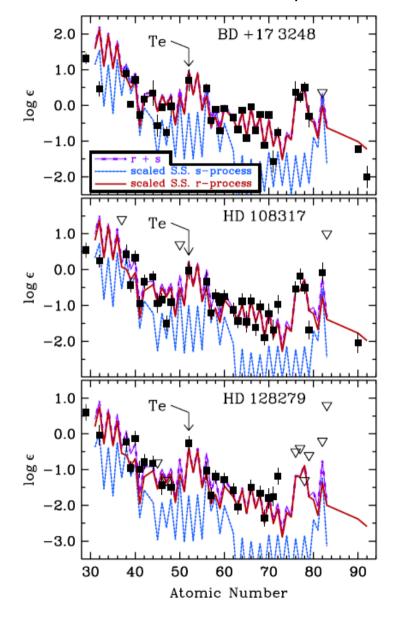
Measurement of β -delayed neutron emission probabilities relevant to the A = 130 r-process abundance peak

A. Estrade, G. Lorusso, and F. Montes for the BRIKEN collaboration

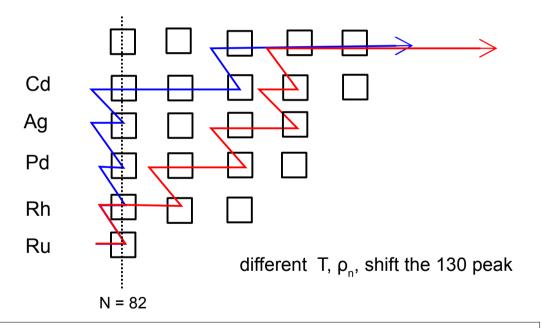
The A = 130 peak and metal poor stars

Observation of Te in metal poor stars



I. Roederer et al., 2012

- New Te observation (A ≤ 130) and Ba (A ≥ 140) highlight r-process conditions in single r-process events
- Te/Ba ratio is sensitive to
 - + r-process conditions
 - + contribution of the weak r-process
- Pn is one of the important unknown affecting the ratio Te/Ba

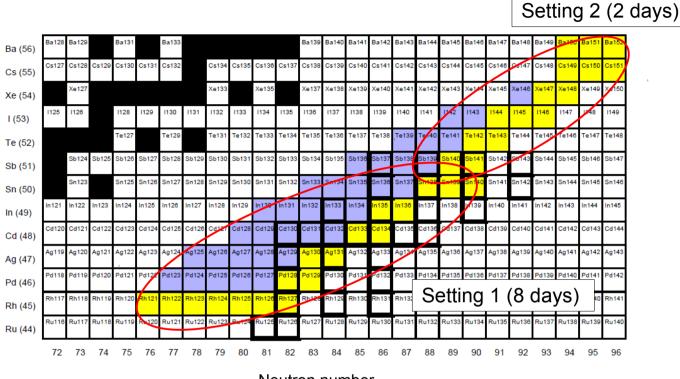


Pn vs. (n, γ) competition during freezout?

Based on current predictions, A = 130 is build up almost entirely during freezout

Farouqi et al., 2010

Goals of the experiment



Measurement of

33 P1n

11 P2n

3 P3n

All relevant to the A=130 peak

Remeasure

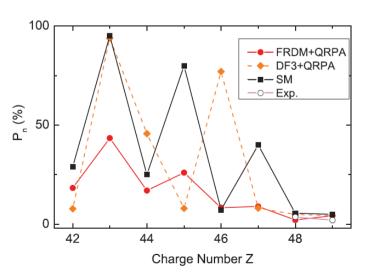
First measured

Neutron number

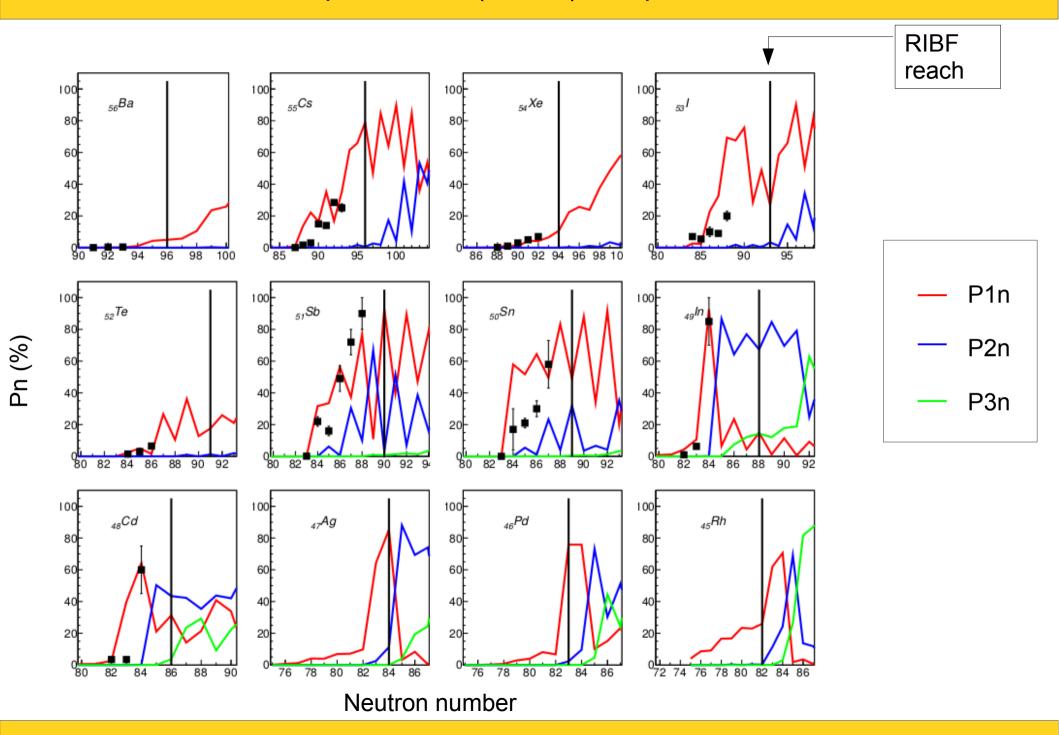


- 1) N = 82 nuclei
- (129Ag, 127Rh)
- possibly the most exotic probe of shell model
- possibly the largest source of neutron during freezout
- 2) Rh, Pd, Ag are progenitors of Te (131Ag, 129Pd) Sb, Sn, In are progenitors of Ba
- 3) Candidate for b-2n, b-3n emission (134,135,136In)

Pn of N = 82 nuclei

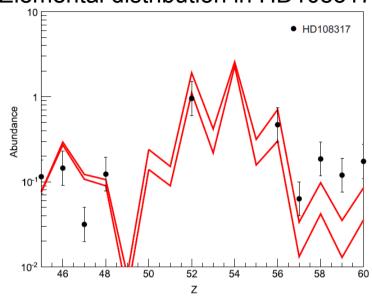


P1n, P2n, P3n predictions (FRDM) and previous measurements



Sensitivity of the Te/Ba ratio to Pn values

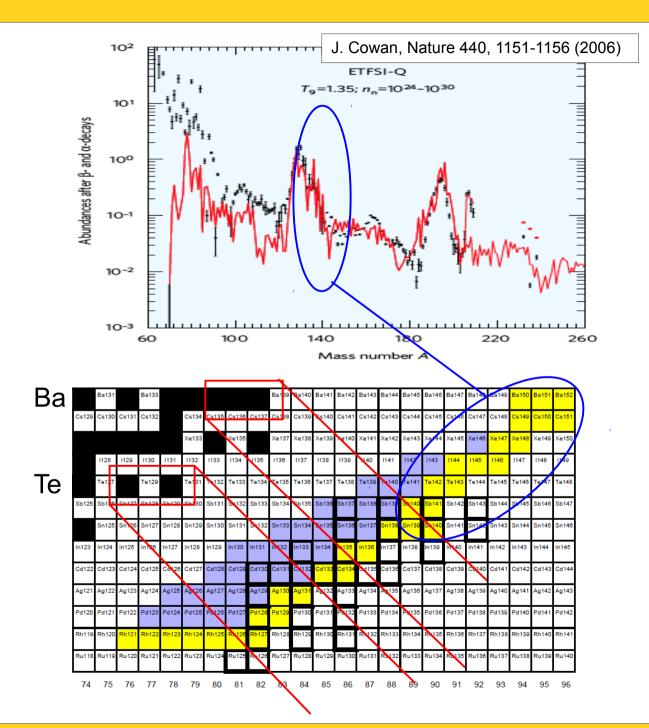
Elemental distribution in HD108317



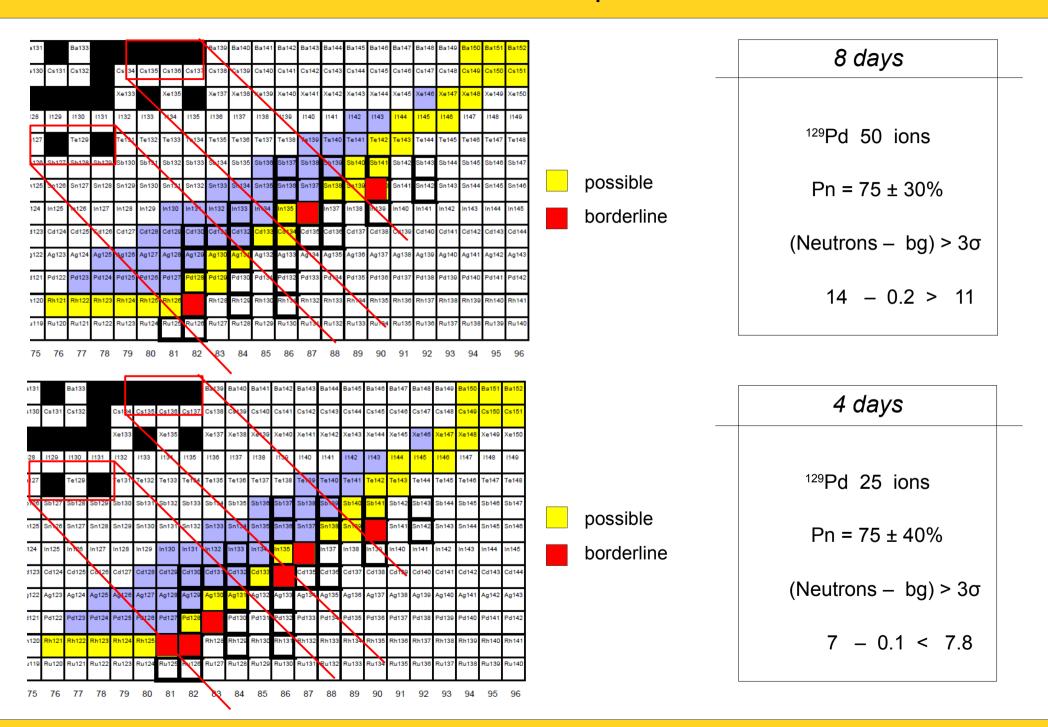
Two r-process calculations changing:

- Only the P-1n values that we will measure
- No P-2n values
- Only shown entropy components for the A=130 peak

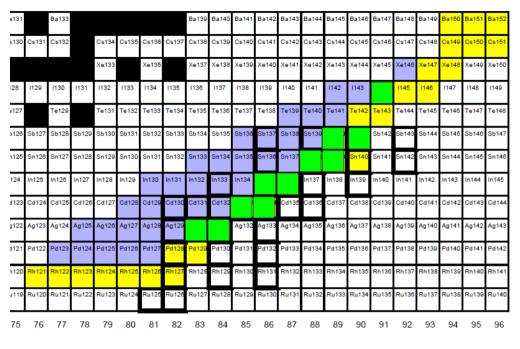
Ratio Te/Ba is affected by a factor > 5



Beam time request



Beam time request (2n emitters)



1131		Ba133						Ba139	Ba140	Ba141	Ba142	Ba143	Ba144	Ba145	Ba146	Ba147	Ba148	Ba149	Ba150	Ba151	Ba152
:130	Cs131	Cs132		Cs134	Cs135	Cs136	Cs137	Cs138	Cs139	Cs140	Cs141	Cs142	Cs143	Cs144	Cs145	Cs146	Cs147	Cs148	Cs149	Cs150	Cs151
				Xe133		Xe135		Xe137	Xe138	Xe139	Xe140	Xe141	Xe142	Xe143	Xe144	Xe145	Xe148	Xe147	Xe148	Xe149	Xe150
28	l129	I130	I131	I132	I133	I134	l135	I136	1137	1138	1139	1140	1141	1142	1143	1144		I146	1147	I148	1149
:127		Te129		Te131	Te132	Te133	Te134	Te135	Te136	Te137	Te138	Te139	Te140	Te141	Te142	Te143	Te144	Te145	Te146	Te147	Te148
126	Sb127	Sb128	Sb129	Sb130	Sb131	Sb132	Sb133	Sb134	Sb135	Sb136	Sb137	Sb138	Sb139	Sb140		Sb142	Sb143	Sb144	Sb145	Sb146	Sb147
1125	Sn126	Sn127	Sn128	Sn129	Sn130	Sn131	Sn132	Sn133	Sn134	Sn135	Sn136	Sn137	Sn138		Sn140	Sn141	Sn142	Sn143	Sn144	Sn145	Sn146
124	In125	In126	In127	In128	In129	In130	In131	In132	In133	In134	In135			In138	In139	In140	In141	In142	In143	In144	In145
1123	Cd124	Cd125	Cd126	Cd127	Cd128	Cd129	Cd130	Cd131	Cd132	Cd133	Cd134	Cd135	Cd136	Cd137	Cd138	Cd139	Cd140	Cd141	Cd142	Cd143	Cd144
1122	Ag123	Ag124	Ag125	Ag126	Ag127	Ag128	Ag129	Ag130	Ag131	Ag132	Ag133	Ag134	Ag135	Ag136	Ag137	Ag138	Ag139	Ag140	Ag141	Ag142	Ag143
1121	Pd122	Pd123	Pd124	Pd125	Pd126	Pd127	Pd128	Pd129	Pd130	Pd131	Pd132	Pd133	Pd134	Pd135	Pd136	Pd137	Pd138	Pd139	Pd140	Pd141	Pd142
1120	Rh121	Rh122	Rh123	Rh124	Rh125	Rh126	Rh127	Rh128	Rh129	Rh130	Rh131	Rh132	Rh133	Rh134	Rh135	Rh136	Rh137	Rh138	Rh139	Rh140	Rh141
ı119	Ru120	Ru121	Ru122	Ru123	Ru124	Ru125	Ru126	Ru127	Ru128	Ru129	Ru130	Ru131	Ru132	Ru133	Ru134	Ru135	Ru136	Ru137	Ru138	Ru139	Ru140

75 76 77 78 79 80 81 82 83 84 85

8 days
11 candidates

possible

4 days
5 candidates

possible

Summary

Tremendous progress have been made in the astronomical side, and more will come from planned metal poor star survey

- Pn values are among the important nuclear physics input, are highly uncertain, and difficult to predict
- We propose to measure 33 P1n, 11 P2n, 3P3n progenitors of the A = 130 that will:

- 1. direct impact in r-process (e.g., reduce the Te/Ba ratio of a factor 5)
- 2. provide a volume of data to improve models

Nucleus	N ⁰ ions Setting 1 (8 days)	N ⁰ ions Setting 2 (2 days)	$P_{1n}(\%)$ FRDM	$P_{2n}(\%)$ FRDM	$P_{3n}(\%)$ FRDM		# β2n detected	
$^{121}\mathrm{Rh}$	1300	(2 days)	8			40		
$^{122}\mathrm{Rh}$	3200		9			106		
$^{123}\mathrm{Rh}$	13500		16			807		
$^{124}\mathrm{Rh}$	4000		16			241		
$^{125}\mathrm{Rh}$	1100		23			93		
$^{126}\mathrm{Rh}$	155		23			13		
$^{127}\mathrm{Rh}$	16		25			1		
128Pd	980		6.7			24		
$^{129}\mathrm{Pd}$	53		75	2.4		14		
130Ag	3200		64	2.5		741	18	
$^{131}\mathrm{Ag}$	480		85	11		147	12	
¹³³ Cd	2350		21	50		178	255	
¹³⁴ Cd	152		31	43		17	15	
$^{135}{ m In}$	20000		23	64	7.5	1693	2776	192
$^{136}\mathrm{In}$	752		4.3	77	12	12	125	12
¹³⁸ Sn	11000	7950	83	4		5683	161	
$^{139}\mathrm{Sn}$	200	130	44	31		58	23	
$^{140}\mathrm{Sn}$	13	8	88	4		7		
¹⁴⁰ Sb	10350	13000	11	67	0.9	907	3422	28
$^{141}\mathrm{Sb}$	4769	630	92	3	0.8	1802	38	
¹⁴² Te		60000	12			2754		
$^{143}\mathrm{Te}$		2200	17	1.2		139		
144I		1.0×10^{5}	28	1.7		10307	365	
$^{145}\mathrm{I}$		7000	49			1233		
^{146}I		230	26	3		22		
¹⁴⁷ Xe		10000	6			235		
$^{148}\mathrm{Xe}$		850	10			33		
¹⁴⁹ Cs		33000	61			7303		
$^{150}\mathrm{Cs}$		2500	65			593		
$^{151}\mathrm{Cs}$		150	78			42		
$^{150}\mathrm{Ba}$		7000	1			25		
$^{151}\mathrm{Ba}$		10000	4			144		
$^{152}\mathrm{Ba}$		5500	5			99		