



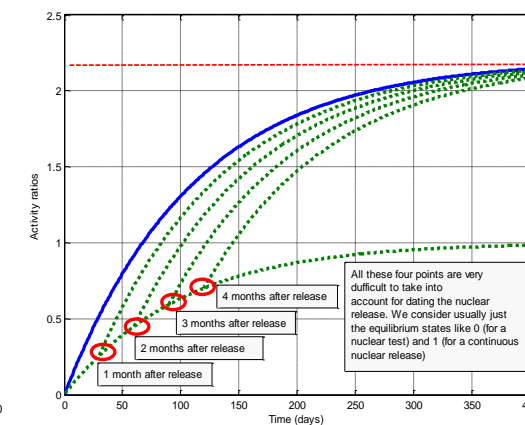
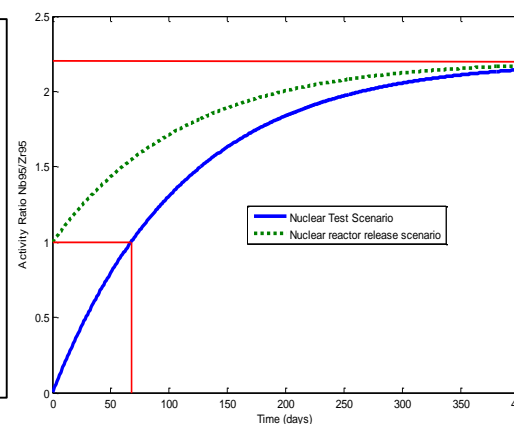
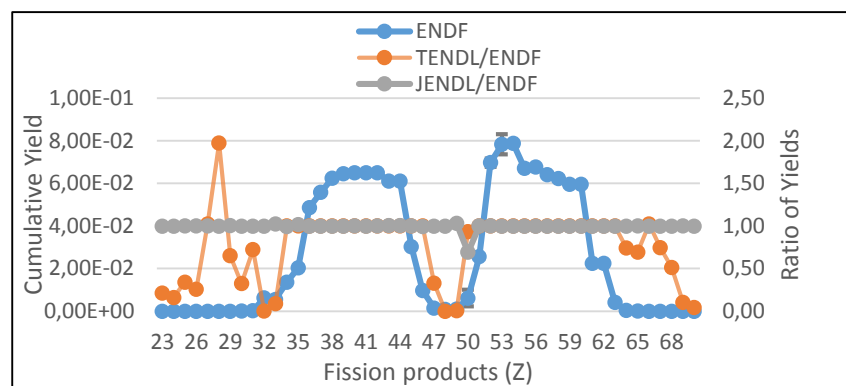
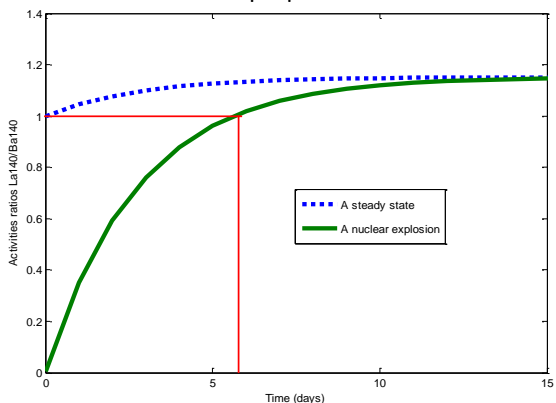
Dating a nuclear event based on isotopic ratios

K. YAMBA, O. SANOGO, M. B. KALINOWSKI, M. MIKKINEN J. KOULIDIATI
SnT2015 – CTBTO, Vienna – Austria

(T2.2-P06)



- Dating of nuclear event by using isotopic activity ratio requires the use of nuclear constants such as ENDF, TENDL, JENDL JEFF or LARA(LNHB-CEA). In order to improve the accuracy of zero time, it is important to take into account these databases which do not give always the same values.
- Activity ratios Y92/Sr92 (usable for a few days), La140/Ba140 (usable for about one week) and Nb95/Zr95 (usable for up to one year) have been studied, and some constants have been proposed for a fast and accurate assessment of zero time.



From left to right

- ❑ Figure 1: Change over time of the activity ratio La140/Ba140 according to nuclear explosion and continuous nuclear reactor release scenarios.
- ❑ Figure 2: Overview of fission product Cumulative Yield according to the various Databases. Data are converging with the high yields.
- ❑ Figure 3: Change over time of the activity ratio Nb95/Zr95 according to the nuclear test and continuous nuclear reactor release scenarios.
- ❑ Solid line in blue: Nuclear explosion scenario. Dotted line in green: Continuous nuclear reactor release scenario.

SAMPLE	COLLECTION START	ACQUISITION START	Zero-time in the case of Nuclear test	Zero-time in the case of Continuous nuclear reactor release
SAMP1	15-MAY-2010	17-MAY-2010	12-MAY 01:00 +17h/-24h	
SAMP2	16-MAY-2010	18-MAY-2010	13-MAY 21:00 +12h/-15h	
SAMP3	17-MAY-2010	19-MAY-2010	12-MAY 07:00 +31h/-62h	no consistent
SAMP4	18-MAY-2010	20-MAY-2010		
SAMP5	19-MAY-2010	21-MAY-2010	13-MAY 18:00 +37h/-93h	no consistent
SAMP6	20-MAY-2010	22-MAY-2010	11-MAY 19:00 +78h/-...	17-MAY 11:00 +78h/-...
SAMP7	21-MAY-2010	23-MAY-2010		
SAMP8	22-MAY-2010	24-MAY-2010	no consistent	

Study Result of recordings La140 and Ba140 on May 2010 AT JPP37

According to our estimation by using these eight samples (La140 and Ba140) recorded at JPP37, consistency is noted with the hypothesis of a nuclear test between May 11 and May 13, 2010.

Disclaimer: The views expressed by the authors do not necessarily reflect those of the CTBTO

Using La140/Ba140 and Y92/Sr92 activity ratios for dating is expressed as:

The age is given as: $t = U \cdot \ln\left(\frac{r-A}{F-A}\right)$

The age limits are given as:

$$t = U \ln(J)$$

$$\begin{cases} t_{up} = (U + \Delta U) \ln(J + \Delta J) \\ t_{low} = (U - \Delta U) \ln(J - \Delta J) \end{cases}$$

With $J = \frac{r-A}{F-A}$

Comparison with others studies based on May 15th 2010 detection

- ❖ DE GEER (*Science & Global Security*, 20:1–29, 2012): **May 11, 06:00 +18h/-30h (UTC)**
- ❖ IHANTOLA (*J Radioanal Nucl Chem* (2013) 298:1283–1291): **May 12, 16:00 (UTC)**
- ❖ ZHANG and WEN (*Seismological Research Letters Volume 86, Number 1- January/February 2015*): **May 12, 00:00 (UTC)**
- ❖ Our estimation (by using the measurement data given by DE GEER) (2015): **May 11, 10:00 (UTC)**

This work has been conducted with EU support

	U	L	P	A	C	F
ENDF. B. VII. I	16.6751 ±0.3042	0.7655 ±0.0036	6.4748 ±0.8277	-3.2651 ±0.0603	1.0070 ±1.3233e ⁻⁴	9.2159e ⁻³ ±4.1493e ⁻³
LARA – LNHB/CEA	15.2067 ±1.3932	0.7486 ±0.0175	6.4748 ±0.6059	-2.9775 ±0.2733	1.0073 ±3.6456e ⁻⁴	9.0118e ⁻³ ±4.0627e ⁻³

Table above: Some constants for a fast and accurate dating of nuclear explosion by using Y92/Sr92 activity ratio

	U	L	P	A	C	F
ENDF. B. VII. I	-2.7888 ±2.4192e ⁻⁴	7.5970 ±1.4739e ⁻³	0.5359 ±8.3073e ⁻³	1.1516 ±1.2945e ⁻³	0.15638 ±2.8893e ⁻⁵	6.3759e ⁻³ ±4.0811e ⁻³
LARA – LNHB/CEA	-2.7886 ±3.5122e ⁻⁴	7.5979 ±2.5042e ⁻³	0.5291 ±6.6218e ⁻³	1.1516 ±0.1861e ⁻³	0.15637 ±4.9409e ⁻⁵	6.3766e ⁻³ ±4.0815e ⁻³

Table above: Some constants for a fast and accurate dating of nuclear explosion by using La140/Ba140 activity ratio

Nb95/Zr95 ratio is given as: $r(t) = K_1 \cdot e^{a_1 t} + K_2 \cdot e^{a_2 t} + K_3$

	K ₁	K ₂	K ₃	a ₁	a ₂
ENDF. B. VII. I	-2.2061 ±9.7815e ⁻³	1.2358e ⁻³ ±0.3594e ⁻³	2.2049 ±9.7748e ⁻³	-8.9845e ⁻³ ±3.5450e ⁻⁶	-1.81185e ⁻¹ ±0.0160e ⁻¹
LARA – LNHB/CEA	-2.2065 ±7.1428e ⁻³	1.2761e ⁻³ ±0.0856e ⁻³	2.2052 ±7.1423e ⁻³	-8.9843e ⁻³ ±3.5450e ⁻⁶	-1.81183e ⁻¹ ±0.0160e ⁻¹

Some constants for a fast and accurate dating of nuclear explosion by using Nb95/Zr95 activity ratio