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# *High Resolution Point Source Search*

Aart Heijboer, Claudio Bogazzi, Joris Hartman  
Nikhef

- aafit production
- detector studies
- latest sensitivity curves
- tau-neutrinos

# aafit status

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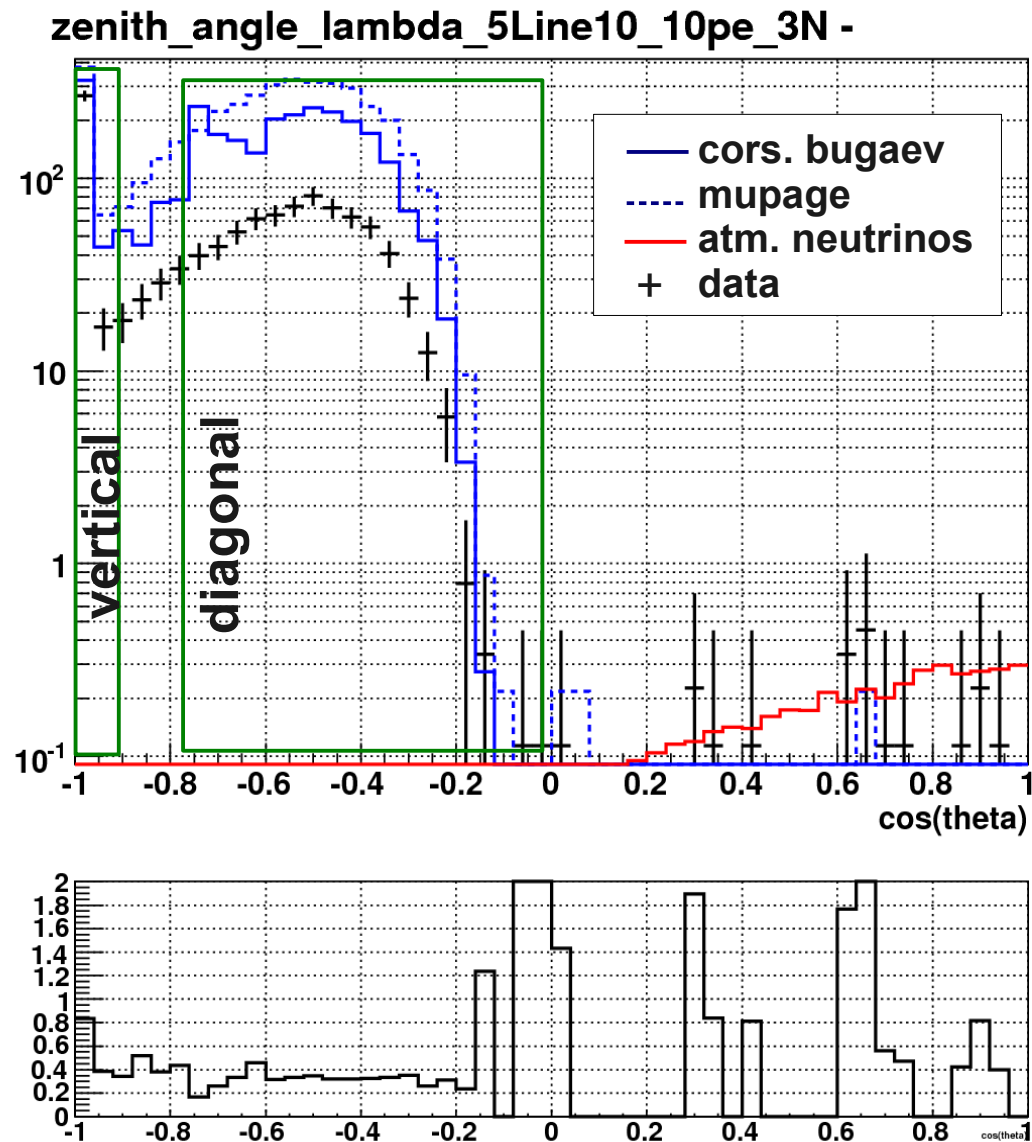
- Soon after cern meeting: version which sets all hit-amplitudes to 1.0 pe
  - embarrassingly: angular resolution improves → keep the change
- currently, v0r4... since v0r1:
  - no changes to algorithm!
  - added histogramming of hit-quantities, hitstudies
  - added some information (e.g. mc header) to output where missing
  - try to make script robust for known problems
- Thanks to early users (Garo, Manuela) for reporting problems (related to 32bit running and two different root installations...)
  
- March 2010 production available
  - 2007, 2008 data + corsika + mupage + neutrinos for 8 periods
  - start as much as possible from official files, but
  - run triggerefficiency (-C2 -A -R etc...) myself to get results soon
    - Use noise-templates from full period, rather than 1 proxy run (see my talk at Feb 26 AWG meeting for why...)

# Production

period	#runs	live-days	#noscan	live-noscan	#align	live-align
Line5_3pe_3N	631	119.3061	630	119.2801	614	117.3451
Line5_10pe_3N	308	47.0327	308	47.0327	307	46.9283
Line10_3pe_3N	376	45.3308	315	38.6656	304	37.2135
Line12_3pe_3NT3	605	42.5275	603	42.4502	592	41.6799
Line9_10pe_3NT3	19	1.7438	19	1.7438	19	1.7438
Line10_10pe_3N	72	8.8621	72	8.8621	70	8.7031
Line9_3pe_3NT3	367	45.9459	279	36.6258	264	34.6884
Line12_10pe_3NT3	364	27.4093	334	25.9956	326	25.4031
sum	2742	338.1582	2560	320.6559	2496	313.7052

- starting from 'Ag' selection as defined by Juergen
- **18 days** of runsetups with 'SCAN' → can't use them, but DQ group working to get them back
- **7 days** of runs with no alignment (at all) → can't use them
  
- root files (aa-ntuples, conversion to FullEvents available.)
- 80 GB of files for full dataset (hits are removed)
- documentend: [http://www.nikhef.nl/~t61/wiki/doku.php?id=march\\_2010\\_aafit\\_production](http://www.nikhef.nl/~t61/wiki/doku.php?id=march_2010_aafit_production)

# Detector studies : the problem

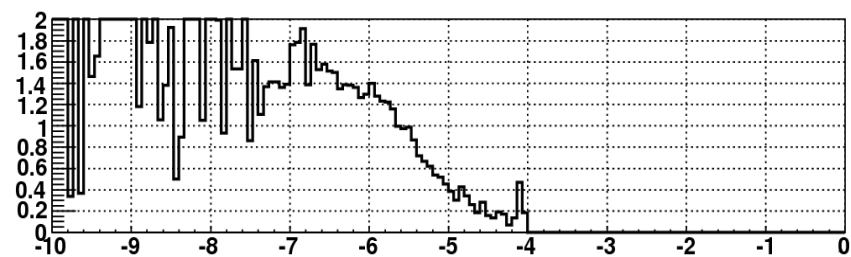
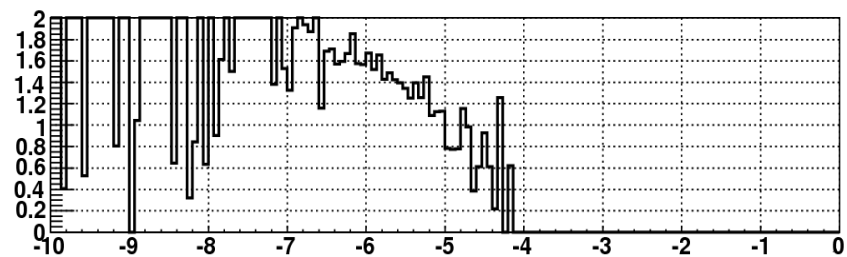
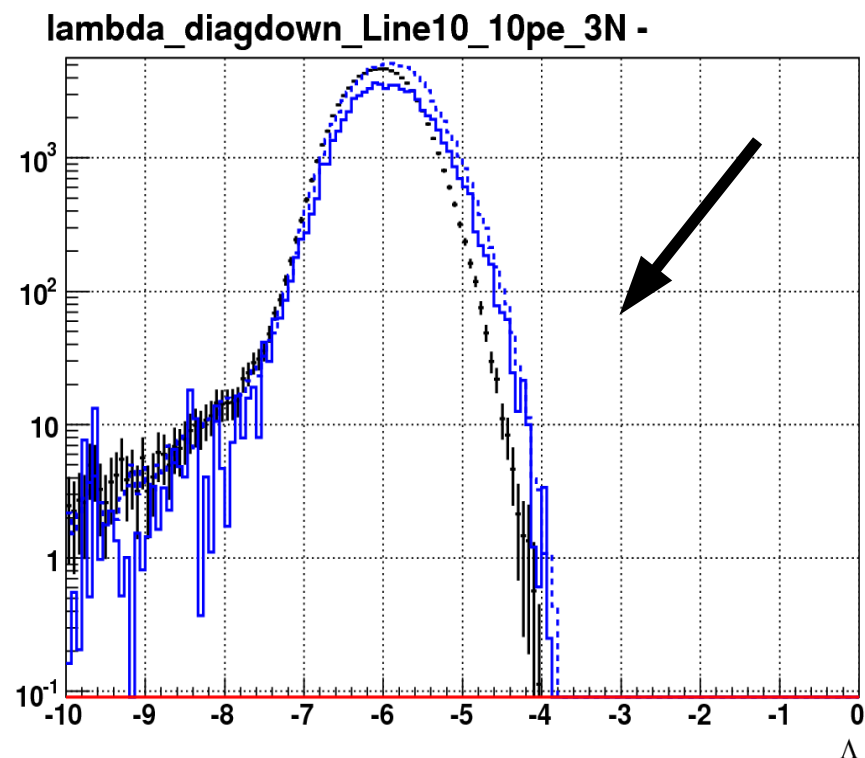
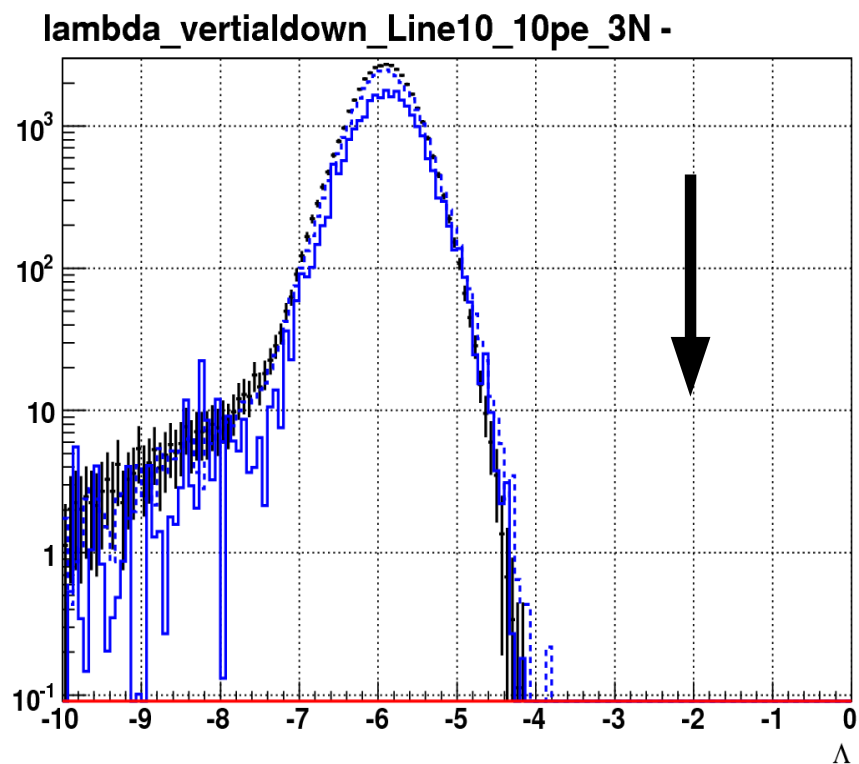


When applying a quality cut,  
too few downgoing, inclined muons  
in the data.

Deficit depends on data-period.. Up to  
factor two!

- Straight downgoing events are ~fine.
- 5 line periods are mostly fine too

# Detector studies : the problem



***looks like strings are misaligned or unsynchronized***

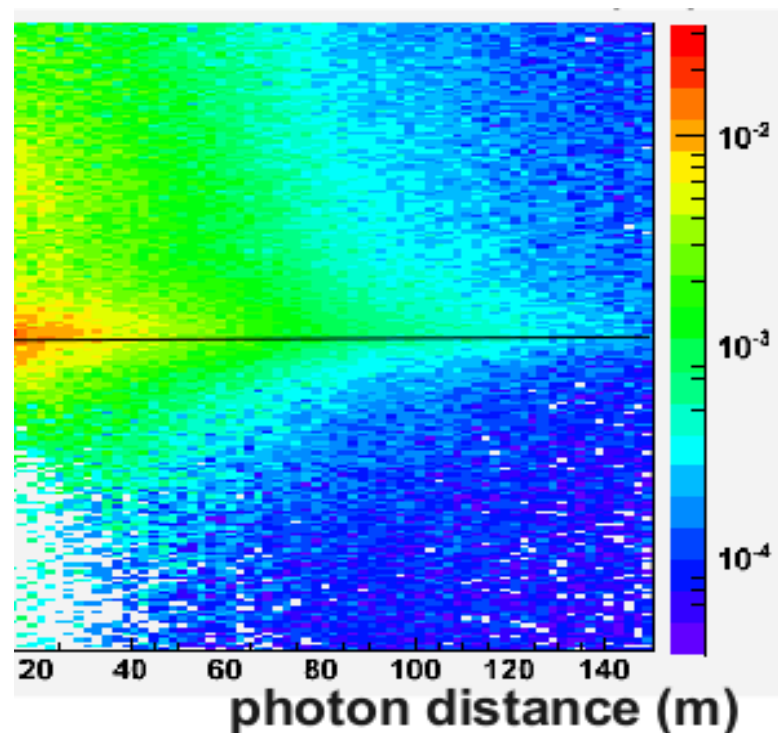
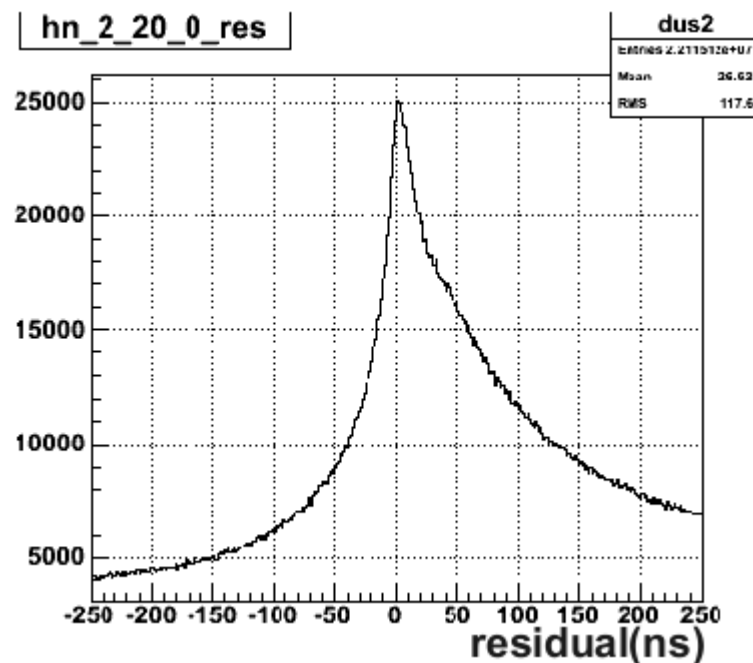
# Hitstudies

- randomly select a probe string
- fit a track using only hits on other strings
- use fitted track to compute residuals on probe string

can study unbiased residuals (as function of line number, photon distance etc etc)

- did this before on 5-line data
- result: few ns offsets between lines
  - comparable with OB-studies
- mc study showed: not large enough to explain effect in my worst data-period.

→ studied many things nhits, ncomp, likelihood, likelihood/ndof, time-residuals....



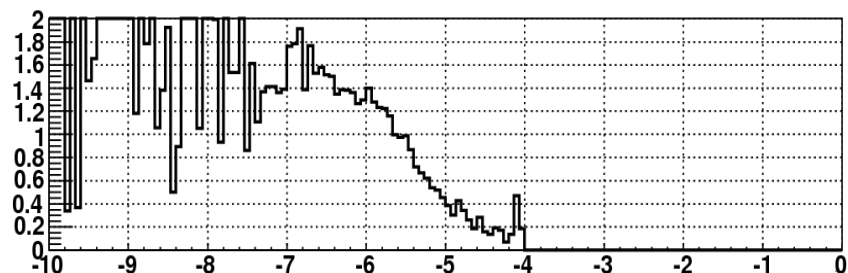
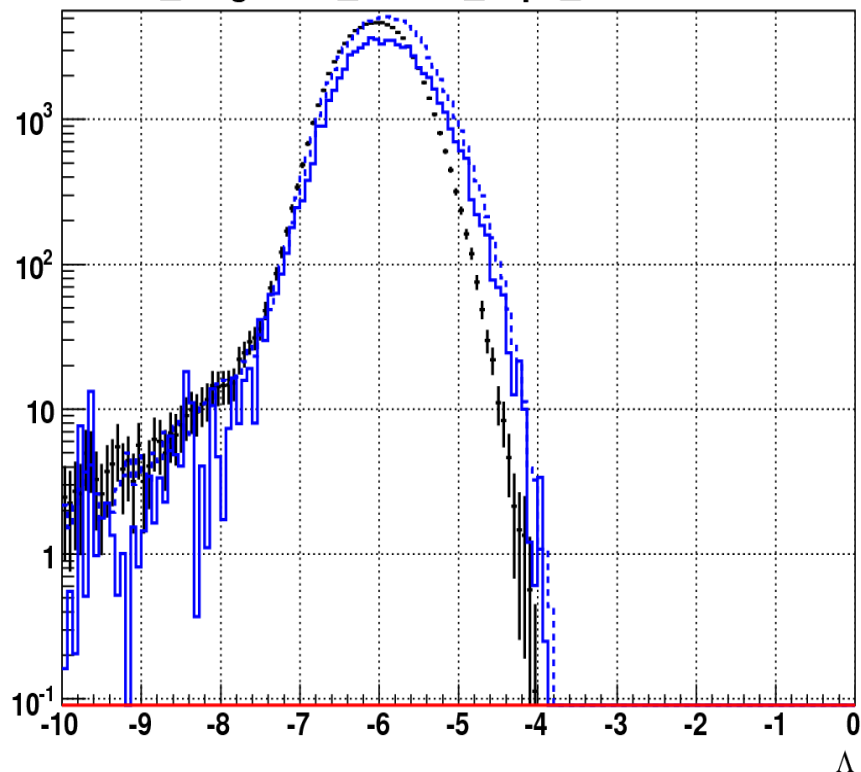
# Hitstudies

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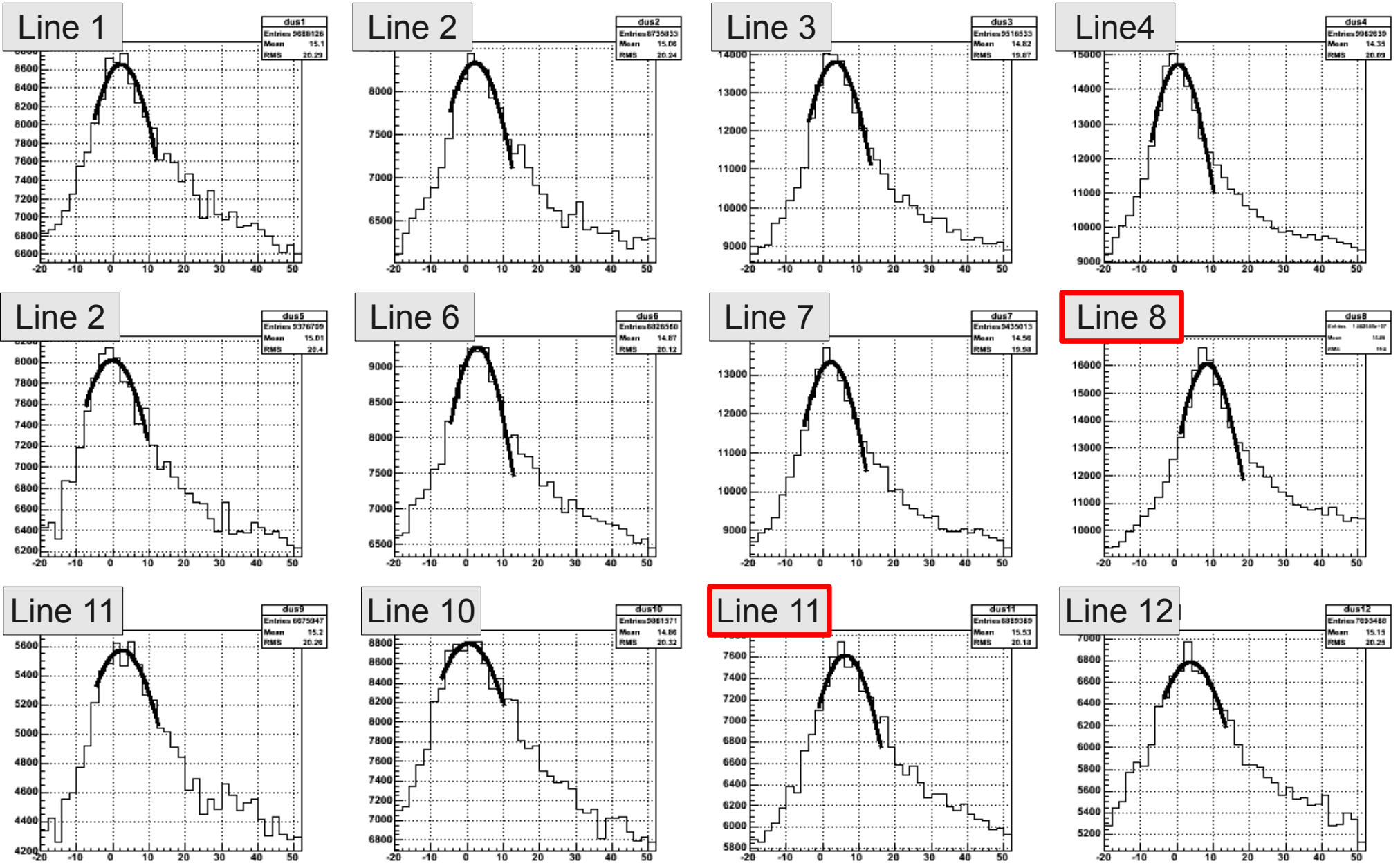
- did this before on 5-line data
- result: few ns offsets between lines
  - comparable with OB-studies
- mc study showed: not large enough to explain effect in my worst data-period.

- turns out, alignment is nonsense for almost entire 10 line 10 pe period!  
(for line >5. bss pos wrong by few meter)
- known to calibration people for >6 months, but not to me...
- → not use these runs (~1 week) for now
- revisit hit residual studies.

lambda\_diagdown\_Line10\_10pe\_3N -



# Hitstudies





# Hitstudies – on 12 lines

Line	offset	OB-offset
1	2.22	-1.19
2	2.13	-1.03
3	3.43	1.61
4	0.27	X
5	-0.15	-1.46
6	2.38	-0.02
7	2.22	0.68
8	8.31	X
9	2.36	1.76
10	0.30	-0.65
11	6.23	X
12	3.67	X

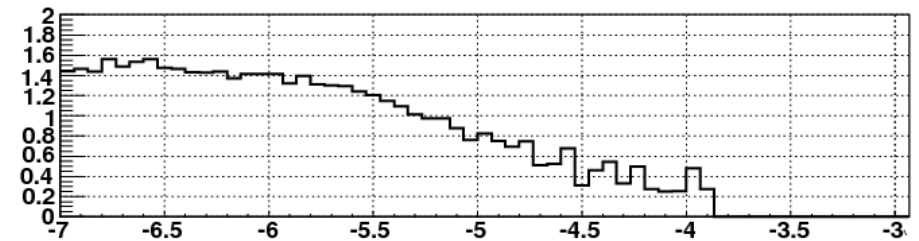
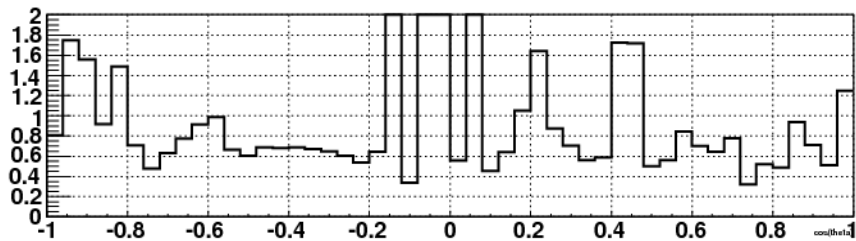
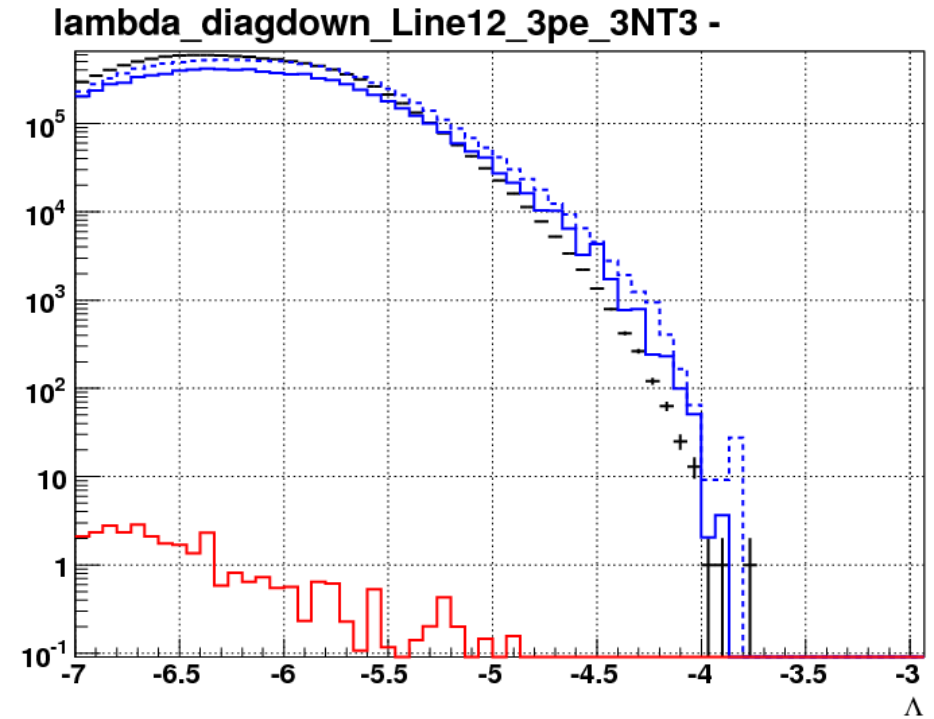
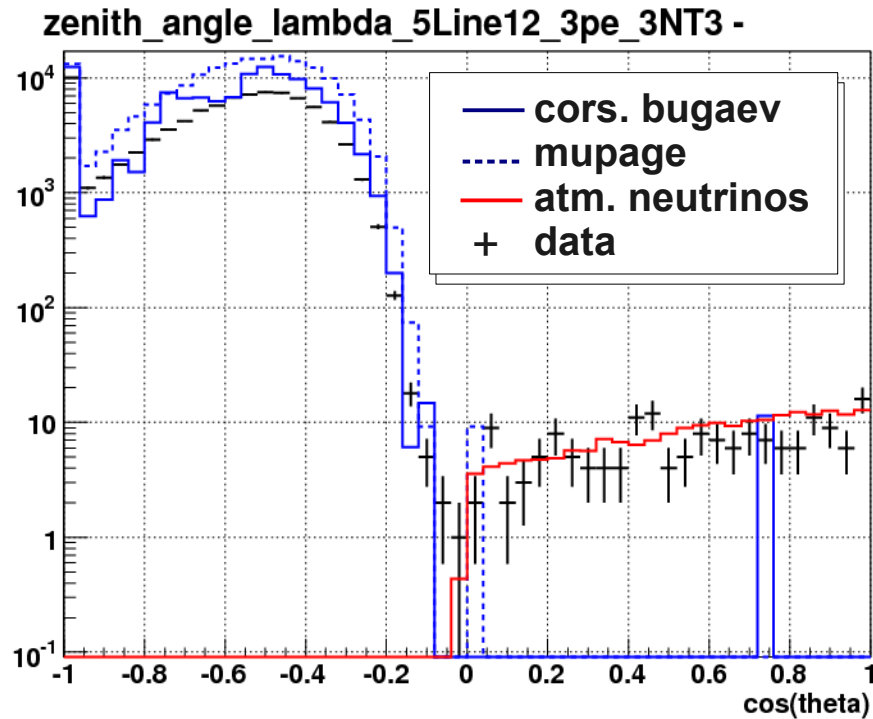
- My hit-study offsets are always a combination of the probe string and the surrounding strings  
→ can only hope the surrounding strings average out.
- Numbers are the mean of a gaussian fit to the peak (see previous slide)
- Alternatively could use [Optical Beacon measurements](#), but we do not have numbers for all lines... in particular **8 & 11** are missing. (hope they will come soon..)
- [blue numbers](#) from F. Salesa & C. Bigongiari talk at cern

→ agrees with observation that downgoing tracks are bad in >5 line data

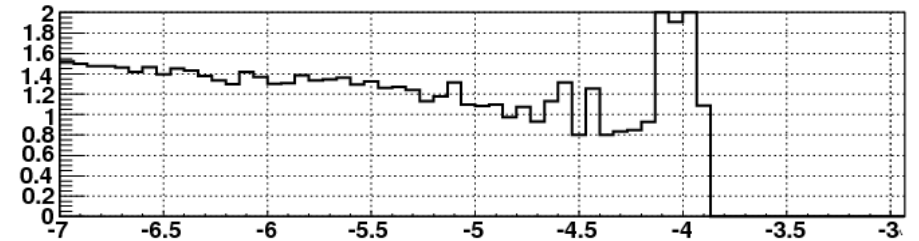
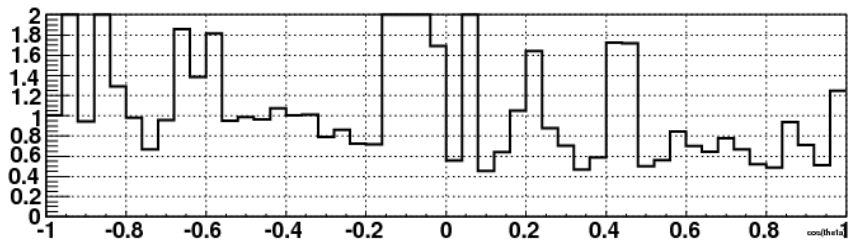
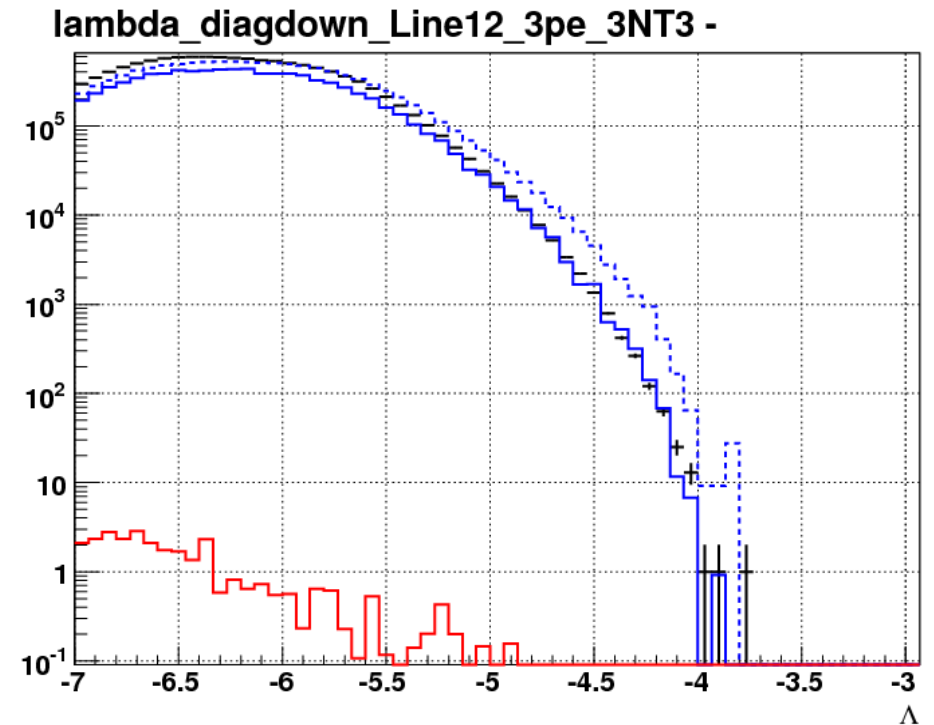
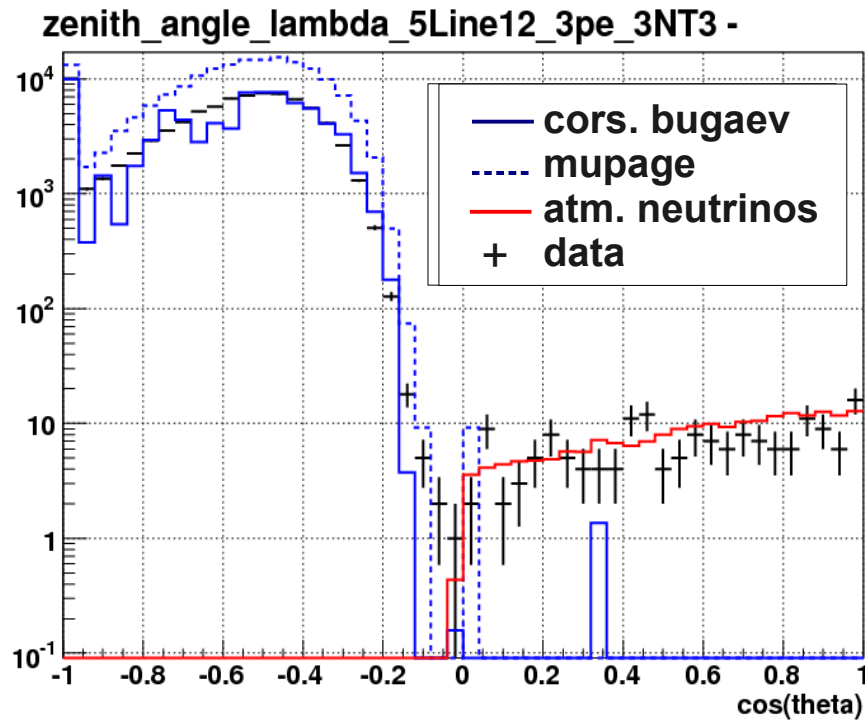
next: do two things

- 1: add offsets to MC
  - see if such offsets could explain the lambda-discrepancy
  - see what is the impact of offsets on neutrinos
- 2: correct the data and see if lambda improves.

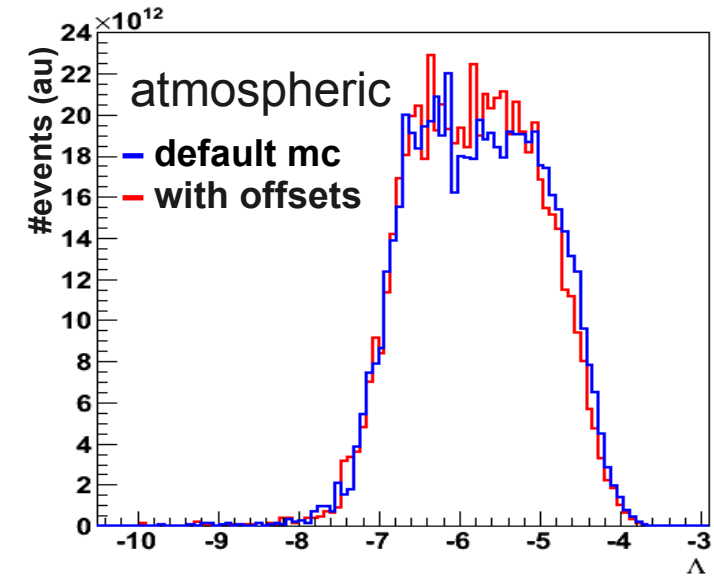
# Adding offsets to the MC : before



# Adding offsets to the MC : after

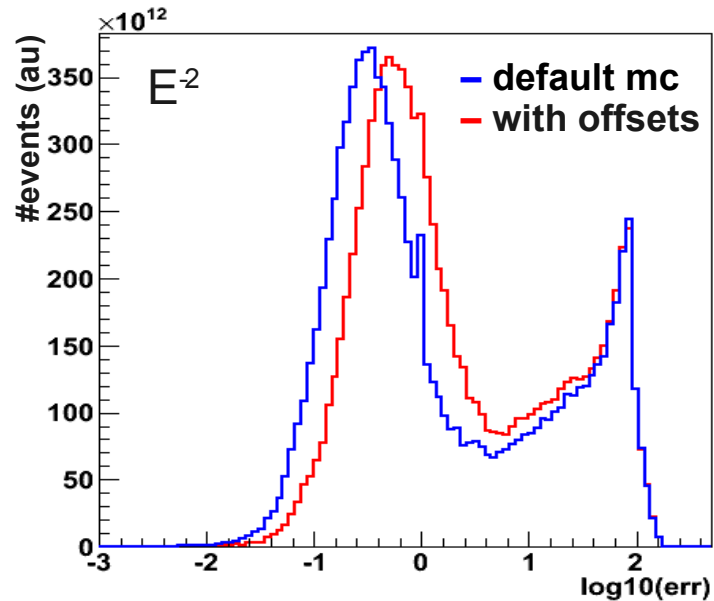


# Adding offsets to the MC - neutrinos



- as expected: tail of lambda affected
  - not extremely sensitive
  - ~20% percent effect for  $\Lambda > -5$

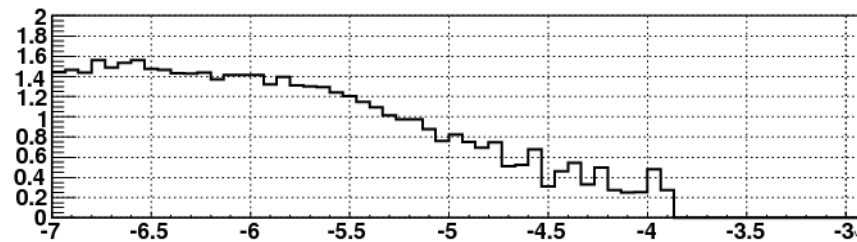
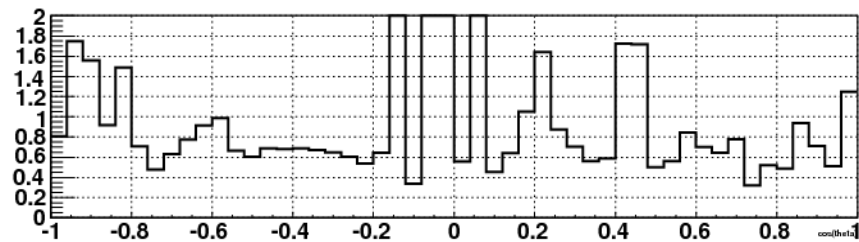
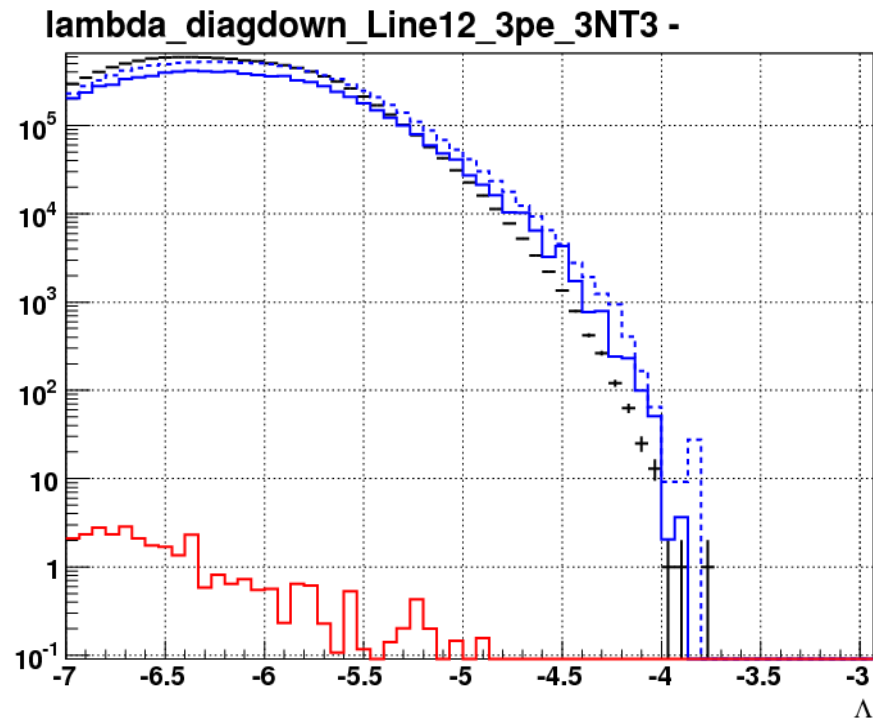
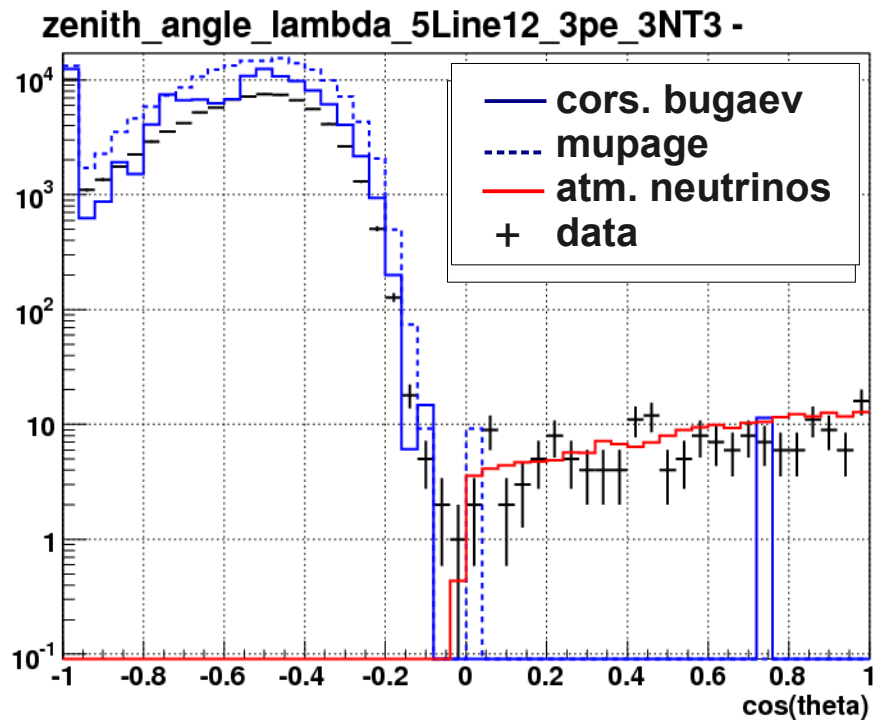
- Angular resolution affected a lot
  - applied offsets result in factor 1.8 degradation of angular resolution.
  - (unless we can understand and measure these offsets perfectly), this will become a systematic.



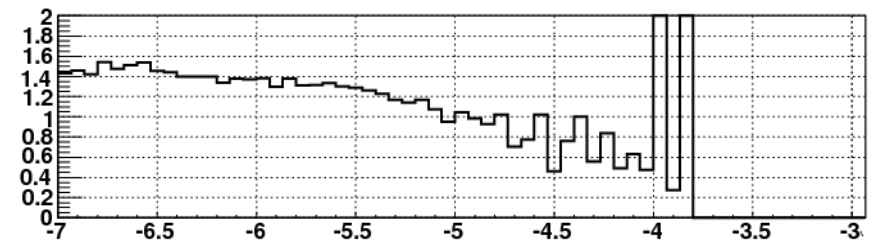
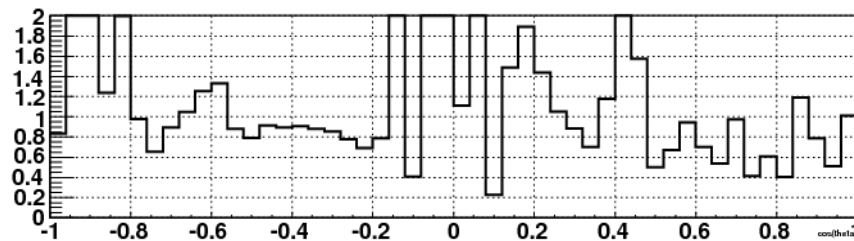
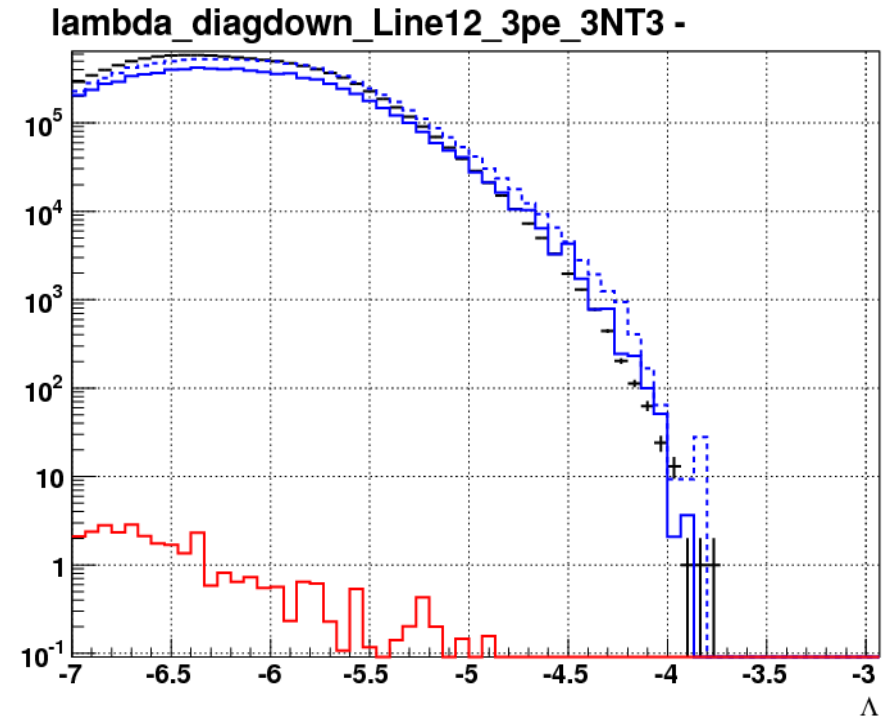
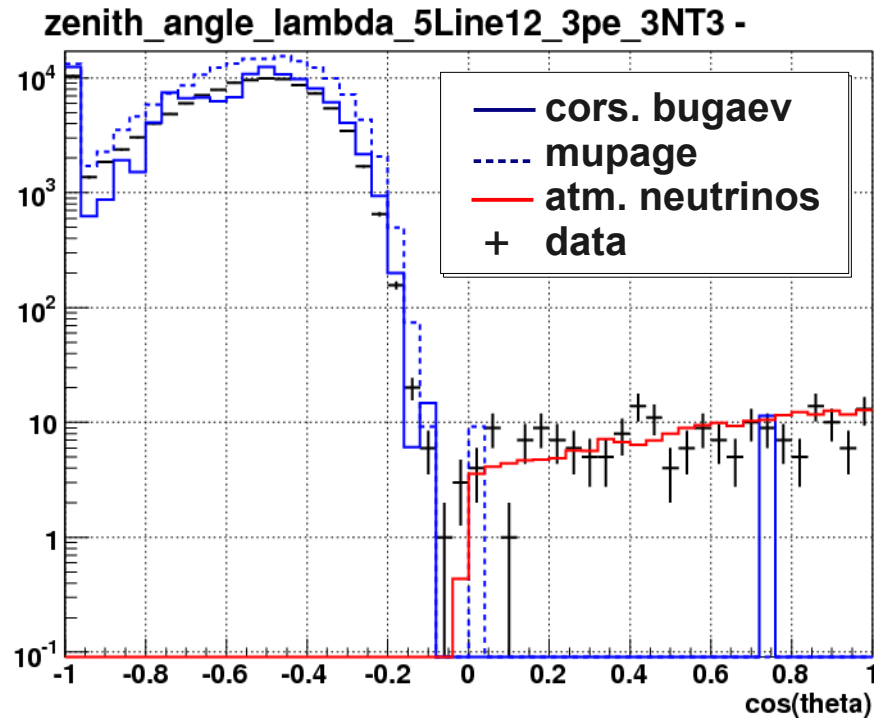
Timing is crucial  
(well duh!)

# Subtracting offsets from the data : before

==same as few slides ago



# Subtracting offsets from the data : after

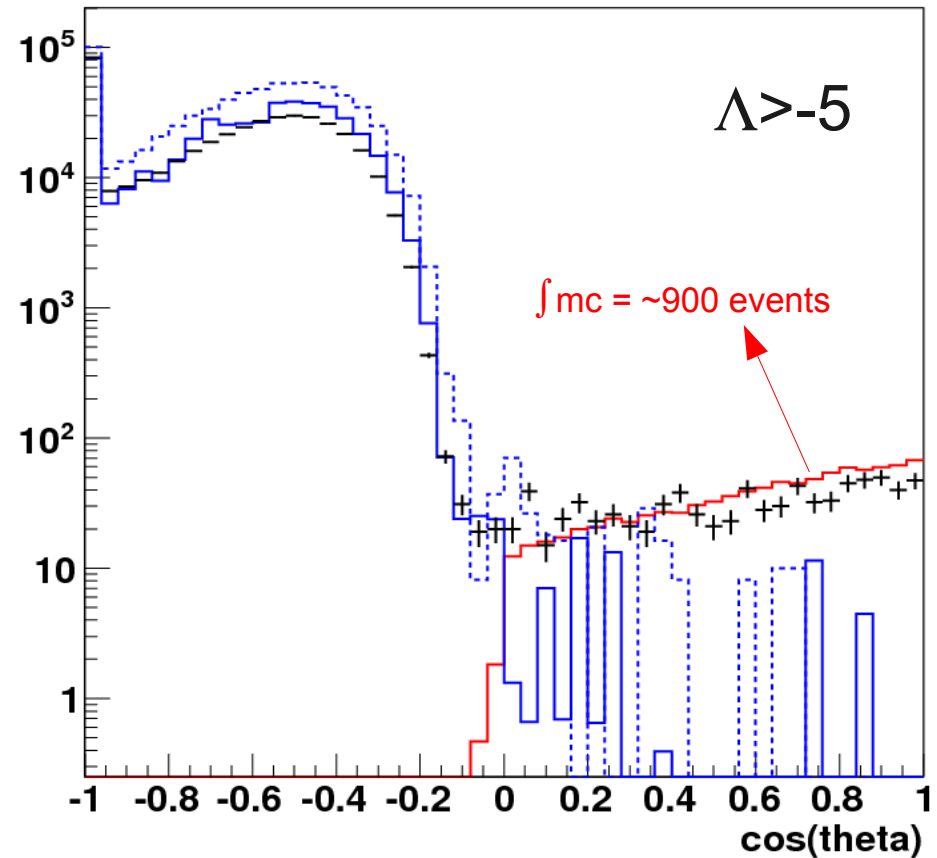
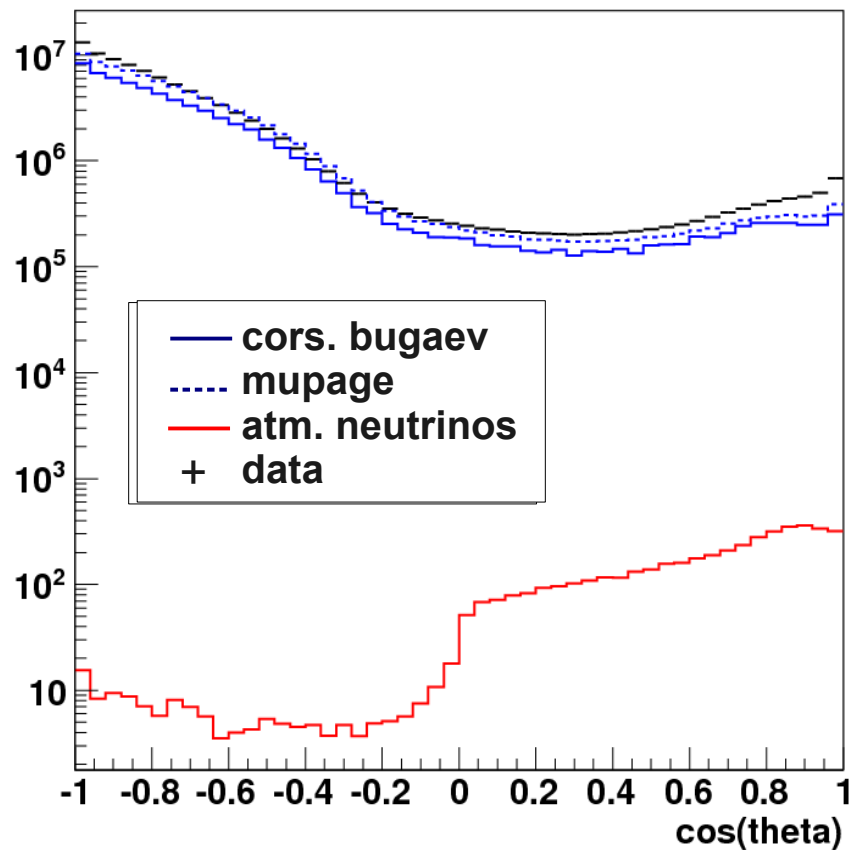


• likelihood of data improves! → offsets are real!

# Some plots for the full dataset

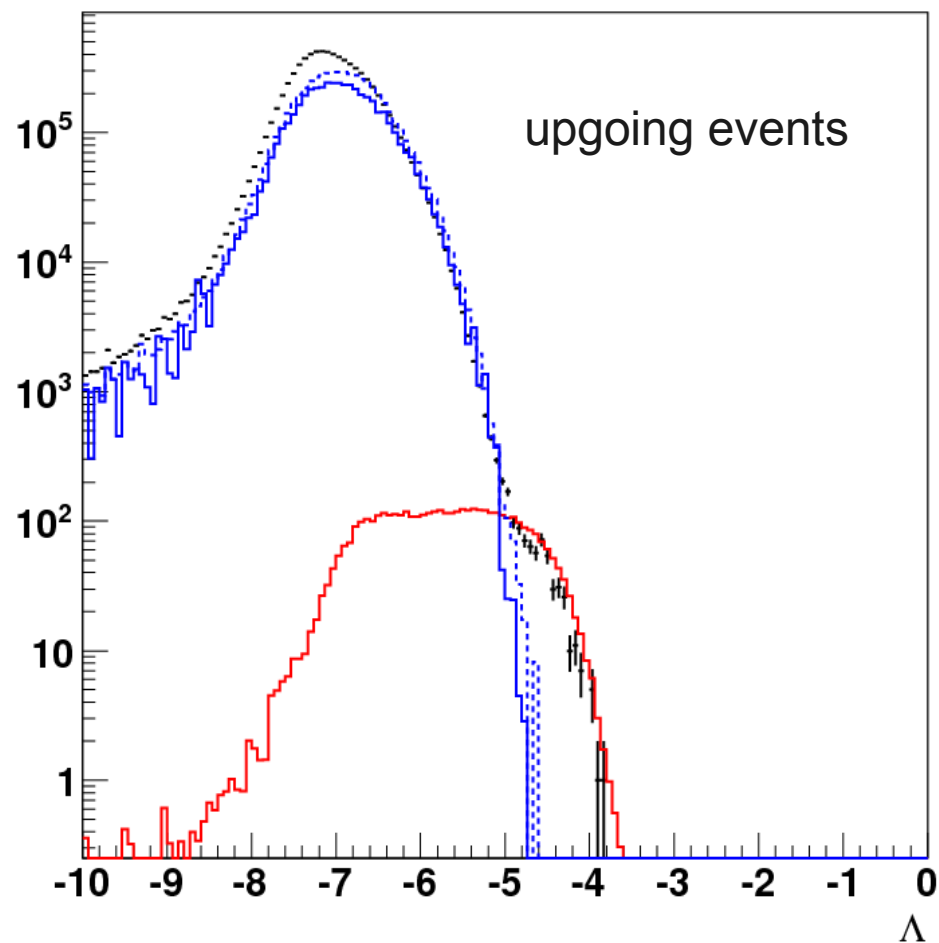
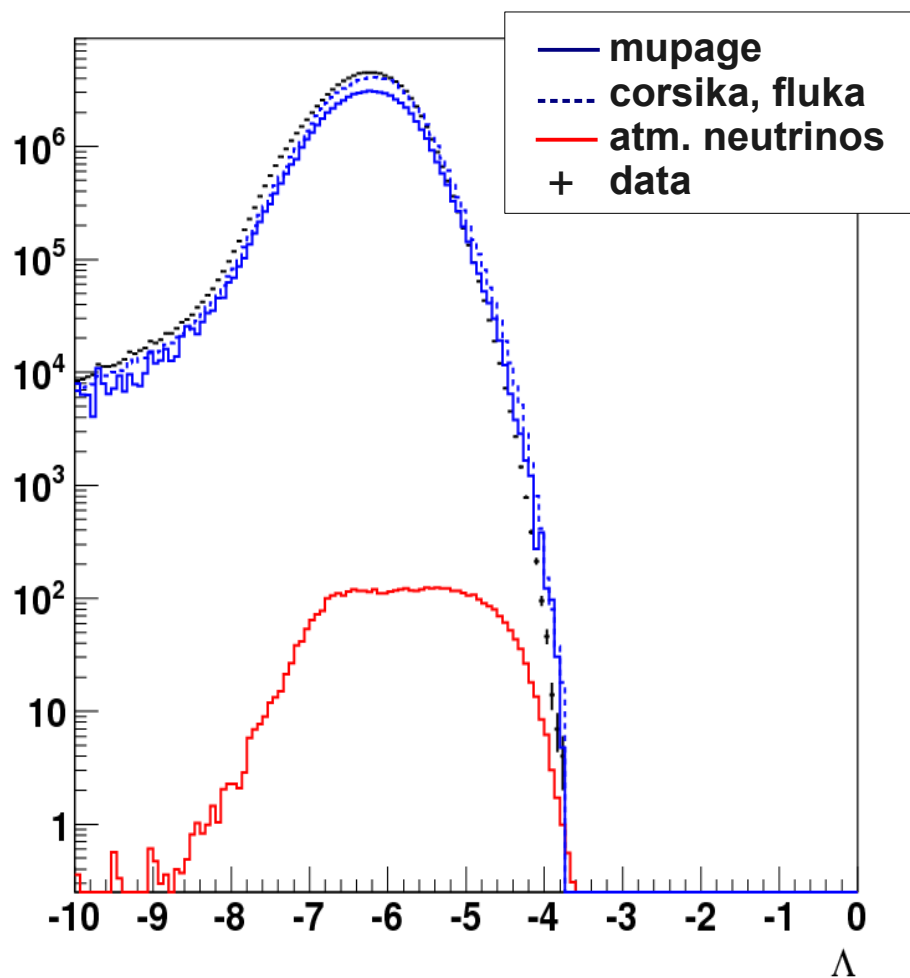
following plots: 2007 & 2008 data,  
9 and 10 line 10 pe periods excluded

*offset-correction shown before now included*



# Some plots for the full dataset

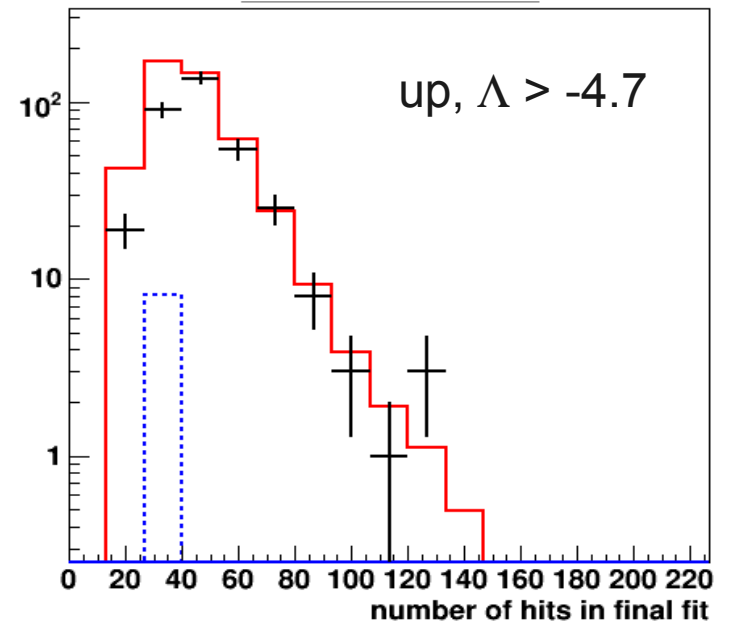
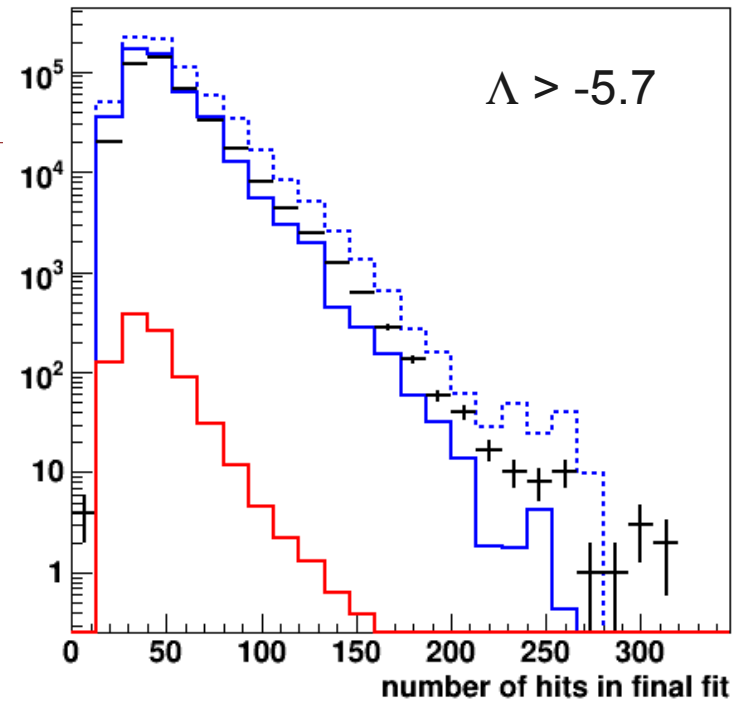
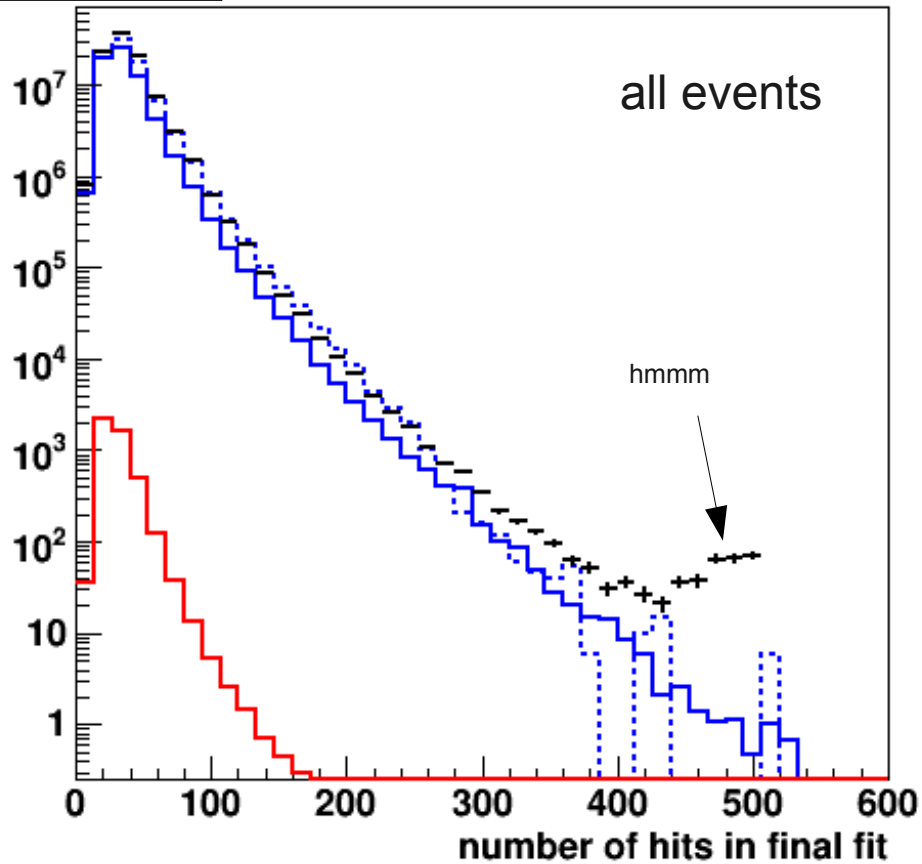
*offset-correction shown before included*



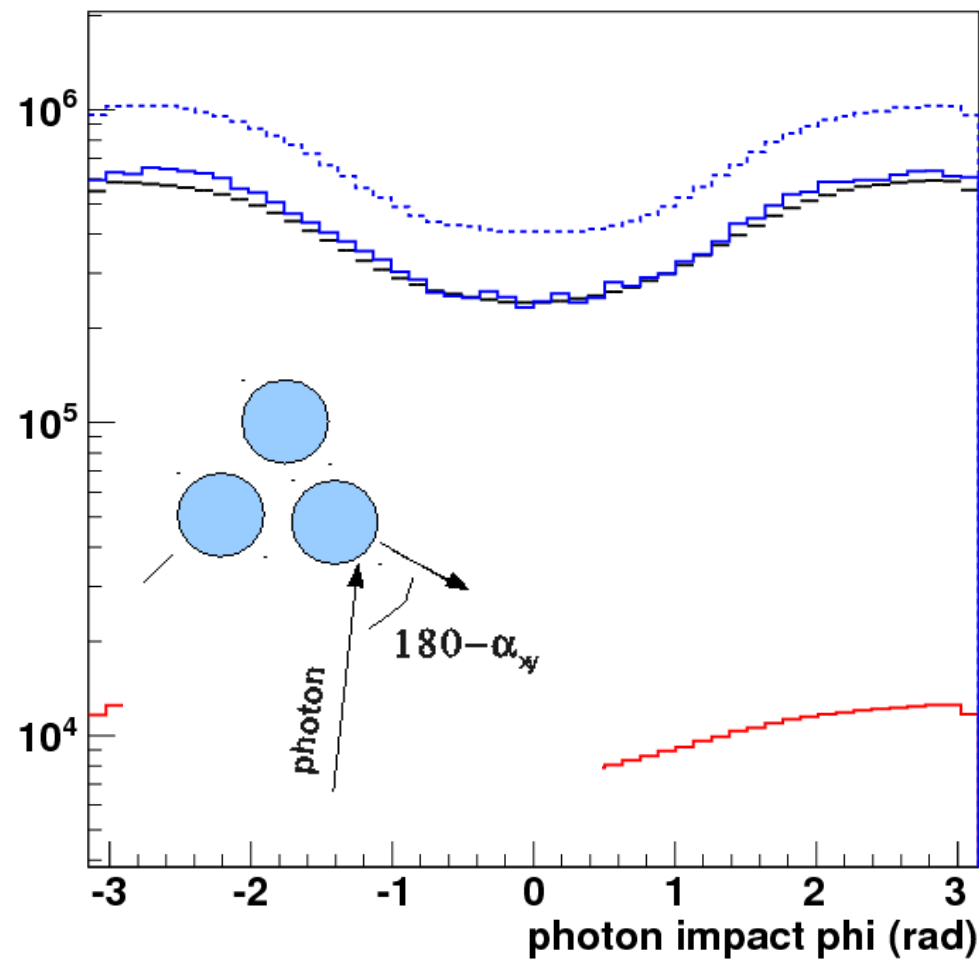
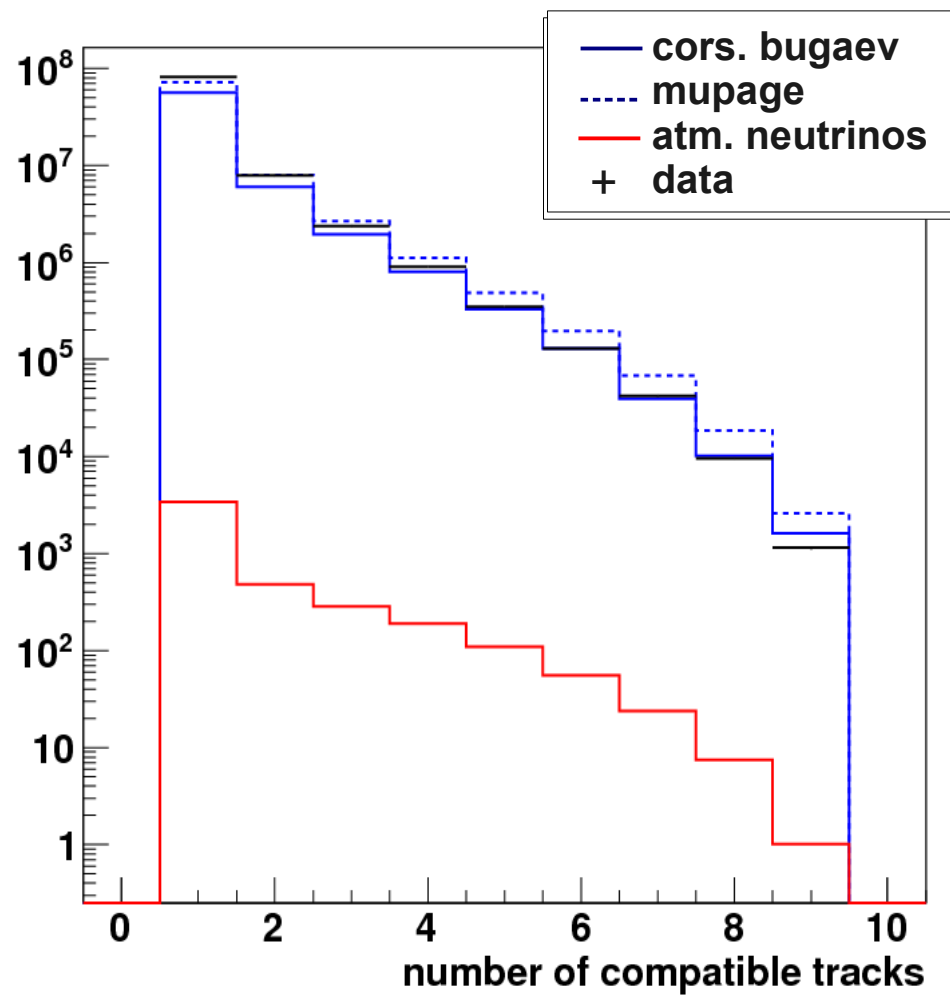


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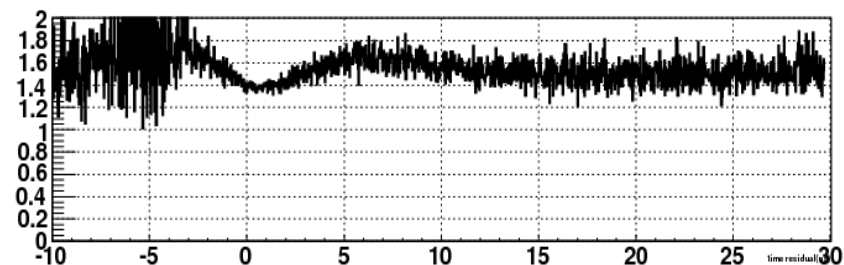
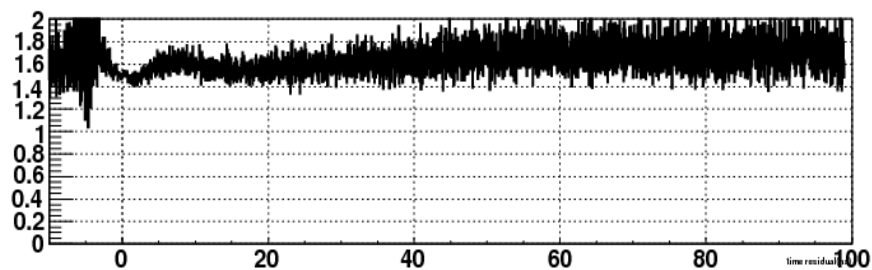
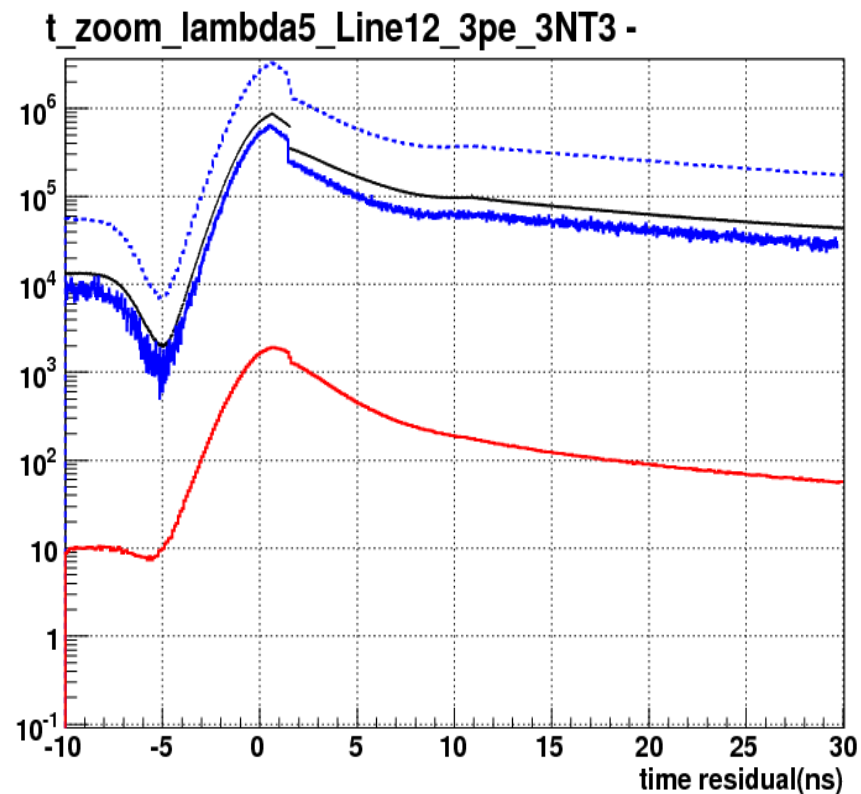
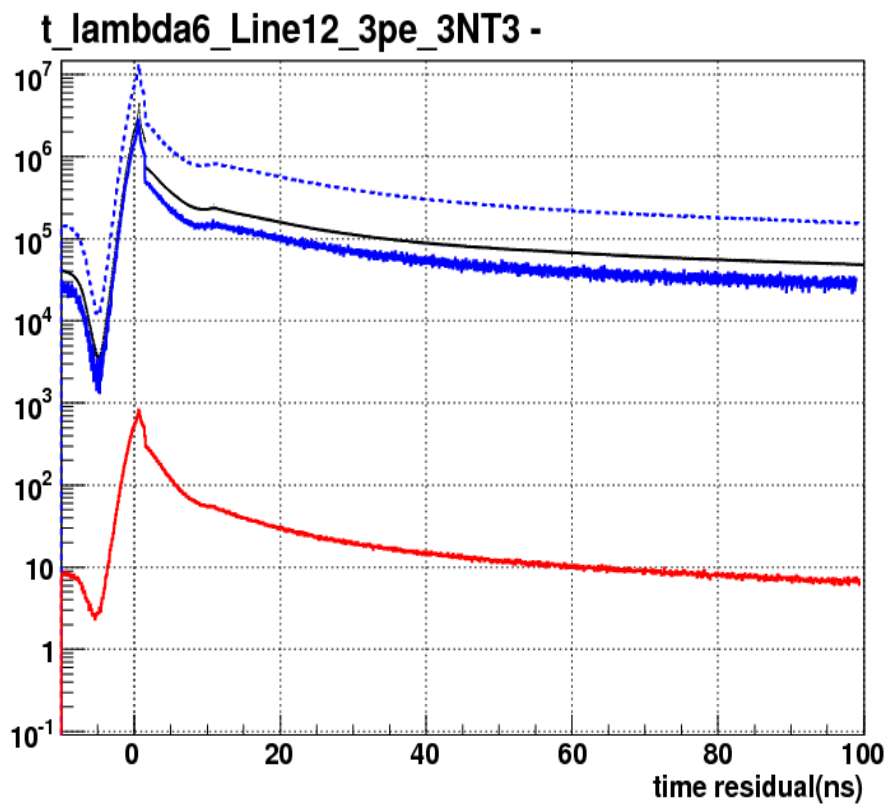
- cors. bugaev
- ⋯ mupage
- atm. neutrinos
- + data



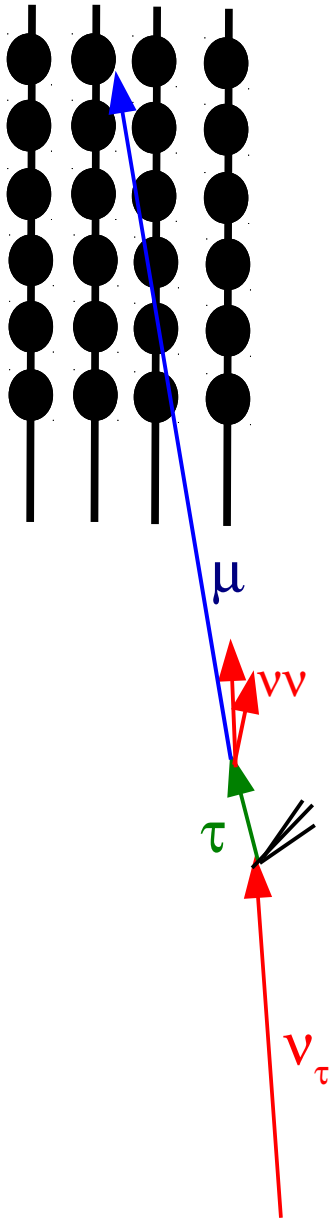
# Some plots for the full dataset



# Time residuals (12 line, 3pe)

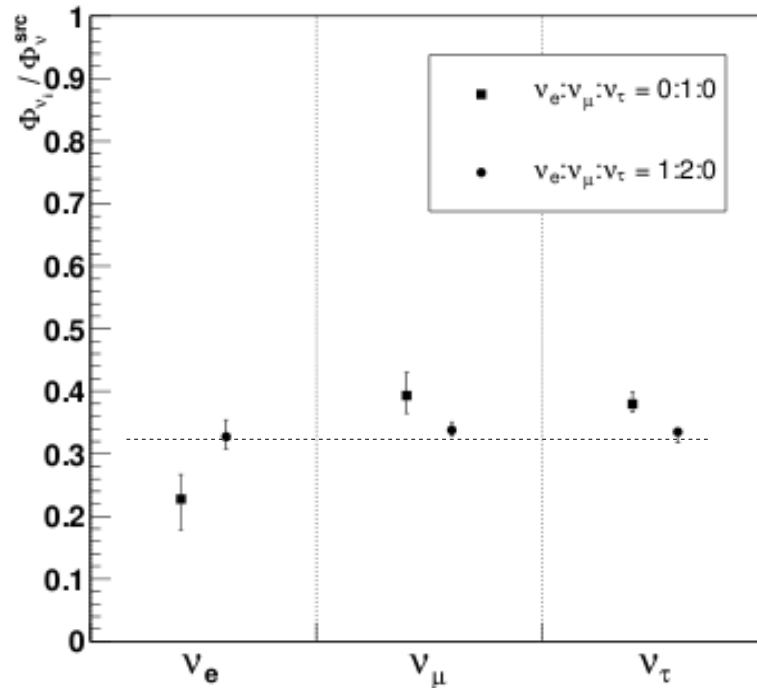


# Muons from $\nu_\tau$

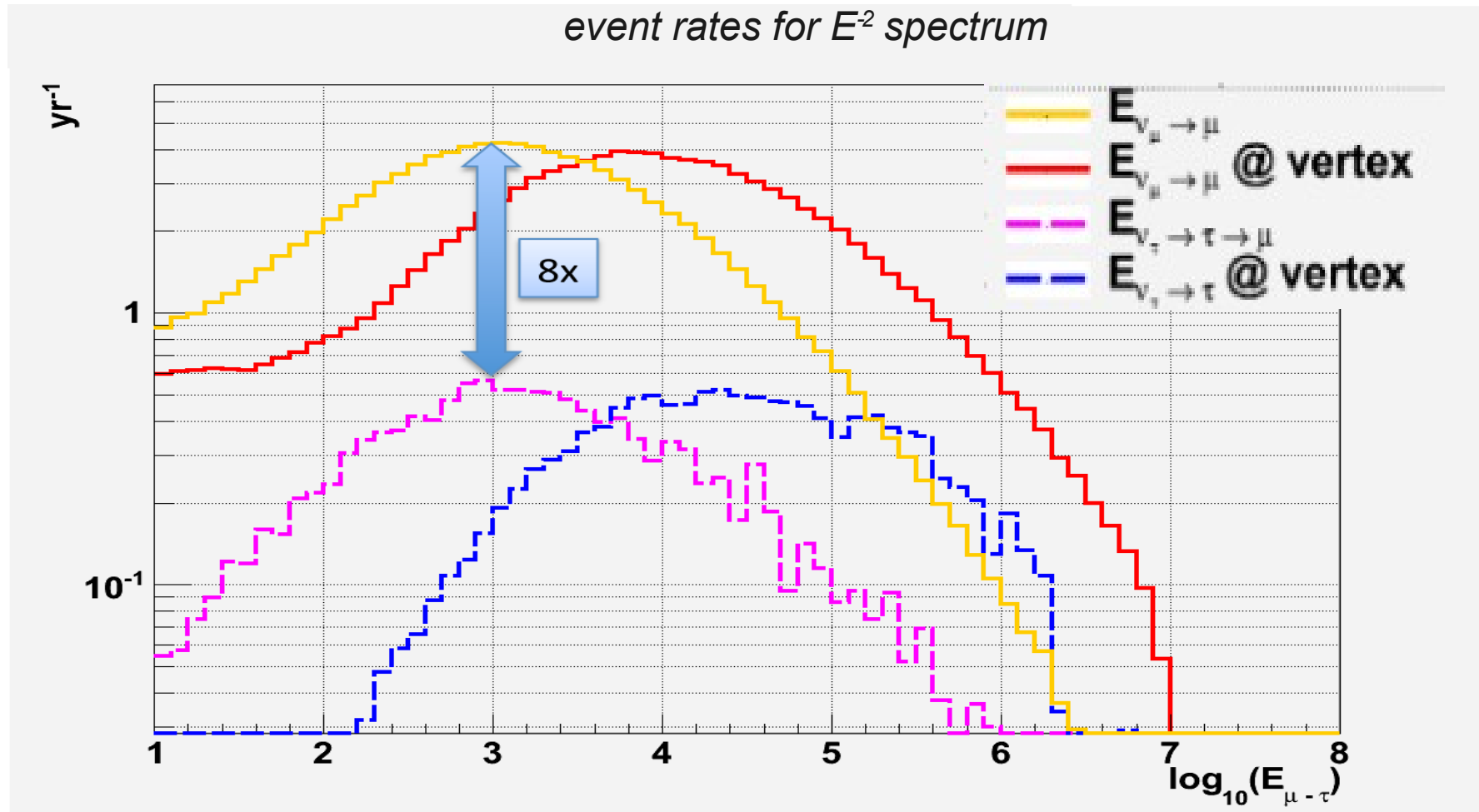


- for any astronomical source  $\Phi_{\nu_\tau} = \Phi_{\nu_\mu}$
- robust prediction, regardless of  $\Phi_{\nu_e} : \Phi_{\nu_\mu}$  at the source
- extra muons expected from cosmic source
- $\text{Br}(\tau \rightarrow \mu) = 17\% \dots$  and some energy lost to neutrinos  $\rightarrow$   
small contribution ... but for free!!

*ratio of fluxes at Earth*



# Muons from $\nu_\tau$ in the detector



generator level study  
 genhen  $\nu_\tau$  mode

- relatively many  $\nu_\tau$  at high E
- some more energy loss
- $E_\mu$  very similar for  $\nu_\mu$  and  $\nu_\tau$  signals
- ~10% contribution to acceptance

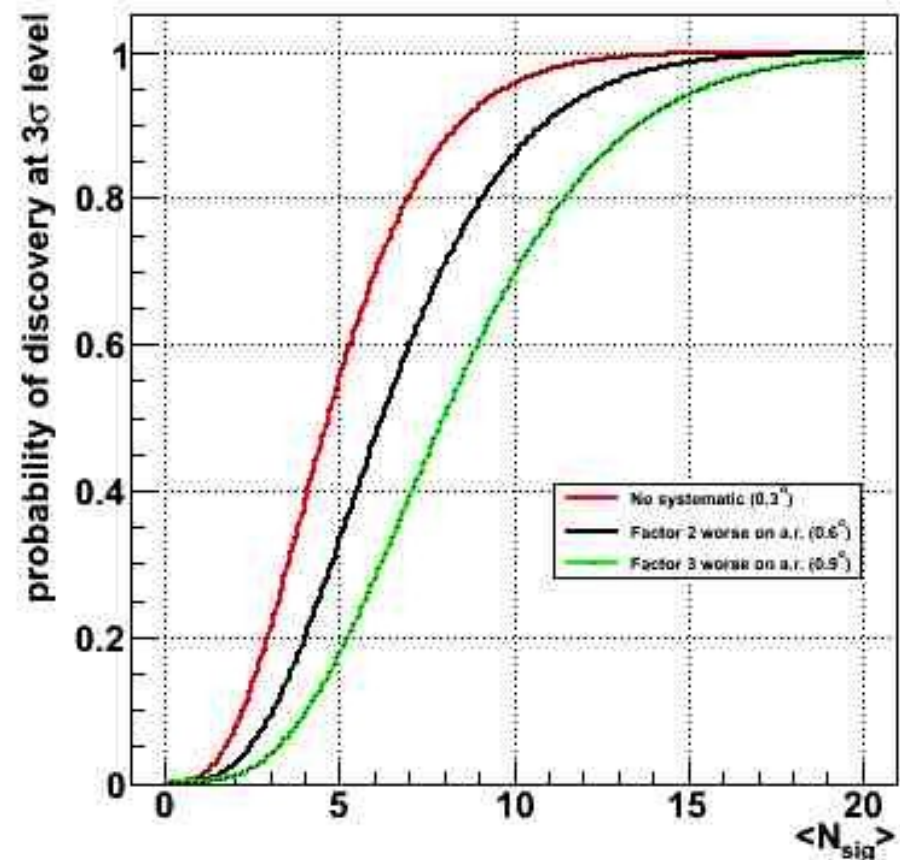
Will include them.  
 Full MC is running.

# limits & discovery potential

(Claudio Bogazzi)

- respun full analysis on aafit production
- comparison with Calreal based results very favorable (40% better than before).
  - needs to be checked
- In general: be careful when comparing  $\Lambda_{\text{calreal}} \neq \Lambda_{\text{aafit}}$

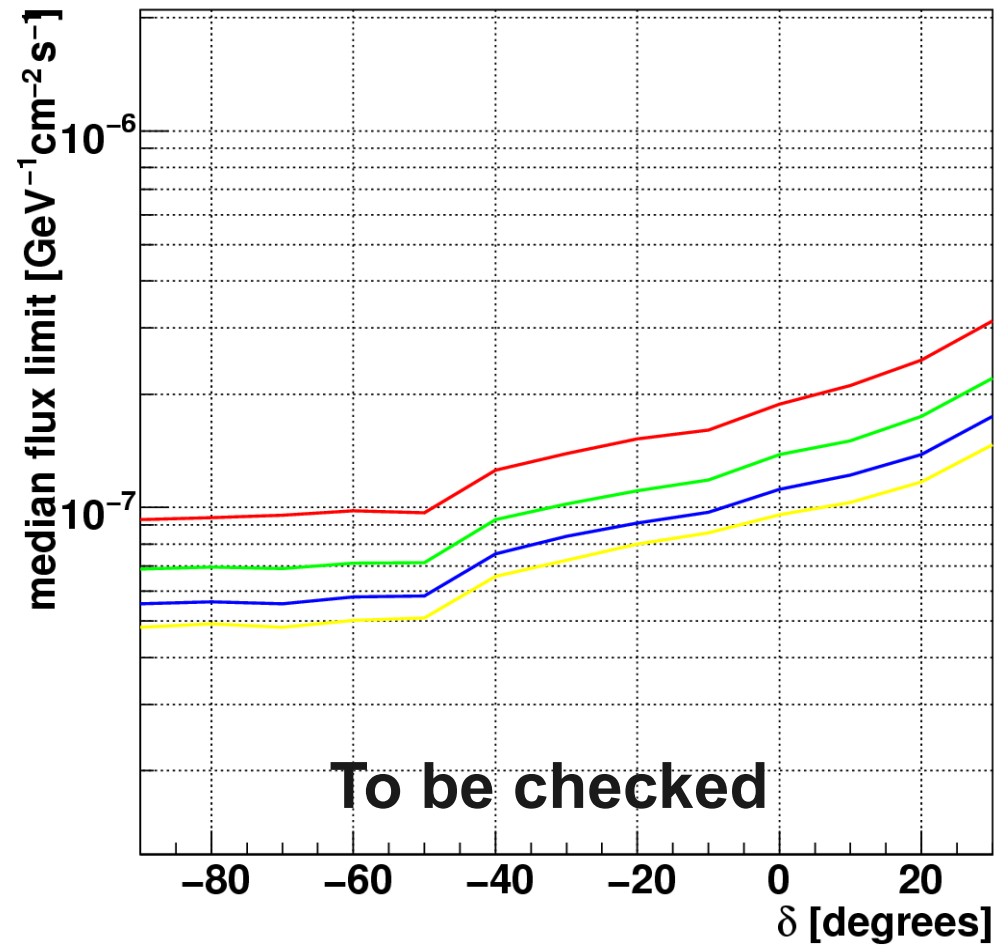
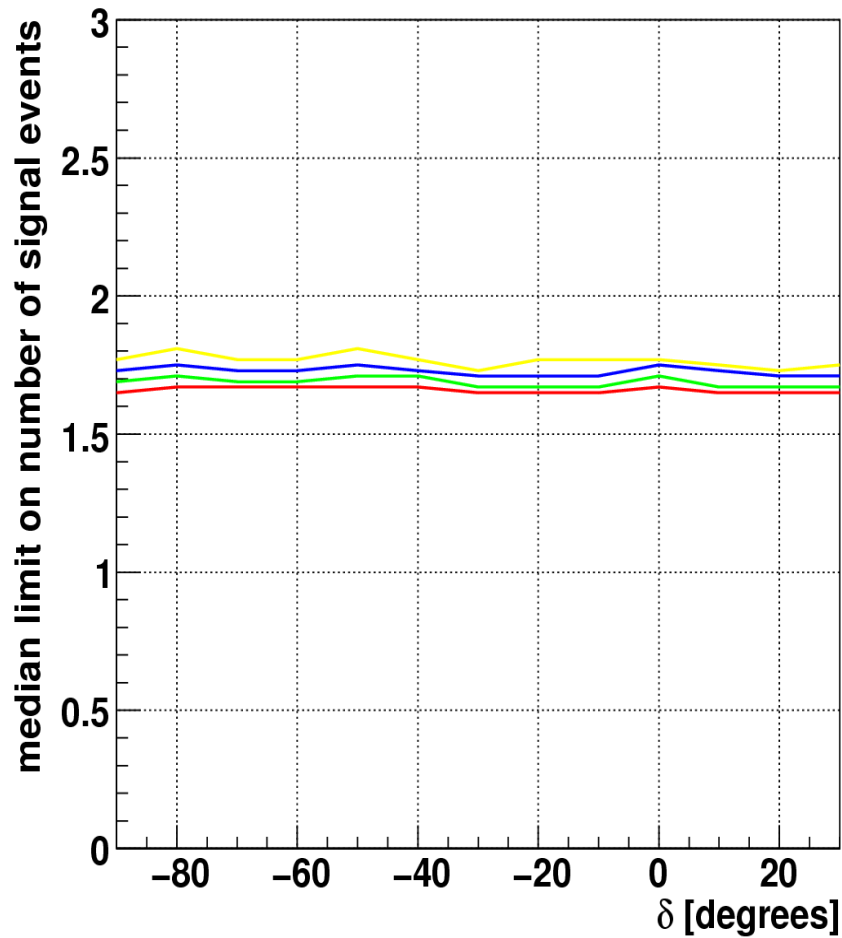
## full sky search



# limits & discovery potential

(Claudio Bogazzi)

point-by-point limits



# Conclusions

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- aafit:
  - stable. no changes foreseen to algorithm.
  - production of 2007, 2008 data available
- Detector studies
  - Converging evidence for timing offsets between lines
  - nb: could also be mis-positioning/mis-alignment
  - offsets are also seen by OB analysis, but
    - different numbers
    - most important lines are still missing
- uncorrected offsets lead to severe degradation of angular resolution
- correcting offsets in data
  - improves data/mc agreement for inclined tracks
  - plots shown for full dataset.
- Search analysis respun on aafit production
  - limits, discovery potential, systematics
  - significant improvement seen over calreal (still working/checking to understand why)
- Tau neutrinos
  - $O(10\%)$  extra events for free
  - will be included in analysis

**in general it seems  
lambda really tells you  
whether the detector description  
is ok → discrepancies are a  
tool to understand the detector.**

**ignoring the effect we saw in lambda  
for downgoing muon would  
have decreased resolution  
by factor 1.8.**