Determination of single-neutron energies and spectroscopic factors outside ^{132}Sn

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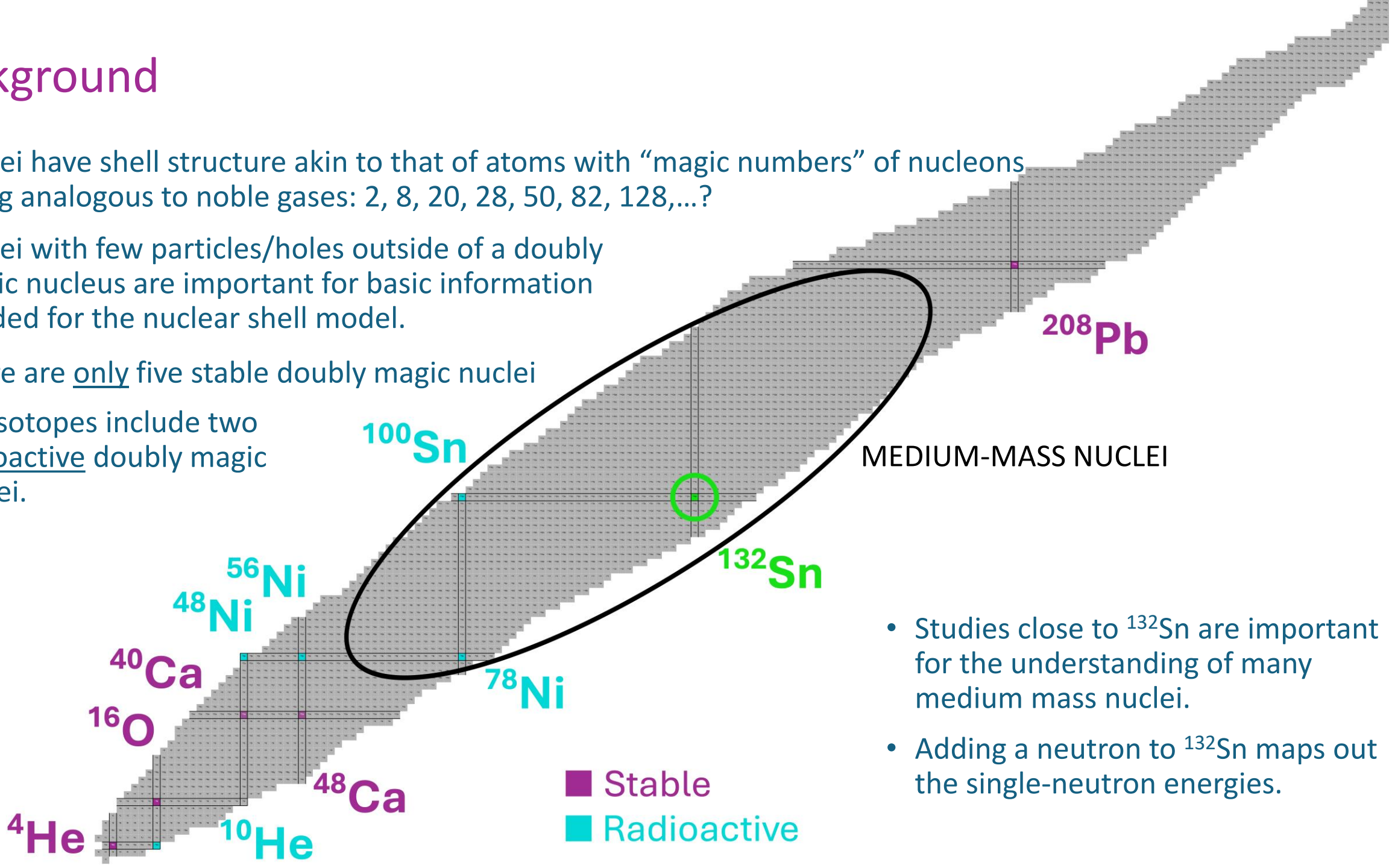
Background

- Nuclei have shell structure akin to that of atoms with “magic numbers” of nucleons being analogous to noble gases: 2, 8, 20, 28, 50, 82, 128,…?
- Nuclei with few particles/holes outside of a doubly magic nucleus are important for basic information needed for the nuclear shell model.
- There are only five stable doubly magic nuclei
- Tin isotopes include two radioactive doubly magic nuclei.

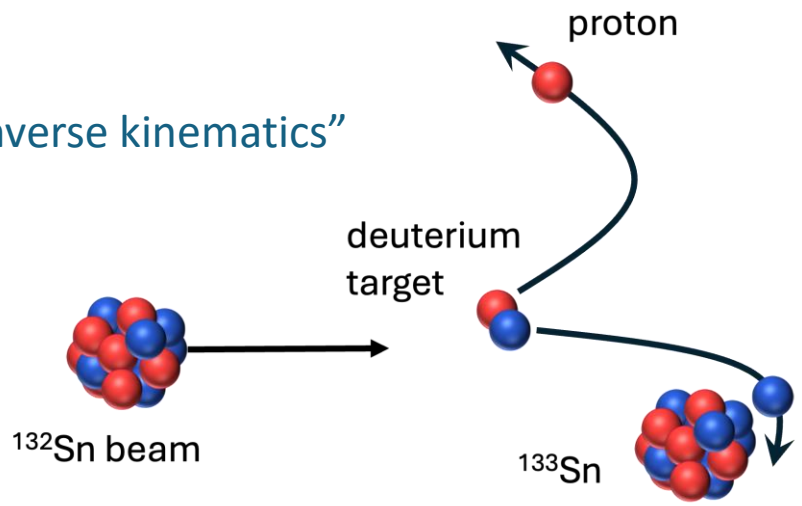


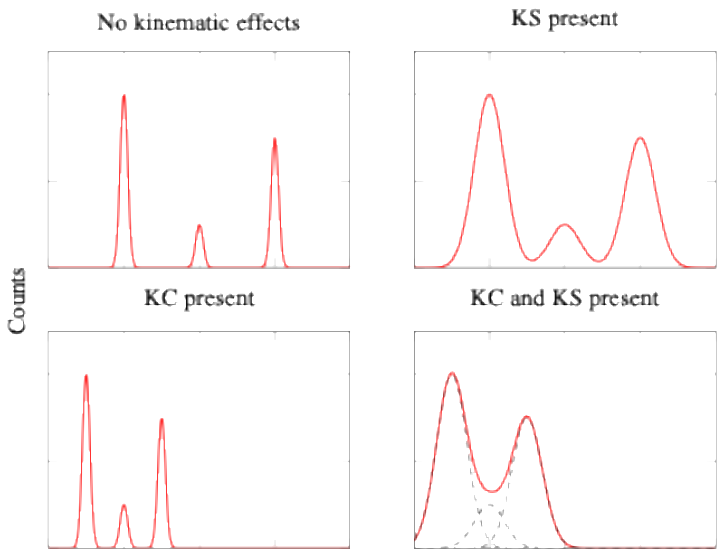
- Studies close to ^{132}Sn are important for the understanding of many medium mass nuclei.
- Adding a neutron to ^{132}Sn maps out the single-neutron energies.

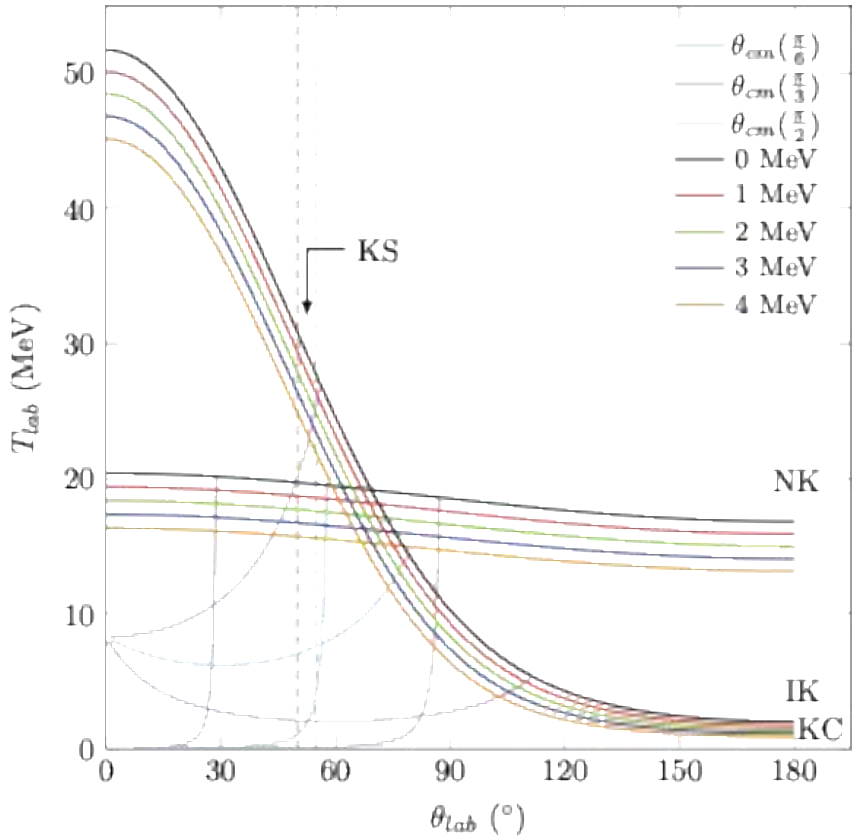
Studying radioactive nuclei is not trivial!

- ^{132}Sn has a half life of 40 seconds – can't make a target.
- Heavy beam on light target means high CM velocity - difficult "inverse" kinematics:
  - Kinematic shift (KS) – fixed-angle setup has broadening of states
  - Kinematic compression (KC) – reduced separation between states compared to "normal kinematics"
- ISOLDE is **unique** in having a ^{132}Sn beam with the intensity and energy, coupled to a high-resolution instrument, needed to undertake a comprehensive study.

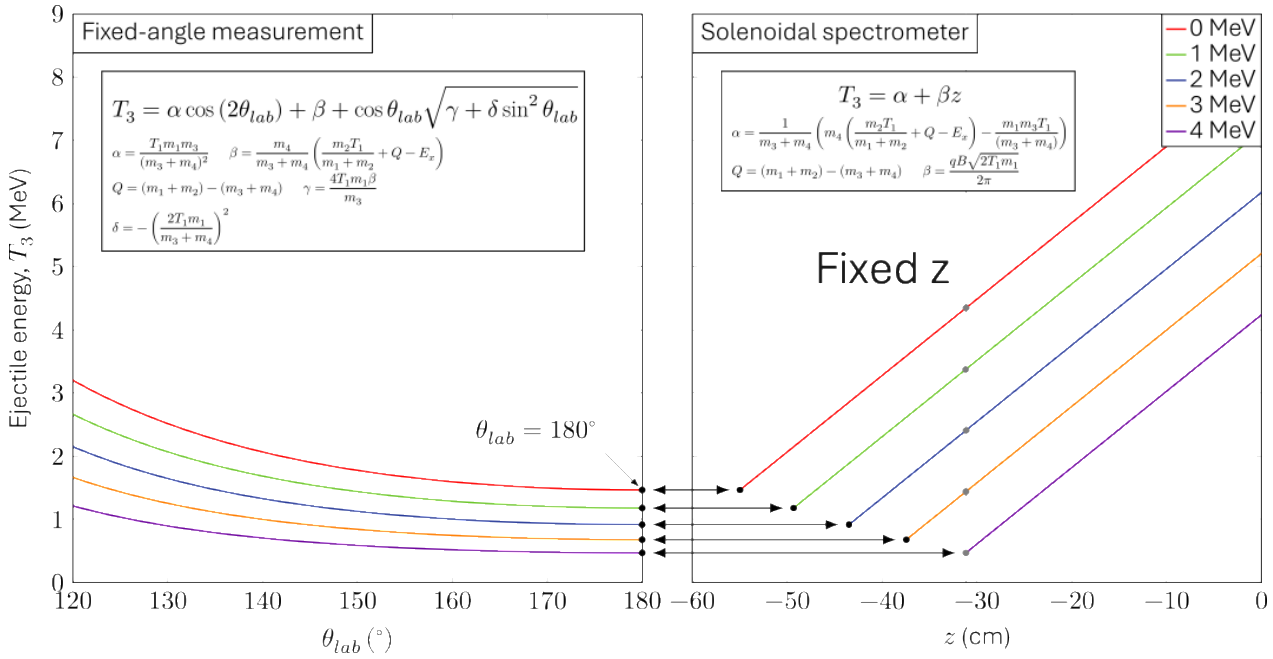
"Inverse kinematics"



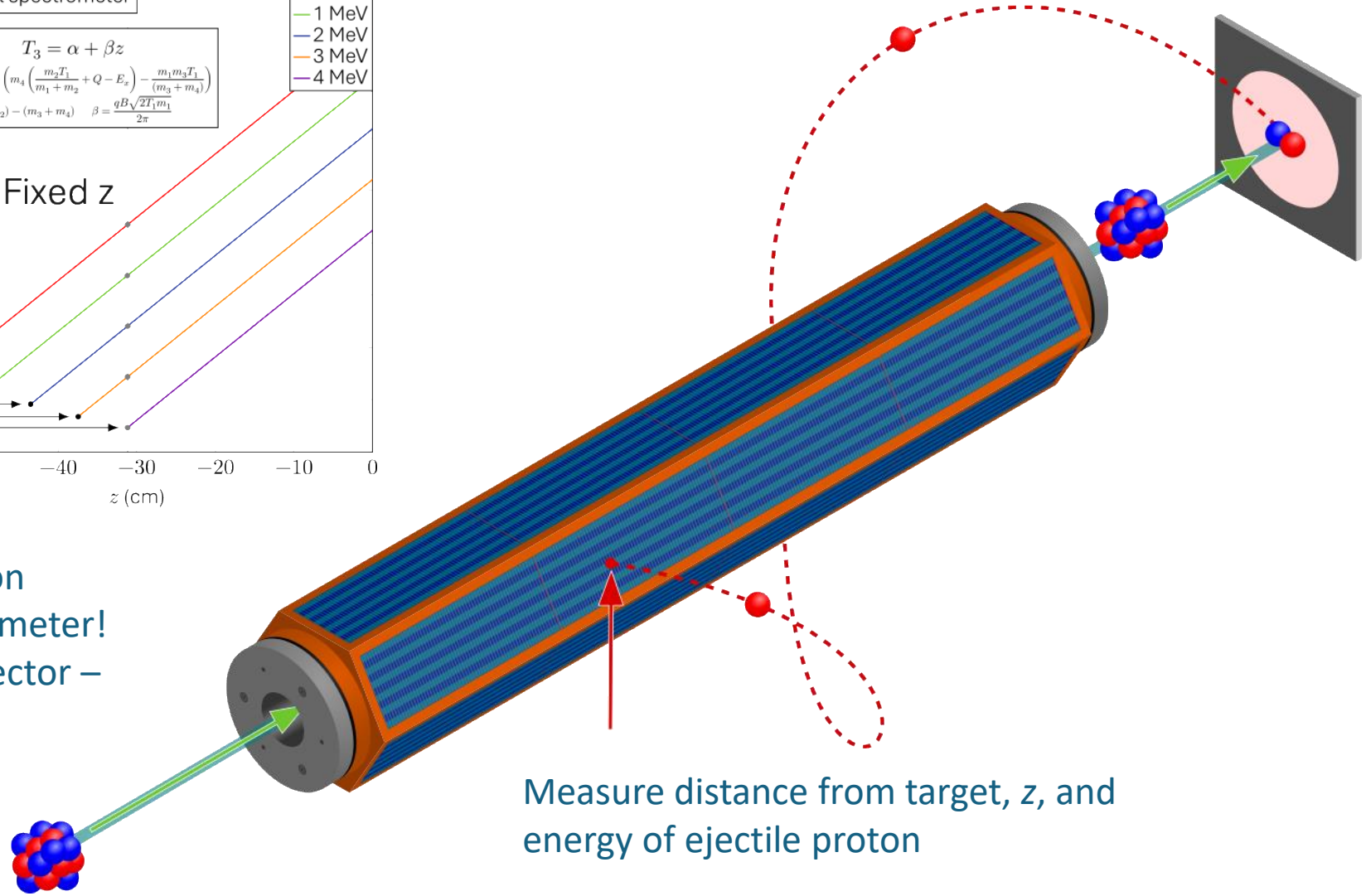




ISOLDE Solenoidal Spectrometer (ISS)



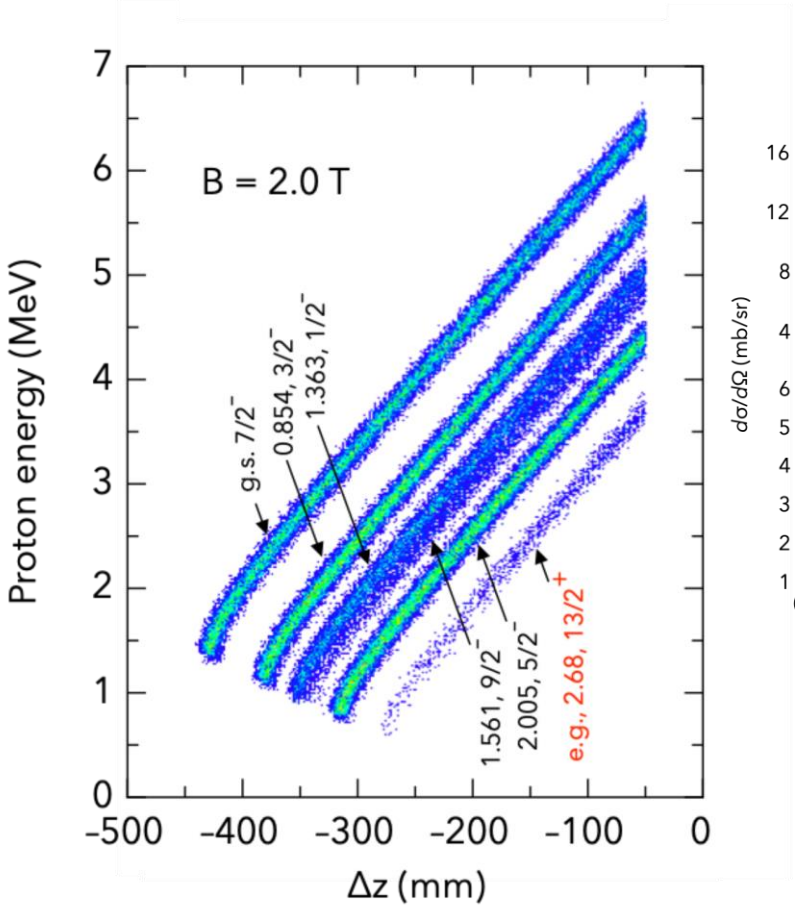
- Problems of kinematic compression disappear for a solenoidal spectrometer!
- Magnet focuses protons onto detector – excellent solid angle coverage!

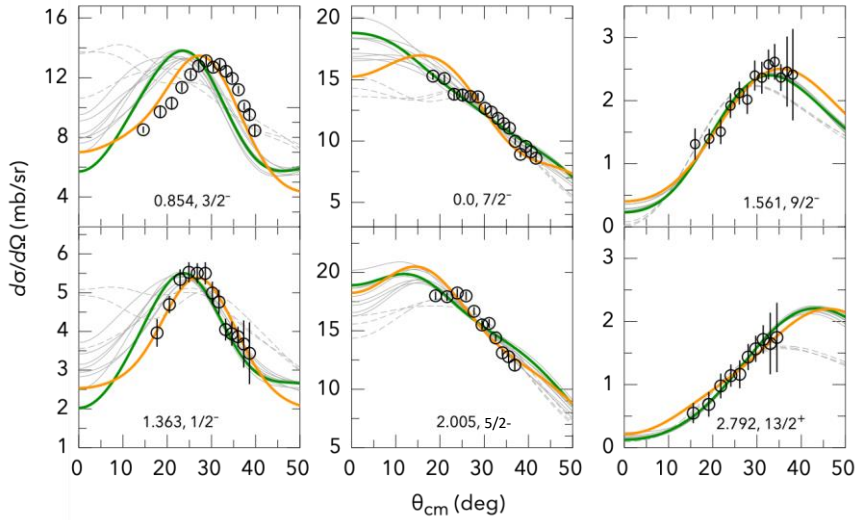


Measure distance from target, *z*, and energy of ejectile proton

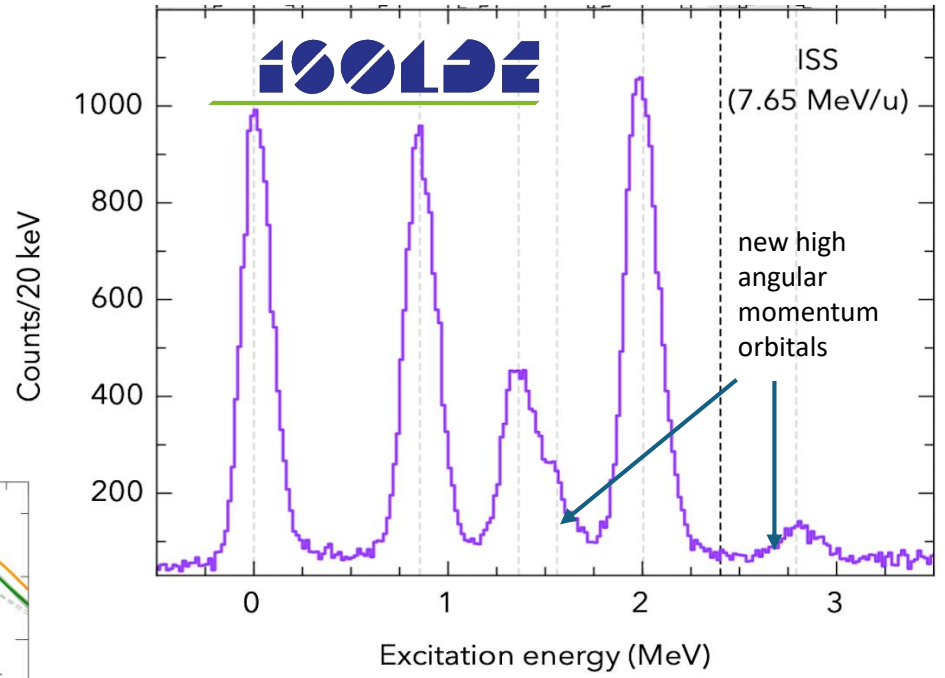
Reveals the high angular momentum single-particles states outside doubly-magic ^{132}Sn

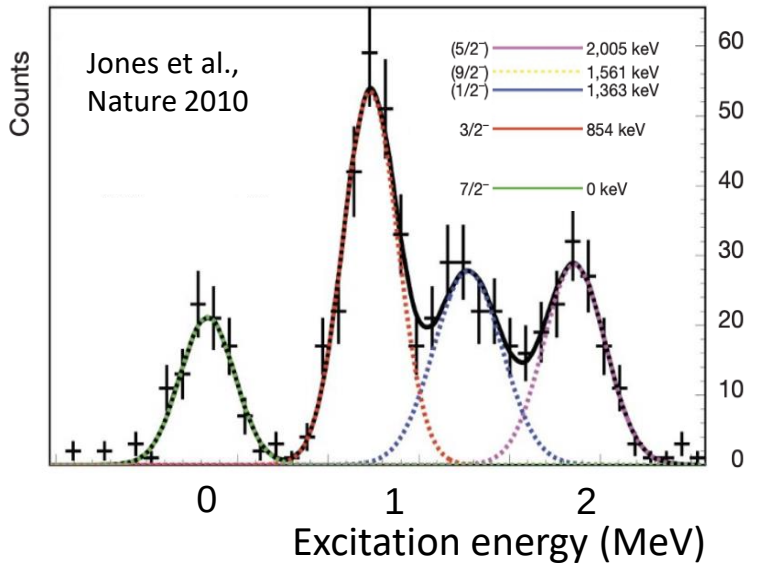
An experiment in July this year made a significant improvement in terms of statistics and resolution compared to the only previous attempt at Oak Ridge more than 15 years ago (lower energy, lower current, worse resolution).





For the first time, **ALL** the valence single-neutron orbitals outside the doubly-magic core in ^{133}Sn have been observed.





Knowledge of these orbitals allows the properties of large numbers of medium-mass nuclei to be calculated using nuclear shell models – before this result, the high-angular momentum orbitals had to be guessed!

Credits

Spokespersons: Ben Kay, Sean Freeman and David Sharp

Patrick MacGregor, Frank Browne, *Sam Reeve*, Alan Wuosmaa, Andreas Heinz, Alice Svärdström, Thorsten Kröll, Björn Johansson, *Maria Vittoria Managlia*, Hans Törnqvist, *Anna Kawecka, Faye Rowntree, Annie Dolan,* Ben Jones, Ivan Anastasov, Carlotta Porzio, Steffen Leyer, Alicia Munoz Ramos, Marc Labiche,
Peter Butler, Liam Gaffney, Ian Lazarus, Robert Page.

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Supported 5 PhD students on this experiment!

I have a poster outside on ISS if you want to chat more!