

# *Lifetime measurement in neutron-rich Cu nuclei*

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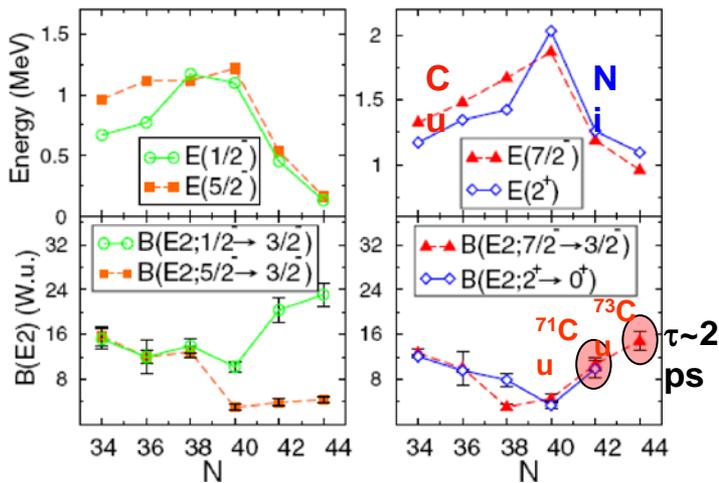
# Physics Motivation

## Monopole tensor effect ....

$$V_{j_1, j_2}^T = \frac{\sum_J (2J+1) \langle j_1 j_2 | V | j_1 j_2 \rangle_{JT}}{\sum_J (2J+1)}$$

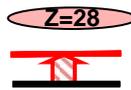
Inversion of the  $(\pi f_{5/2} - \pi p_{3/2})$  effective single-particle states

PRL 100, 112502 (2008)



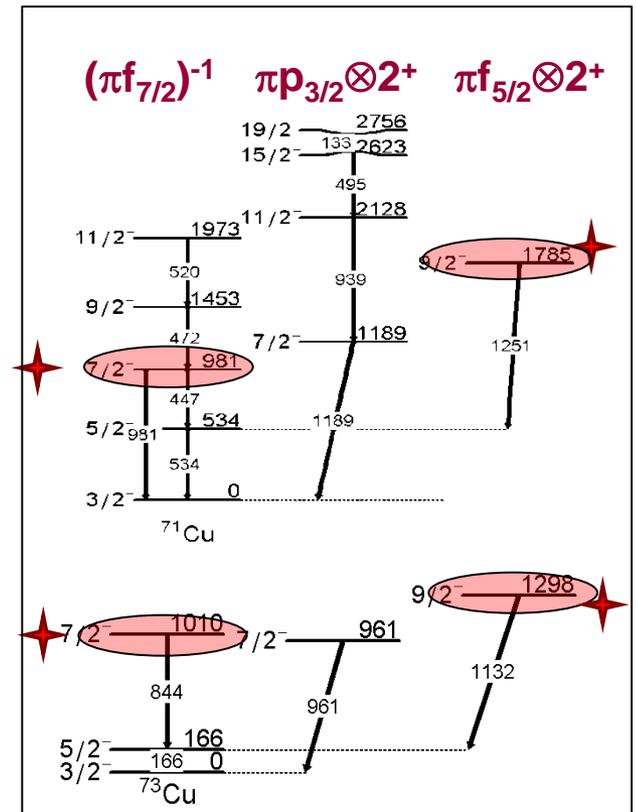
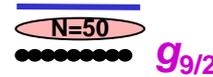
$f_{5/2}$

$f_{7/2}$



proton

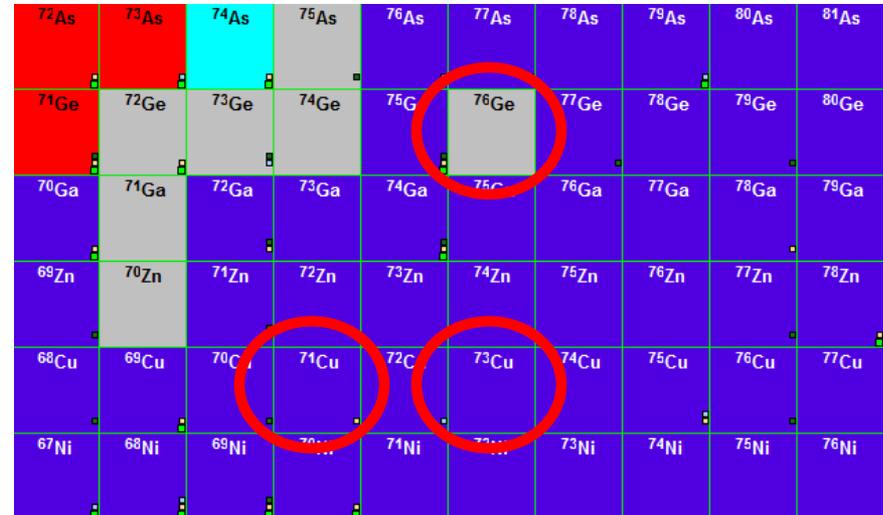
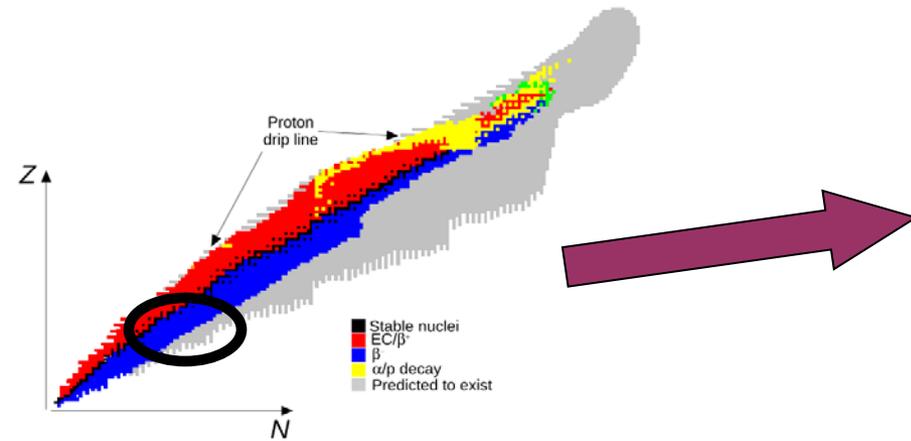
neutron



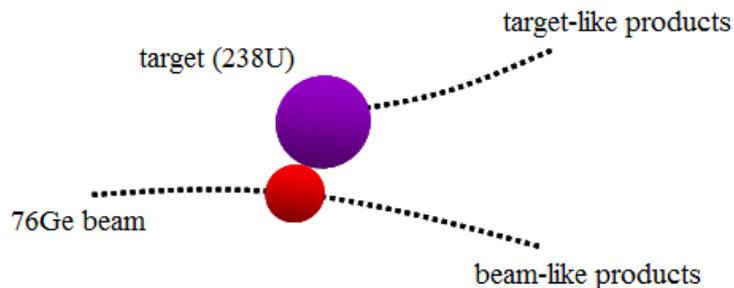
**B(E2) values are essential in order to characterize the levels.**

**Single-particle excitations across the Z=28 shell gap will provide the information on the Z=28 shell gap size and therefore, its evolution.**

# Physics Motivation



## Multi nucleon transfer reaction



Channels of interest:

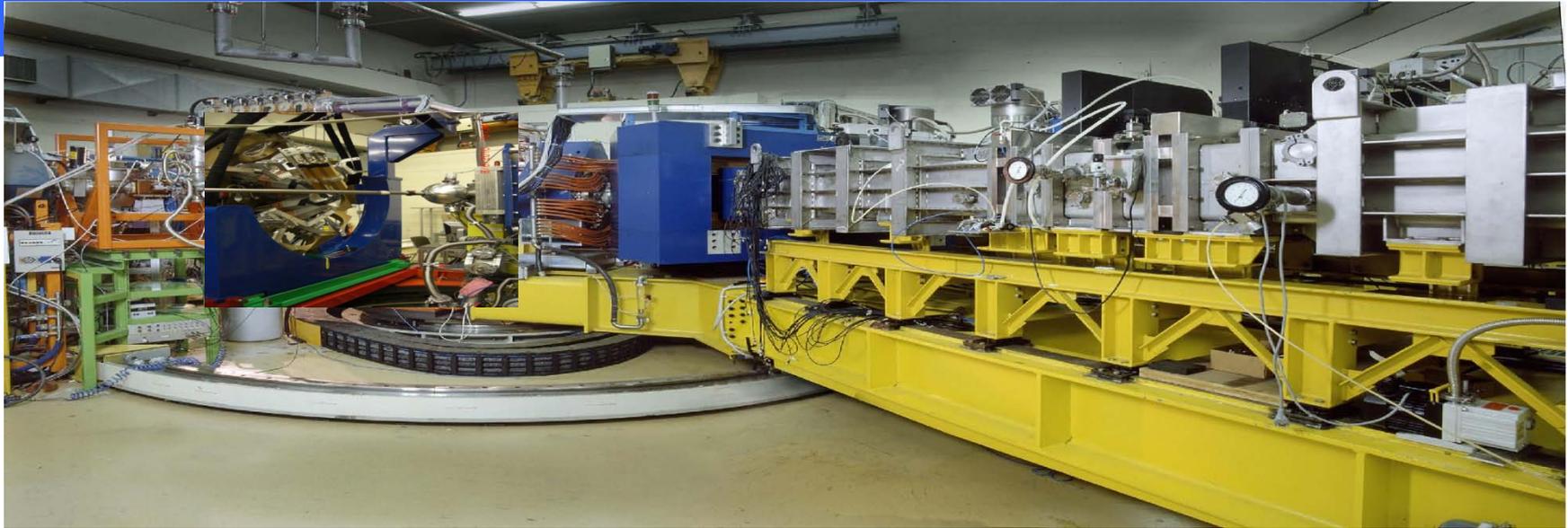
<sup>76</sup>Zn: (-2p, 2n) <sup>74</sup>Zn: (-2p) <sup>72</sup>Zn: (-2p,-2n)

(C. Louchart talk)

<sup>71</sup>Cu: (-3p, -2n)

<sup>73</sup>Cu: (-3p)

# Experimental setup

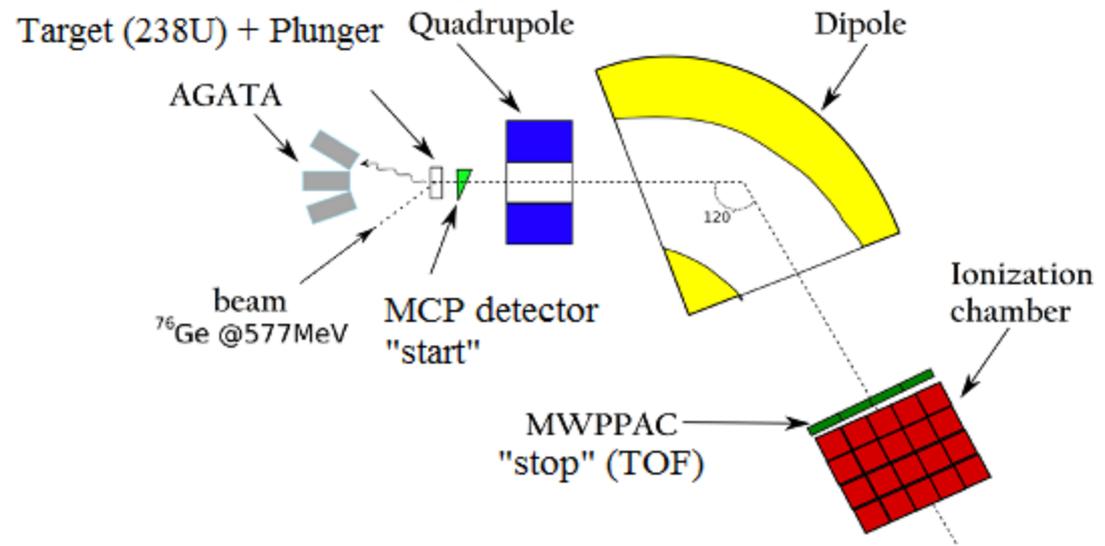


## Agata-D coupled to PRISMA (at 55°) + Köln Plunger

Performed in middle June 2010

Multi-nucleon transfer reactions

$^{76}\text{Ge} + ^{238}\text{U}$  @  $E(^{76}\text{Ge})=575$  MeV



# Experimental setup

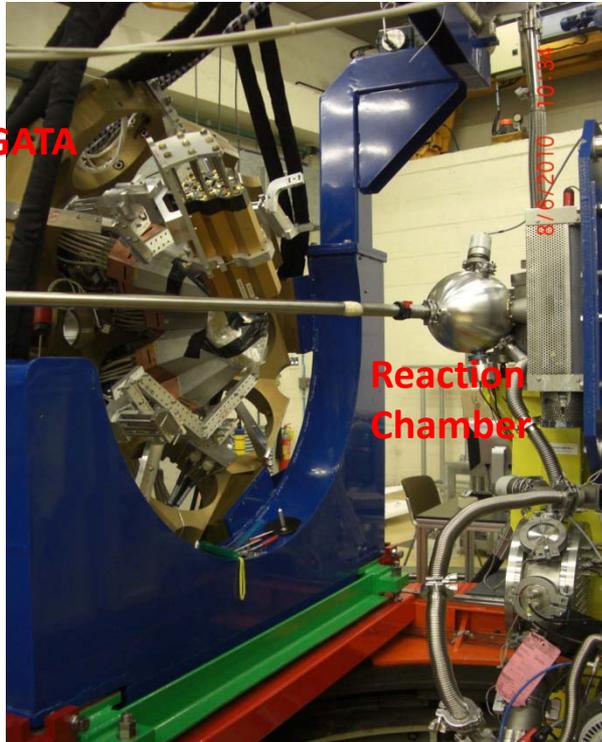
## PLUNGER

beam  
→



U- target

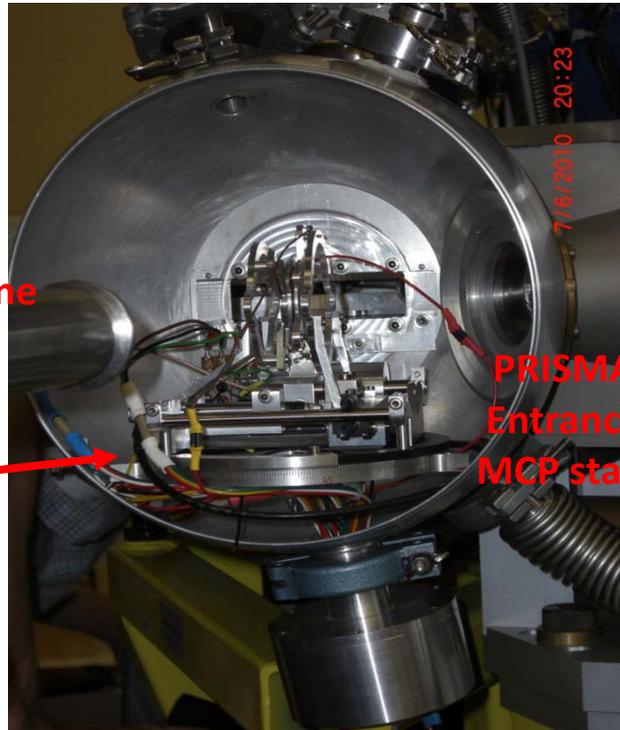
Nb-degrader



AGATA

Beam line  
→

Reaction Chamber



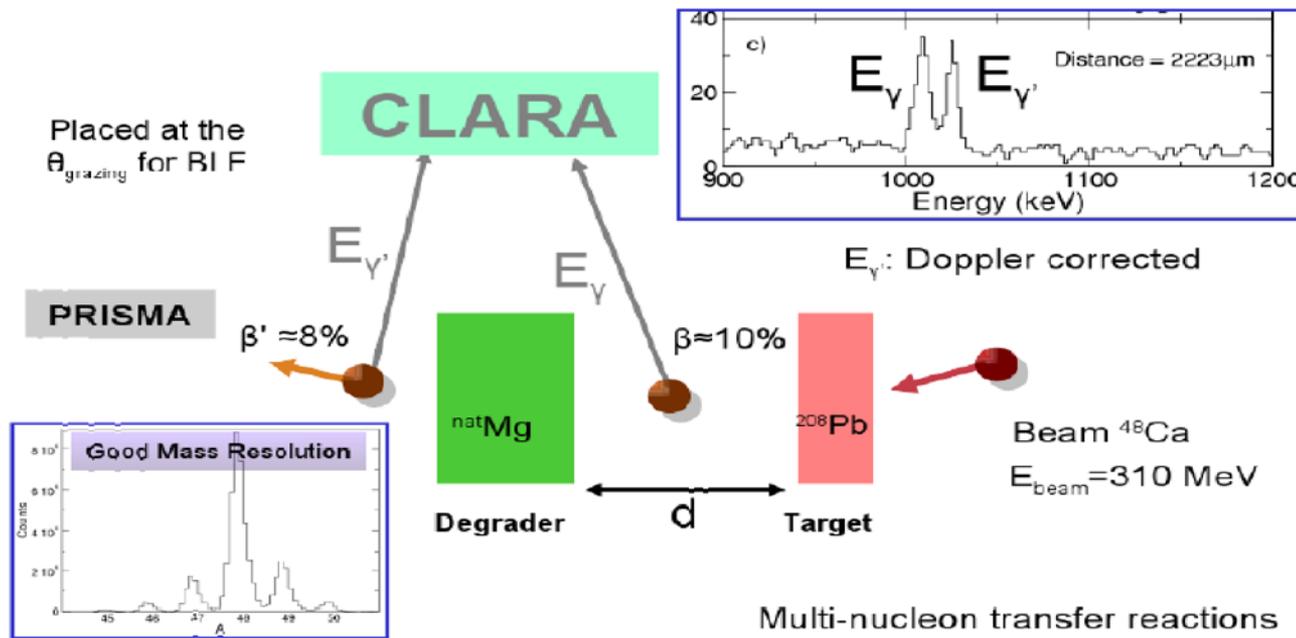
Beam line  
→

PRISMA  
Entrance  
MCP start

# RDDS method

## *Recoil Distance Doppler shift Method (RDDS)*

A novel technique that combines the RDDS method with CLARA-PRISMA has been successfully performed using deep-inelastic reactions



# Real experimental conditions

Proposed exp : 14 days    2 days per distance    5 ATCs  
Given exp. : 10 days    1.5 days per distance    4 ATCs  
Real exp. : 5 days    1 day per distance    4 ATCs  
(F. Haas talk)

Run#	Total Time(day)	Size (GB)	Distance ( $\mu\text{m}$ )
95-98	1	11	200
100-101	1	14	1000
103-105	1	14	500
107-110	1	15	100
111-112	1	11	1900

Beam Intensity: ~ 2pnA

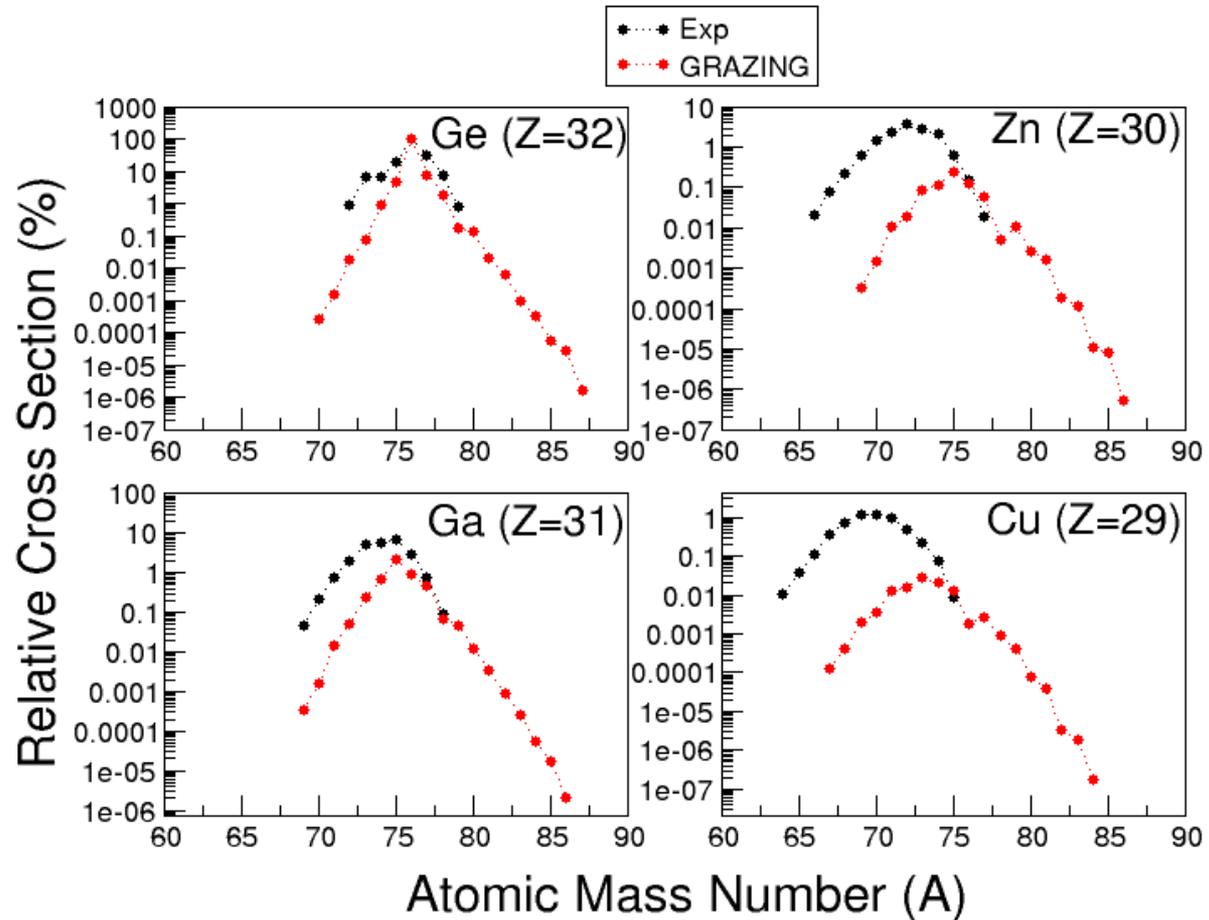
Counting Rates:

Single Crystal: ~ 40 kHz

PRISMA ~ 2 kHz

# Real experimental conditions

## Measured and theoretical cross sections



*(Theoretical cross sections calculated by Suzana Szilner)*

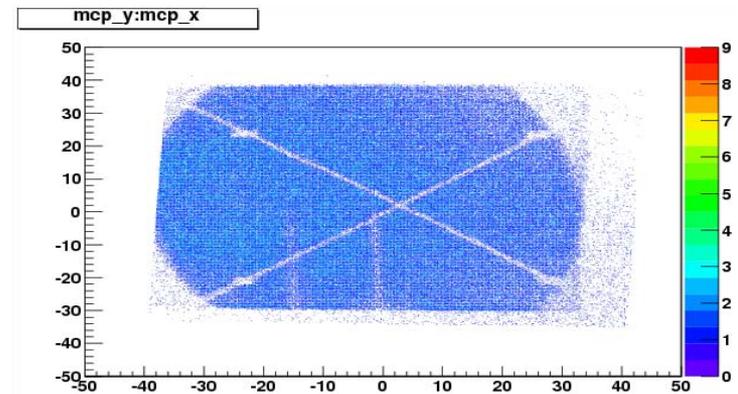
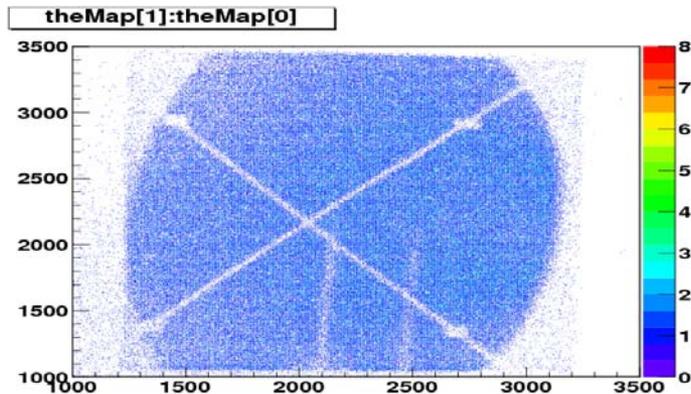
# Data Analysis (1)

## ***MCP detector:***

Exact ion positions in X (theta) and Y (phi) directions (trajectory reconstruction)

Angle between the ion and its emitted gamma ray (Doppler correction)

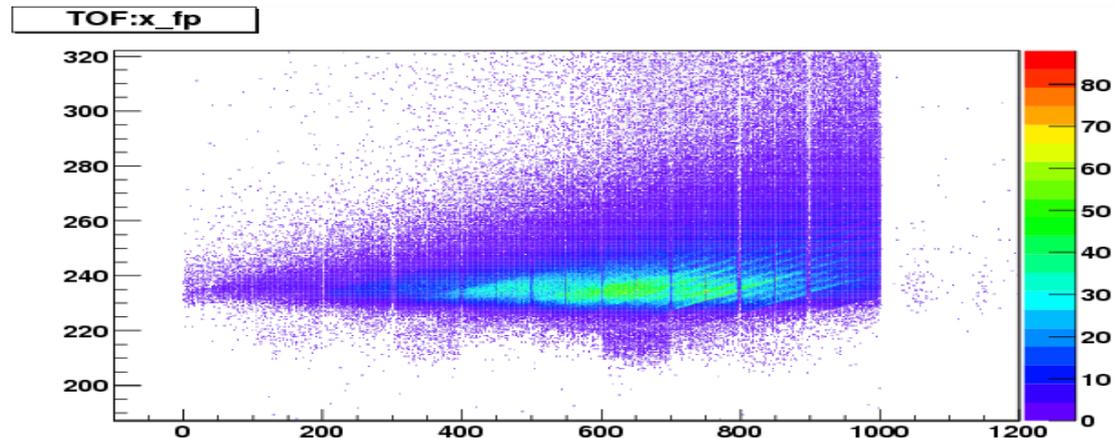
Time signal as START for TOF measurement (velocity determination Dopp. correction)



**Calibration of the PPAC and Ionization Chamber detectors are done before the experiment.**

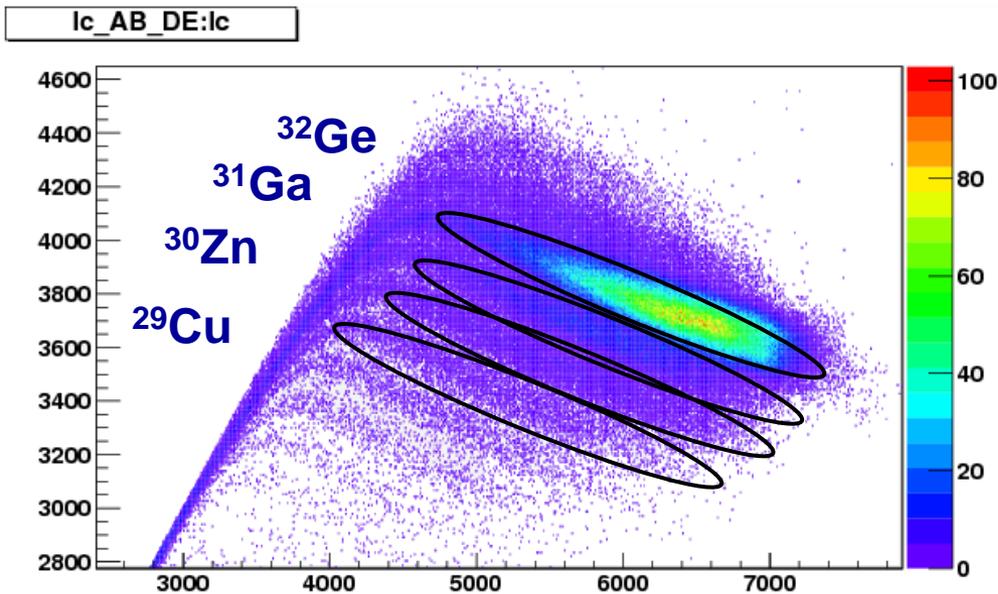


**TOF: Ion flight-time between MCP (START) and PPAC (STOP) detectors**

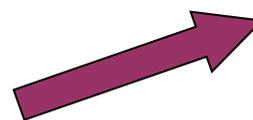
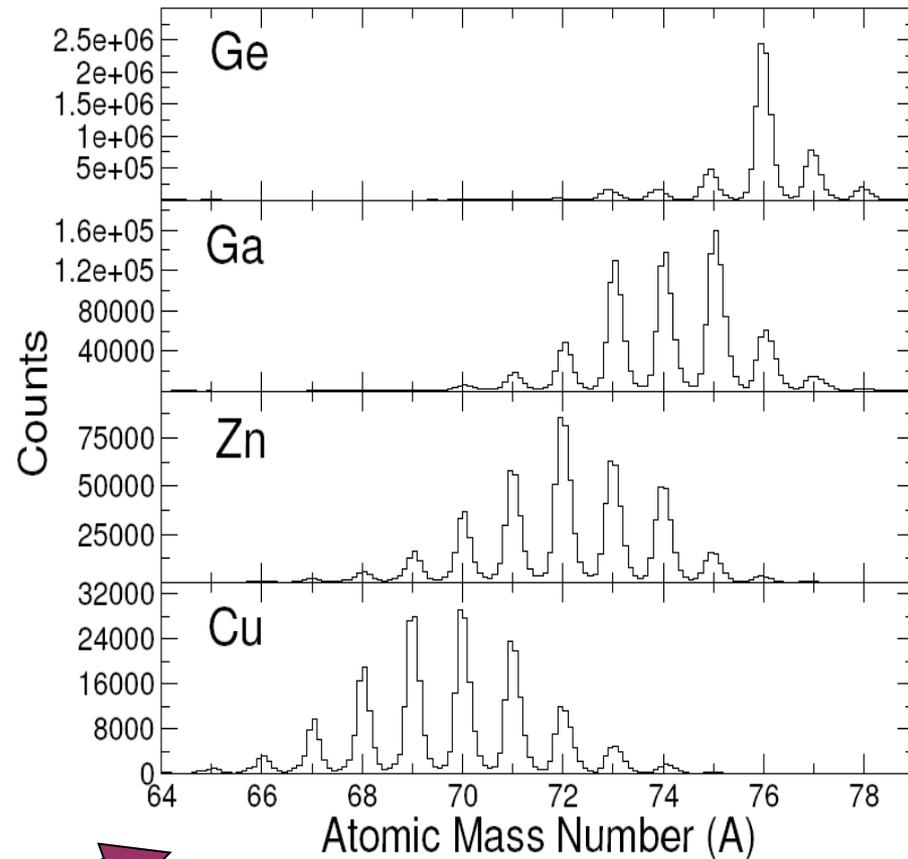


# Data Analysis (2)

## Z identification



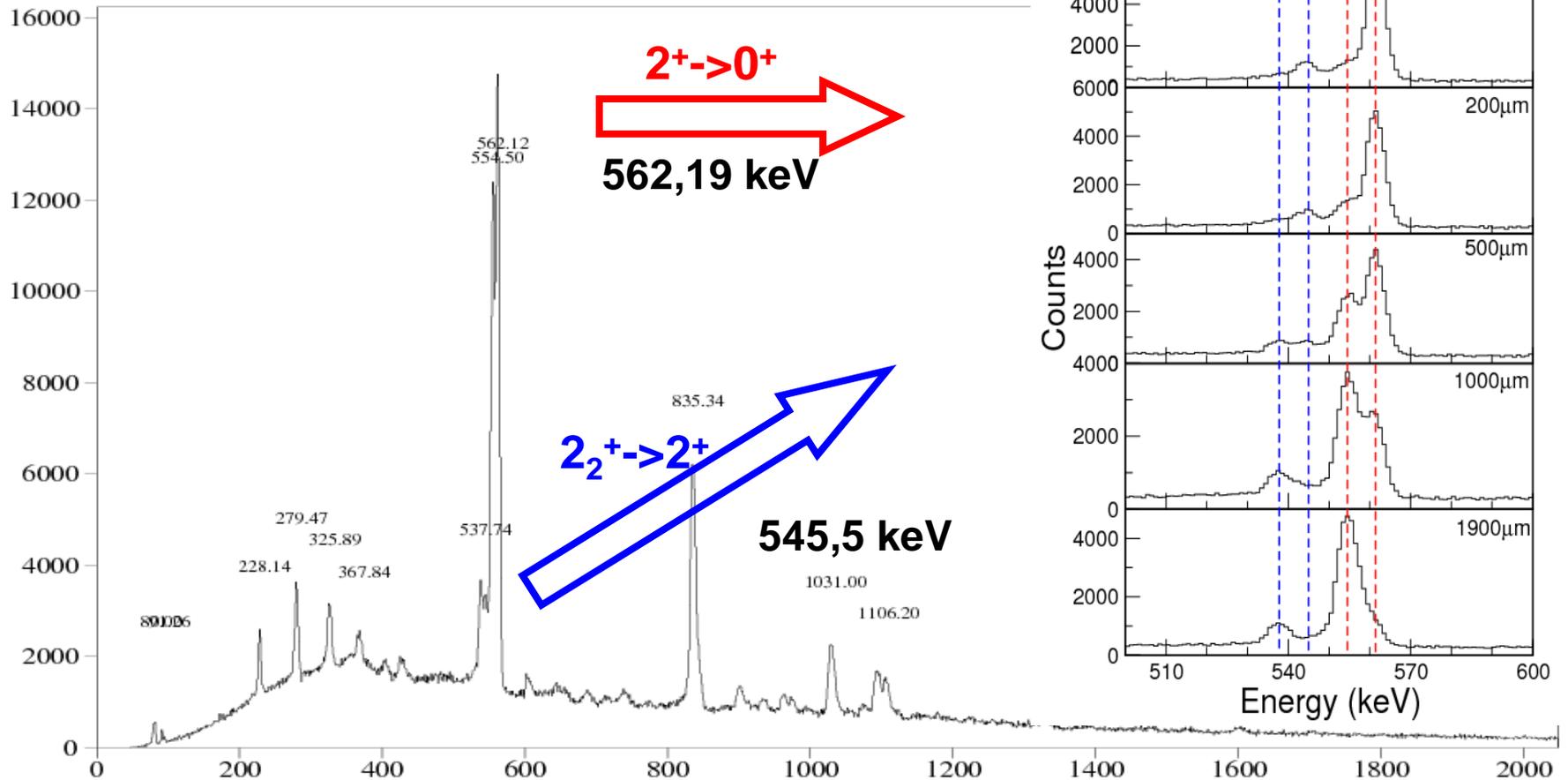
**Charge state determination  
and selection**



**Mass separation  
(all distances together)**

# Experimental results: the beam: $^{76}\text{Ge}$

*After background subtraction*



$2^+ \rightarrow 0^+$

$\zeta = (18.2 \pm 0.2) \text{ ps}$

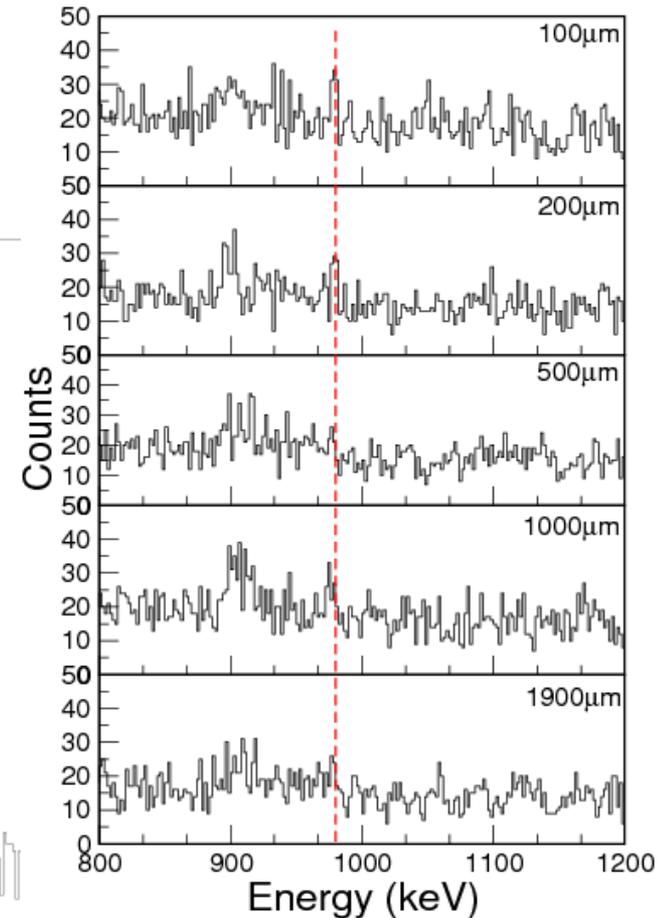
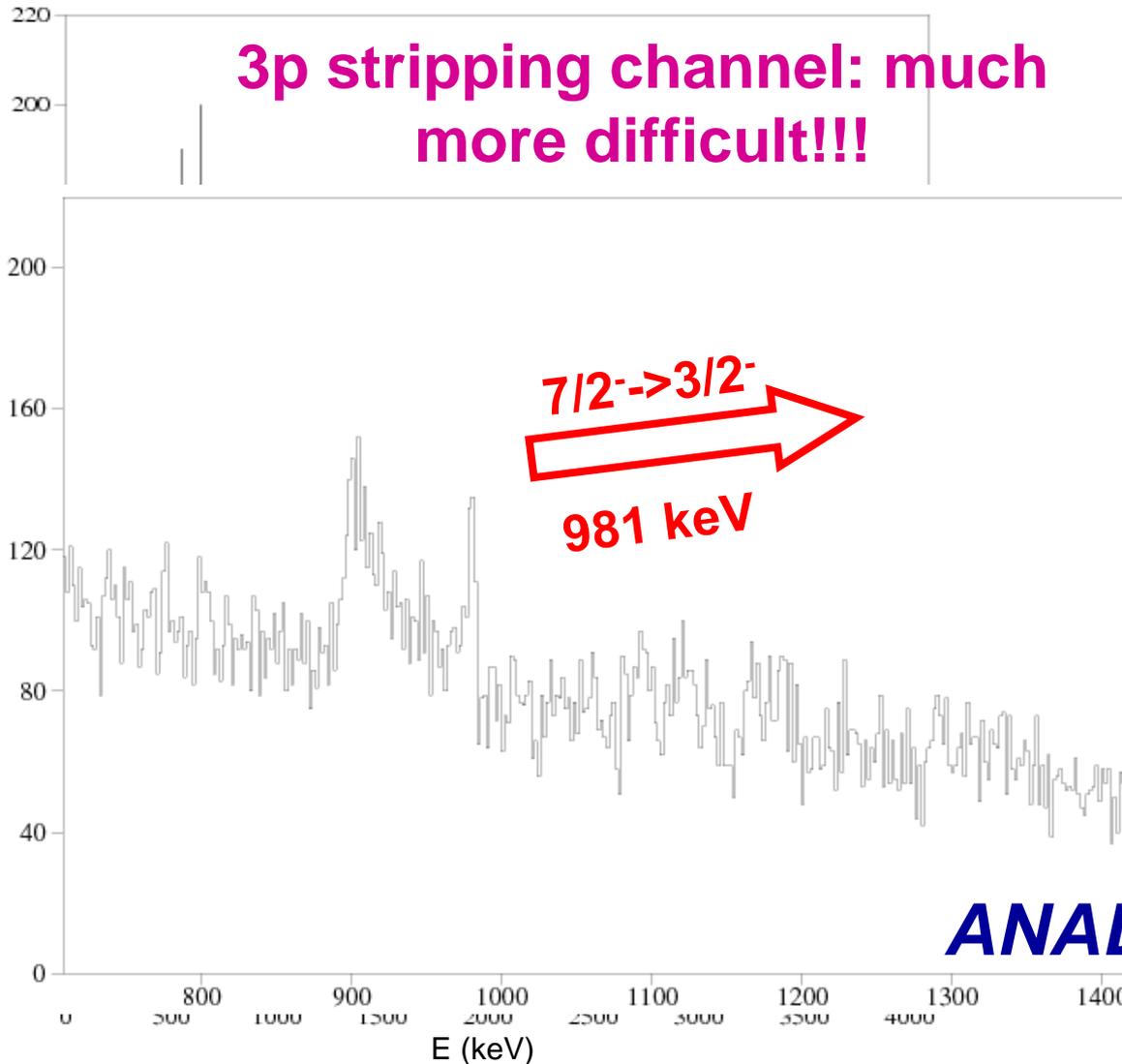
$\zeta = (17.88 \pm 0.03) \text{ ps}$

$2_2^+ \rightarrow 0^+$

$\zeta = (8.0 \pm 1.5) \text{ ps}$

$\zeta = (8.7 \pm 0.2) \text{ ps}$

# Experimental results: $^{71}\text{Cu}$



***ANALYSIS ON GOING...***