Report from LNE-SYRTE / Observatoire de Paris on :

« Calibration of geodetic-type receivers using the traveling BIPM PolarRx2 Septentrio receiver BPO0 and the traveling BIPM Ashtech Z12-T receiver BIPC, May-June 2008 »

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1. Information about equipments under calibration:

1.1 General

OPMT : Ashtech Z12-T (IGS station) with TSA antenna
OPM2 : Ashtech Z12-T with same TSA antenna
OPM3 : Septentrio PolaRx2 first generation with Ashtech choke-ring antenna
OPM4 : Ashtech Z12-T with same Ashtech choke-ring antenna

All receivers are connected to H-maser 1400890.

1.2 Coordinates

OPMT/OPM2 :	X : 4202777,3831 m	L : 48° 50,9168110 N
	Y : 171367,9881 m	l : 2° 20,5579880 E
	Z : 4778660,4665 m	H : + 124,248 m
OPM3/OPM4 :	X : 4202781,56 m	L : 48° 50,1529850 N
	Y : 171369,05 m	l : 2° 20,0970330 E
	Z : 4778658,80 m	H : + 124,316 m
BIPC :	X : 4202783,408 m	L : 48° 50,1517950 N
	Y : 171367,803 m	l : 2° 20,0959533 E
	Z : 4778657,504 m	H : + 124,523 m

BP0O : unknown at the time of measurements

2. Calibratio trip:

BP0O (Sepentrio PolaRx2) and BIPC (Ashtech Z12-T) performed measurements at OP from 22/05/2008 [MJD 54608, DOY 143] to 06/06/2008 [MJD 54624, DOY 157].

3. Relating the internal reference to the laboratory reference

3.1-1) Measure the delay between the laboratory reference 1PPS @ 1V and the 20 MHz in (inverted, positive zero crossing) (oscilloscope range 1V)

OPMT / At the beginning – 26/05/2008:

[Direct Meas.1 V] delta1 = 6,339 ns / [Direct Meas. 50 mV] delta2 = 6,510 ns
[Cross Meas. 1 V] delta1 = 6,834 ns / [Cross Meas. 50 mV] delta2 = 6,852 ns

Mean value @50 mV : $delta_{OPMT}$ = 6,681 ns

OPMT / At the end – 05/06/2008:

[Direct Meas.1 V] delta1 = 7,050 ns / [Direct Meas. 50 mV] delta2 = 6,834 ns
[Cross Meas. 1 V] delta1 = 7,338 ns / [Cross Meas. 50 mV] delta2 = 7,052 ns

Mean value @50 mV : $delta_{OPMT}$ = 6,943 ns

OPM2 / At the beginning – 26/05/2008:

[Direct Meas. 1 V] delta1 = 15,296 ns / [Direct Meas.50 mV] delta2 = 15,143 ns
[Cross Meas. 1 V] delta1 = 15,539 ns / [Cross Meas. 50 mV] delta2 = 15,278 ns

Mean value @50 mV : $delta_{OPM2}$ = 15,211 ns

OPM2 / At the end – 05/06/2008:

[Direct Meas. 1 V] delta1 = 15,448 ns / [Direct Meas.50 mV] delta2 = 15,106 ns
[Cross Meas. 1 V] delta1 = 15,539 ns / [Cross Meas. 50 mV] delta2 = 15,314 ns

Mean value @50 mV : $delta_{OPM2}$ = 15, 210 ns

OPM4 / At the beginning – 26/05/2008:

[Direct Meas. 1 V] delta1 = 16,887 ns / [Direct Meas.50 mV] delta2 = 16,590 ns
[Cross Meas. 1 V] delta1 = 17,023 ns / [Cross Meas. 50 mV] delta2 = 16,852 ns

Mean value @50 mV : $delta_{OPM4}$ = 16,721 ns

OPM4 / At the end – 05/06/2008:

[Direct Meas. 1 V] delta1 = 16,745 ns / [Direct Meas.50 mV] delta2 = 16,592 ns
[Cross Meas. 1 V] delta1 = 17,114 ns / [Cross Meas. 50 mV] delta2 = 16,826 ns

Mean value @50 mV : $delta_{OPM4}$ = 16,709 ns

BIPC / At the beginning – 26/05/2008:

[Direct Meas.1 V] delta1 = 10,261 ns / [Direct Meas. 50 mV] delta2 = 10,144 ns
[Cross Meas. 1 V] delta1 = 10,495 ns / [Cross Meas. 50 mV] delta2 = 10,351 ns

Mean value @50 mV : $delta_{BIPC}$ = 10,248 ns

BIPC / At the end – 05/06/2008:

[Direct Meas.1 V] delta1 = 10,385 ns / [Direct Meas. 50 mV] delta2 = 10,348 ns
[Cross Meas. 1 V] delta1 = 10,684 ns / [Cross Meas. 50 mV] delta2 = 10,555 ns

Mean value @50 mV : $delta_{BIPC}$ = 10,452 ns

3.1-2) Measure the delay between the laboratory reference 1PPS @ 1V vs. 20 MHz out (positive zero crossing) (oscilloscope range 20 mV).
Note: 20 MHz out is not available on all systems.
[20 MHz out should trail inverted 20 MHz in by 18,2 ns]

OMPT / At the beginning – 26/05/2008:

delta 1 : not measured

[Mes 3-1-2] – [Mes 3-1-1] = not available

OMPT / At the end – 05/06/2008:

delta 1 : not measured
[Mes 3-1-2] – [Mes 3-1-1] = not available

3.1-3) Additional measurement: similar to 3.1-1) but connecting the cable of 20 MHz in and 1 PPS in directly to the oscilloscope. **This should be performed before starting and after stopping operation.**

OPMT / At the beginning – 26/05/2008:

[Direct Meas.1 V] delta1 = 6,018 ns / [Direct Meas.50 mV] delta2 = 5,709 ns
[Cross Meas. 1 V] delta1 = 6,123 ns / [Cross Meas. 50 mV] delta2 = 6,033 ns

Mean value @50 mV : $delta_{OPMT}$ = 5,871 ns

OPMT / At the end – 05/06/2008:

[Direct Meas.1 V] delta1 = 6,087 ns / [Direct Meas.50 mV] delta2 = 5,718 ns
[Cross Meas. 1 V] delta1 = 6,294 ns / [Cross Meas. 50 mV] delta2 = 6,042 ns

Mean value @50 mV : $delta_{OPMT}$ = 5,880 ns

OPM2 / At the beginning – 26/05/2008:

[Direct Meas.1 V] delta1 = 11,994 ns / [Direct Meas.50 mV] delta2 = 11,900 ns
[Cross Meas. 1 V] delta1 = 12,152 ns / [Cross Meas. 50 mV] delta2 = 12,034 ns

Mean value @50 mV : $delta_{OPM2}$ = 11,967ns

OPM2 / At the end – 05/06/2008:

[Direct Meas.1 V] delta1 = 12,014 ns / [Direct Meas.50 mV] delta2 = 11,878 ns
[Cross Meas.1 V] delta1 = 12,248 ns / [Cross Meas. 50 mV] delta2 = 11,150 ns

Mean value @50 mV : delta $_{OPM2}$ = 11,514 ns

OPM4 / At the beginning – 26/05/2008:

[Direct Meas.1 V] delta1 = 16,447 ns / [Direct Meas.50 mV] delta2 = 16,213 ns
[Cross Meas. 1 V] delta1 = 16,393 ns / [Cross Meas. 50 mV] delta2 = 16,348 ns

Mean value @50 mV : delta $_{OPM4}$ = 16,281 ns

OPM4 / At the end – 05/06/2008:

[Direct Meas.1 V] delta1 = 16,465 ns / [Direct Meas.50 mV] delta2 = 16,078 ns
[Cross Meas. 1 V] delta1 = 16,645 ns / [Cross Meas. 50 mV] delta2 = 16,501 ns

Mean value @50 mV : $delta_{OPM4}$ 16,290 ns

BIPC / At the beginning – 26/05/2008:

[Direct Meas.1 V] delta1 = 10,818 ns / [Direct Meas. 50 mV] delta2 = 10,675 ns
[Cross Meas. 1 V] delta1 = 11,278 ns / [Cross Meas. 50 mV] delta2 = 10,963 ns

Mean value @50 mV : $delta_{BIPC}$ = 10,819 ns

BIPC / At the end – 05/06/2008:

[Direct Meas.1 V] delta1 = 10,920 ns / [Direct Meas. 50 mV] delta2 = 10,747 ns
[Cross Meas. 1 V] delta1 = 11,269 ns / [Cross Meas. 50 mV] delta2 = 11,062 ns

Mean value @50 mV : $delta_{BIPC}$ = 10,905 ns

3.1-4 Delay between 1 pps IN and H maser 1400890 reference point:

Average value of 100 measurements

At the beginning – 26/05/2008 :

OPMT : 33,017 ns
OPM2 : 39,141 ns
OPM3 : 34,398 ns
OPM4 : 60,009 ns
BIPC : -0,322 ns
BPO0 : -0,513 ns

At the end – 05/06/2008 :

OPMT : 32,898 ns
OPM2 : 39,102 ns
OPM3 : 34,364 ns
OPM4 : 59,976 ns
BIPC : -0,389 ns
BPO0 : -0,599 ns

Uncertainty: 0,300 ns

3.2 Septentrio PolaRx2 :

Measure the delay between the 1PPS-in and 1PPS-out. **The result should be between 213,0 and 246,3 ns (+/- 2ns) for firmware version 2.3 and higher**.

OPM3 / At the beginning – 26/05/2008 :

Meas 1 : 56,733 ns
Meas 2 : 286,209 ns

Delta : 229,476 ns 1 sig = 0,300 ns

OPM3 / At the end – 05/06/2008 :

Meas 1 : 56,643 ns
Meas 2 : 286,128 ns

Delta : 229,485 ns 1 sig = 0,300 ns

BP0O / At the beginning – 26/05/2008 :

Meas 1 : 22,070 ns

Meas 2 : 263,635 ns

Delta : 241,565 ns   1 sig = 0,300 ns

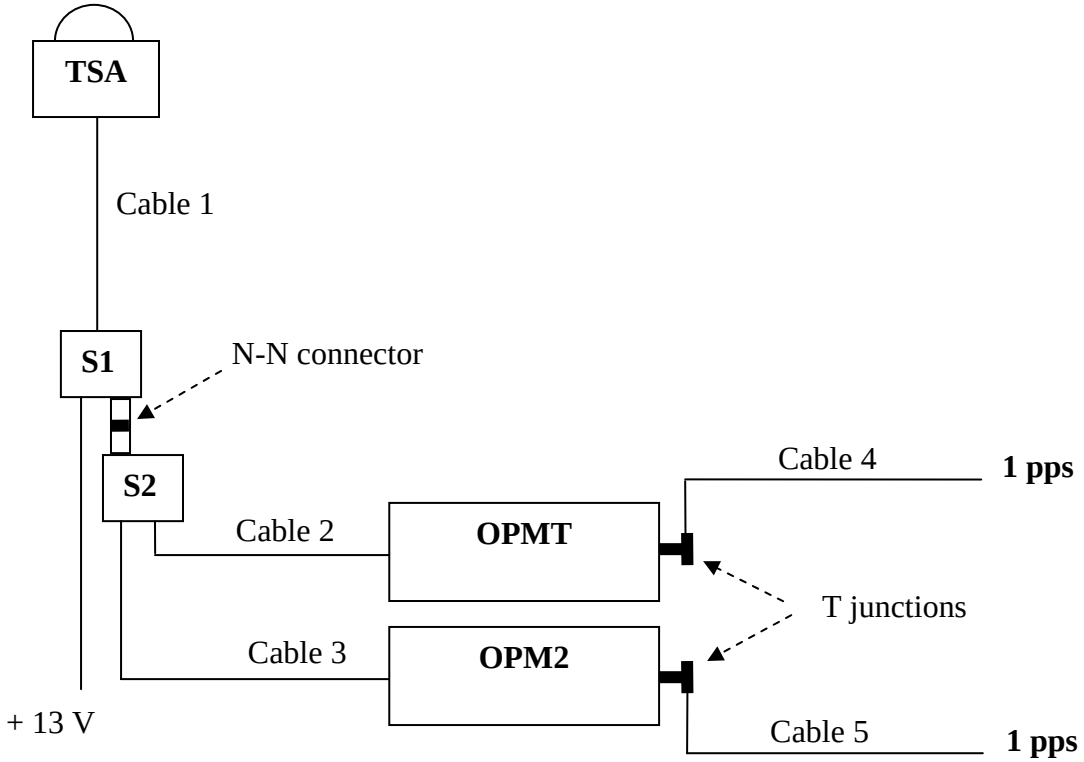
BP0O / At the end – 05/06/2008 :

Meas 1 :   22,050 ns
Meas 2 : 263,652 ns

Delta : 241,602 ns   1 sig = 0,300 ns

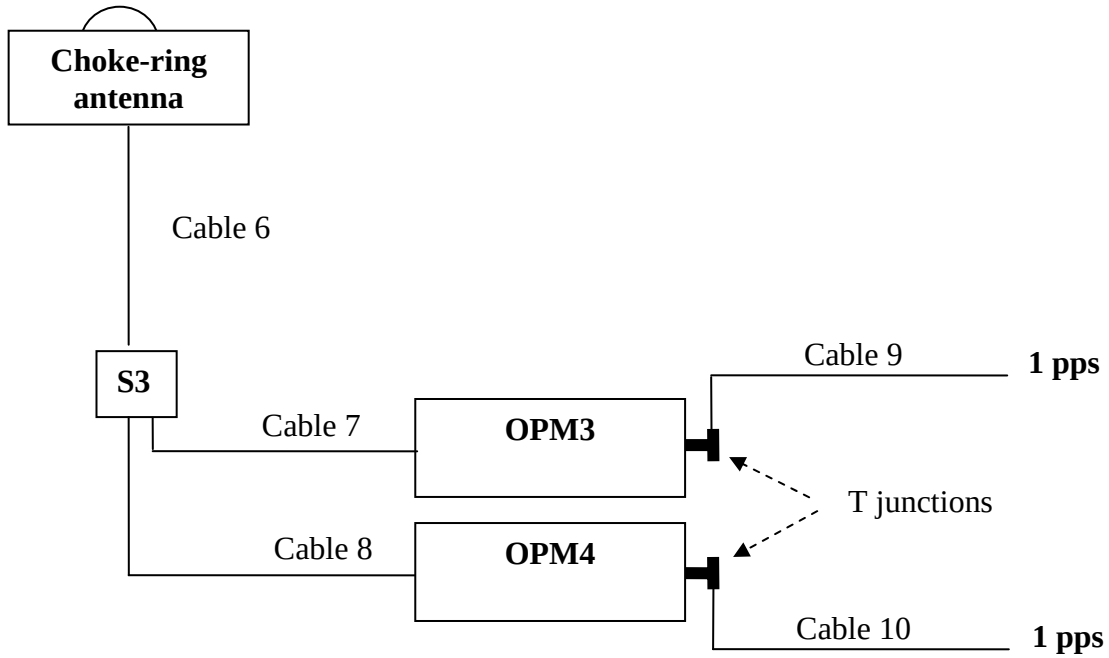
Note: The 10 MHz signal is attenuated by 12 dB for BP0O.

Figure describing the current set-up for OPMT and OPM2 :



TSA + Cable 1 = 151,0 ns (BIPM 2001)
Splitter S1 = 0,7 ns
Splitter S2 = 0,7 ns
Cable 2 = 4,2 ns (OP 2001)
Cable 3 = 5,3 ns (OP 14.02.2005)
Cable 4 = 32,90 ns (H Maser 1400890, OP June 2008)
Cable 5 = 39,10 ns (H Maser 1400890, OP June 2008)
N-N connector = N/A

Figure describing the current set-up for OPM3 and OPM4 :



Shock ring antenna + Cable 6 = N/A
Splitter S3 = 0,7 ns
Cable 7 = N/A
Cable 8 = N/A
Cable 9 = 34,36 ns (H Maser 1400890, OP June 2008)
Cable 10 = 59,98 ns (H Maser 1400890, OP June 2008)

Note: The 1 pps signal level with the H-Maser 890 issued from the Timetech amplifier was too weak (2,6 to 2,7 V), hence the PTF amplifier was used instead (more than 5 V).