

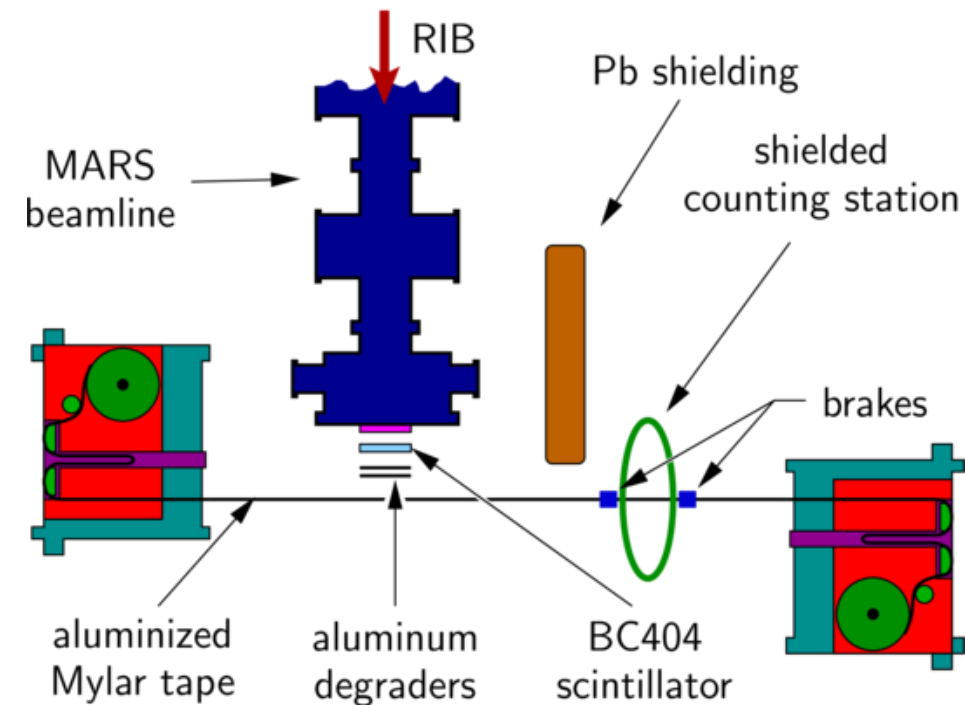
# **$^{10}\text{C}$ Branching Ratio**

## **Update on a new measurement**

**Dan Melconian**

# Fast-tape transport system (Hardy and Iacob)

- Fundamental symmetries:  
fast-tape transport system  
+ HPGe or  $4\pi$  gas counter
- Lifetimes and branching  
ratios ( $V_{ud}$ )



K500 SUPERCONDUCTING



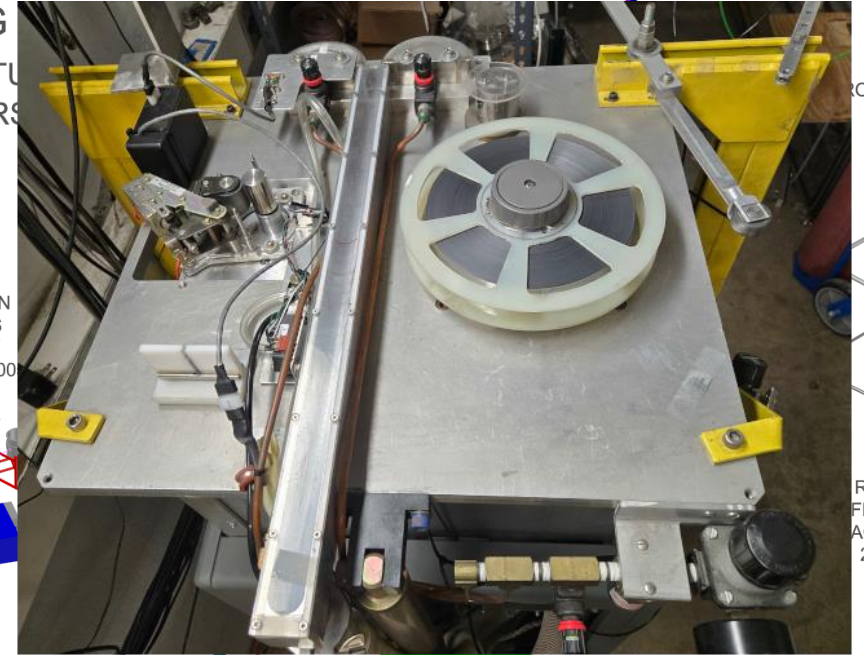
CYCLOTRON INSTITUTE  
TEXAS A&M UNIVERSITY

MARS RECOIL  
SPECTROMETER  
1992

RADIATION  
EFFECTS  
FACILITY  
1994, 2000, 200

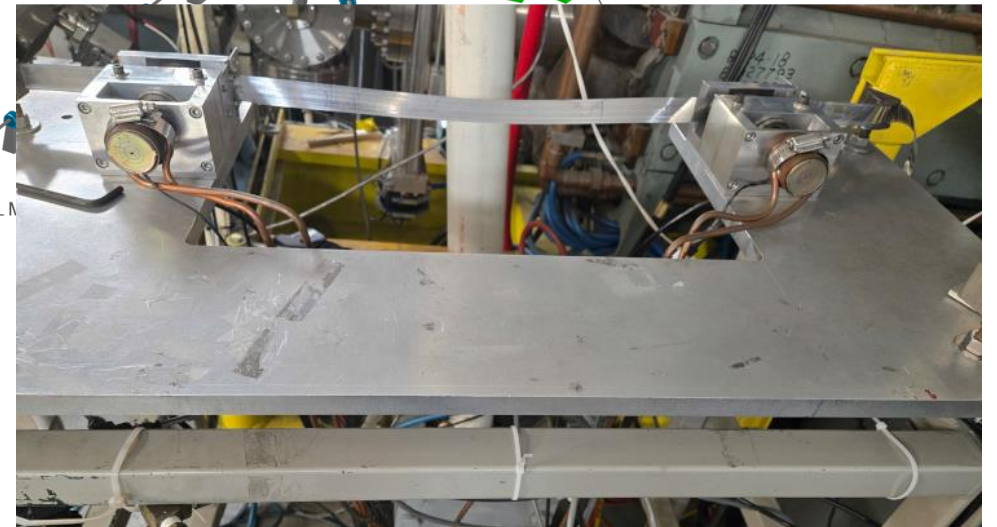
TAPE TRANSPORT &  
PRECISION DECAY  
FACILITY  
1999

Q<sup>3</sup>  
SPECTROMETER  
2012



TAMU TRAP  
2012, 2020

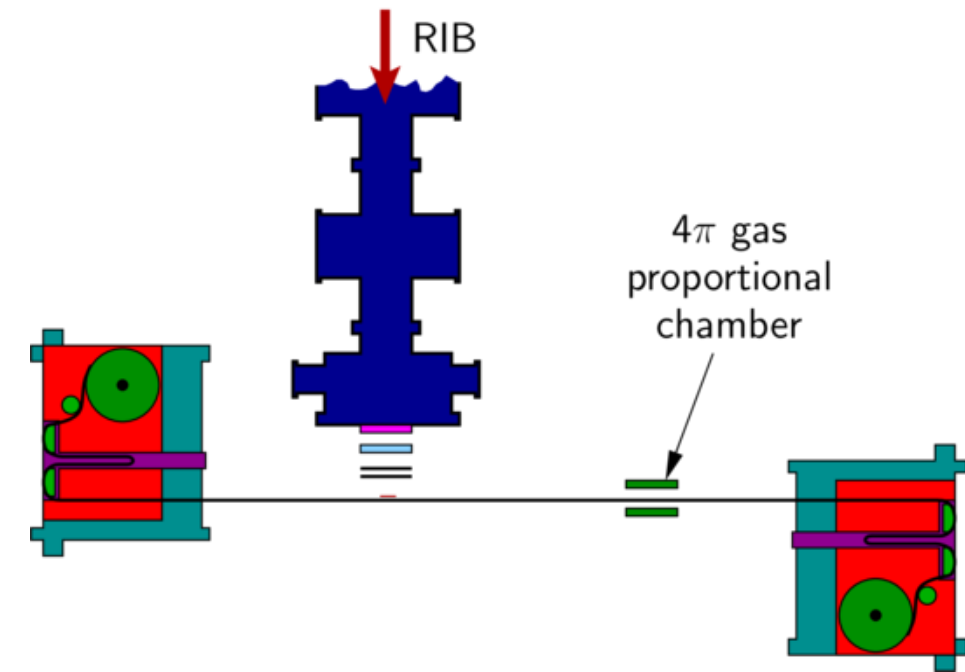
RADIATION  
EFFECTS  
FACILITY  
2015



# Fast-tape transport system (Hardy and Iacob)

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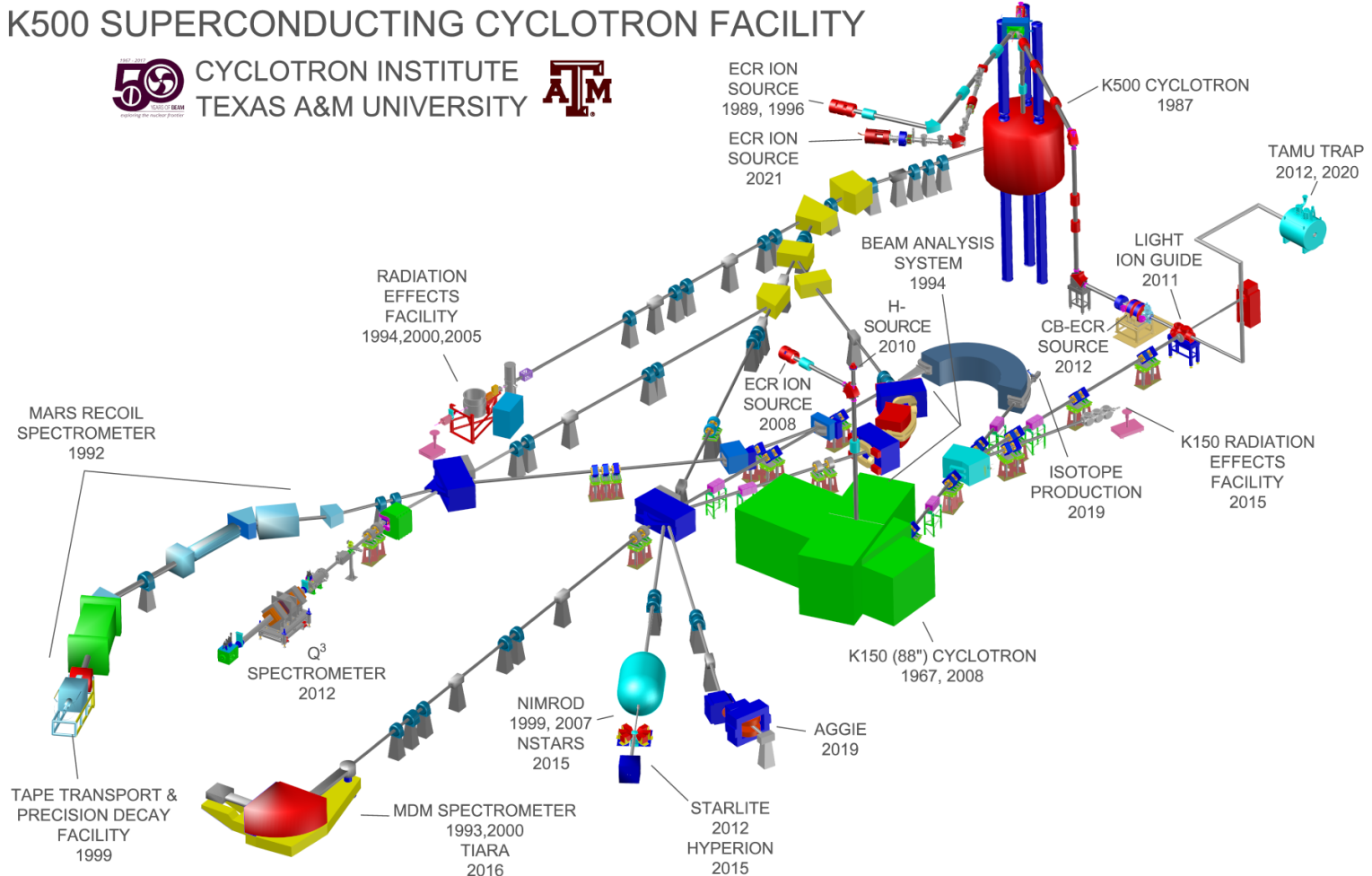
• Lifetimes and branching  
ratios ( $V_{ud}$ )



## K500 SUPERCONDUCTING CYCLOTRON FACILITY



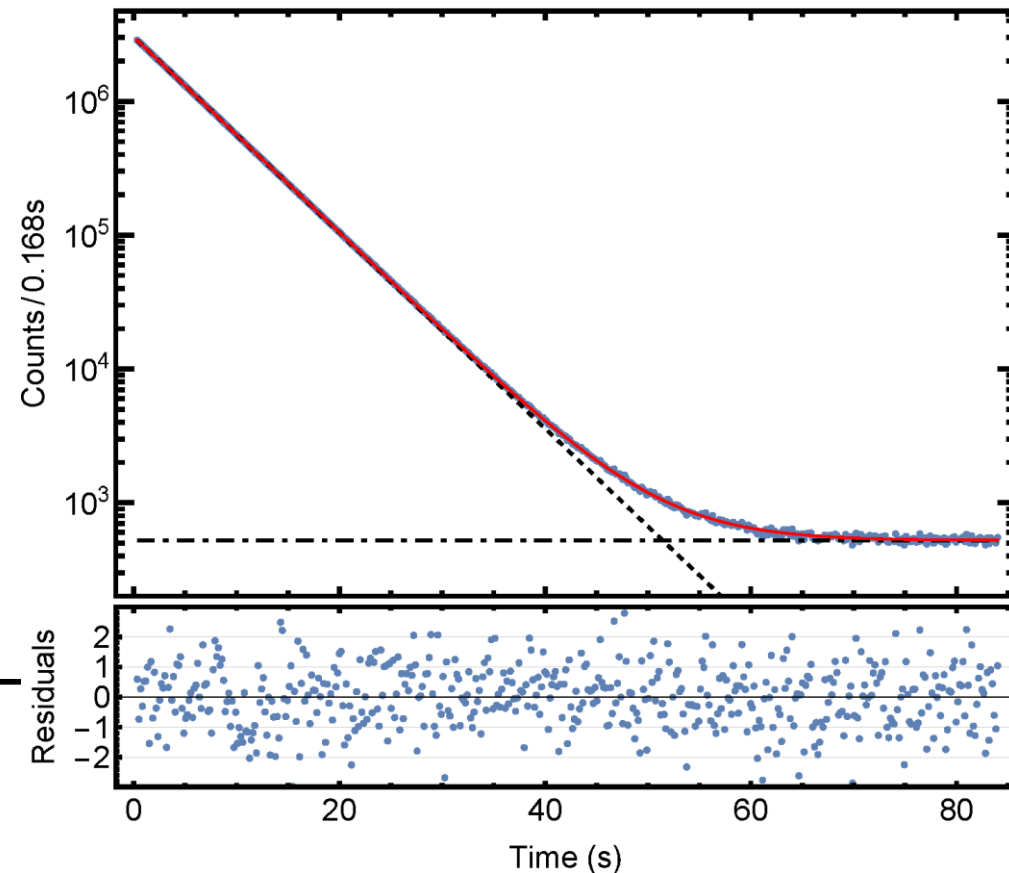
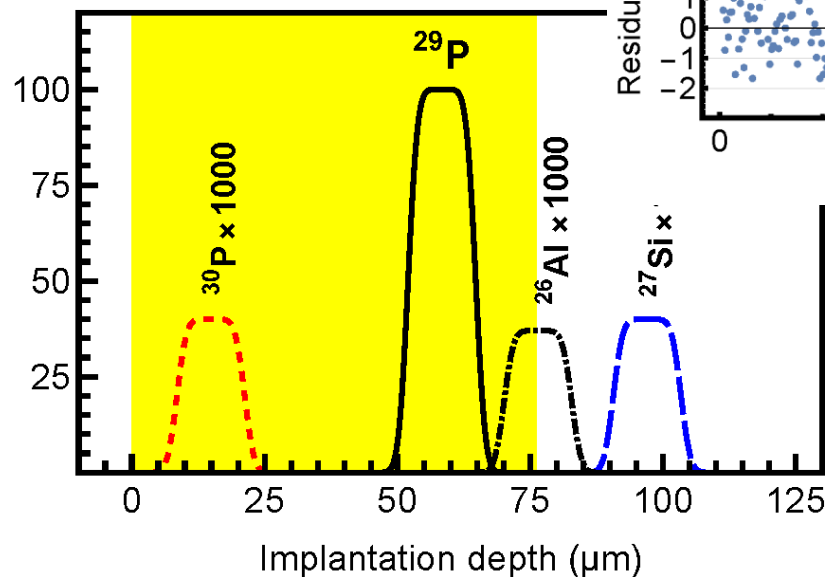
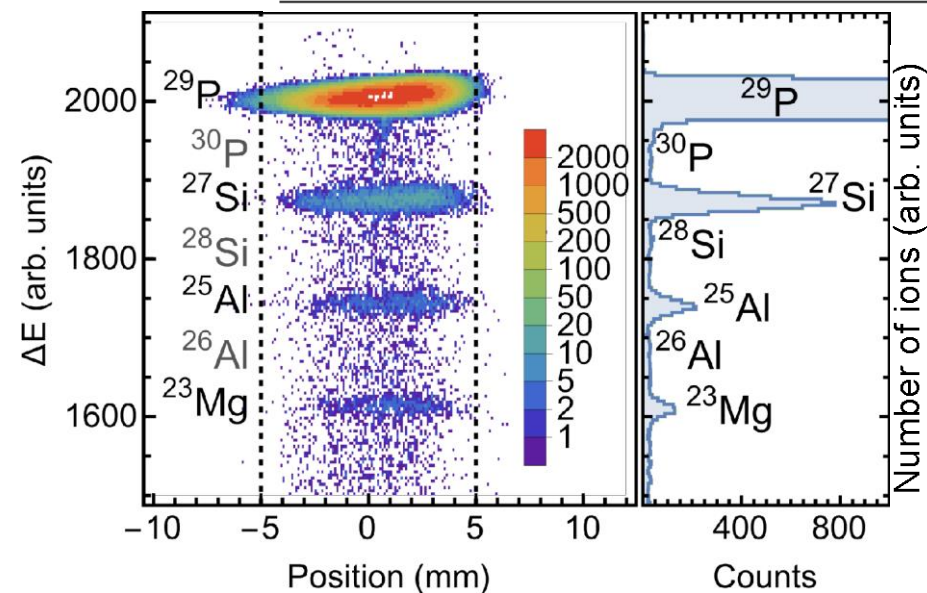
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# Lifetime example: $^{29}\text{P}$

🌐 Degraders let us tune where activity is implanted in the tape and further purify the beam out of MARS

Source	Uncertainty (ms))
statistics	0.6
$^{30}\text{P}$ half-life	0
$^{26}\text{Al}$ half-life	0.01
sample impurities ( $^{30}\text{P} + ^{26}\text{Al}$ )	0.4
total	0.8
$^{29}\text{P}$ half-life	4.1146(8) s



$2\sigma$  tension with 2020  
result of Long *et al.*:

$$t_{1/2} = 4.1055(44) \text{ s}$$

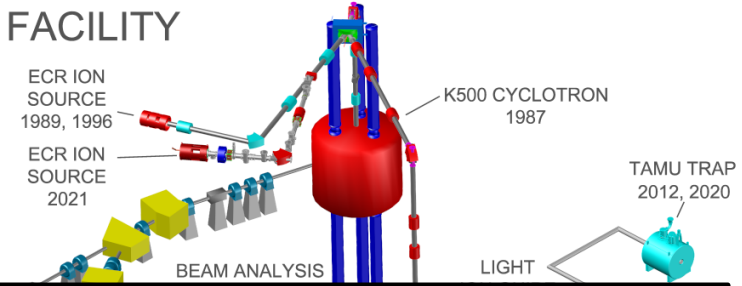


# Fast-tape transport system (Hardy and Iacob)

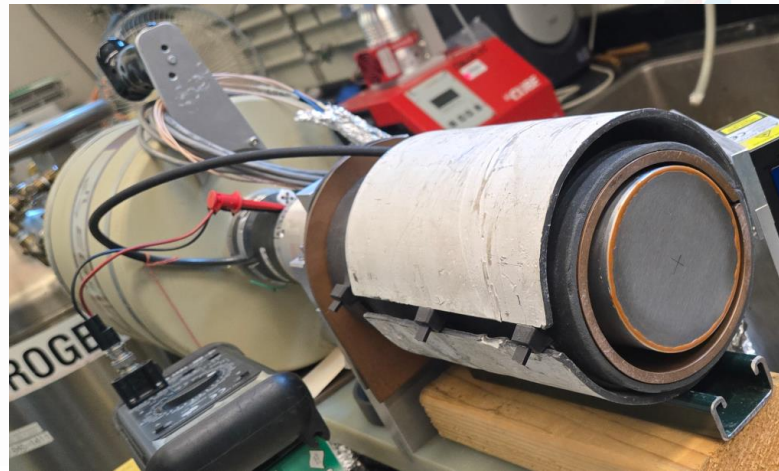
Fundamental symmetries:  
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Lifetimes and branching  
ratios ( $V_{ud}$ )

K500 SUPERCONDUCTING CYCLOTRON FACILITY

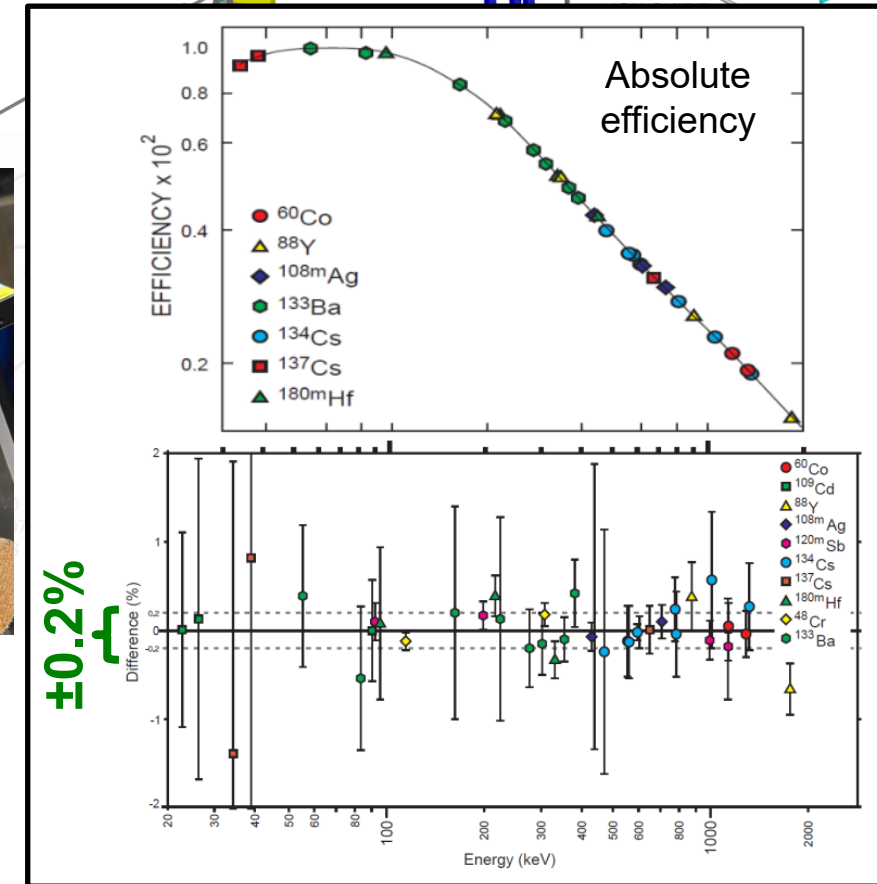
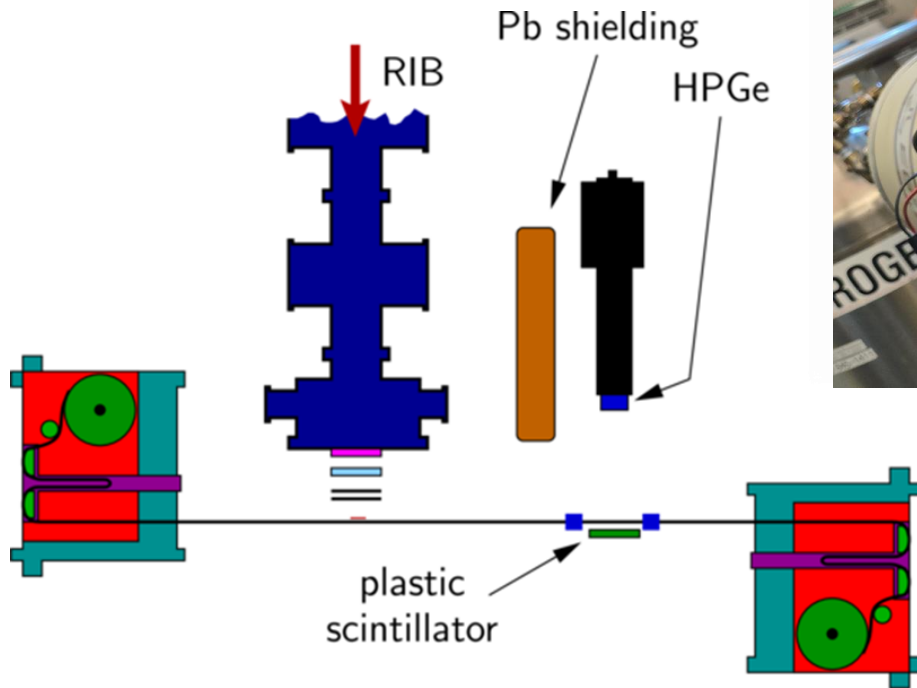


RADIATION  
EFFECTS  
FACILITY  
1994, 2000, 2005

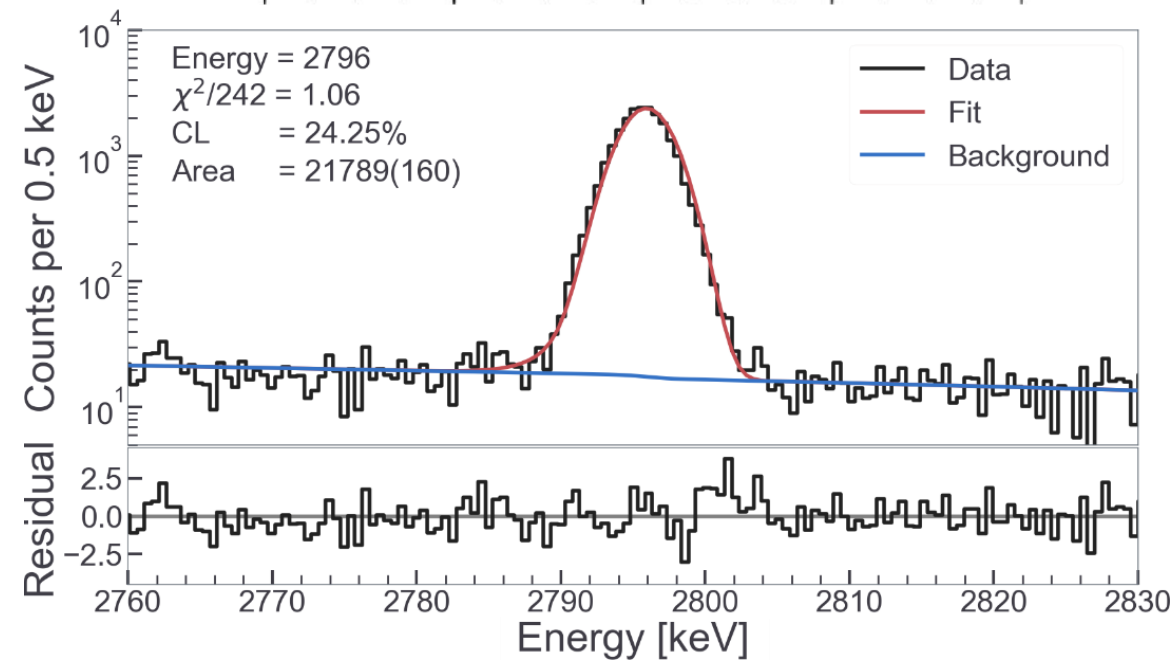
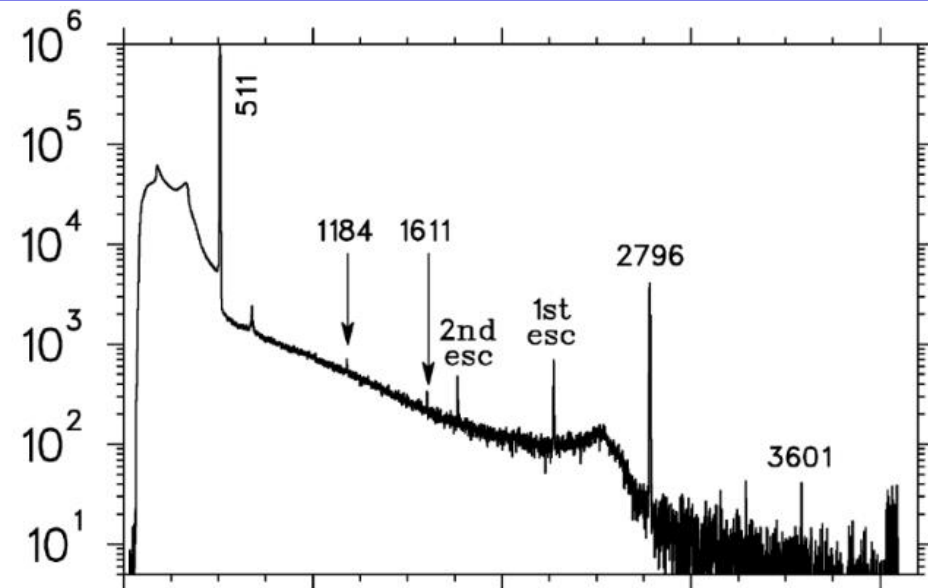
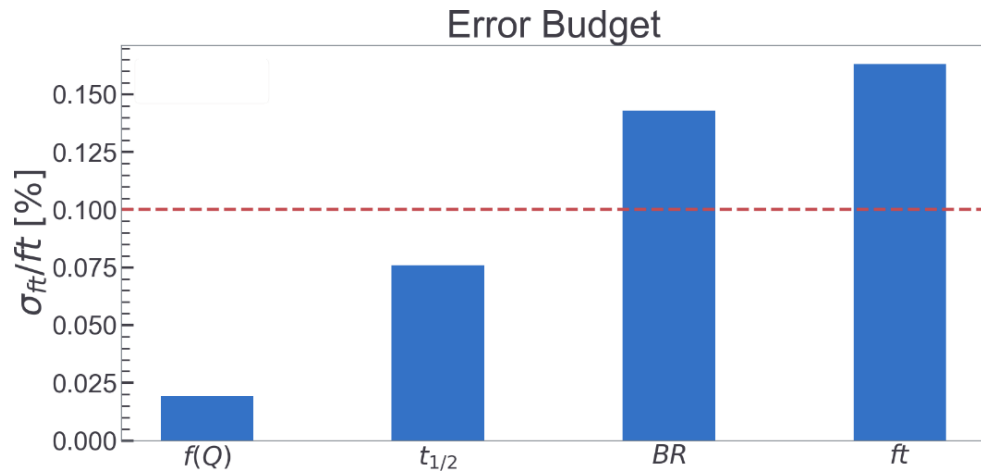
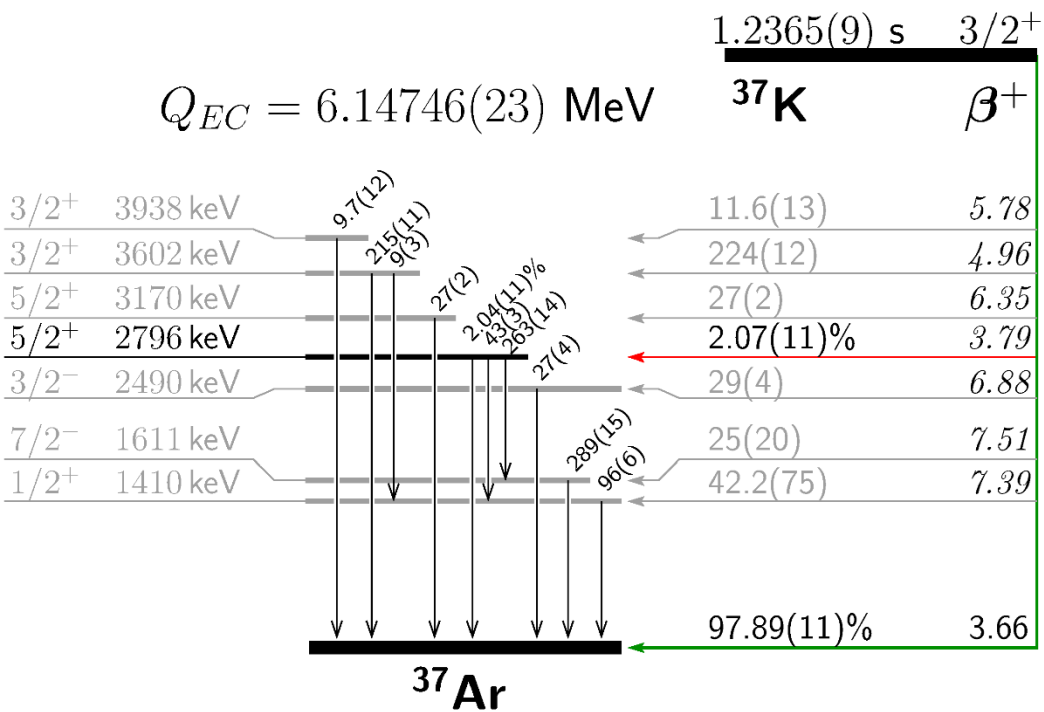


FACILITY  
1999

1993, 2000  
TIARA  
2016

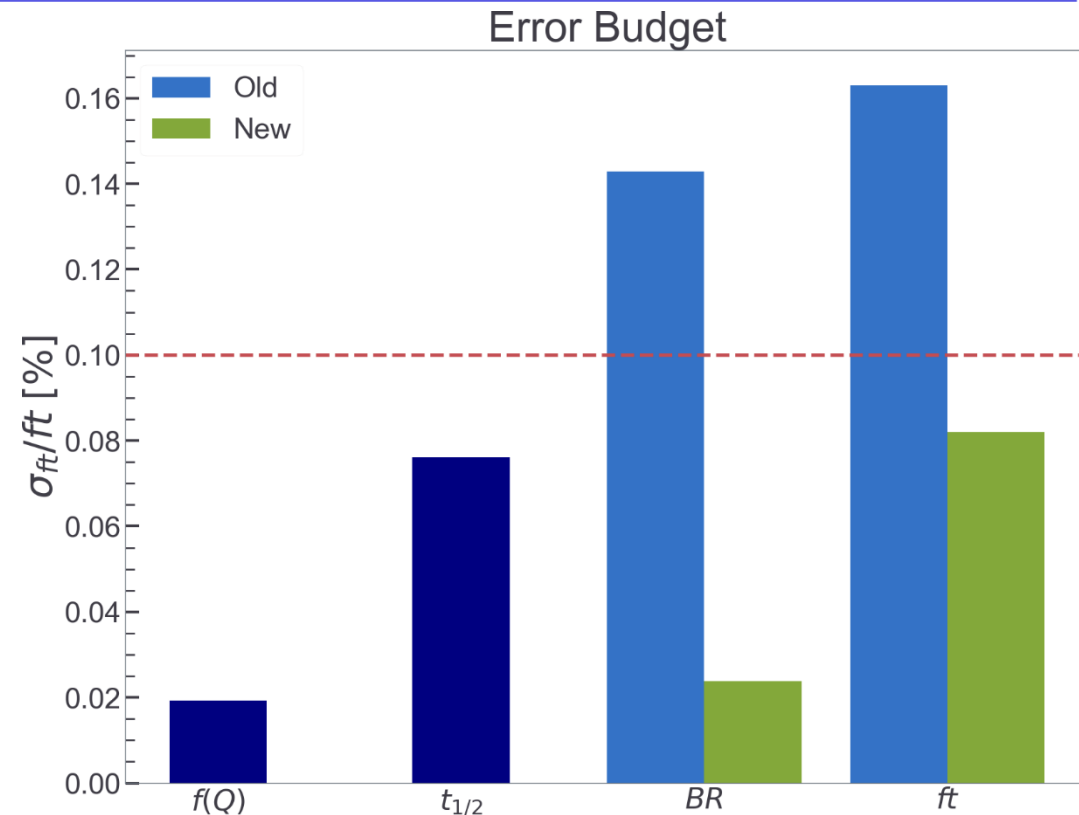


# Branching ratio example: $^{37}\text{K}$



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Source	Uncertainty, $\sigma_{\text{BR}}$ [%]			
	$E_\gamma = 1184 \text{ keV}$	1611 keV	2796 keV	3601 keV
$\gamma$ efficiencies	0.0001	0.0002	0.012	0.0002
$t_\beta - t_\gamma$ cuts	0.0006	0.0007	0.006	0.0012
Preemption	0.0001	0.0001	0.005	<0.0001
$\beta/\text{HI}$ cuts	0.0011	0.0002	0.004	<0.0001
Fitting range	0.0002	0.0002	<0.001	<0.0001
Total systematics	0.0013	0.0008	0.015	0.0013
Statistical	0.0032	0.0030	0.017	0.0024
Total uncertainty	0.0035	0.0031	0.022	0.0027



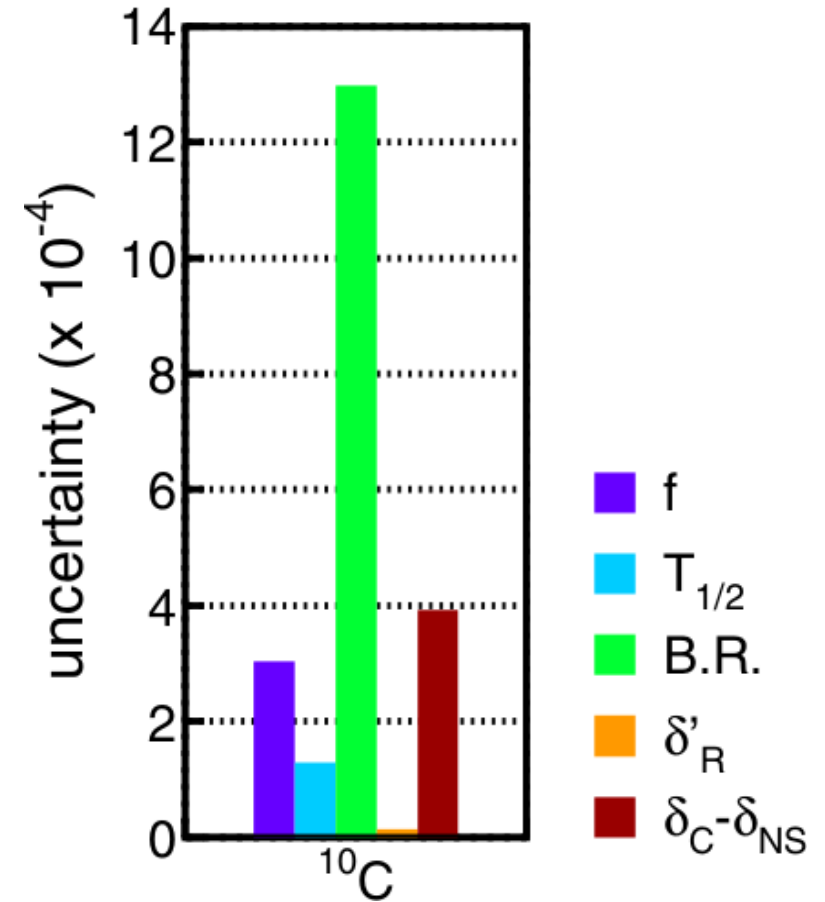
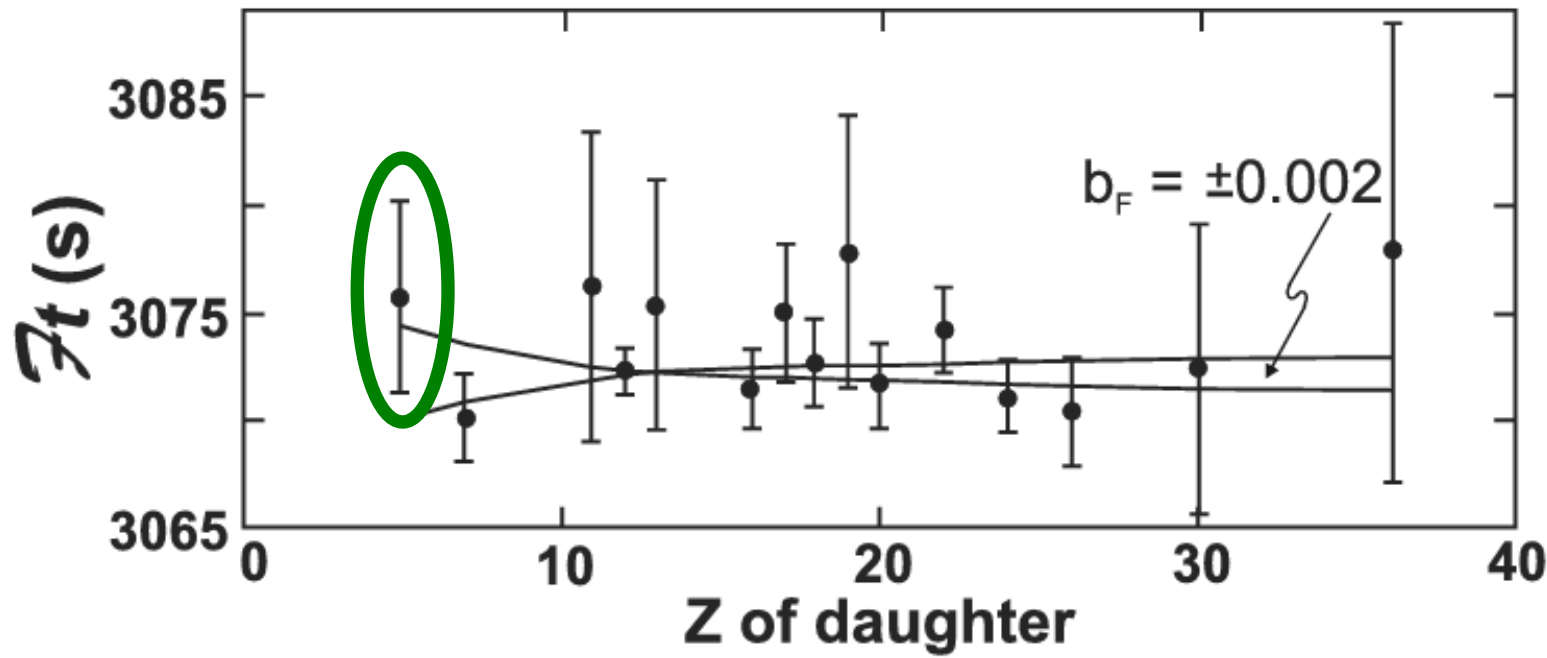
BR: 97.99(14)%  $\rightarrow$  97.81(2)%

$ft$ : 4576(8) s  $\rightarrow$  4585(4) s

$|V_{ud}|$ : stay tuned

# Another branching ratio – $^{10}\text{C}$

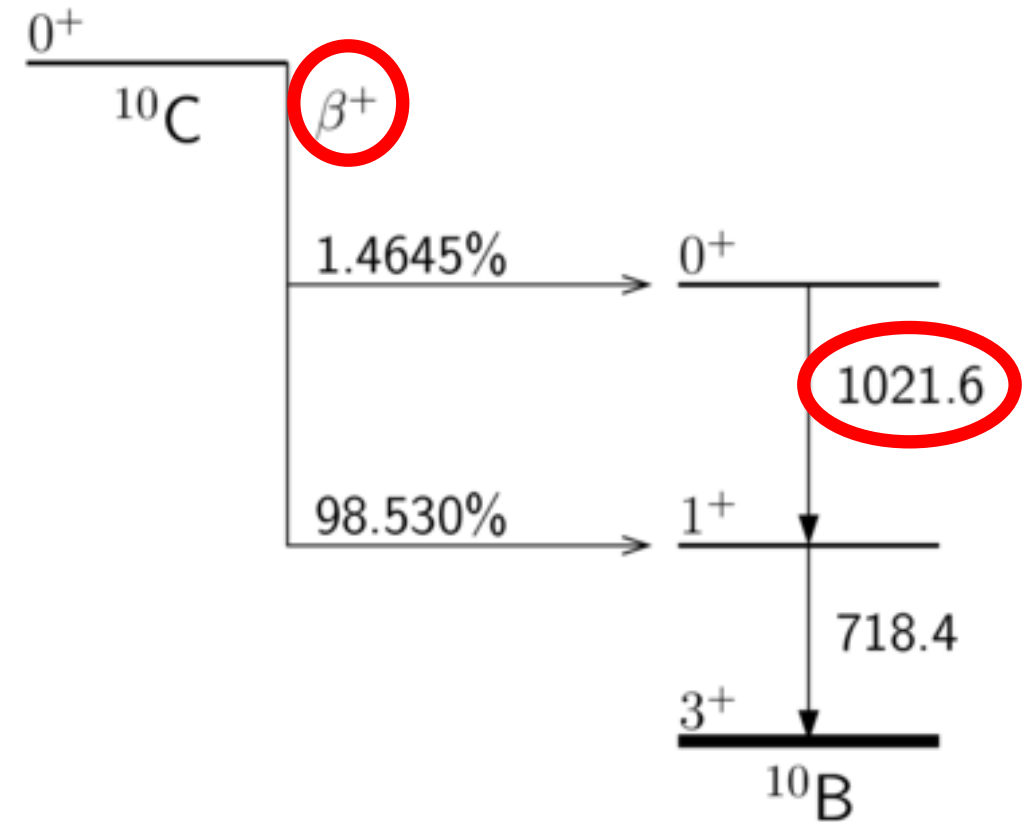
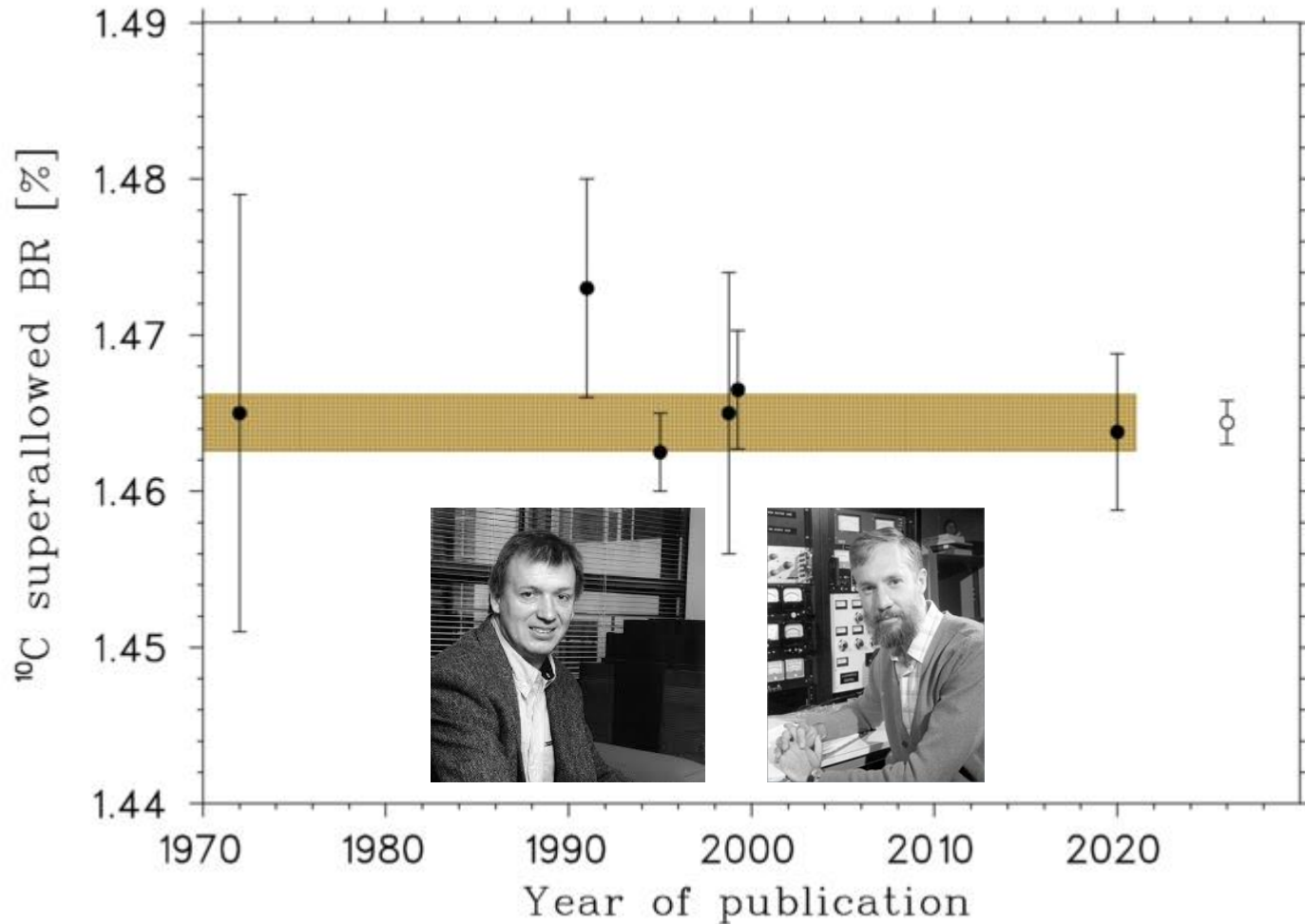
- One of if not the most important  $0^+ \rightarrow 0^+$  decays to be improved





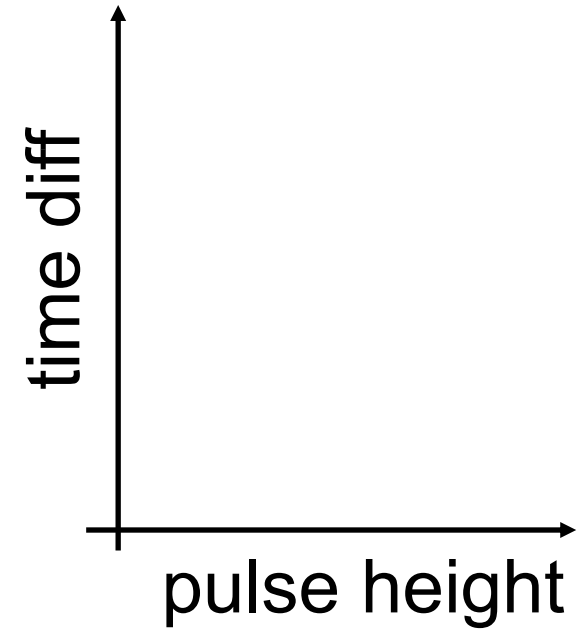
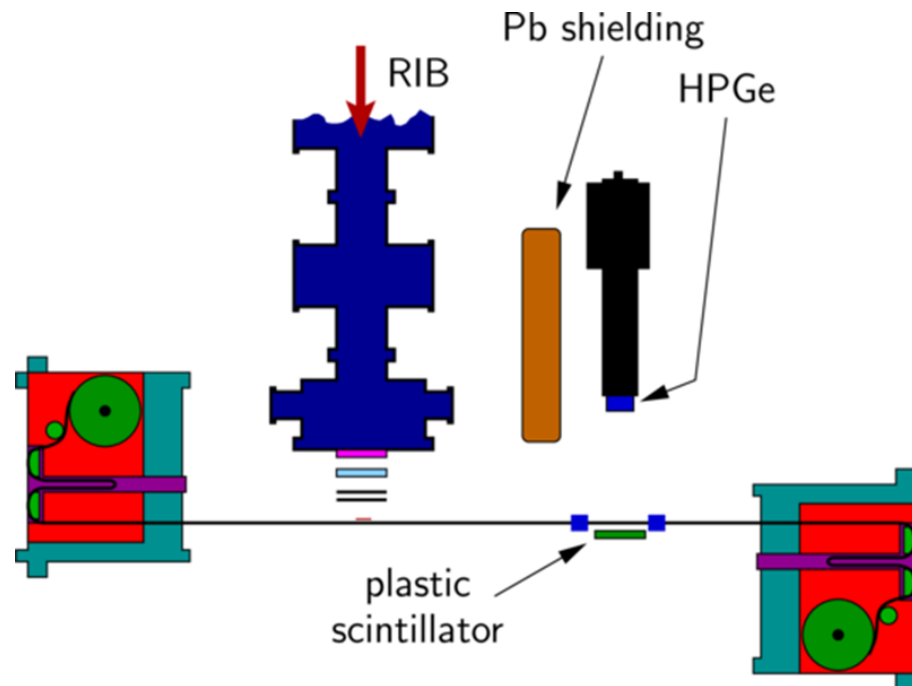
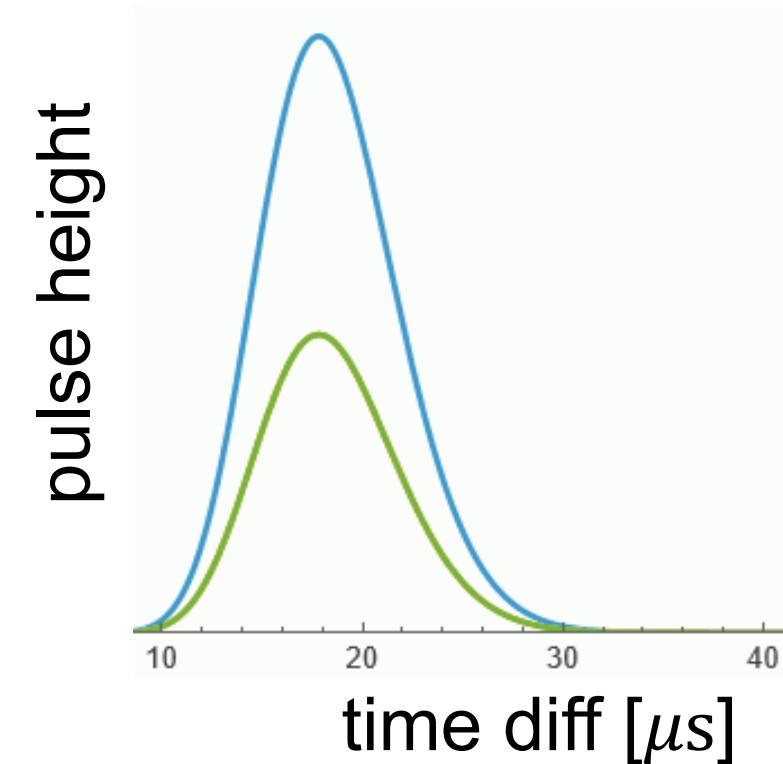
# Another branching ratio – $^{10}\text{C}$

- One of if not the most important  $0^+ \rightarrow 0^+$  decays to be improved
- Sometime, nature can be cruel...



# Victor's idea

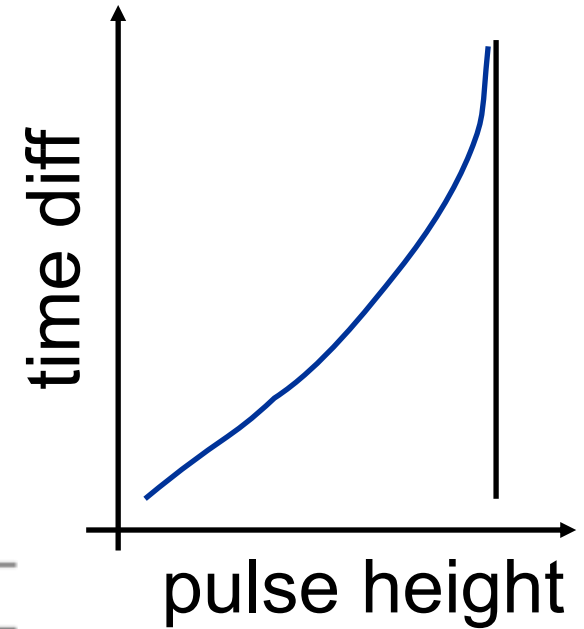
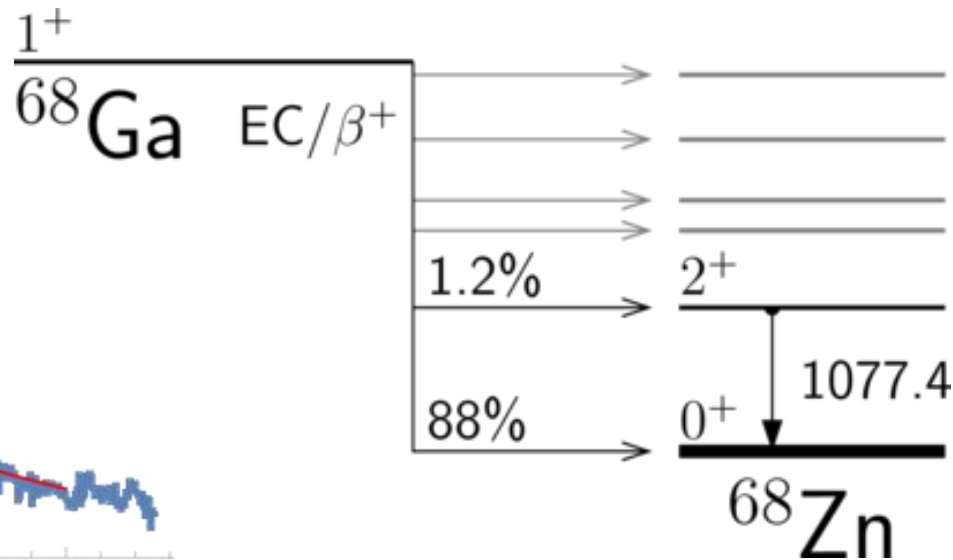
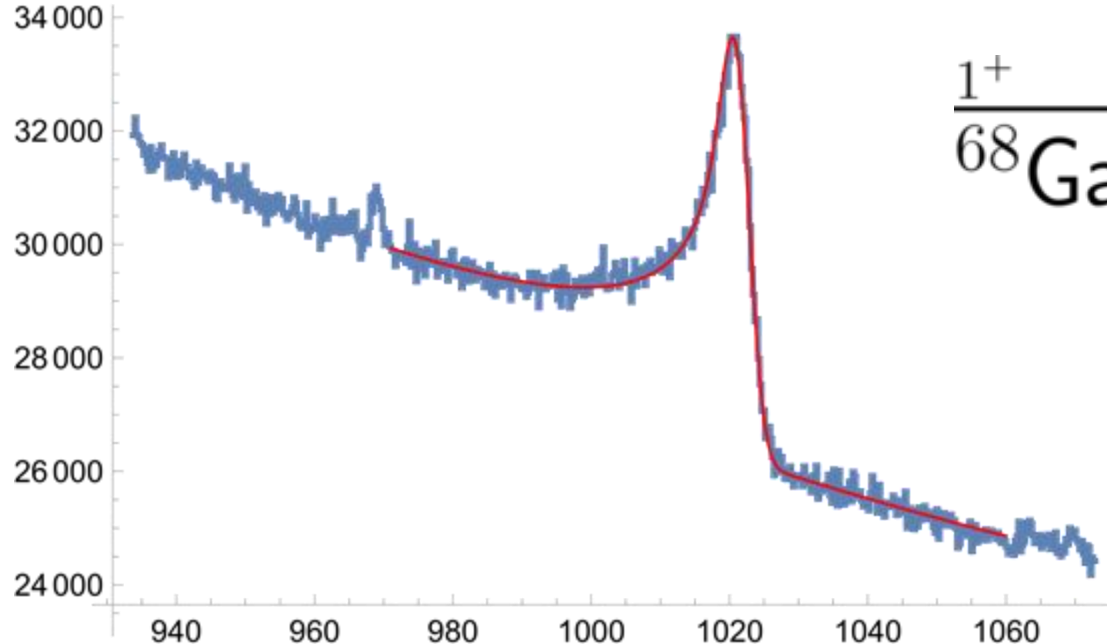
- If you can know how many 511+511s are in your peak, you can still make a precision measurement
- Model summing with HPGe response
  - ✱ Normalize to times prior to coincidence window
  - ✱ Subtract random summing from true 1022-keV peak



# Victor's idea

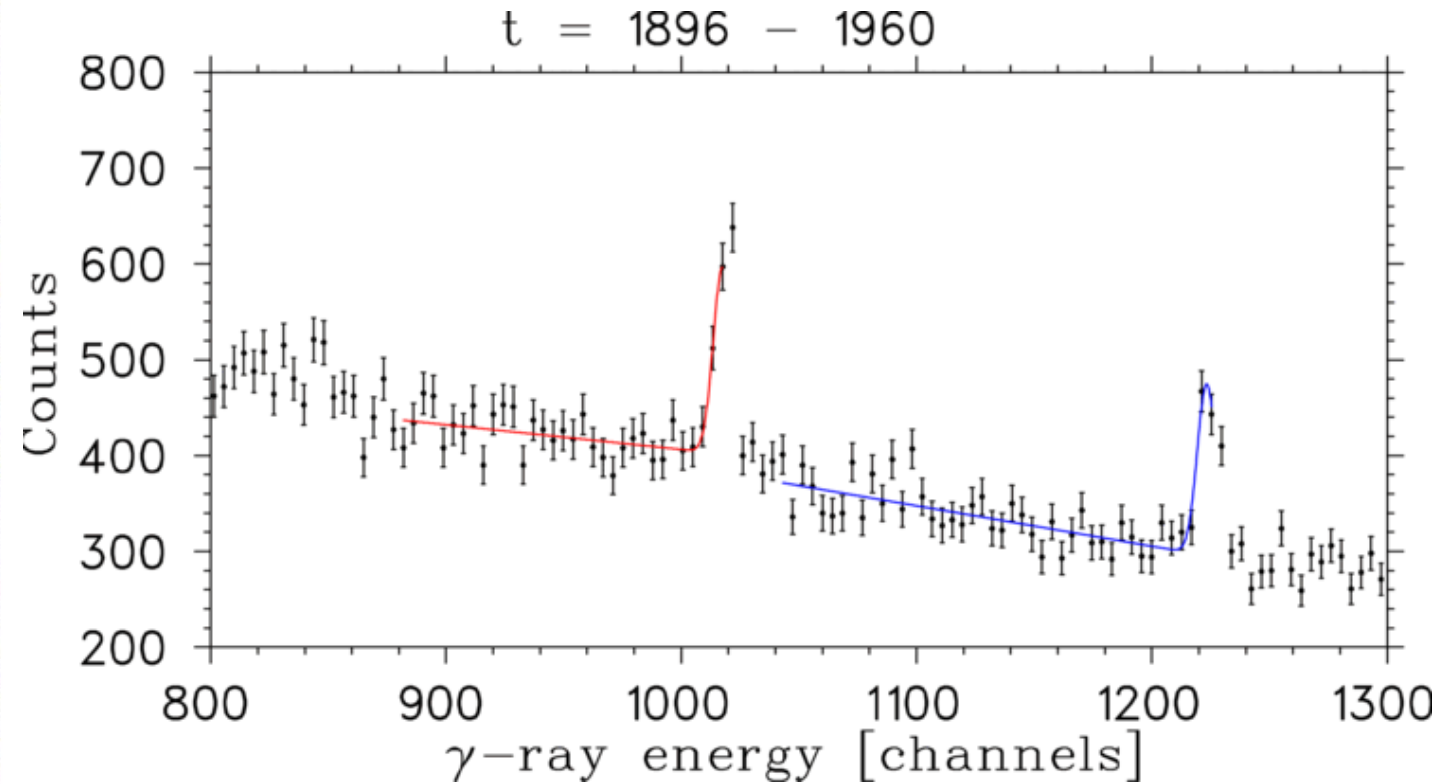
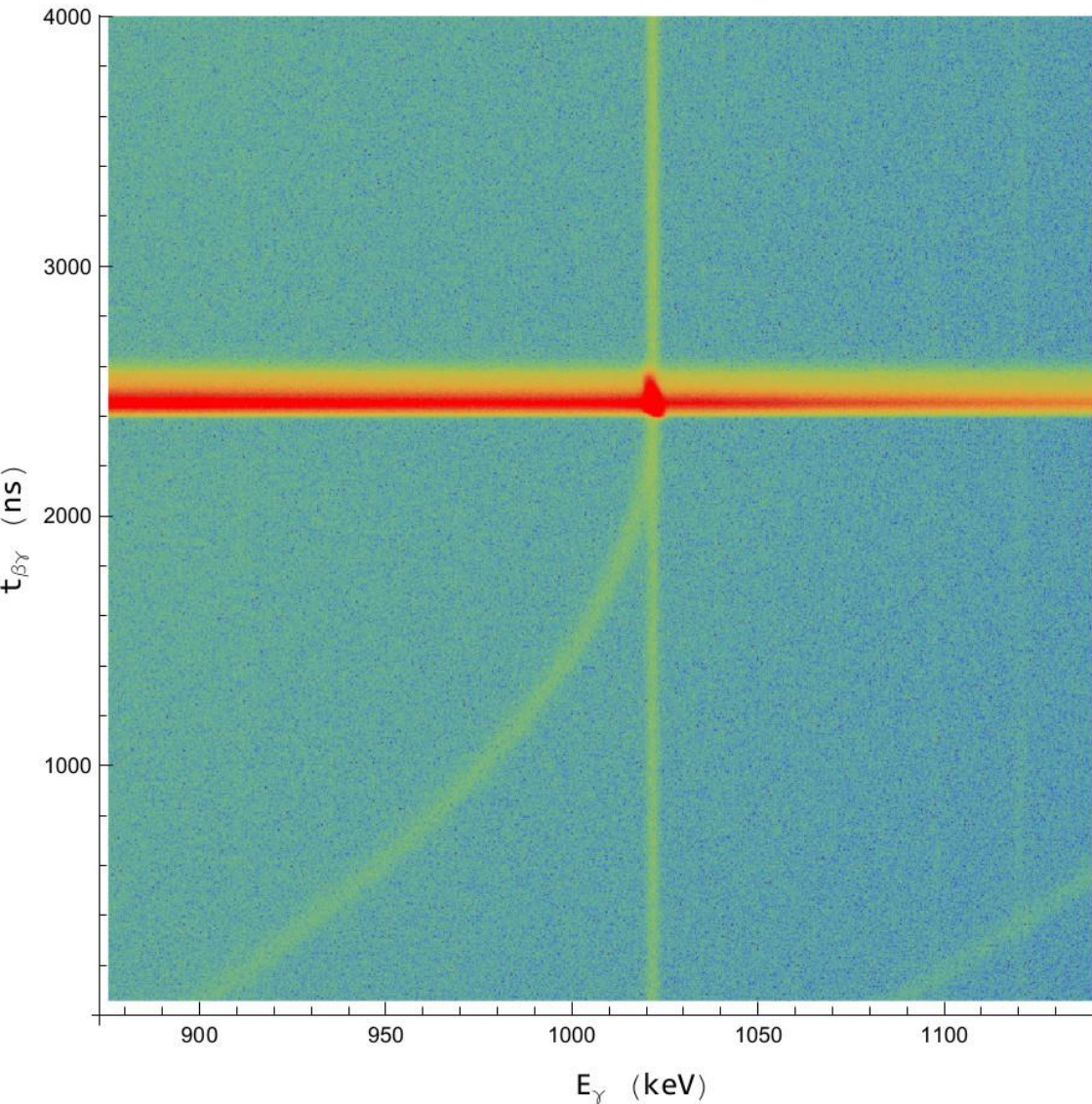
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## • Tested with $^{68}\text{Ge}/\text{Ga}$



# We got a few 2-week beamtimes – and good data!

🌌 Better than expected, really



# Recent $^{10}\text{C}$ – first runs (more data this spring)

- Pile-up is a concern, but at 3 kHz in the HPGe correction is  $<0.2\%$ 
  - ✱ Can test this by making different cuts on the time in the cycle as the intensity drops
- Dominant systematic will be the HPGe efficiency; expect  $0.1\%$  uncertainty
- In 2 weeks of actual beamtime, we got 4 full days of counting. Ended up with  $10^5$  counts in the 1022 peak with a statistical uncertainty of  $0.3\%$ 
  - ✱ Analysis  $\Rightarrow$  no show-stoppers
  - ✱ 3 runs for  $\sim 650\text{k}$  events; one more two-week run should do it
  - ✱ Expect to get statistical uncertainty under  $0.1\%$ , about  $0.15\%$  overall?

Best:  $B = 1.4625(25)\% \pm 0.17\%$

Average:  $B = 1.4644(18)\% \pm 0.12\%$