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# The quadrupole moments of the $2^+_{1st}$ state in the even neutron deficient Sn isotopes

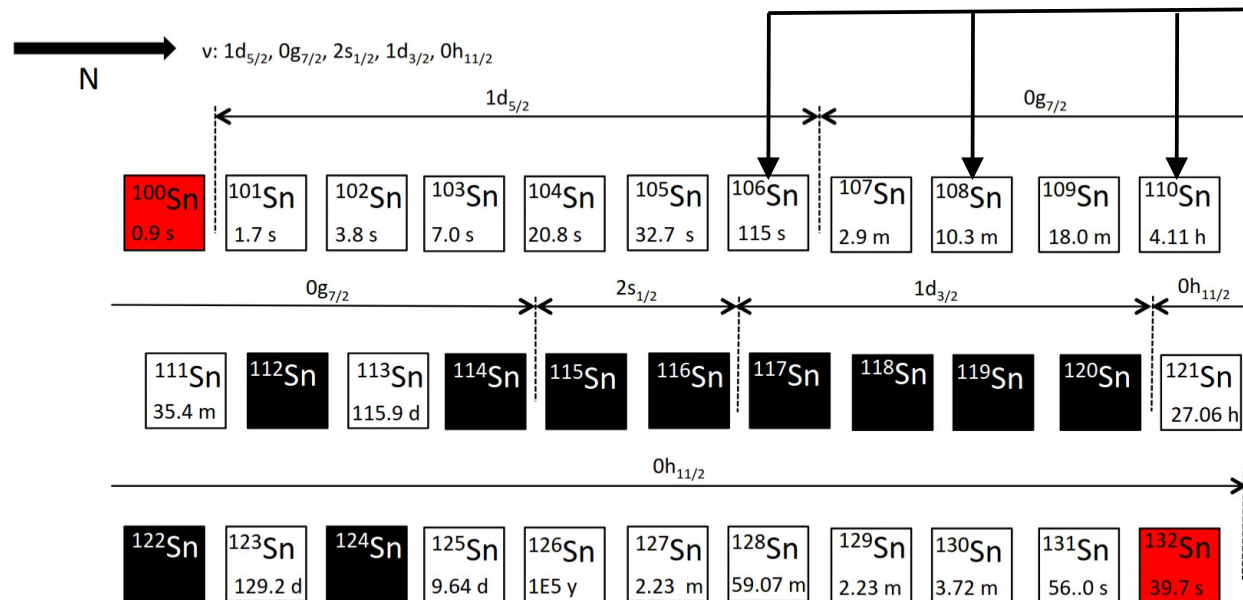
Presenter: Rafael Antonio Lopez



# Overview

- Physics case
- Experimental setup
- Data analysis with higher order effects
- Lifetime study
- Results

# Physics case



Stable isotope

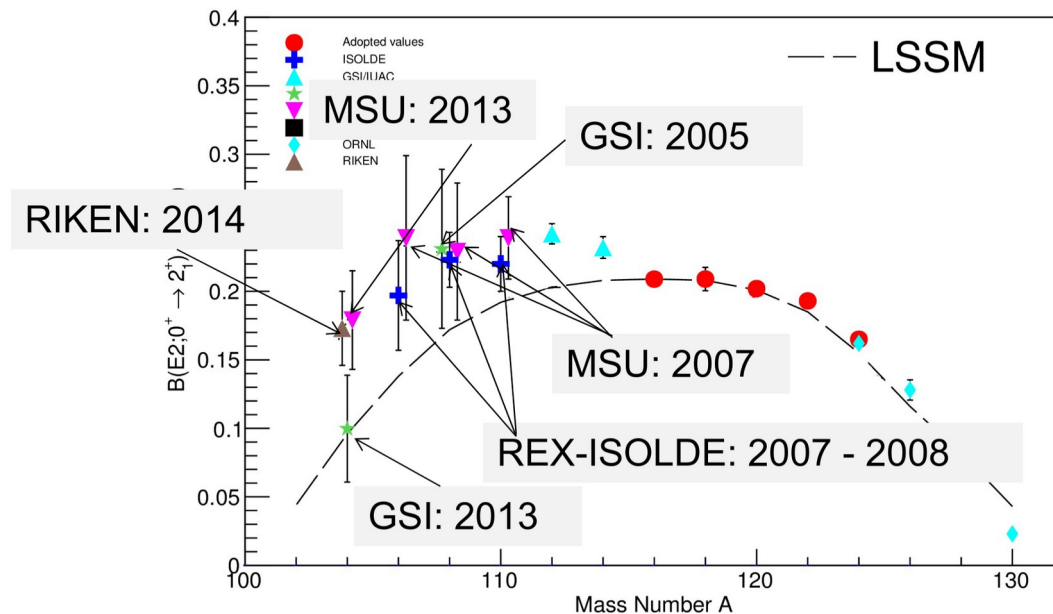


Double shell closure



Unstable isotope

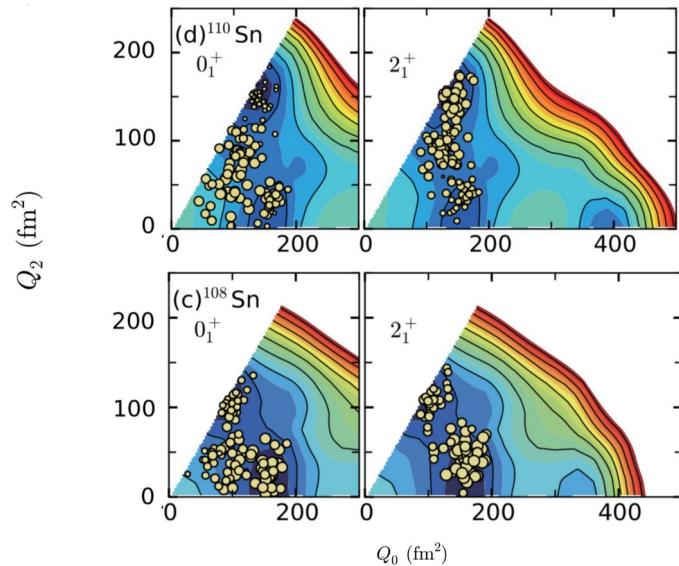
This Study



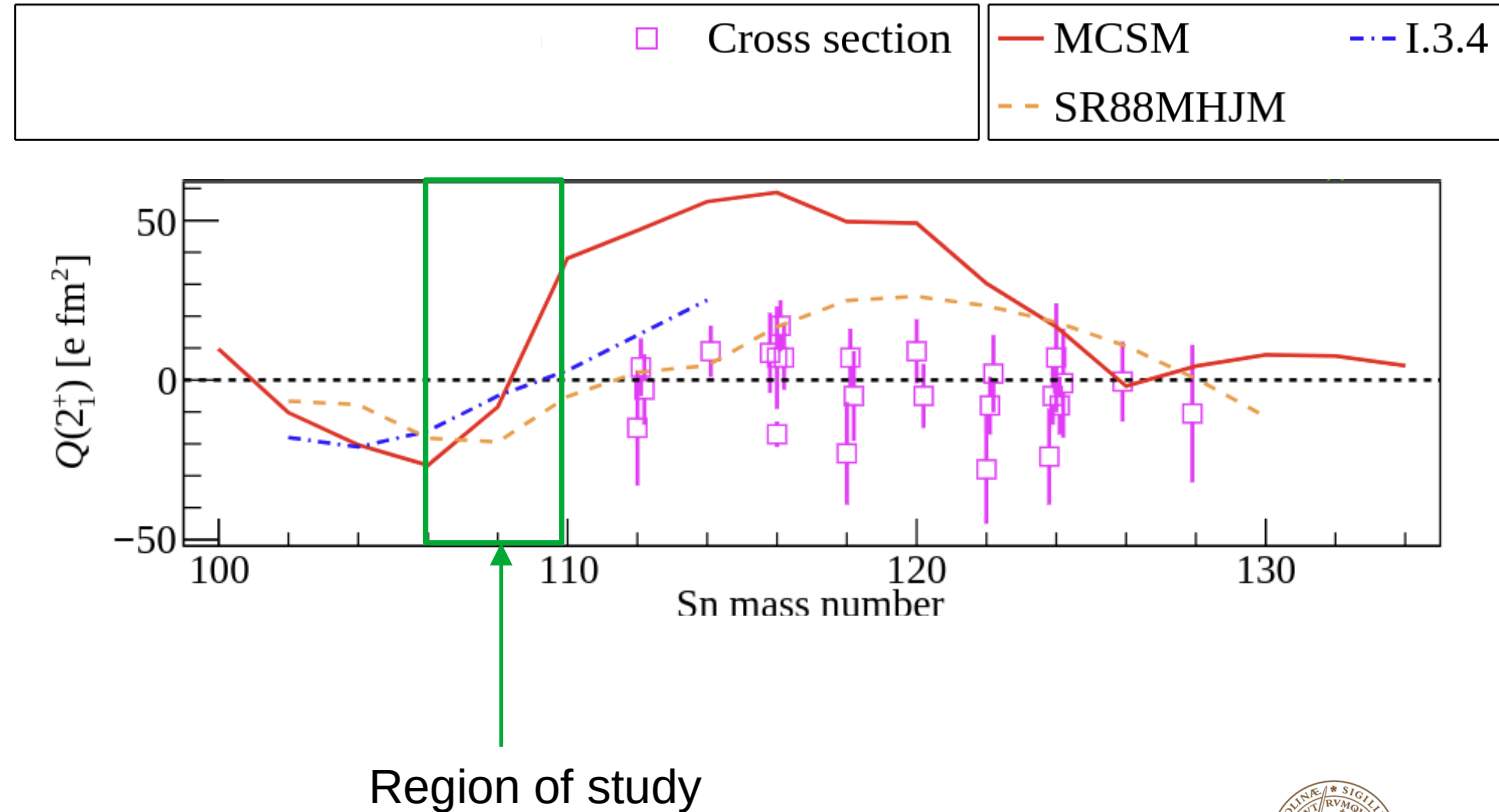
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# Physics case

- MCSM
- Predicted shape change

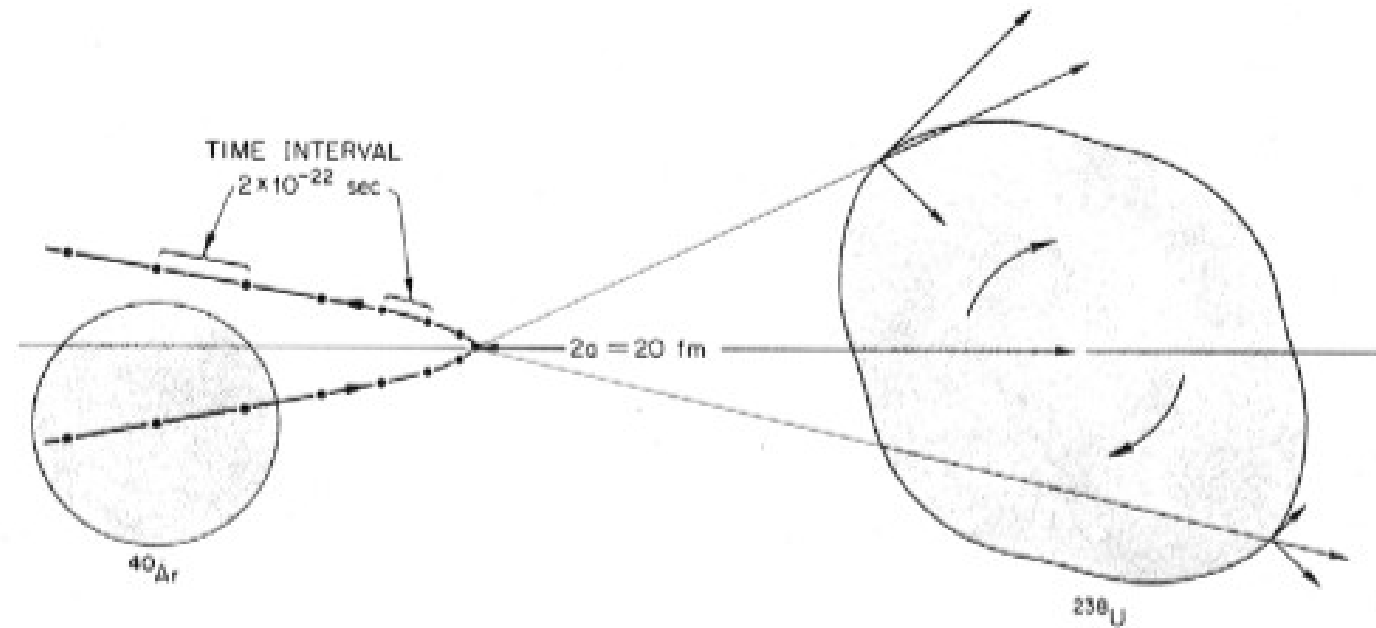


T. Togashi et al., PRL 121, 062501 (2018)



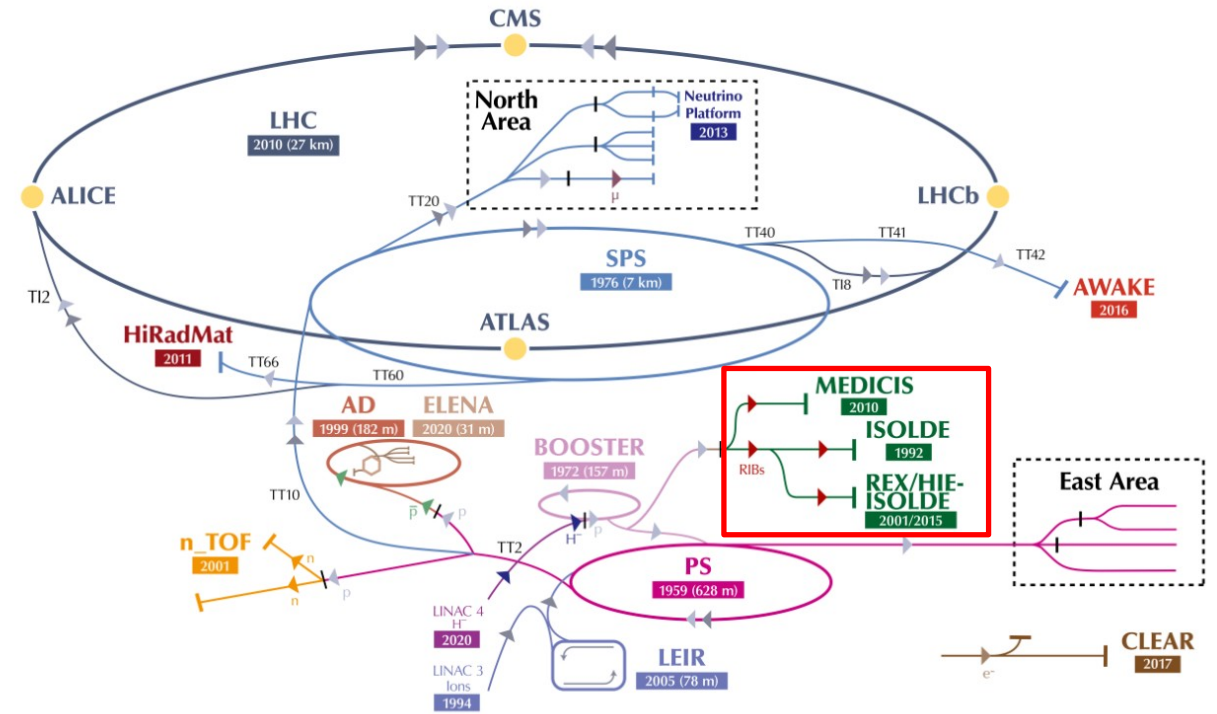
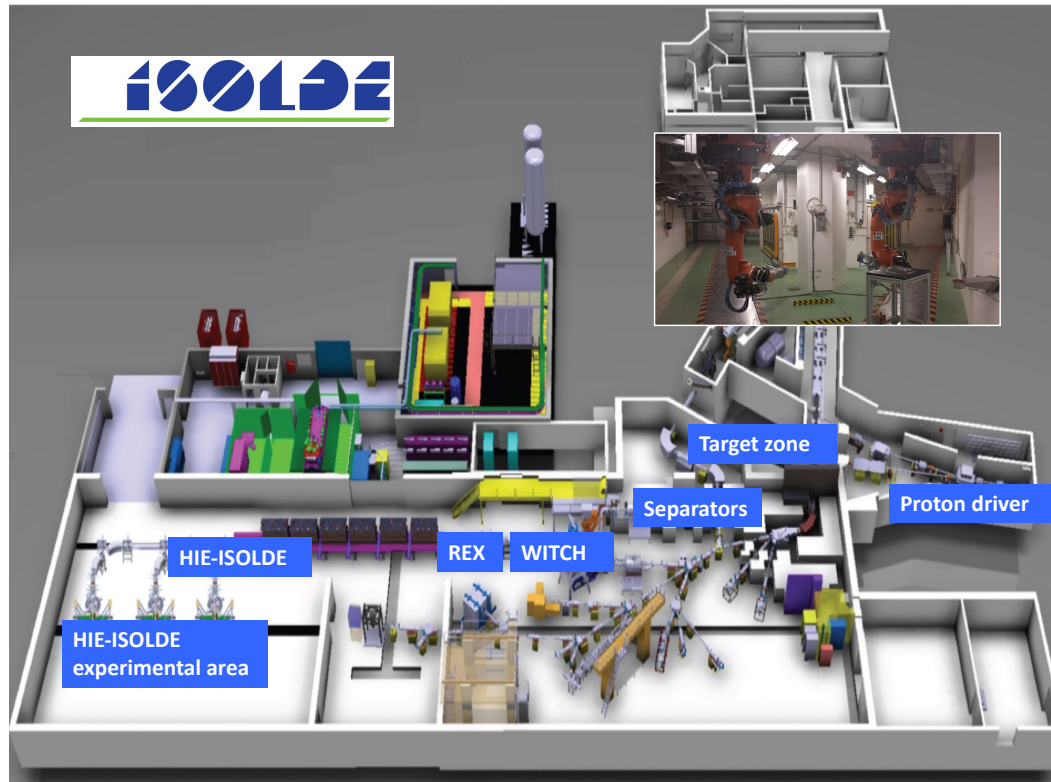
# Physics case

- Coulomb excitation reaction
  - Sn projectile, Pb target
  - 'Safe energy'
  - Reorientation effect



J. Cerny, Nuclear Spectroscopy and Reactions, Part C., Elsevier.

# Experimental setup

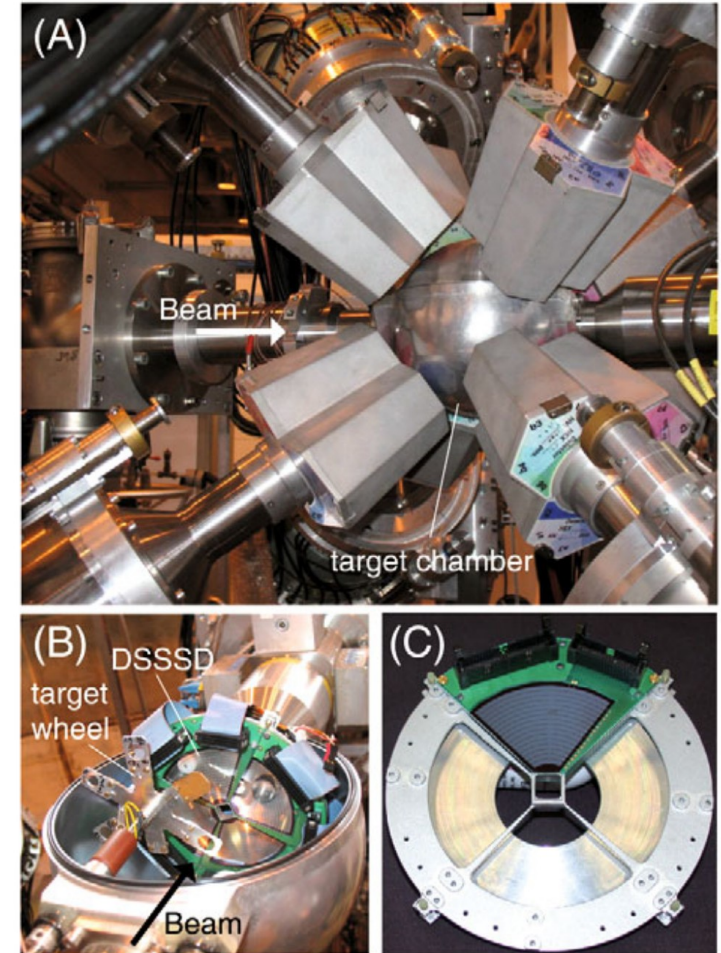


Landua, Fabienne - <https://cds.cern.ch/record/2813716?ln=en>

# Experimental setup

- Data taken during Miniball campaigns
- CD detector for Doppler/Coincidence

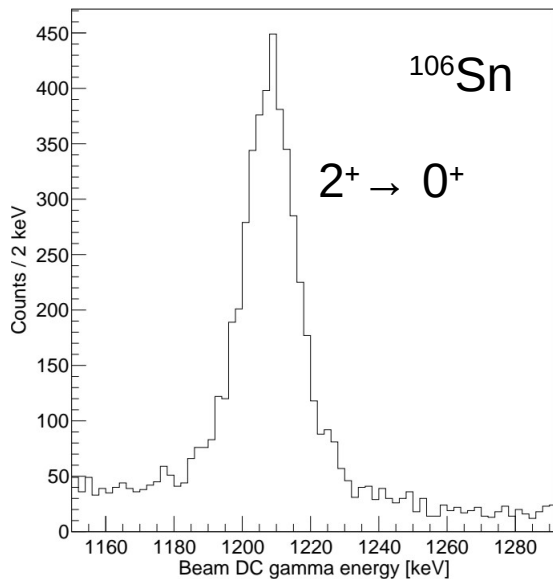
|                             | $^{110}\text{Sn}$                   | $^{108}\text{Sn}$                   | $^{106}\text{Sn}$                   |
|-----------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| $\theta_{\text{lab}}$ [deg] | $21.4^\circ \rightarrow 60.8^\circ$ | $23.3^\circ \rightarrow 63.0^\circ$ | $17.9^\circ \rightarrow 55.9^\circ$ |
| Purity                      | $\sim 98\%$                         | $\sim 87\%$                         | $\sim 61\%$                         |
| $E_{\text{beam}}$ [MeV]     | $4.5 \pm$                           | $4.4 \pm$                           | $4.404 \pm$                         |



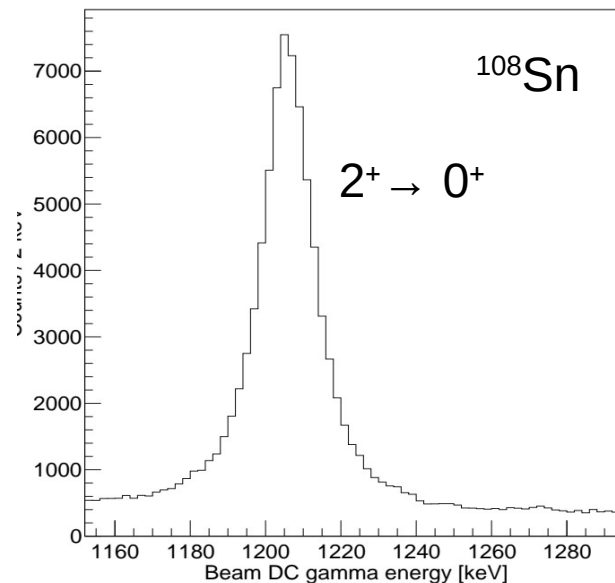
N. Warr et al., EPJA 49, 40 (2013)

# Experimental setup

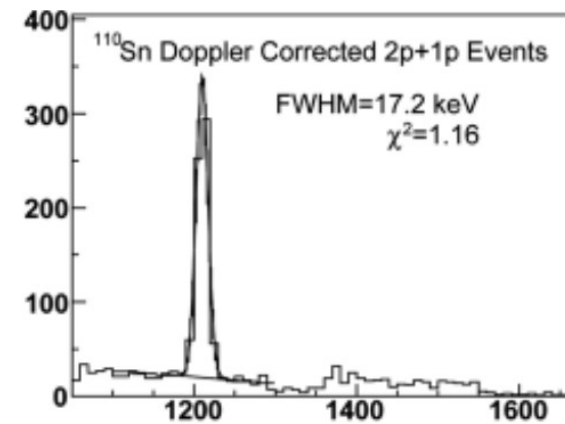
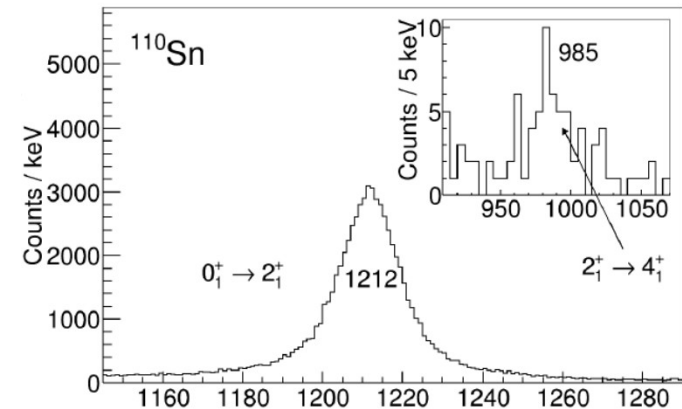
- Statistics



~4300 Counts

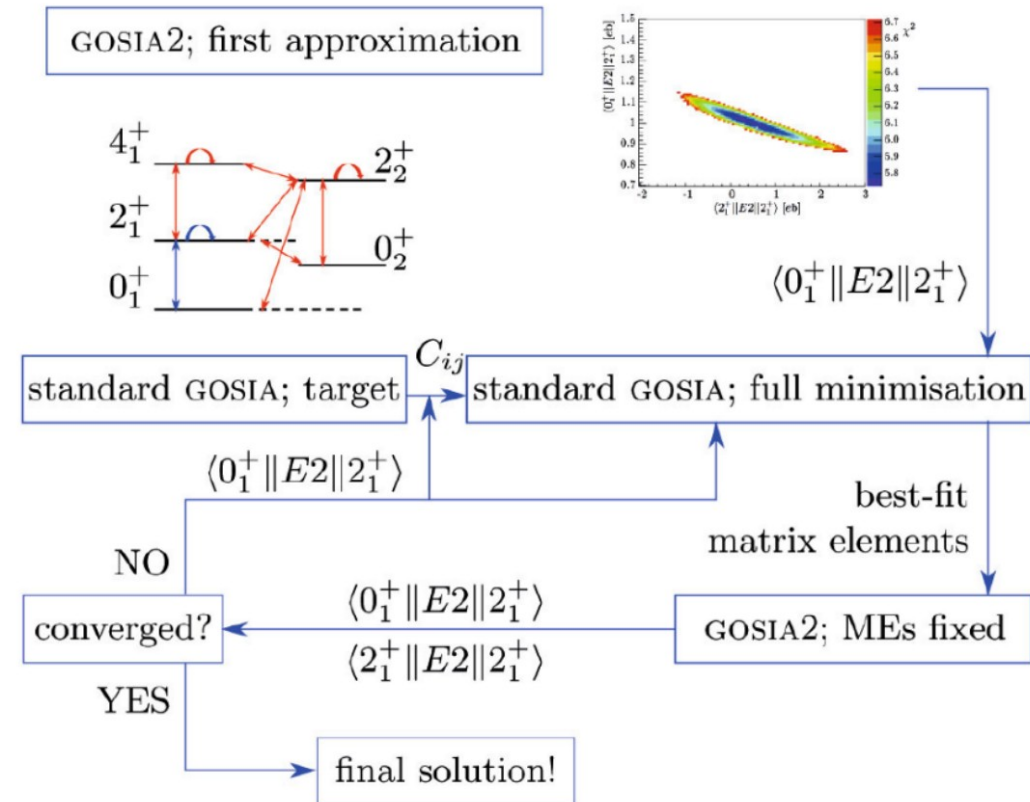
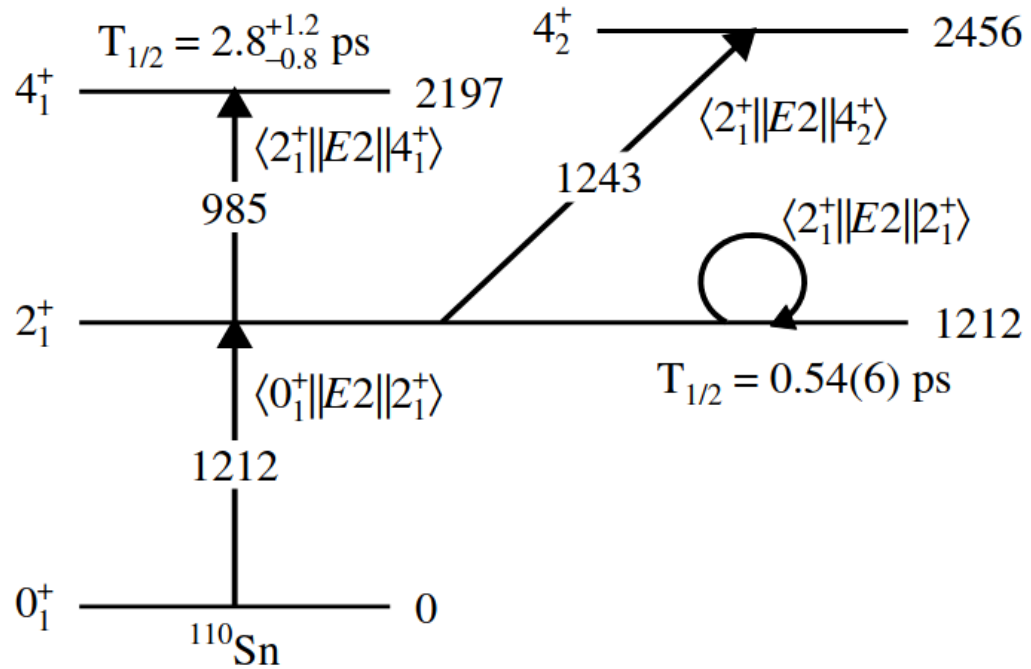


~70k Counts



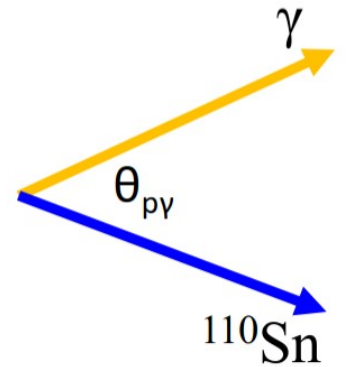
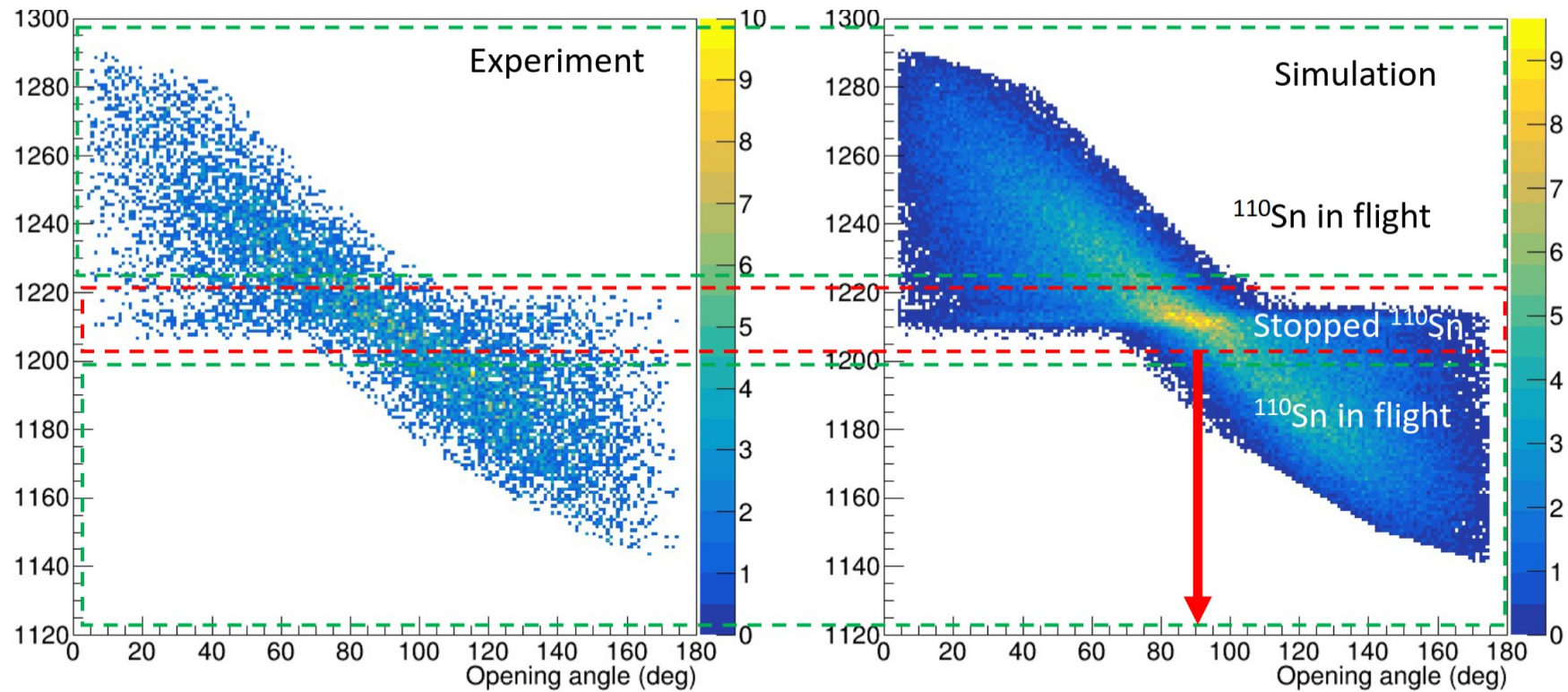
# Data analysis with higher order effects

Example for  $^{110}\text{Sn}$

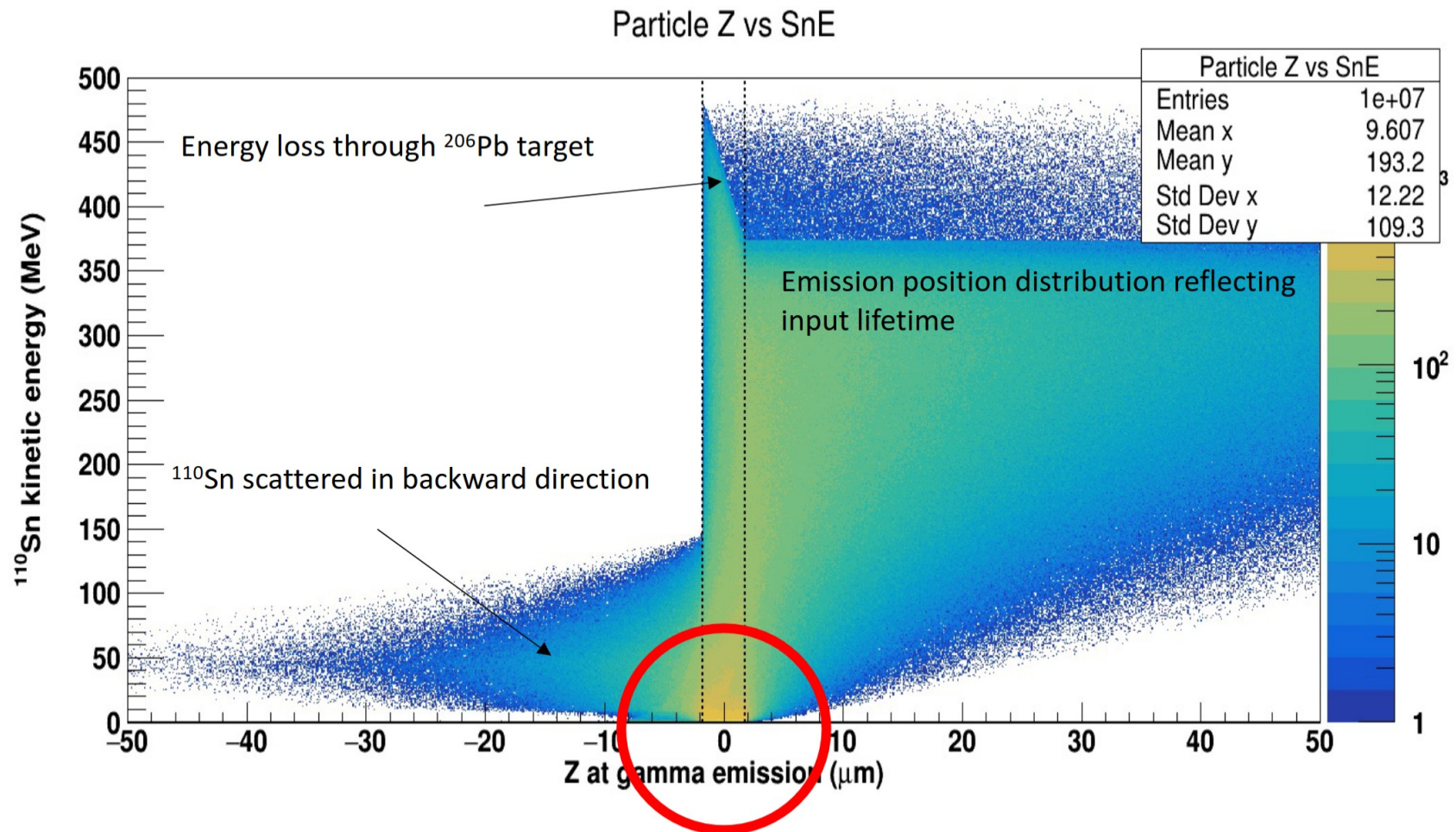


M. Zielińska *et al.*, EPJA 52, 99 (2016)

# Lifetime study

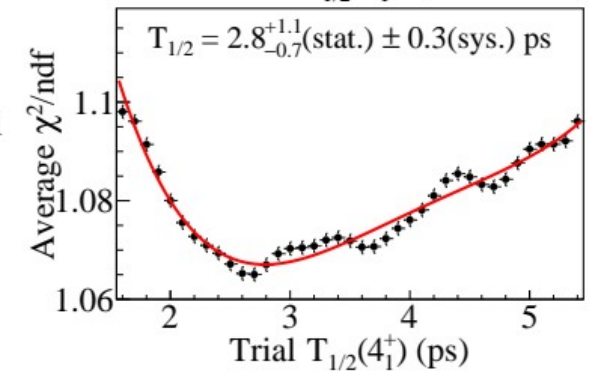
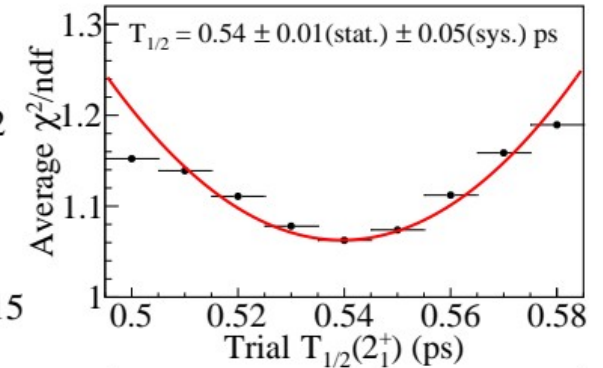
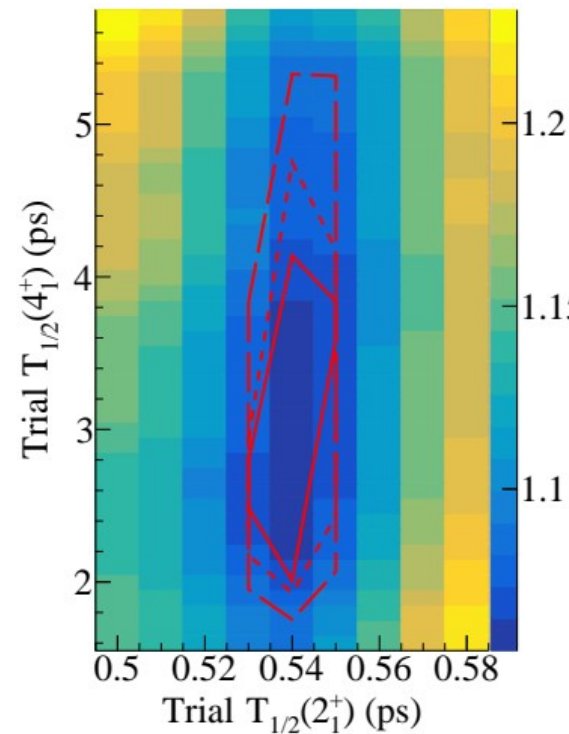
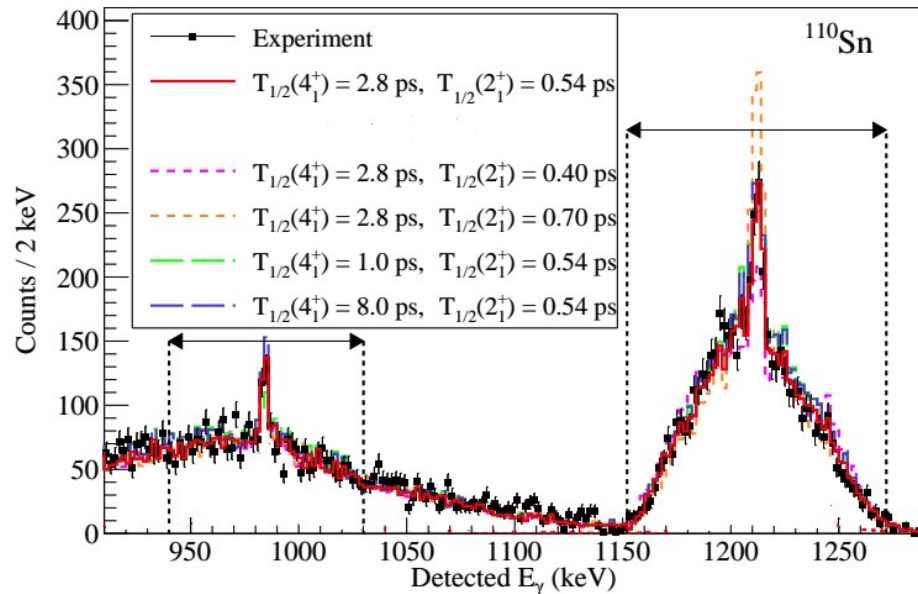


# Lifetime study



# Lifetime study

- Lifetime study
  - Geant4 simulation
  - $\chi^2$  scan



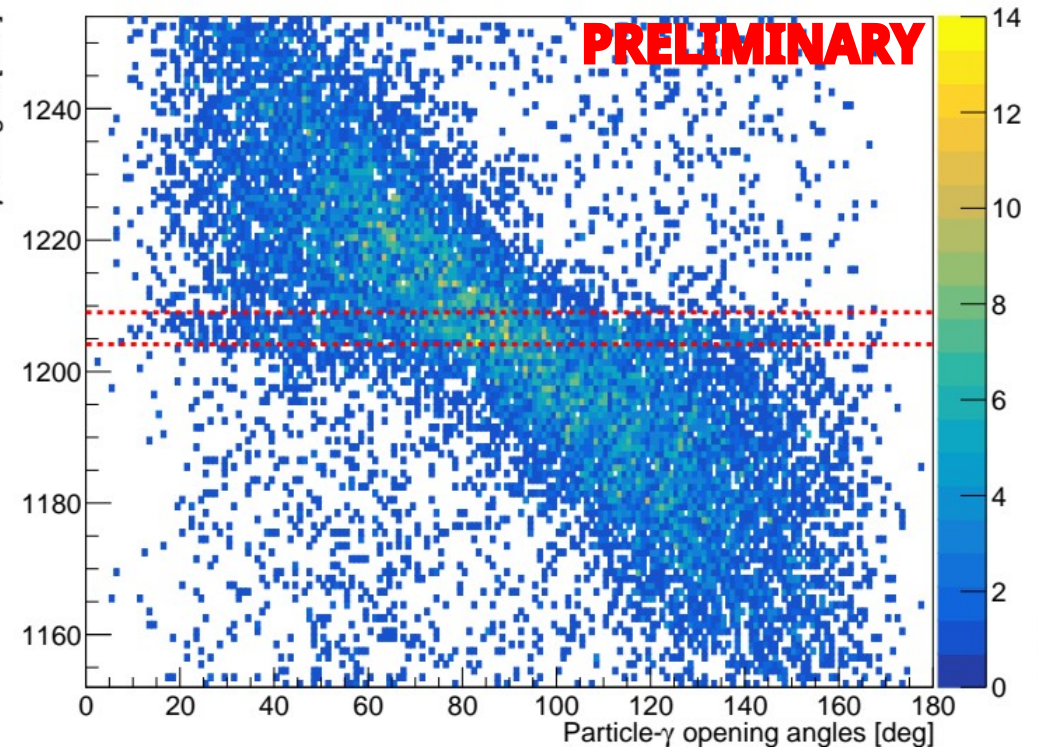
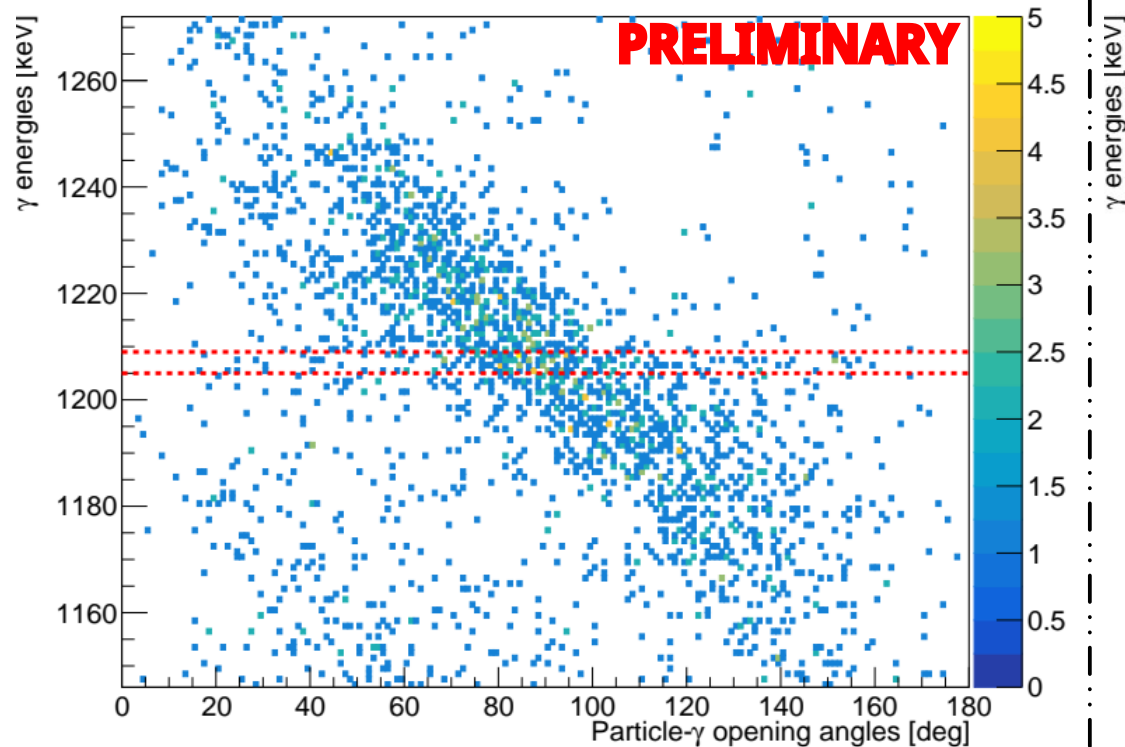
# Lifetime study: Ongoing

$^{106}\text{Sn}$

$^{108}\text{Sn}$

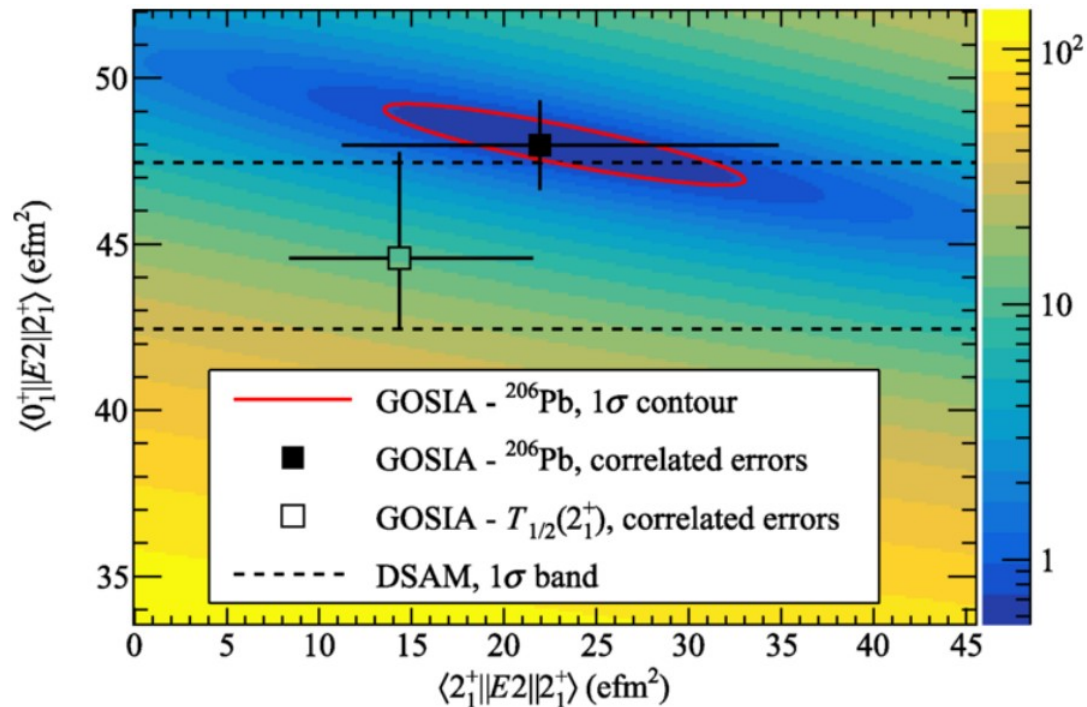
$\gamma$  energies for different opening angles, 1P events.  $^{206}\text{Pb}$  detected

$\gamma$  energies for different opening angles, 1P events.  $^{206}\text{Pb}$  detected,  $80^\circ \leq \theta_{\text{Lab}} \leq 100^\circ$

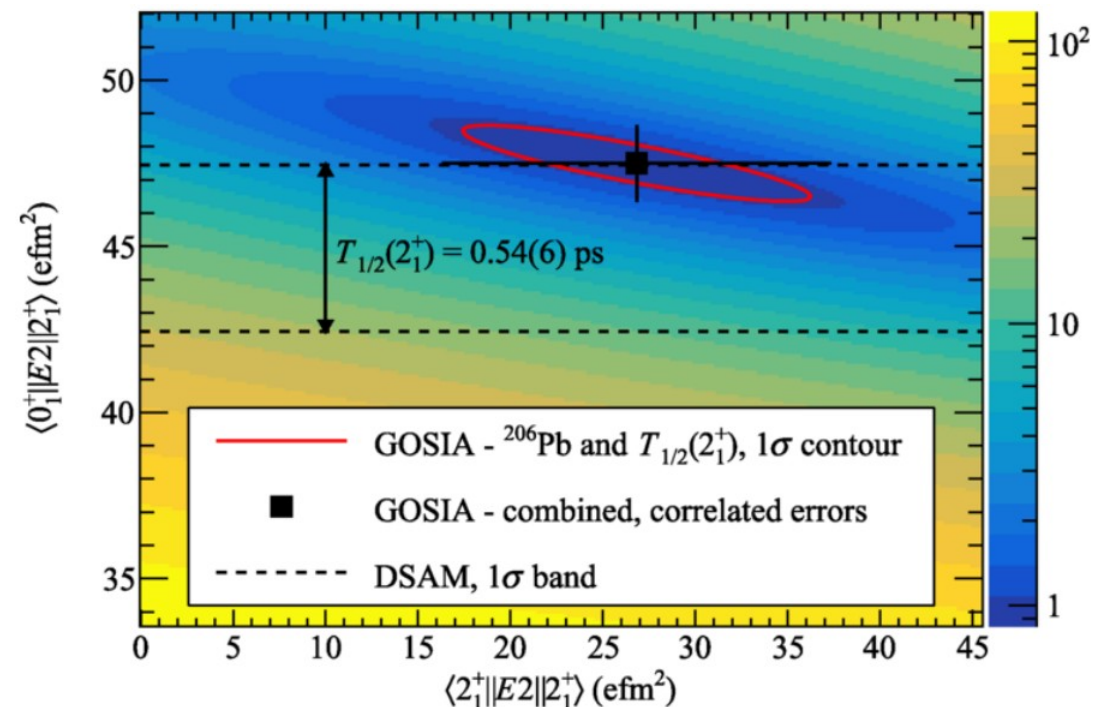


# Results: $^{110}\text{Sn}$

Pre-lifetime band

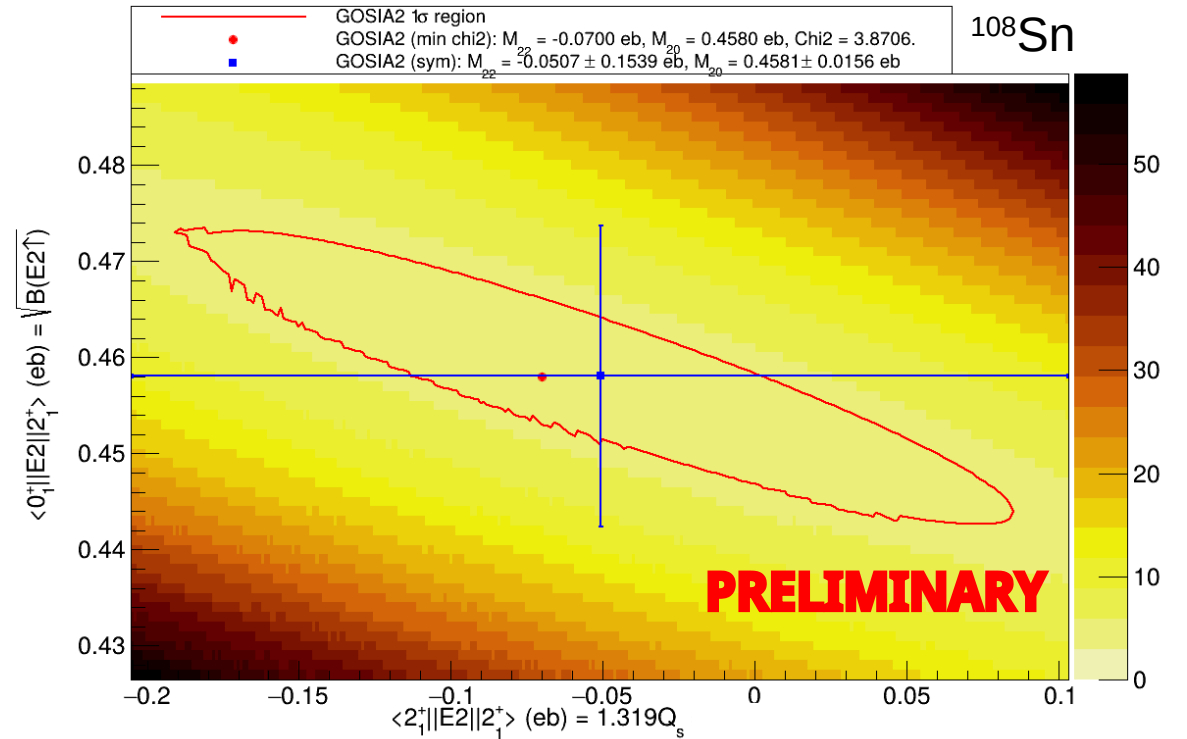
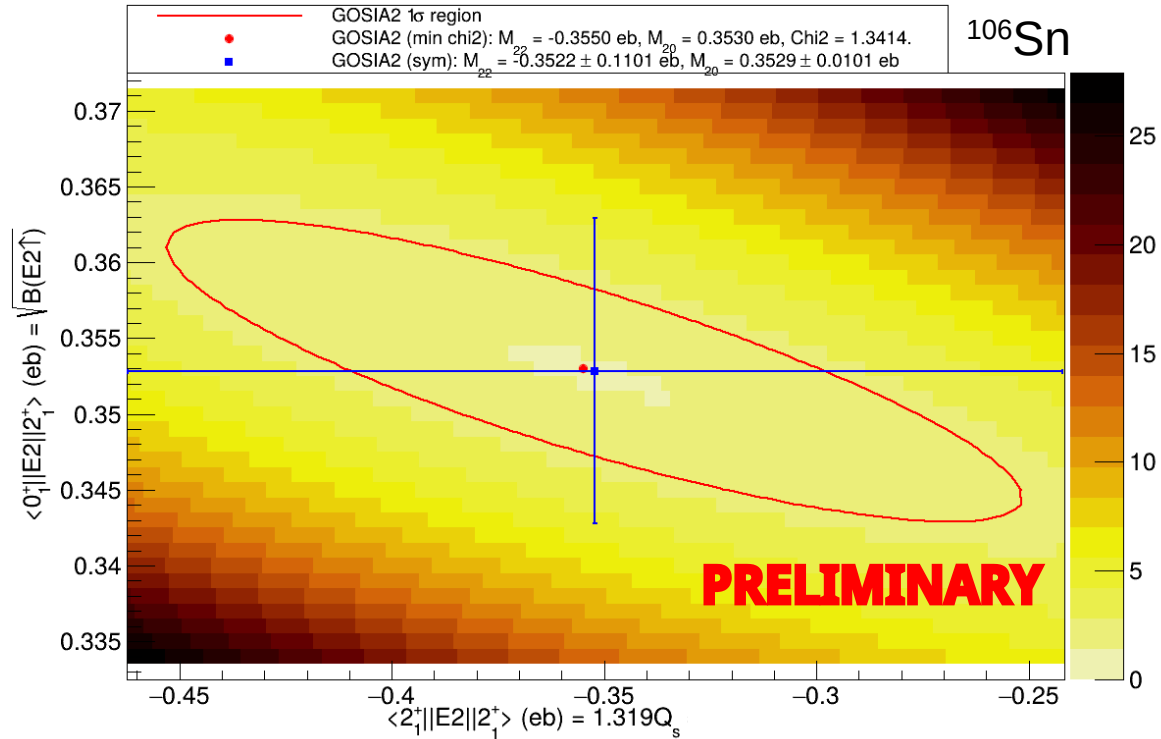


Post-lifetime band



Published: J. Park, R. A. Lopez, J. Cederkäll et. al., Phys. Rev. Lett. 135, 222502 (2025)

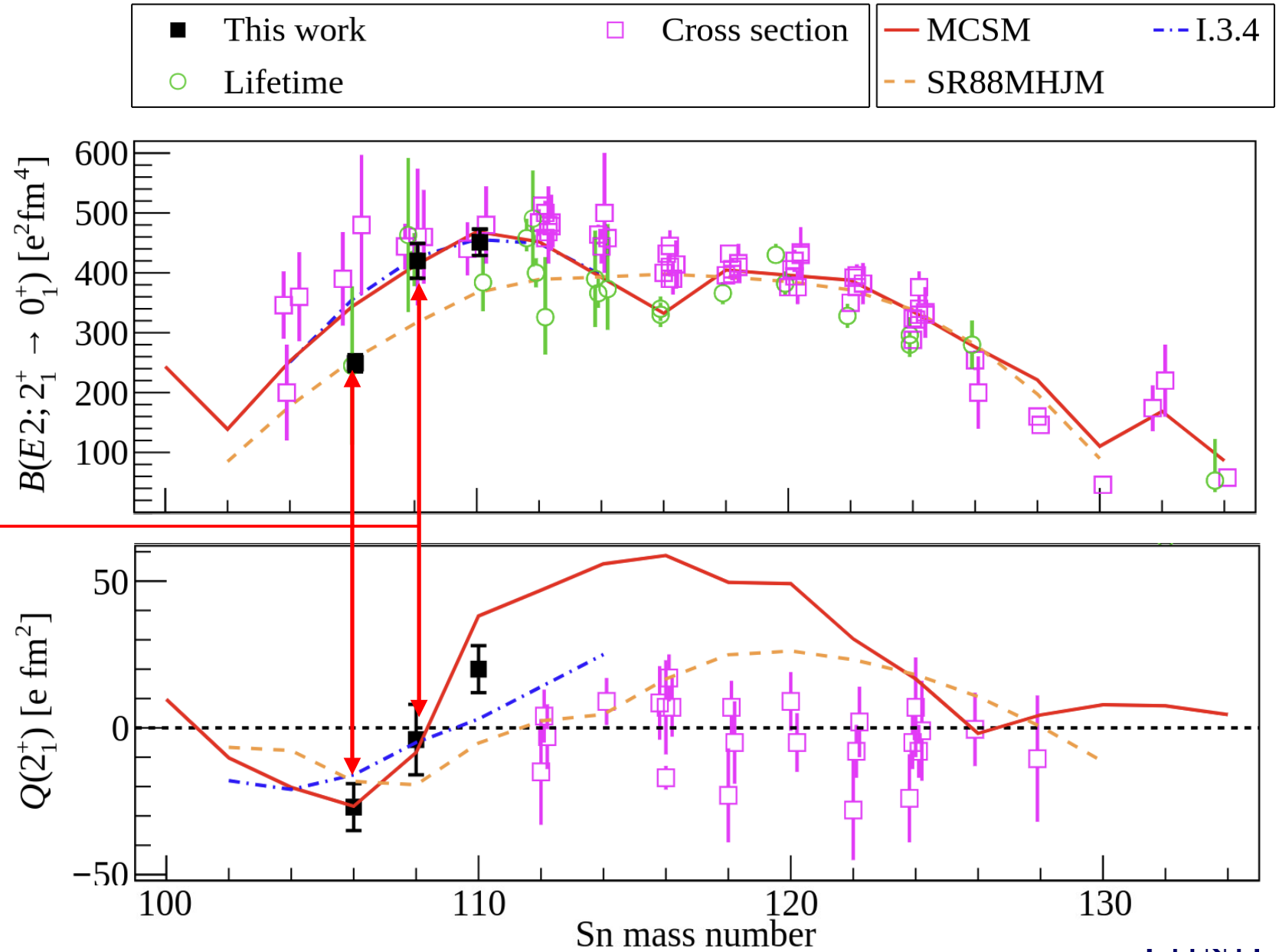
# Preliminary Results: $^{106}\text{Sn}$ & $^{108}\text{Sn}$



**PRELIMINARY**

# Results

PRELIMINARY



# Results

| Observable                                         | N[ <sup>206</sup> Pb] | DSAM $T_{1/2}$    | Combined | MCSM  |
|----------------------------------------------------|-----------------------|-------------------|----------|-------|
|                                                    |                       | 110Sn             |          |       |
| B(E2; $2^+ \rightarrow 0^+$ ) [ $e^2\text{fm}^4$ ] | 460(26)               | $400^{+50}_{-40}$ | 451(22)  | 469   |
| Q( $2_1^+$ ) [efm]                                 | $17^{+10}_{-8}$       | -                 | 20(8)    | 38    |
|                                                    |                       | 108Sn             |          |       |
| B(E2; $2^+ \rightarrow 0^+$ ) [ $e^2\text{fm}^4$ ] | 420(29)               | TBD               | TBD      | 412   |
| Q( $2_1^+$ ) [efm]                                 | -4(12)                | -                 | TBD      | -8.4  |
|                                                    |                       | 106Sn             |          |       |
| B(E2; $2^+ \rightarrow 0^+$ ) [ $e^2\text{fm}^4$ ] | 249(14)               | TBD               | TBD      | 344   |
| Q( $2_1^+$ ) [efm]                                 | -27(8)                | -                 | TBD      | -26.7 |

Thank you for listening!