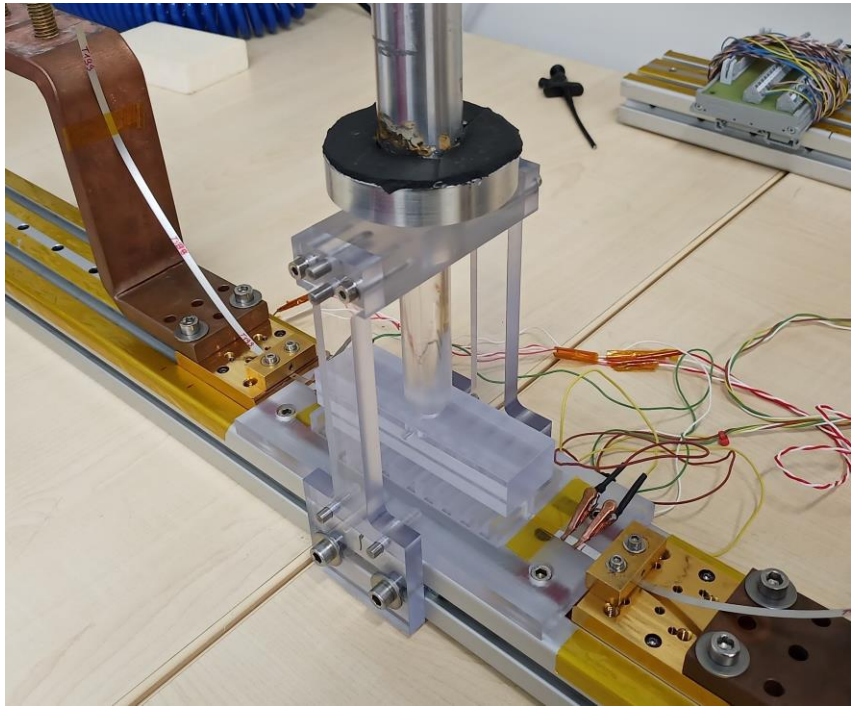
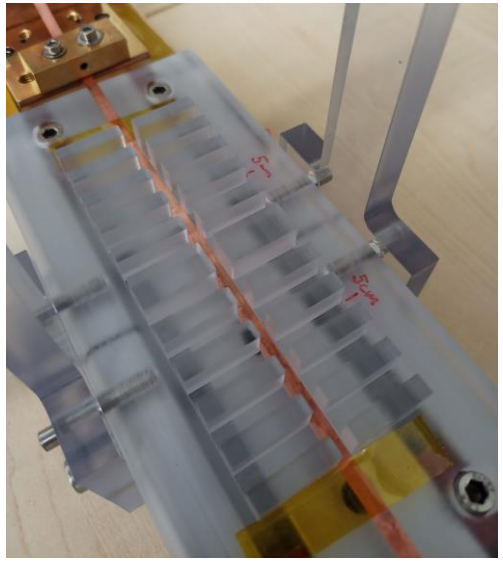
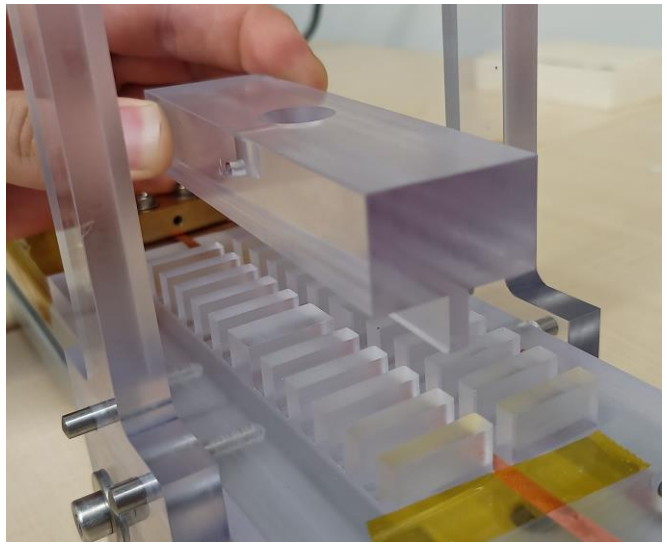
Measurement of unsoldered tape contact resistances

Setup

- New setup designed by Dominik Pridöhl allows to fix singular HTS-tapes in place and apply uniform pressure along a specific section
- This allows measuring the contact resistance between unsoldered tapes, with different variables such as contact length, pressure, and surface treatment

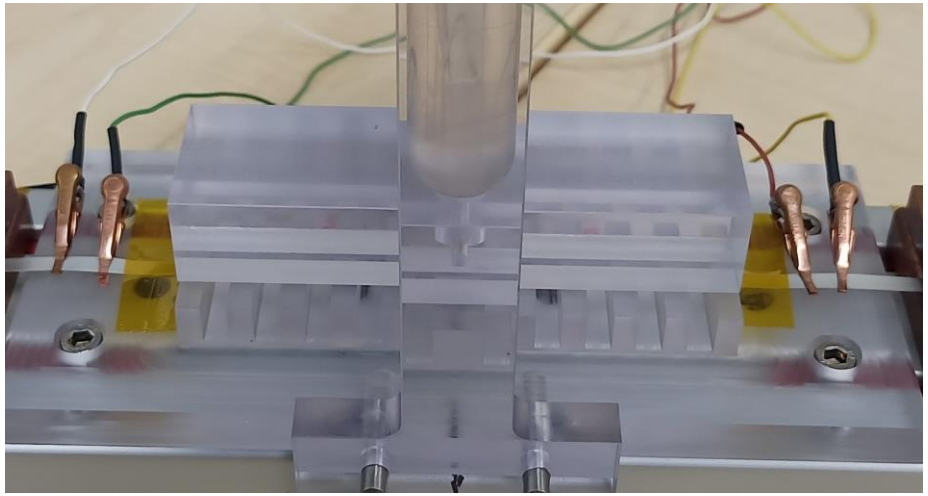






Measurement Procedure

- Notches in plexiglass base were used to measure 5cm of tape
- Tapes are always oriented HTS to Hastelloy
- When sanded, 5 strokes of sanding foam with medium pressure were used
- Gold-plated copper blocks were used to expedite attachment of current supply (just cleaned using isoprop, as sanding and indium were unnecessary to allow a sufficient current to flow)
- 2 pairs of voltage taps attached on plexiglass base



Measurement Procedure

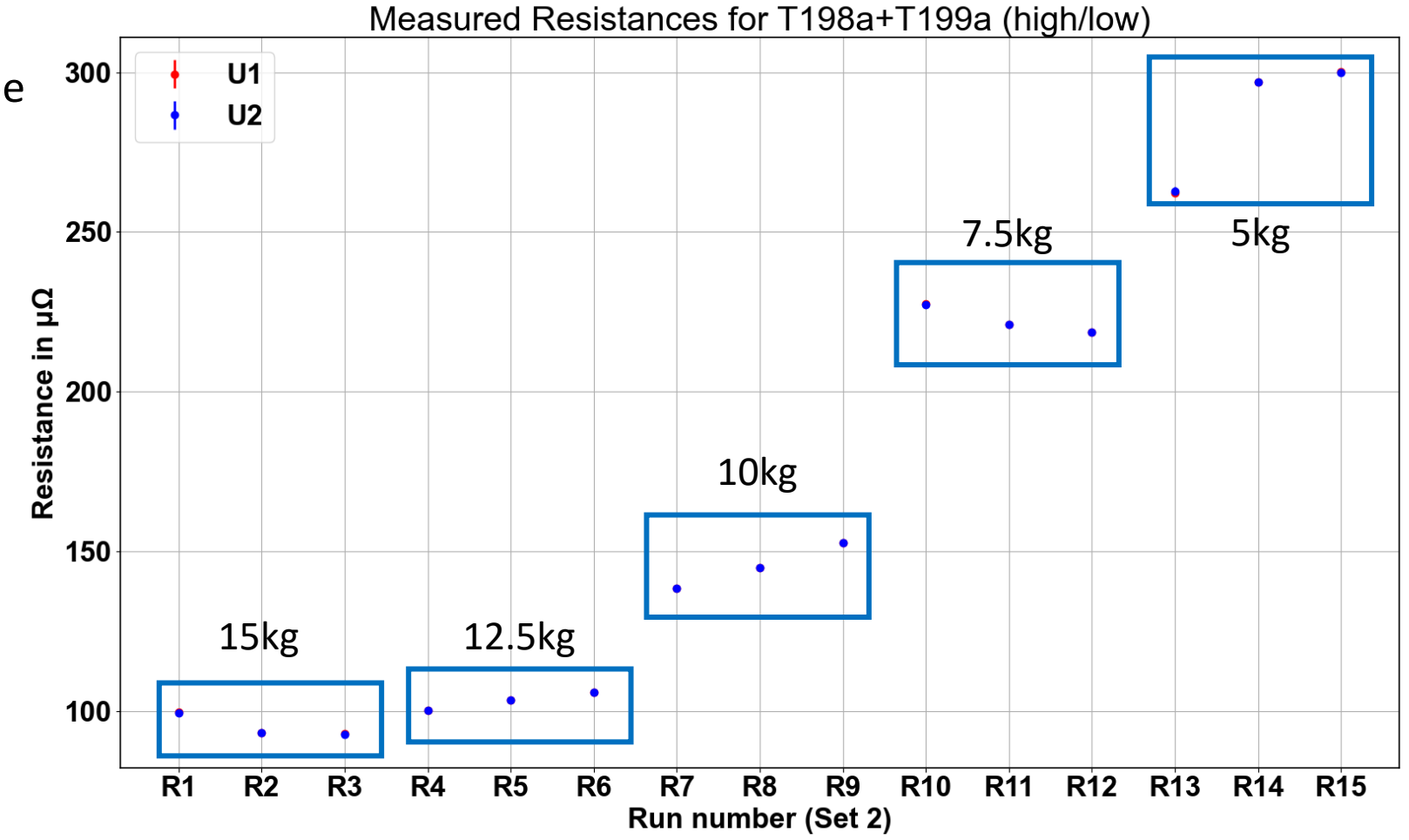
- Setup was placed in LN2 as usual
- Weight applied on top of the tape was varied between 2.5kg and 15kg in steps of 2.5kg
- 3 runs for each weight configuration
- 70 seconds of noise measurement before each run
- 60 second ramp up to 20A

Sample Production

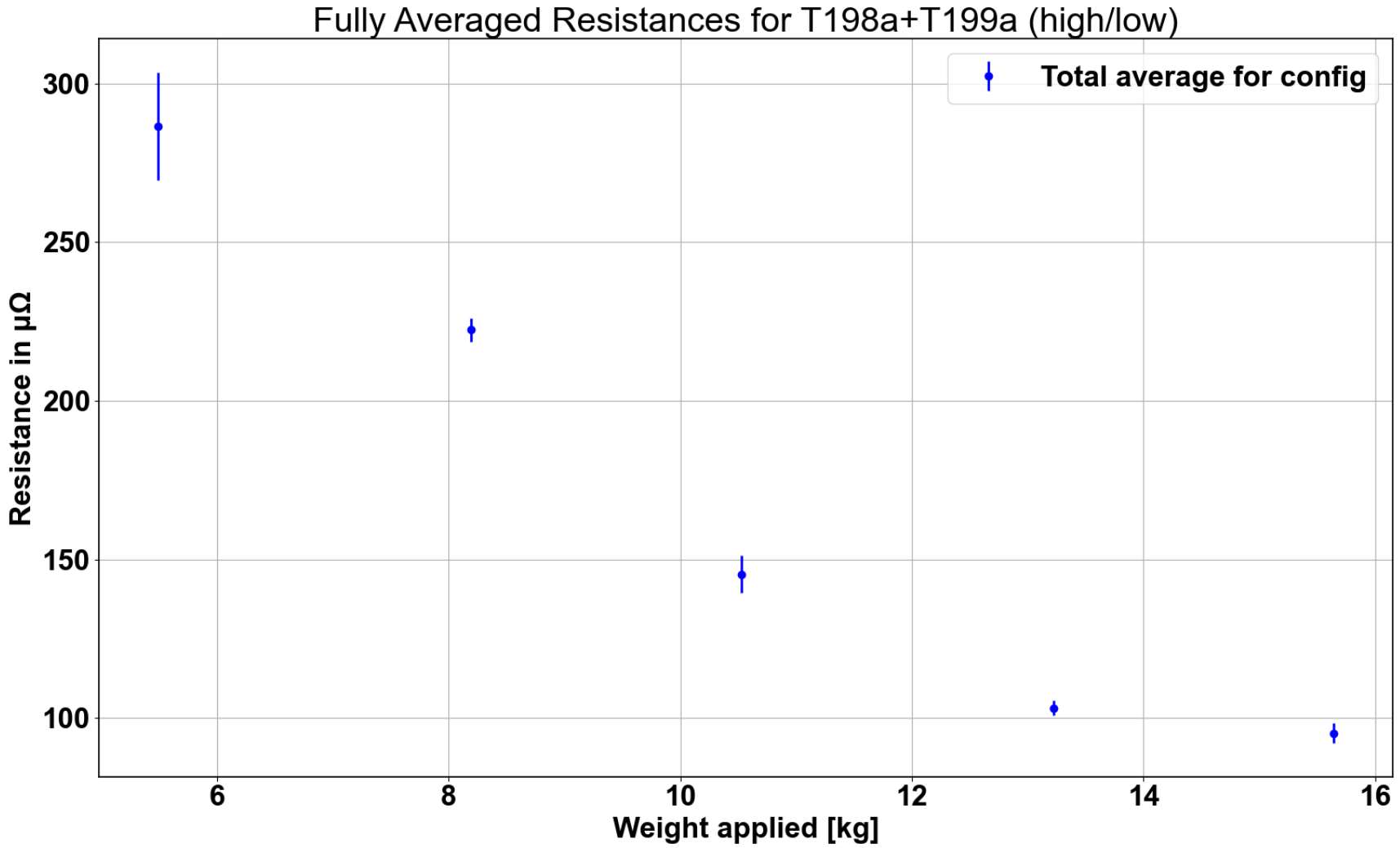
- Limited amount of properly pre-soldered tape → Use long tapes from which “used” sections are removed bit by bit (Usual overlap: 5cm, 5.5cm removed to avoid “cross-contamination” between section)
- Pre-soldered tape samples: T198, T199
- Copper tape samples: T200, T201

Results for Tape Sections T198a & T199a

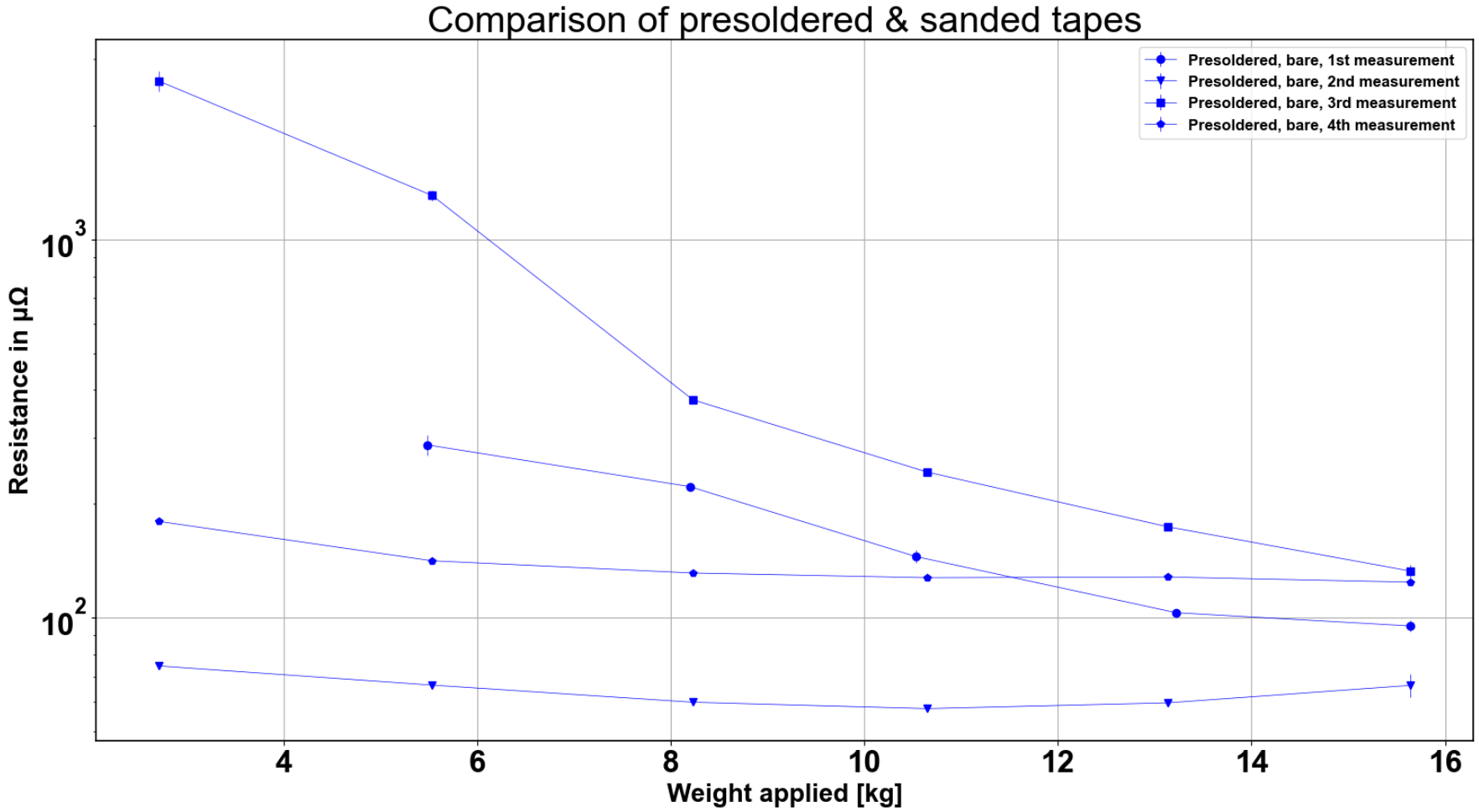
- Presoldered & Sanded Tape
- Nothing between tapes



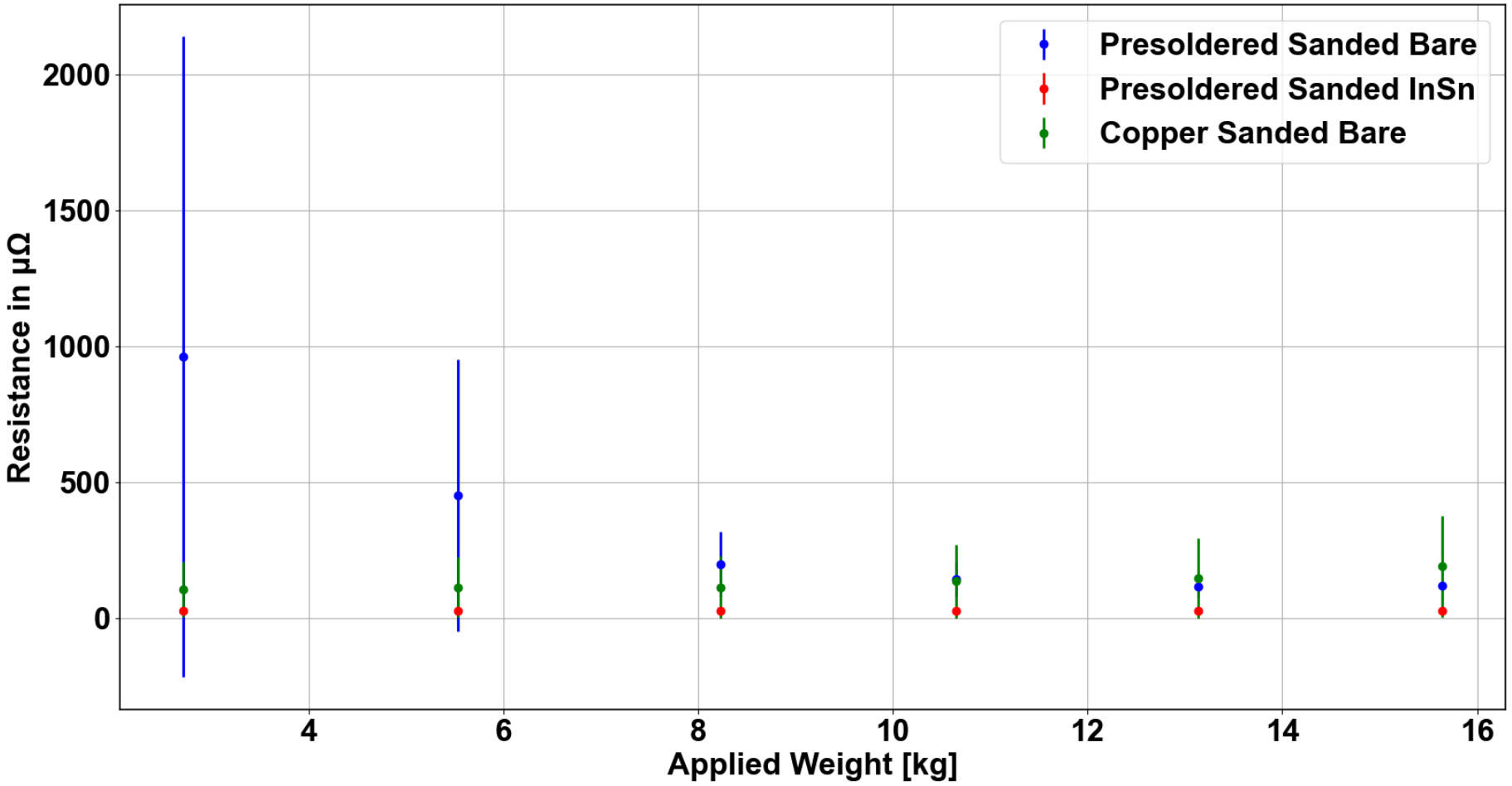
Results for Tape Sections T198a & T199a



Values obtained using standard configuration:



Comparison of main configurations



Conclusion

- Expected general trends can be observed (on average):
  - Sanding decreases resistance
  - Increased pressure decreases resistance
  - Sandwiching InSn foil between tapes greatly decreases resistance
  - Pre-soldering decreases resistance
- However:
  - Best results (~24μΩ) still an order of magnitude worse than soldered contacts (~1μΩ)
  - Very large fluctuations between individual samples, often larger than change through pressure application

→Surface condition is crucial factor for resistance values, and is very hard to keep uniform

Similar Research

- Similar experiments with a different setup were performed by another group, yielding comparable results that show a large dependence of contact resistances on surface treatment and large fluctuations within one particular category

- Citation: *Bonura, Marco & Barth, Christian & Joudrier, Anthony & Troitino, Jose & Fete, Alexandre & Senatore, Carmine. (2019). Systematic Study of the Contact Resistance Between REBCO Tapes: Pressure Dependence in the Case of No-Insulation, Metal Co-Winding and Metal-Insulation. IEEE Transactions on Applied Superconductivity. PP. 1-1. 10.1109/TASC.2019.2893564.*

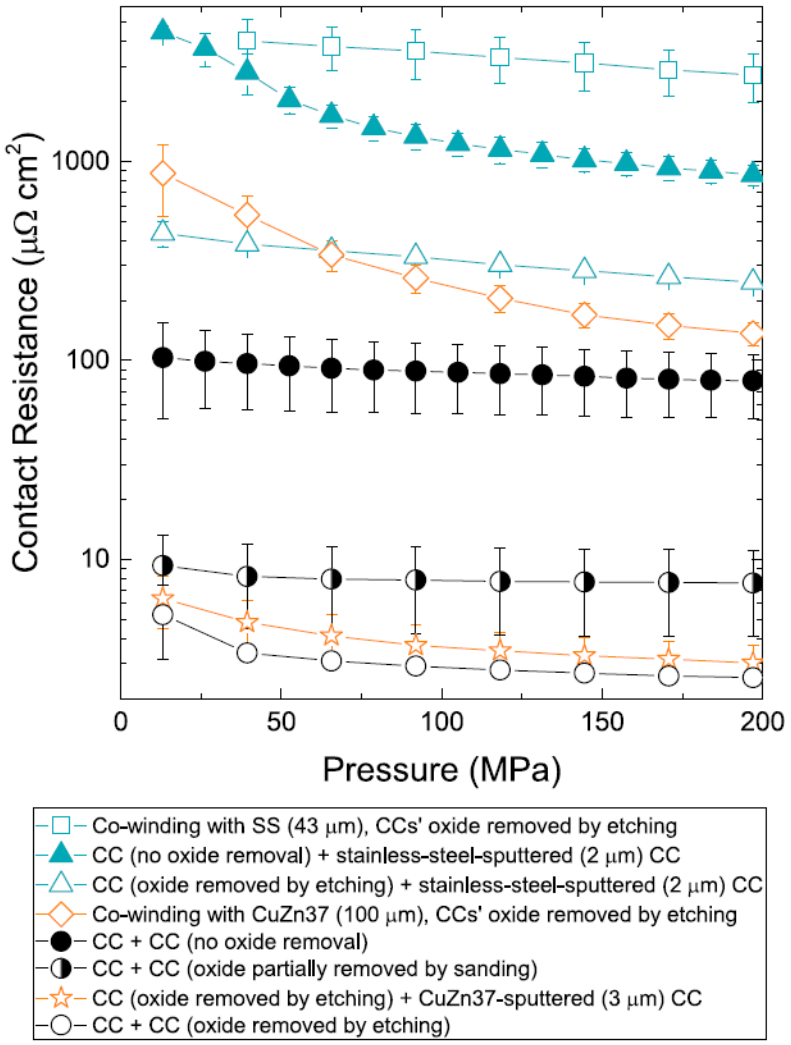
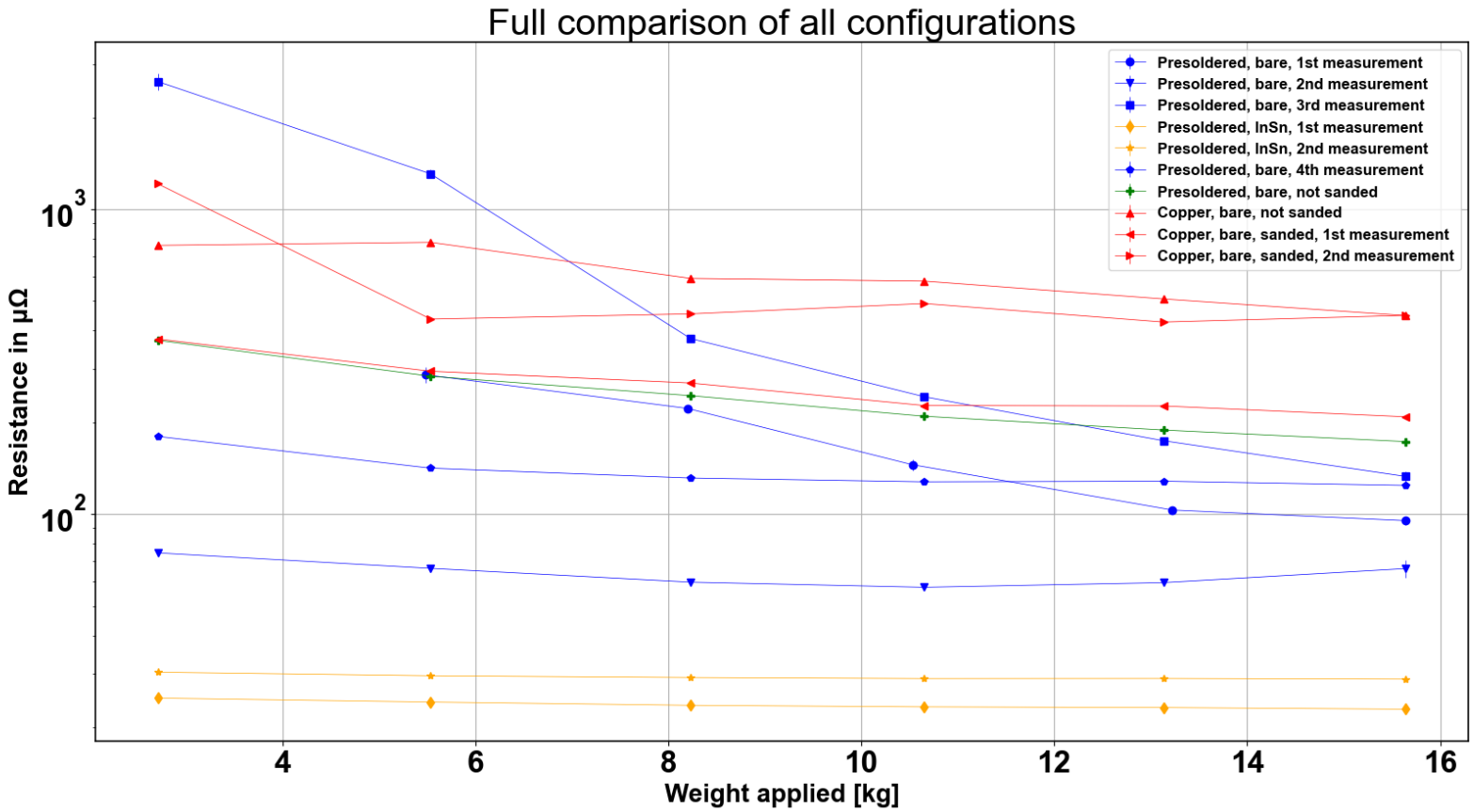
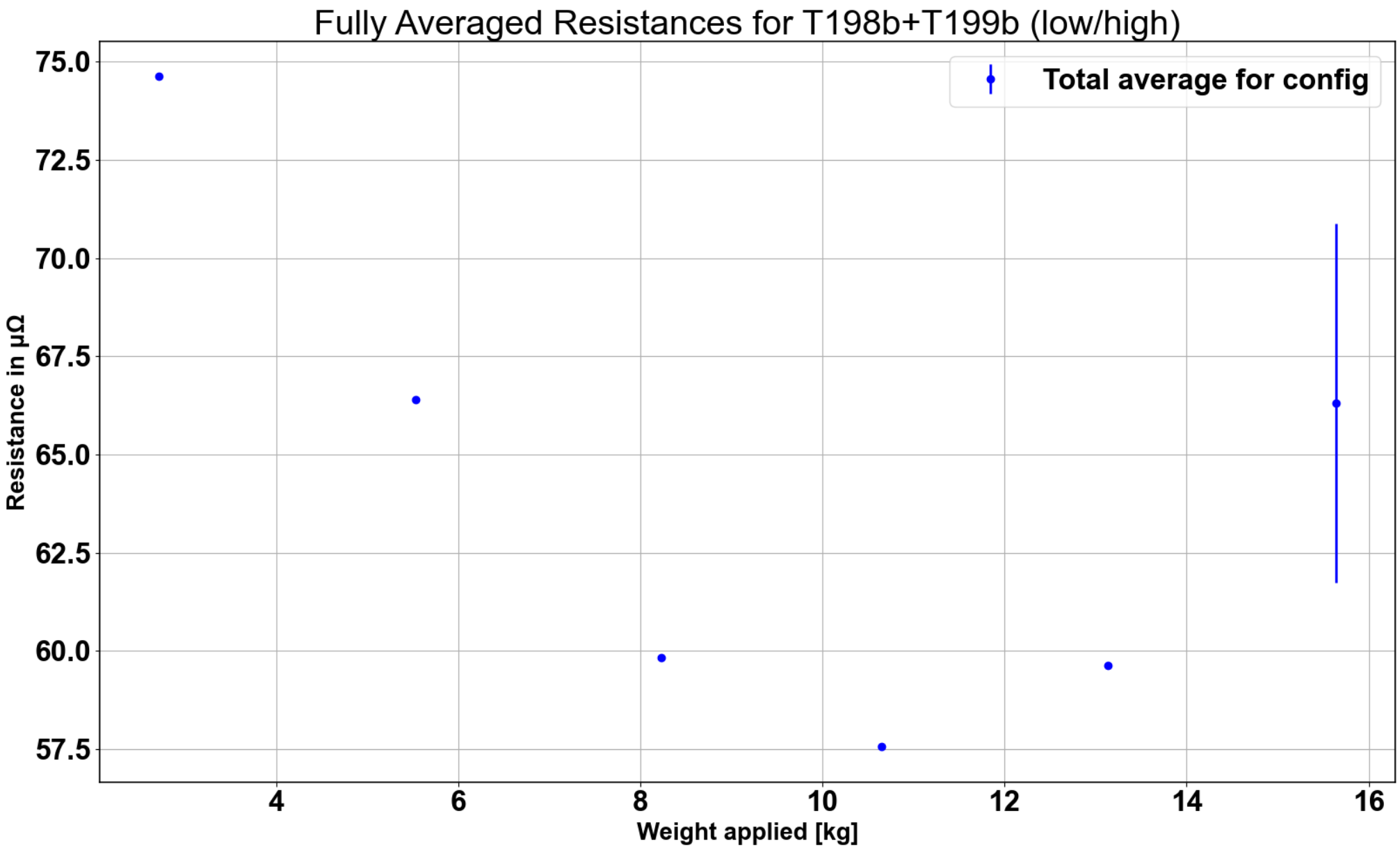


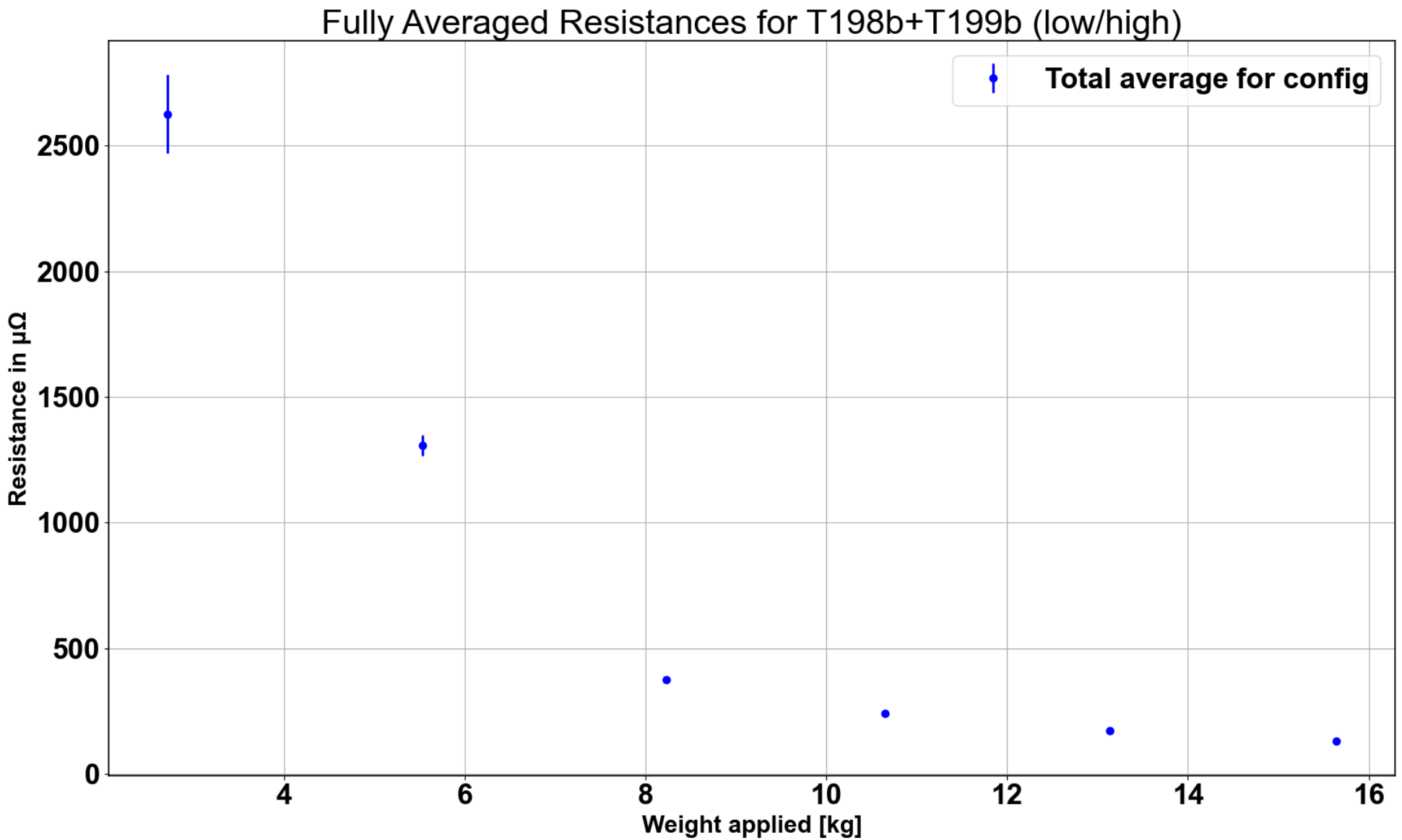
Fig. 4. Contact resistance measured for different contact configurations between SuperPower CCs. Data are average values and standard deviations calculated over 3 to 6 measurements. Open symbols indicate that the CC oxide layer has been removed by etching in CH_3COOH 50 vol.% H_2O, half-full symbols that the CC oxide layer has been partially removed by sanding, full symbols that no oxide removal treatment has been performed.

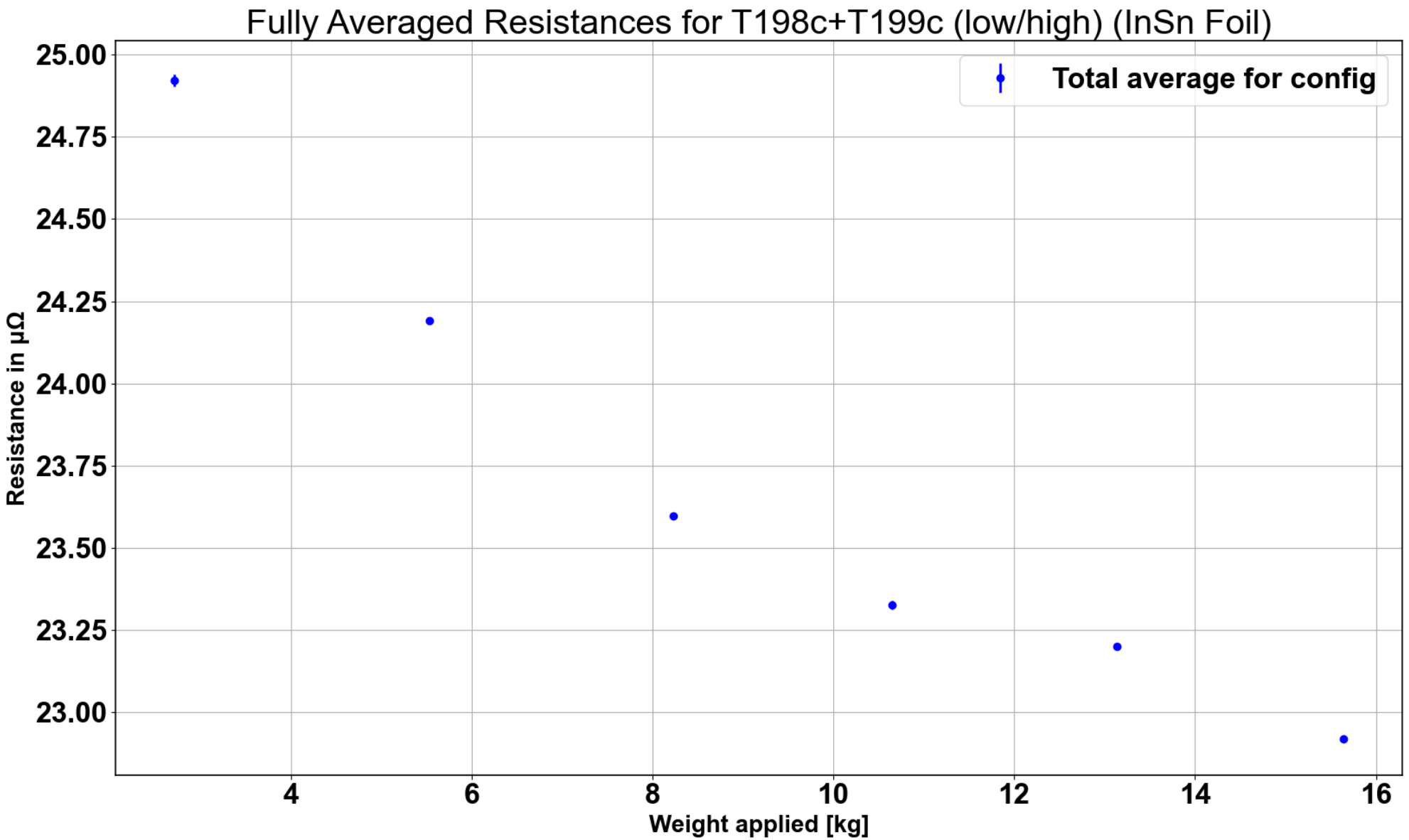
Appendix

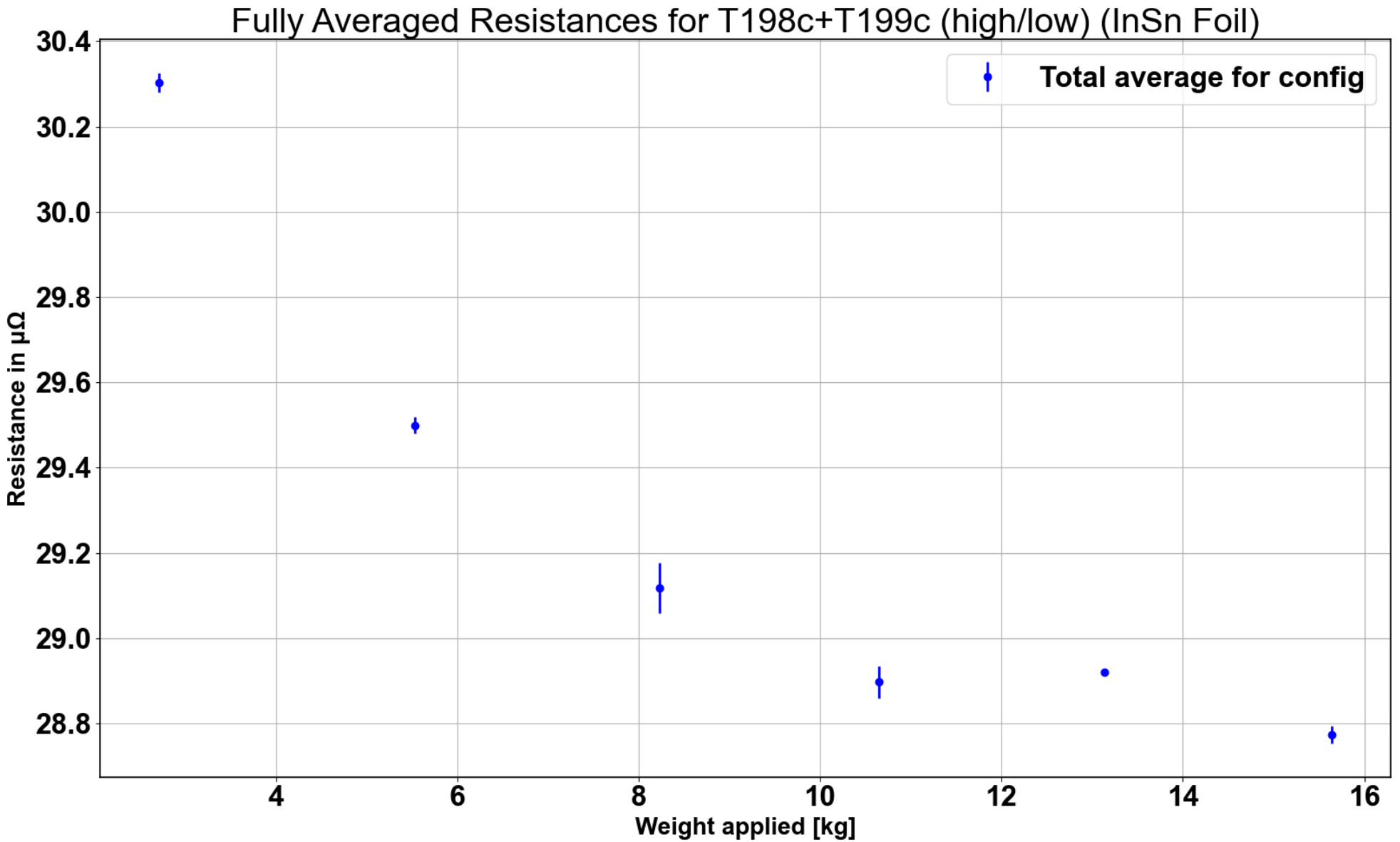
Comparison of all configurations

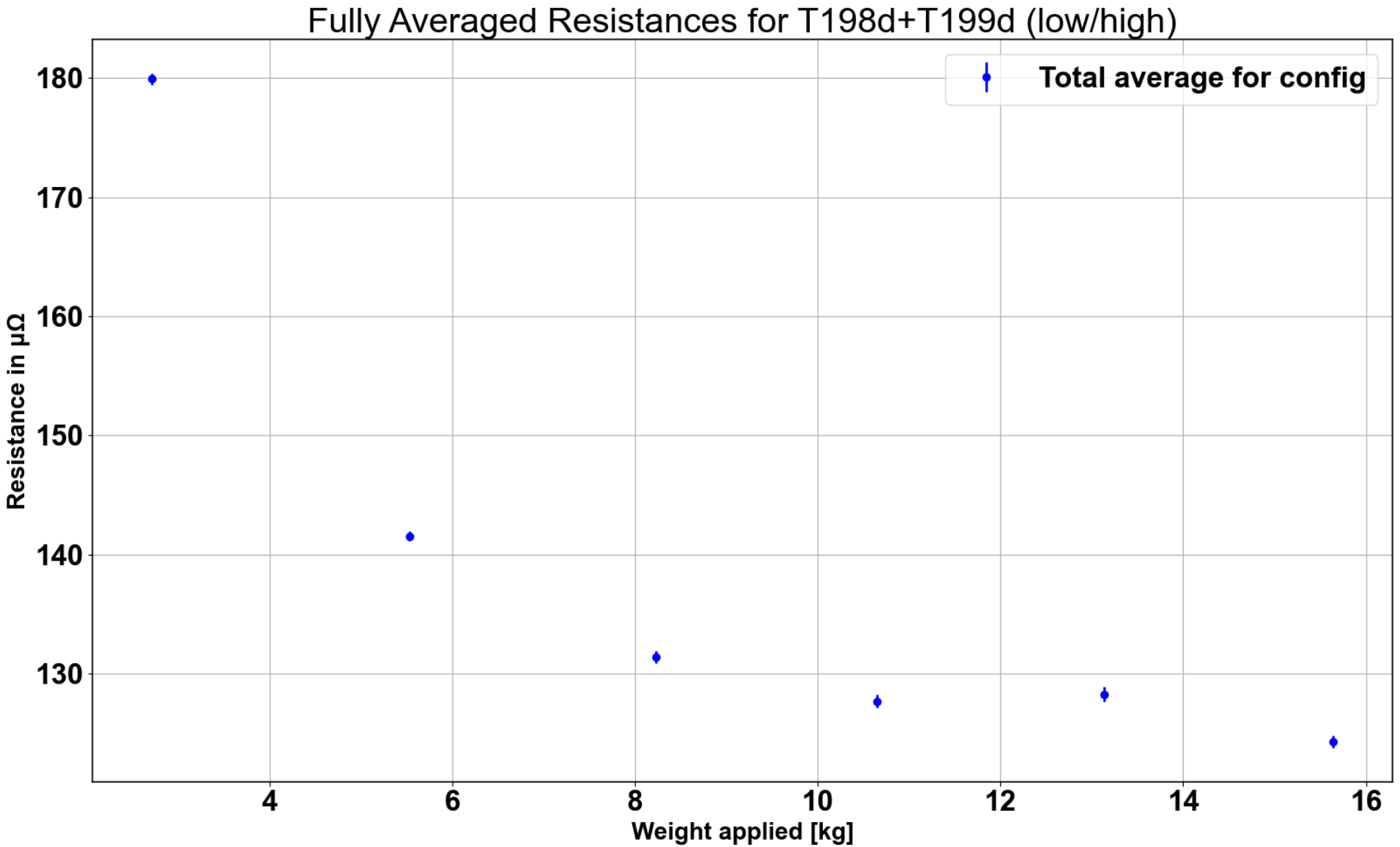


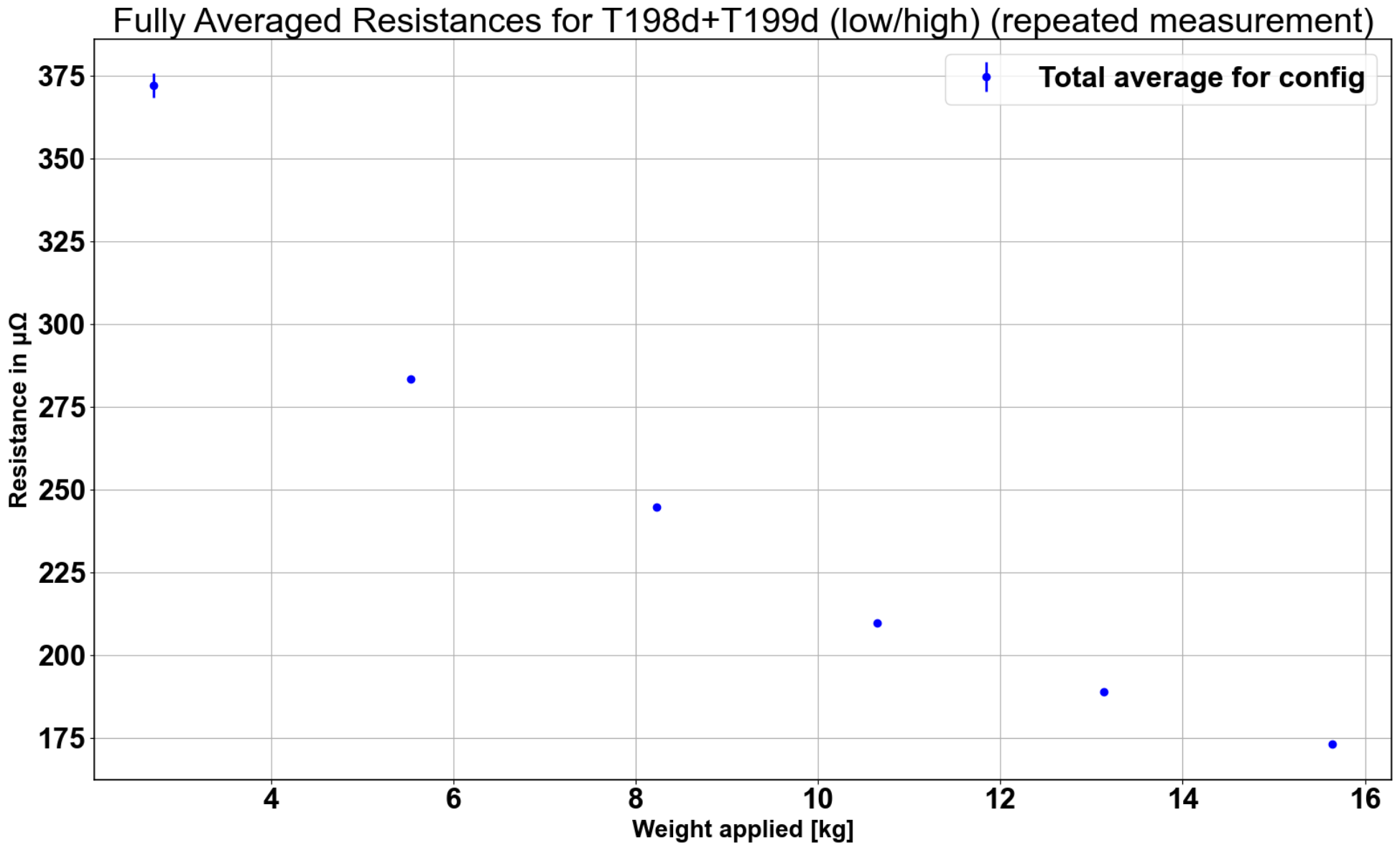

Fully Averaged Resistances for T198b+T199b (low/high)
Total average for config
Resistance in μΩ
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
4
6
8
10
12
14
16
Weight applied [kg]

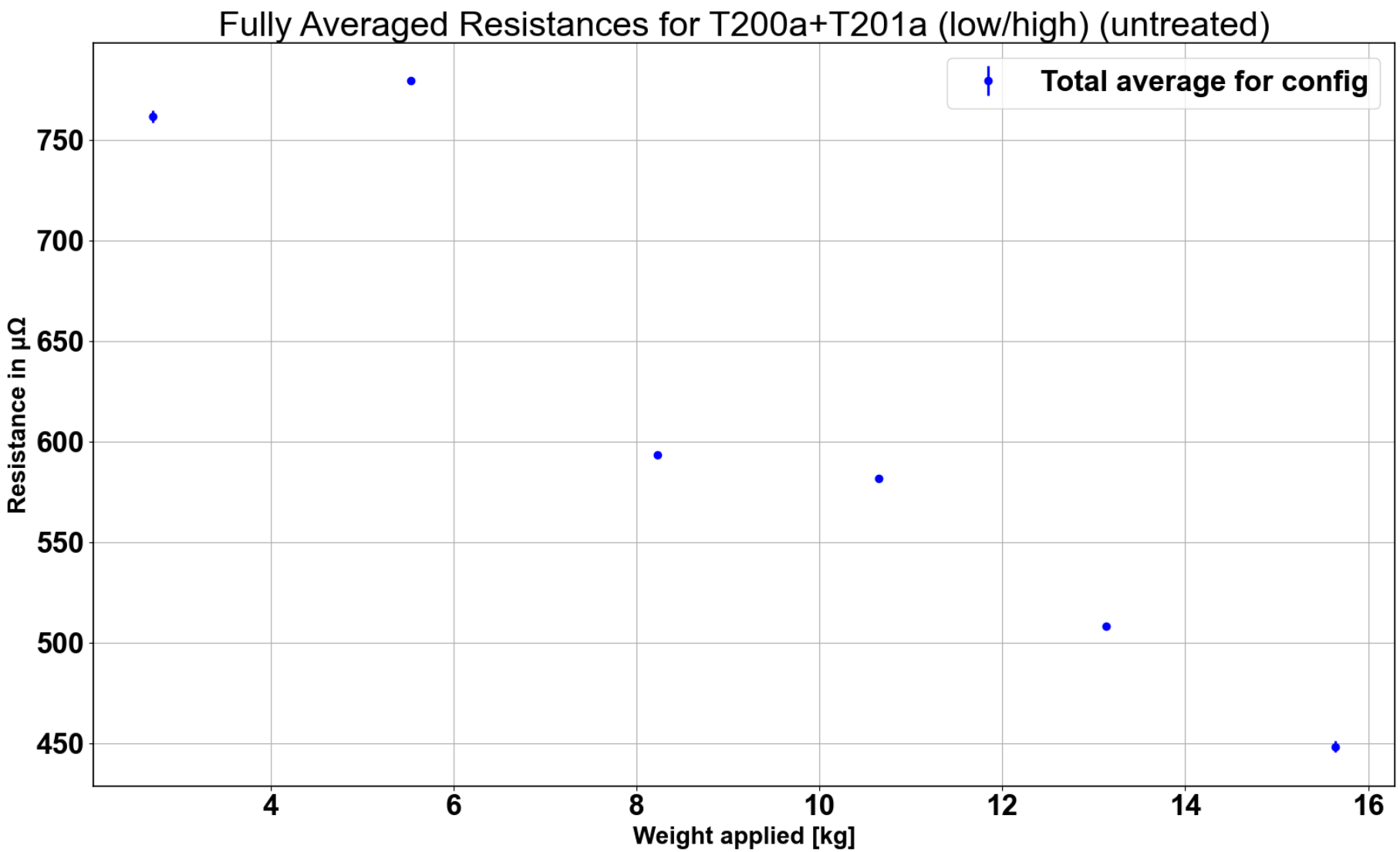

Fully Averaged Resistances for T198b+T199b (low/high)
Total average for config
Resistance in μΩ
2500
2000
1500
1000
500
0
4
6
8
10
12
14
16
Weight applied [kg]

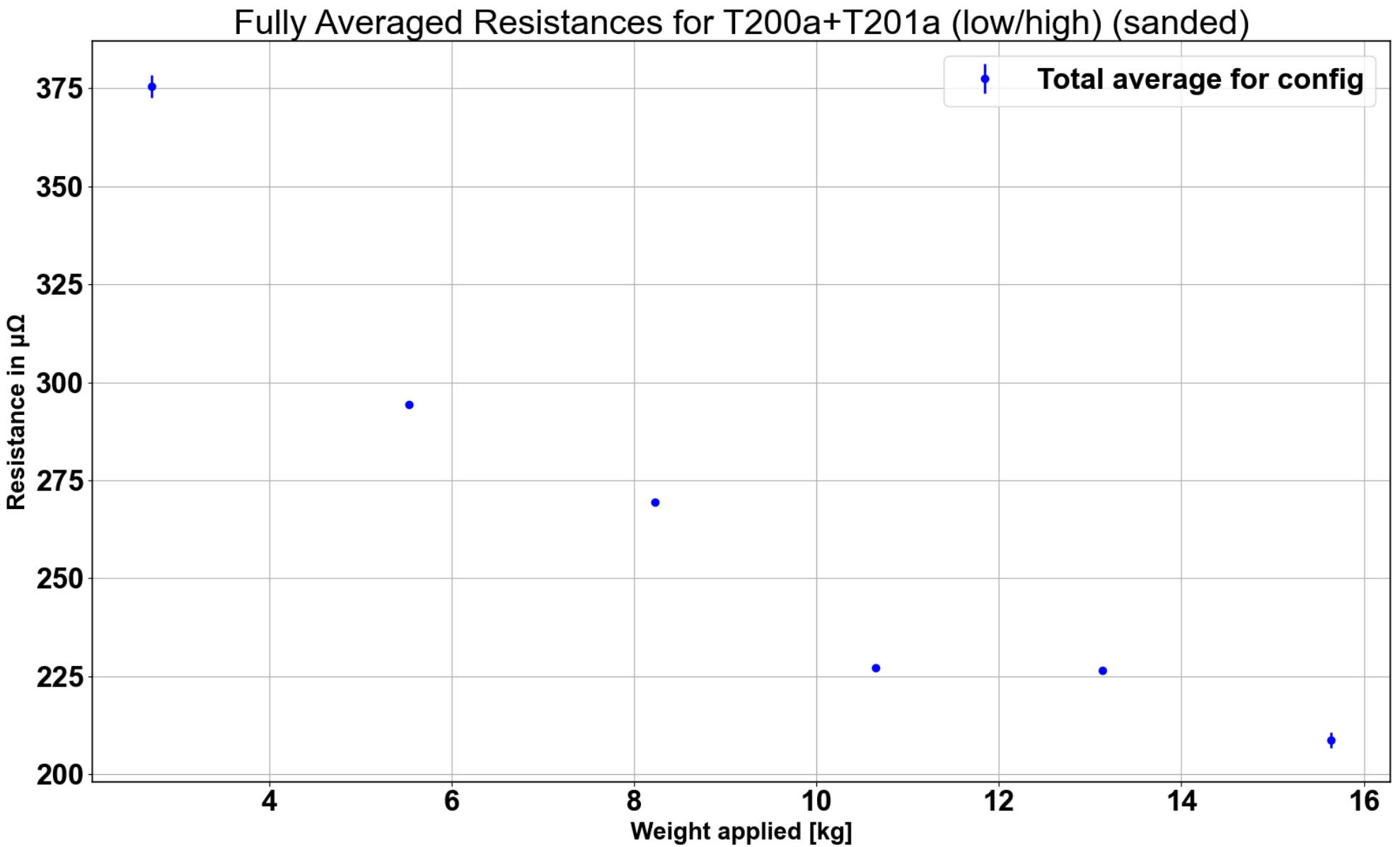

Fully Averaged Resistances for T198c+T199c (low/high) (InSn Foil)
Total average for config
Resistance in μΩ
25.00
24.75
24.50
24.25
24.00
23.75
23.50
23.25
23.00
4
6
8
10
12
14
16
Weight applied [kg]

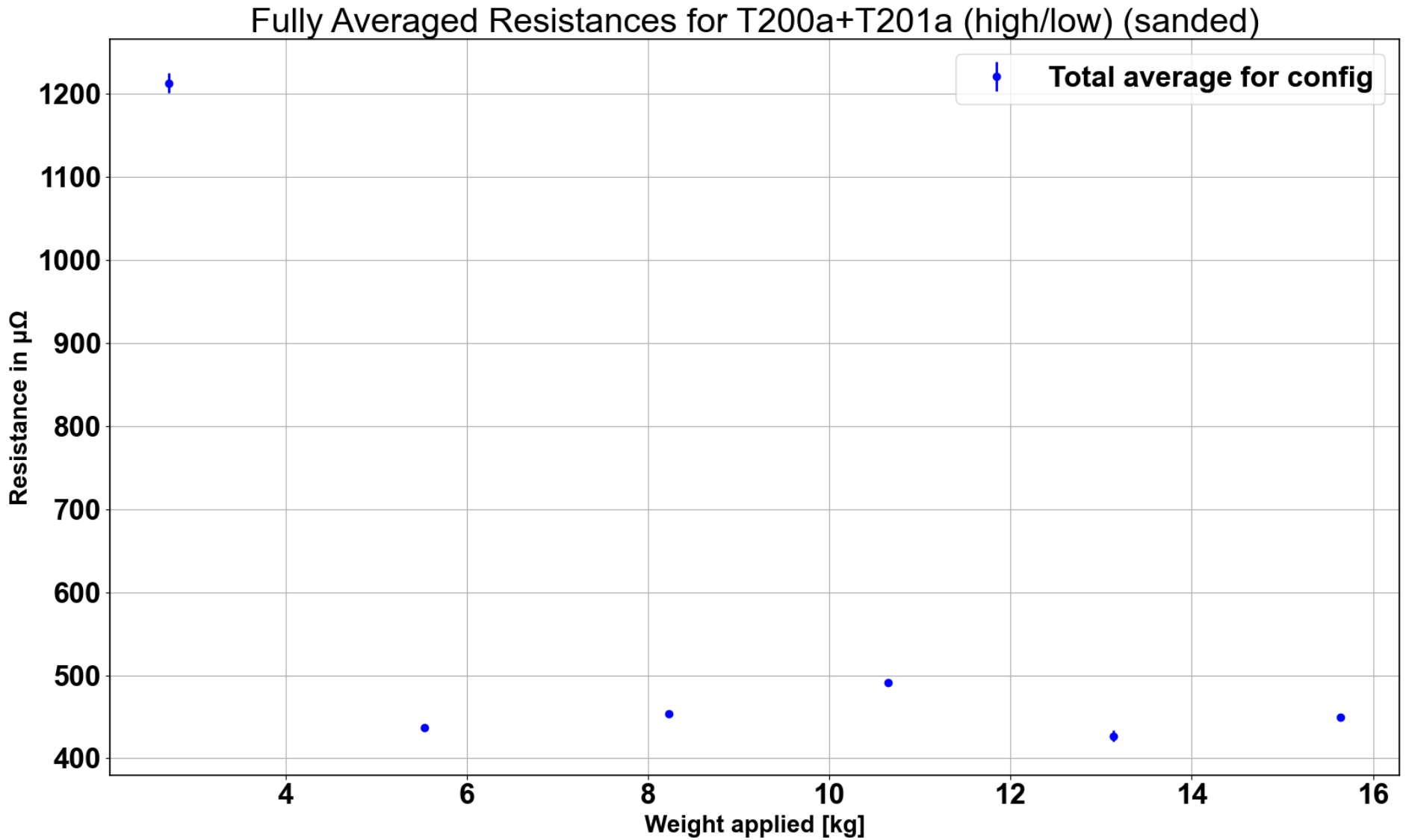

Fully Averaged Resistances for T198c+T199c (high/low) (InSn Foil)
Total average for config
Resistance in μΩ
30.4
30.2
30.0
29.8
29.6
29.4
29.2
29.0
28.8
4
6
8
10
12
14
16
Weight applied [kg]


Fully Averaged Resistances for T198d+T199d (low/high)
Total average for config
Resistance in μΩ
180
170
160
150
140
130
4
6
8
10
12
14
16
Weight applied [kg]


Fully Averaged Resistances for T198d+T199d (low/high) (repeated measurement)
Total average for config
Resistance in μΩ
375
350
325
300
275
250
225
200
175
4
6
8
10
12
14
16
Weight applied [kg]


Fully Averaged Resistances for T200a+T201a (low/high) (untreated)
Total average for config
Resistance in µΩ
750
700
650
600
550
500
450
4
6
8
10
12
14
16
Weight applied [kg]


Fully Averaged Resistances for T200a+T201a (low/high) (sanded)
Total average for config
Resistance in μΩ
375
350
325
300
275
250
225
200
4
6
8
10
12
14
16
Weight applied [kg]


Fully Averaged Resistances for T200a+T201a (high/low) (sanded)
Total average for config
Resistance in μΩ
1200
1100
1000
900
800
700
600
500
400
4
6
8
10
12
14
16
Weight applied [kg]