

# $\beta$ -decay spectroscopy of nuclei around and below $N=82$ including $^{128}\text{Pd}_{82}$

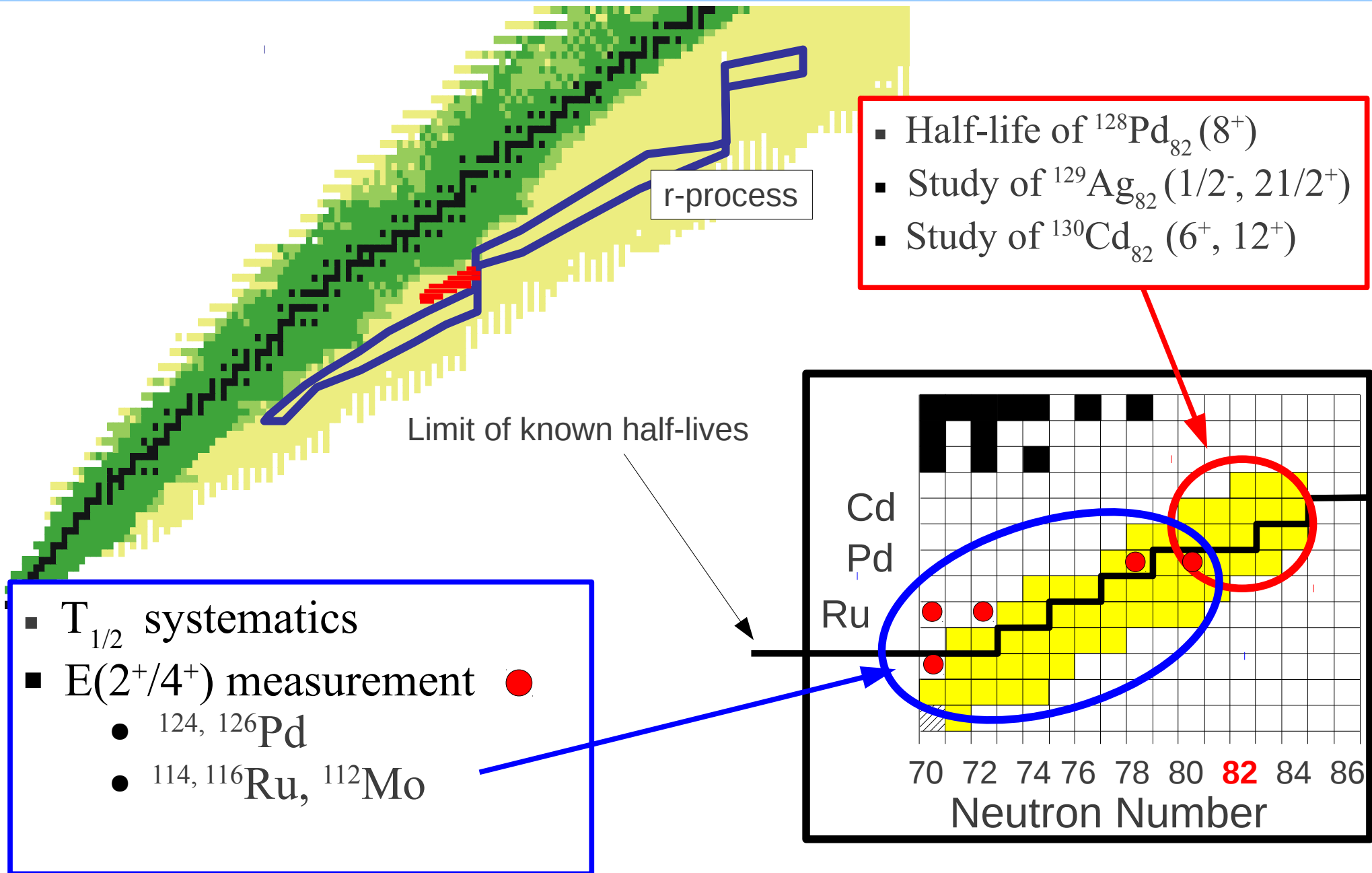
E(U)RICA International Workshop

Giuseppe Lorusso

RIKEN

23-24 May 2011

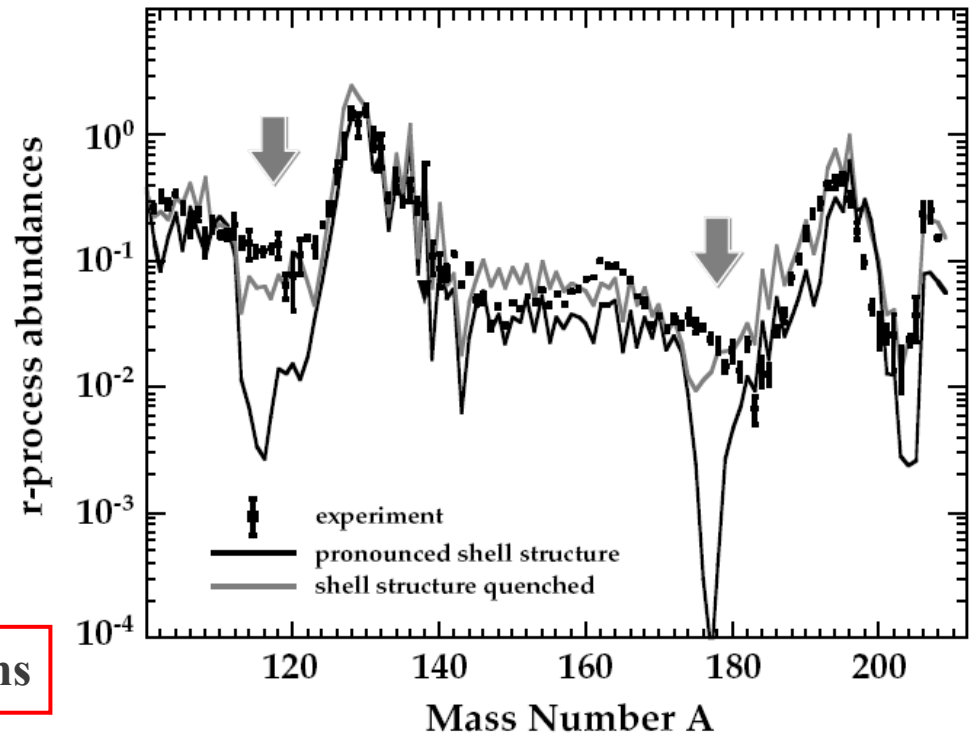
# $\beta$ -decay spectroscopy of nuclei around and below $N=82$ including $^{128}\text{Pd}_{82}$



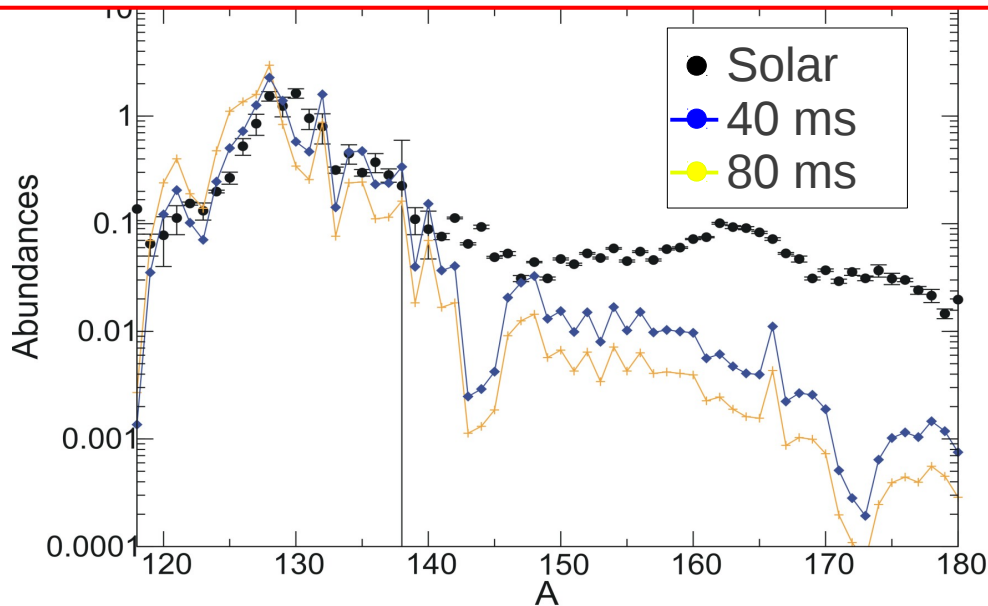
# Impact of the proposed measurements for the r-process

## A. half-lives $^{128}\text{Pd}$ , $^{129}\text{Ag}$

1. Effects the  $A = 126$  peak
2. Effects the flow to heavier mass (cosmochronometers)
4. Benchmark structure models



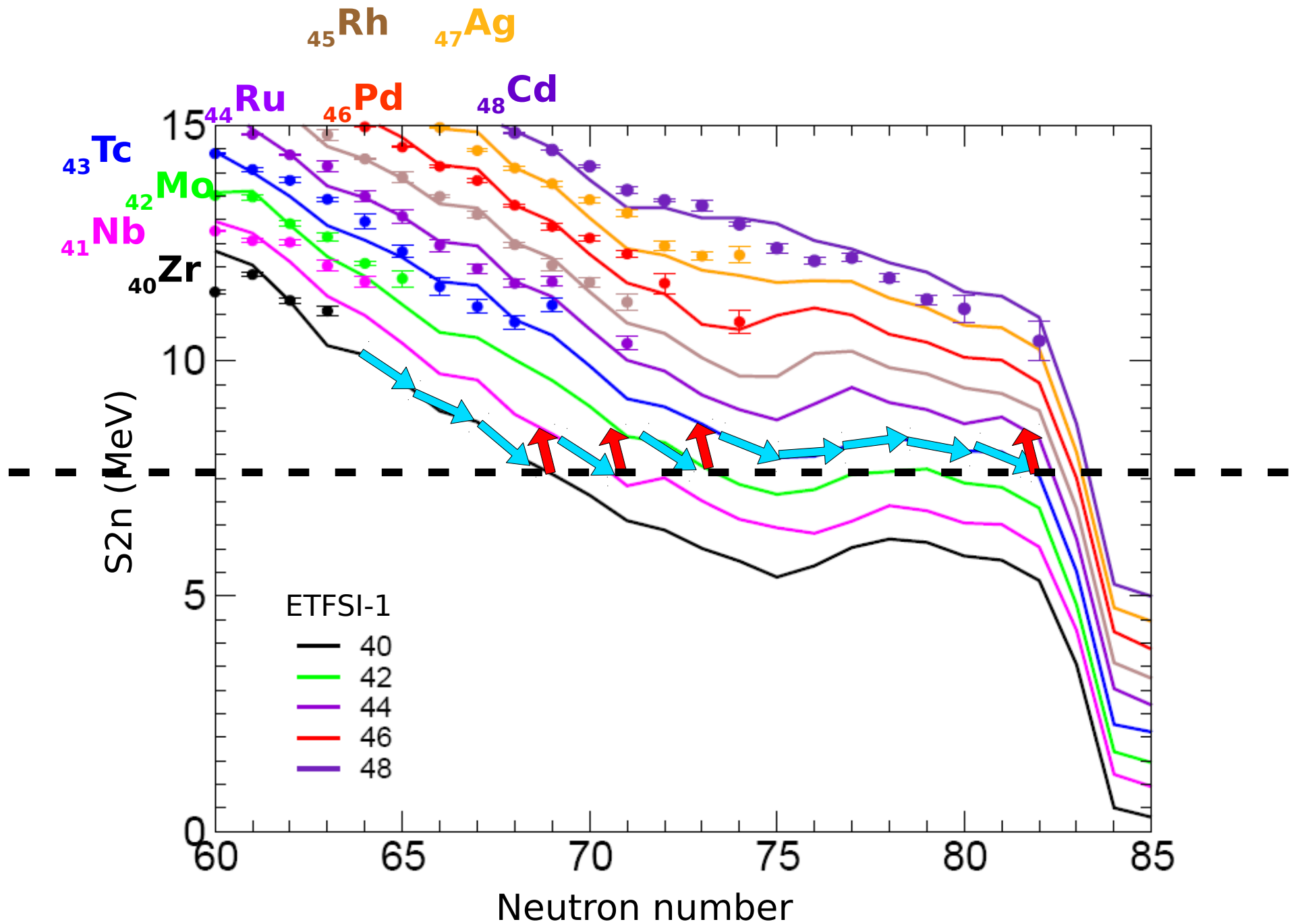
Classical r-process  $T_9=1.35$ ,  $n_n=10^{26} \text{ cm}^{-3}$ ,  $\tau = 800 \text{ ms}$



## B. Region $N \leq 82$

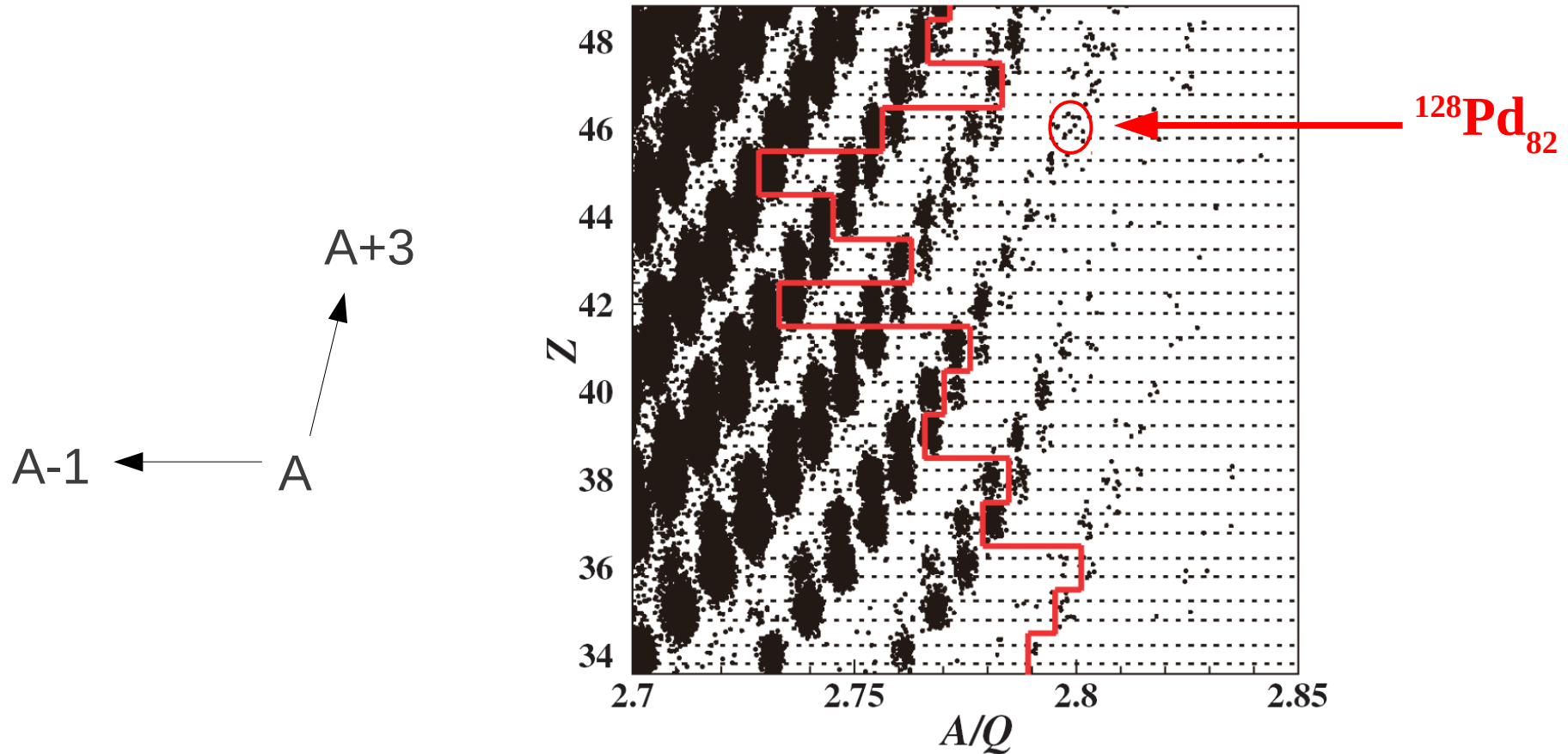
1. Rapid change of deformation
2. Shell quenching

# Study of $^{124,126}\text{Pd}$ effect of deformation on the r-process path



# Feasibility of secondary beam production

T. Ohnishi et al. J. Phys. Soc. Jpn. **79** (2010) 073201

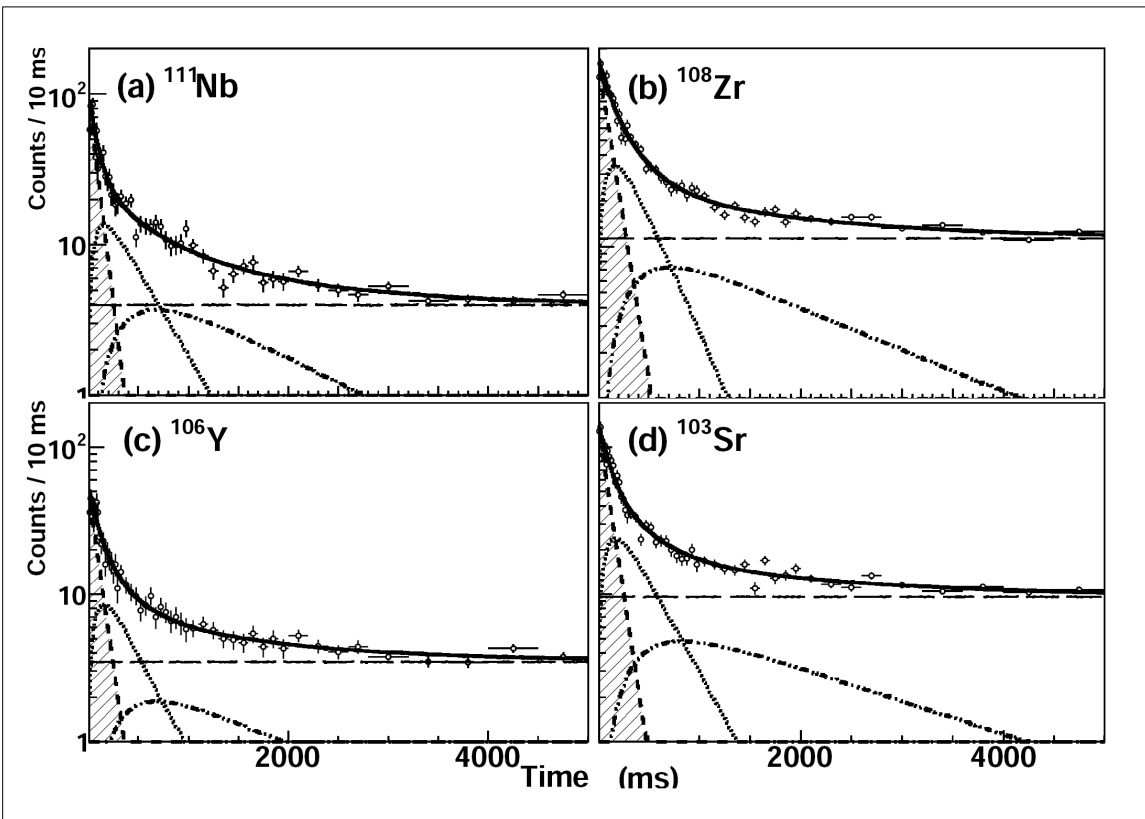


**13 events of  $^{128}\text{Pd}_{82}$  identified in 42.5 h of beam on target**

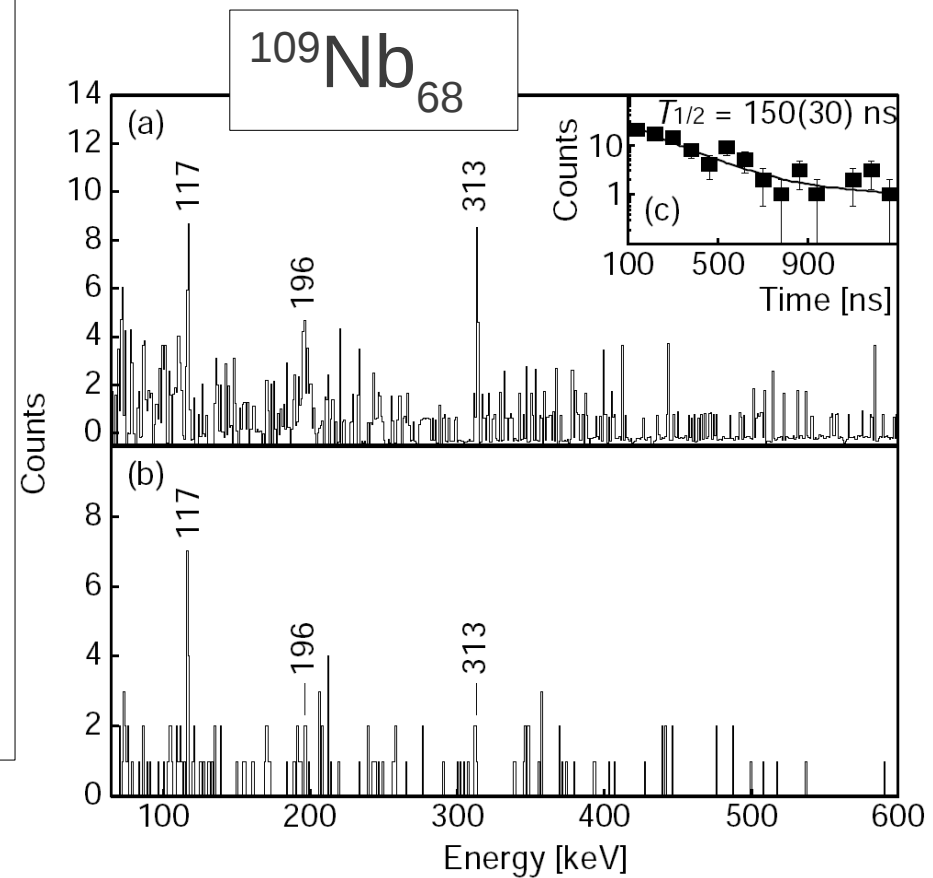
**$^{238}\text{U}$  345 MeV/nucleon and 0.25 pA**

# Feasibility of the $\beta$ -decay study

$\beta$ -decay study around  $^{110}\text{Zr}_{70}$  (2009) was successful

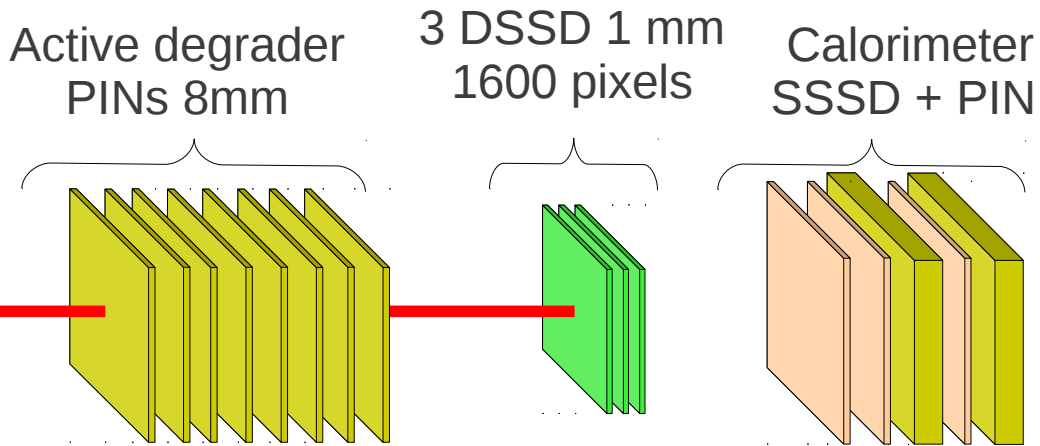


S. Nishimura et al., PRL 106, 05502 (2011)



H. Watanabe et al., PLB 696, 186 (2011)

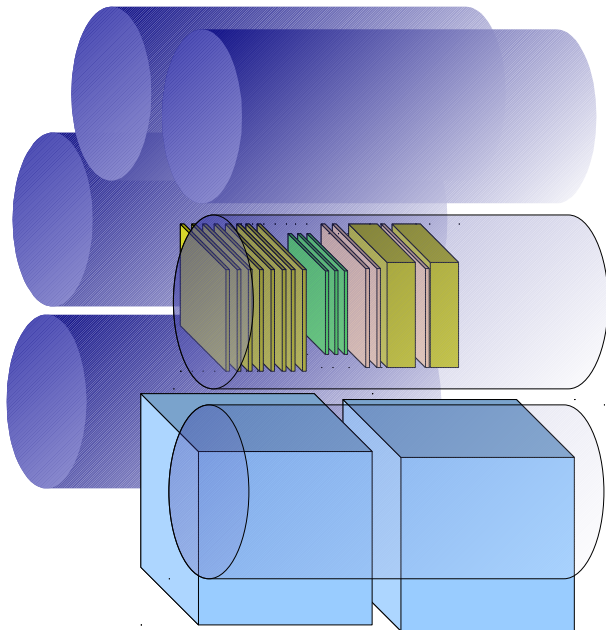
# Implant-decay station and gamma detector



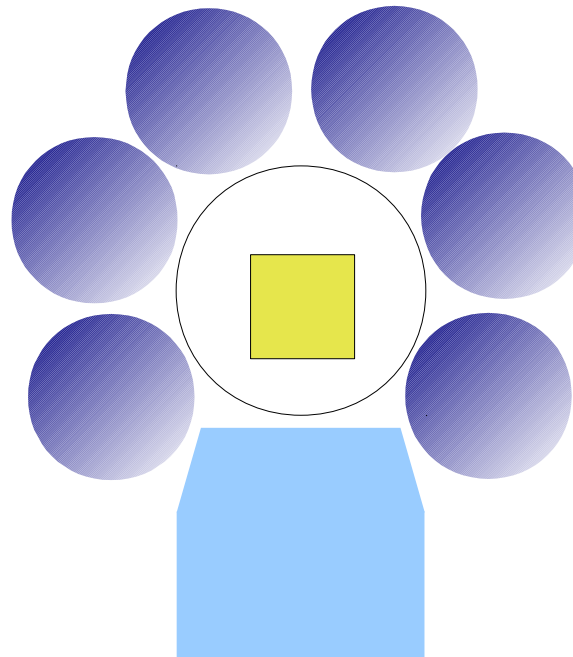
## Performance

- Energy thresholds  $\sim 20$  keV
- Total rate 10 pps (max 500 pps)
- Total energy measurement

Side view



beam view



**6 LaBr<sub>3</sub> (20 cm x 8 cm  $\emptyset$ )**  
efficiency  $\sim 18$  % @ 1 MeV  
resolution  $\sim 3$  % @ 662 keV

**2 Clovers (10 x 10 x 6 cm<sup>3</sup>)**  
efficiency  $\sim 1$  % @ 1 MeV

# BEAM TIME REQUEST

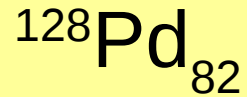
1<sup>st</sup> Setting

6 days

<sup>238</sup>U beam 345 MeV/nucleon 5 pnA

Detected beta decays

Setting optimized for



		N=82		
			<sup>132</sup> In	<sup>133</sup> In
			3 10 <sup>4</sup>	5400
	<sup>129</sup> Cd	<sup>130</sup> Cd	<sup>131</sup> Cd	<sup>132</sup> Cd
	3.5 10 <sup>5</sup>	2.5 10 <sup>5</sup>	5 10 <sup>4</sup>	1.5 10 <sup>4</sup>
<sup>127</sup> Ag	<sup>128</sup> Ag	<sup>129</sup> Ag	<sup>130</sup> Ag	<sup>131</sup> Ag
1.5 10 <sup>5</sup>	1 10 <sup>5</sup>	1 10 <sup>4</sup>	2000	150
<sup>126</sup> Pd	<sup>127</sup> Pd	<sup>128</sup> Pd	<sup>129</sup> Pd	
1 10 <sup>4</sup>	1600	250	65	
<sup>125</sup> Rh	<sup>126</sup> Rh			
1500	35			



r-process nuclei



New half-lives



# BEAM TIME REQUEST

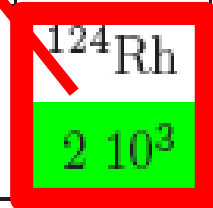
2<sup>st</sup> Setting 5 pnA x 4 days

Setting optimized for  $^{124}\text{Rh}_{79}$

Detected beta decays

						$^{130}\text{In}$ $8 \cdot 10^5$
						$^{128}\text{Cd}$ $3 \cdot 10^6$
						$^{129}\text{Cd}$ $1.5 \cdot 10^6$
				$^{125}\text{Ag}$ $8 \cdot 10^5$	$^{126}\text{Ag}$ $8 \cdot 10^5$	$^{127}\text{Ag}$ $8 \cdot 10^5$
						$^{128}\text{Ag}$ $8 \cdot 10^4$
				$^{123}\text{Pd}$ $6 \cdot 10^5$	$^{124}\text{Pd}$ $1 \cdot 10^5$	$^{125}\text{Pd}$ $5 \cdot 10^4$
						$^{126}\text{Pd}$ $2 \cdot 10^4$
						$^{127}\text{Pd}$ $1 \cdot 10^3$
	$^{121}\text{Rh}$ $5 \cdot 10^2$	$^{122}\text{Rh}$ $4 \cdot 10^4$	$^{123}\text{Rh}$ $2 \cdot 10^4$	$^{124}\text{Rh}$ $2 \cdot 10^3$	$^{125}\text{Rh}$ 200	$^{126}\text{Rh}$ 15
$^{120}\text{Ru}$ 80	$^{121}\text{Ru}$ $2 \cdot 10^3$	$^{122}\text{Ru}$ $2 \cdot 10^2$	$^{123}\text{Ru}$ $5.5 \cdot 10^1$	$^{124}\text{Ru}$ 32		
	$^{120}\text{Tc}$ 30					

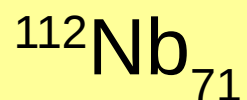
$E(2^+)$



r-process nuclei

New half-lives

Settings optimized for



	$E(2^+)$		$E(2^+)$	$^{117}\text{Ru}$	$^{118}\text{Ru}$	$^{119}\text{Ru}$
				$1.5 \cdot 10^5$	$3 \cdot 10^5$	$7 \cdot 10^4$
		$^{114}\text{Tc}$	$^{115}\text{Tc}$	$^{116}\text{Tc}$	$^{117}\text{Tc}$	$^{118}\text{Tc}$
		$2 \cdot 10^5$	$5 \cdot 10^3$	$7 \cdot 10^4$	$1.5 \cdot 10^4$	1000
	$E(2^+)$	$^{113}\text{Mo}$	$^{114}\text{Mo}$	$^{115}\text{Mo}$	$^{116}\text{Mo}$	$^{117}\text{Mo}$
		$2 \cdot 10^5$	$3.5 \cdot 10^4$	$5 \cdot 10^3$	400	15
$^{111}\text{Nb}$	$^{112}\text{Nb}$	$^{113}\text{Nb}$	$^{114}\text{Nb}$	$^{115}\text{Nb}$		
450	$5 \cdot 10^3$	3000	100	10		
$^{110}\text{Zr}$	$^{111}\text{Zr}$	$^{112}\text{Zr}$				
20	120	7				

 r-process nuclei

 New half-lives

# THE CORE COLLABORATION



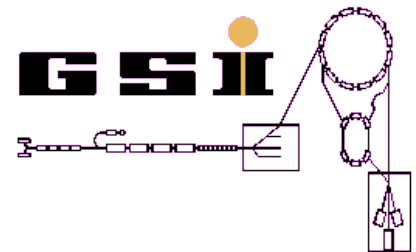
G. Lorusso, S. Nishimura, Z. Li, P. Doornenbal, J. Lee, K. Yoshinaga, H. Sakurai, T. Sumikama, H. Watanabe, J. Xu



A. Becerril, F. Montes, J. Pereira, H. Schatz



N. Blasi, A. Bracco, F. Camera, O. Wieland



A. Estrade



K. Smith