AGATA + FATIMA sub-campaign at GANIL

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**FATIMA for DESPEC**

- **FATIMA** = **FAst TIMing Array** = State of the art array for precision measurements of nuclear structure in the most exotic and rare nuclei. 36 LaBr$_3$(Ce) detectors.
  - Energy resolution better than 3% at 1 MeV.
  - Detection efficiency of ~ 5% Full-energy peak at 1 MeV.
  - Excellent timing qualities (sub 100 ps).

- Use to measure lifetimes of excited nuclear states & provide precision tests of nuclear structure, uses a fully-digitised Data Acquisition System (CAEN 1 GHz digitizers).
FATIMA at GANIL

• 24 LaBr$_3$ detectors, each with ‘new’ mu metal anti magnetic shields.

• Detector dimensions 38mm diameter, 50 mm long.

• Mounted in central ring around target position.

• Standalone DAQ with CAEN 1 GHz digitizers for energies and TDC branch for fast-timing.
AGATA+FATIMA(+VAMOS) experiments (May-June 2017)

• E705 ($^{136}$Xe @ 800 MeV + $^{170}$Er) – Regan, Nyberg, Simpson - **Understanding Nuclear Collectivity Approaching the π–ν Valence Maximum: Transition Quadrupole Moments in $^{166,168}$Dy.** 13 UT. Scheduled from Tues. 23rd May (06.00am) – Sat. 27th May (06.00am). AGATA + FATIMA ONLY.

• E673 ($^{136}$Xe @ 900 MeV + $^{192}$Os) – John, Söderström - **Shape transition in the neutron-rich W isotopes.** 25 UT. Scheduled from Sunday 29th May (10.00am) – Mon. 5th June (14.00) AGATA+FATIMA ONLY.

• E706 ($^{238}$U @ 1475 MeV) – Korten, Görgen, 31 UT. Scheduled from Sat 17th June (10.00am) - Tues. 27th June (18.00) – also included 1.5UT Buffer beam time to 02.00am Weds. 28th June. AGATA+FATIMA+VAMOS+PLUNGER
Experiments Summary

- Pre-experimental source calibrations for mixed system; PRD curve made using $^{152}$Eu spectra and clear correlations between AGATA+FATIMA DAQs.

- E705: Some initial issues with target / beam focusing at 800 MeV beam energy.
  - No evidence in online spectra of Er coulex or transfer products of $^{136}$Xe on 3 mg/cm$^2$ $^{170}$Er on >25 mg/cm$^2$ $^{197}$Au.
  - Strong population of $^{143,44}$Nd and $^{157,8}$Ho from $^{136}$Xe beam reactions on $^{12}$C (glue) and $^{27}$Al (frame).
  - DAQ rate limitation of few kHz for FATIMA$^2$+AGATA$^2$ joint triggered events.
  - Stopped after ~2 days beam-time to move to 900 MeV and put in $^{192}$Os targets for E673.

- E673, $^{192}$Os thick target (>20 mg/cm$^2$) sandwiched between two Au layers (to stop oxidisation).
  - DAQ reformed so FATIMA events processed directly through GANIL DAQ. Increase accepted triggers to ~4-5 kHz.
  - Immediate evidence of $^{192}$Os Coulex events.
  - FATIMA lifetime of $^{192}$Os $I^\pi=2^+$ lifetime consistent with literature values.
  - Evidence in AGATA data of population of transfer products ($^{190}$Os, $^{188}$W, $^{194}$Os).
  - Lifetime of $^{190}$Os $2^+$ also shown to be consistent with literature values.

- E706: $^{238}$U fission fragments for N~60. AGATA+FATIMA events gated using VAMOS fragments.
  - Experiment ran until Weds. 28$^{th}$ June (yesterday 😊).
  - Event rate (gated with VAMOS products) much reduced compared to E705 and E673.
  - Initial on-line singles data suggest smooth experimental conditions and useful AGATA+FATIMA data (with plunger).
  - No spectra to show from this yet.
Target ladder used for E705 (Er+Xe); also included $^{181}$Ta target for DIC calibration/tests.
E673: P. John, P.A. Soderstrom et al.,

Goals

► First in-beam $\gamma$-ray spectroscopy of $^{190}$W and $^{192}$W
► Measurement the of $B(E2; 2^+ \rightarrow 0^+_{gs})$ of $^{190}$W and $^{192}$W

► Reaction $^{192}$Os + $^{136}$Xe at 900 MeV
► 0.2pnA
► 45 mg/cm$^2$ $^{192}$Os target
► AGATA nominal position
► FATIMA (Array of 24 LaBr$_3$(Ce)) at 90° for fast timing, shielded with 1 mm $\mu$ material
AGATA data clearly operational for $^{192}$Os (unsafe) coulex. Gate on $4^+ \rightarrow 2^+$ shows GSB as expected.
PRELIMINARY DATA ($^{192}$Os): few runs from ‘near-offline’ data, $^{192}$Os+$^{136}$Xe.
P. John, P.A. Soderstrom et al., Figures created by M. Rudigier
AGATA gate on $6^+ \rightarrow 4^+$ (509 keV) in $^{192}$Os.
Projections on FATIMA and AGATA for $2^+ \rightarrow 0^+$ (206 keV) and 375 ($4^+ \rightarrow 2^+$) keV transitions in GSB.
Time diff. between 206 and 375 keV transitions in FATIMA to give $T_{1/2}$ for $2^+$ which is consistent with literature.
PRELIMINARY DATA ($^{190}$Os): few runs from ‘near-offline’ data, transfer product from $^{192}$Os+$^{136}$Xe.

P. John, P.A. Soderstrom et al., Figures created by M. Rudigier

AGATA gate on $6^+ \rightarrow 4^+$ (503 keV) in $^{190}$Os.

Projections on FATIMA and AGATA for $2^+ \rightarrow 0^+$ (187 keV) and 361 ($4^+ \rightarrow 2^+$) keV transitions in GSB.

Time diff. between 187 and 361 keV transitions in FATIMA to give $T_{1/2}$ for $2^+$ which is consistent with literature.
Evidence for transfer products population (as expected) in initial AGATA data.

Evidence for population of $^{188}$W and $^{194}$Os in AGATA gated data.

Fewer statistics than expected from count rate estimate in proposals.

Link to total event rate and dead-time limitations of ~5 kHz Master trigger associated with FATIMA read out for gated events.

Data from full set currently under analysis.
$^{194}$Os observed in initial AGATA data. Can compare with recent $^{192}$Os($^{18}$O,$^{16}$O)$^{194}$Os lifetime measurement (RoSPHERE).
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