CYGNO ANALYSIS MEETING

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STUDIES ON THE PMT RECONSTRUCTION

SUMMARY

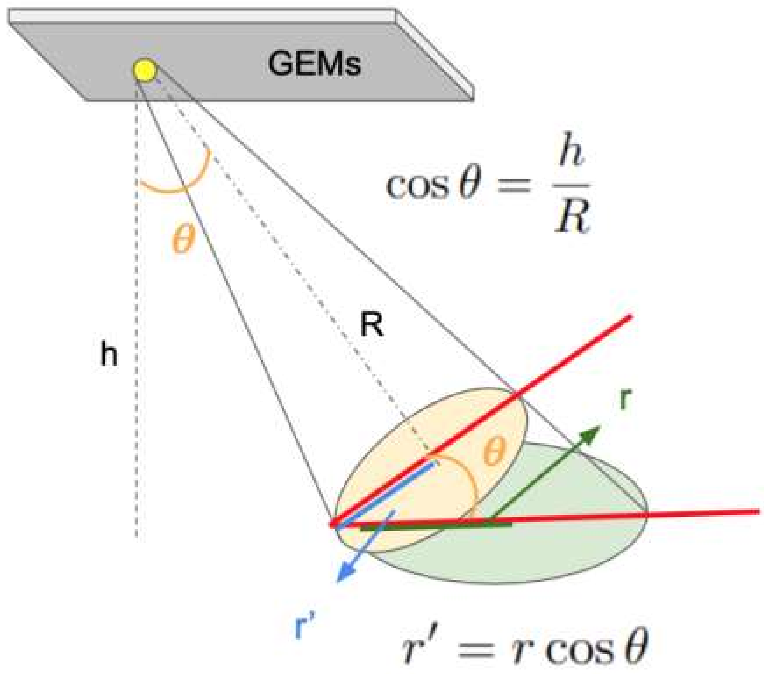
THE ALPHA PROBLEM

IRON SPOTS: A CLEAN DATASET

BACKGROUND CLEAN DATASET

Z DIFFUSION OF IRON SPOTS

THE ALPHA PROBLEM



The light produced by the GEMs is detected by the four PMTs and the light dependence on the distance allows the reconstruction of the signal:

$$L_i = \frac{L}{R_i^{\alpha}}$$

where:

- L_i is the light detected by the i-th PMT
- L is the source intensity (aka the energy of the track)
- R_i is the distance of the source from the i-th PMT

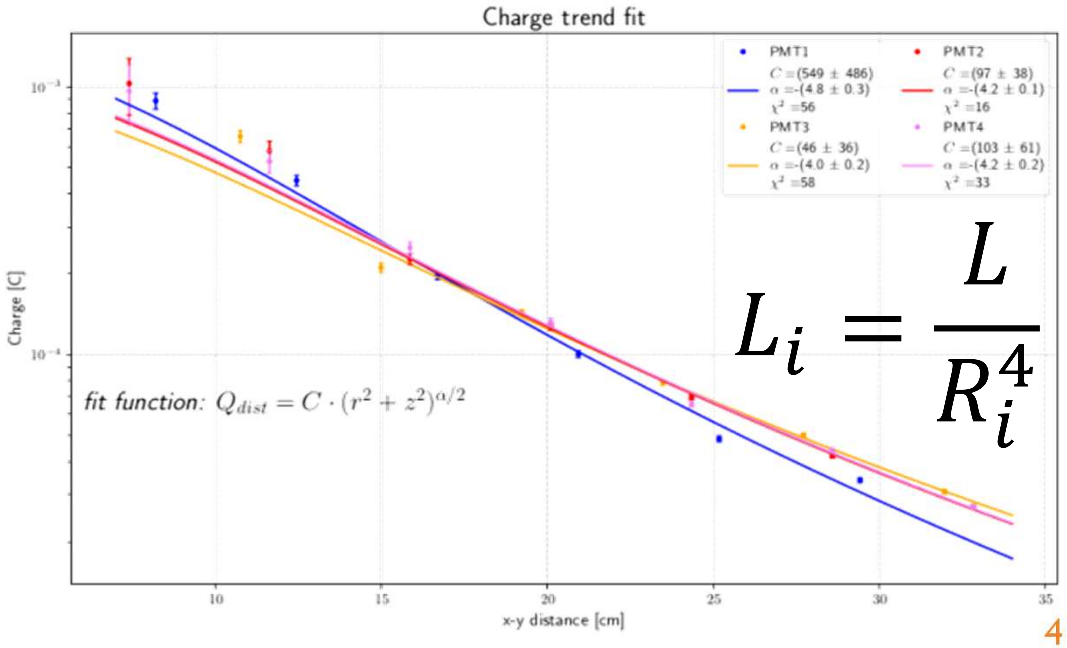
THE ALPHA PROBLEM

Theoretical expectation

- Homogeneous angular distribution $\propto 1/R^2$
- PMT geometrical acceptance $\propto 1/R$

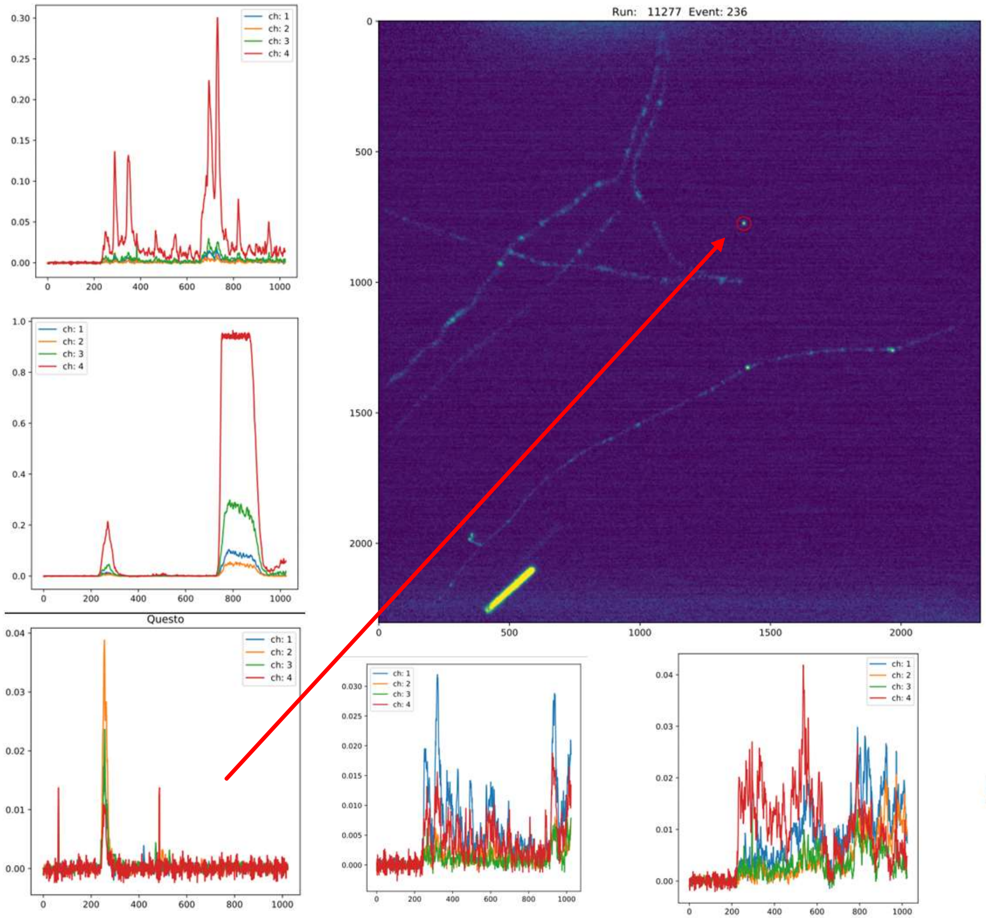
$$L_i = \frac{L}{R_i^3}$$

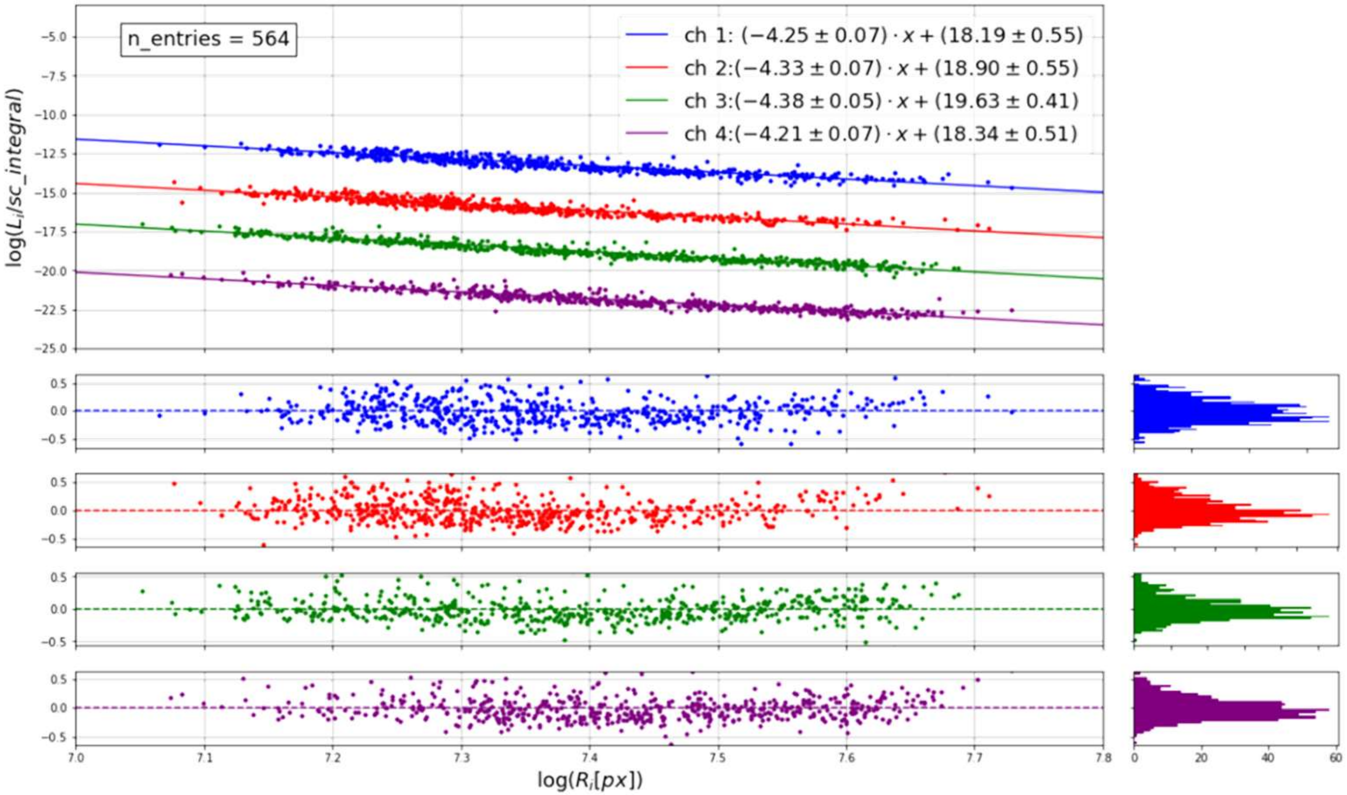
Experimental evaluation (external)



THE IRON CLEAN DATASET

- STRATEGY: Take the position from to images to infer alpha
- METHOD: Creation of a clean dataset of clusters with a unique waveform association. This events are all ER from the ^{55}Fe source and are point like with respect to our spatial resolution
  - Taken all the images with only an iron spots (selection over cluster properties i.e length, width, energy …)
  - From the previous selection taken only pictures with only one iron waveform (number of peak based selection)





The four trends are shown.
On the bottom we just have the distance of the points from the best fit (**not** the residues)

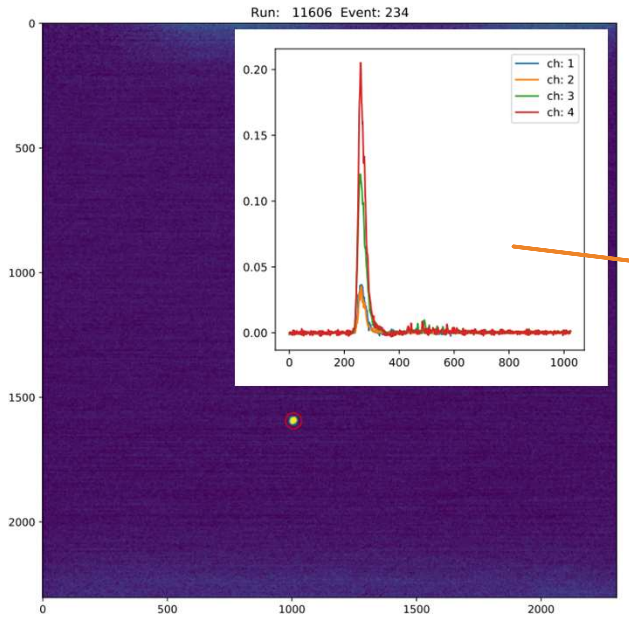
THE IRON CLEAN DATASET

Power law in a double logarithm scale. The charge seen by each PMT has been normalized by the *sc_integral* of the cluster in order to take care of the different light yield off the several runs used

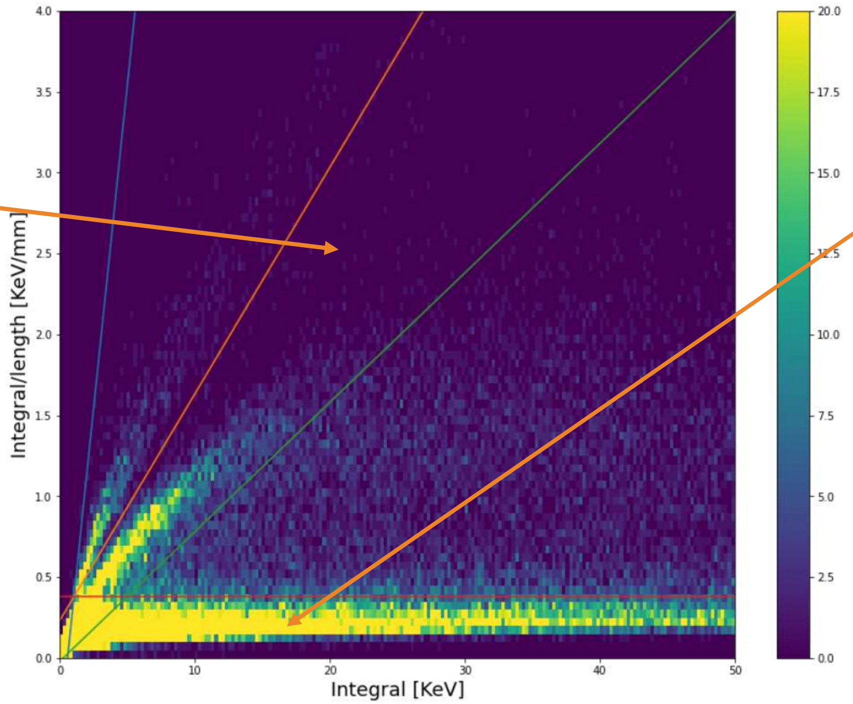
BACKGROUND CLEAN DATASET

Runs: 11590 → 11951

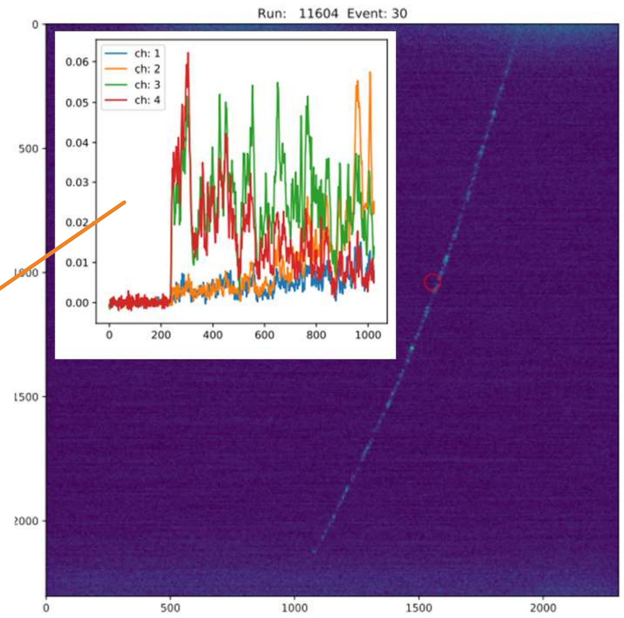
Point like tracks

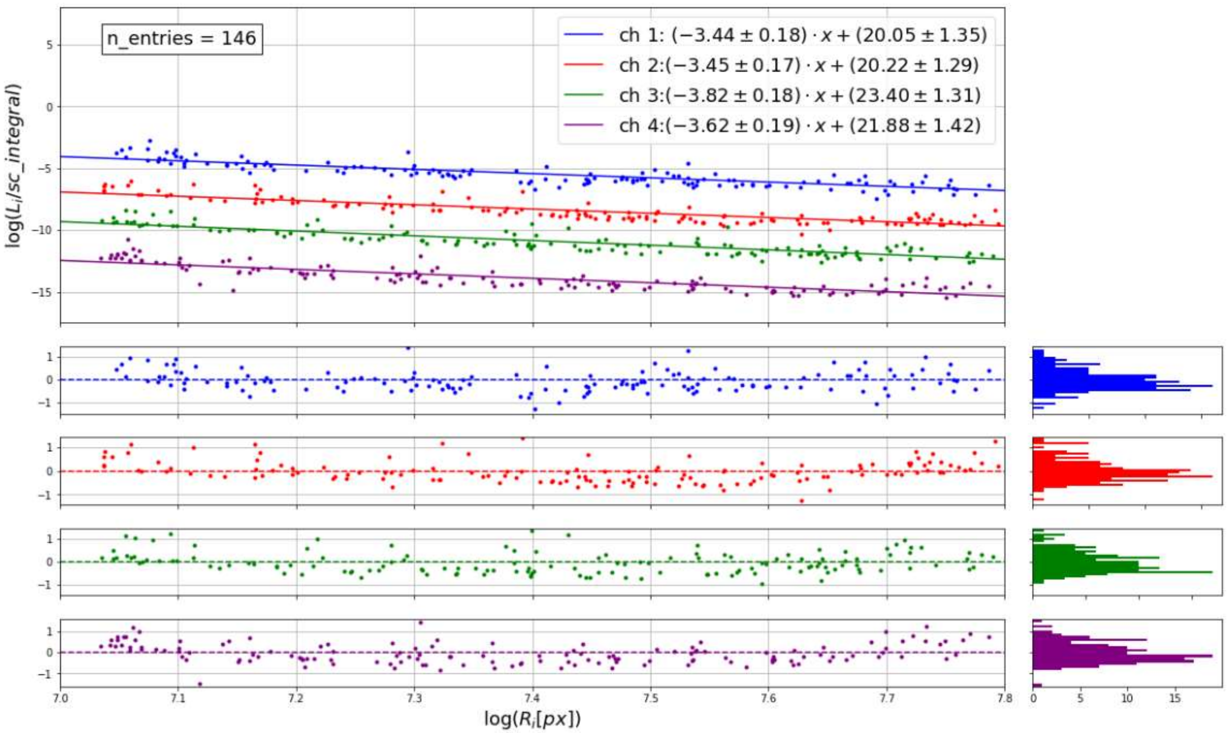


Energy density diagram



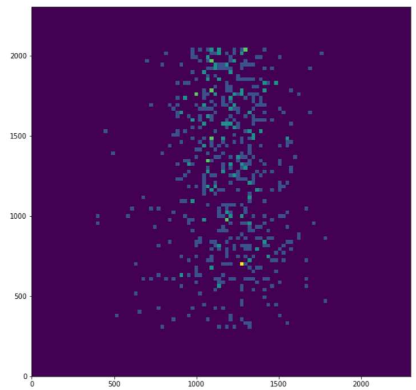
Long tracks



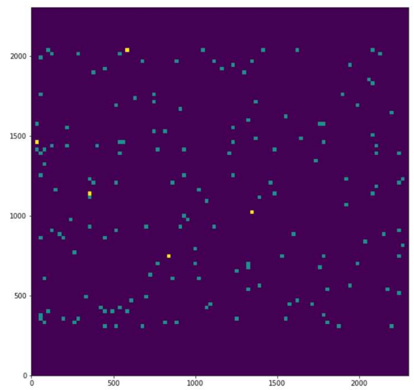


A very different alpha: we are in the middle of two different trends

^{55}Fe distribution



Bkg distribution

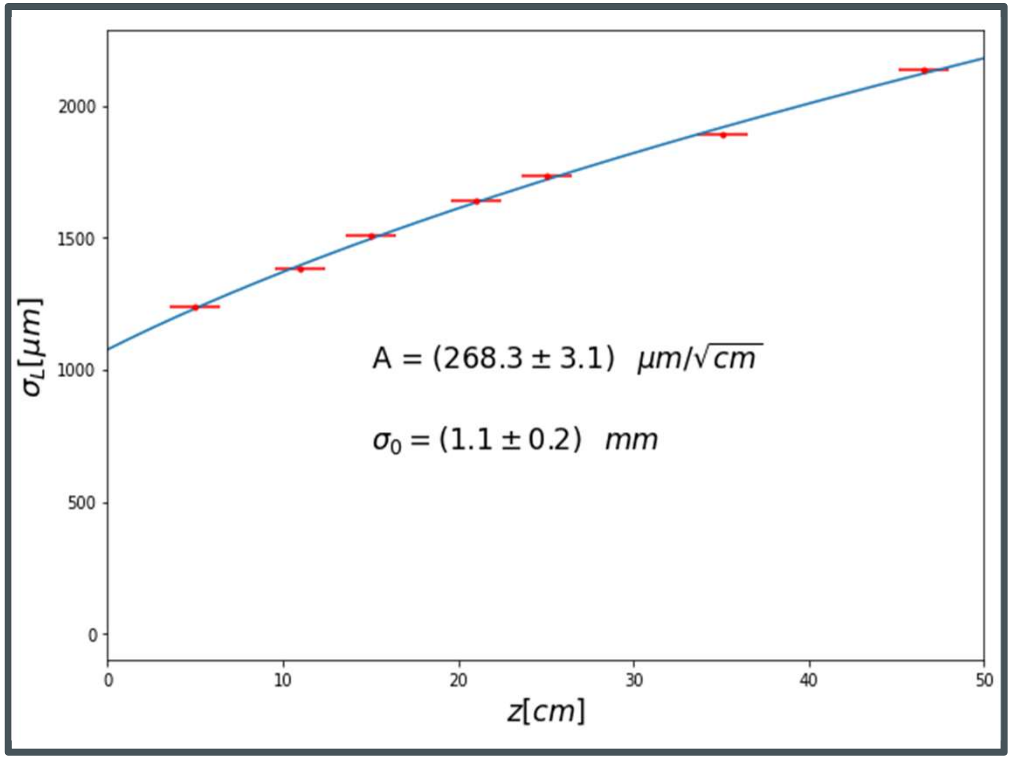


BACKGROUND ALPHA INFERENCE

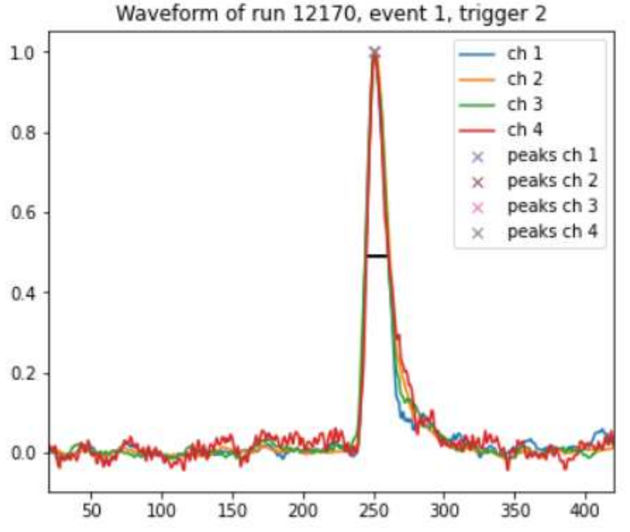
Power law in a double logarithm scale. The charge seen by each PMT has been normalized by the sc_integral of the cluster in order to take care of the different light yield off the several runs used. In addition the charge has been converted in KeV and this results in a vertical shift with respect to the previous plot

Z DIFFUSION

Runs of 9 March 2023



- STRATEGY: Measure the longitudinal diffusion of the signal trhough the time width of its waveform
- METHOD: Selected only iron wf for different positions of the iron source



BACKUP

THE COSINE FOURTH LAW

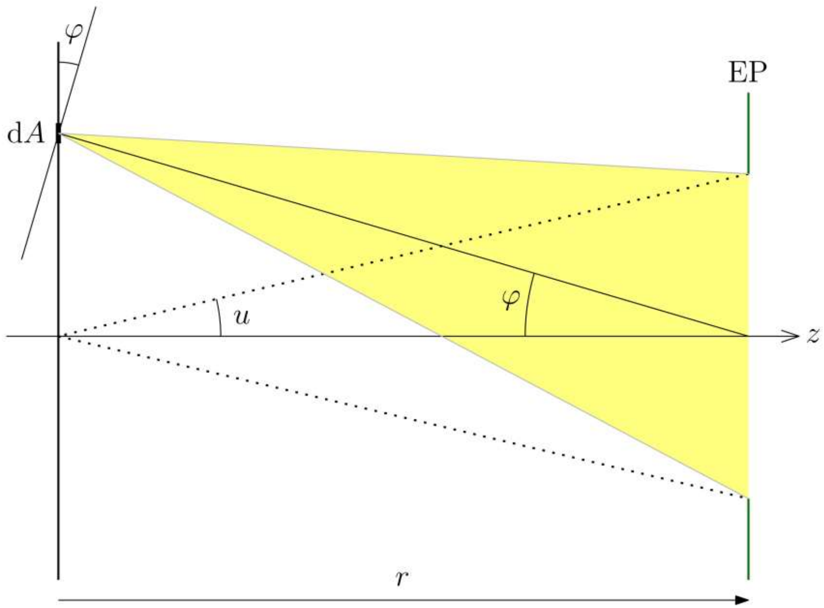


Figure 1.33. Geometry of the cosine fourth law. The base of the cone becomes flat in Gaussian optics.

From the literature it's very familiar the cosine fourth law (aka $1/R^4$):

The flux scales as a fourth power of the distance for a reflecting surface

What happens is that it's assumed that the light source is a Lambertian surface that diffuse light with a $\cos(\phi)$ law.

This adds exactily the missing R power but **can we leave the assumption that GEMs diffuse light isotropically?**

A MATHEMATICAL COUNT AND A SIMULATION

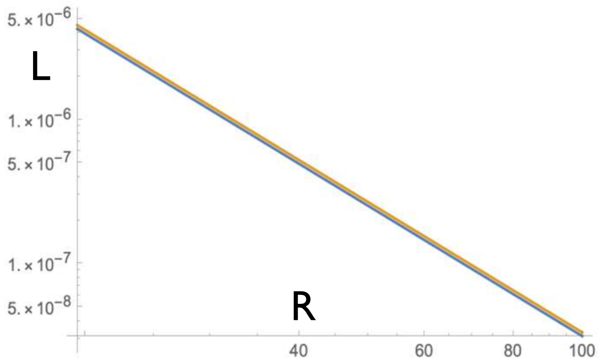
Source dimention = 1 mm

MATHEMATICAL CALCULATION

```
In[12]:= integrando[r_, phi_, R_, h_, L_] :=
          r / ((R^2) + r^2 - 2*r*Sqrt[R^2 - h^2]*Cos[phi])^(3/2)

In[13]:= integrale[R_, h_, L_] :=
          NIntegrate[integrando[r, phi, R, h, L], {r, 0, L}, {phi, 0, 2*Pi}]

In[52]:= LogLogPlot[{integrale[x, 19.5, 0.1], x^(-3)/30}, {x, 19.5, 100}]
[52]=
```



MC SIMULATION