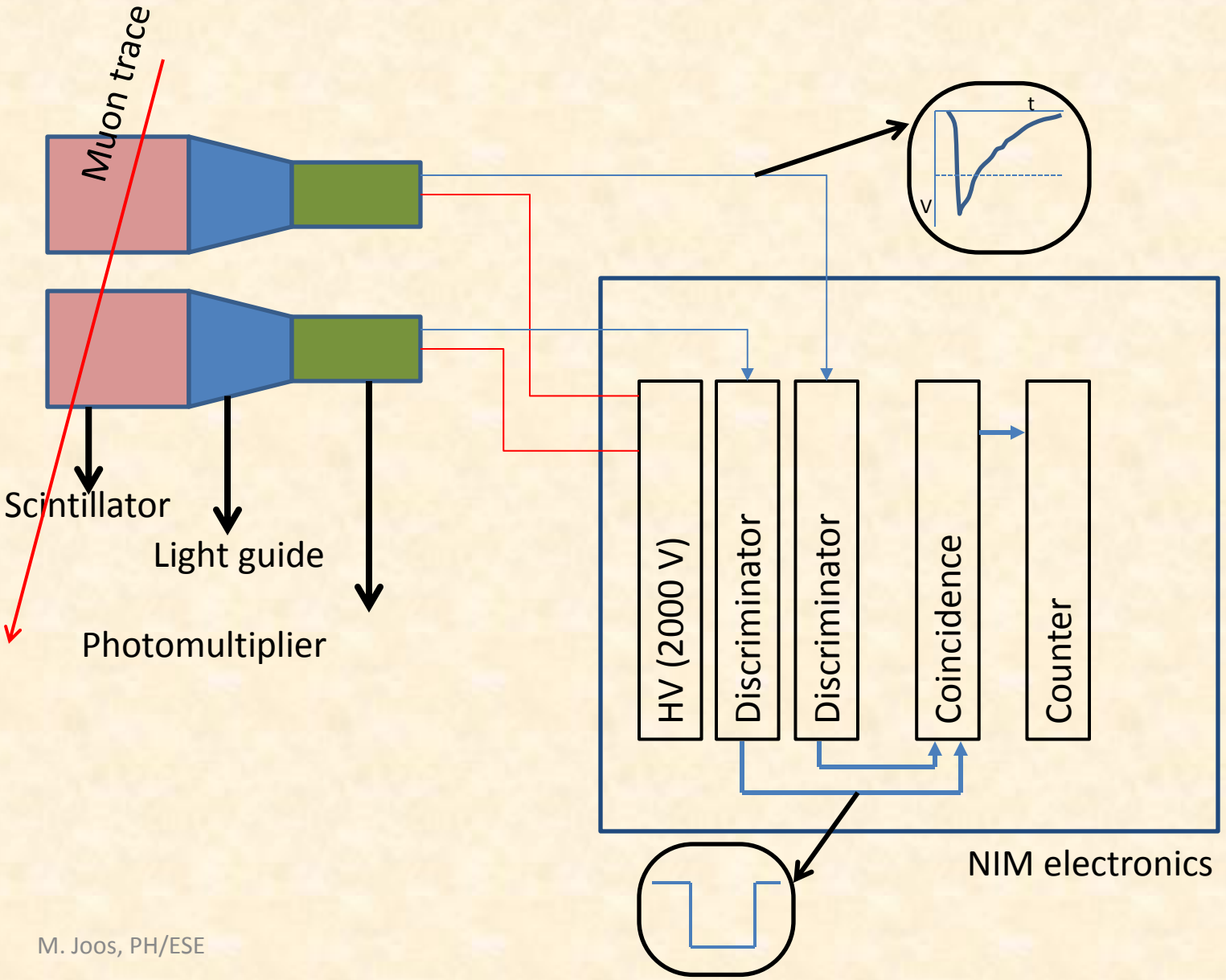
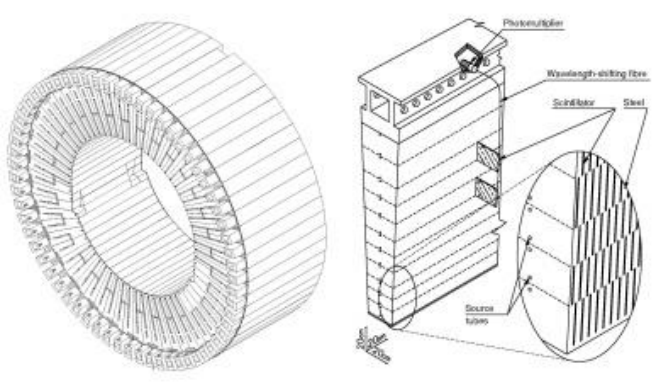
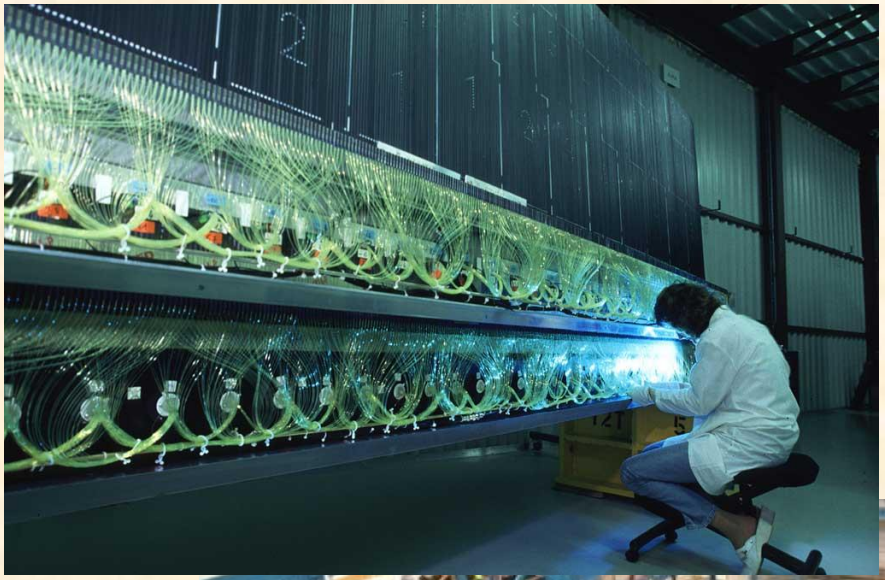
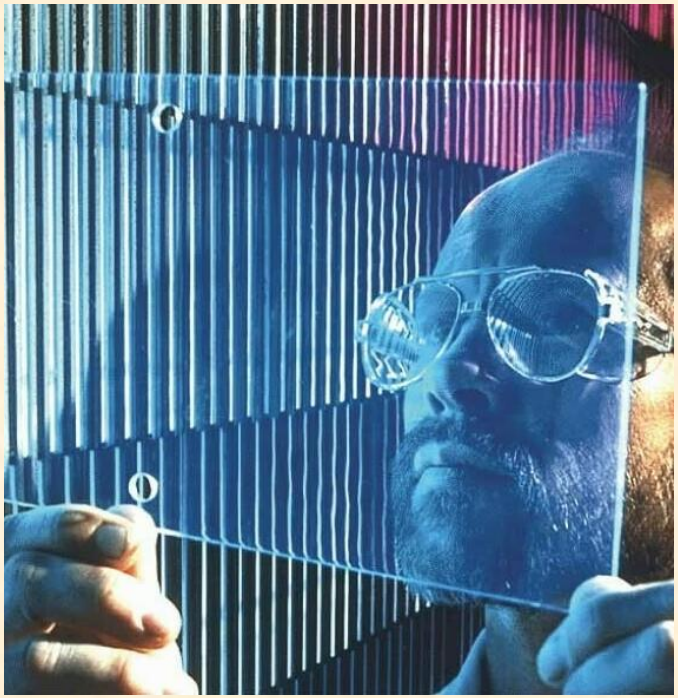
A simple Muon-Detector



Scintillators in LHC experiments
Example: ATLAS Tile calorimeter

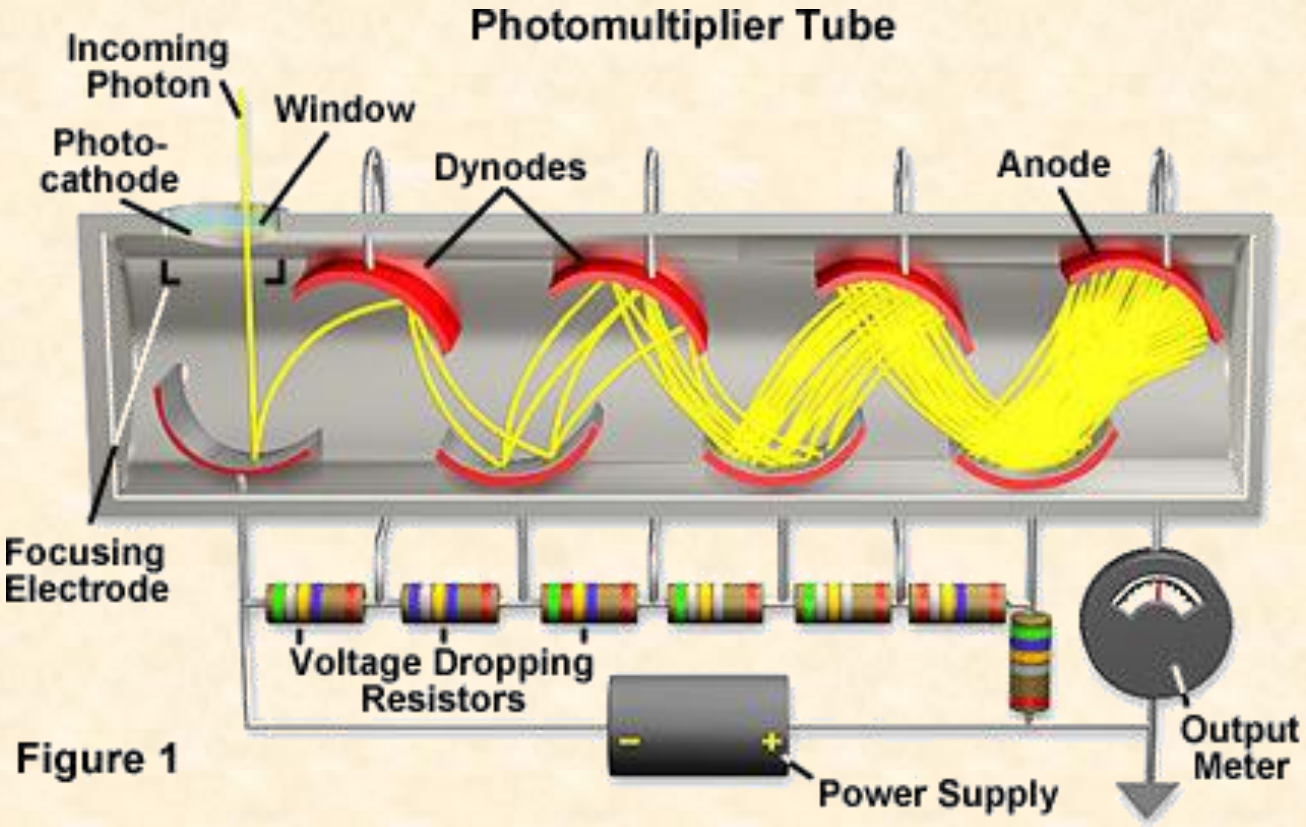






Light guides

Photomultipliers



Reasons for noise:

- Thermal electrons (dark current)
- Light leaks

Computing the number of photons created by the muon in the scintillator

Step1: Compute the number of electrons given by the PMT

$U = R * I$

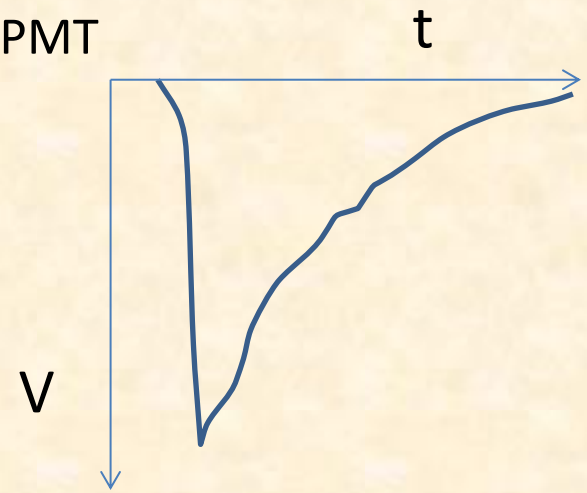
$Q = I * t$

Resistance: 50 Ω

1 Coulomb = 1 As = $6.24150965 \times 10^{18}$ electrons

Therefore: $Q = U * t / R$

For a triangle: $Q = U * t / 2 * R$



Step 2: Properties of the PMT

Additional parameters:

Electron amplification of the PMT: V_E = ~10^6

Efficiency of the Photo-Cathode: E_P = 0.1

Number of photons generated by a muon crossing the scintillator:

$N_{photon} = (U * t * 6.24 * 10^{18}) / (2 * R * V_E * E_P)$

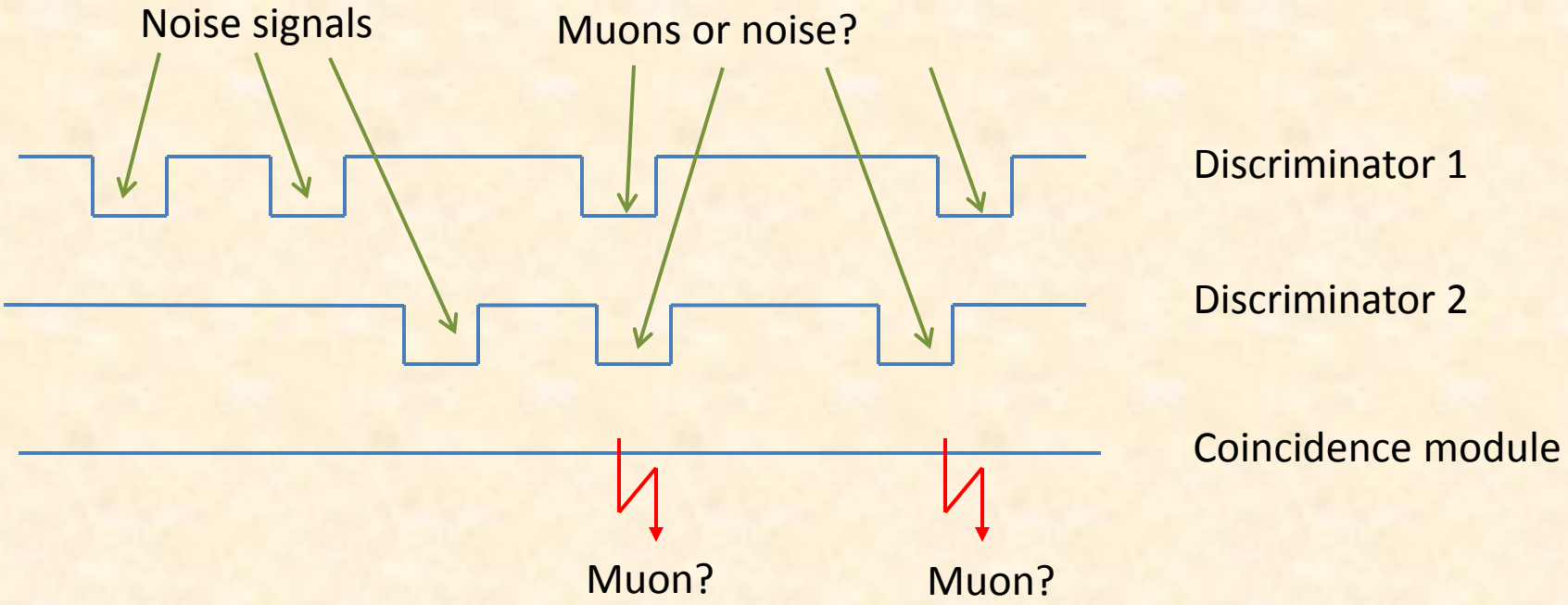
$N_{photon} = (U * t * 3.12 * 10^{14}) / R$

Literature: 20.000 photons / cm

Sensitivity of the human eye: http://en.wikipedia.org/wiki/Rod_cell

A bit of mathematics (without formulas)

Random Coincidences



- How likely is the overlapping of noise pulses on the two channels?
  - What parameters does the formula depend on?
  - How does the formula look like?
- How can we measure the rate of random coincidences with our set-up?

What can be measured with our detector?

- Muon rate
  - Are there less muons inside of a building (due to shielding) than outside?
  - Does the muon flux depend on the time of day?
- Angular distribution of the muons
- Muon life time (would require third PMT or a bigger scintillator)
  - A muon that decays produces a signal with a higher amplitude than that of a muon that just crosses the scintillator
- Muon velocity (would required precise clock)
- Other sources of radiation (e.g. beta decay)

Application: Volcano-Tomography