OPTIME - the system grows - a new 330 km line

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OPTIME project

Description of OPTIME project

The OPTIME creates an ultra-precise time and frequency signals dissemination system. End users obtain access to these signals without incurring huge costs for the purchase their own atomic clocks, and receive the service related to laboratories generating international atomic time scales, to which any precise time must be referred.

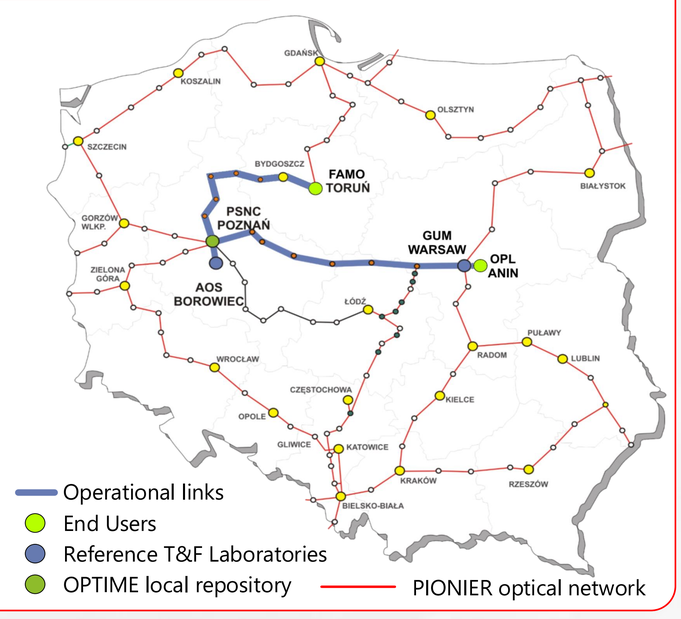
The OPTIME system based on three main elements:

- **Time and frequency reference laboratories** - provide time-frequency signals to the OPTIME system.
- **Local repositories** - synchronized to these laboratories - are responsible to maintain time-frequency signals during any failures caused by lost of connection with laboratories.
- **Fiber optical network** - with specialized transmission equipment transfers time and frequency signals between laboratories, repositories and end-users.

Topology of OPTIME system

System OPTIME consists:

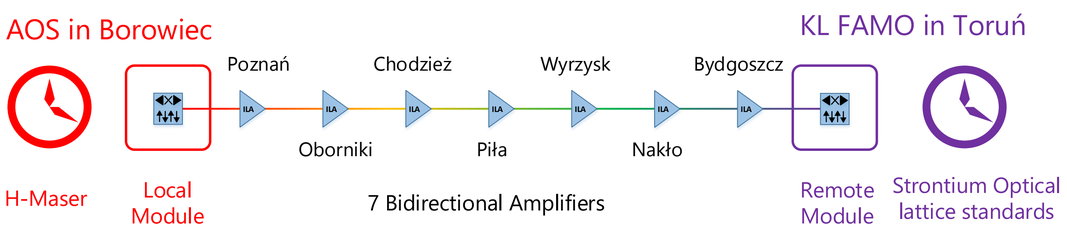
- **2 Time and Frequency Laboratories** – the first one is located in GUM in Warsaw and generates **UTC (PL)**, the second one is located in AOS in Borowiec and generates **UTC (AOS)**;
- **2 Local Repositories** – the first one is located in **PSNC** in Poznan, the second one will be located in **KL FAMO** in Torun;
- **2 fiber optical links 750 km long** – the first 420 km long is **operational** more then **3 years**, the second one 330 km long is operational since December 2014;



New 330 km line AOS – KL FAMO

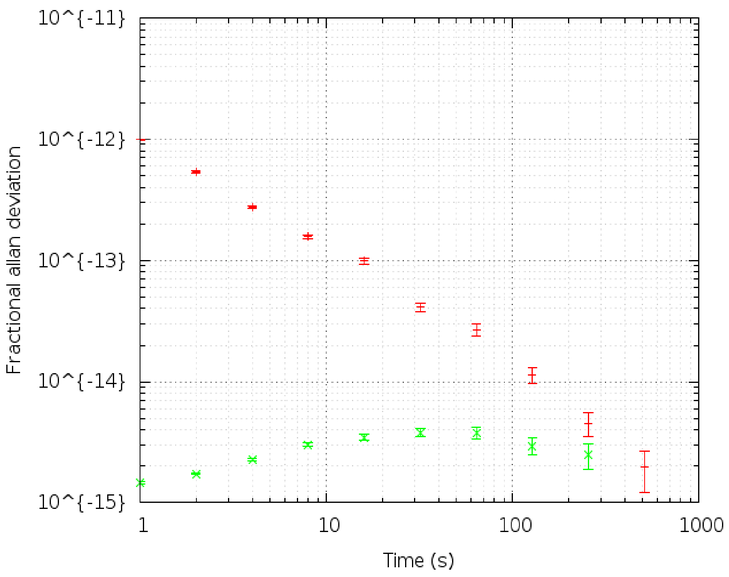
AOS – KL FAMO line topology

The new 330 km time and frequency dissemination line became operational in **December 2014**. This line connects **Astrogeodynamic Observatory (AOS**) in Borowiec to the **National Laboratory of Atomic, Molecular and Optical Physics (KL FAMO)** in Torun.
The line contains 7 specialized optical Bidirectional Amplifiers, one Local Module was installed at the AOS in Borowiec and one Remote Module was installed at the KL FAMO in Torun. All these devices were designed and built by project partner AGH University of Science and Technology.



Comparison 10 MHz signal AOS – KL FAMO

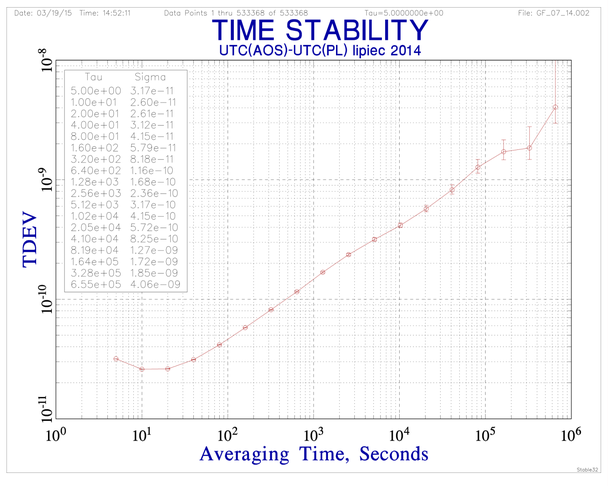
First results of comparison of 10 MHz signal from **H-Maser** located in AOS Borowiec and **Optical Clock** located in KL FAMO Torun. Green points – Allan deviation comparisons of two optical clocks at KL FAMO. Red points – Allan deviation of measurements of optical comb connected at KL FAMO to 10 MHz from Borowiec, and one of the strontium clocks.



420 km line AOS – GUM

Accuracy of comparisions UTC (AOS) – UTC (PL)

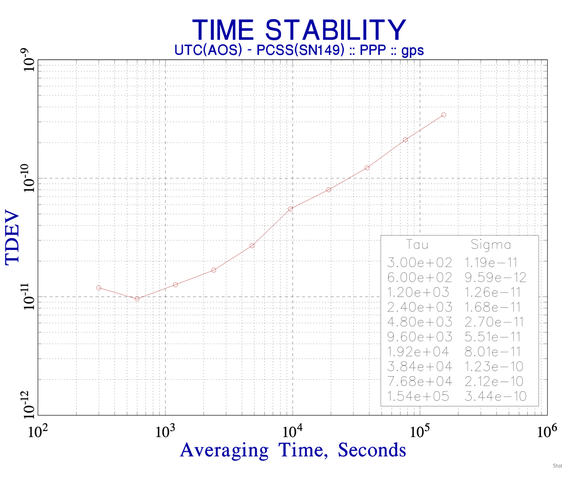
The optical 420 km link between Central Office of Measures (GUM) in Warsaw and Astrogeodynamical Observatory (AOS) in Borowiec near Poznan is **fully operational** and In permanent use for more than **3 years**. It allows for a **continuous real-time comparisons of the UTC (PL) and UTC (AOS) time scales**.
The precision of a single measurement (sampling time 5 s) is 30 ps. For averaging periods 0.5 hour increases to 25 ps. For longer intervals the noise of caesium clock located in GUM – UTC (PL) begins to dominate the comparisons.



First test AOS – PSNC

Comparisions UTC (AOS) – H-maser in PSNC

The results were obtained time using time transfer systems TTS-4, working simultaneously at the repository and AOS laboratory (For the computations of the results, Precse Point Positioning Method for GPS+GLONASS phase measurements was used). The distance between the two laboratories is in the range of 25 km. Short term precision of the measurements equals 10 – 11 ps for 30s and 60s averaging intervals.



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