Gamow-Teller decay of ^{74}Co ground state and isomer (S2-7,S1-10)

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Motivation (used to be)

- Low-energy excited states in the nickel isotopes (Z=28)
- 8+ isomers in Ni and beta decays of $^{70\text{-}76}$Co
- 2^+,4^+ and 6^+ systematics in $^{70\text{-}76}$Ni (Warsaw-GANIL,Leuven,NSCL,UTK... work)

Motivation (this work)

- Gamow-Teller (spin-flip) transformations

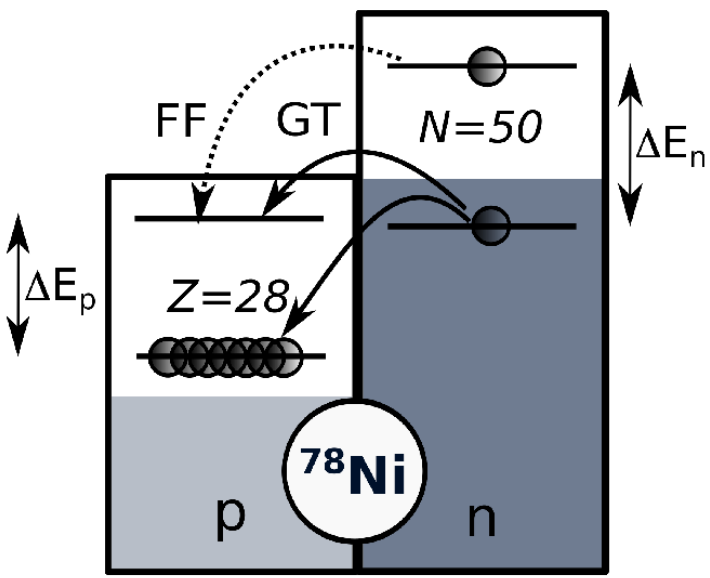
Beta decays of Co isotopes

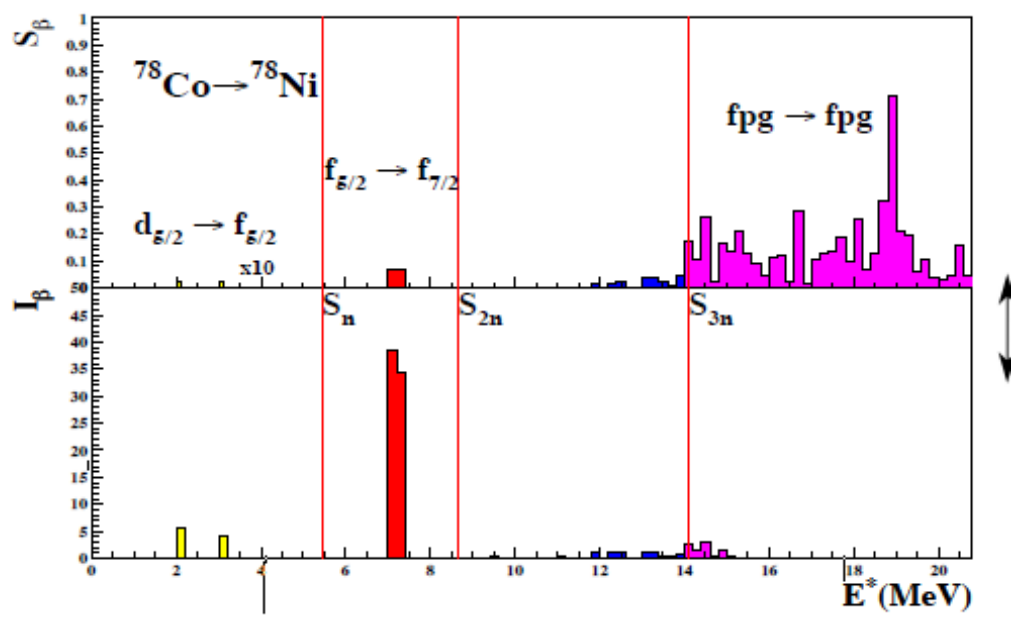
- **Large Q_β values (~15 MeV)**
- **Large Q_β -S_n (~9 MeV)**
- **But small P_n (~10%)**

Strong $\nu f_{52} \rightarrow \pi f_{7/2}$ *transformations populate particle bound states*

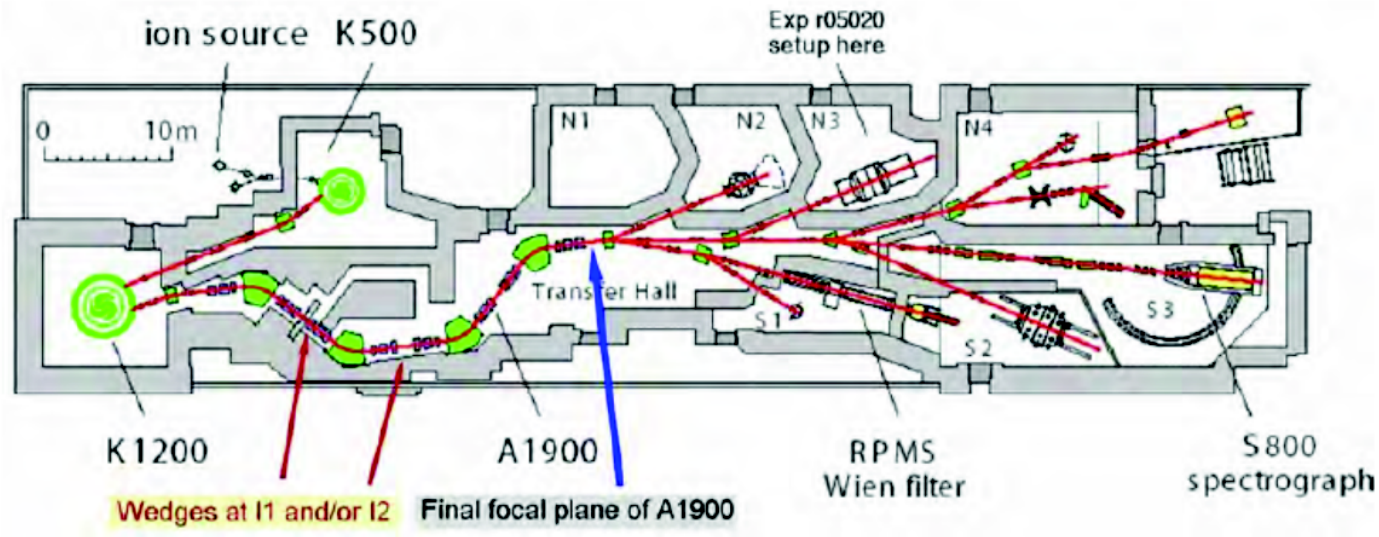
Z=28

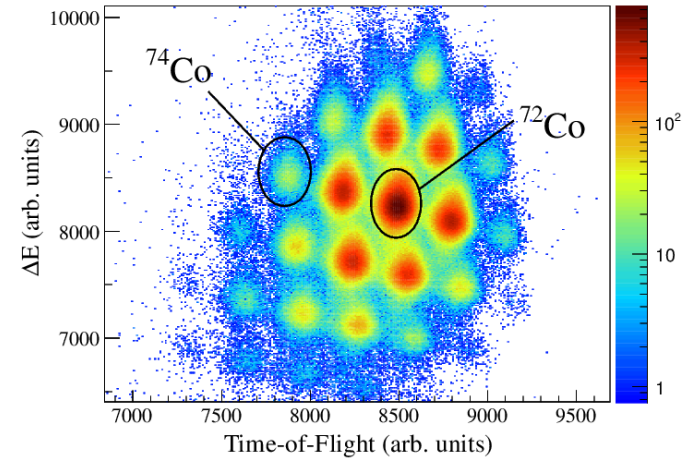
Z	42	43	44	45	46	47	48	49	N
	70Ni 6.0 S β-: 100.00%	71Ni 2.56 S β-: 100.00%	72Ni 1.57 S β-: 100.00%	73Ni 0.84 S β-: 100.00%	74Ni 0.68 S β-: 100.00% β-n	75Ni 344 MS β-: 100.00% β-n: 10.00%	76Ni 0.238 S β-: 100.00% β-n	77Ni 128 MS β-: 100.00% β-n: 30.00%	78Ni 0.11 S β-: 100.00% β-n
27	69Co 229 MS β-: 100.00%	70Co 108 MS β-: 100.00%	71Co 80 MS β-: 100.00% β-n≤ 6.00%	72Co 59.9 MS β-: 100.00% β-n≥ 6.00%	73Co 41 MS β-	74Co 25 MS β-n≈ 18.00% β-	75Co >150 NS β-: 100.00%	76Co >634 NS β-n β-2n	
26	68Fe 180 MS β-: 100.00%	69Fe 110 MS β-: 100.00%	70Fe 71 MS β-: 100.00%	71Fe 28 MS β-: 100.00% β-n	72Fe ≥150 NS β-: 100.00% β-n: 27.60%	73Fe >633 NS β-2n β-n	74Fe >638 NS β-2n β-n		
25	67Mn 51 MS β-: 100.00% β-n > 10.0%	68Mn 28 MS β-: 100.00% β-n	69Mn 18 MS β-: 100.00%	70Mn >360 NS β-n β-	71Mn >637 NS β-2n β-n				
24	66Cr 23 MS β-: 100.00%	67Cr β-	68Cr >360 NS β-n β-						

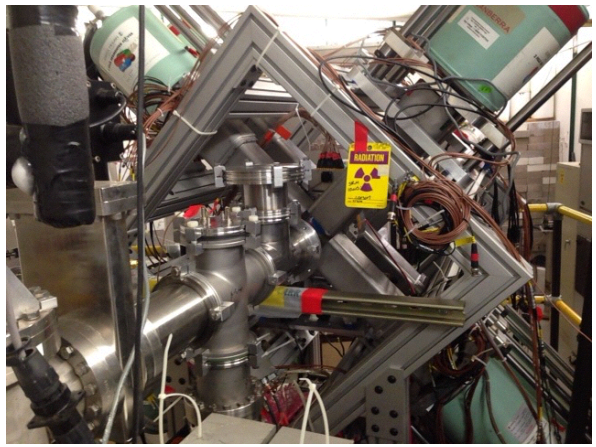




The NSCL experiment







Fragmentation reaction:

Primary beam : 82Se(13+)
Beam energy :140 MeV/u
Target : 9Be 517 mg/cm^2

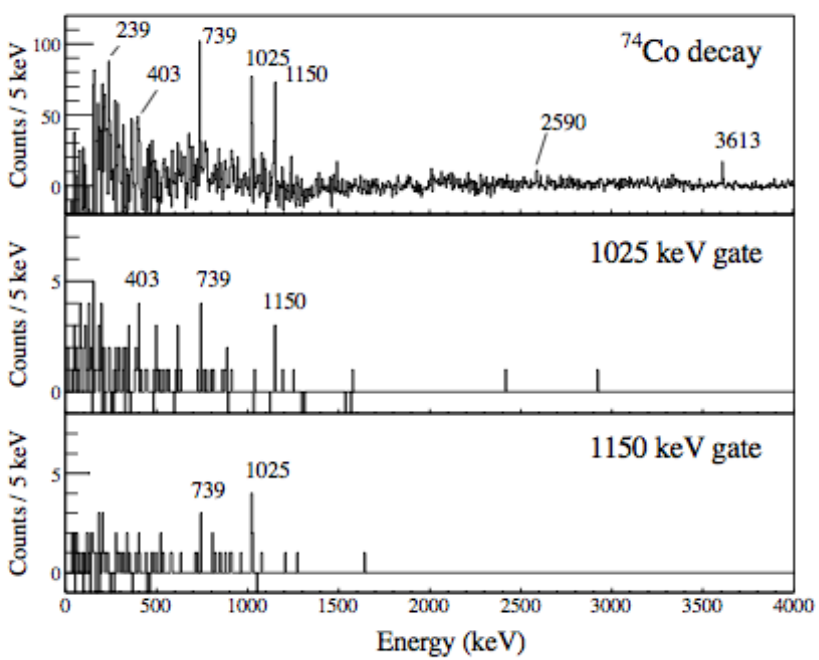
Decay station:

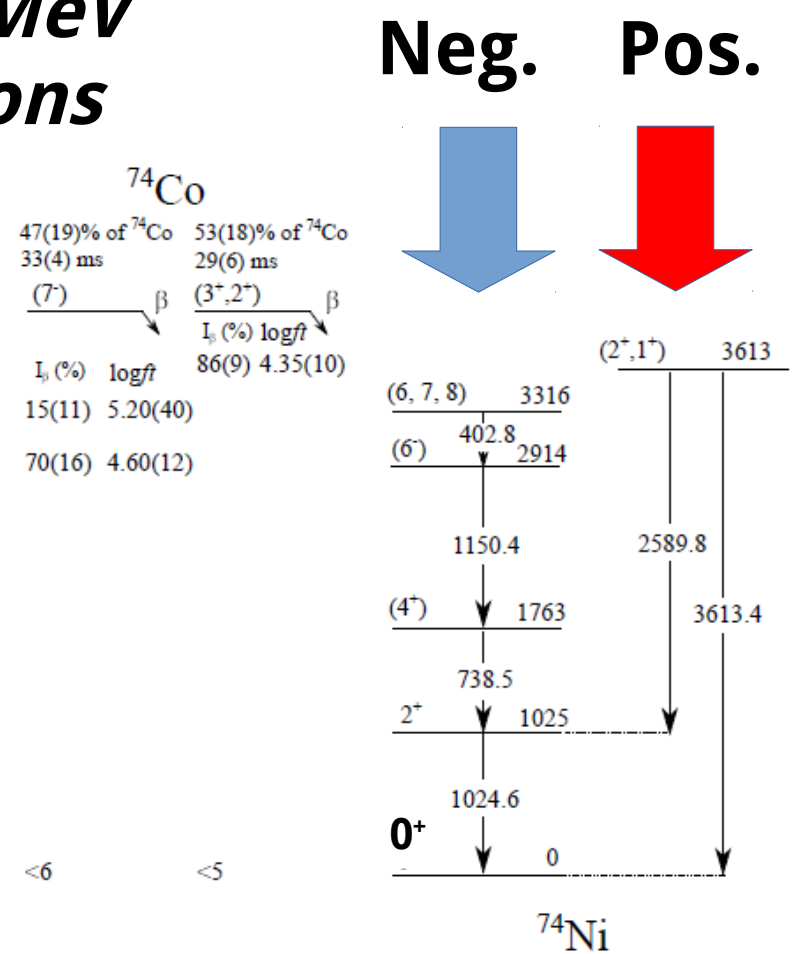
Gammas : 8 clover Ge detectors
Betas and implantations : GeDSSD
Particle identification : ΔE-TOF method
Digital data acquisition
(NSCL-DDAS)

Decay of ^{74}Co

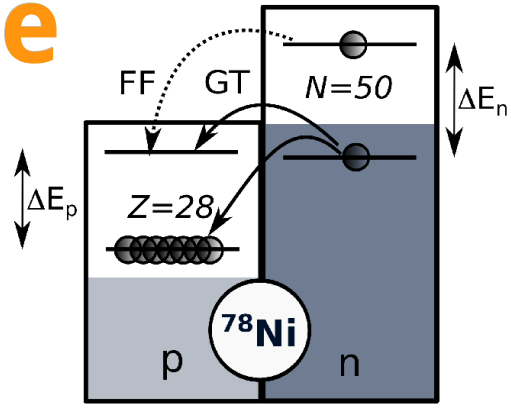
Feeding to low spin positive parity and high spin negative parity states

- ***Isomer and g.s. decay of ^{74}Co***
- ***Strong feeding to states at ~3.5 MeV***
- ***Gamow-Teller $\nu f_{52} \rightarrow \pi f_{7/2}$ transitions***



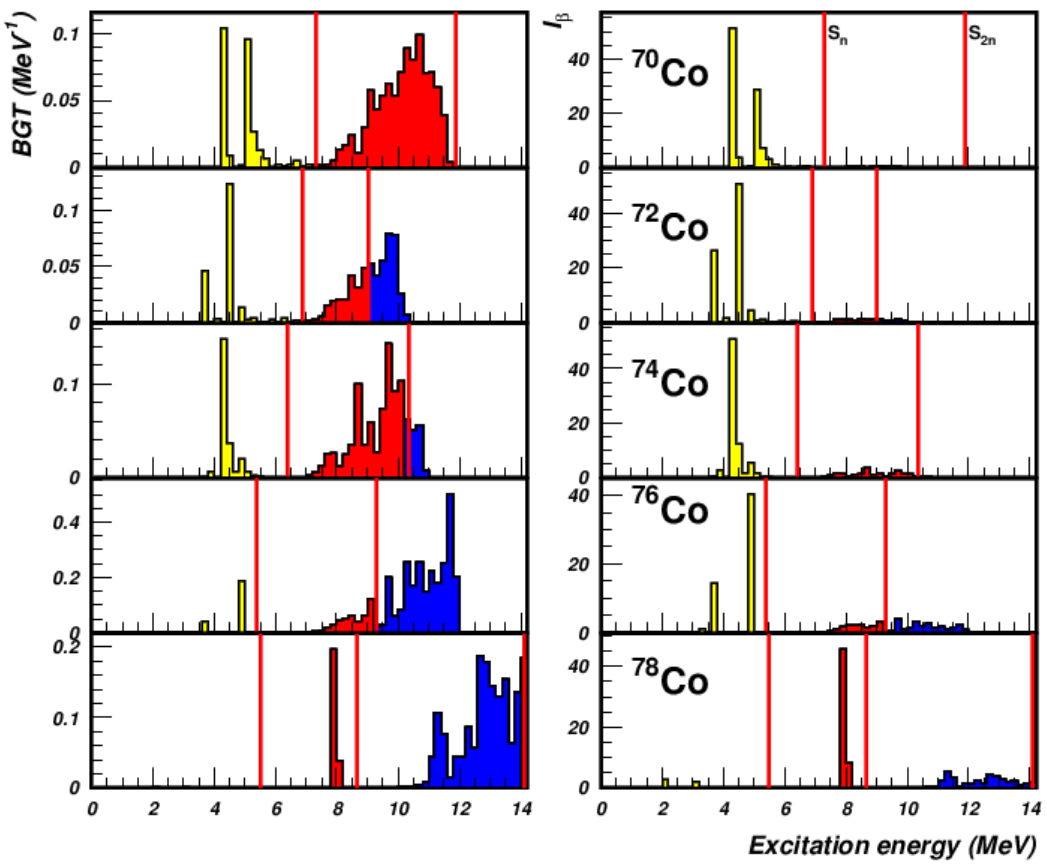


SM-calculations with ^{48}Ca core



- **NushellX**
- **Valence space: $\nu\, f_{5/2}, p_{3/2}, p_{1/2}, g_{9/2} + d_{5/2}$ and $\pi\, f_{7/2}, p_{3/2}, p_{1/2}, f_{5/2}$**
- **Realistic interactions (M. Hjorth-Jensen 2016)**
- **Quenching F=0.3 to reproduce lifetimes**

Negative parity GT decays.



Predicted properties of the ^{78}Co decay:

(shell-model)

$J^{\pi}=2^{-}$

P_{xn} = 95% ,P_{2n}=41%

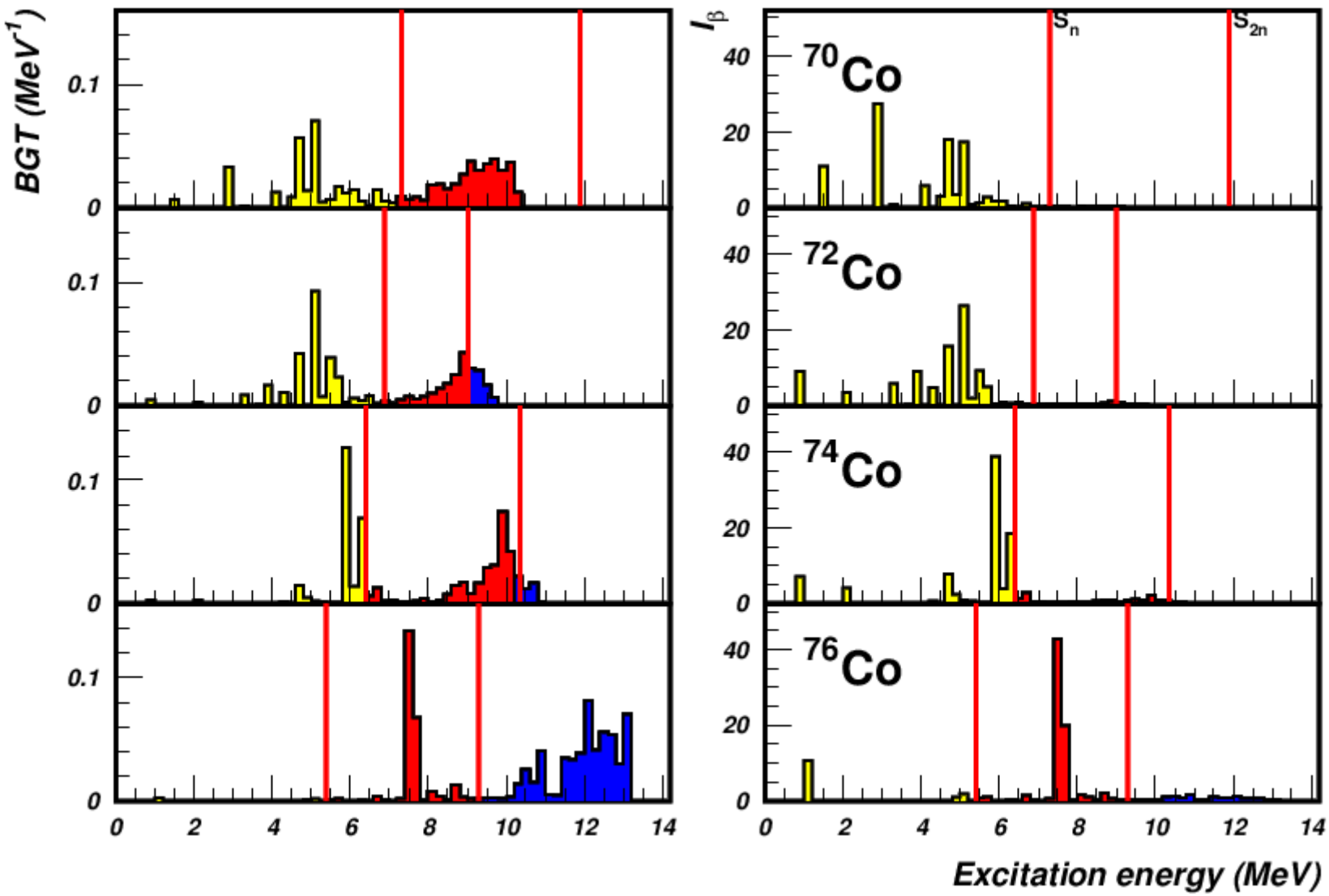
$T_{1/2}$ = 9ms

(FRDM+QRPA)

$T_{1/2}$ = 5ms

P_{xn}=98%

P_{1n}=32% P_{2n}=41% P_{3n}=25%

(Q_{β}=21.1MeV FRDM)

Positive parity decays