GRBAlpha and VZLUSAT-2



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GRBALPHA:

1ST TECHNOLOGICAL PRECURSOR MISSION TO CAMELOT

- 1-U CubeSat with gamma-ray detector same concept planned for CubeSat fleet CAMELOT (see talk by László Mészáros tomorrow)
- Small size of scintillator (75x75x5mm³) readout by 8 MPPCs
- Main goals:
 - confirm detector concept
 - characterize the detector degradation on orbit
 - characterize background at LEO (SSO) for a gamma-ray detector



 our estimation was that 10% of Fermi-GBM GRBs (both long and short) can be detected by GRBAlpha (~10-20 GRBs/year, for ideal 100% duty cycle)



GRBALPHA: DETECTOR ASSEMBLING

Pál+ 2020



CsI(TI) scintillator from Kharkiv (Ukraine)



Wrapped in Enhanced Specular Reflector (ESR)



2 readout channels each with 4 MPPCs (S13360-3050 PE) by Hamamatsu

GRBALPHA: DETECTOR ASSEMBLING

- MPPCs are coupled with crystal by optical glue DOWSIL93-500
- Detector is wrapped by optically thick DuPont TCC15BL3 polyvinyl fluoride (PVF) tedlar to prevent light leakage from outside



wrapping

degradation by trapped protons in SAA

GRBALPHA: ON GROUND GAIN CALIBRATION



For readout ch 0

GRBALPHA: ENVIRONMENTAL TESTS



Thermal vacuum test



Vibration tests by Remred Itd. in Budapest





Ready for shipment to Moscow

GRBALPHA: LAUNCH

https://grbalpha.konkoly.hu

www.spacemanic.com/news/grbalpha-satellite-to-launch-from-baikonur/

- After delivery to Moscow it was integrated into the deployer in the facility of GK Launch Services
- Launched from Baikonur by Soyuz-2.1a rocket with the Fregat upper stage to 550 km SSO on March 22, 2021



GRBAlpha integrated into deployer



Soyuz painted in unusual white/blue colors like Yuri Gagarin's Vostok 1



 38 satellites from 18 countries launched at one time



GRBALPHA: 1ST GRB DETECTION 1ST GRB EVER DETECTED BY 1U SIZE CUBESAT!



GRBALPHA: GRB DETECTIONS



GRBALPHA: BACKGROUND MAP



 Satellite tracks (averaged flux when overlap) with 1s, 4s and 15s time resolution background measurements

- Interpolation of measurements in HEALPix tesselation
- Plan is to use such a map on board to control data taking and in future possibly to control the rate trigger

GRBALPHA: DEGRADATION OF MPPC IN SPACE

- Increasing of dark current (noise) due to the radiation damage of MPPCs by the trapped protons
- Noise peak becomes wider and the low-energy threshold increases
- Expected from the ground beam experiment
- Before launch the low-energy threshold was ~10 keV
- 15 months after the launch it was ~58 keV
- After one year on orbit the degradation remains at acceptable level



VZLUSAT-2: WITH OUR TWO GRB DETECTORS



- VZLUSAT-2 is a technology mission (3U size) with an Earth observing camera as a primary payload developed by Czech Aerospace Research Centre
- Two detectors (75x75x5mm³) as a secondary payload
- The detector concept, the MPPCs and electronics are the same as on GRBAlpha

VZLUSAT-2: DETECTOR ASSEMBLING AND ELECTRONICS

Compact analog electronics



- A simple CSA (LF356) + shaping amplifier (LM6142)
- 12-bit sampling ADC (LTC2315-12)
- HV supply module (LT3482) controlled by DAC

FPG TP5V8 GND2

- FPGA iCE40HX8K-BG121
- MCU STM32F072CBT7 ARM Cortex-M0

Digital board

VZLUSAT-2: DETECTORS READY



Weight: 2 x 280 + 50 g

Power: 0.7 W

VZLUSAT-2: SATELLITE FINISHED AND LAUNCHED

- Satellite was assembled, went through environmental tests and was shipped to USA in Sep 2020
- It was launched to 550 km SSO by Falcon 9 is on Jan 13th 2022



VZLUSAT-2: GRB DETECTIONS

- 4 GRBs detected so far, either with GRB detector unit no. 0, 1 or both
- Compared with detections by Fermi/GBM or INTERGAL/SPI-ACS
- The 1st GRB was detected with 15s resolution during commissioning phase (background mapping)
- Other GRBs were obtained with 1s resolution



VZLUSAT-2: SOLAR FLARE DETECTIONS

- 3 Solar flares detected so far
- Compared with detection by Fermi/GBM
- Measured with 1s resolution



VZLUSAT-2: MEASURED BACKGROUND MAPS









SUMMARY

<u>GRBAlpha successes:</u>

- since launch still functional in orbit >1 year
- detector concept proven
- detected 5 GRBs
- mapping background at LEO
- provides data of in orbit aging of Hamamatsu's MPPCs

• <u>VZLUSAT-2:</u>

- since launch still functional in orbit >0.5 year
- detected 4 GRBs and 3 Solar flares
- mapping background at LEO

• Near future:

- GRBBeta (2U size) next technological precursor mission with improved onboard software, inter-satellite communication, testing of IR sun-sensor system for attitude determination, launch expected in Apr 2023

THANK YOU !

