

# Lifetime measurements for the study of intruder states towards the island of inversion along the $N = 20$ shell closure

R. Nicolás del Álamo, I. Zanon, D. Brugnara on behalf of the collaboration

24<sup>th</sup> AGATA week and AGATA Collaboration Council

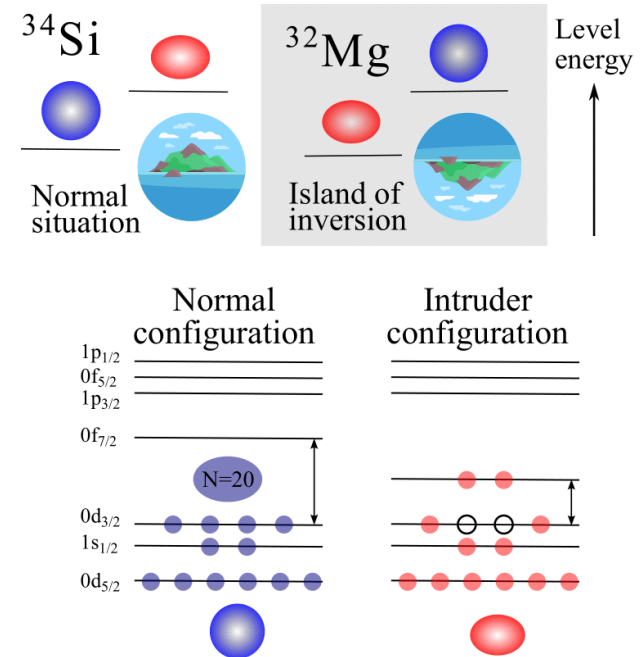
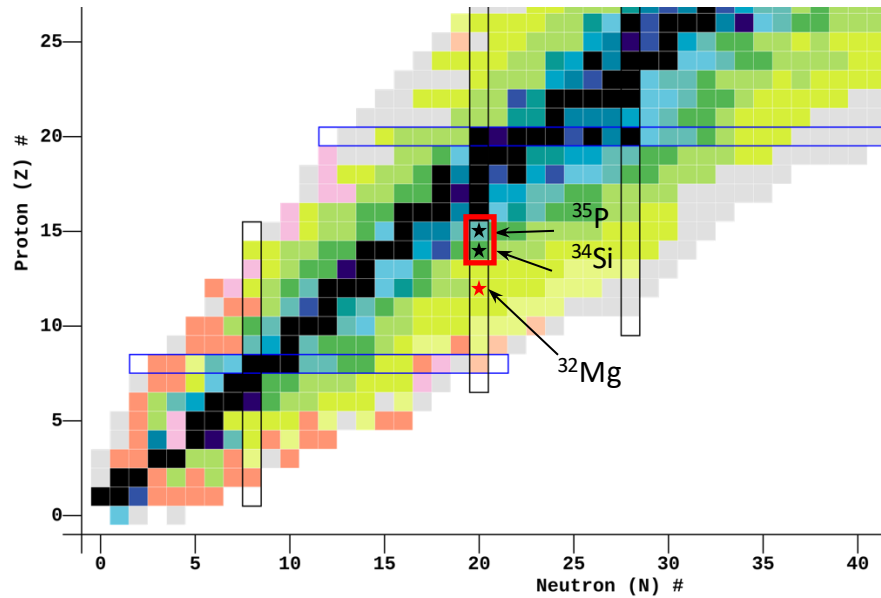
*September 2024*



# Physics case

The aim is to investigate the isotopes in the boundary of the **N=20 island of inversion** by determining the lifetimes of a set of excited states.

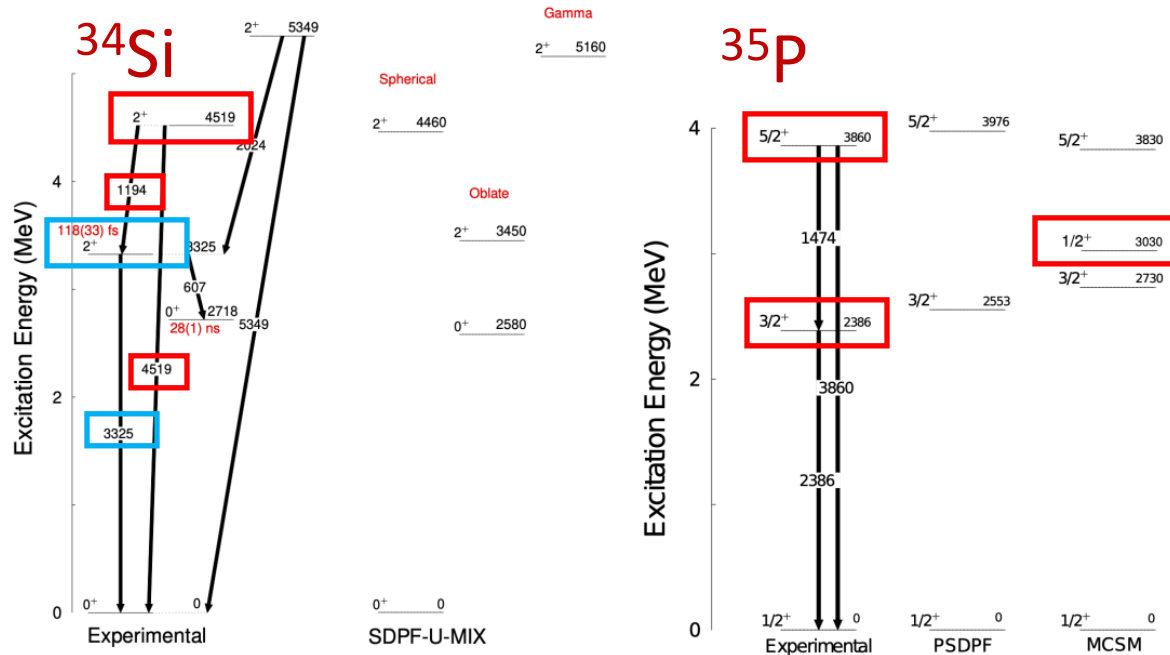
$$\tau^{-1} \sim |\langle \Psi_f || \mathcal{M}(L) || \Psi_i \rangle|^2$$



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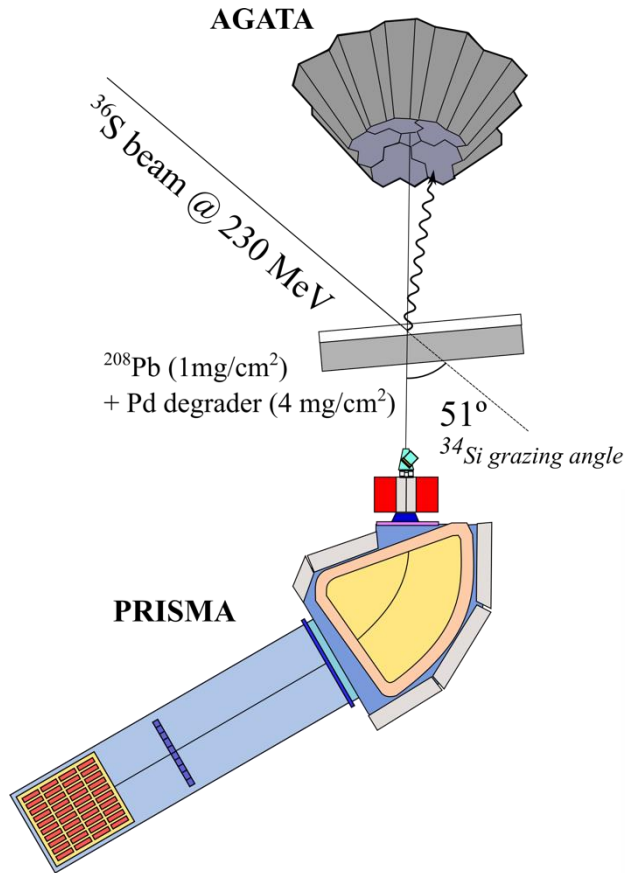
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A. Poves, private communication  
 R. Lica et al., PRC 100, 034306 (2019)

T. Otsuka et al., PRL 81, 1588 (1998)  
 Y. Utsuno et al., PRC 60, 054315 (1999)

# Experimental set-up



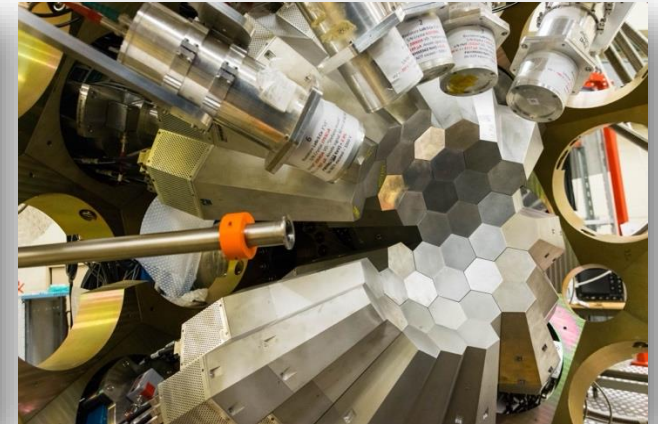
## Experimental details:

**Multi-nucleon transfer** reaction:  
 $^{36}\text{S}$  on  $^{208}\text{Pb}$  (1 mg/cm<sup>2</sup>) @ 230 MeV.

**DSAM** degrader: 4 mg/cm<sup>2</sup> Pd.

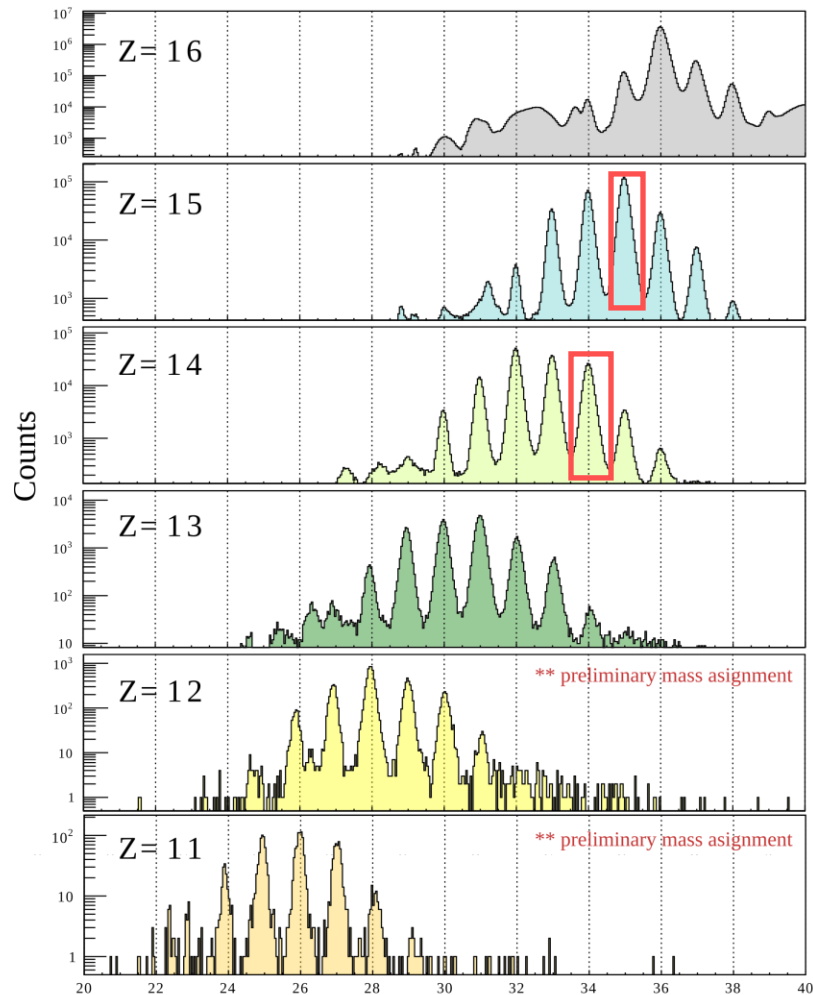
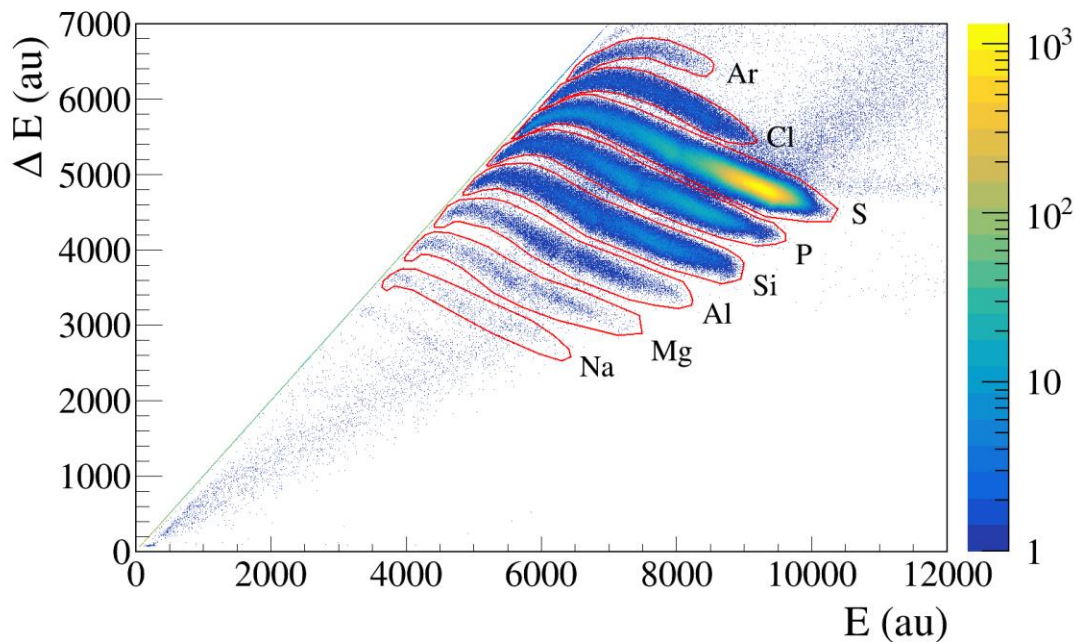
Experiment performed in **November 2022**, during 8 days of beam time.

**TANDEM + ALPI** accelerator complex.



# PRISMA results

Mass resolution: **1/140**

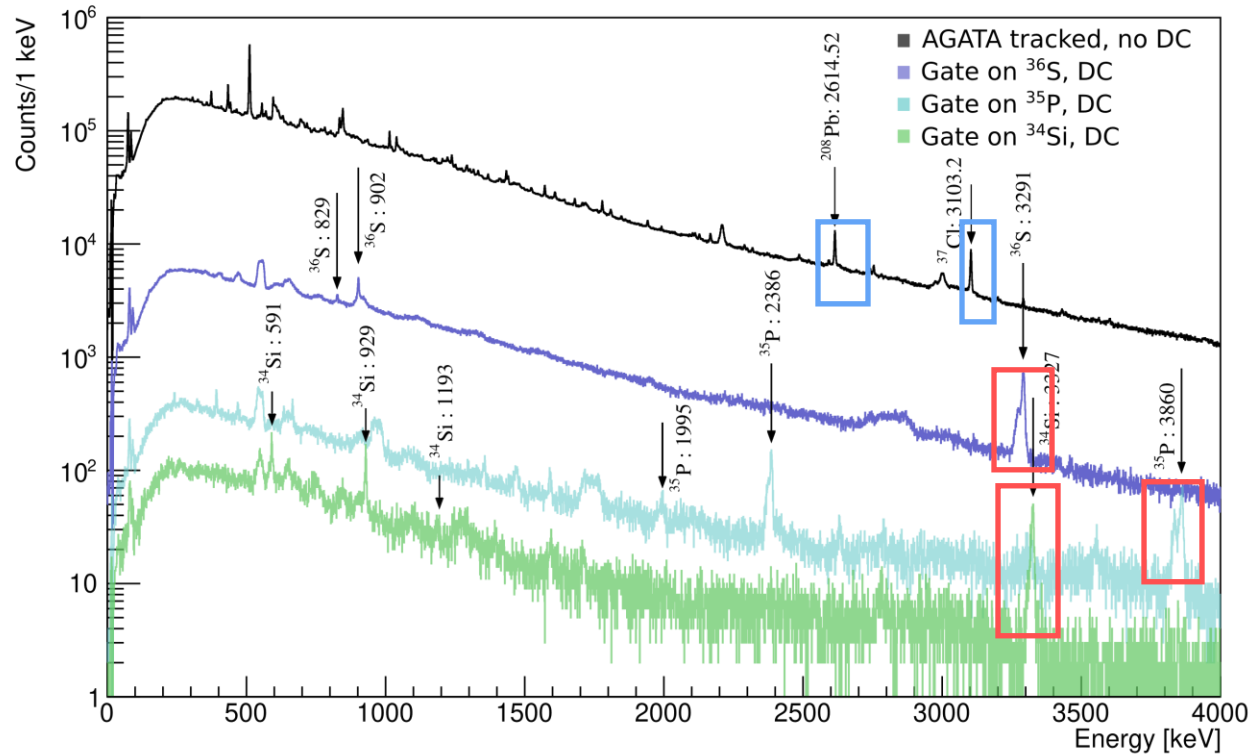


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# AGATA results

Improvements with respect to September 2023:

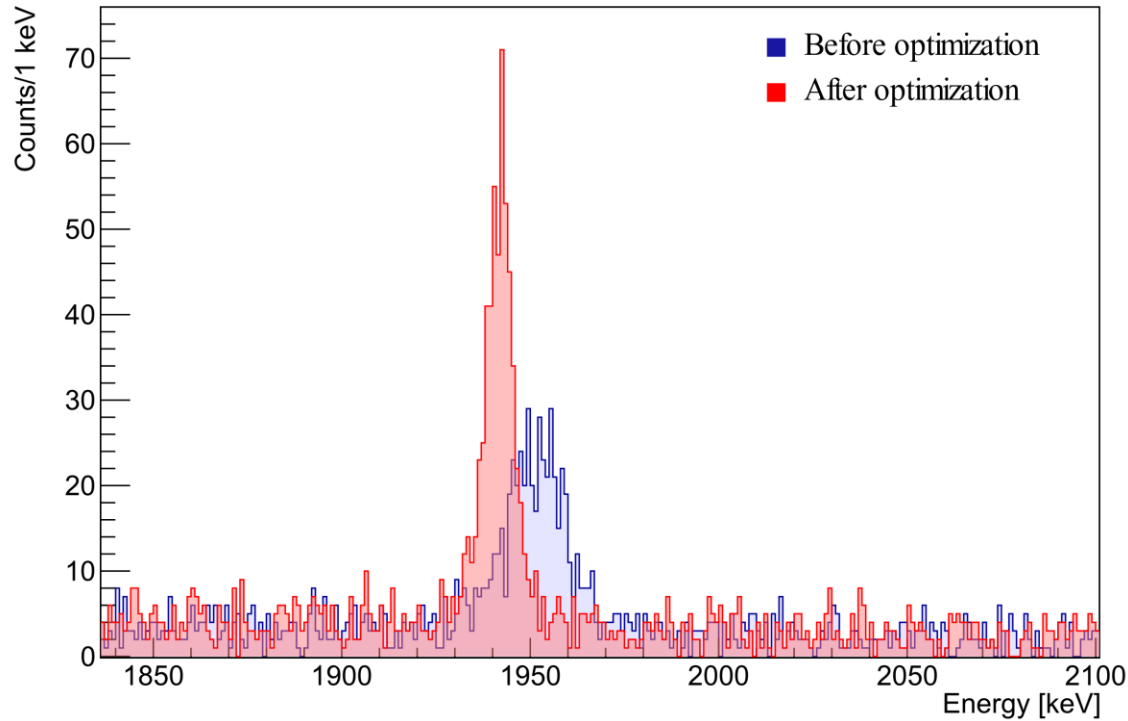
- Recalibration at high energy done with stopped peaks identified on in-beam runs (up to 3 MeV)



# AGATA results

Improvements with respect to September 2023:

- Doppler correction optimized considering a broader set of transitions



Ion	Transition	Energy [keV]	Lifetime
<sup>32</sup> Si	2 <sup>+</sup> → 0 <sup>+</sup>	1941.4	780 fs
<sup>33</sup> P	5/2 <sup>+</sup> → 1/2 <sup>+</sup>	1847.6	770 fs
<sup>33</sup> Si	1/2 <sup>+</sup> → 3/2 <sup>+</sup>	1010.2	-
<sup>34</sup> P	2 <sup>+</sup> → 1 <sup>+</sup>	429.1	1.3 ps
<sup>34</sup> Si	(3 <sup>-</sup> ) → (3 <sup>-</sup> )	590.9	-
<sup>34</sup> Si	(3 <sup>-</sup> ) → (2 <sup>+</sup> )	929.0	-
<sup>37</sup> S	3/2 <sup>-</sup> → 7/2 <sup>-</sup>	646.2	-

**Table 1.** Set of transitions used for the Doppler correction optimization. The 646.2 keV transition of <sup>37</sup>S was the only transition used for the optimization on an earlier stage of the analysis.

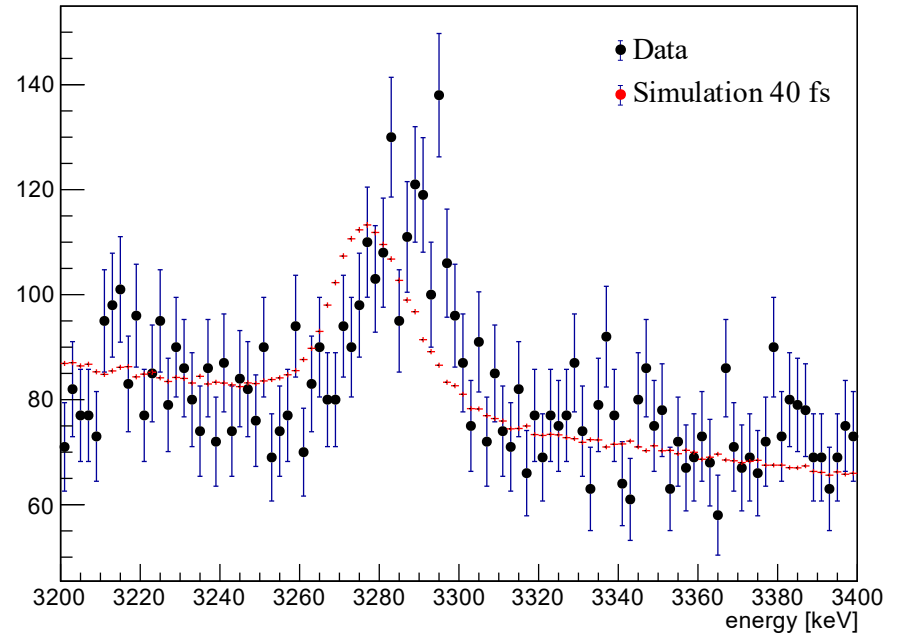
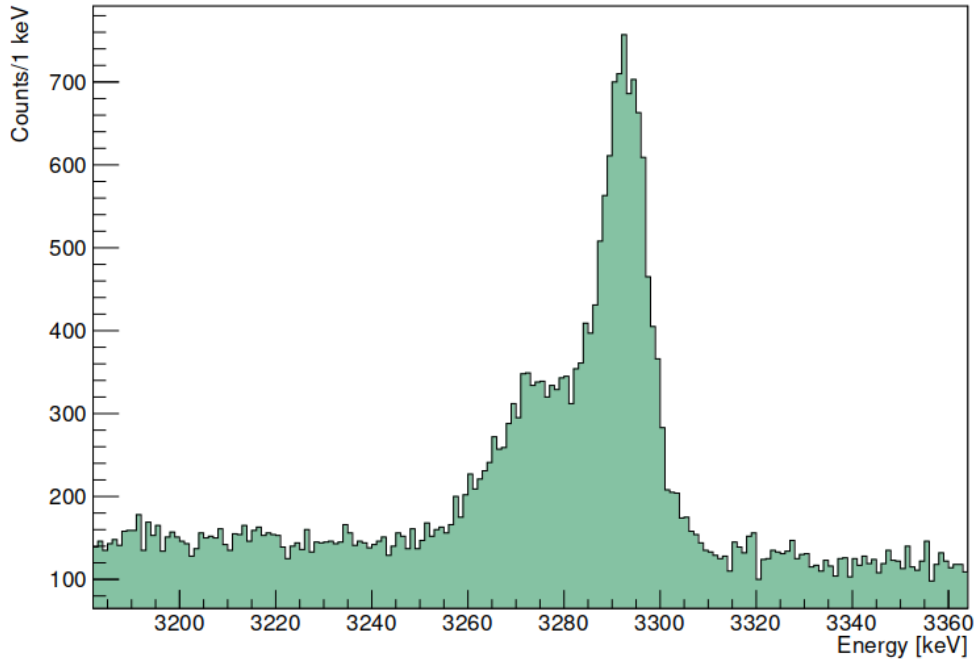
# Simulation

- Smearing effects included.
- Using the  $2+ \rightarrow 0+$  transition of  $^{36}\text{S}$  as a **benchmark**.

**WORK IN PROGRESS**



PRELIMINARY





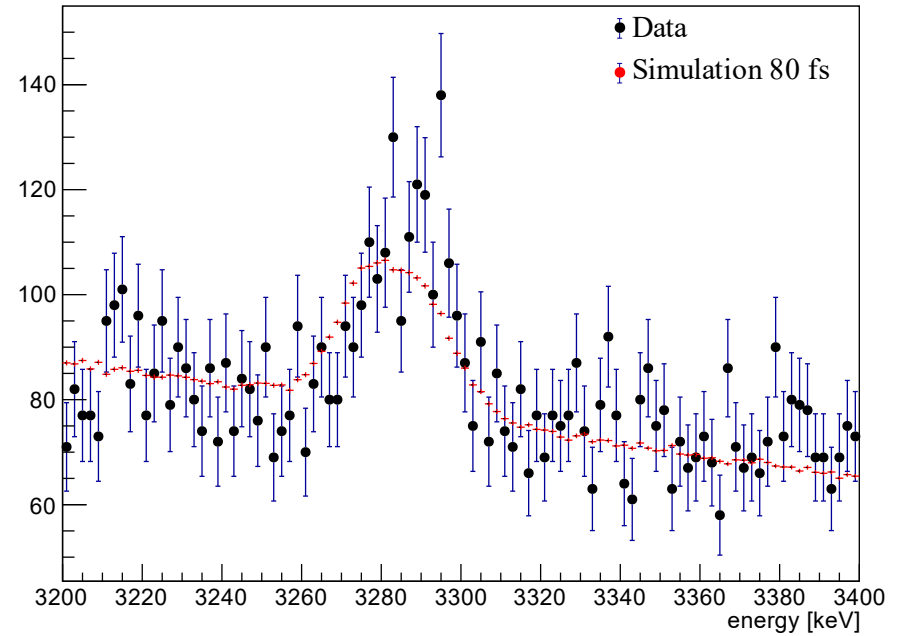
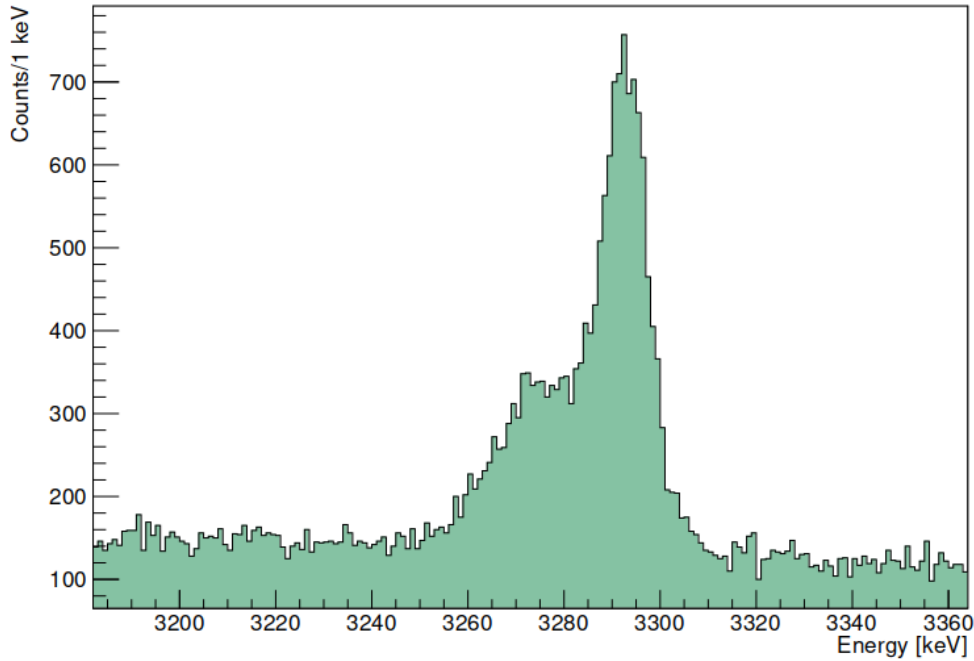
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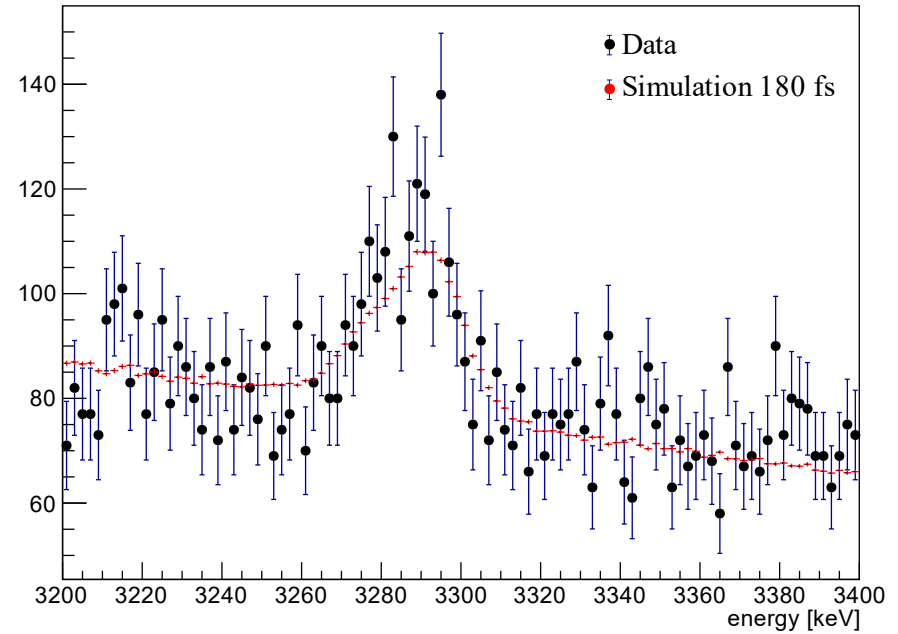
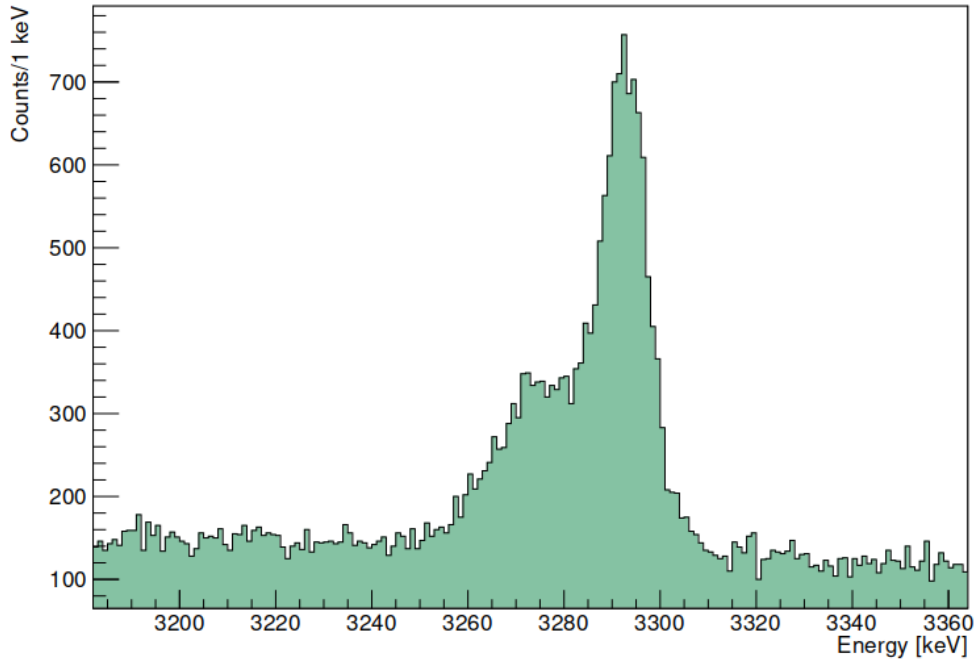
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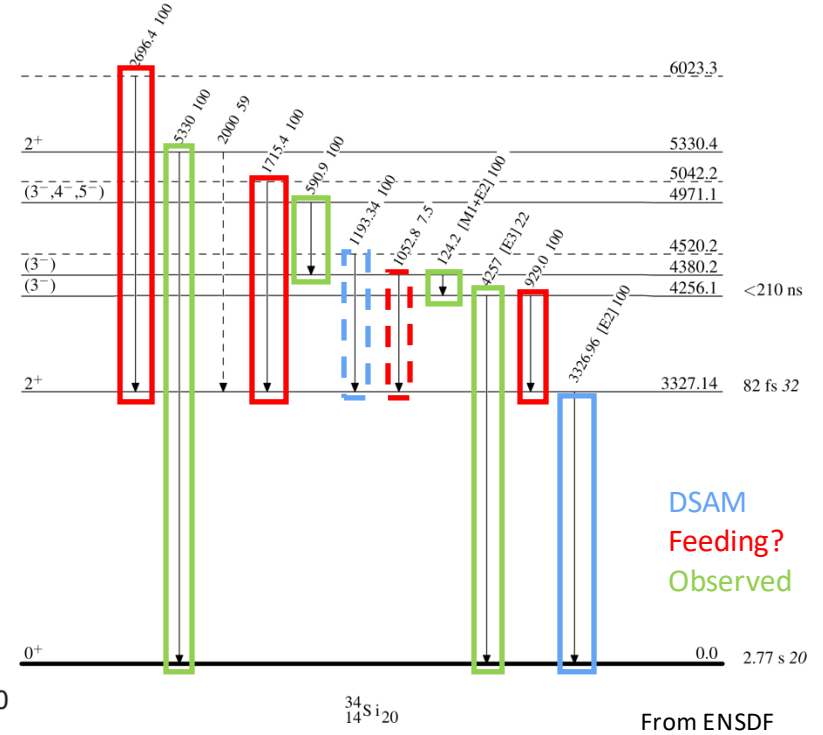
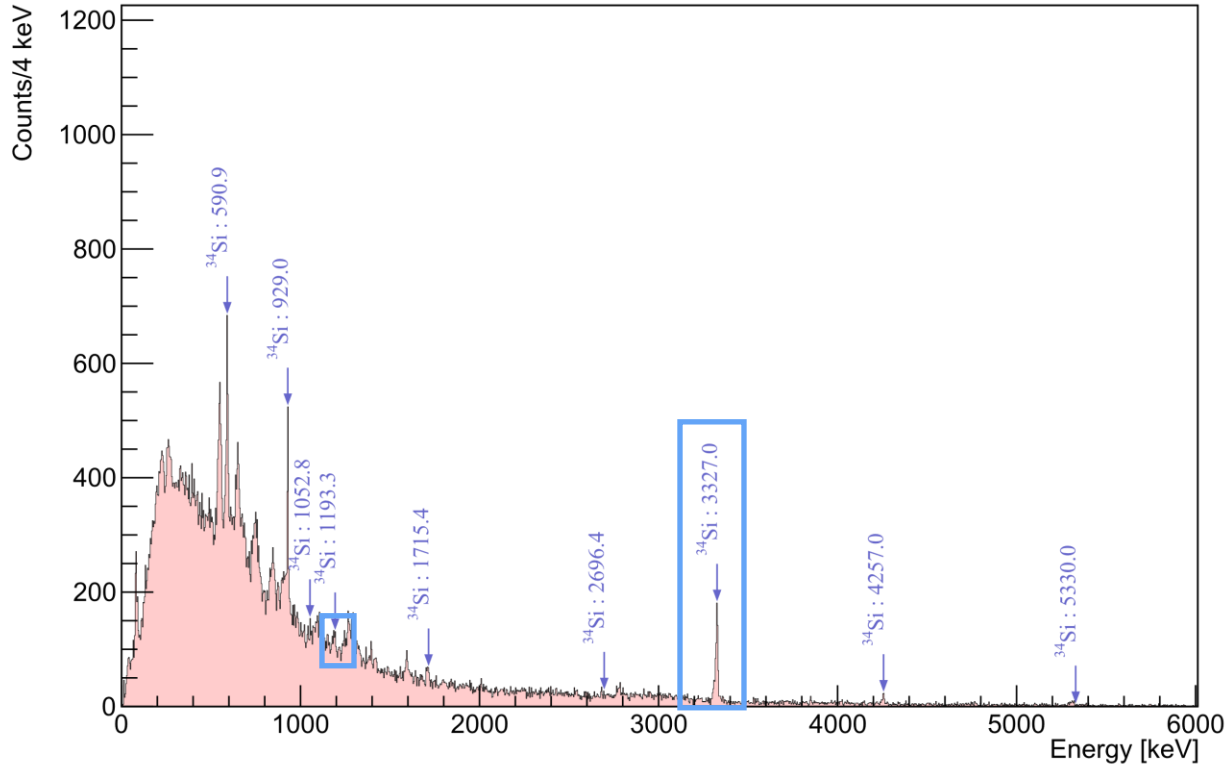
**WORK IN PROGRESS**



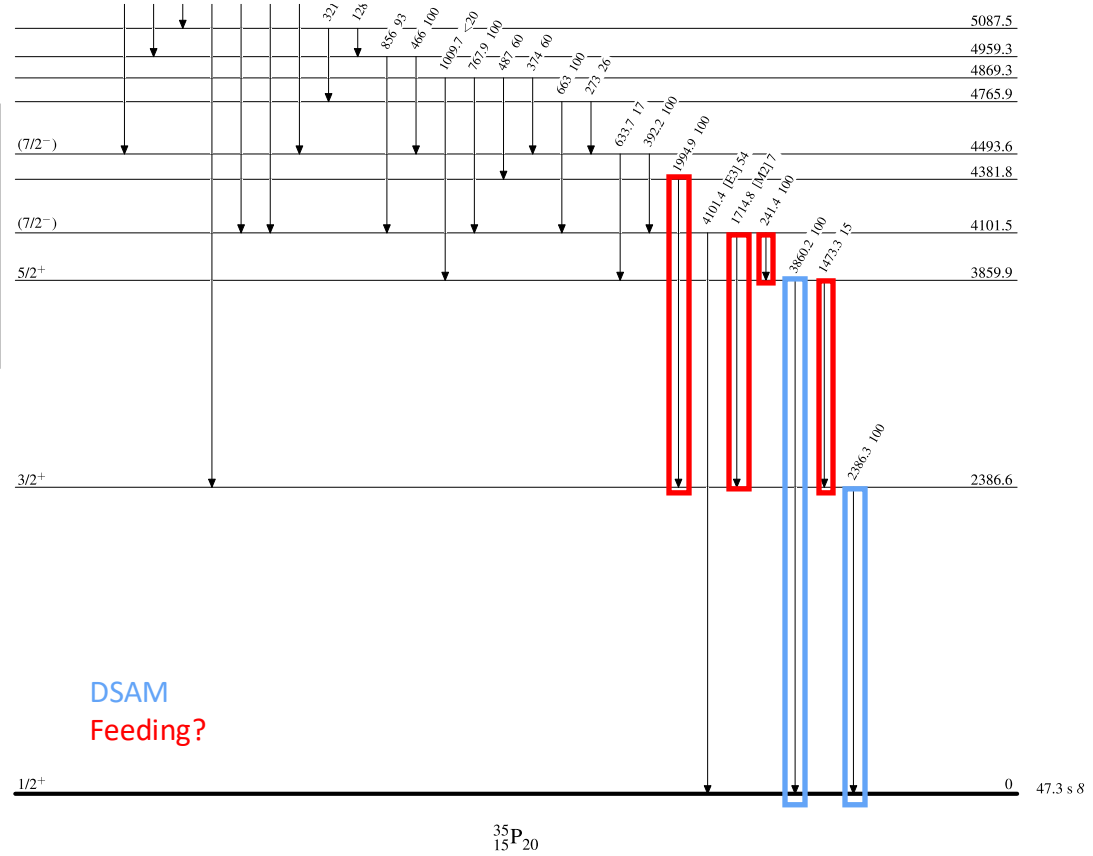
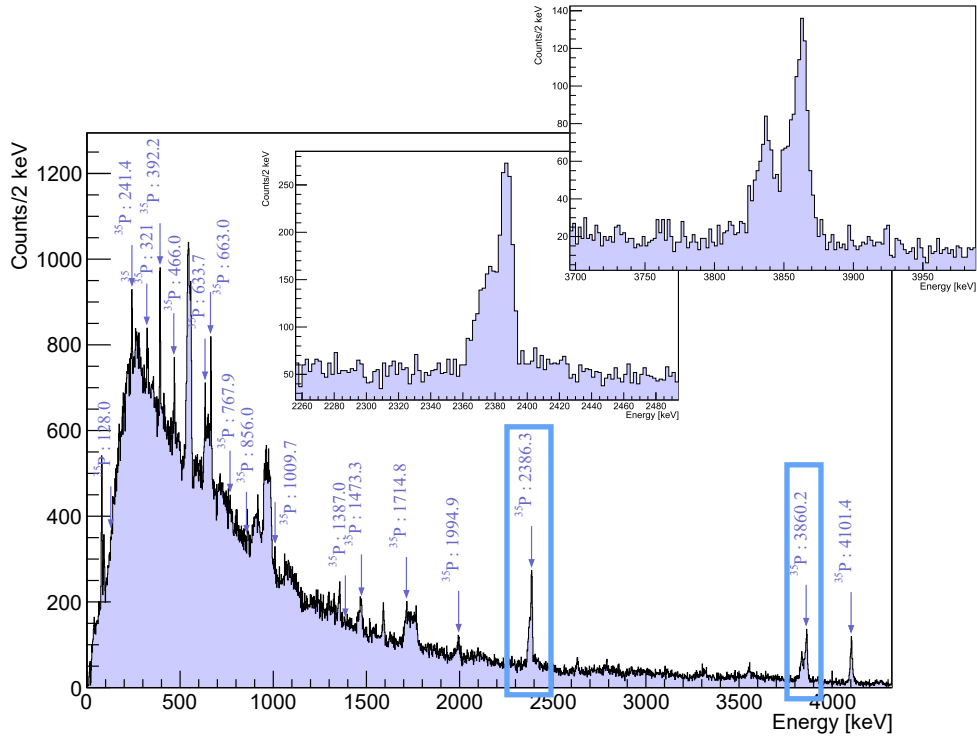
PRELIMINARY



# Spectrum of $^{34}\text{Si}$



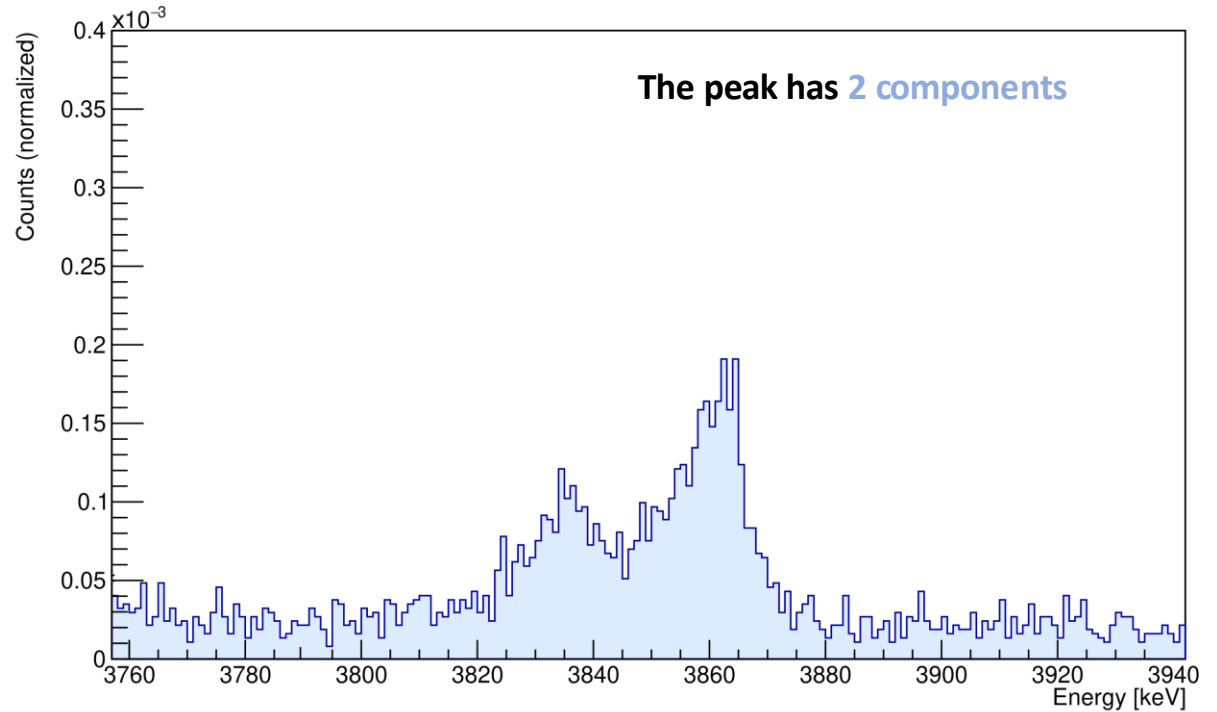
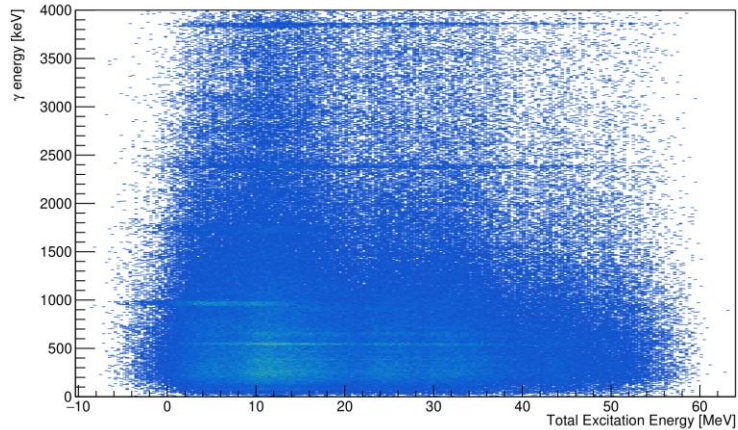
# Spectrum of $^{35}\text{P}$



# Q value selection

Gating on the Q value reconstructed with the Prisma data, we can **control the amount of feeding** to the states of interest from the states above

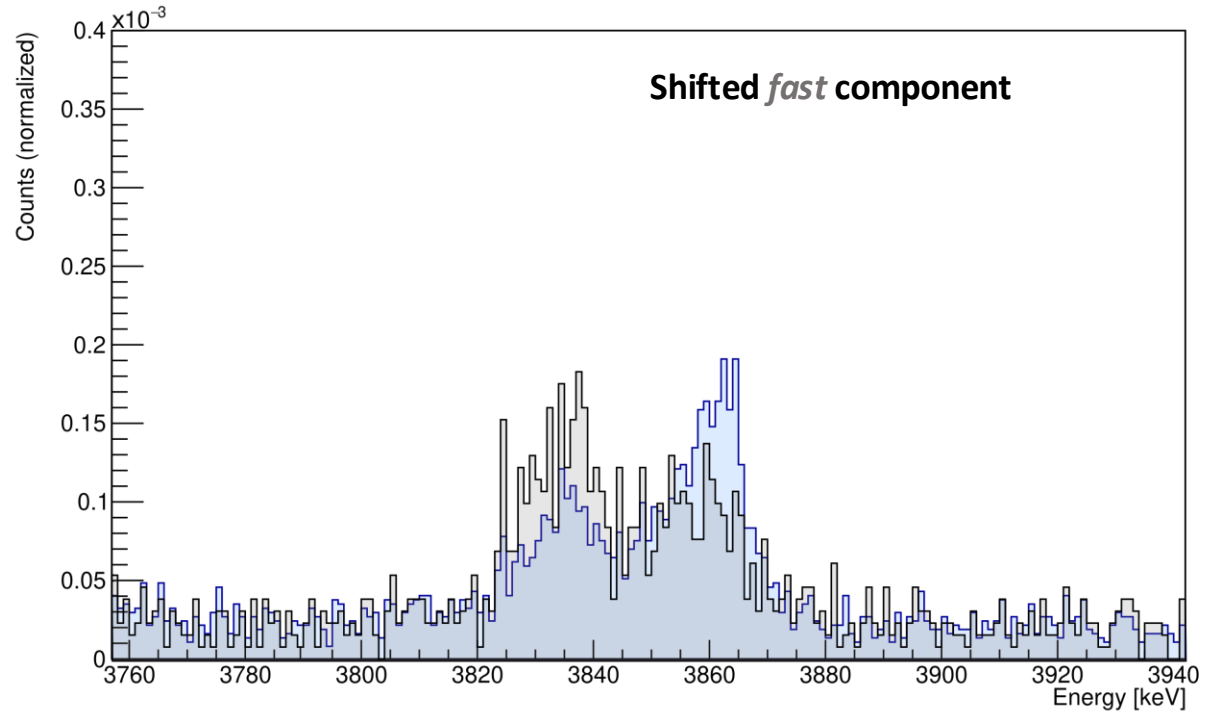
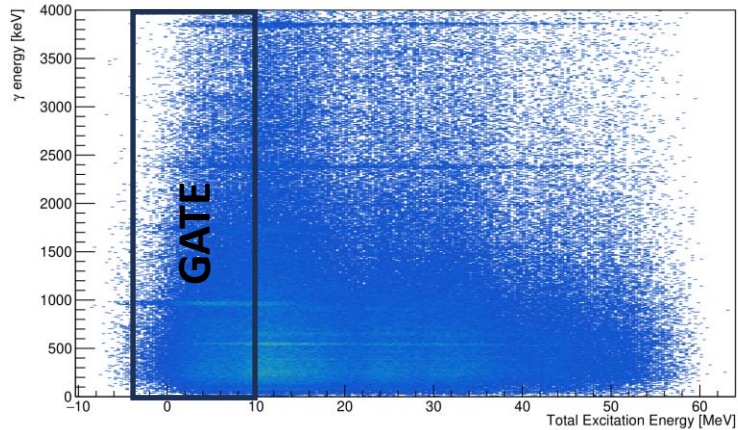
No gate



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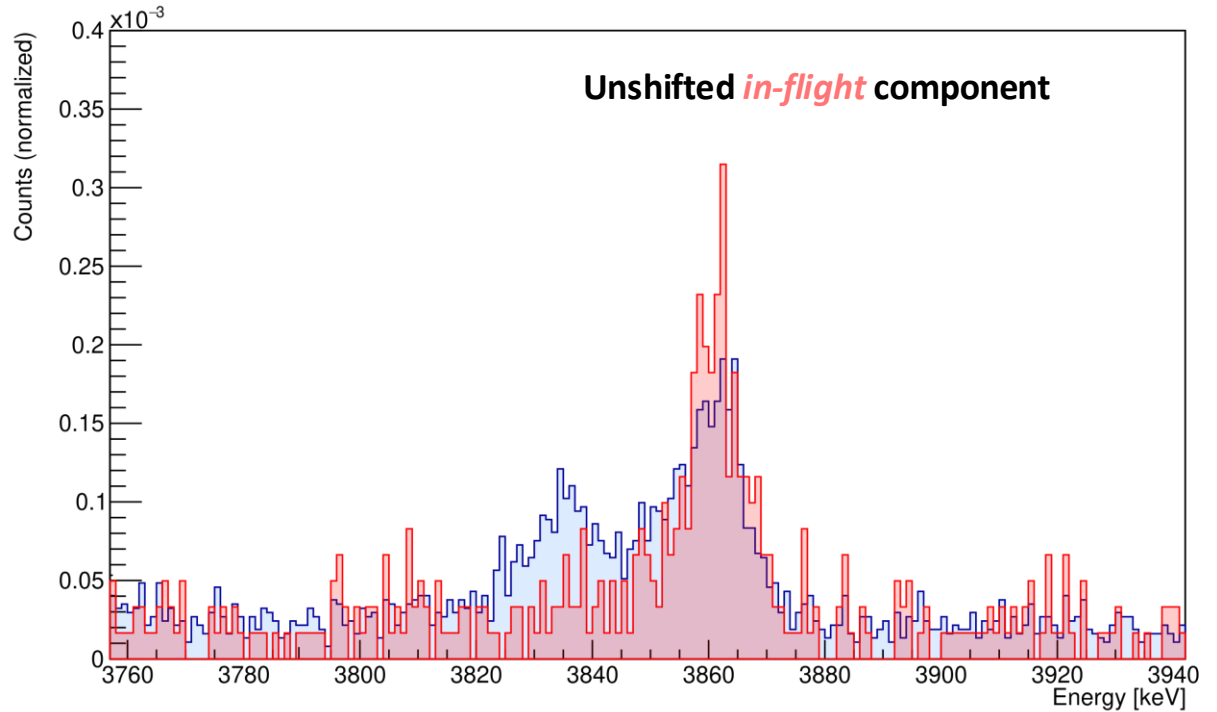
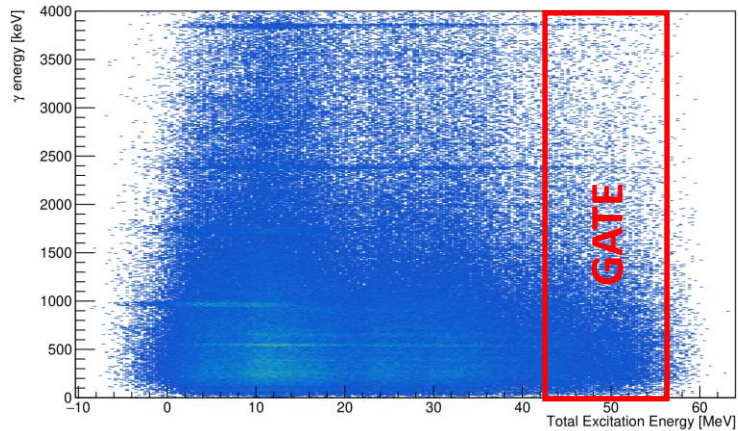
Gate on low excitation energy



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Gate on high excitation energy



## Thanks to all the collaboration!

**Lifetime measurements for the study of intruder states towards the island of inversion along the  $N = 20$  shell closure  
AGATA + PRISMA**

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**& all the rest!**



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