

CAMK Annual Report

Mateusz Pietrzak

mpietrzak@camk.edu.pl

PhD student, supervisors: prof. T. Bulik and Dr. M. Suchenek

ASTROCENT



NICOLAUS COPERNICUS
ASTRONOMICAL CENTER
OF THE POLISH ACADEMY OF SCIENCES



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 952480



Republic
of Poland



Foundation for
Polish Science

European Union
European Regional
Development Fund



AstroCeNT:

- Research Group 2: Seismic Sensors
(leader: Prof. Tomasz Bulik)
- Research Group 3: Electronics and Data Acquisition and Processing
(leader: Dr. Mariusz Suchenek)

My thesis:

- Modeling of Quartz Resonators in Autonomous Sensors Applications.

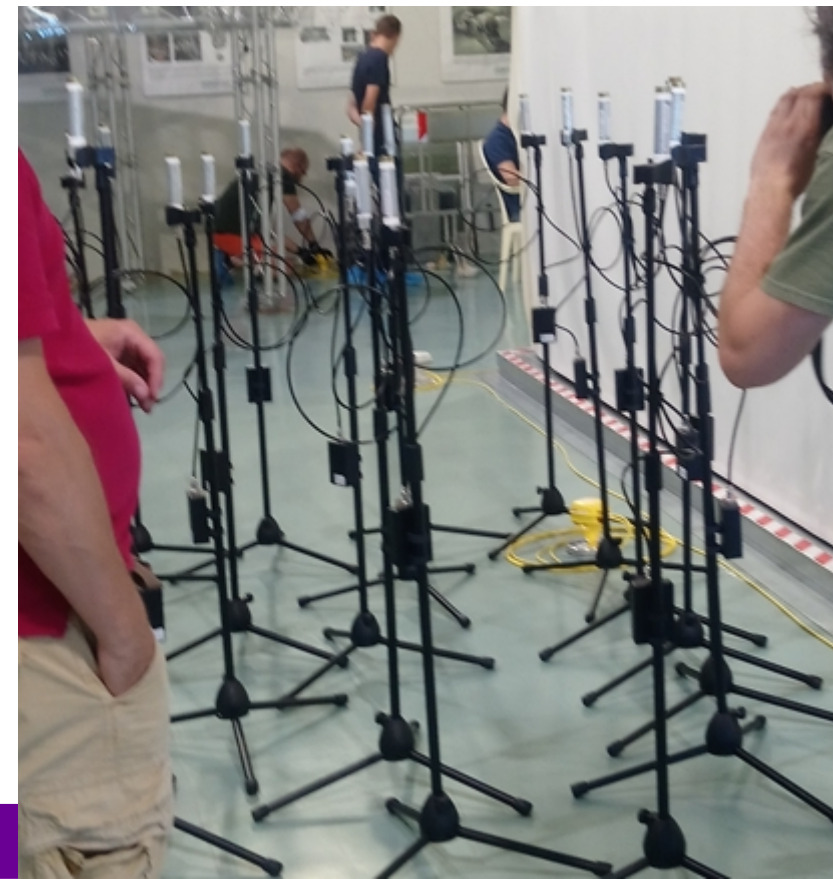


Quartz crystal plate used in electronics

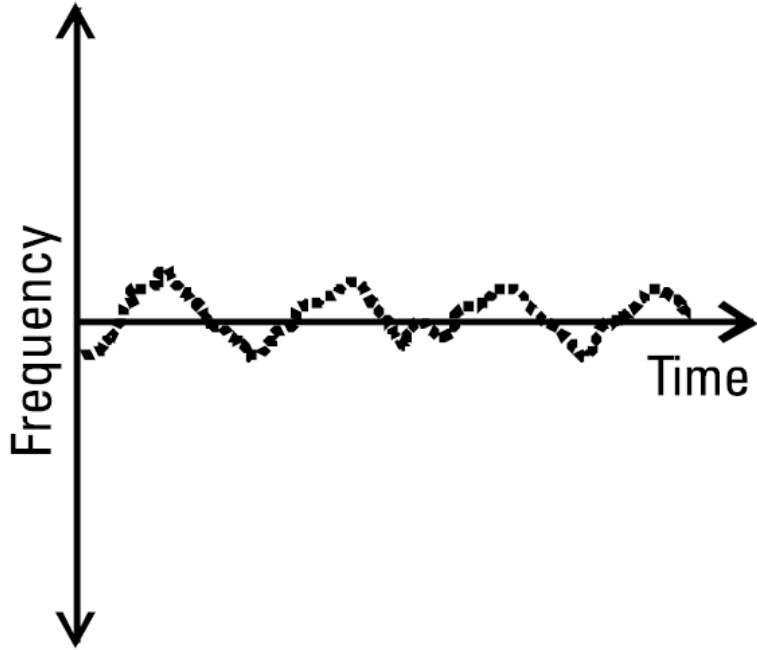


Virgo GW interferometer ©ESO

Infrasound microphones developed at ACT.

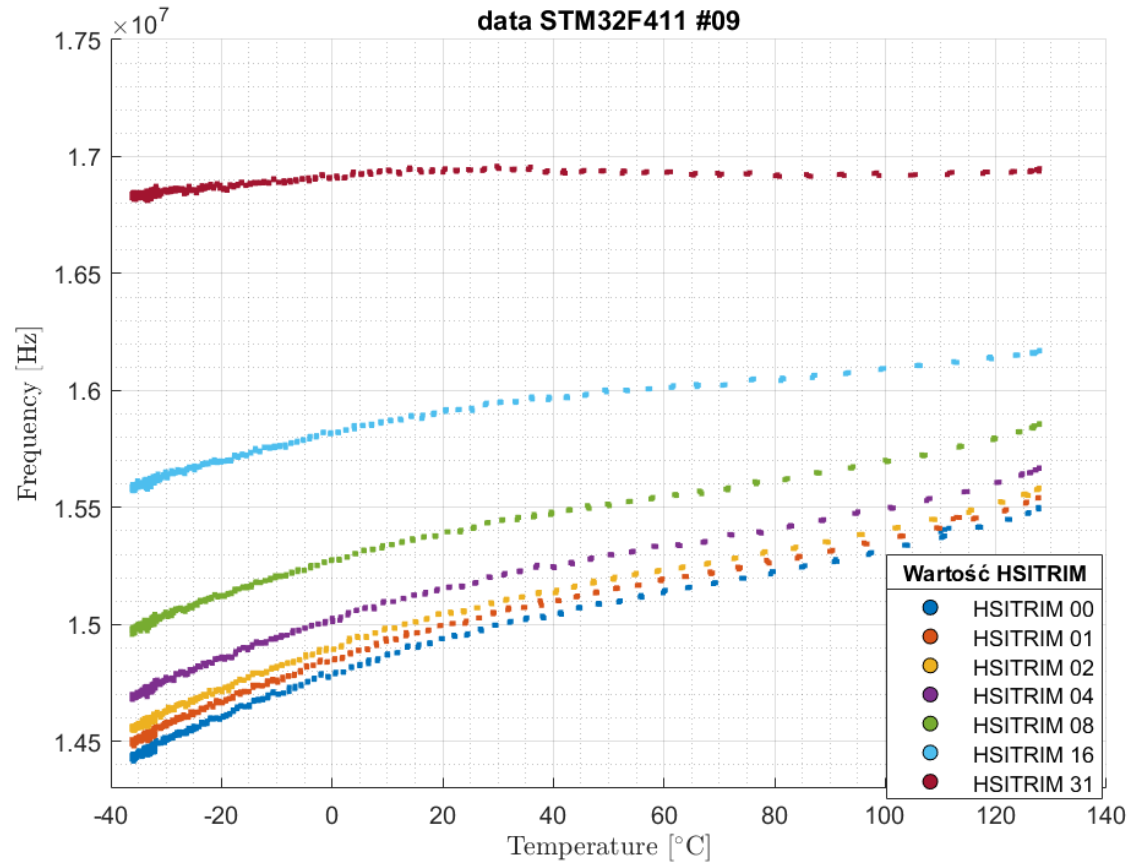


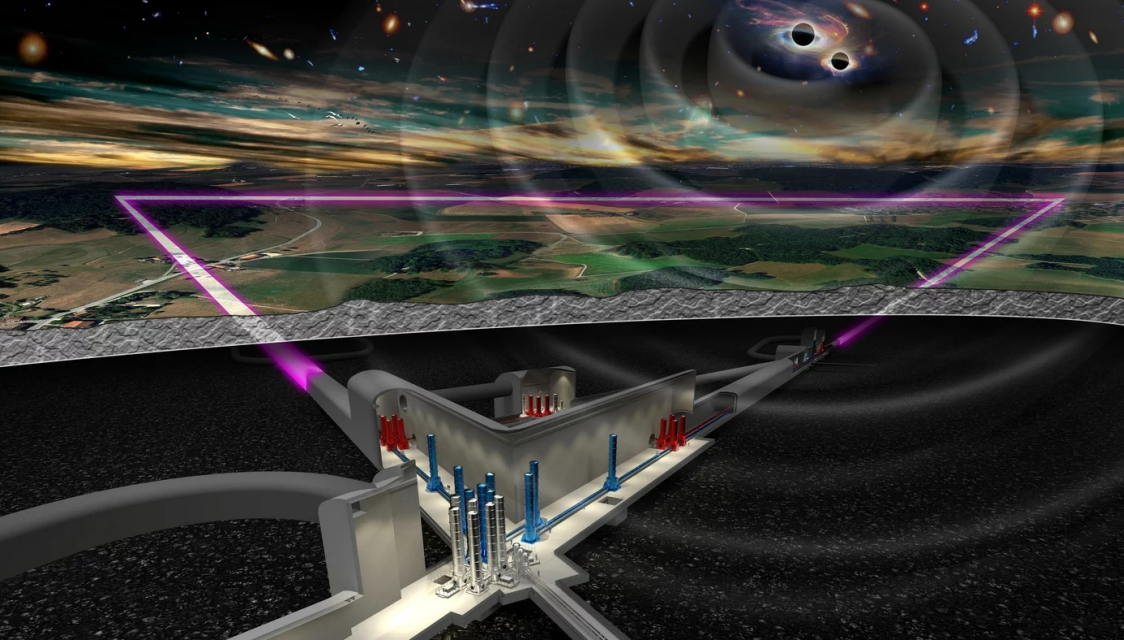
Frequency drift in quartz crystal oscillators



Frequency of the quartz oscillator tends to drift over time

The frequency instability caused by **environmental factors** and crystal structure defects.





The underground Einstein Telescope, a planned third-generation gravitational-wave detector.

© NIKHEF

For the new generation gravitational wave detector ET located **deep underground**, where **GPS is inaccessible**

The AstroCeNT sensor in the Sos Enattos mine, a candidate site for ET.



Design and implementation of a seismic Newtonian-noise cancellation system for the Virgo gravitational-wave detector

Soumen Koley^{*} and Jan Harms

*Gran Sasso Science Institute (GSSI), I-67100 L'Aquila, Italy and
INFN, Laboratori Nazionali del Gran Sasso, I-67100 Assergi, Italy*

Annalisa Allocca, Enrico Calloni, Rosario De Rosa, Luciano Errico, and Marina Esposito

*Università di Napoli "Federico II", I-80126 Napoli, Italy and
INFN, Sezione di Napoli, I-80126 Napoli, Italy*

Francesca Badaracco and Luca Rei

INFN, Sezione di Genova, via Dodecaneso, I-16146 Genova, Italy

Alessandro Bertolini

Nikhef, 1098 XG Amsterdam, The Netherlands

Tomasz Bulik

*Astronomical Observatory, University of Warsaw,
Al. Ujazdowskie 4, 00-478 Warsaw, Poland and*

Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences, ul. Bartycka 18, 00-716 Warsaw, Poland

Marek Cieslar, Mateusz Pietrzak, and Mariusz Suchenek

Nicolaus Copernicus Astronomical Center, Polish Academy of Sciences, ul. Bartycka 18, 00-716 Warsaw, Poland

Irene Fiori, Andrea Paoli, Maria Concetta Tringali, and Paolo Ruggi

European Gravitational Observatory (EGO), I-56021 Cascina, Pisa, Italy

Stefan Hild and Ayatri Singha

*Maastricht University, 6200 MD Maastricht, The Netherlands and
Nikhef, 1098 XG Amsterdam, The Netherlands*

Bartosz Idzkowski and Maciej Suchinski

Astronomical Observatory, University of Warsaw, Al. Ujazdowskie 4, 00-478 Warsaw, Poland

Alain Masserot and Loïc Rolland

Université Savoie Mont Blanc, CNRS, Laboratoire d'Annecy de Physique des Particules - IN2P3, F-74000 Annecy, France

Benoît Mours

Université de Strasbourg, CNRS, IPHC UMR 7178, F-67000 Strasbourg, France

Federico Paoletti

INFN, Sezione di Pisa, I-56127 Pisa, Italy

(Dated: October 27, 2023)

Abstract: Terrestrial gravity perturbations caused by seismic fields produce the so-called Newtonian noise in gravitational-wave detectors, which is predicted to limit their sensitivity in the upcoming observing runs. In the past, this noise was seen as an infrastructural limitation, i.e., something that could be mitigated by improving the detector's infrastructure.

Summary

- **Technical Support at ACT:**
 - the assembly of electronic printed circuit boards (PCBs), testing sensors
- **Field Deployments and Installations:**
 - installing and optimizing seismic and infrasound sensors in Italy
- Designing and implementing **electronics** for doctoral experiments
- Obtained all the **ECTS** points required for courses
- Contributing to the development of seismic-infrasound systems for **Newtonian Noise cancellation at the Virgo**

Plans for the near future

- publish a scientific article



The IRAP Conference (12-13 Oct 2023)