

Development of Compton polarimeters

(COMCUBE and COMPOL)

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1. Developments for COMCUBE

- COMCUBE is a CubeSat project funded by AHEAD2020 in view of observing gamma-ray bursts.
- The COMCUBE design has been finalized by G4 simulations.
- In that framework, CEA will develop a detector card consisting on a DSSD detectors readout by IDefX ASICs.
- This card will be a (small) replicate of what is currently developed in the lab, in view of also testing technologies for ASTROGAM.

ASTROGAM DSSD R&T @ CEA





- Coupling of a 100x100x1,5 mm³
 DSSD with 64 strips to IdefX ASICs.
- Custom made Si detector + board (Micron TTT6).

Dark current : 3-4 nA/strip
Capacitance : 20 pF/strip.
Depletion voltage : 270 V

2. The COMPOL project

- The COMPOL project aims to fly Compton polarimeters in 3U nanosats.
- The problem of the weak effective surface of the nanosat is compensated by a long observation time (several Ms).

\Rightarrow a nanosat is dedicated to one source.

- They are a few bright gamma-ray sources in the sky (Cygnus X-1, Crab, ...) so the COMPOL project comprises a few nanosats.
- With the help of "Université de Paris", it is thought also as a way for "young" space agency and Universities to make steps in space and train future space engineers.
- In that sense, VNSC and NSPO (Vietnam and Taïwan space agencies) have agreed to participate to the project to have their own "COMPOL" nanosat.

The COMPOL project: main ideas

Generally speaking, the COMPOL payload consists of:

- silicon detectors (scatterer).
- Cebr3 scintillators coupled with a SiPM detector matrix (calorimeter).
- All projects are optimized through G4 with students of the different countries.



- Mission duration : 1 2 years; mission dedicated to a single source.
- Orbit : Low Earth Orbits (LEO) are preferred to minimize the background. Low inclination is also better to minimize the time spent in the SAA, where the payload will be shut down, due to the SAA high proton flux.
- Moderate pointing accuracy (degree) is sufficient.

The COMPOL project: status

The COMPOL project starts in 2018. Now, it is composed of three 3U missions studied in parallel, in the spirit of developing new space infrastructure:

- COMPOL @ Munich
 - In collaboration with LRSM (laboratory for Rapid Space Mission, newly created for developing CubeSat in Germany), MPP and TUM.
- COMPOL @ Taïwan
 - In collaboration with NTHU (Taïpeï) and NSPO (National SPace Organization).
- COMPOL @ Hanoï
 - In collaboration with USTH, VGU, VNU and VNSC (Vietnamese National Space Center)



Two words about the precursor : IGOSAT

IGOSat (Ionospheric Gamma-ray Observations Satellite) is a 3U nanosatellite:

- It aims to characterize the **aurora zones and the South Atlantic Anomaly.**
- It is a **student program** from Paris-Diderot University and CNES (JANUS program), supported by the AstroParticule et Cosmologie laboratory and Institut de Physique du Globe.
- It is composed of two payloads :

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- A scintillator (CeBr3+plastics readout by SiPM) to measure electrons and gamma-ray spectra and light curves.
- A dual frequency GPS system to get the electron density in the ionosphere.
- We are currently preparing the Qualification Model for environment tests on 2021; the satellite should be launched **on 2022**.



UnivEarthS 🔘 🍊



Back to COMPOL ...

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COMPOL @ Munich

Low energy detector:

- Silicon drift detector
- "Tristan" type (KATRIN)
- ASIC: IDEF-X HD(BD)
- 32 pixels
- One, maybe two layers
- Provided by MPP and TUM, Münich
- Platform provided by LRSM
- IOV prototype mission to be flown in 2022.



10

20

30

E (keV)

40

50

60

70

COMPOL @ Munich

High energy detector:

- Similar to the IGOSAT scintillator payload.
- CeBr3 detector readout by SiPM matrix (Hamamatsu)
- + ASIC and data treatment card.
- 16 channels.
- Provided by CEA, Saclay





COMPOL @ Hanoï

Low energy detector:

- DSSD (16+16 channels) readout by one IdefX ASIC + HT + ADC.
- Design adapted from ASTROGAM R&T
- Similar to COMCUBE
- Provided by CEA, Saclay



COMPOL @ Hanoï

High energy detector:

- CeBr3 detector readout by a SiPM matrix.
- Detectors developed at USTH (Hanoï).
- Electronics developed at VGU and VNU (Ho Chi Minh city).
- Platform developed by VNSC with a potential ESA support.



COMPOL @ Taïwan

Low energy detector:

- DSSD (16+16 channels) readout by one IdefX ASIC + HT + ADC.
- Design adapted from ASTROGAM R&T
- Similar to COMCUBE
- Provided by CEA, Saclay



COMPOL @ Taïwan

High energy detector:

- This project is being carried out in collaboration with the National Tsing Hua University in Taipei.
- Professor Chang and his students are working on gamma polarization (COSI circumpolar balloon) and are very interested in the science of COMPOL.
- With our Taiwanese colleagues, we did a pre-study of the satellite.
- We have also studied different nanosat configurations via G4 MC simulations.
- Now, they start to produce the CeBr₃ detector readout by a SiPM matrix.
- Platform will be possibly developed by NSPO.





Yang et al., 2020, AJ,, 160,54



Thank you !

