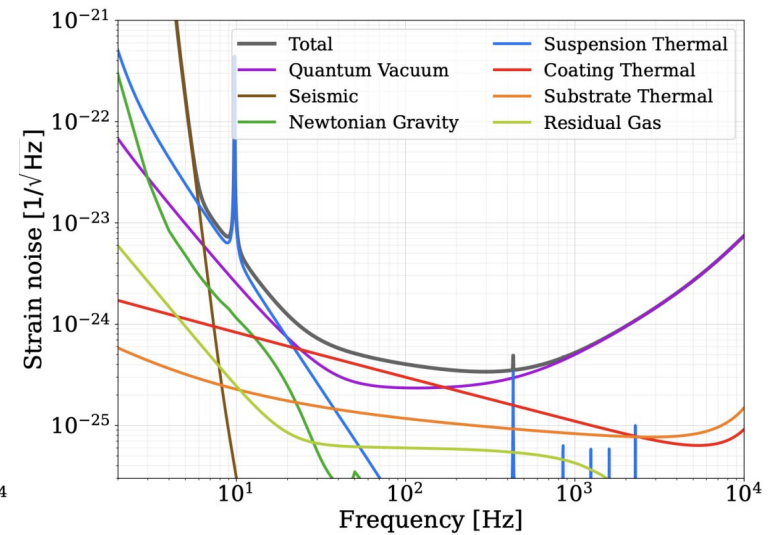
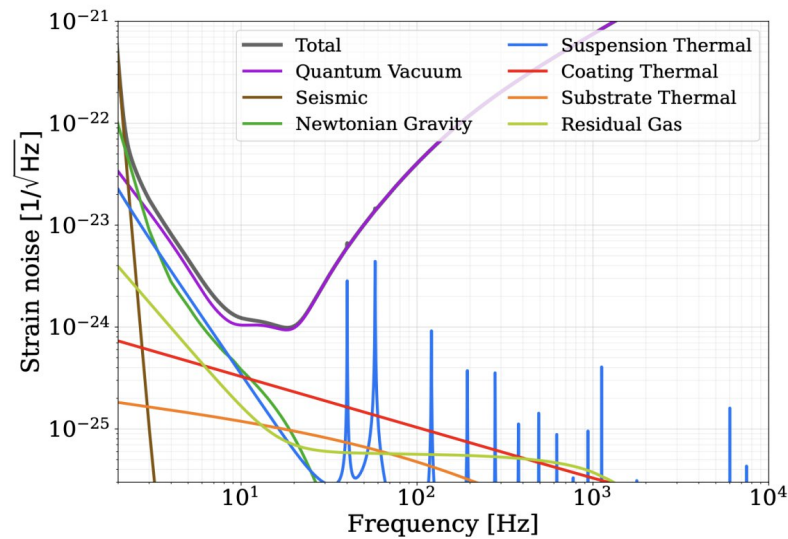


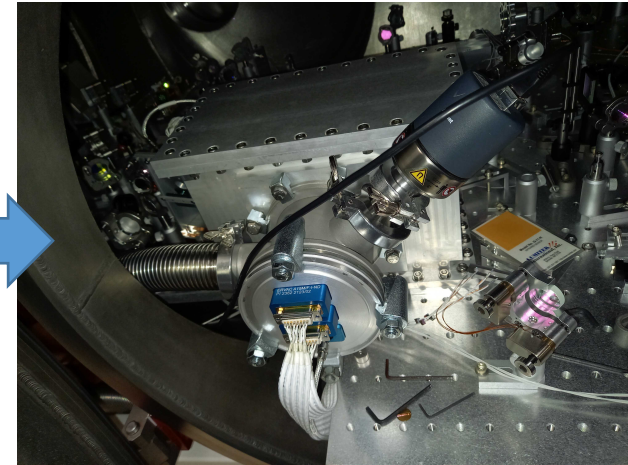
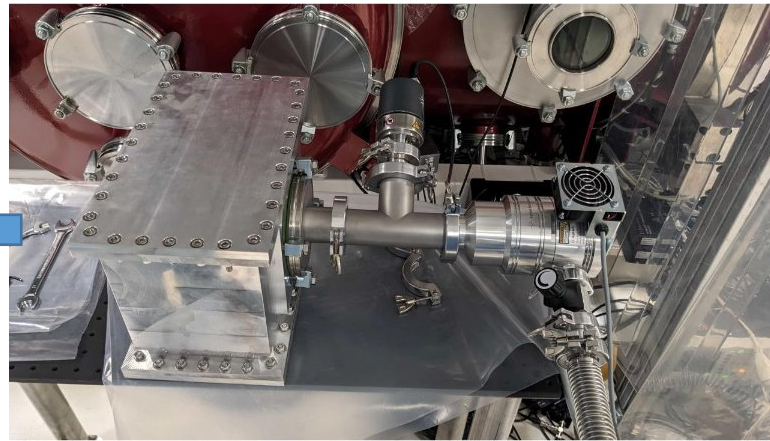
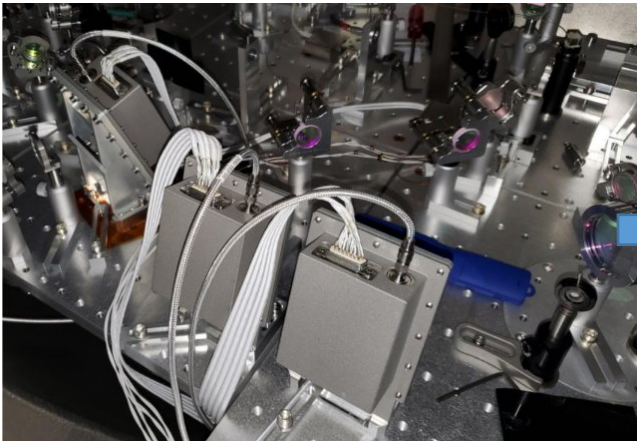
Squeezing for ET





Summary of IJCLab activities since last meeting

- Squeezing still not measured
 - Flooding... Power shutdown... Hope to have a measurement by the end of the year
- Homodyne detection in a new vacuum tank
 - Will allow for comparison measurement in-air/in-vacuum

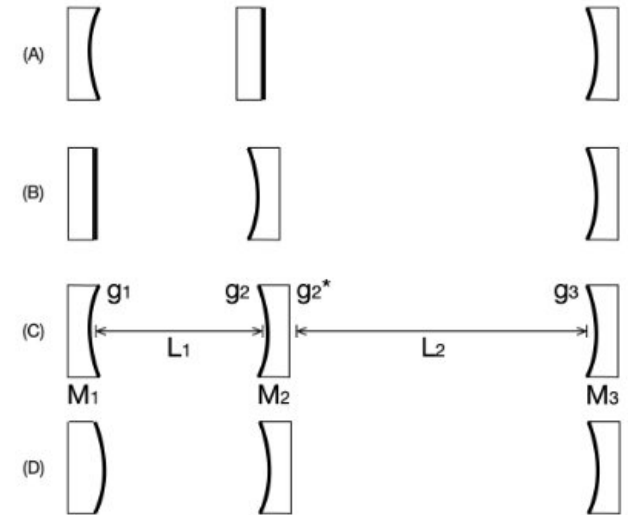
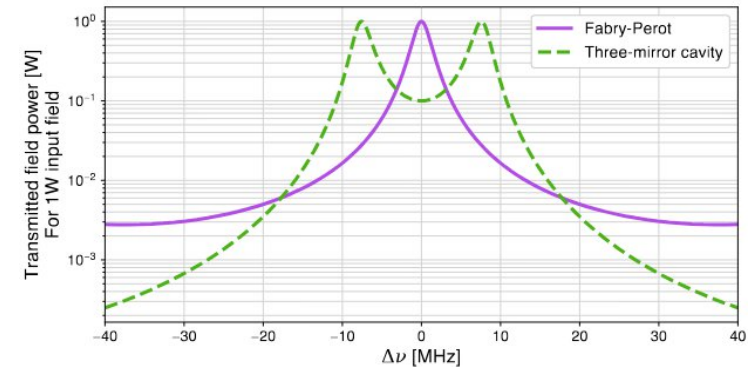


May 2025



Summary of IJCLab activities since last meeting

- Theoretical paper on 3-mirror cavity published
 - <https://iopscience.iop.org/article/10.1088/1361-6382/adb827>
 - Design elements of 3-mirror cavity in 2 cases:
 - Case 1: A single 3-mirror cavity could be used in place of two two-mirror cavities (mainly studied at APC)
 - Mainly studied at APC
 - Need symmetrical 3-mirror cavity leading to a double peak shape
 - In this paper: what influences this shape (and thus squeezing properties)
 - Case 2: Each two-mirror cavity could be replaced by a 3-mirror cavity => variable finesse cavity
 - Mainly studied at IJCLab
 - Need asymmetrical 3-mirror cavity, each sub-cavity being locked out of resonance => no double peak
 - In this paper: how to design a stable 3-mirror cavity





Summary of IJCLab activities since last meeting

- Experimental results on table-top 1-m scale 3-mirror cavity
 - Paper on [arXiv](#) and submitted to Optics Letter

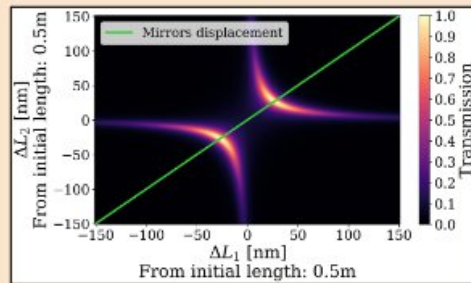
Three-mirror cavity prototype

Slide from Paul Stevens

Double-peak observation

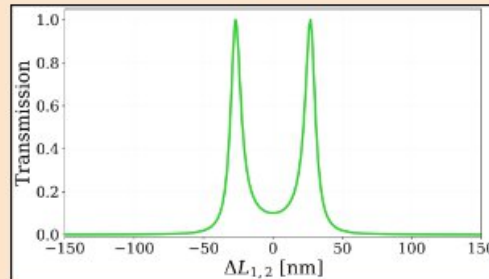


Method

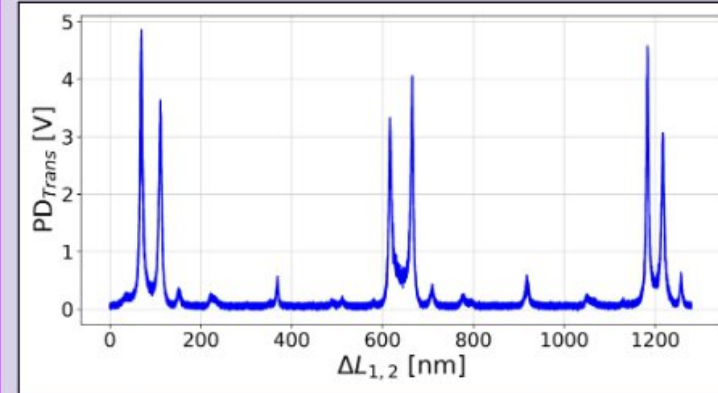


Apply the **same ramp signal to each piezo** so that both sub-cavities contract or expand equally \Rightarrow **equivalent to scanning the laser frequency.**

- Expected double-peak shape = **symmetric**
- Maxima with **equal amplitude**
 - Maxima spacing = **$54 \pm 6 \text{ nm}$**



Results



- **Maxima spacing** in this sample = **$42 \pm 6 \text{ nm}$** ✓
- **Double-peak to double-peak spacing** in this sample = **$555 \pm 4 \text{ nm}$** ✓

Mechanical perturbations \Rightarrow deviations from a symmetric double-peak shape



Summary of IJCLab activities since last meeting

- Experimental results on table-top 1-m scale 3-mirror cavity
 - Paper on [arXiv](#) and submitted to Optics Letter

Slide from Paul Stevens

Three-mirror cavity prototype

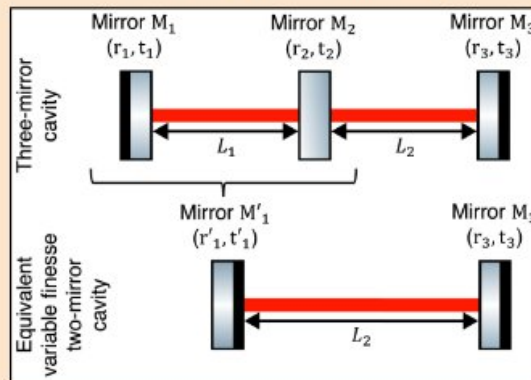
Variable finesse observation



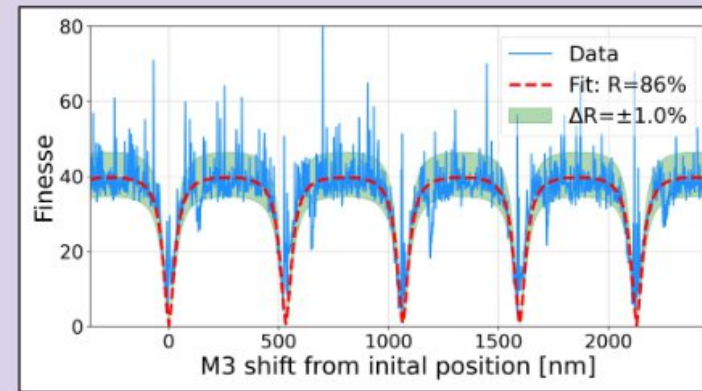
Method

1st mirror: piezo scan at 1mHz
3rd mirror: piezo scan at 100Hz

⇒ Slow variation in the reflectivity of the first sub-cavity (virtual mirror)



Results



(Here, the second sub-cavity was used as a virtual mirror)

→ Estimated uncertainty on R value = 1%
(mechanical instabilities)

→ Residual mode observed between main finesse drops



Summary of IJCLab activities since last meeting

- Project of suspended 50-m scale 3-mirror cavity in CALVA
 - Aim at demonstrating lock of the suspended cavity and phase detuning of light induced by the cavity (linked to frequency dependent squeezing)
 - First implementation for variable finesse cavity (case 2) but ,ay later on be turned into case 1 (symetric cavity in collaboration with APC)
- ✓ Funding from DIM Origines (196 k€) for the clean room
 - Now waiting for the signature of the contract between Observatoire de Paris and CNRS DR4 (since November 2024...)
 - Goal to have the room by summer 2026
- ❖ ANR proposal with LKB and LMA for optics, equipment and postdoc in phase II (waiting for the result soon)
- ERC proposal (including vertical periscope) not selected to phase II (we can think about resubmitting in october 2026)
- ❖ P2I (Université Paris-Saclay) call for renewal of the pumping system (60 k€) waiting for the result





Activities inside the ET collaboration

- Now co-chair of the ET Squeezed Light Work Package
- ET document on the filter cavities design
 - Beam pipe diameter
 - Fitting the cavities inside the main tunnel
 - Need to develop suspended vertical periscope! (between 2 and 4 meters depending on the final design)
- Task force work to reduce the costs
 - <https://gitlab.et-gw.eu/et/eto/eto-task-force-detector-layout-2025-comments-from-etc>
 - Back to 2-mirror cavity => we must convince of the necessity to keep 3-mirror cavity implementation possibility



Flexibility analysis of ET-LF Squeezing Filter Cavities

ET-0098A-25

G. Ciani, M. De Laurentis, A. Lartaux-Vollard, V. Sequino, S. Steinlechner,
M. Vardaro, J.-P. Zendri
on behalf of the Squeezed Light working group

Issue: v1

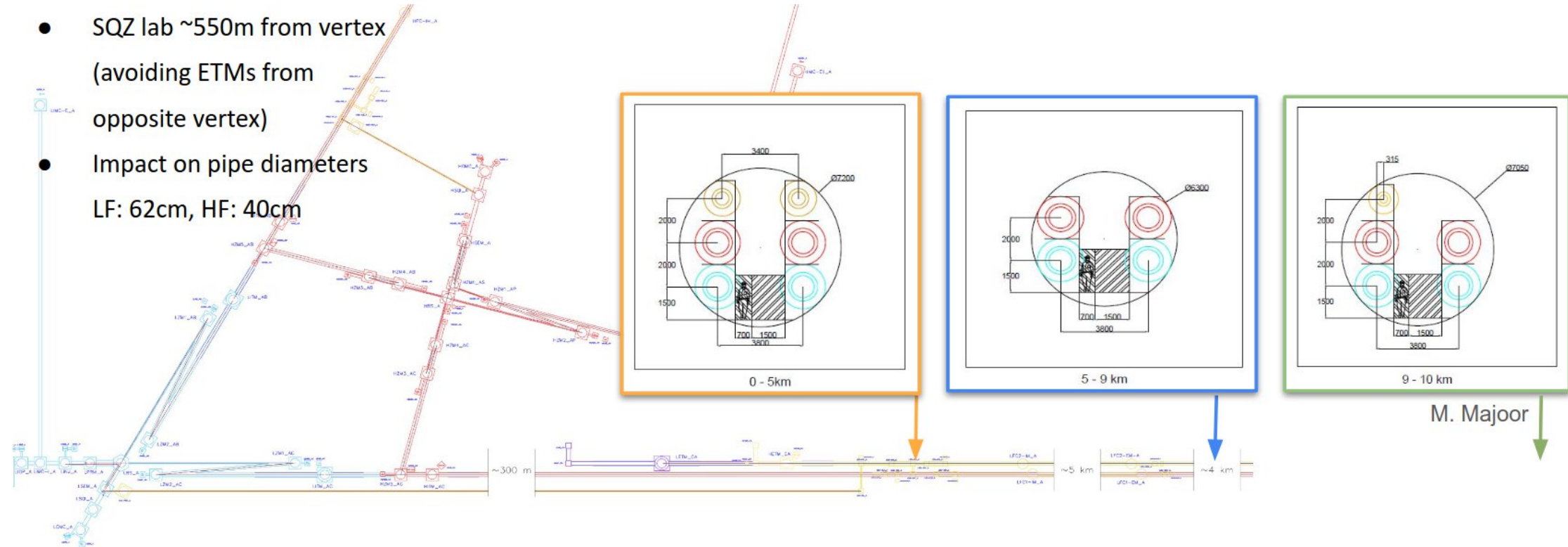
Date: March 31, 2025



Filter cavity in the arms design - triangle baseline

Filter Cavities Relocation: Triangle

- 2m periscope for HF, 4m for LF
- SQZ lab ~550m from vertex (avoiding ETMs from opposite vertex)
- Impact on pipe diameters
LF: 62cm, HF: 40cm





Filter cavity in the arms design - 2L baseline

Filter Cavities Relocation: 2L

- 2m periscope for LF and HF
- SQZ lab ~120m from vertex

