Soyuz launch & ascent observations from International Space Station and from ground/airborne observers on December 15, 2015

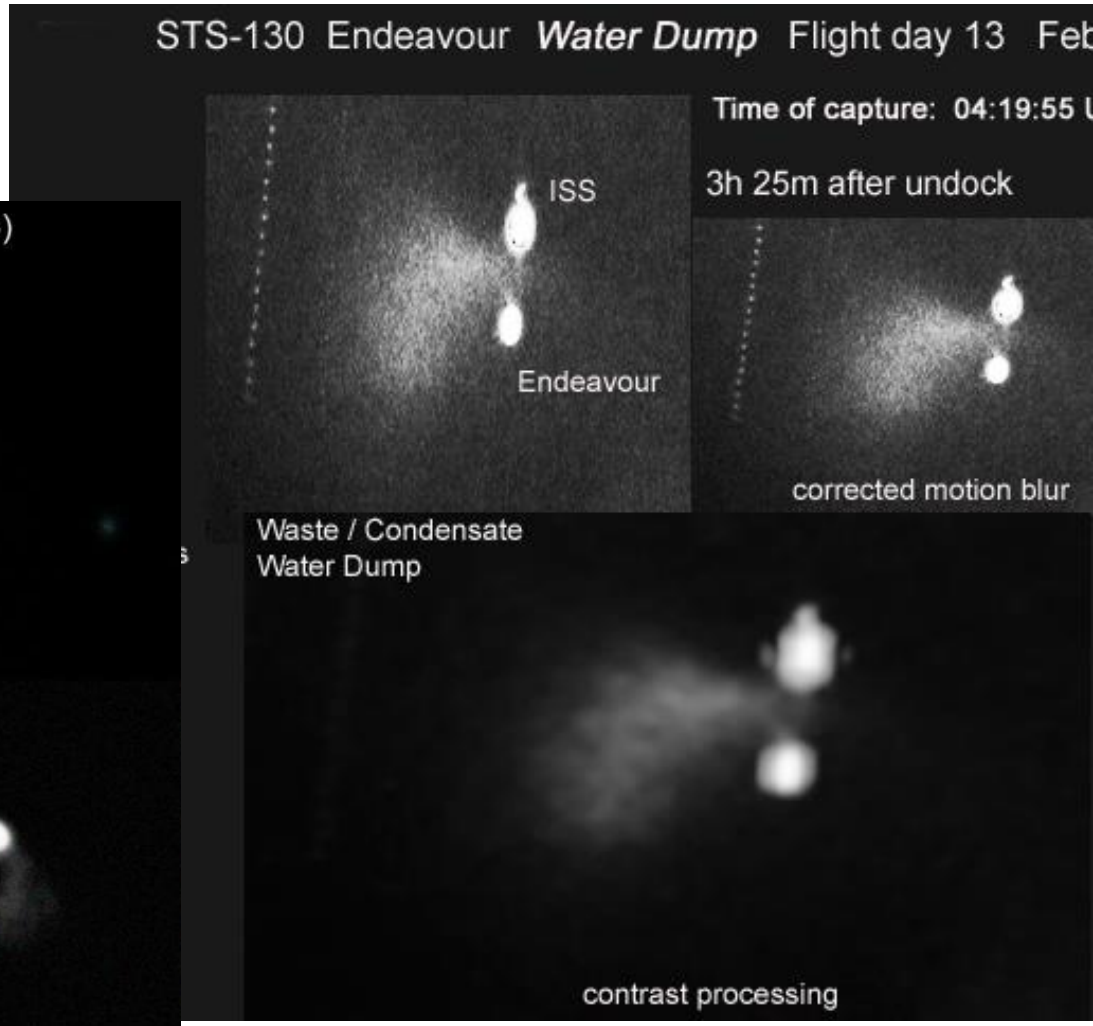
Soyuz TMA-19M 2015/12/15
11:03:09 UTC
from Baykonur

James Oberg
September 24, 2016
FINAL REV 1

All media please verify any material prior to quotation or other reference utilization

Satellite watching is more than just ‘point sources’

EG: Orbiter Water Dumps

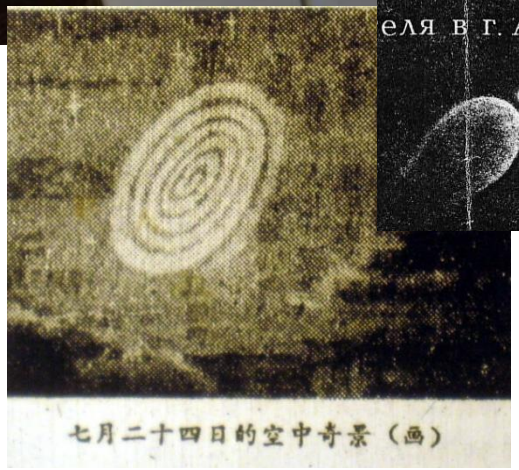


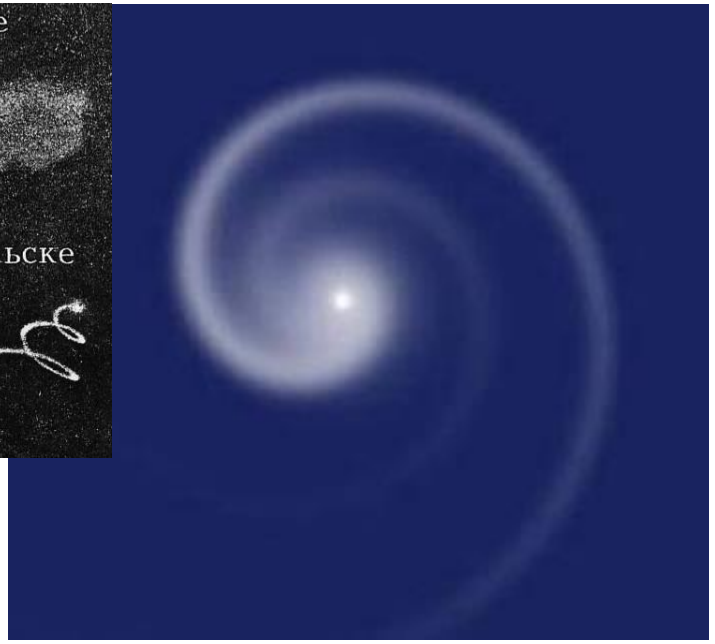
Sometimes it can be pretty awesome……

SKY SPIRALS

[left] Opened thrust dump ports
[below] Post insertion prop dump

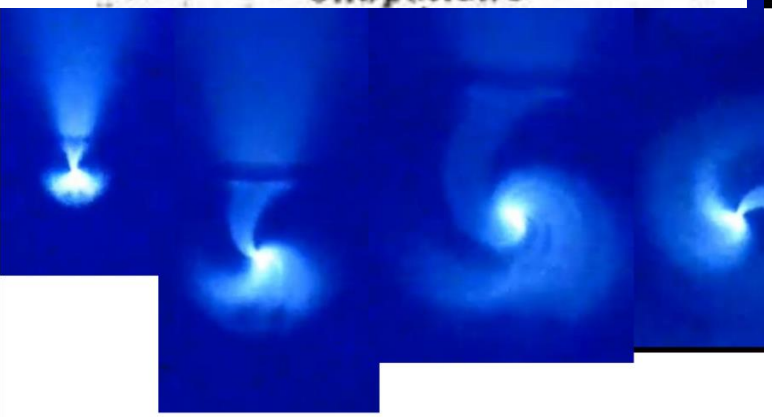
1986 US East Coast, China, Australia



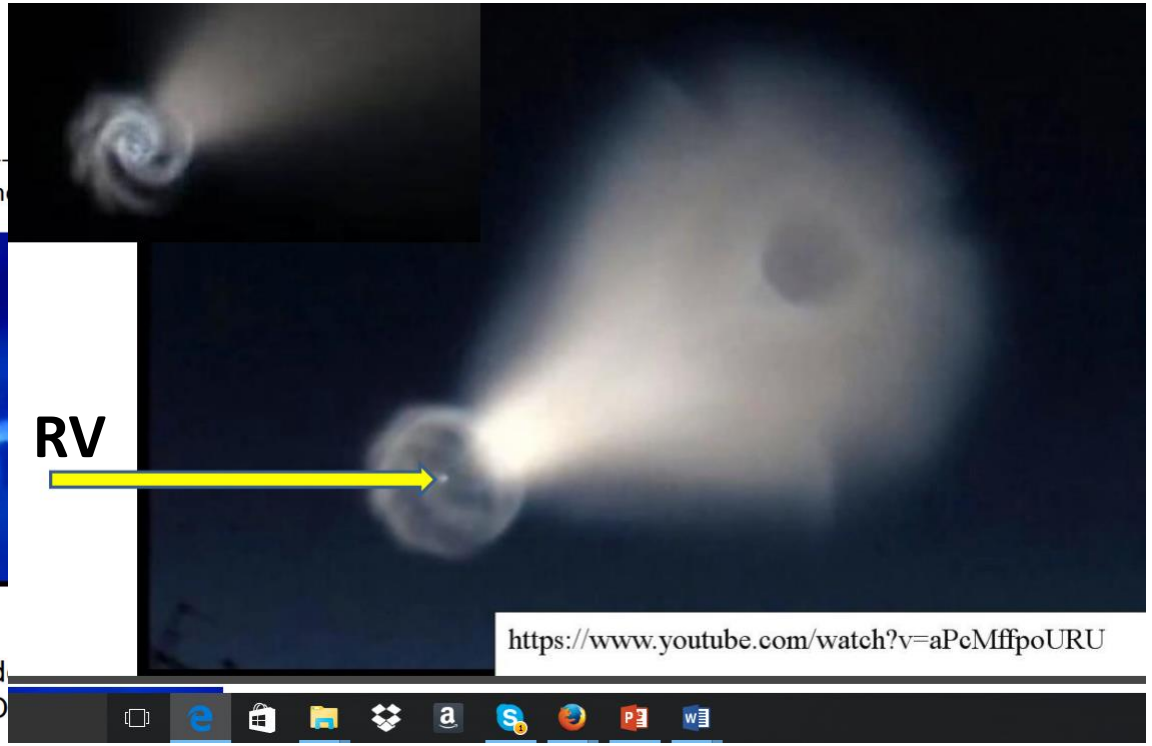


Sometimes it can get eerie and unearthly….

BRIEF EXPANDING SPIRAL FROM ICBM WARHEAD'S SPIN-UP MOTORS
[RUSSIAN 'TOPOL' ICBM SHOWN HERE]



Triple plume completes about one full rev prior to fad
https://www.youtube.com/watch?v=AHX6IU7NcO



OVERVIEW

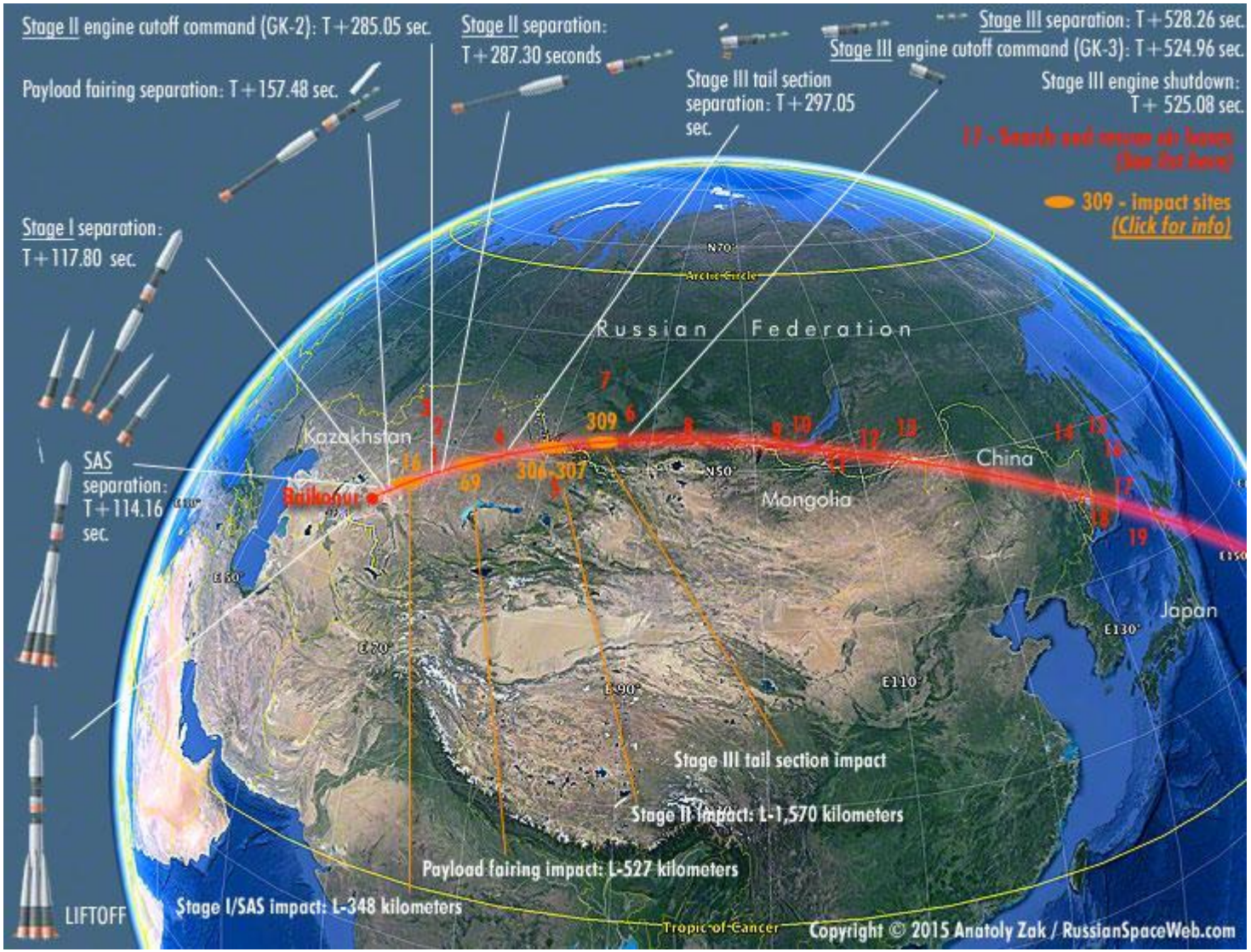
- Soyuz TMA-19M launch of Dec 15, 2015, created possibly most diverse collection of visual imaging observations of large-booster exoatmospheric plume effects ever recorded
- SW Siberia ground observations included both opportunistic imaging and apparently a few well-prepared instrumentation setups
- Result – acquisition of most high-quality stage-3 shutdown/separation sequences ever made [to my knowledge] by private parties
- Lineation patterns and evolution of main stage plumes still not well understood, help needed

[more]

[MORE]

- Best-ever visual/dynamic characterization of post stage-3 ‘Comma Cloud’ phenomenon
- Importance of Soyuz rocketcam launch views
- Subsequent identification of ‘Comma Cloud’ with deliberate O2 tank venting for disposal clearance
- Confirmation of criticality of solar back-lighting of plume components plus observer in darkness
- Confirmation of efficacy of image brightness enhancement to recover invisible plume traces
- Unique illumination, low phase angle rendezvous vehicle launch window, and visiting vehicle traffic model suggest similar visibility conditions only approximately once every two or three years

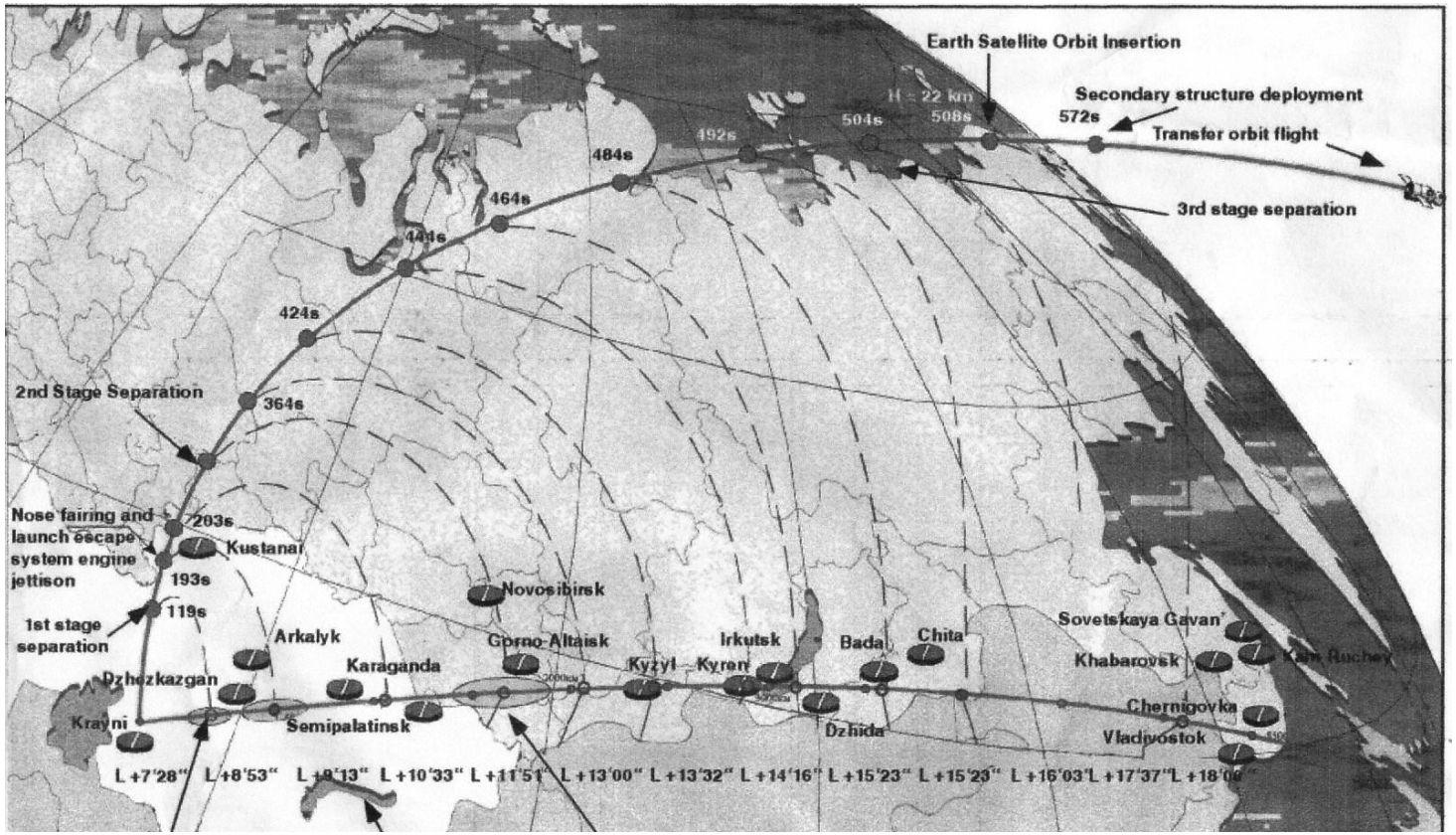
Standard Soyuz ascent from Baykonur Cosmodrome



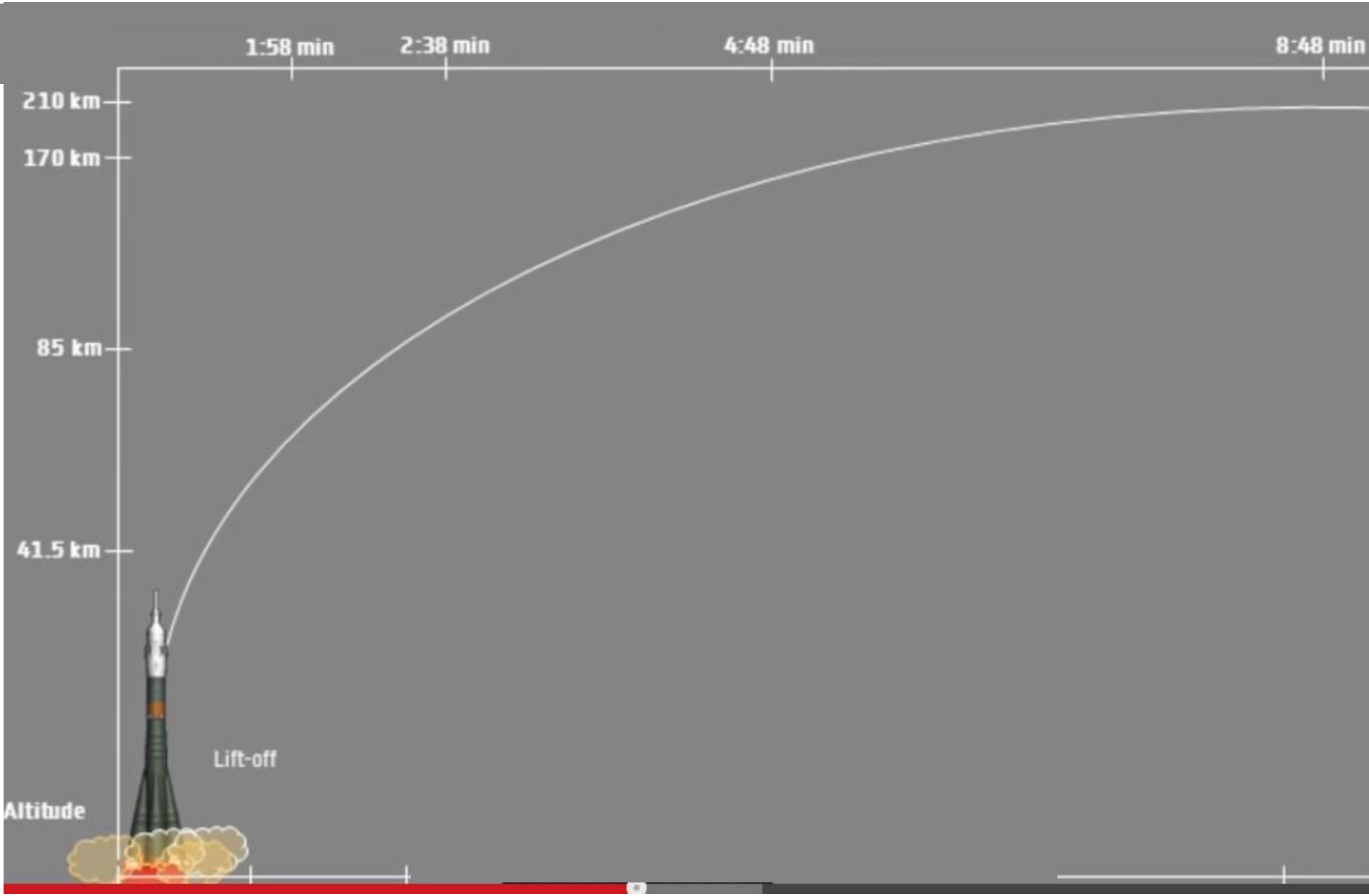
https://scontent-dfw1-1.xx.fbcdn.net/hphotos-xtp1/v/t1.0-9/12341334_10206547917229680_1985048528225802288_n.jpg?oh=17645639f4ef6b24c9ac238699795e3a&oe=57174AAE

Profile [exaggerated vertical scale]

International Space Station orbiting at almost twice the insertion altitude of the Soyuz



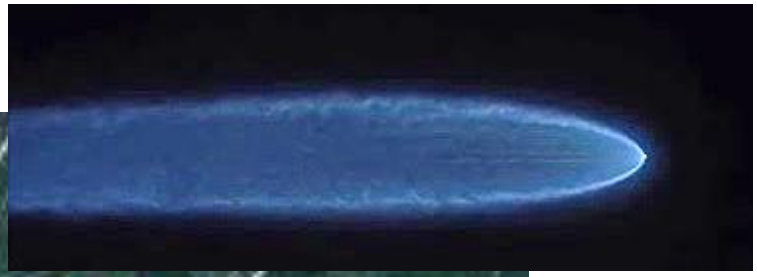
Altitude versus elapsed time [ESA chart]



https://www.youtube.com/watch?v=AVvgpKt5uCA

Trajectory passes within sight of major cities in Western Siberia and Kazakhstan

-- WHEN PLUME IS SUNLIT AND GROUND DARK, HIGHLY VISIBLE --



In cities, crowds on the street…. WITH POCKETCAMS

http://www.youtube.com/watch?v=3iIgesHH9fg

Topol missile watched in Astrakhan -- June 7, 2012

…. And widespread dashcams [this example – Omsk, Topol missile]

- Price 2 999 р.
- Угол обзора: 120° (по диагонали)

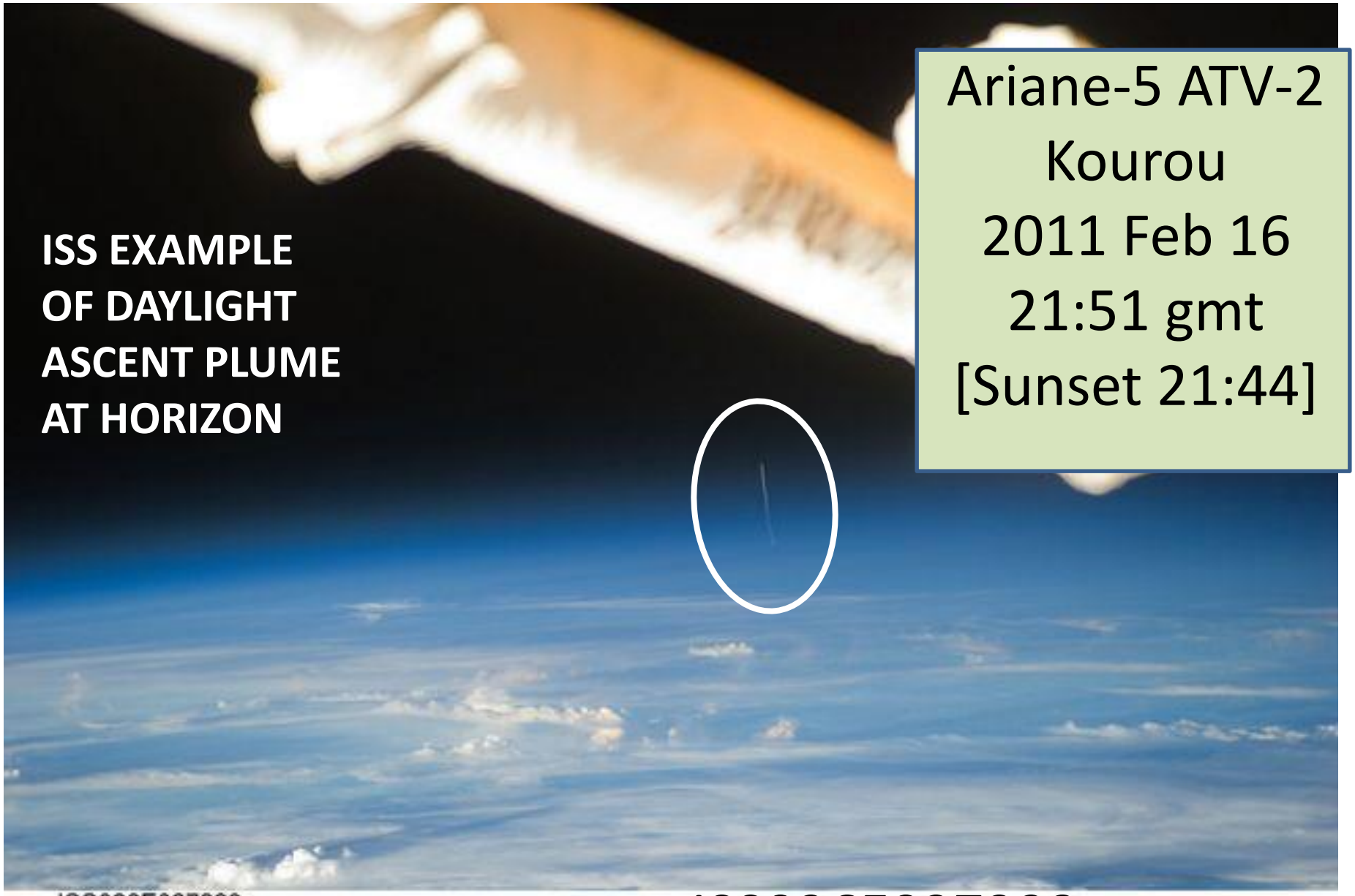
http://omsk.rbt.ru/cat/audio/videoregistratory/mystery_mdr-800hd/?gclid=CLaDz-693rsCFU5a3godWTsAdQ

Rocket launch observations from space

- December 15, 2015 was ‘perfect storm’ of separate factors that created rare spectacle
- Several memorable precedents exist
- But as a rule,
  - Full daytime launches, while trails are noticeable [especially on horizon] aren’t very bright
  - Full dark launches create visible flares but localized
  - Crews are only looking outside a fraction of the time

Previous on-board sightings

- Dozen examples of ISS crews observing scheduled Soyuz & Progress launches but all were full-daylight or full-dark
- [June 15, 2014] ESA astronaut Alexander Gerst accidentally spots twilight launch of Plesetsk 'Soyuz' with GLONASS navsathttp://www.jamesoberg.com/ISS_crew_spots_second_russian_rocket_rev_c.pdf
- [Oct 10, 2013] ESA's Luca Parmitano accidentally spots twilight Russian ICBM test with major in-space stage burn http://www.jamesoberg.com/Topol_Test_with_images.pdf
- Russian Salyut & Mir crews report twilight pluming over South African missile range [1980s] – connection still unclear
- Malenchenko reported seeing ascent plumes only
- Search continues for more anecdotal events

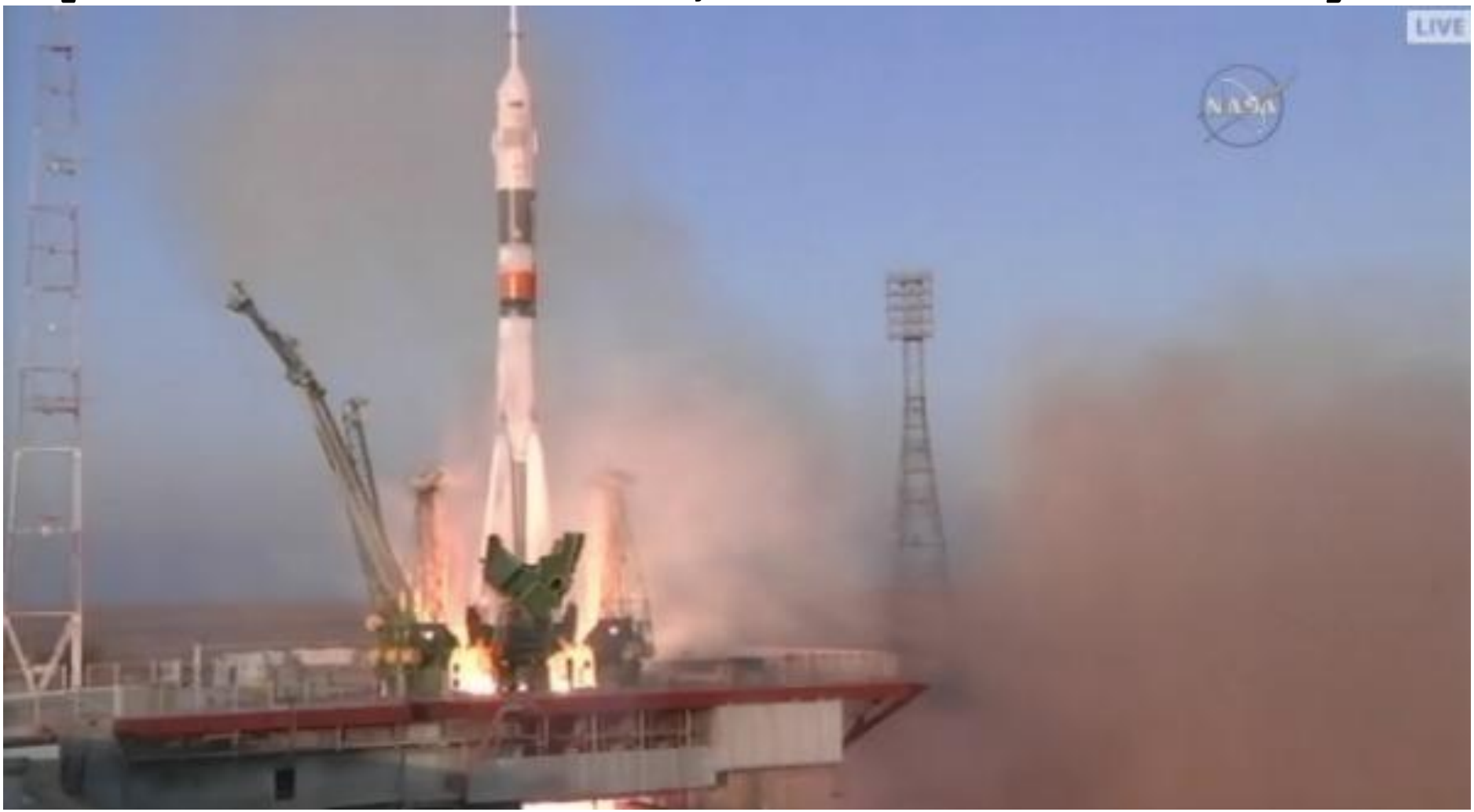


- ISS026E027223

Progress M-22 launch, 2014 Feb 5 16:23 gmt [sunset 12:58 gmt]

- Observed by Rick Mastracchio

THIS particular “space spectacular”: Launch [11:03:09 GMT] was pre-sunset *[12:03 GMT sunset, sun azimuth 237°]*



http://www.russianspaceweb.com/images/rockets/soyuz/stage1/rocketcam_F_2.jpg

Stage-1 [4 strap-ons] jettison [118 sec]; NW horizon out Soyuz window still sunlit

Viewing regions

Depending on season and on launch time relative to sunset, different longitudinal bands on Earth's surface have optimal illumination conditions for best observation:

- Observer in darkness
- Object in sunlight

This time, appropriate conditions were met east of launch area, on ground, in the air, and in space

Ground view [December 15, 2015]

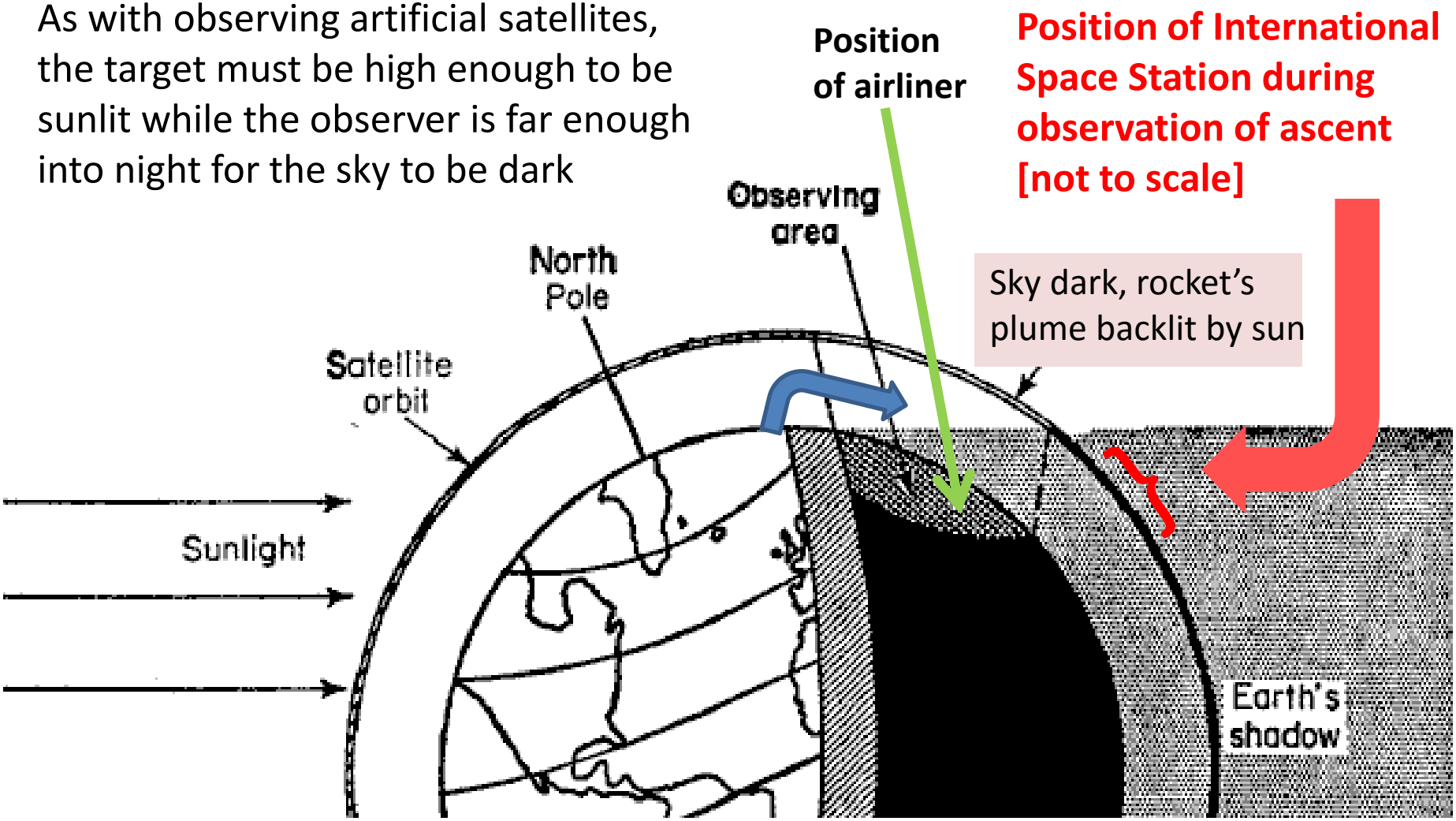
http://siberiantimes.com/PICTURES/OTHERS/Soyuz-lauch-in-Siberia/inside_rocket_and_houses.jpg

From an airliner

From aboard the space station

Evening twilight visibility of ascent plume

As with observing artificial satellites, the target must be high enough to be sunlit while the observer is far enough into night for the sky to be dark

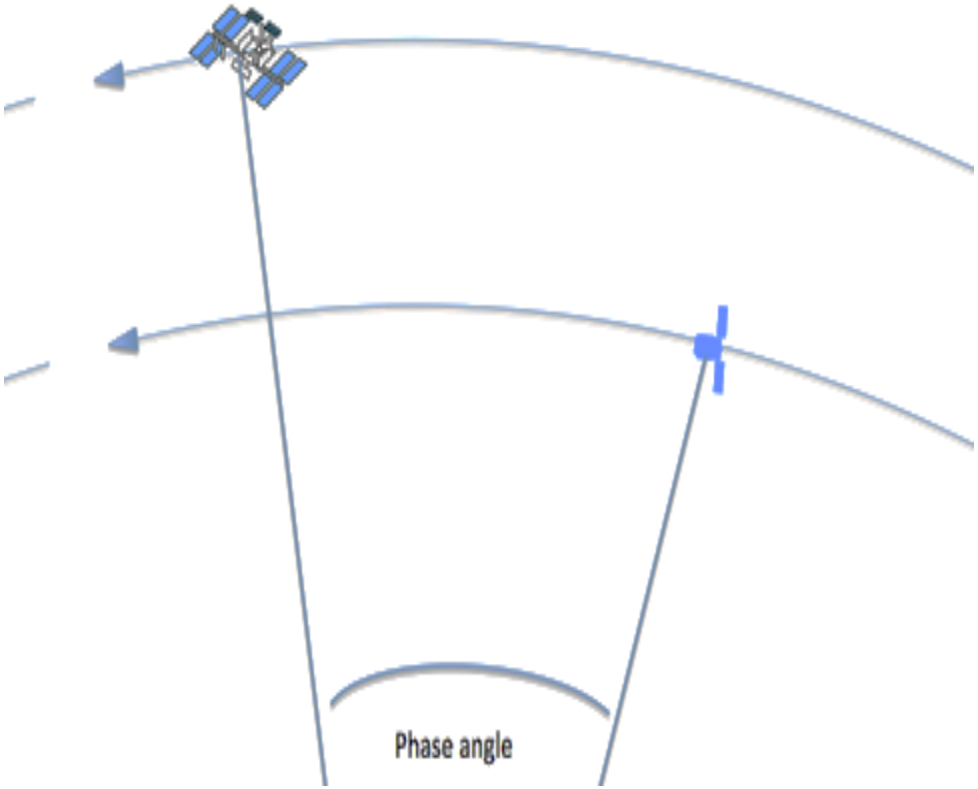


Onboard Observation Opportunity

- In full daylight, plume doesn't stand out; in full darkness, it's invisible aside from engine glow
- Backlit plume illumination with ground in shadow is statistically rare, twilight much longer in May-August
- Backlit plume illumination with space station in shadow is even more rare – only a few cases known
- Traditional rendezvous profiles often launched 1000's of km behind target, often over the horizon, therefore unseeable

- HOWEVER -- Newly-introduced 'fast rendezvous' profile provides closer ISS range at launch [small phase angle]
- AND -- Cupola [installed 2010] provides awesome wide-angle field of view, with seven 80-cm-square windows
- AND – Six-person crew provides more opportunistic eyeballs scanning the sky for serendipitous surprises

“Phase angle” measures how big a ‘lead’ the target is when the chaser is launched



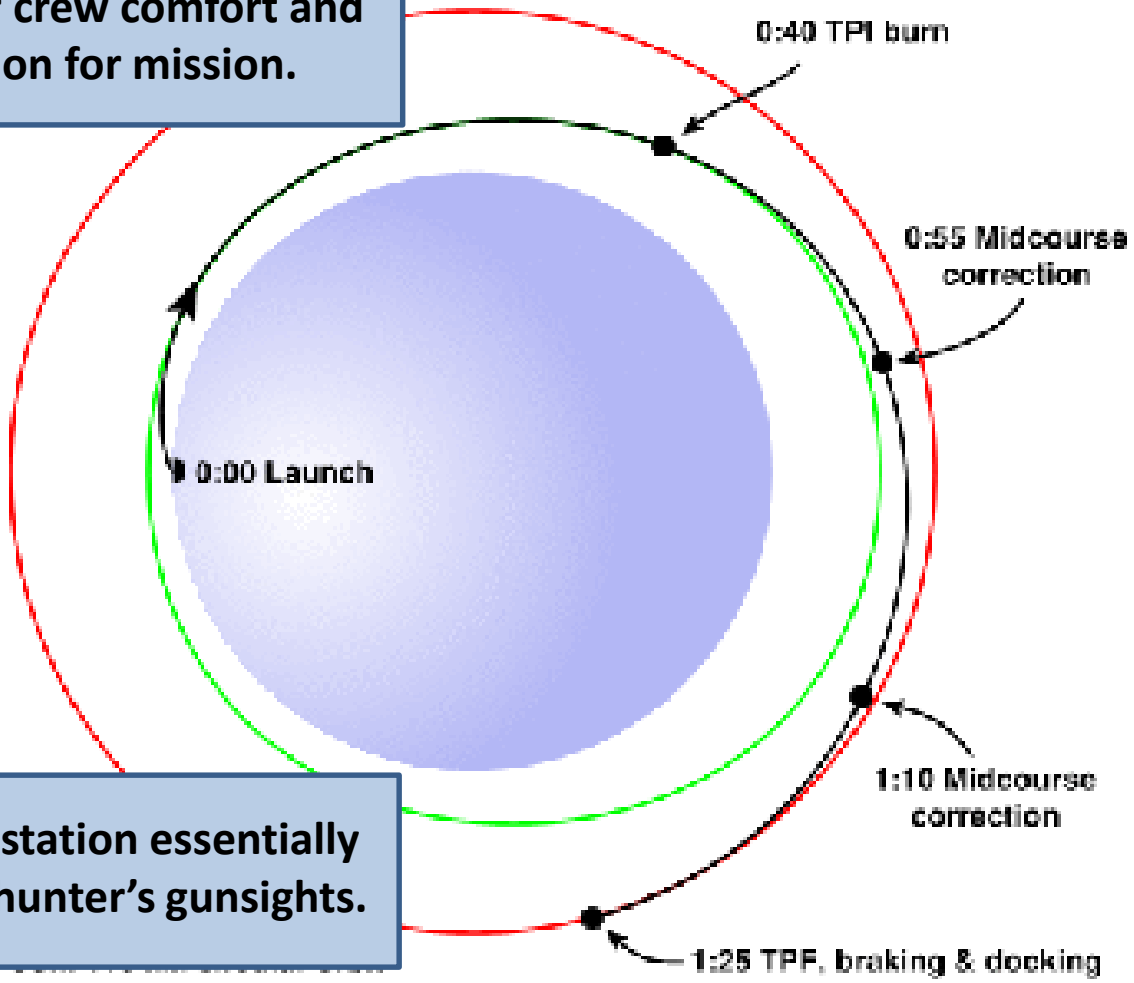
This is crucial for an event to be visible from space since anything more than 1000-2000 km away is over the horizon – so the smaller the phase angle, the better for visibility.

https://qph.is.quoracdn.net/main-qimg-31ab59a616cf855639affd006d12a31b?convert_to_webp=true

“Fast Rendezvous” and “Cooperative Target”

Faster arrival is desirable for crew comfort and for maximizing crew utilization for mission.

Chaser is NOT flying ‘faster’, it gets to the space station SOONER because the overtaking distance at launch is adjusted to be SHORTER than what was standard in the past. This required active modulation of station altitude and also good modeling of atmospheric decay rates, so it’s not trivial to set up.



To achieve this quick trip, the station essentially is deliberately flown into the hunter’s gunsights.

Further reading on ‘fast rendezvous’

- **NBC [**Mar 27, 2013**] Space station shifts its orbit to make speedy crew rendezvous possible**
- http://science.nbcnews.com/_news/2013/03/27/17491180-space-station-shifts-its-orbit-to-make-speedy-crew-rendezvous-possible?lite

- **NBC [**Mar 28, 2013**] Revised ride to space station may be faster – but it's also less comfortable**
- http://science.nbcnews.com/_news/2013/03/28/17503284-revised-ride-to-space-station-may-be-faster-but-its-also-less-comfortable?lite

- Spectrum magazine 1 Aug 2012 -- **Russia Tests Quick Trip to Space Station**
- http://spectrum.ieee.org/aerospace/space-flight/russia-tests-quick-trip-to-space-station

- SEPTEMBER 2015 – ‘NPR’ FALSELY BLAMES SOYUZ RENDEZVOUS DELAY ON HUMAN SPACE POLLUTION [read comments]= [completely misunderstands nature of ‘fast rendezvous’ profile, very amusing and frustrating exchages]
- http://www.npr.org/2015/09/04/437597059/take-the-long-way-home-spacefarers-journey-prolonged-by-space-junk?uidt=1441541780#commentBlock

ISS relative position for December 15, 2015 launching

- The station was orbiting in a 402.41 by 415.29-kilometer [avg 409 km], inclination 51.66°.
- At launch, ISS about 1000 km [9°] ahead
- Soyuz performed 525 sec ascent
- Reached 200.75 – 253.08 km [avg 227 km]
- At orbital insertion, Soyuz TMA-19M was 28.1° [3100 km] behind ISS.
- Delta-height 182 km [so catchup ~ 1800 km/rev]

Sequence of images to be shown

- Views from ISS
  - Live External CCTV
  - Handheld digital camera in cupola
  - Russian segment imagery [not seen]
- Particular ascent events observed
- Comparisons to selected other viewpoints
- Views from aircraft
- Views from ground
- CGI of dynamic events
- Insights into events based on multiple viewing angles
- Other manifestations from other vehicles

Recognize – TWO types of plumes

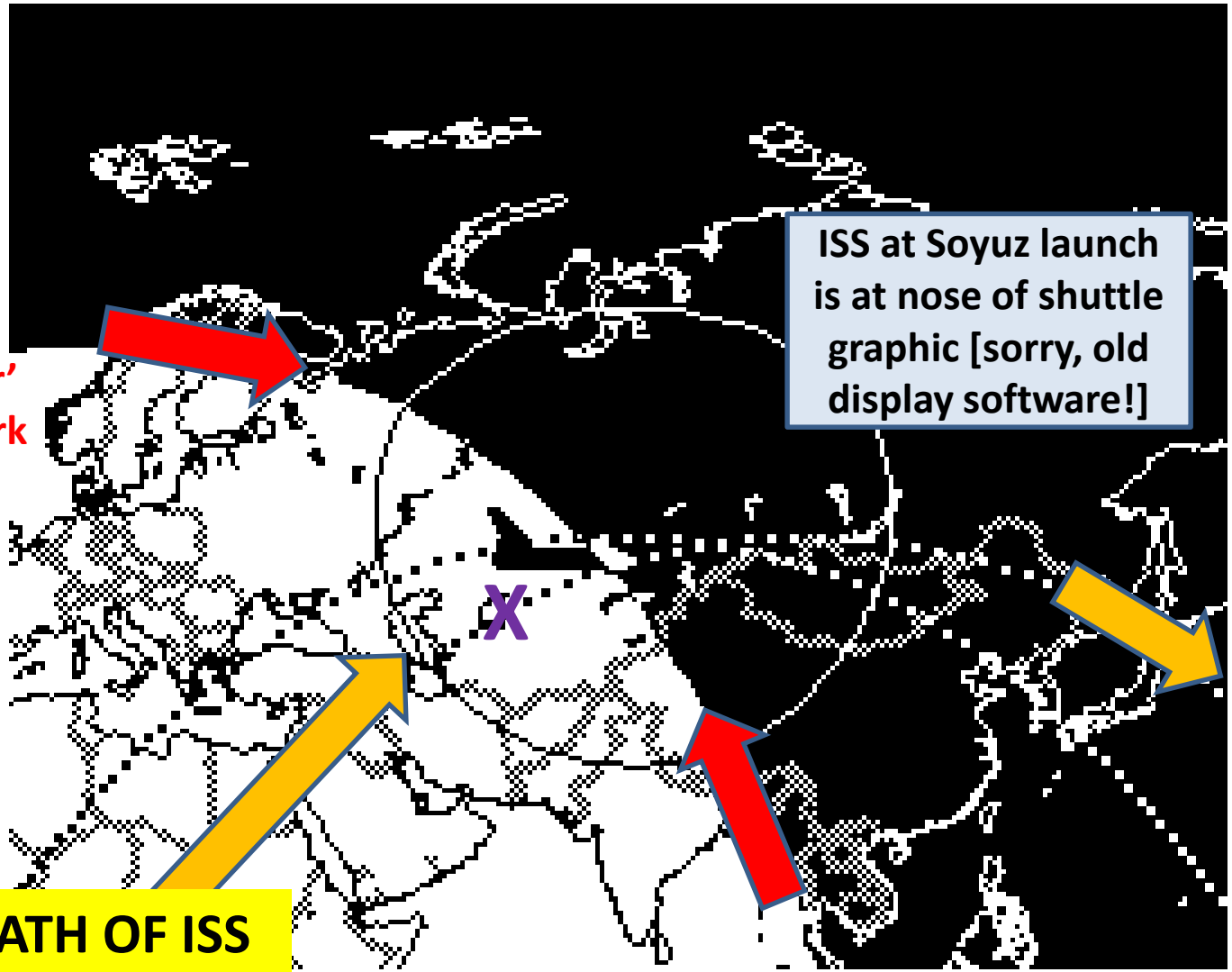
- Endoatmospheric [below ‘Karman line’]
  - Combustion products stopped by air drag
  - Plume material suspended in air
  - Track quickly sheared by crosswinds
- Exoatmospheric [above ‘Karman line’]
  - Combustion particles in free ballistic flight
  - Can take several minutes to ‘fall’ into atmosphere
  - Ejection speed approx 3,000 meters/sec
  - Ground speed of source up to 8,000 meters/sec
  - Doesn’t behave like any familiar earthside plume
  - All familiar ‘plume behavior’ experience is useless

“Three-dimensionalization”

- What is the plume shape we’re looking at?
- Interpreting 2-D white blobs into 3-D shapes is a challenge
- Rocket plume can be seen from front, or oblique, or side
- Think of it as translucent badminton shuttlecock

MOSCOW ‘TsUP’ [CONTROL CENTER]

Relative positions and lighting



Line of 'terminator' showing sunlit/dark surface

ORBITAL PATH OF ISS ACROSS LAUNCH SITE

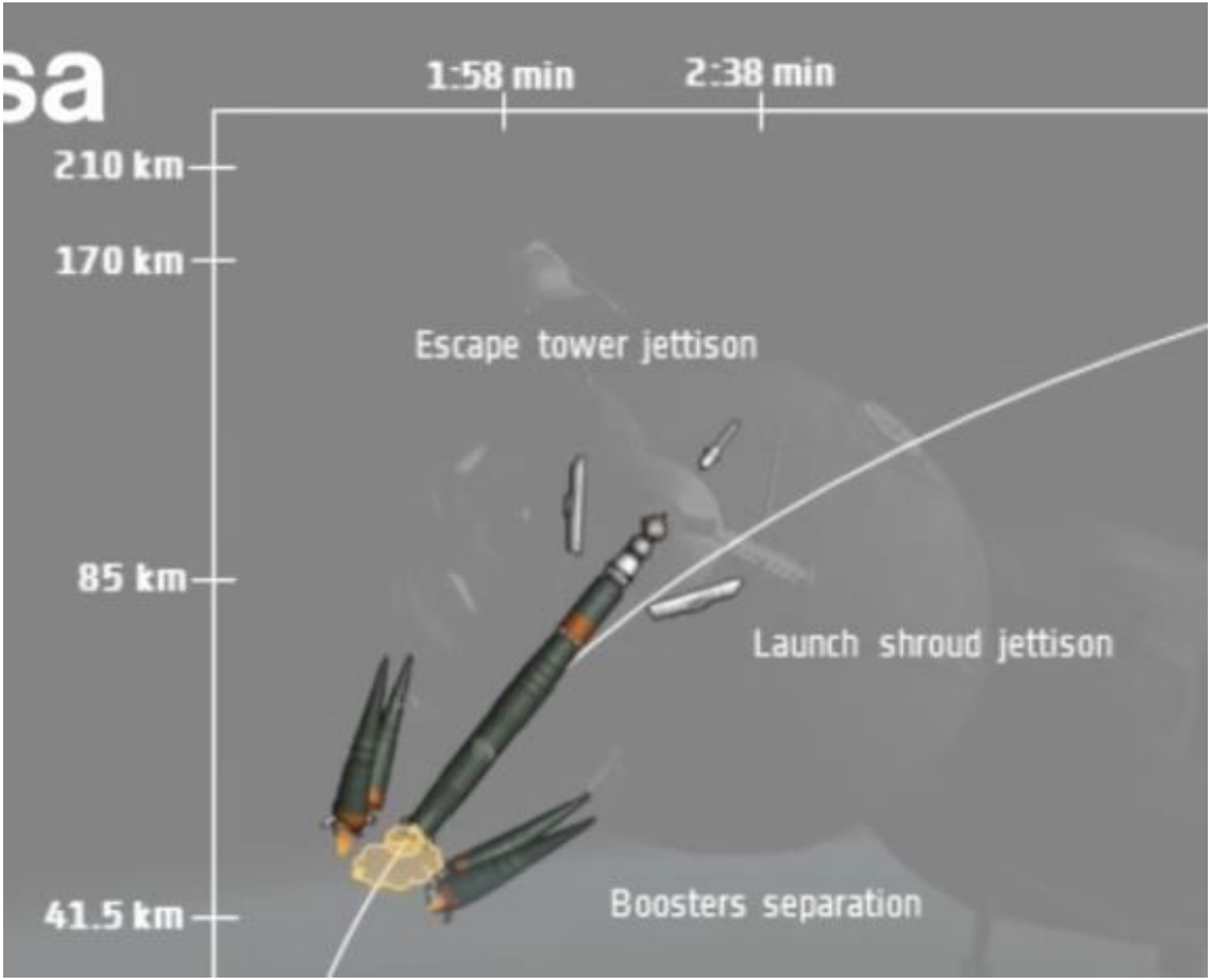
X = Baykonur

Summary of 113 ISS images

NASA photo #	GMT	MET
ISS046e001355	11:06:07	02:57
Initial plume broadening	11:06:30	03:21
2nd stage shutdown	11:08:00	04:51
3rd stage shutdown	11:12:00	08:51
ISS046e001467	11:13:14	10:05

Compared to timeline, camera clock may be ~10 seconds late.

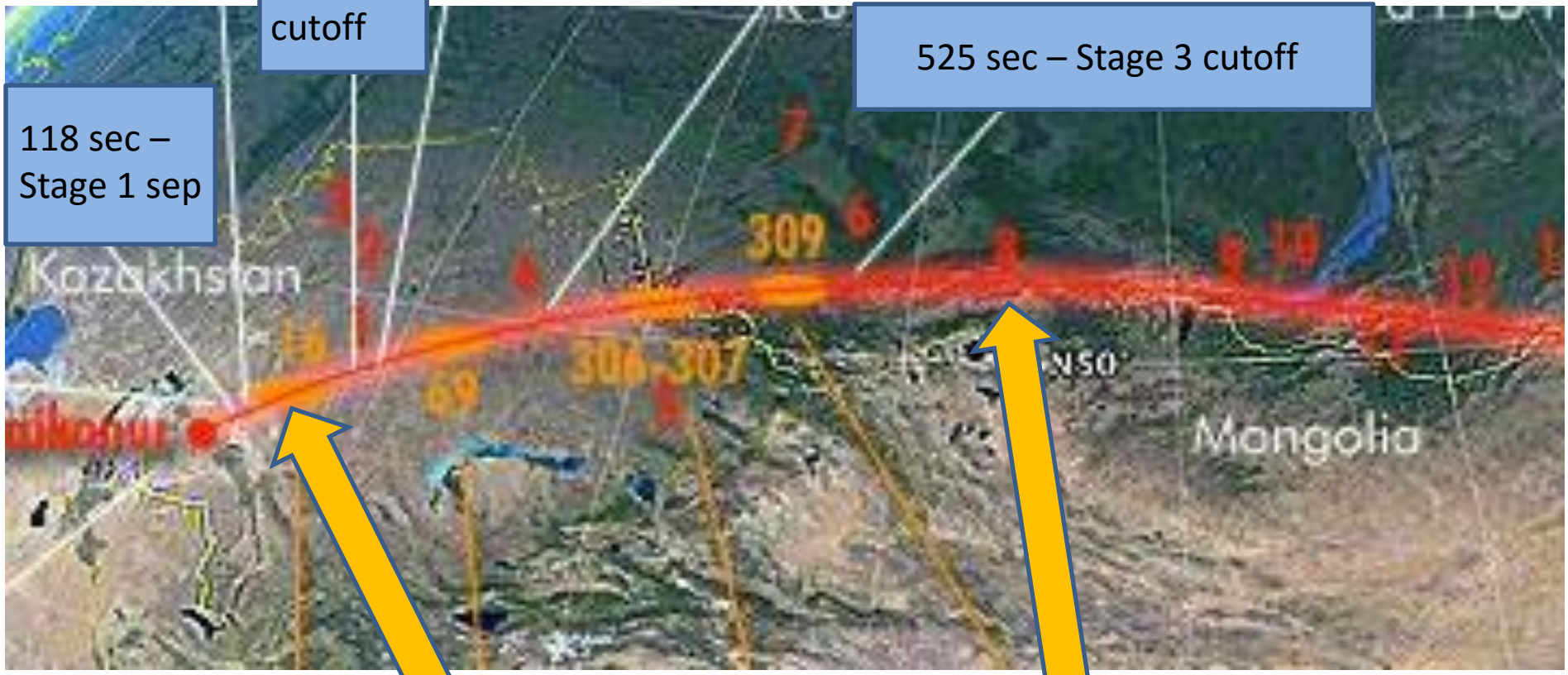
Events preceding first ISS images



Vehicle at time of first ISS image

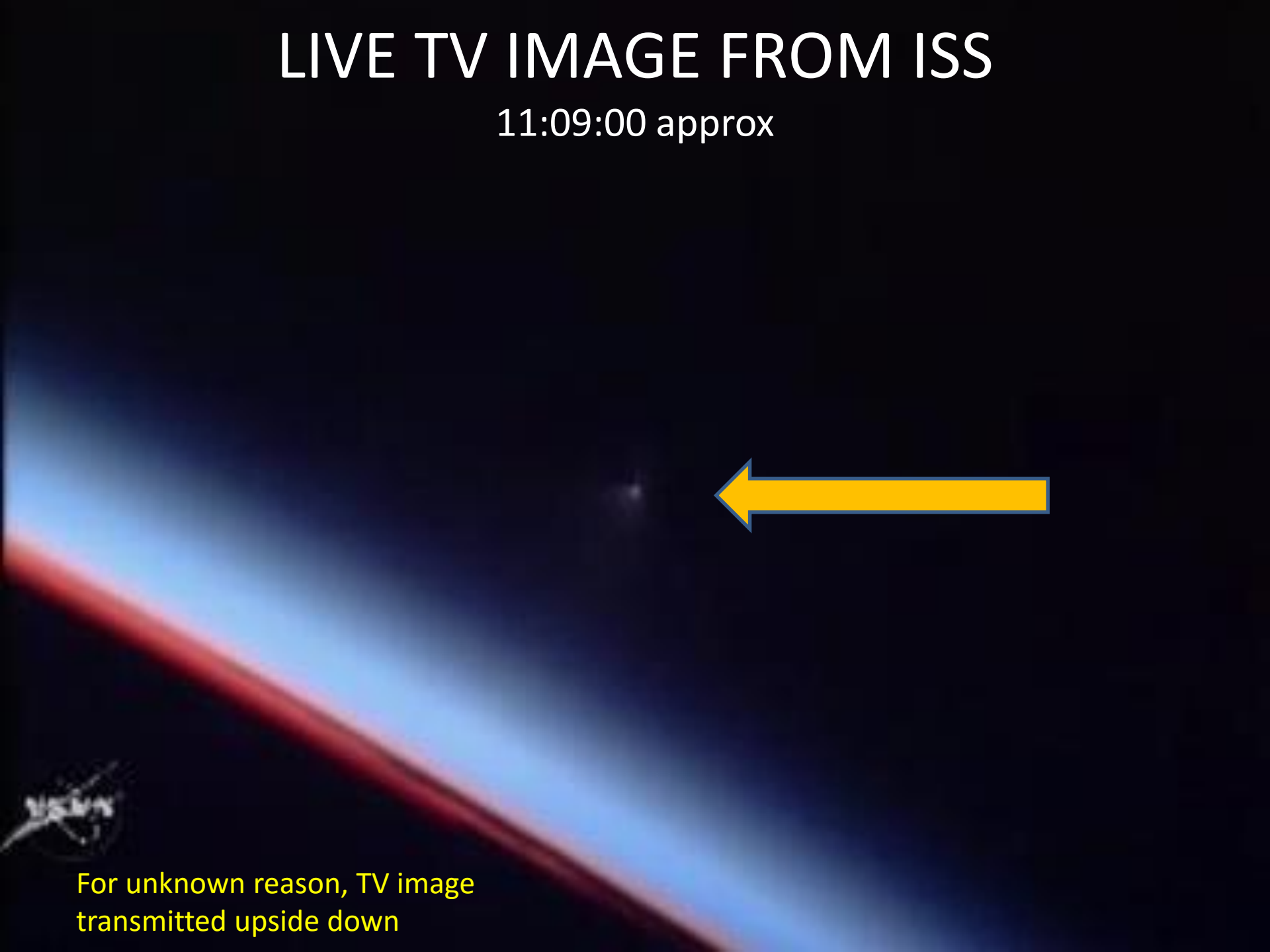
Ascent mostly covered by ISS photographs

[begins after stage-1 jettison, just prior to crossing Karman boundary where engine plume widens spectacularly]



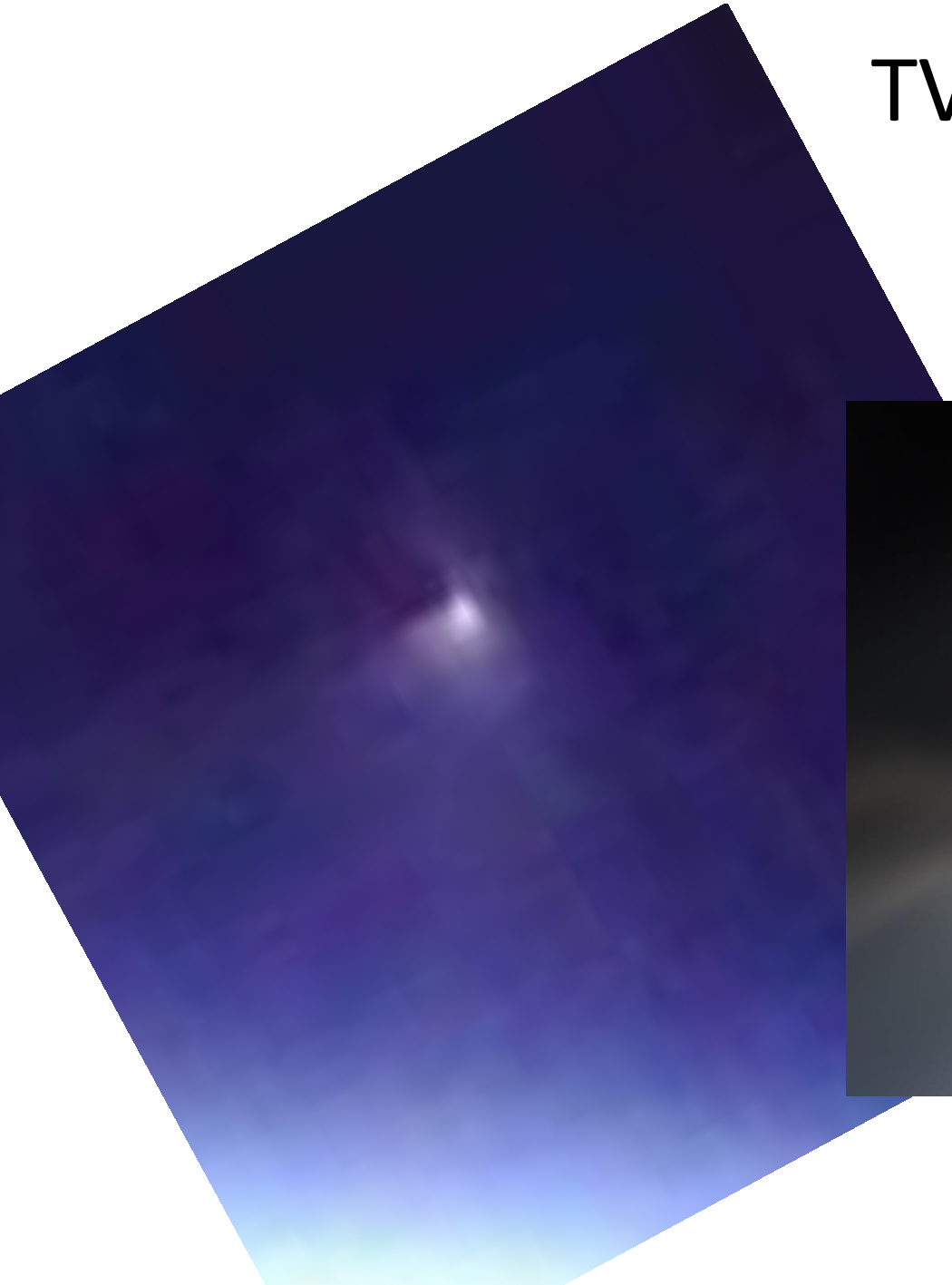
LIVE TV IMAGE FROM ISS

11:09:00 approx



For unknown reason, TV image transmitted upside down

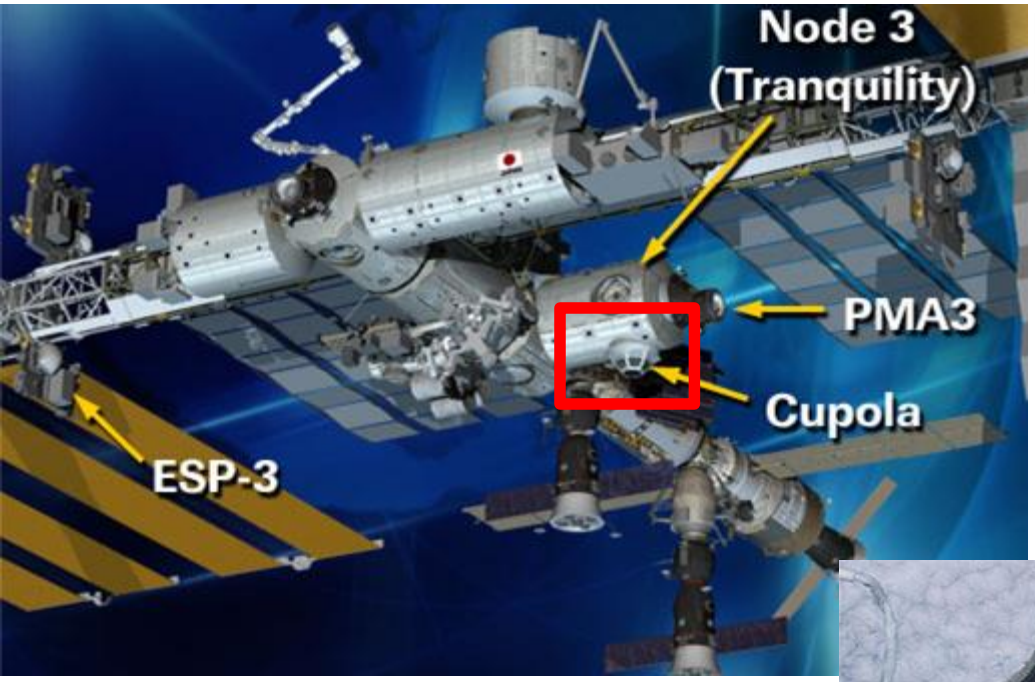
TV image versus crew handheld image [estimated time]



ISS046E001402 11:09:30

International Space Station

"Cupola" observation module



Earth is 'down', below ISS

Astronaut Scott Kelly on watch

What creates visible streaking?

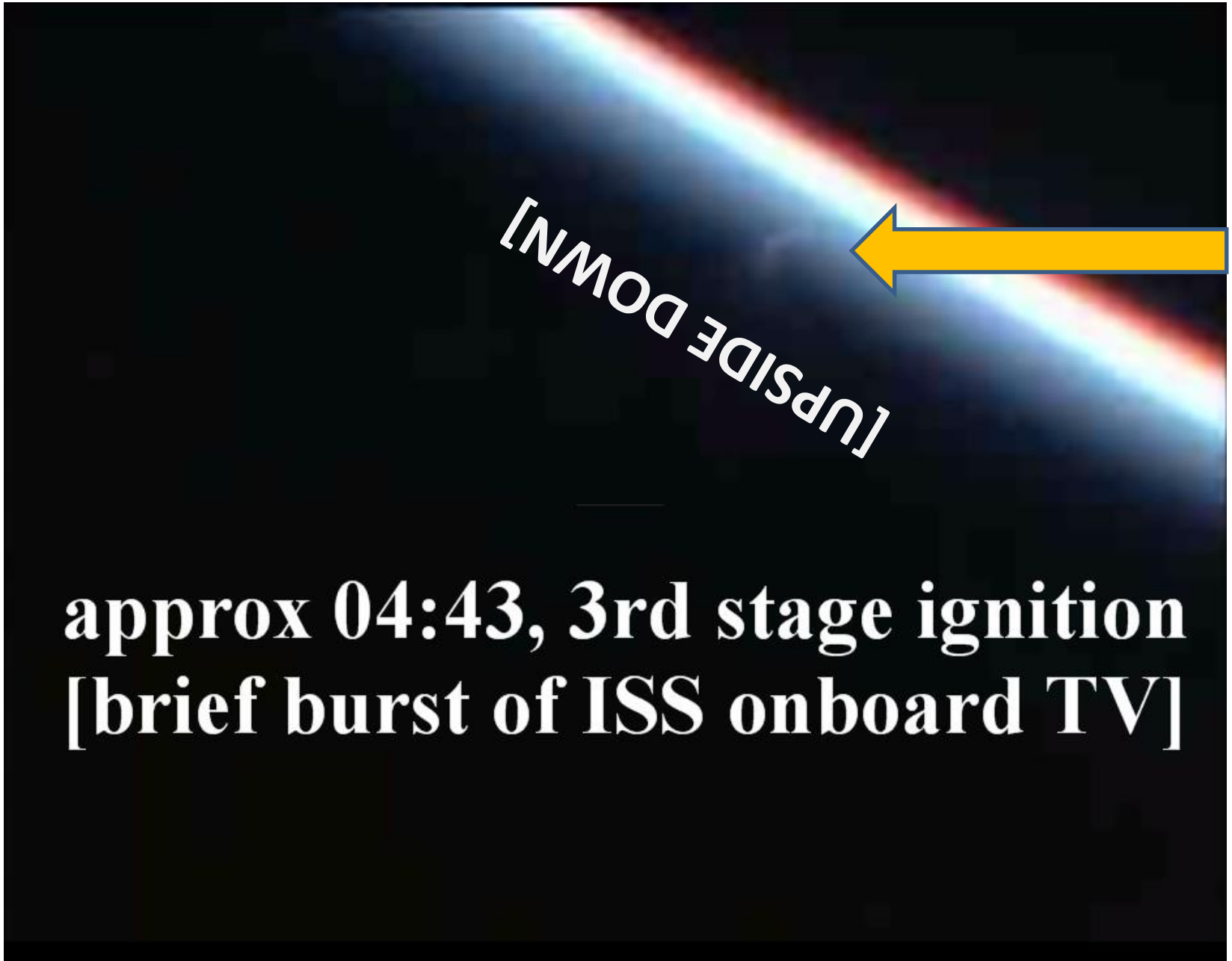
Rocketcam from unmanned Soyuz launch from Kourou in 2014 suggests visible features form at the boundary of multiple engine plumes rather than along centerline. Actual process remains puzzling. KEY FEATURE SEEMS TO BE ILLUMINATION BY SUNLIGHT [not a factor in this view].

Soyuz from ISS

[liftoff at 11:03:10]

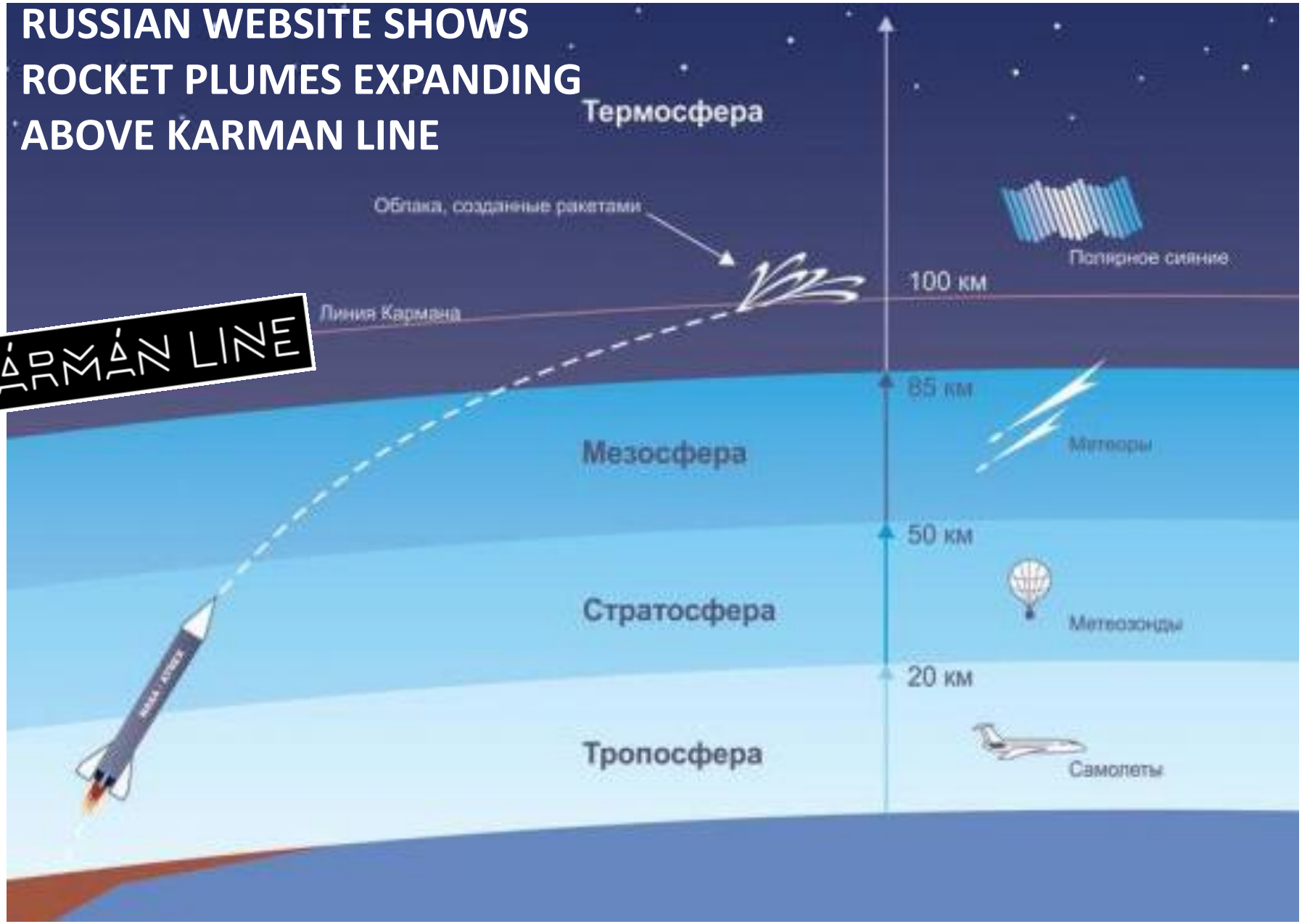
11:06:07, 11:06:31, 11:07:21,

NASA TV live launch coverage



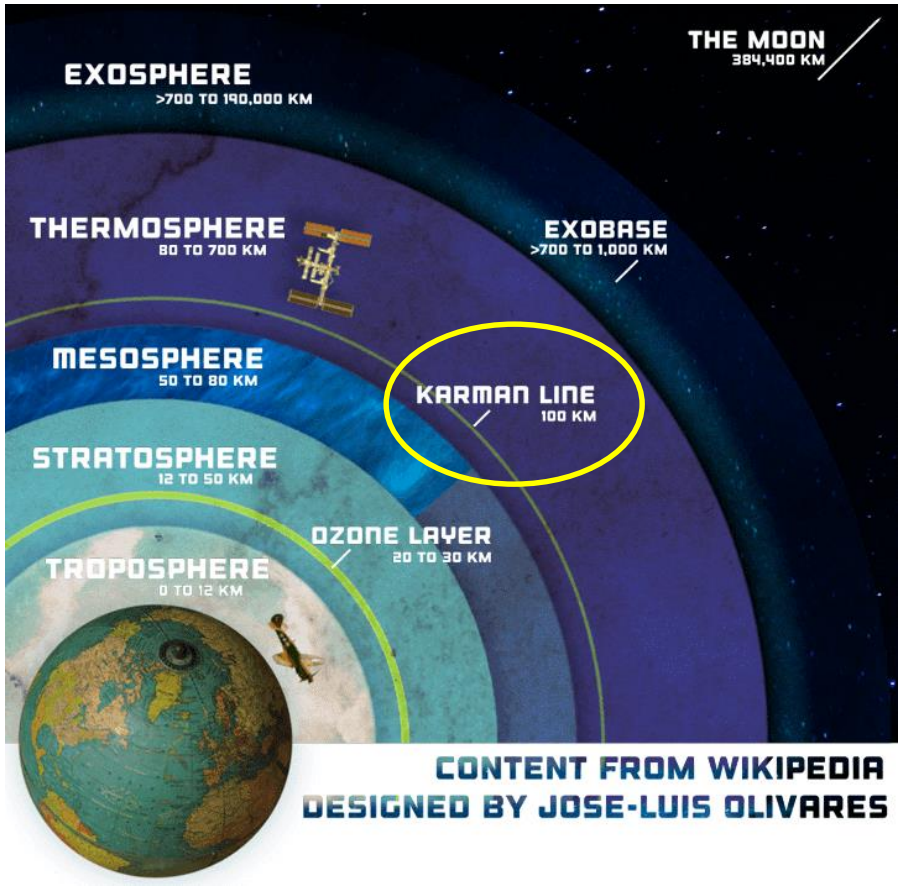
ISS TV captures rocket plume profile above horizon; compare 70-mm photo of Russian missile plume, 2012 [right]

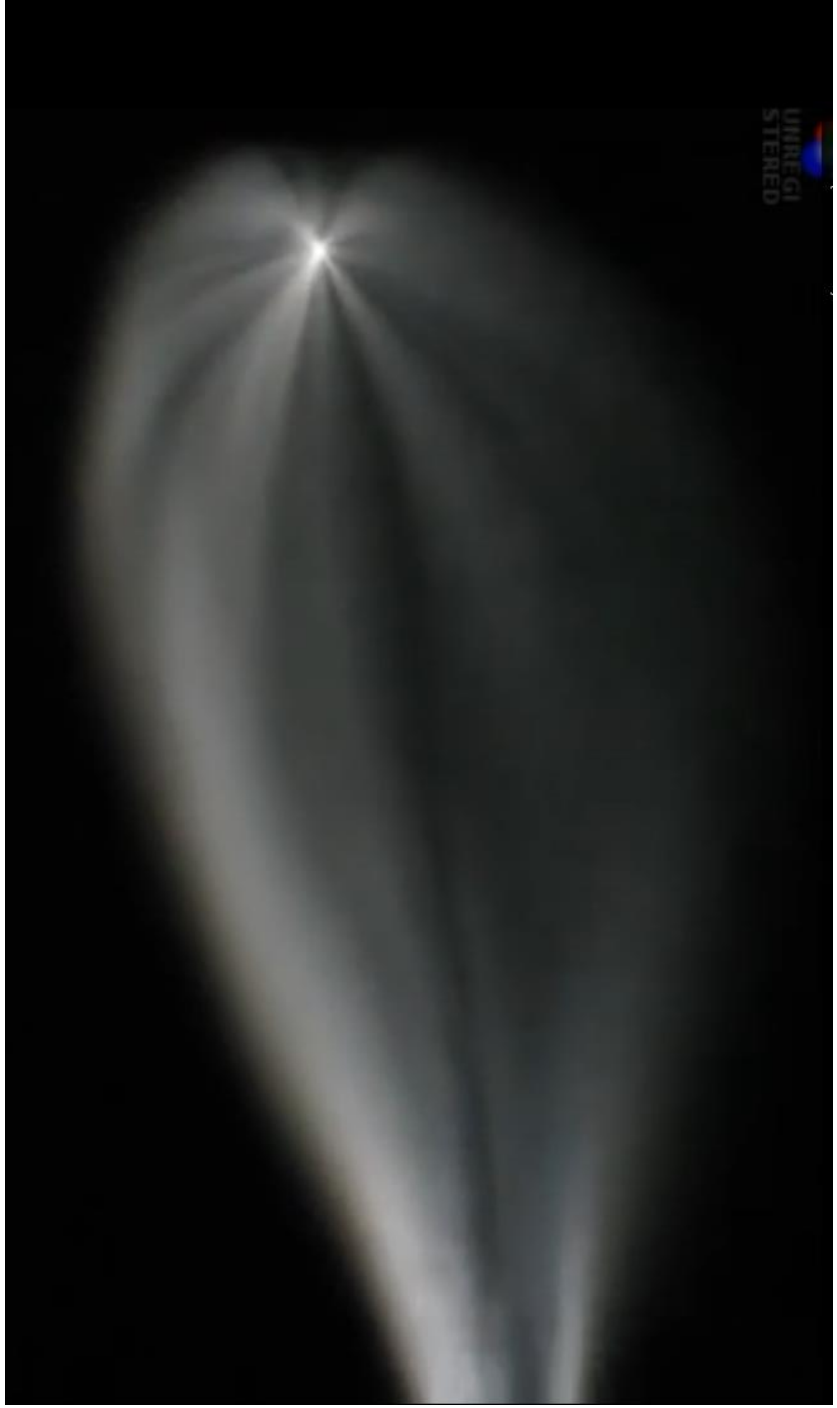
RUSSIAN WEBSITE SHOWS ROCKET PLUMES EXPANDING ABOVE KARMAN LINE



http://bashny.net/uploads/images/00/00/01/2014/06/18/258e5746ce.jpg

Typical early plume as seen from ground [broadens above Karman line]





THIRD STAGE

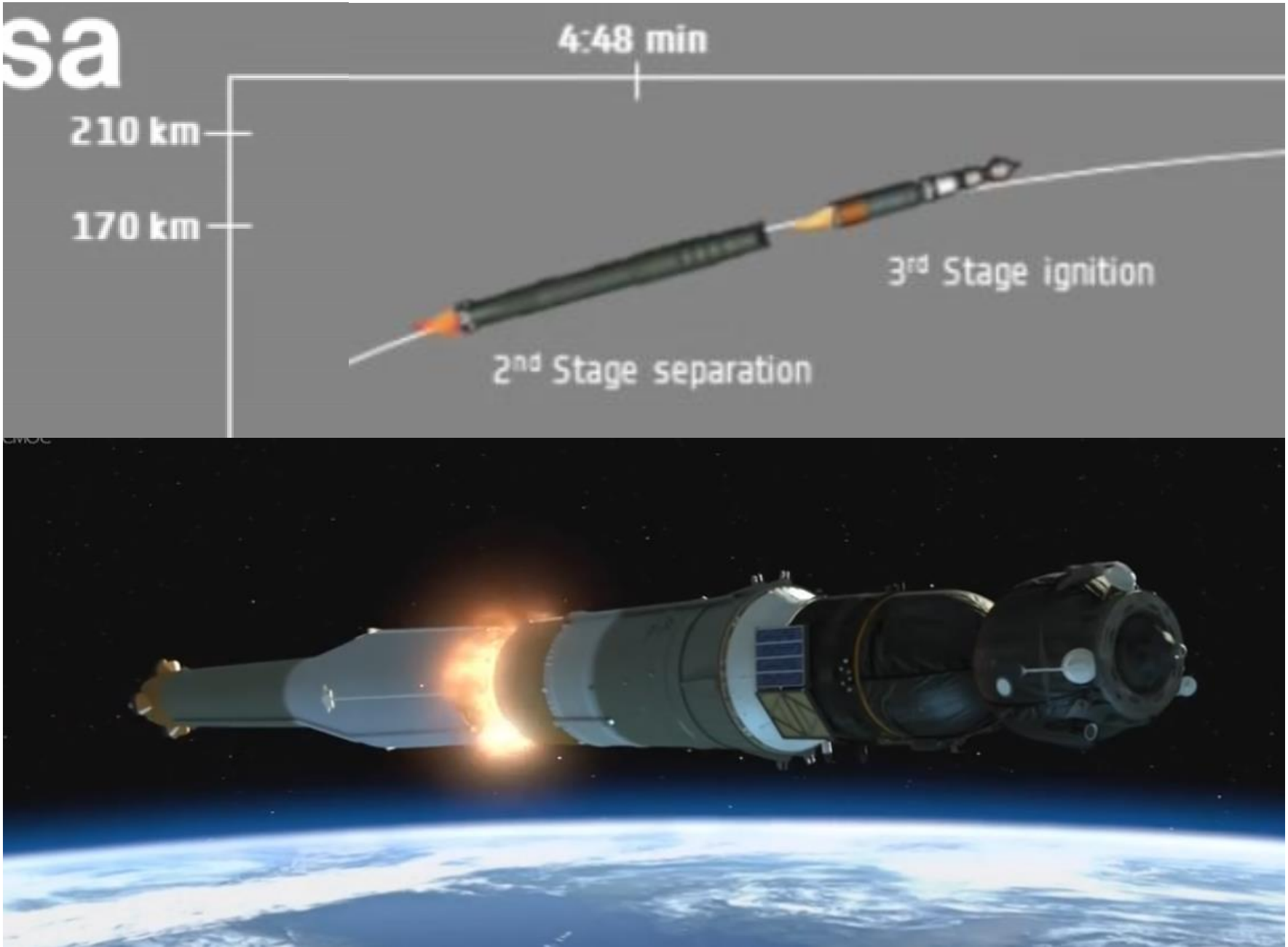
SECOND STAGE

What are they seeing?

4 engines of stage-2, 3

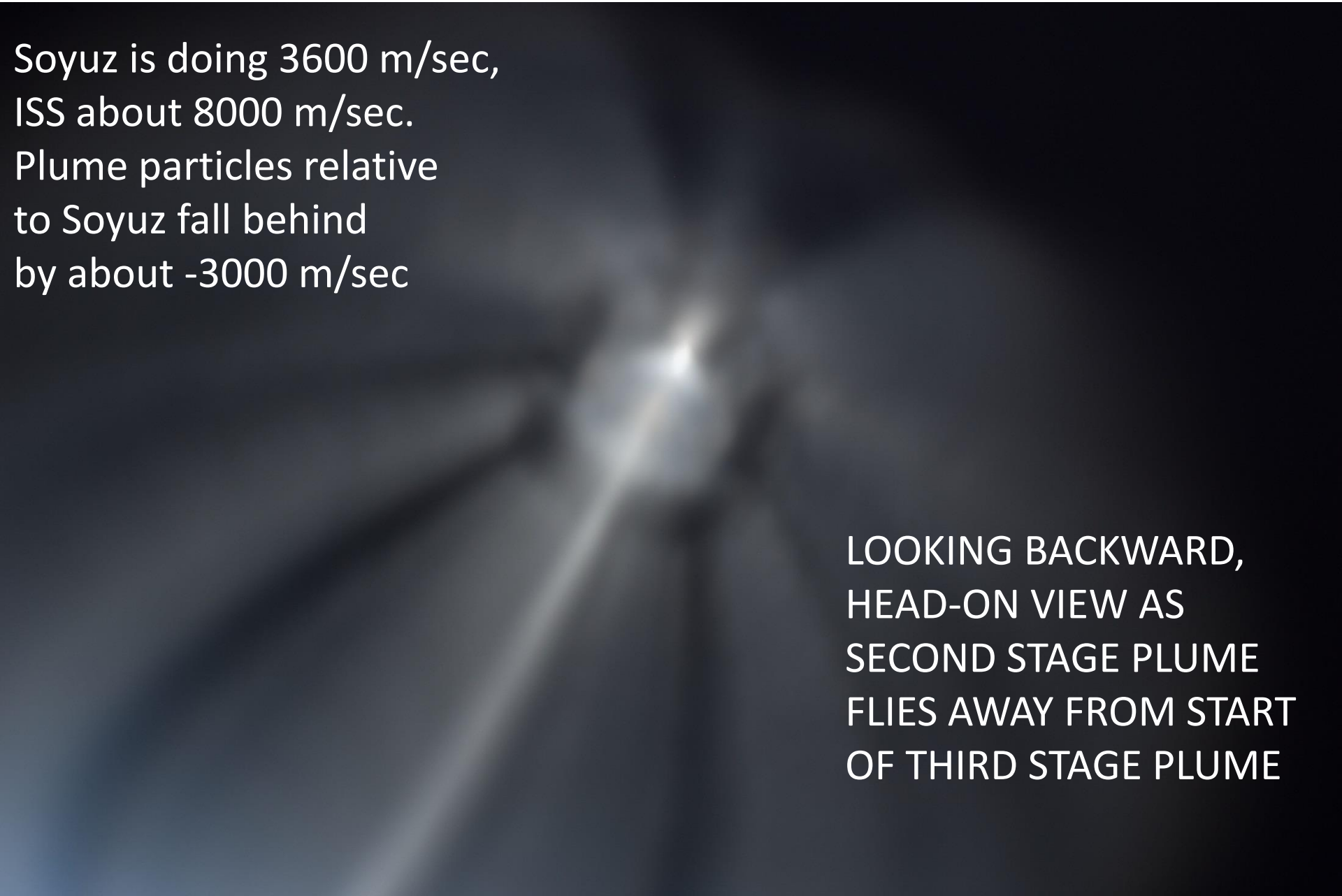
ISS 1383 11:07:54
end of stage-2 firing

Time/altitude of separation



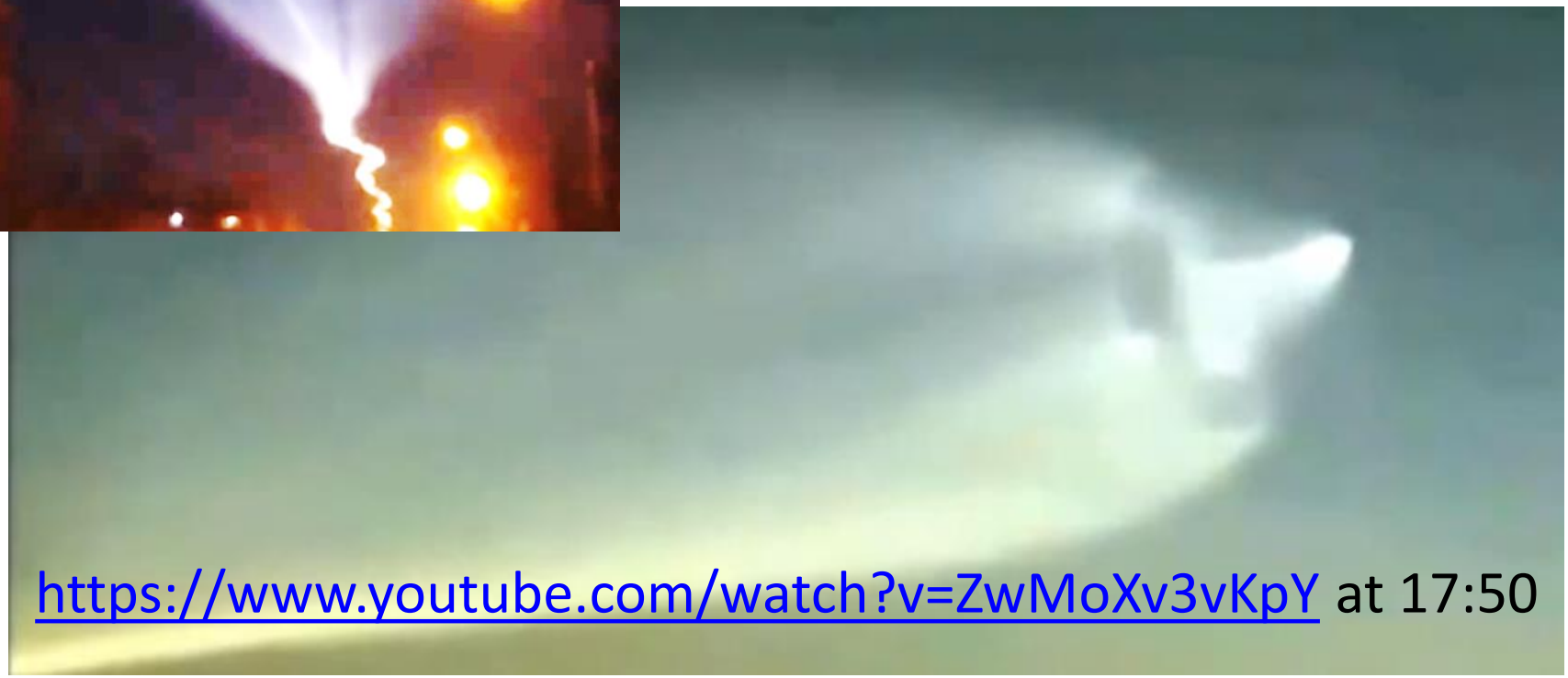
https://www.youtube.com/watch?v=K47QJ63d8EA

Stage-3 ignition -- 1384 11:07:58



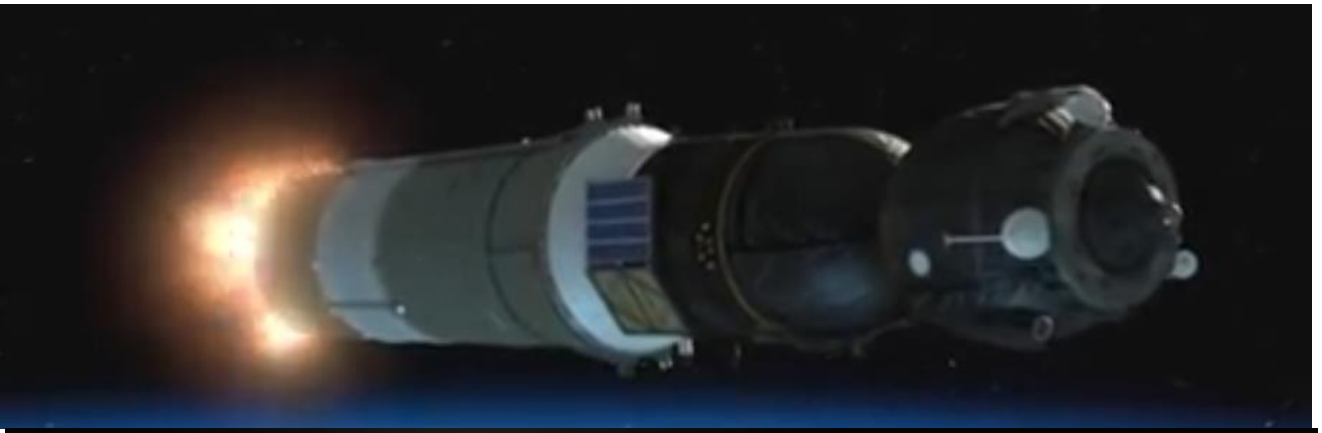
Stage-3 plume expansion – 1386 11:08:04

Ground views [earlier launches]: Third stage ignition as second stage plumes drop behind



https://www.youtube.com/watch?v=ZwMoXv3vKpY at 17:50

Also see https://www.youtube.com/watch?v=0Yo8f7fQFO8



THIRD STAGE BURN

Scott Kelly @StationCDRKelly

#Soyuz blasts through the atmosphere on its way to @Space_Station! #SoyuzTMA19M

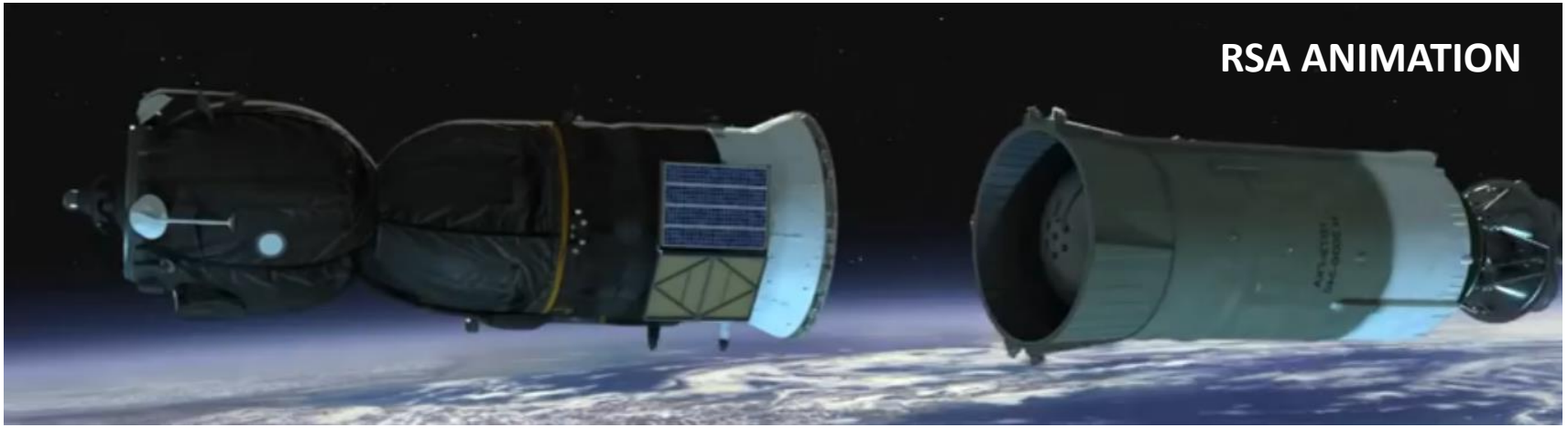
[Image# ISS046e01388 just after stage-3 ignition]

1402 11:09:30

Post stage-3 shutdown, complex maneuvers

- Stage-3 performs backaway thrusting [creates ‘headlight illusion’ to ground observers]
- Soyuz spring slight posigrade separation
- Soyuz performs attitude maneuvers
- Ejected propellant creates curved plume cloud

Third stage shutdown


RSA ANIMATION


The Soyuz launch sequence explained
esa
Third stage separation
T+00:08:57.56

Departing 3rd stage sep thrust [rocketcam view from payload]

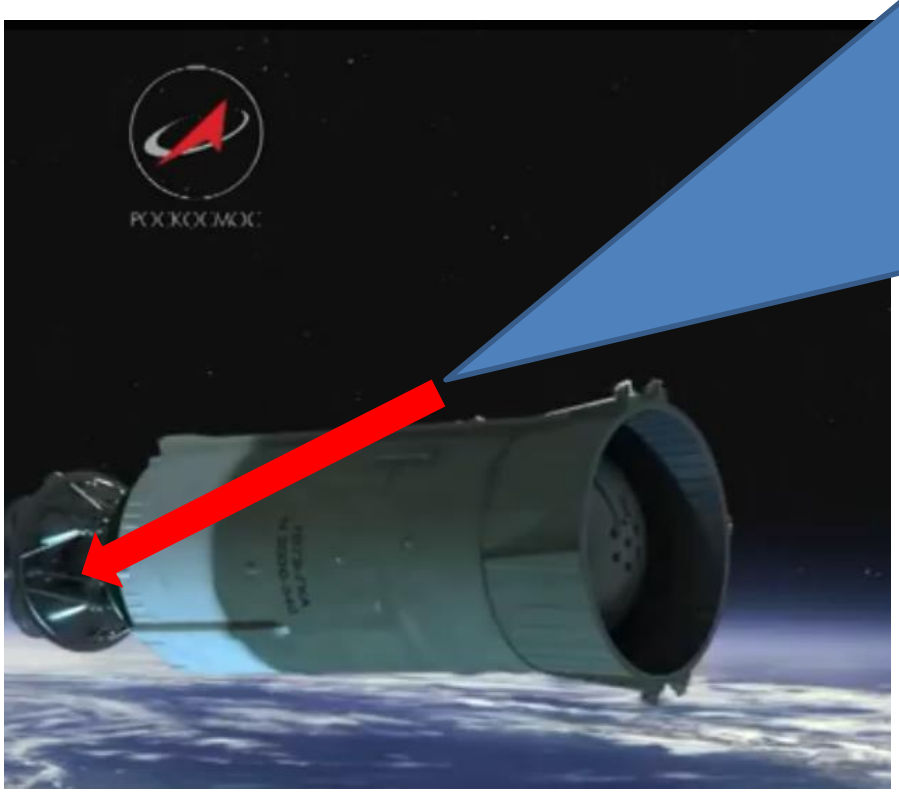
VS07 [ESA] Kourou Apr 3, 2014

https://www.youtube.com/watch?v=vHWDNrrfhnI

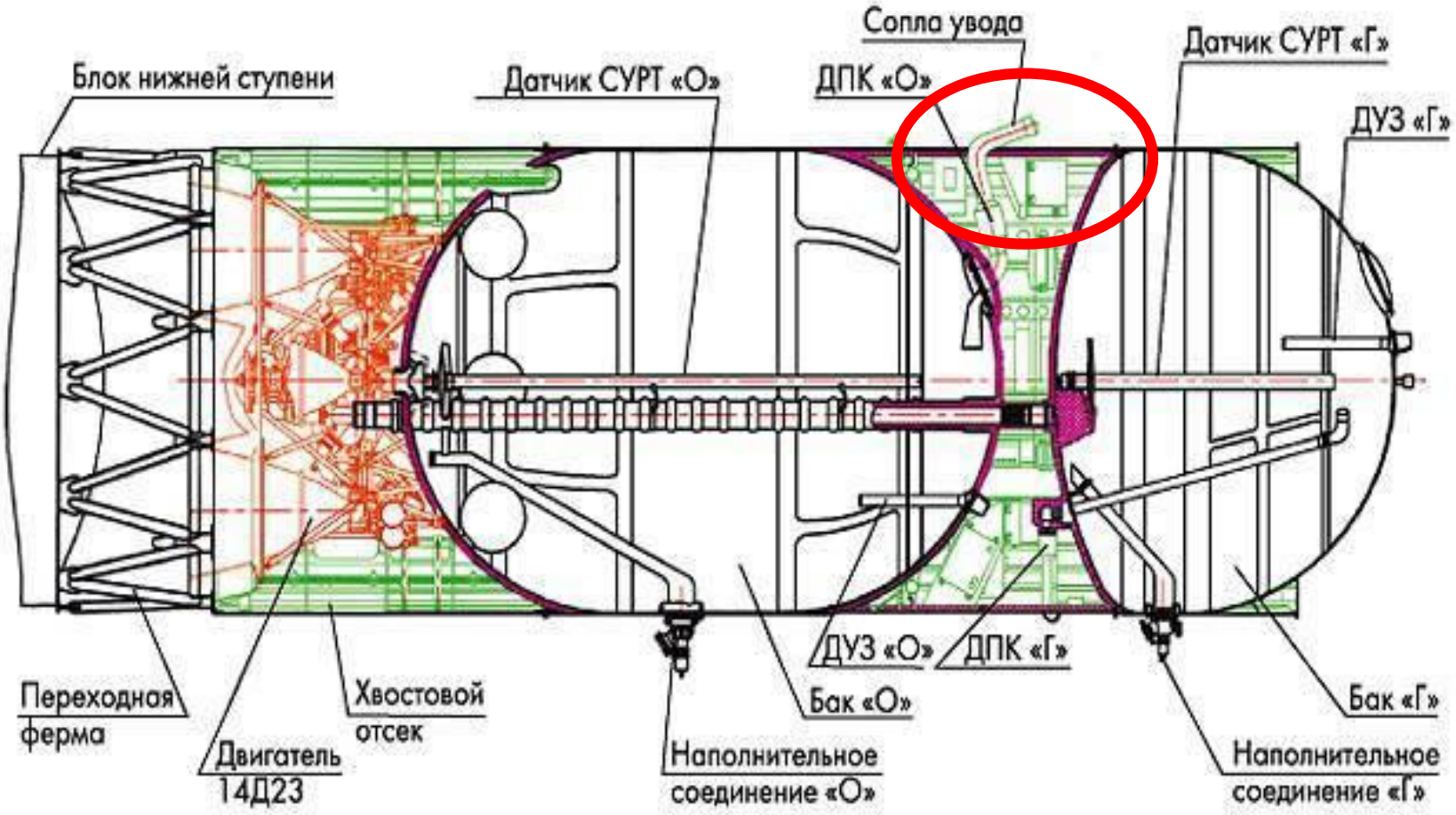
Sep to pluming,
3 seconds;
Scene cuts
after 4 sec [total
duration unknown]

CGI of plume appearance
YOUTUBE: “Soyuz Launch Sequence Explained”

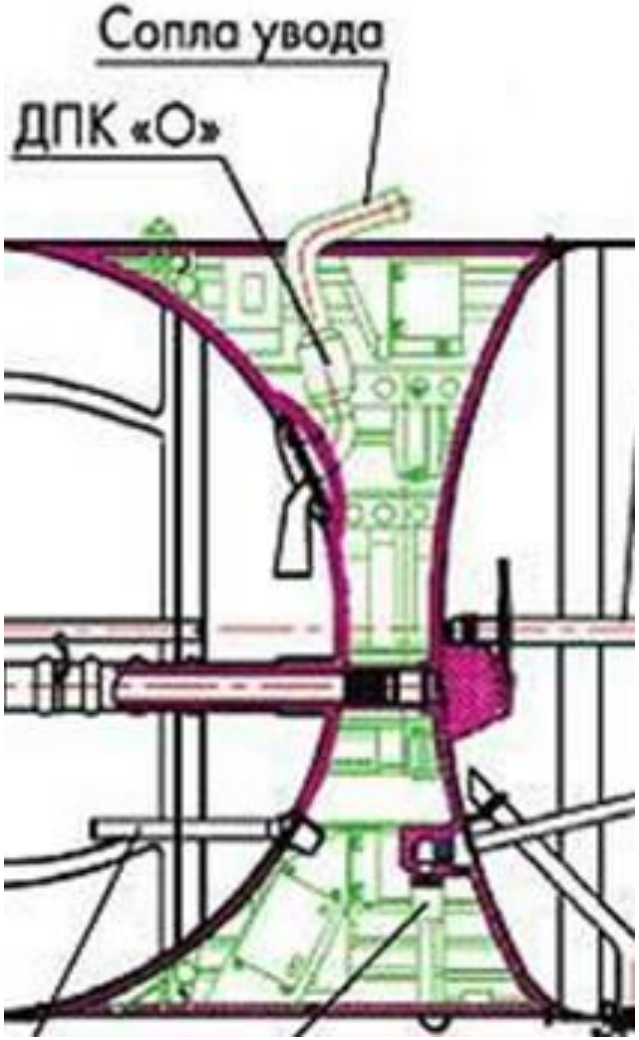
Thrust vector approximately through empty stage center of mass



Oxygen vent line



http://www.pvsm.ru/images/nezametnye-slojnosti-raketnoi-tehniki-chast-4-eshyo-pro-dvigateli-i-baki-16.jpg



Сопла увода [dump nozzle]

View of vent during booster rollout

http://spaceflight.nasa.gov/gallery/images/station/crew-27/hires/201104020008hq.jpg

Common souvenir of Baykonur

<<Снять перед стартом>>

REMOVE BEFORE FLIGHT

[my collection retrieved from flame pit]

Videos of separation

- Soyuz animation
- https://www.youtube.com/watch?v=lVlwzTc0xis
- https://www.youtube.com/watch?v=uJPB-F8C168
  16:10 animation
- https://www.youtube.com/watch?v=BWSD8xvl4TY

11:12:07 post-shutdown “comma”flare

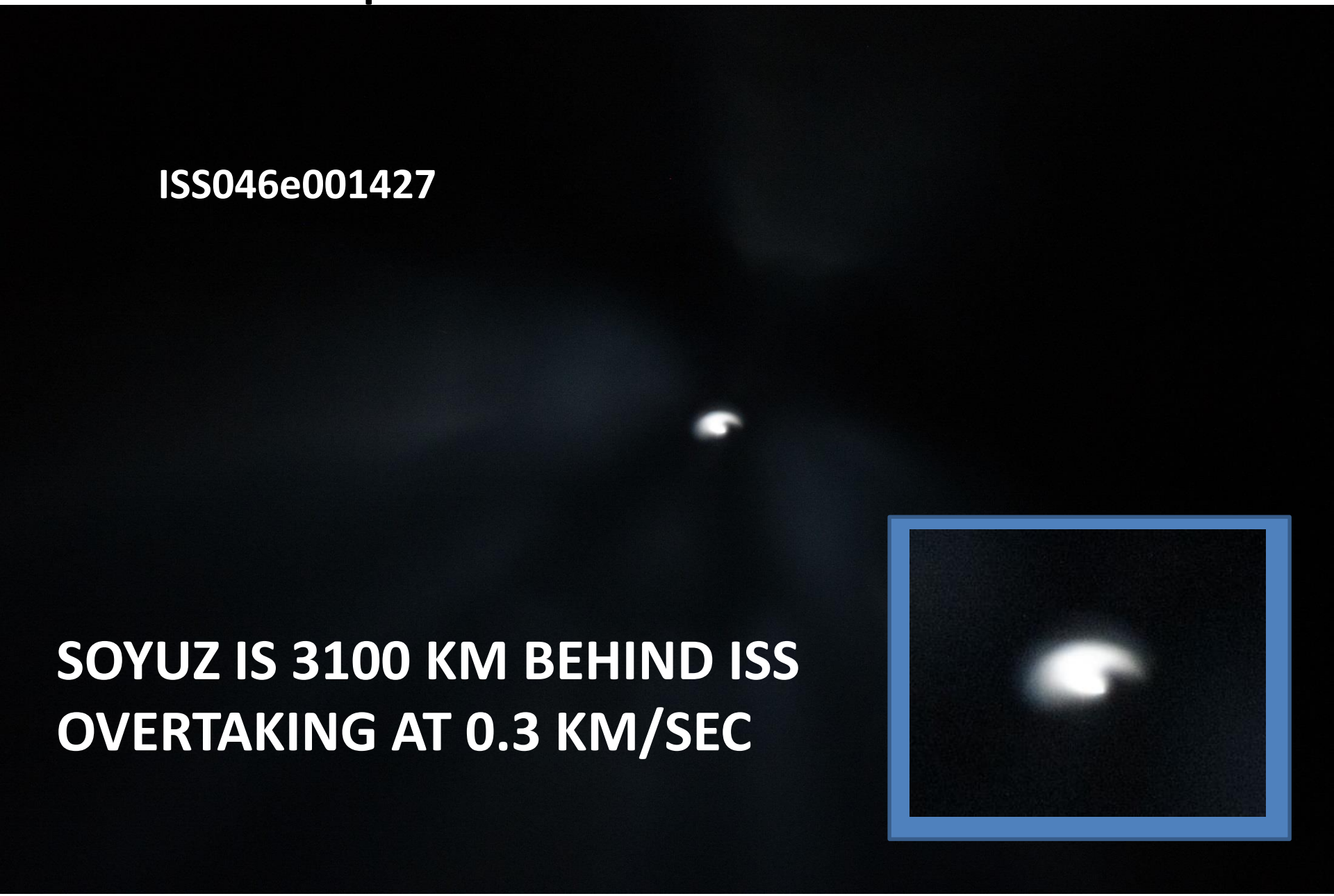
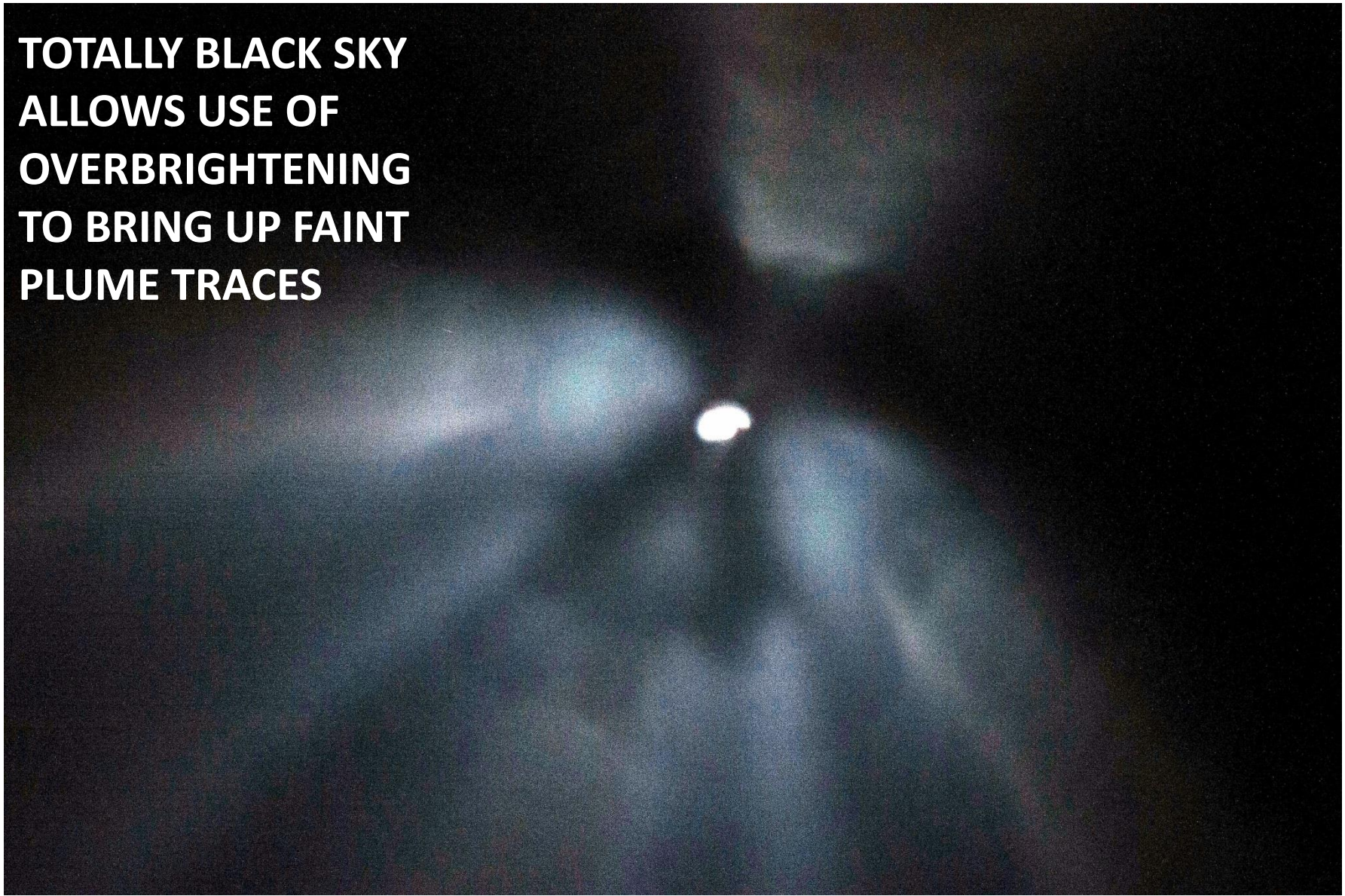
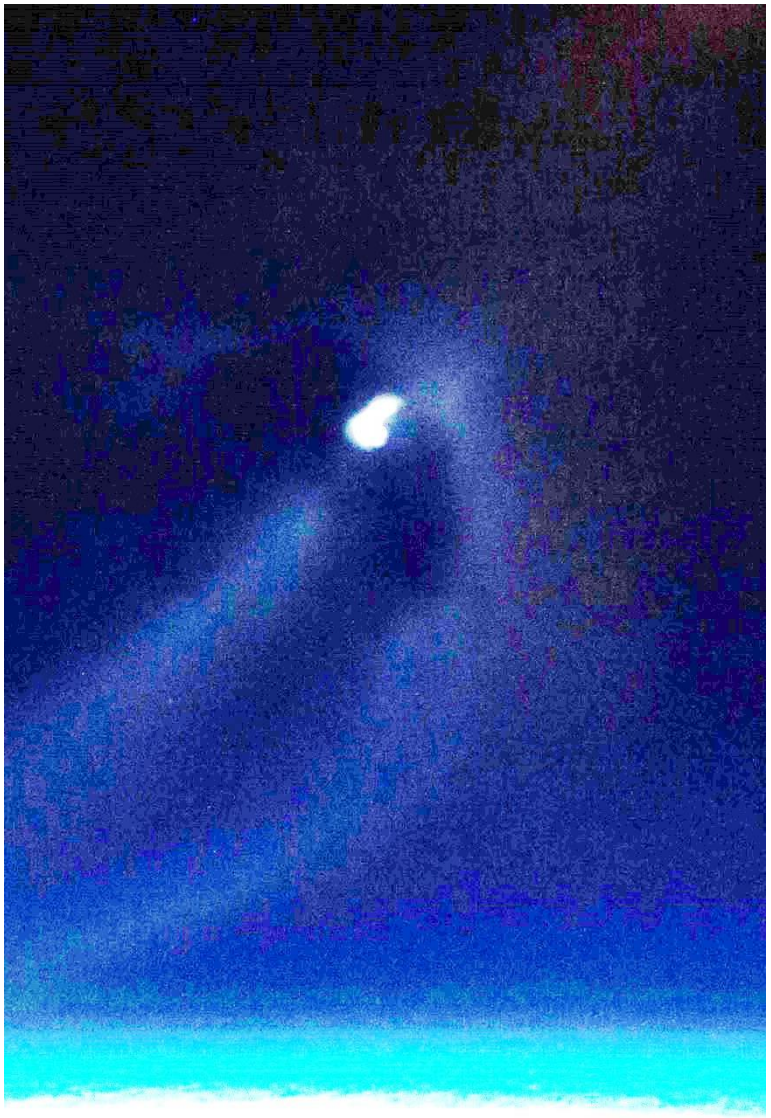
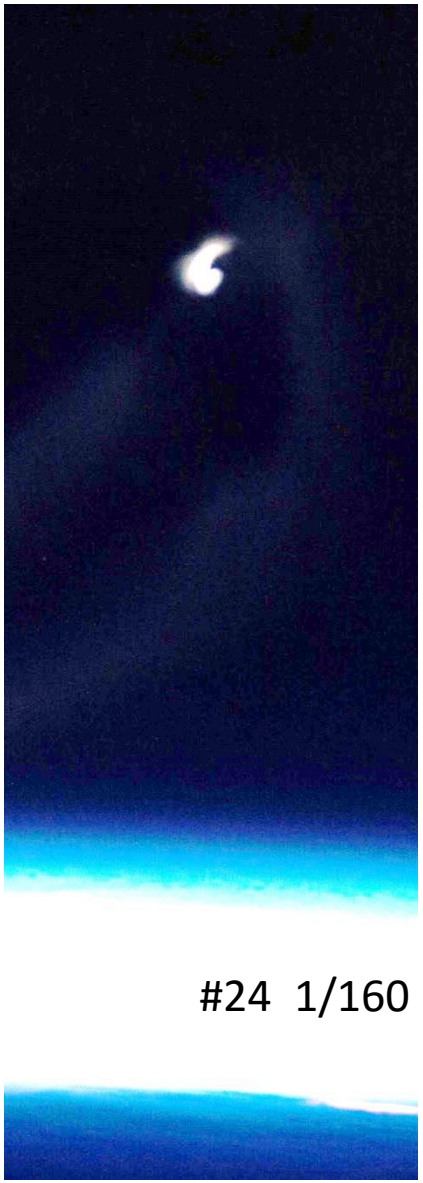


Photo iss046e001427 11:12:07 bright





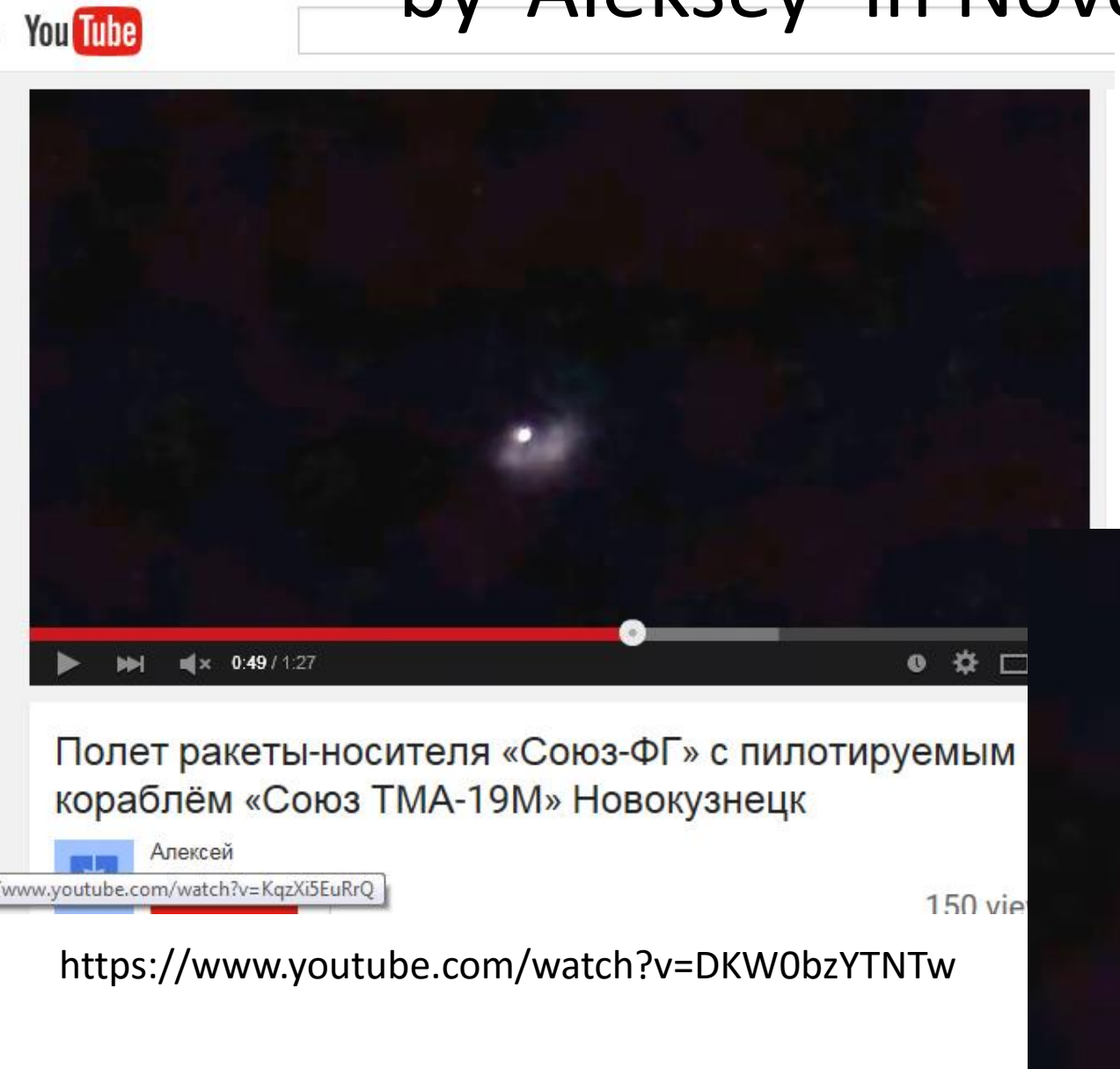
Over-brightening shows traces of former plume dispersal



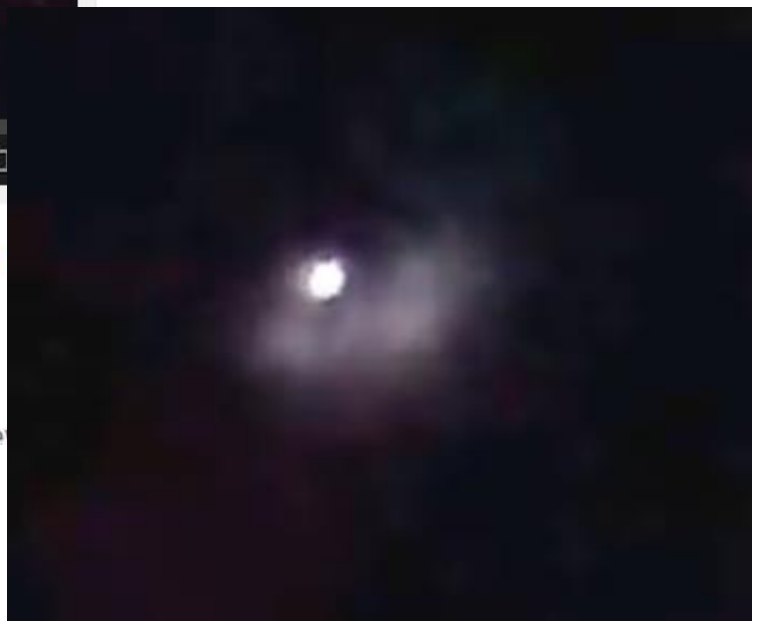
#24 1/160 2014:06:14 17:26:36

Identical "comma" flare imaged from ISS on earlier [Gerst] accidental observation of Soyuz booster navsat launch from Plesetsk [2014 june 15]

Soyuz TMA-19M ALSO observed by ‘Aleksey’ in Novokuznetsk

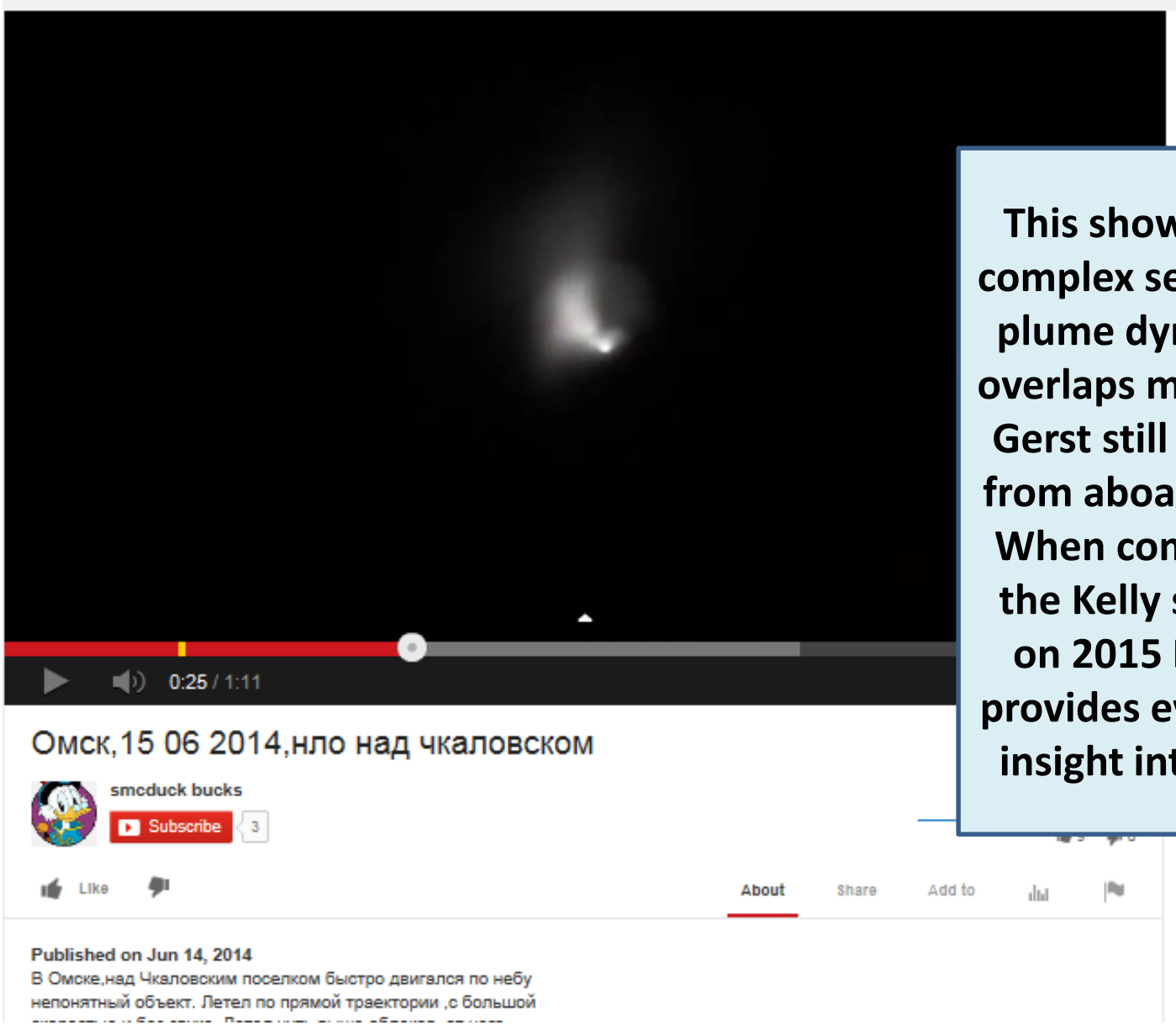


Stabilized zoomed view of 3rd stage cutoff followed by ‘comma cloud’ formation and dissipation – BEST!!



https://www.youtube.com/watch?v=DKW0bzYTNTw

2014 June 15 Plesetsk Soyuz GROUND view



This shows a VERY complex sequence of plume dynamics. It overlaps much of the Gerst still sequence from aboard the ISS. When compared to the Kelly sequence on 2015 Dec 15 it provides even MORE insight into plume.

https://www.youtube.com/watch?v=wfPXJliQCU0

An earlier notorious “comma cloud” -- ”TOMSK, SIBERIA, 2006”

“COMMA CLOUD” FEATURE

Soyuz-TMA-M (Baykonur, 2015) [left, right] ISS view, Novokuznetsk
Soyuz-GLONASS (Plesetsk, 2013) [left, right] ISS view, Omsk view

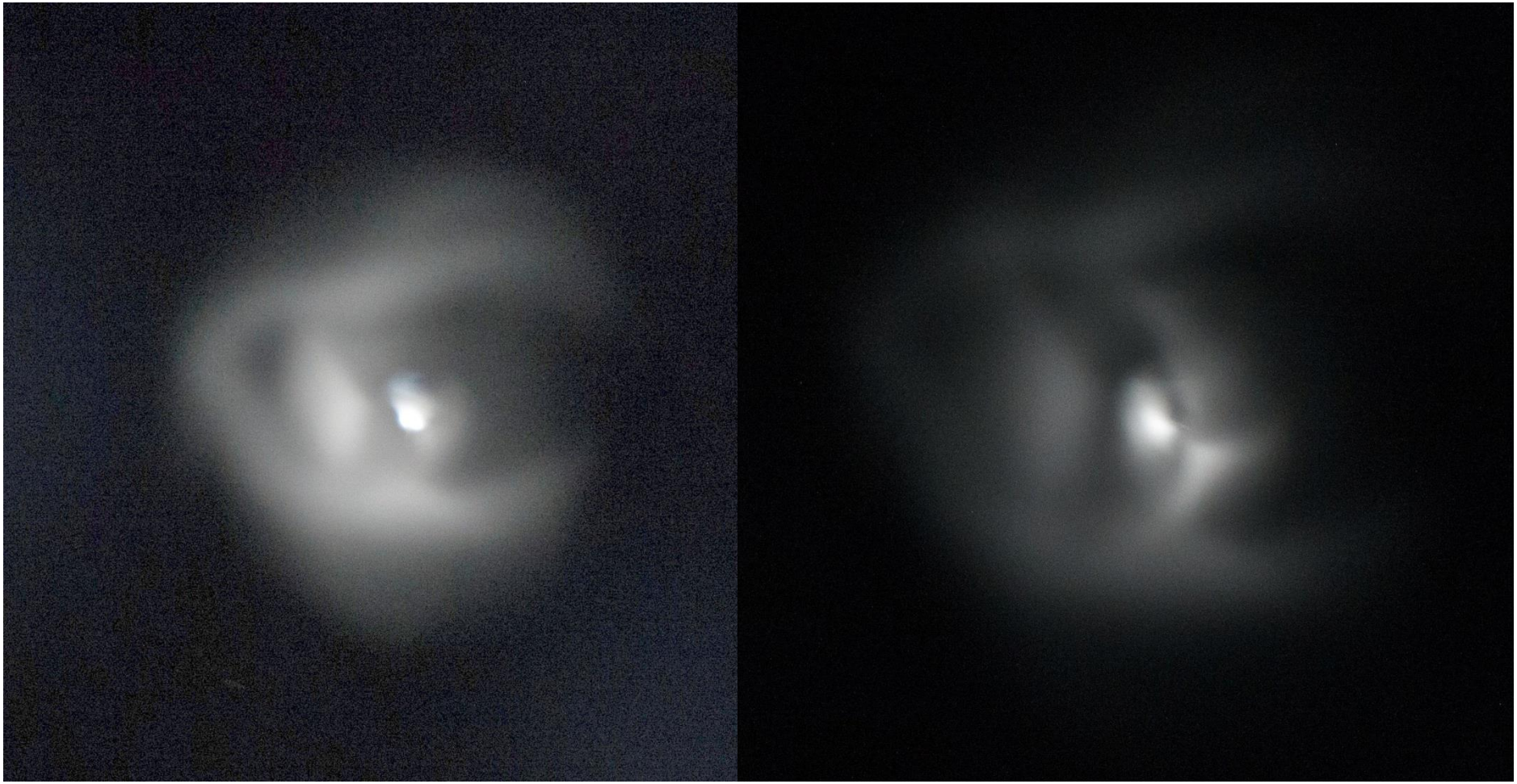
Confirmed by NASA JSC PAO

- [If I'd listened to live NASA launch commentary Dec 15 I'd have learned it THEN]
- NASA: "The third stage performs an avoidance maneuver by opening a valve in its liquid oxygen tank to steer well clear of the Soyuz spacecraft."

- https://archive.org/details/Expedition46ResourceReel
- Scroll down to "Launch-Coverage Expedition-46-prelaunch-broll and launch 328134"
- Footage of interest begins at 01:25:02 thru 1:29:21


Stage shutdown,
plumes depart

Dec 15 Soyuz flare clouds //
image 1439, 11:12:34
image 1464, 11:13:05

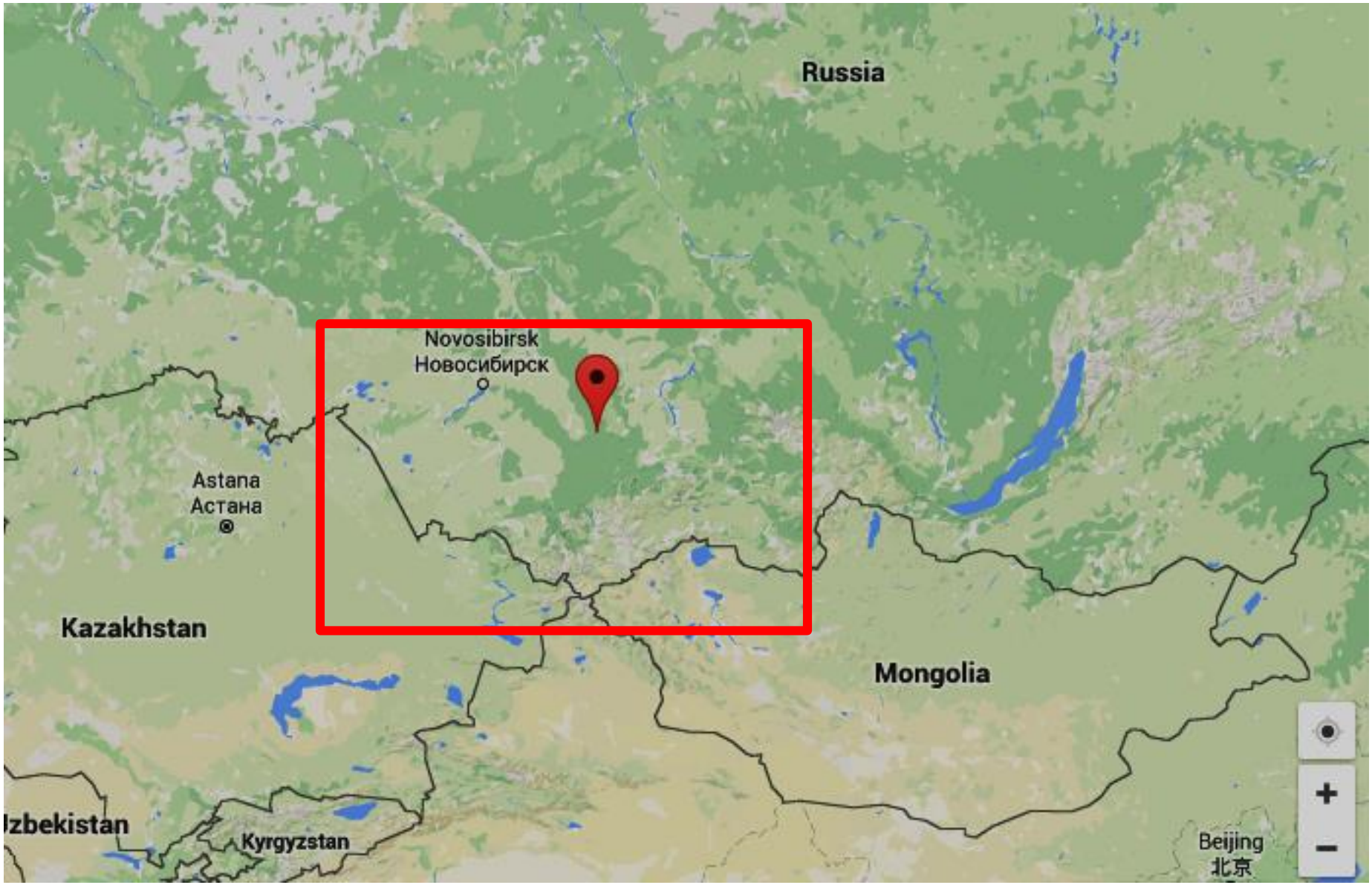


Post-firing – overbright / 1465 at 11:13:08

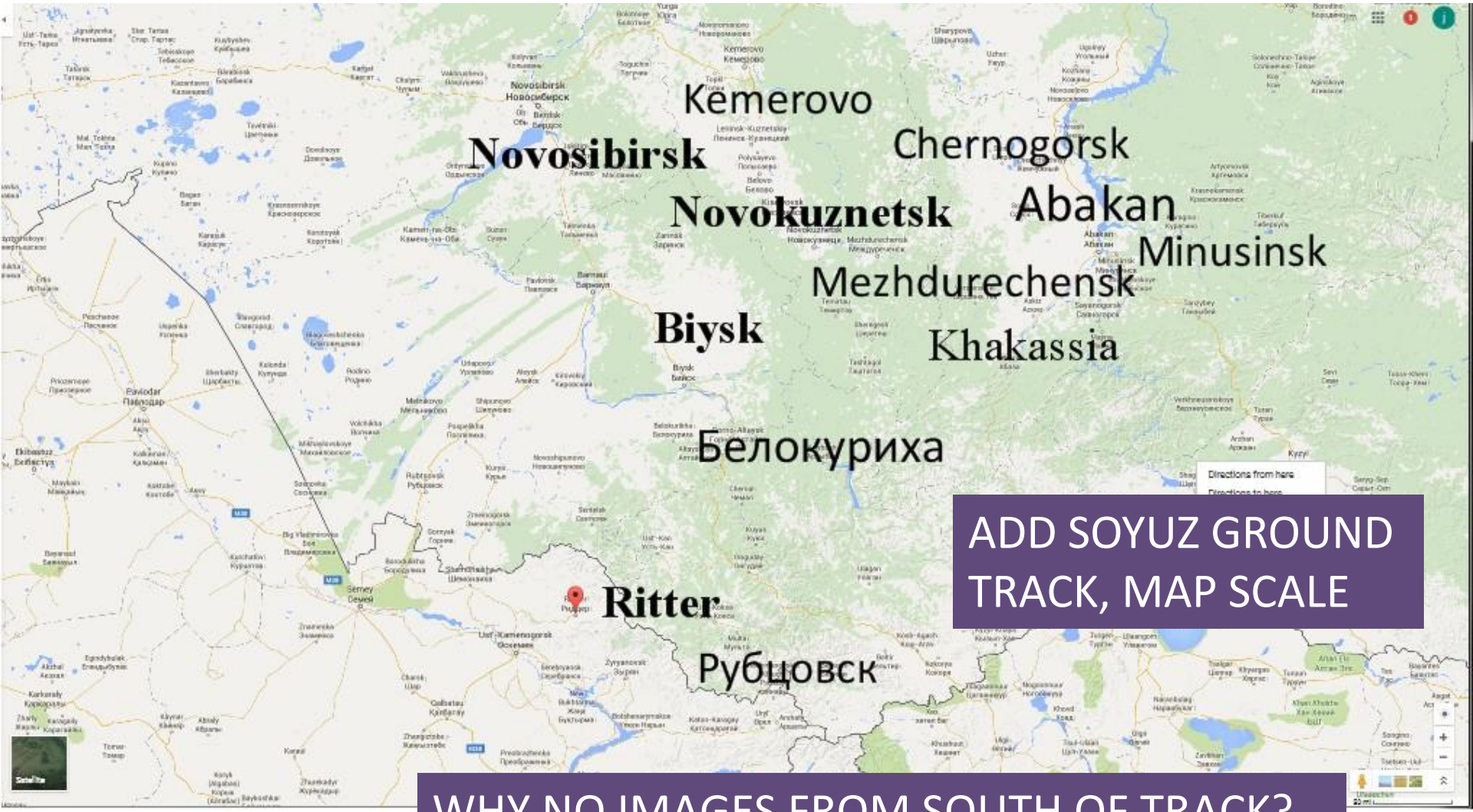
Ground view of 3rd stage shutdown & separation

- Complex post-sep flare plumes also observed with high-quality videos and still imagery from the ground, both from off to the side and also almost directly below
- Six Novokuznetsk videos show shutdown/separation from below and abeam allowing precise timing of flarings – 5 seconds post burnout coast, 10 seconds active 'comma' flare development
- IMAGES IN DETAIL WITH ANALYSIS LATER IN THIS PRESENTATION
- https://www.youtube.com/watch?v=gg4sR-R99u0 and https://www.youtube.com/watch?v=OGvYOJ7oWVY
  [**MVI 2639by** Петр Панктковский] are spectacular
- https://www.youtube.com/watch?v=6kcBeicMfCA also
- https://www.youtube.com/watch?v=co3zA4WLjuE not too shabby Николай Сергеевич, **Ступень от ракеты в Междуреченске**

Region of ground observations



Location of ground reports/videos



Ground-based side view of stage-3 shutdown, separation flare [time exposure ~ 5 sec]

http://siberiantimes.com/upload/information_system_52/3/8/6/item_3862/information_items_3862.jpg

The Siberian Times

'What happens in Sibera stays in Siberia...unless it is covered by The Siberian Times'

http://siberiantimes.com/other/others/news/n0523-amazing-light-show-as-soyuz-rocket-takes-british-and-us-astronauts-to-space/

Home News Features Business City Focus Sport Culture Science Health & Lifestyle Ecology Weird & We

Amazing light show as Soyuz rocket takes British and US astronauts to space

By The Siberian Times reporter

16 December 2015

Siberian night sky illuminated by launch from Baikonur in Kazakhstan.

Soon after blast-off, their Soyuz TMA-19M rocket made a spectacular journey across the Siberian night sky. Picture: Alexey Malitsky

Russian commander Yuri Malenchenko arrived at the International Space Station with astronauts Major Tim Peake, from the United Kingdom, and Tim Kopra, from the US.

But soon after blast-off, their Soyuz TMA-19M rocket made a spectacular journey across the Siberian night sky, with a dazzling display caught on camera by residents in Kemerovo and Altai regions as well as the republics of Altai and

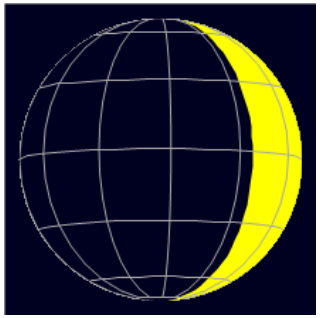
Local news coverage in southwest Siberia

"In fact, the local media in many regions had alerted Siberians to the expected rocket display in advance, and it didn't disappoint."

Lufthansa pilots snap Soyuz [AKA 'Principia' ESA mission] launch from airborne vantage point

European Space Agency website -- During the Principia launch on 15 December, Lufthansa pilots Michael Schwarz and Frank Barma were lucky enough to see the launch of Tim Peake, Tim Kopra and Yuri Malenchenko from the cockpit. They managed to snap these pictures of the Soyuz rocket ascending to space.

At the time these pictures were taken, Lufthansa flight LH 713 was above Russia, approx 100 km east from Novosibirsk. The Boing 747 was enroute from Seoul to Frankfurt.

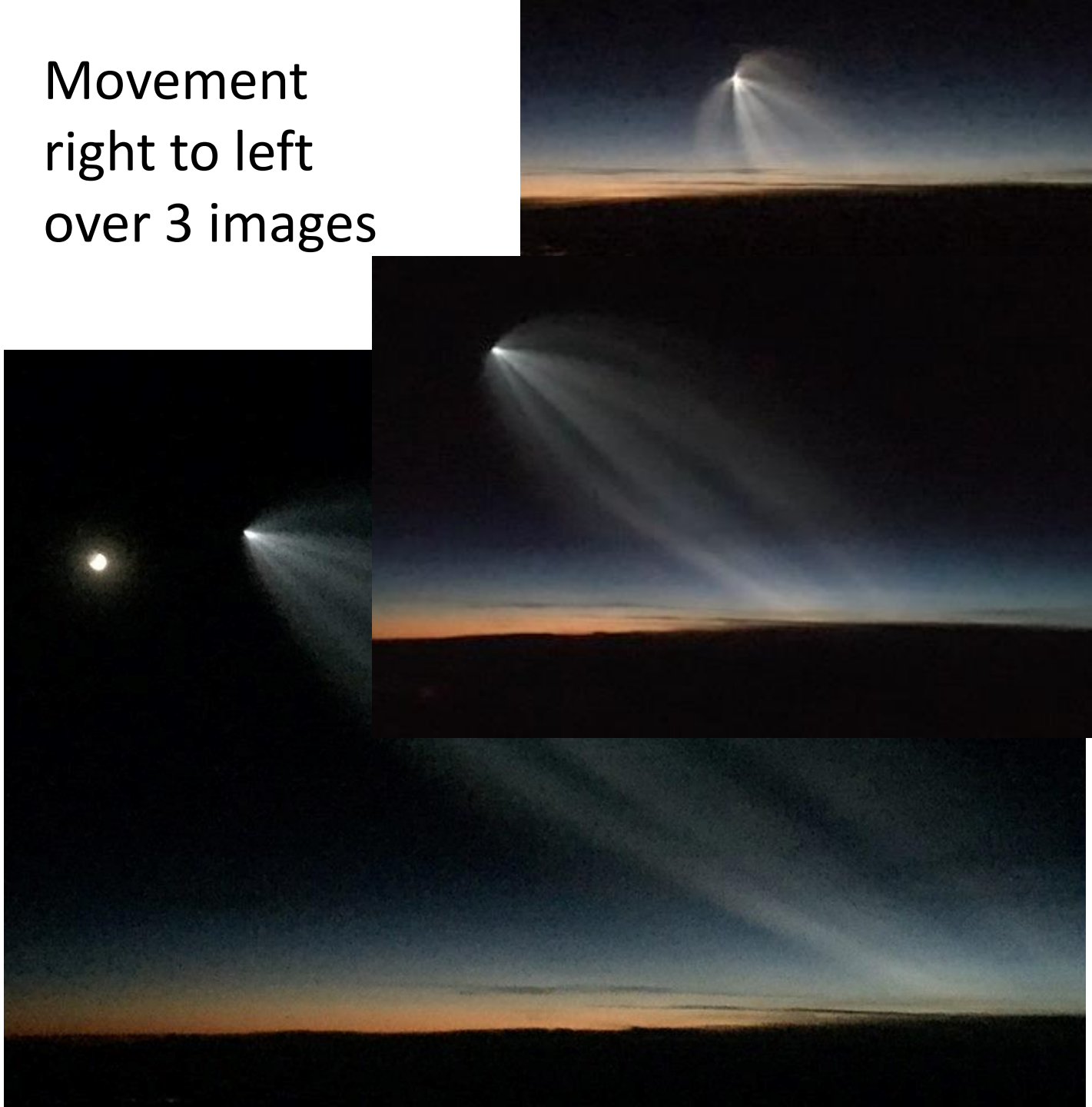


Novosibirsk sunset 16:00 [gmt + 6]
At 17:03 local [launch], sun azimuth 240, el -8
Moon azimuth 199, el 19

NOTE: No personal account from Schwarz or Barma found so far. Main question: were they advised in advance to keep an eye out for the scheduled launch, or was the sight a surprise and they happened to have a camera ready?

http://blogs.esa.int/tim-peake/2015/12/17/lufthansa-pilots-snap-principia-launch-from-the-skies/

Movement
right to left
over 3 images



Line up via
horizon and
cloud features

Lufthansa 747 photo 1 of 3 [westbound dead ahead]

[stock photo]

PILOTS IMAGES NEEDED

Moon azimuth from Novosibirsk region, airliner location marked


Lufthansa-1

Compare to this ground view, same time and close location

http://siberiantimes.com/PICTURES/OTHERS/Soyuz-lauch-in-Siberia/inside_belokurikha.jpg

Compare to near-simo ISS view

Lufthansa 2

Lufthansa 3

Some media reports call it a ‘UFO’

«НЛО» в небе над Черногорском?

Жители Черногорска накануне вечером были взбудоражены появлением в небе над городом яркого светящегося объекта, оставлявшего за собой блестящий хвост.

Как выяснилось позднее, черногорцы беспокоились напрасно. Светящимся шаром оказался пилотируемый корабль «Союз ТМА-19М», запущенный с космодрома Байконур, с международным экипажем на борту.

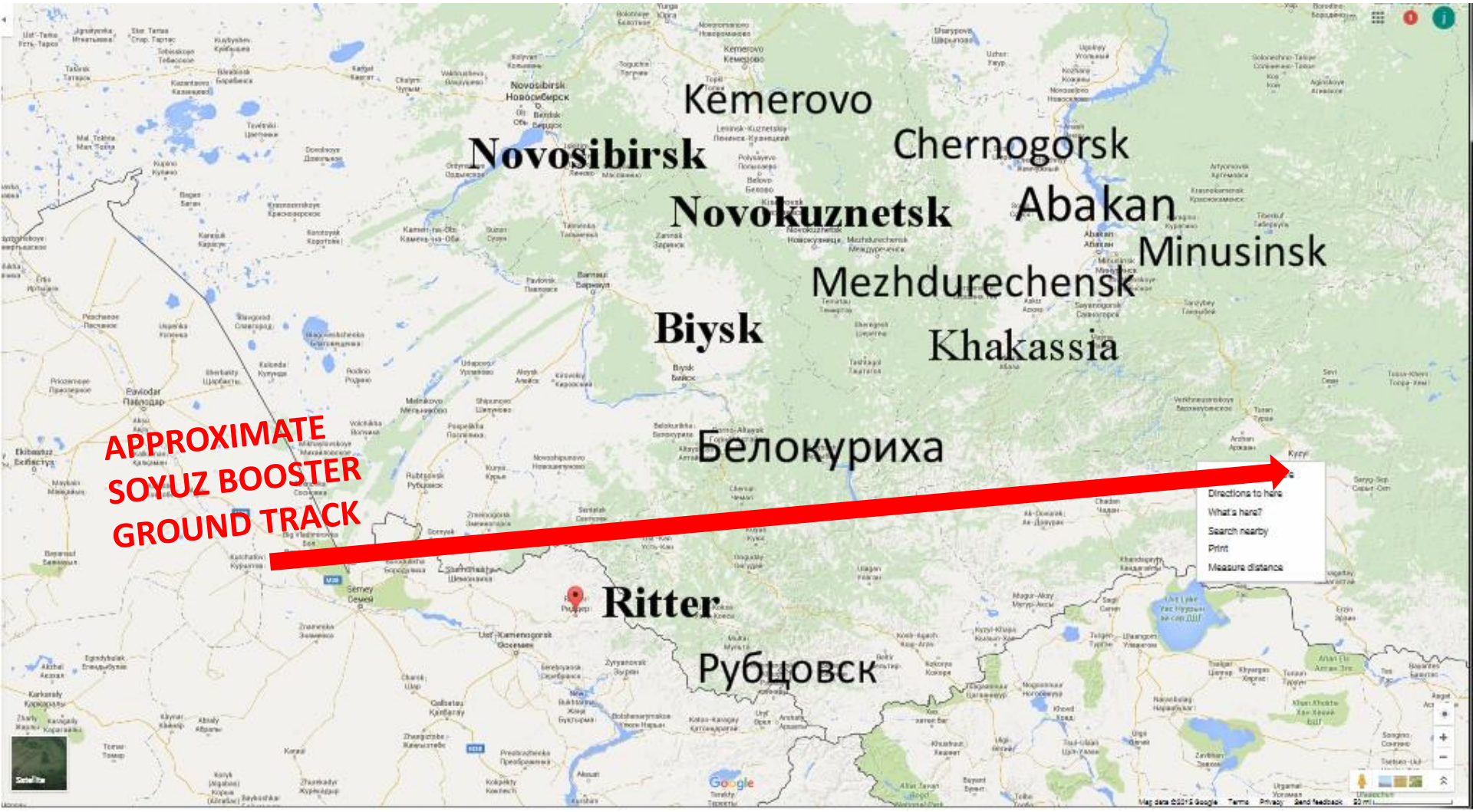
Появление в черногорском небе яркой «медузы» - это всего лишь эффект выхлопных газов работающей ракеты, подсвеченных на больших высотах Солнцем.

«Медузу» в ночном небе наблюдали жители Черногорска, Абакана, Минусинска, Новосибирска, Омска, Новокузнецка, Кемерова и других сибирских городов.

“Inhabitants of Chernogorsk, Abakan, Minusinsk, Novosibirsk, Omsk, Novokuznetsk, Kemerovo, and other Siberian cities saw it.”

http://ch-inform.ru/index.php/novosti/item/1547-nlo-v-nebe-nad-chernogorskom

Additional ground videos



Ground view from near Novosibirsk

http://siberiantimes.com/PICTURES/OTHERS/Soyuz-lauch-in-Siberia/inside_lantern.jpg

В Новокузнецке летало НЛО — очевидцы

16 декабря 11:51

NOVOKUZNETSK ‘UFO’

http://vashgorod.ru/novosibirsk/news/34870

http://siberiantimes.com/PICTURES/OTHERS/Soyuz-lauch-in-Siberia/inside_city_centre.jpg

NOVOKUZNETSK photo 2

NOVOKUZNETSK photo 3

Chernogorsk photo

Yesterday evening many Biyskites observed the spectacular launch of spaceship Soyuz TMA-19M

Вчера вечером многие бийчане наблюдали зрелищный запуск космического корабля «Союз ТМА-19М»

16.12.2015 12:13

Бийск [Biysk]

Good video viewed through tree limbs
https://www.youtube.com/watch?v=Eehx-pIfByE&feature=player_embedded#t=13

http://biwork.ru/novosti/24861-vchera-vecherom-mnogie-bijchane-nablyudali-zrelishchnyj-zapusk-kosmicheskogo-korablya-soyuz-tma-19m.html

Жители Хакасии гадают, что пролетело в ночном небе над республикой

[Khakassia residents wonder what flew through the night sky over the republic]

http://ctv7.ru/news/zhiteli-hakasii-gadayut-chto-proletelo-v-nochnom-nebe-nad-respublikoy

Запуск пилотируемого космического корабля
Launching of a manned space ship

"Союз ТМА-19М“ // from Aleksey T_YMA_N in Рубцовск

Rubtsovsk [southern area of observation zone]

https://www.youtube.com/watch?v=EYC1bG3gJ3g

запуск космического корабля Союз 15.12.15г.

Алекситос // Съемка г. Белокуриха.

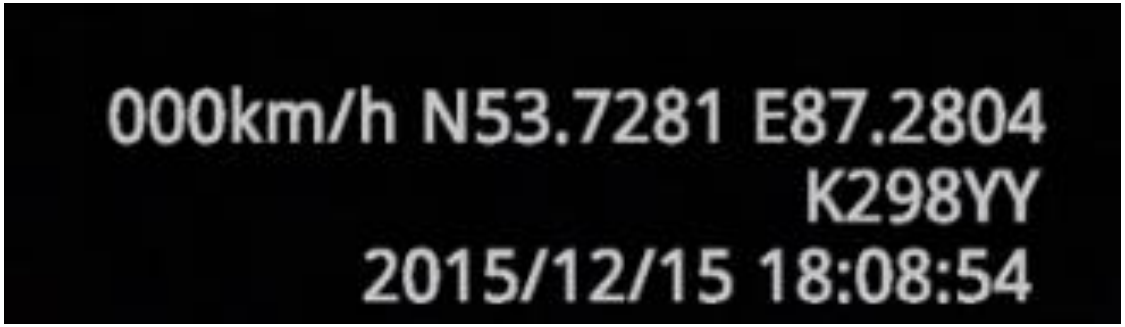
‘Aleksitos’, in Belokurikha, ascending plume, moon on left

https://www.youtube.com/watch?v=3o3IgWJUnak

Detailed observation of **third stage shutdown and Soyuz separation**, from directly off to the side

- **Пролет Союз тма-19 над Новокузнецком**
- **Fly-past of Soyuz tma-19 over Novokuznetsk**
- Роман Смирнов [Roman Smirnov dashcam video]
- https://www.youtube.com/watch?v=cGp82gMO6xc
- **Published on Dec 15, 2015 / Novokuznetsk**
- **~2:05 clears clouds in southwest**
- **4:32 3rd stage shutdown over the moon**
- **4:38 separation plume ignition**

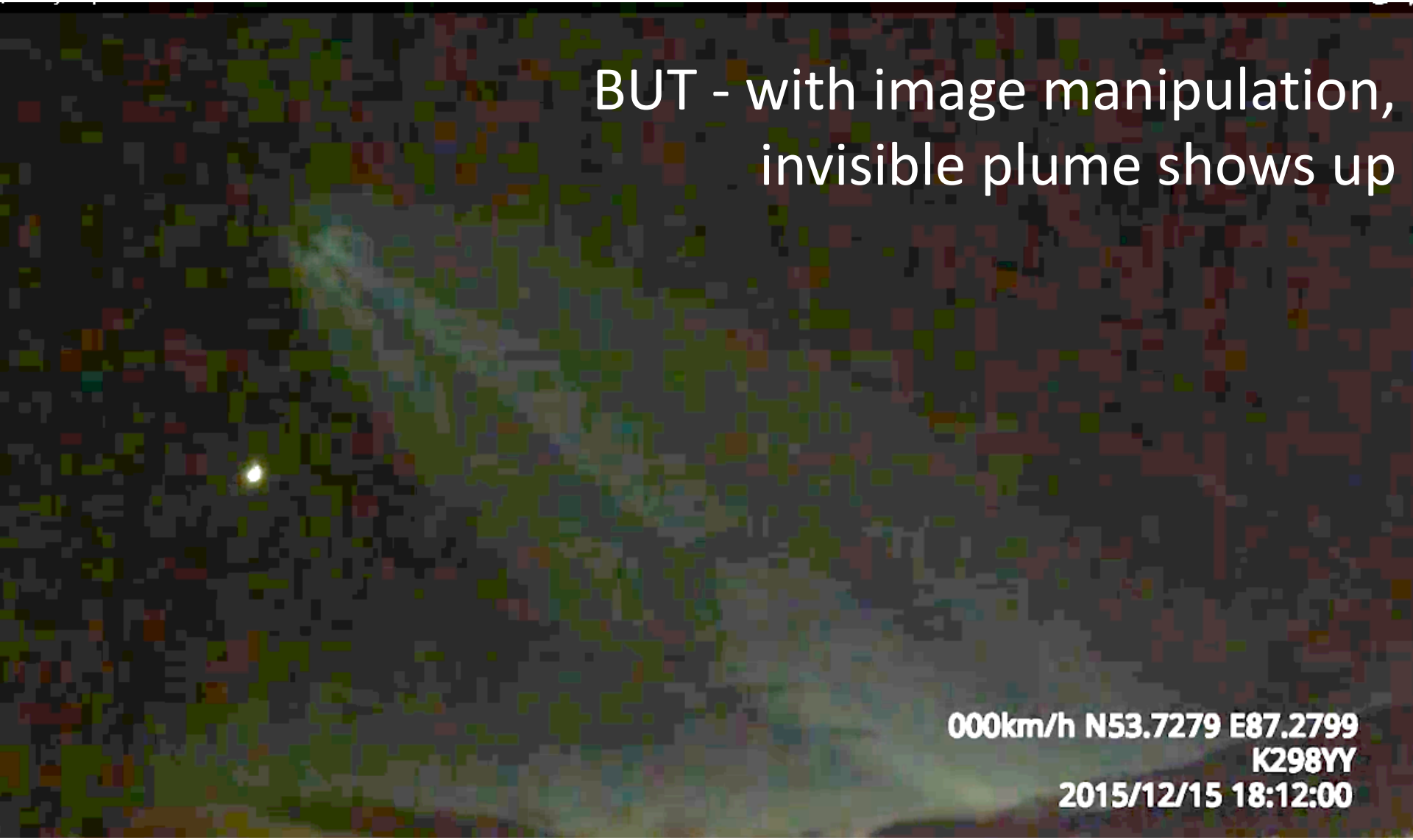
SMIRNOV'S DASHCAM DATA READ-OUT BOX [clock good to 3-4 secs]



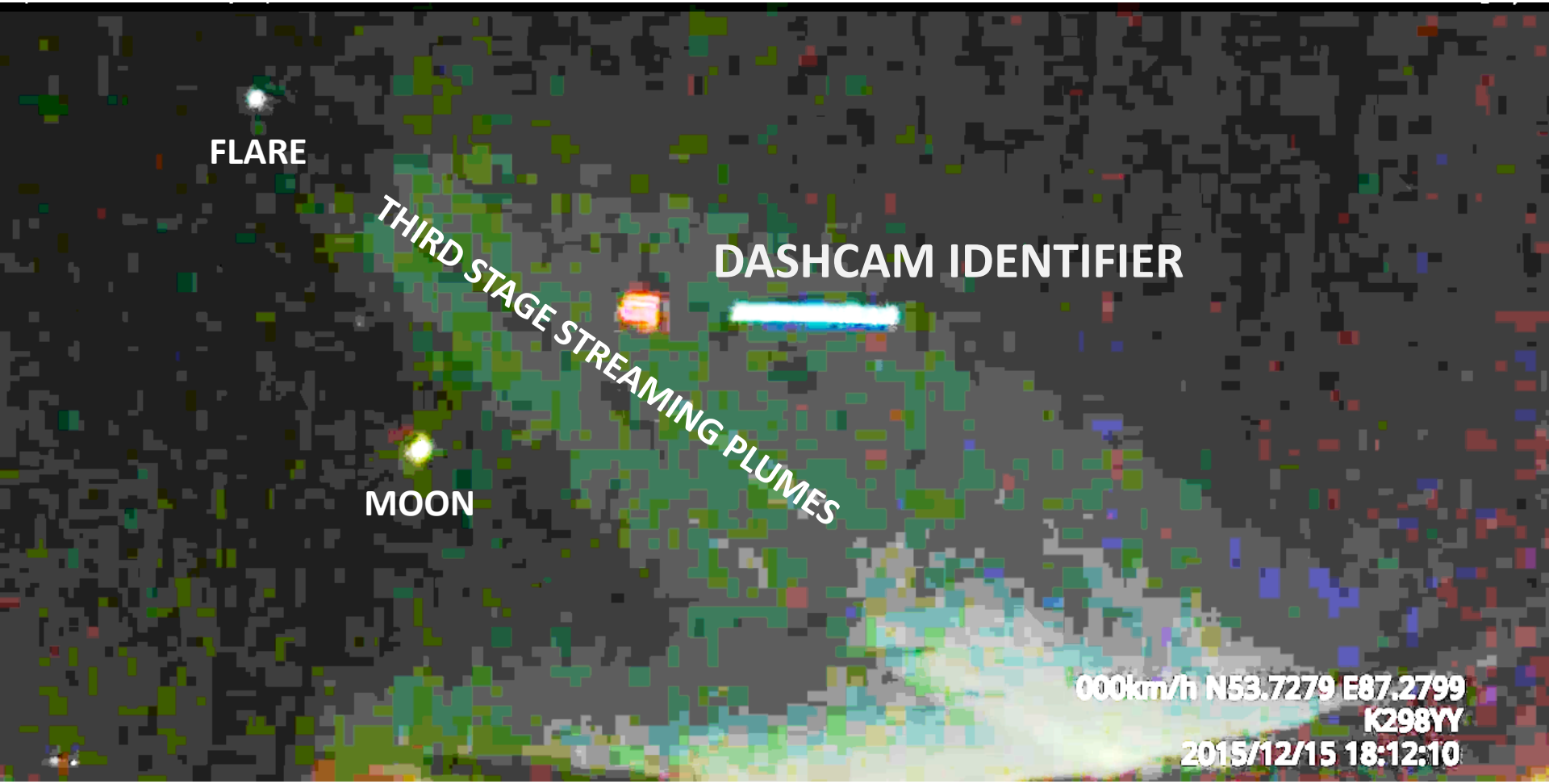
https://www.youtube.com/watch?v=cGp82gMO6xc

Soyuz 3rd stage approaches moon

When 3rd stage shuts down, sky near the moon goes dark.

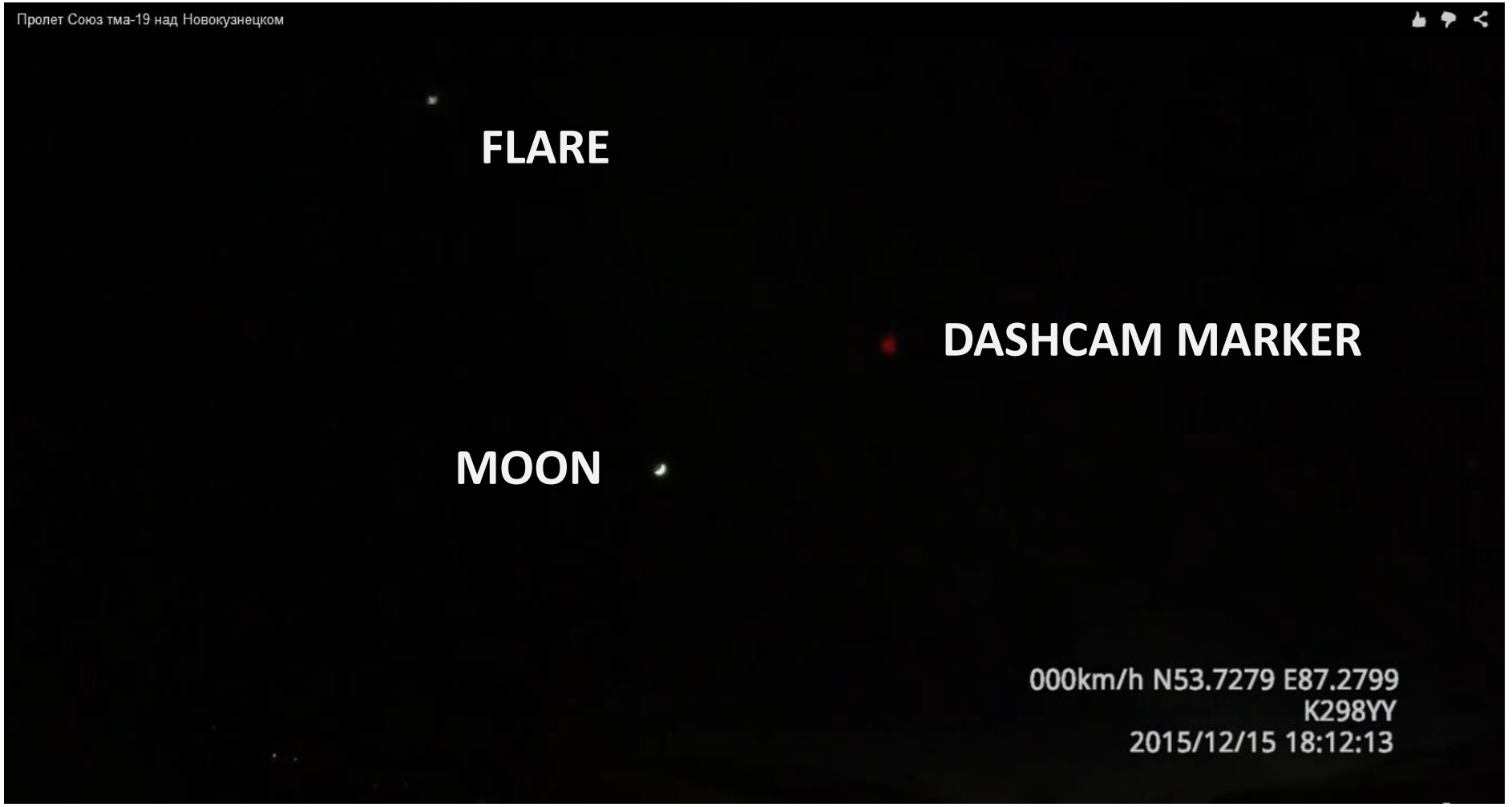


Post-sep flare begins [4:46 into video]



Video shows detailed development of pluming around Soyuz, paralleling plume dispersal recorded from in front by ISS crew.

Passes above moon in the south, light goes out for 5 seconds, then resumes for exactly 20 seconds

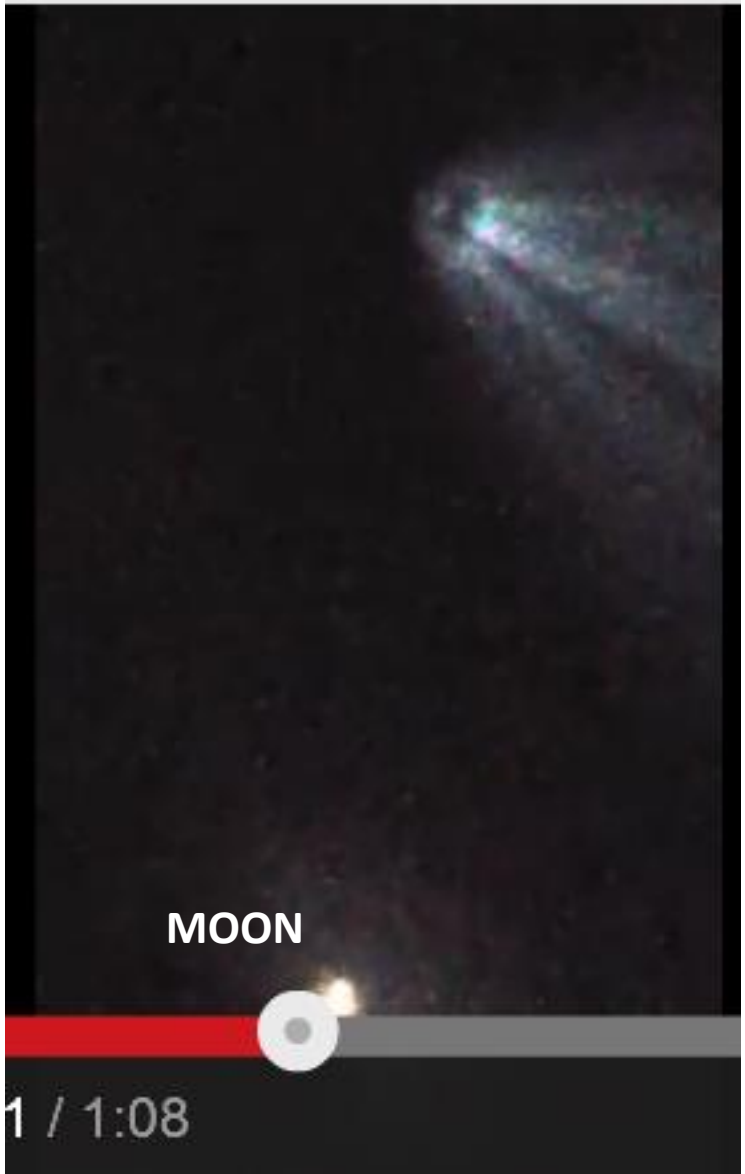


Полёт ракеты в небе над Новокузнецком Точилино

Flight of a rocket in the sky over Novokuznetsk-Tochilino

Novokuznetsk – 2nd video same angle on moon --

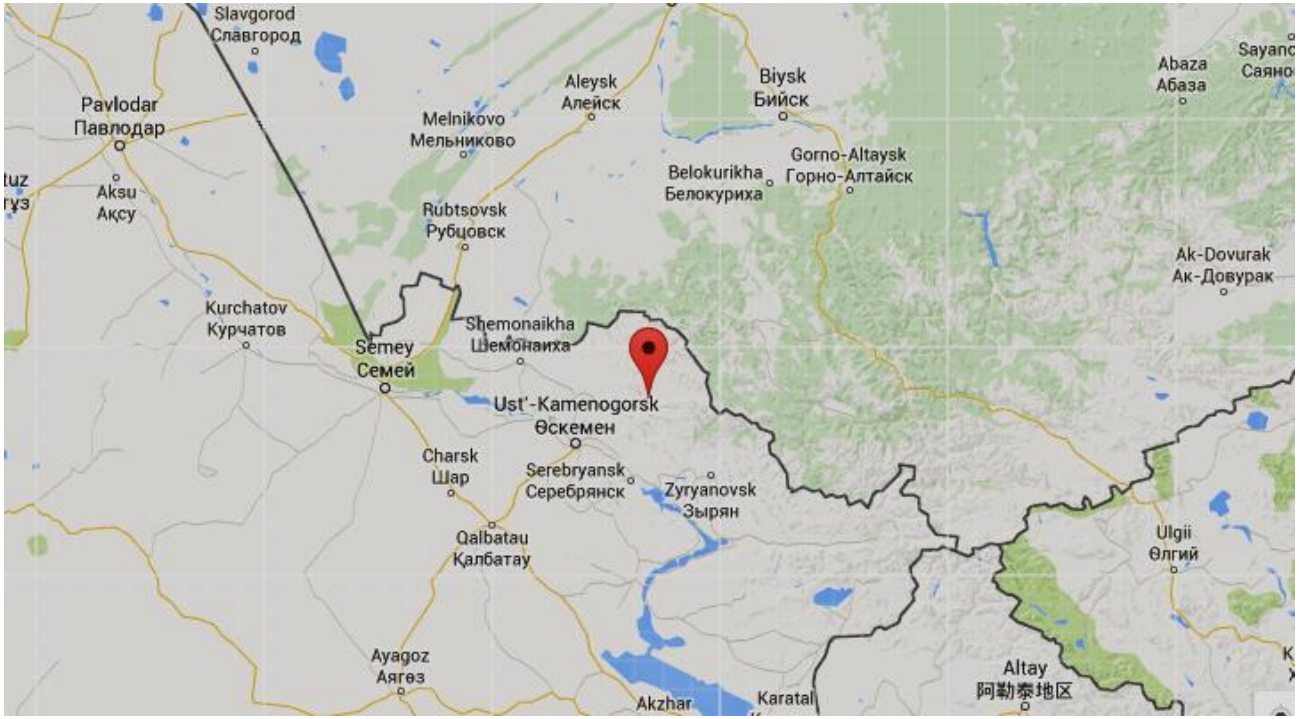
Five seconds between stage shutdown and flare.
Stable medium zoom tracking



Станислав я
https://www.youtube.com/watch?v=gg4sR-R99u0

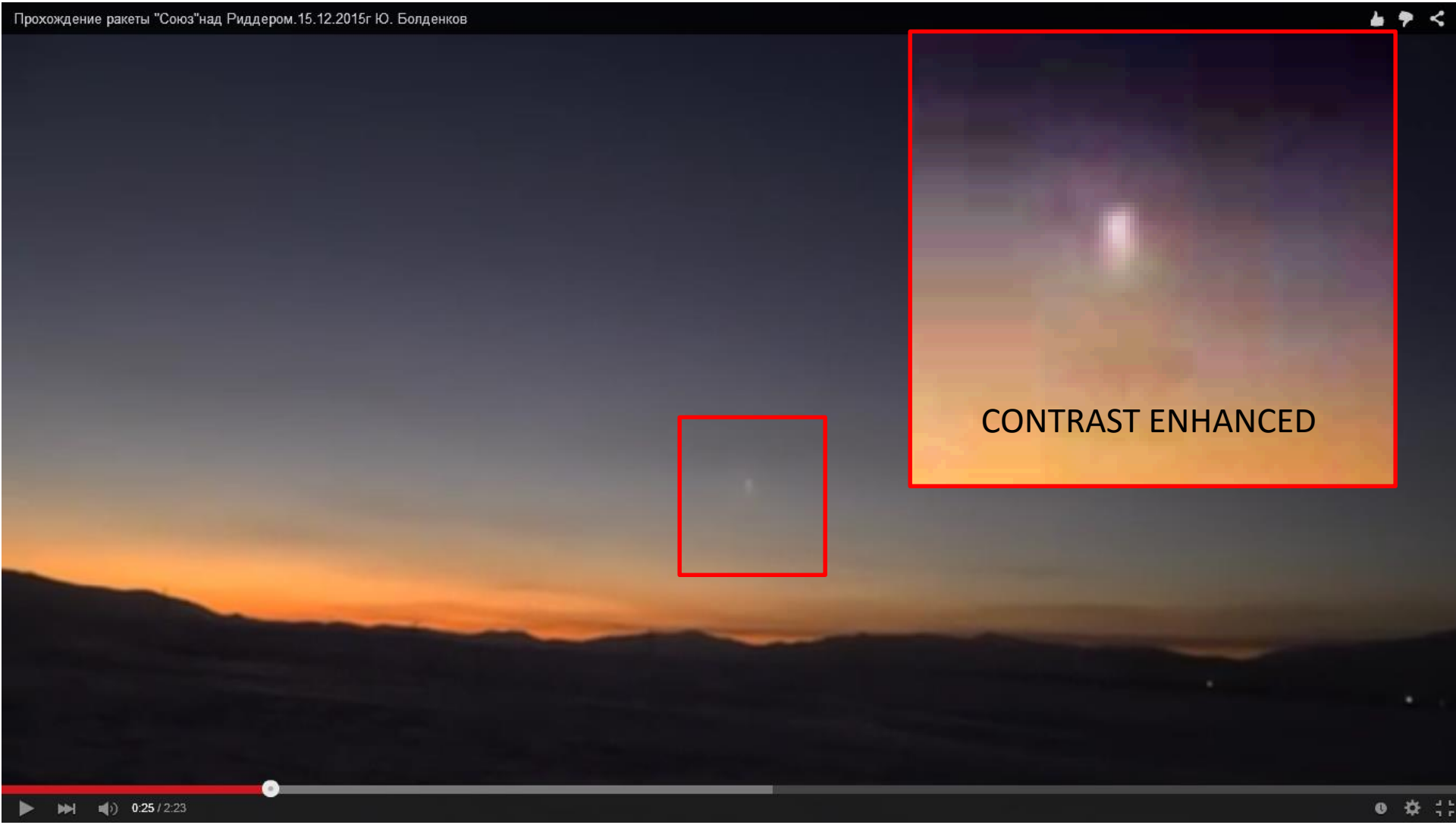
Ridder, Kazakhstan

- **Прохождение ракеты "Союз“ над Риддером.15.12.2015г**
- Юрий Болденков [Yuriy Boldenkov]
- https://www.youtube.com/watch?v=Tl6lWwFWcQ8



Located in far northeast corner of Kazakhstan near Russian Chinese, and Mongolian borders

Soyuz rises into sight [photographer was clearly waiting for it and knew where to look]



Passing directly overhead,
3rd stage shutdown
and plume drops behind

Post-separation
“comma cloud”

“Orbiter 2010” game

[https://www.youtube.com/watch?v=f4hVNNYyFws]

Anton Sergeyev [Антон Сергеев]

Extremely realistic prop venting except… vent vector SEEMS different on rocketcam

Dump duration 15 seconds!
[third stage does two full tumbles]

https://youtu.be/ya_xTsseCxc

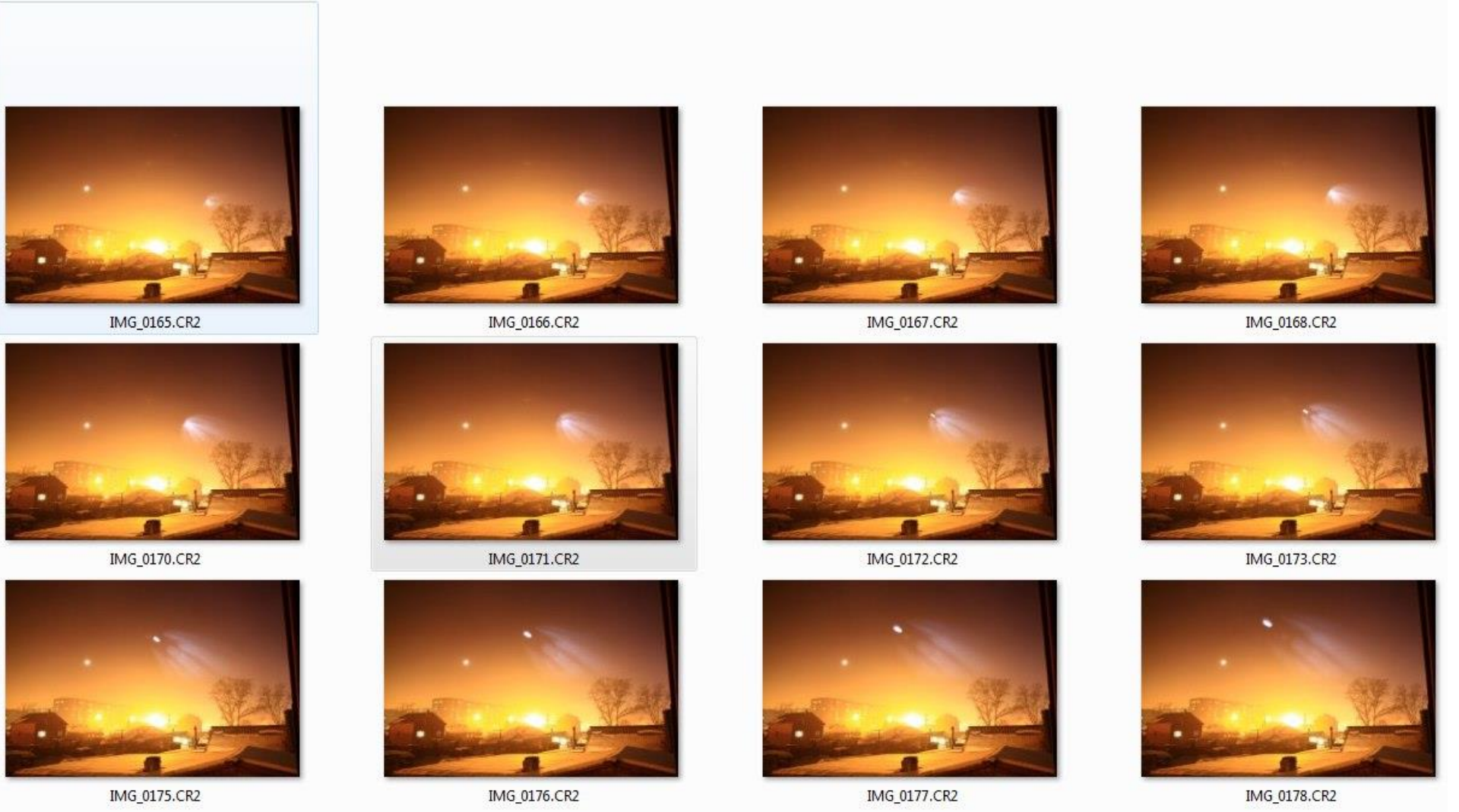
Other ground observations

- **Пролет ракеты «Союз ТМА-19М» над г. Усть-Каменогорском 15 декабря 2015г.**
  https://www.youtube.com/watch?v=RPxPTMY7dHYTbs
- **Запуск Союз ТМА-19М 15 декабря 2015 года.**
  The launch of the Soyuz TMA-19M Dec 15, 2015.
  Roman Kirsanov in Biysk Altai Territory
  https://www.youtube.com/watch?v=SI07hw-WMuQ
- https://www.youtube.com/watch?v=mpbIDx7Fzxo
- **НЛО В НОВОКУЗНЕЦКЕ //** viktor vladimirovij
  https://www.youtube.com/watch?v=KqzXi5EuRrQ
- **Полёт ракеты «Союз ТМА-19М»** Денис Инякин
  Юг Кемеровской области.
  https://www.youtube.com/watch?v=ZRSbuxvuFa8

Abakan, Russia [абакан] – 5 [?] sec exposure

http://www.politonline.ru/media/22884559.html

Degtyarev video [Алексей Дегтярев]



http://gazeta19.ru/news/37926

Time exposure captures 5-sec flare gap

"Oleg Petrov" [location unknown] uploaded many satellite/astronomy videos

https://www.youtube.com/watch?v=KTme3zGuG5k

Enhancing future observations

- Advertise beauty and engineering significance of plume shape & dynamics
- Appreciate rarity of lighting & locational context
- Image continuously including 30+ seconds after apparent shutdown; don’t forget to log location, azimuth/elevation
- The darker the sky, the more that dimmed plume structure can be extracted by image manipulation
- Develop efficient search strategy for finding private postings on youtube.com and rutube.ru and elsewhere
- Search on UFO bulletin boards and CGI/gamer sites
- Obtain specs, operational details from actual missions
- ROCKETCAMS!!!!!

Summation/implications

- Degree to which booster performance is detailed in plume dynamics -- **remarkable**
- Synoptic multi-site stereo views -- **synergistic**
- Additional Soyuz rocketcam videos highly desirable [thru end of stage-3 sep thrusting]

- Once visual manifestations better calibrated against KNOWN booster profile, future video of non-well-documented missile events elsewhere can allow extraction of performance insights
- **Specific US intel groups knew this for decades**
- **UFO enthusiasts remain excitedly clueless**

Further spaceflight visual reports

- California Trident missile freakout [Nov 7, 2015]
  http://satobs.org/seesat_ref/misc/misperceiving_missiles.pdf
- Russian ICBM tests with evasive warheads [ISS observation]
  http://satobs.org/seesat_ref/misc/KYSS-12.pdf
- Plesetsk launch observed from ISS
  http://www.jamesoberg.com/ISS_crew_spots_se cond_russian_rocket_rev_c.pdf
- Norway spiral [December 2009] was Bulava ICBM
  http://spectrum.ieee.org/aerospace/military/russias-ailing-icbm-program
- Misperceptions of satellite reentry fireball swarms
  http://www.jamesoberg.com/1963_kiev-fireball-swarm-rev-B.pdf
- Cross-country visual reports of STS-72 reentry
  http://www.jamesoberg.com/96mar-sts72_entry.pdf
- Soviet massive ‘space war game’ triggered June 1982 UFO flap in China
  http://www.jamesoberg.com/china-em-ufo-1982-draft-2.pdf