

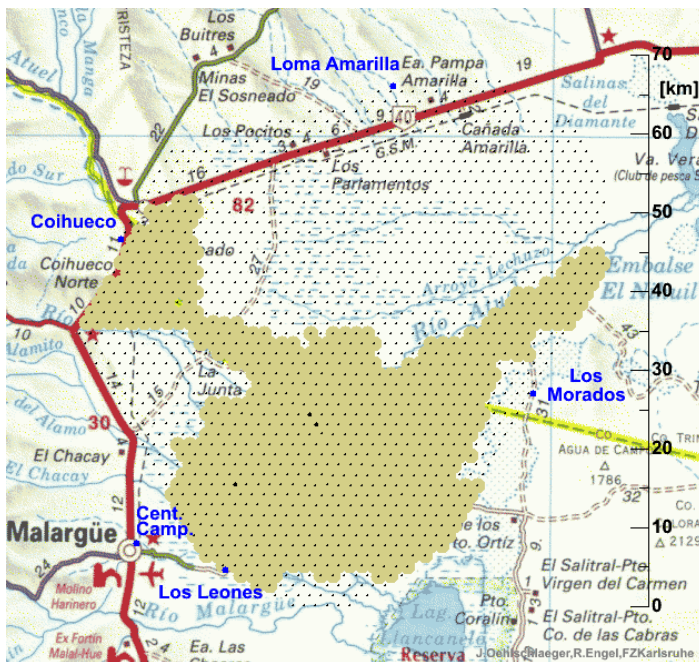


# Investigation of the optical properties of the fluorescence telescopes of the Pierre Auger Observatory

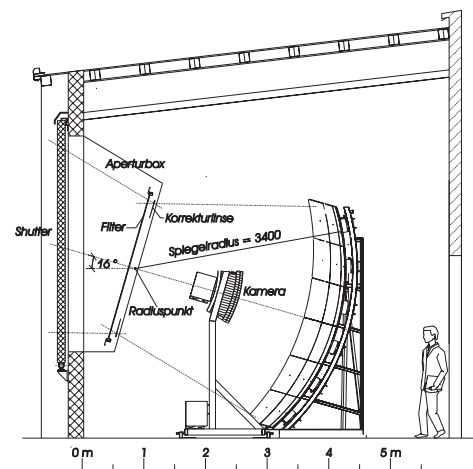
- Jan Becker
- Johannes Blümer
- Hans Klages
- Bianca Keilhauer
- Tilo Waldenmaier



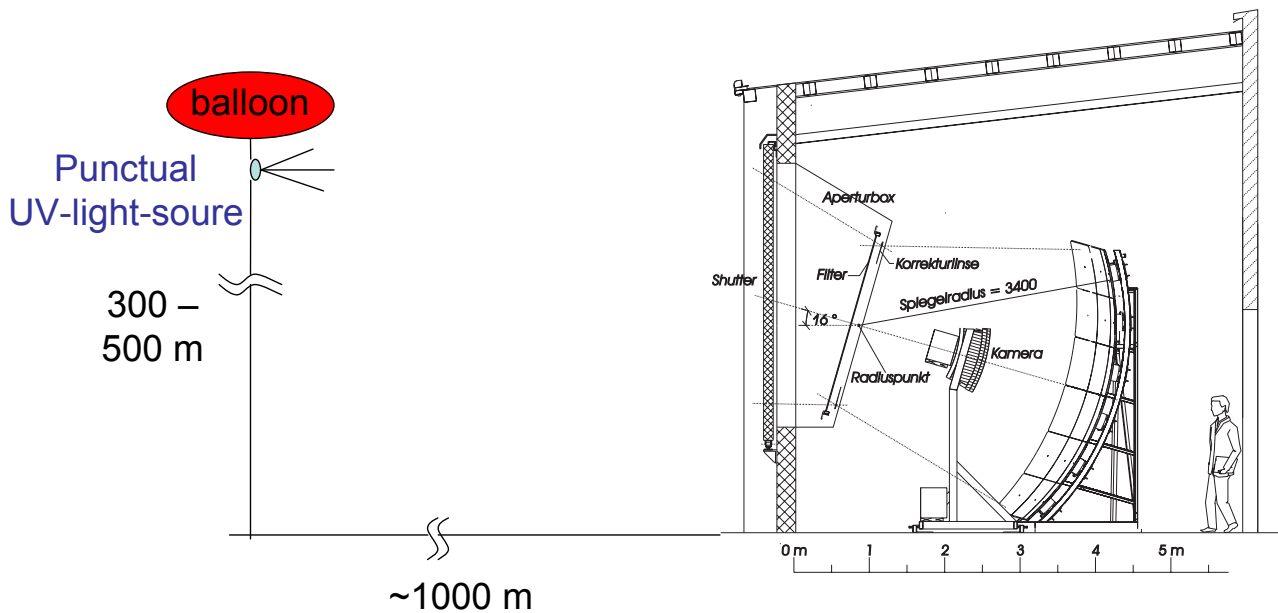
## The Pierre Auger Observatory



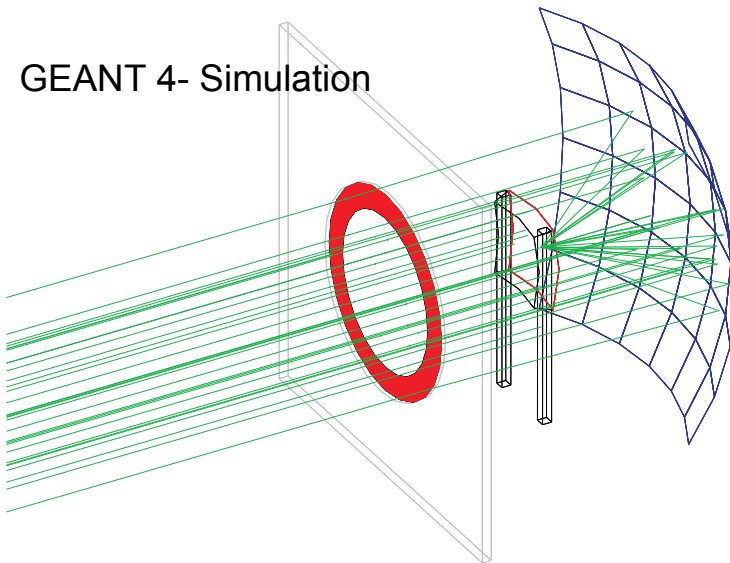
4 Telescope-Stations with 6 Telescopes each



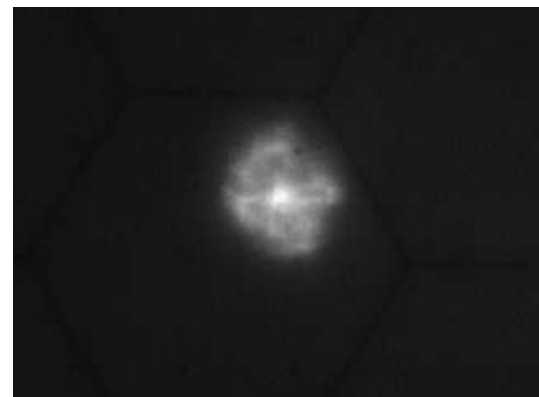
One single Telescope

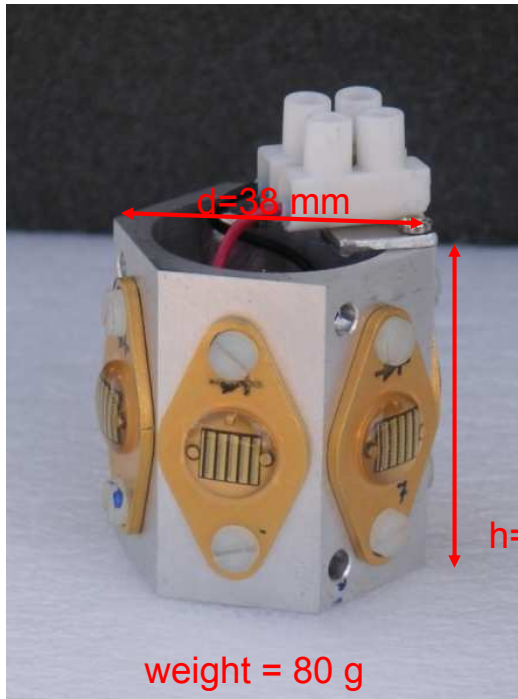


GEANT 4- Simulation



Picture of the Spot on the PMT-Camera to conclude on the optical properties of the telescope

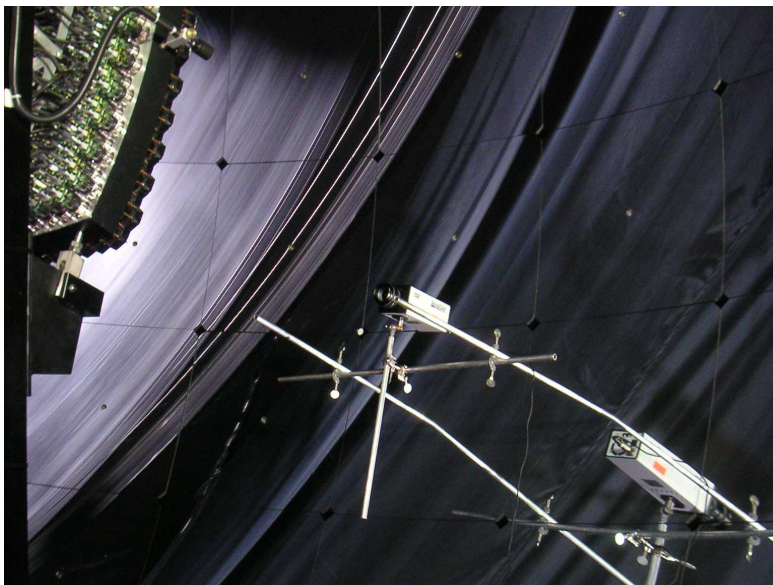




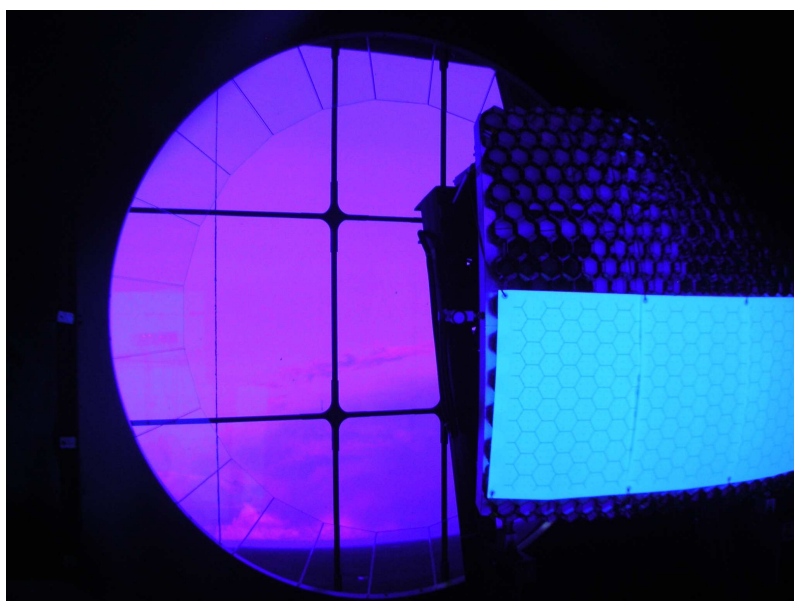
- 6 High-Power-LED-Arrays with maximum at 395nm
  - low weight
  - 250mW radiated power
  - Pulsed Modus with pulse-lengths 1/10s – several seconds
- => energy-saving  
no cooling-system required



- Pay load: 3-4 kg
- Size: 7.5 m<sup>3</sup>
  - Length: 4.5 m
  - Height: 2.2 m
- Max. achievable Height: 1500 m
- Position known from GPS
- Because of unexpected bad weather only one day of measurements possible



- Resolution: 640x480 Pixel
- Exposure time: up to 10 seconds to collect enough photons
- Cooled Chip for low noise

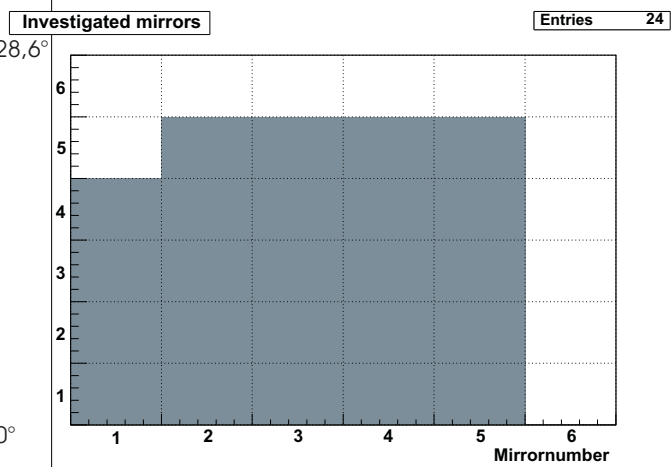
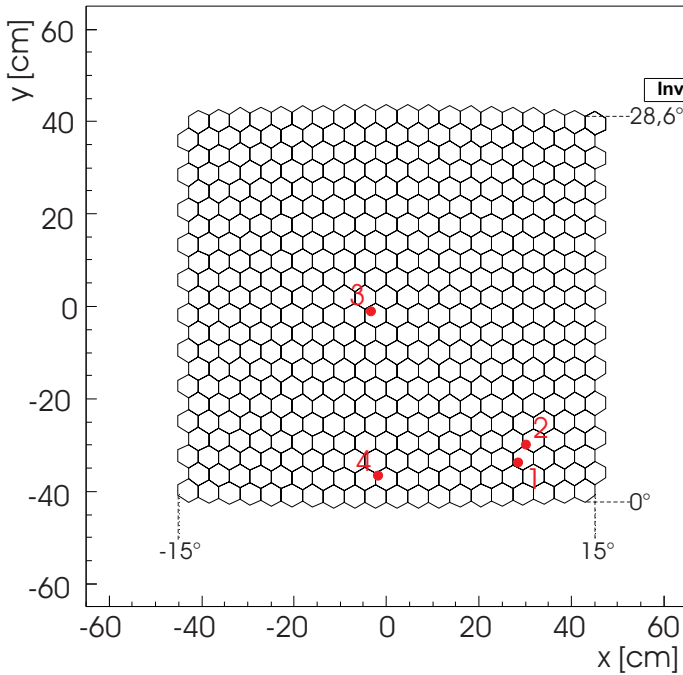


- Covered with paper to photograph the spot
- Hexagons on the paper to determine the spot-size



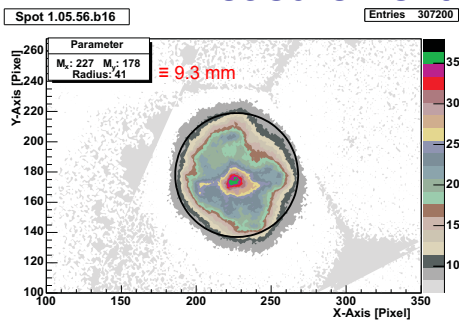
4 Positions on PMT-Camera

24 of 36 mirrors investigated

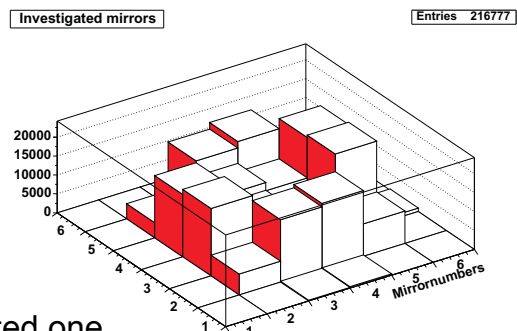
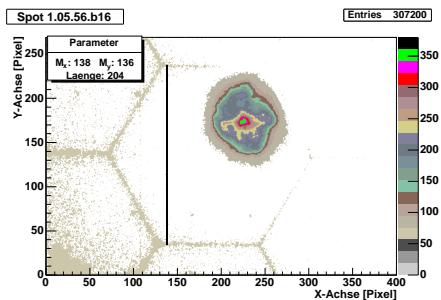
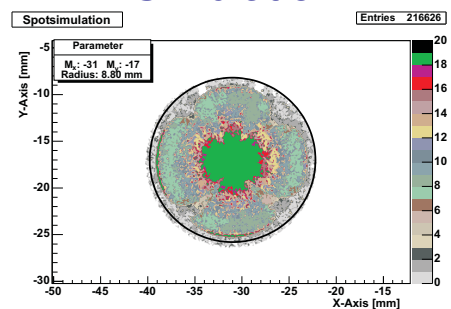


Measurement

Simulation



95% of the Photons (background considered) are in the circular

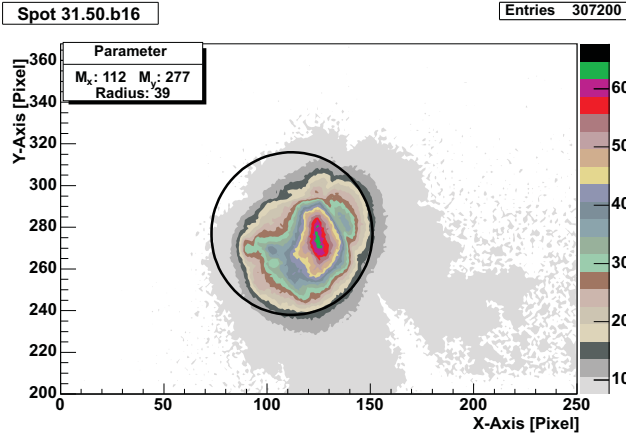


Measured spotsize only 5.3% larger than simulated one  
=> High-quality set-up of the telescope

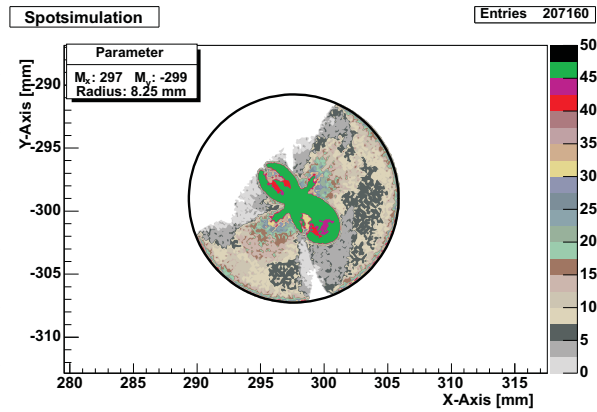
Without PMT-Camera: Spot has a circle-form  
=> Searching for deviations from a circular

Asymmetry in spotform because of inclination

## Measurement



## Associated simulation

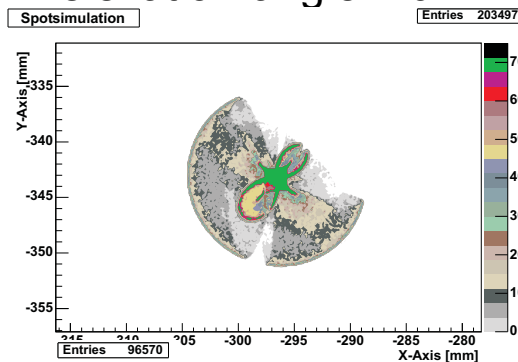


Simulation:

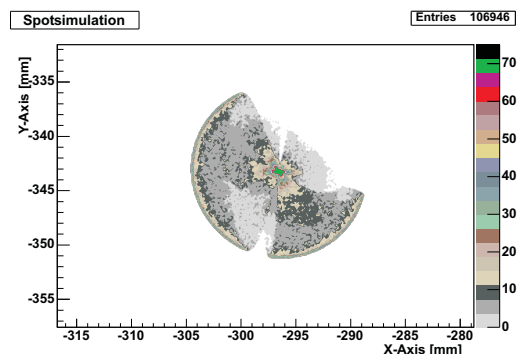
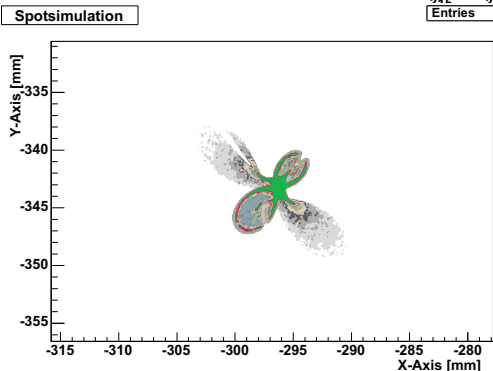
25% - 30% of the light is absorbed by the PMT-Camera, depending on the inclination-angle of the incoming light

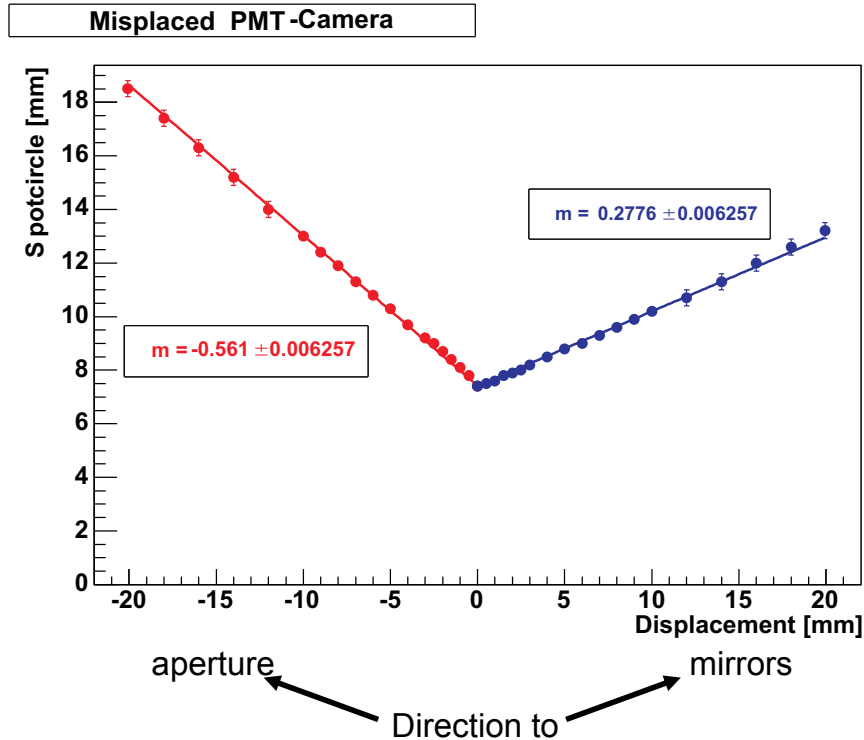
azimuth-angle:  $10^\circ$  + elevation-angle:  $10^\circ$

only photons going through corrector ring



only photons going through aperture





- Investigation of more telescopes
- Resolve the location of the spot on the PMT-Camera  
=> Pointing possible
- With simulation-software the intensity distribution in the spot is known  
=> include in reconstruction-software to improve the reconstruction
- Relative calibration of the PMTs with a constant isotropic light-source  
(same ring with a diffusor and changed electronics)



Spot 1.05.56.b16

