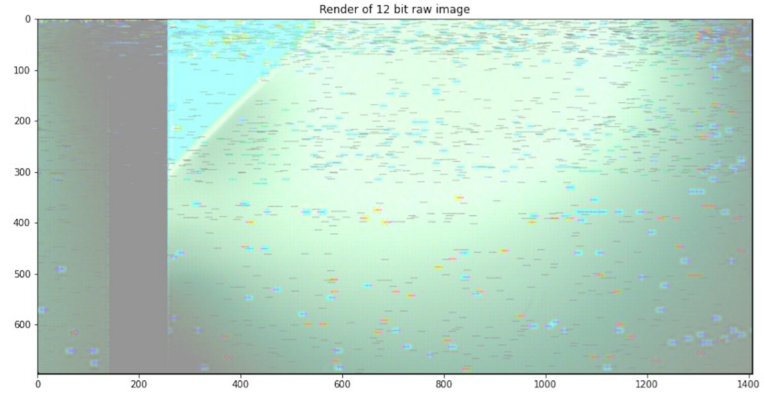
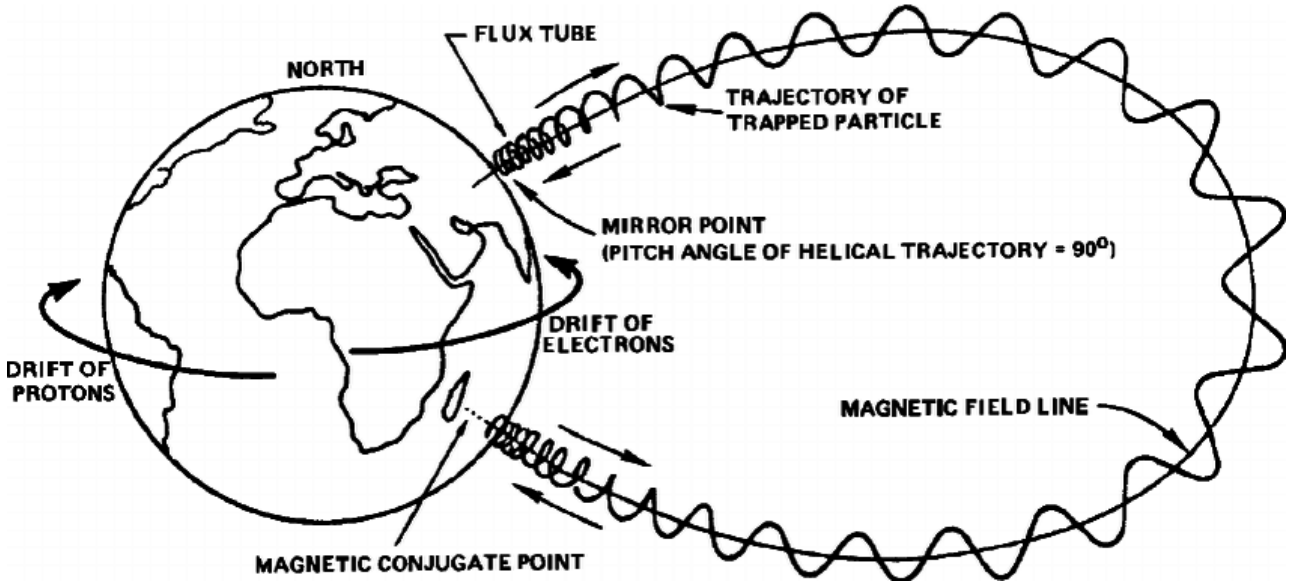
AMICal Sat and ATISE : An imager and a spectrometer for auroral studies

Barthelemy M (UGA) et al.



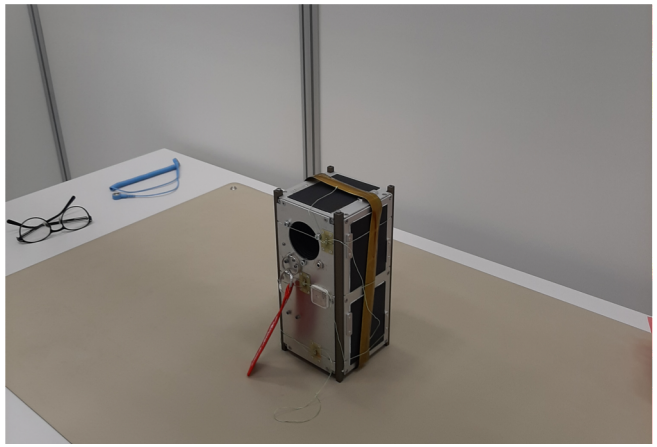
ATISE/AMICal Sat Scientific objectives

- Main questions:
  - Particle fluxes at the top of the atmosphere
    - Energy, total flux, distribution shape
  - Depisition into the atmosphere
    - Especially eV and KeV range
    - Altitude of the emissions
      - Between 90 and 300 km



2 satellites for this…

- AMICal Sat
  - Launched 3 Sept 2020 from Kuru (VV16 flight)
  - 2U
  - Imager
  - Working since then
    - But ADCS module failed
    - After 10 days

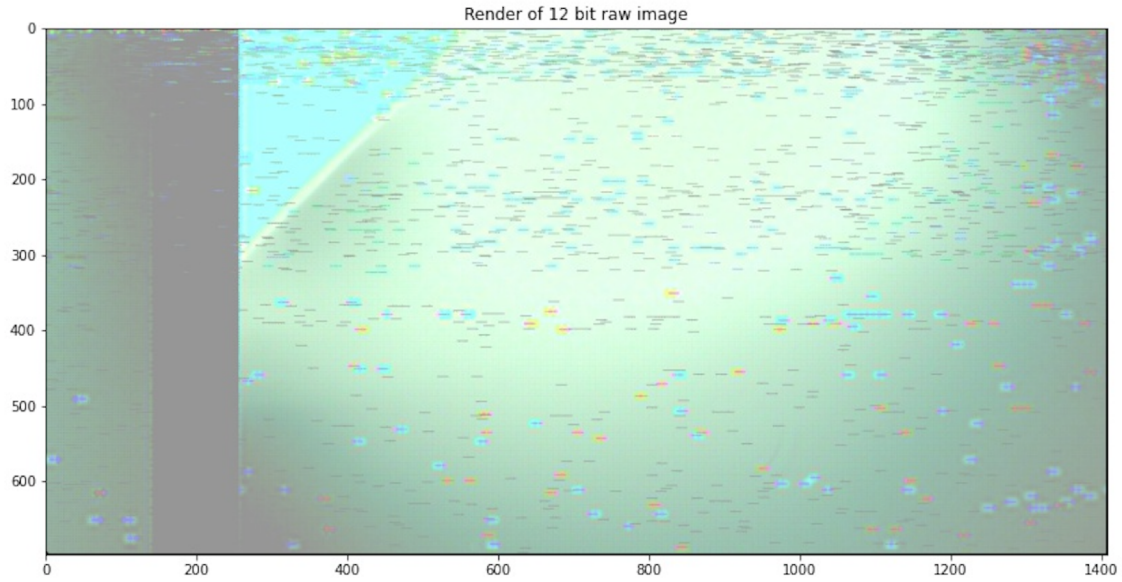


AMICal Sat just before integration in the POD

- ATISE
  - Launch planned in 2024
    - 12U
    - Spectrometer + Particle detector (<50 keV range)
      - REIMEI like configuration

AMICal Sat: Mission profile (NORAD ID: 46287)

- SSO
- 530-540 km
- ADCS failure
- Satnogs: Position and telemetries

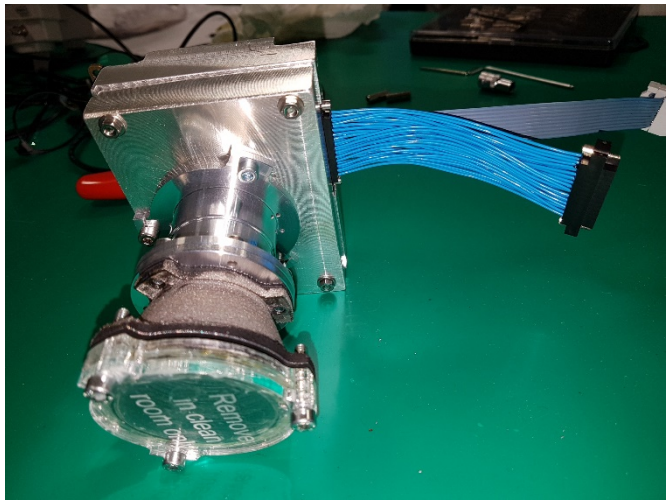


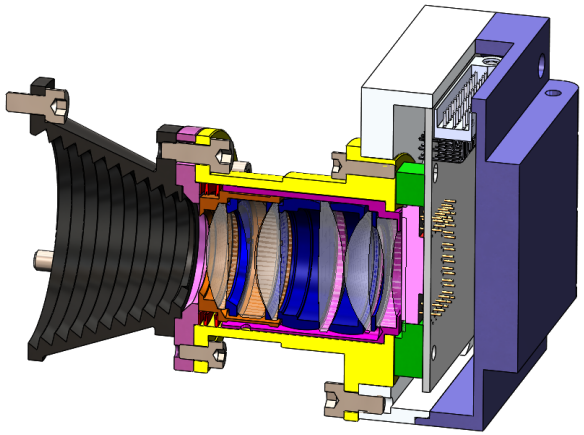
- Images in Sparse RGB (Barthelemy et al. Submitted JMASS, 2021, arXiv:2201.06973)

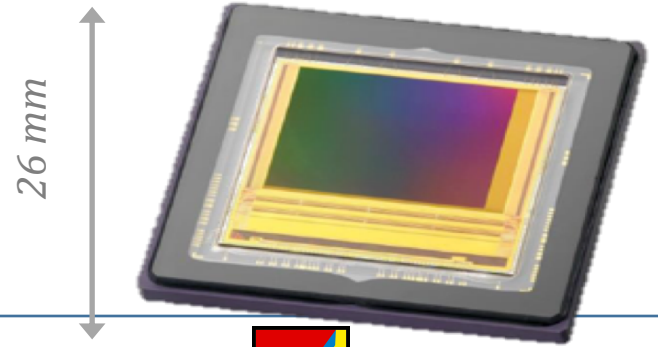
AMICal Sat Payload– Imager

- Commercial detector (ONYX Teledyne E2V)
  - Large pixels : 10µm
  - Sparse RGB matrix: high sensitivity
  - 1.3Mpix

- Objective: Designed at IPAG. f =23mm, f/1.4







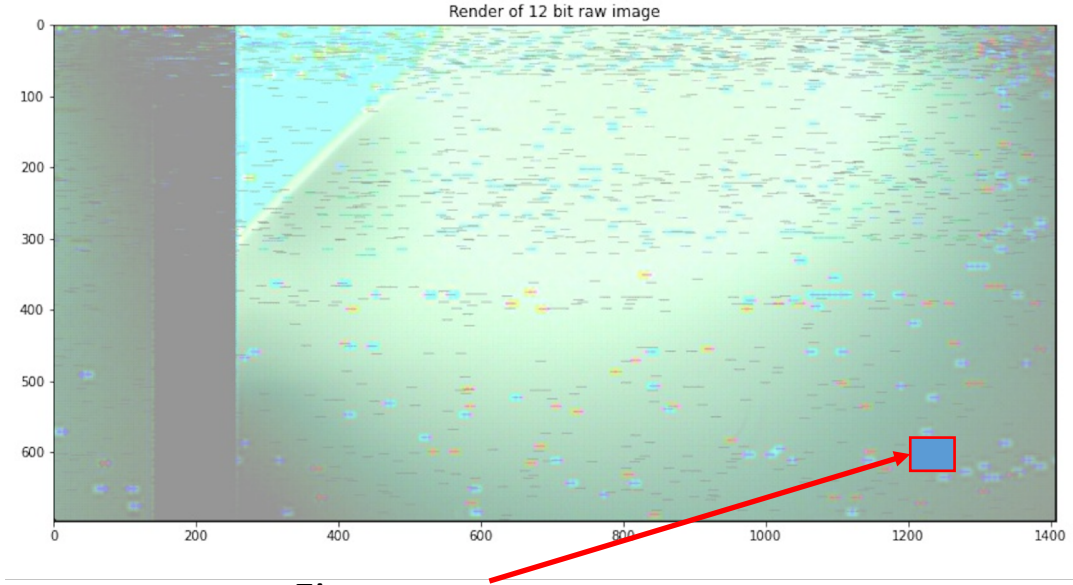
Onyx, 2Mpx, Color

Interpretation method

- From Sparse RGB AMICal Sat data.
- LoS integrated intensities
- Geometry of the observation
  - Using the position and the limb position when existing.

- Ig =Spix ×Ωpix ×(QEg557 ×Absg ×L557 + QEg427 × Absb × L427 + QEg630 × Absr × L630 + QEgN 2Δv=3 × Absr × LN 2Δv=3 + QEgN2Δv=4 × Absr × LN2Δv=4)
- Ir =Spix ×Ωpix ×(QEr557 ×Absg ×L557 + QEr427 × Absb × L427 + QEr630 × Absr × L630 + QErN 2Δv=3 × Absr × LN 2Δv=3 + QErN2Δv=4 × Absr × LN2Δv=4)
- Ib =Spix ×Ωpix ×(QEb557 ×Absg ×L557 + QEb427 × Absb × L427 + QEb630 × Absr × L630 + QEbN2Δv=3 ×Absr ×LN2Δv=3 + QEbN2Δv=4 × Absr × LN2Δv=4)
- IPan = Spix × Ωpix × (QEPan557 × Absg × L557 + QEP an427 × Absb × L427 + QEP an630 × Absr × L630 + QEPanN2Δv=3 ×Absr ×LN2Δv=3 + QEPanN2Δv=4 ×Absr ×LN2Δv=4)

- With higher weight for the Pan intensity (15/16 instead of 1/16)



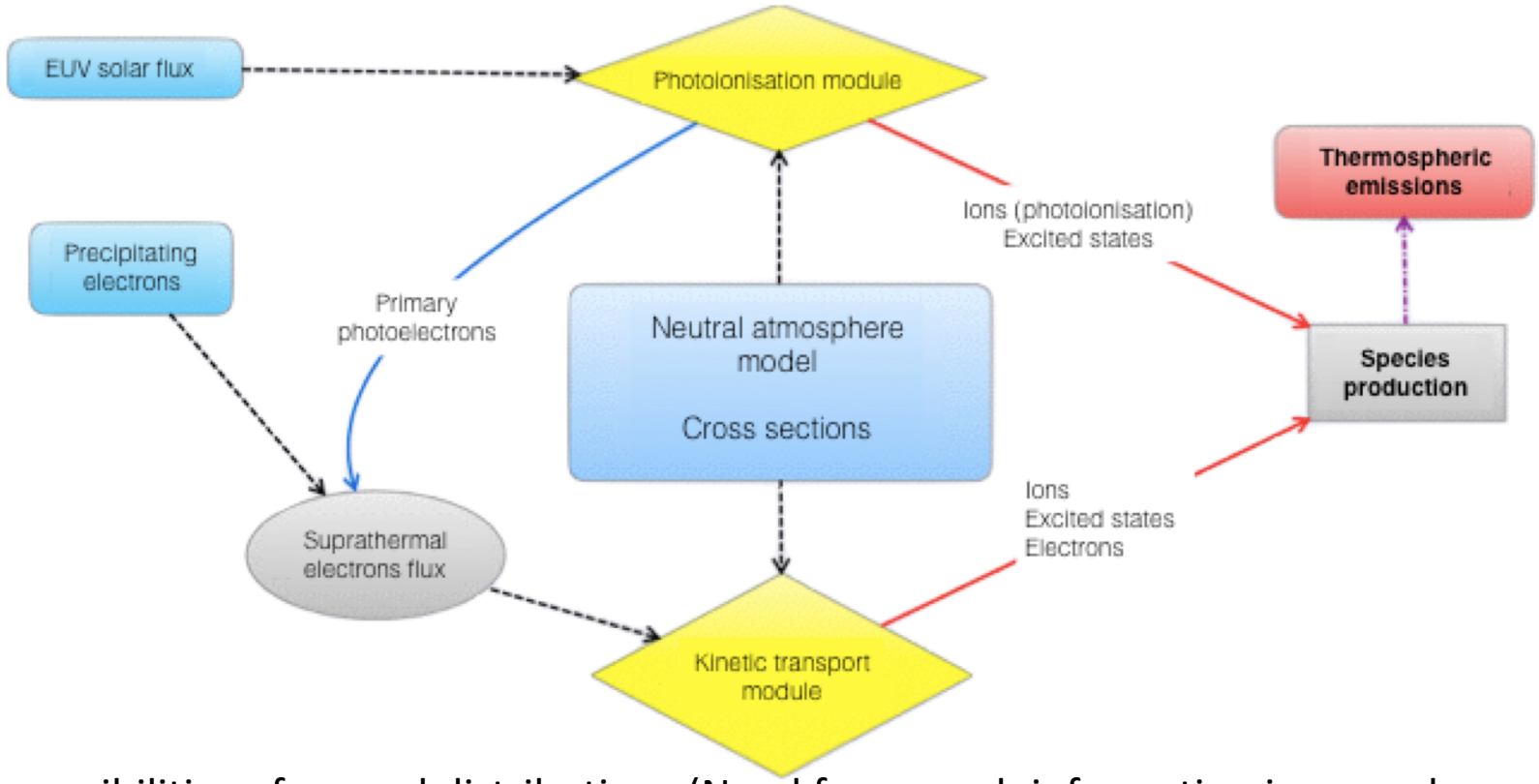
First test

Mean energy of 3.02keV
Total flux of 5.17erg.cm-2 .s-1

But biases still exist (Branching ratio with second positive band, uncertain reconstruction in the red…) as well as multiple solutions
Comparison with GLOW simulations gives errors up to 50% for the total flux.

Interpretation methods: the trans code

- Through the Transolo code



Fitted parameters

E tot

E moy for the distribution

If possible: ΔE

In a near future we are considering the possibilities of several distributions (Need for enough information ie enough emission lines)

Interpretation method (Barthelemy et al. 2021, In revision)

- From Sparse RGB AMICal Sat data.
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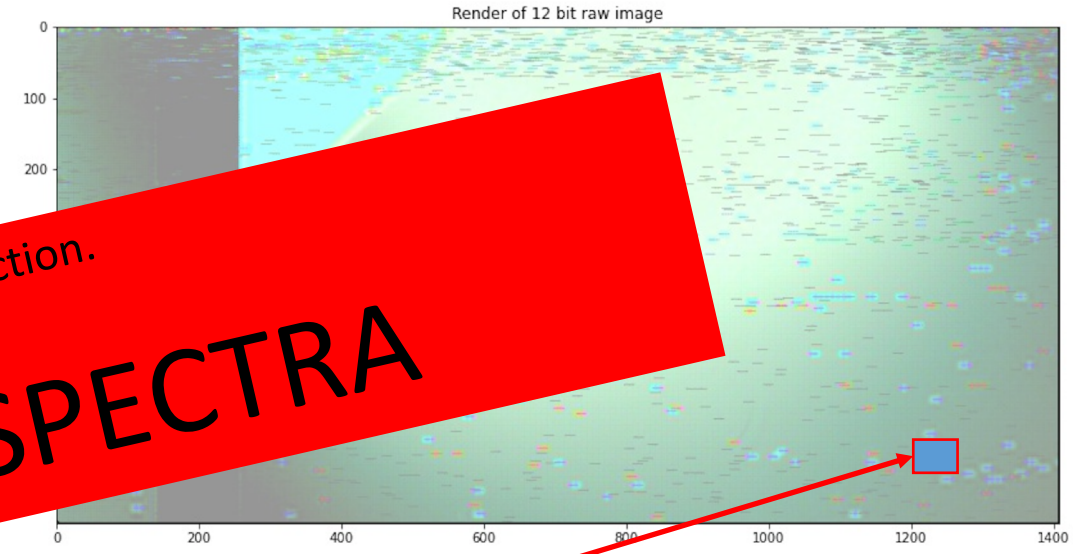
- Ir =Spix ×Ωpix ×(QEr557 ×Absg ×L557 + QE QEr630 × Absr × L630 + QErN 2Δv=3 × Absr × LN 2Δv=3 +
- Ib =Spix ×Ωpix ×(QEb557 ×Absg ×L QEb630 × Absr × L630 + QEbN2Δv=3 ×Absr ×LN2Δv=3 + QE
- IPan = Spix × Ωpix × (QEPan557 × Ab L427 + QEP an630 × Absr × L630 + QEPanN2Δv=3 ×Absr ×LN2Δv=3 + QE ×Absr ×LN2Δv=4)

- With higher weight for the Pan intensity (15/16 instead of 1/16)



However same problem of intensity reconstruction.

NEED FOR SPECTRA

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Total flux of 5.17erg.cm-2 .s-1

But biases still exist (Branching ratio with second positive band, uncertain reconstruction in the red…) as well as possible multiple solutions.
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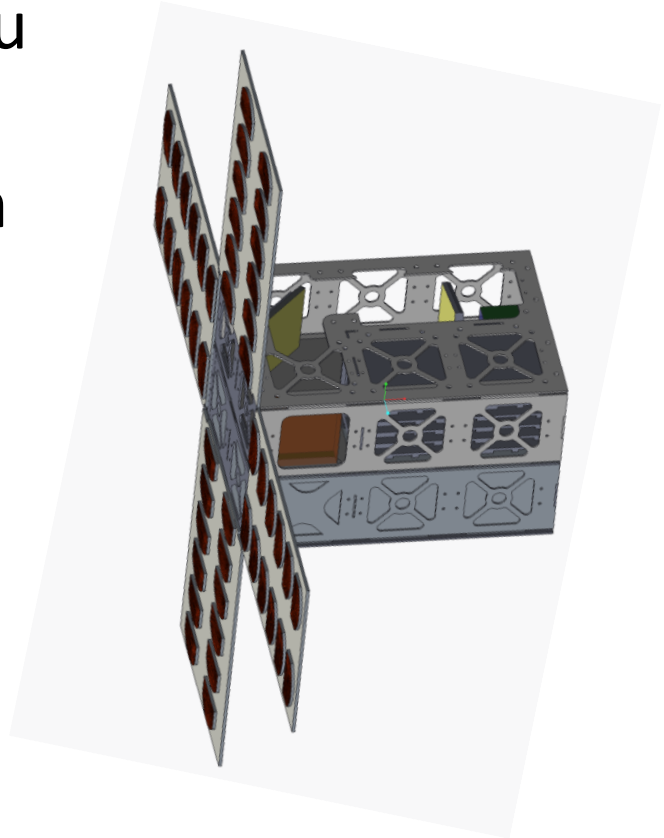
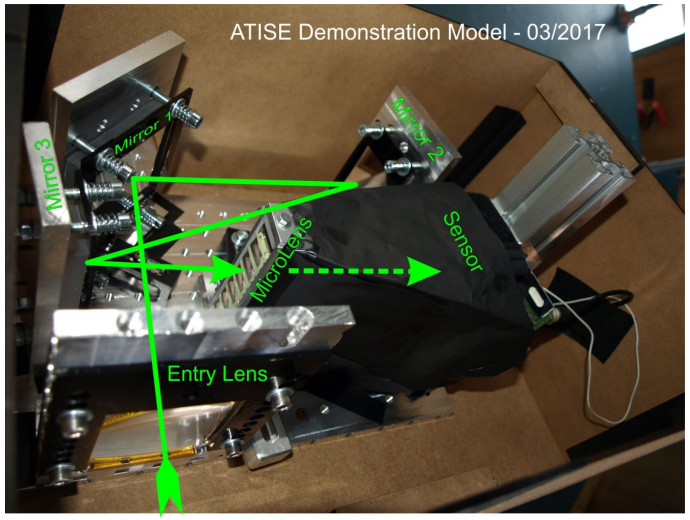
Next: the ATISE spectrometer

Based on a Fizeau concept

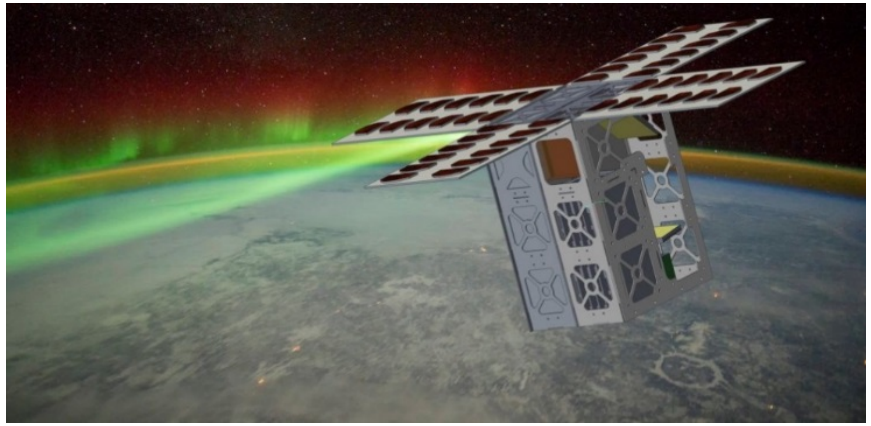
- Fizeau on the entry lens.





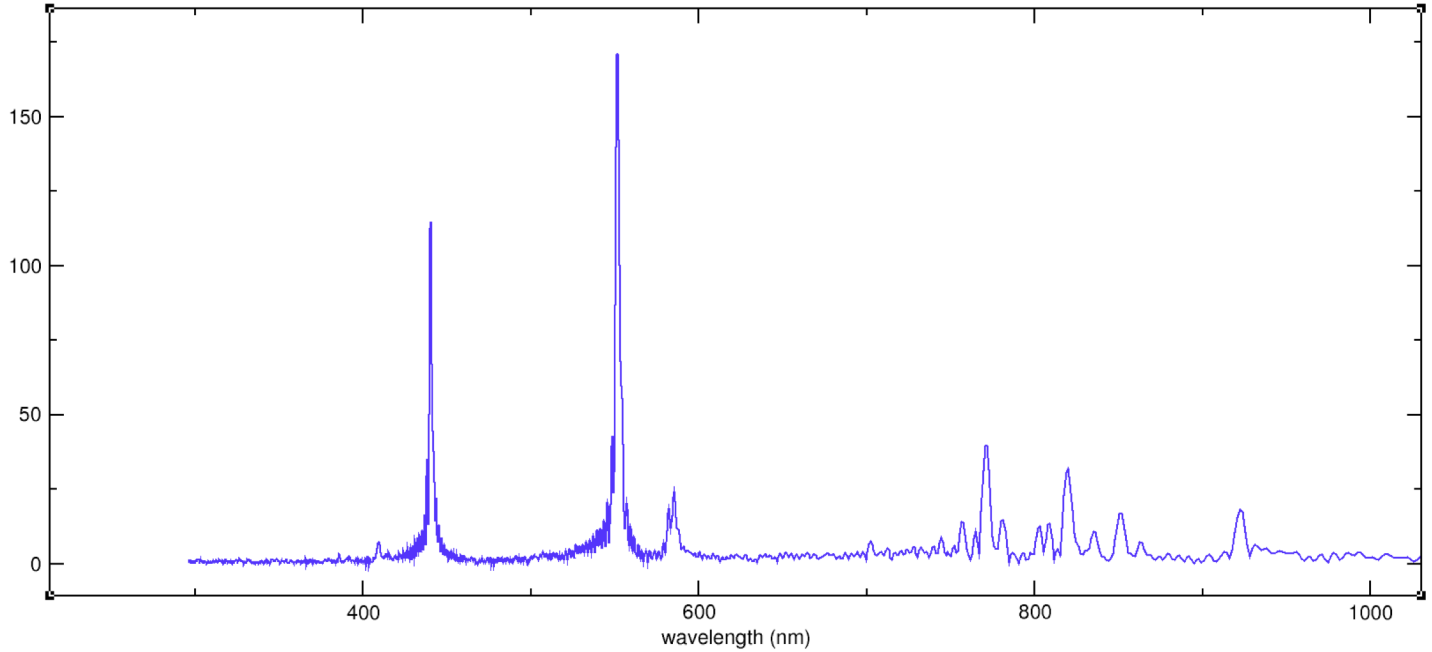
Mission profile

- 2 y nominal (ext 5y)
- Aurora (and Airglow)
- Orbital best choice : 70°, 600km. SSO possible.
  - Shift in Local hours (Not with SSO)
- Vertical profiles of the emissions (6 lines of sight)
  - Limb sighting
  - between 100 and 350 km altitudes. 1°x1.5° for each.
- 1s exposure time (20 s in Airglow)
- Spectral resolution: ~1 nm
- Sensitivity: 5R (1s exp time)
  - Possible Nadir observation in coordination with particle detector
    - REIMEI like configuration



Interpretation method: Spectrometer

- Minimization between Transolo outputs and spectrometer data.
  - Ground based tests
    - Nov 21 and March 22
    - Data processing in progress



Last lab test on Hg-Ar lamp.

Conclusions and take home message: ATISE and AMICal Sat (+ WFAI)

- Three different instruments for space weather monitoring (Low energy electron <30keV)
- Imager: calibrated RGB images (Nadir and Limb)
  - Cartography possible
  - Energy reconstitution: Possible but with remaining bias. Need for cross calibration.
- Spectrometer: 6 vertical calibrated high sensitivity spectra (Limb)
  - Test with calibrated instrument: Next Month (From ground)
- short exposure time (1 s)
- To monitor particle precipitation and energy deposition
- On board Cubesats (2U and 12U)

Coordinated experiment are possible.
If interested contact me:
mathieu.barthelemy@univ-grenoble-alpes.fr