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# Remote optical detection of alpha radiation in daylight

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## Introduction

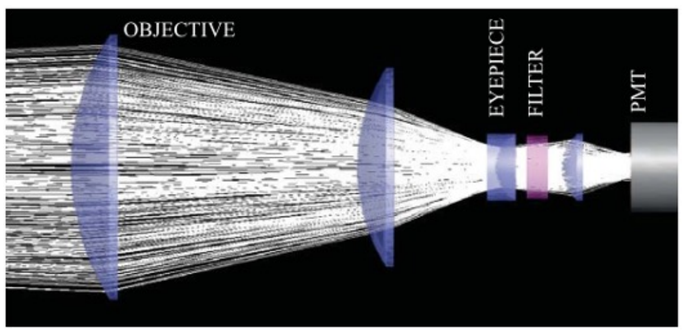
Alpha radiation detection is challenging with traditional radiation detectors. The high stopping power of an alpha particle means that the radiation cannot travel or be directly detected from long distances [1]. In a normal atmosphere alpha particles ionize and excite nitrogen molecules which emit light in the UVB and UVC range making remote detection possible.

Radioluminescence emission for MBq level sources is relatively weak when compared to daylight intensity. In normal atmosphere oxygen and nitrogen cause strong quenching effect on luminous nitrogen states making remote detection even more challenging.

Replacing the oxygen (O2) in the air with nitrogen gas (N2) and few ppm of nitric oxide (NO), the intensity of UVC-light emitted around the radioactive material will be three to four orders of magnitude greater. This allows the indirect detection of alpha radiation from a distance in a daylight.

In this work we measure UVC radioluminescence in daylight conditions and build a rate equation model to match the experimental results.

## Optical setup

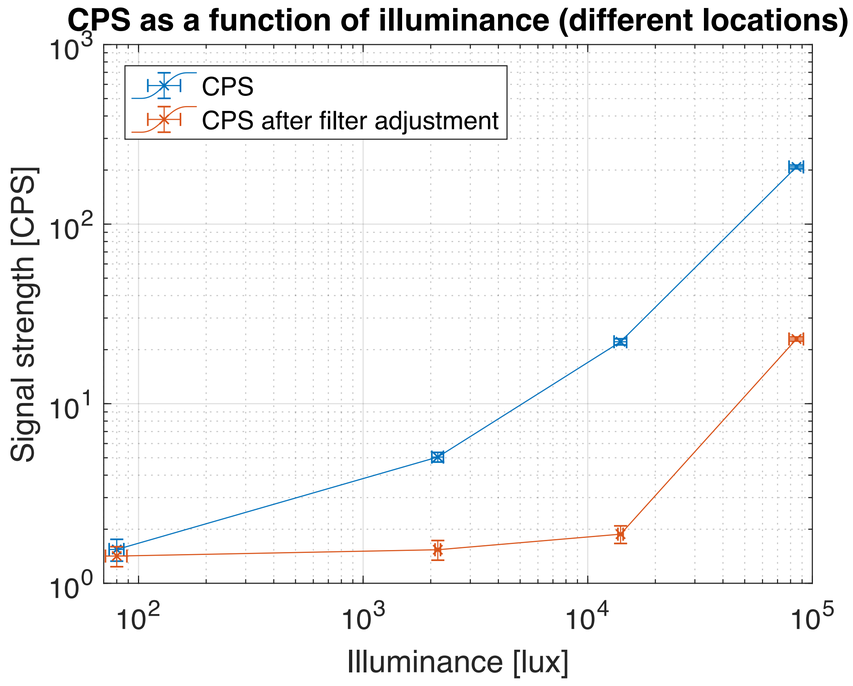



- Critical filter placement and alignment
- UVC-optimized photomultiplier tube
- Optimized for ~1m measurement distance

## Alpha scanner

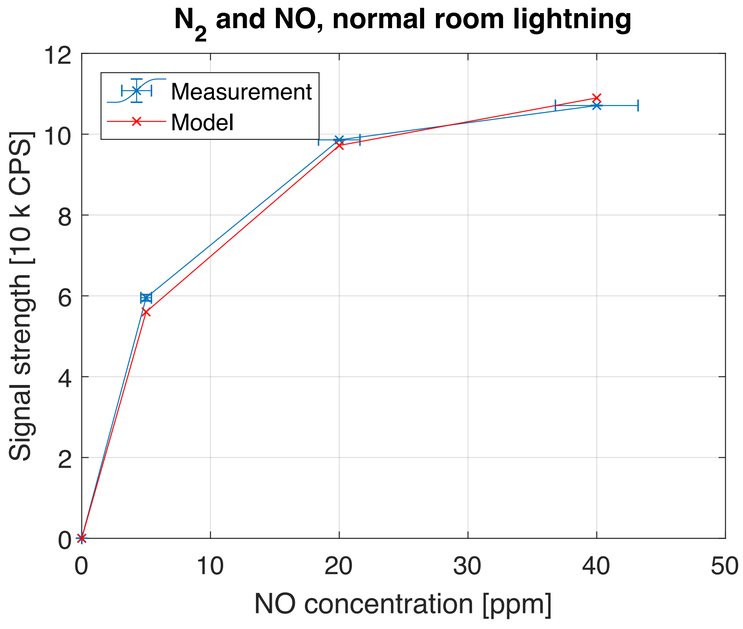
- PC controlled scanner
- Point by point scanning of selected area
- Combines PMT counts as a heat map with regular camera picture
- Filter set can be optimized for different lighting conditions
- Demonstration with 30 MBq Am-241 source at 2 m distance and 3.7 MBq source at 1 m distance in normal lighting conditions

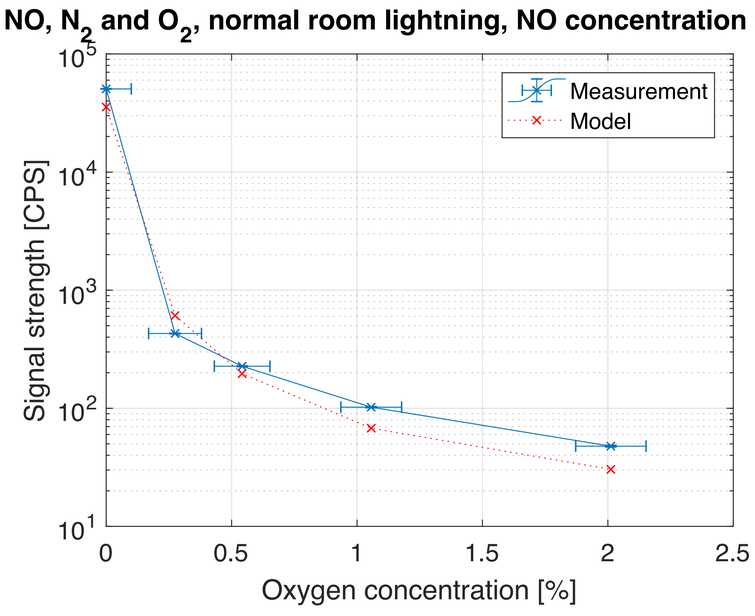
## Background light performance




- Filter performance optimized for 260 nm (NO luminescence)
- Datapoints from:
  - Office, window closed
  - Office, window open
  - Outdoors, cloudy
  - Outdoors, sunlight

## Detection and modelling performance




- Rate-equation model including $N_2$, $O_2$ and NO was created
- Measurements were done in controlled gas chamber
- Model response was tested with a set of gas mixtures
- Oxygen quenching reduces $N_2$ luminescence and eliminates NO luminescence

References
1. T. Kerst, ”Optical Stand-off Detection of Alpha Radiation in Nuclear Facilities,” http://urn.fi/URN:ISBN:978-952-03-1247-3