

# Commissioning the Fast TIMing Array (FATIMA) at FAIR-0: Lifetimes of Excited states in the N=50 isotones $^{96}\text{Pd}$ and $^{94}\text{Ru}$

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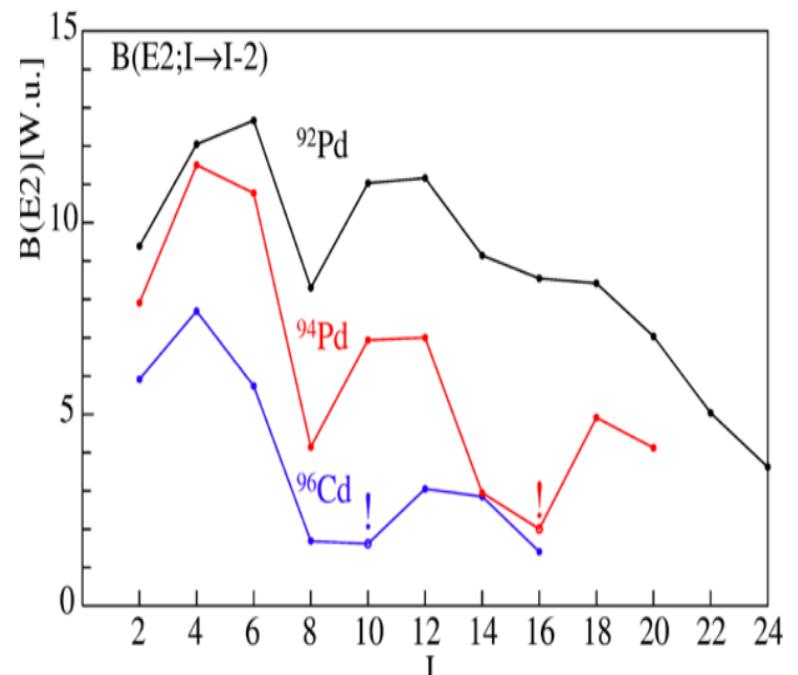
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On behalf of the DESPEC Collaboration for the  
IOP Nuclear Physics Conference 2022

# Context and Aims

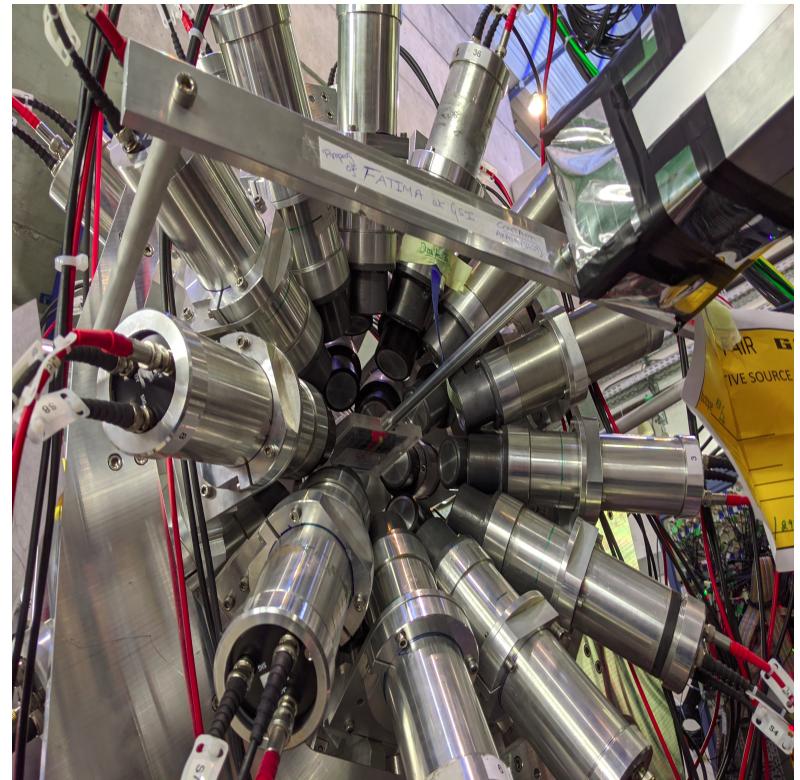
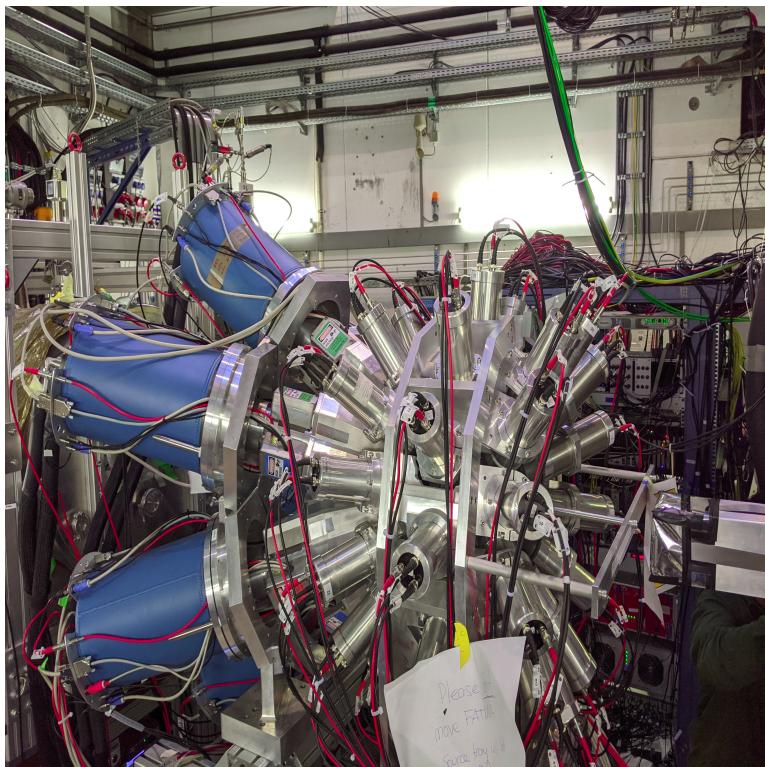
Investigation into seniority around the  $A \sim 100$  region ( $g_{9/2}$  subshell):

- $^{96}\text{Pd}$  ( $N = 50$ ) is a classic case for seniority – 2 proton hole resulting in an energy staggered  $2^+$ ,  $4^+$ ,  $6^+$ ,  $8^+$  yrast cascade
  - $^{92}\text{Pd}$  ( $N = 46$ ) behaves differently to what is expected if one carries out shell model calculations based on seniority
  - Exists as a result of the  $T = 0$  pn pairing from 4 extra valence neutrons
  - $^{94}\text{Pd}$  exists at a transition point between these two interesting cases
- 
- A large drop is seen in  $B(E2)$  in the  $8^+ \rightarrow 6^+$  transition in  $^{94}\text{Pd}$  when carrying out SM calculations in a pure  $vg_{9/2}$  state
  - Aim – Extract a  $B(E2)$  value for this transition and others to verify the shell model calculations by measuring the lifetimes of the Yrast band states in  $^{94}\text{Pd}$  as well as validate a novel GEANT4 Simulation



# Experimental Details

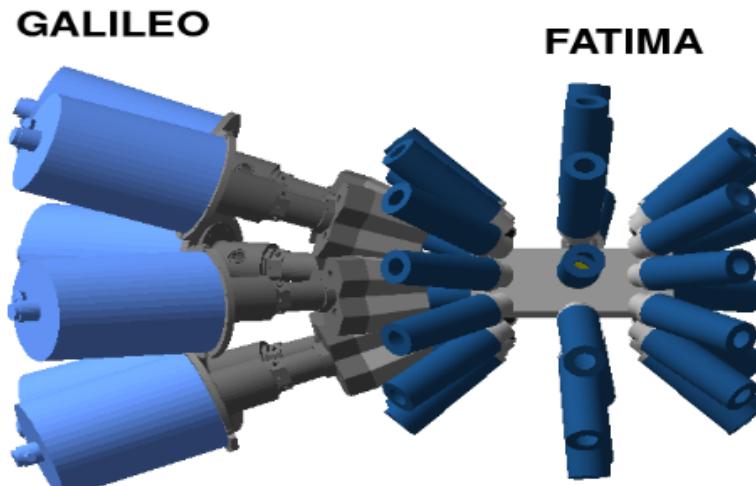
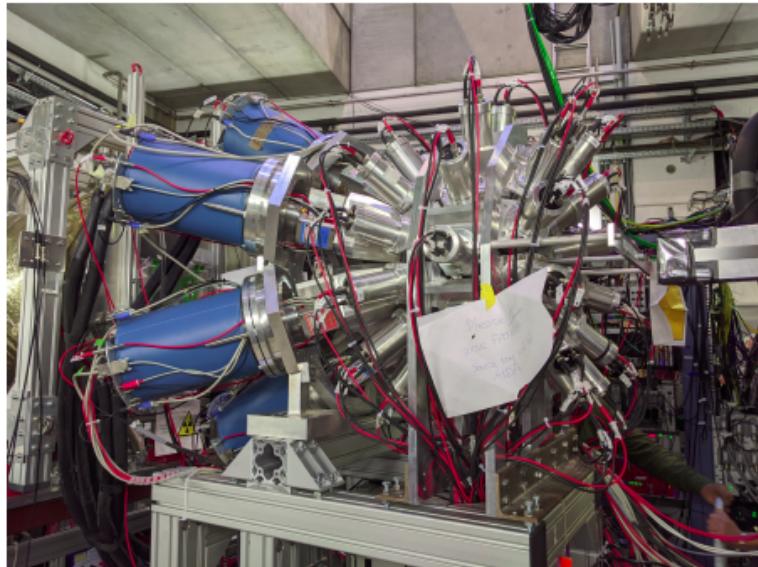
- $^{124}\text{Xe}$  Primary fragmentation beam at 850MeV/Nucleon
- FRS used to steer fragments of interest to the focal plane detectors
- 110 hours of usable data collected over a 1 week period
- “Time stitched” events using the white rabbit clock to generate detector correlated events



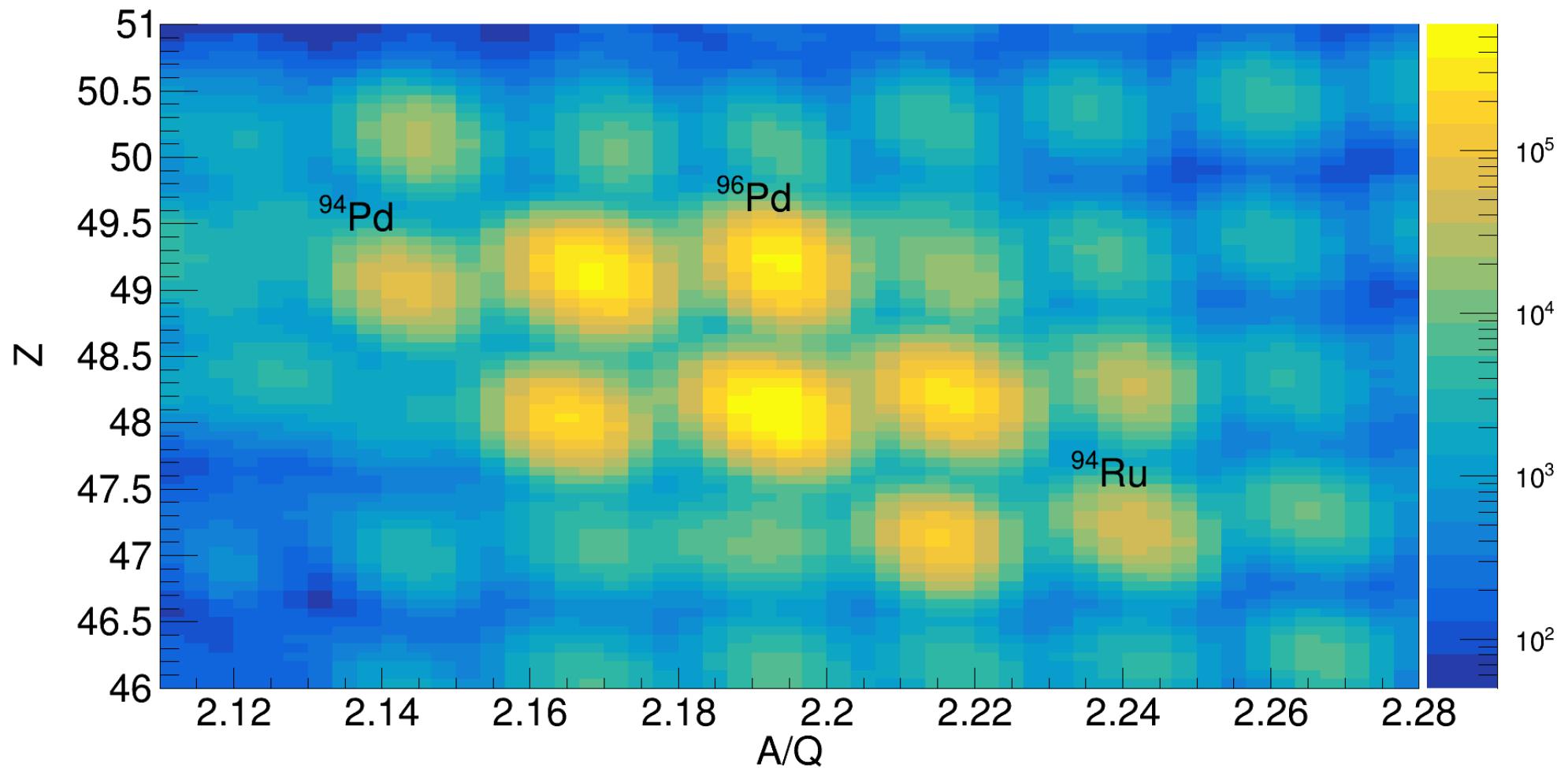
# DEcay SPECtroscopy (DESPEC) @ GSI

Collection of detectors composed of:

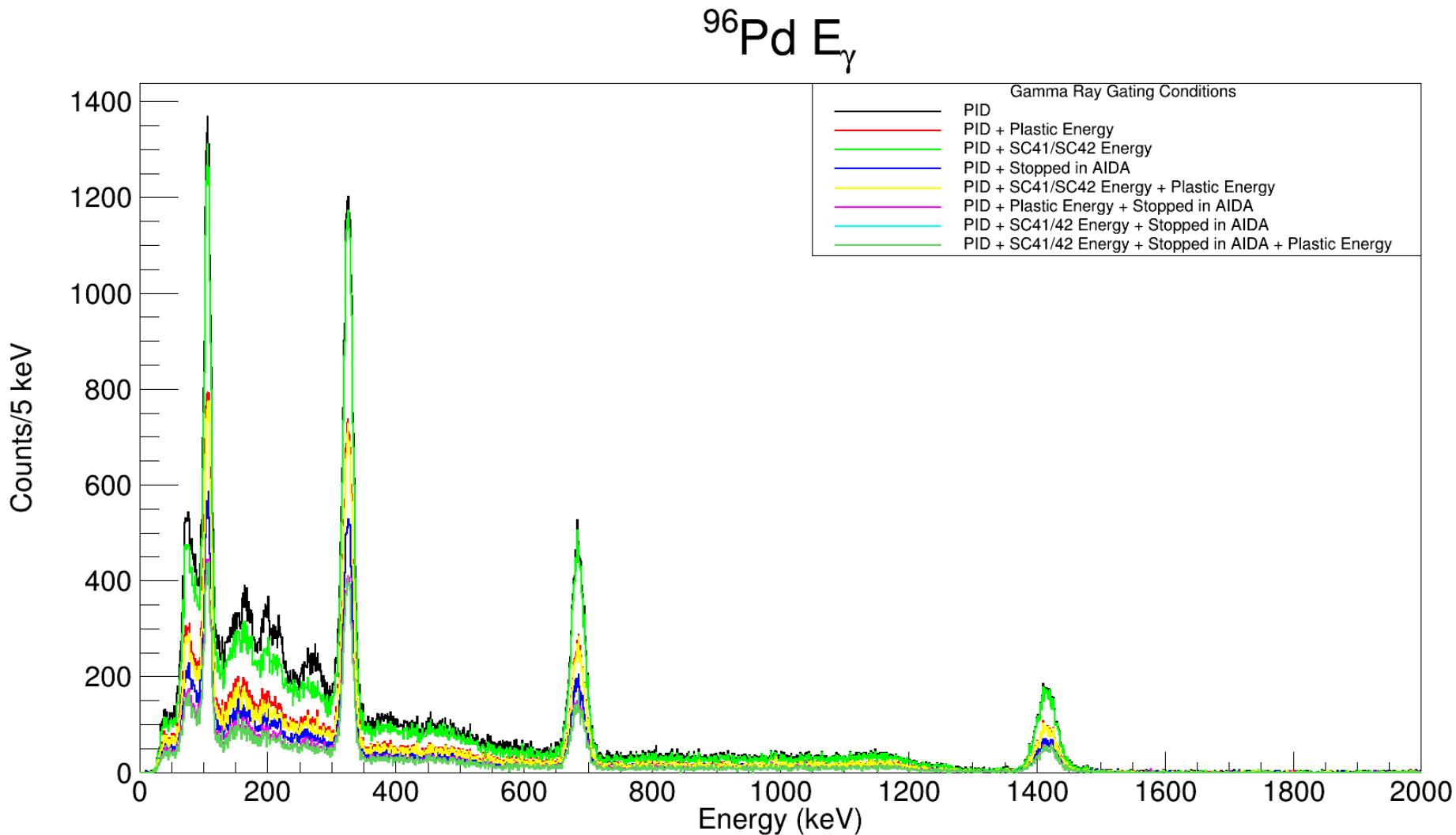
- AIDA: 3 Double Sided Silicon Strip Detectors for implant and beta decay identification
- bPlast: Plastic scintillation detector
- DEGAS: 6 Triple clustered HPGe
- Fatima: 36 LaBr<sub>3</sub>(Ce) detectors
- White Rabbit: Common clock between detectors for event building



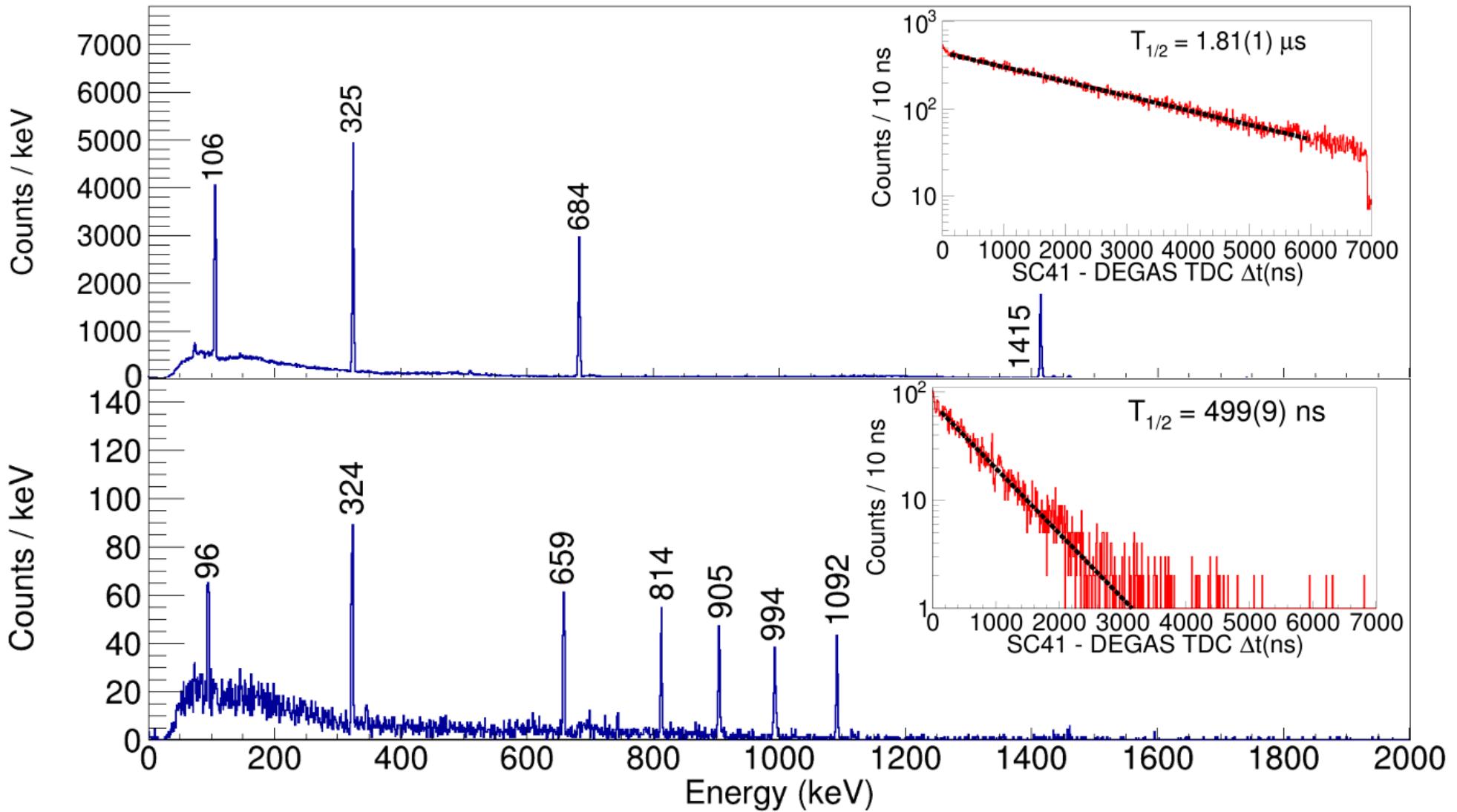
# PID



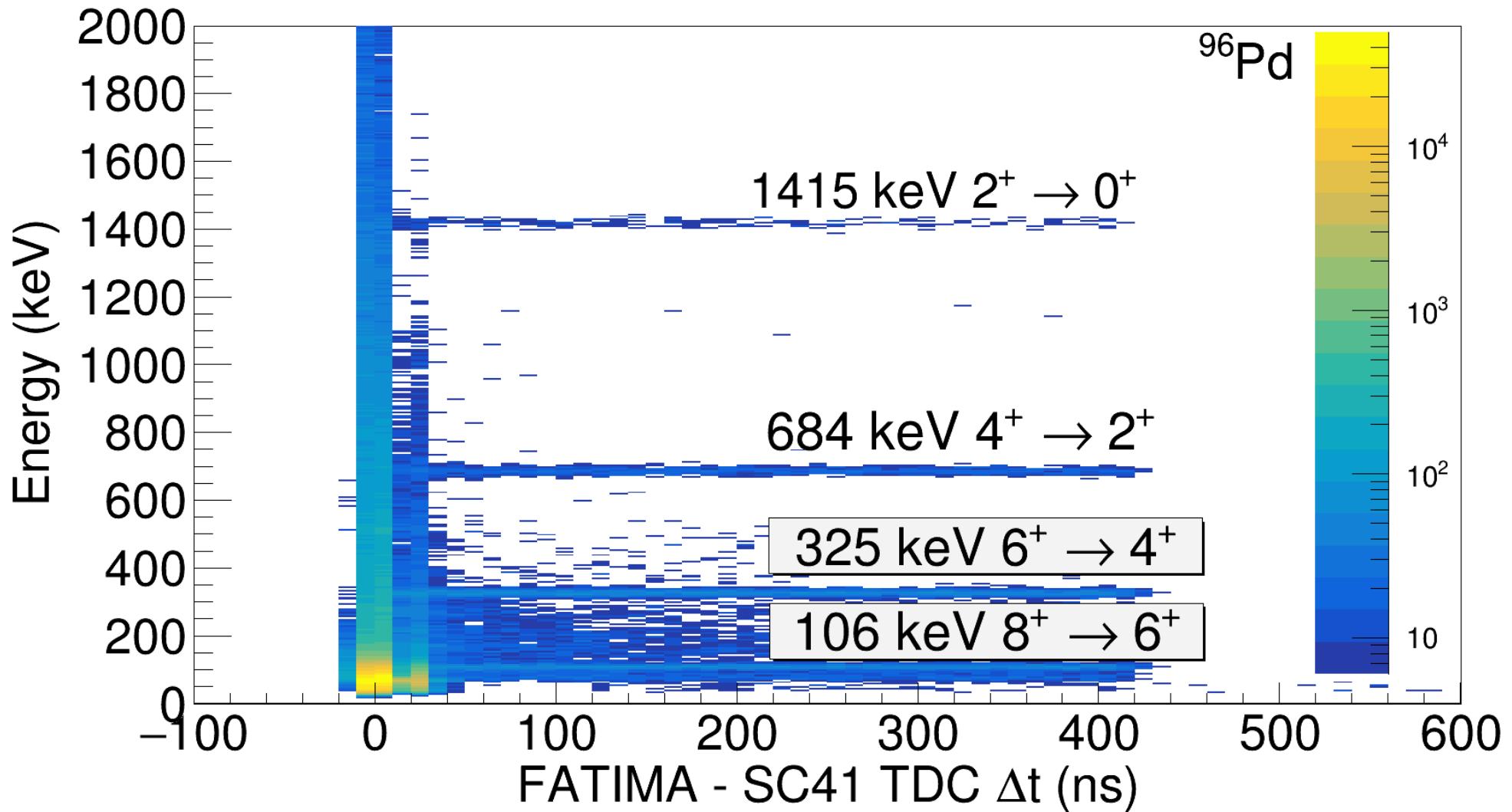
# $^{96}\text{Pd}$ PID Gating Levels



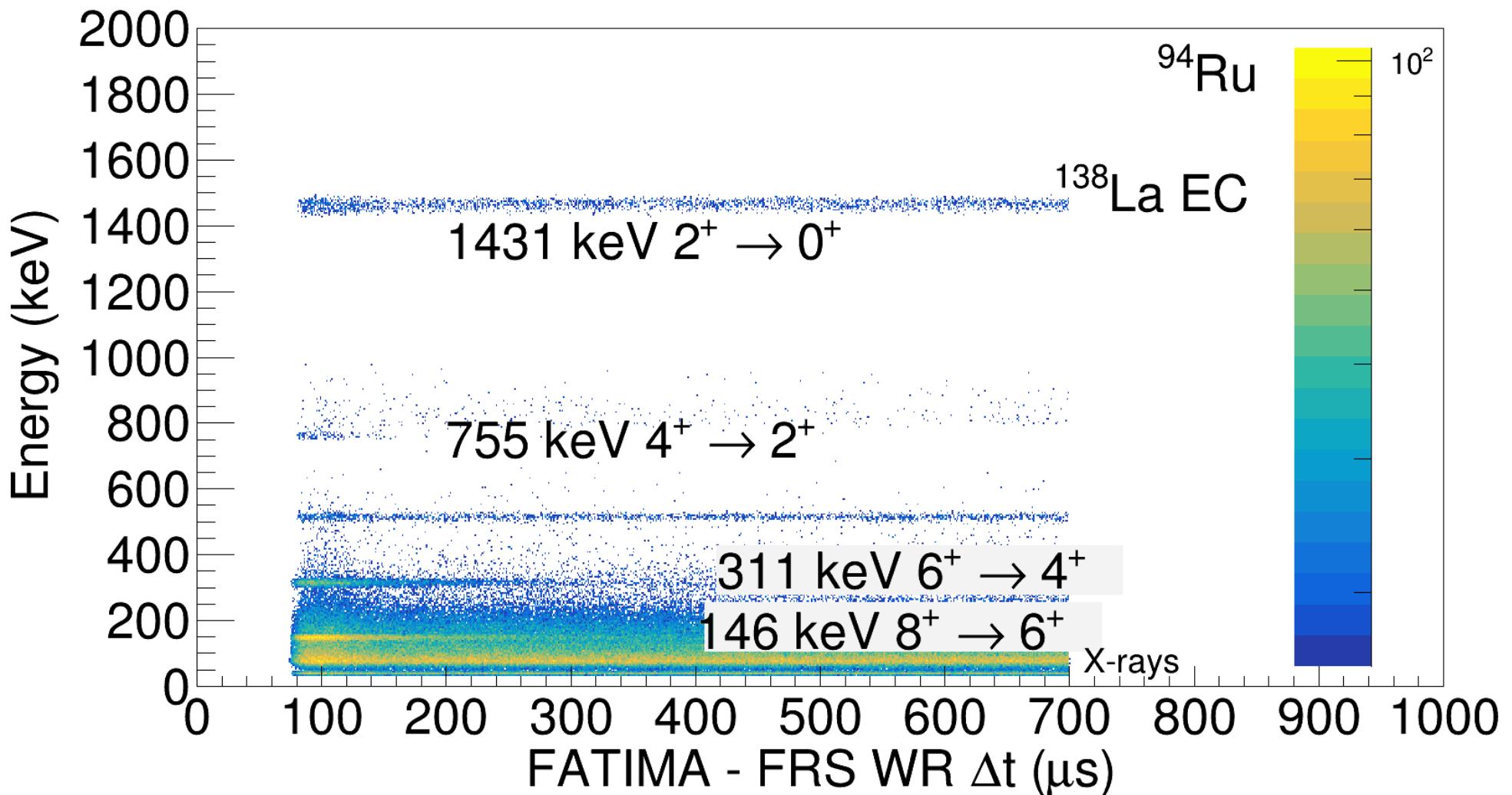
# DEGas Timing Spectra



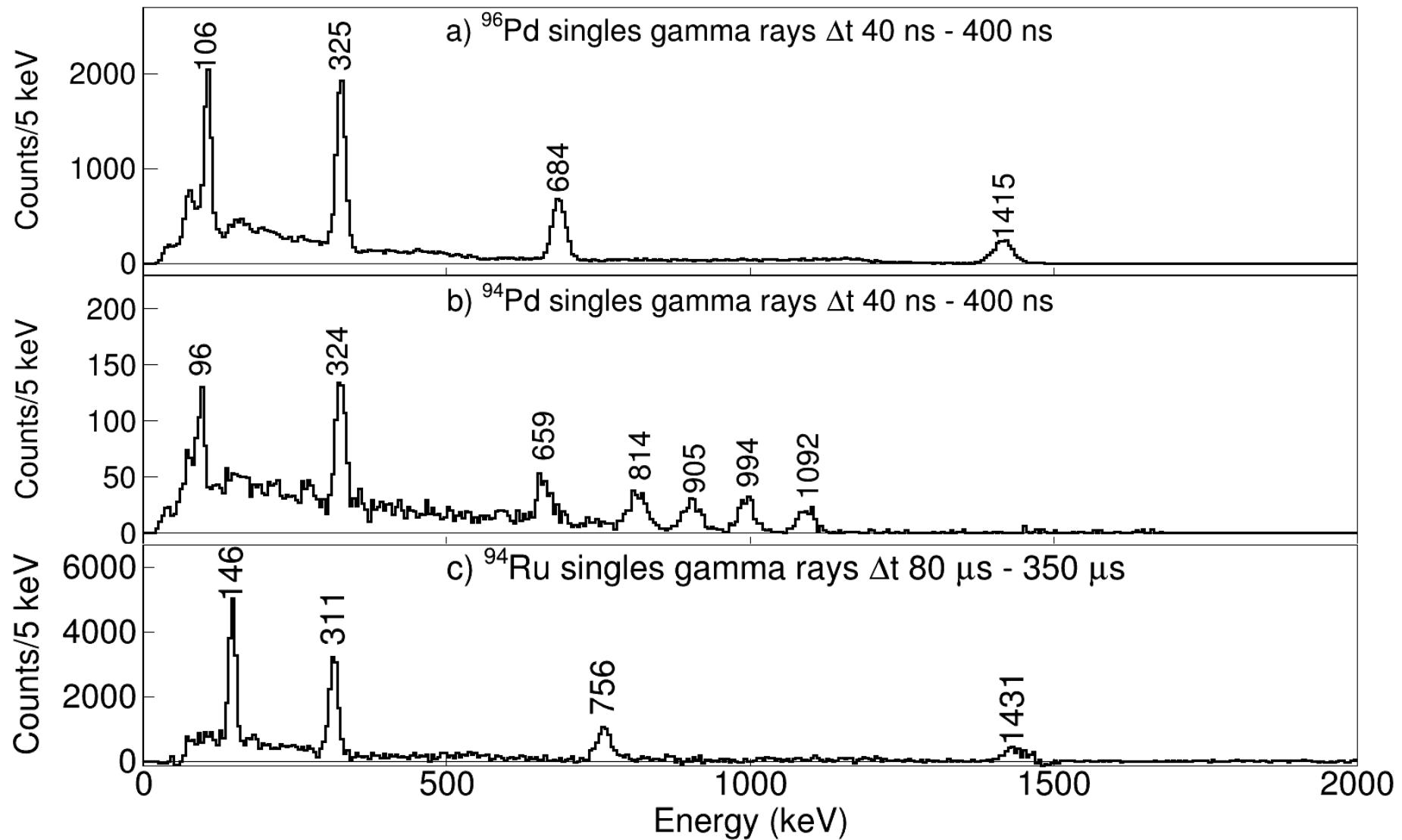
# $^{96}\text{Pd}$ PID Energy Time Matrix



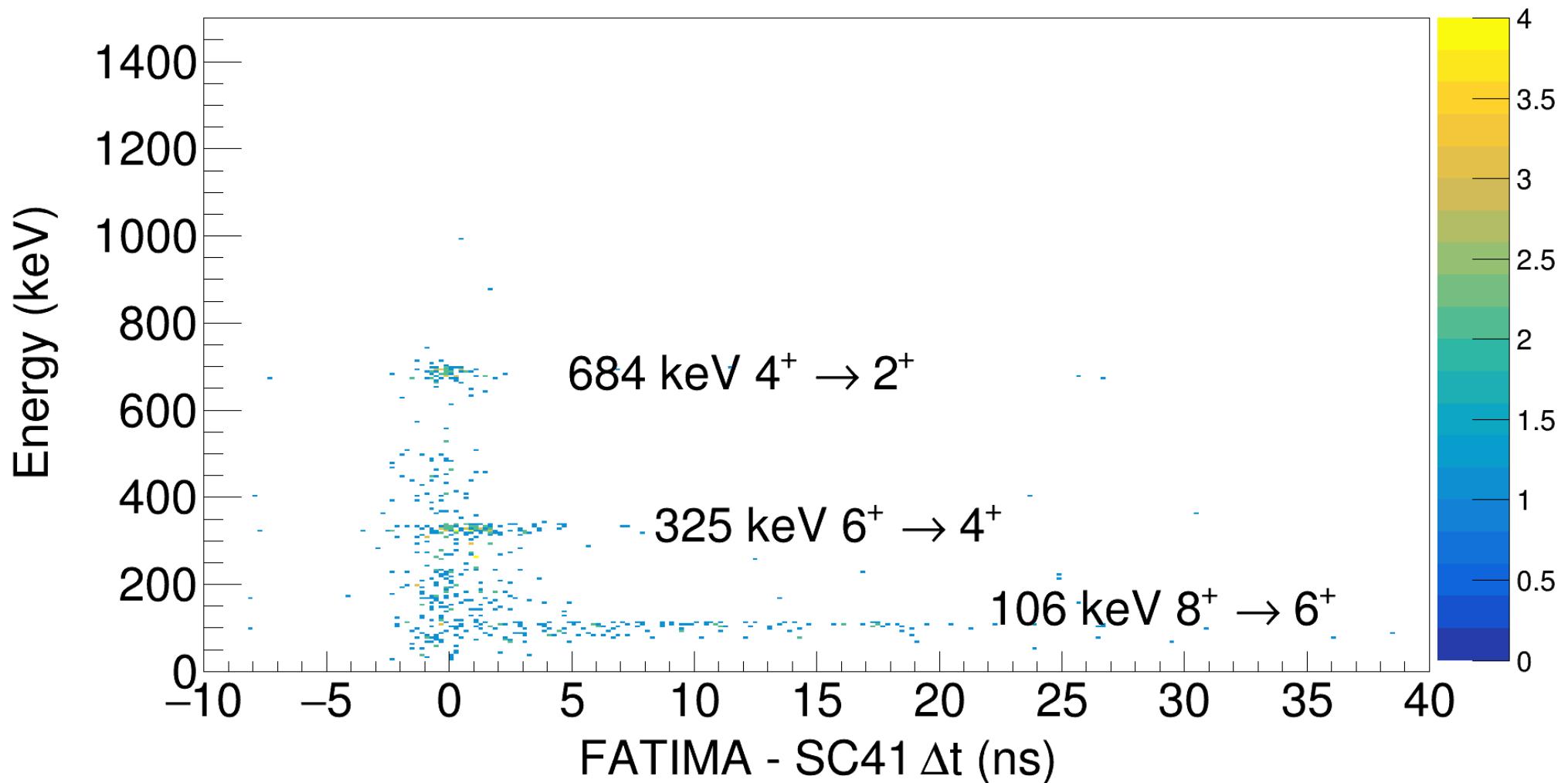
# $^{94}\text{Ru}$ Energy Time Matrix



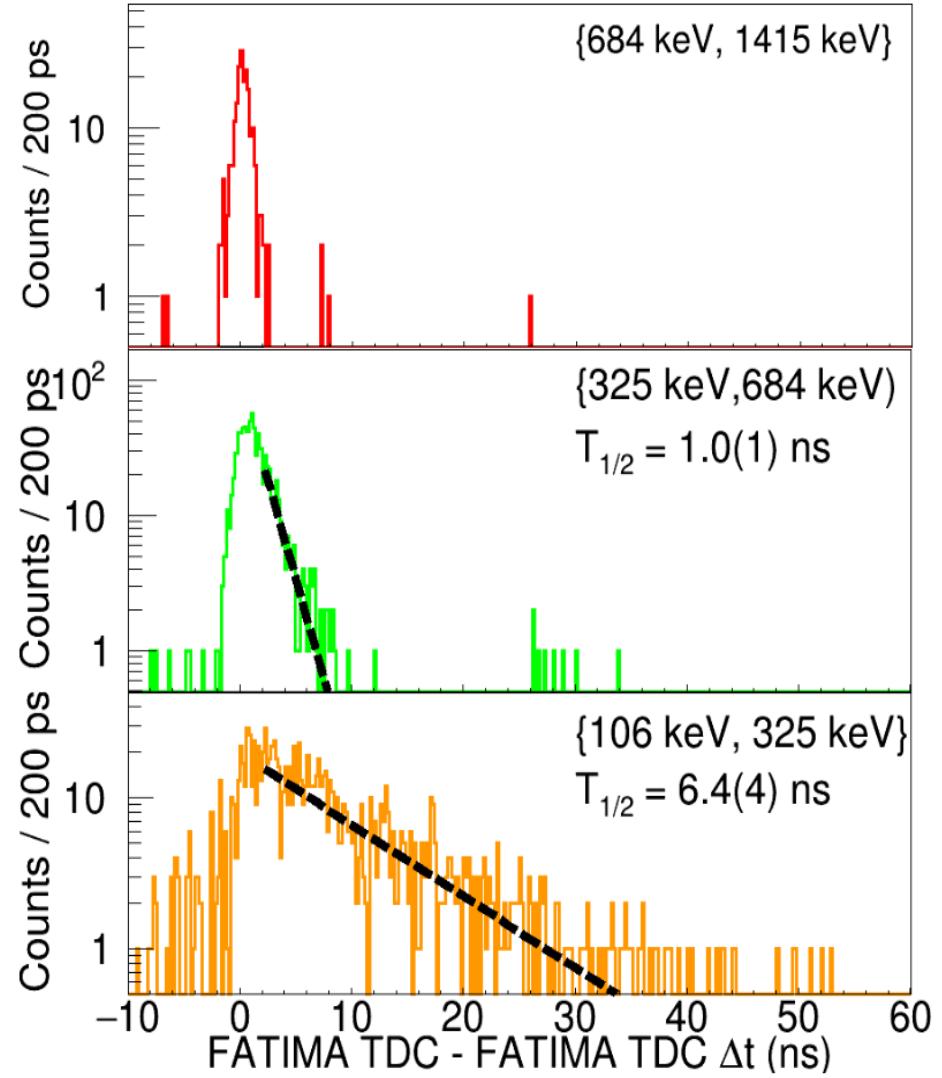
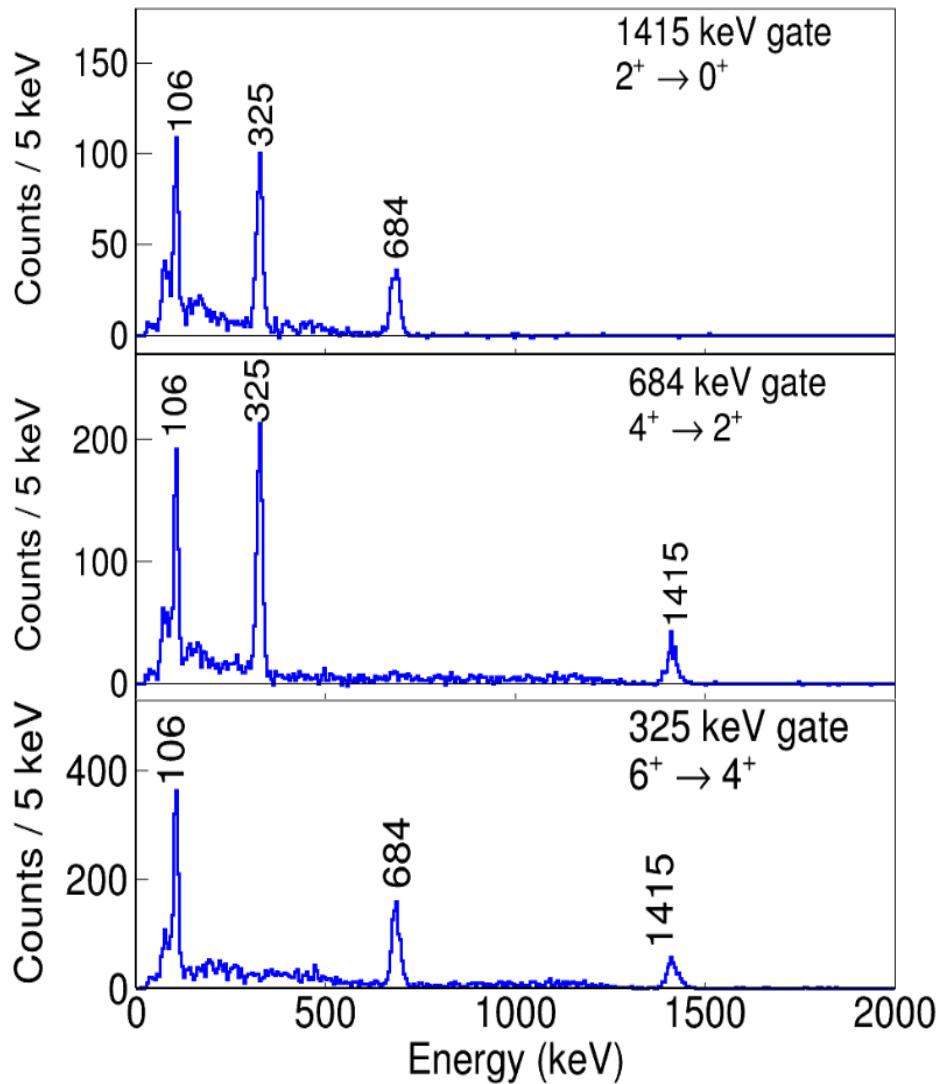
# FATIMA PID Gated Gamma Rays



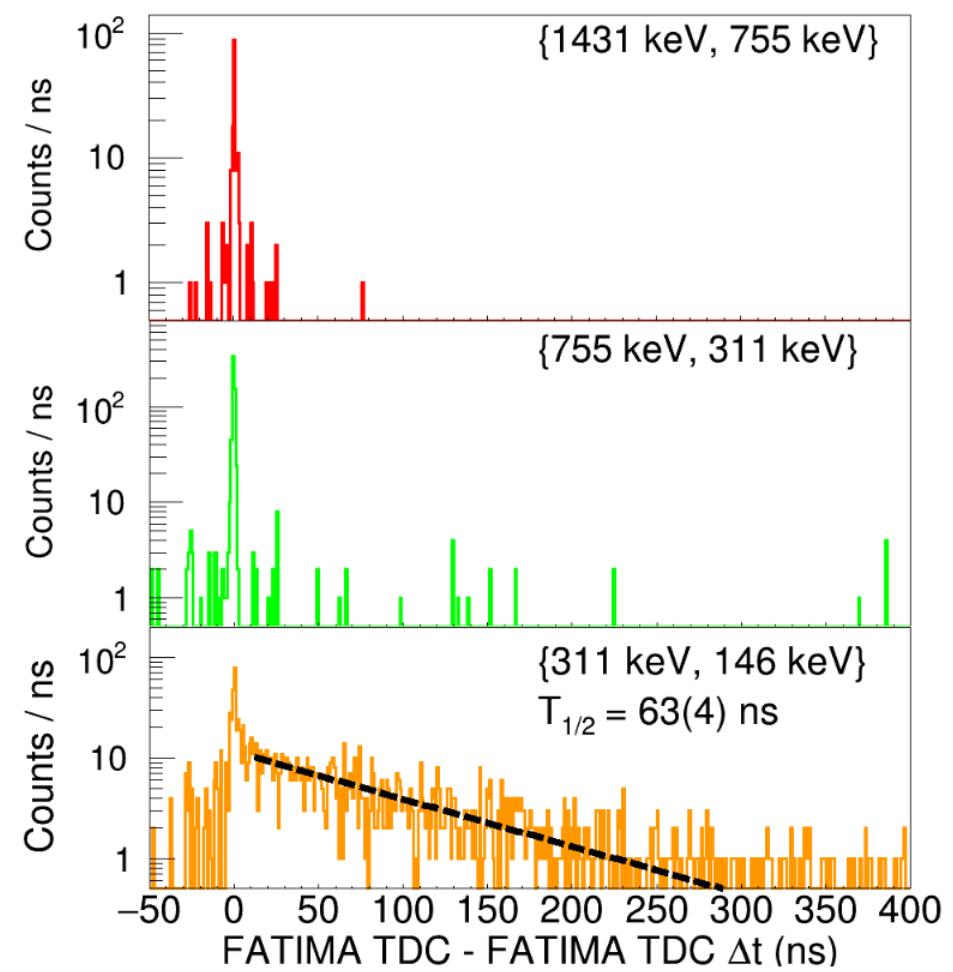
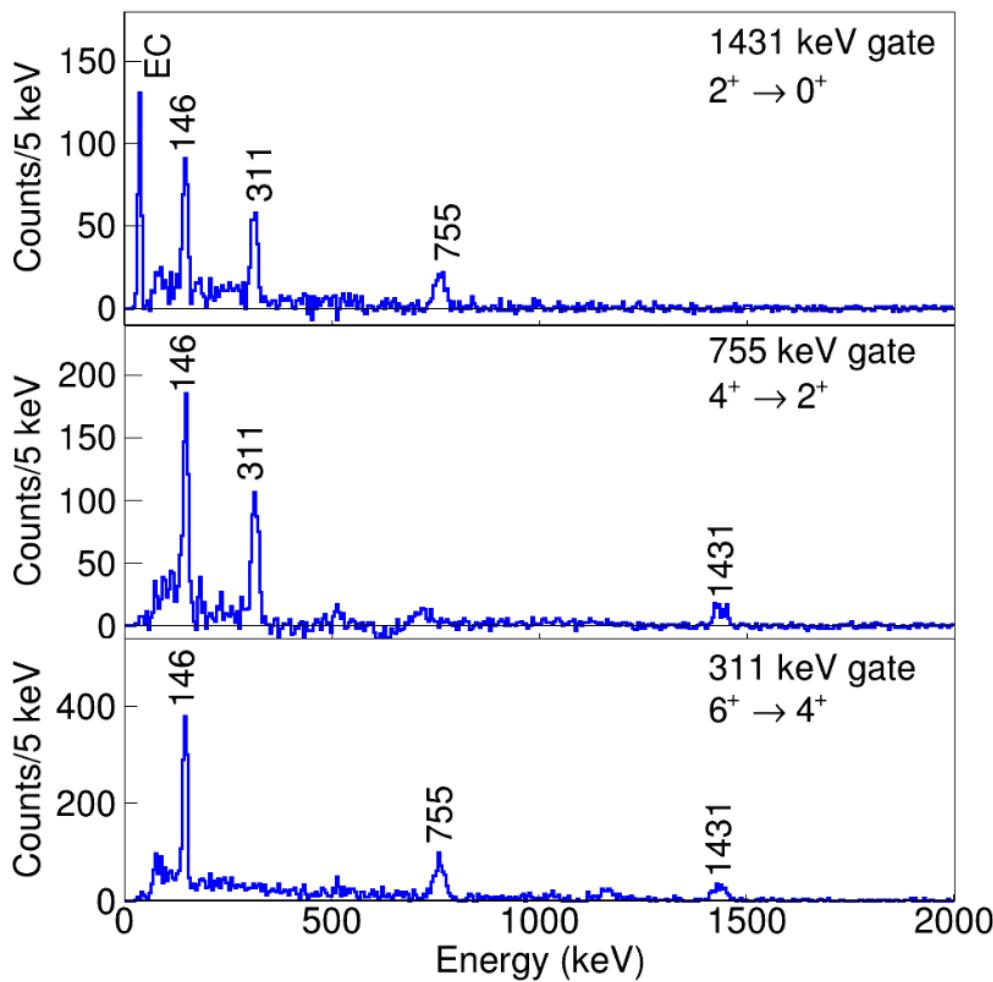
# 1415 keV Gated Time Difference



# $^{96}\text{Pd}$ Half Lives



# $^{94}\text{Ru}$ Half Lives



# B(E2) Values

Ion	E <sub>x</sub> (keV)	E <sub>γ</sub> (keV)	I <sub>i</sub> - I <sub>f</sub>	T <sub>1/2</sub> S480	Lit.T <sub>1/2</sub>	α <sub>tot</sub>	B(E2: I → I-2)↓ e <sup>2</sup> b <sup>2</sup>
<sup>94</sup> Pd <sub>48</sub>	4884	96	14 <sup>+</sup> → 12 <sup>+</sup>	499(9)	515(10) ns	1.62(2)	5.3(1)x10 <sup>-3</sup>
<sup>96</sup> Pd <sub>50</sub>	2531	106	8 <sup>+</sup> → 6 <sup>+</sup>	1.81(1) μs	1.84(2) μs	1.134(16)	1.09(1)x10 <sup>-3</sup>
	2424	325	6 <sup>+</sup> → 4 <sup>+</sup>	6.4(4) ns	6.3(6) ns	0.0227(4)	2.4(2)x10 <sup>-3</sup>
	2099	694	4 <sup>+</sup> → 2 <sup>+</sup>	1.0(1) ns	1.0(1) ns	0.00243(4)	3.5(3)x10 <sup>-4</sup>
	1415	1415	2 <sup>+</sup> → 0 <sup>+</sup>	Prompt	< 17 ps	<0.001	>5x10 <sup>-4</sup>
<sup>94</sup> Ru <sub>50</sub>	2644	146	8 <sup>+</sup> → 6 <sup>+</sup>	64(1) μs	64(4) μs	0.334(5)	1.0(1)x10 <sup>-5</sup>
	2498	311	6 <sup>+</sup> → 4 <sup>+</sup>	63(4) ns	65(2) ns	0.0238(4)	3.1(2)x10 <sup>-4</sup>

# Conclusions

- The commissioning run of the DESPEC setup was successfully carried out in March 2020
- The effectiveness of the setup in the determination of short lived gamma-ray decaying states as well as the determination of the lifetimes of isomeric states has been proven
- The Yrast band half-lives and  $B(E2)$  of  $^{96}\text{Pd}$  and  $^{94}\text{Ru}$  have been determined and found to be in agreement current literature values when compared to Haefner et al and Mach et al
  - This has given confidence in the not yet published results for  $^{94}\text{Pd}$

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