Gemini++ Updates: v.3.3

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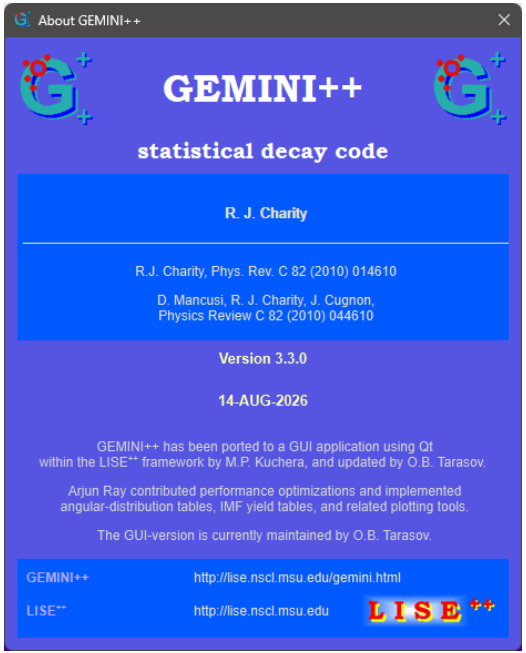
GEMINI Update Details

- **3.1.09–3.1.11 — Arjun:**
  - introduced project-wide optimization,
  - residual angular-distribution tables,
  - plotting windows,
  - Gaussian fits for 1D plots.
- **3.2.0–3.2.7 — Arjun:**
  - consolidated the 2026 GUI development,
  - including gamma angular-distribution tables,
  - center-of-mass spectra,
  - IMF angular tables and plots,
  - Boltzmann overlays,
  - yield-table output updates.
- **3.2.8–3.3.0 — Oleg:**
  - covers the Codex-assisted development changes, including startup defaults,
  - **migration to double precision,**
  - **MinGW/MSVC warning cleanup**,
  - result-window scrollbar support,
  - About-dialog attribution,
  - synchronized version metadata.



Optimization

Gemini profiling to search for bottleneck points

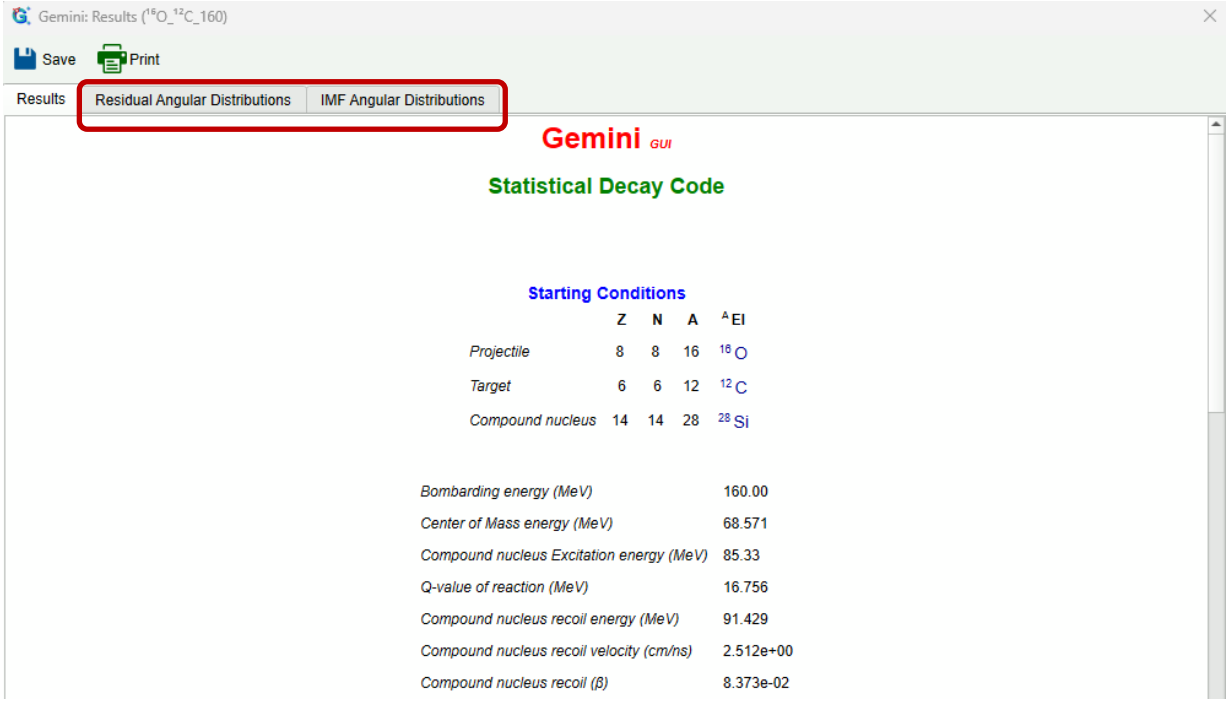
BOTTLENECKS ADDRESSED AND CHANGES MADE

No.	Location	Bottleneck	Change Made
1	Nucleus.cpp(CNucleus::getSumTl())	storeSub.push_back() caused heavy reallocations and copies	Reused a thread_local buffer, reserved capacity using (IMax - IMin + 1), and replaced push_back with emplace_back
2	Nucleus.cpp(CNucleus::getSumTl())	Repeated calls to getTl(L, ek*scale, temp) for same inputs	Added a small local cache to store computed getTl values and reused them
3	Nucleus.cpp (decay-product generation)	Heavy new/delete churn for CNucleus objects during decay	Introduced a recycle pool (acquire() / release()) to reuse CNucleus objects instead of allocating each time
4	Nucleus.cpp (decay-product generation)	Deep recursive decay traversal causing function call overhead	Replaced recursive decay traversal with an explicit stack-based loop
5	Project-wide	Extensive use of pow() in performance-critical code paths	Replaced pow() with equivalent direct arithmetic (e.g., x*x)
6	Nucleus.cpp (constructors & initialization)	Duplicated constructor logic and repeated setup code	Centralized all setup logic into initializeDefaults() and initialize(...)
7	Nucleus.cpp (decay-product handling)	Frequent temporary vector allocations across events	Reused decay-product vectors across events instead of recreating them
8	gm_mwExecFusion.cpp,gm_mwExecCompound.cpp	Throttled progress + cancel handling	Updated progress bar only every 10 iterations to reduce UI overhead

Gemini optimization at bottleneck points and more to result in Gemini being ~1.6x faster

TIMES			
	old time(s)	new time(s)	Time ratio (%)
Compound Nucleus Decay			
Decay events.= 1000	7.07	4..30	39%
No. Of decay events.= 3000	21.51	12.61	41%
A=195,J=50,Events= 3000	23.63	15.43	35%
Average speed increase: 38.4% time spent, 1.6× faster			
Fusion Reaction			
Default	10.23	5.67	45%
Events= 1000	20.5	11.38	44%
A=27,100 MeV	7.46	3.94	47%
A=27,200 MeV	11.28	7.06	37%
Average speed increase: 43.9% time spent, 1.8× faster			

Tabs for Residual and Angular distributions



IMF production table

Gemini: Results (^{16}O_^{12}C_160)

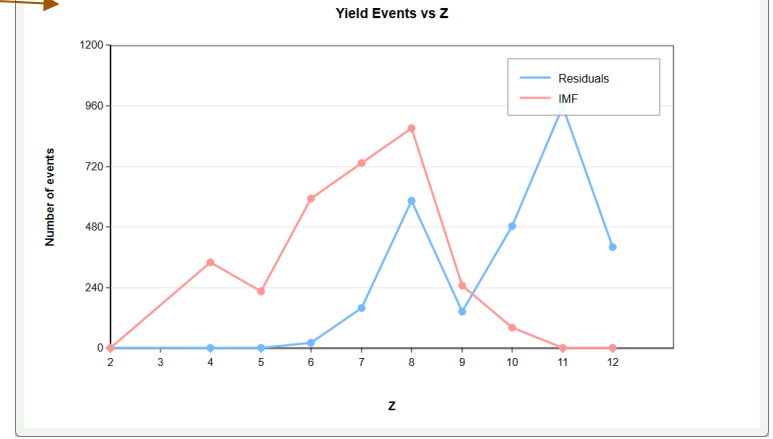
Save Print

Results | Residual Angular Distributions | IMF Angular Distributions

Yields of Residual Nuclei and IMF Particles (plot)

	Residual Nuclei					IMF Particles				
Z	Name	Events	Percent	x-section (mb)	err(mb)	Name	Events	Percent	x-section (mb)	err(mb)
12	^{26}Mg	2	0.1%	0.3749	0.2651	-	-	-	-	-
	^{25}Mg	70	2.5%	13.12	1.568	-	-	-	-	-
	^{24}Mg	279	10.1%	52.29	3.131	-	-	-	-	-
	^{23}Mg	50	1.8%	9.372	1.325	-	-	-	-	-
11	^{24}Na	145	5.3%	27.18	2.257	-	-	-	-	-
	^{23}Na	607	22.0%	113.8	4.618	-	-	-	-	-
	^{22}Na	132	4.8%	24.74	2.153	-	-	-	-	-
	^{21}Na	74	2.7%	13.87	1.612	-	-	-	-	-
10	^{23}Ne	5	0.2%	0.9372	0.4191	^{22}Ne	1	0.0%	0.07487	0.07487
	^{22}Ne	66	2.4%	12.37	1.523	^{21}Ne	18	0.6%	1.348	0.3176
	^{21}Ne	403	14.6%	75.54	3.763	^{20}Ne	39	1.3%	2.92	0.4675
	^{19}Ne	9	0.3%	1.687	0.5623	^{19}Ne	20	0.6%	1.497	0.3348
	-	-	-	-	-	^{18}Ne	5	0.2%	0.3743	0.1674
9	^{21}F	4	0.1%	0.7497	0.3749	^{20}F	22	0.7%	1.647	0.3512
	^{20}F	29	1.1%	5.436	1.009	^{19}F	49	1.6%	3.669	0.5241
	^{19}F	62	2.3%	11.62	1.476	^{18}F	109	3.5%	8.161	0.7816
	^{18}F	49	1.8%	9.184	1.312	^{17}F	67	2.2%	5.016	0.6128
8	^{18}O	28	1.0%	5.248	0.9918	^{18}O	48	1.6%	3.594	0.5187
	^{17}O	342	12.4%	64.1	3.466	^{17}O	263	8.5%	19.69	1.214
	^{16}O	202	7.3%	37.86	2.664	^{16}O	416	13.4%	31.14	1.527
	^{15}O	12	0.4%	2.249	0.6493	^{15}O	140	4.5%	10.48	0.8858

Gemini: Yield events vs Z



Angular Distribution Table

– Implemented PACE style angular distribution tables for Gemini

7. Energy and angular distribution of residual nucleus Z = 11 and N = 12 (23 Na)

Residual velocity/c Vz = 8.29e-02 (sig = 4.77e-03) rms Vxy = 9.30e-03

Energy Range	Angular range (deg)																	
(MeV)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
54.0 - 60.0				2														
60.0 - 66.0		1			1	1	1				1		1					
66.0 - 72.0		2	4	3	3	1	1	1					1				1	
72.0 - 78.0			1		1	2		2	1									
78.0 - 84.0			2	2	1	3	1		3	1	1	1						
84.0 - 90.0	1	2	3	1						1	1							
Above 174																		
Total	1	5	10	8	6	7	3	3	4	2	3	1	2				1	
dSig/dOmeg	1.1e+03	1.8e+03	2.2e+03	1.2e+03	7.2e+02	6.9e+02	2.5e+02	2.2e+02	2.5e+02	1.1e+02	1.5e+02	47	87	0.00	0.00	0.00	33	0.00
0 - 0																		
0 - 90	1	5	10	8	6	7	3	3	4	2	3	1	2				1	
90 - 180																		
Above 180																		

Plot E vs Theta Plot N vs Theta Plot N vs E Plot dCS/dTheta vs Theta

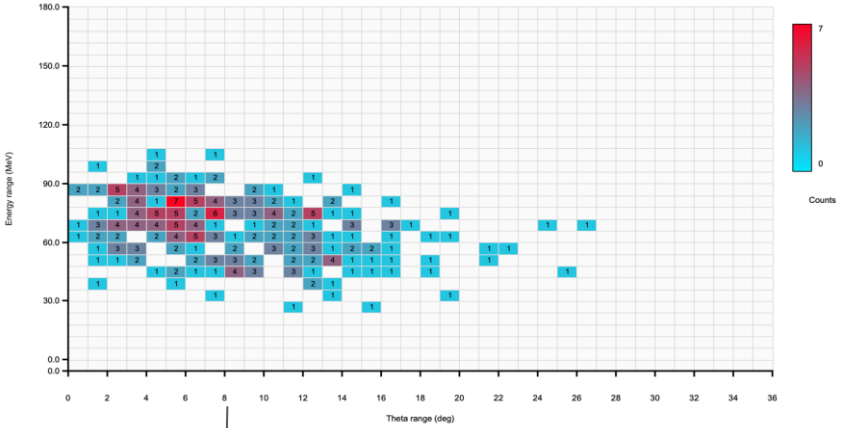
4 types of plots for each table

Plots

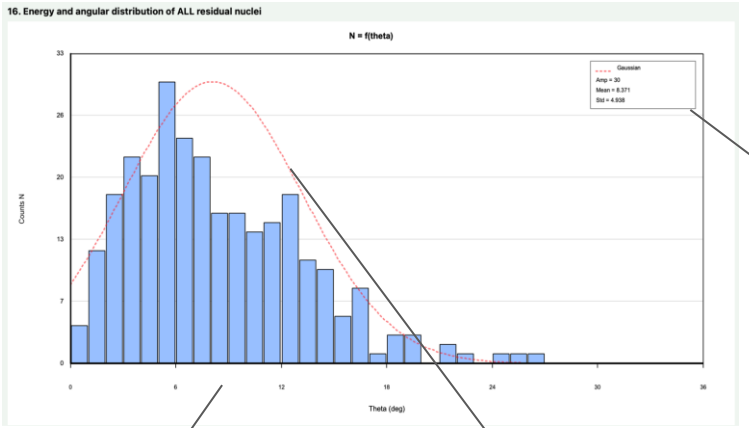
Plot All: E vs Theta Plot All: N vs Theta Plot All: N vs E Plot All: dCS/dTheta vs Theta

*** Spin alignment perpendicular to recoil axis - standard compound nucleus angular distribution

"Plot All" option for each type of plot to display plots for all tables



2D E vs Theta Plot example



1D plot example

Gaussian distribution for all 1D plots with N(count)