Decay Spectroscopy of Neutron-Rich Nuclides Near A~110

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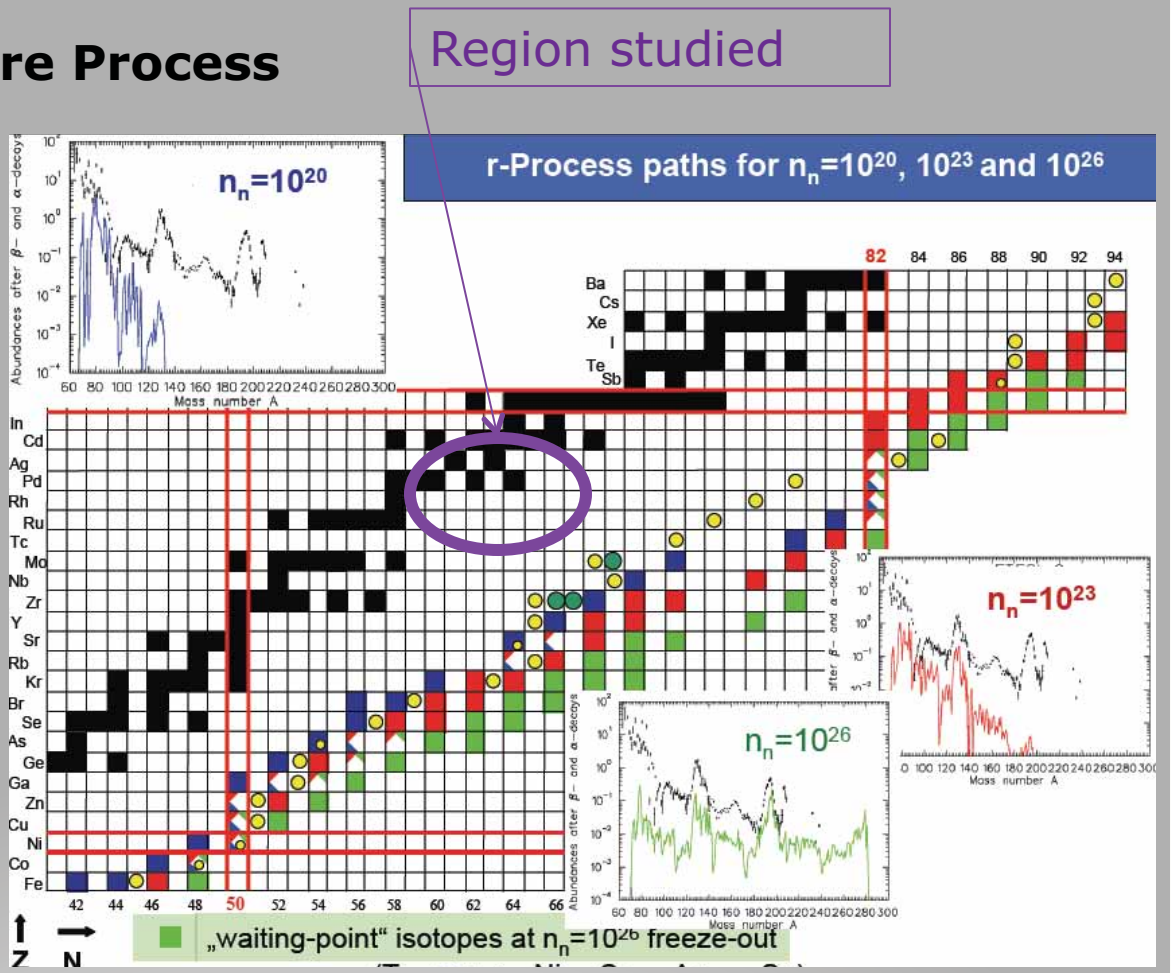
AFC Workshop
April 14-16, 2011
Argonne National Laboratory

Rapid Neutron Capture Process

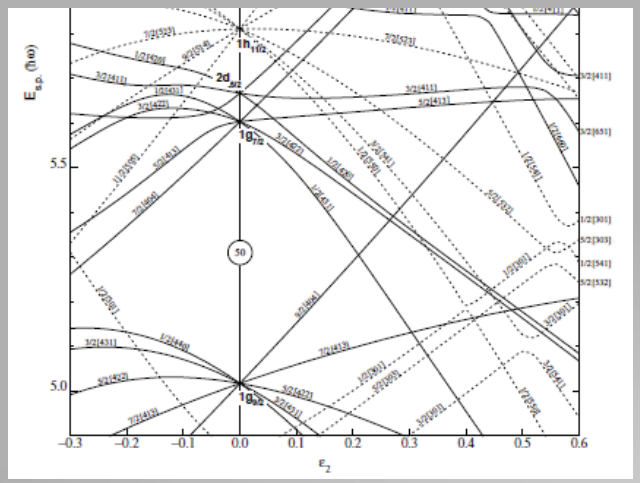
- responsible for ½ of heavy elements
- Nucleosynthesis path uncertain
- Not practical to measure all relevant nuclides and properties
- Must rely on nuclear structure data for extrapolation



Kratz, 2009 Eur. Nuc. Astro. Sum. Sch.

Motivation

- Rapid shape transitions
- Shape Isomerism
- Triaxiality
- Structure not well-understood



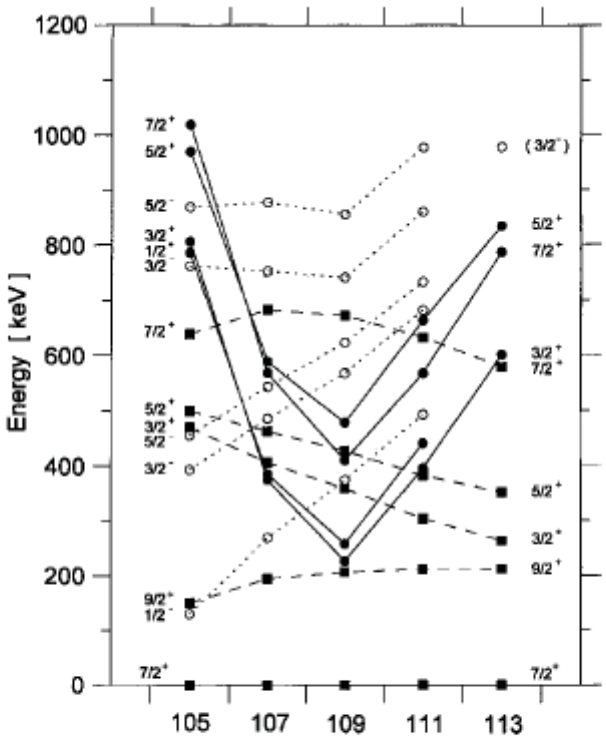
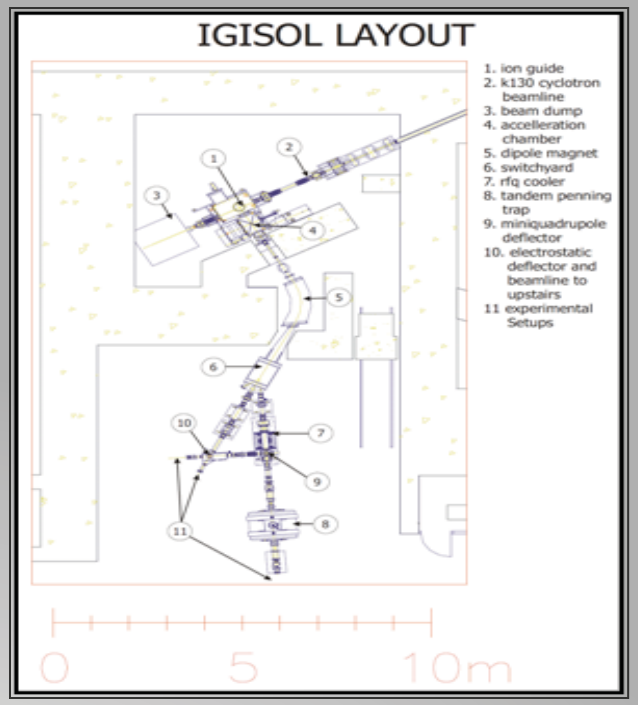


Fig. 4. Level systematics of odd-mass neutron-rich Rh isotopes. Spherical even (resp. odd) parity levels are connected by *dashed* (resp. *dotted*) *lines*. The intruder states are connected by *solid lines*. The extension towards ^{113}Rh is made on the basis of the level scheme in [9,10]

Lhersonneau et al. 1998

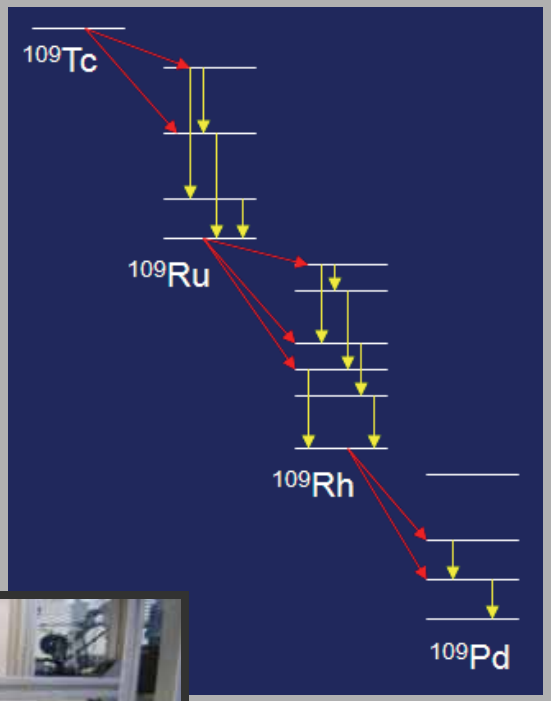
Why A~110 Region?

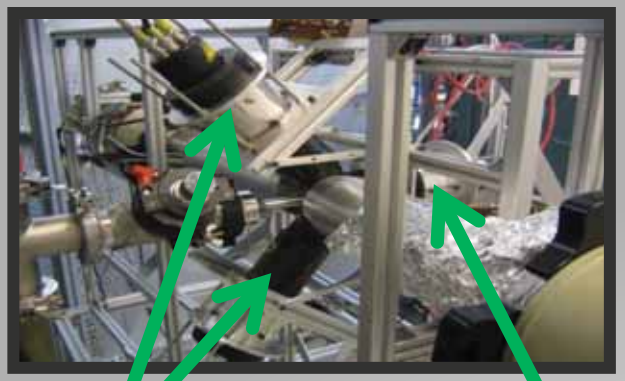
- Measure sub-nanosecond lifetimes of excited states
- Populated by β decay
- p-induced fission of ^{238}U, IGISOL Jyväskylä
- $\beta\gamma\gamma(t)$ fast timing method



Level Lifetimes

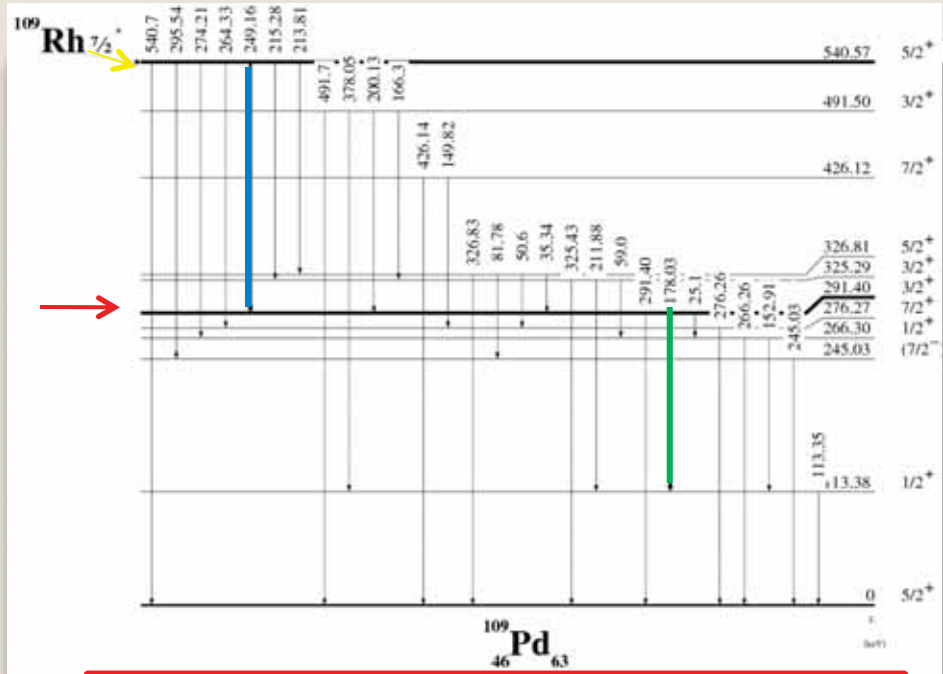
- Thin plastic β counter
- 2 $LaBr_3$(Ce) scintillators
  - Timing and energy resolution
  - 1″ & 1.5″ cylindrical
- 2 HPGe detectors
  - Superior energy resolution

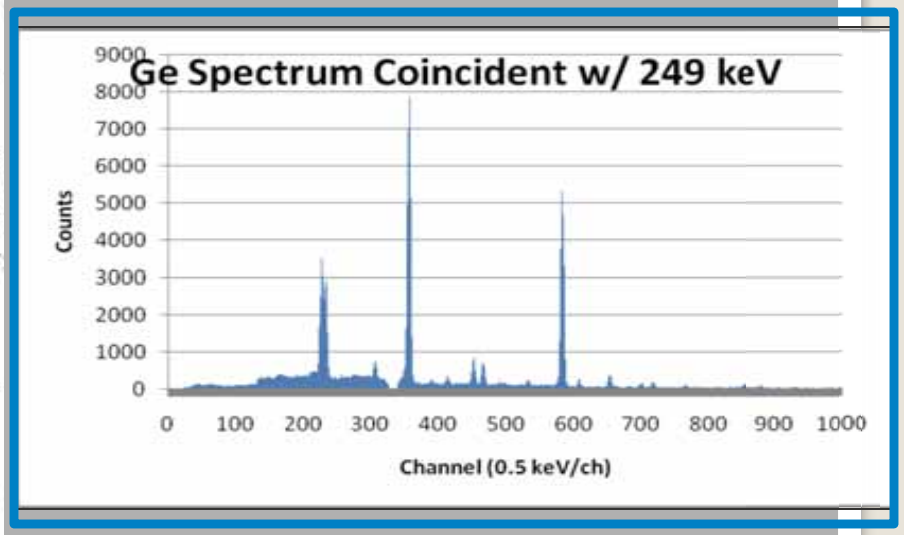


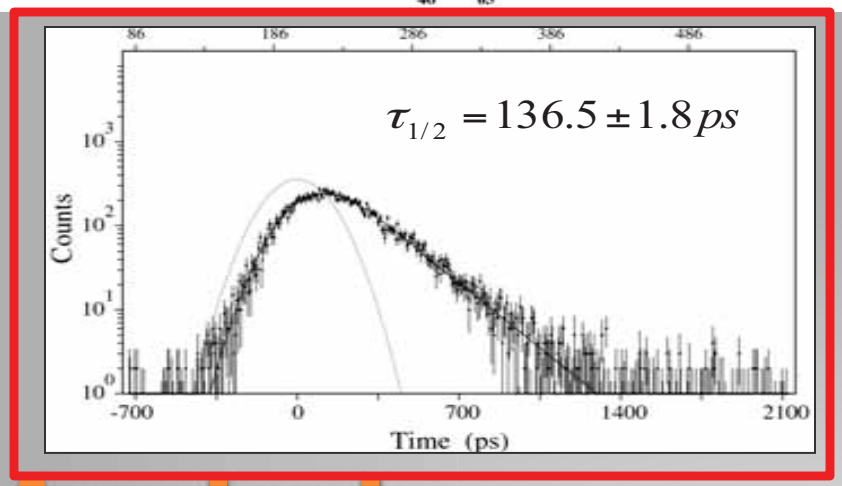


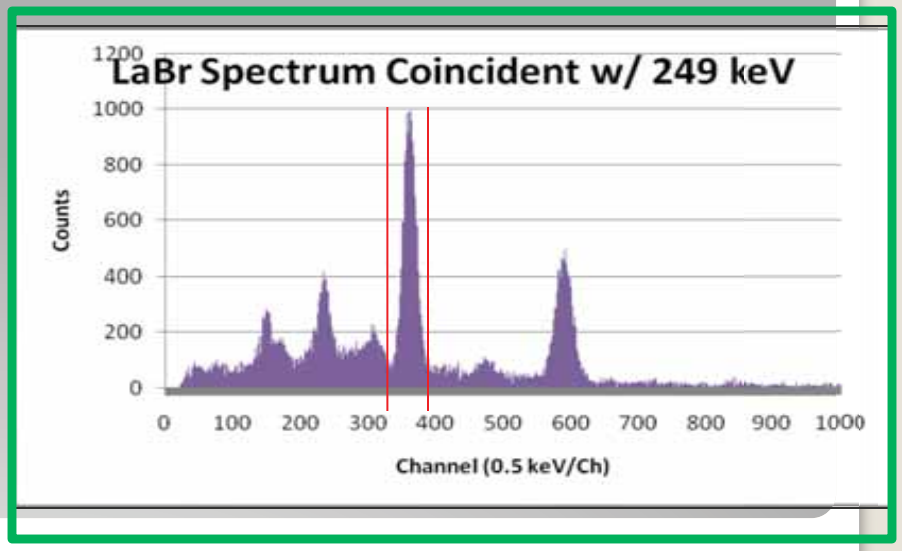
$LaBr_3$ Scintillators Plastic β Counter Ge Detectors

βγγ(t) Setup

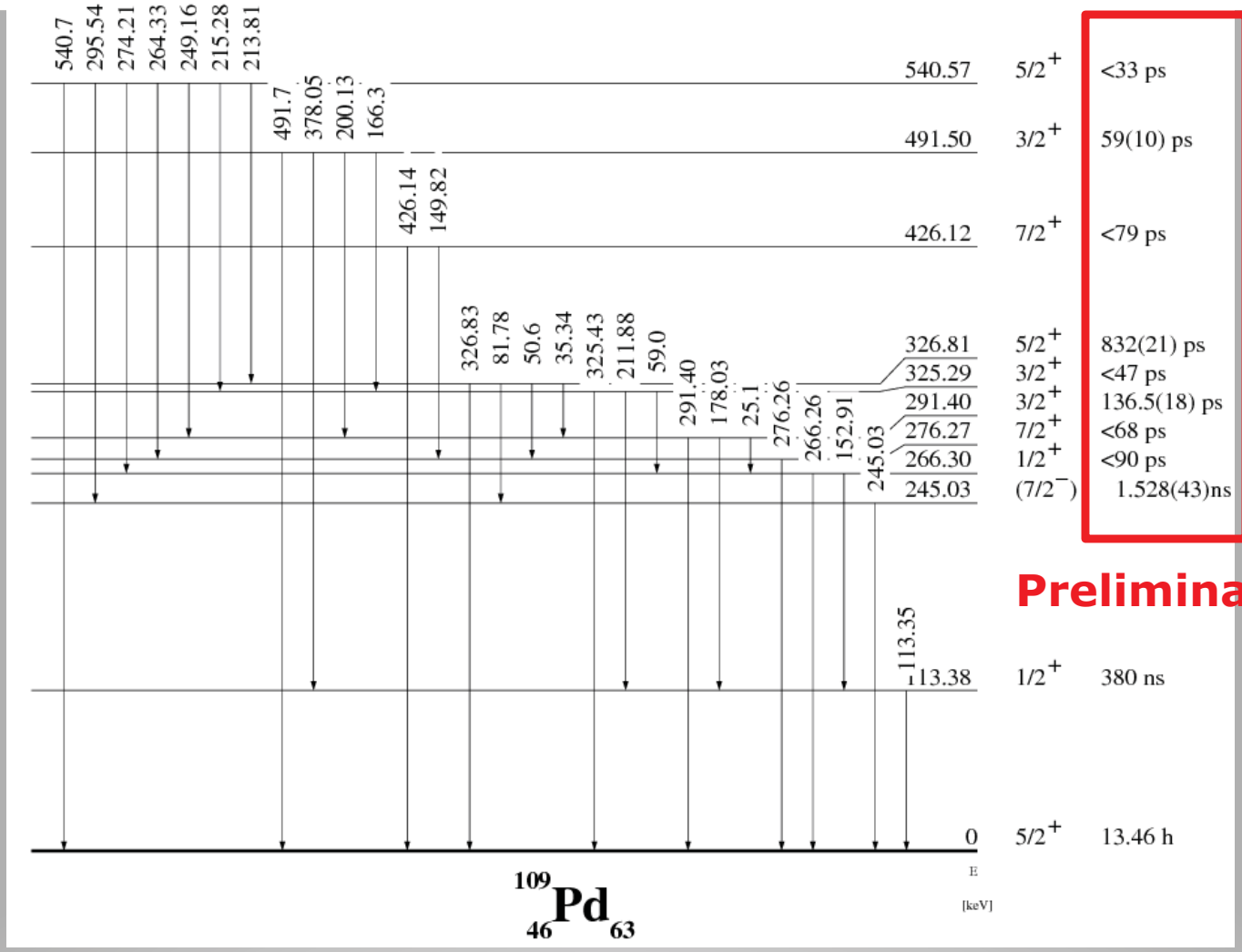

^{109}Rh 7/2$^+$
$^{109}_{46}$Pd$_{63}$


Ge Spectrum Coincident w/ 249 keV
Counts
Channel (0.5 keV/ch)


$\tau_{1/2} = 136.5 \pm 1.8\,ps$
Counts
Time (ps)


LaBr Spectrum Coincident w/ 249 keV
Counts
Channel (0.5 keV/Ch)

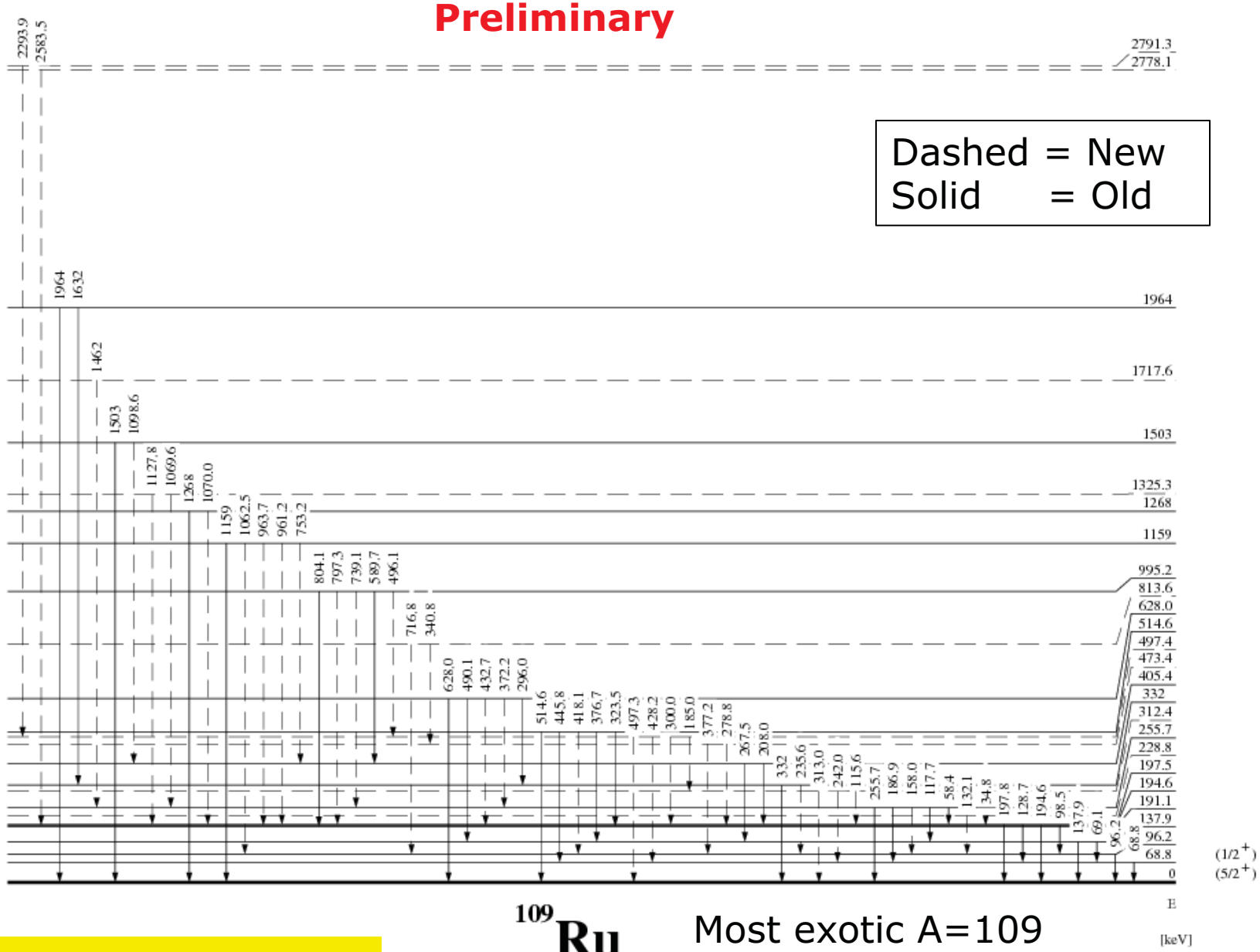
Analysis



Preliminary

Results

Preliminary

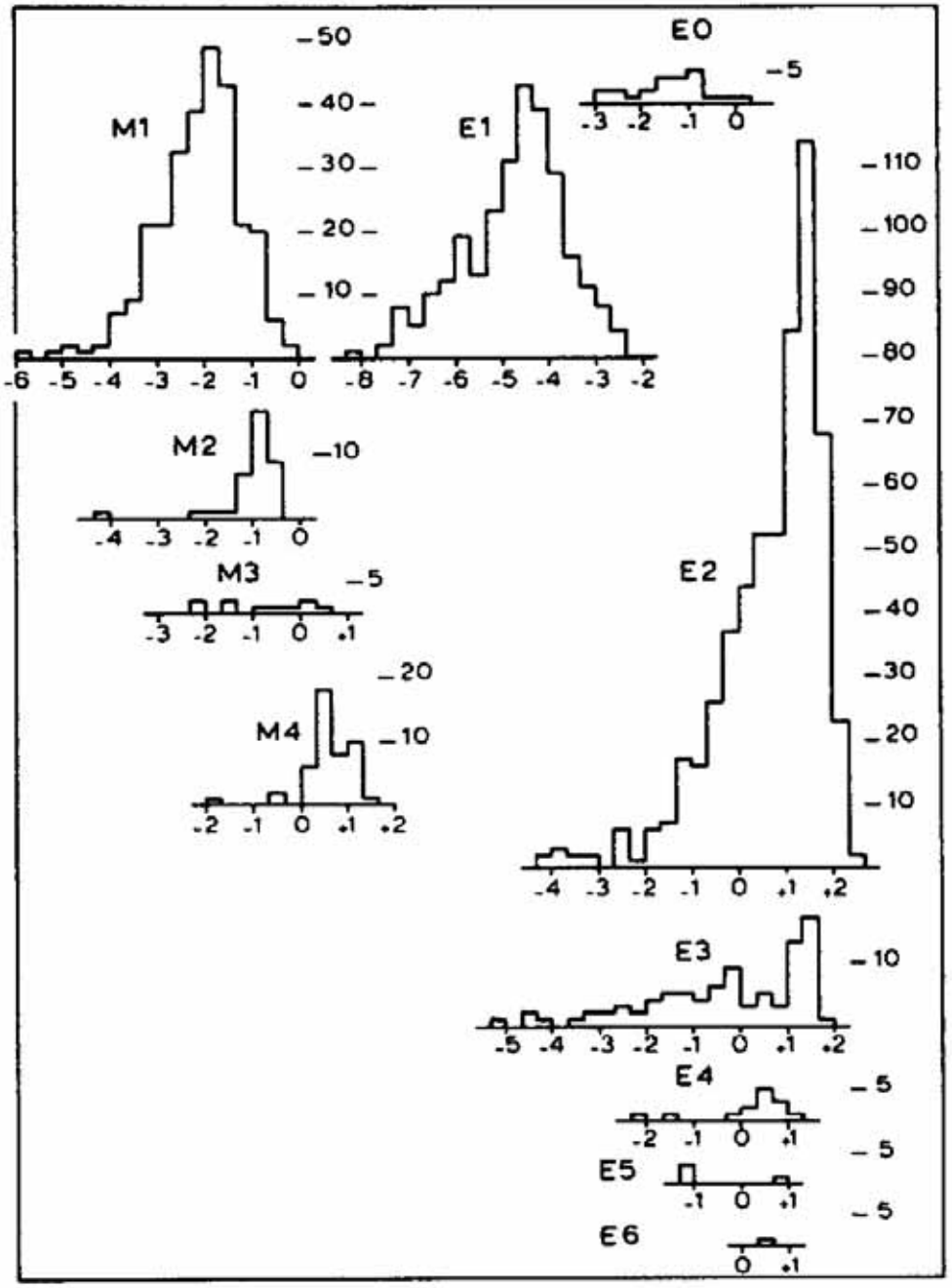


Dashed = New
Solid = Old

30 new γ's,
9 new levels so far!

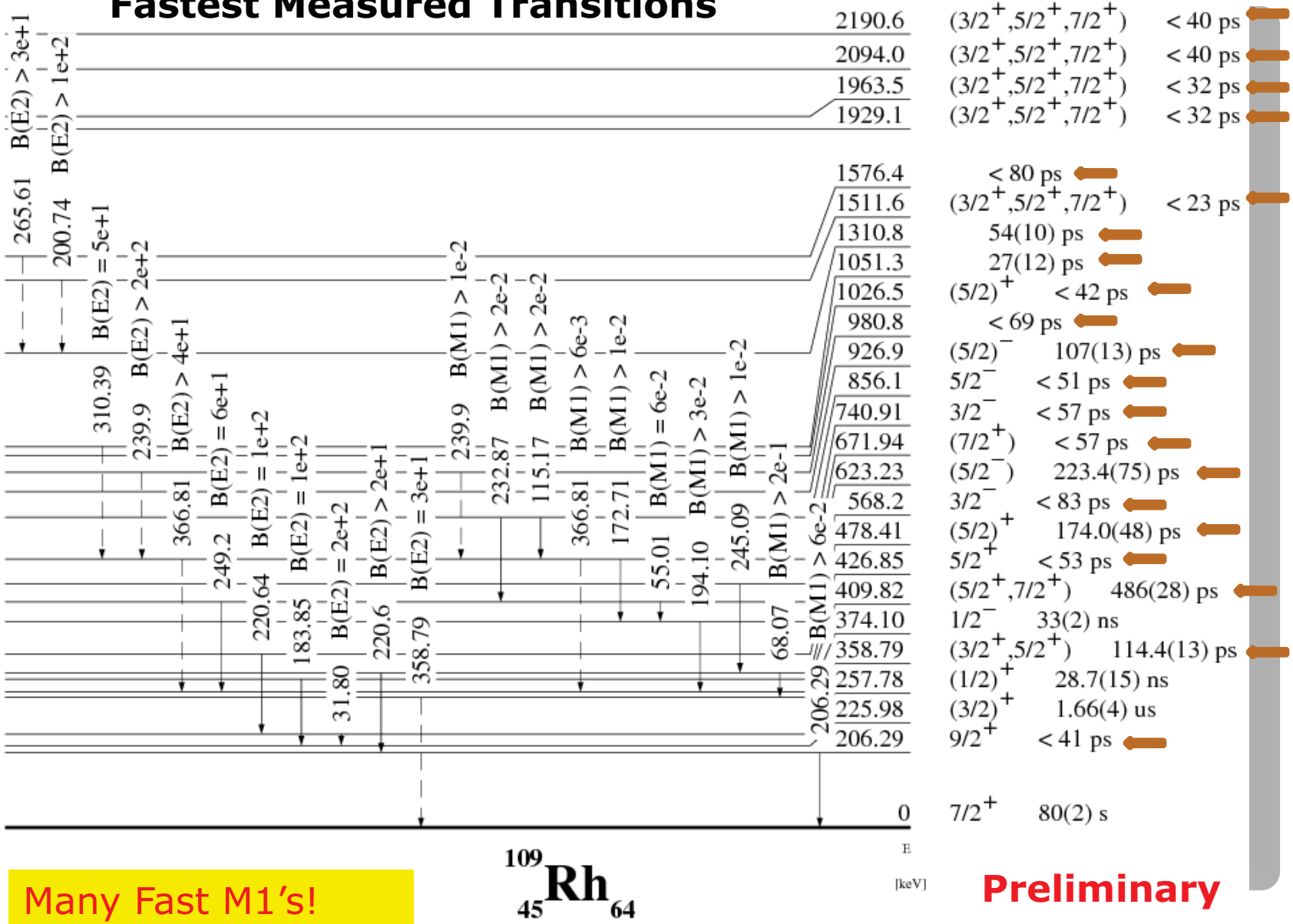
$^{109}_{44}Ru_{65}$

Most exotic A=109 nuclide measured in this experiment



Transition rates systematic for the A=90-150 mass region from Endt.

Fastest Measured Transitions



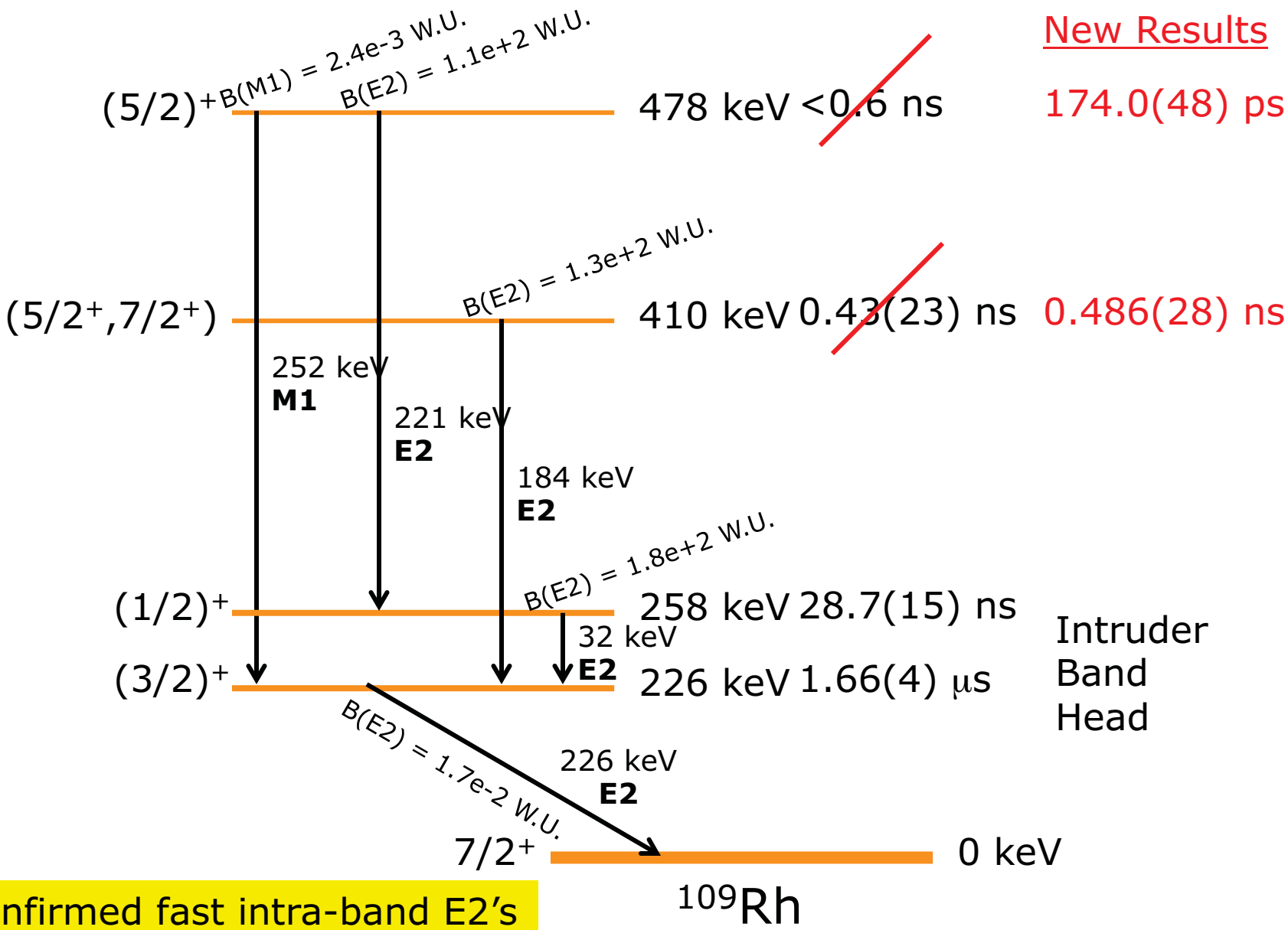
Many Fast M1's!

$^{109}_{45}Rh_{64}$

Preliminary

K=½ Intruder Band

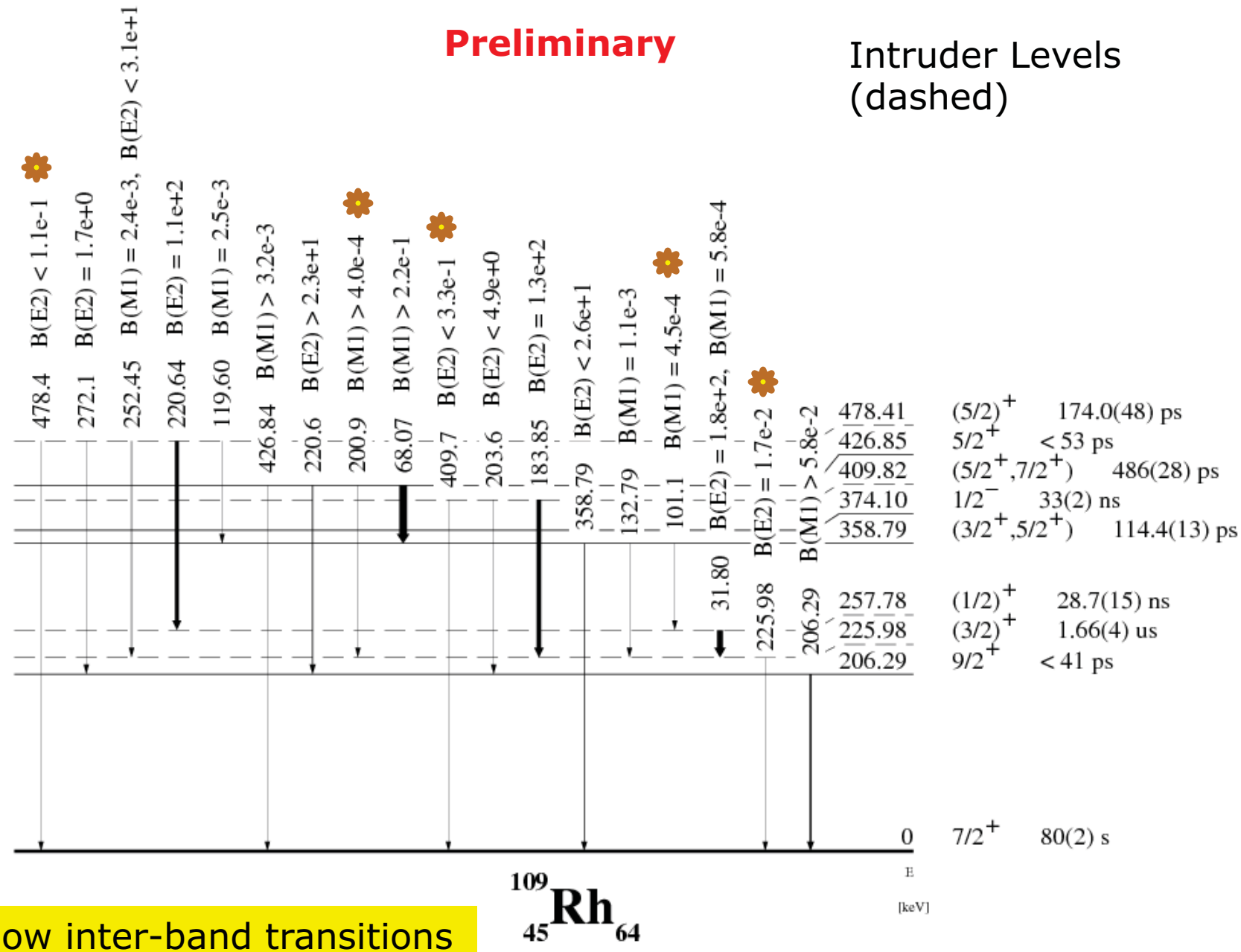
Preliminary



Confirmed fast intra-band E2's

Preliminary

Intruder Levels (dashed)



Slow inter-band transitions

Conclusions

- $\beta\gamma\gamma(t)$ fast timing method good for measuring picosecond lifetimes
- Many new γ's, levels, and lifetimes discovered in A~110 region
- New data for K=1/2 intruder band
- Work ongoing to piece together underlying structure physics

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Collaborators:

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Thank you!