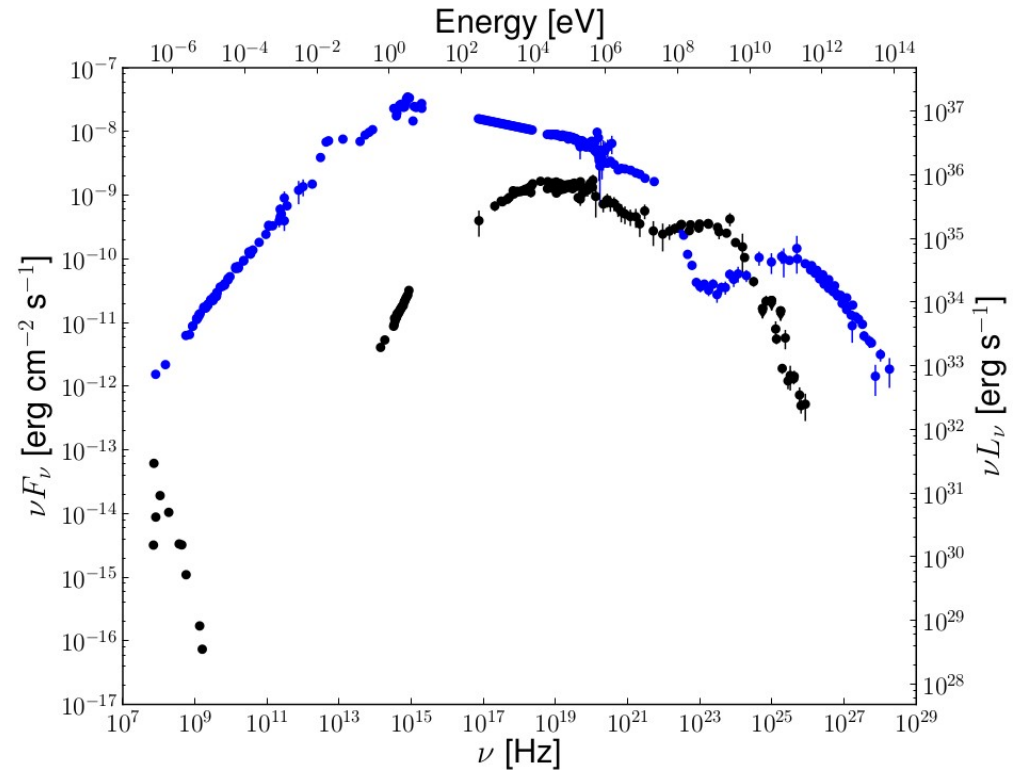
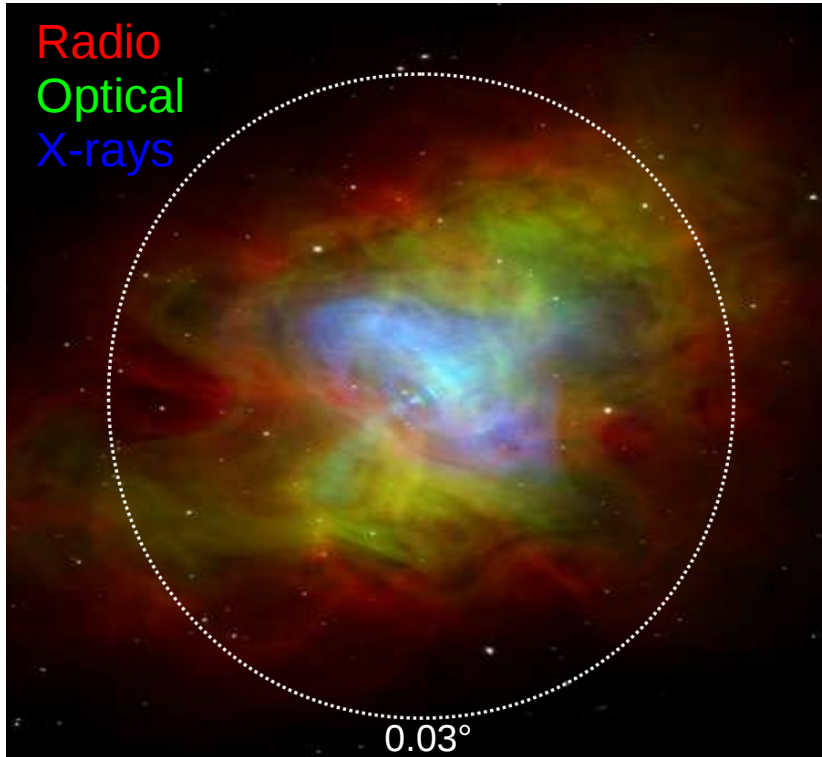


The Crab Nebula with CTA

Rolf Bühler – `ctools` coding sprint 3 – 7/7/14 Heidelberg

Would like to measure..



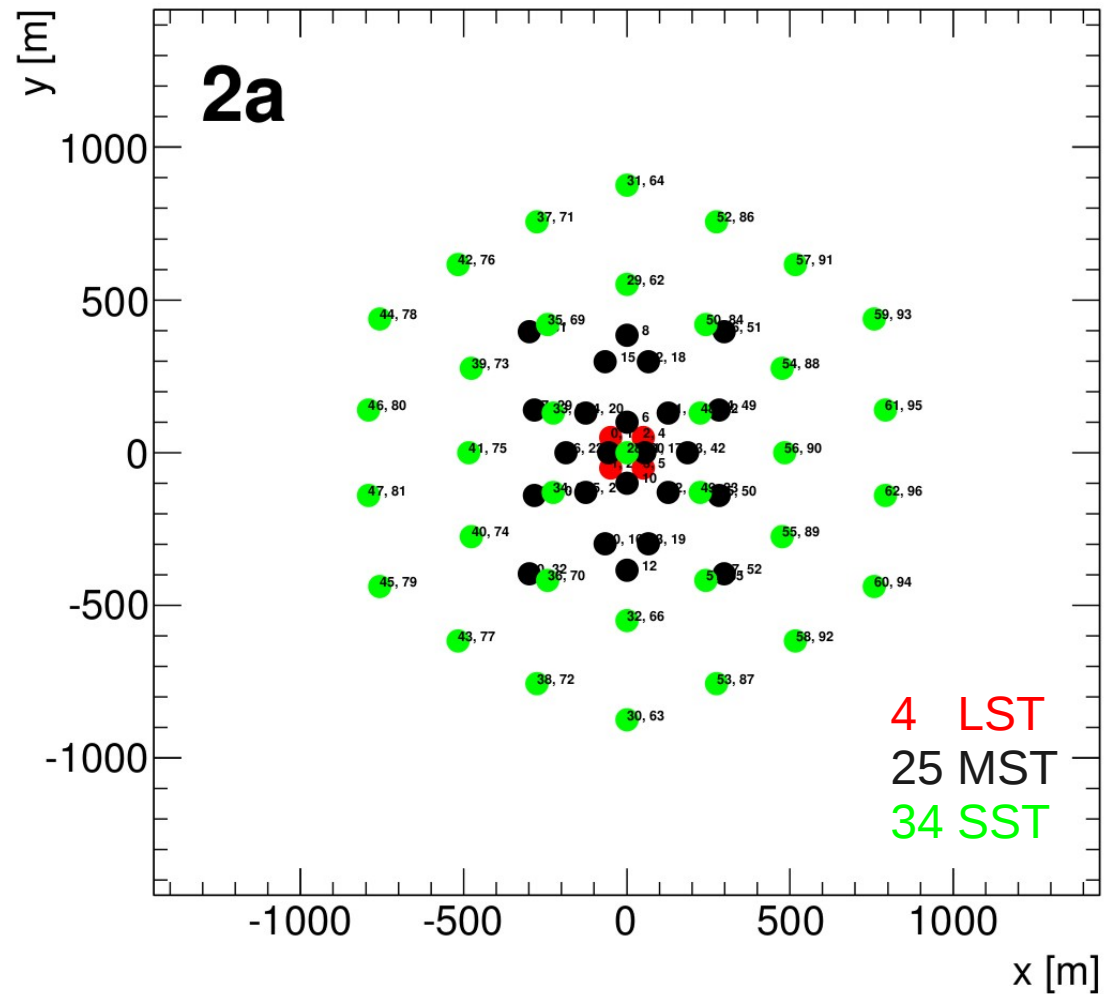
CTA can measure the Crab nebula's (energy dependent) extension, spectrum at ~100 TeV and maybe variability

Electrons emitting synchrotron at uv to X-rays emit IC ~0.1-1TeV
→ expected size ~0.02°

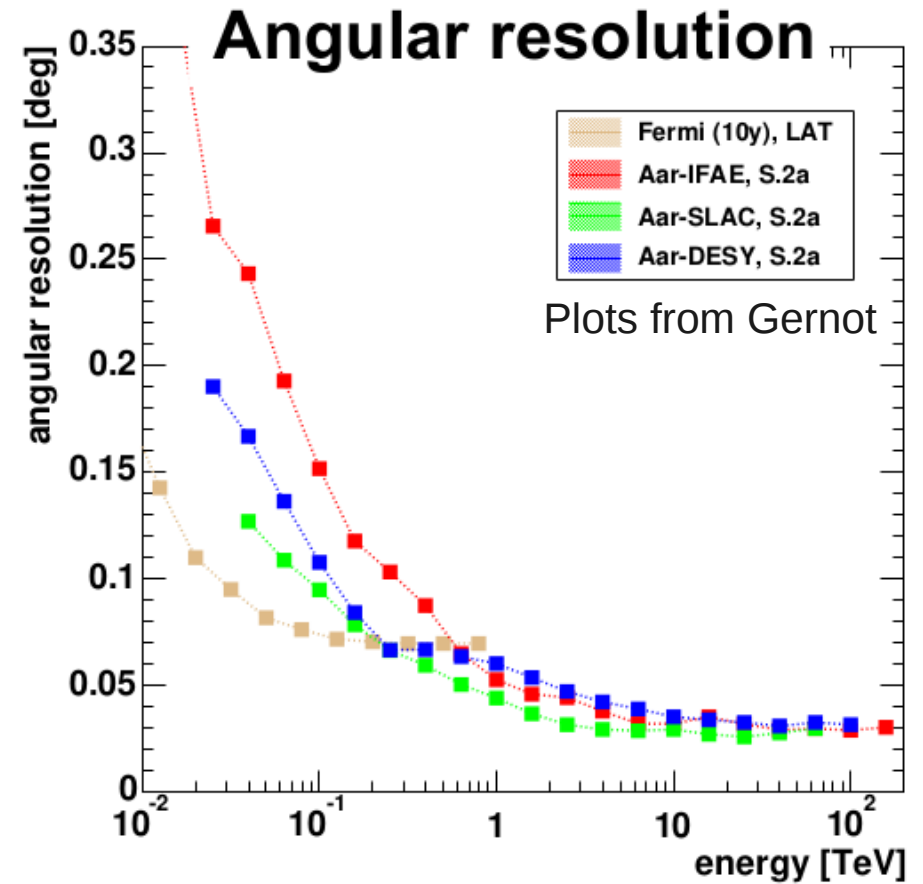
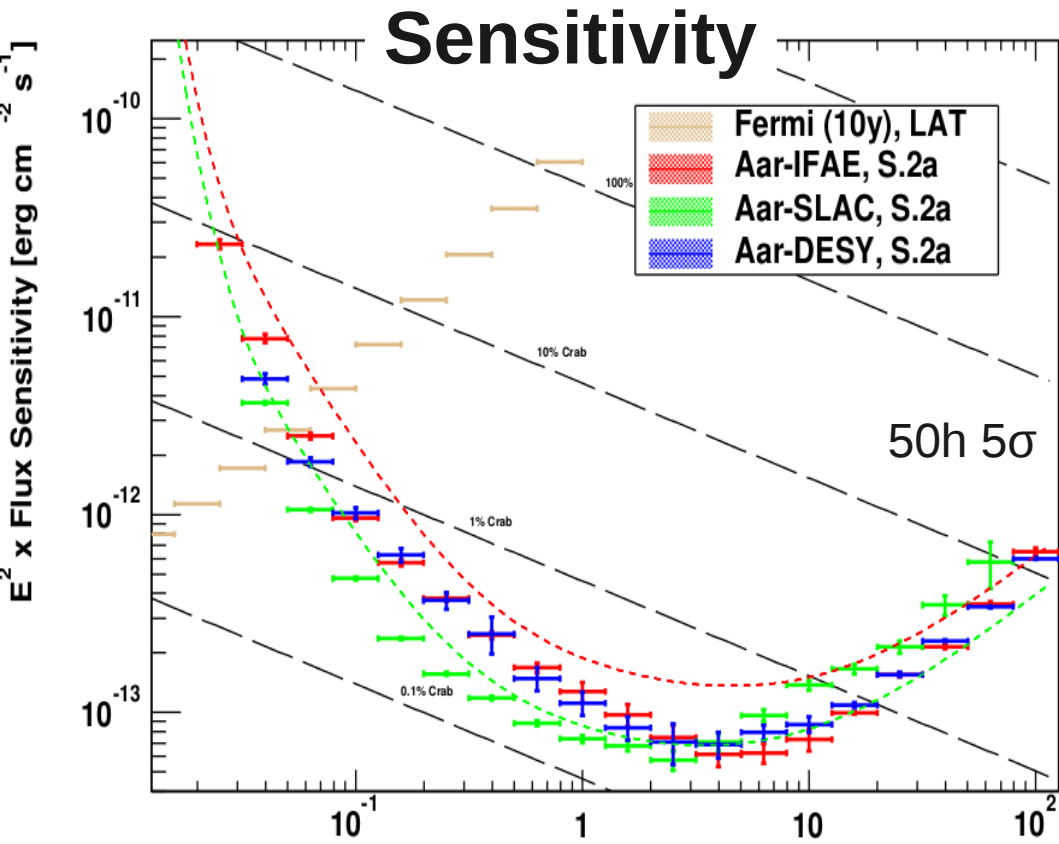
Analysis setup

Simulate using:

- DESY prod 2 Aar array 2a
- Energy range 0.1-1 TeV,
- Offset 1° & ROI of 8°
- 10 hours of observation at 20° zenith (Crab at $b=+22^\circ$)
- Spatial templates: point, gauss, disk, ellipse
- Spectrum power law from Aharonian et al. 2006



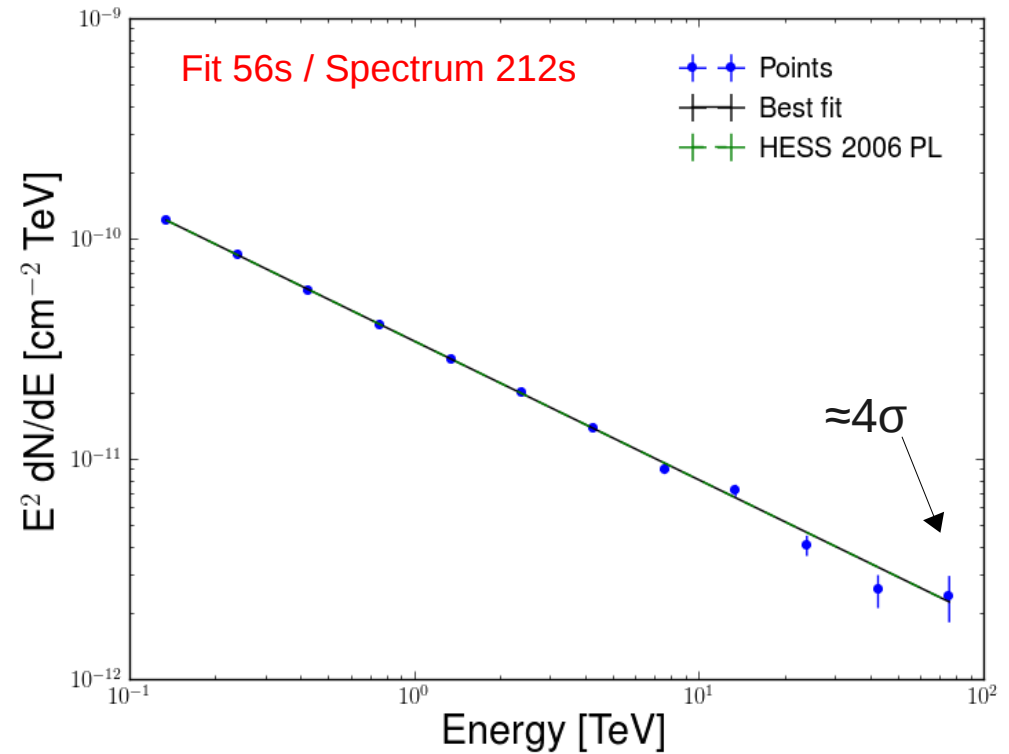
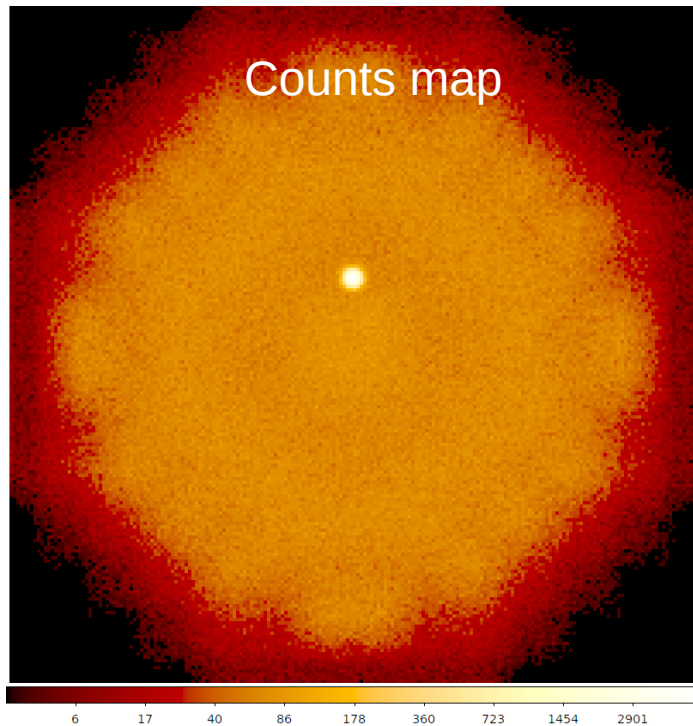
Expected performance



Plots from Gernot

In 10 hours ~ 1 Crab should be detectable at ~ 100 TeV. An extension of ~ 0.02 should be detectable (within statistics)

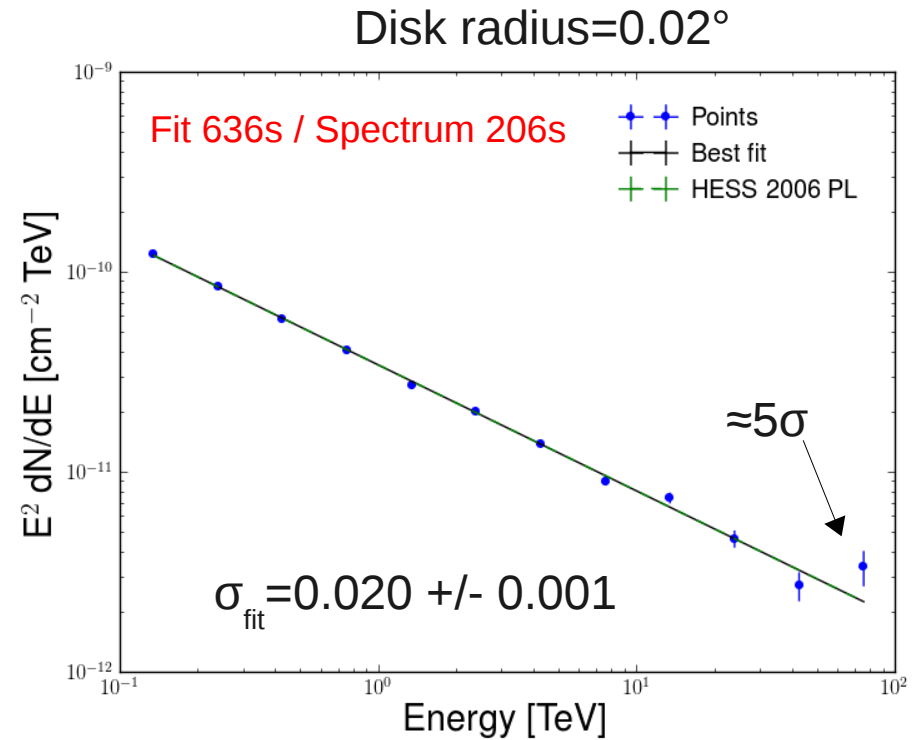
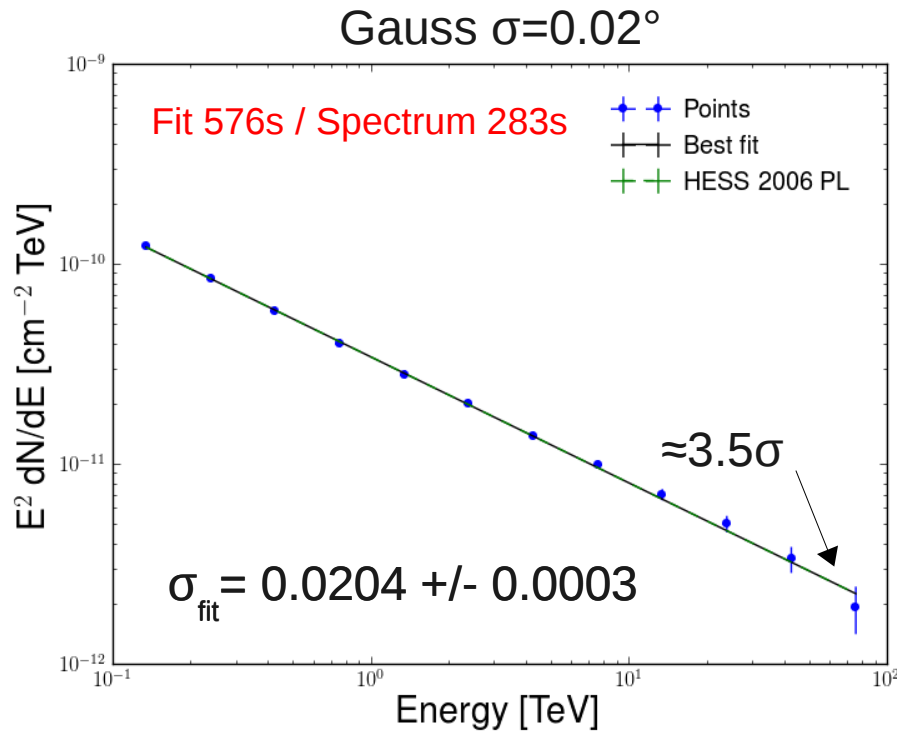
Result – Point source



Recovers simulated spectral values, spectral points also in good agreement. Detection out to ~ 75 TeV

Result – Gauss

636



Width is recovered. Errors very small → Within statistic CTA will resolve the Crab, main challenge to get systematics down

Two things I could not get to work..

GModelSpatialEllipticalDisk fit did not converge (killed after 2 hours), with many warnings:

```
+++ WARNING in GIntegral::romb(0, 6.28319, 5): Integration uncertainty 5.4266e+08 exceeds tolerance of 1.67882e+07 after 21 iterations. Result 1.67882e+12 is inaccurate.  
+++ WARNING in GIntegral::romb(0, 6.28319, 5): Integration uncertainty 5.69512e+08 exceeds tolerance of 1.76189e+07 after 21 iterations. Result 1.76189e+12 is inaccurate.  
+++ WARNING in GIntegral::romb(0, 6.28319, 5): Integration uncertainty 5.99295e+08 exceeds tolerance of 1.85403e+07 after 21 iterations. Result 1.85403e+12 is inaccurate.  
+++ WARNING in GIntegral::romb(0, 6.28319, 5): Integration uncertainty 6.29078e+08 exceeds tolerance of
```

Log parabola spectral model pushes Prefactor to zero (after disabling minimum of 0.1, why?)

```
+++ WARNING in GIntegral::romb(100000, 1e+08, 5): Integration uncertainty nan exceeds tolerance of nan after 21 iterations. Result -nan is inaccurate.  
+++ WARNING in GIntegral::romb(100000, 1e+08, 5): Integration uncertainty nan exceeds tolerance of nan after 21 iterations. Result -nan is inaccurate.
```

Conclusions

Results

- Within statistics CTA will detect the extension of the Crab with a resolution down to $<0.001^\circ$ within statistics, systematics will be the limiting factor
- The Crab spectrum will be extended to ~ 100 TeV

Wishlist

- Origin of EllipticalDisk and LogParabola fail likely originate in the integrator and requires fixing
- Fit energy dependent morphology not yet implemented, general implementation if possible?