



The role and the performance of CIRCE lab in the framework of the Isonitrate Italy Project

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The CIRCE lab

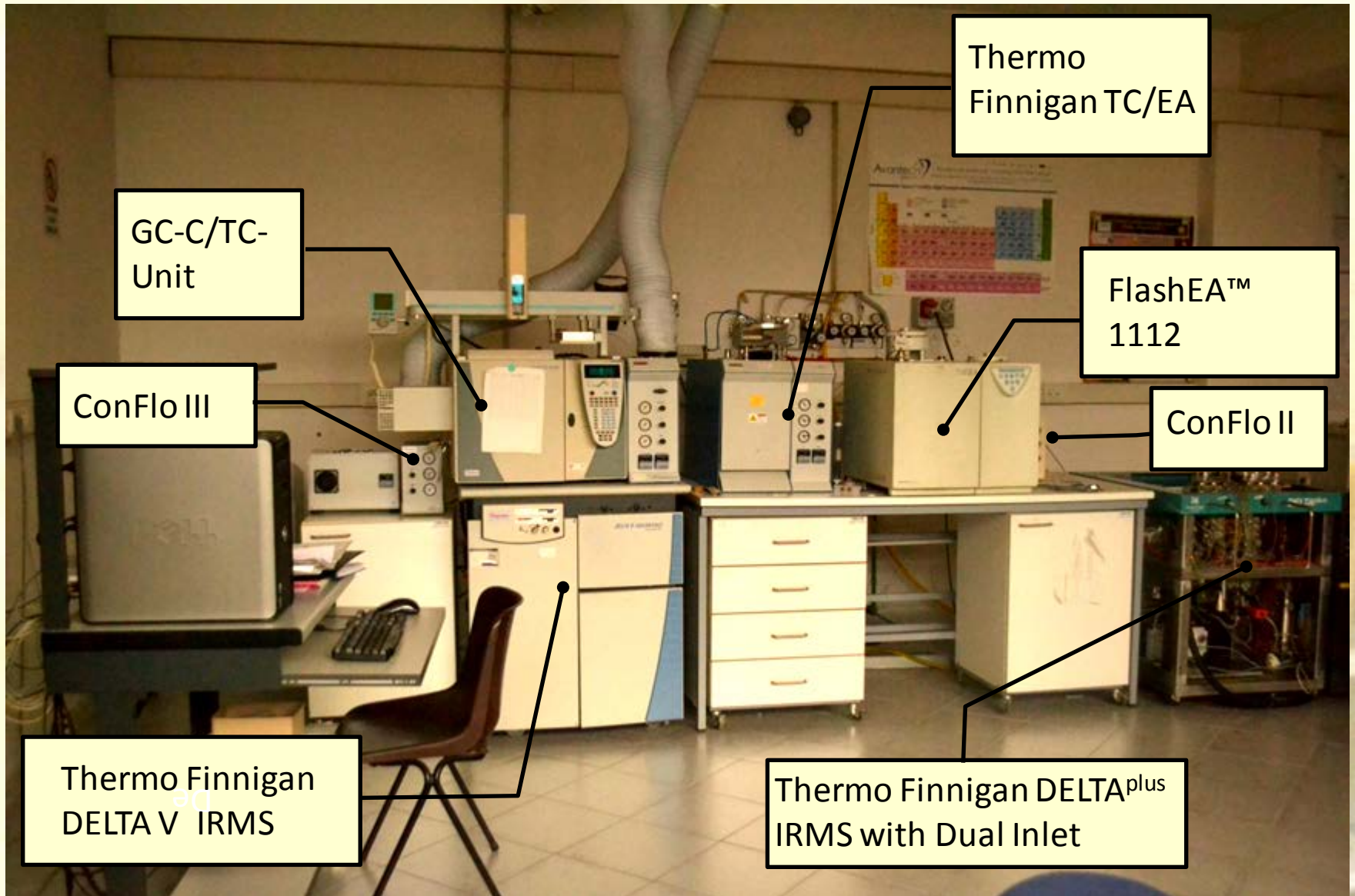
- A 3 MV accelerator mass spectrometer (AMS) for the ultrasensitive measurements of rare isotope ratios (e.g. actinides and ^{14}C).
- A mass spectrometry lab (IRMS) for the stable isotope analysis of solid, gaseous and liquids samples.
- An environmental radioactivity laboratory allowing also the ^{222}Rn and gamma emitters measurement.
- An isotope chemistry lab involved also in methodological developments (e.g. AMS measurement of ^{11}B).
- An isotope hydrology and cryogenic lab.
- A facility for the study of nuclear reactions in the framework of nuclear astrophysics.



CIRCE - FIELDS OF ACTIVITY

- a) Archaeometry by high-precision radiocarbon dating;
- b) Environmental science by ^{14}C -based global carbon cycle studies;
- c) Isotope hydrology;
- d) Nuclear astrophysics by the ERNA recoil mass separator;
- e) Nuclear safeguards and contrast to illegal nuclear fuel use by actinides AMS;
- f) Forensic applications of AMS;
- g) Tribology by ^7Be implantation.

The IRMS lab



Number of isotopic analyses in the Isonitrate Italy project

Matrix	$\delta^{15}\text{N}_{\text{NO}_3}$	$\delta^{18}\text{O}_{\text{NO}_3}$	$\delta^{15}\text{N}_{\text{BULK}}$	$\delta^{11}\text{B}$
Surface waters	105	105		11
Groundwaters	361	361		74
Soils (2mm sieved and homogeneized)			54	
Soil extracts (1:5 soil to water ratio)	32	32		
Mineral fertilizers			2	
Manure			8	in progress
Sewage effluents (at inlet of TP)			12	in progress
Sewage effluents (at outlet of TP)	9	9		in progress

Total: **668 samples**

The environmental samples and isotopic analyses in the Nitrate Project



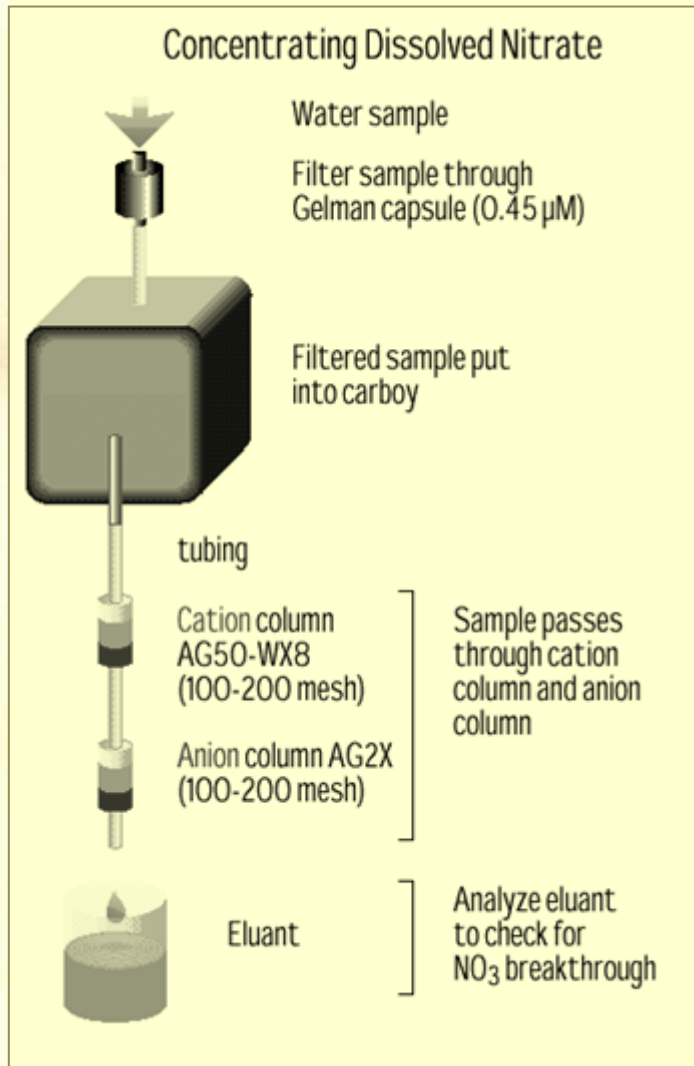
The samples reception: the Nitrobase

The screenshot displays the Microsoft Access interface for a database named '150115_NITROBASE_Luisa'. The 'ACCETTAZIONE' table is open in 'Foglio dati' (Data Sheet) view. The table contains 27 records, each representing a sample reception. The columns are: DATA, ID Campione, COD ISPR, ID C, Data campion, Primary Key, Tipologia An, Sa, MATRIC, Regi, Contenitore, and Data passa. The data shows a variety of sample types (e.g., Taratura, Colonna anionica) and locations (e.g., ISPRASU, ISPRAGW, ISPRACI).

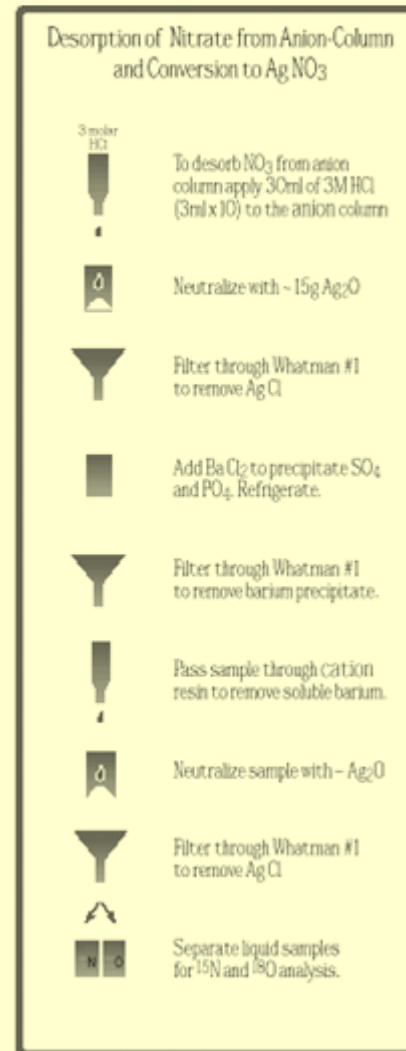
DATA	ID Campione	COD ISPR	ID C	Data campion	Primary Key	Tipologia An	Sa	MATRIC	Regi	Contenitore	Data passa
16/04/2014	ISPRASU5001	ISPRASU	ISPRASU	04/04/2014	1	Taratura	c	SU	VEN	Sacchetto polietilene	
16/04/2014	ISPRASU5002	ISPRASU	ISPRASU	04/04/2014	2	Taratura	c	SU	VEN	Sacchetto polietilene	
16/04/2014	ISPRASU5003	ISPRASU	ISPRASU	04/04/2014	3	Taratura	c	SU	VEN	Sacchetto polietilene	
16/04/2014	ISPRASU5004	ISPRASU	ISPRASU	04/04/2014	4	Taratura	c	SU	VEN	Sacchetto polietilene	
16/04/2014	ISPRASW5206	ISPRASW	ISPRASW	09/04/2014	5	Taratura	c	SW	VEN	Colonna anionica	
16/04/2014	ISPRASW5202	ISPRASW	ISPRASW	09/04/2014	6	Taratura	c	SW	VEN	Colonna anionica	
16/04/2014	ISPRAGW5002	ISPRAGW	ISPRAGW	09/04/2014	7	Taratura	c	GW	VEN	Colonna anionica	
16/04/2014	ISPRAGW5001	ISPRAGW	ISPRAGW	09/04/2014	8	Taratura	c	GW	VEN	Bottiglia di plastica	
16/04/2014	ISPRAGW5000	ISPRAGW	ISPRAGW	09/04/2014	9	Taratura	c	GW	VEN	Colonna anionica	
16/04/2014	ISPRACI5001	ISPRACI	ISPRACI	09/04/2014	10	Taratura	c	CI	VEN	Tubi Falcon	
16/04/2014	ISPRACI5000	ISPRACI	ISPRACI	09/04/2014	11	Taratura	c	CI	VEN	Tubi Falcon	
16/04/2014	ISPRASU8001	ISPRASU	ISPRASU	01/04/2014	12	Taratura	c	SU	EMR	Sacchetto polietilene	
16/04/2014	ISPRASU8002	ISPRASU	ISPRASU	01/04/2014	13	Taratura	c	SU	EMR	Sacchetto polietilene	
16/04/2014	ISPRASU8003	ISPRASU	ISPRASU	01/04/2014	14	Taratura	c	SU	EMR	Sacchetto polietilene	
16/04/2014	ISPRASU8004	ISPRASU	ISPRASU	01/04/2014	15	Taratura	c	SU	EMR	Sacchetto polietilene	
16/04/2014	ISPRAZO8001	ISPRAZO	ISPRAZO	01/04/2014	16	Taratura	c	ZO	EMR	Bottiglia di plastica	
16/04/2014	ISPRAZO8002	ISPRAZO	ISPRAZO	01/04/2014	17	Taratura	c	ZO	EMR	Bottiglia di plastica	
16/04/2014	ISPRACI8001	ISPRACI	ISPRACI	28/03/2014	18	Taratura	c	CI	EMR	Tubi Falcon	
16/04/2014	ISPRACI8002	ISPRACI	ISPRACI	28/03/2014	19	Taratura	c	CI	EMR	Tubi Falcon	
16/04/2014	ISPRAGW8002	ISPRAGW	ISPRAGW	25/03/2014	20	Taratura	c	GW	EMR	Colonna anionica	
16/04/2014	ISPRAGW8003	ISPRAGW	ISPRAGW	25/03/2014	21	Taratura	c	GW	EMR	Colonna anionica	
16/04/2014	ISPRAGW8001	ISPRAGW	ISPRAGW	25/03/2014	22	Taratura	c	GW	EMR	Colonna anionica	
16/04/2014	ISPRAGW8001	ISPRAGW	ISPRAGW	01/04/2014	23	Taratura	c	GW	EMR	Colonna anionica	
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16/04/2014	ISPRAGW8003	ISPRAGW	ISPRAGW	01/04/2014	25	Taratura	c	GW	EMR	Colonna anionica	
16/04/2014	ISPRASW8001	ISPRASW	ISPRASW	01/04/2014	26	Taratura	c	SW	EMR	Colonna anionica	
16/04/2014	ISPRASW8002	ISPRASW	ISPRASW	01/04/2014	27	Taratura	c	SW	EMR	Colonna anionica	

The Silver Nitrate method (Silva et al., 2000) for $\delta^{15}\text{N}_{\text{NO}_3}$ and $\delta^{18}\text{O}_{\text{NO}_3}$ analyses

Pretreatment



Protocol



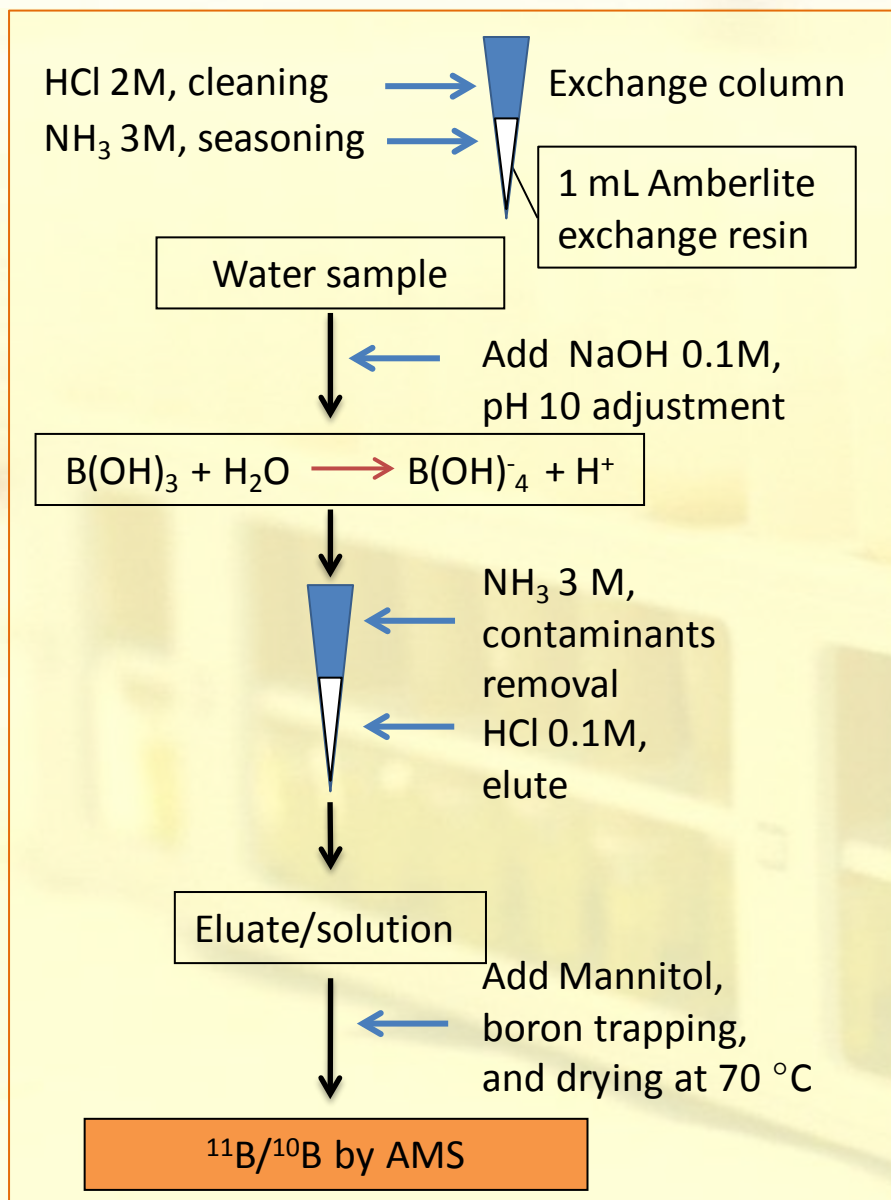
Minimum quantity of NO_3^- :

6 mg (100 μmol)

3 Internal Reference Materials (**RM**)
in two replicates processed along
with **Unknown** samples:

- 1) **USGS 34** ($\delta^{15}\text{N} = -1.8 \pm 0.2\text{‰}$;
 $\delta^{18}\text{O} = -27.9 \pm 0.6\text{‰}$);
- 2) **SIAl KNO_3** ($\delta^{15}\text{N} = 26.9 \pm 0.8\text{‰}$;
 $\delta^{18}\text{O} = 23.8 \pm 0.1\text{‰}$);
- 3) **CIRCE KNO_3 3** ($\delta^{15}\text{N} = 2.5 \pm 0.5\text{‰}$;
 $\delta^{18}\text{O} = 24.8 \pm 0.5\text{‰}$).

The preparation protocol for $\delta^{11}\text{B}$ analyses



Minimum quantity of B required:

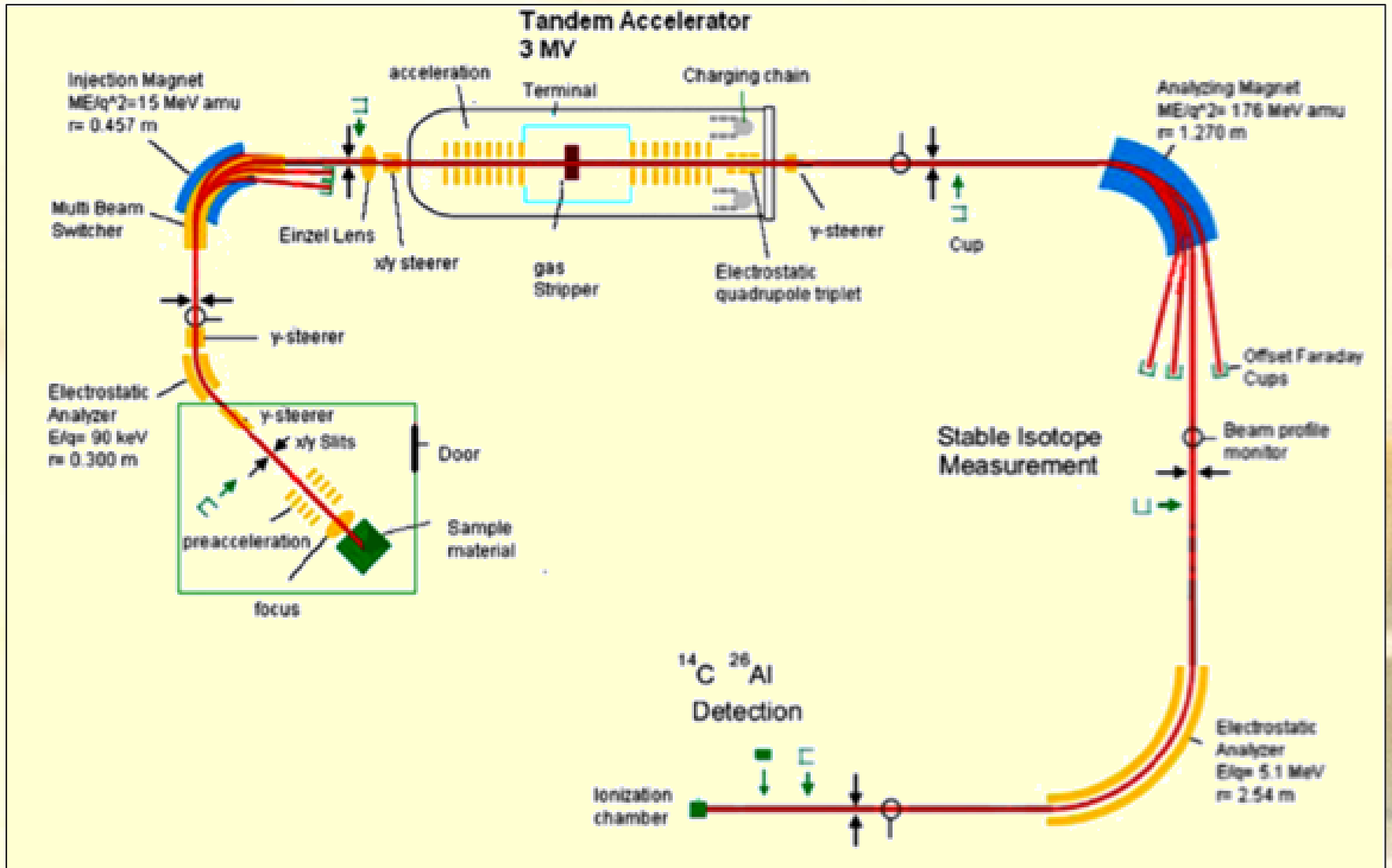
500 μg

International Reference Materials
 (RM) in 5 replicates processed along
 with **Unknown** samples:

NIST951 ($\delta^{11}\text{B}=0 \text{ ‰}$)

$$\delta^{11}\text{B}[\text{‰}] = \left[\frac{R_{\text{sample}}}{R_{\text{SRM 951}}} - 1 \right] \times 1000$$

The AMS analysis of $\delta^{11}\text{B}$



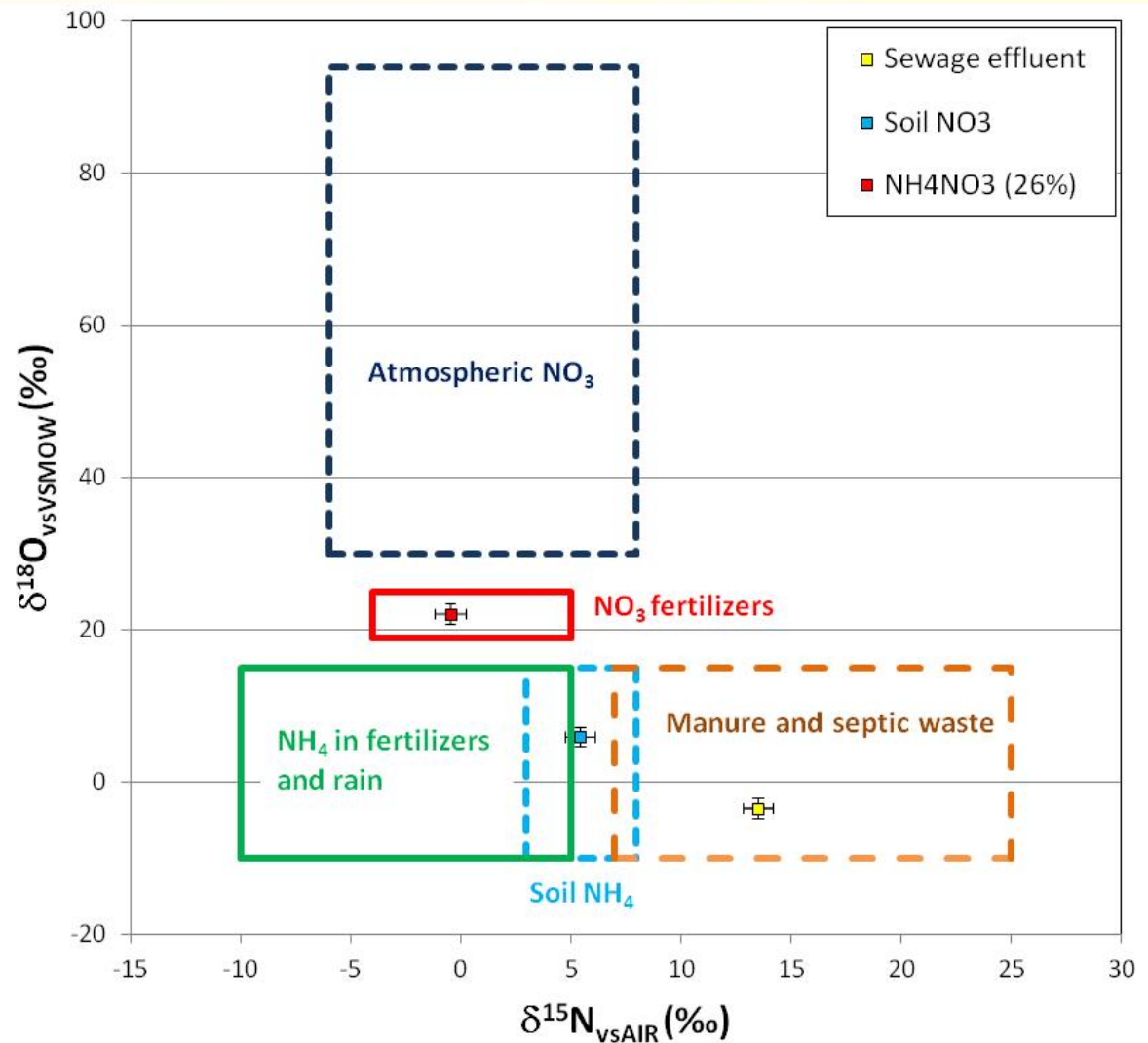
The isotopic analyses: Measurement performances

Measurement precision:

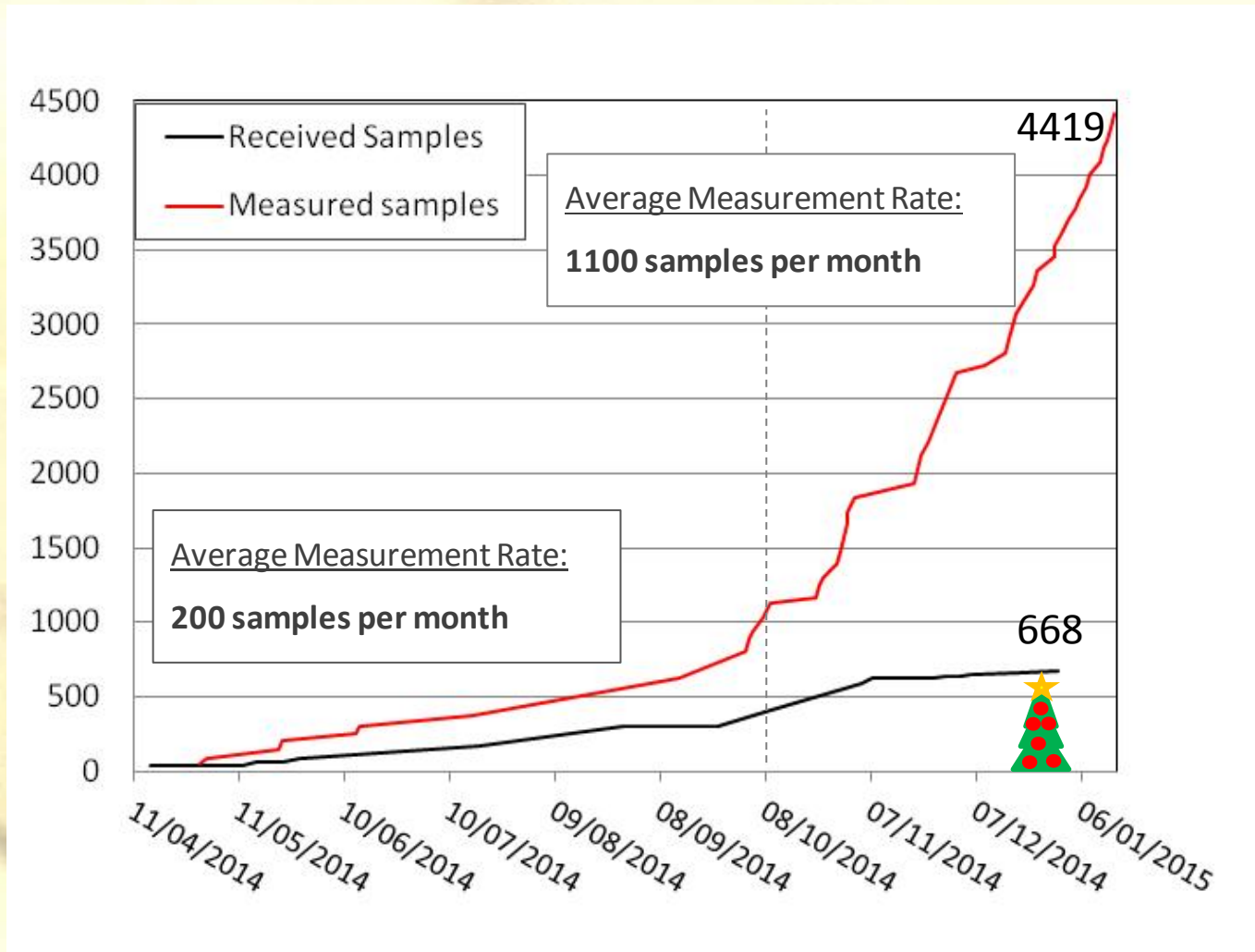
$$\delta^{15}\text{N}_{\text{NO}_3} = \pm 0.7 \text{ ‰}$$

$$\delta^{18}\text{O}_{\text{NO}_3} = \pm 1.3 \text{ ‰}$$

$$\delta^{11}\text{B} = \pm 6 \text{ ‰}$$



Throughput of the CIRCE lab for the Isonitrate Italy project



Average Measurement Rate: 510 samples per month

The CIRCE working group



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(Artwork made of TC/EA consumables)