



Investigating the Nuclear Shell Closure at $N=32$ in Neutron Rich ^{52}Ca

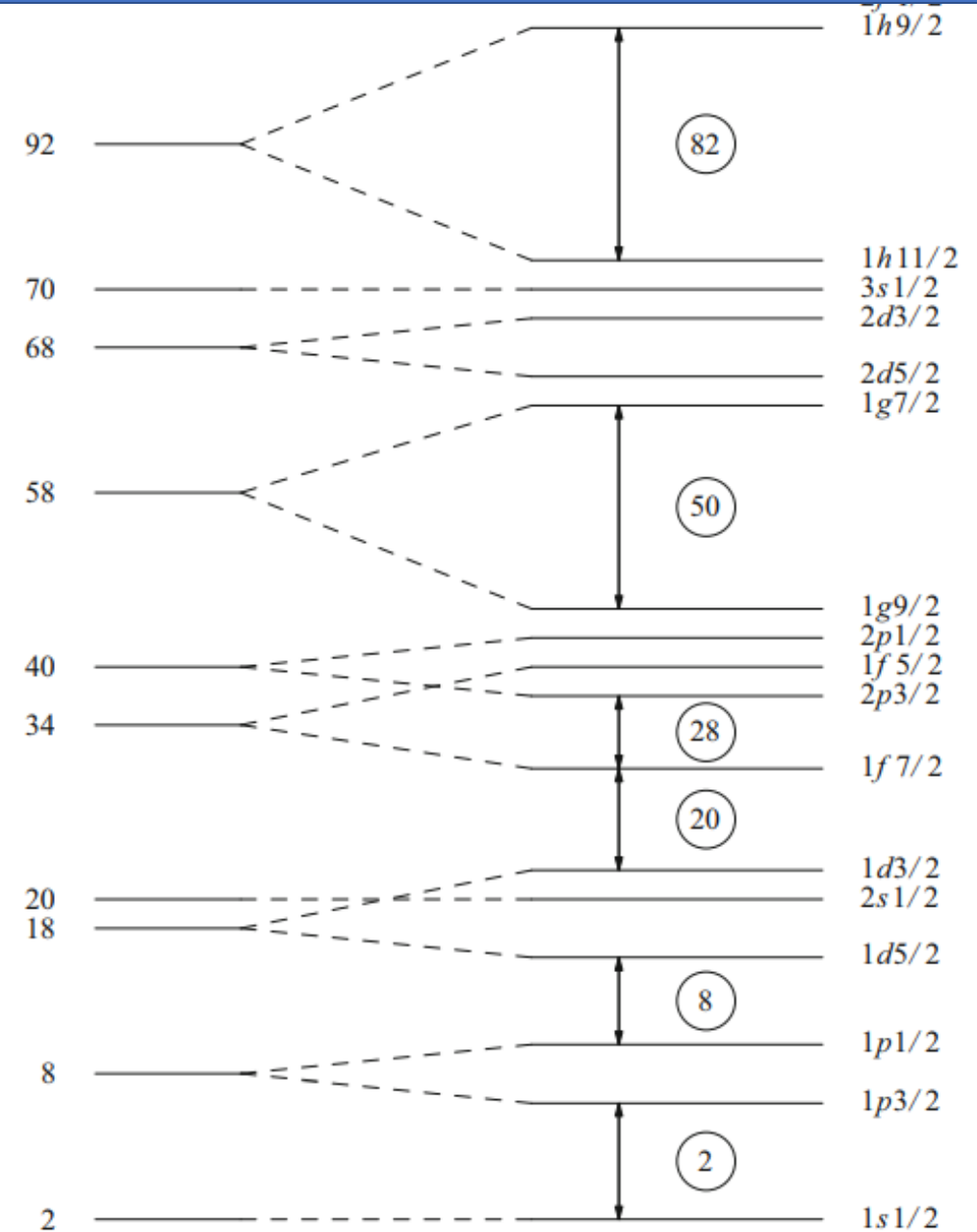
Robin Coleman – University of Guelph

CAP Congress, SFU

June 3, 2019

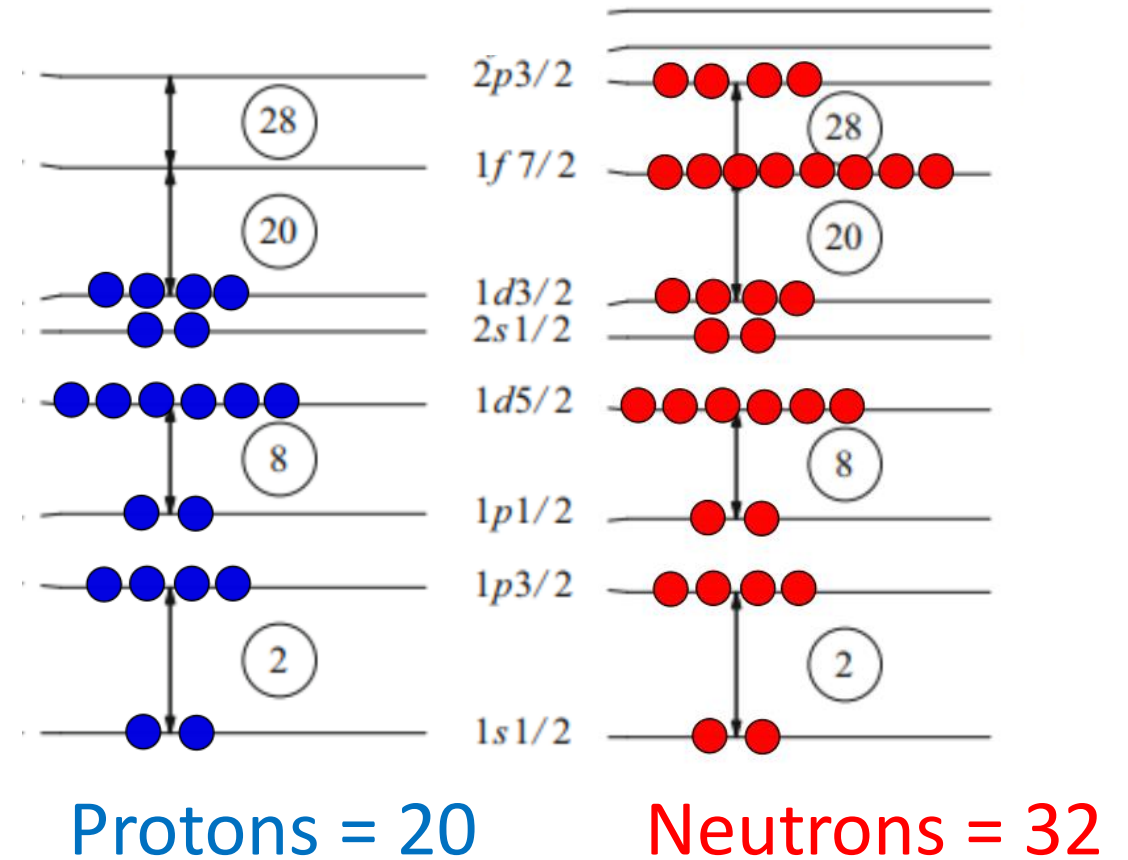
MOTIVATION

- Shell model Calculations
- Magic Numbers
 - Elevated first 2+ level
 - Small Charge Radius
 - High Separation Energy



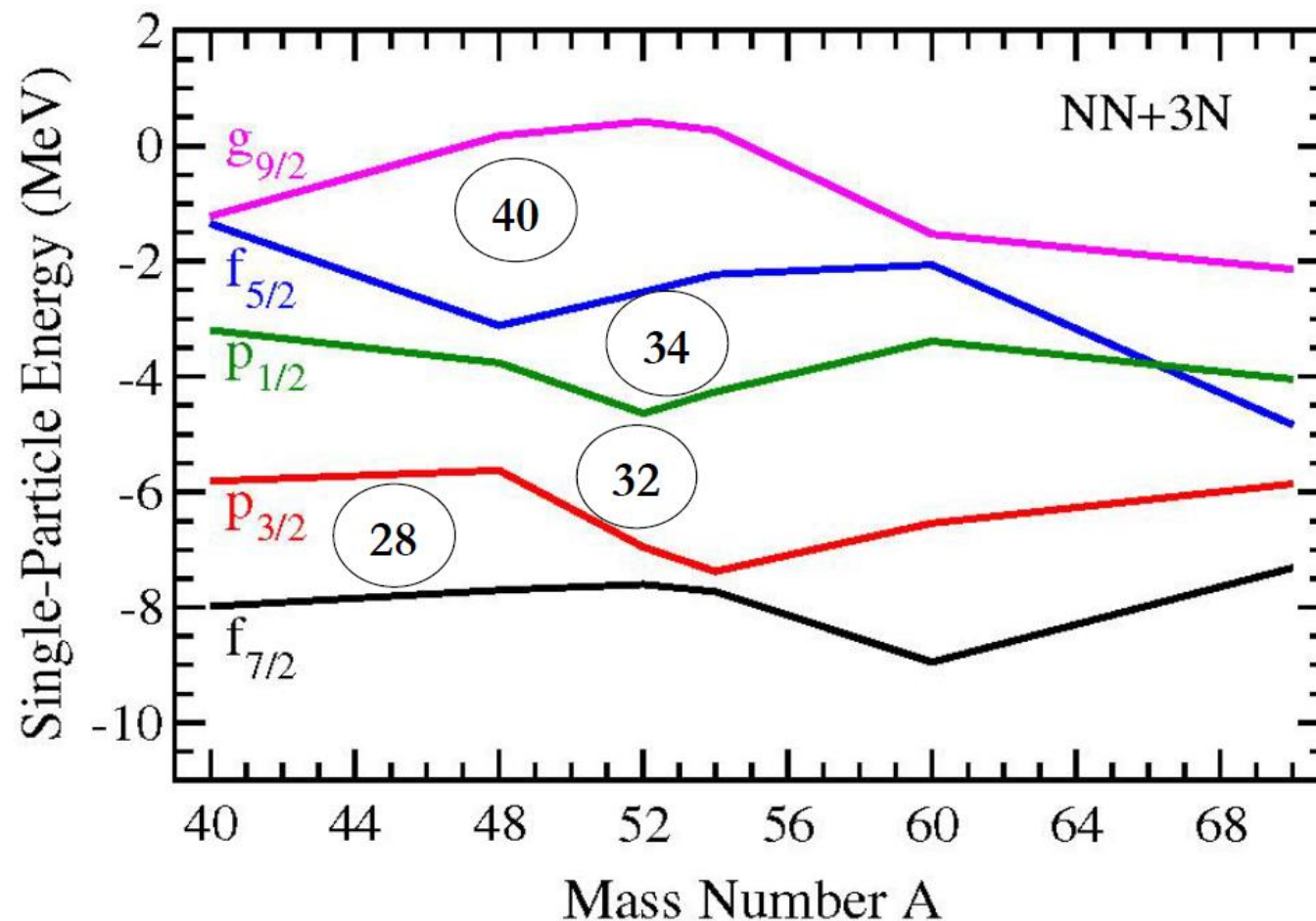
MOTIVATION

- Calcium 52
 - Traditionally Magic Protons



MOTIVATION

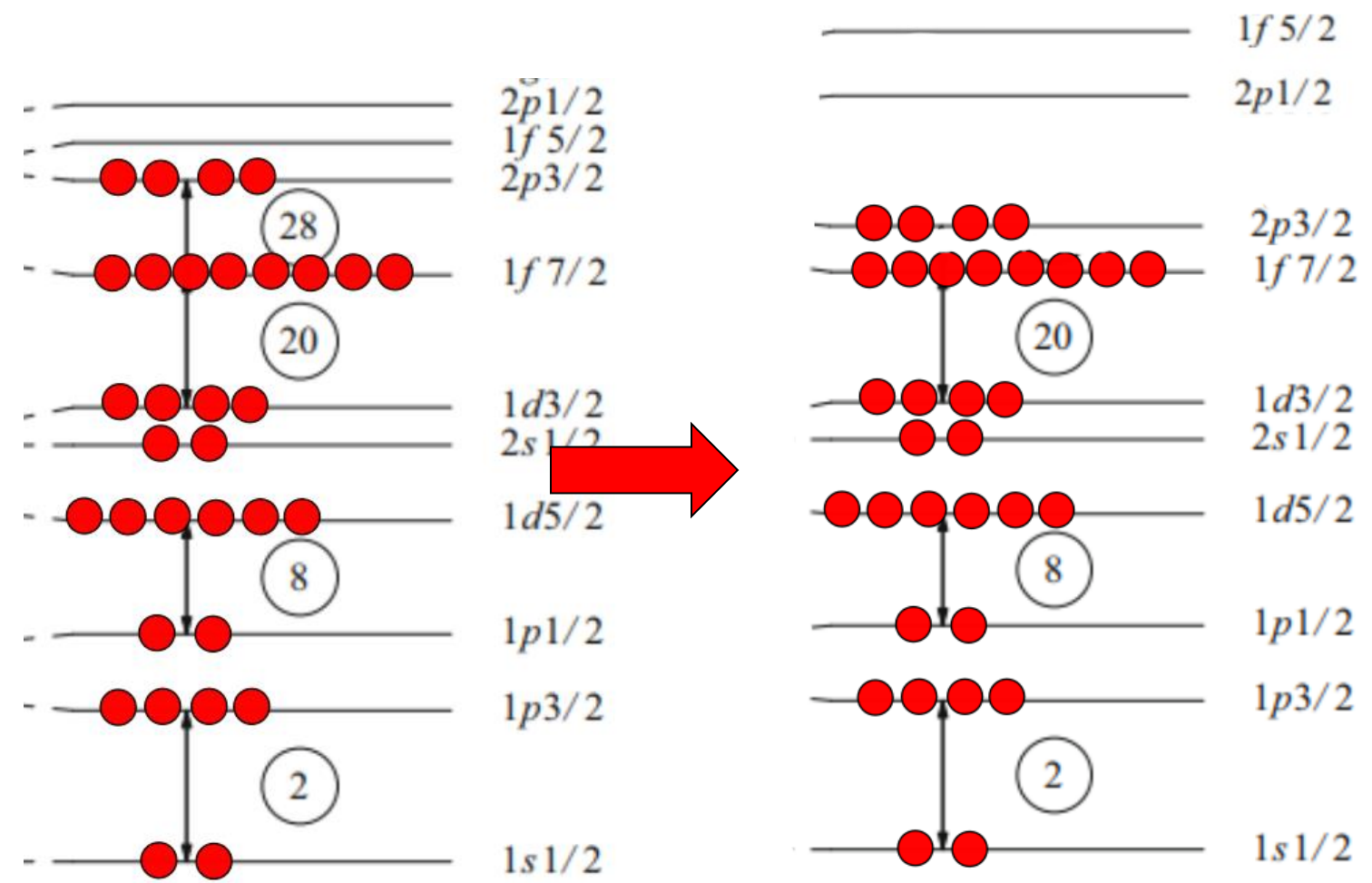
- Shell model Evolution
- 3N interaction required to reproduce 28 Shell closure



J.D. Holt et al., Phys. Rev. C 90, 024312 (2014)

MOTIVATION

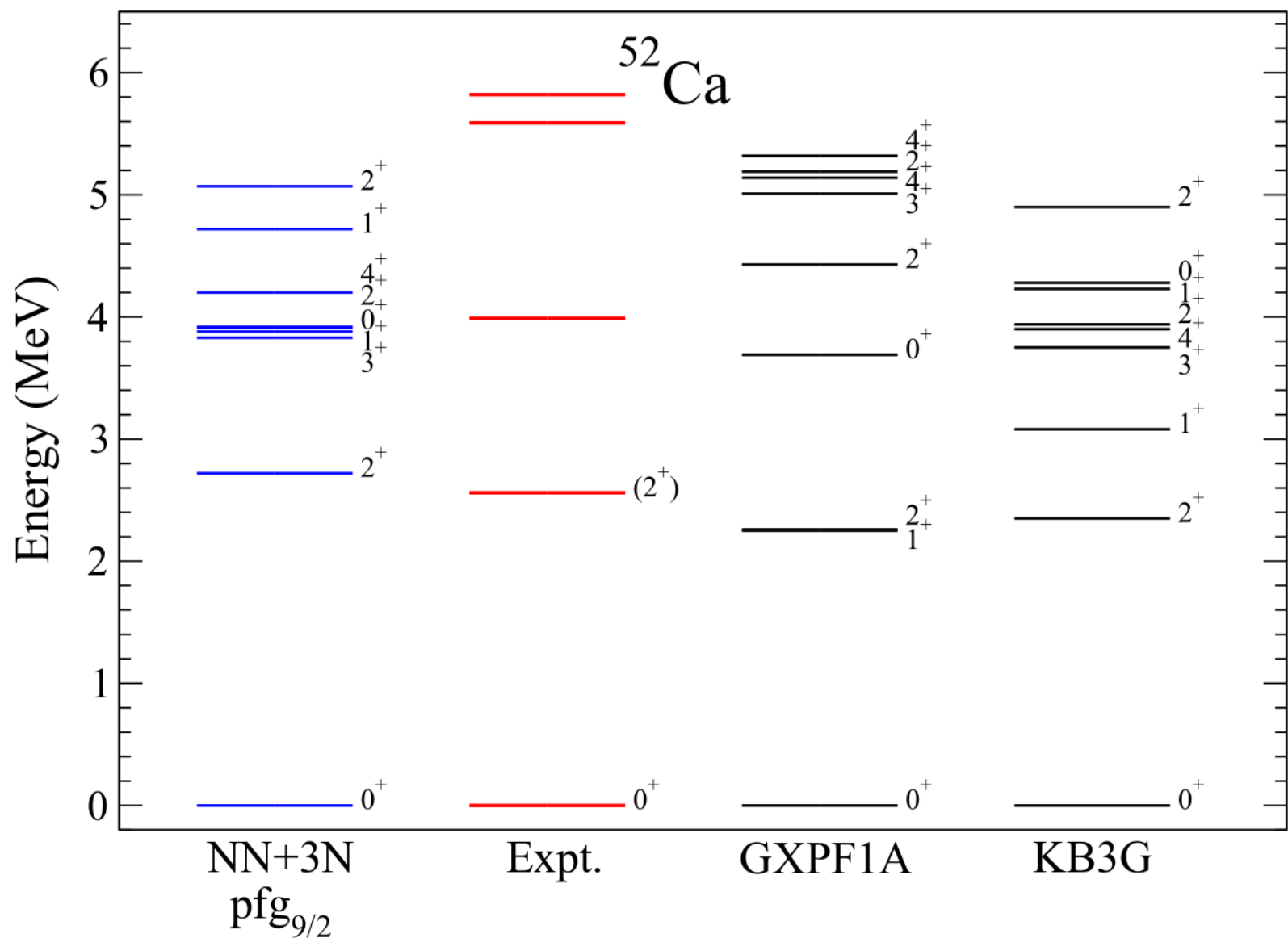
- Calcium 52
 - Traditionally Magic Protons
 - Evolution to Magic Neutrons



Neutrons = 32

Motivation

- Different Interactions
 - NN+3N
 - GXPF1A- G Matrix pf interaction
 - KB3G- Kuo-Brown Interaction

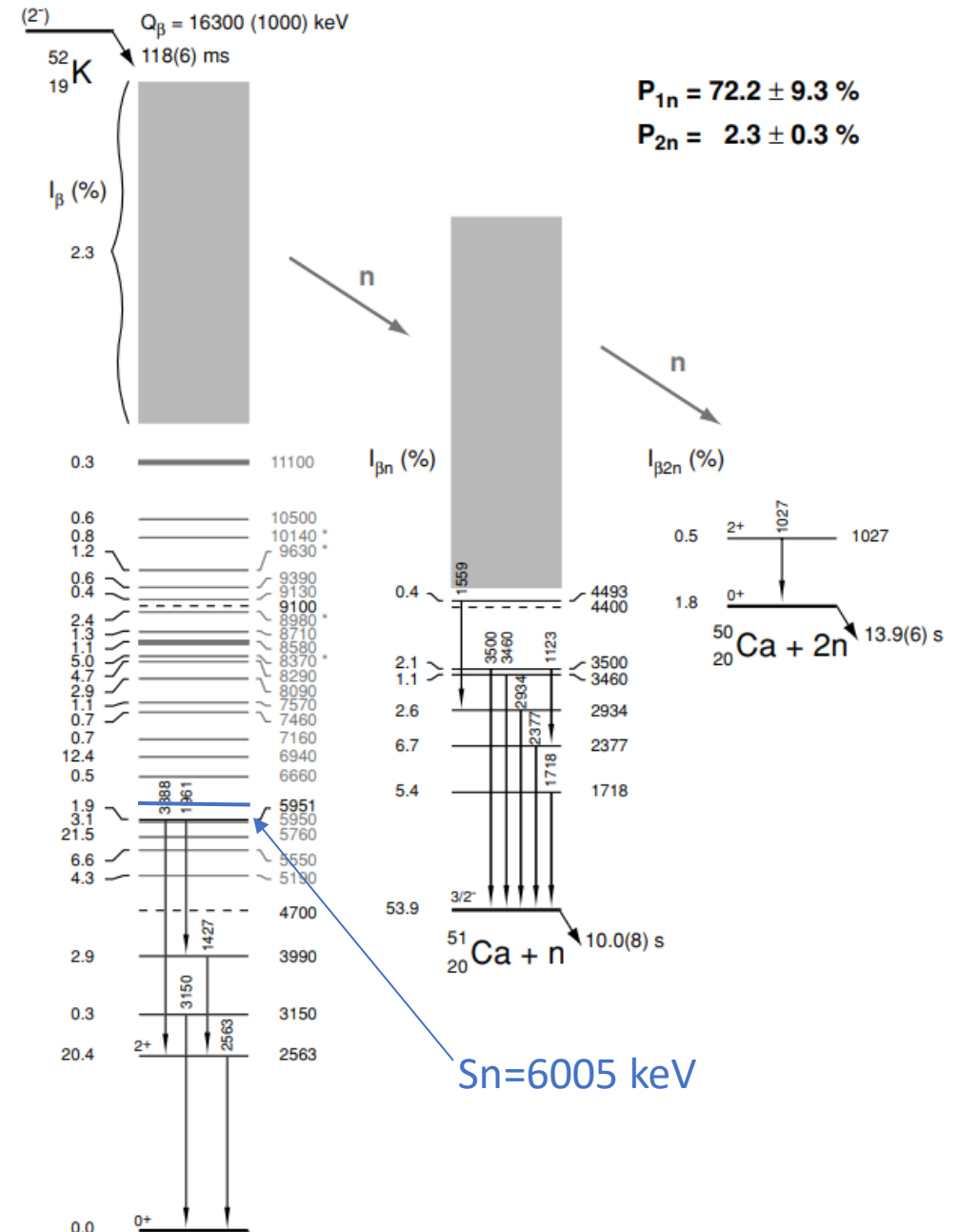


J.D. Holt, et al. PHYSICAL REVIEW C 90, 024312 (2014)

Motivation

- Previous Level Scheme
 - 5 Gamma-ray Transitions
 - 4 Observed Excited Levels
 - Other levels are deduced from the beta-delayed neutron energy spectra

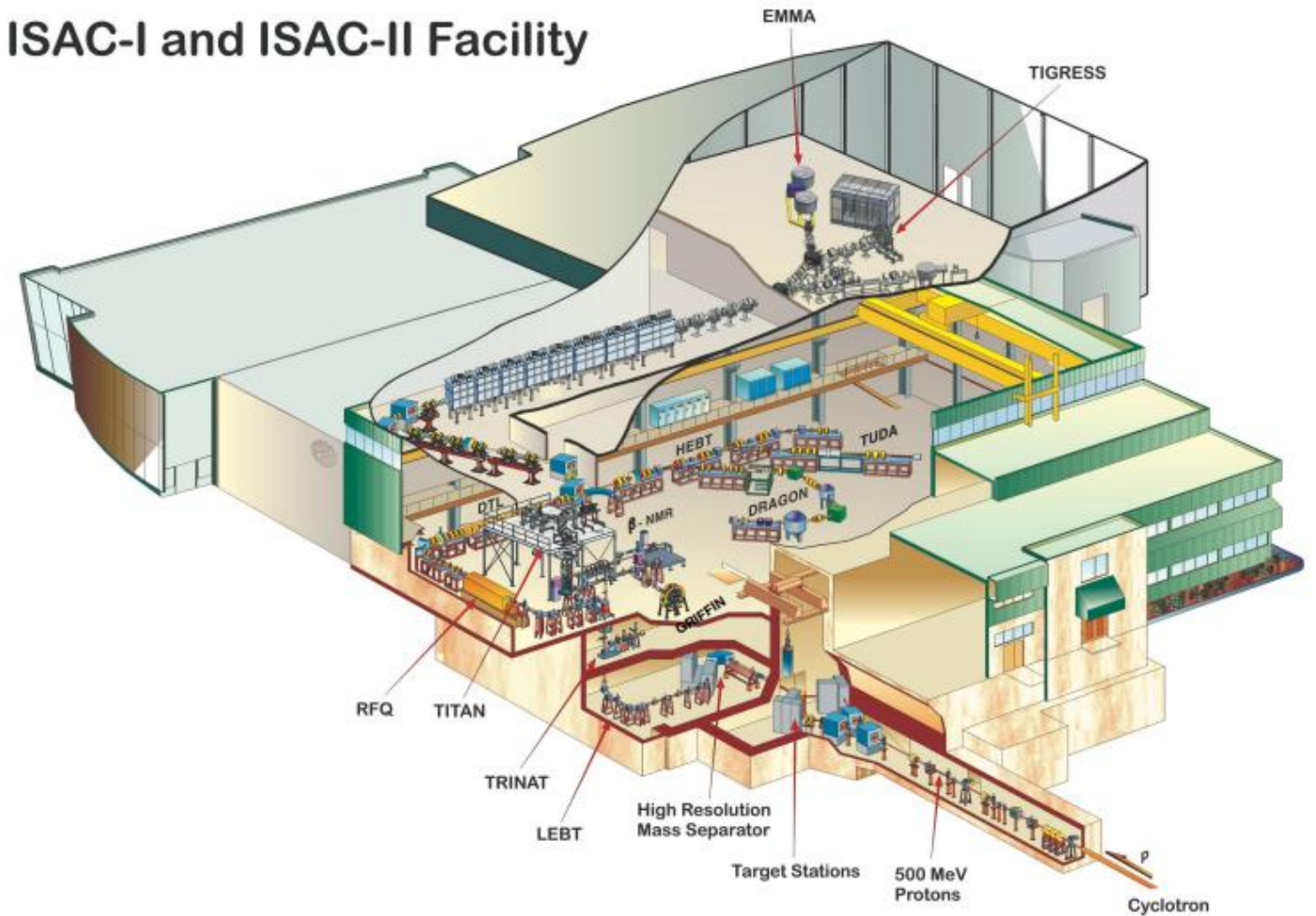
F. Perrot et al., Phys. Rev. C74, 014313 (2006).



Experiment

- TRIUMF – Vancouver, BC
 - ISAC 1
- **GRIFFIN** – High precision gamma energy
 - **ZDS & SCEPTAR** – Beta tagging Scintillators

ISAC-I and ISAC-II Facility

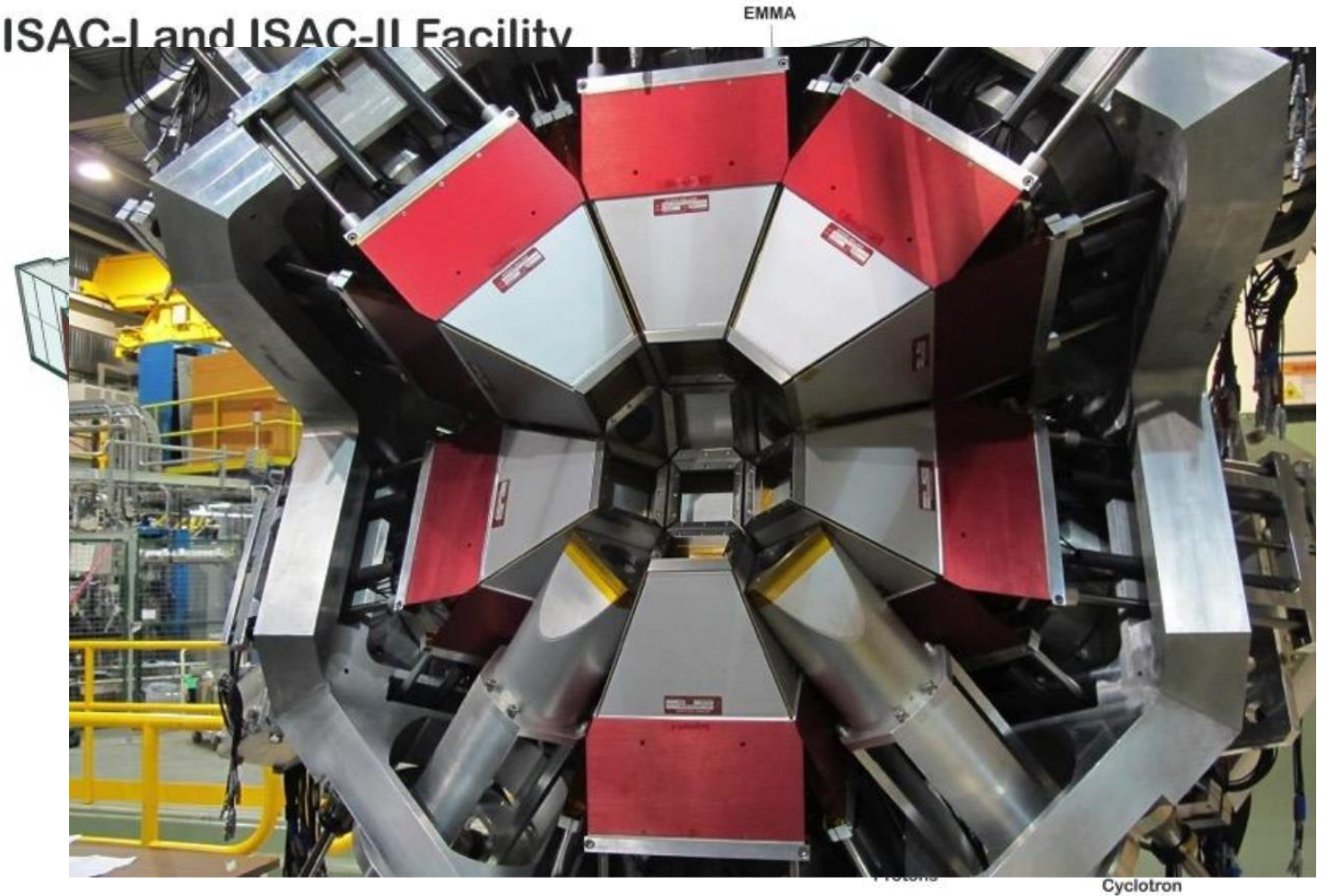


<https://www.triumf.ca/research-program/research-facilities/isac-facilities>

Experiment

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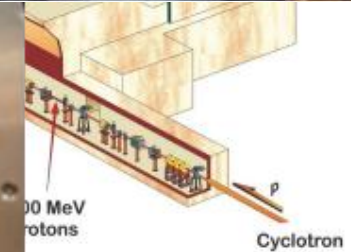
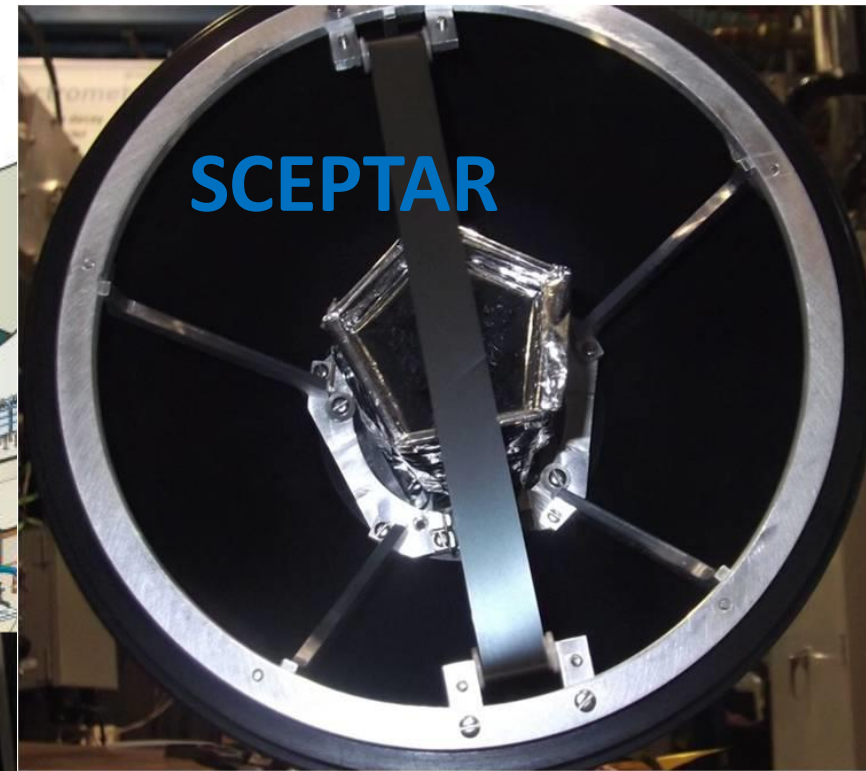
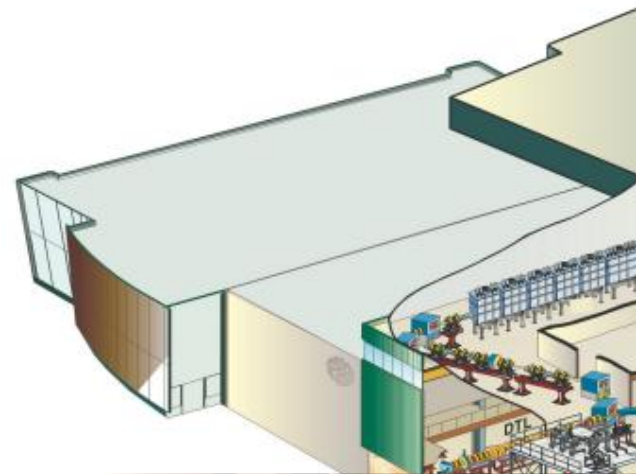


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Experiment

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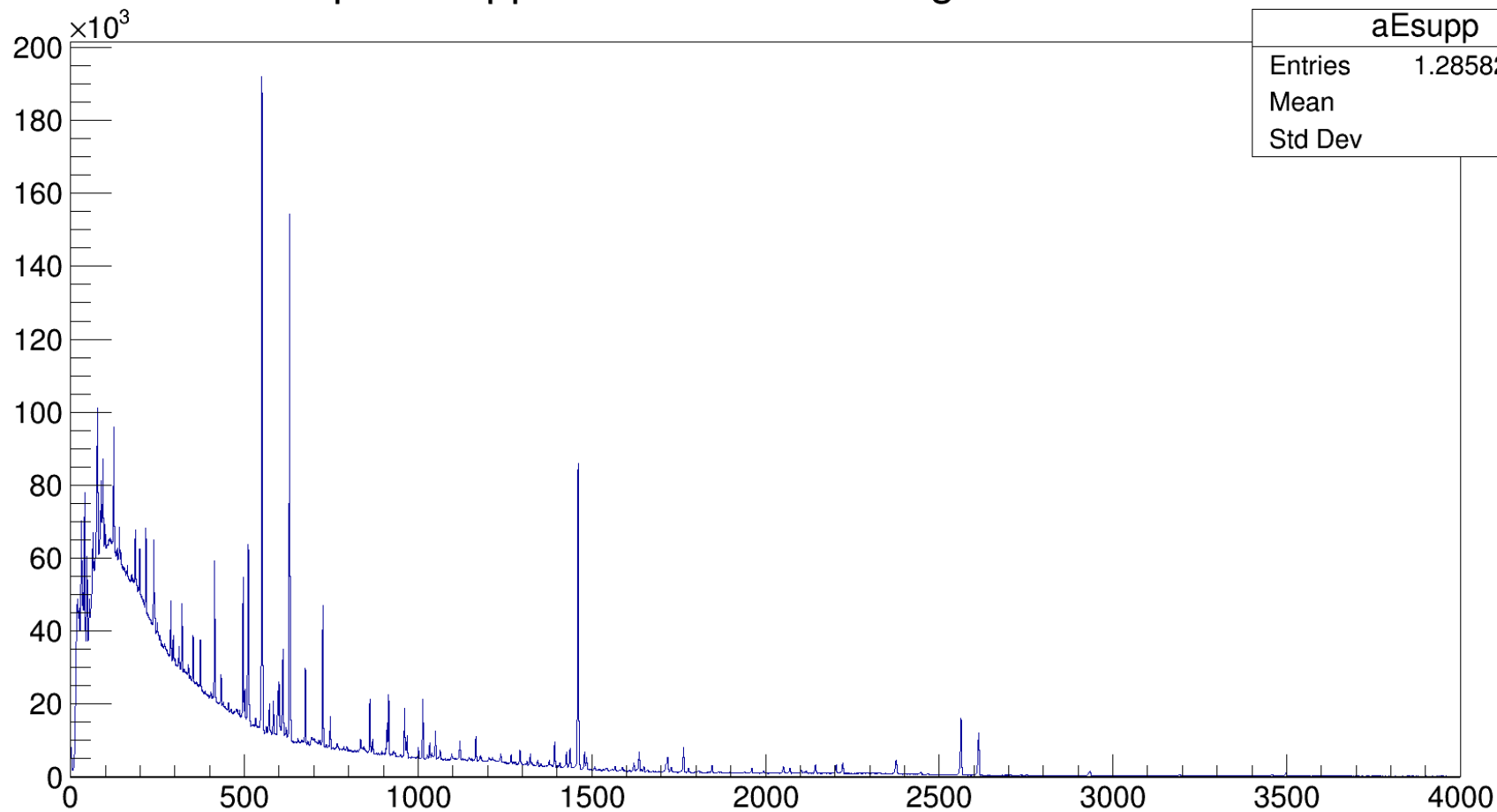


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Experiment

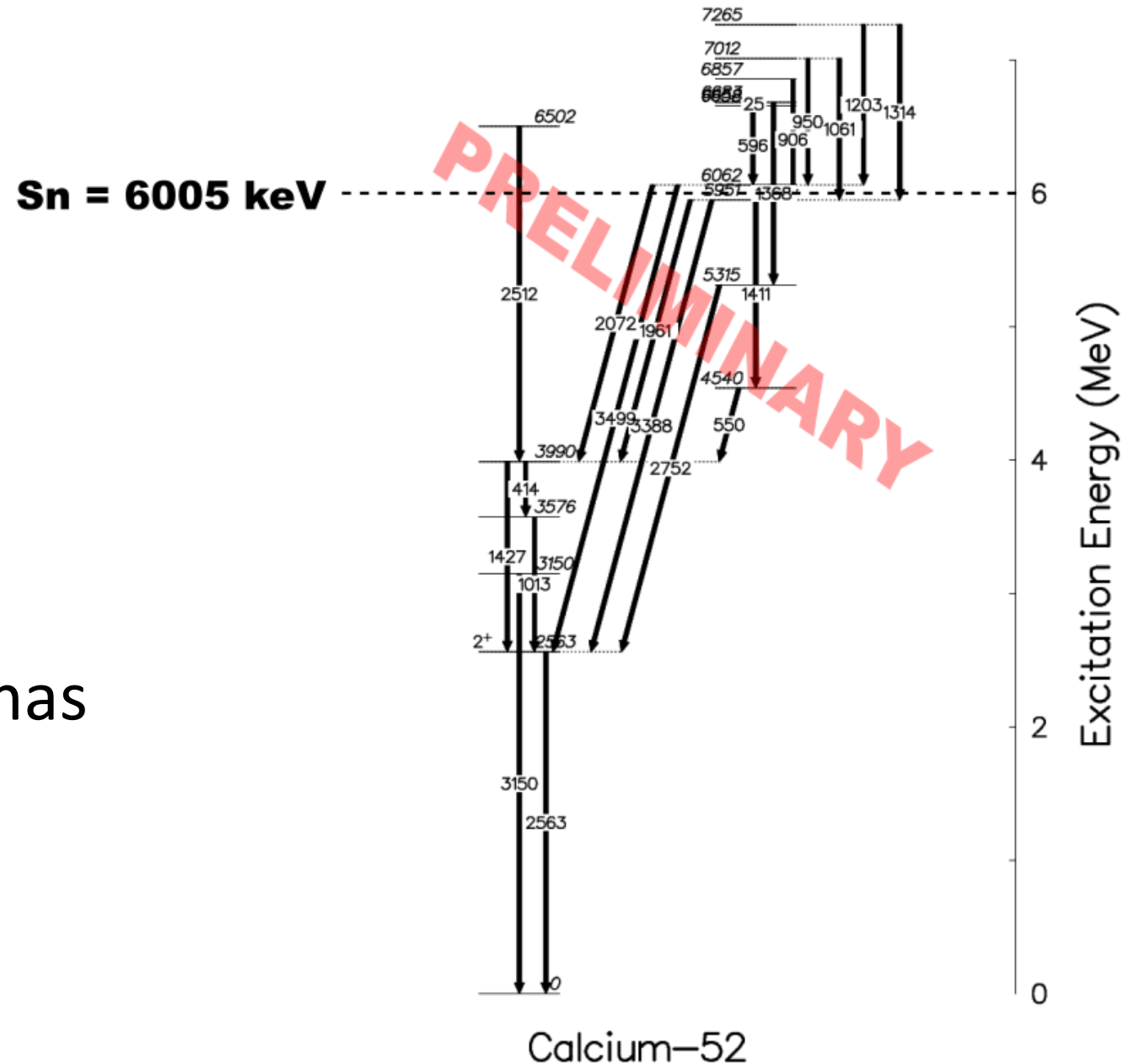
- ^{52}Ca Compton-suppressed Gamma spectrum
 - Following 48 hrs of ~ 300 pps

Compton Suppressed Addback Singles threshold 200



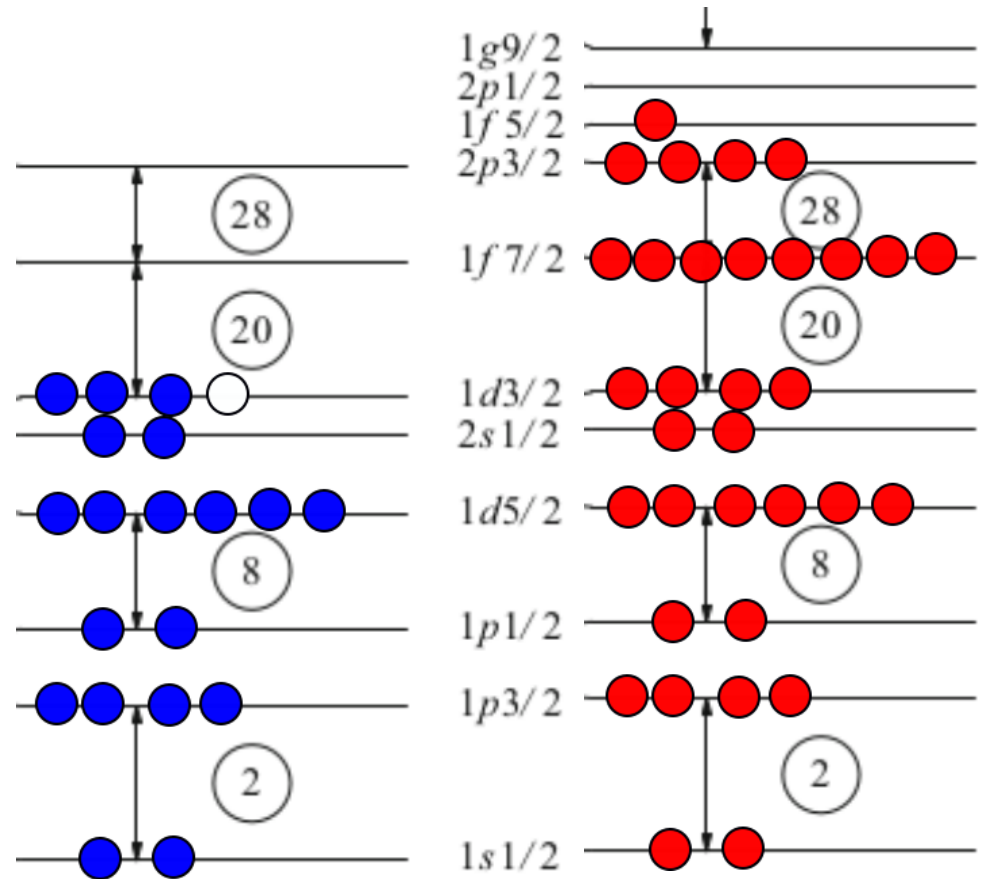
Preliminary Results

- Preliminary Level Scheme
 - 14 Levels
 - 10 New
 - 21 Transitions
 - 16 New
- States 2MeV above the Neutron Separation energy has been observed previously in Ni70 [1]



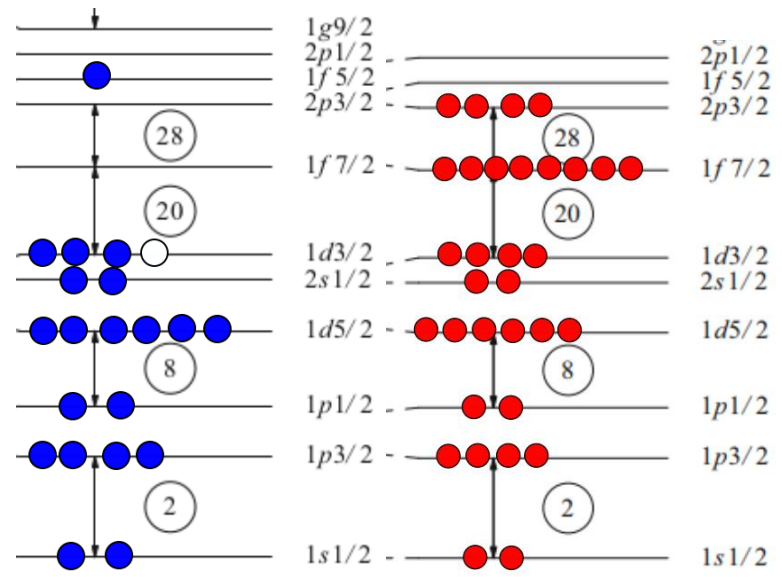
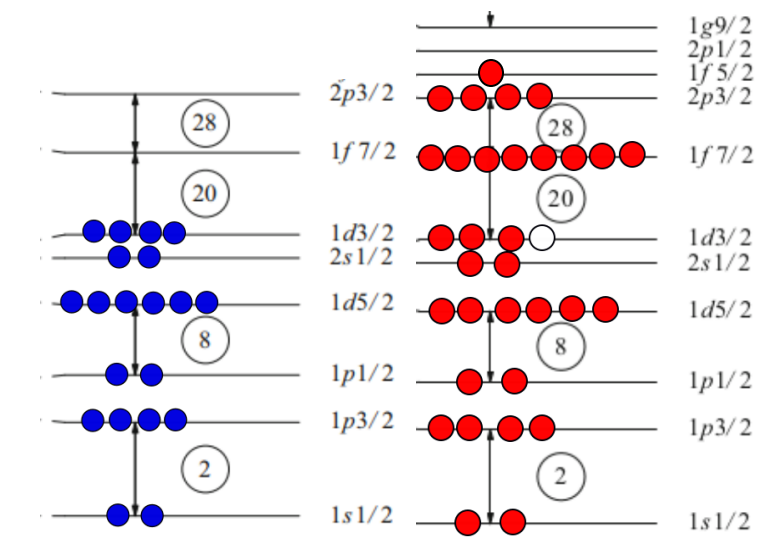
[1] A. Spyrou et al., PRL 117, 142701 (2016)

Preliminary Results



52K

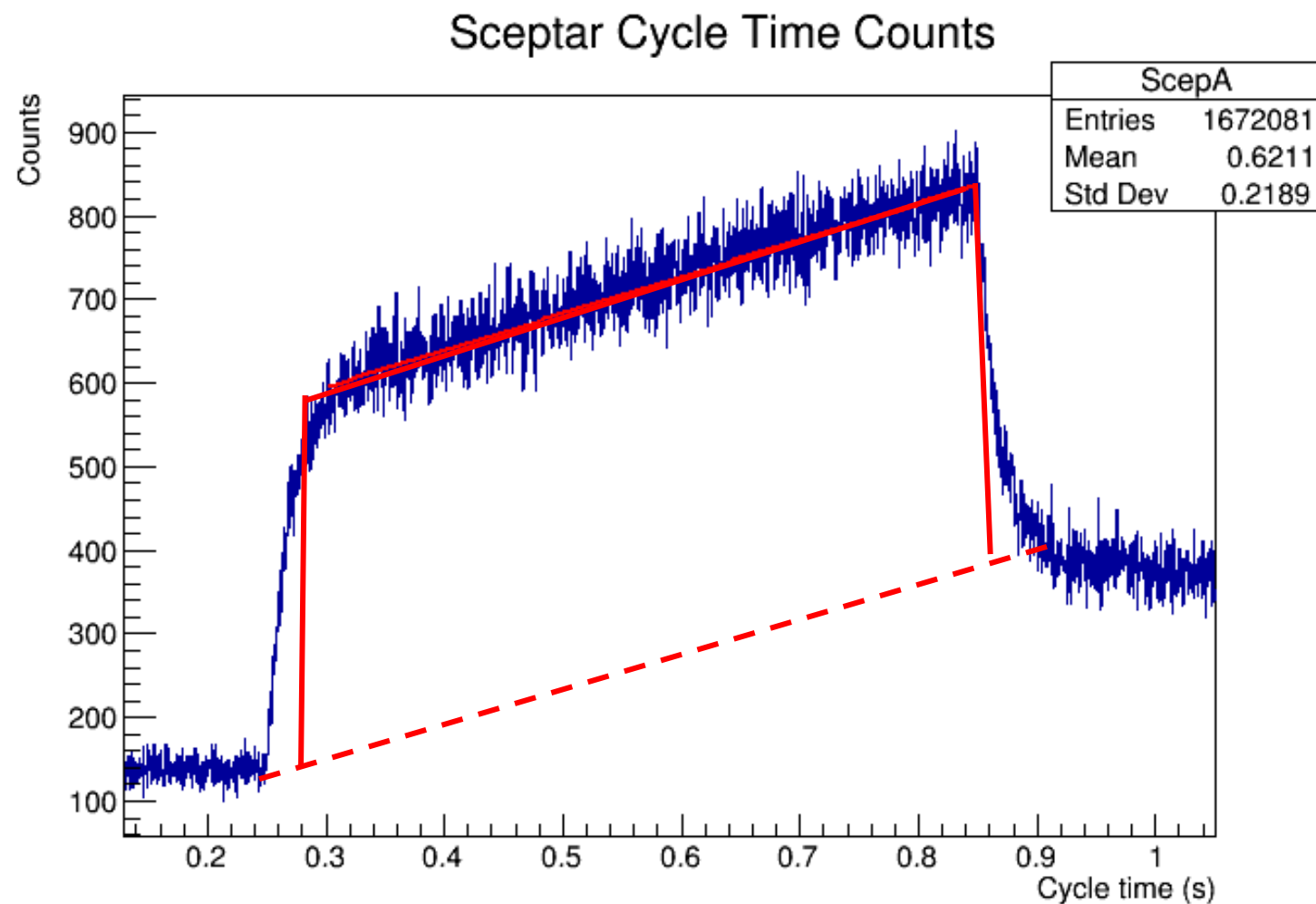
Allowed Beta



PRELIMINARY RESULTS

- Measurement of gamma branching ratio
- Gamma- Efficiency
- N-Counts
- I-Intensity

$$\frac{\Gamma_{\gamma}}{\Gamma_{\beta}} \frac{N_{\gamma}}{N_{\beta}} = I_{\gamma}$$



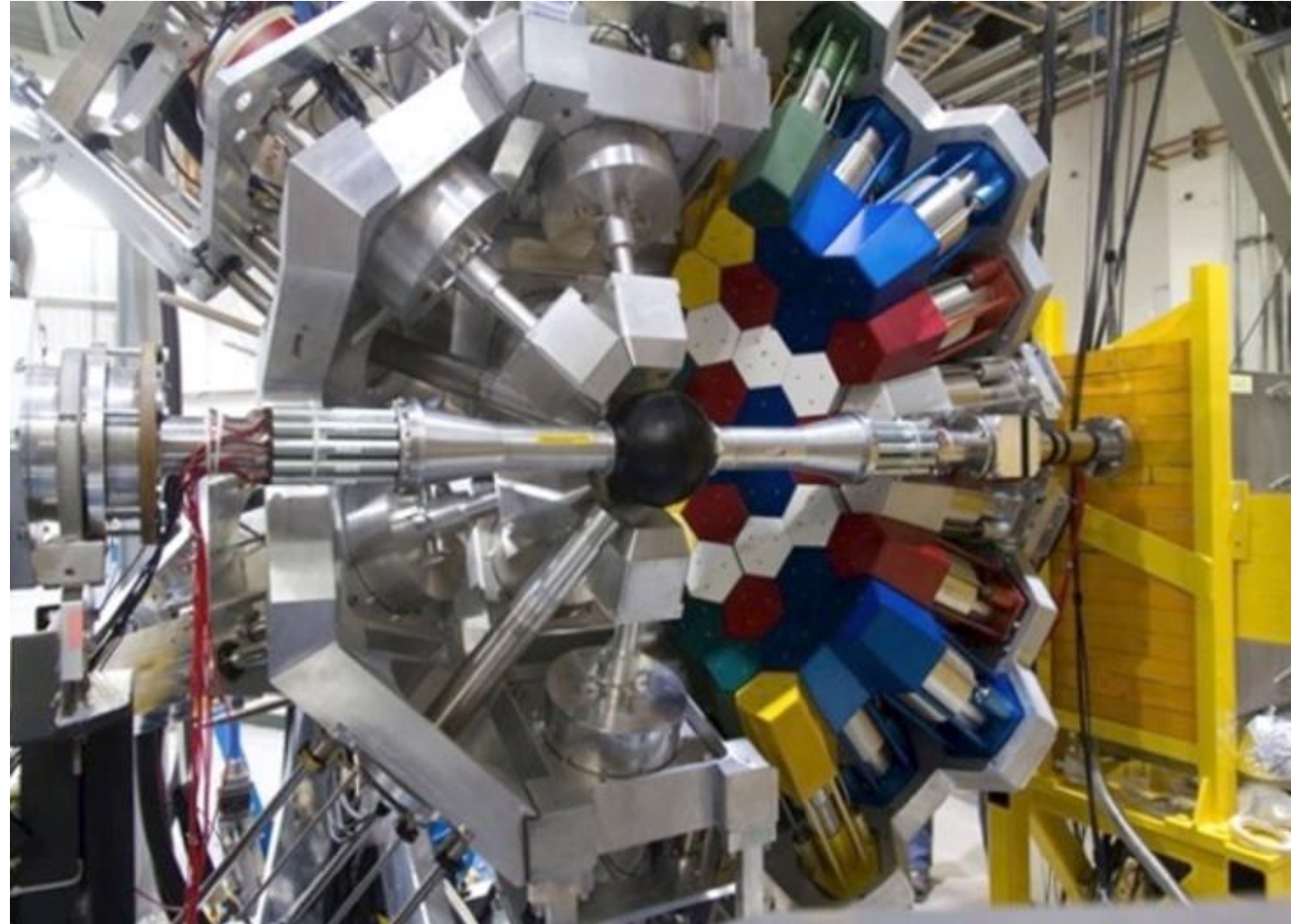
PRELIMINARY RESULTS

- Comparison to previous work
- Previously deduced from emitted neutron energies
- Currently measured through gamma cascades

Neutron Excitation Energy (keV)	Neutron Intensity (%)	Preliminary Gamma Excitation Energy (keV)	Preliminary Gamma Intensity %
		6062	0.66 +/- 0.02
6495+/-20	4.3	6502	1.71 +/- 0.3
		6658	33.0 +/- 0.9
		6683	1.68 +/- 0.01
6855+/-30	6.6	6857	2.77 +/- 0.2
7065+/-40	21.5	7012	10.5 +/- 0.2
7255+/-40	3.1	7265	6.65 +/- 0.05
8245+/-80	12.4		
8465+/- 20	0.7		

FUTURE WORK

- Finalize level Scheme
- Investigate Shell Model Calculations
- Further Data taken in August
 - Explore Ca 52, 53, 54



Collaborators



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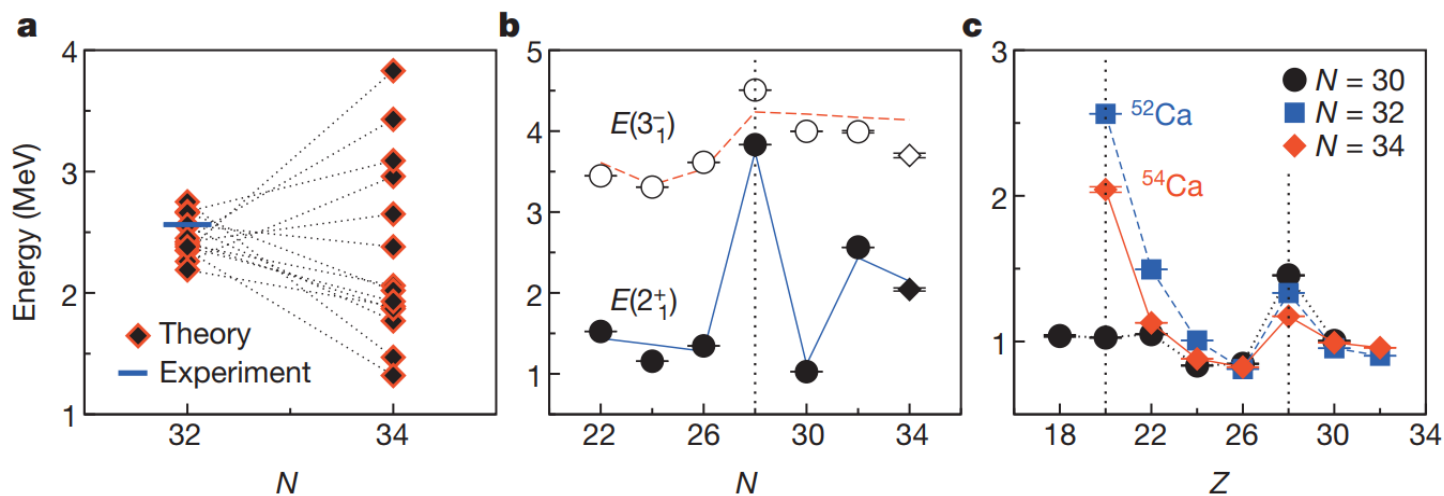


L. Sexton

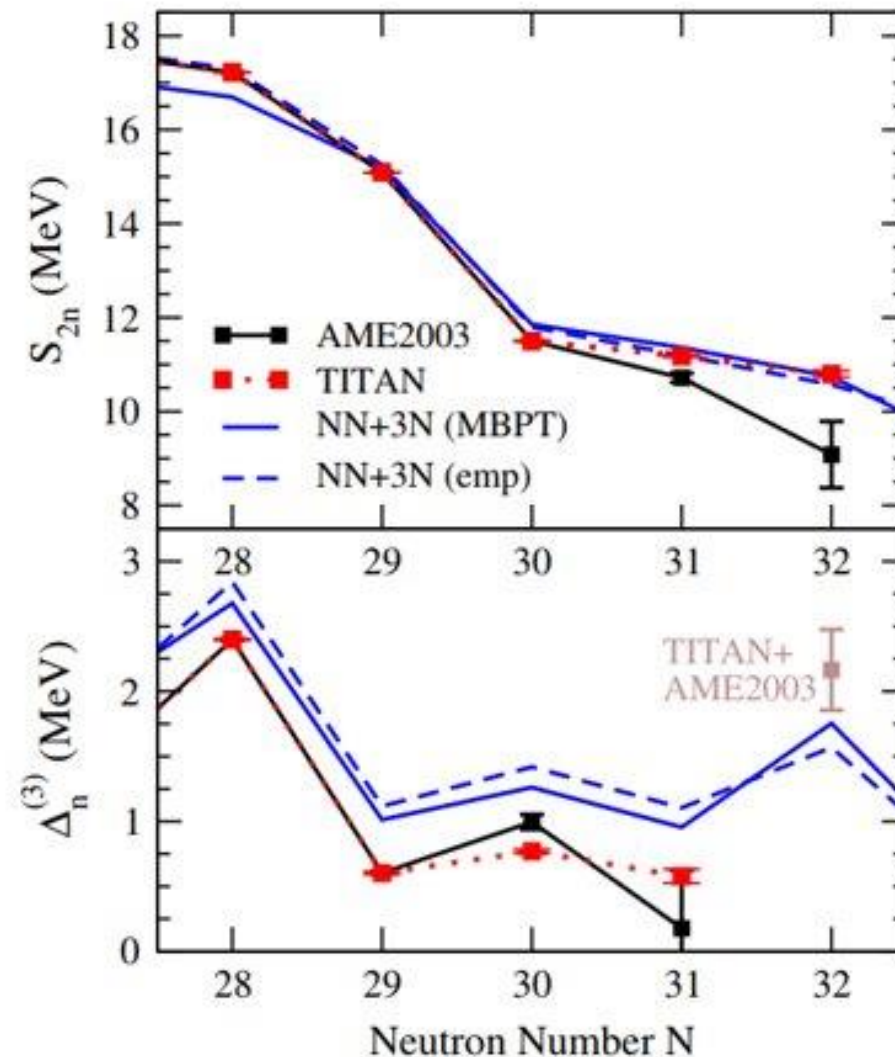
THANK YOU!

Motivation

- Separation Energy
 - Measured at TITAN 2012
- Excitation Energy
 - Measured at RIKEN 2013



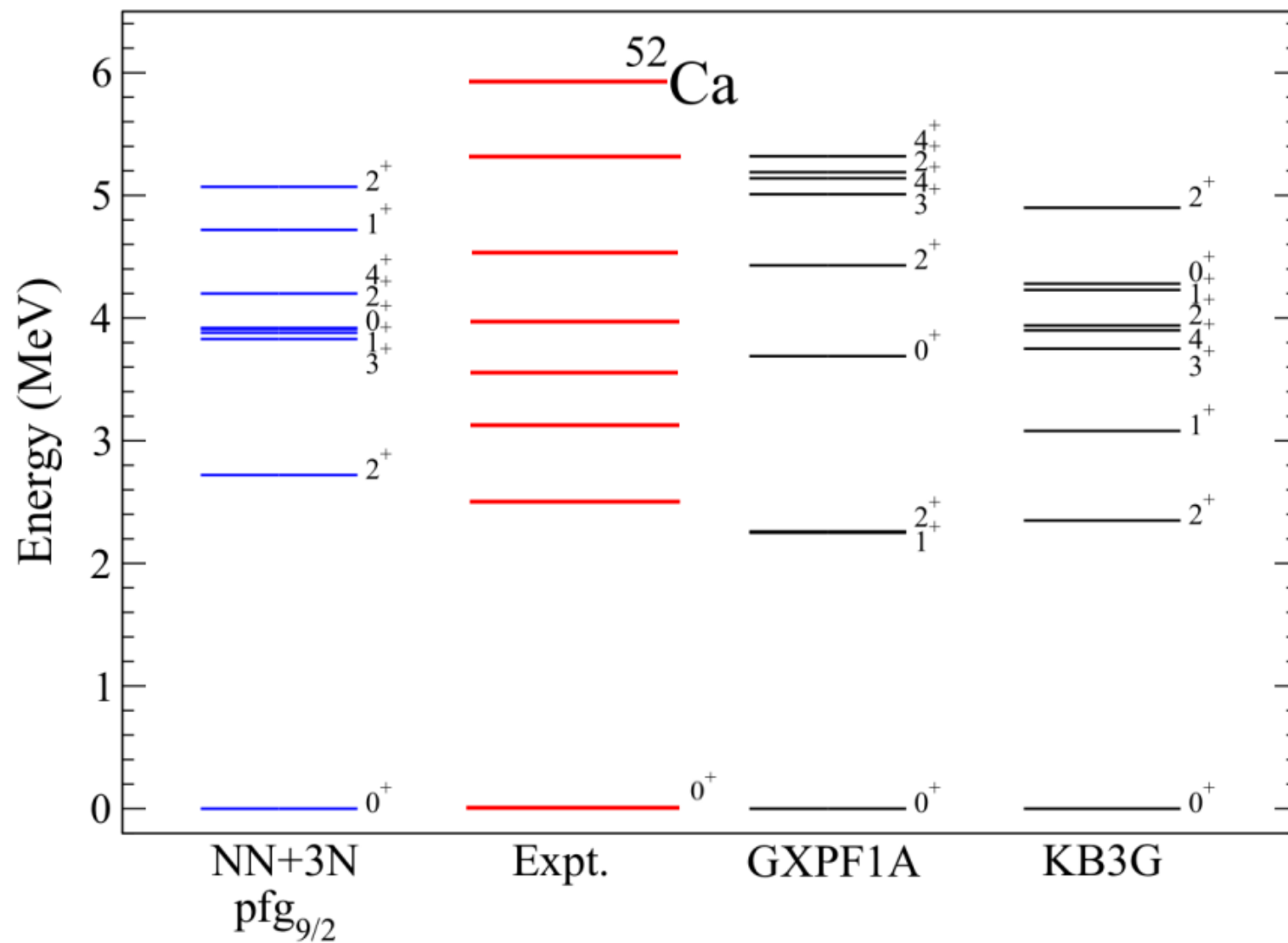
D. Steppenbeck et al., Nature 502, 207 (2013)



A.T. Gallant et al., Phys. Rev. Lett. 109, 032506 (2012)

PRELIMINARY RESULTS

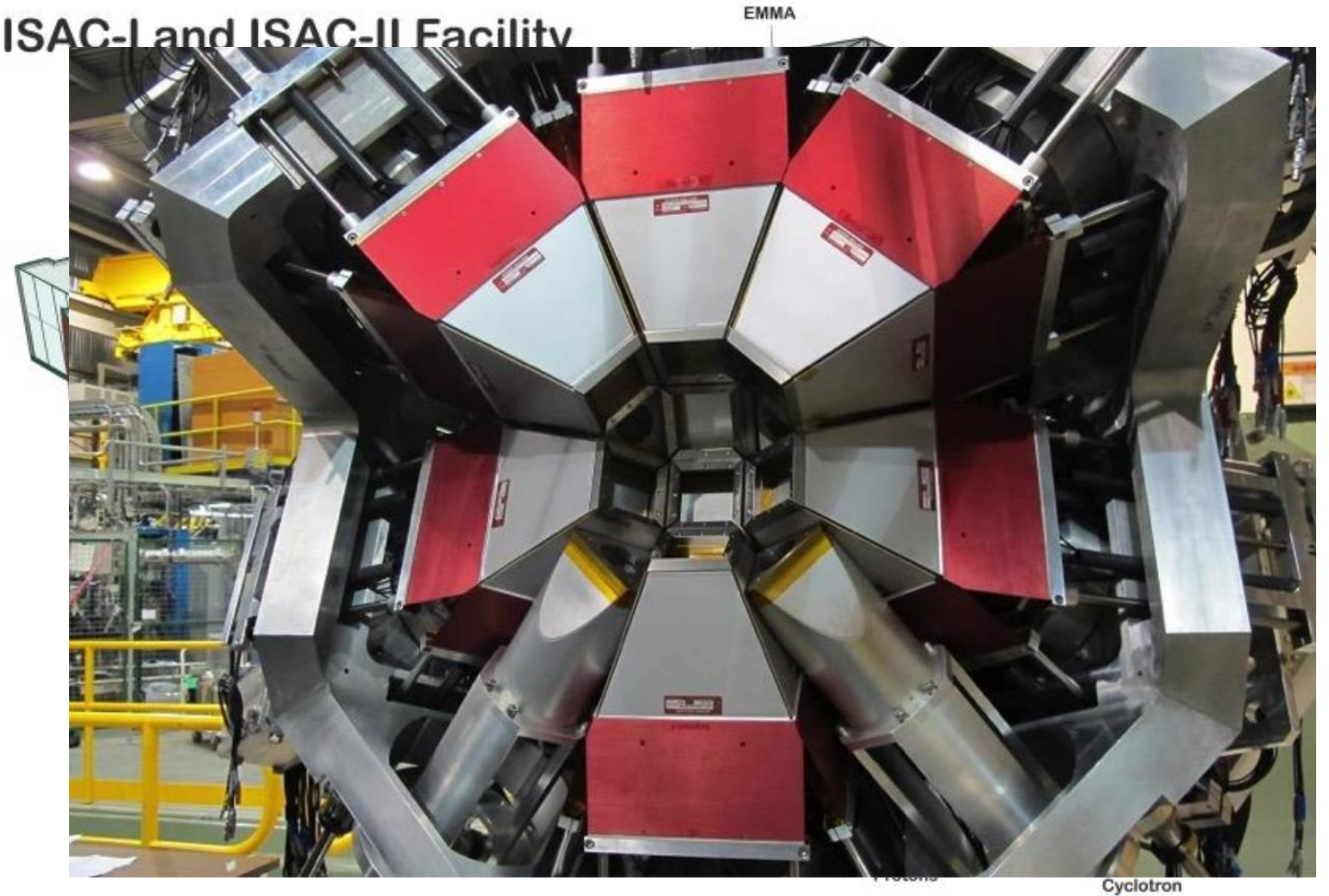
- Comparison to Shell model calculations



Experiment

- GRIFFIN
 - Gamma-Ray Infrastructure For Fundamental Investigations of Nuclei

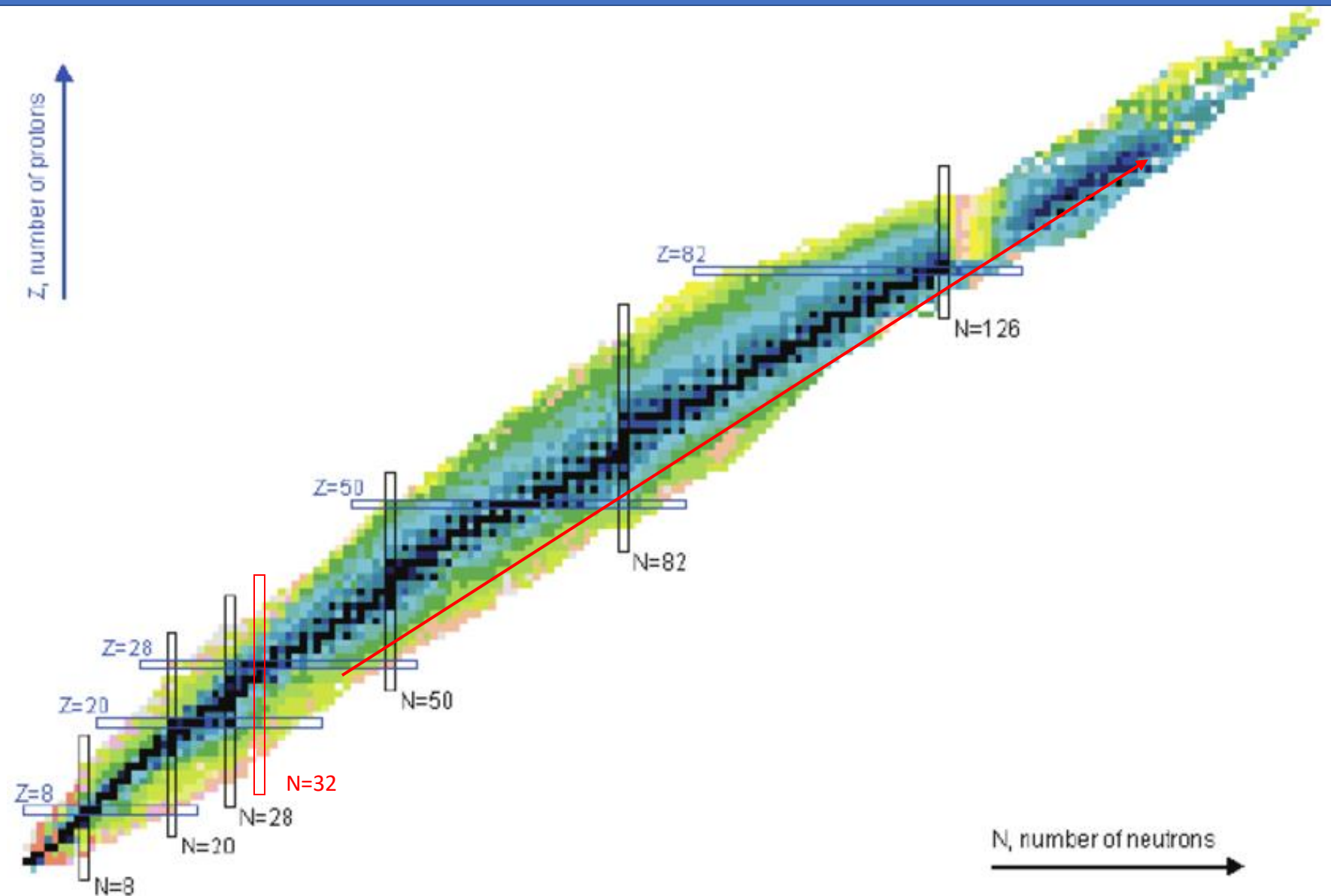
ISAC-I and ISAC-II Facility



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Motivation

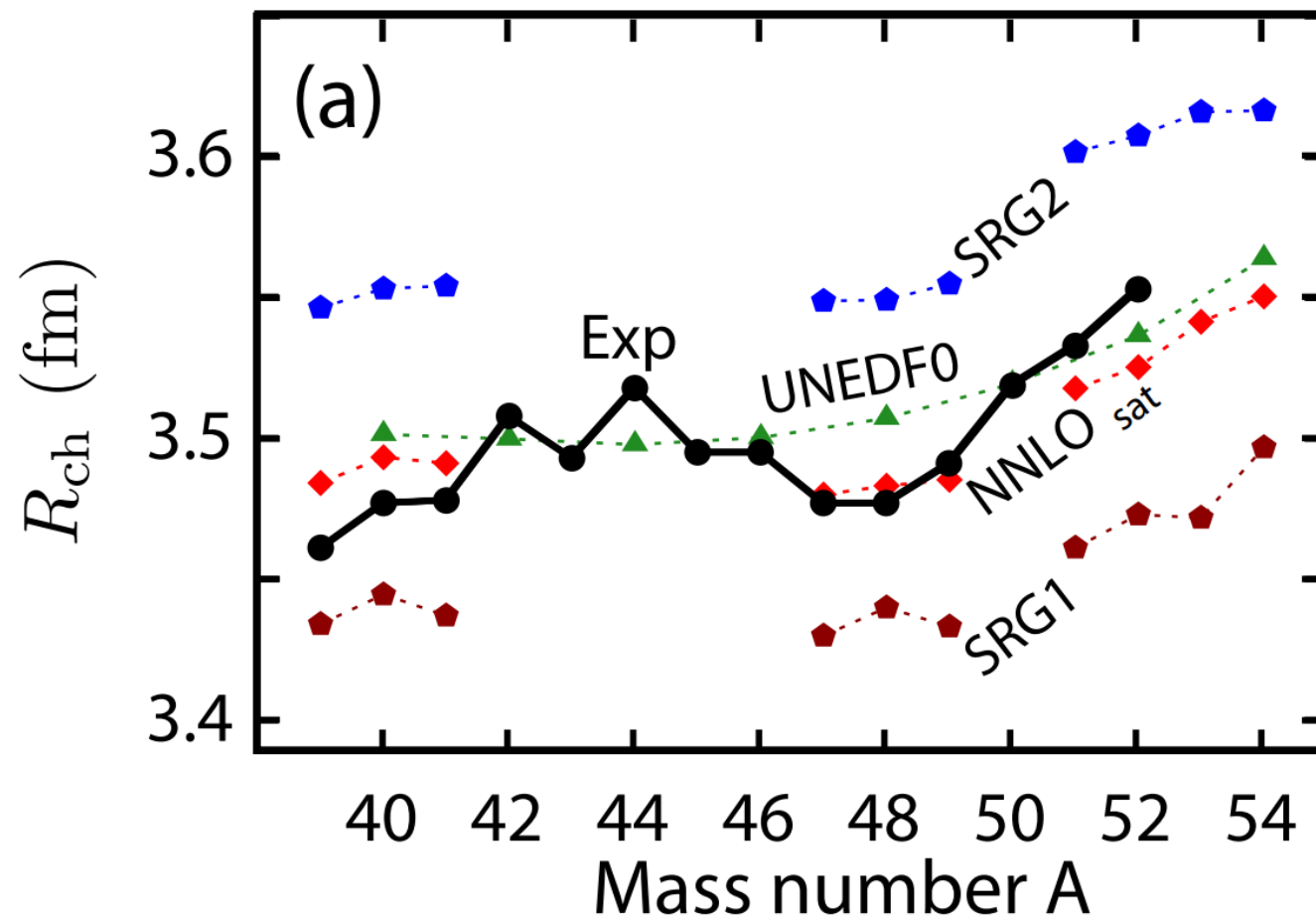
- R-Process
 - Rapid capture of Neutrons
 - Synthesis depends on Stability
 - Magic Nuclei



<https://www.nndc.bnl.gov/nudat2/>

FUTURE WORK

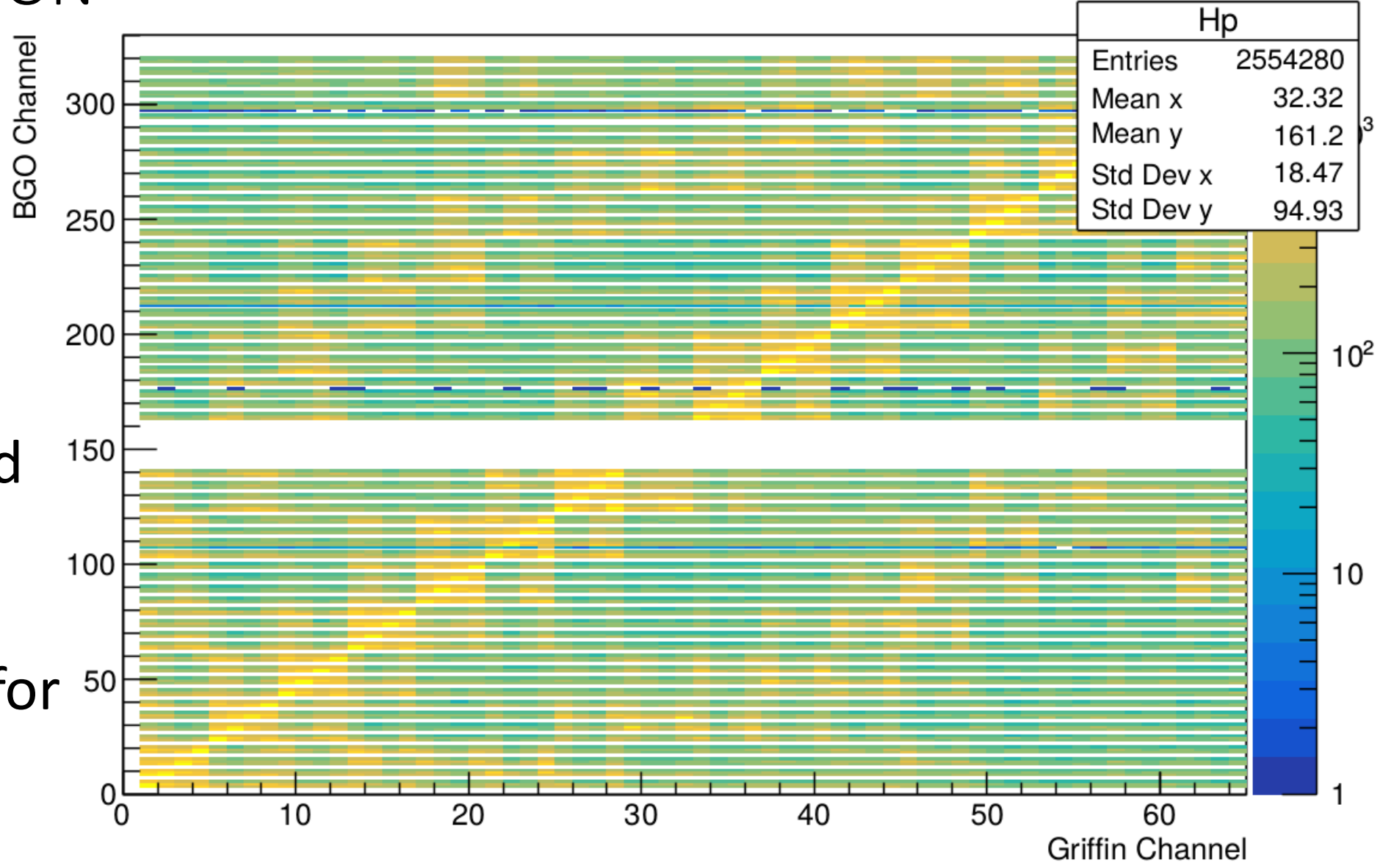
- Charge Radius



arXiv:1602.07906v1 [nucl-ex] 25 Feb 2016

BGO SUPPRESSION

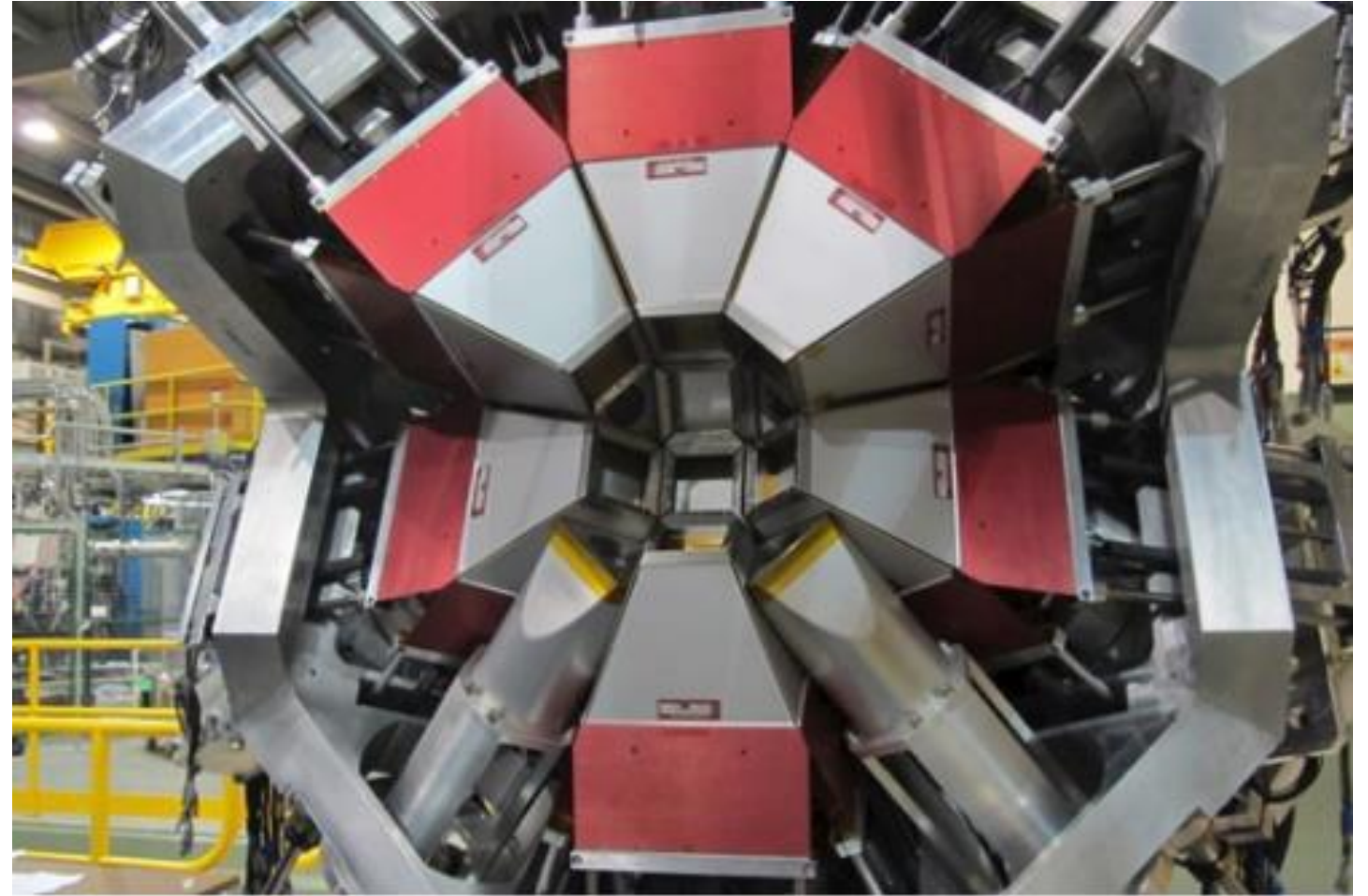
Bgo Griffin Hit Pattern



- Hit Pattern Shows Real and False coincidences
- Threshold Set for event vetoes

BGO SUPPRESSION

- 15 of 16 Clovers had BGO shields installed
- Shields pulled back in configuration



Credit: C. Andreoiu