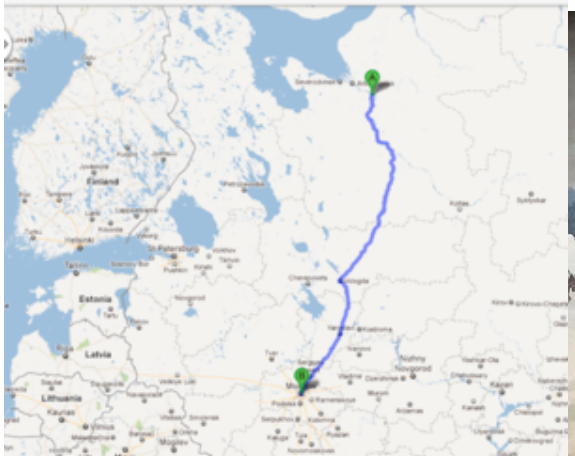
Our GRB Pathfinder and the Mikhailo Lomonosov Satellite Launch

Prof. George F. Smoot

303 years ago

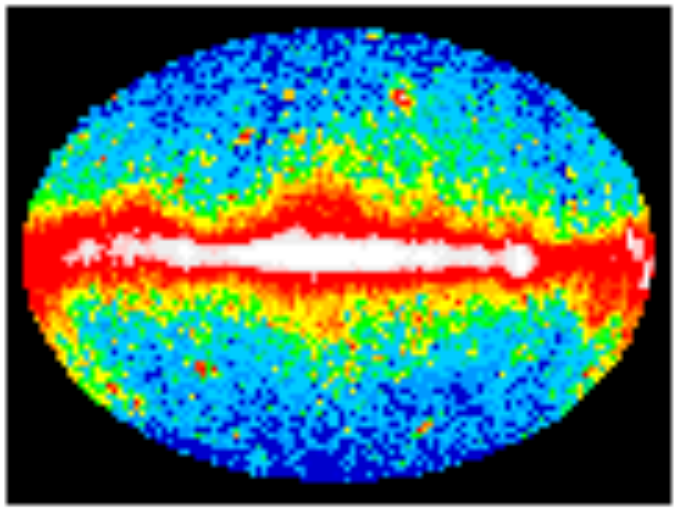


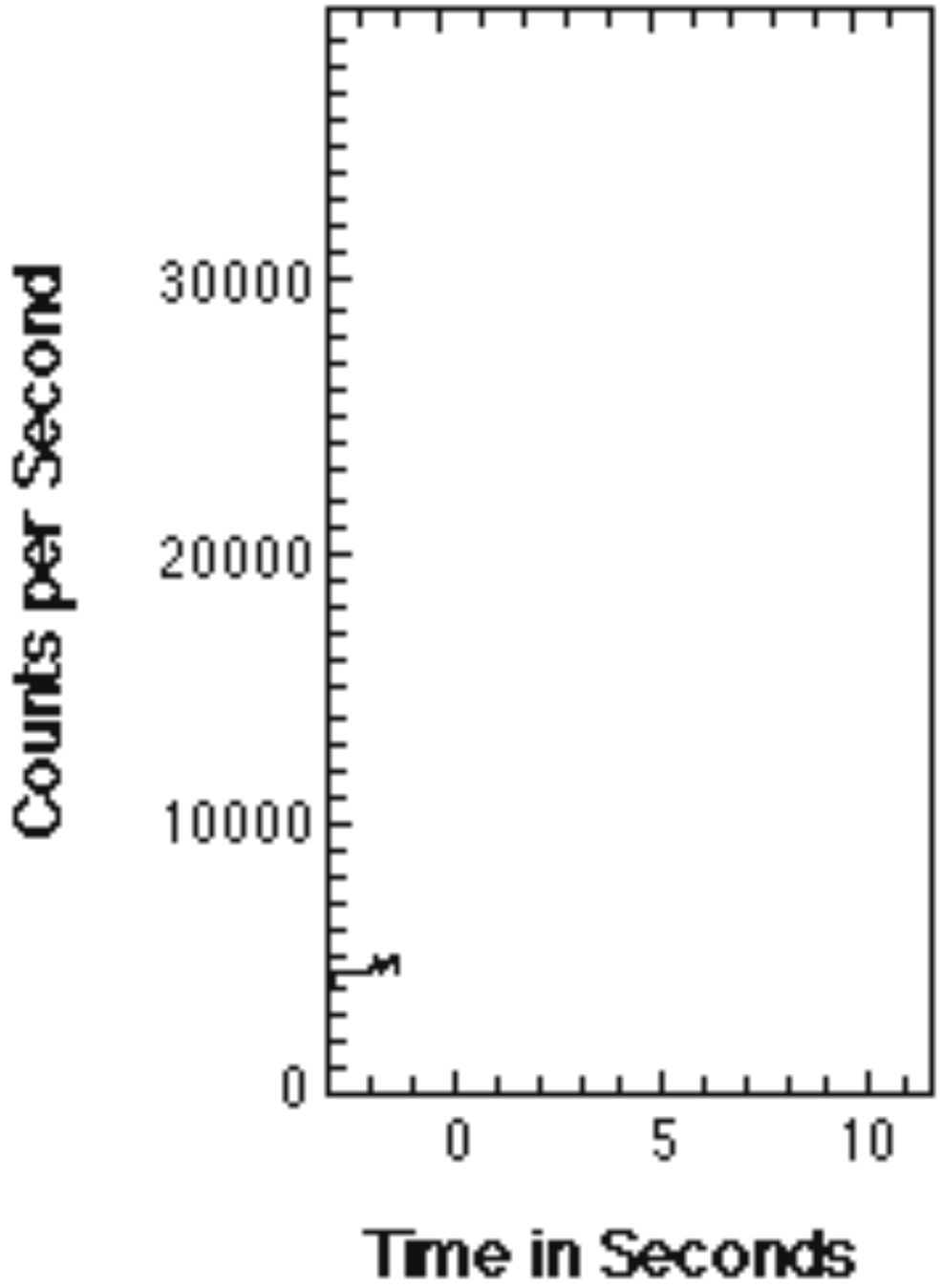
1000 km

Gamma-Ray Bursts in 1 Slide

- Most powerful events in the universe
  - Measured to z = 8.2 (GRB090423)
  - Can be seen to z~12 with large detectors

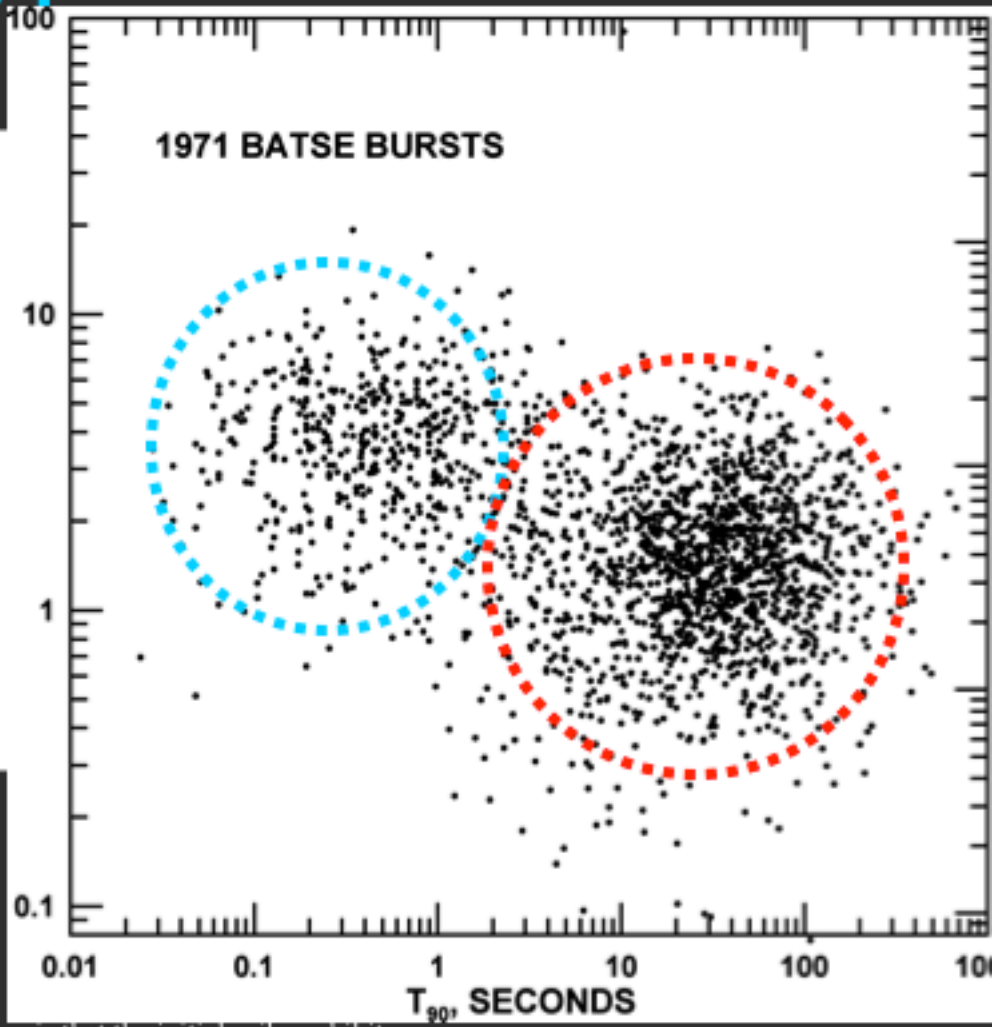
- Gamma-Ray Bursts (GRB) last msec – hr.
- Measured up to GeV (rest energy of a proton)
- Afterglow can be detected weeks after burst, has power law decay light curve in all bands for some long type GRBs
- Long Type GRB associated with massive star collapse SuperNovae




Counts per Second
30000
20000
10000
0
0
5
10
Time in Seconds

2 Main Types of GRB

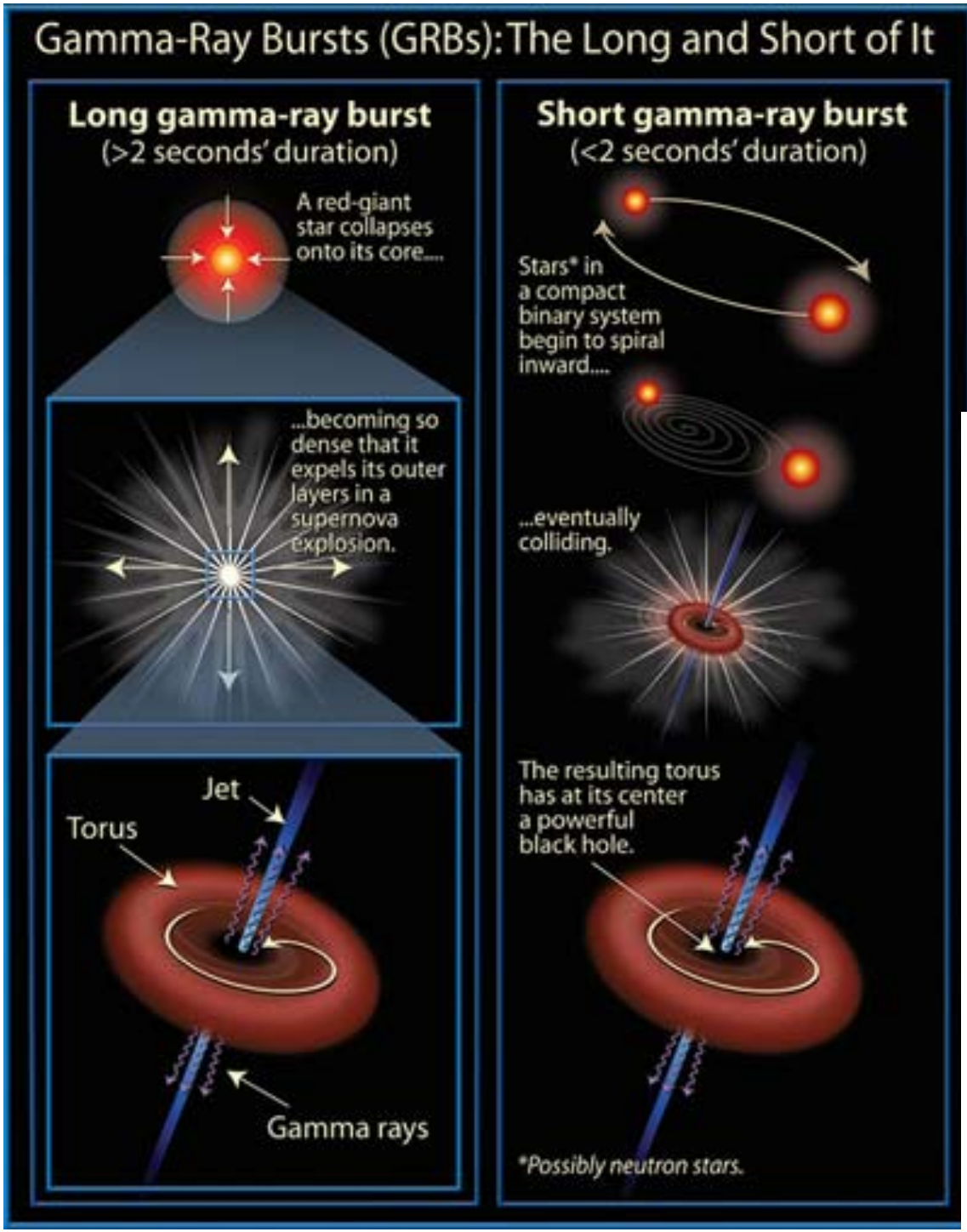
- GRB=Gamma-Ray Burst
- LGRB=Long, softer
  $t_{90\gamma}$ >2 s, Typical ~ 20 s
- SGRB = Short GRB
  $t_{90\gamma}$ < 2 s, Typical ~ 0.4 s
  - "harder" X-γ spectra,
  - much fainter all optical
  - faint X-γ afterglow
- (OTHER classifications exist)

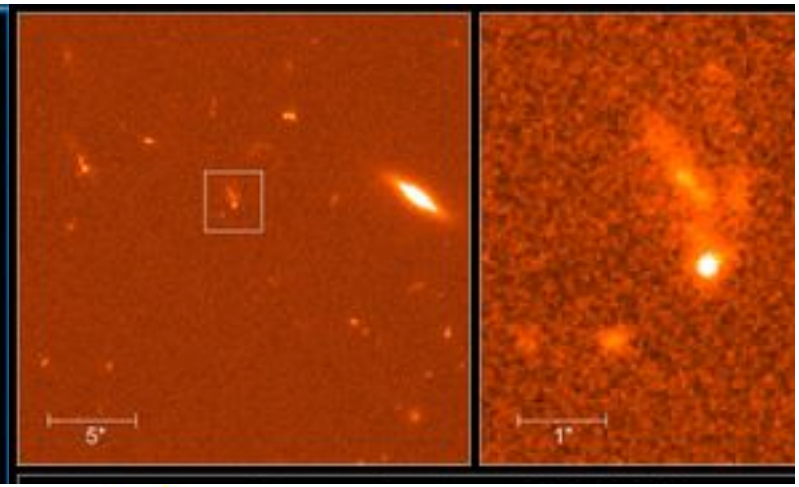


-we show that the fundamental defining characteristic of the short-burst class is that the initial spike exhibits negligible spectral evolution at energies above ~25 keV. *- Norris & Bonnell 2005

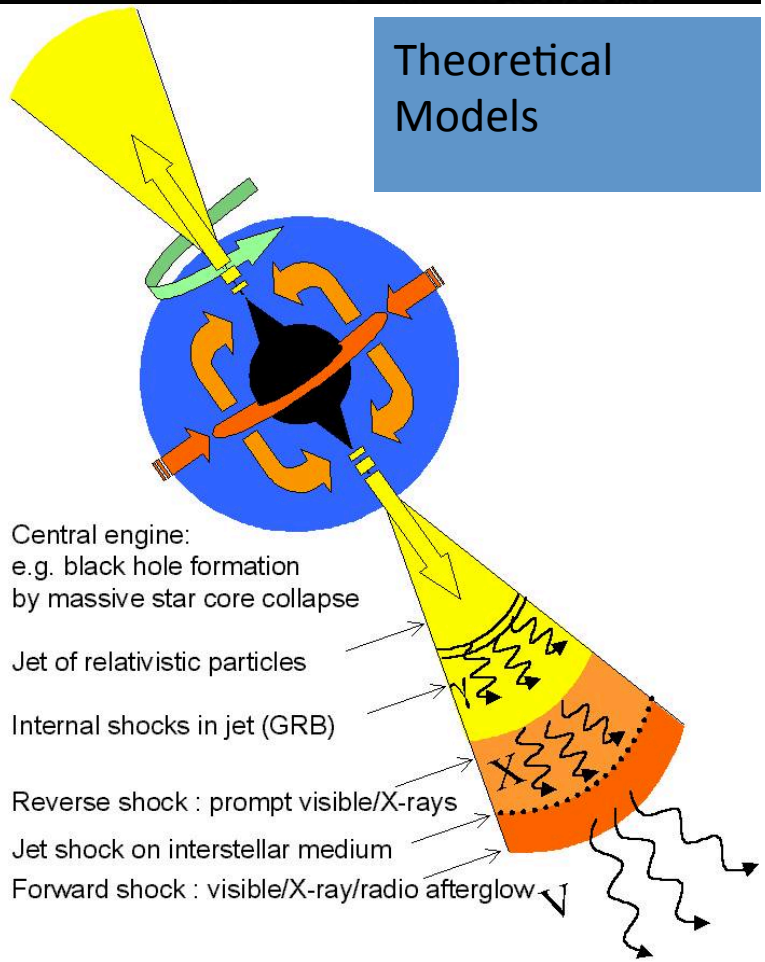
$t_{90\gamma}$ = GRB duration = interval of 90% fluence in γ light curve.

Hard = flatter spectrum = crude ratio of high, low energy channels.

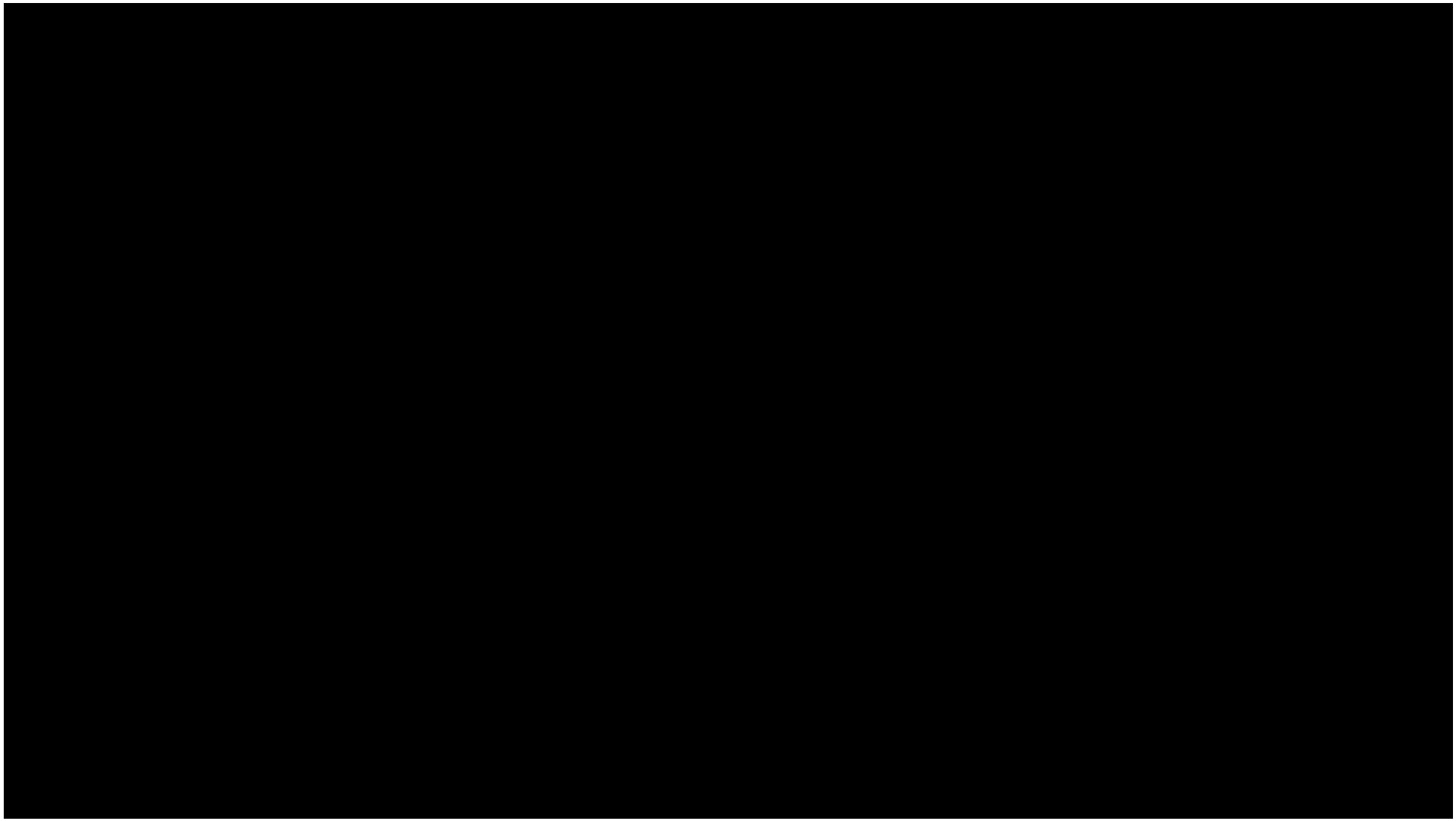




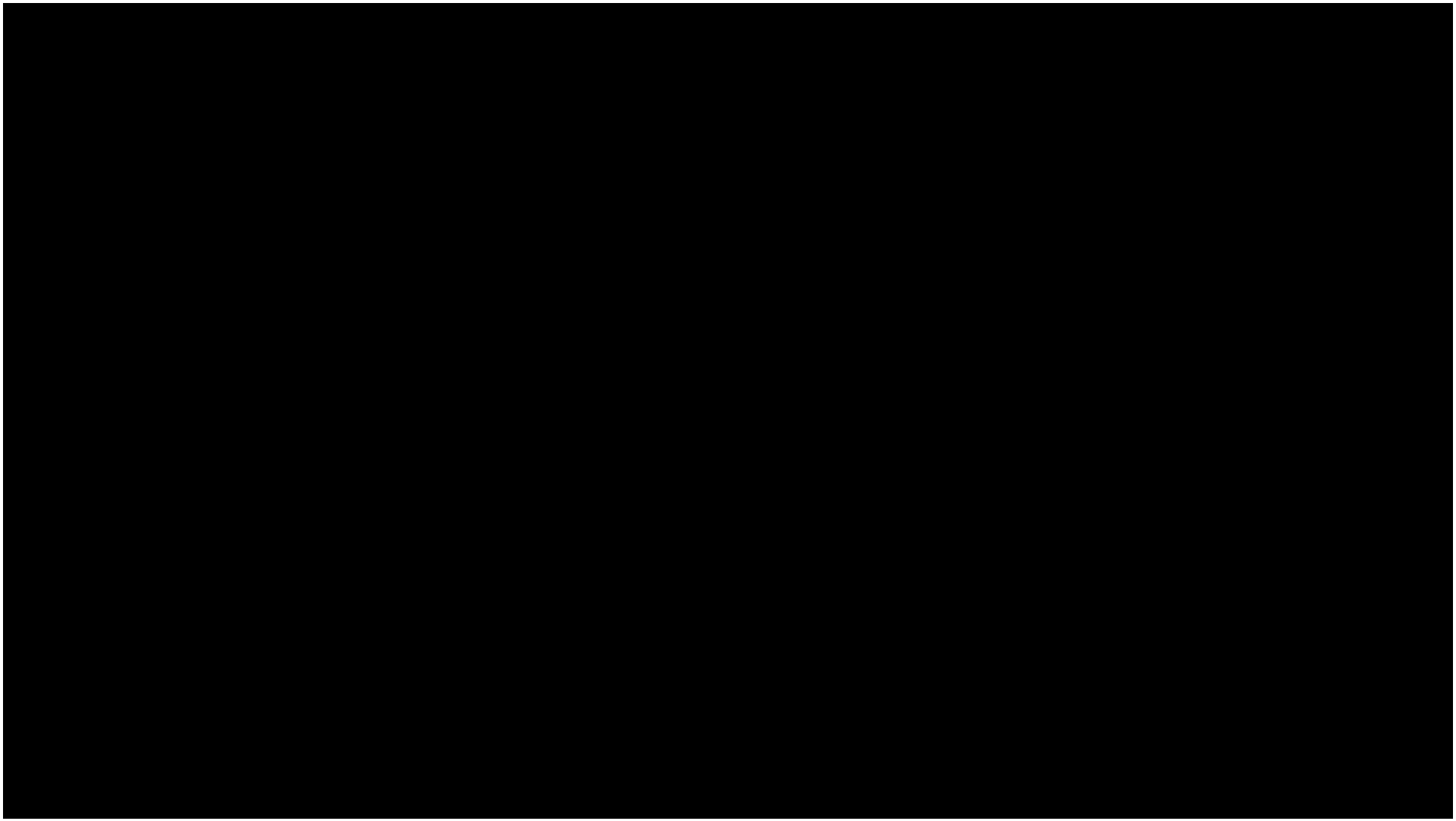
Theoretical Models



Neutron Star Inspiral Model Video



500 GRBs Observed by Swift

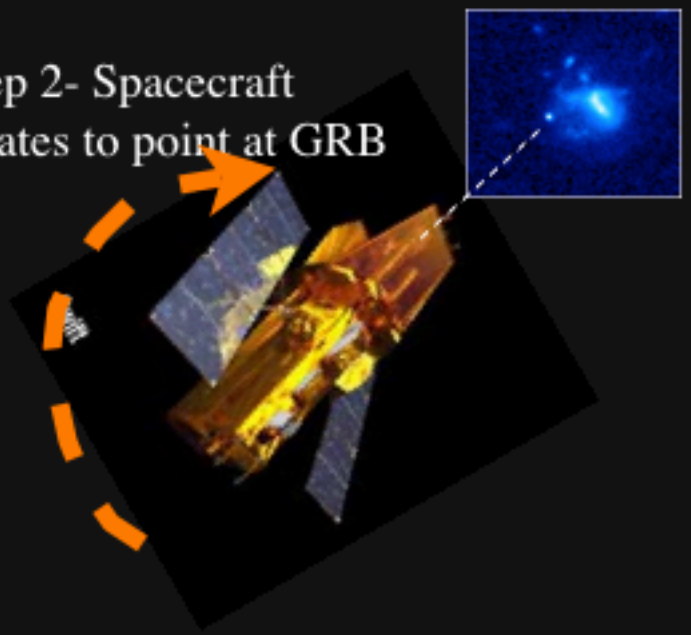


Faster-Steer the Beam

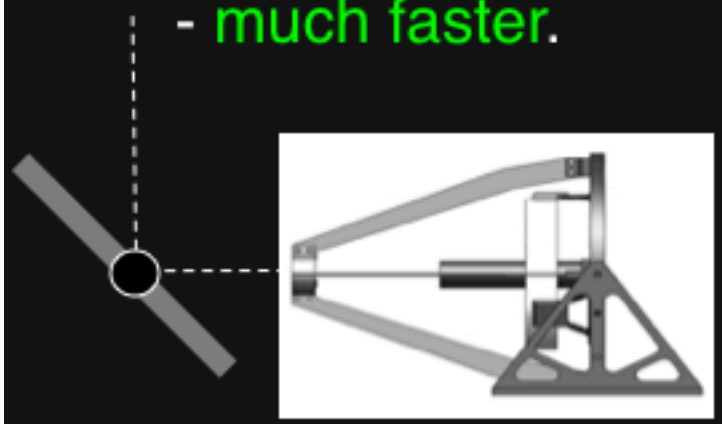
- SWIFT rotates entire spacecraft to point opt instrument

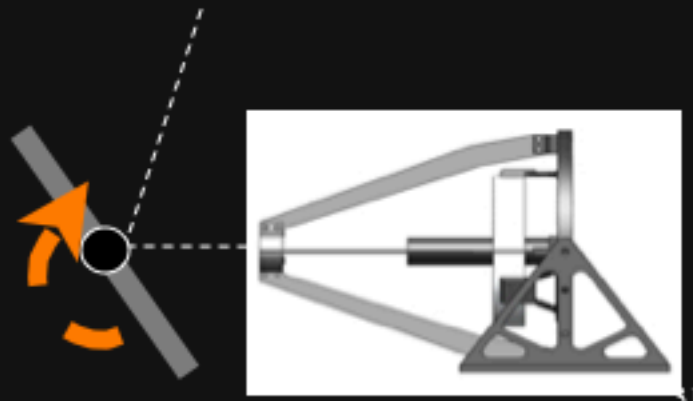
Step 1- Wide FOV X/γ-camera locates GRB

Step 2- Spacecraft rotates to point at GRB



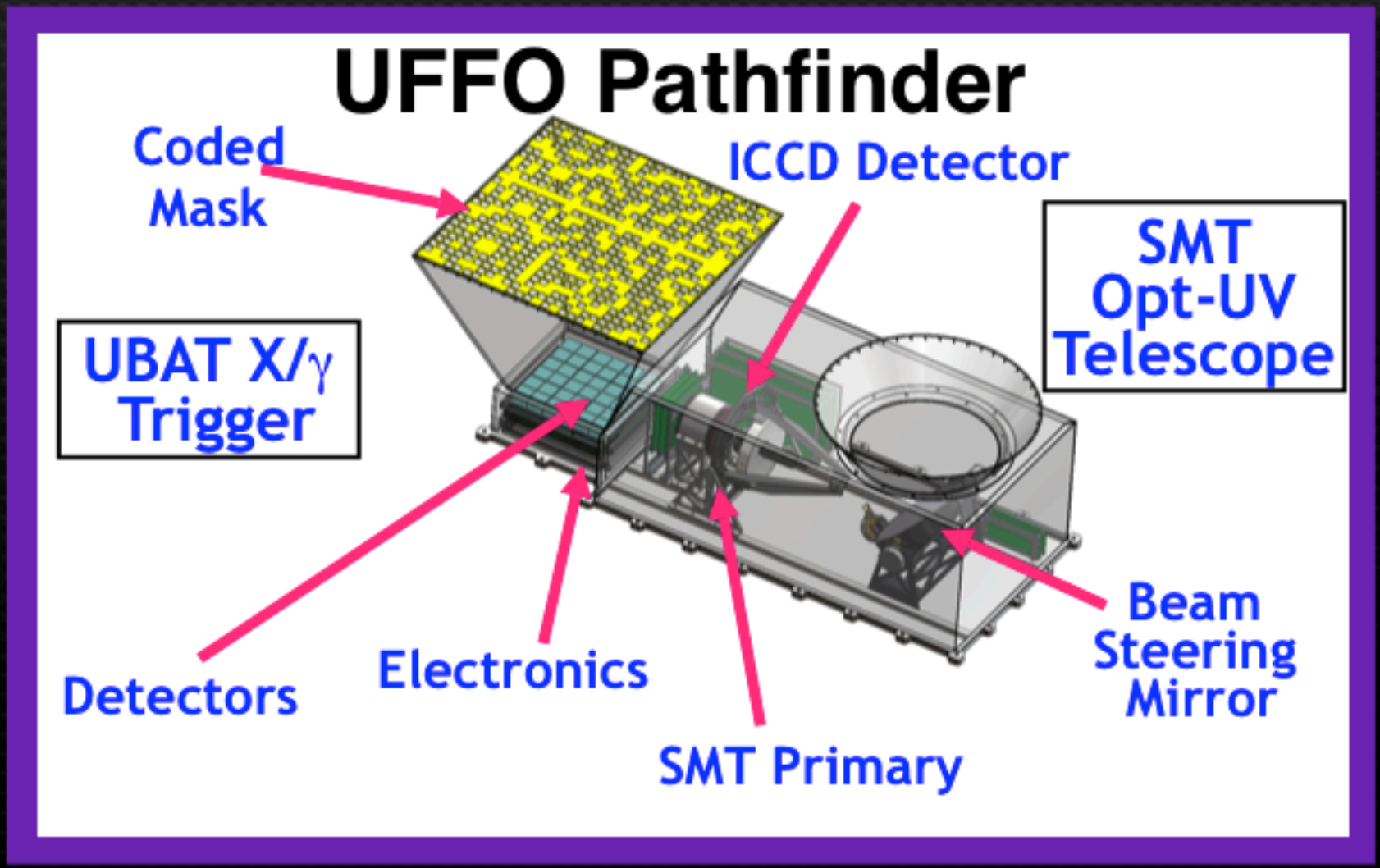
- We use mirrors to steer the *beam*, not the spacecraft - much faster.





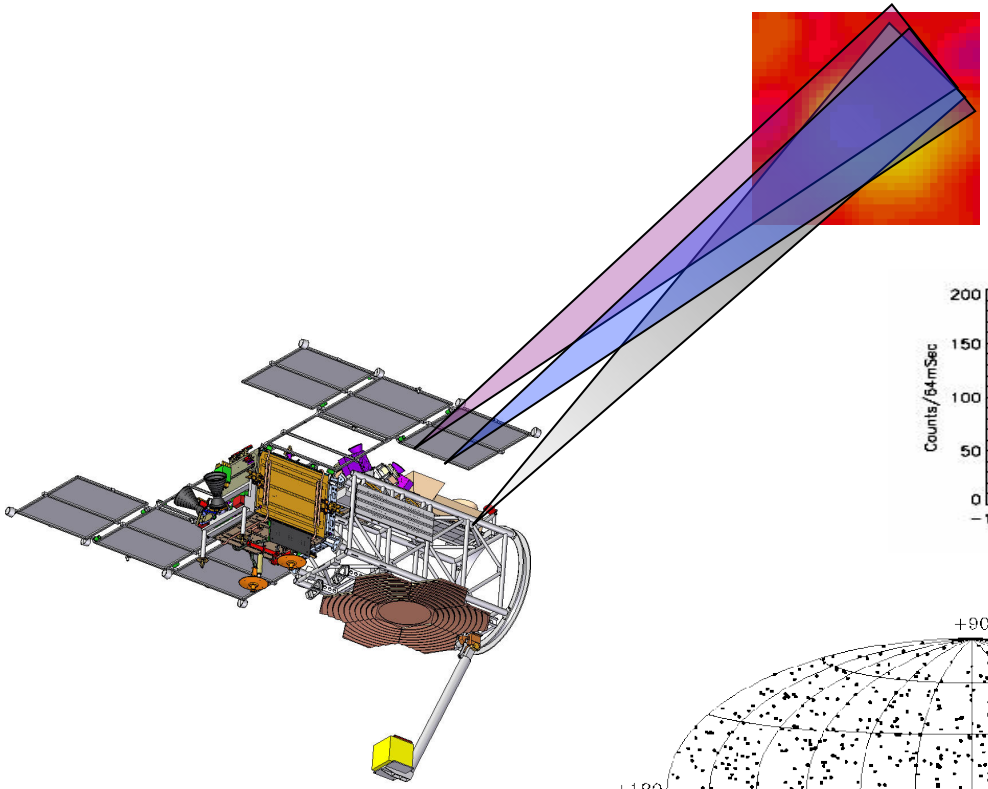
UFFO pathfinder design

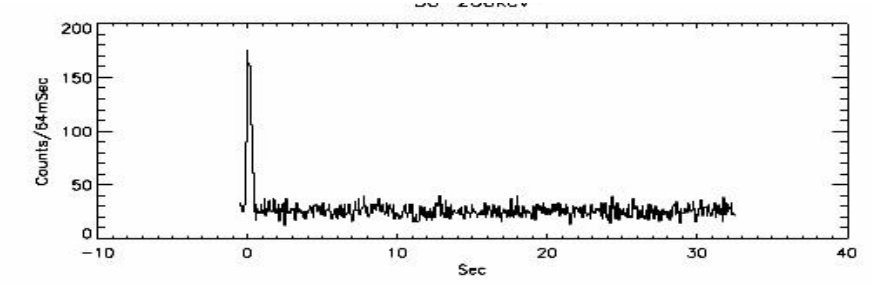
- MODEST! - 20 kg, 10 W

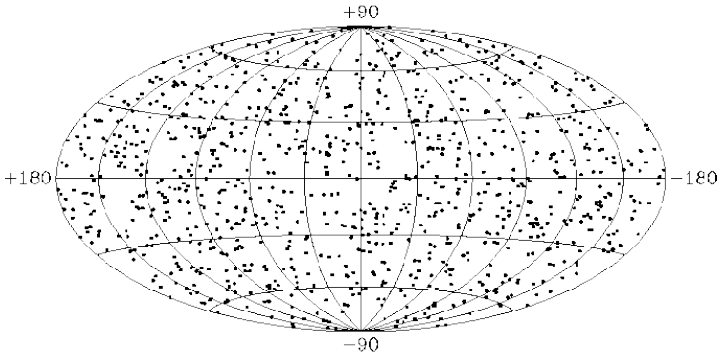


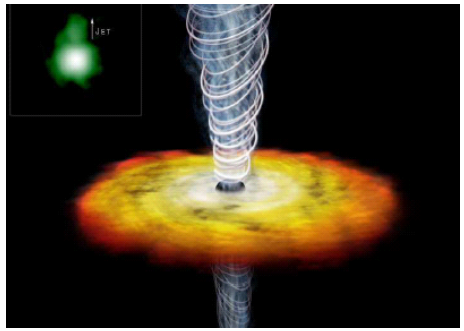
Гамма -всплески

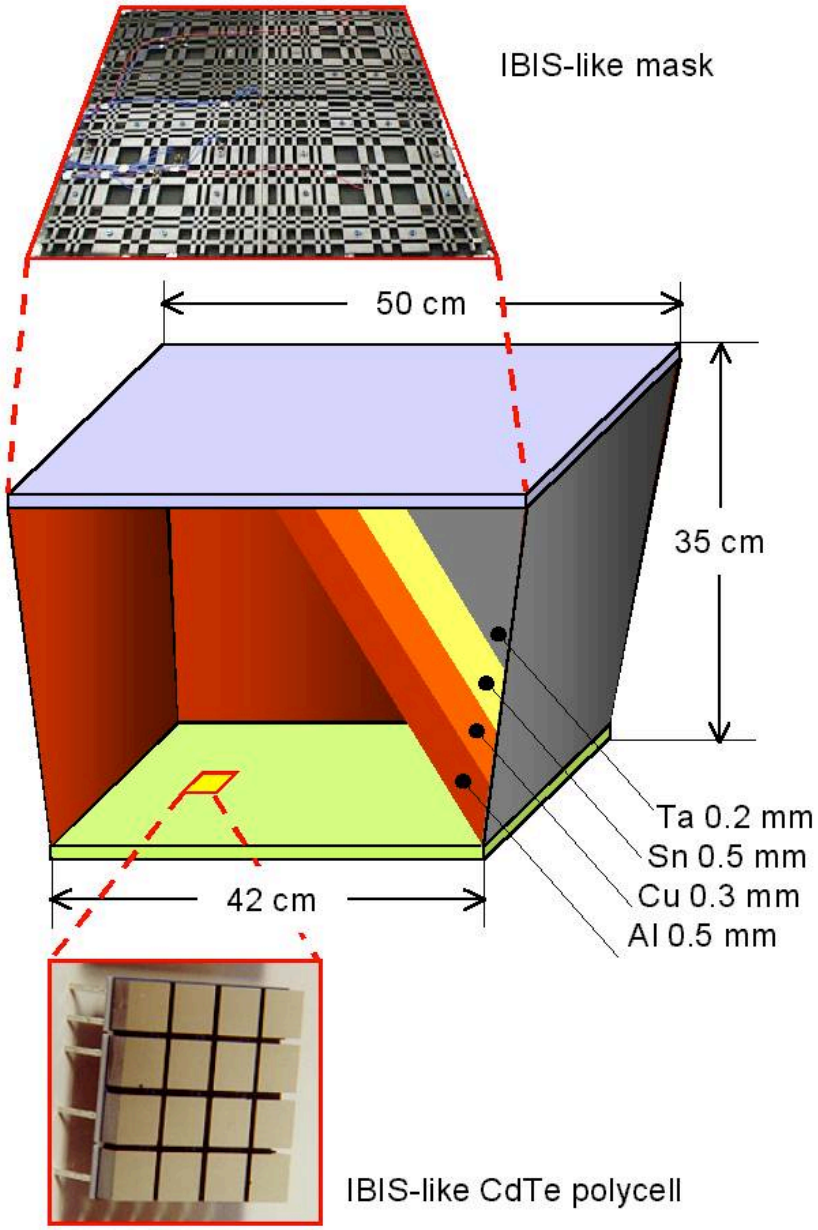
Эксперименты на «Ломоносове» обеспечат наблюдения гамма-всплесков в гамма, рентгене, Ультрафиолете и видимом свете



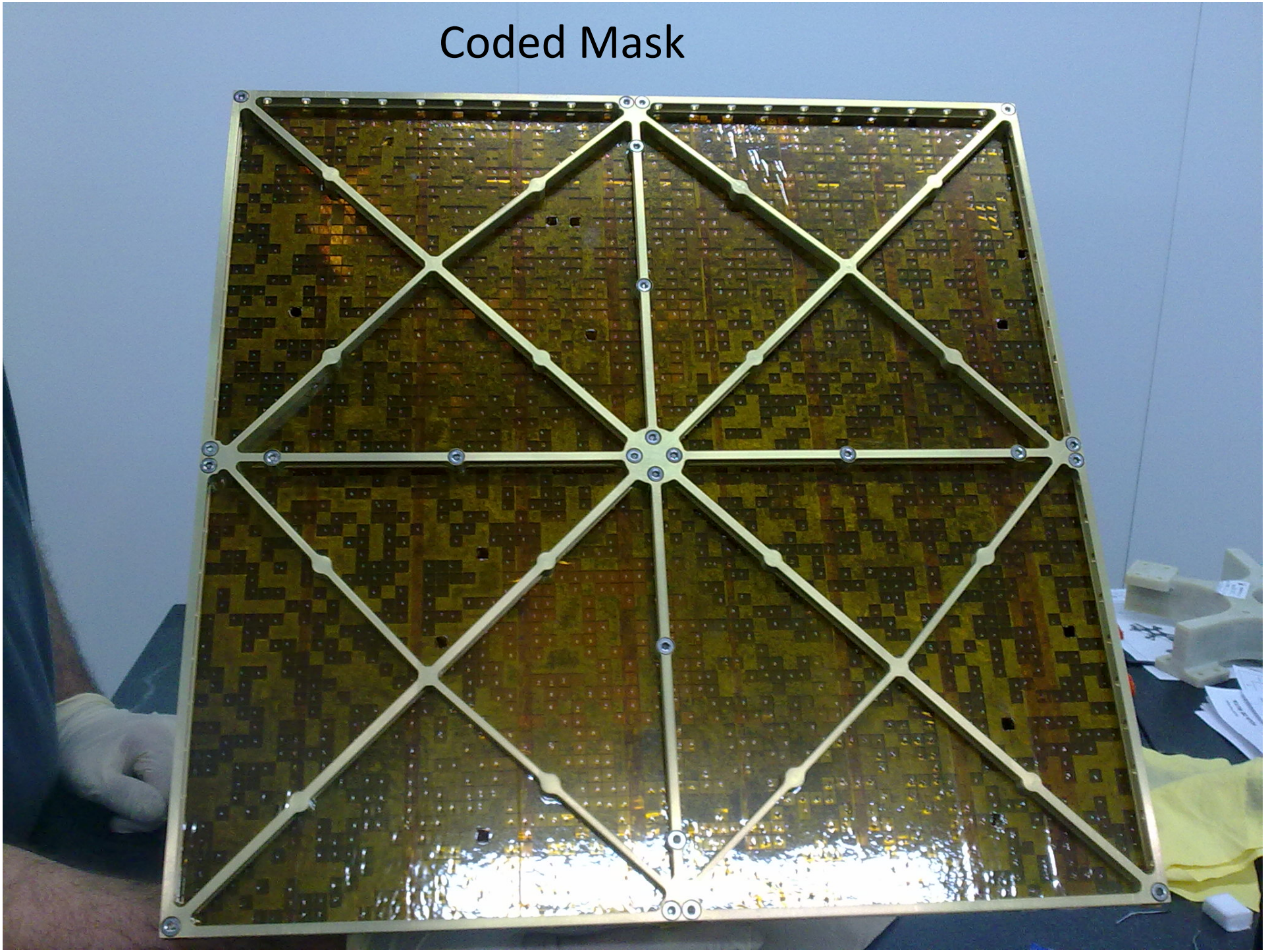




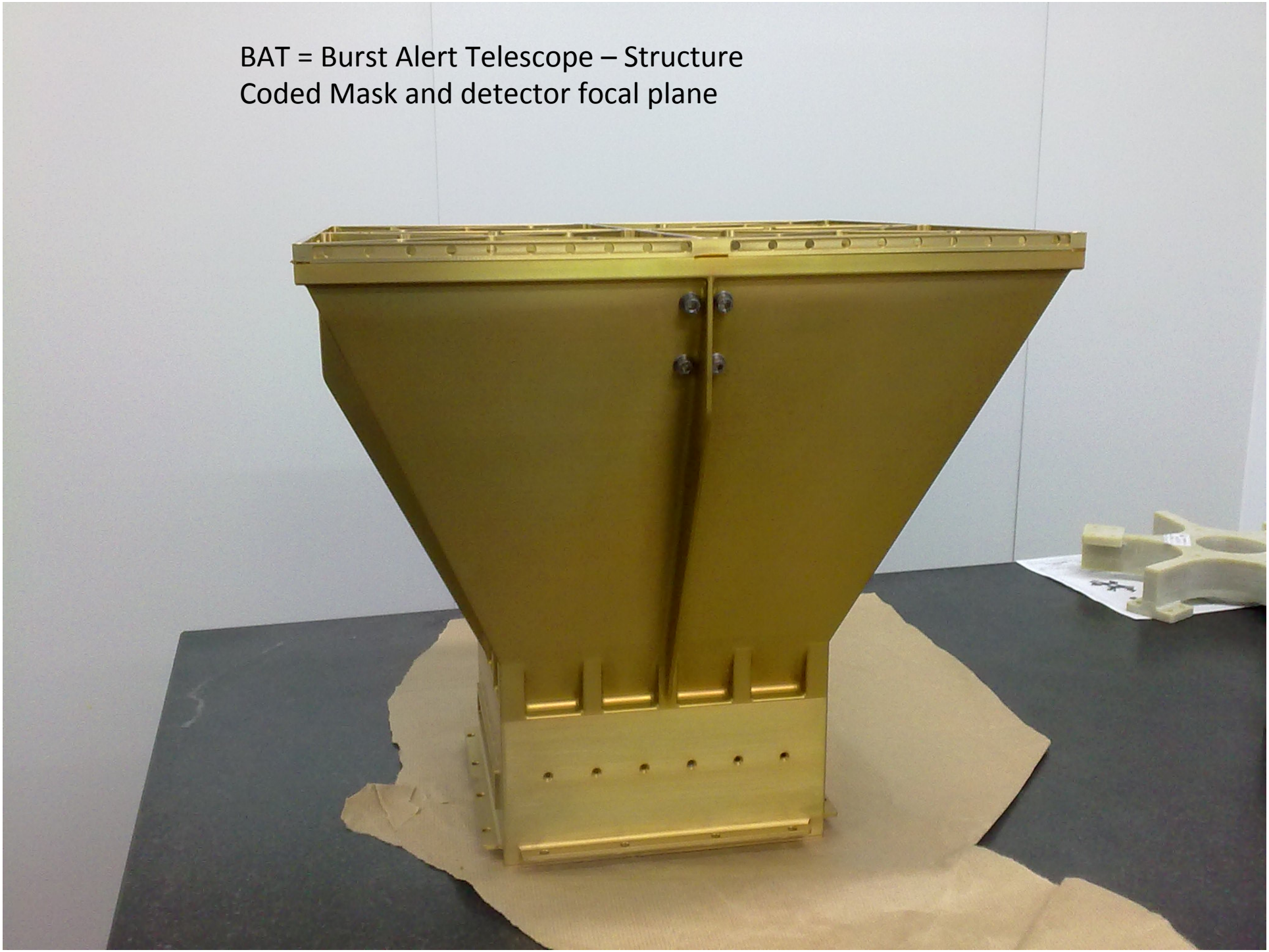


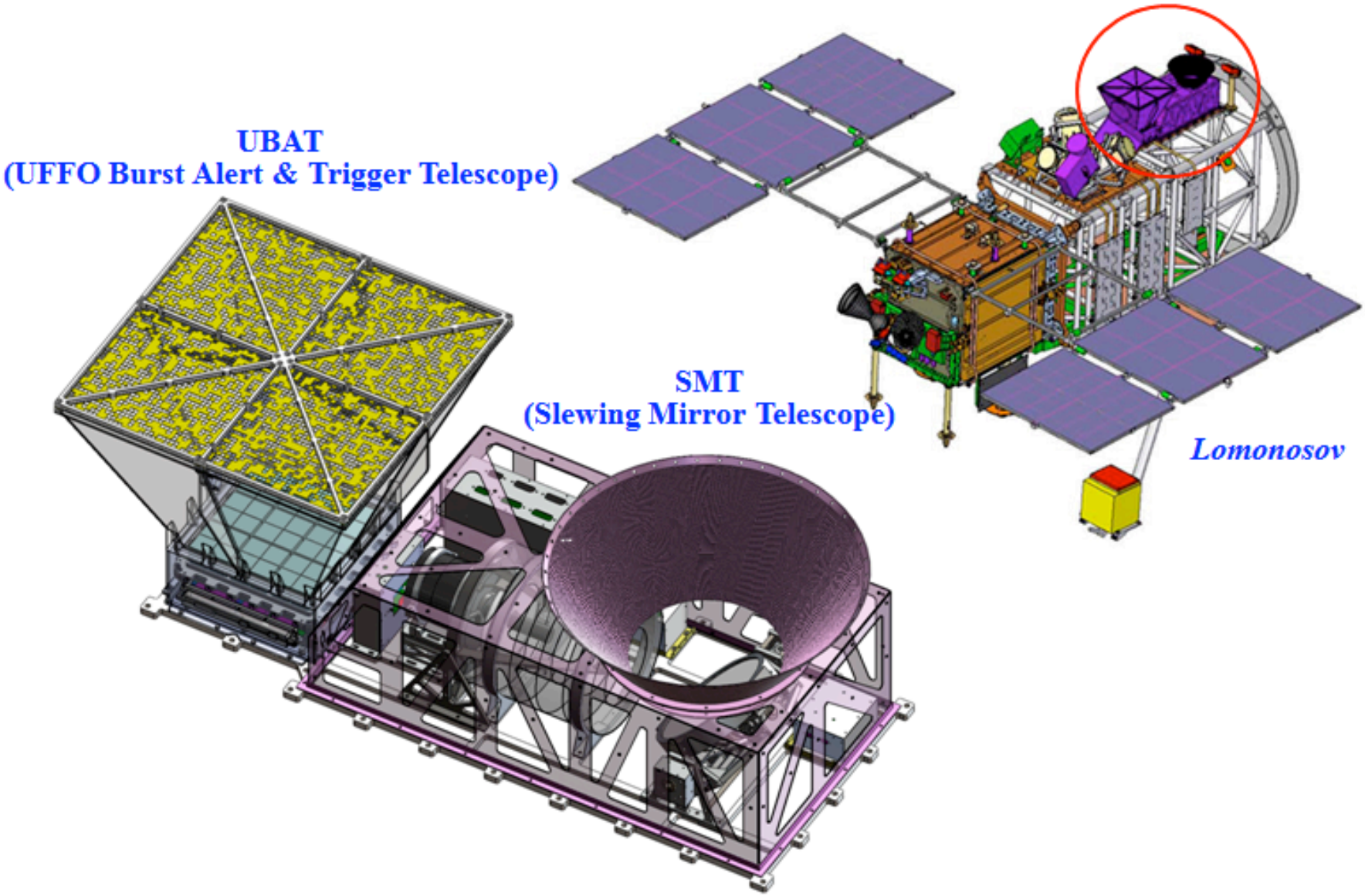

IBIS-like mask
50 cm
35 cm
Ta 0.2 mm
Sn 0.5 mm
Cu 0.3 mm
Al 0.5 mm
42 cm
IBIS-like CdTe polycell

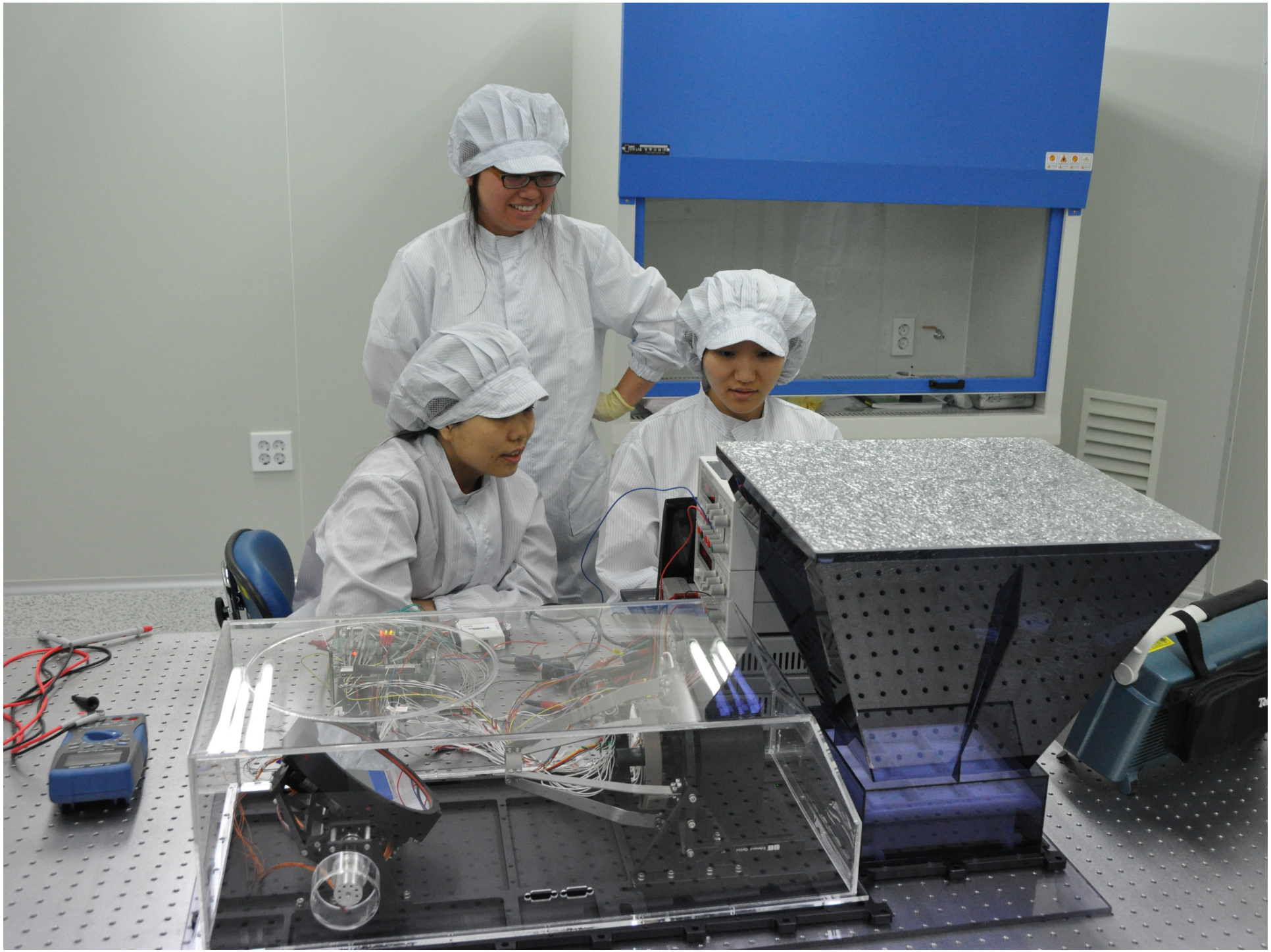
Coded Mask



BAT = Burst Alert Telescope – Structure
Coded Mask and detector focal plane



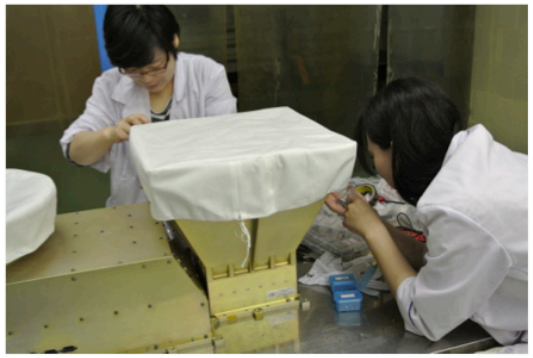

UBAT
(UFFO Burst Alert & Trigger Telescope)
SMT
(Slewing Mirror Telescope)
Lomonosov




Ultra Fast Flash Observatory
UFFO
Observation of early photons from Gamma-Ray Bursts
(한국주도 국제공동연구 프로젝트)
RCMST
ABCDEF
GHJKLM
NOPQRS
TUVXYZ
WOW!

Space Agency Assembly near Moscow

Big-MIK at ISTRA

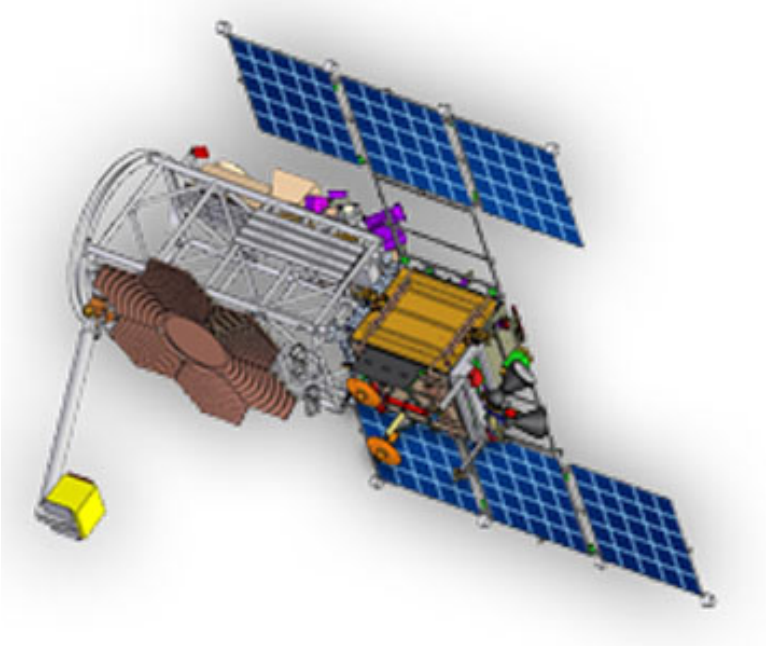


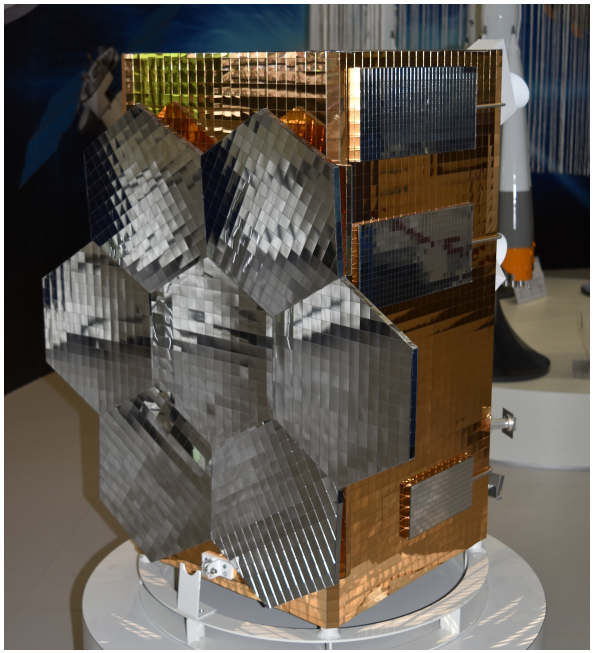
MVL-300 (Mikhailo Lomonosov)

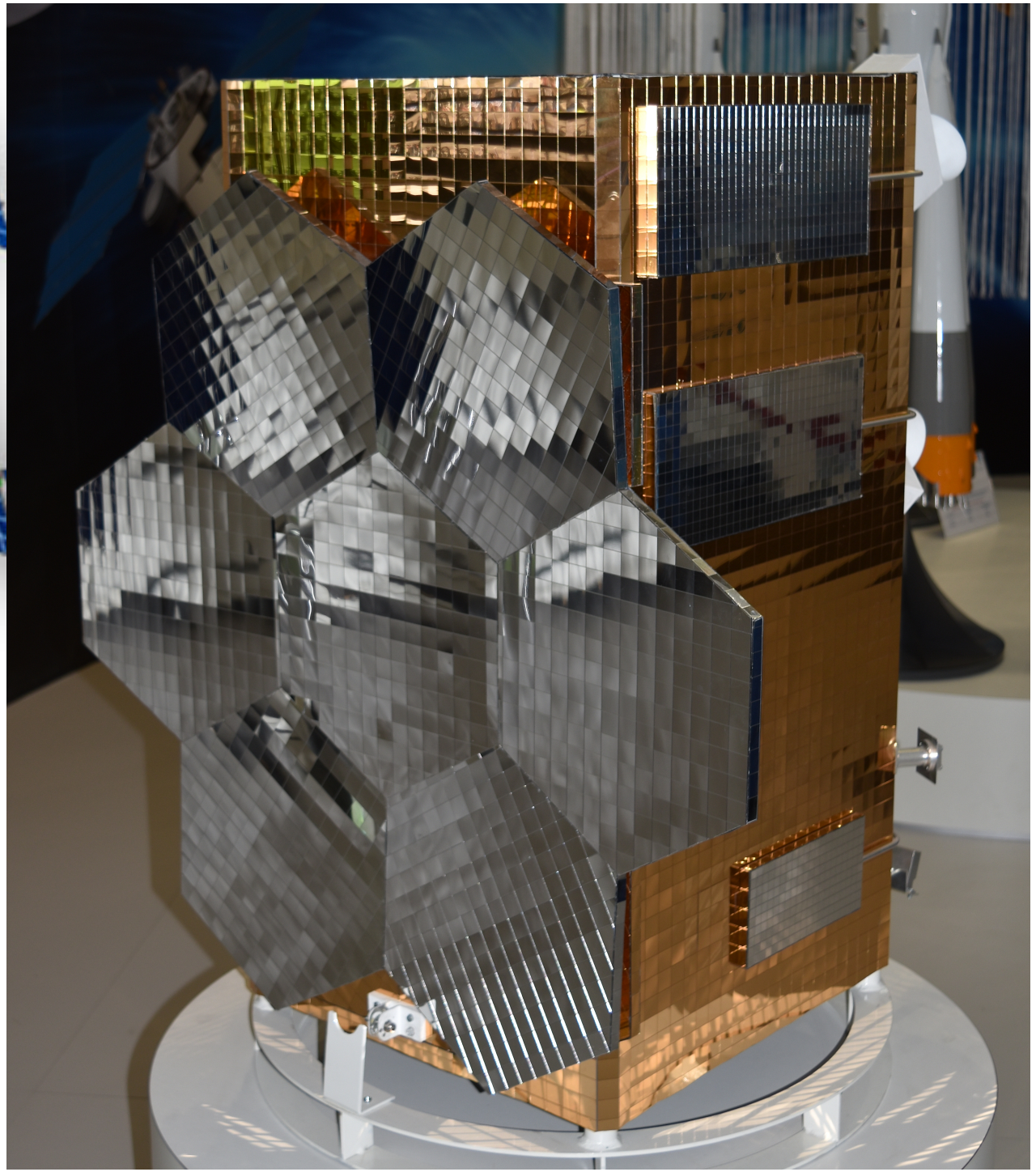
- TUS detector, which was originally planned to be a independent free flying satellite called TUS. The TUS (Tracking Ultraviolet Set Up) detector will be used for measurements of fluorescence light, radiated by EAS (Extensive Air Showers) of Ultra High Energy Cosmic Rays (UHECR) in the earth atmosphere as well as for transients' studies within UV-range.
- BDRG (Block for X-ray and gamma-radiation detection) is intended for monitoring and locating of gamma-sources at the celectial vault within the gamma-range and for the development of the trigger signal for the ShOK wide-angle optic cameras.
- UFFO, intended for the studies of gamma-bursts, is a 20 cm UV-optic telescope and X-ray camera.
- ShOK (Optic cameras of super-wide field of vision) consists of two stationary fast wide-angle cameras. Their field of vision is situated within the area of gamma-bursts' detection of other instrumentation onboard the satellite.
- DEPRON (Dosimeter of Electrons, PROtons and Neutrons) is intended for the measurements of the absorbed doses and linear energy transfer spectra from high-energy electrons, protons and nuclei of space radiation, and for detecting of thermal and slow neutrons flux.
- ELFIN-L (Electron Loss and Fields Investigator for Lomonosov) instrument is a joint project of The Institute of Geophysics and Planetary Physics at the University of California Los Angeles (IGPP/UCLA) and Skobeltsyn Institute of Nuclear Physics of the Lomonosov Moscow State University. It consist of a Flux Gate Magnetometer (FGM), an Energetic Particle Detector for Electrons (EPDE), and an Energetic Proton Detector for Ions (EPDI), the same as used on the ELFIN CubeSat.
- The IMISS-1 device has the purpose to test the performance quality of microelectro-mechanical inertial measuring modules in space. The possibility of using of this device in order to solve the problems of personal spatial orientation correction under extreme conditions, in particular, in an automatic gaze stabilization corrector, will be also studied.

MVL-300 (Mikhailo Lomonosov) Satellite

Instrument	Sous composant	Description	Objectif	Masse	Consommation électrique
TUS		Télescope ultraviolet	Détection fluorescence liée aux rayons cosmiques à haute énergie	60 kg	60 watts
BDRG		Détecteur gamma	Détection et localisation des sursauts gamma	7 kg	7,5 watts
UFFO	UBAT	détecteur rayons X	Détection des sursauts gamma	10 kg	10 watts
	SMT	Télescope ultraviolet	Détection des sursauts gamma	10,5 kg	10 watts
ShOK		2 caméras optiques grand angle	Observation manifestation optique des sursauts gamma	?	?
DEPRON		Compteurs neutrons, protons et électrons	Étude des particules de la magnétosphère et de l'environnement raidatif	3 kg	?
ELFIN-L		Compteurs particules et magnétomètre	Étude des particules de la magnétosphère et de l'environnement raidatif	2 kg	?

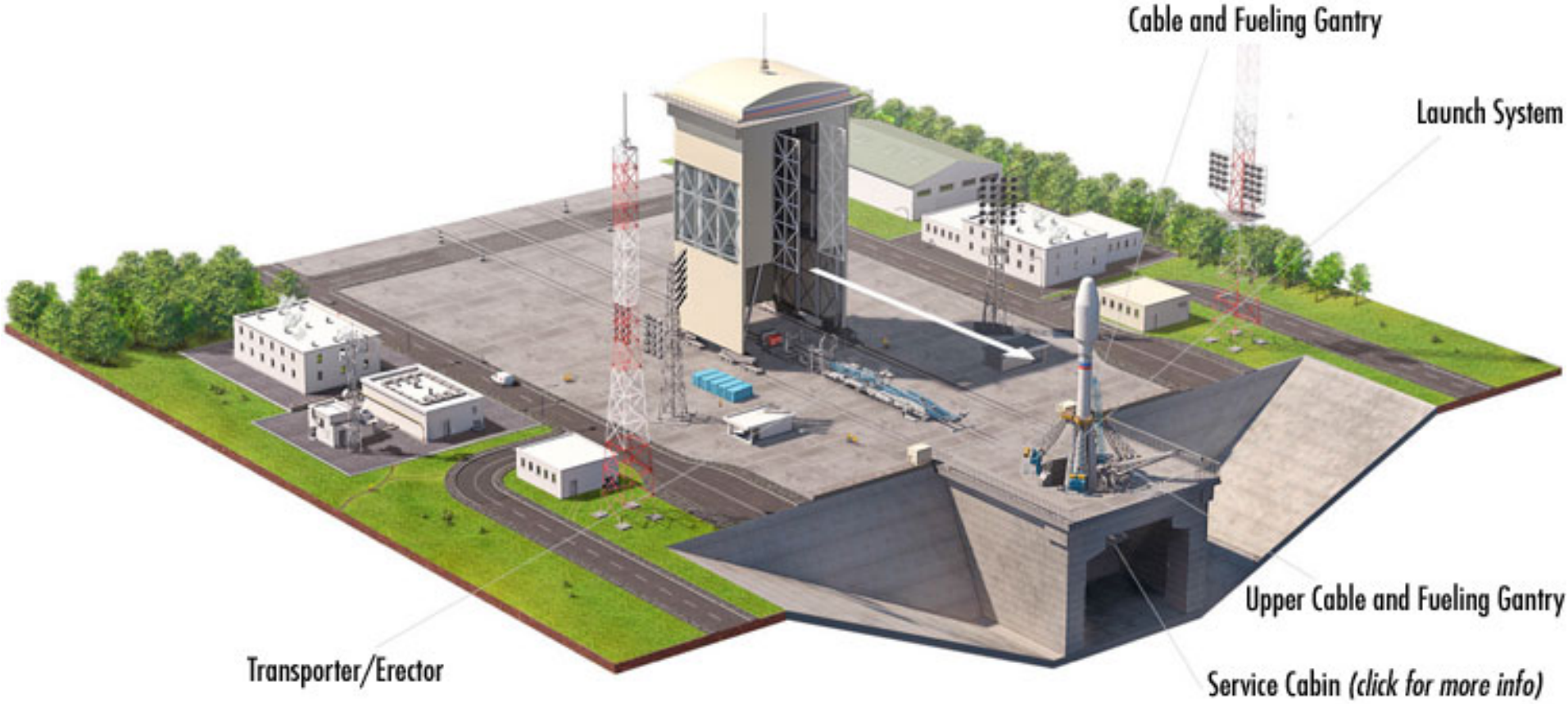






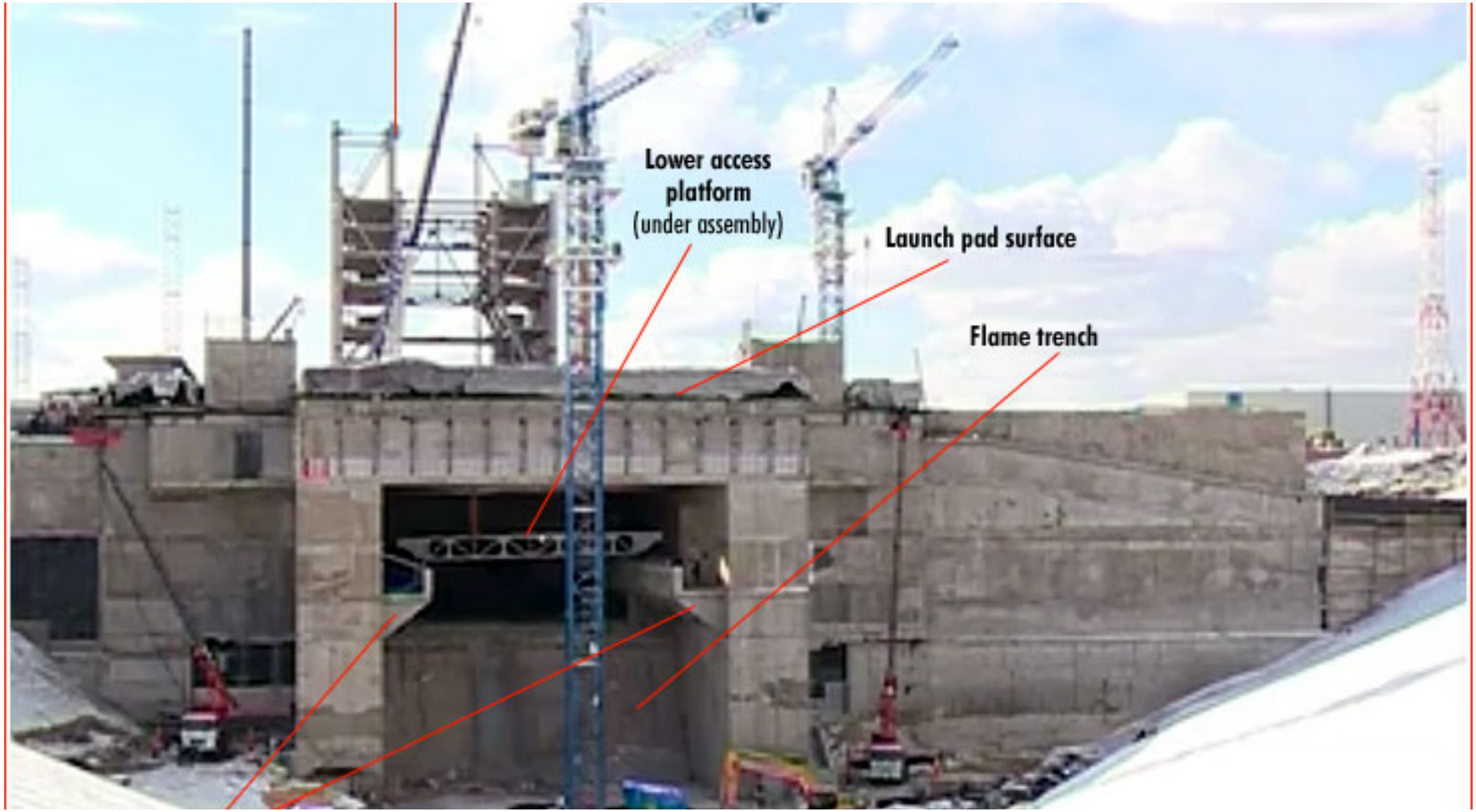
1st Launch Vostochny Cosmodrome

Rollout Launch Pad



Launch Pad, Tower and Protective Tower

Satellite Image of Launch Pad


Lower access platform (under assembly)
Launch pad surface
Flame trench

Launch Pad in November 2015

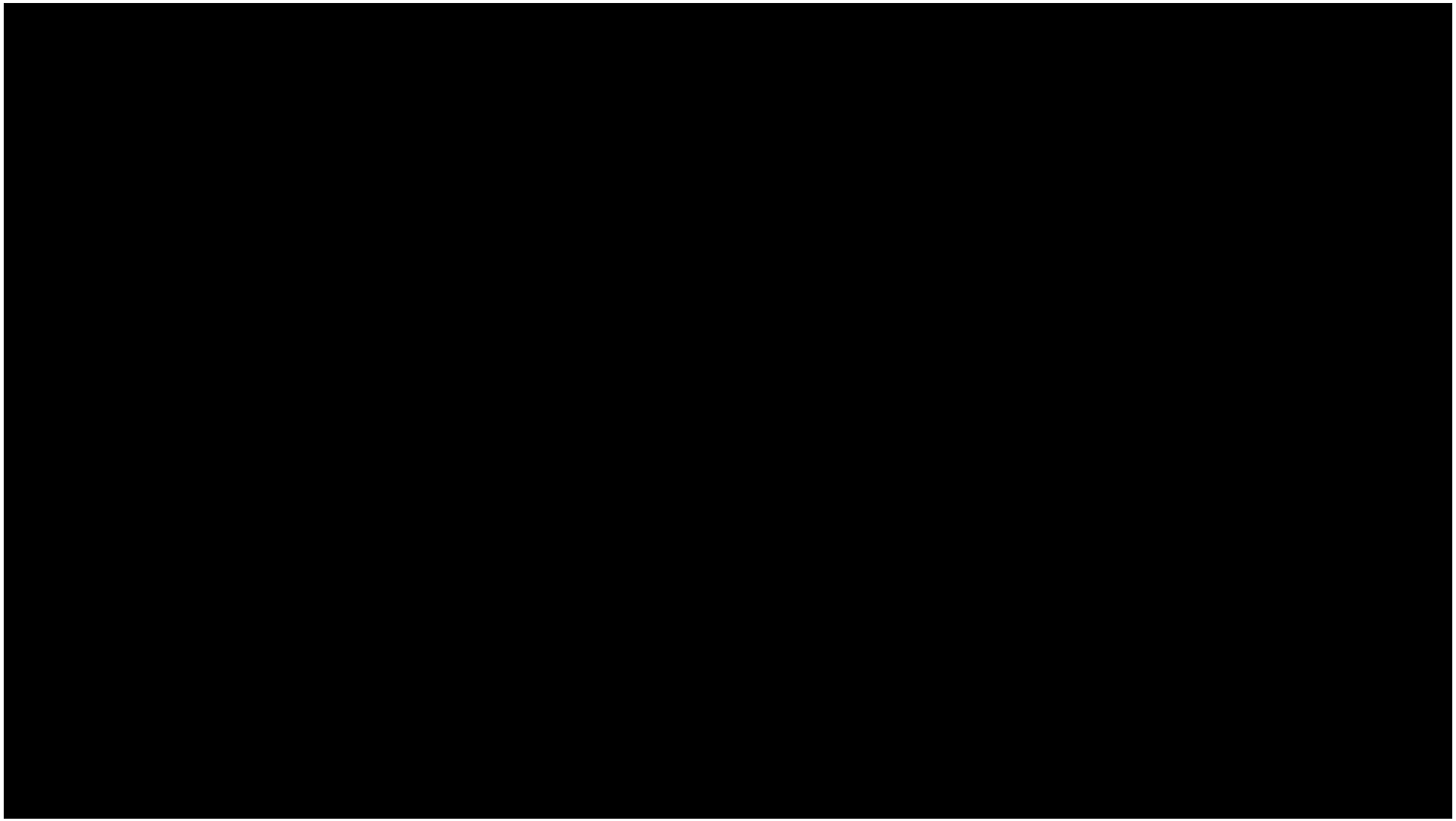
Putin Visits the Cosmodrome

VOSTOCHNY READY FOR FIRST LAUNCH AND FOR THE LONG HOLIDAYS

- It seems that Vostochny Cosmodrome will be fully operational not in 2016 but in 2017 or even 2018. First launch from this most modern Russian Cosmodrome will be performed on April 27th 2016. It will be Soyuz-2.1a with research Satellite MVL-300 “Mikhail Lomonosov”.
- Assembling of the rocket was started in Vostochny on 20 January 2016 and first dry roll-out of the rocket was performed on March 21 2016. There was no problem during roll out and everything gone as it was planned – according to Igor Komarov, chief of Roscosmos:

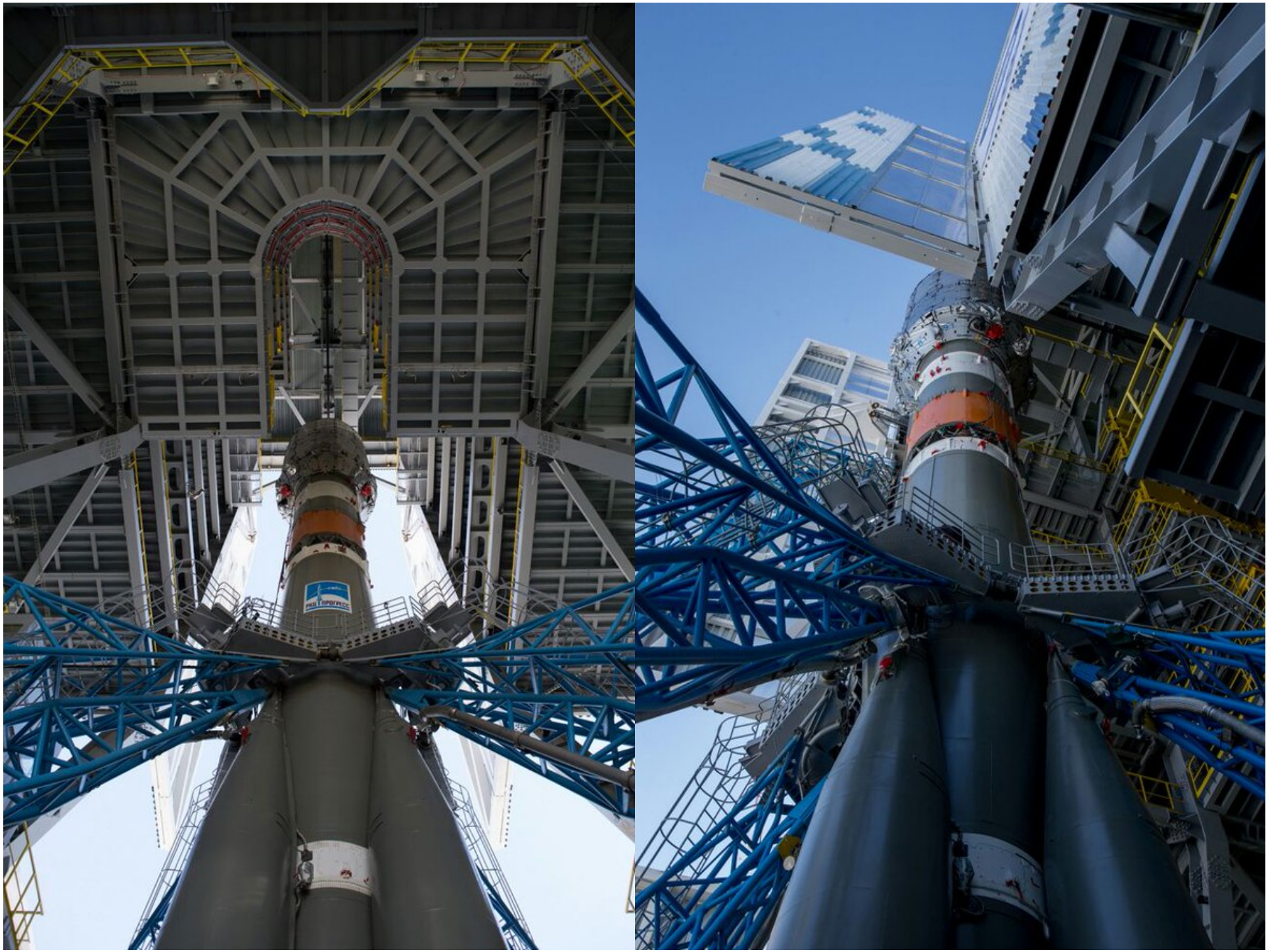

Roskosmos

Drone footage of Vostochny Cosmodrone




Roskosmos

Set up on Launch Pad

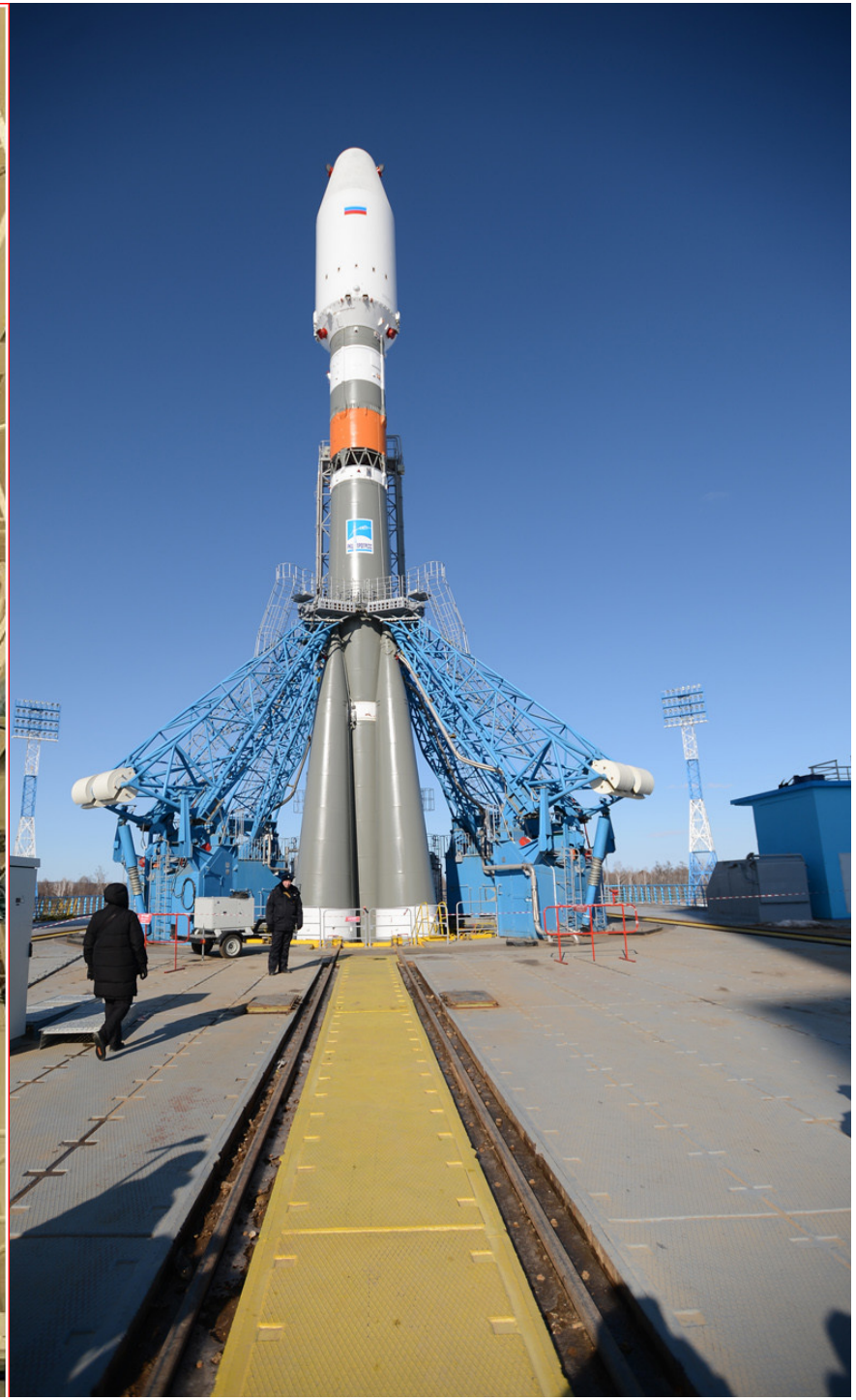



ГАГАРИН.55
РОСКОСМОС
ВОСТОЧНЫЙ


Roskosmos

Time Lapse of Launch Preparations

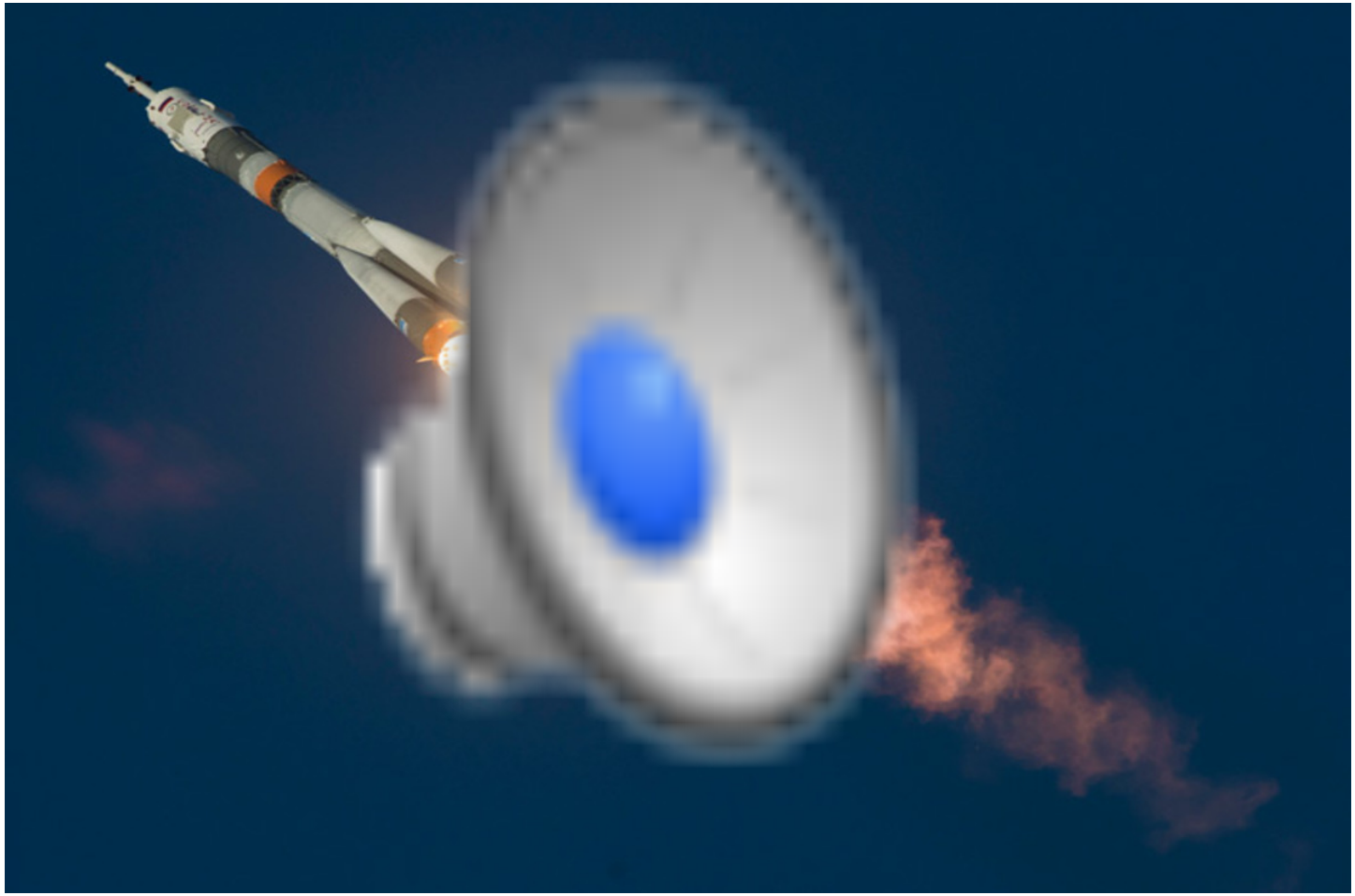
Vertical Assembly for Launch

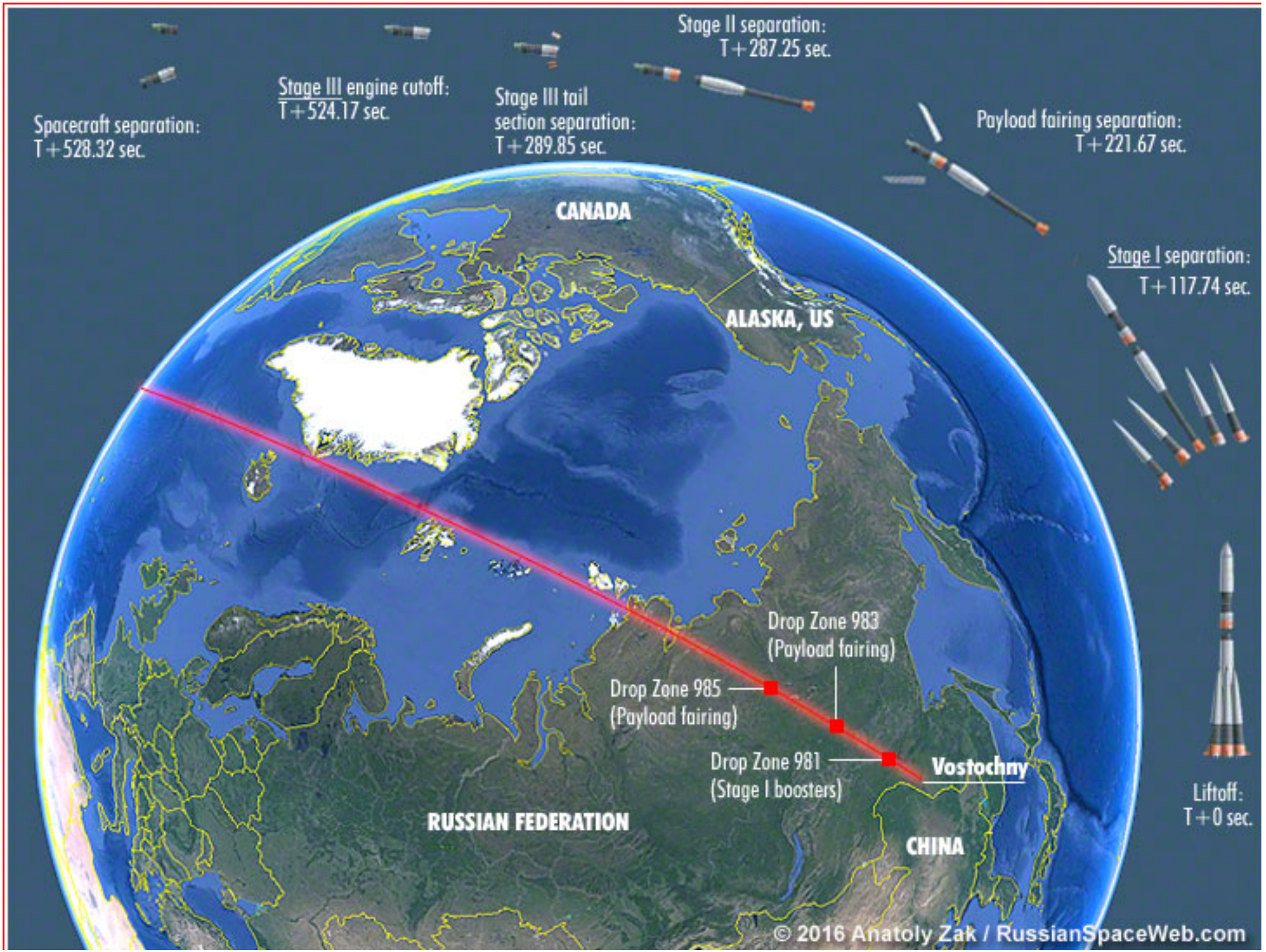


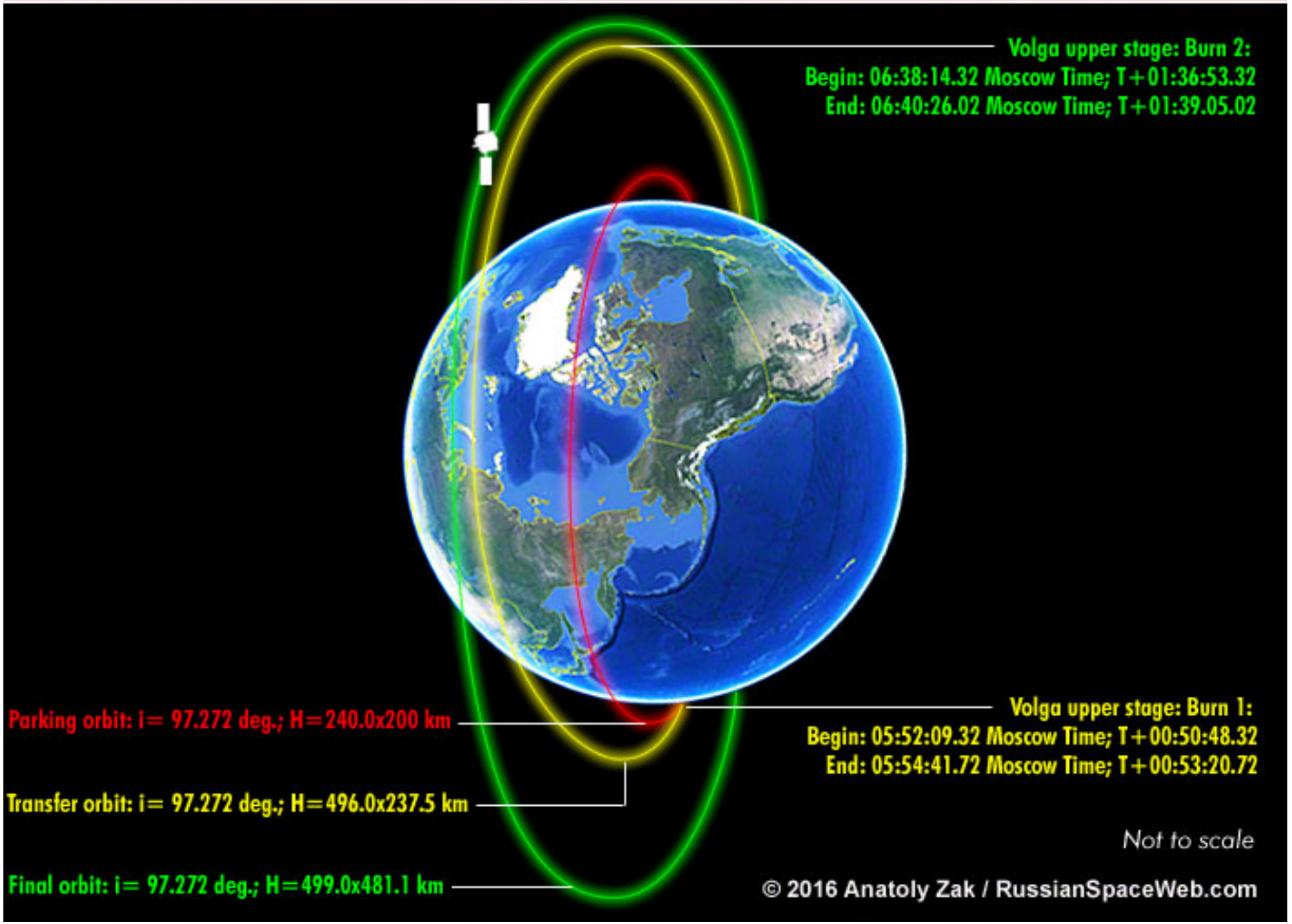
Lomonosov Spacecraft at VNIIEM (Moscow)

Lomonosov Launch & Back Story

Soyuz Launch of Lomonosov Satellite




Stage II separation:
T+287.25 sec.
Stage III engine cutoff:
T+524.17 sec.
Stage III tail
section separation:
T+289.85 sec.
Spacecraft separation:
T+528.32 sec.
Payload fairing separation:
T+221.67 sec.
Stage I separation:
T+117.74 sec.
CANADA
ALASKA, US
Drop Zone 983
(Payload fairing)
Drop Zone 985
(Payload fairing)
Drop Zone 981
(Stage I boosters)
Vostochny
RUSSIAN FEDERATION
CHINA
Liftoff:
T+0 sec.
© 2016 Anatoly Zak / RussianSpaceWeb.com


Volga upper stage: Burn 2:
Begin: 06:38:14.32 Moscow Time; T+01:36:53.32
End: 06:40:26.02 Moscow Time; T+01:39.05.02
Parking orbit: i= 97.272 deg.; H=240.0x200 km
Transfer orbit: i= 97.272 deg.; H=496.0x237.5 km
Final orbit: i= 97.272 deg.; H=499.0x481.1 km
Volga upper stage: Burn 1:
Begin: 05:52:09.32 Moscow Time; T+00:50:48.32
End: 05:54:41.72 Moscow Time; T+00:53:20.72
Not to scale
© 2016 Anatoly Zak / RussianSpaceWeb.com

Launch Results/Status 7 May 2016

- Now one of three satellites carried into space on the unmanned flight appears to be doomed.
- Fragmentary signals were received from the SamSat-218D Nanosatellite, but it appears inoperable.
- 'The spectrum contains specific bands, which indicate that the satellite is serviceable, but its signal is practically inaudible amidst the noise, which may prove that its antenna has failed to unfold,' said a source.
- Initial signals received from the jinxed satellite later stopped.
- Two other satellites - the Lomonosov and Aist-2D - are reported functioning normally.
- The antennas and solar panels on the Mikhailo Lomonosov satellite had deployed and it had began sending telemetry and was maintaining proper orientation.
- On May 6, 2016, Roskosmos announced that testing of scientific instruments onboard Lomonosov was to begin after the completion of ongoing checks of the satellite's service module. According to the agency, all systems onboard Lomonosov were operating as scheduled.

Status 11 May 2016

- Hosted the first session of the transmission of scientific data from the satellite "Lomonosov".
- Preliminary data analysis showed that the inclusion of in-orbit scientific equipment MSU in the composition of the devices "IMISS" and "Depron" was successful, and confirmed their absolute serviceability and performance.
- Today waiting for the inclusion of BDRG.

Status Today: May 24th, 2016

- ?
- I hoped to tell that all the instruments are on and working but have not gotten the information yet.
- At this time 6 devices are on and operating: DEPRON, IMISS-1, ShOK, BDRG, ELFIN-L. All devices work well!
- Only one not tried is UFFO. Plan to include it in the next week.

10 June 2016

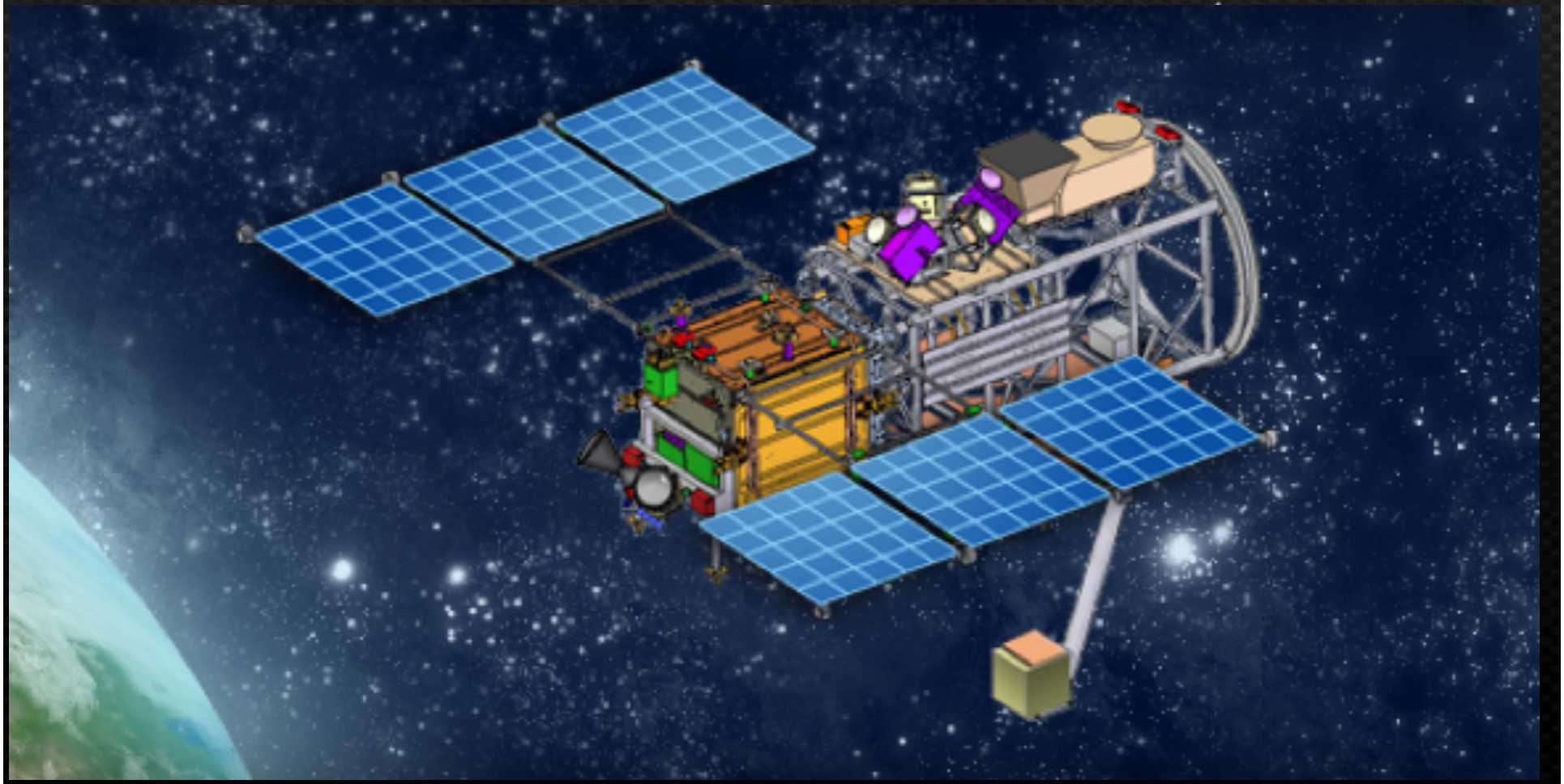
- UFFO instruments each have been included.
- Now comes the testing process.
- UFFO works. It gives service information.
- The scientific data is not yet.

Status 22 July 2016

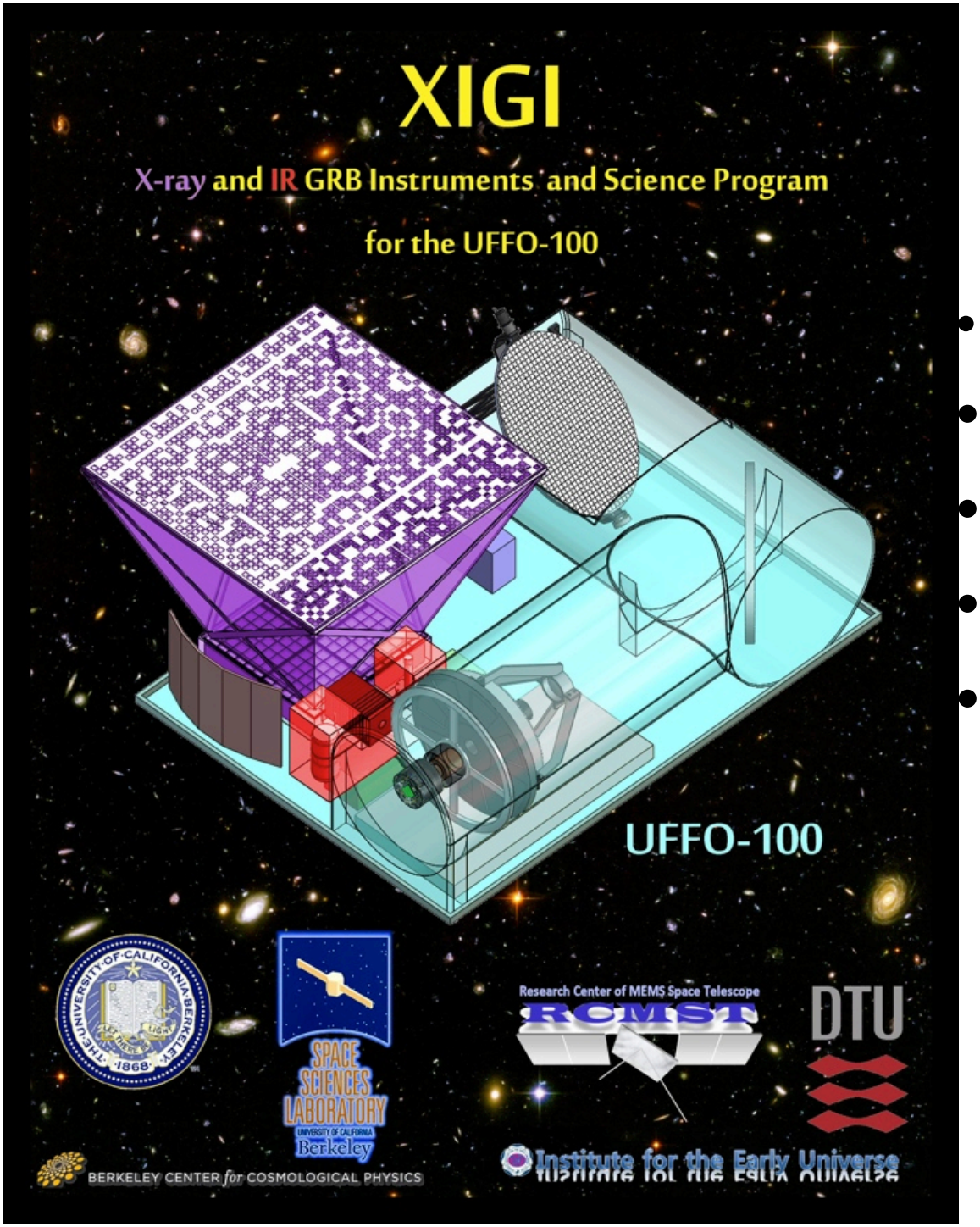
- All instruments on and taking data
- In principle our GRB instruments now have one month of science data
- I have yet to see any of this data yet
- But understand that the first week and second week have been sent to Korea for some one outside of Russian Federation to process

UFFO -pathfinder mission

- We were *given* 20 kg on the Russian Lomonosov spacecraft in UNIVERSITAT program-Launch in Christmas ? NOW



Il Park is P.I. UFFO-Pathfinder



XIGI -> UFFO-100 Next Generation

- Dr. Bruce Grossan PI
- 120 kg design
- X-Ray Coded Mask
- 30-cm optical telesc
- Science Goals
  - Lorentz factor
  - Calibration
  - Internal vs External shocks
  - Multimessenger

Empress Elizaveta Petrovna visits M. Lomonosov