AGATA + FATIMA sub-campaign at GANIL

Paddy Regan
(University of Surrey & National Physical Laboratory, UK)

FATIMA for DESPEC

- **FATIMA** = **FA**st **TIM**ing **A**rray = 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).

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Technical Notes

A $LaBr_3$: Ce fast-timing array for DESPEC at FAIR

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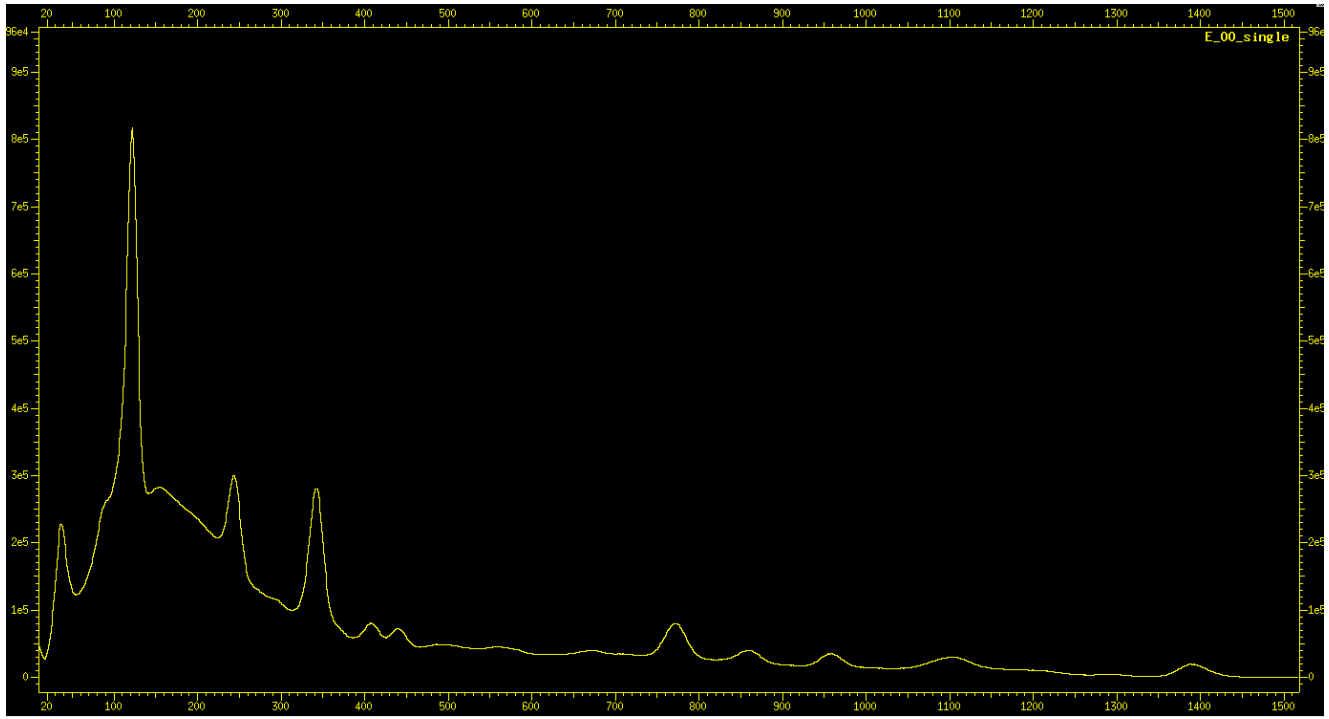
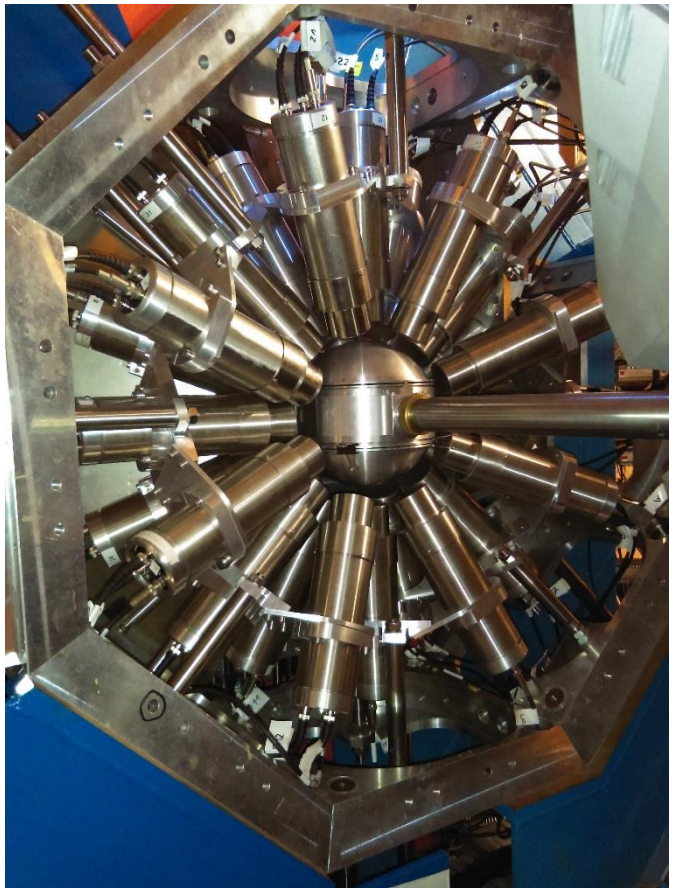
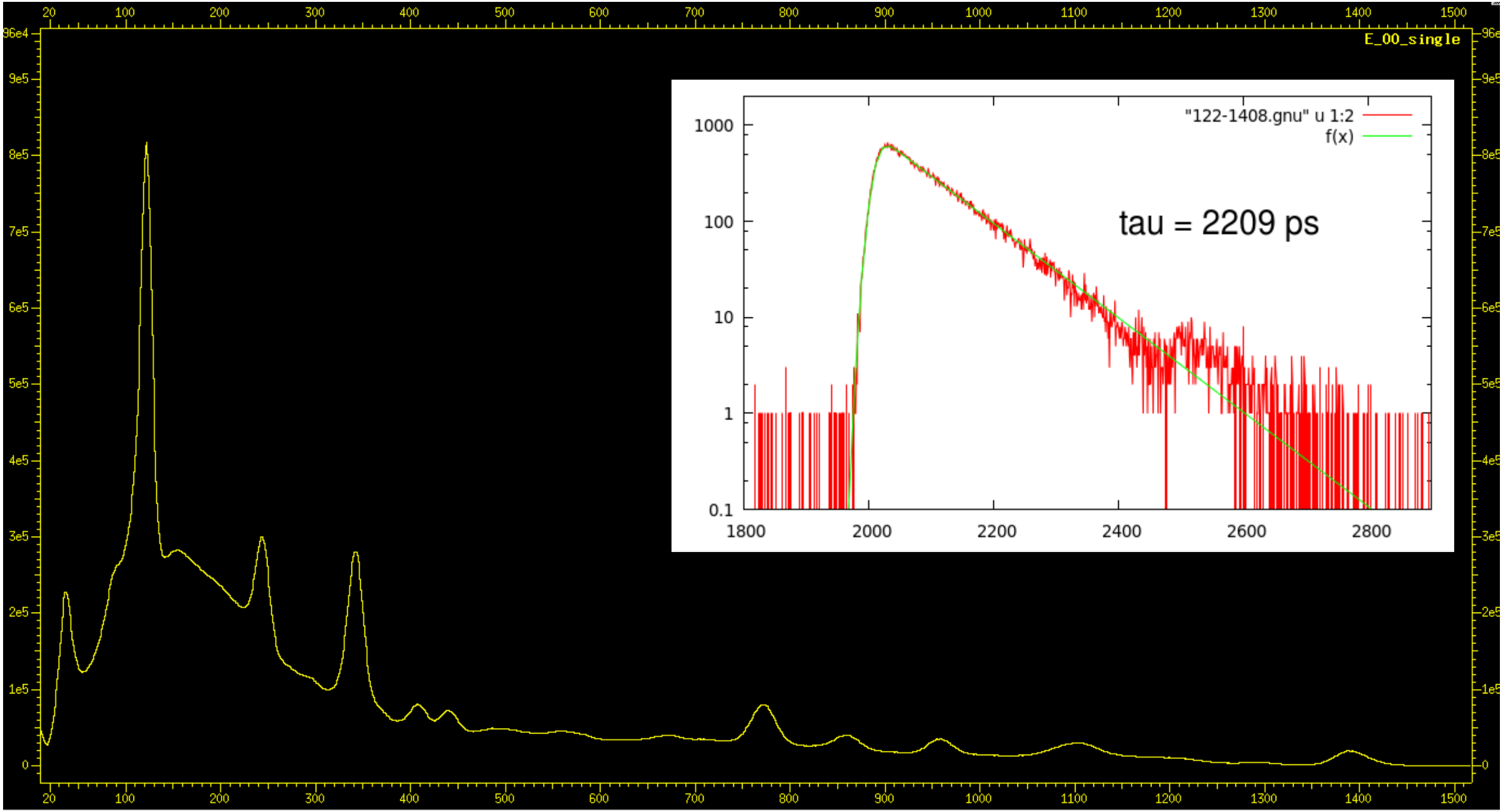
FATIMA at GANIL

- 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.



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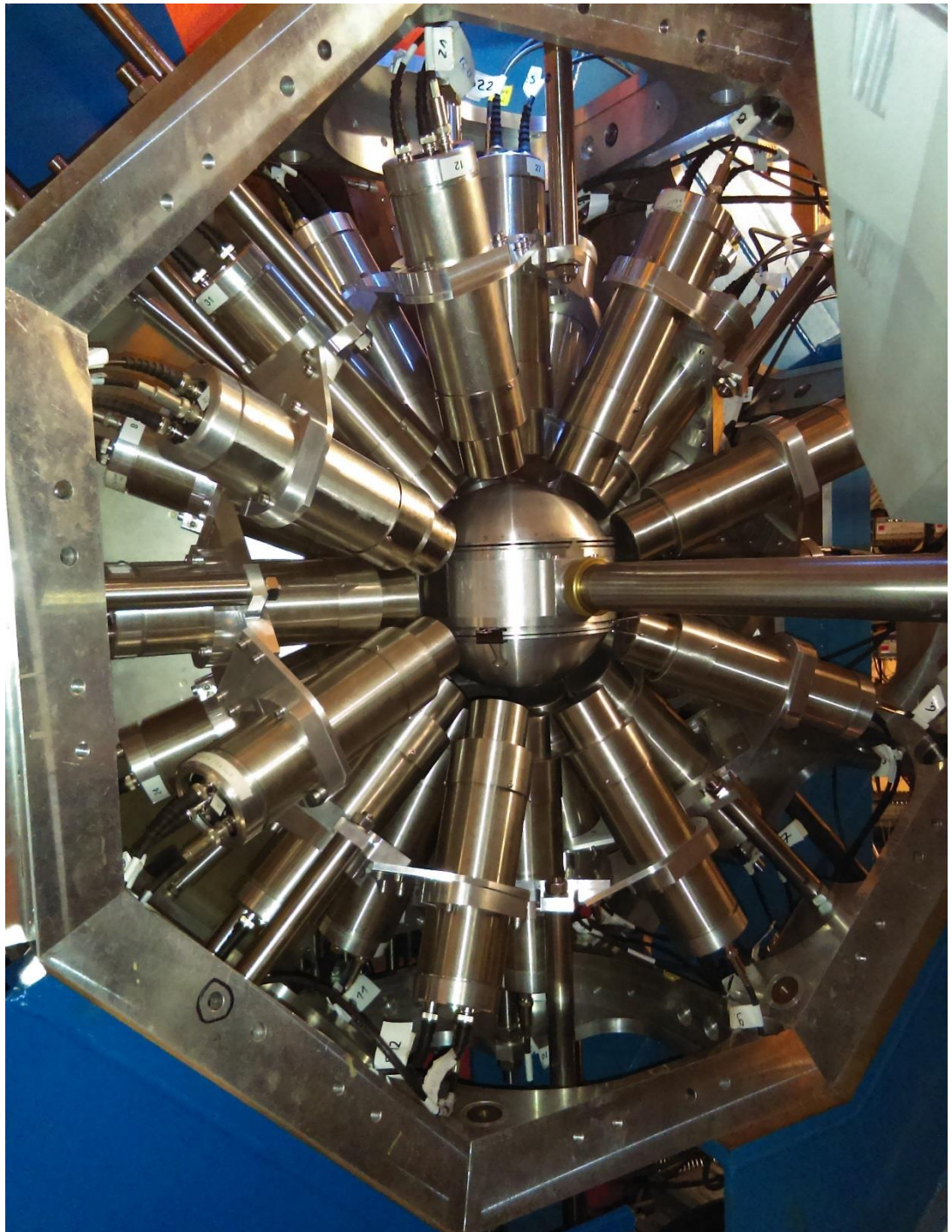
"122-1408.gnu" u 1:2
f(x)
tau = 2209 ps

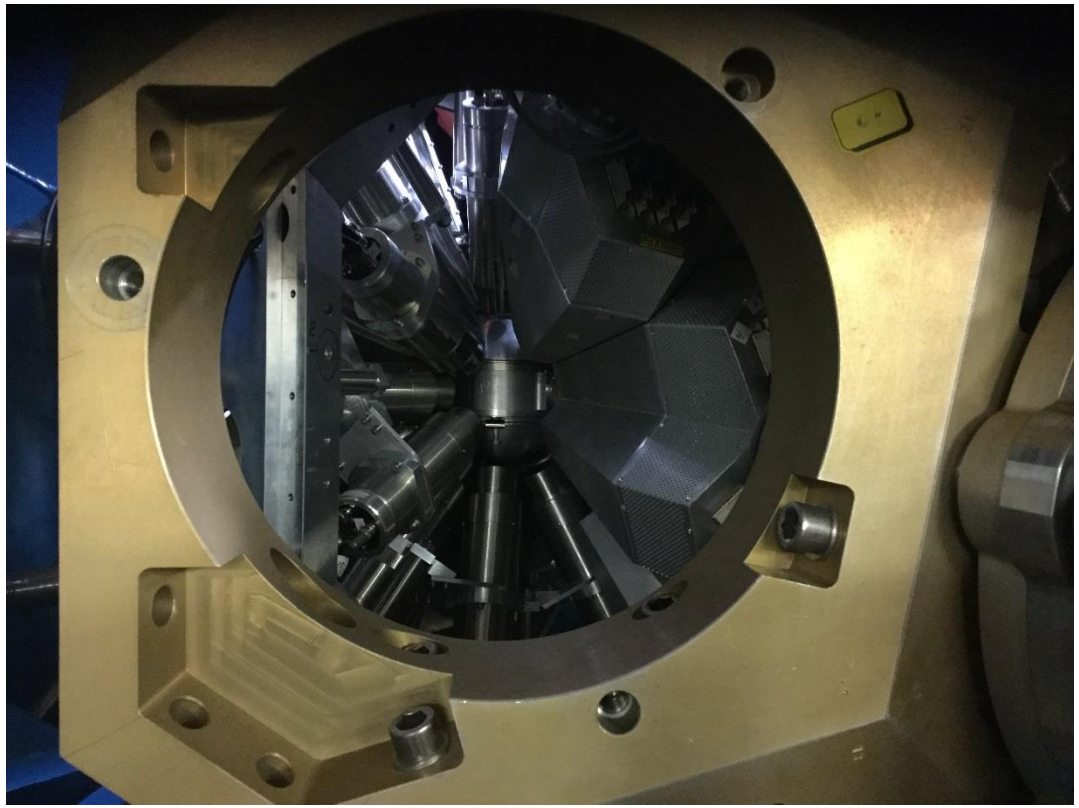
AGATA+FATIMA(+VAMOS) experiments (May-June 2017)

- 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





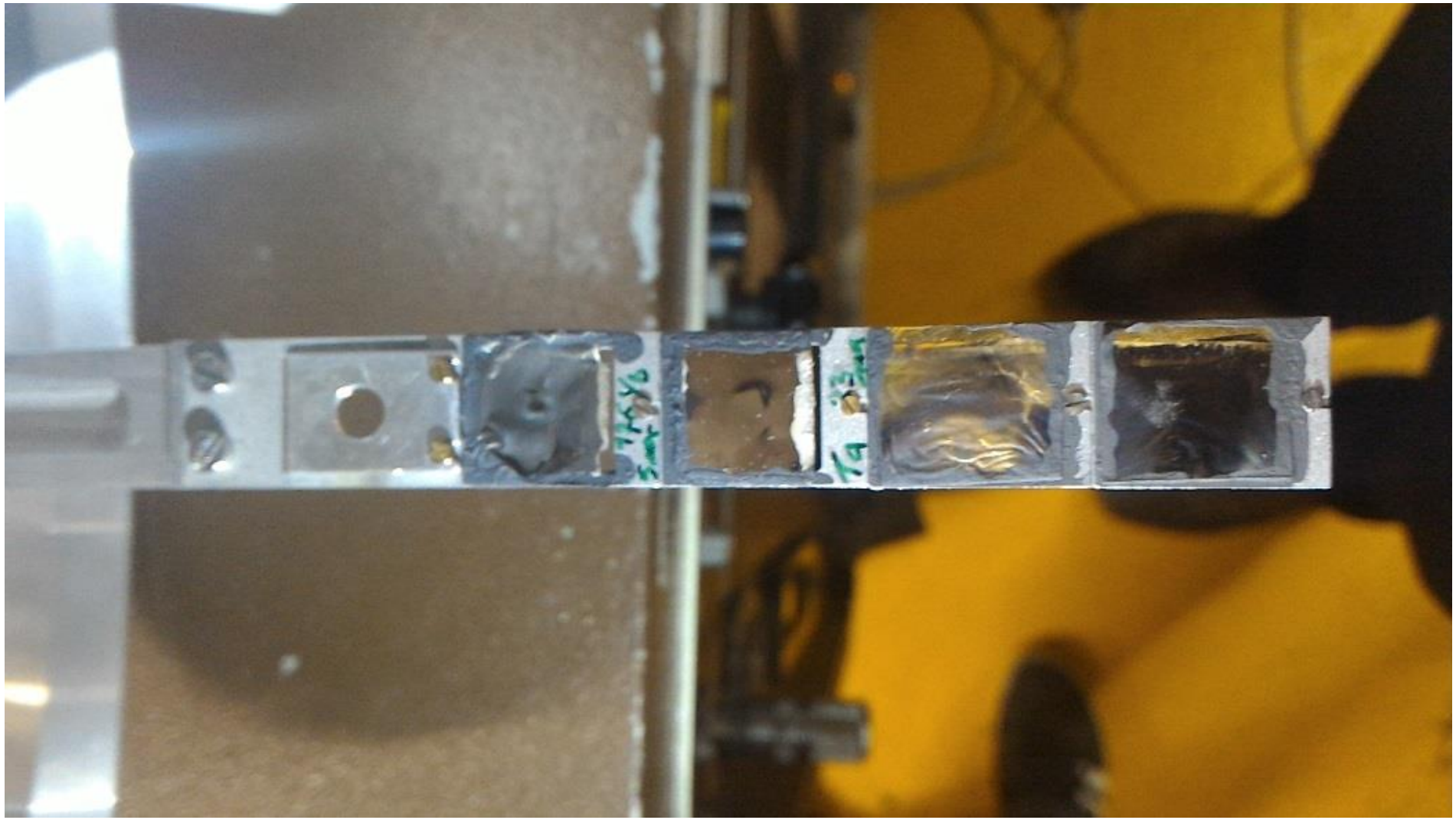
Experiments Summary

- 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 focussing 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. 28th 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.

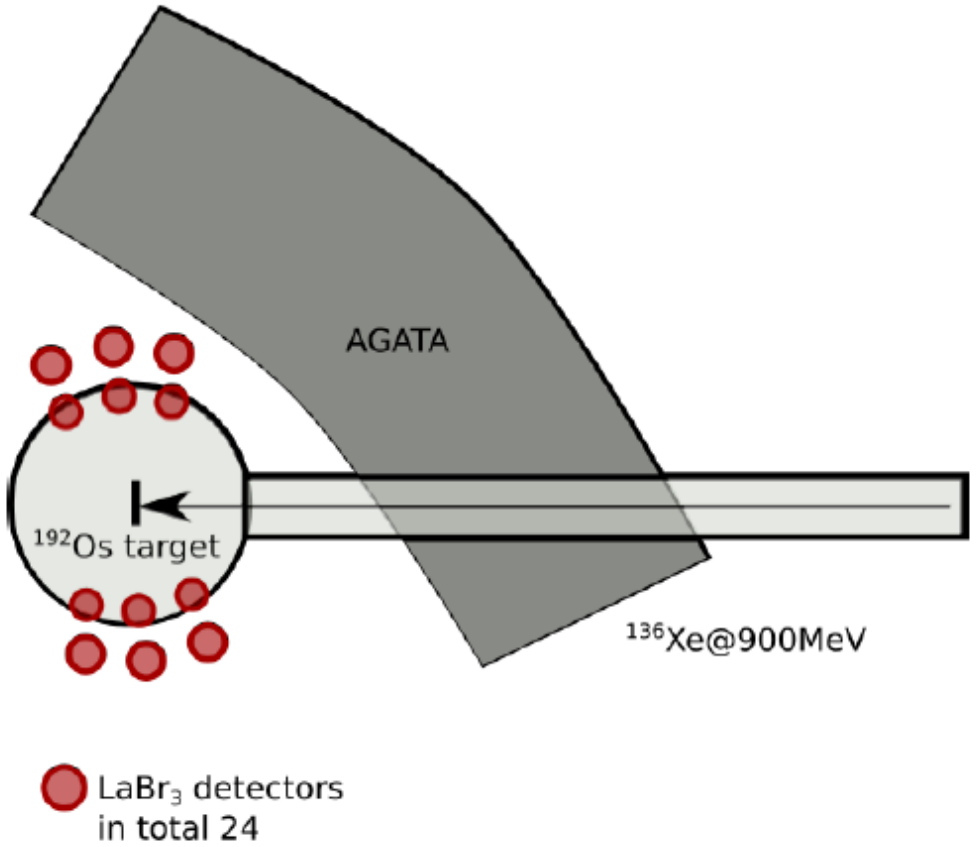


E673: P. John, P.A. Soderstrom et al.,

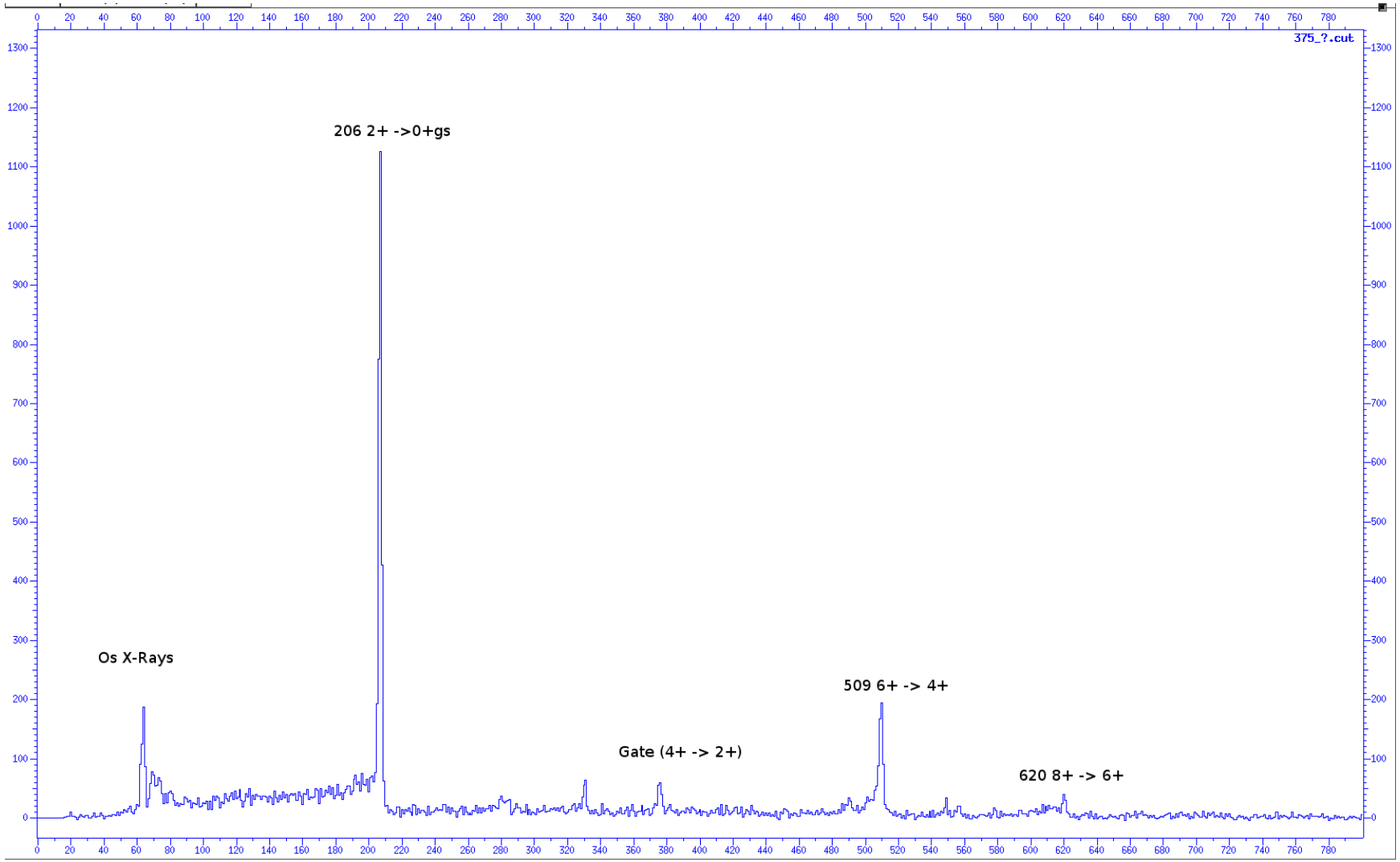
Goals

- First in-beam γ-ray spectroscopy of ^{190}W and ^{192}W
- Measurement the of $B(E2; 2_1^+ \rightarrow 0_{gs}^+)$ of ^{190}W and ^{192}W

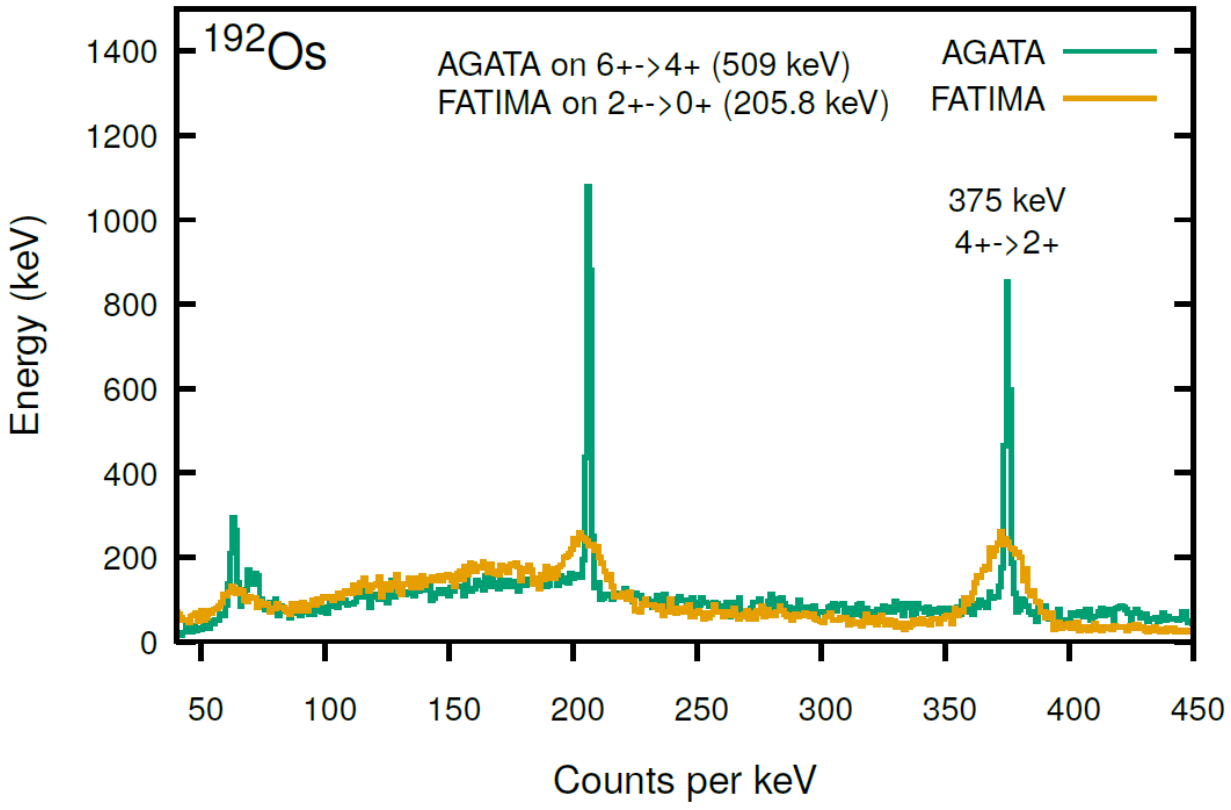
- Reaction ^{192}Os + ^{136}Xe at 900 MeV
- 0.2pnA
- 45 mg/cm^2 ^{192}Os target
- AGATA nominal position
- FATIMA (Array of 24 $LaBr_3(Ce)$) at 90° for fast timing, shielded with 1 mm μ material

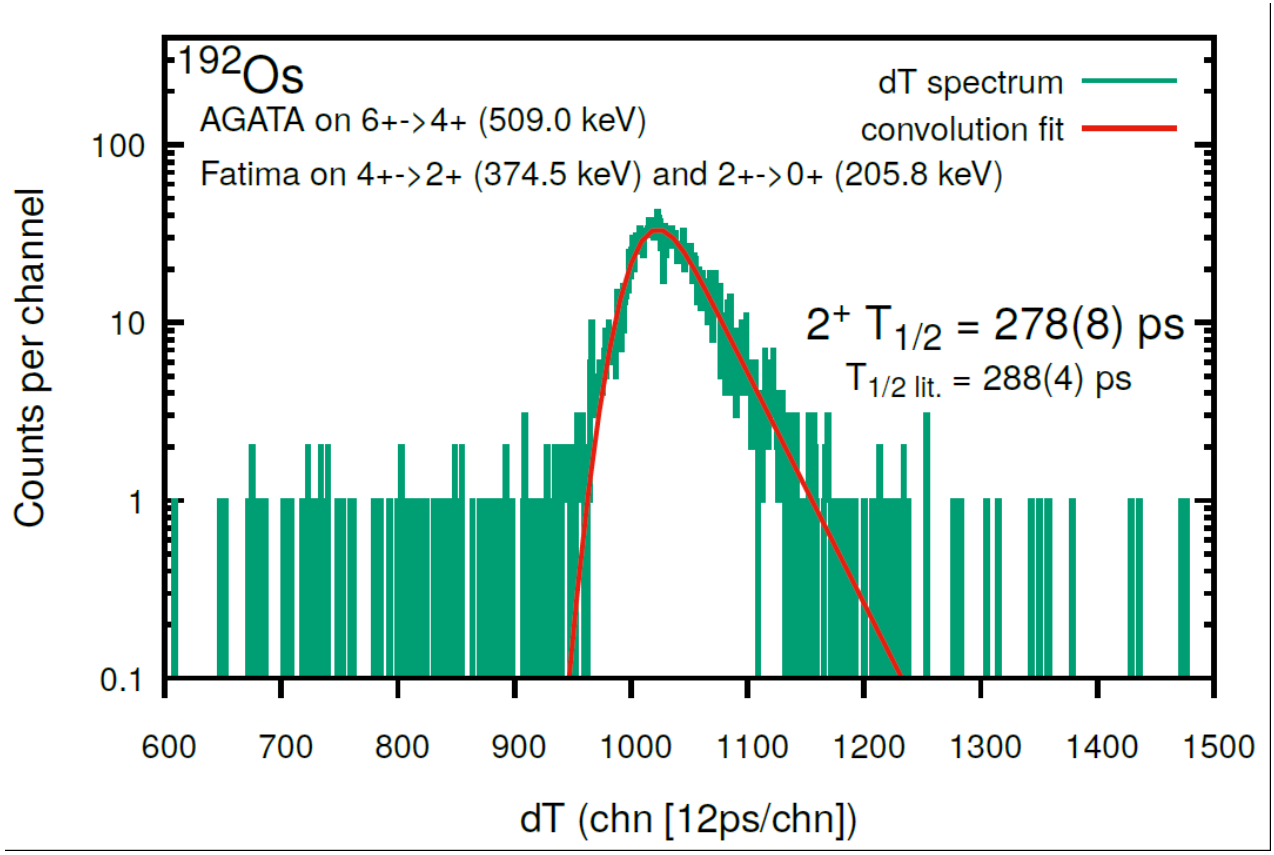


AGATA data clearly operational for ^{192}Os (unsafe) coulex. Gate on $4^+ \rightarrow 2^+$ shows GSB as expected.

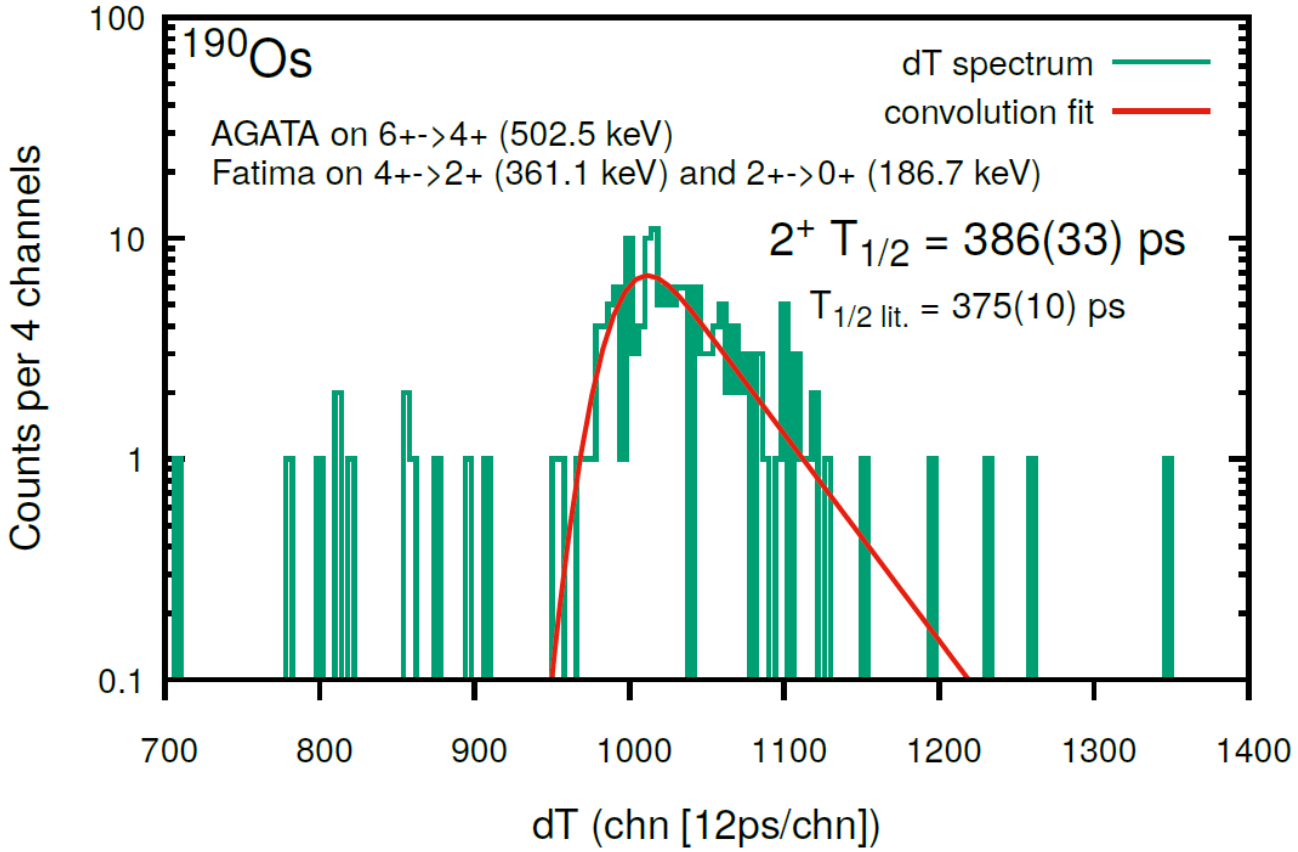


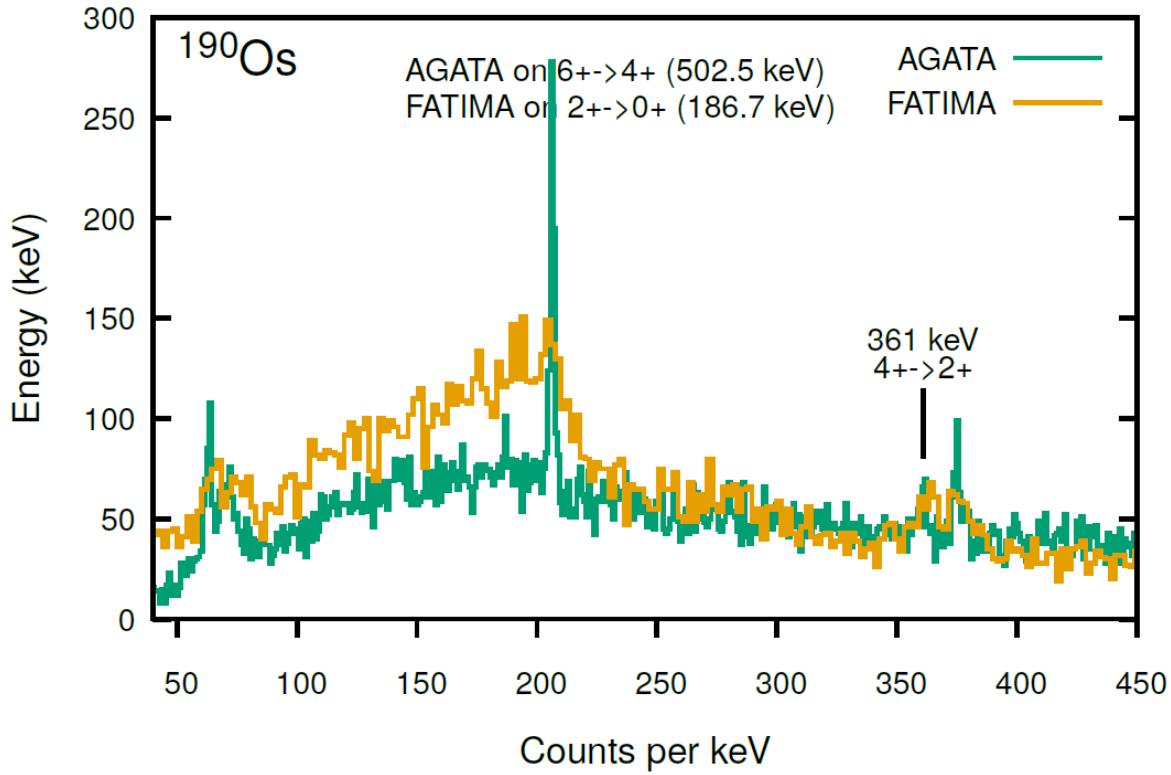
PRELIMINARY DATA (^{192}Os): few runs from 'near-offline' data, ^{192}Os+^{136}Xe.
P. John, P.A. Soderstrom et al., Figures created by M. Rudigier
AGATA gate on $6^+ \rightarrow 4^+$ (509 keV) in ^{192}Os.
Projections on FATIMA and AGATA for $2^+ \rightarrow 0^+$ (206 keV) and 375 ($4^+ \rightarrow 2^+$) 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.

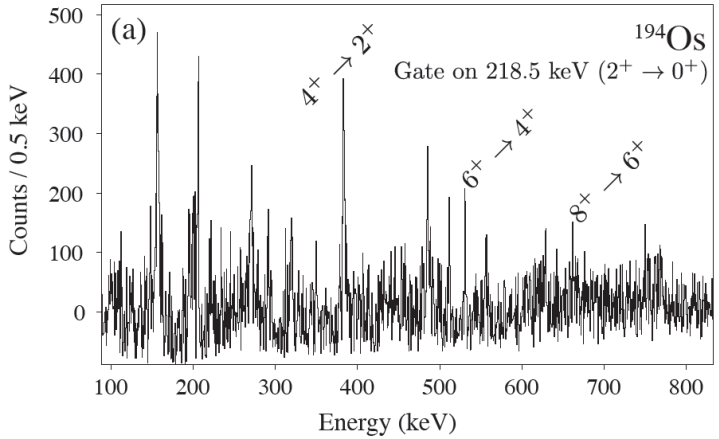


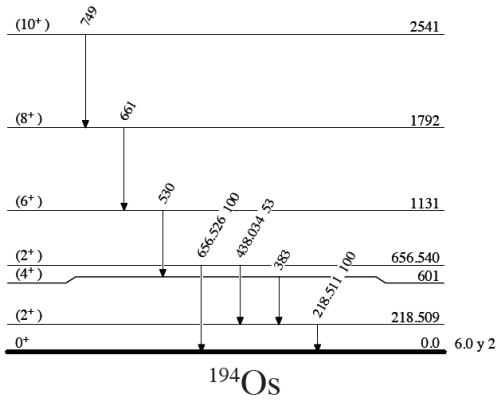


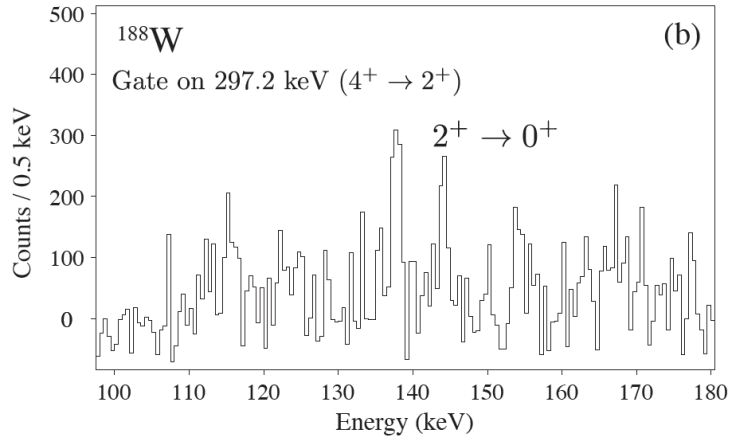
PRELIMINARY DATA (^{190}Os): few runs from ‘near-offline’ data, transfer product from ^{192}Os+^{136}Xe.
P. John, P.A. Soderstrom et al., Figures created by M. Rudigier
AGATA gate on $6^+ \rightarrow 4^+$ (503 keV) in ^{190}Os.
Projections on FATIMA and AGATA for $2^+ \rightarrow 0^+$ (187 keV) and 361 ($4^+ \rightarrow 2^+$) 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.

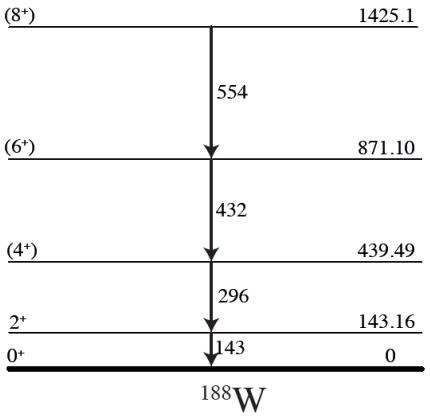


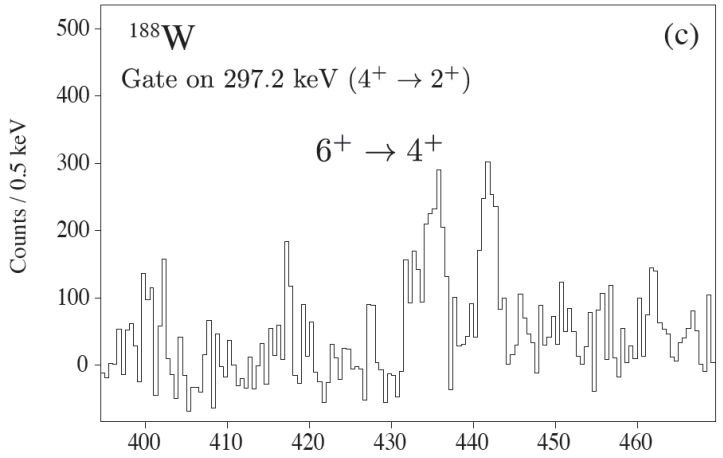


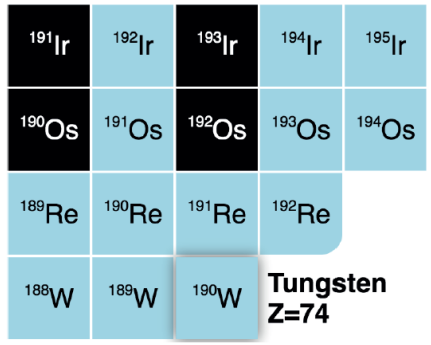












E673: P. John, P.A.Soderstrom et al.,

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.

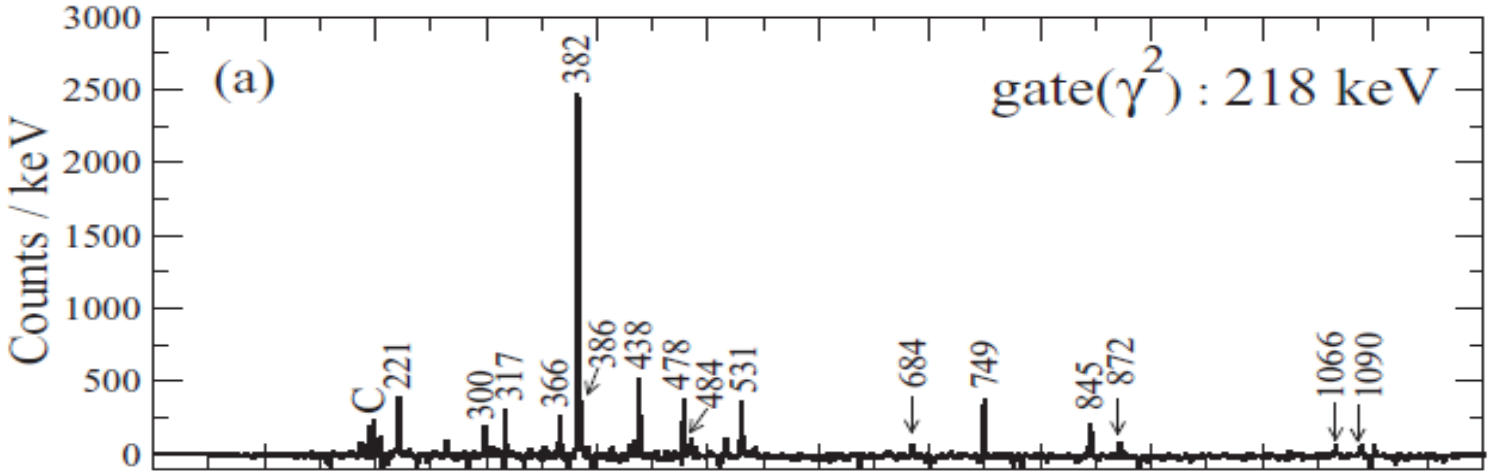
Data from full set currently under analysis.

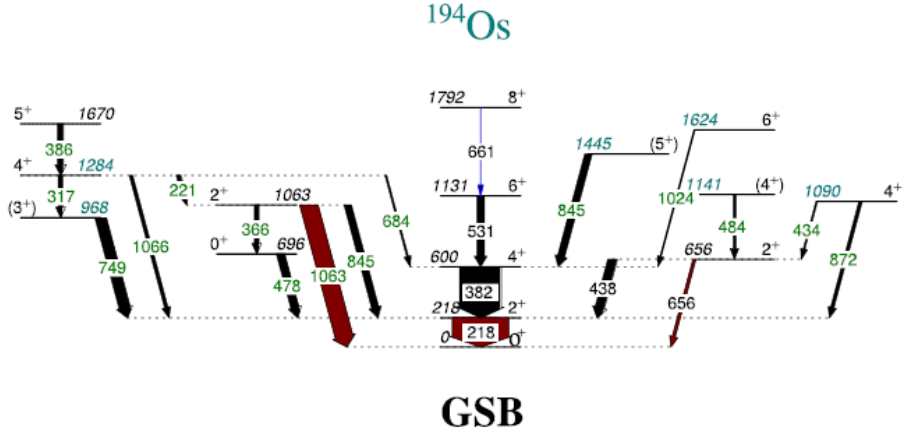
PHYSICAL REVIEW C **95**, 024328 (2017)

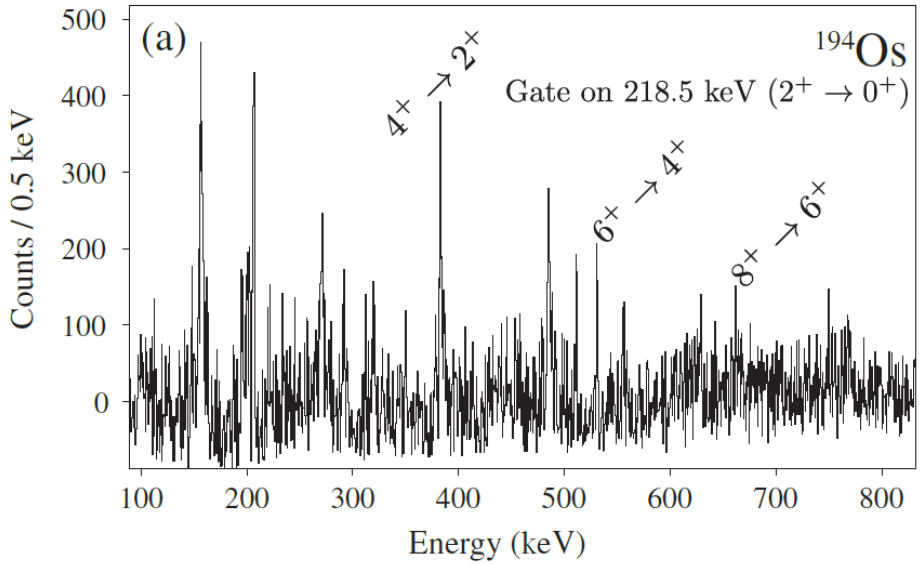
^{194}Os observed in initial AGATA data.
Can compare with recent ^{192}Os(^{18}O,^{16}O)^{194}Os
Lifetime measurement (RoSPHERE).

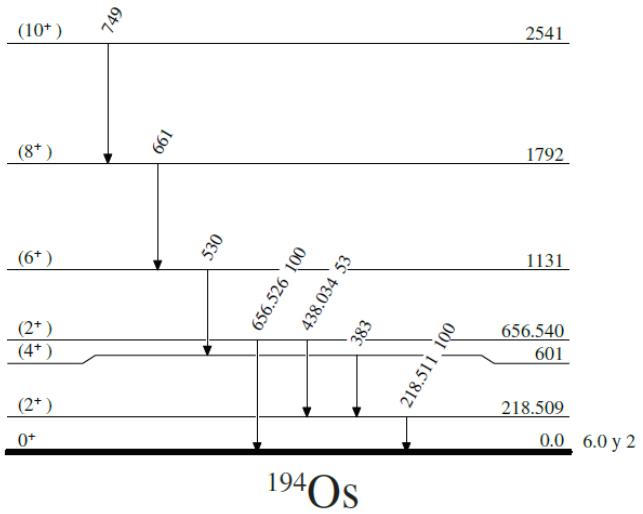
γ-ray spectroscopy of low-lying excited states and shape competition in ^{194}Os

T. Daniel,[1,2,*] S. Kisyov,[3] P. H. Regan,[1,4] N. Marginean,[3] Zs. Podolyák,[1] R. Marginean,[3] K. Nomura,[5,6] M. Rudigier,[1] R. Mihai,[3] V. Werner,[7] R. J. Carroll,[1] L. A. Gurgi,[1] A. Oprea,[3] T. Berry,[1] A. Serban,[3,8] C. R. Nita,[3] C. Sotty,[3] R. Suvaila,[3] A. Turturica,[3] C. Costache,[3] L. Stan,[3] A. Olacel,[3] M. Boromiza,[3,8] and S. Toma[3]









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