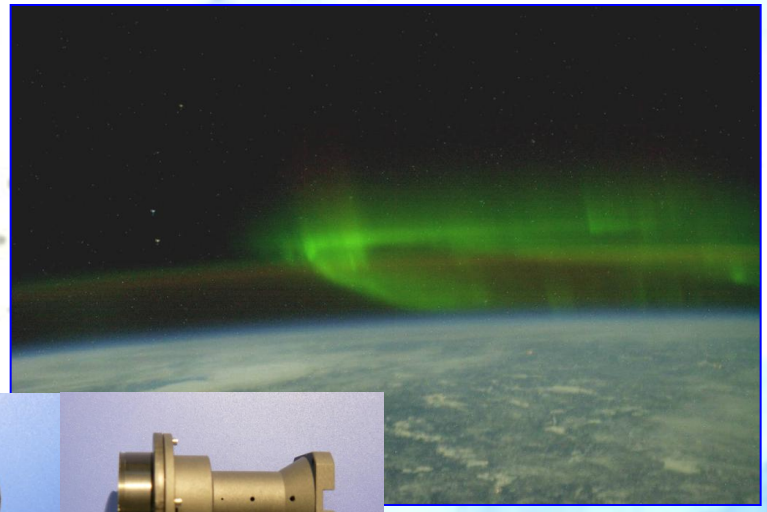
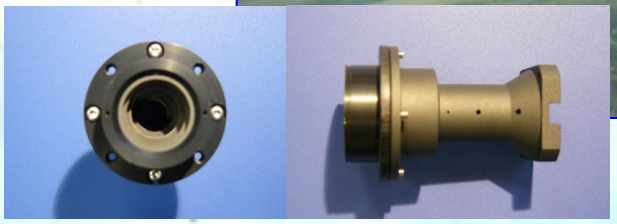
SwissCube

Science Mission and Payload Design





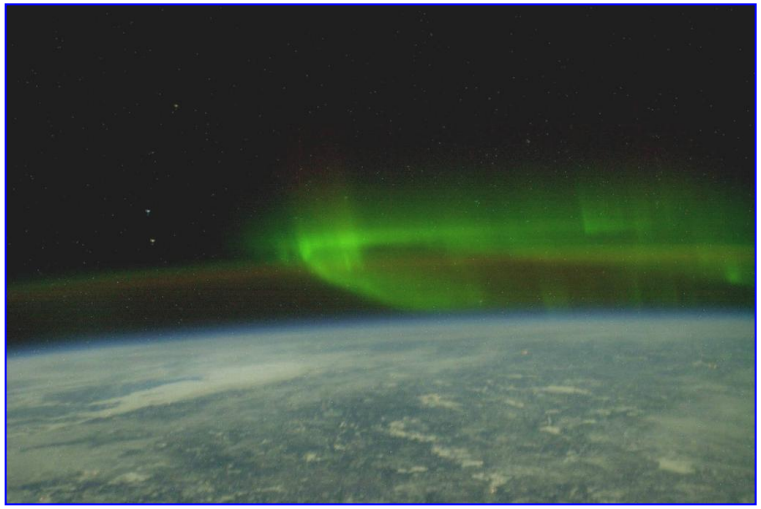
Noémy Scheidegger

Science Objectives

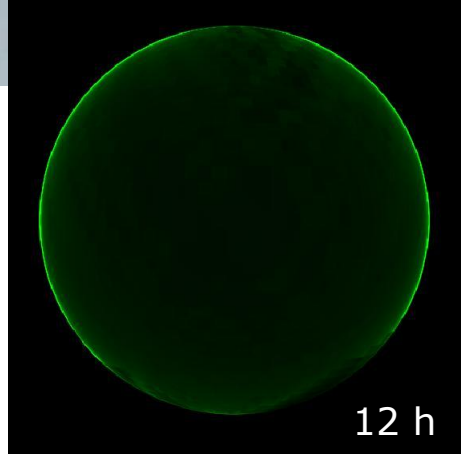
Measure the airglow emission in the upper atmosphere at 100 km altitude to :

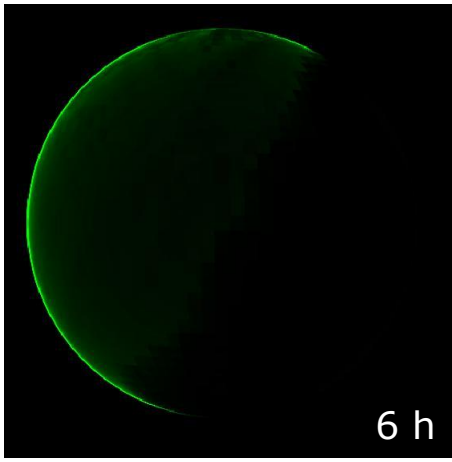
- Demonstrate the feasibility of using airglow as a basis for a low-cost earth sensor
- Validate the established airglow model or bring additional information about airglow dependence on

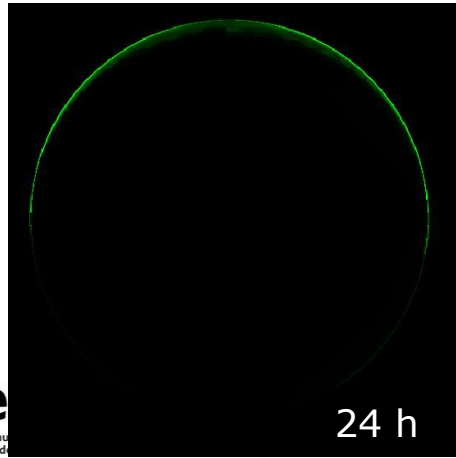
→ latitude
→ altitude
→ local solar time



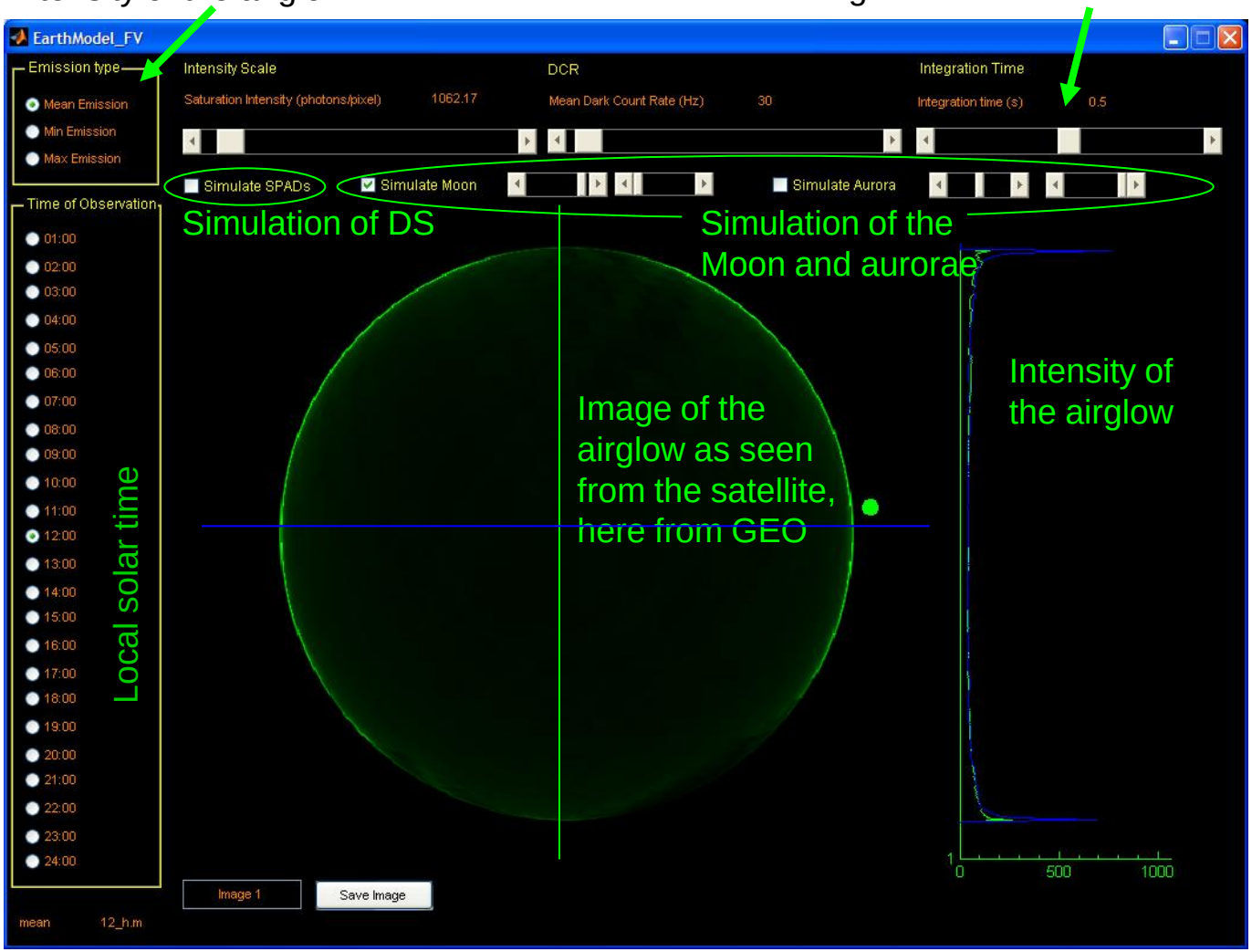
nightglow and aurora borealis







Aiglow Model

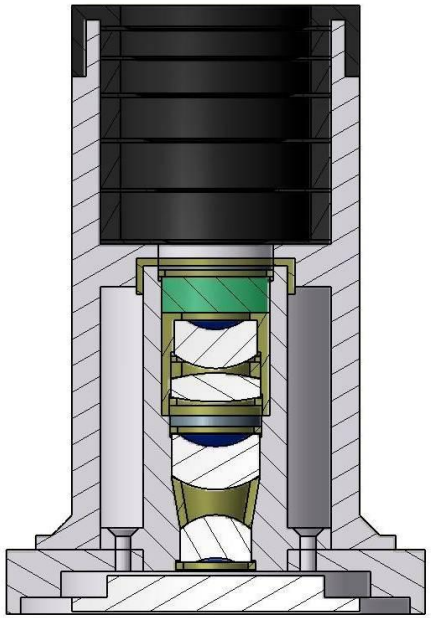


Driving Requirements for the SwissCube Payload

- Payload may be a technology demonstrator of an earth sensor based on airglow
  - Observes the emission at 762 nm with a bandwidth between 10 nm and 40 nm
  - Has a spatial resolution of at least 0.3° and a FOV of 20°
  - Can perform science mission with the sun no closer than 30° from its boresight.

- Physical and electrical constraints
  - Volume: 30 x 30 x 65 mm^3 for the optics
    80 x 35 x 15 mm^3 for the payload board
  - Mass: < 50 g
  - Peak Power: < 450 mW during 30 s for each image

- Additional design driver
  - The PL board is not a critical element of the SwissCube satellite
    → no redundancy has been taken into account for this subsystem



optics of the AIRES earth sensor

Operational Scenario: Frequency of Measurements

- During the first 3 month one image each 4.5 days:
  - 5 images of dayglow/nightglow measured at limb/nadir
  - Number of images limited by ground station coverage and relatively low data rate
  - Total: 20 measurements, cycle repetition of 18 days

- After 3 month: observation of variation of emission intensity depending on latitude
  - Dayglow/nightglow above 85° N/S
  - Dayglow/nightglow between 40° and 50° N/S
  - Dayglow/nightglow between 5° N and 5° S

  - Total : 10 measurements, cycle of repetition of 45 days

    8 measurements per latitude in one year

Operational Scenario: Data Exploitation

- Data Products
  - Each image provides a measurement of the intensity of the phenomena
    - Range measured: [500 – 61400] photons
    - Resolution: 500 photons
  - Complementary information: time, latitude, solar local time, altitude

- Data Exploitation
  - Data will be used to validate model
  - Data will then be available to public and scientific institutions (interest from World Radiation Center in Davos/CH)
  - Space Weather relevance has not yet been assessed, will be done once data is received

Operational Scenario: PL Board

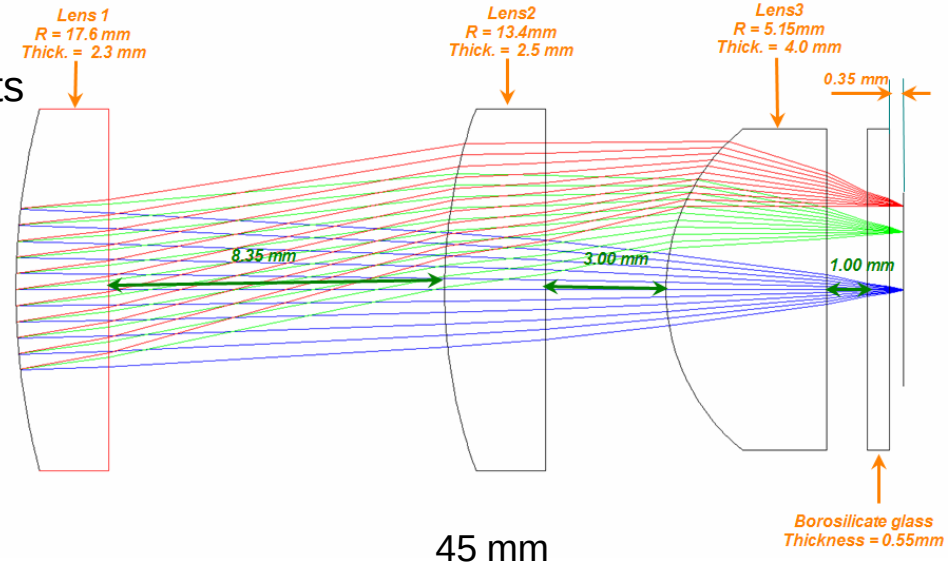
- PL board always turned on for housekeeping
- Detector turned on only when science observations are carried out
- Science observations are triggered by EPS
- Power consumption:
  - 8 mW when no science observations are performed
  - < 450 mW during science observations

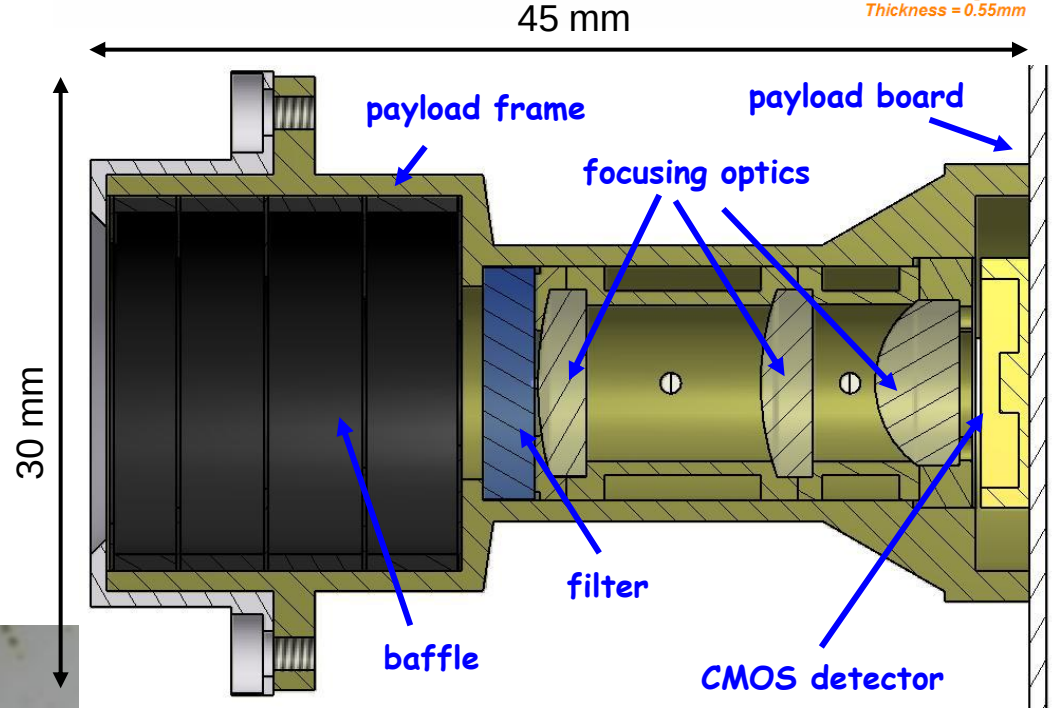
Design Description: Overview

first SwissCube payload prototype

Design Description: Optical System

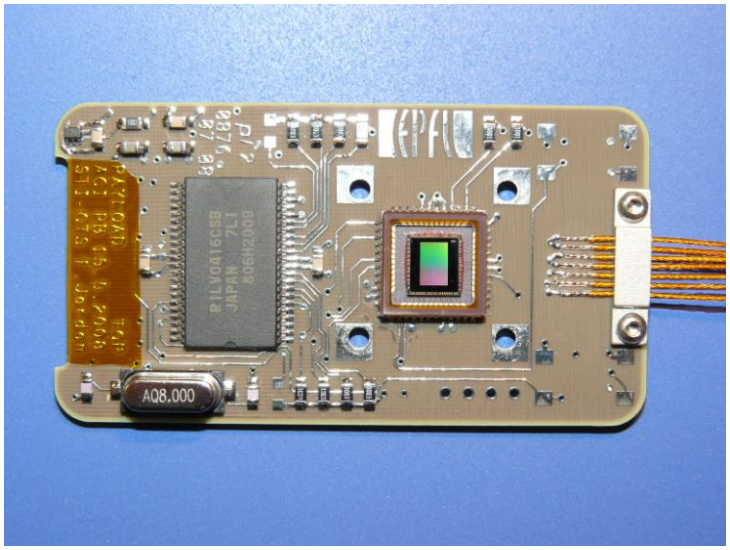
- Triplet design with off-the-shelf components
- FOV 18.8° x 25°
- Resolution 0.16°/pixel
- Baffle for a solar exclusion angle of 30° with an attenuation factor of 10^{-4}
- Filter with a central wavelength at 767 nm and a bandwidth of 20 nm

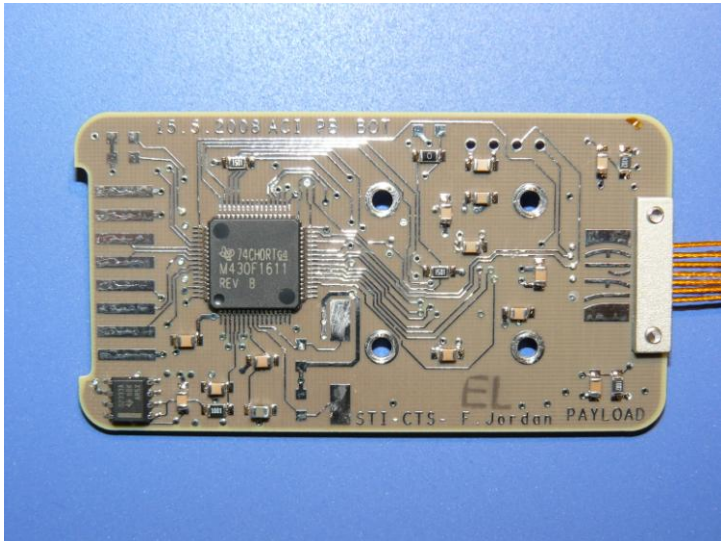




Design Description: Payload Electronics

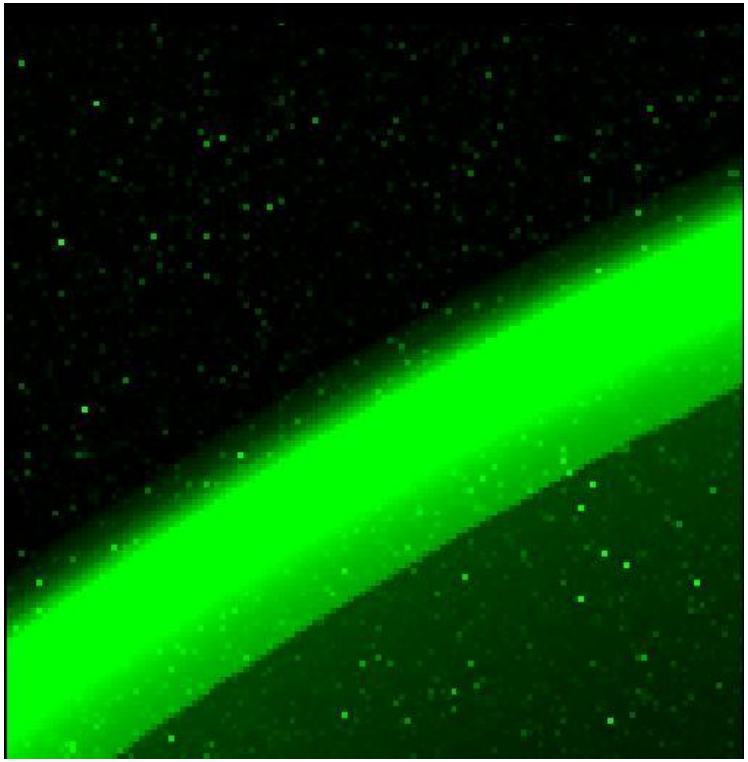
- Microcontroller MSP430F1611
  - Operate the detector
  - Communicate with the EPS
  - Read temperature sensors
- CMOS Detector MT9V032
  - Capture images of the airglow
- Temperature Sensor LM94022
  - Used for dark signal correction
- Oscillator HC-49/US SMD
  - Provide clock reference for the CMOS detector
- RAM R1LV0416CSB-7LI
  - Store images until transmission to ground station





Design Description: Expected Airglow Images

Limb Observations



Zenith Observations