
DIAS
GEOPHYSICAL

Requirements for a successful survey

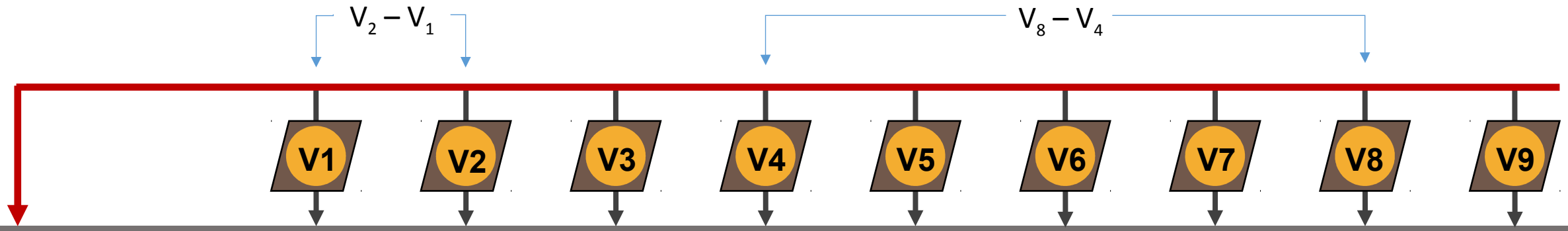
- Voltage at the measurement locations
- Current at the injection point
- Position - Remember: $K_g = 2\pi(1/C_1P_1 - 1/C_1P_2 - 1/C_2P_1 + 1/C_2P_2)^{-1}$
- Interpretation of results is based on more than just voltages!

Common Voltage Reference

A single voltage reference wire extends along the entire survey line to a local or remote grounding electrode. All electrodes in the survey area are measured relative to this common reference electrode.

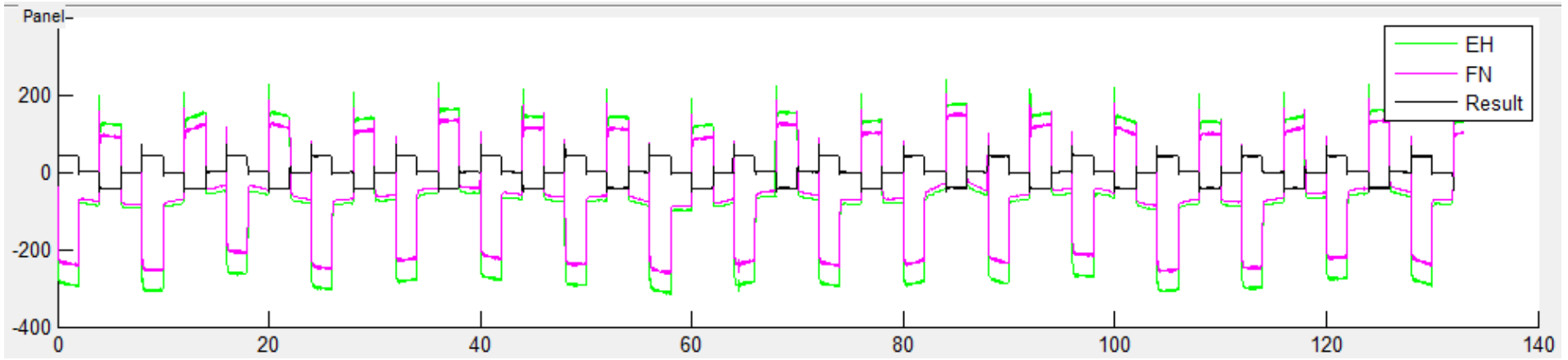
Advantages of CVR

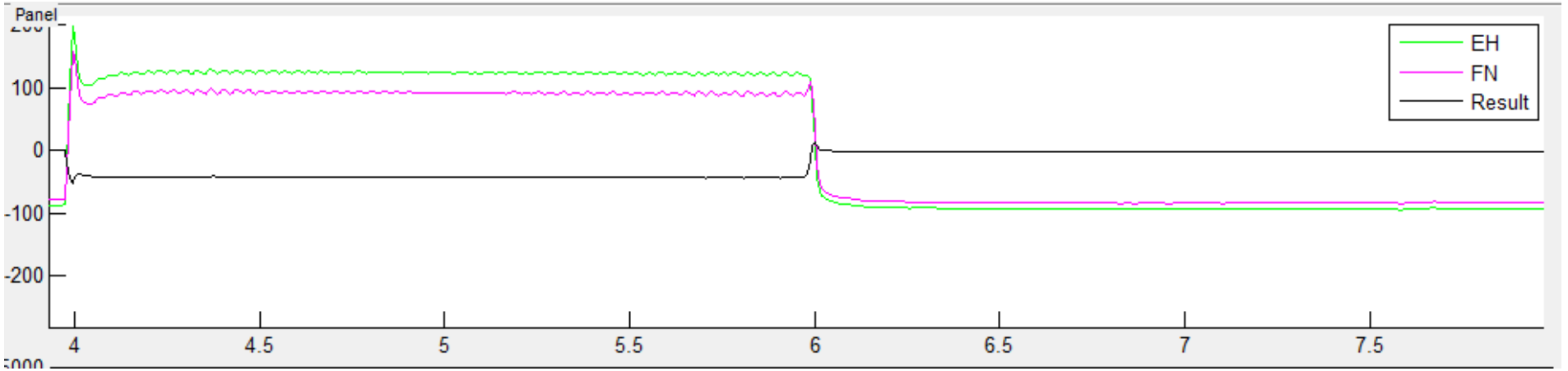
- Common mode rejection – any noise in the CVR wire cancels in the dipole calculation
- Any two electrodes can be used to compute a dipole – larger dipoles increase depth sensitivity
- Less wire - one wire along each line is the minimum amount for this type of survey
- No Rx 'move-ups' – safety and operational efficiency



Extracting a Dipole

Dipole produced by subtracting time series at two locations





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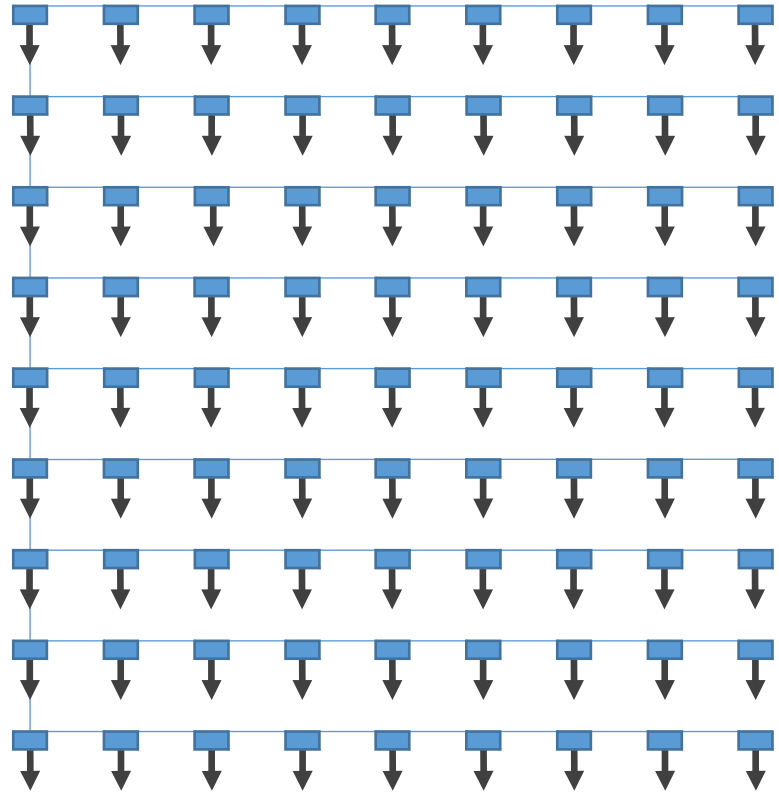
Scalable and Flexible

DIAS32 receiver

Fully Distributed - single-channel recorders



- Full flexibility in design and layout
- Focused troubleshooting
- Less wire – operations/noise
- Ease of communication
- Lightweight, compact

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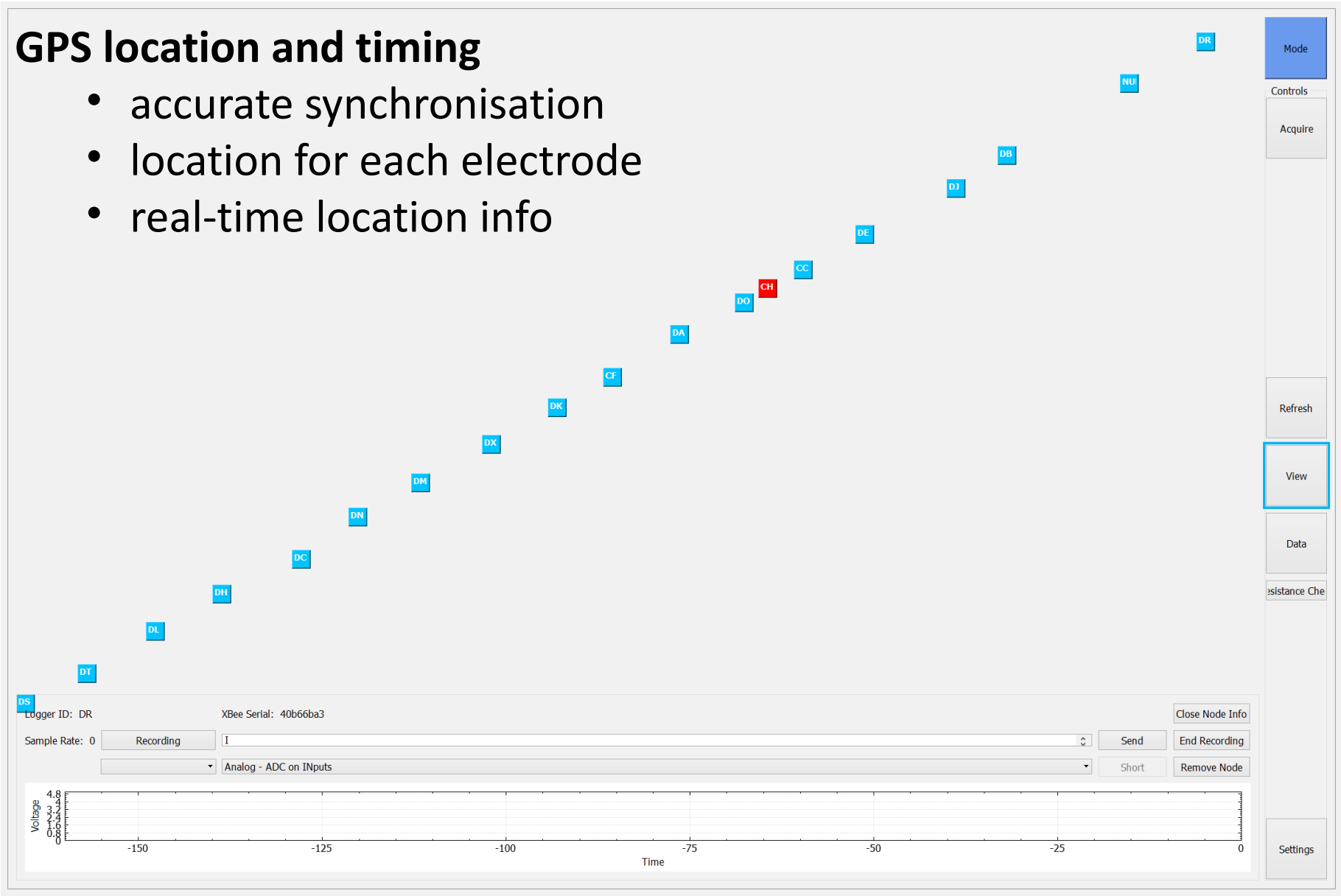
GPS location and timing

- accurate synchronisation
- location for each electrode
- real-time location info



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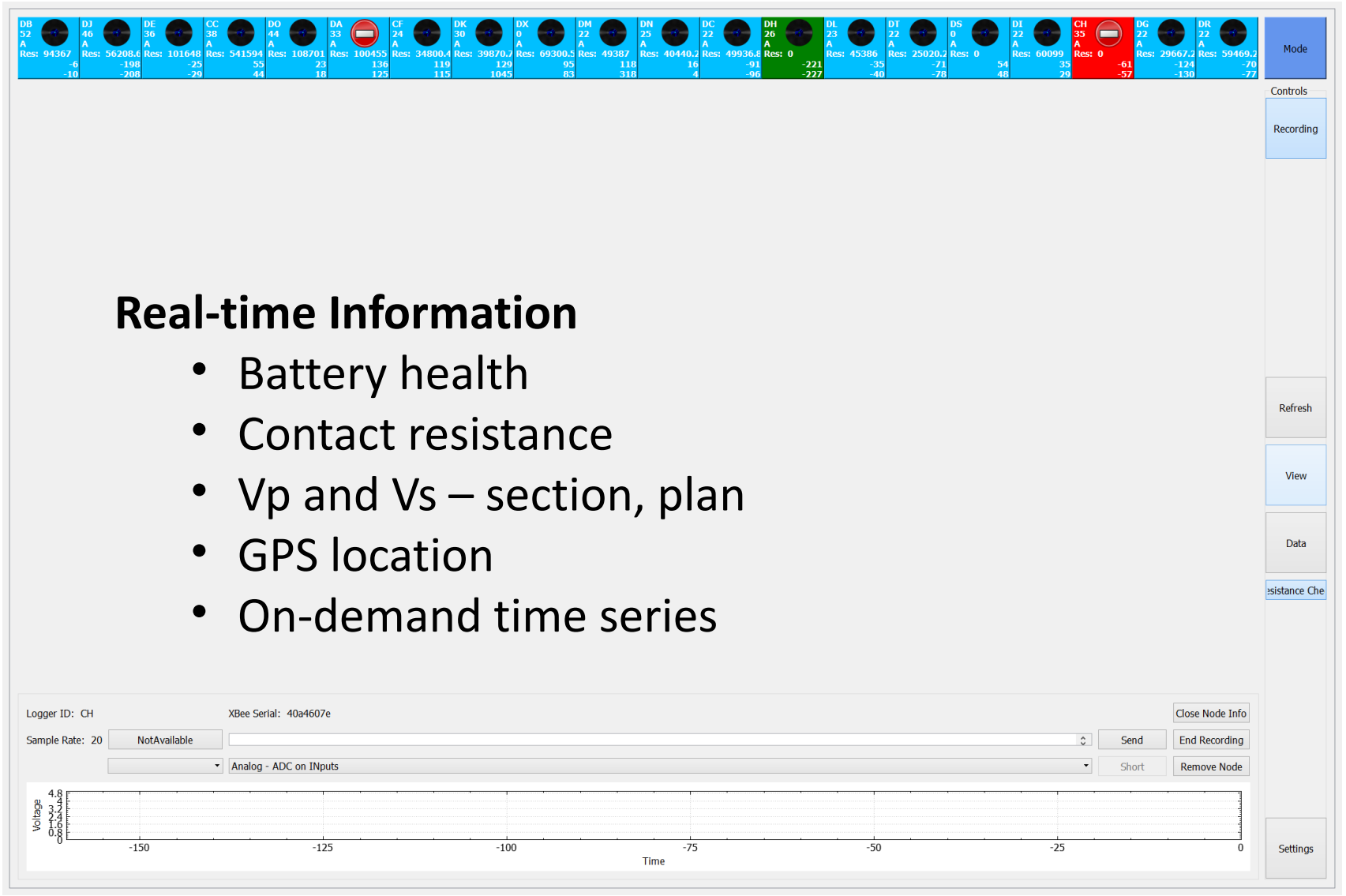

Real-time Information

- Battery health
- Contact resistance
- Vp and Vs – section, plan
- GPS location
- On-demand time series

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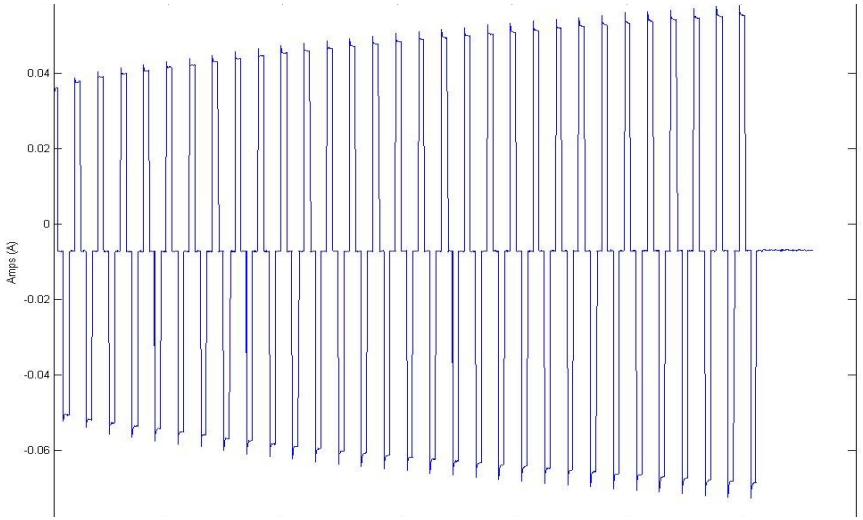
Injection Point Current Recording



Injection Point Monitoring

- Measure at local current injection point
- Time series recording
- Full time series data used in the processing

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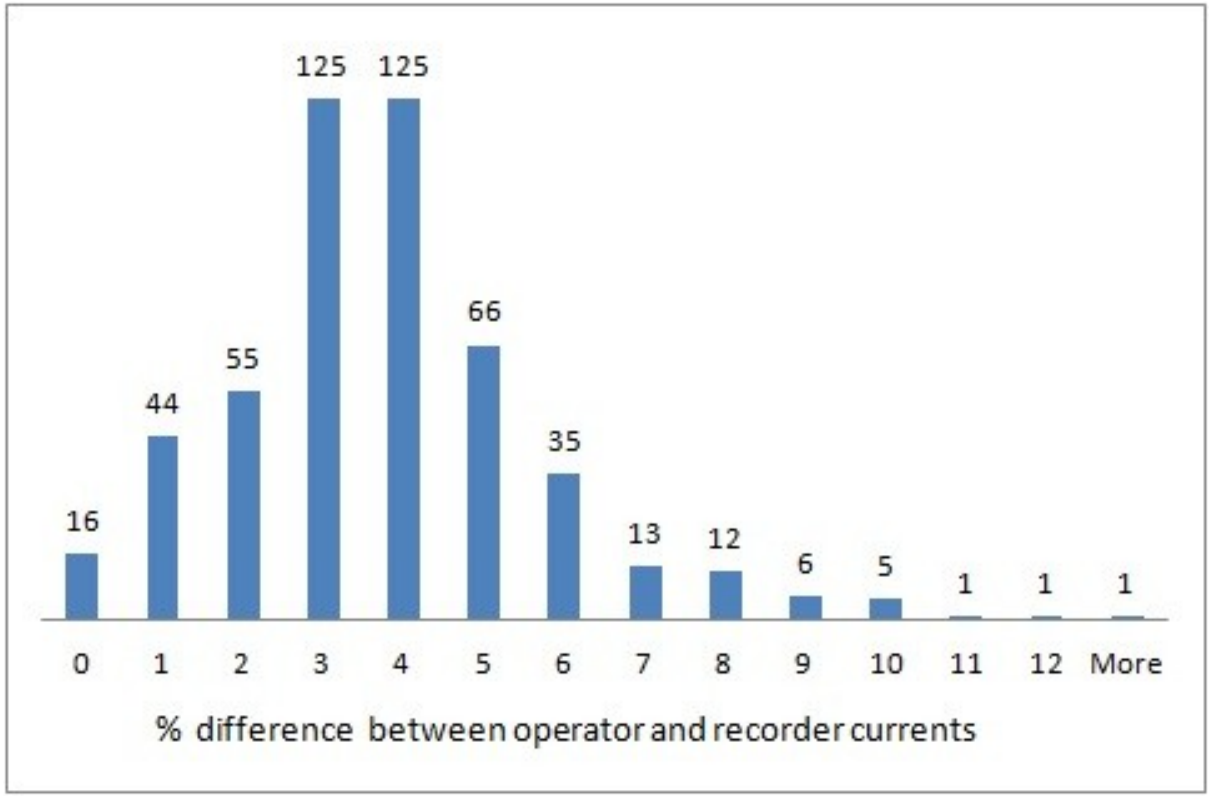
Monitoring Leakage



Monitoring at both the injection and the transmitter allows us to look at leakage – done in real time during acquisition

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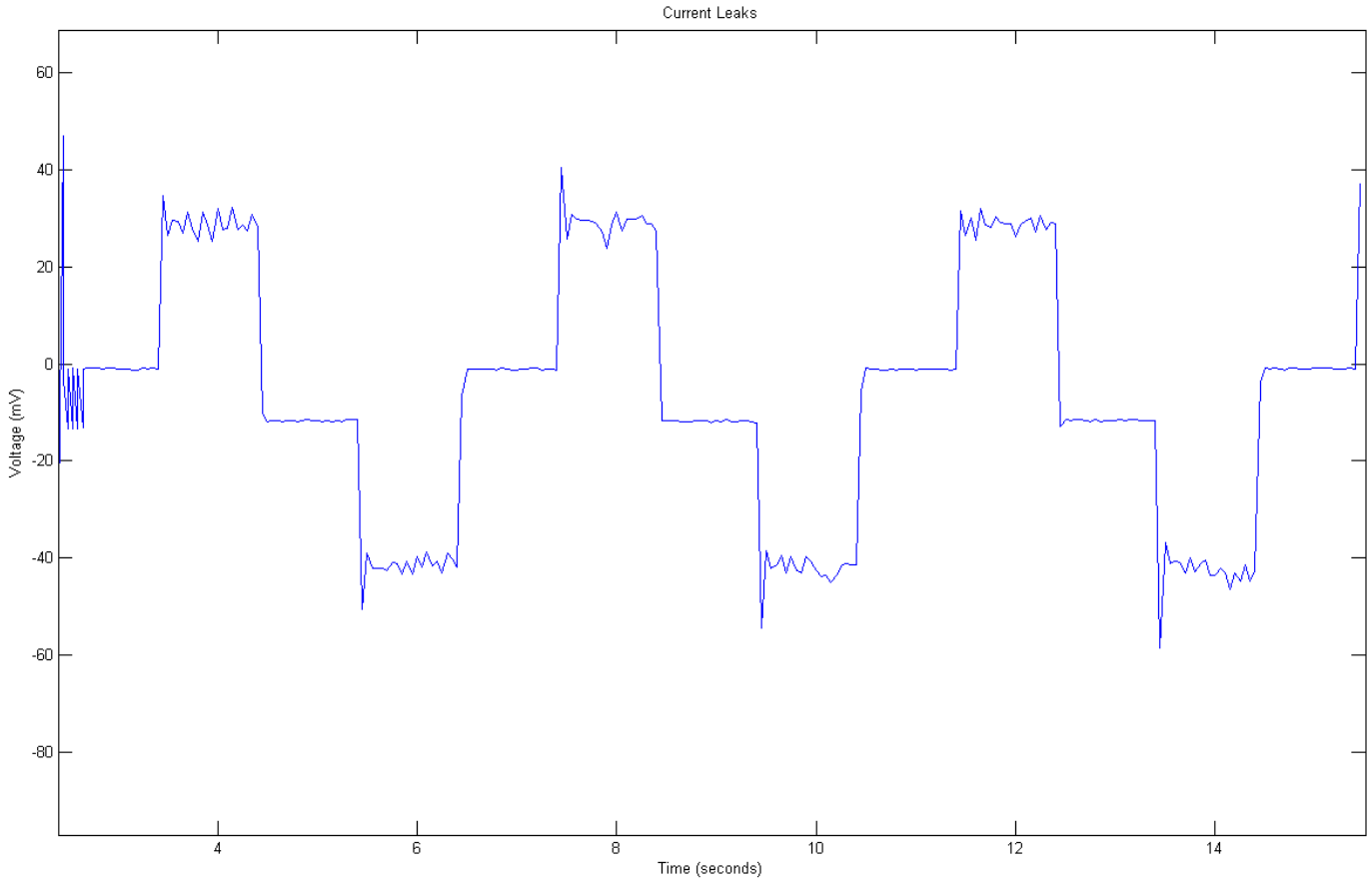
Monitoring Leakage

View the difference between the current recorders in real time or in post processing

A 40 mA leak on a 200 mA injection is a 20% error



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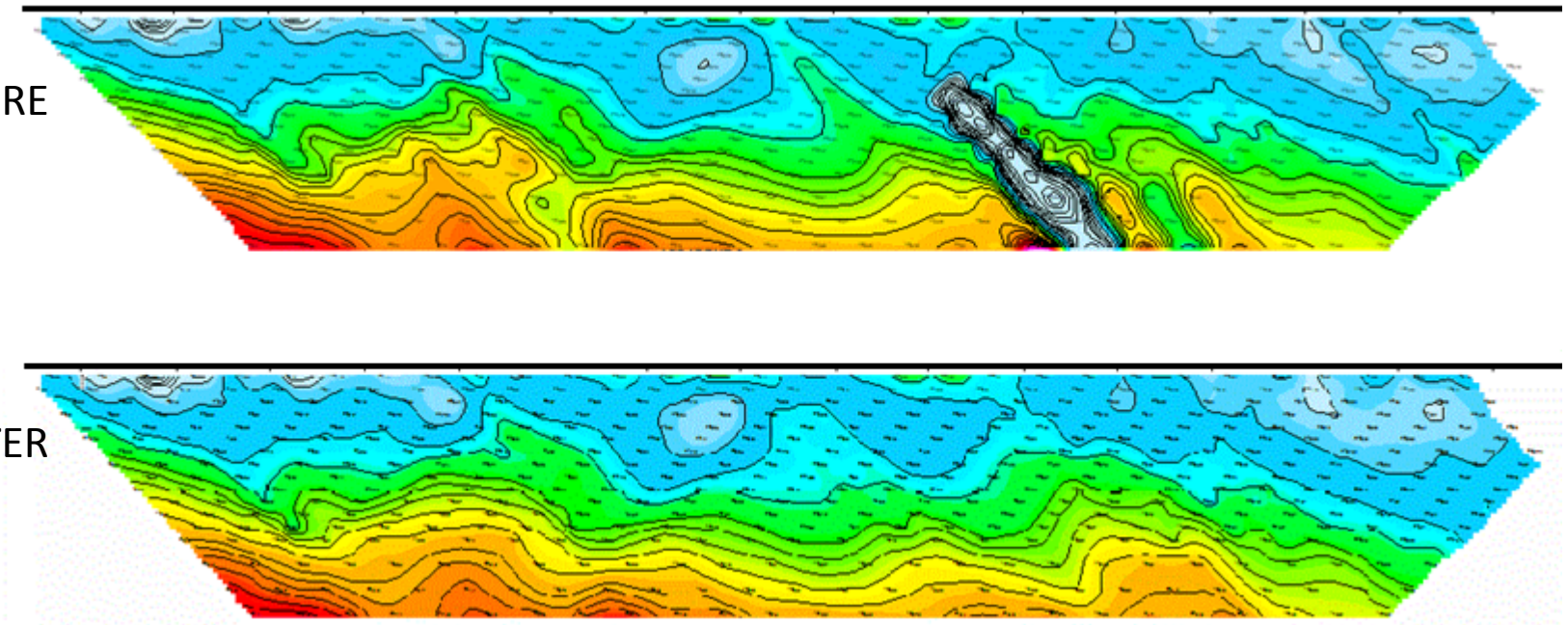
Injection Point Current Recording

Correcting for current variation – conventional 2D example



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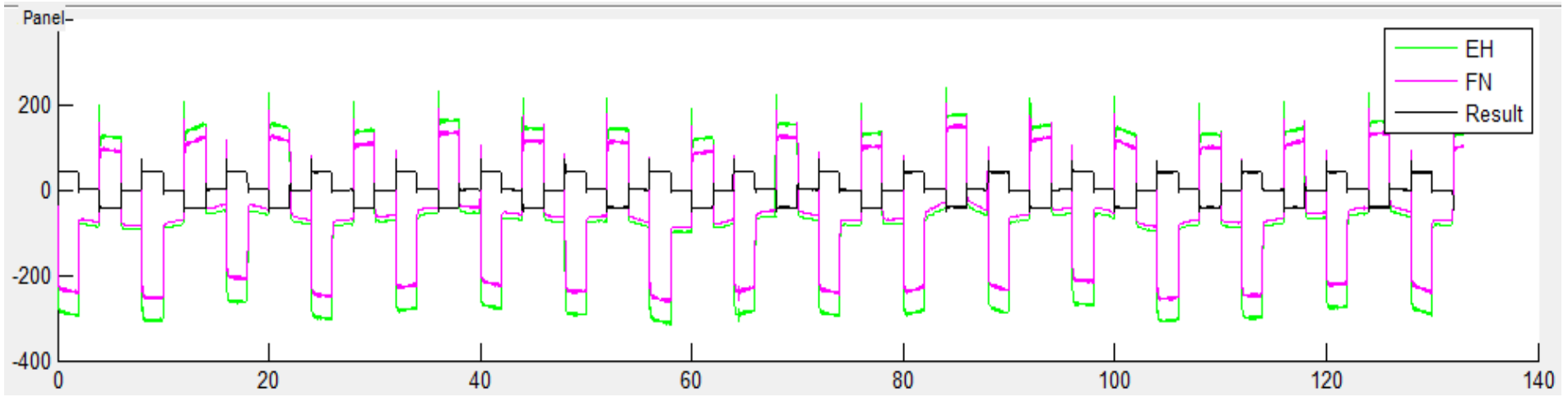
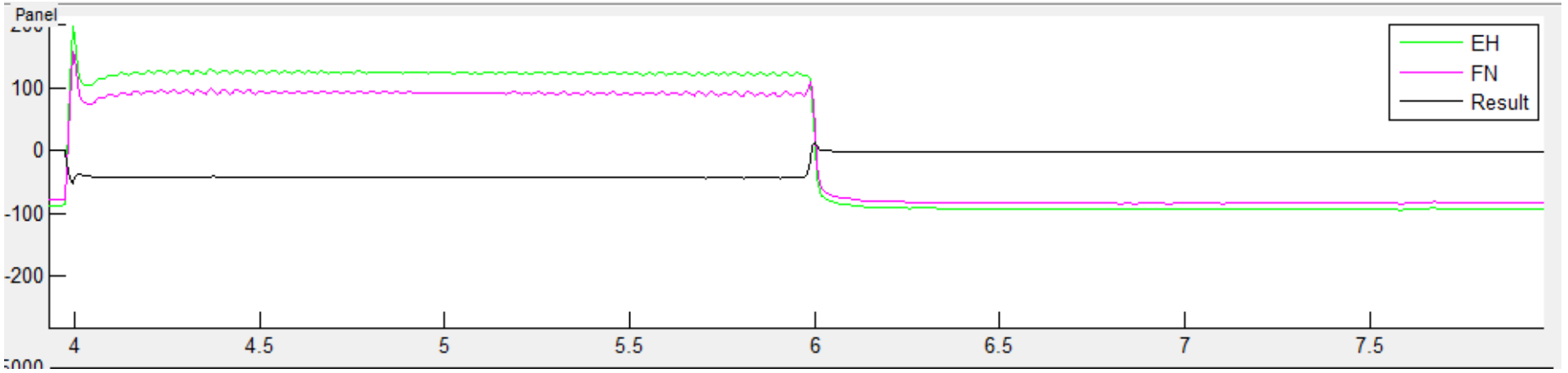
Dipole produced by subtracting time series at two locations





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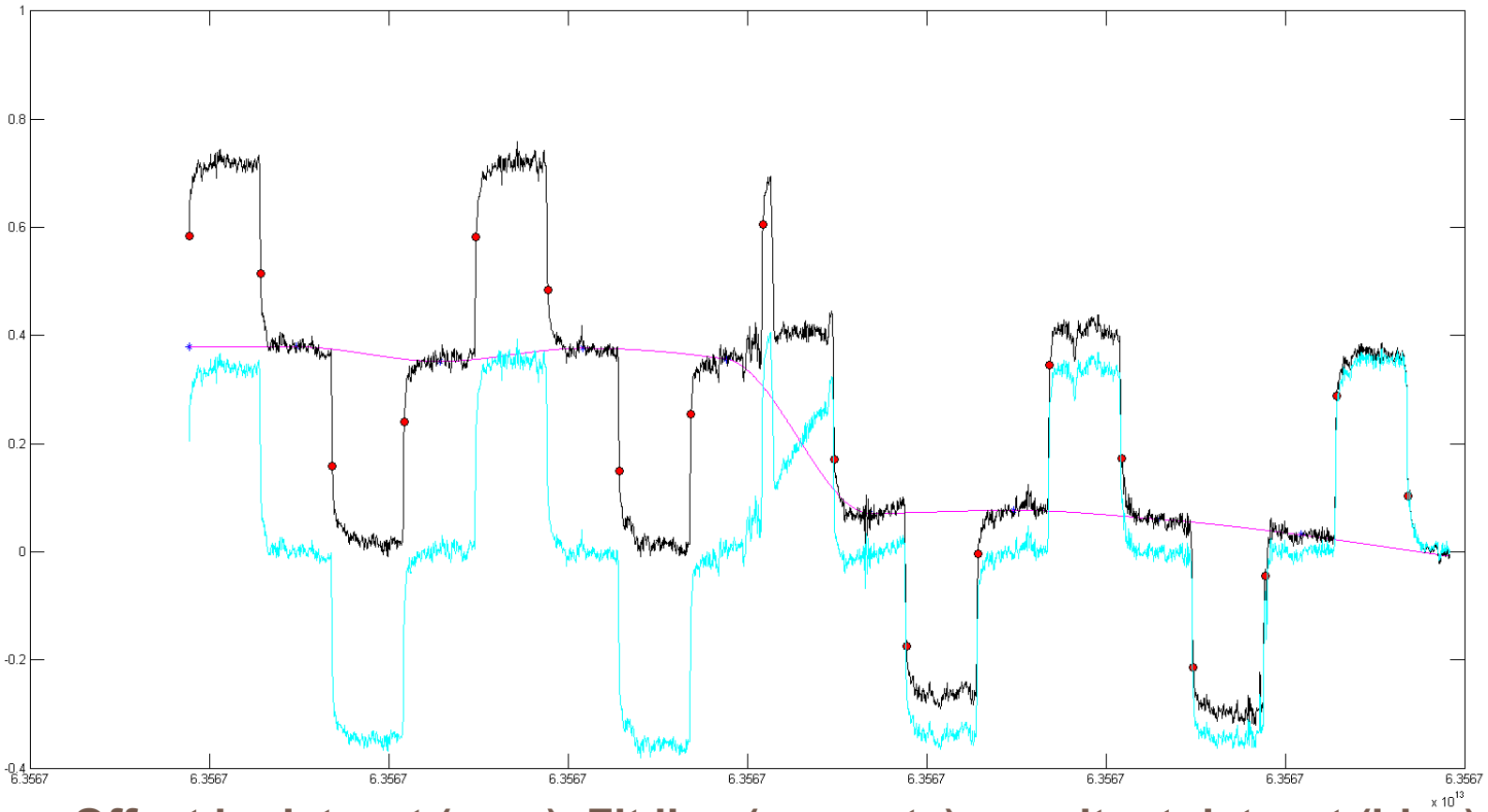
Standard Stacking with Rejection



Offset in dataset (grey), Fit line (magenta), resultant dataset (blue)

Fit a curve to remove noise and subtract.

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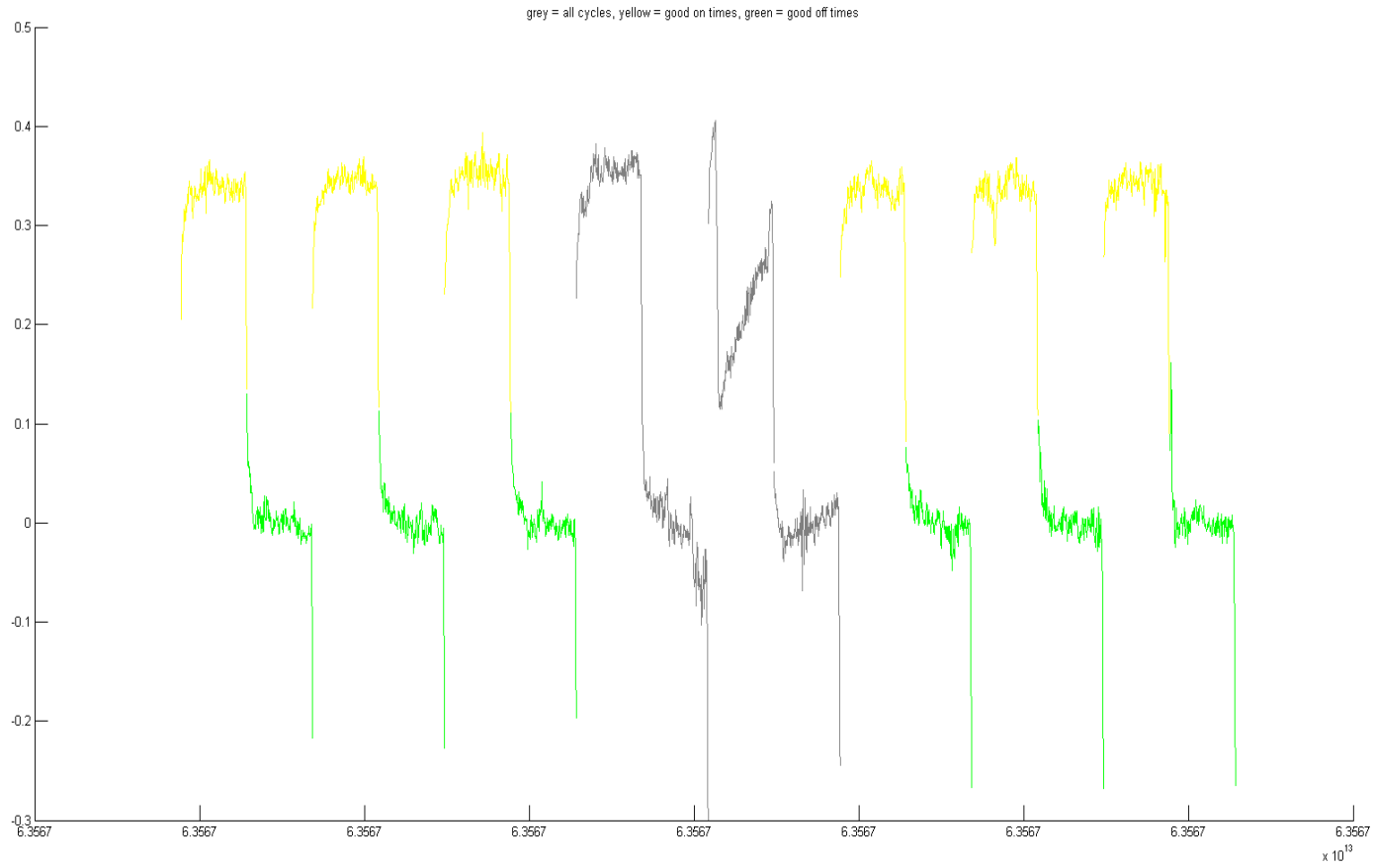

Reject based on:

- Vp
- Tau
- Model fit (noise)
- Late time offset

Break into individual cycles and compare Vp, Tau, smoothness, etc. Reject outliers (grey).

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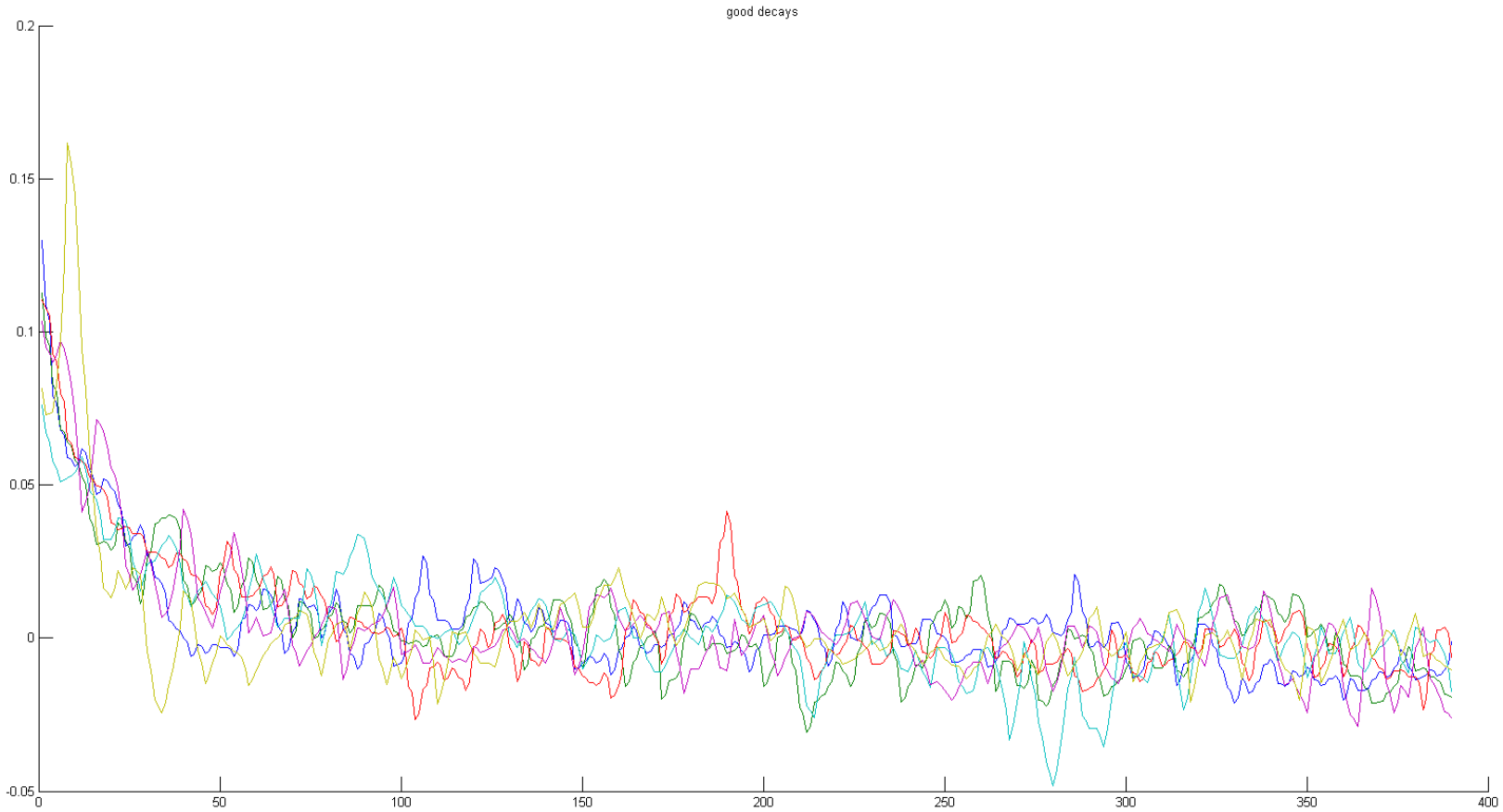
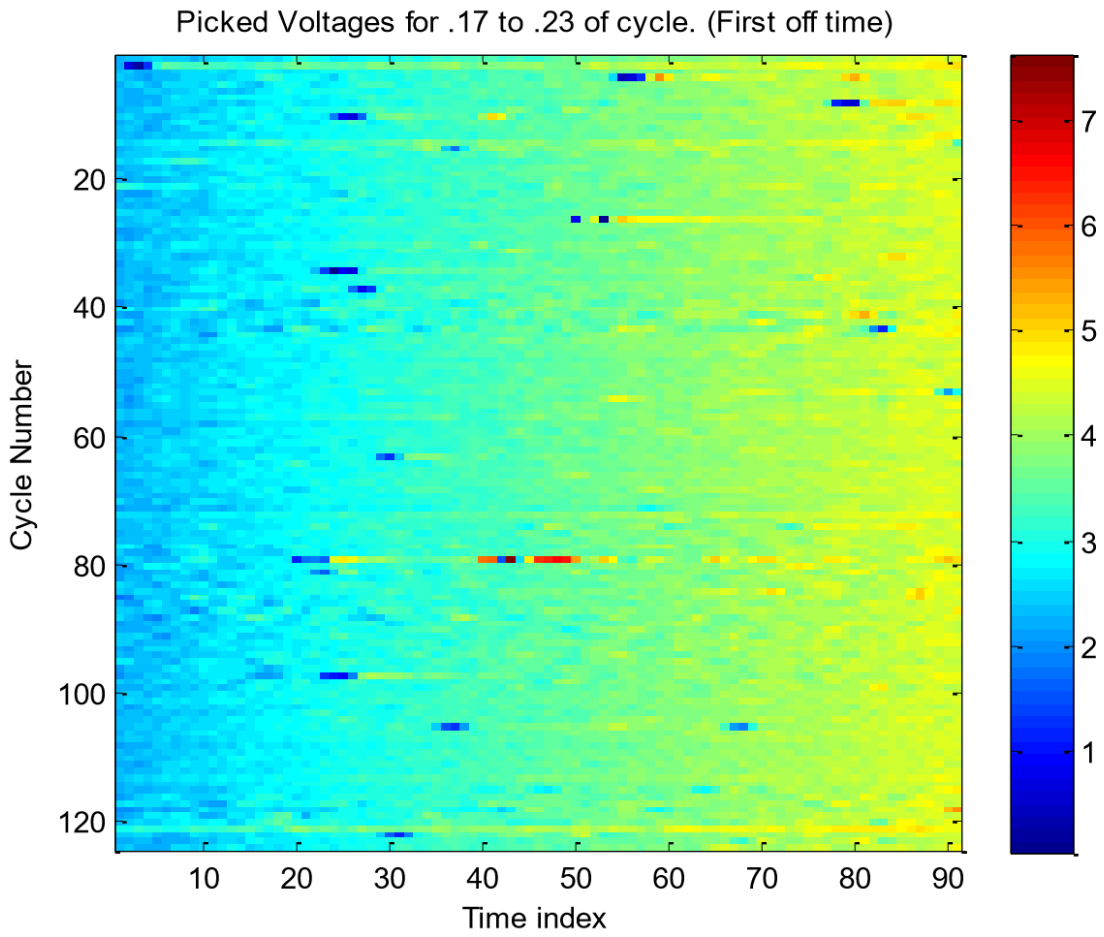


Stack remaining data

Quality Metrics



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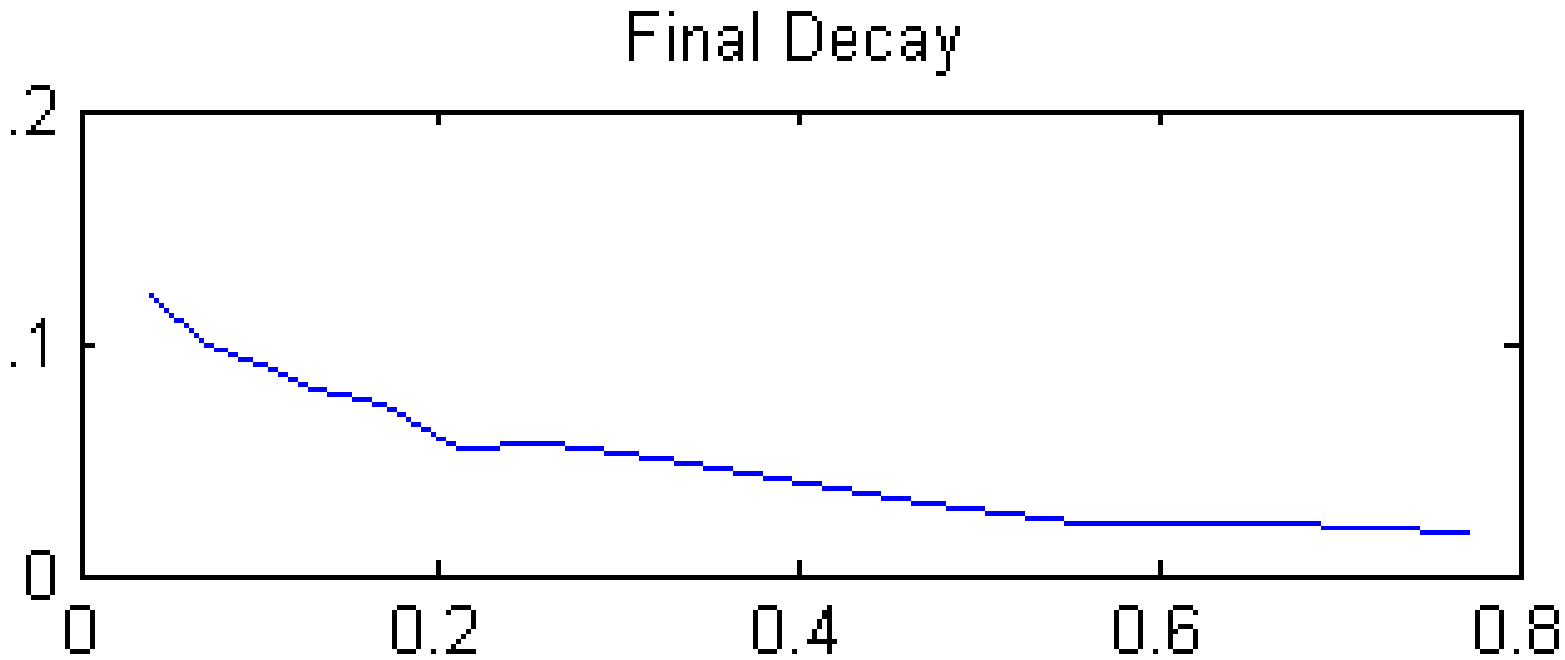

Stack remaining data

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Stacking and Windowing

Halverson/Tapered Stack

- Excellent at removing linear drift and offset
- Can be configured to have a notch filter at 50/60 Hz.
- Can struggle with noise bursts
- Sharp inflections in noise produce error in result
- Works best on longer recordings
- Memory/Processor efficient
- Can be used with rejection methods

Brute Stack with rejection and drift removal

- Uses curve fitting to remove linear drift and offset
- Excellent at removing “bursty” noise
- Concerns about changing the shape of decay curves and level shifts
- Works well on short recordings
- Requires significant processing power and memory

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Stacking and Windowing

Halverson/Tapered Stack

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Brute Stack with rejection and drift removal

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Stacking methods

- It is good to have a few tools in the box BUT…..
- If you can get a wide range of values with different stacking methods, the S/N of the data probably just isn't good enough
- We need a good way of evaluating the quality of the raw data before stacking

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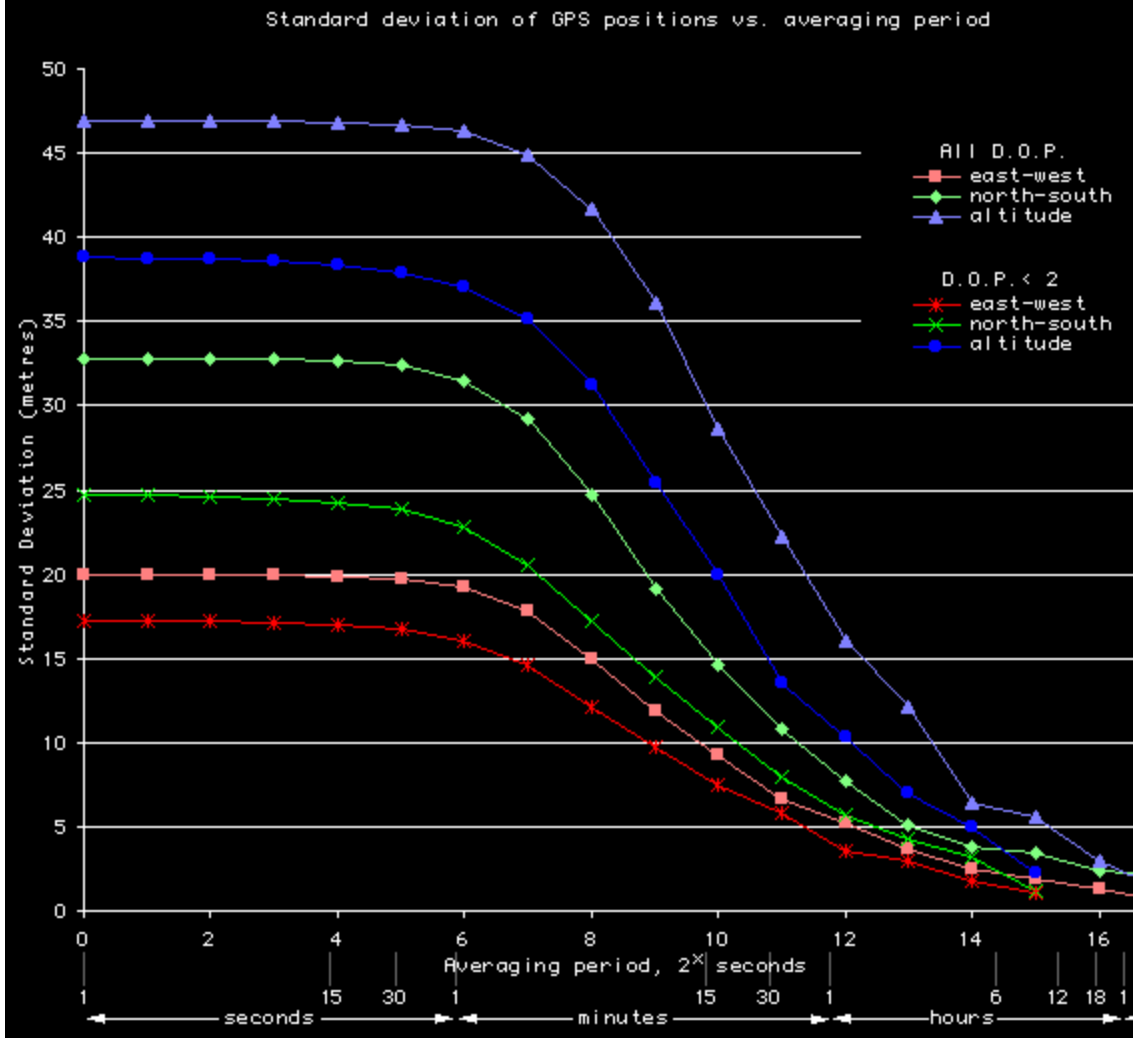
Locating Static Electrodes

- Handheld GPS accuracy is 7.6 m 95% of the time not including local factors
- WAAS provides 1.6 to 4 m accuracy 95% of the time (NA only)
- Longer read time improves accuracy
- Differential GPS provides sub-meter to cm scale accuracy and will allow for more complete recovery of data



Moving Electrodes – water bodies

- Real-time GPS allows for in-survey changes to electrode location

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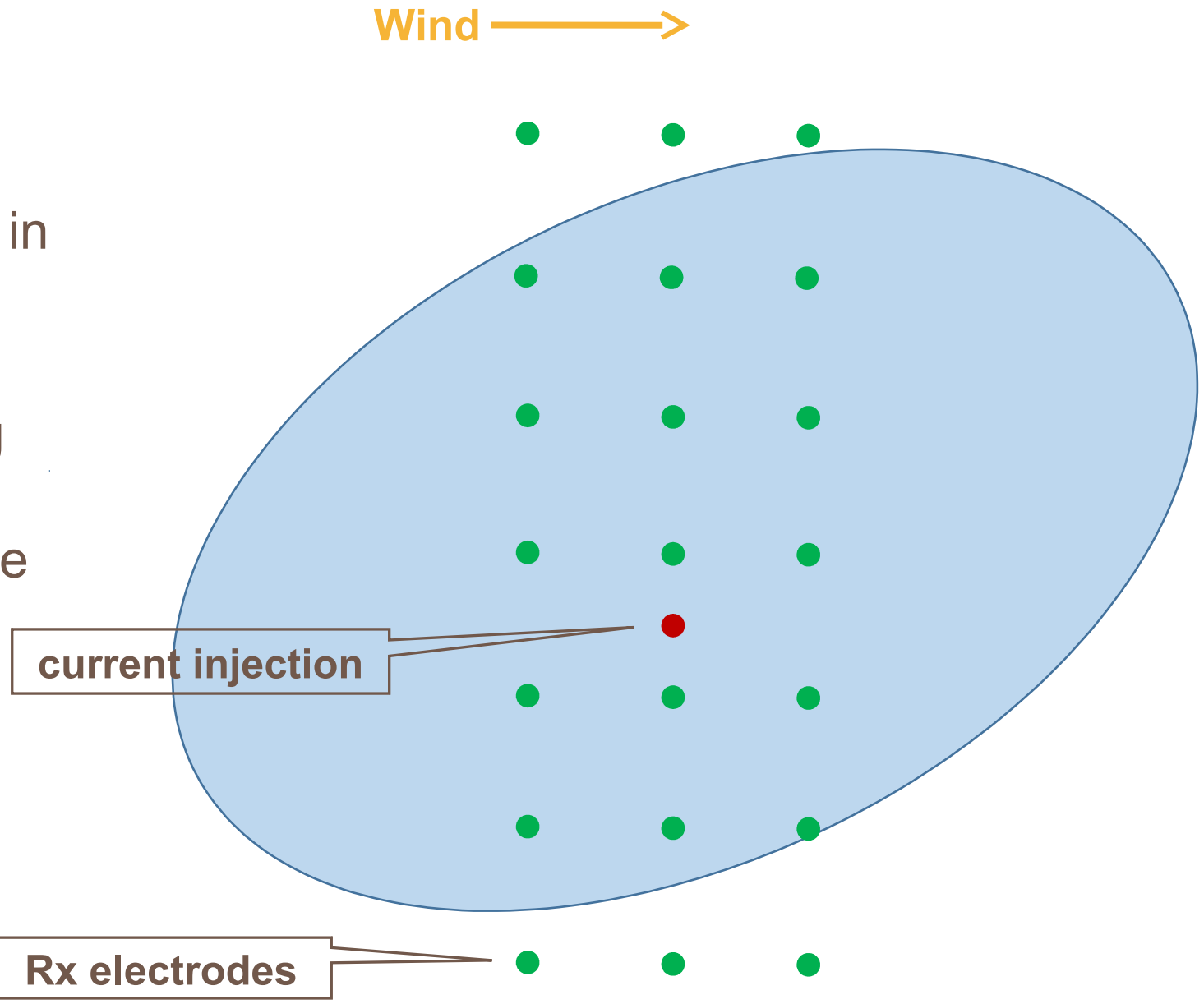
Location Error

- Error in position is just as much of a problem as error in voltage or current
- Flexible deployment of electrodes during surveying leads to efficiencies and better data quality due to the quality of the plants
- On lakes, the electrode positions may not be fixed during a survey



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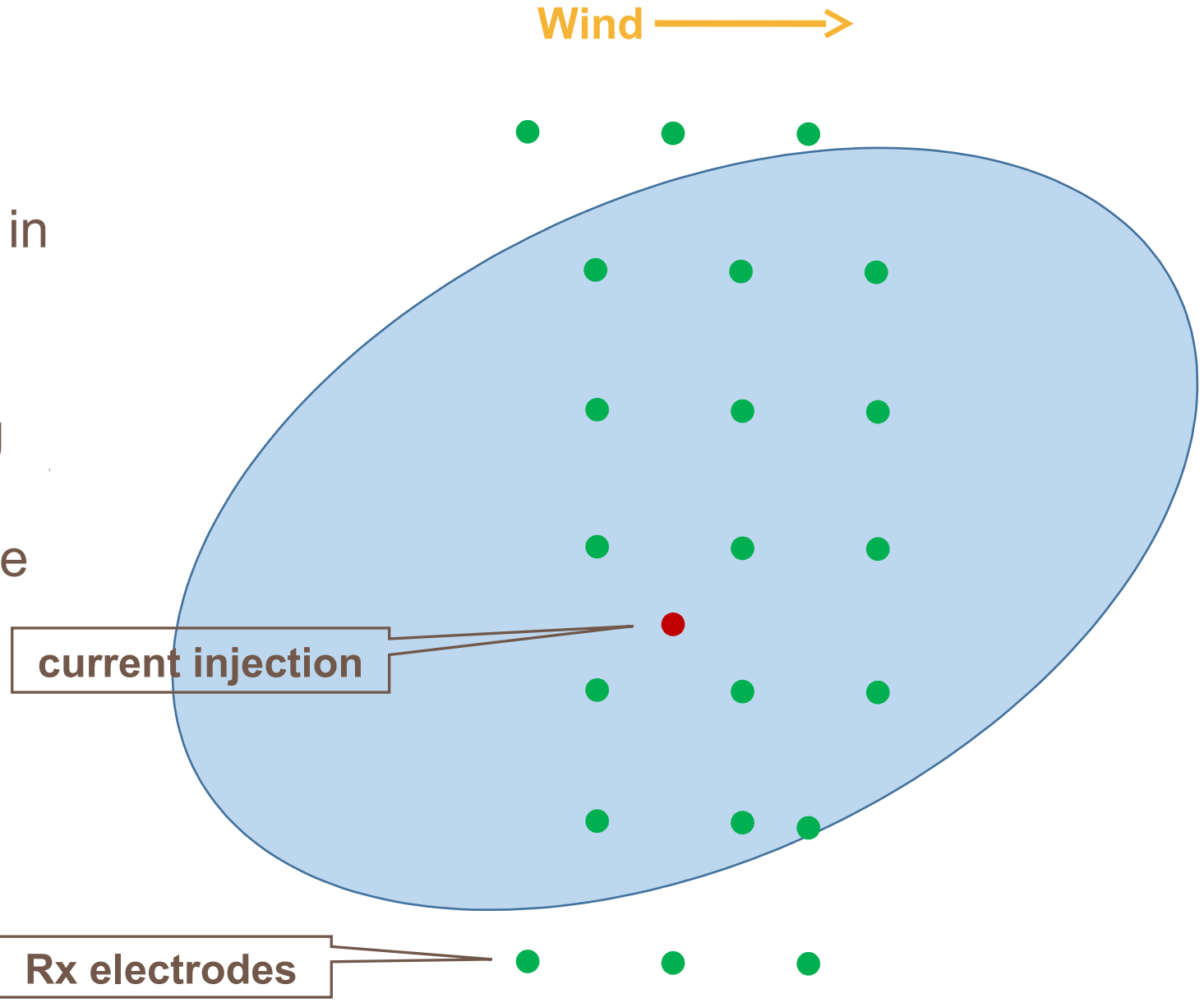

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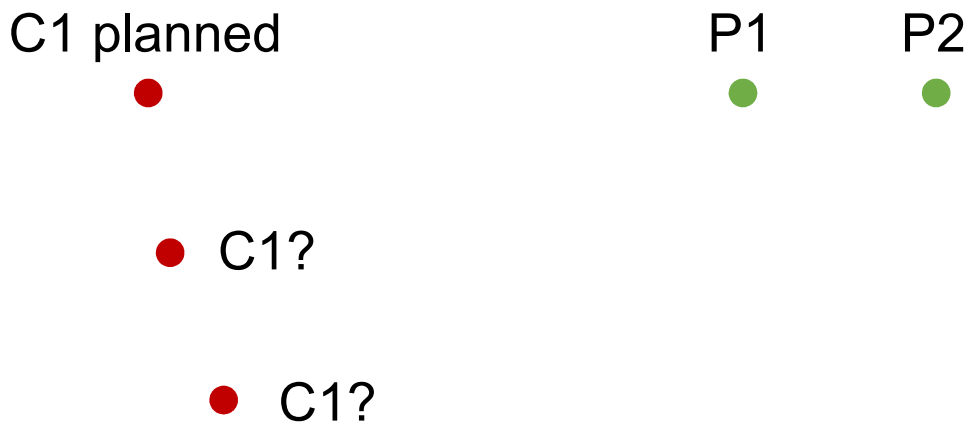
Apparent Resistivity (DC)

$$\rho_a = kV/I$$

$$k = 2\pi n(n+1)a$$



V – high accuracy
I – good accuracy
n, a – lower accuracy

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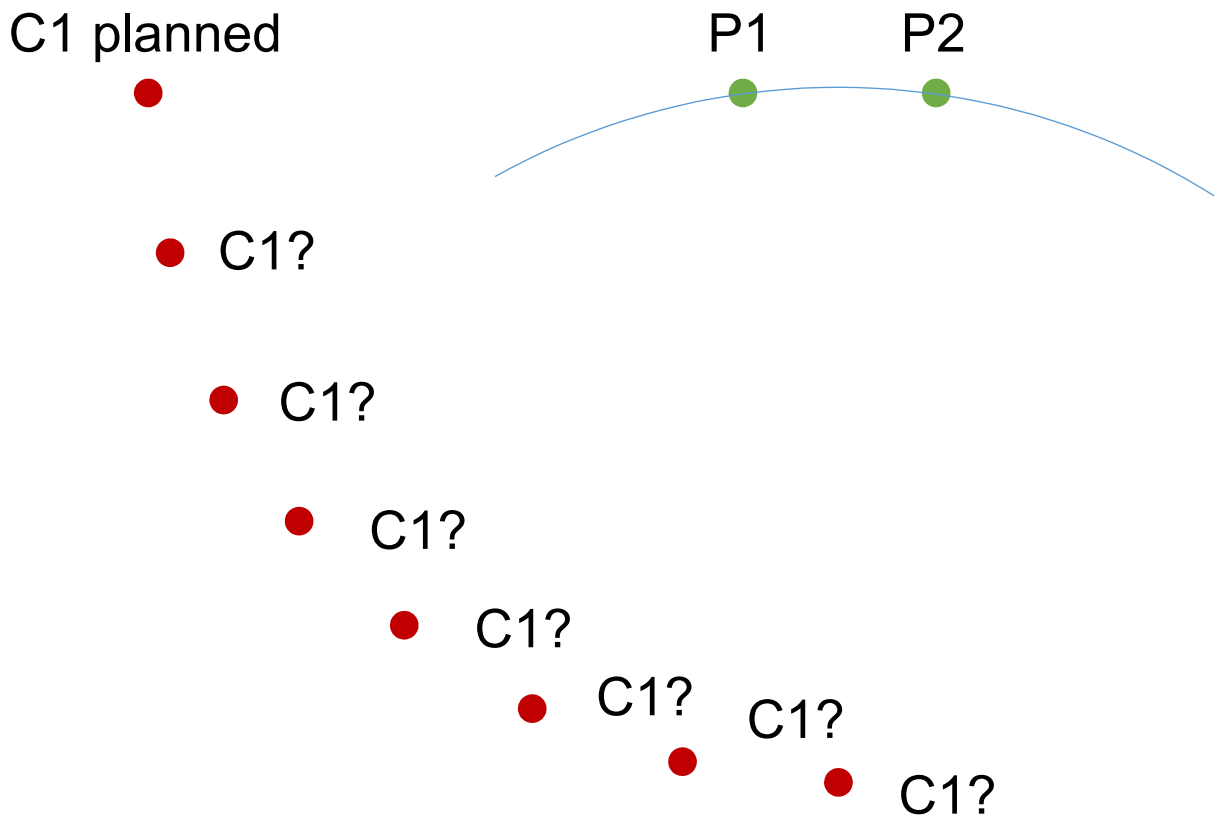
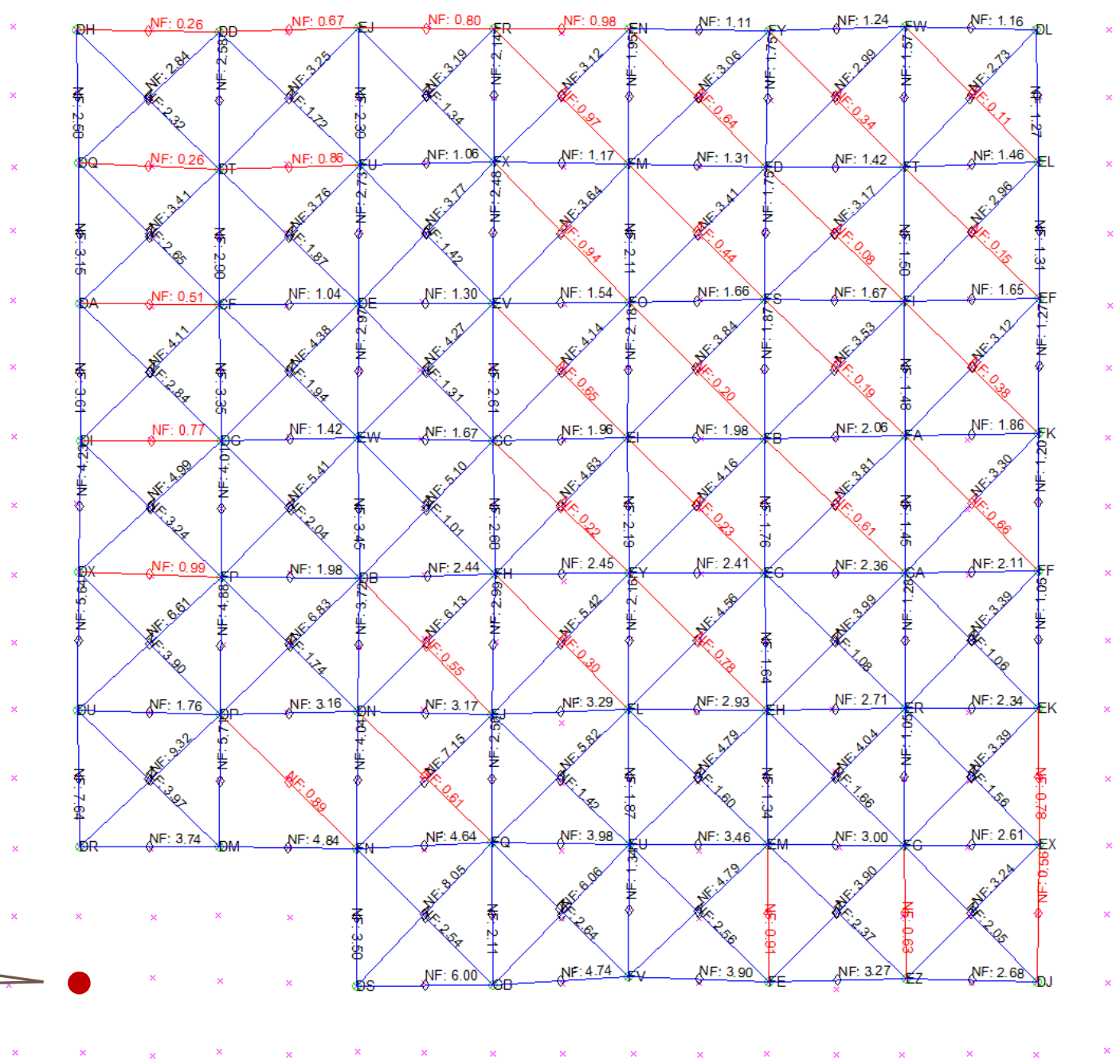


The lower accuracy n and a measurements become a significant problem when the voltage equipotential is parallel or sub-parallel to the two dipole electrodes.

Removing Poorly-coupled Data

- Build all dipoles using sides and diagonals of each square of receivers.
- Convert positional error to resistivity error and the user selects a rejection threshold.
- In this example, red dipoles have been rejected because the ‘null factor’ is less than 1.



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Final QC

Voltage (Vp) plotting can be used for QC of data in real time. The erroneous data value shown is a receiver that was connected backwards.

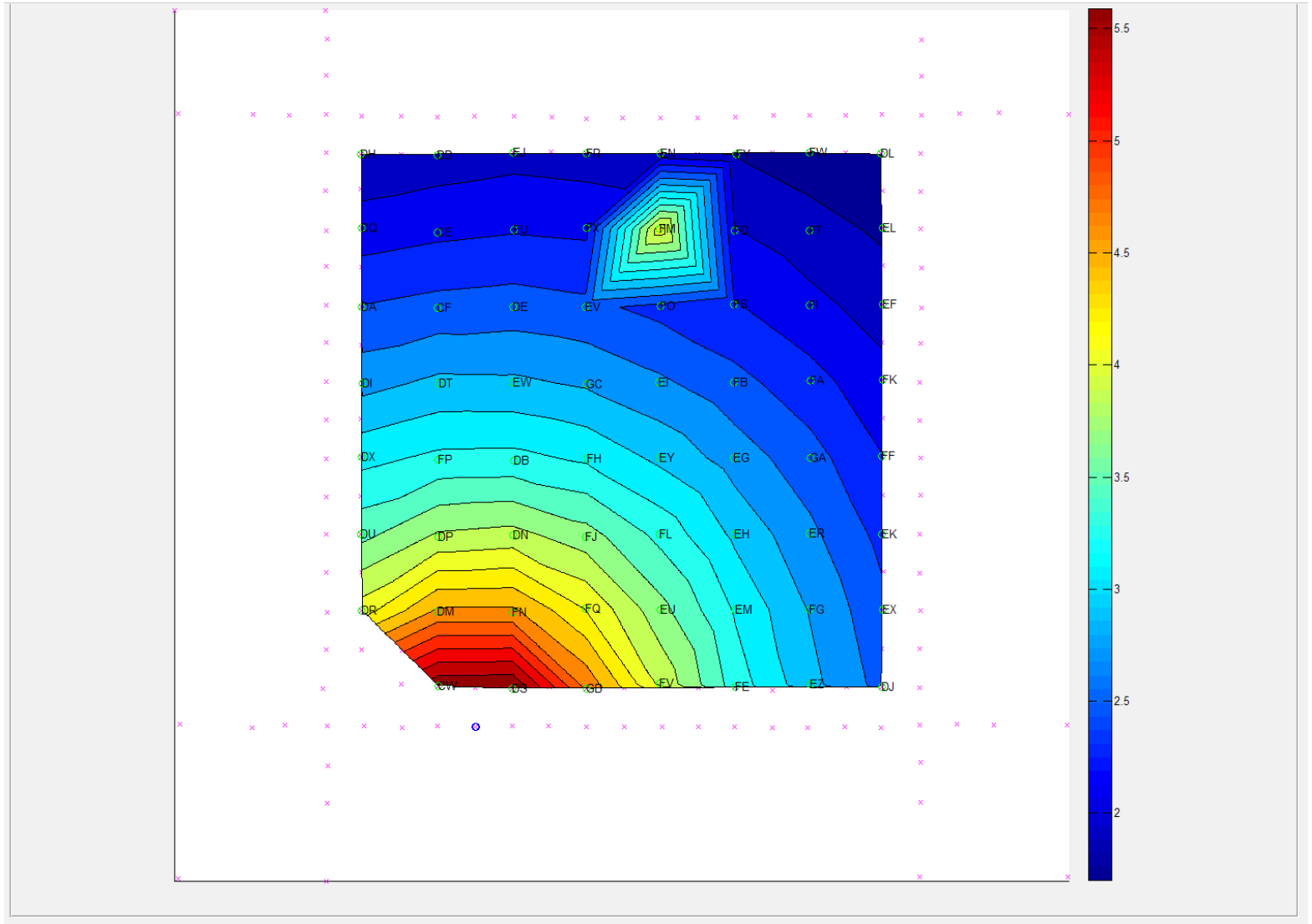

Image of Vp for all receivers from a single injection point. The Vp is measured from the pole-pole data. The injection point is the small blue circle near the south edge of the survey area.

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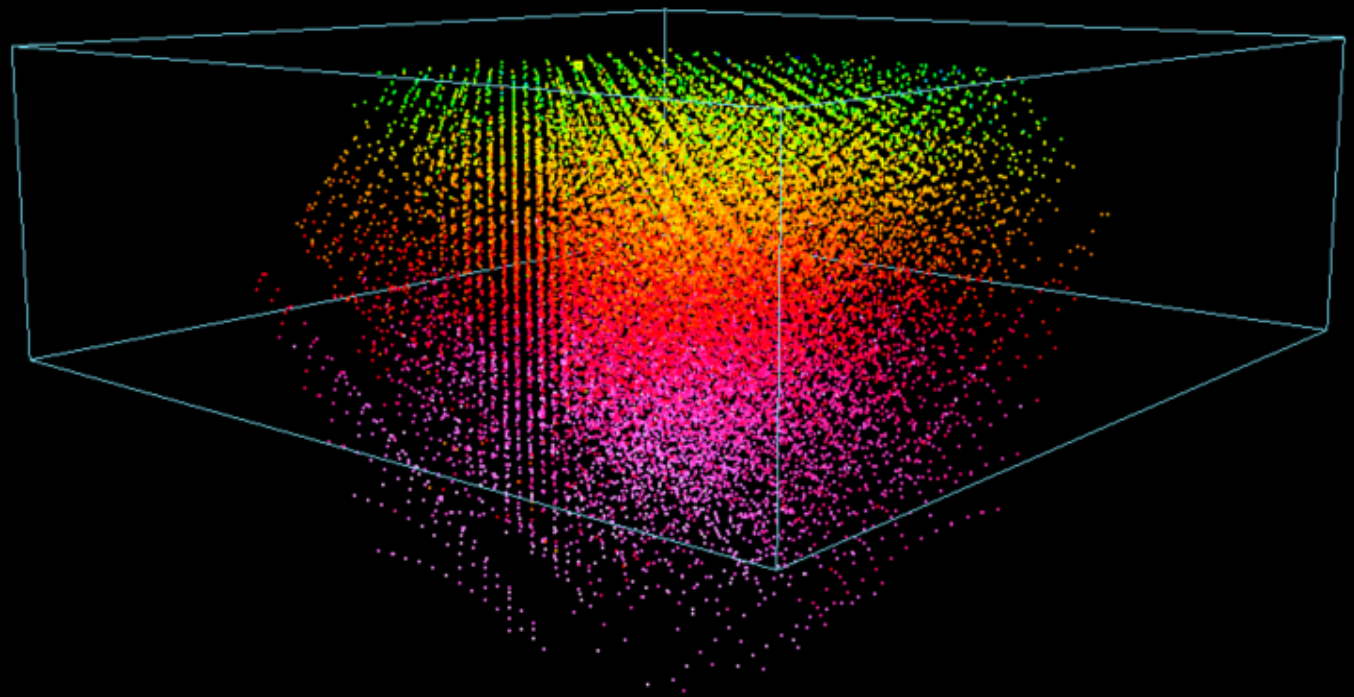
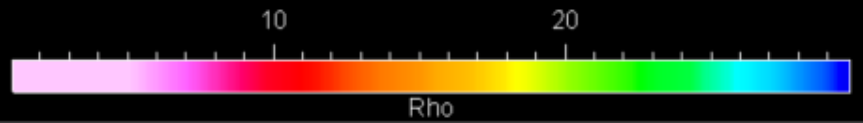
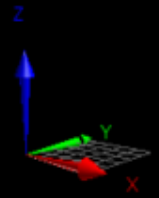
Final QC

Point cloud of the resistivity values from each pole-dipole result.
In this survey area, there is a conductive shale layer at depth.



Final visual checks before the dataset is completed





Inversion and imaging courtesy of Mira Geoscience.

Summary

The final dataset requires 3 measurements

- Voltage
  - Use stacking method that works best for the data. Halverson is nice as it is easier to understand what frequency filtering is happening with the data
- Current should be measured at the injection location and monitored for leakage.
- Position – error here is just as problematic as error in voltage or current.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