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Alpha decay in the actinide region

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2022 STFC Nuclear Physics Summer School

Motivation

Experiment JM20 was carried out in the Accelerator Laboratory of the Univeristy of Jyväskylä in November 2021.

Its main objective was to study Quasi-Fission.

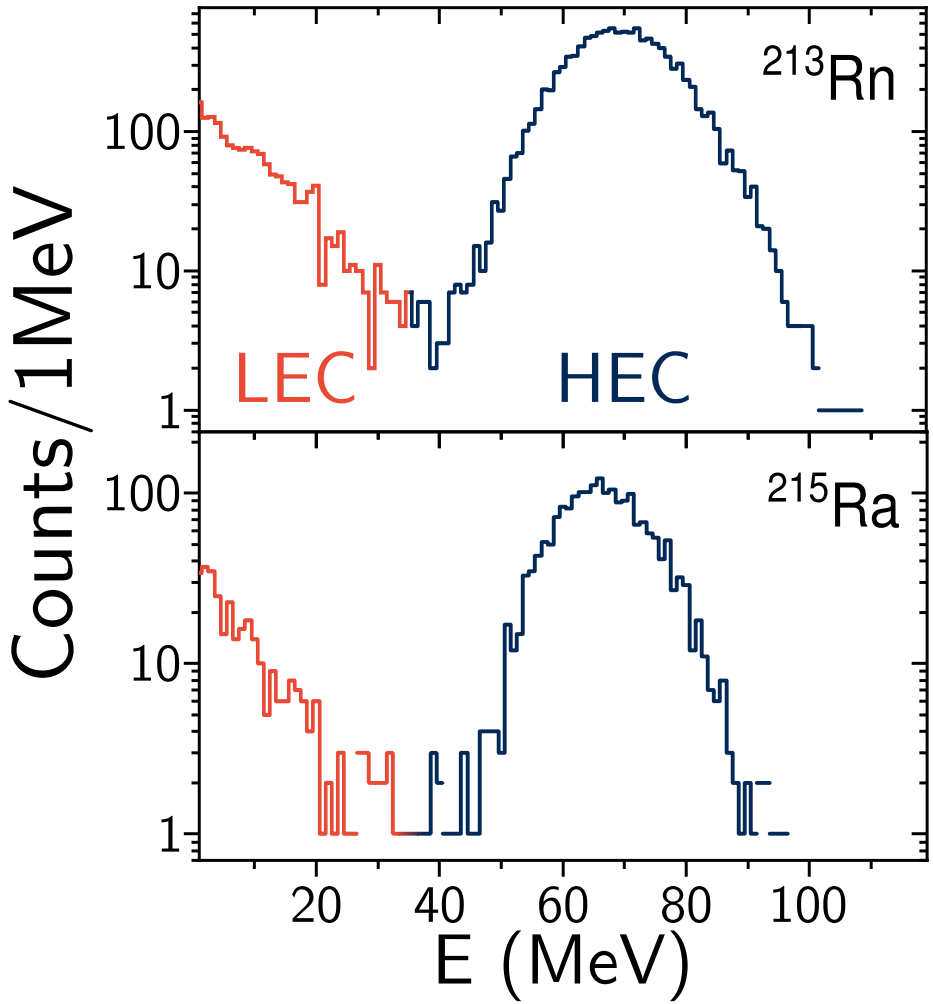
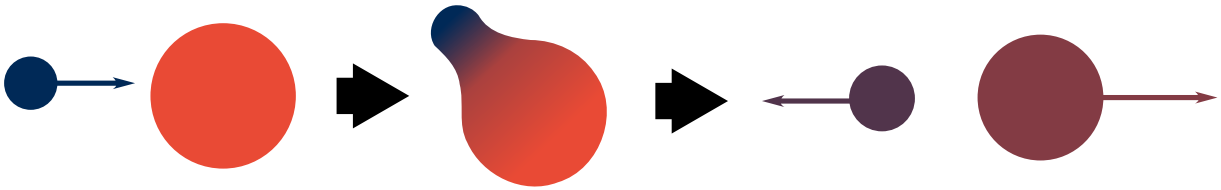


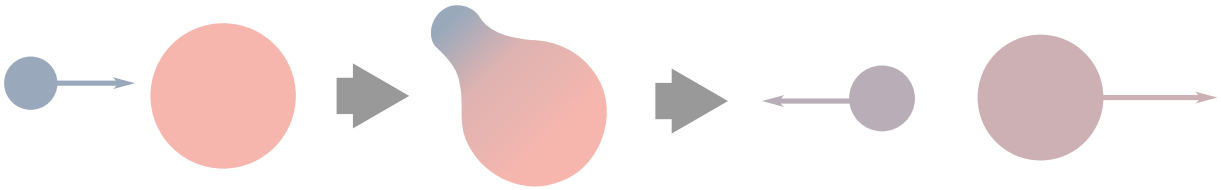
Fig 1: Energy distribution of the non-fusion products of ^{50}Ti+^{249}Cf at TASCA.

Motivation

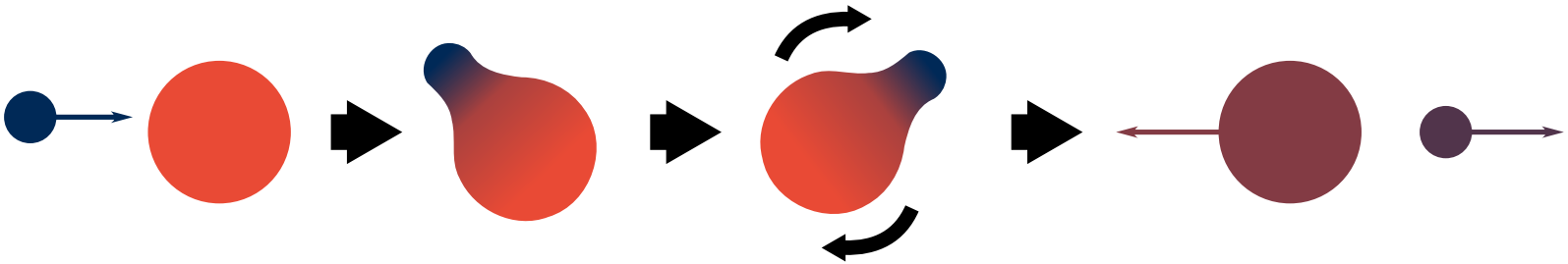


The high energy component is analogous to a usual fission reaction, where an inelastic collision occurs.

Motivation



The low energy component can be interpreted as the rotation of the compound in the centre-of-mass frame before fission.



Motivation

Reactions used:

$$^{65}\mathrm{Cu} + \begin{cases} ^{209}\mathrm{Bi} \\ ^{238}\mathrm{U} \end{cases}$$

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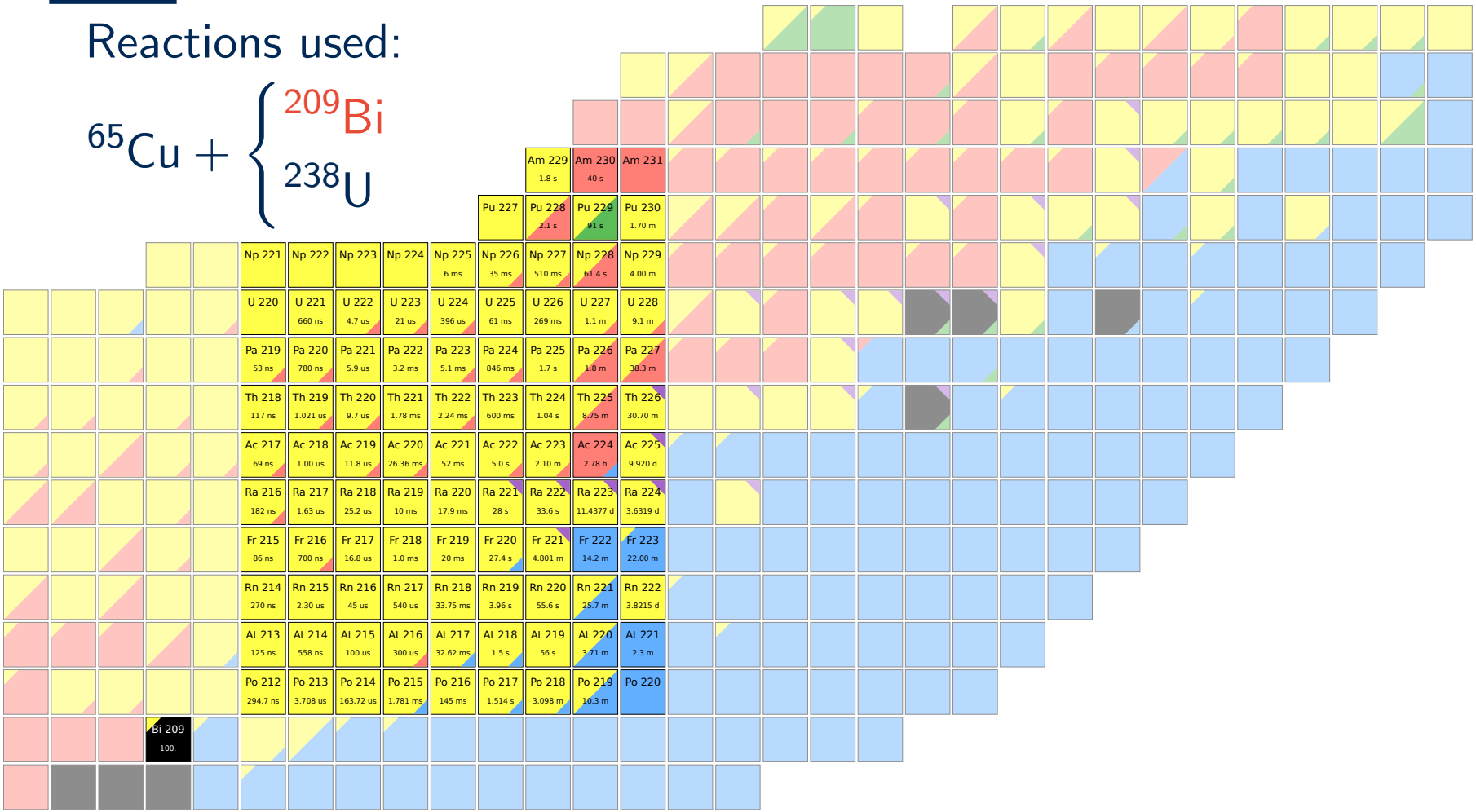

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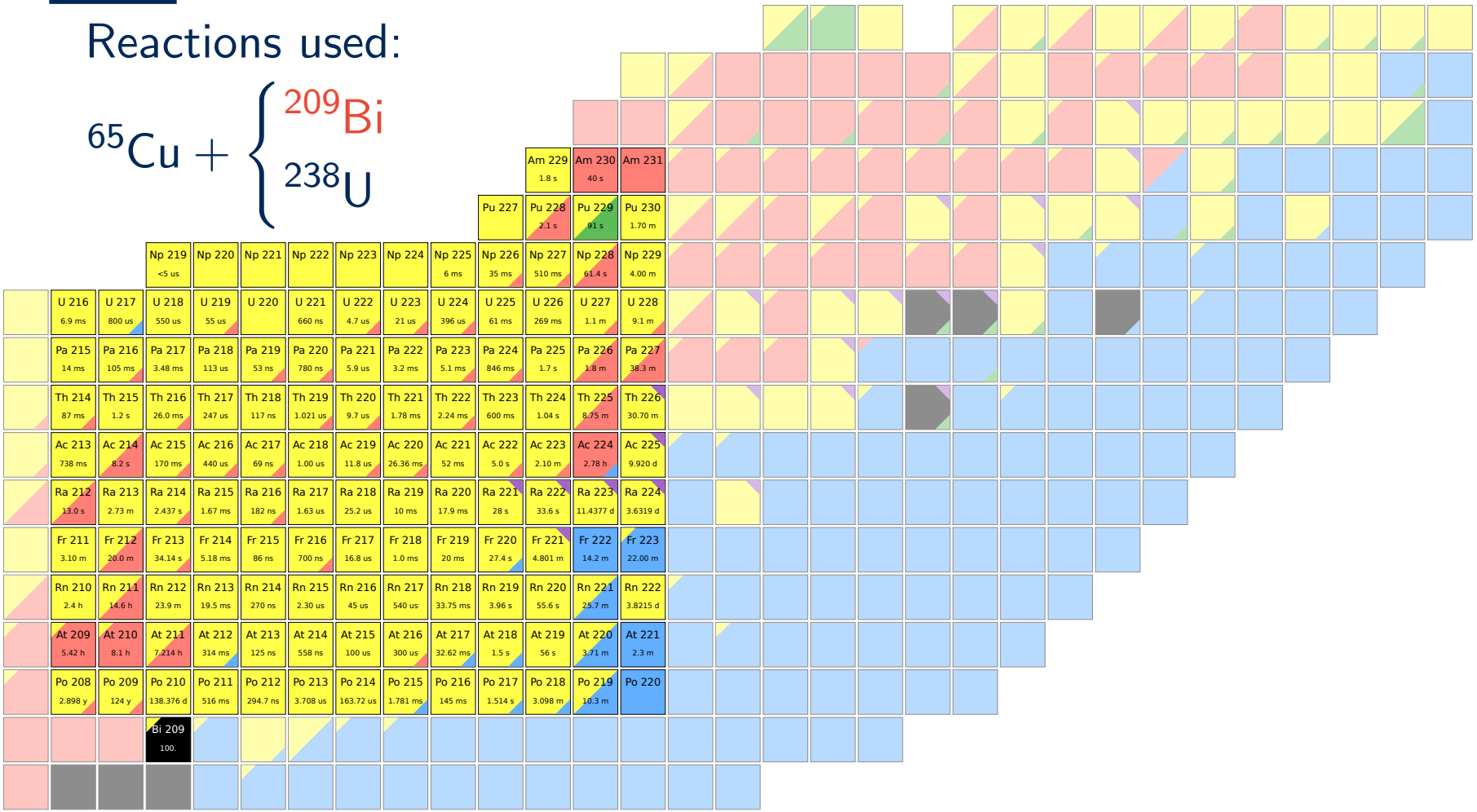

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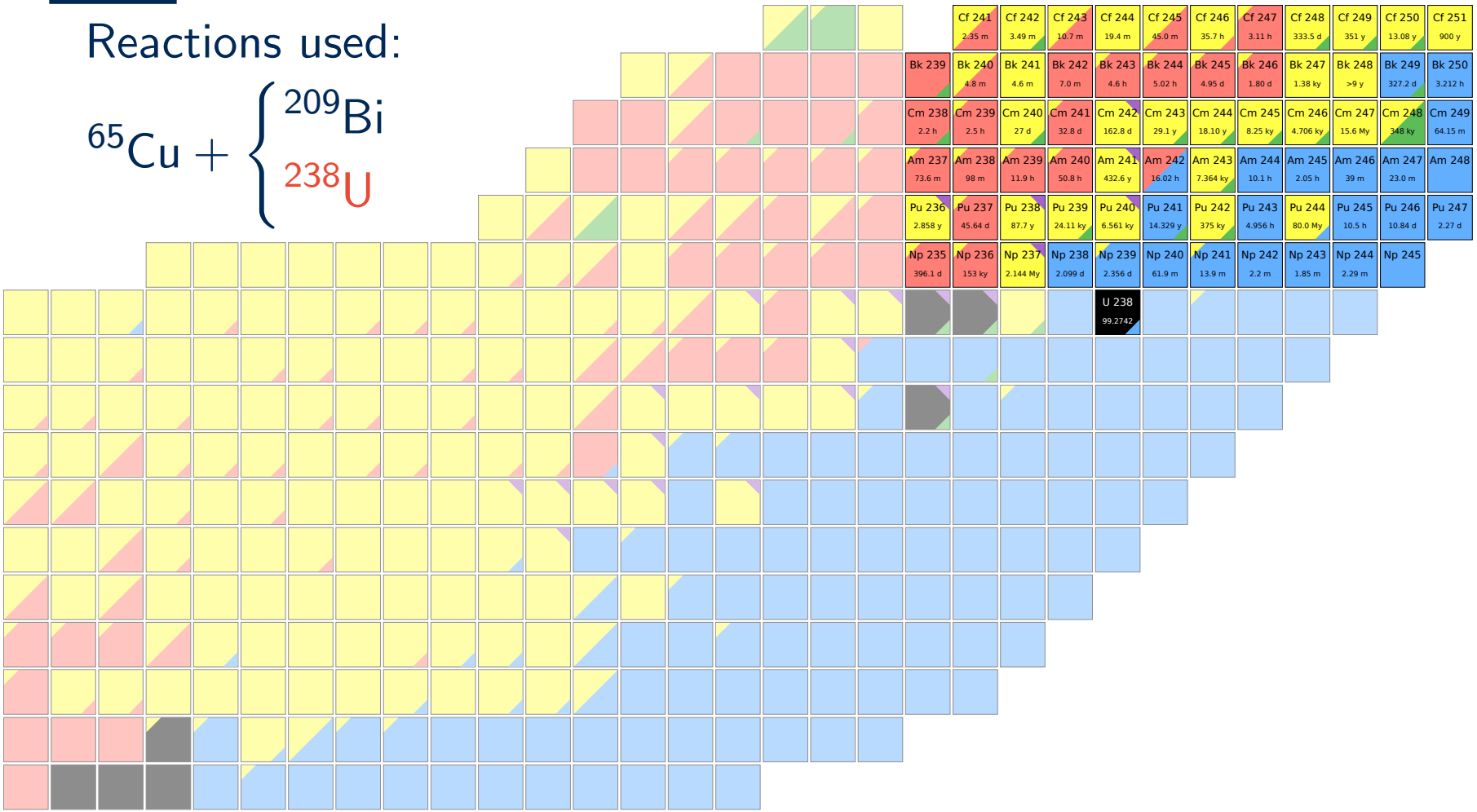

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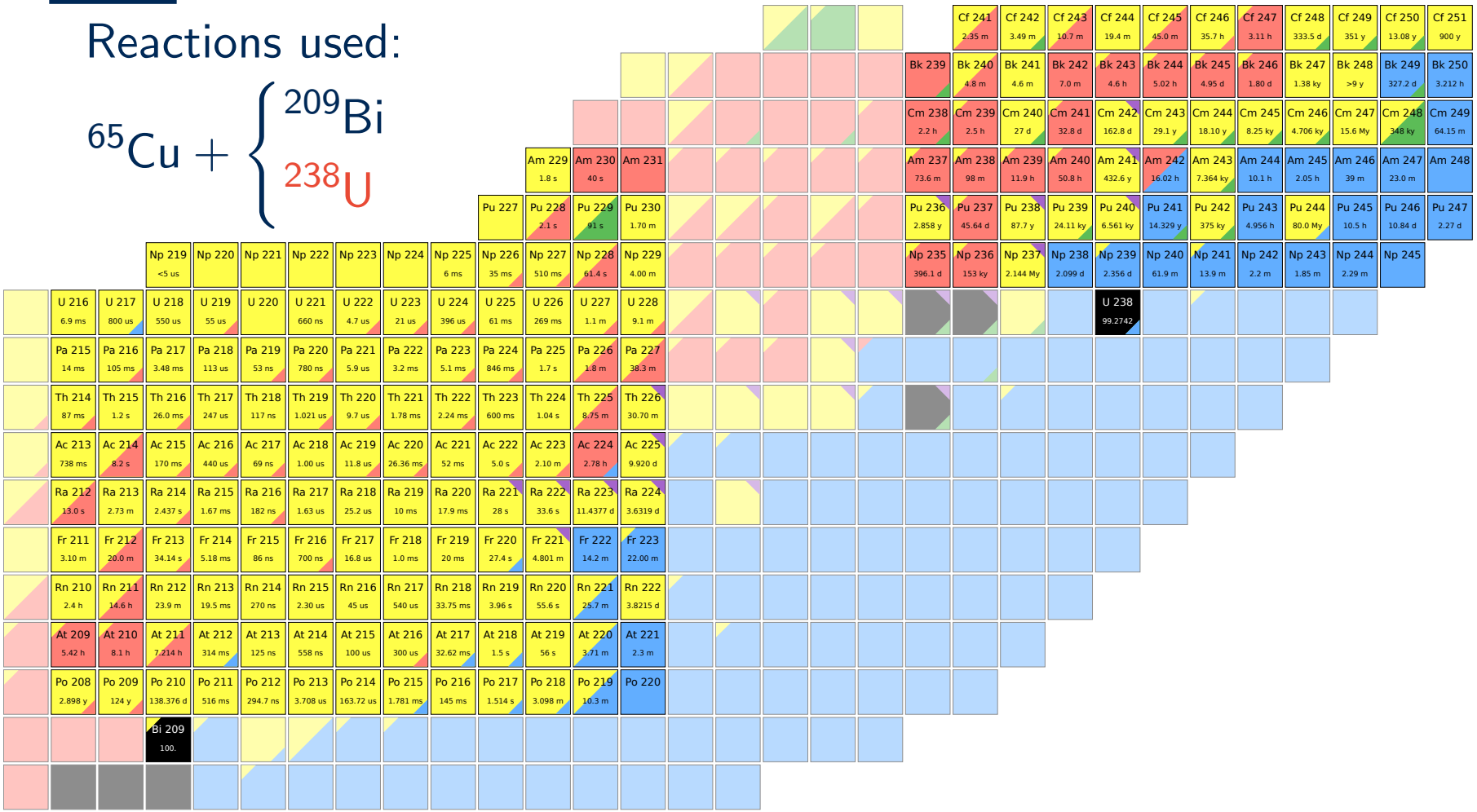
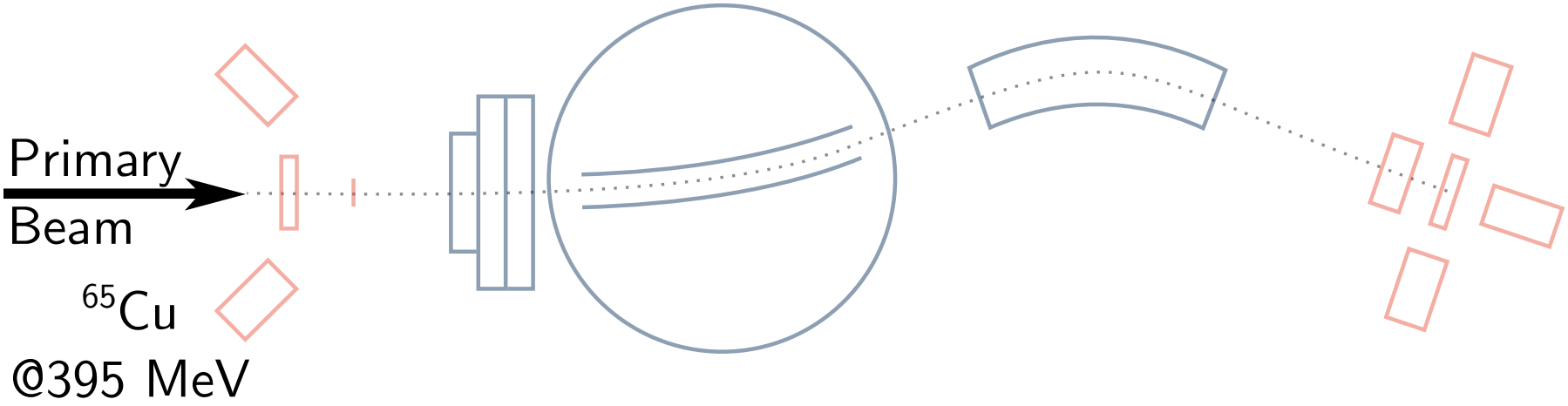


Setup



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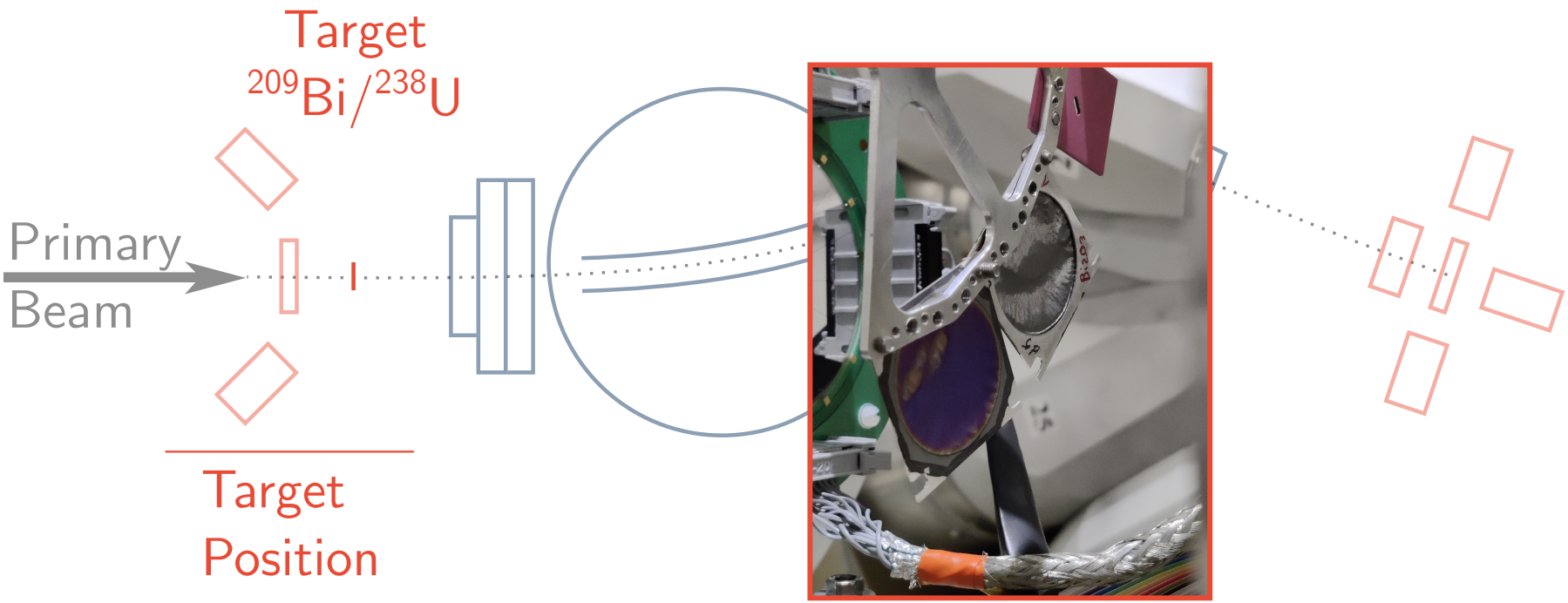

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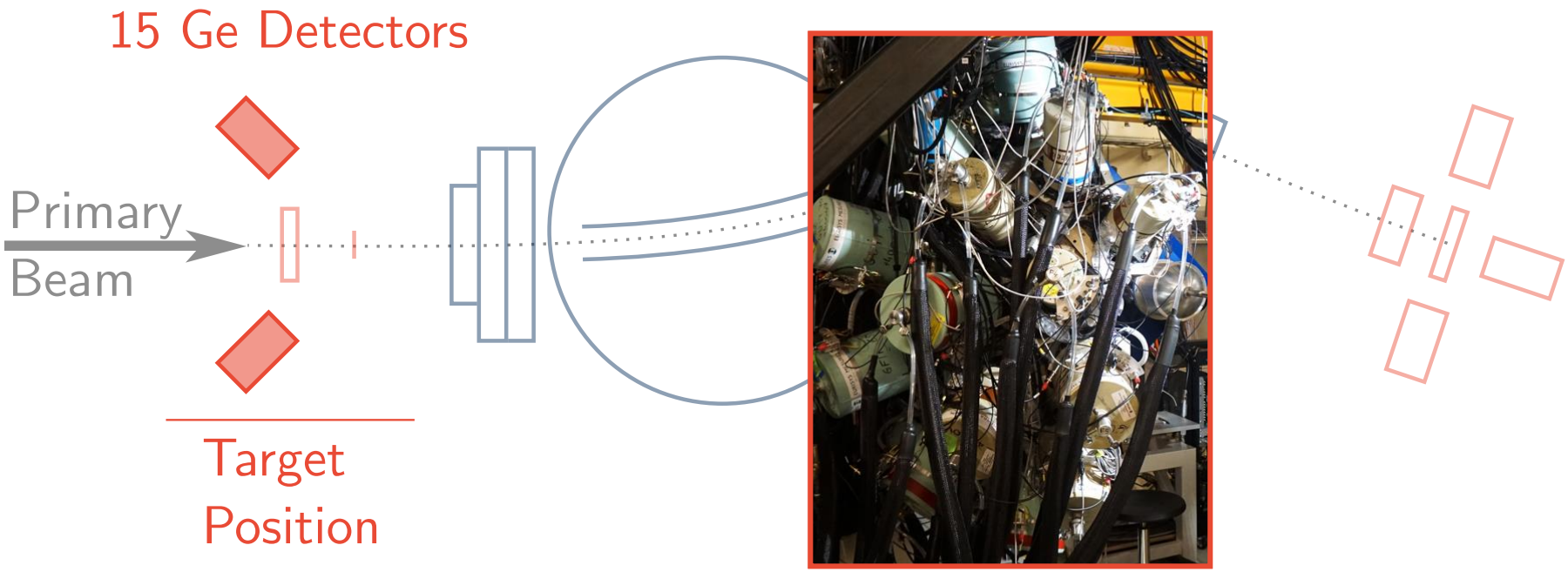

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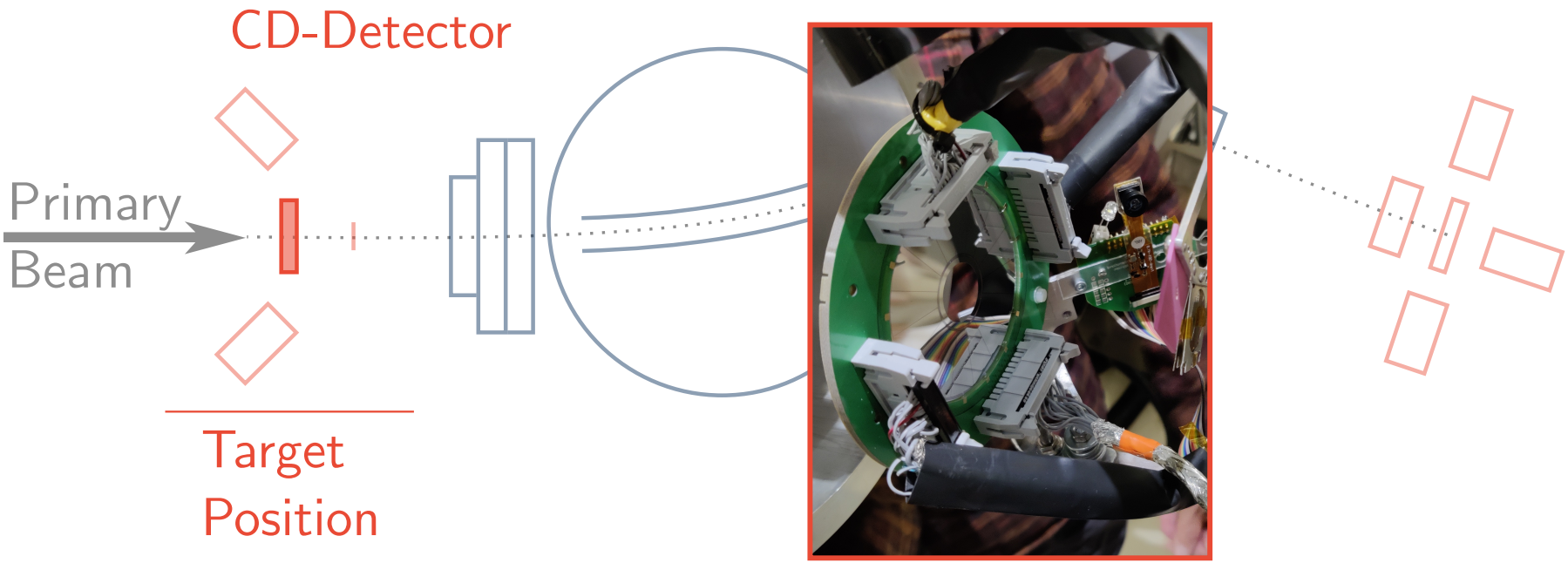

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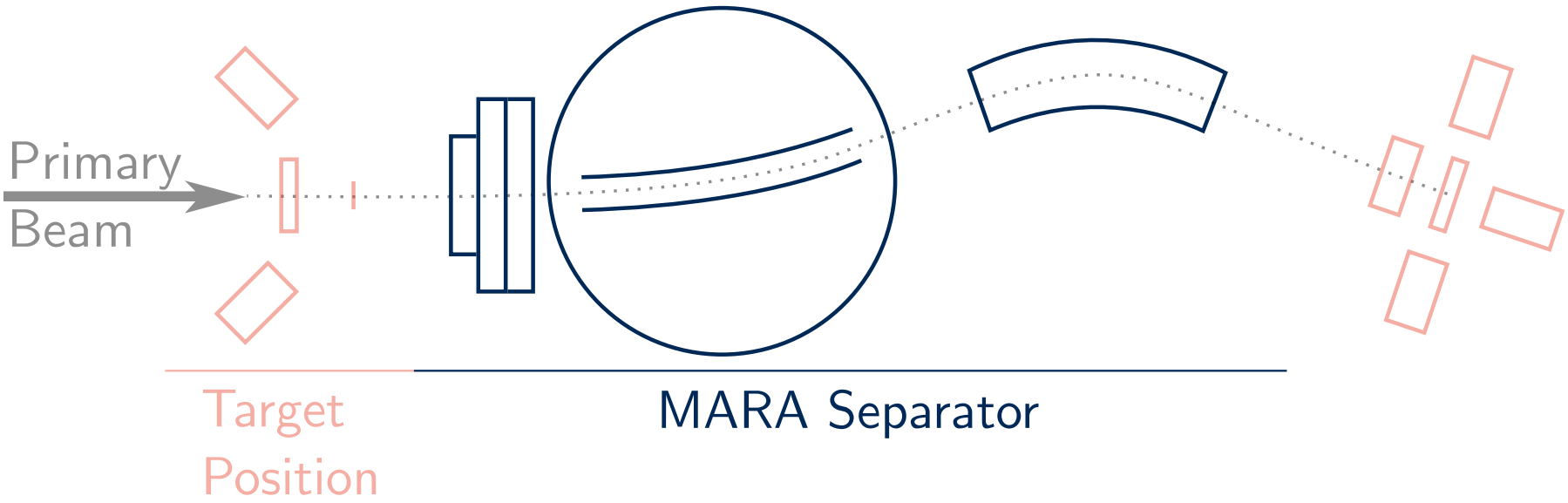
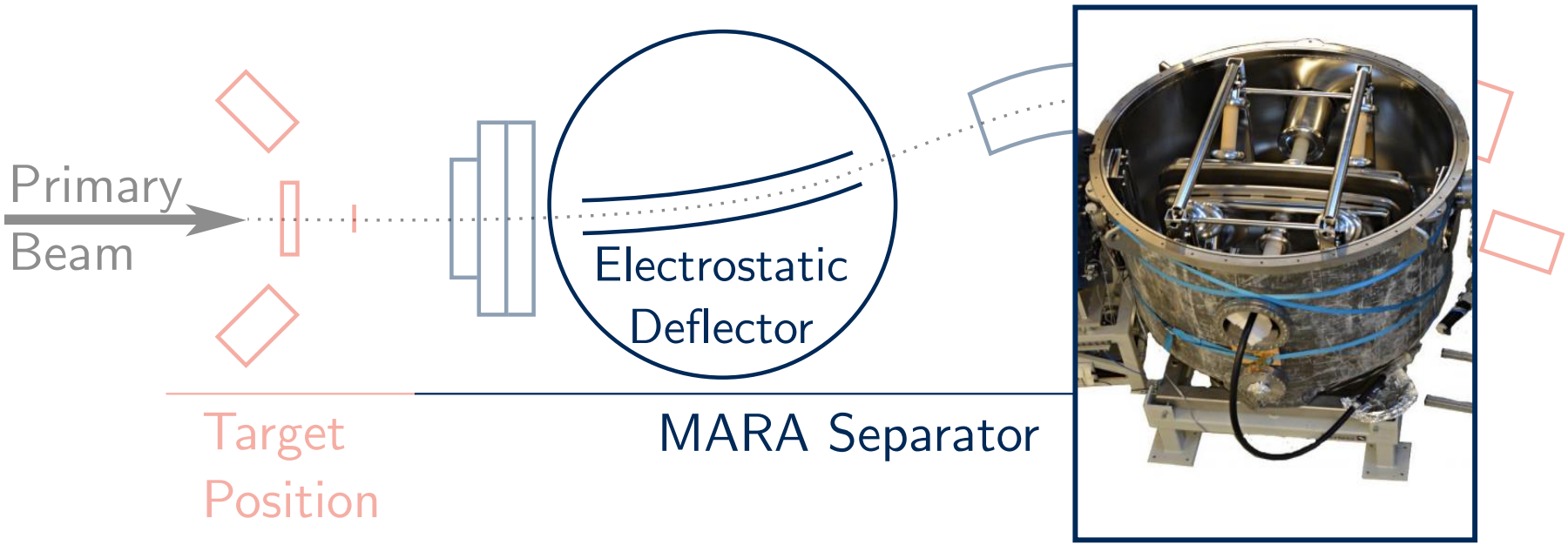
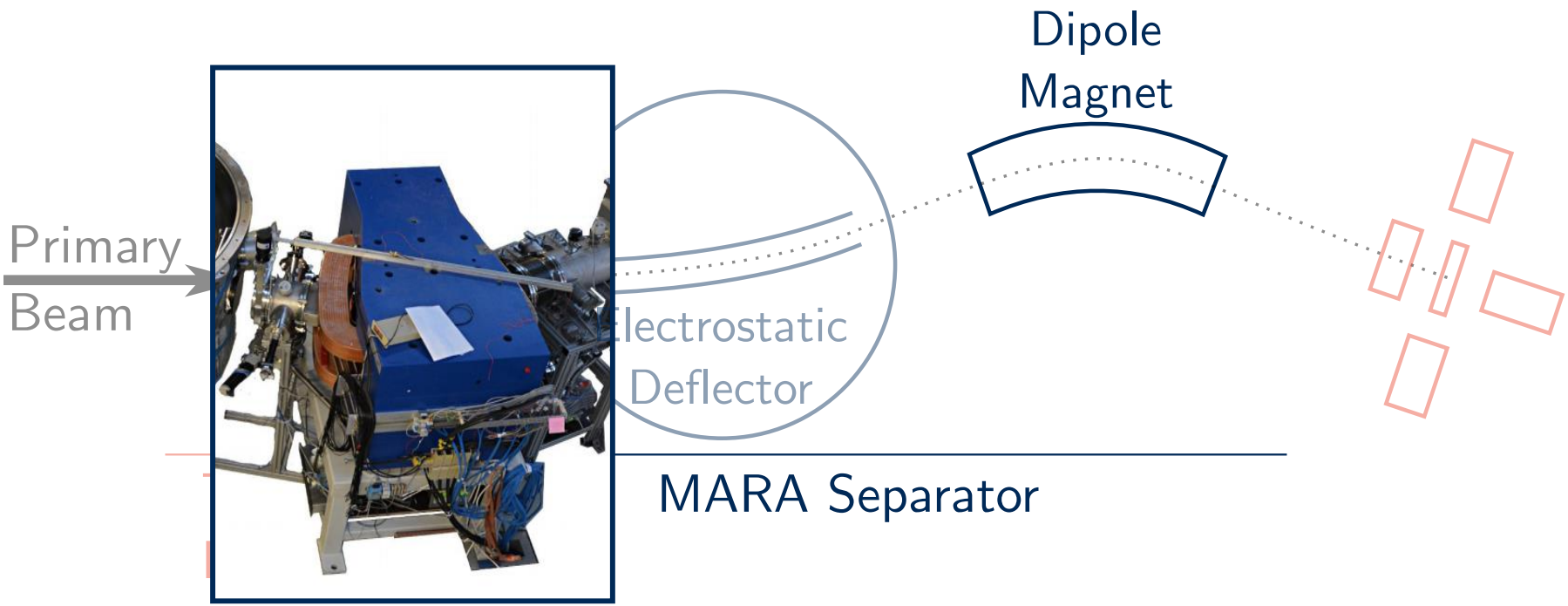


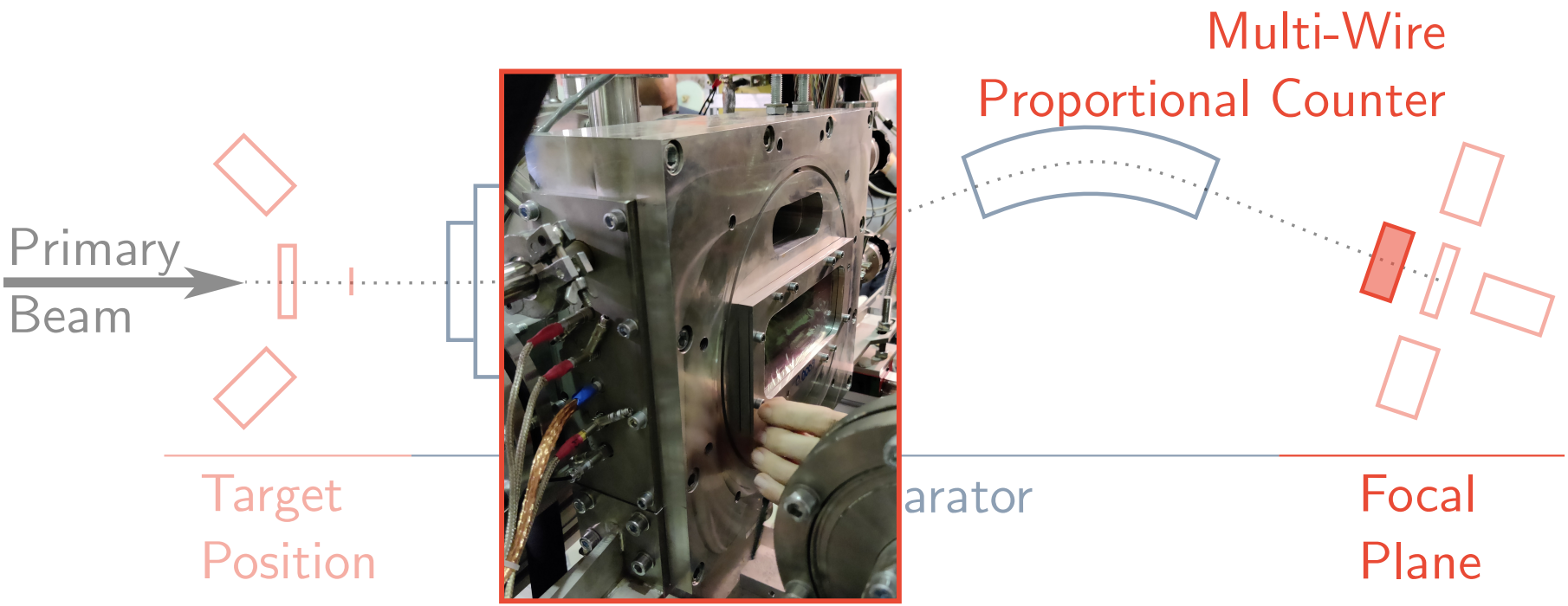
Setup


Primary
Beam
Electrostatic
Deflector
Target
Position
MARA Separator

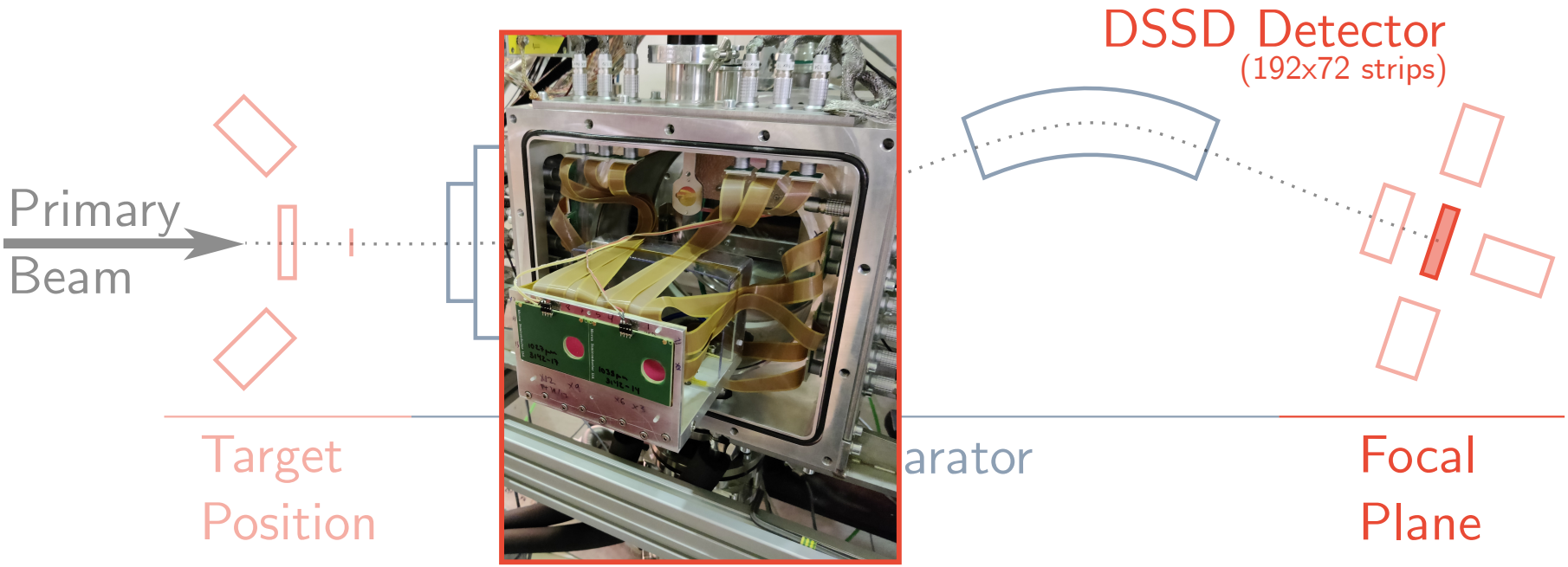
Setup


Dipole
Magnet
Primary
Beam
lectrostatic
Deflector
MARA Separator

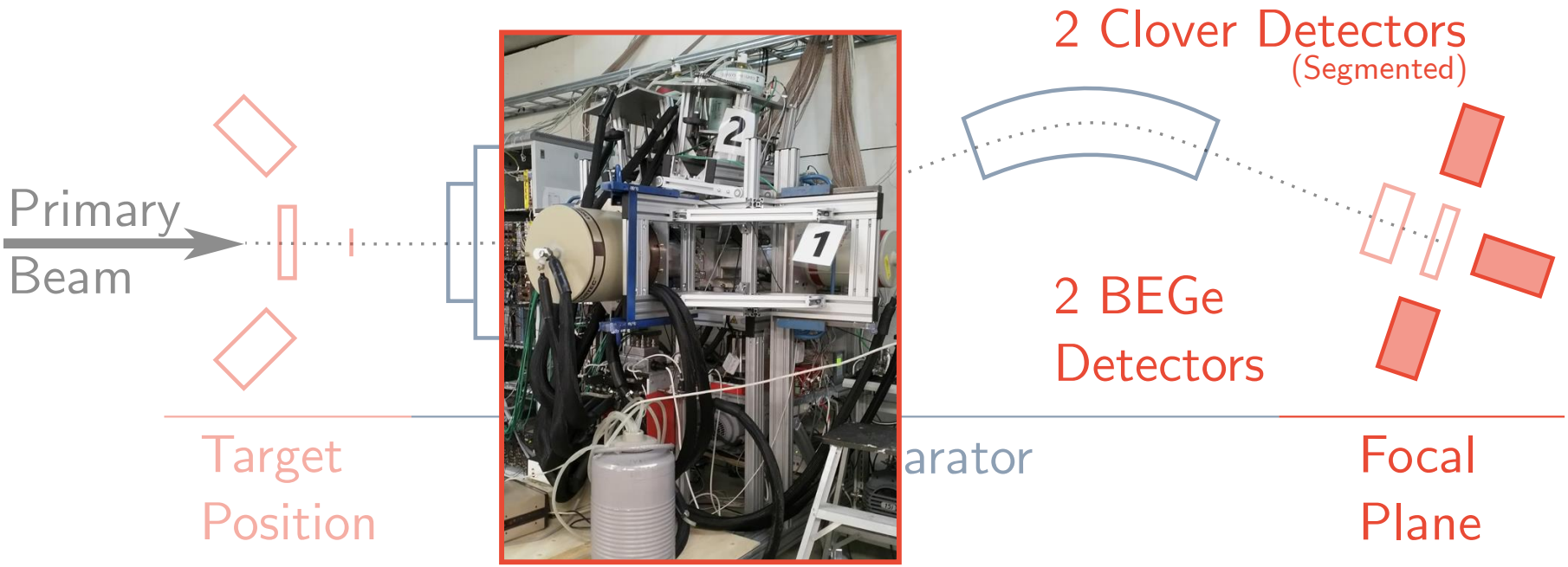
Setup


Multi-Wire
Proportional Counter
Primary
Beam
Target
Position
arator
Focal
Plane

Setup

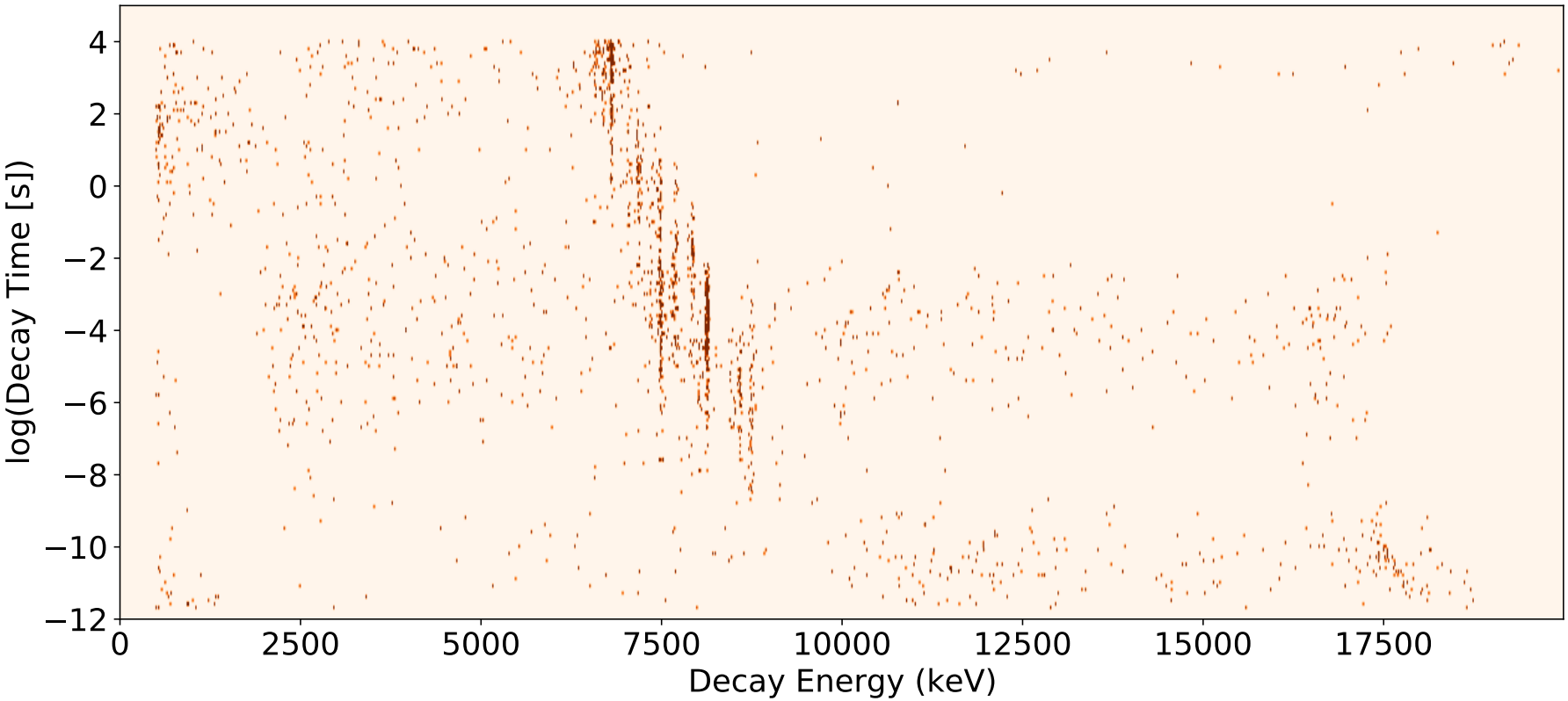

DSSD Detector
(192x72 strips)
Primary
Beam
Target
Position
arator
Focal
Plane

Setup

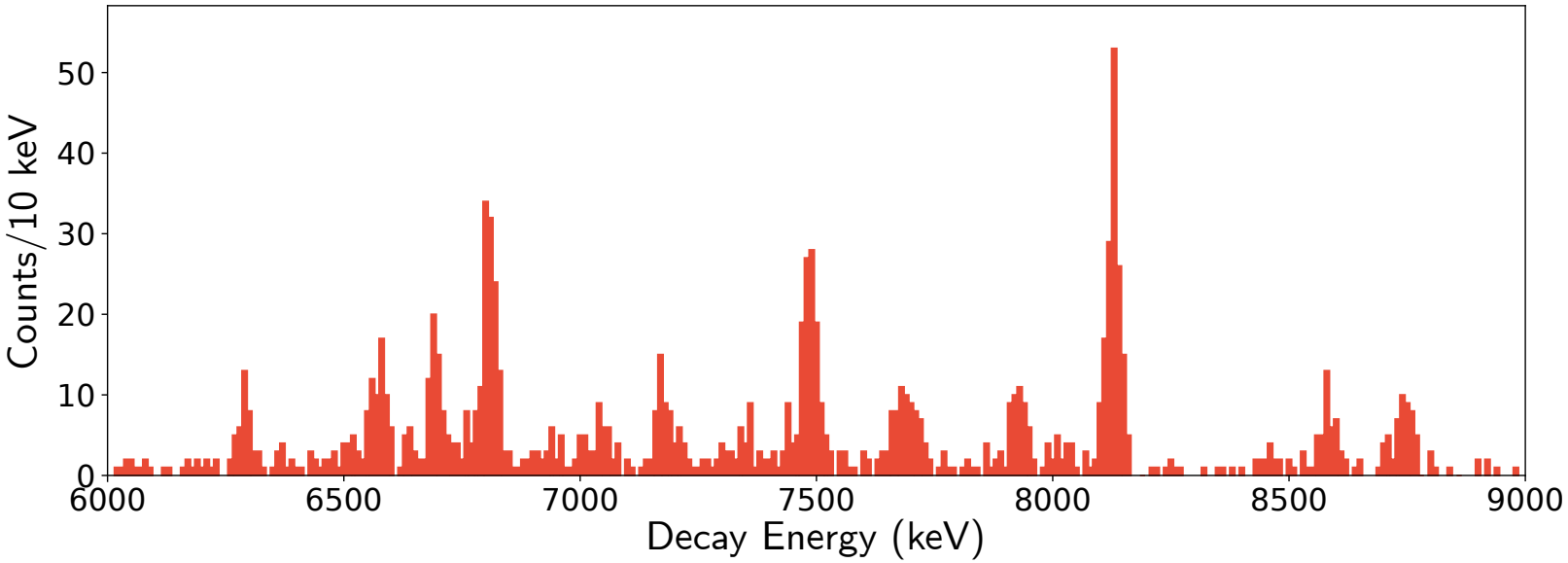

2 Clover Detectors
(Segmented)
Primary
Beam
2
1
2 BEGe
Detectors
Target
Position
arator
Focal
Plane

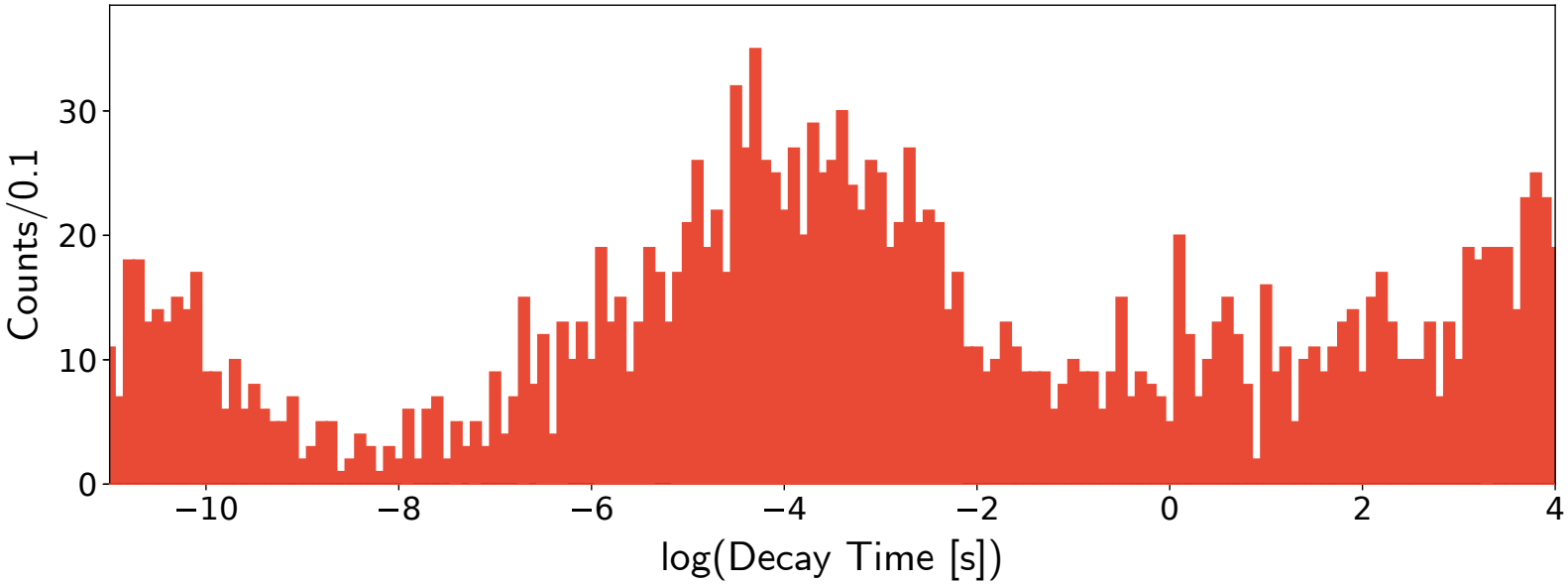
Analysis

Alpha decays are identified by their energy and timing.

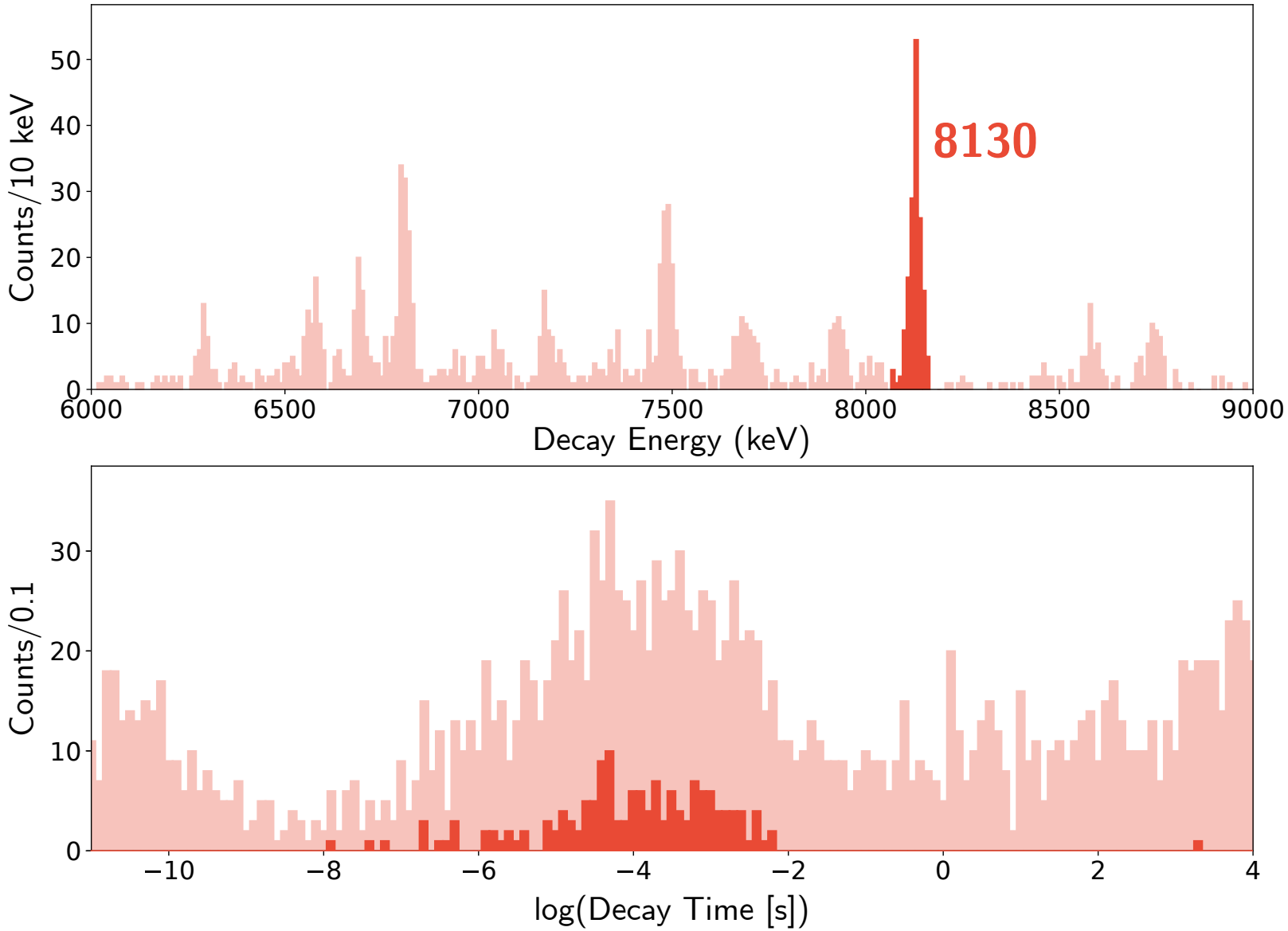


Analysis

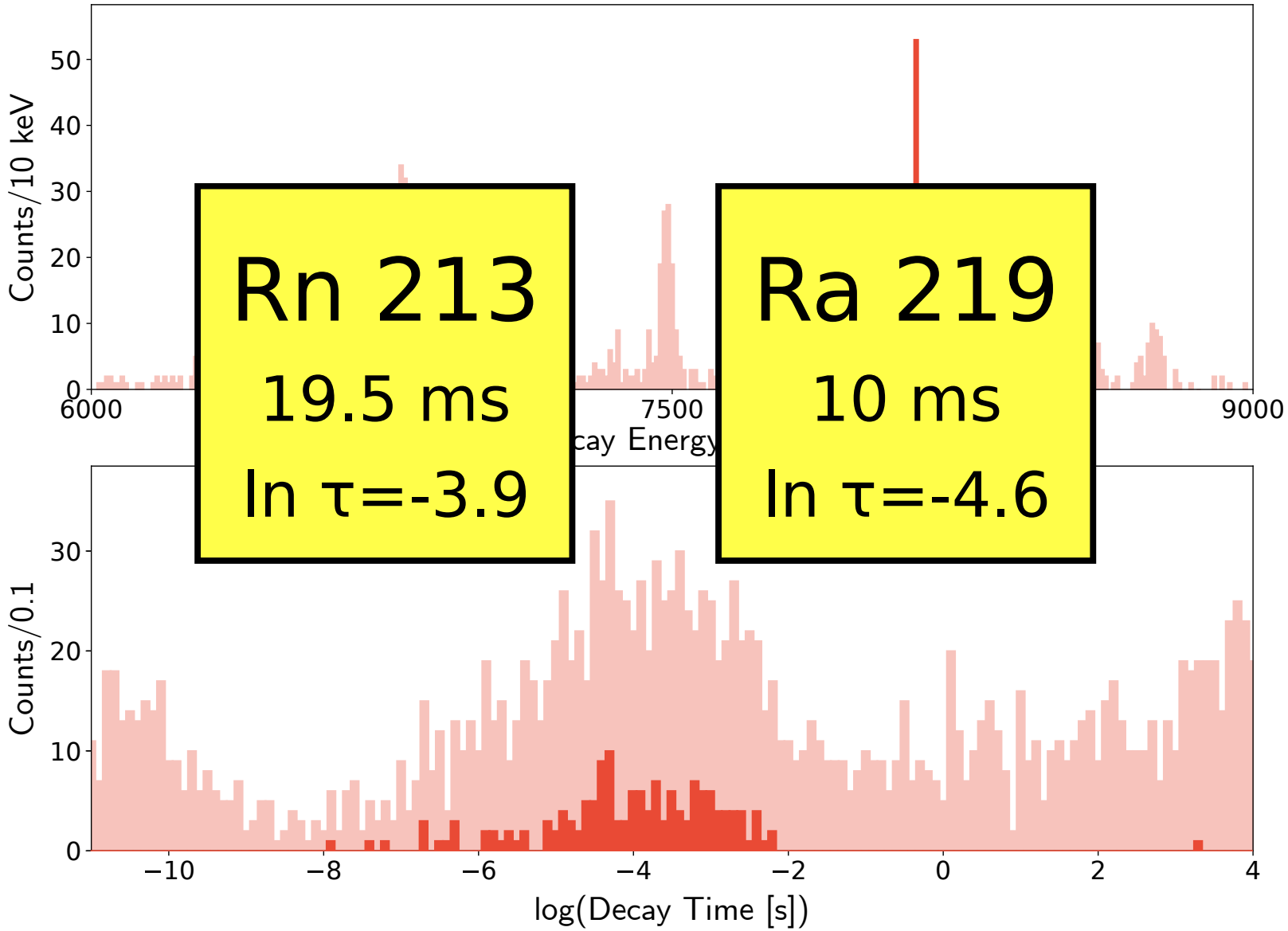

Counts/10 keV
0
10
20
30
40
50
6000
6500
7000
7500
8000
8500
9000
Decay Energy (keV)


Counts/0.1
0
10
20
30
−10
−8
−6
−4
−2
0
2
4
log(Decay Time [s])

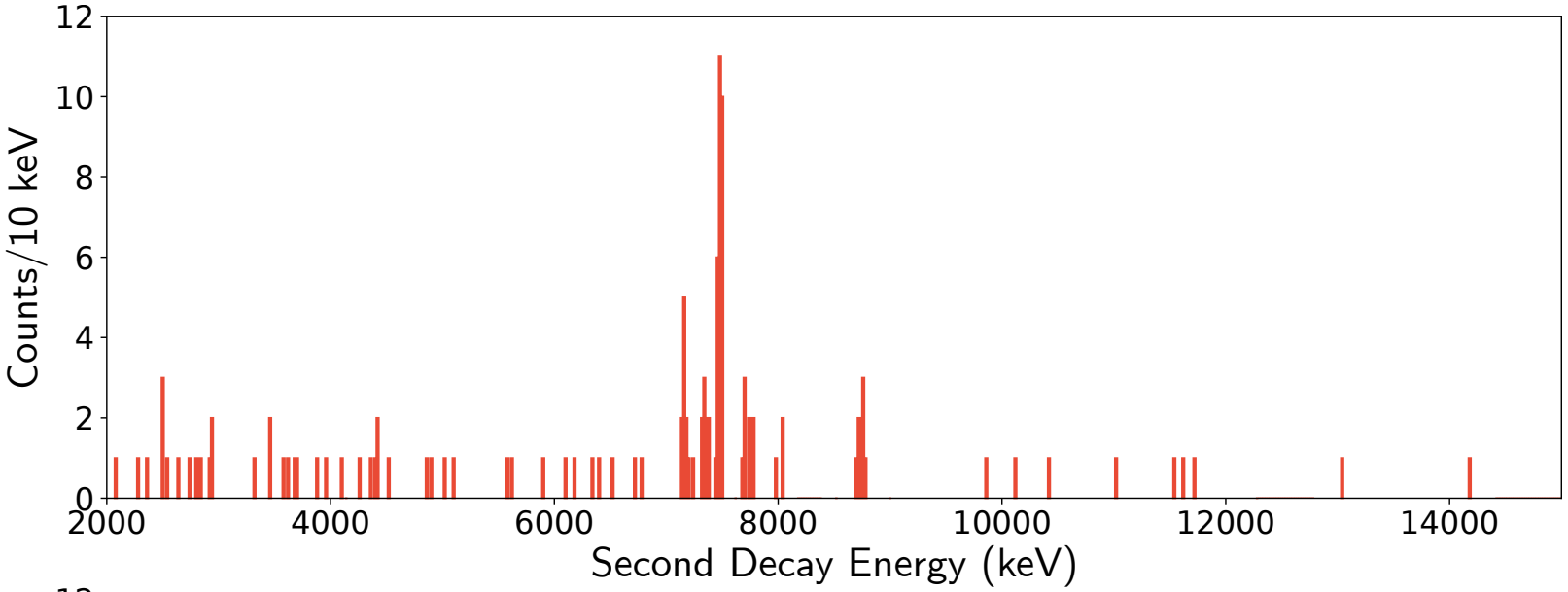
Analysis

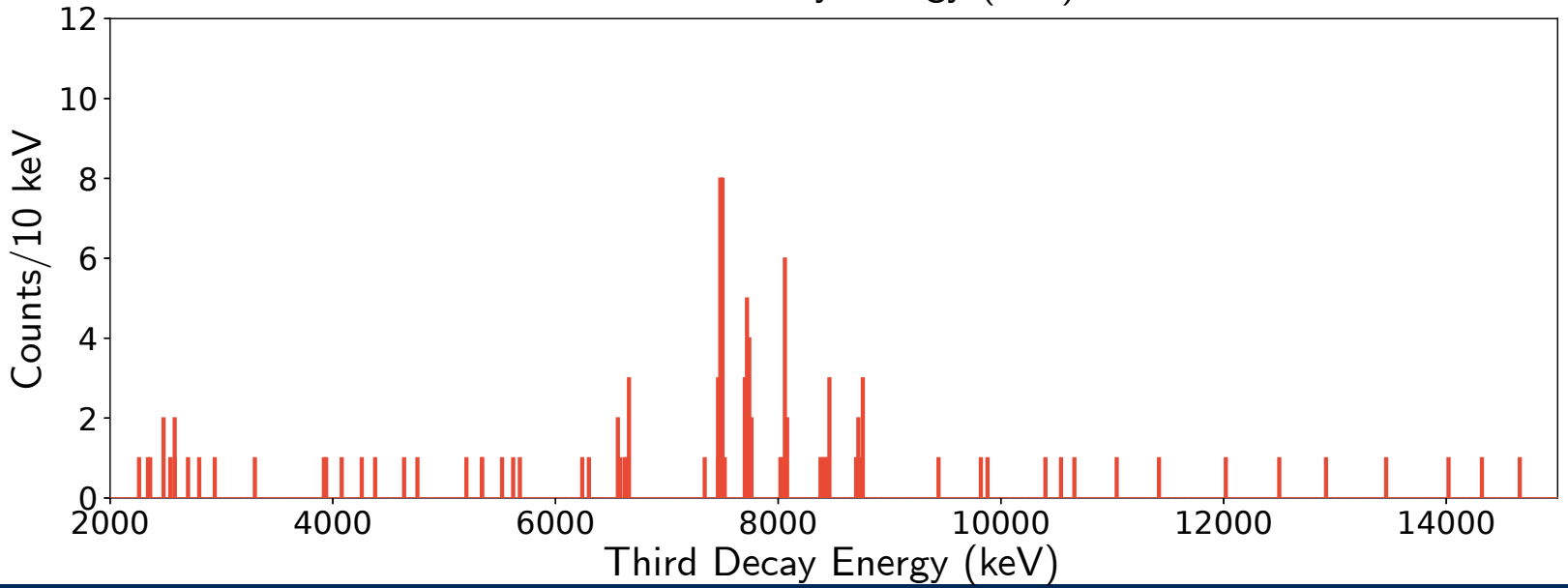

8130
Counts/10 keV
Decay Energy (keV)
Counts/0.1
log(Decay Time [s])

Analysis

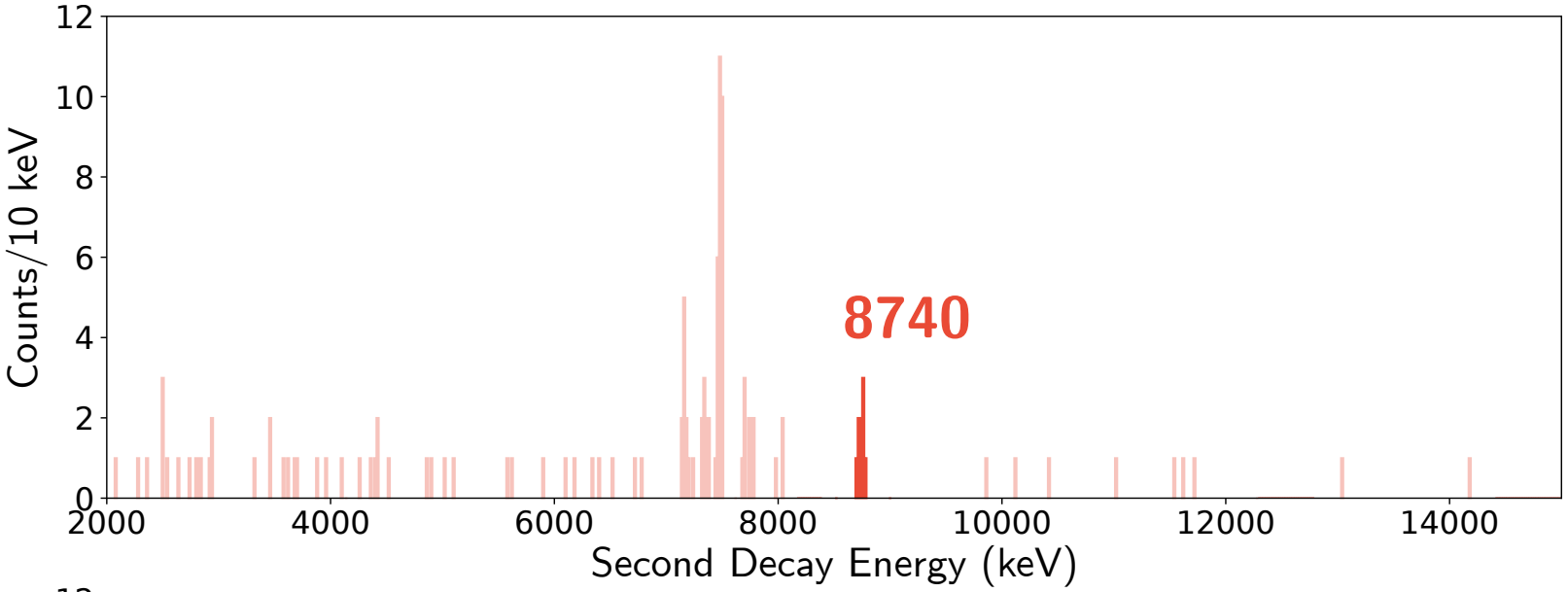

Rn 213
19.5 ms
ln τ=-3.9
Ra 219
10 ms
ln τ=-4.6
Counts/10 keV
Counts/0.1
log(Decay Time [s])

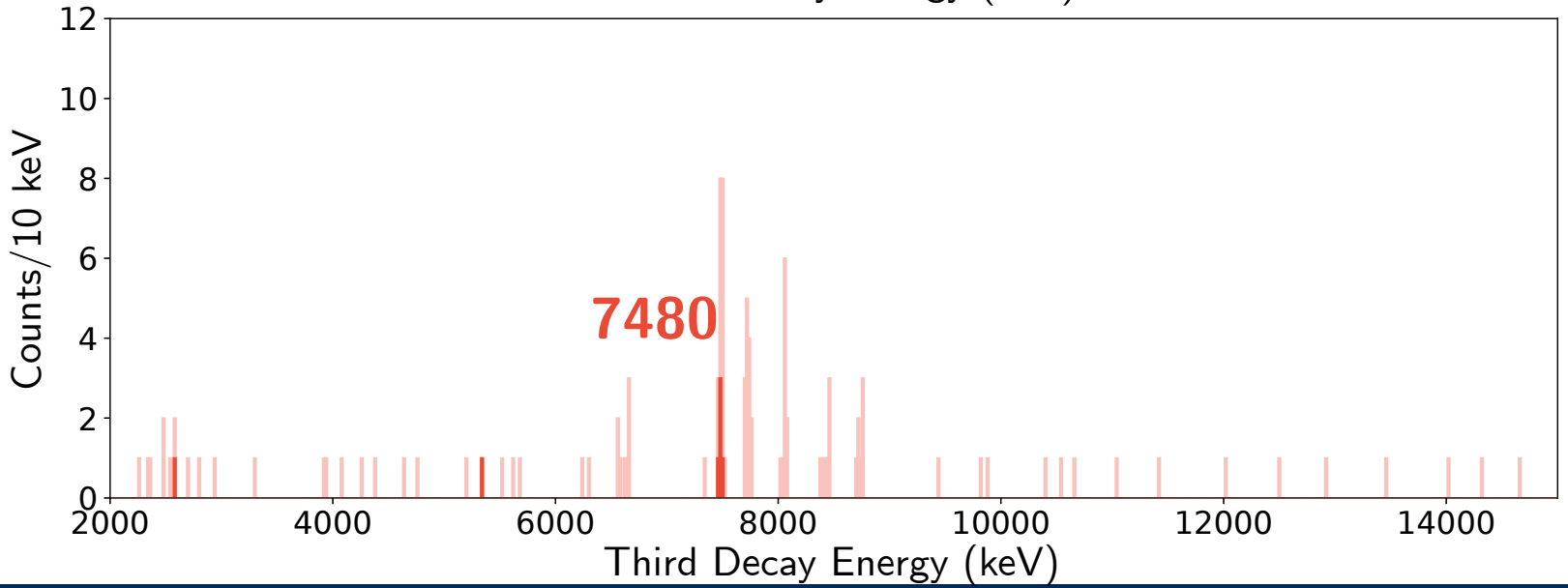
Analysis


Counts/10 keV
Second Decay Energy (keV)
0
2
4
6
8
10
12
2000
4000
6000
8000
10000
12000
14000

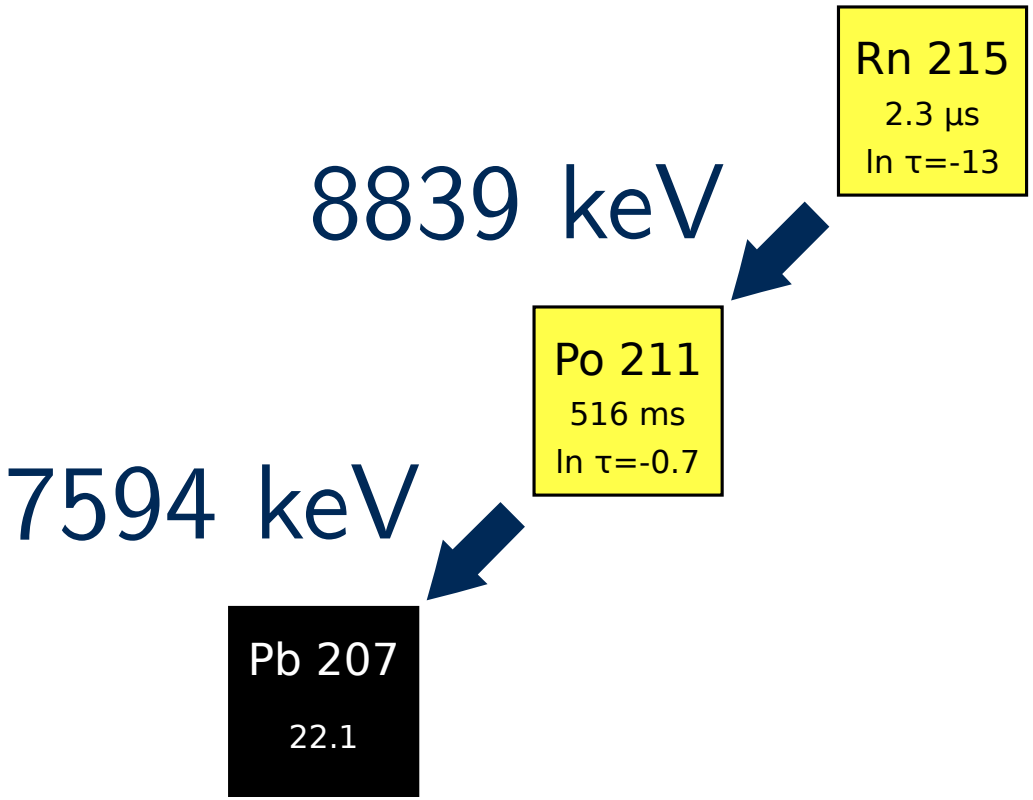

Counts/10 keV
Third Decay Energy (keV)
0
2
4
6
8
10
12
2000
4000
6000
8000
10000
12000
14000

Analysis

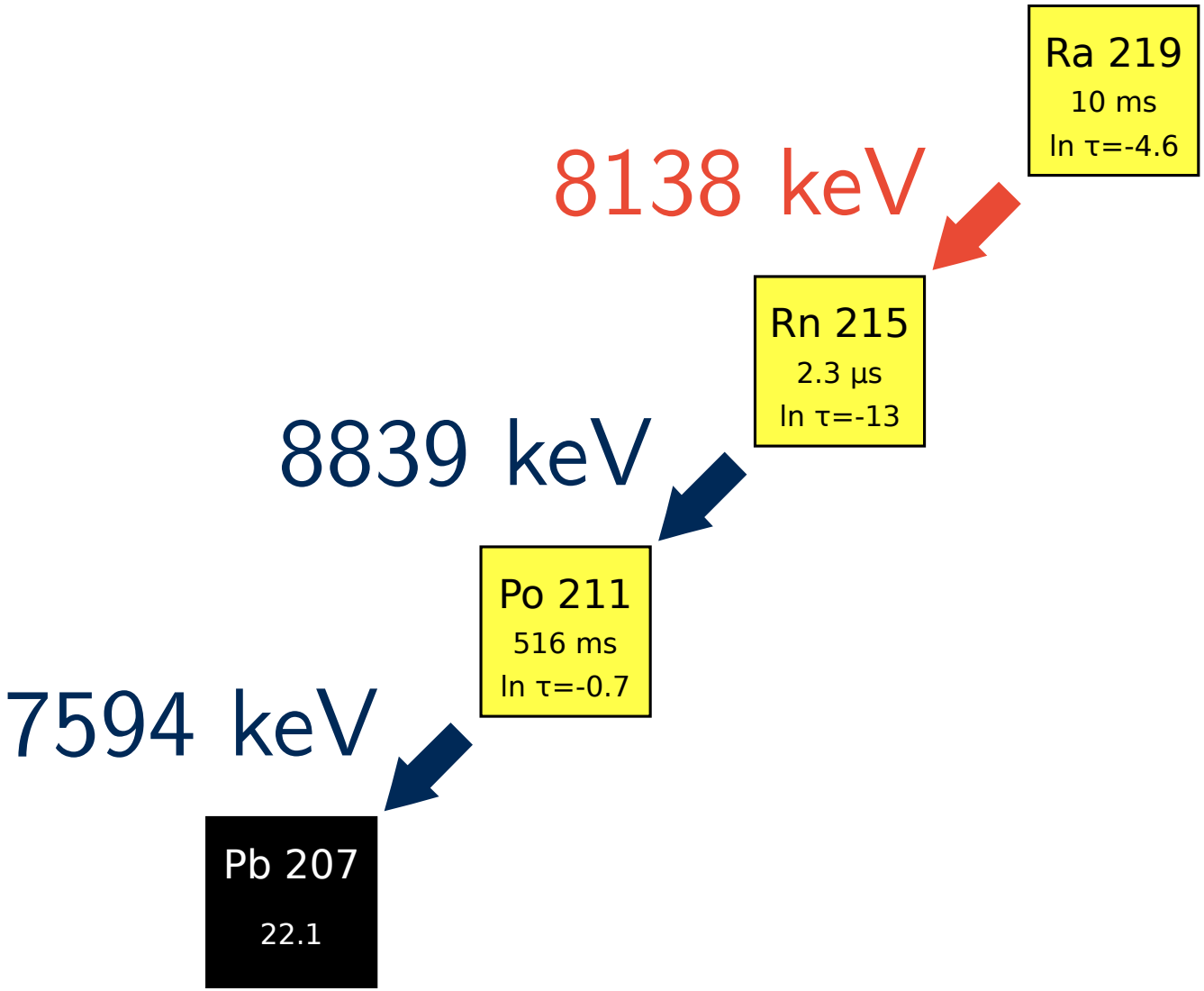

Counts/10 keV
Second Decay Energy (keV)
8740
0
2
4
6
8
10
12
2000
4000
6000
8000
10000
12000
14000


Counts/10 keV
Third Decay Energy (keV)
7480
0
2
4
6
8
10
12
2000
4000
6000
8000
10000
12000
14000

Analysis


Rn 215
2.3 µs
ln τ=-13
8839 keV
Po 211
516 ms
ln τ=-0.7
7594 keV
Pb 207
22.1

Analysis


Ra 219
10 ms
ln τ=-4.6
8138 keV
Rn 215
2.3 µs
ln τ=-13
8839 keV
Po 211
516 ms
ln τ=-0.7
7594 keV
Pb 207
22.1

Outlook

Current Status

- Several alpha decay chains identified.

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- Several alpha decay chains identified.

Expected Outcomes

- Determine actinide production yields via quasi-fission.
- Improve precision for alpha half lives in the actinide region.
- Possible gamma spectroscopy of alpha-gated species.