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LISA AIVT Optical Ground Support Equipement technology developments

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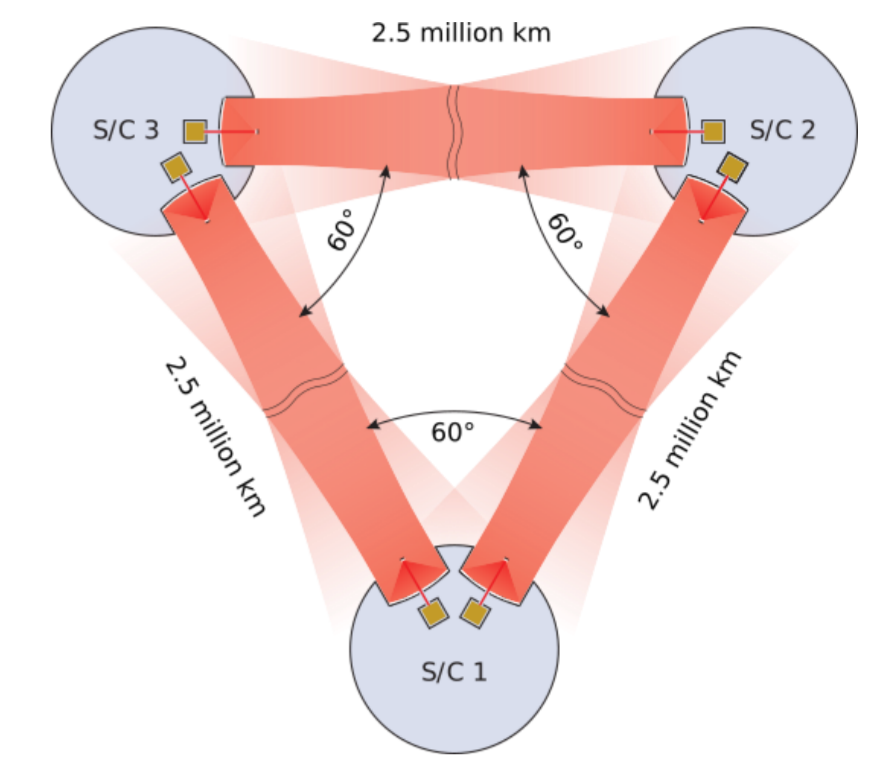
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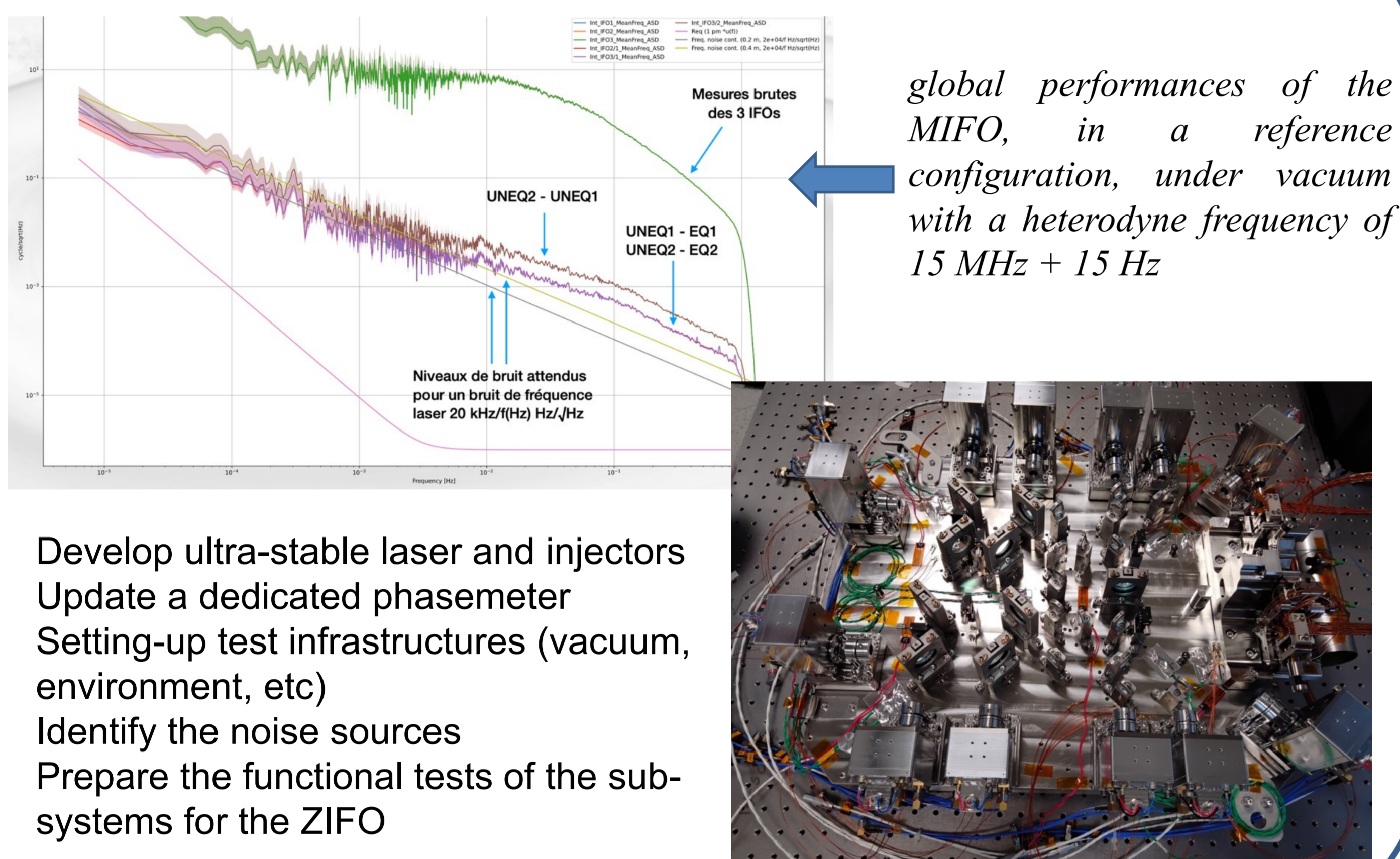


Context

- LISA based on heterodyne laser interferometry -> measure tiny change distance between free-falling mirrors
- LISA strain sensitivity: $1 \cdot 10^{-20} \sqrt{\text{Hz}}$
- LISA displacement sensitivity: $10 \cdot 10^{-12} \text{ m} / \sqrt{\text{Hz}}$ over $2.5 \cdot 10^9 \text{ m}$
- France is in charge of the Interferometric Detection System (IDS) tests and Optical Test System (OTS)
- Specific test equipments to verify the requirements



MIFO: Metalic InterFEROmeter

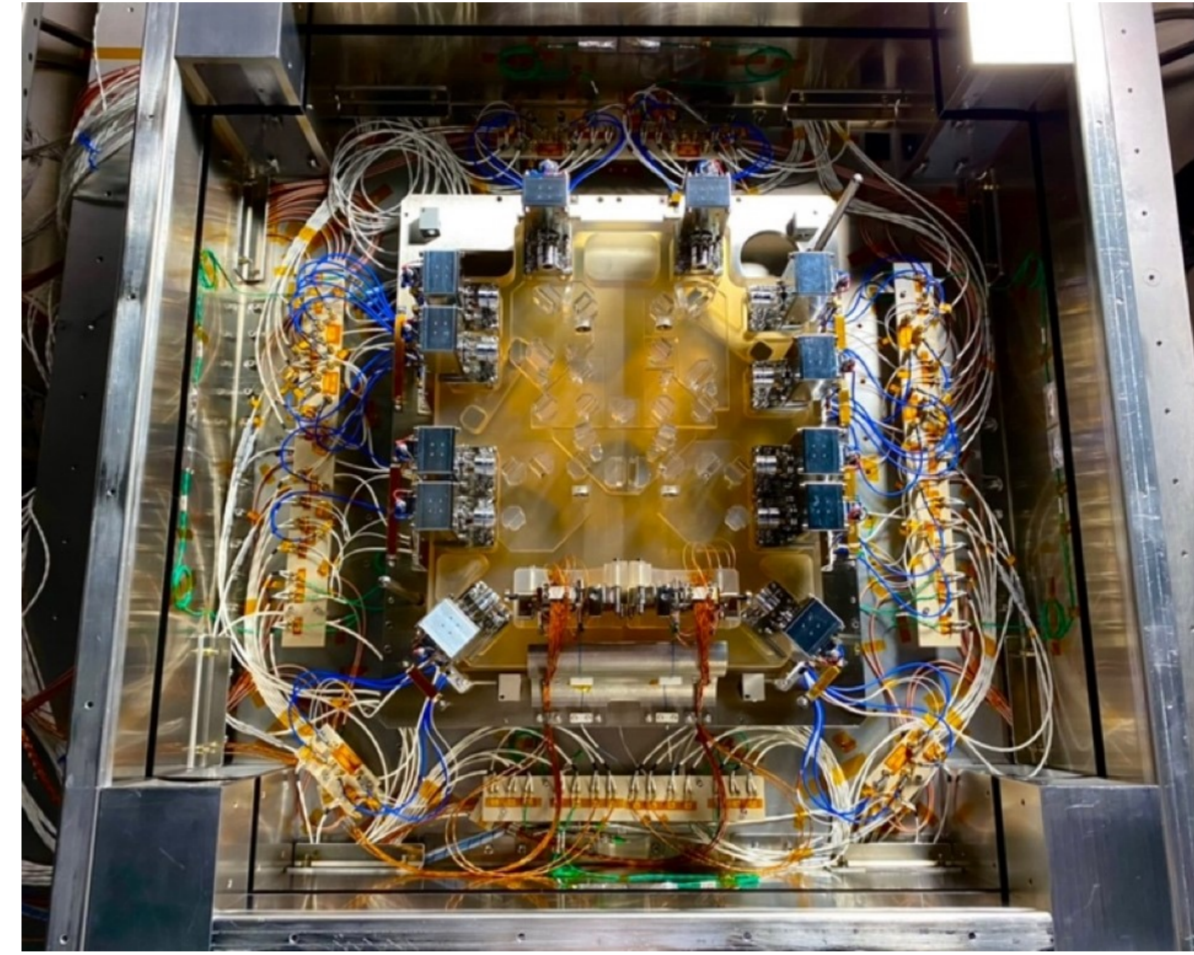


global performances of the MIFO, in a reference configuration, under vacuum with a heterodyne frequency of 15 MHz + 15 Hz

- Develop ultra-stable laser and injectors
- Update a dedicated phasemeter
- Setting-up test infrastructures (vacuum, environment, etc)
- Identify the noise sources
- Prepare the functional tests of the sub-systems for the ZIFO

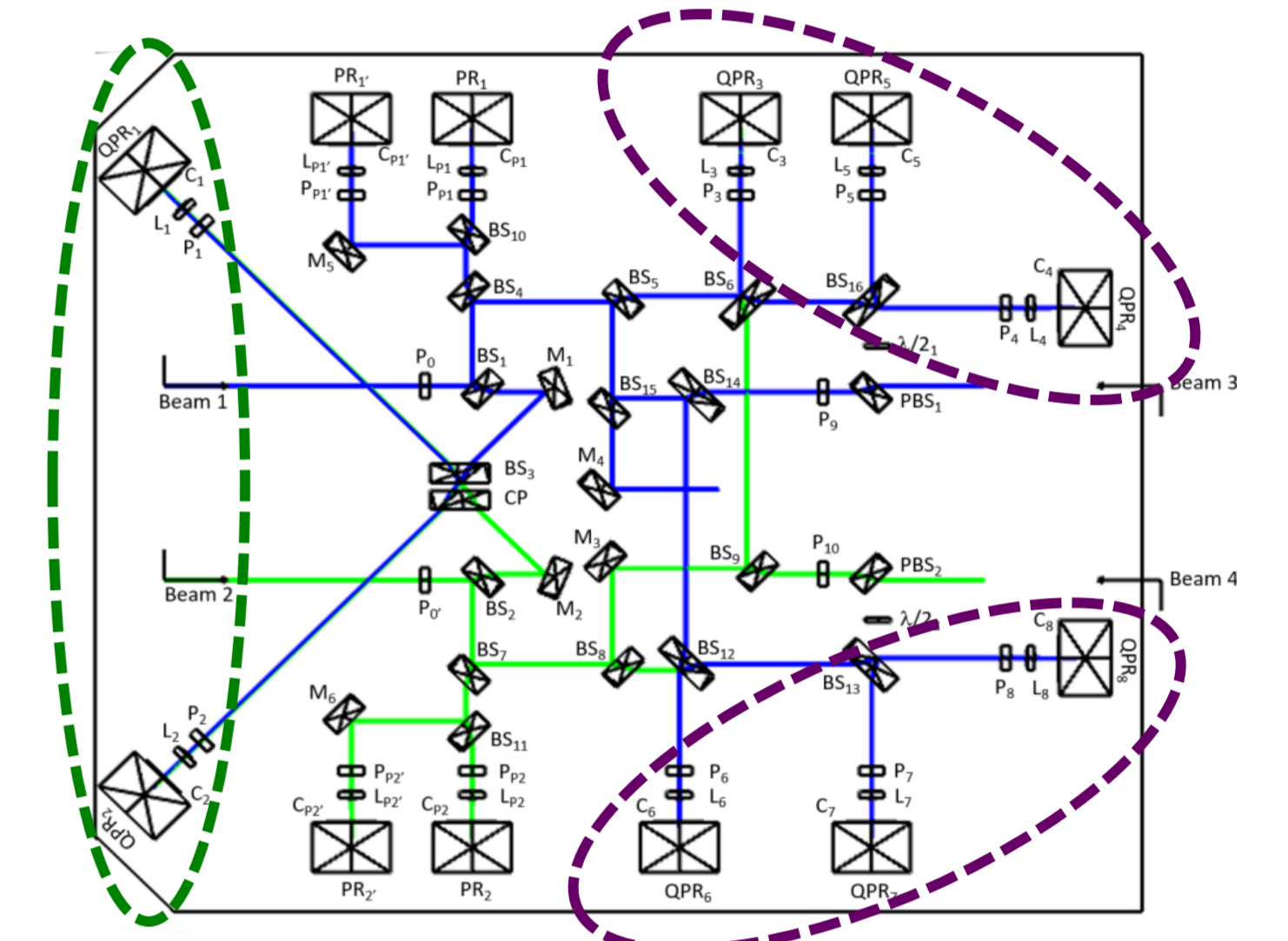
ZIFO: Zerodur InterFEROmeter

Dimensions: 530 x 450 x 47 mm



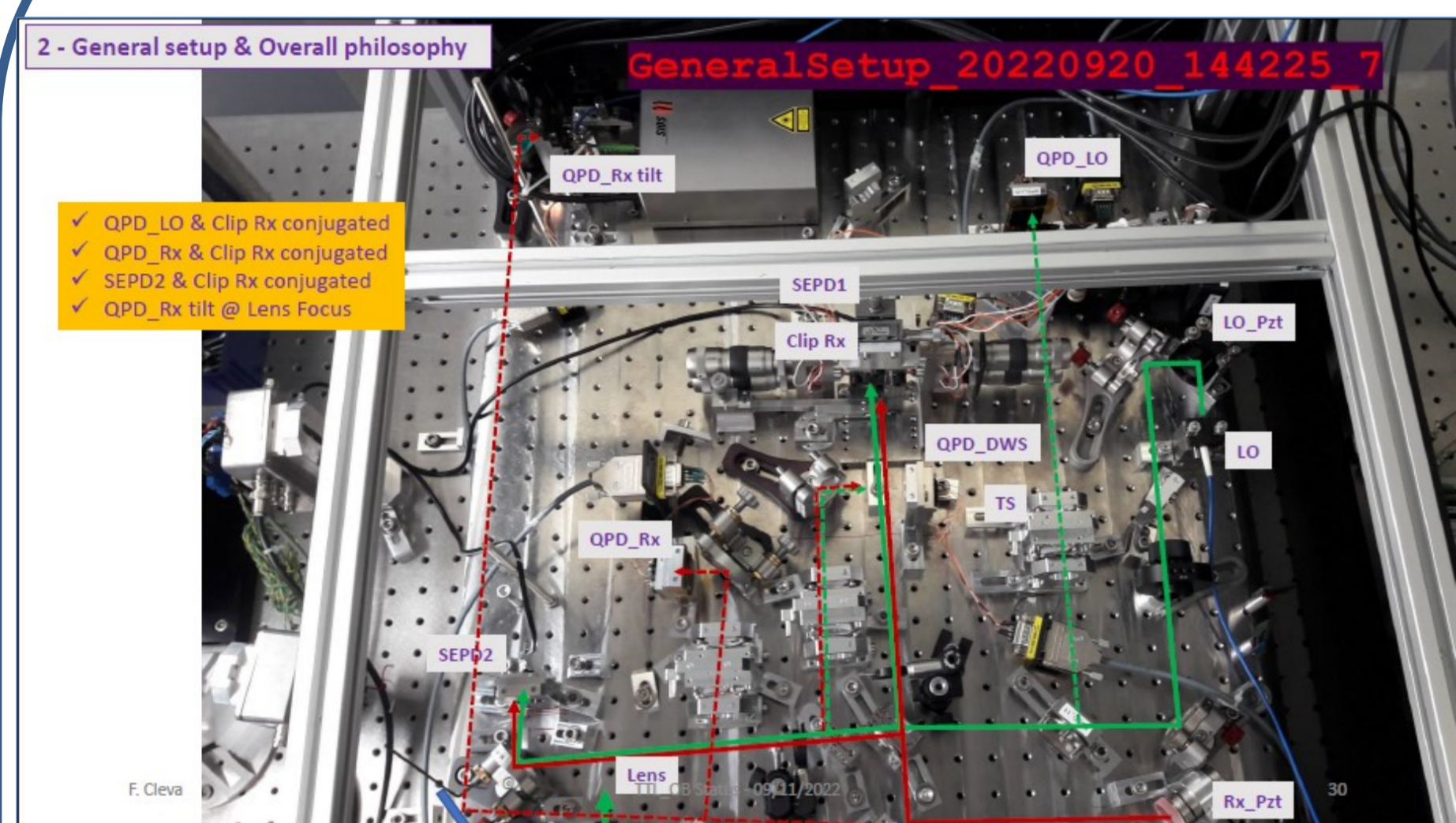
- Develop a demonstration bench
- Determine the excess level of metrology stability -> objective $5\text{-}10 \text{ pm} / \sqrt{\text{Hz}}$ in the band 1-10mHz
- Evaluate the performance limits achievable with the optical contacting

- 3 interferometers:
 - 1 with equal arms
 - 2 with unequal arms

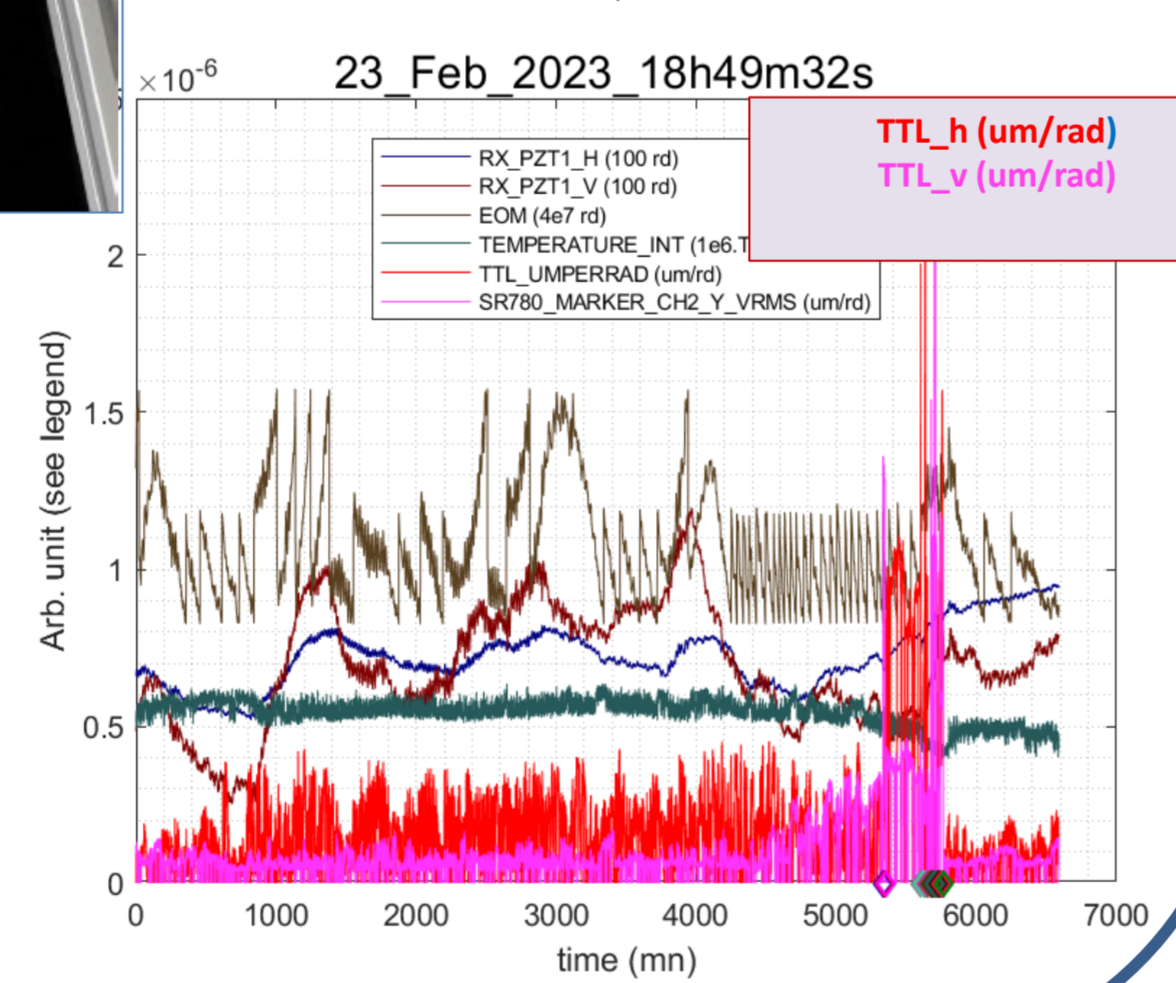


Optical simulations: Optocad, Zemax®

TTL-OB: Tilt-To-Length measurements

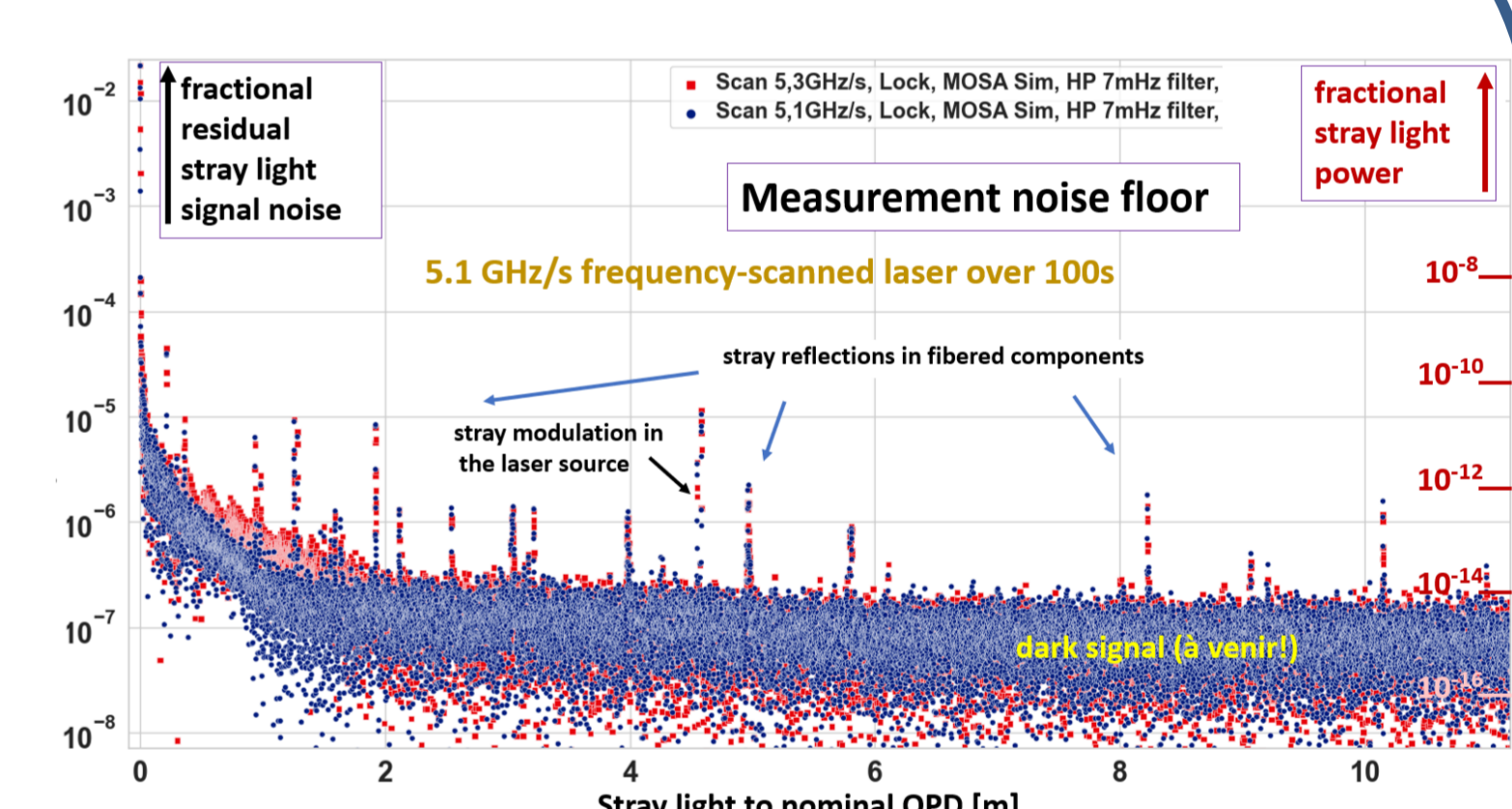
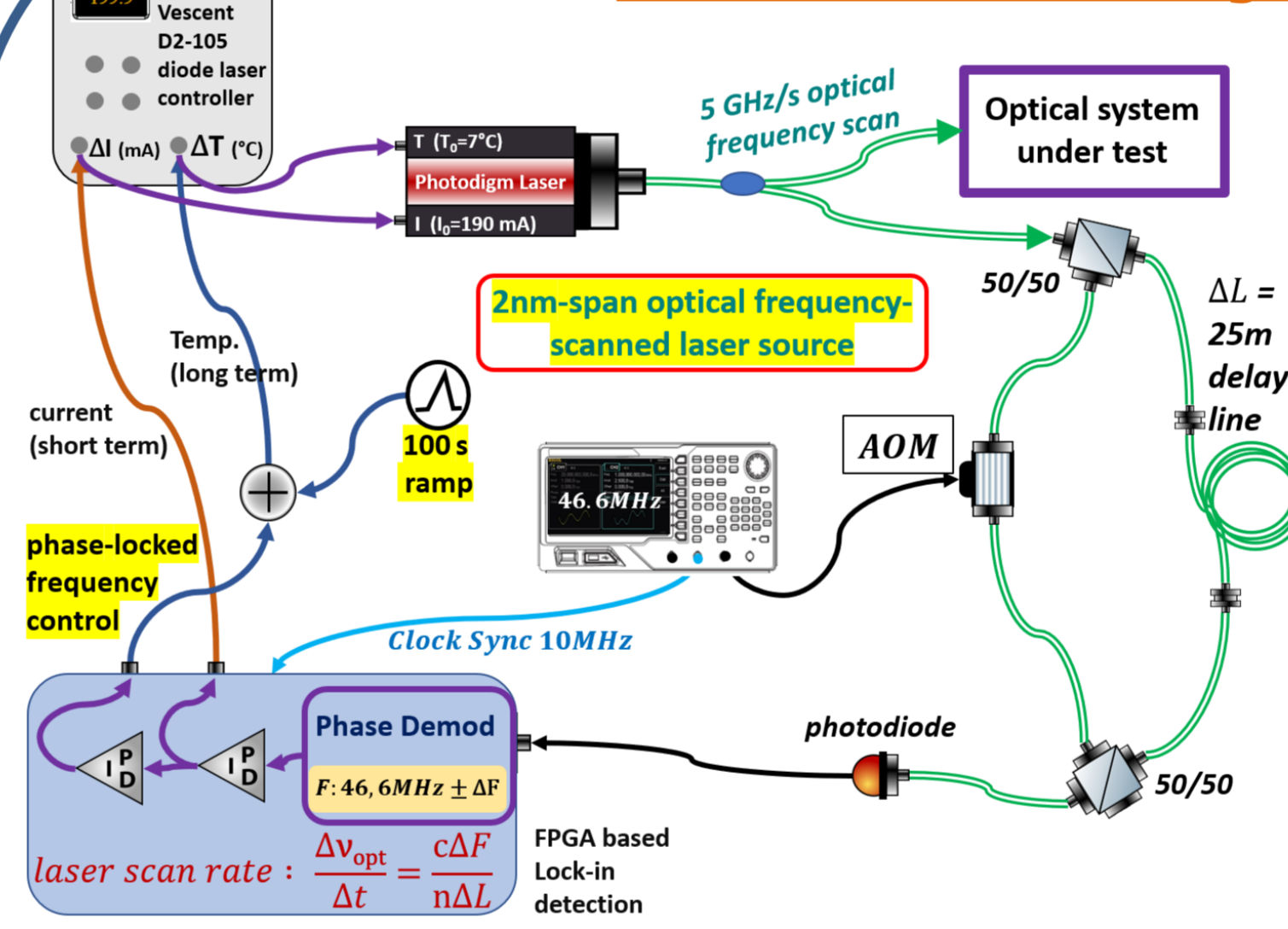


TTL measurements over 100 hours, with a stability of +/- 0.2µm

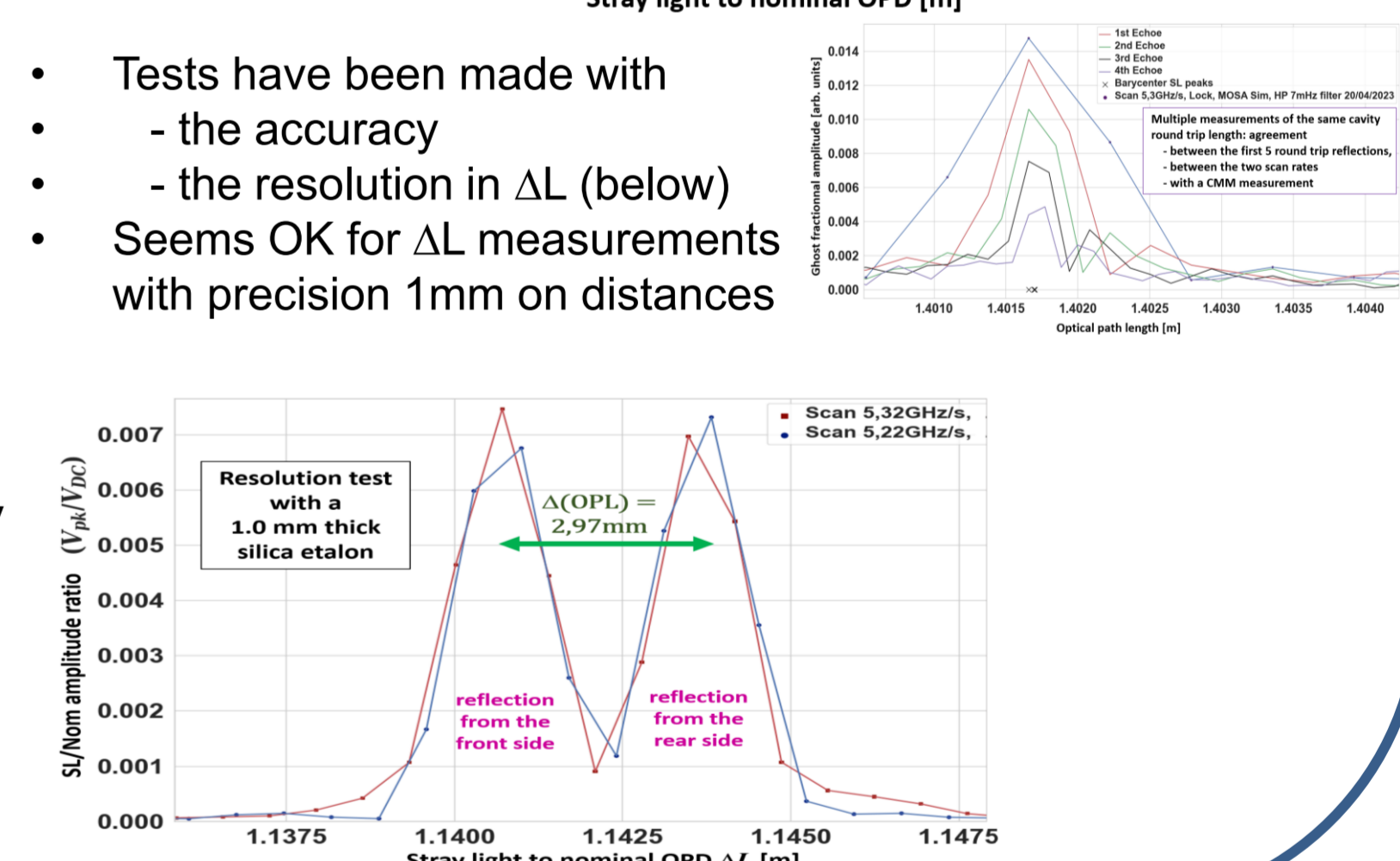


- FF-OGSE shall measure TTL coupling -> develop a bench to demonstrate the feasibility
- Accuracy of the measurement: $< 0.77 \mu\text{m}/\text{rad}$
- Deliver Rx (flat-top) and REF beams, receive Tx beam
- Heterodyne detection scheme

SLOGSE: Stray light measurements



- Phase-locked frequency-scanned laser source
- 2 nm span, over 100 s: 5 GHz/s scan
- Detection noise floor $< 10^{-12}$ in fract. stray light power, degrades at $\Delta L/2 < 25\text{cm}$
- Work under way to eliminate power modulations due to the set up's fibered components



Conclusions & prospects

- France is in charge of the IDS tests and OTS
- Several OGSEs are needed to test the IDS and the MOSA
- First prototypes are under development to test:
 - The sub-systems as laser, injectors, phasemeters, control/command
 - Assess the limits on sensitivity of the set-up and the precision of the path length measurements achievable on ground
 - Identify the noise sources
 - Measure the TTL coupling
 - Measure the straylight at system level, component by component
- Further investigation are ongoing to validate all the objectives
- Preparation of the final OGSE are in progress

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