Volume slicing with multi-directional muon radiography

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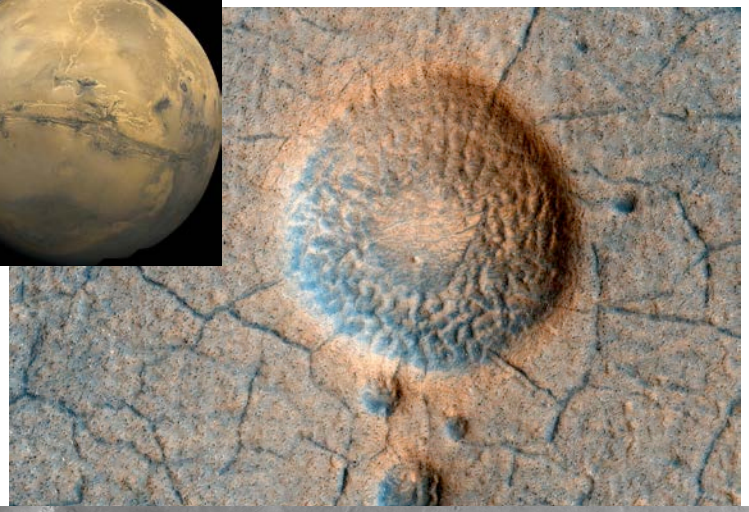
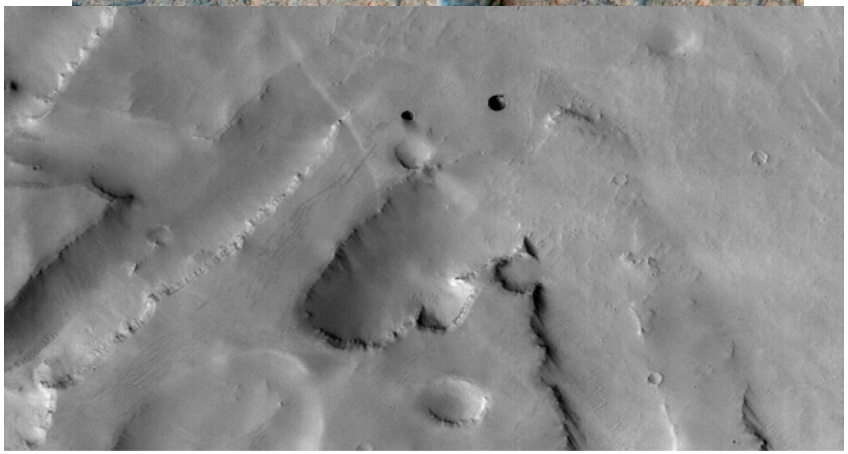
Geological problems to be solved by muon radiography



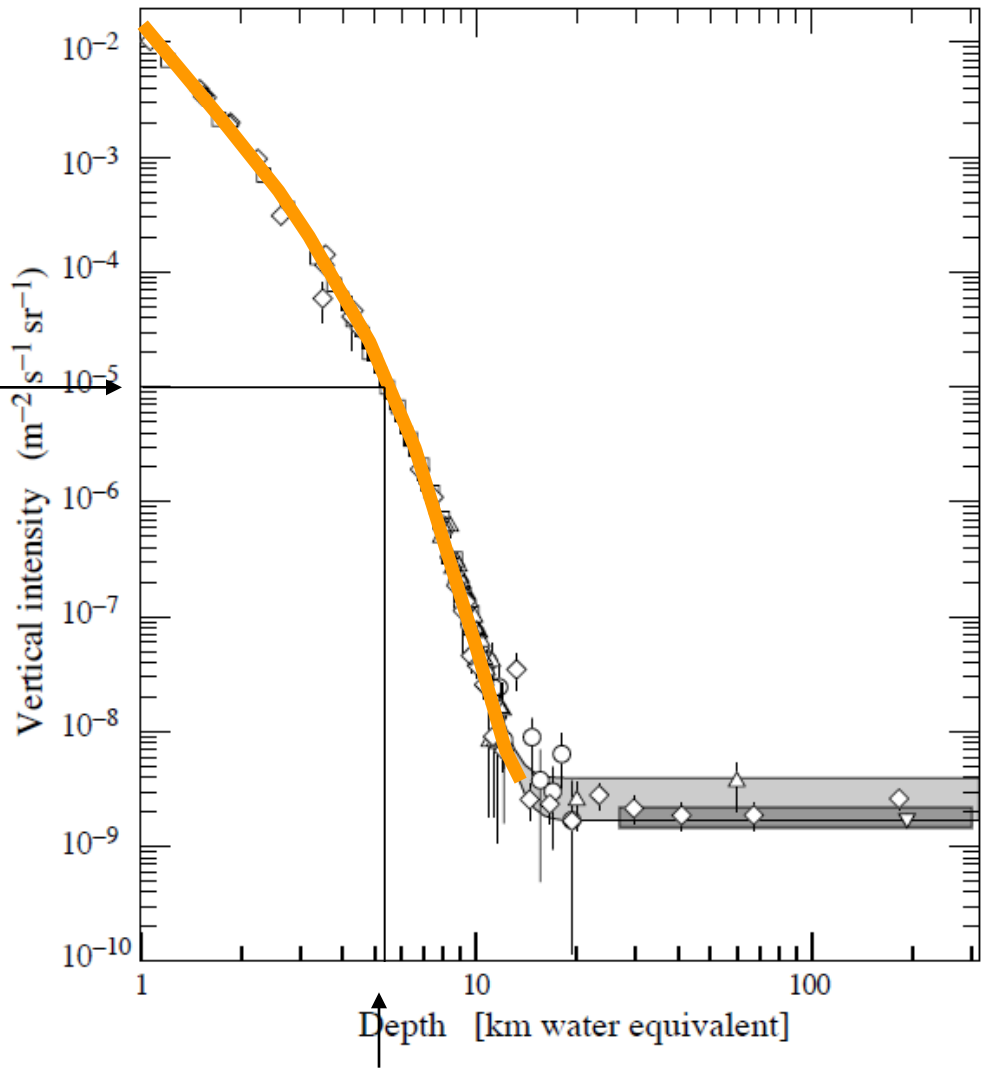


Growing lavadome
Degassing evolution
Eruption dynamics

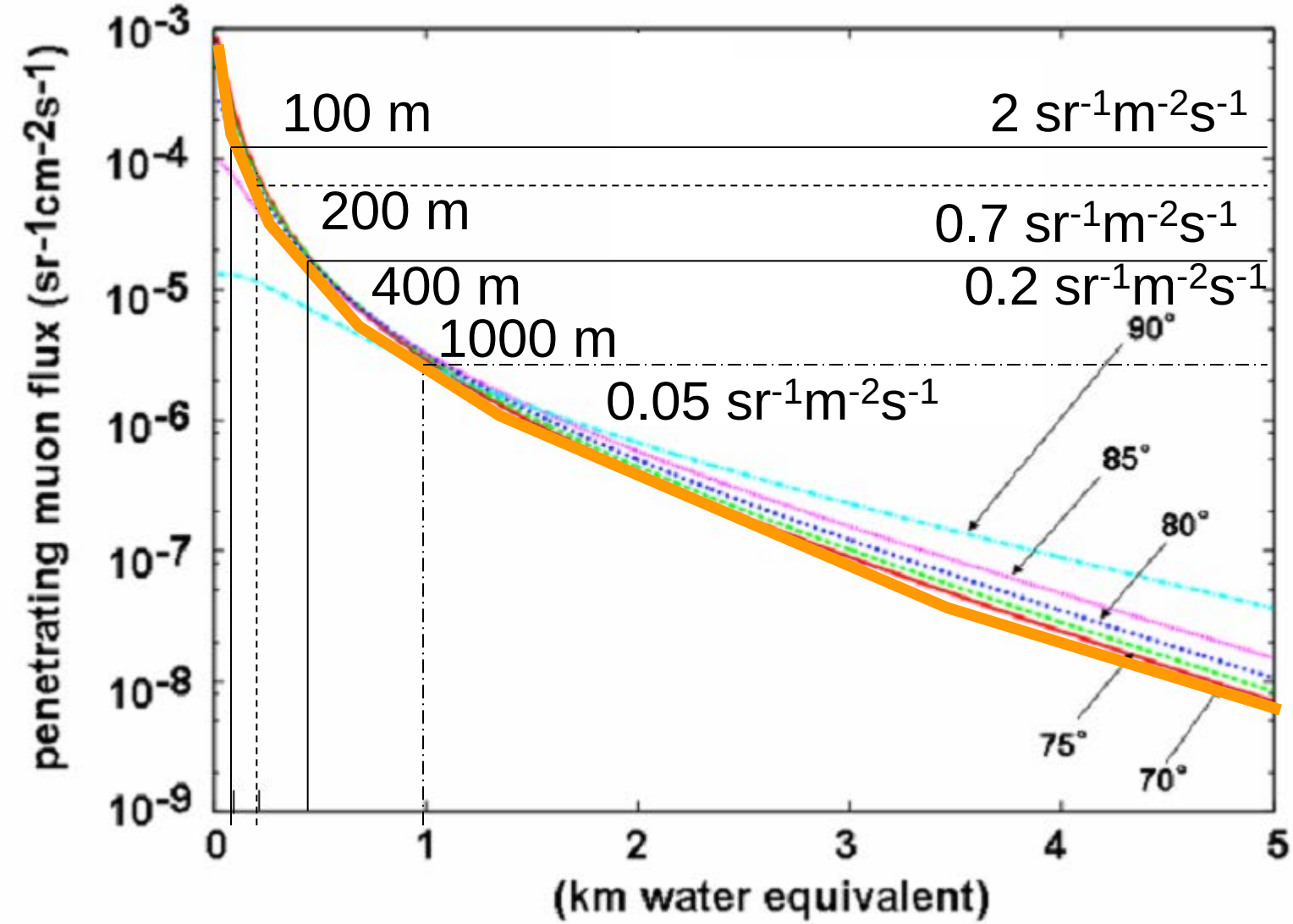
- Short time scale
- Short time restriction
- Shape changes with time

Muon radiography principle

Counting the number of events



Integrated density along the muon path



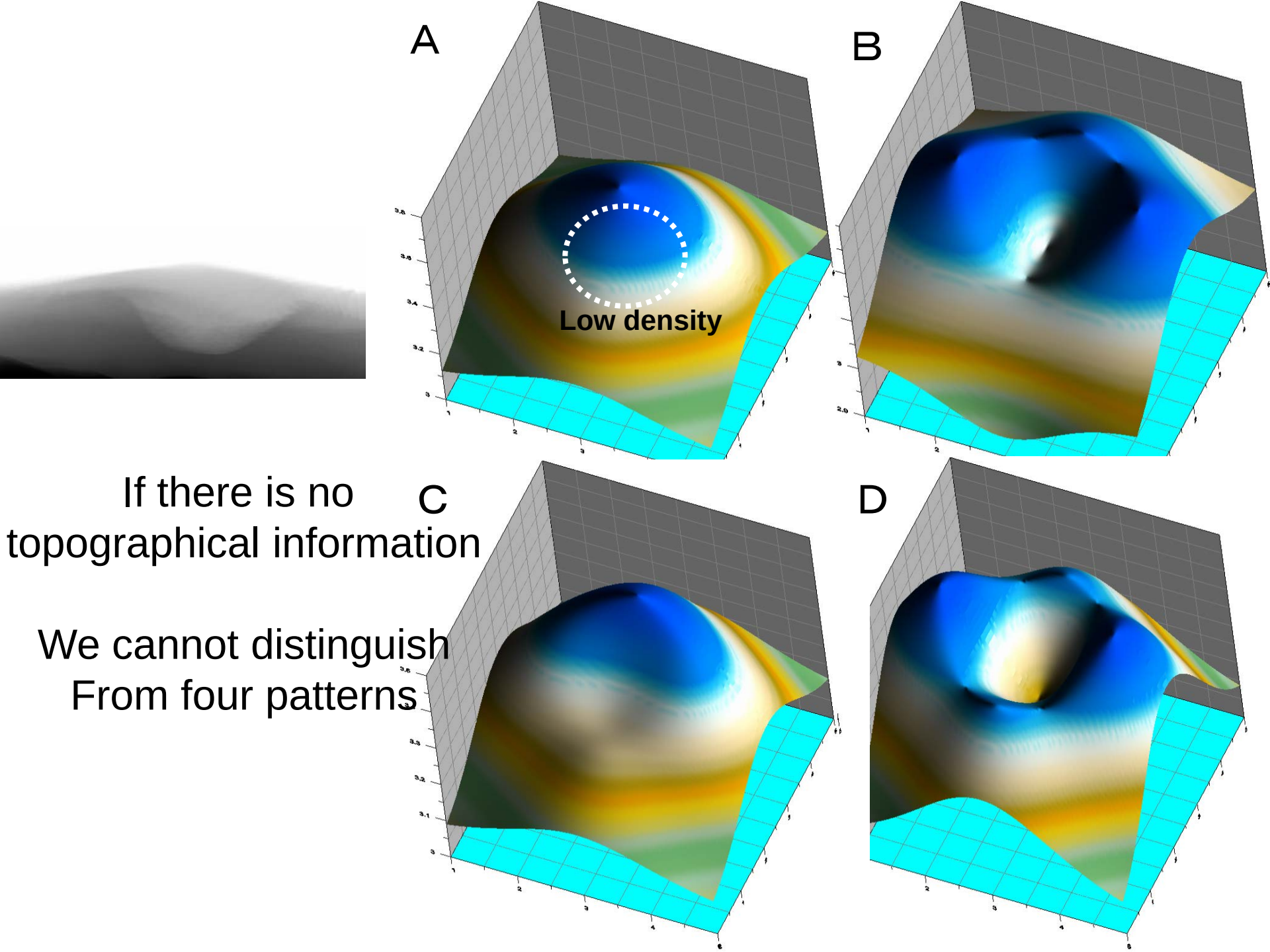
Thickness 400 m 20 events/20min
Thickness 200 m 70 events/20min
Thickness 100m 210 events/20min

Density 50% off distinguishable

(S=50x50 cm^2 L= 1.5 m)

However

- There still has a problem
- If we cannot measure the density length



If there is no
topographical information

We cannot distinguish
From four patterns

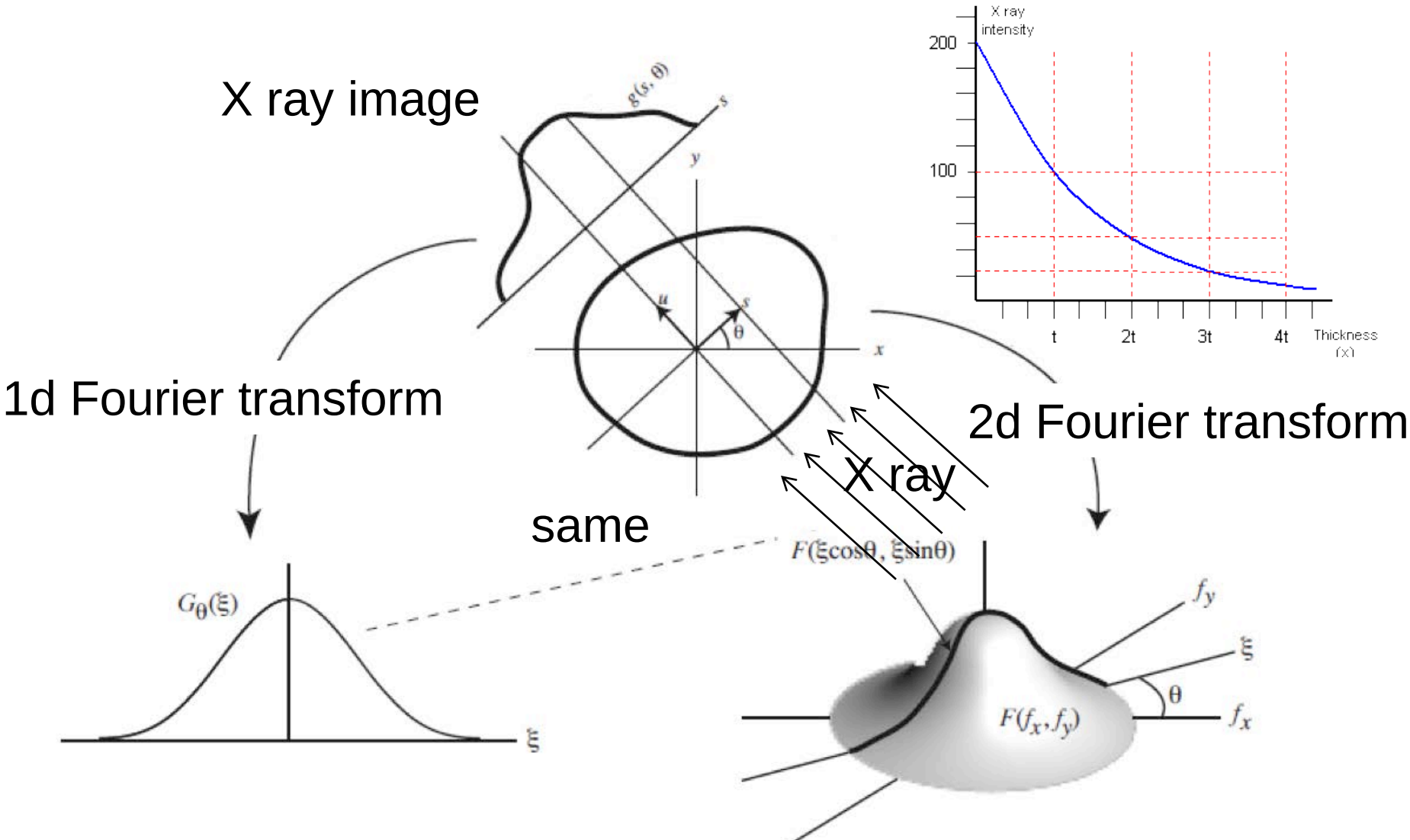
How about x ray tomography?

We do not need
the exterior geometry

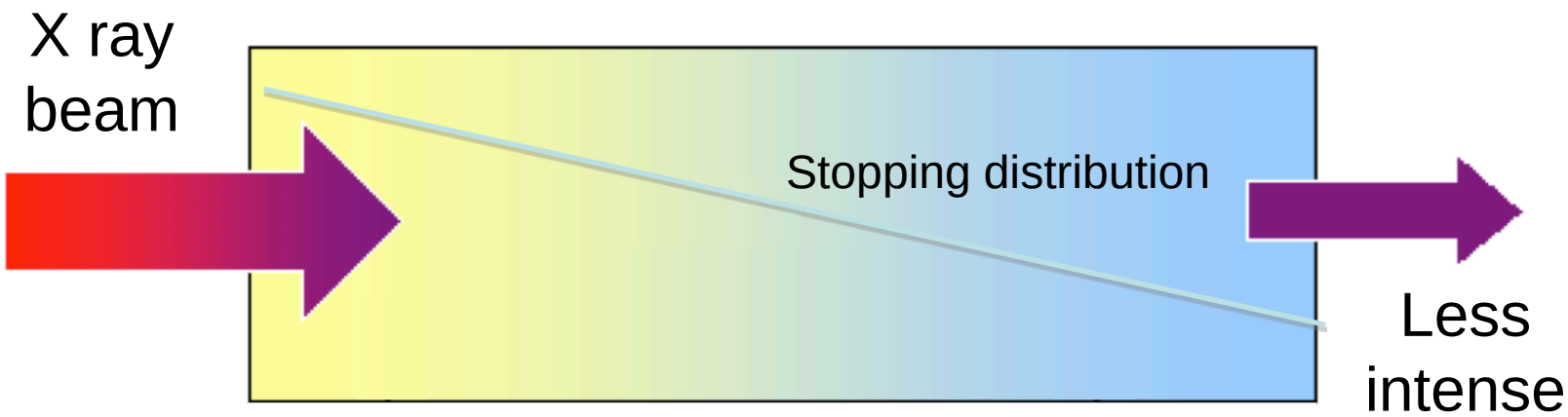
Why?

Radon's theory

A value $\rho(x_1,y_1)$ in a 2d function $f(x,y)$ is uniquely determined from an integration of $f(x,y)$ along arbitrary lines that cross (x_1,y_1)

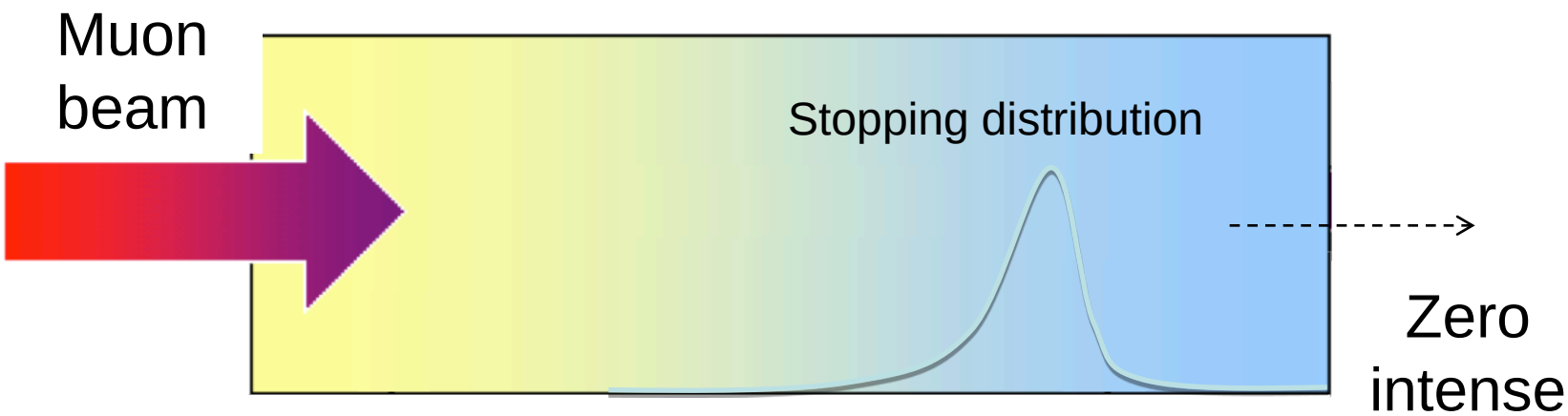


X ray absorption

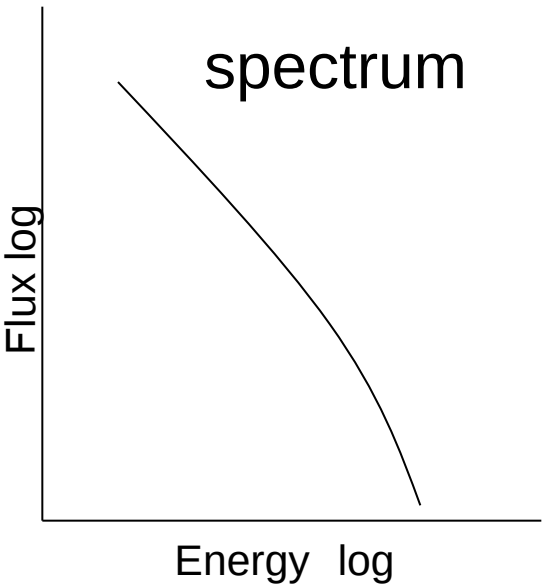


80 kV have a half value thickness of about 3 mm

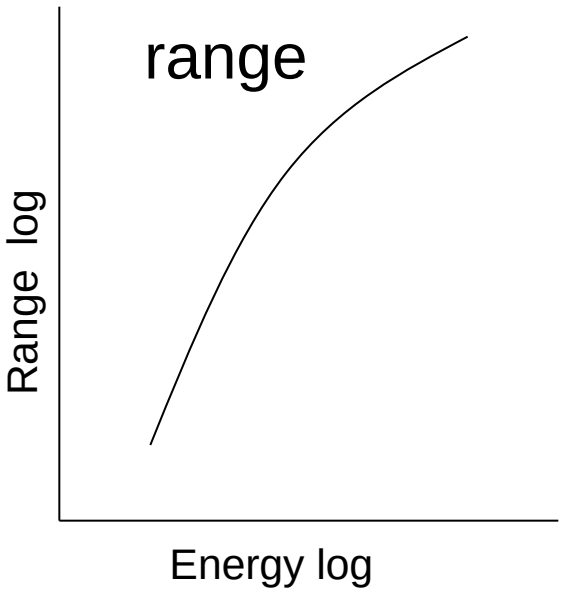
Muon absorption

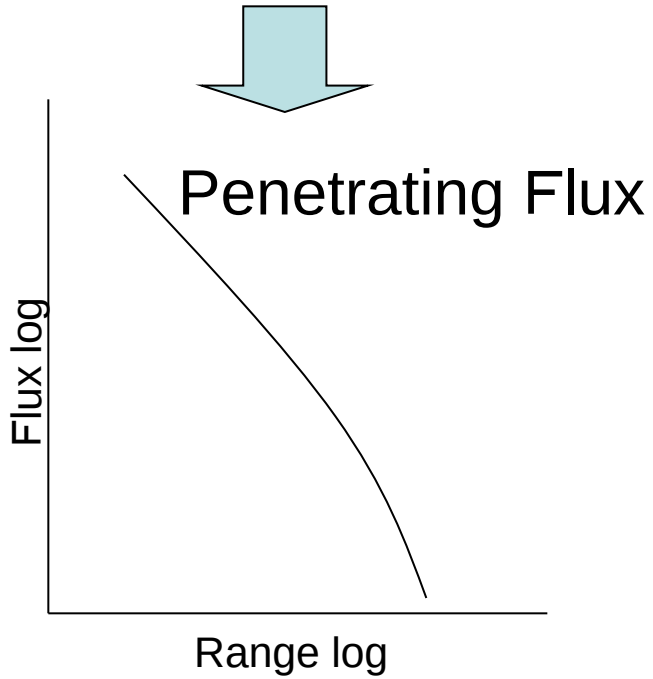


Cosmic ray muons

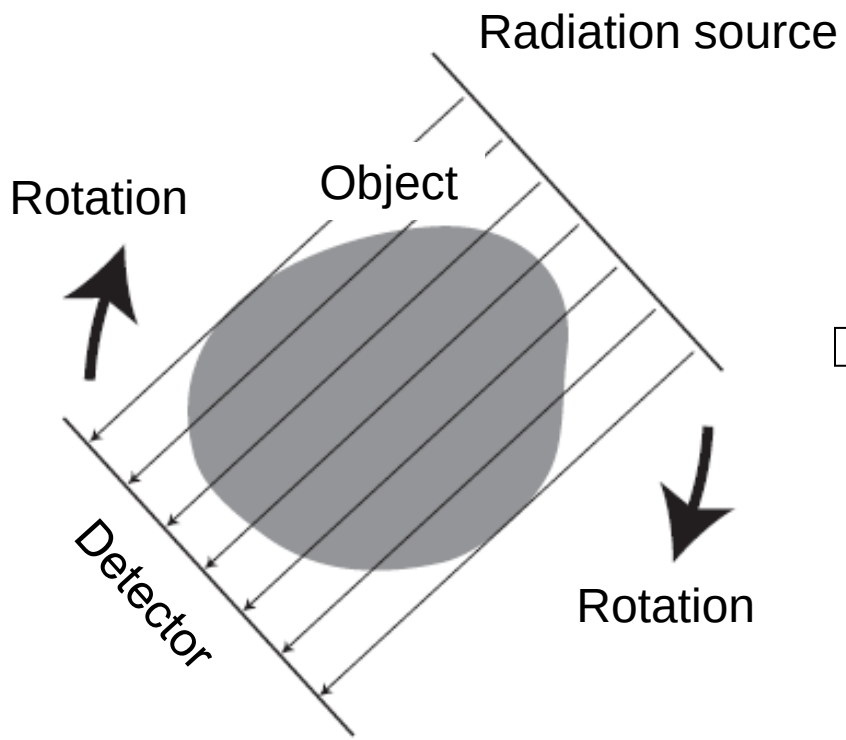


+

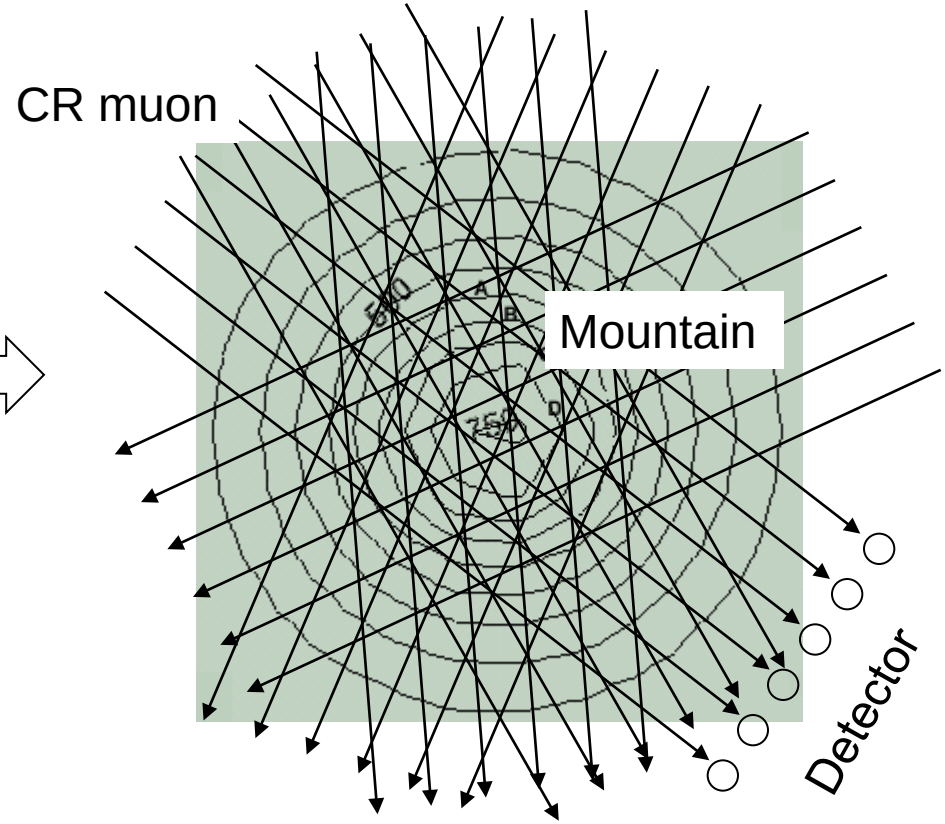




X ray tomography

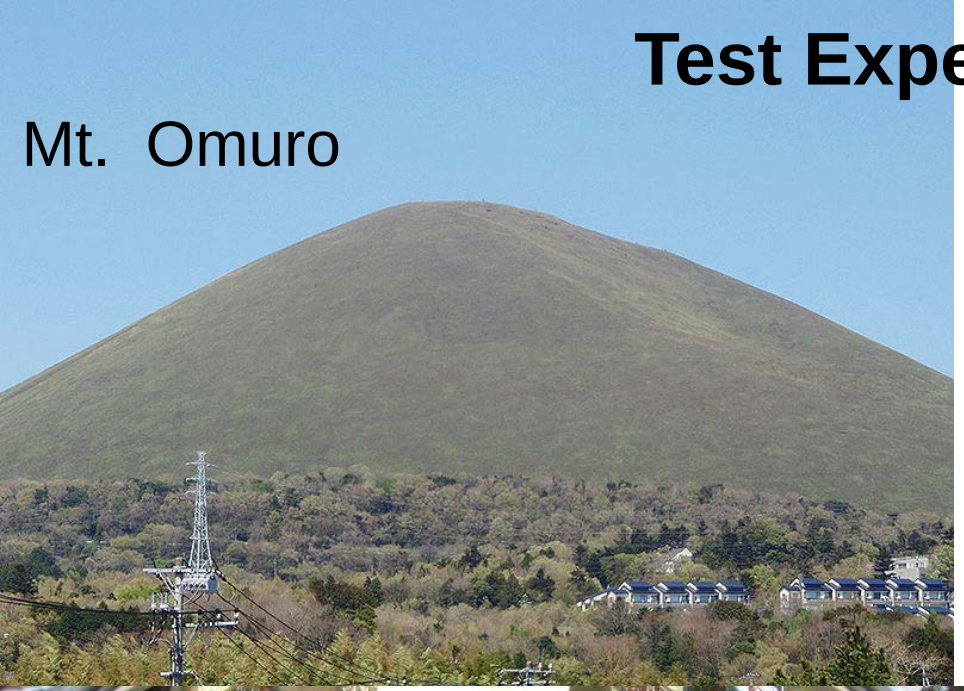


Muon tomography

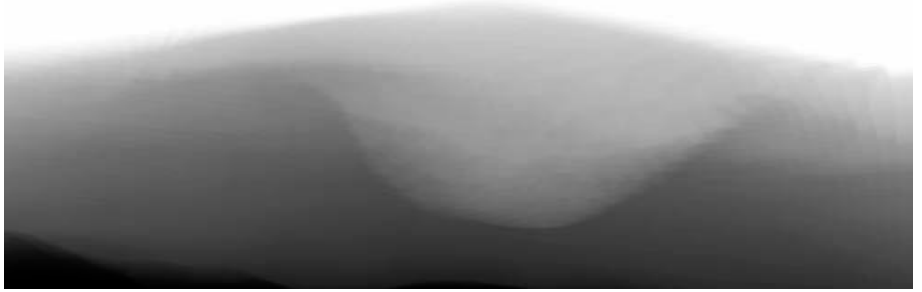


Exterior information is not necessary

Test Experiment

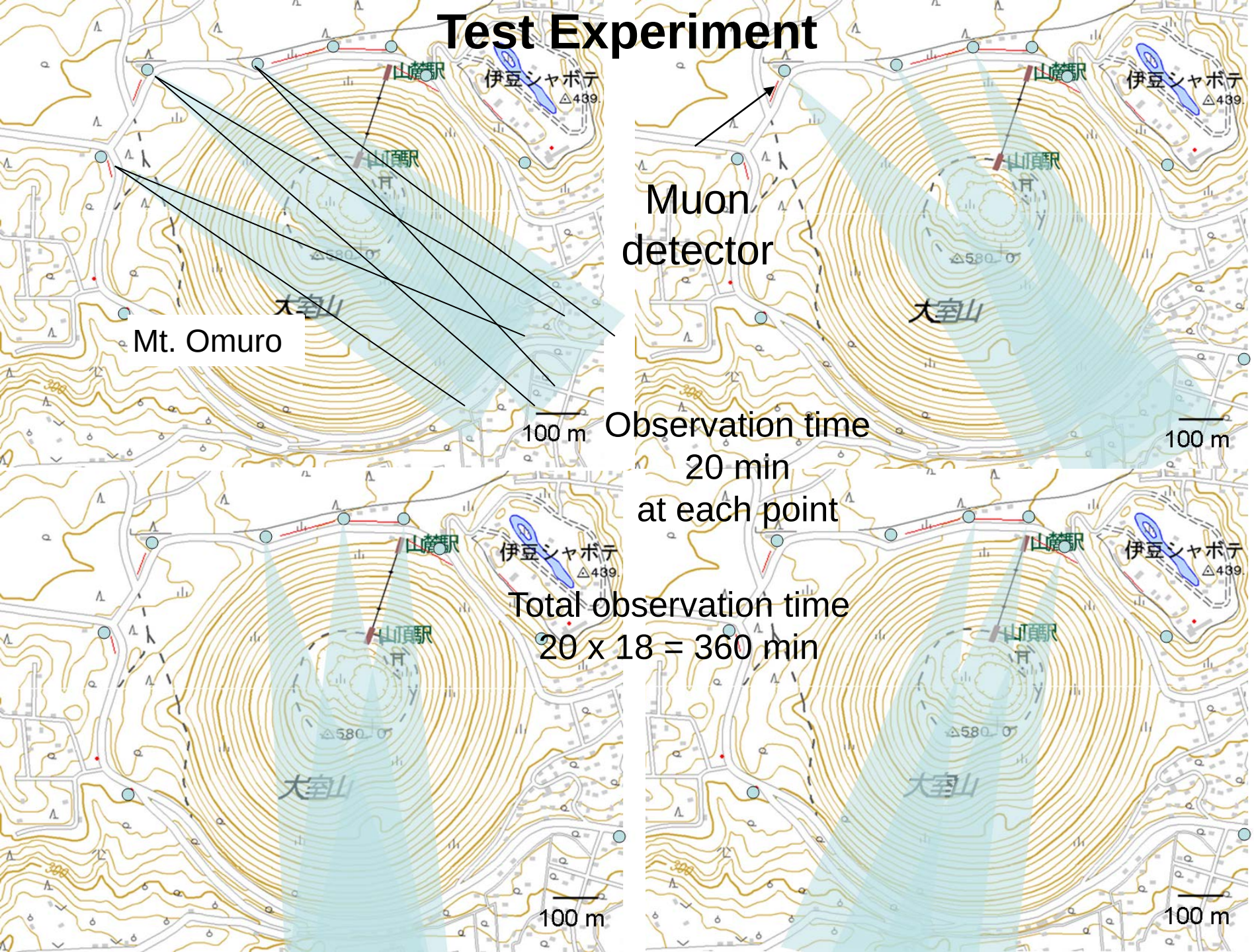


Crater on the top

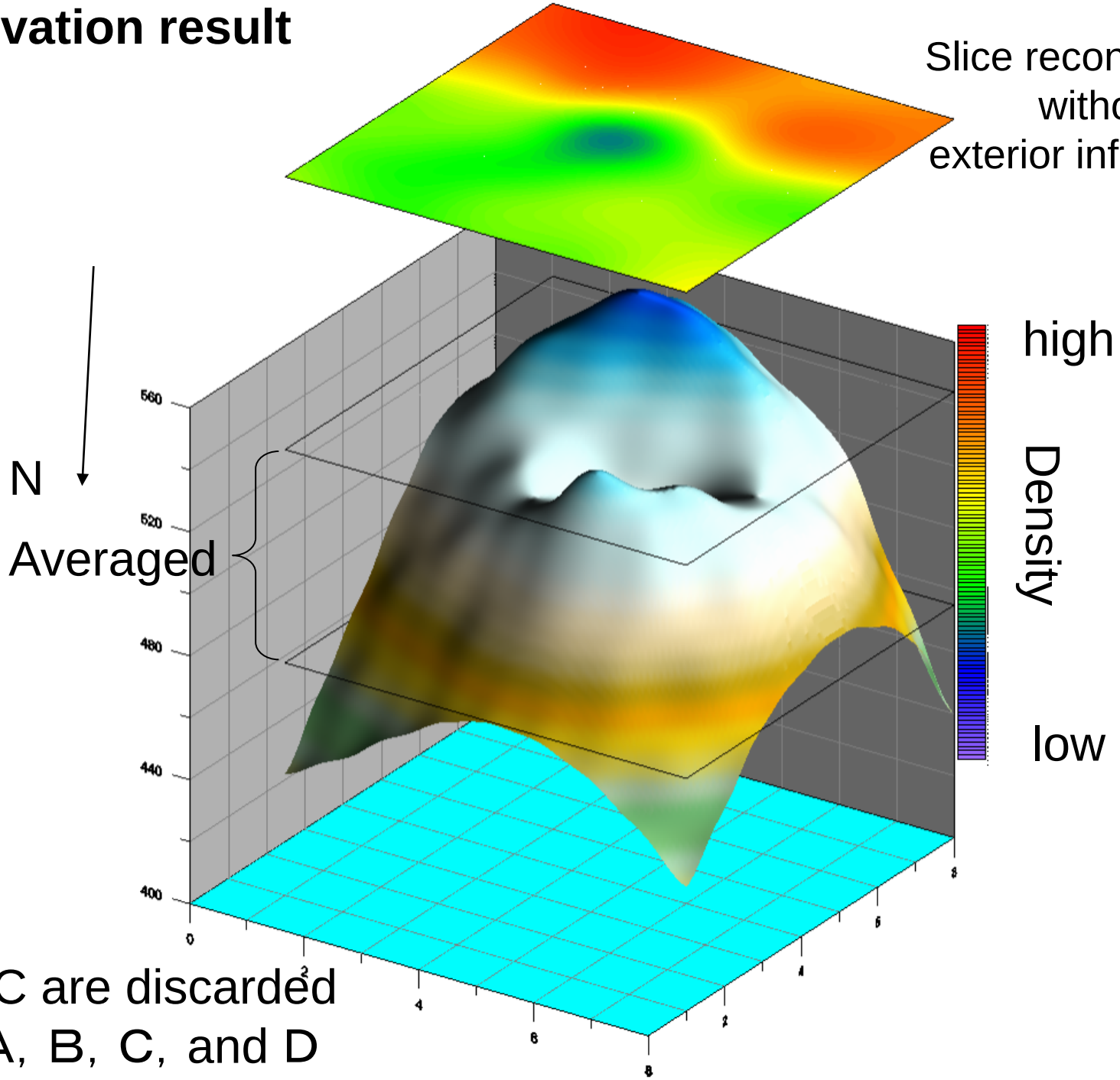


Mobile
observation

Test Experiment

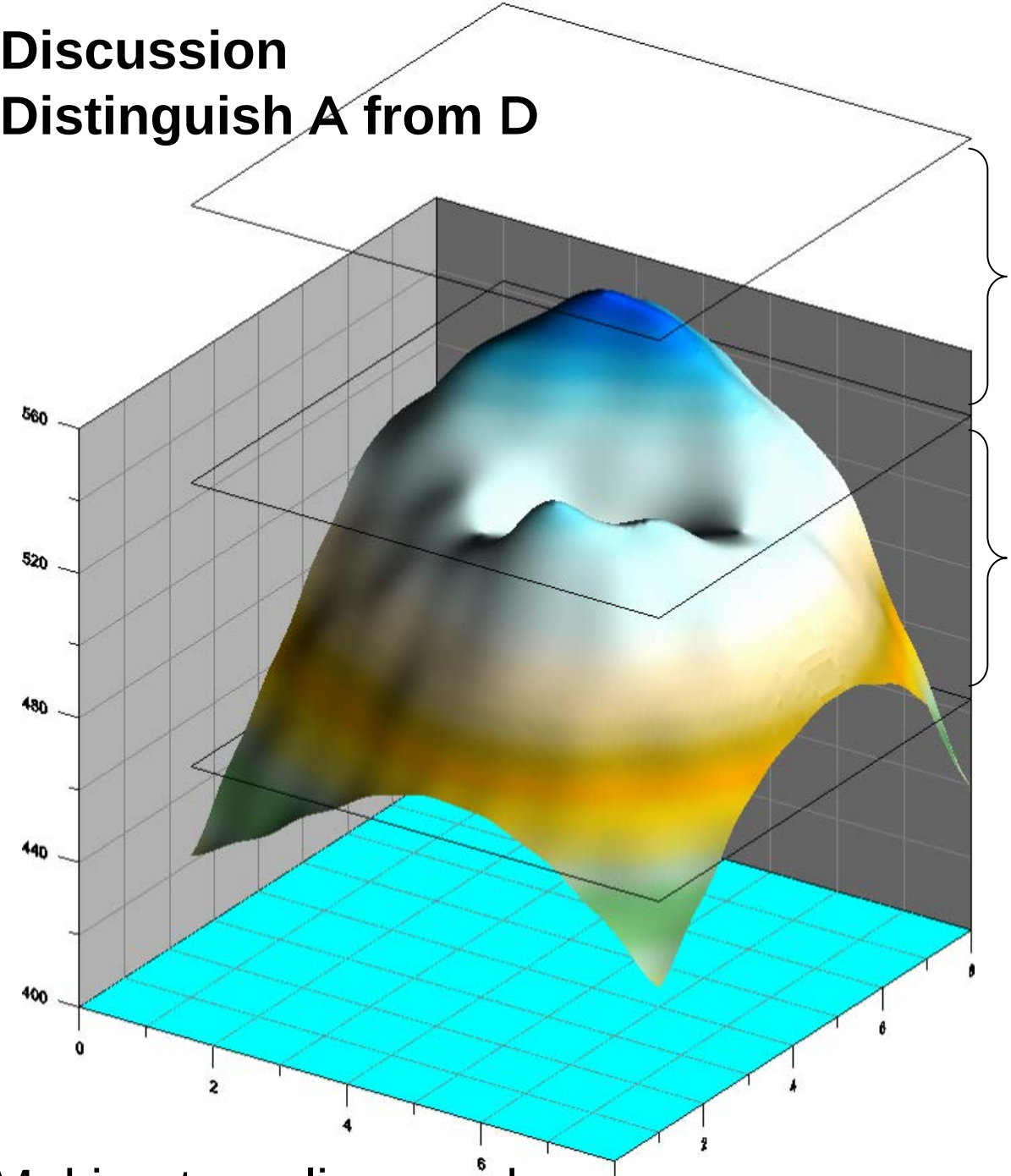


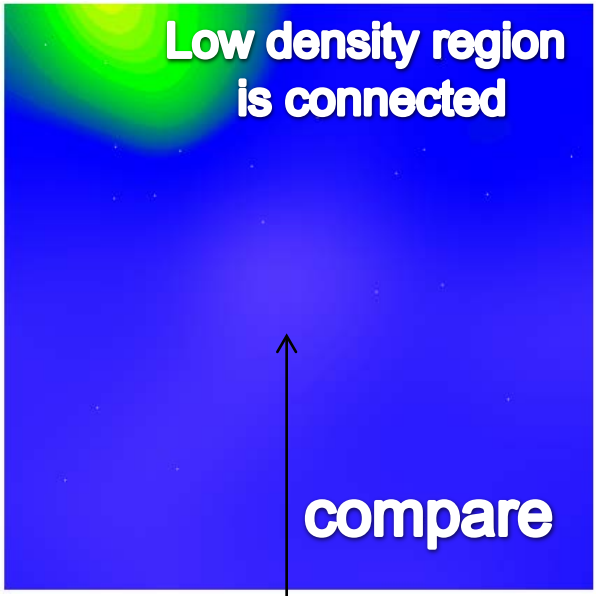
Observation result



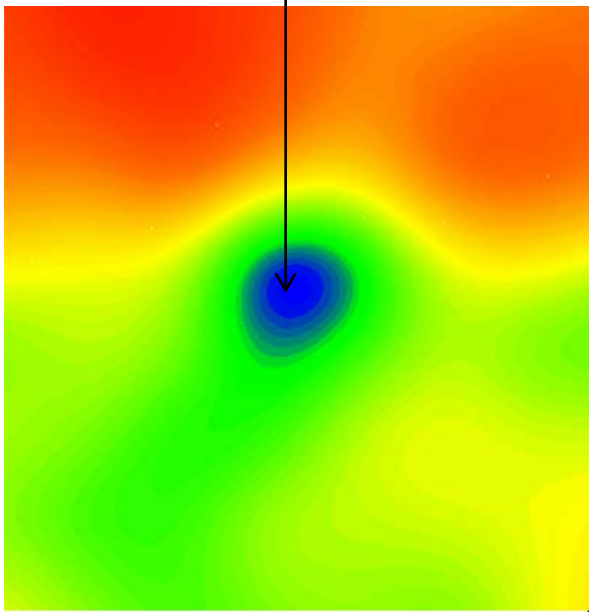
B and C are discarded
from A, B, C, and D

Discussion
Distinguish A from D



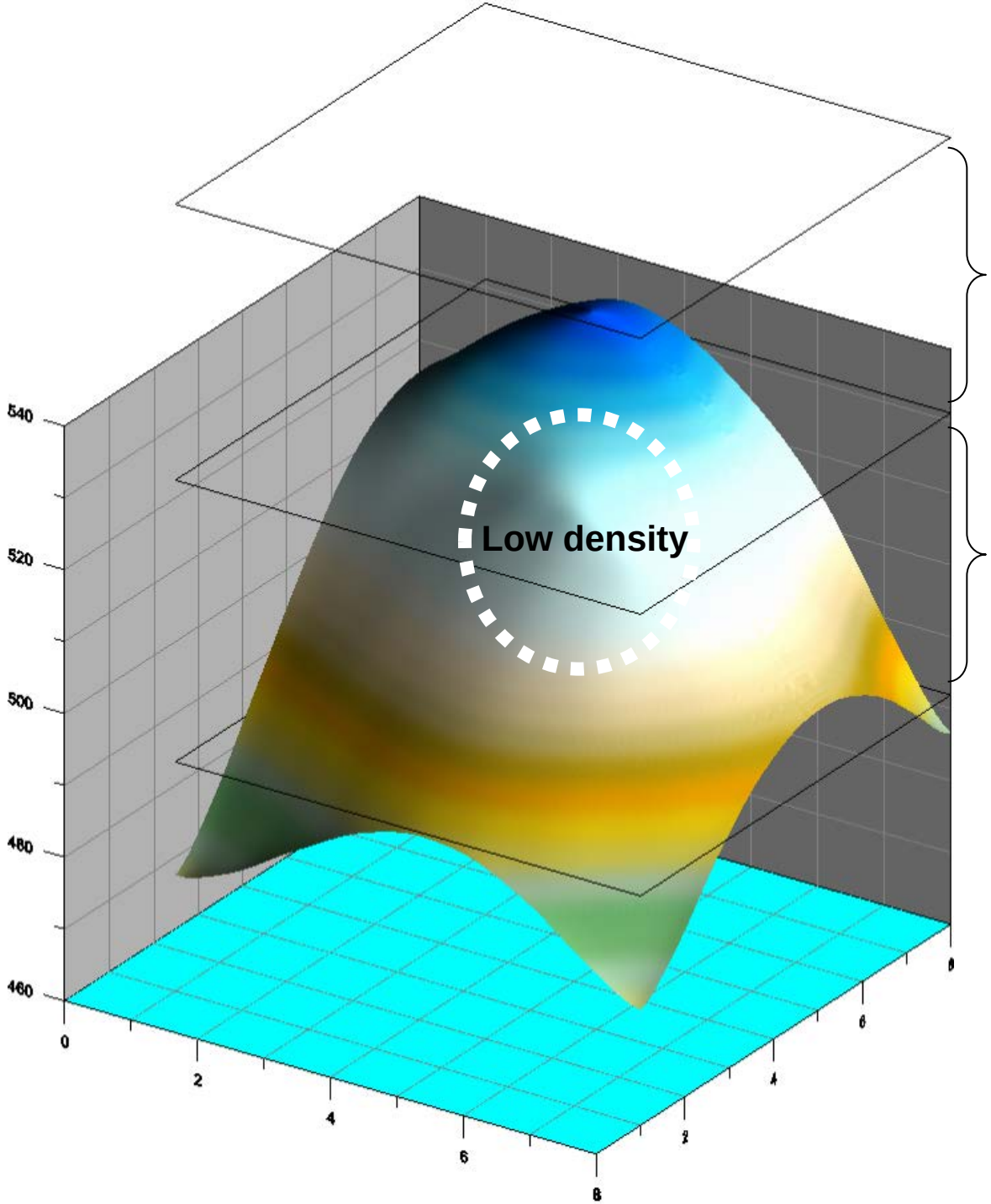


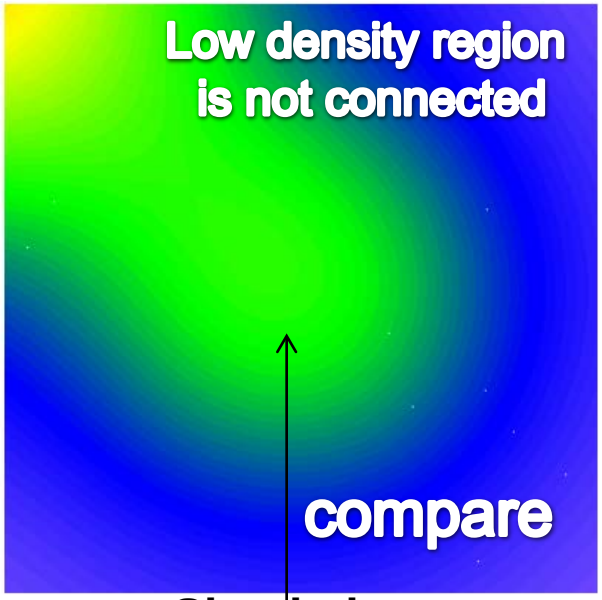
Simulation



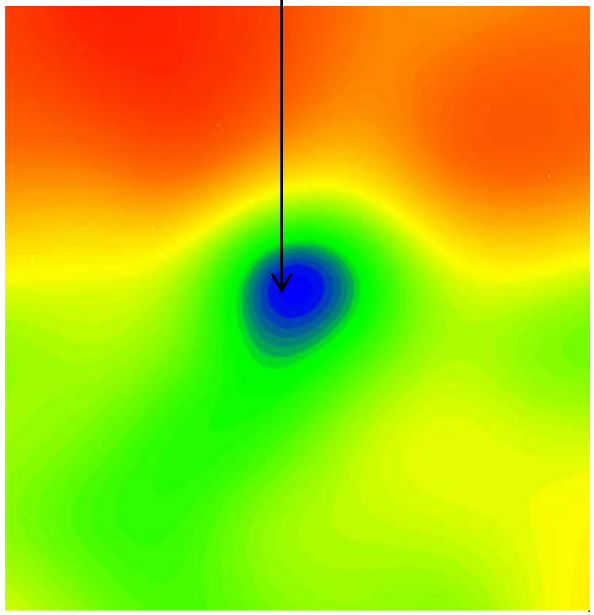
Experimental Result

Making two slices and compare





Simulation



Experimental Result

Conclusion

- Regular radon transform could be applied to the mobile muon spectrometry.
- Only 20 minute observation time is necessary for each point.