PACE4 Break-up calculations

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I General comments

From AJ: "While it looks like break up of Li and/or Be will be the likely way to go, it would be good to do due diligence on predicting other reaction channels. PACE will calculate fusion-evaporation cross sections for a given beam-target combination ... that would be a good reference to use when we do the first beam measurements/tests."

However, it is worth noting that while PACE4 calculations do a good job of predicting the shape of the cross-section for any given reaction channel as a function of energy, they do not predict the actual magnitude of the cross-section well for any given energy. However, the relative heights of the cross-section for different isotopes are typically reflective of reality.

Currently, if PACE4 did not return any data for a given energy, no data point is included at that energy. This may change in future.

II Li-7 on Pd-110

Only data for energies less than or equal to 60 MeV are shown, based on the capability of the 14UD pelletron accelerator. This holds for all calculations in this document. The cross-section for ^{113}Cd appears to be maximised around a beam energy of $E = 40$ MeV (Figure 2), although the cross-sections for ^{112}In (by a factor of ≈ 3), ^{113}In (by a factor of ≈ 25) and ^{114}In (by a factor of order of magnitude 1) are greater at this energy (Figure 1).

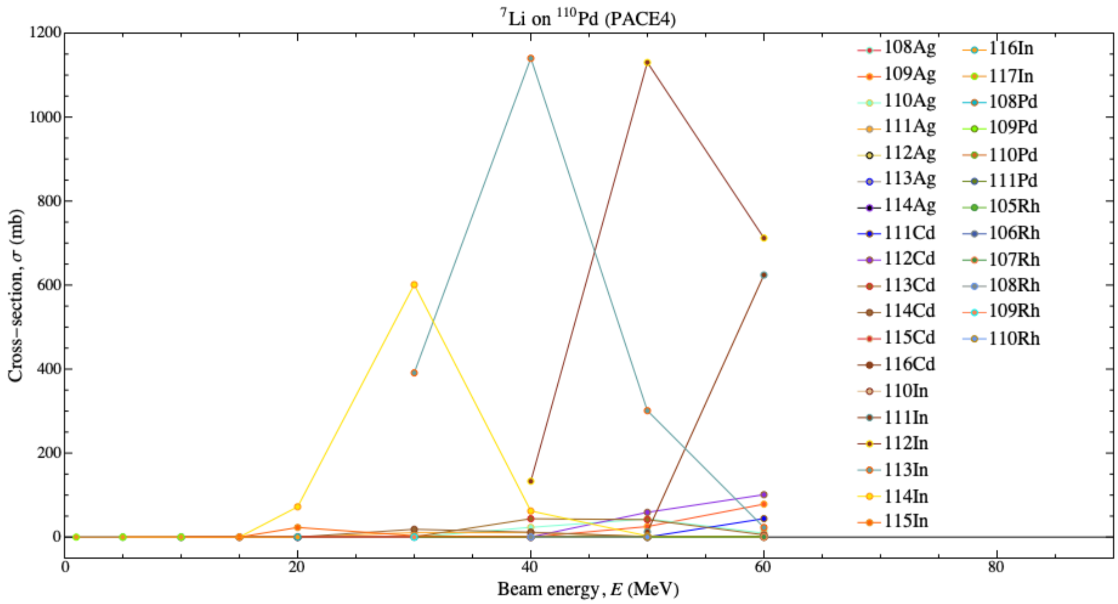

Figure 1: Excitation function for a ^{7}Li beam on a ^{110}Pd target (cross-section as a function of energy). All isotopes that were produced during the Monte Carlo simulation are shown.

III Be-9 on Pd-110

Only data for energies less than or equal to 70 MeV are shown. The cross-section for ^{113}Cd in this reaction channel appears to be peaked around 40 MeV (Figure 4). There are multiple isotopes with greater cross-sections than that of ^{113}Cd at this energy, however (Figure 3).

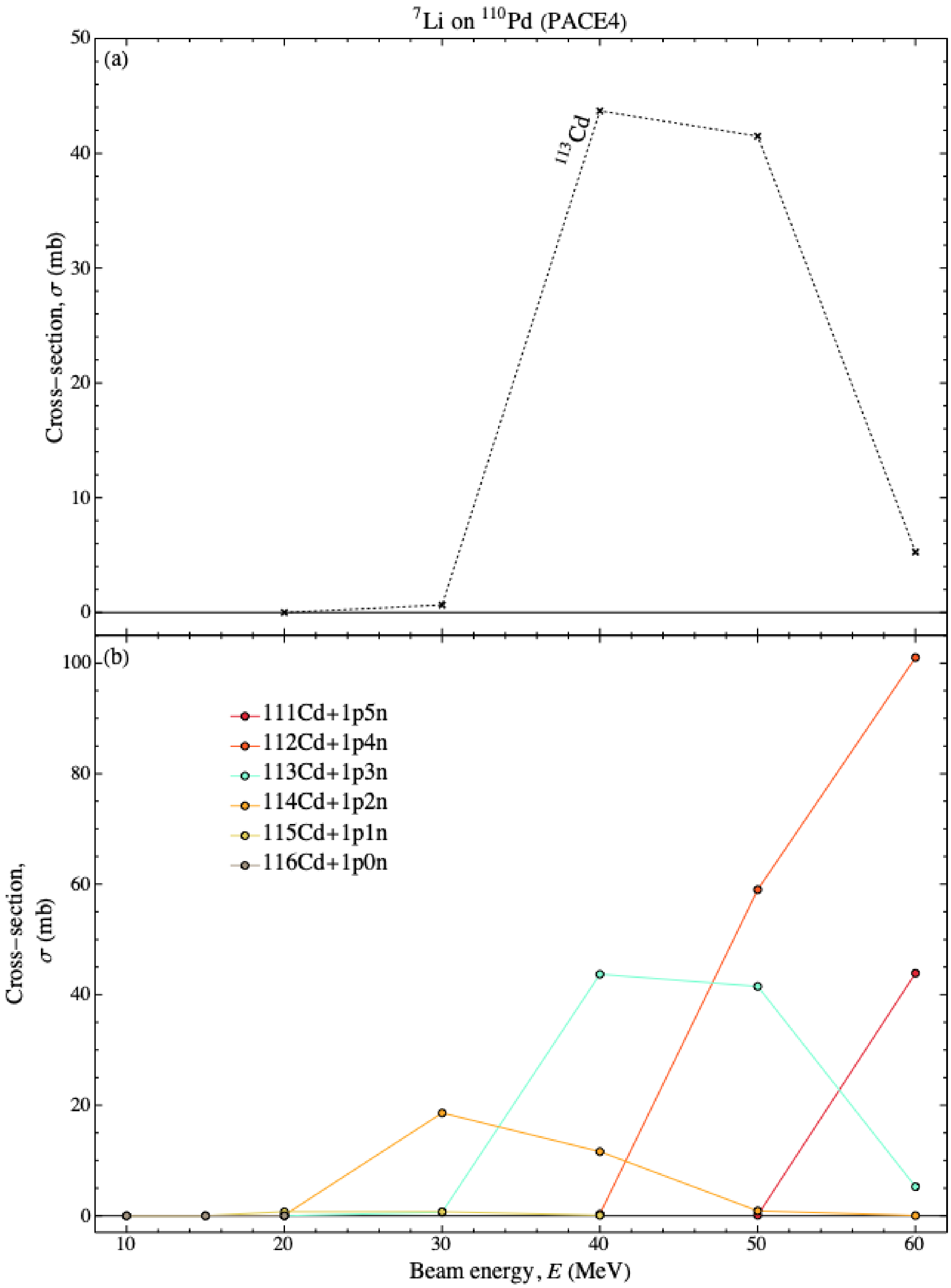

Figure 2: Excitation function for a ^{7}Li beam on a ^{110}Pd target (cross-section as a function of energy). Only cadmium isotopes that were produced during the Monte Carlo simulation are shown.

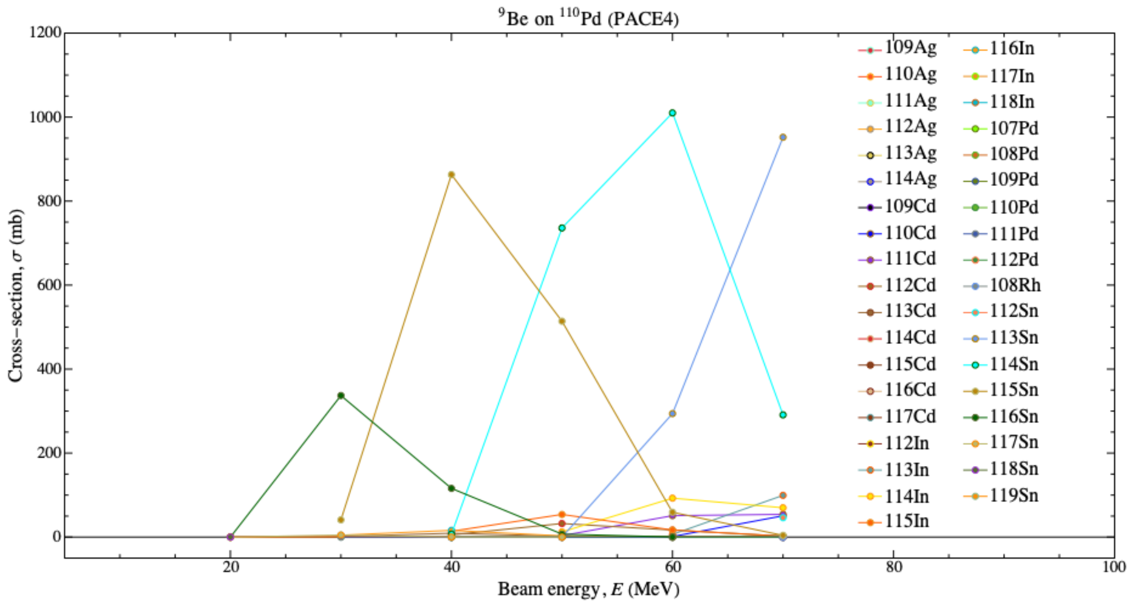

Figure 3: Excitation function for a ^{9}Be beam on a ^{110}Pd target (cross-section as a function of energy). All isotopes that were produced during the Monte Carlo simulation are shown.

IV He-4 on Pd-110

^{4}He was used as a substitute for α-particles because PACE4 does not explicitly allow for these to be the beam particle. Only data for energies less than or equal to 40 MeV are shown. It is worth noting that as found by Warr et. al. [1], the optimum energy for producing ^{113}Cd using the ^{110}Pd$(\alpha, n\gamma)$ reaction channel is around 16 MeV (Figure 5). Promisingly, the ^{110}Pd$(\alpha, \gamma 1n)^{113}$Cd reaction channel appears to be the strongest between around 10 and 18 MeV, before it is dominated at higher energies by the production channels for other isotopes.

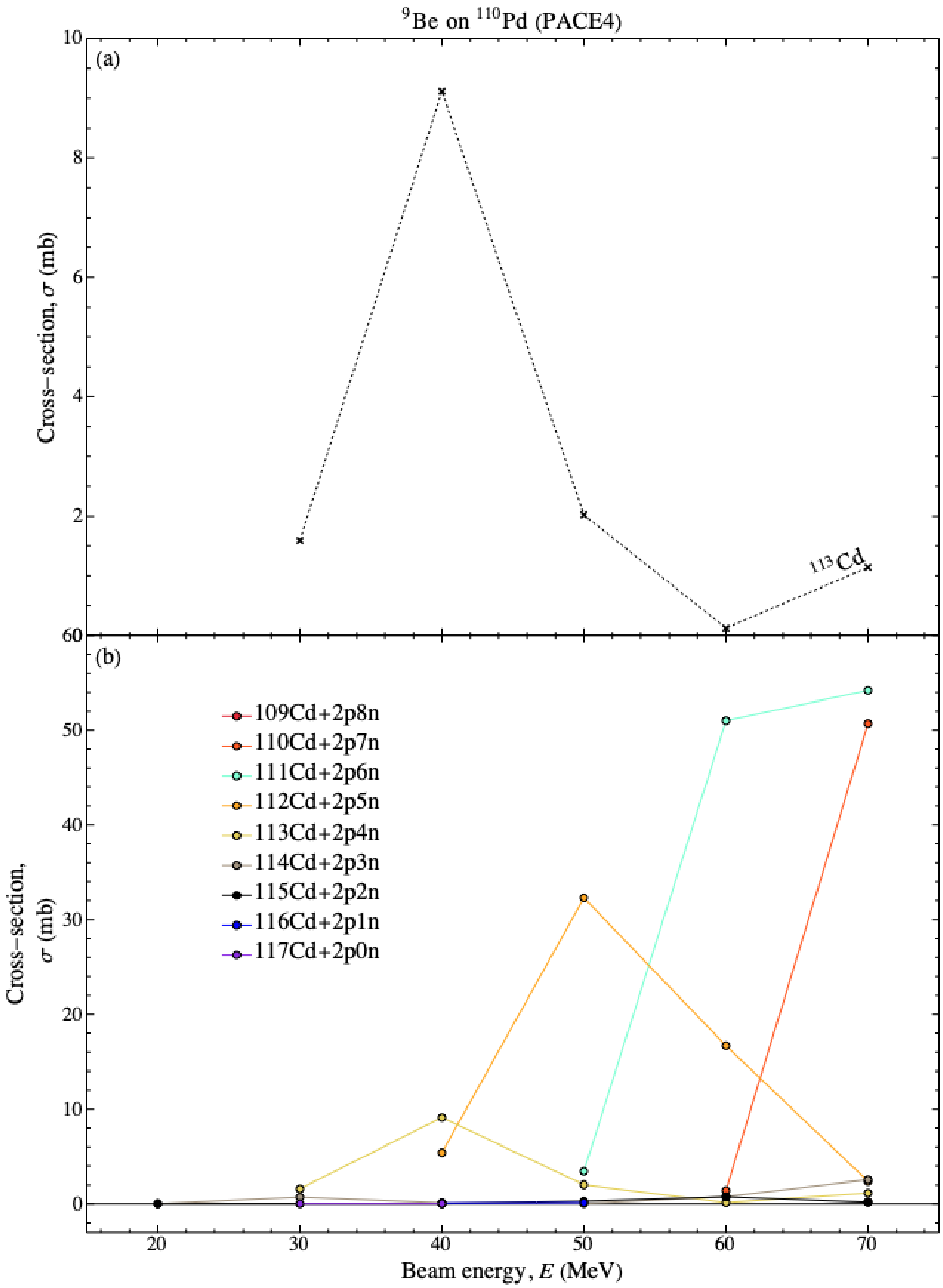

Figure 4: Excitation function for a ^{9}Be beam on a ^{110}Pd target (cross-section as a function of energy). Only cadmium isotopes that were produced during the Monte Carlo simulation are shown.

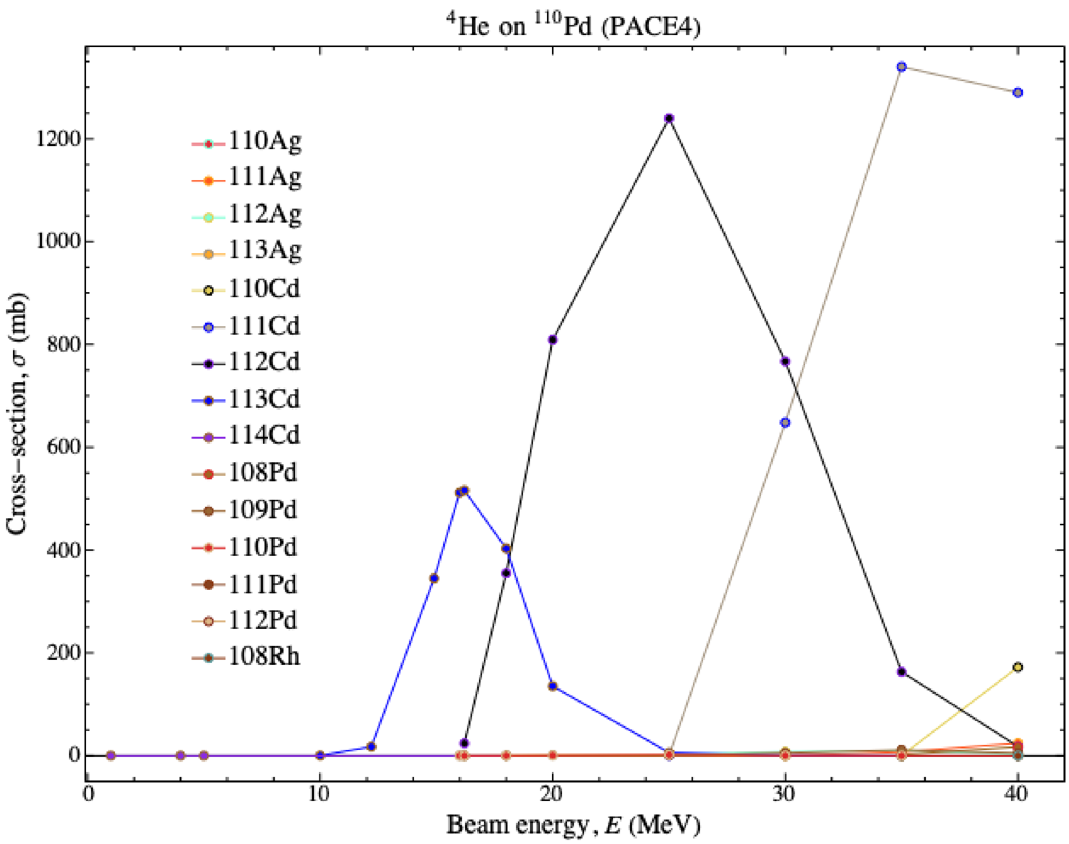

Figure 5: Excitation function for a ^{4}He beam on a ^{110}Pd target (cross-section as a function of energy). All isotopes that were produced during the Monte Carlo simulation are shown.

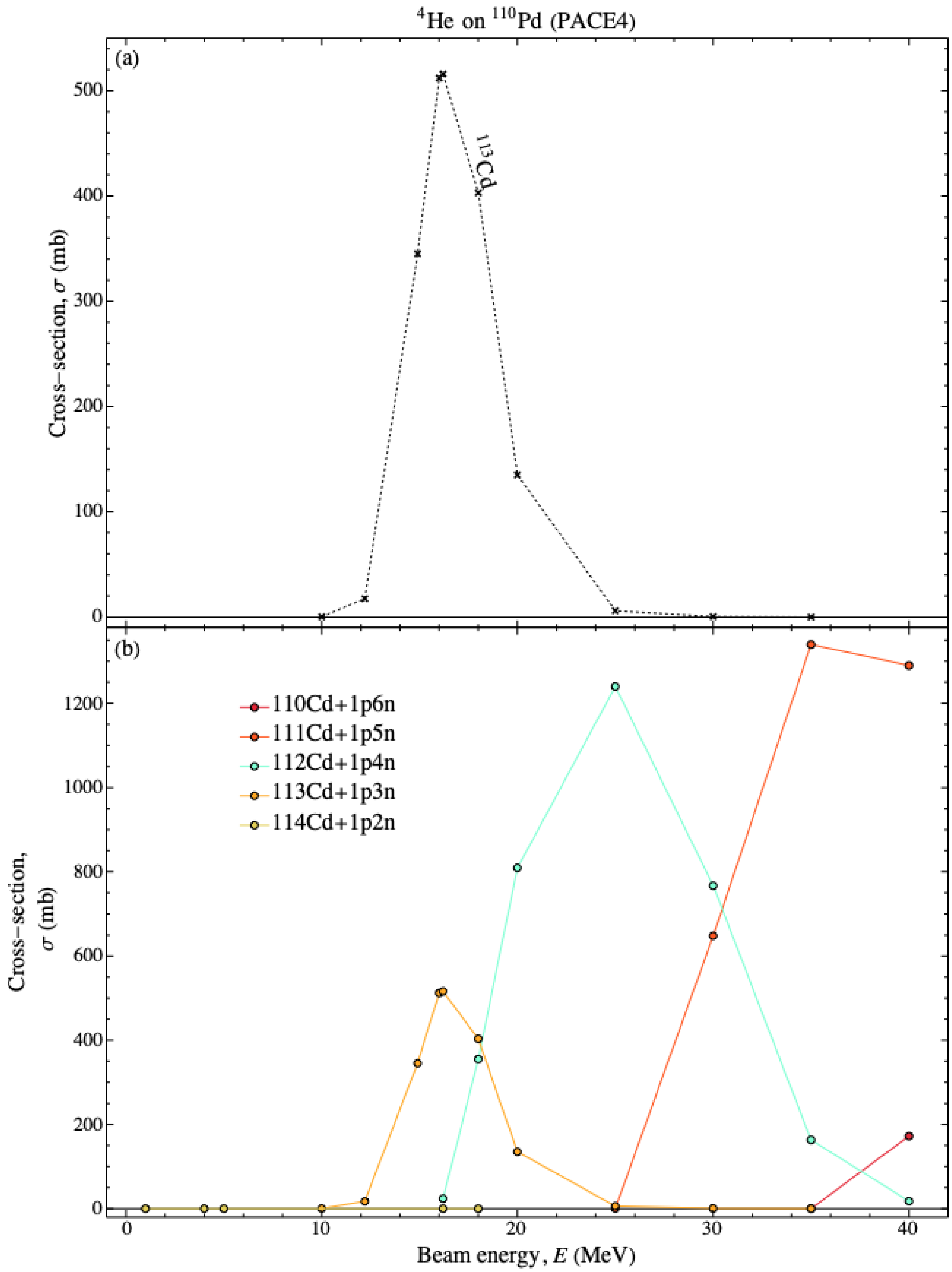

Figure 6: Excitation function for a ^{4}He beam on a ^{110}Pd target (cross-section as a function of energy). Only cadmium isotopes that were produced during the Monte Carlo simulation are shown.

V REFERENCES

[1] N. Warr, S. Drissi, P. Garrett, J. Jolie, J. Kern, S. Mannanal, J.-L. Schenker, and J.-P. Vorlet, "Study of 113cd by the 110pd(α,nγ) reaction," *Nuclear Physics A*, vol. 620, no. 2, pp. 127–150, Jul. 1997. [Online]. Available: https://linkinghub.elsevier.com/retrieve/pii/S0375947497001656