First steps with Moon Shadow

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- Carla analysis: CalReal
  - Data: 2007 to 2009, silver runs, no alignment cut
  - Simu: Full MC (Corsika Moon)
- This analysis:
  - Data: All experimental SeaTray production
    Lots of discrepancie, no info on alignment, small proportion of the silver runs.
  - Simu: Toy Monte Carlo (corresponds to experimental data plus randomized direction)

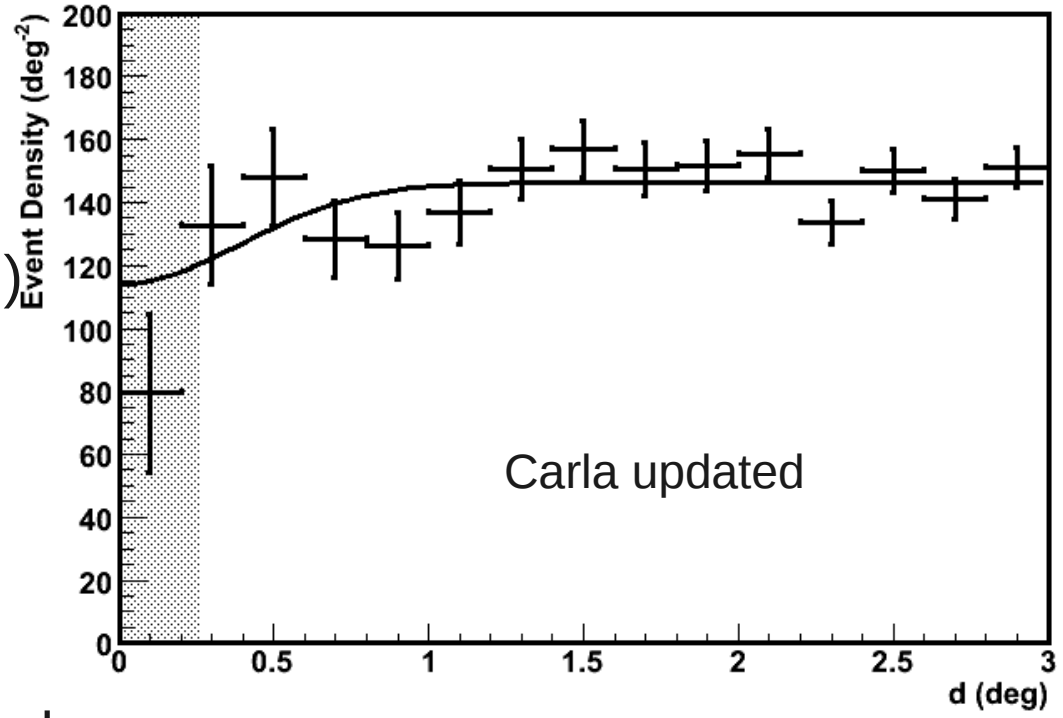
Coordinate check

Deep check of SeaTray code (but still insufficient?)

- All based on SlaLib.
- Different frames (UTM pointing 1.93 deg from east counting anticlockwise, SlaLib pointing North counting clockwise)
- Equatorial calculation in j2000 frame, then precession applied (no nutation)

Coordinate check

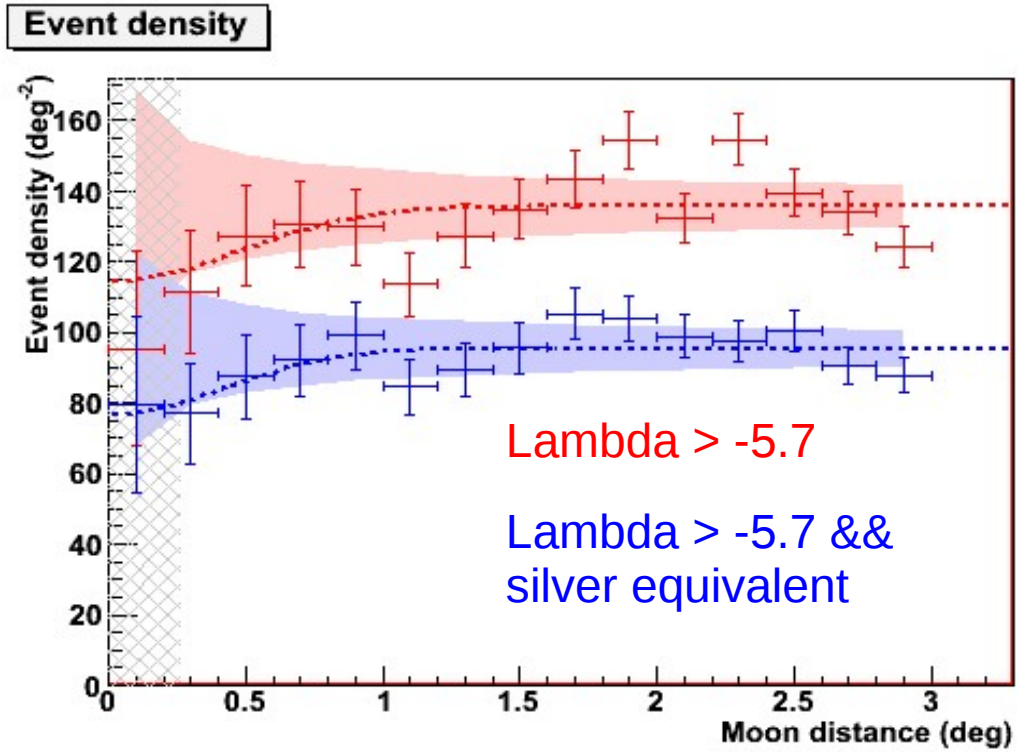
- Carla:
  - Correction of 90 deg (North or East)
  - Correction of 1.93 deg (UTM grid)
  - Fixed the MJD precision
- Teresa:
  - Same angles as Carla
  - Difference with me = precession ?!? (should be included in both codes, but I find her results when I deactivate it...)
- Manuela:
  - Frame ok, about 0.2 degree difference



Moon shadow, data sample

- I use all the seatray productions I found, without knowing exactly what's inside:
  - Rtd-processing-1 (only 6 month, far from all silver runs in this period)
  - reco-prod-0 (couldnt find any documentation)
- No information about alignment in these files
- I see discrepancies between the two productions (lambda value presents 2 maxima...)
- ==> I use it anyway, that's all I have now!
- In the following:
  - Always Aart strategy, cut lambda > -5.7
  - Red = no cut on DQ
  - Blue = cut similar to silver runs, but with seatray DQ variables

Moon shadow, data sample



Crosses: data points, errors in sqrt(evts), normalized by bin solid angle

Line: Fit with the function Constant*(1-Smoon*Gauss(r,sigma))

- Just 2 degrees of freedom, the integral of the deficit is fixed by the intergral **FALSE: It would de true in 1D, but in 2D there should be something similar ti r**2 in front of the Gauss function !**

Colored surface: error extapolated from the constant of the fit, taking into account the bin solid angle. To be used for significance calculation instead of sqrt(evts)

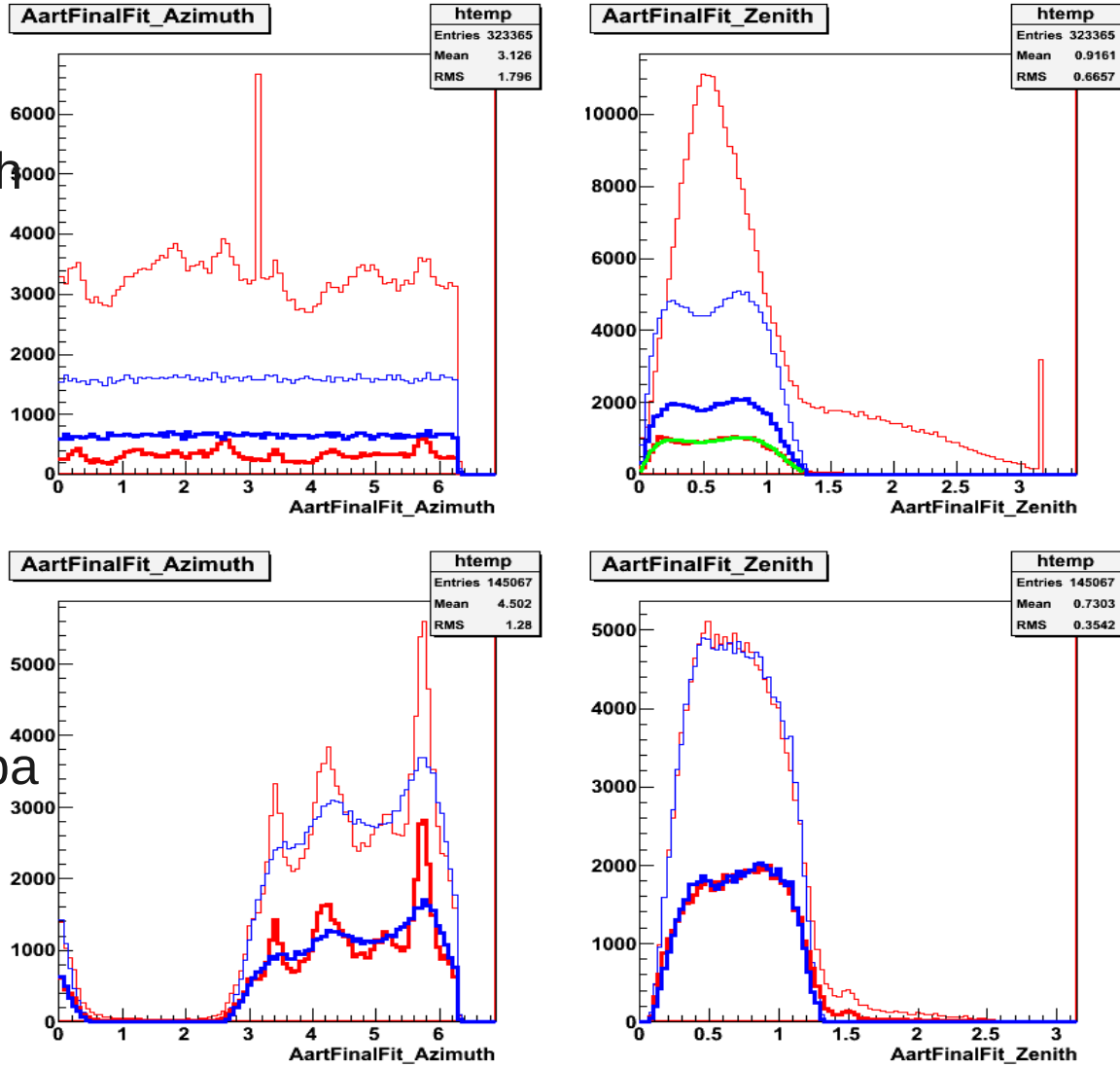
Moon shadow, toy MC

- Take experimental root output
- Take random direction
- Remove (or not) moon events
- Smear direction: Gauss 0.5deg for now
- After: same analysis

- Can generate much statistics
- Helps to understand significance

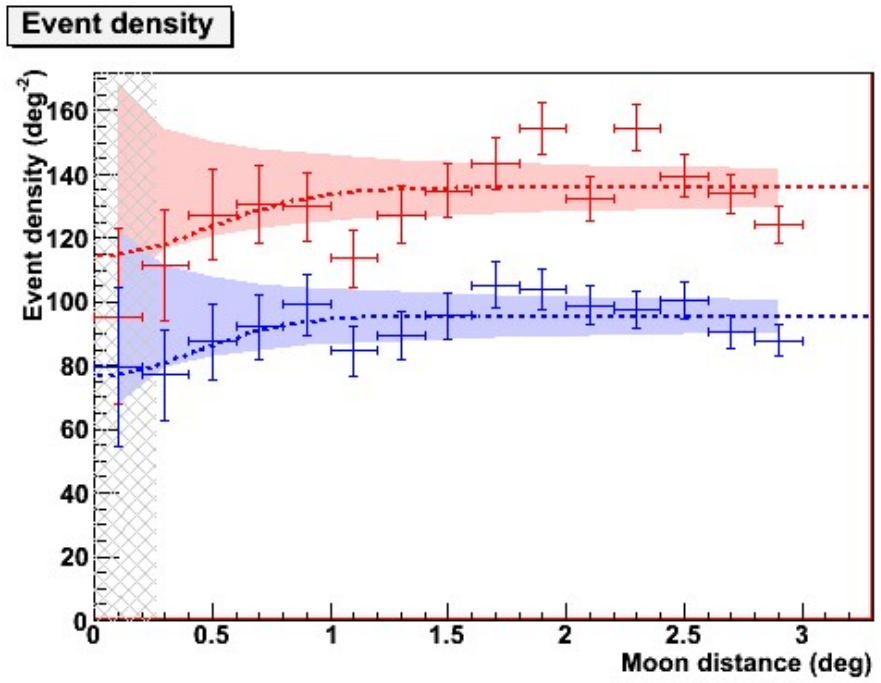
Moon shadow, toy MC

- Zenith & Azimuth distributions chosen to reproduce approximately experimental distribution of events with lambda > -5.7 (based on 4 randomly chosen silver runs)
- Plots:
  - Top=all events (used to define the distribs), bottom=events at less than 0.2 rad from the moon.
  - Red: data, blue: MC
  - Thin: no(top) or poor(bottom) lamba cut, thick=lambda > 5.7
  - Green: polynomial fitted on data, used to compute random zenith
  - Atimuth: uniform random

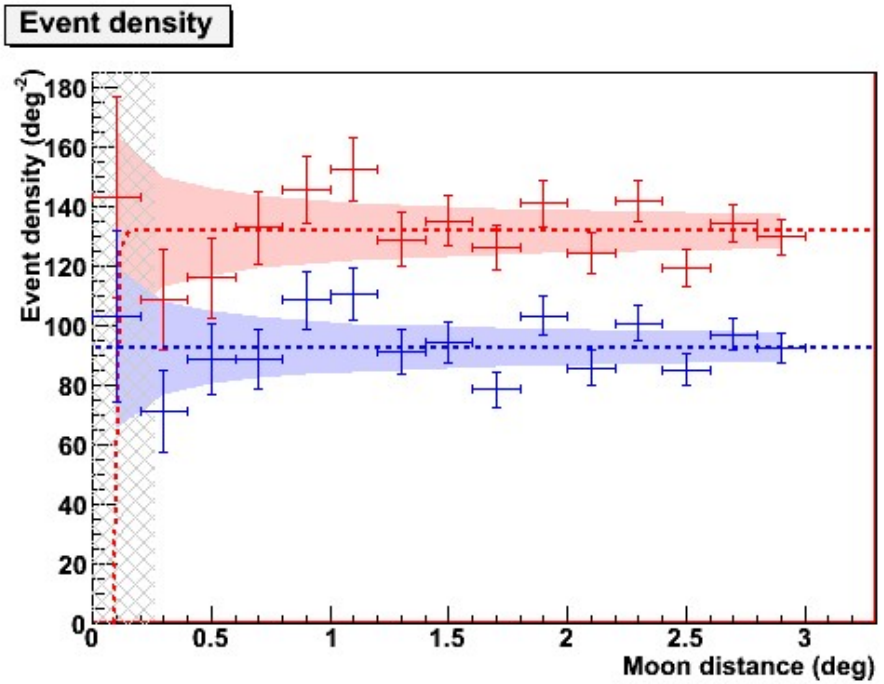


Moon shadow, toy MC

- Exp

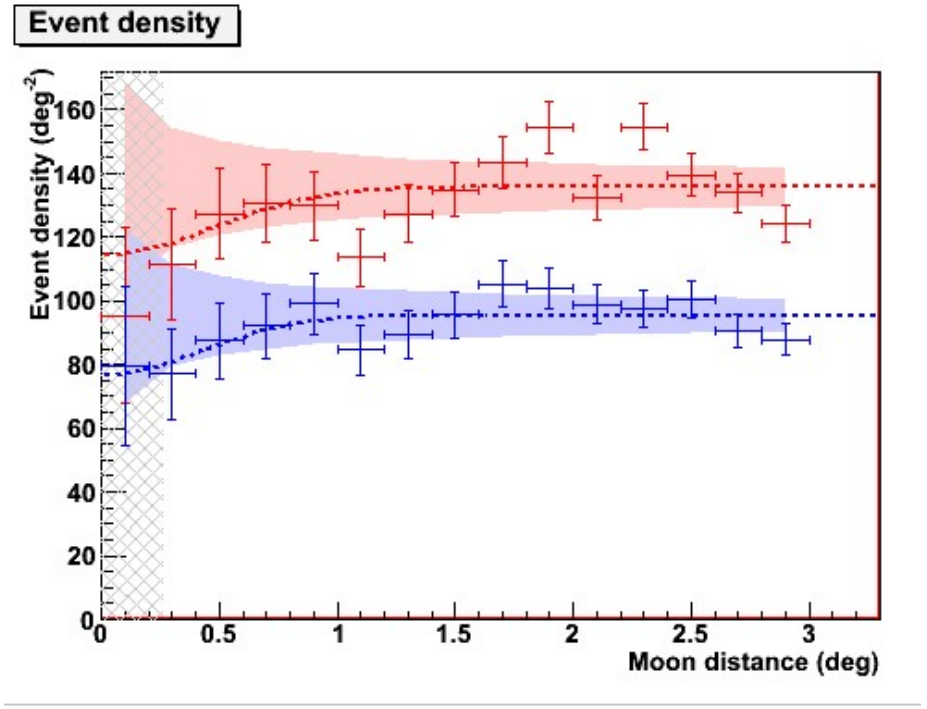


- No moon, same stat

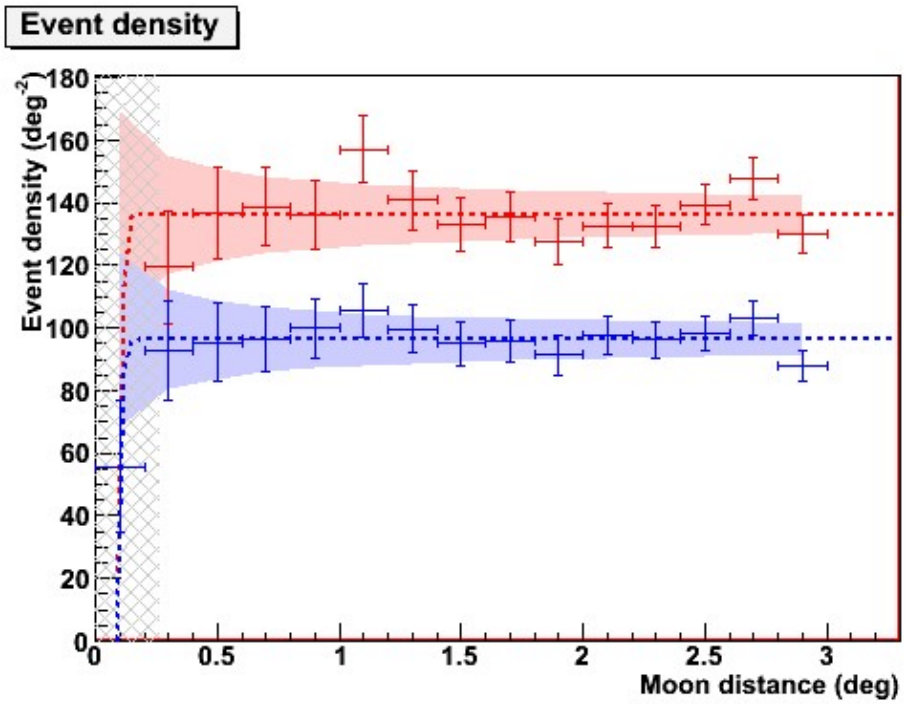


Moon shadow, toy MC

- Exp

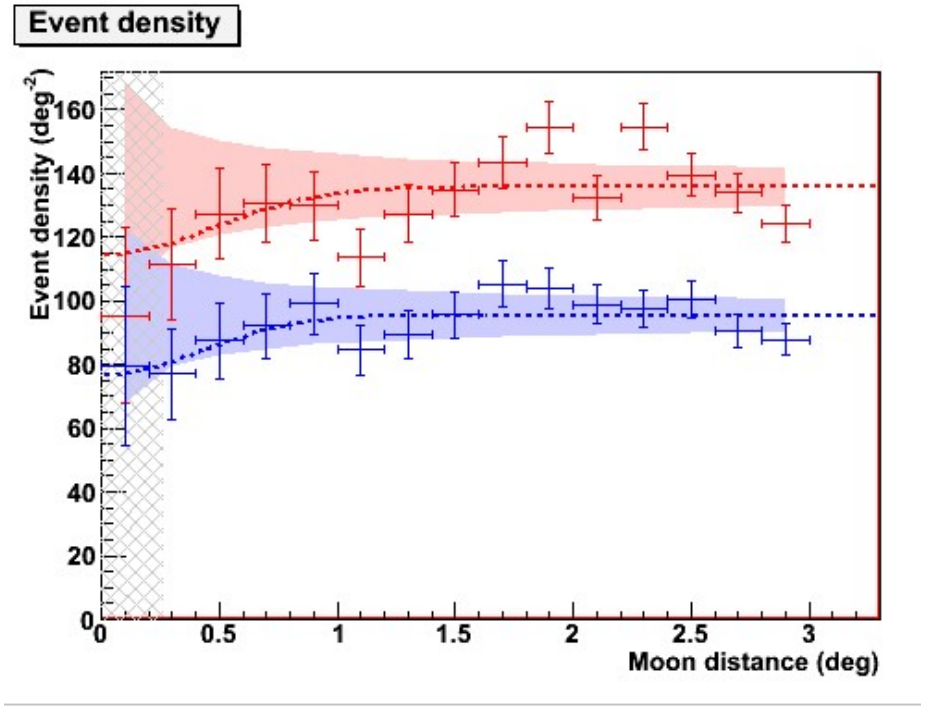


- With moon, same stat

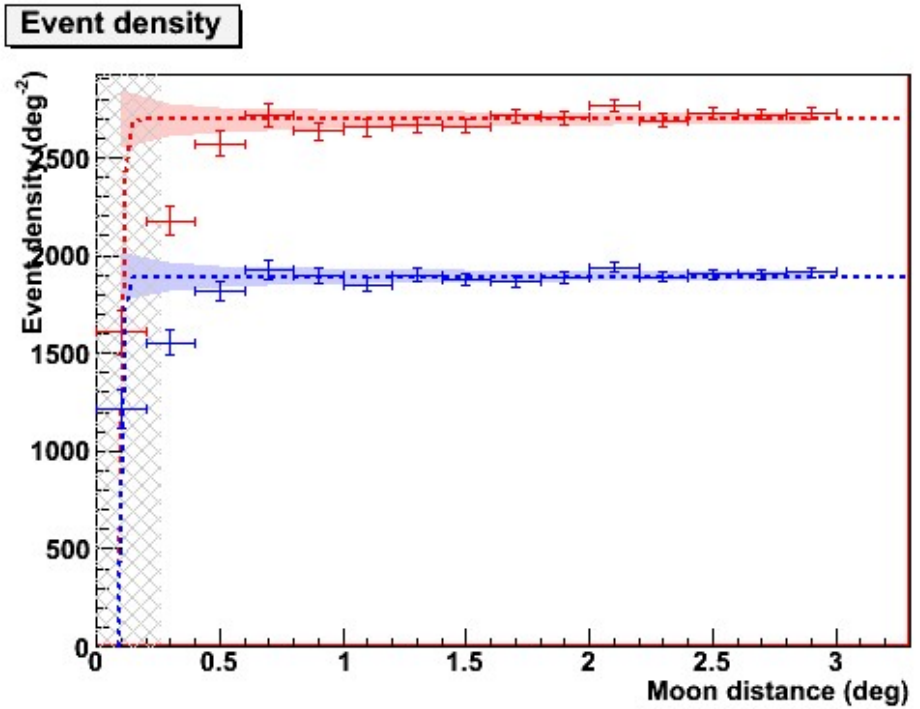


Moon shadow, toy MC

- Exp



- With moon, stat*20



Moon shadow

- How to compute significance? From these curves? Scanning the sky, a la IceCube (arXiv:1002.4900)?

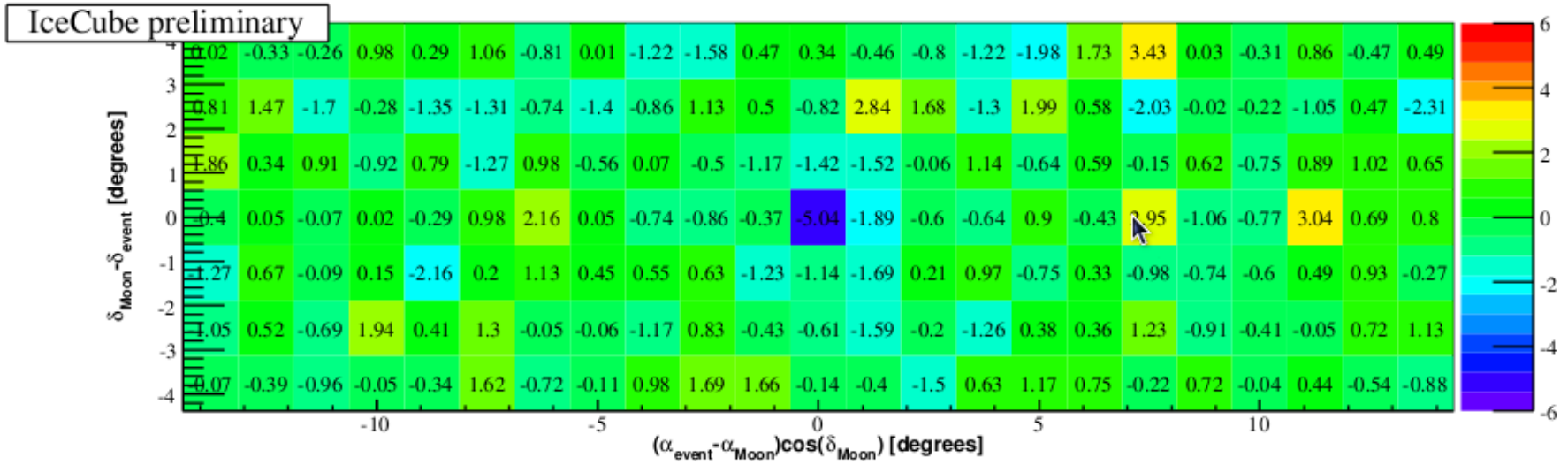


Fig. 5: The significance of deviations in a region centered on the Moon.

$$S = \frac{N_{\mathrm{on}} - \alpha N_{\mathrm{off}}}{\sqrt{\alpha(N_{\mathrm{on}} + N_{\mathrm{off}})}}.$$

Computed for each cell from the neighbours of the same line

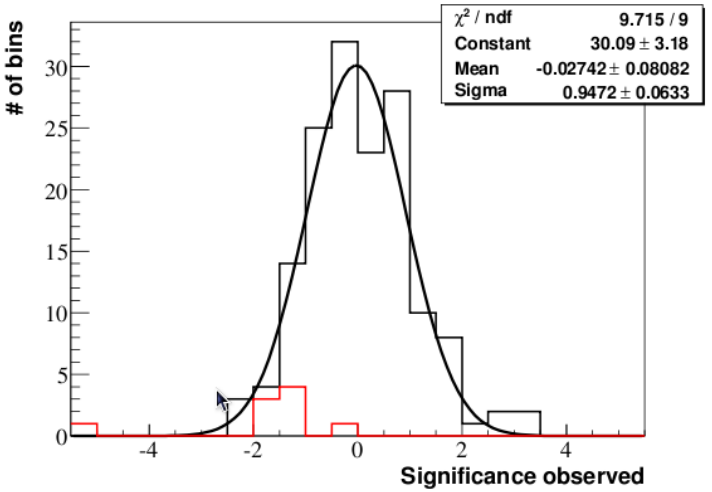
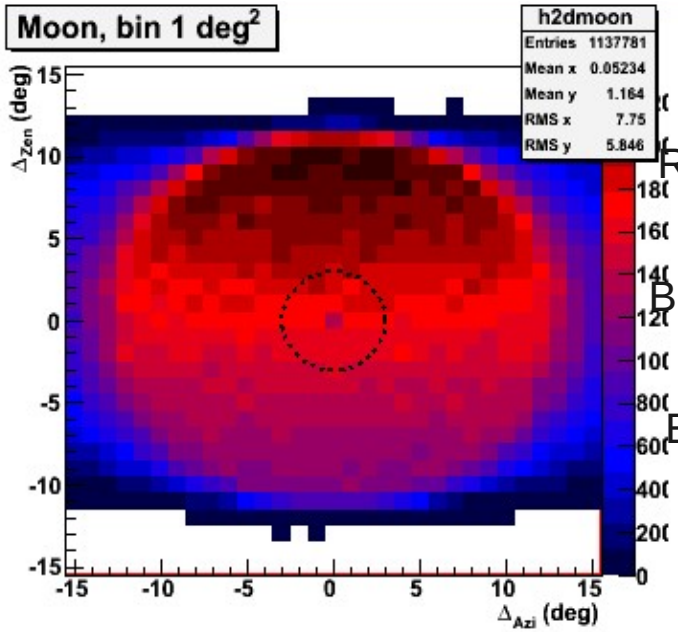


Fig. 6: Each of the deviations shown in Fig. 5 is plotted

Moon shadow, toy MC

Simu, stat*20



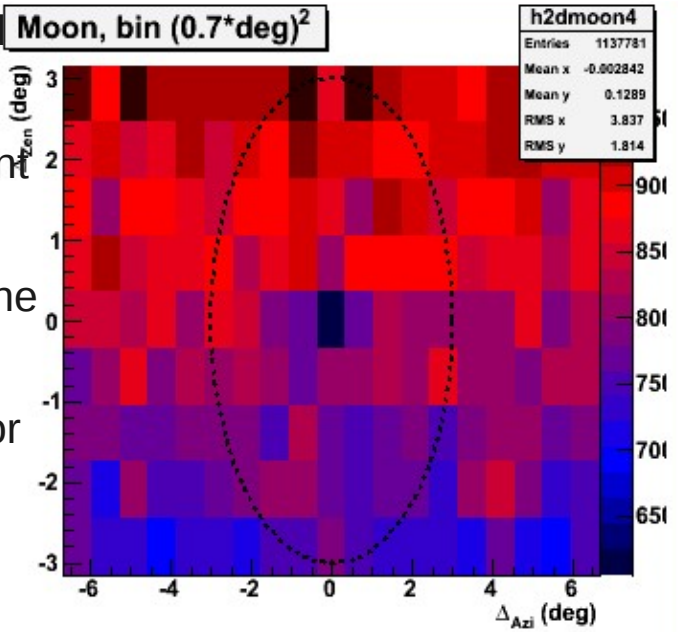
Left: All events kept in root file (<0.2 rad from moon)

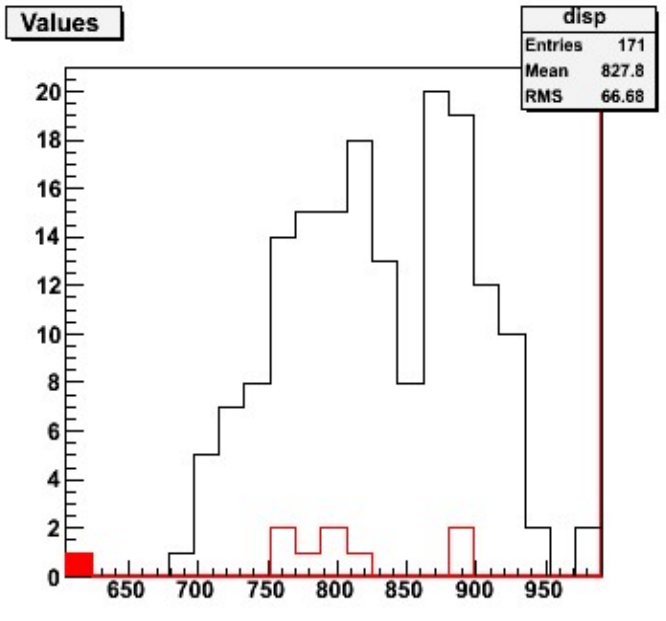
Right: Zoom in the central region, different binning

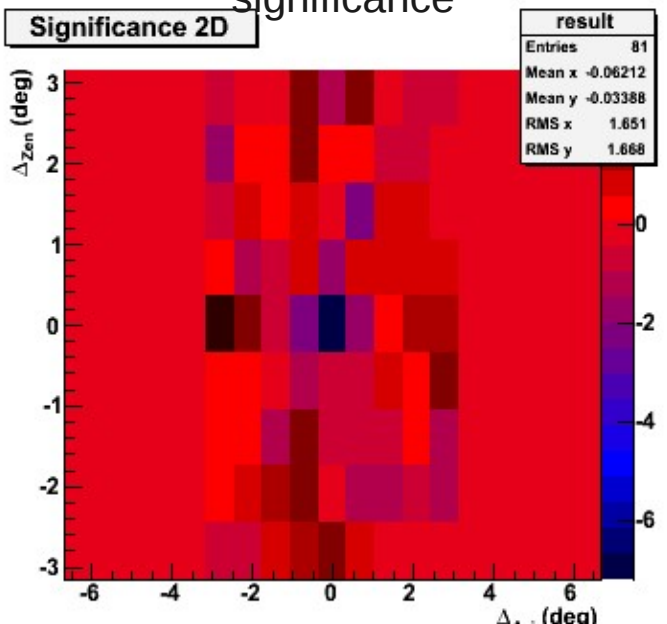
Bottom left: Distribution of the values of the bins of the previous plot

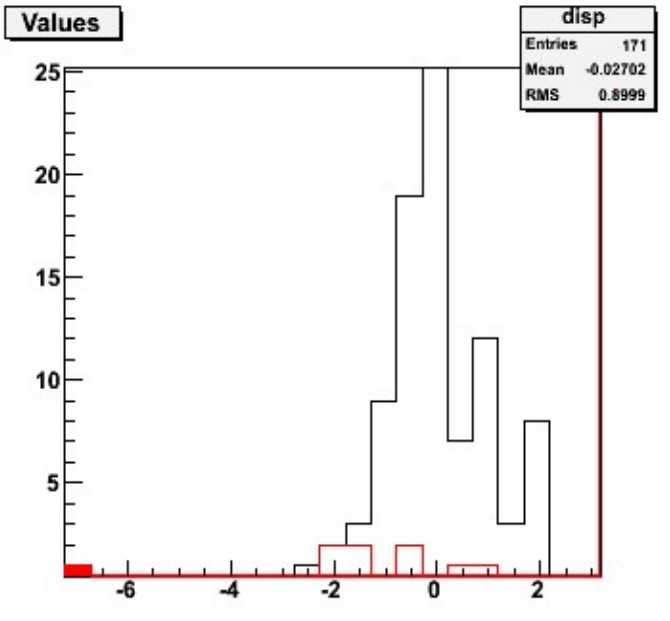
Bottom center: Significance computed for each bin from neighbours: ....NNN..S..NNN.

Bottom right: Idem bottom left, with significance



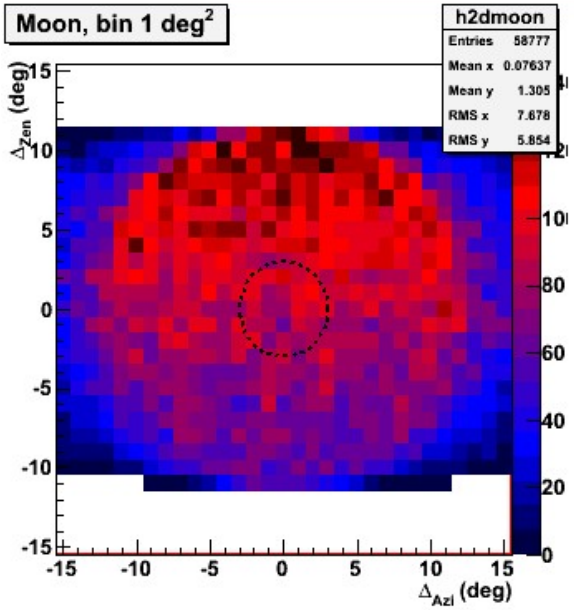


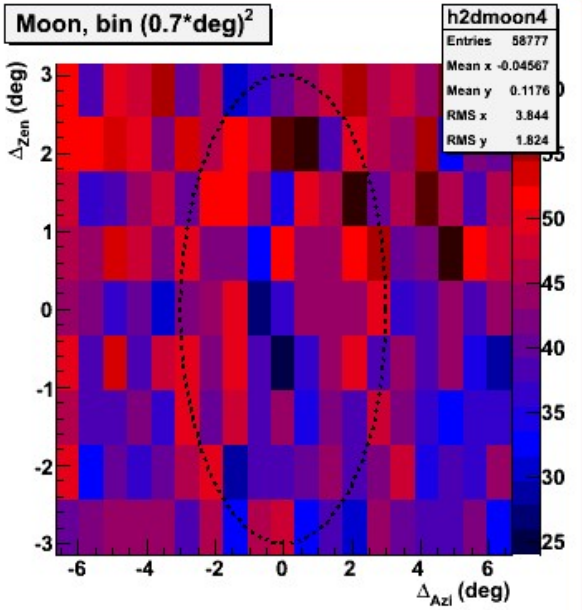


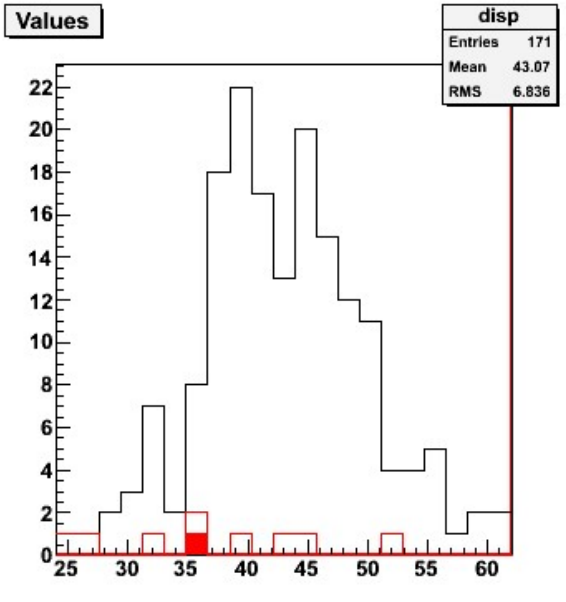


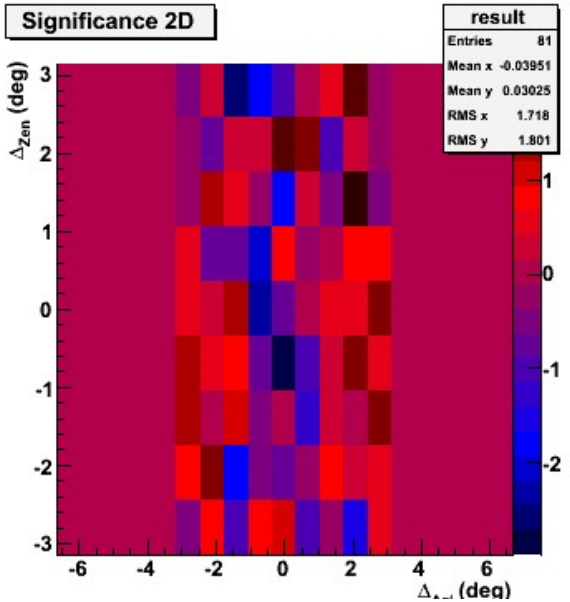
Moon shadow, toy MC

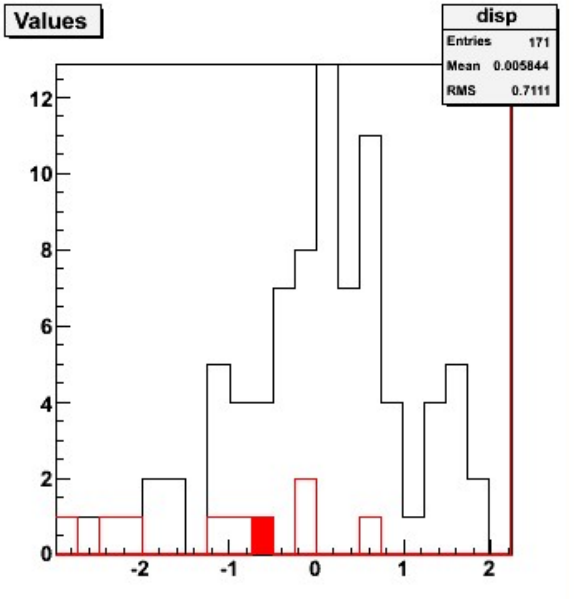
Exp





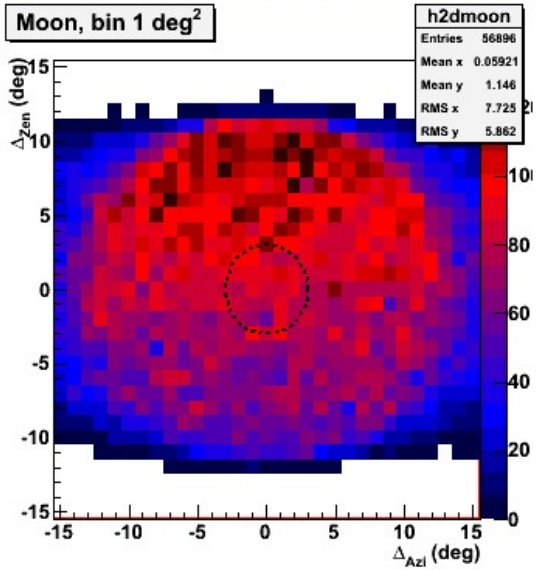


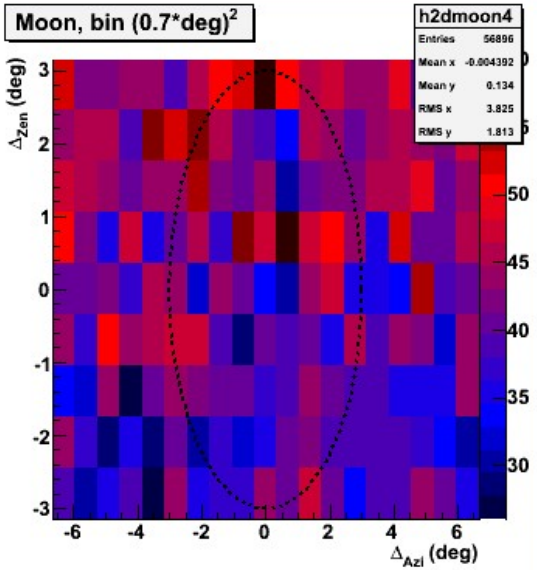


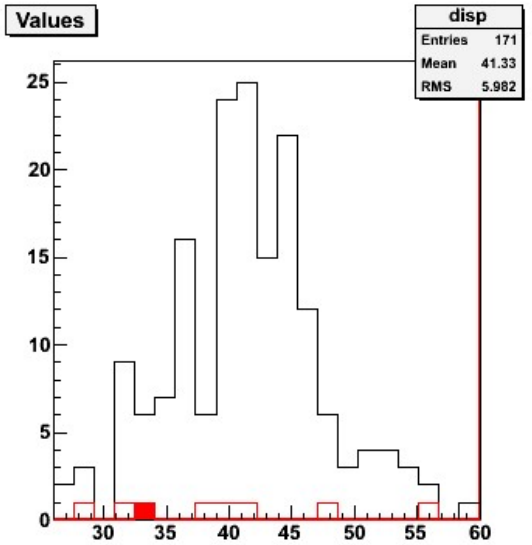


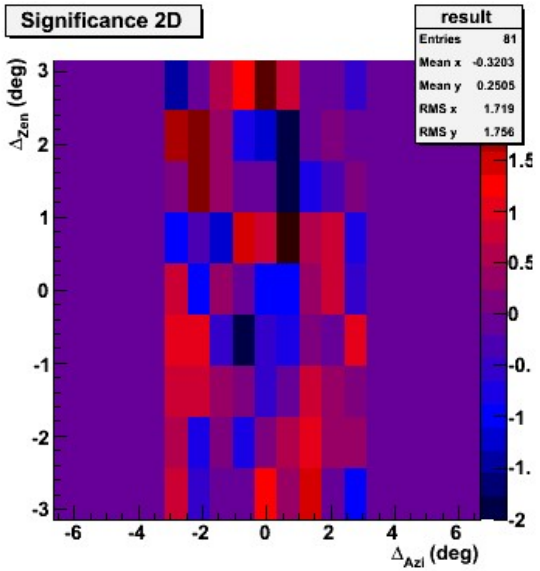
Moon shadow, toy MC

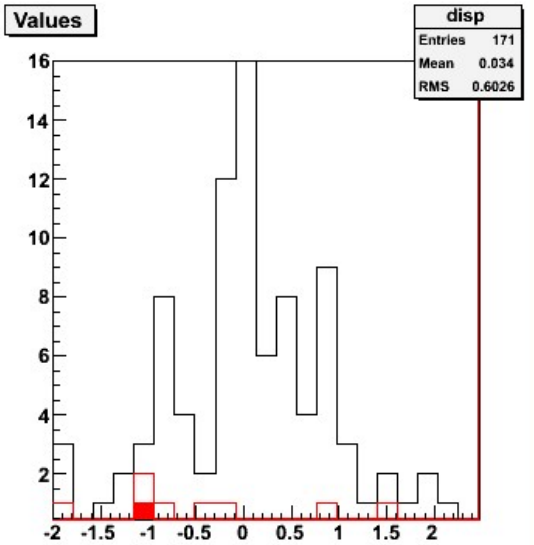
Simu, stat*1











Moon shadow, toy MC

- What's next?
  - Produce numerous simulations without moon. Compute the probability to obtain Carla's or my plot by chance.
  - Improve toy MC (choose a better function for smearing - probably complicated task to get something realistic and certain)
  - Evaluate effects of the different parameters
  - Make a full SeaTray production, for all data, including some alignment information (i3 files with alignment too big?)
  - Update my experimental plots with more and safer data