# 2-Proton Radioactivity of $^{67}$Kr

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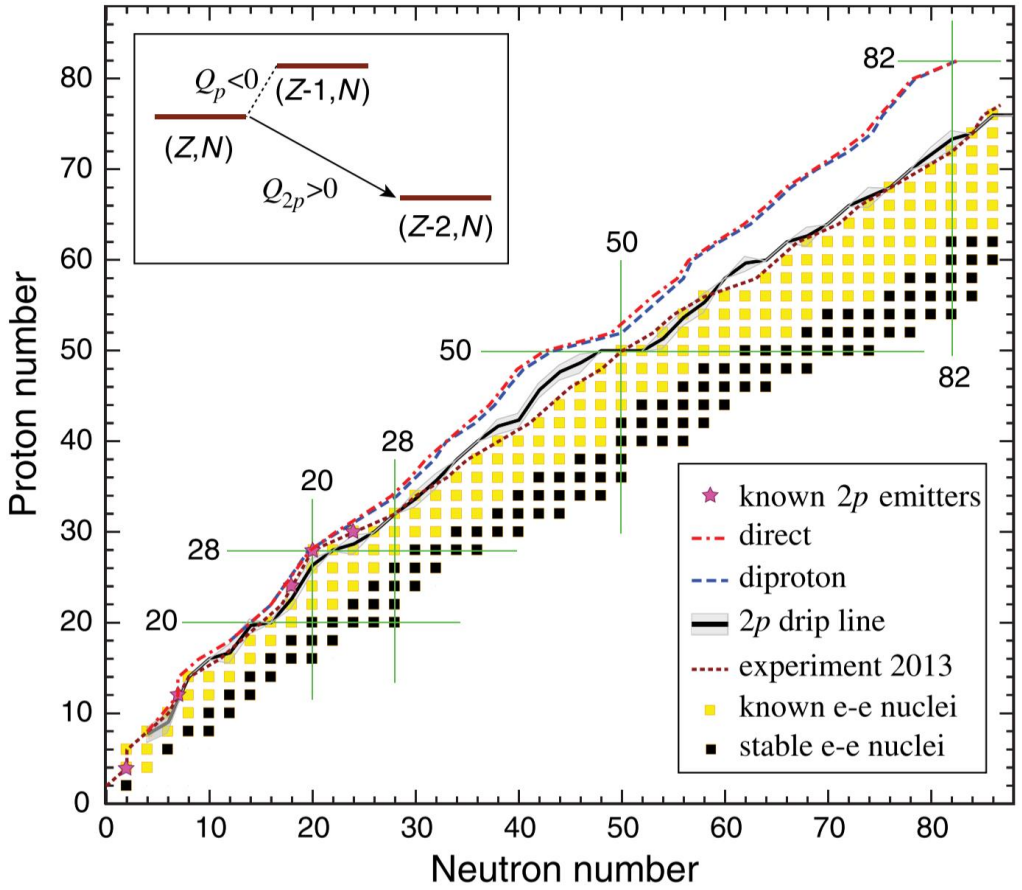
# Introduction

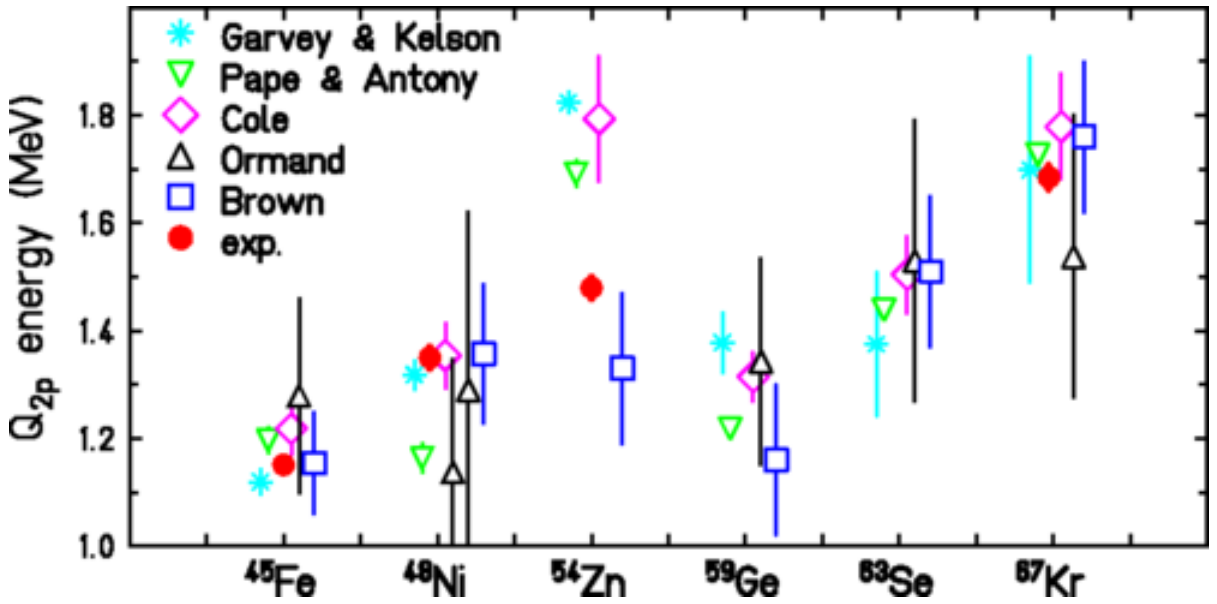



[1]

- Q-value increases as binding energy decreases toward proton drip line
- 2p decay must have positive $S_p$ values to occur
- For medium-mass nuclei, the half life is on the order of ms
- Powerful tool for studying nuclear structure beyond limits of stability

# Introduction

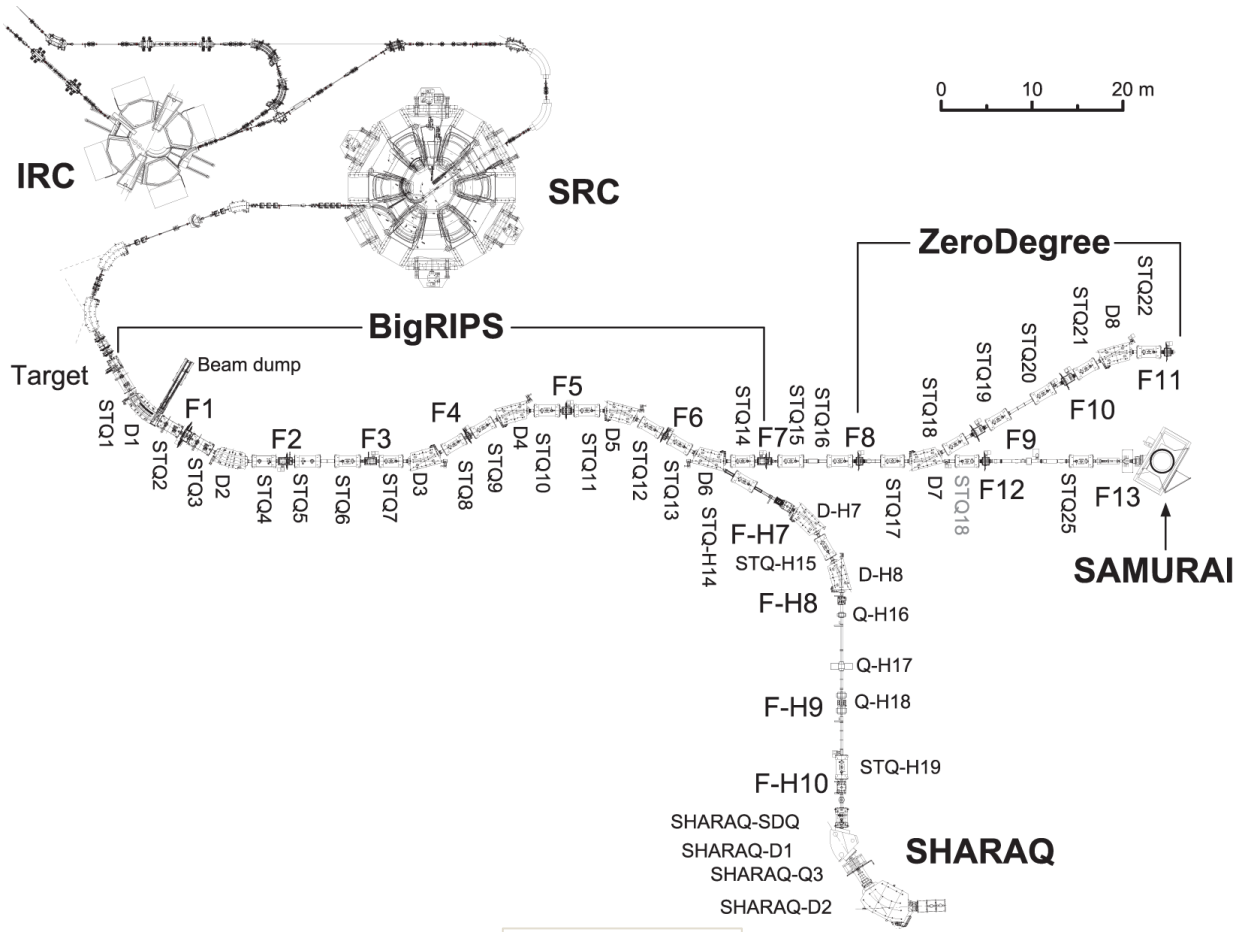
- 2p-decay was first discovered in $^{45}$Fe and $^{54}$Zn at GANIL
- From mass and Q values, $^{59}$Ge, $^{63}$Se, and $^{67}$Kr were the next candidates
- Between the 3 rare isotopes, $^{67}$Kr was the most likely candidate




[2]

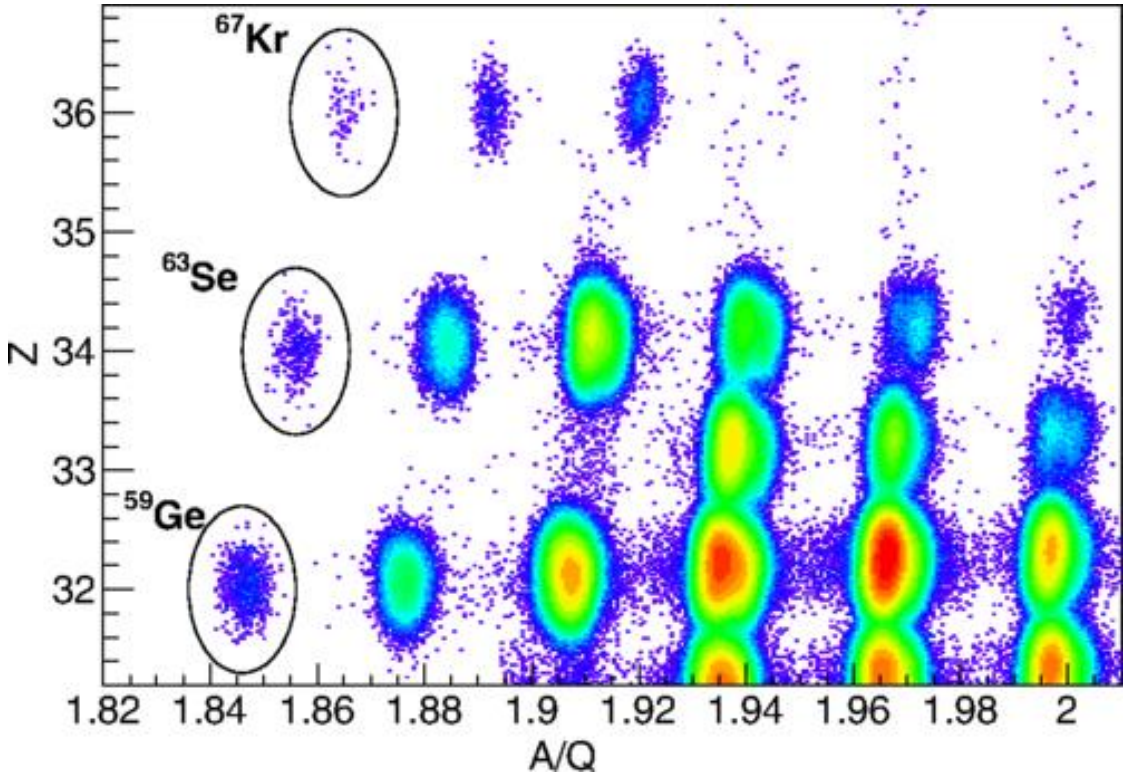
# RIKEN Facility

- Fragmented a $^{78}$Kr beam at 345 MeV/u on Beryllium target
- Fragments of interest identified at F5 in BigRIPS
- Fragments of interest sent through the ZeroDegree Spectrometer (ZDS)
- Sent down beamline where two experimental detectors are set up




[3]

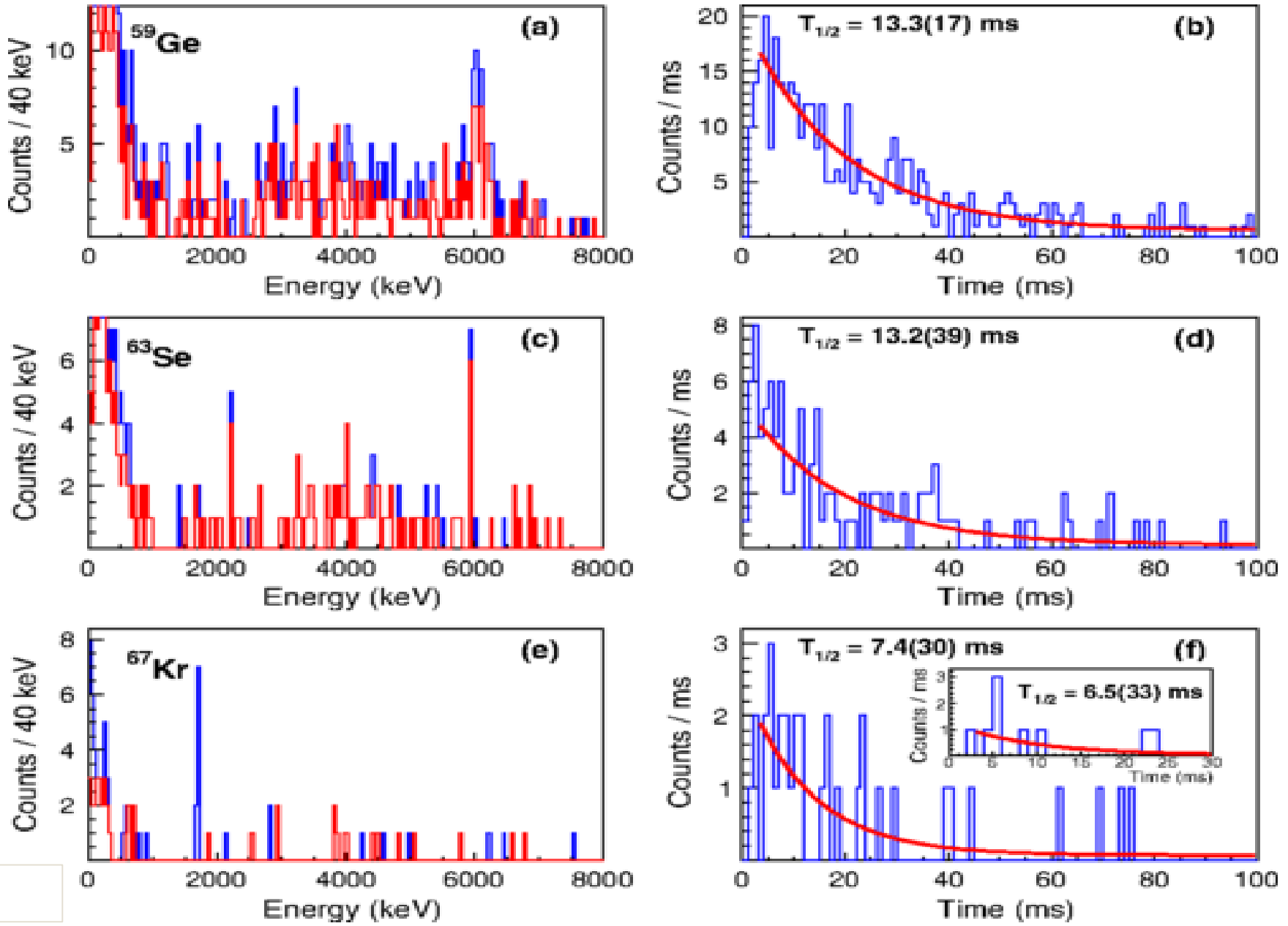
# Experimental Design




[2]

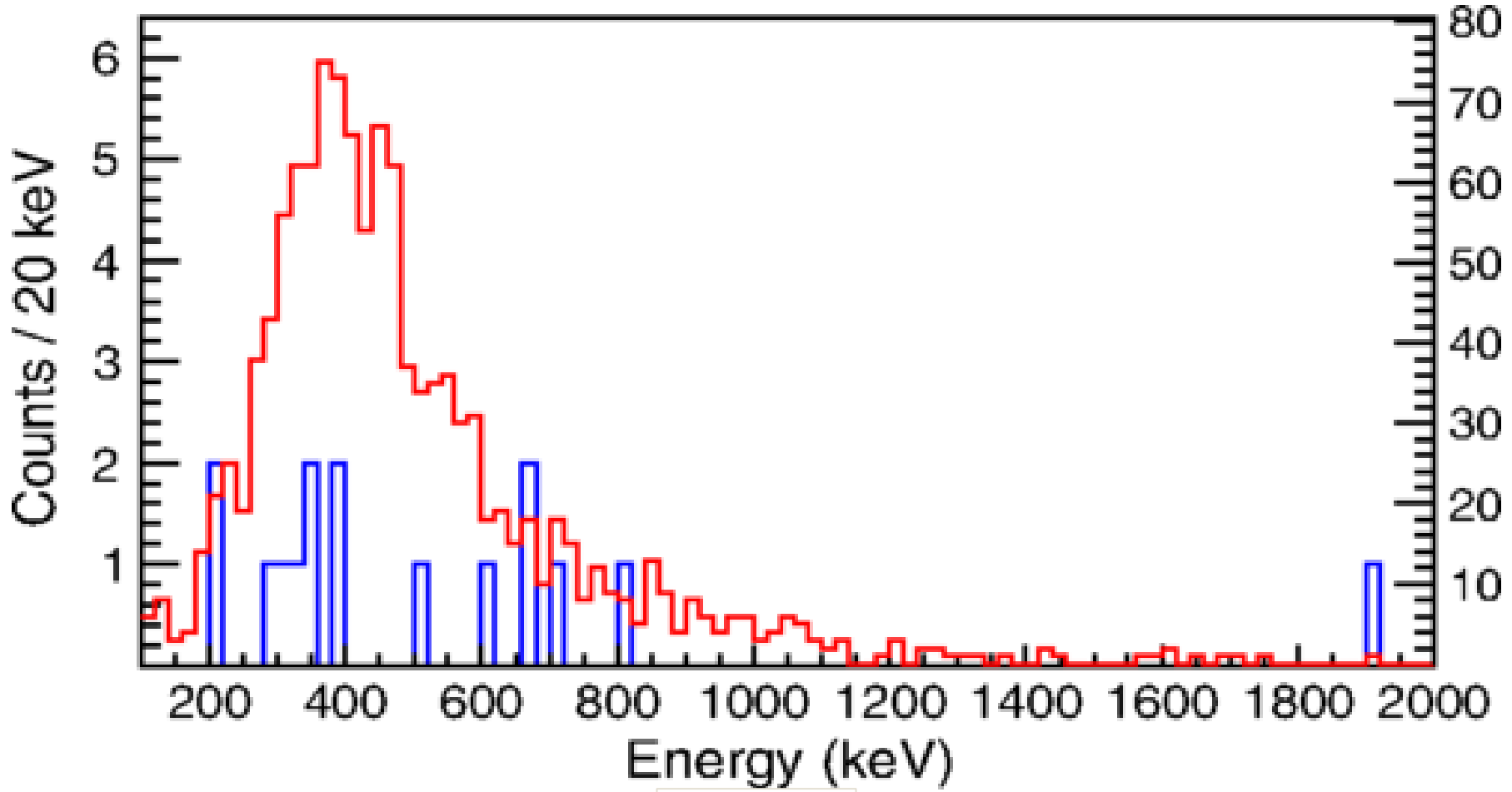
- Fragments implanted in WAS3ABi for charged particle detection
  - Consists of 3 DSSSD
- Surrounded by EURICA, a germanium detector array
  - Consists of 12 EUROBALL clusters that have 7 germanium crystals

# Results


(a)
$^{59}$Ge
Counts / 40 keV
Energy (keV)
(b)
$T_{1/2}$ = 13.3(17) ms
Counts / ms
Time (ms)
(c)
$^{63}$Se
Counts / 40 keV
Energy (keV)
(d)
$T_{1/2}$ = 13.2(39) ms
Counts / ms
Time (ms)
(e)
$^{67}$Kr
Counts / 40 keV
Energy (keV)
(f)
$T_{1/2}$ = 7.4(30) ms
$T_{1/2}$ = 6.5(33) ms
Counts / ms
Time (ms)

[2]

# Results


Counts / 20 keV
1
2
3
4
5
6
10
20
30
40
50
60
70
80
200
400
600
800
1000
1200
1400
1600
1800
2000
Energy (keV)

[2]

# Discussion

- 2p-decay is absent in both $^{59}$Ge and $^{63}$Se
- After corrections due to dead-time losses, approximately 13 2p events at an energy E = 1690(17) keV
- Branching ratio of 37% for the 2p-decay in $^{67}$Kr
- No signals were found for a coincidence between the 2p-decay and β decay
- 511 keV photons were also not in coincidence with the 2p-decay

# Conclusions

- Experimental confirmation of a new ground state 2p emitter, with a $T_{1/2}$ = 7.4 ms and a peak at E = 1690 keV
- Next step is an experiment with Time Projection Chamber to study nuclear structure
- This would provide evidence for the deformation of 2p emission process
- Theoretical models that include mixing configuration and deformation are needed

# References


1. E. Olsen, M. Pfützner, N. Birge, M. Brown, W. Nazarewicz, and A. Perhac, Phys. Rev. Lett. **110** 222501 (2013)
2. T. Goigoux *et al.*, Phys. Rev. Lett. **117** 162501 (2016)
3. T. Kubo *et al.*, Prog. Theor. Exp. Phys. 03C003 (2012)