

GPS Carrier Phase and TWSTFT comparisons of clock ensembles based at UWA and NMI

Hartnett J.G.¹, Tobar M.E.¹, Ivanov E.N.¹, Anstie J.D.¹, Locke C.R.¹, Luiten A.N.¹,
McFerran J.J.¹, Warrington R.B.², Wouters M.J.², Fisk P.T.H.²,
Chambon D.³, Santarelli G.³

¹Frequency Standards and Metrology research group, School of Physics, University of Western Australia, 35 Stirling Hwy, Crawley, WA 6009 Australia

²National Measurement Institute, Bradfield Road, West Lindfield, NSW 2070 Australia

³LNE-SYRTE, 61, avenue de l'Observatoire, 75014 Paris, France

The Frequency Standards and Metrology research group at the School of Physics, the University of Western Australia (UWA) and the Time and Frequency group of the National Measurement Institute (NMI) are developing apparatus and analysis to compare clocks across the continental baseline of Australia, using both GPS carrier phase as well as two way satellite time and frequency transfer (TWSTFT) techniques. The UWA group has purchased a Hydrogen Maser, which will complement an existing Cesium beam clock. The group is continuing the development of an in-house cold atom Calcium optical clock as well as a liquid-helium cooled ultra-stable Whispering Gallery (WG) mode sapphire cryogenic oscillator (CSO) and a solid Nitrogen cooled dual WG mode CSO. A microwave synthesis chain is currently under development that combines the output of the Cs clock, the hydrogen Maser and the sapphire oscillator to generate signals across the RF and microwave domain that exhibit the best properties of each of the reference oscillators. The synthesizer will provide a stable 10 MHz reference for our ongoing experiments. The NMI group has an ensemble of H-Masers and Cesium clocks, a high accuracy (10^{-15}) Ytterbium cold ion clock that is still under redevelopment, as well as a liquid-helium cooled ultra-stable WG mode CSO. NMI has substantial experience of both two-way satellite and GPS time and frequency transfer, and currently operates the SYDN node of the IGS network in partnership with Geoscience Australia. Independent GPS carrier phase and TWSTFT time and frequency transfer between UWA and NMI will allow not only the ensembles but also the techniques to be compared for short, medium and long timescales over a baseline of 3300 km. The experience gained from this collaboration will assist the UWA-NMI team to be ready for the Atomic Clock Ensemble in Space (ACES) mission. UWA and NMI have formed an official ACES user group and are Southern hemisphere laboratories preparing for ACES clock comparisons to support ACES science goals. An update on our progress in achieving these goals will be given at the workshop.