THE 2012 LYRIDS FROM NON-TRADITIONAL OBSERVING PLATFORMS

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2012 LYRIDS

- Typically ZHR = 18
- New Moon near shower peak
- Favorable viewing geometry from ISS
- Astronaut Don Pettit onboard ISS

A chance to observe meteors from ISS!

GOALS

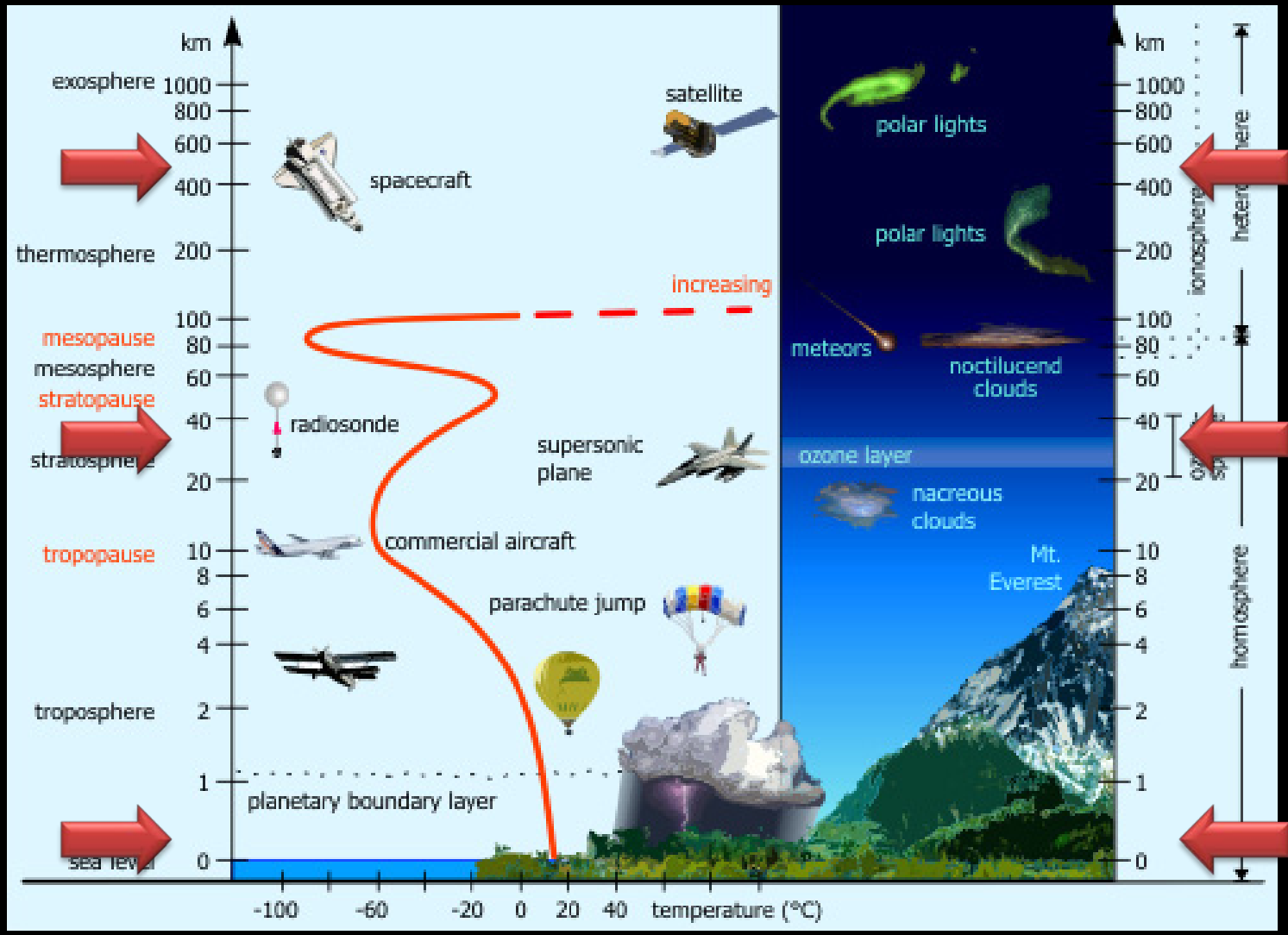
- Observe the 2012 Lyrids from
  - Ground
  - International Space Station (ISS)
  - Balloon
- "Proof of concept" balloon flight
  - Detect meteors with a simple, inexpensive payload
- Correlate any meteors seen between platforms

3 OBSERVING PLATFORMS

ISS

Balloon payload

Ground-based

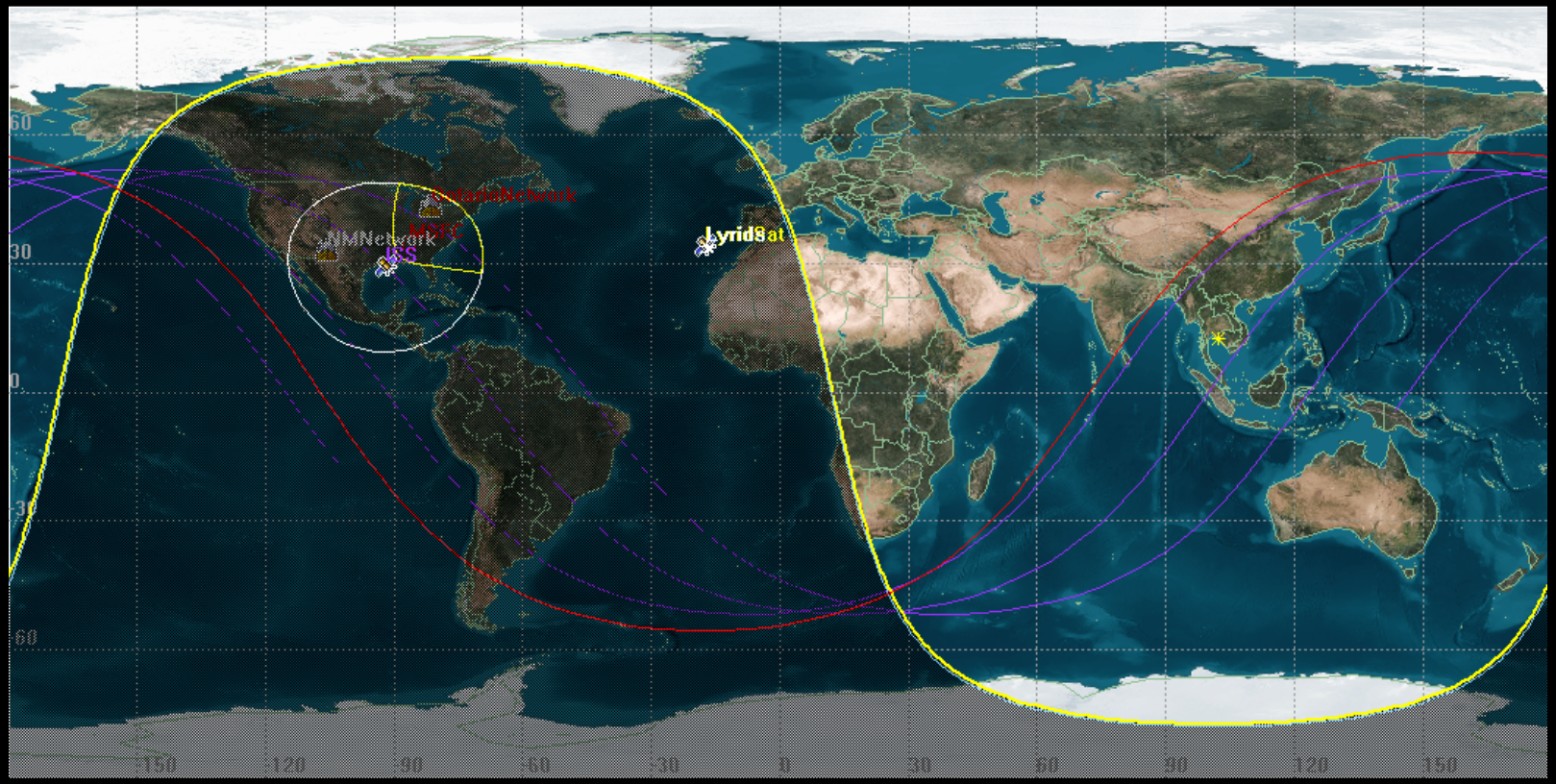


GROUND-BASED OBSERVATIONS

22 April 2012 – during the Lyrid meteor shower peak

Notice to Meteor Camera Operators

- A message was sent to meteor camera operators on 17 April requesting observations during the night of the Lyrid peak
- Maximize the chance of simultaneous ground-based and ISS observations



Ground-based Meteor Observer Responses

- A good number of observers responded to the observation request!

James Beauchamp (A)
Jeff Brower (A)
Peter Brown (A)
Apostolos Christou (W)
John Eckert (A)
Ralph Megna (A)
D. R. Mynatt (A)
Rick Nowell (A)
Kevin Palivec (A, C)
Chris Peterson (W)
Wayne Sanders (A)
Gordon Sarty (A)
Jim Wooddell (A)

(A) – All sky
(C) – Color
(W) – Wide field

Ground-based Results

- 155 meteors reported by observers
  - NASA's SE network and Peter Brown's SOMN network mostly cloudy
  - NASA's SW network observed 26 meteors on 22 Apr, 16 double-station, only 6 confirmed Lyrids
- Only 3 of the 155 could possibly have been seen by ISS

Composite image of meteors observed by NASA's NMSU camera

BALLOON OBSERVATIONS

22 April 2012 – during the Lyrid meteor shower peak

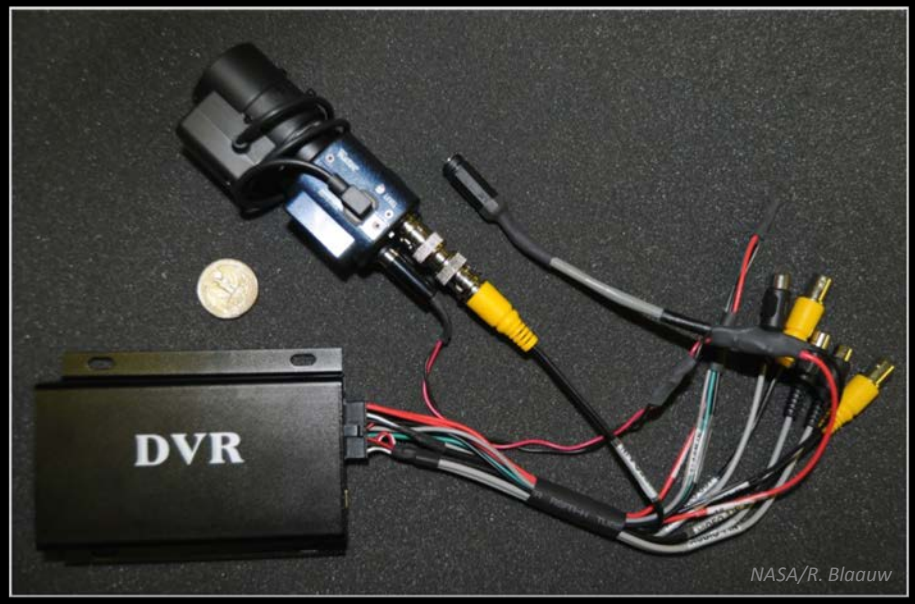
Balloon

- Helium filled
- 18 cm wide at launch
- 1200 cm wide when it bursts
- Parachute returns balloon to Earth
- GPS tracks & transmits location every ~10 min
- Launched by “Earth to Sky Calculus” in California
  - Bishop Union High School
  - Home Street Middle School

Balloon just before launch

Balloon Payload

- Semi-rigid insulated pack with PVC pipe exoskeleton, roughly 28 cm × 23 cm × 23 cm
  - Low light level Watec video camera
  - Lightweight digital video recorder
  - 32 GB SD card memory
  - 2 GPS units
  - Thermometer
  - Power supply



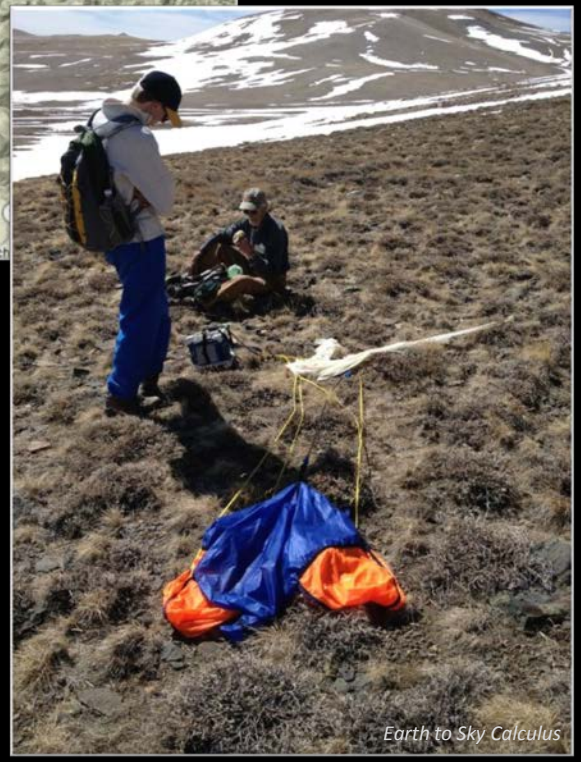
Part of the payload: Video camera and recorder

Balloon + payload cost ≤ 1000 USD

Balloon Flight

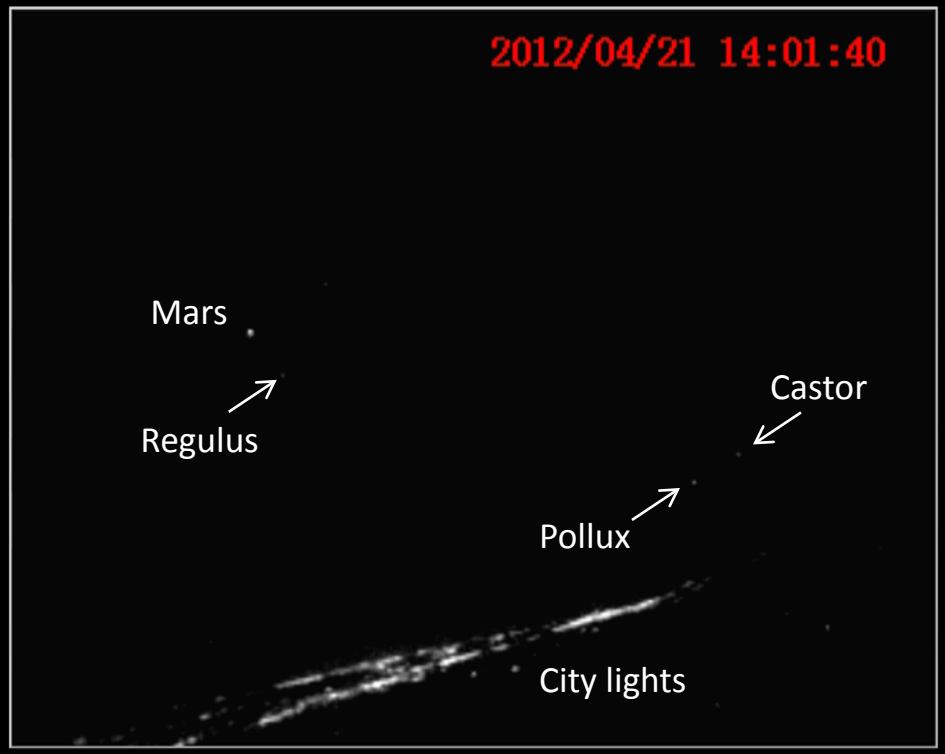
- Launched 22 April 2012 at 6:54 UT from Bishop, California
- Entered stratosphere at 8:10 UT
- Maximum altitude of ~35.8 km (117,500 ft) at 9:46 UT
- Landed in the mountains at 10:15 UT
- Total flight time = 3.35 hr
- Total stratosphere (steady) time = 1.6 hr

Balloon flight path above Bishop, CA



Payload recovery in the White Mtns

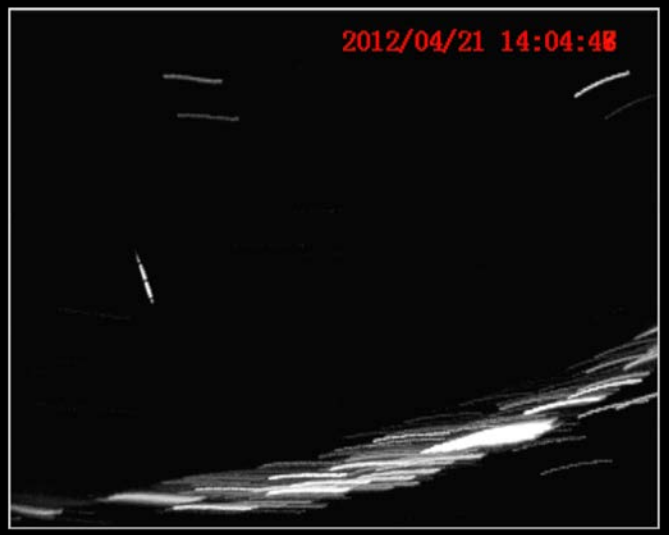
Balloon Video



22 April 2012 09:01:40 UT, FOV 65° × 80°

Manual review of the balloon video

Meteors seen by balloon



22 April 2012 09:04:46 UT

22 April 2012 09:05:32 UT

22 April 2012 09:34:32 UT

22 April 2012 09:40:59 UT

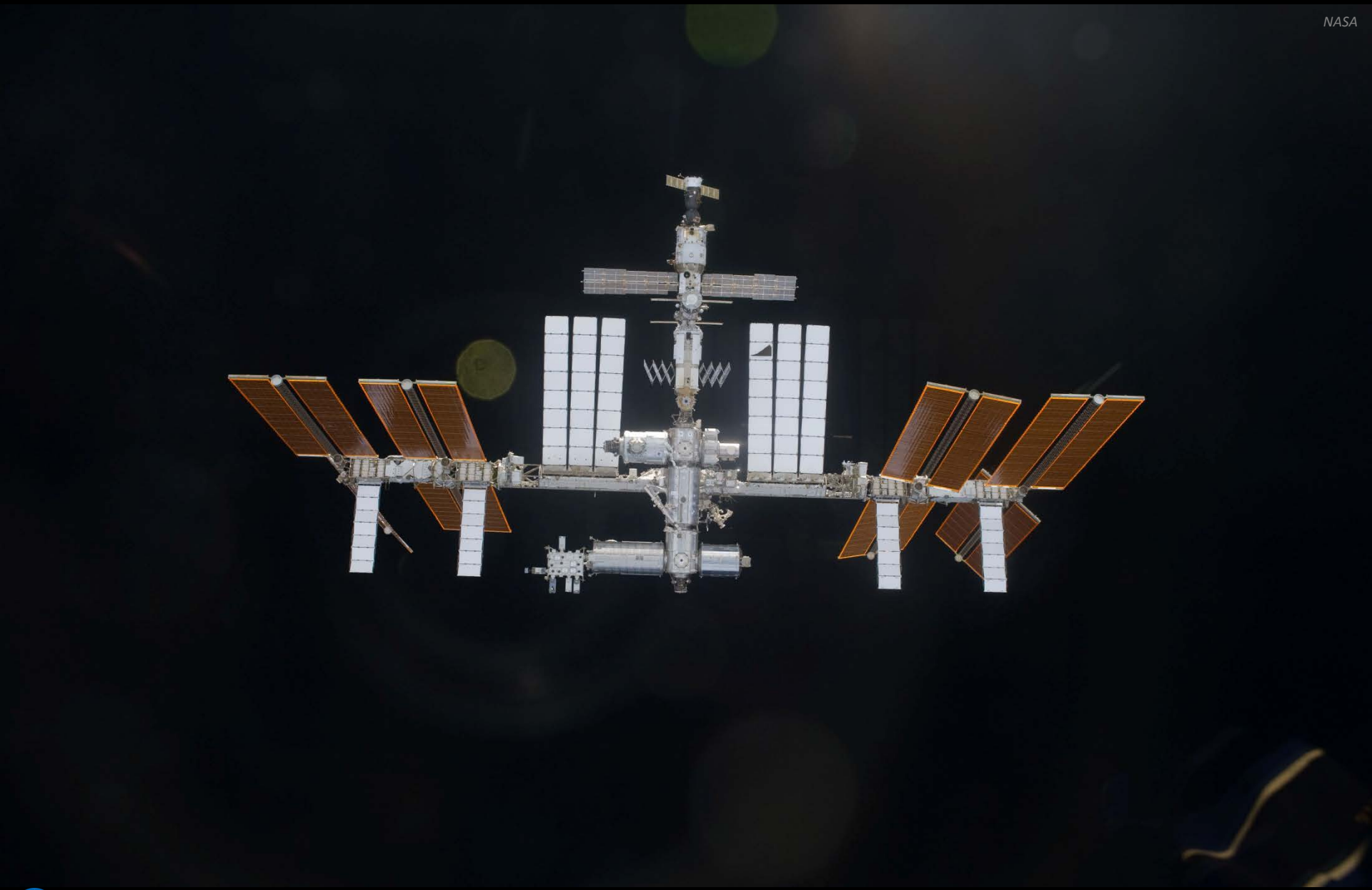
Balloon Meteor Breakdown

Meteor type	Number of meteors
>90% confidence it's a Lyrid	14
70-90% confidence it's a Lyrid	11
50-70% confidence it's a Lyrid	4
<50% confidence it's a Lyrid	1
Not a Lyrid	1
Total	**31**

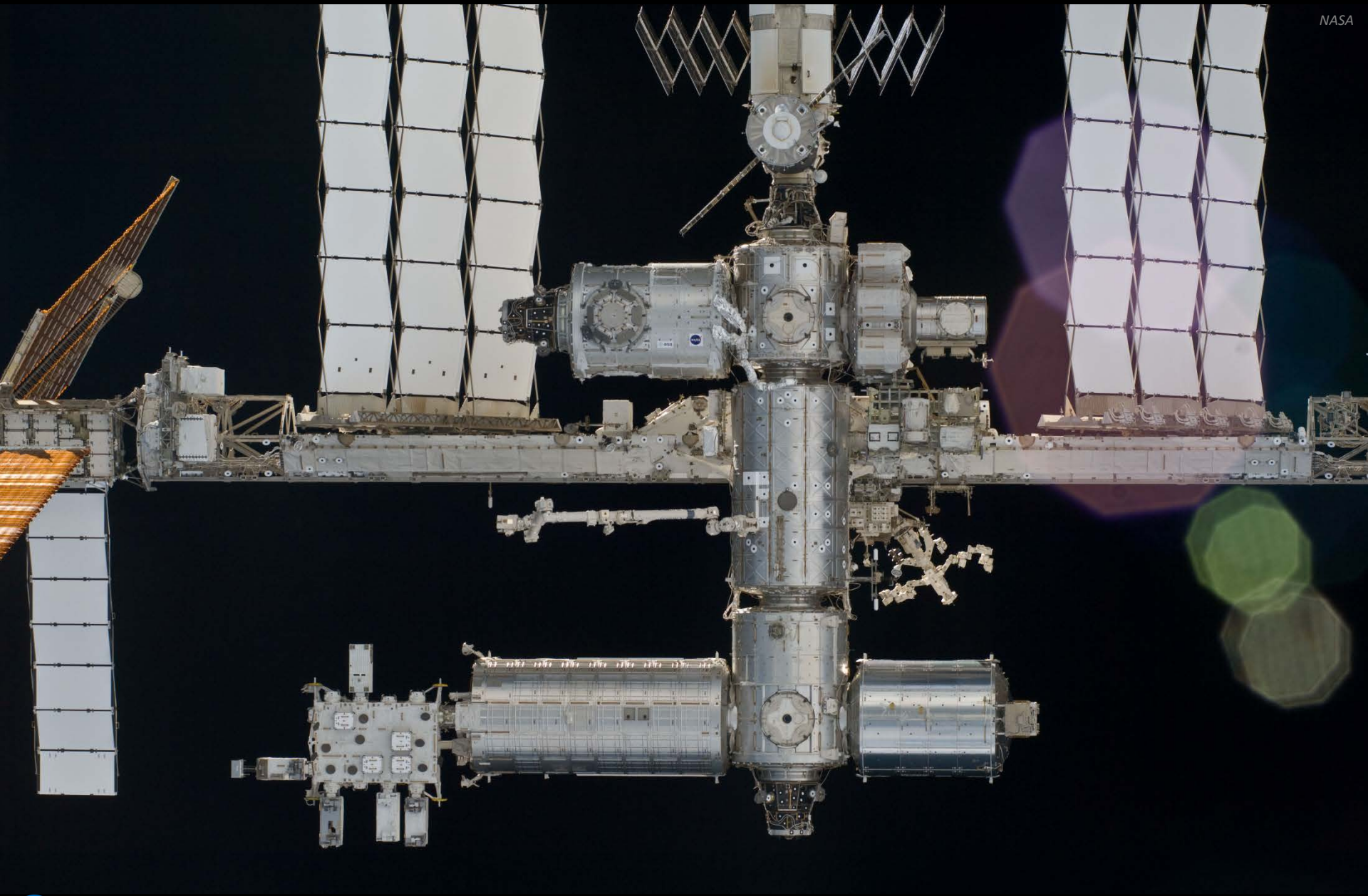
ISS OBSERVATIONS

22 April 2012 – during the Lyrid meteor shower peak

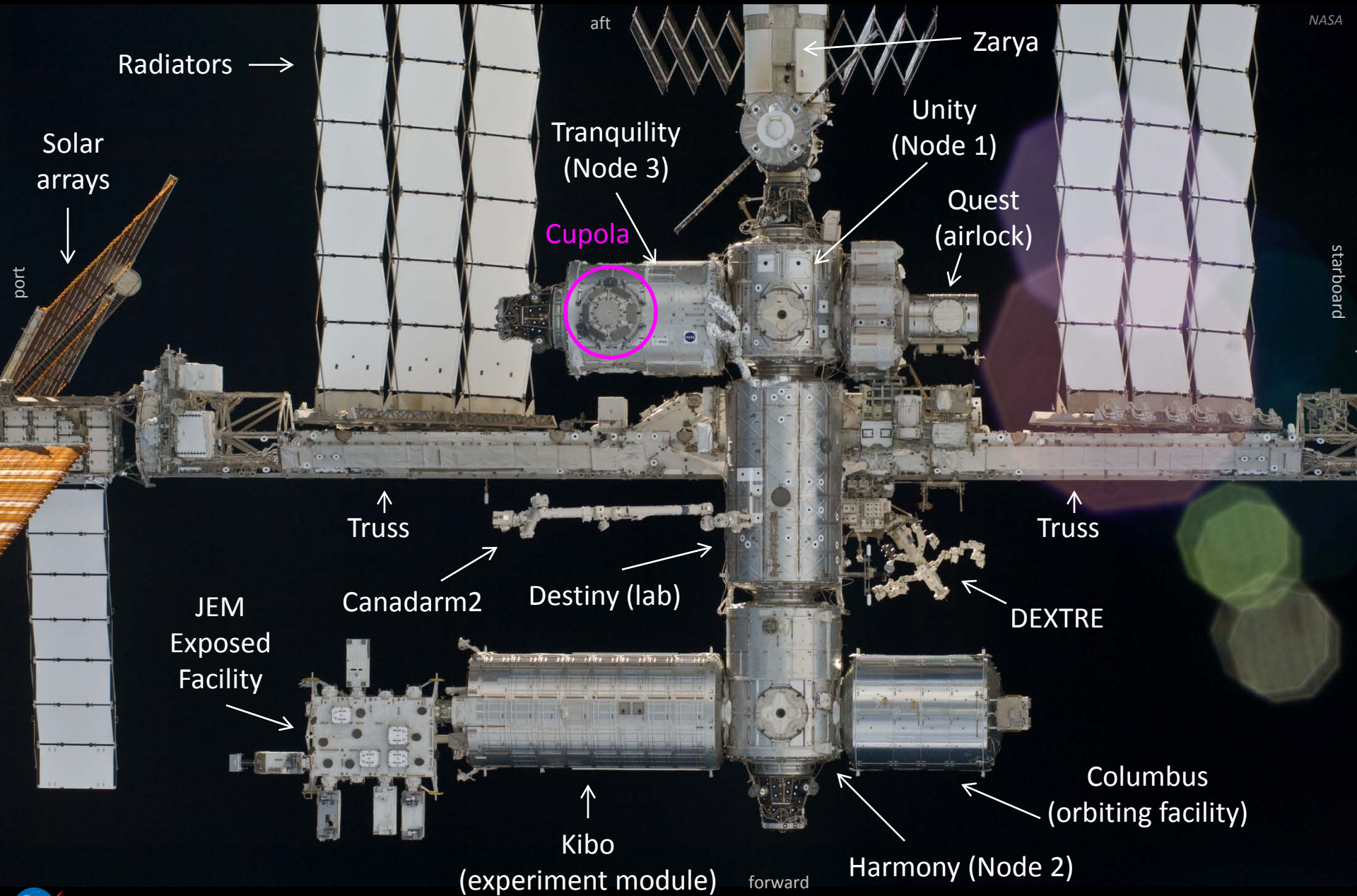
ISS



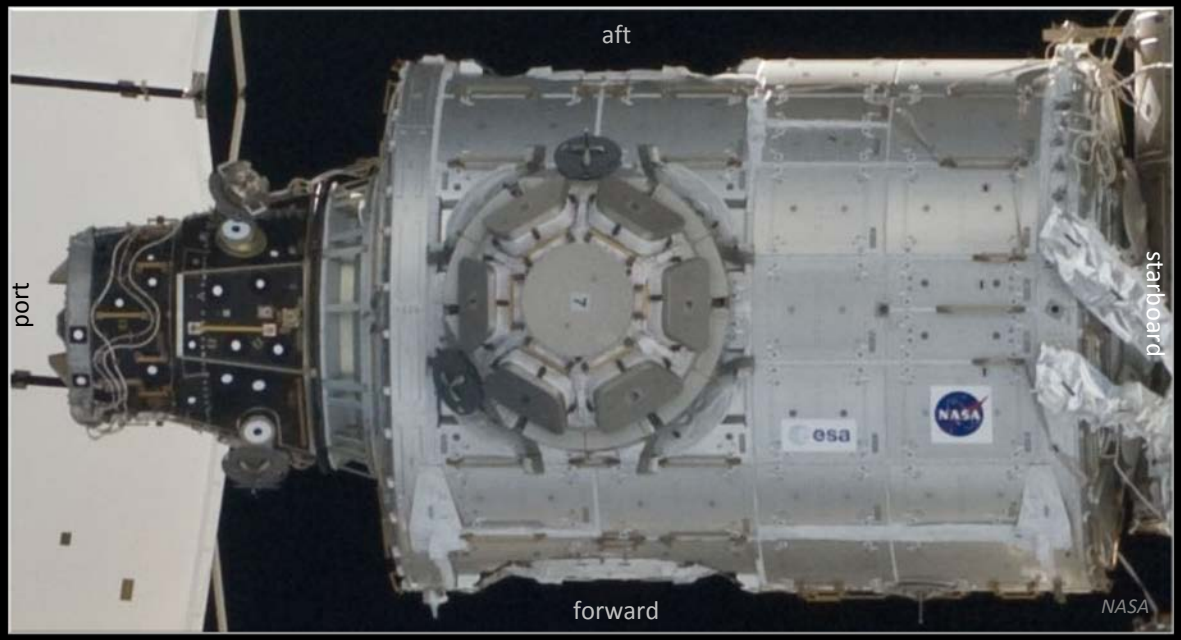
ISS – zoom



ISS – zoom


aft
NASA
Radiators
Zarya
Unity
(Node 1)
Tranquility
(Node 3)
Solar
arrays
Cupola
Quest
(airlock)
port
starboard
Truss
Truss
Canadarm2
Destiny (lab)
DEXTRE
JEM
Exposed
Facility
Columbus
(orbiting facility)
Kibo
(experiment module)
forward
Harmony (Node 2)

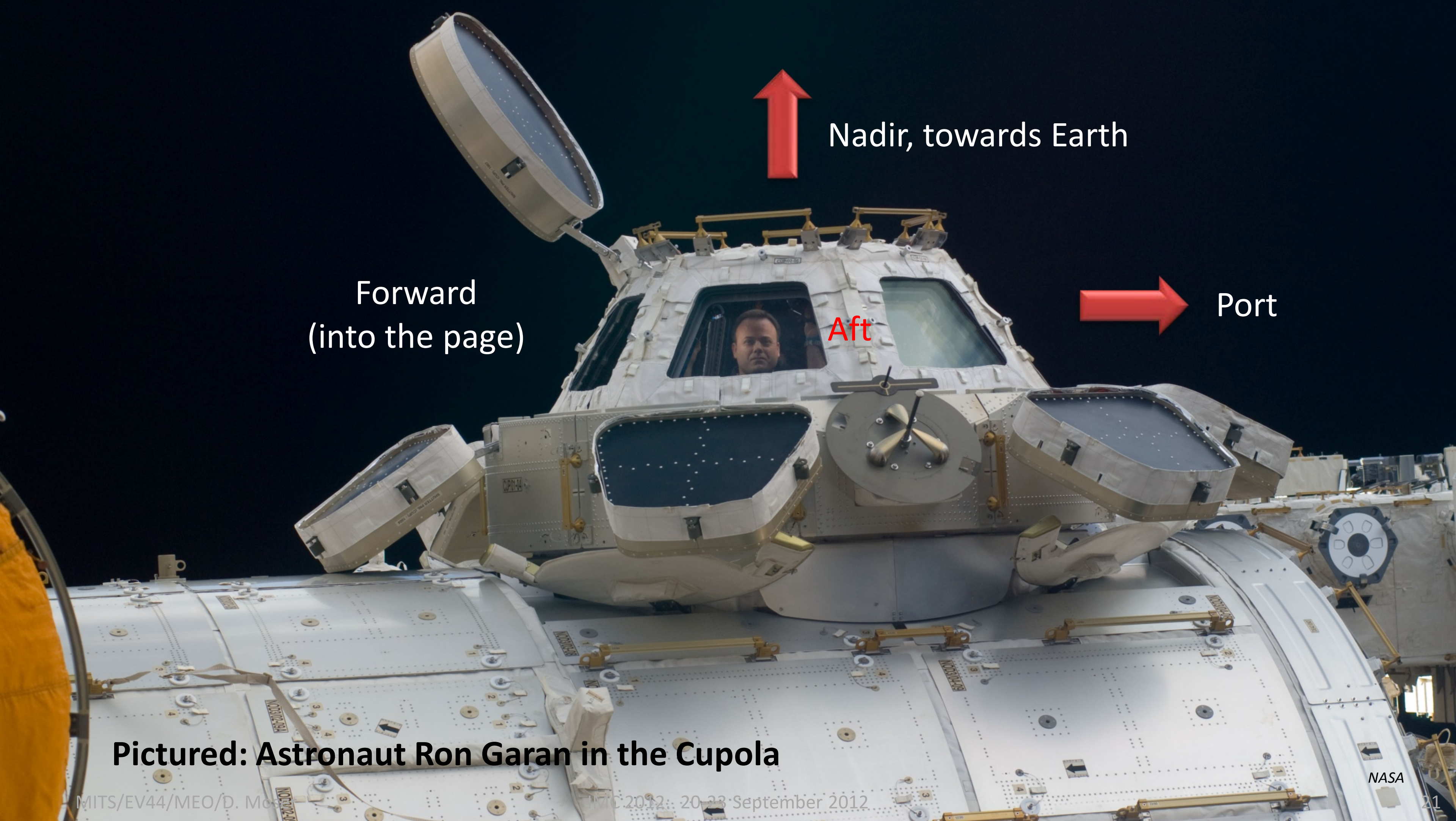
ISS – Cupola



- ESA-built observatory module
- Launched on February 8, 2010
- Attached to the Tranquility (node 3) module
- 7 windows, top window has 80 cm (31 in) diameter

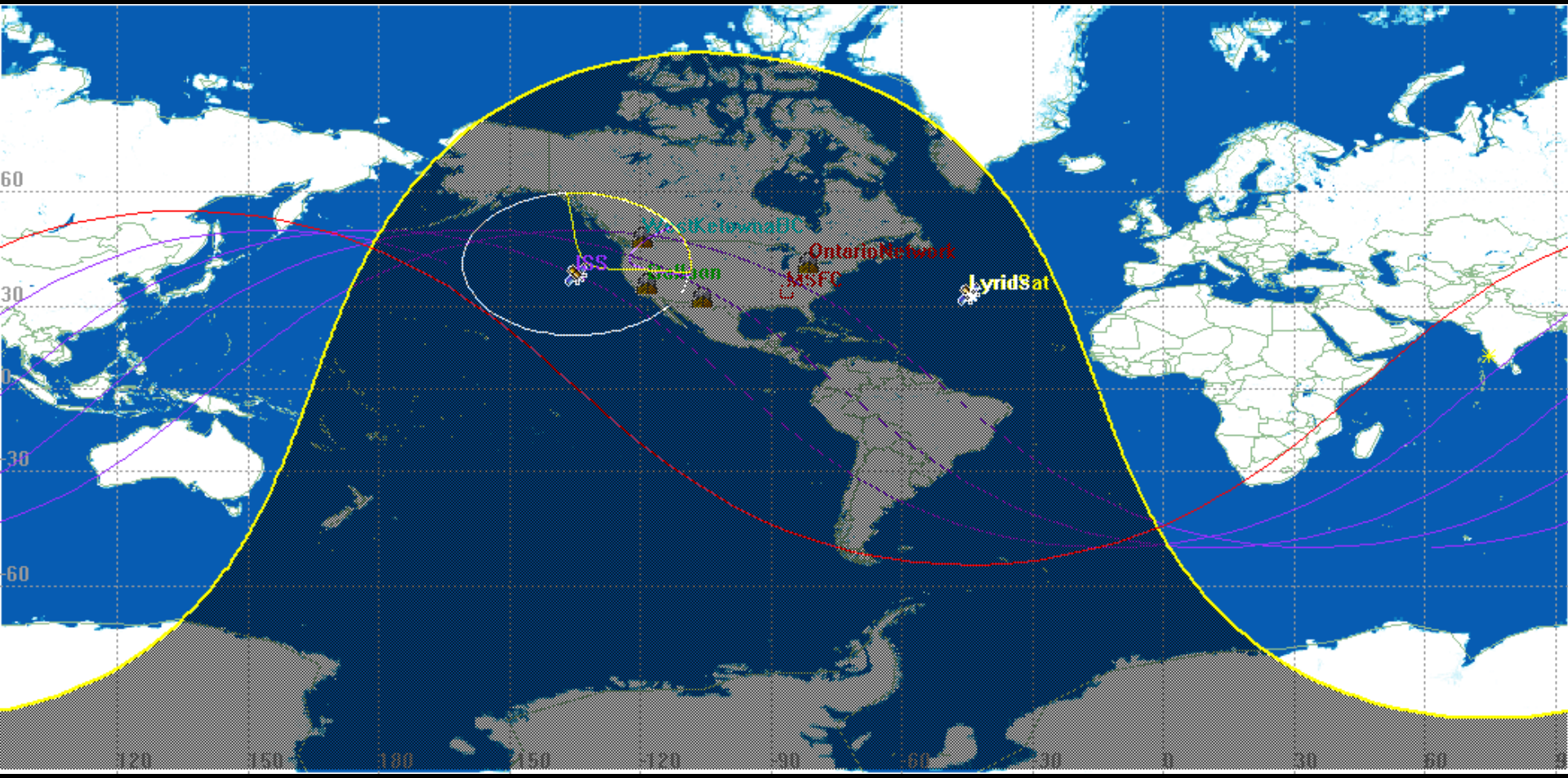
ISS – Cupola

- Astronaut Don Pettit set up 4 Nikon D3S DSLR cameras



Pictured: Astronaut Ron Garan in the Cupola

3 ISS Passes over N. America

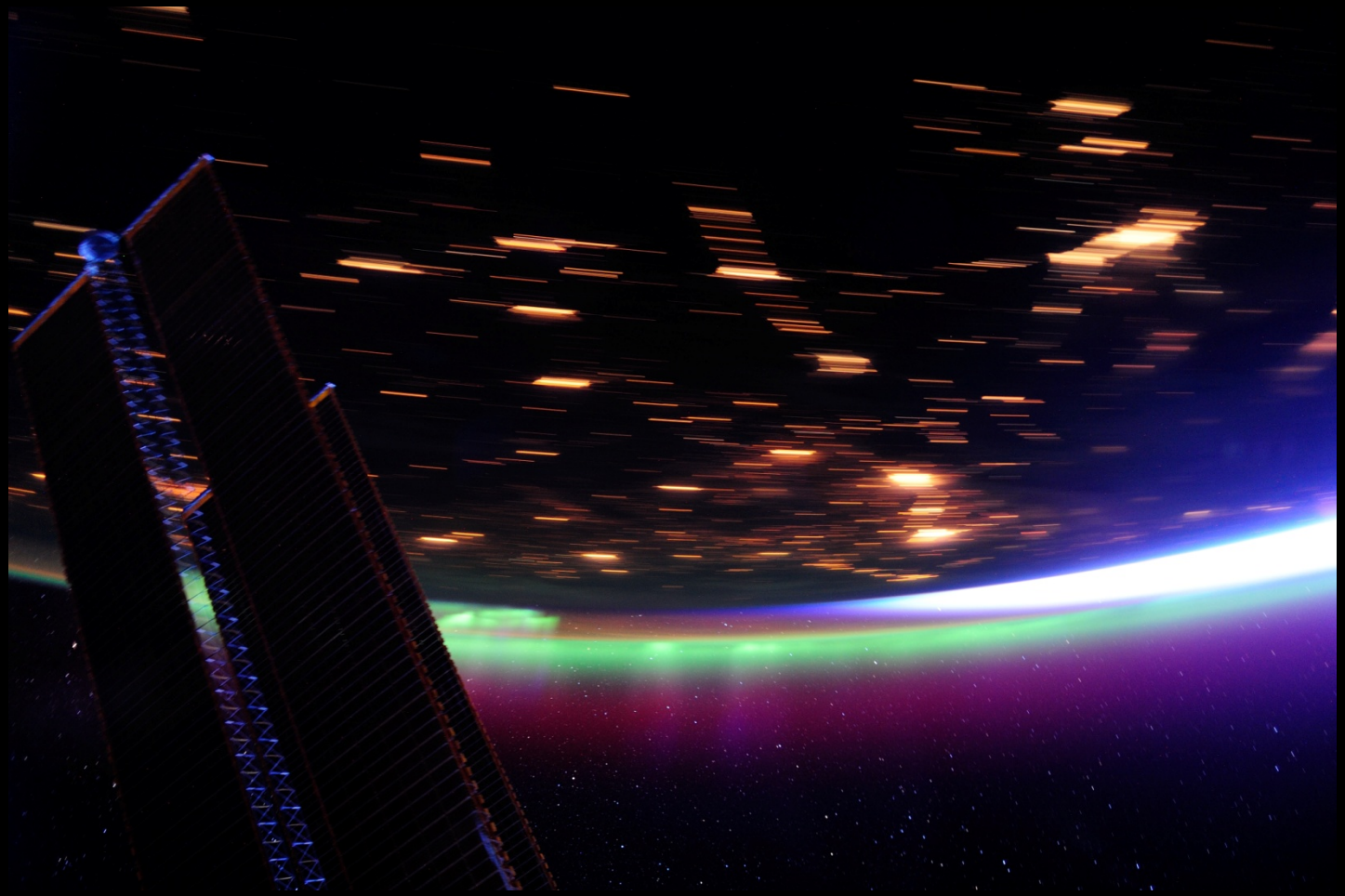


Pass	Time	Target
1	3:50 – 4:01 UT	MSFC
2	5:24 – 5:34 UT	New Mexico
3	6:57 – 7:07 UT	California

ISS Image Details

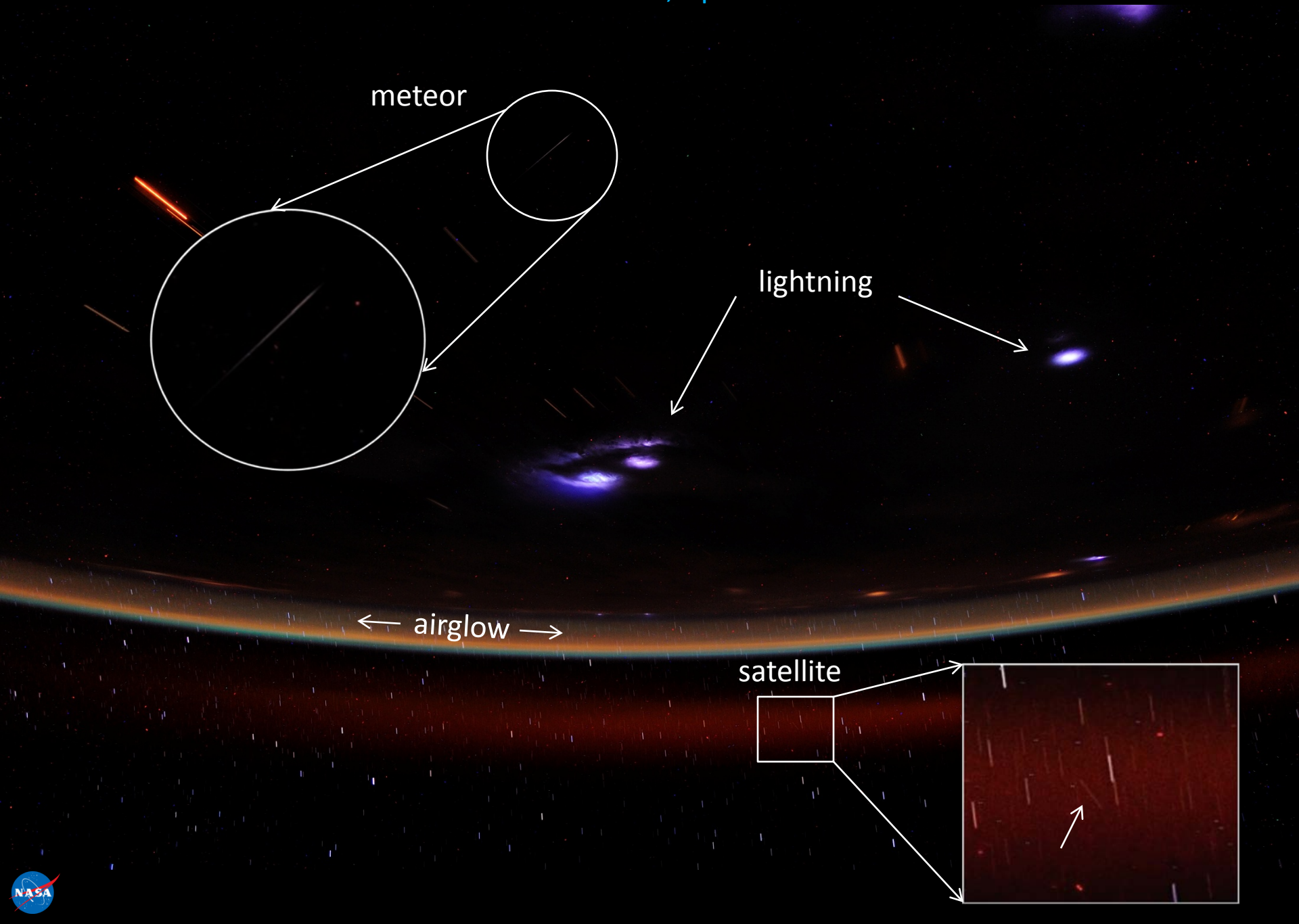
- FOV = 70° horizontal
- 5 sec exposures with 1 sec gap to download
  - Lights on Earth appear as streaks
  - Lightning is not streaked
  - Stars slightly elongated
- Other phenomena present
  - Airglow (80-300 km): broad band of light emission from chemical reactions between atoms & molecules excited by solar radiation
  - Aurora (100-500 km): structured bands of light at the poles caused by collision of energetic charged particles from the magnetosphere with particles in the atmosphere, directed by Earth's magnetic field
  - Appleton anomaly: area of enhanced plasma density at the equator
  - Zodiacal Light: diffuse white glow caused by sunlight scattered by dust particles

Pass 2 - Port

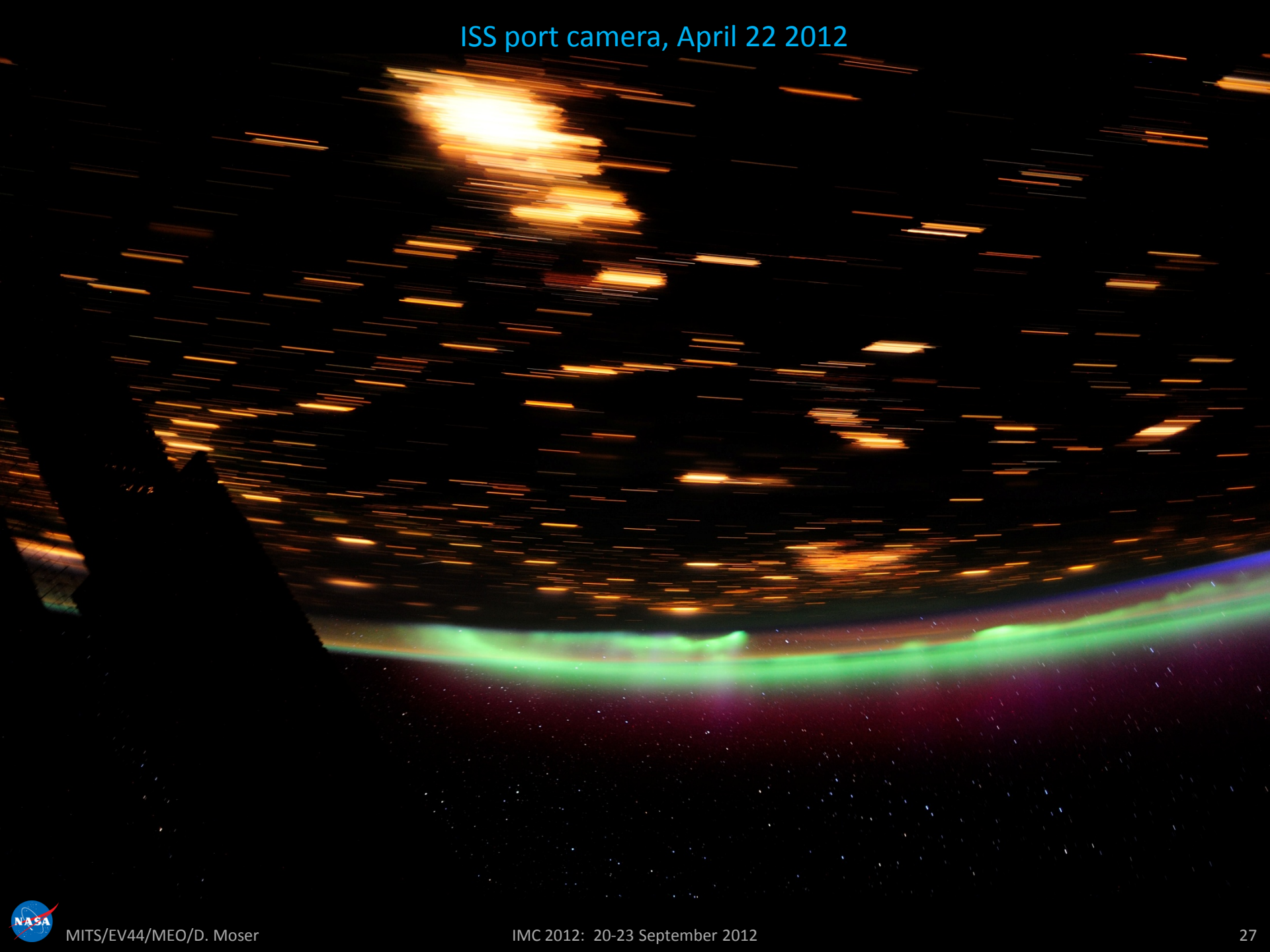


ISS aft camera, April 22 2012

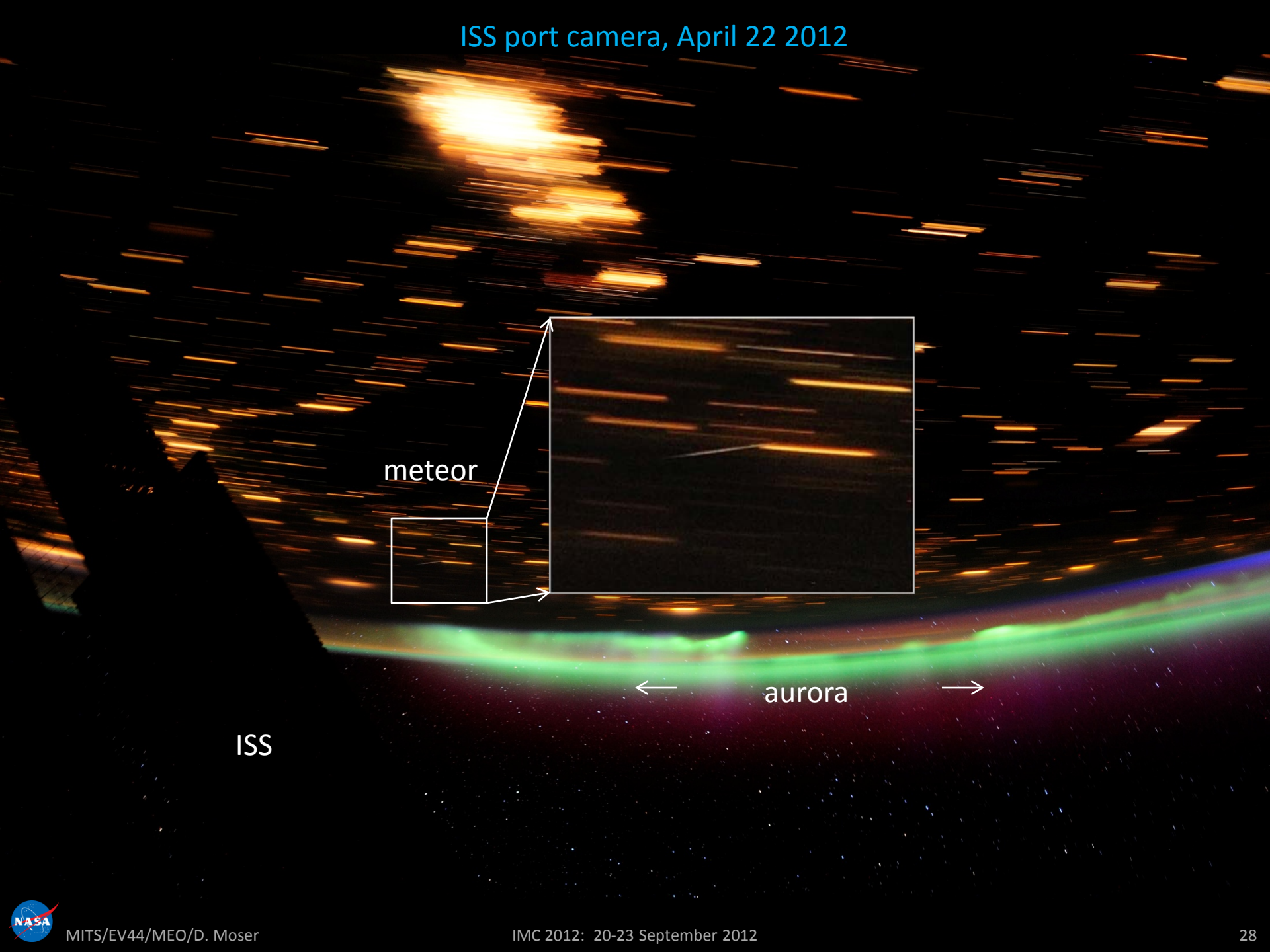
ISS aft camera, April 22 2012



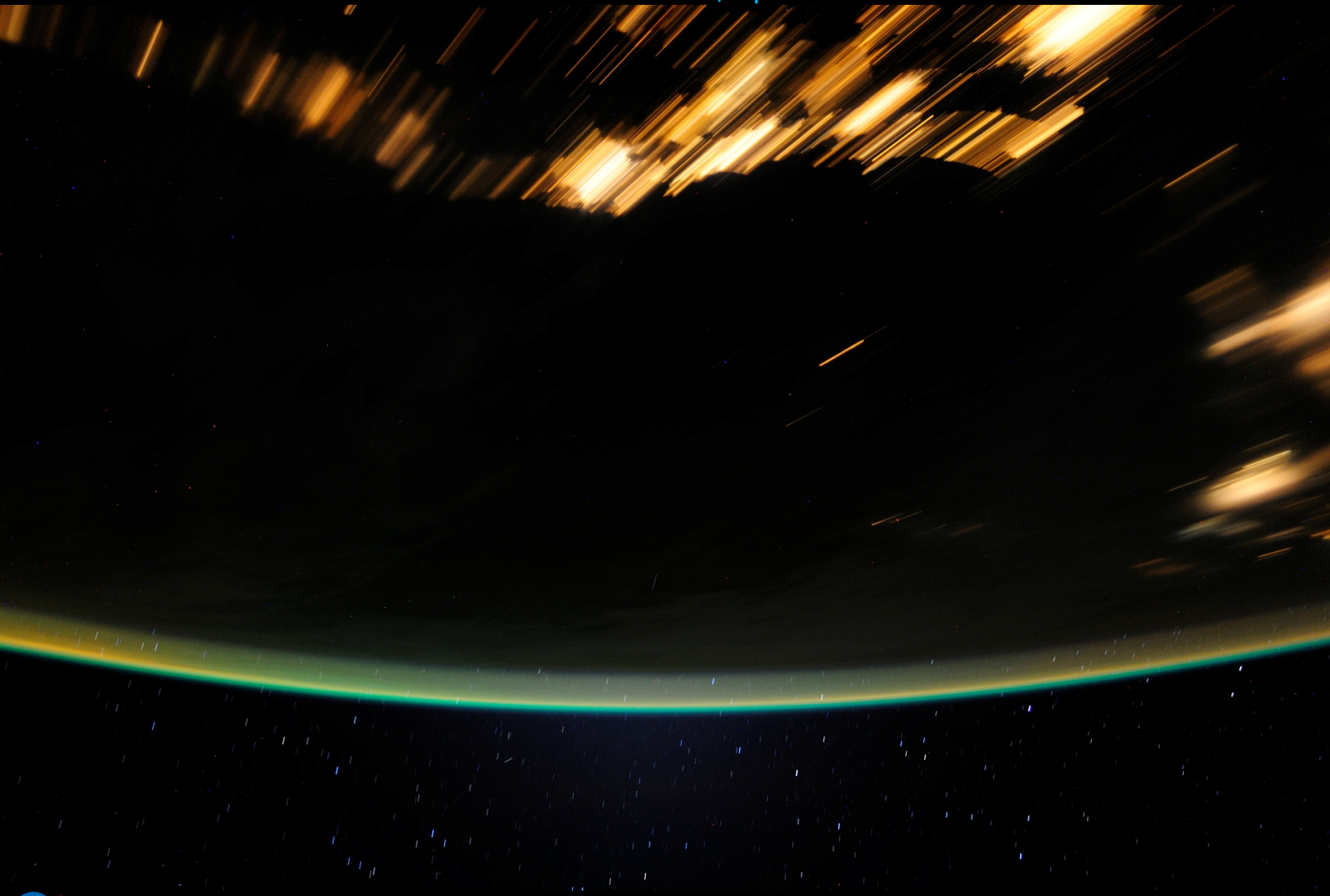
ISS port camera, April 22 2012



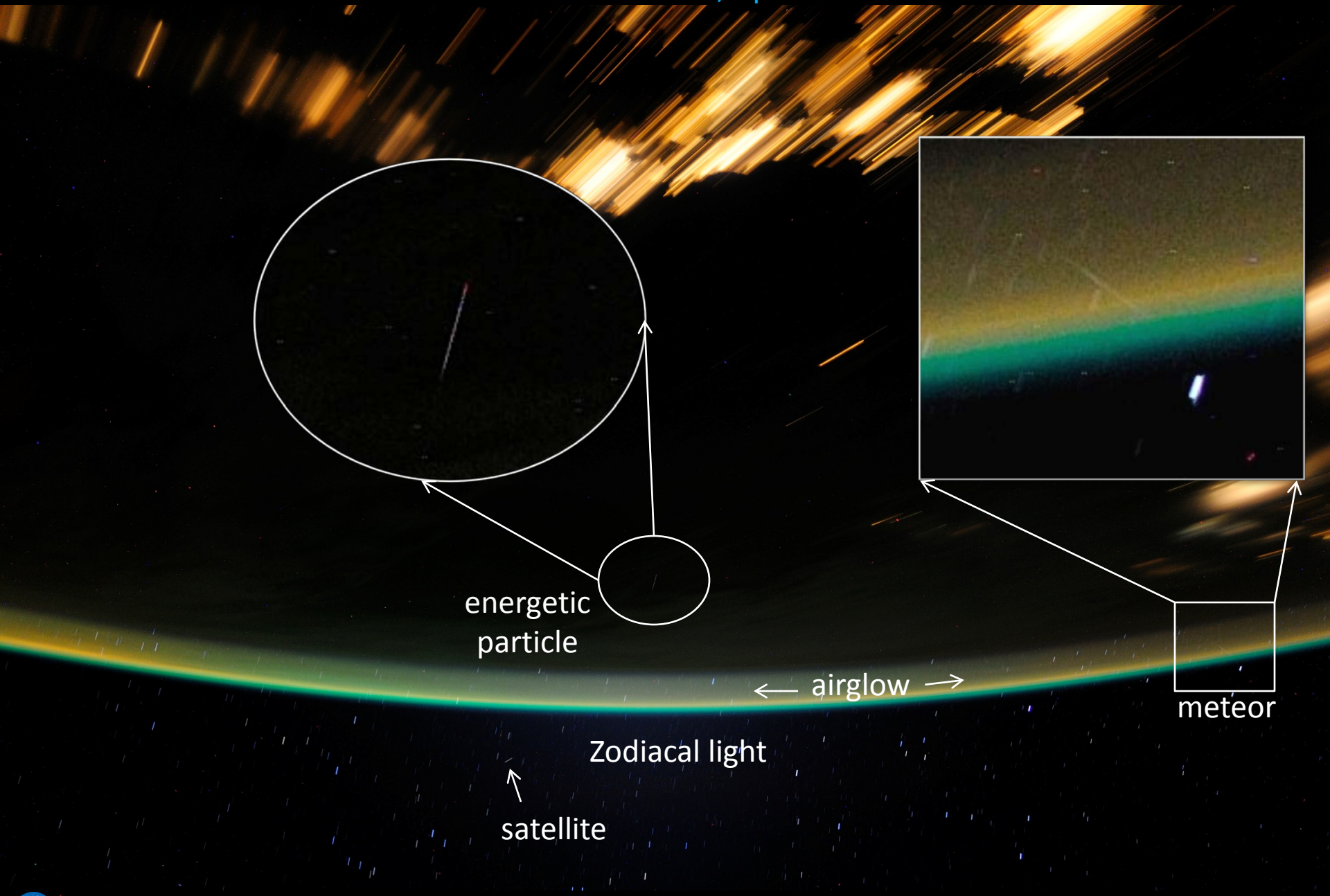
ISS port camera, April 22 2012



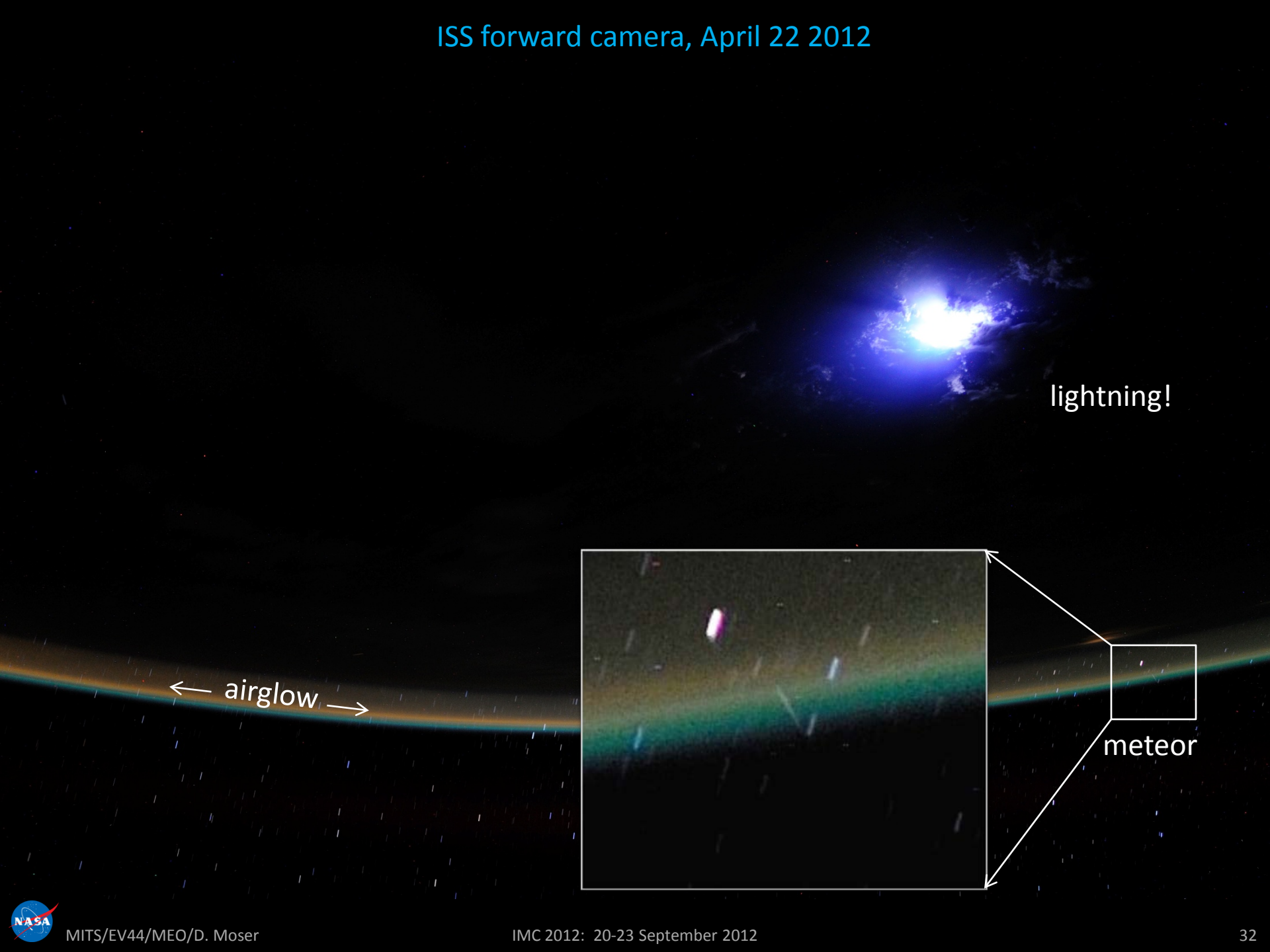
ISS forward camera, April 22 2012



ISS forward camera, April 22 2012

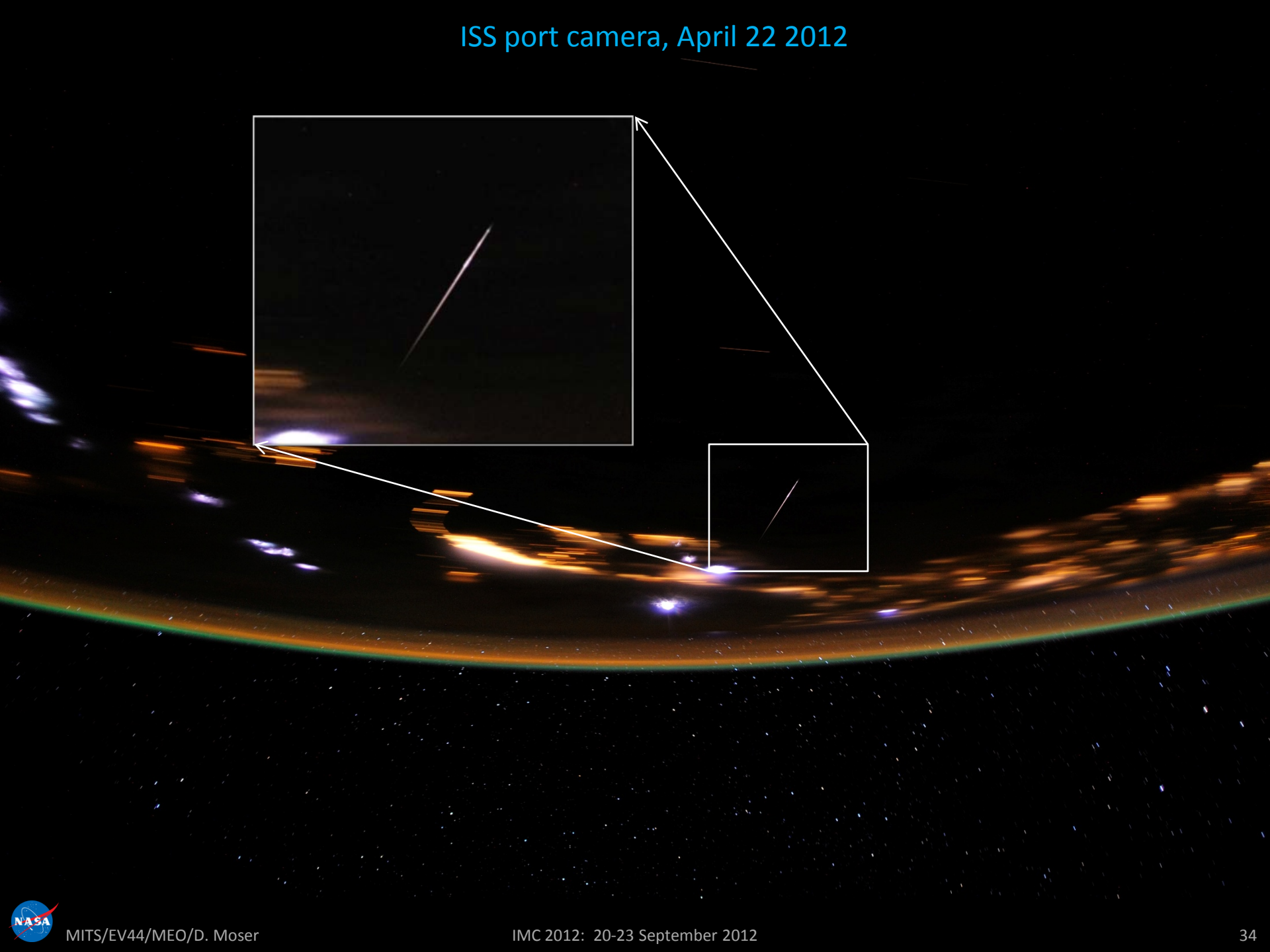


ISS forward camera, April 22 2012



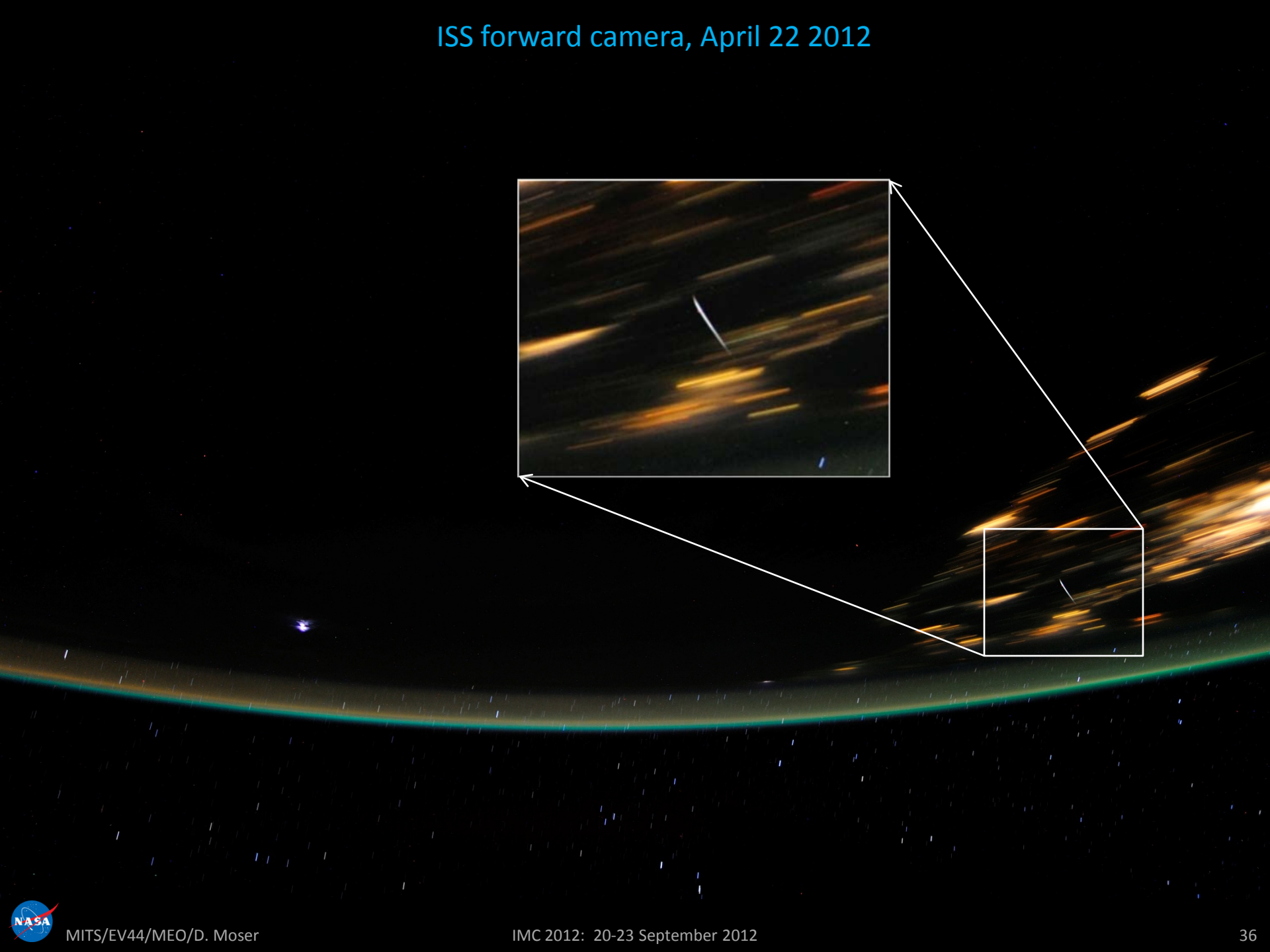
ISS port camera, April 22 2012

ISS port camera, April 22 2012



ISS forward camera, April 22 2012

ISS forward camera, April 22 2012



ISS Results

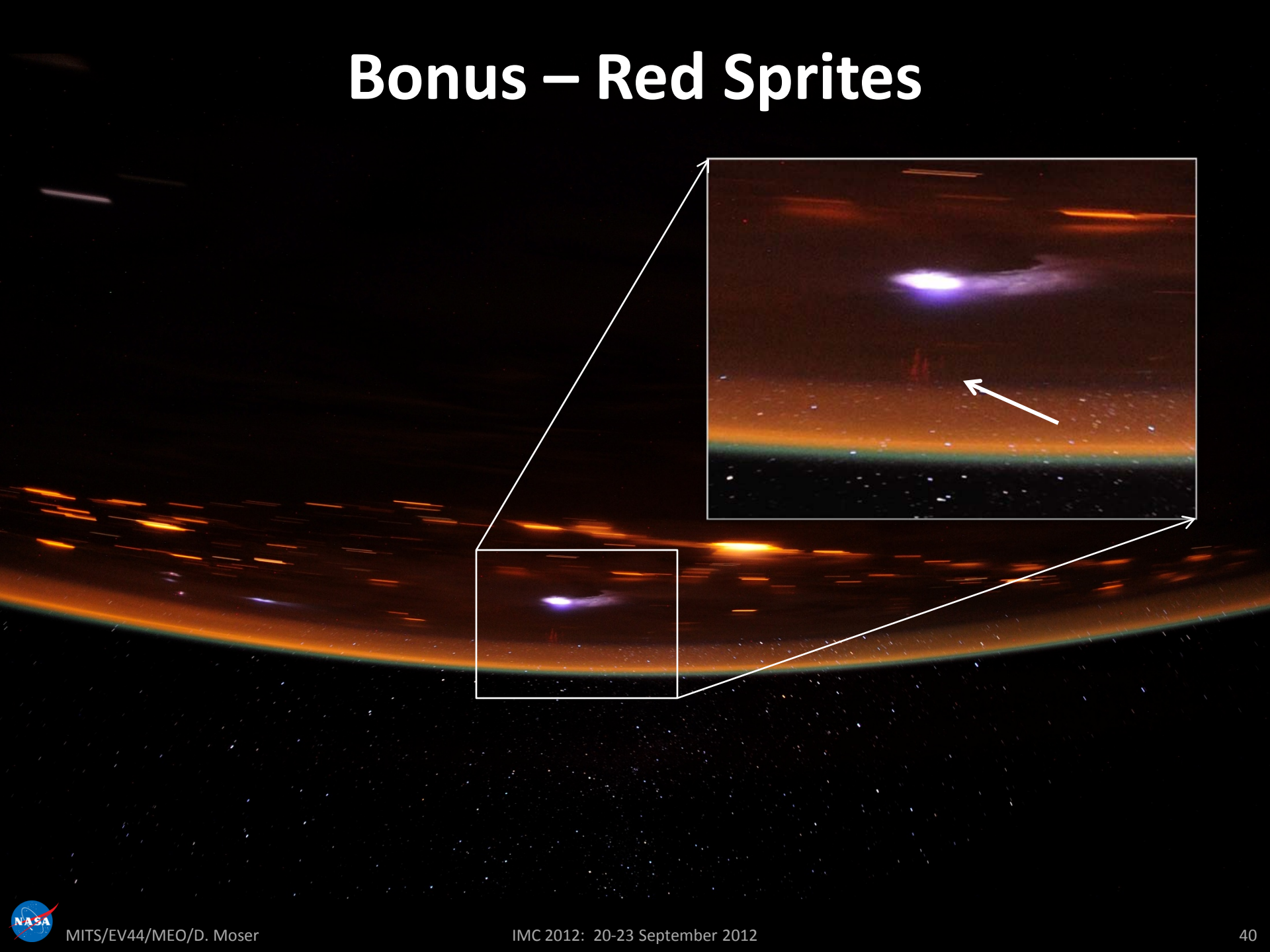
ISS Pass Number	Num of images received/ Total num	Number of meteor candidates
1	0 / 374	-
2	942 / 1272	70
3	579 / 1215	31

Results

- Unfortunately no events were simultaneously observed from the ground, balloon, or ISS
- All 3 platforms detected meteors, some possible Lyrids
- Need ground-based observations to confirm Lyrids in balloon and ISS
- Balloon observations successful and inexpensive, though difficult to calibrate

BACKUP SLIDES

Bonus – Red Sprites



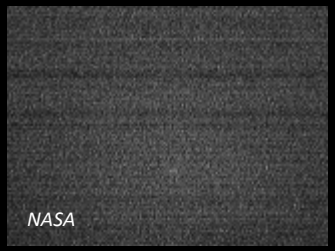
ISS Image Details

View	Camera	Lens
Forward	Nikon D3S	28mm f/1.4D
Aft	Nikon D3S	28mm f/1.4D
Port	Nikon D3S	24mm f/1.4G
Nadir	Nikon D3S	8mm f/2.8

Manual Focus
Manual Exposure
Exposure time = 5 s
Image quality = Lossless compressed RAW
Image size = 4256 x 2832
ISO 1600

Past NASA Balloon Observations

3 balloon flights launched from MSFC
Main purpose: aerogel to capture micrometeorite particles
November 1998, 1999, 2000



LEO from balloon
One of 8 fireballs observed
Nov 17, 1998

Serendipitous Past NASA Spacecraft Observations

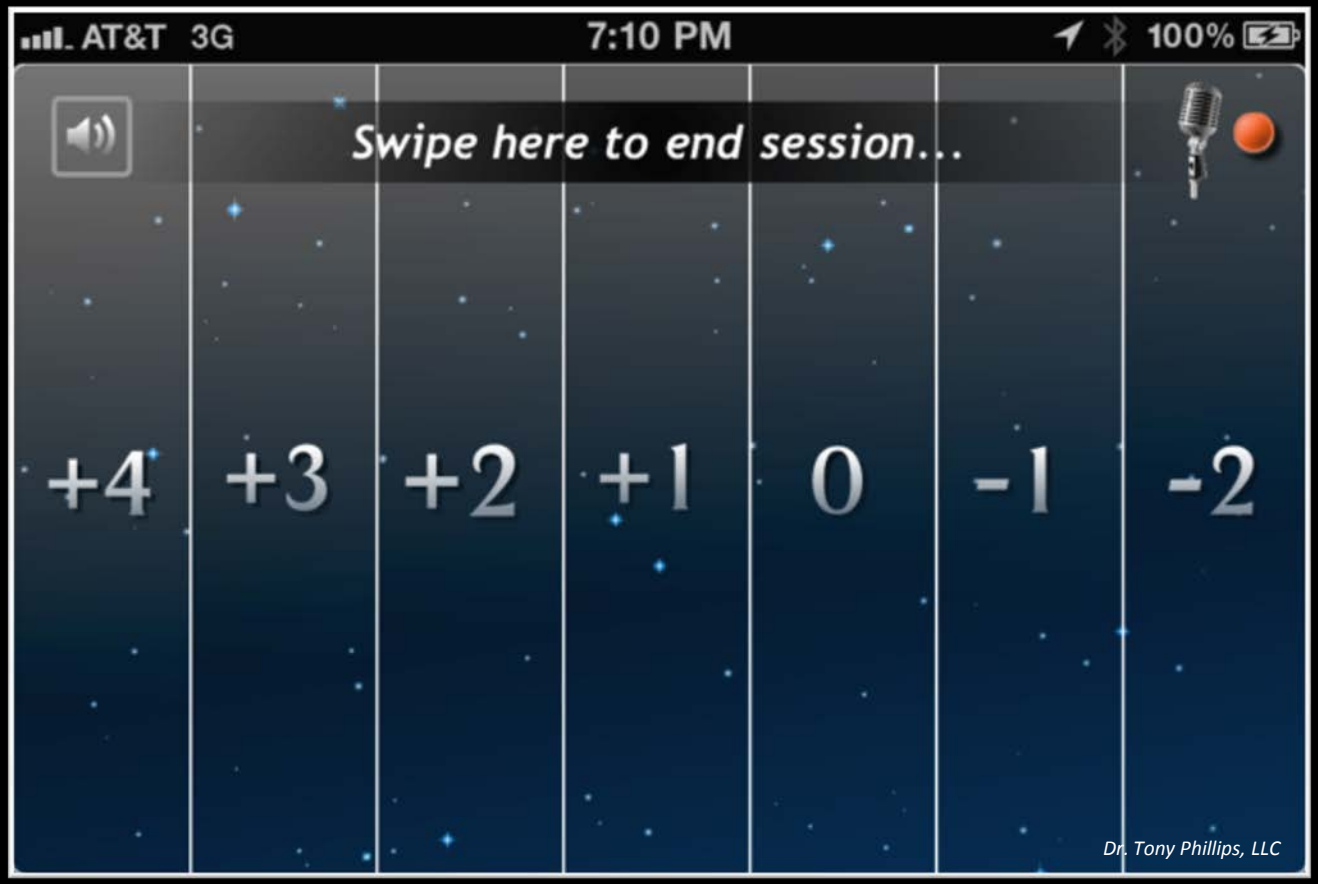
PER from STS-105 (Discovery)
Over Mongolia, 2001

2 PER from STS-105 (Discovery)
From Payload Bay cameras, 2001

Serendipitous Past NASA Spacecraft Observations

PER from ISS Expedition 28 by Astronaut Ron Garan
Over China, 2011

Meteor Counter App



Record meteor observations with the Meteor Counter App for iPhone, iPad, iPod Touch, and Android

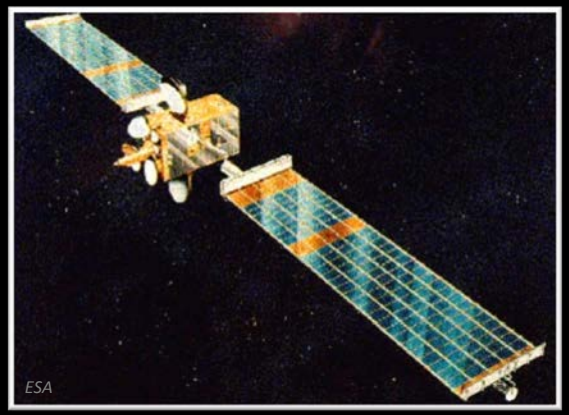
Spacecraft Affected by Meteoroids

Mariner IV

NASA planetary exploration spacecraft

Encountered meteoroid stream between the orbits of Earth and Mars in Sept 1967

Thermal shield damage



Olympus

ESA communication satellite

Struck by a Perseid near the time of the shower peak in August 1993

Sent tumbling, fuel exhausted, end of mission

Chandra

NASA X-ray observatory

Struck by a Leonid or sporadic(?) near the time of Leonid shower peak in November 2003

Temporary wobble

The Risk

- Earth is protected by its atmosphere
  - 73,000 pounds of meteoroids burn up in Earth's atmosphere every 24 hours
- Satellites/International Space Station are completely exposed to these dangers
  - ISS has a 1/100 chance of being penetrated in its 20 year operational lifetime
  - Particles 0.04 cm in size can penetrate spacesuits
- The sporadic background meteoroids account for 90% of spacecraft meteoroid risk