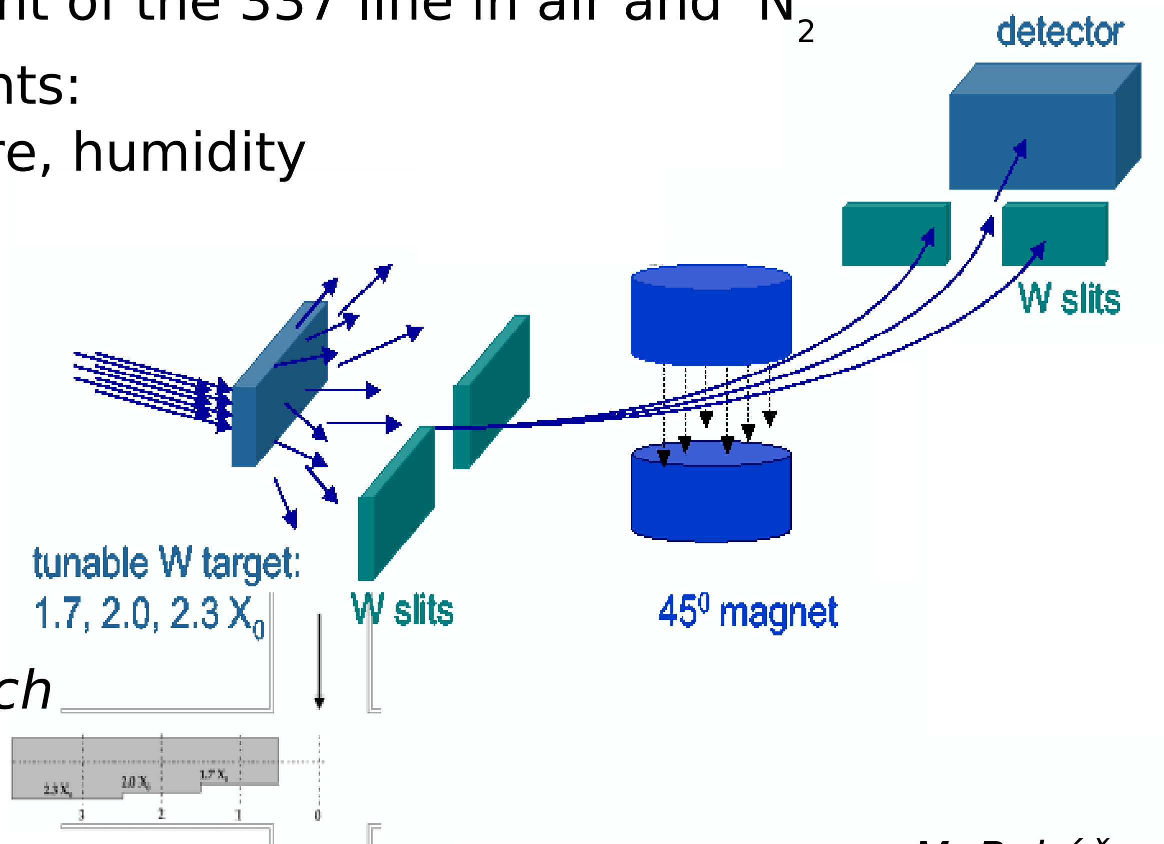
Some results of AIRFLY

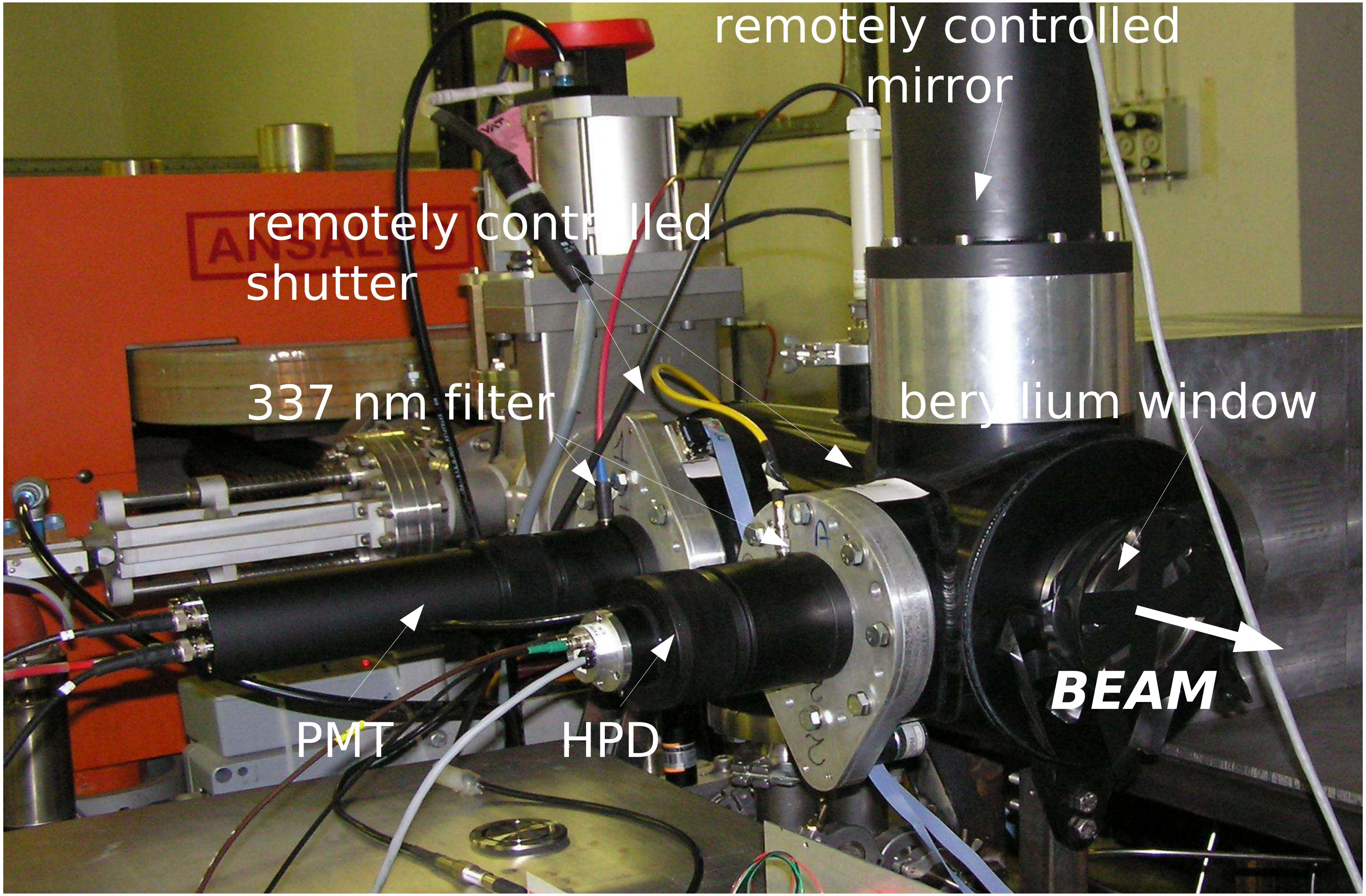
Martina Boháčová
for AIRFLY collaboration

- Absolute measurement of the 337 line in air and N_2
- Relative measurements:
  pressure, temperature, humidity
  energy dependence
  spectrum

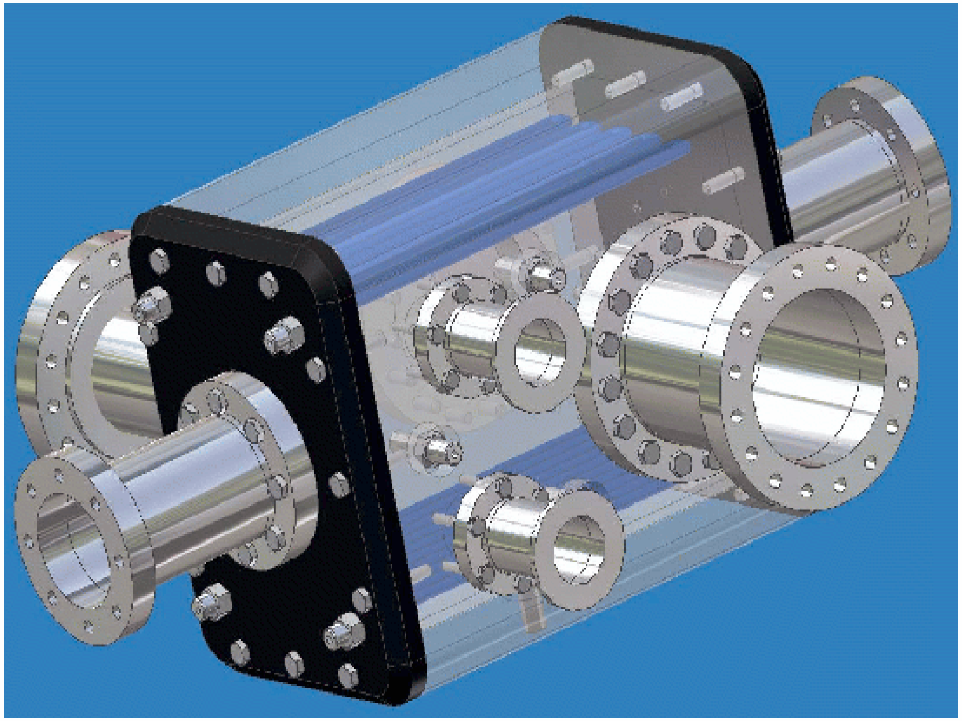
- *Beam Test Facility*
  Frascati, Italy
  e-/e+ 25 - 800 MeV
  1 - 10^{10} particles/bunch
  1ns, 10ns bunch

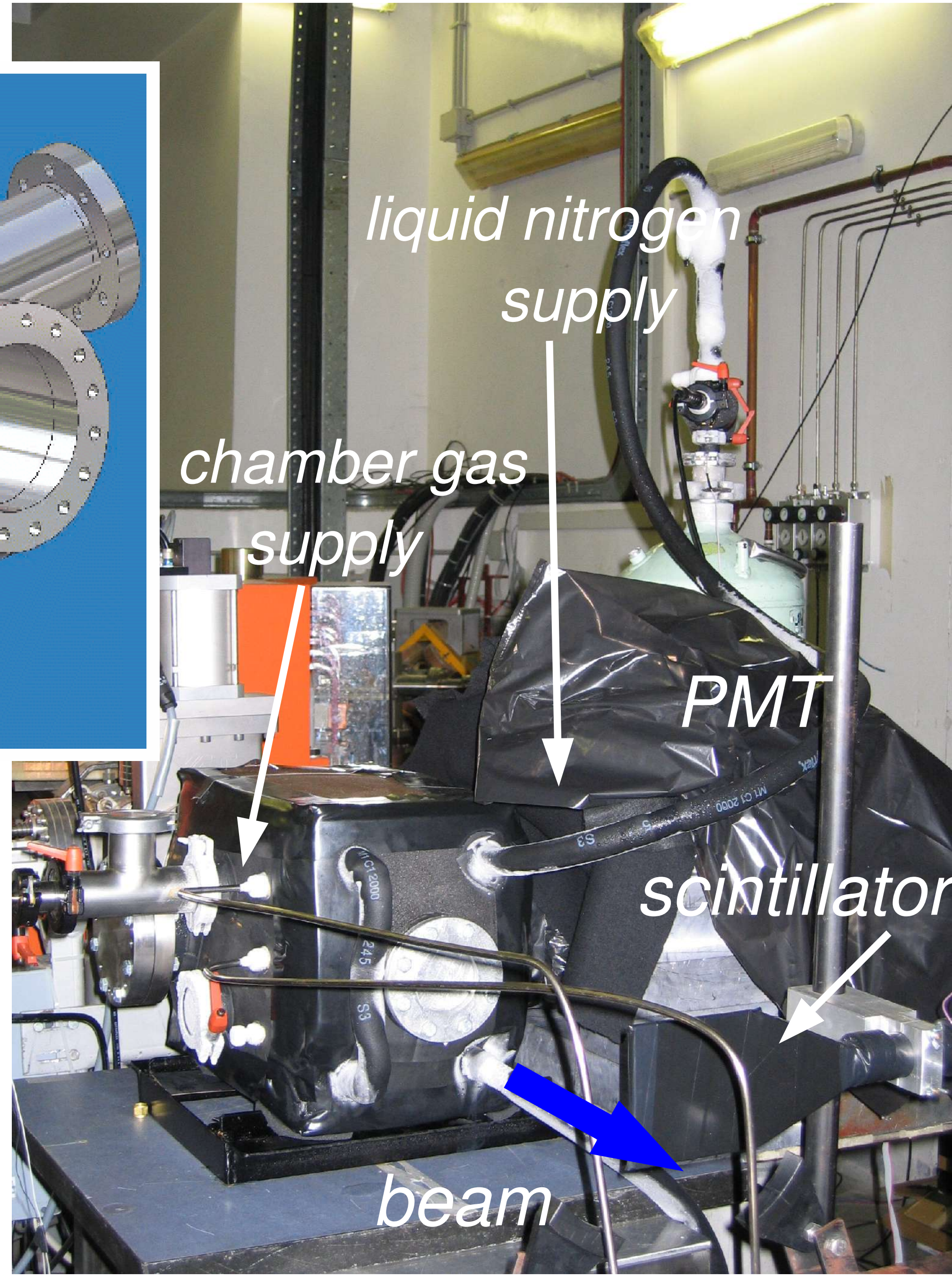


Final Setup



pressure and energy dependence, absolute FLY, ...





temperature dependence chamber

- liquid nitrogen cooling system

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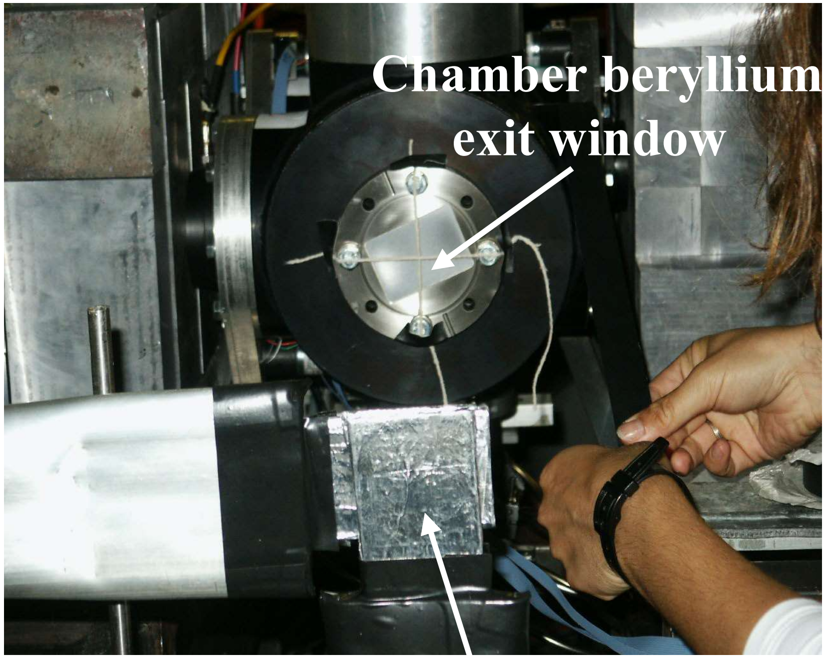
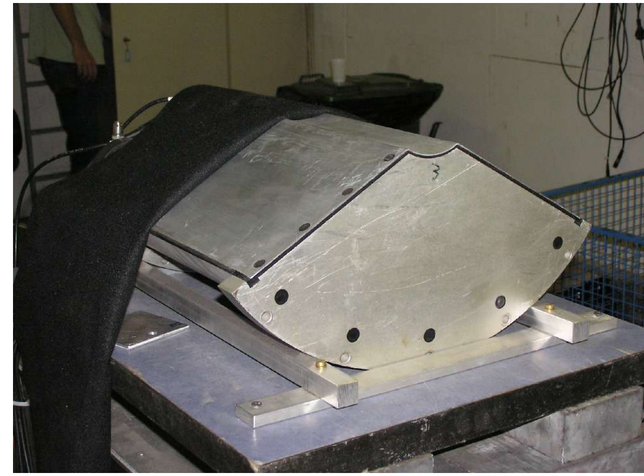
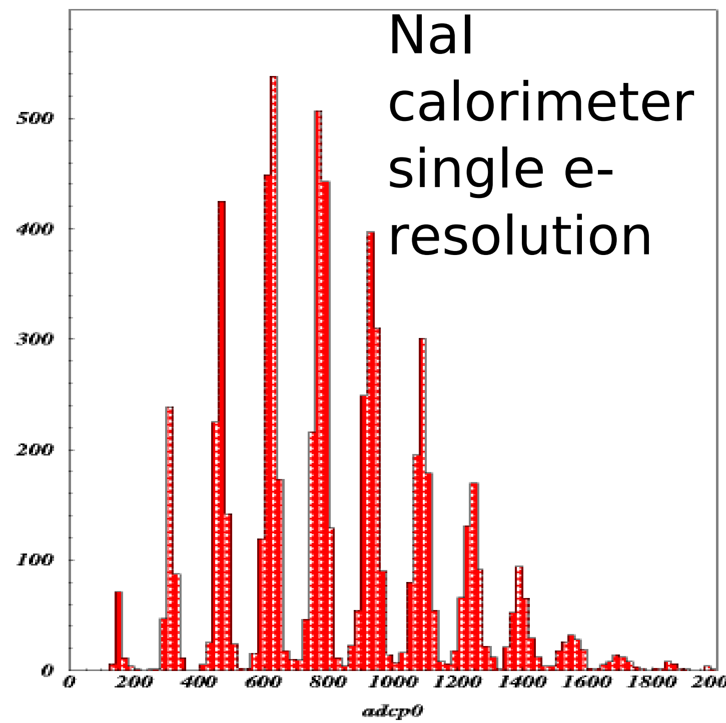
beam monitoring



X-Y scintillating fibers
to monitor beam position





A thin scintillator is also used
to monitor beam intensity variations

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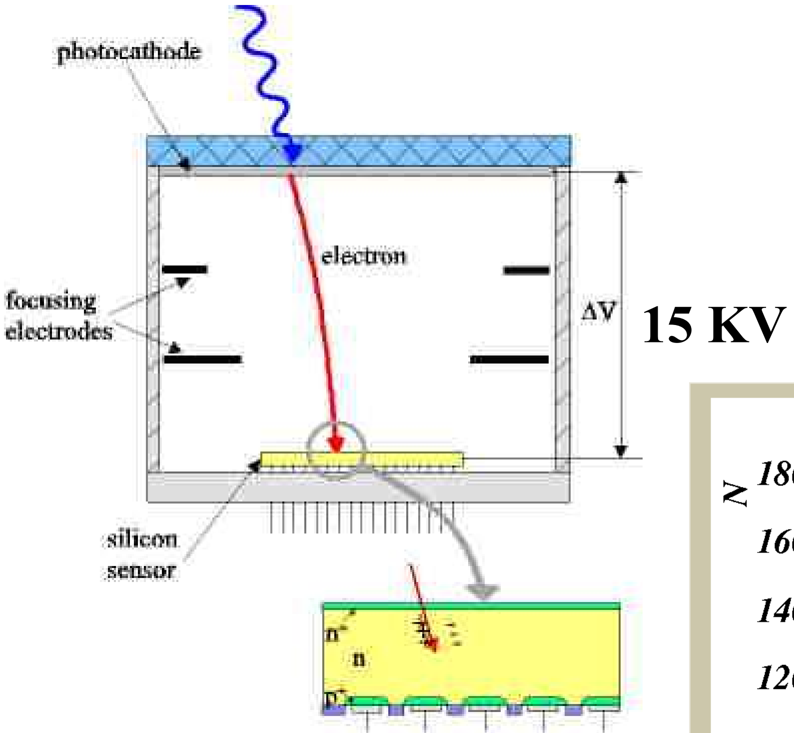
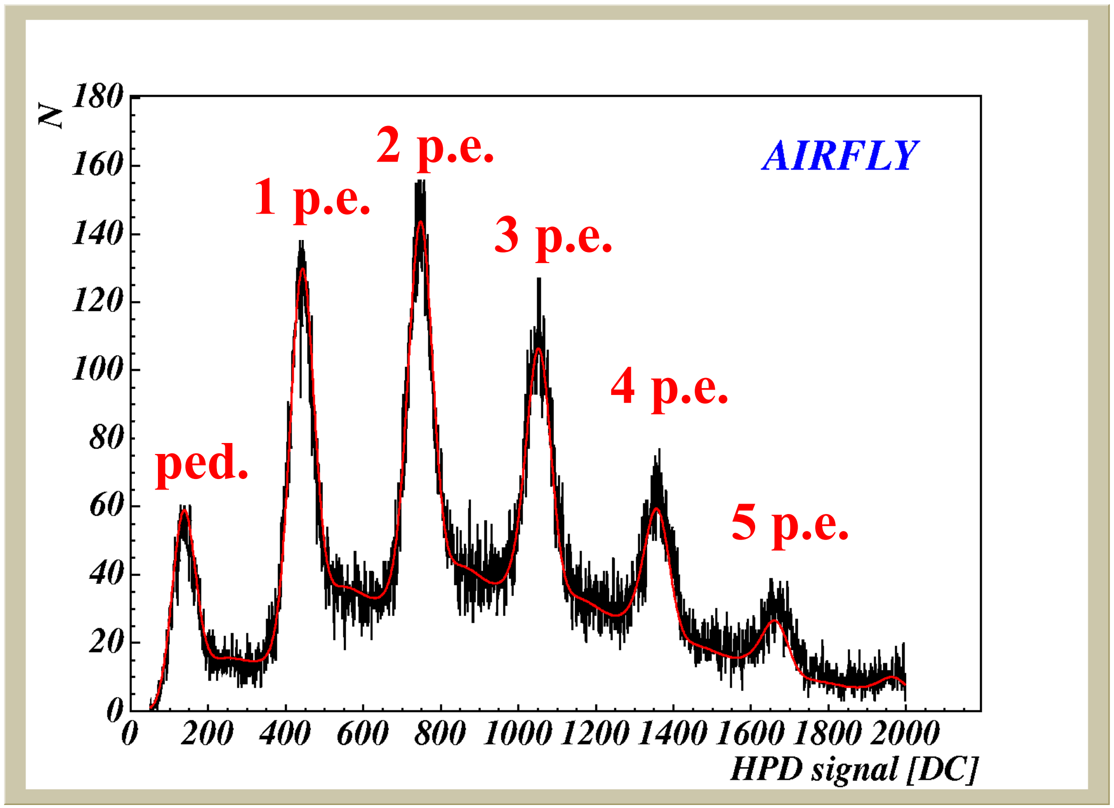
main light detector: HPD



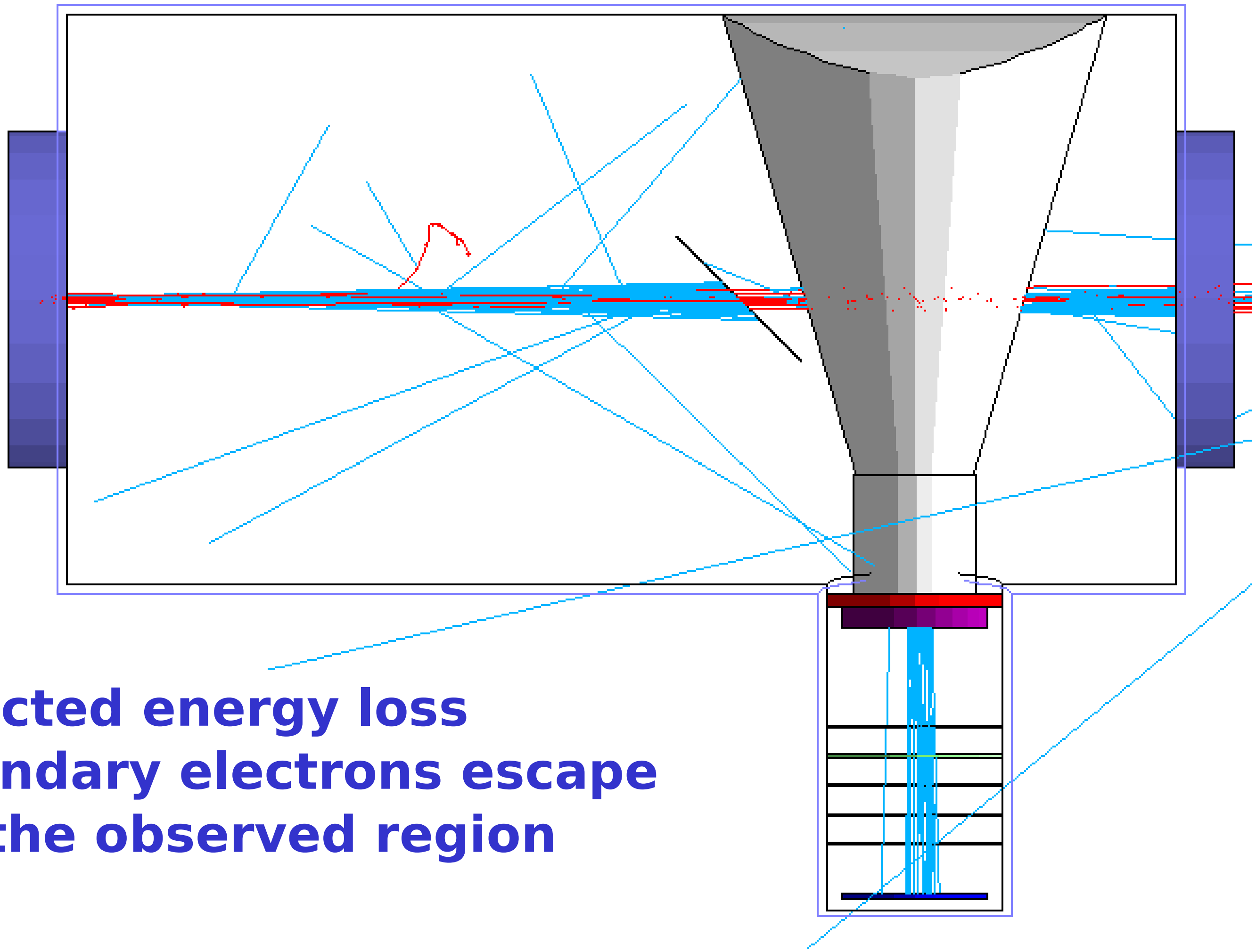
Light spectra sum rule
T. Tabarelli de Fatis,
NIM A385 (1997) 366

The fit gives the average
n. of photoelectrons



Hybrid Photo Diode
- single p.e. resolution

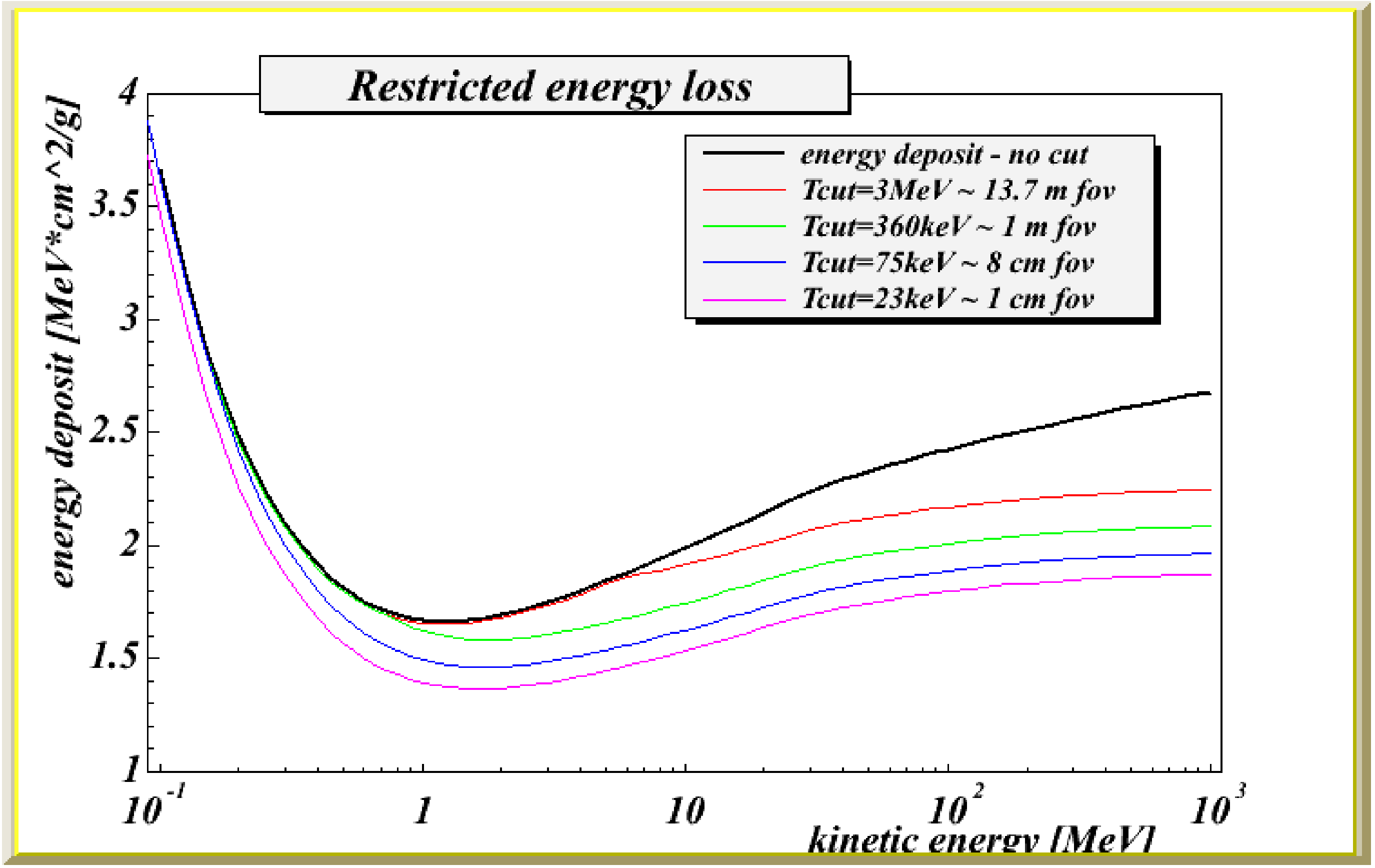
HPD: the field of view



Restricted energy loss
- secondary electrons escape
from the observed region

HPD: the field of view

360 keV electron will travel ~1m in dry air, sea level
=> may escape the field of view



Data have to be related to the appropriate energy deposit curve

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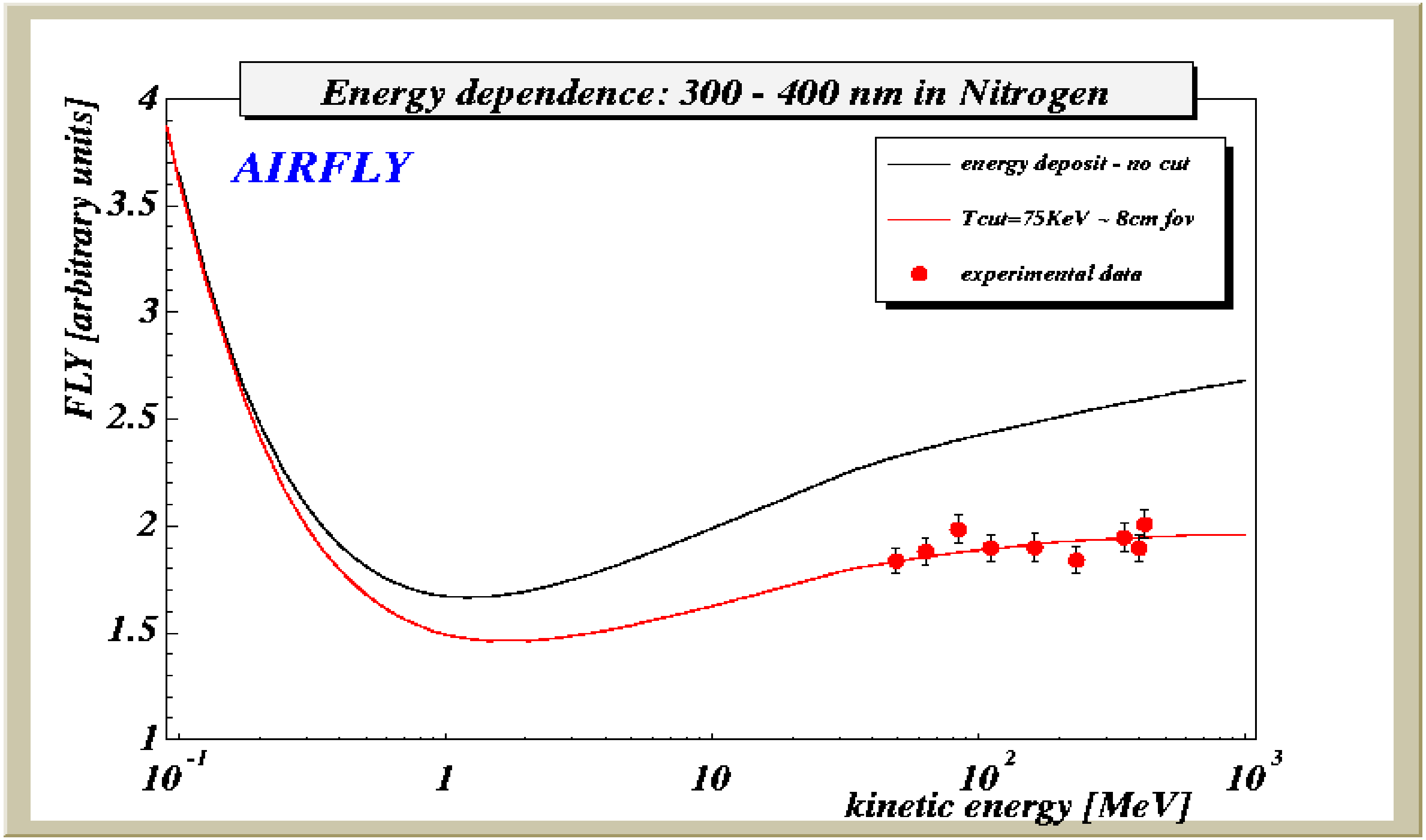
Energy dependence



- *energy region 50 - 420 MeV*
- *pure nitrogen, 291.5 K, ~1000 hPa*
- *UG6 filter (300 - 400 nm)*

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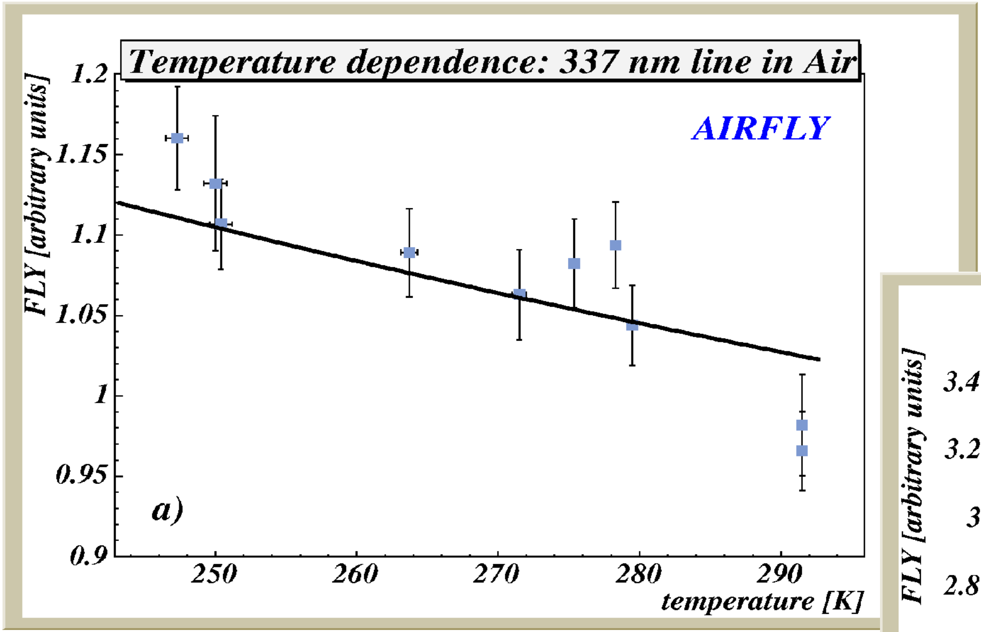
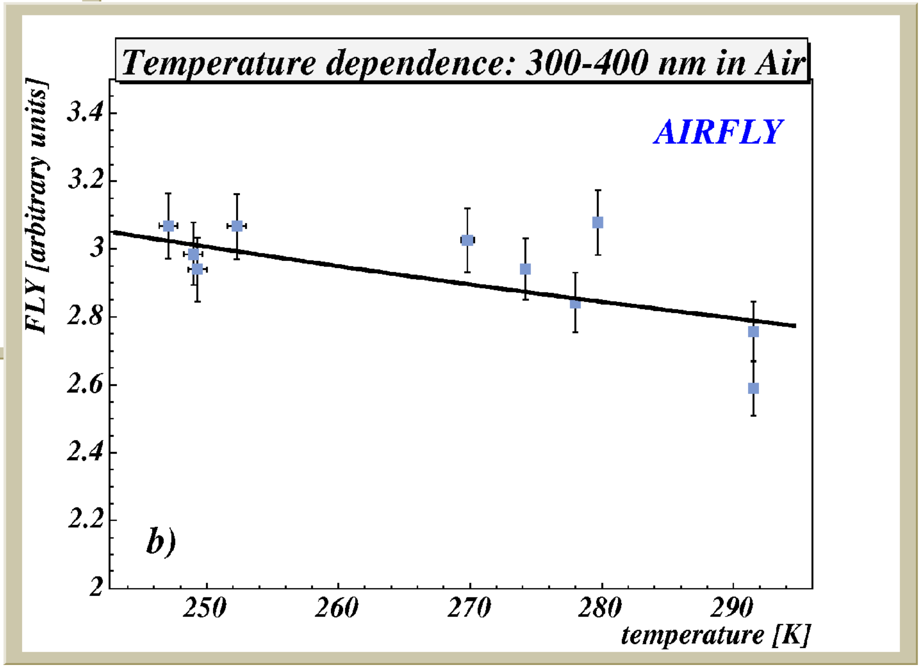
Temperature dependence



- *238 - 291.5 K (corresponds to 0 ~9km asl.)*
- *energy of the beam 173 MeV*



- *superimposed curve*

$$\varepsilon_i = \frac{A_i \rho}{1 + \rho B_i \sqrt{T}}$$

A_i , B_i from the Nagano paper

- *HPD outside of the cooled region*
- *flushed with dry nitrogen to avoid condensation*

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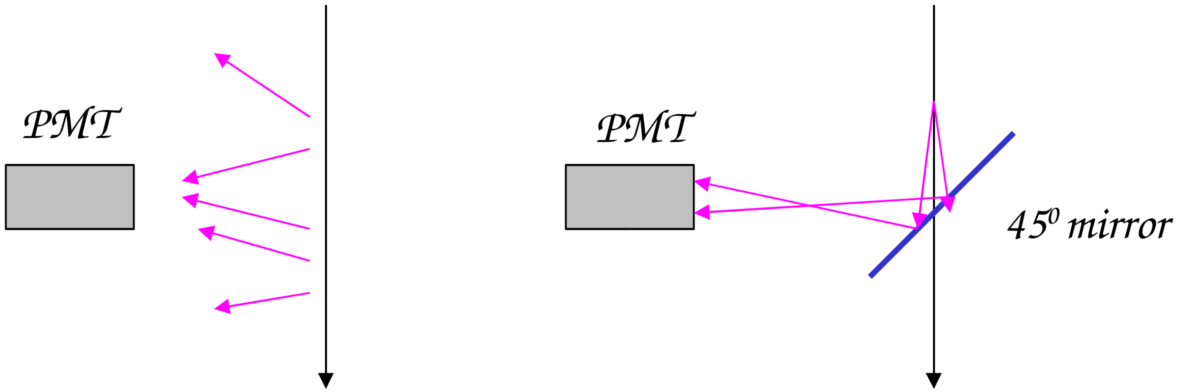
New method for absolute measurement of fluorescence yield with AIRFLY

- IDEA: normalize to a well known process (Čerenkov emission) to cancel the detector systematics

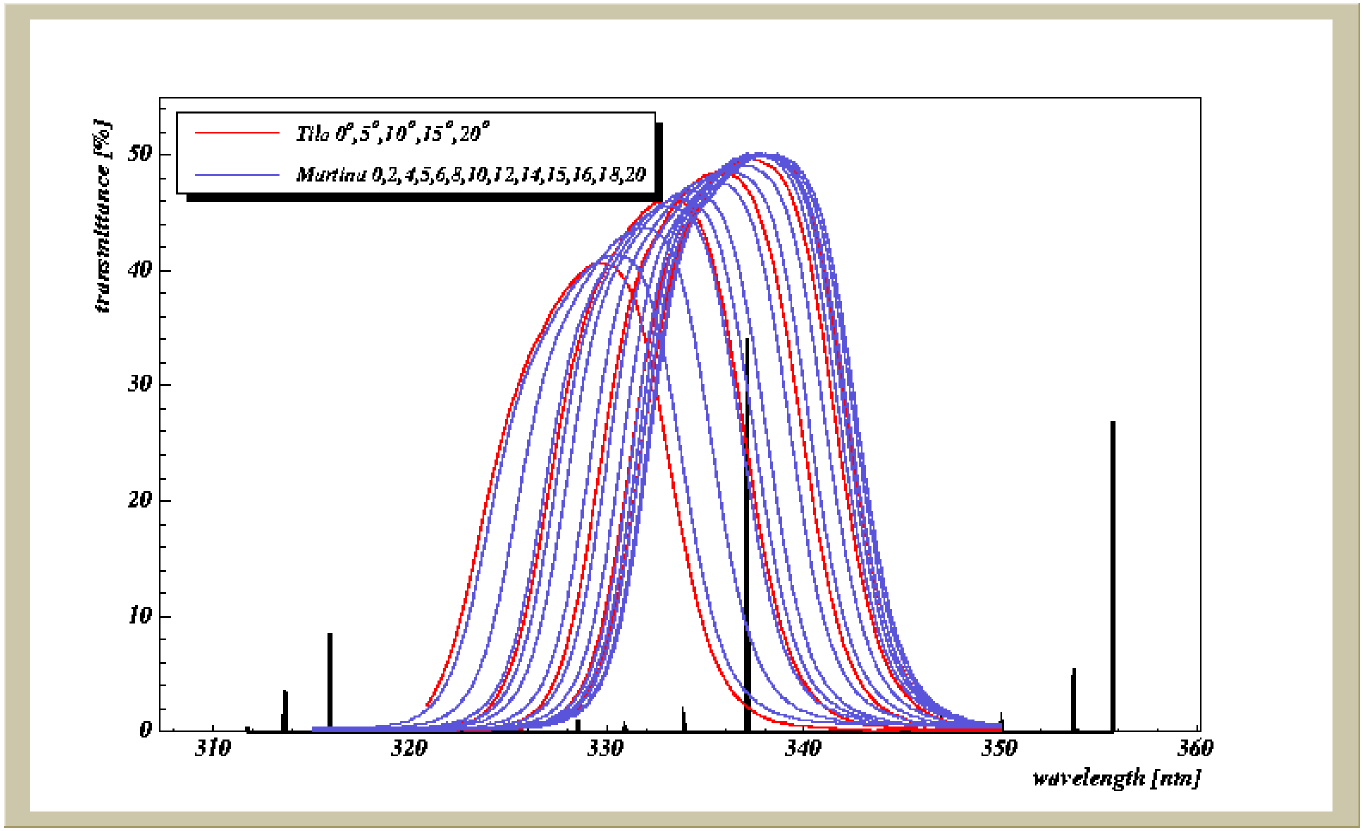
$$N_{337}(\text{fluor.}) = \boxed{FLY} \times Geom_{fluor} \times T_{filter} \times QE_{337} \times N_{electr.}$$

measured *known* *MC* *~ cancel!* *measured* *relative meas.*

$$N_{337}(\text{cher.}) = CHY \times Geom_{cher} \times T_{filter} \times QE_{337} \times R_{mir} \times N_{electr.}$$



narrow band interference filter (10nm)
- transmittance measured for 13 angles and interpolated



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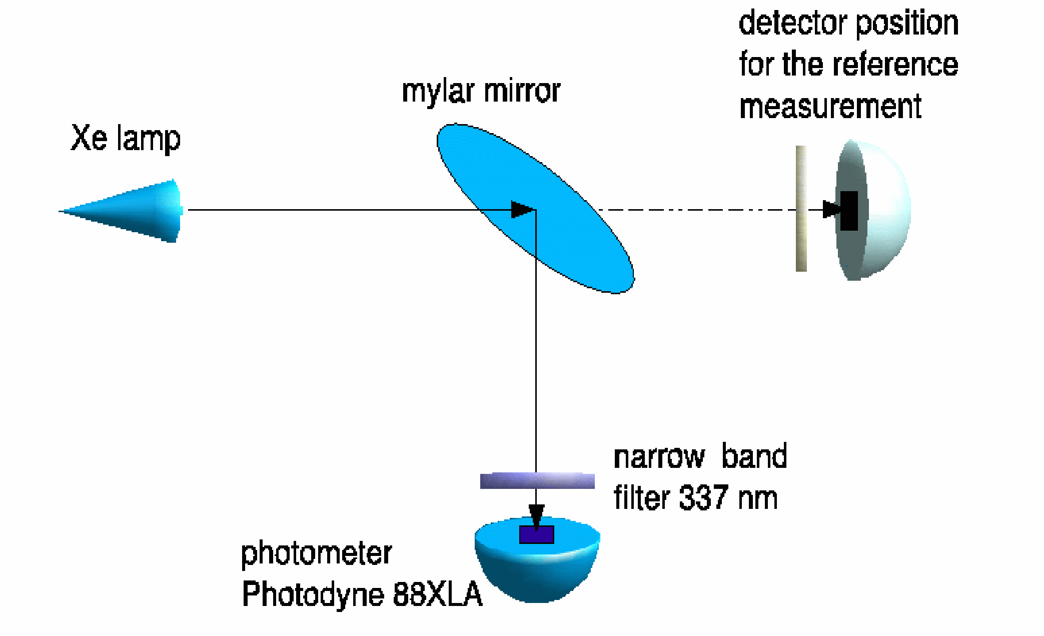
relative measurement of the mylar reflectivity



-> (83.6+1)%

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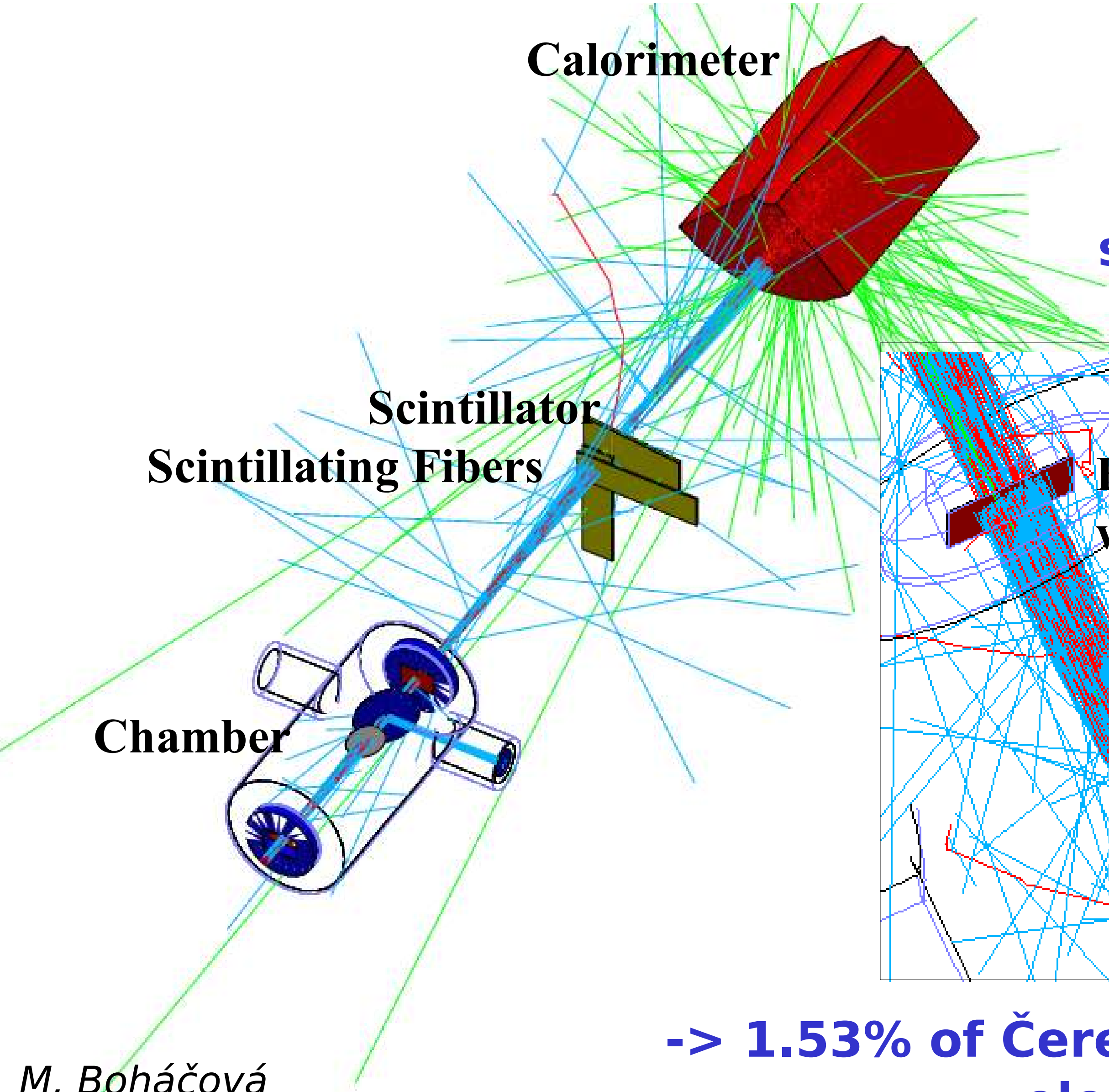
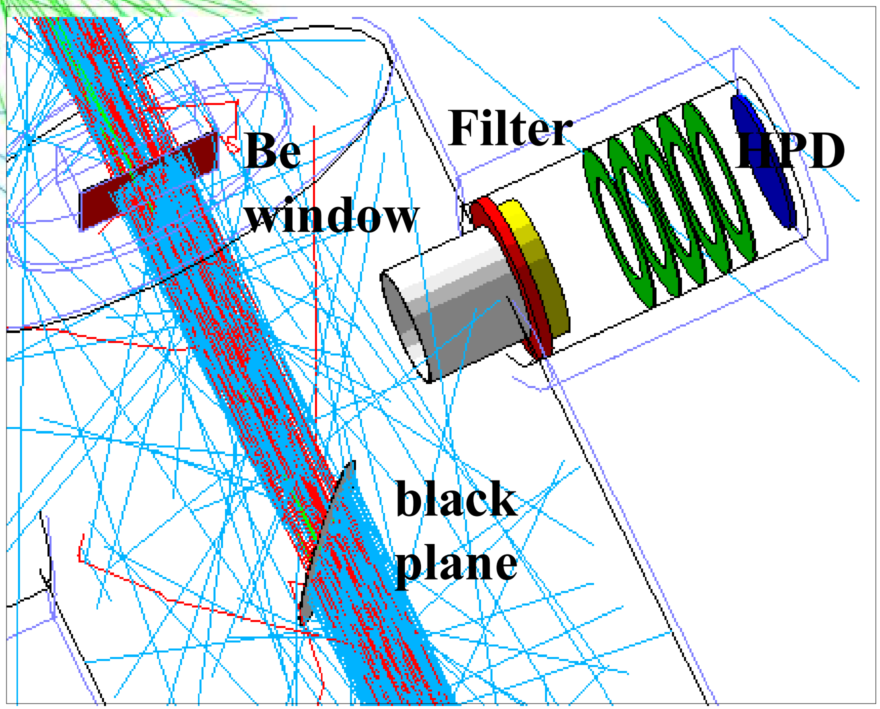
Full GEANT4 Simulation



Penelope processes
250 eV cut for
secondary electrons



-> 1.53% of Čerenkov photons per electron

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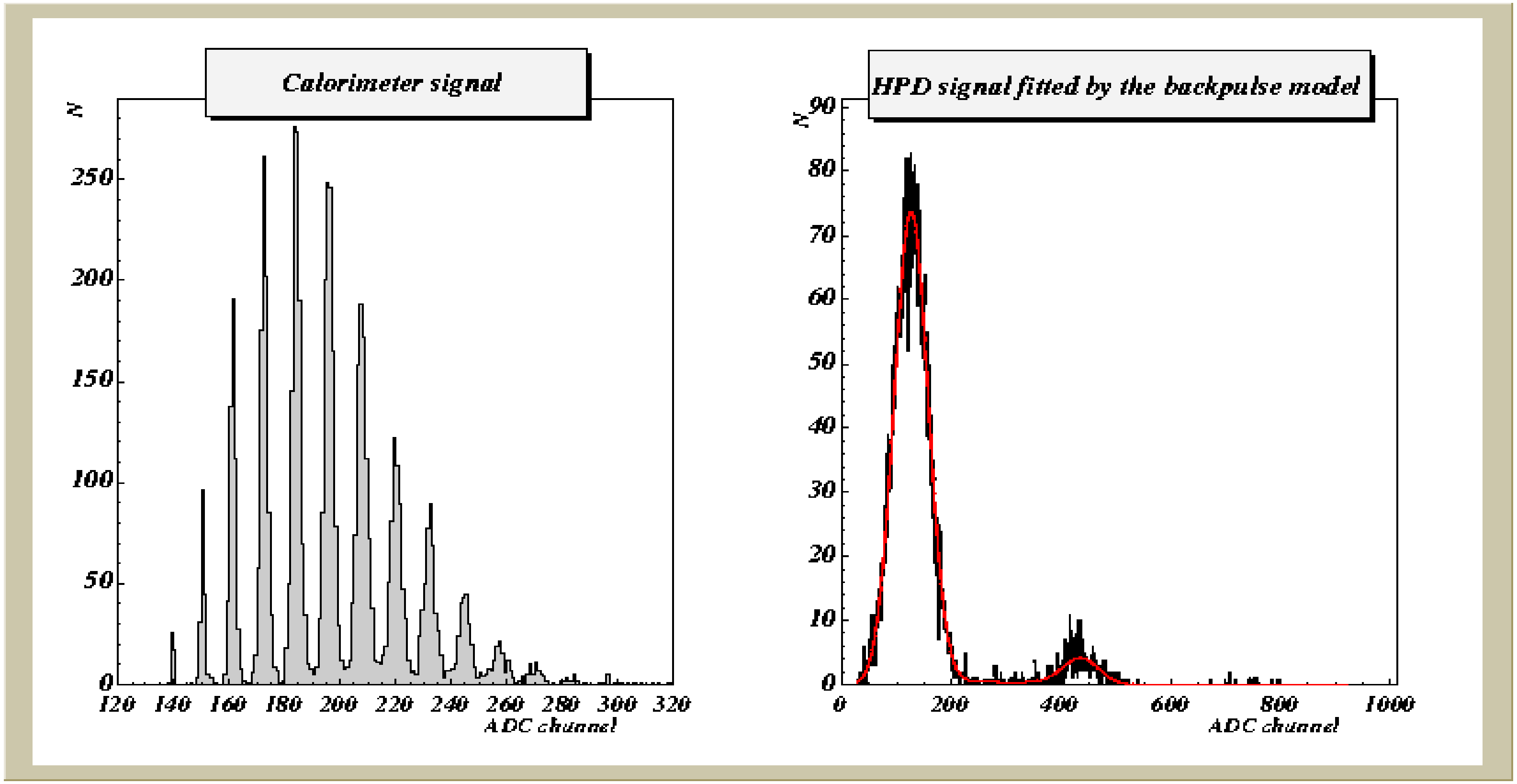
Full GEANT4 Simulation

can be compared with the data ...



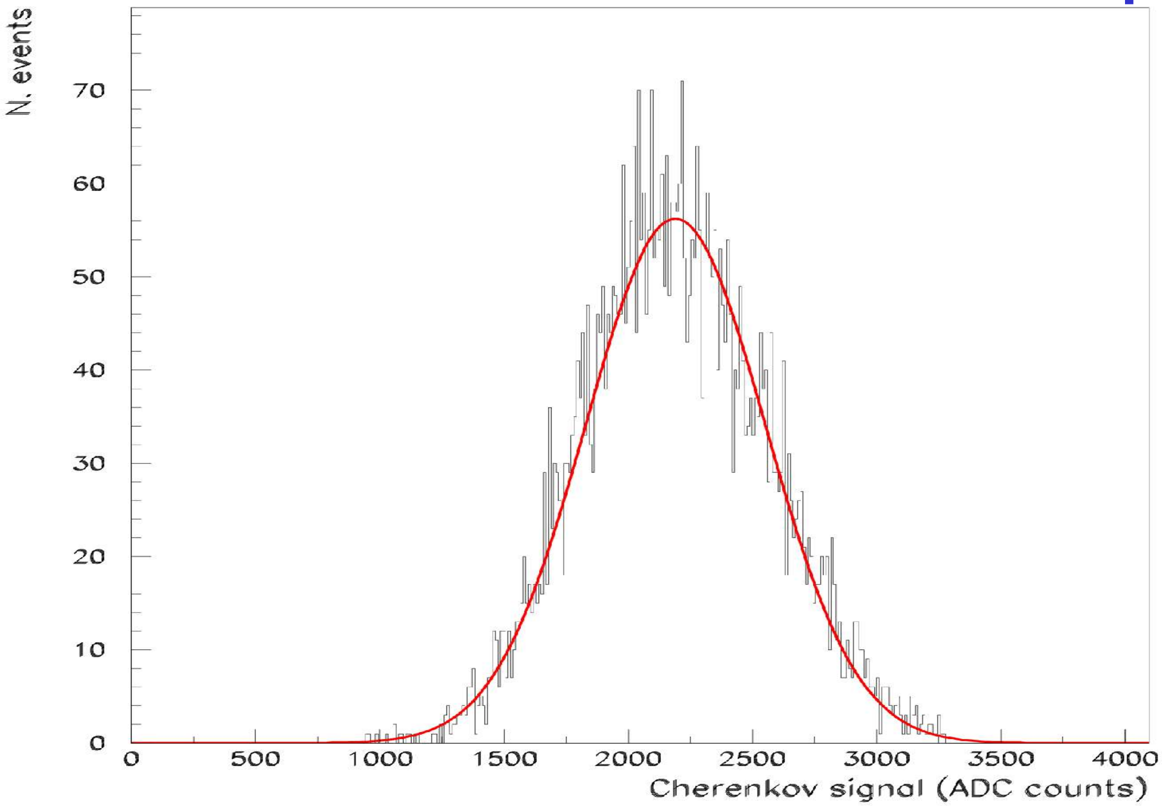
-> 1.54% of Čerenkov photons per electron
- geometry seems to be correct

Čerenkov conversion factor

to increase the dynamic range we lower the high voltage

higher intensity - do not see the individual photon

->need to determine the conversion ADC to p.e.



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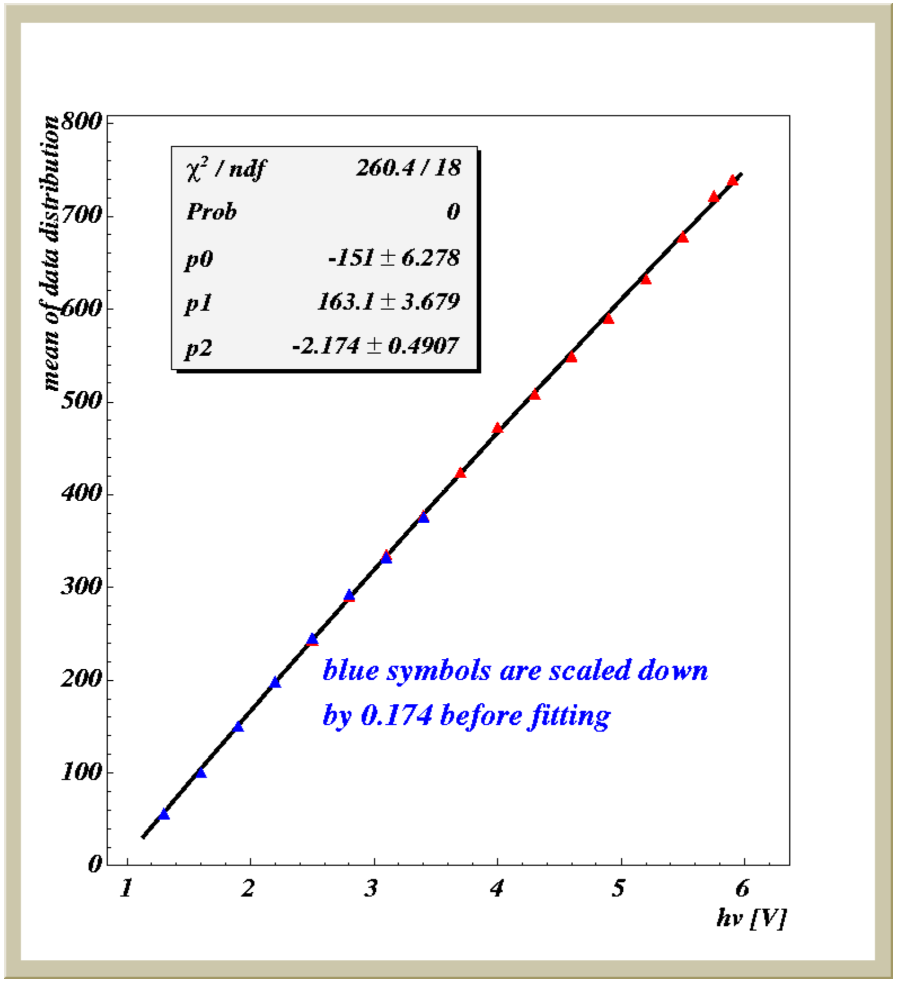
Čerenkov conversion factor

1. high voltage scan with LED light



2. measure Čerenkov with two different beam intensities and normalize with the scintillator

=> (43.2±1.4)ADC/p.e-

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Preliminary absolute yield of 337nm line

- G4Scintillation process used to simulate fluorescence photons
- 19 ph/MeV deposit in a step using Bunner spectrum
(corresponds to 4.74 ph/e- at 350 MeV in 1m^3 of air - sea level or 1.24 ph/e- at 337nm, 4.17 ph/e between 300-400 nm)
- 337 nm line forms 26.2% of the total photons
- the simulated ratio Fluo/Cere is 1.344e-3

For the absolute yield:

$$\frac{(0.0573 - 0.0049)}{(2134 - 126)} * 43.2 * \frac{(529 - 42)}{(527.6 - 42)} * \frac{1}{1.344.10^{-3}} = 0.841$$

19 ph/MeV * 26.2% * 84.1% = 4.18 ph/MeV

Bunner reports 4.32 ph/MeV at sea level

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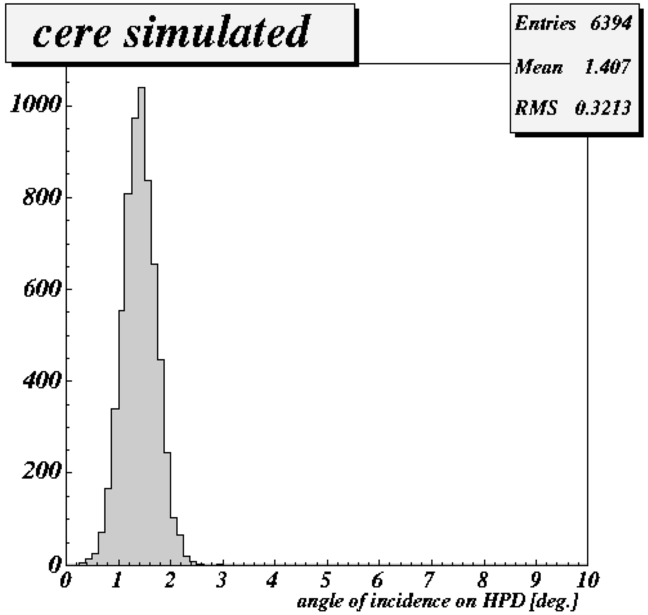
Preliminary systematic uncertainties

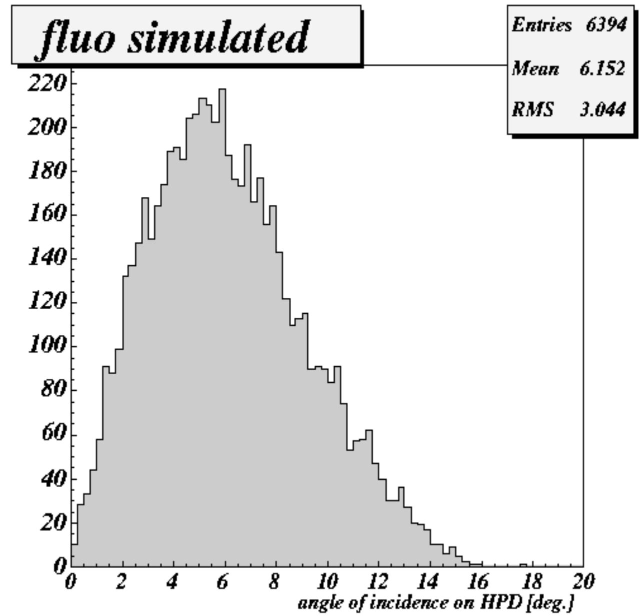
Bkg. Subtraction	1 %
Normalization with scintillator	1 %
HPD fit method	3 %
Beam position	1 %
Beam spot	1 %
HPD calibration (ADC/p.e.)	3 %
Simulation	2 % (energy deposit model?)
45° mirror reflectivity	3 %
337 nm filter transmission	1 %
Photocathode uniformity and angle (fluorescence vs Čerenkov)	2 %
contribution of 333.9 nm line	negligible
Transition radiation from mirror (measured evacuating chamber)	negligible

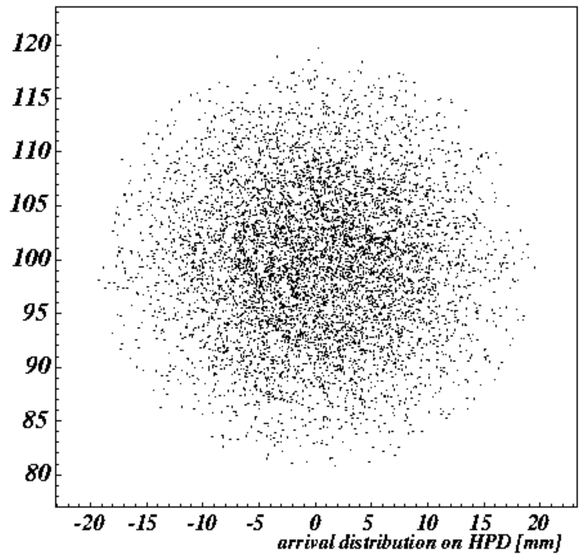
Total syst. ≈ 6.5 %

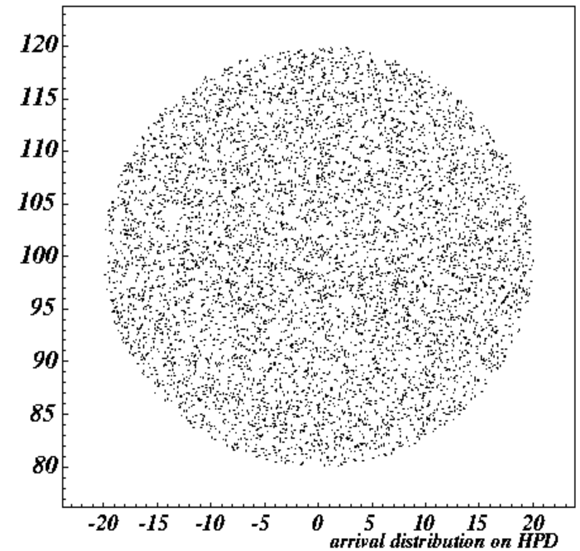
looking for other sources of systematic errors

Full GEANT4 Simulation









in progress

Summary

- the effect of secondary electrons has to be treated carefully
- the temperature dependence of FLY is observed at the level of 10%
- the preliminary value of the absolute yield of the 337 nm line - 4.18ph/MeV - is consistent with Bunner
- the systematic error is estimated at 6.5%
- measurements at ANL (Argonne National Laboratory, USA) will be covered in the next talks