Geometry and optics calibration of WFCTA telescopes using star light

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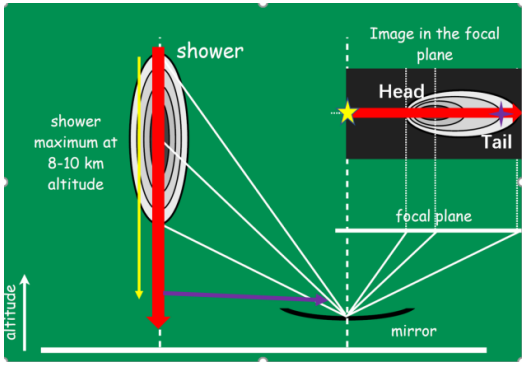
Wide Field of view Cherenkov Telescope Array

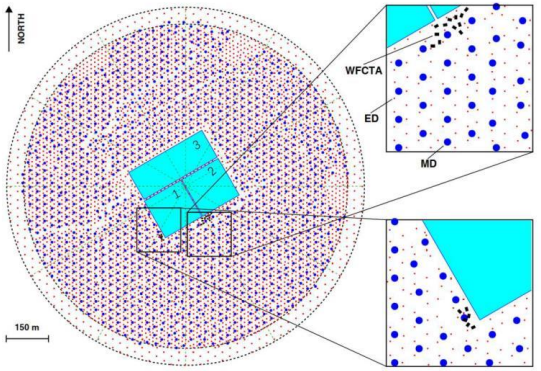


- Camera
  32x32 SiPMs Arry
  Cone:25.8mm
  Pixel size: 0.5°x 0.5°
  Fov: 16° x 16°
  Quartz glass

- 18 Telescopes

- Mirror
  Spherical,$5m^2$
  Focus:2870mm

- Main scientific goal
  Measure energy spectrum of CRs

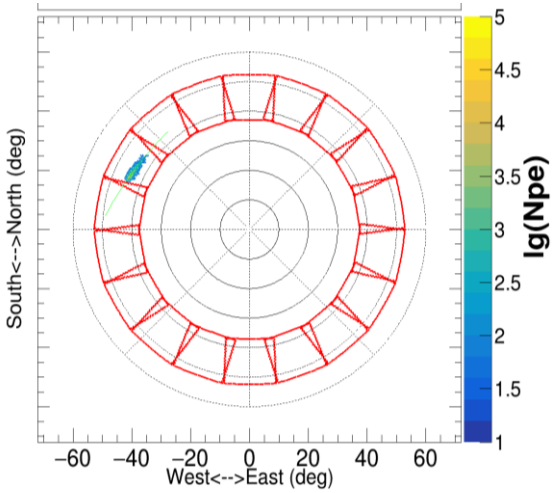


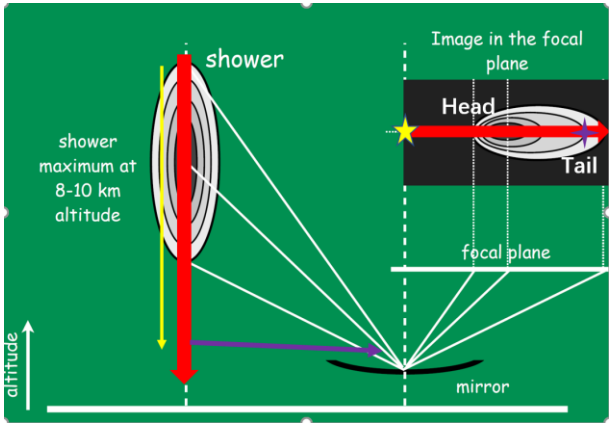
Motivation

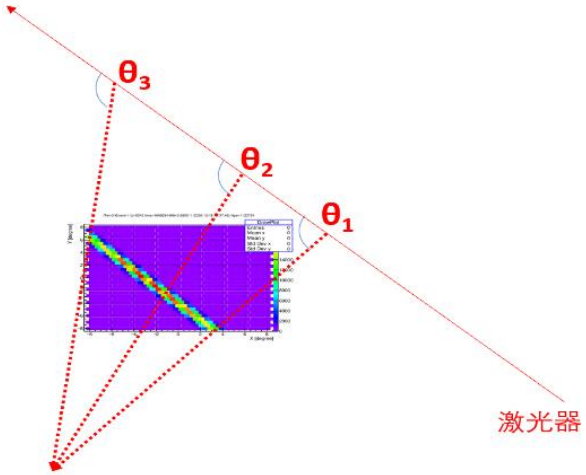
The splicing of the FOV of adjacent telescopes

Turn the reconstruction direction and core position of KM2A, WCDA to the focal plane of the telescope

Laser absolute energy calibration, (need to calculate the number of photons reaching the door of the telescope)

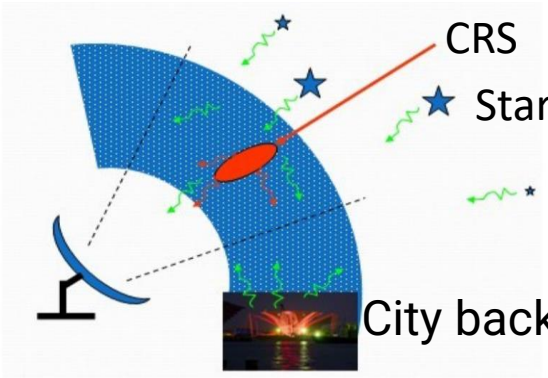


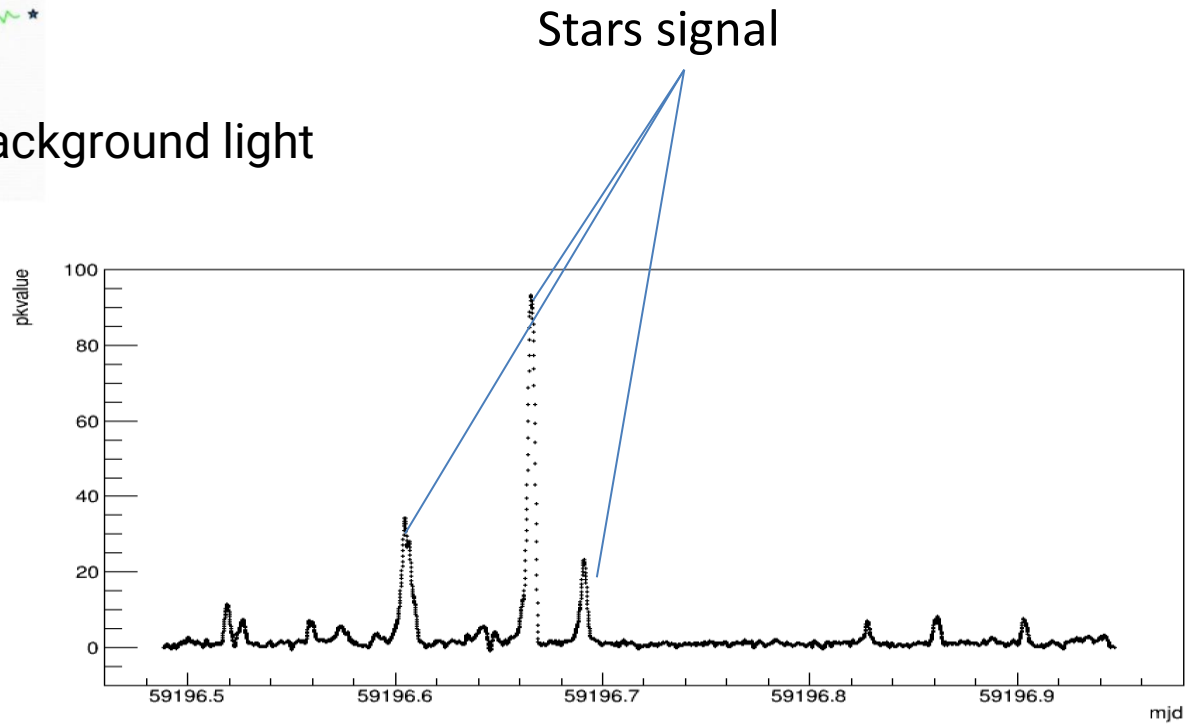




Stars

TD1 Cataloge(274nm) [TD1 - TD1 Stellar Ultraviolet Fluxes Catalog (nasa.gov)]



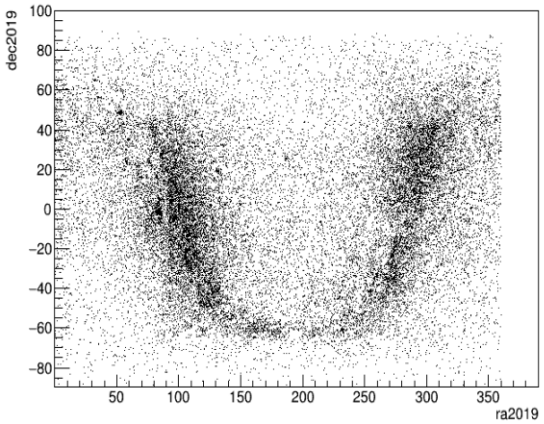


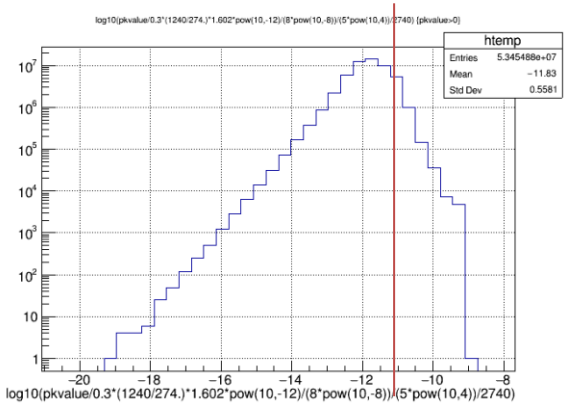
A NSB curve recorded by a SiPM in one night

Calibration Process

1. Get Oranph Stars

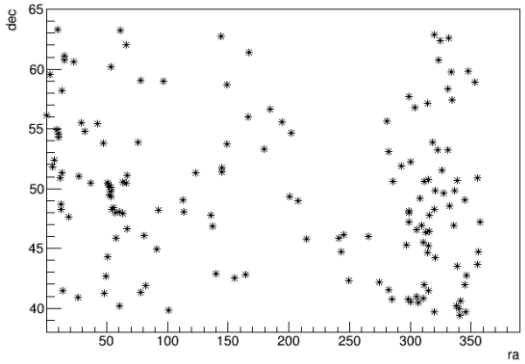
TD1 Star Map

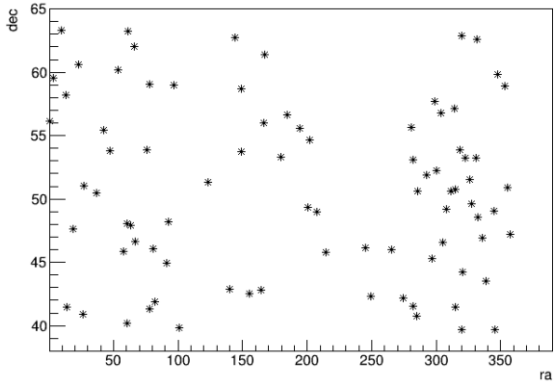




Get flux threshold

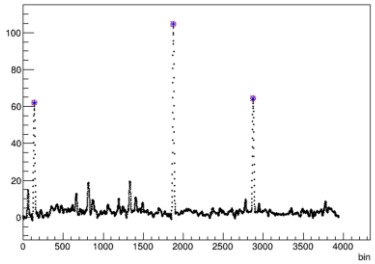
Star Map
(After flux cut)





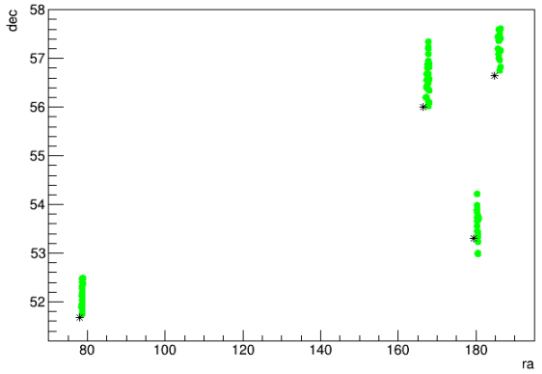
Oranph Stars Map
(2°)

2. Choose Peaks (position,time)



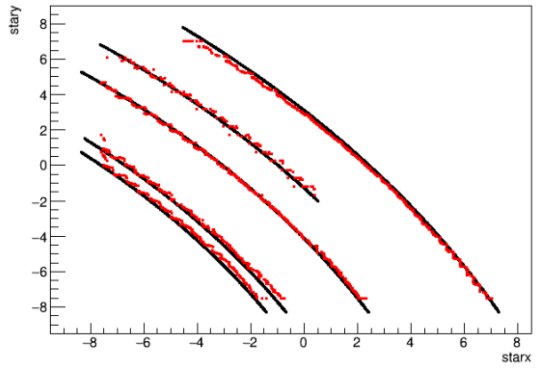
Calibration Process

3. Under telescope point(TelA,TelZ) , turn peaks to the equatorial coordinate, match

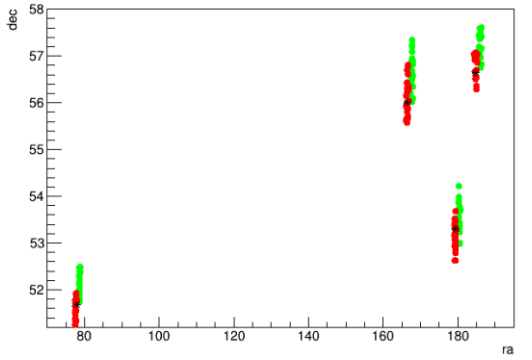


4. Construct χ^2

$$\chi^2 = \frac{\sum((starx-chx)^2+(stary-chy)^2)*Pe^2}{\sum Pe^2}$$

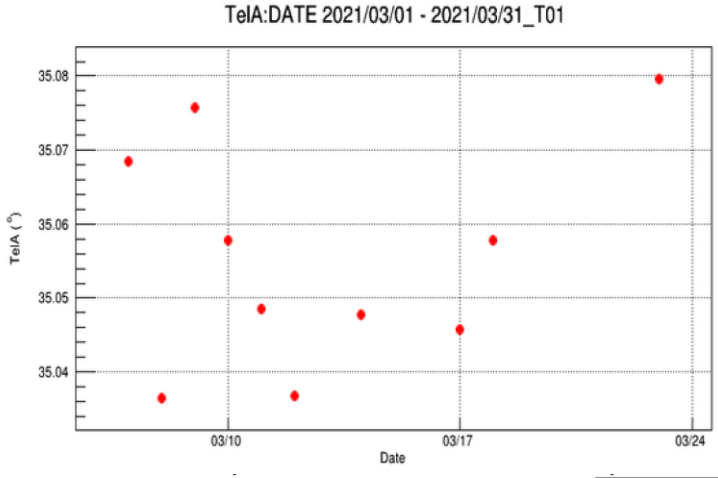


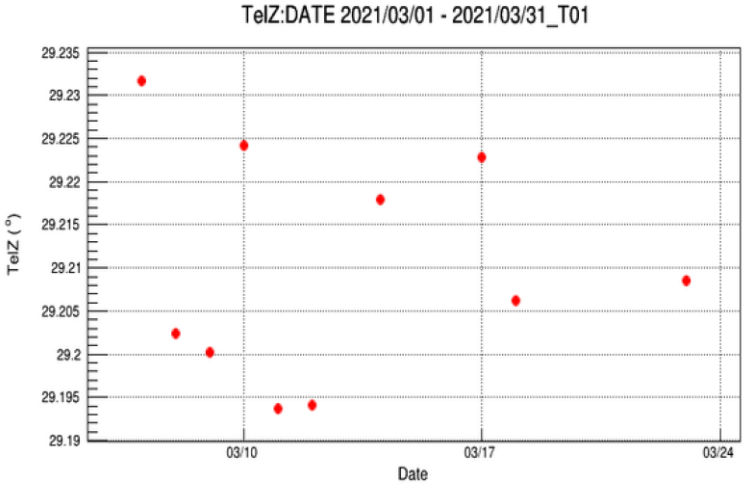
5. The point that minimizes the χ^2 is the true point of the telescope

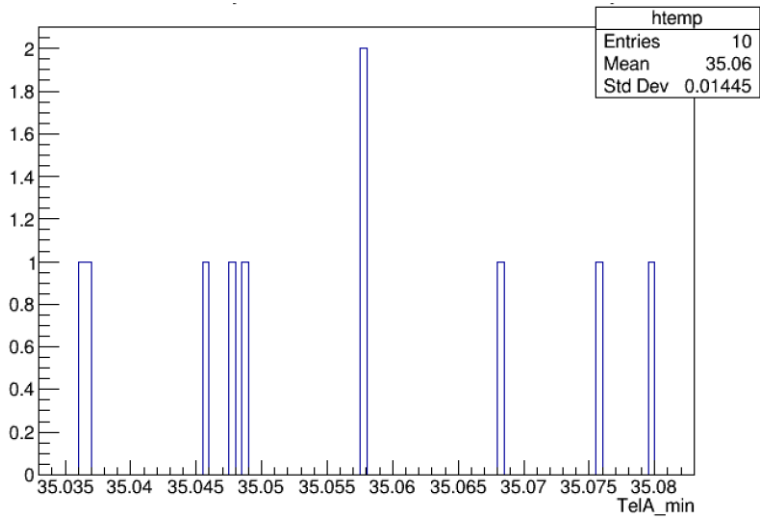


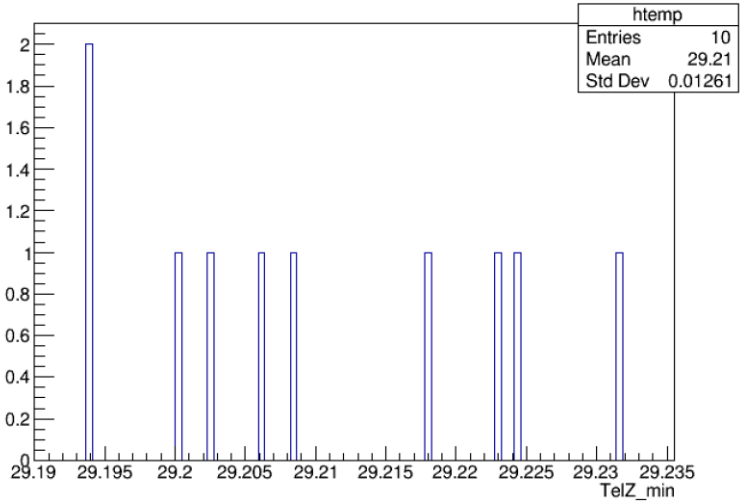
Results

2021.03 T01







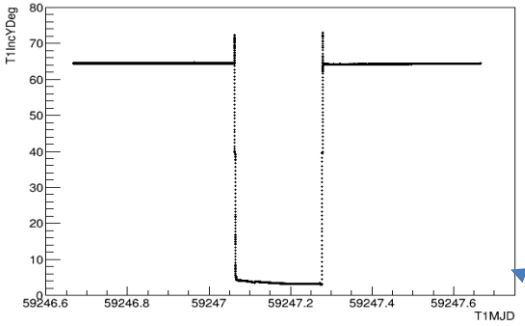


The telescope‘s pointing needs to be released daily !

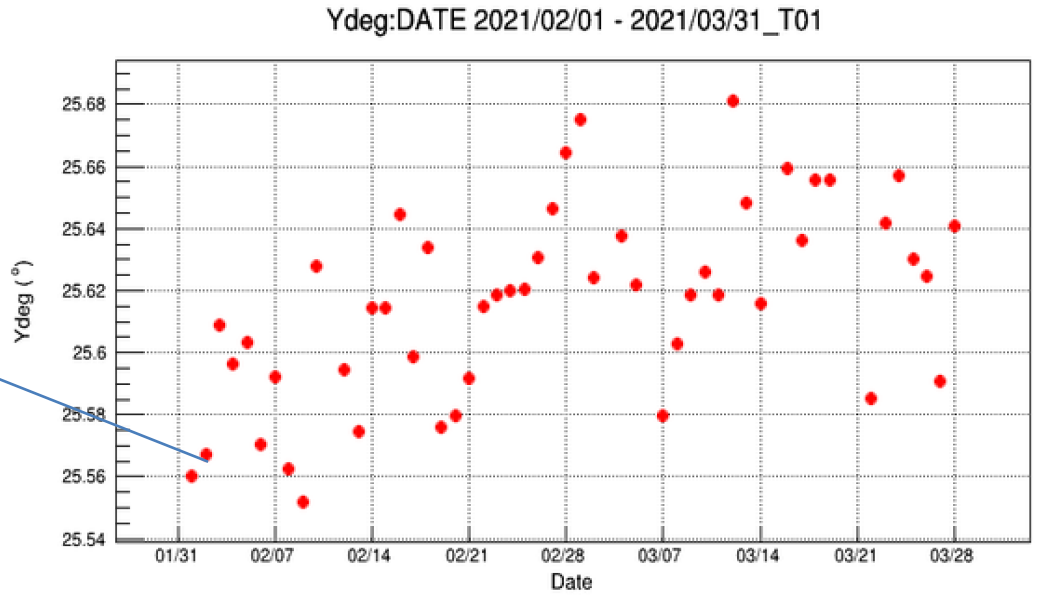
Special circumstances:

- There was a moon all night

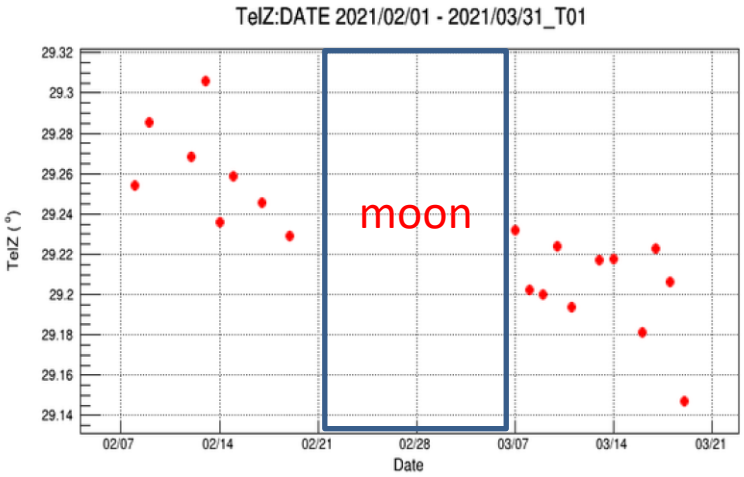
Inclinometer!

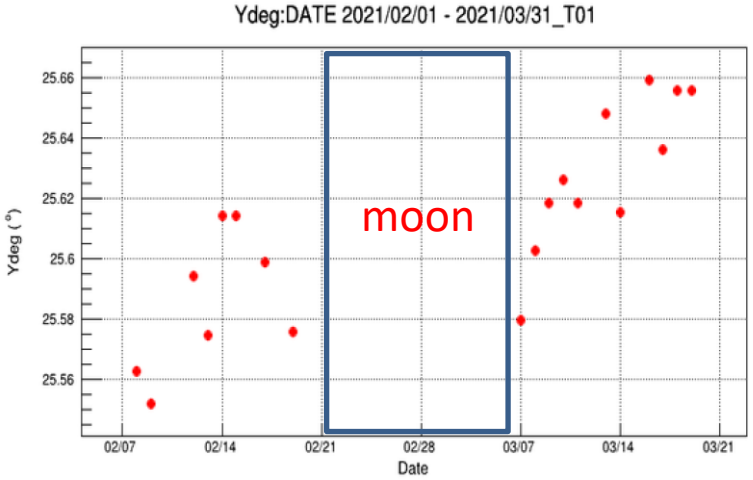


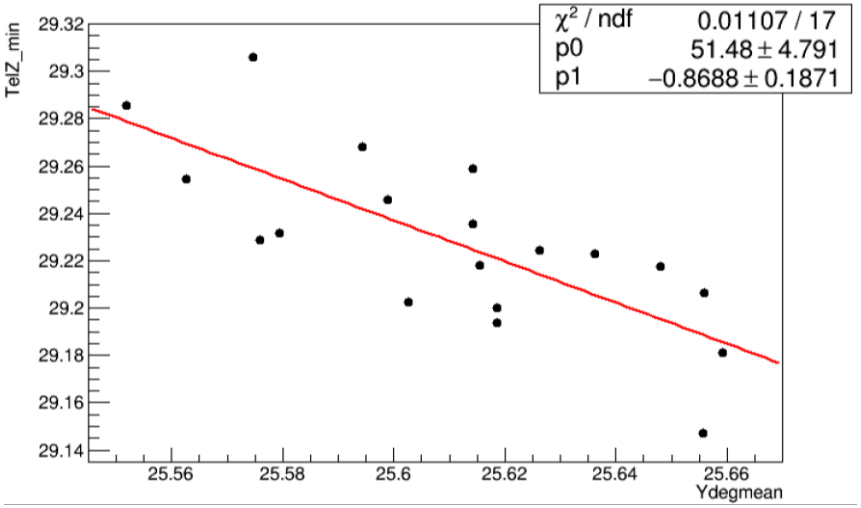
The inclinometer was pitched in 2021.0202



Results


TelZ:DATE 2021/02/01 - 2021/03/31_T01
TelZ (°)
Date
moon
02/07
02/14
02/21
02/28
03/07
03/14
03/21


Ydeg:DATE 2021/02/01 - 2021/03/31_T01
Ydeg (°)
Date
moon
02/07
02/14
02/21
02/28
03/07
03/14
03/21


TelZ_min
Ydegmean
χ² / ndf 0.01107 / 17
p0 51.48 ± 4.791
p1 −0.8688 ± 0.1871

Summary

- Use the starlight to calibrate the telescope point and publish it every day.
- Stars simultaneously monitor the long-term stability of the telescope's pointing direction .

Next step

- Use starlight to study spots

Thanks!