

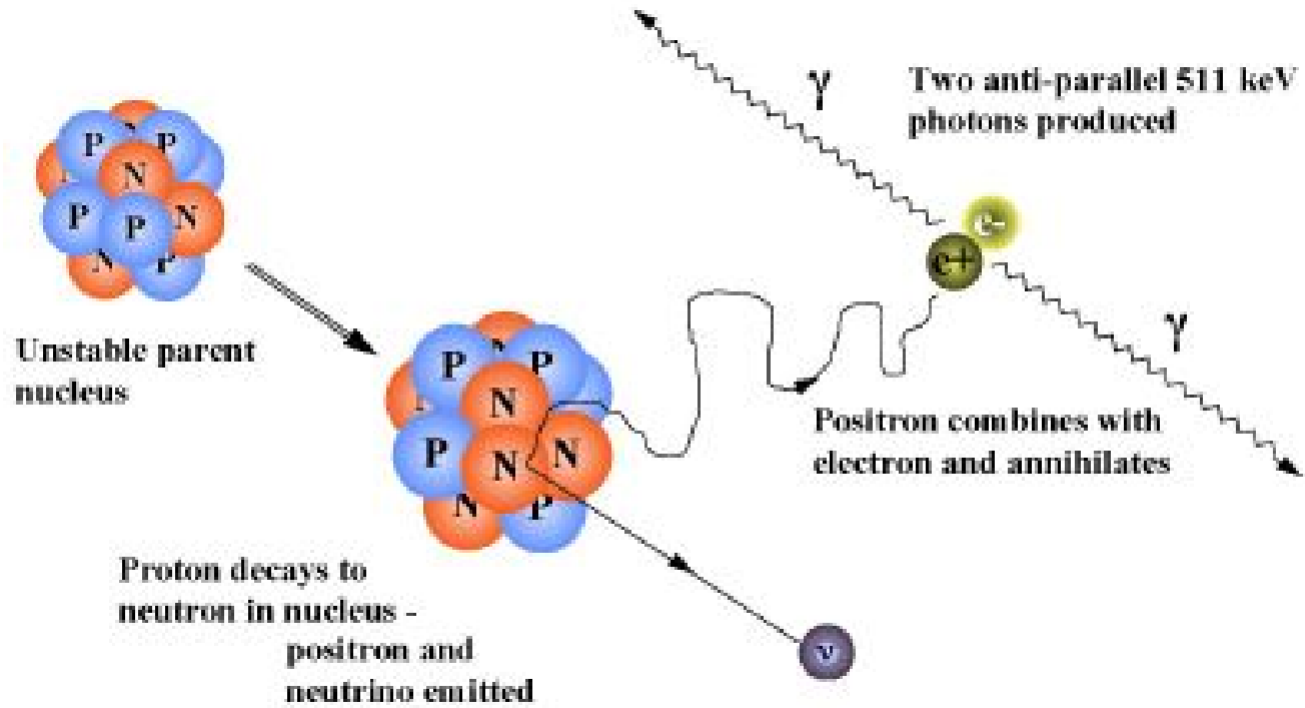
PAUL SCHERRER INSTITUT



Martin Grossmann :: Center for Proton Therapy :: Paul Scherrer Institute

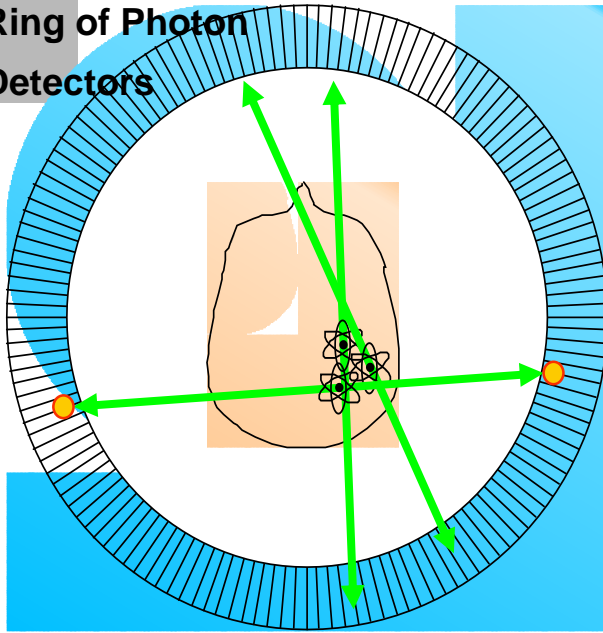
# Introduction to EasyPET Exercise

# What is PET



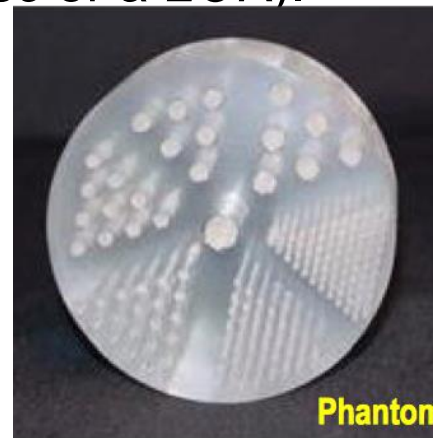
# PET – Positron Emission Tomography

Ring of Photon  
Detectors

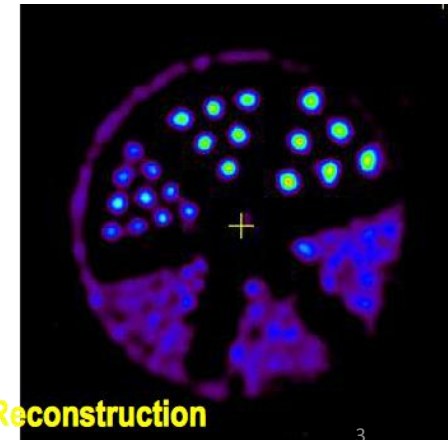


- Radionuclide decays, emitting  $\beta^+$ .
- $\beta^+$  annihilates with  $e^-$  from tissue, forming back-to-back 511 keV photon pair.
- 511 keV photon pairs detected via time coincidence.
- Positron lies on line defined by detector pair (known as a *line of response* or a *LOR*).

- Back-to-back 511KeV photons are detected



Phantom Reconstruction

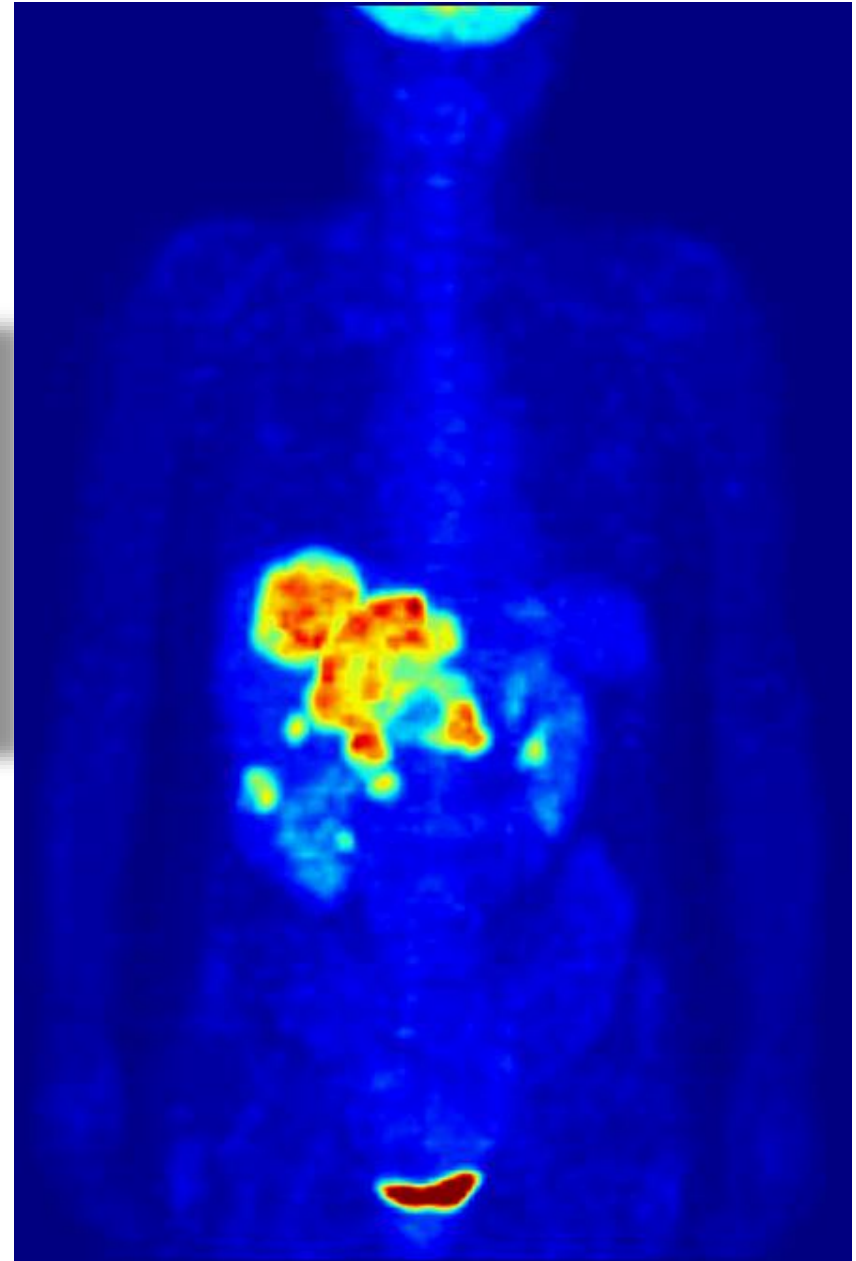


## An Example - $^{18}\text{F}$

- $^{18}\text{F}$ -FDG - Fludeoxyglucose is one of the commonly used radiotracers
- It is a sugar, so it accumulates where the body burns a lot of energy (“uptake”)
- Unusual “hot spots” can point to cancer

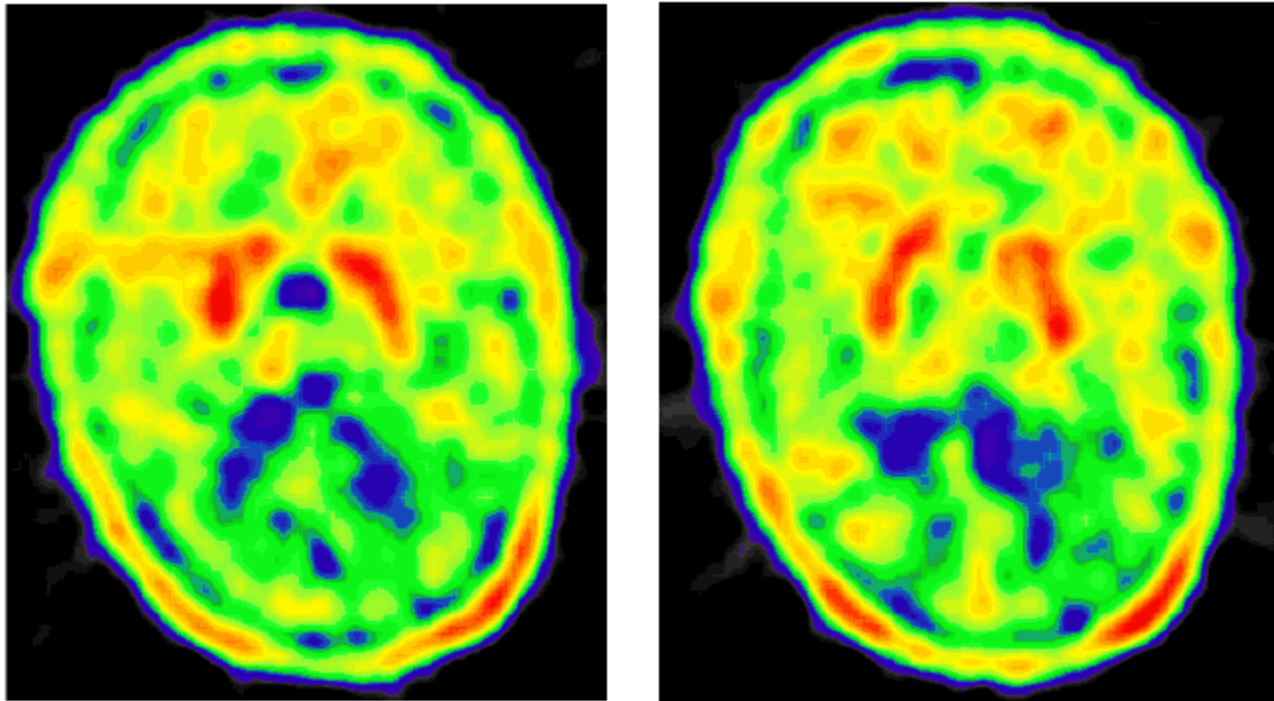
Whole-body PET scan using  $^{18}\text{F}$ -FDG to show liver metastases of a colorectal tumor

From Martin Purschke!



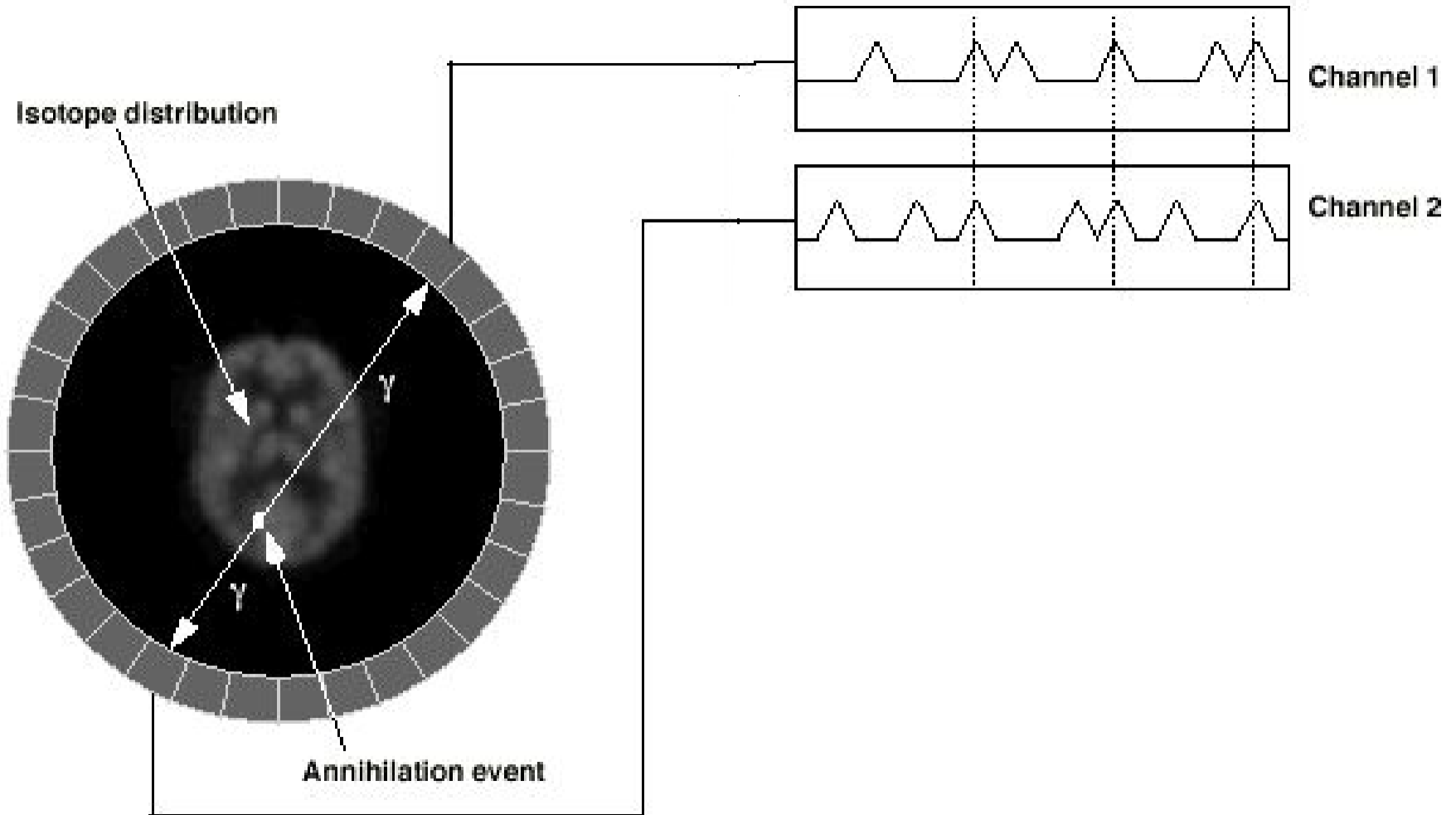
# PET image of the brain

- Dopamine = chemical messenger in our body
- Parkinson's disease: dopamine production in the central brain not properly working
- PET image using dopamine with  $F^{18}$  isotope



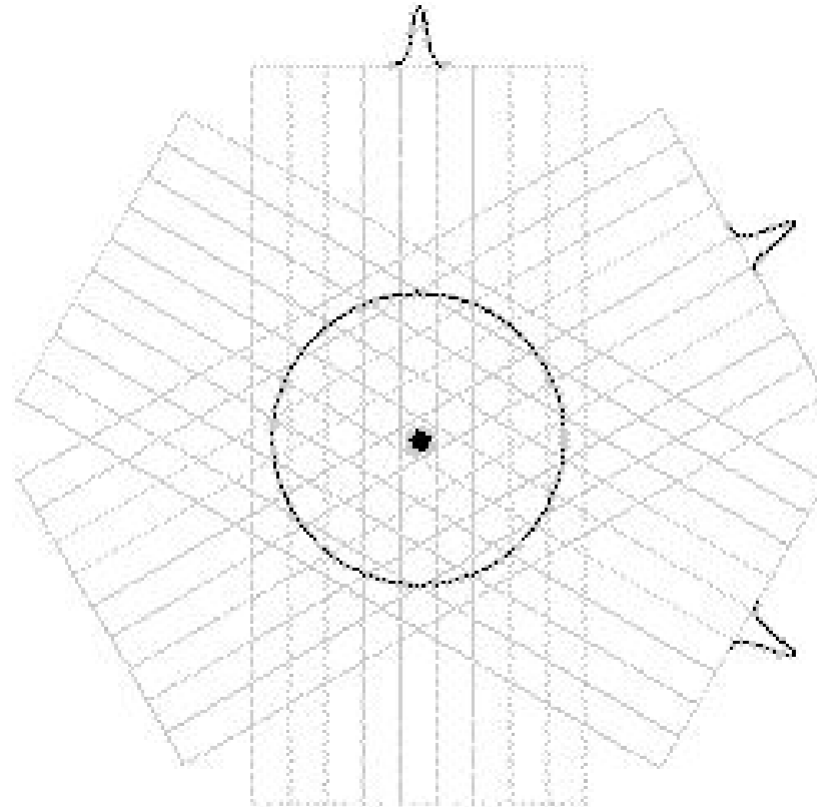
[F-18]fluoro-L-DOPA, 13. November 1997, Grossmann Martin

# Coincidence detection



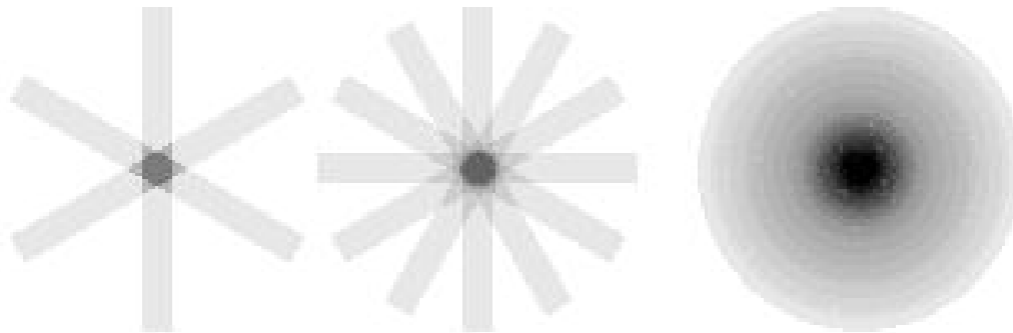
# 2D PET image

- LOR (lines of response) arranged into sets of 1-dimensional parallel projections



# 2D PET image

- Back-Projection allows to reconstruct original source distribution

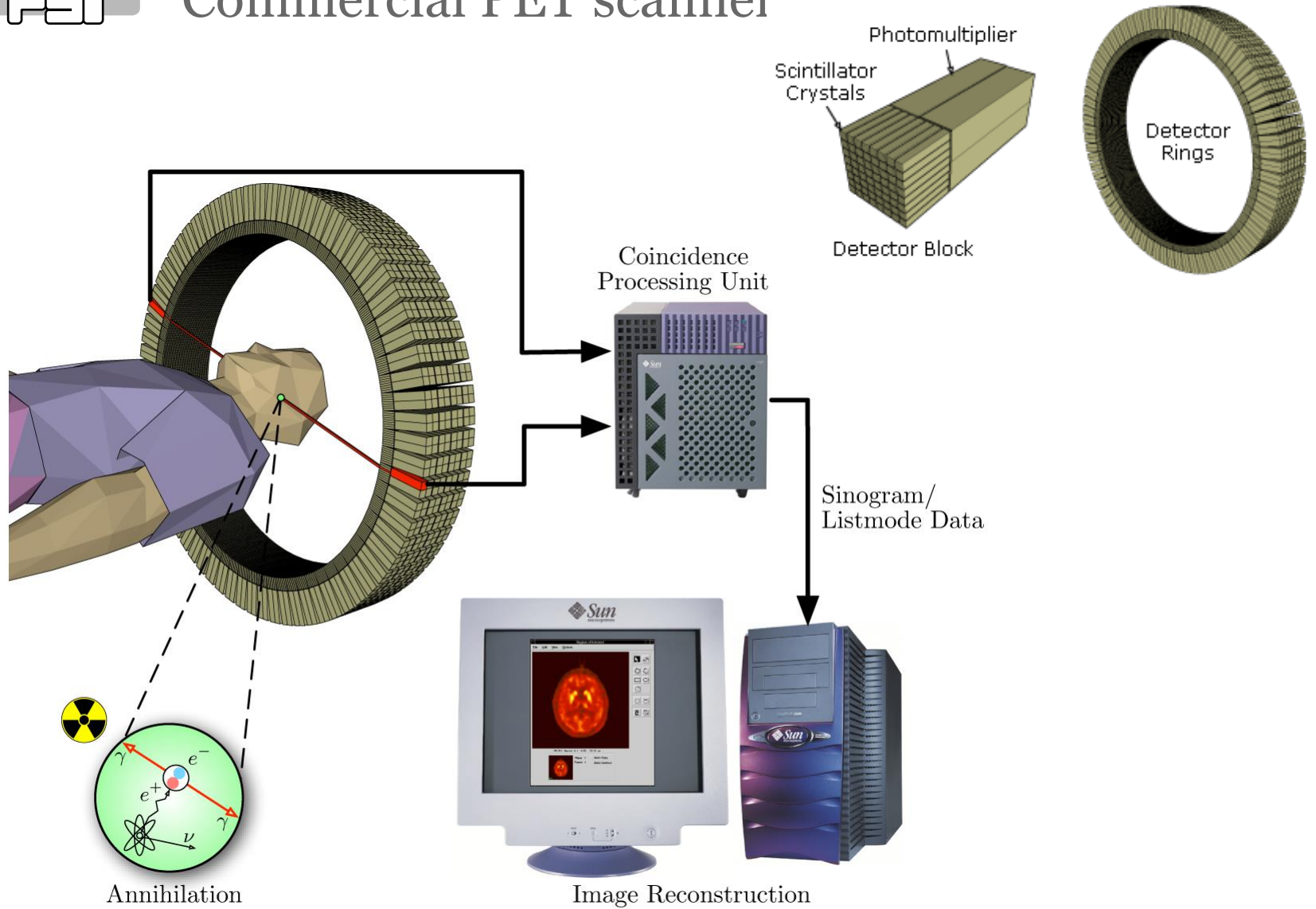




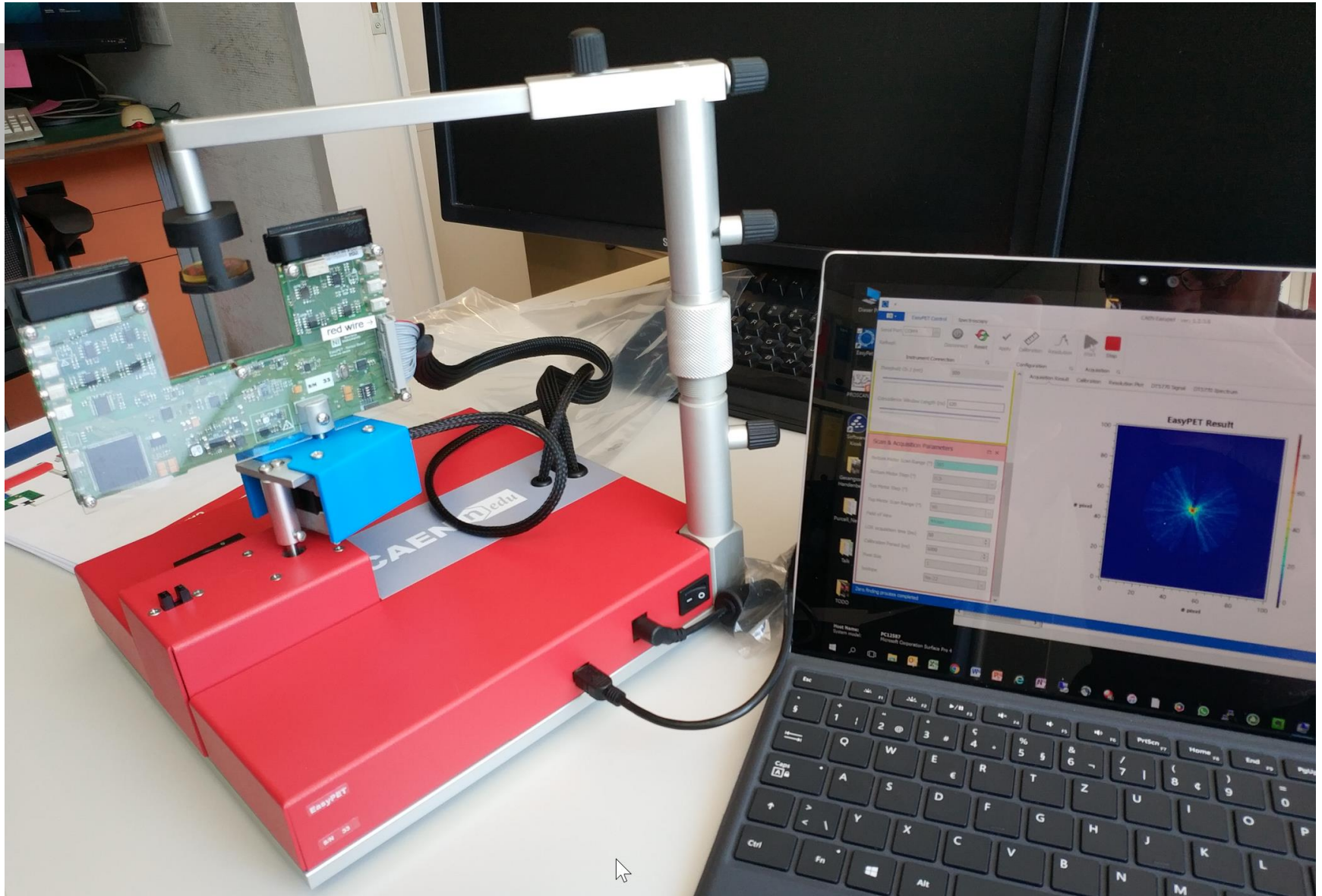
# Commercial PET scanner



# Commercial PET scanner



- 2 detectors moving around the target



# LySO Crystals

- Lutetium-yttrium oxyorthosilicate  
 $\text{Lu}_2(1-x)\text{Y}_2x\text{SiO}_5$
- Scintillator crystal



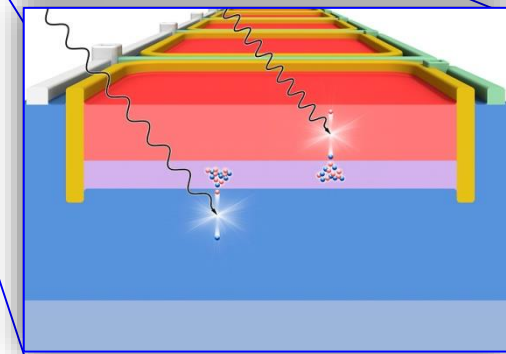
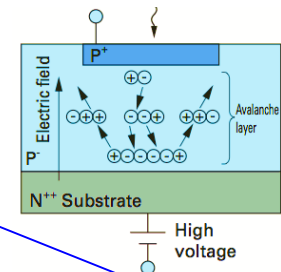
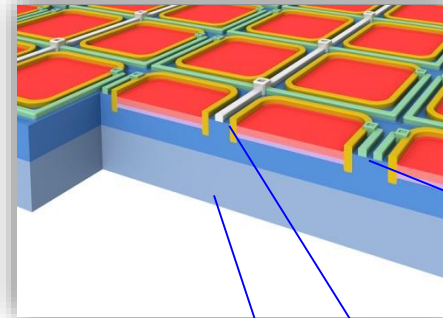
# Silicon Photo Multiplier - SiPM

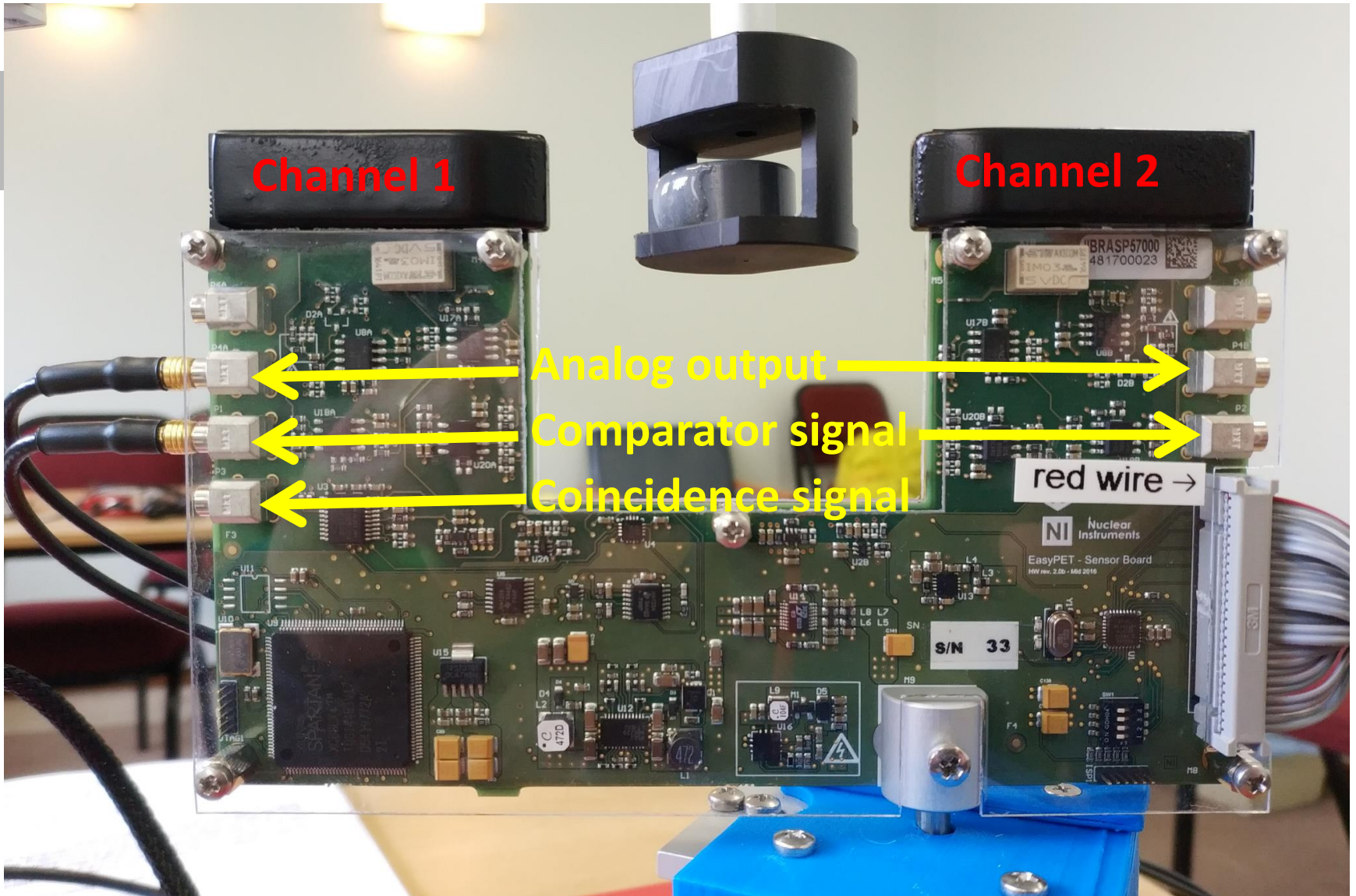
- Solid state photon detectors
- High gain, low voltage («bias»)
- Very compact
- Compatible with magnetic resonance imaging MRI



# Silicon Photo Multiplier - SiPM

- SiPM is a High density (up to  $10^4/\text{mm}^2$ ) matrix of diodes with a common output, working in Geiger-Müller regime
- Common bias is applied to all cells (few % over breakdown voltage)
- Each cell has its own quenching resistor (from  $100\text{k}\Omega$  to several  $\text{M}\Omega$ )
- When a cell is fired an avalanche starts with a multiplicative factor of about  $10^5$ - $10^6$
- The output is a fast signal ( $t_{\text{rise}} \sim \text{ns}$ ;  $t_{\text{fall}} \sim 50 \text{ ns}$ ) sum of signals produced by individual cells
- SiPM works as an analog photon detector





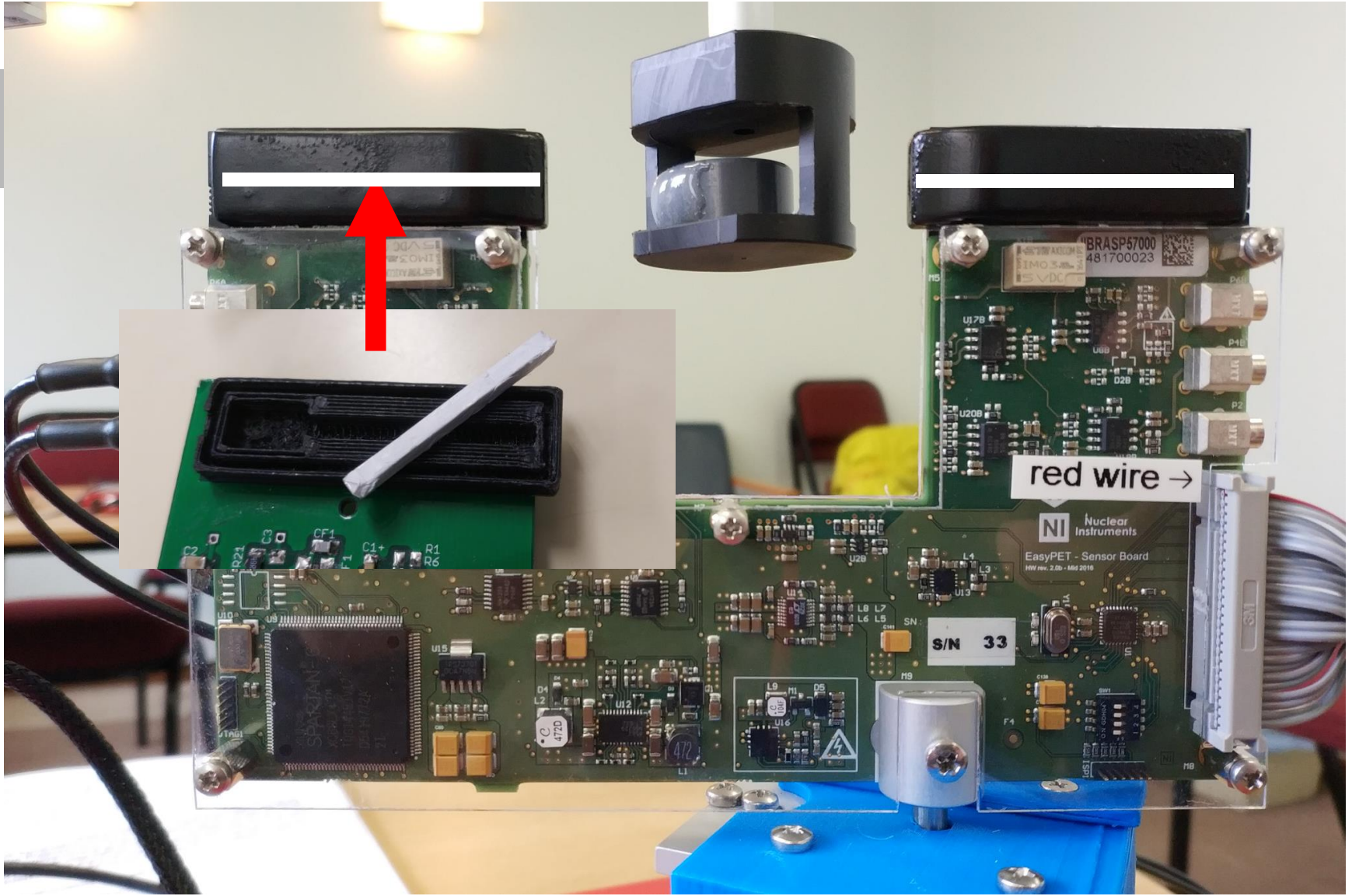
# DT5770 Multi Channel Analyzer (MCA)

- Analyze pulses
- Accept signal and trigger input
- Readout with PC



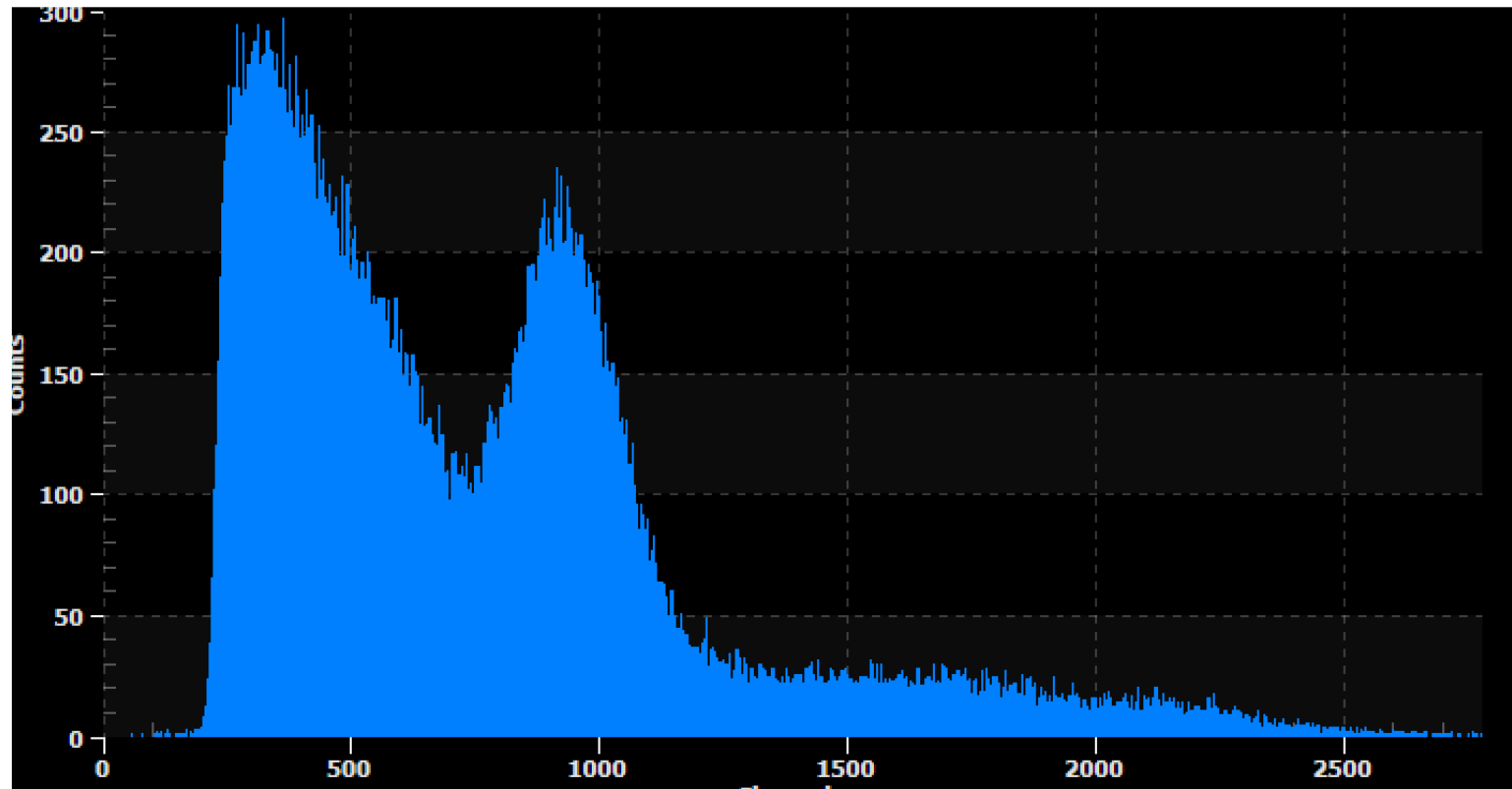
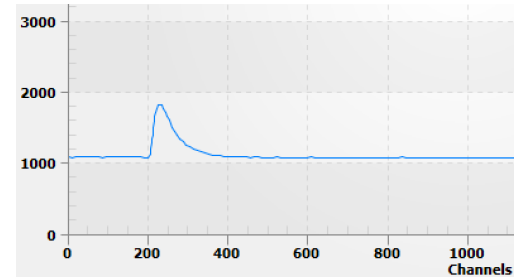


# Source Alignment



# Multi Channel Analyzer (MCA)

- Look at individual pulses
- Acquire spectrum



CAEN EasyPET - ver: 1.2.4.0

EasyPET Control Spectroscopy

Serial Port: COM4

Refresh Disconnect Reset Apply Calibration Resolution Start Stop

Instrument Connection Configuration Acquisition

### SiPM Bias Control

Channels Status: On

SiPM BIAS Voltage:

Power off after acquisition

### Coincidence Parameters

Threshold Ch 1 (mV):

Threshold Ch 2 (mV):

Coincidence Window Length (ns):

### Scan & Acquisition Parameters

Acquisition Result Calibration Resolution Plot DT5770 Signal DT5770 Spectrum

## EasyPET Result

### EasyPet

Status:

Top Angle:

Bottom Angle:

Counts:

Total Counts:

Run Time:

Acq Length:

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### DT5770 MCA

Status:

Input Count Rate:

Output Count Rate:

Successfully connected to DT5770



# Handling radioactive sources



