LBNL Isotopes Project

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Other support: Recovery Act (ARRA), Applications of Nuclear Science and Technology Initiative (ANS&T)

Isotopes Project Collaborations

- **Budapest Reactor** – Zs. Revay, T. Belgya, L. Szentmiklosi
- **Garching Reactor** – Zs. Revay, P. Kudejova
- **DICEBOX Calculations** – M. Krticka, Charles University, Prague
- **LLNL/LBNL ENDF Capture γ-ray Library** – B. Sleaford, N. Summers
- **National Ignition Facility/Stars+LiBerACE Collaboration** –

  L. Bernstein, D. Bleuel, J. Burke, J.A. Caggiano, J. Escher, J. Ressler, D.H.G. Schneider, W. Stoeffl (LLNL)
  M. Wiedeking (iThemba Labs, South Africa)
  M. Krticka, F. Becvar (Charles University, Prague)
  S. Siem, A. Goergen, M. Guttormsen, A.C. Larsen (U. Oslo)
- **Youngstown State U. (Ohio)** – J. Carroll
- **IAEA EGAF/RIPL** – D. Abriola, R. Capote, M. Kellett, V. Zerkin
- **Berkeley Geochronology Center** – P. Renne, T. Becker, K.-N. Leung

Isotopes Project Activities

Nuclear Structure Evaluation	Nuclear Data Sheet publication RIPL library evaluations
Cross Section Evaluation	EGAF database ENDF capture gamma-ray library
Nuclear Data Measurements	Cold neutron beams – Budapest/Munich Surrogate reactions - STARS-LiBerACE Astophysics/Environmental research
Nuclear Data Calculations	DICEBOX – collaboration with Prague, LLNL Shell model – under development

Nuclear Structure Evaluation Status

FY2011 Mass Chain Publications

- A=27, S. Basunia, NDS 112, 1875-1948 (2011)
- A=93, C.M. Baglin, NDS 112, 1163-1389 (2011)
- A=99*, E. Browne and J.K. Tuli, NDS 112, 275-446 (2011)
- A=220*, E. Browne and J.K. Tuli, NDS 112, 1115-1161 (2011)
- A=245*, E. Browne and J.K. Tuli, NDS 112, 447-494 (2011)
- A=246*, E. Browne and J.K. Tuli, NDS 112, 1833-1873 (2011)

* Work supported by the NNDC

Cross Section Measurements

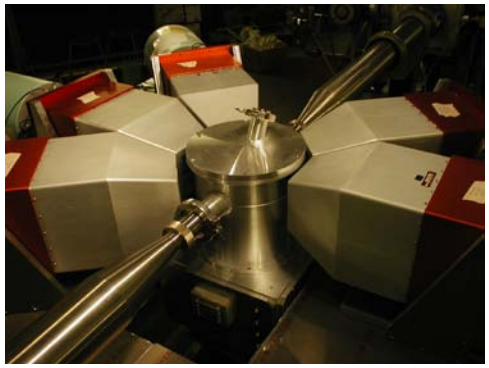
Current Status of the EGAF thermal (n,γ) cross section measurements

Target	σ_0(EGAF)	σ_0(Atlas*)	Target	σ_0(EGAF)	σ_0(Atlas*)	Target	σ_0(EGAF)	σ_0(Atlas*)
^{6}Li	52.6(22) mb	44.8(3) mb	^{28}Si	186(2) mb	171(3) mb	^{102}Pd	1.1(4) b	1.82(20) b
^{7}Li	46.3(13) mb	45.2(14) mb	^{29}Si	128(4) mb	119(3) mb	^{104}Pd	750(60) mb	650(30) mb
^{9}Be	8.8(6) mb	8.5(3) mb	^{30}Si	112(6) mb	107(2) mb	^{105}Pd	21.7(5) b	21.0(15) b
^{10}B	3.90(11) mb	3.05(16) mb	^{31}P	169(5) mb	165(3) mb	^{106}Pd	360(100) mb	300(30)
^{11}B	9.06(20) mb	5.5(33) mb	^{32}S	542(7) mb	518(14) mb	^{108}Pd	8.6(6) b	7.6(5) b
^{12}C	3.86(6) mb	3.53(7) mb	^{33}S	449(7) mb	454(20) mb	^{108m}Pd	185(10) mb	185(11) mb
^{13}C	1.51(3) mb	1.37(4) mb	^{34}S	285(8) mb	256(9) mb	^{110}Pd	340(100) mb	700(170) mb
^{14}N	78.5(7) mb	80.1(6) mb	^{35}Cl	44.00(20) b	43.6(4) b	^{151}Eu	6900(300) b*	5900(200) b
^{15}N	39(3) μb	24(8) μb	^{37}Cl	50.0(8) mb	43.3(6) mb	^{151m1}Eu	2265(300) b*	3300(200) b
^{16}O	197(7) μb	190(20) μb	^{39}K	2.28(4) b	2.1(2) b	^{153}Eu	292(12) b*	312(7) b
^{19}F	9.36(12) mb	9.51(9) mb	^{40}K	90(7) b	30(8) b	^{155}Gd	56300(1900) b*†	60900(500) b
^{23}Na	541(3) mb	517(4) mb	^{41}K	1.62(3) b	1.46(3) b	^{157}Gd	238900(6800) b*†	254000(815) b
^{24}Mg	535(20) mb	538(13) mb	^{54}Fe	2.26(5) b	2.25(18) b	^{182}W	20.3(10) b	19.9(3) b
^{25}Mg	196(8) mb	199(3) mb	^{56}Fe	2.43(1) b	2.59(14)	^{183}W	10.4(4) b	10.4(2) b
^{26}Mg	38.8(14) mb	38.4(6) mb	^{57}Fe	1.65(3) b	2.48(30) b	^{184}W	1.15(10) b	1.7(1) b
^{27}Al	232.2(17) mb	231(3) mb	^{89}Y	1.34(4) b	1.28(2) b	^{186}W	43.2(12) b	38.1(5) b
			^{89m}Y	1.9(3) mb	1.0(2) mb			

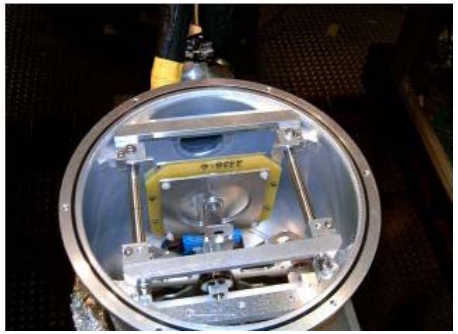
* Corrected for Westcott g-factor, † Preliminary value subject to correction γ-ray self absorption in the target.

Study of ^{168}Er statistical γ-ray decay

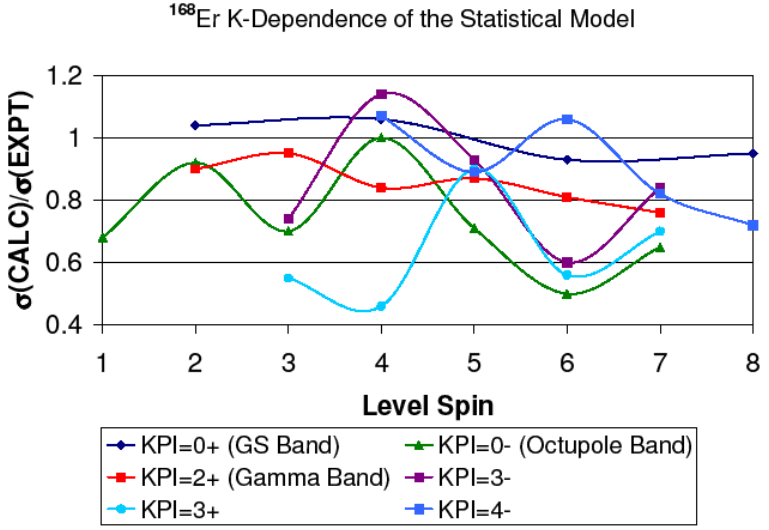
Target Chamber+6 “Clover” Ge

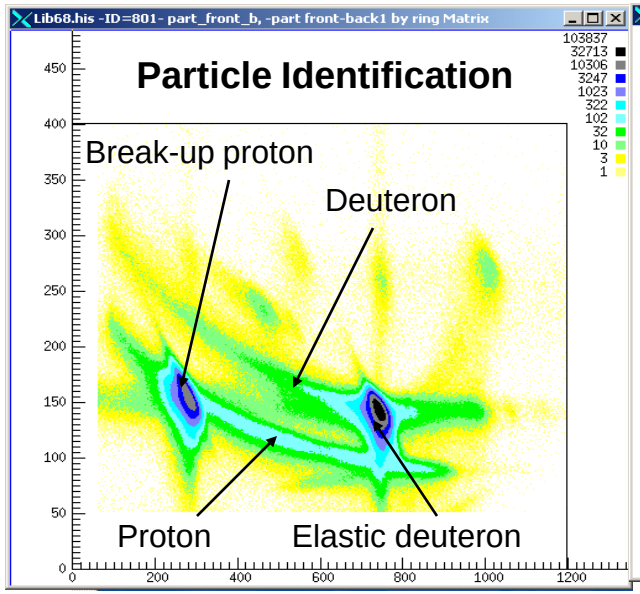


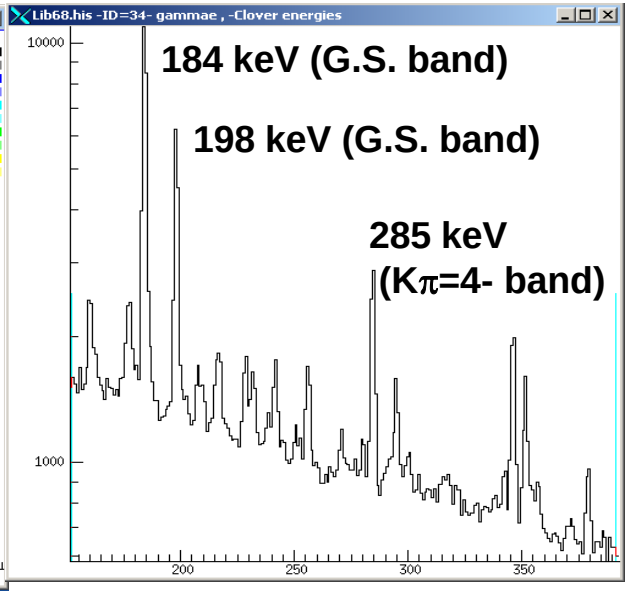
Interior w/S2 Si detectors



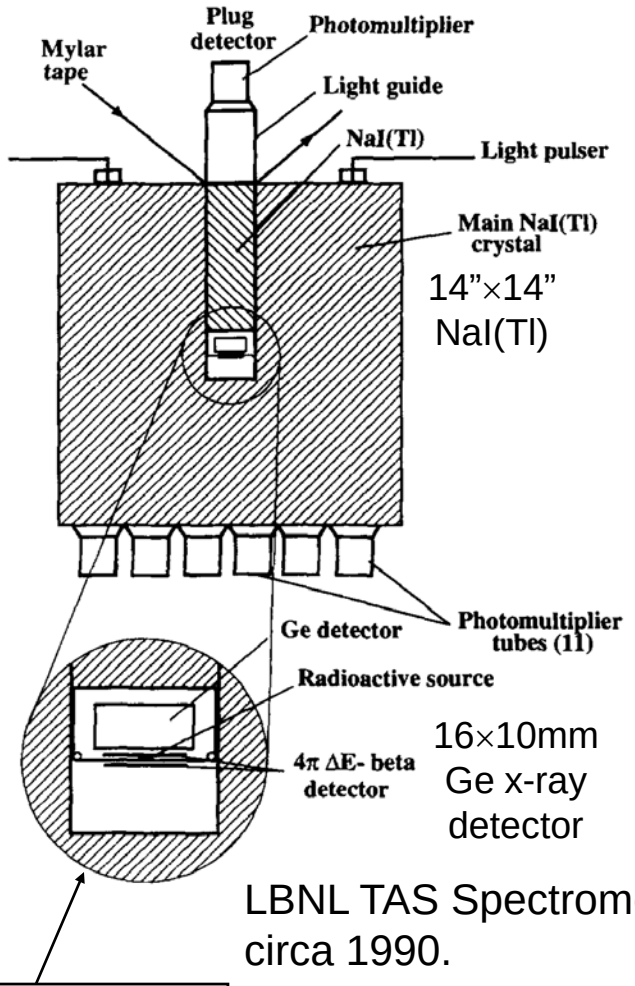
STARS/LiBeRACE







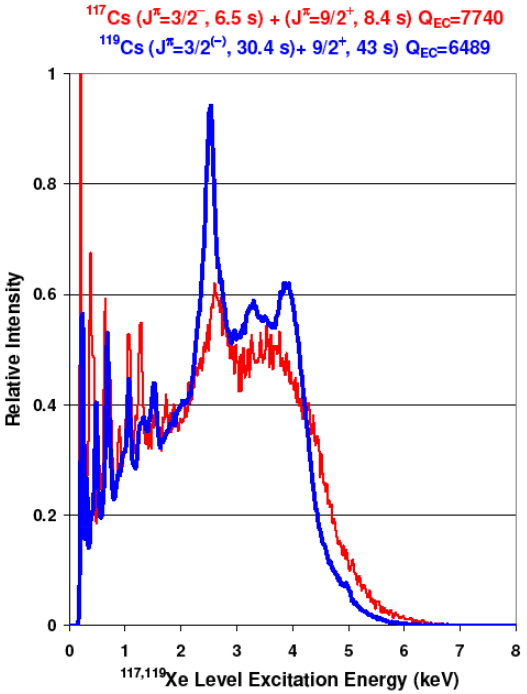
Total Absorption Spectroscopy (TAS)

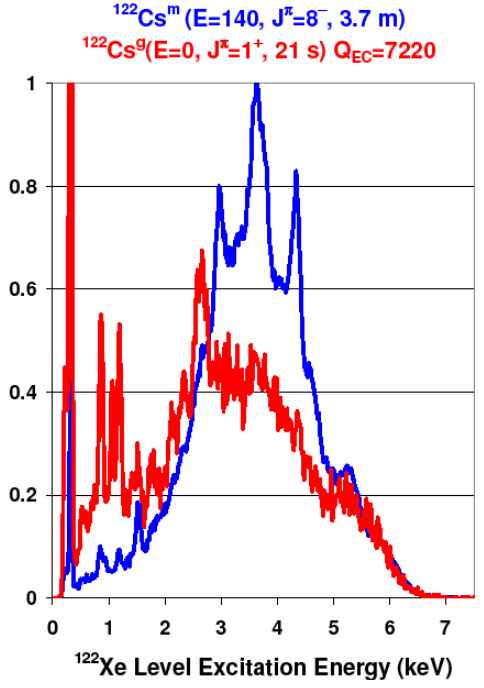


LBNL TAS Spectrometer circa 1990.

$^{100}Mo(^{28}Si,xnyp)$

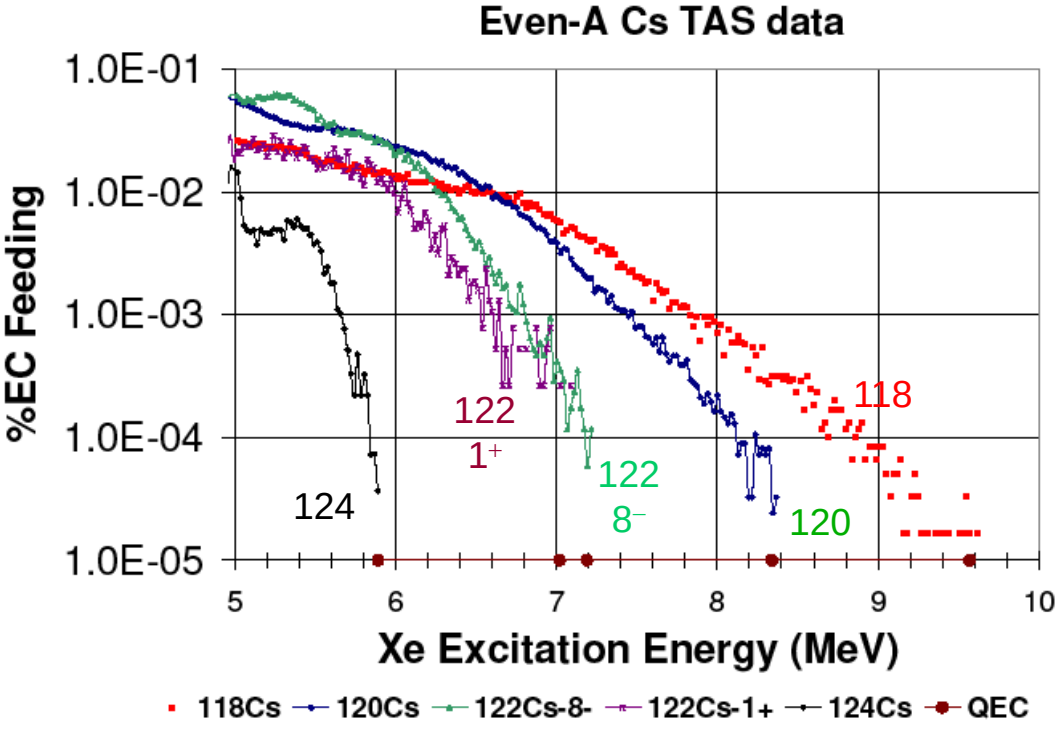
Measured TAS spectra for $^{117\text{-}124}Cs$, $^{117\text{-}121}Xe$, and $^{121\text{-}124}Ba$





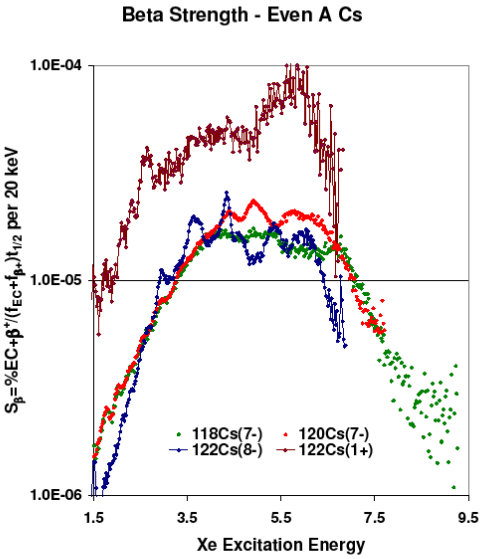
Presented at the Workshop on "Decay Spectroscopy at CARIBU: Advanced Fuel Cycle Applications, Nuclear Structure and Astrophysics, Argonne

Total Absorption Spectroscopy (TAS)



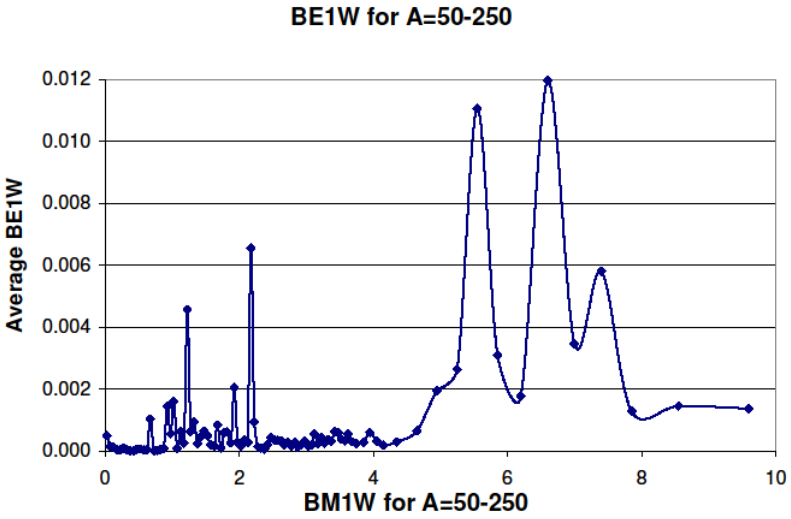
Q_{EC}-value Measurements

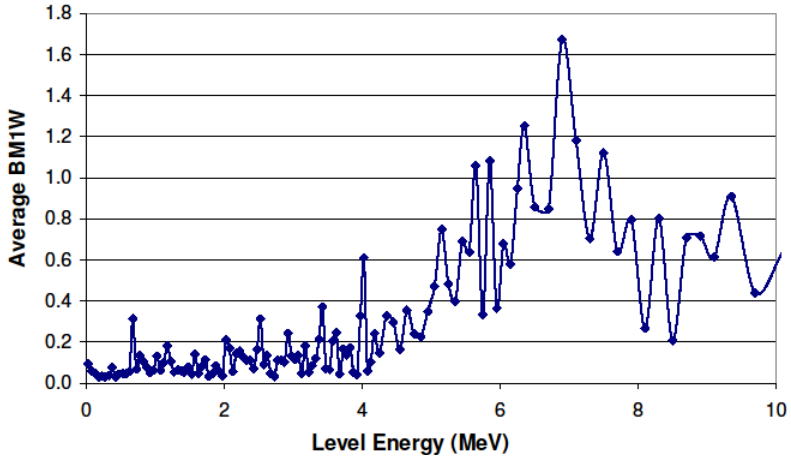
Isotope	AME (Audi)		TAS
	E	Q_{EC}	
^{118}Cs(2)	0	9670(16)	9570(100)
^{118}Cs(7$^-$)	100(60)		
^{120}Cs(2$^-$)	0	8284(15)	8340(100)
^{120}Cs(7$^-$)	100(60)		
^{122}Cs(1$^+$)	0	7220(30)	7020(100)
^{122}Cs(8$^-$)	140(30)		7190(100)
^{124}Cs(1$^+$)	0	5929(9)	5890(100)



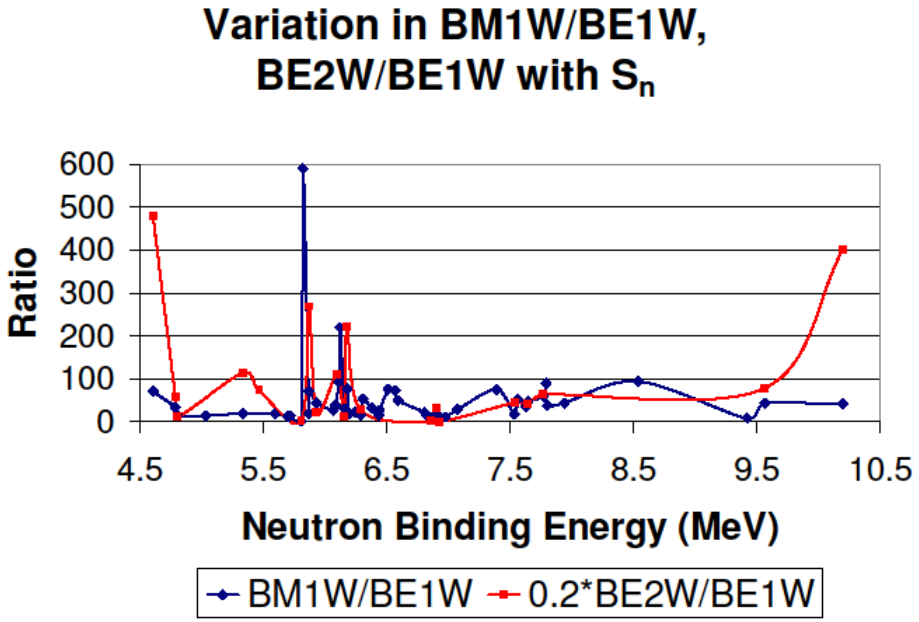
Failure of the Gross Theory of β-decay

Statistical Model Systematics





ENSDF transition probabilities



EGAF Primary γ-ray transition probabilities

Significant evidence of nuclear structure contributions seen in both ENSDF and EGAF data.

Presented at the 3rd Workshop on Level Density and Gamma Strength, Oslo.

Neutron Generator Project

D+D neutron generator, >10^{11} n/s

Central ~2.5 MeV neutron port

Thermal/Epithermal neutron ports

Collaboration with the Berkeley Geochronology Center and the UC Nuclear Engineering Department.

- Ar-Ar dating
- Analytical nuclear chemistry NAA/PGAA
- Fast neutron (n,γ) cross sections
- Electronic chip testing
- Nuclear medicine
- Nuclear engineering
- Replacement of disappearing research reactors

Nuclear Applications

YD impact: *New Evidence from Central Mexico supporting the Younger Dryas Boundary (YDB) Cosmic Impact Hypothesis,* I. Israde-Alcántara, J. Bischoff, G. Domínguez-Vázquez, H.-C. Li, P. DeCarli, T. Bunch, J. Wittke, J. Weaver, R. Firestone, A. West, J. Kennett, C. Mercer, S. Xie, E. Richman, J. McGeehin, C. Kinzie, and W. Wolbach, submitted to Proc. Nat. Acad. Sci.

Discovery of 12.9 ka cal sediment layer in Lake Cuitzeo, Mexico containing exotic markers in high abundance, including nanodiamonds, magnetic spherules with rapid-melting textures and carbon spherules confirming a massive impact event that caused the extinction of the Mammoths and megafauna and 1300 years of global cooling.

Beringian Impact: Field trips to British Museum, NY Museum of Natural History, and the Whitehorse Yukon Beringian Interpretive Centre uncovered dozens of Mammoth tusks, Caribou antlers, and Bison, Musk Ox, and Rhinocerous skulls dating to >20 ka BP containing magnetic particles of meteoritic origin.

Near Earth Supernovae: 18 new near Earth supernovae (<300 pc) were discovered in the ^{10}Be isotopic record of the past 300 ka. Correlation between near Earth SN cosmic rays and global temperature increase of ~5ºC was observed. *Evidence of near-Earth prehistoric supernovae and SNR cosmic ray production in the radiocarbon record,* R.B. Firestone, to be submitted to Science.


That's All Folks