Search for Solar ALPs in the Low Energy Range at CAST

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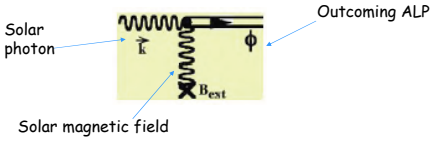
Abstract

Axion Like Particles (ALPs) could be continuously produced in the Sun via the Primakoff process . The ALP flux could be seen on Earth by observing the photons produced by the ALP "decay". The expected energy distribution of reconverted photons is peaked at 3 keV, while the average is found at 4.2 keV. However there is a low energy tail that could be enhanced by various mechanisms. We report results of the first test measurements in the low energy range performed at CAST, the experimental setup and the future developments.

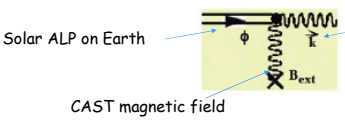
Search for Solar ALPs

ALPs could be produced in the Sun via the Primakoff effect

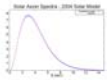


Sun to Earth propagation

ALPs could be detected using a strong magnetic field



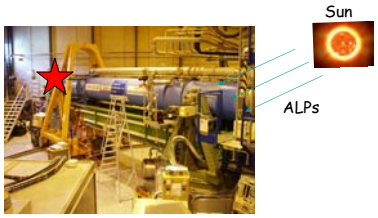
Photon Energy spectrum peaked at a few keV



Raffelt: arXiv:hep-ph/0504152 v2 2 May 2005

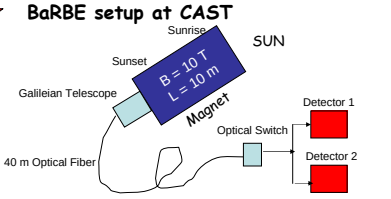
INFN BaRBE (Basso Rate Bassa Energia) project = Development of a detector system for low-background single photon counting at low energy

Measurements with the first prototype



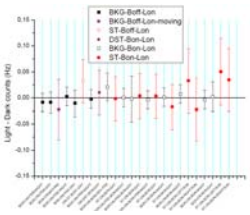
CAST experimental hall at CERN
The CAST magnet is fixed on a moveable mount in order to follow the Sun

BaRBE setup at CAST



Each detector:
50 % time Light
50% time Background

2007-2008 runs: Photomultiplier Tube
Cooled @ -20 °C
Active area = 9 mm
DCR = 0.5 Hz
QE @ 350 nm = 25%

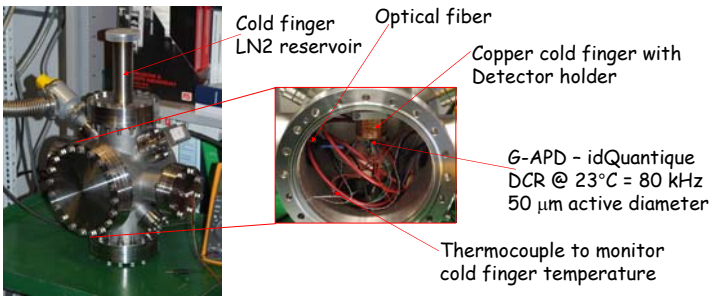


First measurements at CAST show no signal above Background

Poissonian distribution for events was considered with afterpulses correction

Future = LN2 cooled Geiger mode-APD

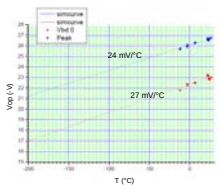
Cryostat for LN2 cooled G-APD



First test measurements done using a test chip
With commercial front end electronics:

- DCR = 80 kHz @ 23°C
- V_{bd} = 22.80 V @ 23°C
- Output pulse = 2V – 20 ns with 50 Ω load
- Output pulse after TTL circuit shaping = 5V – 80 ns
- Dead time = 40 ns
- QE = 35% @ 532 nm

Operating Voltage (Vop) vs Temperature

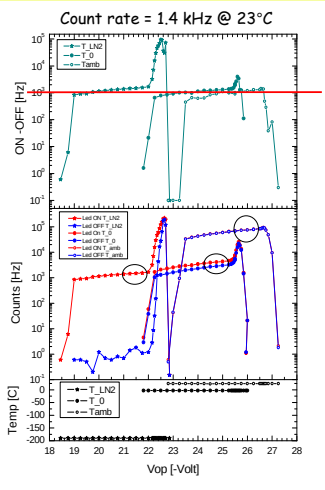


- Different rates of photons from a blue LED are sent to the detector via an optical fiber
- For each rate three curves are obtained at different cooling temperatures (23°C, -20°C, -180°C)
- All counts are corrected for afterpulses events
- **At LN2 the DCR is about 1 Hz → 10^5 lower with respect to ambient temperature**

⬭ = working reagion of operating voltage Vop. For each temperature it is chosen to be at the same voltage difference with respect to the brakdown voltage Vbd at that temperature.

—— = expected rate of photon in the working region
The expected rate is defined as the rate observed at room temperature (23°C)

Count rate = 1.4 kHz @ 23°C



Count rate = 4 kHz @ 23°C