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# Practical hints for area measurements using portable systems

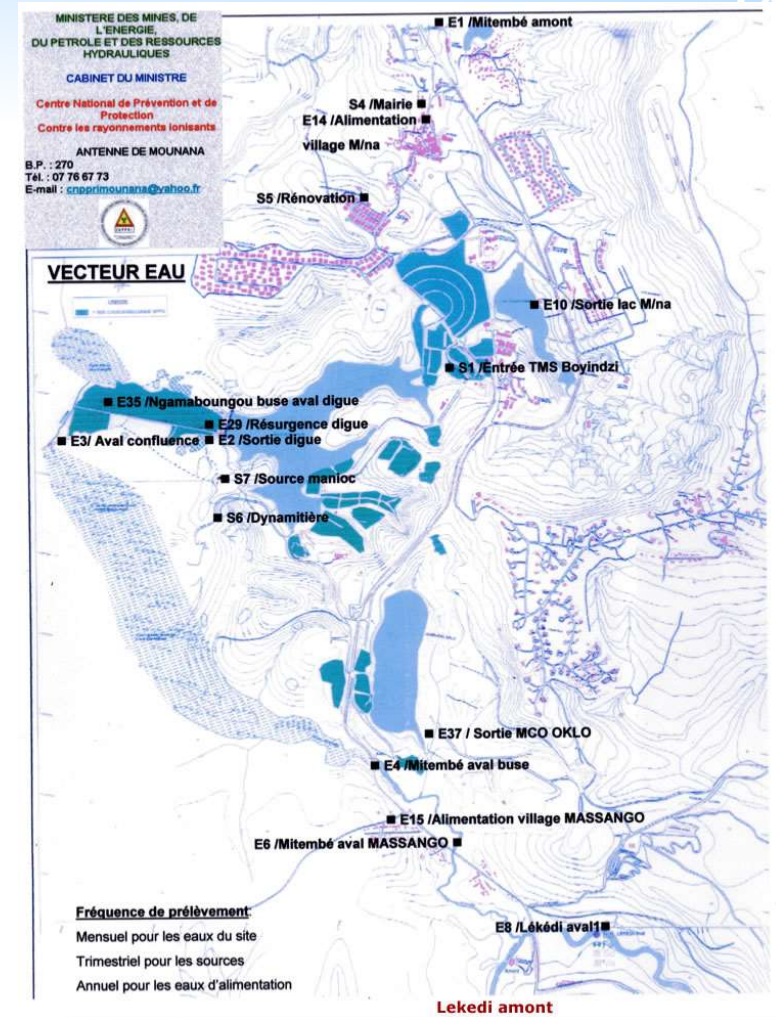
*Roman Padilla Álvarez Petr Sladek  
Nuclear Instrumentation Physicist  
Division of Physical and Chemical Sciences,  
Department of Nuclear Sciences and Applications*

# Outline

- Practical recommendations
  - Considering background information
  - Instrument calibration / comparison
  - GPS readings accuracy
  - Assessment of field of view and density of transects in survey paths
  - Speed of translation and data logging
  - (non)Trivial recommendations

# Relevance of background information to outline measurement strategies

- All information available for the site must be collected
  - Assessment of natural background
  - Criteria of verification
  - Selection of areas to be surveyed
  - Definition of measurement strategies
  - Design of output reports



## Starting up detectors

- Check for the level of charge of the batteries or availability of power supply
- Check the level of LN2, stabilization of temperature, and any other parameter required as pre-condition for operation of the detector
- Wait for the time required for the detector to stabilize (as per recommendations from manufacturer)
- Perform a quality control measurement using sources (if available)

## Quality assurance of measurement results

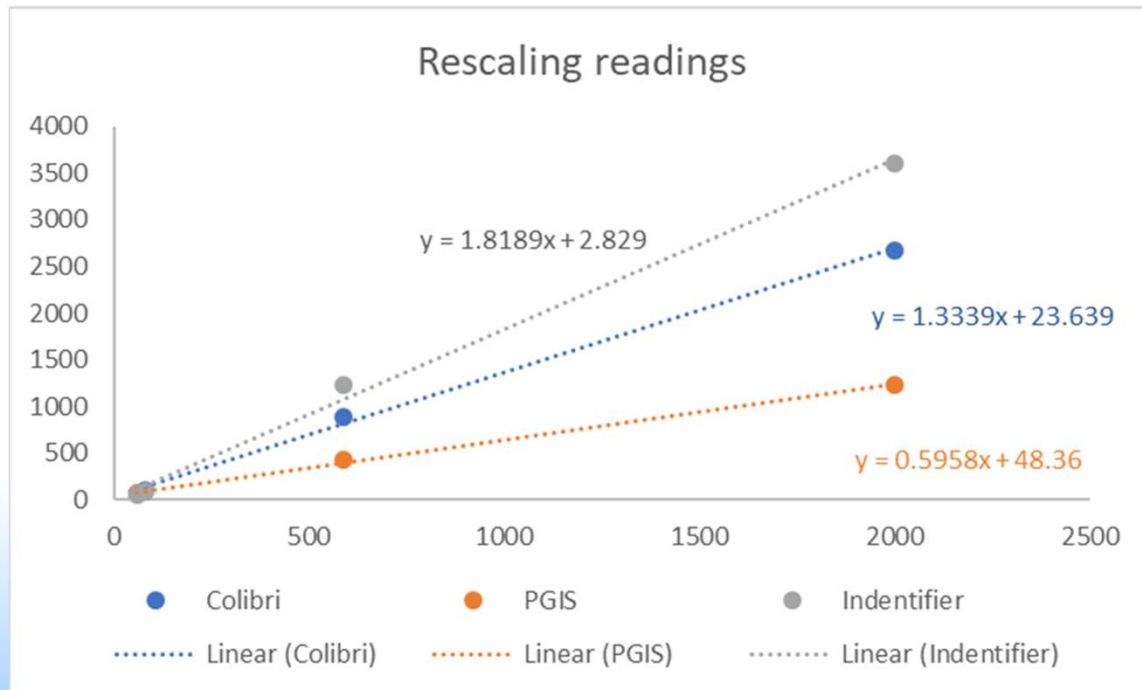
- Ideally, all instruments shall be properly calibrated
- Common: Comparing readings with those obtained by using a calibrated instrument at different activity/dose rate levels



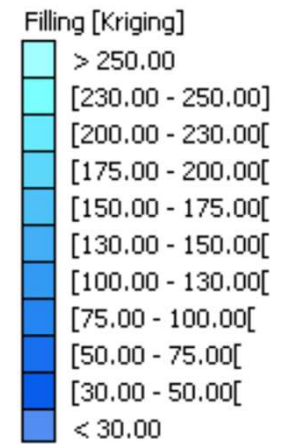
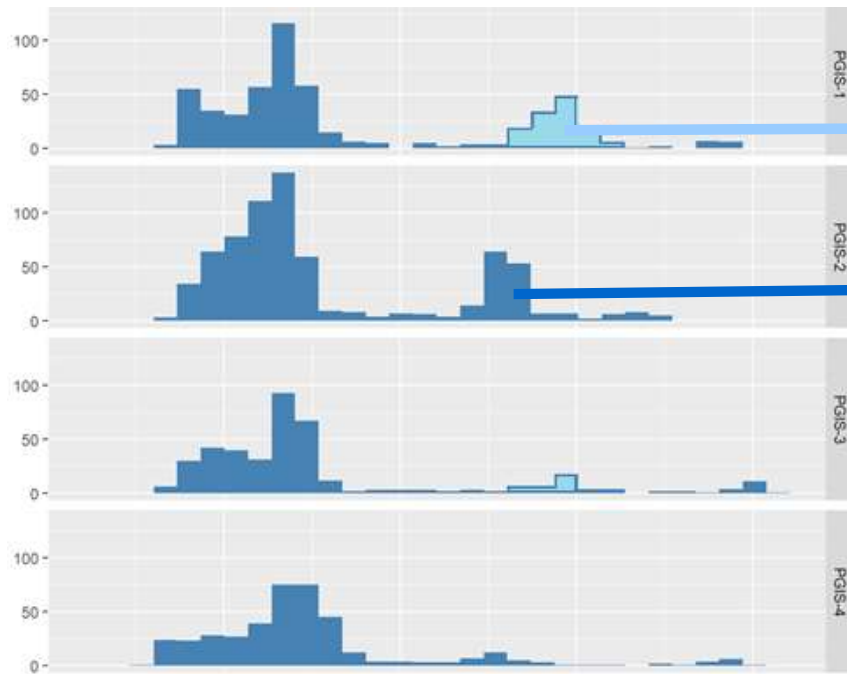


## Use of multiple detector packs

- When using different instruments, compare readings across the instruments by conducting measurements at spots with different dose rate / activity levels
- Verify linearity and establish proportionality to readings of one instrument (ideally calibrated)



# Effect of biased readings



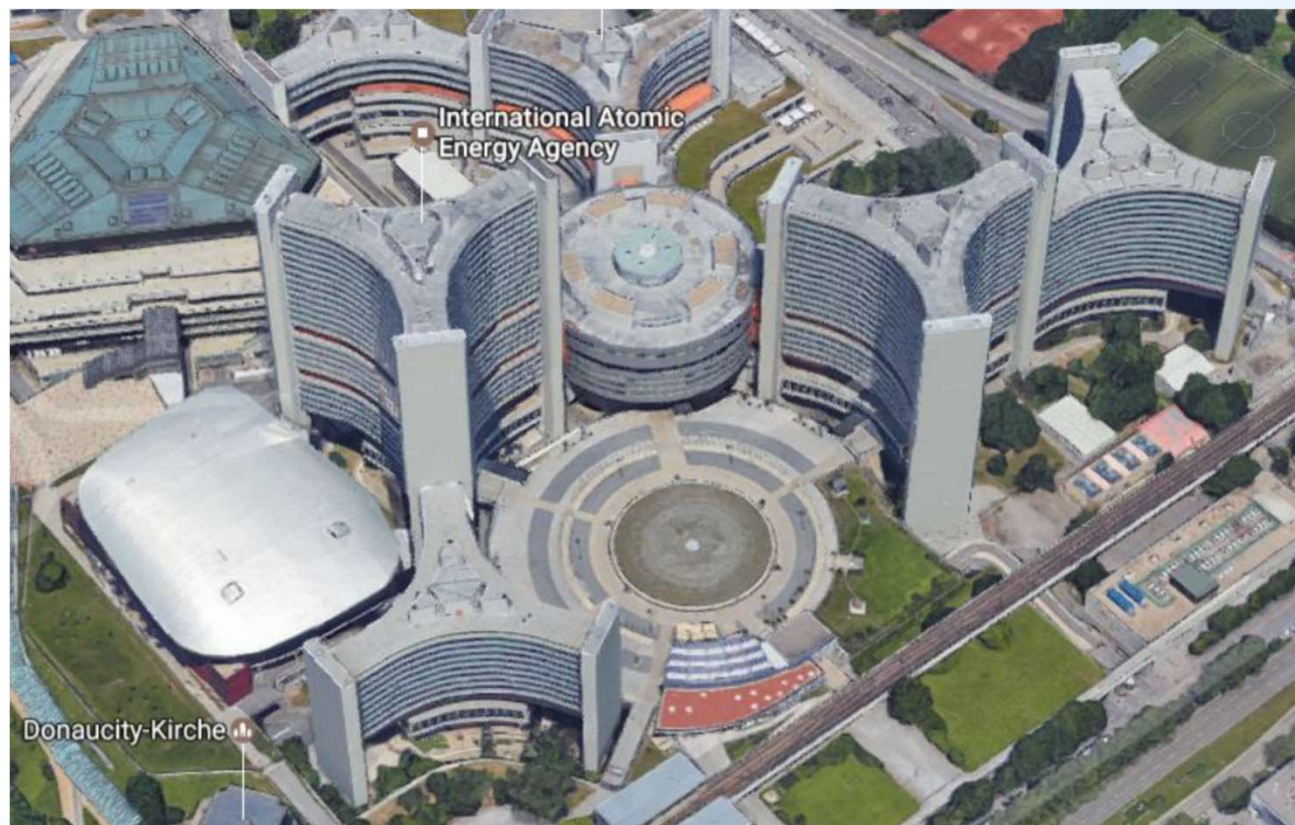
# GPS logging

## Accuracy in coordinate readings:

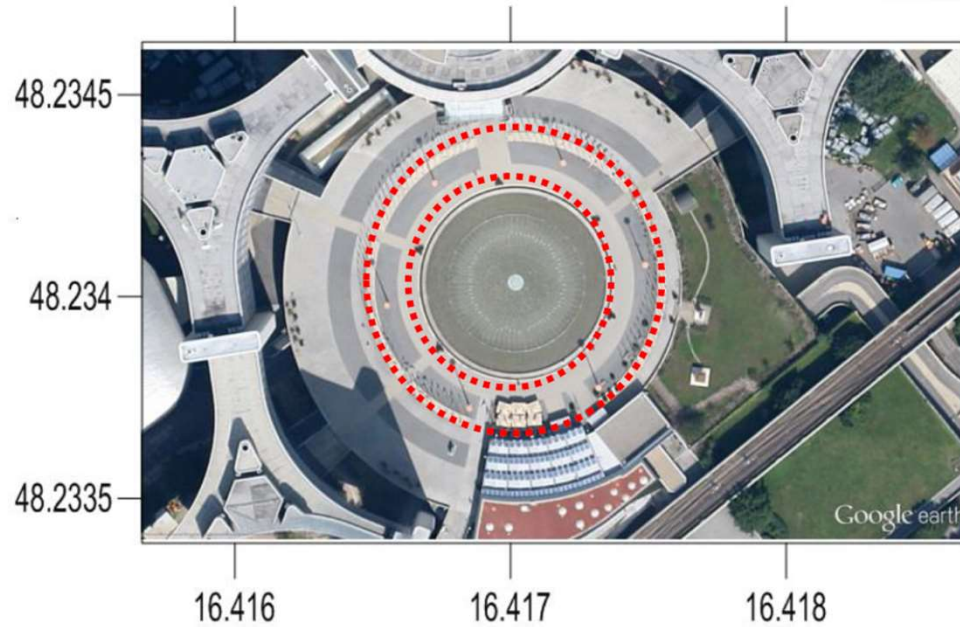
- For cheap devices
  - usually 3-5 m,
  - possible only in open areas
  - Affected by multiple reflections in proximity of buildings
- Choices for better accuracy
  - Down to cm range
    - OmniStar: Satellite base augmentation system, requires subscription
    - Differential Global Positioning Systems (DGPS), using reference radio beacons, possible in non-open environments



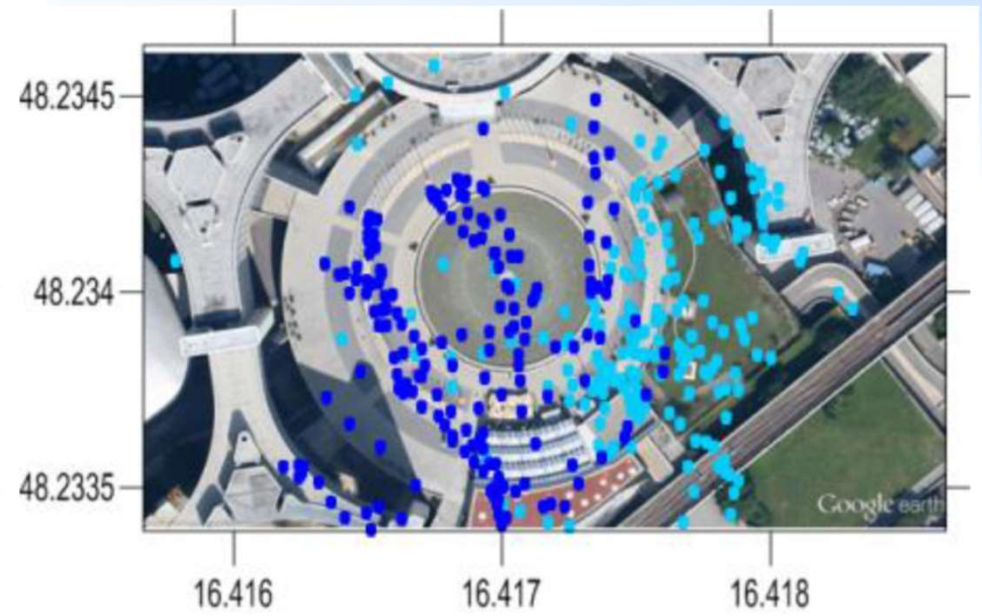
# GPS readings in the vicinity of tall structures



# GPS readings in the vicinity of tall structures

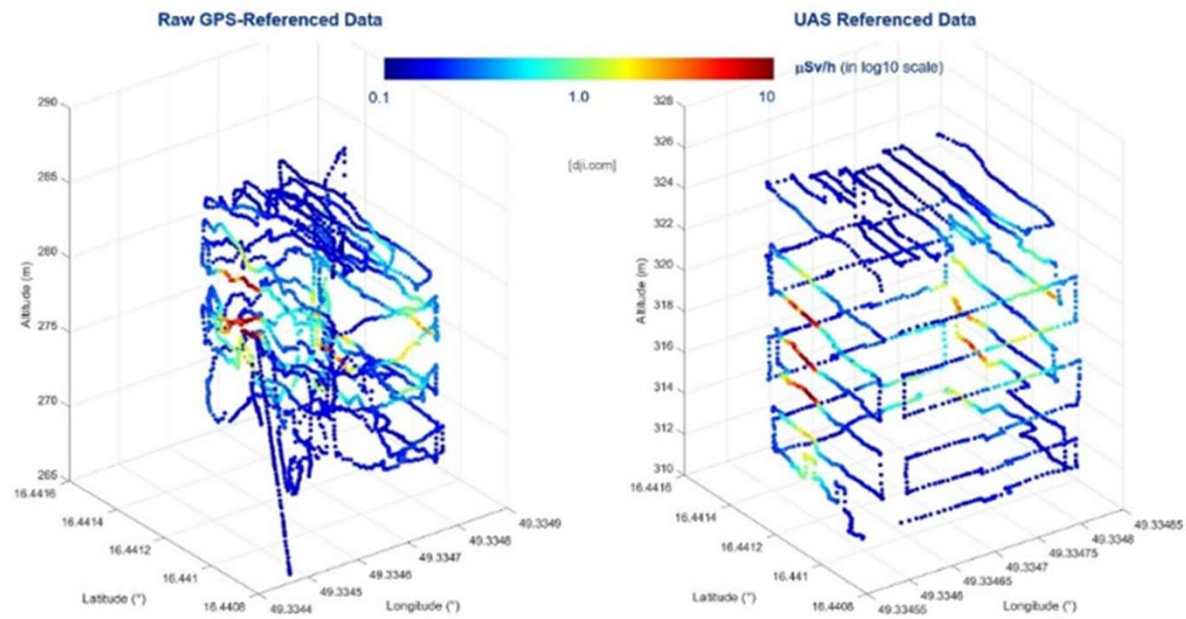
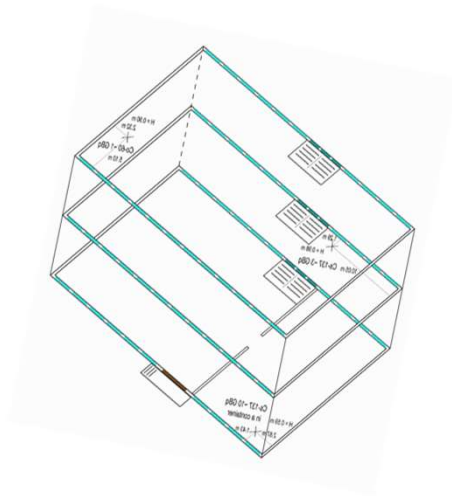


Real pathways



GPS coordinated measured with two different systems

# GPS readings correction



Raw GPS data

Corrected GPS



# Field of view (effectively probed area) in Surface measurements

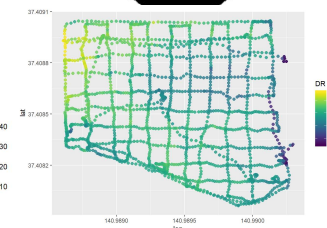
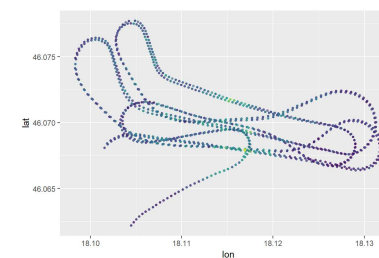
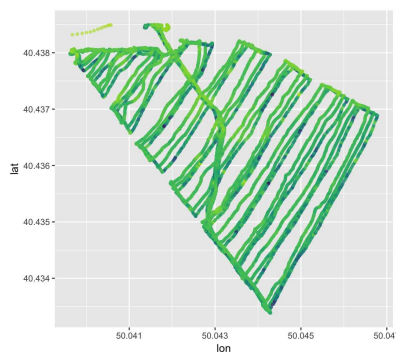


Ground level			Aerial		
	Stationary	Backpacks/ HH	Car-borne	Different platforms	
Data logging period T (s)	10 – 10 <sup>3</sup>	~ 5 to 10	~ 1 - 2	~ 1	~ 1
Distance to surface H (m)	1	1	~ 0.15 - 30	300 - 1000	50 - 100
Measured effective area	<p>d ~ 10 m</p>	<p>Width ~ 10 m, Length = 10 + V*T</p>	<p>Width ~ 3 - 4 m, Length = Width + V*T</p>	<p>Courtesy T.Tori, JAEA</p> <p>Width ~ 2 H, Length ~ 2H + V*T</p>	

V [m/s]. T [s]

# Transects and data logging in surface measurements

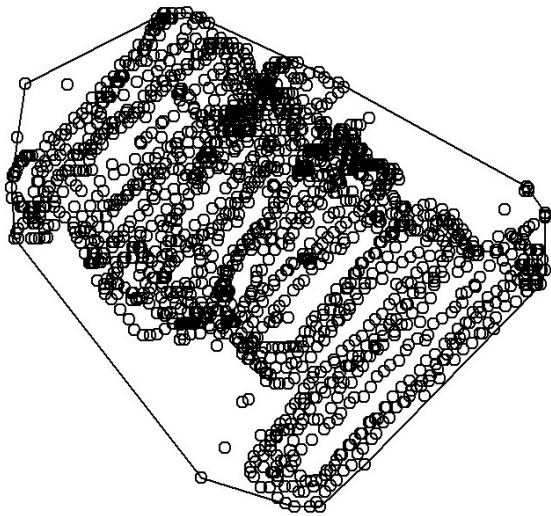
	Ground level			Aerial		
	Stationary	Backpacks / HH	Car-borne (*)	Different platforms		
Measurement spots	Fixed locations	Following parallel transects, trying to produce a grid <b>as symmetric as possible</b> Increased density results from finding 'hot spots'		Following parallel flight trajectories, but in the case of high speed of flight biased by loops		
Distance between transects (m)	0	10 - 15	3 - 10 20 - 30	1000	100	5 - 20
Speed of translation V (ms <sup>-1</sup> )	0	~ 1	~ 3- 6 (10 - 20 kph)	➤ 60 ms <sup>-1</sup> (> 200 kph)	20 - 40 ms <sup>-1</sup> (75 - 150 kph)	~ 1 - 10 ms <sup>-1</sup> (3 - 35 kph)
Recommended datalogging period (s)	-	~ 5 to 10	~ 1 - 2	~ 1		~ 1



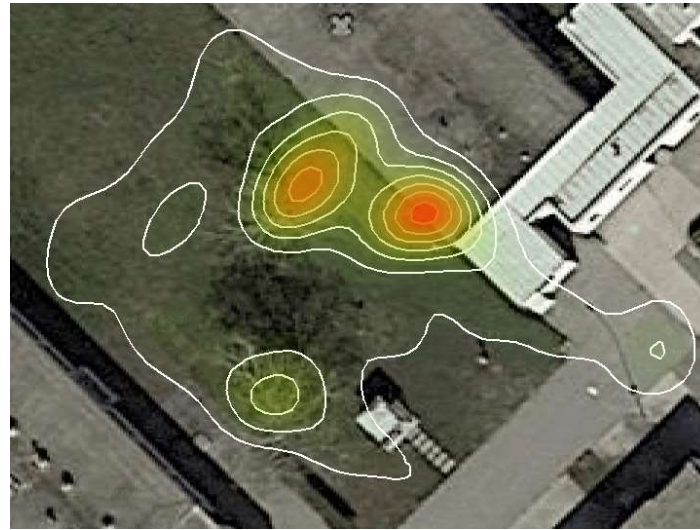
(\*) Mike Davies et al 2007 J. Radiol. Prot. 27 A51, <https://doi.org/10.1088/0952-4746/27/3A/S07>



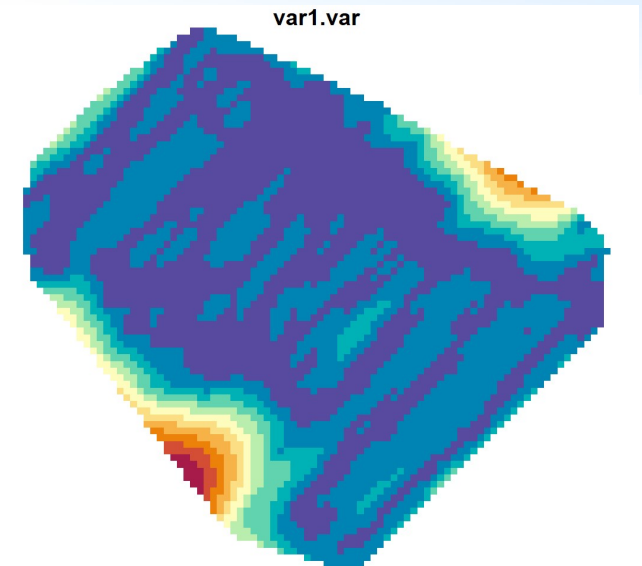
# Effect of unequal density of readings



Measurement points



Density of Measurements



Interpolation Variance

## Trivial advices for field measurements...

- Make sure your batteries are fully charged!
- Plan your measurements strategies based on available information and expected needs
- Avoid measurements near high structures (GPS coordinates will be biased!)
- Plan your survey as to avoid the need of revisiting
- Optimize your pathway as to reduce the total travelled distance
- If working in team, follow the leader instructions!

## Other general recommendations...

- Protective clothing and dosimetry should always be considered when entering an area of unknown radiological conditions.
- If available, alarm levels must be set-up by adopting a triggering value of twice the background in terms of exposure to gamma radiation rates.
- When performing radiation surveys on equipment and tubular, it is important to ensure that the probe is held within 1 centimetre of the surface
- Soil and land should be marked at observed hot spots for probable further sampling and laboratory analysis.