MAY 2022

The ABALONE Photodetector

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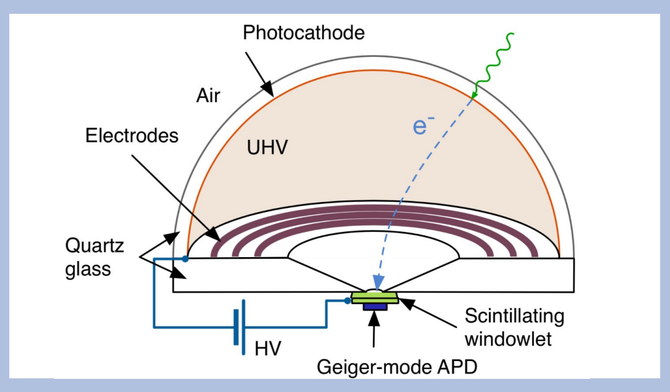
The **ABALONE** is a novel vacuum photosensor produced by PhotonLab, Inc. It is based on idea of accelerating photoelectrons (PE) generated in a traditional photocathode and guide them towards a window of scintillating material.



The scintillation light can then be read from the outside via an optically coupled silicon photo-multiplier (**SiPM**).

DESIGN

ABALONE Advantages

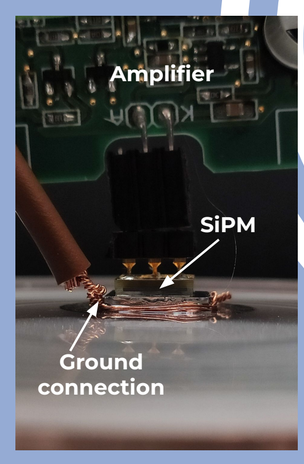
- **Low costs**
- **Low level of radioactivity**
- **Robust & shock resistant**
- **High gain ~10^8**
- **Low afterpulsing rate** ~5 x 10^{-3}
- **Low dark count rate** ~0.01 Hz/mm^2
- **Sub-nanosecond** timing resolution

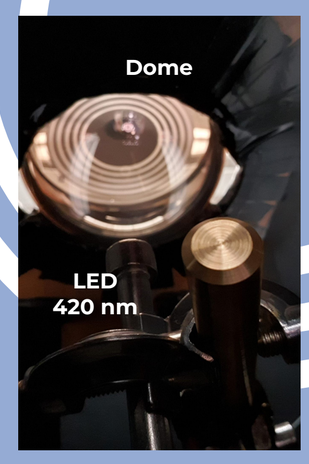
ABALONE Challenges

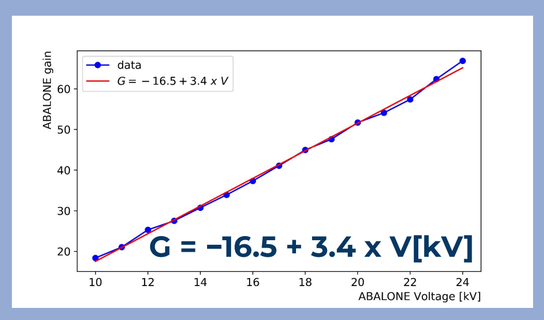
- **New technology**
- **High electric field**
- Has to be combined with **another light detector** like a **SiPM**

SET-UP

We built a test facility at **LNGS** (**Laboratori Nazionali del Gran Sasso**), Italy.
The **ABALONE gain** was found to linearly depend on the high voltage supplied. At 25 kV the total gain is **$3.2x10^8$**.

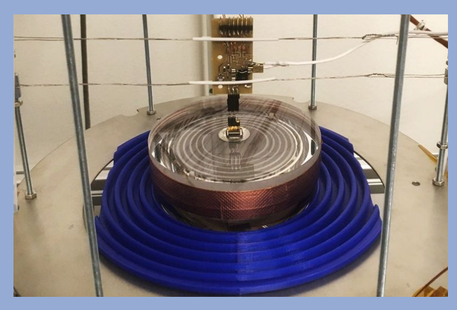


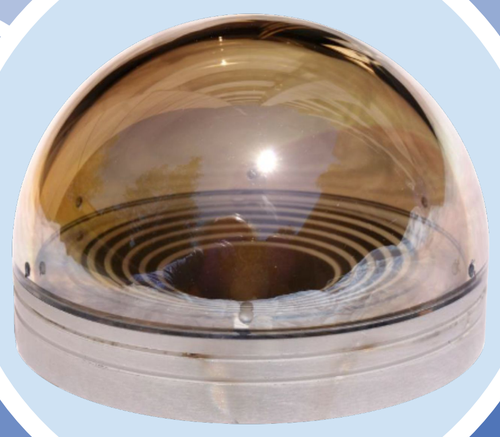




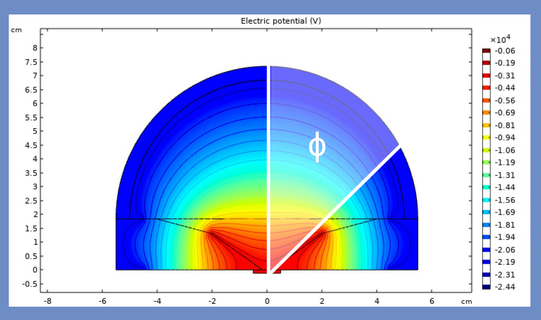
A second test facility in **University of Stockholm**, Sweden, will probe this photosensor in a **cryostat** filled with **Xenon** in both **gas** and **liquid** phase.

For the cryogenic tests a special support was designed to **hold** and **dump** the ABALONE **electric field lines**.



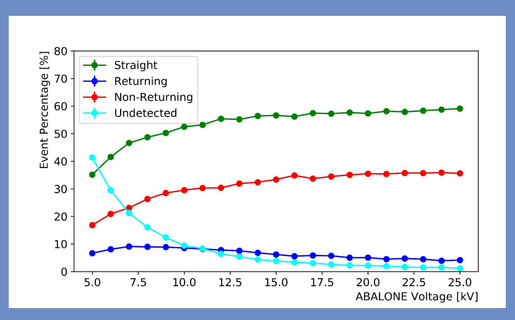


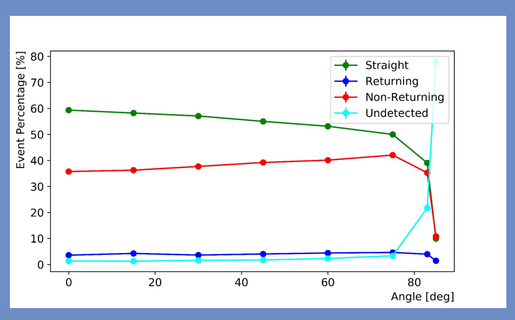
SIMULATIONS



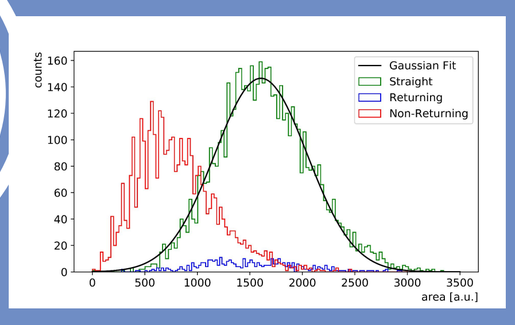
Simulations in **GEANT4** and **COMSOL™** to study PEs collection efficiency and ABALONE response.

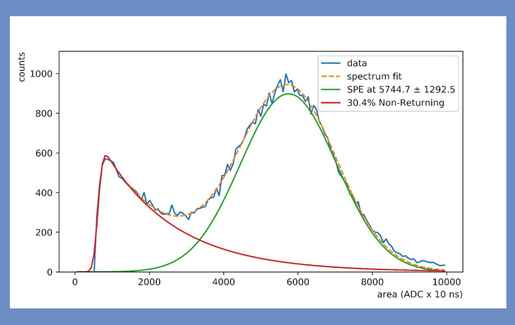
A good detection efficiency is achieved for voltages (HV) **larger than 15 kV** and angles with respect to the vertical axis (ϕ) **smaller than 80°**. For these values, 35% of PEs release only part of their energies (non-returning PEs).





Simulated ABALONE response function to photons generated at ϕ=0 (left) and the **experimental** result (right).





BACKGROUNDS

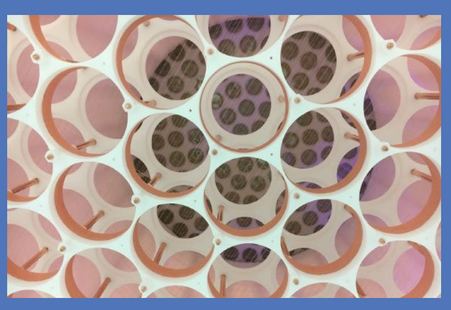
The ABALONE photosensor has three main advantages against PMTs and SiPMs in **background reduction**

reduced residual gas:
afterpulses rate**~10^2 less** than common PMTs

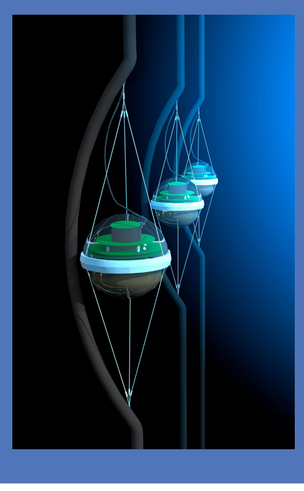
made of three **glass** components only: great **radio-purity**

signal-to-noise ratio:
$S_{1\ P.E.}/DC_{1\ P.E.}$ ~ 100

The **ABALONE** photosensor is a **great candidate** for **several applications**.



It can be exploited both for **astroparticle physics** and **medical imaging**.



ACKNOWLEDGEMENT

This work was supported by the Swedish Research Council (VR) under the Starting Grant Agreement 2020-04070 and by the INFN Astroparticle Physics Commission 2 (CSN2).
Images credits: XENON Collaboration, IceCUBE Collaboration, PhotonLab, Inc.

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