

B(E2; $2^+_{1} \rightarrow 0^+_{\text{g.s.}}$) in ^{98}Zr : QPT in Zr Nuclei due to Shell Evolution

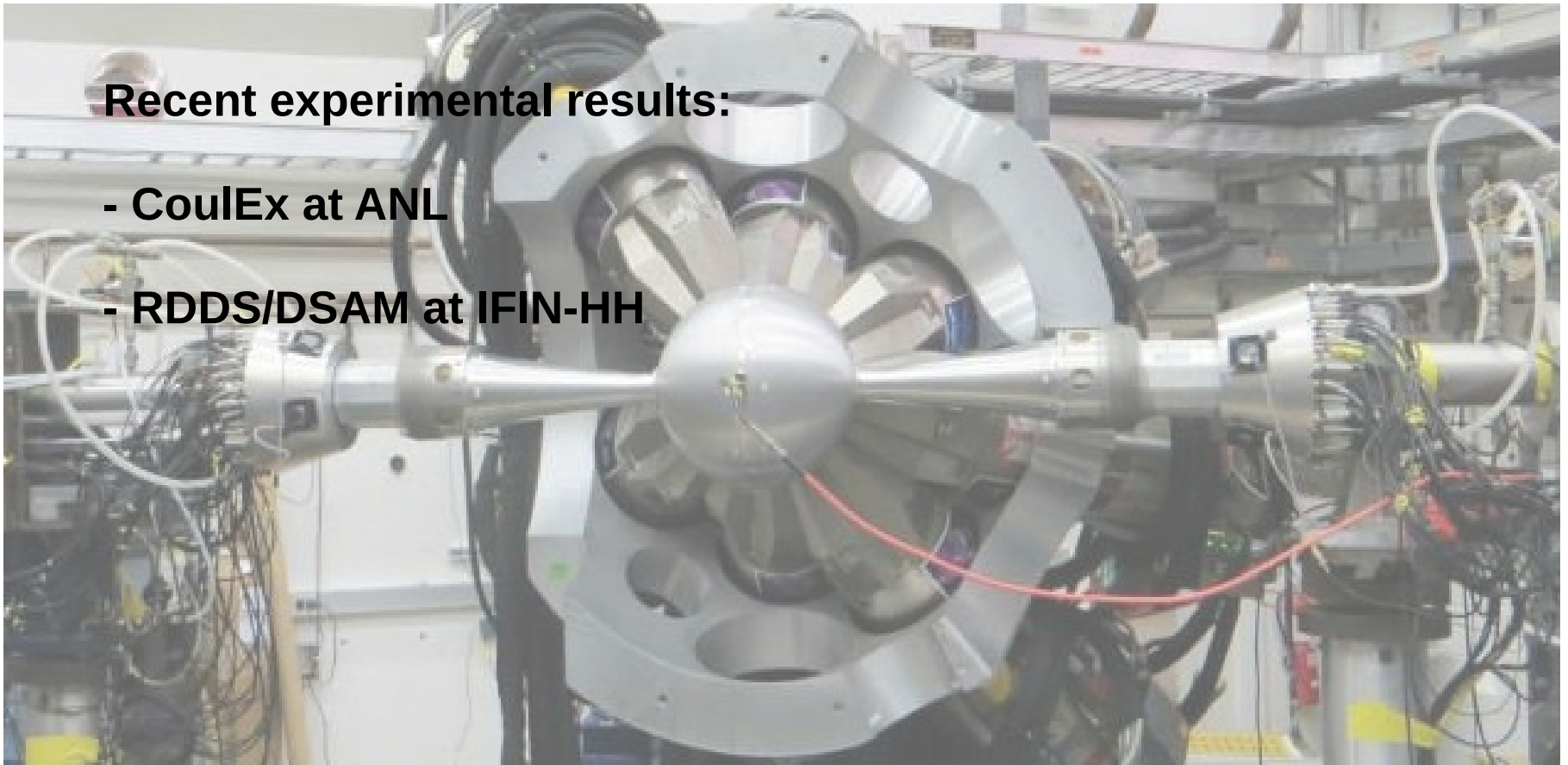


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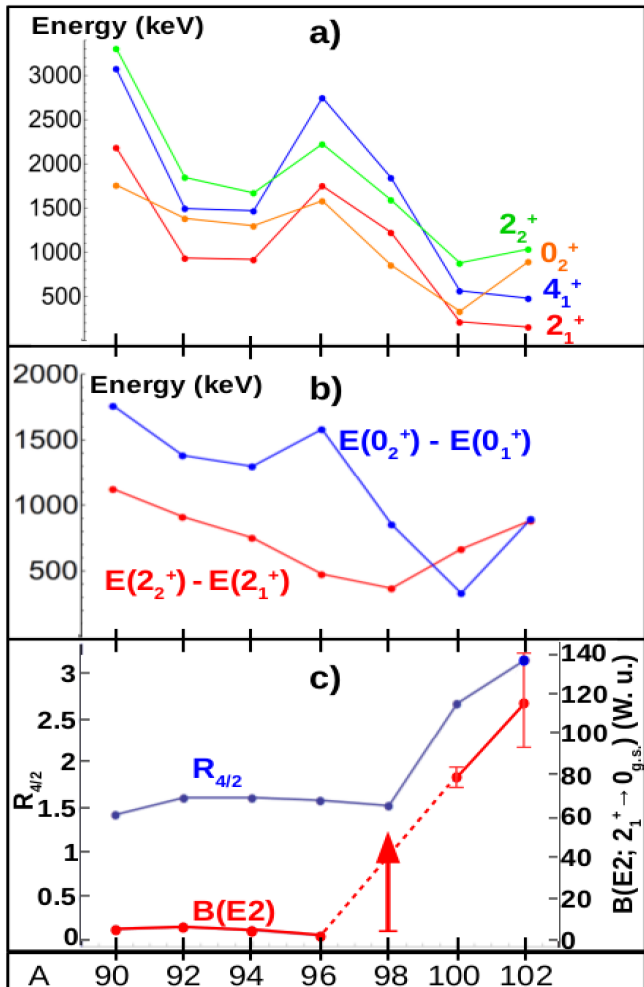
Session IV - Waldemar Witt

Recent experimental results:

- Coulex at ANL
- RDDS/DSAM at IFIN-HH

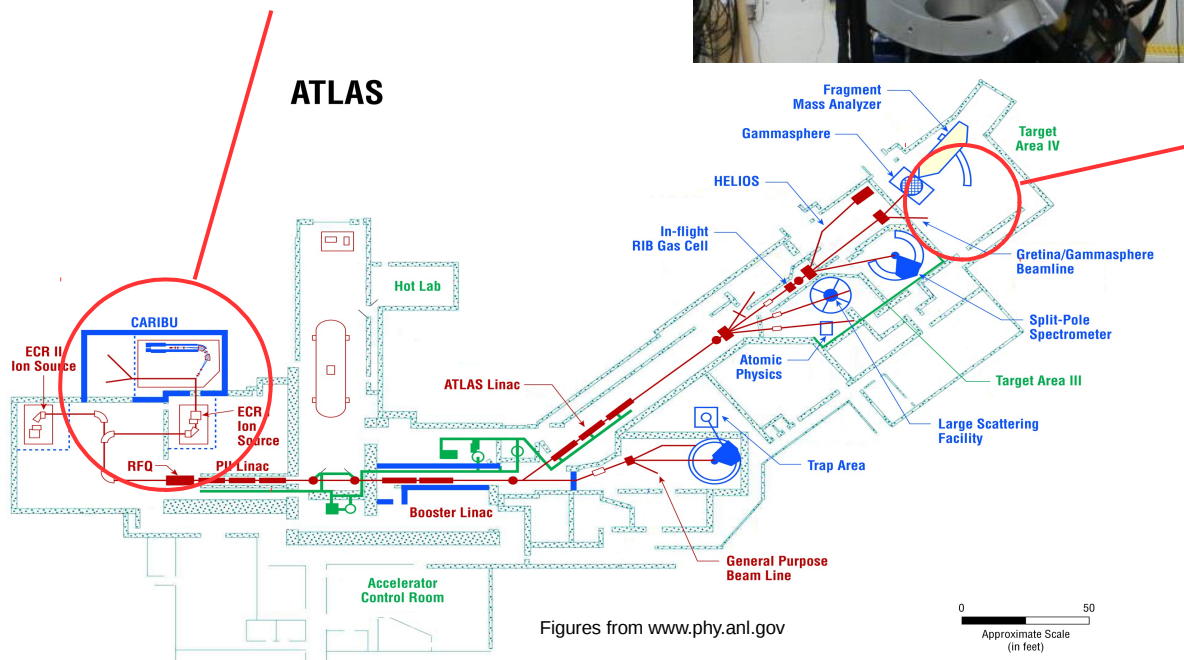
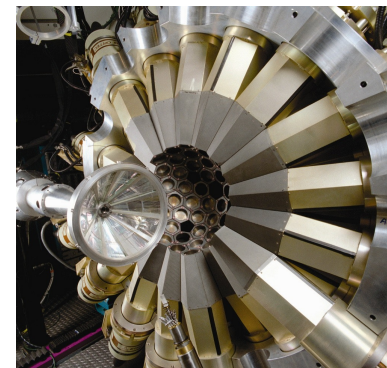
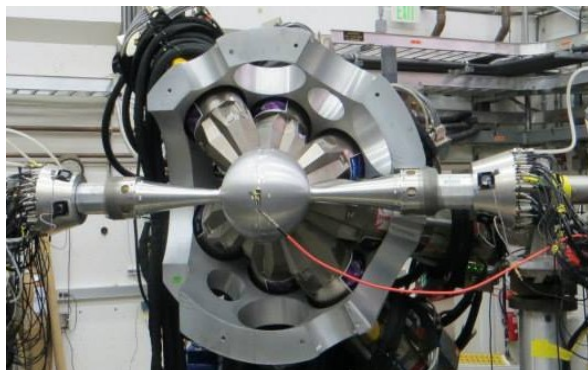


Systematics in the Zr isotopic chain



- Closed $d_{5/2}$ -shell in ^{96}Zr
- Deformation in ^{100}Zr
- Shape coexistence in ^{96}Zr (Kremer et al., PRL 117, 2016)
- ^{98}Zr : $B(E2; 2_1^+ \rightarrow 0_{g.s.}^+)$ value only limited from below (Ansari et al., PRC 96, 2017)

- ^{252}Cf fission source
- Gas catcher
- ECR charge breeder



GRETINA & CHICO2
 $(\epsilon_{\gamma} = 6.5\%, \Delta E/E \sim 1\%, \Delta\theta \sim 1^\circ)$

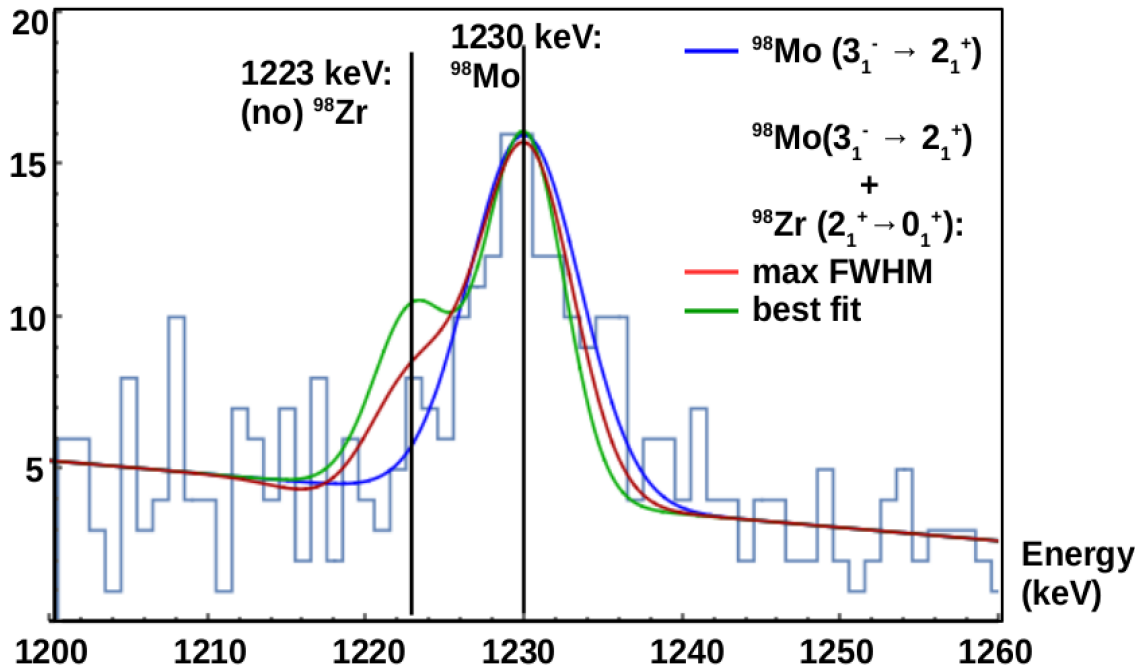
- Beam energy:
464 MeV
- Target:
 ^{196}Pt , 1.6 mg/cm²
- ~6 days beam time



Result for $B(E2; 2^+_1 \rightarrow 0^+_{g.s.})$

- Stopped Beam Analysis \rightarrow min. amount of ^{98}Zr in beam
- Transition would have been observed with >40 transition counts
- CLX calculations of cross-sections/yields

Counts / keV

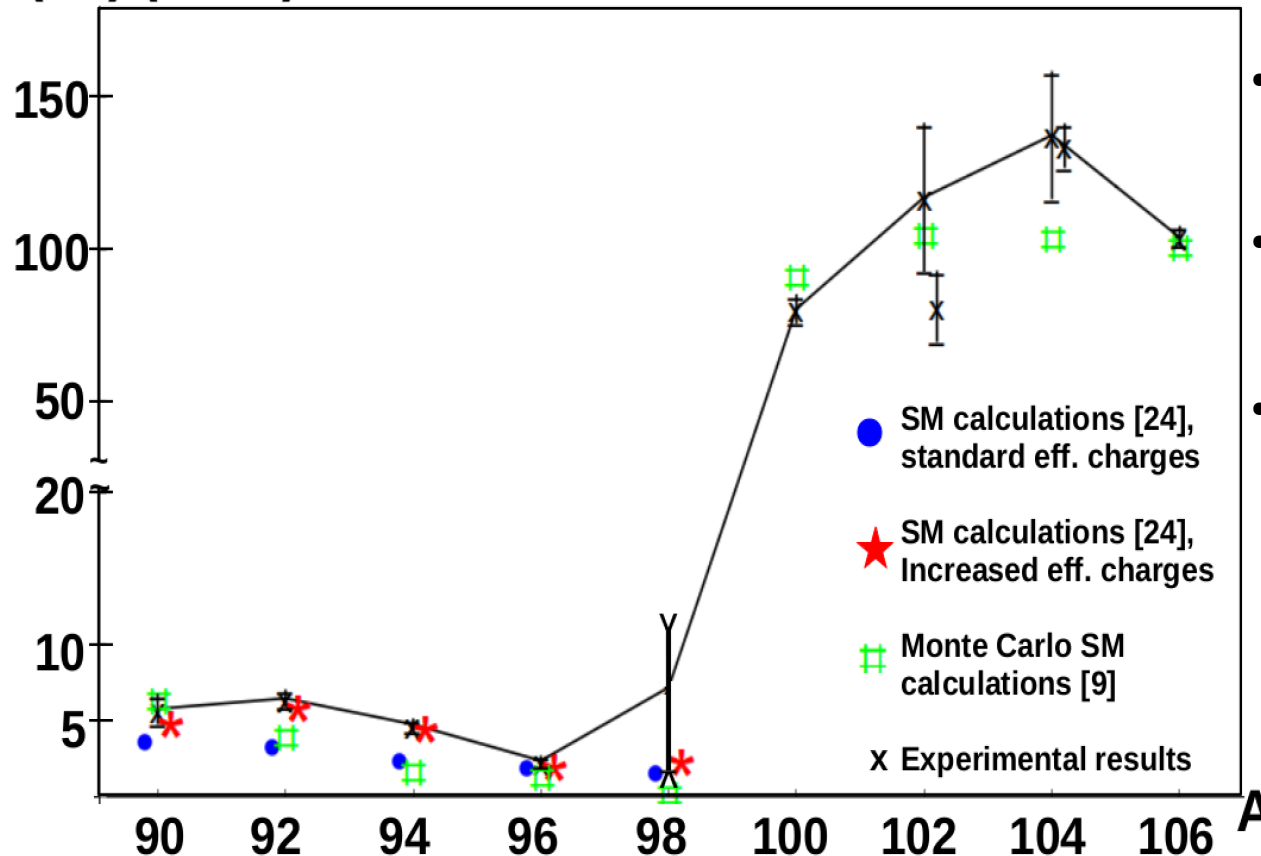


$\rightarrow B(E2) < 11 \text{ W.u.}$

$$11 \text{ W.u.} > B_{\text{Zr-98}}(E2; 2^+_1 \rightarrow 0^+_{g.s.}) > 0.7 \text{ W.u.} \quad (\text{Ansari et al, 2017})$$

Final Results from ANL

B(E2) (W. u.)



- Little collectivity in ground state (cp. $^{94,96}\text{Zr}$)
 - Agreement with Togashi et al. (PRL 117, 2016)
 - $B(E2; 2_1^+ \rightarrow 0_2^+)$
~ magnitude higher
→ 2_1^+ coll. exc. on 0_2^+
- submitted to PRC (R)



RDDS Experiment at IFIN-HH

- Coulex at ANL results → $^{98}\text{Zr } 2^+_{1} \rightarrow 0^+_{\text{g.s}}$ lifetime limited to 1-15ps
→ perfect for precise Plunger measurement
- Performed test experiment 2017: $^{18}\text{O}(^{96}\text{Zr}, ^{98}\text{Zr})^{16}\text{O}$ reaction promising
- Full experiment in March 2018:
 - $^{18}\text{O}(^{96}\text{Zr}, ^{98}\text{Zr})^{16}\text{O}$ at 50MeV
 - 1-1.5 mg/cm² (enriched) ⁹⁶Zr target
 - ROSPHERE (Ge, LaBr)
 - Plunger
- 21 days beamtime (8d RDDS)



https://tandem.nipne.ro/nuclear_structure.php

RDDS Experiment at IFIN-HH: Preliminary RDDS spectrum

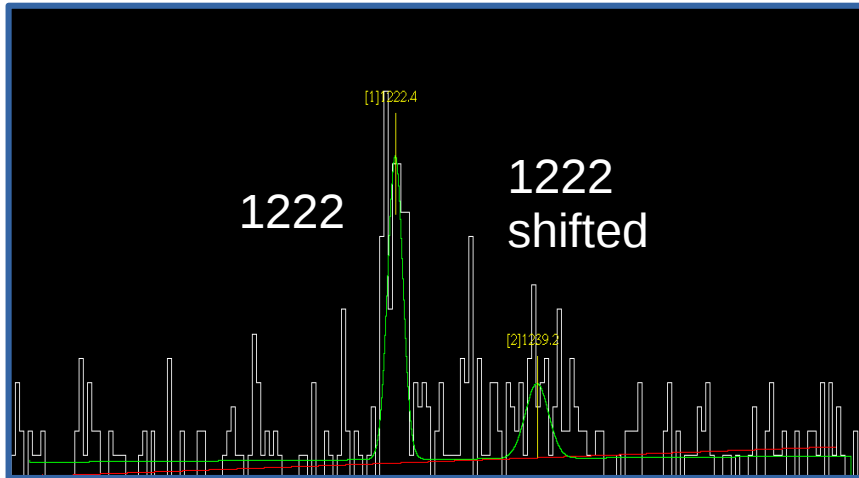


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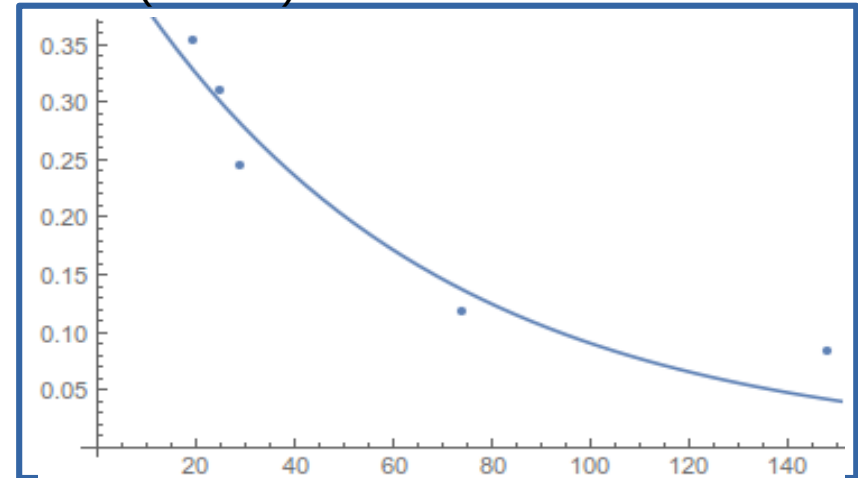
uncomplete statistics

Recoil velocity (distr. center) $\sim 1.6\%c$

decay curve



u.s. / (s.+us.)



distance / um

$2^+_{1} \rightarrow 0^+_{g.s.}$ @ 1222keV (u.s.), 1239keV (s.)

$\rightarrow \tau \sim 3ps$

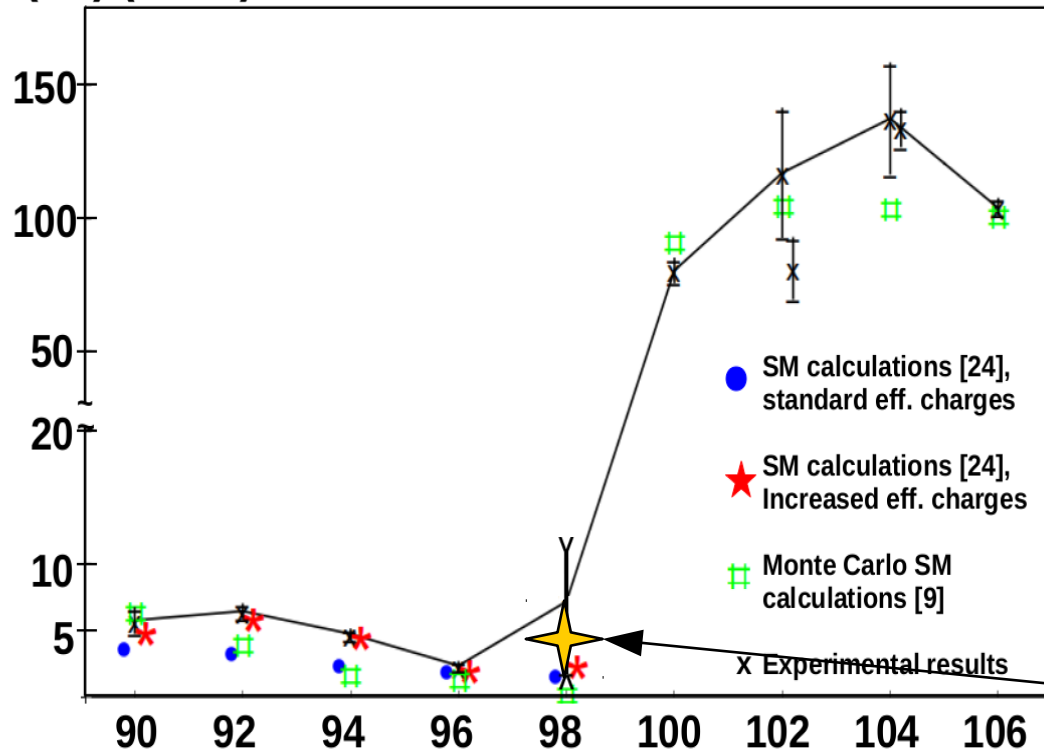
After gate on shifted $2^+_{3} \rightarrow 2^+_{1}$

$\rightarrow B(E2) \sim 4 W.u.$

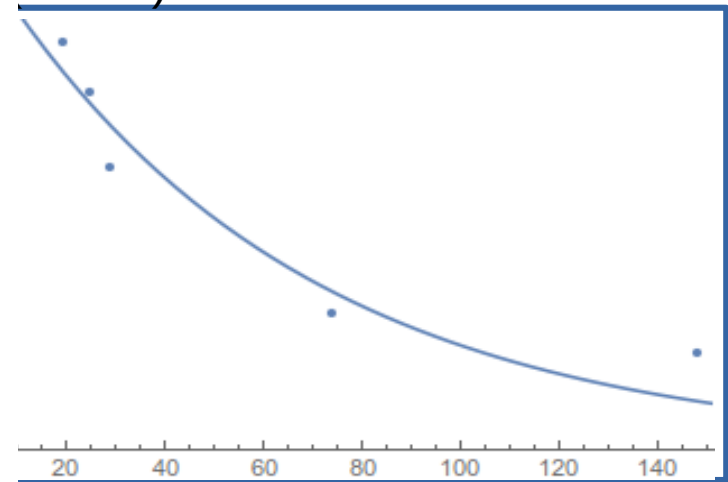
RDDS Experiment at IFIN-HH: Preliminary RDDS spectrum

Recoil velocity (distr. center) $\sim 1.6\%c$ incomplete statistics
decay curve

B(E2) (W. u.)



... (s.+us.)



distance / μm

$\rightarrow \tau \sim 3\text{ps}$

$\rightarrow B(E2) \sim 4 \text{ W.u.}$

RDDS Experiment at IFIN-HH: Outlook



- γ - γ coinc. Spectrum
→ **branching ratios**
- RDDS for all relevant coinc. pairs (fw-fw, fw-bw, bw-bw)
→ **lifetimes** of $2^+_3 \rightarrow 2^+_1$ (~ 3 ps), $2^+_1 \rightarrow 0^+_{\text{g.s.}}$ (~ 4 ps), $3^-_1 \rightarrow 2^+_1$ (\ll ns)
- DSAM
→ **lifetime** of $4^+_1 \rightarrow 2^+_1$ (~ 400 fs), ...

Analysis ongoing ...

Thanks for your attention!



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Collaborators:

RDDS/DSAM @ IFIN-HH

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CouEx @ ANL

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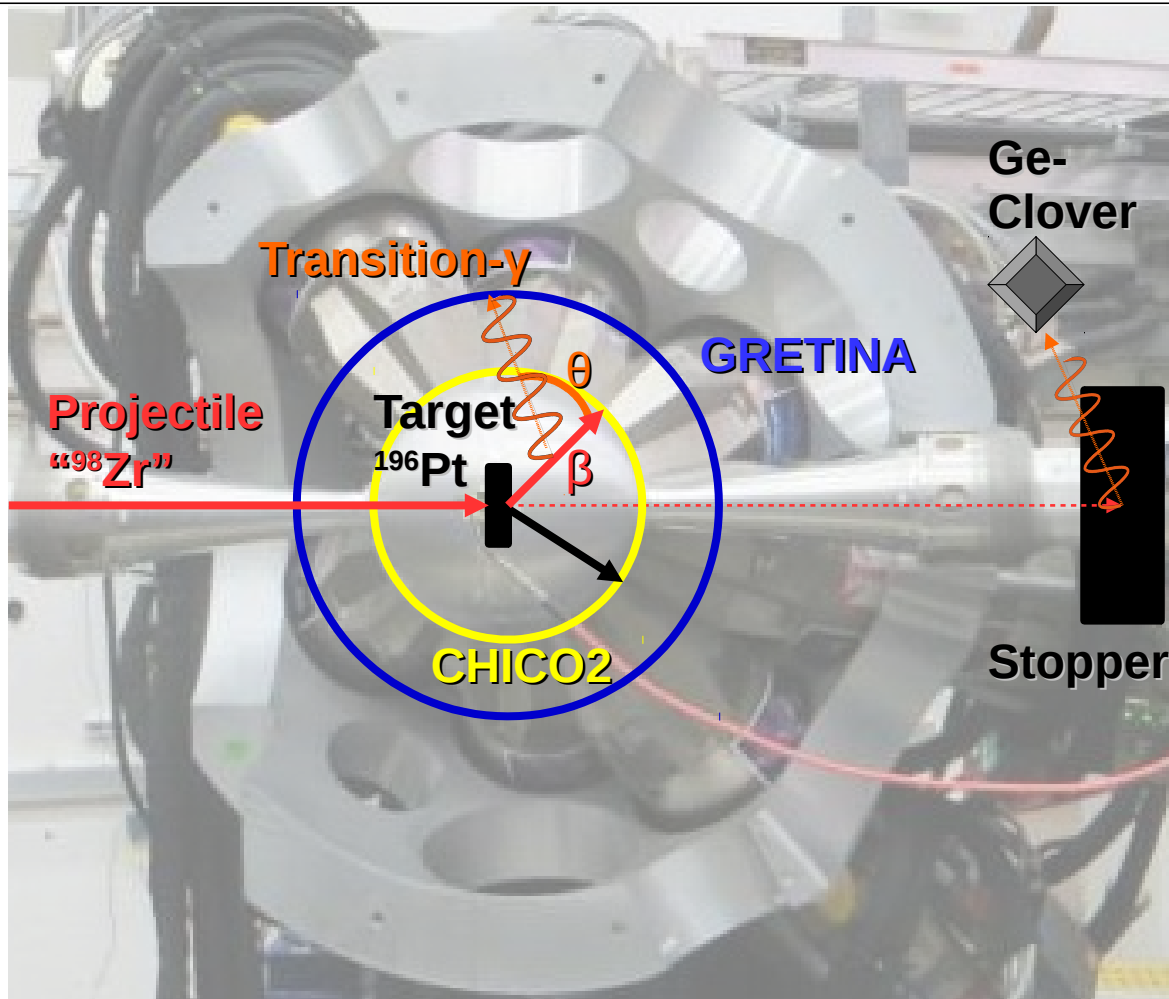
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CoulEx at ANL: Setup and Kinematics

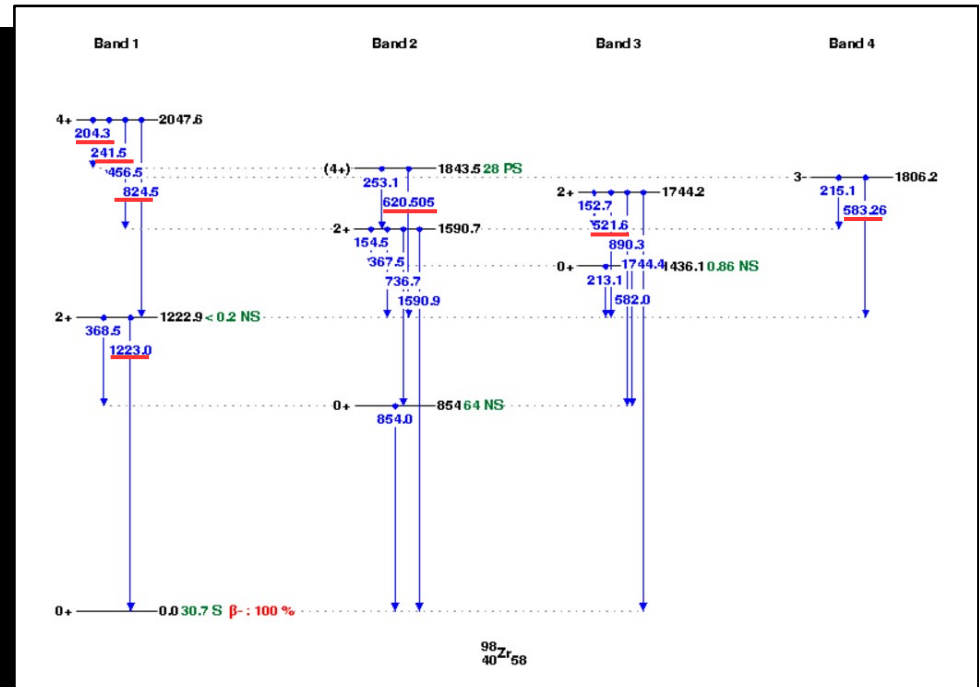
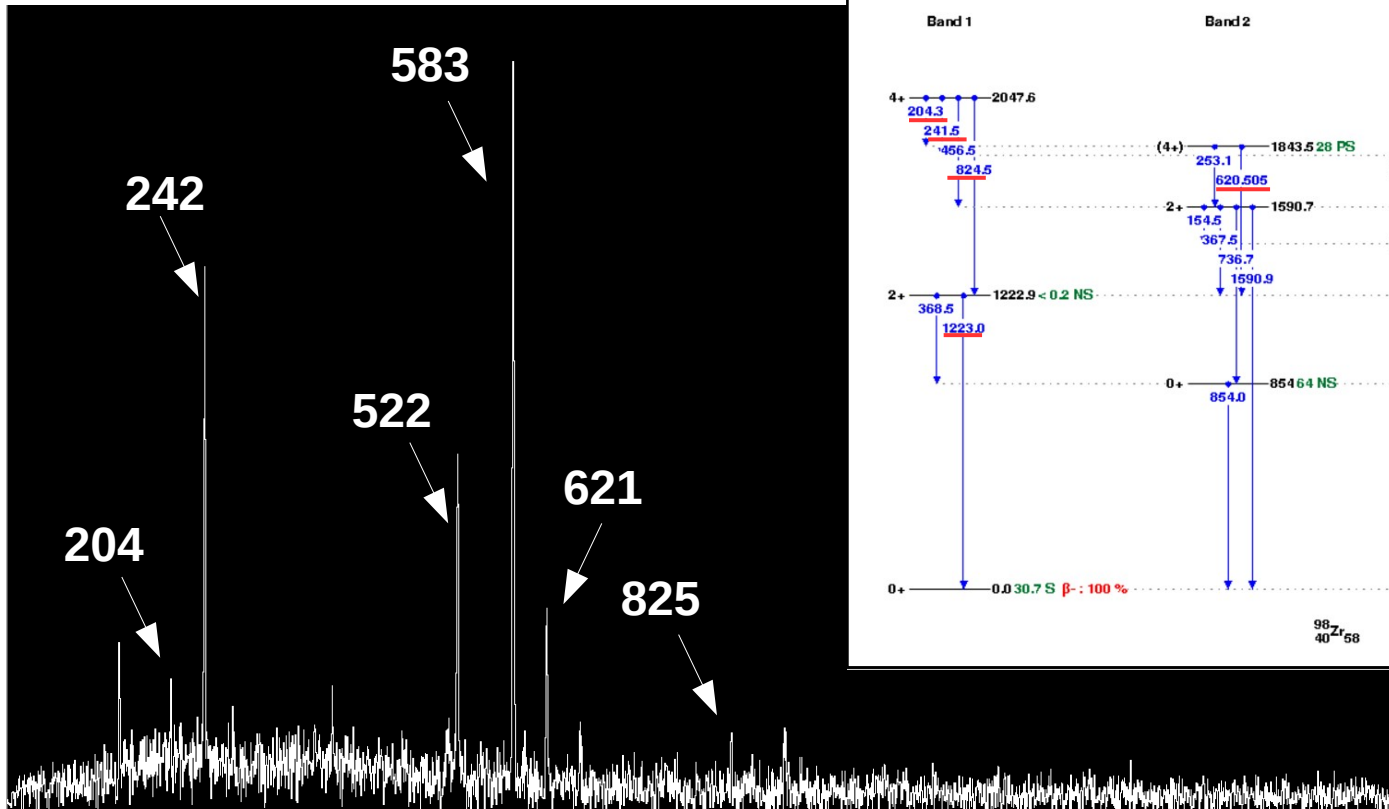


- CoulEx of P/T
 - Detection of Ejectiles (P/T) with CHICO2
 - Calculate γ -angle θ & velocity β
 - Correct for Doppler-shift in energy:
 $E' \approx E (1 + \beta) \cos(\theta)$
- use of CHICO2 for Doppler-correction & safe CoulEx

RDDS Experiment at IFIN-HH: γ-γ coinc. Spect. & Level Scheme



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Gate on $1222 \text{ keV } 2^+_1 \rightarrow 0^+_{\text{g.s.}}$