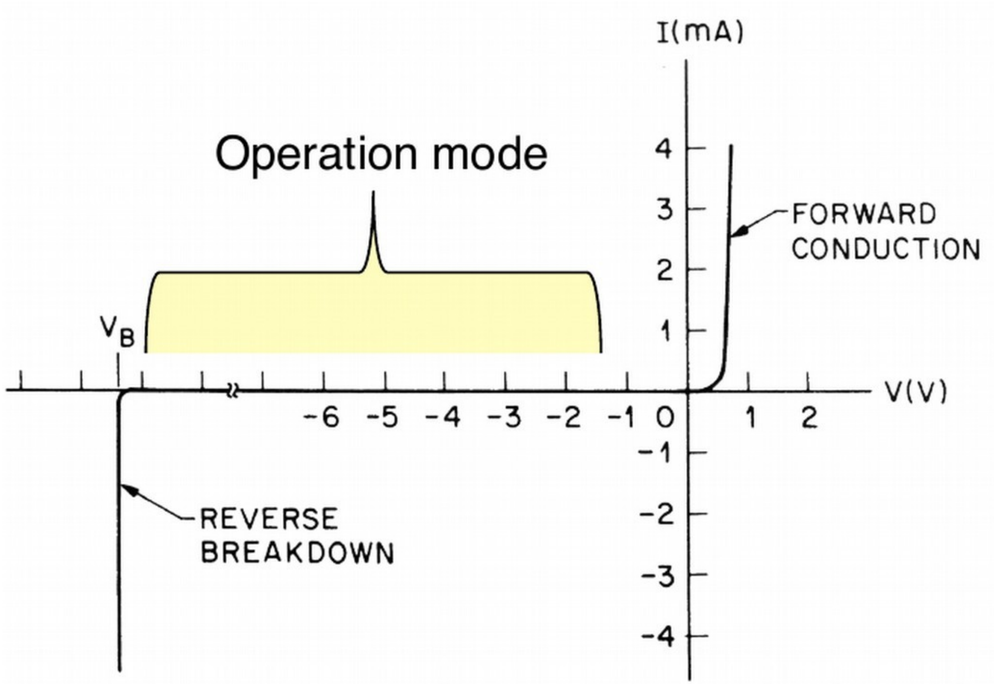
# Solid state or Semiconductor Detectors



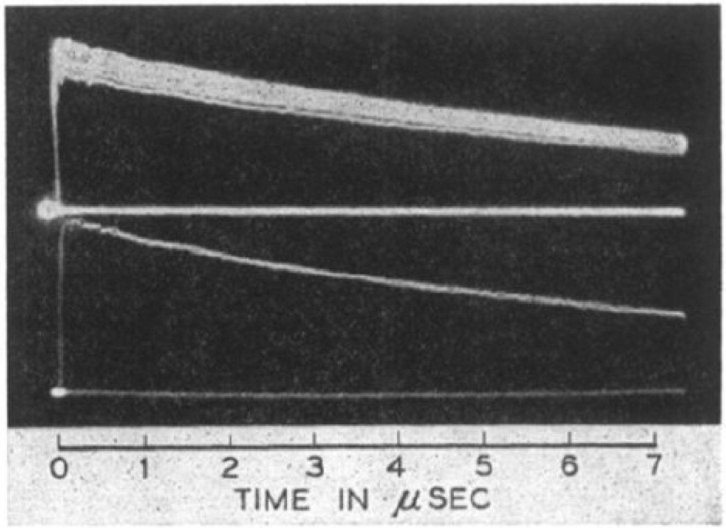
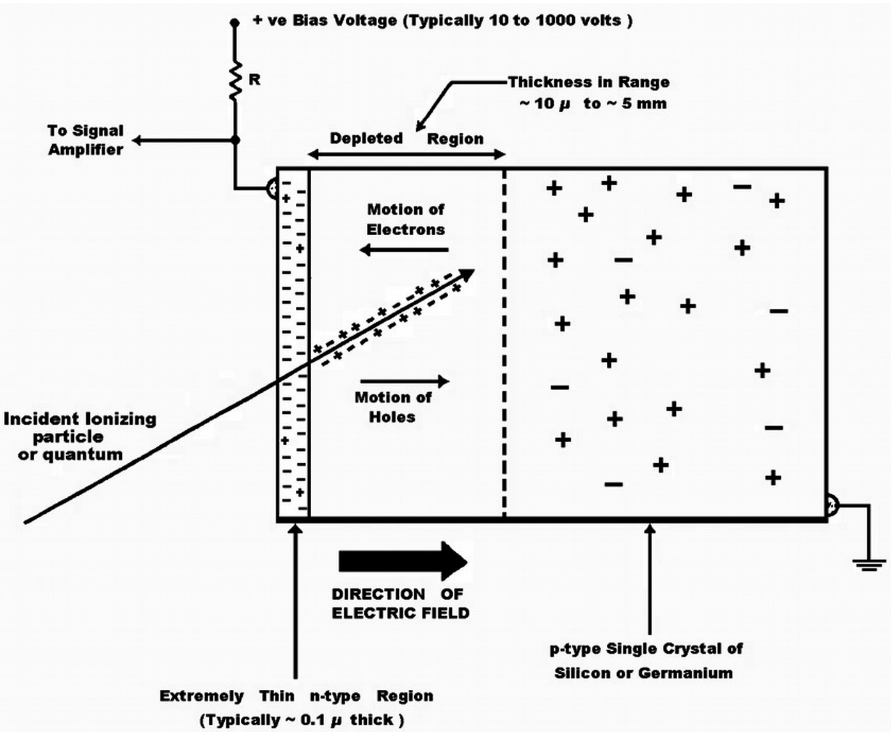
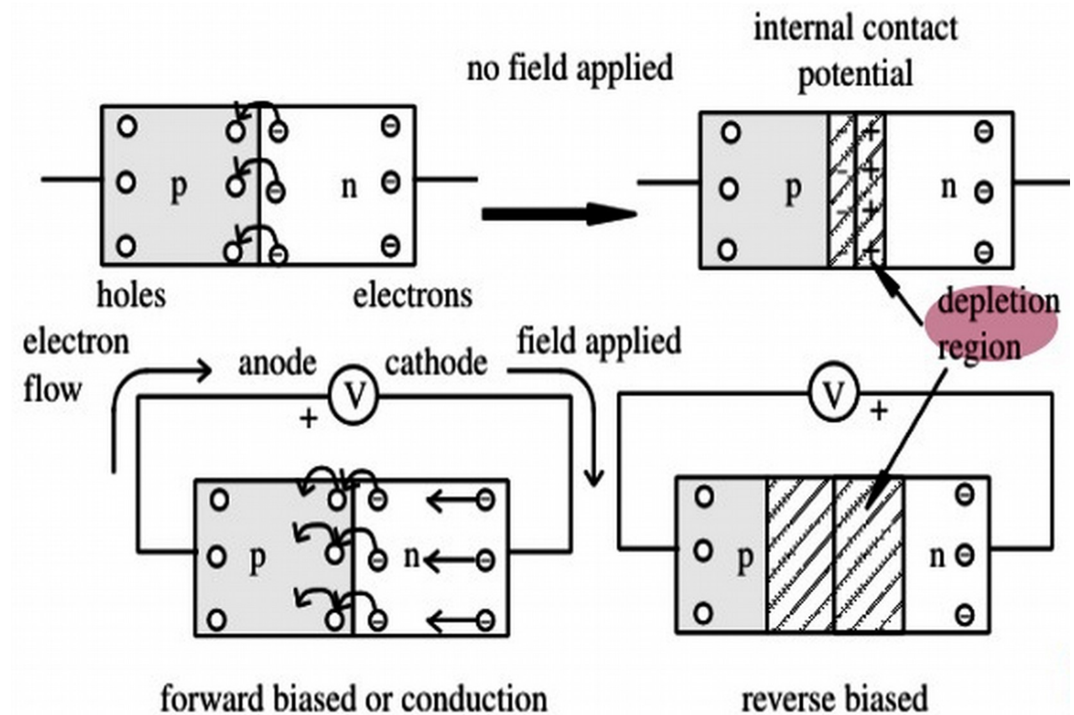



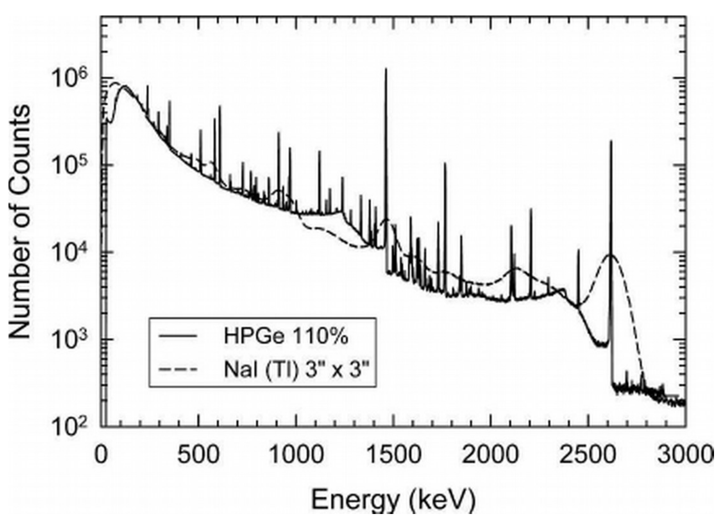

FIG. 3. Photograph of pulses from sixteen alpha-particles striking the $n-p$ barrier.

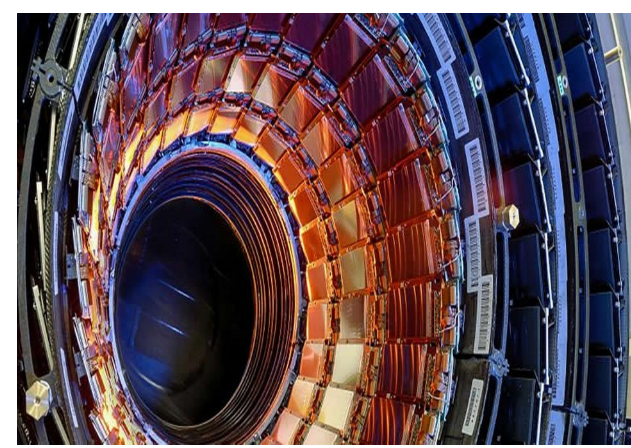
# Semiconductor detectors



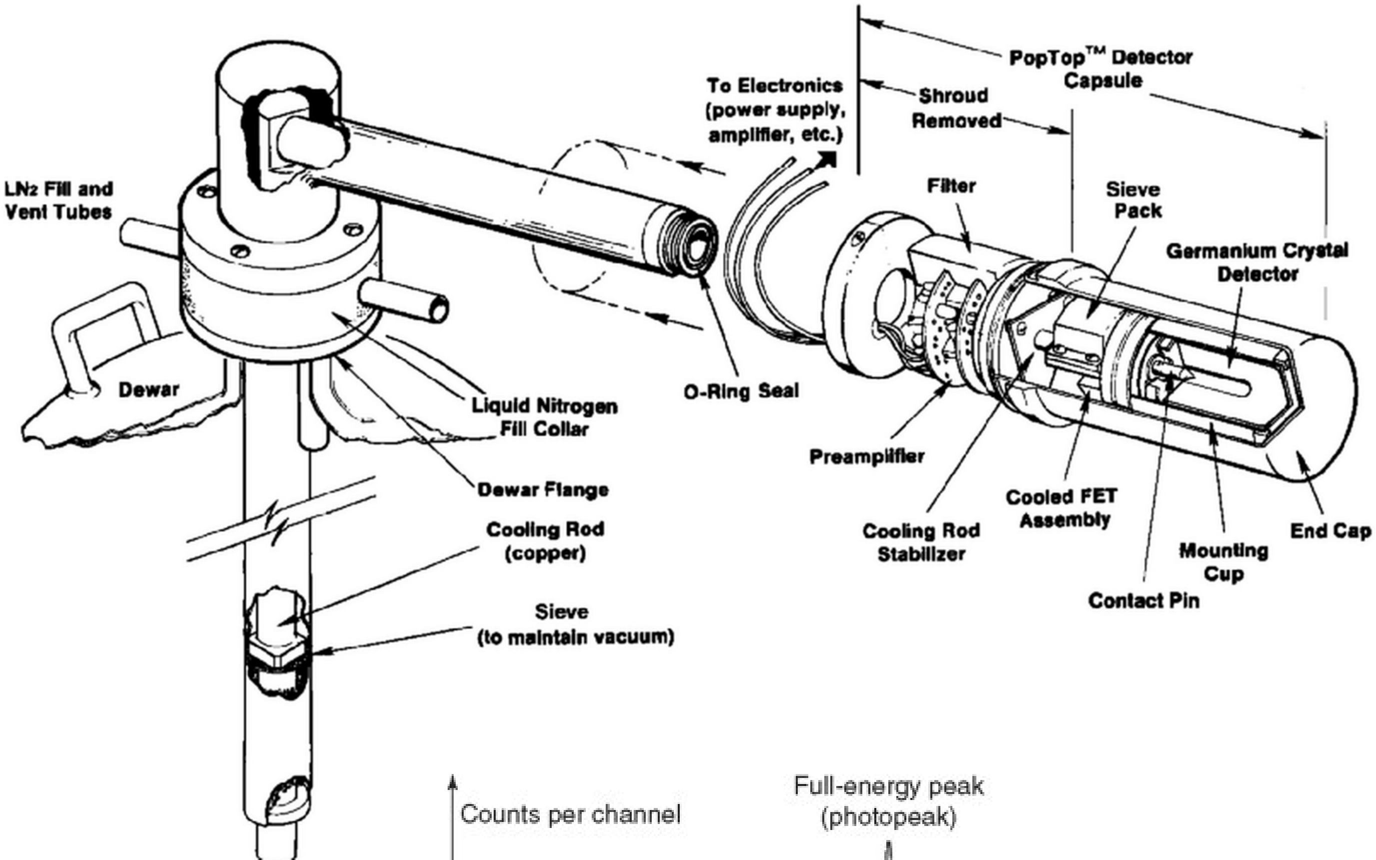



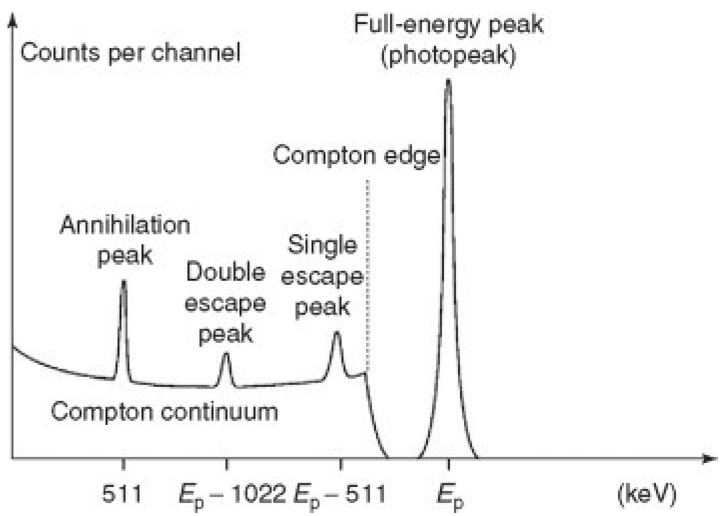




# SemiCons for Gamma Spectroscopy



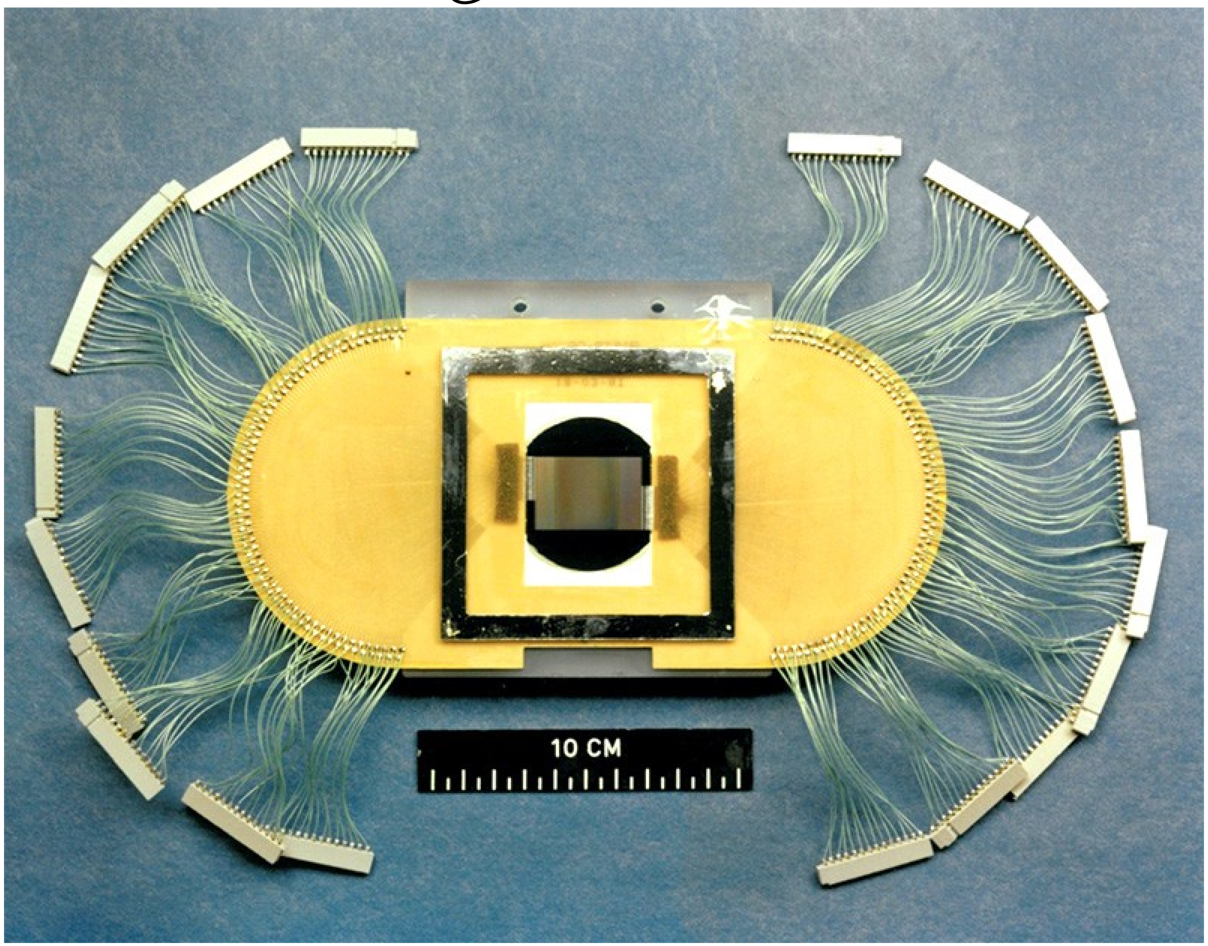



JÜLICH Forschungszentrum

# First Silicon Strip Detector

Goal: Measure lifetime and mass of the charm mesons $D^0$, $D^-$, $D^+$, $D^+_s$, $D^-_s$

The NA11 / NA32 @ CERN 1983



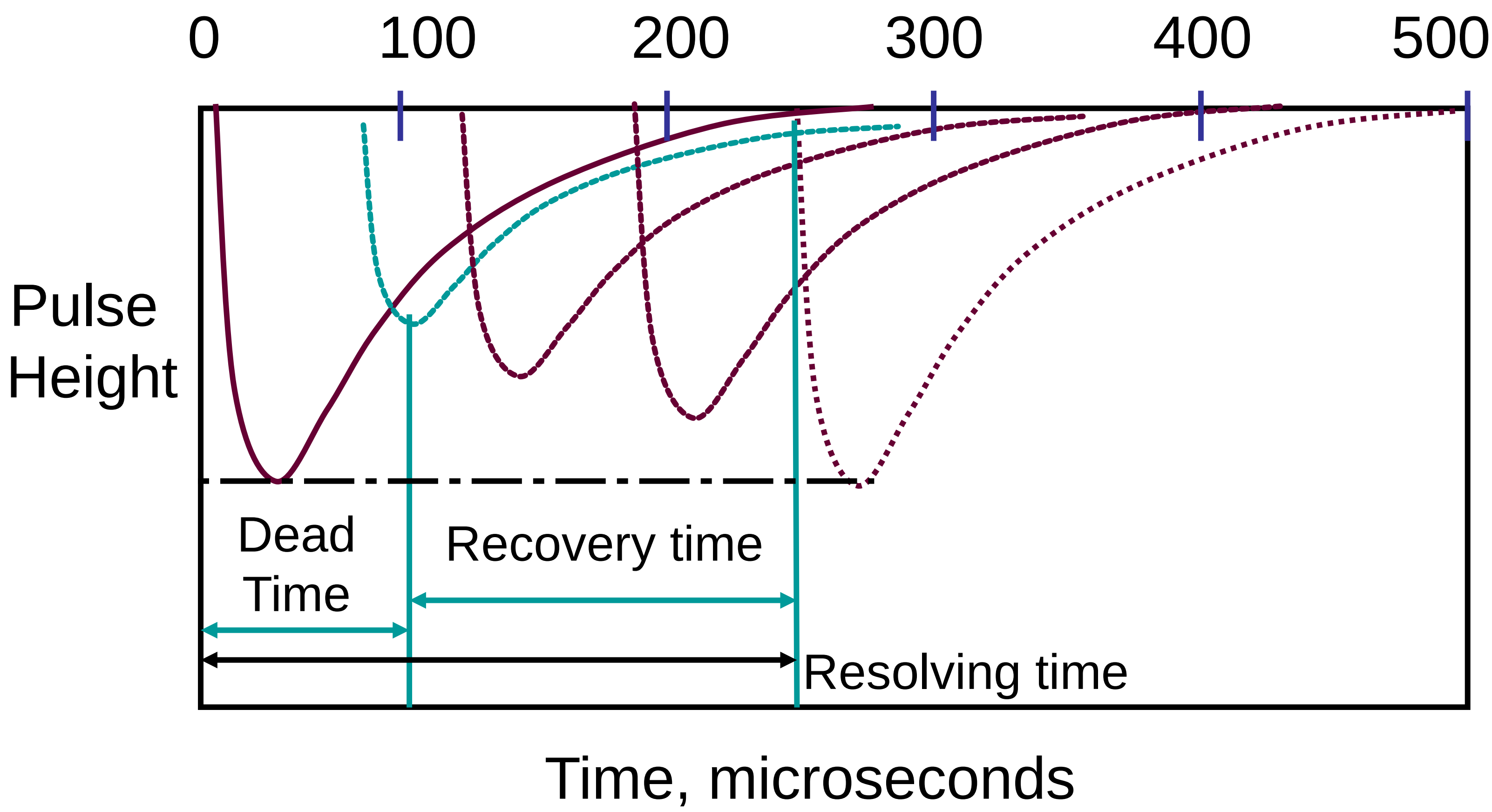

NIM205 (1983) 99

Surface 24 cm2 (2" wafer)
1200 strip, 20 µm pitch
Ever 3rd/6th strip connected.
**Precision 4,5 µm**

8 silicon detectors!
- 2 in front,
- 6 behind the target

Ratio detector surface ! to nearby electronics!
**surface 1:300**

# Signal Characteristics



# Detector Dead Time Correction

For random hit rate &

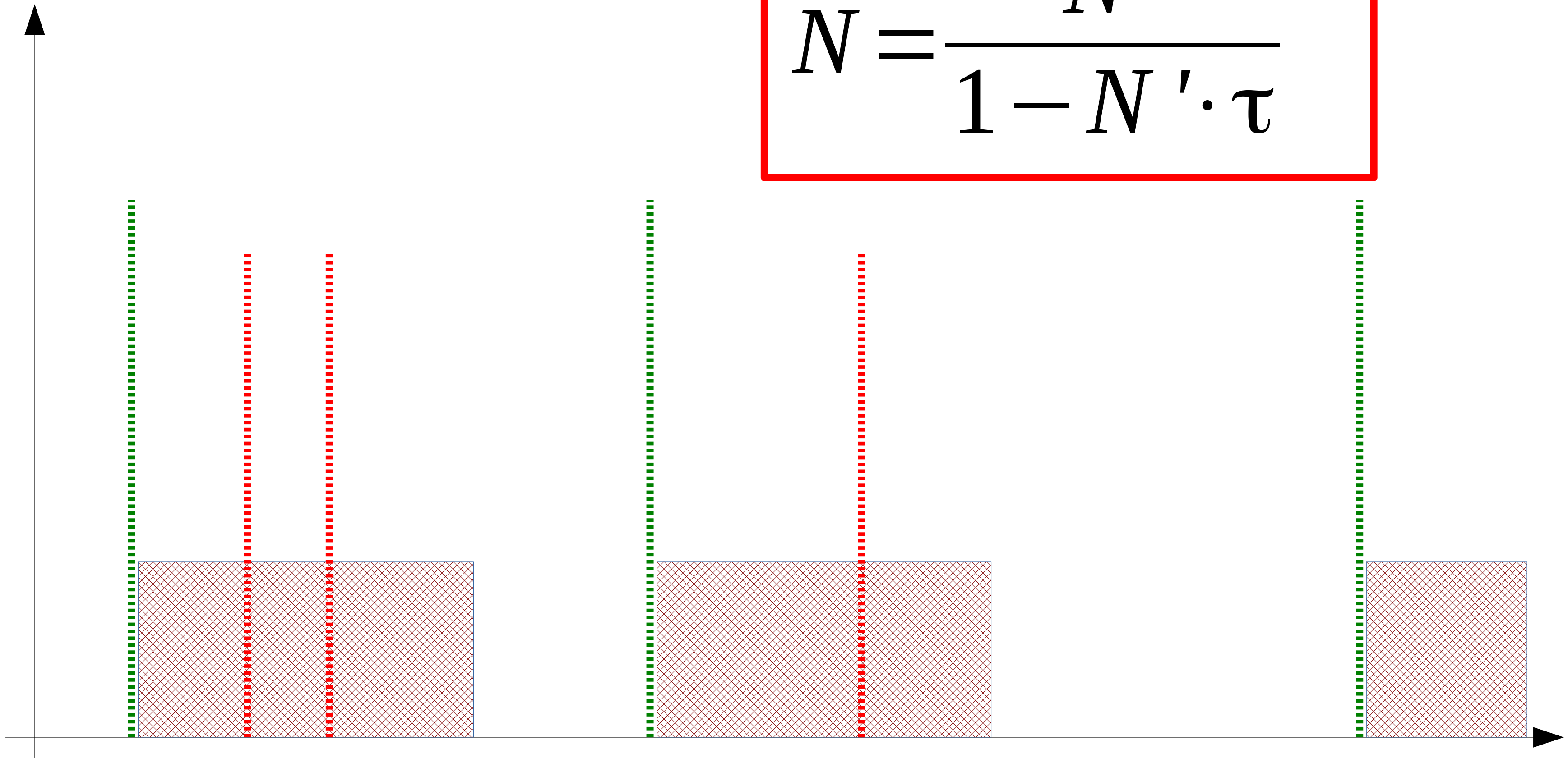
Constant τ

N = real number of events

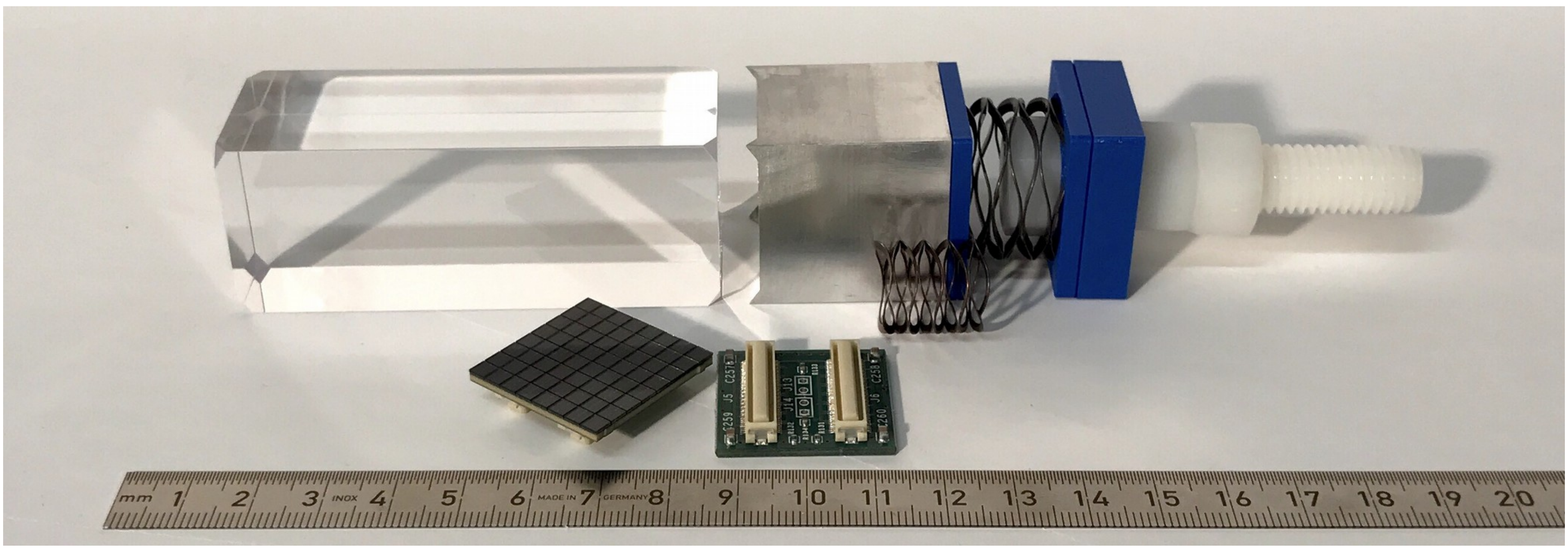
N' = Recorded number of events

$$\frac{N}{N'} = \frac{1}{1 - N' \cdot \tau}$$

$$N = \frac{N'}{1 - N' \cdot \tau}$$



# Scintillating Detectors



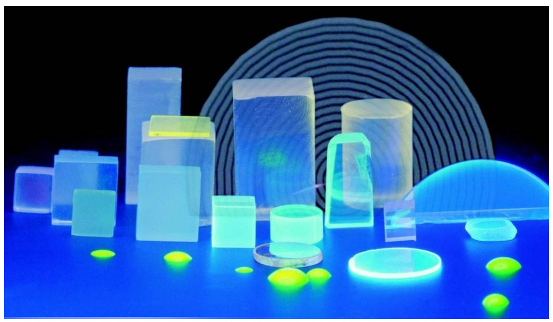
# Scintillation detectors

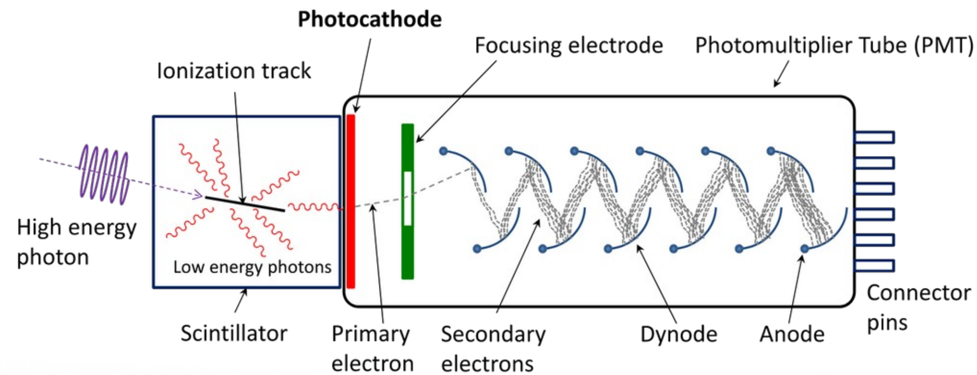
The light emission is governed by the electronic transitions in the molecule.

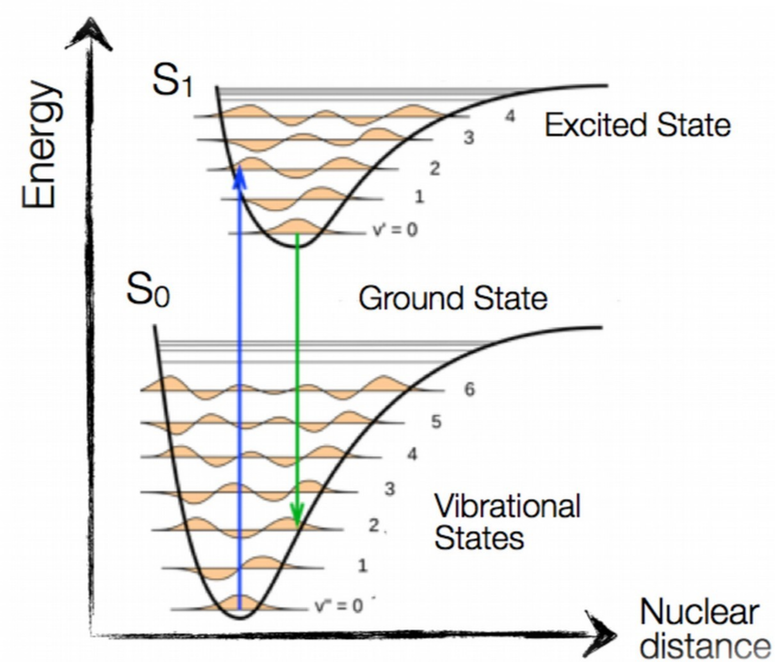
The electronic levels have a typical energy spacing of ~4 eV.

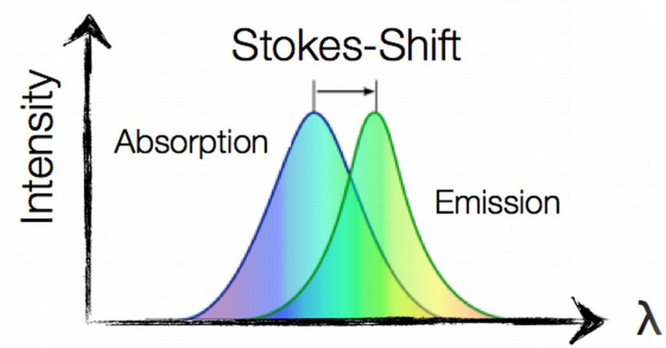
The vibrational levels of the molecule (dE ~ 0.2 eV) also play a role.

Electrons in high levels typically deexcite to the lowest excited state without emission of radiation.





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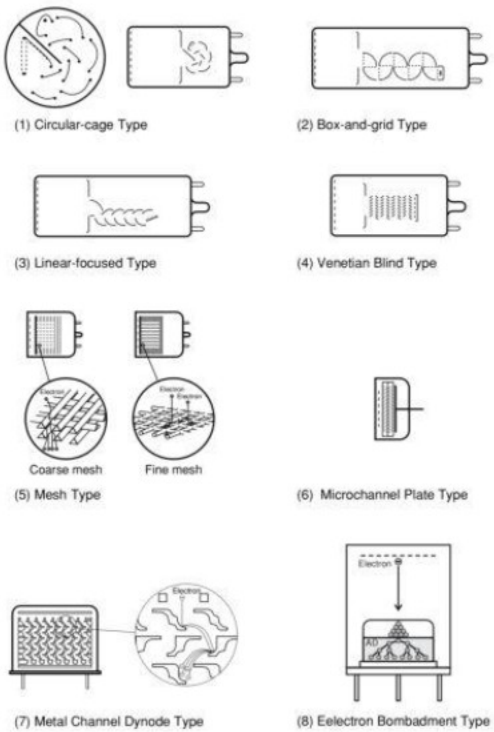
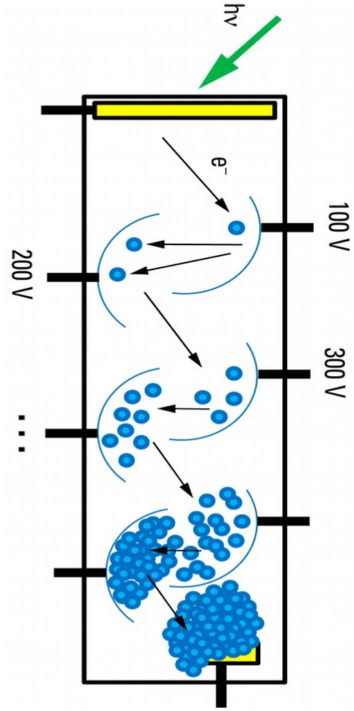
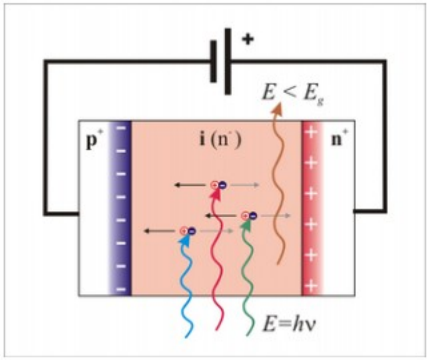
# Photosensitive sensors

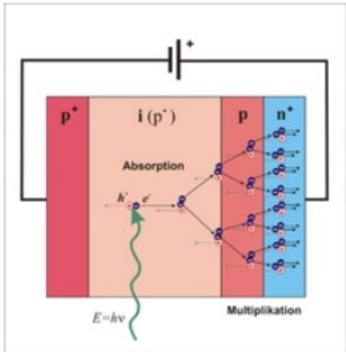


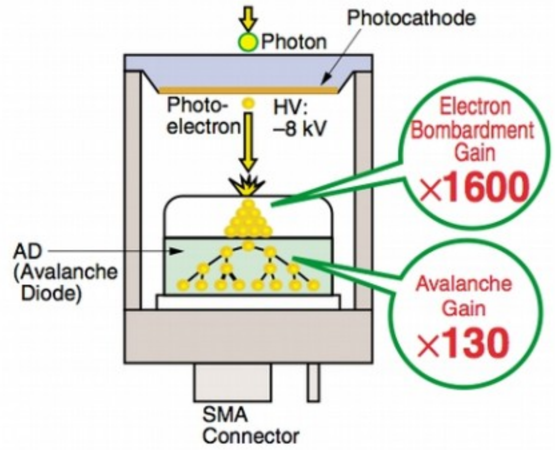



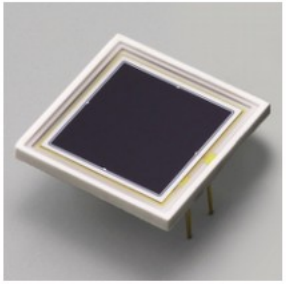

PIN




APD

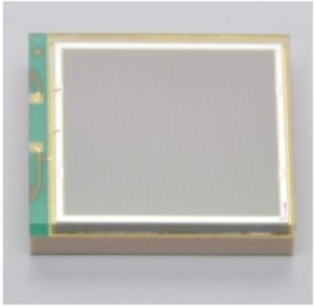


PIN/APD

SiPM





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# Energy Resolution

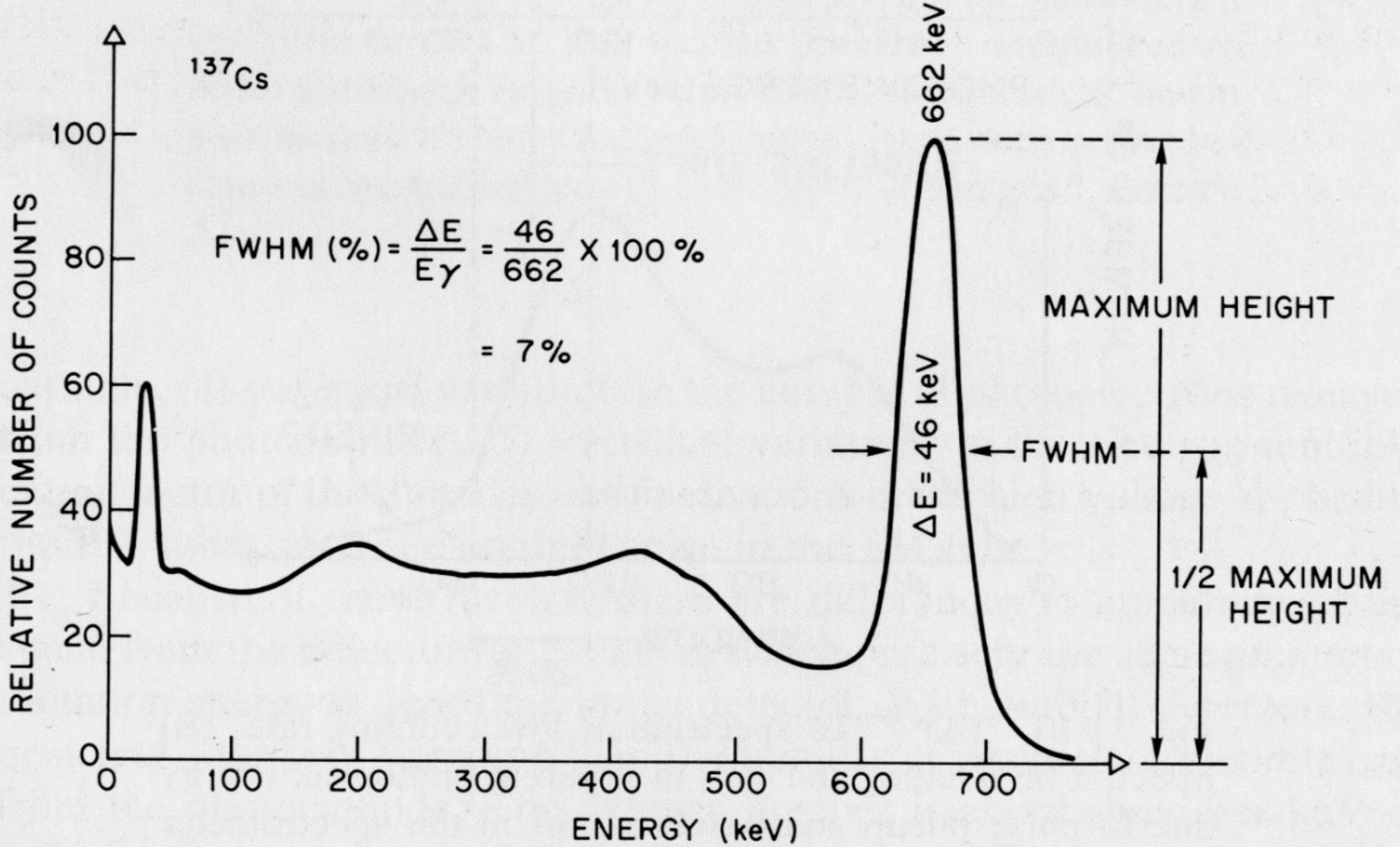
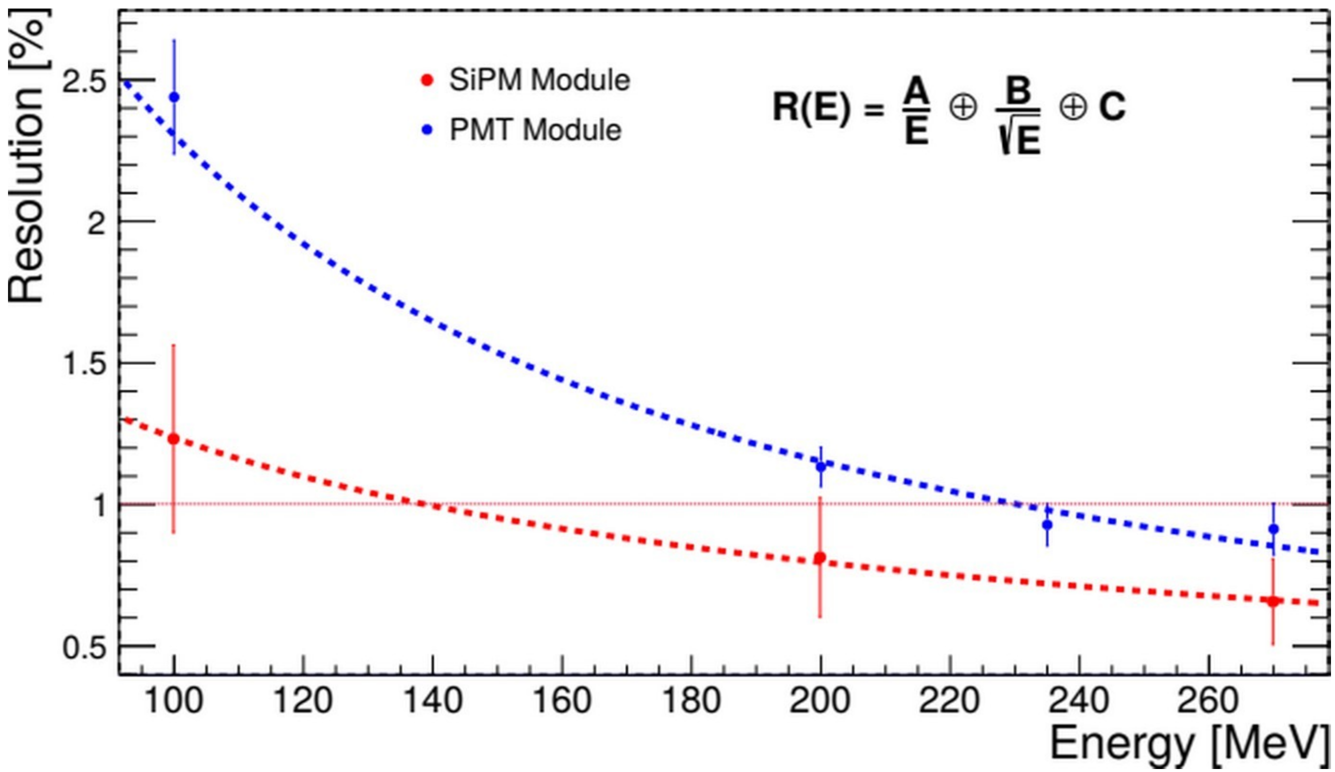
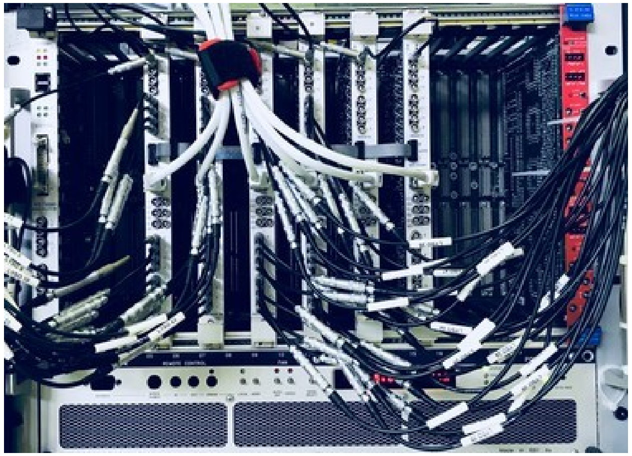


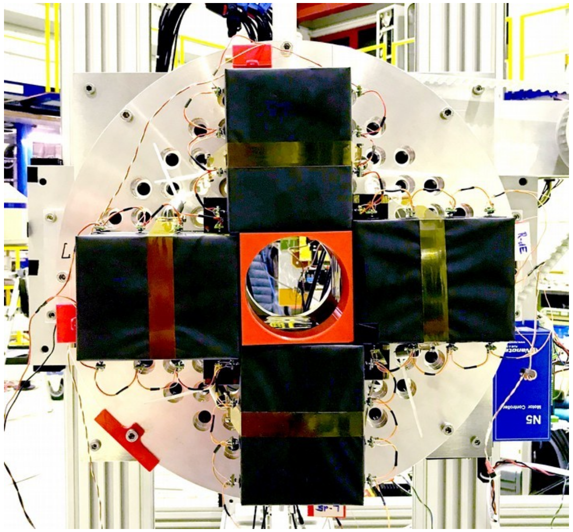

Fig. 11-11. Calculation of FWHM energy resolution of a NaI(Tl) detector for $^{137}$Cs 662 keV $\gamma$ rays.

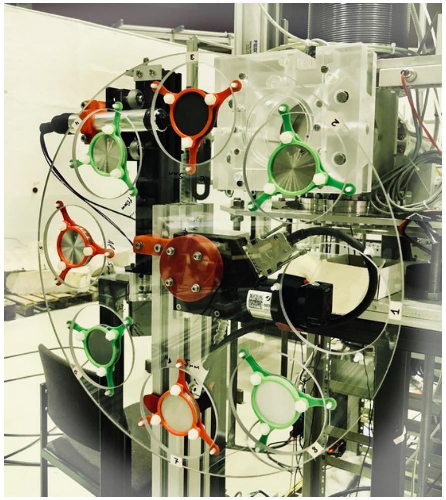
# Energy Dependence

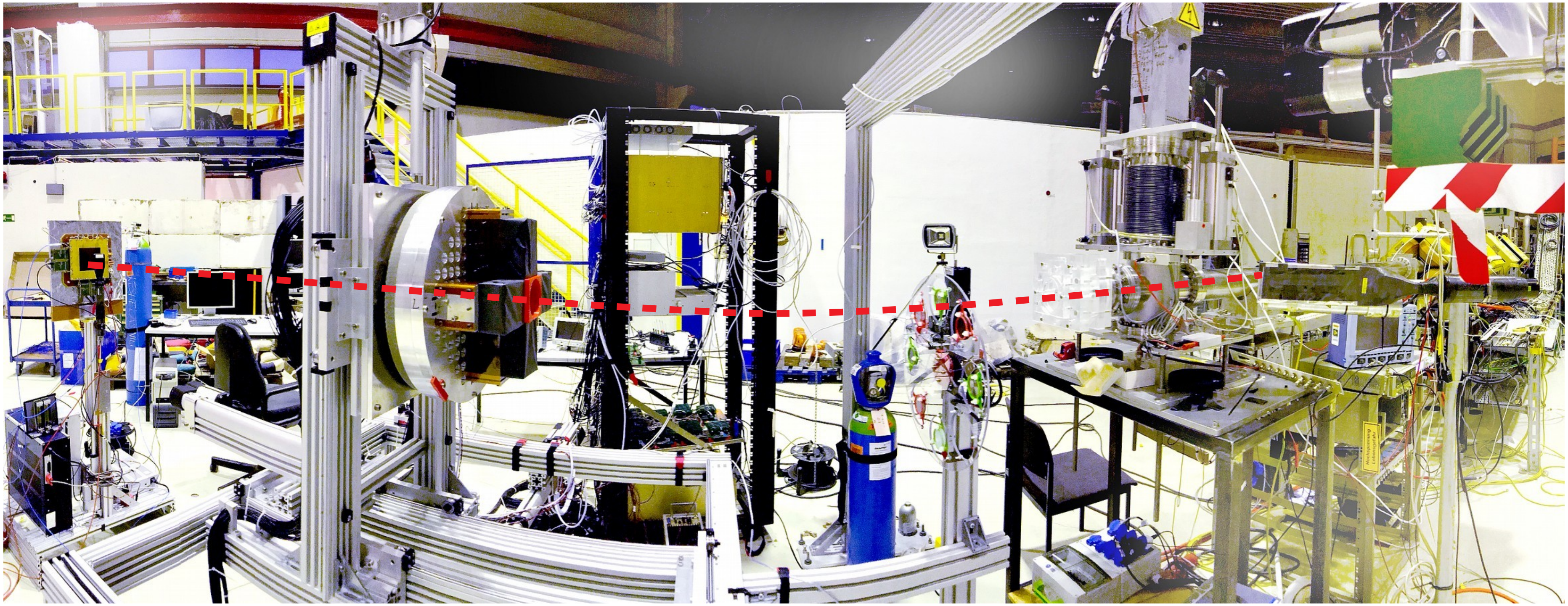


# Jedi Polarimeter



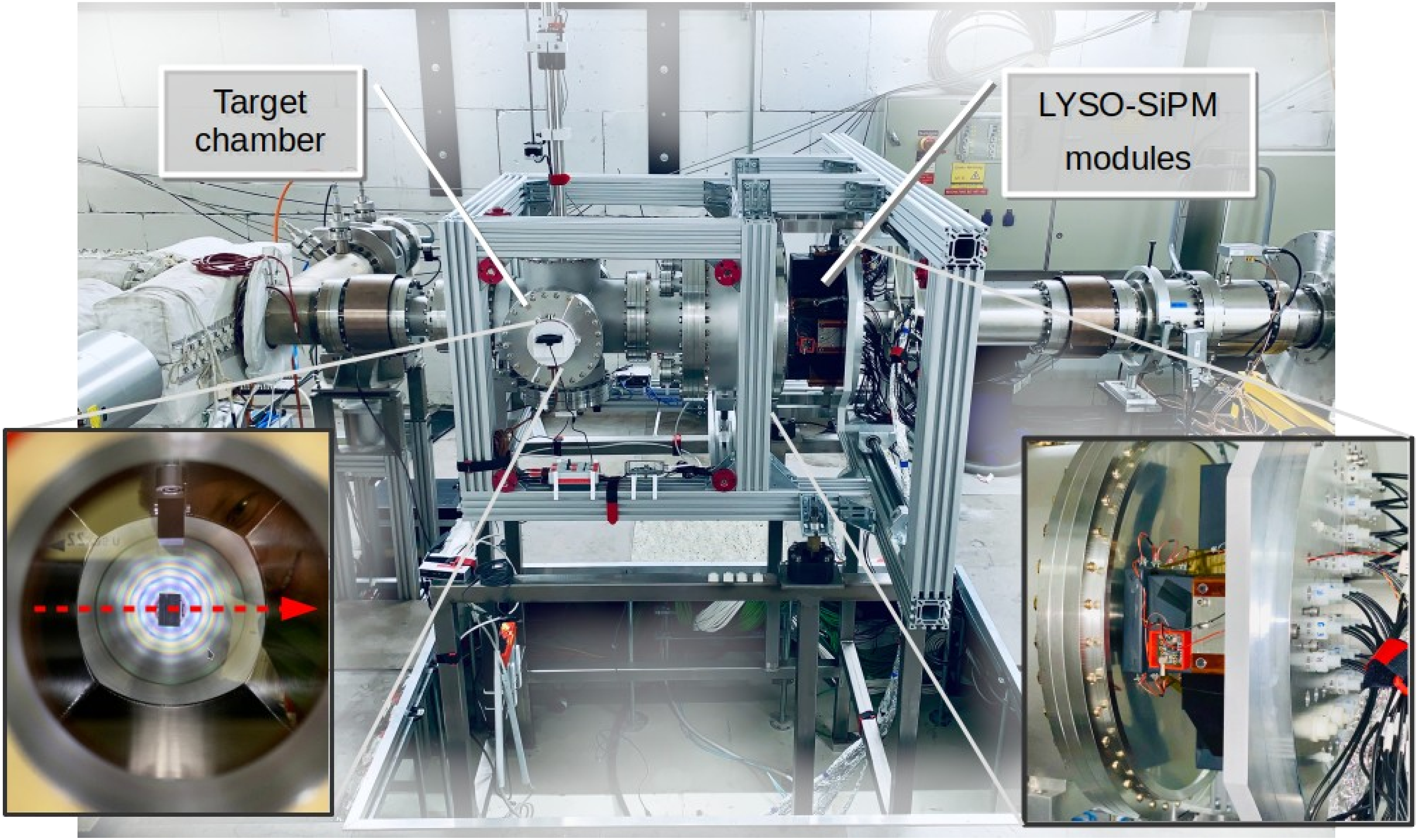




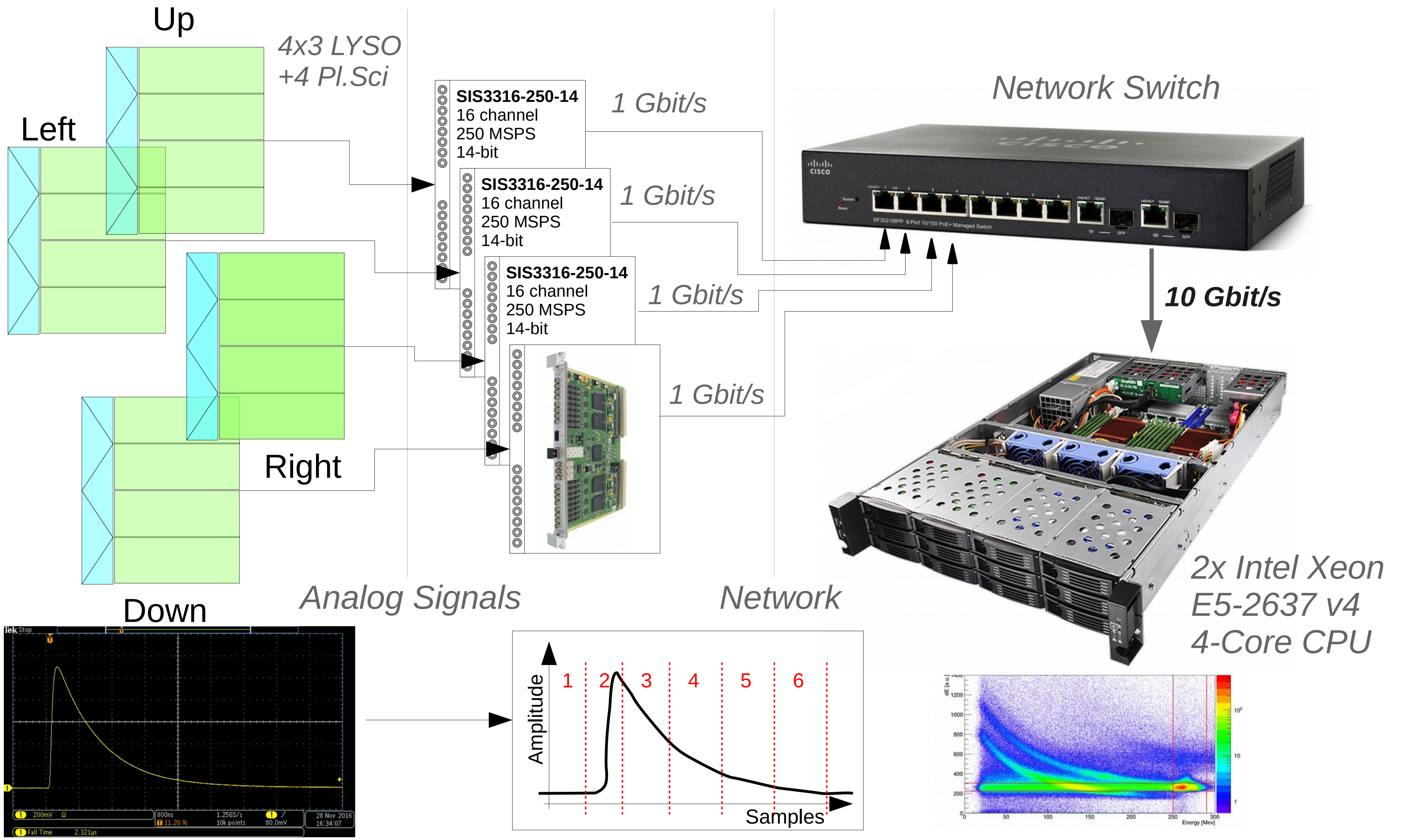


# LYSO SiPM Module

# JePo @ COSY

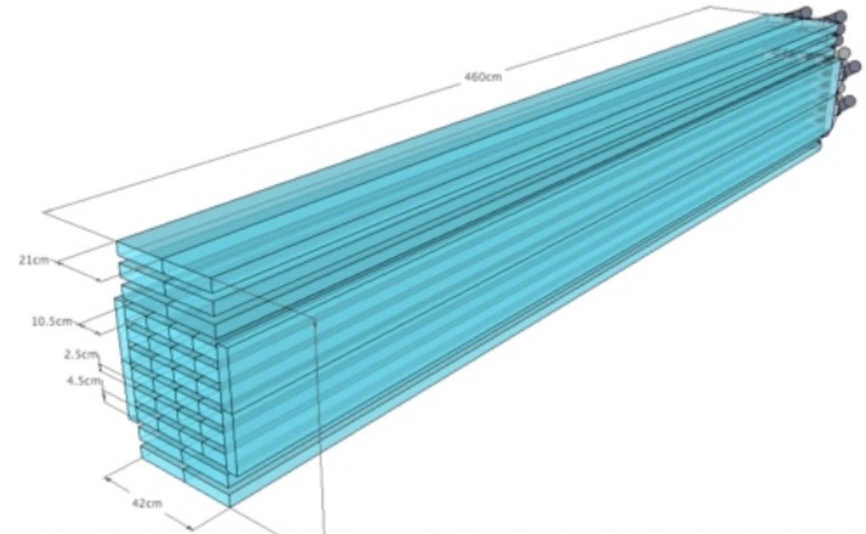


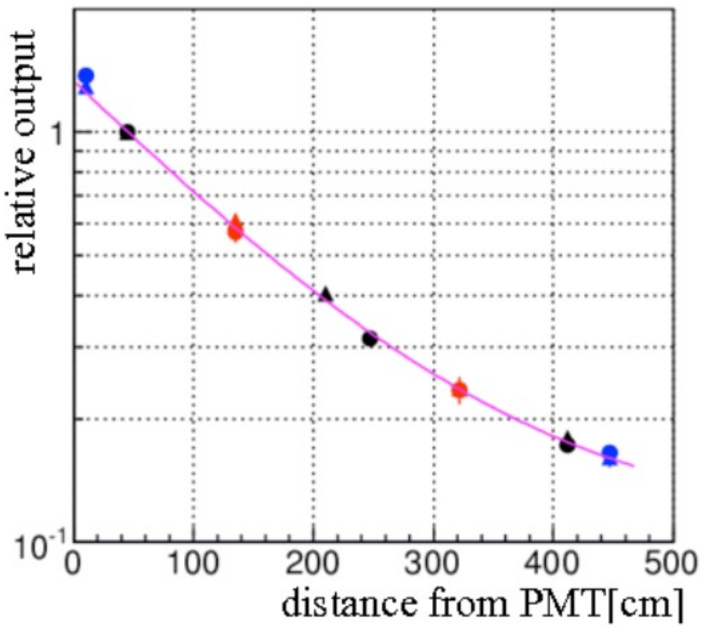
# Readout of JePo

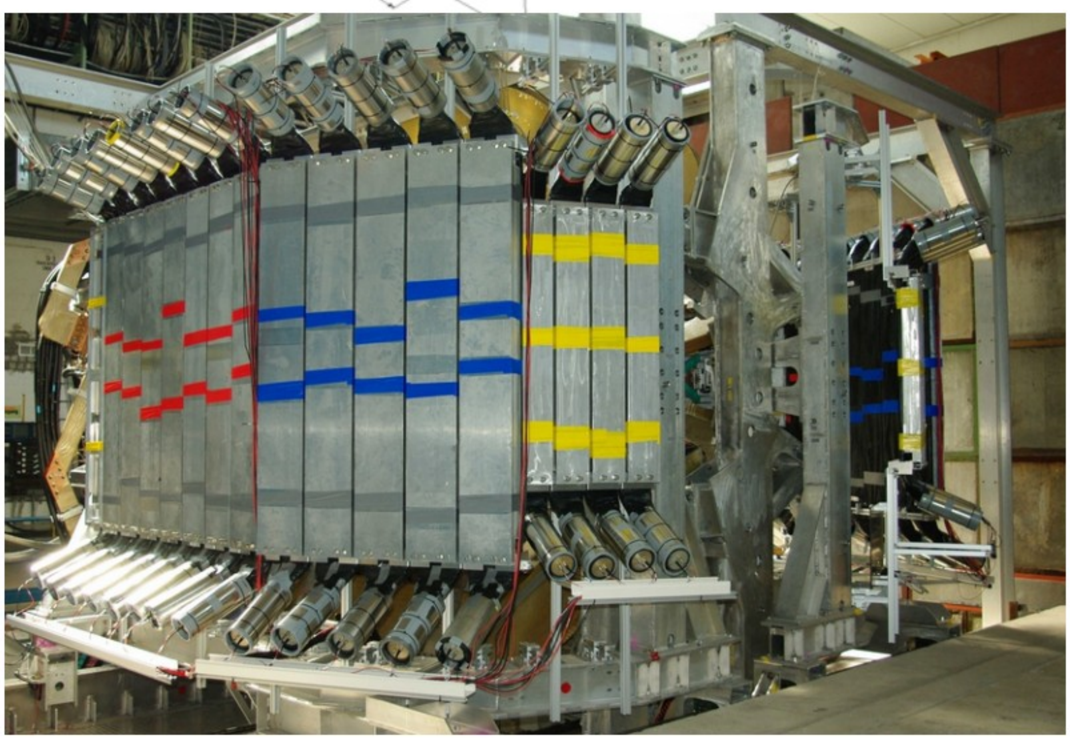


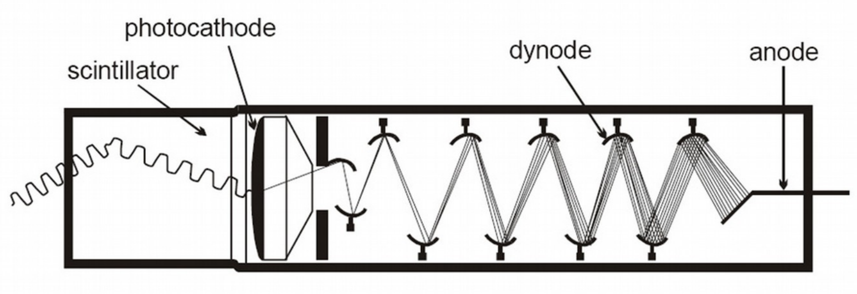
# TOF—time of flight technique

$$Y = Y_0 \cdot e^{\frac{-l}{\lambda}}$$

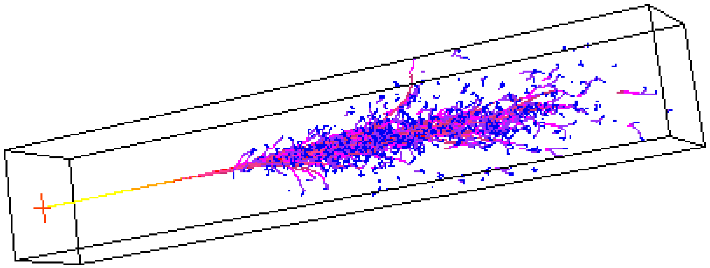


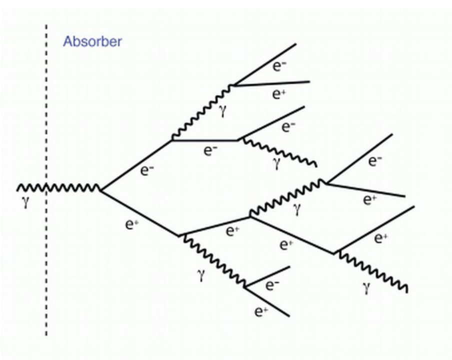



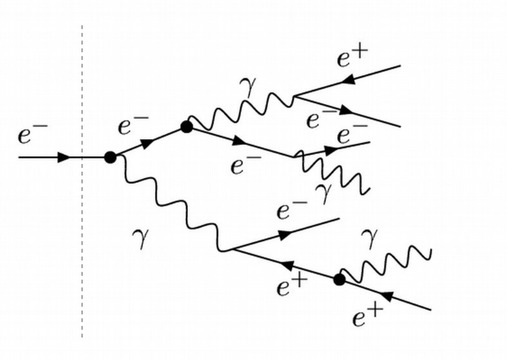



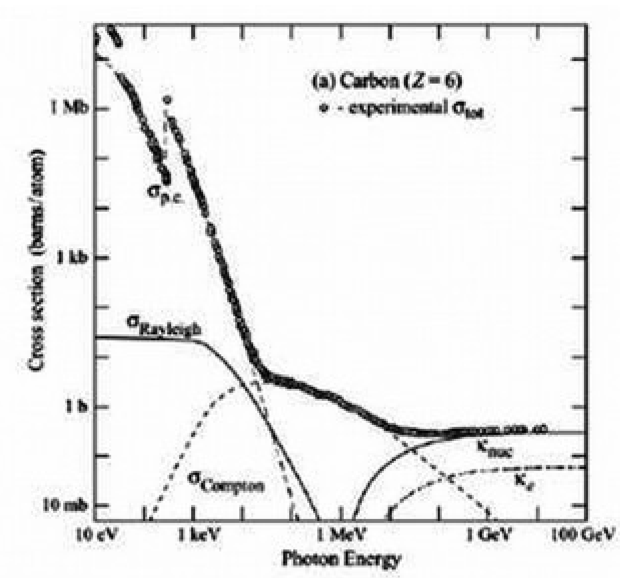


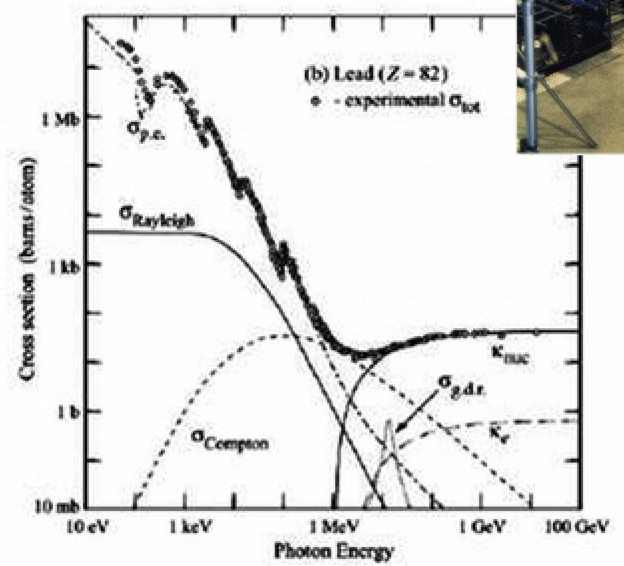
# EMC—electro magnetic calorimeters

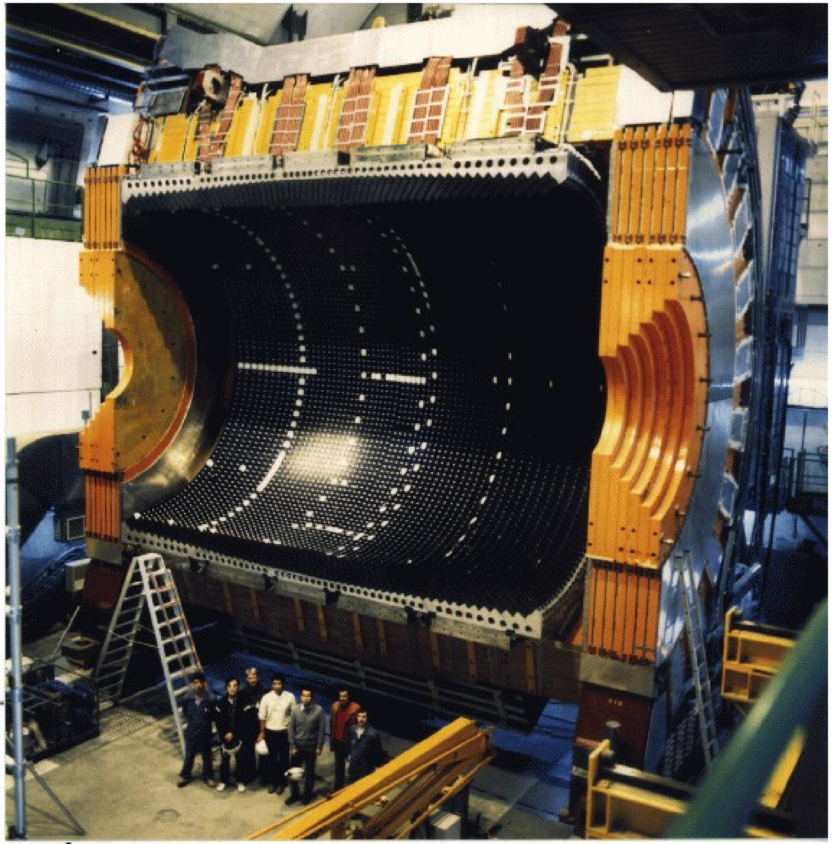




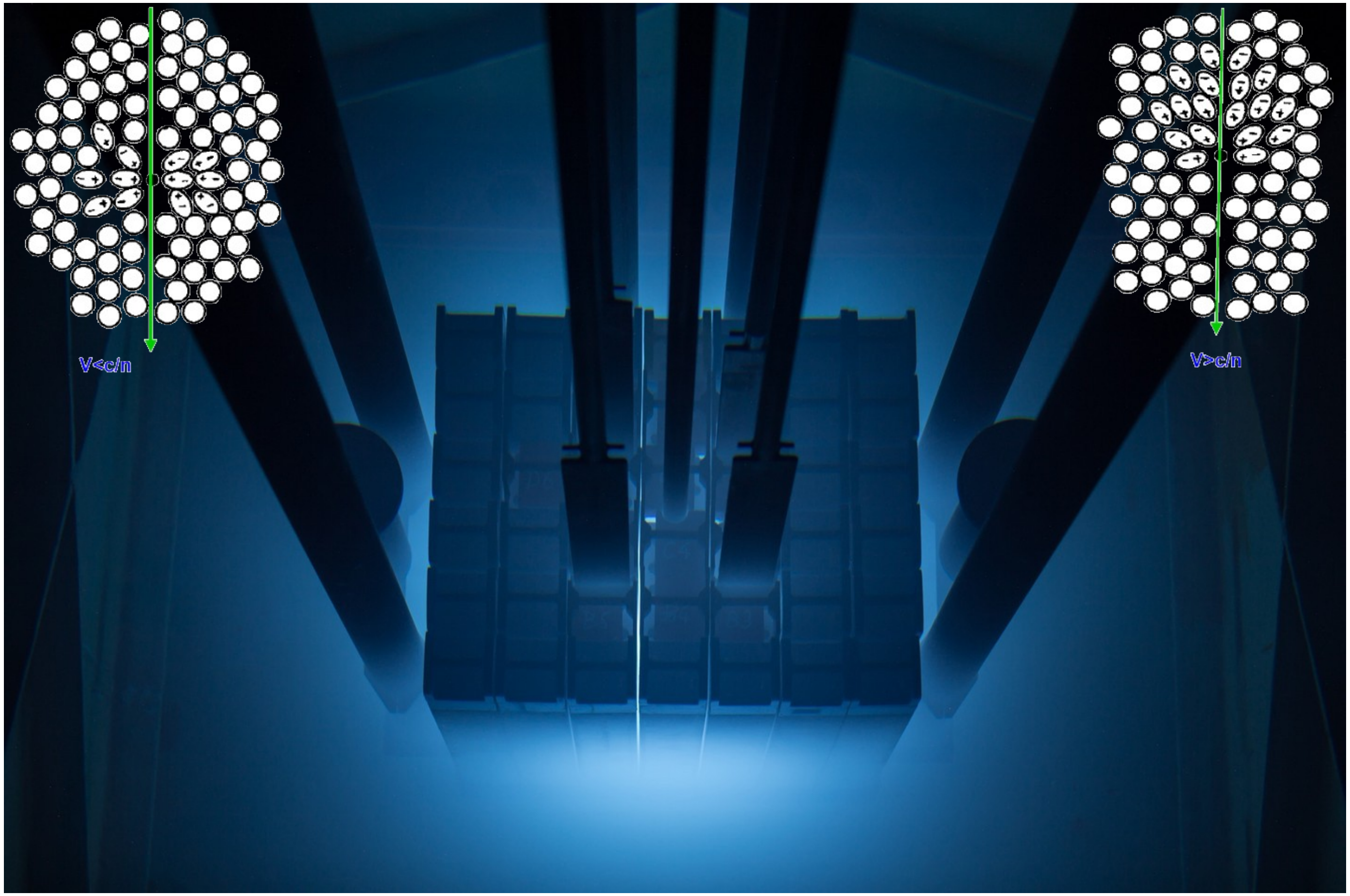



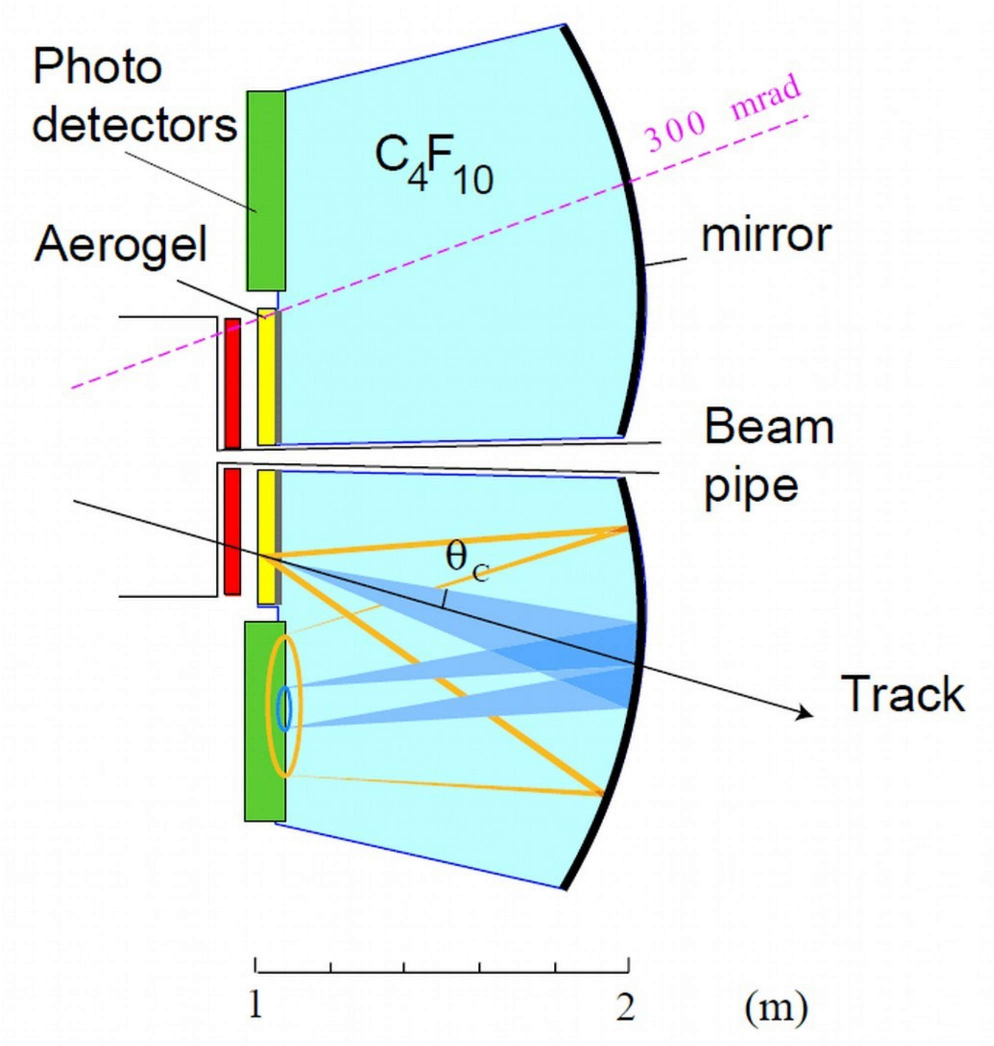



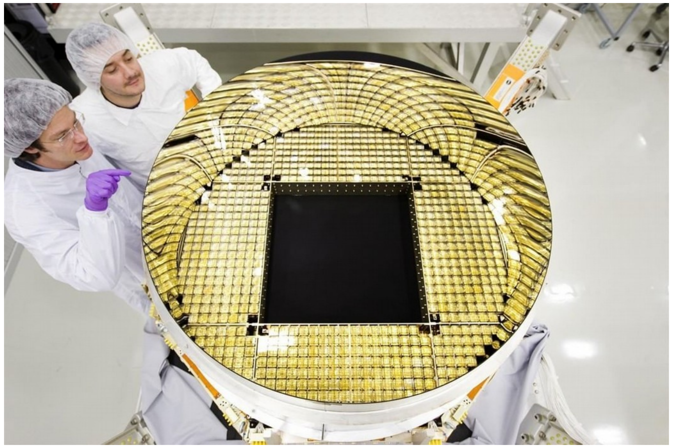
# Cherenkov Detectors

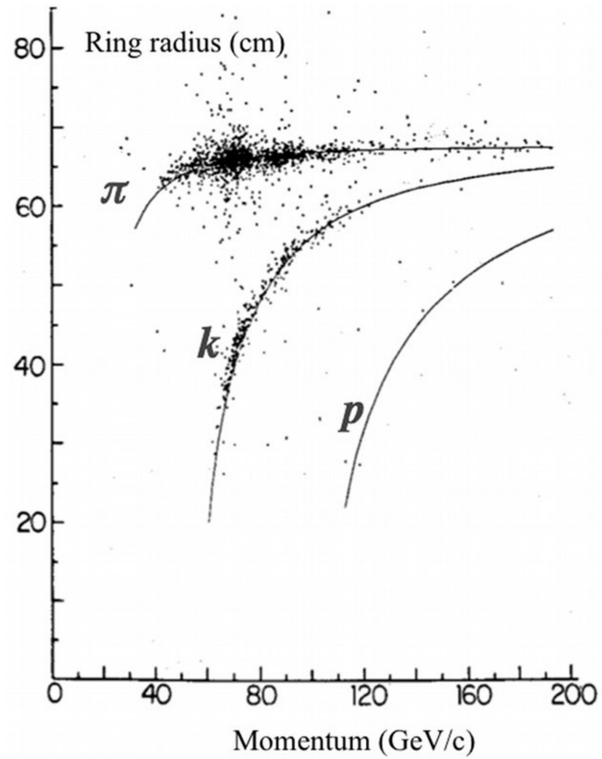


# RICH – Ring Image Cherenkov

$$N \propto 1-\frac{1}{n^2\beta^2}=1-\frac{1}{n^2}\left(1+\frac{m^2}{p^2}\right)$$

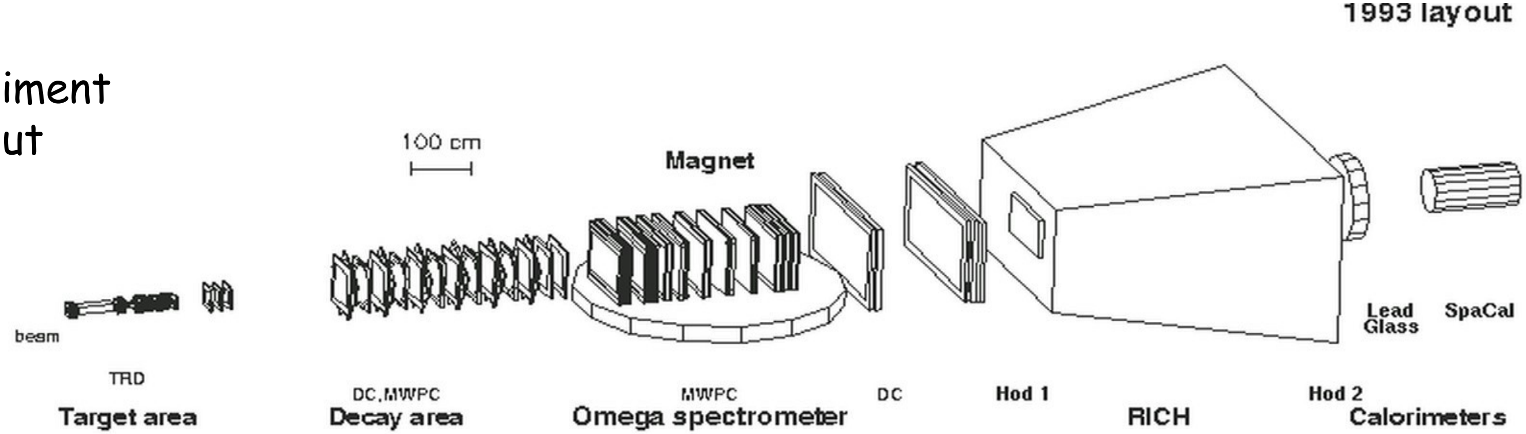


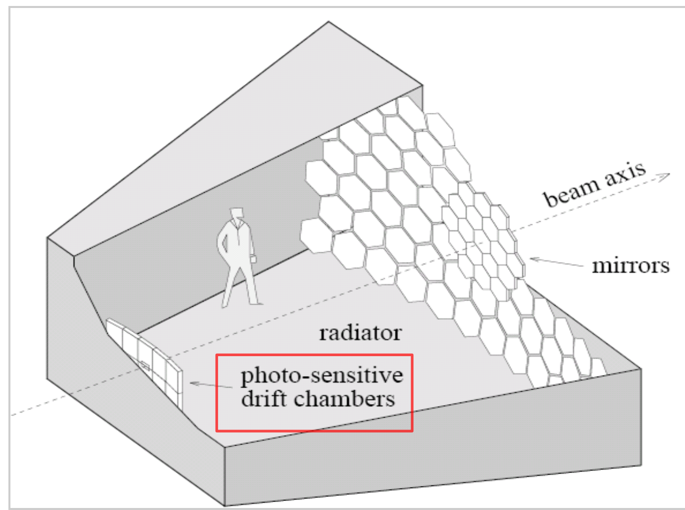



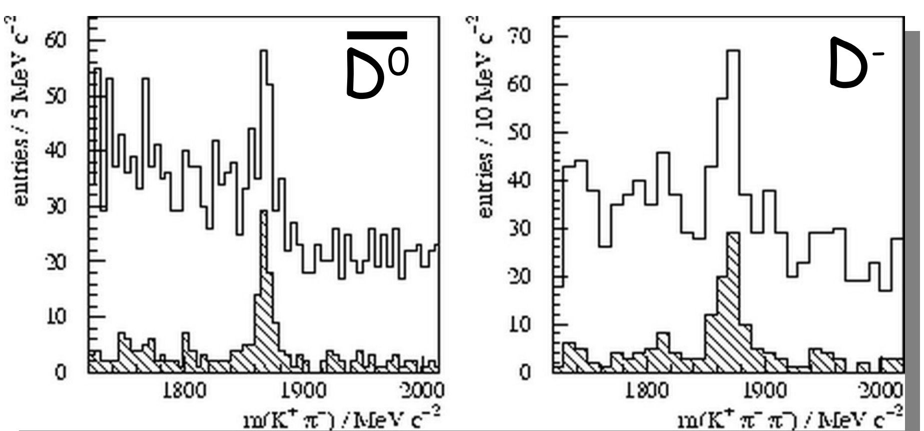


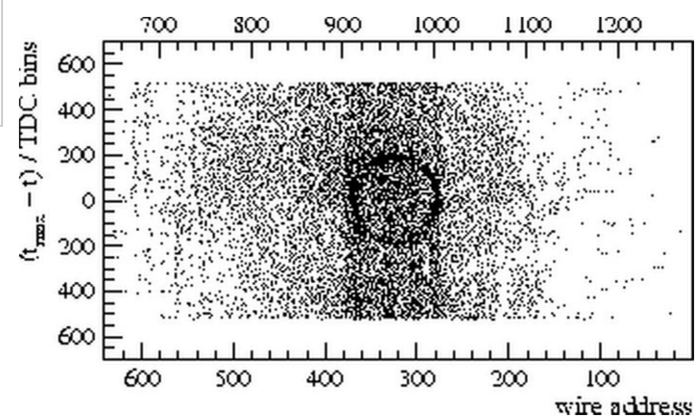
# RICH -- Ring Image Cherenkov detectors

WA89 experiment
1993 layout

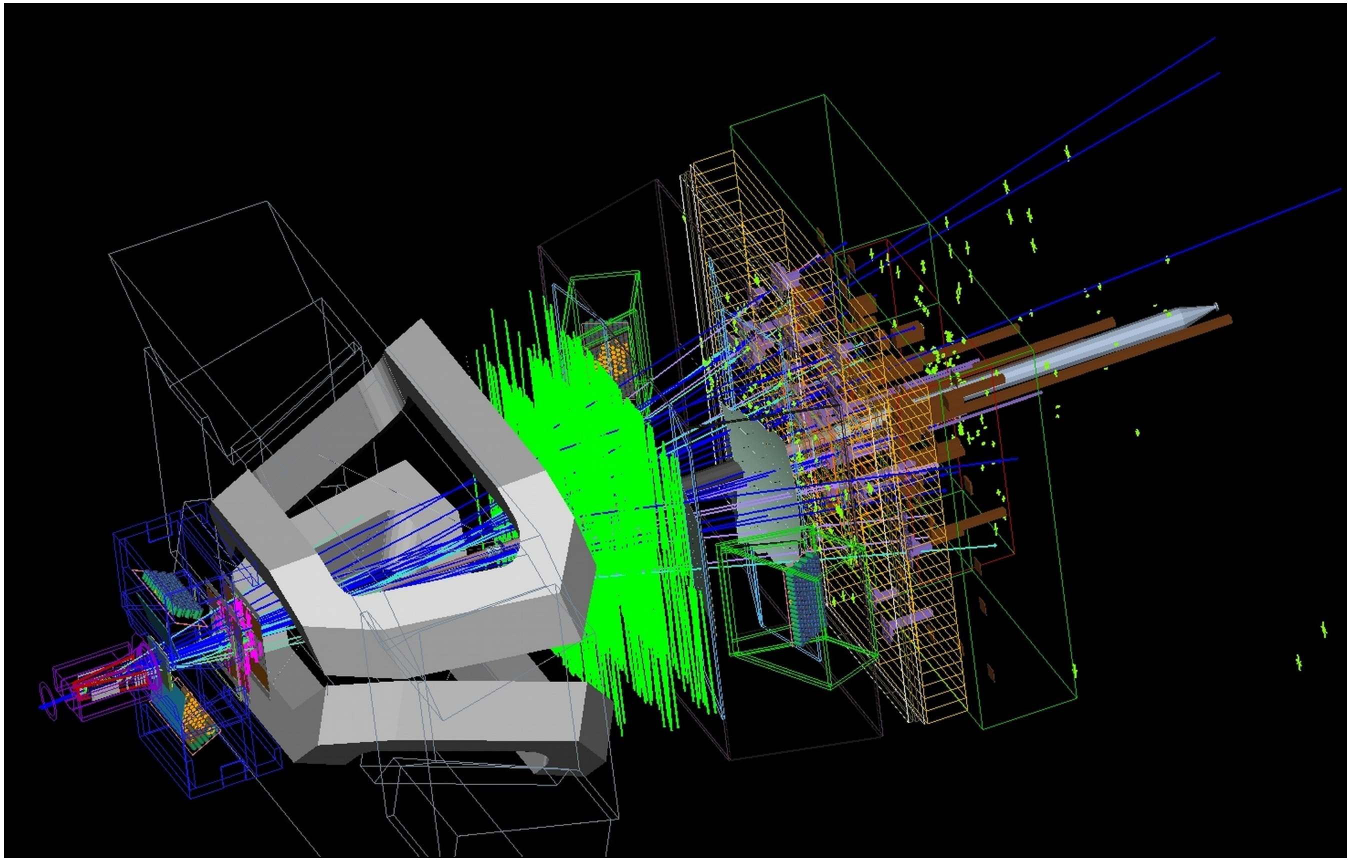


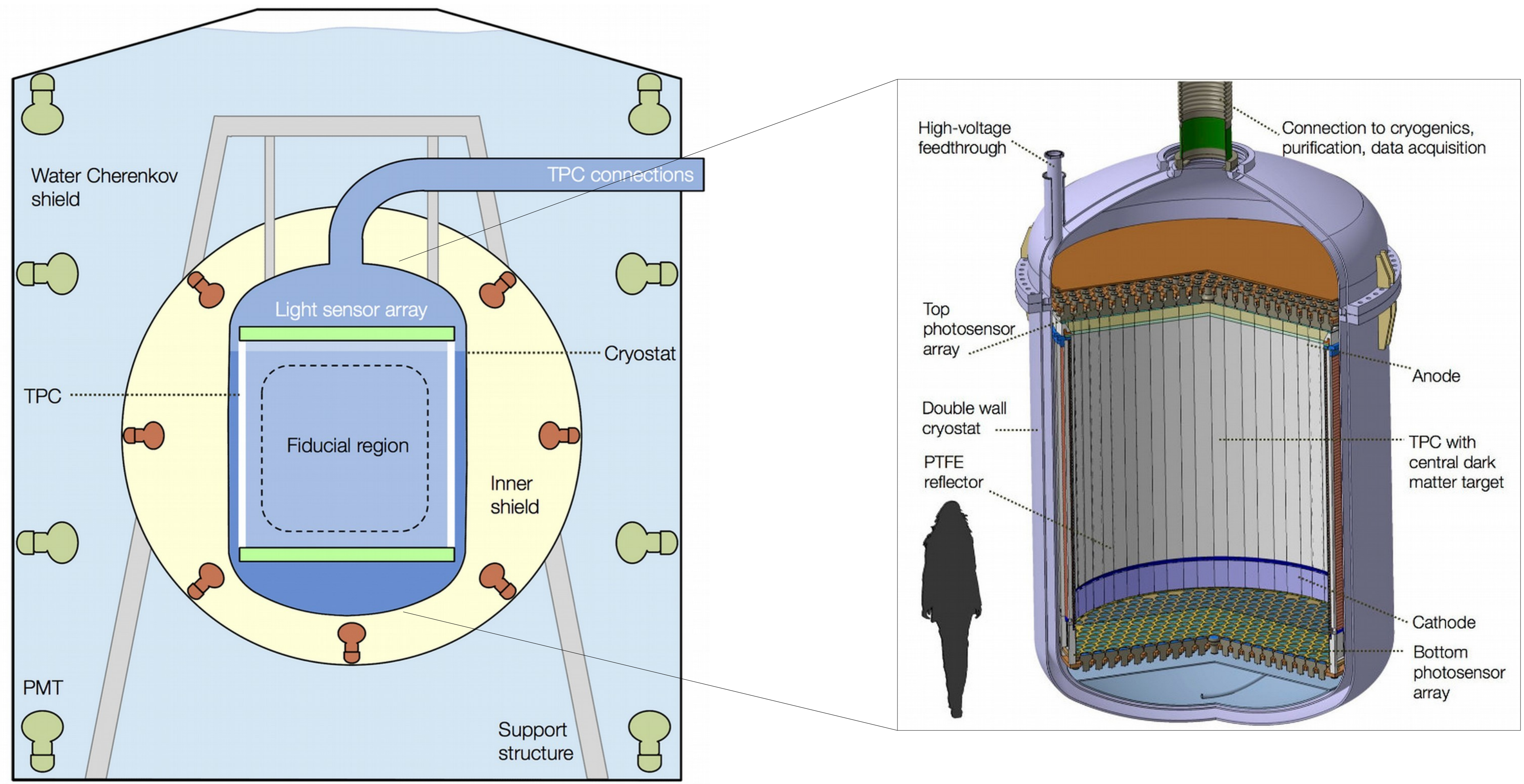



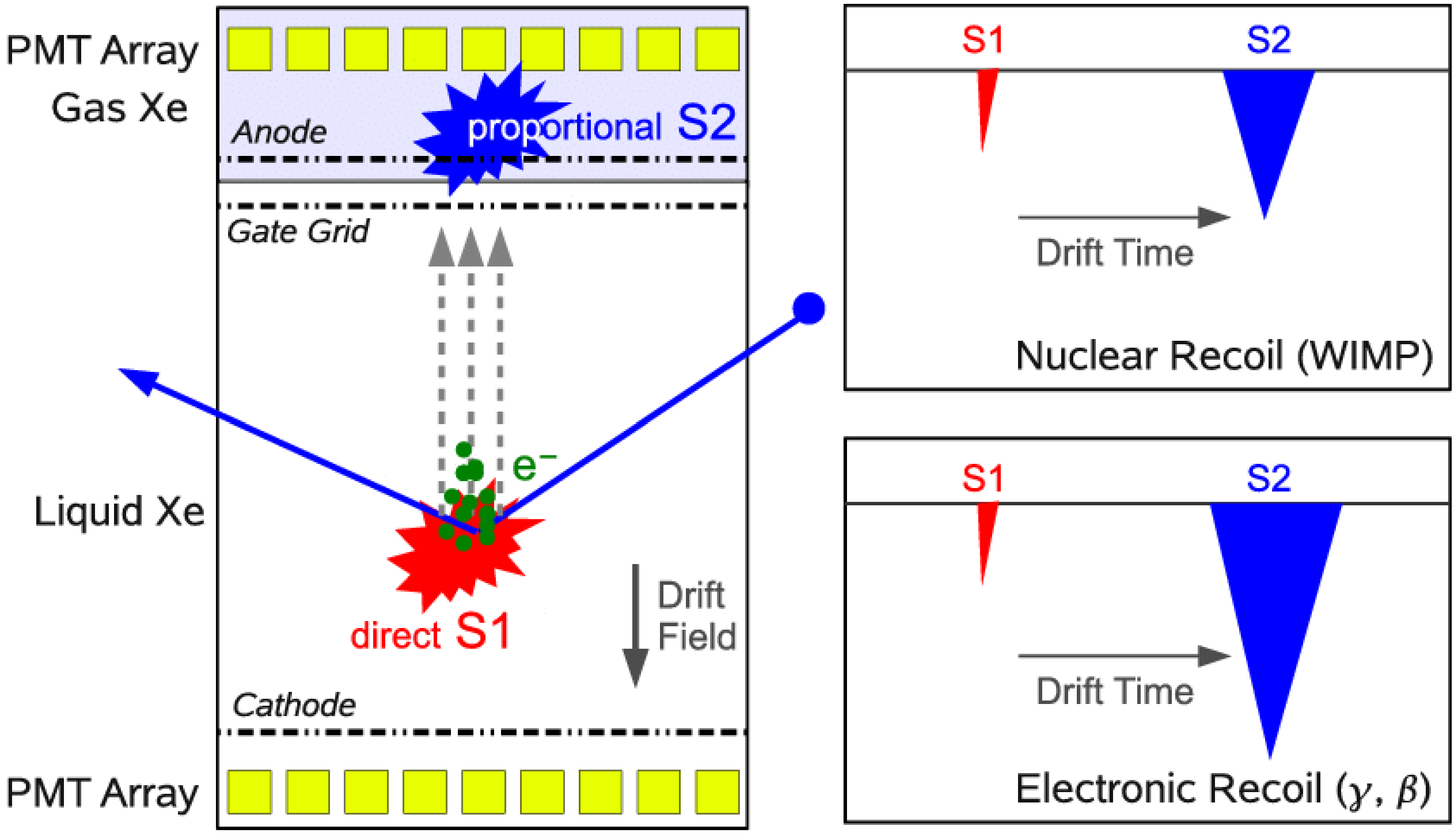
# Complex Detector Systems



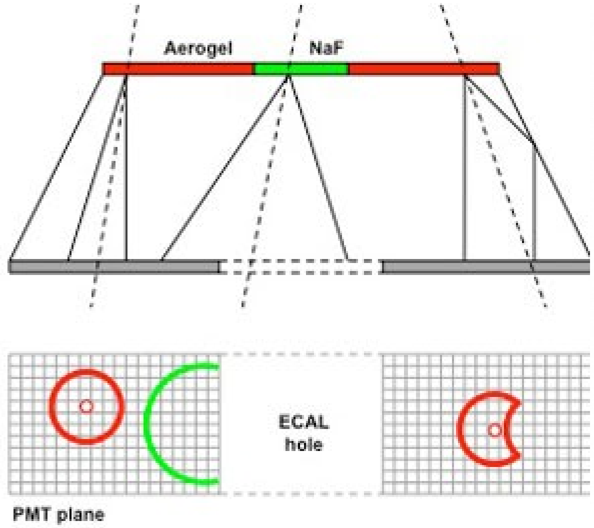
# DARWIN (DARk matter WImp search with liquid xenoN)



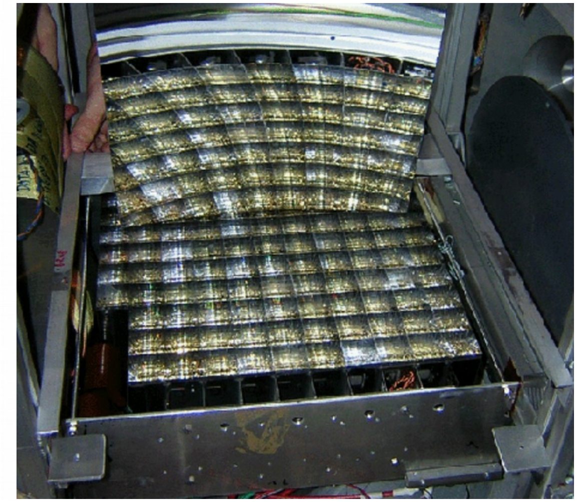
# Liquid Xenon Detectors

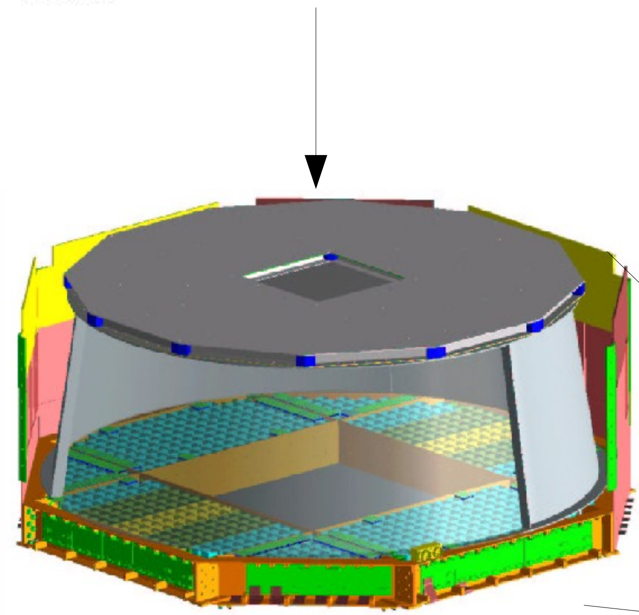


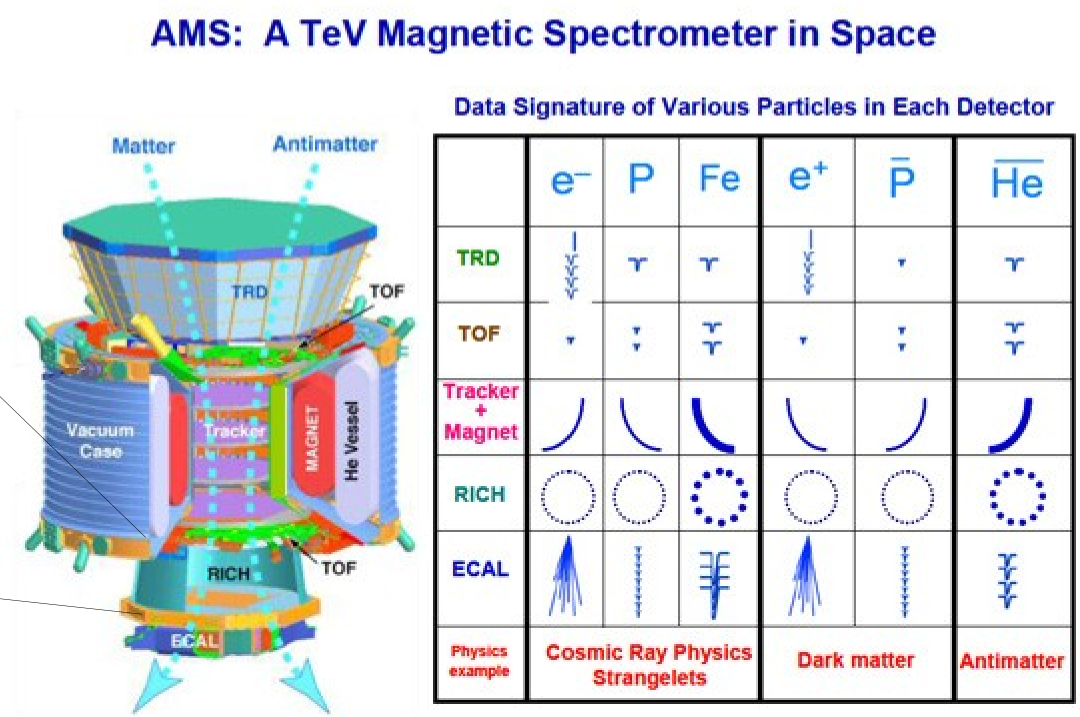
# AMS-2 alpha magnetic spectrometer



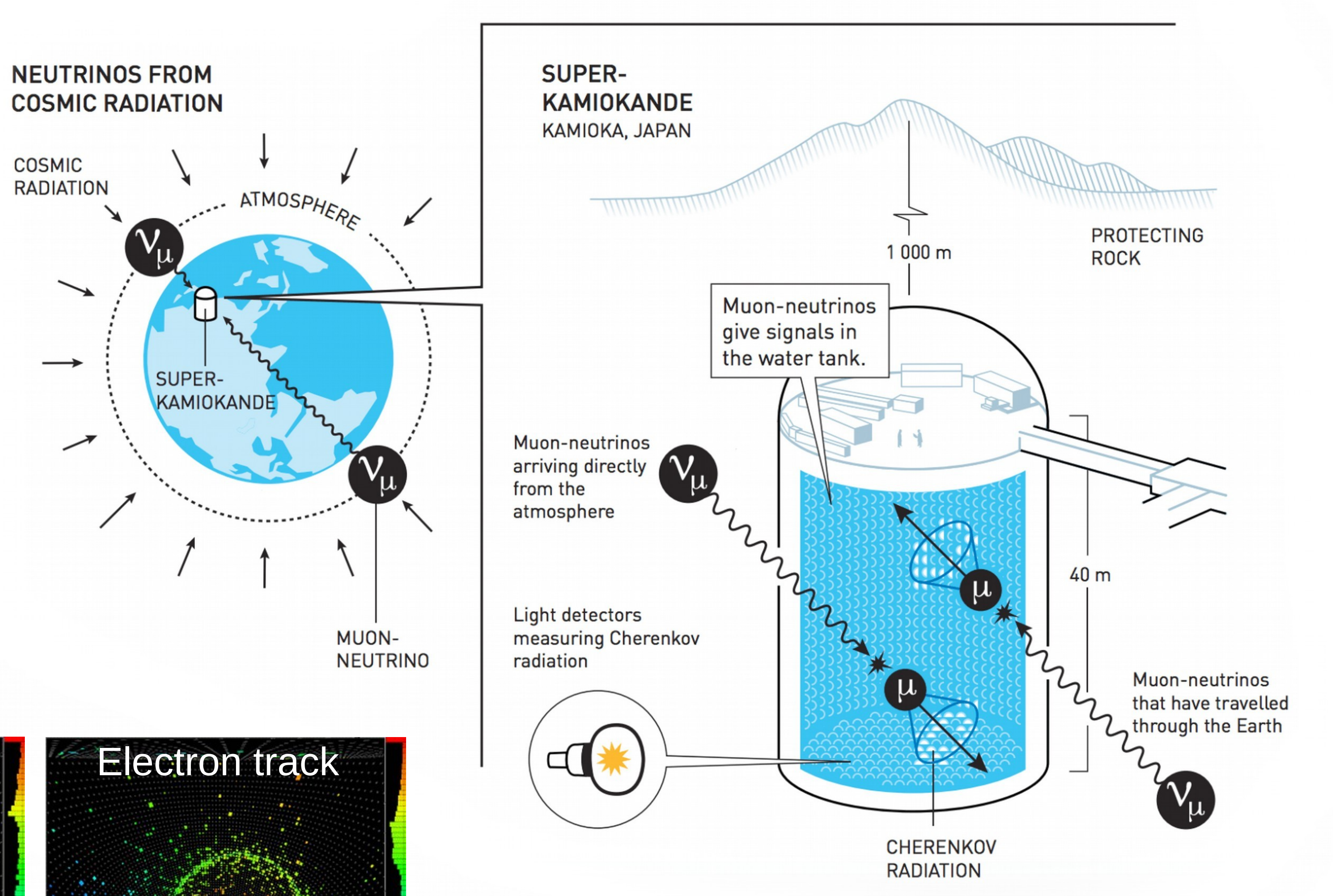


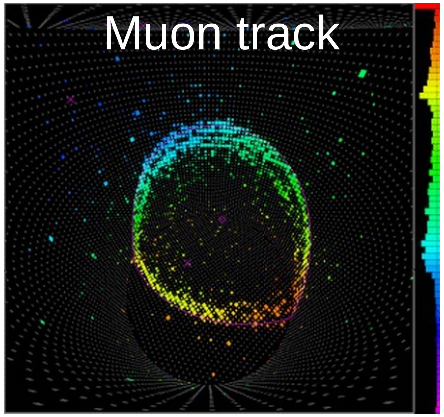


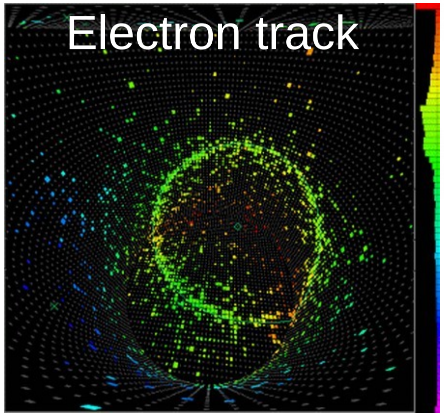




# Super-Kamiokande neutrino detector



# CMS--detector at LHC, CERN