

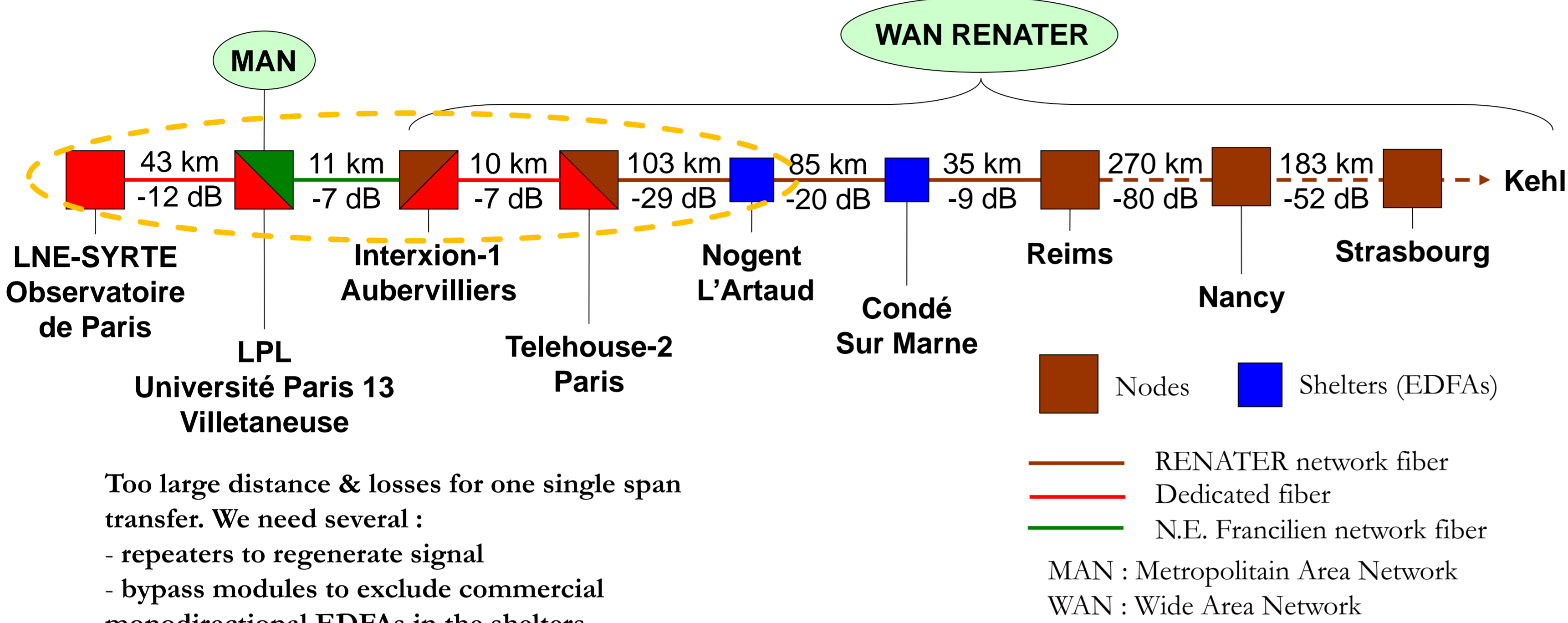
From a French towards a European Metrological Fiber Network for accurate Frequency and Time comparison and dissemination

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DISSEMINATION ON RENATER

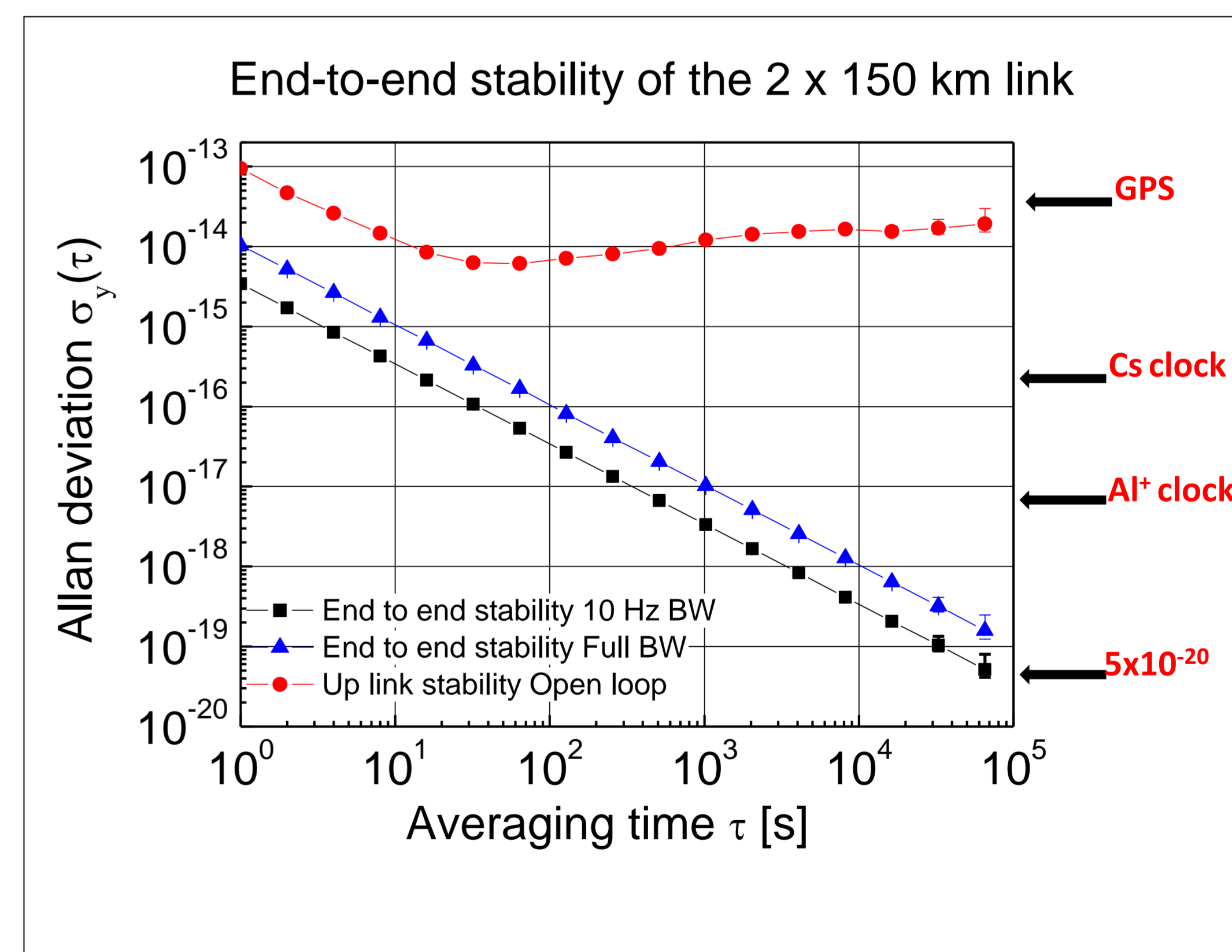
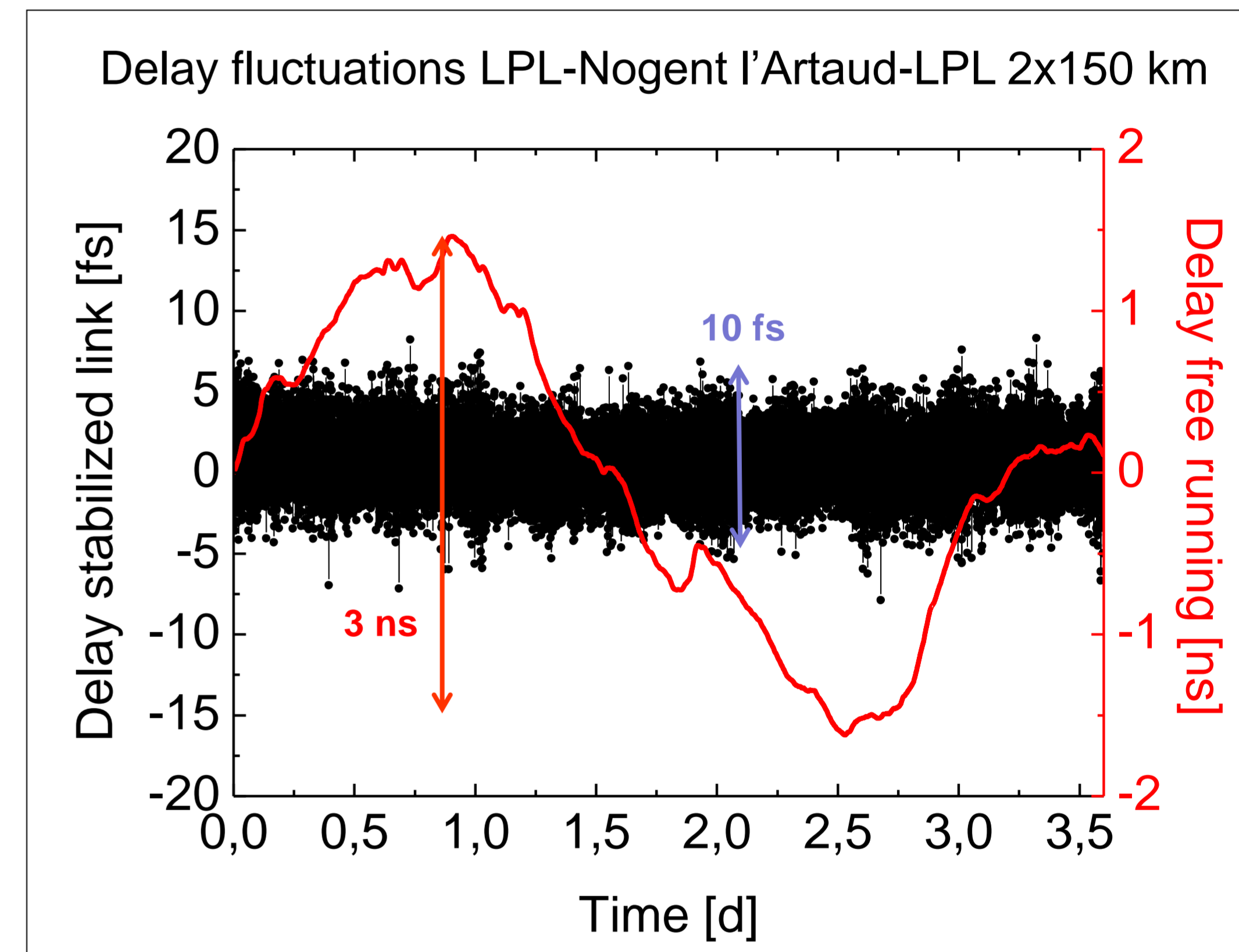
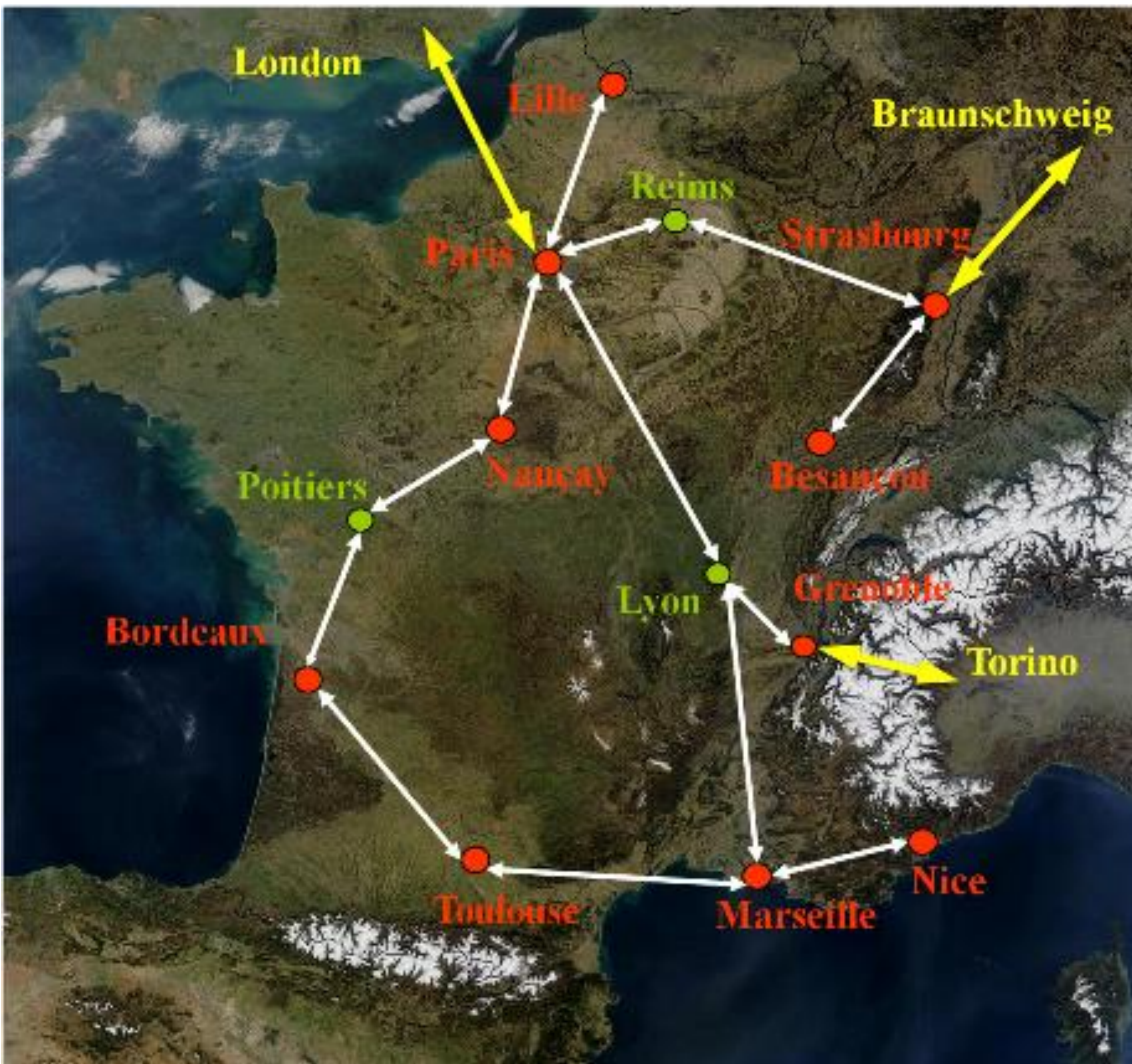
French National Telecommunication network for Technology Education and Research



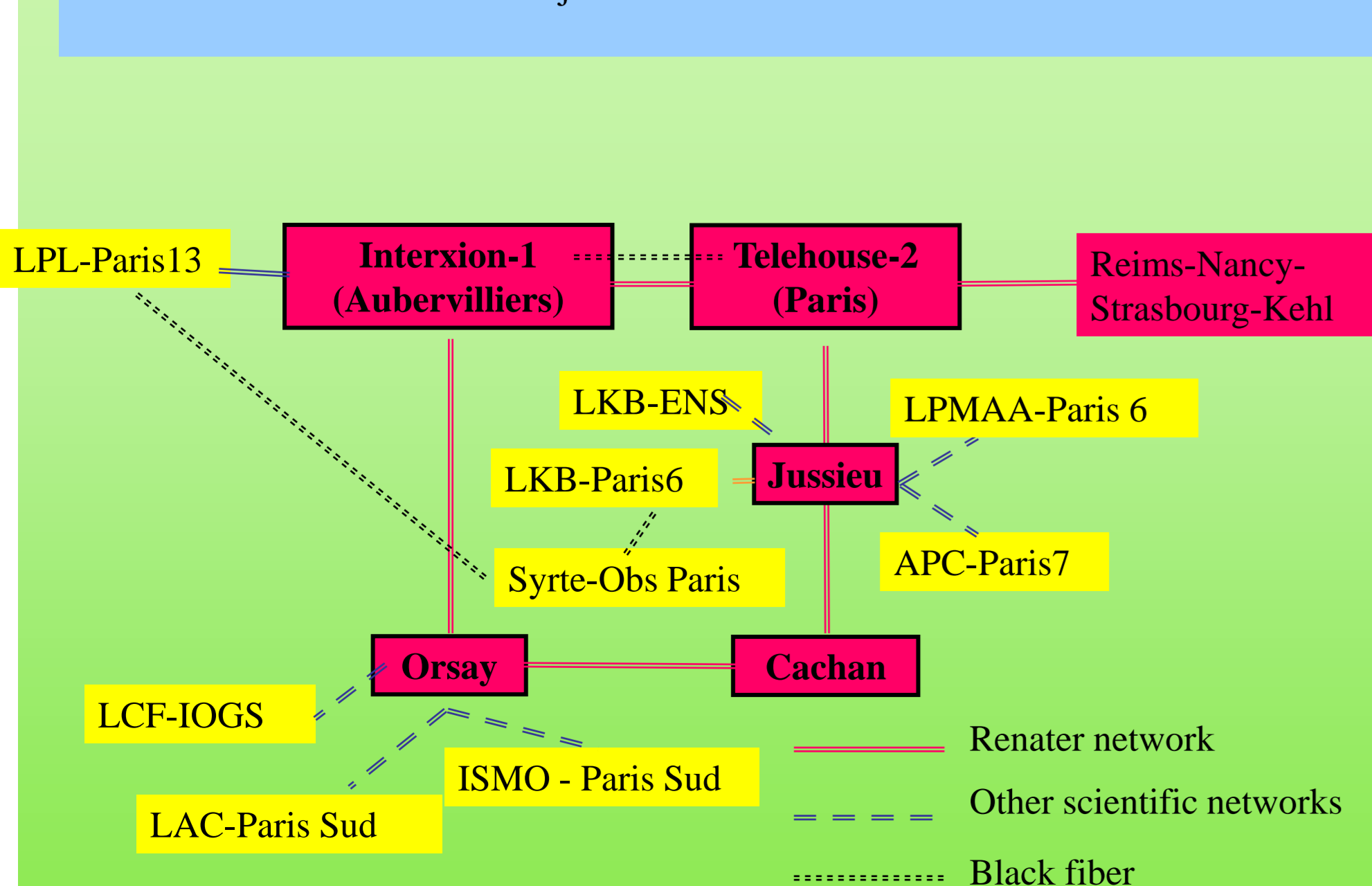
Too large distance & losses for one single span transfer. We need several :
- repeaters to regenerate signal
- bypass modules to exclude commercial monodirectional EDFAs in the shelters

Abstract

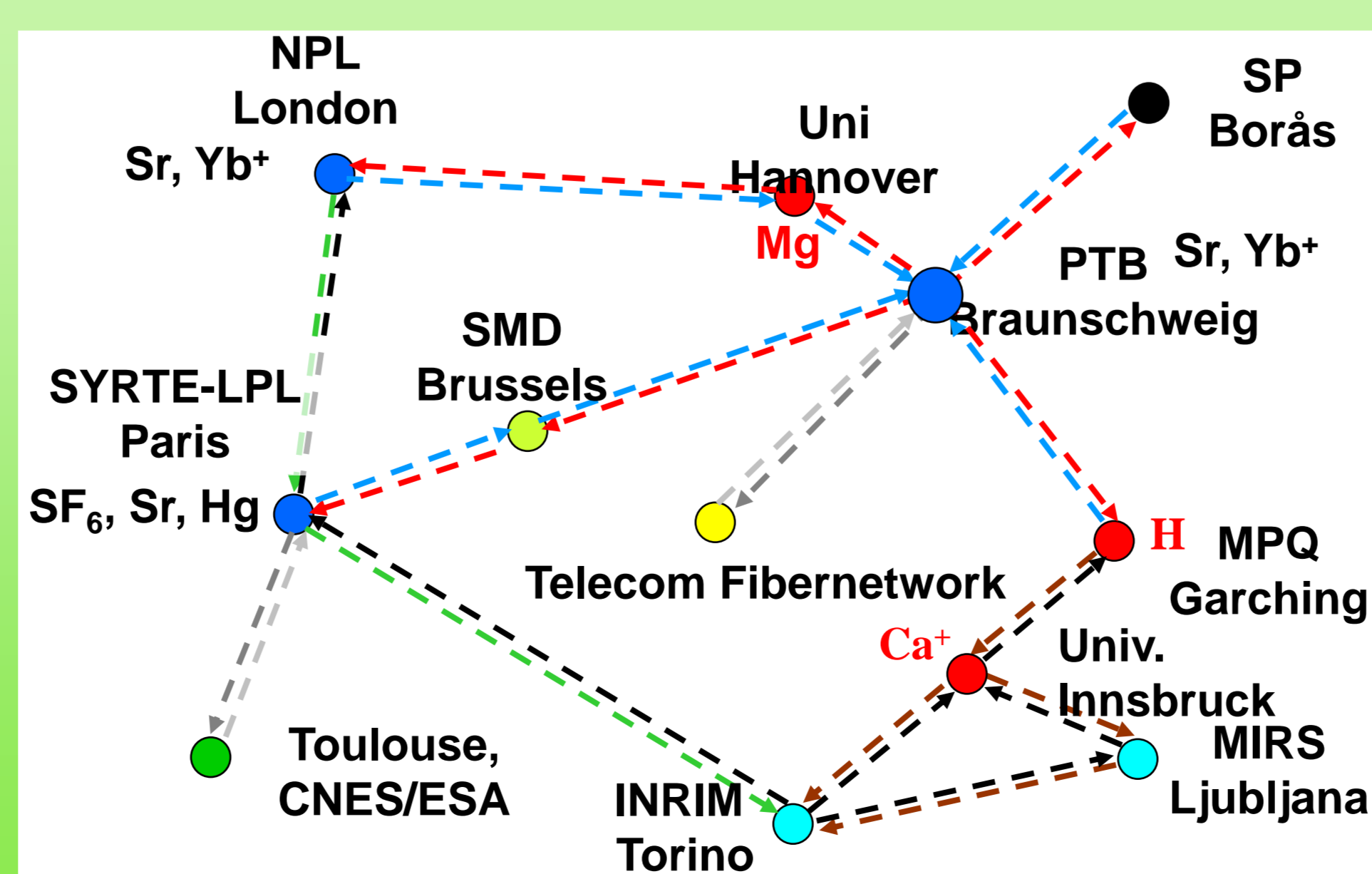
Nowadays optical clocks reach a fractional frequency uncertainty of the order of 10^{-17} and outperformed the best caesium-based atomic clocks in both accuracy and stability. This outstanding performance makes them the most promising candidates for the redefinition of the SI unit of time, the Second, and an ideal tool for various tests of fundamental physics. In Europe the most advanced state-of-the-art optical clocks are separated by distances of a few 100 km to 1500 km. The large effort invested in optical clocks development would be fruitless without an adequate comparison method. The need for improved time and frequency comparisons has been stressed by the Consultative Committee for Time and Frequency (CCTF) and is regarded as of extremely high priority for a future redefinition of the SI Second. Optical fiber links are the sole alternative to satellites based distant clock comparison, besides using transportable optical clocks. The demonstrated instability of an optical frequency transmitted over a fiber link is several orders of magnitude more stable than the signal used in satellite transmission systems. Up to now experiments used dedicated and specially selected fiber routes within national testbeds. To tap into the full potential of optical clocks and optical time and frequency dissemination, however, user-friendly and reliable pan-European fiber links, as well as new time and frequency transfer protocols need to be developed. Such an operation requires a combined and coordinated effort of the European NMIs and academic laboratories. The French REFIMEVE+ project recently financed for the next 8 years will allow a distribution of the best time and frequency references available at LNE-SYRTE to a set of about 20 French users including CNES at Toulouse. The principle is to use the RENATER internet infrastructure and bidirectional propagation on a given dark channel (#44). The experience acquired for a reliable distribution at a national level will pave the route for a distribution at a European level by connecting the National Metrologic Institutes with their national fiber network and thanks to European fiber network under the responsibility of the consortium DANTE which will greatly facilitate the trans-border connections



Project: Link in Ile-de-France



European fiber network for 2-way frequency comparison of optical clocks



Perspectives and Applications

The construction of the French Metrological Network connecting about 20 labs will last about 3 years. In parallel, discussions with European partners as well with the European consortium DANTE will prepare the extension of this network to Europe. This will first allow direct comparisons of the various frequency standards developed through Europe. Other applications will also take place :
- Very high precision measurements
- Test of variation of fundamental constants
- Geodesy, Astrophysics, ...
- Space - Earth clock comparison (PHARAO, ACES)

H. Jiang & al. "Long-distance frequency transfer over an urban fiber link using optical phase stabilization", *J. Opt. Soc. Am. B*, 25, 2029 (2008).

F. Kéfélian & al. "High-resolution optical frequency dissemination on a telecommunication network with data traffic", *Opt. Lett.*, 34, 1573-1575 (2009).

O. Lopez & al. "Cascaded multiplexed optical link on a telecommunication network for frequency dissemination", *Opt. Express*, 2010, 18, 16849-16857.