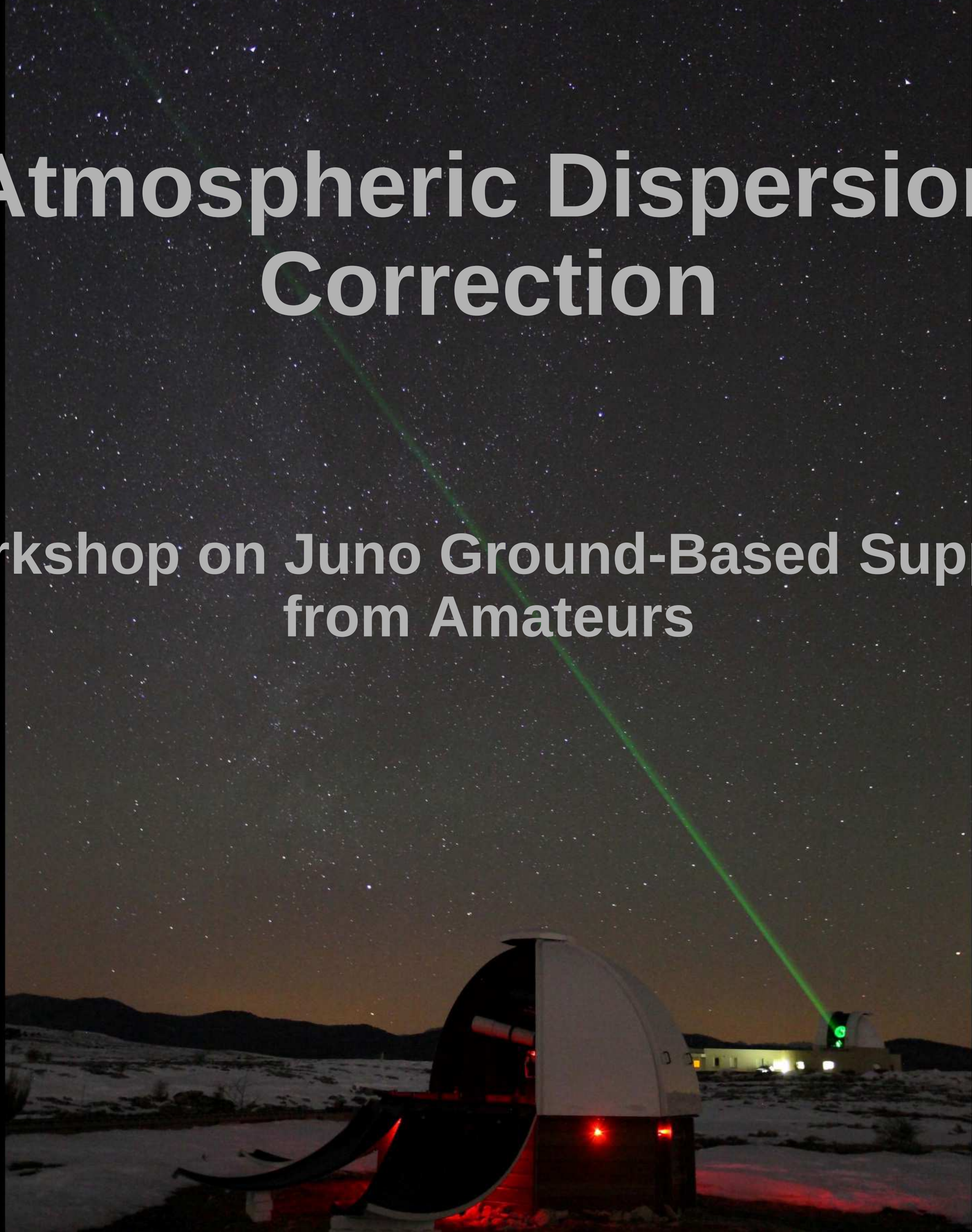


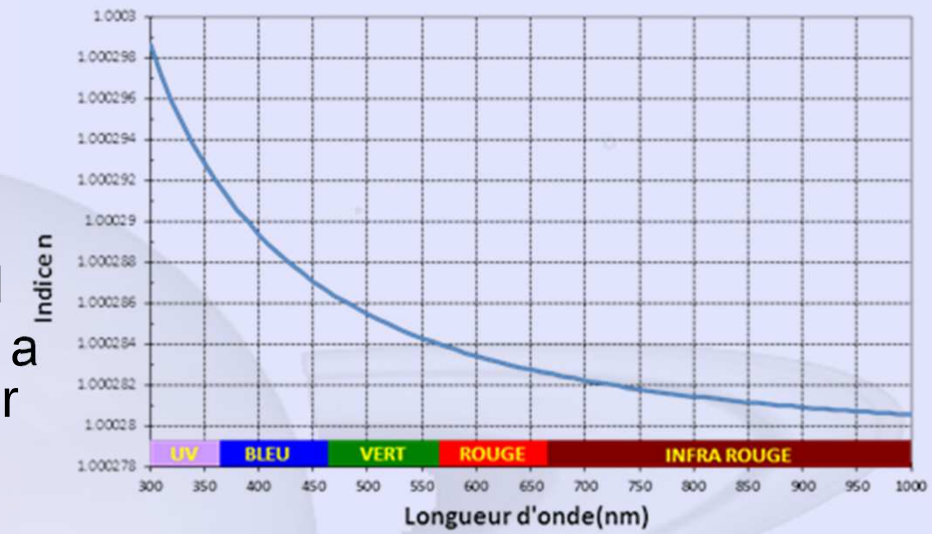
Atmospheric Dispersion Correction

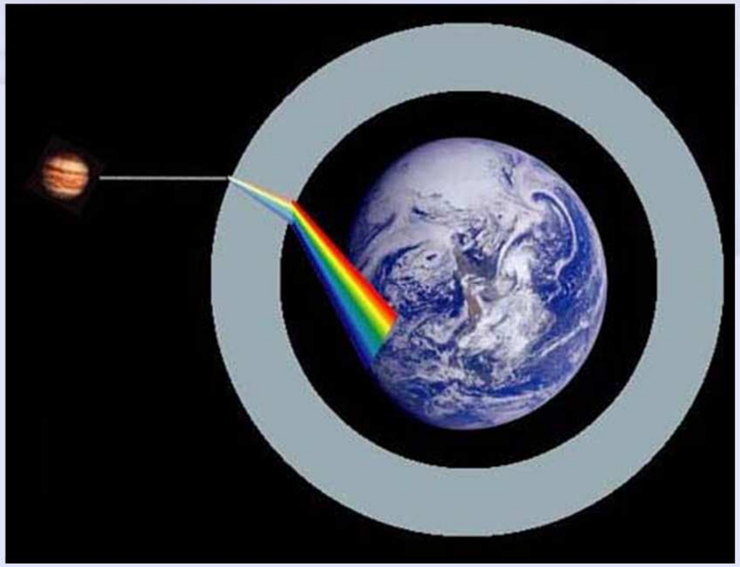
Workshop on Juno Ground-Based Support from Amateurs

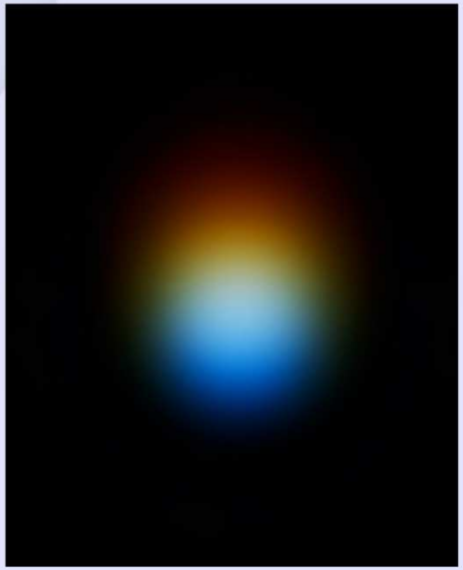
europlanet

Atmospheric Dispersion Correction

- Atmospheric Dispersion is induced by Earth atmosphere
  - Due to refraction of incoming light from planets or stars
  - Due to Earth atmosphere refraction index variable with wavelength ➔ blue is more deviated than red
- Spread vertically light spectrum ➔ for astronomers a red border on one side and blue border on the other side
- Phenomenon all the more accentuated when the incoming light angle with atmosphere normal is important ➔ thus for low elevation objects





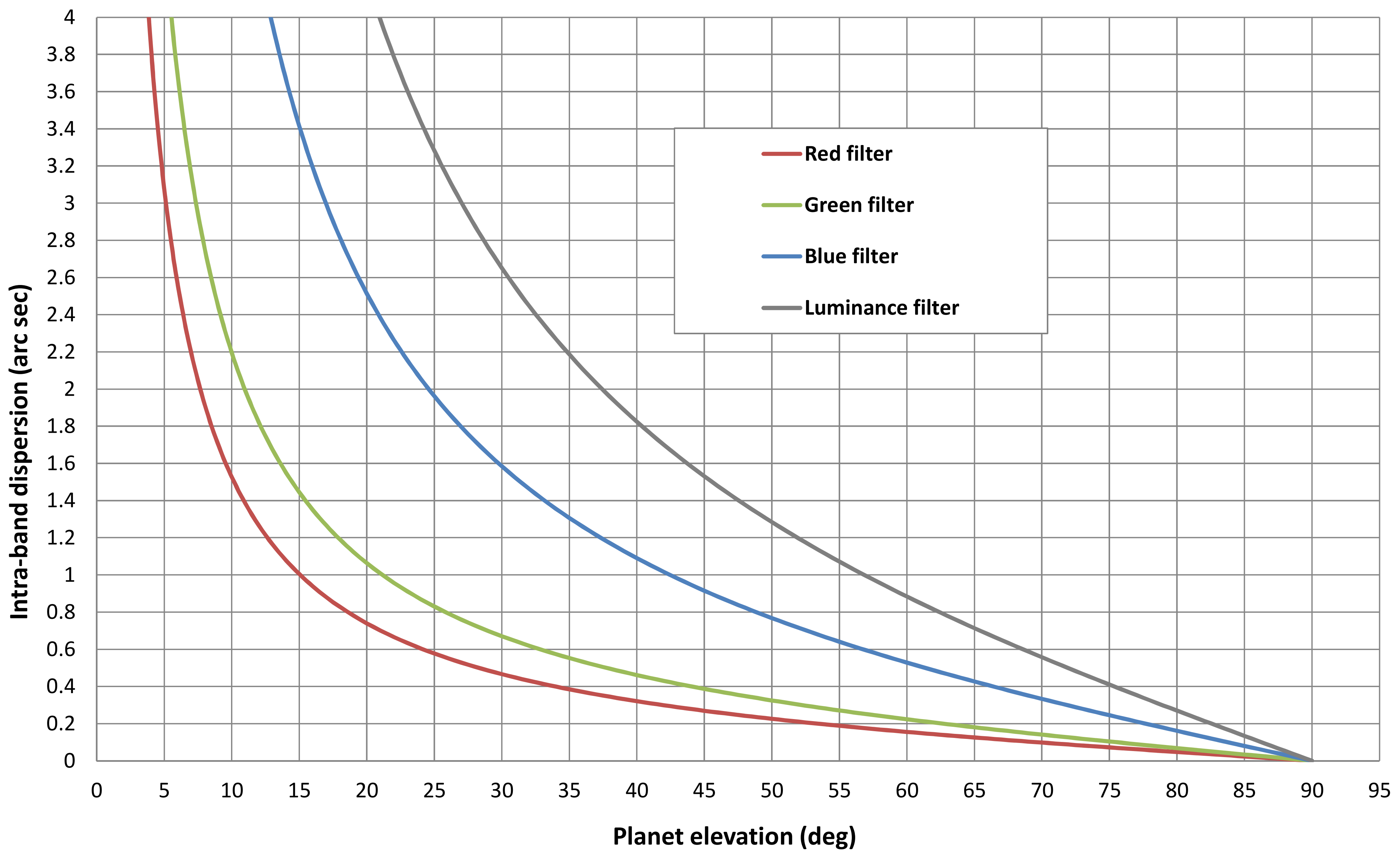


Atmospheric Dispersion Correction

- For imaging ➔ possible realignment of color planes alleviate the problem
- But this method will only partially correct it
  - Atmospheric Dispersion inside filters bandwidth is not corrected
  - Correction all the more incomplete with larger filter bandwidth ➔ luminance filter particularly affected
  - The effect can be assimilated to a blur inside each bandwidth
- Simulation of Atmospheric Dispersion done with Astronomik filters
  - Blue images will be more affected by Atmospheric Dispersion than Green or Red ones
  - The highest degradation is observed for Luminance filter as expected
- Following table provides for different instrument diameter & Astronomik filters bandwidth center elevations under which Atmospheric Dispersion is greater than telescope resolution (using Dawes criteria at 1.02 λ /D)
- Shows Atmospheric Dispersion has noticeable influence for many situations of telescope diameter / elevations ➔ simple color planes realignment process not enough
- A correction at images acquisition level is required ➔ use of CDA

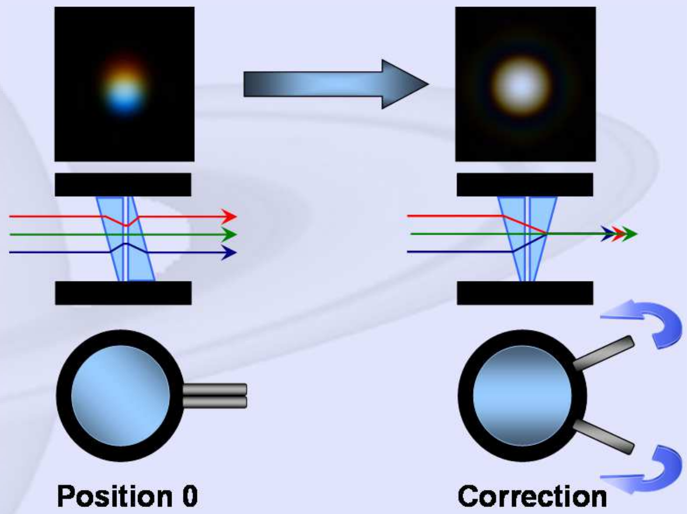
Instrument diameter	Min elevation Blue	Min elevation Green	Min elevation Red	Min elevation Luminance
100 mm	45°	19°	12°	55°
150 mm	56°	28°	18°	65°
200 mm	63°	35°	23°	71°
250 mm	68°	41°	28°	74°
350 mm	74°	51°	36°	79°
400 mm	76°	54°	40°	80°
500 mm	79°	60°	46°	82°

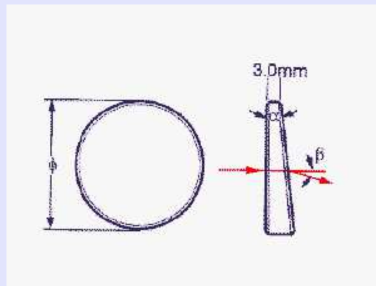
Atmospheric Dispersion Correction



Atmospheric Dispersion Correction

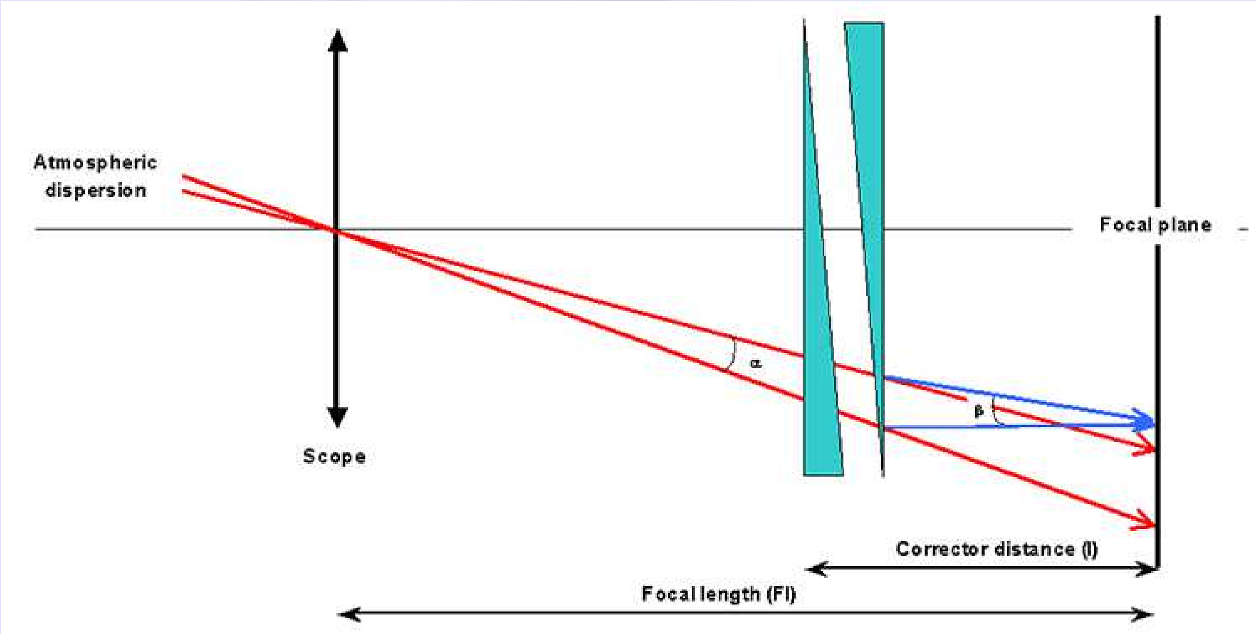
- Studies on Atmospheric Dispersion phenomenon performed since several years shown that
  - Chromatic shift could be compensated at first order through use of glass prisms
  - With good performances between 350nm/900nm ➔ largely enough for amateur astronomers
  - ➔ Use of Atmospheric Dispersion Corrector (ADC) more recent for amateur astronomers
- Several possible concepts elaborated, mainly
  - Single prism design
    - Prism oriented in “vertically” so as to counteract atmosphere effect
    - The oldest design used by amateur astronomers
    - Not convenient to use :
      - A prism is designed for a given range of elevations
      - Prisms shall be exchanged regularly during night when elevation change
  - 2 identical prisms design : so-called Risley prisms
    - Both prisms built with the same glass : usually BK7 or Fused Silica
    - Prisms installed in a mechanism allowing to obtain counter-rotating system generating a variable compensation as function of the angle of rotation
    - Much more convenient to use : rotation of prisms can be tuned all along the night depending on elevation
    - Correction capacity depends on prisms angle : usually 2° or 4° α-angles
    - But this system induces a lateral deviation of incoming light
      - Deviation even at position 0
      - Object image moves on detector during ADC tuning ➔ re-center required after tuning
      - Might be problematic for applications with small Field of View
  - Amici prims assembly
    - Each Amici prism is made of 2 identical prisms built from glass with different refraction index
    - Use of 2 Amici prisms allow to obtain same tuning capacities than with Risley prisms
    - But avoid having the lateral deviation mentioned above
    - Concept much more complex to built
    - More glass elements with coating ➔ light transmission degraded (particularly in UV)





Atmospheric Dispersion Correction

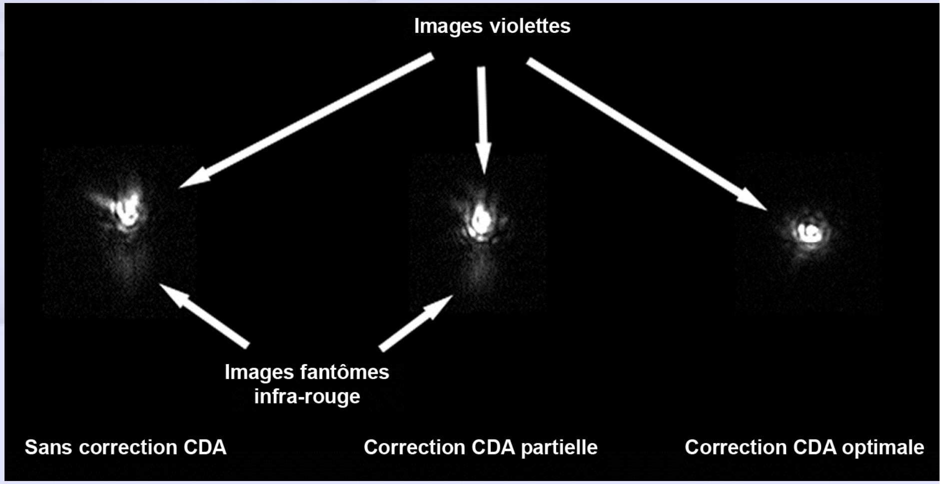
- ADC efficiency
  - Depends on its distance to focal plane
    - The nearest ADC from focal plane, the less efficient ie the larger required prisms tuning angle
    - ADC near focal plane
      - Allow to have good tuning sensitivity
      - But reduces correction capacity (ie minimum elevation angle accessible) depending on prisms angles
  - Depends on system focal length
    - The larger the system focal length the less efficient is the ADC
    - But the focal length is mainly driven by resolution & sampling



$$Disp_{ADC} = Disp_{atm} * \left[\frac{F}{l} - 1\right]$$

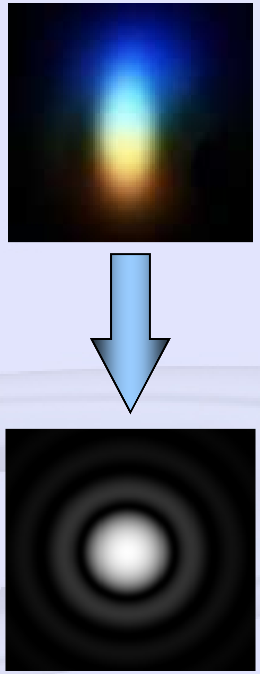
Atmospheric Dispersion Correction

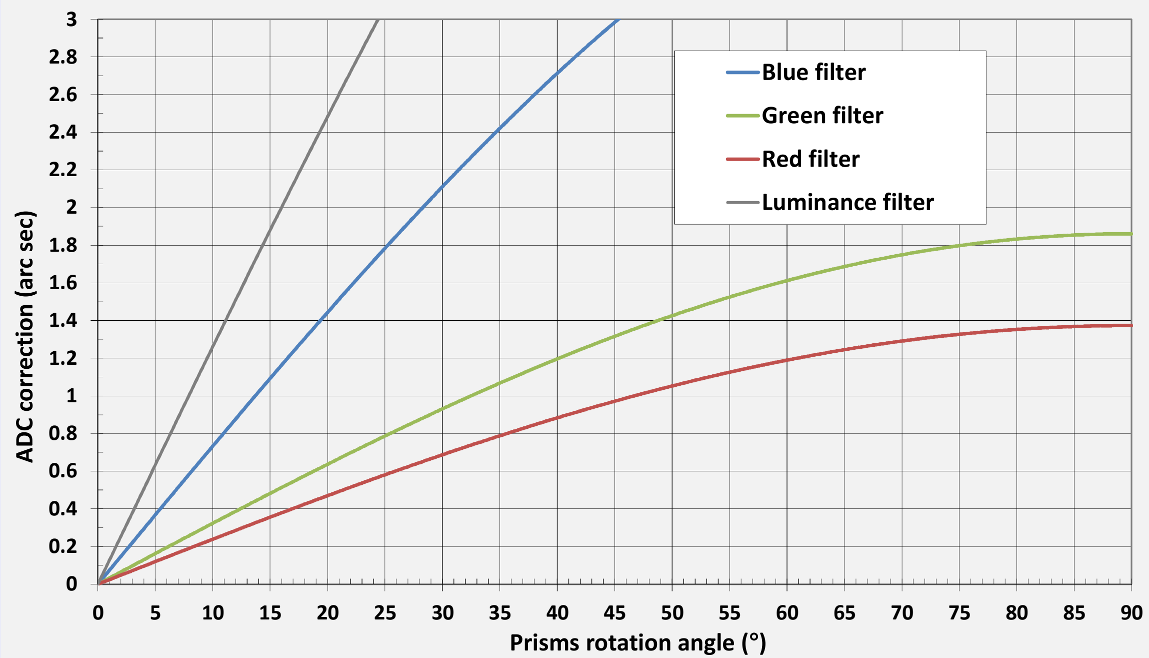
- ADC use rules & tuning
  - ADC shall be used with F/D large enough to avoid impact on instrument optical quality (astigmatism ?) ➔ placed after the Barlow
  - ADC shall be placed at the right position wrt efficiency considerations presented previously
  - ADC levers shall be tuned symmetrically wrt horizontal to counteract vertical effect of Atmospheric Dispersion
  - ADC levers shall be placed on East or West sides of the telescope depending on optical setup
  - Tuning possibilities
    - Visually on planet using the same optical setup as for imaging
    - Using violet filter (W47) with its IR leak generating a ghost but hardly seen visually
    - Using software features : Firecapture includes a tool showing real-time shift of RGB color layers

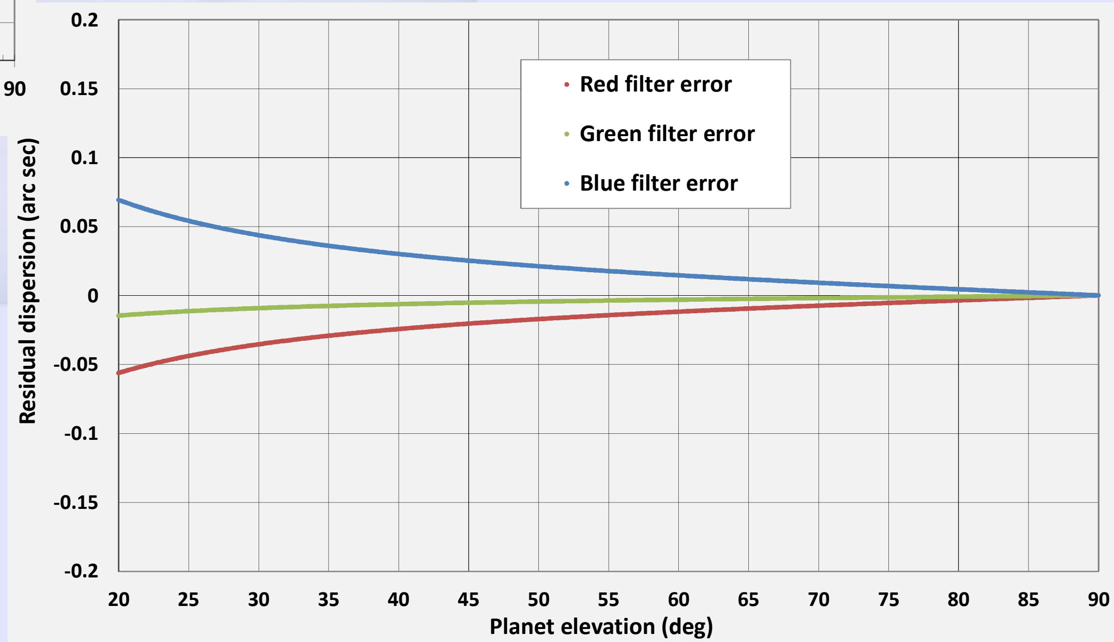


Atmospheric Dispersion Correction

- Simulation of ADC efficiency
  - Done for a 200mm telescope with F/D of 30
  - SFS ADC located 100mm from focal plane







Atmospheric Dispersion Correction

- Available correctors
  - Few in the past
    - Astrovid : single prism mechanism ➔ use of 2 assemblies with rotating tubes
    - Astro Systems Holland (ASH) ➔ rotating BK7 prisms with levers
  - Much larger offers on the market today
    - Pierro Astro : SFS prisms with levers and scale – 2 possible coatings (VIS or UV oriented) – T2-compatible
    - New ASH ADC ➔ coated or uncoated BK7 or SFS prisms - scales by levers – T2-compatible
    - ZWO ADC (new) ➔ similar to the 2 other ADC : BK7 prisms, broadband coating, levers & scale – T2-compatible
    - Gutekunst Optiksysteme (sold through apm-telescope) : made of 2 pairs of 2 crown-flint prisms
      - ➔ Amici concept allowing to avoid deviation
      - Said to maintain optical performances of the telescope ➔ wide field or even on-axis ?
      - Simple ADC adjustment through 1 screw with scale
      - But cost 12 to 30 times more than other ADC !!