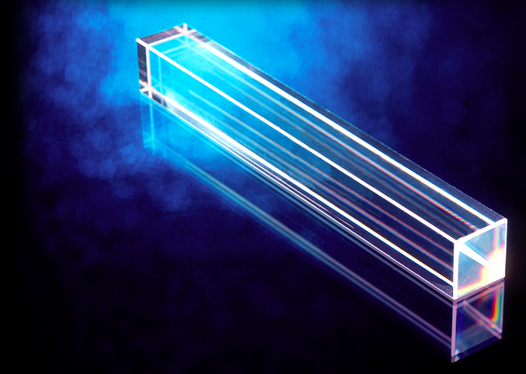
MEDICAL APPLICATIONS: PET

# Investigating DOI



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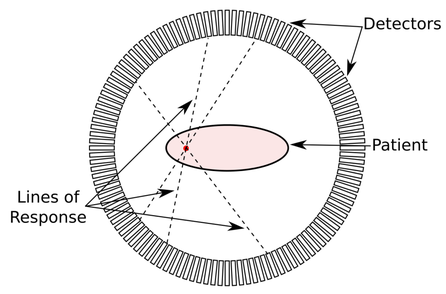
## Introduction

PET-scanners are essential devices in the medical industry. A $\beta^+$- source is injected into the patient's body and emits positrons that annihilate with electrons and emit back-to-back photons, which are detected.



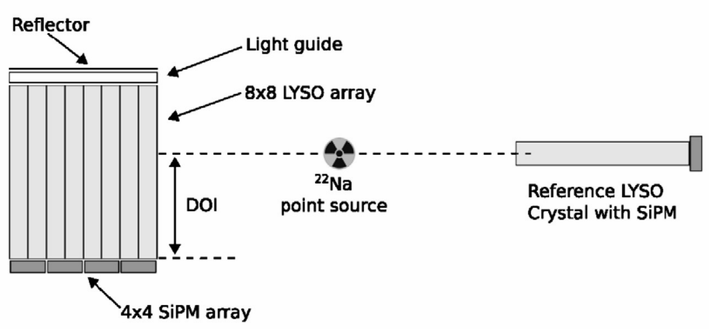

PET-scans close to the body entail a loss of resolution by not having the right information about the depth of interaction (DOI). Is there a useful relationship between the total light recorded ($P_{tot}$) and the amount of light that hits the crystal of interaction ($p_{max}$)?

## Hypothesis

The ratio between the light collected by the detector in front of a given crystal and the total light collected by all the detectors is correlated to DOI of an incident gamma ray.

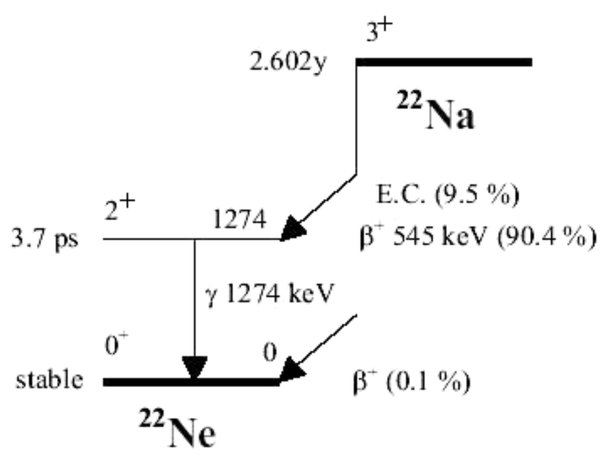
## Project Overview

The aim of the project is to develop a setup that will prove this hypothesis and find out how reliable the new method is.




## Materials

- $Na^{22}$
- Scintillator
- Photomultiplier: SiPM
- Digital caliper
- Reflector
- ADC-channel




## Variables

**Controlled variables**

- Back-to-back production of 511 keV photons
- The relative positions of the single crystal and the decay source to the crystal matrix
- The dimentions of the crystals

→ Change of height

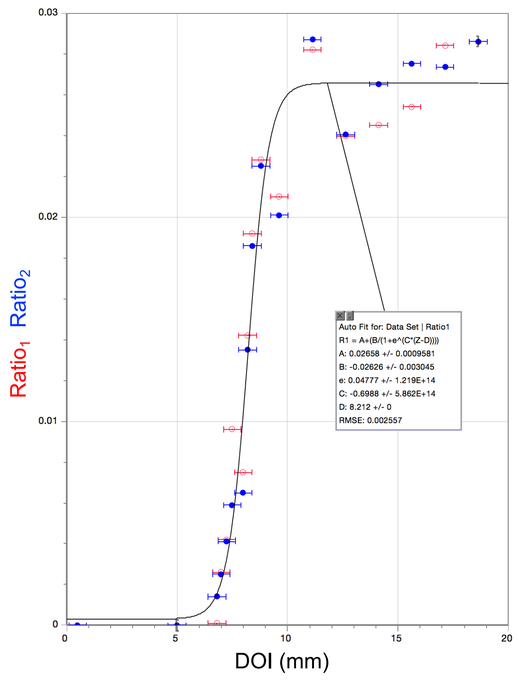
**Dependent variables**

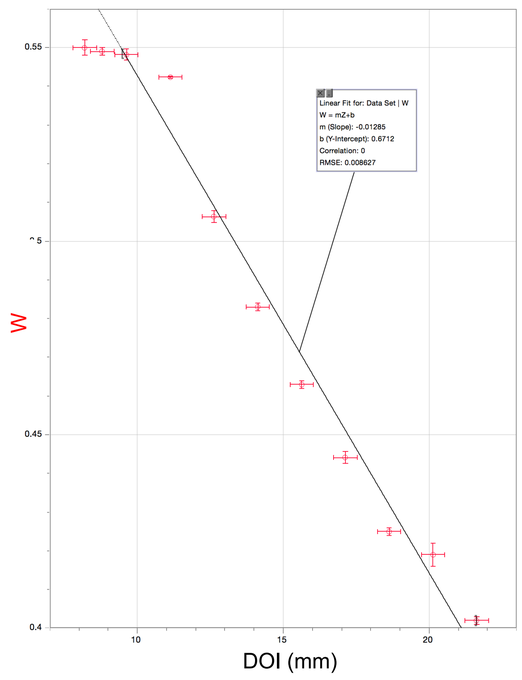
$P_{tot}$
$p_i$
u: mean x-position
v: mean y-position
w: $p_{max}/P_{tot}$

## Procedure

| Step 1 | Step 2 | Step 3 | Step 4 |
|---|---|---|---|
| Alignment | Electronic setup | Measurements | Data analysis |

## Results




## Conclusion

It is proven that there is a correlation between the DOI and the ratio of $p_{max}$ and $P_{tot}$ and it has shown to be proportional.

Therefore this method will improve the PET scans precision and help in the diagnose and intervention of cancer and other clinical conditions.

Literature:

Pizzichemi, M. 2016. „Positron emission tomographie: state of the arts and future developments". University of Milano-Bicocca: Milano.
Pizzichemi, M. et al. 2016. „A new method of depth of interaction determination in PET detectors". CERN: Genéva et al.