

Status of the DWA* operation

* Digital Wire Analyzer

Roxanne Guenette for the DWA team

(Anyssa Navrer-Agasson, Josh Grocott, Shion Kubota, Nick Lane, Graham Miller, Guilherme Ruiz, Chris Stanford, John Waiton)

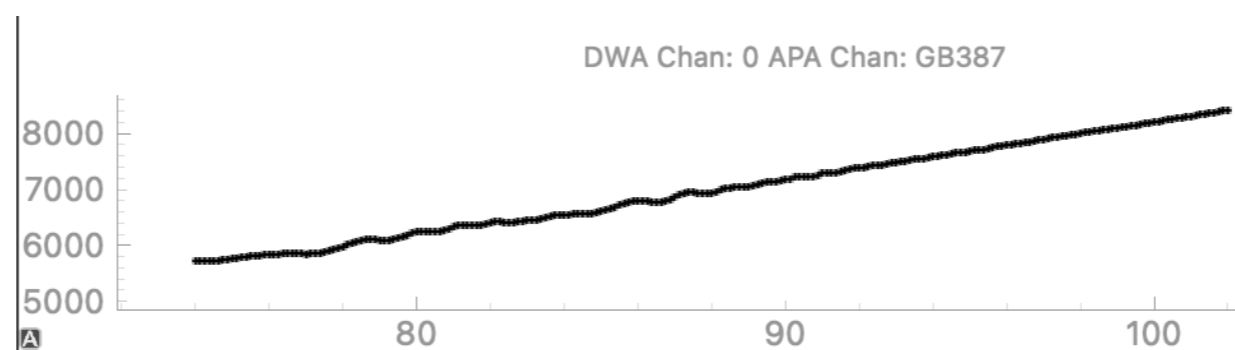
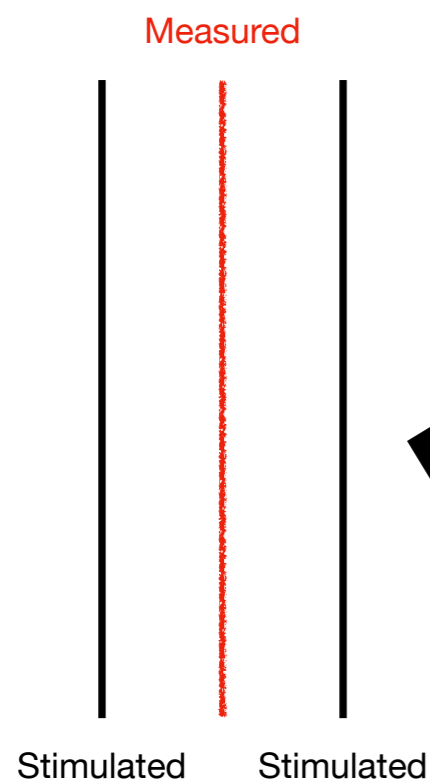
DUNE UK Meeting
11-12 January 2023

MANCHESTER
1824

Intro and reference

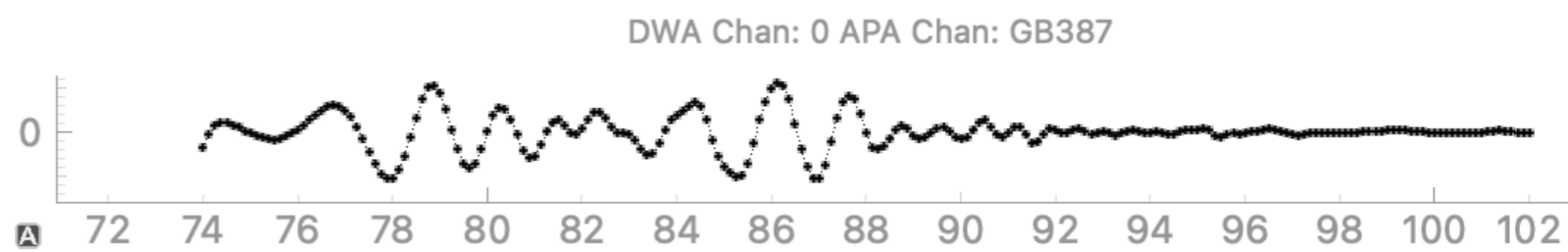
- For more details on DWA see Anyssa's talk at previous CM (https://indico.fnal.gov/event/53964/contributions/250684/attachments/159769/210119/dwa_cern_dune_cm_sep2022.pdf)

Tension is extracted by measuring the fundamental frequency of the wire



2. Read out middle wire while sweeping frequency of AC current

3. Smooth and subtract the baseline



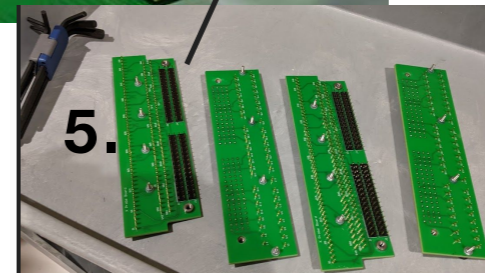
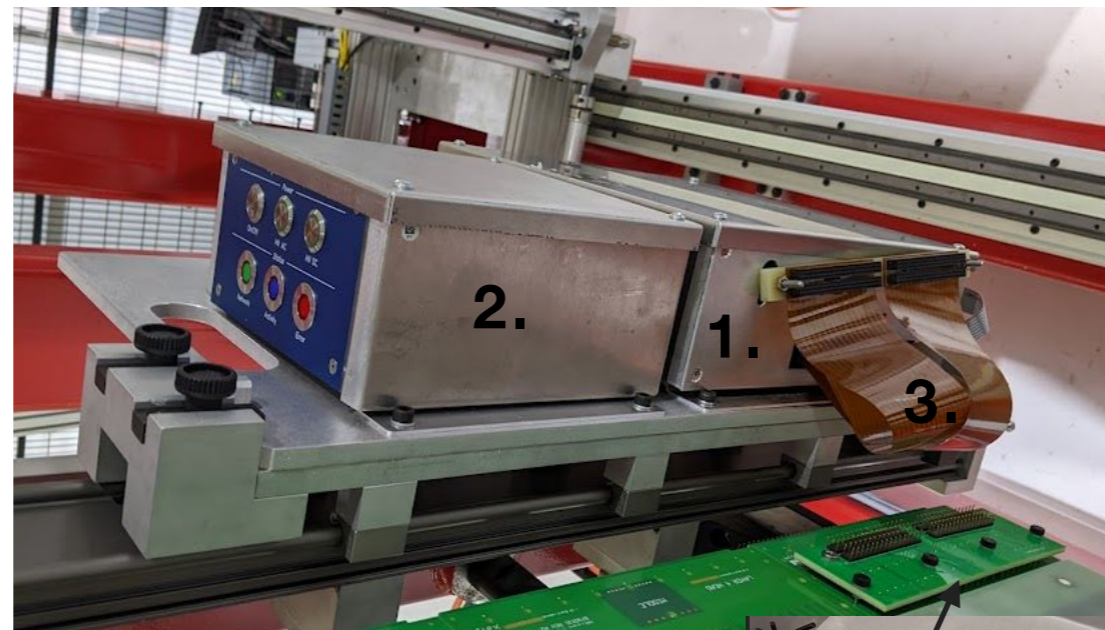
- The two neighbouring wires are stimulated with a mix of AC and DC current.

From Anyssa's talk at previous CM

DWA Hardware

Parts:

1. DWA box
2. Power distribution box
3. Flex cable
4. Laptop
5. Probe boards
6. Support rail



DWA #	Location	Status
1	CERN	Damaged flex cable (replacement being sent)
2	Daresbury	Functional
3	Fermilab	Functional
4	Daresbury	Functional
5	Fermilab	Functional

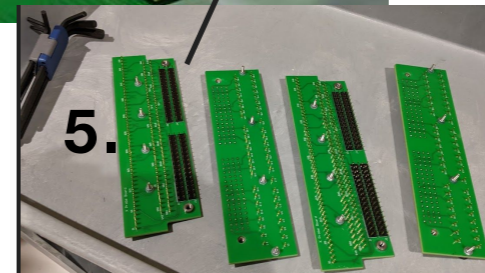
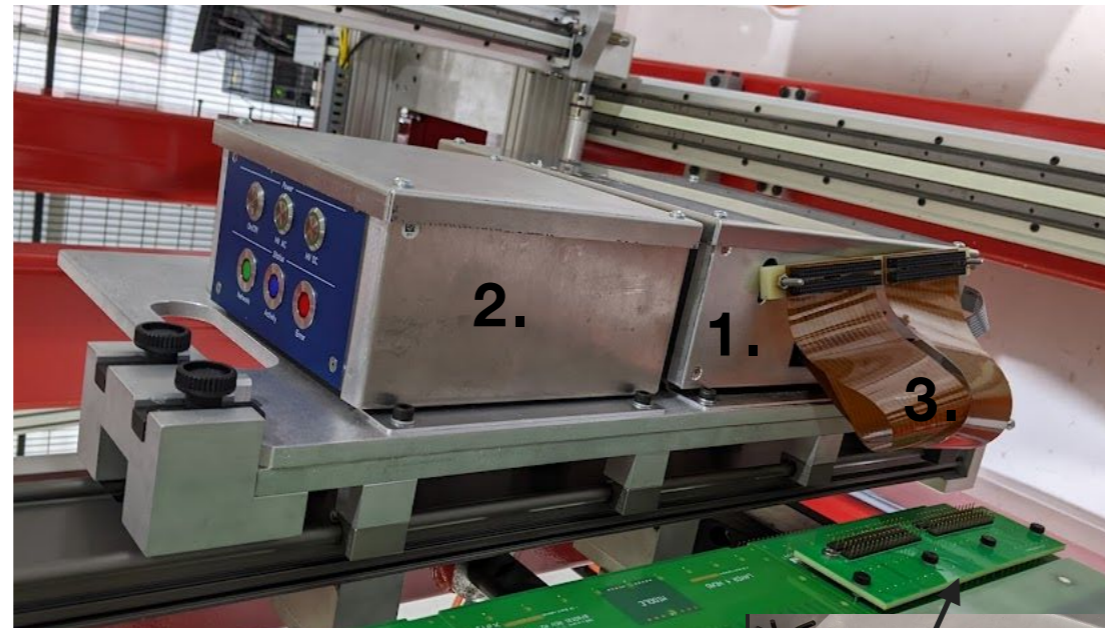
Power Supply #	Location	Status
1	CERN	Functional
2	Daresbury	Functional
3	Daresbury	Being repaired
4	Daresbury	Functional
5	Fermilab	Functional

Probe Boards	X	G	ProtoDUNE
Daresbury	90	25	
CERN	25	25	
Fermilab	50	50	5

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3 new DWAs (+ spare parts) under construction!

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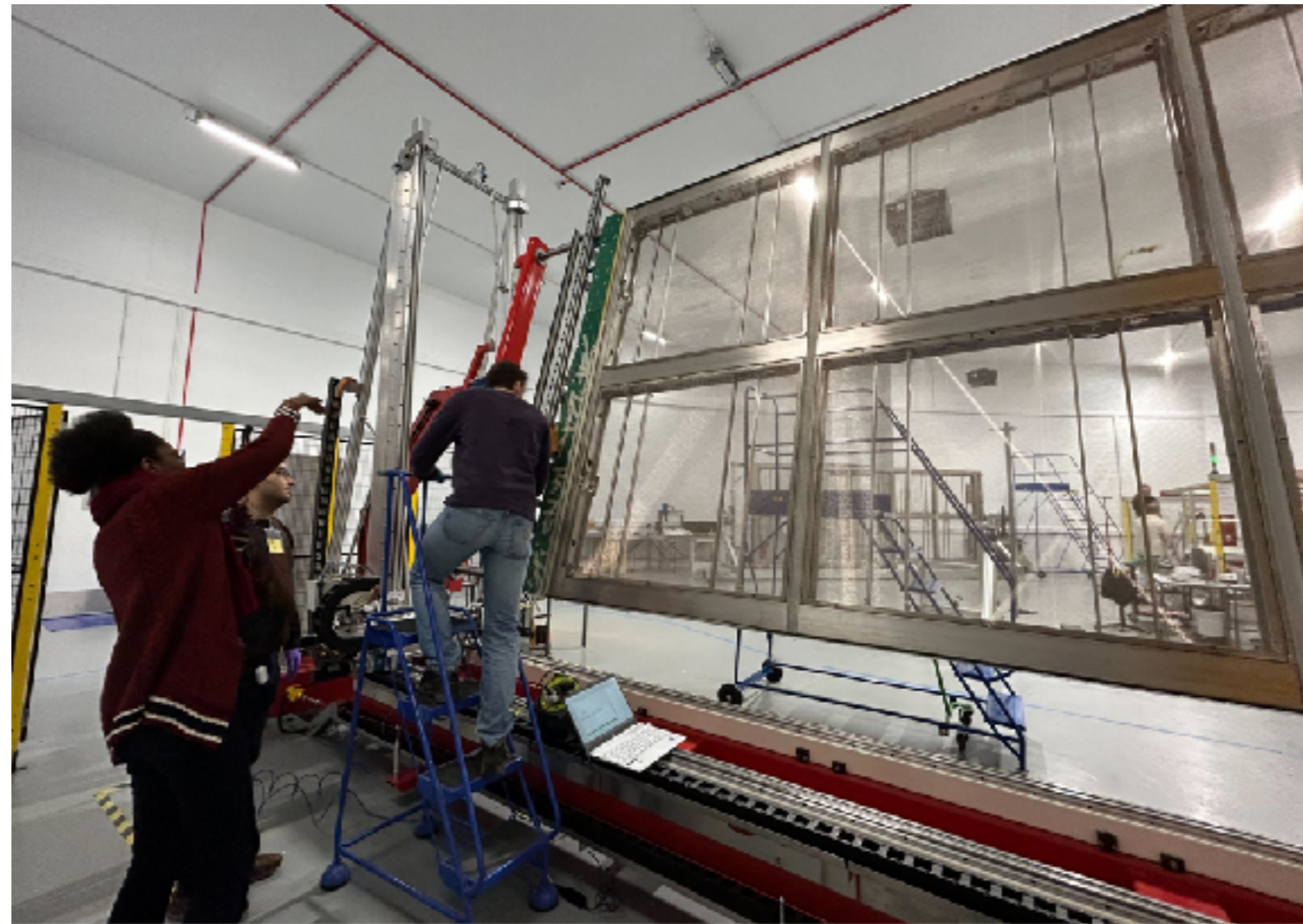
Recent updates

- Two fully functional DWAs at Daresbury
- Two postdocs and four PhD students trained to perform tension measurements
- Always two people on standby to travel to Daresbury to make tension measurements (when a layer is done)
- Several days of DWA measurements for testing and training at Daresbury in November and December
- Got some upgrades to the software to improve the *user-friendliness*



Recent updates

- At Daresbury:
 - ➔ APA #4: Tensions for X, V: waiting for U
 - ➔ APA #5: waiting for U
 - ➔ APA #6: Waiting for U



DWA operation

- User manual (<https://edms.cern.ch/ui/#!/master/navigator/document?P:100788027:101054576:subDocs>)
- Probe boards installation (before APA is placed in winder!)
- Measure X, V, U layers (separately or at once)
- Install probe boards and measure G layer
- Measurement time:
 - G: 50min
 - X, U, V together: 200min

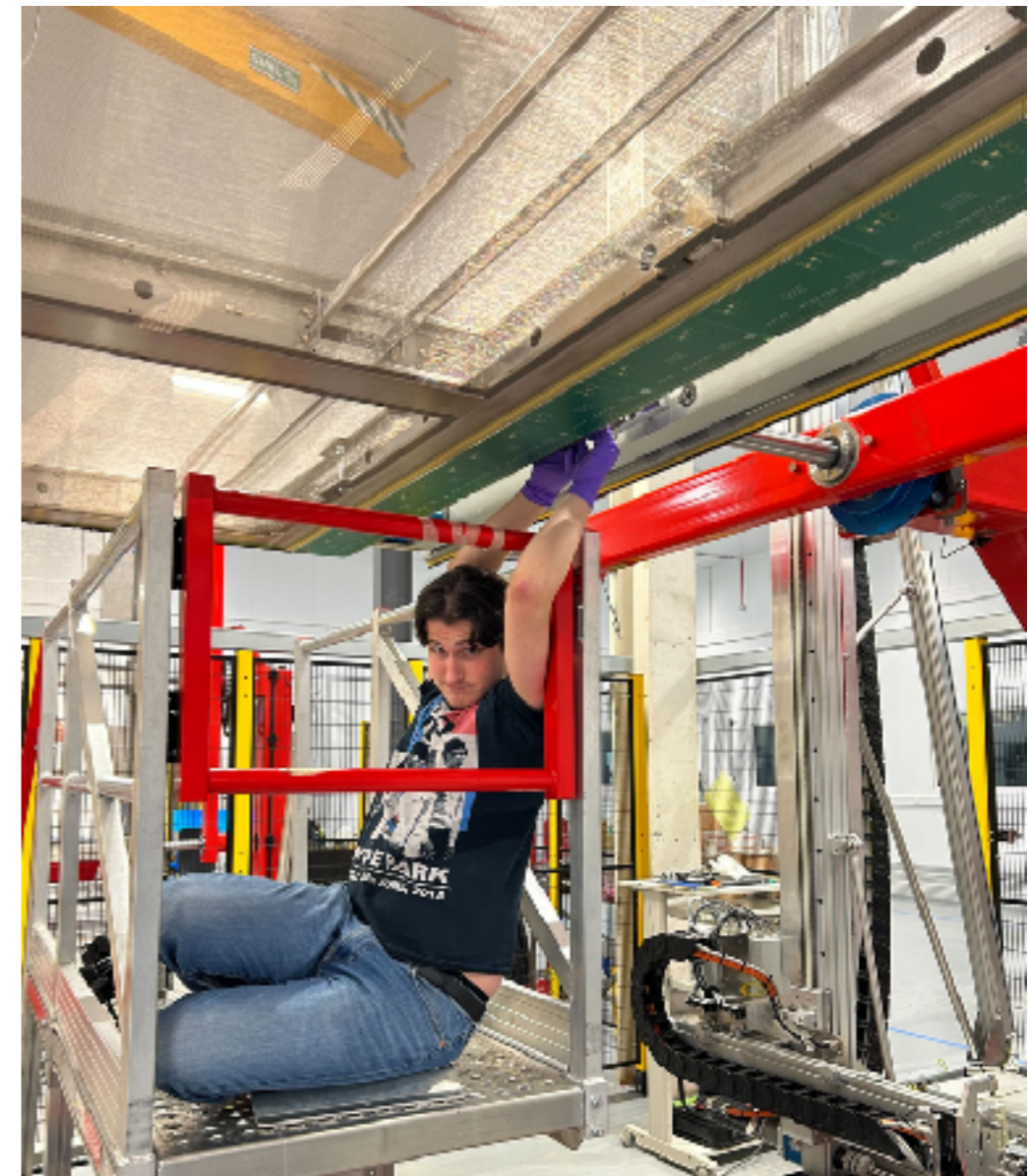
Both sides



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Both sides



Need ~1h after each layer to measure tension

Live operation and tension data analysis

- Many new improvements to the software
- Visual indication when scan had issues (user can retake immediately the scan)

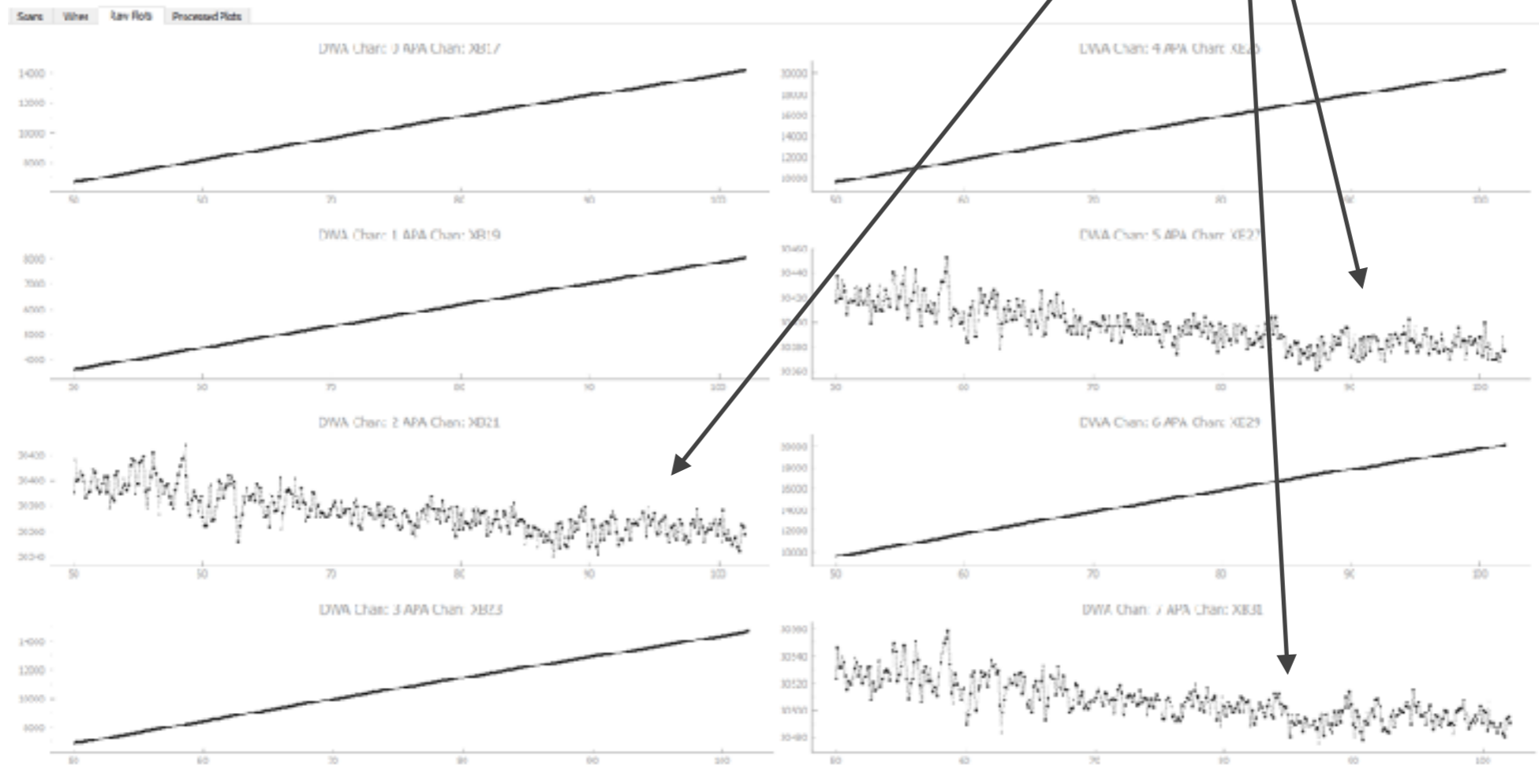
The screenshot displays the DWA: Digital Wire Analyzer software interface. The main window is titled "DWA: Digital Wire Analyzer" and shows a configuration screen. The interface includes a sidebar on the left with "DWA Info" (Not Connected), "Run Status", and "Scan frequencies". The main area contains a "Measured By" field (Chris Stanford), a "Stage" dropdown (DWA Development), a "Layer" dropdown (XV), a "Grid" dropdown (A), a "Flex Direction" dropdown (Away from APA), and a "Headboard" dropdown. There are checkboxes for "Type" (Continuity and Tension) and a "Configure Scan List" button. A red error message "DWA is not connected" is visible. Below the configuration options is a table of scan results.

Type	Layer	Status	Wires	Freq Min (Hz)	Freq Max (Hz)	Step Size (Hz)
14	Tension	Pending	[1, 3, 5, 7, 9, 11, 13, 15, 40, 403, 405, 407, 409, 411, 413, 415, 801, 803, 805, 807, 809, 811, 813, 815]	50	414	0.25
15	Continuity	Pending	[2, 4, 6, 8, 10, 12, 14, 16, 402, 404, 406, 408, 410, 412, 414, 416, 802, 804, 806, 808, 810, 812, 814, 816]	100	1000	50
16	Tension	Pending	[2, 4, 6, 8, 10, 12, 14, 16, 402, 404, 406, 408, 410, 412, 414, 416, 802, 804, 806, 808, 810, 812, 814, 816]	50	401	0.25
17	Continuity	Pending	[17, 19, 21, 23, 25, 27, 29, 31, 417, 419, 421, 423, 425, 427, 429, 431, 817, 819, 821, 823, 825, 827, 829, 831]	100	1000	50
18	Tension	Pending	[17, 19, 21, 23, 25, 27, 29, 31, 417, 419, 421, 423, 425, 427, 429, 431, 817, 819, 821, 823, 825, 827, 829, 831]	50	168	0.25
19	Continuity	Pending	[18, 20, 22, 24, 26, 28, 30, 32, 413, 415, 417, 419, 421, 423, 425, 427, 429, 431, 433, 815, 817, 819, 821, 823, 825, 827, 829, 831]	100	1000	50
20	Tension	Pending	[18, 20, 22, 24, 26, 28, 30, 32, 413, 415, 417, 419, 421, 423, 425, 427, 429, 431, 433, 815, 817, 819, 821, 823, 825, 827, 829, 831]	50	169	0.25
21	Continuity	Pending	[33, 35, 37, 39, 41, 43, 45, 47, 49, 833, 835, 837, 839, 841, 843]	100	1000	50
22	Tension	Pending	[33, 35, 37, 39, 41, 43, 45, 47, 49, 833, 835, 837, 839, 841, 843]	50	419	0.25
23	Continuity	Pending	[34, 36, 38, 40, 42, 44, 46, 48, 448, 834, 836, 838, 840]	100	1000	50
...	Tension	Pending	[34, 36, 38, 40, 42, 44, 46, 48, 448, 834, 836, 838, 840]	50	406	0.25

At the bottom of the interface, there are status indicators: "erorbits" (N/A), "battenStatus" (N/A), and "Head boards" (N/A). A legend on the right side of the interface identifies "Comb" (black line), "Wire side A" (red line), and "Wire side B" (blue line).

Live operation and tension data analysis

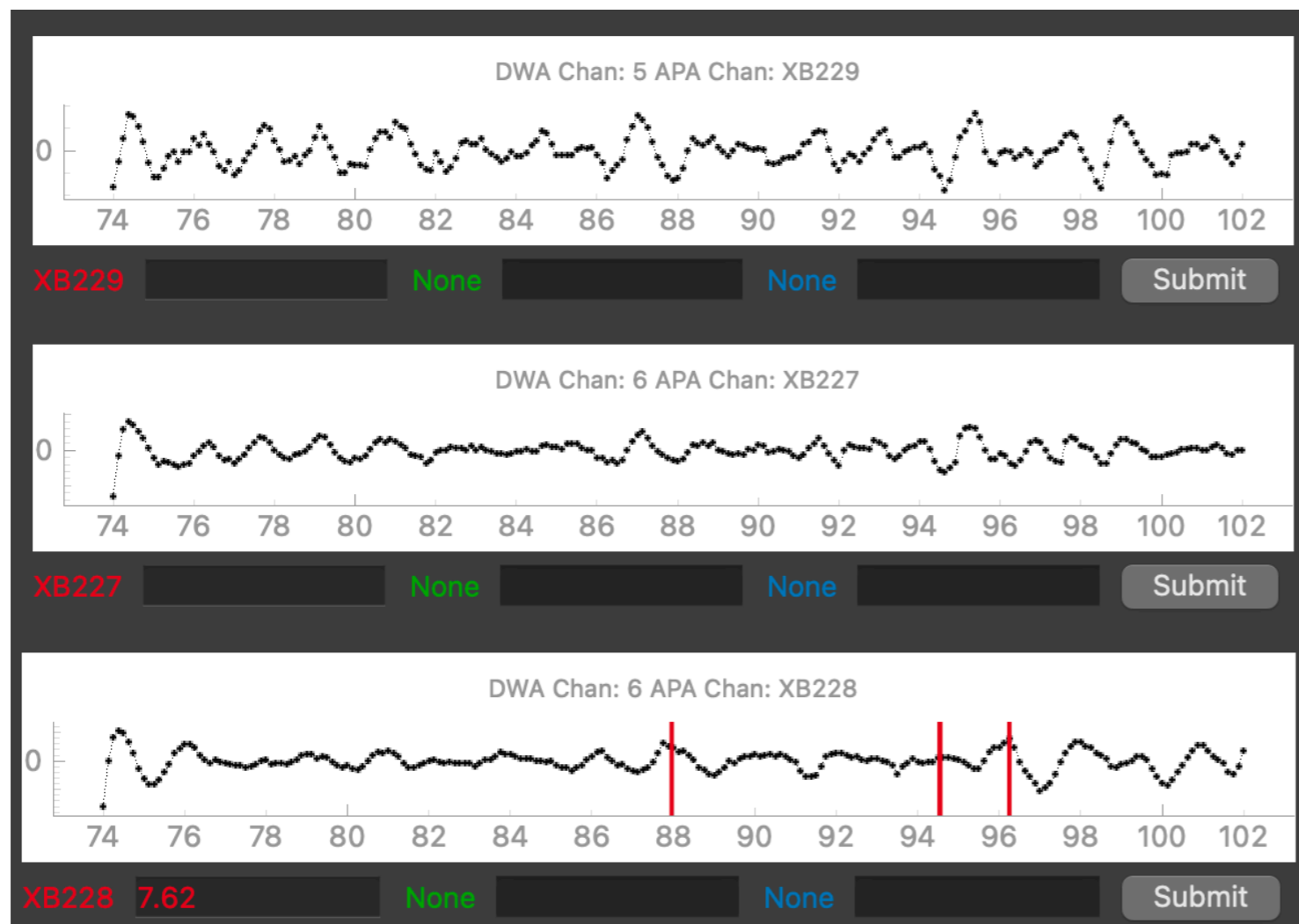
- Many new improvements to the software
 - Visual indication when scan had issues (user can retake immediately the scan)
 - Broken wires (when shorting others) very easy to spot



These will be flagged automatically to the user

Live operation and tension data analysis

- Many new improvements to the software
 - Visual indication when scan had issues (user can retake immediately the scan)
 - Broken wires (when shorting others) very easy to spot
 - Missing wires are harder to identify for sure (requires to combine to a visual inspection during winding)

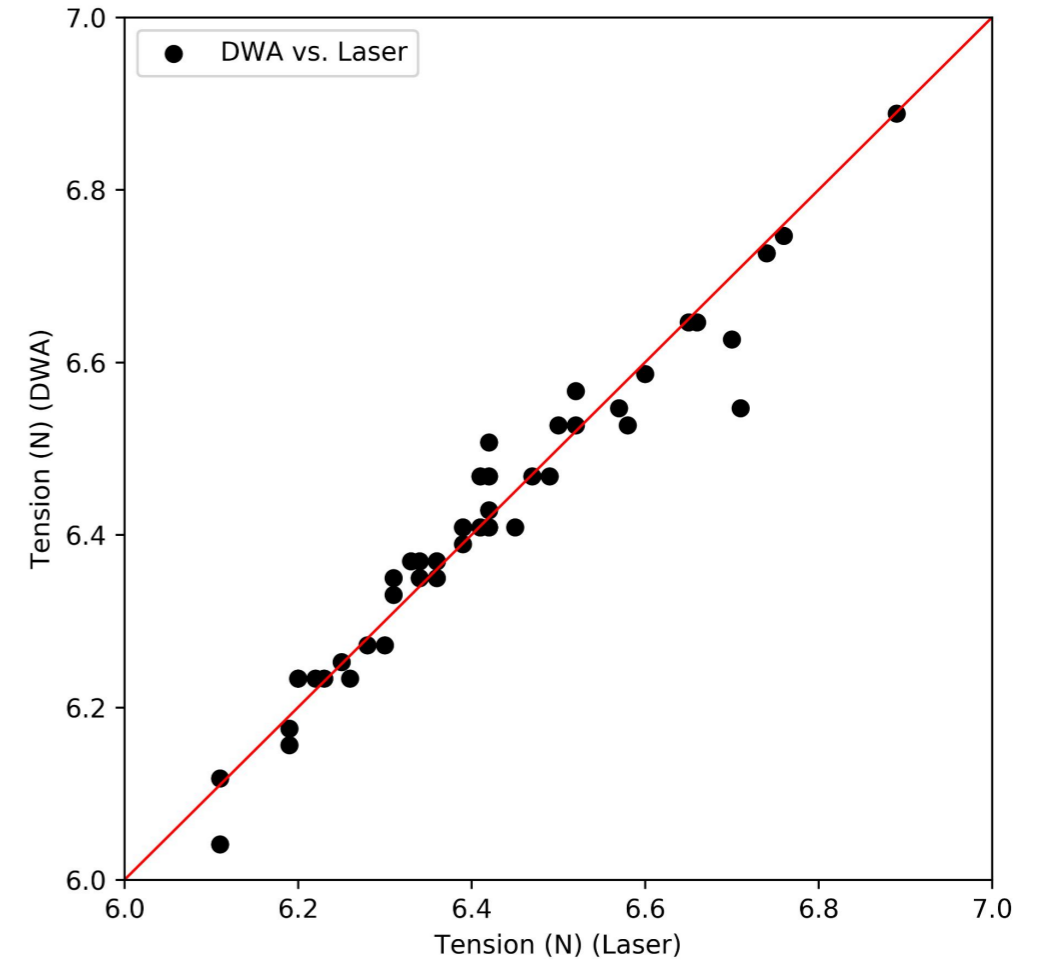
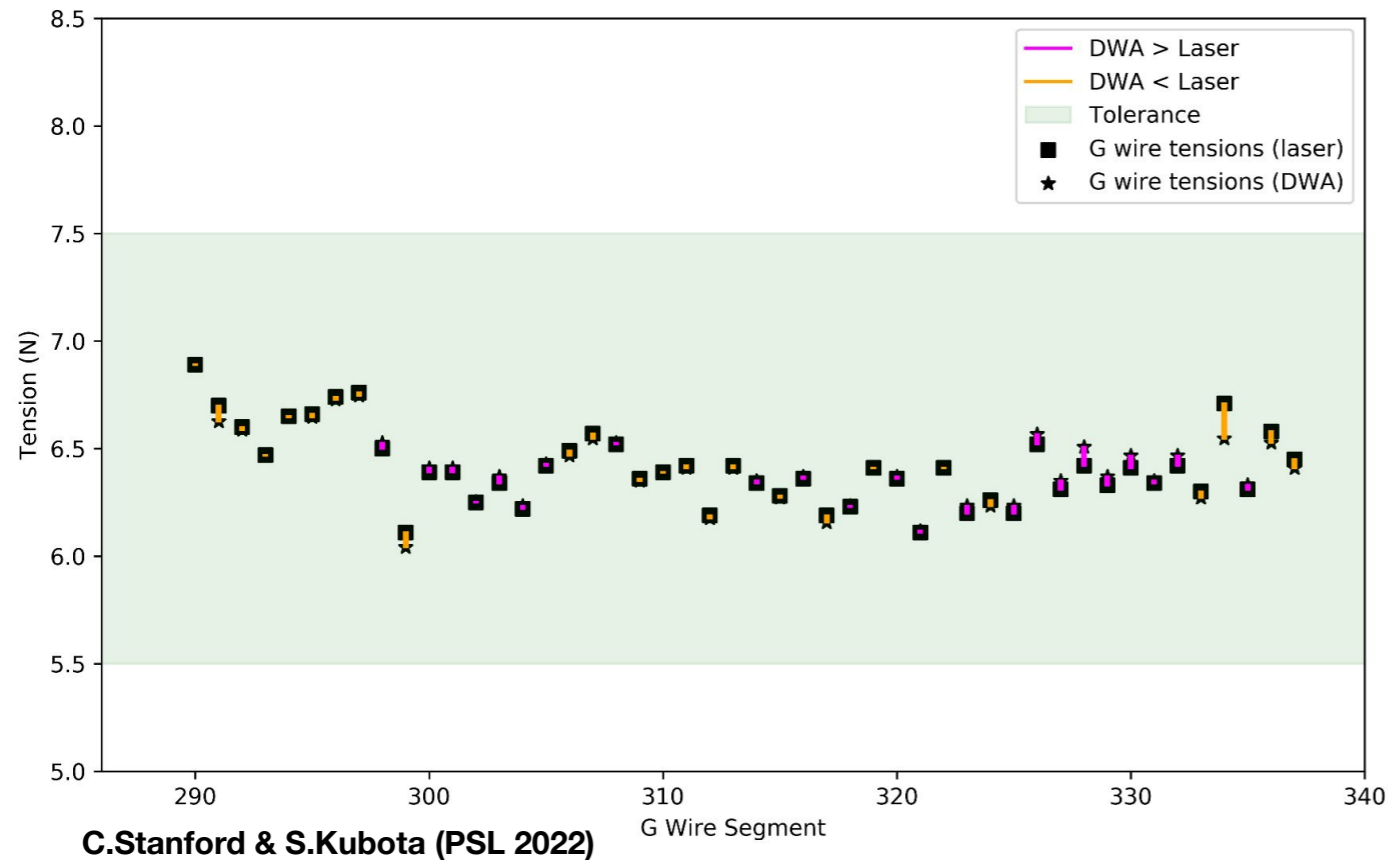


Easy to address live

Need to understand how many times the algorithm is failing this

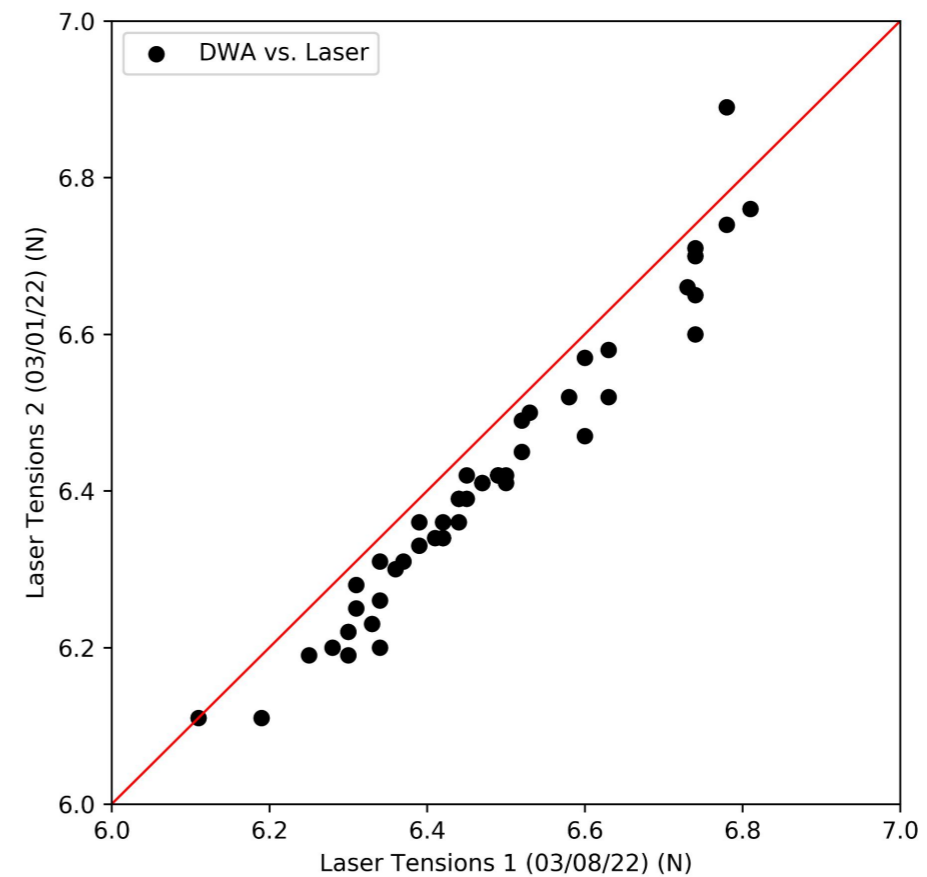
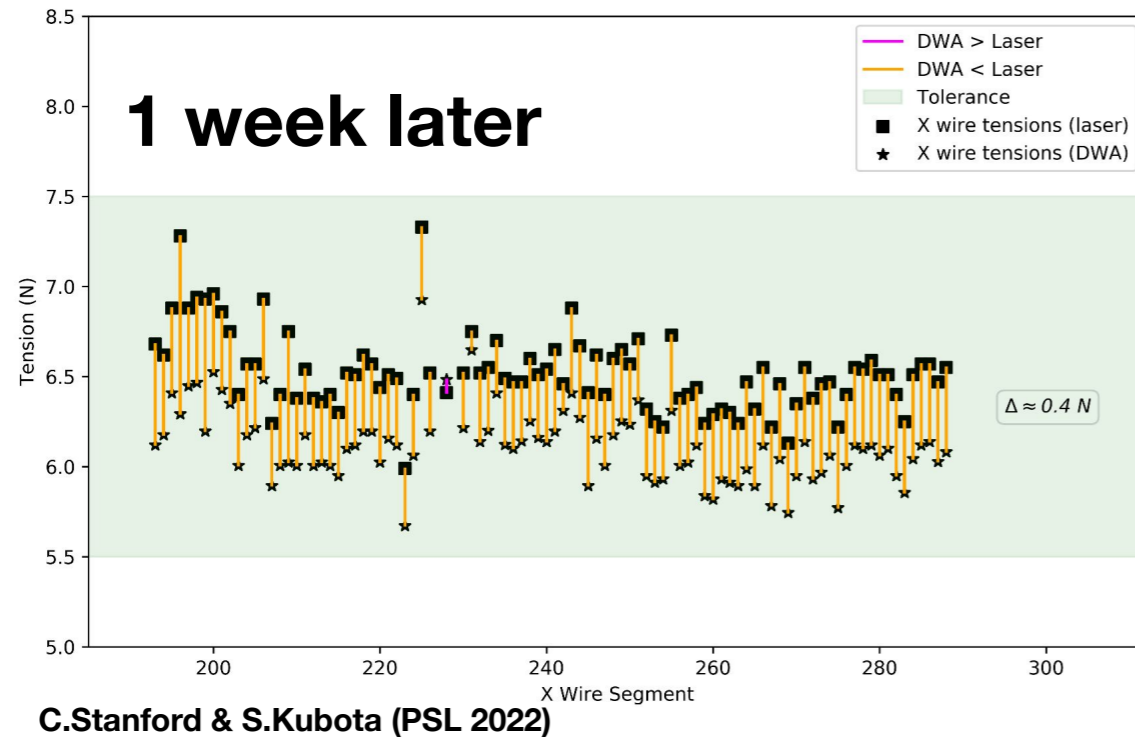
Offline tension analysis

- Calibration is not an issue



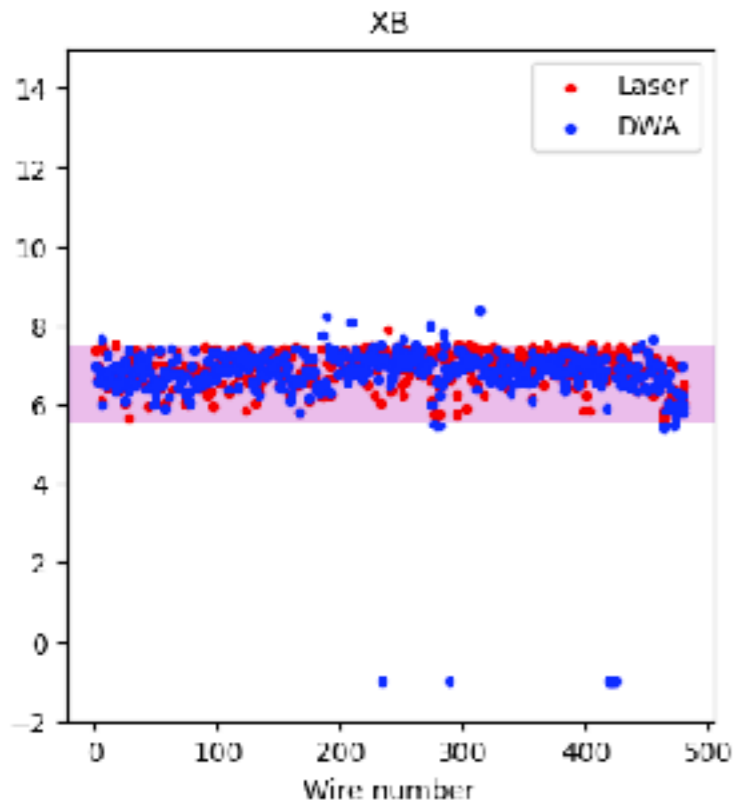
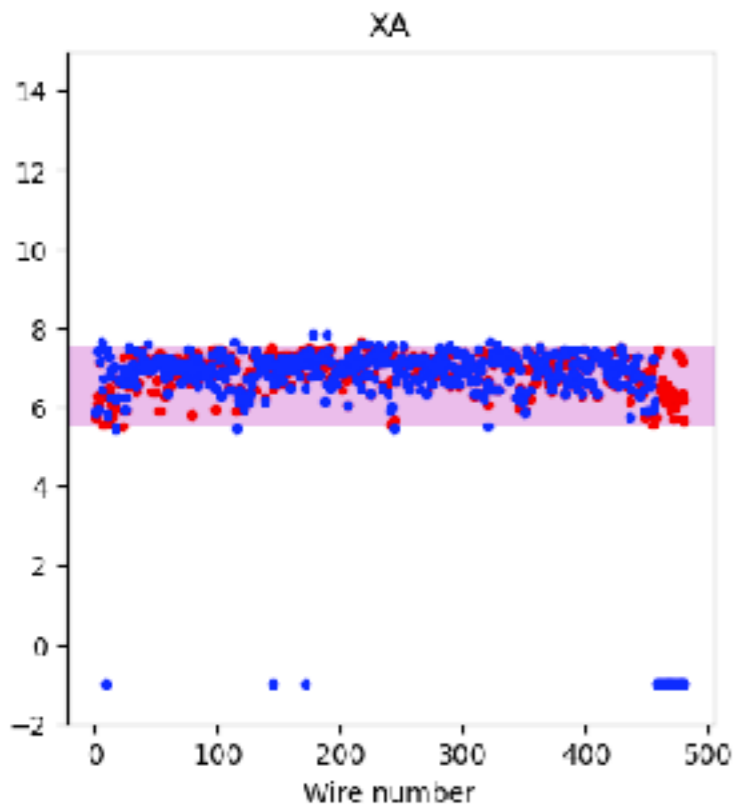
Offline tension analysis

- Calibration is not an issue
- Note that the tension of a layer changes (slightly $\approx 0.5\text{N}$) over time (even days)

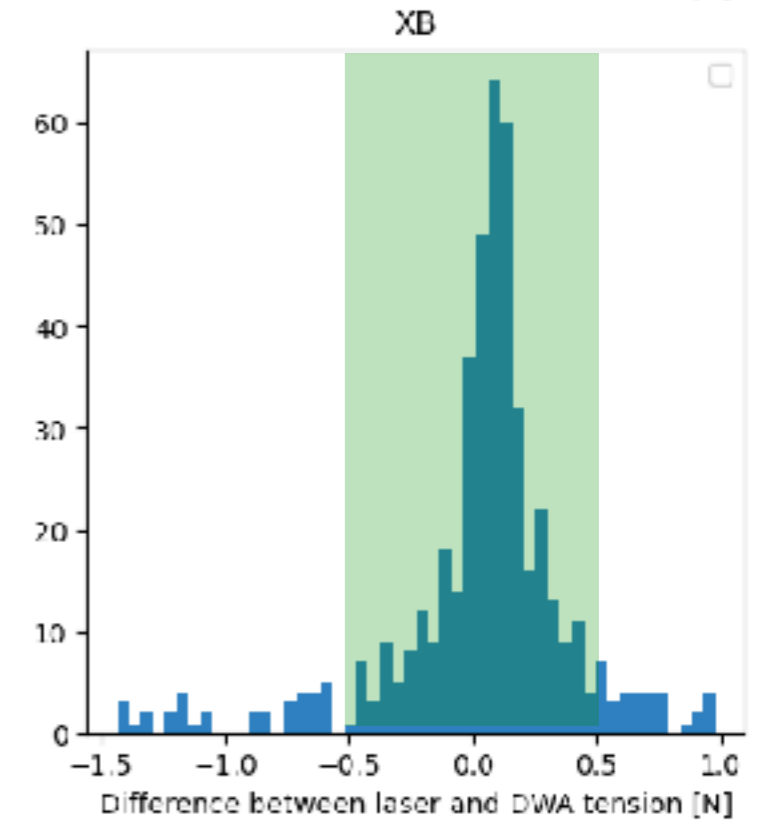
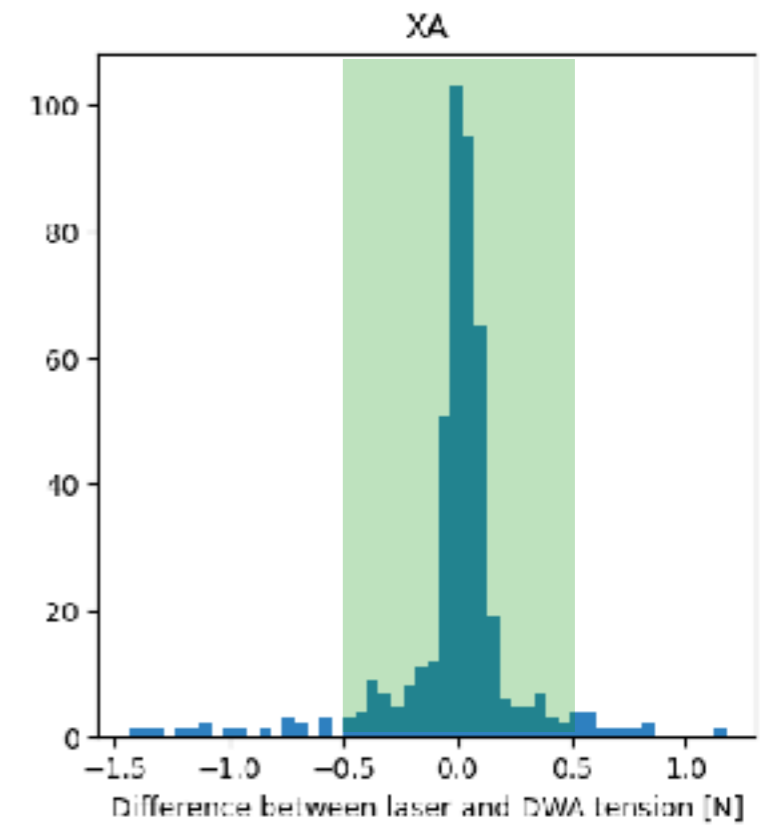


Offline tension analysis

- Recent Daresbury analysis on APA #4 (X layer)

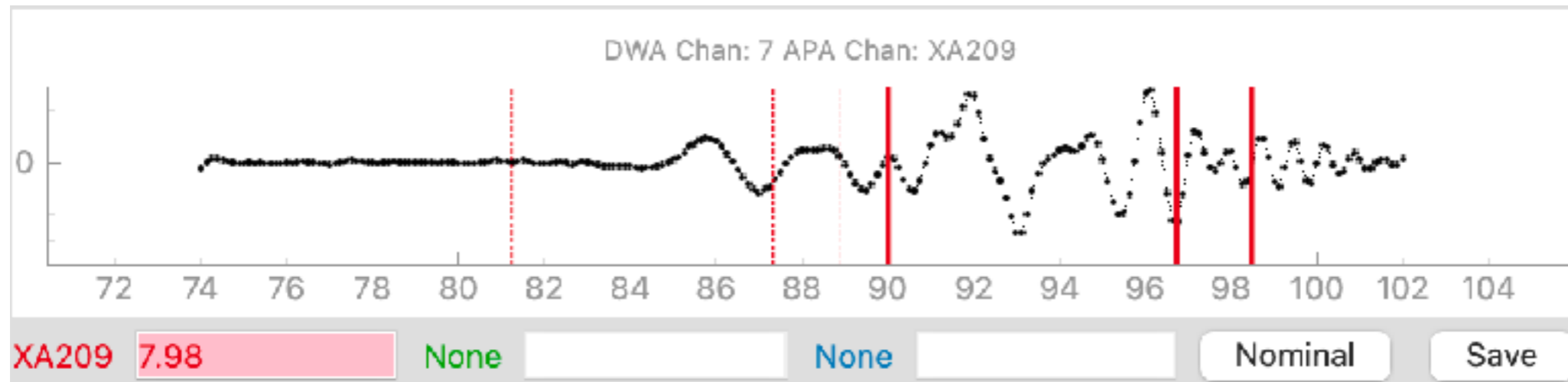


**Quite straightforward for X, G layers
(Vertical wires)**

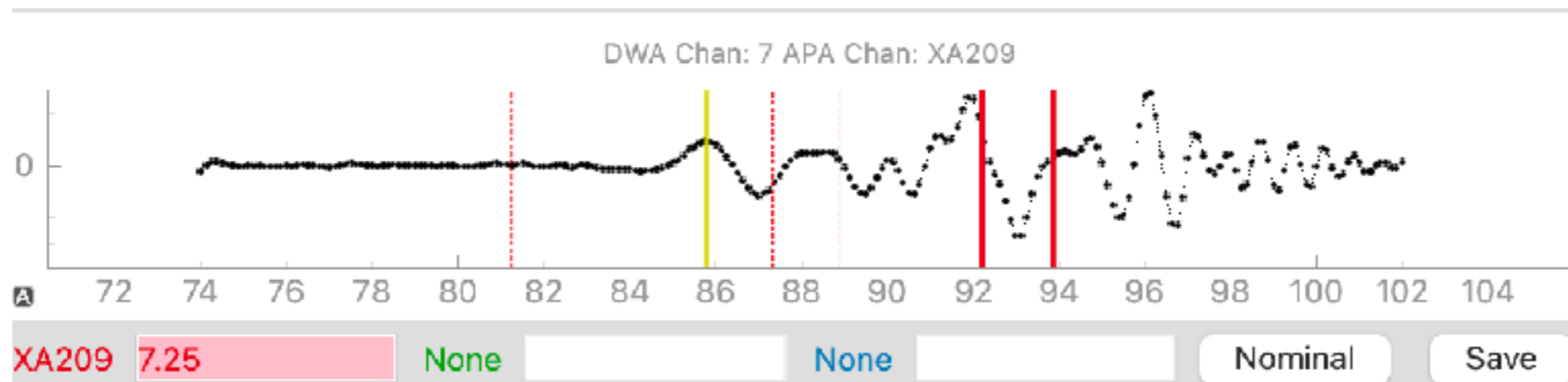


Offline tension analysis

- Examples of manual correction (X layer)

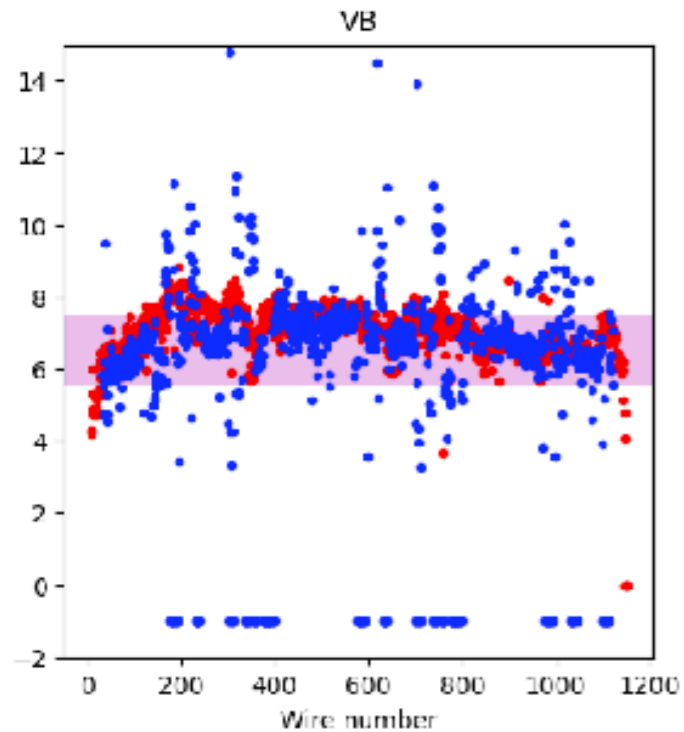
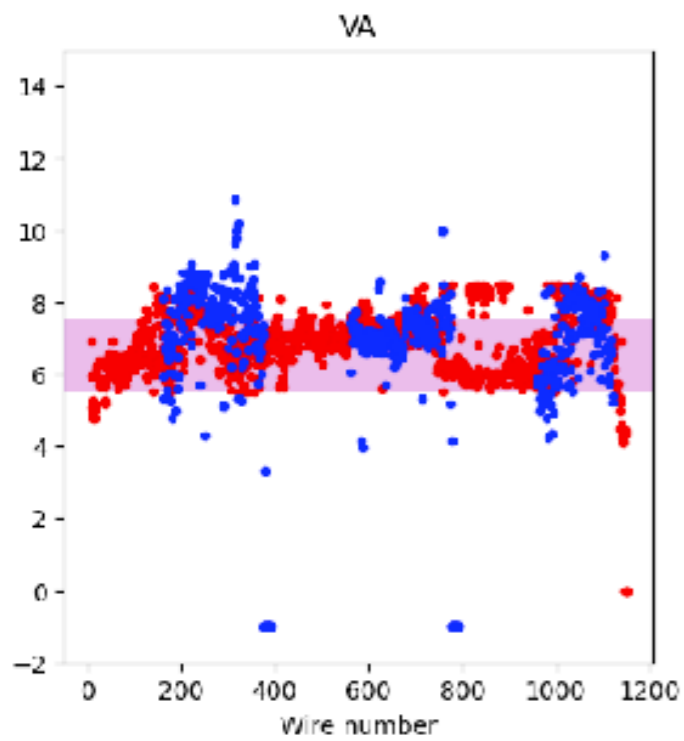


Manual adjustment

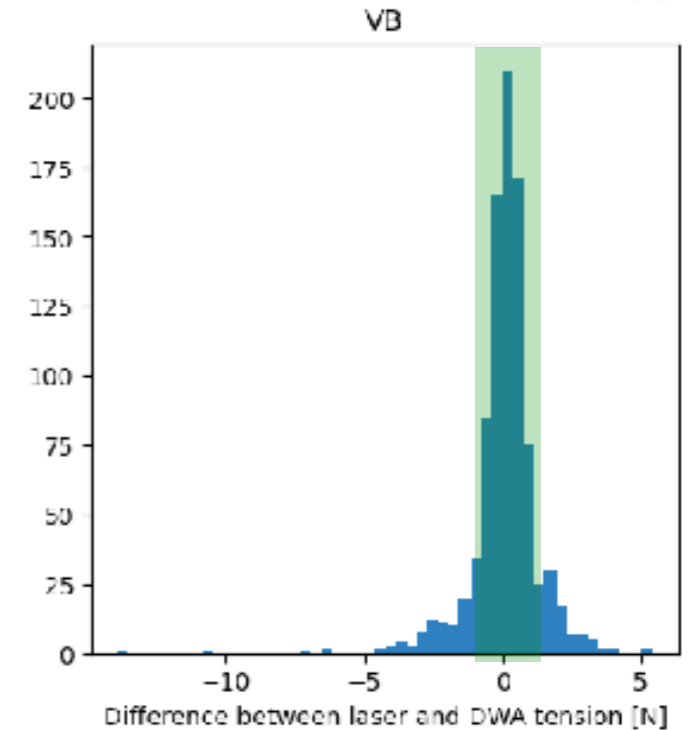
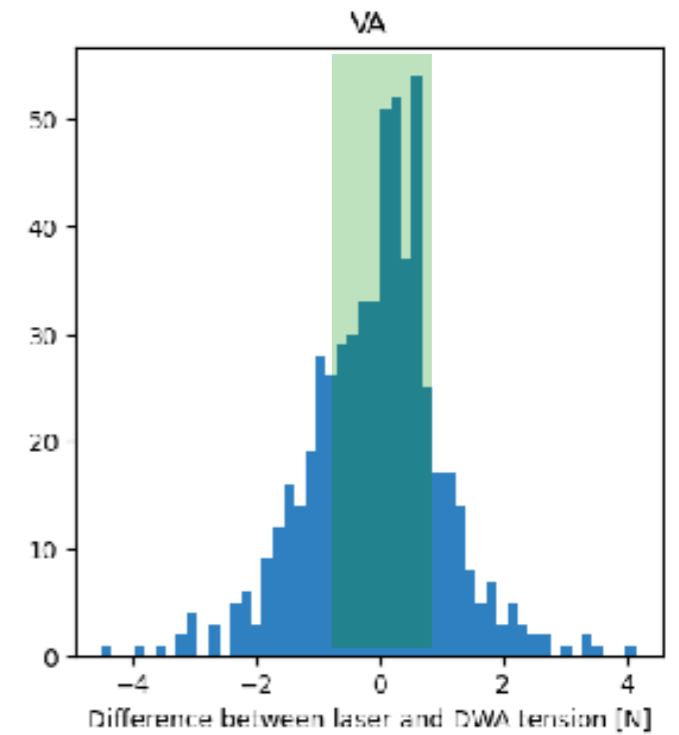


Offline tension analysis

- Recent Daresbury analysis on APA #4 (V layer)

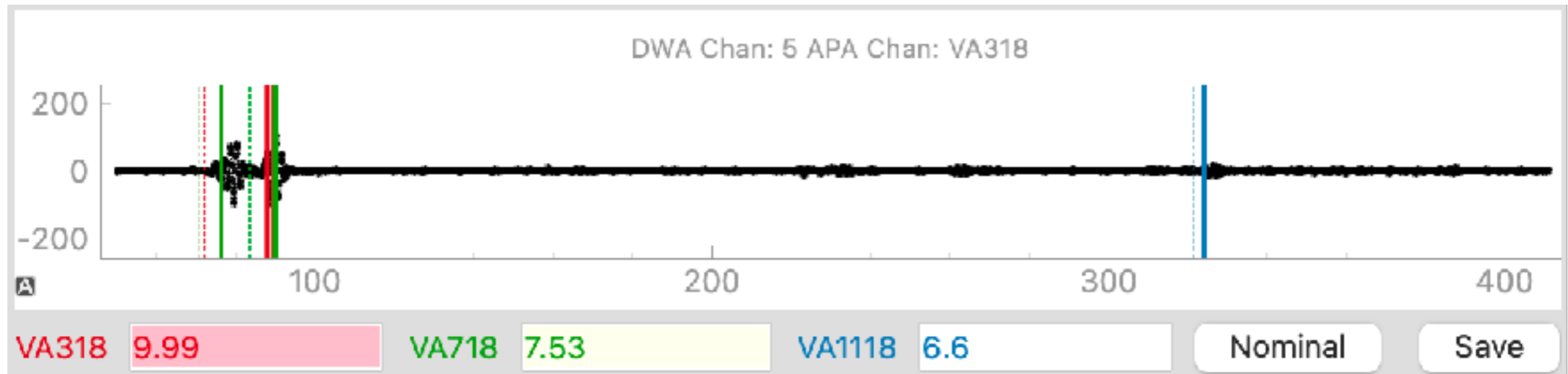


**Much more complicated for U, V layers
(Multiple wire segments)**

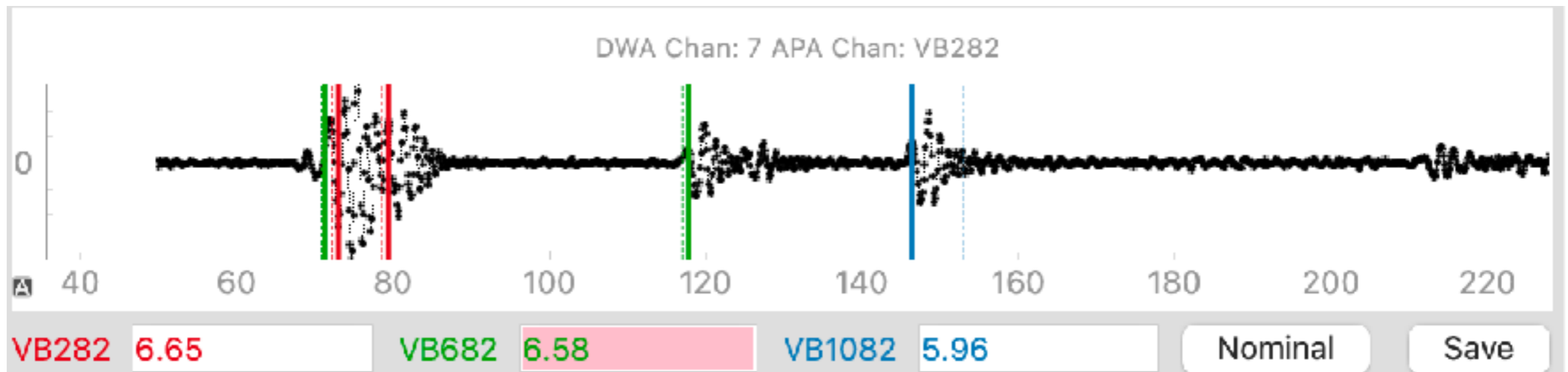


Offline tension analysis

- Examples of manual correction (V layer)



Manual adjustment

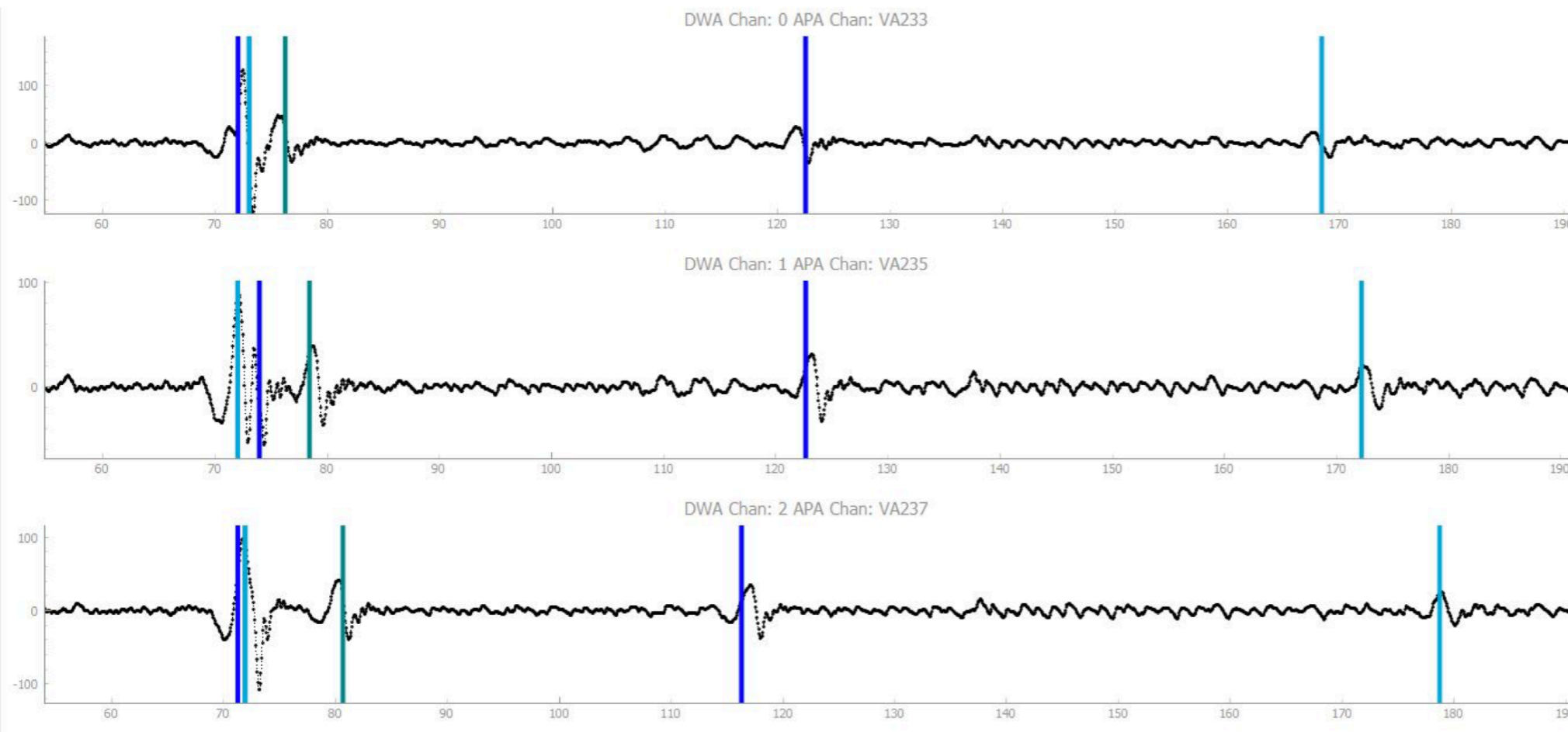


Summary and next steps

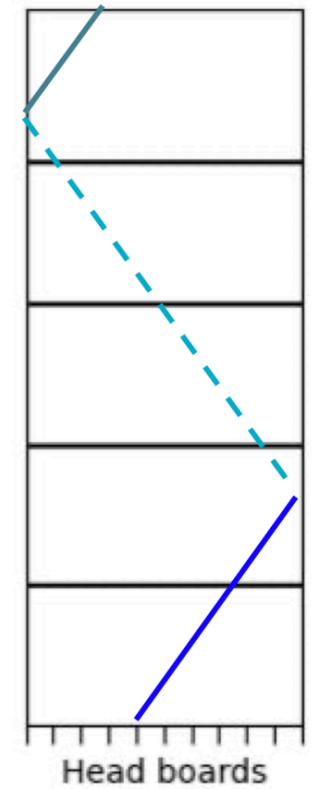
- DWA currently operated by trained experts from Manchester (and will be for the next months/year)
- DWAs are fully operational and almost completely user-friendly (more tests being done to ensure that)
- Some challenges with analysis of U,V layers given the nature of the resonances that require manual inputs
- The next APAs should be able to rely fully* on DWA
- Plan to test the DWA with storage box containing 2 APAs to ensure there is no difference than with 1 APA.

* except for the 412 (-46) short wires that need laser

The DWA uses an algorithm to identify resonances and assign them to different wire segments



Channel: VA235



Slide by Chris Stanford