



Quality assessment of k_0 -INAA by analysis of different
reference materials with inorganic matrices
using the KAYZERO/SOLCOI software

R. Jacimovic, Z. Jeran

“Jožef Stefan” Institute, Ljubljana, Slovenia

International Workshop: Combining and reporting analytical results

Rome, 6-8 March 2006

Introduction

- TRIGA Mark II reactor (250 kW) at the JSI from 1966.
- The k_0 -standardization method was introduced in 1987 at the JSI.
- TRIGA Mark II reactor (250 kW)
 - irradiation channels,
 - neutron spectral parameters,
 - neutron fluence gradients,
 - neutron self-shielding.
- Calibrated HPGe detector
 - absolutely calibrated point sources,
 - counting geometry.

Nuclear research reactor TRIGA Mark II (250 kW)

- Short and long irradiation in the CC:

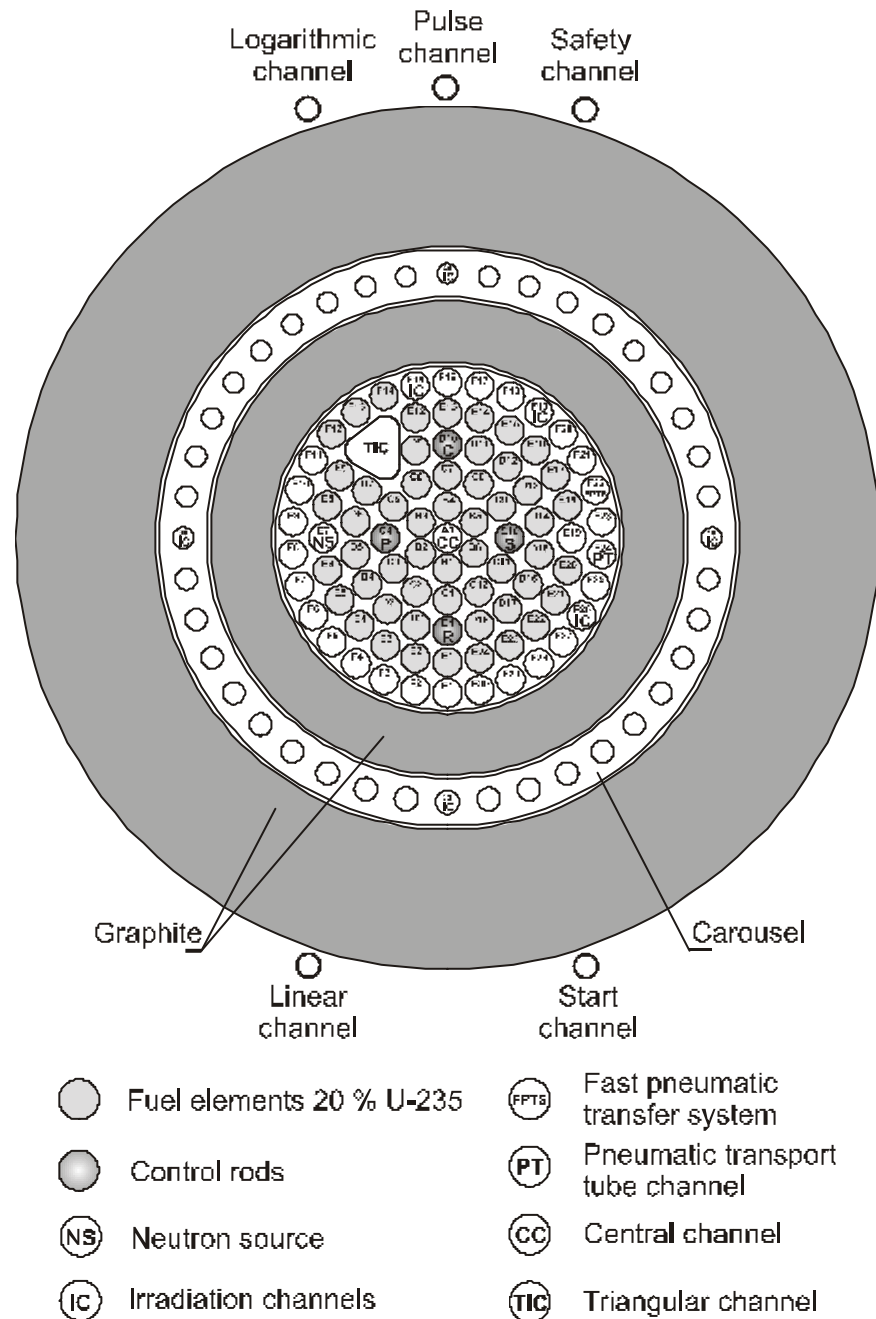
$$\phi_{th} \sim 10 \cdot 10^{12} \text{ cm}^{-2} \text{ s}^{-1}$$

- Short irradiation in the PT and in the FPTs (up-to 30 min.)

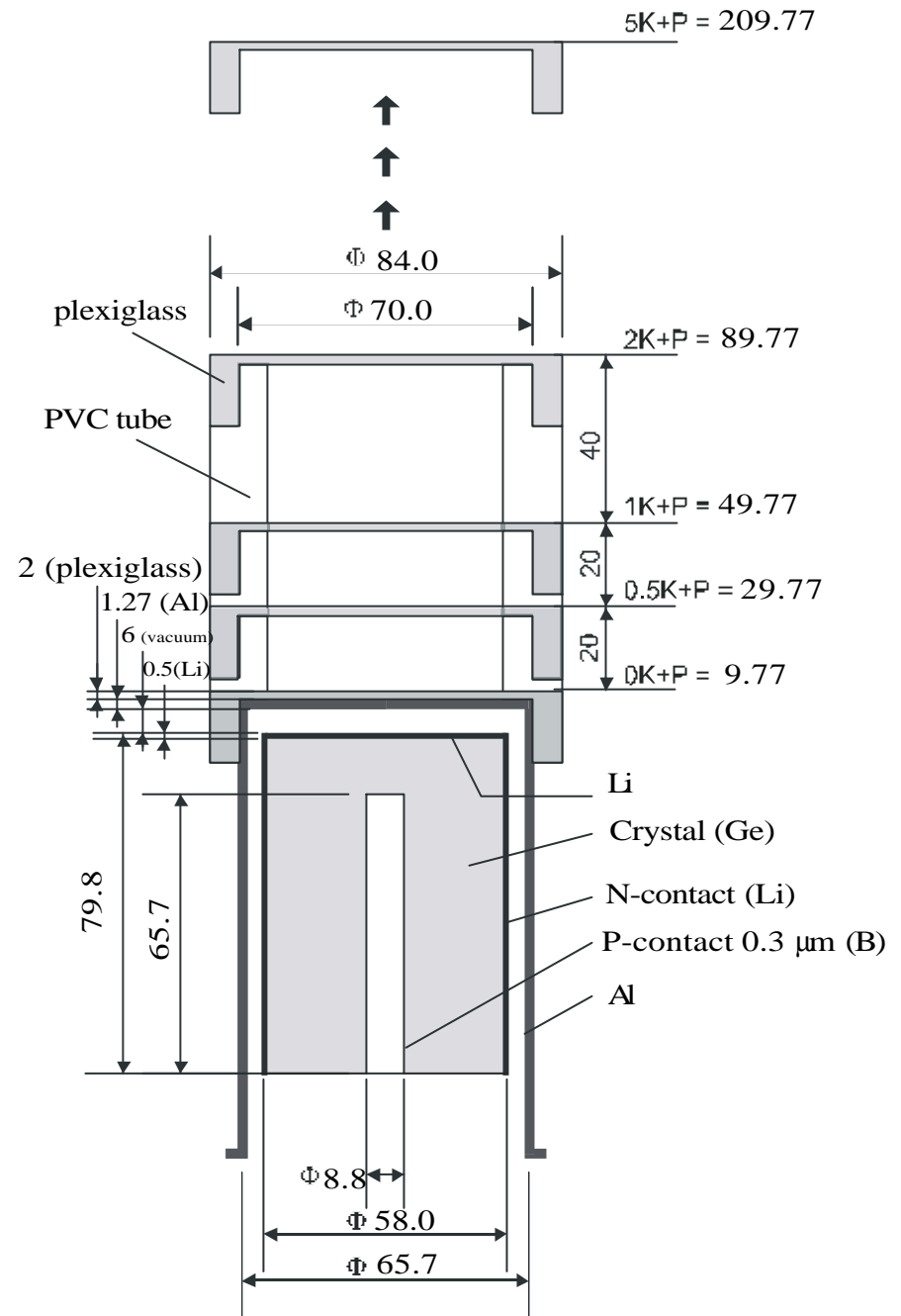
$$\phi_{th} \sim 3.5 \cdot 10^{12} \text{ cm}^{-2} \text{ s}^{-1}$$

- Long irradiation in the IC-40 (typically 20 hours)

$$\phi_{th} \sim 1.1 \cdot 10^{12} \text{ cm}^{-2} \text{ s}^{-1}$$



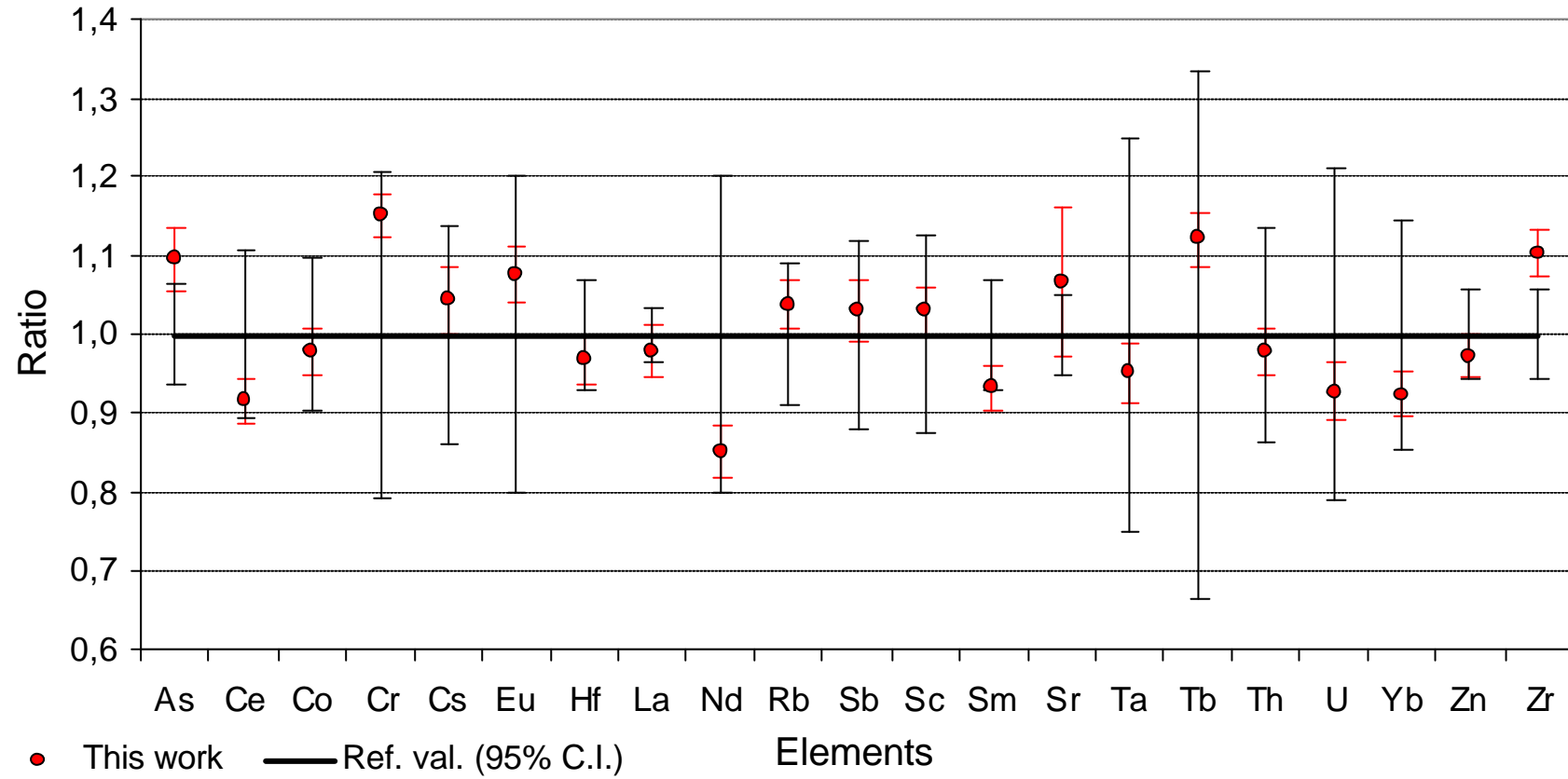
HPGe closed end coaxial detector (OR4)
 40% relative efficiency
 at 1332.5 keV (^{60}Co)
 (dimensions are in mm)



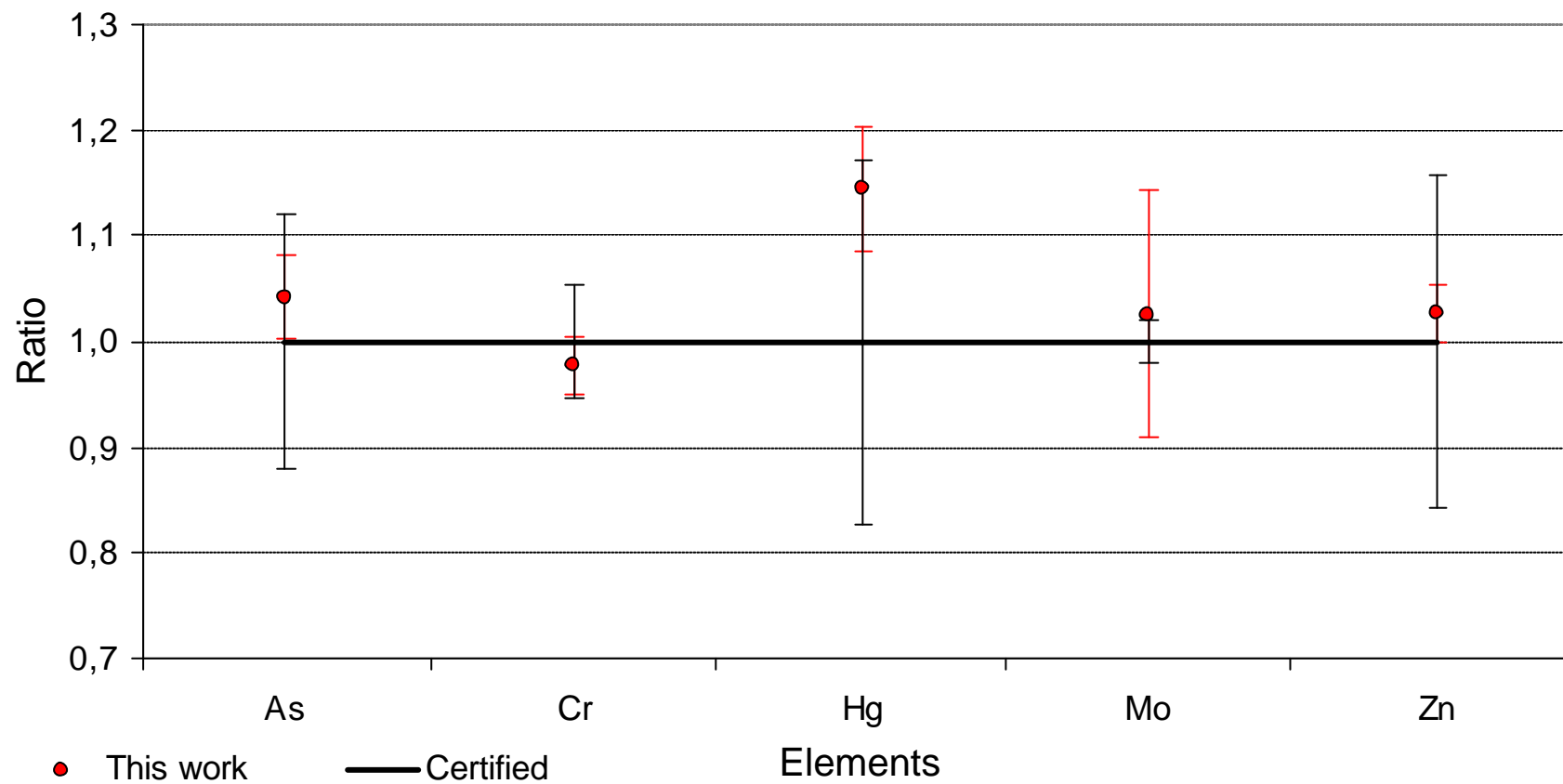
Experimental

- About 200 mg of **IAEA Soil-7** or 100 mg of **NIST 2782** Industrial Sludge (inorganic matrix)
- Carousel facility of 250 kW TRIGA reactor for irradiations
- Measurements after 5, 9-14 and 30 days cooling time on one of five absolutely calibrated HPGe detectors of 17%, 20%, 40% and 45% relative efficiency.
- HyperLab program for net peak area
- KAYZERO/SOLCOI program for elemental concentrations
- Comparison of the results obtained over an extended time period (2002-2005) by k_0 -INAA to the certified or recommended values provided by NIST and the IAEA during the framework of a **SOILSAMP** project (APAT, Italy)

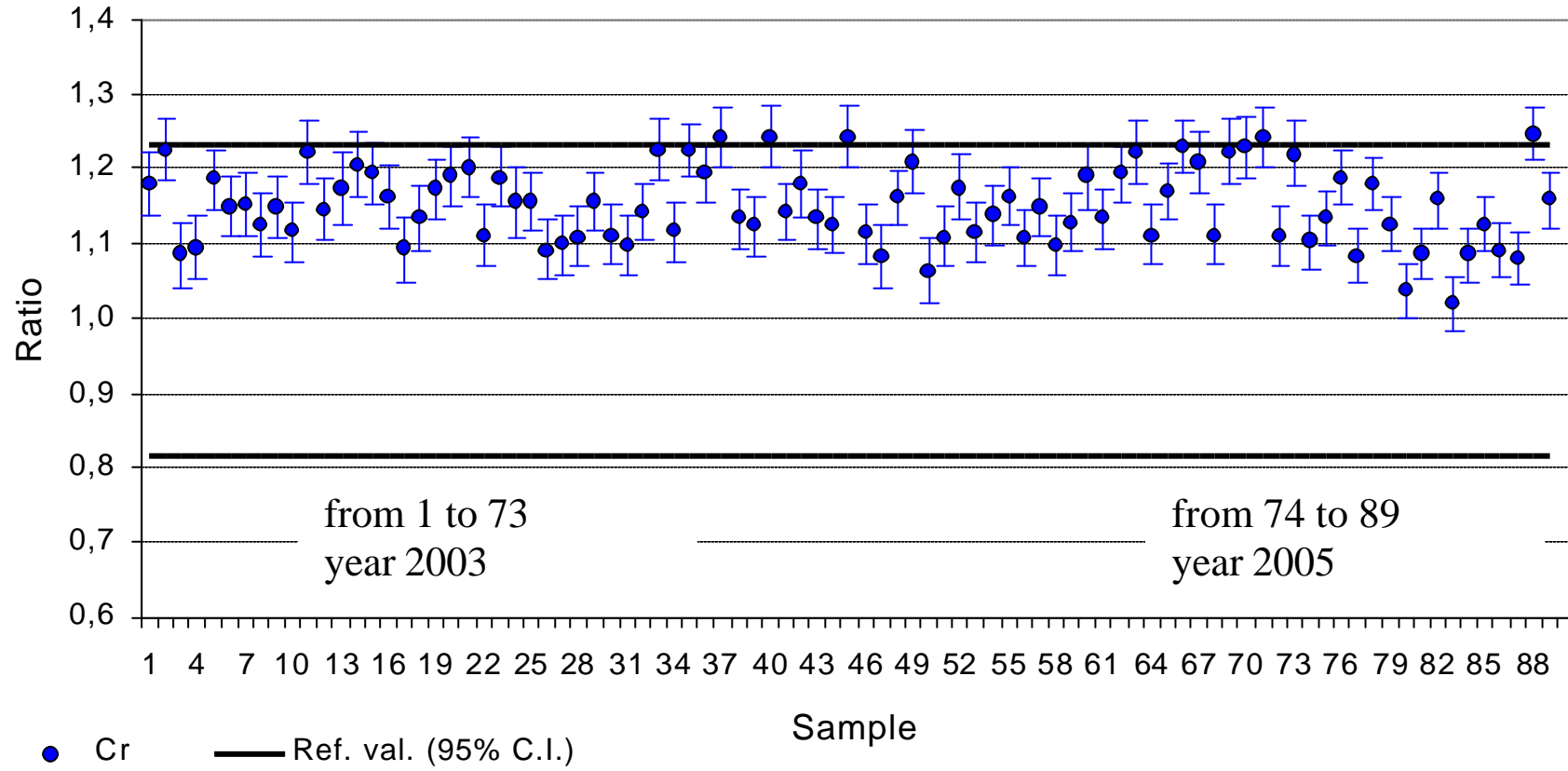
IAEA Soil-7 (89 samples)



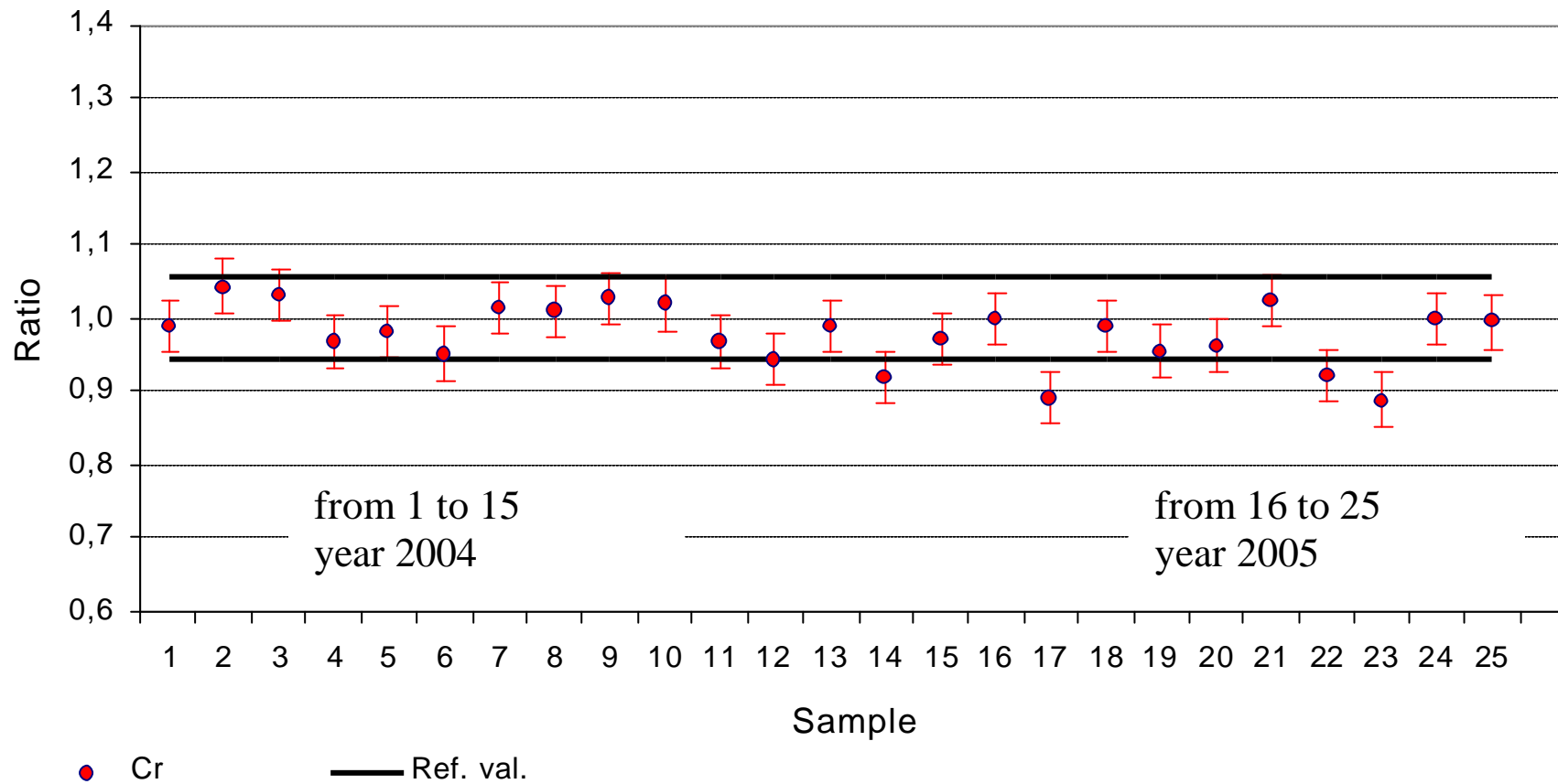
NIST 2782 (25 samples)



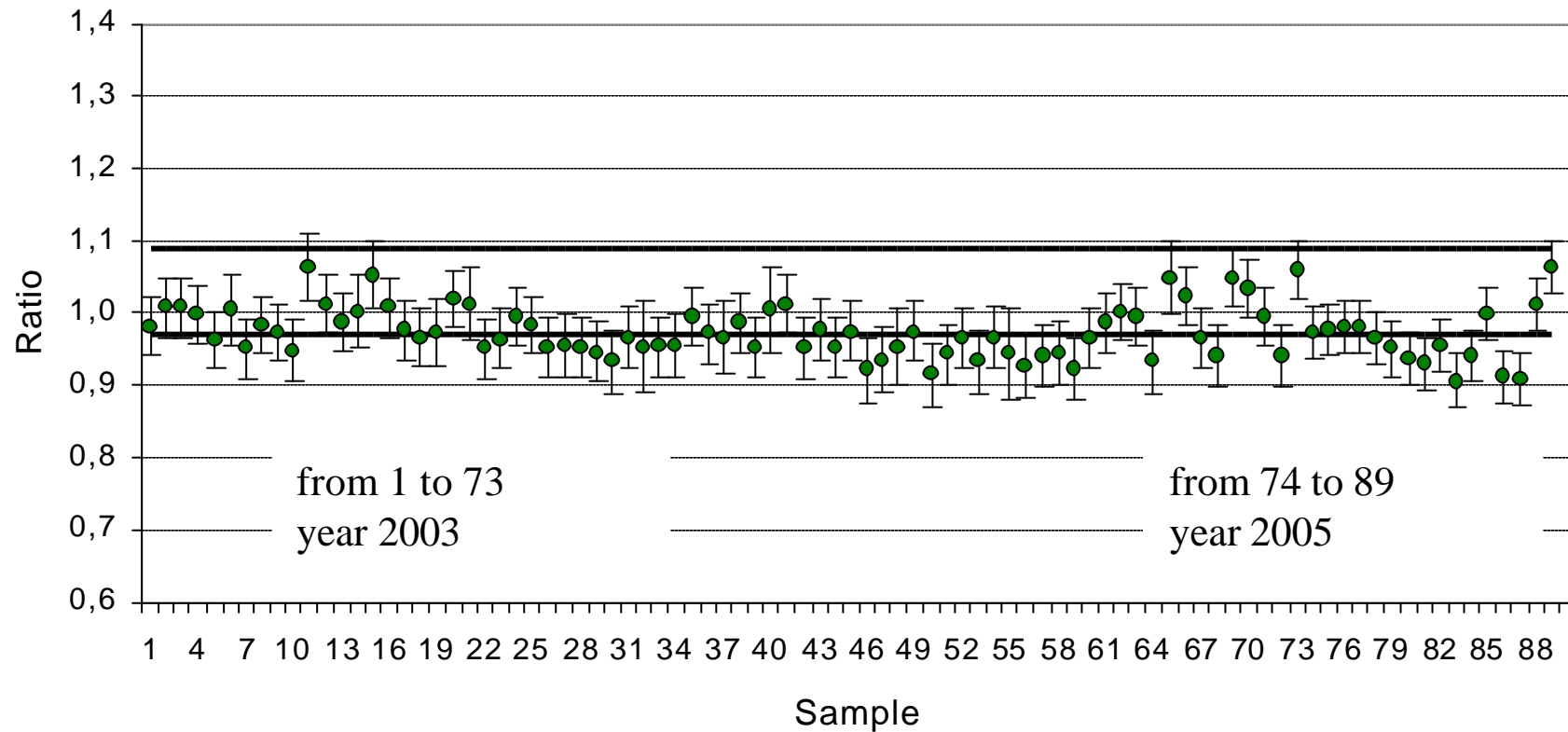
IAEA Soil-7 (89 samples)



NIST 2782 (25 samples)

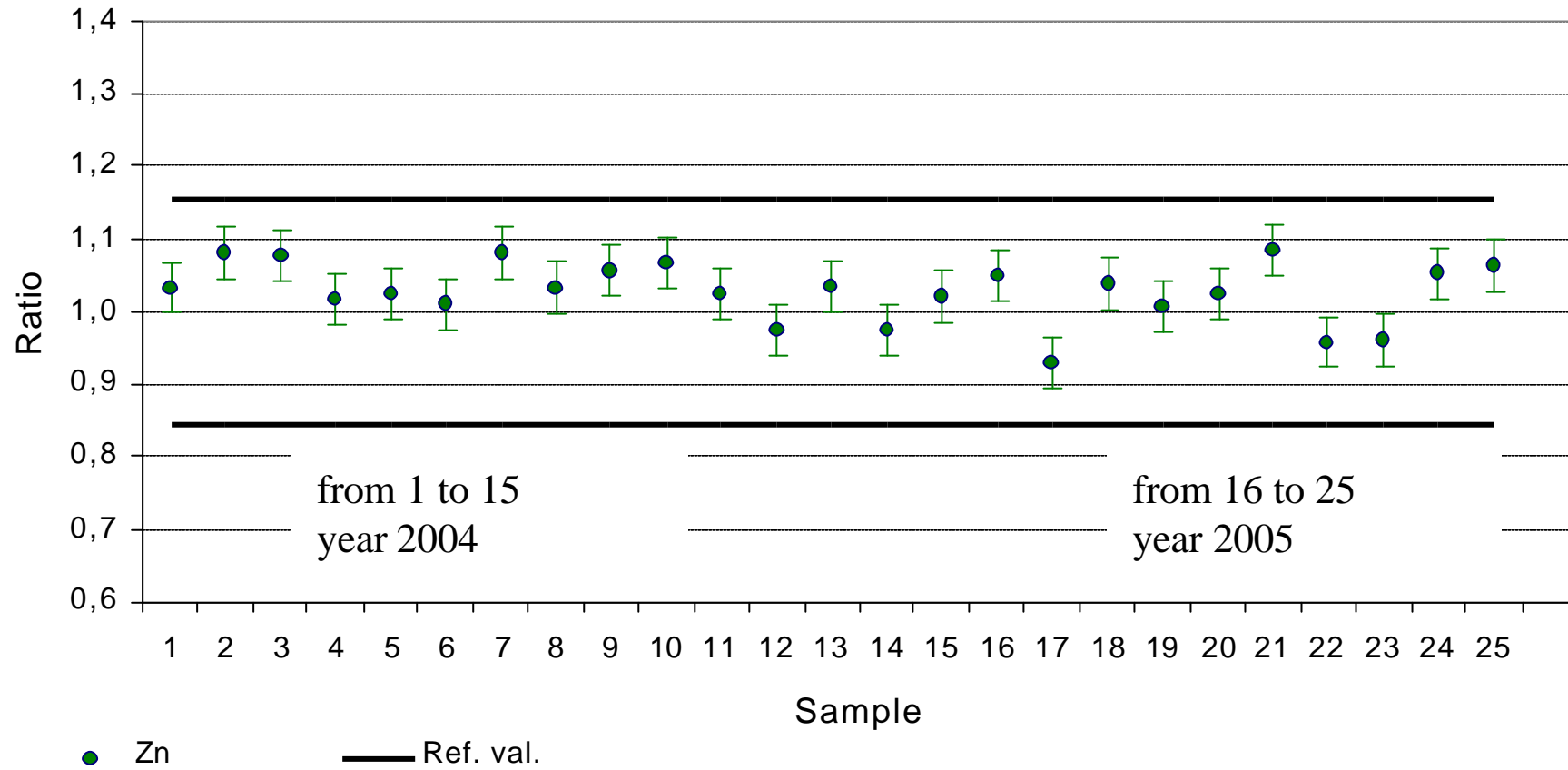


IAEA Soil-7 (89 samples)



● Zn — Ref. val. (95% C.I.)

NIST 2782 (25 samples)



IAEA Soil-7	Units	Value	St. unc.	RSD, %	Unc. Contr.	Index (%)
sample weight	g	0.2140	0.0005	0.23%	-1.55E-01	0.76%
Al-Au weight	g	0.00969	0.00005	0.52%	-3.42E-01	3.68%
Au conc.	%	0.1000	0.001	1.00%	-6.59E-01	13.70%
counts, Cr		207117	290	0.14%	9.32E-02	0.27%
counts, Au		49653	159	0.32%	2.13E-01	1.43%
meas.time sample	s	60000	0.5	0.00%	-5.55E-04	0.00%
meas. time Au	s	300	0.5	0.17%	-1.11E-01	0.39%
f		28.74	0.273	0.95%	-6.27E-01	12.38%
efficiency, Cr		3.72E-02	0.00074	2.00%	-1.31E+00	53.73%
efficiency, Au		1.56E-03	0.000008	0.50%	3.33E-01	3.49%
Q0, Cr		0.53	0.001	0.11%	-7.53E-02	0.18%
Q0, Au		15.71	0.1	0.64%	-4.21E-01	5.59%
k0, Cr		2.62E-03	0.000013	0.50%	-3.29E-01	3.41%
COI, Cr		1.0000	0.0001	0.01%	-6.66E-03	0.00%
alpha		-0.0113	0.00003	0.27%	-1.76E-01	0.98%
Result	mg/kg	66.6	1.8	2.67%	(k=1)	100%

IAEA Soil-7	Units	Value	St. unc.	RSD, %	Unc. Contr.	Index (%)
sample weight	g	0.2140	0.0005	0.23%	-2.28E-01	0.74%
Al-Au weight	g	0.00969	0.00005	0.52%	-5.03E-01	3.57%
Au conc.	%	0.1000	0.001	1.00%	-9.70E-01	13.28%
counts, Zn		64270	450	0.70%	6.86E-01	6.64%
counts, Au		49653	159	0.32%	3.14E-01	1.39%
meas.time sample	s	60000	0.5	0.00%	-8.17E-04	0.00%
meas. time Au	s	300	0.5	0.17%	-1.63E-01	0.37%
f		28.74	0.233	0.81%	-7.87E-01	8.74%
efficiency, Zn		1.36E-02	0.00027	2.00%	-1.92E+00	52.07%
efficiency, Au		1.56E-03	0.000008	0.50%	4.90E-01	3.39%
Q0, Zn		1.91	0.01	0.34%	-3.33E-01	1.56%
Q0, Au		15.71	0.1	0.64%	-6.20E-01	5.42%
k0, Zn		5.72E-03	0.000023	0.40%	-3.92E-01	2.17%
COI, Zn		1.0000	0.0001	0.01%	-9.80E-03	0.00%
alpha		-0.0113	0.000025	0.22%	-2.16E-01	0.66%
Result	mg/kg	98.0	2.7	2.72%	(k=1)	100%