



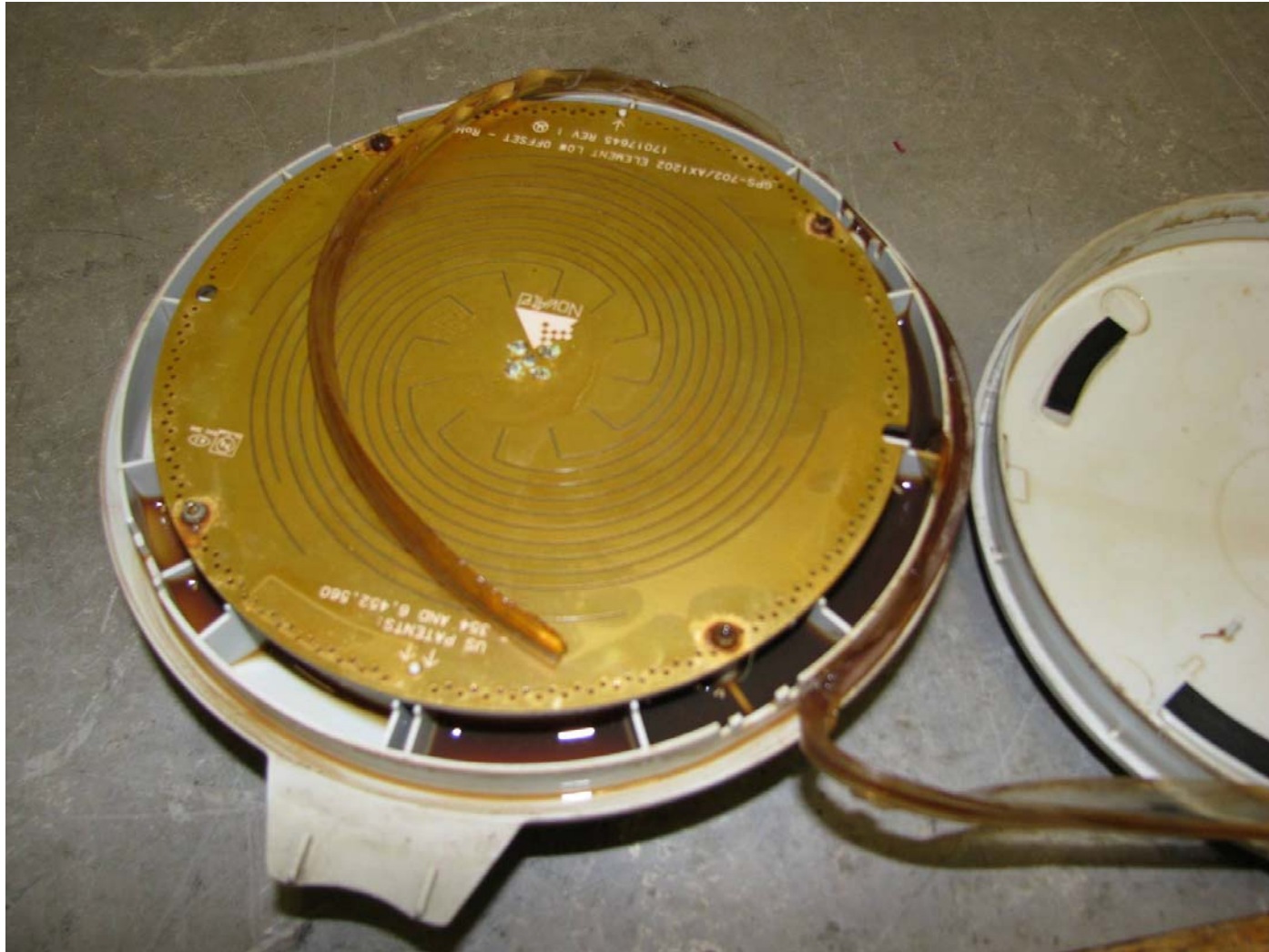
Australian Government
National Measurement Institute

Report on BIPM receiver calibration visit at NMIA October 2010

Michael Wouters, NMIA



Iteration 1: failed antenna



Iteration 2: Five months later ...



Dicom GTR50

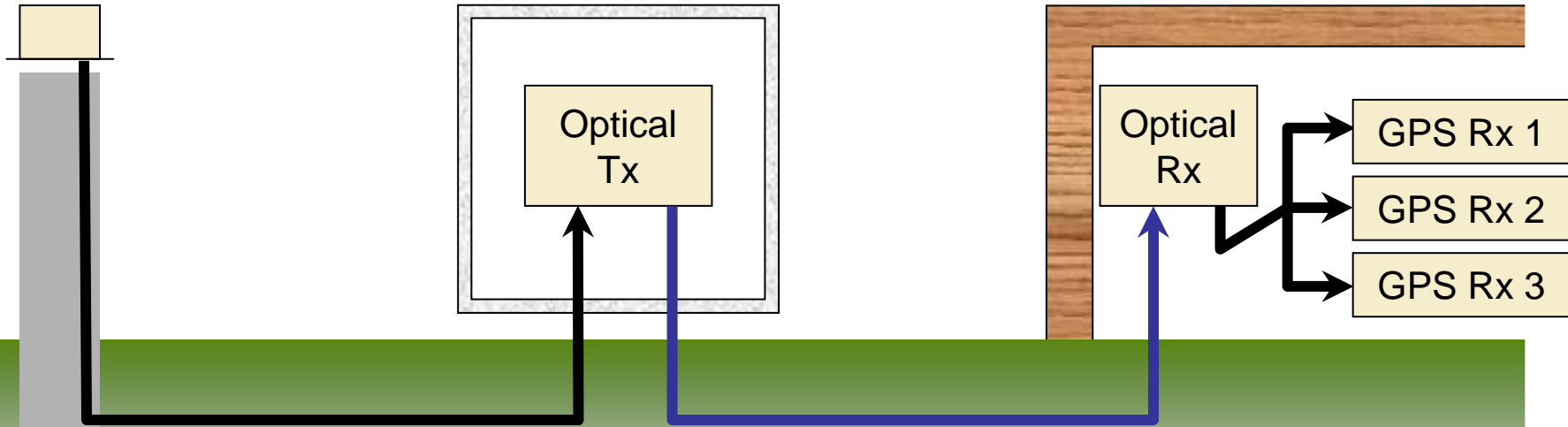


NMIA receiver setup (SYDN)

Ashtech choke-ring antenna

Weatherproof enclosure

Laboratory



Monument pillar
10m depth

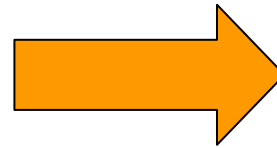
LMR400 antenna cable
~40m, in conduit

Corning SMF28 optical fibre
~520m, in trench and tunnels
Spare cores available (*eg* delay measurement)

2xTopcon Euro-160
L1/L2 GPS receiver,
Septentrio PolarX2e

Receiver reconfiguration

Javad Euro GGD (SYDN)

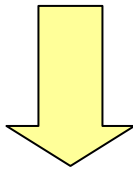


Test on backup receiver

Javad Euro GGD (NMI4)



1 PPS



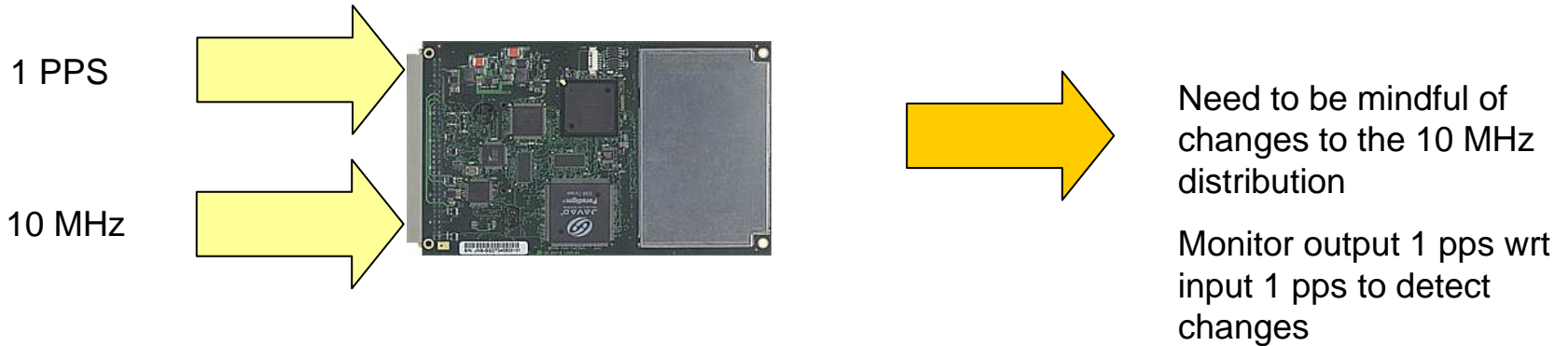
The output 1 pps is normally tied to the reference time scale (GPS)

but

The calibration protocol required that it be untied.

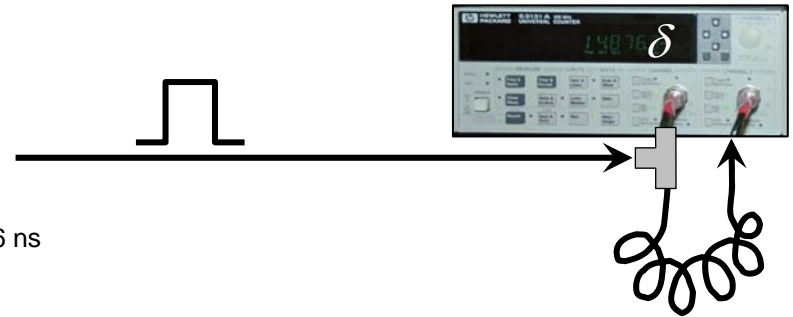
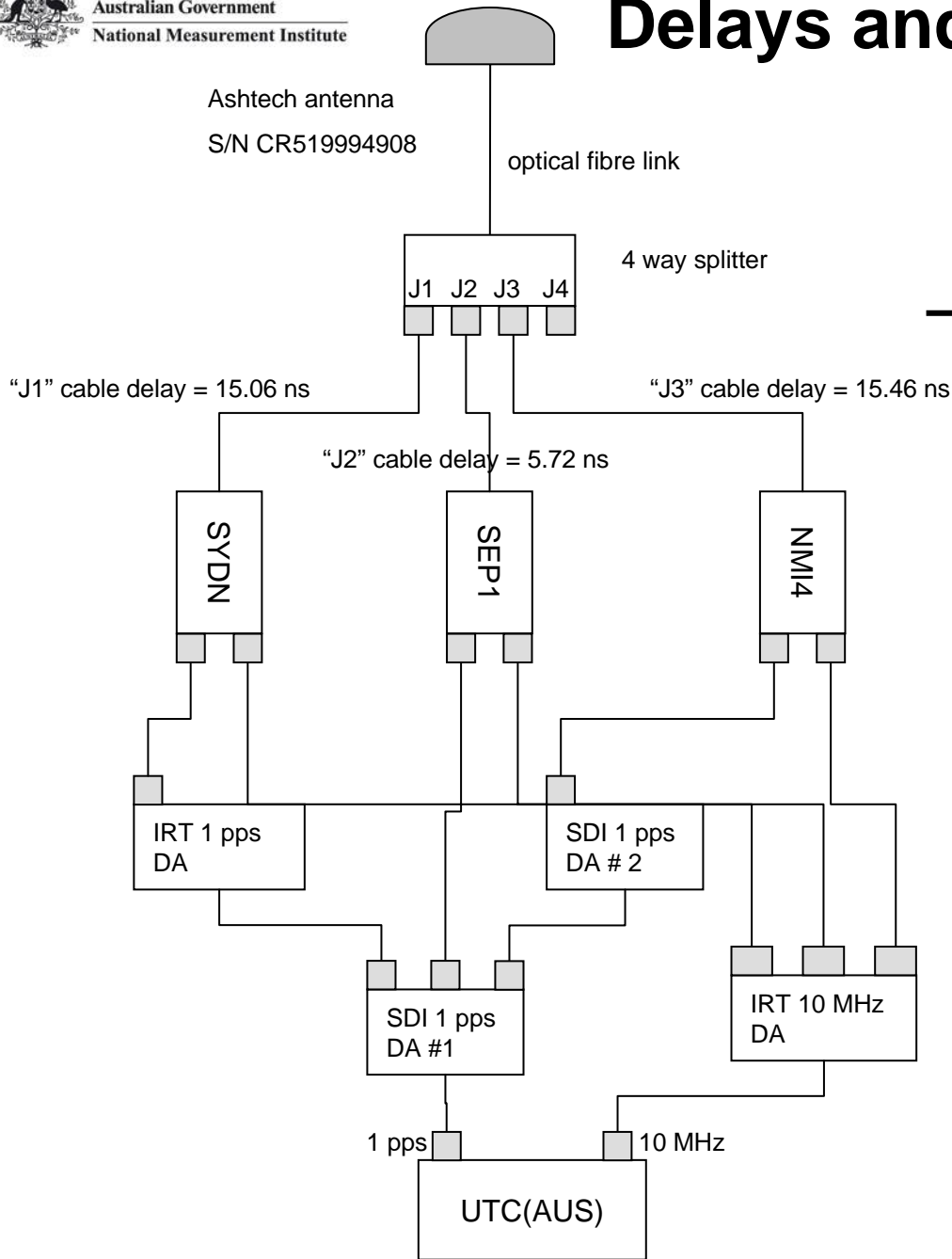
Operational changes

Javad Euro GGD



Internal delay as defined by the calibration protocol depends on the phase difference between the 1 PPS and 10 MHz

Delays and signal distribution



Measurement of cable delays

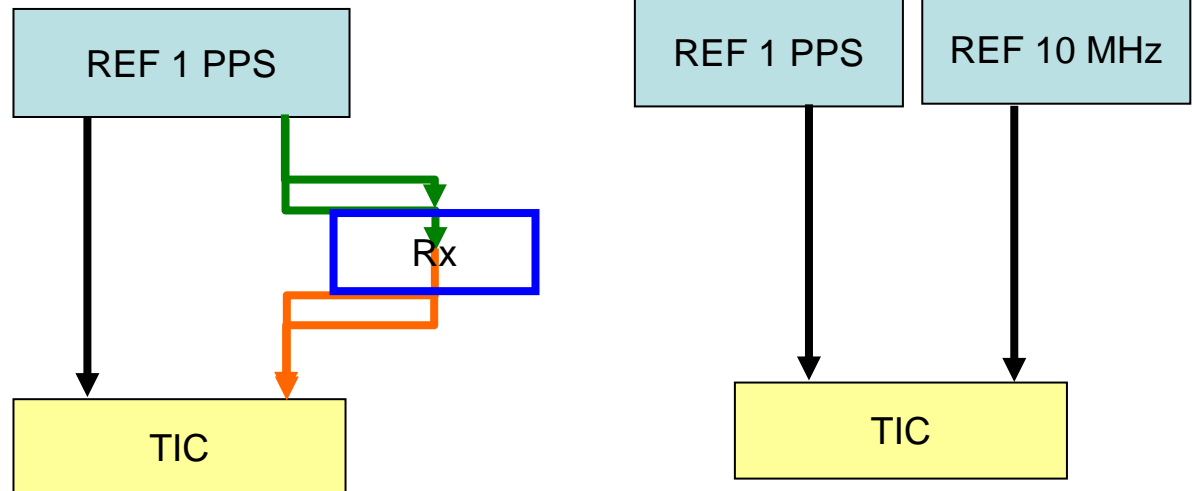
Local delay measurements

travelling receiver

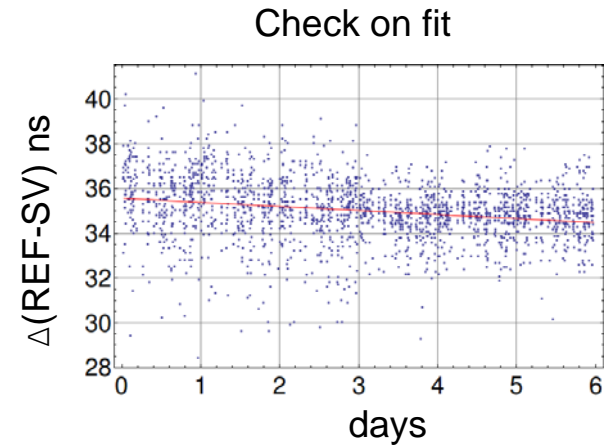
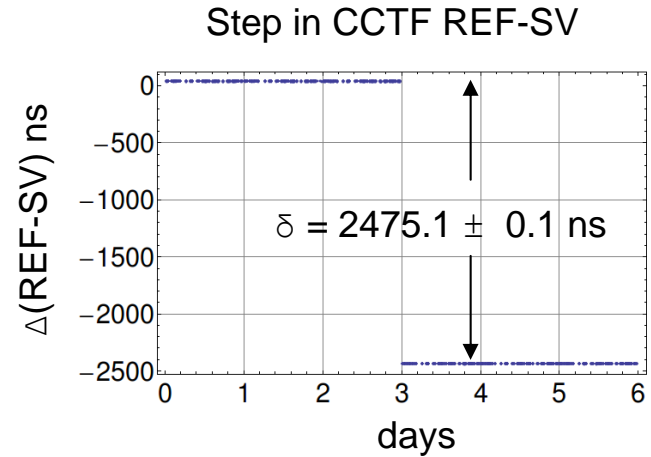
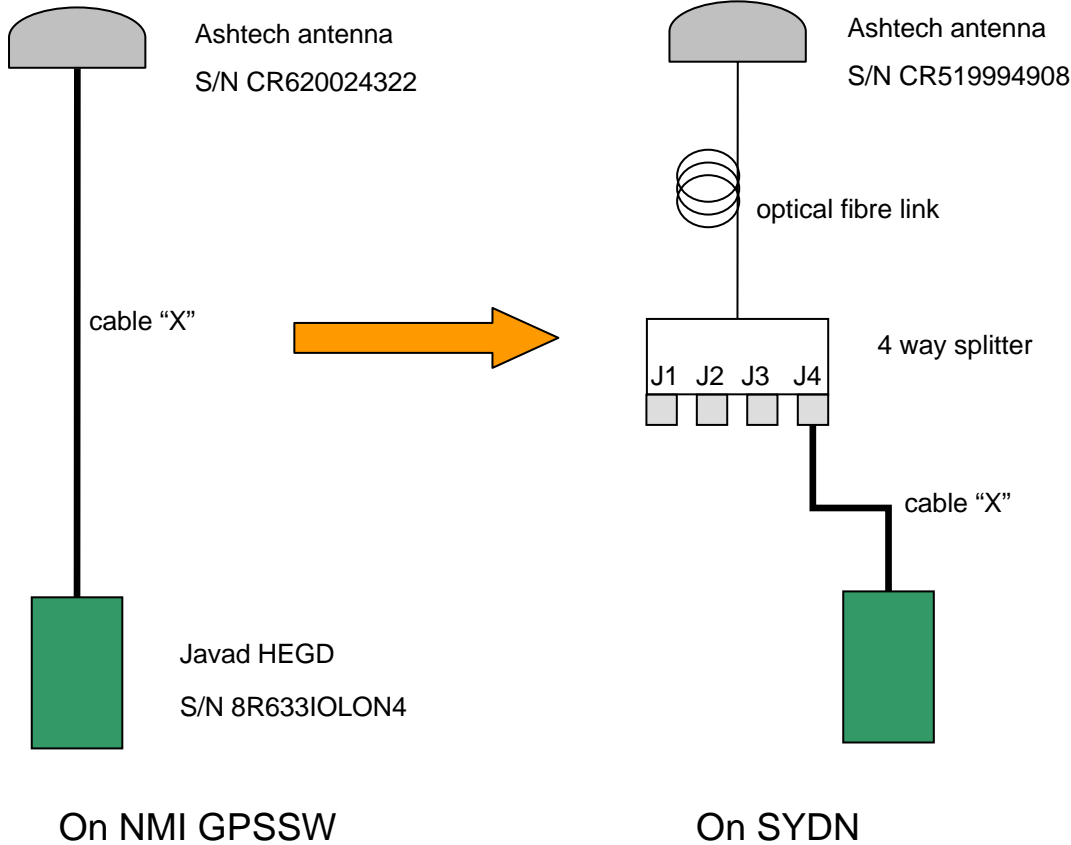


only need to measure
the delay of the
reference 1 pps input

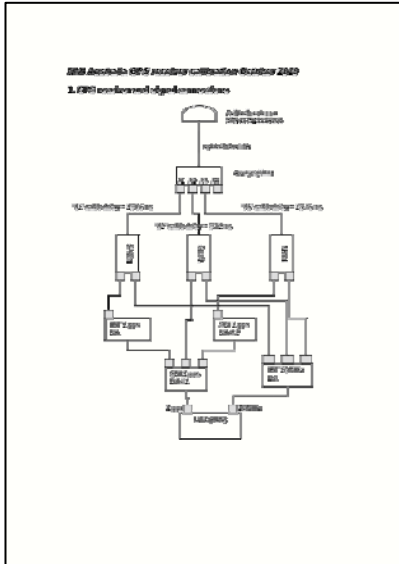
Insertion delay measurement
to measure the delay
between the input 1 pps and
output 1 pps.



Optical fibre link delay measurement



Documentation



signal distribution

2. 2017-01-01

№:	№:	№:
№:	№:	№:
№:	№:	№:
№:	№:	№:
№:	№:	№:

2. 2017-01-01

№:	№:
№:	№:
№:	№:
№:	№:
№:	№:

3. 2017-01-01

№:	№:
№:	№:
№:	№:
№:	№:
№:	№:

event log
receiver information
antenna information

2017

№:	№:
№:	№:
№:	№:
№:	№:
№:	№:

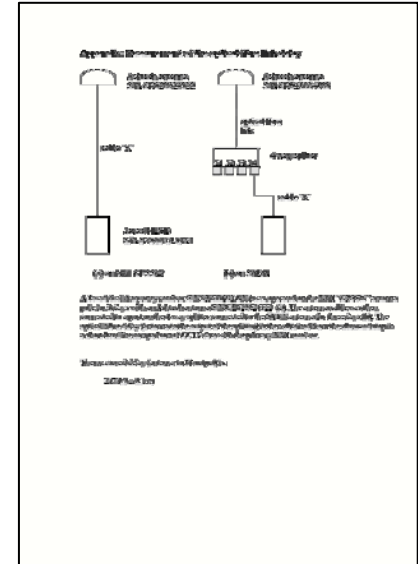
2017

№:	№:
№:	№:
№:	№:
№:	№:
№:	№:

2017

№:	№:
№:	№:
№:	№:
№:	№:
№:	№:

delays



Shipping problems



Lesson: dealing with these kinds of problems can be the hardest part

BIPM report

XP: From external reference to 1PPS in
 PolaRx2 XO: From 1PPS in to internal reference (i.e. 1PPS out (Meas 3.4) delayed by 8.7 ns)
 Javad Euro GGD: XO From 1PPS-in to 1PPS-out (taken as "internal reference")
 XC, XD: Cables etc... from antenna to receiver (typically XC is long cable, XD is short cable(s) + splitter if needed)
 XR: receiver internal delay; XS antenna delay
Reference values for BPOU (provisional August 2010): XR1+XS1 = -7.6 ns XR2+XS2 = -2.7 ns
Set-up at NMIA October 2010

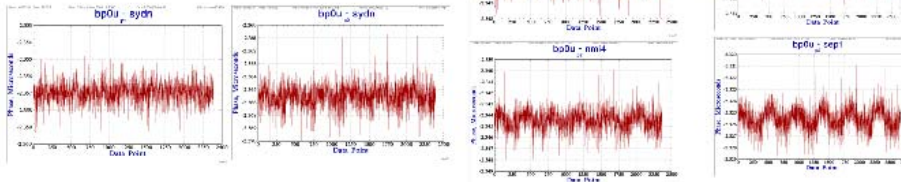
	x	y	z	ref - PPSin / ns	Meas 3.1 (3.3) / ns	Meas 3.2 / ns	Ant. Cable / ns
BPOU (GTR50)				95.7	N/A		XC = 182.0 ns
				XP = 95.7 ns	Int ref - 1PPSin (XO) = N/A ns		XC+XD = 182.0 ns
				INT_DLY0 = -99.07 ns	REF DLY = 95.7 ns		CAB DLY = 128.5 ns
SYDN (Euro GGD S/N AGE3M)				90.1	-7.4 / -7.3 (before/after)		XC = 2474.9 ns; XD = 15.1 ns
				XP = 90.1 ns	Int ref - 1PPSin (XO) = -7.3 ns		Short baseline: XC+XD = 2490.0 ns
NMI4 (EURO GGD S/N AGGT)				99.1	-2.1 / -2.3 (before/after)		XC = 2474.9 ns; XD = 15.5 ns
				XP = 99.1 ns	Int ref - 1PPSin (XO) = -2.2 ns		Short baseline: XC+XD = 2490.4 ns
SEP1 (PolaRx2 S/N 3252)				80.0	237.5 / 236.8 (before/after)		XC = 2474.9 ns; XD = 5.7 ns
				XP = 80.0 ns	Int ref - 1PPSin (XO) = 245.8 ns		Short baseline: XC+XD = 2480.6 ns

Observations

Short baseline: 55476-55482, day 280-286 (7-13 October 2010).

Measurement results

13/10/2010 (L. Tisserand)



SYDN Short baseline: Delta (-XP-XO+XR1+XC+XD+XS1) (SYDN - BPOU) = 2357.3 ns (NMI4-BPOU) = 2345.2 ns
 Delta (-XP-XO+XR2+XC+XD+XS2) (SYDN - BPOU) = 2366.1 ns (NMI4-BPOU) = 2344.4 ns

NMI4 Short baseline: SEP1 Short baseline: (SEP1 - BPOU) = 2329.8 ns
 (SEP1 - BPOU) = 2326.0 ns

Calibration results

03/03/2011 (G. Petit)

BPOU: -XP-XO+XR1+XC+XD+XS1 = 45.9 ns
 BPOU: -XP-XO+XR2+XC+XD+XS2 = 50.8 ns
 SYDN: -XP-XO+XC+XD = 2407.2 ns

For BPOU, XC+XD-XP-XO is the difference between the actual value (86.3 ns) and the value entered in the receiver (128.5-95.7 = 32.8 ns)

NMI4: -XP-XO+XC+XD = 2393.5 ns
 SEP1: -XP-XO+XC+XD = 2154.8 ns

Therefore

SYDN: XR1+XS1 = -4.0 ns
SYDN: XR2+XS2 = 9.7 ns

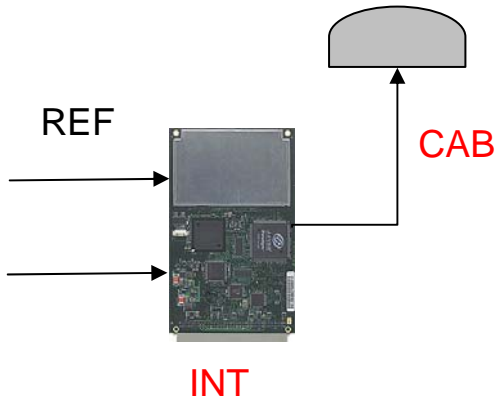
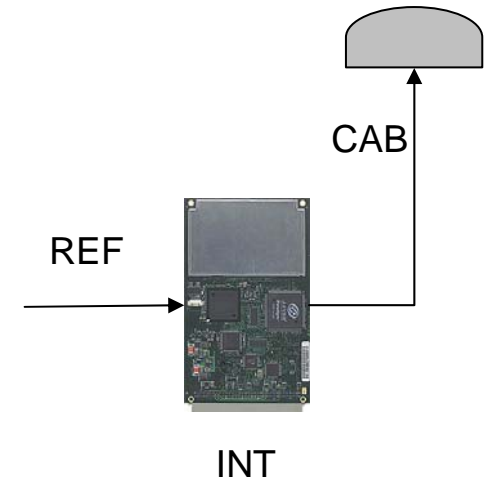
NMI4: XR1+XS1 = -2.4 ns
NMI4: XR2+XS2 = 1.7 ns

SEP1: XR1+XS1 = 220.9 ns
SEP1: XR2+XS2 = 222.0 ns

Checking the receiver delays

Primary receiver (Topcon Euro-80) *no ext. 10 MHz, 1 pps sync*

	L1 C/A delay (ns)	Reference
	46.5	Transfer from our TTR6
2002	37,5 ± 4	BIPM_H
2004	37,6 ± 4	BPON
2005	42,3 ± 3	OP-APMP



Unknown P3 delay
calibrated by alignment
with the GPS MC link

Using the new P3 calibration get a
delay of

33.4 ns

Correct by +4 ns for C/A – P1 delay

37.4 ns

BIPM assigns $u_B = 5$ ns to all GPS links calibrated via
a receiver comparison (G.Petit)



Australian Government
National Measurement Institute

This presentation will be available on the NMIA ftp server

<ftp://time.nmi.gov.au/APMP2012>

National Measurement Institute
Bradfield Road
West Lindfield NSW 2070
Australia

Phone: +61 2 8467 3501

Email: michael.wouters@measurement.gov.au

Web: www.measurement.gov.au/time

