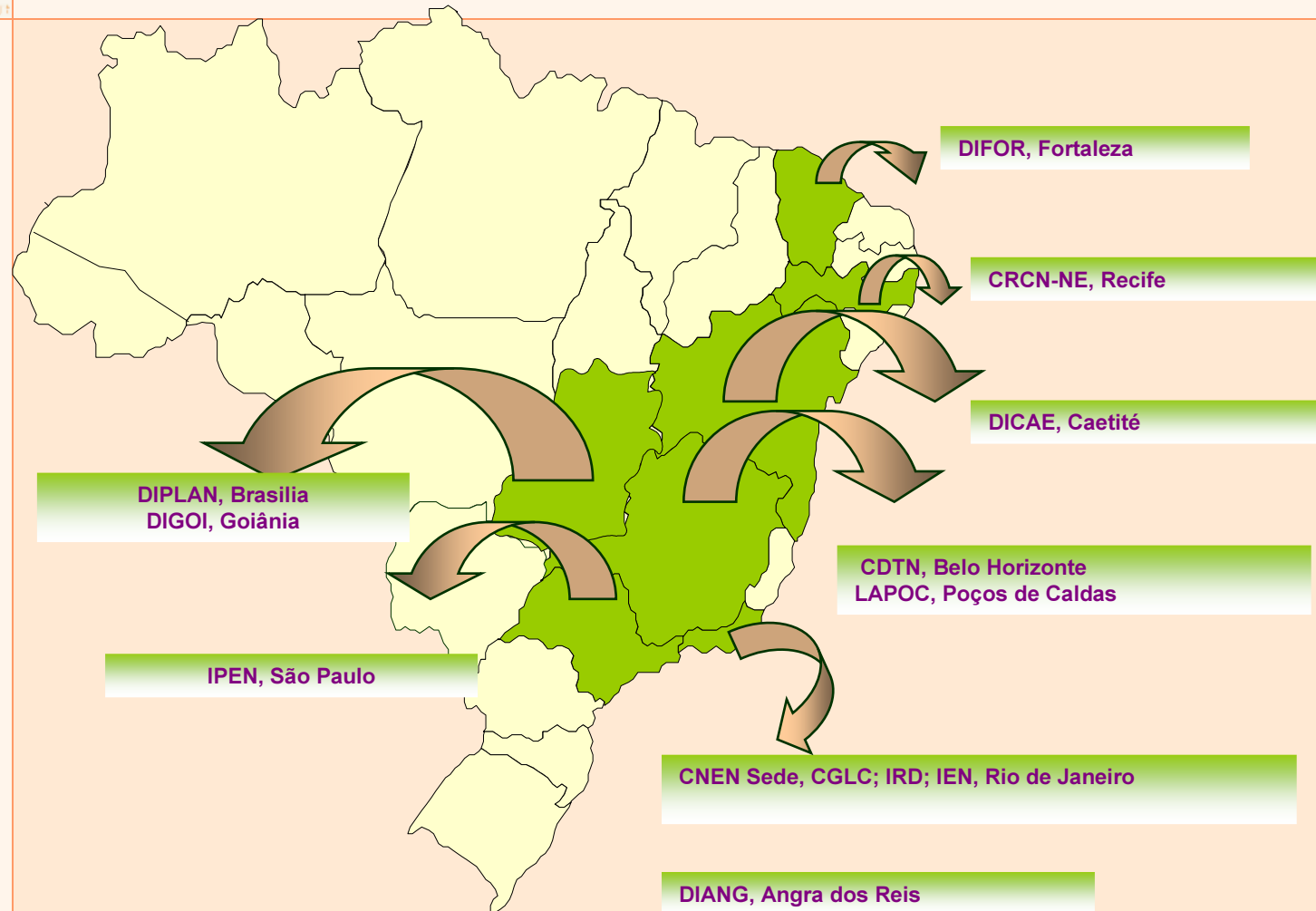


**Use of *in-situ* gamma  
spectrometry for  
environmental monitoring of a  
former disposal site of by  
product from monazite  
chemical processing**

**Nivaldo Carlos da Silva, D.Sc.  
Physicist**

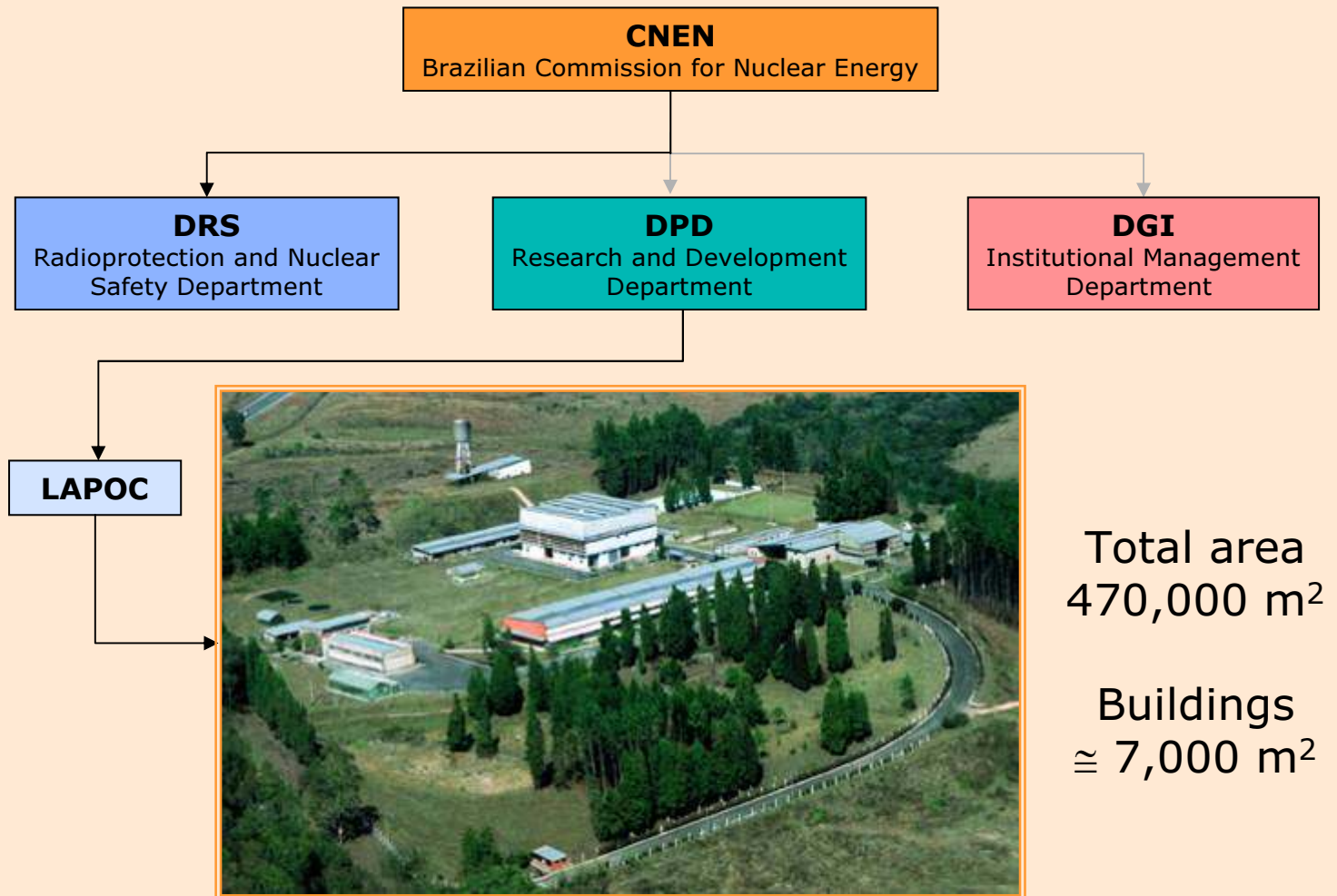


# Brazilian Commission for Nuclear Energy - CNEN



Nuclear regulatory authority and research & development

# Organization chart - CNEN





# Monazite processing legacy in Brazil

- Monazite is a NORM (39% cerium oxide, 5% of yttrium, 6% thorium oxide e 0.3 % uranium oxide)
- Exploitation from 1949 to 1992 ( $\sim 1.6 \times 10^6$  ton/year at peak production)
- Two by products (residues) were produced (Cake II and mesothorium)
- Cake II ( $\sim 30.000$  ton/year at peak production)



# Monazite processing legacy in Brazil

- Cake II - (20 % thorium hydroxide and 1 % uranium hydroxide)
- Current Disposal sites
  - USIN (São Paulo City) - project for soil decontamination (60000 m<sup>2</sup>) – material in drums
  - Botuxim (Itu/SP) – Concrete container
  - INB/Caldas (Caldas – MG) ~16000 200-liters drums and concrete container



## Monitored area (former disposal site)



- Former disposal site of by-product of monazite chemical processing (mesothorium and cake two).
- The area was requested by an aluminium company for bauxite exploitation



# Monitored area



- Site located inside the propriety of Poços de Caldas Laboratory



# Monitored area



- Area requested for bauxite exploitation  $\sim 100000 \text{ m}^2$





# Monitored area



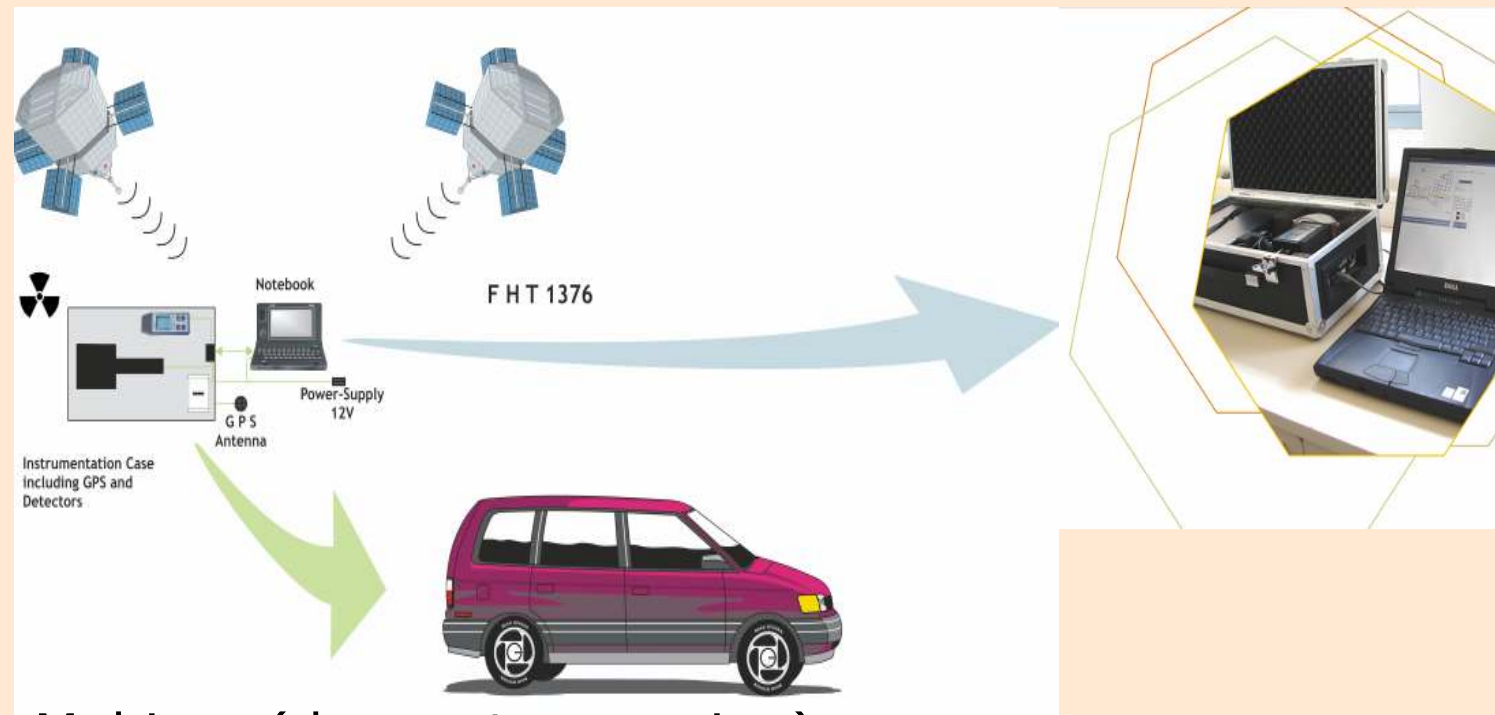
- The building was dismantled in 1992 and the by products transferred do INB/Caldas (uranium mine)



# Objectives:

- To assure that the site was not contaminated
- To gain expertise for the USIN remediation project.

# Mobile gamma radiation detection system - Mobisys



Mobisys (dose rate mapping):

- 5 liter scintillation organic detector
- in-built GPS
- Dose rate measurements at 1m above the soil



# Mobisys doserate map (preliminary results)



The dose rate is compared to those observed in the region of Poços de Caldas Plateau



# *In-situ* NaI gamma spectrometry system (Inspector 1000)

Portable gamma spectrometer with 3 x 3 inches NaI detector

Operation modes:

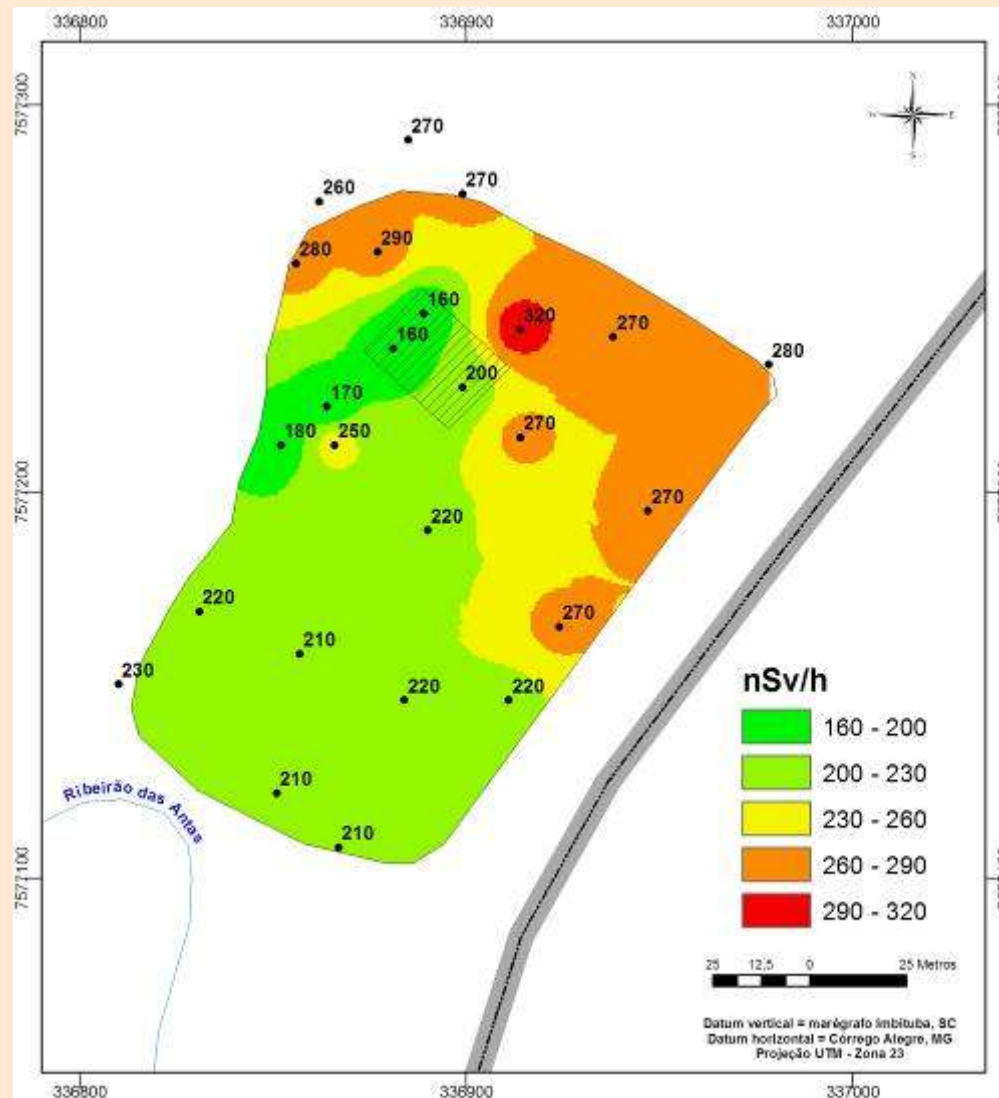
- Counts rate
- Dose rate (Dose rate equivalent  $H^*(10)$ )
- Identifier
- Gamma spectrometry



Measured at 0.60m above the soil (Dose rate and gamma spectrometry)



# Doserate map (Inspector 1000) – Preliminary results





# *In-situ* HPGe gamma spectrometry system (ISOCS)



- Portable gamma spectrometer with HPGe (20% efficiency) detector
- Beryllium window
- Mounted in a trolley
- Shield and collimators
- software with templates for efficiency calibration

# Efficiency calibration for *in situ* soil measurement

**CIRCULAR PLANE**

1.1 wall thickness  
2.1-11.1 Typical each layer  
Reference Plane  
R  
1.2 inside diameter  
11  
10  
9  
8  
7  
6  
5  
4  
3  
1  
2

12.1  
13.1  
Reference Plane  
R  
D  
14.1  
14.2  
14.3  
14.4  
14.5  
A  
Direction Convention

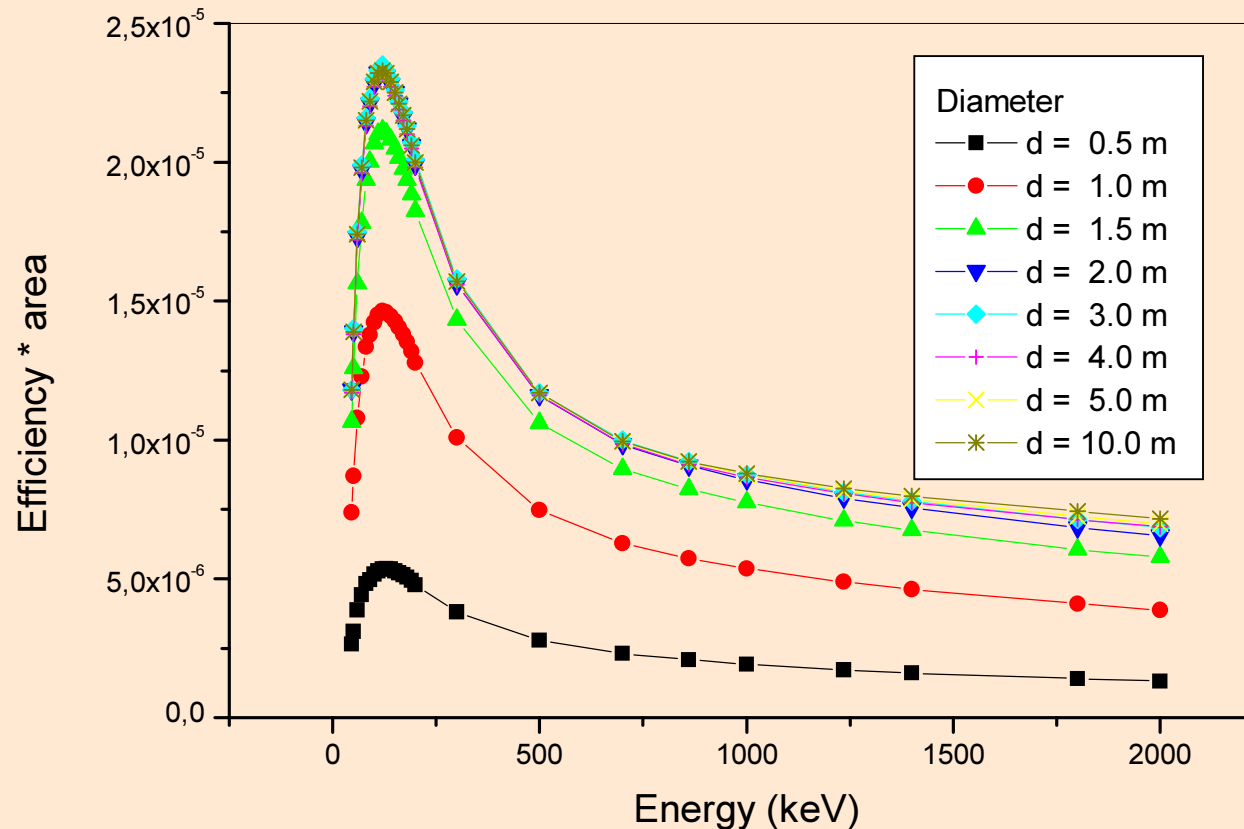
Reference Plane = Nearest face of Plane  
R = Source Reference Point (center of circular plane)  
D = Detector Reference Point (center of end cap)  
A = Detector Aiming Point (anywhere on reference plane)

GEOMETRY PARAMETERS		d.1	d.2	d.3	d.4	d.5	MATERIAL IDENTIFIER	DENSITY	SOURCE CONCENTRATION
Filename (8):									
Geometry Desc. (16):									
Comments (50):									
Detector Used:									
Collimator Used:									
<input type="checkbox"/> Special Collimator Used									
Comments:									
1:	2:	3:	4:	5:	6:				
7:	8:	9:	Matt:	Dens:					
Rect. Coll.	10:	11:	12:	13:	14:				
ITEM NO.	DESCRIPTION	DIMENSION	DIMENSION	DIMENSION	DIMENSION	DIMENSION			
1	Side Walls								
2	Layer 1								
3	Layer 2								
4	Layer 3								
5	Layer 4								
6	Layer 5								
7	Layer 6								
8	Layer 7								
9	Layer 8								
10	Layer 9								
11	Layer 10								
12	Absorber 1								
13	Absorber 2								
14	Source-Detector								

DATE: 15Jan01



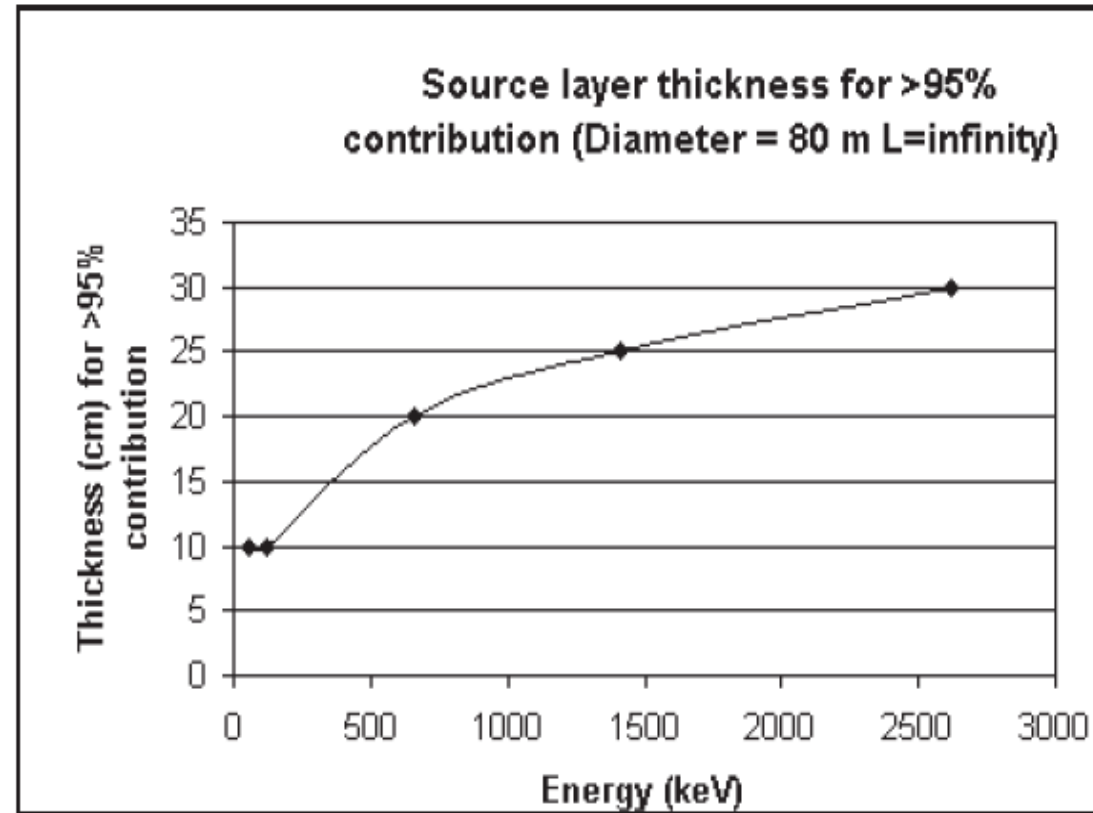
# Efficiency\*area versus source diameter



- 3 m diameter was considered "infinite diameter". Any further increase in the diameter results in very little change in the efficiency\*area value.



# Efficiency\*area versus source diameter



- 0.3 cm depth was considered "infinite thickness"

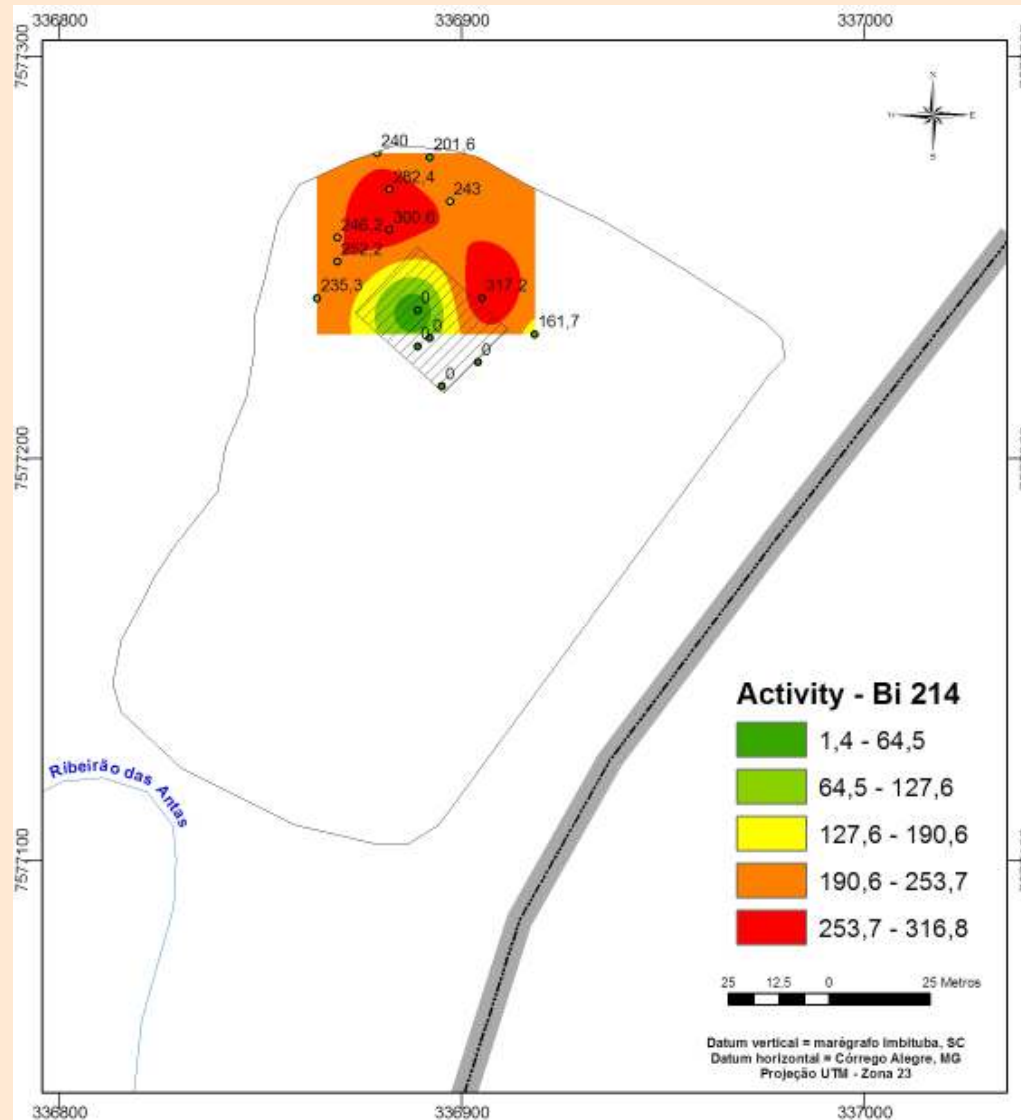


# Bulk soil density measurements

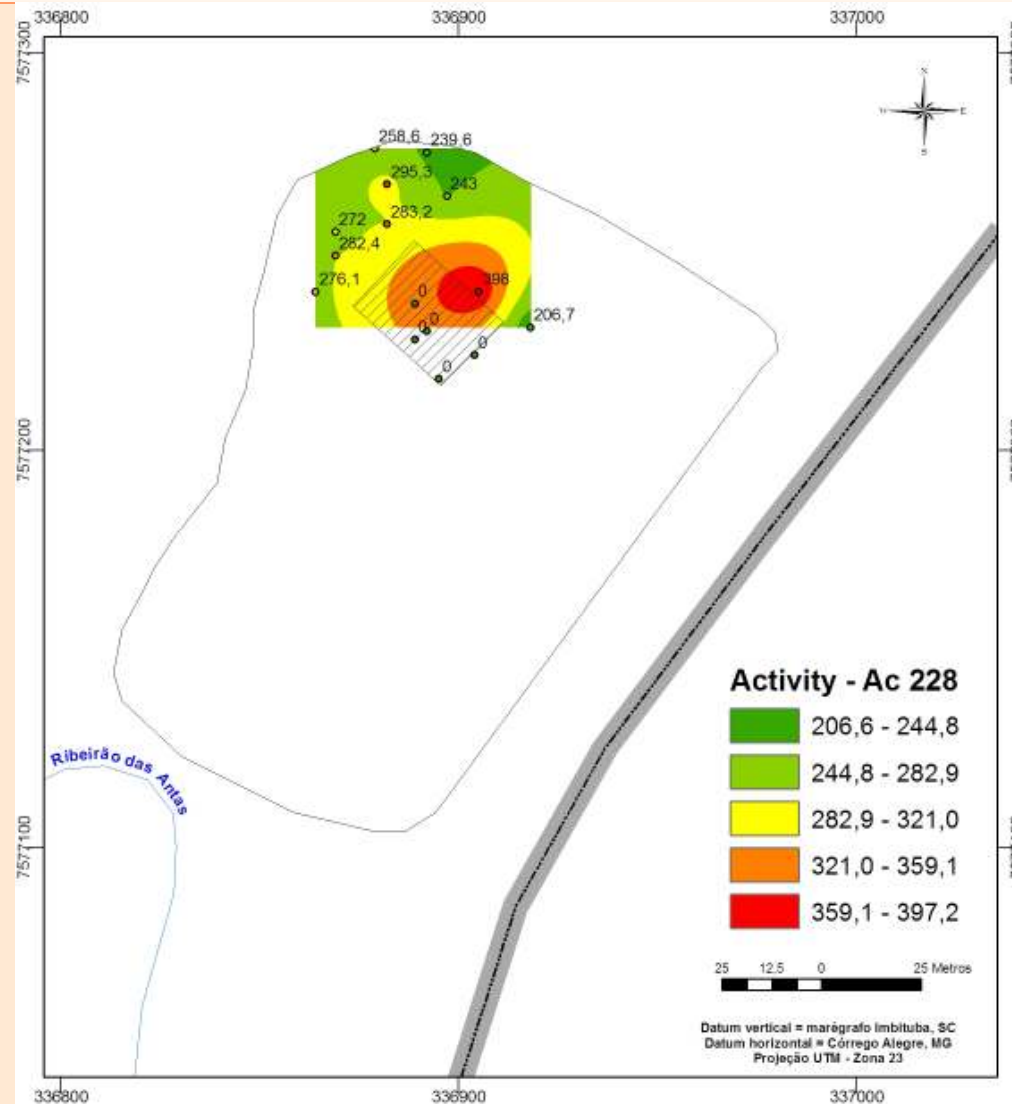


Mean value  $1.567 \text{ g cm}^{-3}$  ( $1.39 - 1.75 \text{ g cm}^{-3}$ )

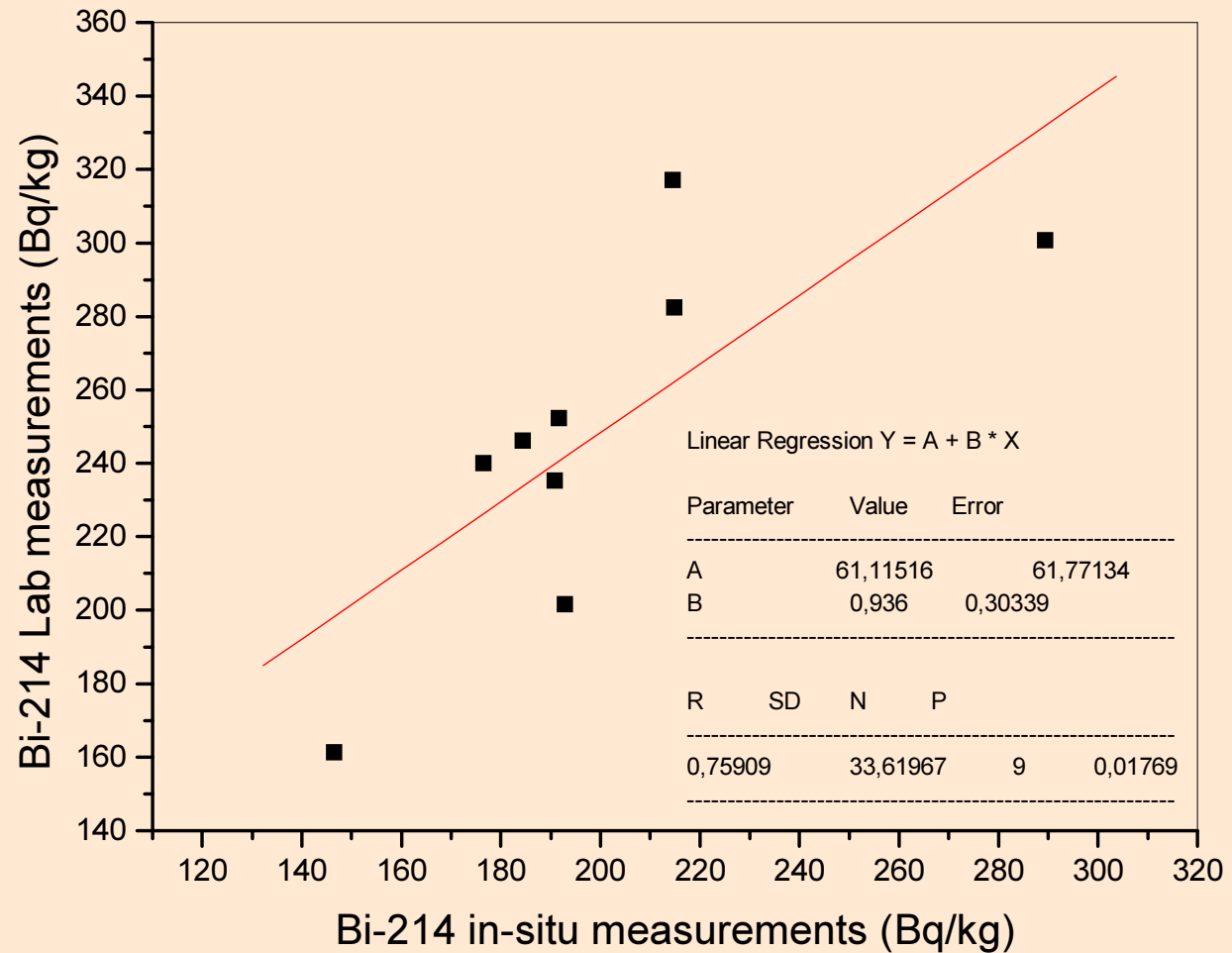
# Preliminary results (Lab measurements) – Bi-214



# Preliminary results (Lab measurements) – Ac-228



# *In-situ* versus Lab measurements – Bi-214





# Conclusion remarks

- There is no indication that there is a highly contaminated area (dose rate, Bi-214 and Ac-228 concentration are similar to the surrounding area).
- The correlation between *in-situ* and lab results must be improved.

# Thank you

## Contacts

Phone

+55 35 2107-3537

+55 35 3722-3266

Dr. Nivaldo Carlos da Silva

[ncsilva@cnen.gov.br](mailto:ncsilva@cnen.gov.br)

[www.cnen.gov.br/lapoc](http://www.cnen.gov.br/lapoc)

