Historical ELCID trending and analysis

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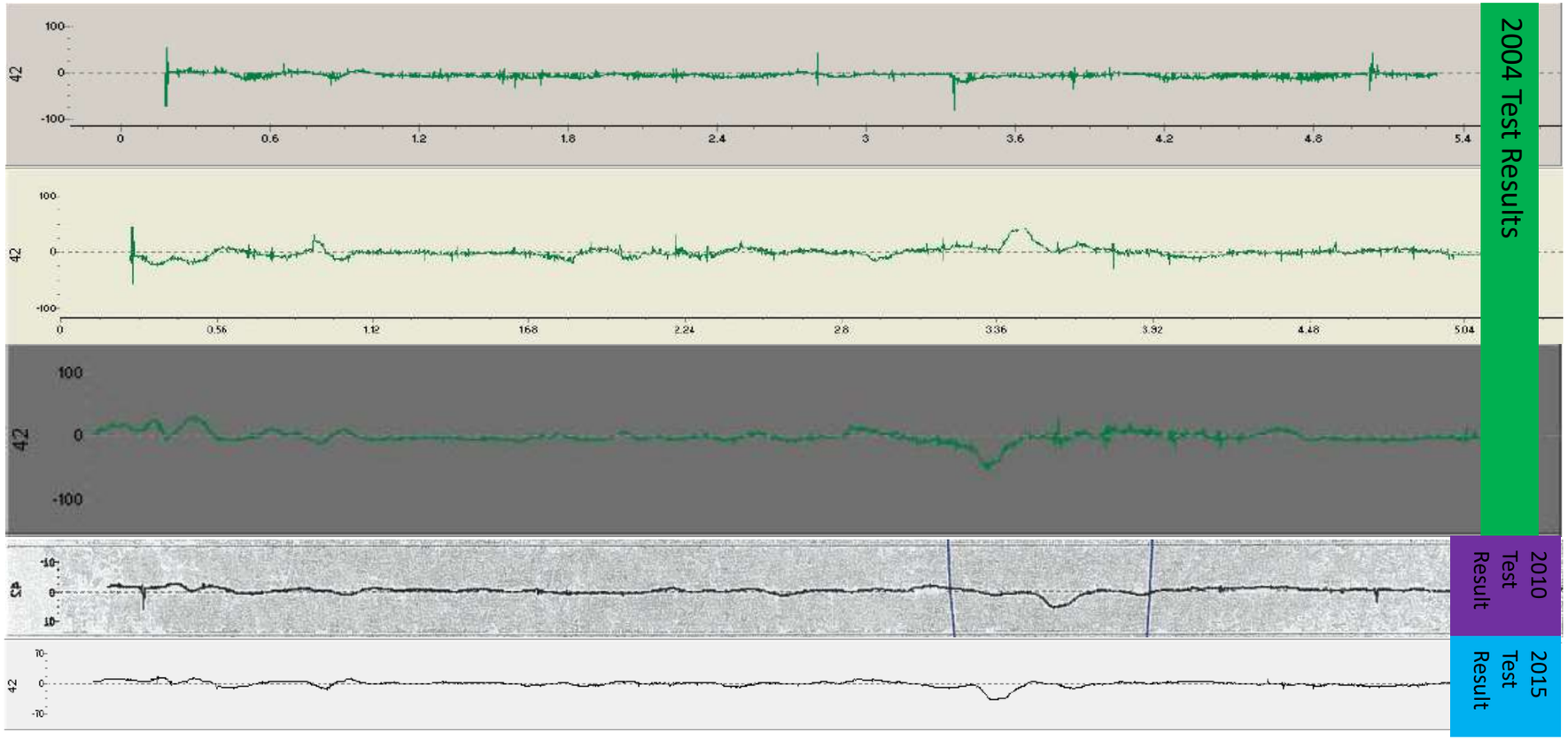
ATCO
ALWAYS THERE. ANYWHERE.

Overview

- Background
- Challenges with ELCID trending/analysis
- The anatomy of a digital ELCID file
- Trending challenges
- Benefits of digital trending
- How ATCO does trending

Background

- **EL**ectromagnetic **C**ore **I**mperfection **D**etector (**ELCID**) is a low excitation test to assess core health
- Wide industry acceptance



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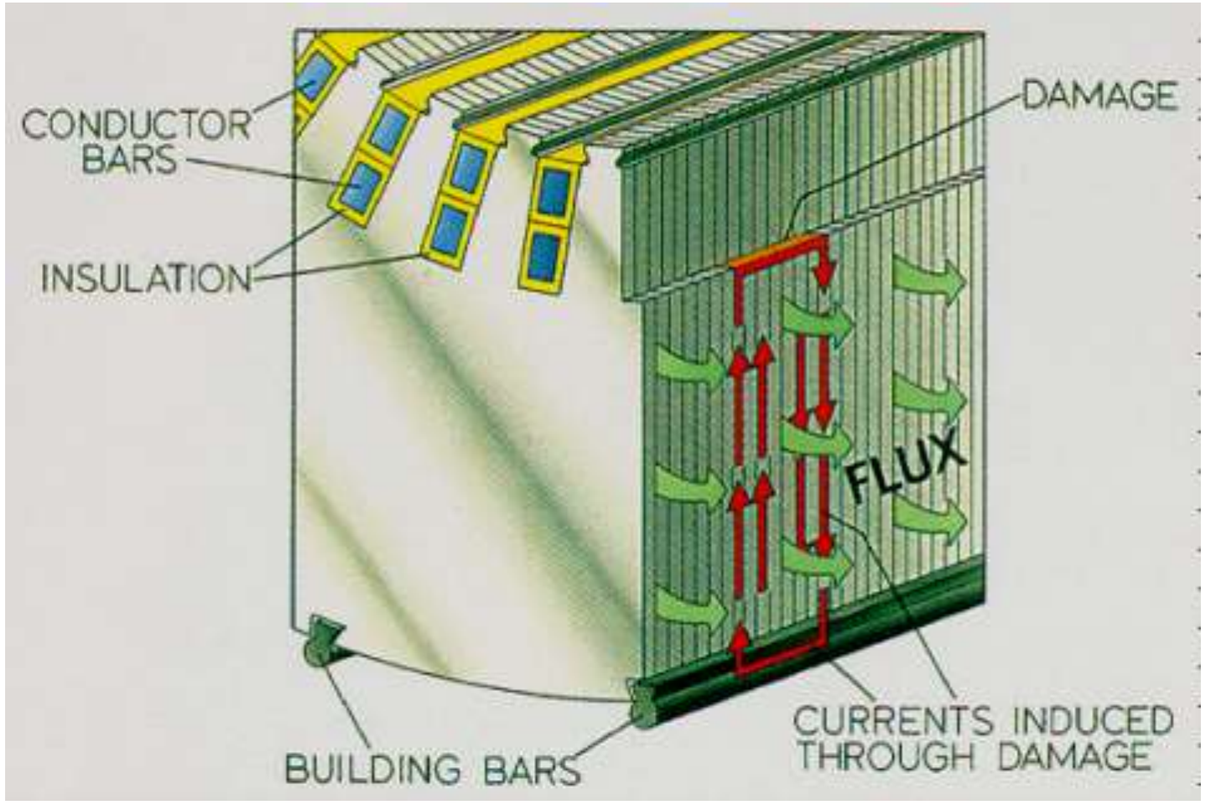
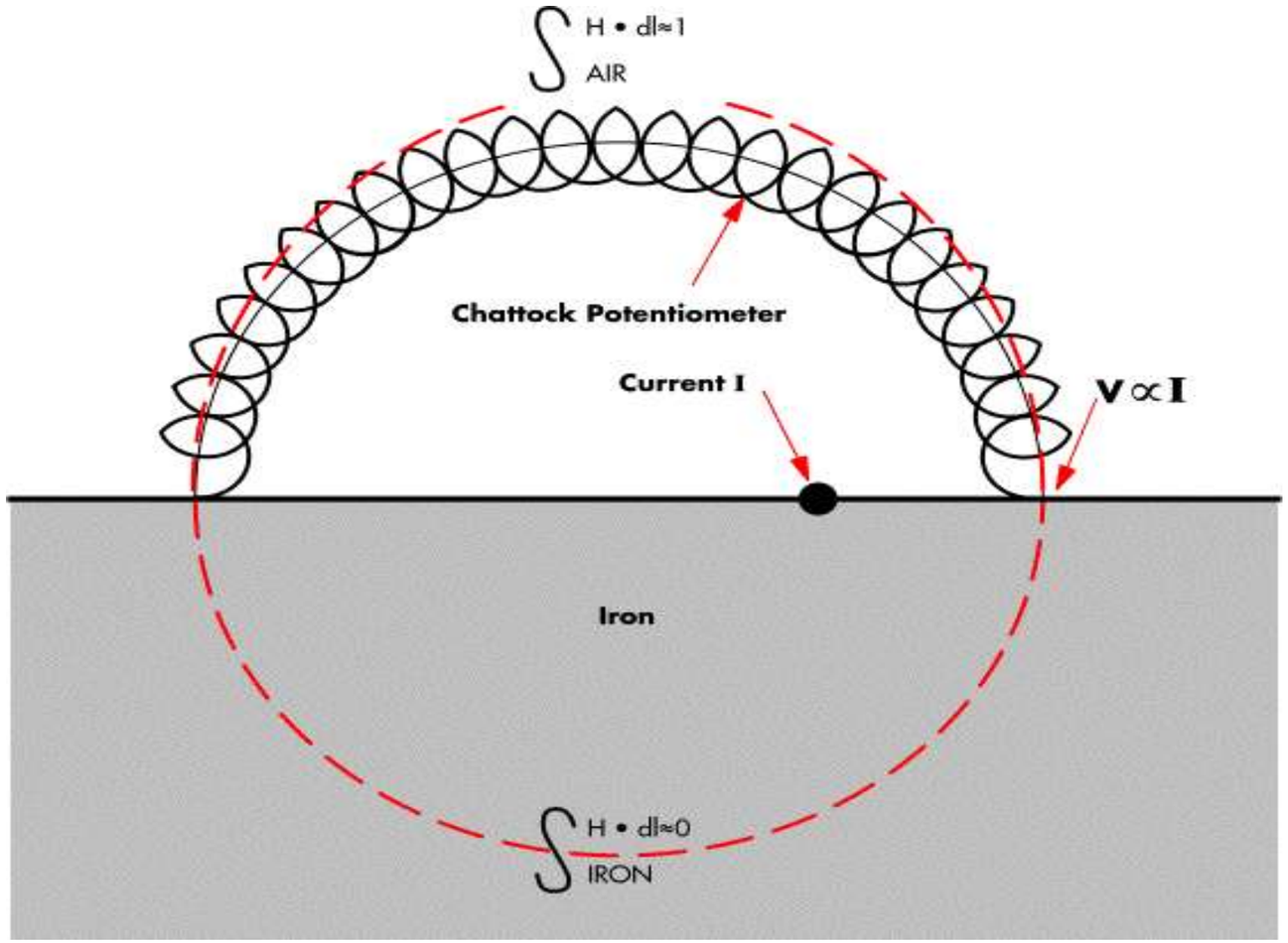


Insulation breakdown causes fault currents to be set up as illustrated. These fault currents (Foucault, 1851) create hot spots which can cause further deterioration to the core.

If left unchecked, this can lead to damage to the stator core, windings and the machine as a whole.

Courtesy of IRIS Power

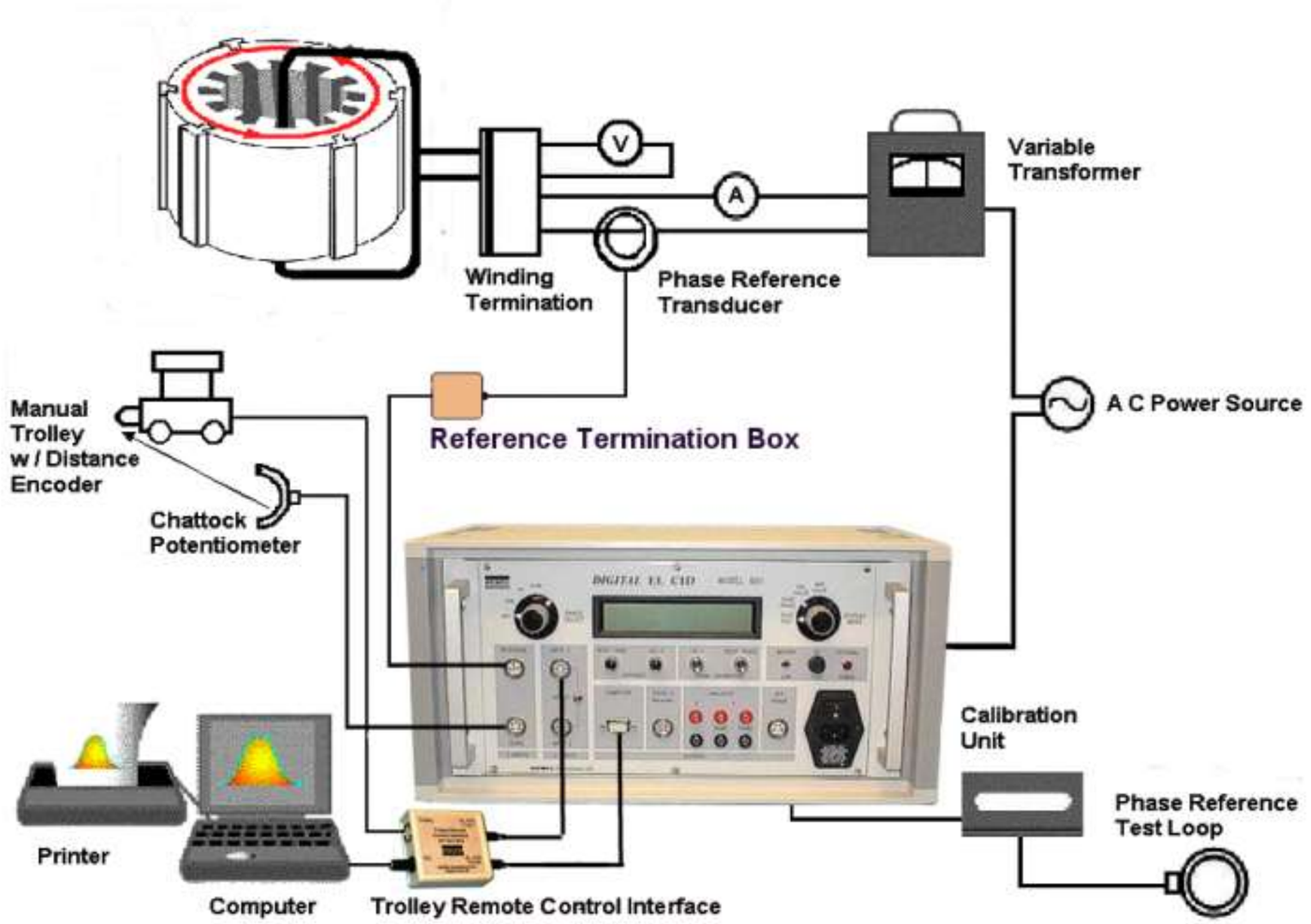
Background



The Chattock Potentiometer measures the Magnetic Potential Difference (m.p.d.) between its ends

Courtesy of IRIS Power

Background



Courtesy of IRIS Power

Challenges

- Setup differences
  - **Core length**

    Depending on the operator and OEM vs. non-OEM, different core lengths are often used. This leads to scaling issues in the traces and makes exact positioning a challenge.

    The operator also has the option to select the “start” and “end” position of the test which creates offset issues if not done correctly.
  - **Polarity**

    The orientation of the chattock coil, and the orientation of reference transducer can lead to inversion problems with the signals.
  - **Slot Numbering**

    Clockwise vs. Counter-Clockwise

Challenges

- Trending areas of interest

  Results are often standalone and on various scaling in the report. This makes assessment of areas of interest more difficult and in some cases more judgement based. In addition the digital files are not often retained by the site/tester which has valuable information such as phase current.

- Software

  The owner doesn’t necessarily have the software to read the digital file; **It is free to download** but can be difficult to convince IT to let you install it. Furthermore the software is needed to export the values to a usable format, but only *.csv is available.

Challenges

- Filtering

  The raw data files have noise, and filtering is applied to the final reported results. While not necessarily a problem it can be valuable to look at the raw data.

- Duration Between Tests

  Depending on the machine, the duration can be quite long. Results can be lost over time which is important for establishing baseline values and fault tracking.

The anatomy of a digital ELCID file

ATCO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Quad Data

Phase Data

The anatomy of a digital ELCID file


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```

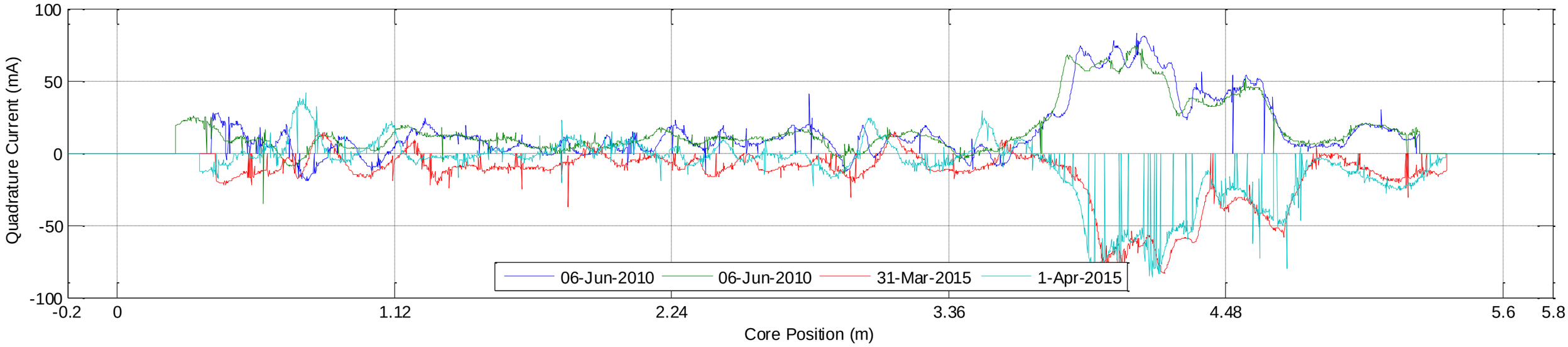

- Measurements are taken every 0.002m (2mm)
- Pre-buffer automatically populated (0.2m)
- Post-buffer allotted for any measurement/transducer issues (0.2m)

Length of trace = 0.2m + Core Length + 0.2m

If Length of Core is 3m, 100+1500+100 = 1700 samples are recorded.

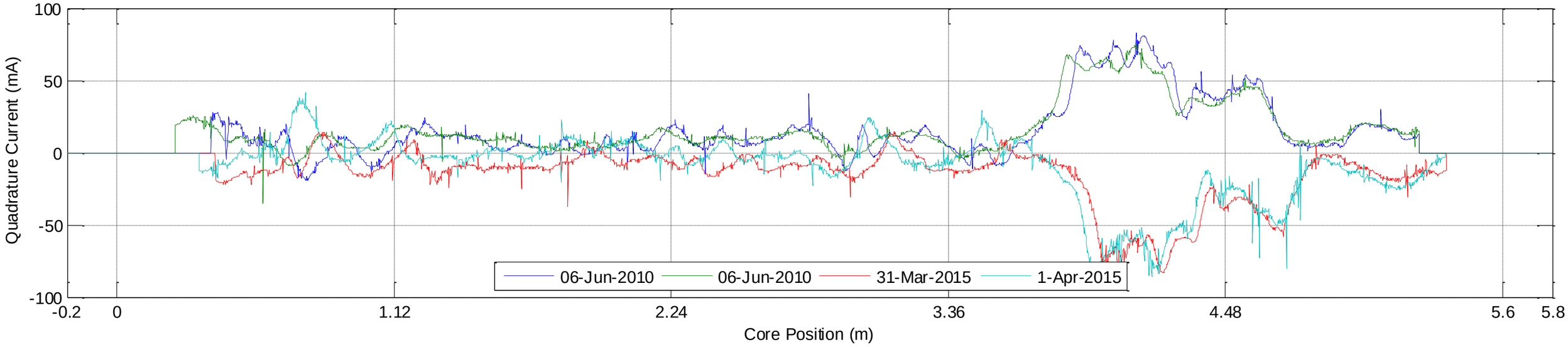
Trending challenges

- No filtering applied
  - Noise in April 2010 trace
  - Inversion on June 2010 traces
  - Offset/Scaling Issues



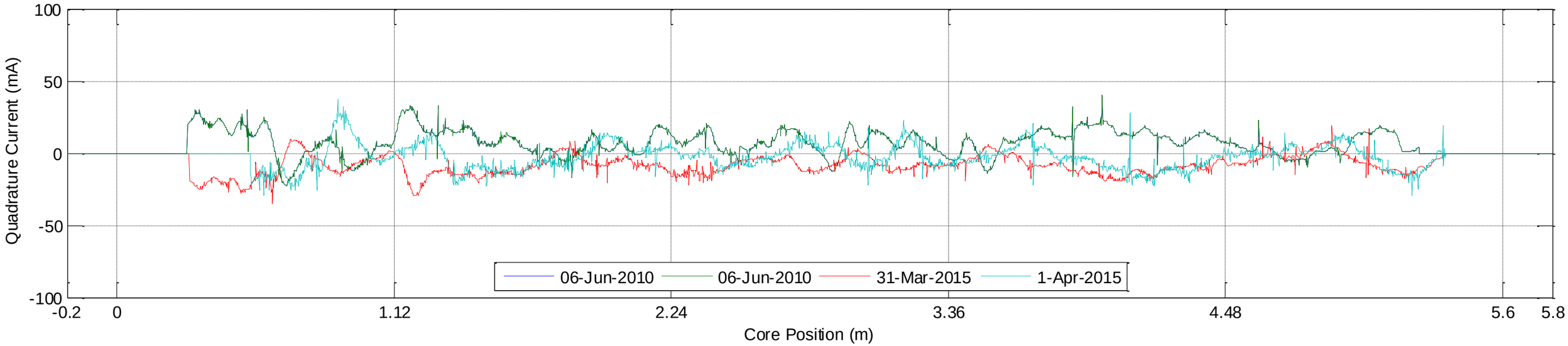
Trending challenges

- Noise
  - Just remove the 0’s. This is the same methodology that is used in the ELCID software.

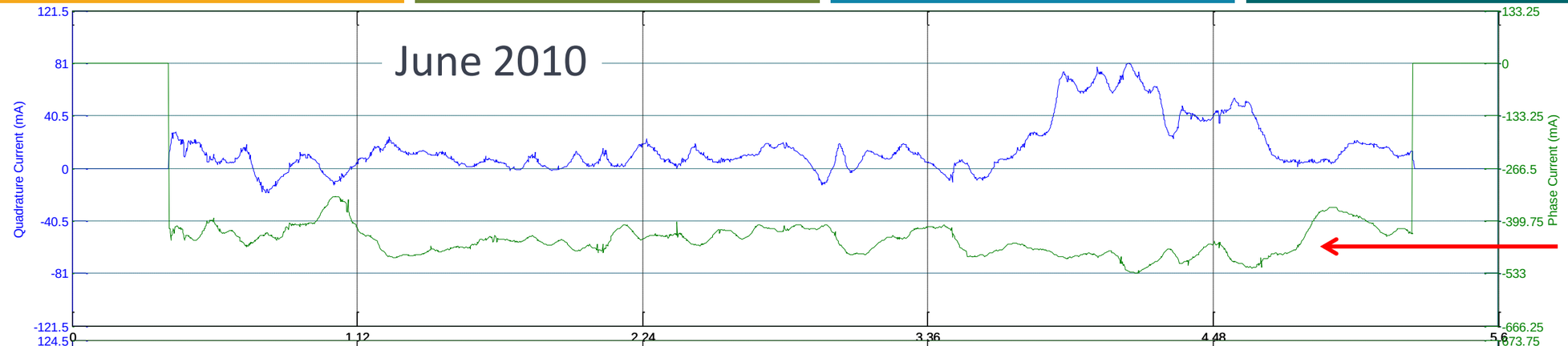


Trending challenges

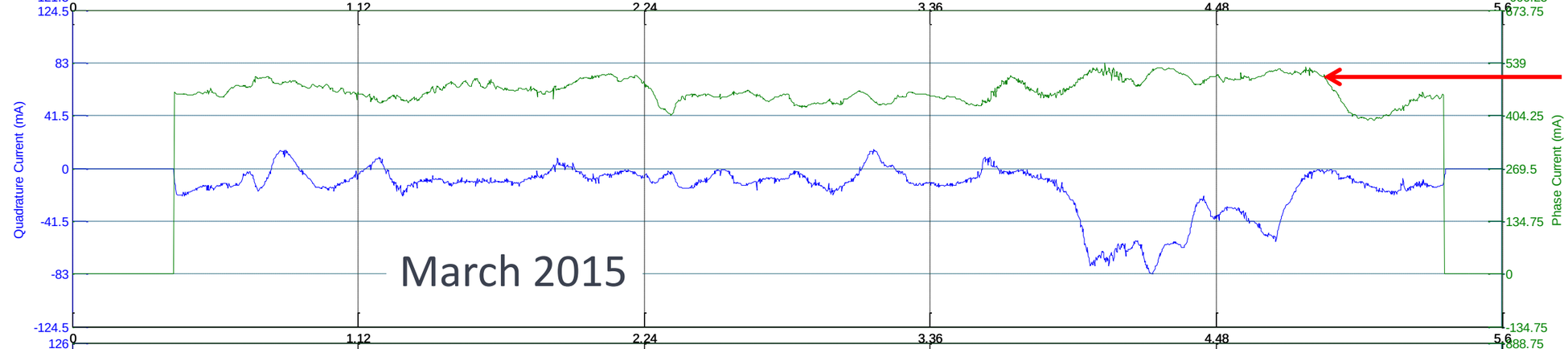
- Inversion
  - Easy to tell when you have a significant fault (as shown below)
  - Can use the phase values to correct this for signals that are not so obvious



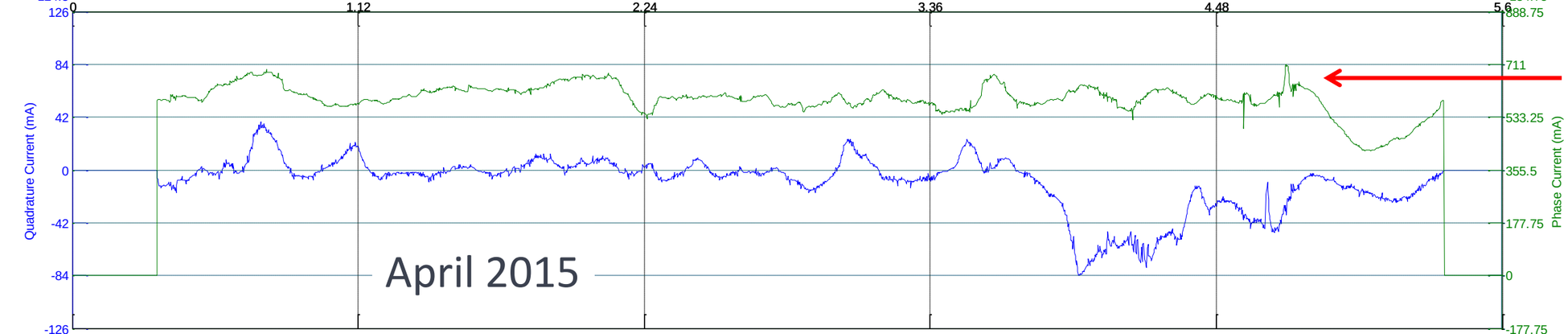
Trending challenges



Phase Current is negative



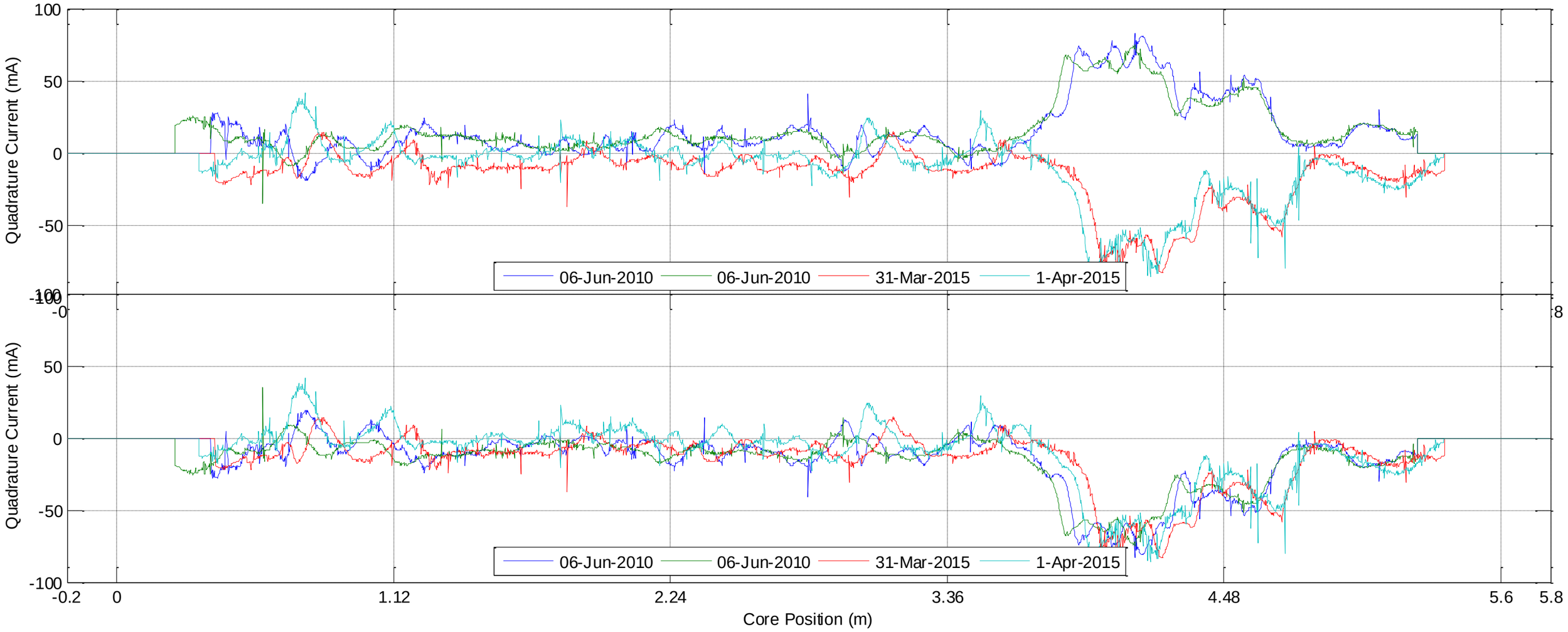
Phase Current is positive



Phase Current is positive

Trending challenges

Inverted based on positive polarity convention

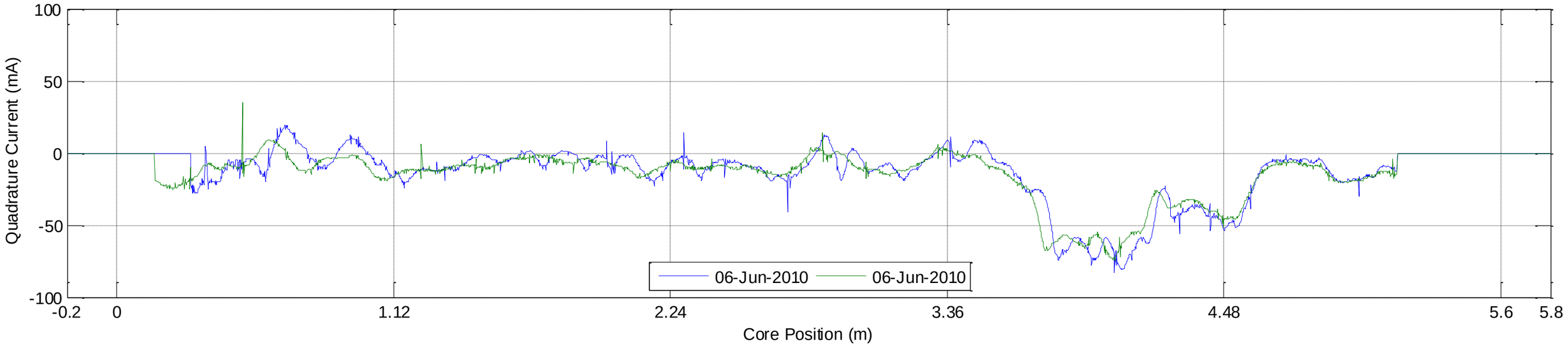


Trending challenges

- Alignment
  - Not all ELCID testers are the same; the position of the chattock can vary in the trolley. Robotic vs. manual can give different positioning. Even if they are calibrated, alignment issues can persist.
  - “Start” position can be different depending on the operator and what was entered into the software.
  - Can either be done by judgment, or with algorithm but you need to choose a reference plot
  - Easier when there is an artifact

Trending challenges

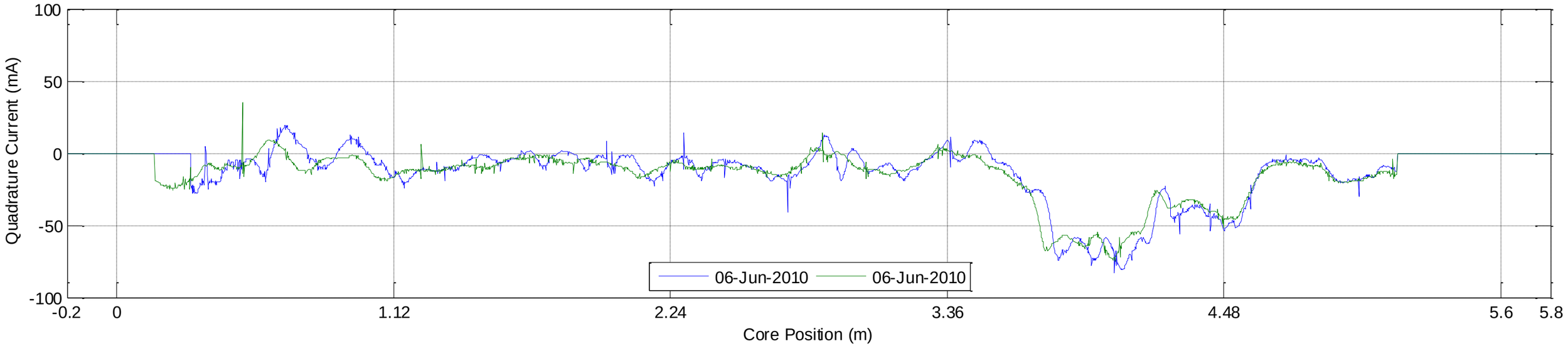
- Alignment
  - Two traces taken on the same day, with the same equipment



IRIS Rotating Machines Conference slot:024 Report Generated:27-Feb-2018

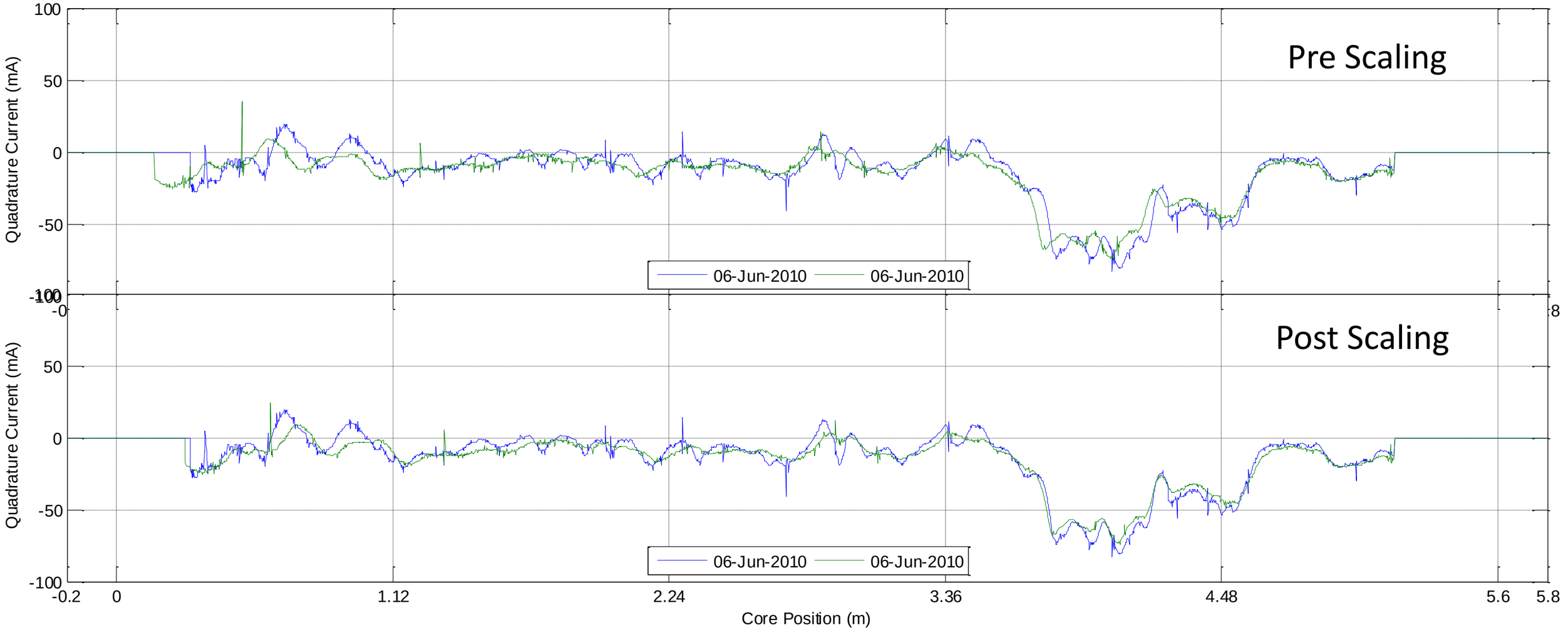
Trending challenges

- Alignment
  - Two traces taken on the same day, with the same equipment
  - Likely do to position feedback, speed, etc.



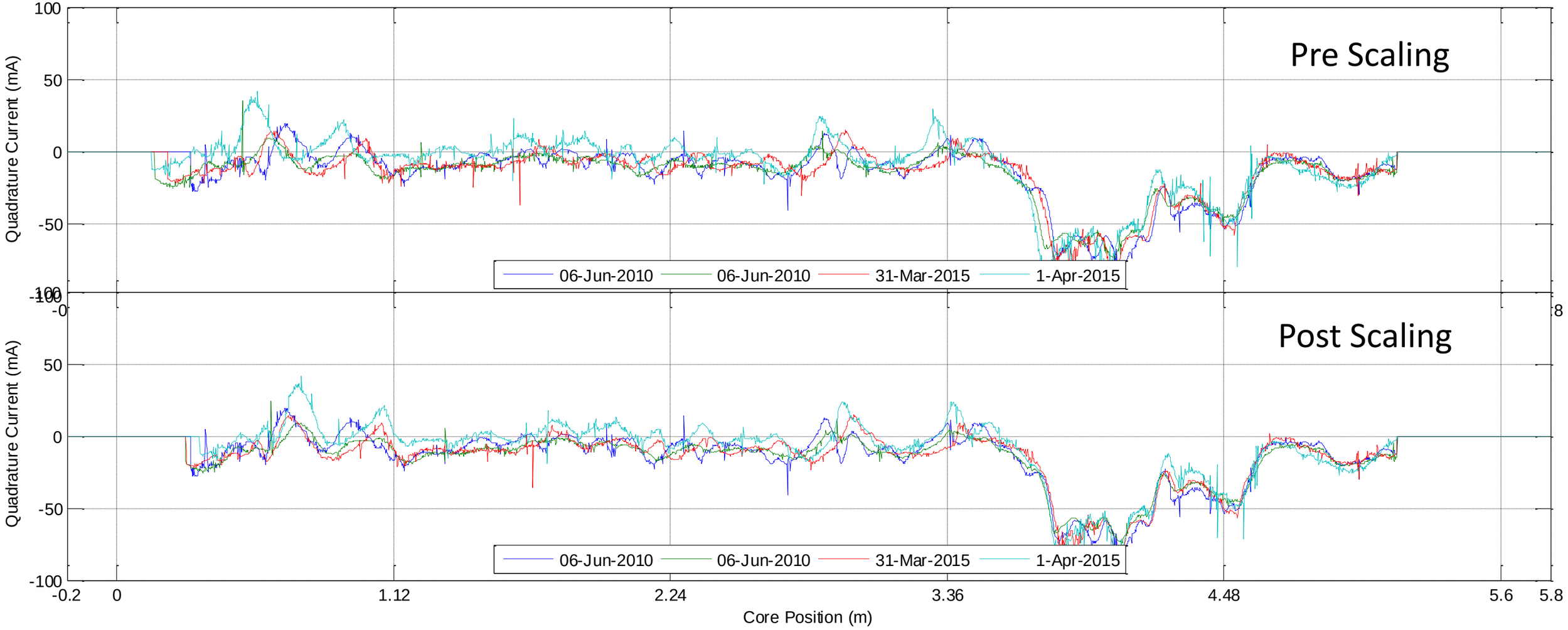
Trending challenges

Scaling factor of 1.025



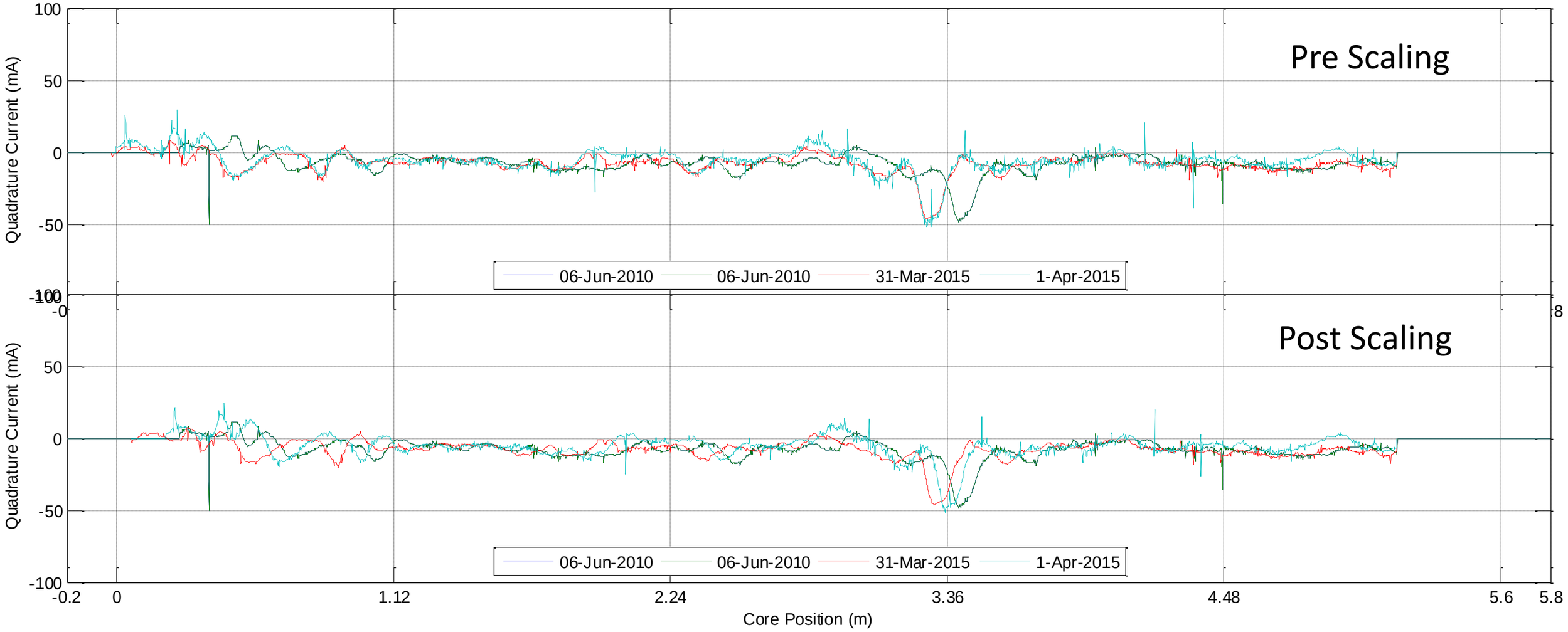
Trending challenges

Scaling factor of 1.025, 1.015, 1.04 respectively.



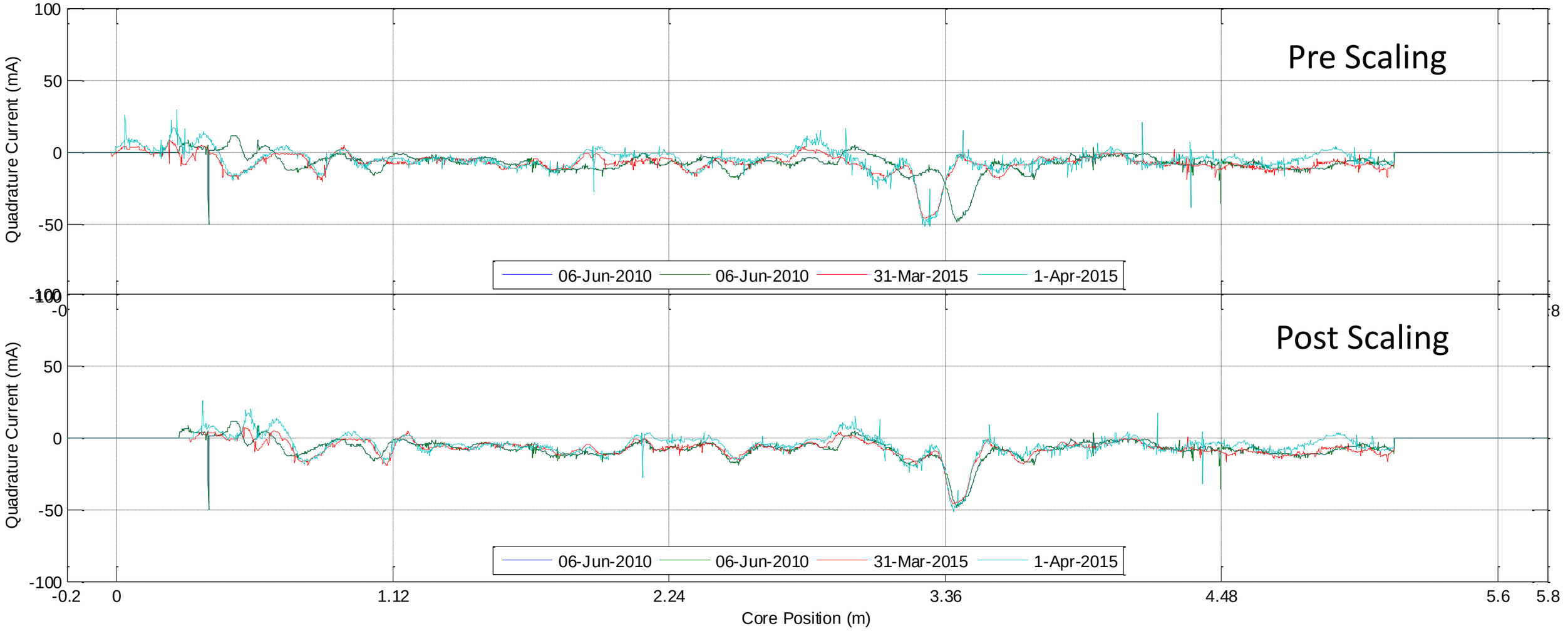
Trending challenges

Scaling factor of 1.0, 1.015, 1.04 respectively.



Trending challenges

Scaling factor of 1.0, 1.065, 1.065 respectively.

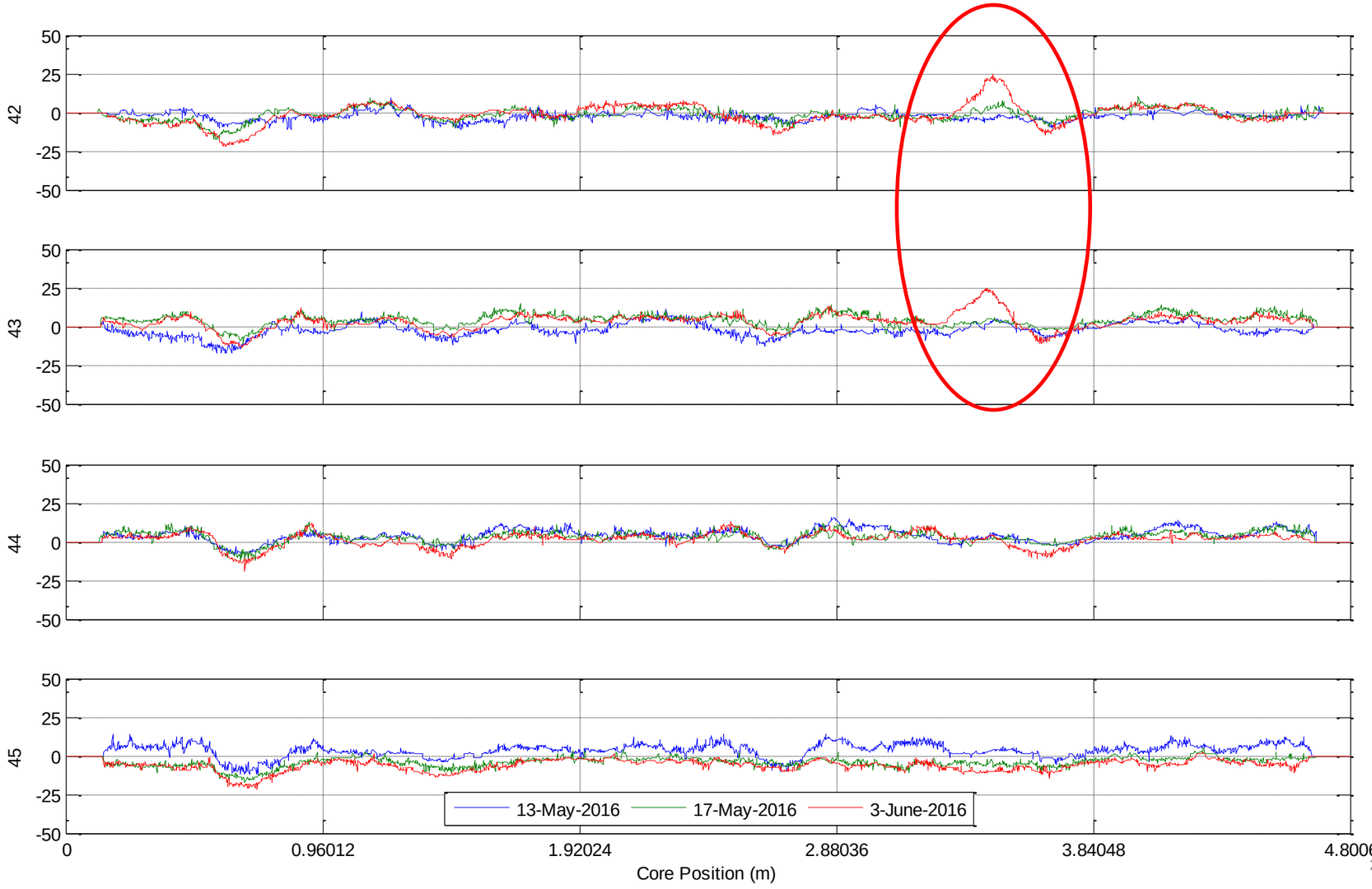


Trending challenges

- Other manipulations
  - Vertical Scaling
  - Vertical Offset
  - More?
- You can spend a lot of time trying to make one trace “perfect” but need to evaluate the impact on the rest (less is more).
- The end goal is to have a clean result to track developing conditions

Benefits of digital trending

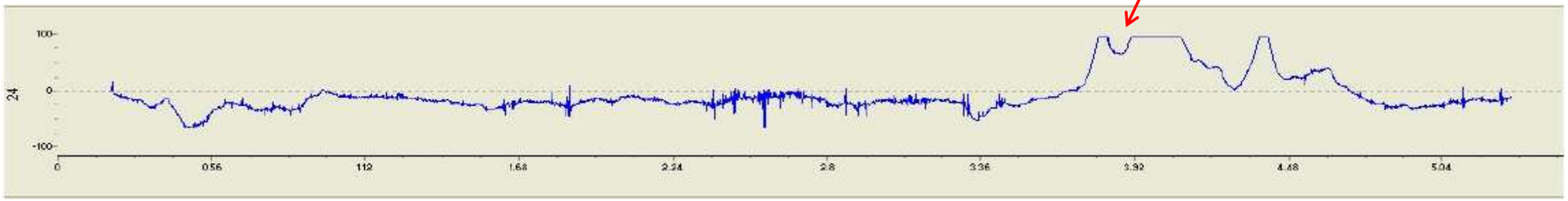
- Small changes (<100mA) are easier to spot and monitor
- Adjustable scaling

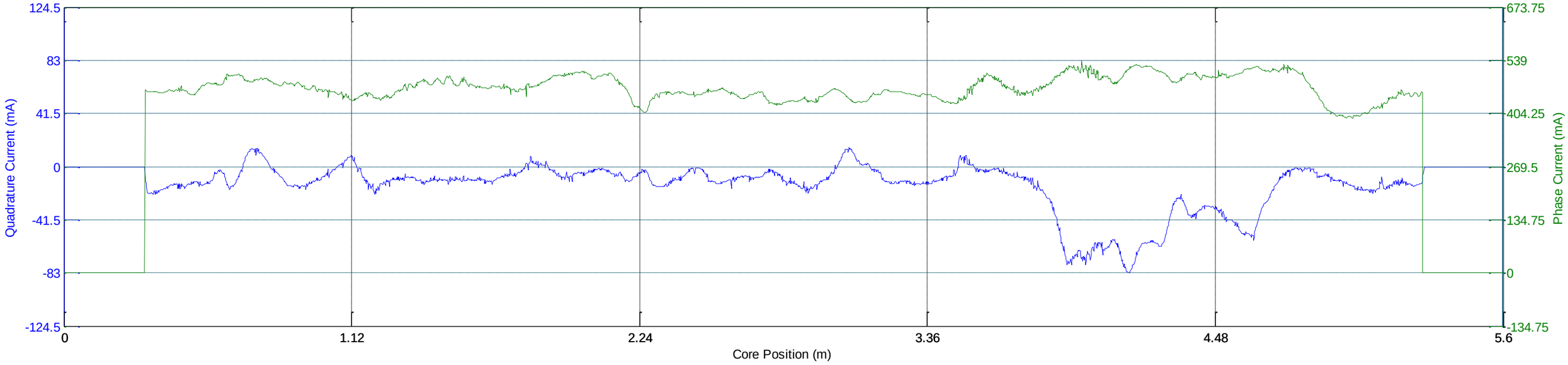


Benefits of digital trending

- You have ALL the data from the test

Truncated in report due to scaling



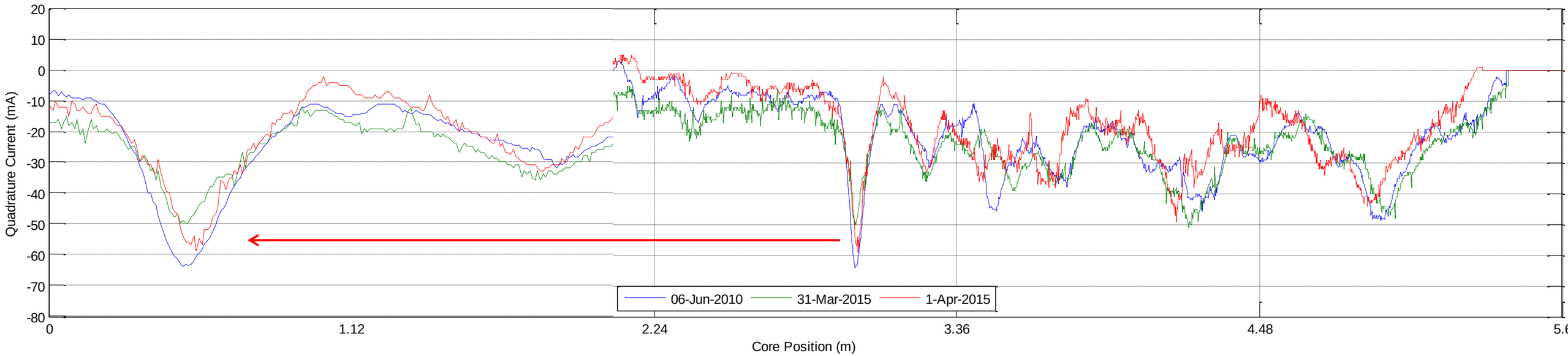


- Provide to 3rd party for analysis/opinion

Benefits of digital trending

- Rated Flux Testing Avoidance
  - Trending can be elected in favor of doing repeated loop tests
  - More frequent ELCID tests can be evaluated quickly

- Better quantification on how much things are changing

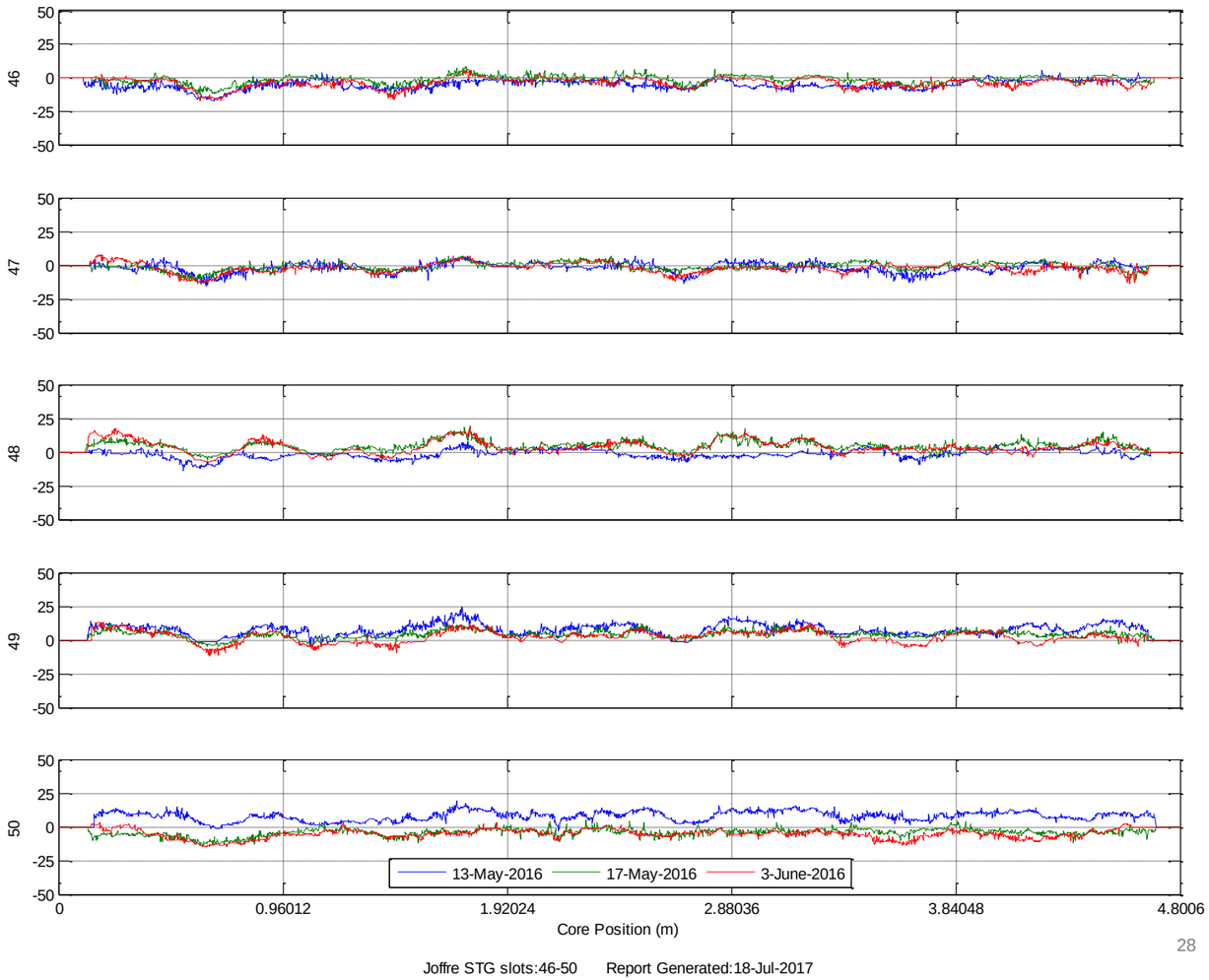


XBR-5 slot:32 Report Generated:18-Jul-2017

Benefits of digital trending

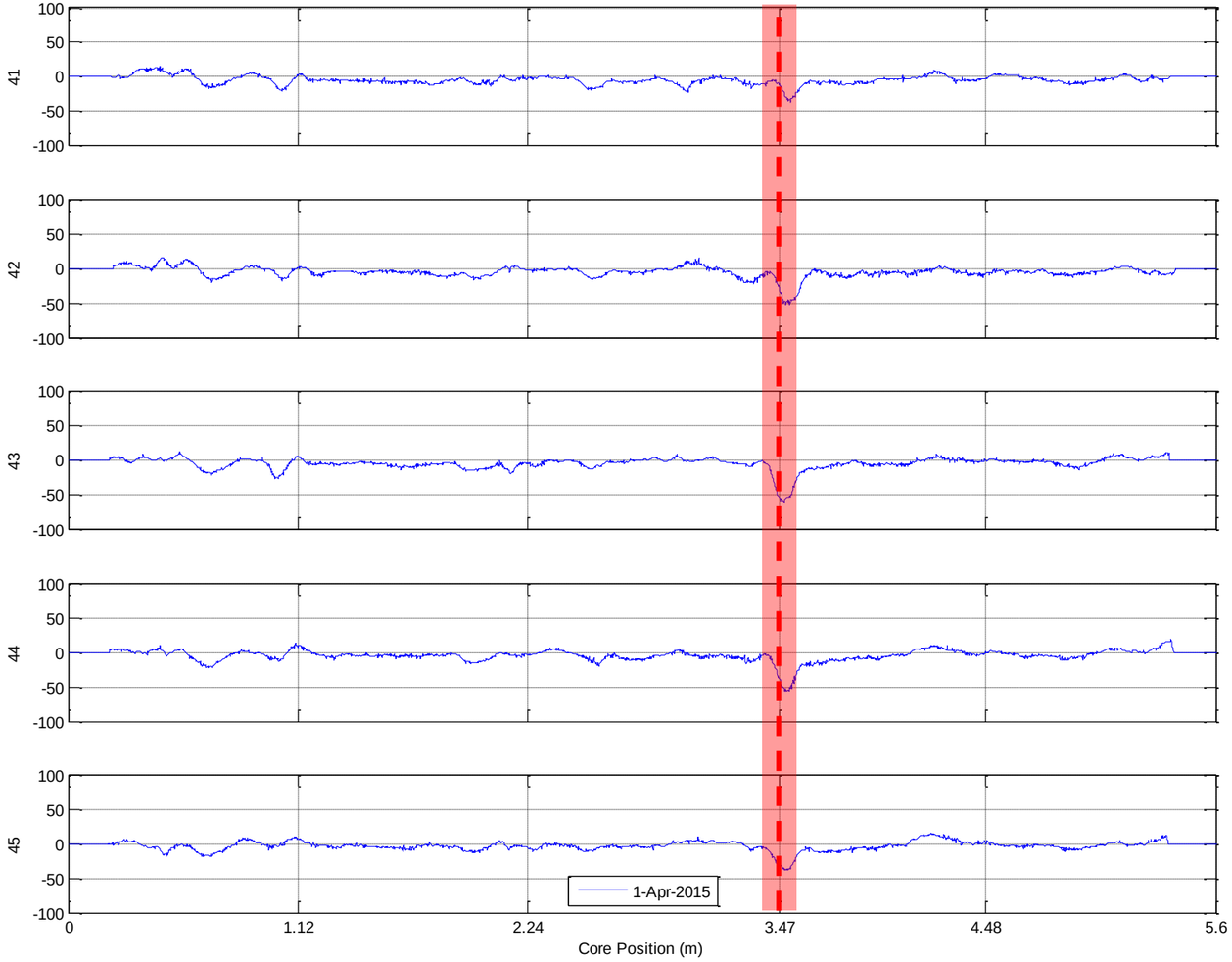
- Reporting enhancements
  - All tests are in one place, and in one report
  - Compatible with robotic insp.
  - Can evaluate entire history every maintenance outage

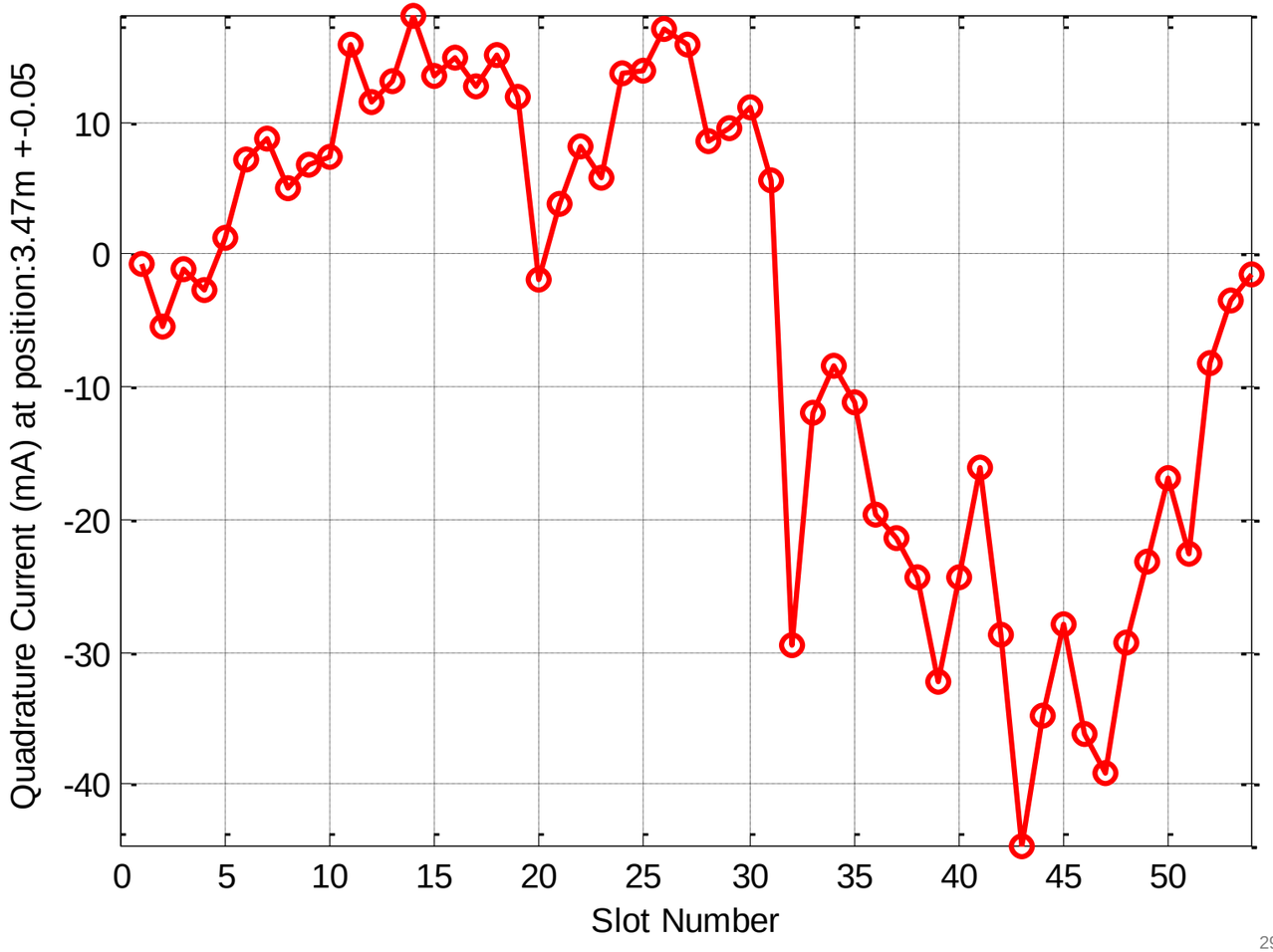
But you can't do any of this without the digital file!



Benefits of digital trending

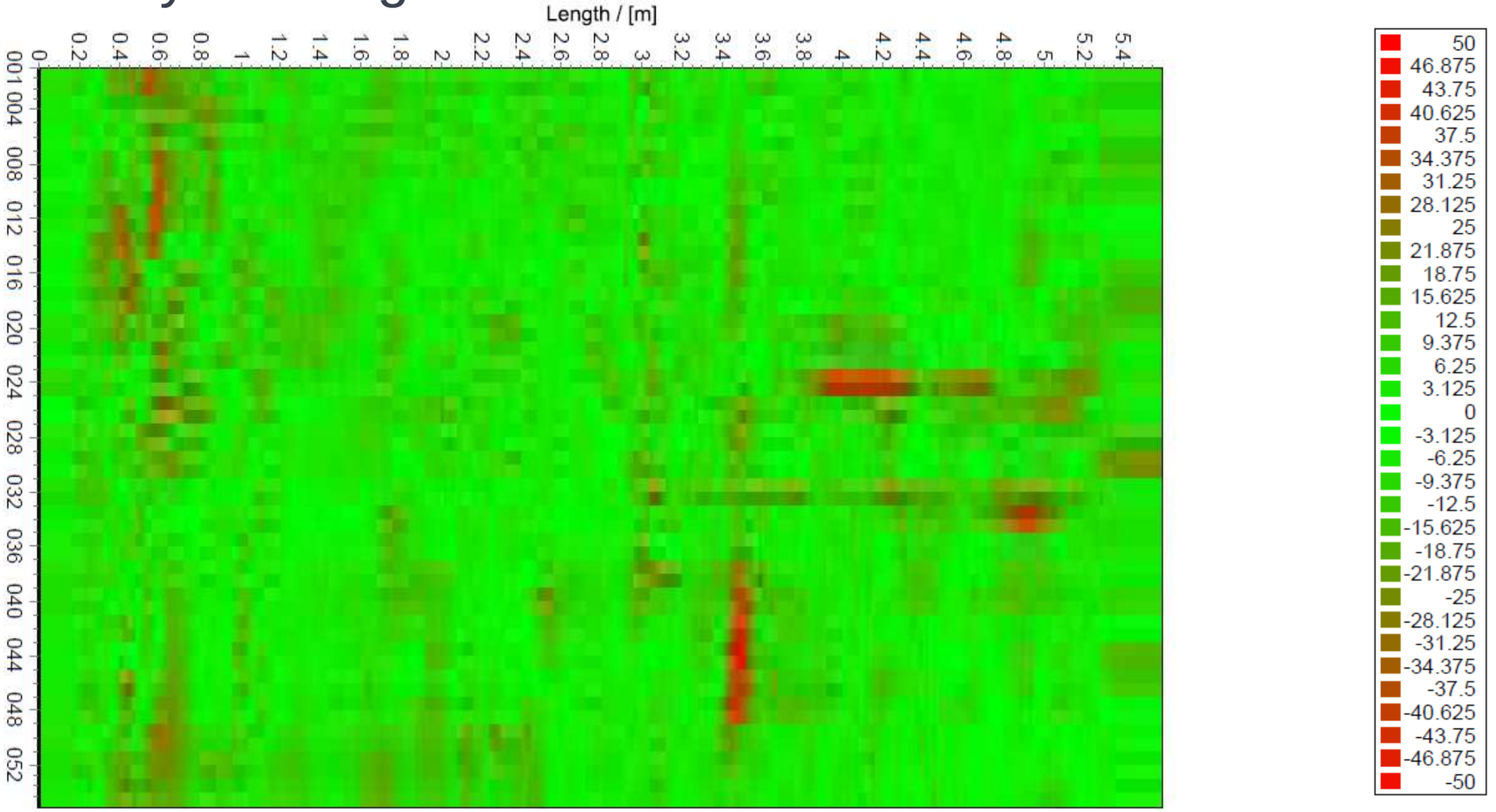
- Advanced Diagnostics
  - The sky is the limit!





Benefits of digital trending

- Advanced Diagnostics
  - What you can get from the software



Benefits of digital trending

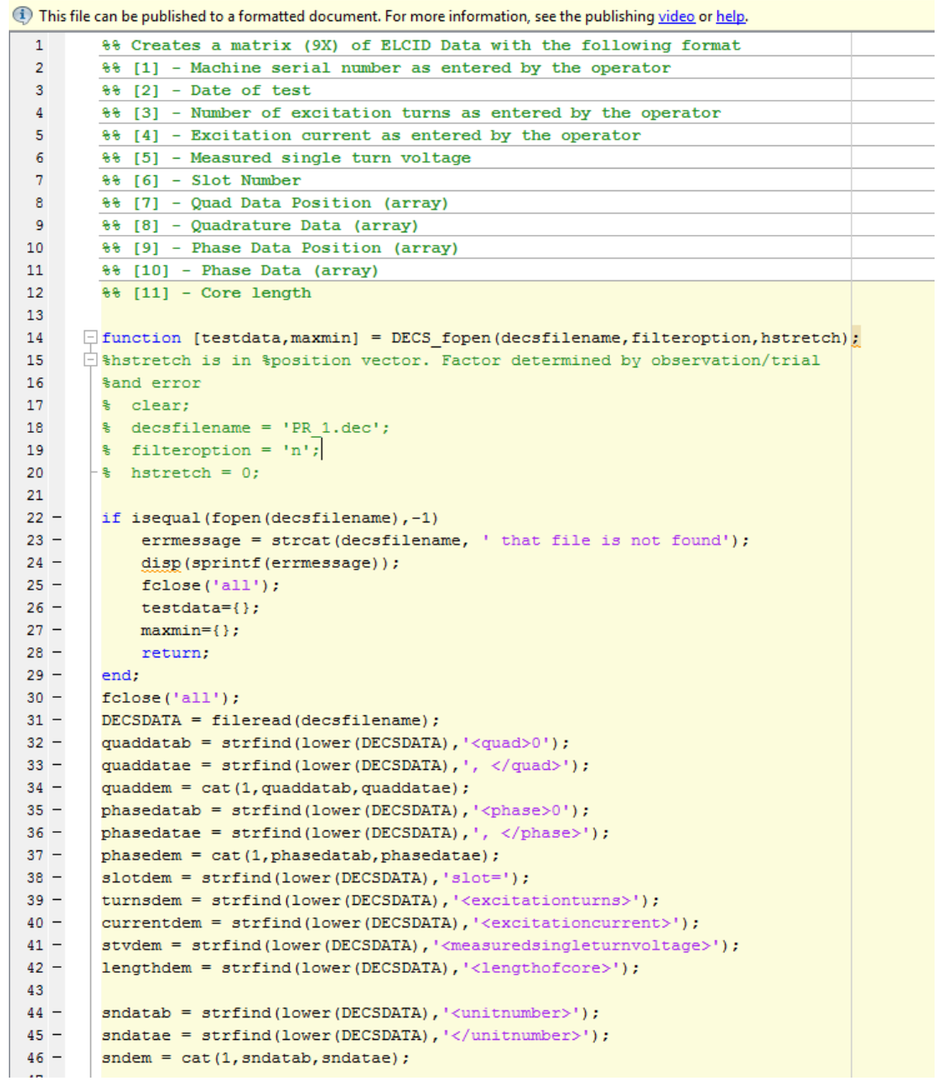
- Advanced Diagnostics

Benefits of digital trending

- Advanced Diagnostics

How ATCO does trending

- MATLAB (r2012, but any will do)
  - Easy programming language
  - Custom reporting
  - Extremely flexible
  - Built in tools for matrix manipulation
  - Handles large datasets easily
- Started to do evaluation after every test
- Could import hard copy to same format
  - Limited resolution
  - Very time consuming
  - Haven’t done this on a whole machine… yet



This file can be published to a formatted document. For more information, see the publishing video or help.

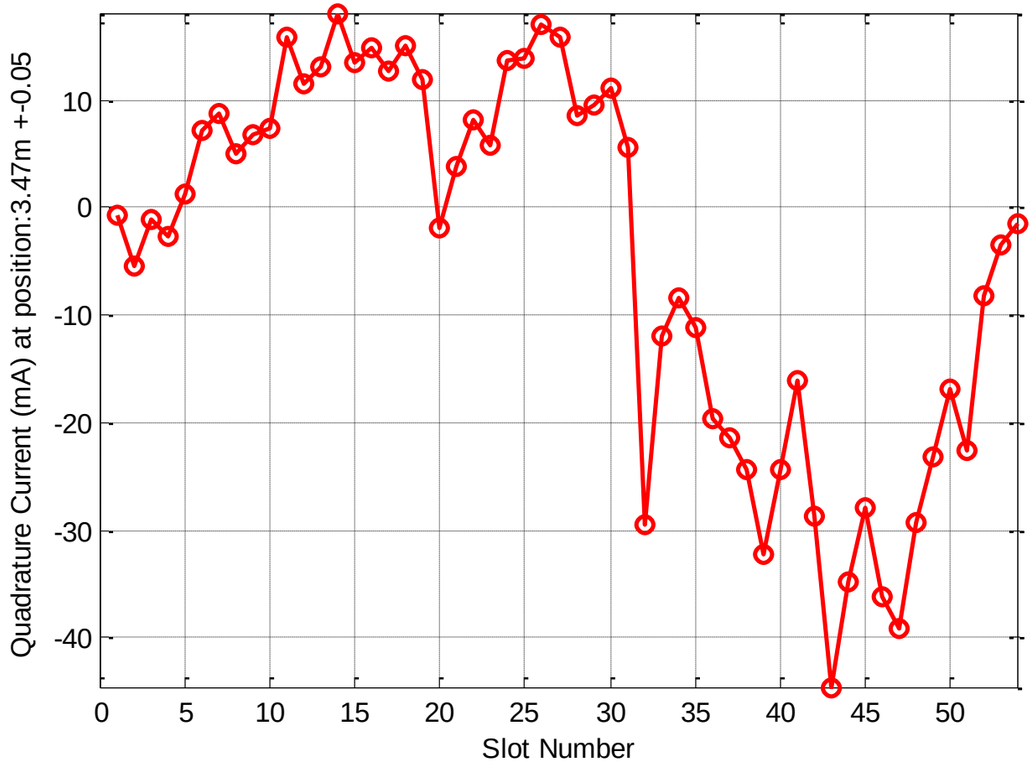
```
%% Creates a matrix (9X) of ELCID Data with the following format
%% [1] - Machine serial number as entered by the operator
%% [2] - Date of test
%% [3] - Number of excitation turns as entered by the operator
%% [4] - Excitation current as entered by the operator
%% [5] - Measured single turn voltage
%% [6] - Slot Number
%% [7] - Quad Data Position (array)
%% [8] - Quadrature Data (array)
%% [9] - Phase Data Position (array)
%% [10] - Phase Data (array)
%% [11] - Core length

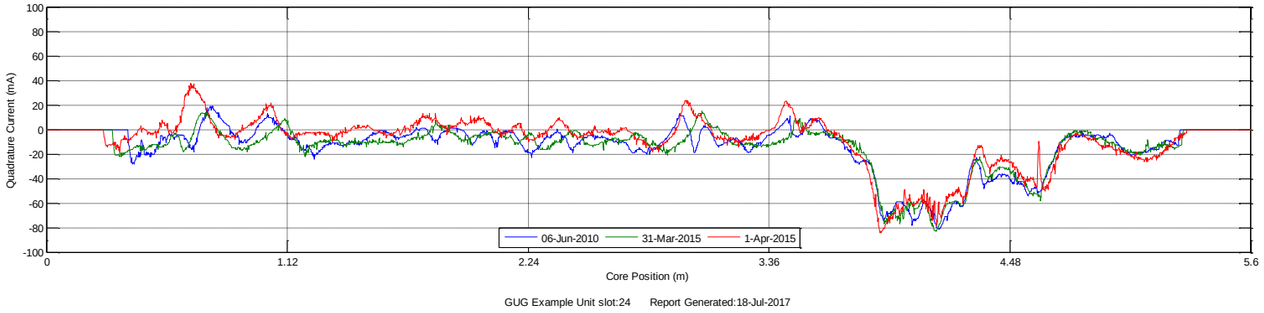
function [testdata,maxmin] = DECS_fopen(decsfilename,filteroption,hstretch);
%hstretch is in %position vector. Factor determined by observation/trial
%and error
%  clear;
%  decsfilename = 'PR_1.dec';
%  filteroption = 'n';
%  hstretch = 0;

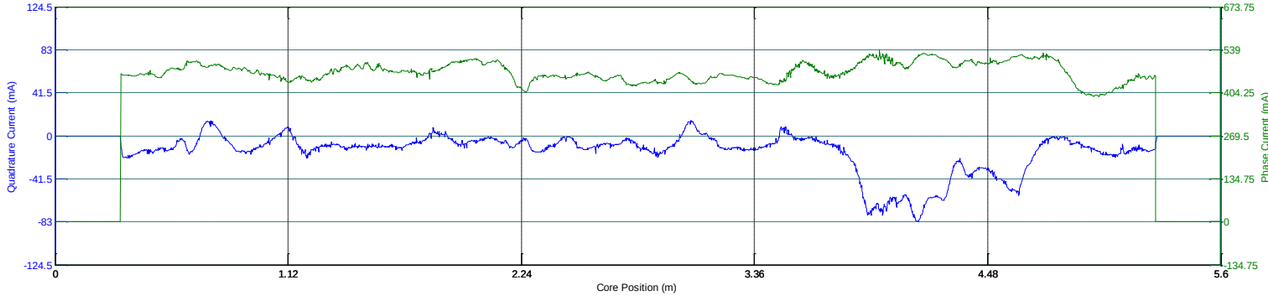
if isequal(fopen(decsfilename),-1)
    errmessage = strcat(decsfilename, ' that file is not found');
    disp(sprintf(errmessage));
    fclose('all');
    testdata={};
    maxmin={};
    return;
end;
fclose('all');
DECSDATA = fileread(decsfilename);
quaddatab = strfind(lower(DECSDATA),'<quad>0');
quaddatae = strfind(lower(DECSDATA),', </quad>');
quaddem = cat(1,quaddatab,quaddatae);
phasedatab = strfind(lower(DECSDATA),'<phase>0');
phasedatae = strfind(lower(DECSDATA),', </phase>');
phasedem = cat(1,phasedatab,phasedatae);
slotdem = strfind(lower(DECSDATA),'slot=');
turnsdem = strfind(lower(DECSDATA),'<excitationturns>');
currentdem = strfind(lower(DECSDATA),'<excitationcurrent>');
stvdem = strfind(lower(DECSDATA),'<measuredsingleturnvoltage>');
lengthdem = strfind(lower(DECSDATA),'<lengthofcore>');

sndatab = strfind(lower(DECSDATA),'<unitnumber>');
sndatae = strfind(lower(DECSDATA),'</unitnumber>');
sndem = cat(1,sndatab,sndatae);
```

Questions?


Quadrature Current (mA) at position:3.47m +-0.05
10
0
-10
-20
-30
-40
0
5
10
15
20
25
30
35
40
45
50
Slot Number


Quadrature Current (mA)
100
80
60
40
20
0
-20
-40
-60
-80
-100
0
1.12
2.24
3.36
4.48
5.6
Core Position (m)
06-Jun-2010
31-Mar-2015
1-Apr-2015
GUG Example Unit slot:24
Report Generated:18-Jul-2017


Quadrature Current (mA)
124.5
83
41.5
0
-41.5
-83
-124.5
Phase Current (mA)
673.75
539
404.25
269.5
134.75
0
-134.75
0
1.12
2.24
3.36
4.48
5.6
Core Position (m)