### AGATA + DIAMANT + NEDA subcampaign at GANIL

G. de France, JJ Valiente-Dobon, I Kuti et al

## **Physics goals**



## Physics goals

- M. Bentley: In beam gamma-proton coincidence spectroscopy in 65As isospin symmetry at the limits of proton binding. ( + DIAMANT) - 20 UTs
- A. Boso: Isospin symmetry breaking and shape coexistence in mirror nuclei 71Kr 71Br. (+ DIAMANT) – 20 UTs
- B. Cederwall: Search for isoscalar pairing in 88Ru. (+ DIAMANT) 36 UTs
- B. Fornal, S. Leoni & M. Ciemala: Gamma decay I from near-threshold states in 14C: a probe of clusterization phenomena in open quantum systems. (+ DIAMANT + DSSD + LaBr3 + PARIS) – 22 UTs
- S. Lenzi: Effects of Isospin Symmetry Breaking in the A=63 mirror nuclei. (+ DIAMANT) 17 UTs
- J. Nyberg: Studies of excited states in 102,103Sn to deduce two-body neutron interactions, singleparticle energies and N = Z = 50 core excitations. (+ DIAMANT) – 32 UTs
- M. Palacz: Purity of the g9/2 configuration based on lifetime measurements and energies of excited states in 94Pd. (+ FATIMA) - 23 UTs
- E. Clement & J.J. Valiente Dobon: Shell evolution of neutron-deficient Xe isotopes: Octupole and Quadrupole Correlations above 100Sn. (+ DIAMANT + Plunger) 32 UTs

# **NEDA Status**

### Status detector production



## Performance of detectors

- Experiment performed at Orsay with 20 detectors LICORNE
- Tomographic imaging with LICORNE fast directional neutrons
- using the p(<sup>7</sup>Li,n) inverse kinematic reaction and used to scan phantoms with a known complex composition.



#### NEDA6\_ngd\_35

# **NEDA Electronics**

- NUMEXO2 board
- GTS on board
- GTS logic trigger tree
- Mezzanines FADC 200 MHz 14 bits

#### <u>Status</u>

- Hardware all ready
- First version fully compiled → debugging



Figure 20: Global electronics layout for 48 NEDA detectors









### NEDA Electronics $\rightarrow$ outputs



## **NEDA Infrastructure scheme**



Cables and connectors [installed spares in square brackets]:

- 96 [+14] Double-shielded coax BNC-MM1150-LEMO from detectors to SEDIFF units (15 m)
- 96 [+14] Single-shielded coax SHV-RG174-SHV from detectors to HV units (20 m)
- Single-shielded coax BNC-RG58-BNC from VAMOS racks to LeCroy 428A logic FIFO (~15 m)
- 7 Single-shielded coax Lemo-RG174-Lemo from Lecroy 428A logic FIFO to NUMEXO2 (-1 m)
- 28 HDMI Real Cable INFINITE II from SEDIFF to NUMEXO2 (1.5 m)
- 7 Optical fibres MPO-MPO (-20 m?), plus MPO-to-SAMTEC data transfer from NUMEXO2 to servers (10 m)
- 11 Optical fibres OM3 duplex LC-50/125-C for GTS signals (7x0.5 m, 3x0.1m, 1x60m)
- 18 Network cables Cat5e or Cat6
- RS232 cable with DB9-RJ45 connector from HV crate to terminal server
- 2 RS232 cable with ???-RJ45 connector from NIM crate to terminal server (uncertain if NIM crates have such an output)
- 7 RS232 cable with RJ45-RJ45 connectors from NUMEXO2 rear panel to terminal server

## NEDA+AGATA@GANIL

NW+NEDA



THE EUROPEAN PHYSICAL JOURNAL A

Special Article – Tools for Experiment and Theory

### Conceptual design of the early implementation of the NEutron Detector Array (NEDA) with AGATA

Tayfun Hüyük<sup>1,a</sup>, Antonio Di Nitto<sup>2,3</sup>, Grzegorz Jaworski<sup>4</sup>, Andrés Gadea<sup>1</sup>, José Javier Valiente-Dobón<sup>4</sup>, Johan Nyberg<sup>6</sup>, Marcin Palacz<sup>5</sup>, Pär-Anders Söderström<sup>7</sup>, Ramon Jose Aliaga-Varea<sup>1,8</sup>, Giacomo de Angelis<sup>4</sup>, Ayşe Atag<sup>9,10</sup>, Javier Collado<sup>11</sup>, Cesar Domingo-Pardo<sup>1</sup>, Francisco Javier Egea<sup>11</sup>, Nizamettin Erduran<sup>12</sup>, Sefa Ertürk<sup>13</sup>, Gilles de France<sup>14</sup>, Rafael Gadea<sup>8</sup>, Vicente González<sup>11</sup>, Vicente Herrero-Bosch<sup>8</sup>, Ayşe Kaşkaş<sup>9</sup>, Victor Modamio<sup>4</sup>, Marek Moszynski<sup>15</sup>, Enrique Sanchis<sup>11</sup>, Andrea Triossi<sup>4</sup>, and Robert Wadsworth<sup>16</sup>





T. Huyuk et al., Eur. Phys. J. A (2016) 52.

## NEDA+AGATA@GANIL struct.



### NEDA+AGATA@GANIL struct.



### Work flow chart

	hun Ct	hur 02	Ind Cf	lul co	4 1	4 2	Sec. 01	C == 07	0-1-01	0-1-02			01 0	02	- 01	- 02 -	L 01 5		Mar 01													
<u>.</u>	Jun-01	Jun-02	Jui-01	Jui-02	Ago-1	Ago-2	Sep-01	Sep-02	Oct-01	Oct-U2 P	NOV-U1 NO	ov-U2 Dec	c-01 Dec-	-O2 Jai	in-01 Ja	in-UZ Fe	10-01 F	eb-02	Mar-01	Mar-u	2											
2 Mechanics														_							-											
3 production NEDA and NW pieces														_							-											
4 UK pieces (only ones needed for NEDA test in G2)	-																				-											
5 Poland Pieces	_													_							_											
5 Italy pieces																																
7 Mounting in G2 of NEDA																		_	Λ	Λ		h	ani	inc	· _	- ^	lot	· 🛆 (	str	١rc	•	
Tests (with/without) detectors																			1		50	110			) Т	- U				ЛЗ	)	
9 NW structure mounting in G2																		- 5				_				_		_				
0 Liquid collection																																
1 Reaction Chamber																																
2 Transport to G1																					1											
3 Transport of NW																					1											
4 Test of NW structure	_																				+											
														-							+											
L5 Installation of NEDA+NW in G1																					-											
.6																					-											
7 Detectors																					-											
.8 Refurbishment and transpor of 20 det from Orsay	-													_				_			-											
9 Preparation 40 det at LNL					_									_							-											
0 Test 40 det at LNL																					_											
Transport 40 det from LNL to GANIL																					_											
22																																
							1						Jun-01	1 Jun-0	02 Jul-0	1 Jul-02	2 Ago-1	Ago-2	Sep-	01 Sep	-02 Oct	t-01 Oct	-02 Nov-01	Nov-02 D	ec-01 Dec	c-02 Jan	01 Jan-02	Feb-01	Feb-02 N	lar-01 Ma	r-02	
							23	nfrastructu	re																							
							24 0	ables							_				_													
							25	HV, 20 m, Signal CO	96 + span	es (LNL)	es (INI.)		ok		_	-	_	_	_	_	_	_				_	_					
							26	Signal HD	MI, 1.5 m,	, 28+2 (Up	opsala)		UK					-		_											_	
							28	Optical SA	AMTEC-M	PO, 10 m,	6+1 (IFIC)		ok																			
							29	Optical M	PO-MPO,	length 60	im, 6+1 (LN	L)					_															
							30	m)	M3 for GT	5, 11+1 (L	.nil) (7x ~0.	5 m, 3x ~0.	1																			
							31	RS232 fro	m NUMEX	KO2 r.p. to	IOLAN, 6+	1 (GANIL)																				
							32	RS232 fro	m NIM cra	ates to IOI	LAN, 2 (GA	NIL)								_												_
							33	Network	cables Cat	Se or Cate	6, 18+2 (GA	NIL)					-				_						<b>. .</b>				4	
							35 H	īV																		ľ	ntr	a	str	uc	τu	re
							36	Crate Cae	n SY727, 1	1+1 (LNL)			ok																			
							37	Cards Cae	n A734N o	cards, 6+1	l (LNL)		ok				_	_	-	_											_	
							38	Crates Wi	ener, 2+1	(2 LNL, 1	Valencia)		ok		-	-	-	-	-	-	_						_				_	
							29	HV SY727	, nr: 1+1 a	ind A734N	cards, 6+	? (LNL) Hov	v ok			-			-									-			_	
							40	MUMEXO	h cards do 2. 6+1	o we have	?		ok		_																	
							41	FADC mea	zzanines, 2	28+20			ok			-															_	
							43	SEDIFF, 74	+1 (LNL, IF	IC)																						
							44	GTS V3 ca	rrier, 1 (G	ANIL). Do	we need a	spare unit	? ok																			
							45	spare unit	anines, 4 ( t?	(Who LNL	, IFIC). Do v	we need a	ok																			

### Work flow chart

-				 -	 											
46	Servers															
47	Servers that are compatible with SAMTEC, 6+1															
48	PCIe cards SAMTEC, 6+1 (IFIC)															
49	Network															
50	IOLAN, nr: 1 (LNL). Do we need a spare unit?	ok														
51	Switches, 2 (GANIL). Do we need a spare unit?															
52	Racks															
53	Cooled rack for NEDA electronics in G1 (ordered by GANIL, delivery by end of June 2017?)							_								
54	Cooled rack for servers in G2 (GANIL, GdF will check if we can use one of the existing EXOGAM racks)									In	fra	asti	ruc	tur	es	
55	Rack for HV crate G2 (GANIL)													-con	00	
56	Safety								Fi	rm	พล	re	+ 9	sof	tw	are
57	Xylene leakage detector	ok											-			
58																
59	Firmware and software															
60	Virtex 5															
61	NEDA PCI integration															
62	Virtex 6															
63	PSA trigger request															
64	TDC															
65	Register server GUI	ok														
66	Test of V5-V6 with a Cf source at LNL															
67	GTS epics															
68	Narval NEDA producer actor															
69	Mergers and filter for NEDA/AGATA															
70	Run control and configuration															
71	Trigger processor															
72																
73	In beam test															
74	Physics campaign AGATA+NEDA+DIAMANT															

# **DIAMANT Status**

### Configuration for the 2018 campaign FW config (plunger)



5x 1Gbps

## Cabling schematics for the 2018 campaign



### Configuration for the autumn tests

FW config (plunger), reduced channel number



### Cabling schematics for the atumn tests



### Timeline

available / ready
not ready yet, progressing as planned
missing, but resolvable / no problem
might be a problem

	July	Aout	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Hardware						-			
Detectors									
NUMEXO2 modules									
FADC mezzanines									
GTS carrier									
GTS mezzanines									
NIM crate									
Cooling rack									
Reaction chamber									
Flexiboard gen1 (repurposed)									
Flexiboard gen2		_							
SeDif units									
PSU gen1 (2nd stage)									
PSU gen2 (NIM)									
Network switch									
DAQ server, data storage									
Cables									
SCSI									
HDMI									
Optical									
Serial									
UTP									
Firmware and software									
DIAMANT data frame integration									
Virtex 6 8ch									
Virtex 6 1/8/16ch (DSP48E1)									
Narval actor, software mods									
Testing									
Pulser tests with 1/8/16ch FW									
Beam test in ATOMKI									
Comissioning									
Transport to GANIL									
Mounting in G2		1							
Mounting in G1		1							
Campaign		-							
			1					-	
	First	tull test	GANIL	ru	n 3			Can	npaign

### **Status**

#### Firmware

- pulser tests for the 2ch/8ch version: results o.k., but can't route more than 13ch
- using DSP48E1 slices it can be managed to route 16ch, but needs further testing
- testing method with 1ch first
- trigger needed additional filter (noise) => implemented. To be tested in beam.

#### Software

- NARVAL actors (in-place division, producer) need to be done
- integration easier than NEDA (no PCIE)
- data frame similar to EXOGAM2

#### Tests

- pulser tests of firmware with DSP48E1 filters in July
- requested beamtime for beam test ->early September
- pulser tests until then

### **Status**

Plunger configuration:

56ch FlexiBoard + 8ch ForwardWall (24ch ChessBoard) - 64 (80) ch, 16ch/NUMEXO2

- all of the NUMEXO2s are ready
- all FADC mezzanines are ready
- GTS, crates, racks: help from EXOGAM2
- detectors ready (upgrade FW to the chesboard ongoing)
- FlexiBoard: the current FB will be cut & used
- chamber: plans from Lyon are being finalized -> manufacturing funds are also allocated in ATOMKI for some parts (vc. feedthrough, inner mount), final design & manufacturing in progress



- power supply: no funds for NIM, the gen1 2<sup>nd</sup> stage will be used
- SeDif: prototype was used with pulser test, revealed minor design flaws on the carrier board - 2 redesigned carrier board, and mezzanines will be manufactured in July - 3rd in Q4 2017
- DAQ hw: purchase of server and for data storage (if required)



• AGATA Trigger not compliant with AGATA+NEDA+DIAMANT needs (limited to max 40 TRs)

- Development of the EXOGAM2 Trigger Processor. Specs:
  - $\circ$  Full compatibility with GTS
  - Extension to 256 TRs (max possible for GTS)
  - Multiple simultaneous trigger capabilities
  - $_{\odot}$  Define precise trigger timing
  - $\circ$  No dead time; continuous coincidence analysis
  - Validate data not participating to trigger decision
  - Flexibility (easy to change trigger conditions)
  - o Generate an event pattern

#### Main steps of the trigger processing cycle:

- 1) SORTING: To sort the TR labels issued from the GTS leaves messages and to dispatch them into partitions
- 2) MULTIPLICITY: To perform the multiplicity of each partition and to issue the multiplicity result
- 3) COINCIDENCE: To combine the multiplicity results of partitions in time coincidence windows
- 4) DECISION: To source the event validation or reject result
- 5) EVENT PARAMETERS: To register the event TR pattern, the event number and the event time stamp.
- 6) REPLY MESSAGE: To send back to each GTS leaves the validation or reject messages



### Partitionning:

- TR labels (up to 256) are assigned to partitions
- Up to 32 partitions can be built

### Multiplicity:

- Partition Multiplicity Window: Width
- Threshold
- Acceptance window: Width

### Coincidence:

- Partition Coincidence Window: Delay and Width

### Logical Equation:

- Coincidence Windows are OR/AND combined in the Logical Equation

$$LE = \bigcup_{n=0}^{n=31} R \left[ \underset{p=0}{\overset{p=31}{A}} ND (ENp AND CWp) \right]$$

# EXOGAM2 TP\_V1

#### Completed end of 2016



#### **TCP/IP** protocol

- Linux OS in RASPBERRY PI
- SPI link to/from VC707
- => It is a temporary solution because of its very low bandwidth

# EXOGAM2 TP\_V1

### VHDL implementation of 2 partitions in the Virtex 7 successfully tested

- Partition 1 : 8 TR; MW width = 4T; AW witdh = 10T; CW witdh 10T, CW delay = 101T; Multiplicity = 4
- Partition 2: 1 TR; MW width = 2T; AW with = 2T; CW with 10T, CW delay = 6T; Multiplicity = 1
- Validation: LE = CW1 AND CW2

# VC707, connected to the GTS tree, has been successfully tested Connected to AGATA with 32 leaves through GTS NIM carrier

 $\Rightarrow$  Similar performance as AGATA TP (rejection rate ~1%)

#### • Next step (EXOGAM2 TP\_V2):

- $\Rightarrow$  Connect to EXOGAM2 for long term tests (rejection =f(rate); multipartition; reliability;...)
- $\Rightarrow$  Connect to AGATA (check 10 µs latency vs idle cycle)
- $\Rightarrow$  Replace Raspberry PI by IP BUS protocol

# Workflow

	07/17	09/17	11/17	03/18
Connection to EXOGAM2				
Connection to AGATA				
Use in-beam run3				
Rerouting SPI connection (V2)				
IP BUS (V2) IPHC				
2018 Campaign				

- 2 EXOGAM2 TP\_V1 exist
  - •1 permanently online for tests
  - •1 for rerouting SPI
- 1 Being built at IPHC for IP BUS protocol implementation

# **Target chamber**

## **Target Chamber**



T. Dupasquier, IPNL

# Summary and outlook

- Target chamber with many constraints (DIAMANT, plunger, target loader, thickness,...) designed.
- NEDA:
  - Detectors and mechanics ready and tested early September
  - Hardware: all ready (except sediff end of July)
  - Firmware: <sup>252</sup>Cf source tests @ LNL until end of July
  - Software: ready for run3
- DIAMANT:
  - Detectors existing.
  - Hardware: all ready (except sediff mid August)
  - Firmware: 8ch and 13ch versions running. Add filter for trigger request. 16ch version compiling. Pulser tests in August. In-beam tests in ATOMKI early September
  - Software: ready for run3
- EXOGAM2 TP\_V1 running. Requires extensive tests. Connection to EXOGAM2 and AGATA. Collaboration with IPHC
- Test of NEDA+DIAMANT+EXOGAM2+target chamber+TP sometime in November
- AGATA+NEDA+DIAMANT will be taking data in 2018  $\rightarrow$  8 experiments approved A/B
- Necessity of a beam comissioning in G1 with AGATA+NEDA+DIAMANT → beginning of 2018.