

Isospin symmetry in the fp-shell mirror nuclei

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Mirror Energy Differences and the Isospin symmetry

The **nucleon-nucleon force**, V_{NN} is (nearly):

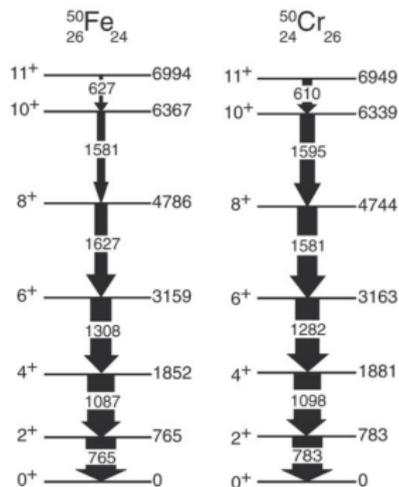
- charge symmetric ($V_{pp}=V_{nn}$)
- charge independent ($V_{pp}=V_{nn}=V_{pn}$)



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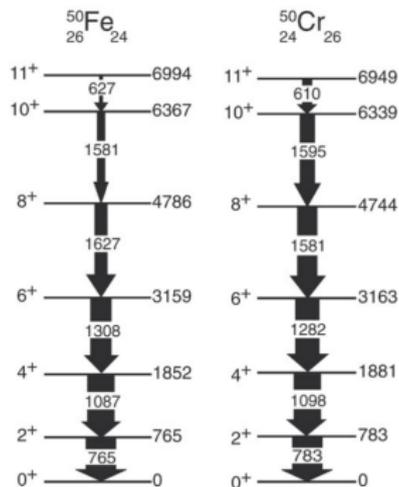
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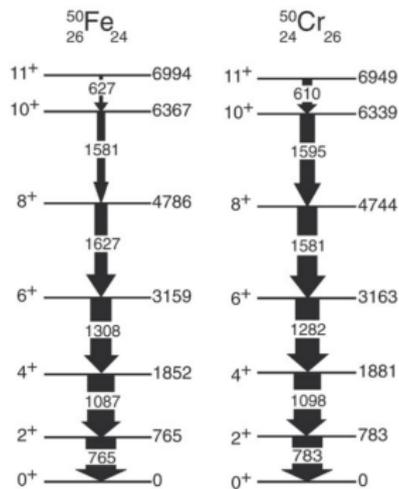
$$MED_{J,T} = E_{J,T,T_z}^*(Z_>) - E_{J,T,T_z}^*(Z_<)$$



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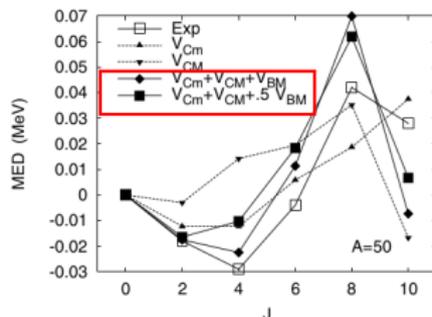
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The inclusion of a isospin non conserving (INC) term is essential for a proper quantitative description of the Mirror Energy Differences (MEDs)



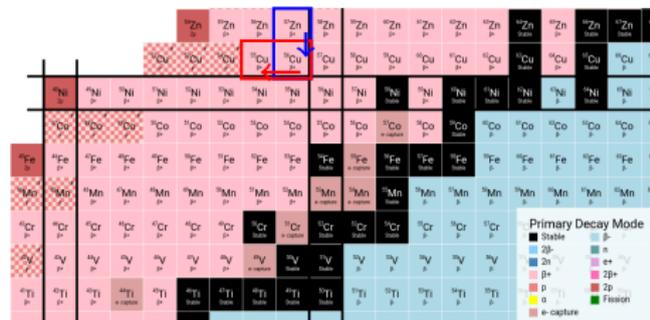
S. M. Lenzi et al. PRL 87.12 (2001): 122501
 A. P. Zuker et al. PRL 89.14 (2002): 142502.



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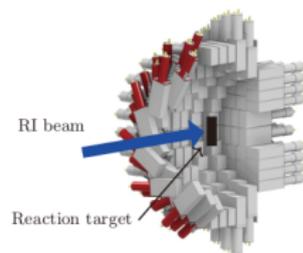
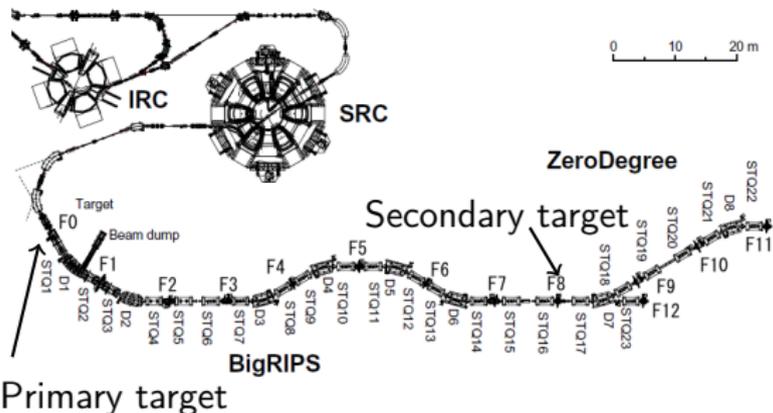
Overview

- Exotic proton-rich nuclei like ^{55}Cu and ^{56}Cu
 - Best candidates to study isospin non-conserving interactions
 - Still unknown level scheme
- New estimates on inclusive knockout cross-sections
- To extend the information with respect Mirror Energy Differences (MEDs)
 - To investigate the mass dependence of the isospin-breaking effects
 - To investigate to which extent weak binding and coupling to the continuum affect isospin symmetry



Experimental Setup

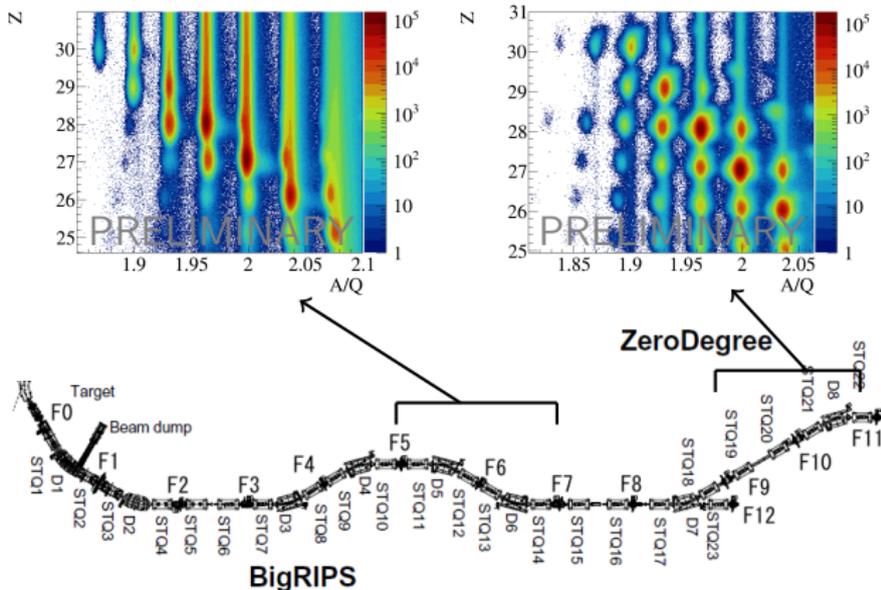
- Secondary beam collected in the **BigRIPS** separator
- The beam is then focused to the secondary Beryllium target (6mm)
- Reaction products collected and analyzed in the **ZeroDegree** spectrometer



Data analysis

We analyzed the performance of each detector for each acquisition run:

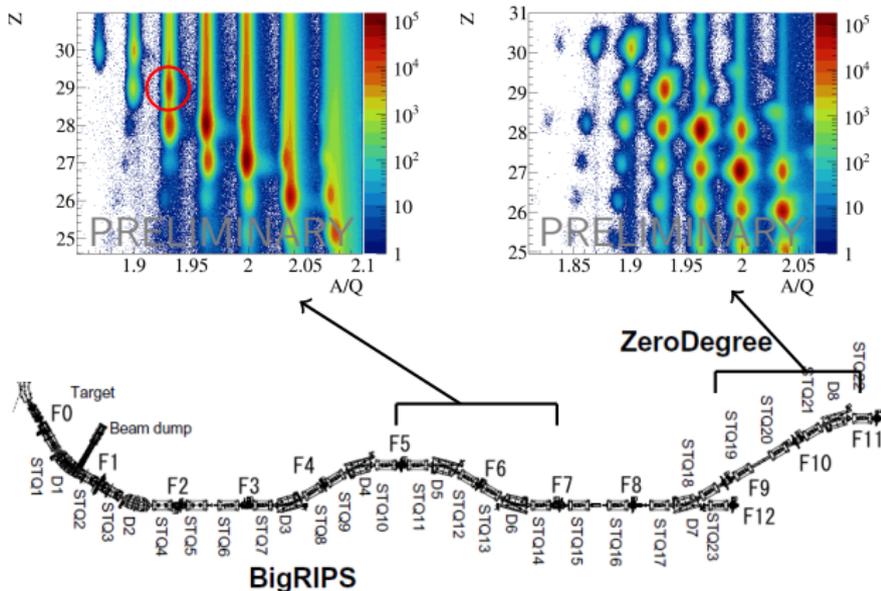
- Position detectors efficiencies
- Time, charge and time-charge correlation in plastic detectors
- Ionization chambers gain
- γ -detector array calibration



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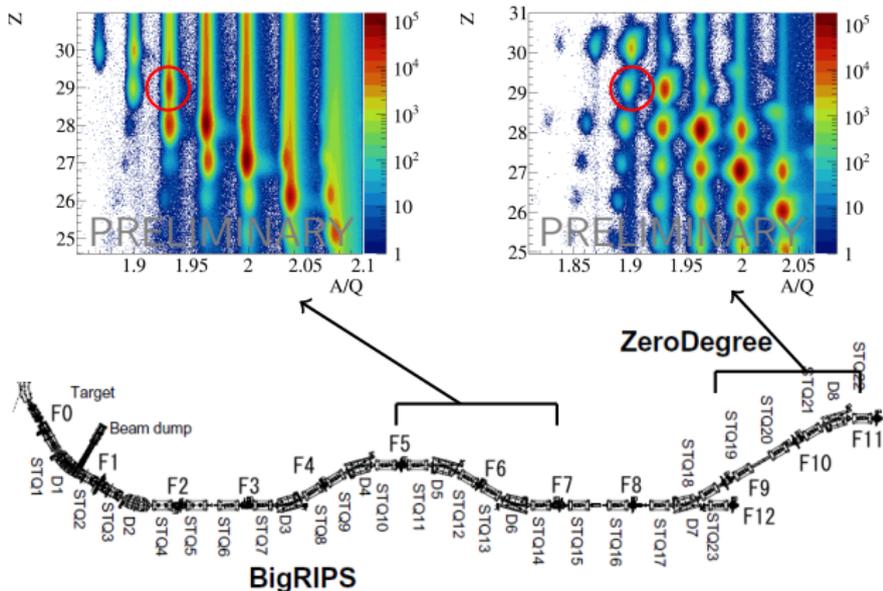
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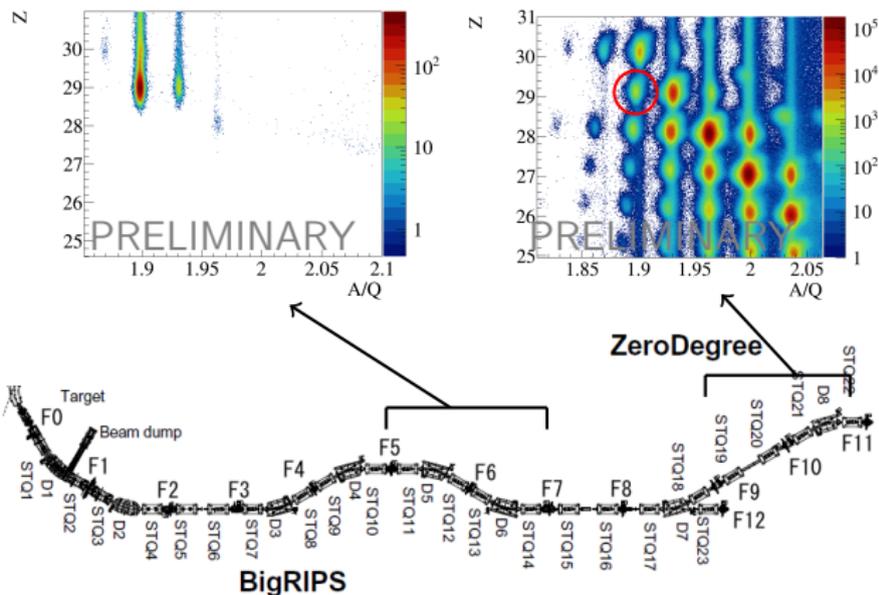
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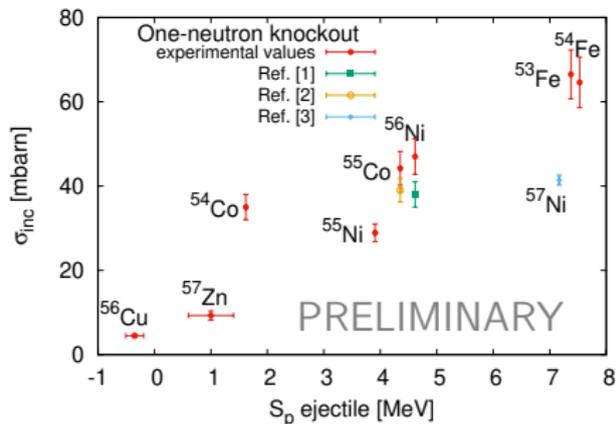
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Inclusive cross sections

- Estimations of inclusive knock-out cross-sections extended even to the more proton-rich region of the fp-shell
- Systematics in agreement with other experimental results. (N. Paul et al. PRL 122.16 (2019): 162503)

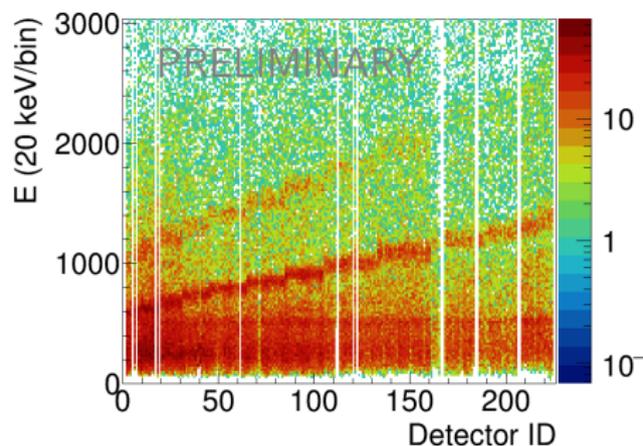


- [1] M. Spieker et al., Phys. Rev. C 99.5 (2019): 051304. [2] M. Spieker et al., Phys. Rev. C 100.6 (2019): 061303.
 [3] K. L. Yurkewicz et al., Phys. Rev. C 74.2 (2006): 024304.



Doppler Correction and γ -analysis

- Relativistic regime ($\sim 0.6c$)

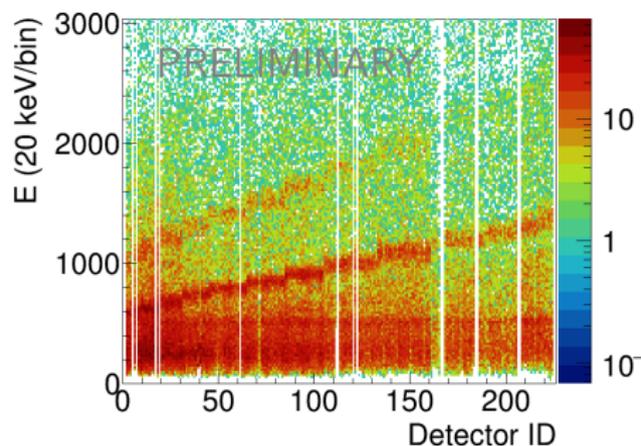


γ -spectrum of the ^{52}Fe from the one-neutron knock-out from ^{53}Fe in the laboratory system.

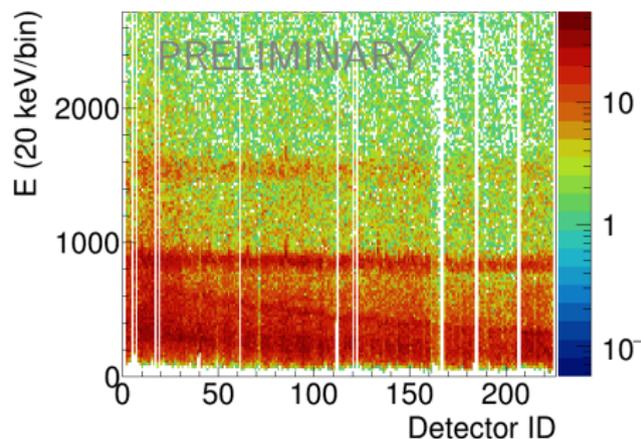


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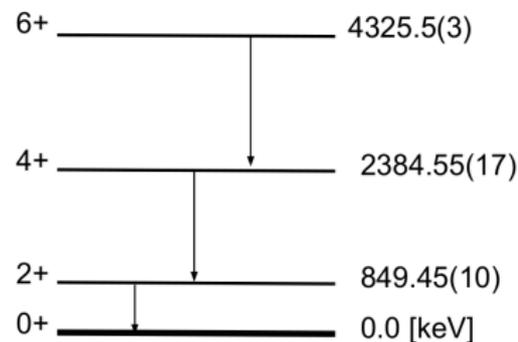
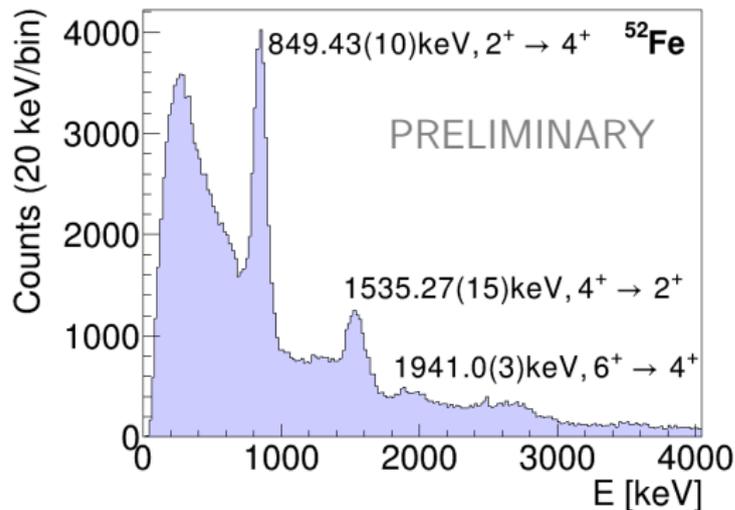


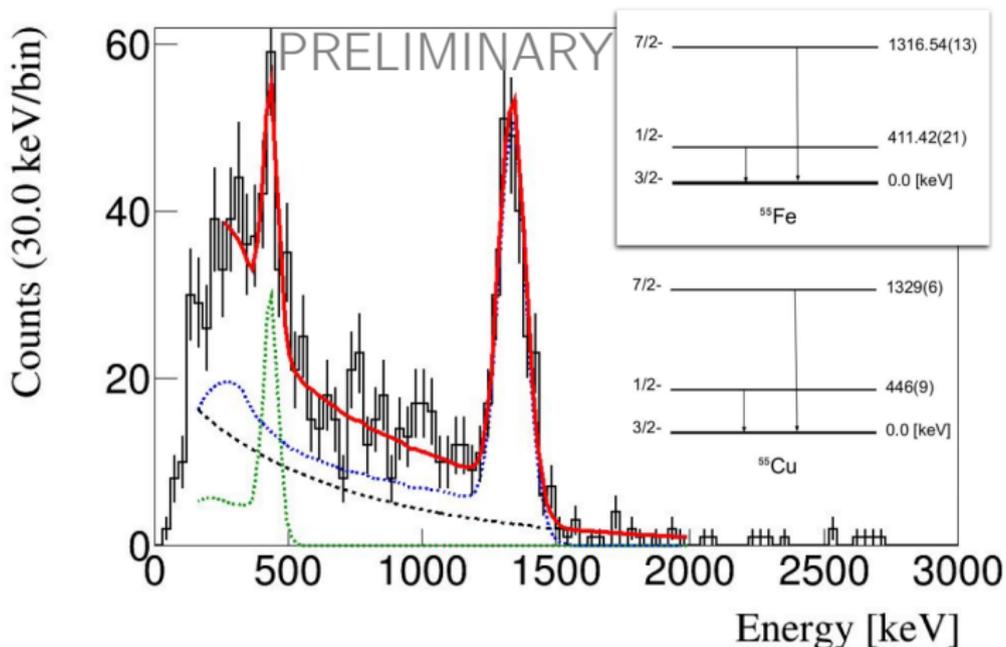
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Doppler-corrected γ -spectrum of the ^{52}Fe from the one-neutron knock-out from ^{53}Fe .



Doppler Correction and γ -analysis

γ -spectrum of ^{55}Cu 

γ -spectrum of the ^{55}Cu from the ^{56}Cu neutron knock-out. The spectrum has been created requesting an event multiplicity equal to one.



Summary and conclusions

- Detectors proper data selection, calibration and efficiencies estimations
- Inclusive cross-sections for the p-ko and n-ko channels
 - The observed systematic is in agreement with other experimental results
 - Theoretical calculations will help the interpretations of the results
- Doppler correction and γ -analysis:
 - First inspection of γ -rays from the exotic proton-rich ^{55}Cu
 - First estimation on the two transition energies.



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*Thank you for the
attention!*

