Coulomb excitation of the presumably super-deformed band in ^{42}Ca

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HIL ŚLCJ

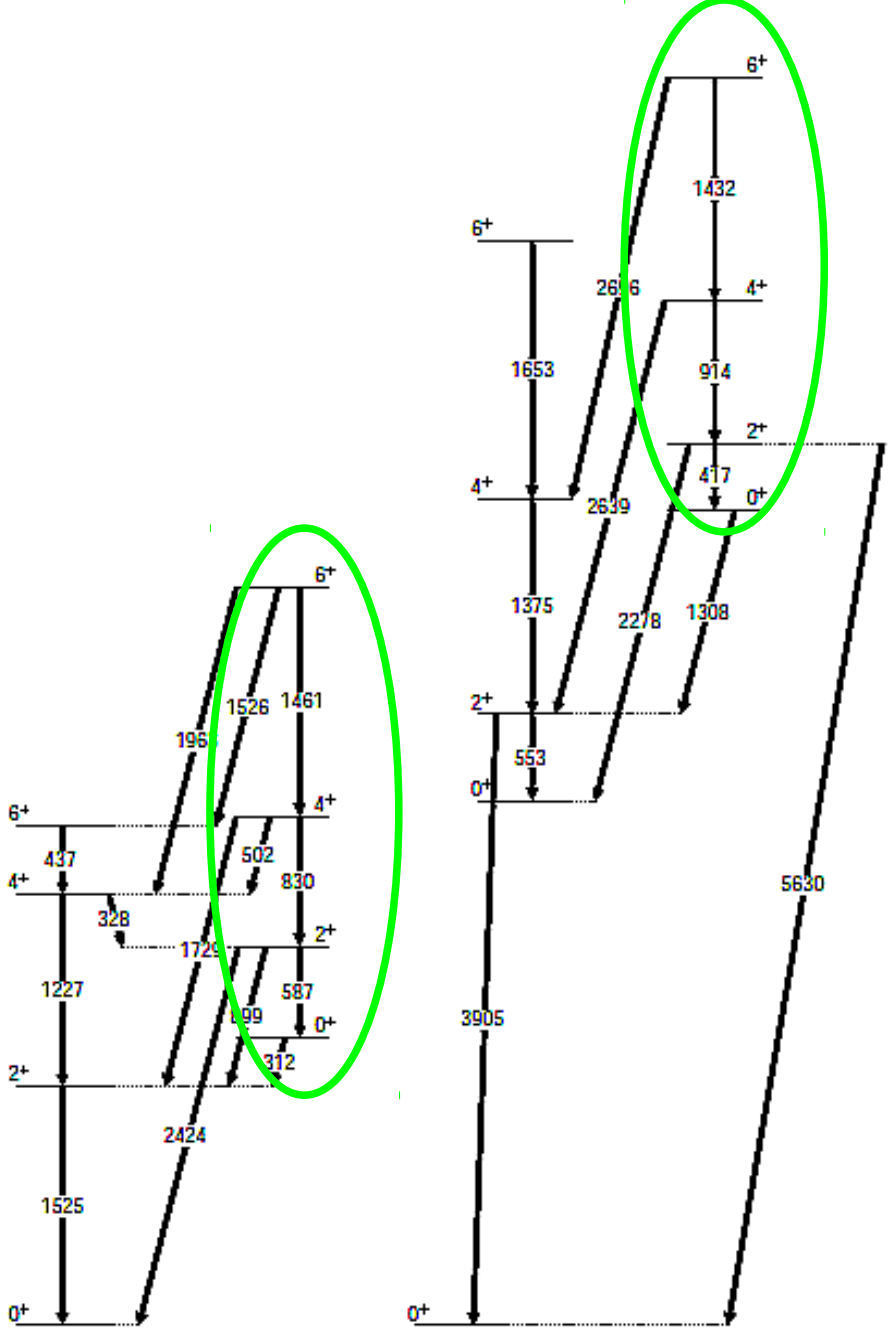
EAGLE

EGAN Workshop 2012

EGAN
European Gamma and Ancillary detectors Network

AGATA
ADVANCED GAMMA TRACKING ARRAY

^{42}Ca vs ^{40}Ca



^{42}Ca ^{40}Ca

Highly colective structure found in ^{40}Ca

B(E2; $4^+ \rightarrow 2^+$ in SD) = 170 W.u (DSAM)

Deformation of the 2^+ state in the superdeformed band: β_2=0.59(9)

Super-deformation in this mass region:

^{36}Ar : C.E. Svensson et al., PRL 85 (2000) 2693

^{38}Ar : D. Rudolph et al., PRC 65 (2002) 034305

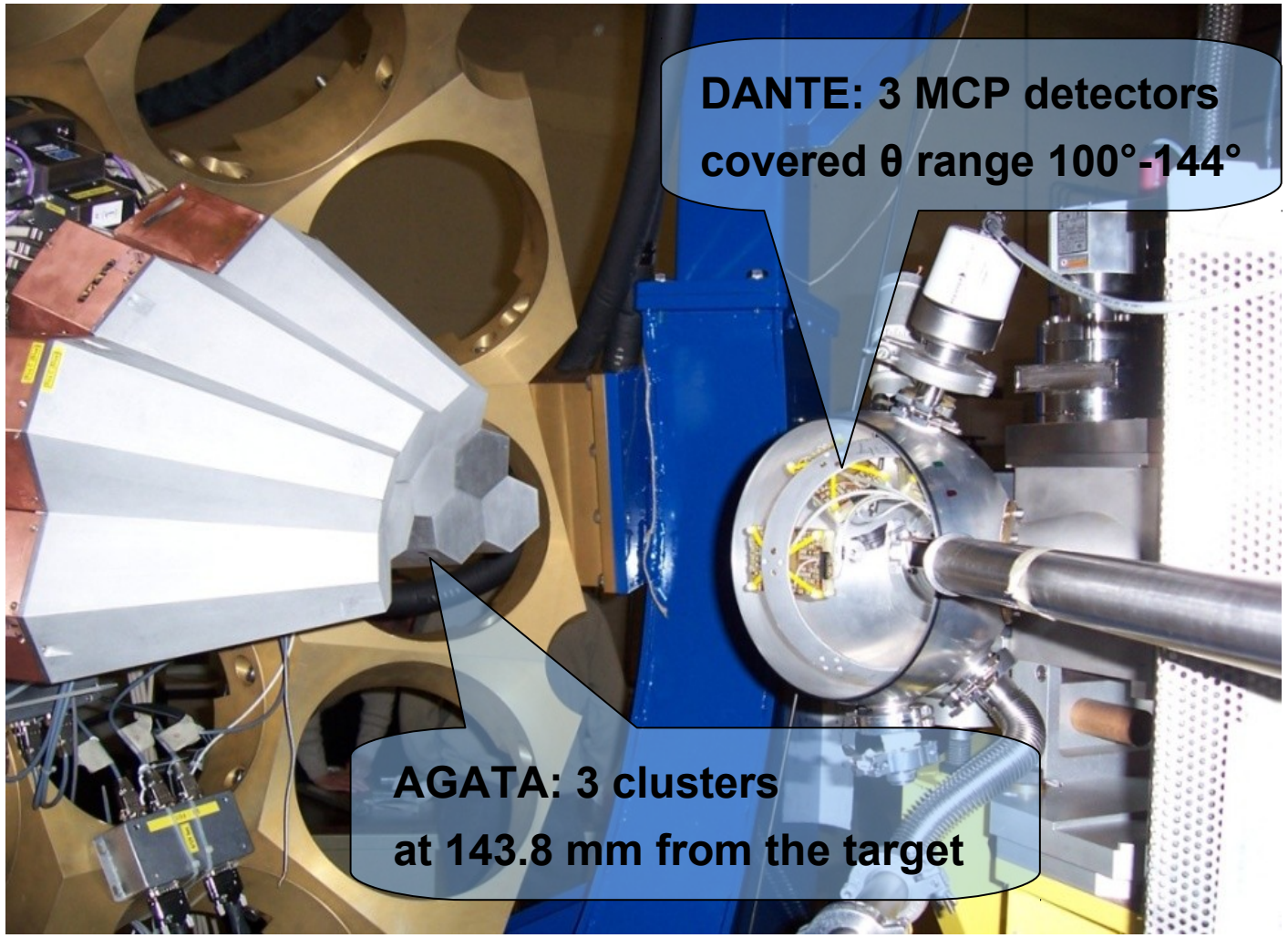
^{40}Ar : E. Ideguchi et al., PLB 686 (2010) 18

^{40}Ca: E. Ideguchi et al., PRL 87 (2001) 222501 and C.J.Chiara et al., PRC 67 (2003) 041303(R)

^{42}Ca: M. Lach et al., EPJA 16 (2003) 309

^{44}Ti : D.C. O'Leary et al., PRC 61 (2000) 064314

^{42}Ca Coulomb excitation experiment at LNL



beam-time: Feb.2010

beam: ^{42}Ca, 170 MeV

target 1: ^{208}Pb, 1 mg/cm2

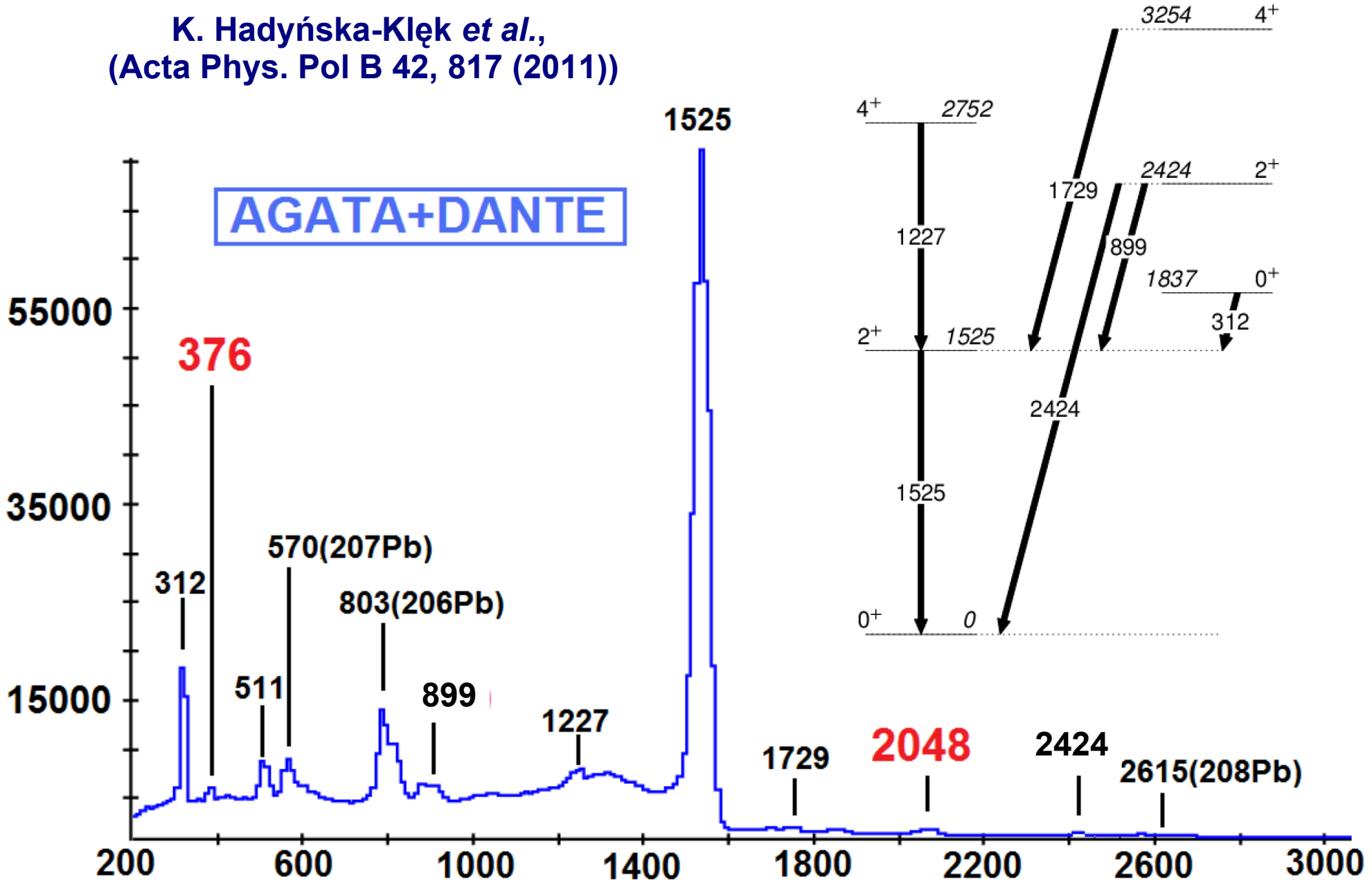
target 2: ^{197}Au, 1 mg/cm2

particle-γ coincidence

AGATA+DANTE

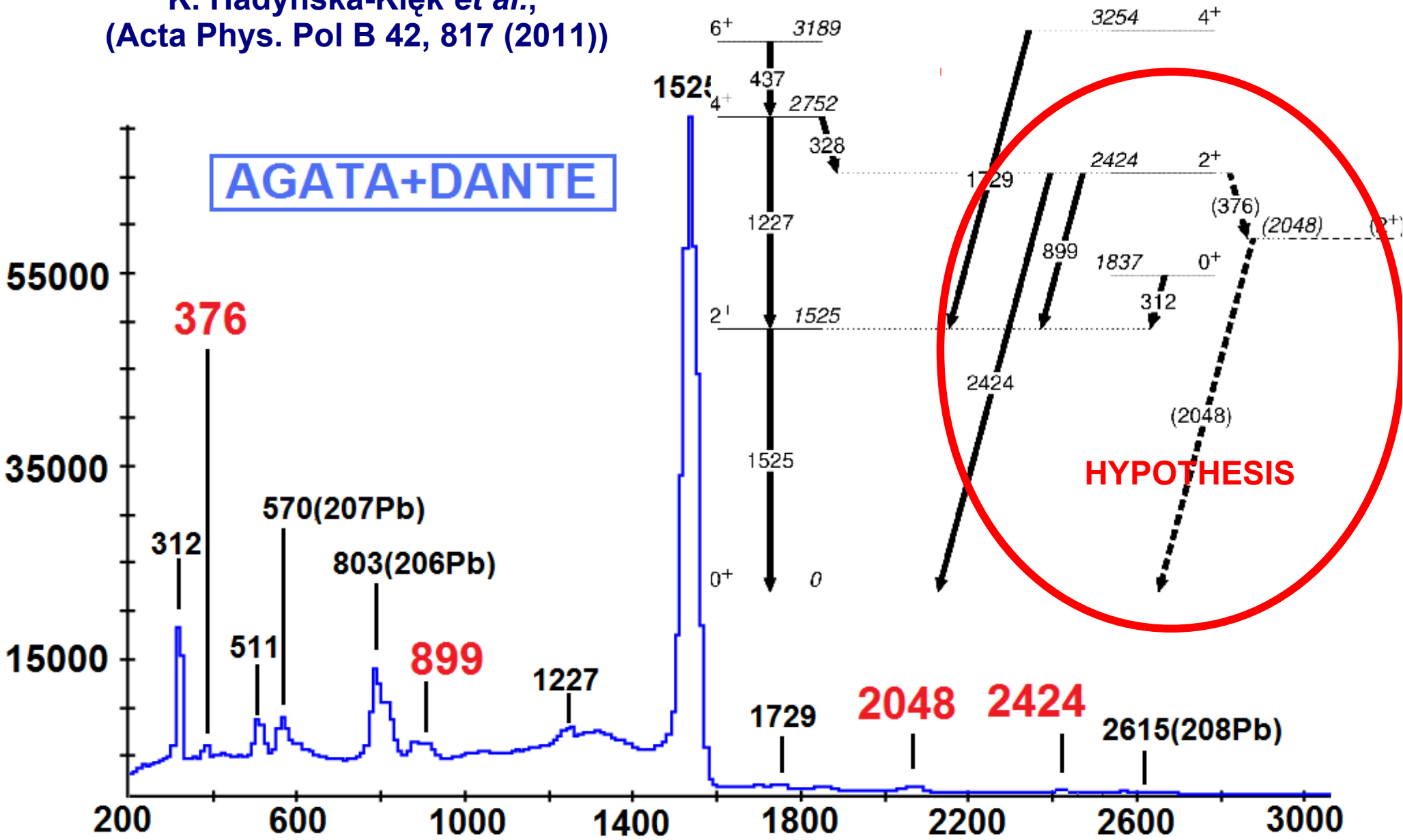
spectrum – $^{42}Ca+^{208}Pb$ unknown lines

K. Hadyńska-Klęk *et al.*,
(Acta Phys. Pol B 42, 817 (2011))



γ spectrum – ^{42}Ca+^{208}Pb unknown lines & postulated interpretation

K. Hadyńska-Klęk *et al.*,
(Acta Phys. Pol B 42, 817 (2011))

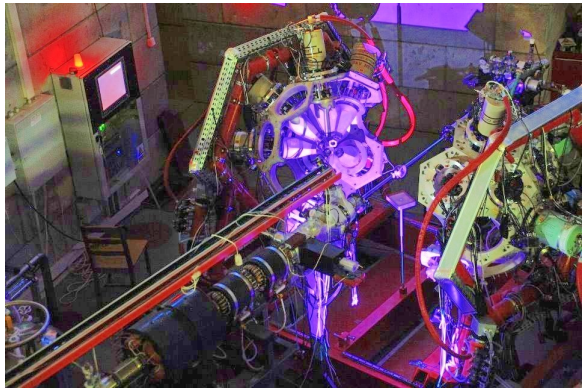


Fusion-evaporation experiment
Heavy Ion Laboratory, Warsaw (Oct.2011)

Reaction: $^{12}C(^{32}S,2p)^{42}Ca$, 76 MeV

EAGLE array: 16 HPGe in ACS

beam-time: 4 days

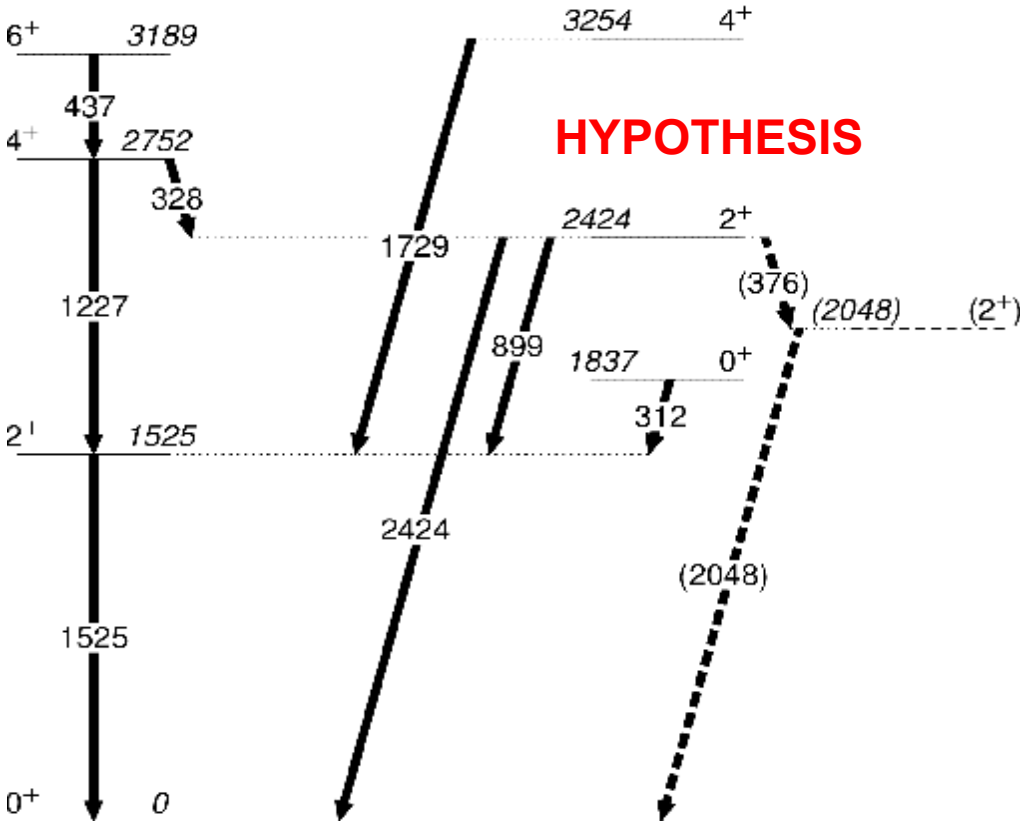


The aim of the additional experiment:

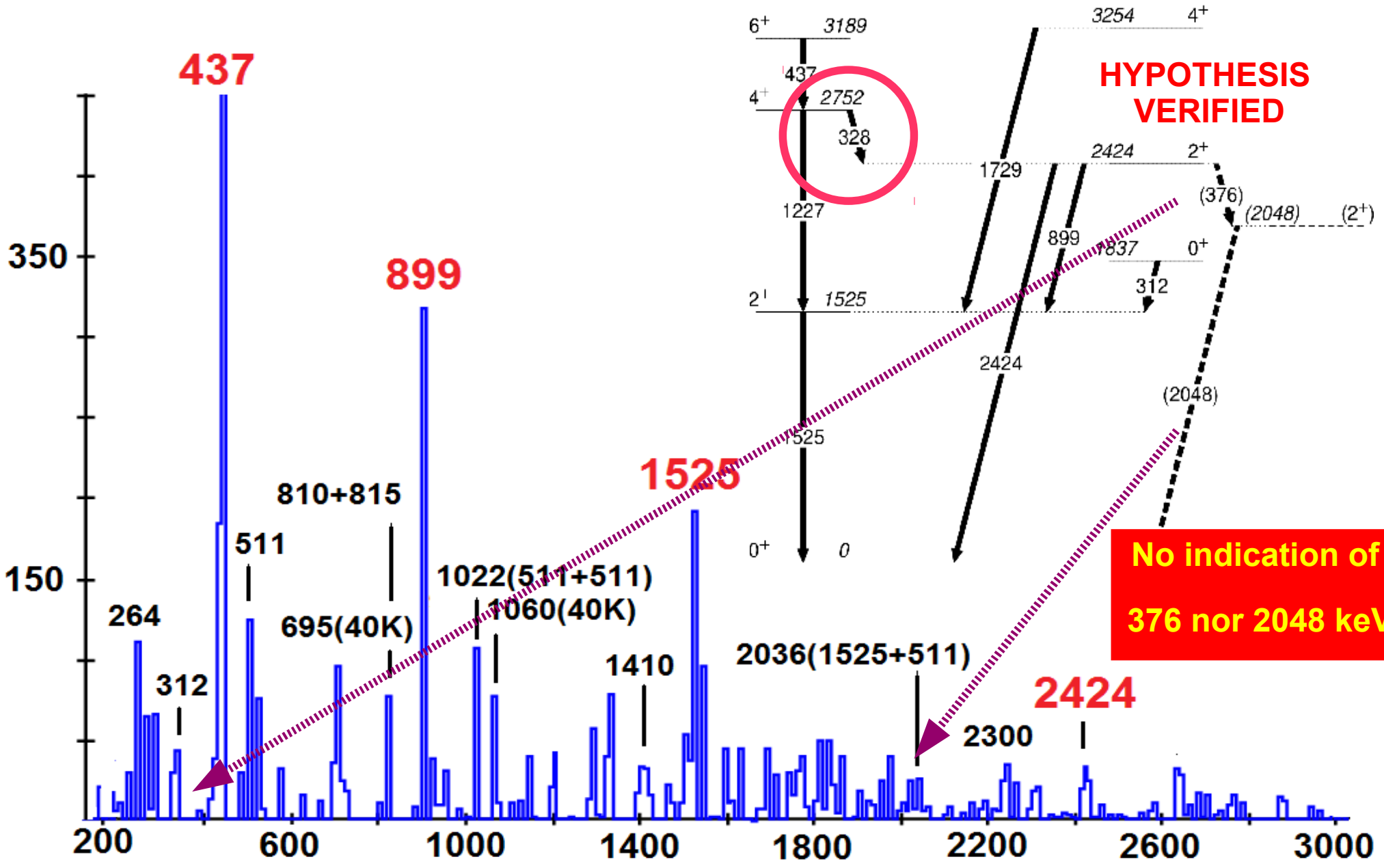
investigation of the medium and low spin region in ^{42}Ca

The most important issues:

- possible new level at 2048 keV
- branching ratio determination of the decay γ-lines from 2424 keV level

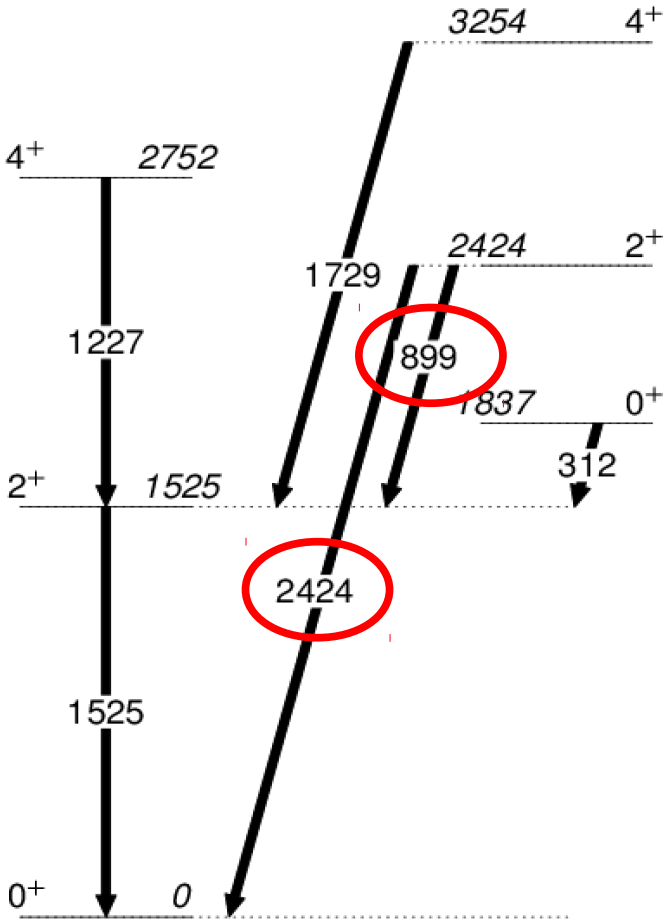


Fusion-evaporation experiment @ HIL Warsaw (Oct.2011) - results

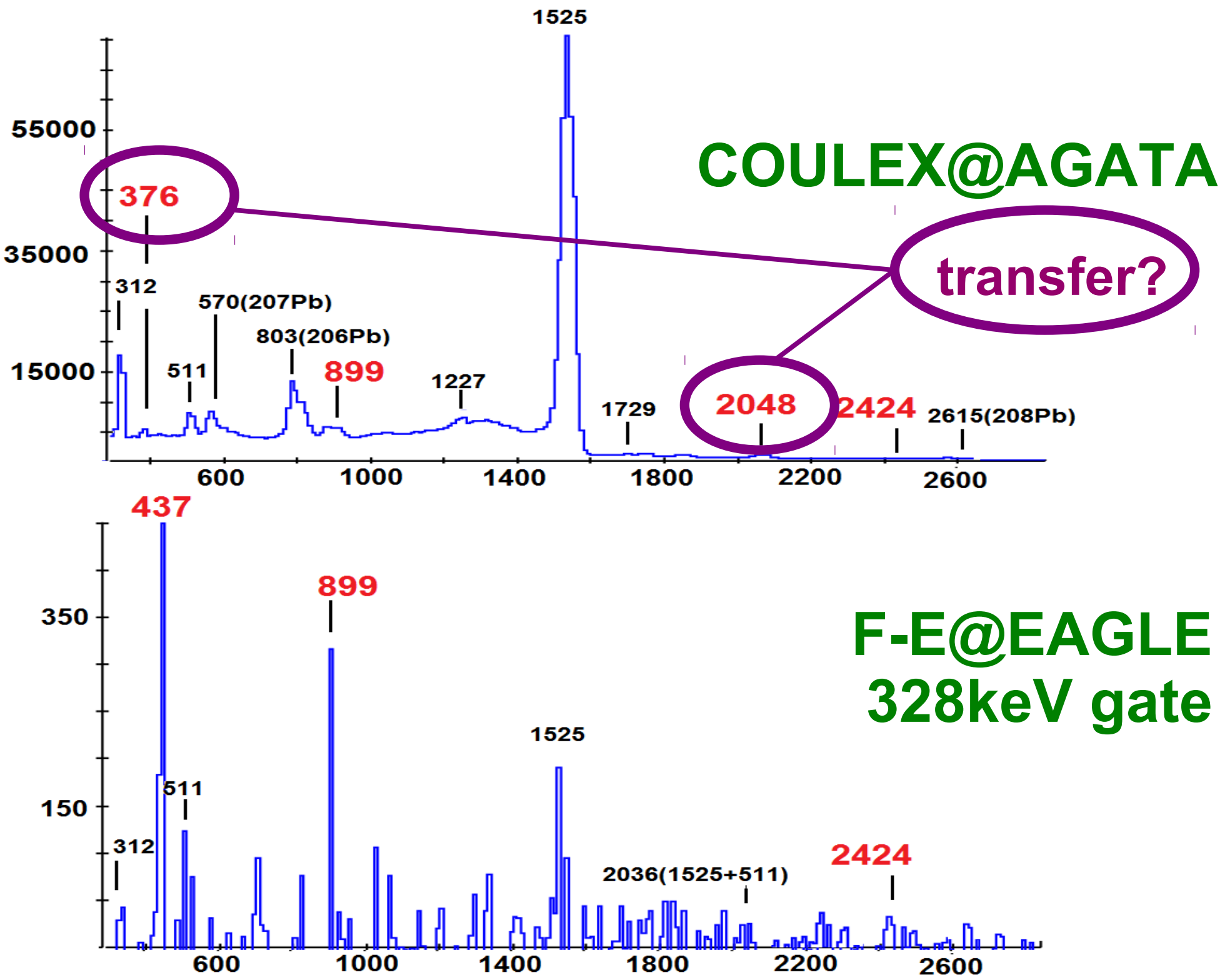


Fusion-evaporation experiment @ HIL Warsaw (Oct.2011) – results <u>branching ratio</u>

Branching Ratio (2424keV/899keV)	REFERENCE
0.443 (0.021)	Kossler (1969)
0.333 (0.048)	Kern (1980)
0.351 (0.065)	**This work**



Obtained value will be applied to the COULEX analysis as an additional spectroscopic data

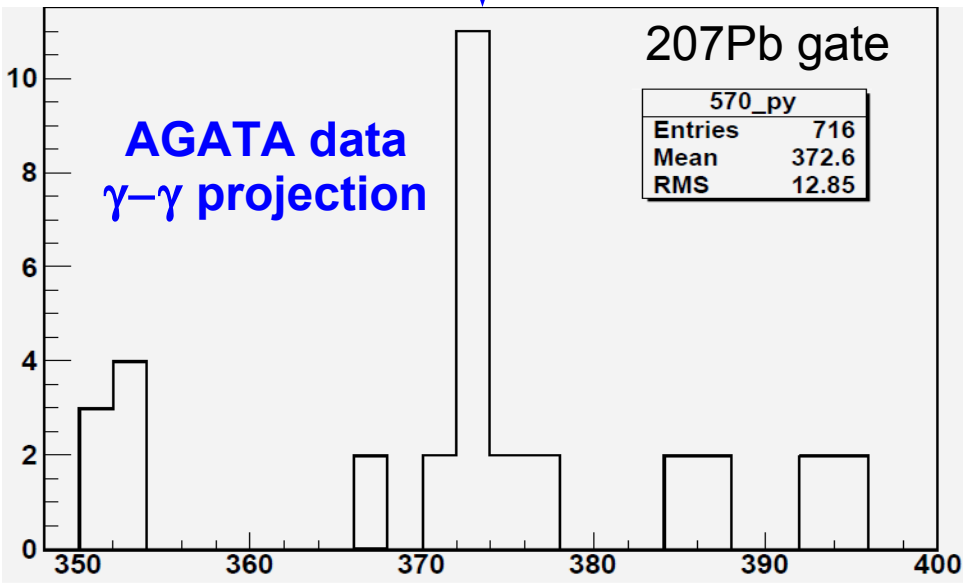

COULEX@AGATA
transfer?
1525
55000
35000
15000
376
312
570(207Pb)
803(206Pb)
511
899
1227
1729
2048
2424
2615(208Pb)
600
1000
1400
1800
2200
2600
F-E@EAGLE
328keV gate
437
899
350
150
1525
511
312
2036(1525+511)
2424
600
1000
1400
1800
2200
2600

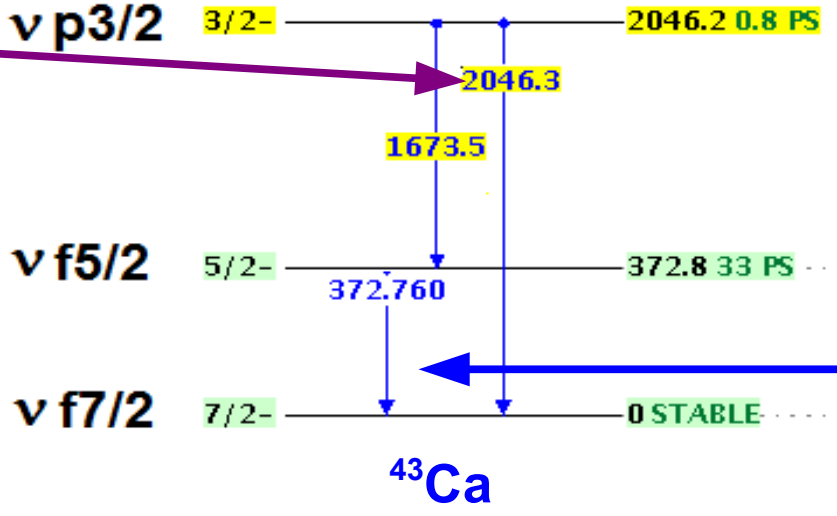
Sub-barrier transfer reaction?

^{208}Pb(^{42}Ca,^{43}Ca)^{207}Pb @ 170MeV

(85% of the Coulomb barrier)

Level	dσ/dω (mb/sr) (max)
0	2.85
373	0.06
593	1.36
990	0.29
1393	0.03
1676	0.03
1899	0.05
1928	0.02
1954	2.79
2041	28.2
2096	0.04
2219	0.02
2246	0.06
2269	0.06





Brown et.al., Nucl. Phys. A225 (1974) 267-299
(^{42}Ca(d,p)^{43}Ca reaction investigated)

Sub-barrier transfer reaction?
^{208}Pb(^{42}Ca,^{43}Ca)^{207}Pb @ 170MeV
(85% of the Coulomb barrier) - calculations

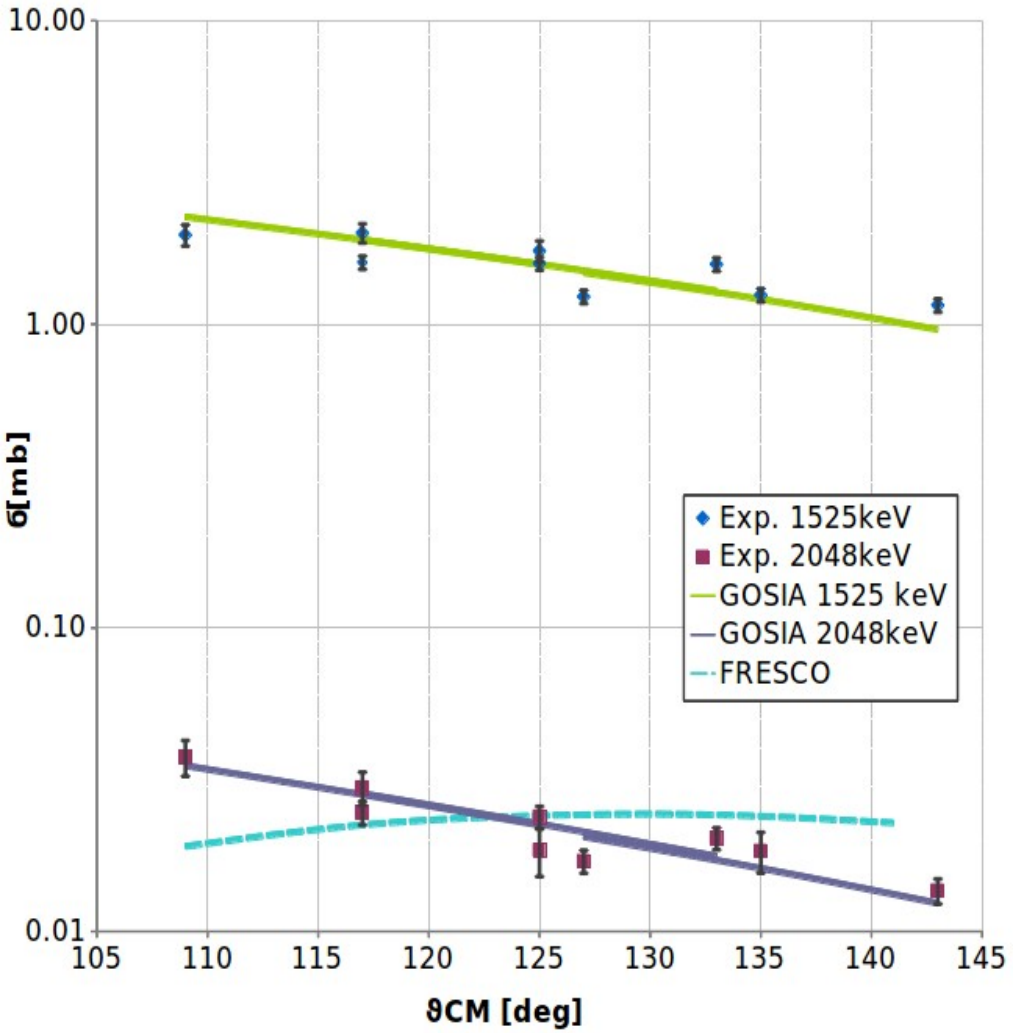
- angular range of the DANTE detectors was divided into 9 bins

- angular distributions of the yields for the 1525 keV and 2048 keV transitions compared with the results of calculations performed by using the **GOSIA** (COULEX formalism) and **FRESCO** transfer code (thanks to K. Rusek)

- ratio of 2048 and 376 keV ~ 30%
like the ratio of 2046 and 373 keV transitions in ^{43}Ca

- 1-neutron transfer hypothesis seems possible

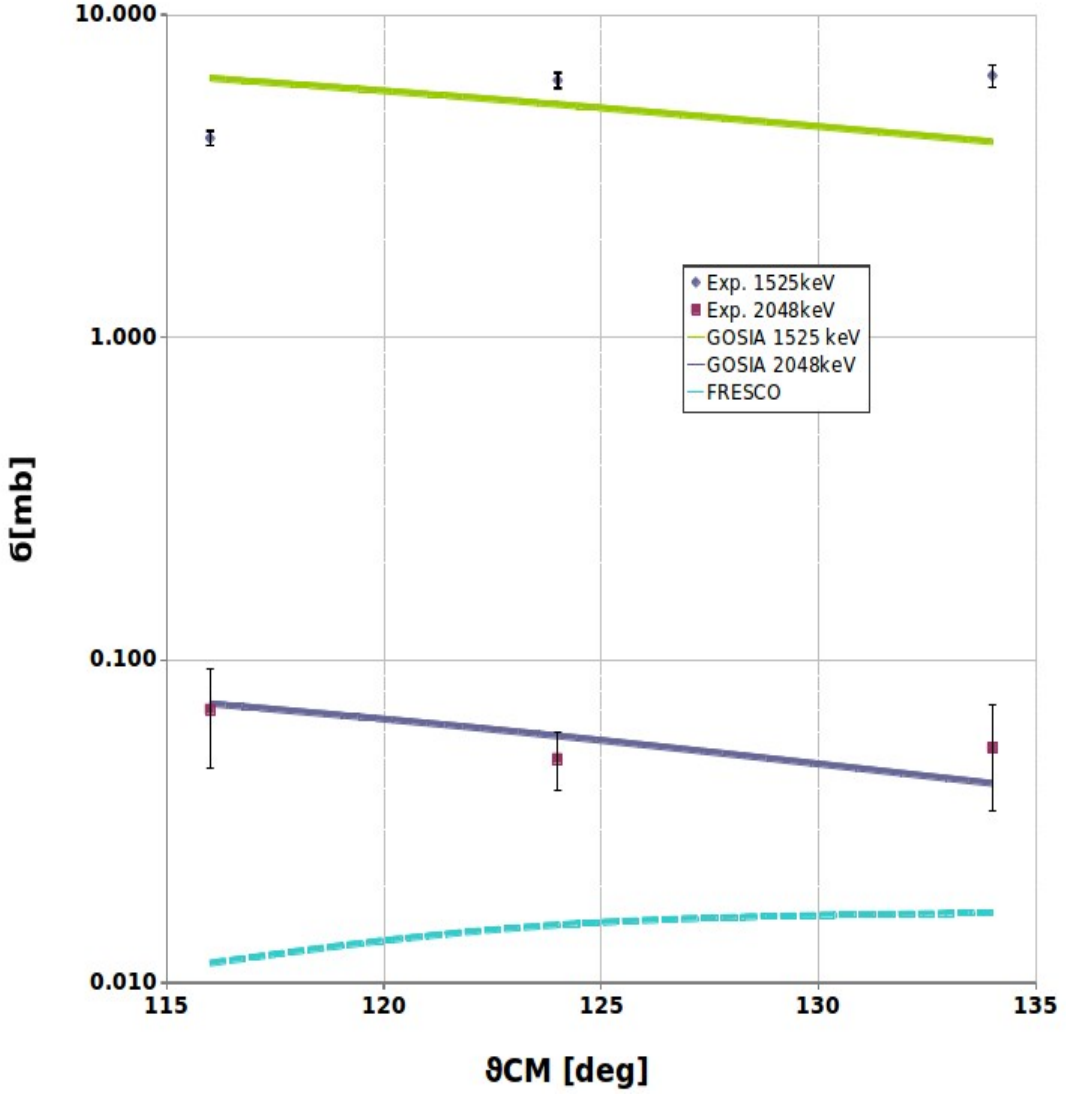
...BUT...



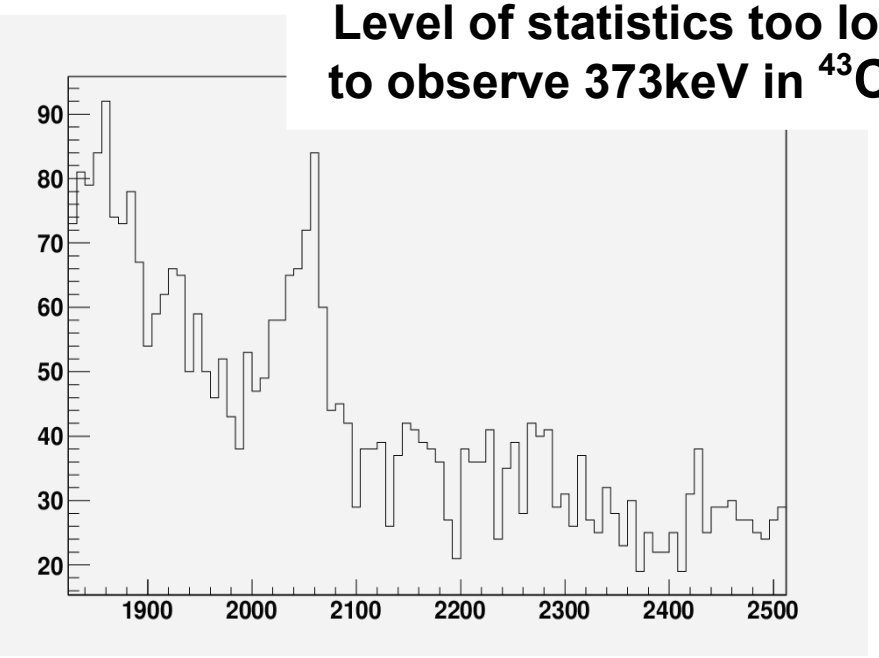
Sub-barrier transfer reaction?

^{197}Au(^{42}Ca,^{43}Ca)^{196}Au @ 170MeV

(87% of the Coulomb barrier)



Level of statistics too low to observe 373keV in ^{43}Ca



The same procedure was applied...

… but there is one order of magnitude difference between experimental 2048 keV yields and the cross section calculated by using the FRESCO code

Conclusions

-Coulomb excitation of ^{42}Ca performed at LNL using the AGATA demonstrator coupled to DANTE array

-low-lying levels in ^{42}Ca were successfully populated via multi-step COULEX up to 4^+ states

-376 and 2048 keV γ-lines of unknown origin were observed – possible new level?

-additional fusion-evaporation reaction of ^{12}C(^{32}S,2p)^{42}Ca was performed with EAGLE array at HIL Warsaw

-no coincidence between 376 and 2048 keV and between those lines and other in ^{42}Ca was observed

-2424keV/899keV branching ratio determined

-possibility of the sub-barrier neutron transfer reactions is being studied using calculations performed by using the GOSIA and FRESCO codes for both ^{208}Pb and ^{197}Au targets

AGATA and EAGLE

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