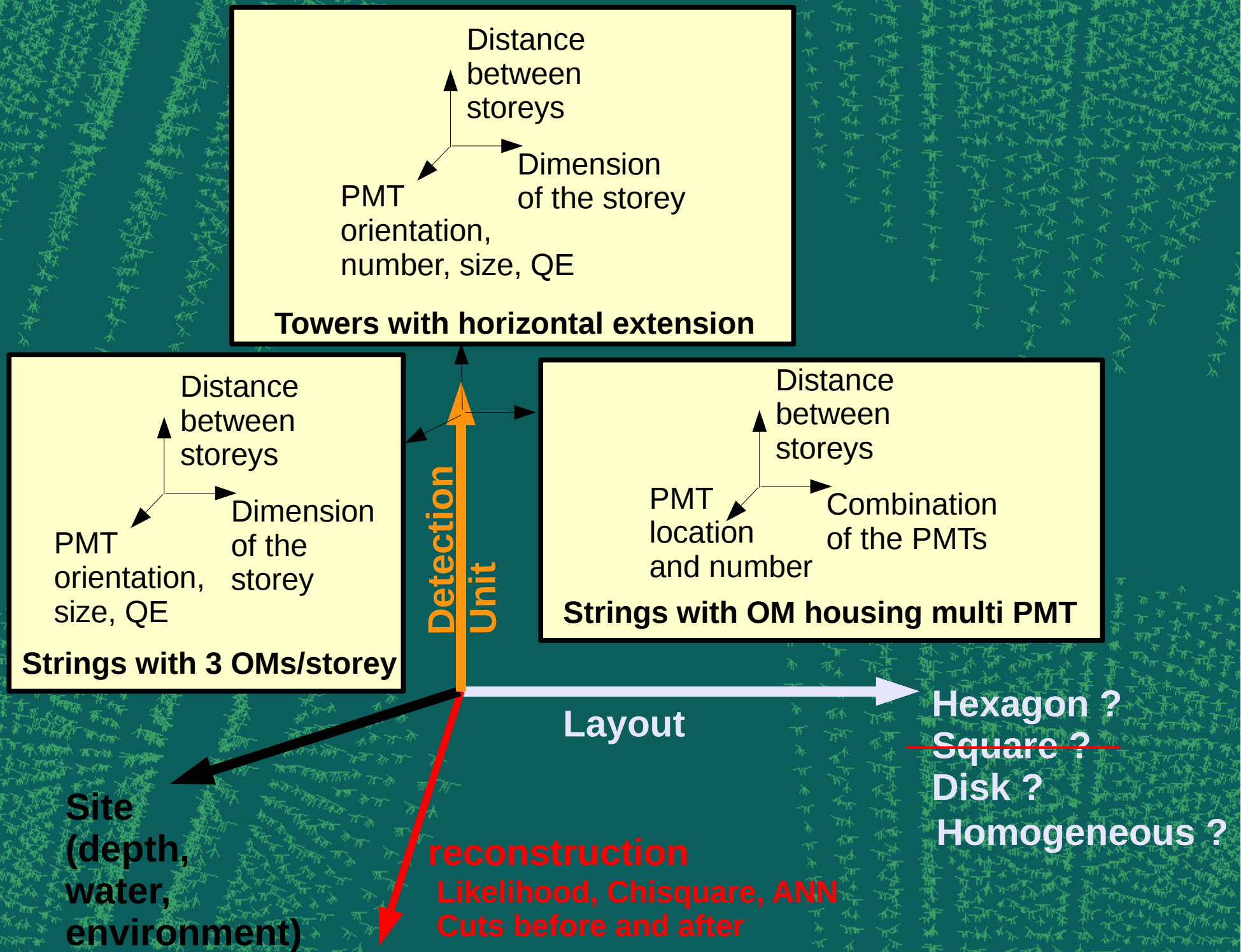
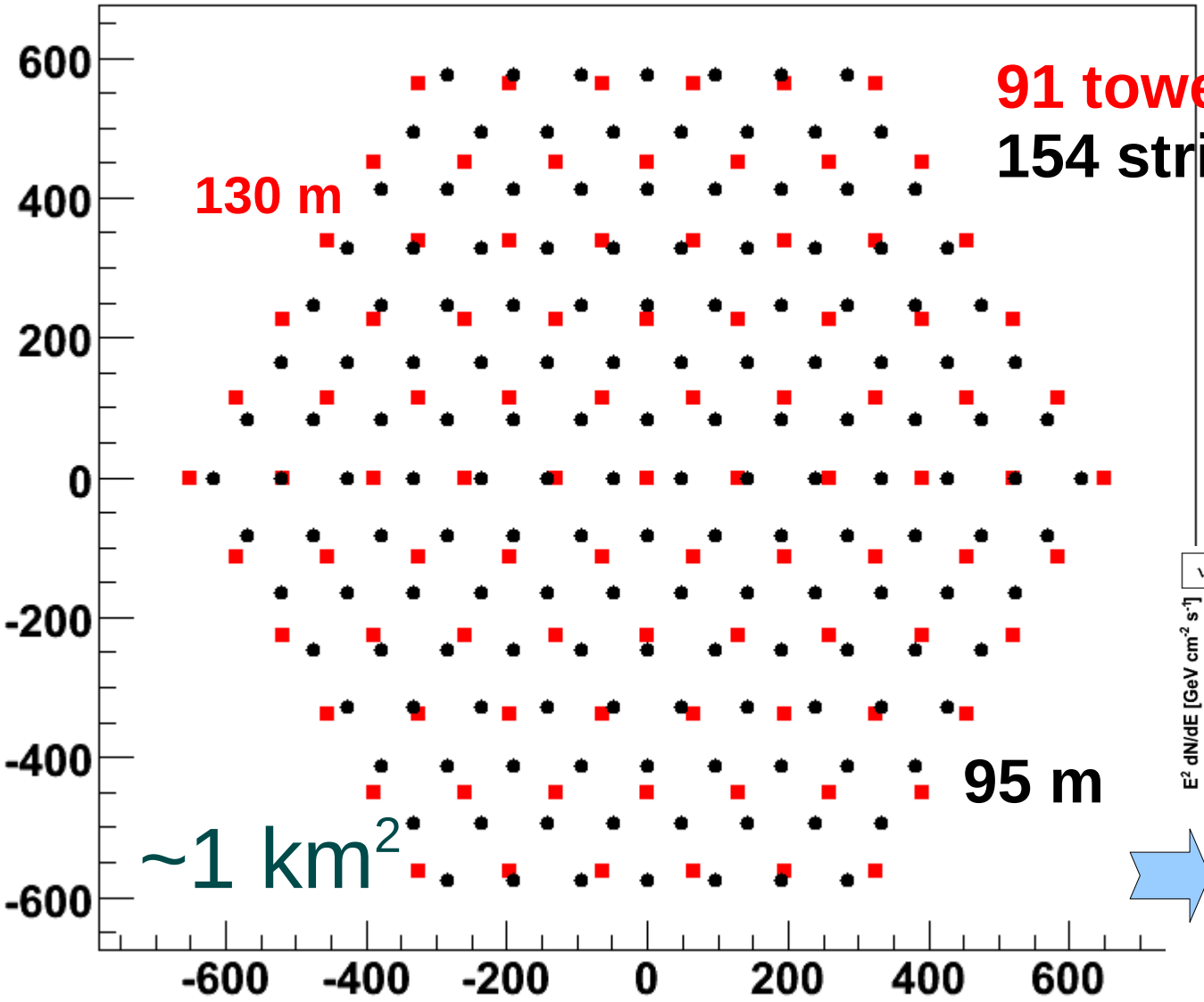
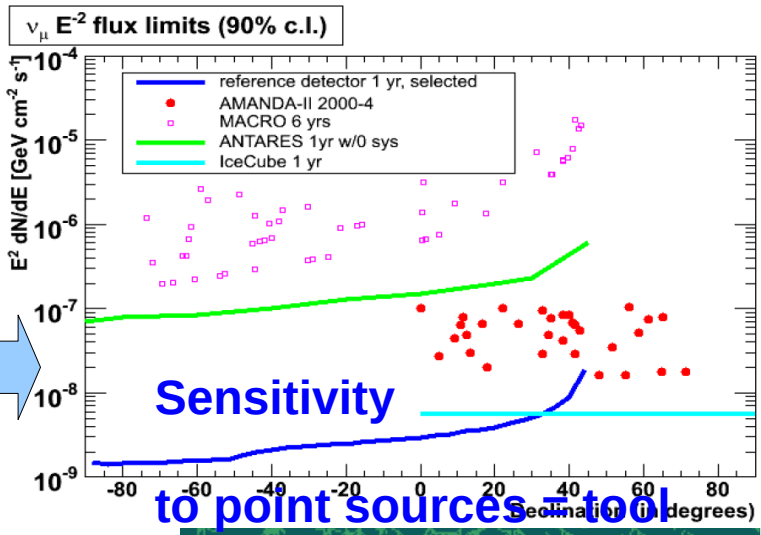
WP2 session, Paris, Feb 23 2009

JP Ernenwein


Distance between storeys
Dimension of the storey
PMT orientation, number, size, QE
Towers with horizontal extension
Distance between storeys
Dimension of the storey
PMT orientation, size, QE
Strings with 3 OMs/storey
Distance between storeys
Combination of the PMTs
PMT location and number
Strings with OM housing multi PMT
Detection Unit
Layout
Hexagon ?
Square ?
Disk ?
Homogeneous ?
Site (depth, water, environment)
reconstruction
Likelihood, Chisquare, ANN
Cuts before and after

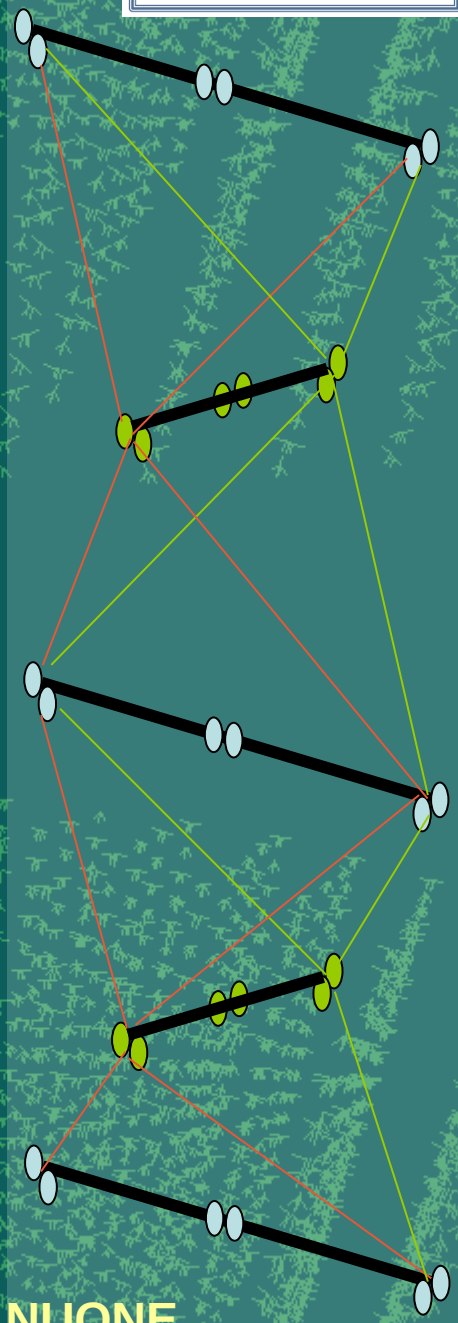
LAYOUTS to be used for the optimization within each design (start points) :





to point sources → tool

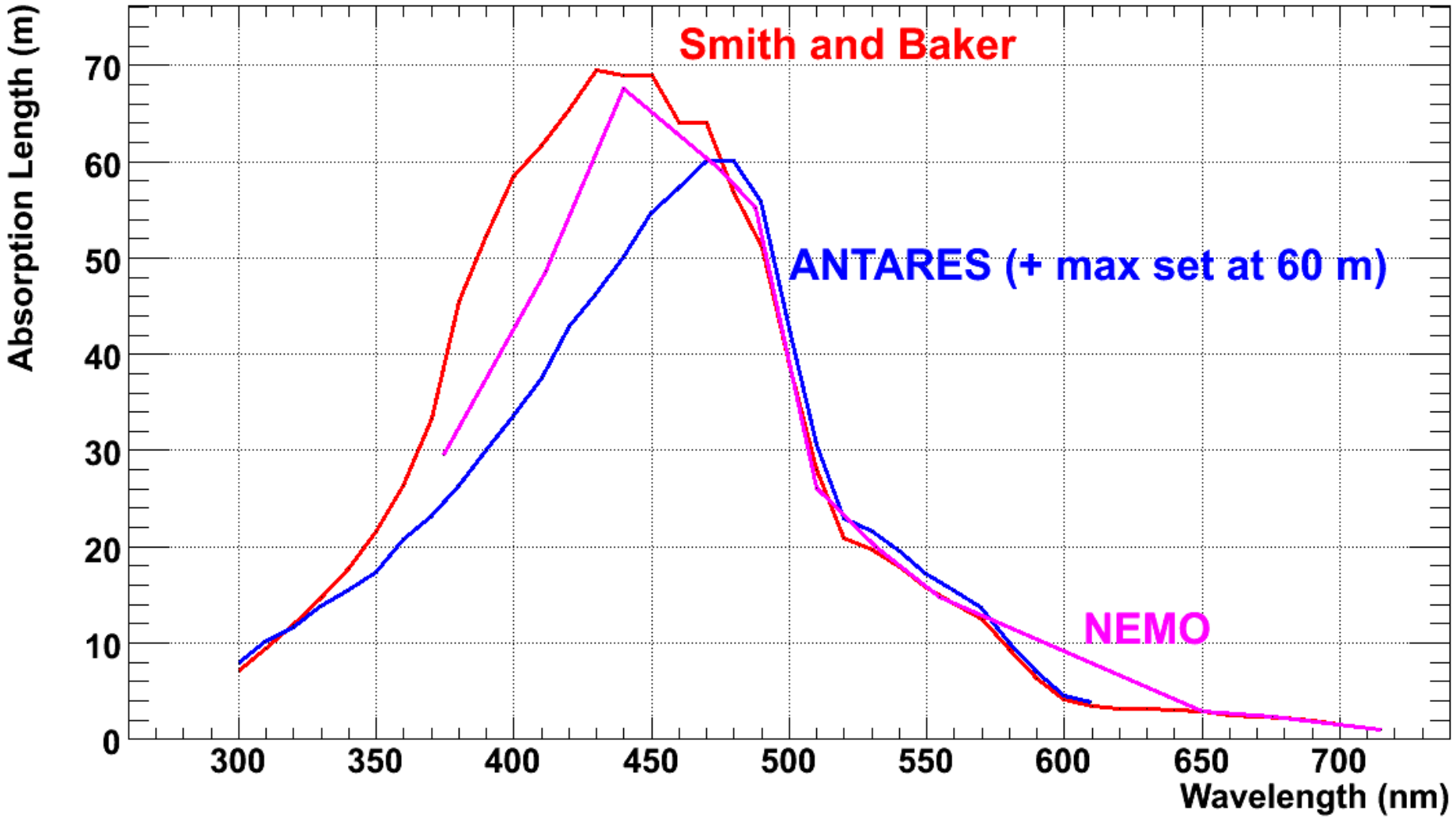
DESIGNS



NUONE

Medusa
(impossible to open the pptx)

Medium properties

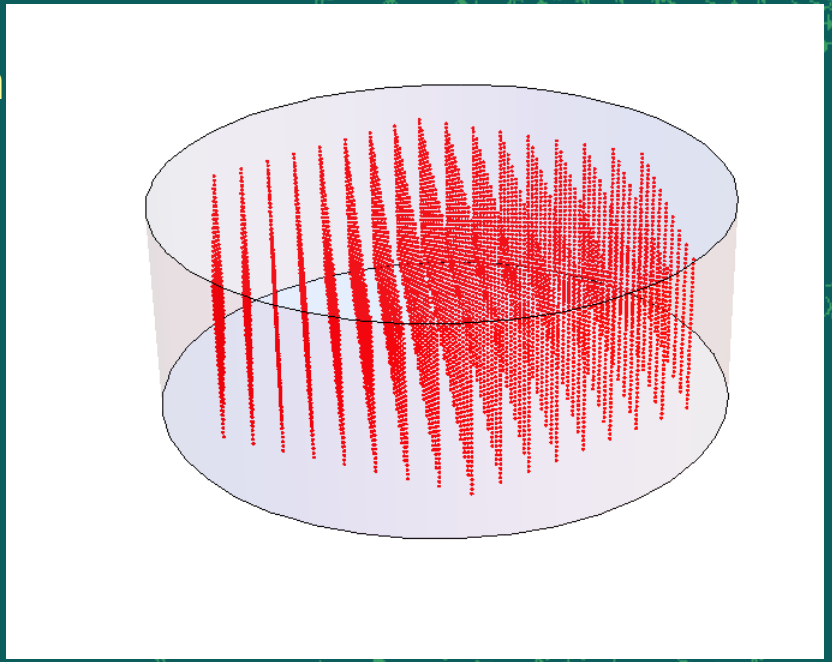


Scattering : same model for all

Mathematica work (D Dornic)

Parameters:

2) Distance between lines: 85, 100, 115, 130 and 145m
3) Distance between storeys: 15, 22.5 and 30m
4) PMTs configurations in a storey:
   - Number of PMTs: 3, 4 and 6
   - Dimension or QE
   - Distance to line axis: 1.1, 2 and 4m
   - PMTs Orientation: 0, 22.5, 45 and 60°



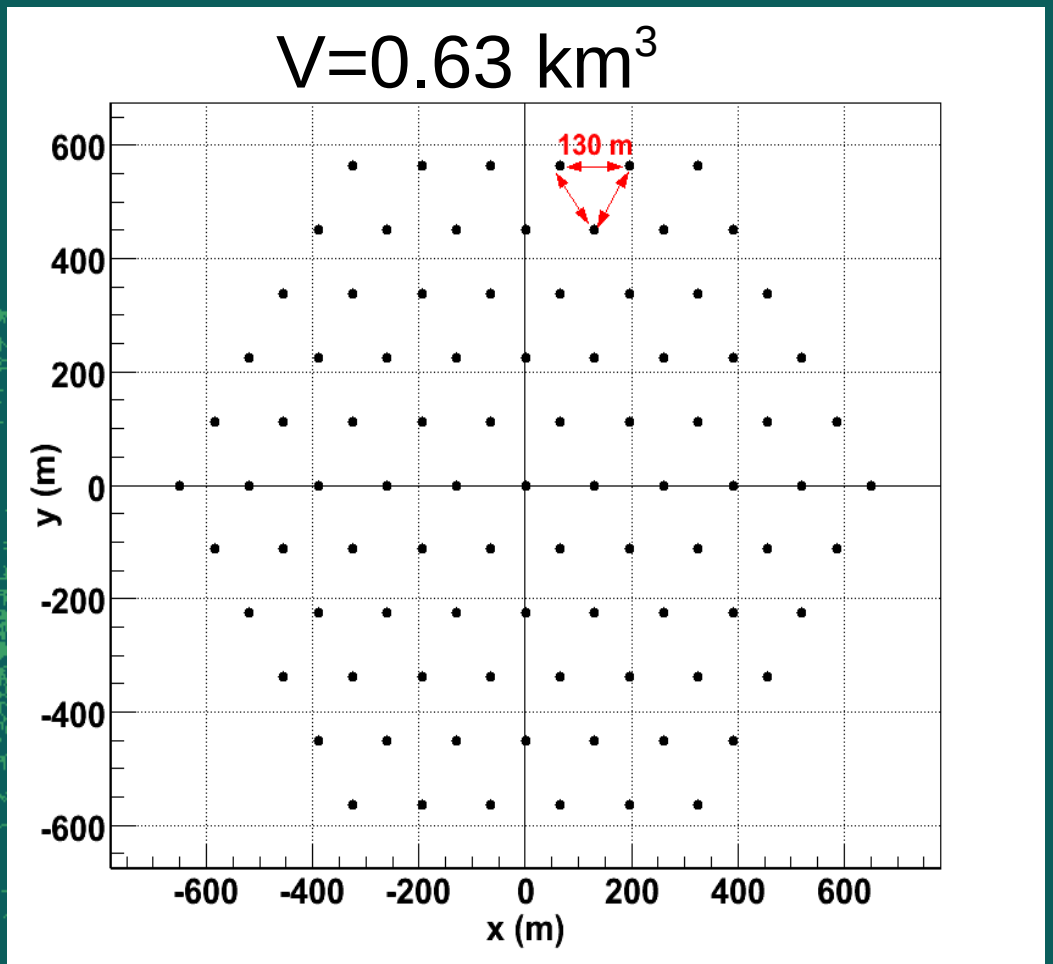
Configuration:

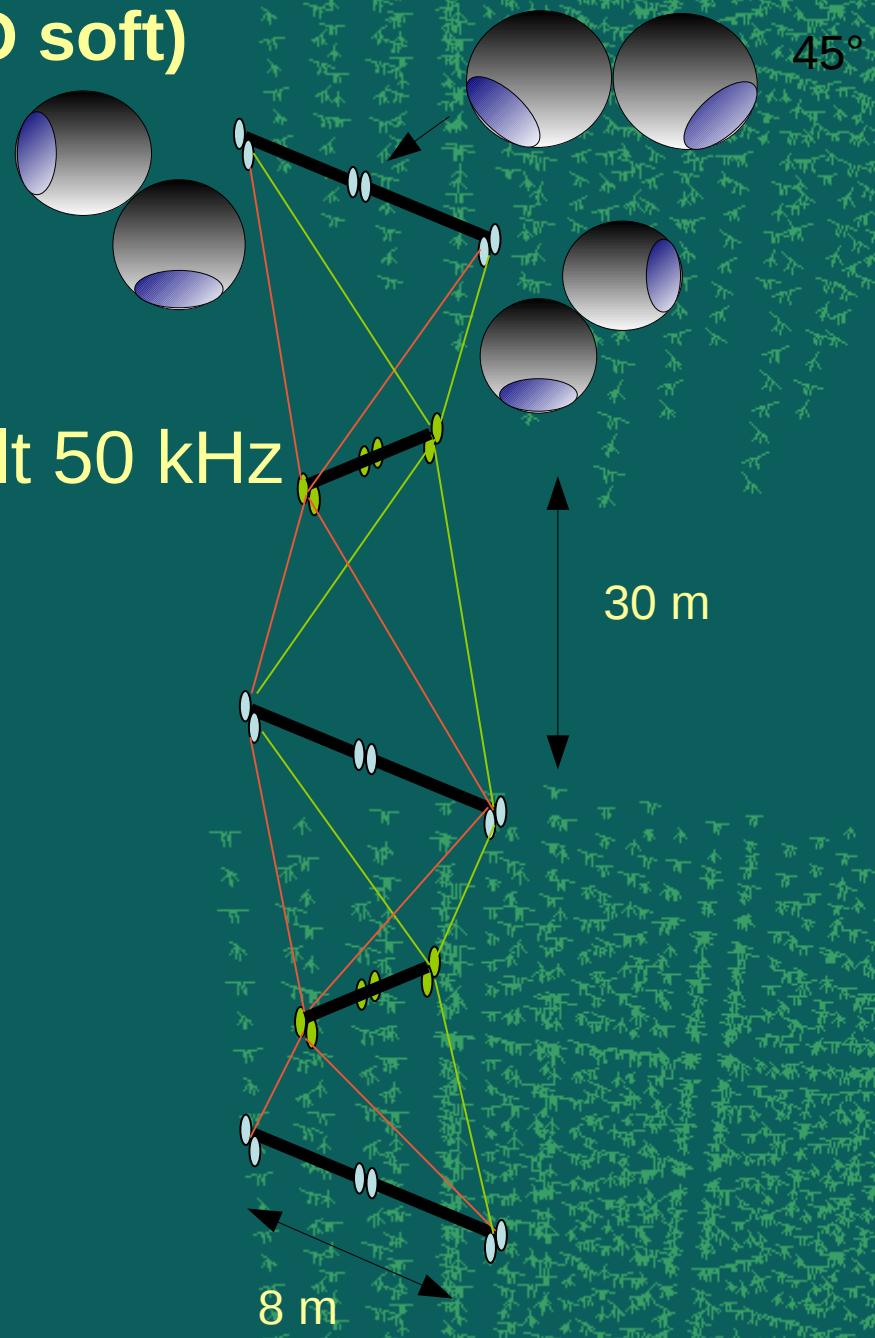
Perfect hexagon: 217 lines (8 crowns)

Fixed height of lines: 500m instrumented

Some results of an exploration of the phase space (ANTARES/NEMO soft)

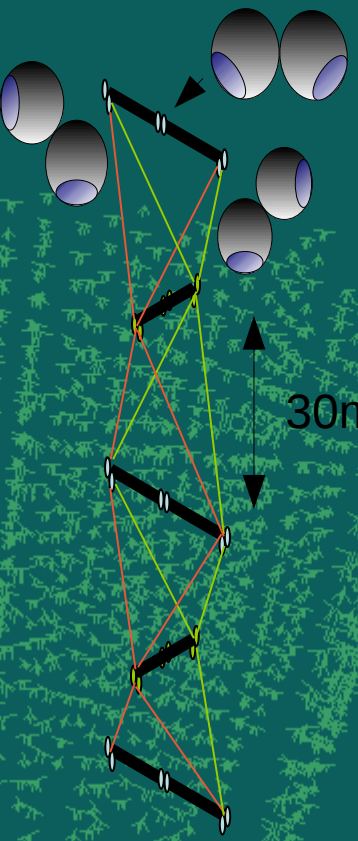
20 floors
91 lines
hexagonal layout
130 m
between lines, 10” PMTs, default 50 kHz



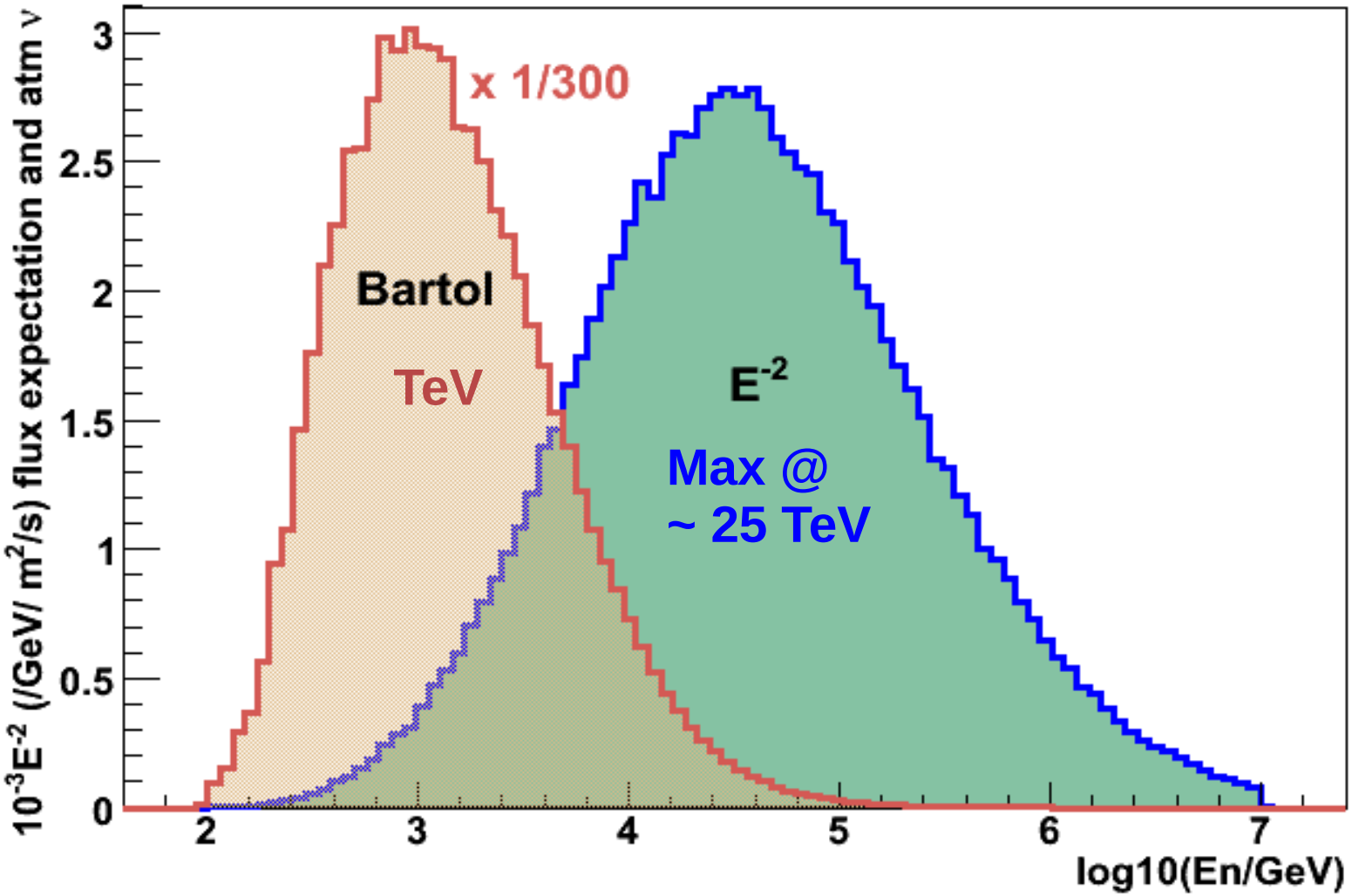


E^{-2} Signal and Atmospheric neutrinos

35% QE
Antares
water 60m



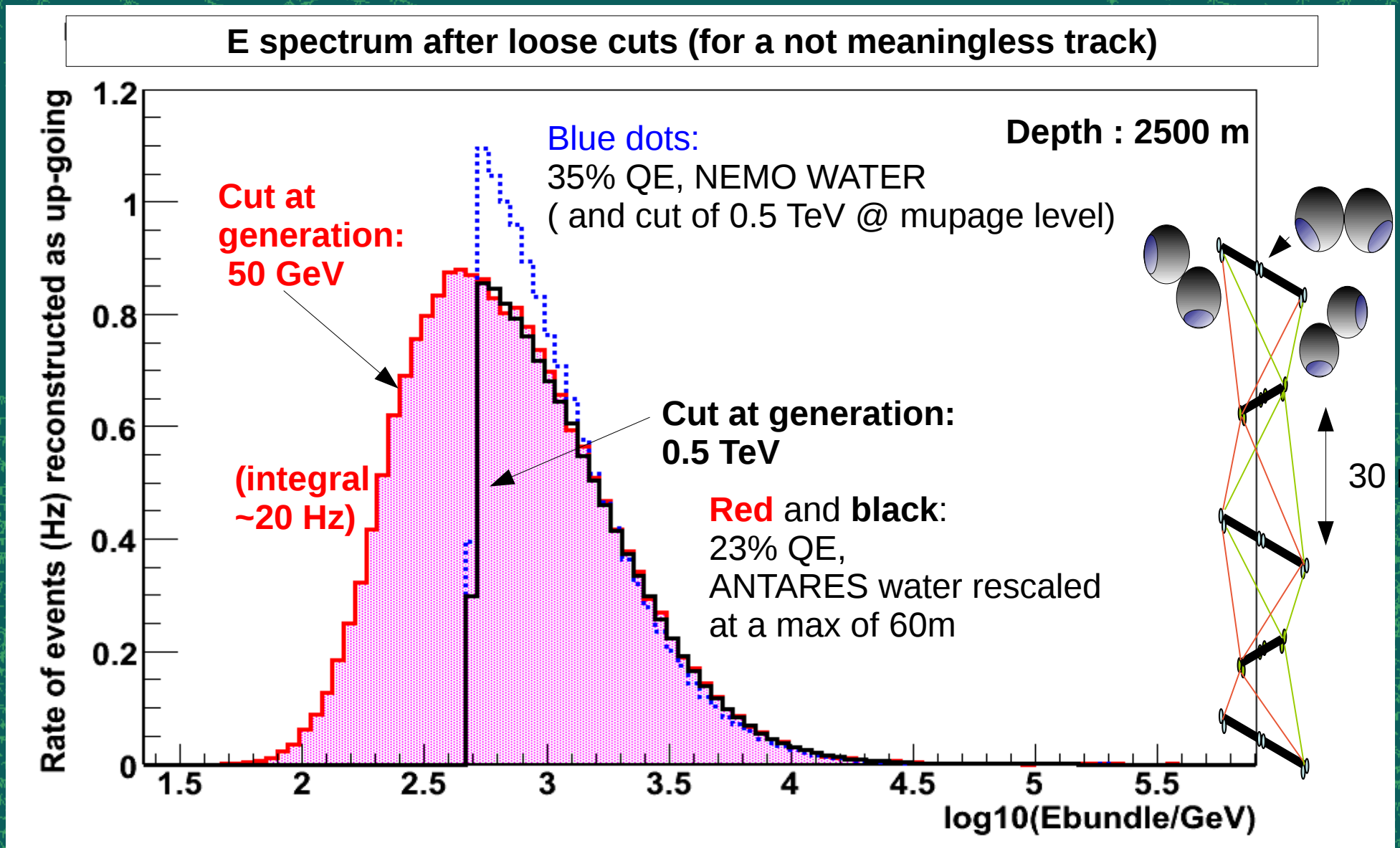
E spectrum after typical cuts (final step)



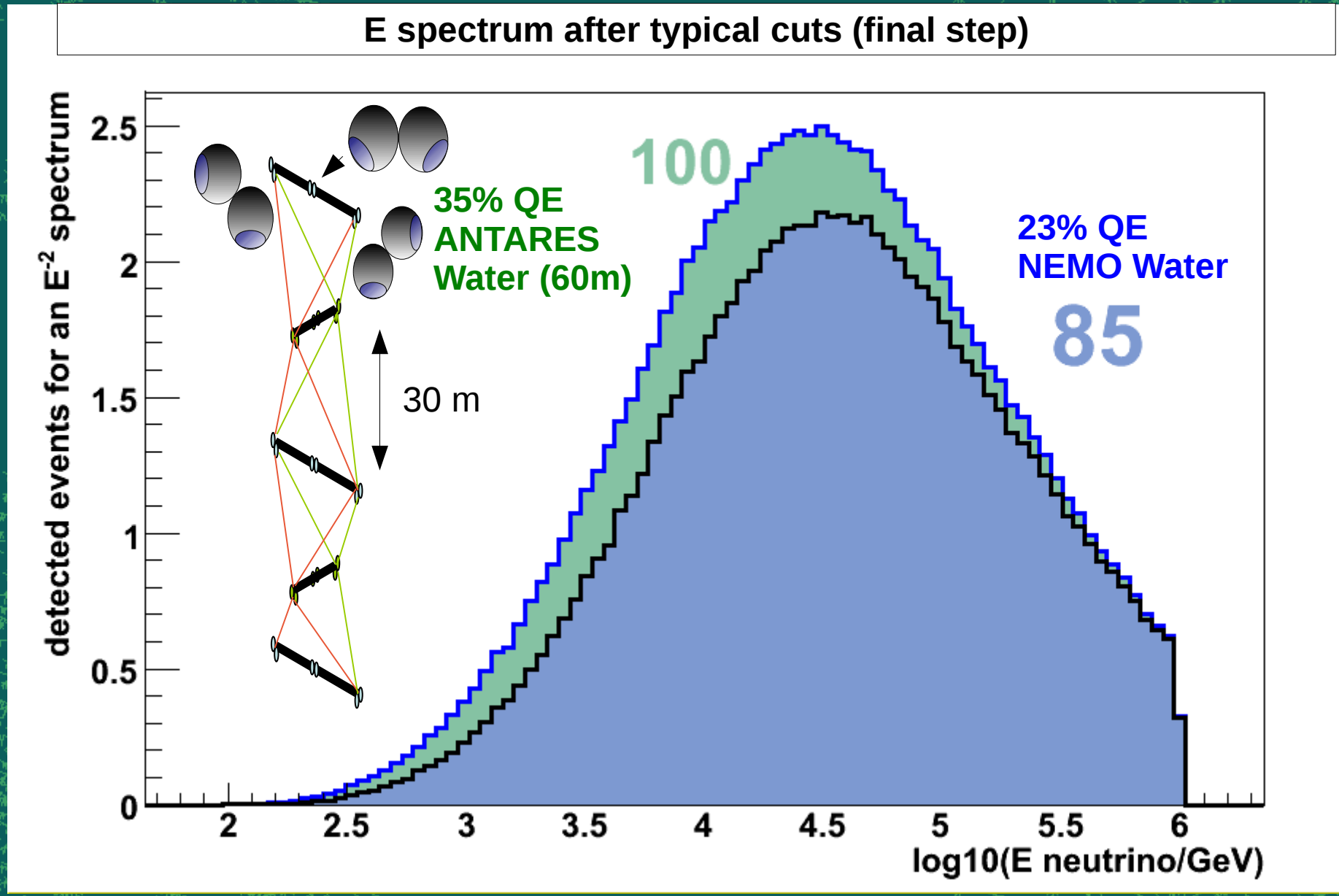
Atmospheric muons

Difficult to simulate a high stat : MUPAGE (see Annarita talk)

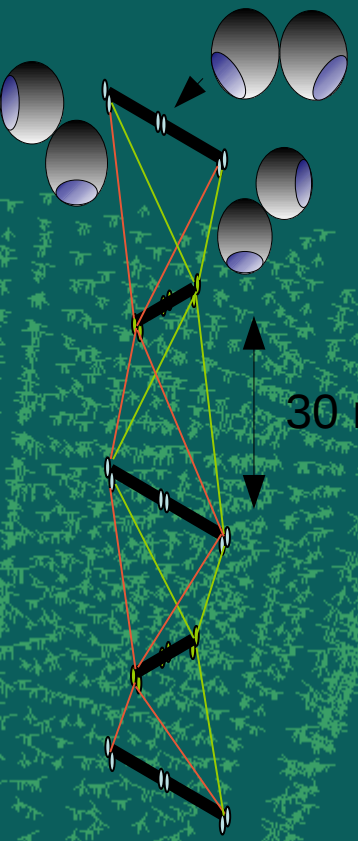
Some cuts applied at the generation level, to save time :
Ebundle > 0.5 TeV :

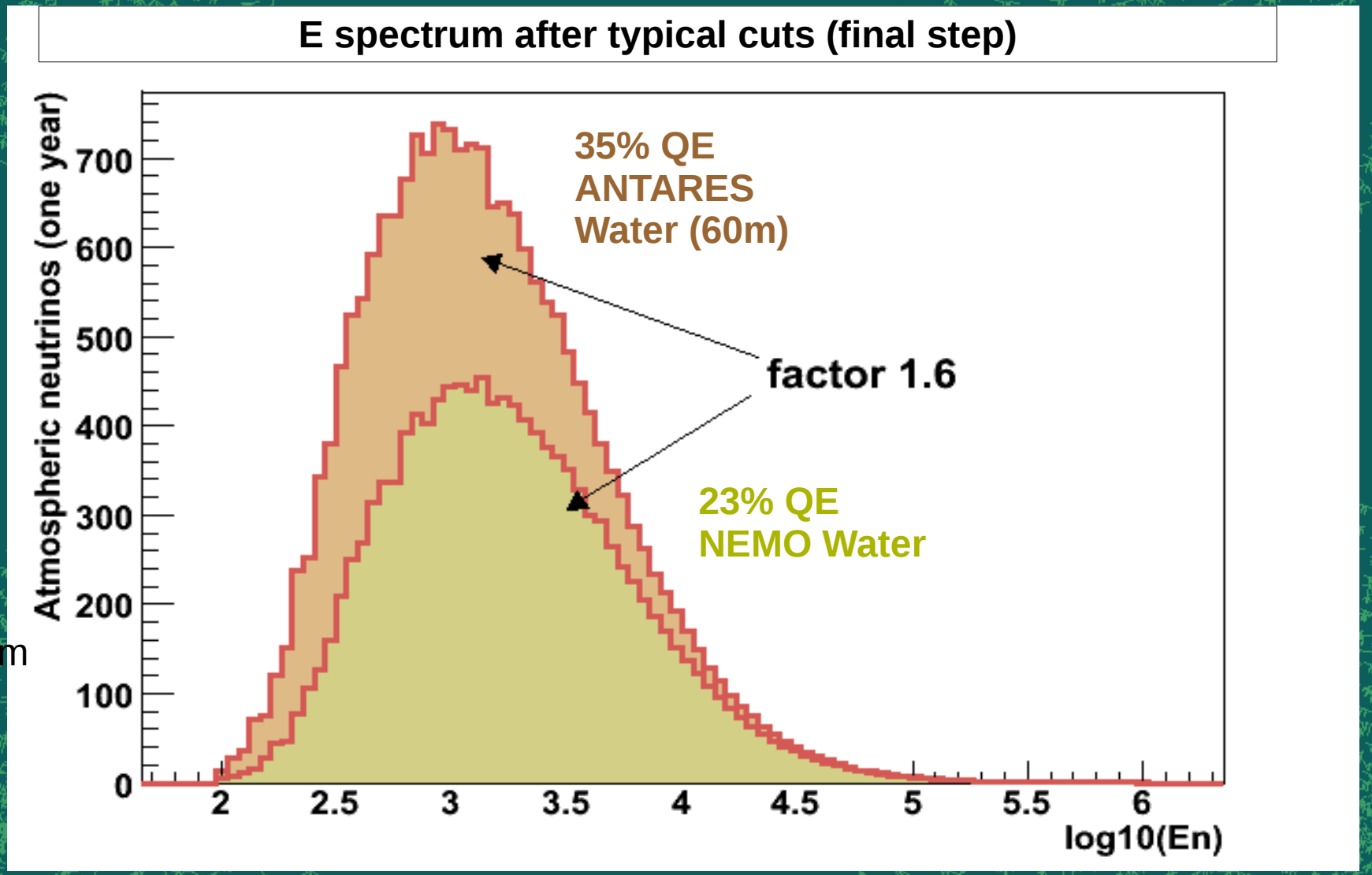


QE effect on E^{-2} neutrinos



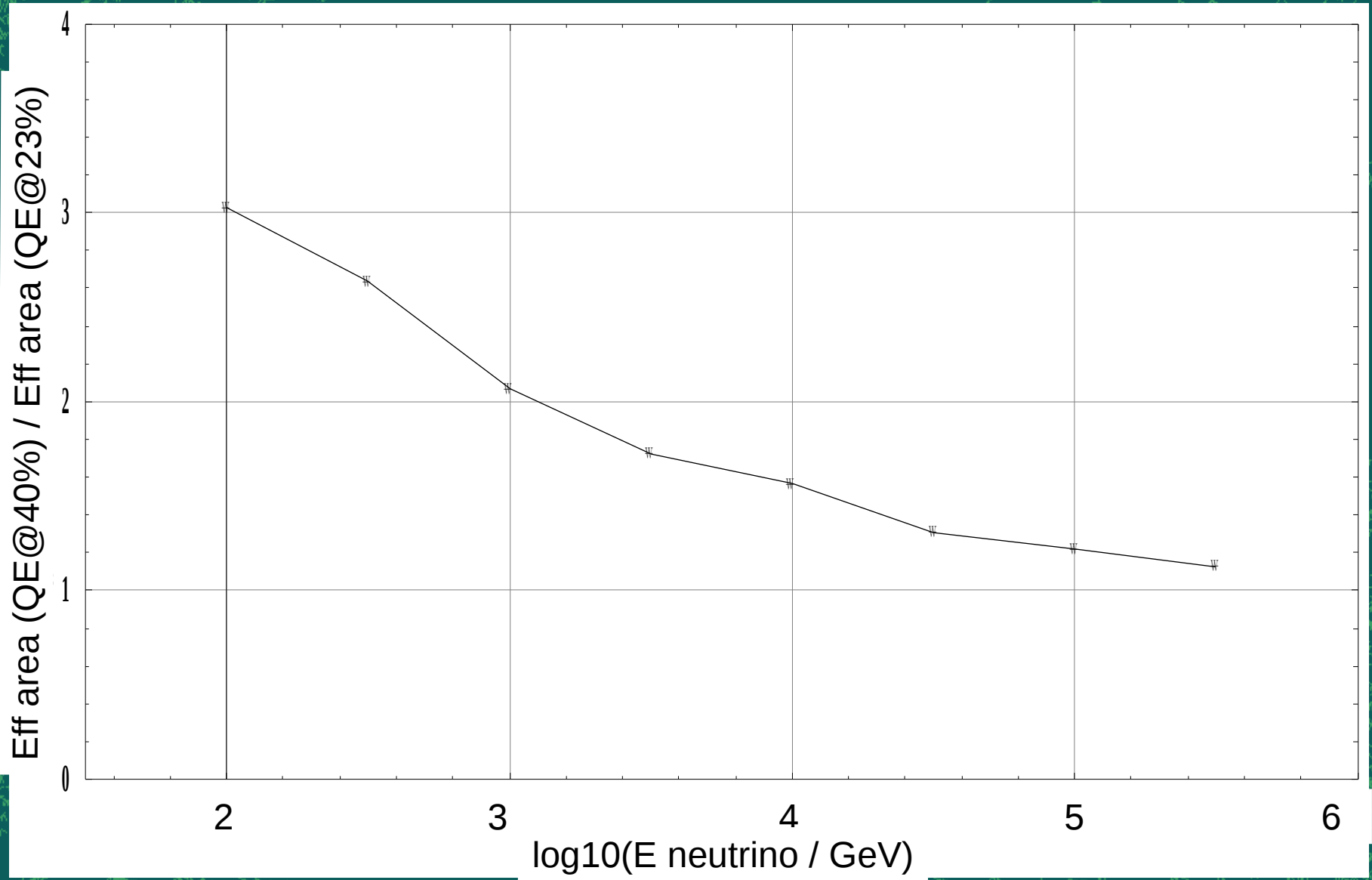
QE effect on atmospheric neutrinos





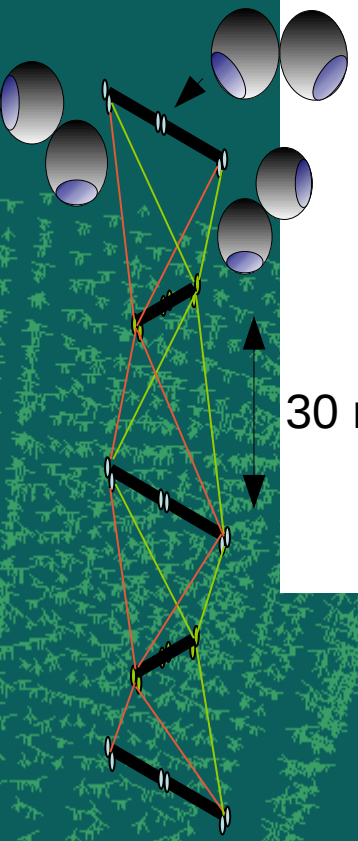
Mathematica work (D Dornic)

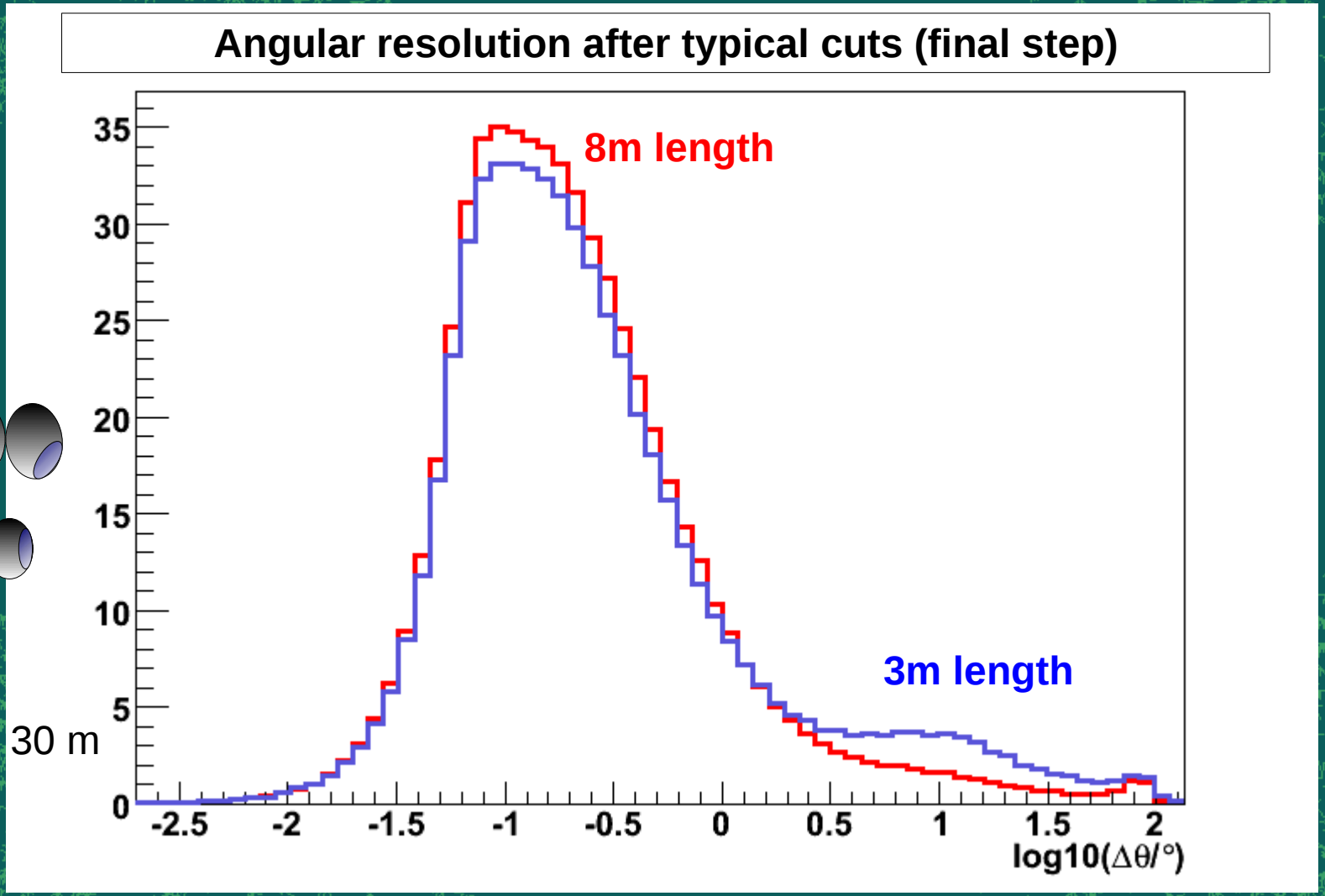
QE effect



Bar length effect in tower design

35% QE
Antares
water 60m

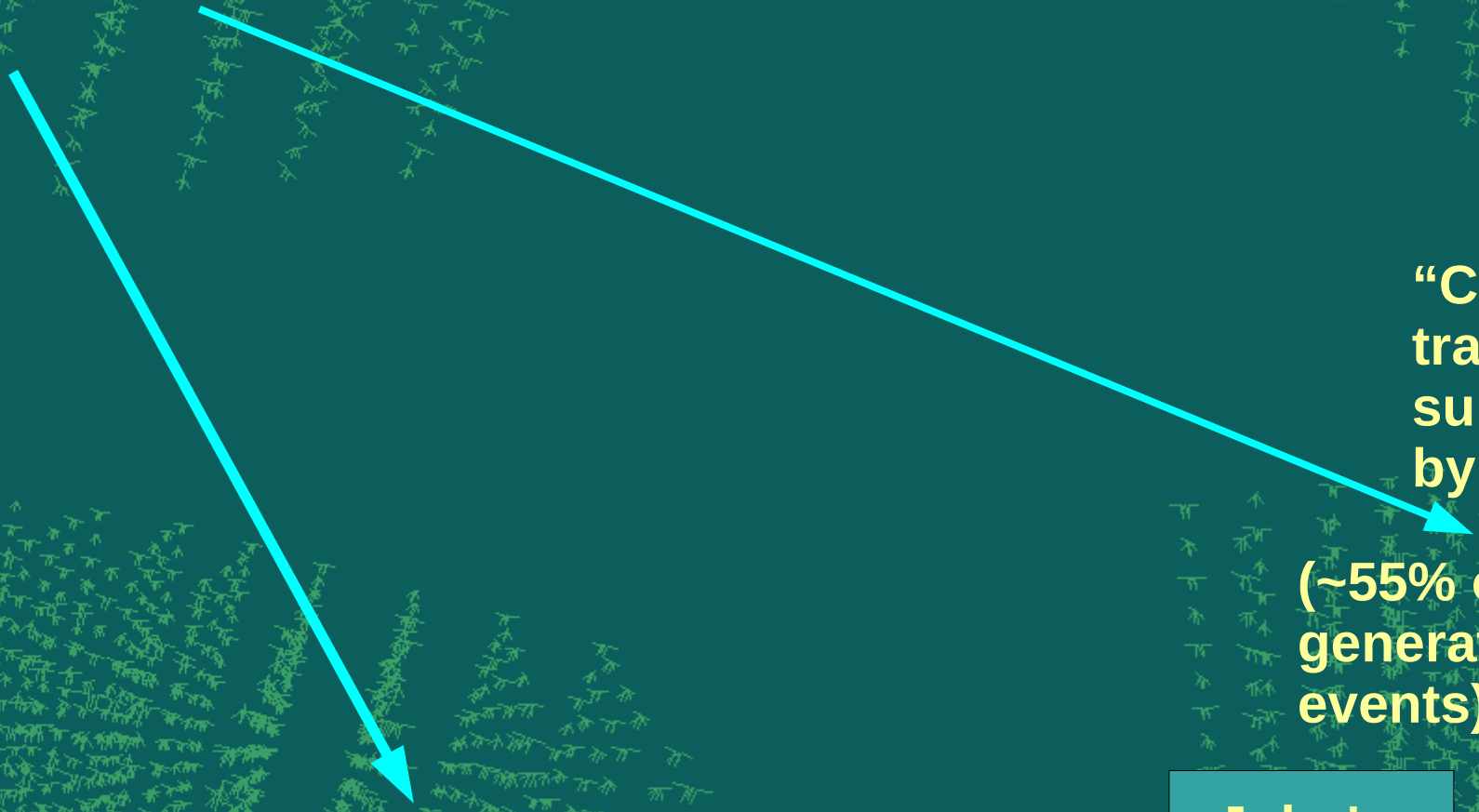




John's talk

Efficiency of the detectors :

Efficiency of the detectors : the estimate of such a quantity requires a reference



“Contained track” : is surrounded by OMs

(~55% of the generated events)

“Not contained track” : pass next to the detector

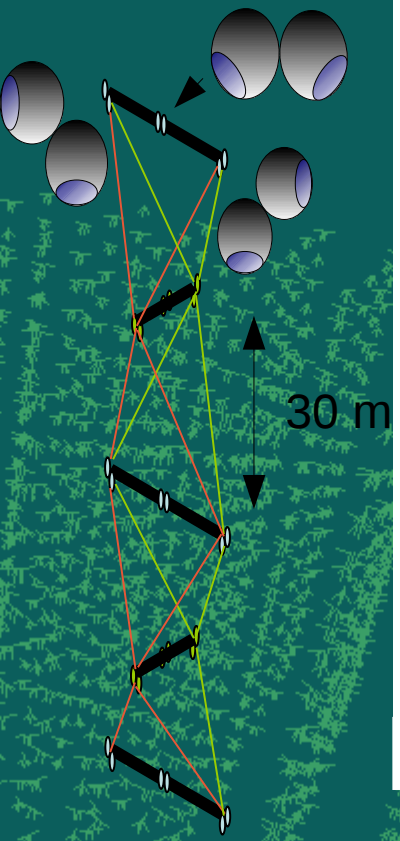
John's talk

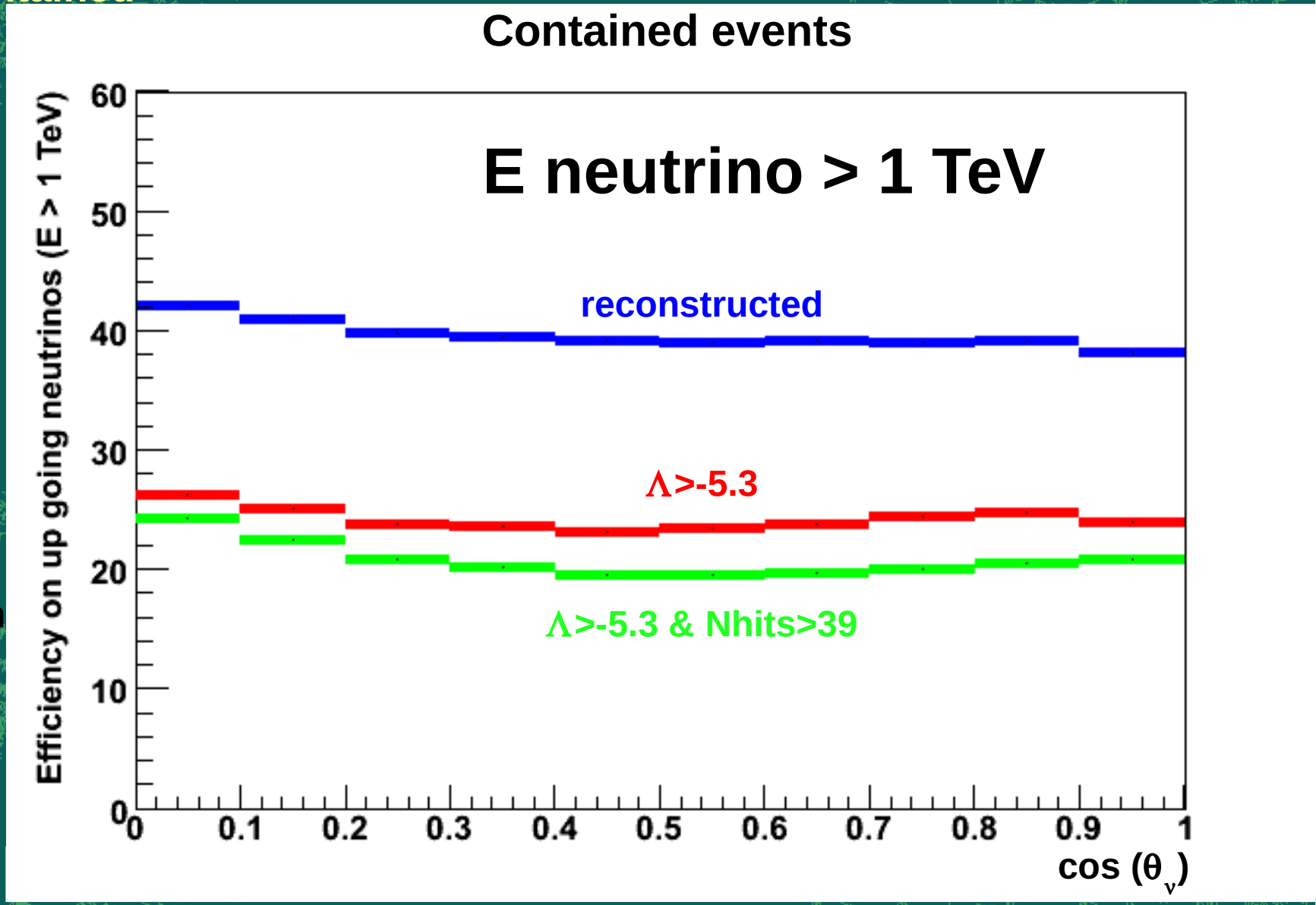
Warning : the track used here to define containment is the neutrino track

Efficiency=f (Neutrino zenith)

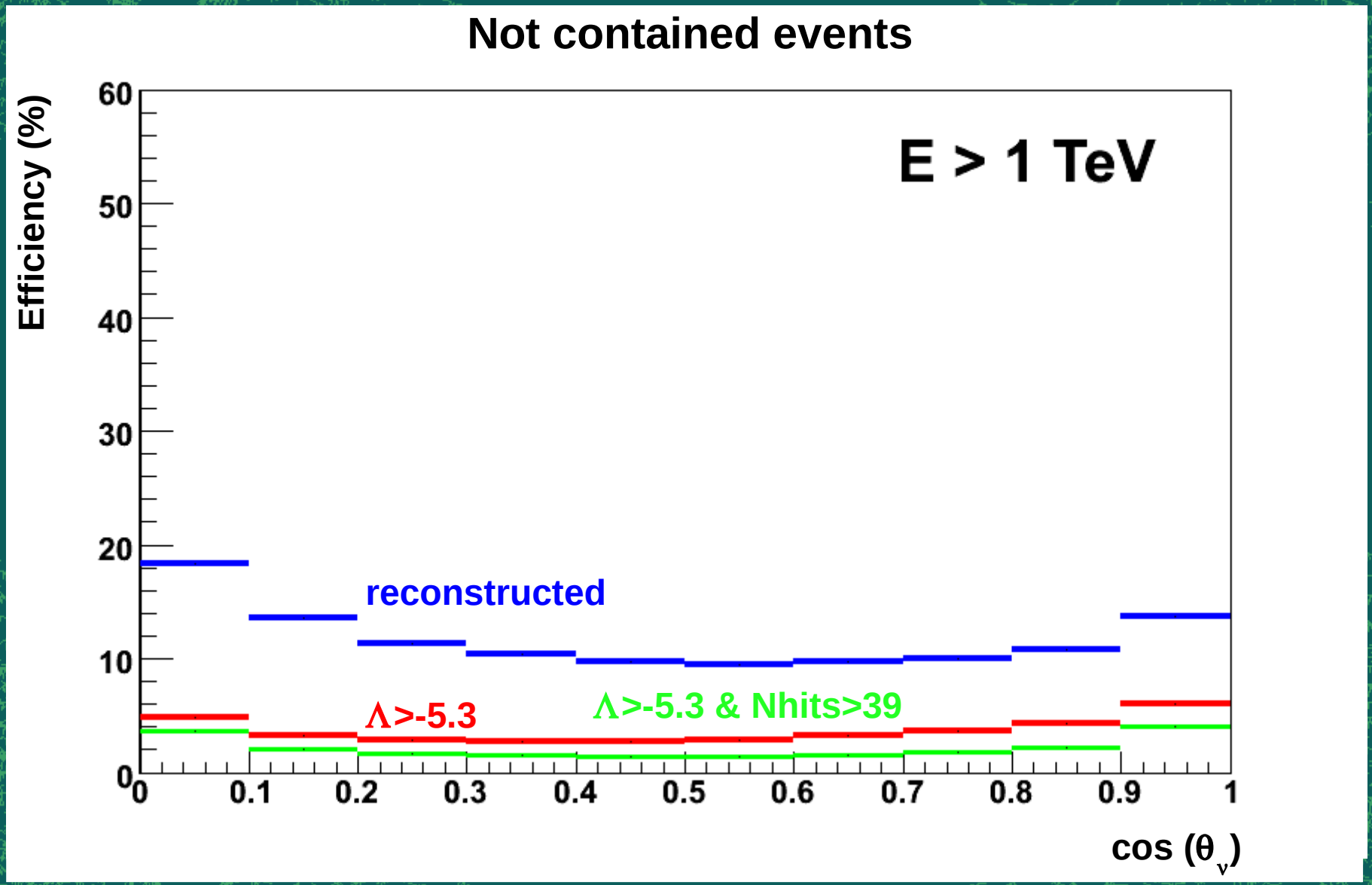
35% QE
Antares
water 60m

Efficiency computed with respect to the generated tracks which are contained



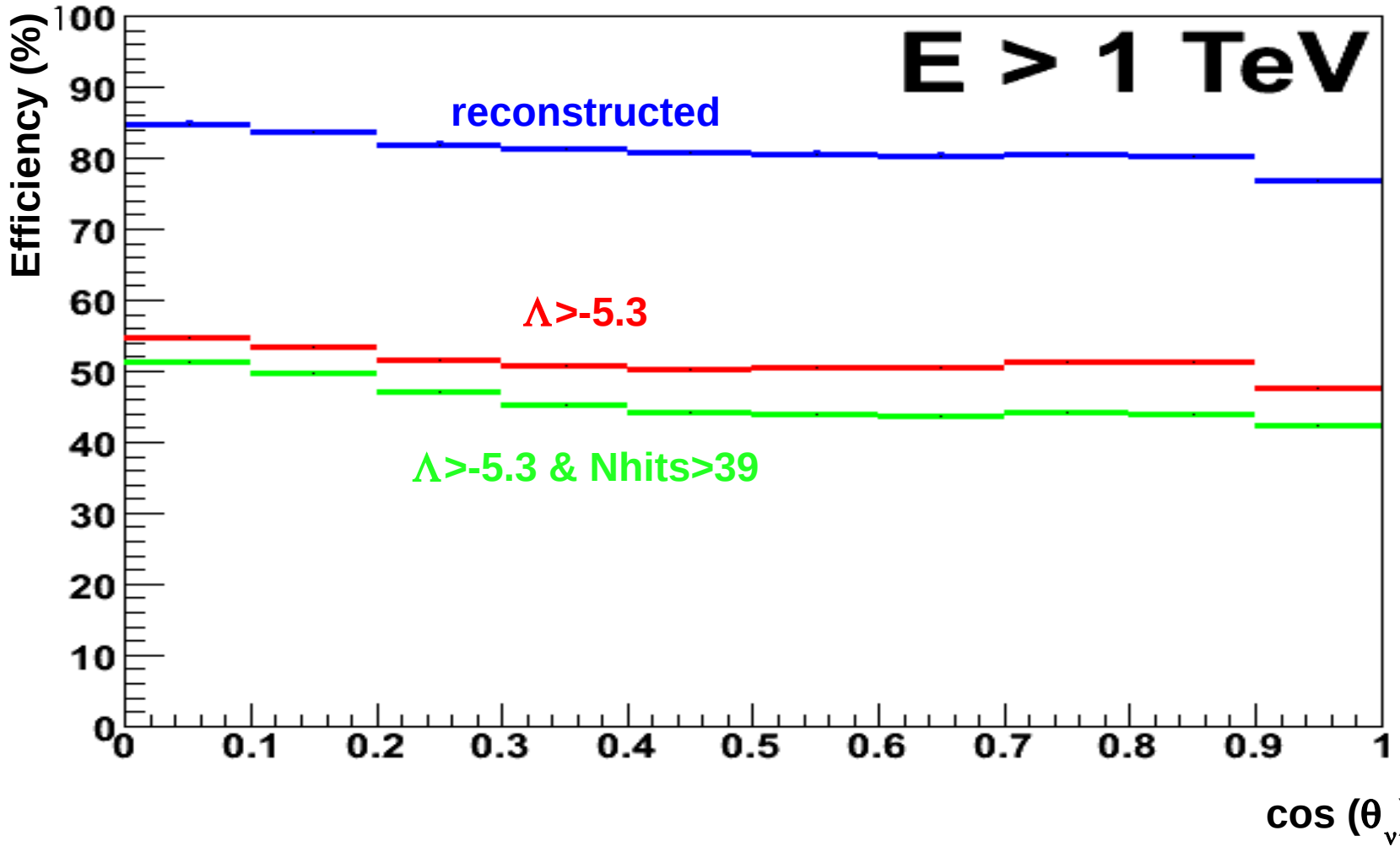


Efficiency computed with respect to the generated tracks which are not contained



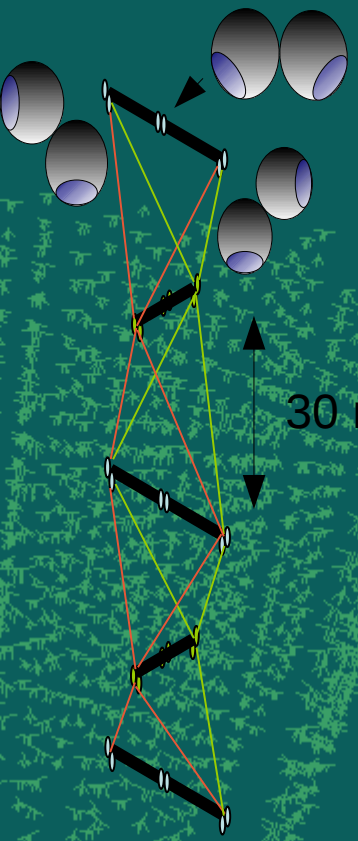
Efficiency computed with respect to the generated tracks which are "well" contained

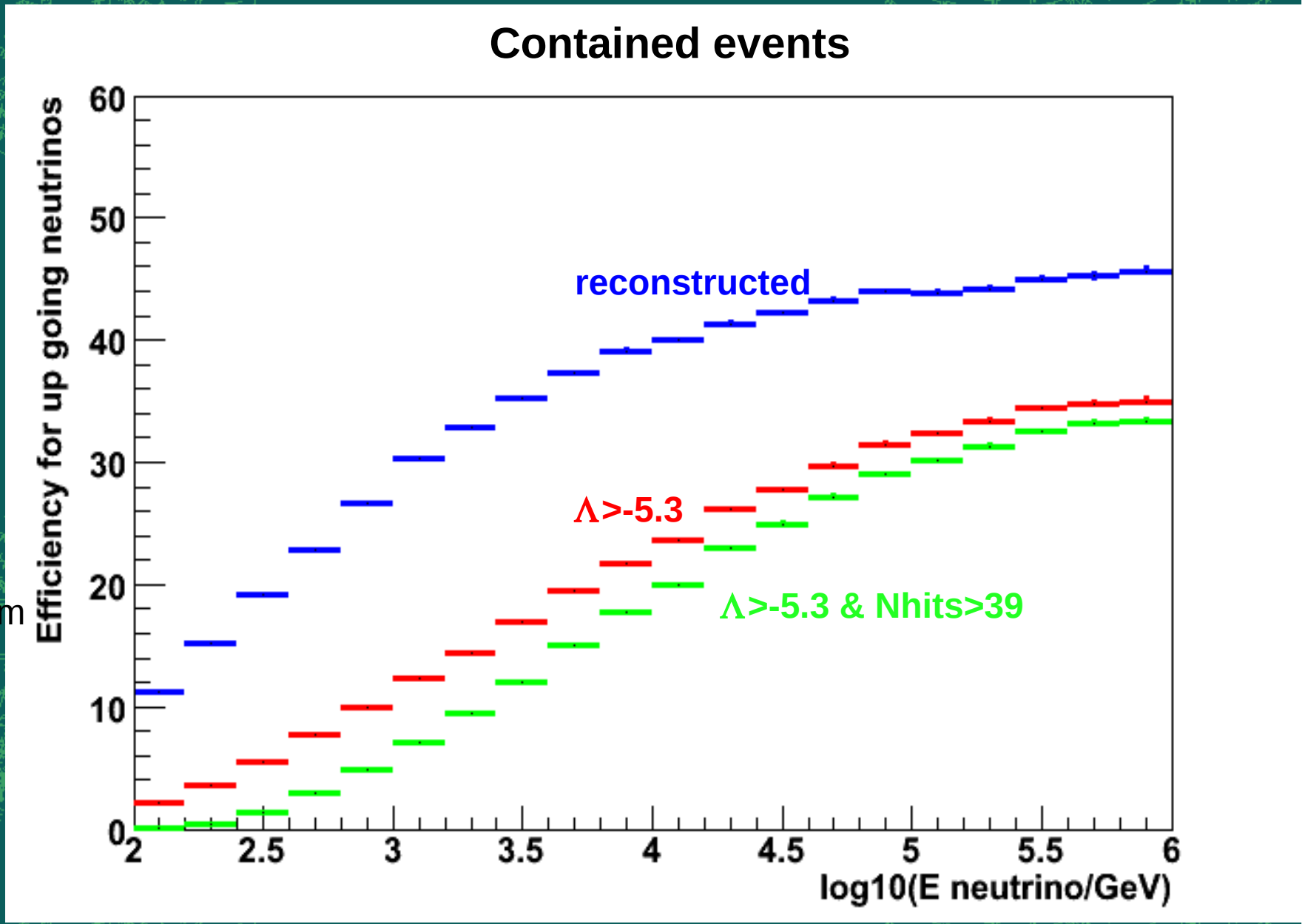
"Well" contained events (here well means surrounded by at least 5 floors)



Efficiency=f (Neutrino Energy)

35% QE
Antares
water 60m

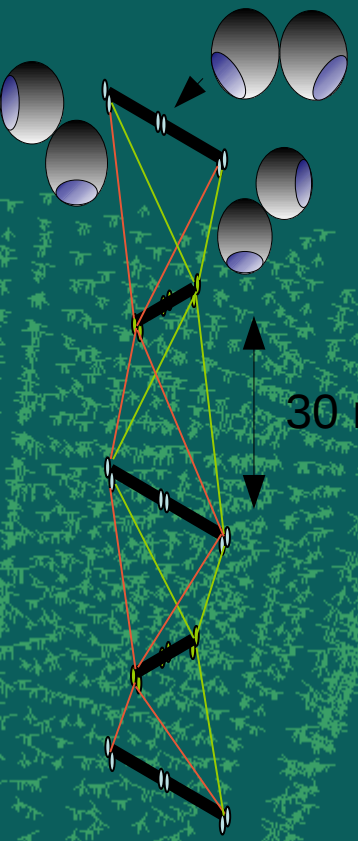


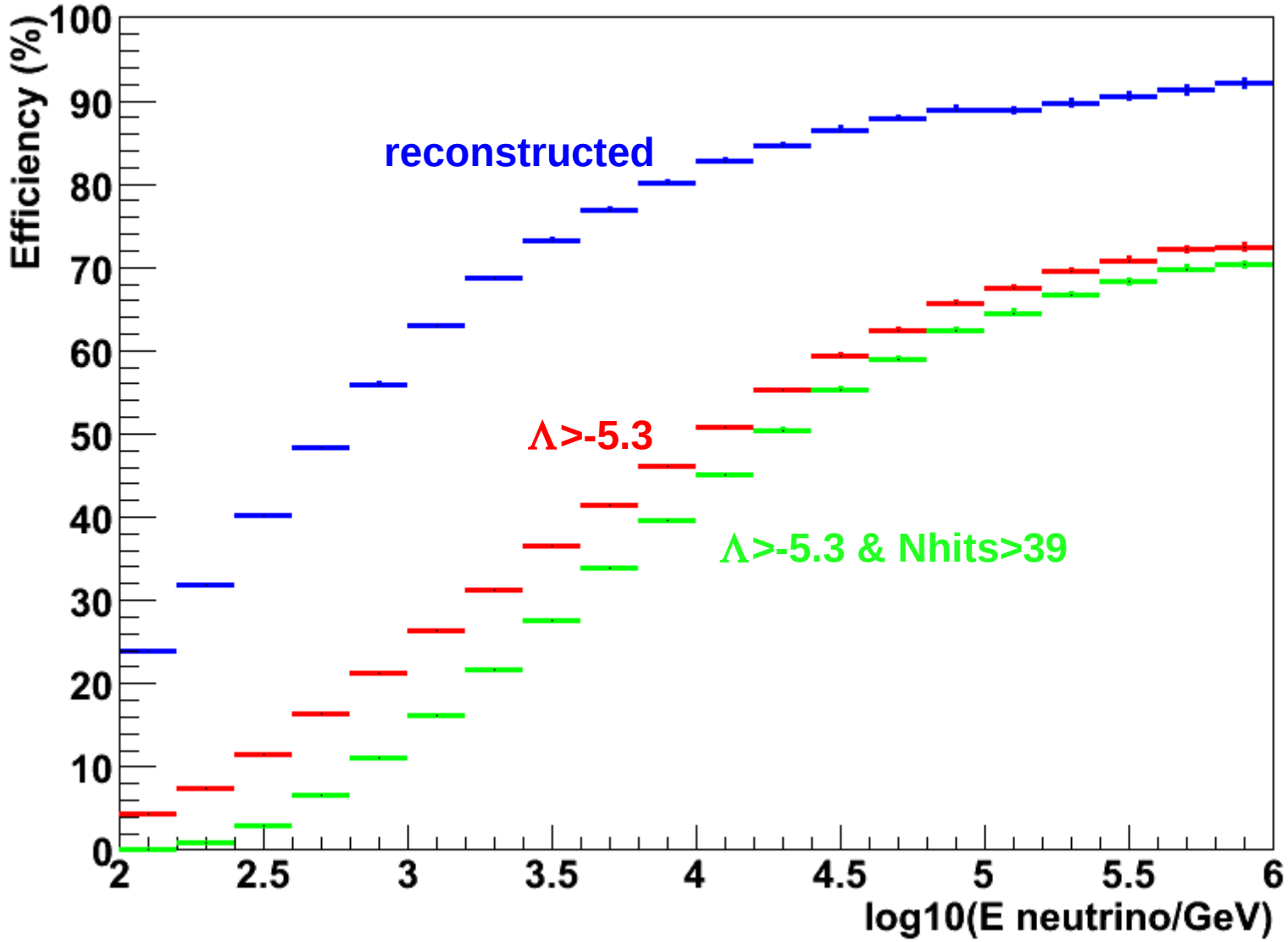


Efficiency=f(Neutrino Energy)

35% QE
Antares
water 60m

“Well” contained events (here well means surrounded by at least 5 floors)

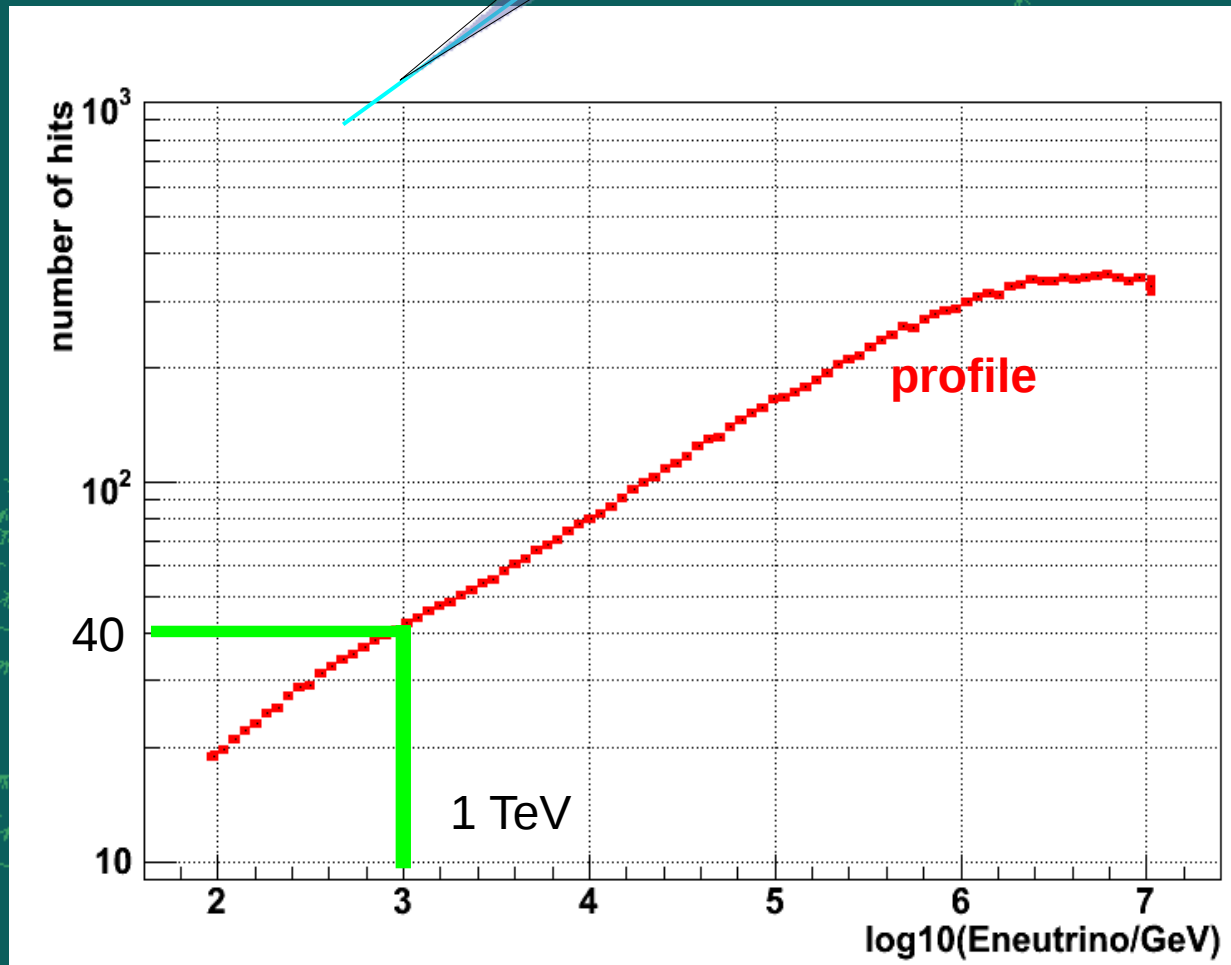


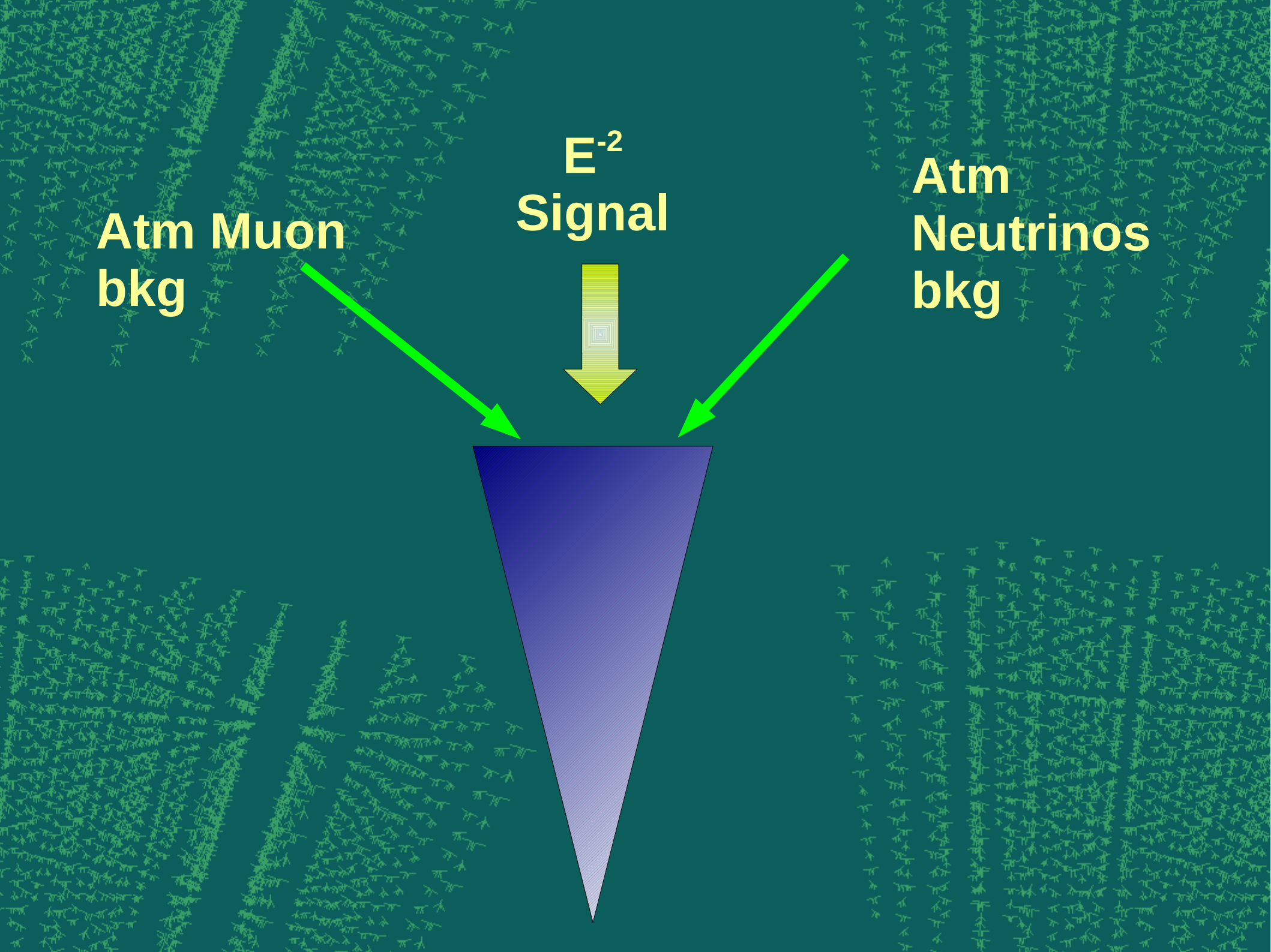


Sensitivity:

Cone aperture +
Nhits associated to the track (~raw E estimator)
+
Λ
+
N compatible

globally optimized by MRF




Atm Muon
bkg
E-2
Signal
Atm
Neutrinos
bkg

$$\Phi(E) = K\,E^{-2}$$

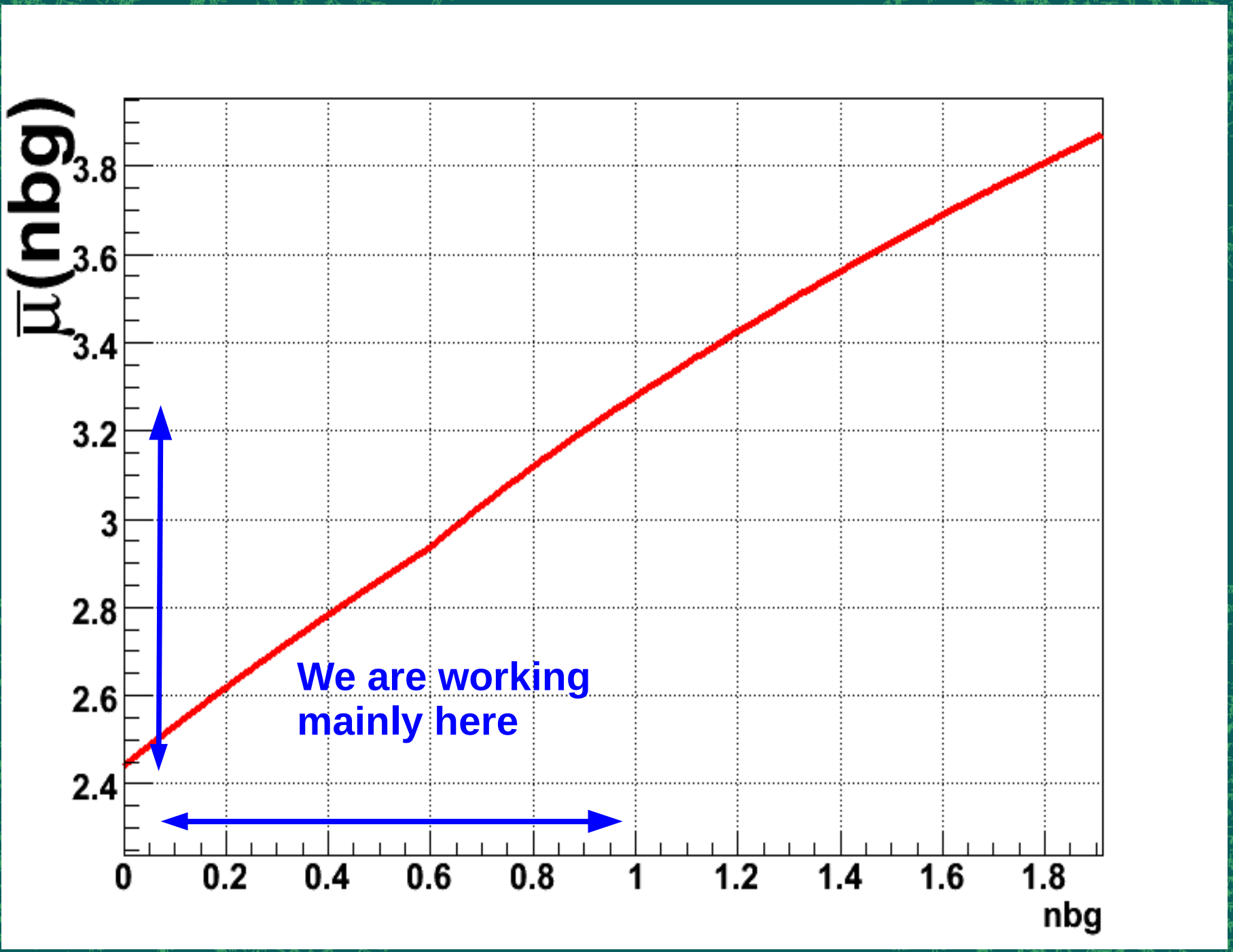
E^{-2} Signal

Atm Muon bkg

Atm Neutrinos bkg

$$\overline{\mu}_{90}(n_{bg}) = \sum_{n_{obs}=0}^{\infty} \mu_{90}(n_{obs}, n_{bg}) \times \frac{(n_{bg})^{n_{obs}}\ e^{-n_{bg}}}{n_{obs}!}$$

In a cone of 0.4° : factor of $2.5 10^{-5}$


$\overline{\mu}(nbg)$
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
We are working
mainly here
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
nbg

$$\Phi(E) = K\,E^{-2}$$

E^{-2} Signal

Atm Muon bkg

Atm Neutrinos bkg

$$\overline{\mu}_{90}(n_{bg}) = \sum_{n_{obs}=0}^{\infty} \mu_{90}(n_{obs}, n_{bg}) \times \frac{(n_{bg})^{n_{obs}}\, e^{-n_{bg}}}{n_{obs}!}$$

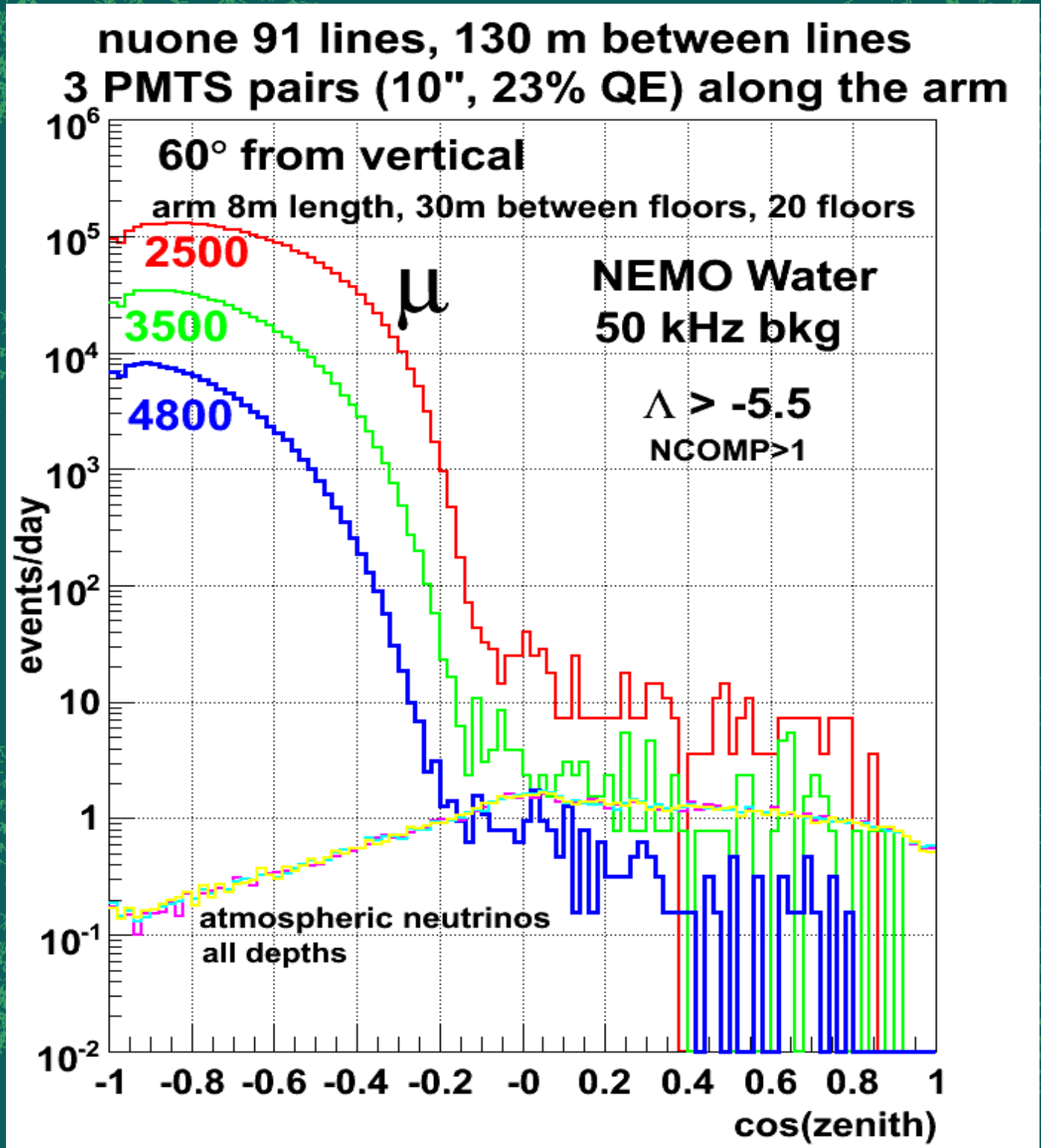
In a cone of 0.4° : factor of $2.5 10^{-5}$

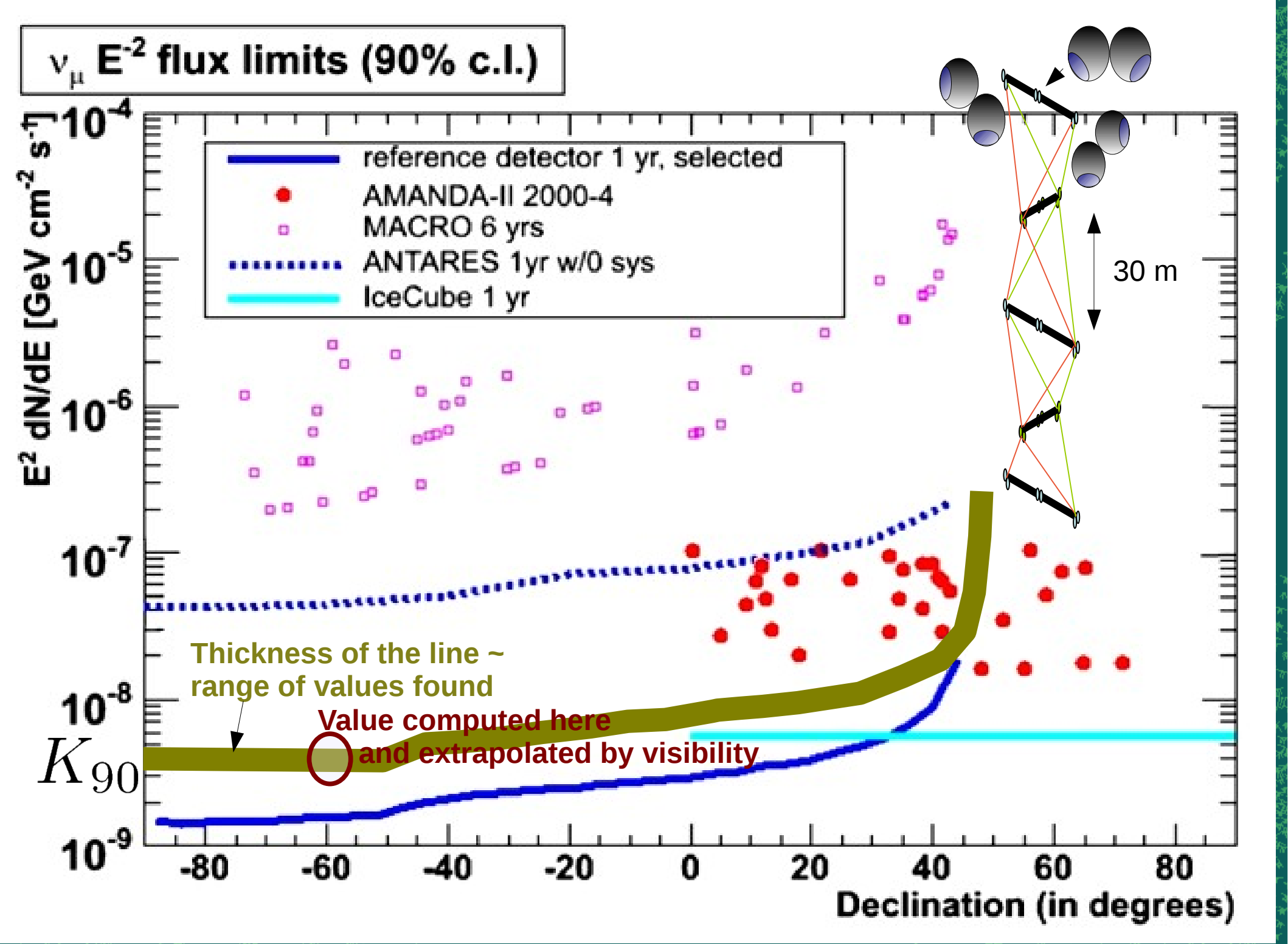
Sensitivity

$$K_{90} = K \frac{\overline{\mu}_{90}(n_{bg})}{n_s}$$

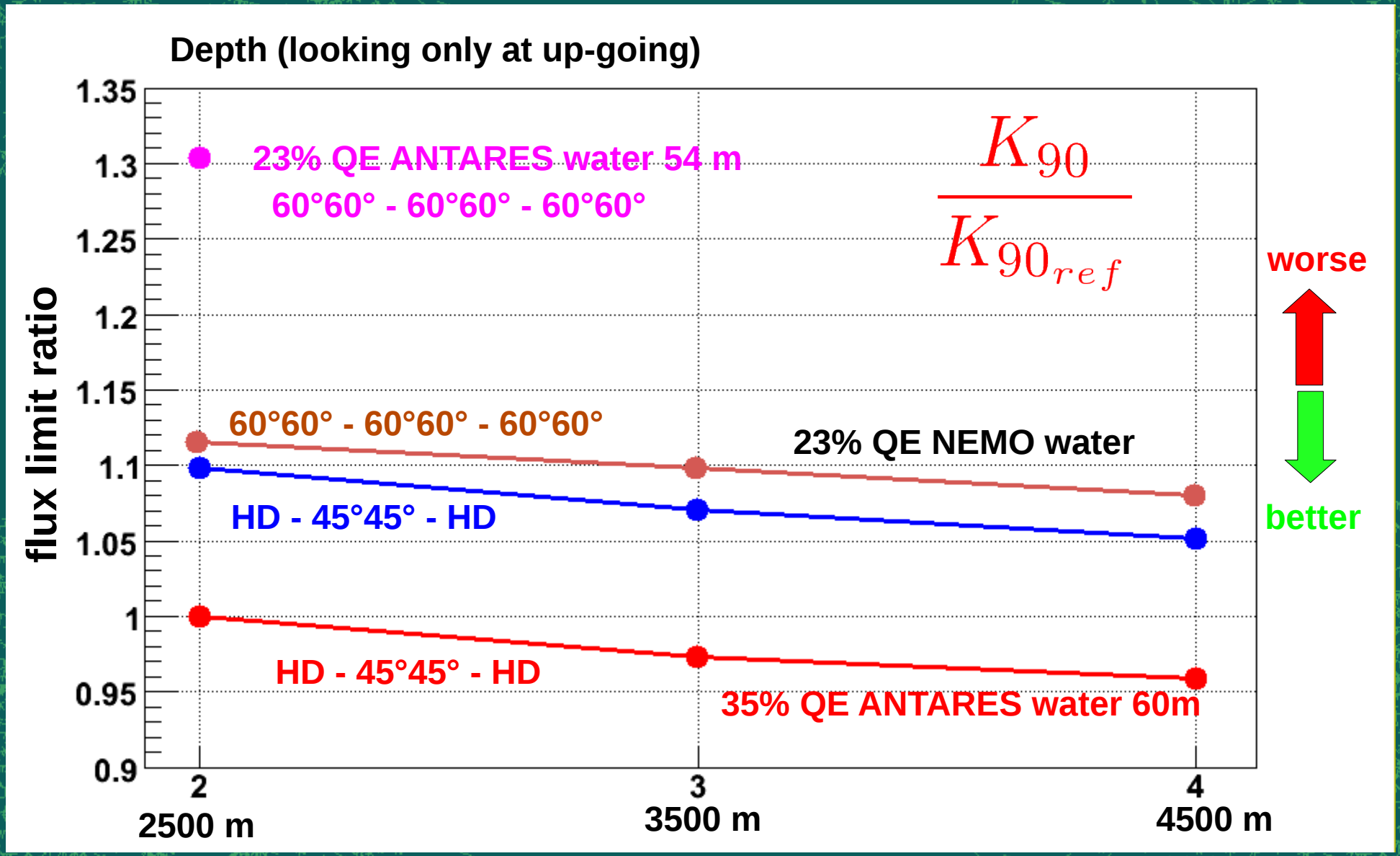
Feeds the cone (angular resolution)

Backgrounds

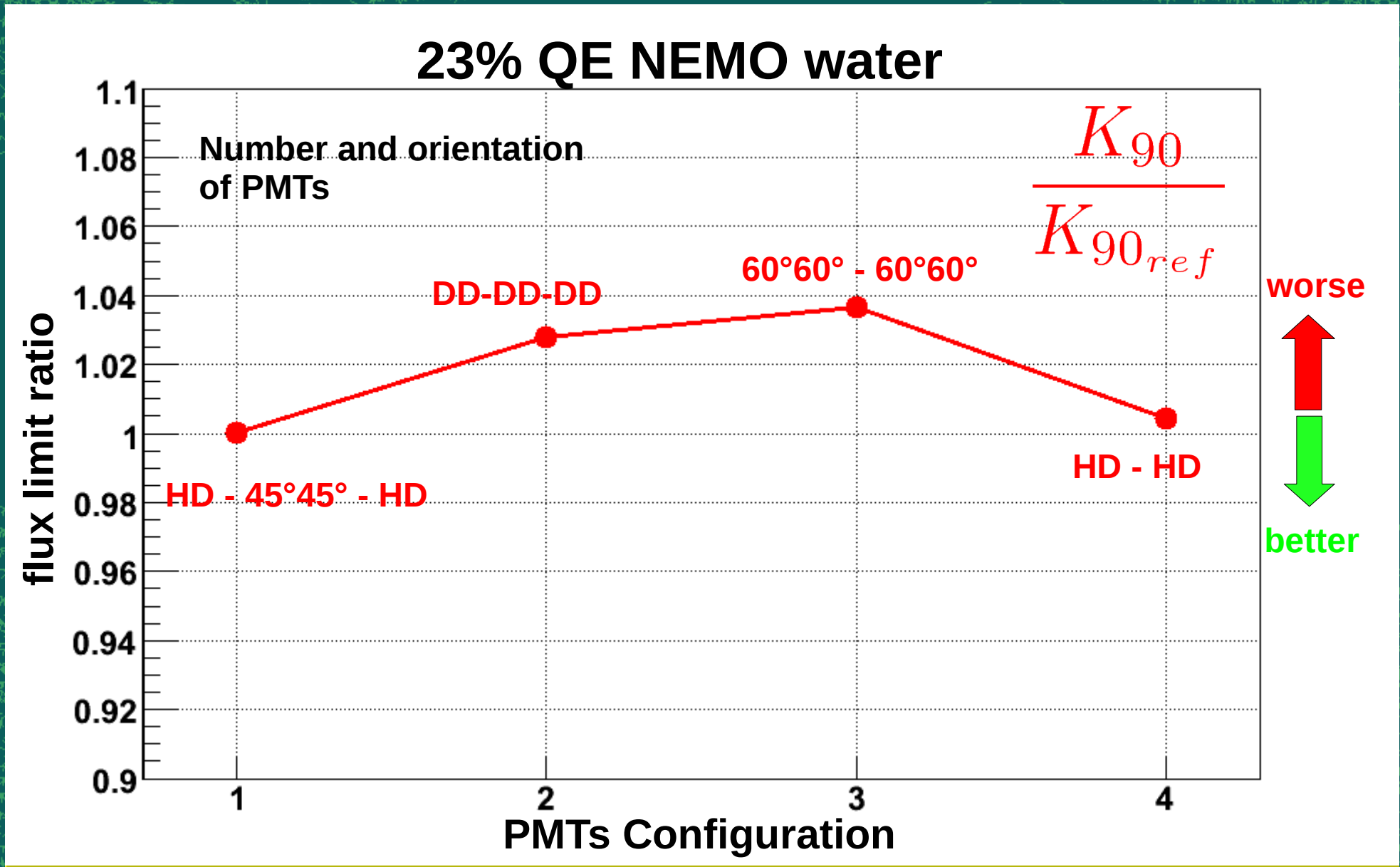



ν_μ E^{-2} flux limits (90% c.l.)
reference detector 1 yr, selected
AMANDA-II 2000-4
MACRO 6 yrs
ANTARES 1yr w/0 sys
IceCube 1 yr
30 m
E^2 dN/dE [GeV cm^{-2} s^{-1}]
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
Thickness of the line ~
range of values found
Value computed here
and extrapolated by visibility
K_{90}
-80
-60
-40
-20
0
20
40
60
80
Declination (in degrees)

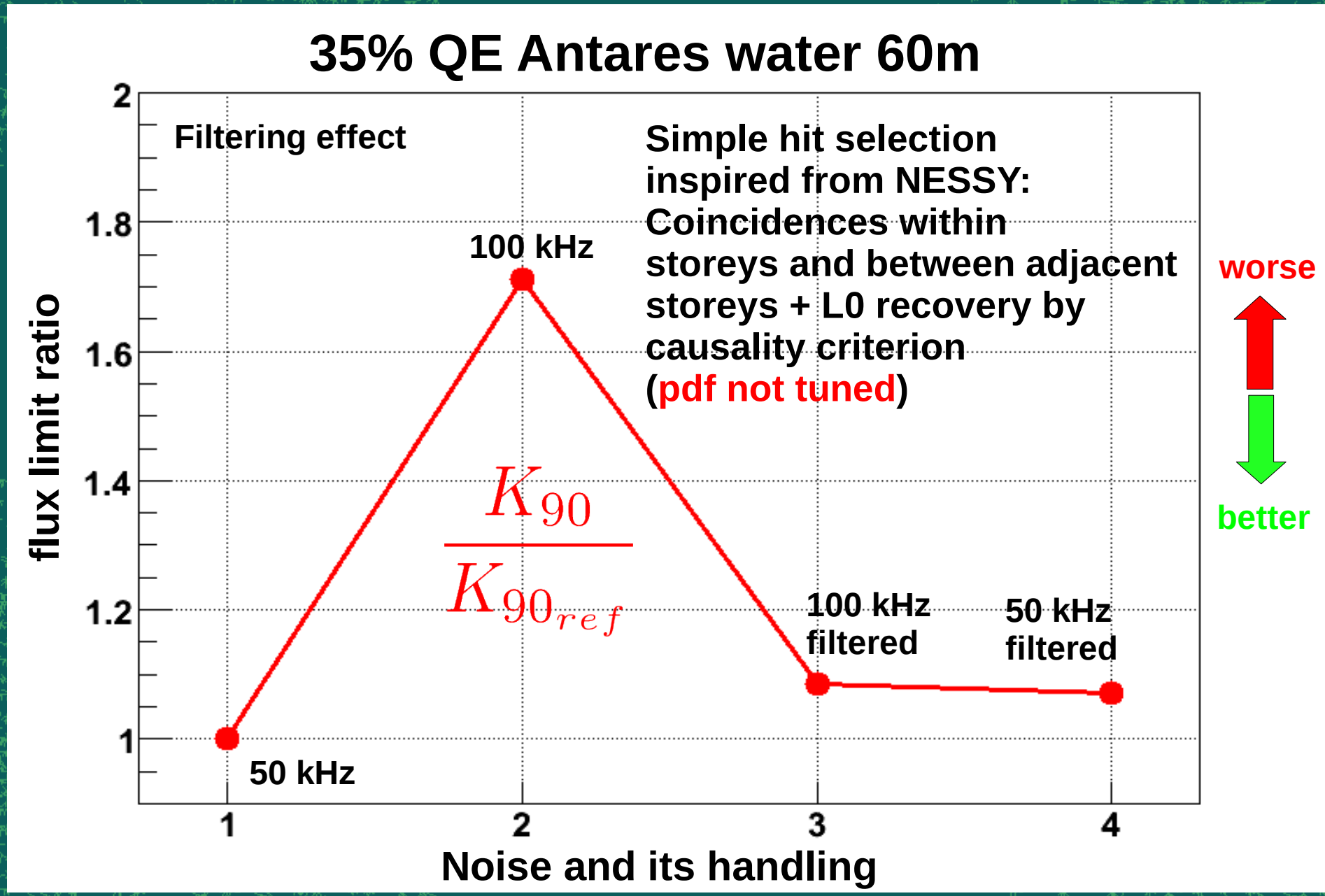
Trends on E^{-2} flux limits (relative values)



Trends on E^{-2} flux limits (relative values)

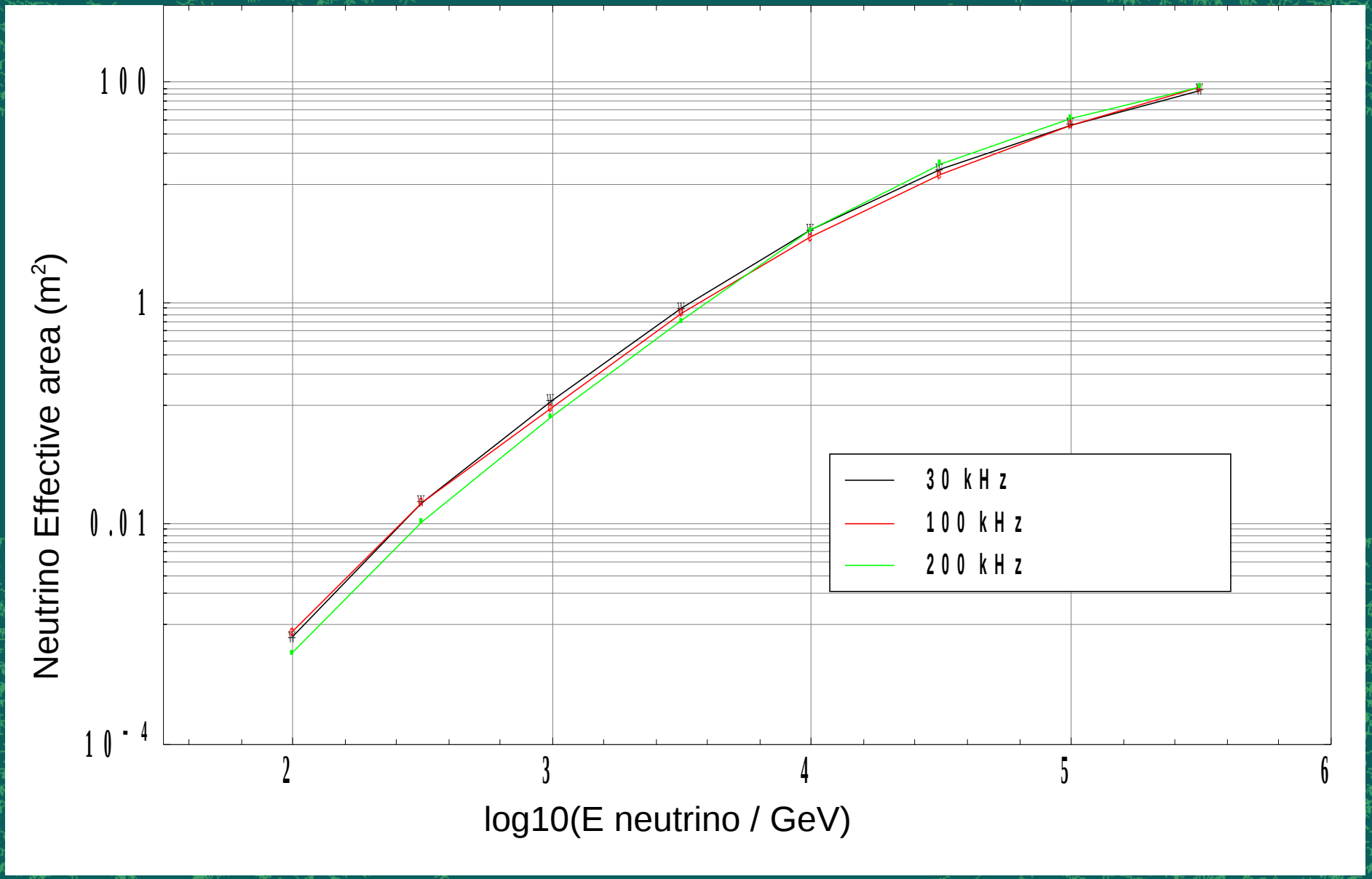


Trends on E^{-2} flux limits (relative values)

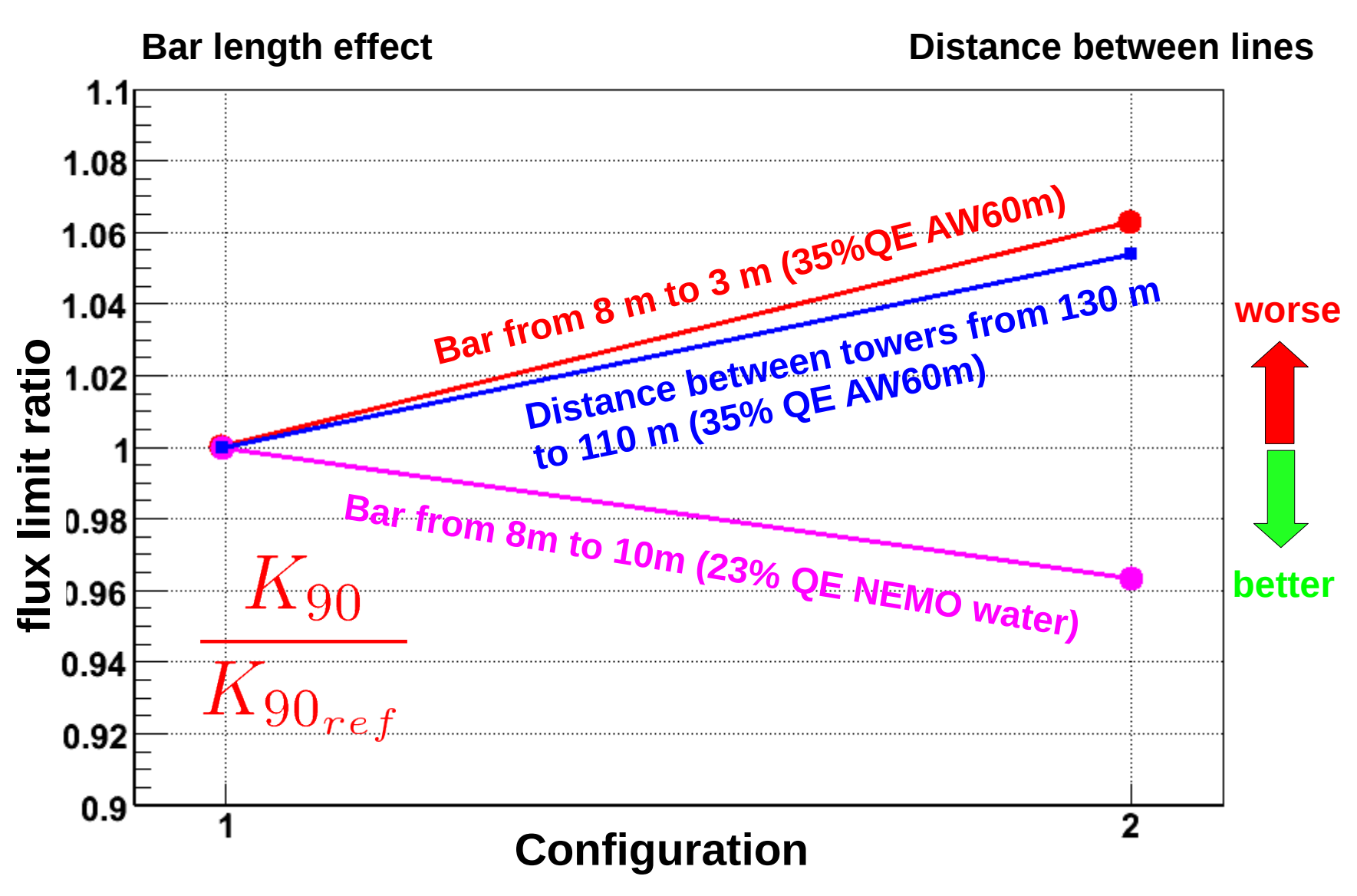


Mathematica work (D Dornic)

Effect of filtering

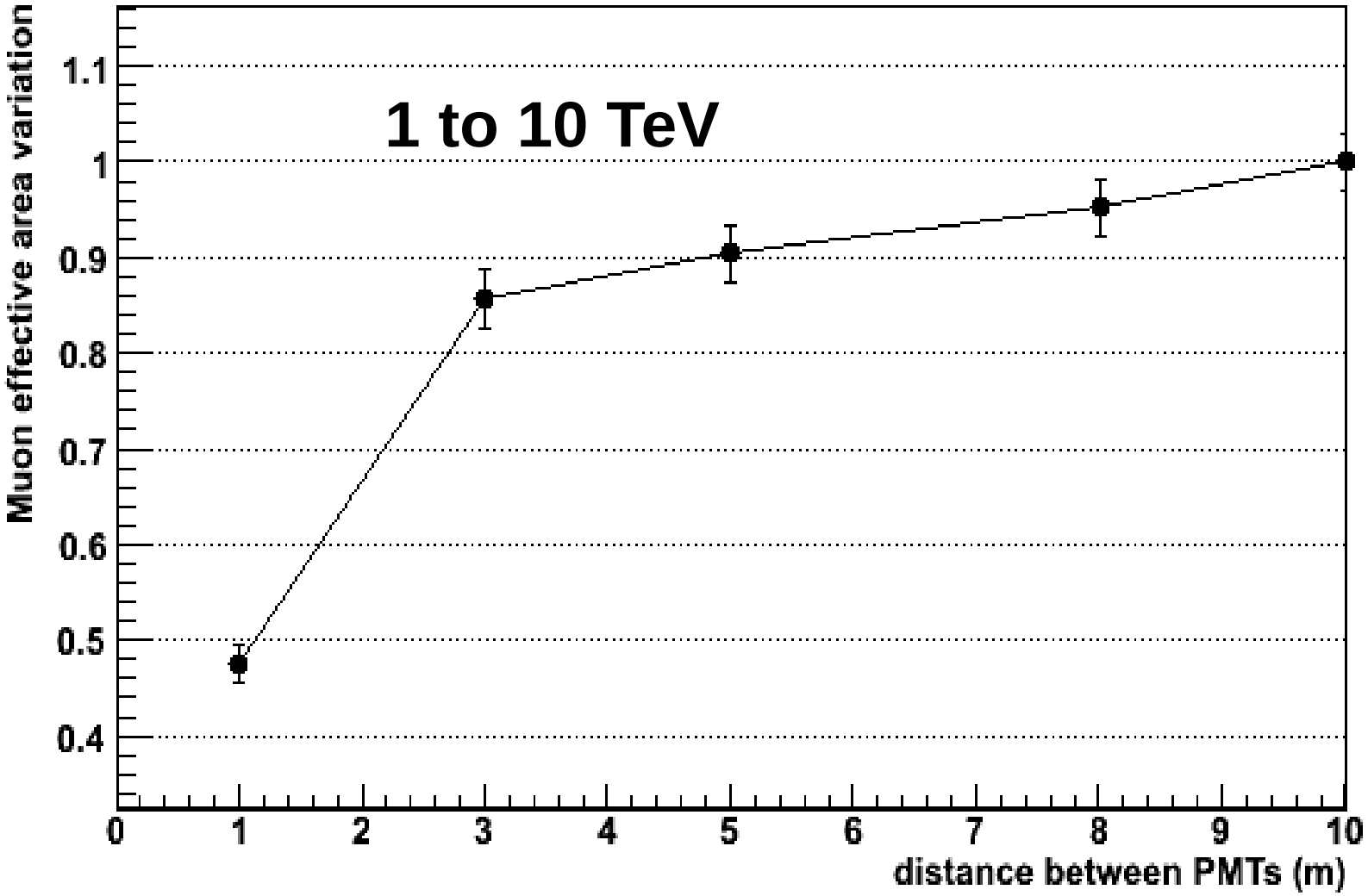


Trends on E^{-2} flux limits (relative values)



Mathematica work (D Dornic)

Bar effect

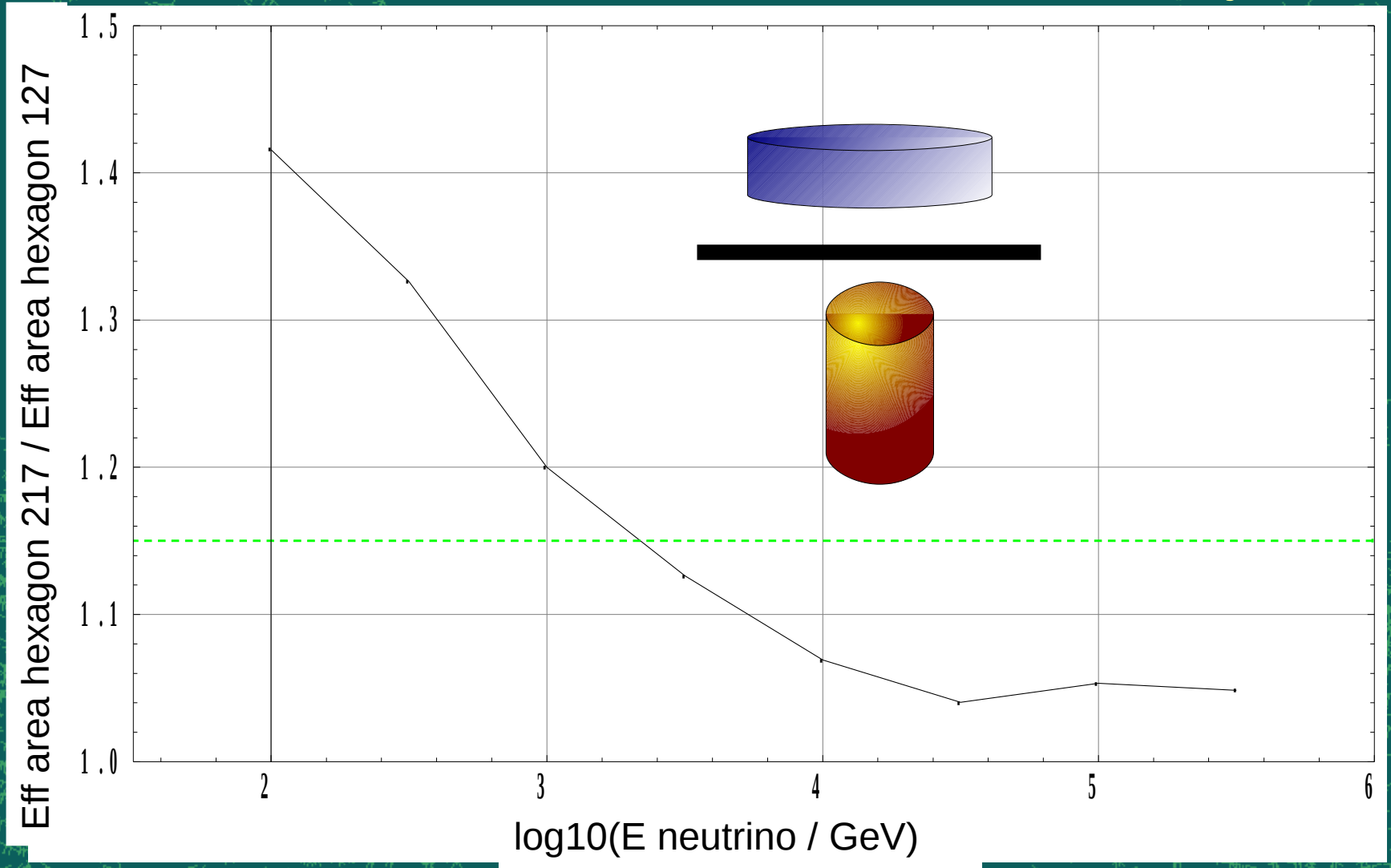


Mathematica work (D Dornic)

Flat or tall ?

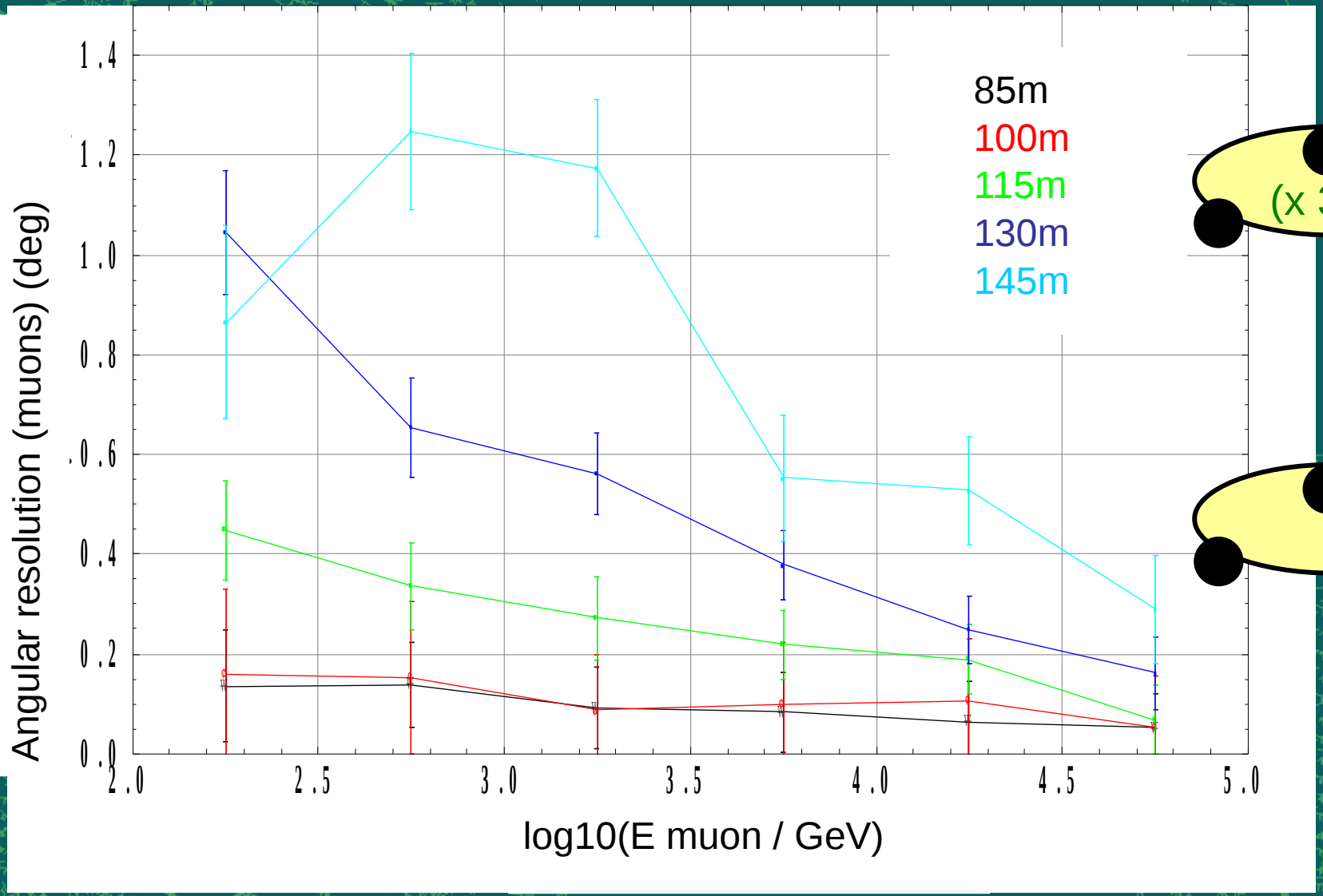
Flat

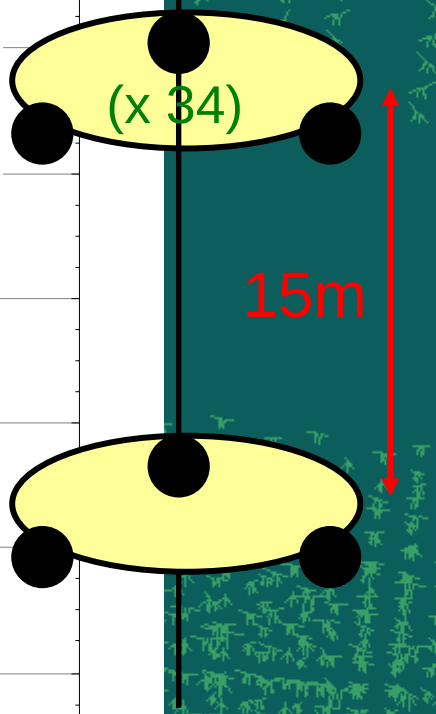
Comparison of the effective area: 217 lines with 34 storeys
127 lines with 58 storeys



Mathematica work (D Dornic)

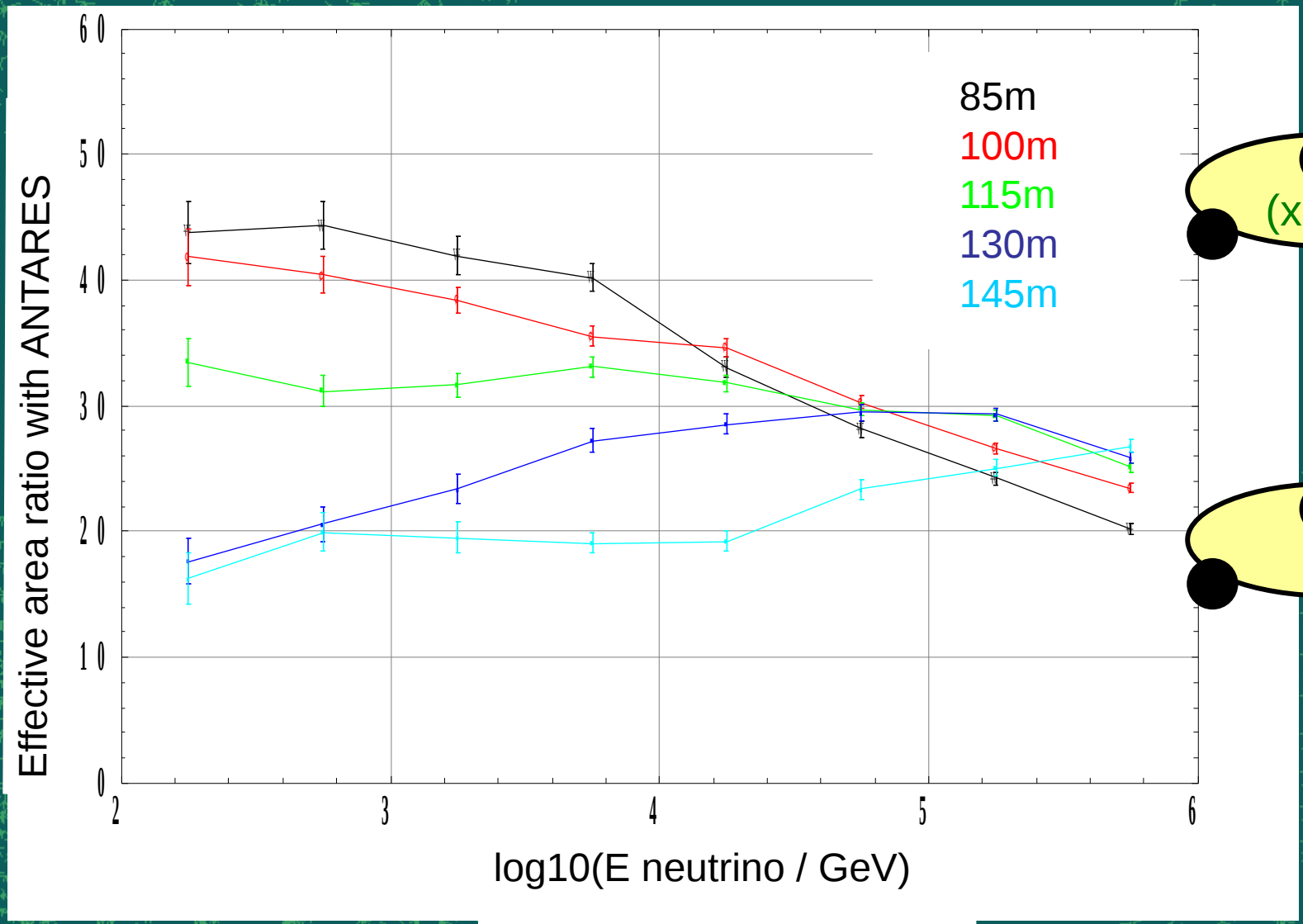
Distance between lines

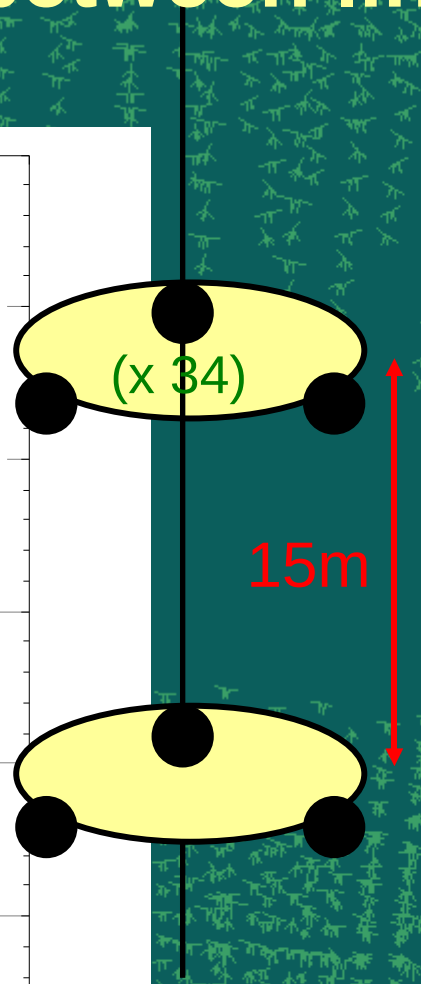




Mathematica work (D Dornic)

Distance between lines





Conclusions

The observed effects on sensitivity are expected
But they are of the level of a few percent to O(10%)

They may be enhanced or reduced by the reconstruction strategy, the hierarchy could be inverted.
Needs cross-check between different softs.

The used reconstruction is not intrinsically robust against high noise but a filtering seems efficient to recover nominal values.

A more important effect :
$E^{-\Gamma}$: ex : if Γ =2.1, the sensitivity is degraded by a factor 3.
(and atm muon MC becomes incomplete because biased in energy)