AGATA + DIAMANT + NEDA sub-campaign at GANIL

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

M. Bentley

As – isospin symmetry

M. Palacz/M. Gorska
Pd high spin

S. Leoni
Iso. Symmetry Breaking A~63

E. Clement/J.J. Valiente-Dobon
Octupoles N=Z region Ba

J.. Nyberg
$^{102,103}$Sn excited levels

B. Cederwall
T=0 pairing $^{88}$Ru

A. Boso
$^{71}$Kr-$^{71}$Br – isospin symmetry

N=Z

S. Leoni/B. Fornal
Gamma decay near threshold $^{14}$C

Fusion-evaporation reactions involving 1 or 2 neutrons tagging.

202 UTs = 67 beam days
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 \( \gamma \) 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, single-particle 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

Goal 60 detectors (54 + 6 spare)
• 20 detectors already produced
• 40 detectors to be produced by July 2017
Performance of detectors

- Experiment performed at Orsay with 20 detectors LICORNE
- Tomographic imaging with LICORNE fast directional neutrons
- using the $p(^7\text{Li},n)$ inverse kinematic reaction and used to scan phantoms with a known complex composition.
NEDA Electronics

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

Status
- Hardware all ready
- First version fully compiled → debugging

Figure 20: Global electronics layout for 48 NEDA detectors
NEDA Electronics → outputs

V6 - input real NEDA signal - offset subtraction

V6 - input real NEDA signal - PSA (slow/fast)

V6 - input real NEDA signal - CFD
NEDA Infrastructure scheme

NEDA and NWall equipment for the AGATA@GANIL campaign 2018

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)
- 1 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, 3x0.1 m, 1x60m)
- 18 Network cables Cat5e or Cat6
- 1 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 _54_

NWall 14x3 =42

G1

RF signal (fast NIM) from VAMOS racks

NIM crate (max 100 W)

HV crate SYS27 (max 500 W)

NIM crate (max 800 W)

Network Switch

Terminal Server

Electronics rack

To GTS in AGATA DAQ room

G2

Server

Server

Server

Server

Server

Server

Server

Network Switch

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

Tayfun Huyuk1,4, Antonio Di Nitto2,3, Grzegorz Jaworski4, Andrés Gadea5, José Javier Valiente-Dobón6, Johan Nyberg7, Marcin Palacek7, Pär-Anders Söderström7, Ramon Jose Alliaga-Varea1,8, Giacomo de Angelis4, Ayşe Ataş9,10, Javier Collado11, Cesar Domingo-Pardo5, Francisco Javier Egea11, Nizamettin Erduran12, Sofi Ertürk13, Gilles de France14, Rafael Gadea5, Vicente González11, Vicente Herrero-Bosch8, Ayşe Kaşkaoğlu9, Victor Modamio4, Marek Moszynski14, Enrique Sanchís11, Andrea Triossi14, and Robert Wadsworth15

NEDA+AGATA@GANIL struct.
NEDA+AGATA@GANIL struct.

Status
- Design finished
- Into production
Work flow chart

Infrastructures
Firmware + software

- Servers
  - Servers that are compatible with SAMTEC, 6+1
  - PCIe cards SAMTEC, 6+1 (IFIC)

- Network
  - IOLAN, nr: 1 (LNL). Do we need a spare unit?
  - Switches, 2 (GANIL). Do we need a spare unit?

- Racks
  - Cooled rack for NEDA electronics in G1 (ordered by GANIL, delivery by end of June 2017?)
  - Cooled rack for servers in G2 (GANIL, Gif will check if we can use one of the existing EXOGAM racks)
  - Rack for HV crate G2 (GANIL)

- Safety
  - Xylene leakage detector

- Firmware and software
  - Virtex 5
  - NEDA PCI integration
  - Virtex 6
  - PSA trigger request
  - TDC
  - Register server GUI
  - Test of V5-V6 with a Cf source at LNL

- Others
  - GTS epics
  - Narval NEDA producer actor
  - Mergers and filter for NEDA/AGATA
  - Run control and configuration
  - Trigger processor
  - In beam test
  - Physics campaign AGATA+NEDA+DIAMANT
DIAMANT Status
Configuration for the 2018 campaign
FW config (plunger)

Csl
56+8(24) channels

2nd stage
1 double NIM
3 single NIM

NUMEXO2
5 single NIM

GTS
1 double NIM

64(80) channels:
10 NIM slots
5x 1Gbps
Cabling schematics for the 2018 campaign

- **PSU**
- **NUMEXO2**
- **GTS**
- **Network switch**
- **Electronics rack**

### Cables Types and Lengths

1. **Molex-DIN 4-wire power cable**: 3’ m
2. **HDMI-HDMI SEDIF to NUMEXO2**: 1.5m
3. **SCSI-SCSI Shielded flat cable**: 3’ m
4. **OM3-OM3 GTS optical**: 0.5m
5. **RJ45-RJ45 NUMEXO2 to switch**: 1.5m
6. **HDMI-HDMI to NUMEXO2**: 1.5m
7. **OM3-OM3 Optical**: 0.5m
8. **RJ45-RJ45 Power cable**: 3’ m
9. **SCSI-SCSI Shielded flat cable**: 3’ m
10. **HDMI-HDMI SEDIF to NUMEXO2**: 1.5m
11. **OM3-OM3 GTS optical**: 0.5m
12. **RJ45-RJ45 NUMEXO2 to switch**: 1.5m
Configuration for the autumn tests

FW config (plunger), reduced channel number

CsI
56+8 channels, 48 used

2nd stage
2 single NIM

NUMEXO2
3 single NIM

GTS
1 double NIM

48 channels:
6 NIM slots
3x 1Gbps
Cabling schematics for the autumn tests

1. Molex-DIN 4-wire power cable 3’ m
2. SCSI-SCSI Shielded flat cable 3’ m
3. OM3-OM3 GTS optical 0.5m
3. RJ45-RJ45 NUMEXO2 to switch 1.5m
3. HDMI-HDMI SEDIF to NUMEXO2 1.5m

- PSU
- Electronics rack
- Network switch
- LAN

Connections:
1. PSU to Electronics rack
2. Electronics rack to Network switch
3. Network switch to LAN
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**Timeline**

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<th>GANIL</th>
<th>run 3</th>
<th>Campaign</th>
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<td>might be a problem</td>
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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
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 2nd 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)
Trigger Processor
• AGATA Trigger not compliant with AGATA+NEDA+DIAMANT needs (limited to max 40 TRs)

• Development of the EXOGAM2 Trigger Processor. Specs:
  - Full compatibility with GTS
  - Extension to 256 TRs (max possible for GTS)
  - Multiple simultaneous trigger capabilities
  - Define precise trigger timing
  - No dead time; continuous coincidence analysis
  - Validate data not participating to trigger decision
  - Flexibility (easy to change trigger conditions)
  - 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

\[
LE = \bigcup_{n=0}^{n=31} \bigcup_{p=0}^{p=31} \left[ \bigcap_{n} \left( EN_p \text{ AND } CW_p \right) \right]
\]

\( LE = 1 \Rightarrow \text{event validation is sourced} \)
EXOGAM2 TP_V1

Completed end of 2016

Xilinx VC707 (Virtex 7) housed in the custom box (19” case, rack mount, 1 U)

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 width = 10T; CW width = 10T, CW delay = 101T; Multiplicity = 4
  - Partition 2: 1 TR; MW width = 2T; AW width = 2T; CW width = 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**
  ⇒ Similar performance as AGATA TP (rejection rate ~1%)

- **Next step (EXOGAM2 TP_V2):**
  ⇒ Connect to EXOGAM2 for long term tests (rejection = f(rate); multipartition; reliability;…)
  ⇒ Connect to AGATA (check 10 μs latency vs idle cycle)
  ⇒ Replace Raspberry PI by IP BUS protocol
## Workflow

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<th>07/17</th>
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<td>Connection to AGATA</td>
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<td>Use in-beam run3</td>
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<td>Rerouting SPI connection (V2)</td>
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<td>IP BUS (V2) IPHC</td>
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- 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: $^{252}$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 → 8 experiments approved A/B
- Necessity of a beam commissioning in G1 with AGATA+NEDA+DIAMANT → beginning of 2018.