M13 Beamline Power Supply Stability

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Following the installation of DC current transformers (DCCTs) to improve reproducibility of the M13 beamline magnet power supplies, the current regulation voltage signals have been monitored for extended periods, over 500 hours in most cases. This is a summary of the results obtained.

Similar measurements, for a shorter term and without DCCTs on all supplies, were reported previously (http://stoney.phys.ualberta.ca/~e614/Projects/E614-S2/00009/index.html).

The figures show graphs of the voltages for extended periods for Q1, Q2, and B1 (Fig.1), Q3, Q4, and Q5 (Fig. 2), and for B2, Q6, and Q7 (Fig. 3). In addition, Fig. 4 shows the temperature measurements using probes near the beamline controls CAMAC crate and also inside the Q5 power supply.

Each graph indicates the start and end times of the measurements, and the number of points, which is approximately one per hour. Also displayed are the mean value, standard deviation and "stability", which is simply the ratio of standard deviation to mean value.

The long dashed (green) lines, where visible, correspond to variations of 10^{-4} from the mean, which is our nominal requirement for dipole field stability, while the short dashed (magenta) lines, where visible, correspond to variations of 10^{-3}, our nominal requirement for quadrupoles.

Data for most graphs began April 9 and ended May 2. One exception was B1, which we were able to monitor only for about 70 hours from April 10. It was locked out for maintenance purposes earlier, and was required to be shut off when the cyclotron and beam line BL1A were turned on following the shutdown. The other was Q5, which was turned on a day later.

Q1 shows a discontinuity at about 260 hours, from unknown origin, but still the stability is below 10^{-4}, more than adequate for a quadrupole. Q2 and Q3 are well within the 10^{-3} limits, while Q4 meets the requirements also. Variations in Q5 and Q7 are slightly beyond the limits, while Q6 is well beyond the limits and requires attention.

B1 is within the 10^{-4} stability requirement, at least over the shorter period of measurement, but B2 shows variations several times this value, and requires attention. Correlation of the currents with NMR measurements of the magnetic fields remains to be done.

Finally, the temperature variations show the expected diurnal period, with the Q5 temperature warmer as expected and indicating a warmup period following the turning on of the power supply.

Further tests will be made subsequent to the installation of isolation transformers on all signals connecting the power supplies to the beamline controls crates. These signals consist for each power supply of a DAC supplying the reference control voltage and a scanning ADC reading the DC current monitor voltage. They use a common ground and have been known to lead to ground loop problems and intermittent power supply instabilities.

This information would not be available without the help of several people. Peter Green has managed to set up the monitoring of the precision scanning DVM with an easy-to-use interface to MIDAS. Pierre Amaudruz was able to make communication to this DVM via RS232 possible by supplying and installing a terminal server near the DVM. Brian Evans installed the DVM and made the connections with the power supply signals and thermometers. Chuck Yee installed the DCCTs, which were specified by Klaus Reiniger. Thanks for your help.

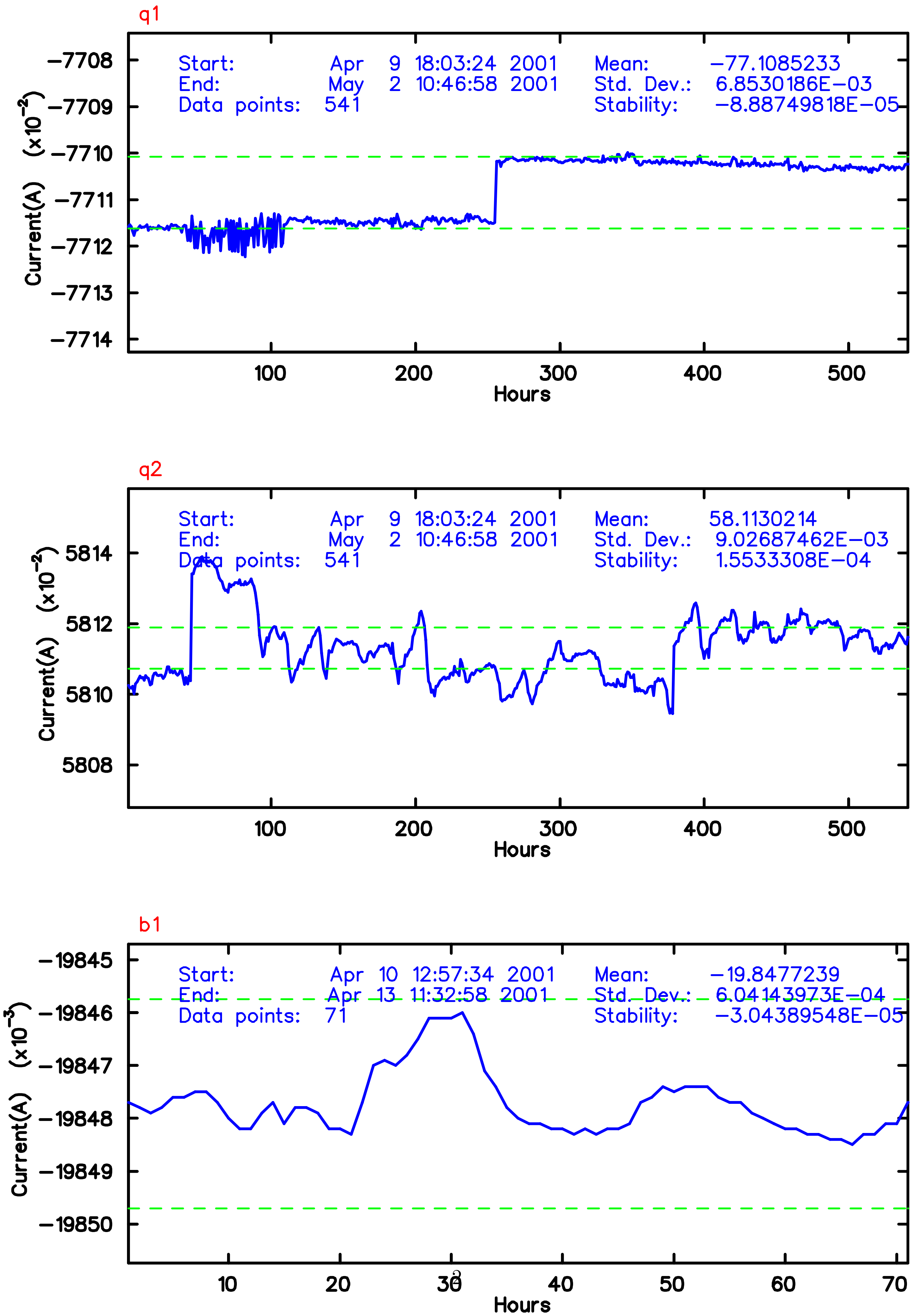
q1
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: −77.1085233
Std. Dev.: 6.8530186E−03
Stability: −8.88749818E−05
Current(A) (x10−2)
−7708
−7709
−7710
−7711
−7712
−7713
−7714
100
200
300
400
500
Hours
q2
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: 58.1130214
Std. Dev.: 9.02687462E−03
Stability: 1.5533308E−04
Current(A) (x10−2)
5814
5812
5810
5808
100
200
300
400
500
Hours
b1
Start: Apr 10 12:57:34 2001
End: Apr 13 11:32:58 2001
Data points: 71
Mean: −19.8477239
Std. Dev.: 6.04143973E−04
Stability: −3.04389548E−05
Current(A) (x10−3)
−19845
−19846
−19847
−19848
−19849
−19850
10
20
30
40
50
60
70
Hours

Figure 1:

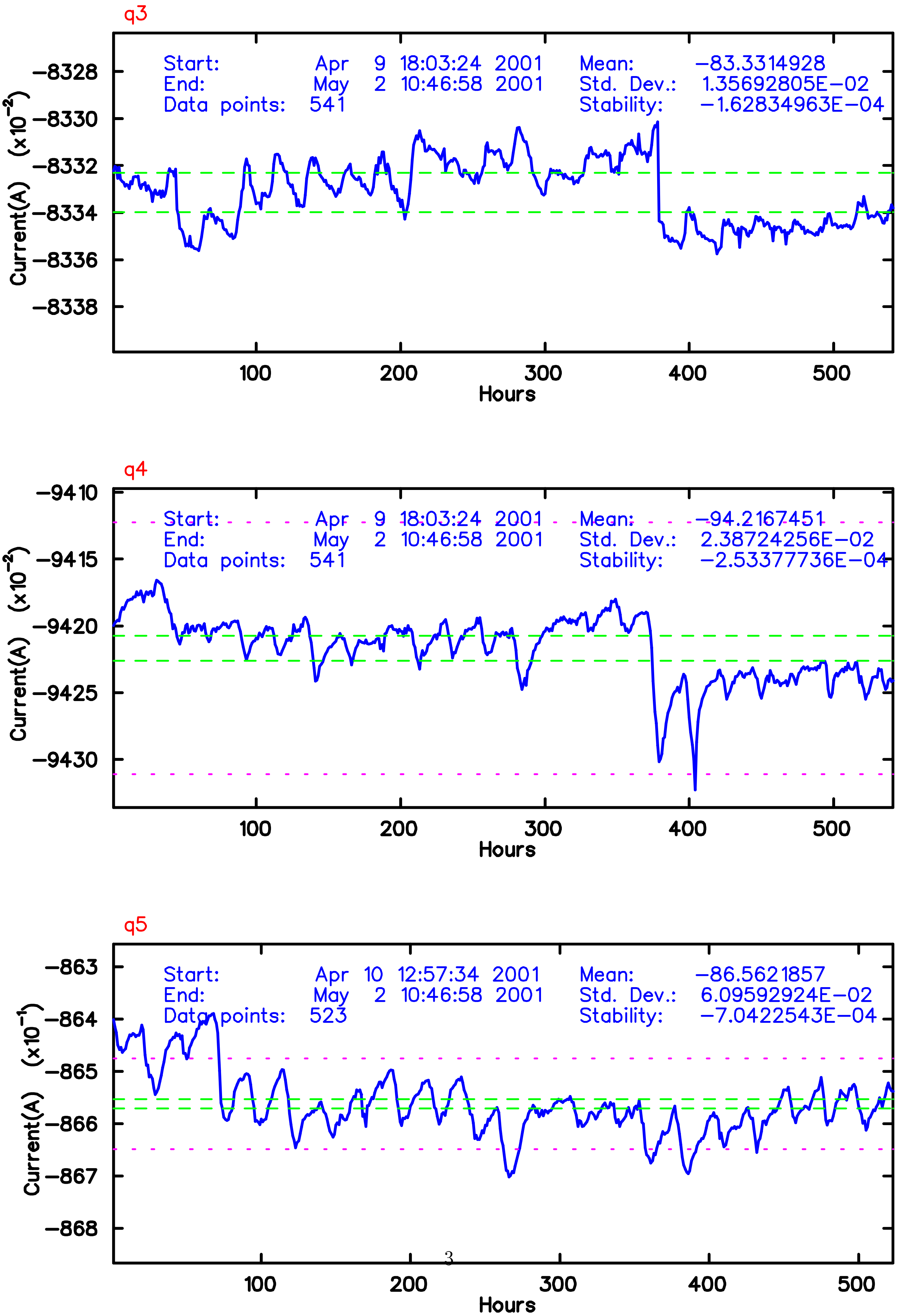
q3
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: −83.3314928
Std. Dev.: 1.35692805E−02
Stability: −1.62834963E−04
Current(A) (x10^-2)
−8328
−8330
−8332
−8334
−8336
−8338
100
200
300
400
500
Hours
q4
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: −94.2167451
Std. Dev.: 2.38724256E−02
Stability: −2.53377736E−04
Current(A) (x10^-2)
−9410
−9415
−9420
−9425
−9430
100
200
300
400
500
Hours
q5
Start: Apr 10 12:57:34 2001
End: May 2 10:46:58 2001
Data points: 523
Mean: −86.5621857
Std. Dev.: 6.09592924E−02
Stability: −7.0422543E−04
Current(A) (x10^-1)
−863
−864
−865
−866
−867
−868
100
200
300
400
500
Hours

Figure 2:

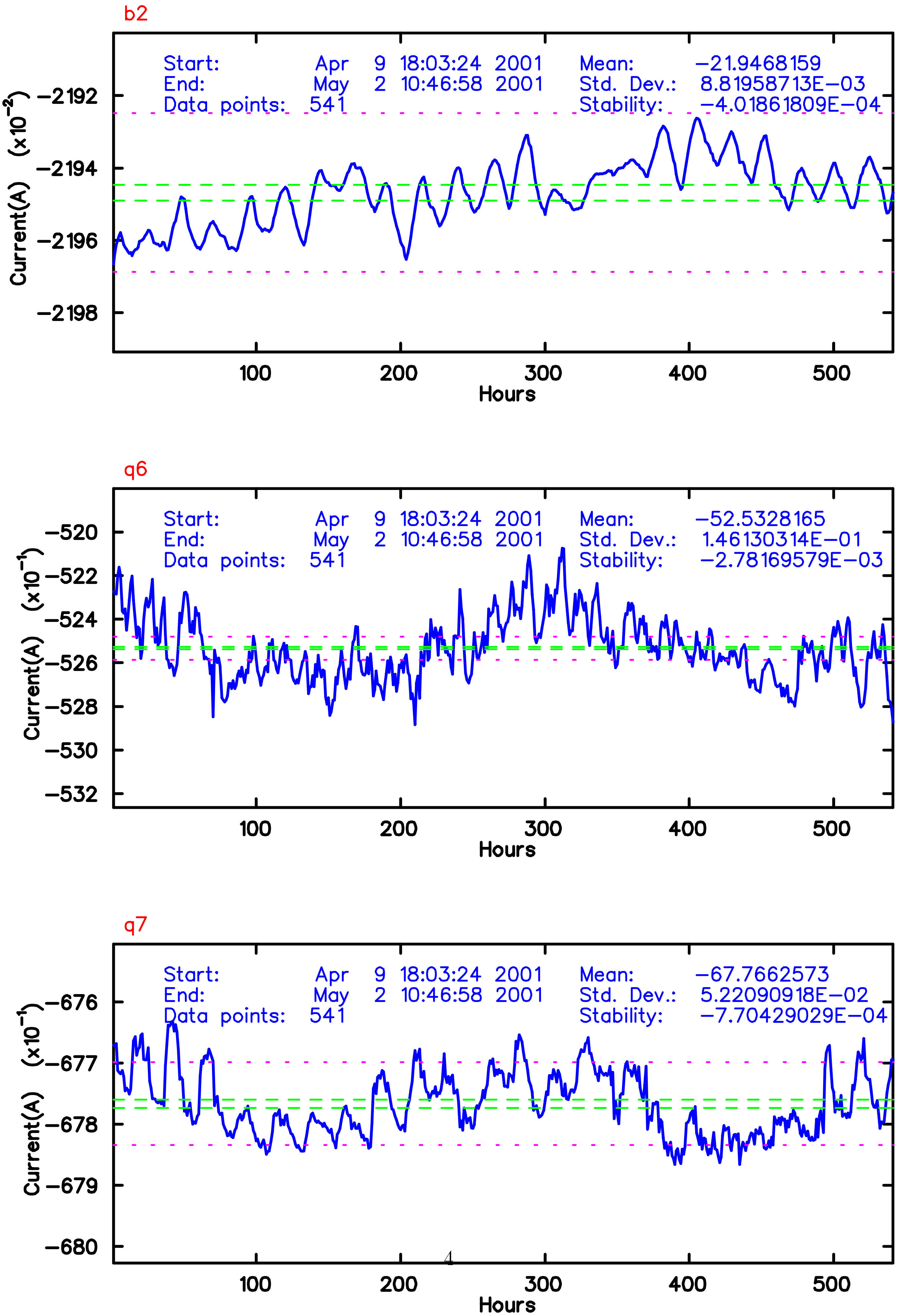
b2
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: −21.9468159
Std. Dev.: 8.81958713E−03
Stability: −4.01861809E−04
Current(A) (x10^−2)
−2192
−2194
−2196
−2198
100
200
300
400
500
Hours
q6
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: −52.5328165
Std. Dev.: 1.46130314E−01
Stability: −2.78169579E−03
Current(A) (x10^−1)
−520
−522
−524
−526
−528
−530
−532
100
200
300
400
500
Hours
q7
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: −67.7662573
Std. Dev.: 5.22090918E−02
Stability: −7.70429029E−04
Current(A) (x10^−1)
−676
−677
−678
−679
−680
100
200
300
400
500
Hours

Figure 3:

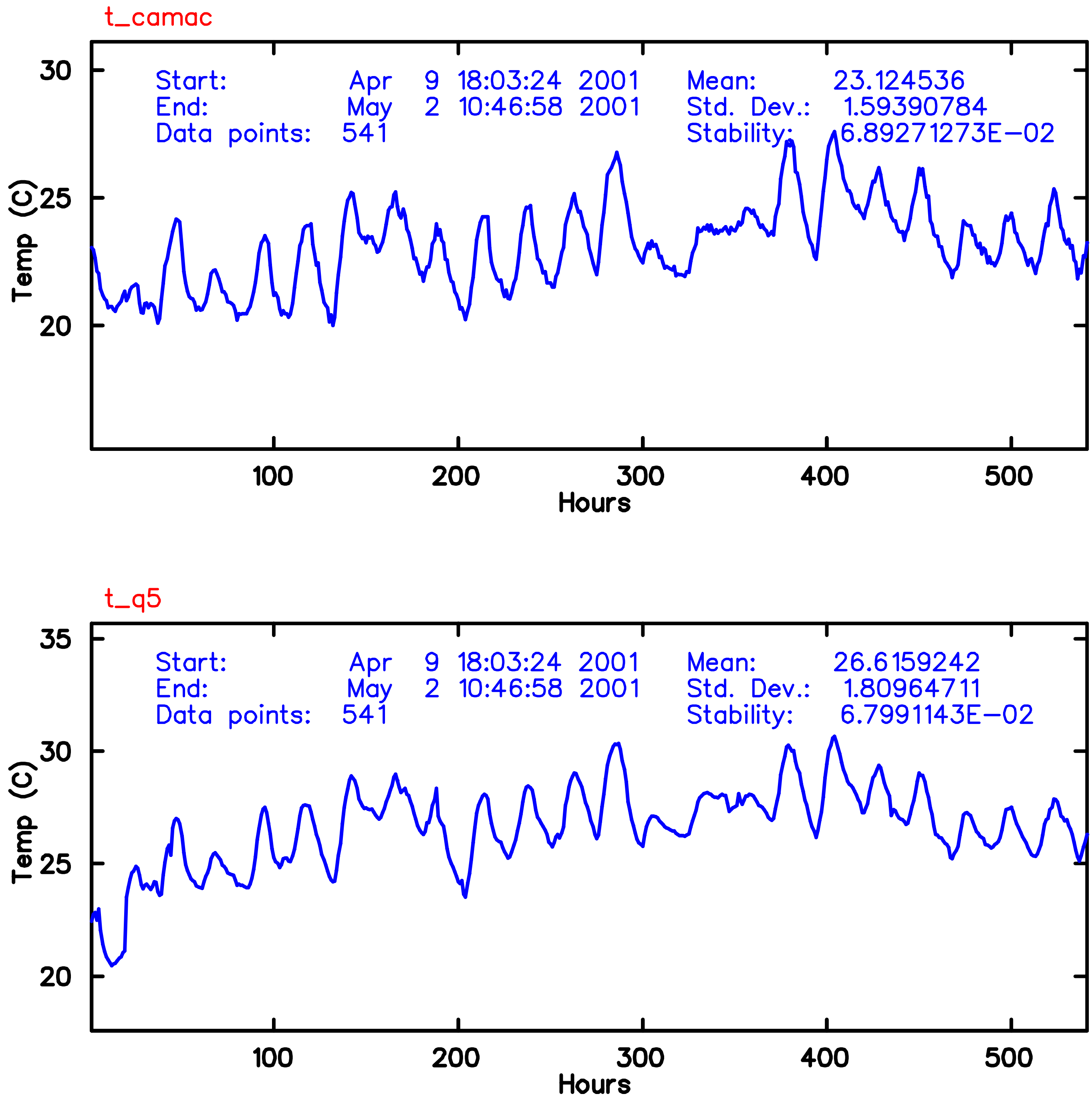
t_camac
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: 23.124536
Std. Dev.: 1.59390784
Stability: 6.89271273E−02
Temp (C)
Hours
t_q5
Start: Apr 9 18:03:24 2001
End: May 2 10:46:58 2001
Data points: 541
Mean: 26.6159242
Std. Dev.: 1.80964711
Stability: 6.7991143E−02
Temp (C)
Hours

Figure 4: