Gaseous Anger Camera Emulation

An experimental system to study the design and
optimization of a neutron detector using an Anger camera readout

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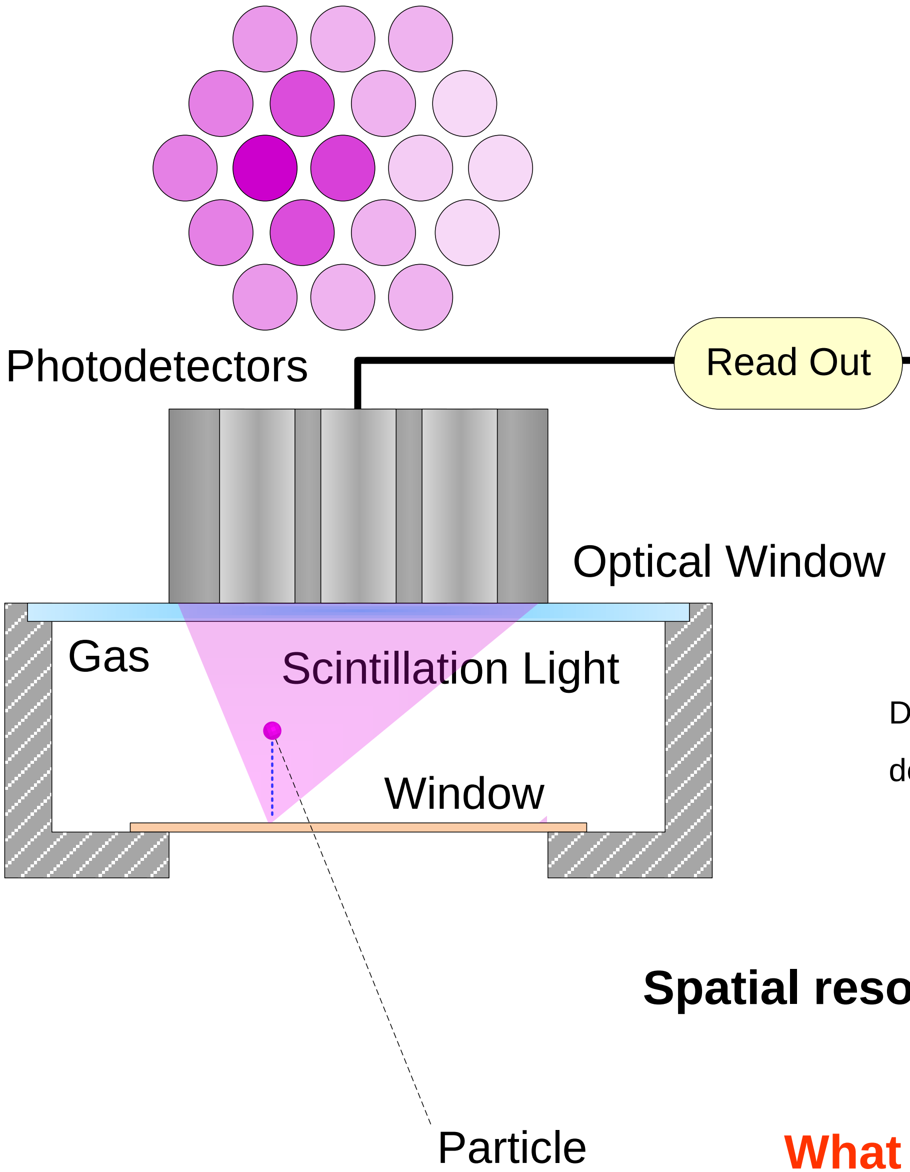
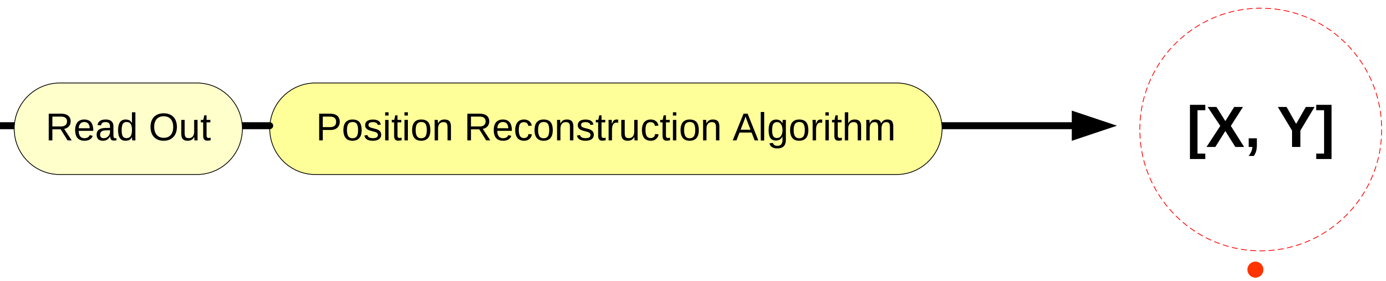
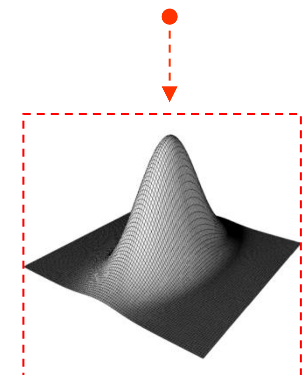
Gaseous Anger Camera





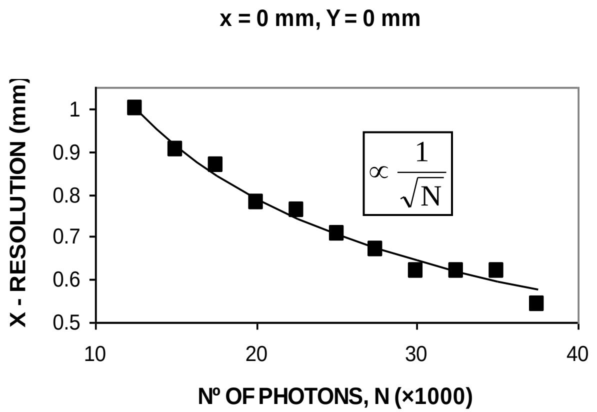


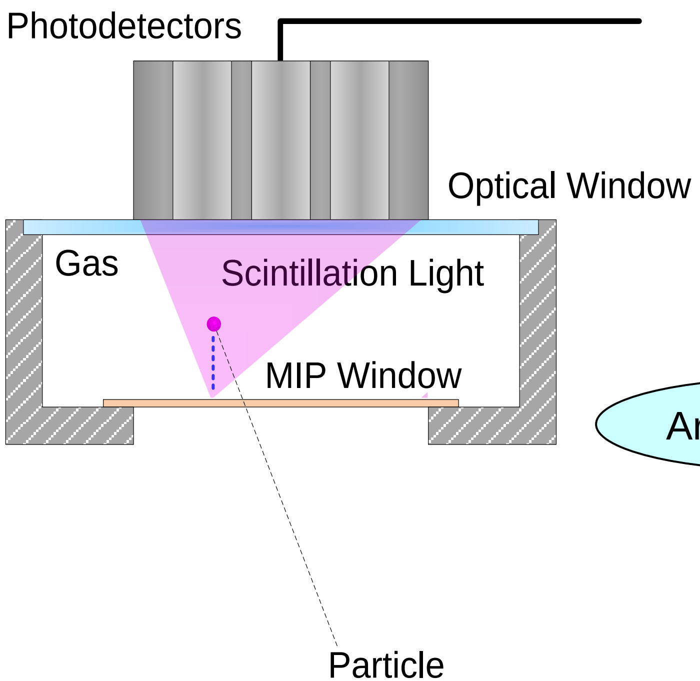
Distribution of (X, Y) positions with an associated width determining the spatial resolution of the camera

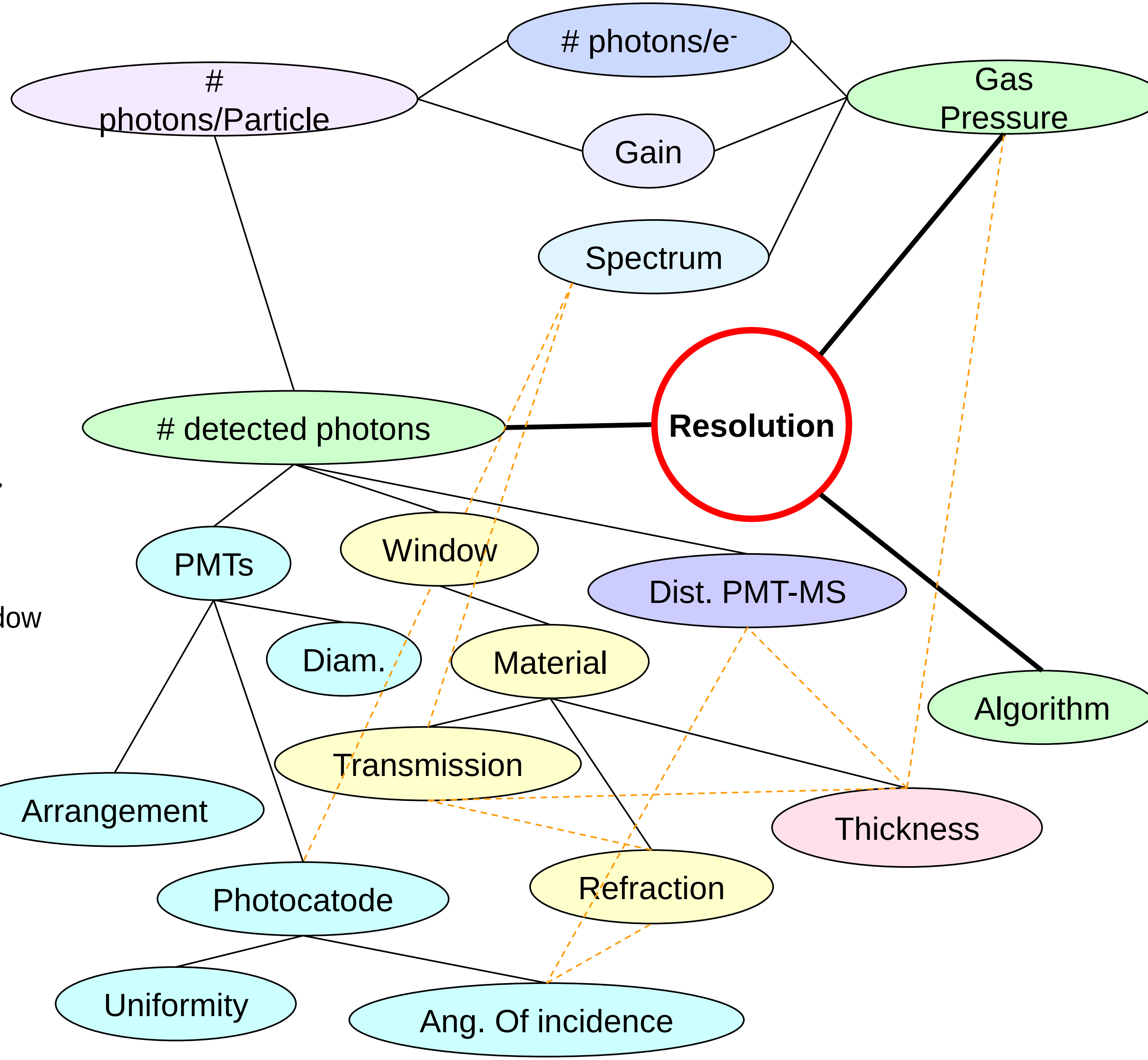
Spatial resolution is a key parameter for any Anger Camera.

What is the best achievable spatial resolution ?

Spatial Resolution



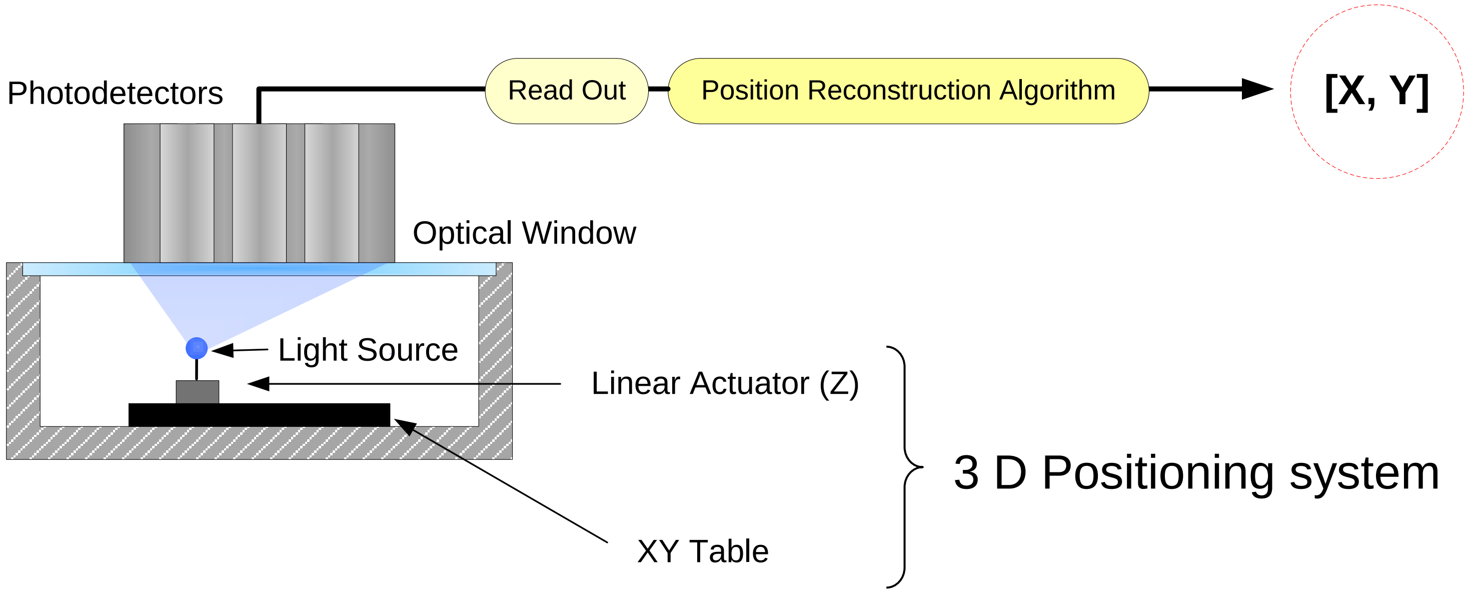




An experimental system to study the design and optimization of gaseous detectors with Anger camera readout

<u>The experimental system should allow to:</u>

- Control the **geometric parameters** of the detector.
- <u>**Emulate** the scintillation in a detector in a **controllable** way</u>.
- Develop and test position reconstruction algorithms such as Maximum likelihood, Gradient LS and Neural Networks.
- Experimentally test the performance of ANTS ***.
- To establish the **limit resolution** of the detector.



Light Source

Requirements

- Size comparable with the light emission region in a gaseous scintillation detector (~< 1mm diam.)

- Isotropic

- Light emission within a suitable wavelength range (i.e. ~ 300 nm to ~800 nm)

- Allow pulse mode operation

- Controlable light output from ~10^3 to ~10^6 photons/4π per pulse

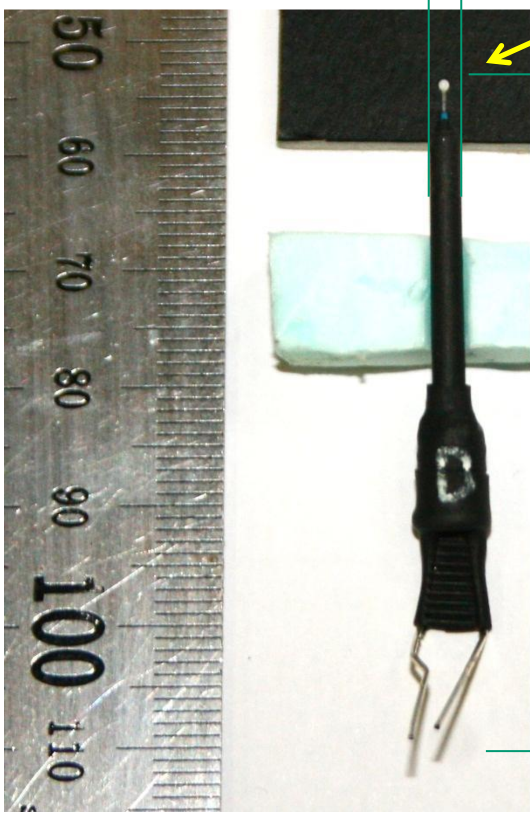
- Stable

- Robust and easily positioned

Light Source

Ø 5mm LED
λ ~ 470 nm
LI ~ 6000 mCd

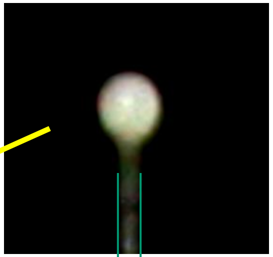
3 mm



60 mm

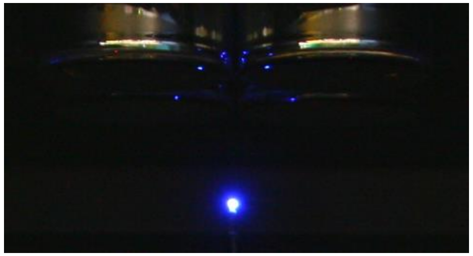
(mm)

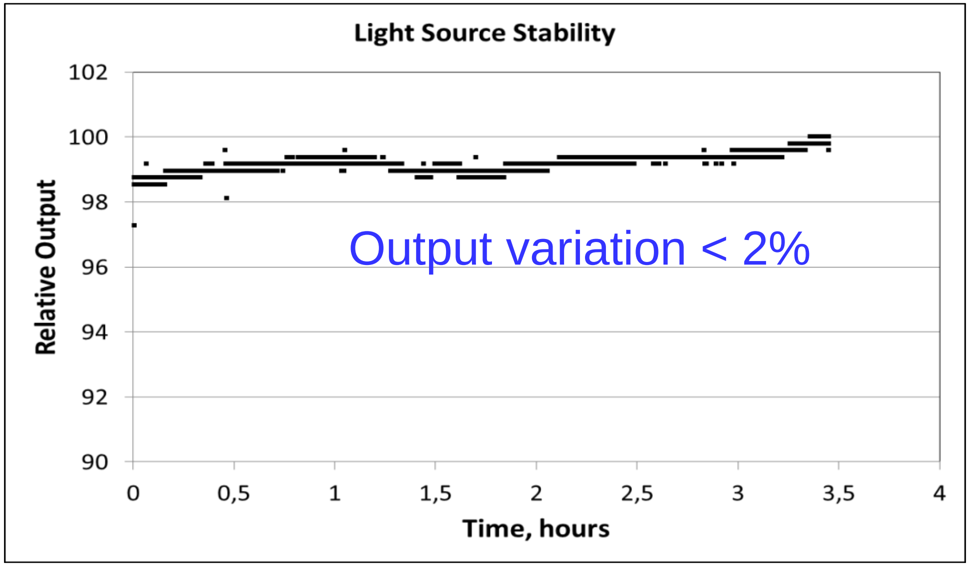
Diffuser diam. < 1 mm



225 µm (Cladding)

200 µm core F.O.

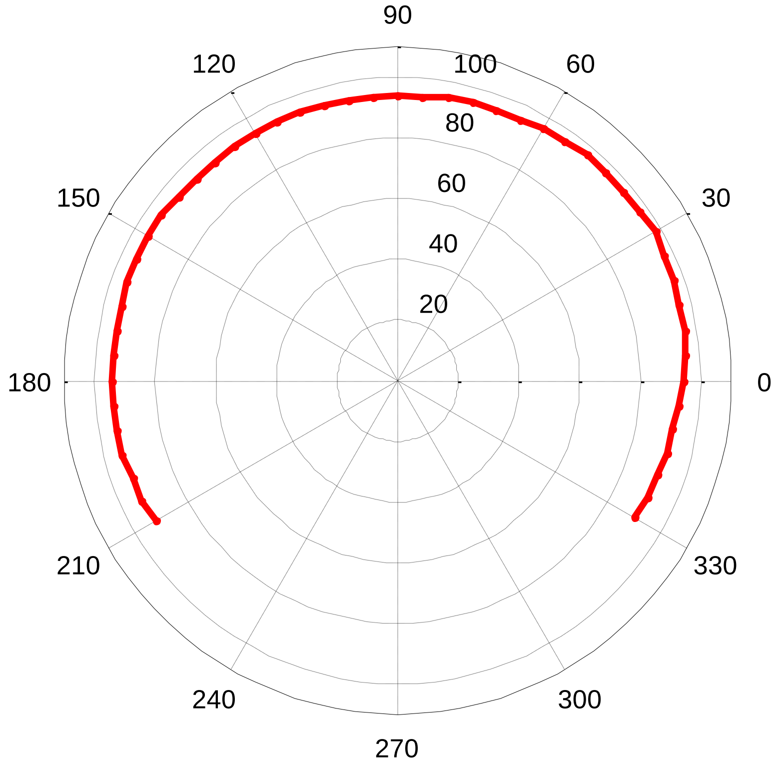




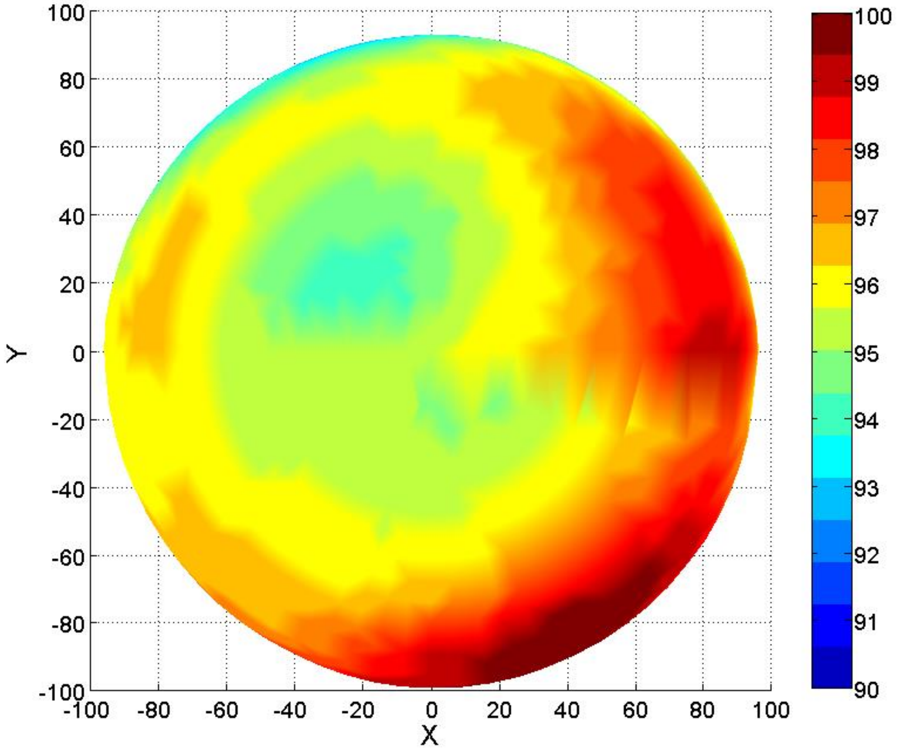
Isotropy

Diffuser diam. = 800 µm

Angular Res. = 5º



Top view



Azimuth = 0º
I ~ 20 mA
D = 6 cm

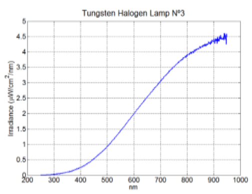
How about the number of photons emitted per pulse in 4π ?

- We adress this question using a NIST calibrated photodiode.

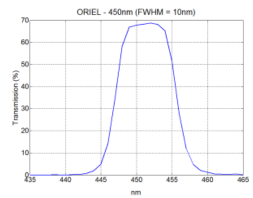
Number of photons emitted in 4π

''Extending'' the photodiode NIST calibration to the visible

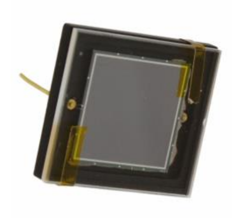
Calibrated tungsten halogen lamp



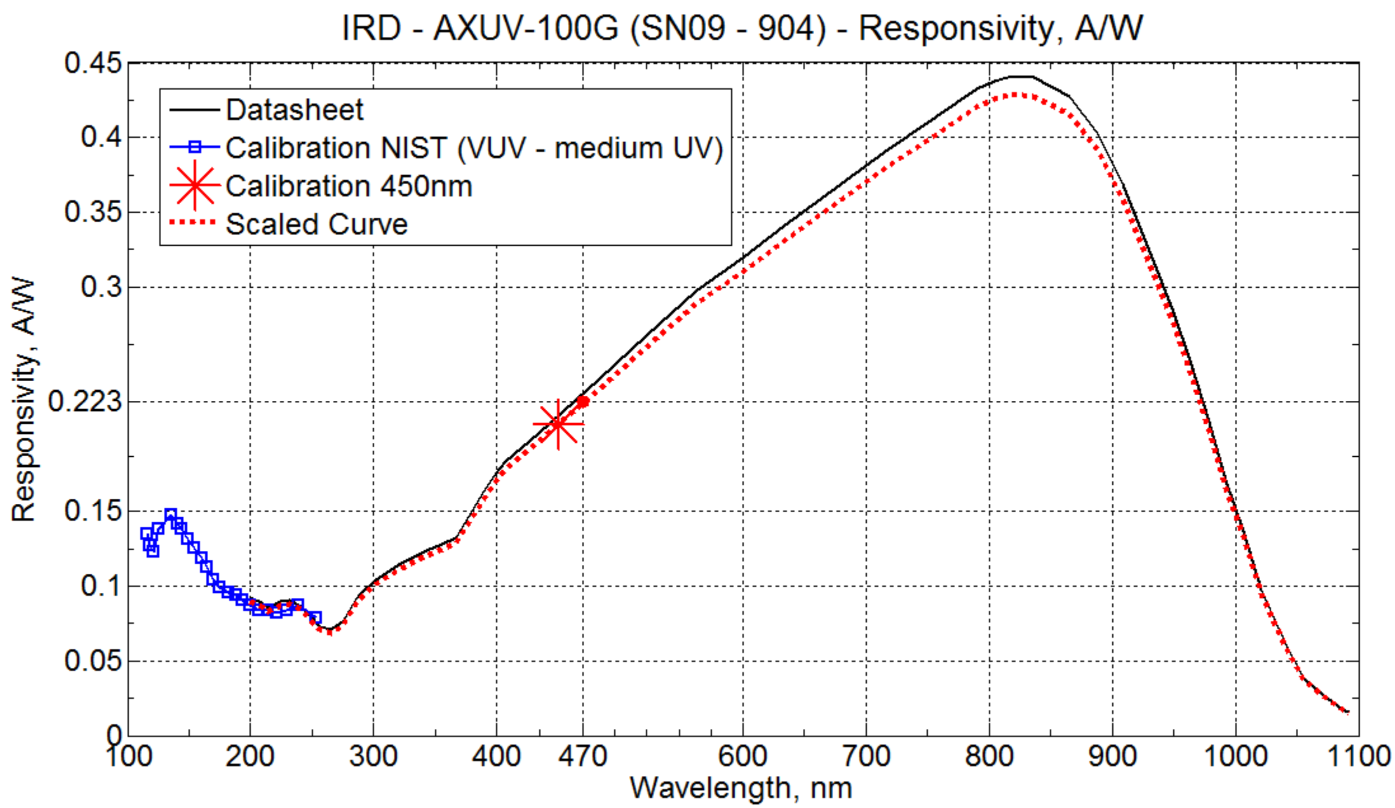
Narrow band filter (oriel 450 nm +-10nm)



AXUV-100G



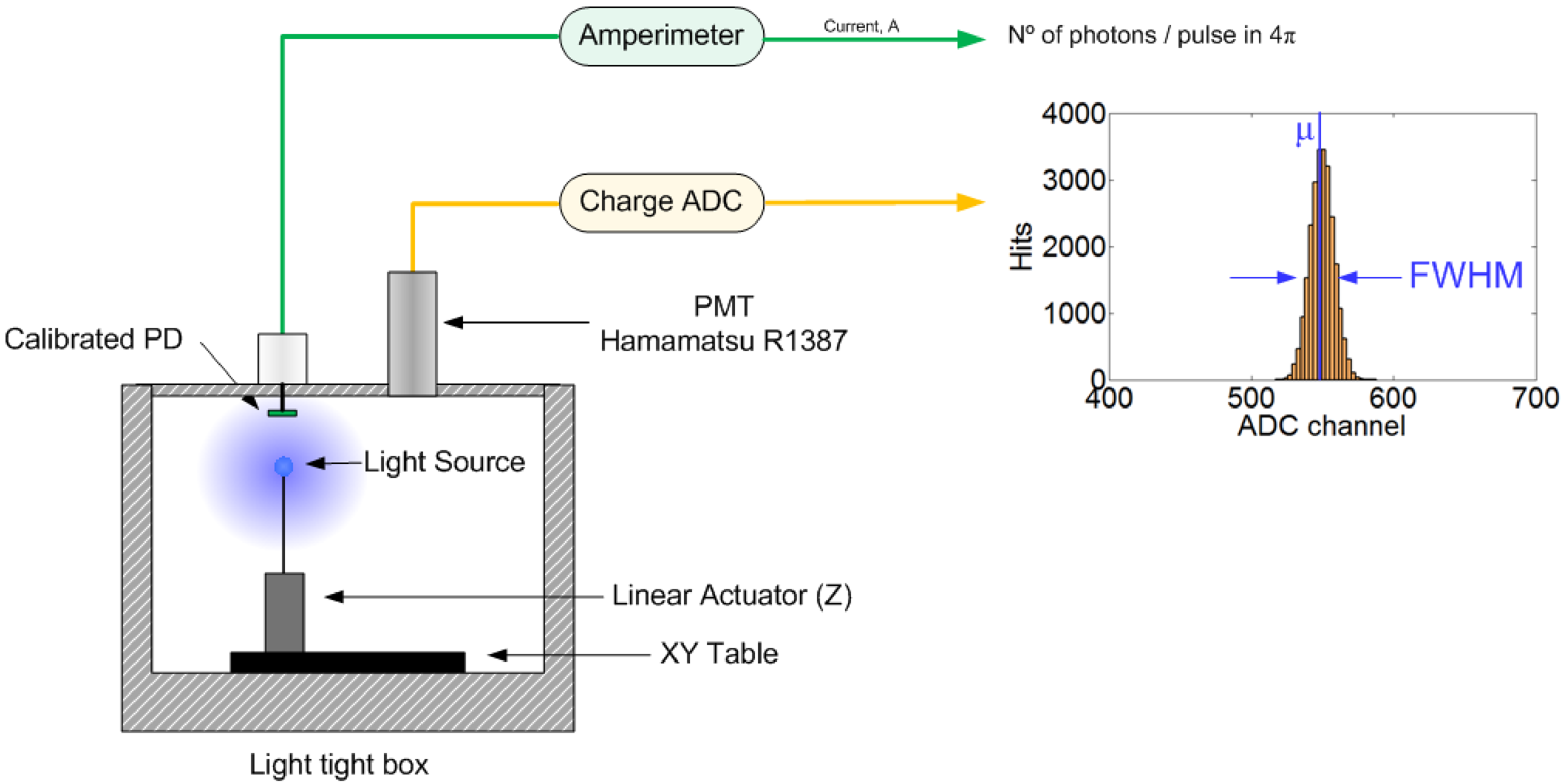
Picoamperimeter



How does PMT signal histograms reflect the number of emitted photons by the light source?

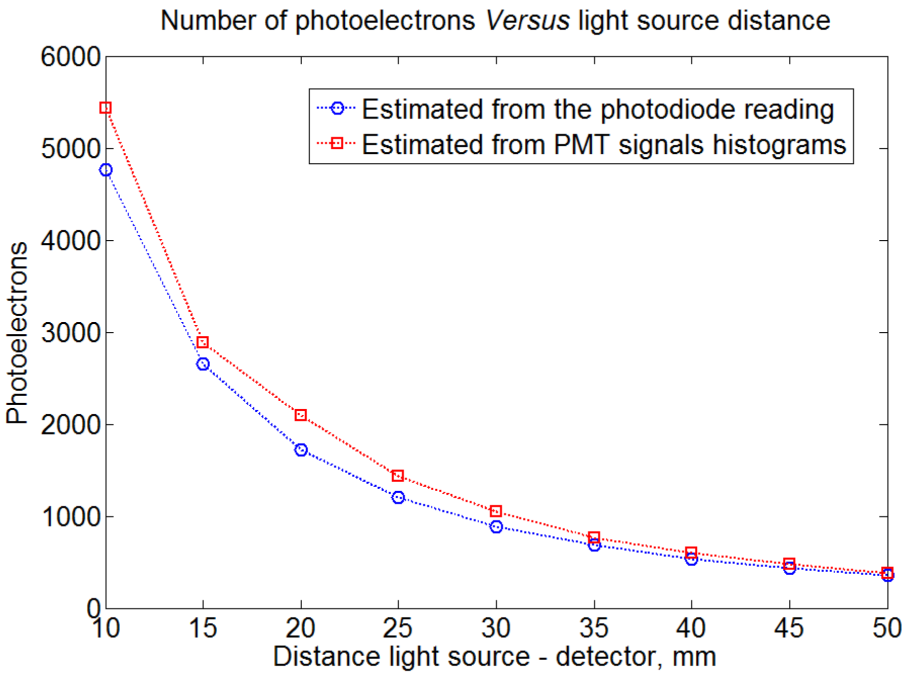
– We set the light source emission in 4π to a certain number of photons per pulse, (using the current reading from the photodiode) and we record PMT signal histograms.

Photomultiplier signals



Assuming that photoelectron emission obey to a Poisson distribution

$$N_{phe} \approx \left(\frac{2.35}{\frac{FWHM}{\mu}} \right)^2$$



Assumptions

- QE = 16%
- Ecol . Effic. = 1
- ENF = 1

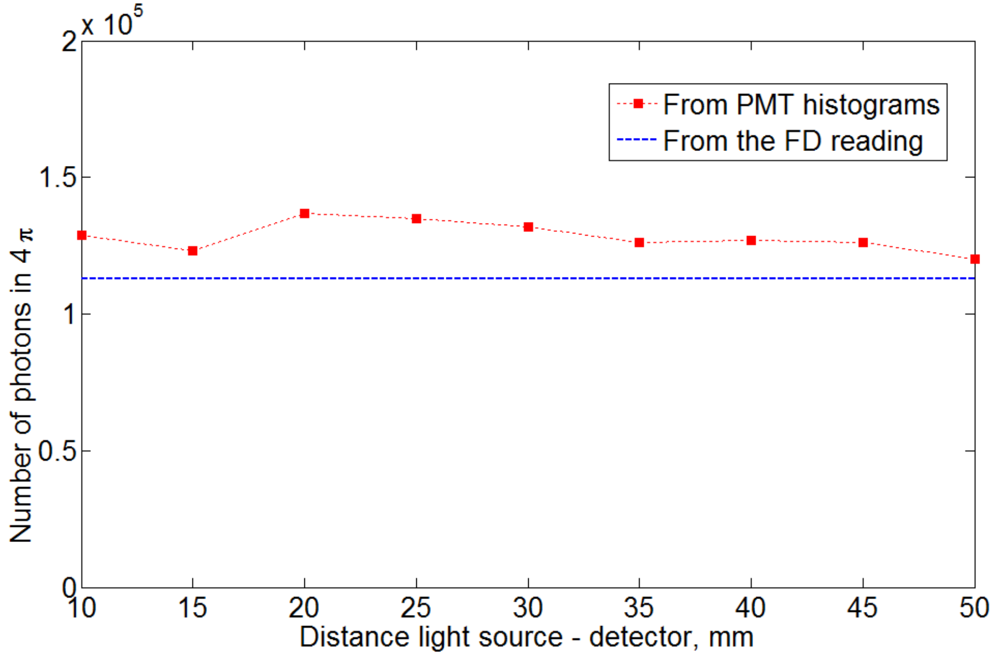
All solid angles were calculated with ANTS, in the case of the PMT using experimental data on the angular dependence and spatial uniformity.

Possible reason leading to this apparent ly good agreement

- Nphe [FD] are understimate

Possible causes

- PMT Q.E. Is in fact larger than 16%
- The eff. solid angles are larger than those given by ANTS



Allready in progress and future prespectives

- Optimization of the geometrical parameters in order to achieve the best possible resolution.
- Measure light response functions of the PMTs and estimate effective PMT angular response.
- Acquire data using a glass window and compare results with simulations.
- Acquired data using different reflective surfaces and c0mpared with simulations.
- Test adaptative algorithms with emulated experimental data.
- Try other algorithms such as NN, SCoG and GLS.
- Try different optical elements.
- Increase the number of PMTs.
- Upgrade the readout electronics.

END