

The GALILEO gamma array @LNL: commissioning & first experiments

D. Mengoni, F. Recchia and J.J. Valiente Dobón

for the GALILEO collaboration







γ -ray spectroscopy at LNL









- 80% nuclear physics research
- 50% γ-ray spectroscopy
- Proton- and neutron-rich nuclei



EUROBALL 1998



AGATA 2008

GALILEO - phase 1

2015

25 HPGe
25 BGO shields
240 digital channels

Phase 1 - The present implementation

■25 HPGe + AC + NW



The GALILEO spectrometer – phase 2





- digital sampling
- preprocessing

DAQ





- 30 GASP detectors
 @ 22.5cm
- 10 triple cluster detectors
 @ 24 cm

The GALILEO spectrometer – phase 2



GALILEO digital electronics





COMMISSIONING: July 2014

GALILEO stand alone

 ^{32}S at 130 MeV impinged into a ^{58}Ni target (1 mg/cm²) backed with 15 mg/cm² of Au



Infrastructure & LN₂
 5 HPGe dets + 5 BGOs
 GTS, trigger less mode
 Digital Electronics



GALILEO complementary dets

- Light charged particle detectors EUCLIDES, SPIDER, TRACE
- Neutron detector
 N–Wall
- Lifetime measurements
 Plunger from Cologne
- Recoil detectors
 RFD
- Fast timing High–energy gamma– rays detector

LaBr3 detectors

Study of weak reaction channels stable beams

High efficiencyHigh resolving power

Commissioned dets Commissioning phase

To be commissioned

light charged particles: EUCLIDES







 $\Delta E-E$

110 Silicon detectors (80%4π)
 ε_α~30%; ε_p~50%;
 ~100% working, ~ 80keV FWHM
 New compact preamps
 Digital electronics
 Trigger-less mode

commissioning Dec 2014 – Mar 2015



Neutron detection: NWALL



Experimental efficiencies: ε(1n) = 28(2)%,ε(2n) = 2(1)%
 50 (45) detectors, organic scintillators [BC501A]
 Three types of signals for each of them: QVC, TOF, ZCO
 Preselected neutron condition provided to the trigger.
 VME electronics ... going to digital



Commissioning May-June 2015

NWALL collaboration

lifetimes: plunger

³²S (172 MeV) + ¹⁵⁴Sm target (1 mg/cm² + 10 mg/cm² Au)



talk by A.Goasduff





Compact plungerConstraints: mechanics and ancillaries

IKP Cologne collaboration

Online spectrum



commissioned Feb 2016

Science Campaign: Fall 2015



MED in mirror nuclei A=31

¹²C(50 MeV) + ²⁴Mg [A.Boso, S.Lenzi]





The same type of V_B term as in the $f_{7/2}$ shell is needed in the lower sd shell to reproduce MED

High-spin states in mirror 31P and 31S

- B(E1) strength via lifetime
- J>13/2 states not yet observed in 31S

quasi-online



Experiment performed in early March. Analysis at an early stage, but higher spins already visible.

March 2016

Octupole deformation in ¹¹⁶Ba

⁵⁸Ni(250 MeV) + ⁶⁴Zn [J.F.Smith, G.Jaworski]



December 2015

Shape coexistence in ⁶⁰Zn

¹²C(50 MeV) + ⁵⁴Fe [D.Mengoni, V.Modamio]



Lifetimes: 188,190 Hg

³⁴S (180 MeV) + ¹⁵⁴Gd target (1 mg/cm² + 10 mg/cm² Au) [P.R.John, M.Siciliano]

Online spectrum



Shape transition/degree of mixing
 2+,4+,6+ visible/measurable



¹⁸⁸Hg, 2+ \rightarrow 0+, gated on 4+

March 2016

Plan for the -near- future

- **High-energy** γ -ray spectroscopy LaBr
- Resonant states TRACE
- Coulomb Excitation SPIDER
- Fusion-evaporation nuclei with high-fission background - direct recoil detection (RFD)
 g factors

Coulomb Excitation: SPIDER





- Energy resolution: ~25 keV for α-particles @~5.5 MeV
 Doppler correction (MC simul): FWHM ~ 0.2%@1.3MeV, β~3%
 - Angle [8 independent strips, 8 sectors]
 Range: 133 168 deg
 Digital electronics

talk by K.Hadinska

Commissioning case





...July 2016

Residues: Recoil Filter Detector





IFJ PAN Kraków collaboration

Summary and outlook

- GALILEO is a permanent spectrometer available at LNL
- Its first implementation, Phase-1, is now operational with 25 detectors
- GALILEO will make use of various ancillary detectors managed by national and international collaborations.
- First campaign GALILEO Phase-1 in 2015-2017 NW + Euclides + plunger
- Other campaigns will follow, soon: SPIDER, LaBr, TRACE, RFD ...
- It is expected to represent the resident γ -ray spectrometer, in combination with AGATA, with the advent of RIBs at SPES.



First radioactive beam: 2018

light charged particles: EUCLIDES









- 110 Silicon detectors (80%4 π) ■ $\varepsilon_{\alpha} \sim 30\%$; $\varepsilon_{p} \sim 50\%$; ■ 100% working = 20(c)/ Γ ///
- ~100% working, ~ 80keV FWHM
- New compact preamps
- Digital electronics
- Trigger-less mode

commissioning Dec 2014 – Mar 2015

COMMISSIONING: December 2014

⁵⁸Ni at 210 MeV impinged into a ⁵⁸Ni target (0.5 mg/cm²)



■ p channel: 113I(3p), 81Sr (3p1n), 81Rb

- • •
- $\blacksquare \alpha$ channel: 110Te (α pn)
- Full kinematic reconstruction







Channel selection, Doppler corr.





PSA 2500 (a.r.) 2000 2000 1mm, flip 10^{2} α 1500 p,d,t 10 1000 500 20 30 50 60 70 40 ∆Time_{CFD} (a.u.)

 Digital trigger
 Online trapezoidal filter: 3us
 Off line short trace filtering: 0.5 µs
 Trigger-less mode, max rate ~40 khZ/det

Digital triggerDigital CFDZ separation

COMMISSIONING: June 2015 n-γ discrimination





Digital acquisition

lifetimes: plunger



Compact plunger
 Constraints: mechanics and ancillaries

talk by A.Goasduff







commissioned Feb 2016

plunger commissioning

³²S (172 MeV) + ¹⁵⁴Sm target (1 mg/cm² + 10 mg/cm² Au)

Online spectrum





Lifetime in 188,190Hg to be run mid March



