# Charge reconstruction

## with the RICH detector in AMS

28th June 2002

LIP-AMS

# Flight simulation

## Simulation conditions

Radiator : Aerogel , n=1.030, c=0.0042 $nm^4$ $cm^{-1}$, L = 3cm

Mirror : ρ =0.85

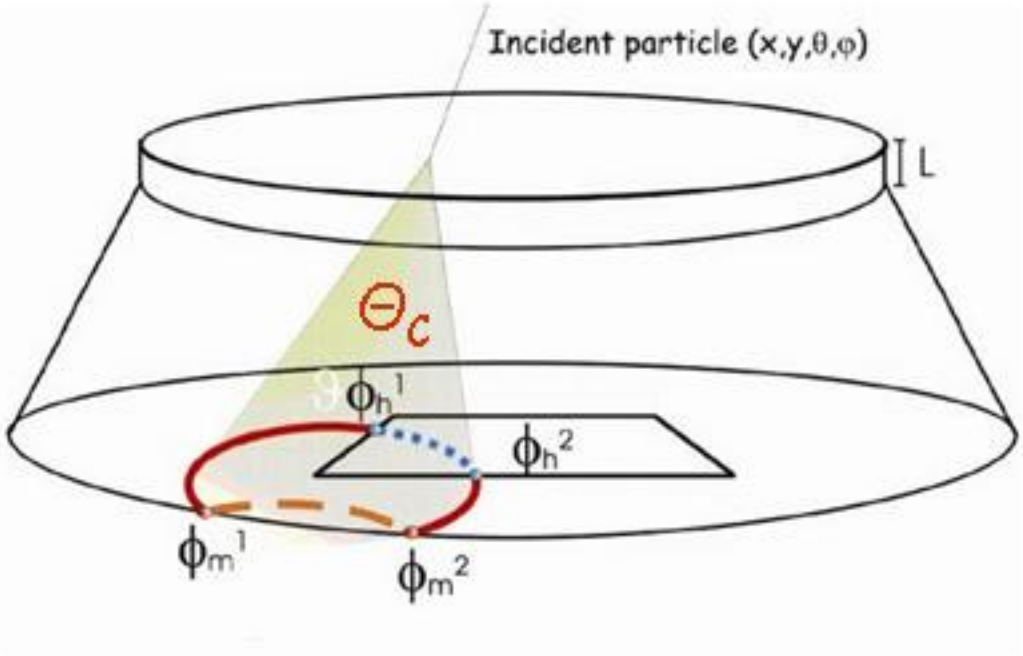
Light Guides : pitch = 31 mm

PMTs : pitch = 37mm

6 simulated sets - He, Li, Be, B, C, N

10000 events , β=0.999 c

# Geometry




Pattern:

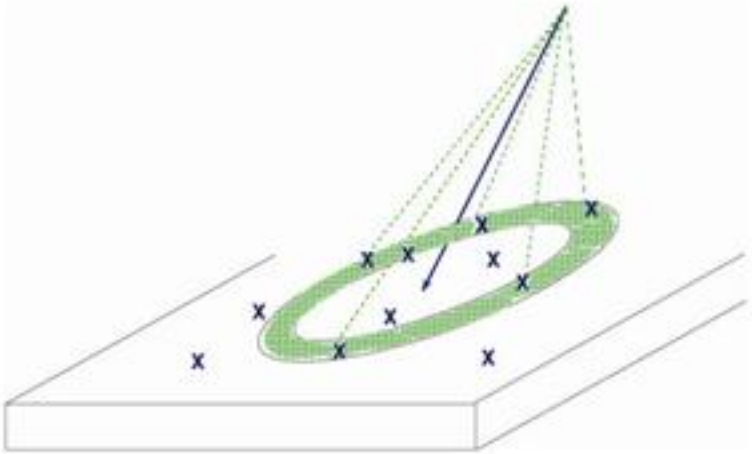
- Direct branch : $Acc_{dir} \in [\varphi m^1, \varphi h^1] \cup [\varphi h^2, \varphi m^2]$
- Reflected branch: $Acc_{ref} \in [\varphi m^1, \varphi m^2]$
- Invisible branch : $Acc_{inv} \in [\varphi h^1, \varphi h^2]$

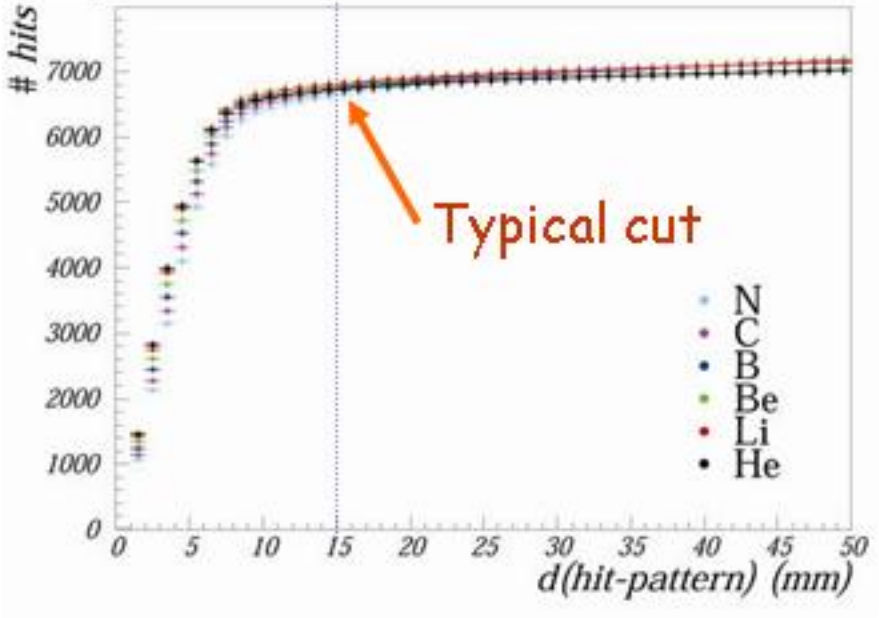
# Method

$$N_\gamma \propto Z^2 \Delta L \left(1 - \frac{1}{\beta^2 n^2}\right) = Z^2 \Delta L \sin^2\Theta_c$$

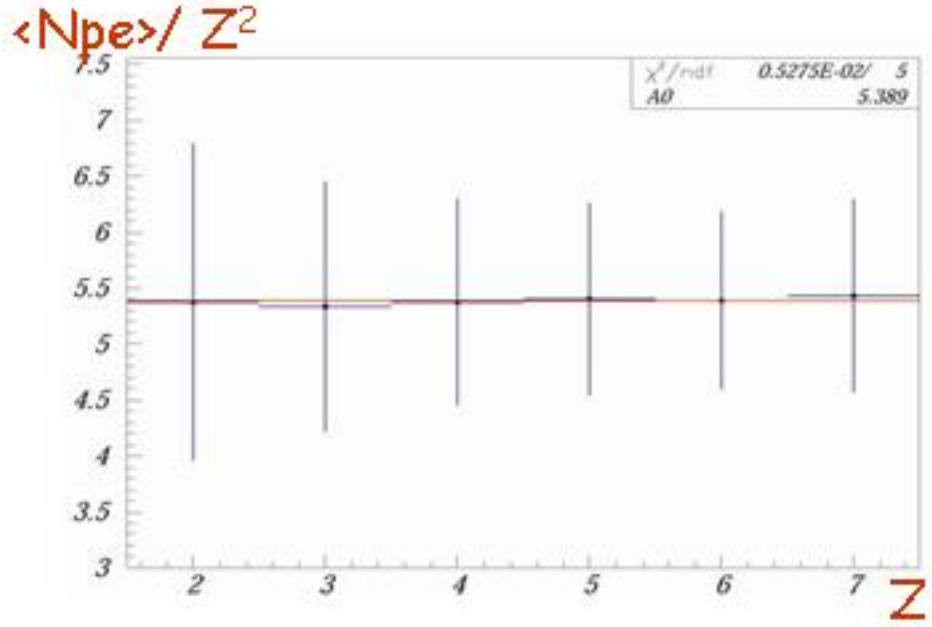
1) Cerenkov Angle reconstruction

2) Counting photoelectrons (p.e.s)





# Method




3) Evaluate photon detection efficiency

$$Npe = N\,\varepsilon$$

$$Npe \sim k\,Z^2\,\Delta L\,\sin^2\Theta c\,\underbrace{\varepsilon_{rad}\varepsilon_{geo}\varepsilon_{lg}\varepsilon_{pmt}}_{\varepsilon_{tot}(\Theta c,\varphi,\Theta,IP)}$$

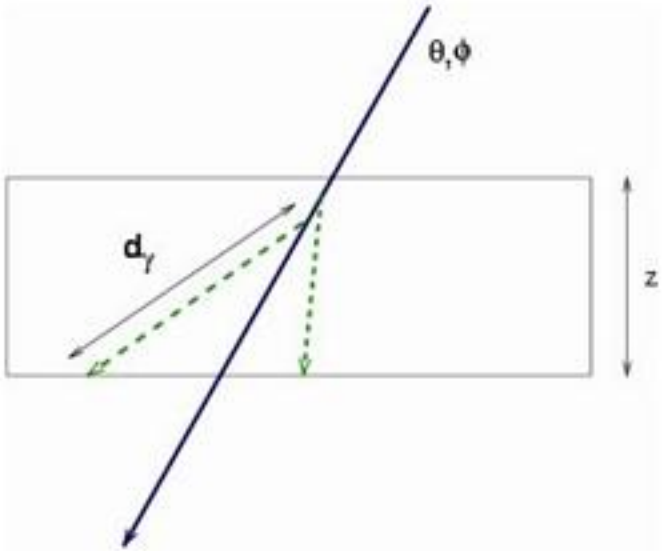
# Radiator Efficiency

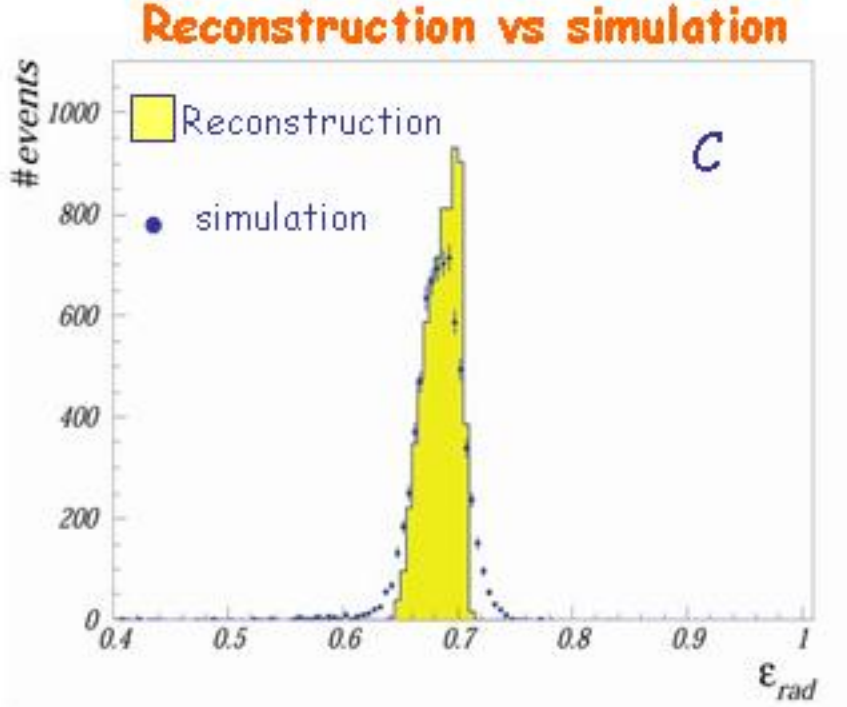
## Photon non-interaction probability

Rayleigh Scattering ( & Absorption )

$L_{int} \sim \lambda_\gamma^4 / c$ $\lambda\gamma$ : photons wavelength , c : clarity

$$P_{int} = \int e^{-d\gamma(\Theta c, \varphi, \Theta, l)/L_{int}} dl$$



# Geometrical Acceptance

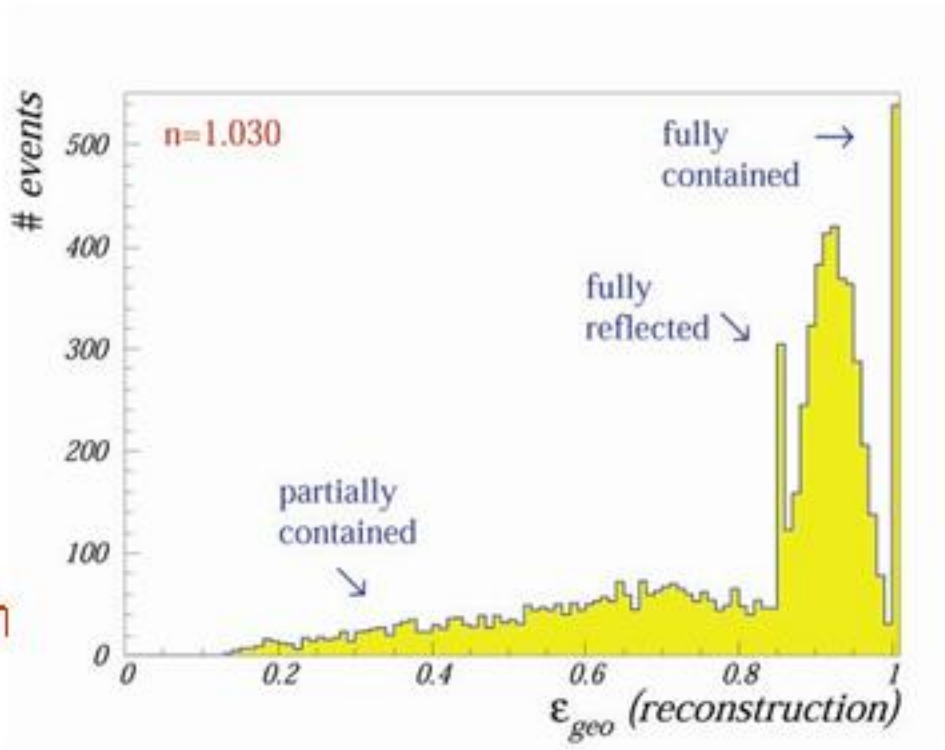
$$\varepsilon_{geo} = Acc_{dir} + Acc_{mirr}\,\rho$$

Photon loss:

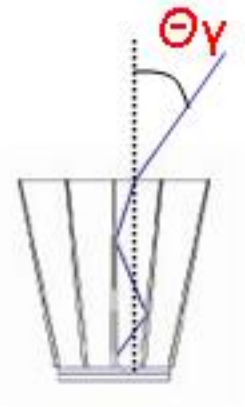
-Radiator lateral walls

-Mirror absorption (1-ρ)

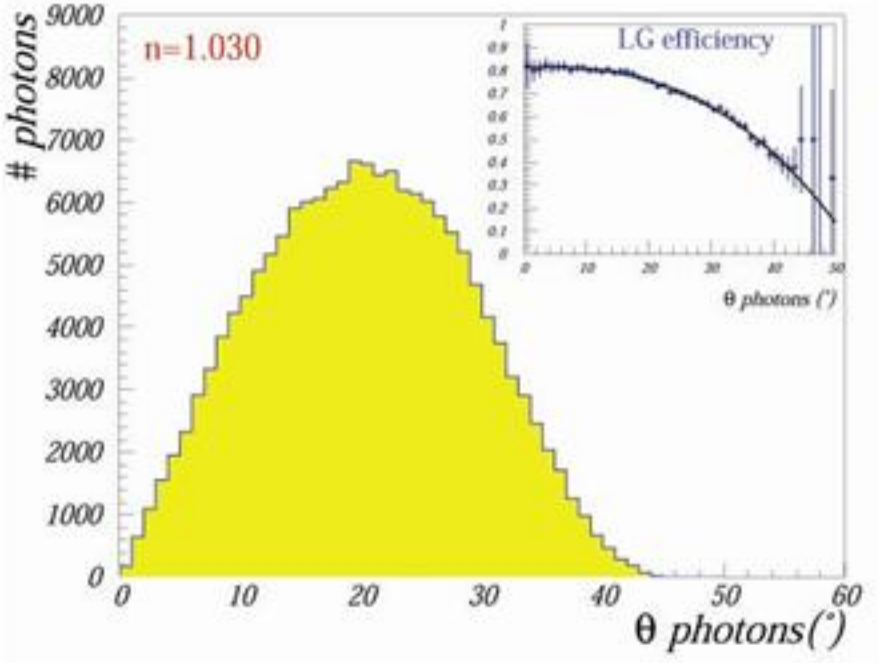
-Non-active detection region

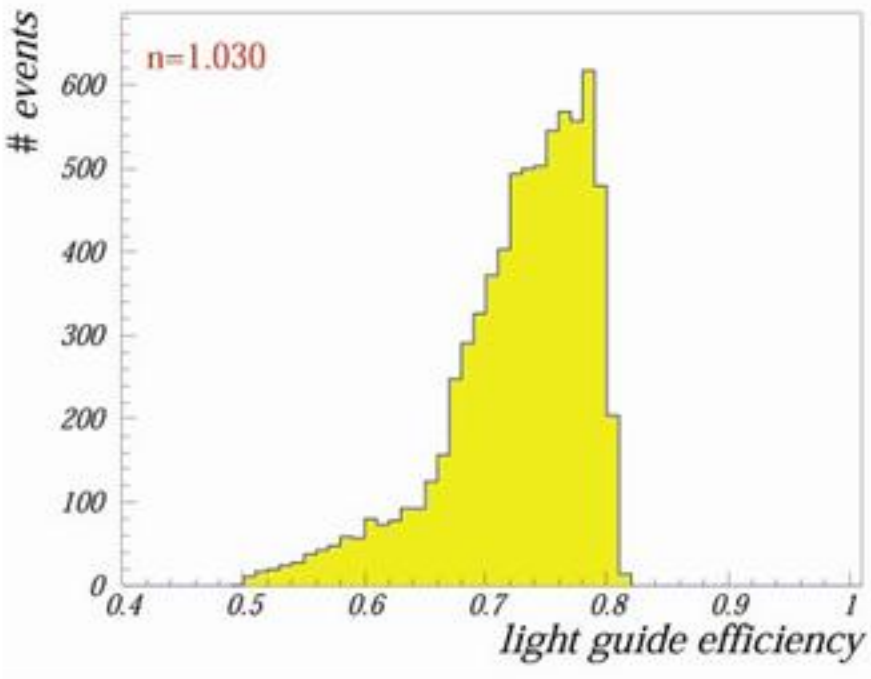


# Light-Guide Efficiency

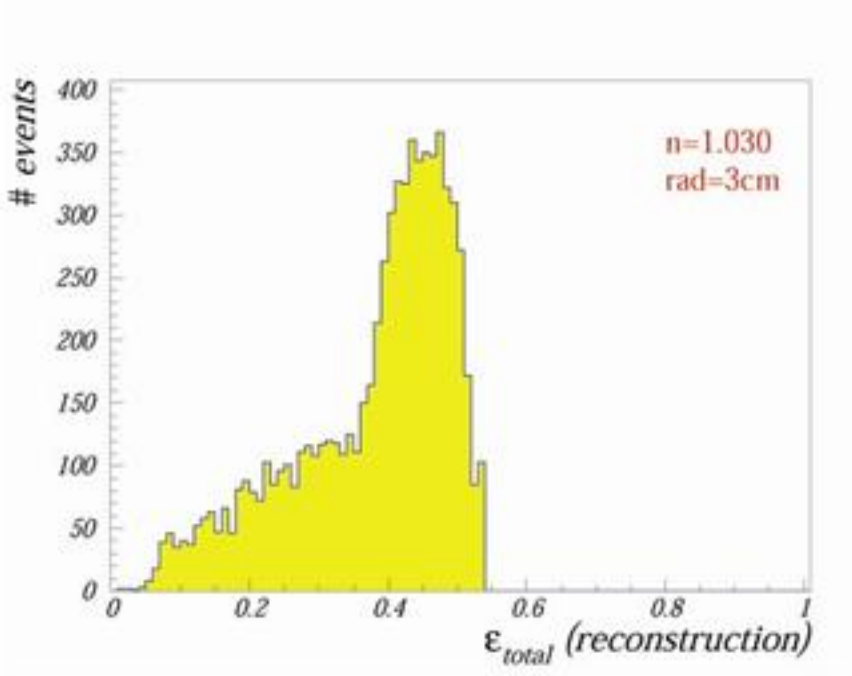


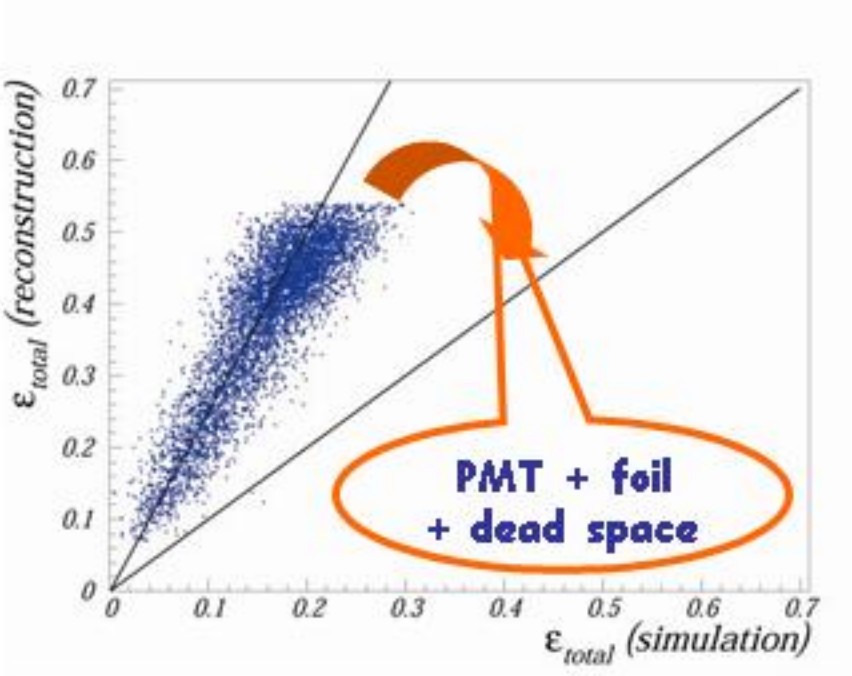

$$\varepsilon_{lg} = \int_{\varphi 1}^{\varphi 2} \varepsilon_{lg}\,[\Theta_\gamma(\Theta, \Theta c, \varphi)]\,d\varphi$$



# Total Efficiency

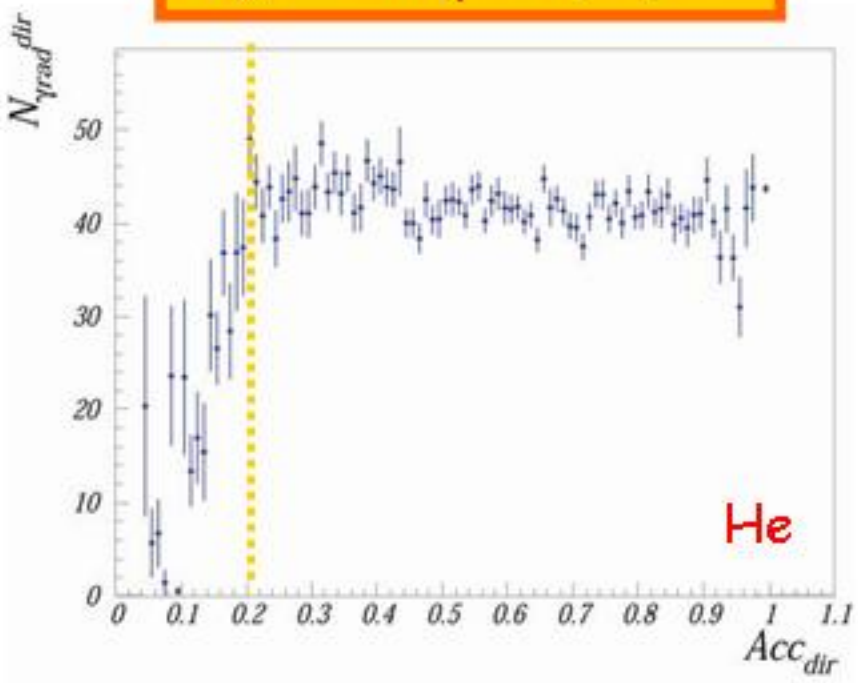


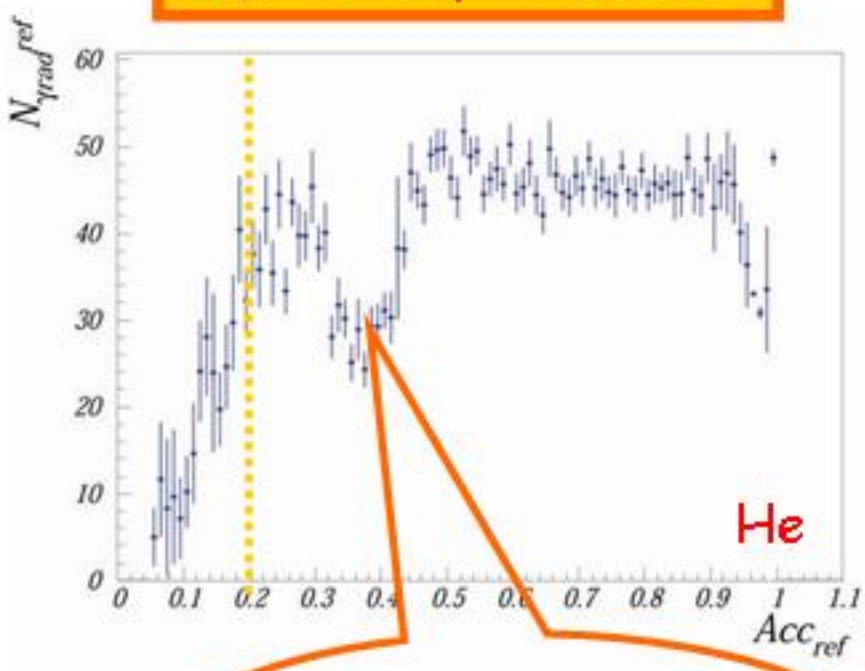

$$\varepsilon_{tot} = \int_0^H \{ \Sigma_i^{n.paths} \rho_i \int_{\varphi_{min}^i}^{\varphi_{max}^i} e^{-d_\gamma / L_{int}} \varepsilon [\Theta_\gamma(\Theta,\varphi)] \langle \varepsilon_{pmt} \rangle \, d\varphi \} \, dz/2\pi H$$

# Number of radiated photons

$N_\gamma^{rad} = Npe^{dir} / \varepsilon^{dir}$

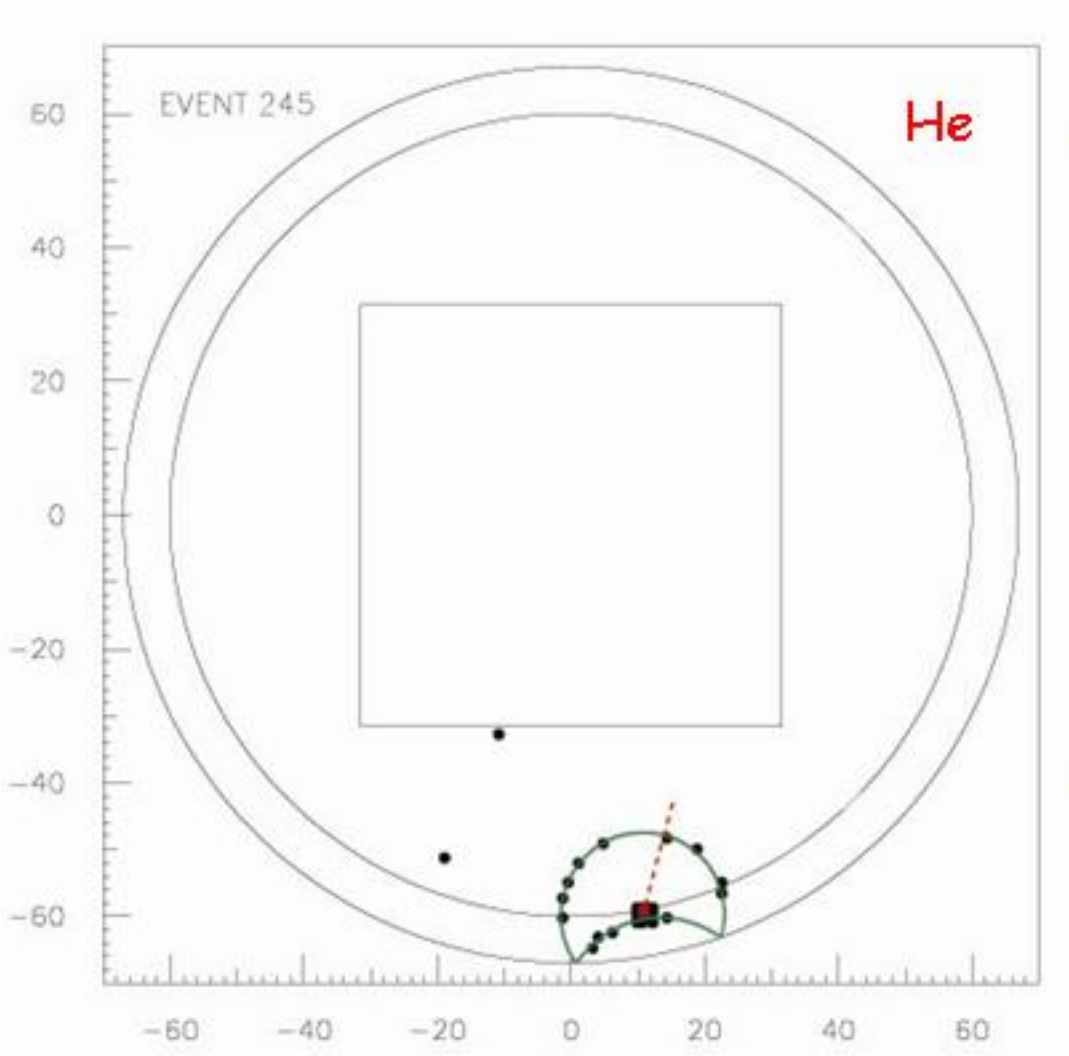



$N_\gamma^{rad} = Npe^{ref} / \varepsilon^{ref}$




Particle *IP* near reflected branch: hits were excluded

# Number of radiated photons




**Criteria**

use branch if:

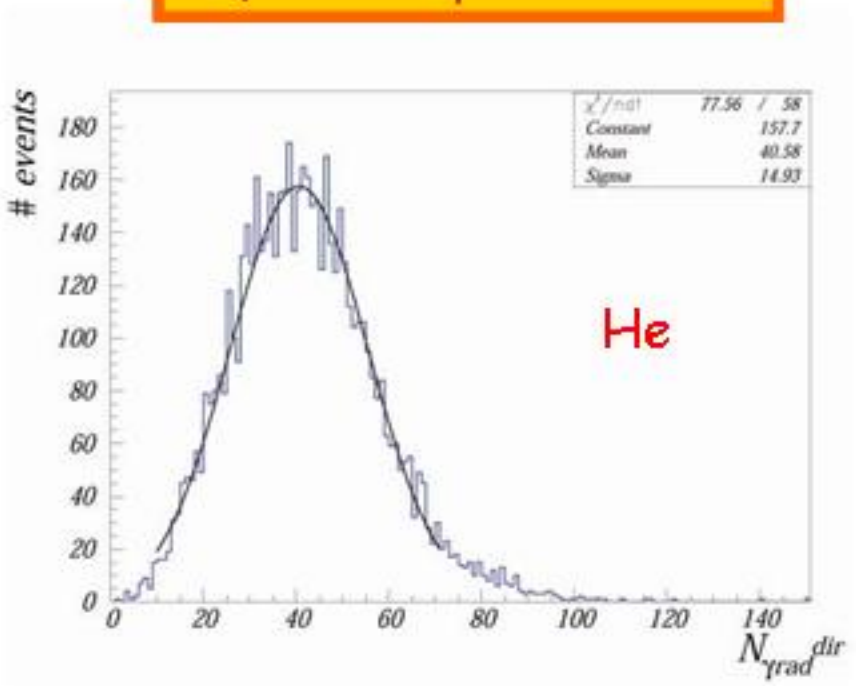
$Acc_{branch}$ > 20 %

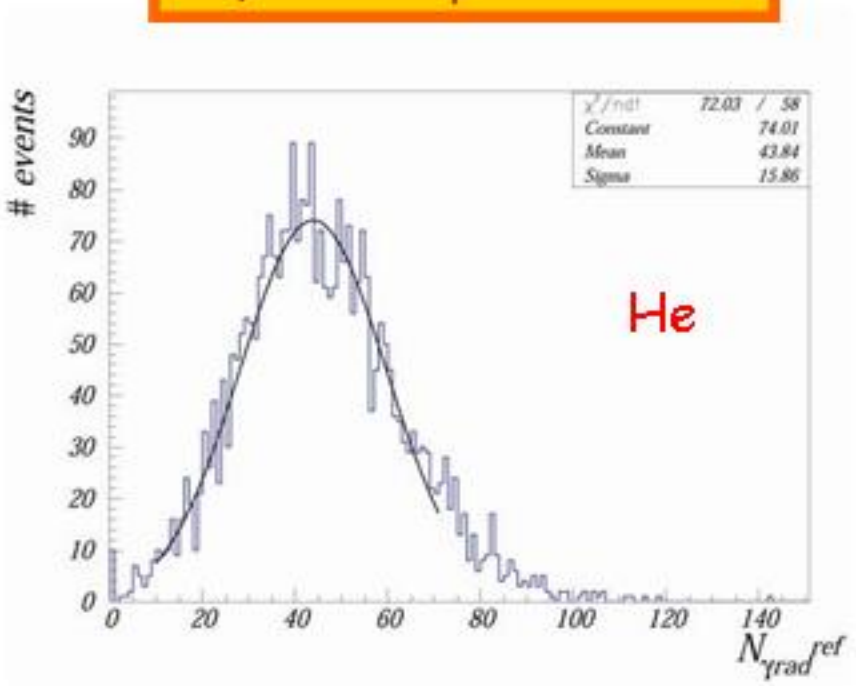
d(IP-branch) >5cm

# Number of radiated photons

$N_\gamma^{rad} = Npe^{dir} / \varepsilon^{dir}$

$N_\gamma^{rad} = Npe^{ref} / \varepsilon^{ref}$

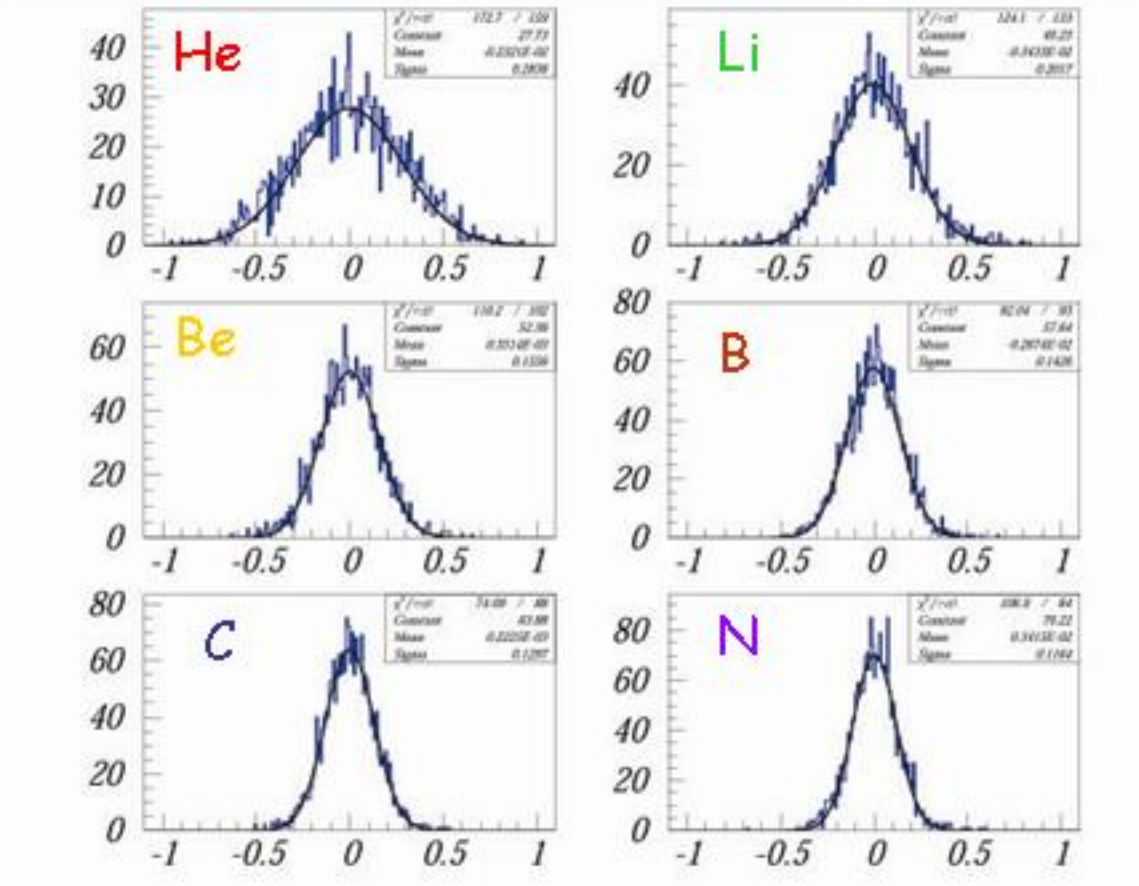



$N_\gamma^{rad}(ref) / N_\gamma^{rad}(dir) = 1.08 = f_{cor}$ !!

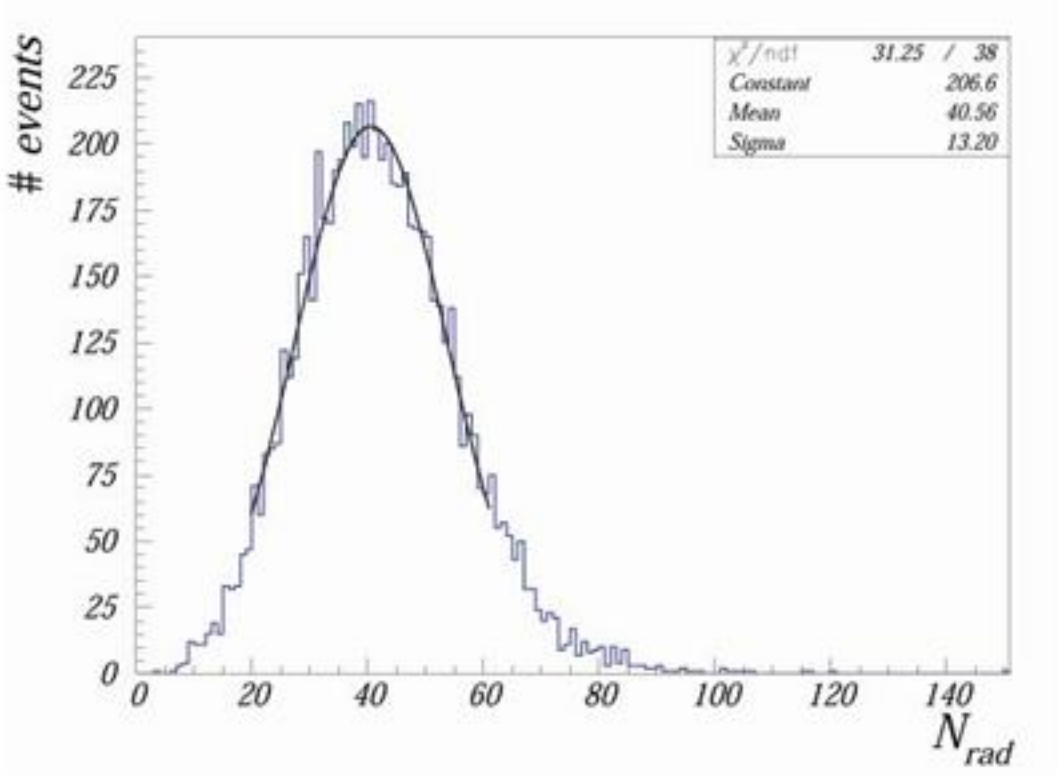
# Number of radiated photons

Asymmetry = $(N_\gamma^{dir} - N_\gamma^{ref}) / (N_\gamma^{dir} + N_\gamma^{ref})$



# Number of photoelectrons

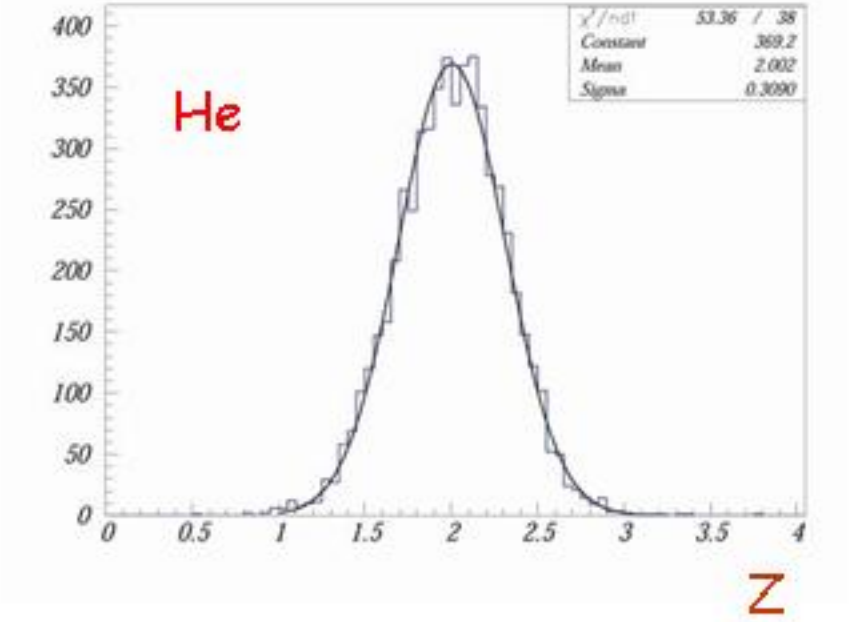
$$N_y^{rad} = \frac{(Npe^{dir} + Npe^{ref}/f_{cor})}{\varepsilon_{tot}}$$

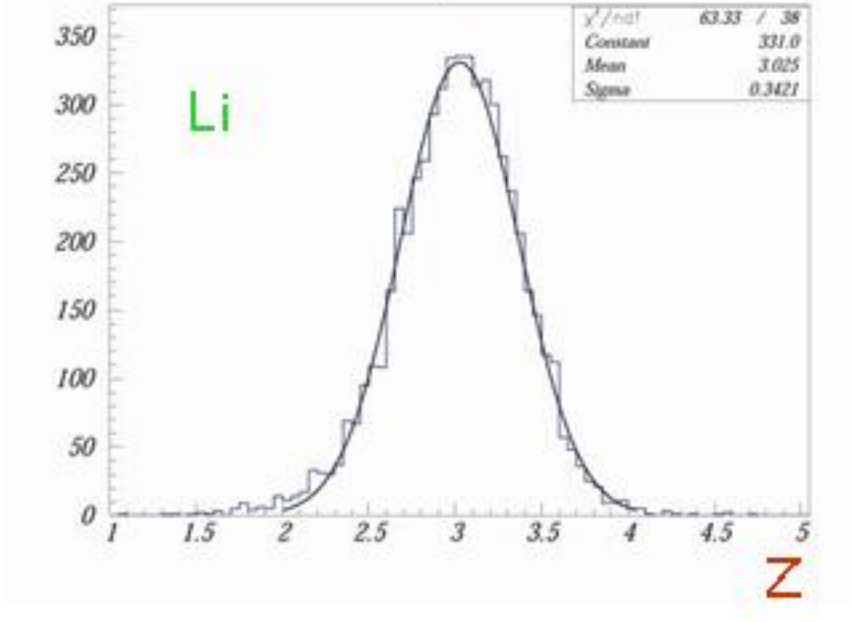


# Charge reconstruction

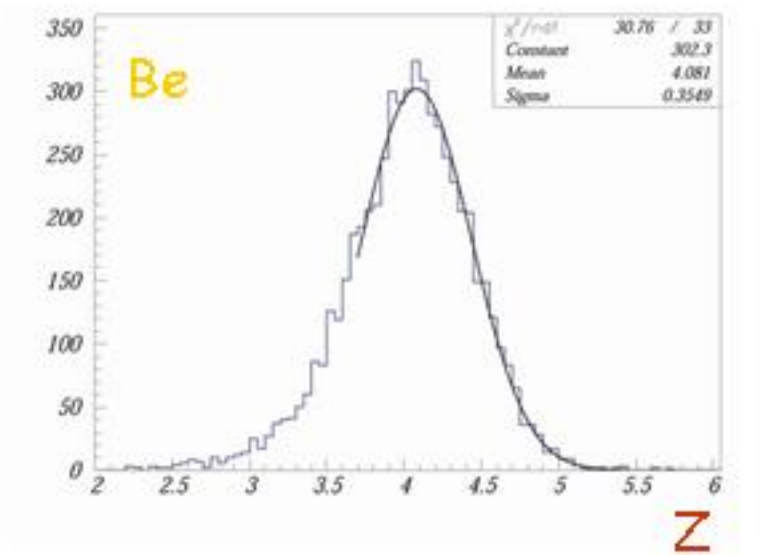
$$Z^2 = K \frac{N_\gamma^{rad}}{\Delta L \sin 2\Theta_c}$$

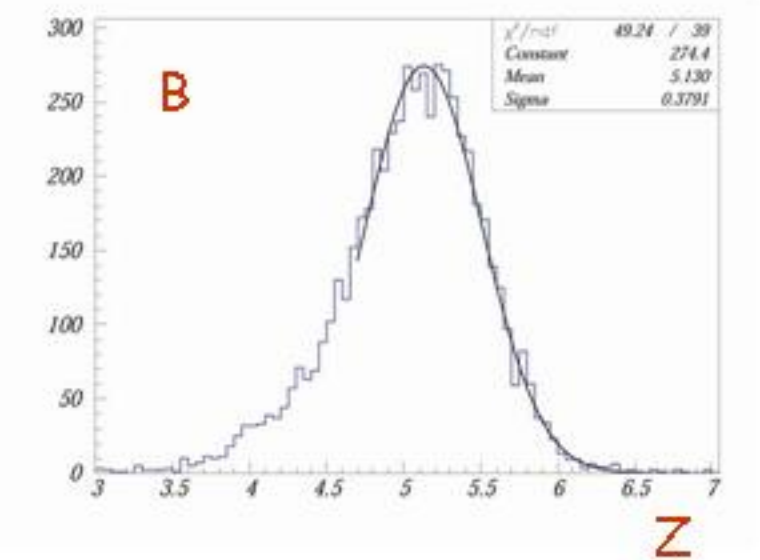
K was obtained from the He distribution for $N_\gamma^{rad} / \Delta L \sin 2\Theta_c$

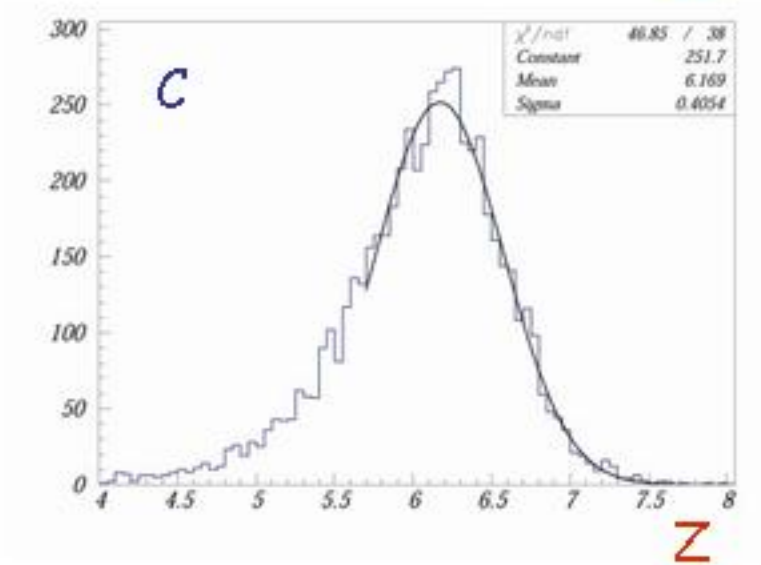


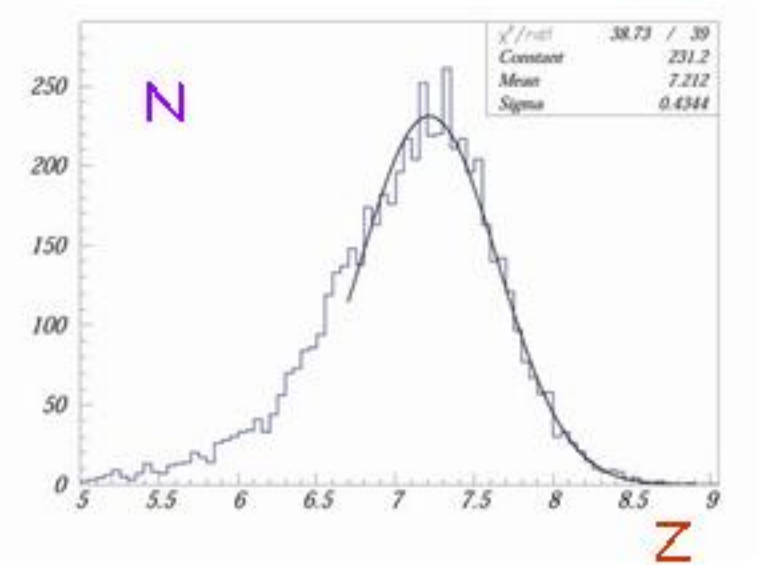



# Charge reconstruction



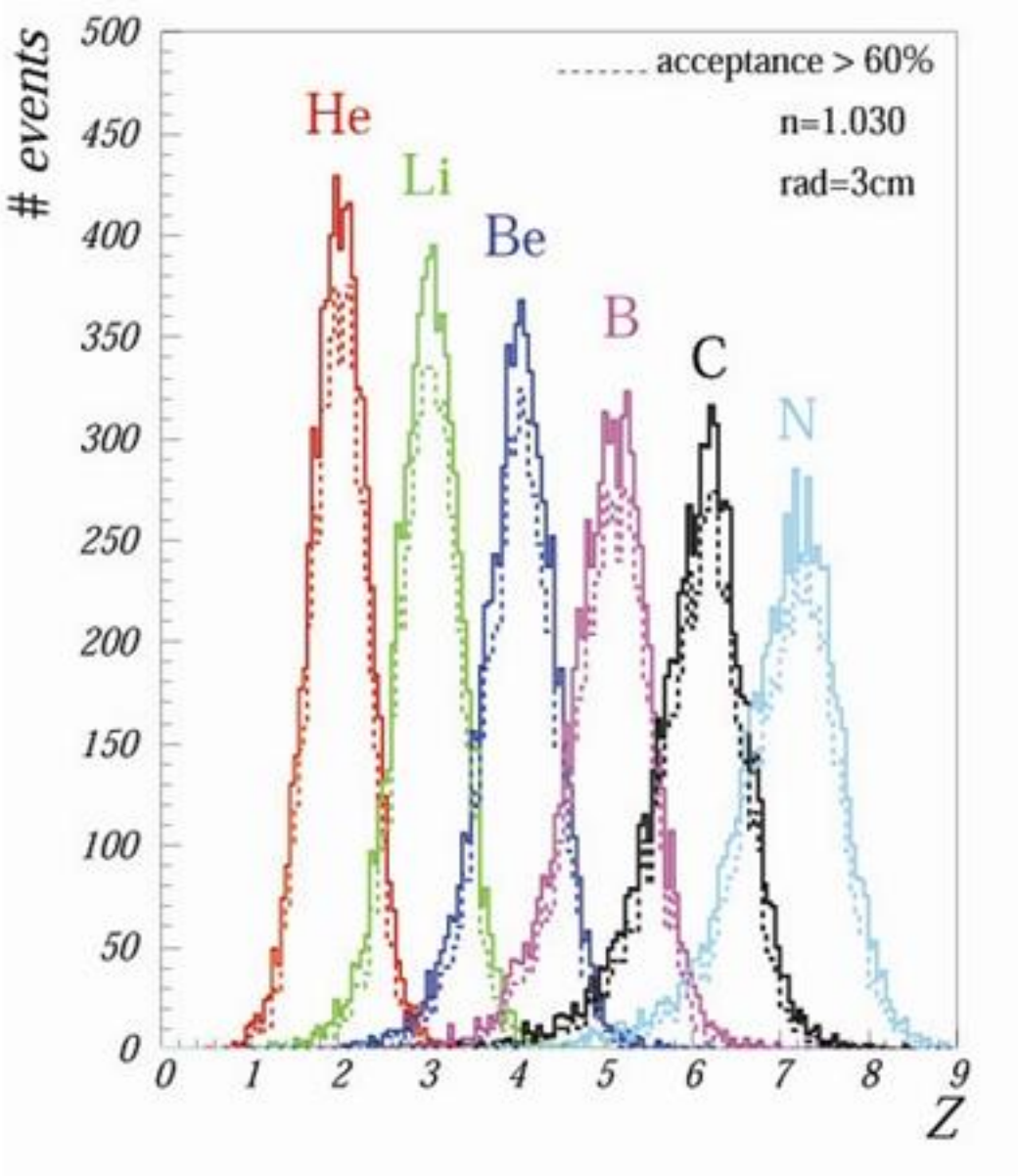



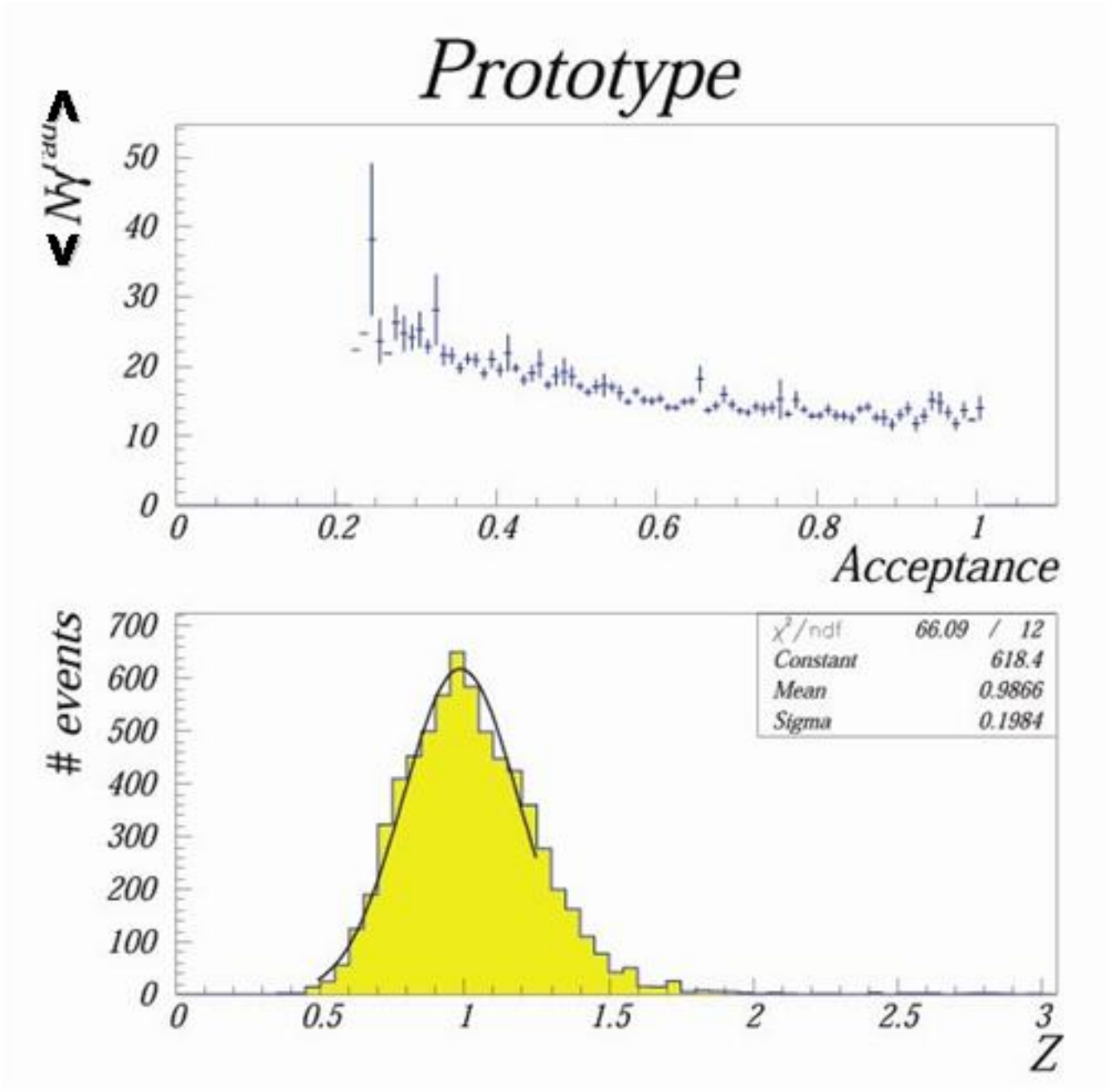



# Charge resolution

| | $\epsilon_{geo} > 60\ \%$ | $\epsilon_{geo} > 99\%$ |
|---|---|---|
| He | 0.154 | 0.135 |
| Li | 0.113 | 0.094 |
| Be | 0.086 | 0.075 |
| B | 0.073 | 0.063 |
| C | 0.066 | 0.056 |
| N | 0.060 | 0.056 |

# Charge reconstruction




Prototype
< Nγ rad >
50
40
30
20
10
0
0
0.2
0.4
0.6
0.8
1
Acceptance
# events
700
600
500
400
300
200
100
0
0
0.5
1
1.5
2
2.5
3
Z
χ²/ndf 66.09 / 12
Constant 618.4
Mean 0.9866
Sigma 0.1984