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UNIVERSITY OF JYVÄSKYLÄ

# Spectroscopy of neutron deficient Actinium isotopes

TASCA 22

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# Motivation

- Probe whether “spectator proton + vibrating core” behavior continues in actiniums
- Establish level schemes
- Look for intruder isomeric states
- Look for shears bands



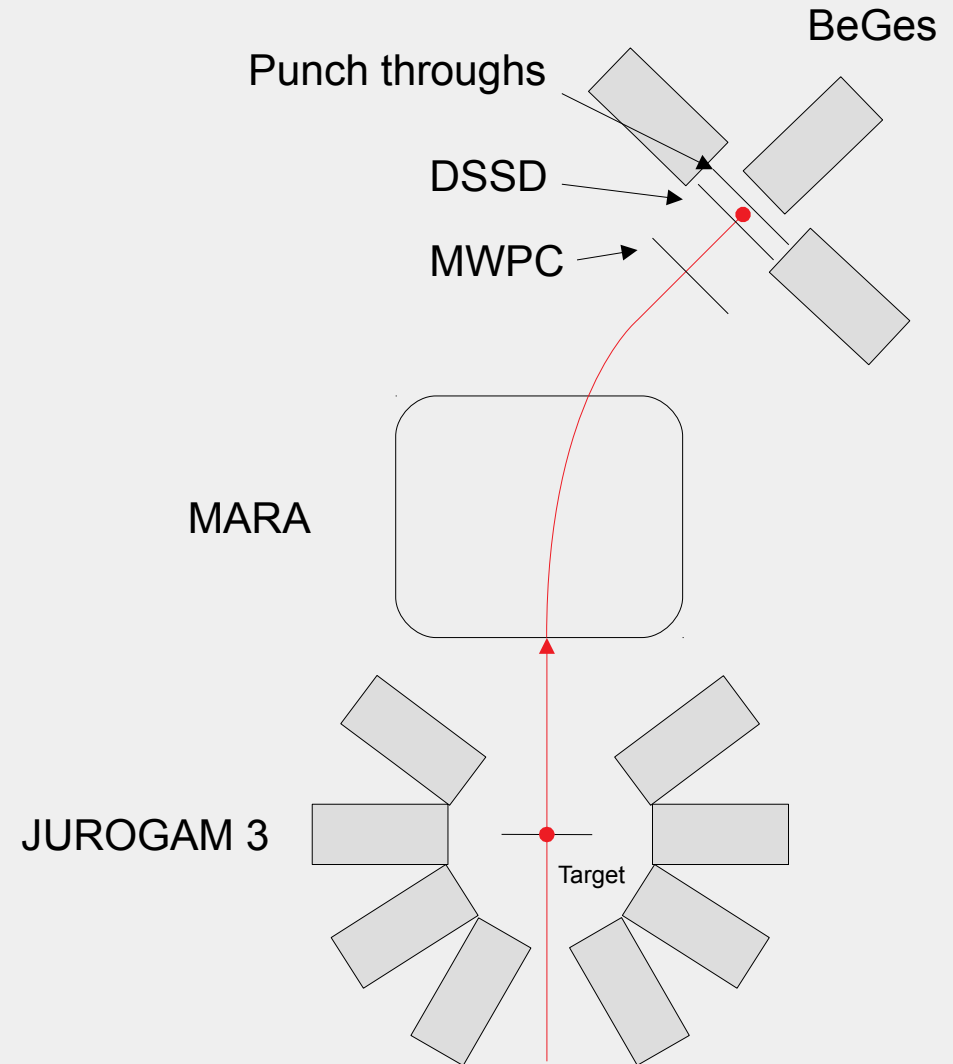
# Experiment

- Nuclei of interest produced via fusion-evaporation reactions:
  - $^{180}\text{Hf}(^{37}\text{Cl},4n)^{213}\text{Ac}$  @170 MeV
  - $^{175}\text{Lu}(^{40}\text{Ar},4n)^{211}\text{Ac}$  @186 MeV
  - $^{209}\text{Ac}$  in future, tests indicate sufficient yield
- Products identified using recoil- $\alpha$  decay tagging



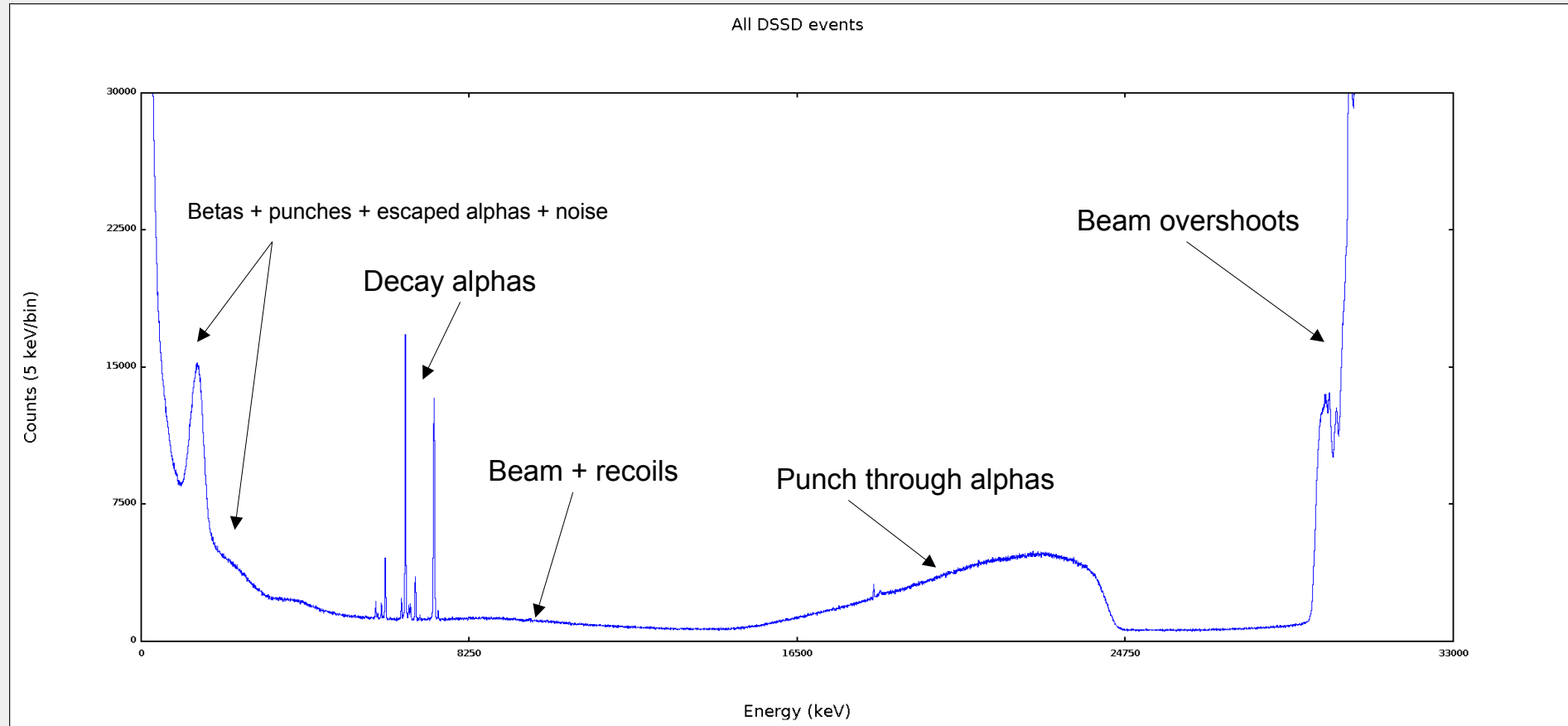
# Instrumentation

- ECR ion source + K130 cyclotron
- MARA vacuum mode recoil separator
- JUROGAM 3 spectrometer for prompt  $\gamma$ -rays
- Focal plane detectors:
  - Gas counter
  - DSSD for implantation and decay tagging
  - 2 Punch through detectors
  - 3 BeGe detectors for delayed  $\gamma$ -rays
- Triggerless Data Acquisition:
  - Events from all channels are recorded into a continuous data stream that can be analyzed later





# Analysis – DSSD events

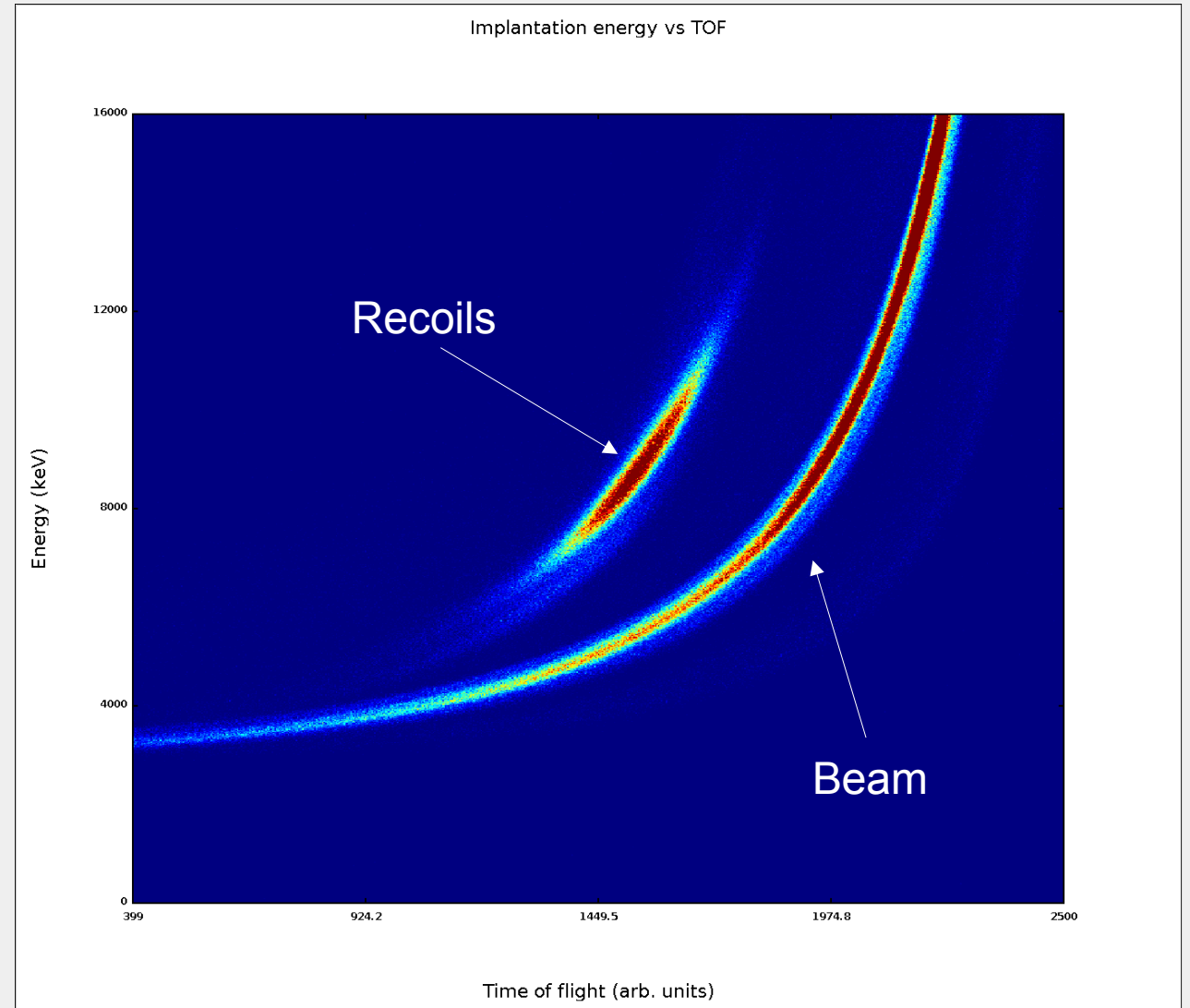


All DSSD events, need to separate different species



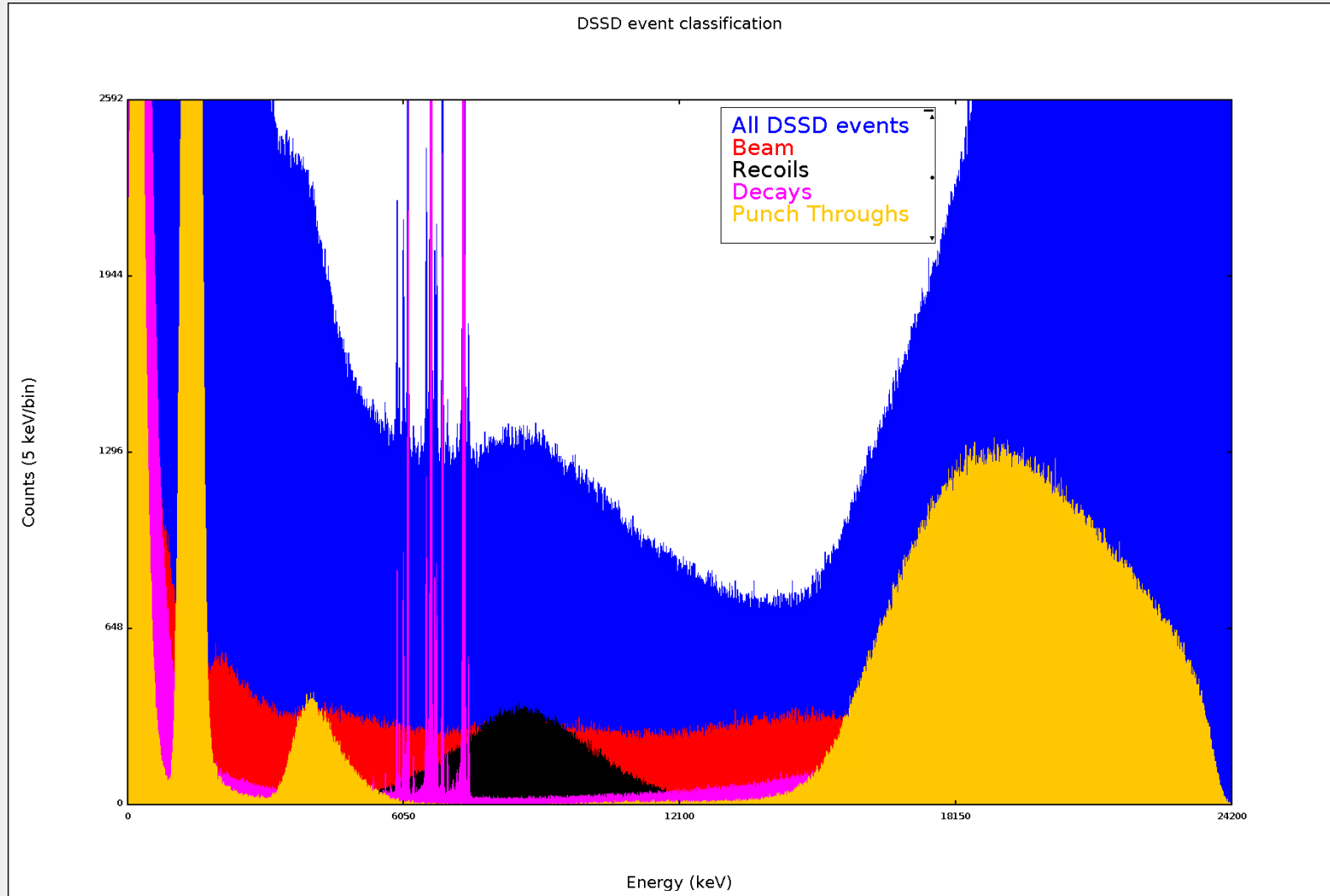
# Analysis - Identification

- Time of flight between the MWPC and DSSD is measured with TAC to get higher resolution than what DAQ's 10 ns clock offers
- Punch through detectors, behind the DSSD, clean up light particles
- Recoils and their decays can be separated from the scattered beam



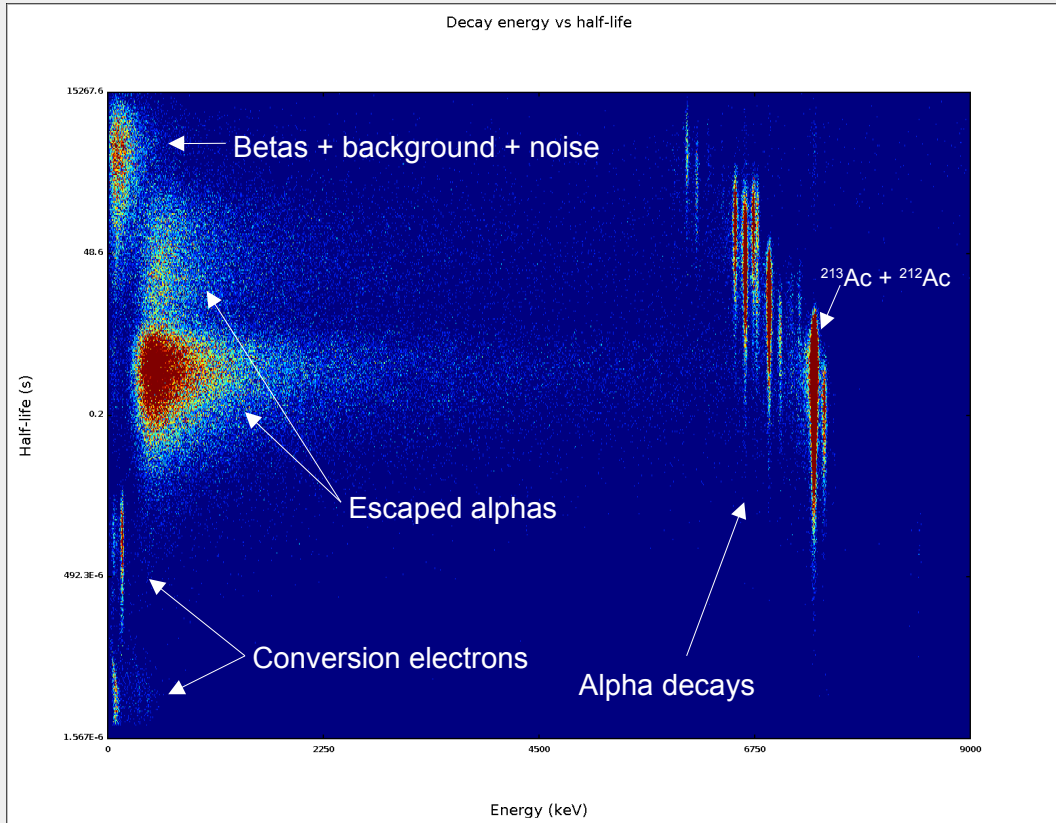


# Analysis - Identification

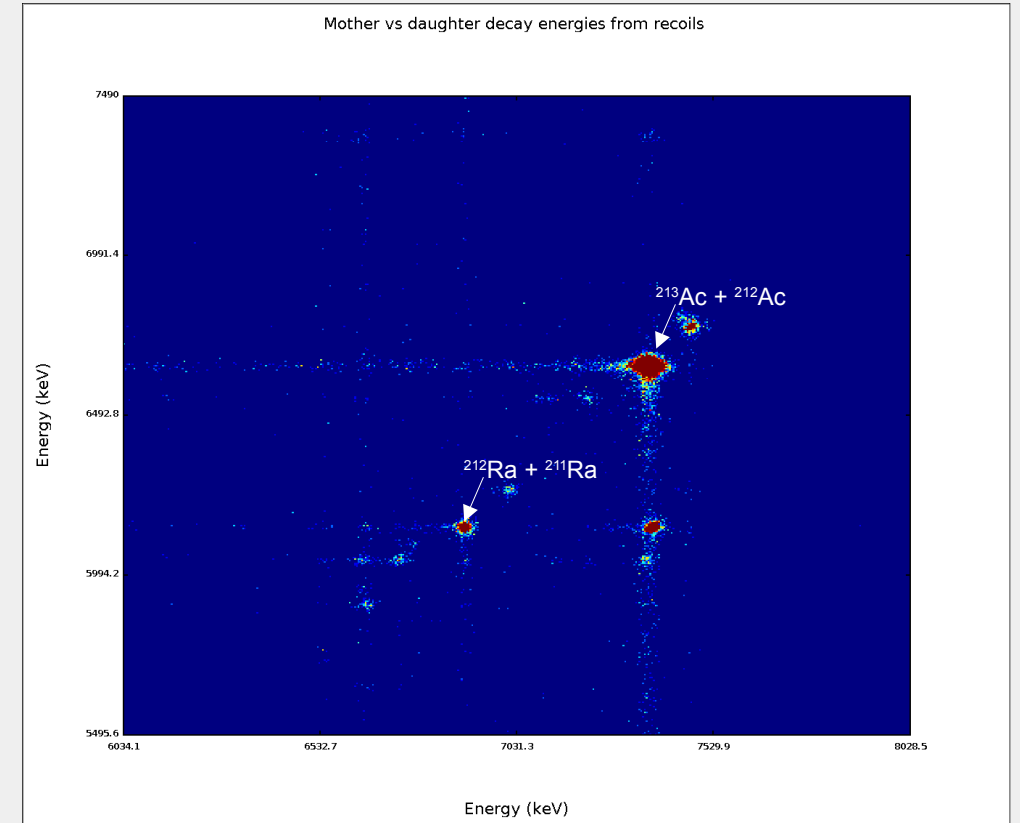




# Analysis - Correlation



Recoils are identified by their decay properties: energy and decay time

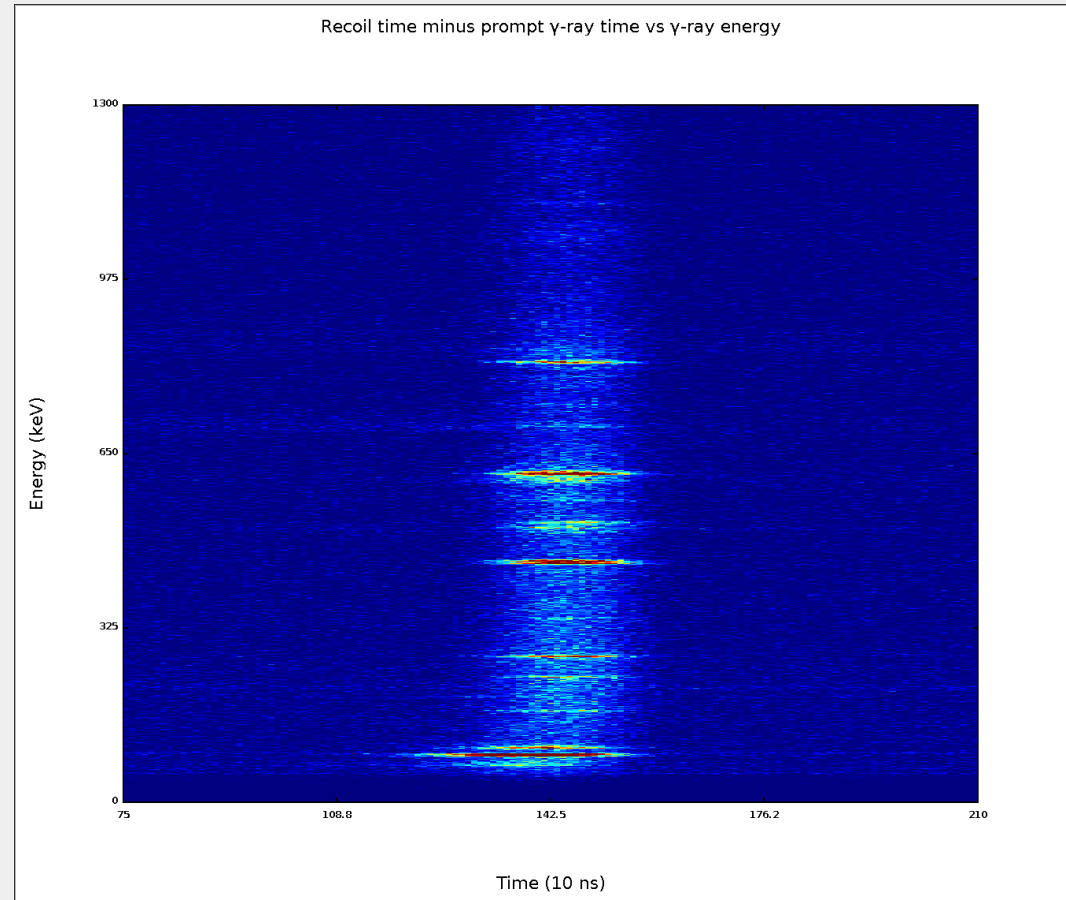


Further generations of decays can be also used, if needed





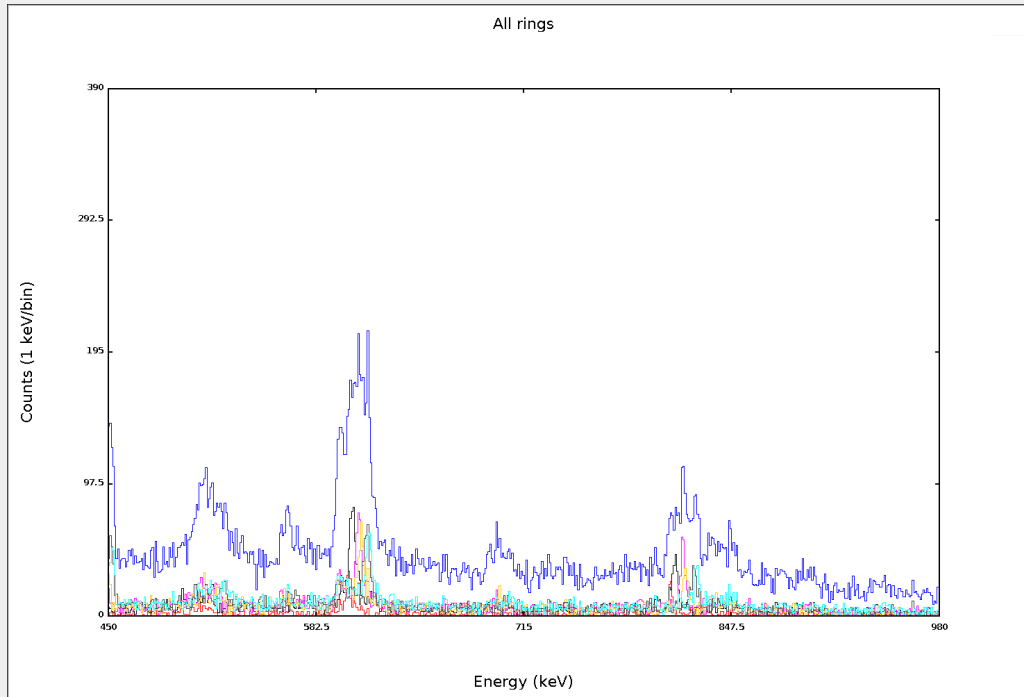
# Analysis – Prompt $\gamma$ -rays



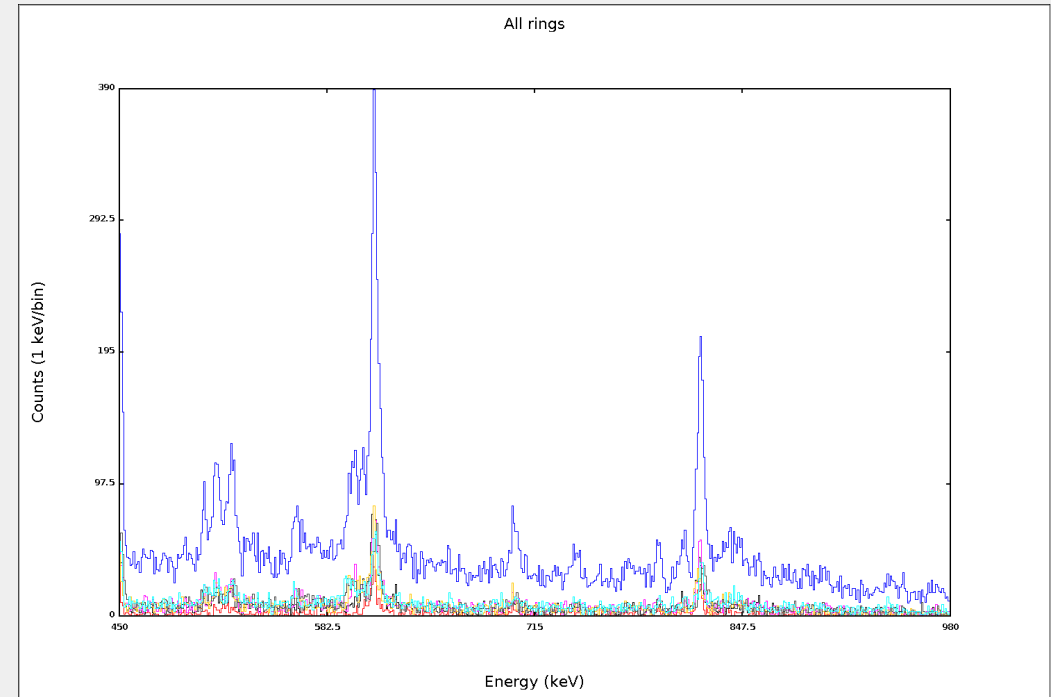
Looking back at JUROGAM events, a clear correlation can be seen



# Analysis - Prompt $\gamma$ -rays



Without Doppler correction, not much can be seen

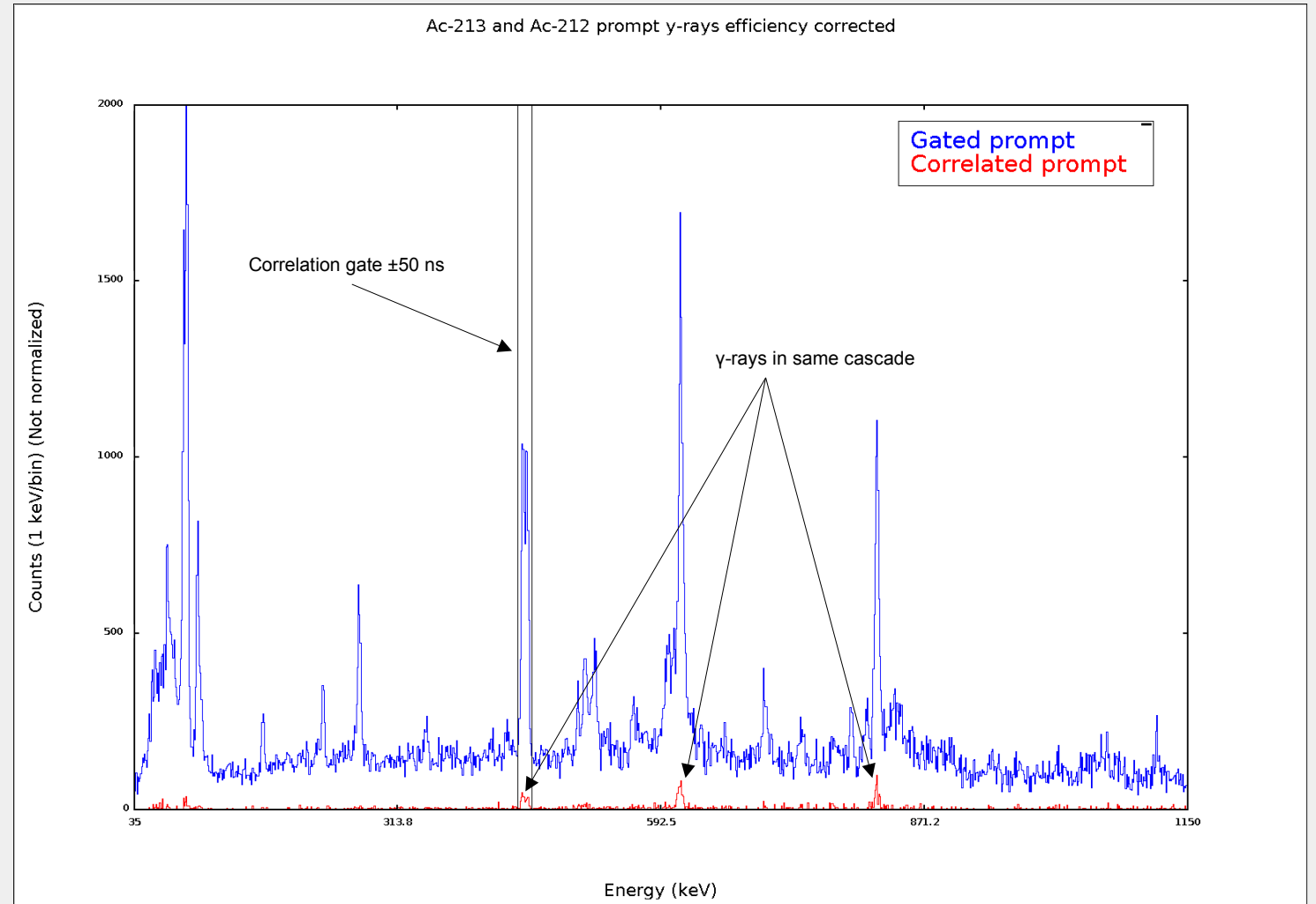


With Doppler correction peaks originating from moving nuclei appear



# Analysis – Prompt $\gamma$ -rays

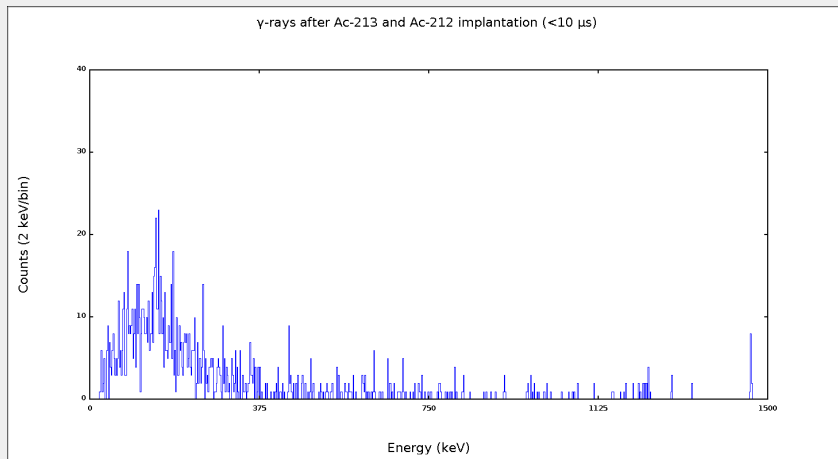
- Energy and intensity
- Transition order can be deduced from relative intensities and  $\gamma$ - $\gamma$  correlations
- Multipolarities can be deduced from intensities at different angles



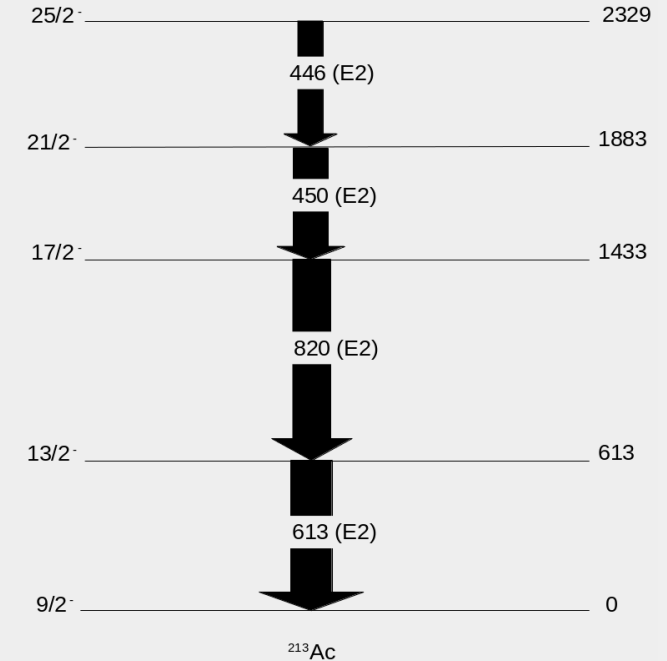


# Preliminary results

- Established level schemes
- Systematics still follow even-even isotone core
- No evidence for shears bands
- No longer living isomers were seen



No sign of isomers, at least between 1-10 μs from formation



Preliminary level scheme and assignments for  $^{213}\text{Ac}$



**Thank you for listening**

**Questions**



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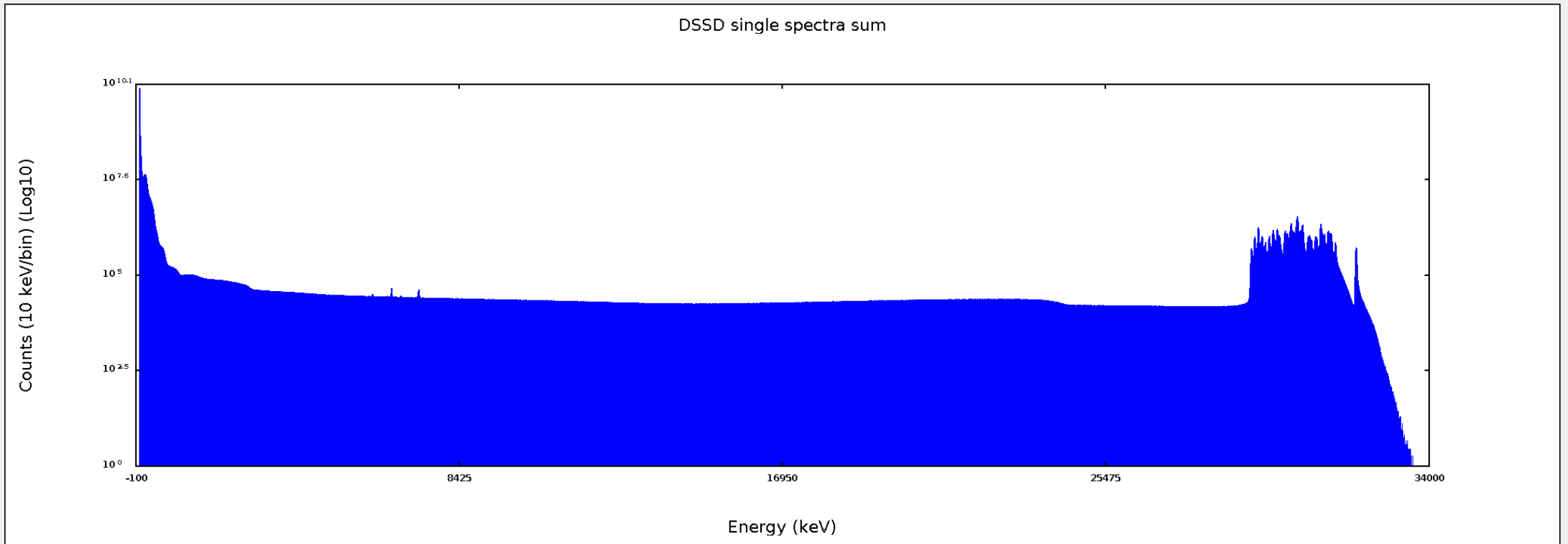


# Outline

- Motivation
- Experiment
- Instrumentation
- Data analysis
- Preliminary Results



# Analysis - Extras Building events

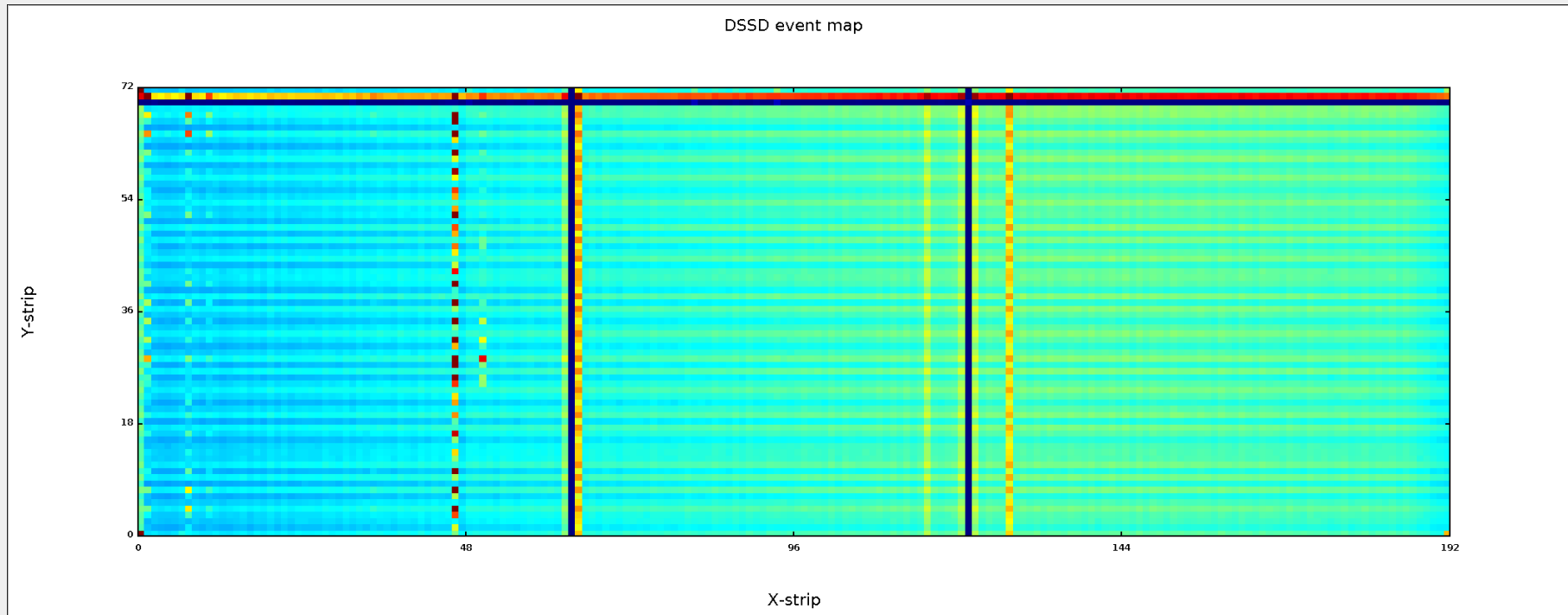


Without parsing the events, not much can be seen





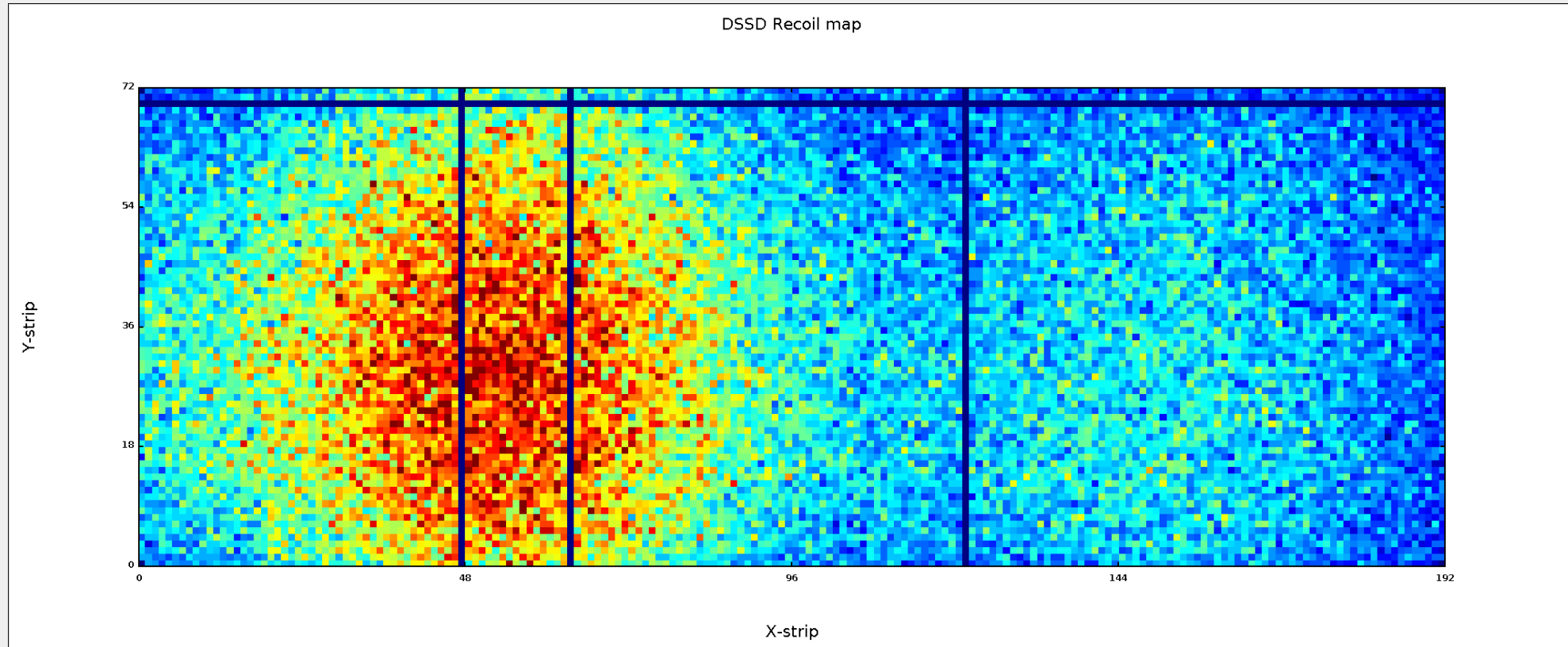
# Analysis - Extras Building events



But still, unwanted events are obstructing the view



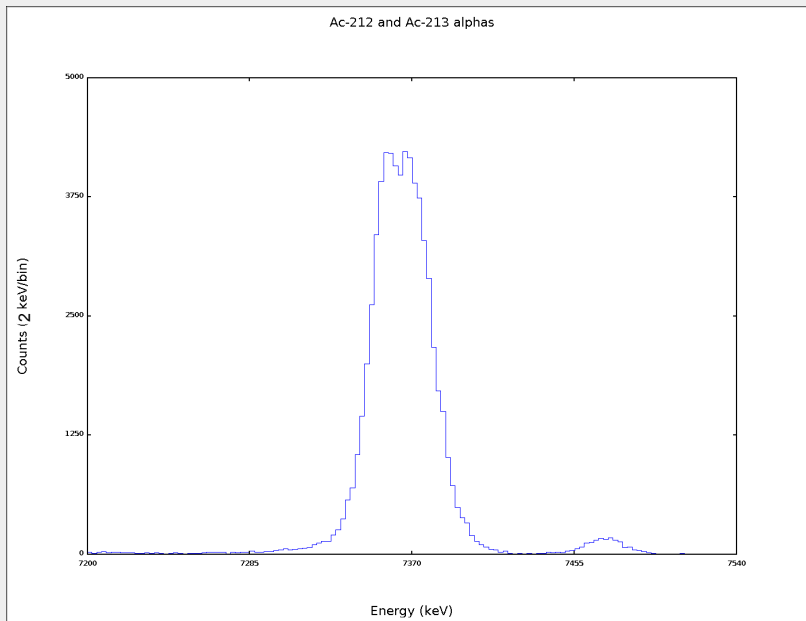
# Analysis - Extras Identification



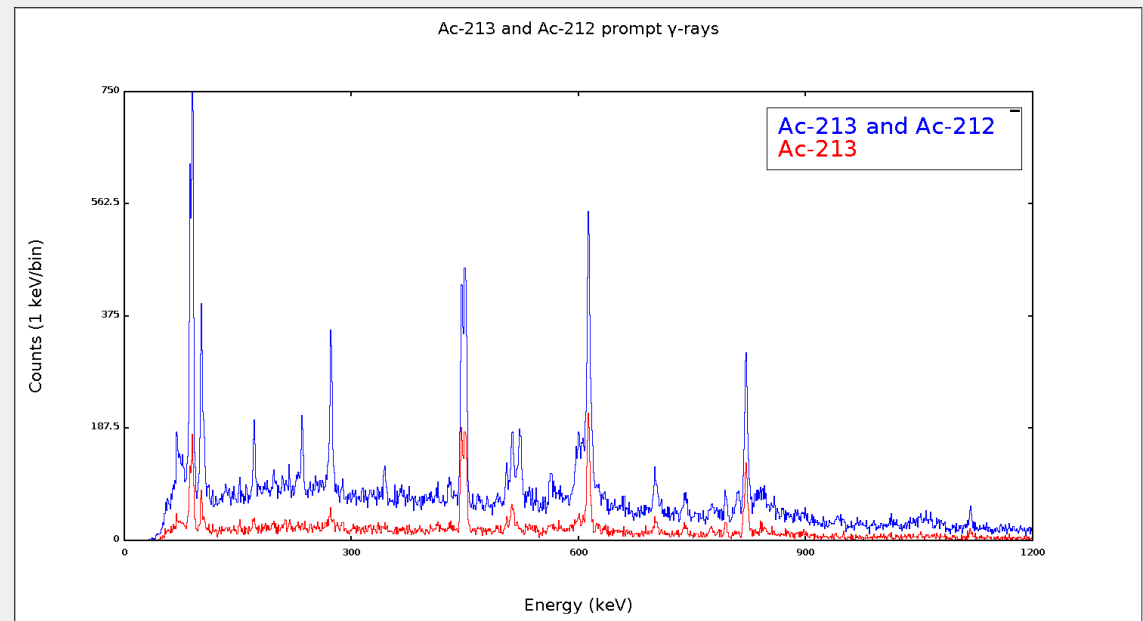
DSSD image looks good now



# Analysis - Extras Alpha energies



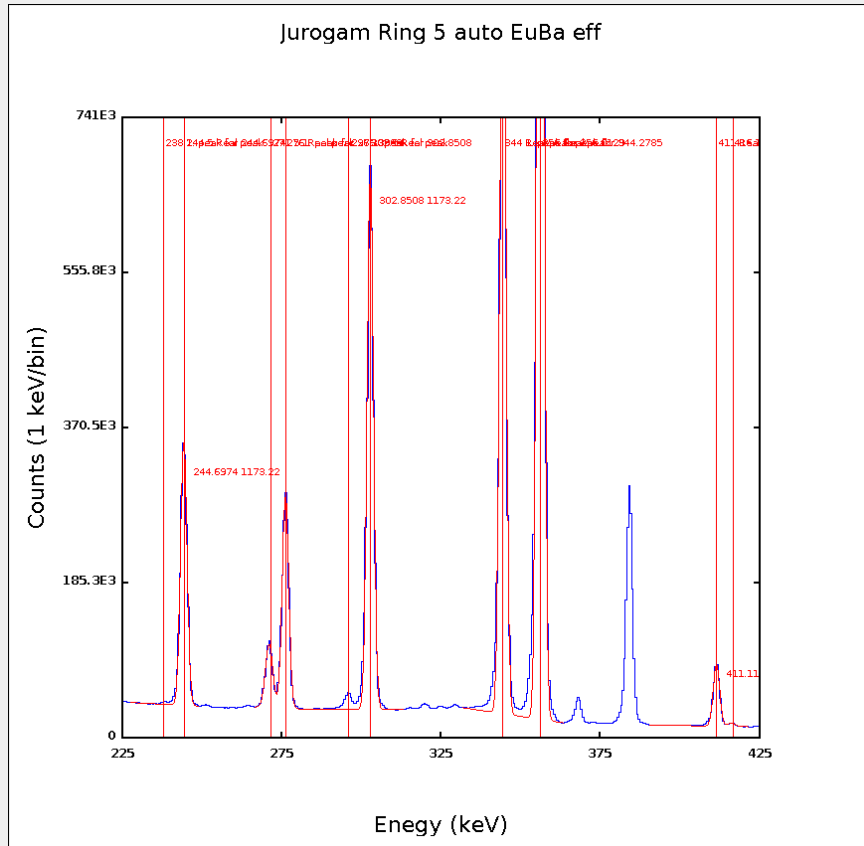
Ac-213 and Ac-212 share very similar decay properties



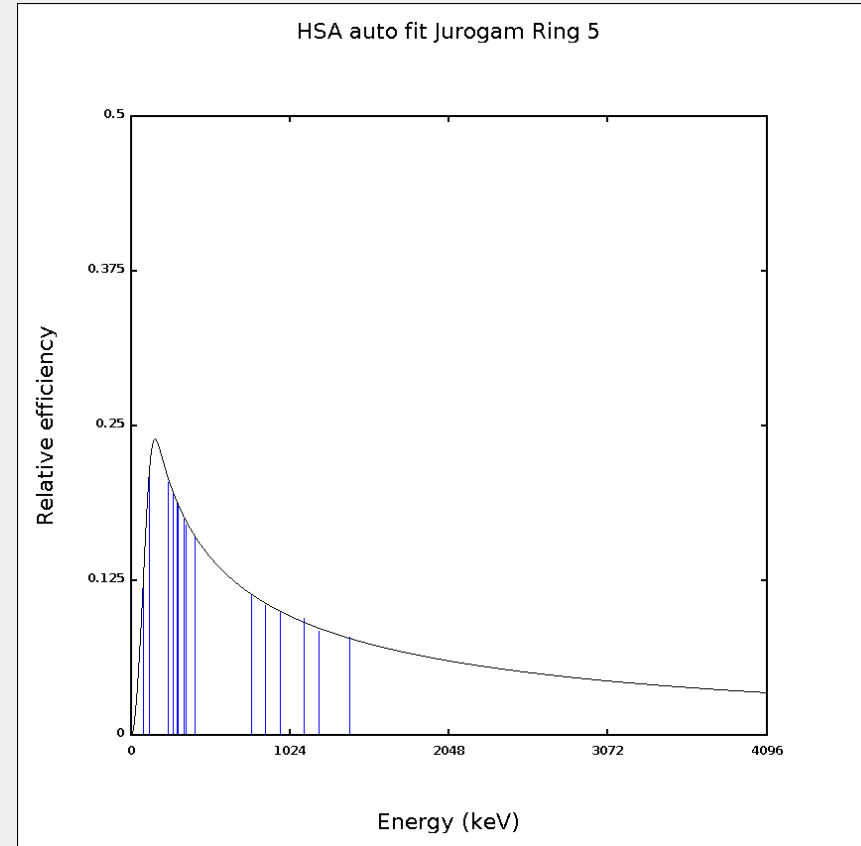
They can still be separated, at cost of statistics



# Analysis - Extras Efficiency



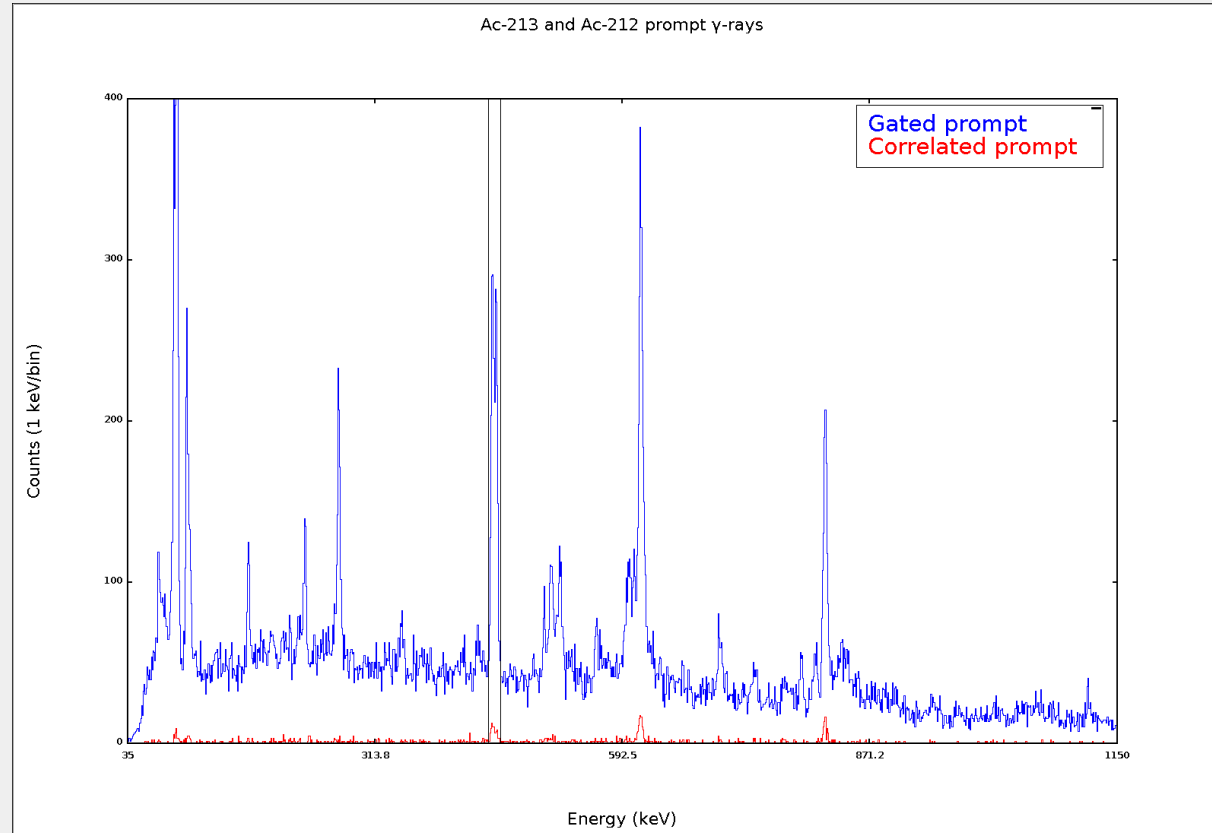
Fitting EuBa source peak intensities



Fitted efficiency curve for ring 5



# Analysis – Extras Without efficiency



Prompts without efficiency correction