WP2 Meeting, Paris 10-11 December

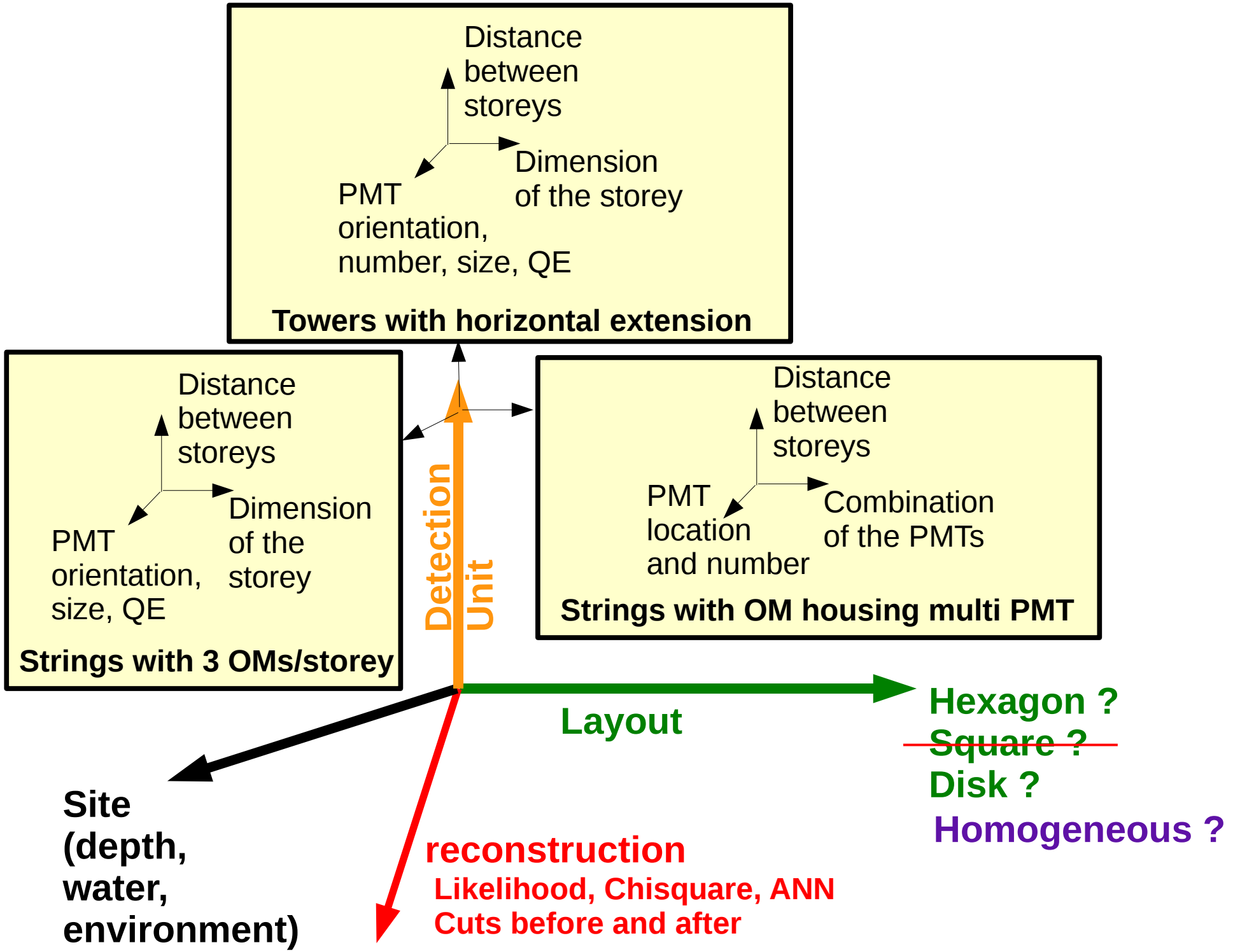
Goals :

make a status on the on-going optimization work,

discuss on the priorities: we cannot explore all the phase space,

define more clearly the role of WP2 in the DS : which inputs can we really give to the other WPs,

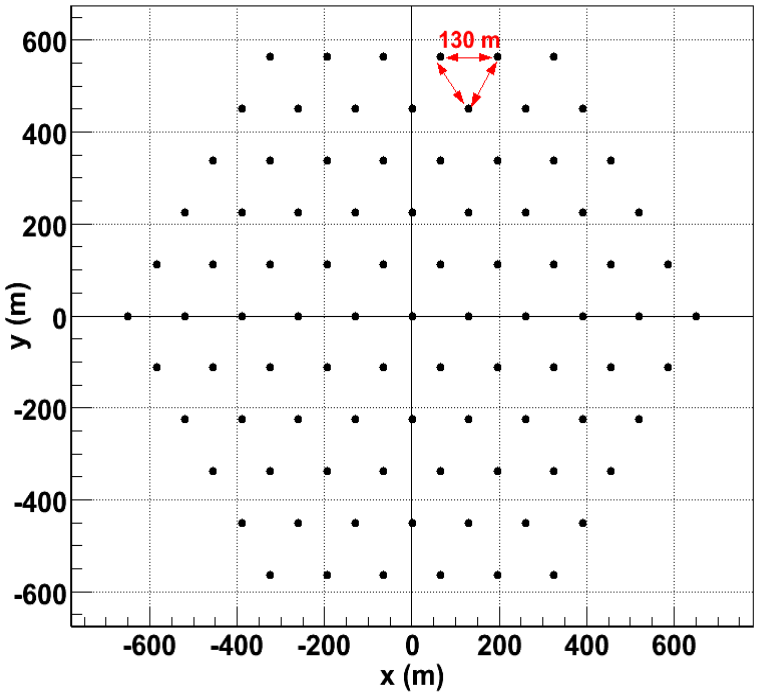
complete the “Who does what” list

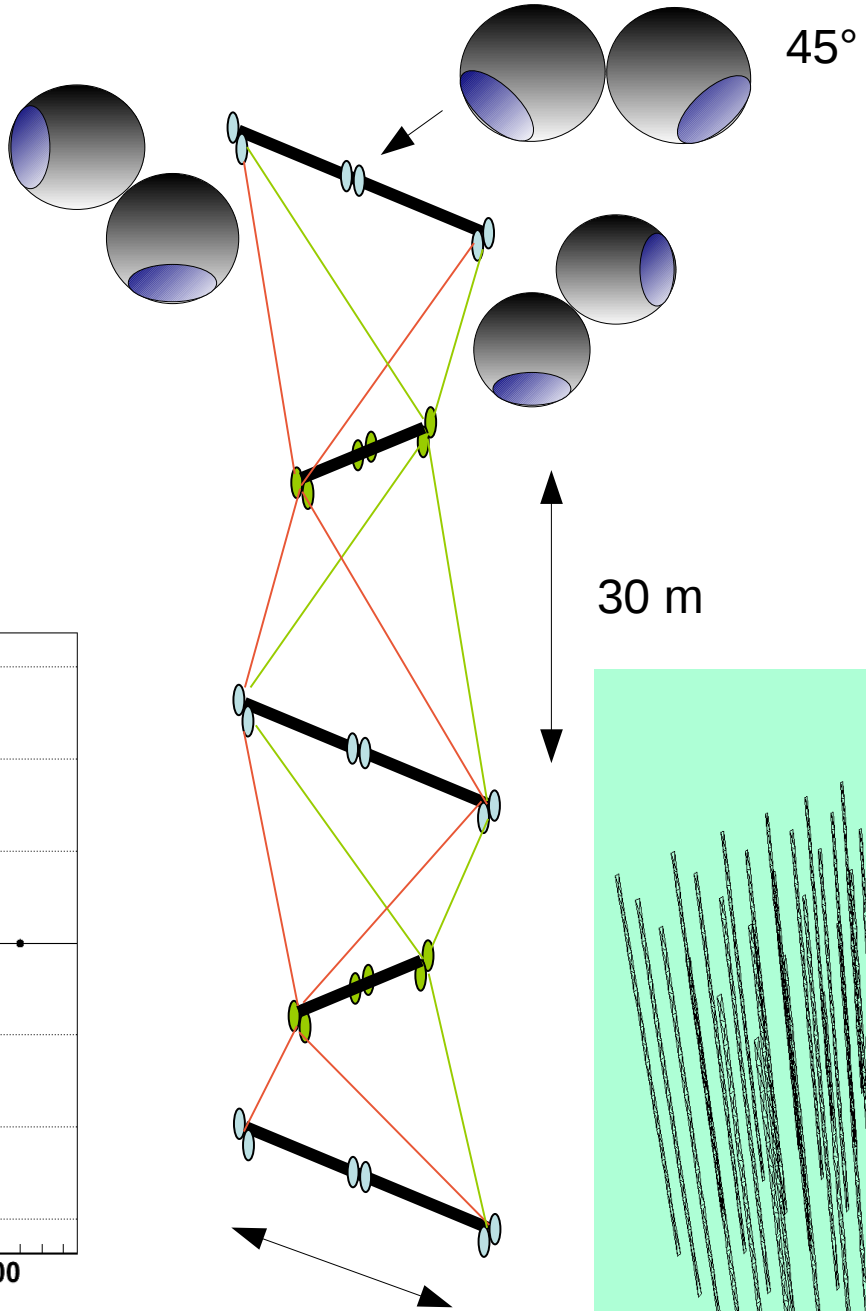

Distance between storeys
Dimension of the storey
PMT orientation, number, size, QE
Towers with horizontal extension
Distance between storeys
Dimension of the storey
PMT orientation, size, QE
Strings with 3 OMs/storey
Distance between storeys
Combination of the PMTs
PMT location and number
Strings with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

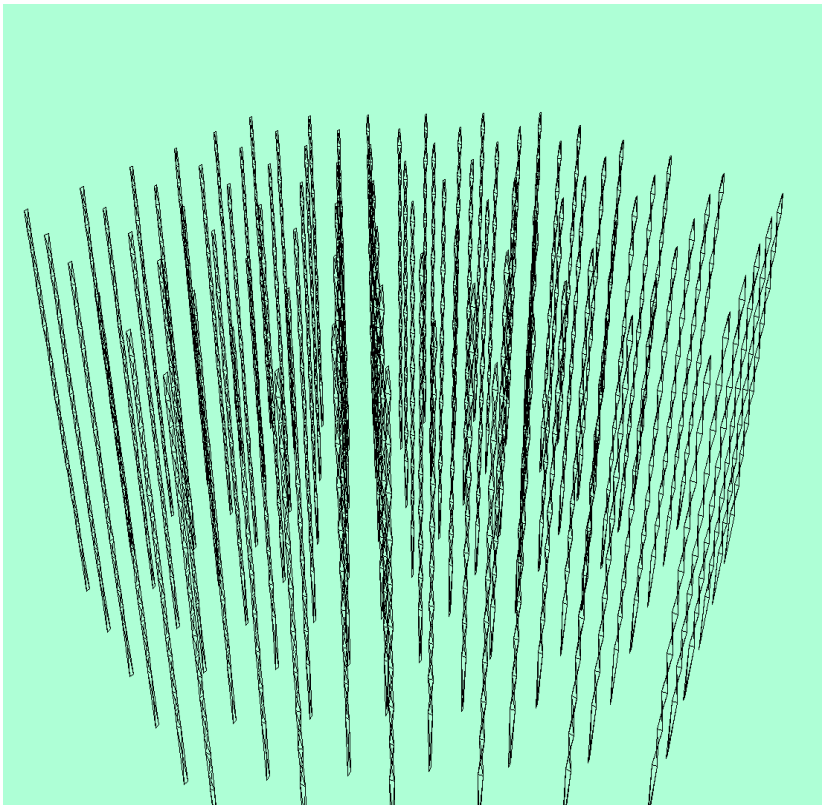
Some results of an exploration of the phase space

20 floors
91 lines
hexagonal layout
130 m
between lines

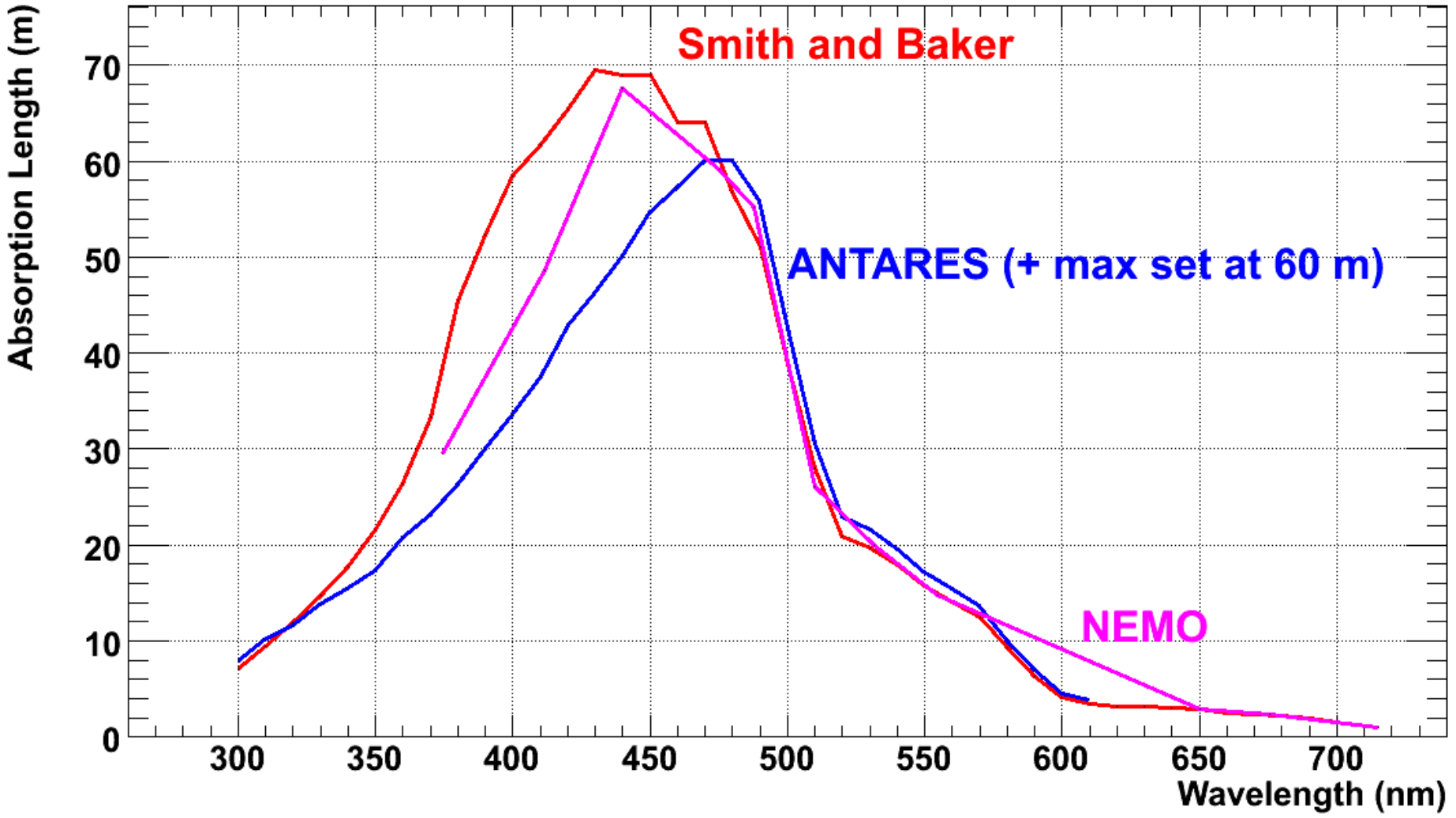
$V=0.63\ km^3$





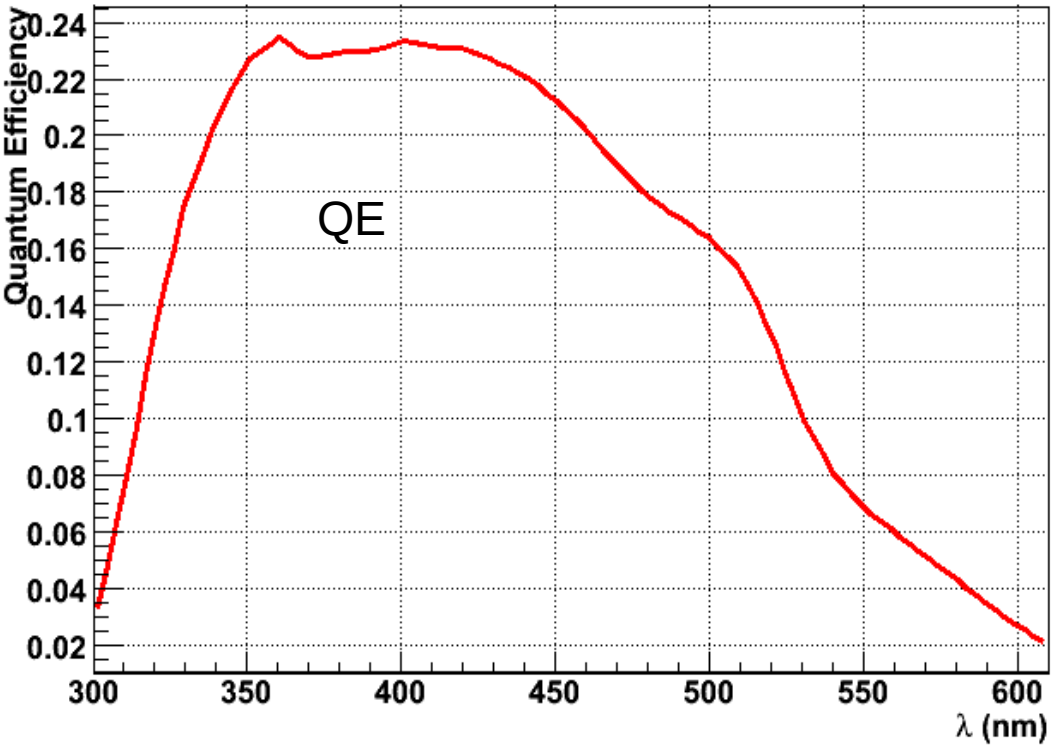


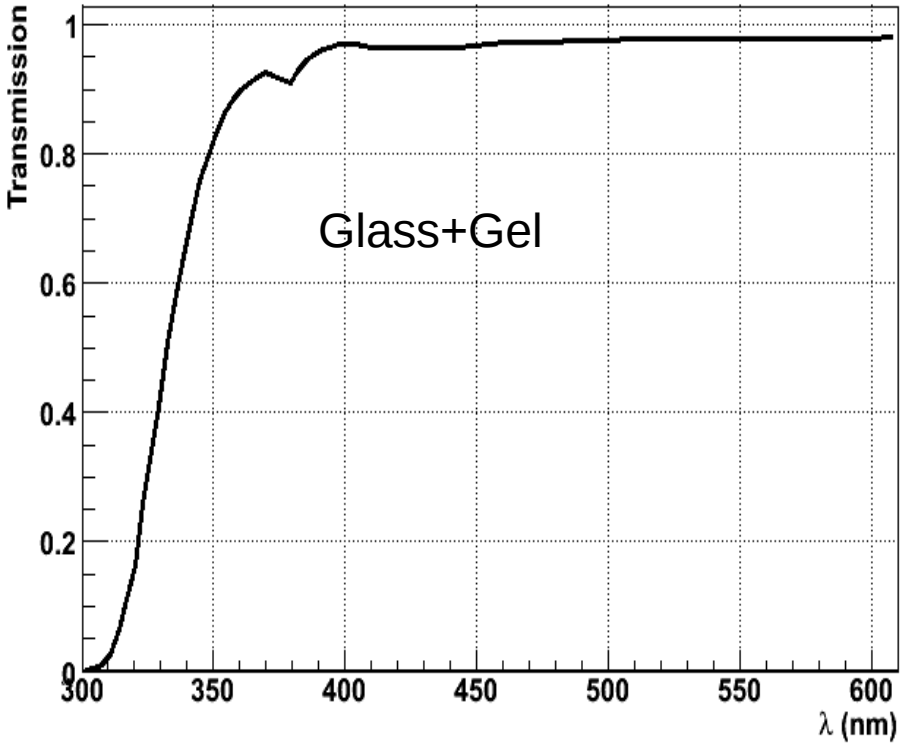
Medium properties

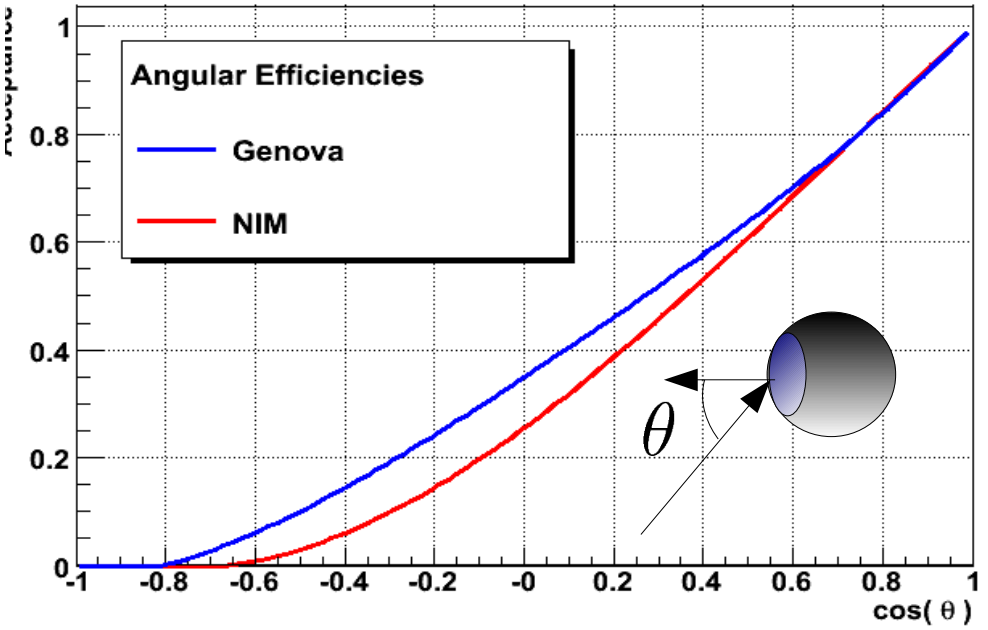


Scattering : same model for all

OM characteristics







Generation of atmospheric muons (5-10h) and of neutrinos

50 kHz of noise, try at 100 kHz to test some filtering

Reconstruction : Aart Strategy adapted for NEMO / χ^2 + KF from HOU

Cuts on : Λ and on the number of the intermediate tracks compatible in angle.

Tested configurations : Hexagonal layout with 110 m / 130 m between lines
Bar length 8 m / 10 m

Antares depth

Reconstruction

Hits selection (coincidence in time window or big hit)

Linear Prefit : mean track approximation:
not precise enough to use Maximum Likelihood Fit yet: O(20°)
ML fit needs start track with angular resolution better than few degrees:
ML fit highly sensitive to wrong input track

M-estimator Fit: robust step, partially independent of starting track error, required to get better input track for ML fit

maximized function: $G = \sum_i K(-2\sqrt{1 + A_i r_i^2/2}) - (1 - K) f_{ang}(a_i).$

A_i: amplitude of hit i, r_i: time residual of hit i,

$f_{ang}(a_i)$: angular response of Optical Module, K=0.05 from MC.

Result: angular resolution of a few degrees

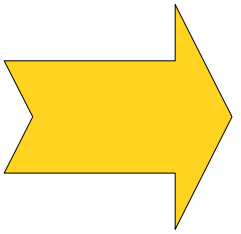
Likelihood fit only with time residuals, without background hits
(so-called original PDF)

(M estimator + ML fit) repeated with different starting tracks obtained by translation & rotation of the linear Prefit track.
Best result kept ➡ input for next step.

Number of compatible tracks defined here

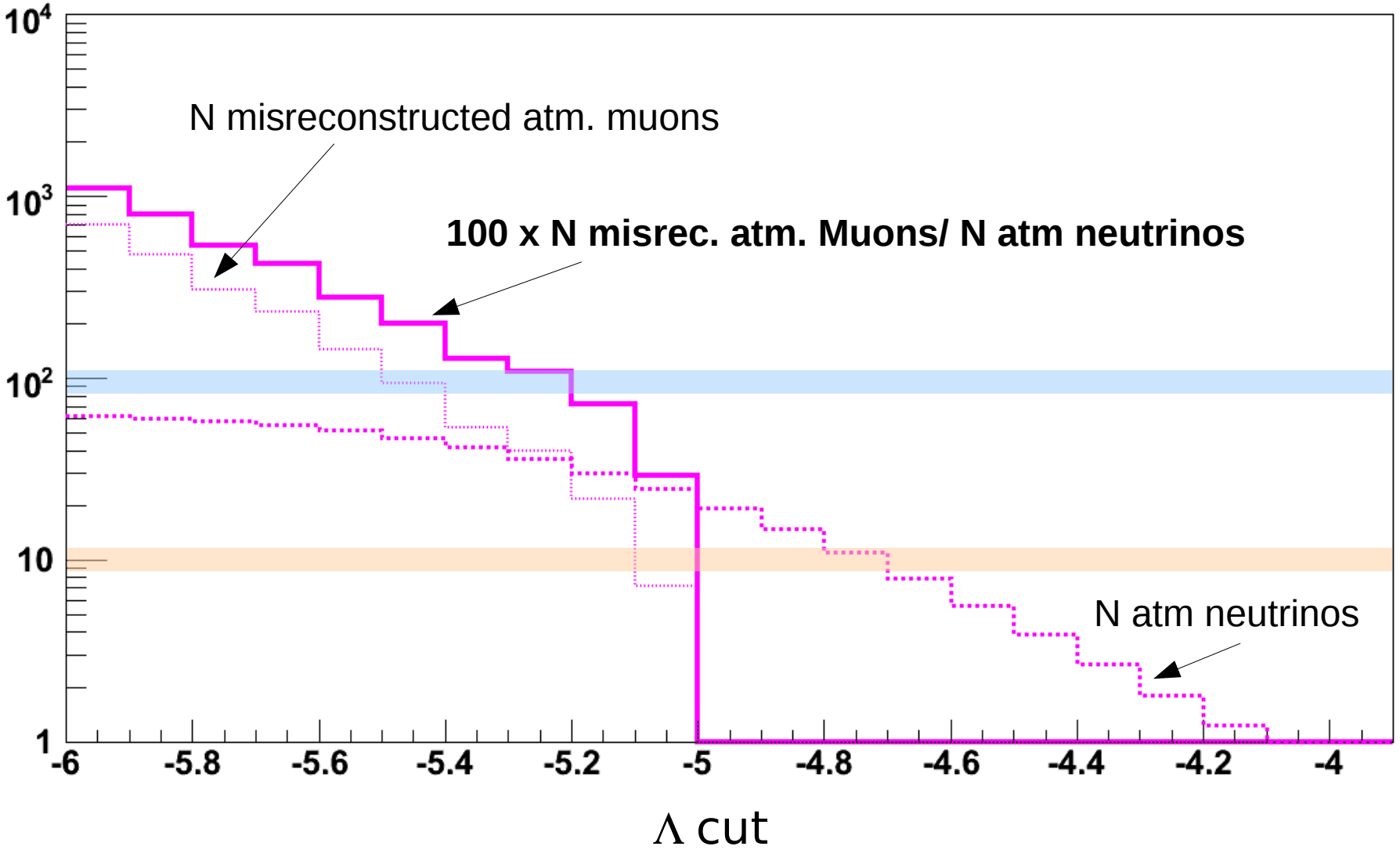
Maximum Likelihood using Full PDF (time, charge, background)

Which cuts to have a number of mis-reconstructed atmospheric muons (i.e. reconstructed as up-going) close to 10% of the up-going atmospheric neutrinos ?



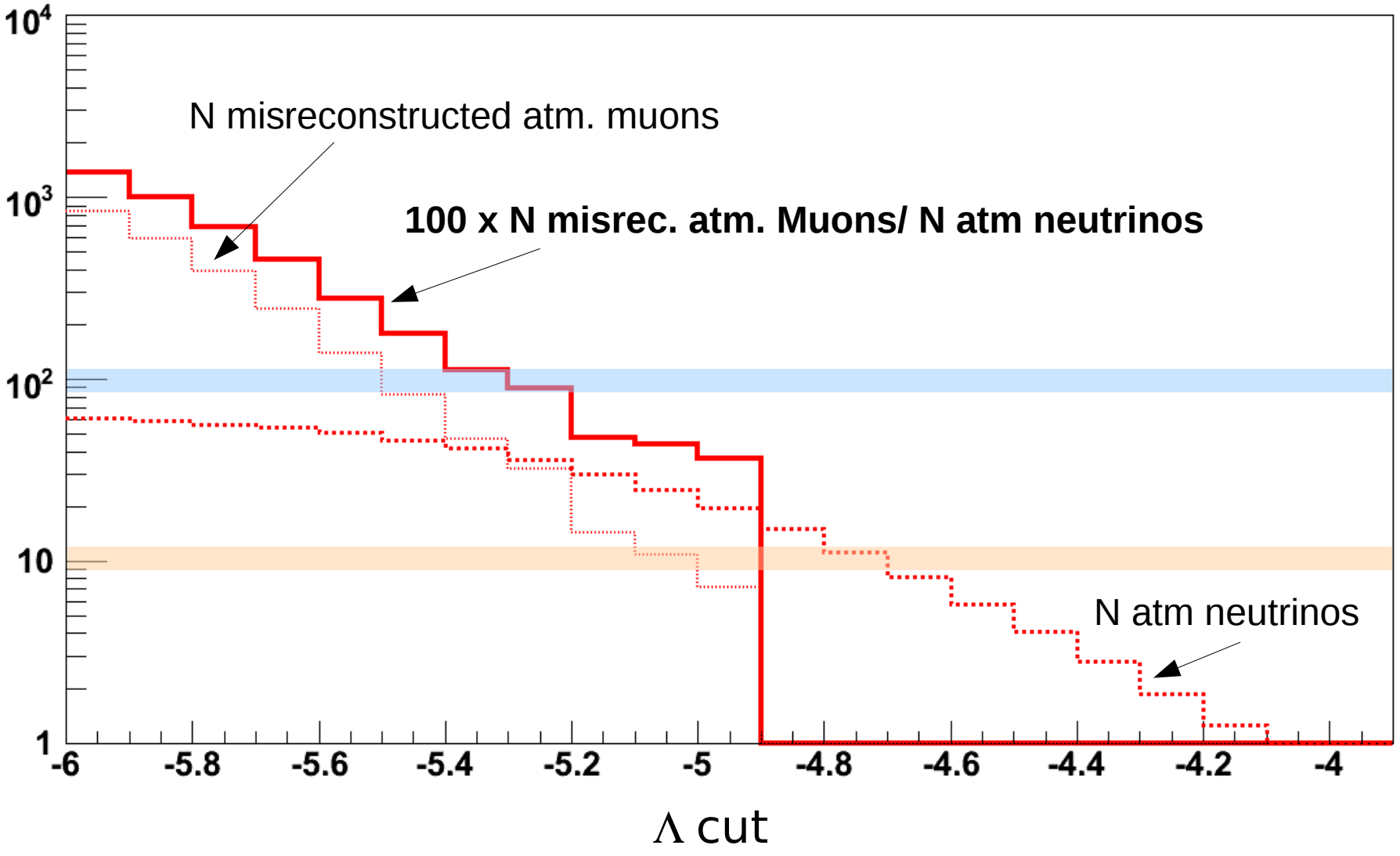
10m length, NEMO water, 23 % QE, 10'', 130 m between towers

Events/day



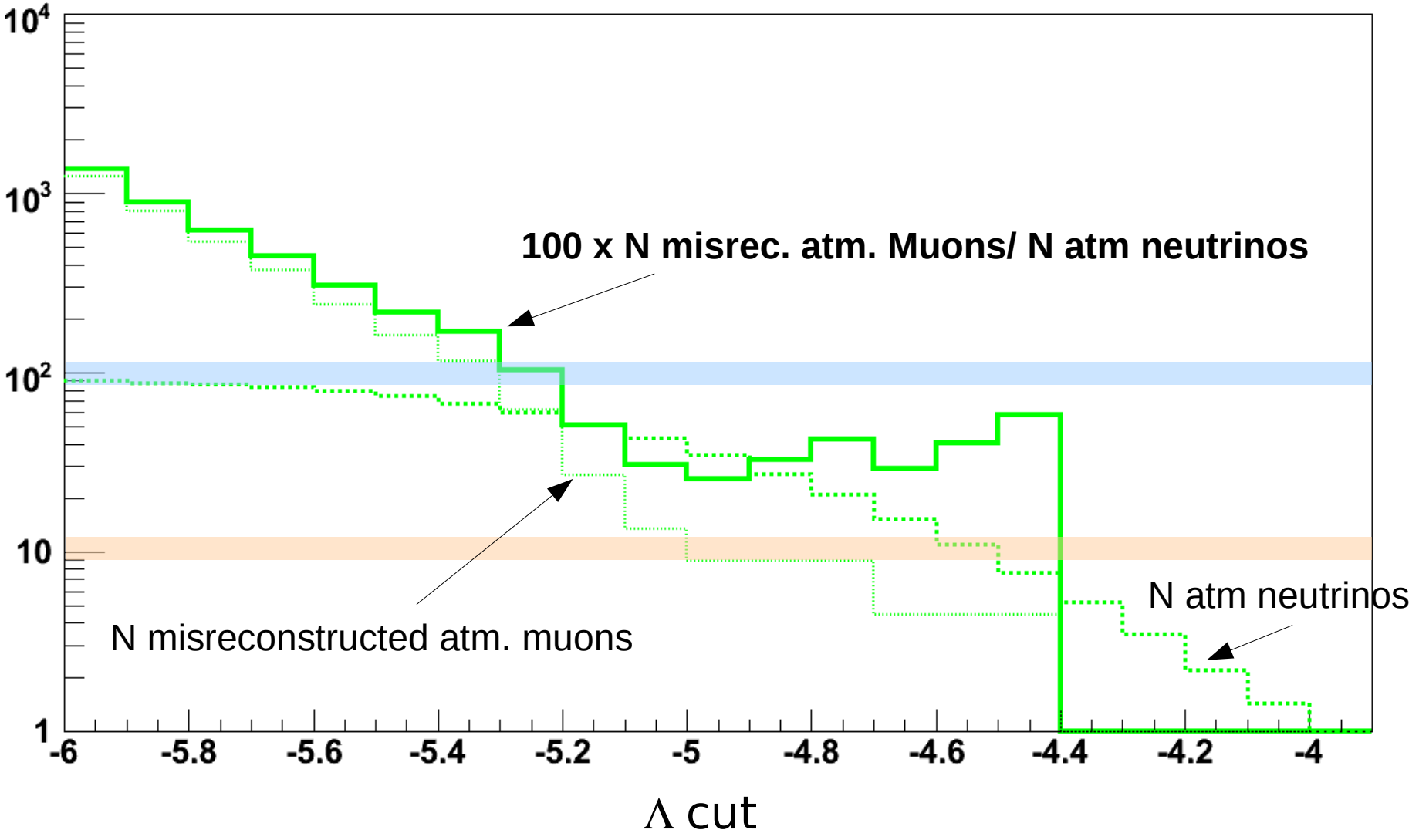
8m length, NEMO water, 23 % QE, 10'', 130 m between towers

Events/day



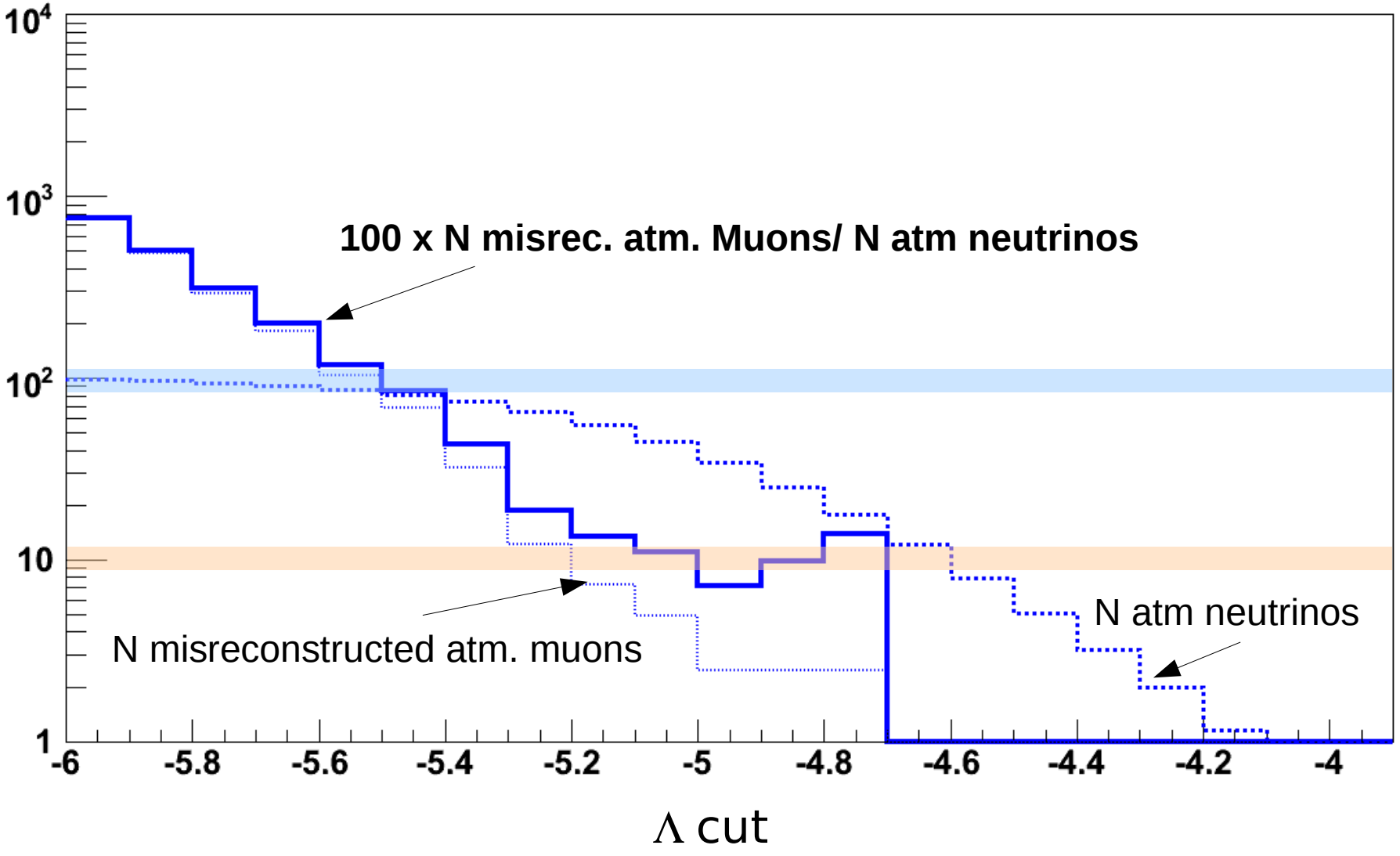
8m length, ANTARES water, 35 % QE, 10'', 130 m between towers

Events/day



8m length, ANTARES water, 35 % QE, 10'', 110 m between towers

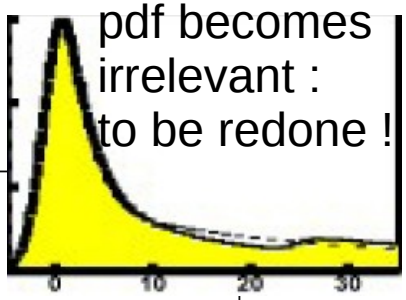
Events/day



8m length, ANTARES water, 35 % QE, 10'', 130 m between towers

Events/day

100 kHz , filtered



N misreconstructed atm. muons

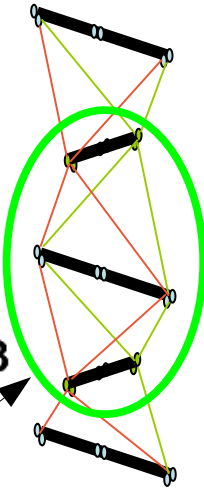
100 x N misrec. atm. Muons/ N atm neutrinos

N atm neutrinos

10^4
10^3
10^2
10
1

-6 -5.5 -5 -4.5 -4 -3.5 -3

Λ cut

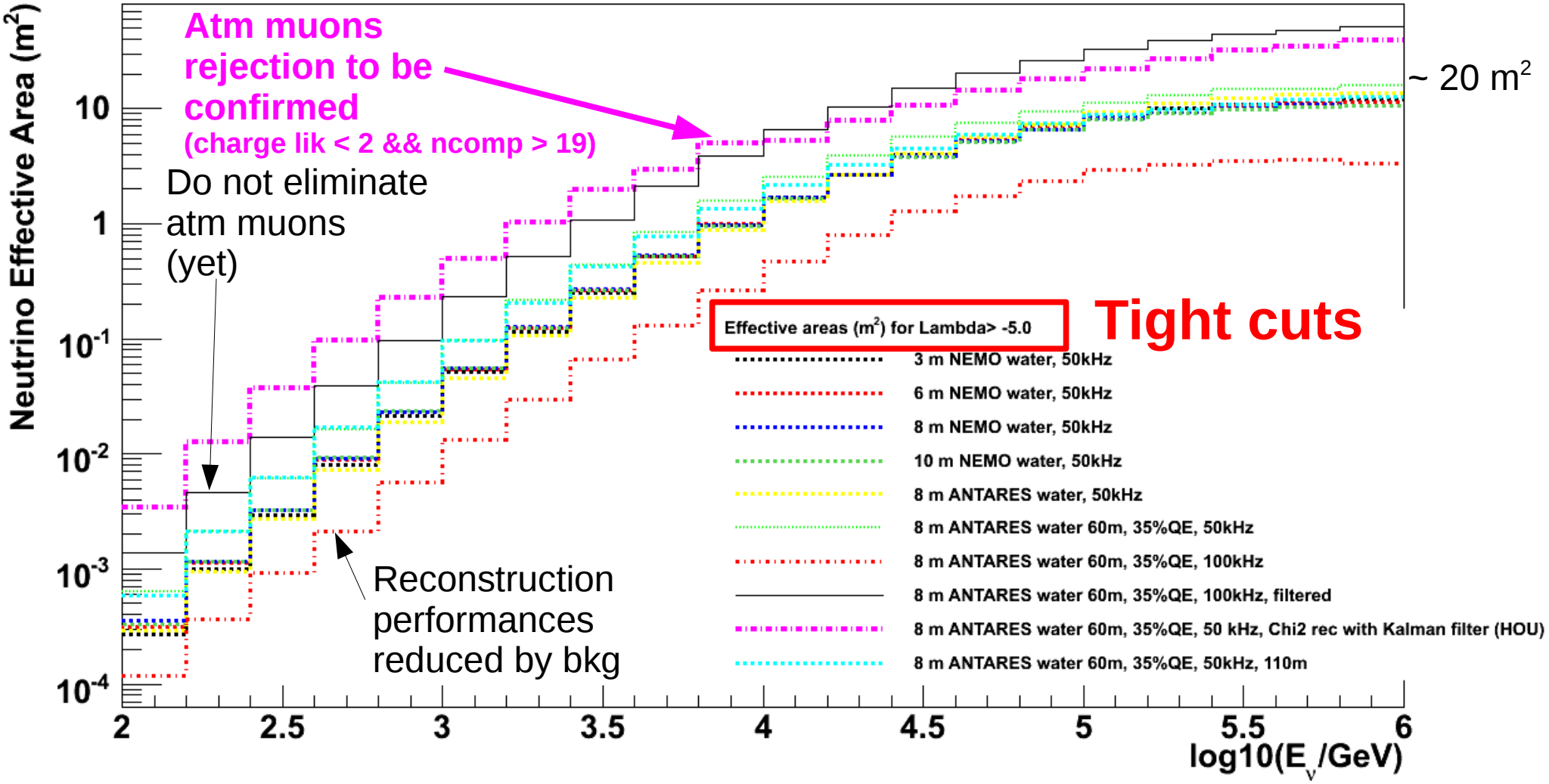


T3+ L0
recovery by
causality

Tight cuts are required to have a number of mis-reconstructed atmospheric muons (i.e. reconstructed as up-going) close to 10% of the up-going atmospheric neutrinos

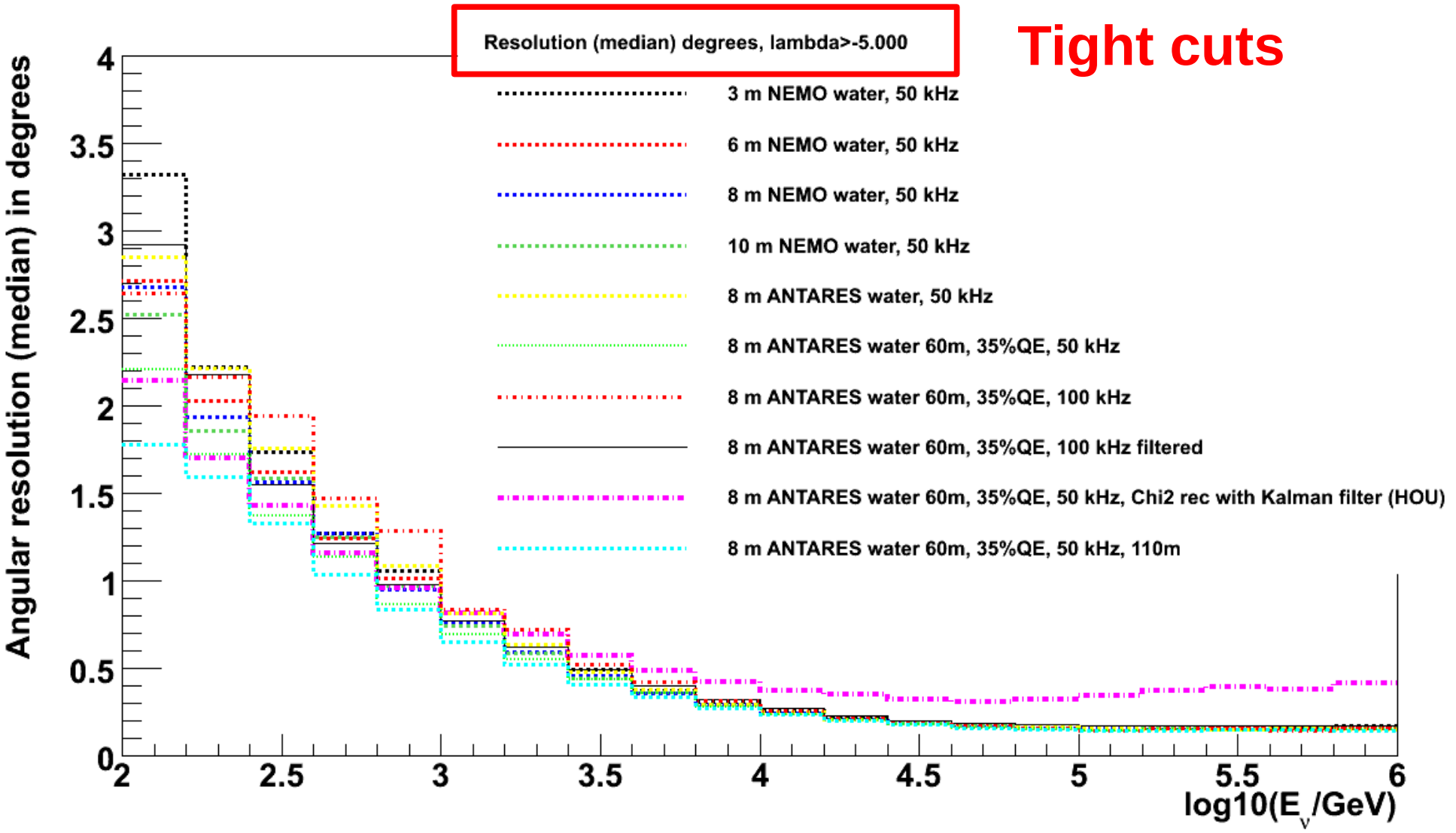
At least 2 compatible tracks

Effective area



At least 2 compatible tracks

Resolution (median)



Tight cuts

Sensititvity estimates (point sources)

Rough : I assume that misreconstructed (up-going) atm muons are flat in cos(θ)

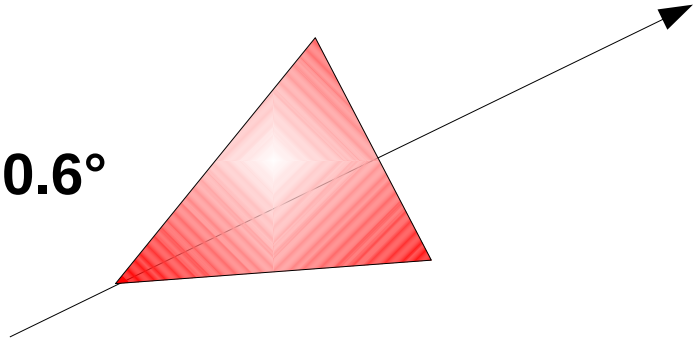
Test flux : $E^2 \Phi = 2.25\ 10^{-8}$ Gev/cm^{-2}/s

The normalisation value is arbitrary : the sensitivity will be fixed by MRF : $<\mu_{90}>/n_s$.

Fixed cuts :

cone aperture : 3 x resol (median~0.2°) = 0.6°

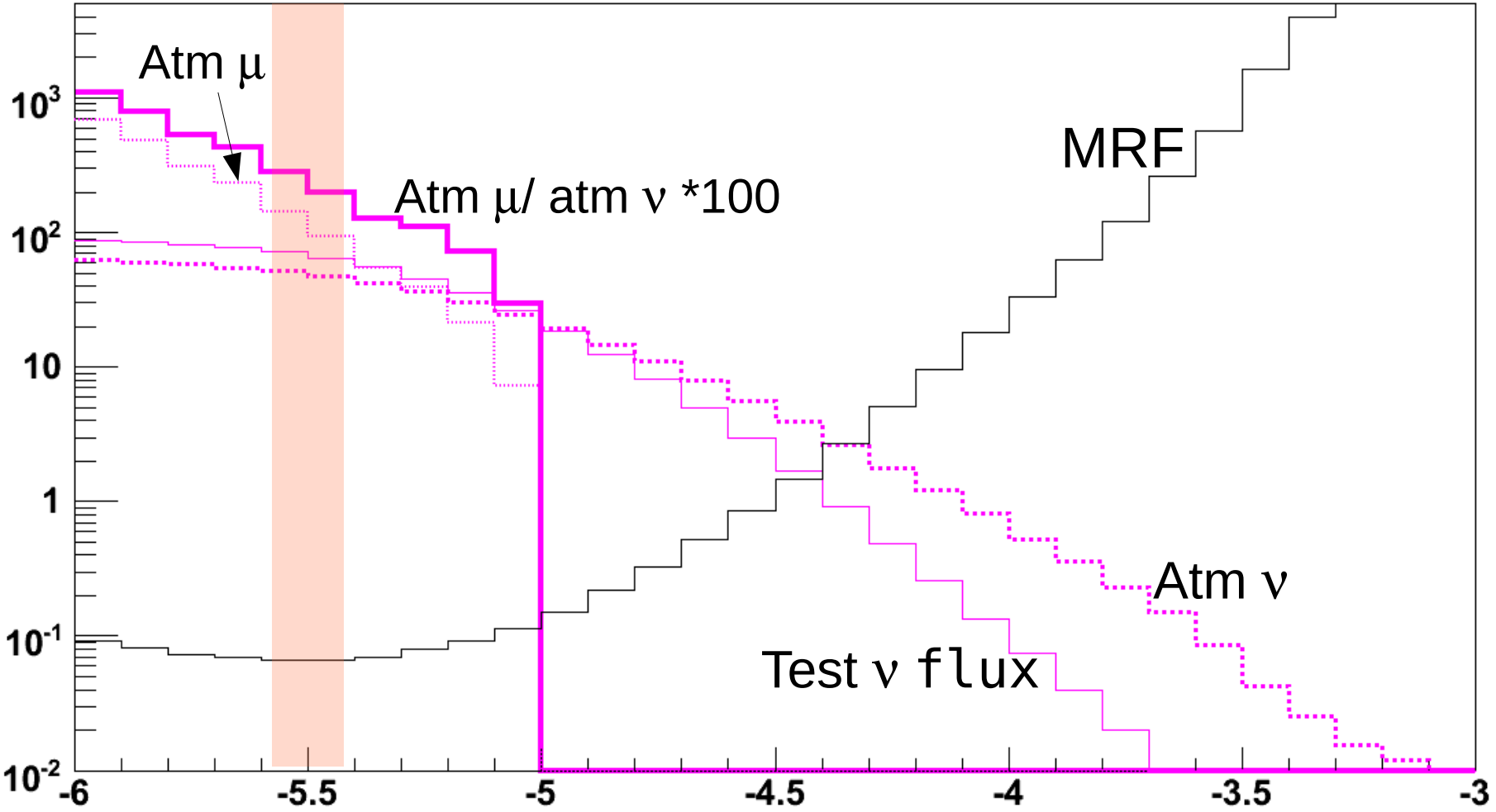
number of compatible tracks : 2



Running cut : Λ

10m length, NEMO water, 23 % QE, 10'', 130 m between towers

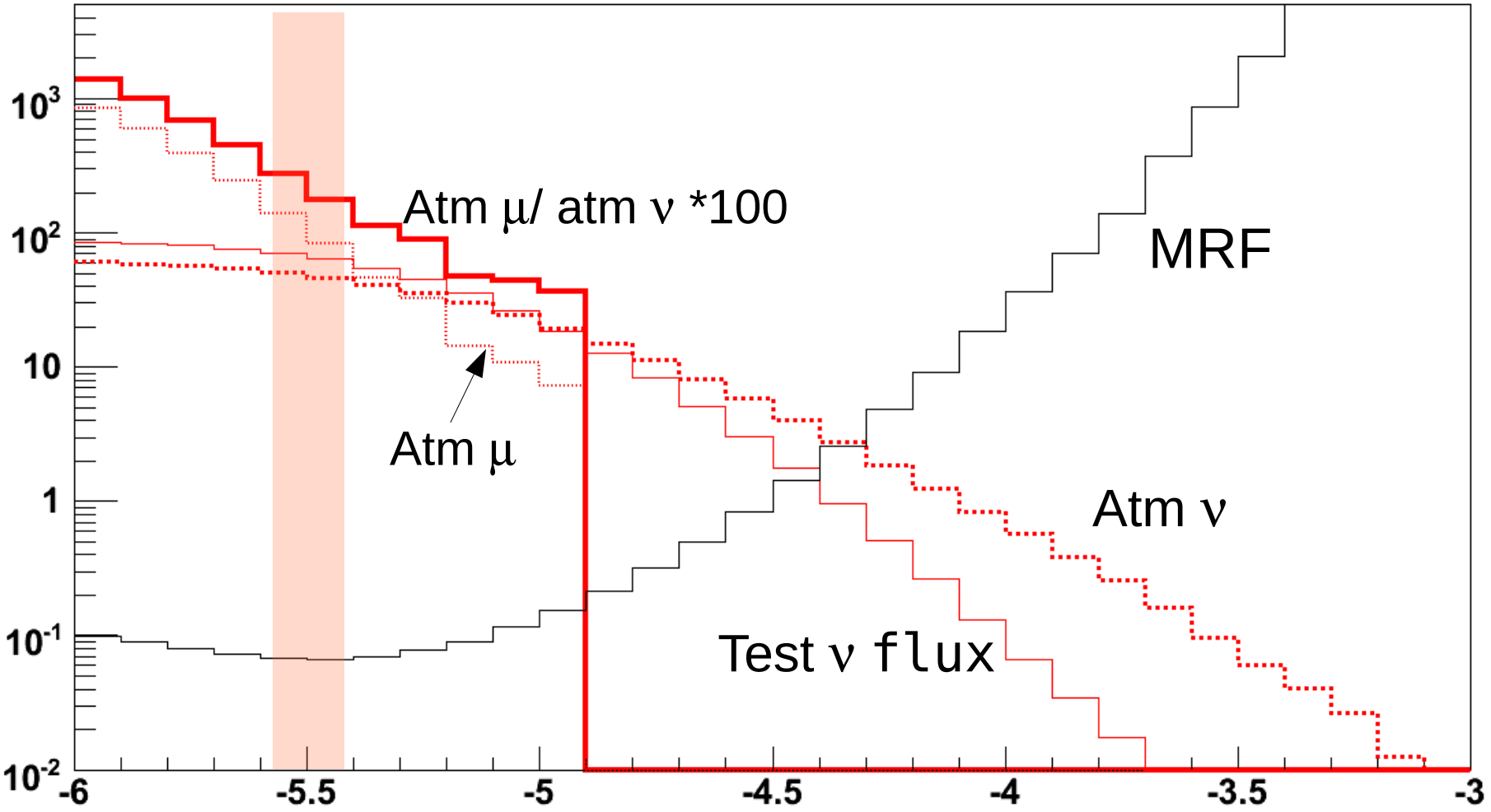
Events/day for atm muons and neutrinos, evts/year for the test flux



~50 atm neutrinos/day
~150 misrec atm muons/day

8m length, NEMO water, 23 % QE, 10'', 130 m between towers

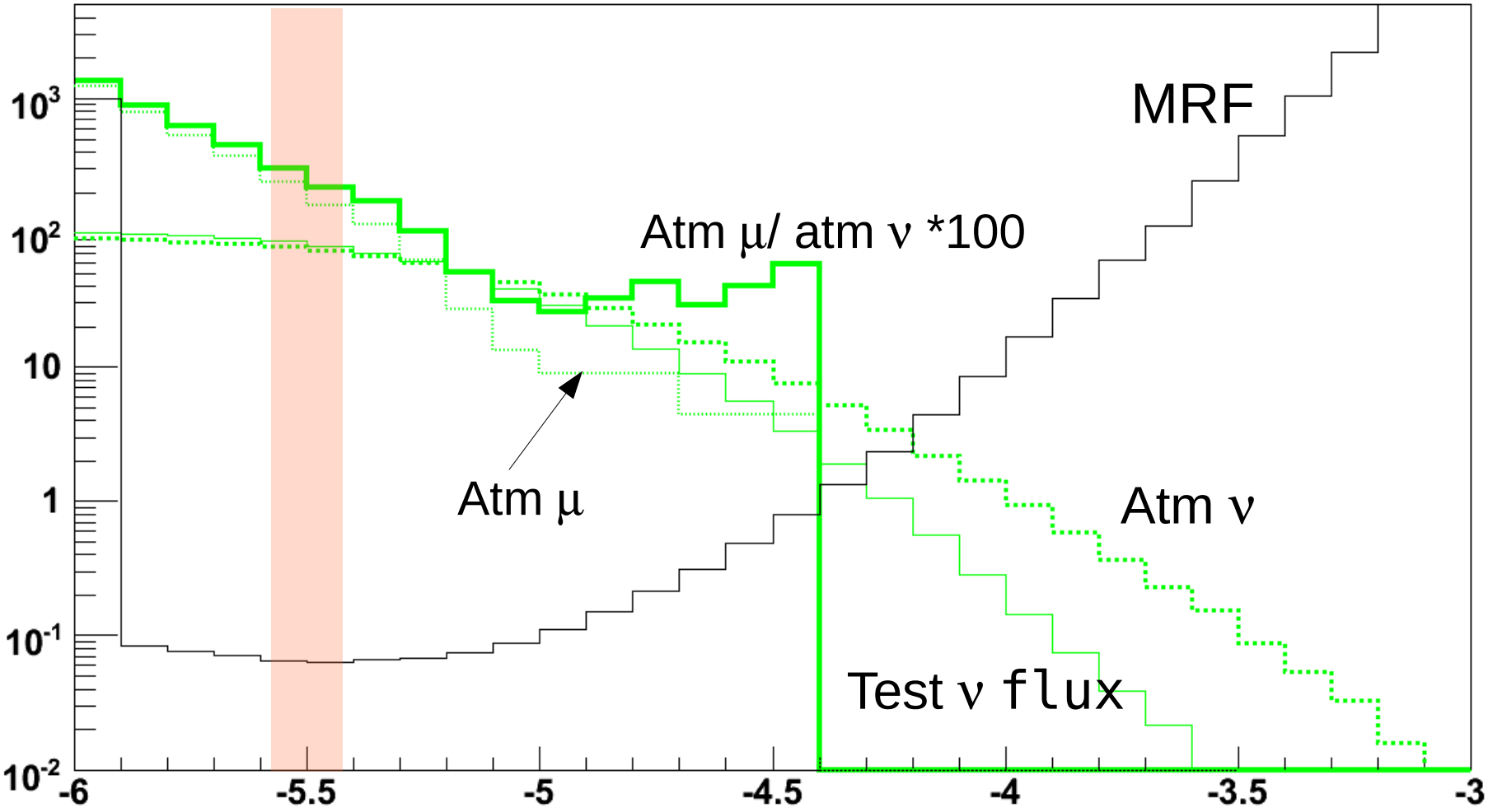
Events/day for atm muons and neutrinos, evts/year for the test flux



~50 atm neutrinos/day
~ 100 misrec atm muons/day

8m length, ANTARES water, 35 % QE, 10'', 130 m between towers

Events/day for atm muons and neutrinos, evts/year for the test flux

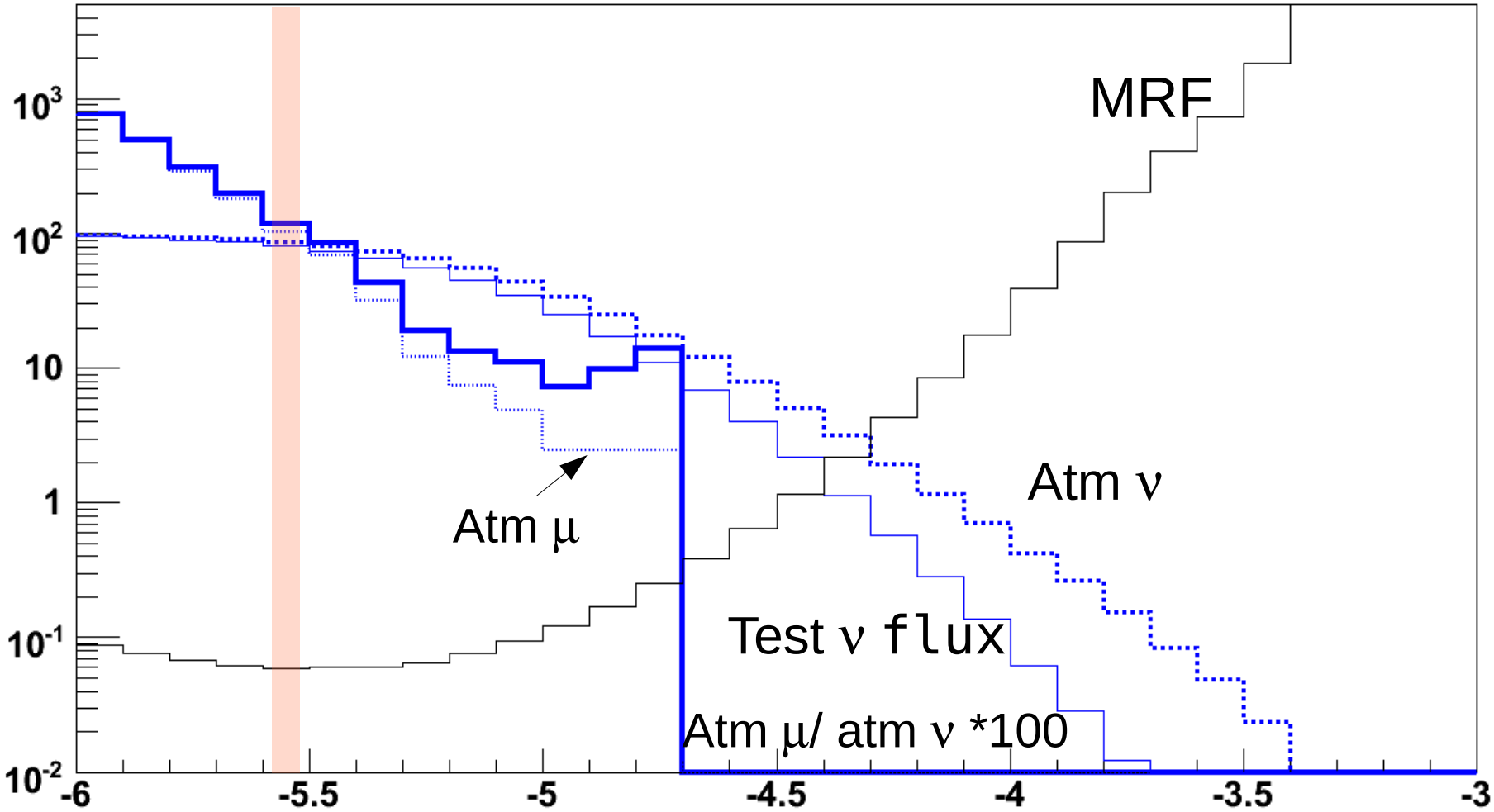


~100 atm neutrinos/day
~200 misrec atm muons/day

Λ cut

8m length, ANTARES water, 35 % QE, 10'', 110 m between towers

Events/day for atm muons and neutrinos, evts/year for the test flux

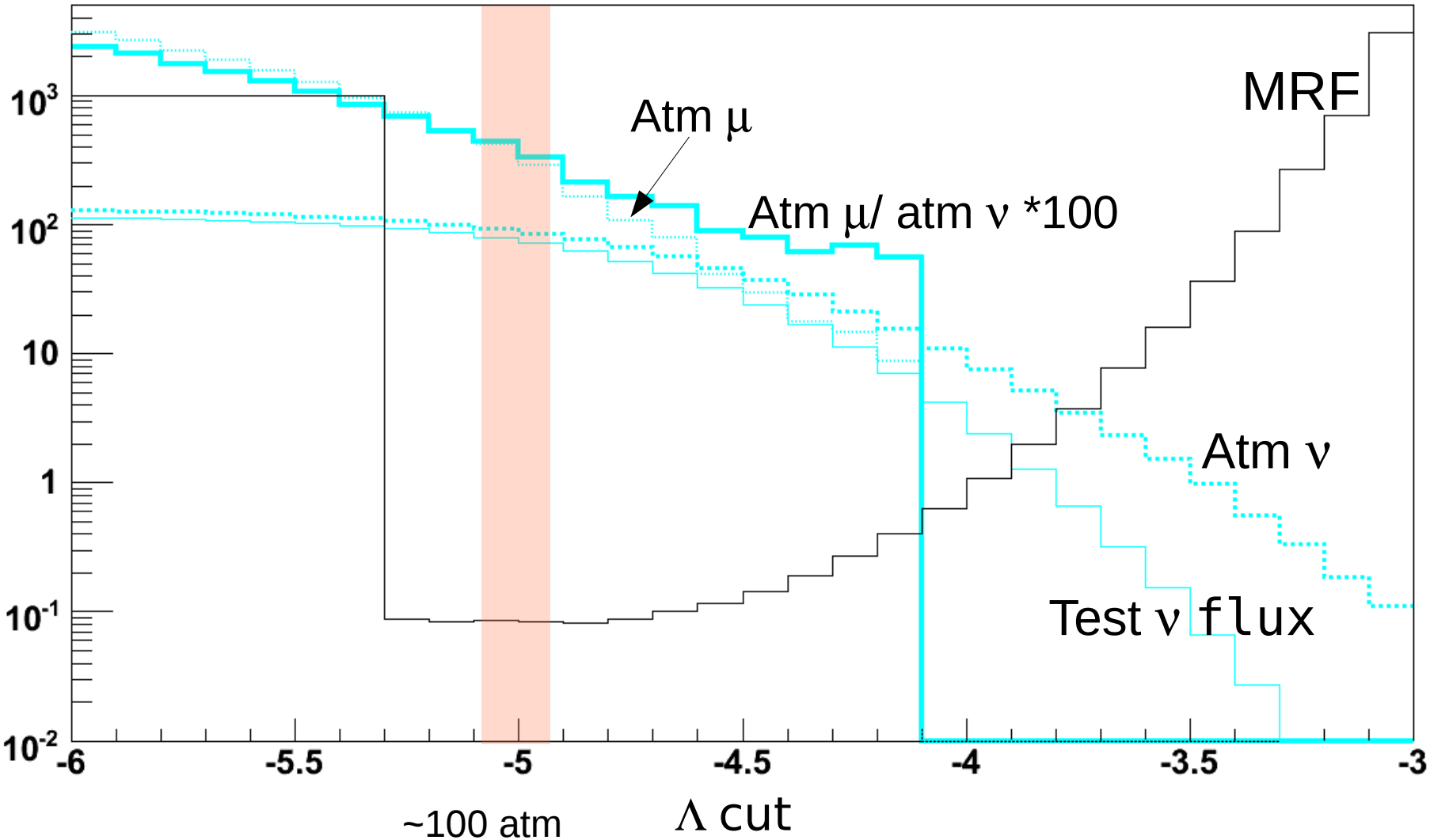


~100 atm neutrinos/day
~120 misrec atm muons/day

Λ cut

8m length, ANTARES water, 35 % QE, 10'', 130 m between towers

100 kHz , filtered



~100 atm neutrinos/day
~300 misrec atm muons/day

Events/day for atm muons and neutrinos, evts/year for the test flux

For each configuration, we obtain a sensitivity of about

$E^2\Phi=1.5\ 10^{-9}$ GeV/cm^2/s (one year)

Λ cut @ -5.5

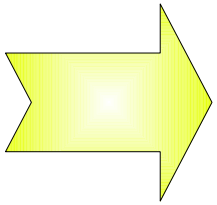
except for filtered hits:

Λ cut @ -5

N compatible tracks @ 2

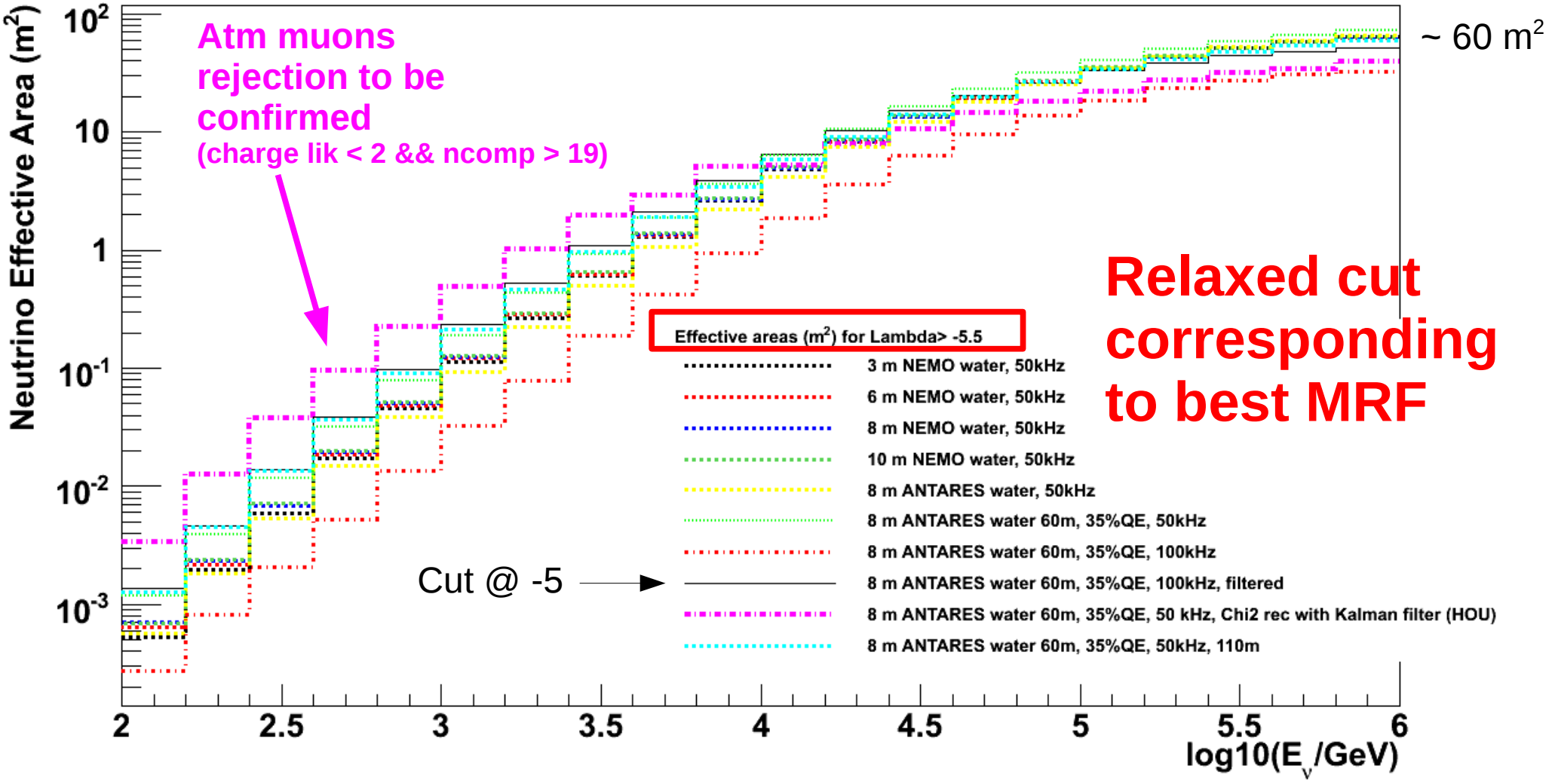
cone 0.6°

Λ and compatible tracks cuts are used for the effective area and resolution estimates :



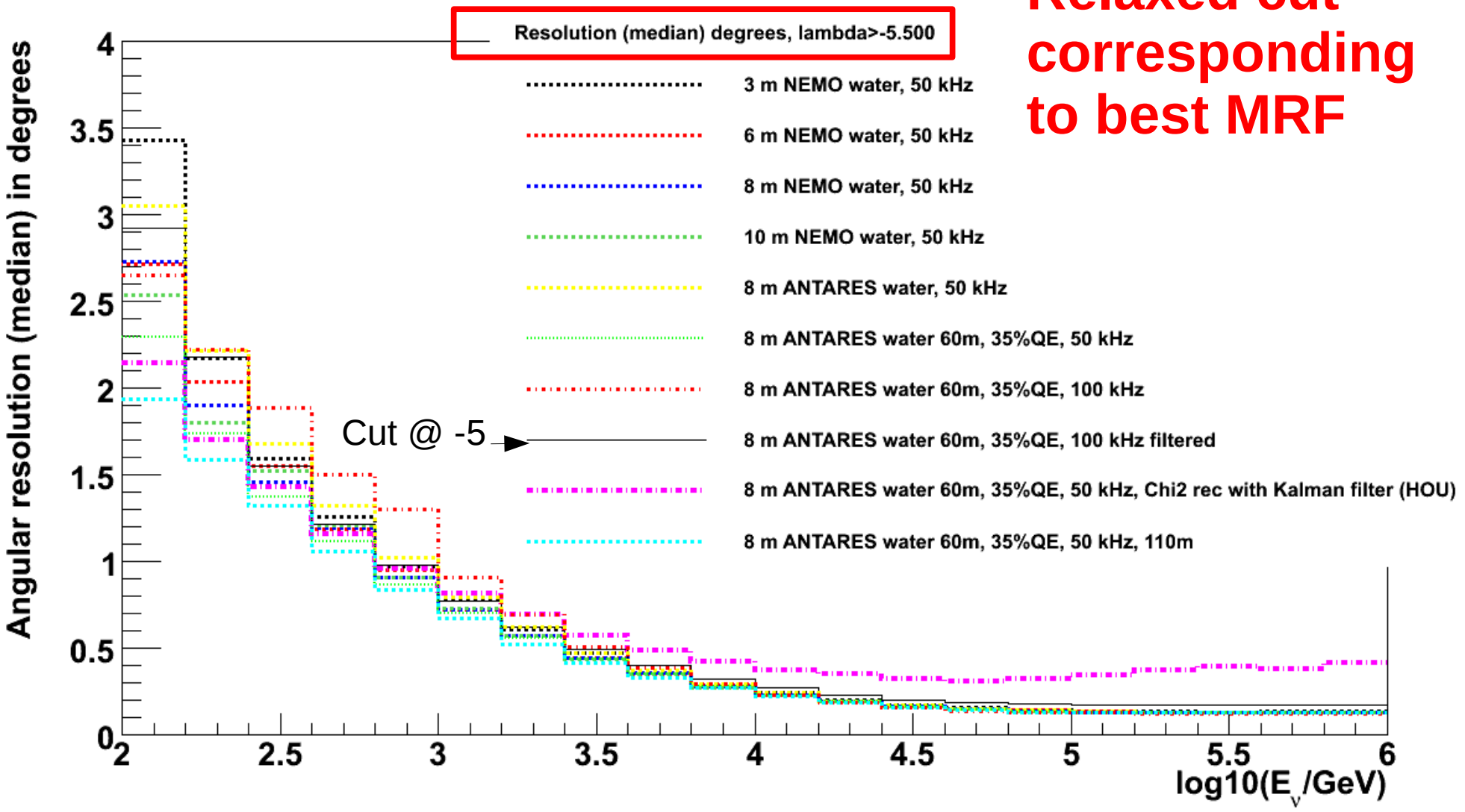
At least 2 compatible tracks

Effective area



At least 2 compatible tracks

Resolution (median)



Relaxed cut corresponding to best MRF

First conclusions :

Distance between lines is important for atm. muon rejection

Distance between floors (? because not tested) : probably : to be tested

Number/orientation of PMTs in a storey : see presentations in this meeting

Filtering : essential to improve performances, but pdf has to be tuned according to the new set of hits.

Kalman filters + χ^2 : very efficient

Electronics (ex. Waveform to reject atm muons) : not yet tested

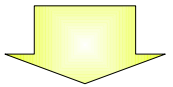
Conclusions :

Need to show effective areas together with the rate of mis-reconstructed muon events and/or with the sensitivities to point sources.

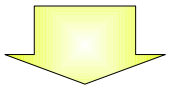
A possible (and common) reference is to tune the cuts to have misreconstructed (as up going) atm muon =10% of atmospheric neutrinos : **does not correspond to the best sensitivity**

Phase space long to explore and not very sensitive.

Moreover, the reconstruction and the associated cuts play a fundamental role.



WP2 can give trends and reasonable ranges, but must not give "the" detector.



We have to define these reasonable ranges and to align them with the technical constraints (WPX).