Experience with long-baseline optical resonators at DESY

The search for Axion-like particles with ALPS II

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ALPS

DESY. UF UNIVERSITY of FLORIDA JG|U

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

Light Shining through a Wall Concept

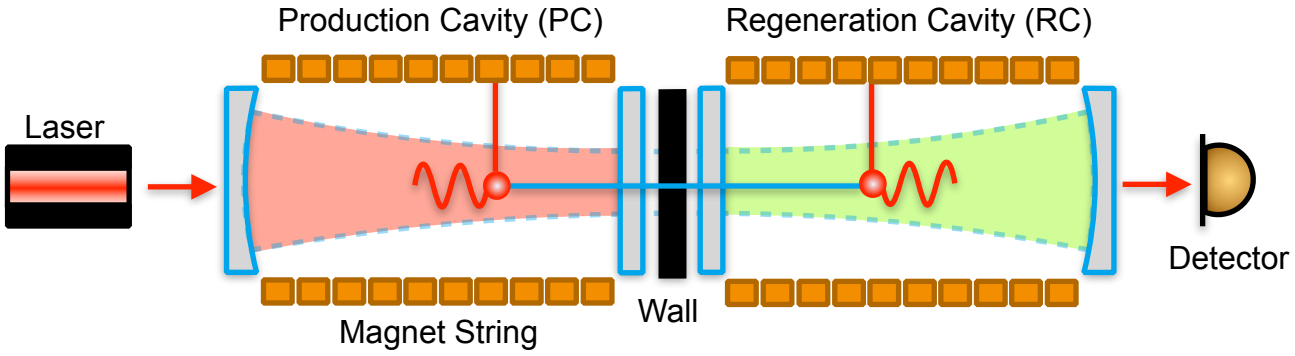
Measuring the conversion and reconversion of Axion-like particles

Axion-like particles

- Axion proposed as a solution to the strong CP problem
- Extension to the standard model
- Low mass (<1meV), weakly interacting
- Couple to photons and vice versa in the presence of magnetic fields

LSW concept

- High power light source propagating through a magnetic field creates flux Axion-like particles through a wall
- Magnetic field on other side of the wall converts Axion-like particles back to photons
- ALPS II: Optical cavities amplify the conversion-reconversion probability

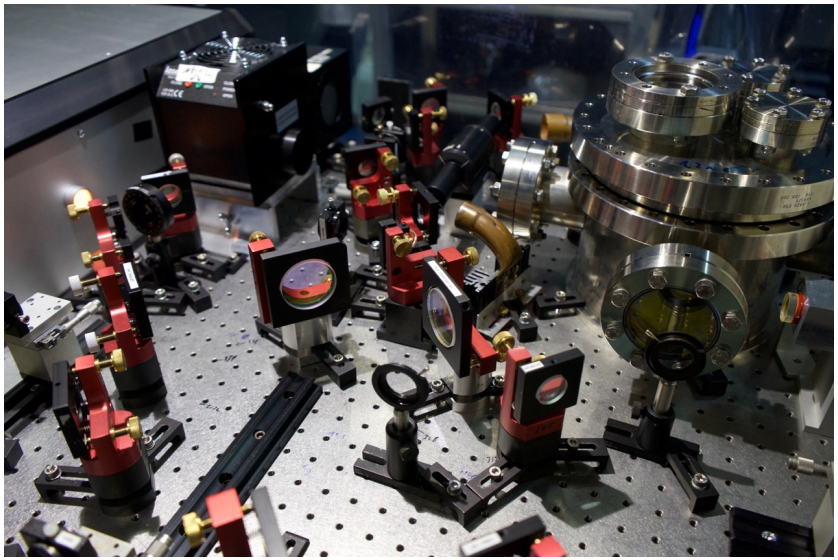


ALPS II Optical System

A unique set of challenges

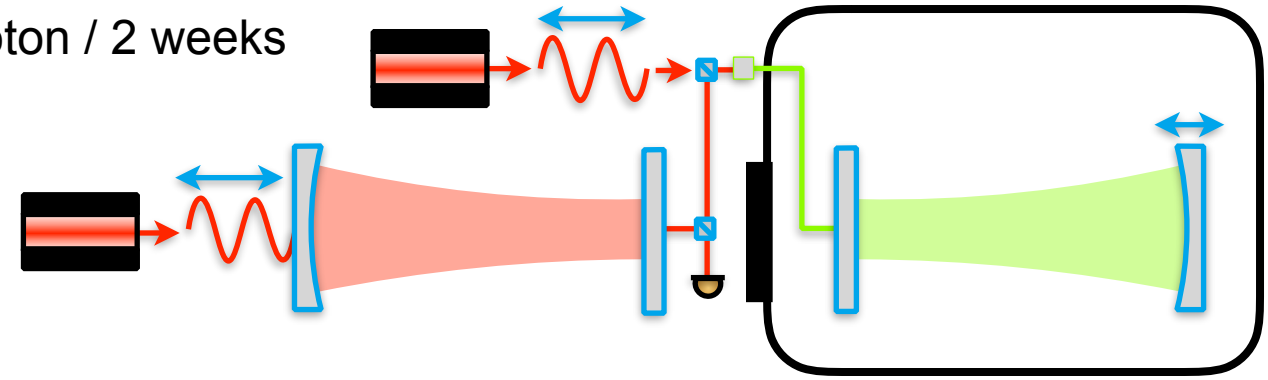
Two 100 m optical resonators

- 30 W NPRO input laser
- PC: 150 kW circulating power
- RC: 120,000 finesse



Challenges

- Maintenance of spatial overlap
- Maintenance of dual resonance
- Light tightness 1 photon / 2 weeks

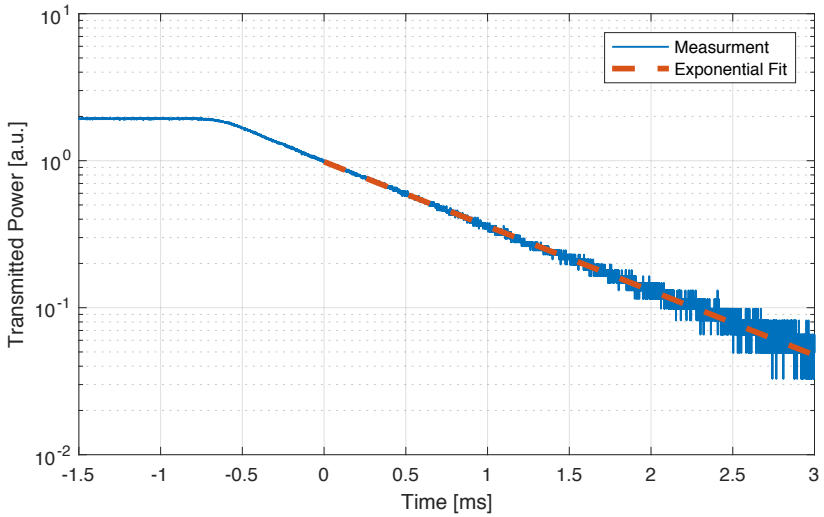


ALPS II Status

Addressing these challenges in the lab

Optical system tested in 20 m setup

- 50 kW circulating in 10 m PC
- Finesse of ~93,000 in 10 m RC
- Length stabilization system meets relative stability requirements without additional seismic isolation
  - 5 kHz actuation on a 2” mirror



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Characterization of optical systems for the ALPS II experiment

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Demonstration of the length stability requirements for ALPS II with a high finesse 10 m cavity

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arXiv:1710.06634v1 [physics.ins-det] 18 Oct 2017

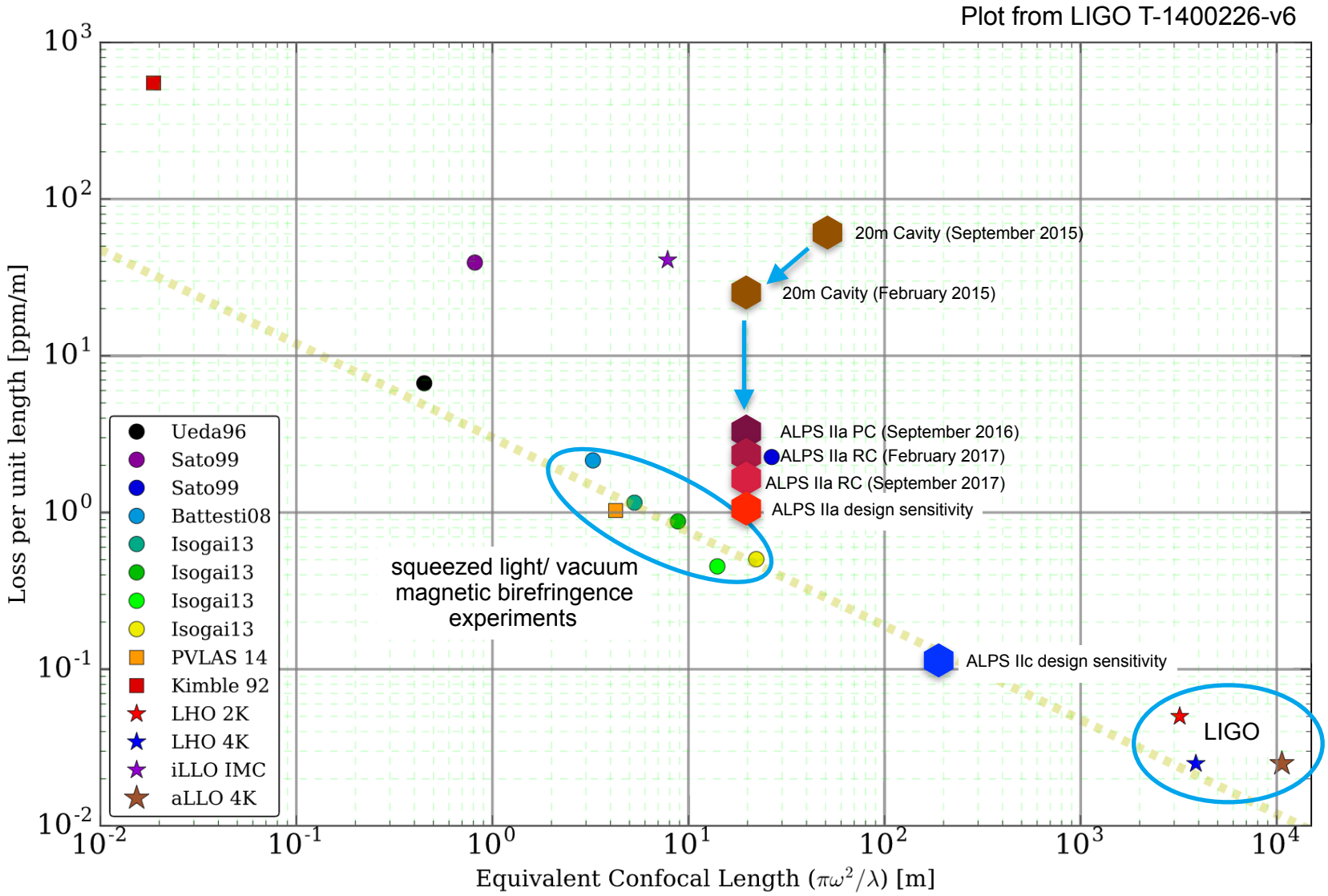
Conclusions

- ALPS II employs similar technologies to GW detectors
  - ALPS Group has built up an infrastructure for optics research at DESY
  - Optical tables, lasers, optics, expertise, etc.
- ALPS II data run scheduled 2020 with follow on VMB measurement
- Opportunities for future research (2024) with existing infrastructure

Questions?

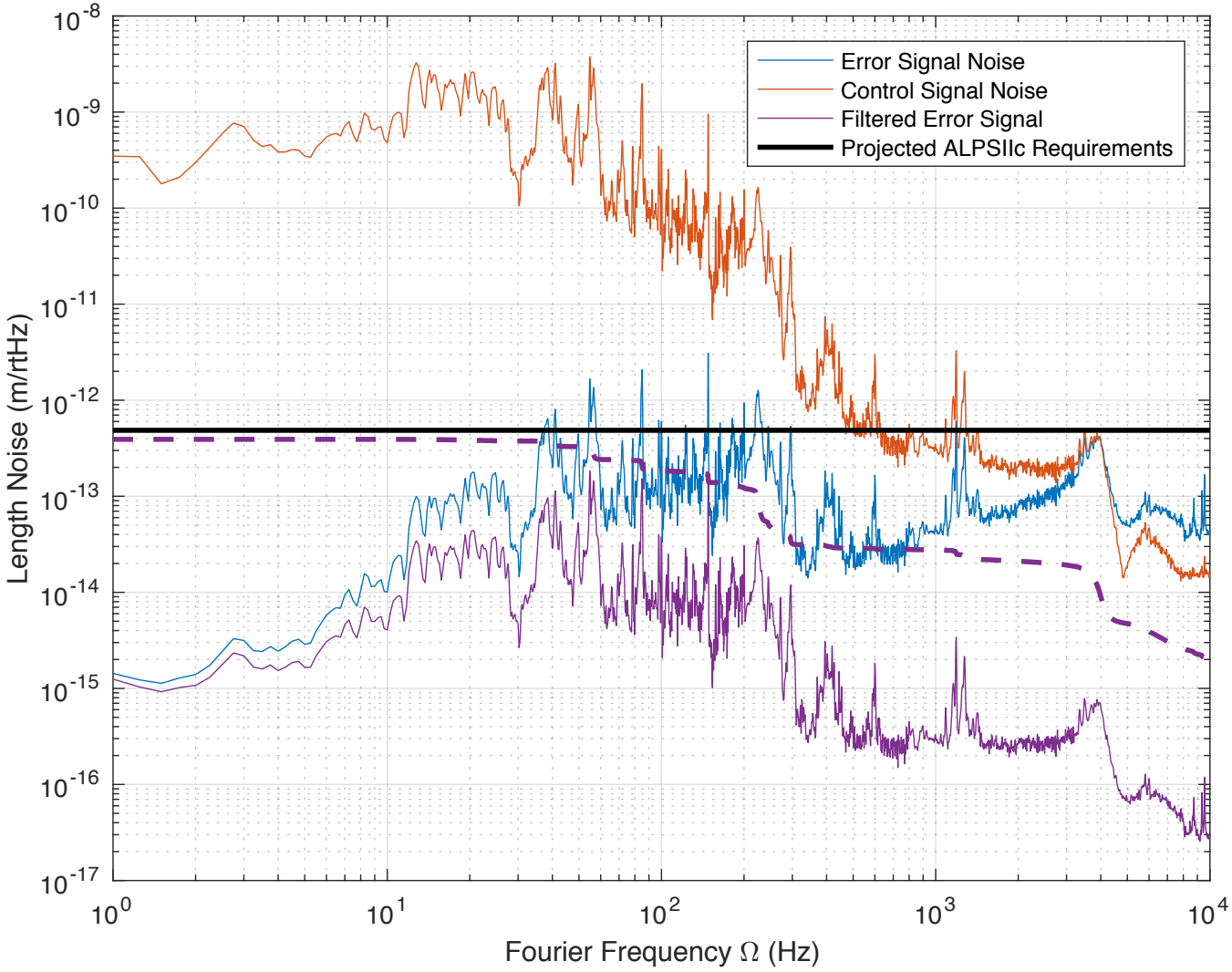
ALPS II cavities in context

Approaching the state of the art



Length Stabilization Results

Actuating on a 2” mirror with a 5 kHz bandwidth



ALPS II Sensitivity