Development of a Soil Conductivity Meter for MIST

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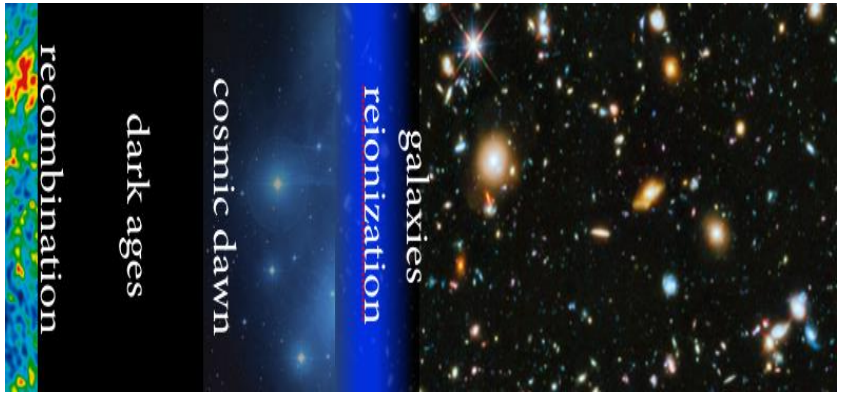
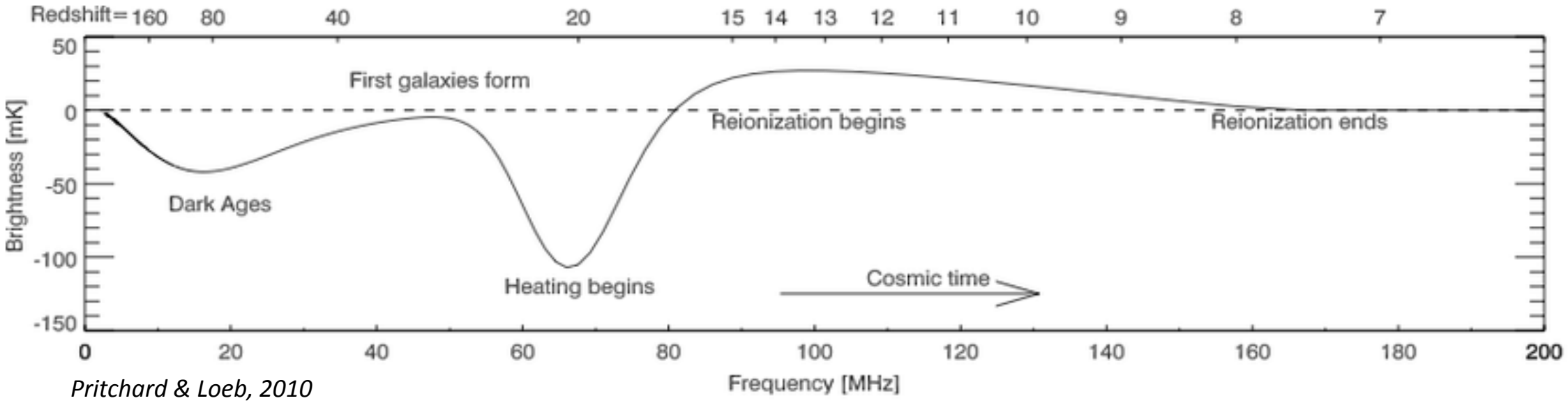
What is 21cm Cosmology?

- Probing the era of Cosmic Dawn
- Primordial Hydrogen 21cm hyperfine line
- Spectral distortion observable <200MHz
- Important results: EDGES in 2018

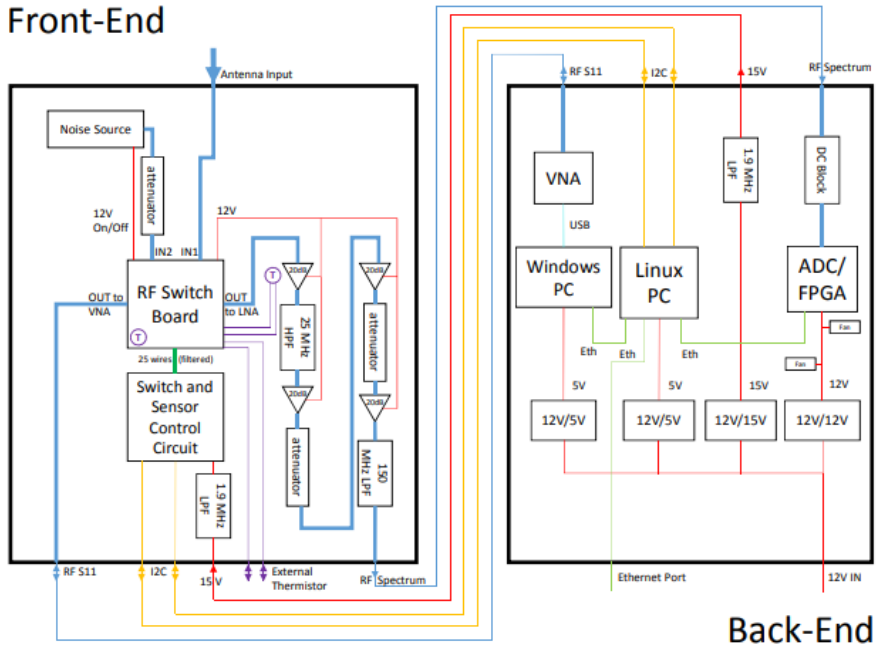




Pritchard & Loeb, 2010

MIST Experiment Background

- Mapper of the IGM Spin Temperature
- What: observations of global averaged 21cm emission
- How: sky-averaged radio spectrum



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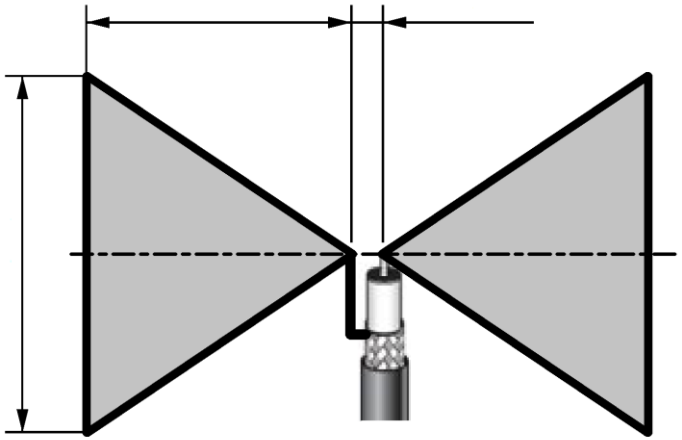
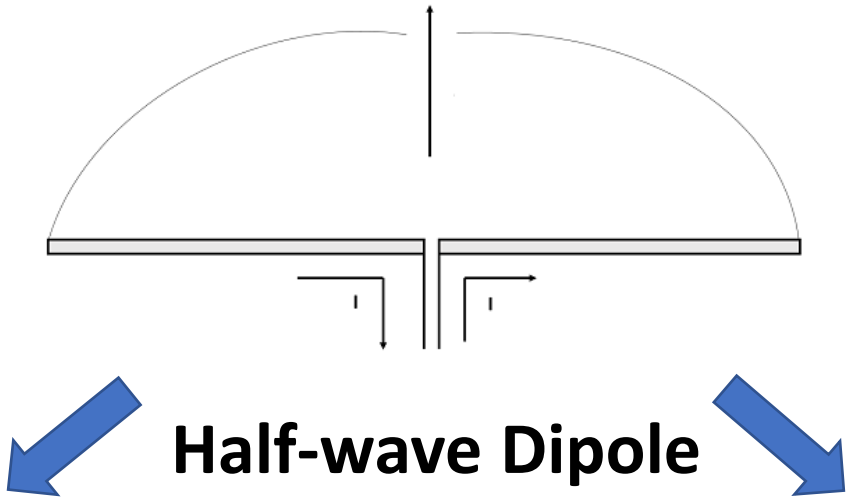
Potential Antenna and MIST Simulations



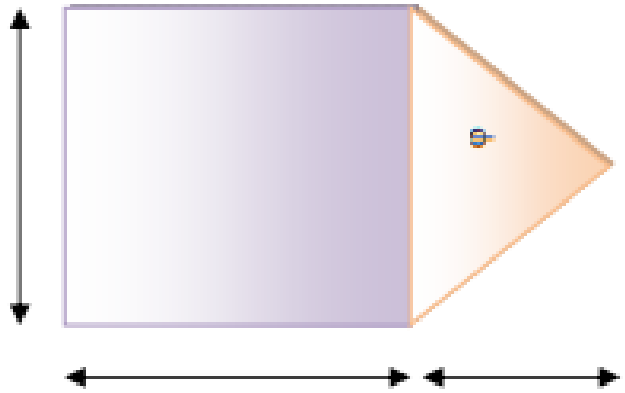
Bow-tie Antenna

RFWireless World

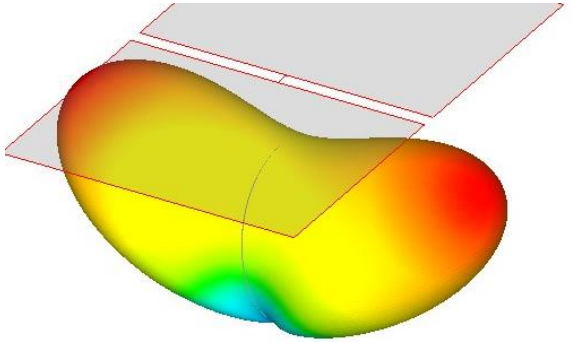


Half-wave Dipole

ResearchGate



Blade Antenna



- Wide-band antenna
- Need high peak gain, stable radiation pattern
- Consider effect of no ground plane

Statement of Purpose

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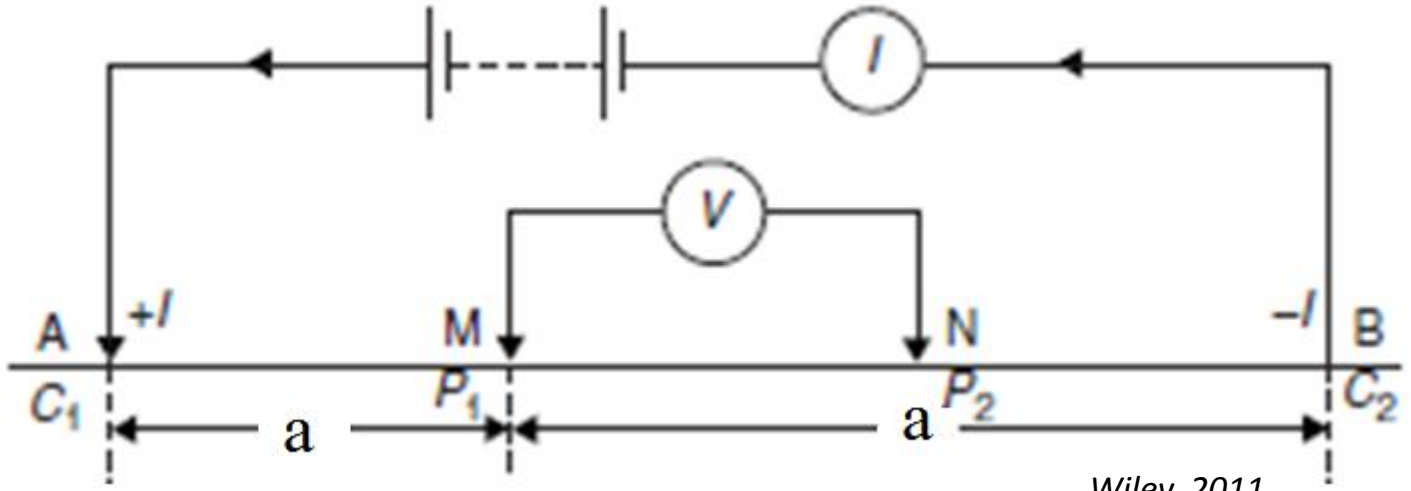
- In a nutshell: development of a conductivity meter

- Important features: robust and precise

4 Point Measurement Background

- Wenner array for measuring soil resistivity
- Probe characteristics: diameter *d*, separation *a,* depth *p*



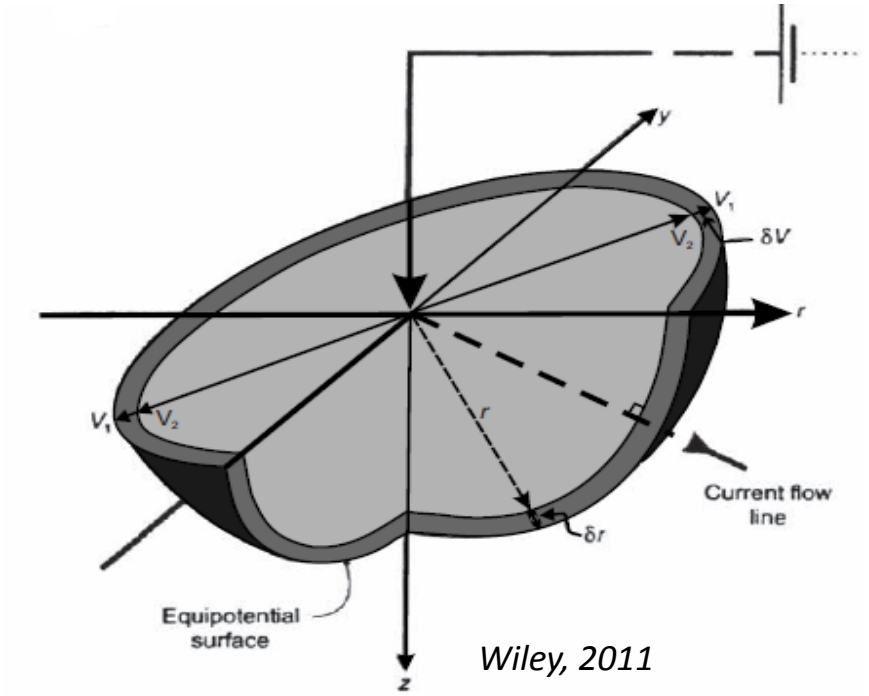
Wiley, 2011

$$\rho = \frac{4\pi aR}{1 + \frac{2a}{\sqrt{a^2+(2p)^2}} - \frac{2a}{\sqrt{(2a)^2+(2p)^2}}}$$

$$\rho = 2\pi aR$$

What Affects Resistivity?

- Diameter of probe: $d < 0.1a$
- Separation of probes, a
- Depth of probes, p



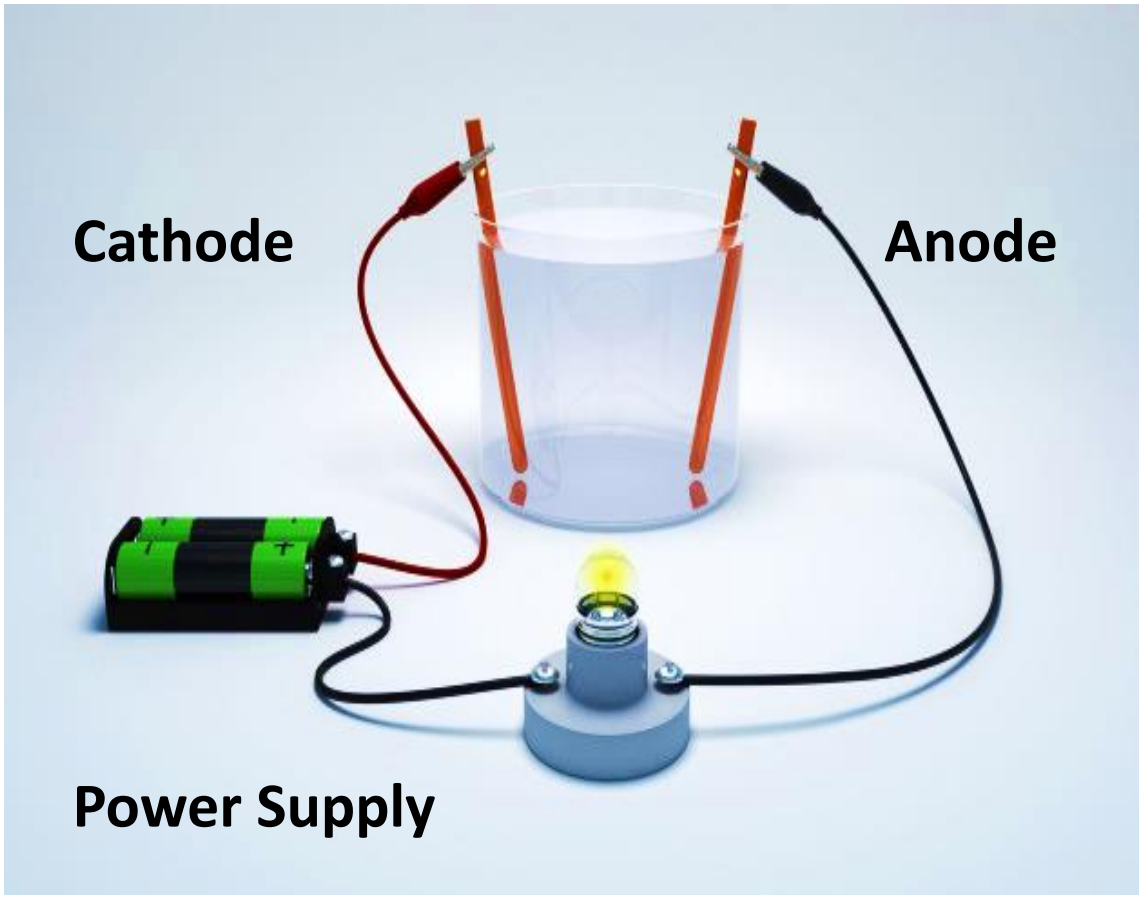
Wiley, 2011

How about probe material?

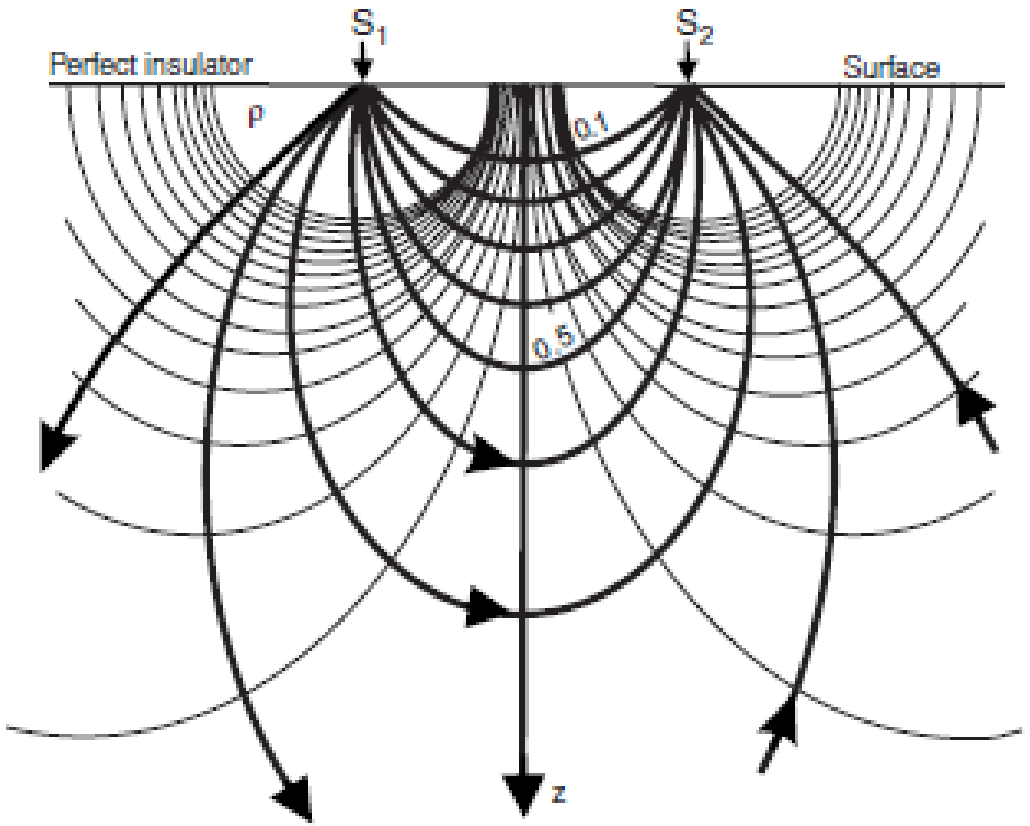
Wait a minute… resistivity is an **intrinsic** property!

Should measure around the same value, given a fixed d and a?

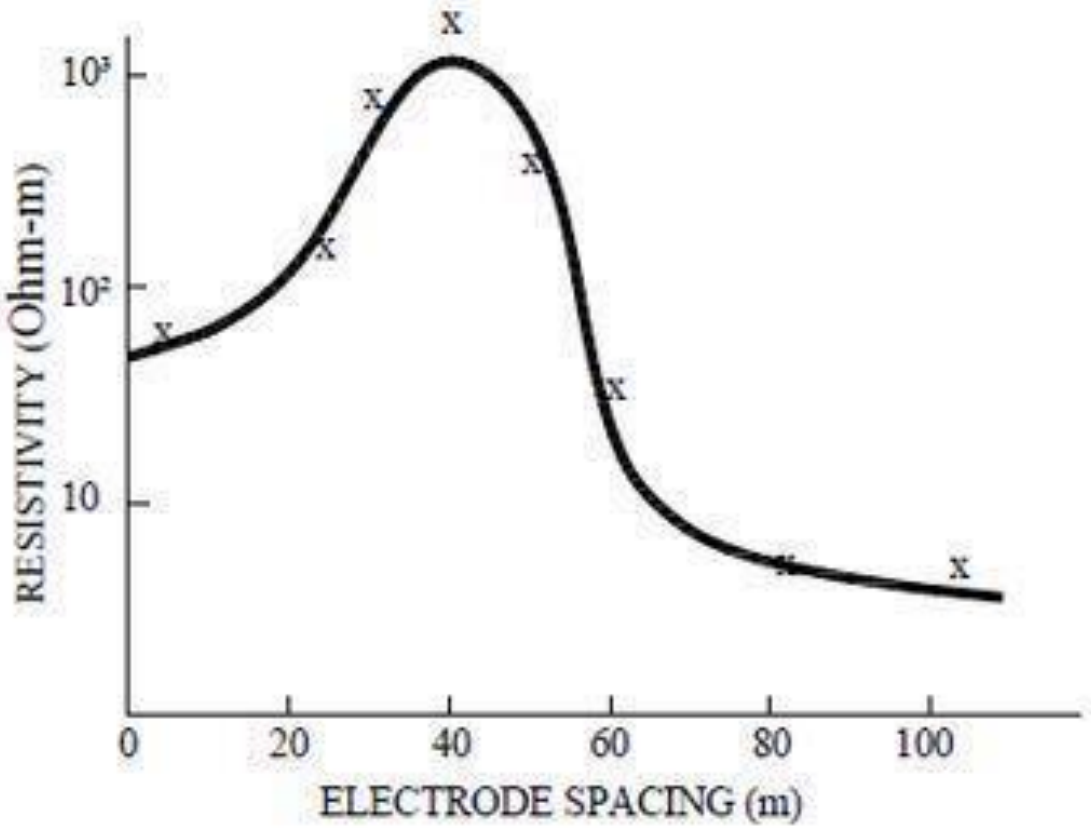
Experimental Setup



Expected Trends

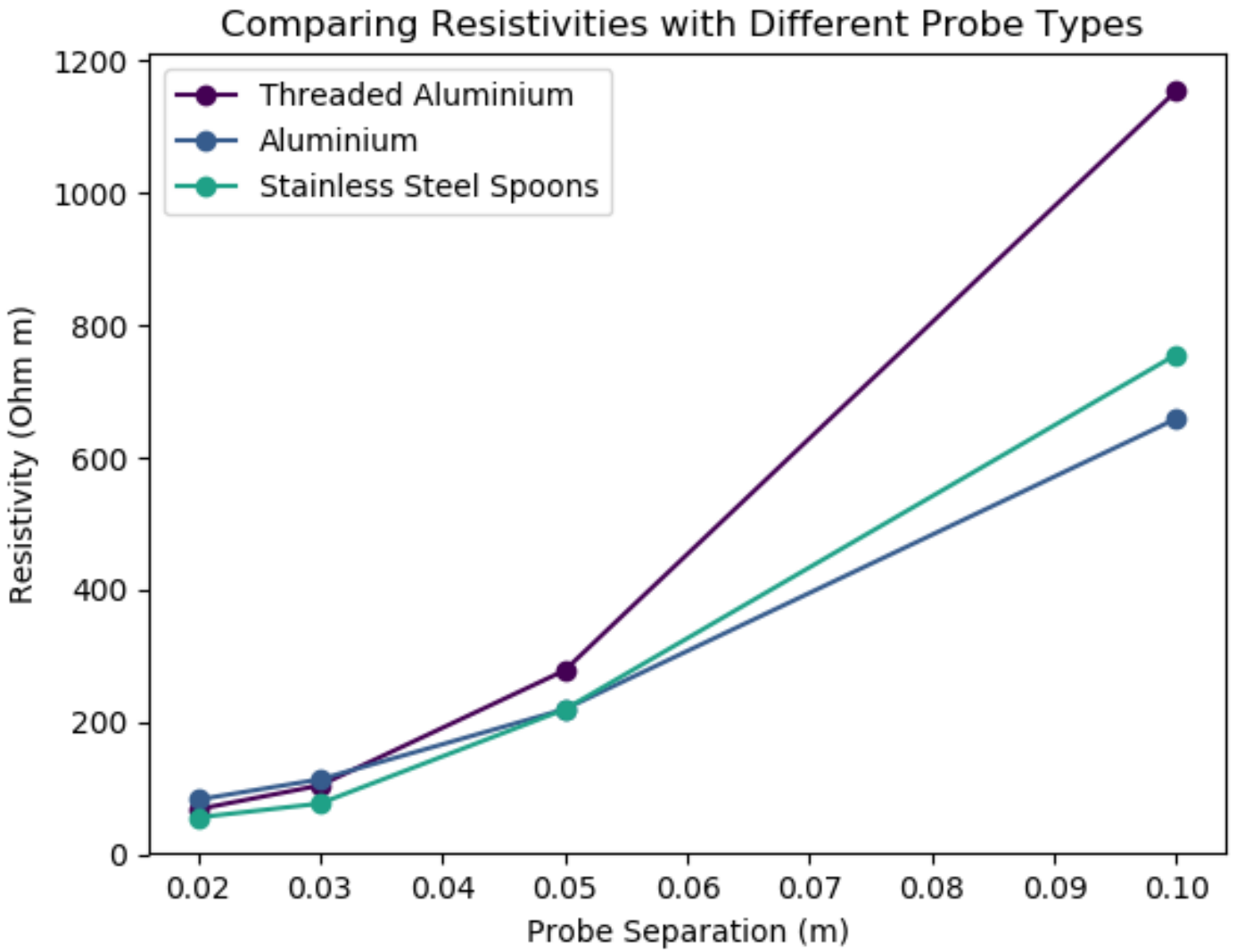


Wiley, 2011



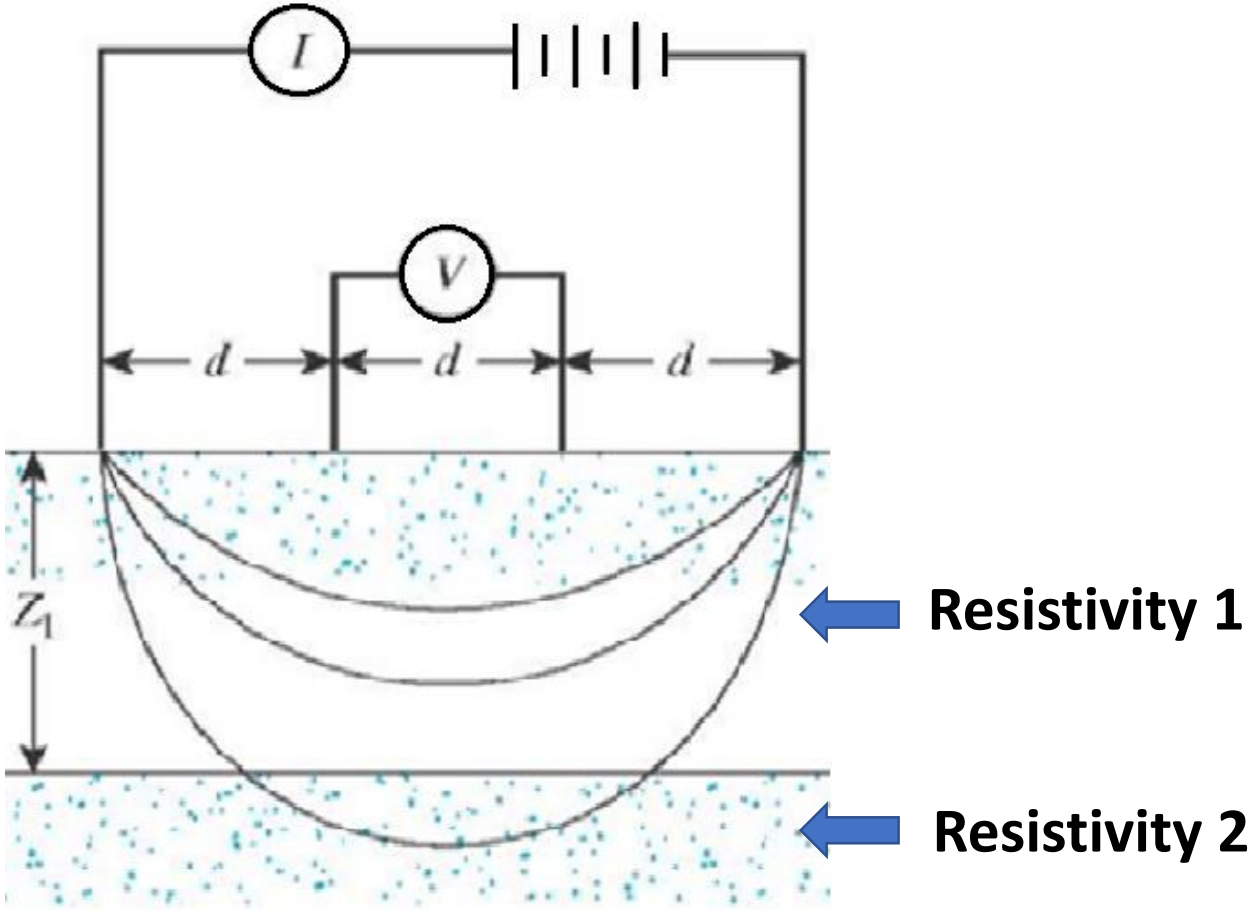
IEEE Guide for Measuring Earth Resistivity

Preliminary Findings



Future Directions

- Make soil model and explore different layers
- Consider depth of probes
- 4+ probes?
- Automated system with a Raspberry Pi



Wiley, 2011

Summary and Acknowledgements

- The Wenner probe array demonstrates potential for conductivity measurements

- We are limited by the size of the set-up

Special thanks to Matheus Pessoa and Professor Cynthia Chiang for their guidance and support!

MIST Memo 2

Fonds de recherche sur la nature et les technologies Québec

NSERC CRSNG