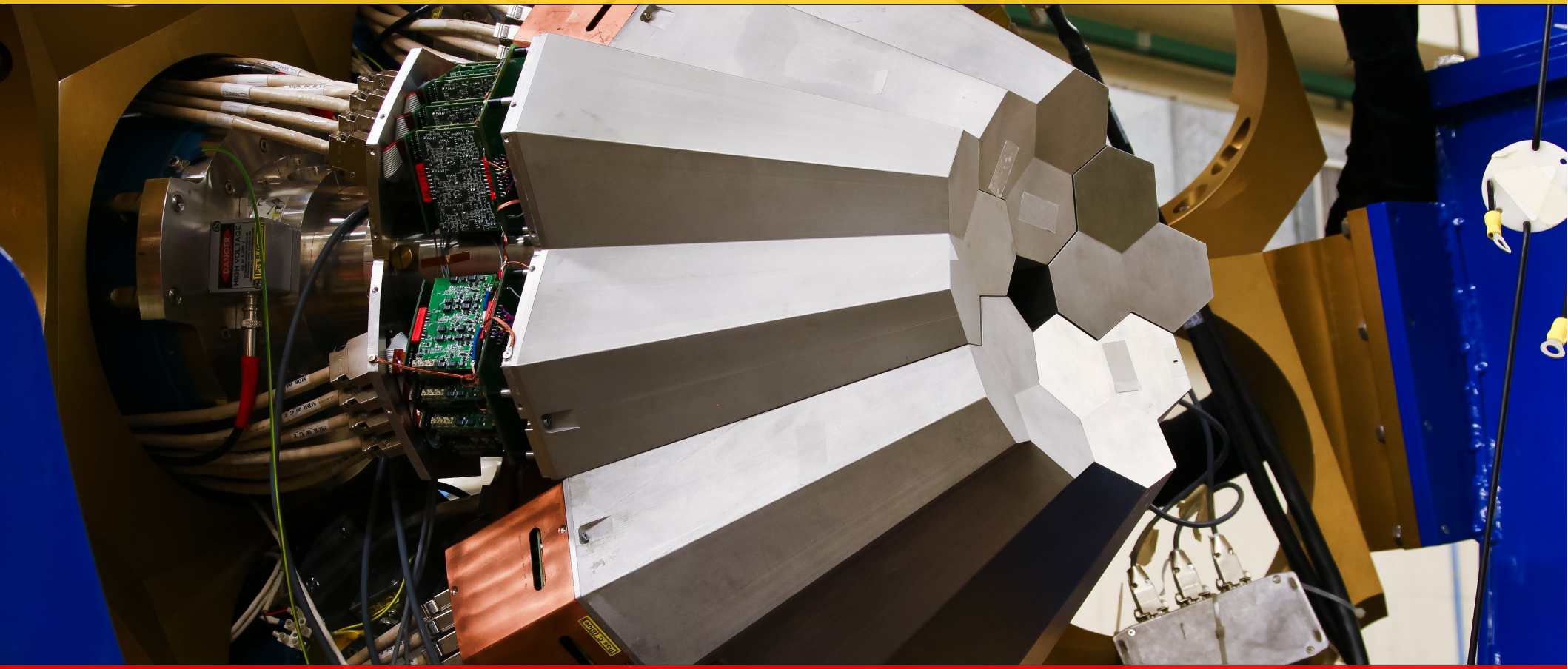
Spectroscopy of neutron rich Th and U nuclei after multi-nucleon reactions



DPG 2013 Dresden

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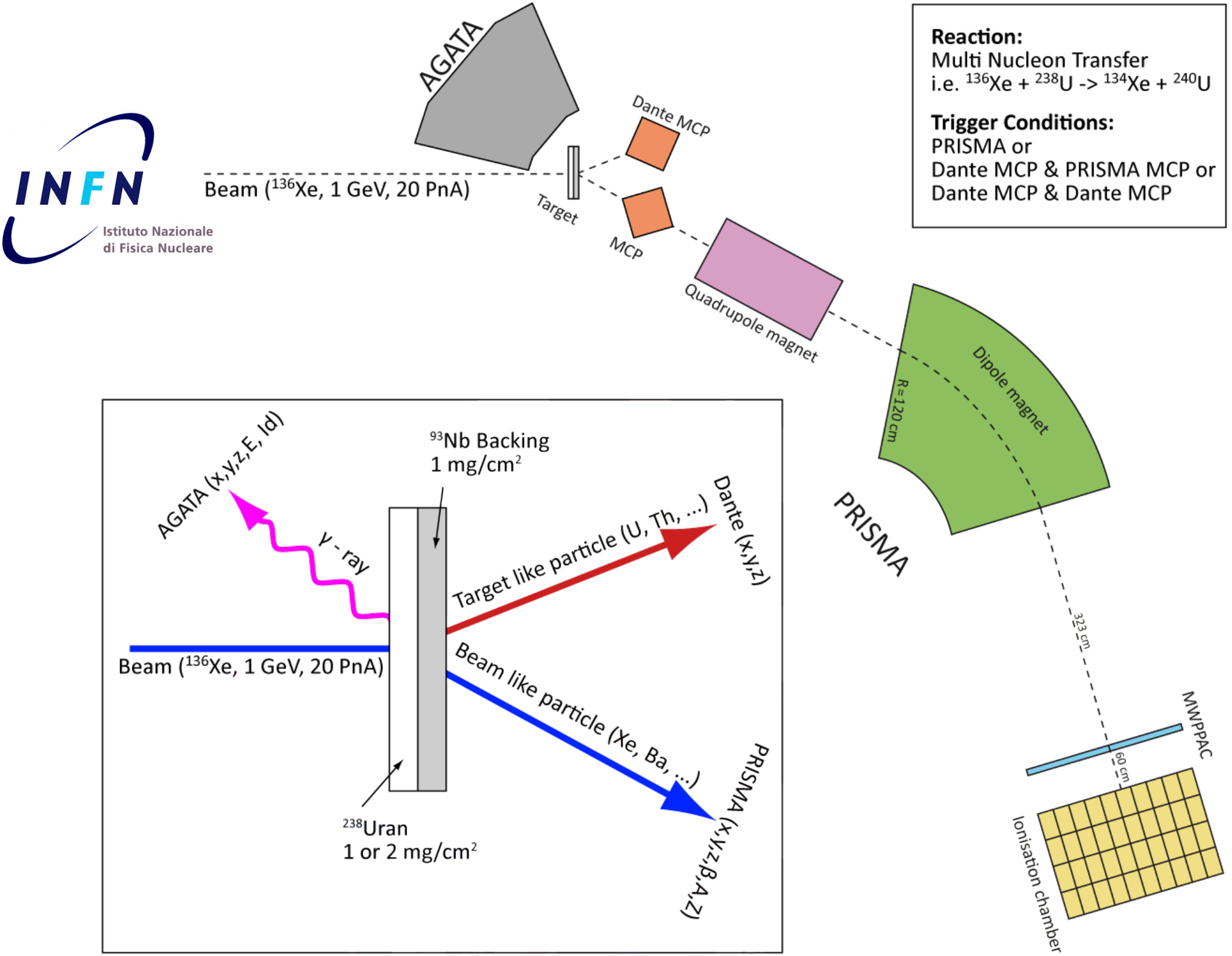
Physics motivation: spectroscopy of neutron rich Z=90-92 actinides

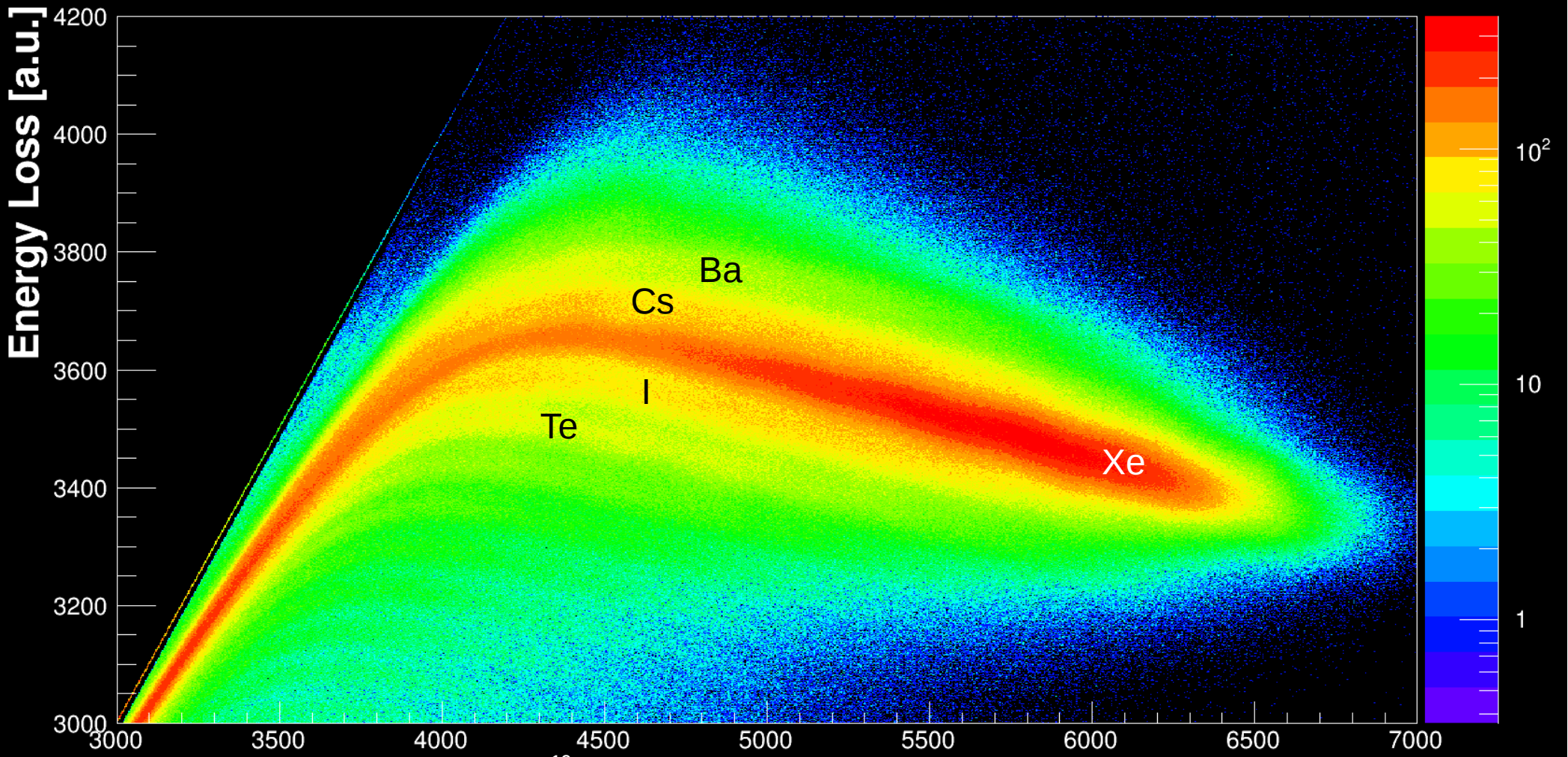
- Recent theoretical investigation of the neutron rich actinide nuclei
  - Shell Correction Energy
    A.Sobiczewski, I. Muntian, Z. Patyk, PHYS. REV. C, 63 (2001) 034306
  - Alternative Parity States
    Shneidman, et al. PHYS. REV. C 74, 034316 (2006)
  - Mean field and beyond mean field calculations, Gogny force
    J.-P. Delaroche et al. Nuclear Physics A 771 (2006) 103–168
  - Relativistic nuclear energy density functionals
    D. Vretenar, et al., Int. Journal of modern Physics E (2010)
- Experimental proof of theories needed for extrapolation to SHE
  - Longer living SHE are expected to be neutron rich
- Explore hardly accessible neutron rich actinide region
  - Lack of target and beam combinations
  - Only a few reactions can produce neutron rich actinides
  - Cross sections of the reactions compared to fission background are very small
- Multi nucleon transfer reactions can produce neutron rich actinides
  - Feasibility of recoil coincidence method (Prisma / Dante)
  - Prisma clara experiment showed good results

Reaction:
Multi Nucleon Transfer
i.e. $^{136}Xe + ^{238}U \rightarrow ^{134}Xe + ^{240}U$

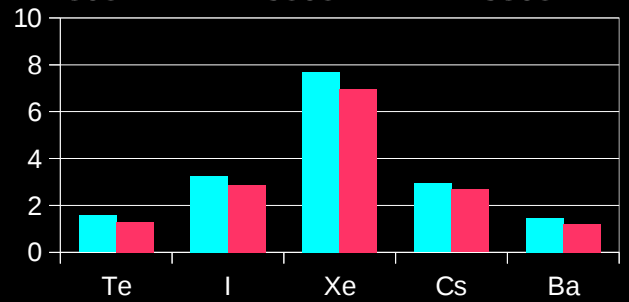
Trigger Conditions:
PRISMA or
Dante MCP & PRISMA MCP or
Dante MCP & Dante MCP



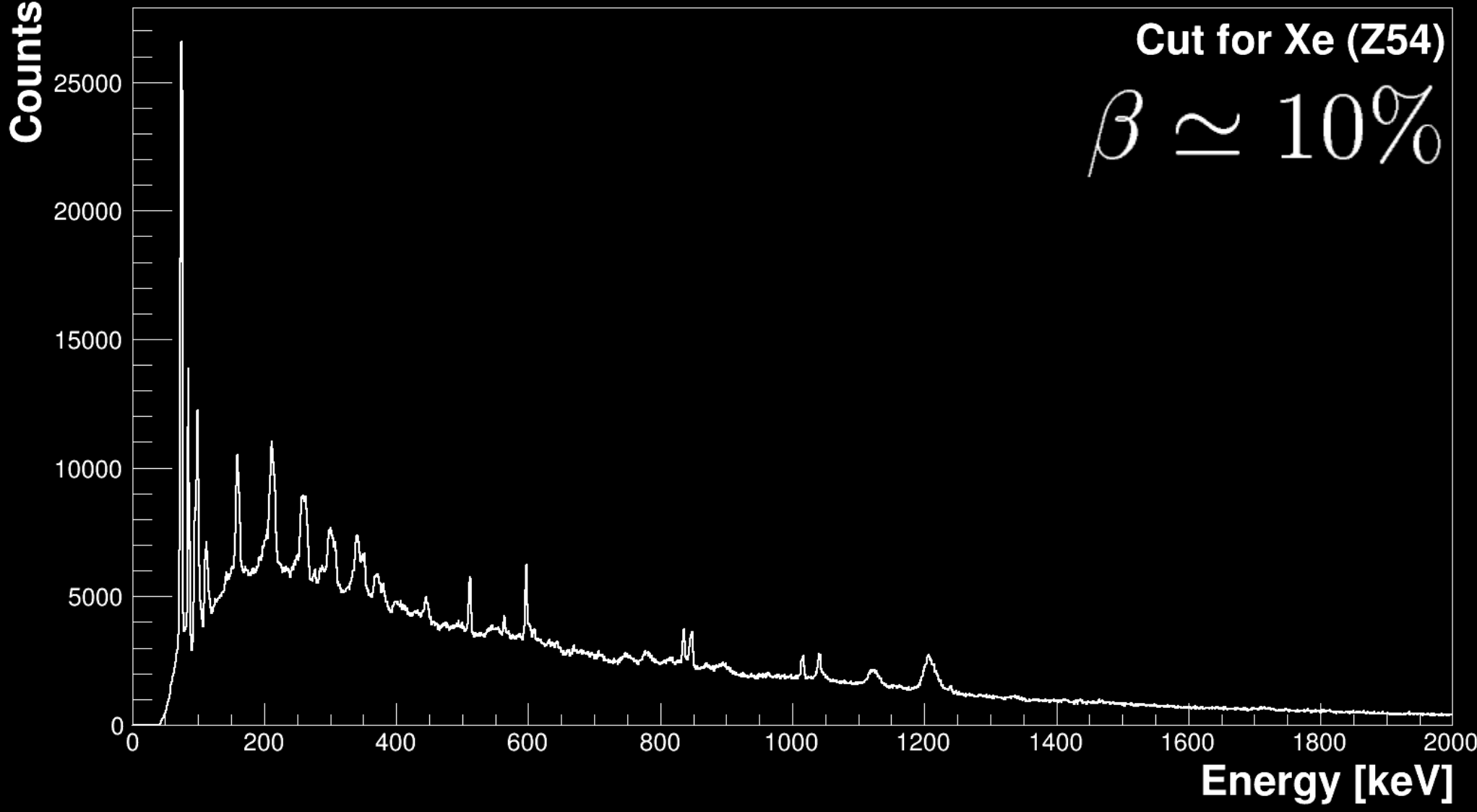
Selection of the different Z



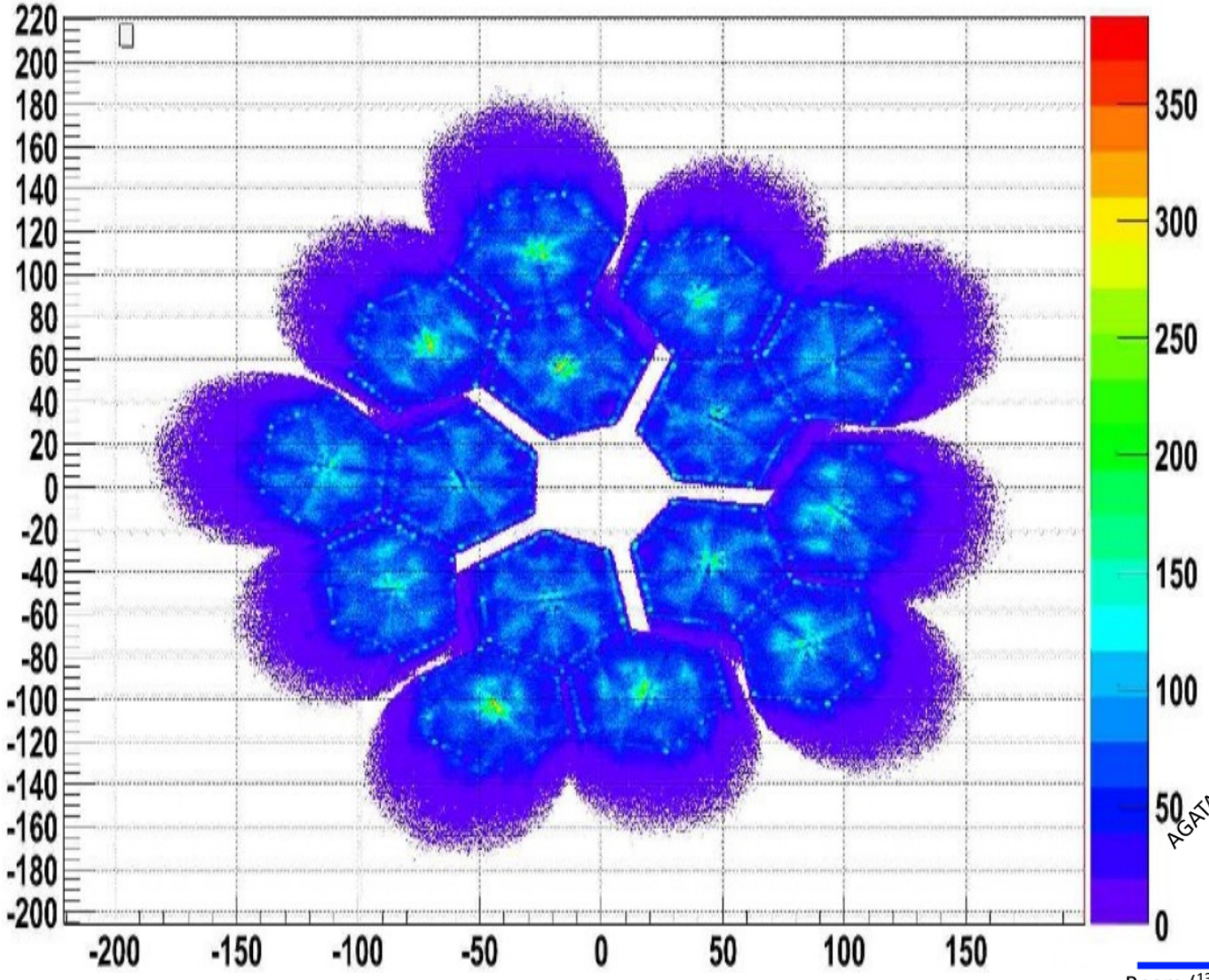
$$-\frac{dE}{dx} \propto \frac{Z^2}{E}$$



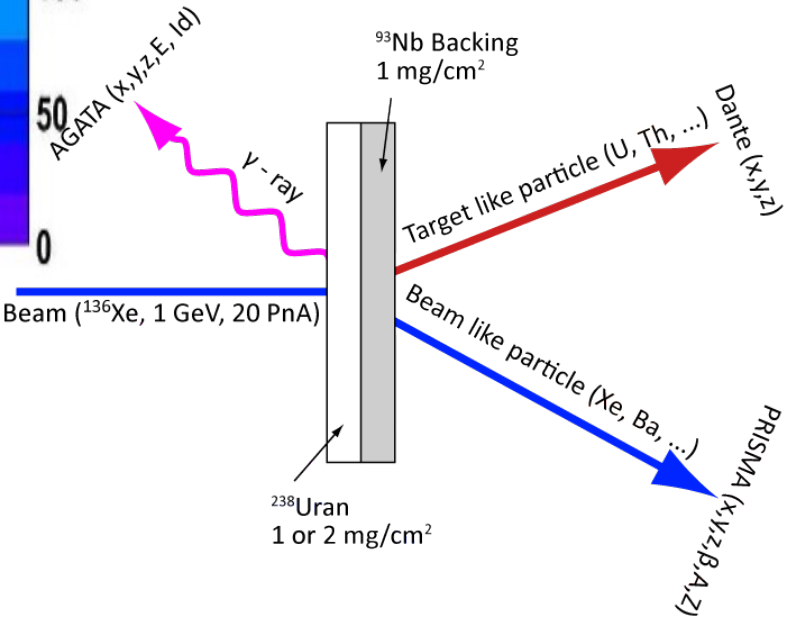
Spectra after selection of Z equals 54 (Xe)



AGATA – Tracking and PSA

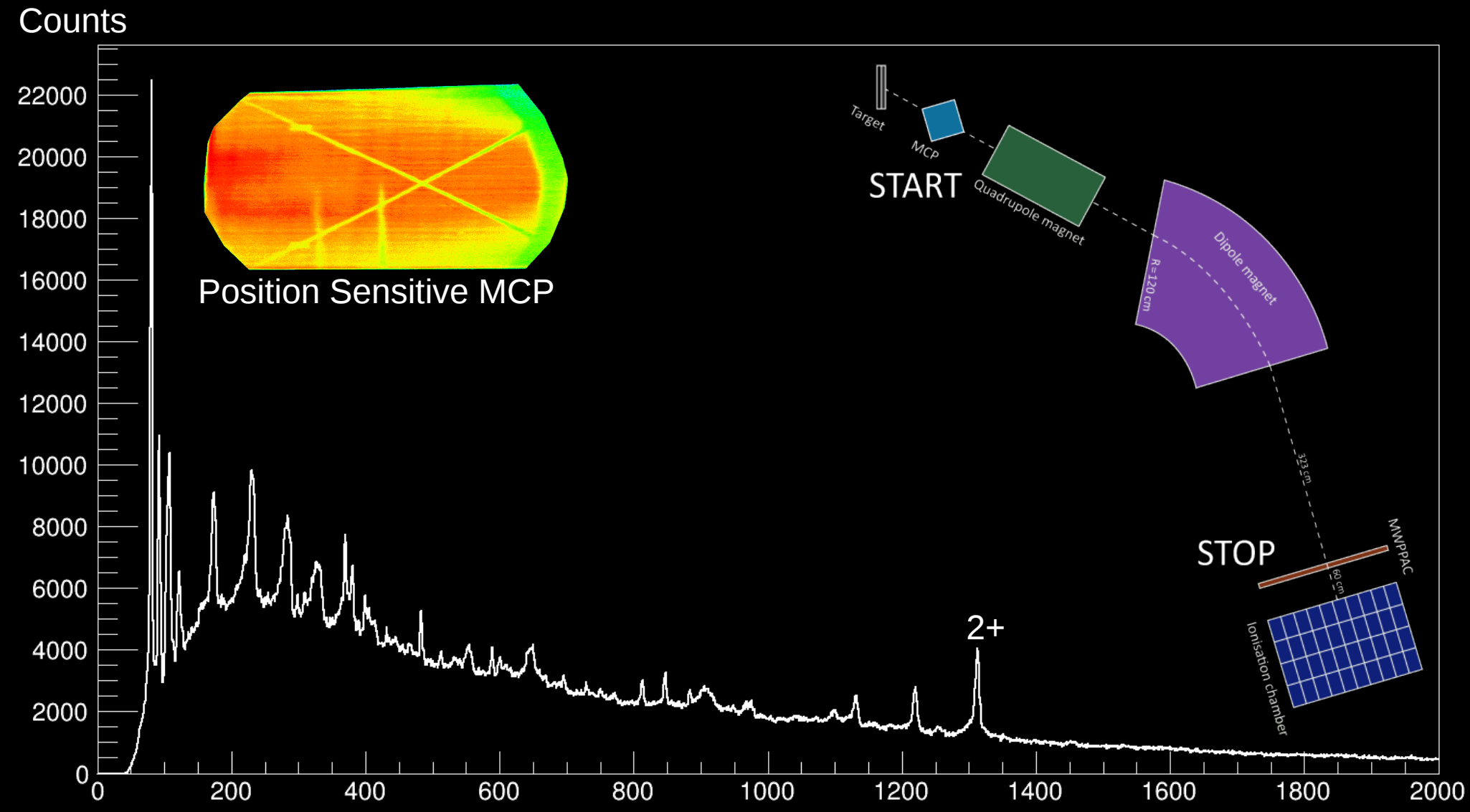


- Pulse Shape Analysis
  - Identfication of interaction
  - Less than 5mm (FWHM)
    P.-A.Söoderström, et al. NIMA 638(2011)96.
- Gamma Ray Tracking
  - Reconstruction of the gamma ray track
  - Identification of the first interaction



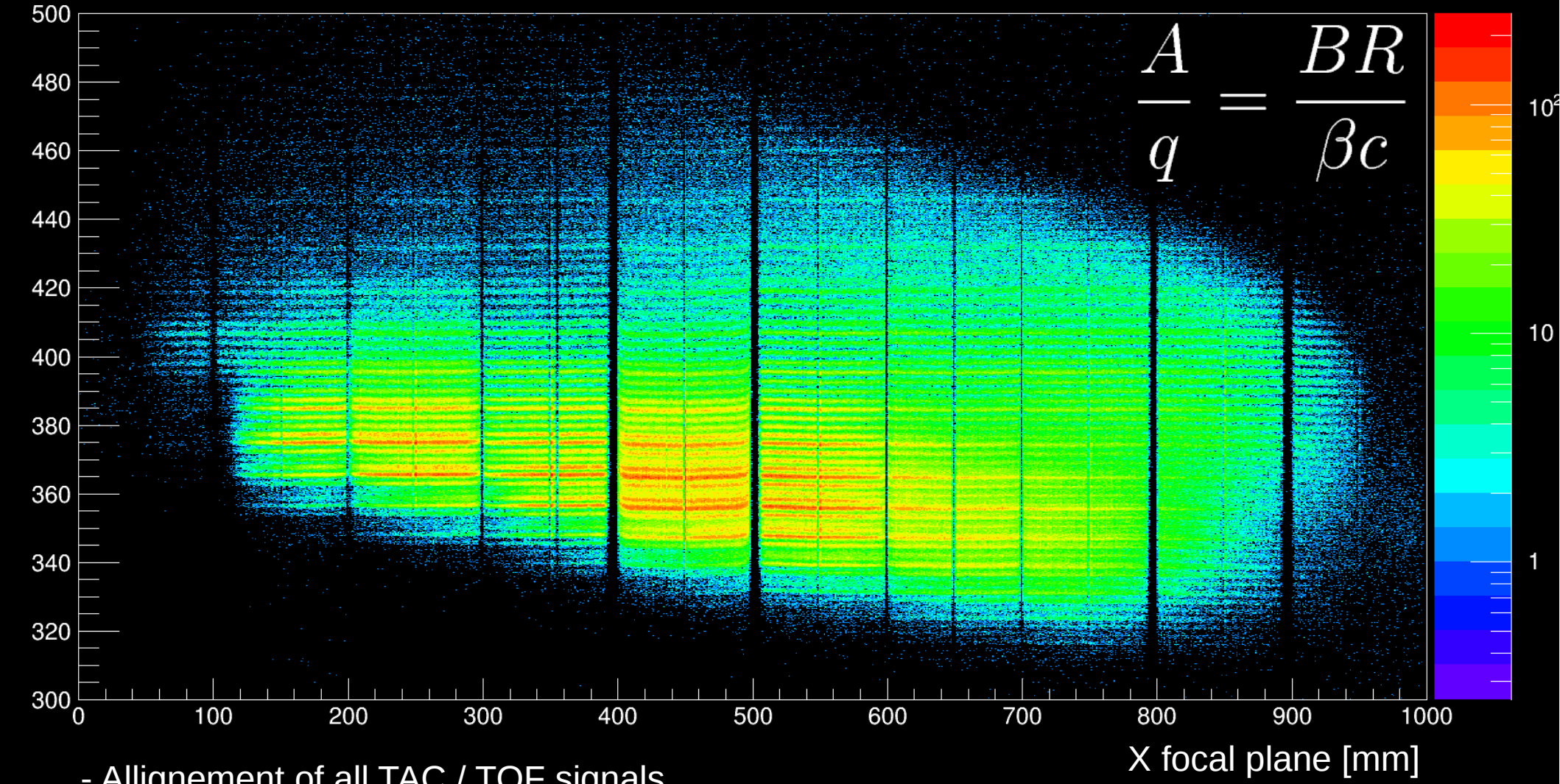
$$E_\gamma = E_{\gamma 0} \frac{(1-\beta^2)^{\frac{1}{2}}}{(1-\beta\cos\theta)}$$

Doppler corrected spectra for beam like nuclei (Z=54)



- angle from the position sensitve MCP and AGATA (Tracking and PSA)
- beta from the time of flight and path reconstruction of PRISMA software

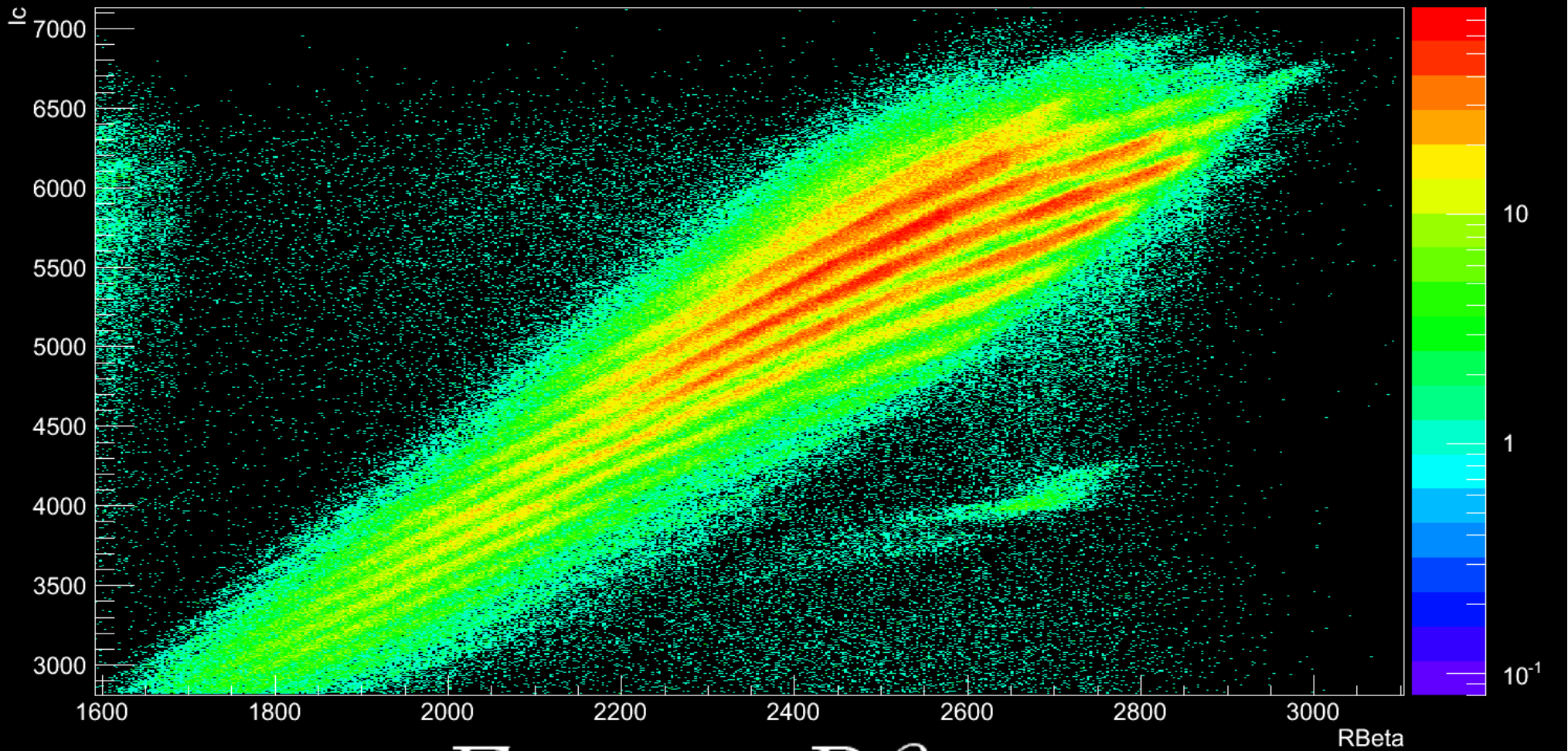
A / q vs x focal plane (MWPPAC) for Z 54 (Xe)



- Allignement of all TAC / TOF signals
- Abberation corrections

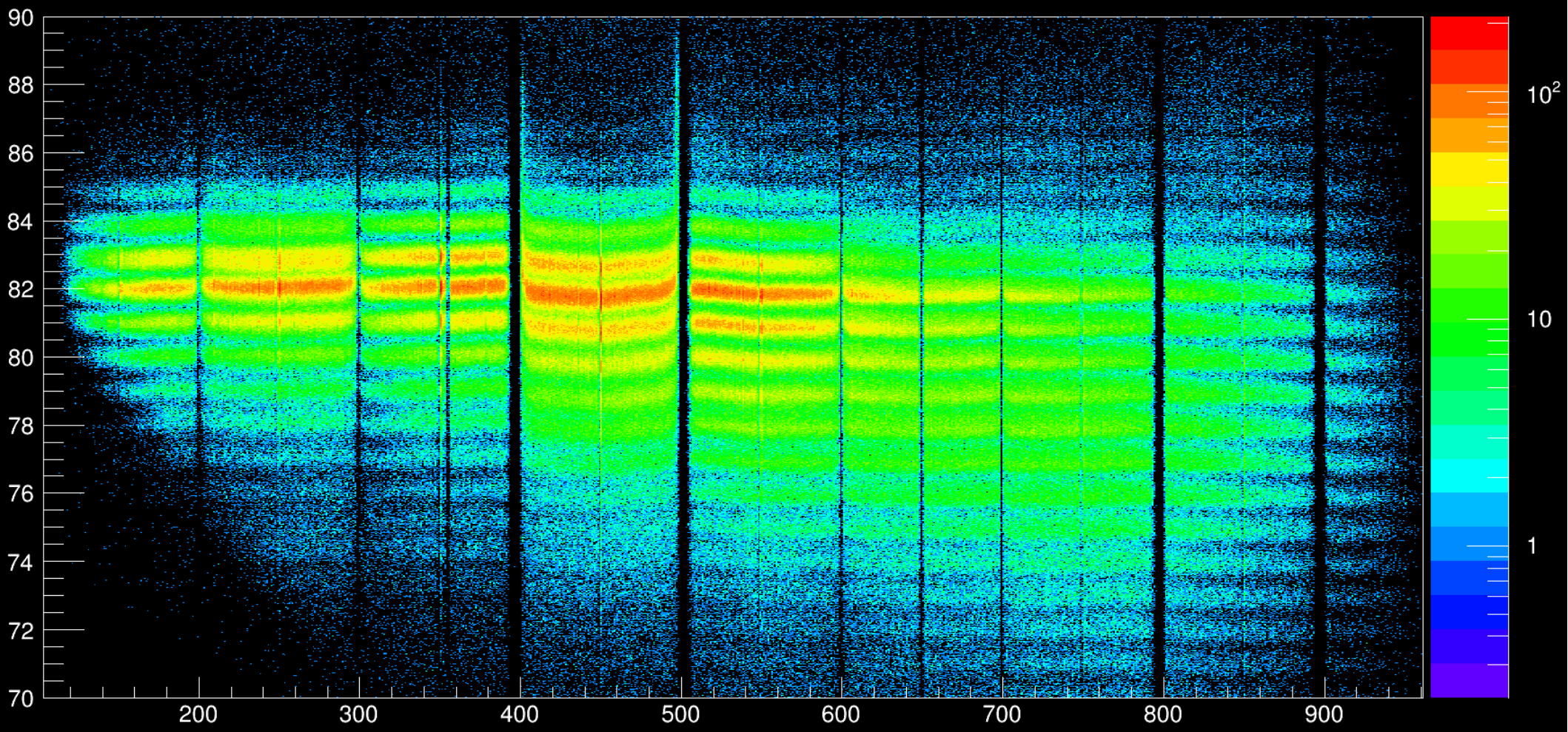
Charge state ambiguity

Energy deposited in ionization chamber vs R times Beta for Z 54 (Xe)



$$E_{IC} \propto qR\beta$$

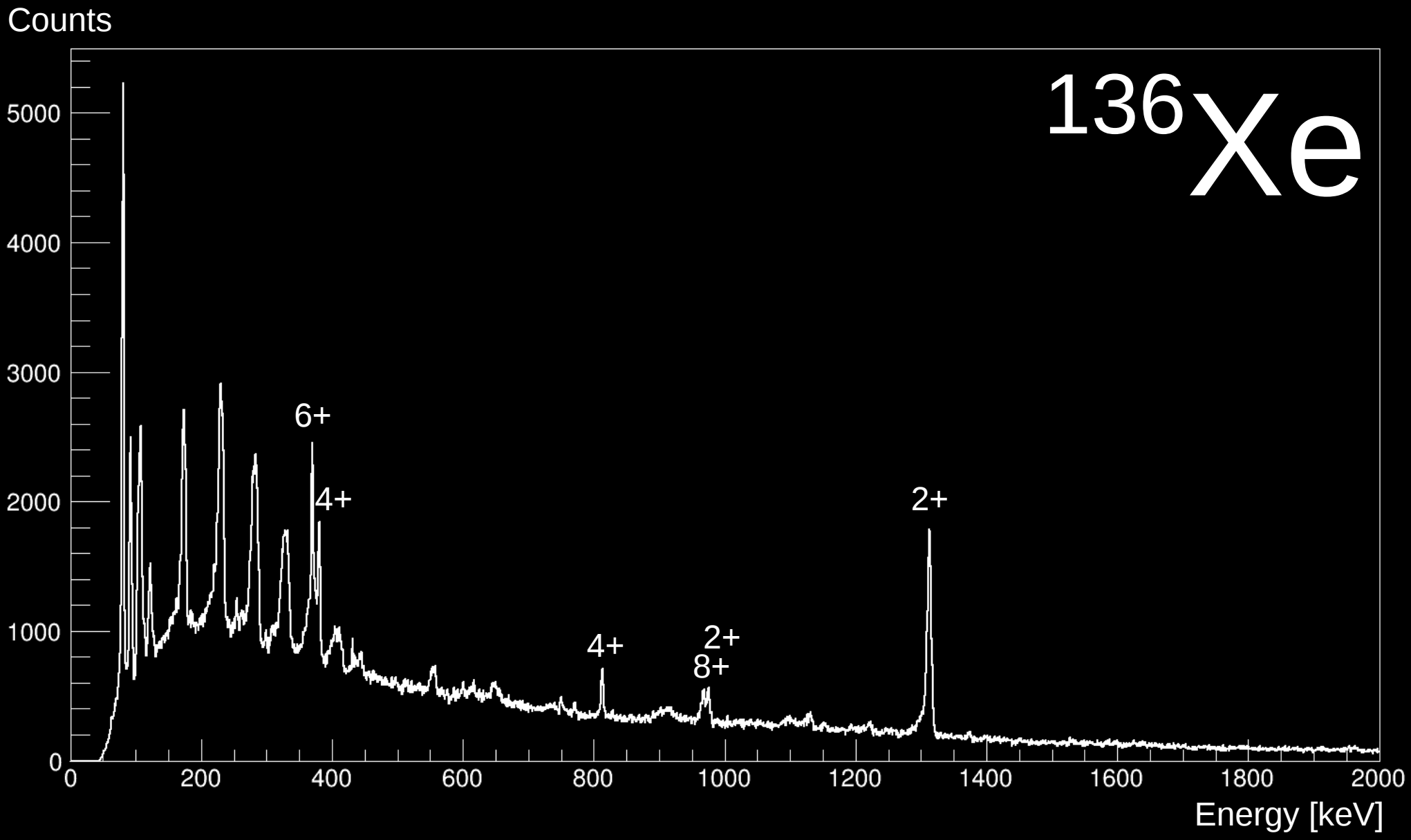
Mass vs x focal plane (MWPPAC) for Z 54 (Xe)



- Selection of charge states in Rbeta vs Energy (IC)
- overlay for all charge states using linear functions

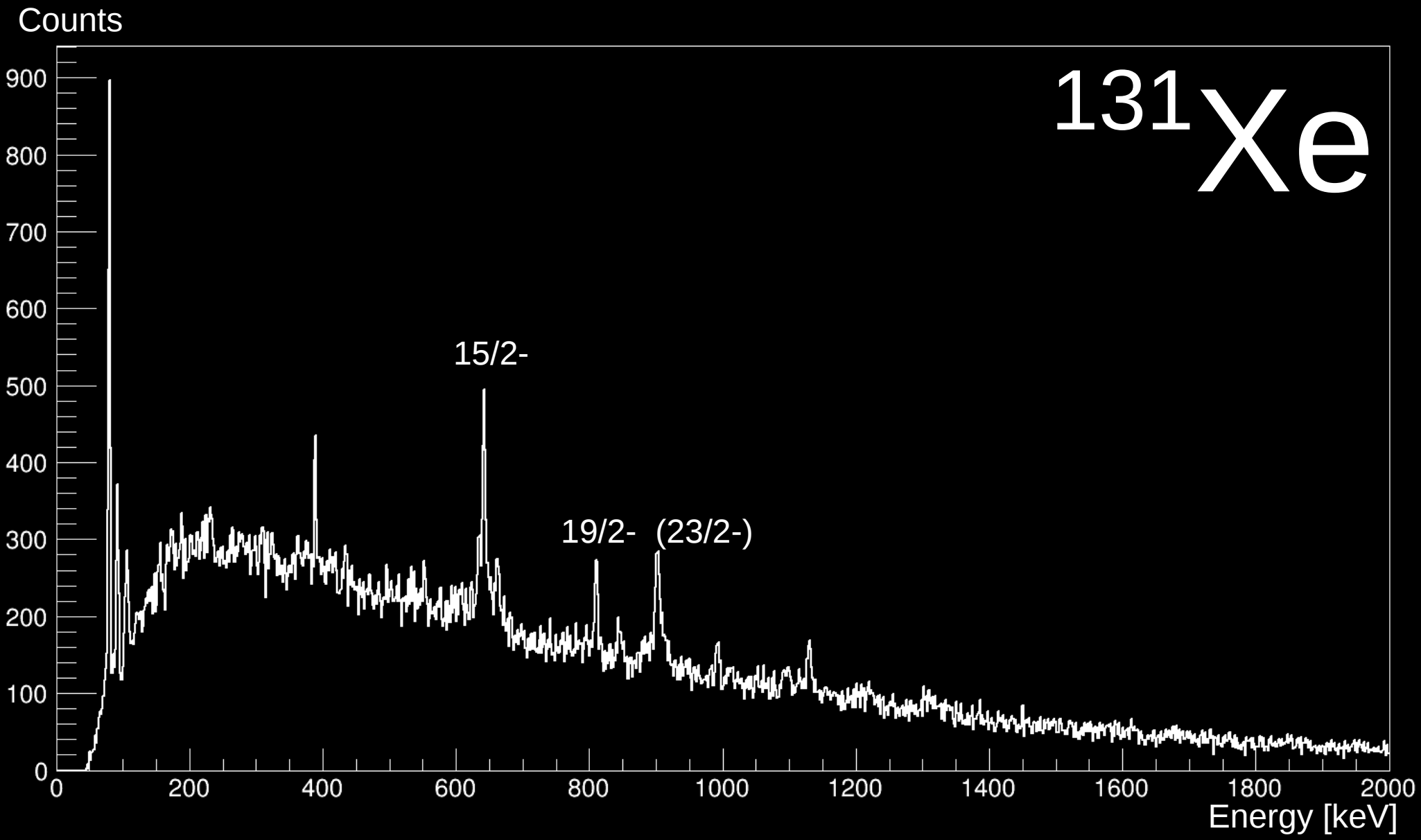
$$\frac{A}{q} = \frac{BR}{\beta c}$$

Doppler corrected spectra for beam like nuclei (Z=54 and A=136)



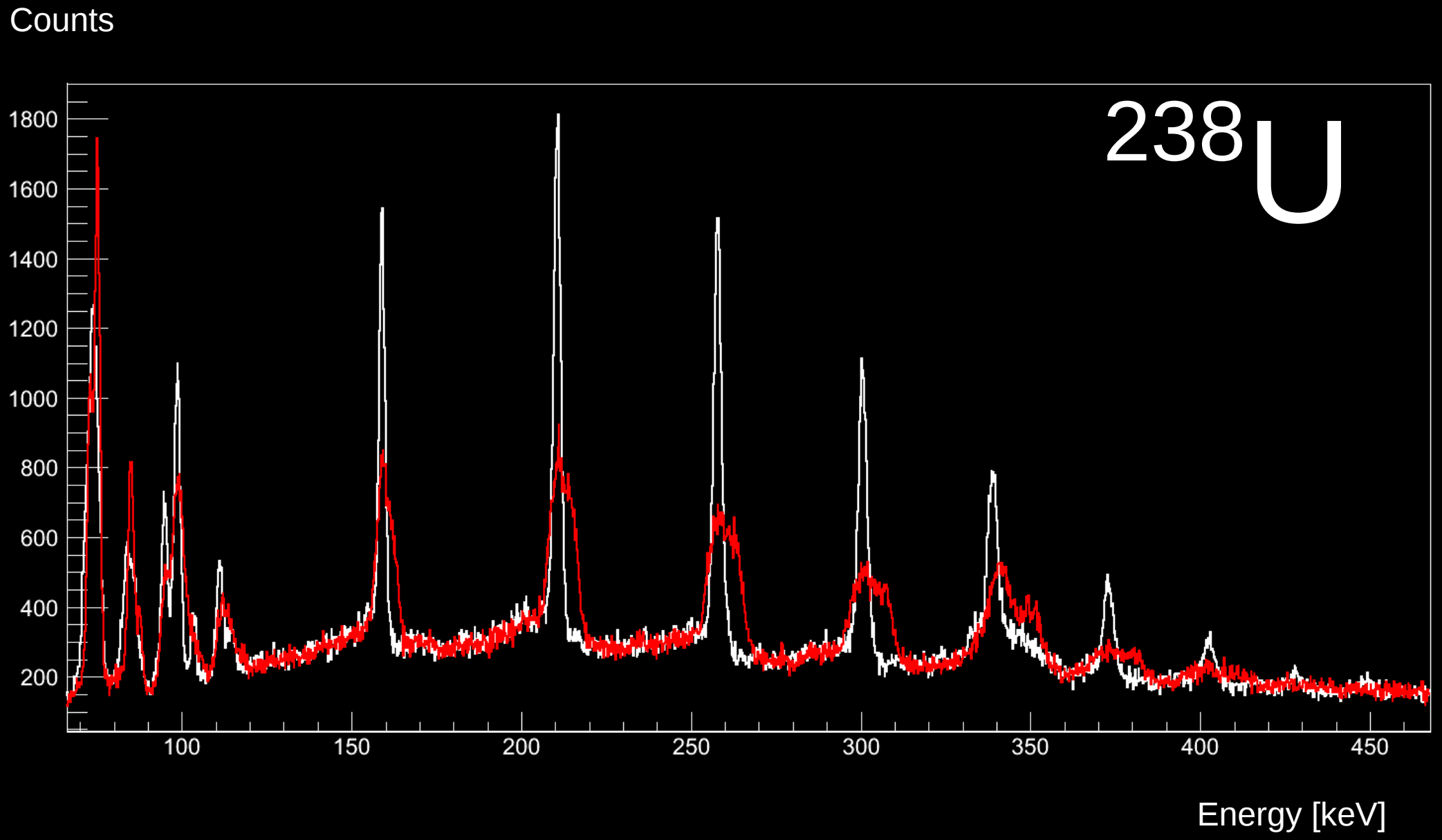
FWHM of 1313 keV (2+) line: 6.59 keV (with left tail free)

Doppler corrected spectra for beam like nuclei (Z=54 and A=131)

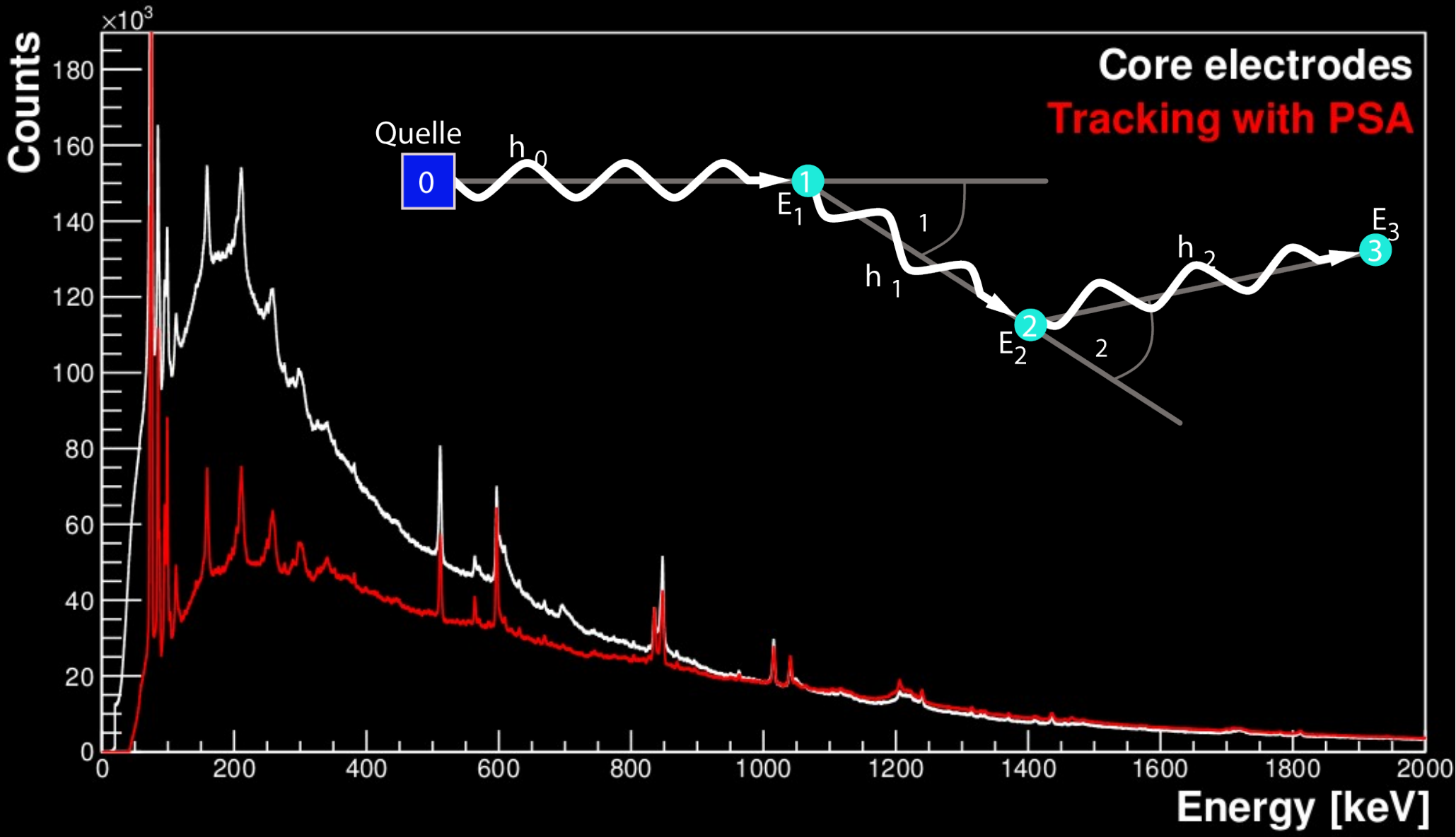


^{131}Xe is 5 Neutrons away from the beam

Doppler corrected spectra for target like nuclei (Z=92 and A=238)

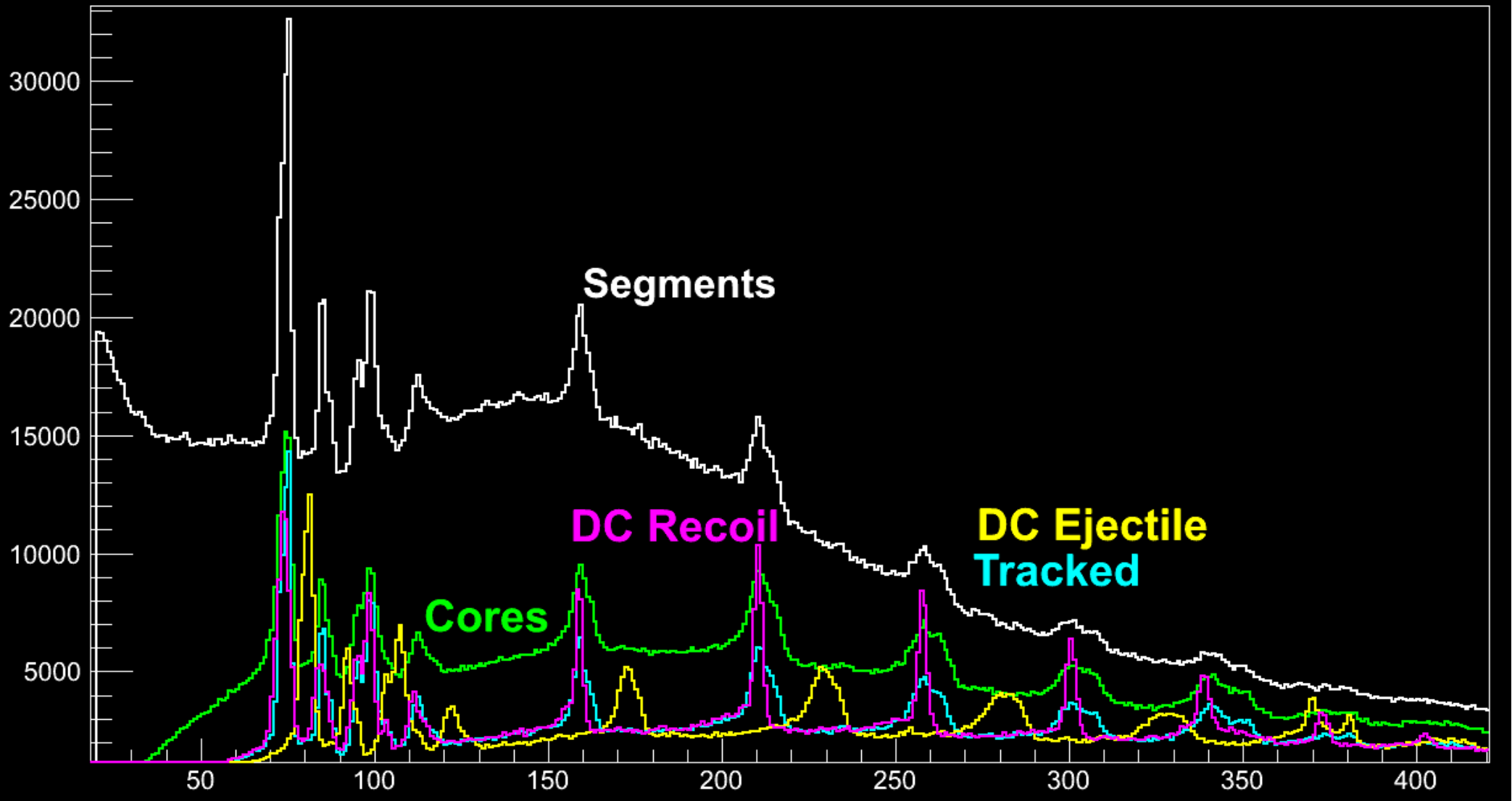


Preliminary Tracking Result



AGATA—Advanced GAmma Tracking Array, NIM A, Volume 668, 11 March 2012, Pages 26–58

Preliminary Tracking Result



Summary:

- Successful experiment with AGATA – Prisma Setup
- Identification of Beam like particles
- Doppler Corrected Spectra for Beam and Target like particles

Outlook:

- Apply new PSA and Tracking algorithms
- Investigate Z unequal 54 nuclei
- Coincidence conditions and q-Value cuts for cleaner spectra
- Coincidence trigger for better statistics

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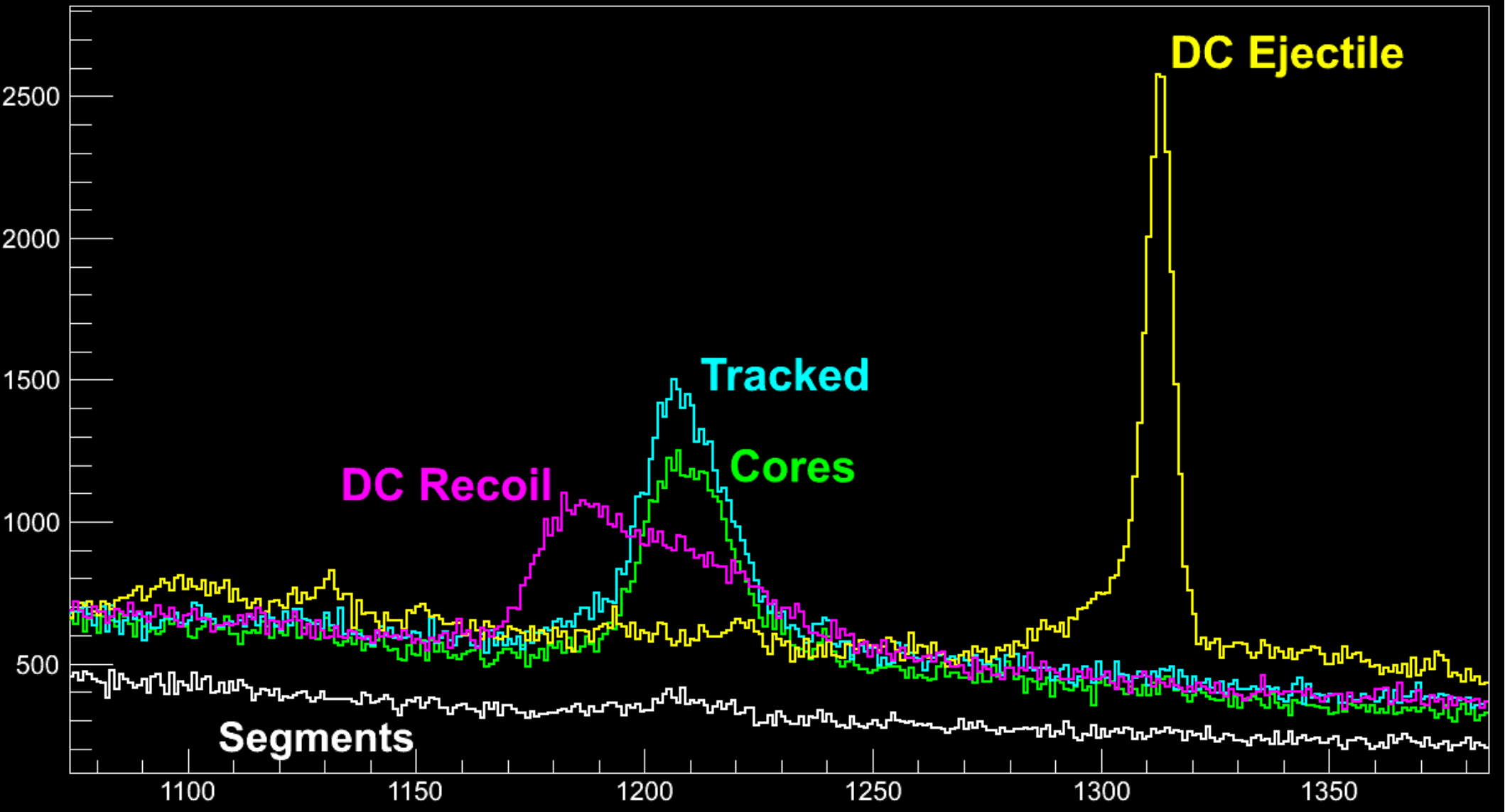
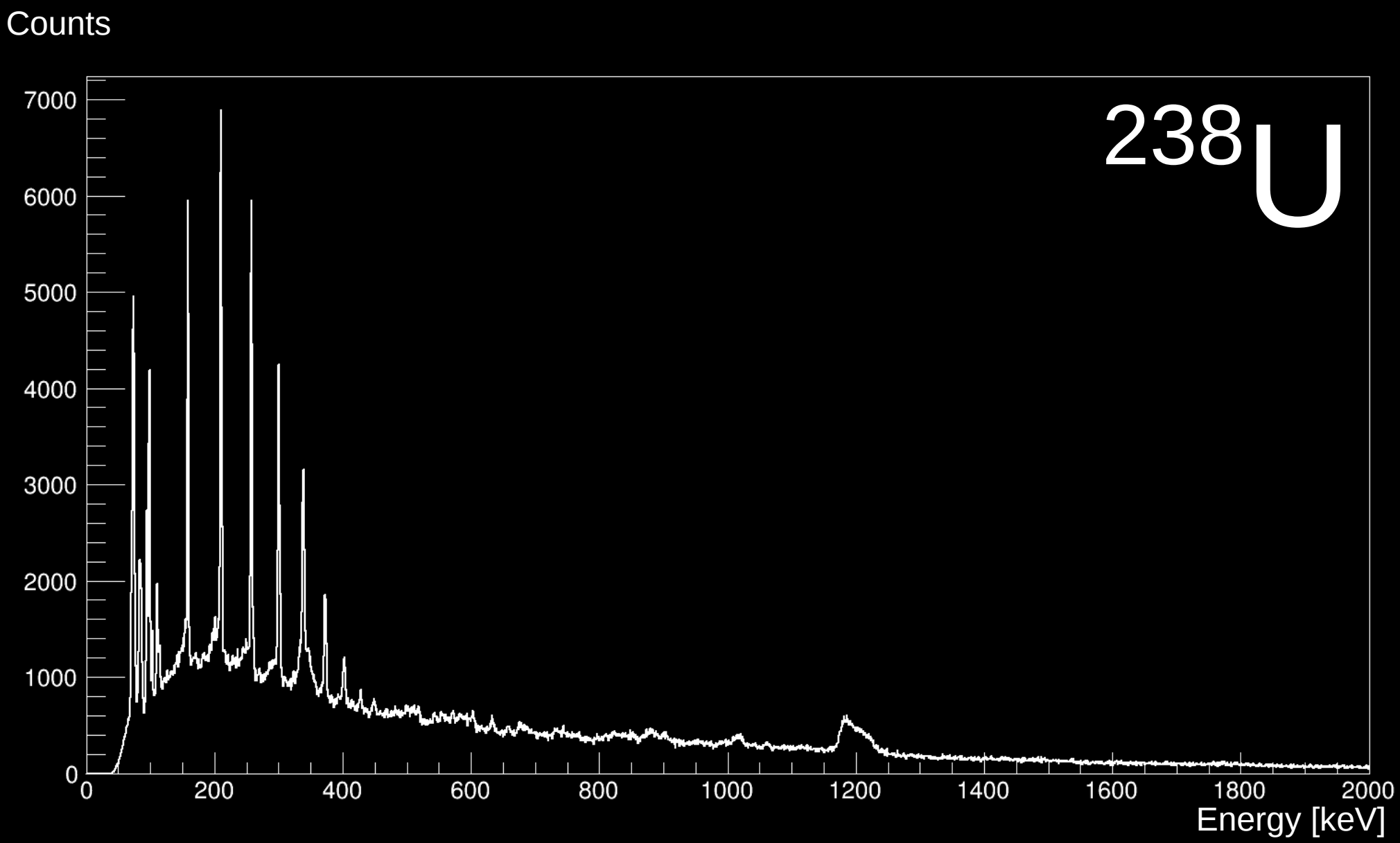
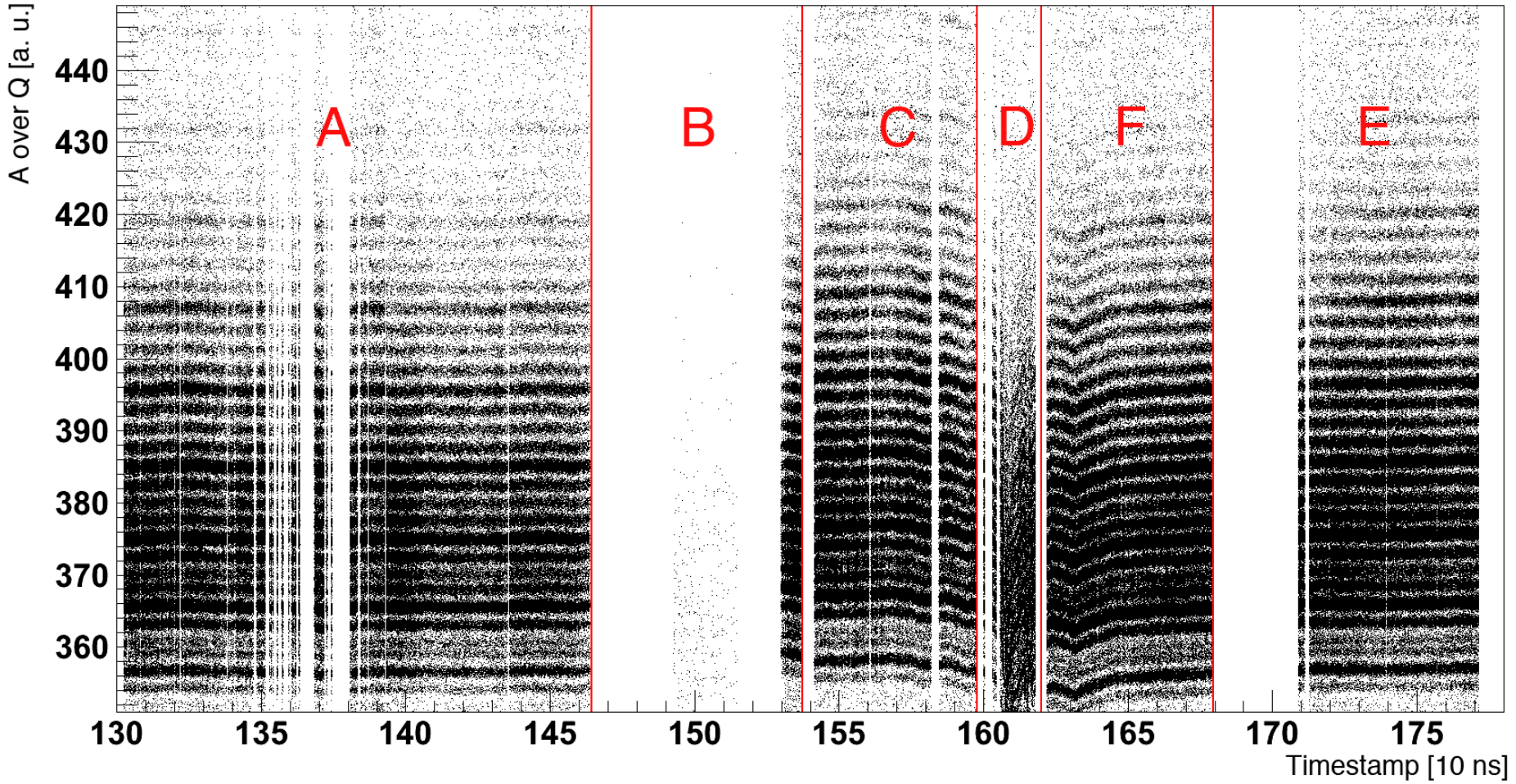
Preliminary Tracking Result



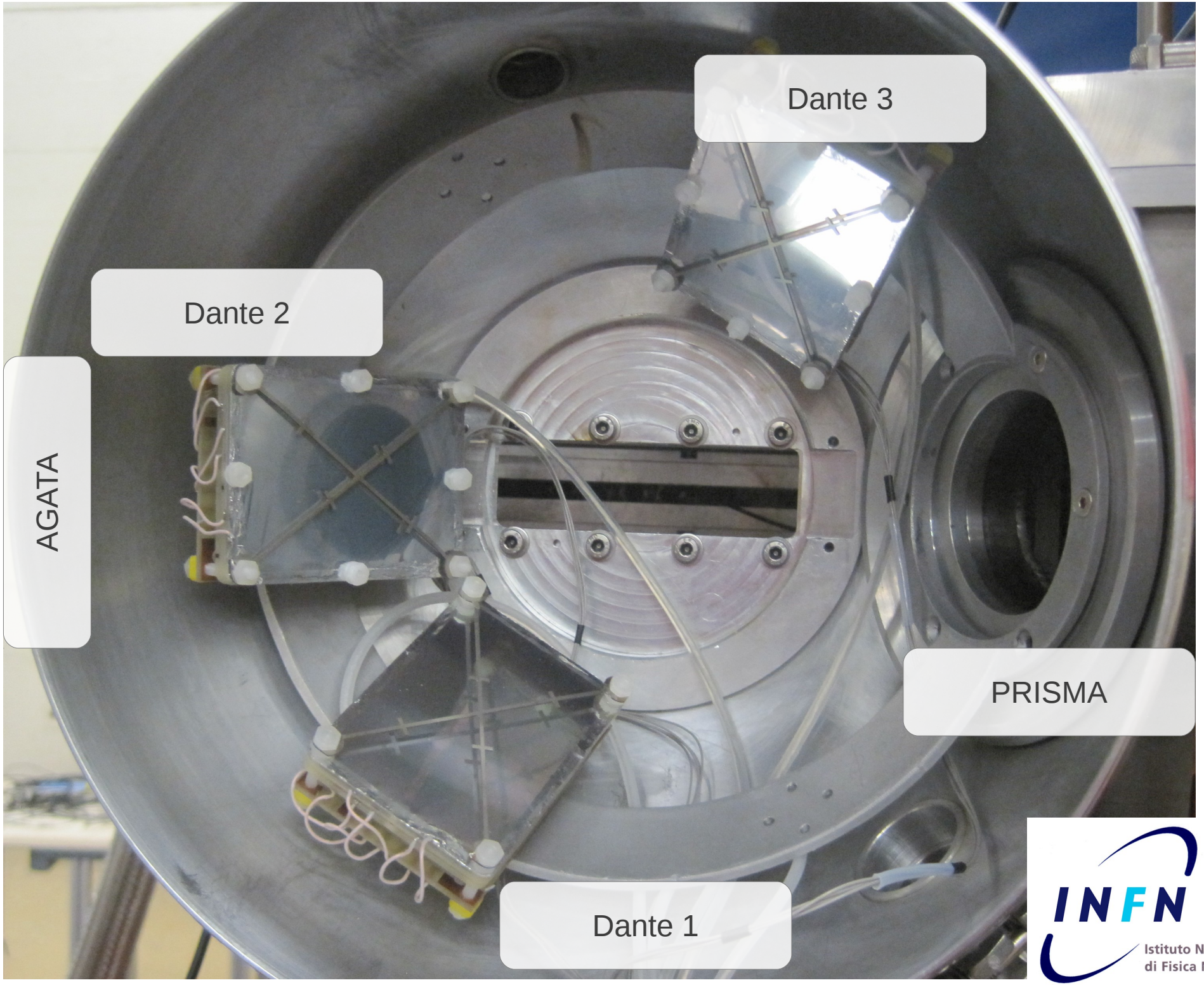
Doppler corrected spectra for target like nuclei (Z=92 and A=238)



Time Dependence



A / Q for one TAC of the MWPPAC against Ancillary Time Stamp



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