FLORIDA STATE UNIVERSITY

Nuclear shell evolution & study of exotic nuclei

High resolution γ-ray spectroscopy group

Vandana Tripathi
Graduate Students & Post Doc
NSF Site Visit, John D. Fox Laboratory, Florida State University

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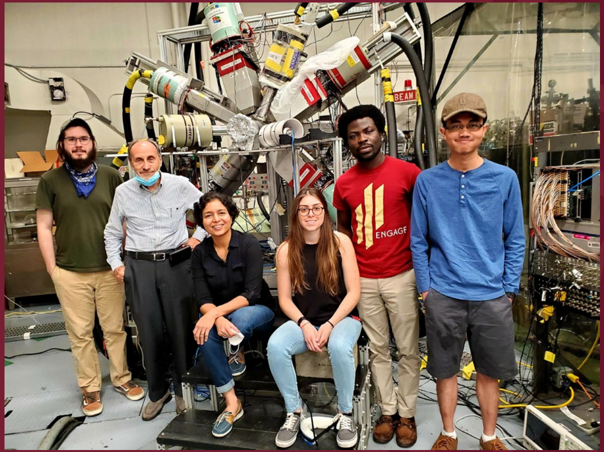
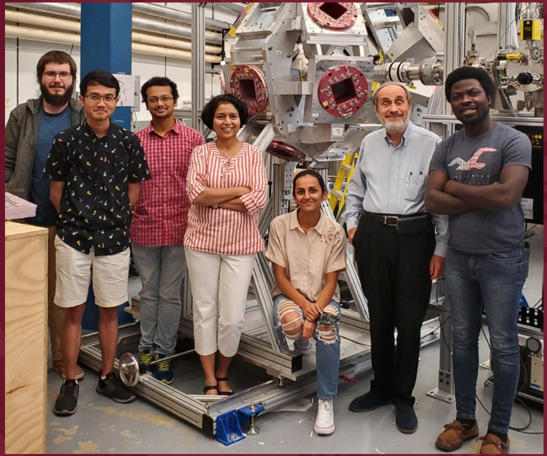
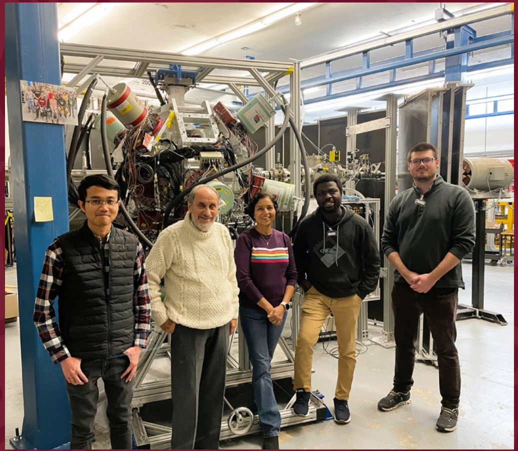
As times passes …



2020

2021





2024

Goals and Plan for 2020-2024

- ❑ Investigating the N=28 shell closure in exotic nuclei
- → beta decay at FRIB
- ❑ Role of occupancy of the g9/2 orbital in fp shell nuclei
- → CLARION2 @FSU (ORNL and FSU collaboration)
- ❑ Analysis: E18016@NSCL; ^{14}C + ^{48,50}Ti @ FSU

Additional space for a title

Selected Publications

Supported by NSF and FSU startup

Details of the work presented can be found in these recent publications:

Phys.Rev. C 109, 014305 (2024)
S.Ajayi*, V.Tripathi, et al., (*GS)
Observation of collective modes of excitations in ^{59}Co, ^{59}Ni, and ^{61} Co and the influence of the $g_{9/2}$ orbital

Phys.Rev. C 107, 054311 (2023)
S.Bhattacharya* V.Tripathi, et al., (*Post Doc)
Coexistence of single-particle and collective excitation in ^{61} Ni

Phys.Rev. C 108, 024312 (2023)
S. Bhattacharya*, V.Tripathi, et al., (*Post Doc)
β- decay of neutron-rich ^{45} Cl located at the magic number N=28

Phys.Rev.Lett. 129, 212501 (2022)
H.L.Crawford, V.Tripathi, et al., (FRIB first paper)
Crossing N = 28 Toward the Neutron Drip Line: First Measurement of Half-Lives at FRIB

Phys.Rev. C 106, 064314 (2022)
V.Tripathi, et al., (NSCL e18016)
β- decay of exotic P and S isotopes with neutron number near 28

Nuclear Inst and Methos in physics Research, A 1041 (2022) 167392 106, 064314 (2022)
T.J. Gray, et al., (CLARION2 commissioning)
CLARION2-TRINITY: A Compton-suppressed HPGe and GAGG:Ce-Si-Si array for absolute cross-section measurements with heavy ions

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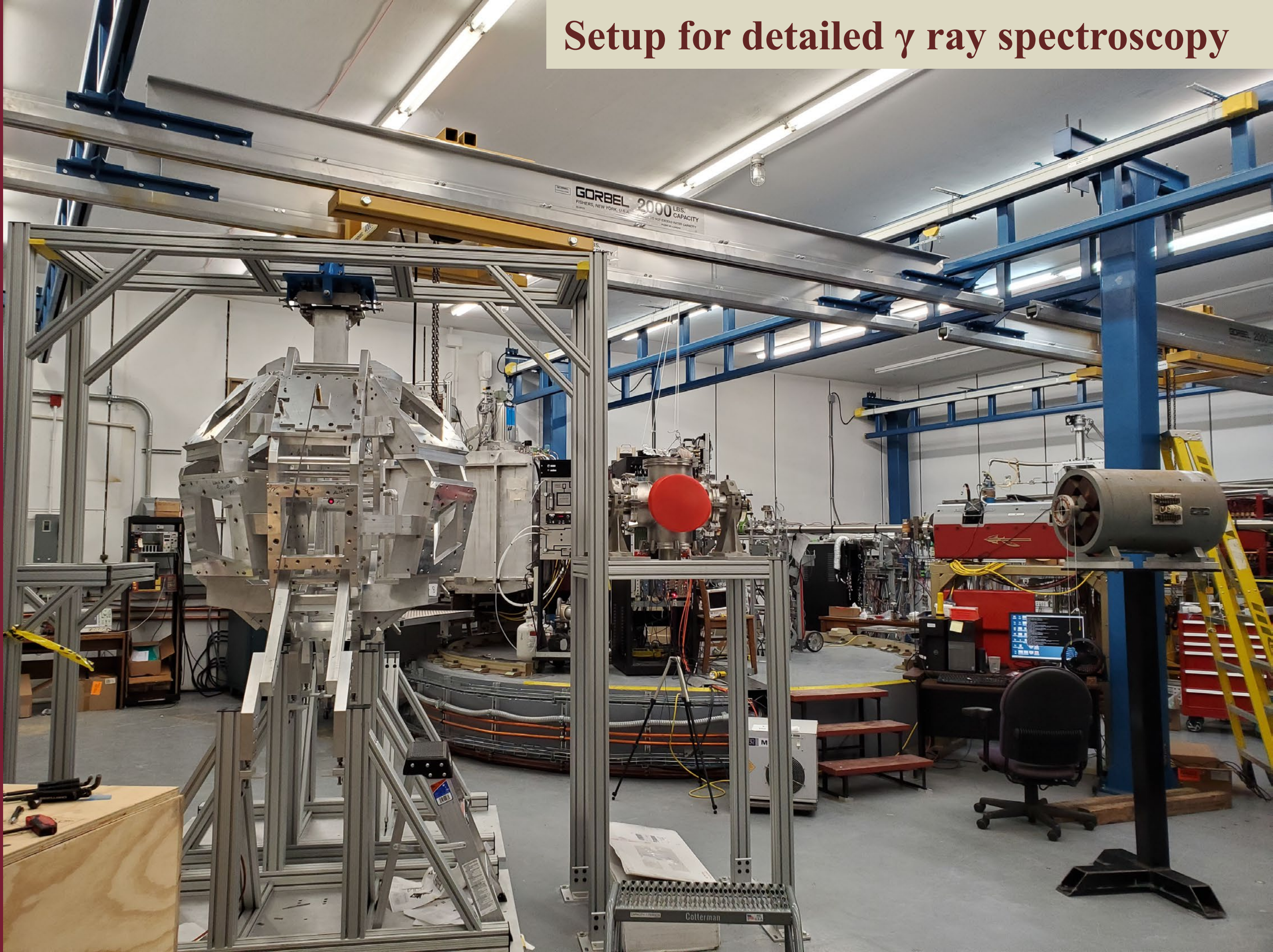
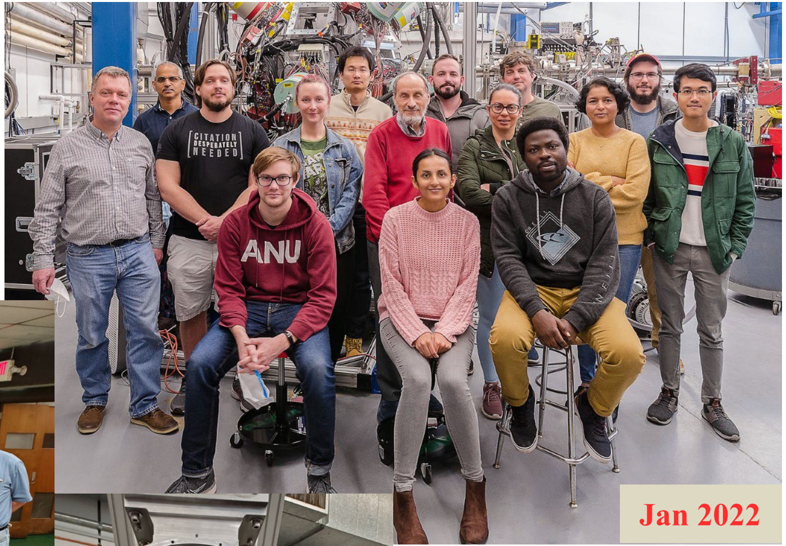
CLARION-2 - TRINITY

An ORNL and FSU collaboration

Setup for detailed γ ray spectroscopy



CLARION2-TRINITY

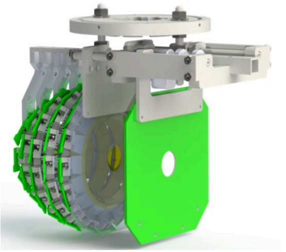


Jan 2022


March 2021


Sept 2021

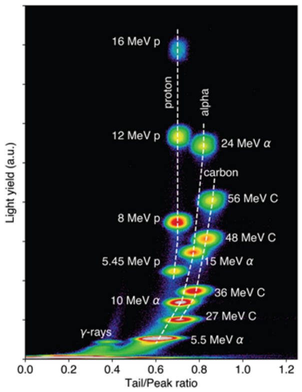

Dec 2021

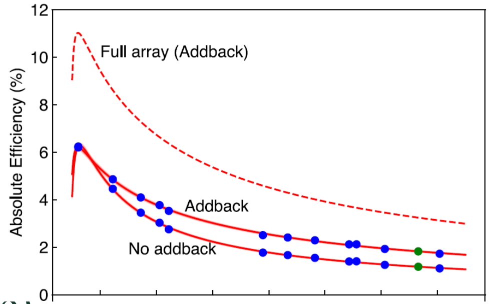


project delayed by a year due to covid

CLARION2-TRINITY: 2021/22

- CLARION2 is an array of 16 CS HPGe clovers (ORNL,FSU,++), ~4% @ 1 MeV
- $LaBr_3$/$CeBr_3$ detector options from UTK, UNC, Miss.U (Ben Crider)
- TRINITY charged-particle detector (GAGG-Si-Si) and other possibilities
- GAGG:Ce-SiPM component of TRINITY has PID by PSD and can count at 40 kHz / xtl
- Digital data acquisition (PIXIE)
- **Commissioning in Dec2021 (NIMA Published)**
- **First campaign completed Dec 2021 – June 2022 (ORNL,FSU)**
- 9 clovers (6 ORNL + 3 FSU); 3 rings of GAGG detector
- 10^{th} Clover added in 2023 (FSU)
- 1 BeGe to be added in 2024 (Robert Haring Kaye, Westmont College)
- 2 more of rings of GAGG (ORNL) in 2024
- Request for 2 S2 type annular Si detectors in this proposal





LECM -2022 summary

Invitation to the community to collaborate

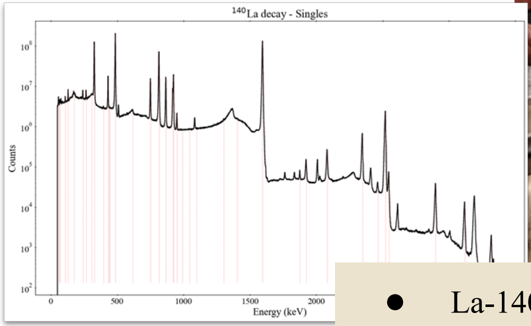
γ-ray Spectroscopy with CLARION2 @ FSU

Tuesday at 10:20 pm EST, August 9, 2022 – Vandana Tripathi and Mitch Allmond
~40 in attendance

Brookhaven National Laboratory

Contributed talks (Topics from Nuclear Structure to Astrophysics)

- ✓ I. Wiedenhoever (FSU)
- ✓ Tim Gray (ORNL)
- ✓ Bob Kaye (Westmont)
- ✓ Ram Yadav (SCSU)
- ✓ Peter Bender (UML)
- ✓ Sergio Almaraz (FSU)
- ✓ Libby Richard-McCutchan (BNL)
- ✓ Catur Wibisono (FSU)
- ✓ Rebeka Lubna (FRIB-MSU)
- ✓ Scott Marley (LSU)
- ✓ Soumik Bhattacharya (FSU)
- ✓ Ben Crider (MSU)



- La-140 is a well-known chronometer used to date a nuclear event. Decay data based on work from 1990.
- 100µCi ^{140}La source produced at UMass Lowell Research Reactor (^{nat}La(n,γ)) - measured for 4 Half-lives at FSU using Clarion2

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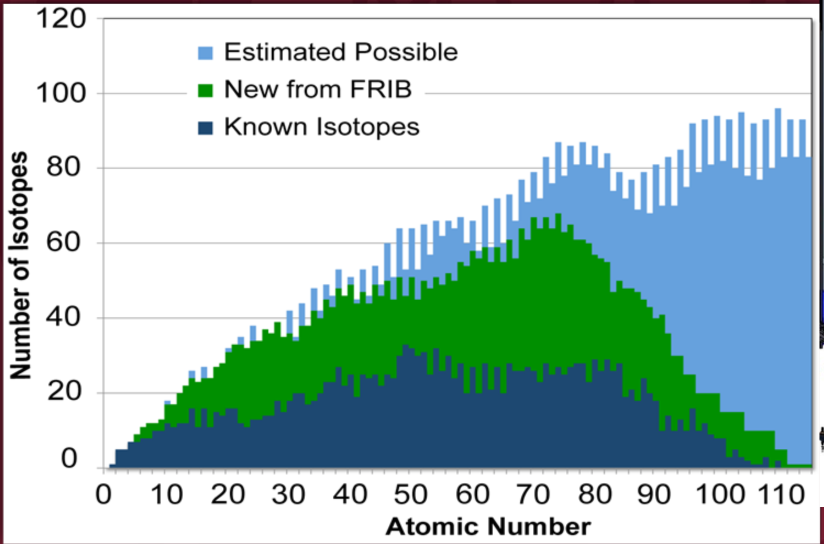
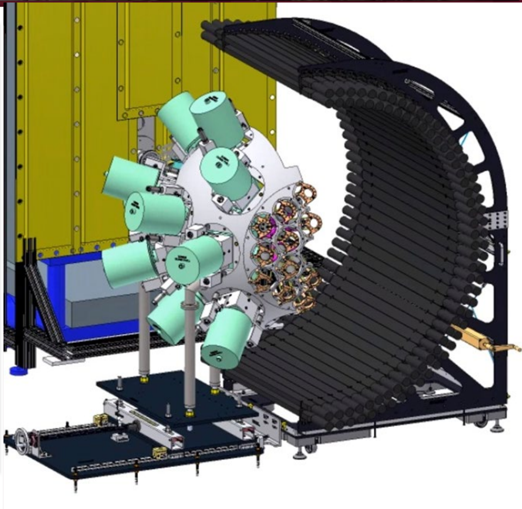
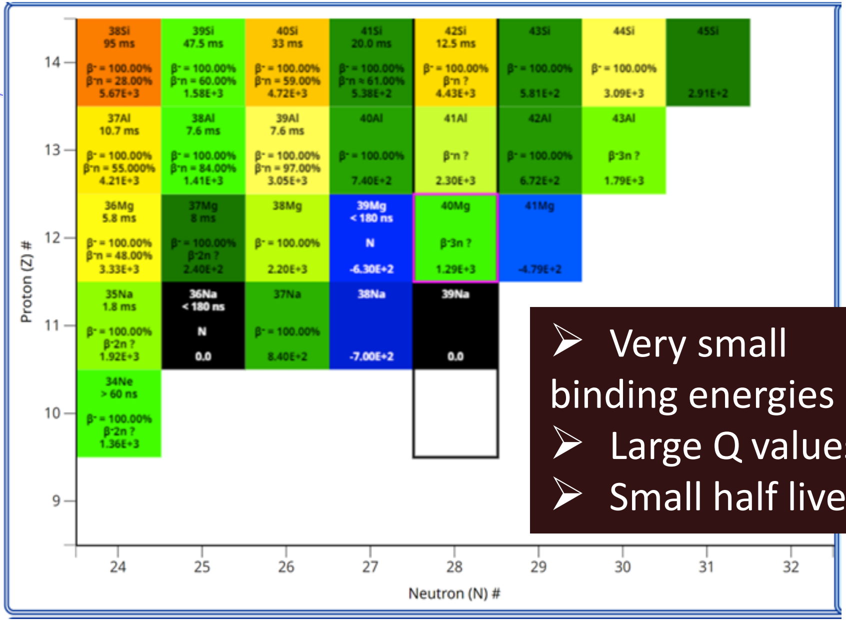
FRIB: FDSi

Day 1 Experiment

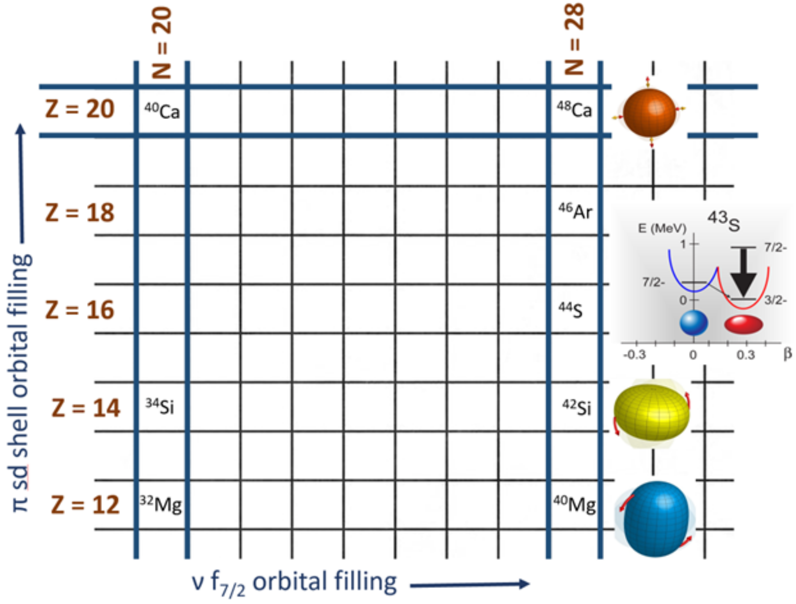




FRIB PAC1: E21062 Motivation



- Very small binding energies
- Large Q values
- Small half lives



- Exotic Na-P isotopes with N~28
- Limited experimental information
- Refinement of theoretical predictions

- Evolution of proton and neutron SPE as a function of increasing neutron excess
- Understanding emergent collective phenomenon and shape changes
- Understanding β delayed neutron emission in these very neutron rich nuclei

FRIB day 1 experiment : E21062

Allmond, James (Mitch); Crawford, Heather; Crider, Benjamin; Grzywacz, Robert; Tripathi, Vandana	Decay Spectroscopy Near N=28: Shell Structure, Shapes and Weak Binding

Lansing State Journal

NEWS

The first experiment at MSU's FRIB is Wednesday. Here's what scientists hope to learn.

Mark Johnson
Lansing State Journal

Published 9:42 p.m. ET May 9, 2022

EAST LANSING — Michigan State University believes its Facility for Rare Isotope Beams will unlock the door to new discoveries — and scientists could find the first key this week.

Though the FRIB officially opened last Monday, smaller lead-up experiments have been underway for months. However, Wednesday is the first time scientists will blast a particle beam from FRIB's 400-kilowatt linear accelerator at full power. When that beam collides with a target element — say, magnesium or aluminum — the element's protons and neutrons break apart, forming new variations called isotopes. The rare variations of those isotopes are what the FRIB will unlock.

DOE Office of Science @does... · 11h
"What I am most excited about @FRIBLab is the dive into the unknown which may present some unanticipated results." - Vandana Tripathi @floridastate, who has been chosen as a Visiting Scholar Program for Experimental Science: frib.msu.edu/news/2022/2022...

frib.msu.edu/news/2022/2022...

- The first FRIB experiment to run in the first week of May 2022
- Expect 1 kW of power
- Complete FDSi setup

The first experiment at MSU's FRIB is Wednesday. Here's what scientists hope to learn.

A team of scientists from around the country will conduct the first experiment at Michigan State's ...

Lansing State Journal on MSN.com · 22h

FRIB day 1

PHYSICAL REVIEW LETTERS **129,** 212501 (2022)

Editors' Suggestion | Featured in Physics

Crossing $N = 28$ Toward the Neutron Drip Line: First Measurement of Half-Lives at FRIB

H. L. Crawford,[1,*] V. Tripathi,[2] J. M. Allmond,[3] B. P. Crider,[4] R. Grzywacz,[5] S. N. Liddick,[6,7] A. Andalib,[6,8] E. Argo,[6,8] C. Benetti,[2] S. Bhattacharya,[2] C. M. Campbell,[1] M. P. Carpenter,[9] J. Chan,[5] A. Chester,[6] J. Christie,[5] B. R. Clark,[4] I. Cox,[5] A. A. Doetsch,[6,8] J. Dopfer,[6,8] J. G. Duarte,[10] P. Fallon,[1] A. Frotscher,[1] T. Gaballah,[4] T. J. Gray,[3] J. T. Harke,[10] J. Heideman,[5] H. Heugen,[5] R. Jain,[6,8] T. T. King,[3] N. Kitamura,[5] K. Kolos,[10] F. G. Kondev,[9] A. Laminack,[3] B. Longfellow,[10] R. S. Lubna,[6] Luitel,[4] M. Madurga,[5] R. Mahajan,[6] M. J. Mogannam,[6,7] C. Morse,[11] S. Neupane,[5] A. Nowicki,[5] T. H. Ogunbek... J. Ong,[10] C. Porzio,[1] C. J. Prokop,[12] B. C. Ras... Schaedig,[6,8] D. Seweryniak,[9] K. Siegl,[5] M. Sin...

[1]Nuclear Science Division, Lawrence Be...
[2]Department of Physics, Florid...
[3]Physics Division, Oak Ridge Na...
[4]Department of Physics and Astronomy, Miss...
[5]Department of Physics and Astronomy...
[6]Facility for Rare Isotope Beams, Mic...
[7]Department of Chemistry, Michig...
[8]Department of Physics and Astronomy, ...
[9]Argonne National ...
[10]Lawrence Livermore Natio...
[11]Brookhaven Nationa...
[12]Los Alamos National La...
[13]Department of Physics and Astronomy, ...

(Received 19 July 2022; acce...

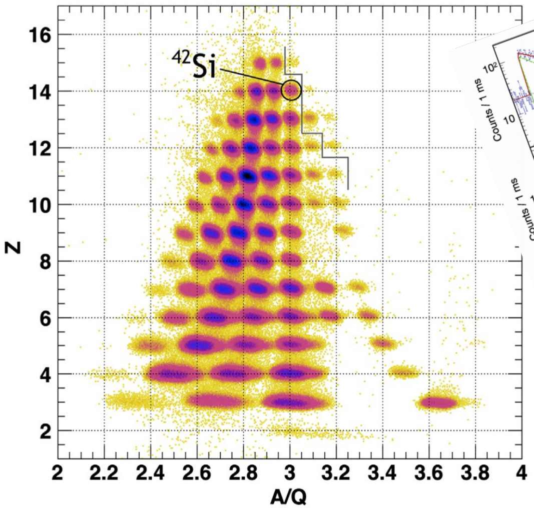


FIG. 1. Particle identification plot for the cocktail of heavy ions delivered to the FDSi in the present experiment. Z was determined based upon the energy loss in the upstream PIN detector(s), while the A/Q is derived from $B\rho$ and the time of flight as described in the text. The five newly measured half-lives are to the right of the solid gray line from $Z = 12$–15.

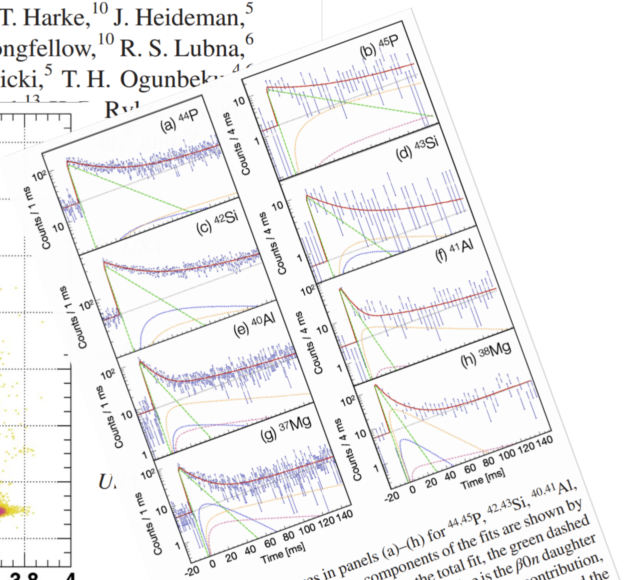


FIG. 2. Decay curves in panels (a)–(h) for ^{44,45}P, ^{42,43}Si, ^{40,41}Al, and ^{37,38}Mg respectively. The components of the fits are shown by the curves, where the solid red line is the total fit, the green dashed curve is the parent decay, the dot-dash blue line is the $\beta 0n$ daughter contribution, the dot-dot-dash orange line is the $\beta 1n$ contribution, the dot-dot-dot-dash magenta line is the $\beta 2n$ contribution, and the dotted gray line is the constant background. The derived half-lives are included in Table I.

Publications

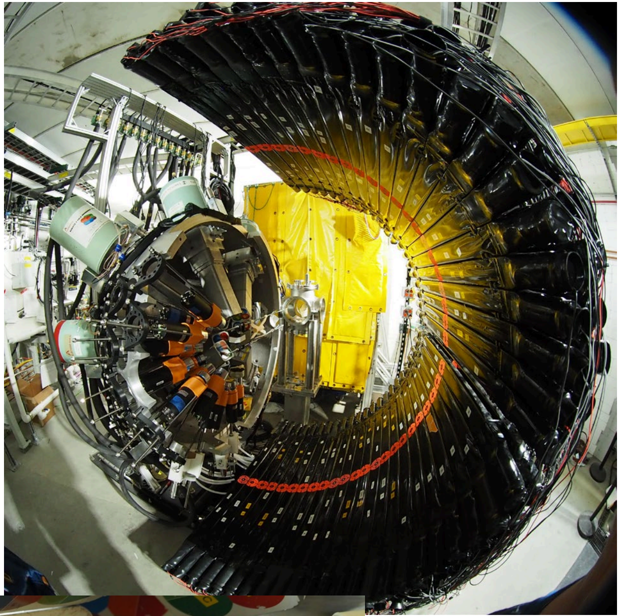
Crawford, H.L., *et al.*, Crossing N=28 Toward the Neutron Drip Line: First Measurement of Half-Lives at FRIB. *Physical Review Letters* **129**, 212501 (2022). [DOI: 10.1103/PhysRevLett.129.212501]

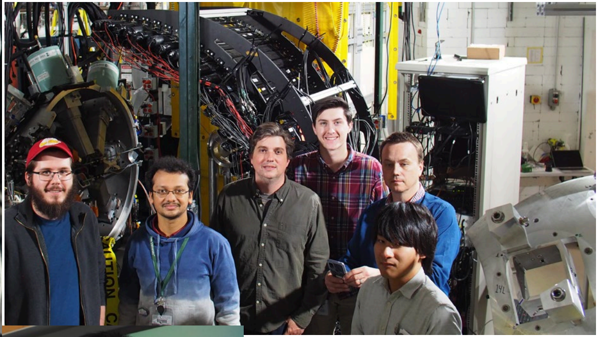
Gray, T., *et al.*, Microsecond Isomer at the N=20 Island of Shape Inversion Observed at FRIB. *Physical Review Letters* **130**, 242501 (2023). [DOI: 10.1103/PhysRevLett.130.242501]

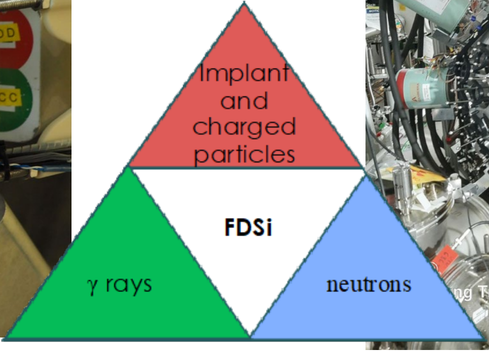
Lubna, R.S., *et al.*, β decay of 36Mg and 36Al: Identification of a β-decaying isomer in 36Al. *Physical Review C* **108**, 014329 (2023). [DOI: 10.1103/PhysRevC.108.014329]

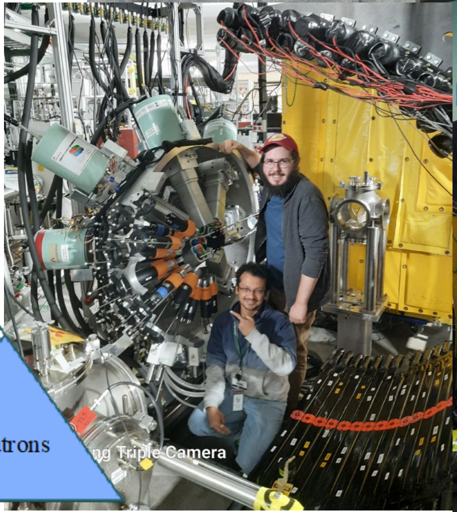
FRIB day1: FSU team was there !

FSU student/PD/faculty/alumnus









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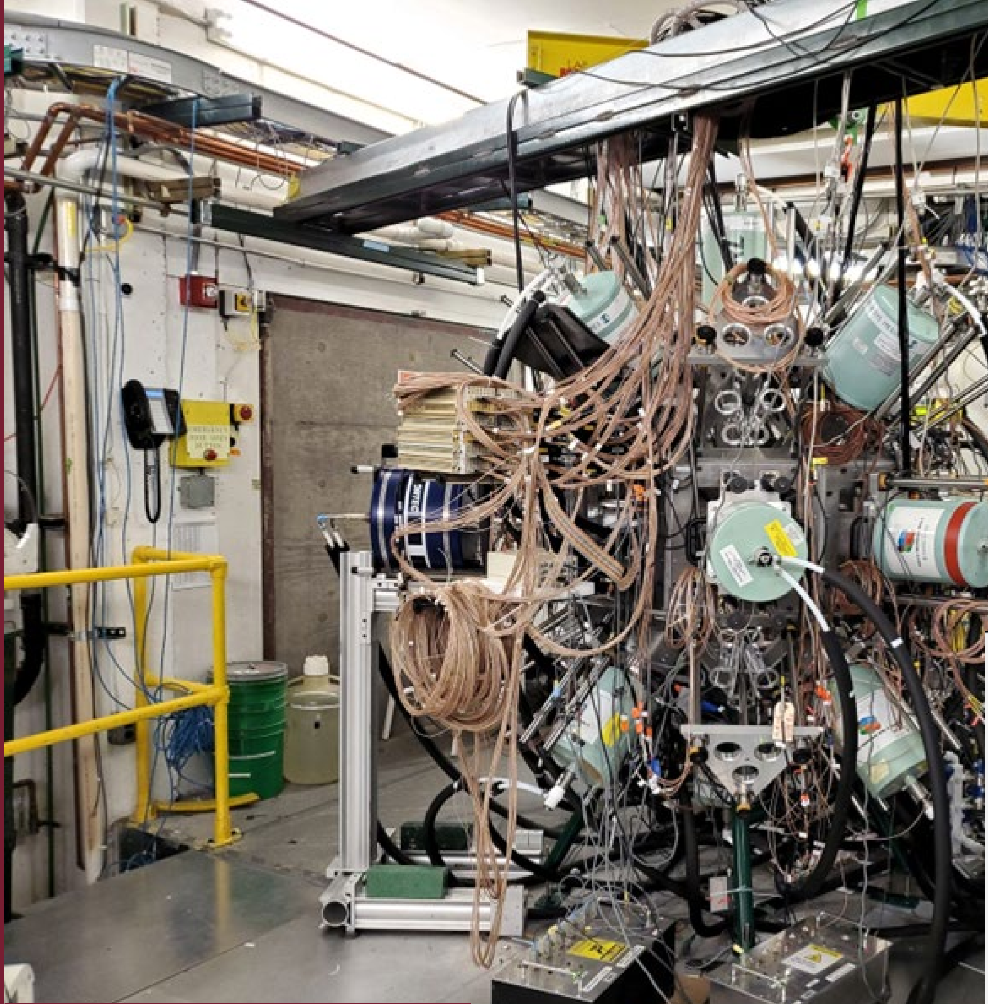
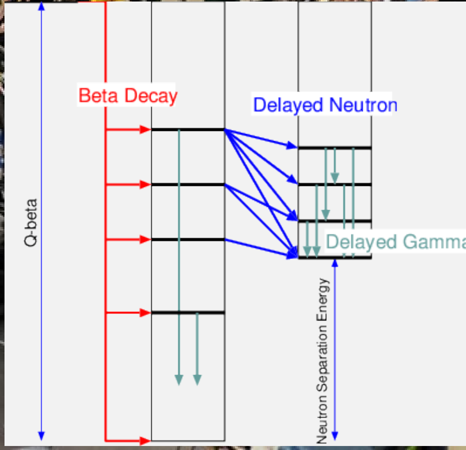
NSCL

Exp 18016: Dec 2019

Analysis and Publication

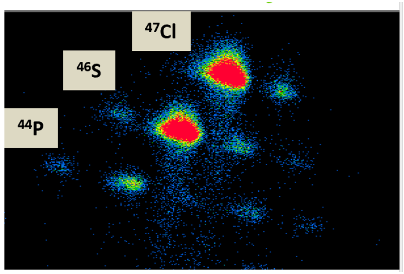


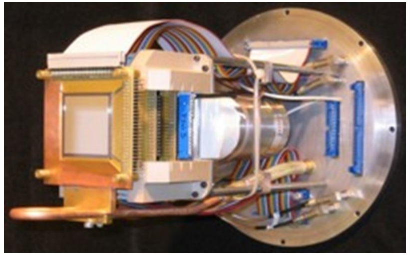
S2 vault @ NSCL



NSCL E18016 : experiment performed in Dec 2019

16 Clovers + Si DSSD as implant detector



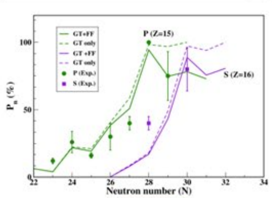


S.B. et al., PRC 108, 024312 (2023)
V.T. et al., PRC 106, 064314 (2022)
V.T. et al., PRC under review
V.T. et al., in preparation

T_z = 11/2, 6, 13/2, 7

Z =	N = 27	N = 28	N = 29	N = 30
17		^{45}Cl $T_{1/2}$ = 513(36) ms	^{46}Cl $T_{1/2}$ = 201(16) ms	^{47}Cl $T_{1/2}$ = 109.5(25) ms
16	^{43}S $T_{1/2}$ = 250.2(25) ms	^{44}S $T_{1/2}$ = 125.5(25) ms	^{45}S $T_{1/2}$ = 69(1) ms	^{46}S $T_{1/2}$ = 41(4) ms
15	^{42}P $T_{1/2}$ = 47.1(20) ms	^{43}P $T_{1/2}$ = 37.5(22) ms	^{44}S $T_{1/2}$ = 18(1) ms	

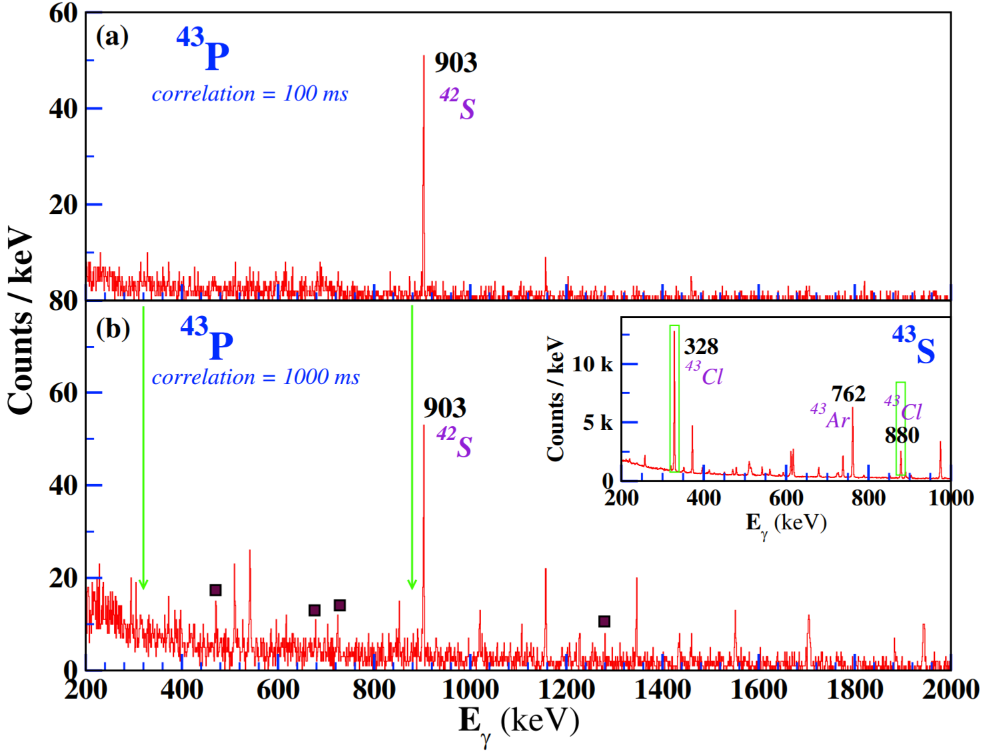
PHYSICAL REVIEW C 106, 064314 (2022)

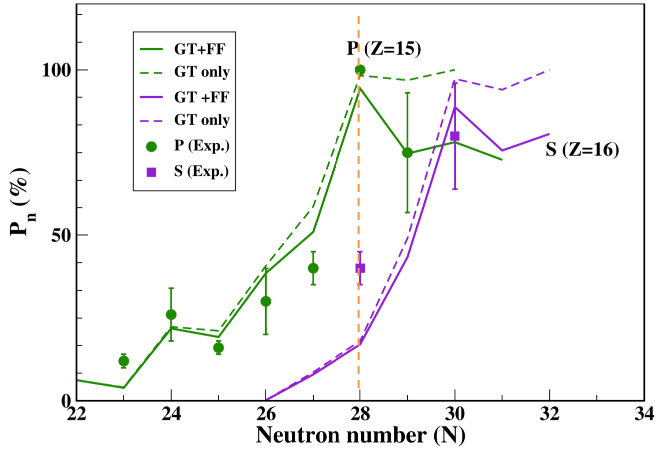


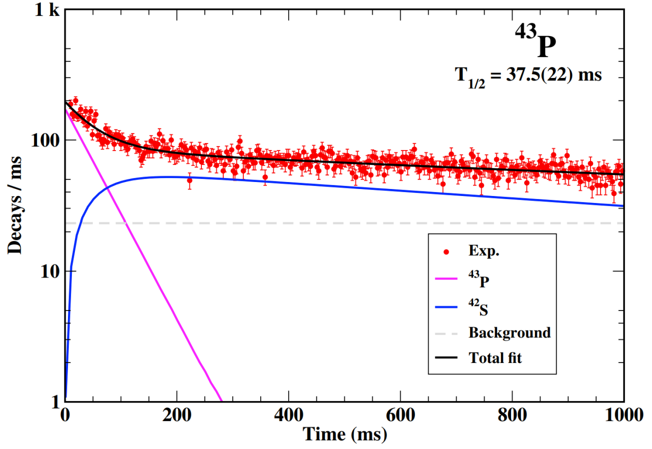
2 setting of the A1900

PRC 106, (2022): β decay of ^{43}P

- ❑ P_n = 100% for ^{43}P (N=28)
- ❑ Mostly P_{1n}
- ❑ P_n decreases for N=29, FF







β decay of ^{46}S studied for the first time

1p1h states expected to be populated move to high energies

VANDANA TRIPATHI *et al.* PHYSICAL REVIEW C **106**, 064314 (2022)

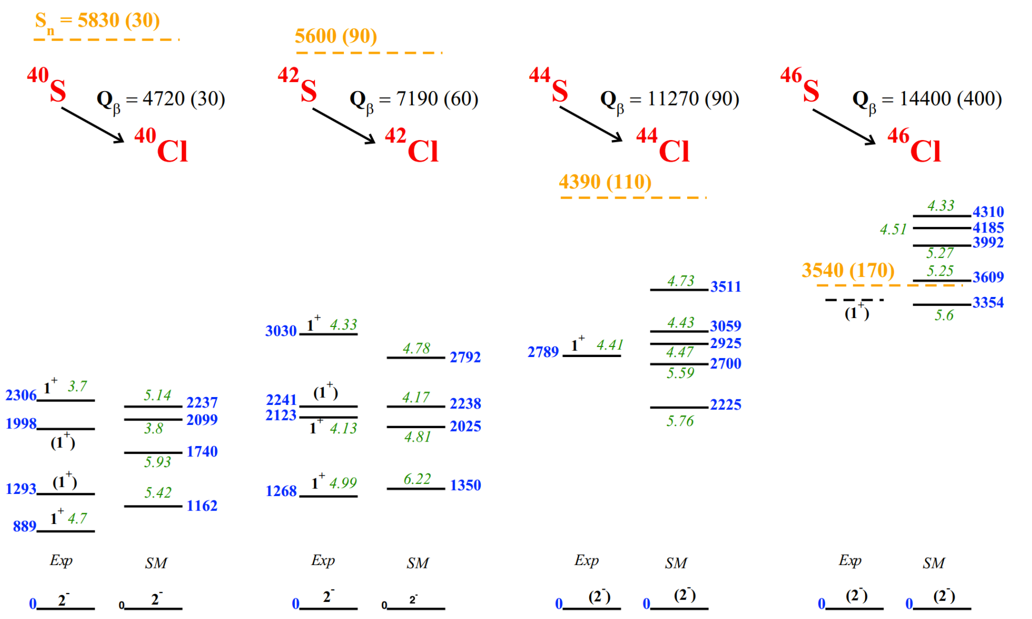
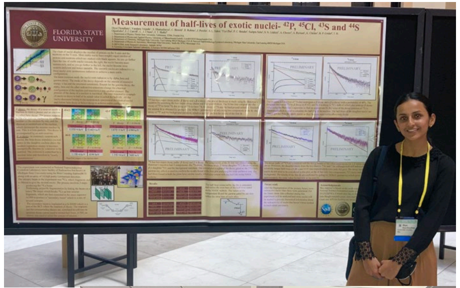
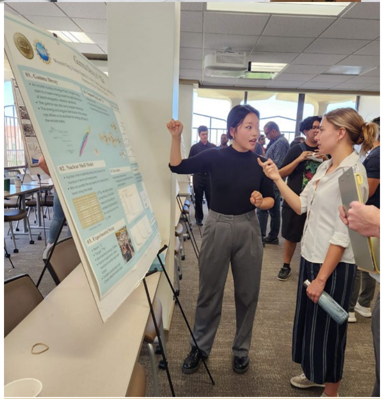


FIG. 17. *β* decay of even-even S isotopes from $A = 40$ to 46. Data for ^{40,42}S are from NNDC [31]. Only the 1^+ states expected to be populated via allowed GT transitions along with SM prediction are shown. As mentioned in the text we could not isolate the weakly populated bound 1+ state in ^{46}Cl. The focus is to illustrate that with increasing neutron number the GT strength imbibed by the 1^+ states moves to higher energies eventually residing in the neutron unbound states for ^{46}S.





UG Researchers
Diya & Wonmin

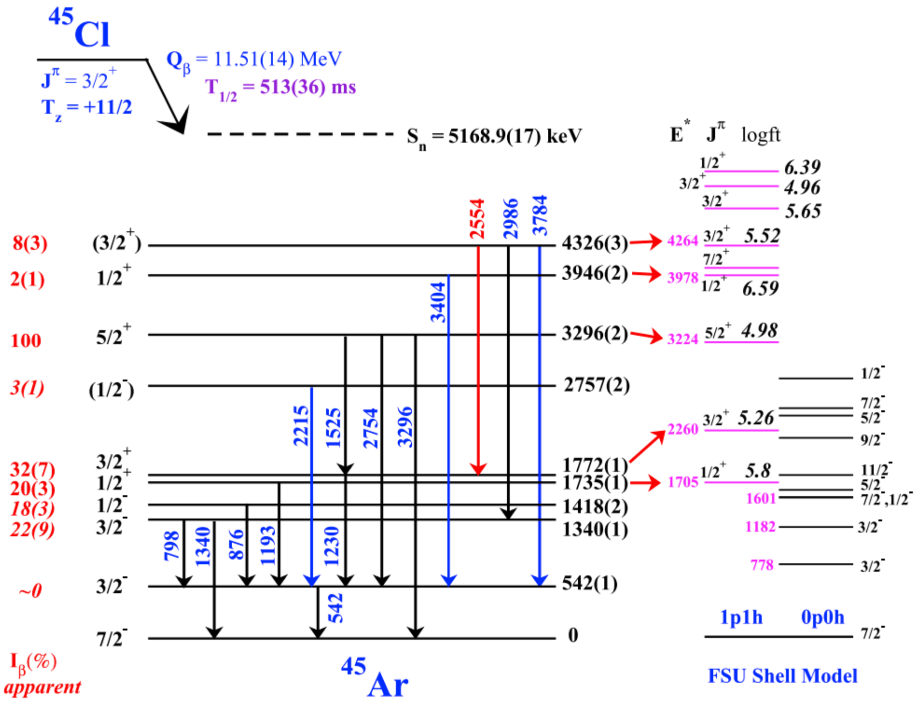
Best poster: Physics Department
Acknowledged in the paper

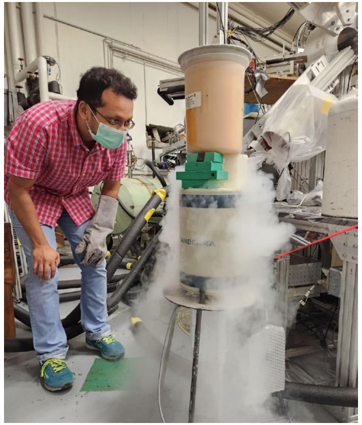
PRC 108 (2023): β decay of ^{45}Cl

Analysis led by Dr Soumik Bhattacharya
(Post doc: 2021-23)

- Based on our experiment and shell model calculation using the "FSU" interaction we provided evidence in favor of a $3/2^+$ ground state for ^{45}Cl

- For ^{43}Cl, the likely gs is ½+; shell evolution





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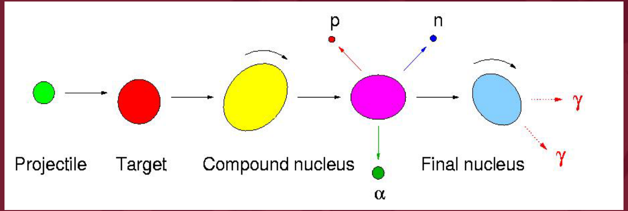
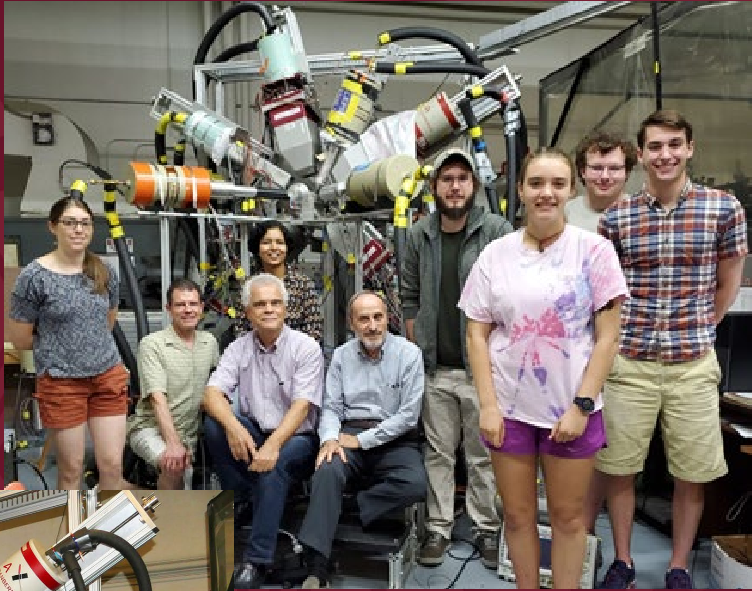
Fox Lab

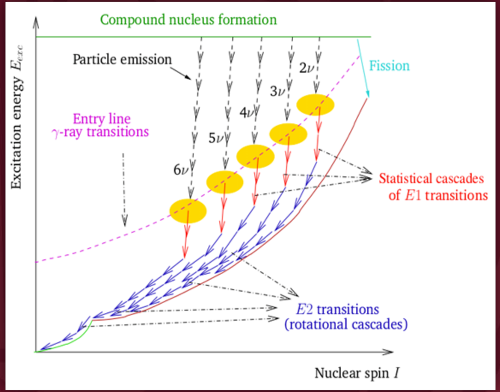
$^{14}C + ^{48,50}Ti$ @ 35 MeV 2019

Analysis and Publication



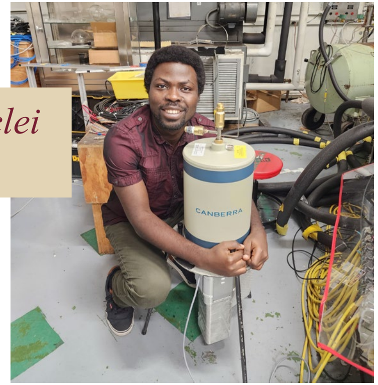
TR1 @ John D Fox Lab





PhD thesis: Samuel Ajayi

High spin γ-ray spectroscopy of "fp" shell nuclei
→Role of $g_{9/2}$ orbital in ^{59}Co, ^{61}Co, ^{59}Ni



Polarization

SAMUEL AJAYI *et al.*

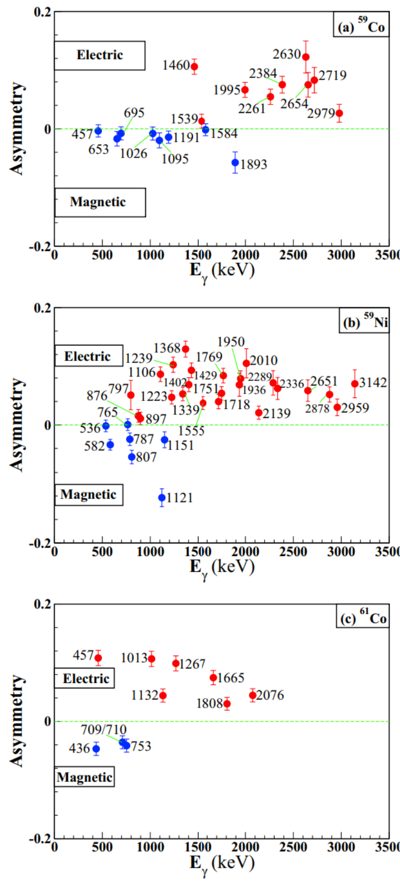
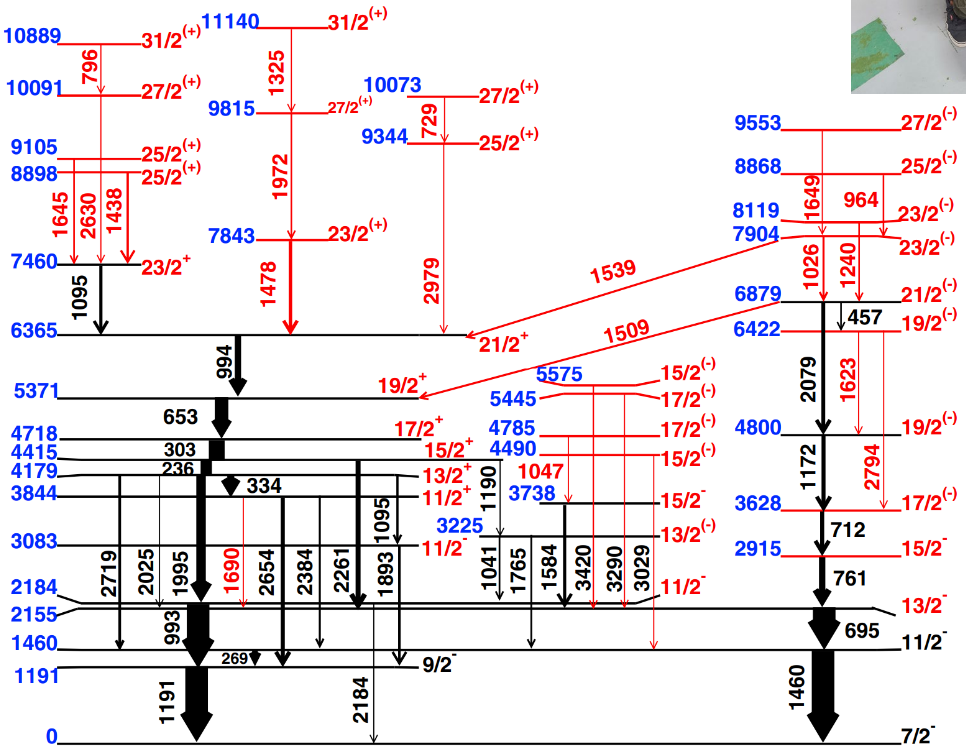


FIG. 2. The plot of polarization asymmetry vs energy of γ ray for (a) ^{59}Co, (b) ^{59}Ni, and (c) ^{61}Co. Point 709, 710 in (c) represents the two transitions 709 and 710 keV which are magnetic in nature. The points in red are electric transitions while the points in blue represent magnetic transitions.



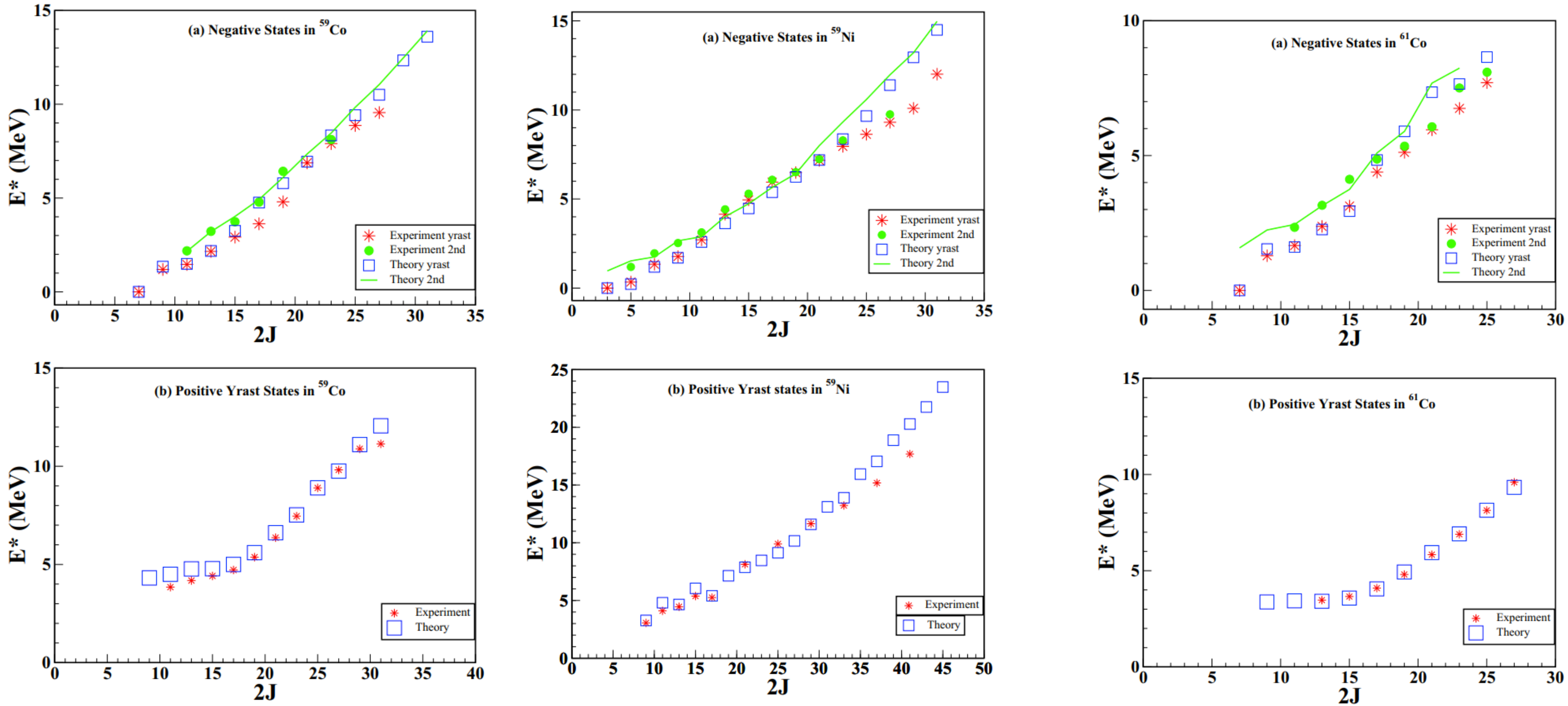
^{59}Co

Status of the state-of-the-art calculations

SDPFSDG interaction

Y. Utsuno et al.,

^{59}Co,^{61}Co & ^{59}Ni :
Comparison of positive parity and negative states with SM
Discrepancies at high spin (focus on red stars and blue boxes)



More Results

Post Doc : Dr Soumik

^{61}Ni

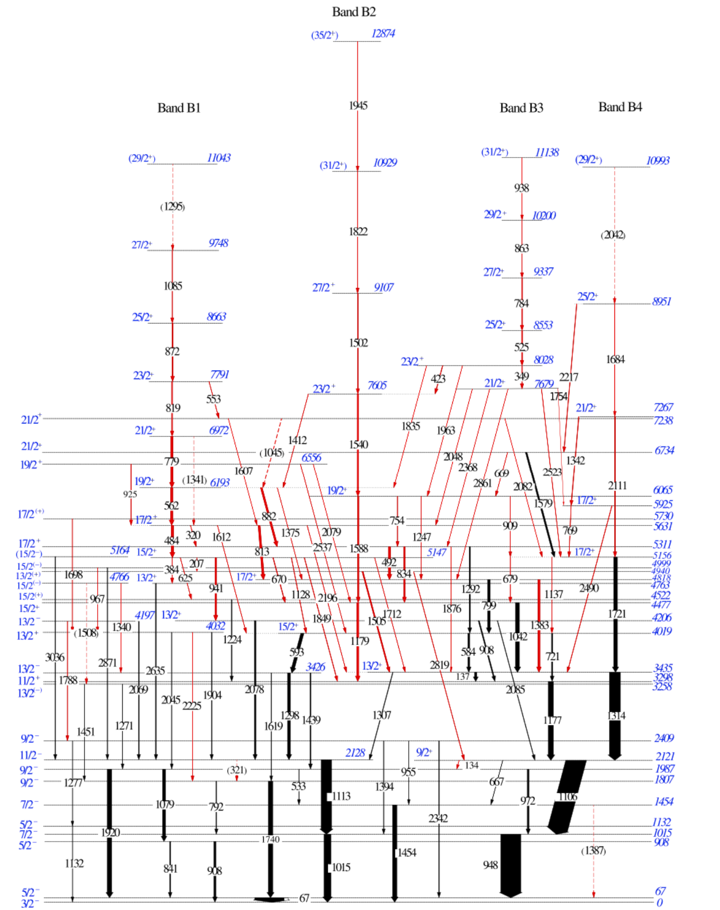
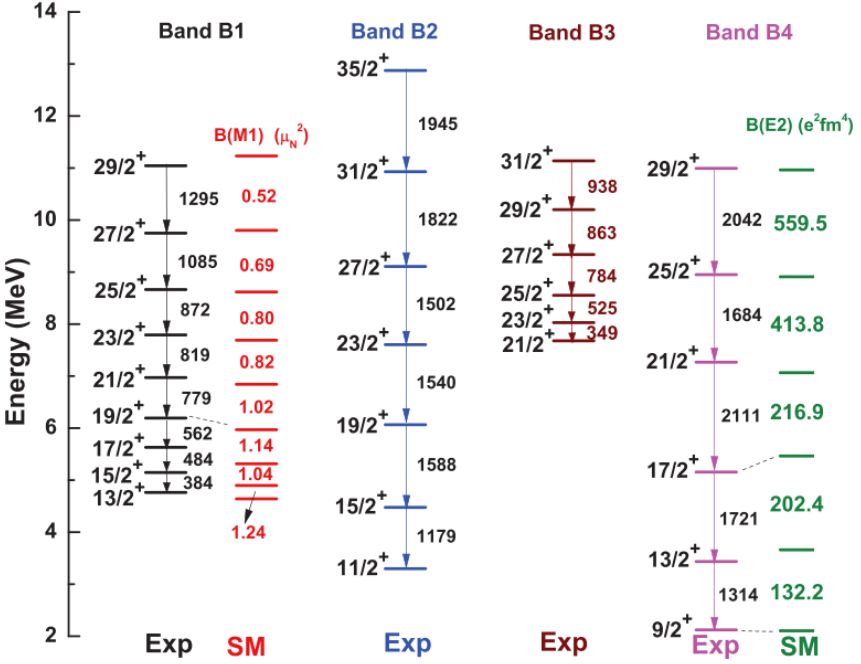


FIG. 2. Level scheme for ^{61}Ni from present work. The newly found transitions and repositioned transitions are shown in red. The width of the transitions represents the corresponding relative intensity. For clarity and easy comprehension of the level scheme, the energy values for the levels and the γ rays are labeled to the nearest integer values. The accurate energy values up to one decimal place are listed in Table I with corresponding error.



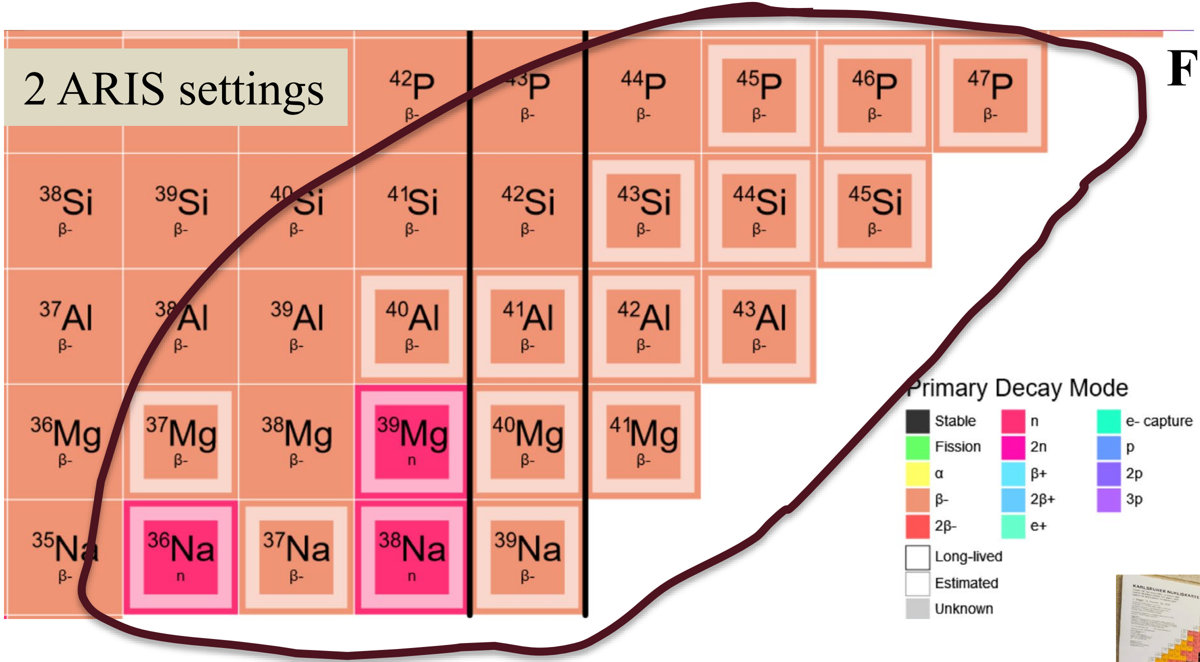
Look Ahead …

Goals and Plans: 2024-2028

- ❑ Investigating the N=28 shell closure in exotic nuclei
- → β decay at FRIB, rerun 21062B and analysis
- → Phd thesis of GS Mac Wheeler
- ❑ Investigating fp shell nuclei to isolate the role of $g_{9/2}$ orbital, collective phenomenon, magnetic rotation bands and more
- → CLARION2 @FSU : ^{69}Zn, ^{62}Ni, ^{69}Ga (New GS student)
- → Shell model interaction refinement
- ❑ PAC3 proposal to FRIB, expand the landscape to even more exotic nuclei, understand delayed neutron emission

E21062-B

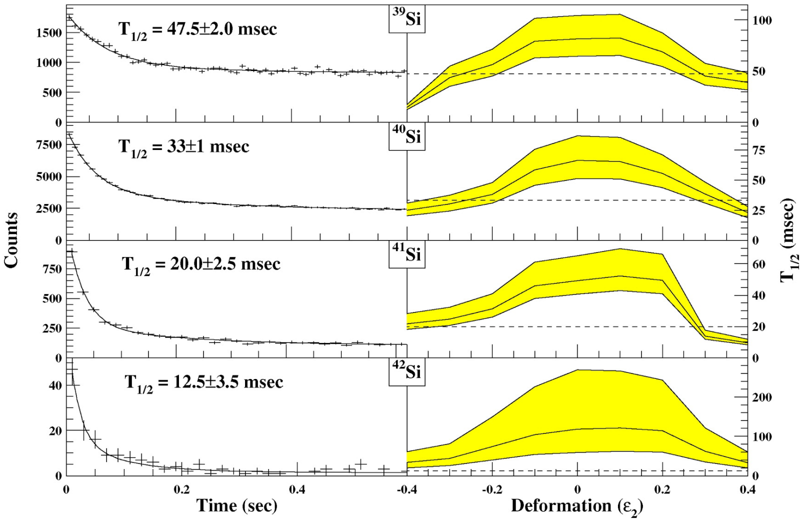
Feb 25-March 3, 2024



41Si	42Si	43Si	44Si	45Si
20.0 ms	12.5 ms			
β^- = 100.00%	β^- = 100.00%	β^- = 100.00%	β^-2n ?	
β^-n ≈ 61.00%	β^-n ?			
1.81E+4	1.57E+4	1.92E+4	1.82E+4	2.11E+4

#1

β decay of very exotic Si isotopes



S. Grevy et al.,
PLB 594, (2004) 252
GANIL

VT *et al.*, (^{38,40}Si)
PRC 95, 024308 (2017)

BA, VT *et al.*, (^{37,39}Si)
PRC 100, 014323 (2019)

^{40}Si $t_{1/2}$ = 27.6 (14) ms

^{39}Si $t_{1/2}$ = 38.6 (13) ms

Latest calculated data of beta-decay properties of $A \sim 40$ nuclei: update on Phys. Rev. C 97, 054321 (2018): "Systematic shell-model study of β-decay properties and Gamow-Teller strength distributions"

Sota Yoshida[1]
[1]Institute for Promotion of Higher Academic Education, Utsunomiya University, Mine, Utsunomiya, 321-8505, Japan

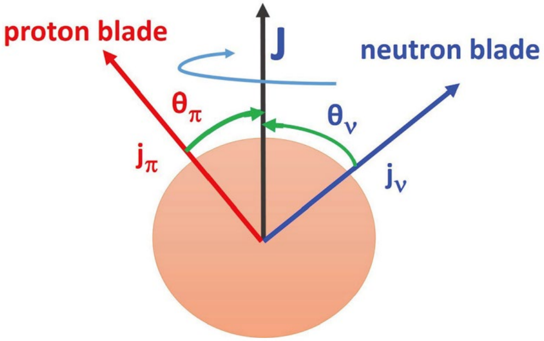
(Dated: November 15, 2022)

TABLE 3. Half-lives $T_{1/2}$ and beta-delayed neutron emission rates $P_n(\%)$ of Si isotopes

parent	$T_{1/2}$						$P_n(\%)$				
	Exp.	Exp. err.	GT+FF,$Q_{\rm exp.}$	GT,$Q_{\rm exp.}$	GT+FF,$Q_{\rm tho.}$	GT,$Q_{\rm tho.}$	Exp.	GT+FF,$Q_{\rm exp.}$	GT,$Q_{\rm exp.}$	GT+FF,$Q_{\rm tho.}$	GT,$Q_{\rm tho.}$
Si36(j0p)	503ms	2	374.684 ms	375.703 ms	368.398 ms	369.402 ms	12(5)	3.64	3.62	3.69	3.67
Si37(j5n)	141.0ms	3.5	126.122 ms	128.797 ms	118.215 ms	120.698 ms	17(13)	6.24	6.37	6.48	6.62
Si38(j0p)	63ms	8	90.237 ms	91.606 ms	72.161 ms	73.260 ms	25(10)	18.54	18.78	20.02	20.27
Si39(j3n,Ex.=0.10 MeV)	41.2ms	4.1	41.853 ms	45.973 ms	34.097 ms	37.218 ms	33(3)	31.12	34.18	32.87	35.88
Si39(j5n)	41.2ms	4.1	36.442 ms	37.687 ms	31.405 ms	32.466 ms	33(3)	20.34	21.04	21.37	22.10
Si39(j7n,Ex.=0.04 MeV)	41.2ms	4.1	44.007 ms	45.225 ms	36.894 ms	37.906 ms	33(3)	23.24	23.89	24.53	25.20
Si40(j0p)	31.2ms	2.6	24.433 ms	25.409 ms	23.967 ms	24.923 ms	38(5)	30.64	31.40	30.80	31.57
Si41(j3n)	20.0ms	2.5	10.922 ms	11.438 ms	14.092 ms	14.789 ms	>55	57.00	59.67	55.34	58.05
Si42(j0p)	12.5ms	3.5	8.959 ms	9.394 ms	10.665 ms	11.188 ms		76.90	77.65	76.33	77.01
Si43(j1n,Ex.=0.05 MeV)	30#ms	>260ns	8.381 ms	9.305 ms	6.192 ms	6.827 ms		90.87	99.86	91.44	99.87
Si43(j3n)	30#ms	>260ns	10.248 ms	11.410 ms	7.646 ms	8.469 ms		89.52	99.23	90.06	99.28
Si44(j0p)	4#ms	>360ns	8.809 ms	10.563 ms	6.069 ms	7.194 ms		87.25	100.00	88.02	100.00
Si45(j1n)	4#ms		6.914 ms	8.989 ms	3.998 ms	5.036 ms		80.95	100.00	83.27	100.00
Si45(j3n,Ex.=0.12 MeV)	4#ms		8.649 ms	11.452 ms	4.710 ms	6.014 ms		79.63	100.00	82.06	100.00
Si46(j0p)			-	-	3.466 ms	4.650 ms		-	-	90.46	100.00
Si47(j1n)			-	-	2.480 ms	3.792 ms		-	-	85.32	100.00
Si48(j0p)			-	-	1.715 ms	2.665 ms		-	-	-	-

Magnetic Rotation band in “fp” shell nuclei

Clarion 2



- The semiclassical model (SCM): Macchiavelli et al.
- The SCM describes schematically how the energy states of a shears band are generated from the coupling of long spin vector of proton particles (or holes) jπ and neutron holes (or particles) jν .
- he effective interaction V [I(θ)] between the proton and neutron angular momenta, dynamics of the system gives rise to a rotation like spectrum consisting of M1 transitions.

$$\cos[\theta(I)] = \frac{\vec{j_\pi} \cdot \vec{j_\nu}}{|\vec{j_\pi}| . |\vec{j_\nu}|} = \frac{I(I+1) - j_\pi(j_\pi+1) - j_\nu(j_\nu+1)}{2\sqrt{[j_\pi(j_\pi+1) j_\nu(j_\nu+1)]}}.$$

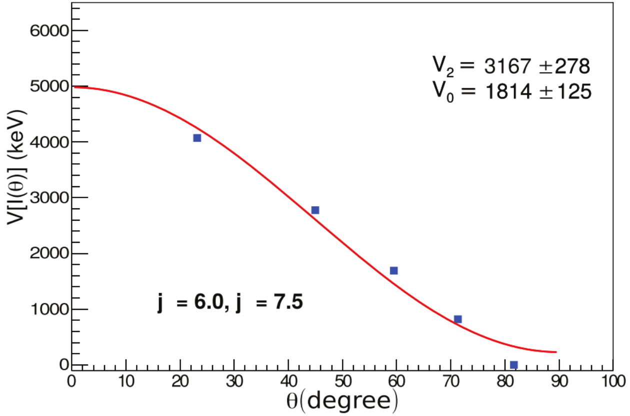
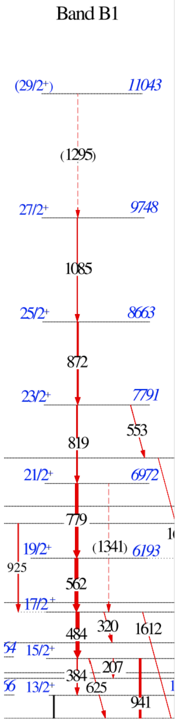


FIG. 11. SCM fit with the experimental data for magnetic rotational band B1.



^{61}Ni

SB, VT et al.,

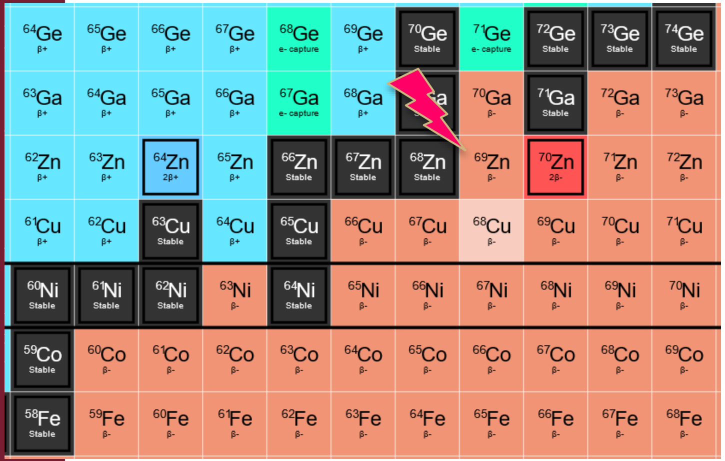
PHYSICAL REVIEW C **107**, 054311 (2023)

#2

Polarization measurements, neutron rich beams like ^{14}C, ^{18}O

New GS,PD

- ❑ E*, J, π together determine a nuclear state completely
- ❑ Allowing for a detailed comparison with theoretical predictions



^{69}Zn

No states above $9/2^+$ are known

Angular distribution & Polarization

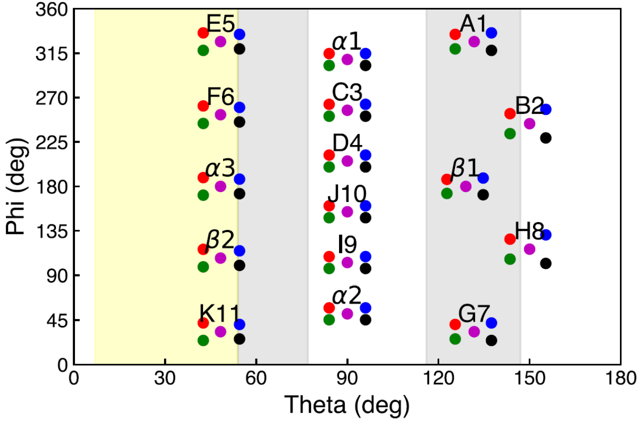
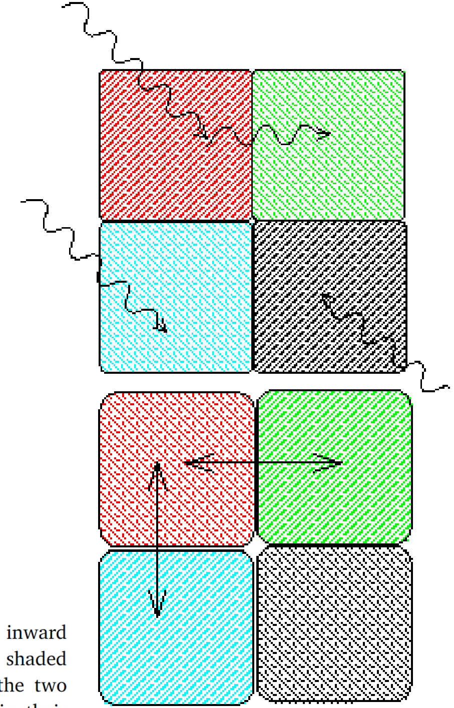


Fig. 17. Angle map for CLARION2. The crystal angles represent the most inward position, where crystal faces are 20 cm from the target position. The yellow shaded region from 7–54 degrees represents the GAGG:Ce angular coverage, while the two gray shaded regions show the angular coverage of the annular Si detectors in their nominal position; see text for further details.



The FSU interaction

physics MDPI

Review

The Nuclear Shell Model towards the Drip Lines

B. Alex Brown

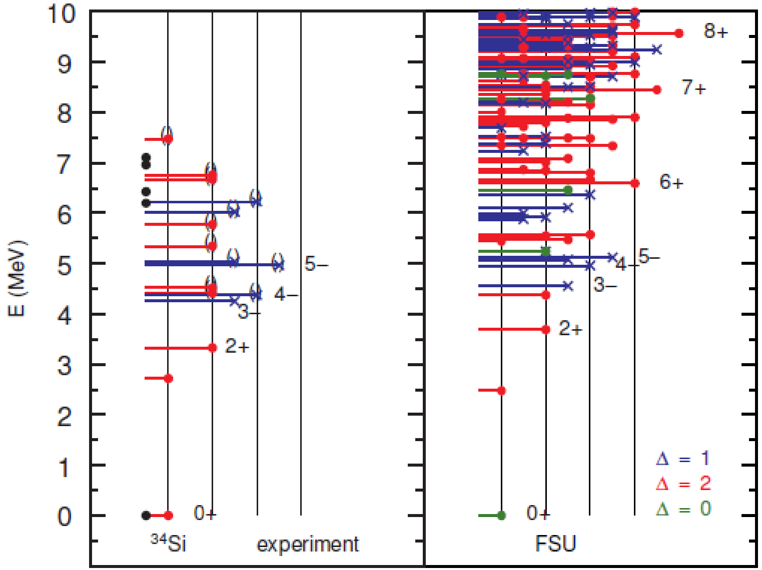


Figure 5. Spectrum of ^{34}Si obtained with the Florida State University (FSU) Hamiltonian [56] compared to experiment. The length of the horizontal lines are proportional to the the angular momentum, J. The experimental parity is indicated by blue for negative parity and red for positive parity. Experimental spin-parity, J^{π}, values that are tentative are shown by "()", and those with multiple of no J^{π} assignments are shown by the black points. The calculated results are obtained with the FSU Hamiltonian with pure Δ configurations. The parities are positive for $\Delta = 0$ (green) and $\Delta = 2$ (red) and negative for $\Delta = 1$ (blue).

R. S. Lubna, K. Kravvaris, S. L. Tabor, V. Tripathi, E. Rubino, and A. Volya, Phys. Rev. Res. 2, 043342 (2020).

- Collaboration with Alexander Volya
- More experiments
- Expand the fit to more exotic nuclei
- Include $g_{9/2}$ orbital in the valence space

3 FRIB PAC3 proposal

β-decay of ^{45,46}P and ^{48,49}Cl: First Forbidden beta decays and the physics of the continuum

Our recent investigation of neutron rich isotopes P and Cl with N around 28 revealed interesting results

a) The P_n value for P isotopes peaked at 100% for ^{43}P (N=28) but then fell to about 80% for ^{44}P (N=29) due to the increased role of first forbidden beta decays. Extending this systematics to higher neutron number will be useful for a better understanding of beta-decay of extremely neutron-rich nuclei.

b) For ^{47}Cl decay, the P_n is about 93% and we observe several states in ^{46}Ar which should likely have positive parity. Exploring how beta-delayed transitions proceeding through broad unbound states can illuminate physics of overlapping resonances, interference, and probe effects of continuum.

Goal: Extend the β-decay studies to hitherto unexplored isotopes of P and Cl (discovery) and do detailed spectroscopy.

Further, explore physics of overlapping resonances and interference in the continuum through beta delayed neutron emission.

In collaboration with FDSi

Continue Collaborative work
CLARION 2

1. Study of ^{72}Ga
^{4}He + ^{70}Zn
~ 35 MeV alpha beam (LINAC)
Ben Crider, Mississippi State University
Robert Haring Kaye, Westmont College, CA

2. Lifetime measurements (DSAM) using implanted targets made at UMass Lowell
Peter Bender, University of Massachusetts, Lowell

3. Look for fully aligned 7^{+} state in ^{40}Cl predicted by the FSU shell model interaction
Rebeka Lubna, Facility for Rare Isotope Beams

4. Sergio A. Calderon / P. Cottle (FSU)

Timeline

Year 1	Year 2	Year 3	Year 4
2024-2025	2025-2026	2026-2027	2027-2028

- Samuel Ajayi graduating
- New Graduate Student
- E21062B: analysis and publication (MW)
- CLARION 2: ^{72}Ga & more (BC & BK)
- CLARION 2: ^{69}Zn (FSU new GS)
- CLARION 2: FSU PD
- FRIB PAC3 proposal
- CLARION 2: MW
- Mac Wheeler graduating
- Collaborative experiments

FLORIDA STATE UNIVERSITY

Thanks

Questions ?