STRIP DETECTOR CALIBRATION USING DECAY CHAINS OF PRE-RECORDED DATA IN FULL FUSION REACTIONS OF $^{40}Ar + ^{148}Sm$ AND $^{40}Ar + ^{166}Er$ AND IN MULTINUCLEON TRANSFER REACTION OF $^{48}Ca + ^{242}Pu$

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Joint Institute for Nuclear Research
SCIENCE BRINGING NATIONS TOGETHER

JINR 114 Flerovium FLNR Dubna

NRF National Research Foundation
iThemba LABS Laboratory for Accelerator Based Sciences

AIM OF THE PROJECT

- Acquaintance with MASHA
  - ECR source
  - Rotating target with hot catcher
  - Mass Separator
  - Detector
- Analysis of Data
  - Plotting Graphs of different isotopes and their alpha decay energies
  - Calibration of Mass-energy spectrum

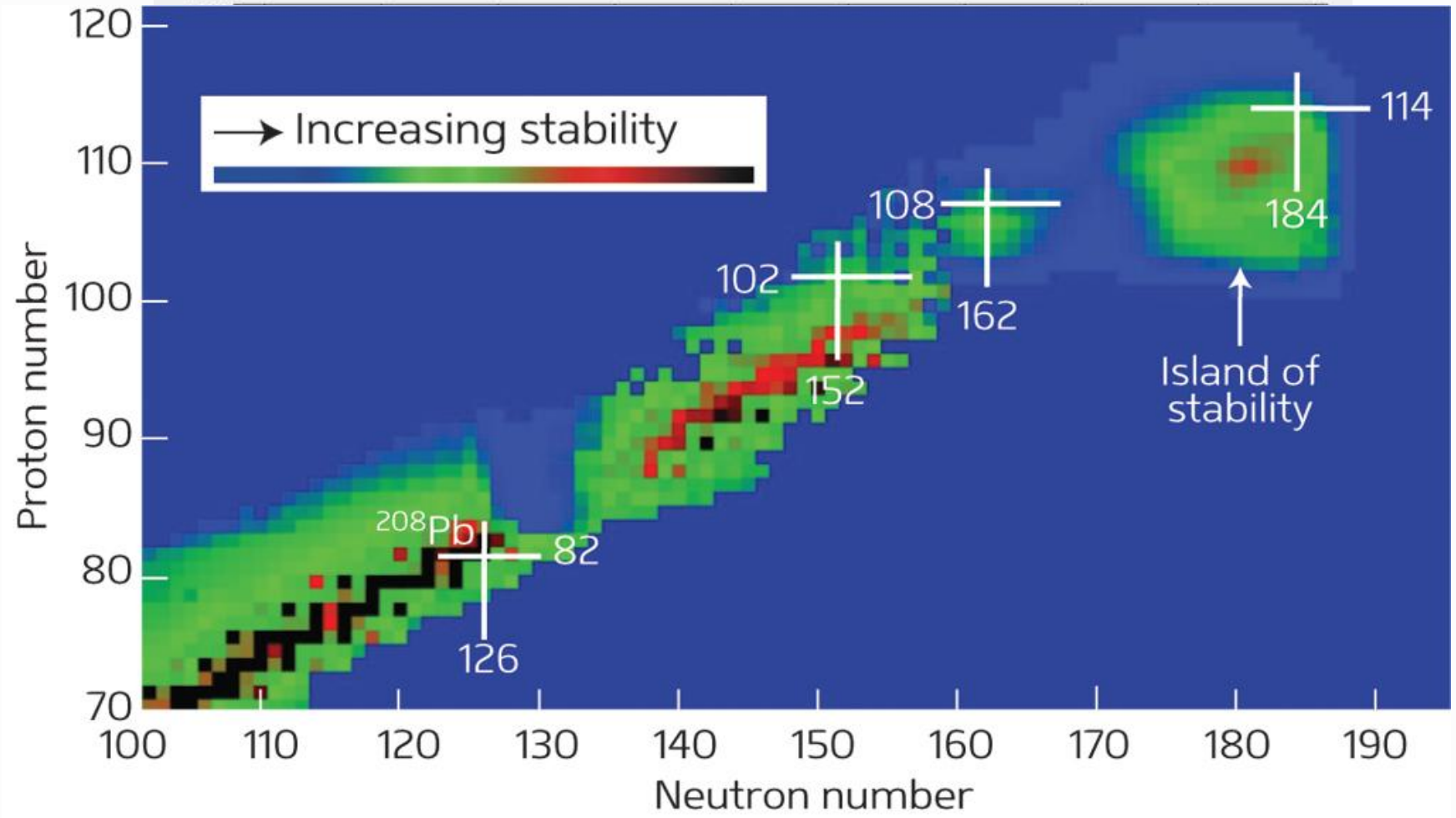
INTRODUCTION

- Super heavy elements
  - Stability, island of stability
  - Half life, properties, cross section

- Fusion Reaction
  - Collision and compound nuclei
  - Alpha decays
- MASHA

  - Alpha decay and half life

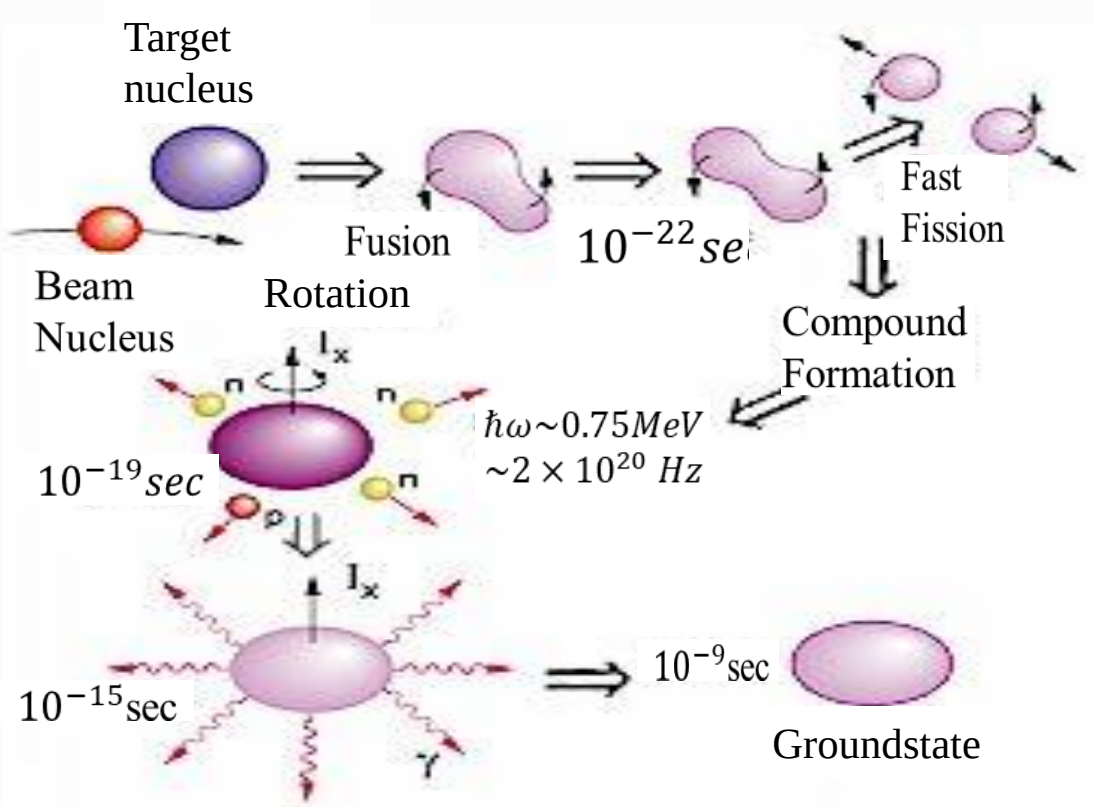
Introduction (cont.)



[Source:Kelley, L. (2019, March 12). What Is the Island of Stability? Retrieved from https://owlcation.com/stem/What-is-the-Island-of-Stability]

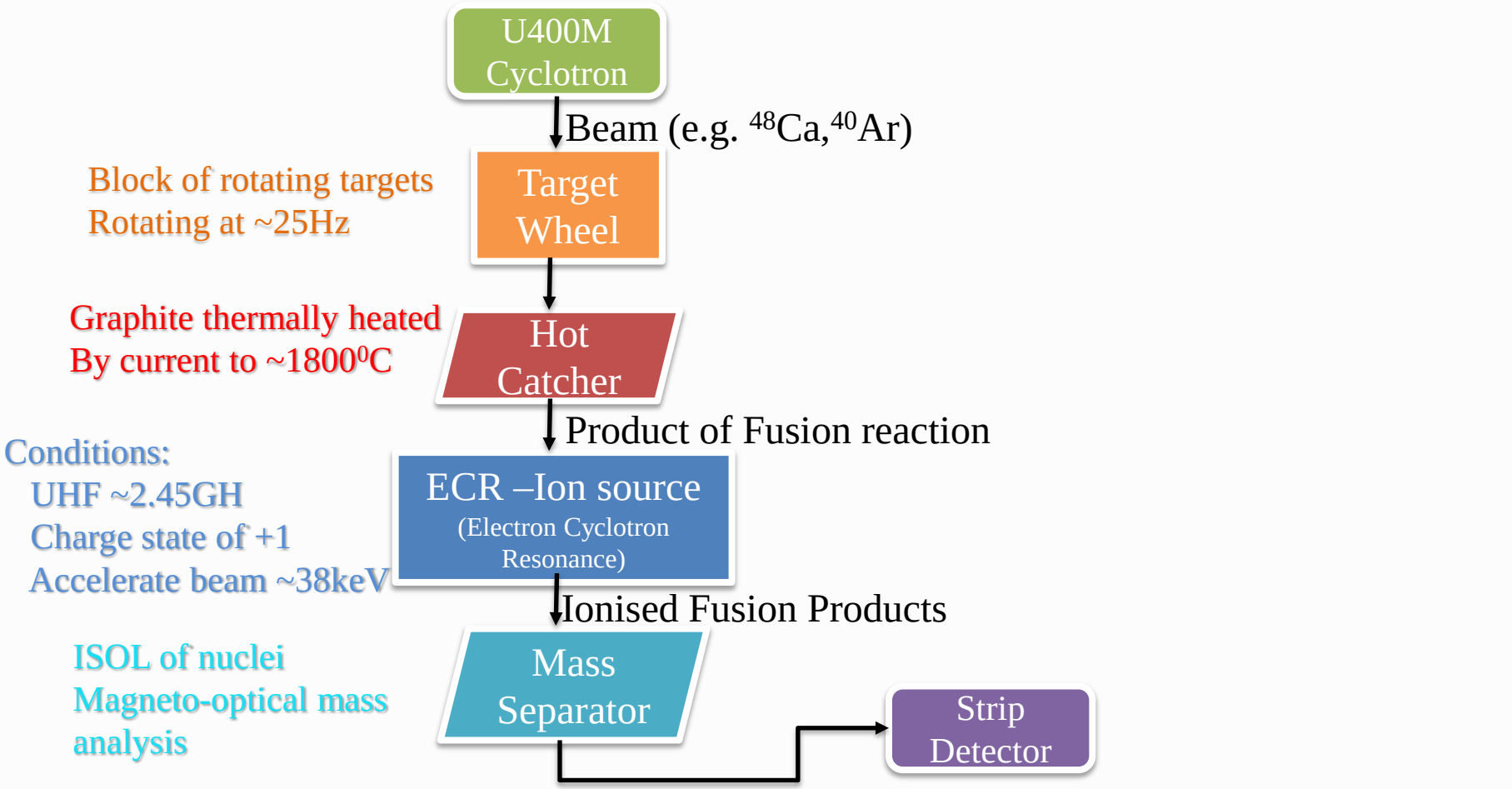
INTRODUCTION(cont.)

- Fusion Reactions

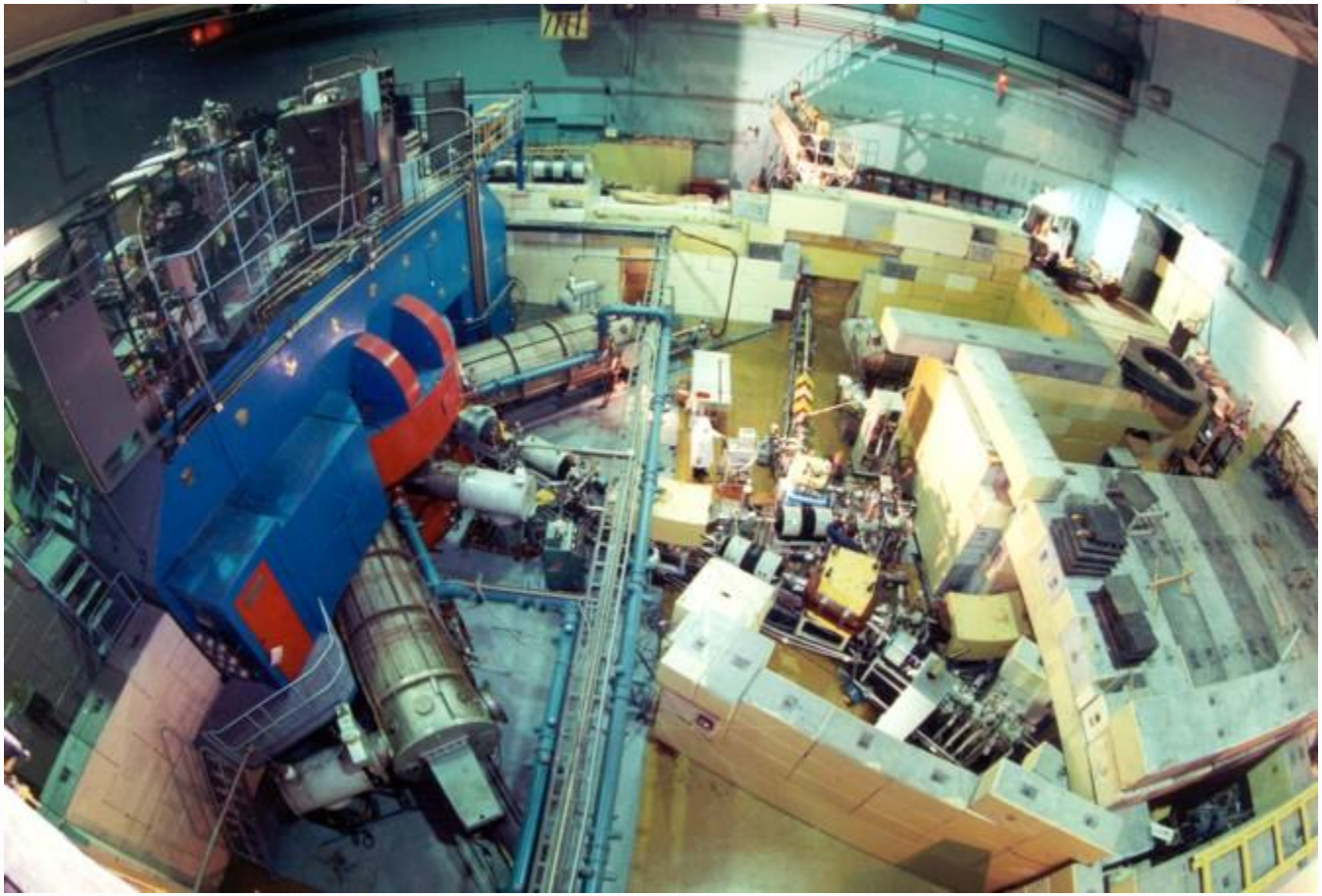


[Source:*(n.d.). Retrieved from https://www2.lbl.gov/Science-Articles/Archive/dizzy-nuclei.html*]

FLOWCHART FOR EXPERIMENTAL SETUP



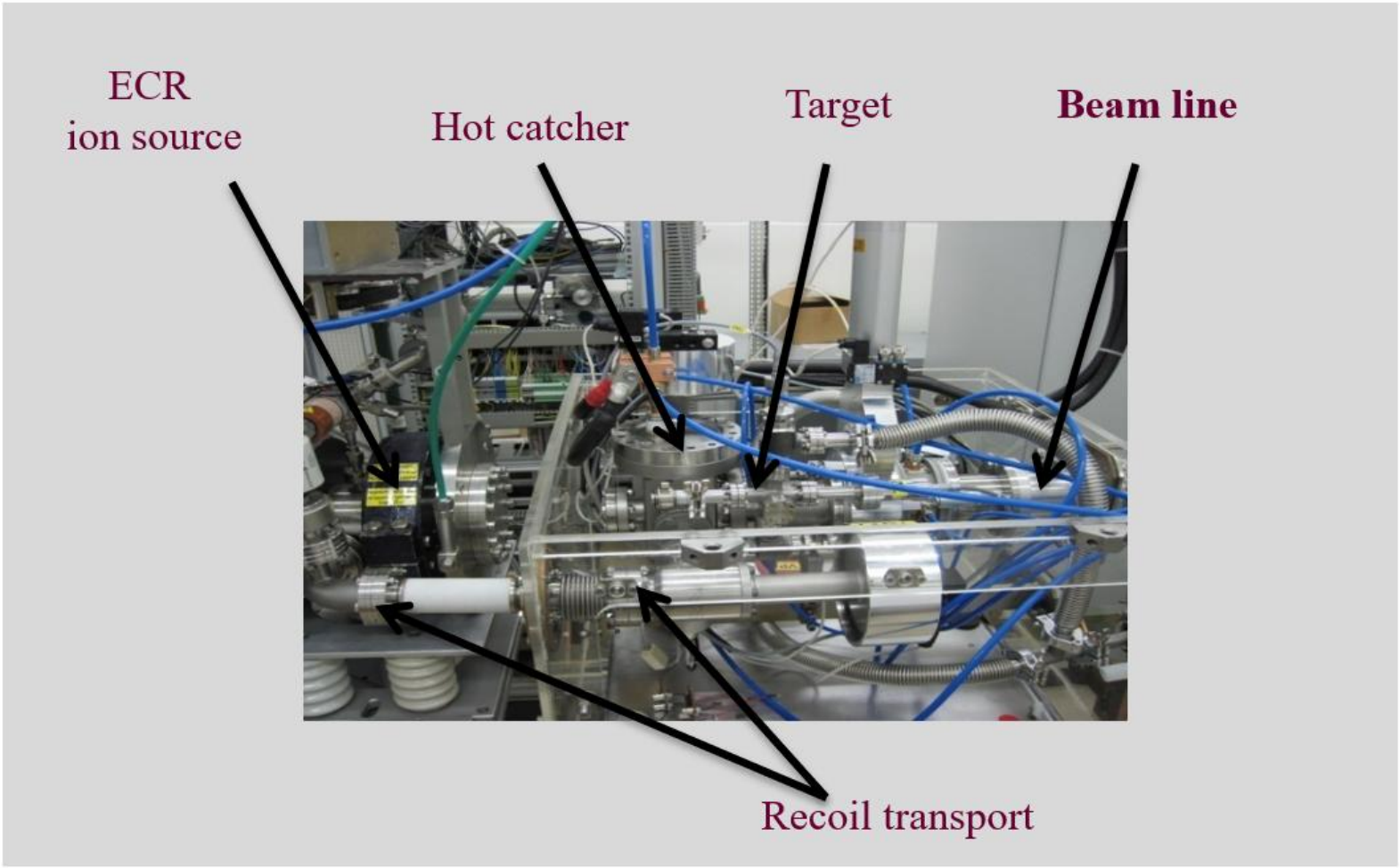
Experimental set-up



MASHA is connected to the U400M Cyclotron at the beam line

[Source:© 2003 By Default! A Free sample background from Slide 1 JINR SCIENTIFIC COUNCIL 104 th Session, 25 September 2008, Dubna. - ppt download. (n.d.). Retrieved from https://slideplayer.com/slide/8410610/]

Experimental set-up (cont.)



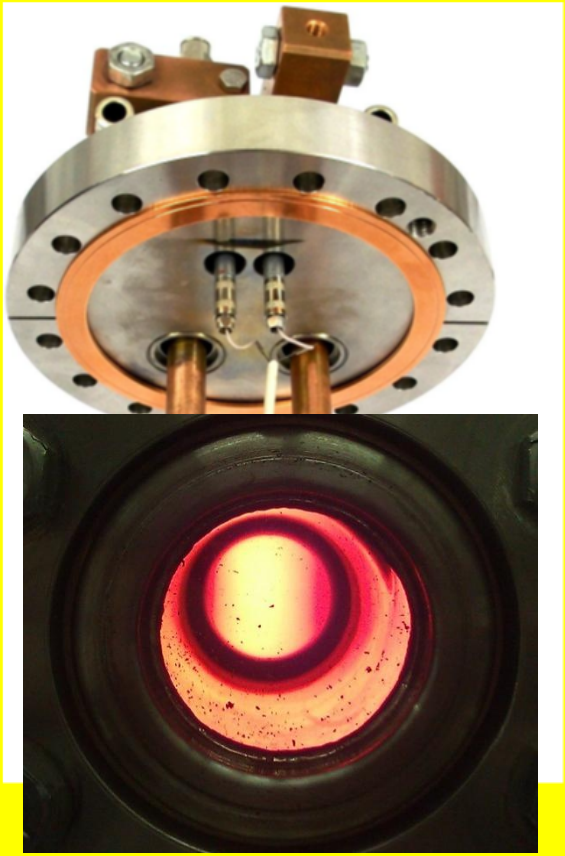
Experimental set-up (cont.)

Target Wheel:

- Diameter of disc :140mm
- Consists of 12 sectors,14mm width each and 30mm arc length.
- Grants heat distribution

[Source: Viacheslav, V. (n.d.). *Upgrading of MASHA setup. Using the cryogenic gas stopping cell*. Lecture presented at JINR Seminar in Russia, Dubna.]

Experimental set-up (cont.)



Hot catcher:

- Refer as “Hot” because it is heated by electric current to temperature of 1800°C – 2000°C.
- Role: catches energetic products where they are stopped.
- Composed of flexible Graphite
- Delivery time of nuclides to the ECR (electron cyclotron resonance) ion source about 1.8 s.

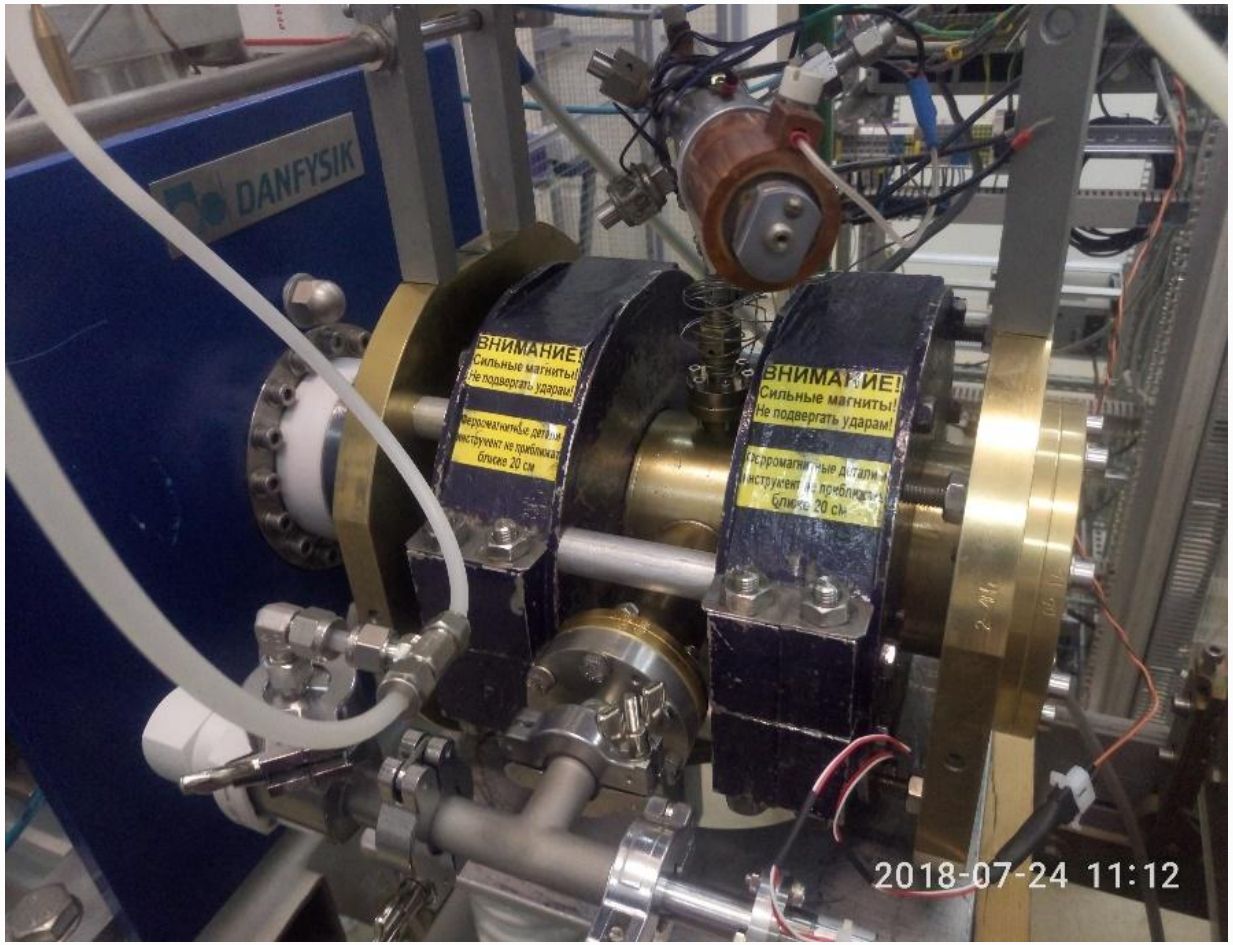
[Source: Viacheslav, V. (n.d.). *Upgrading of MASHA setup. Using the cryogenic gas stopping cell*. Lecture presented at JINR Seminar in Russia, Dubna.]

Experimental set-up (cont.)

Electron Cyclotron Resonance (ECR) ion Source

Principles:

- Ionizes products to +1 state
- Energy of ions 38 keV up to 50 keV
- UHF (Ultra High Frequency) wave (2.45 GHz)

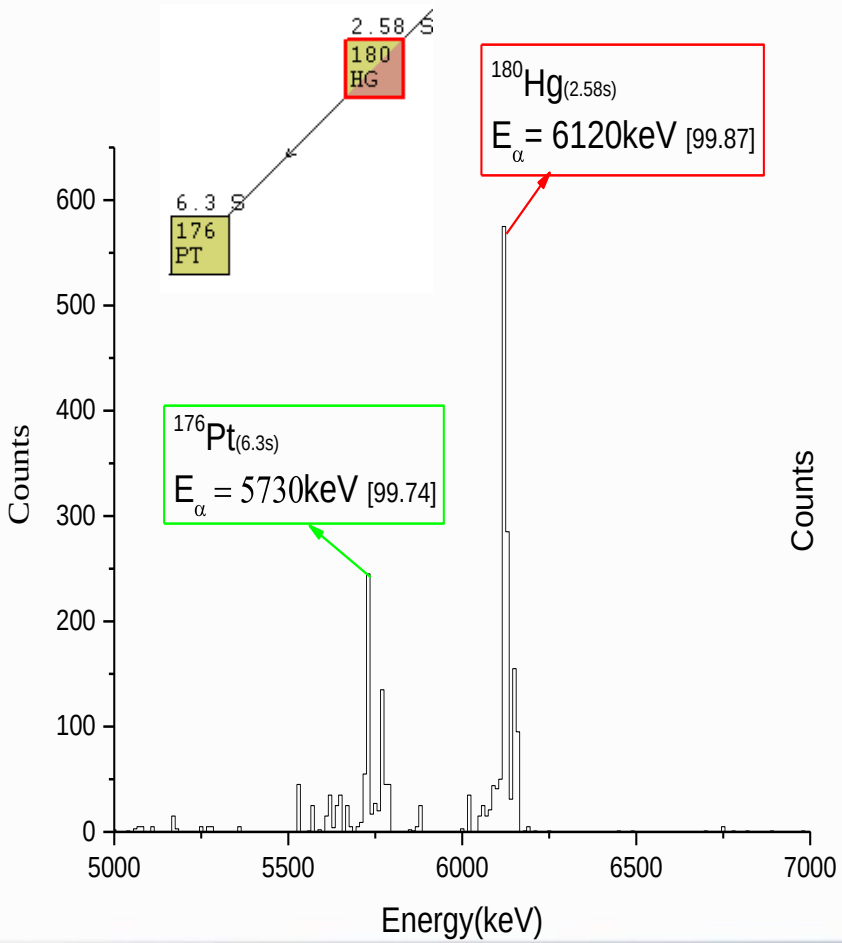


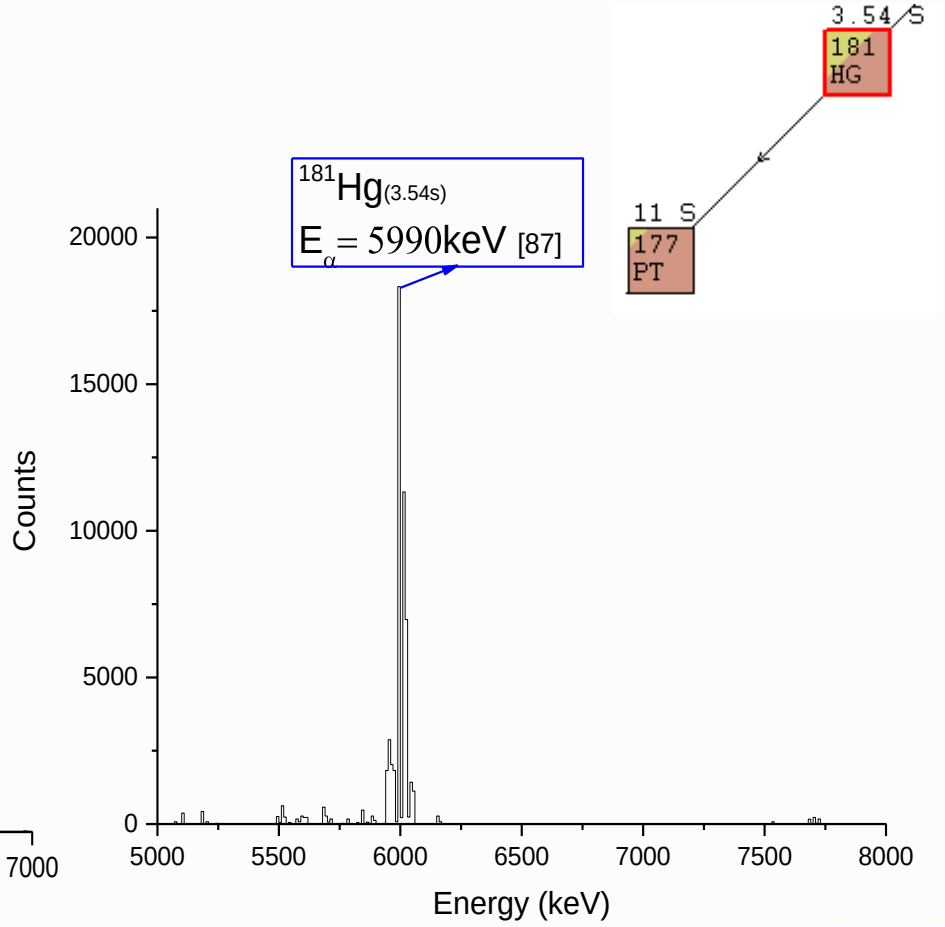
[Source: Viacheslav, V. (n.d.). *Upgrading of MASHA setup. Using the cryogenic gas stopping cell*. Lecture presented at JINR Seminar in Russia, Dubna.]

Experimental set-up (cont.)

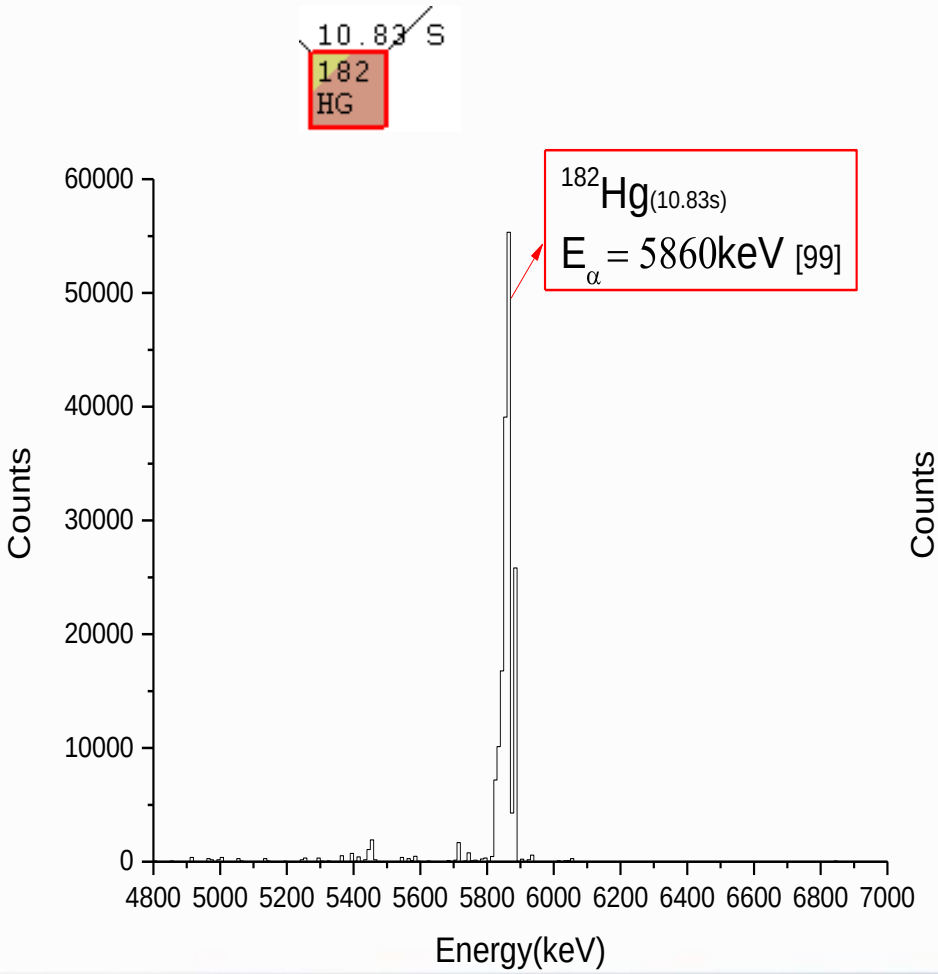
Results and Discussions

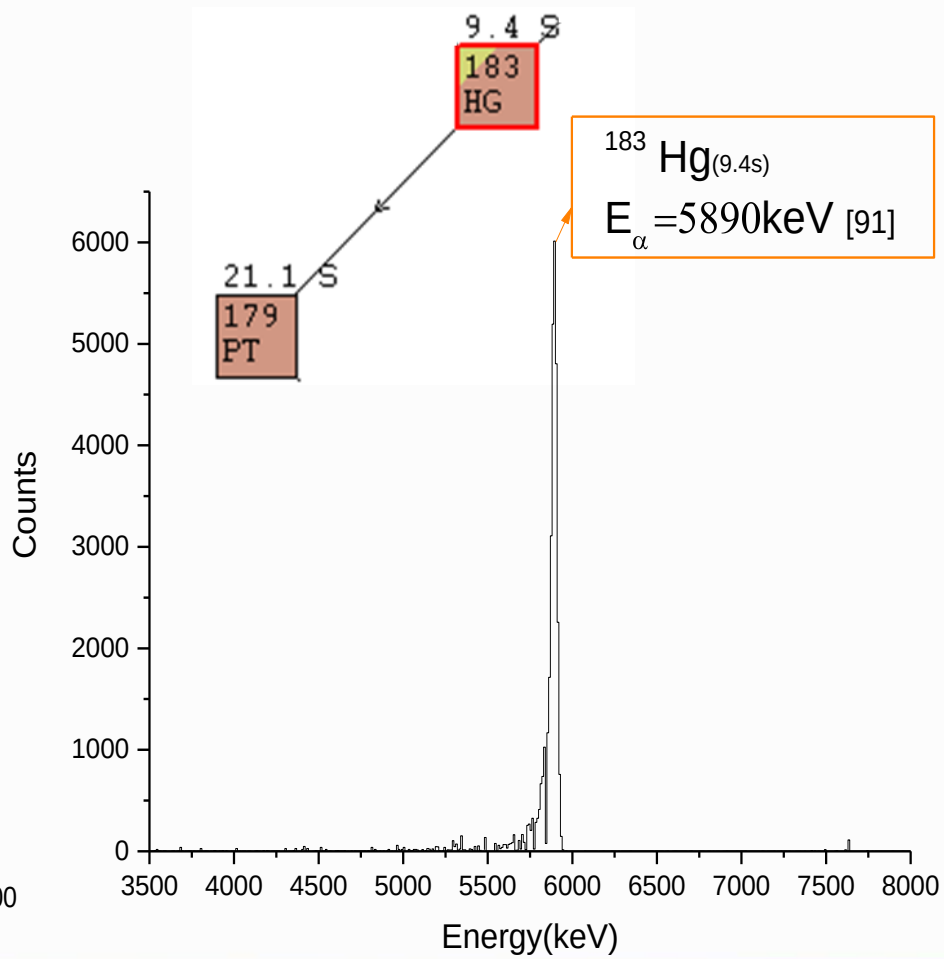
$$^{40}Ar + ^{148}Sm \longrightarrow ^{188\text{-}xn}Hg + xn$$



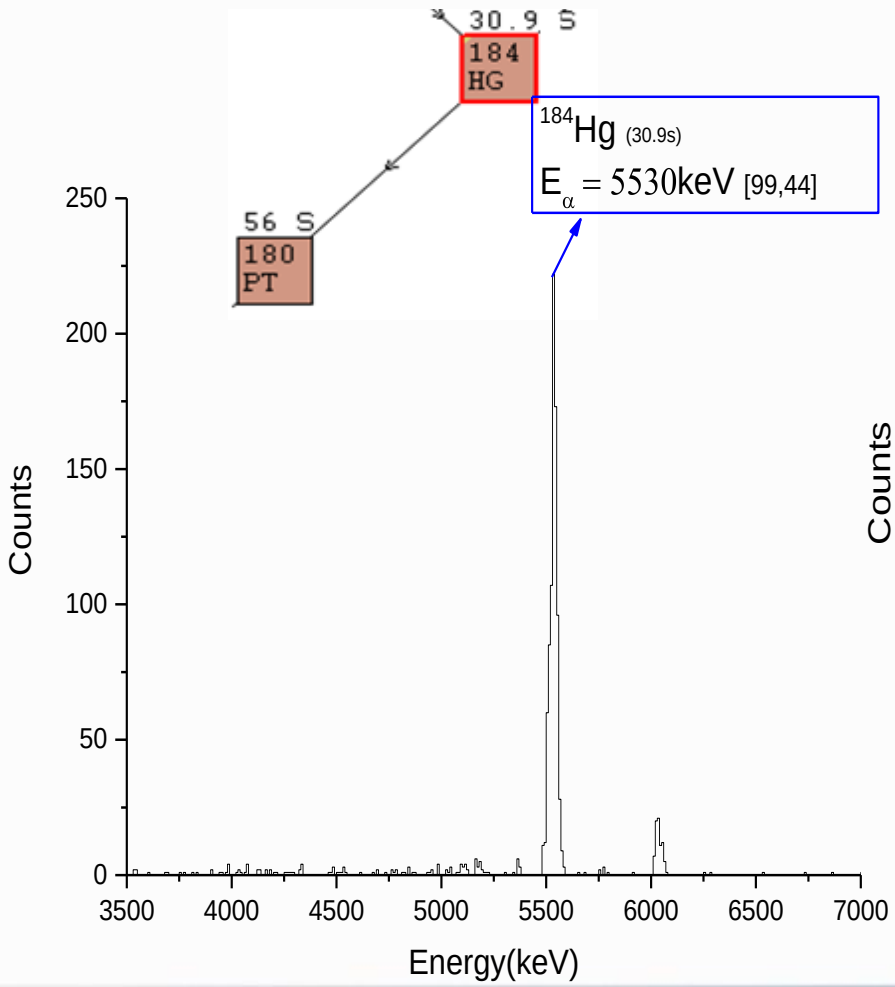


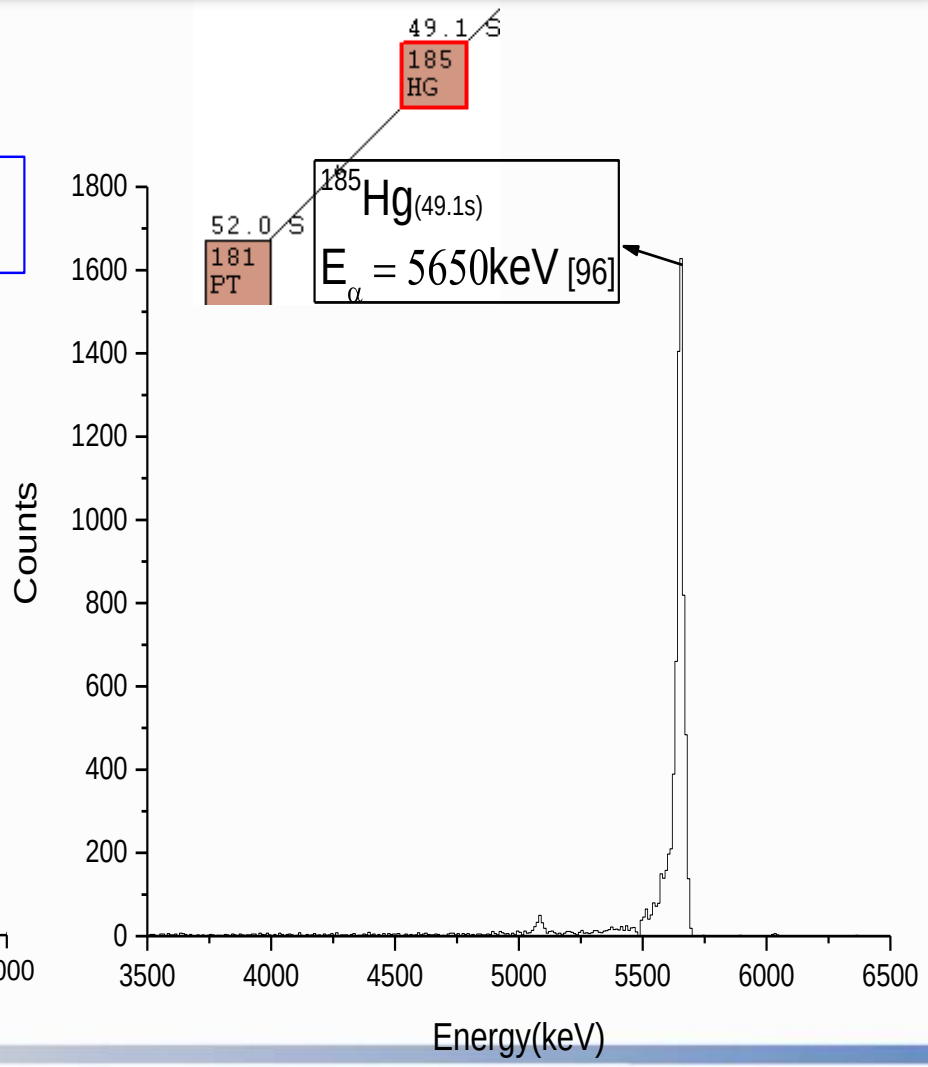
Results and Discussions (cont.)





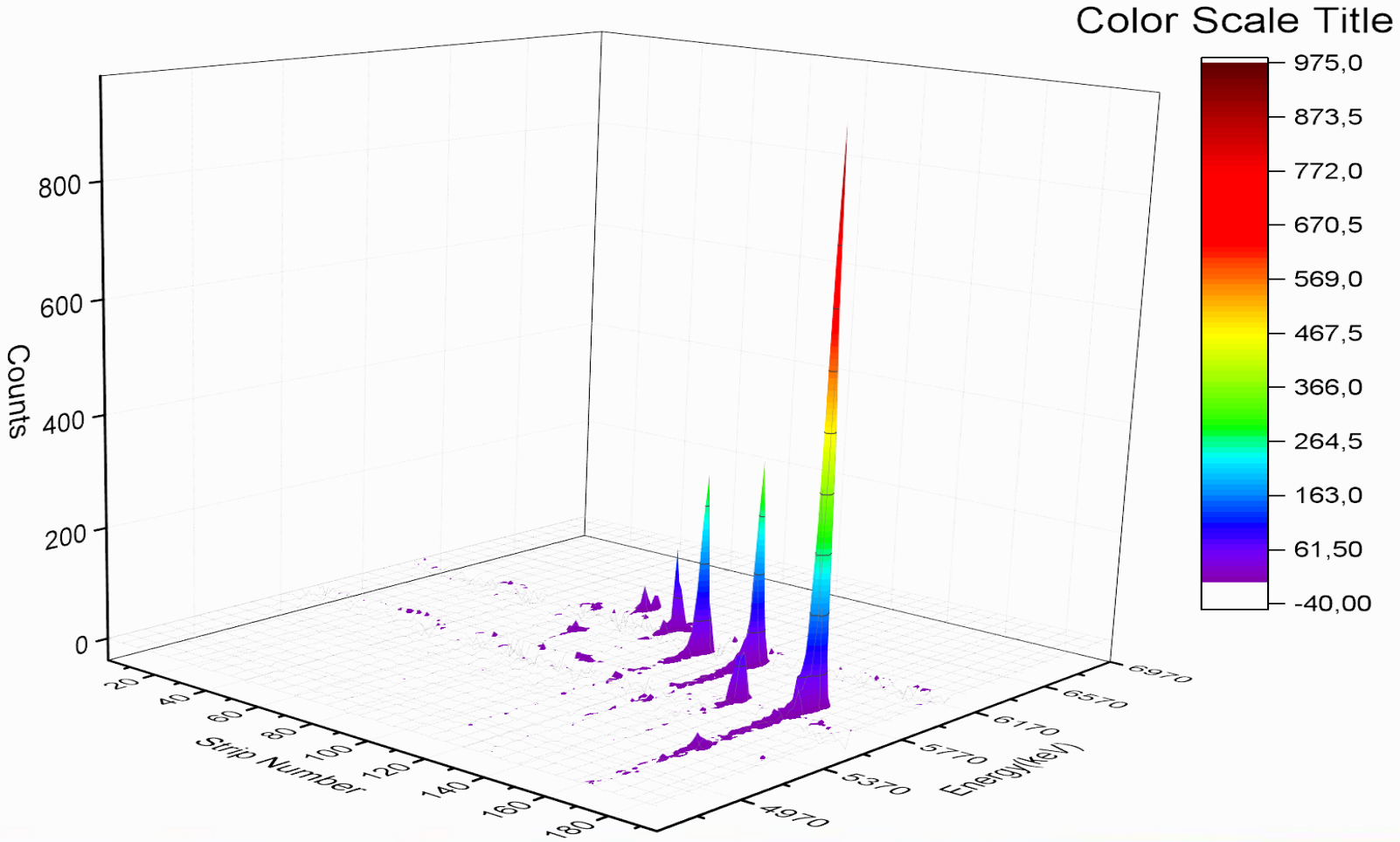
Results and Discussions (cont.)





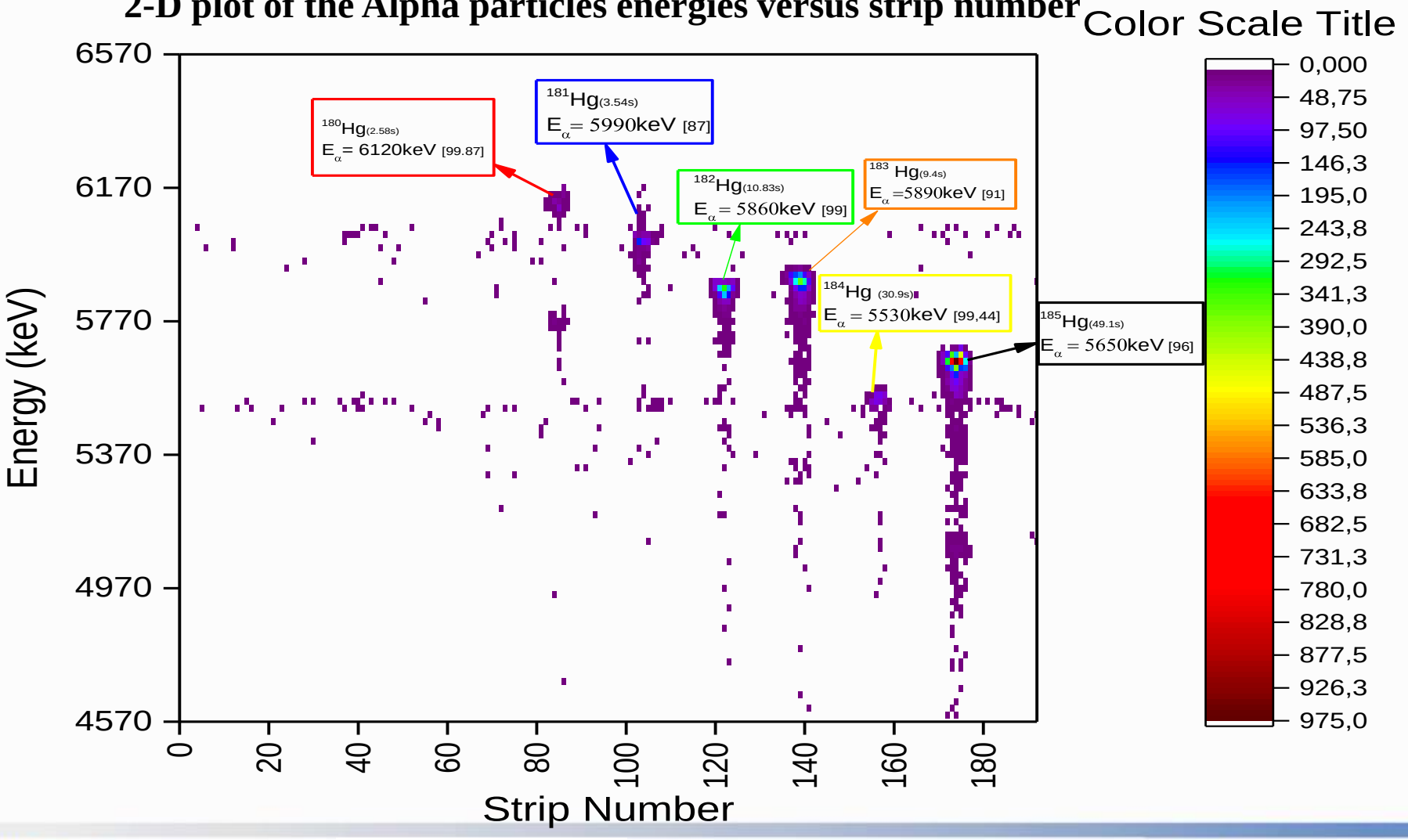
Results and Discussions (cont.)

3-D plot of the Alpha particles energies versus strip number and counts



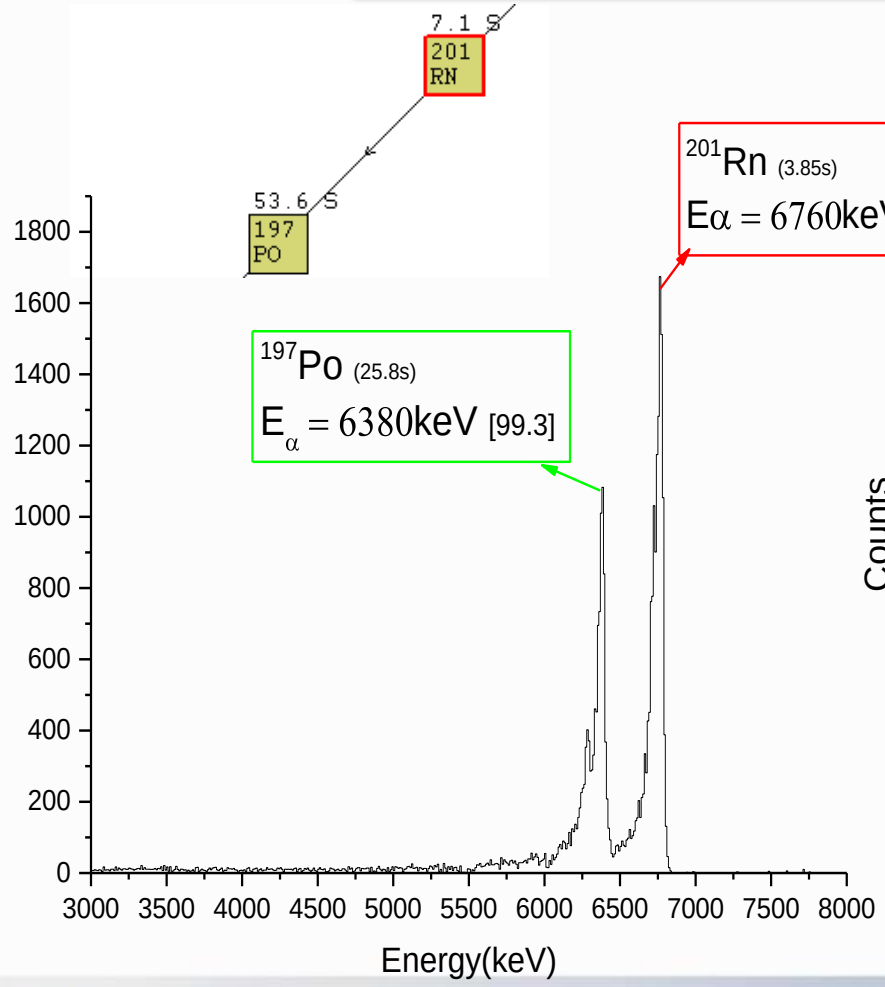
Results and Discussions (cont.)

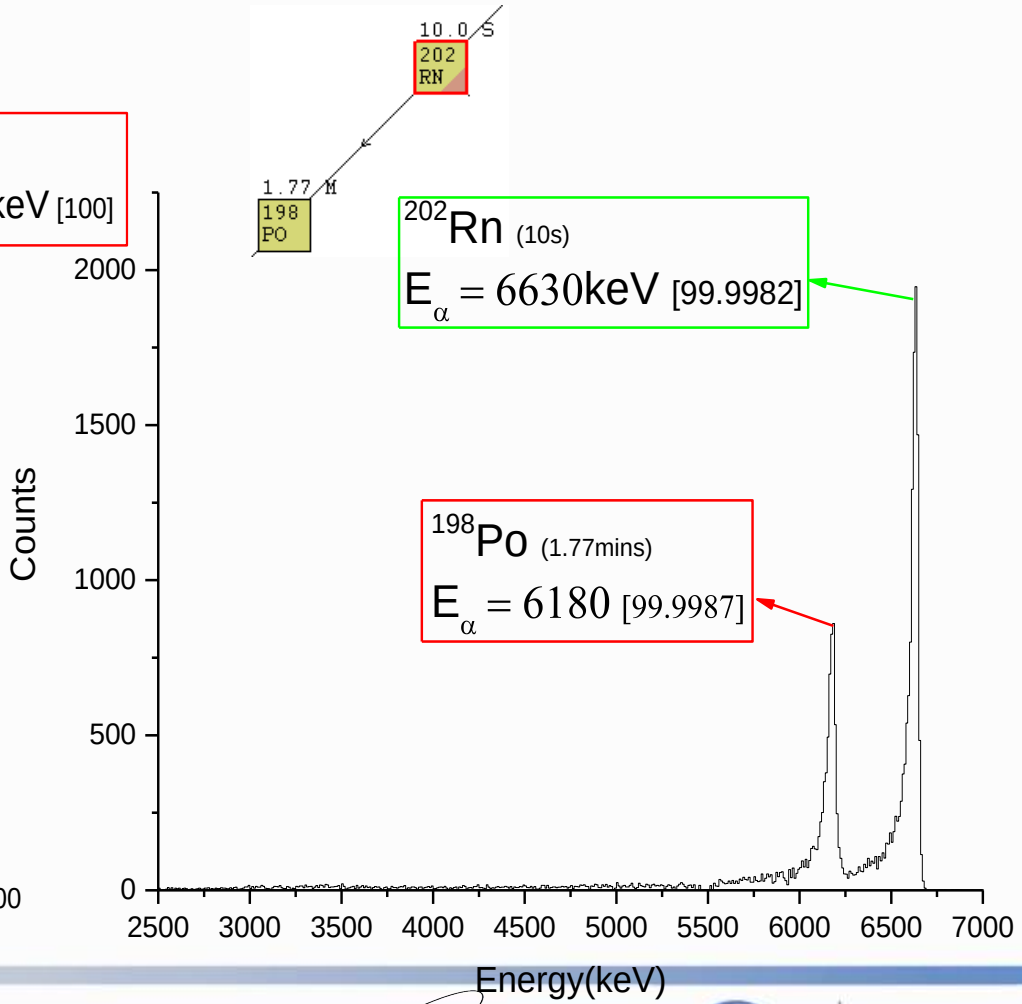
2-D plot of the Alpha particles energies versus strip number



Results and Discussions (cont.)

$$^{40}Ar + ^{166}Er \longrightarrow ^{206\text{-}xn}Rn + xn$$





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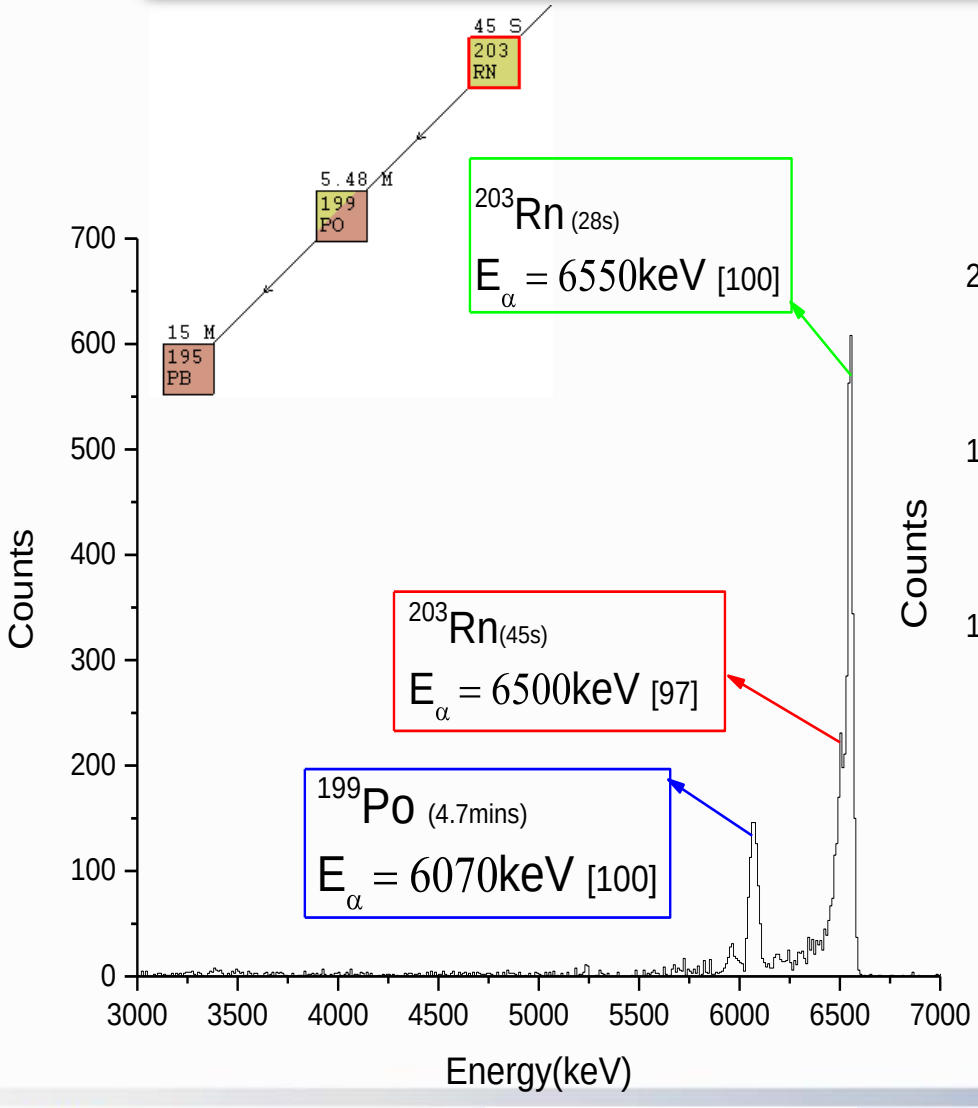

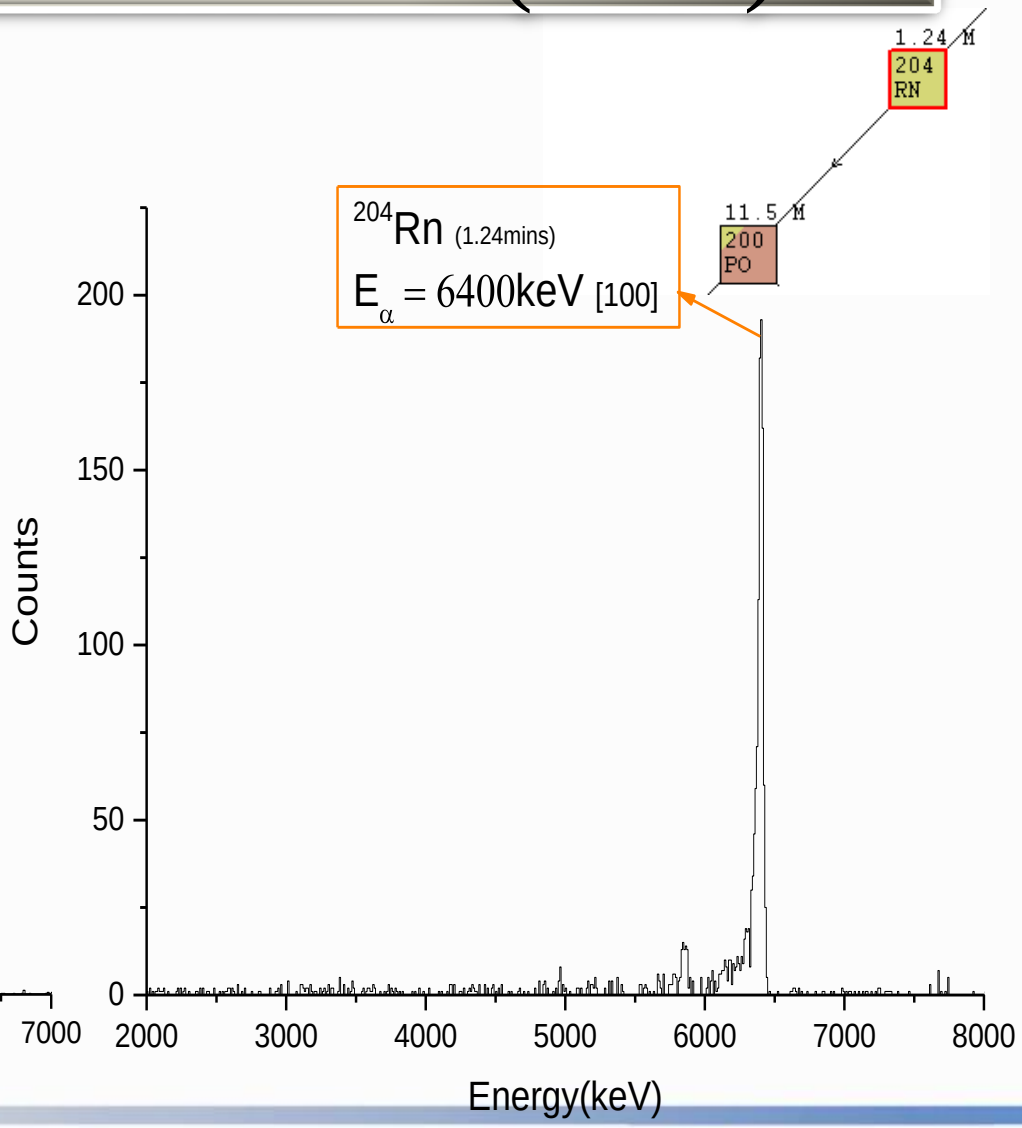

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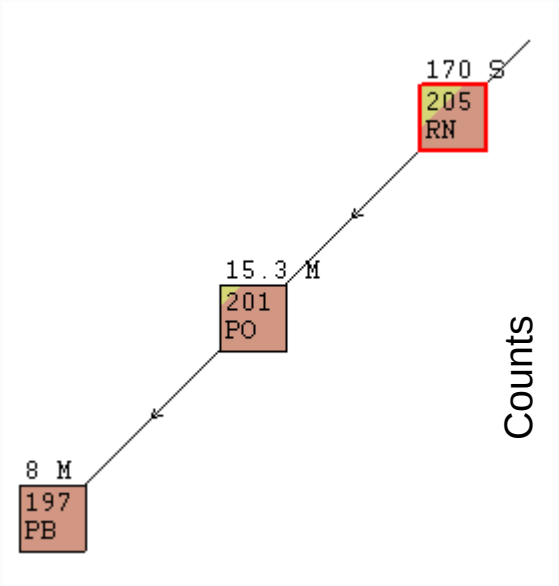

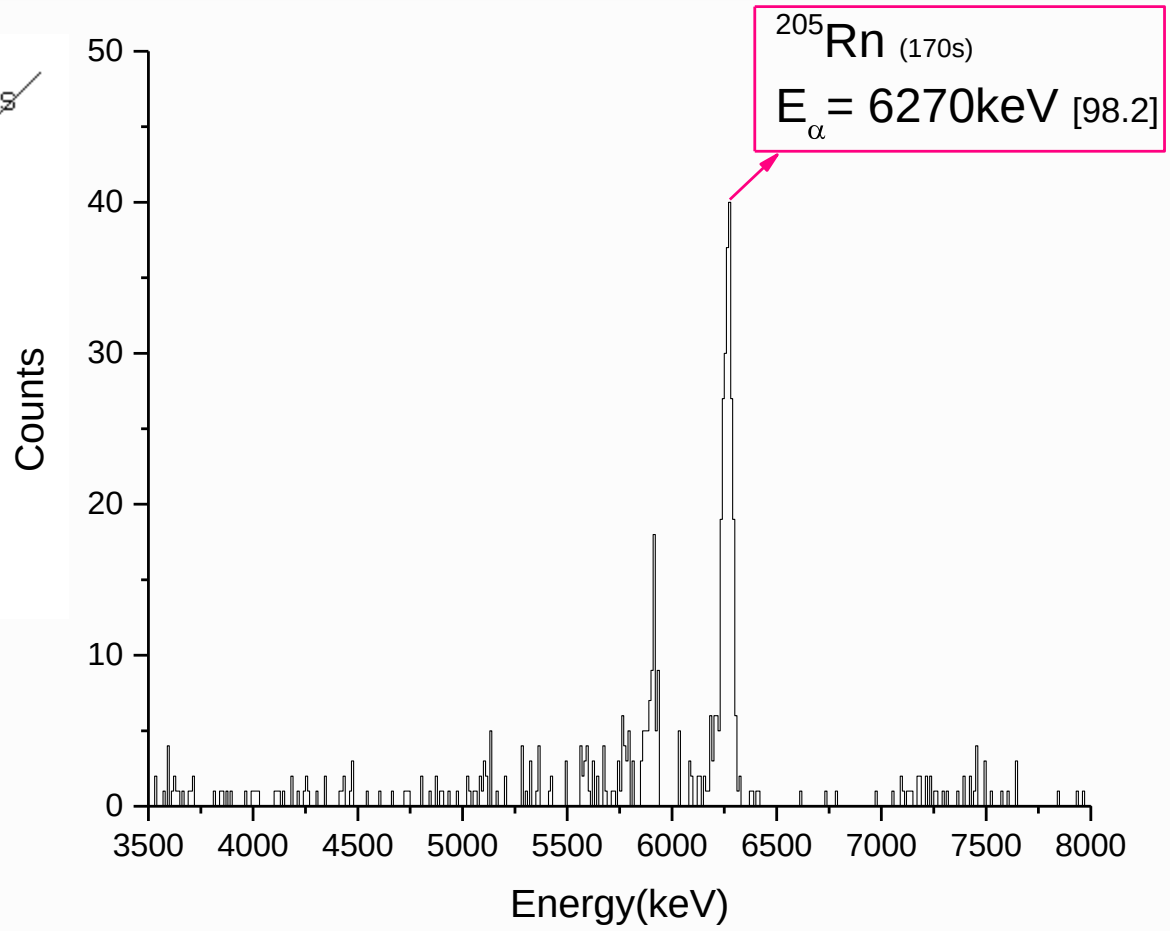

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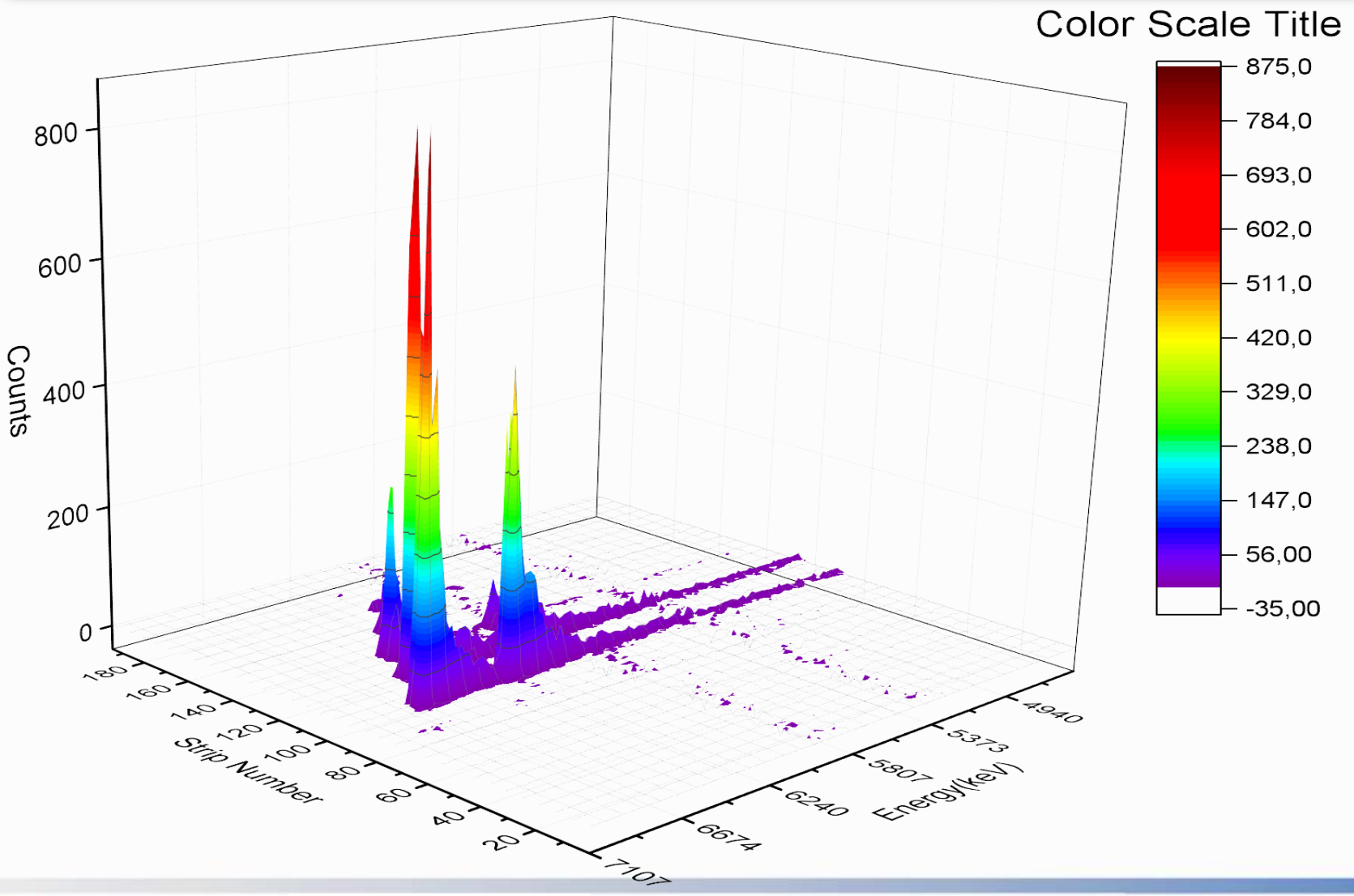

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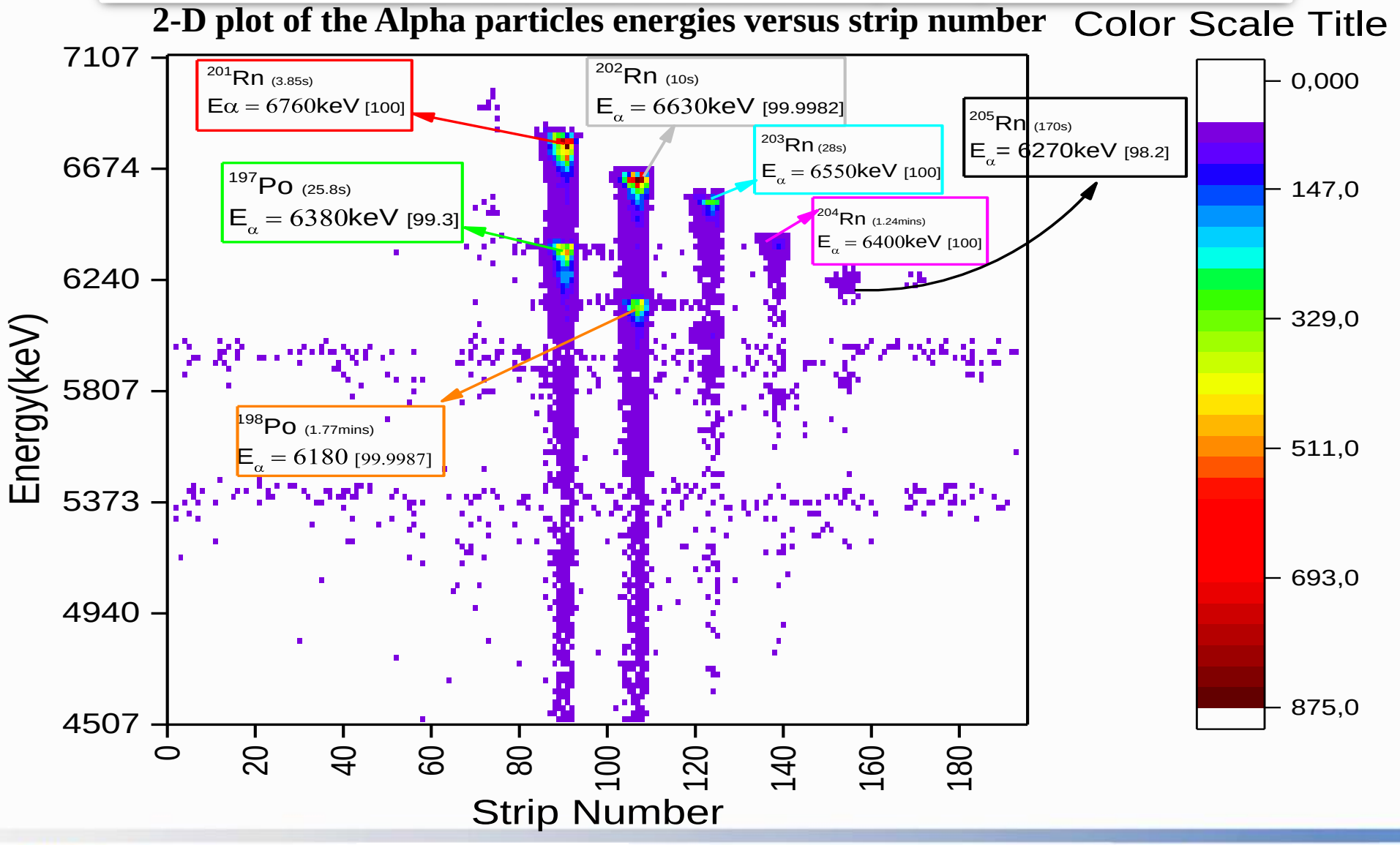
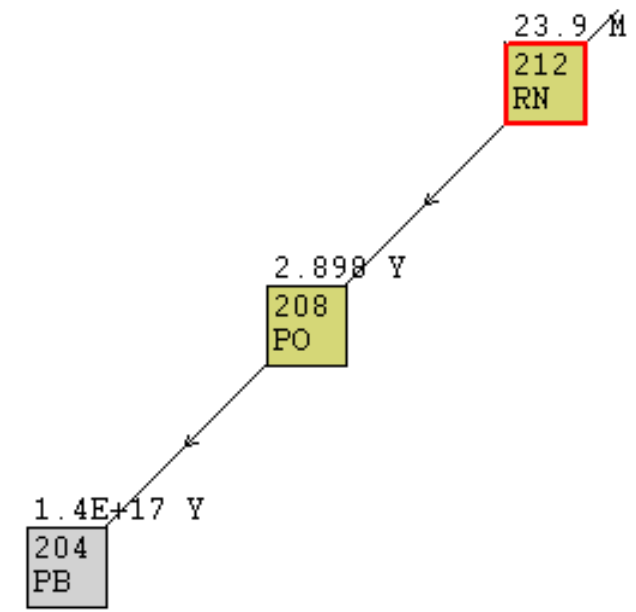
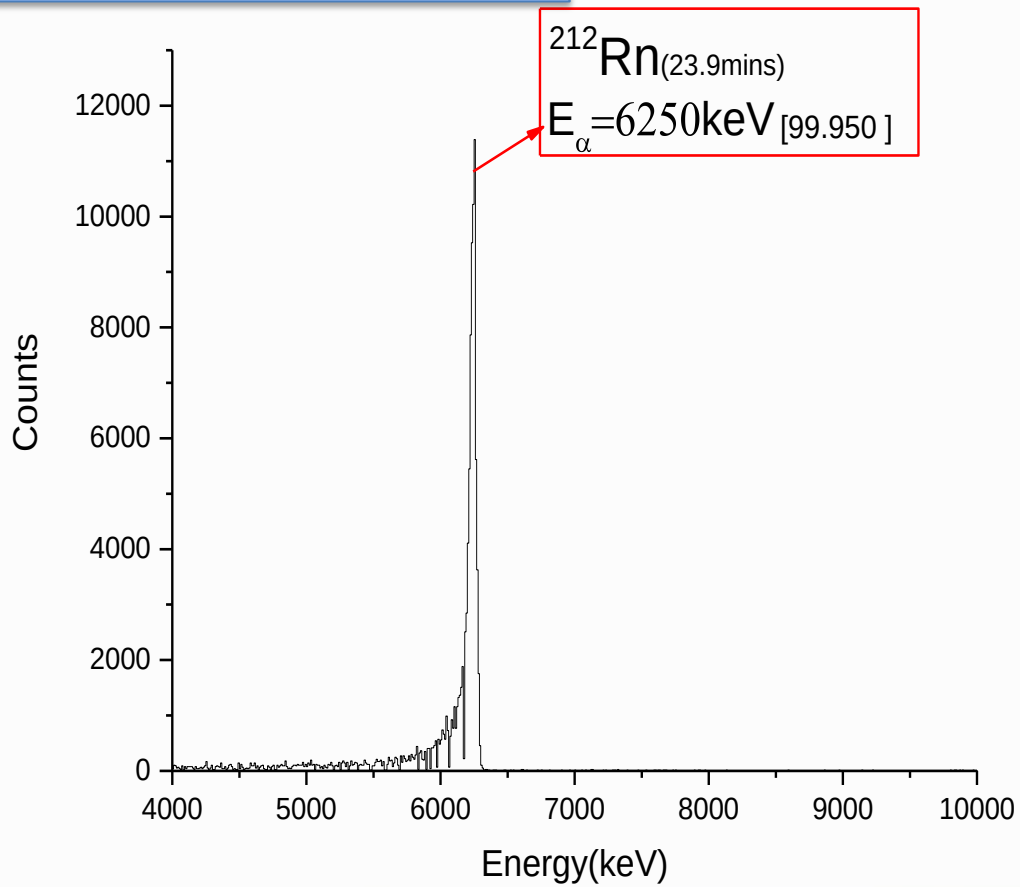
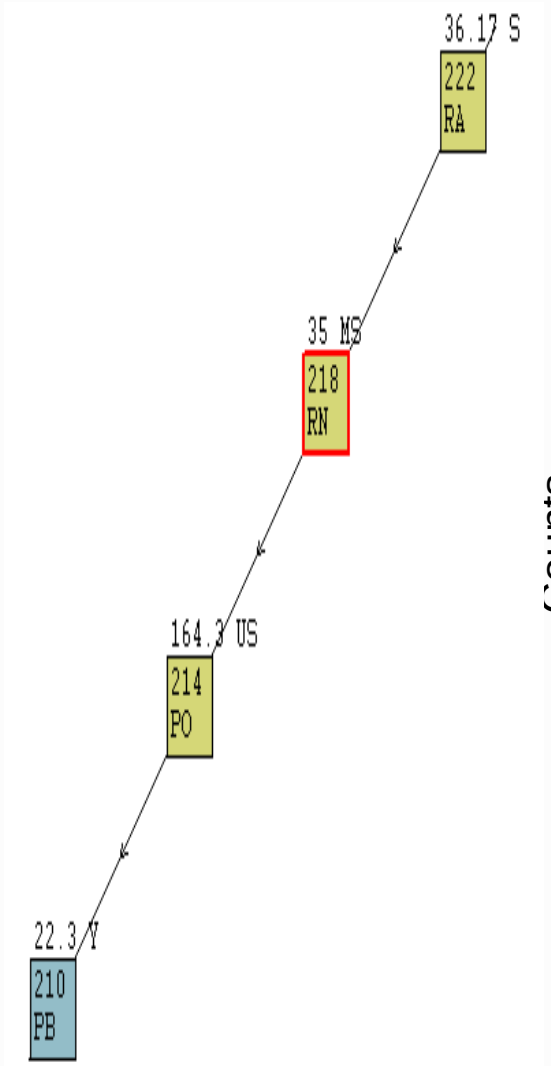


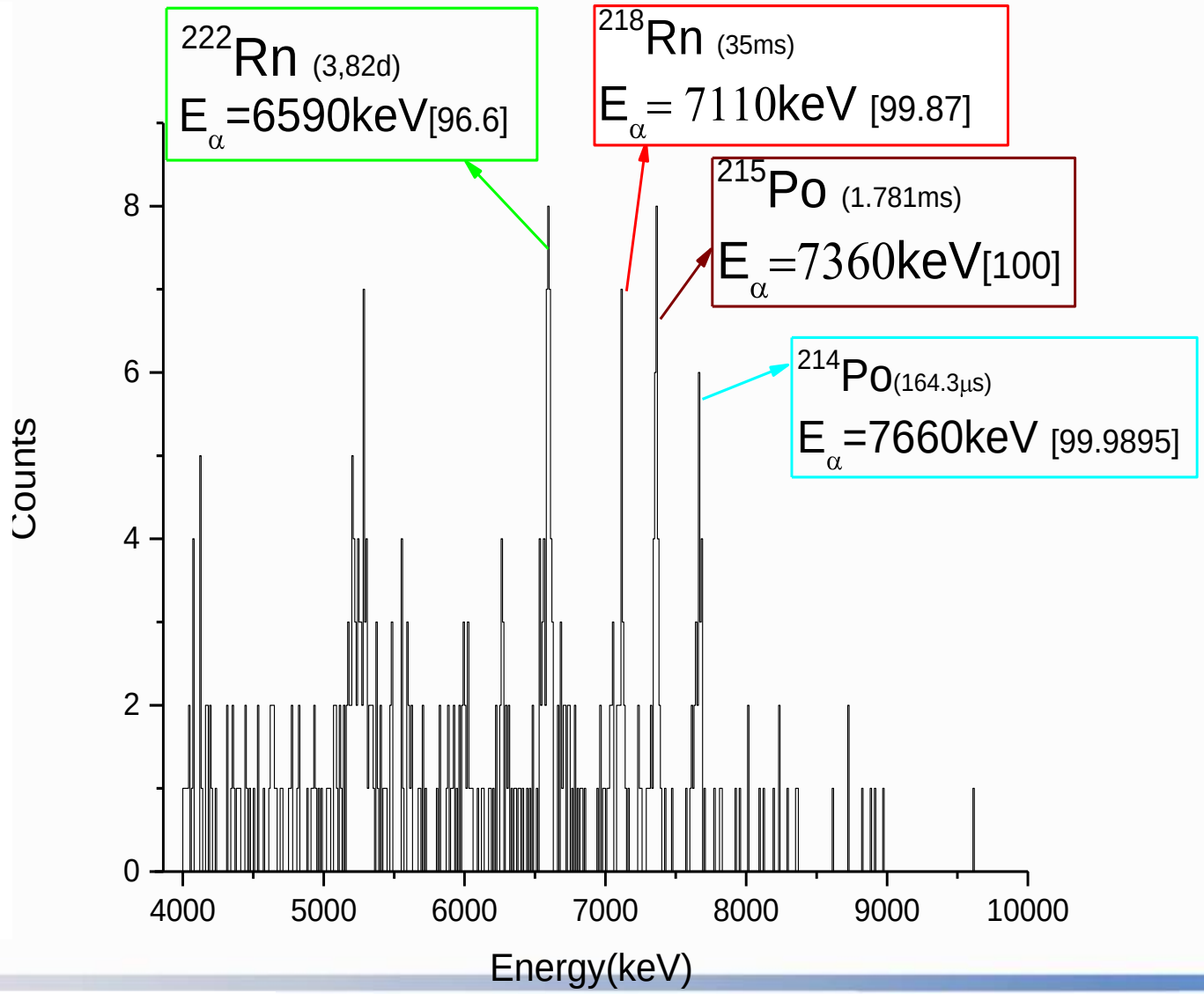
Results and Discussions (cont.)

$$^{48}Ca + ^{242}Pu \longrightarrow \{Rn\}$$









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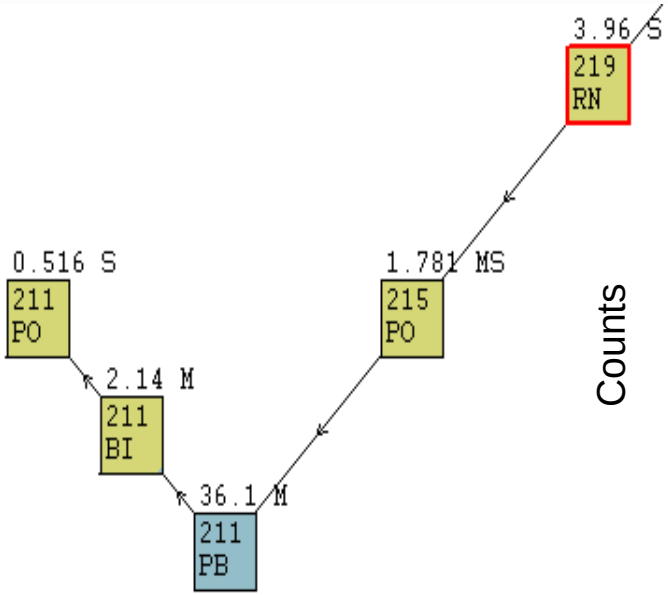
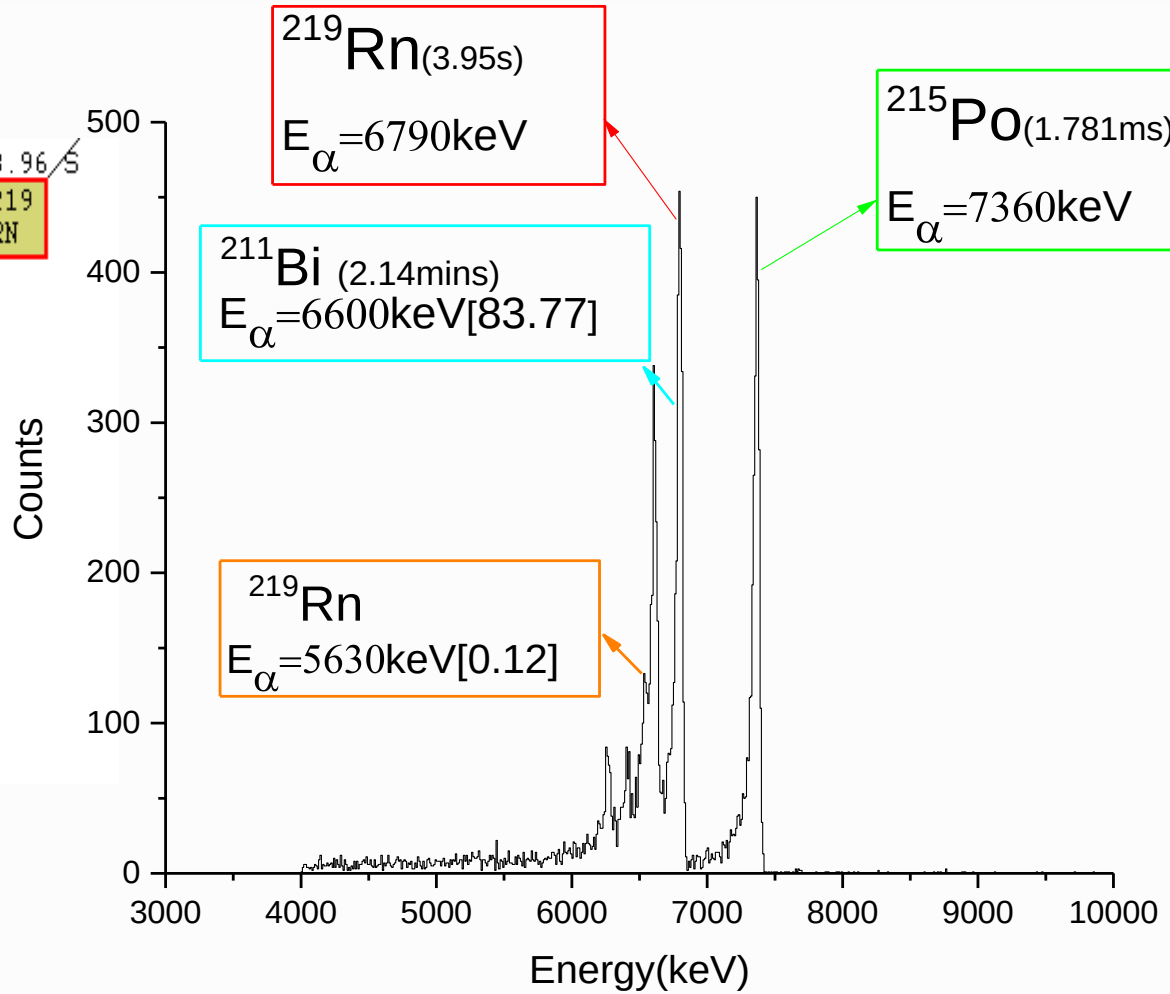
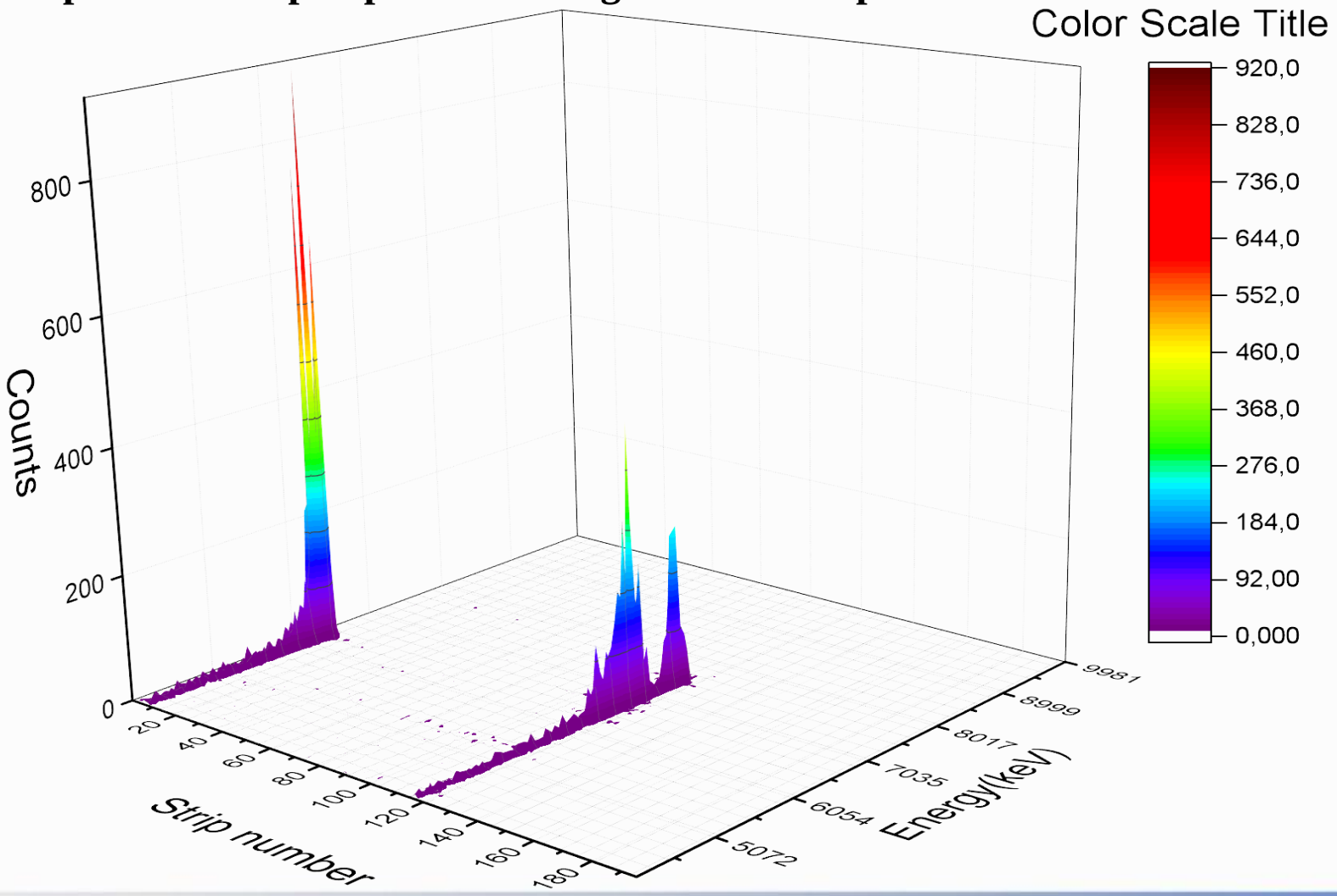




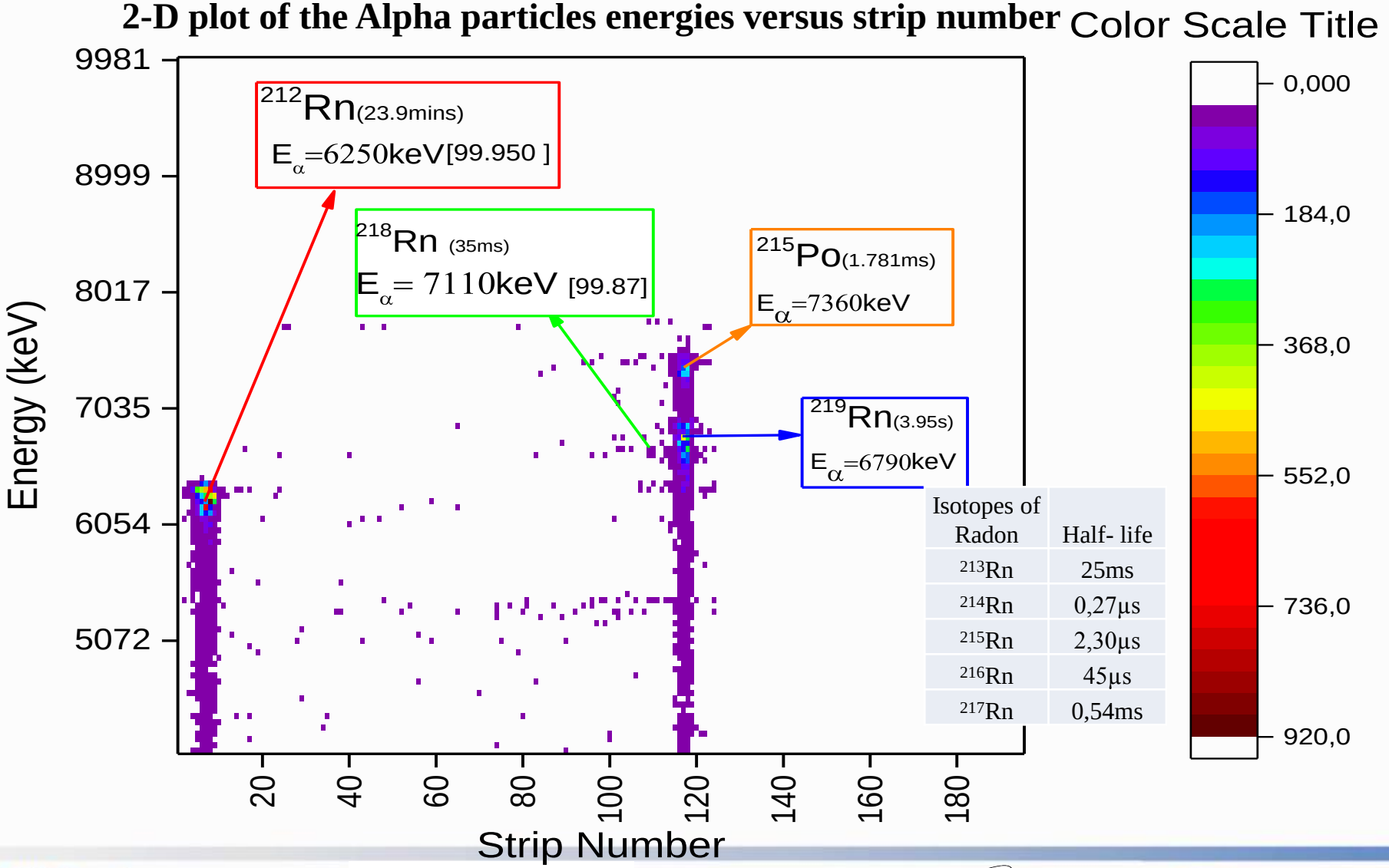
Results and Discussions (cont.)

3-D plot of the Alpha particles energies versus strip number and counts



Results and Discussions (cont.)

2-D plot of the Alpha particles energies versus strip number



Isotopes of Radon	Half- life
^{213}Rn	25ms
^{214}Rn	0,27µs
^{215}Rn	2,30µs
^{216}Rn	45µs
^{217}Rn	0,54ms

Conclusion

- Calibration of the strip detector using pre-recorded data of decay chains of the following fusion reaction was done:
  - $^{40}Ar + {}^{148}Sm \longrightarrow \{{}^{188\text{-}xn}Hg + xn\}$
  - $^{40}Ar + {}^{166}Er \longrightarrow \{{}^{206\text{-}xn}Rn + xn\}$
  - Multinucleon transfer reaction of $^{48}Ca + {}^{242}Pu \longrightarrow \{Rn\}$

- MASHA was visited . Description and functionality of the different parts of MASHA was done.

References

1.] Zagrebaev, V., & Greiner, W. (2008). New way for the production of heavy neutron -rich nuclei. *Journal of Physics G: Nuclear and Particle Physics*, *35*, 1-14.

2.] Schadel, M. (2016). *Chemistry of superheavy elements*. Darmstadt Germany: Springer-Verlag Berlin An.

3.] Eichler, R., & Al., E. A. (2007). Chemical Characterization of Element 112. *ChemInform*, *38*(32). doi:10.1002/chin.200732020.

4.] Krupa, L. (2010, July 12). *Synthesis of Superheavy elements using the mass spectrometer MASHA*. Lecture presented at JINR Seminar Presentaion in Russia, Dubna.

THANK YOU