

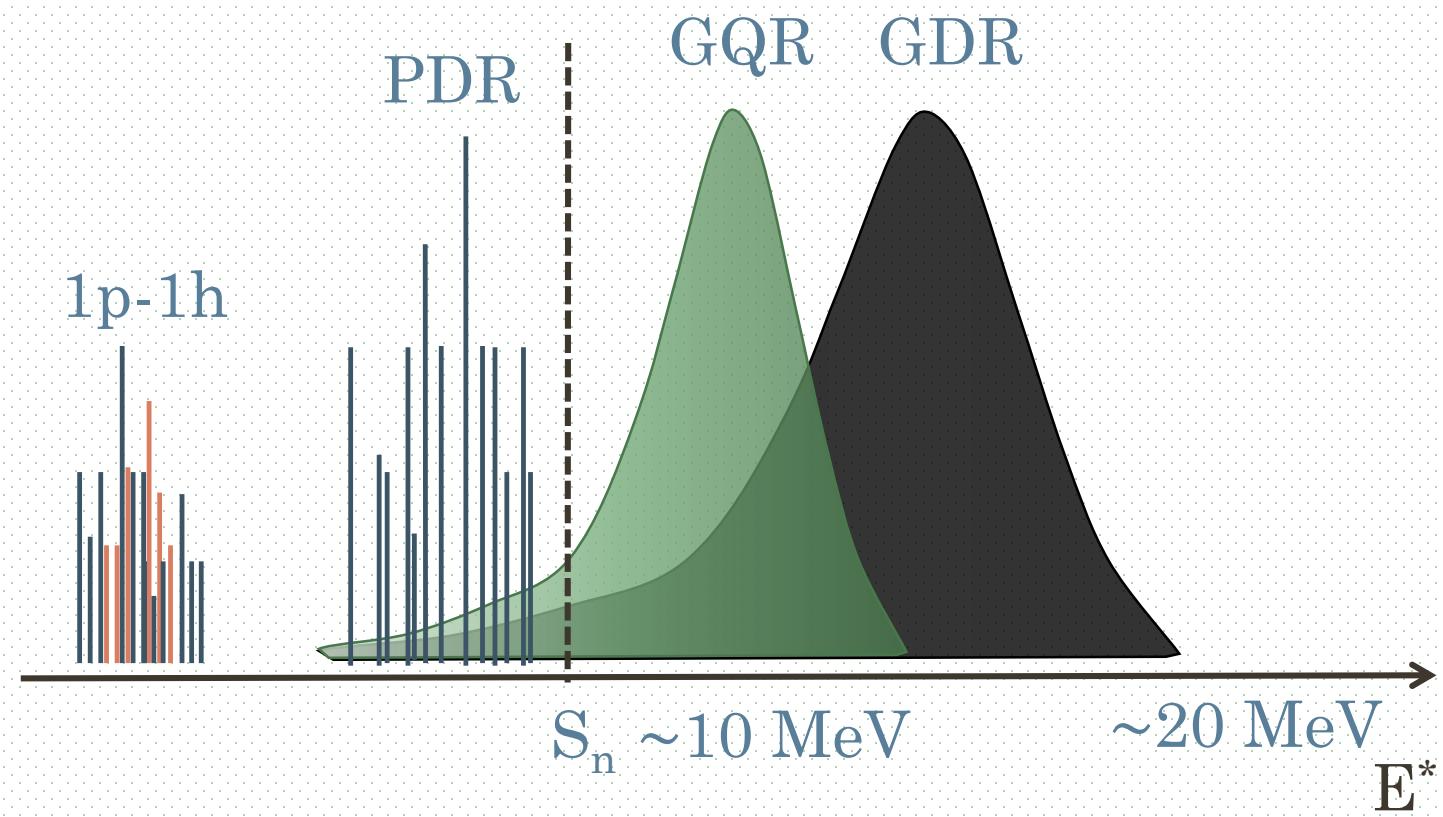
# Giant Resonances built on cold nuclei

Barbara Wasilewska IFJ PAN

# Giant Resonances

GR built on cold nuclei in inelastic scattering reaction

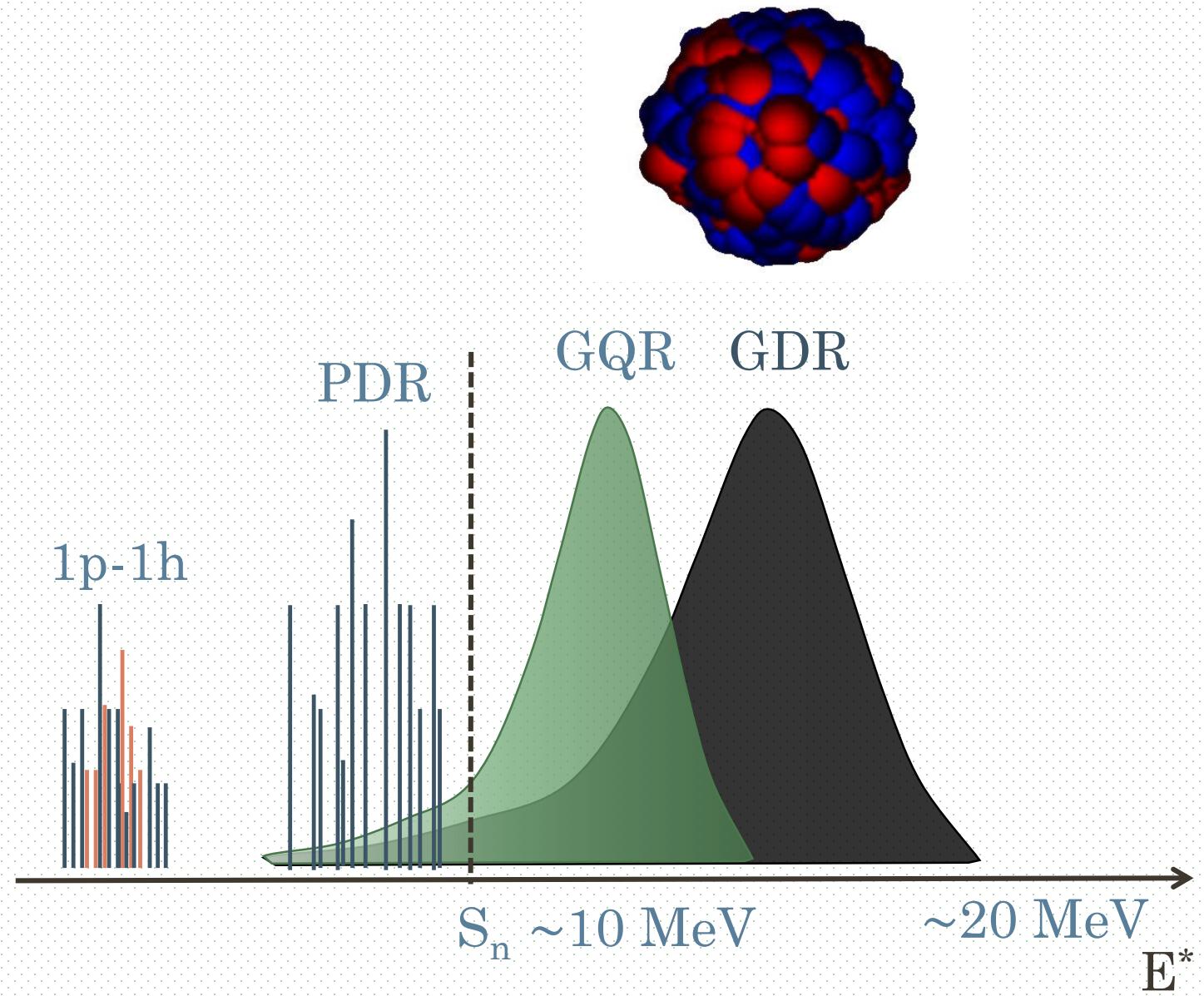
- GDR well known
- GQR general knowledge
  - only one  $\gamma$ -decay of GQR results ever published
  - very challenging experiments
- PDR under intense studies worldwide
  - recently discovered
  - not fully understood



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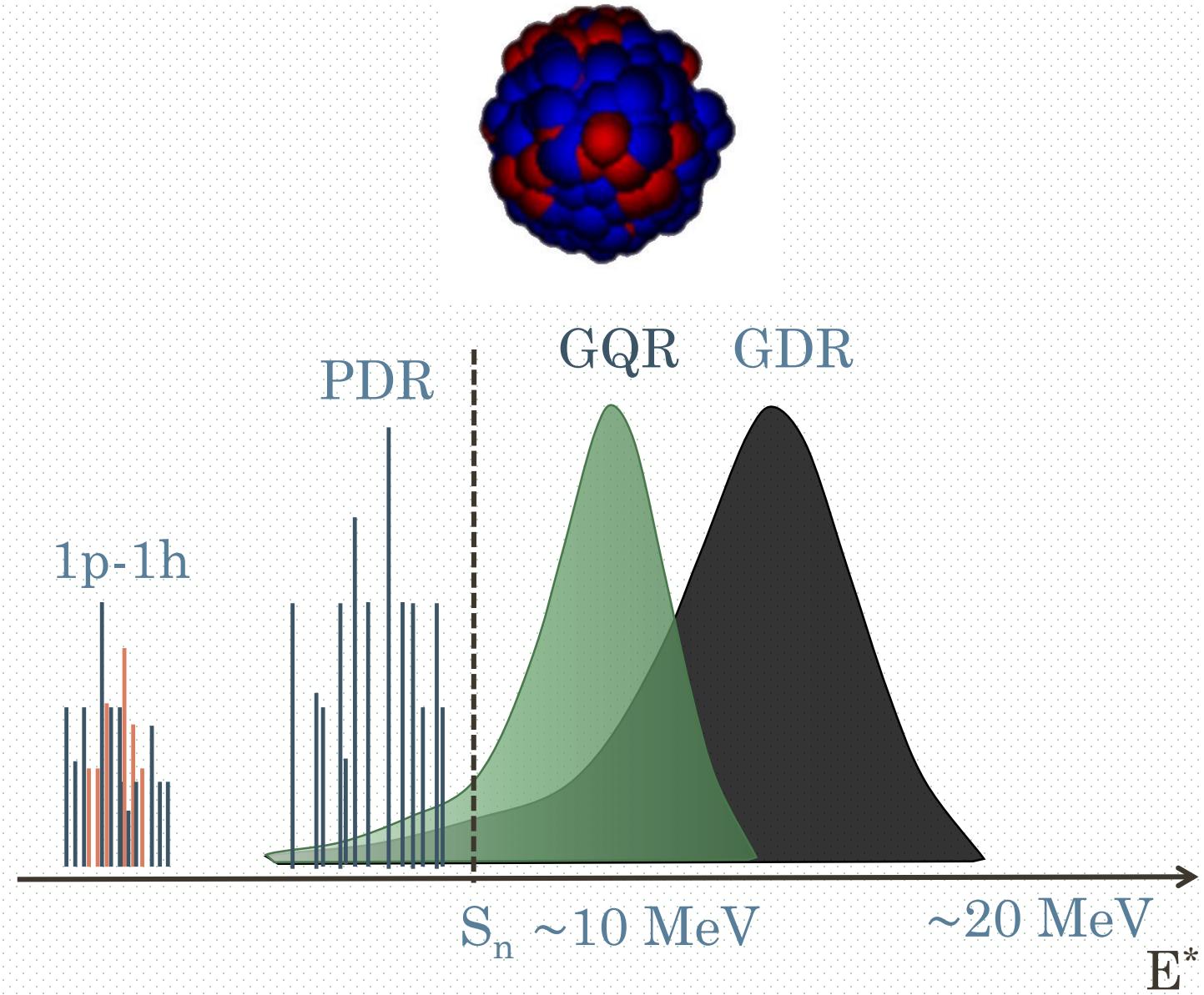
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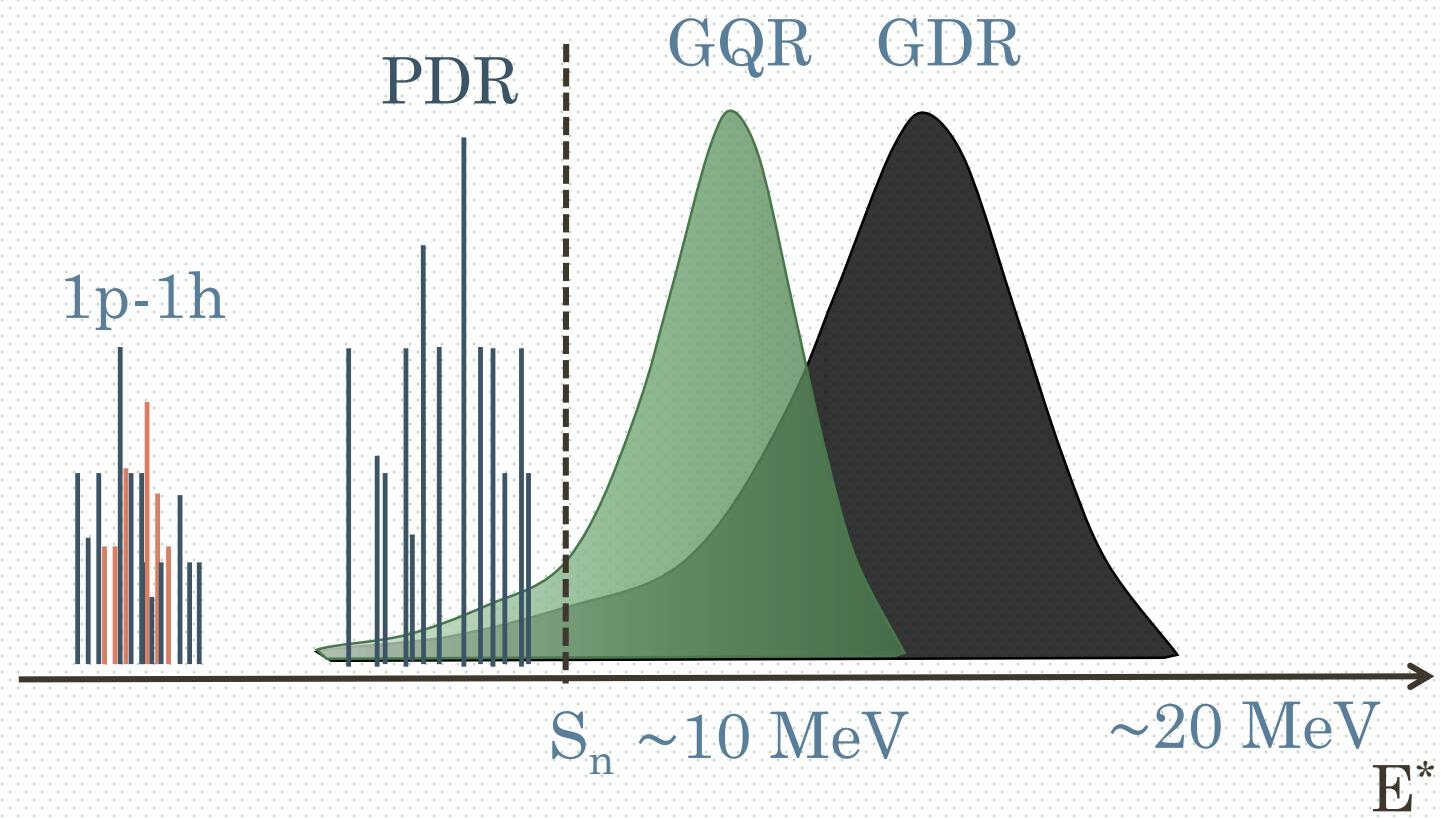
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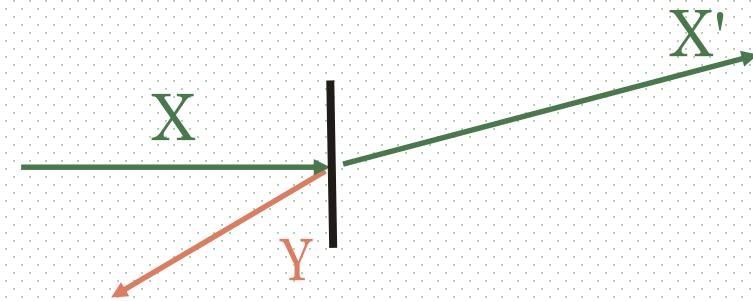
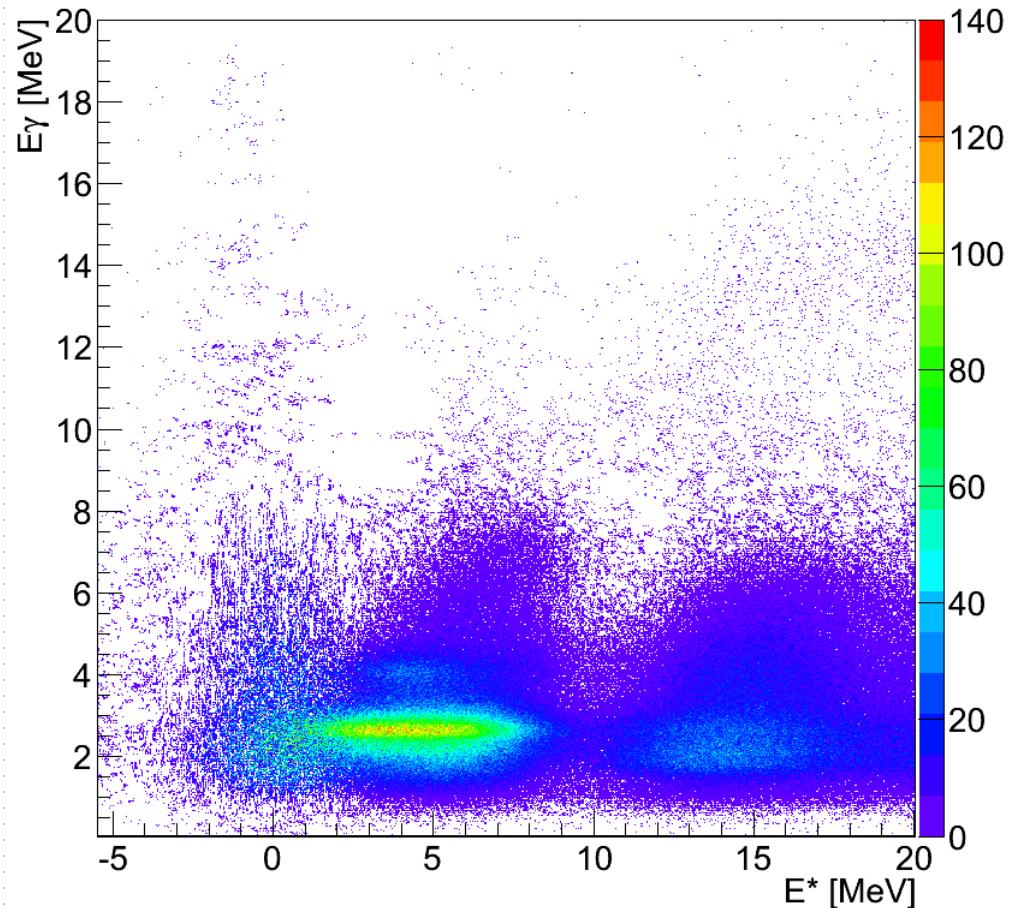
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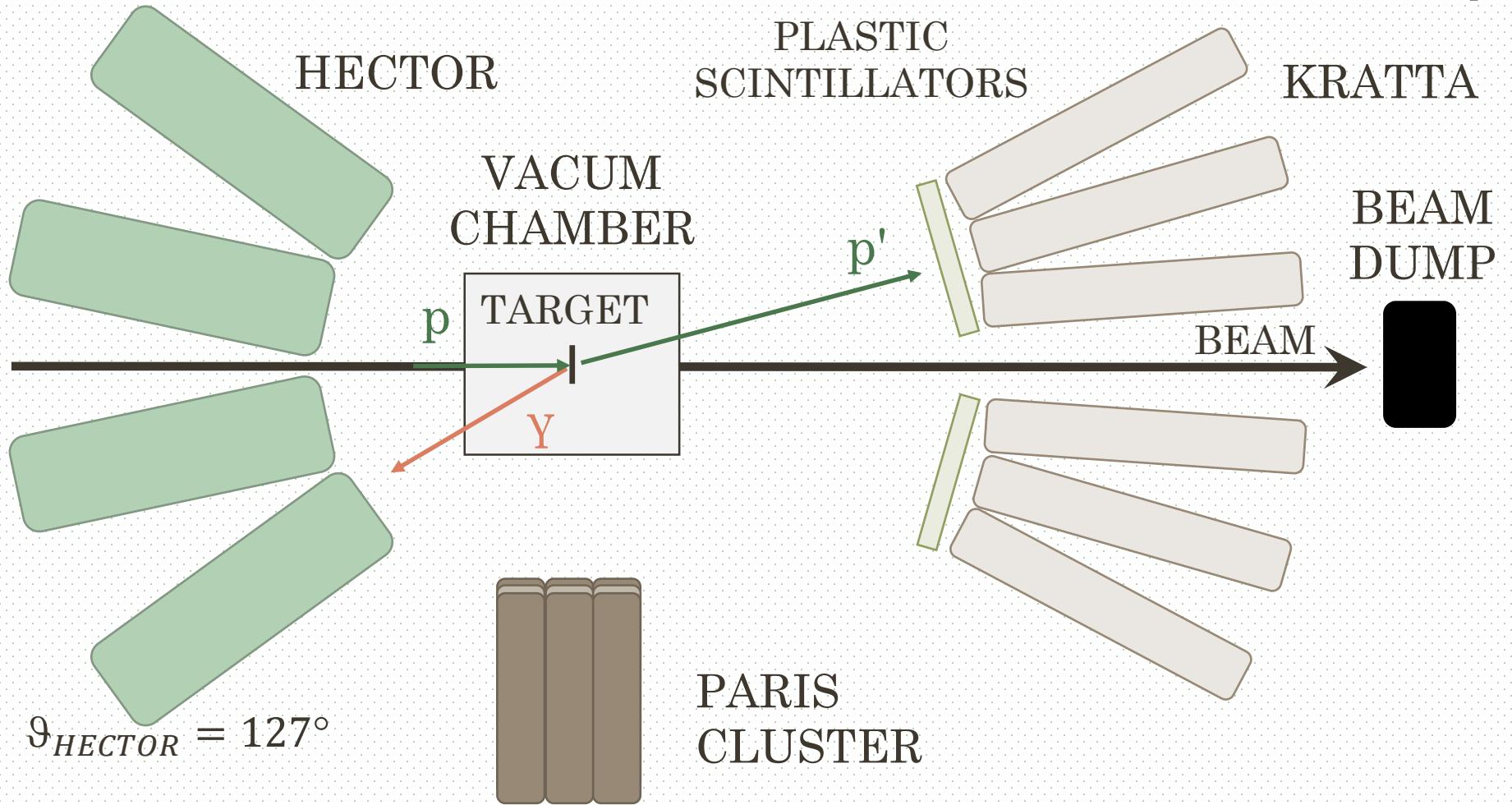
# Method



- Inelastic scattering of charged particles
- Coincidence measurement of scattered particles and emitted  $\gamma$  rays
- Result – coincidence matrix
- Information on  $\gamma$ -decay of excited states

# Example – experiment at CCB Krakow

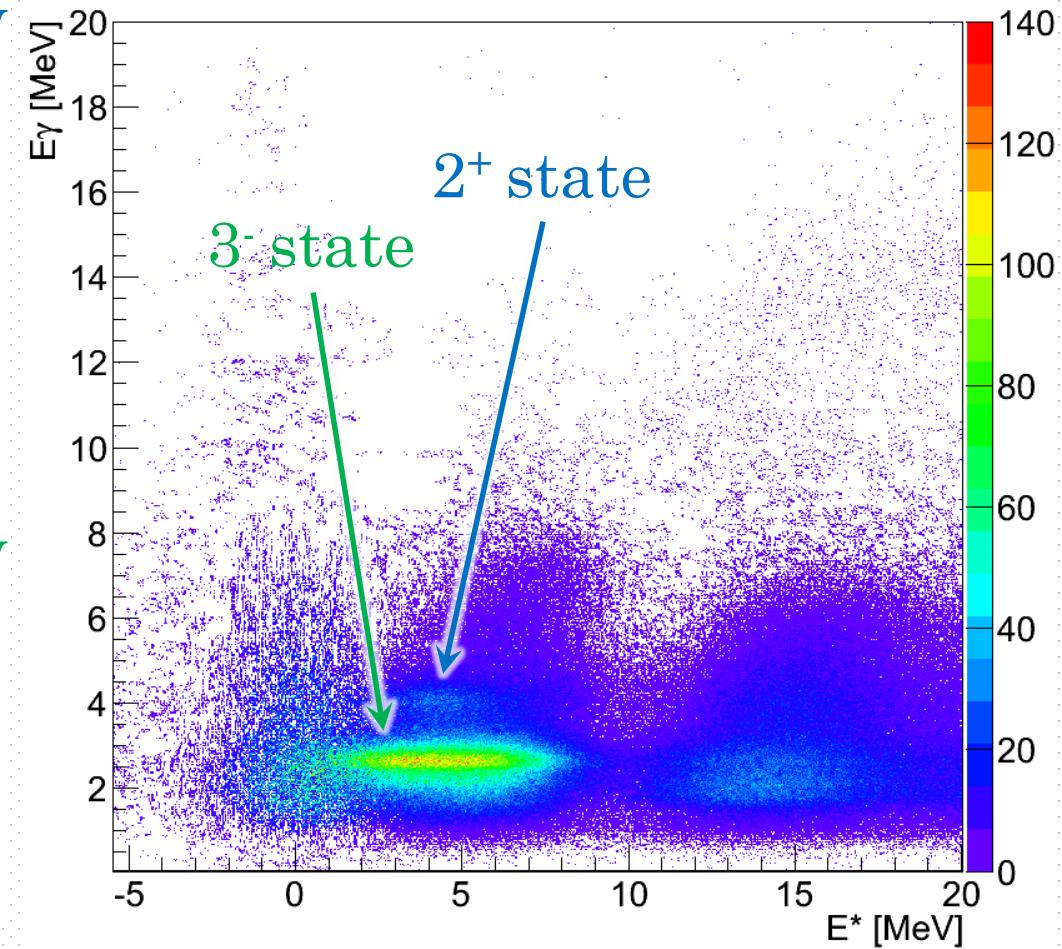
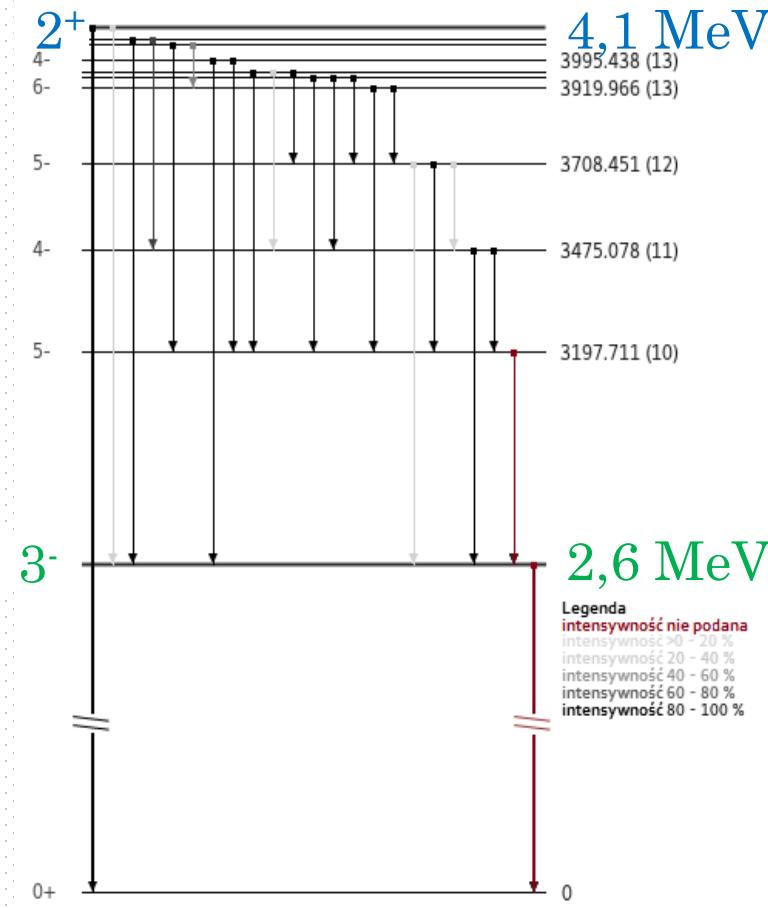
$^{208}Pb(p, p'\gamma)@85\text{ MeV}$



KRATTA  
angles:

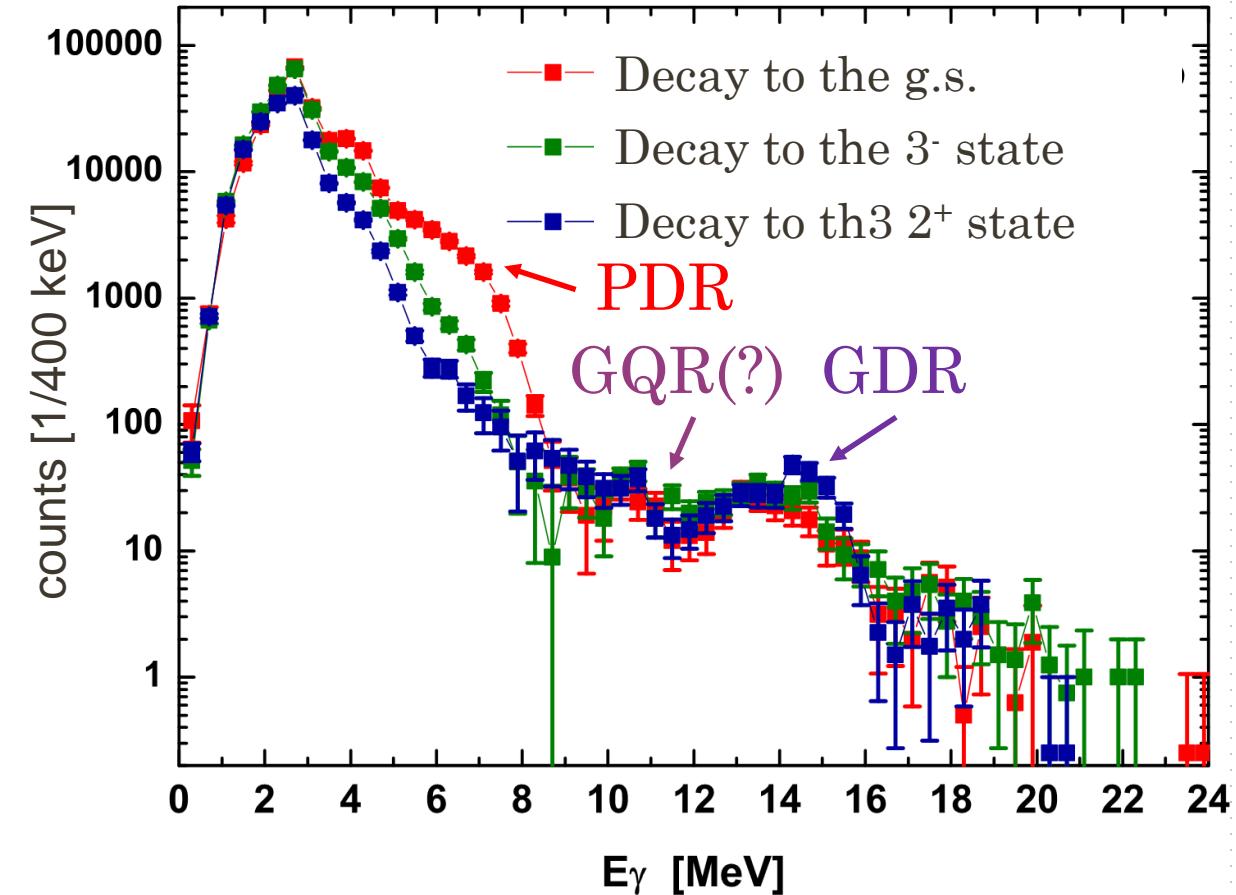
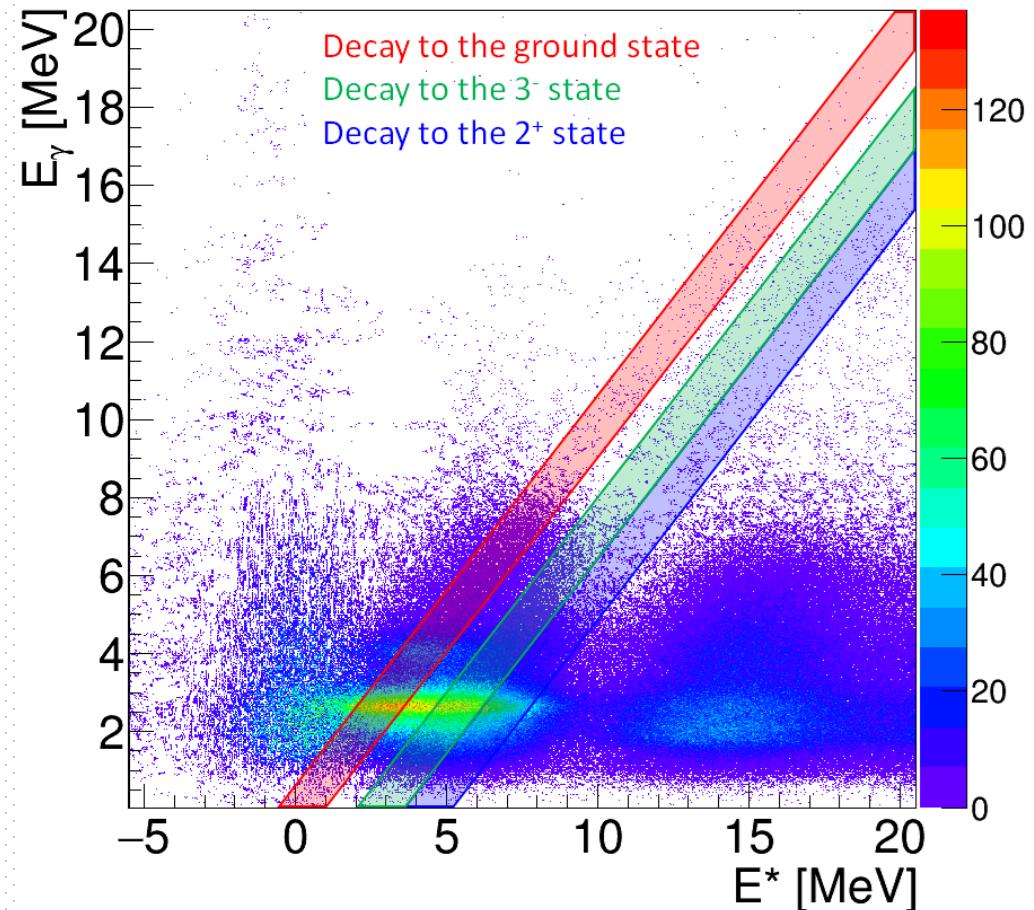
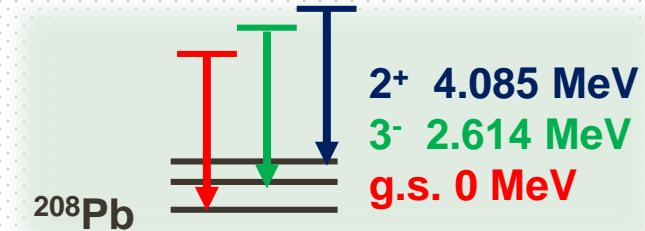
- $\vartheta_3 = 8.9^\circ$
- $\vartheta_4 = 10.7^\circ$
- $\vartheta_5 = 12.5^\circ$
- $\vartheta_6 = 14.3^\circ$

# Coincidence matrix



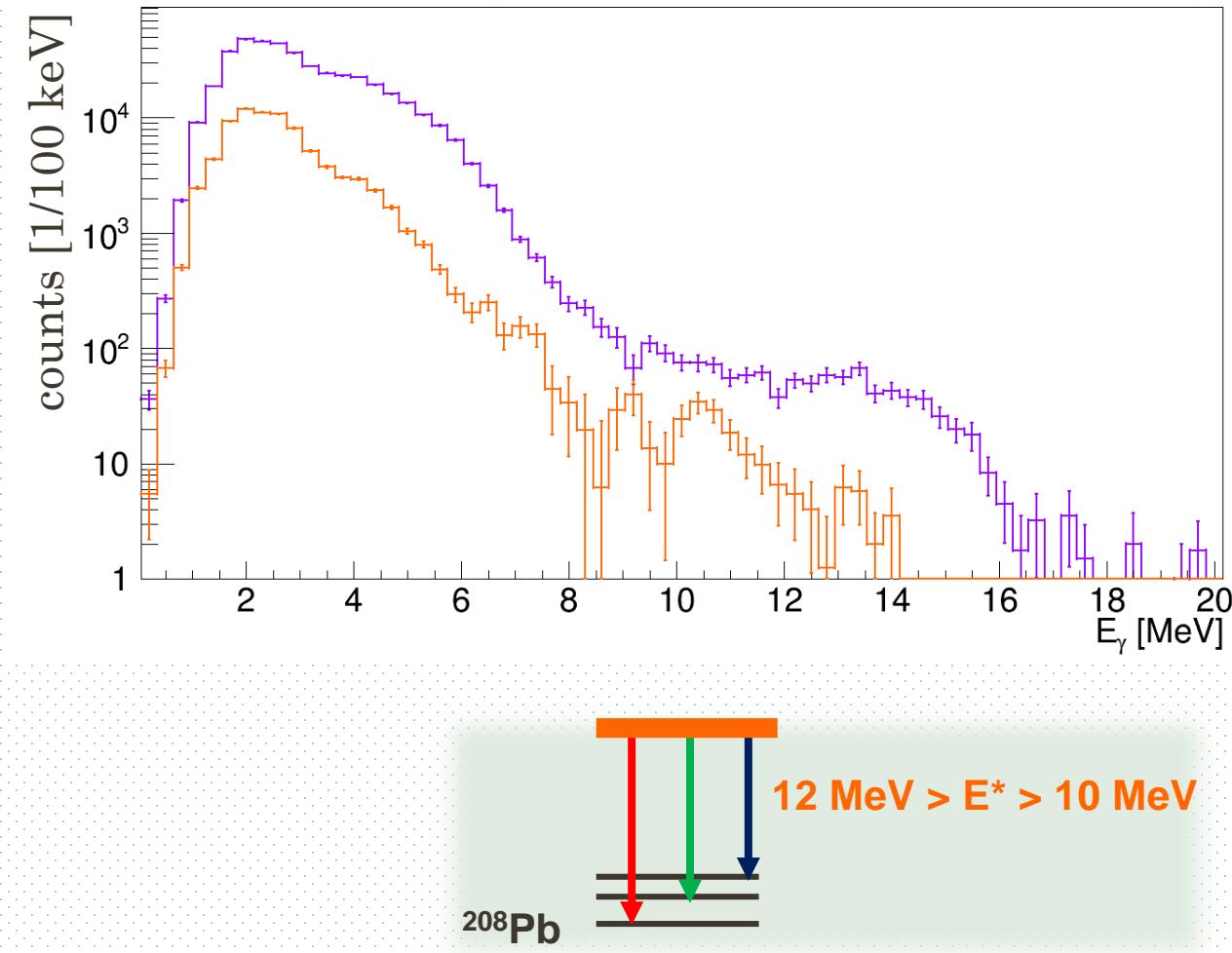
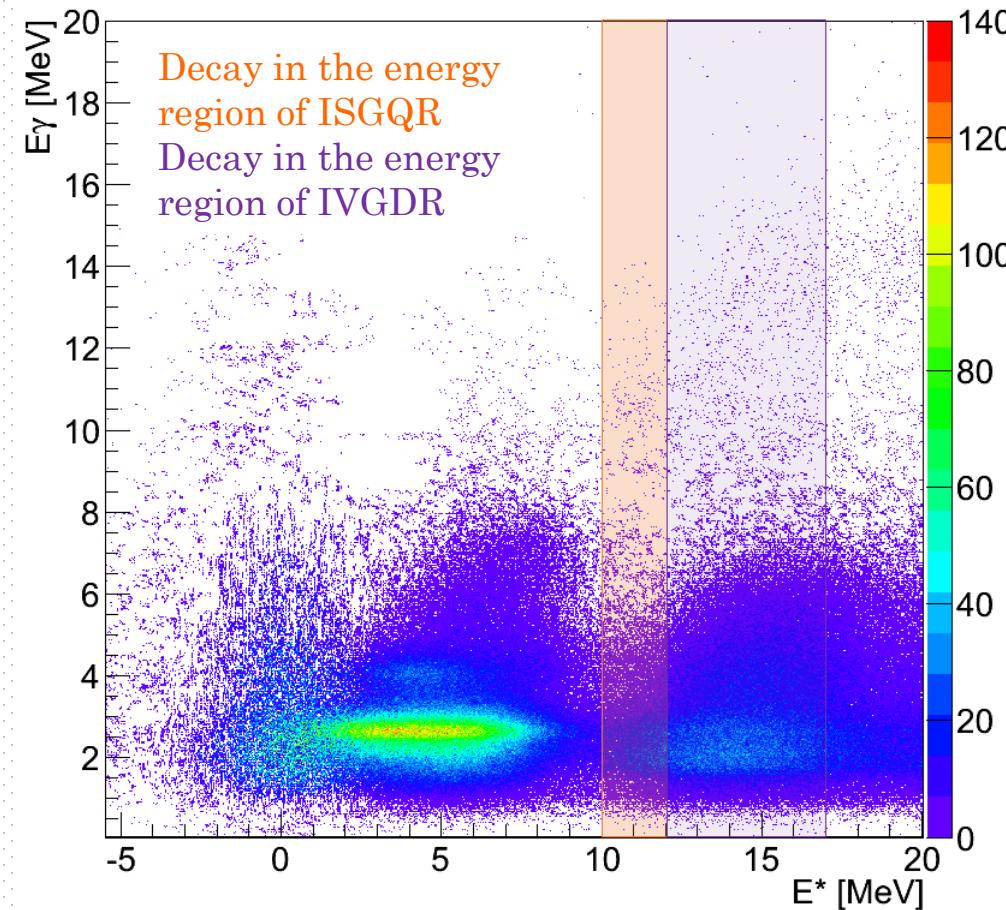
- $E^*$  – excitation energy (from proton energy: KRATTA)
- $E_\gamma$  – γ-ray energy (HECTOR)

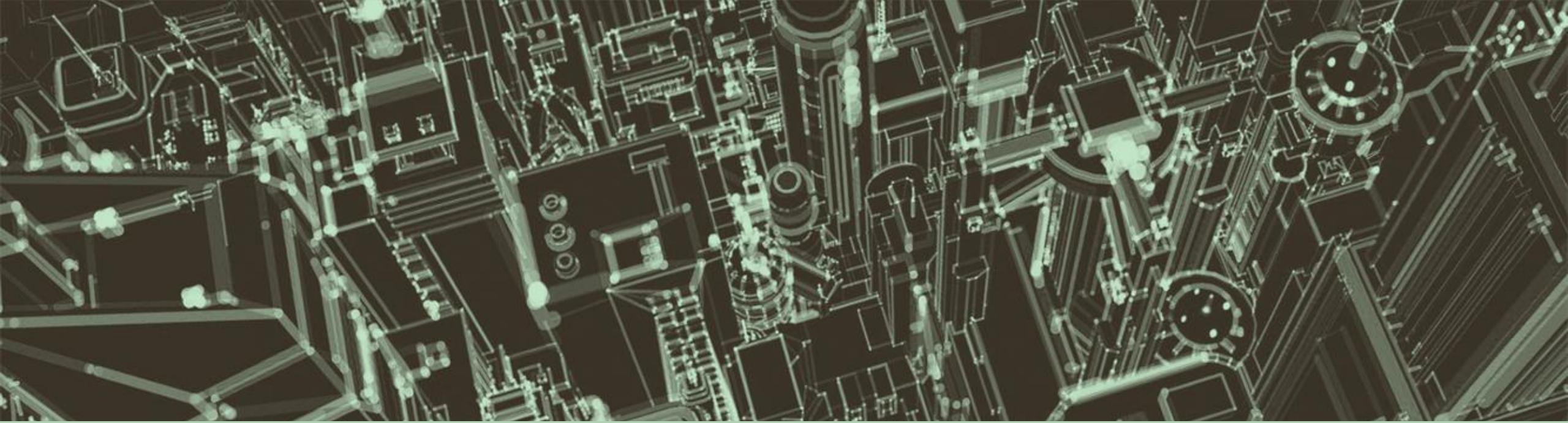
# $\gamma$ decay of the excited states to chosen final levels



# Introduction

## $\gamma$ decay of the chosen excited states





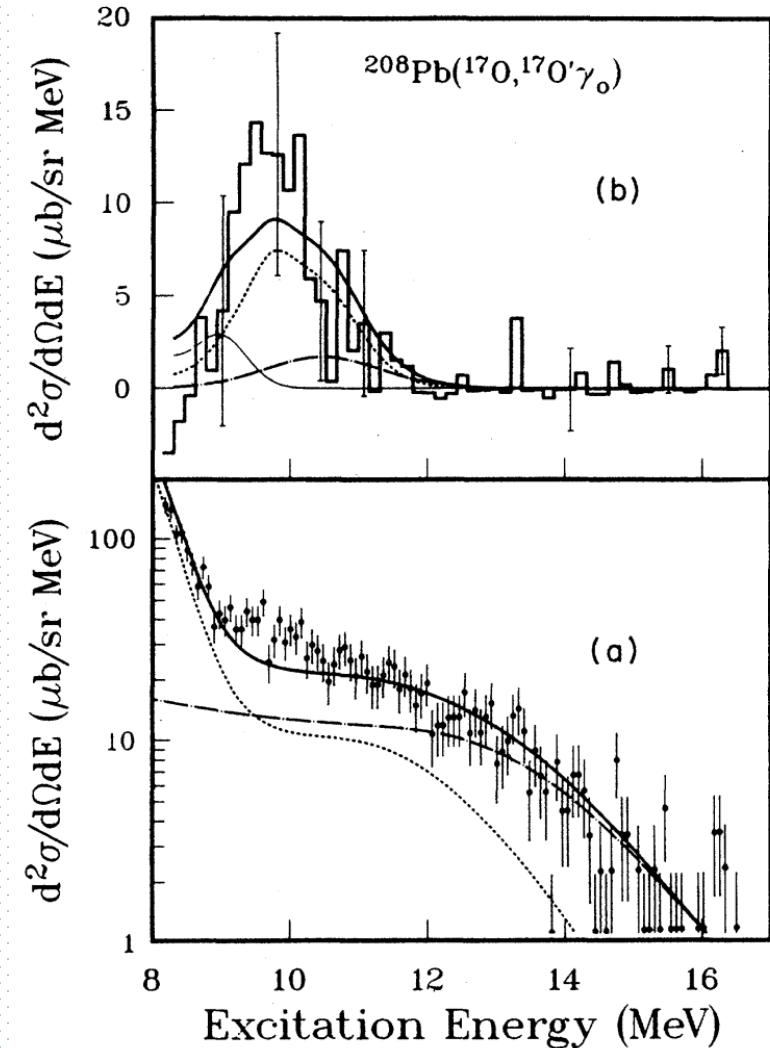
# Possible physic cases for CCB and HIL



# Topic 1: $\gamma$ -decay of GQR from $^{208}\text{Pb}$

J. R. Beene et al., Phys. Rev. C 39 (1989) 1307

- The only one experimental observation so far
- $^{208}\text{Pb}({}^{17}\text{O}, {}^{17}\text{O}'\gamma)$  reaction @ 381 MeV



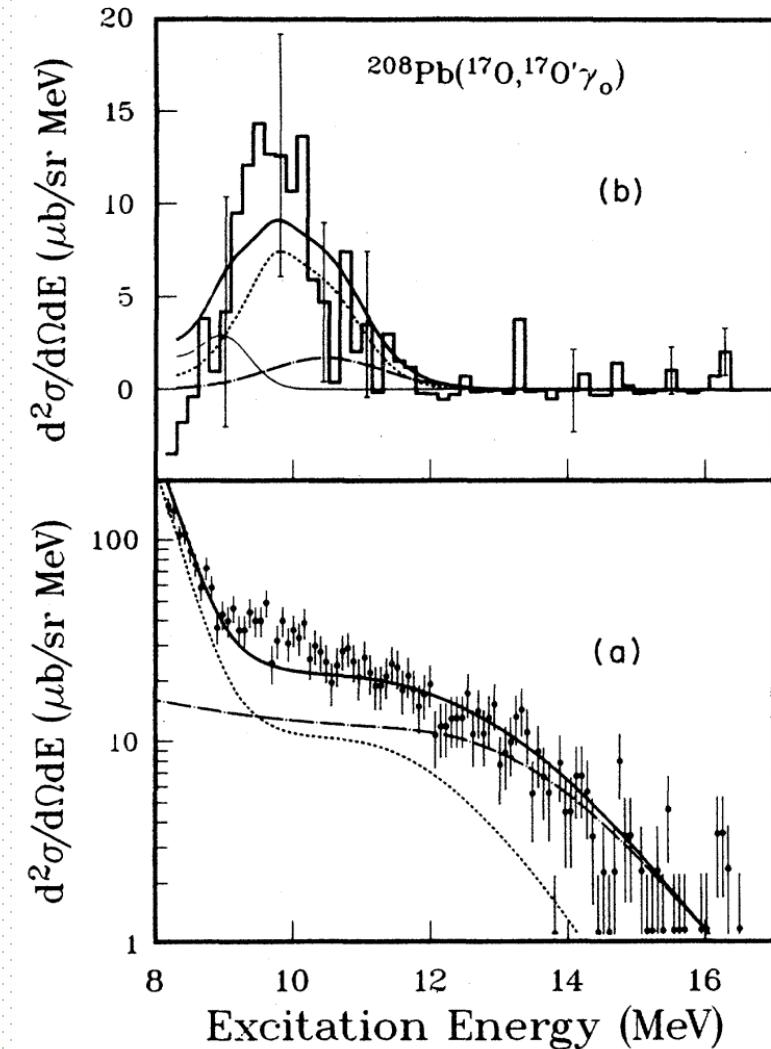
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- The only one experimental observation so far
- $^{208}\text{Pb}(^{17}\text{O}, ^{17}\text{O}'\gamma)$  reaction @ 381 MeV

## Proposal:

- Confirmation of the observation:
  - $^{208}\text{Pb}(\text{p}, \text{p}'\gamma)$  – CCB @ various energies
  - $^{208}\text{Pb}(\alpha, \alpha'\gamma)$  – HIL @ maximal energy
  - $^{208}\text{Pb}(^{17}\text{O}, ^{17}\text{O}'\gamma)$  – HIL
- HIL: Higher beam energy – booster?



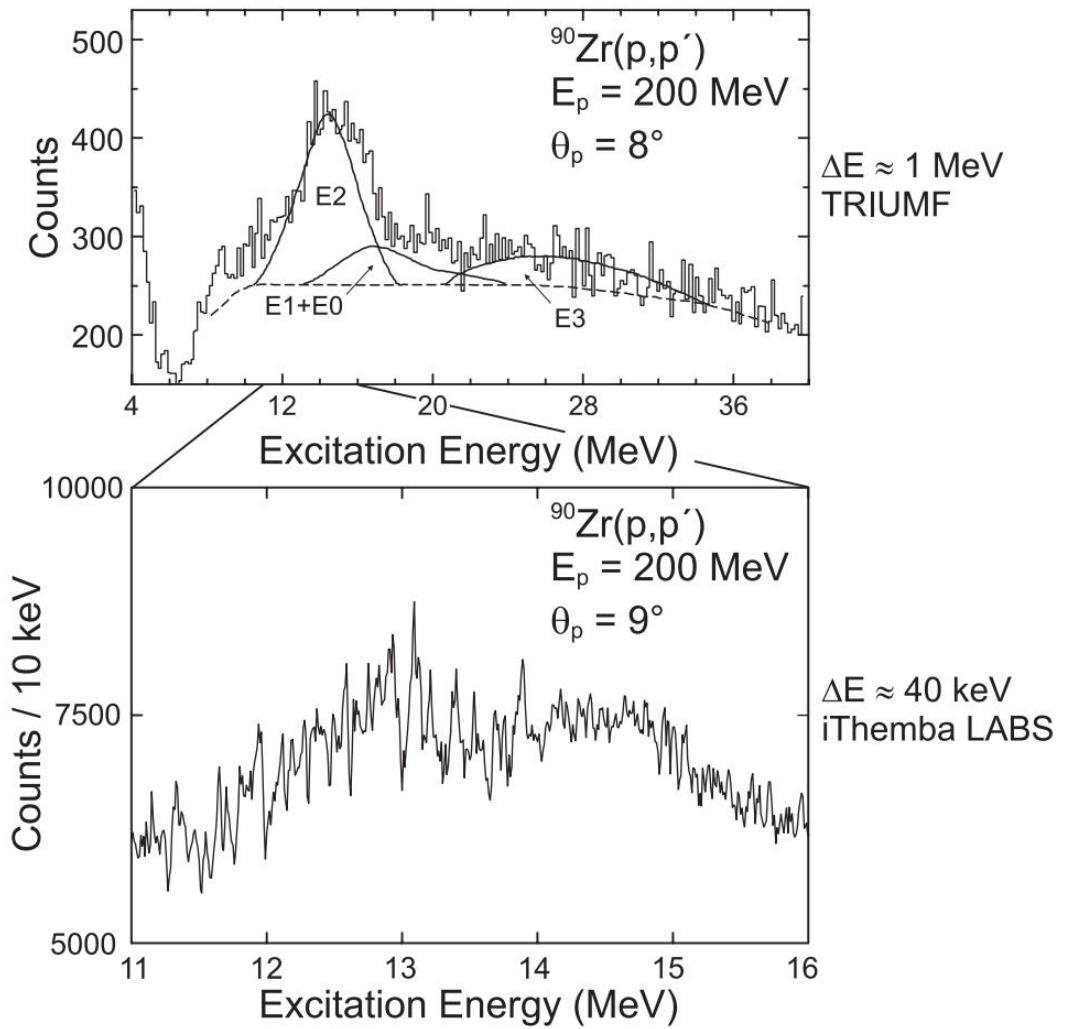
# Topic 2: $\gamma$ -decay of GQR in different nuclei

- Method established for  $^{208}\text{Pb}$
- Further development
- Complementary measurements at CCB and HIL

## Proposal

- Systematic studies of  $\gamma$ -decay of previously observed GQR ( $^{90}\text{Zr}$ ,  $^{124}\text{Sn}$ )
- Search of GQR in isotopes not yet studied –  $^{140}\text{Ce}$

A. Shevchenko et al., Phys. Rev. C 79 (1989) 044305



# Topic 3: deformation sensitivity of the GQR shape

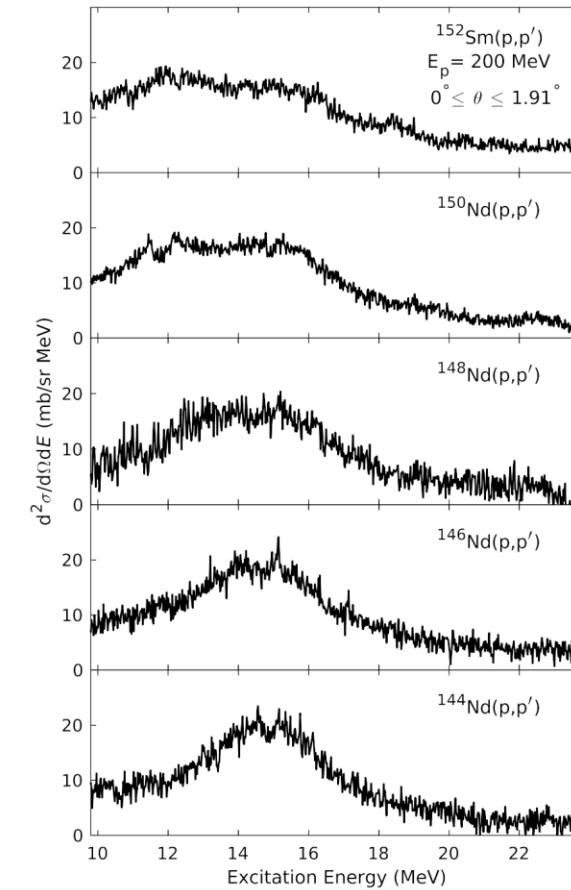
- Theoretical prediction of the shape dependence of the GQR shape
- Weaker effect than in GDR

## Proposal

- Systematic measurements of isotopes of the same element – Sn?
- Study at CCB and HIL
- High precision: spectrometer?

PARIS?

Experimental results for GDR!!!



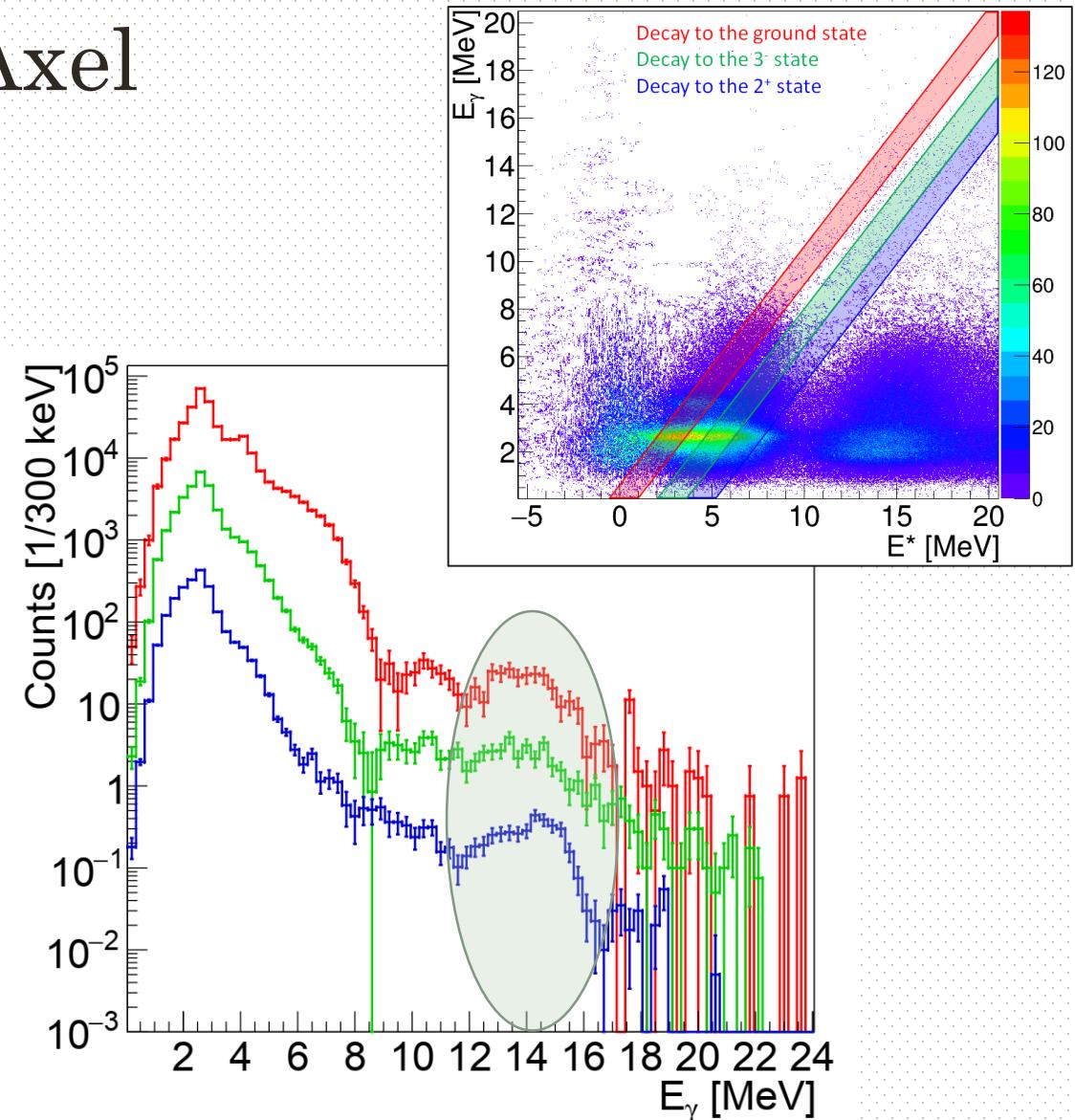
L.M. Donaldson et al., Phys. Lett. B 776 (2018) 133

# Topic 4: generalised Brink-Axel hypothesis

- Hypothesis: Gamma Strength Function same for all states
- Basis of ( $n, \gamma$ ) calculations – nucleosynthesis
- Popular topic
- Results vary

Proposal:

- Use of the data measured for the GQR  $\gamma$ -decay
- Higher precision of measurement?



B. Wasilewska et al., Acta Phys. Pol. B (2019) *in print*

# Summary

“Two-legs” experimental campaign: CCB+HIL

- GQR  $\gamma$ -decay
  - Confirmation of the observation of the GQR  $\gamma$ -decay in  $^{208}\text{Pb}$
  - Development of the method for the studied of the GQR  $\gamma$ -decay
  - Systematic measurements for different nuclei
  - Systematic measurements of the GQR shape for isotopes of the same nucleus
- Brink-Axel hypothesis
  - By-product of the measurements
- $\gamma$ -decay of other Giant Resonances (?)
  - Possible observation of the HEOR  $\gamma$ -decay to  $2^+$  state in CCB data



Thank you

