



REFIMEVE+ project: a tool at hand for ultra-stable and accurate measurements



O. Lopez

A. Amy-Klein

C. Chardonnet



Systèmes de Référence Temps-Espace

E. Cantin

P.-E. Pottie



N. Quintin

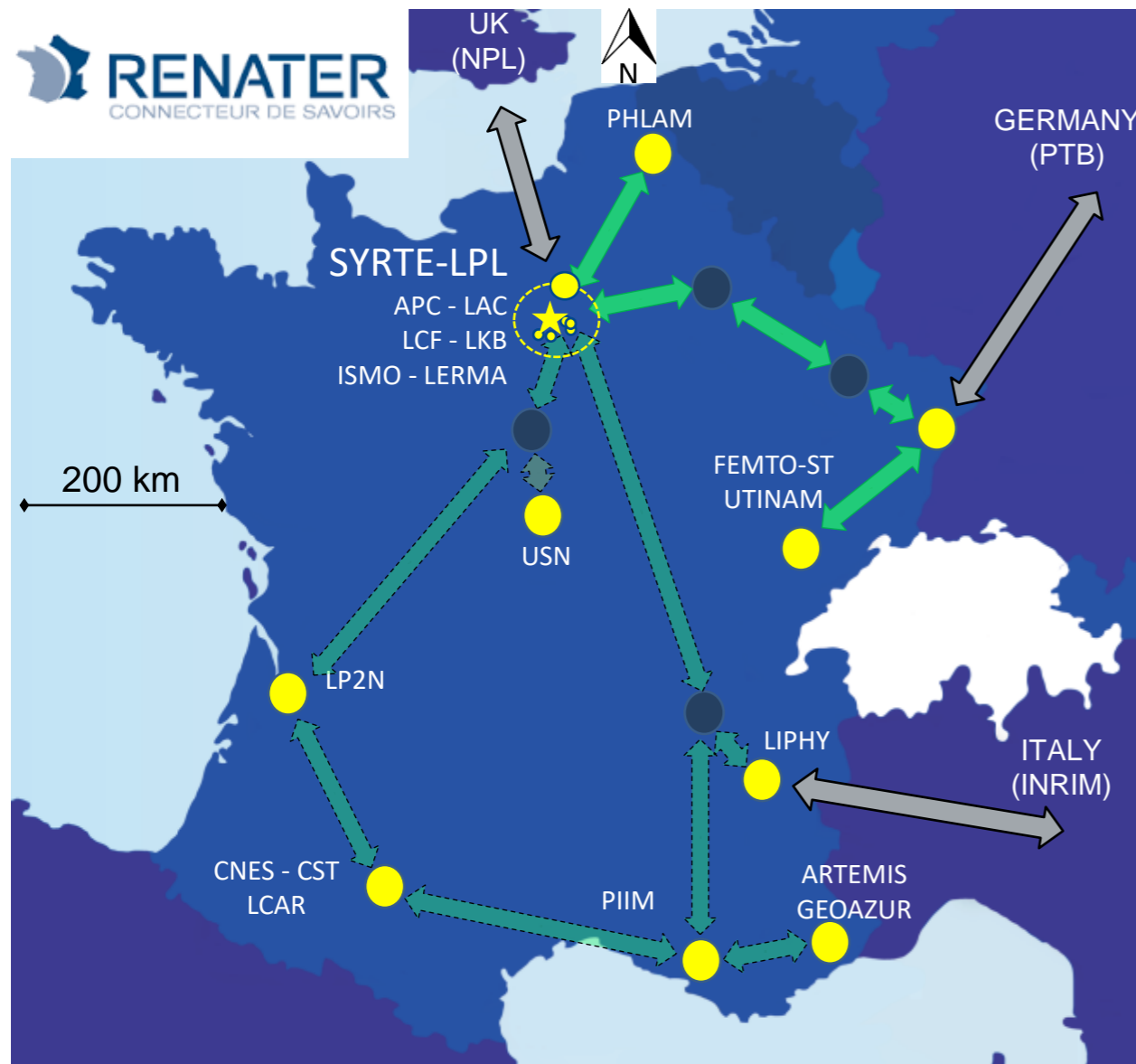


G. Santarelli

Contents

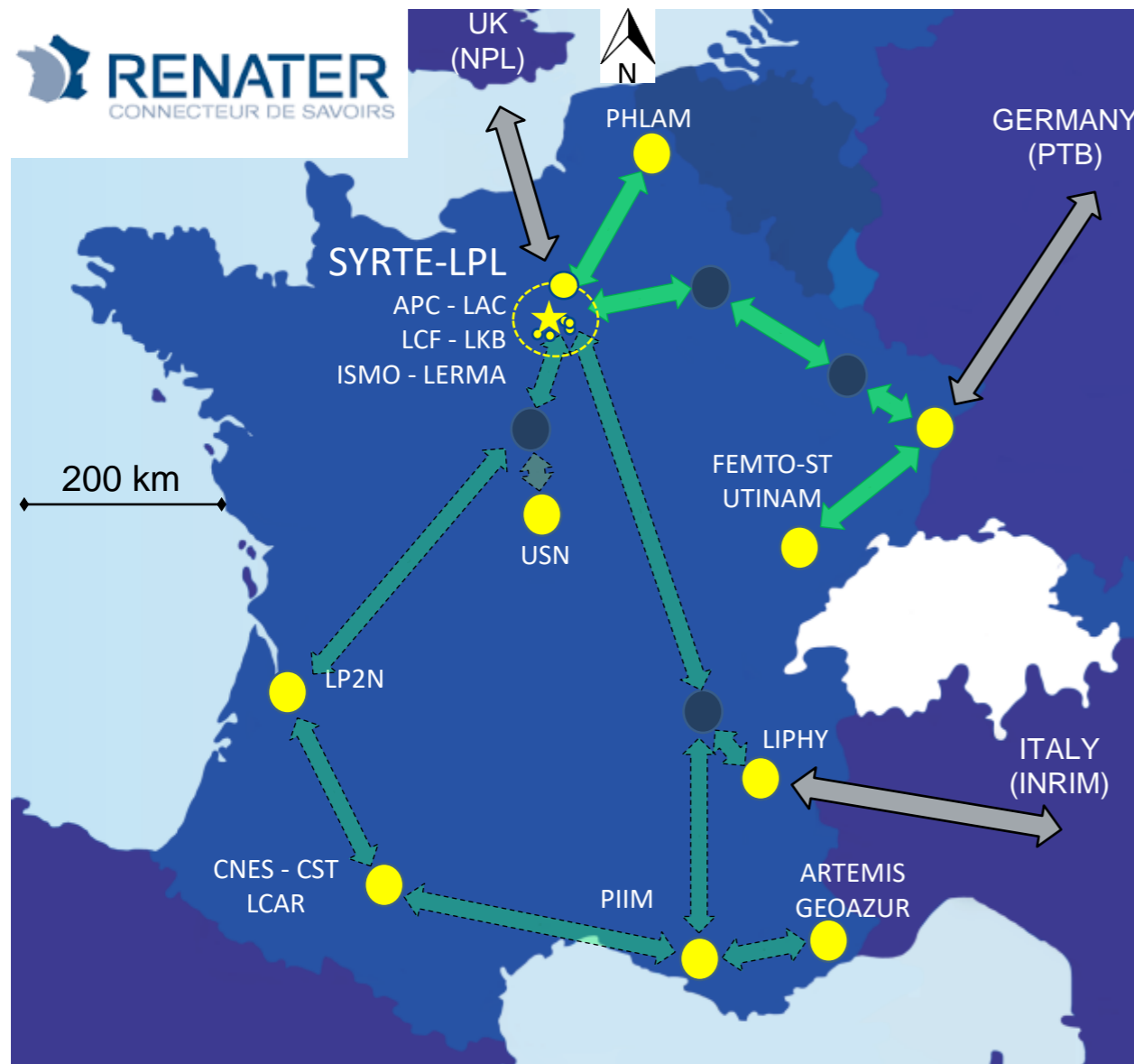
- The REFIMEVE+ project
- Industrial partnership
 - First industrial-grade fiber link
- Central hubs operation
- Conclusion and Outlook

REFIMEVE+ network



- **Objective:** Distribution of an ultra-stable frequency reference to partners laboratories
- 20 partners laboratories all over France
- **A Large Research Infrastructure**
→ Metrological service to laboratories
- Applications:
 - Clocks comparaison
 - High resolution spectroscopy
 - Chronometric geodesy
 - Test of General Relativity
 - ...

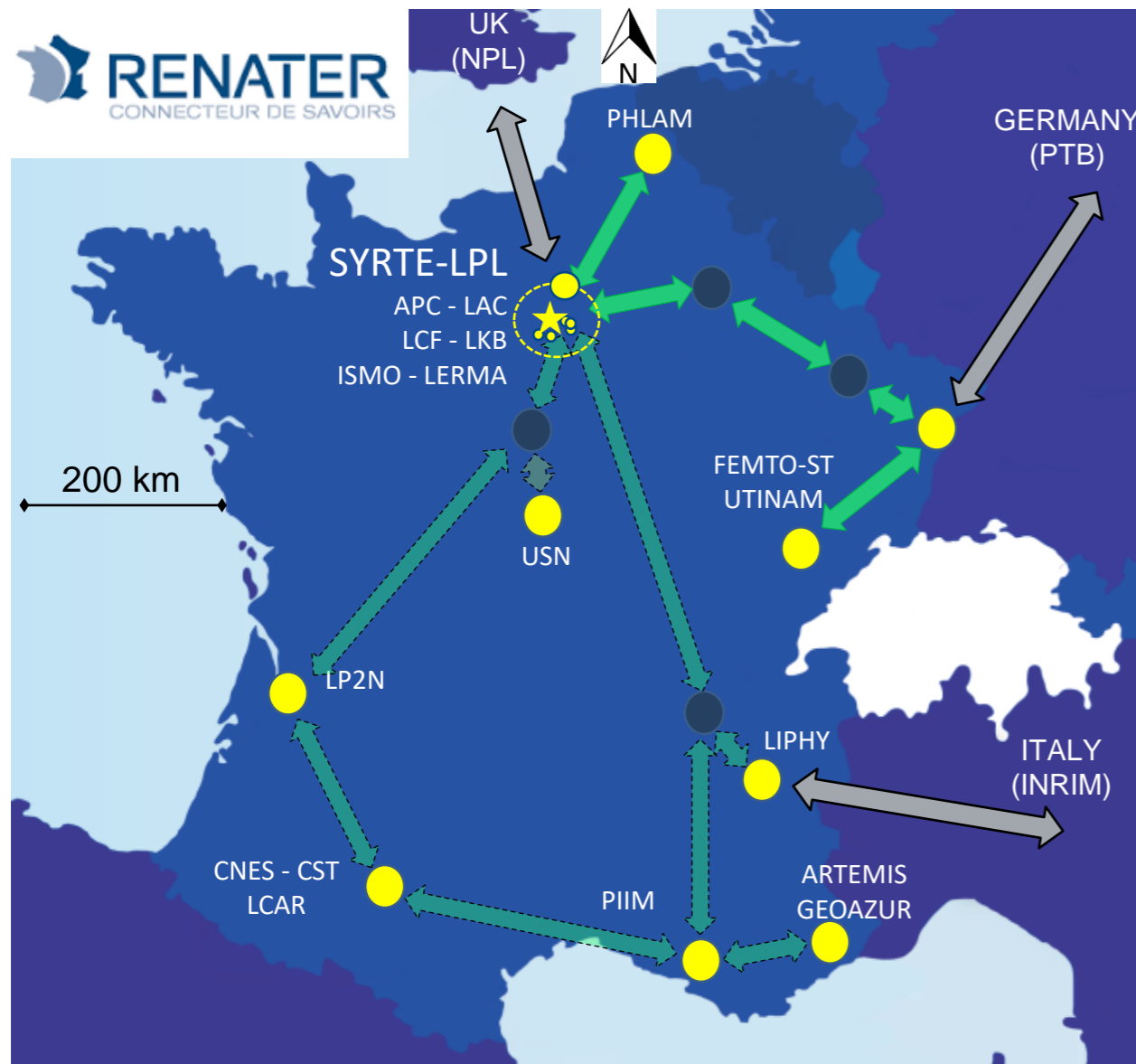
REFIMEVE+ network



4000 km of fibers

- Network Architecture
 - Collaboration with RENATER
 - Signal in **parallel of data traffic**

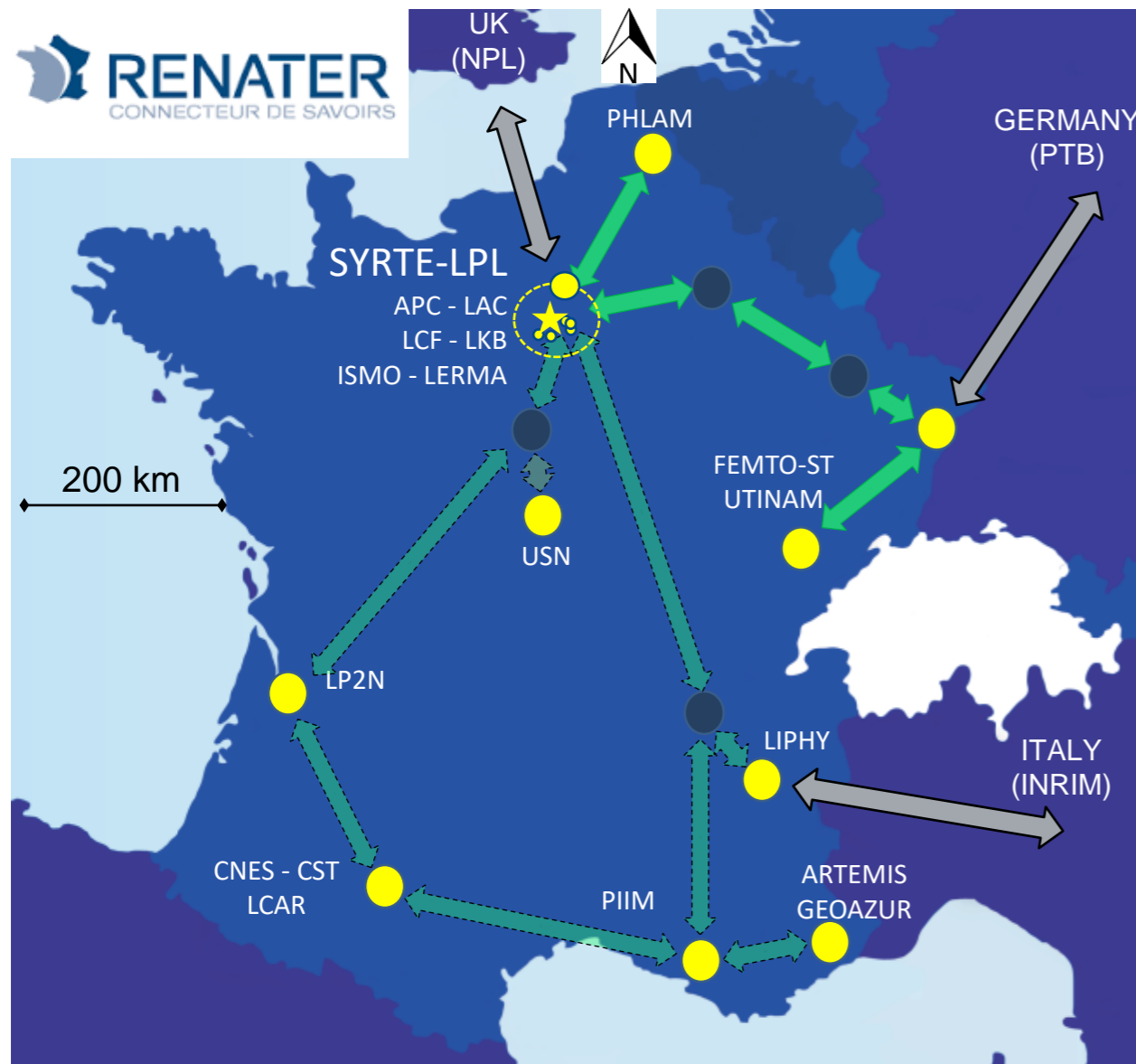
REFIMEVE+ network



4000 km of fibers

- Network Architecture
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- Redundancy
- Sustainability
 - Dedicated Fiber $\approx 200\text{€} / \text{km}$
 - Fiber sharing : $\approx \text{cost} / 10$
 - + Supervision embedded in a **Network Operation Center**

REFIMEVE+ network

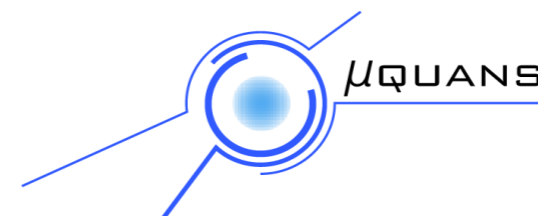


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 - Robustness
 - Reliability
 - Knowledge transfer / industrialization
- TRL = 8** **Adaptable to telecom**



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Industrial partnership

Industrialization and knowledge transfer

KEOPSYS
THE LIGHT TOUCH



Bi-directional Amplifiers

Infractive
Vitalisez votre réseau

Optical Multiplexer OADM

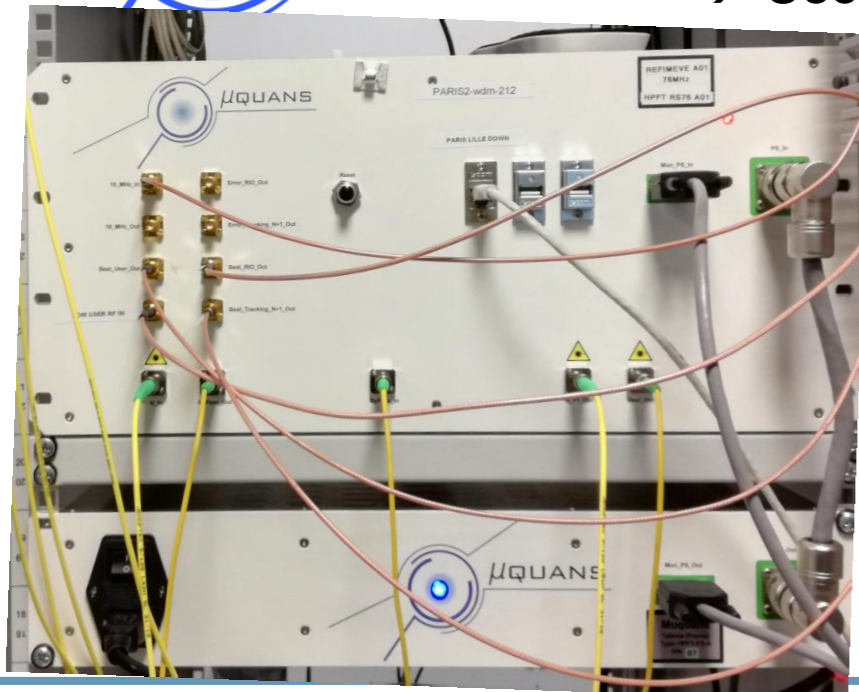


μQUANS

- Repeater Laser Station
- Extraction stations
- User modules

Syrlinks

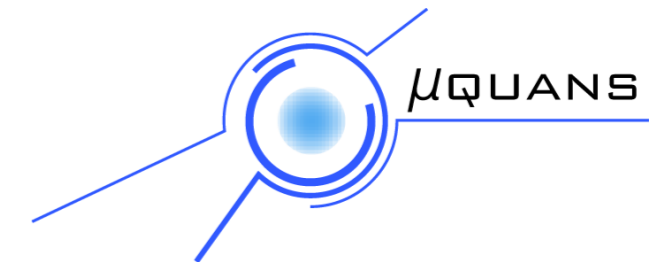
Electronic cards



- Installation and Optimisation of the links
- Operation and Maintenance
- Supervision of the network

First industrial-grade optical fiber link

applied optics

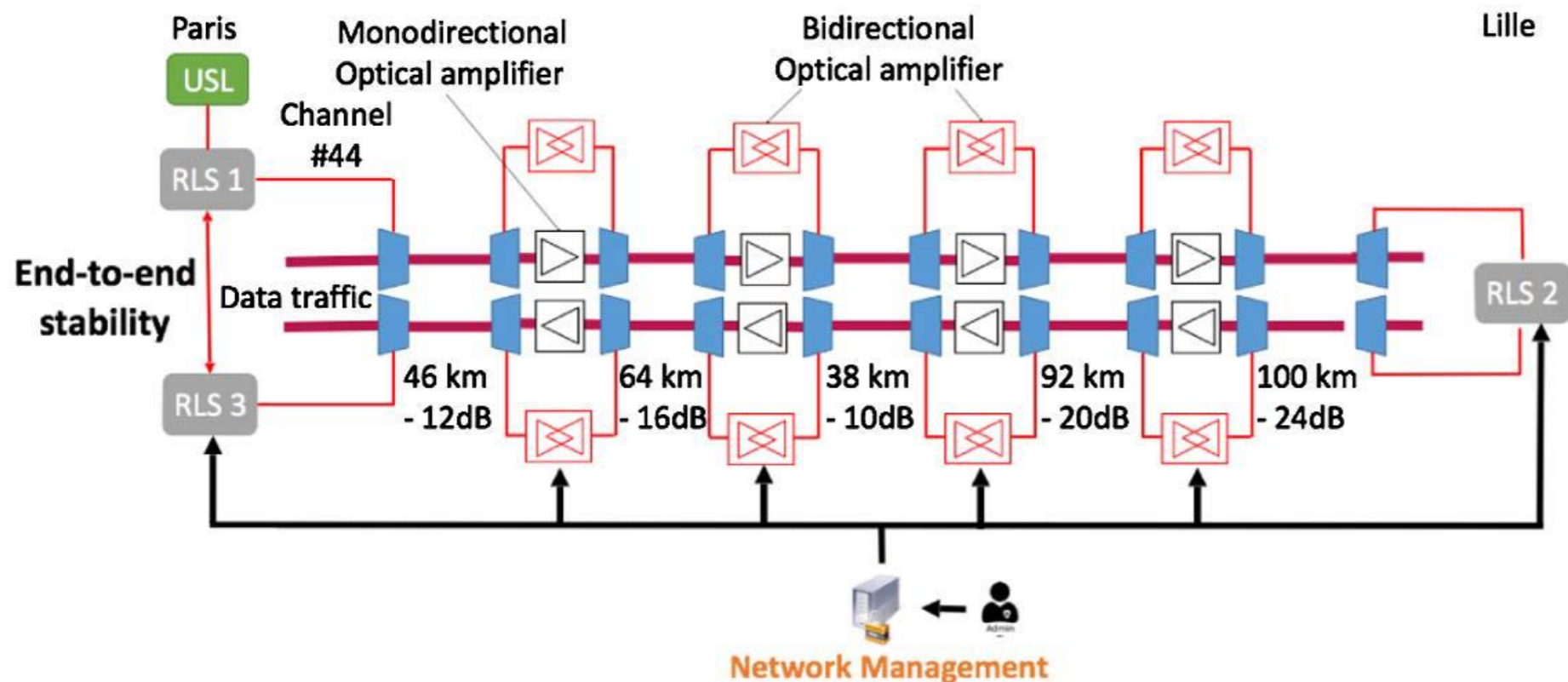


First industrial-grade coherent fiber link for optical frequency standard dissemination

F. GUILLOU-CAMARGO,¹ V. MÉNORET,¹ E. CANTIN,^{2,3} O. LOPEZ,² N. QUINTIN,^{2,4} E. CAMISARD,⁴ V. SALMON,⁵ J.-M. LE MERDY,⁵ G. SANTARELLI,^{3,6} A. AMY-KLEIN,² P.-E. POTTIE,³ B. DESRUELLE,^{1,*} AND C. CHARDONNET²

Construction, installation, operation, maintenance and supervision of the link

Test-bed link on the Paris-Lille-Paris of 2x340km



- 3 RLS
- 4 double EDFAs
- 20 OADMs
- Parallel data traffic

First industrial-grade optical fiber link

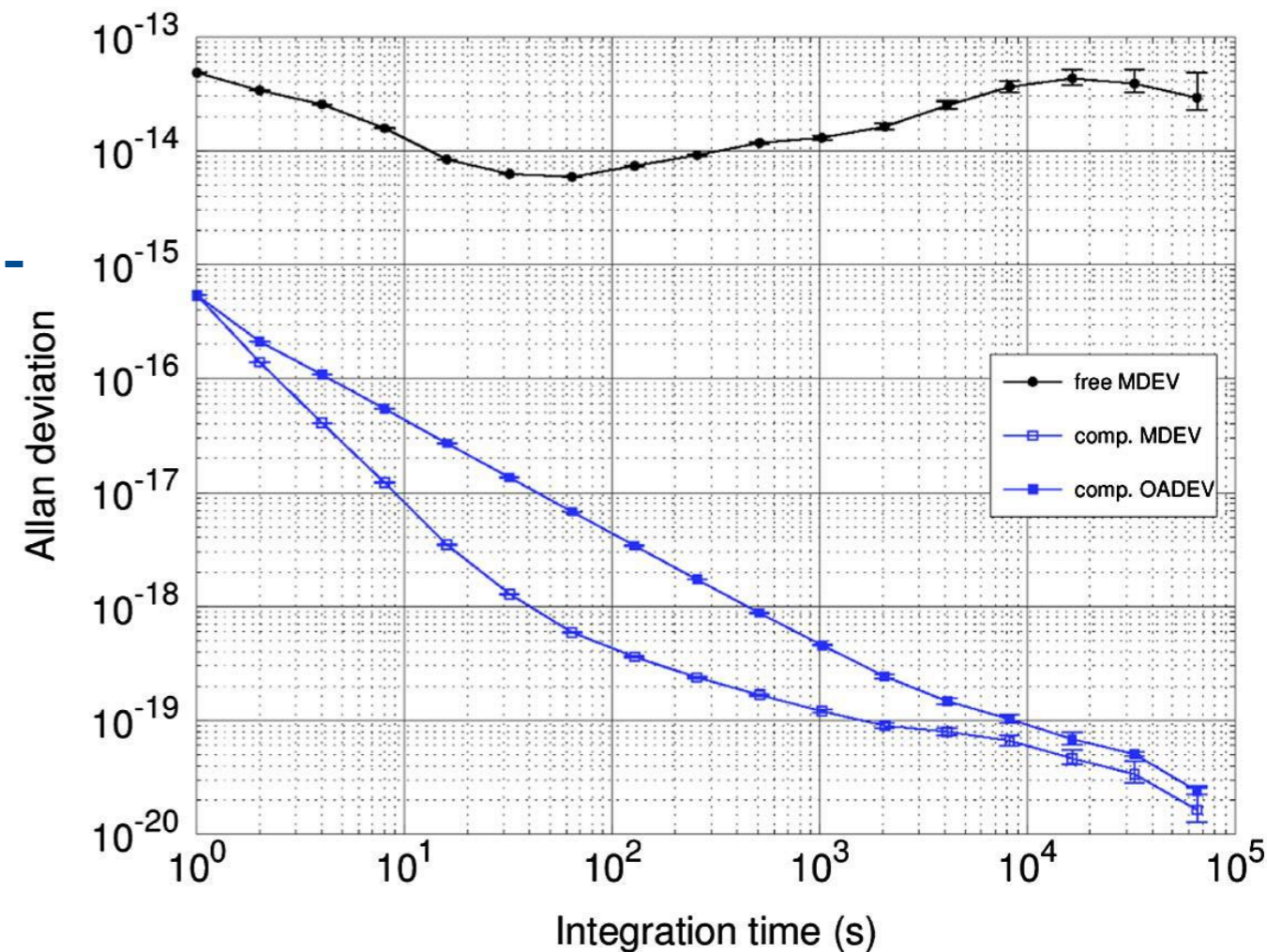
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→ Uptime of **99.5%** during 1 month

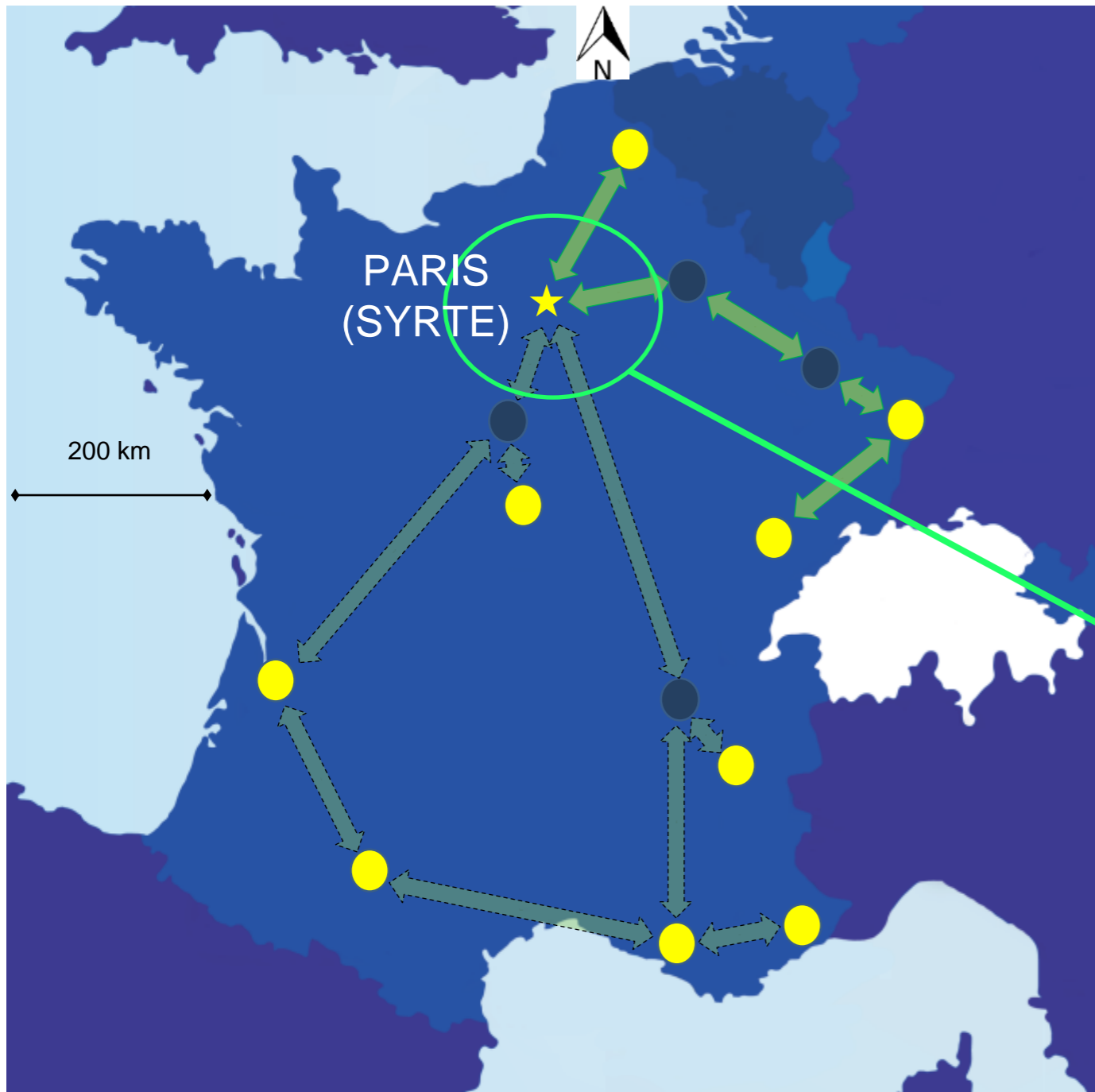
→ **Stability and accuracy** at the state-of-the-art



Contents

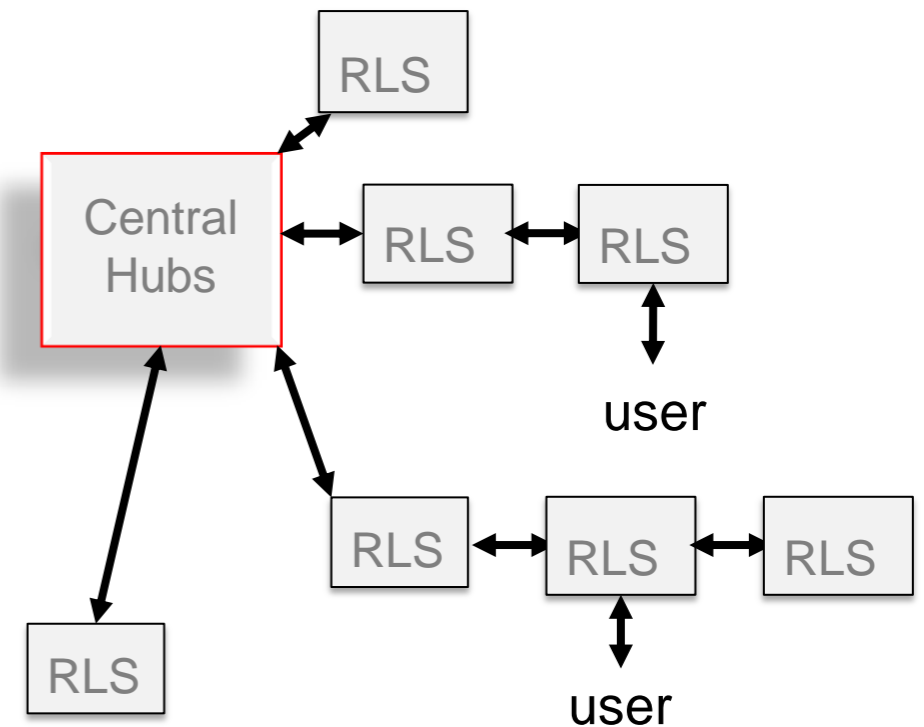
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Need of Central hubs



Central hub required for a dissemination of more than 2 links/users

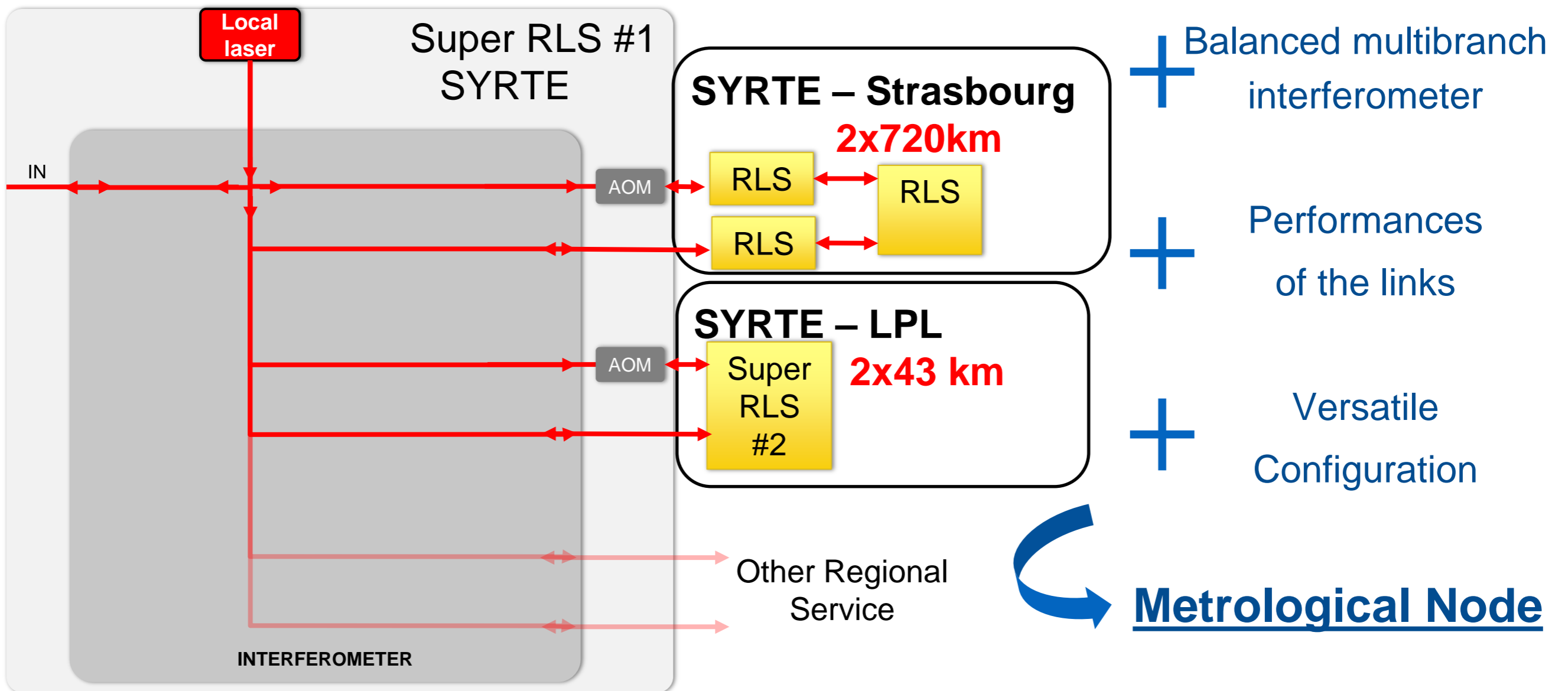
Hub configuration



Central hub = Super-RLS

- Repeater Laser Station based conception:
electronics locks + remote control + automatisisation

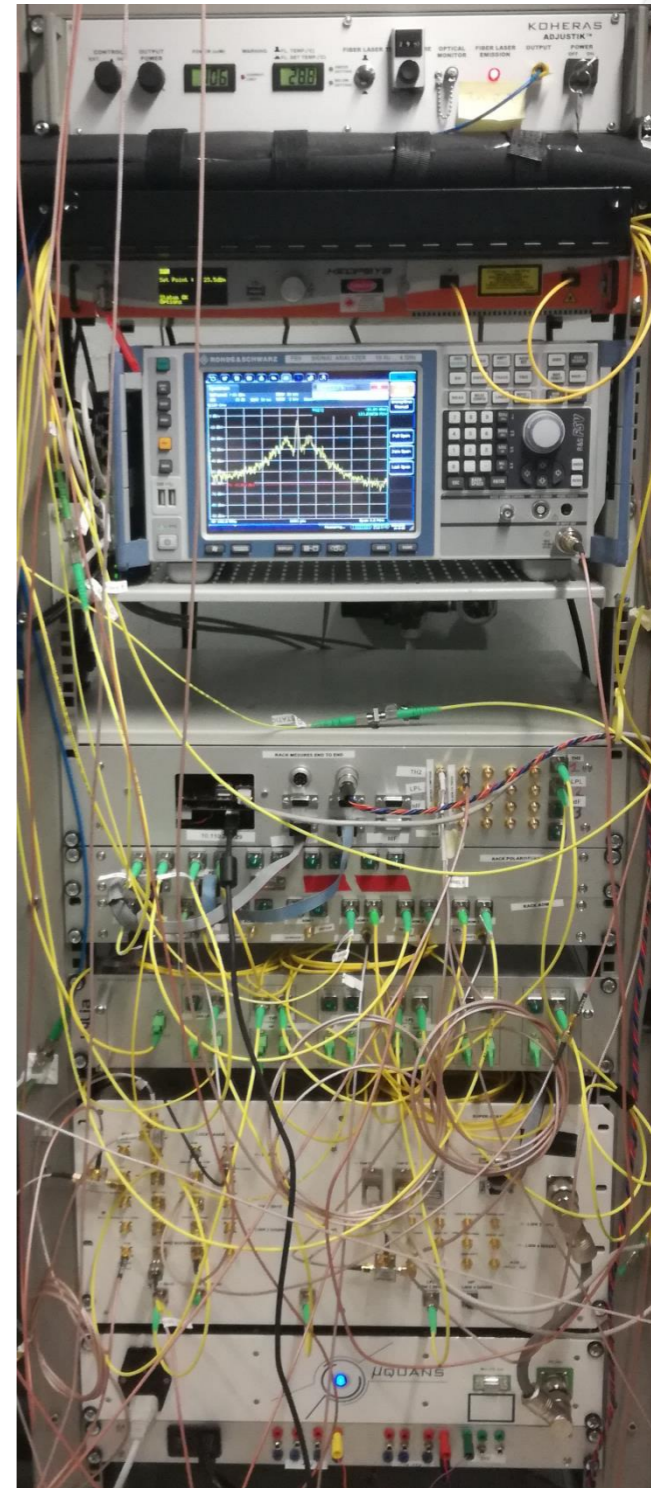
→ Same advantages than RLS



Central hub at SYRTE

- 3 central hubs developed with 2 different techniques
- Interferometer developed with KYLIA company
- Operational 1 day after being placed

Racks
30 U



Super Station

Local
Laser

Measurement
rack

Multibranch
interferometer

Electronics
Lock

Supplies

Results with the Super-RLS at SYRTE

SYRTE – Univ. Strasbourg

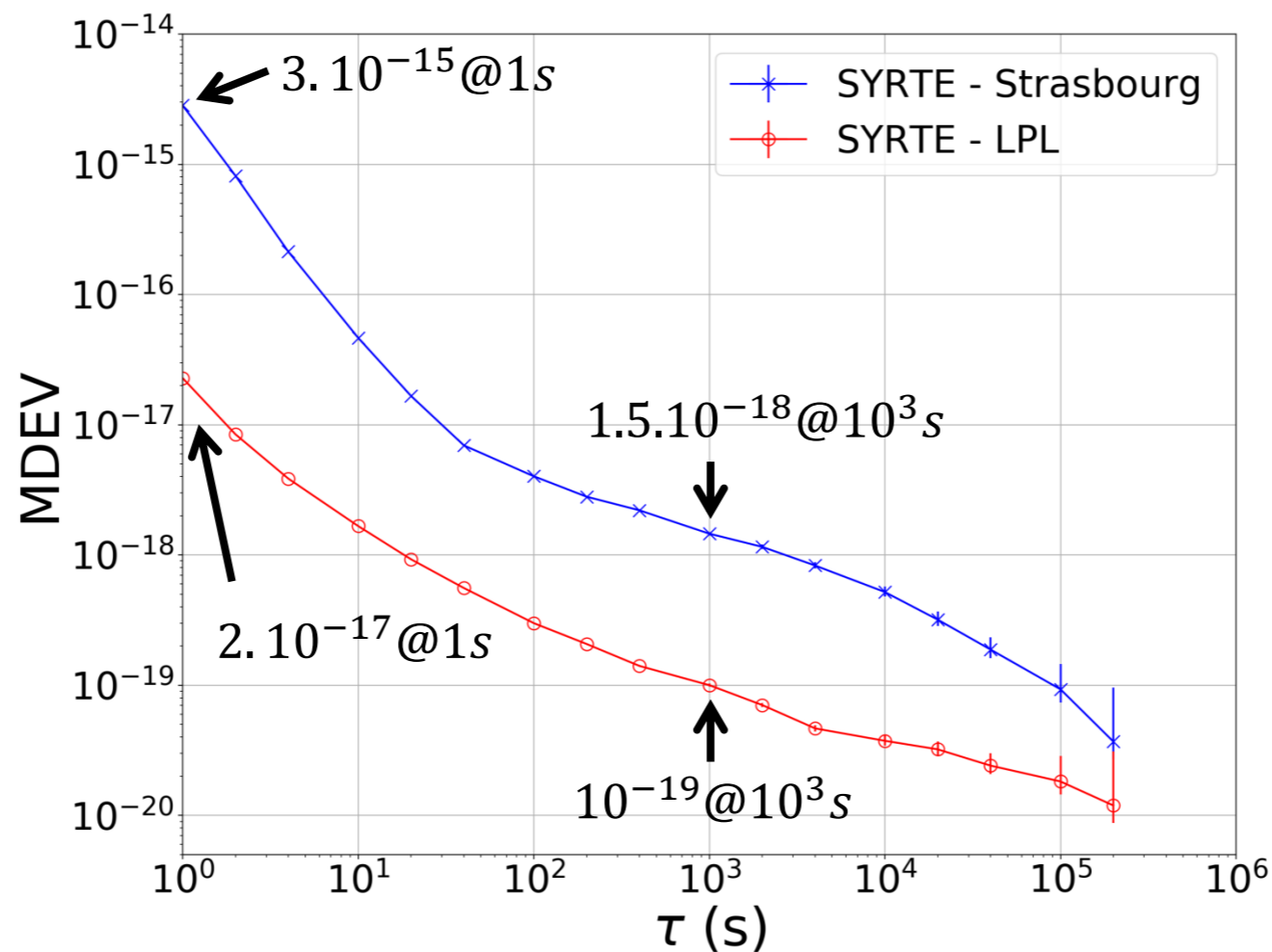
From 2018-03-10 to 2018-05-10

→ 61 days with Uptime of **92.2%**!

SYRTE – LPL

Uptime of **95.3%**!

From
2018-03-23
to
2018-04-02



Dead Time Free Counter K+K
Lambda counting
1s gate time

Accuracy:
Preliminary budget

SYRTE – Strasbourg: 3.2×10^{-19}

SYRTE – LPL: 2.3×10^{-20}

Conclusion

- **Industrialization validated**

 - The first industrial metrological link done by a company

- **Central hubs**

 - Metrological nodes of the network

 - Simultaneous transfer of several links

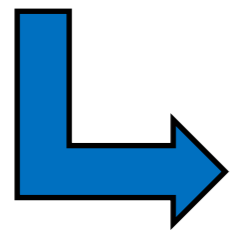
 - Uptime > **90%** for several months (still running)

- **Architecture of the network + collaboration RENATER + Industrialization**

 - **Robustness, reliability, redundancy and sustainability**

Outlook

- **REFIMEVE+ to be fully deployed in 2 years**



AG REFIMEVE+
20/21 Novembre
FEMTO-ST Besançon



Assemblée Générale 2018

Le Mardi 20 et mercredi 21
Novembre à Besançon

Thank you for your attention !



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 **Information online www.refimeve.fr**



Advances of the REFIMEVE+ EquipEx
General Assembly FIRST-TF – Toulouse – 09/10/2018

