An overview over Recoos

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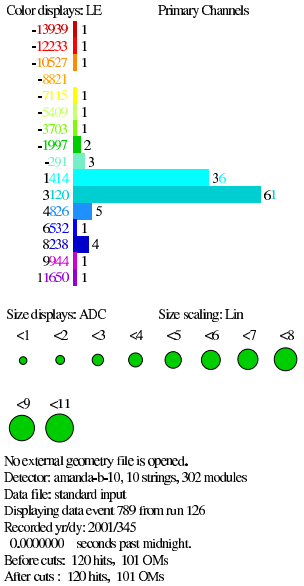
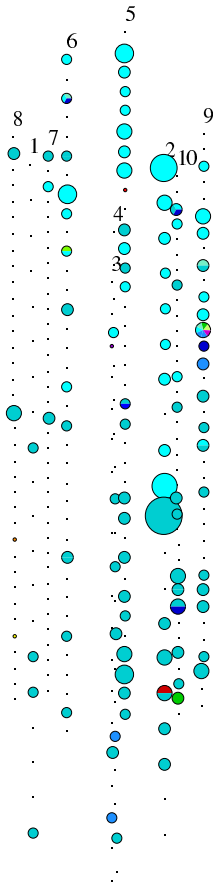
Overview

1. A simple example
2. First guesses
3. Reconstruction with likelihood

Hits to patterns

This is how the DAQ of AMANDA sees a down going muon



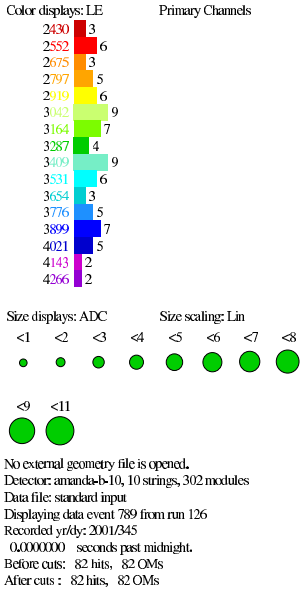


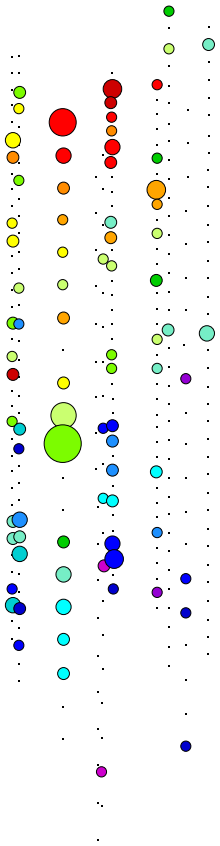
- Zoom into region around the trigger (0. . . 4500 ns)
- Cut the low amplitudes - they're just noise
- Cut away hits with no neighbours
- Only take first hits

Experts use `deff` here.

Patterns to guesses

`recoos` comes to action!



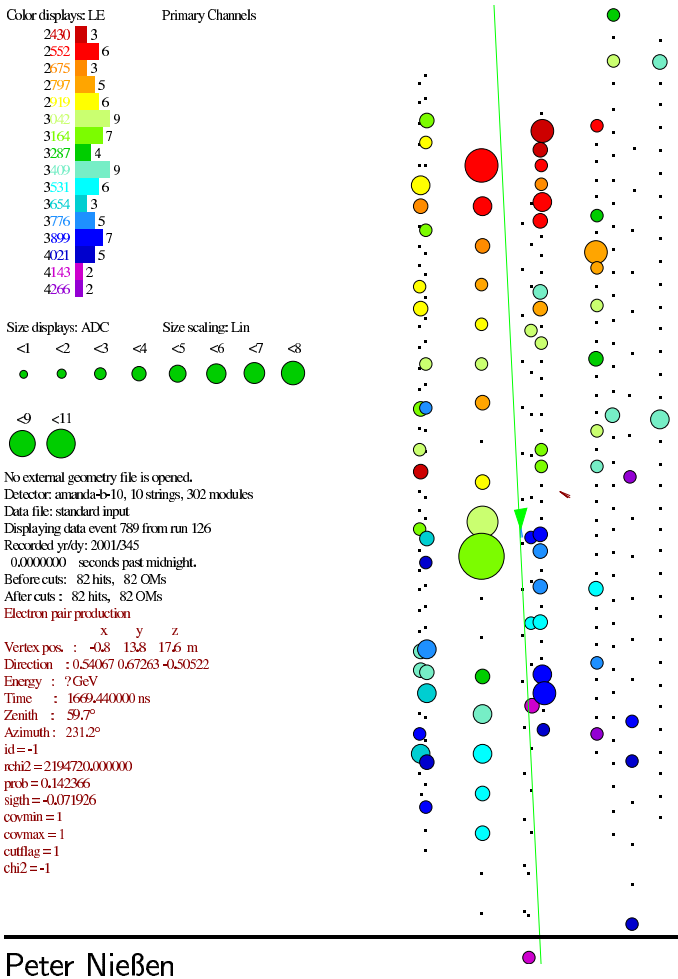


- Calculate Eigenvalues of
  $I^{kl} = \sum_i a_i^w \cdot (\delta^{kl}\vec{x}_i^2 - x_i^k \cdot x_i^l)$,
  $I_1 < I_2 < I_3$,
  Tensor of Inertia.

- Minimise
  $\chi^2 = \sum_{i=1}^{N} a_i^w \left(\vec{x}_i - \vec{X}_0 - \vec{v} \cdot t_i\right)^2$

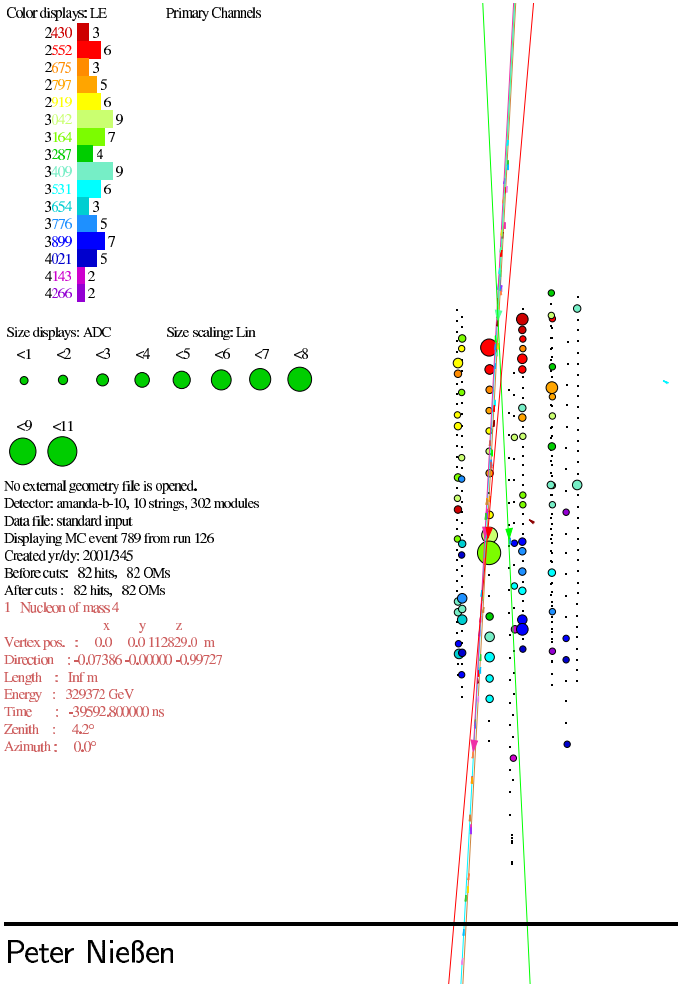
- Minimise
  $\chi^2 = \sum_{i=1}^{N} a_i^w \left(\vec{x}_i \cdot \vec{n} - v \cdot (t_i - t_0)\right)^2$

Guesses to fits

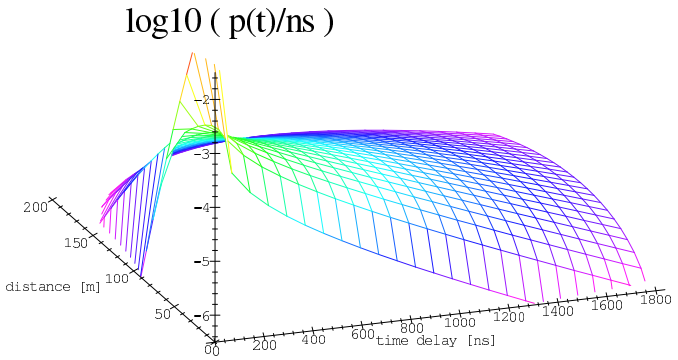


- Tensor of Inertia
- Line fit
- Plane Wave

Fits



- Likelihood fit



- Cascade fit

How to find out what's what

Is it a shower or a track?

- From tensor of inertia: $I_1/I_3 = 0.17$ (low), should be around 1 for shower
- From line fit: $v_{\mathsf{LF}} = 0.18$ m/ns (high), should be low for shower
- From track likelihood fit: $n_{-15;75} = 23$
- From shower likelihood fit: $n_{-15;75} = 0$

The script

```
#!/bin/bash

# fits tensor of inertia, line fit, plane wave,
# fits track likelihood
# fits shower

# some cleaning (don't take numbers to serious, it's just for the show
# list weird behaved oms
DEAD_OM="-y N=3 -y N=18 ..."
NOISY_OM="-y N=267 ..."
# only hits around the trigger peak
HC_WIN="-y R=0.:4500."
# no noise with low amplitudes below .3 pe
HC_AMP="-y a=0.3:1000."
# no noise with feeble TOT (anti X-talk)
HC_TOT="-y b=125:2000:1:302"
# first hit in the PMT only
HC_1ST="-y A=1"
# remove hits without 1 neighbour in 70 m vicinity and 500 ns
HC_ISOL="-y I=70.:500.:1"

# now the first guesses:
TOI_LF_PW="-r n -i a -X g=f -p w=0. -X s=n -p t=0:10"
# explanation:
# -r n: first guess only
# -i a: does the TOI, LF, PW
# -X g=f: centers time residuals around the first of all time residuals
# -p w=0: amplitude weight is 1
# -X s=n: keep origin of track at where algorithm calculates it
# -p t=0:10: triggers on at least 0 strings, 10 oms
```

```
# the real thing for the track:
TRACK_FIT="-r m -i f -p f=2 -X g=n -m x -X s=o -z a_upandel\
 -x x:step=10,y:step=10,z:step=10,zenith:step=0.1,azimuth:step=0.25\
 -p t=0:0"
# explanation
# -r m: muon reco
# -i f: use reconstructed track as first guess. Previous by default but
# -p f=2: makes it track number 2 (the LF from TOI_LF_PW)
# -X g=n: see above
# -m x: minimise with SIMPLEX
# -X s=o: put track origin as close as possible to center of detector
# -z a_upandel: Selects Pandel function for tracks
# -x ...: Starting values for simplex
# -p t=0:0: no triggering, all pass

# the cascade:
CASCADE_FIT="-r m -i f -p f=3 -X g=n -m x -X s=n -z a_pp_upandel\
 -l xyzt -x x:step=10,y:step=10,z:step=10,time:step=25\
 -p p=1003 -p t=0:0"
# explanation
# -r m: see above
# -i f -p f=3: use track 3 (PW) as first guess
# -X g=n -m x -X s=n: see above
# -z a_pp_upandel: selects 1 pe cascade pandel function
# -l xyzt: the result is given by the position and time of the cascade
# -p p=1003: particle id is 1003 (see phone book)
# -p t=0:0: see above

# now we are ready to go:
recoos $DEAD_OM $NOISY_OM $HC_WIN $HC_AMP $HC_TOT $HC_1ST $HC_ISOL $TOI_LF_PW\
| recoos $DEAD_OM $NOISY_OM  $HC_WIN $HC_AMP $HC_TOT $HC_1ST $HC_ISOL $TRACK_FIT\
| recoos $DEAD_OM $NOISY_OM $HC_WIN $HC_AMP $HC_TOT $HC_1ST $HC_ISOL $CASCADE_FIT

# script ends.
# How did I know about the -X , -i and -p? Check recoos -hh |& less !
```

Further reading

- Muon reconstruction with AMANDA
  C. Wiebusch,
  Proceedings of Workshop on Simulation and Analysis Methods for Large Neutrino Telescopes, DESY ZEUTHEN,
  Germany July 6-9, 1998 edited by C. Spiering
  DESY Zeuthen, Zeuthen, Germany

- Direct-Walk II
  P. Steffen, AMANDA Internal Report 20020201

Conclusions

The renovated `recoos` manual features . . .

- . . . a separation of first guess methods into track and shower methods
- . . . the same for the "real" reconstruction
- . . . a (too) large section on "OOO" (obsolete/old/obscure) likelihoods
- . . . an example

Some missing features are the description of the extended flags `-X`, `-p` . . . . Please confer the online help (`recoos -H |& less`, `zsh`, `bash` users do `recoos -H 2| less`).

Don't forget: Use the Code, Luke!