Premier cru : a new instrument to study the auroral lines polarisation

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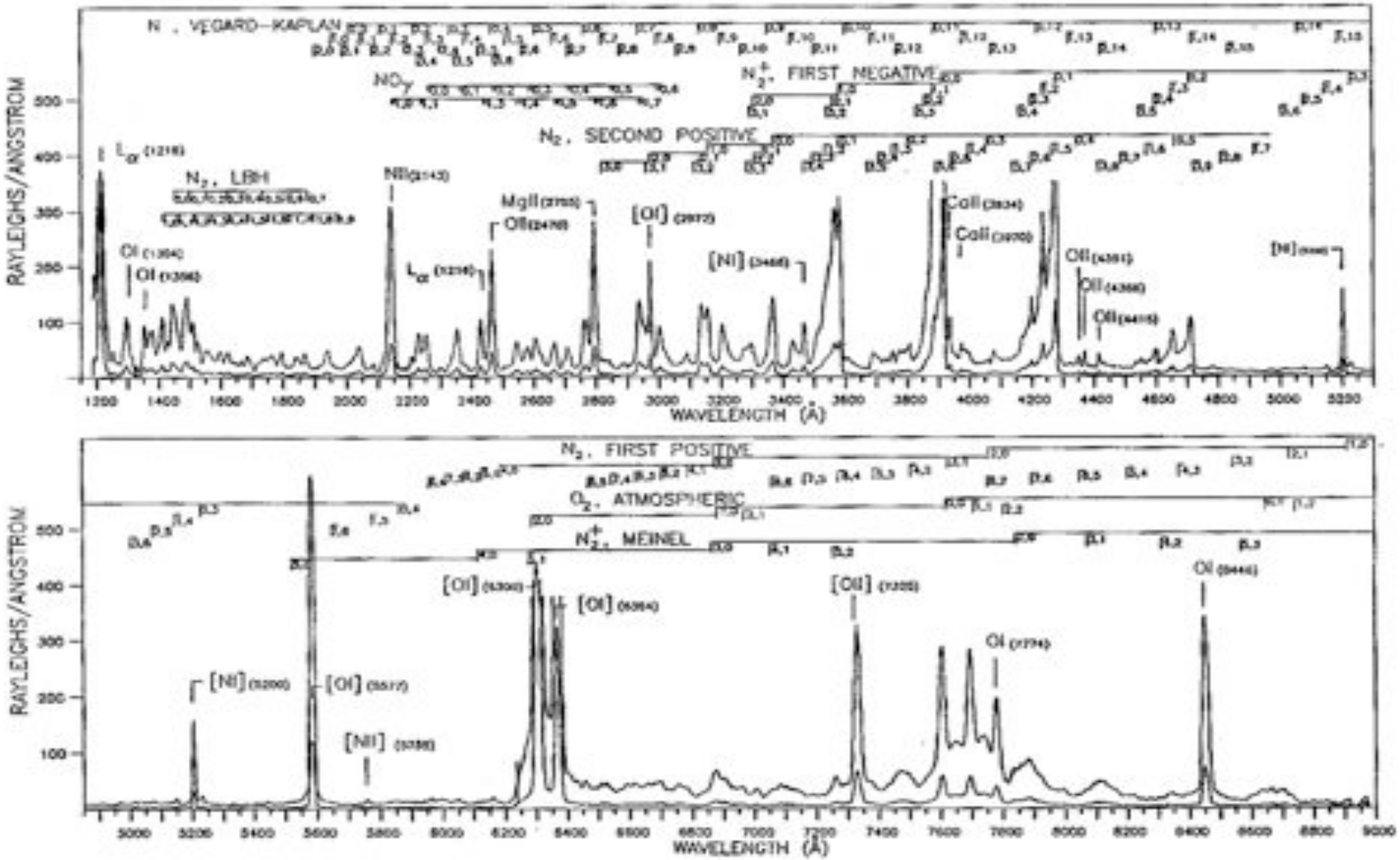
Context

- Study of the polarisation of the auroral emission lines.
  - Measurement of the auroral red line line polarisation through a photopolarimeter (Lilensten et al. 2008; Barthelemy et al; 2011a)
    - Polarisation degree: 1-2%
    - Direction parallel to B
    - Links between the polarisation and the ionospheric condition (Bommier et al. 2011 and Bommier et al. Poster EGU2012)
  - Measurement of the polarisation of the jovian H3+ Q(1,0-) line at 3.95µm (Barthelemy et al. 2011b).

Context

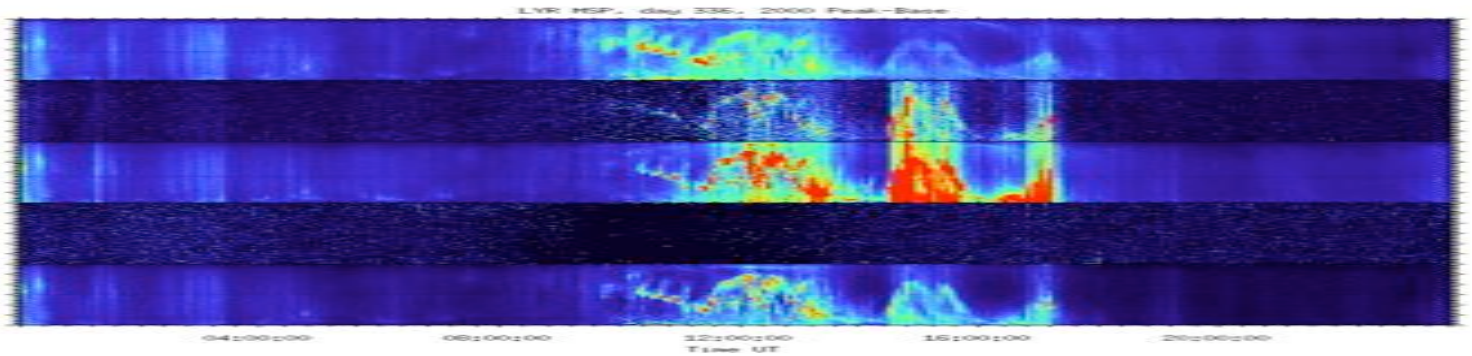


Broadfoot et al., N2 triplet band systems and atomic oxygen in the dayglow, *J. Geoph. Res.*, vol 102, p 11567-11584, 1997

Context

- In the Earth case, need for measurement of other lines especially:
  - N2+ lines at 427 nm
  - N2, 1st and 2nd positive bands.
  - O I line at 844 nm

630 nm
427 nm
557 nm
486 nm
844 nm



MSP, UNIS-KHO. D. Lorentzen

➔Need for a new spectropolarimeter: “1er Cru”

Fluxes

- Red line intensity ~ few kR (ie few 10^9 ph.cm^{-2}.s^{-1})
  - Other lines less intensive by a factor of :
    - 2 or 3 for the N_2^+ 427 nm line.
    - 2 or 3 for the O I 846nm
    - 10 for the H-Balmer lines
- Variations
    - Line dependant.
    - Different processes, different altitudes (ex: N2+ at low altitude around 100 km, red line at 220 km, green line at 120 km)
      - Question of the time resolution and field of view.

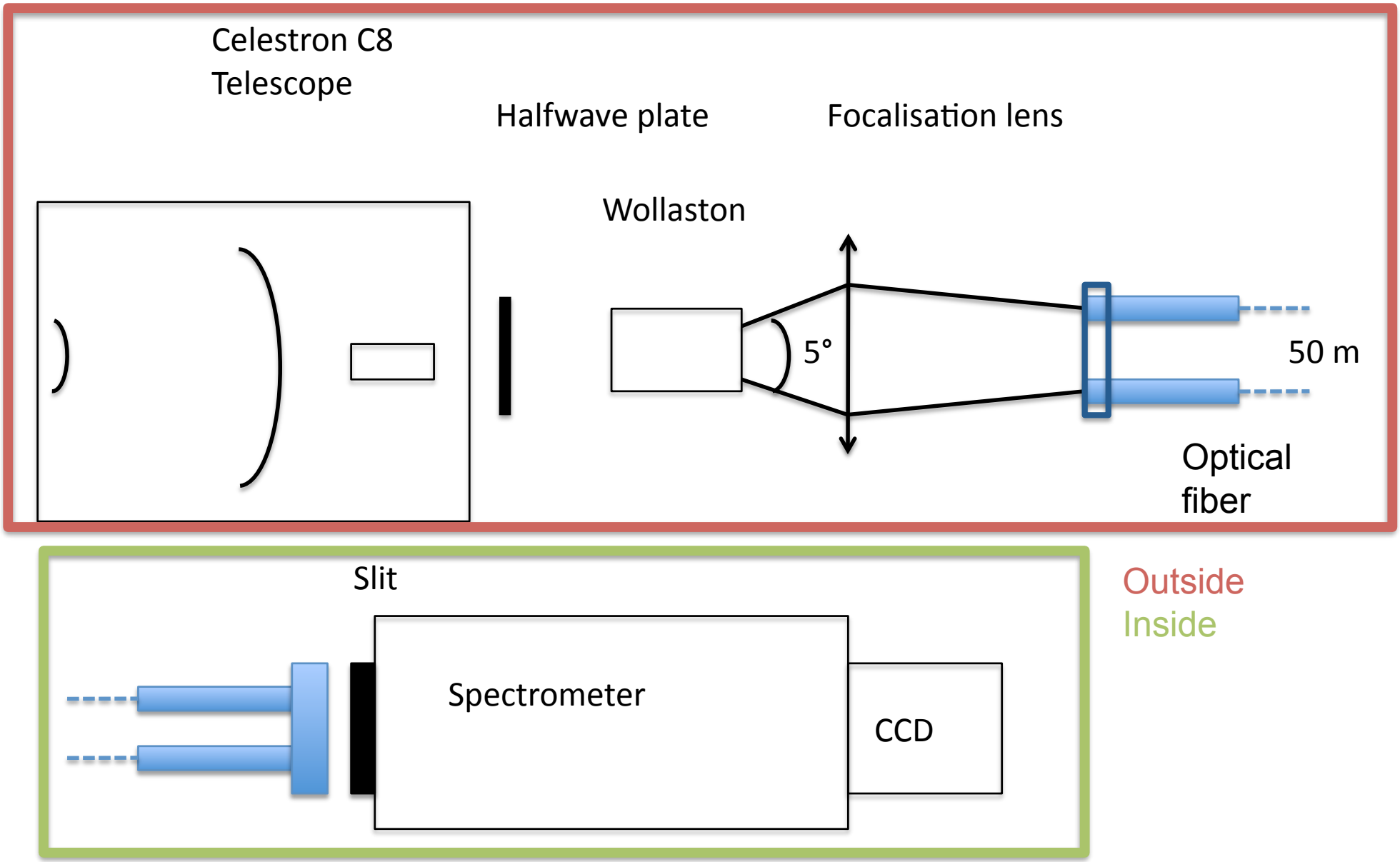
Time resolution and field of view

- 4 exposures for a polarisation measurement
  - Need for high S/N

  But
  - Pb of the time variation of the aurora

  - Goal: Maximum of few seconds for each exposure
    - ~10s for a polarisation measurement
- Field of view: 0.6° or 1.2° depending on the eyepiece.

Concept of the instrument



KHO. Longyearbyen Svalbard. Credit: O. Grundwald

Characteristics

- ½ wave plate: diameter 12.5 mm; ½ wave at 530nm. Zeroth order plate. Coating 400-700nm.
- Wollaston prism: width 12.5 mm. Angle separation 5°. Same coating.
- Telescope C8 (~200mm, f/d ~10), Schmitt Cassegrain to avoid instrumental polarisation (cylindrical symmetry). Collecting surface: $2.76e^{-2}m^2$
- Optical fiber diameter: 600µm. Length: 50m.

Characteristics

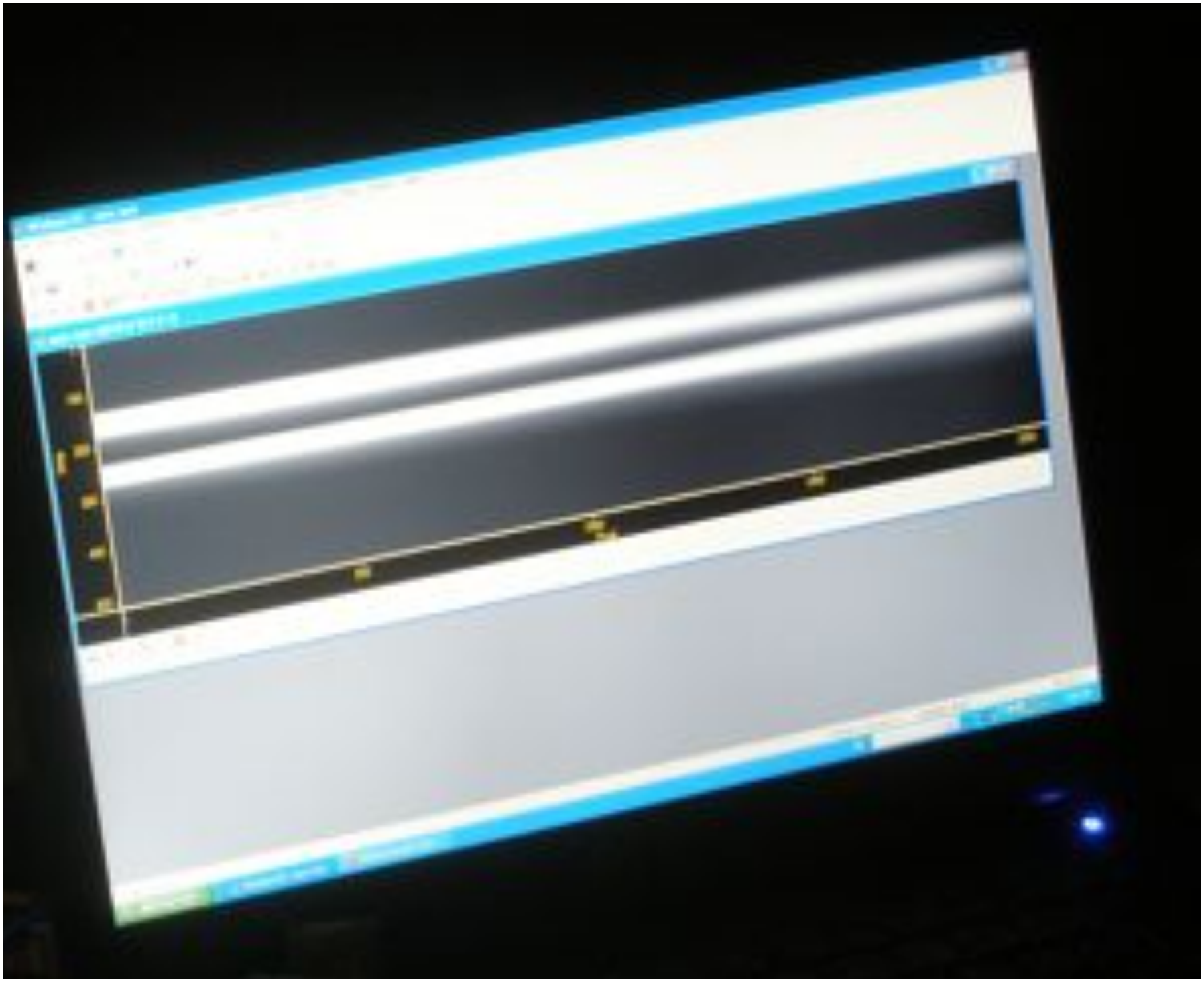
- Spectrometer:
  - two options: Avantes dual channel with detector or Newport coupled with a matcher.
  - Slit: Adjustable with Newport solution. Pb of the spectral resolution (Needed to be between 1 and 2 nm).
- Detector: In discussion. High sensitivity CMOS (sCMOS).

Calibration and data processing

- Several calibration procedure
  - In lab: on Hg lamp with polarizer. Fully polarised light. Angle calibration. Lines from 400 to 650nm.
  - In field: Green line at 557 nm is not polarised (Transition O1S➔O1D)
    - » Level of remaining polarisation due to Rayleigh scattering have to be determined but it should represent a reference with $p<10^{-3}$ (Red line calculation in Barthelemy et al 2011a)
- Data processing
  - By default if S/N is sufficient: Ratio method.
    - Pb: The waveplate is ½ wave only at 530nm.
  - Use of the method described in Barthelemy et al. (2011b): inversion of the system.

Operations

- First test in feb 2012
  - Polarisation spectrum obtained with test lamp
    - Pb with the light injection in the optical fiber: small movements due to the wind causes misalignment. Defocalisation reduce the flux too much.
    - Solution: Using optical fiber collimating systems (With mirrors for achromaticity problems).



Operations

- Spring 2012: finalisation of the concept
- New field experiments on the light pollution (Belgium June 2012)
- New field experiments in cold conditions (Pic du Midi, Fall 2012)
- Winter coordinated, EISCAT/SPP/1er Cru in Svalbard.