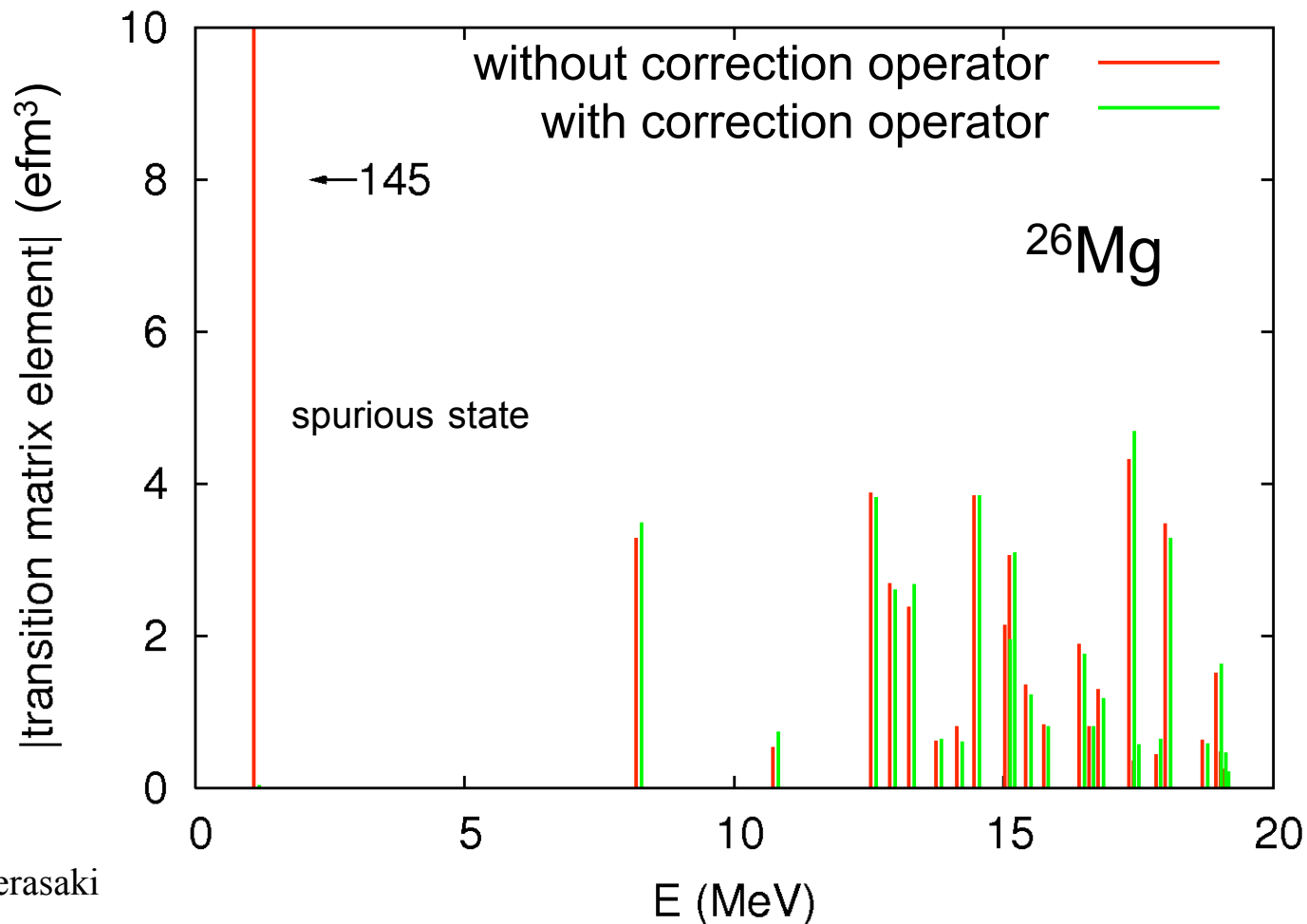


# Year 3 Deliverables: Status, Work to be Done

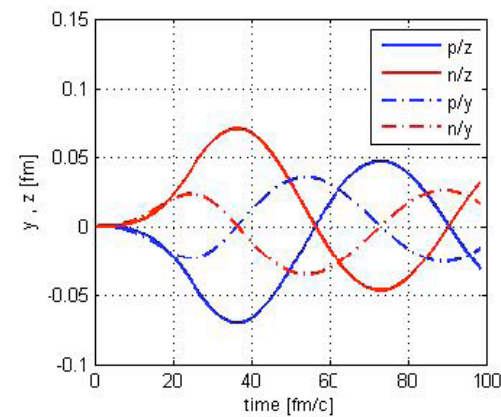
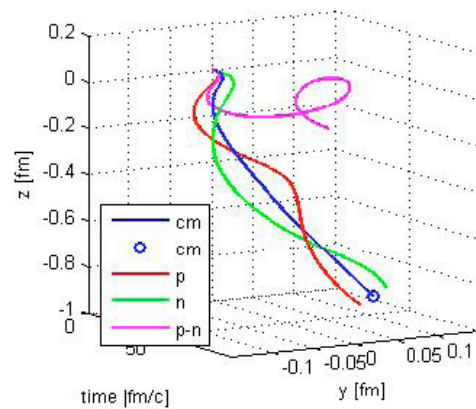
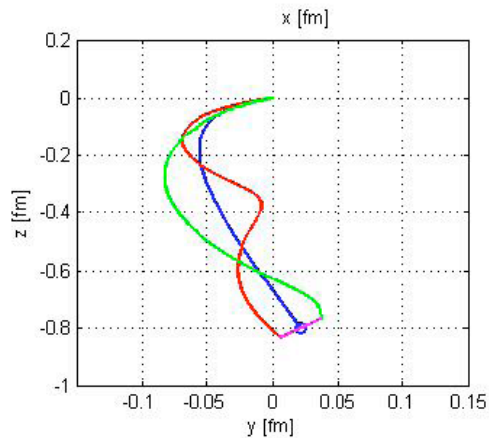
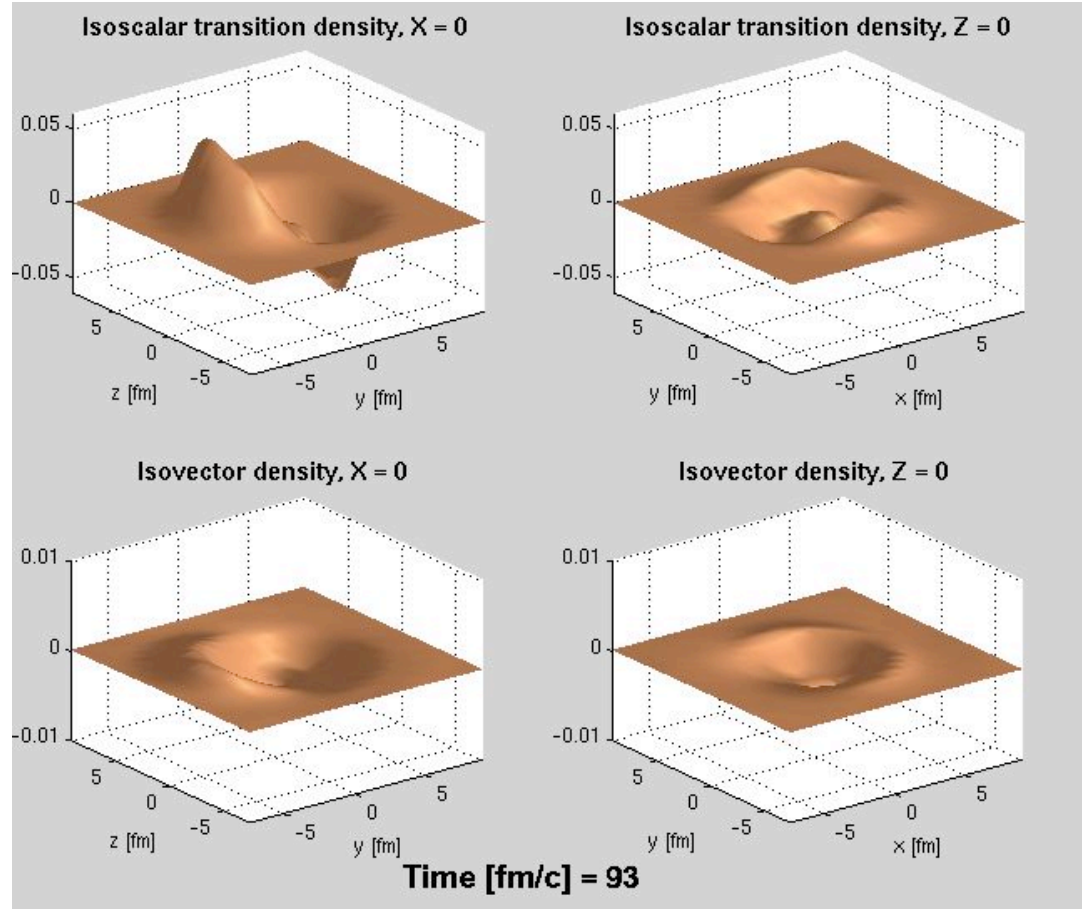
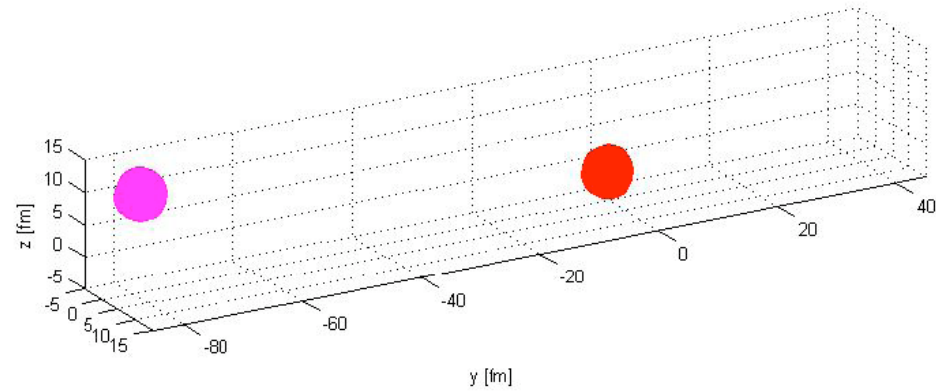
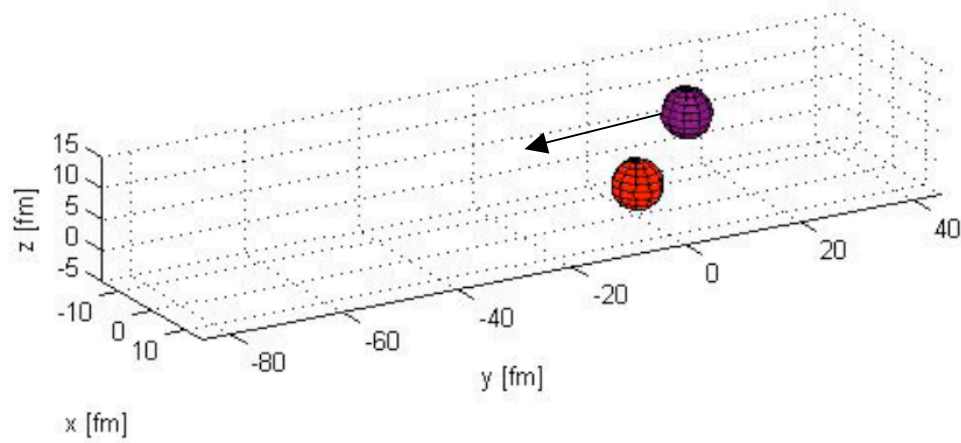
- o **Engel, Terasaki, University of North Carolina at Chapel Hill:**
  - ✓ Use the deformed QRPA code to study low-lying collective states and weak decays: on track, major goals accomplished, study of the  $2^+$  states and resonances near the drip line remains to be done;
  - ✓ develop second-QRPA extension needed for reaction theory: formulation started, coding moved to year 5.
- o **Bulgac, Stetcu, Magierski (UW), Roche (ORNL):**
  - ✓ Develop a coordinate representation Time-Dependent-DFT code TD-SLDA and apply it to excited states of nuclei: on track, major goals accomplished, extensive testing and applications remain to be done.
- o **Horoi, Scott, Gao, Central Michigan University:**
  - ✓ Use CI Moments code to calculate the nuclear level densities for the rp-process nuclei and provide input to Hauser-Feshbach treatment of reaction rates: on track, major goals accomplished, reaction cross sections remain to be calculated.
- o **Brown, Lisetskiy, Michigan State University:**
  - ✓ Optimize performance of CI-NuShellX and speed it up by an order of magnitude: on track, to be finalized this summer.
- o **Johnson, Krastev, San Diego State University, Ormand (LLNL):**
  - ✓ Optimize performance and load-balance of CI-REDSTICK code with three-nucleon forces to reach 500M basis states in  $^{12}\text{C}$ : on track, major goals accomplished, efficient 3-body Lanczos to be implemented by the end of Year 3 (CS help needed).

QRPA: Absolute value of transition matrix elements of  $e \sum_{i=1}^A r_i^3 Y_{10}(\theta_i, \varphi_i)$  between ground and  $K^\pi=0^-$  states

Difference between results with and without “correction operator” in excitations is measure of size of spurious components.

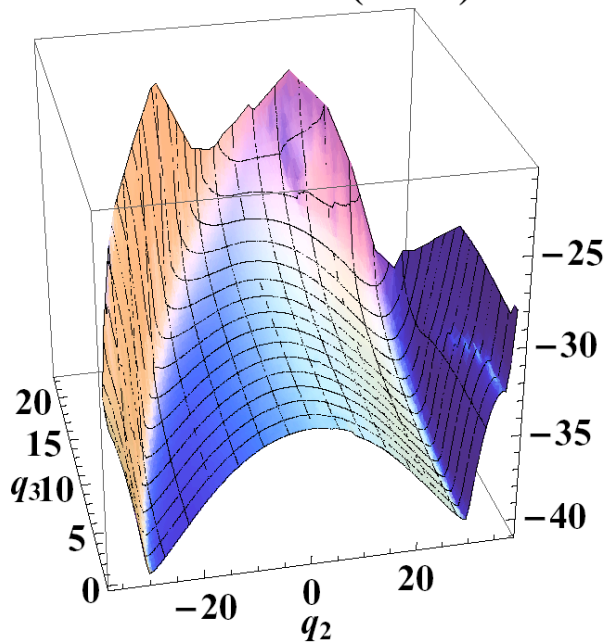


# Bulgac, Stetcu, Magierski, Roche

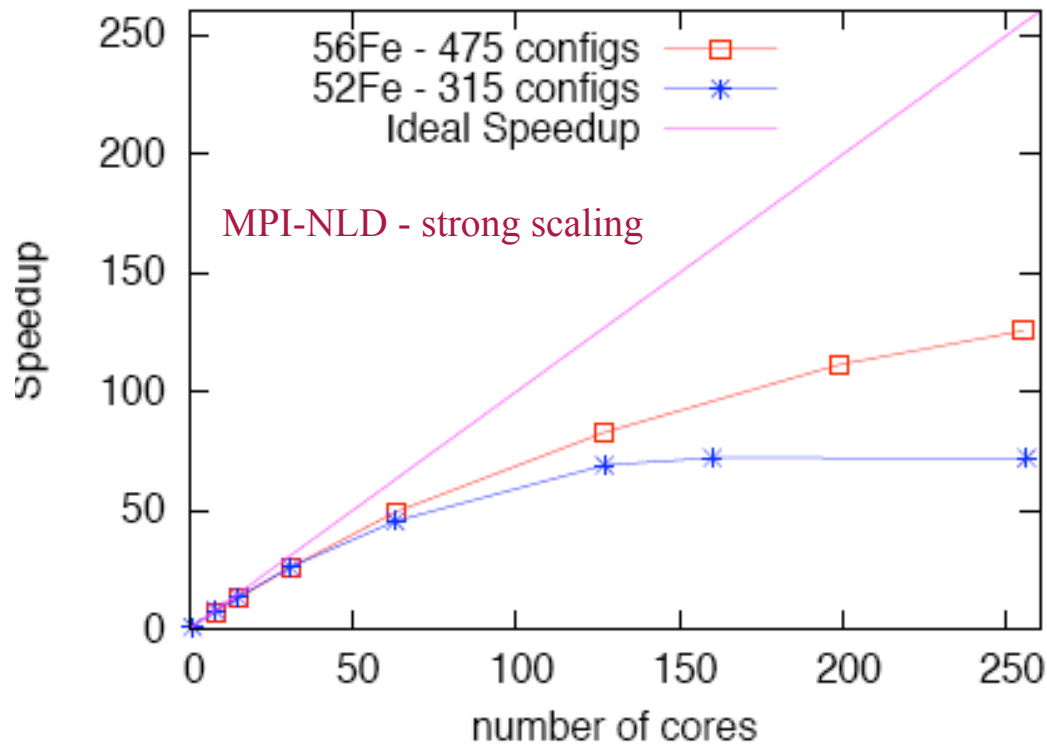
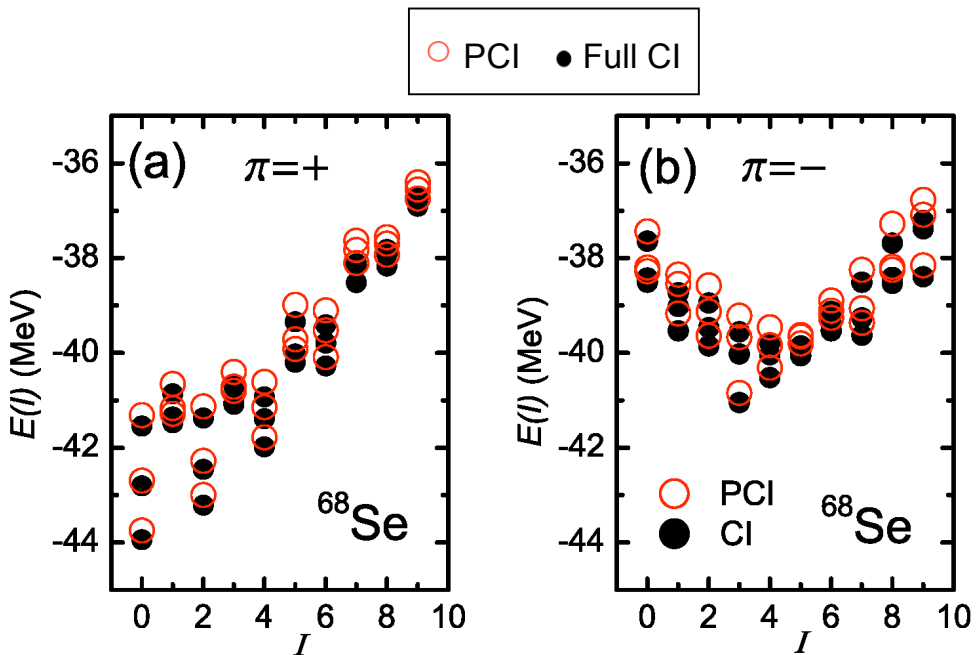
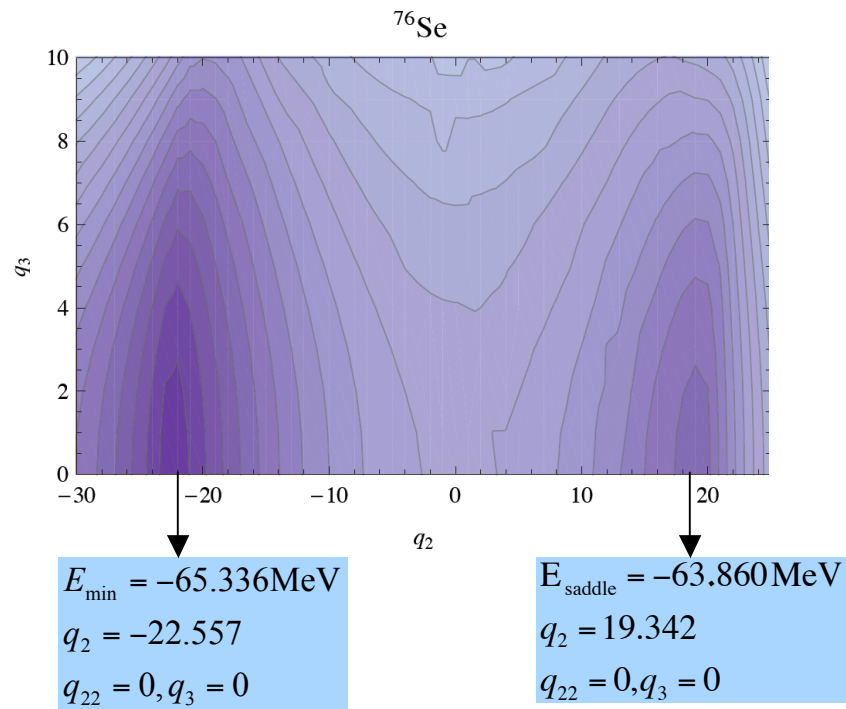


# Parity Projected CI (PPCI)

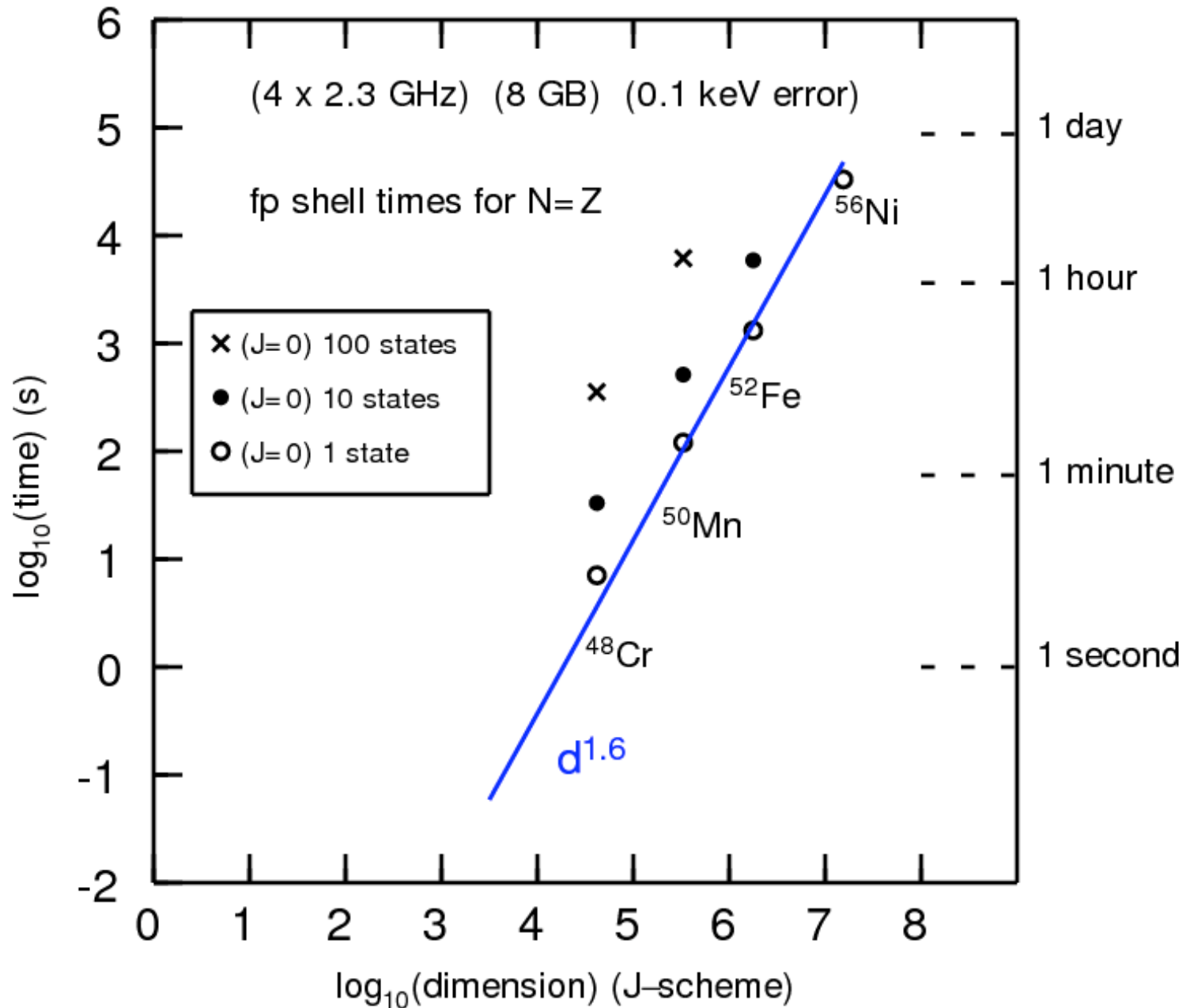
CHF for  $^{68}\text{Se}(\text{MeV})$



Extension of PCI:  
Gao, Horoi PRC **79**,  
014311 (2009),  
arXiv:0906.3756



# Brown: Performance of the J-scheme code NuShellX



# SHELL-MODEL CI CODES AND APPLICATIONS

Johnson, Krastev

Why "on-the-fly"?

Factorization of Hamiltonian (H) -> reduced memory  
-> larger problem on same machine

10x faster than the  
old REDSTICK

Comparison of RAM requirements (2-body interactions only)  
Does not include lanczos vector storage

Nuclide	Space	Basis dim	Half H store	BIGSTICK store
$^{56}\text{Fe}$	<i>pf</i>	501 M	290 Gb	0.72 Gb
$^7\text{Li}$	$N_{\max}=12$	252 M	3600 Gb	96 Gb
$^7\text{Li}$	$N_{\max}=14$	1200 M	23 Tb	624 Gb
$^{12}\text{C}$	$N_{\max}=6$	32M	196 Gb	3.3 Gb
$^{12}\text{C}$	$N_{\max}=8$	590M	5000 Gb	65 Gb
$^{12}\text{C}$	$N_{\max}=10$	7800M	111 Tb	1.4 Tb
$^{16}\text{O}$	$N_{\max}=6$	26 M	142 Gb	3.0 Gb
$^{16}\text{O}$	$N_{\max}=8$	990 M	9700 Gb	130 Gb

# Year 4 Deliverables

- **Engel, Terasaki, University of North Carolina at Chapel Hill:**
  - Developed the charge-exchange QRPA code, and use it to study beta decay of nuclei in the r-process.
- **Bulgac, Stetcu, Magierski (UW), Roche (ORNL):**
  - Improve the generation of initial conditions for TD-SLDA, and study dilute fermion systems, and nuclear systems.
- **Horoi, Senkov, Central Michigan University:**
  - Improve the scalability of the CI Moments code, and calculate the nuclear level densities for the heavier nuclei in the rp-process path. **It may require CS help.**
- **Brown, Michigan State University:**
  - Improve the scalability of the CI code NuShellX to hundreds of cores.
- **Johnson, Krastev, San Diego State University, Ormand (LLNL):**
  - Improve the scalability of the new CI code REDSTICK up to 10,000 cores, and use it to investigate  $^{12}\text{C}$ ,  $^{16}\text{O}$  ( $N_{\text{max}}=8$ ) with 3-body interactions (**CS help needed**).

# Future Plans: Year 5

- **Engel, Terasaki, University of North Carolina at Chapel Hill:**
  - Develop the 2nd QRPA code and investigate the spreading widths of resonances.
- **Bulgac, Stetcu, Magierski (UW), Roche (ORNL):**
  - Use TD-SLDA ASDLA with consistent initial conditions to study nuclear spectral functions and nuclear reactions.
- **Horoi, Senkov, Central Michigan University:**
  - Use CI techniques to investigate the double beta decay of  $^{76}\text{Ge}$ ,  $^{82}\text{Se}$ , and  $^{150}\text{Nd}$ .
- **Brown, Michigan State University:**
  - Use NuShellX to optimize the effective interaction for  $A=56-100$  nuclei.
- **Johnson, Krastev, San Diego State University, Ormand (LLNL):**
  - Improve the scalability of the new REDSTICK code up to 30,000 cores, and used to investigate  $^7\text{Li}$  ( $N_{\text{max}}=12$ ) with 3-body interactions.