

Systematics of moon shadow in Antares

Why another study? (we have Carla, Matteo, Tommaso, Jürgen, Jean-Pierre, Aart, Clancy ...)

Trying to help with understanding systematics with some easy basic/fast explorations
It's nice to be able to study a signal instead of limits once in a while ...

Data samples available:

My own:

2007-2012 All runs with $QB \geq 1$

Trigger 3N, T3, TQ

$$\Lambda > -5.9, |\beta| < 0.8$$

Carla's:

All runs 2007-2015 (QB?)

Trigger?

- Make Δ_{zenith} vs Δ_{azimuth} 2D histogram (5degx5deg with 0.2deg binning)
- Fit Background (2nd order polynomial in both azimuth and zenith, using IDL routines)
- Fit in every pixel an additional 2D gaussian (width&height free, $0.3\text{deg} < \text{width} < 1.2\text{degrees}$, keeping background parameters fixed (also using IDL routines))
- Compare χ^2 of gaussian fit with background χ^2

Coordinate systems and implications for measurements

1) Matteo/Carla/Tommaso:

- $\text{zenith_track} - \text{zenith_moon}$
- $(\text{az_track} - \text{az_moon}) * \cos(\text{elevation_moon})$ ← must be $\cos(\text{elevation_track})$

2) Jürgen:

- rotate for every track coordinates in system where moon elevation=0

- 1) + shifts in detector coordinate system directly apply to the coordinates in the 2D plot
 - slightly distorts proper sky pattern
- 2) + keeping gaussian form of source (in case of proper pointing)
 - does not conserve direct association to detector coordinates
 - => azimuth shift not directly associable to detector misalignment in azimuth

Also beware: We observe the moon with the muons mostly high in the sky, so a measured shift of 0.5 degrees would translate into a detector azimuth shift of ~ 0.7 degrees

Variations

Routines set up to digest data samples within ~1 minute for a given set of cuts

Looked some at variations with the chosen coordinates, binning, width, day/night, cuts

Cuts and binning/width seemed to not change the main features significantly

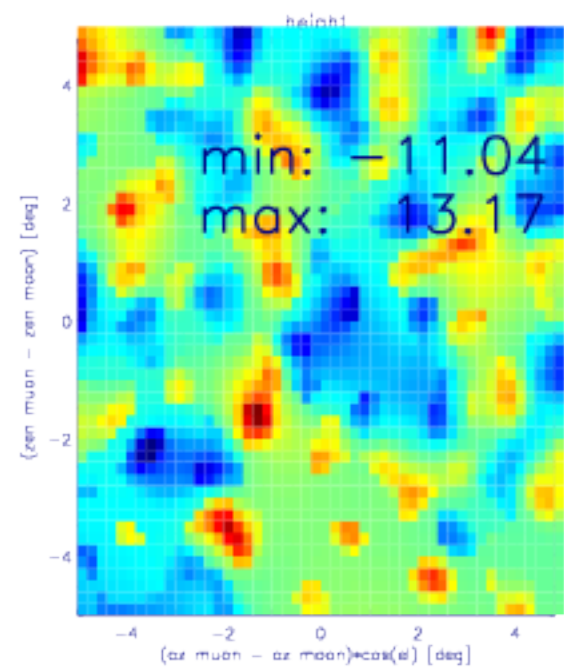
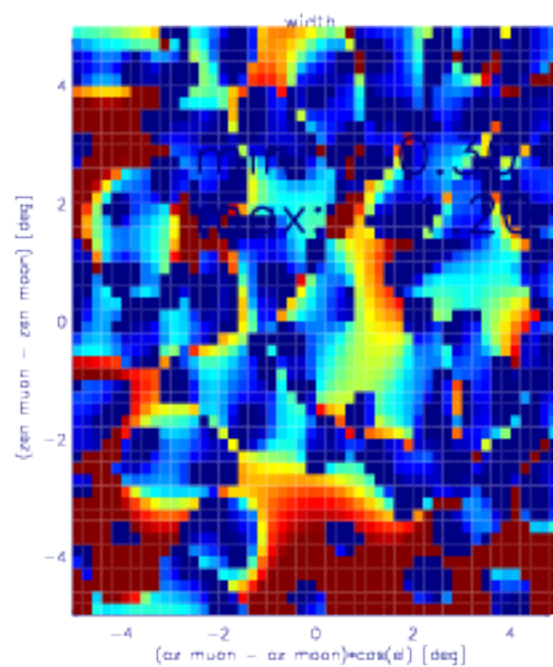
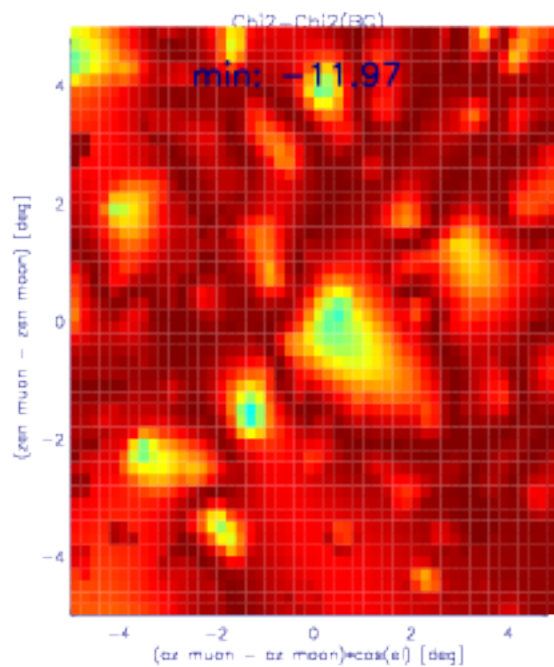
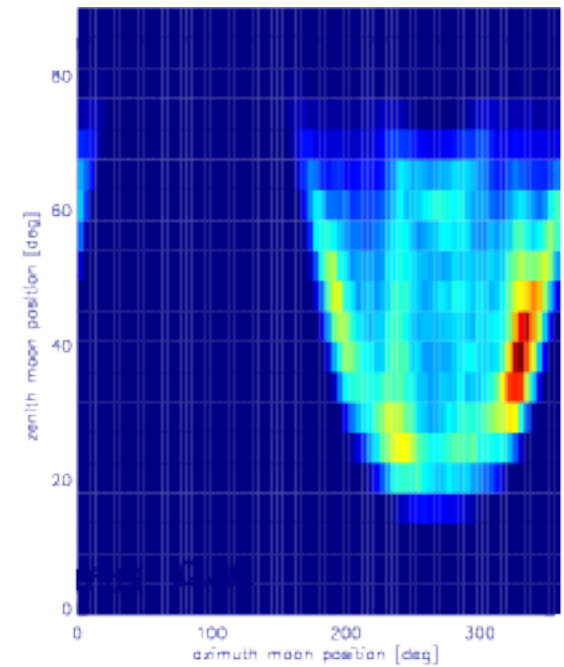
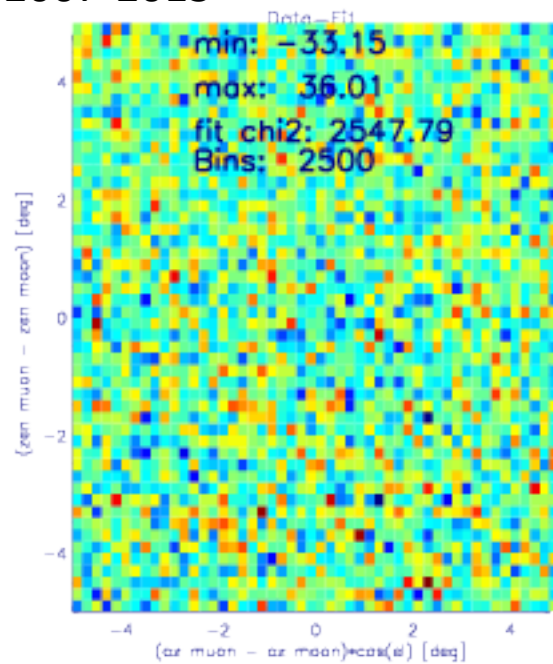
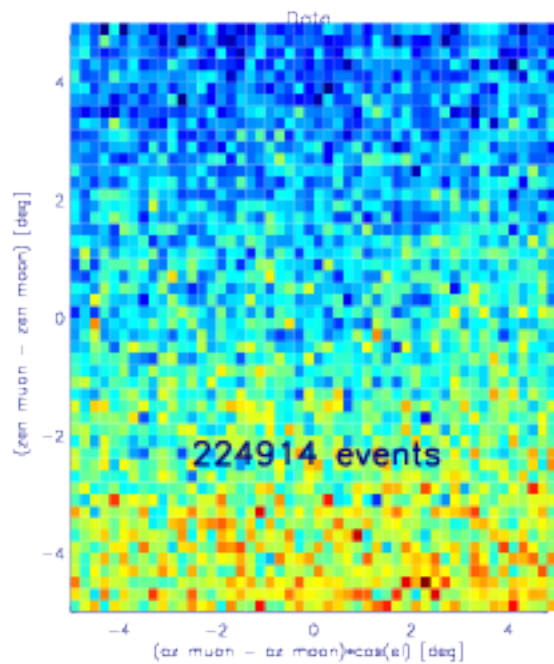
Night showed some weird fluctuations

Excluding single years affects background shape and signal some

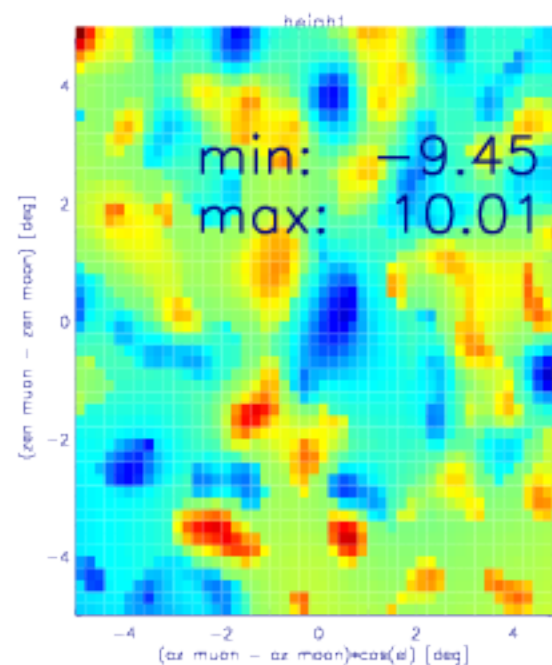
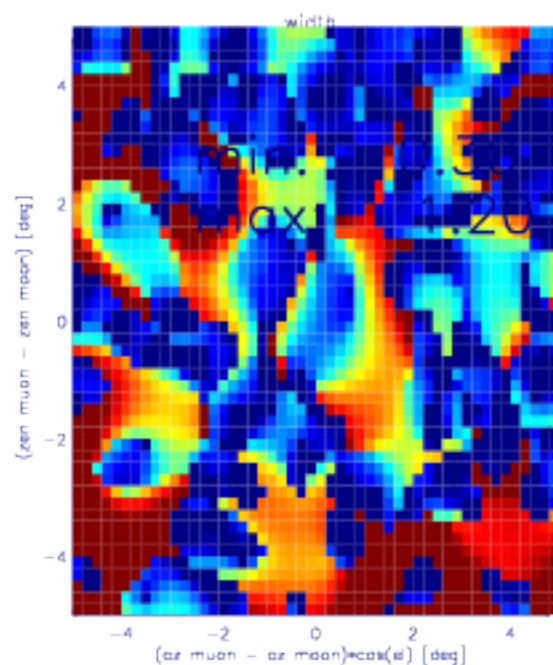
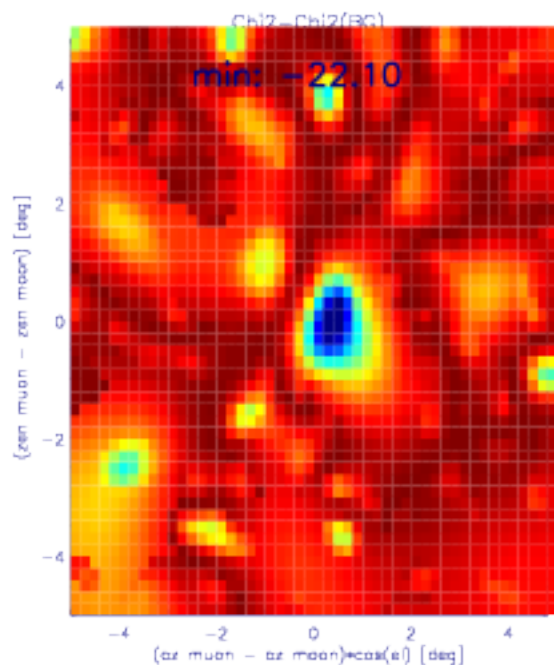
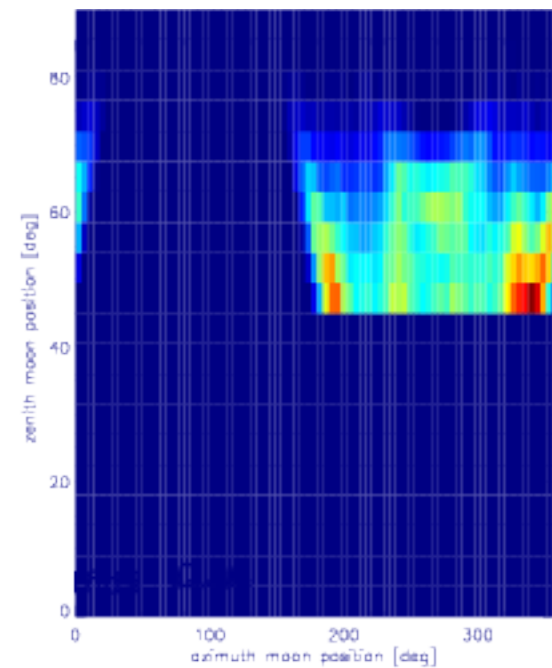
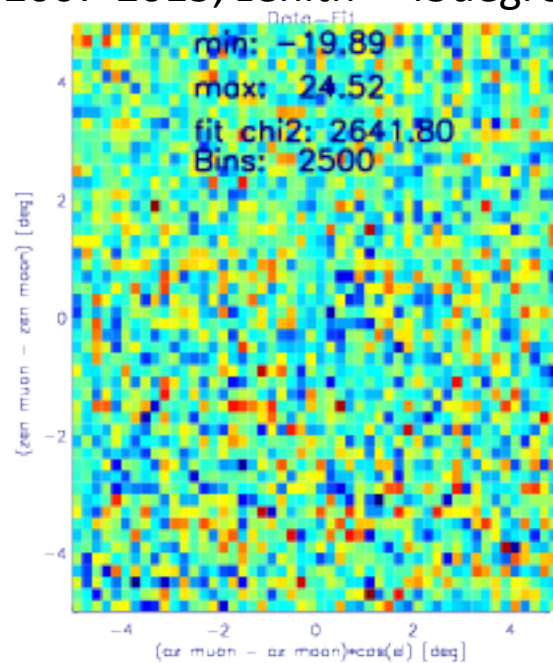
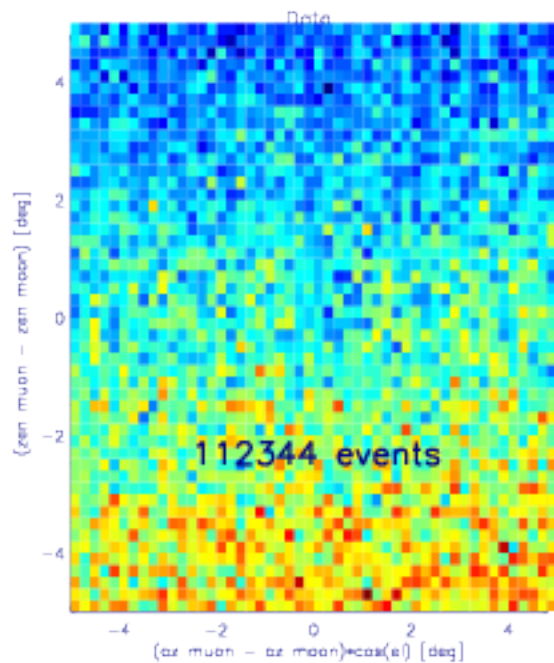
Shown here samples at different coordinate locations:

- All 2007-2015 (Carla's ntuple)
- 2007-2015 zenith > 45 degrees
- 2007-2015 zenith < 45 degrees
- 2007-2015 azimuth > 280 degrees
- 2007-2015 azimuth < 280 degrees
- 2007-2012 (my ntuple) zenith > 45 degrees
- 2007-2012 fake moon (8 hours shifted) zenith > 45 degrees
- 2007-2012 fake moon (-8 hours shifted) zenith > 45 degrees

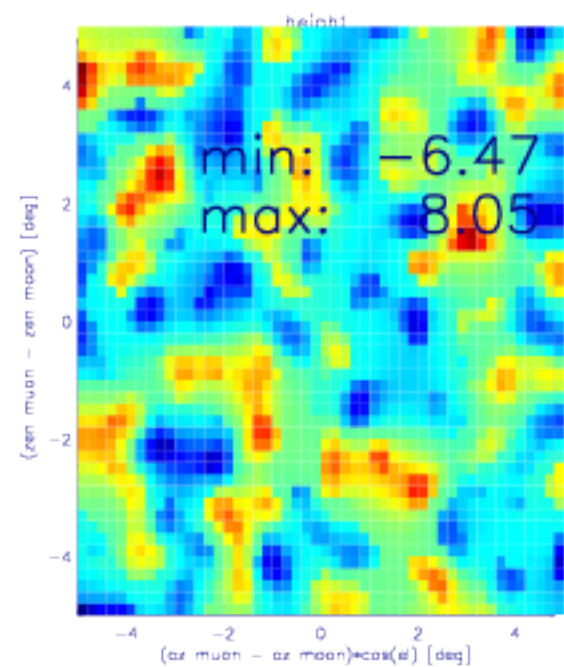
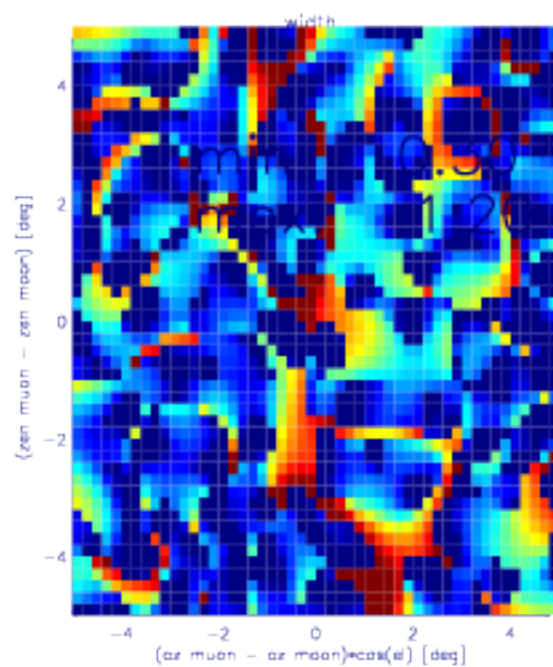
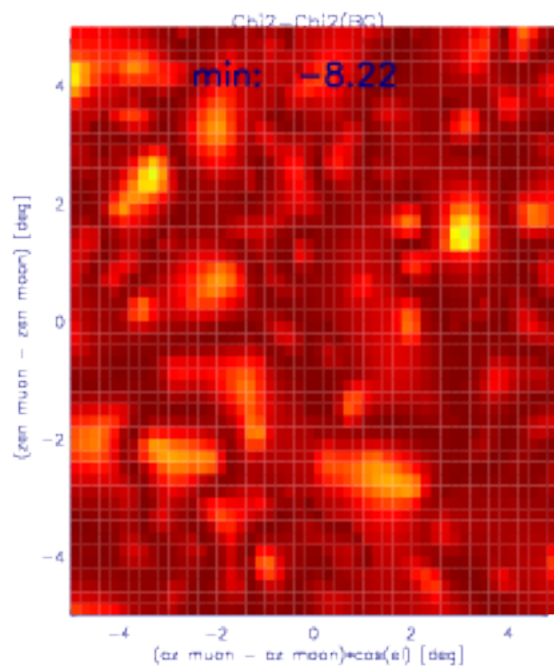
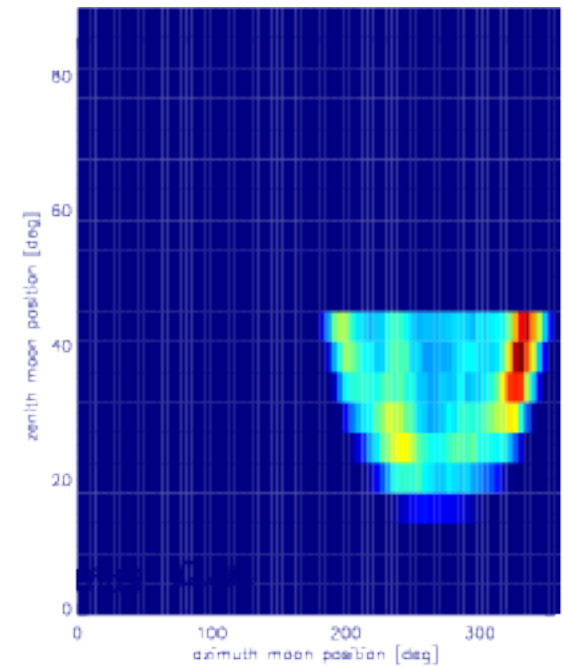
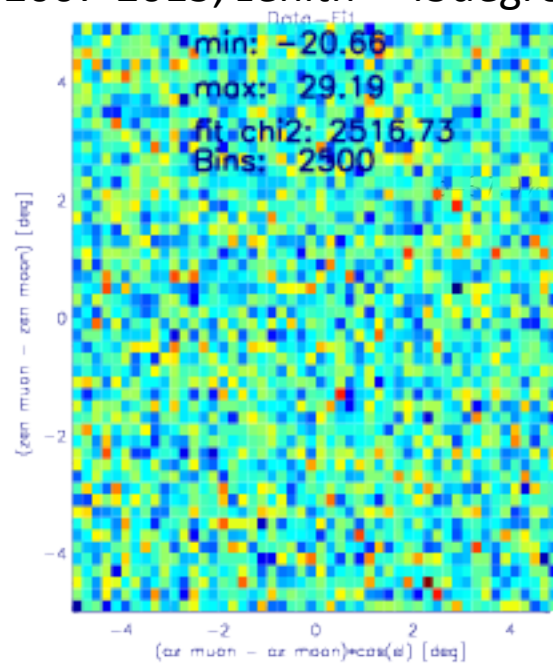
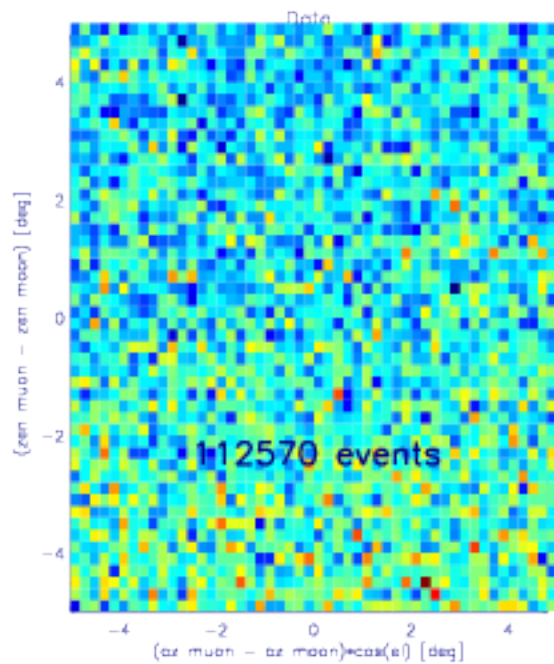
2007-2015



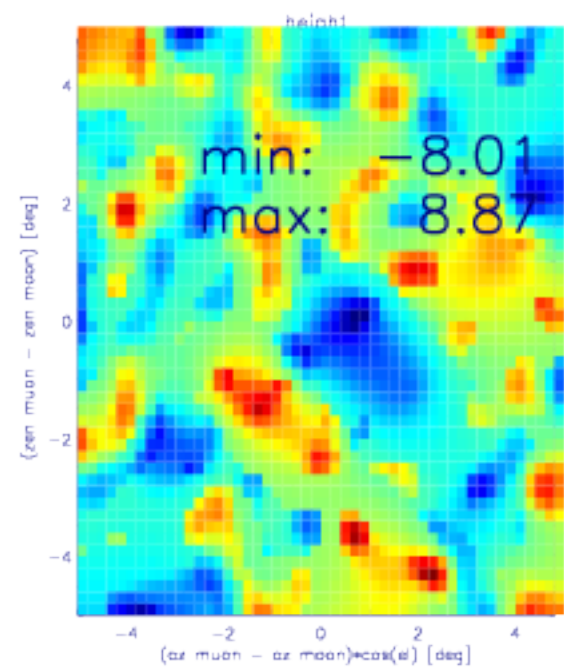
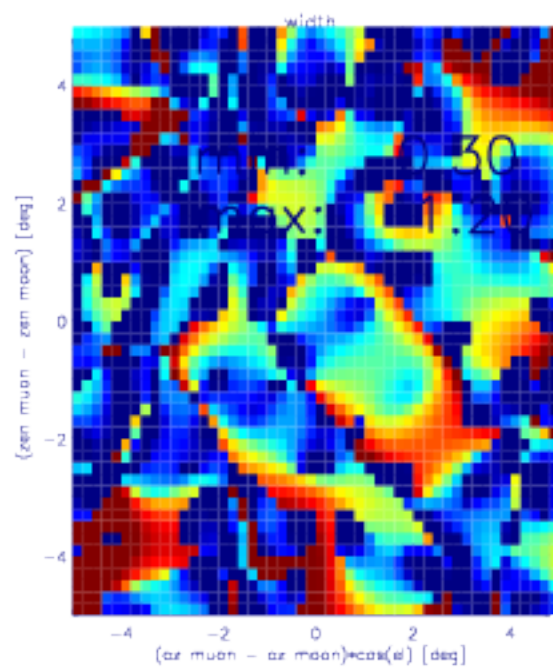
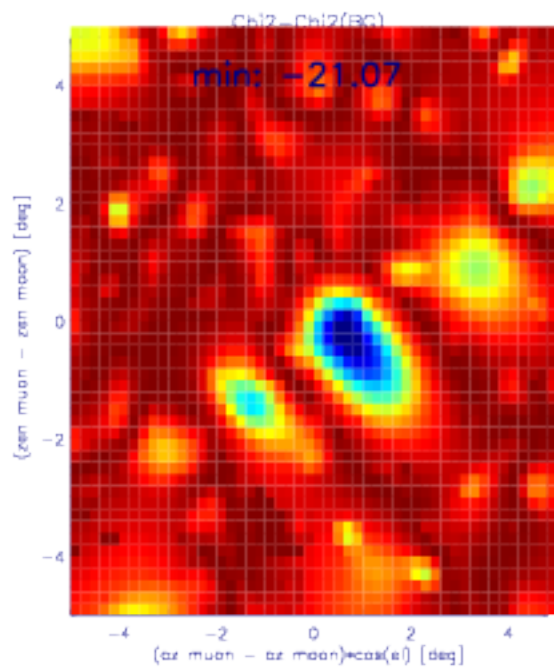
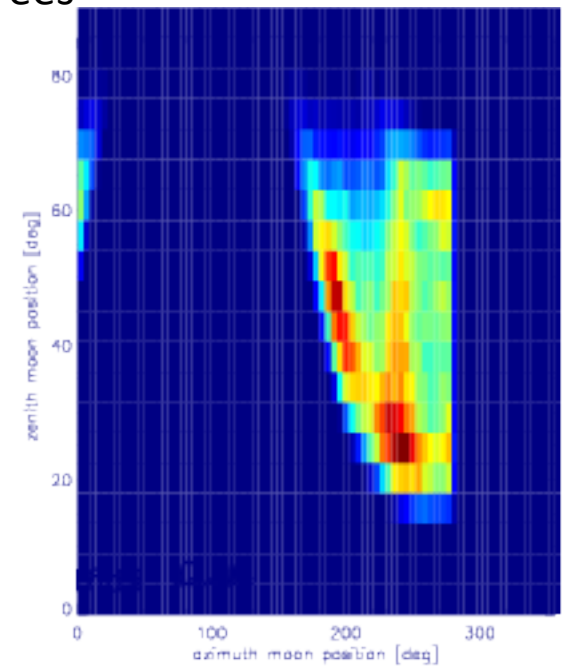
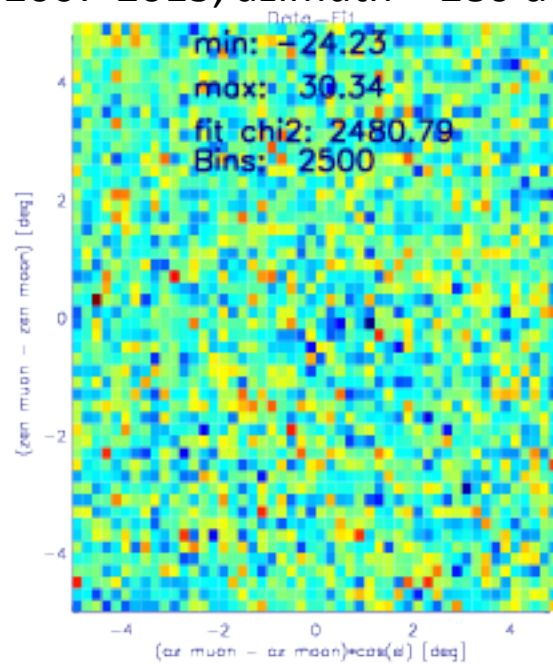
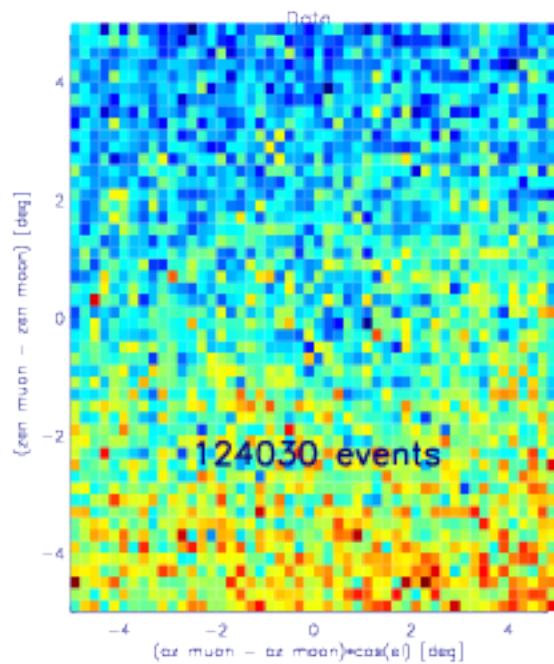
2007-2015, zenith > 45degrees



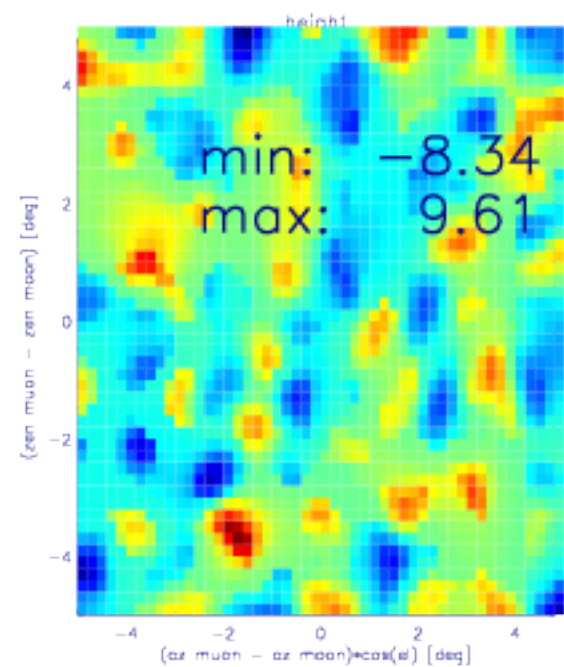
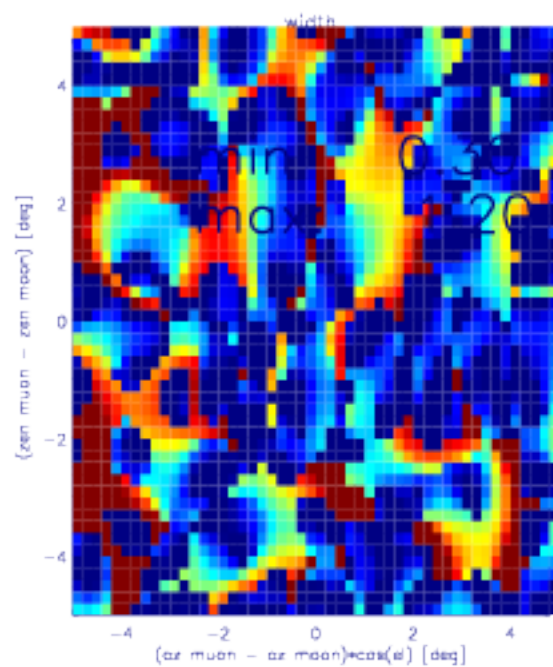
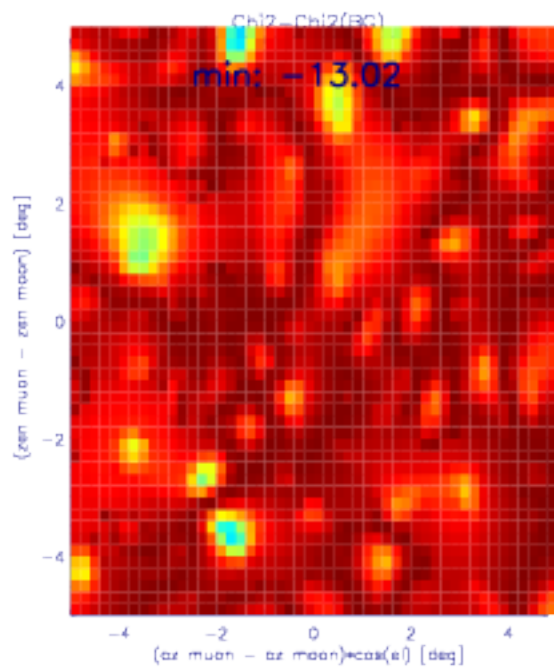
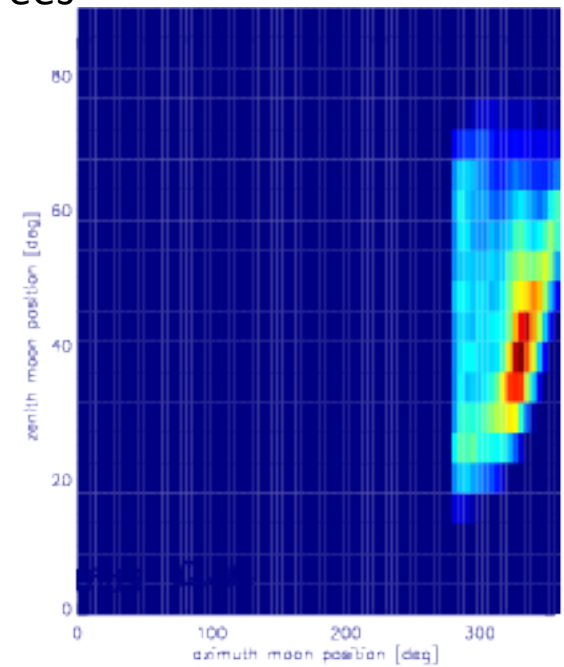
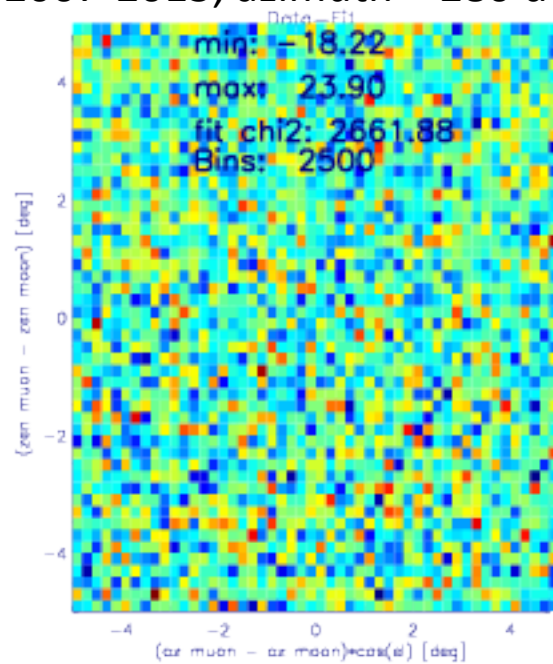
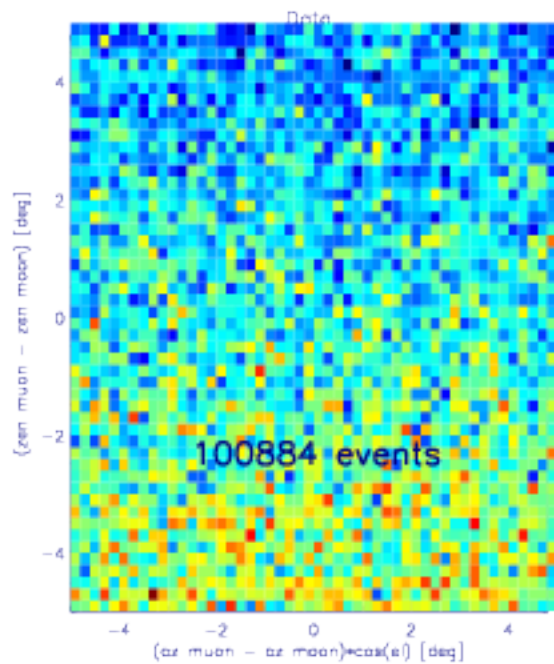
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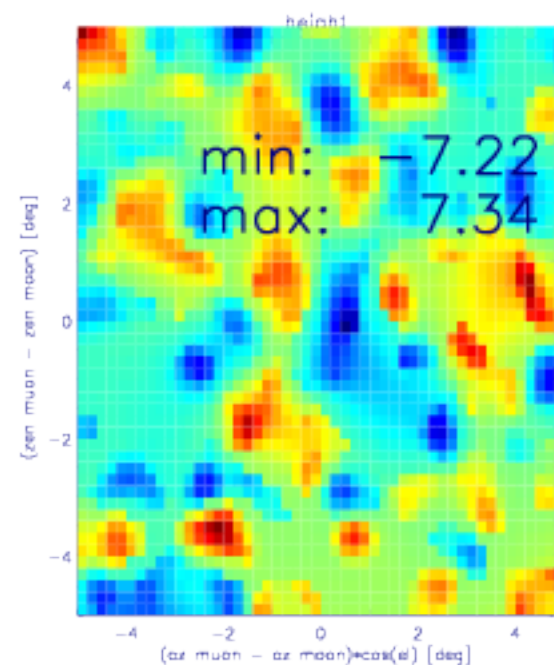
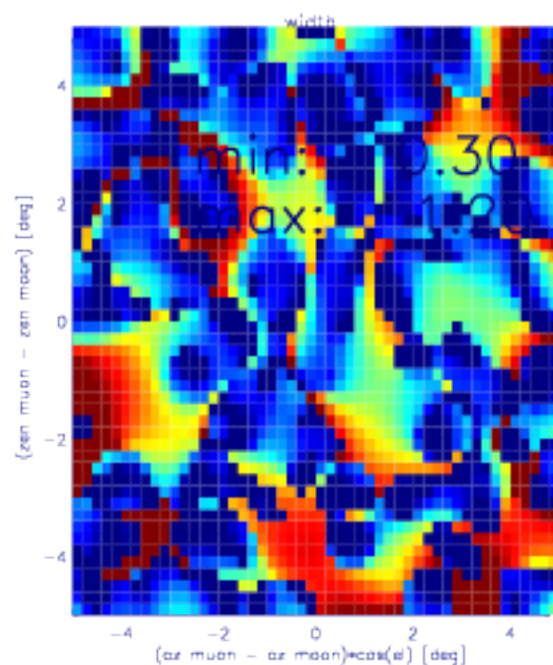
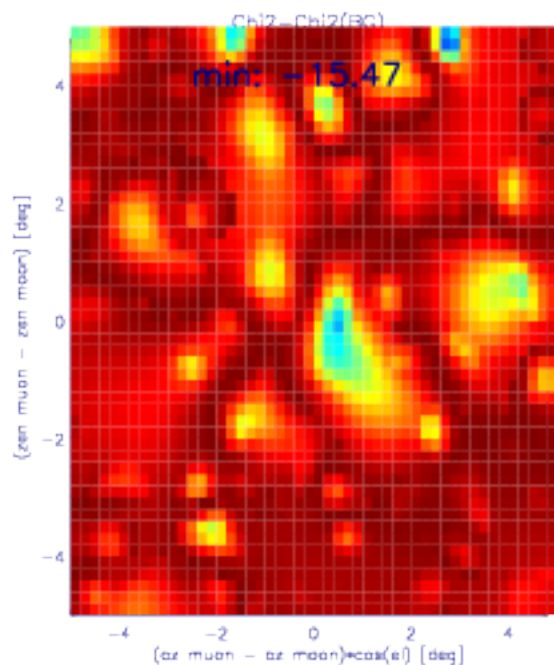
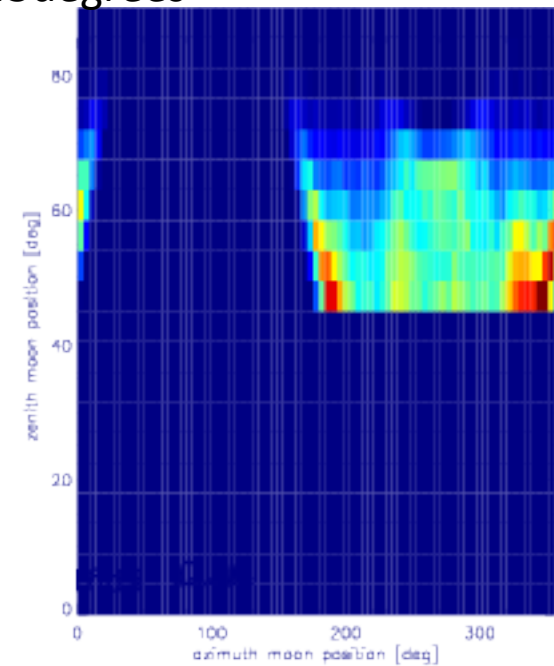
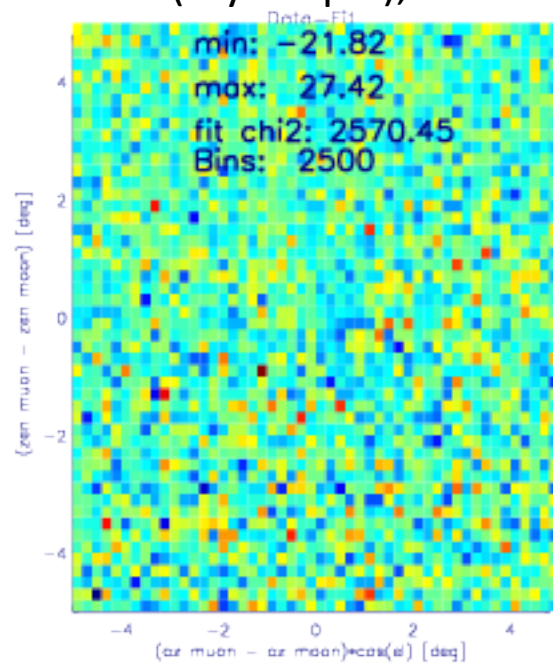
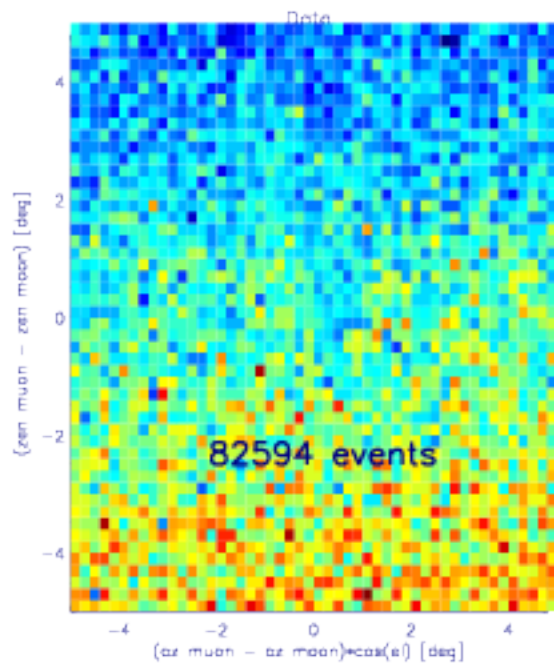
2007-2015, azimuth < 280 degrees



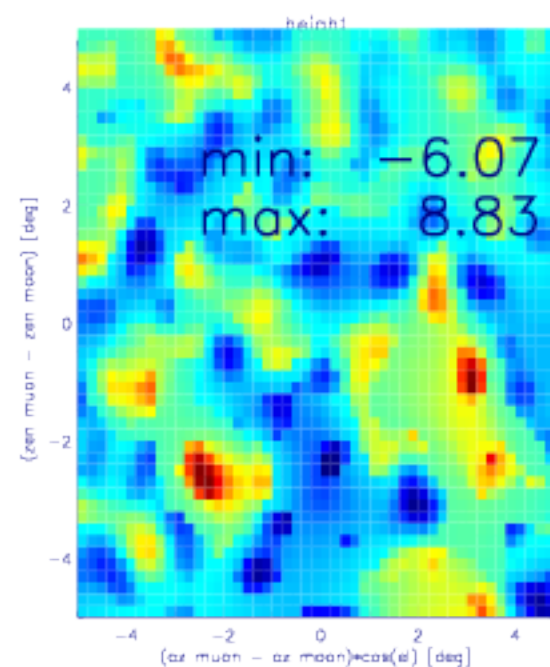
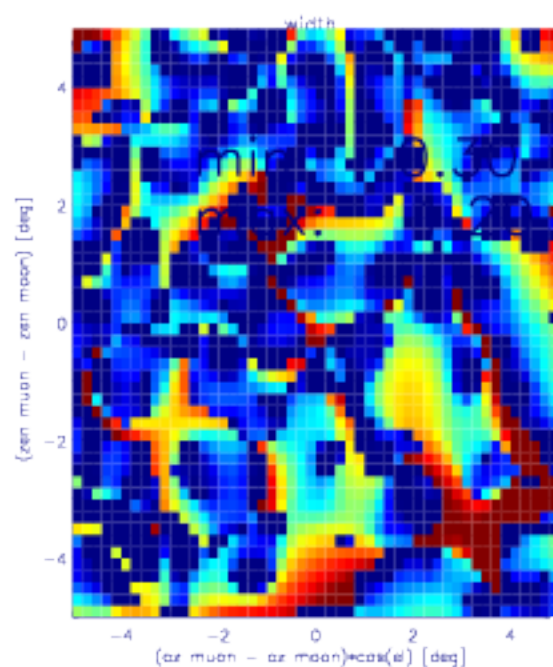
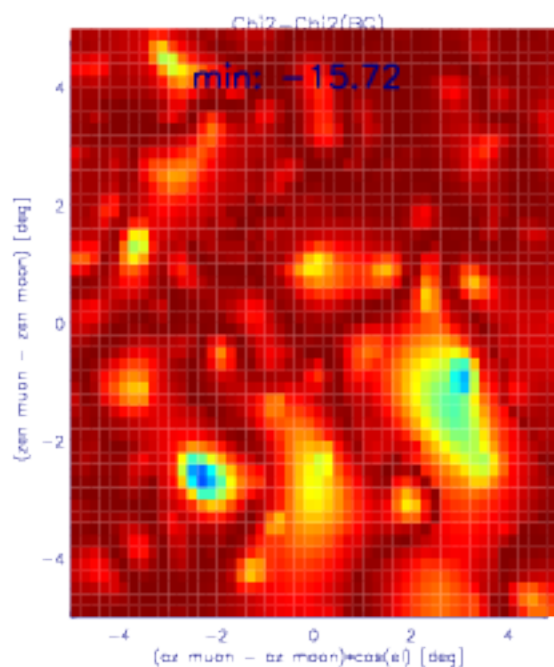
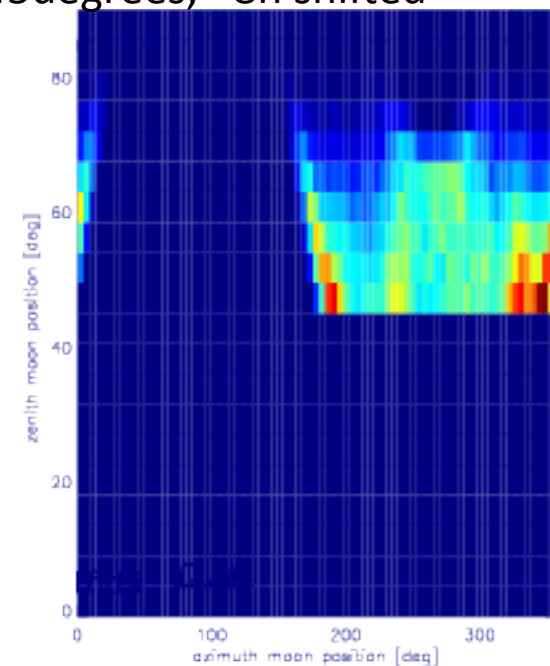
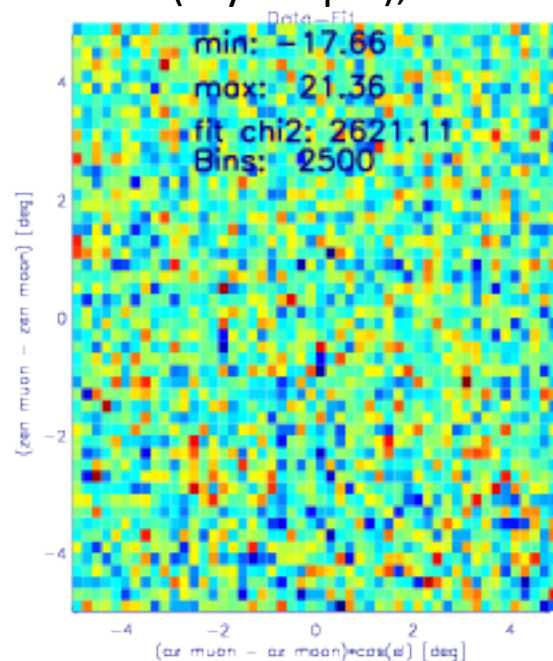
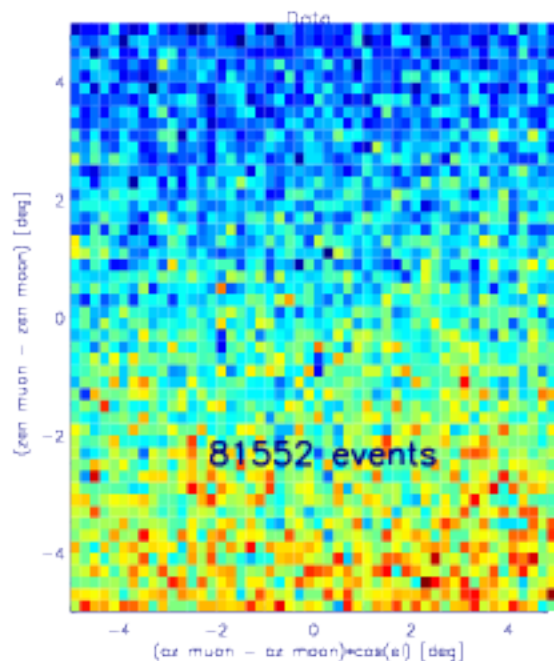
2007-2015, azimuth > 280 degrees



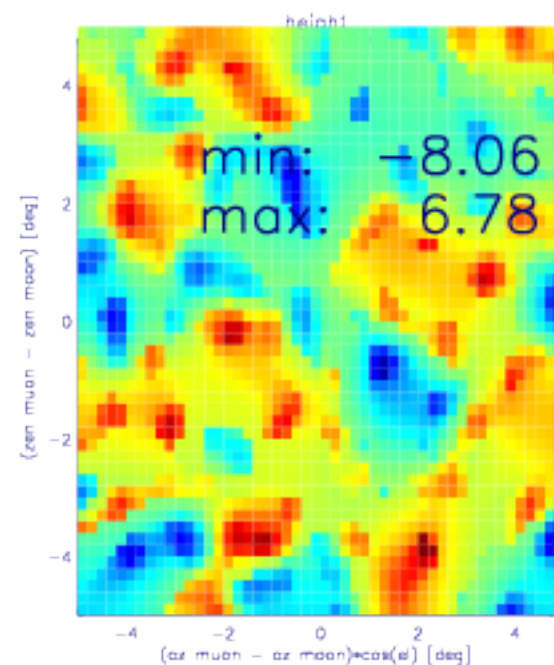
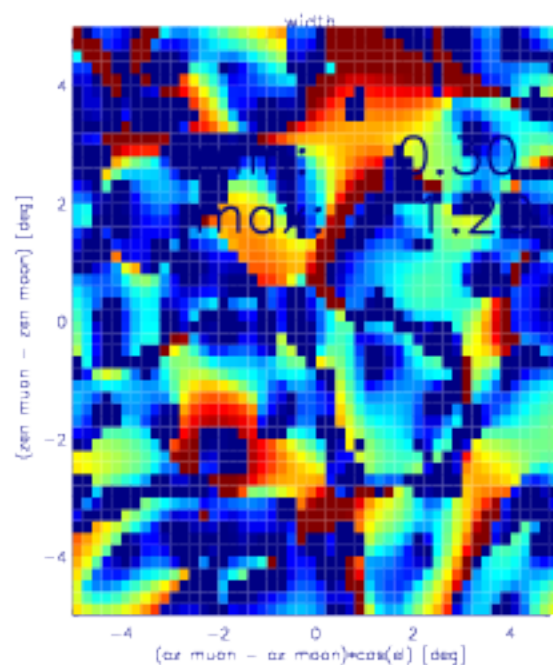
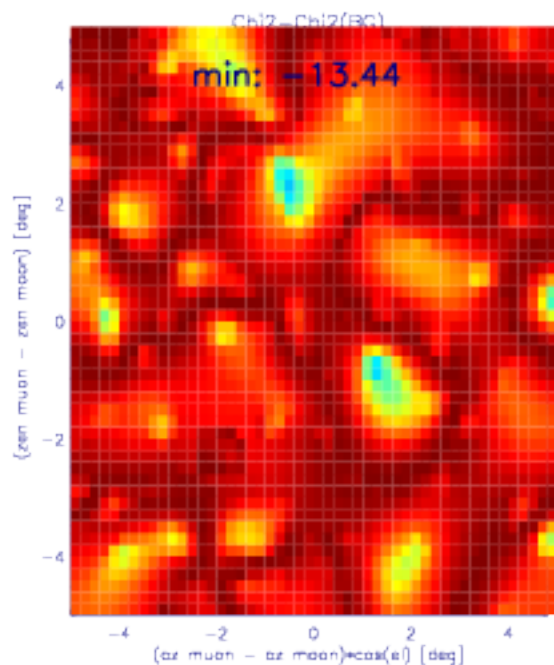
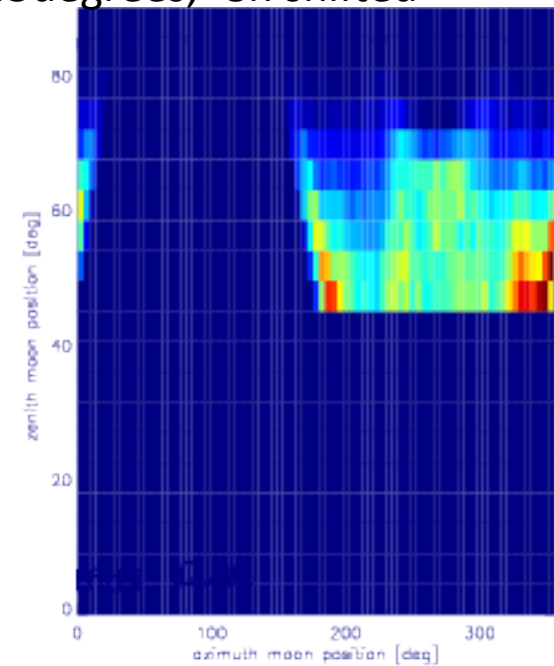
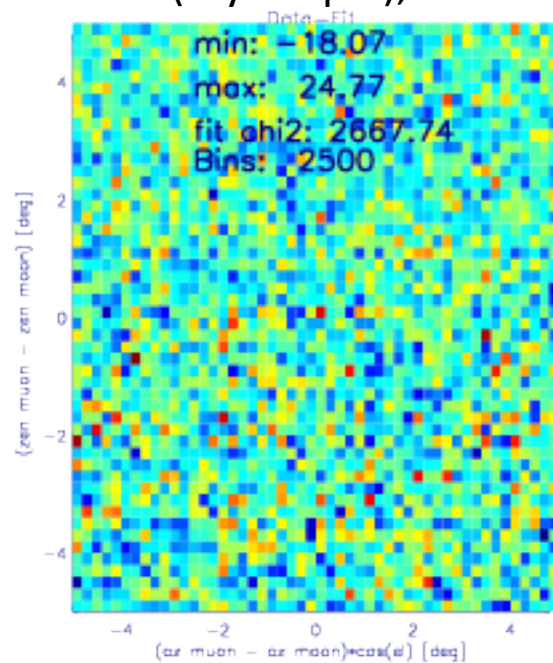
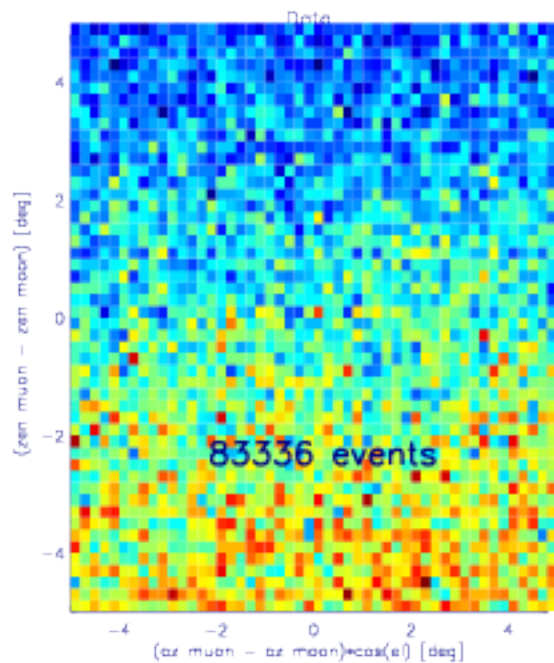
2007-2012 (my ntuple), zenith > 45degrees



2007-2012 (my ntuple), zenith > 45degrees, +8h shifted



2007-2012 (my ntuple), zenith > 45degrees, -8h shifted



Conclusion

Not necessarily straight forward to interpret measured shifts of moon signal with respect to detector coordinates

Background seems to introduce position dependent artefacts

Fake sources should help for a better understanding of the systematics (real background modeling)

Next steps

Look some at the sun which is not seen (also Jürgen and Jean-Pierre don't see it)
=> time cuts (due to sun activity should be best only visible til 2009)

Try to understand better the dependence on coordinate locations to help with interpreting the moon signal

Look at fake shifted source