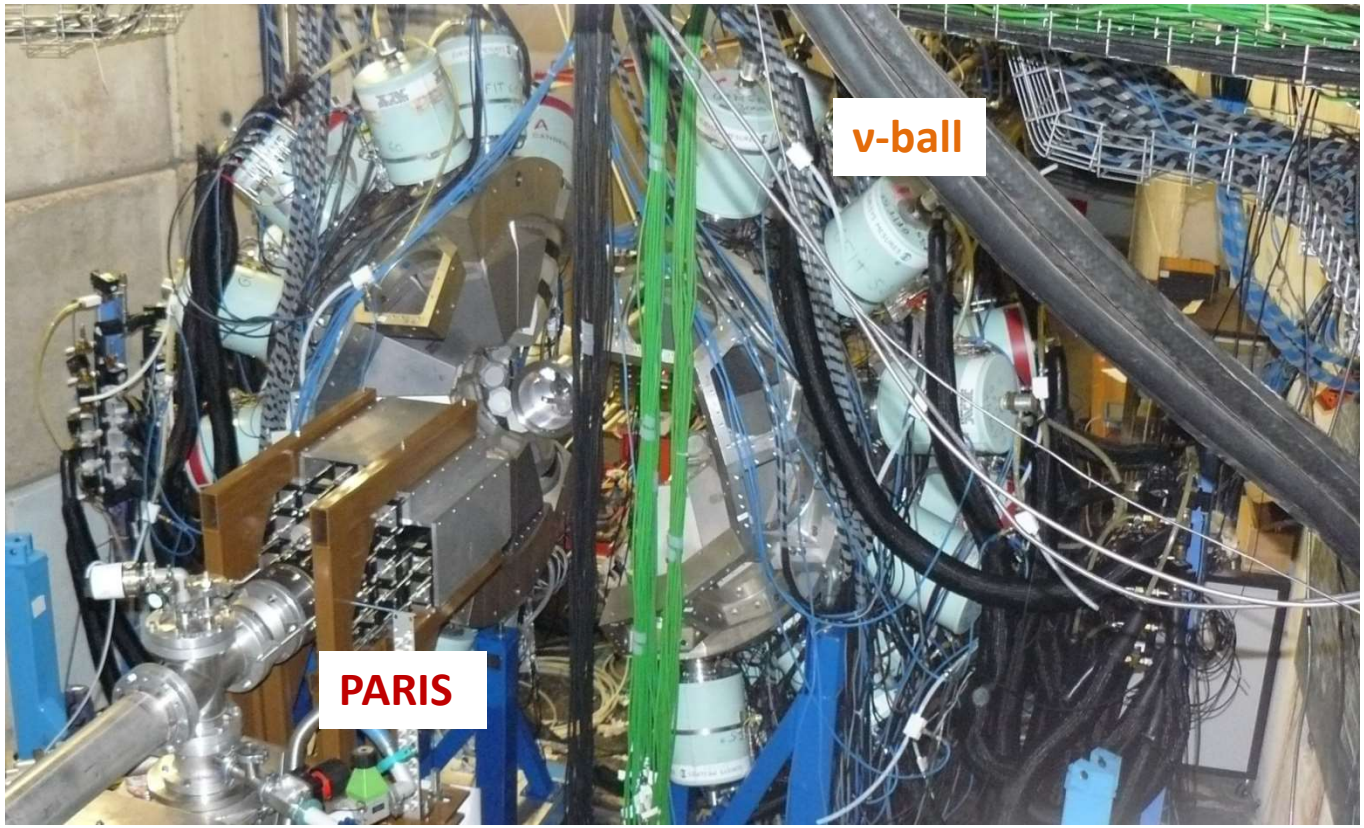


β =0.18and γ=−6° near prolate

Set-up

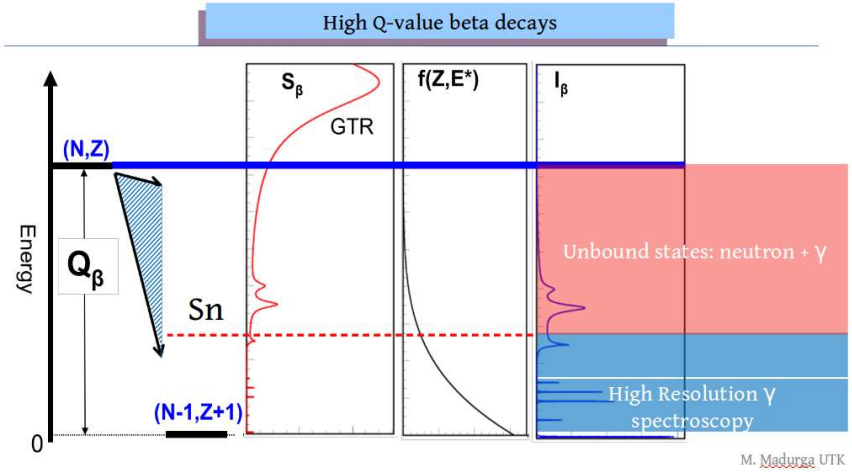
v-ball array: 33 Clovers +10 Coaxial HPGe
coupled to 33 PARIS detectors:
11 CeBr:NaI phoswiches,
22 LaBr3:NaI phoswiches.

Triggerless DAQ by FASTER digitizer

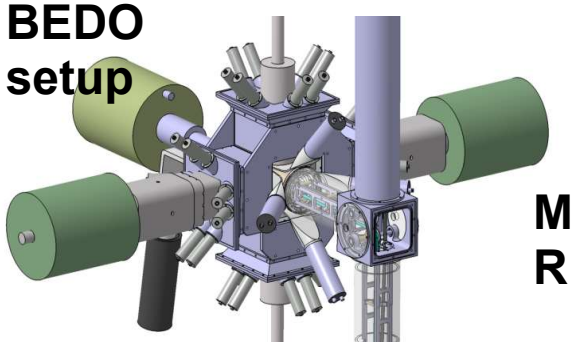


Beta delayed combined neutron and HE gamma spectroscopy at ALTO

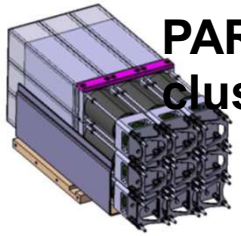
Courtesy of A. Gottardo



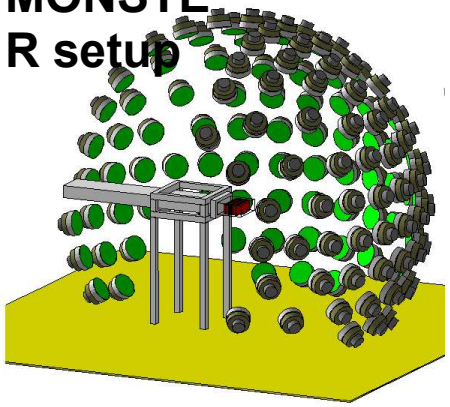
BEDO setup



PARIS cluster



MONSTER setup



RIB – ALTO

→ n-rich exotic nuclei (high Q values) (PDR in the decay window)
→ pure RIB (laser ionization)
→ ^{83,84}Ga decays to be studied

Goal :

→ investigate discrete states and resonances above S_n as ,e.g., population of collective resonant states at high E* (like PDR)

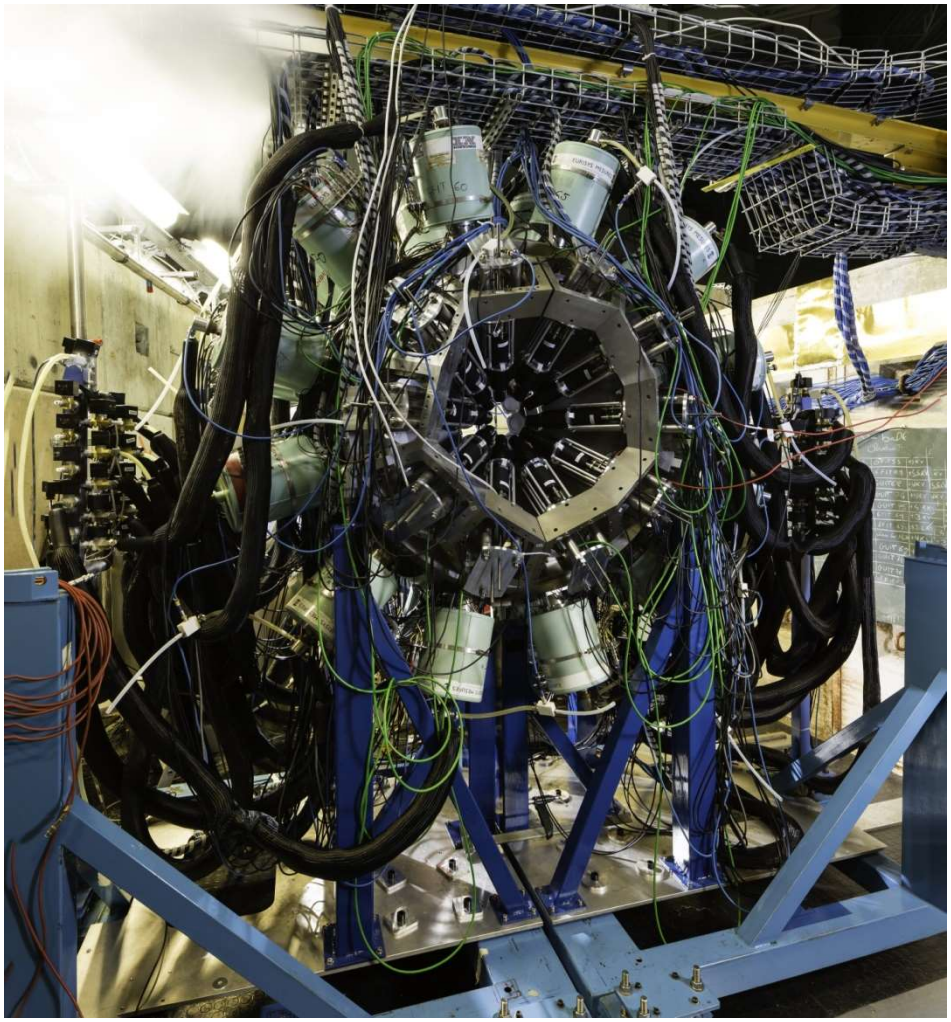
→ study of B(GT) in a large energy window

Method :

→ coupling BEDO and MONSTER for neutron spectroscopy
→ coupling BEDO and PARIS for HE gam spectroscopy (gamma multipolarity measurements)

ν-ball @ ALTO with PARIS

Main configuration



24 Clover Ge + BGO
10 Coaxial Ge + BGO
36 PARIS phoswich

200 channels

nu – ball

24 Clover Ge + BGO
10 Coaxial Ge + BGO
20 LaBr3

184 channels

125 MHz 14 bit for Ge
500 MHz 12 bit for scintillators

FASTER