NMI Australia AU05 receiver calibration 2020

The GNSS receiver designated AU05 was calibrated by transfer of the calibration of AU04.

1. GNSS receiver and signal connections

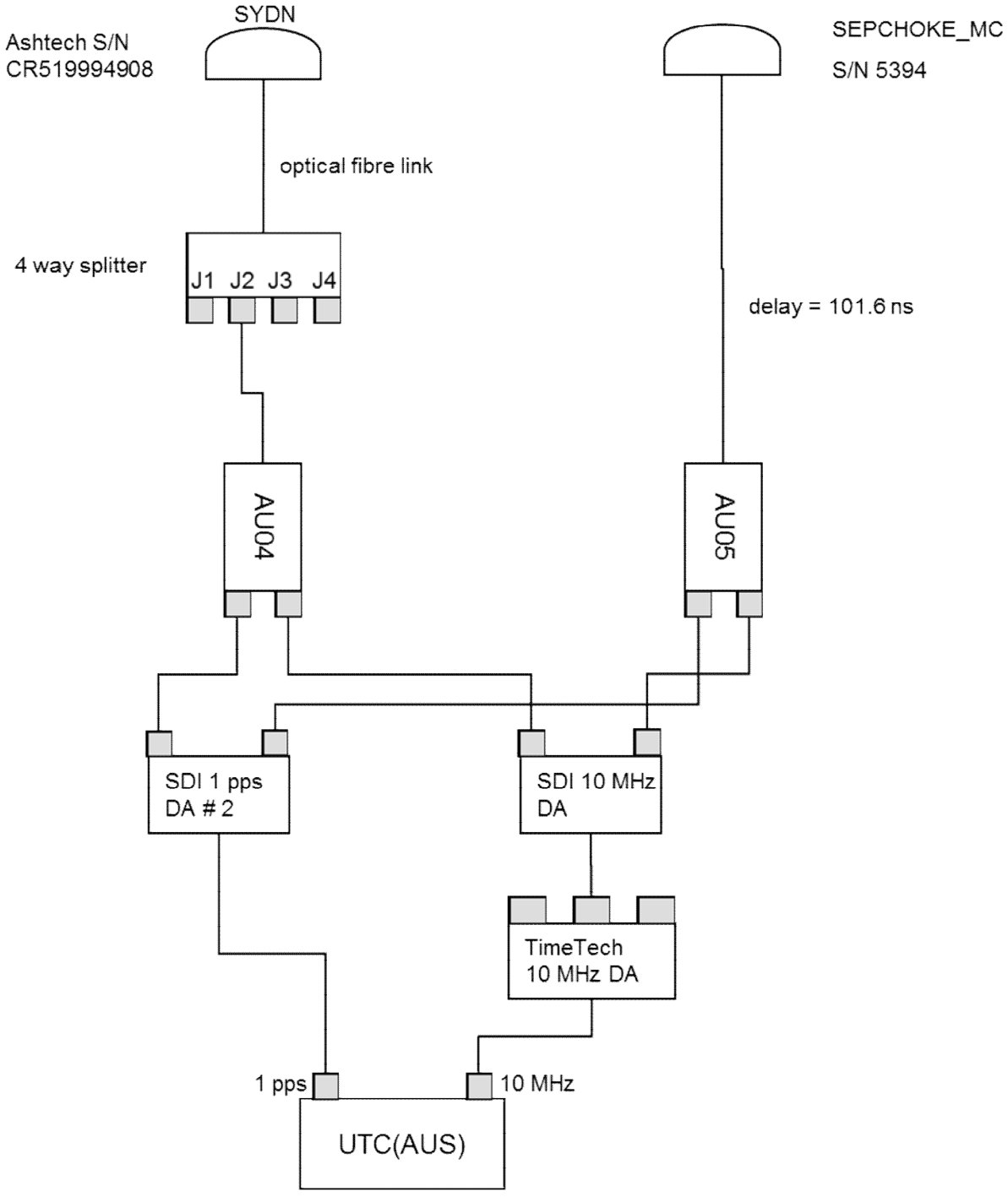


Figure 1 Signal distribution

2. GNSS antenna installations

Figure 2 AU04 antenna

Figure 3 AU05 antenna (centre)

3. Event log

Date	Time (UTC)	Event
2020-05-16	0000	Calibration starts
2020-05-20	0000	Calibration ends

4. NMI antenna information

AU04 antenna

Manufacturer	Ashtech
Model	Choke ring antenna 701945C_M
S/N	CR519994908
Coordinates	
Reference frame	ITRF2014
X	- 4648240.87
Y	2560636.49
Z	- 3526317.92

AU05 antenna

Manufacturer	Septentrio
Model	Choke ring antenna SEPCHOKE_MC
S/N	5394
Coordinates	
Reference frame	ITRF2014
X	- 4648198.702
Y	2560482.054
Z	- 3526508.465

Antenna coordinates were computed using the AUSPOS positioning service.

5. GNSS receiver information and delays

AU04 receiver

GNSS receiver	
NMI RINEX identifier	SEP1
Manufacturer	Septentrio
Model	PolaRx2TR
S/N	3252
Delay measurements	
As reported in 1002-2010	

AU05 receiver

GNSS receiver	
NMI RINEX identifier	SEP2
Manufacturer	Septentrio
Model	PolaRx4TR PRO
S/N	3102181
Delay measurements	
Antenna cable	101.6 ± 0.5 ns
REF 1 pps delay	217.4 ± 0.5 ns

6. Processing of RINEX observations

RINEX observation files were processed using dclrinex (v 19/02/2020) with a fixed baseline using the coordinates reported here.

dclrinexplot.sh plots are attached in Appendix A .

The raw (median) delays for the AU04-AU05 comparison were:

Signal	Delay (ns)	u (ns)
C1	2422.92	0.1
P1	2420.61	0.1
P2	2423.47	0.1

The uncertainty is estimated from the TDEV of the comparison, as per the Guidelines.

C1 and P1 delays were checked using CGGTTS time-transfer data generated using r2cggttts (v8.1) and compared in common-view to calculate delays. These delays agreed with the dclrinex-calculated delays within the 0.1 ns resolution of CGGTTS time-transfer data. Note that the same antenna coordinates were used with both dclrinex and r2cggtts so this degree of freedom has been removed.

7. Uncertainty analysis

The uncertainty analysis does not include AU04 cable delays because these are already included in the uncertainty of the UTC-AU04 link. The presumption is that the the total uncertainty of the AU05-UTC link is obtained by combining the uncertainty reported here with the uncertainty of the AU04-UTC link.

Uncertainty sources considered are tabulated below:

Source	u (ns)
AU04	
Antenna position Multipath	0.2 0.2
AU05	
Antenna cable delay REF 1 pps delay Antenna position Multipath	0.5 0.5 0.2 0.2

8. Final GPS signal delays

The original calibration report for the AU04 delays does not provide the C1 delay. This has instead been determined by transfer from the P1 delay and is assigned a nominal uncertainty of 0.1 ns.

Sample calculation: P1 delay

The delay of a GPS signal with respect to the local reference is:

REF – GPS = INT DLY + CAB DLY – REF DLY

For AU04:

REF – GPS = 220.9 + 2480.6 – 345.3 = 2356.2 ns

For AU05:

REF – GPS = INT DLY + 101.6 – 217.4 = INT DLY - 115.8 ns

So for the raw difference AU04 – AU05:

2420.61 = 2356.2 – (INT DLY – 115.8)

giving:

INT DLY = 51.4 ns

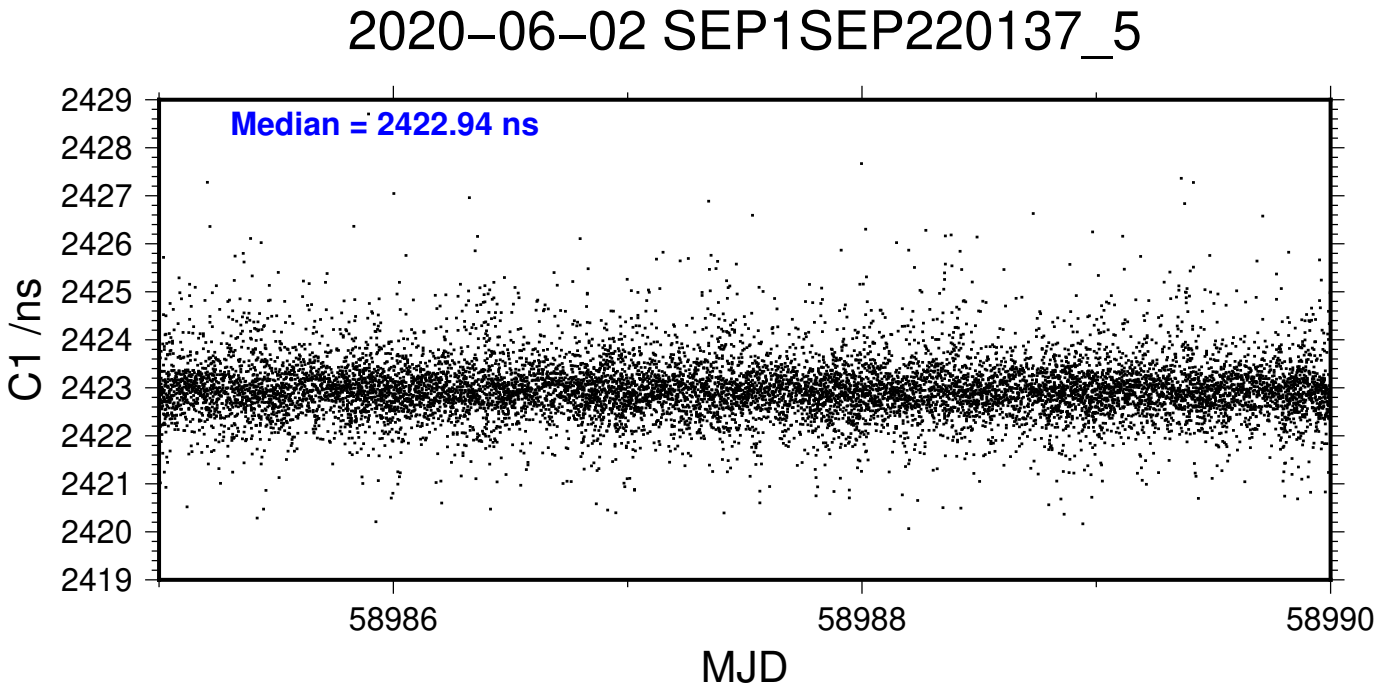
Final signal delays and their uncertainties are tabulated below:

Signal	INT DLY (ns)	u (ns)
C1	52.3	0.8
P1	51.4	0.8
P2	49.6	0.8

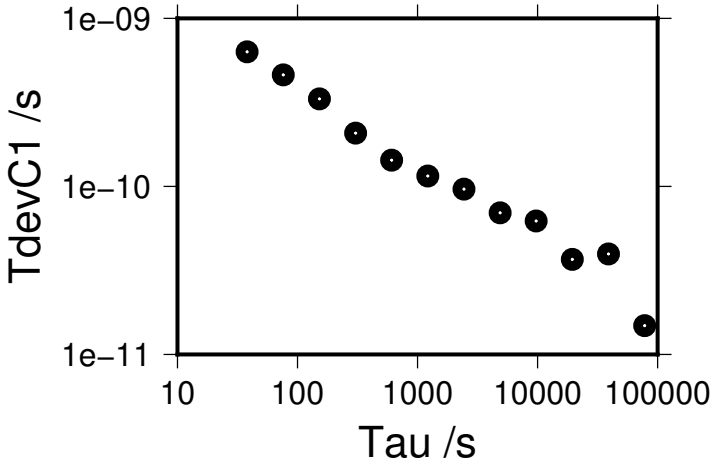
Final delays were checked via a comparison of AU04 and AU05 (using the new delays) CGGTTS data.

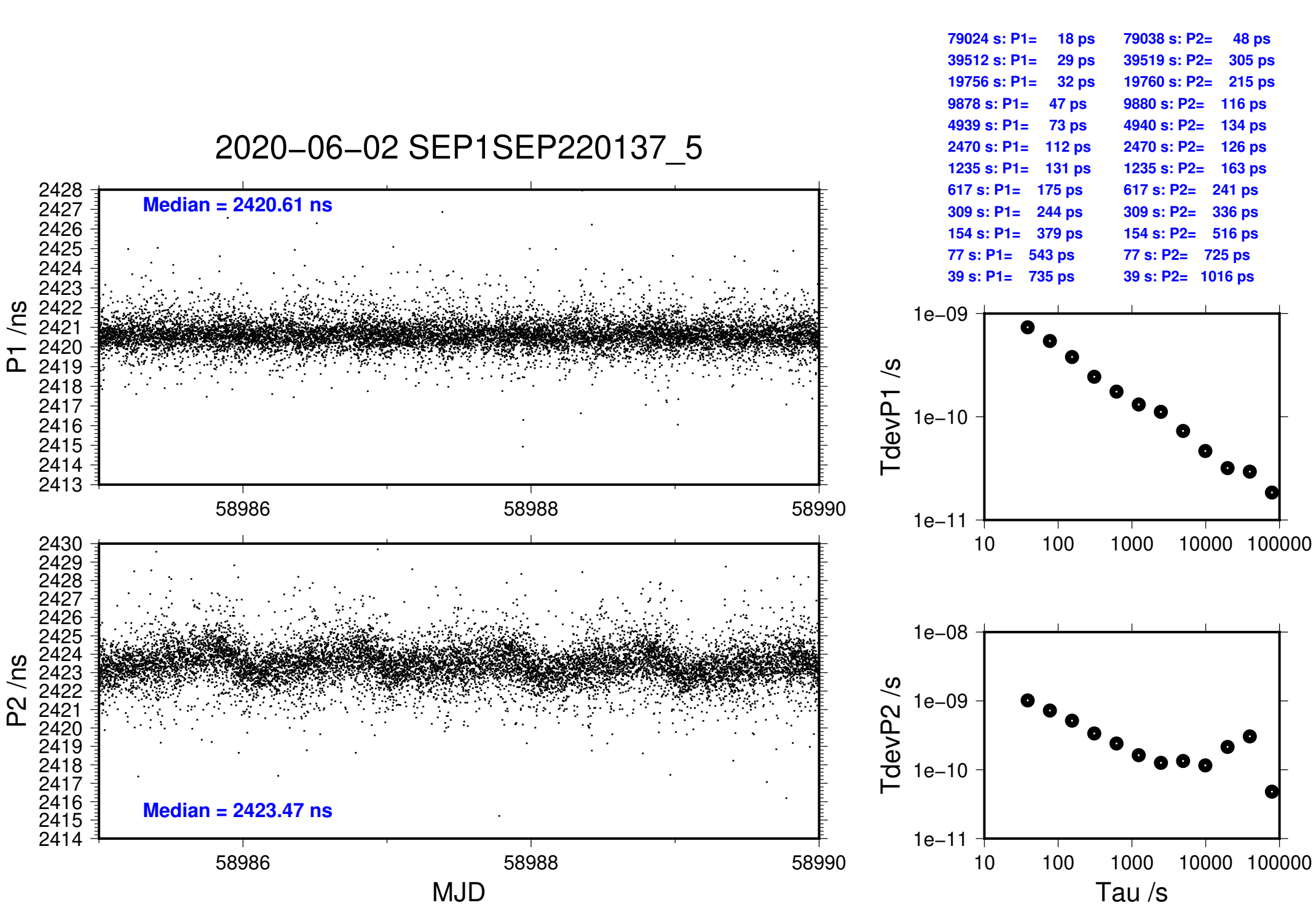
Appendix A: dclrinexplot.sh output

Plots follow.



77917 s: C1= 15 ps
38958 s: C1= 40 ps
19479 s: C1= 37 ps
9740 s: C1= 62 ps
4870 s: C1= 70 ps
2435 s: C1= 96 ps
1217 s: C1= 115 ps
609 s: C1= 143 ps
304 s: C1= 207 ps
152 s: C1= 332 ps
76 s: C1= 461 ps
38 s: C1= 632 ps




2020–06–02 SEP1SEP220137_5
Median = 2420.61 ns
Median = 2423.47 ns
P1 /ns
P2 /ns
MJD
58986
58988
58990
79024 s: P1= 18 ps
39512 s: P1= 29 ps
19756 s: P1= 32 ps
9878 s: P1= 47 ps
4939 s: P1= 73 ps
2470 s: P1= 112 ps
1235 s: P1= 131 ps
617 s: P1= 175 ps
309 s: P1= 244 ps
154 s: P1= 379 ps
77 s: P1= 543 ps
39 s: P1= 735 ps
79038 s: P2= 48 ps
39519 s: P2= 305 ps
19760 s: P2= 215 ps
9880 s: P2= 116 ps
4940 s: P2= 134 ps
2470 s: P2= 126 ps
1235 s: P2= 163 ps
617 s: P2= 241 ps
309 s: P2= 336 ps
154 s: P2= 516 ps
77 s: P2= 725 ps
39 s: P2= 1016 ps
TdevP1 /s
TdevP2 /s
Tau /s