



Passive Seismic Recording Performance

Henry Bland

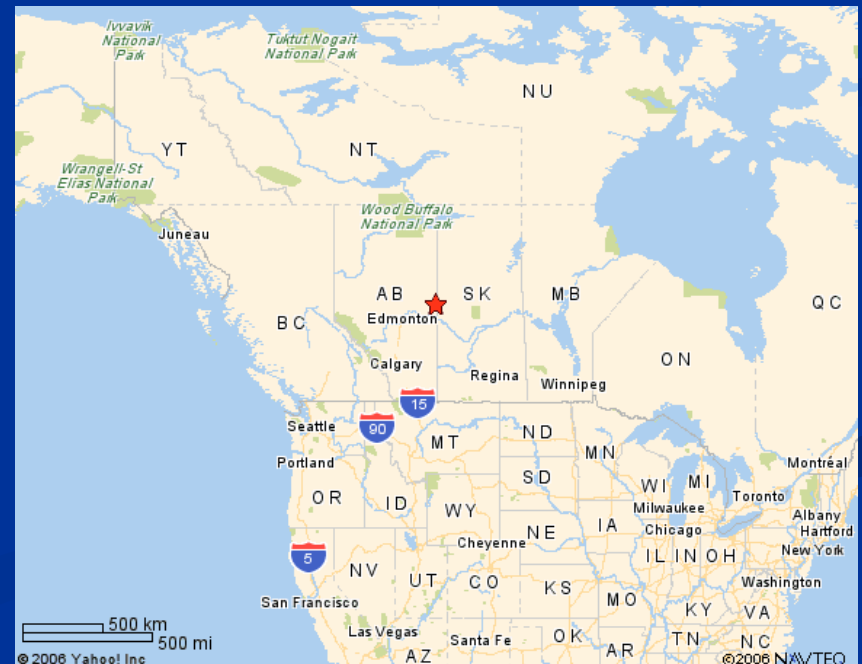
Outline

- Quick introduction to the Passive Seismic
- System sensitivity
- Fidelity
- Noise
- Field example

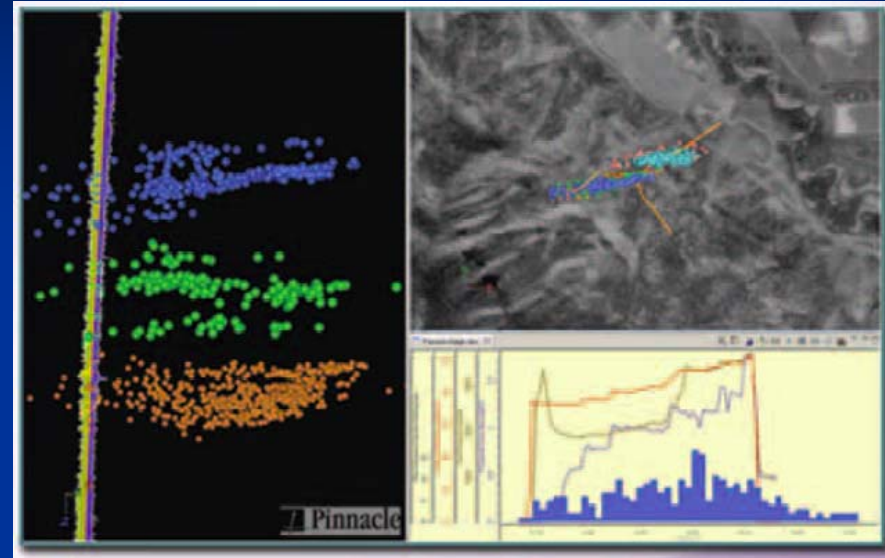
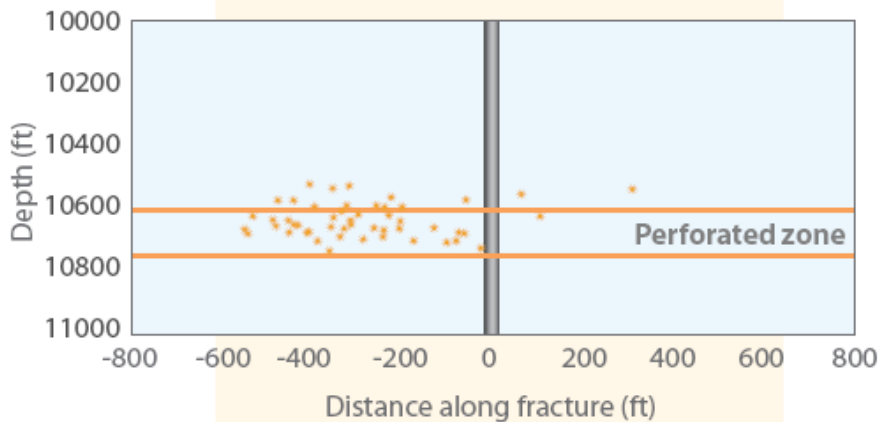
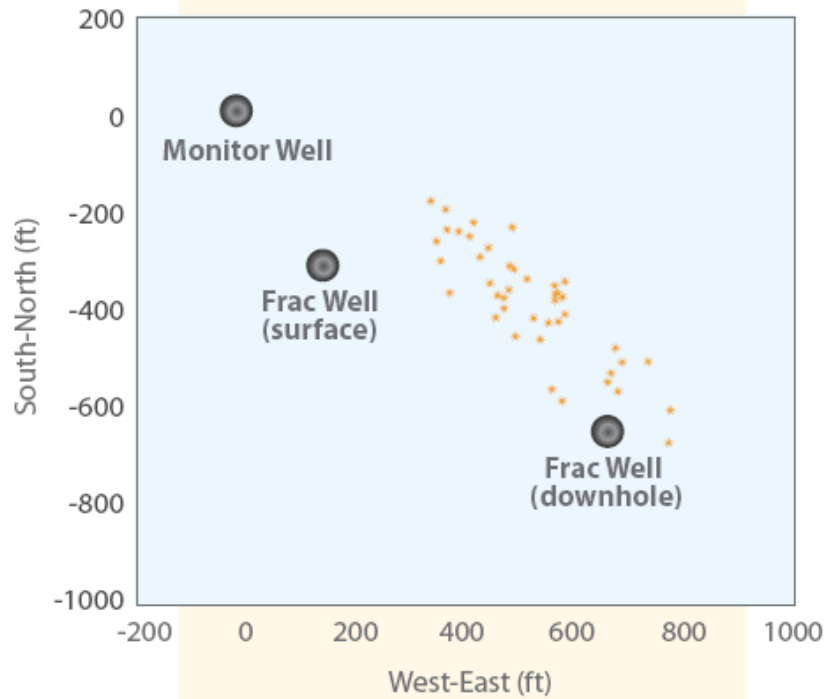
Types of Passive Seismic Monitoring



> 80 Passive Seismic permanent installations monitoring for casing failures.



Fracture Mapping



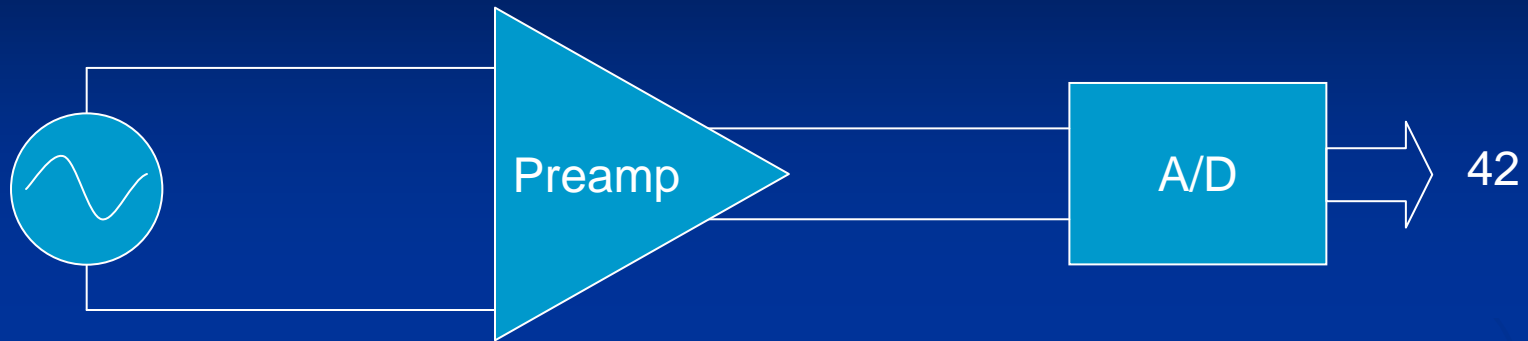
3-D mapping

Transform Software & Services

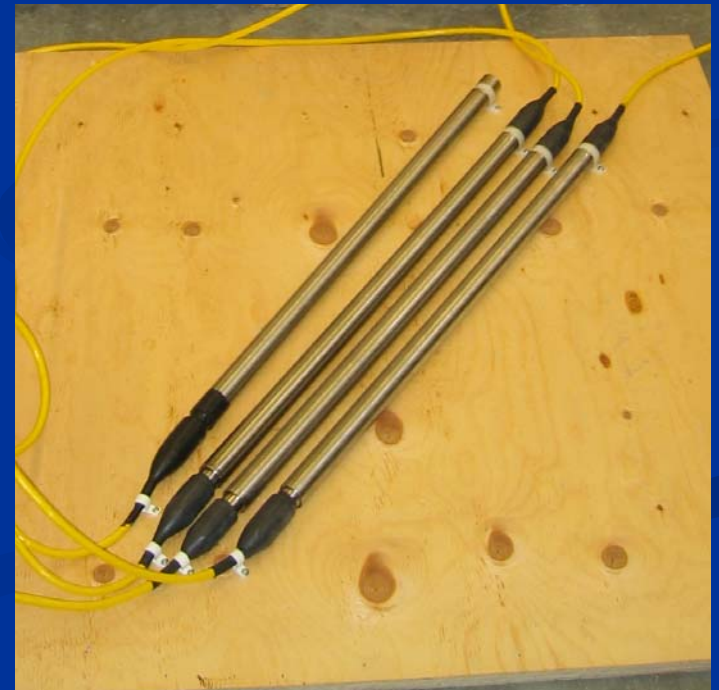
The challenge for data acquisition

- Small event amplitude
- Noisy environment
- We need to understand the system sensitivity

System Sensitivity



| <i>Sensor</i> | <i>Sensitivity</i> |
|------------------------------------|--------------------|
| ESG G3070 triaxial geophone | 27.5 V/(m/s) |
| Colibrys Si-Flex accelerometer | 30 V/g |
| Geophone sonde with three GS-14-L3 | 65 V/(m/s) |



Geophone sondes

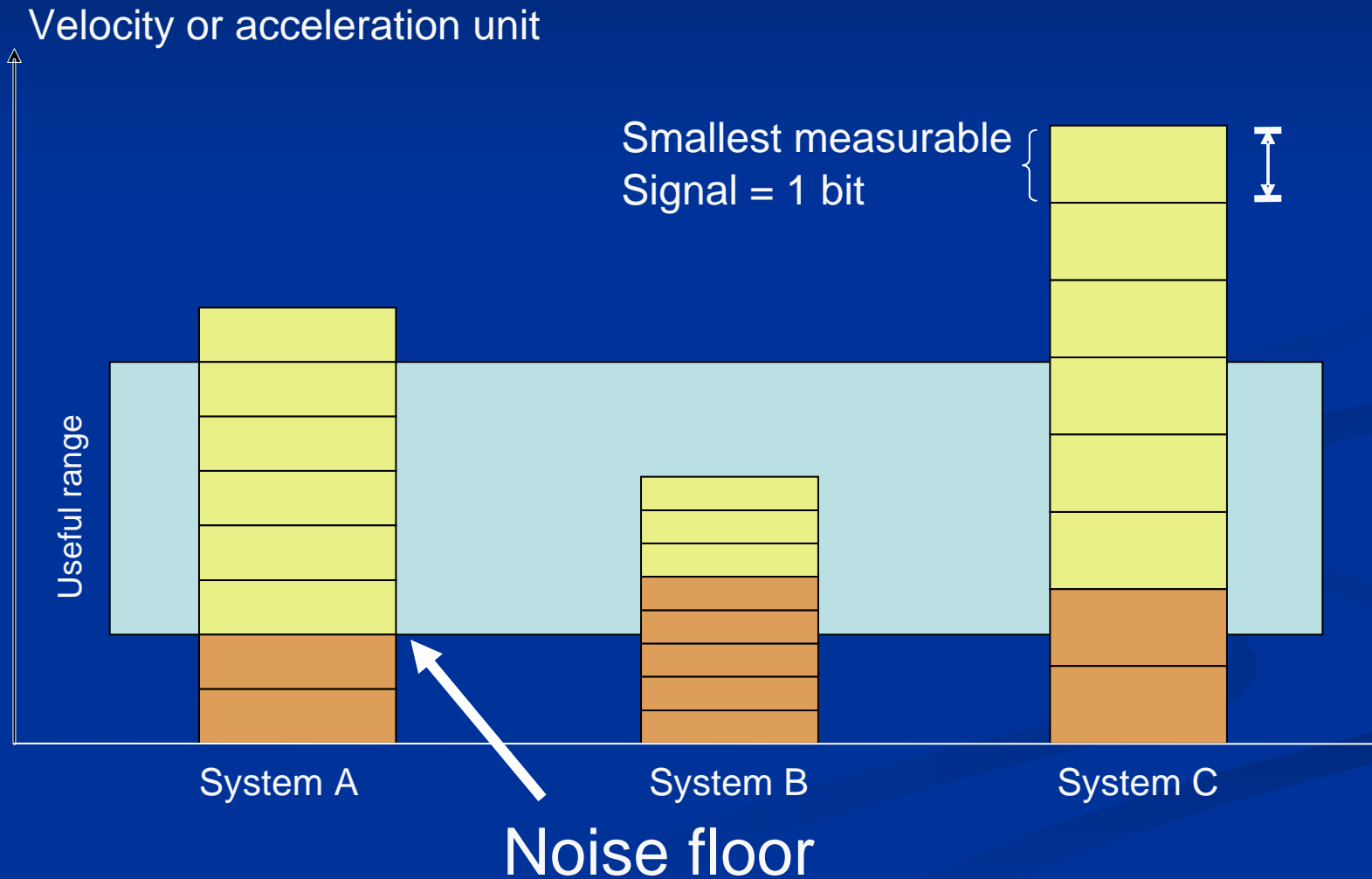
Digitizer sensitivity

| <i>Instrument</i> | <i>Minimum measurable value</i> |
|-------------------------------------|---------------------------------|
| ARAM Aries RAM | 18 nV/bit |
| Geometrics Geode | 40 nV/bit |
| Turtle Mountain digitizer | 6.2 nV/bit |
| Terrascience TMA unit (older model) | 18 nV/bit |



Terrascience digitizer at
Penn West CO2 Injection Pilot

Digitizer Sensitivity



Zero phase / minimum phase

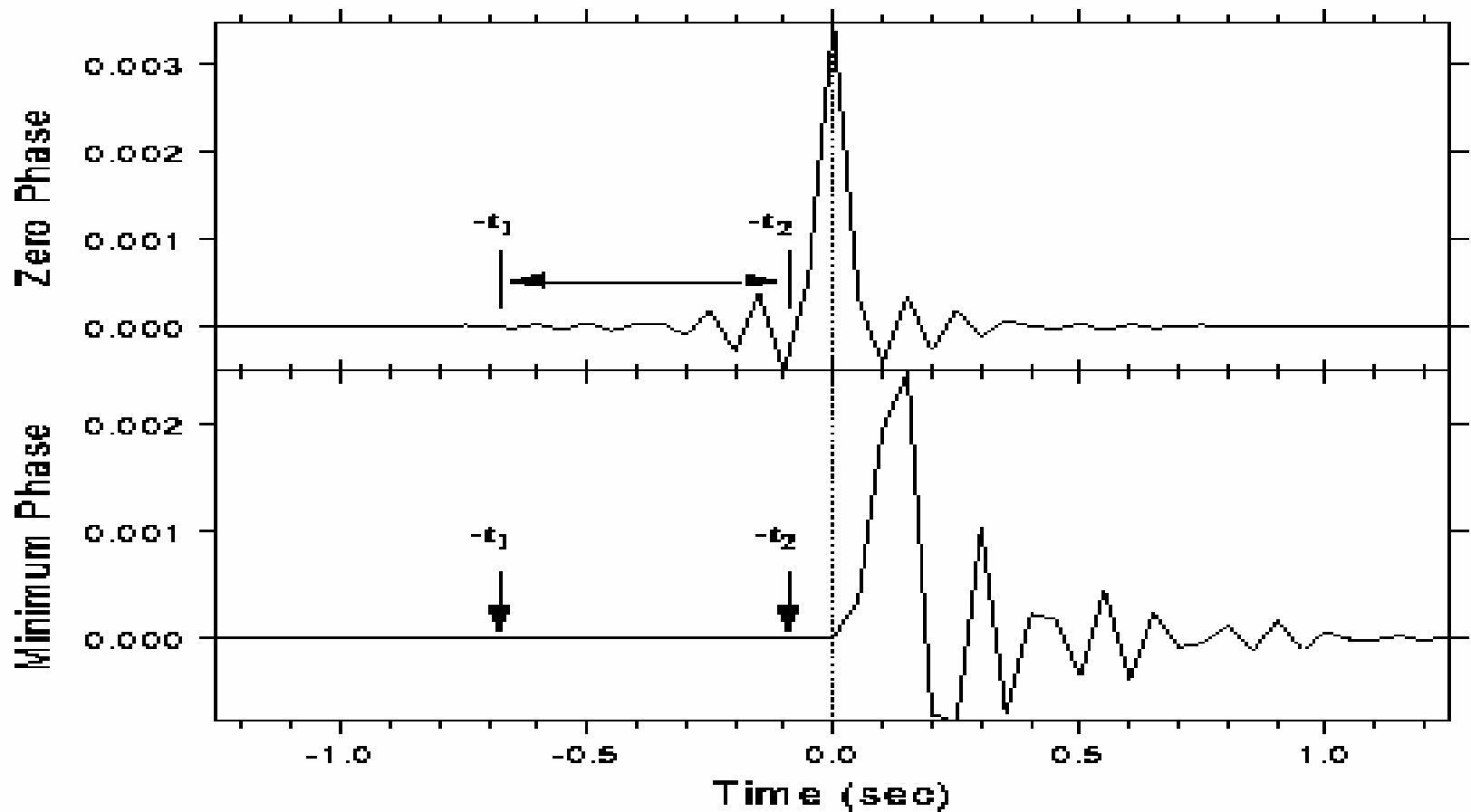
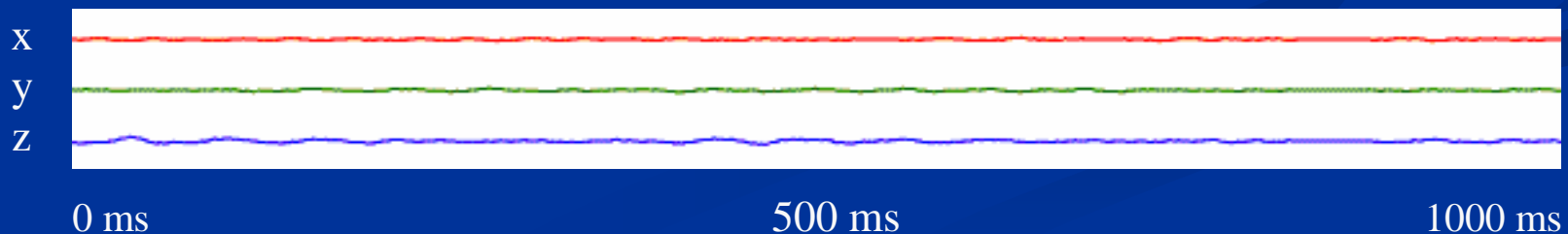
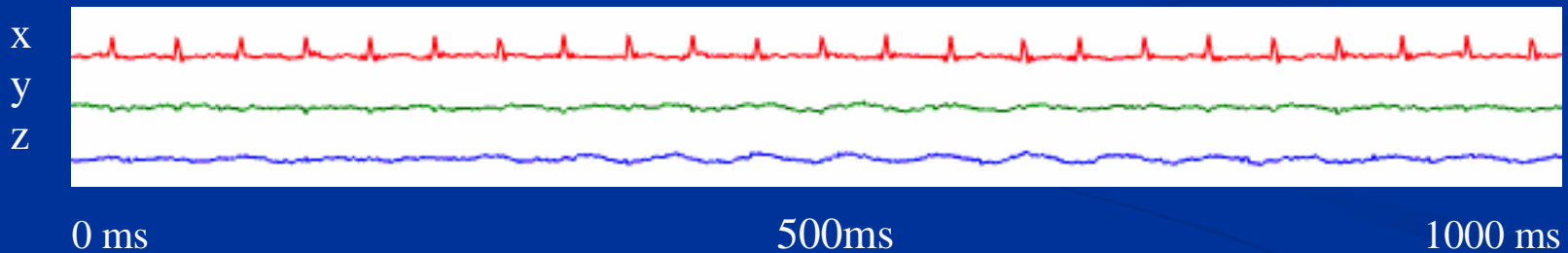


Figure: Frank Scherbaum Institut für Geowissenschaften, Universität Potsdam

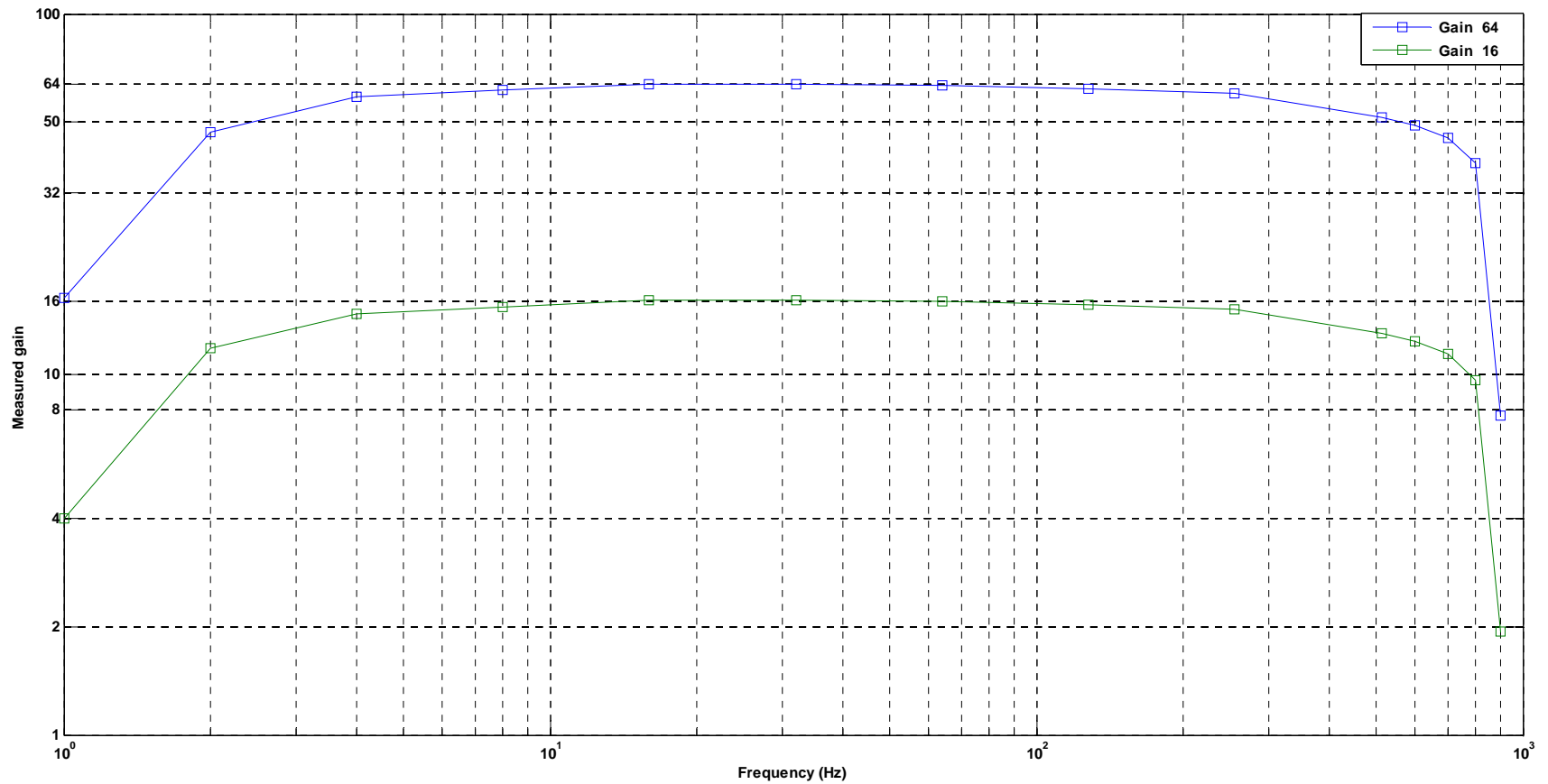
Noise

- Johnson Noise
- Electromagnetic interference
- Radio Frequency interference

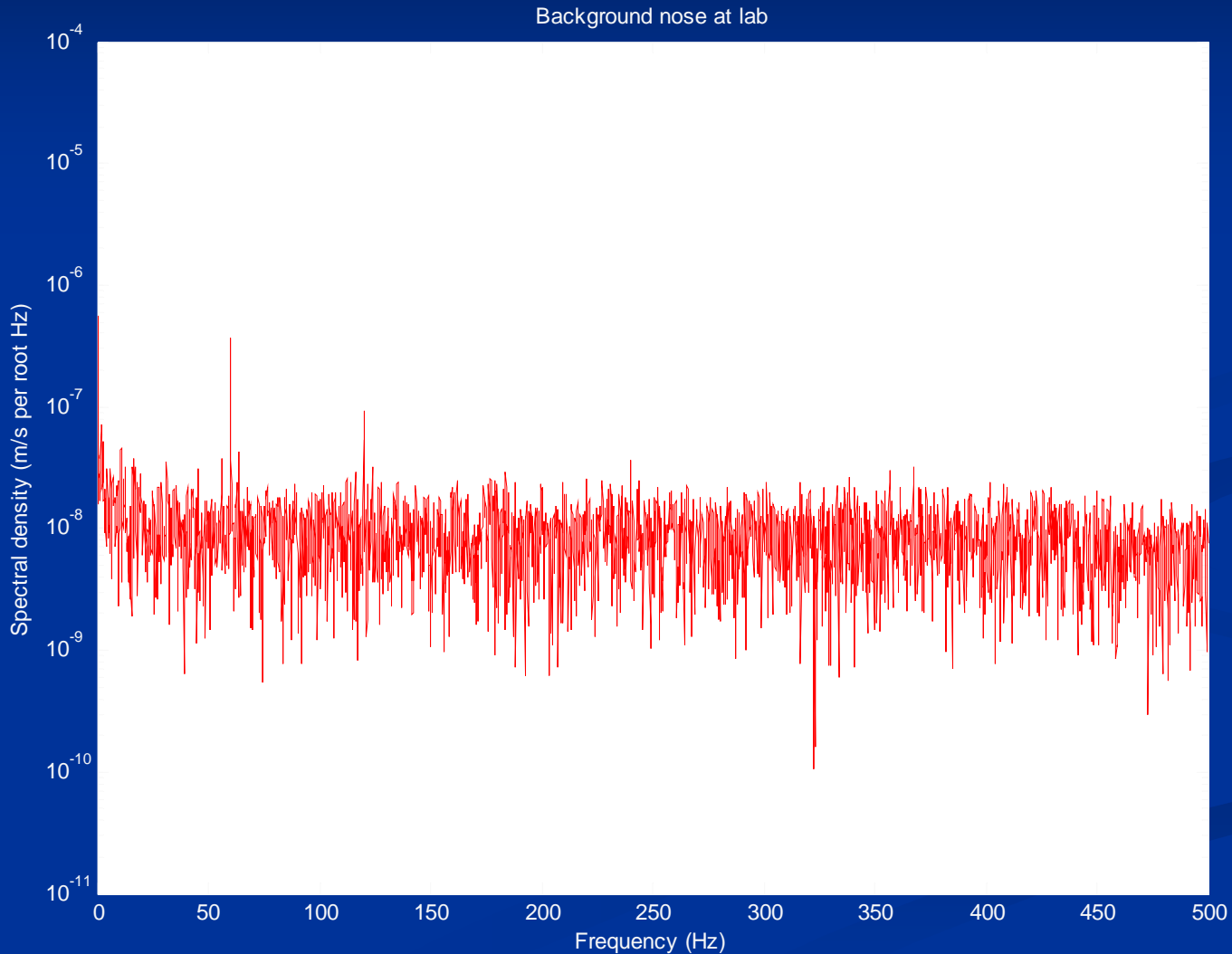
$$E_n = \sqrt{4kTBR}$$



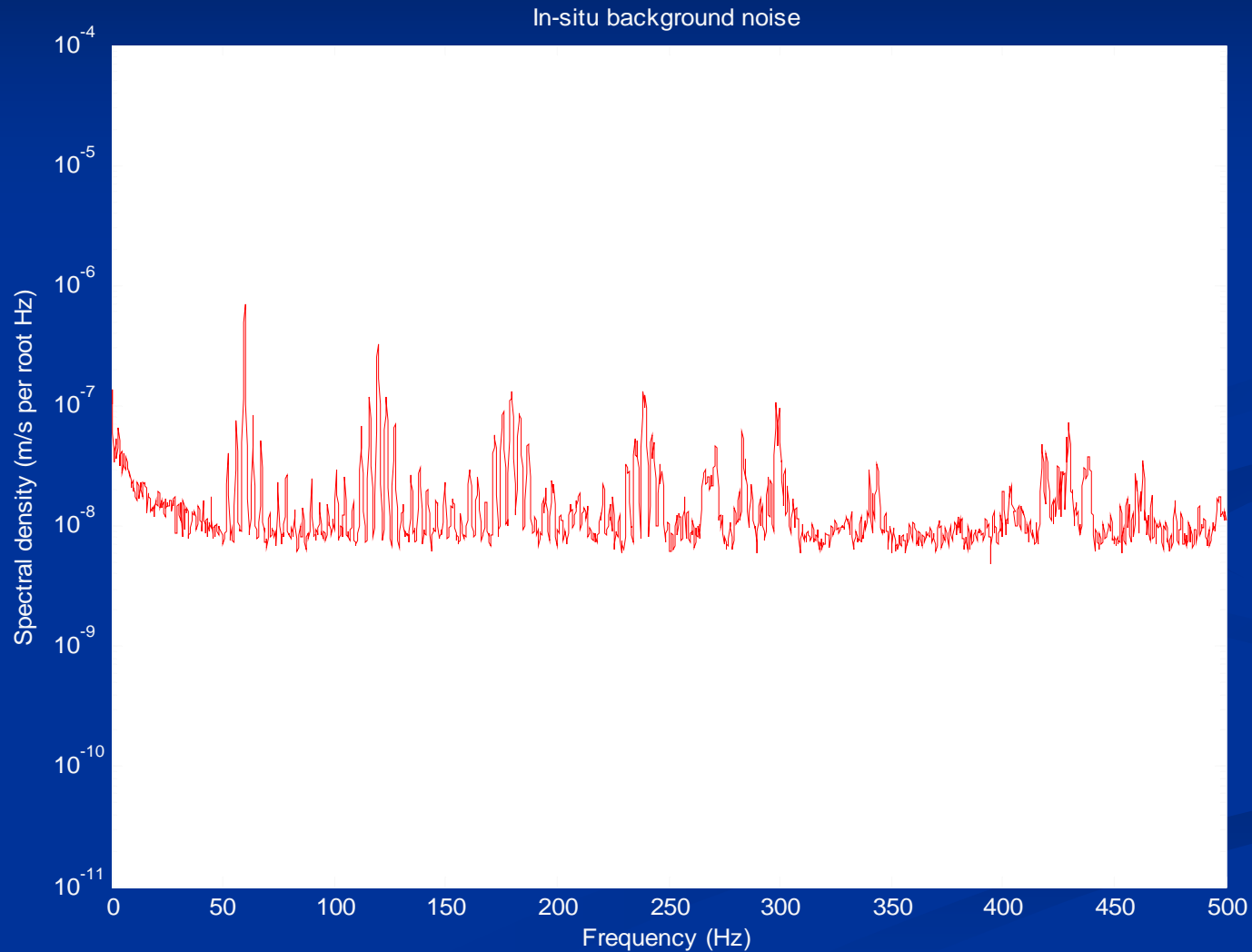
Bandwidth



Case Study: noise in the lab



Same system in the field



Conclusions

- Find out the sensitivity of the system in real-world units: minimum/maximum
- Become familiar with the background noise spectrum, monitor noise in the field
- Get detailed specifications from vendors including amplitude/phase plots