

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

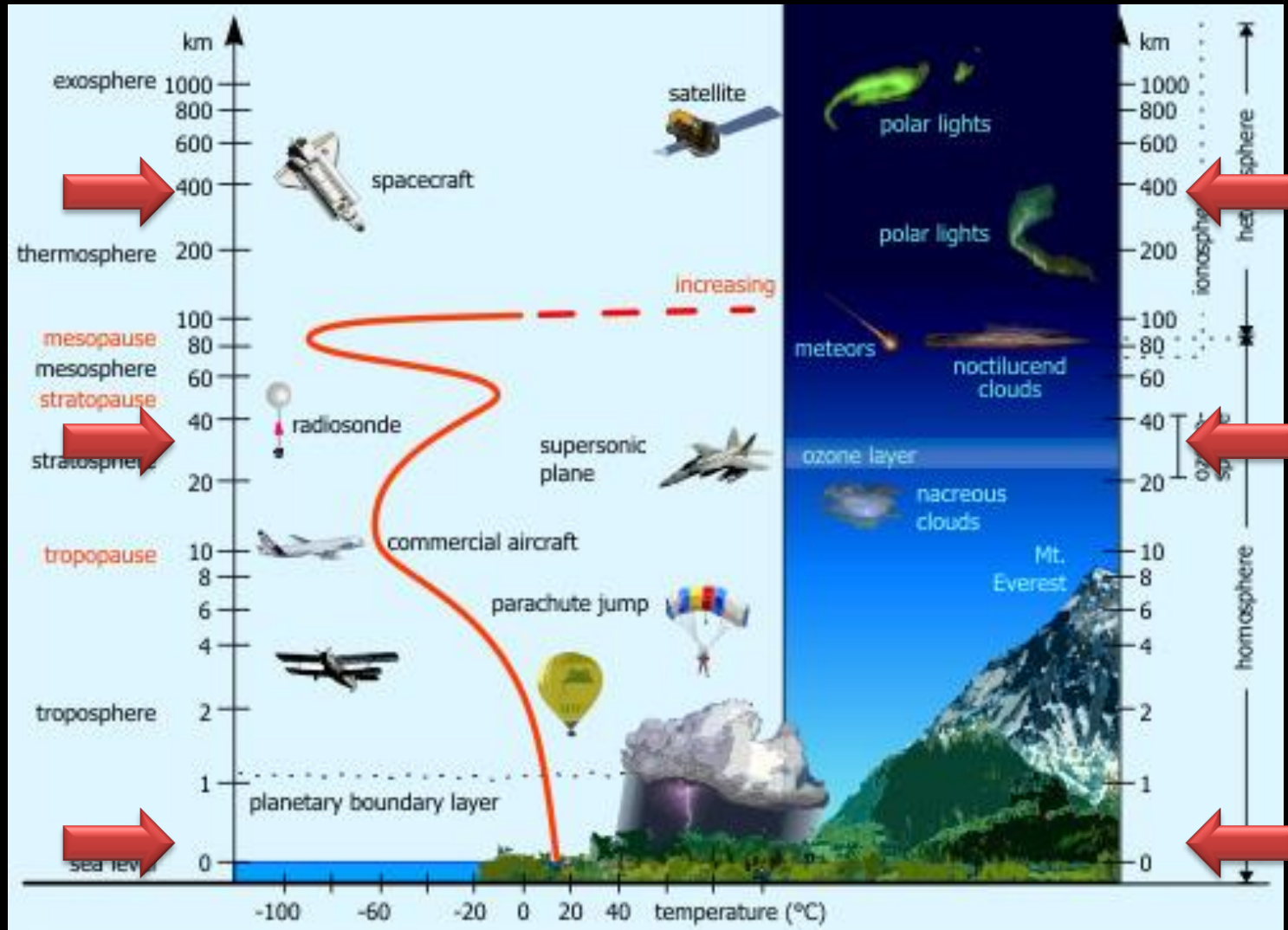
- Observe the 2012 Lyrids from
 - Ground
 - International Space Station (ISS)
 - Balloon
- “Proof of concept” balloon flight
 - Detect meteors with a simple, inexpensive payload
- Correlate any meteors seen between platforms

3 OBSERVING PLATFORMS

ISS

Balloon
payload

Ground-
based

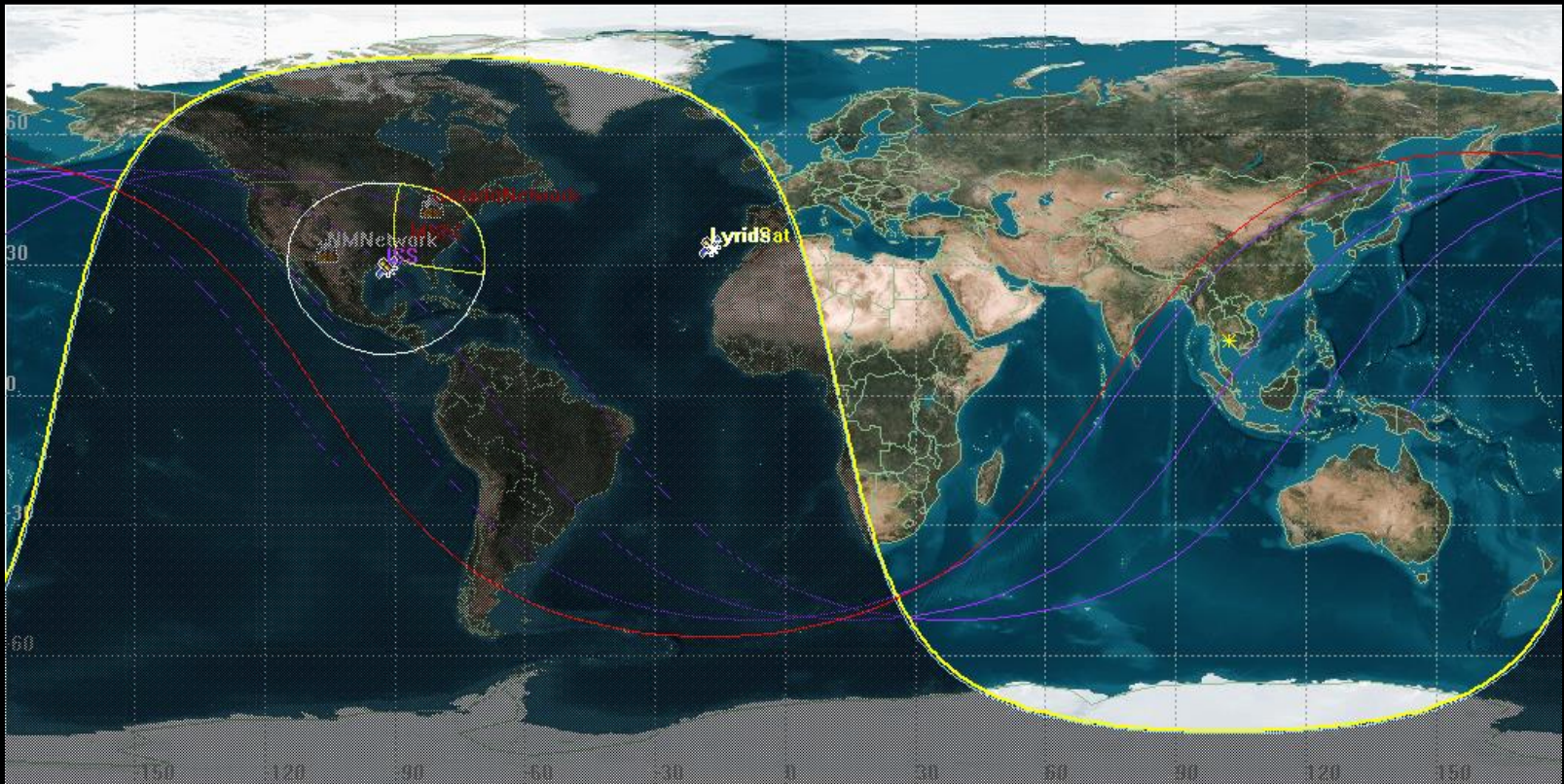


GROUND-BASED OBSERVATIONS

22 April 2012 – during the Lyrid meteor shower

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 on the ground
 - Most between 8-8:30 UT
 - 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 2 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

Balloon

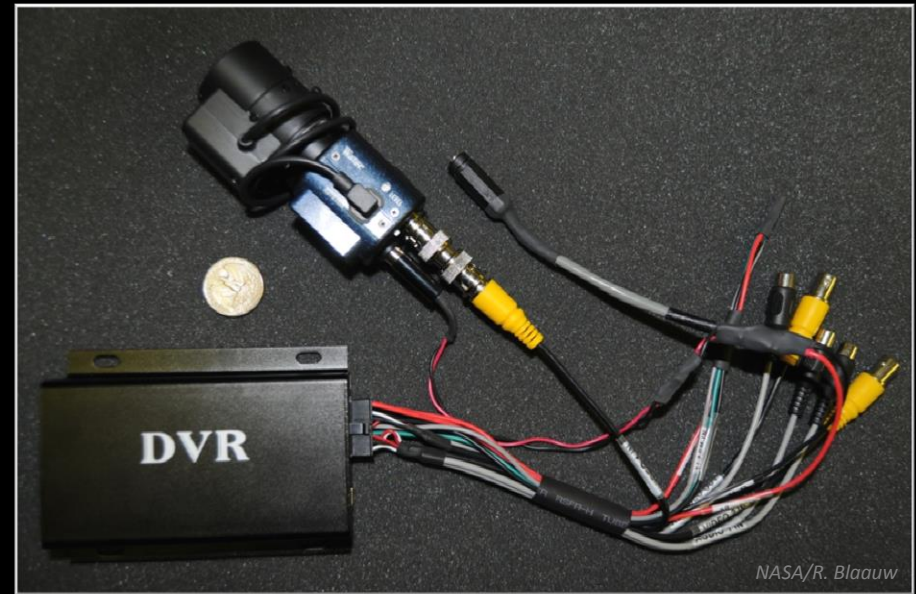
- Helium filled
- 18 cm wide at launch
- 1200 cm wide when it bursts
- Parachute returns balloon to Earth
- GPS tracks & transmits location every ~10 min
- Launched by “Earth to Sky” in California
 - Bishop Union High School
 - Home Street Middle School



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 \leq 1000 USD

Balloon Flight

6:54 UT Launched from Bishop, California

8:10 UT Entered stratosphere

9:46 UT Maximum altitude of ~35.8 km (117,500 ft)

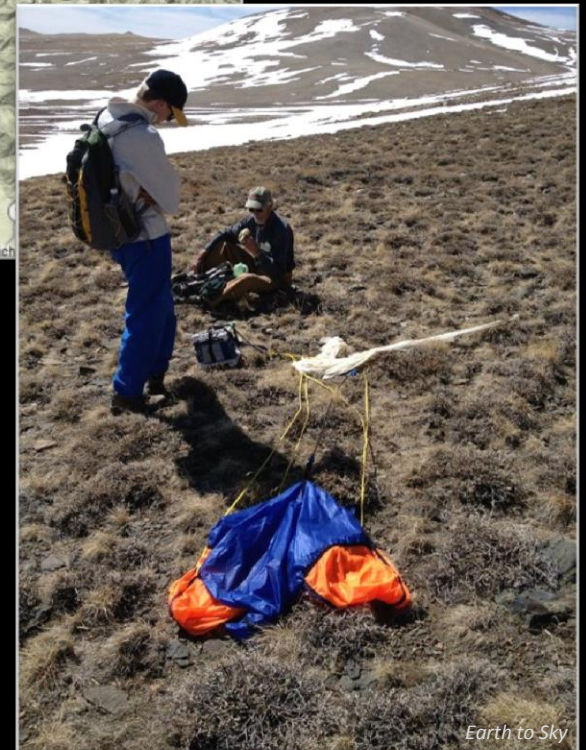
10:15 UT Landed in the mountains

Total flight time = 3.35 hr

Total stratosphere ('steady') time = 1.6 hr

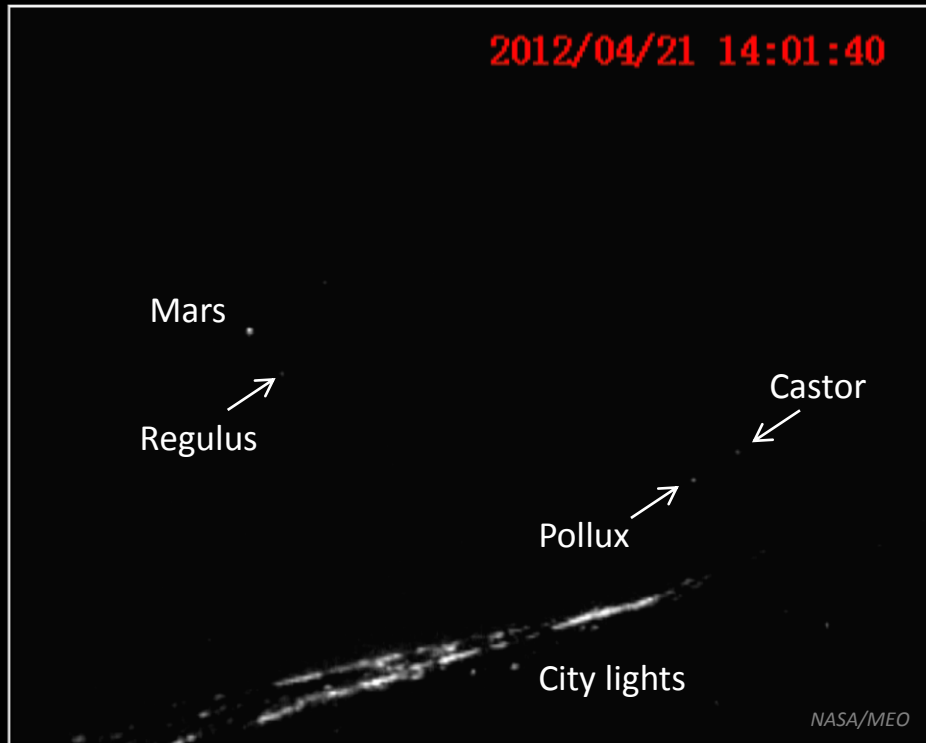


Balloon flight path above Bishop, CA



Payload recovery in the White Mtns

Balloon Video



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

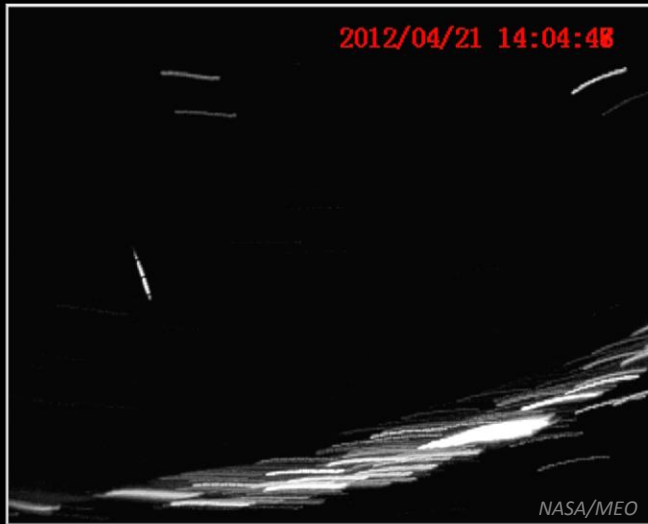


Manual review of the balloon video

Balloon Video

2012/04/21 14:04:46

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 Results

Meteor type	Number of meteors 8:10 – 9:46 UT
>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 (in 1.6 hrs)	31

Balloon launched minutes before ISS Pass 3.

Platform unstable & difficult to analyze during Pass 3 – no ISS correlations.

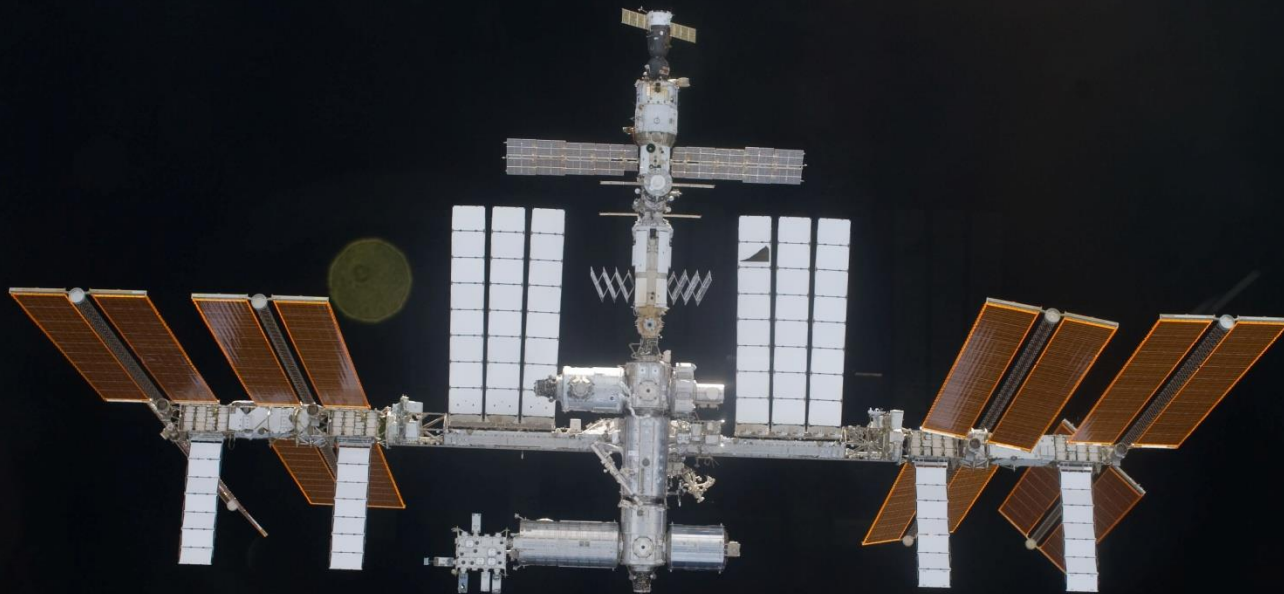
No overlapping ground coverage reported.

ISS OBSERVATIONS

22 April 2012 – during the Lyrid meteor shower

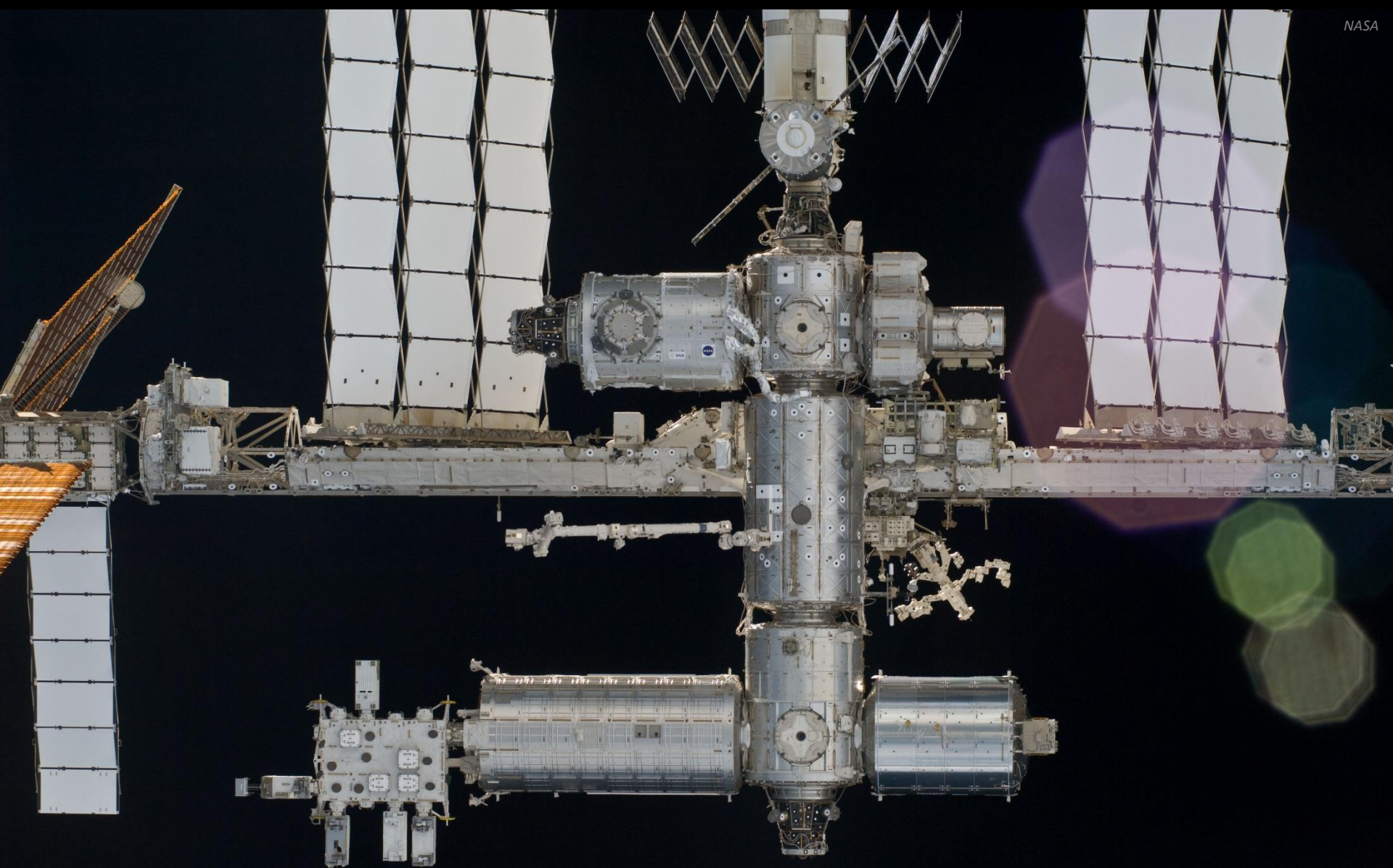
ISS

NASA

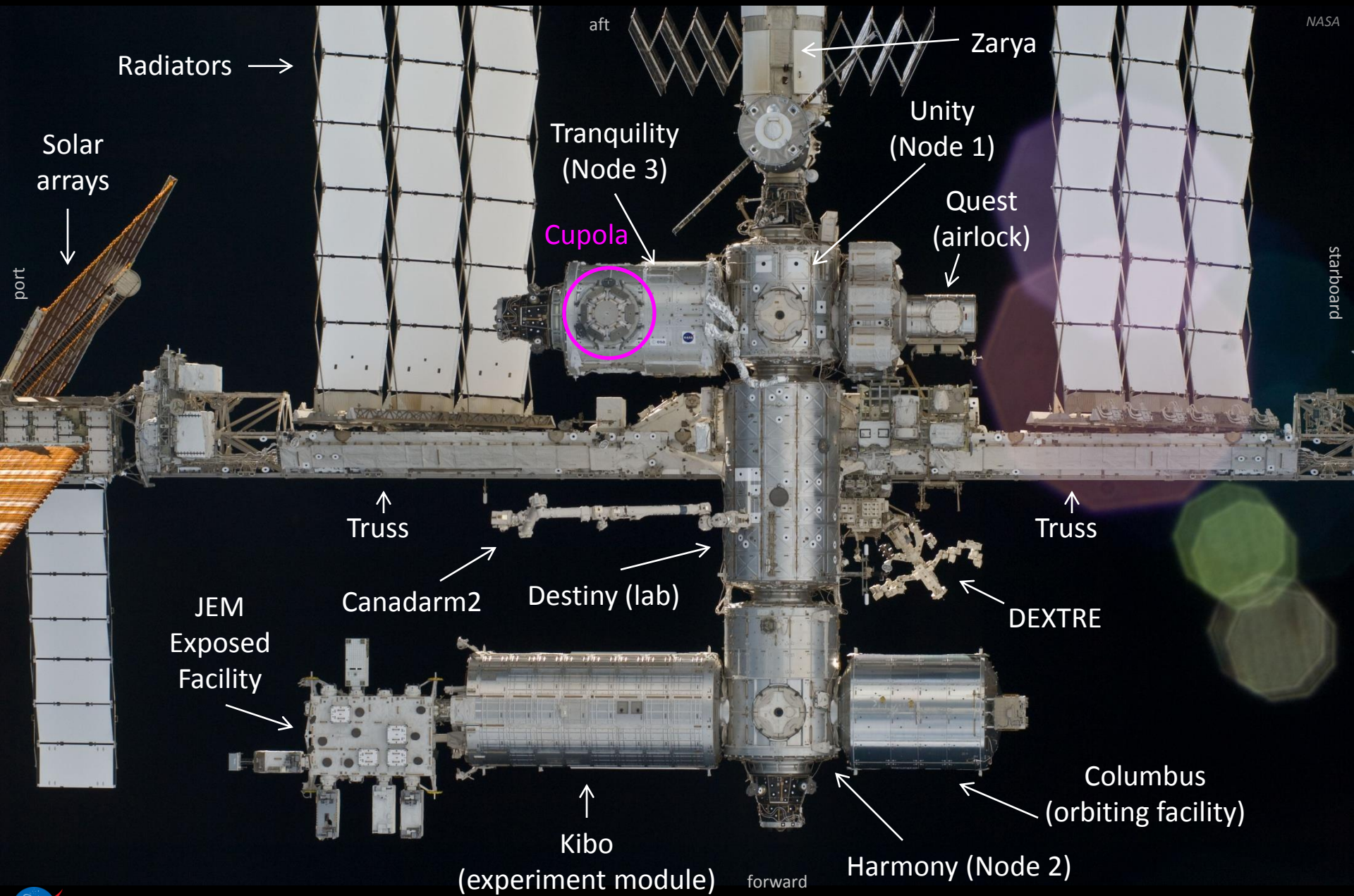


ISS – Zoom

NASA



ISS – Zoom



NASA

starboard

Radiators →

Solar arrays

port

aft

Zarya

Tranquility (Node 3)

Unity (Node 1)

Quest (airlock)

Cupola

↑ Truss

↑ Truss

JEM Exposed Facility

Canadarm2

Destiny (lab)

DEXTRE

↑ Kibo (experiment module)

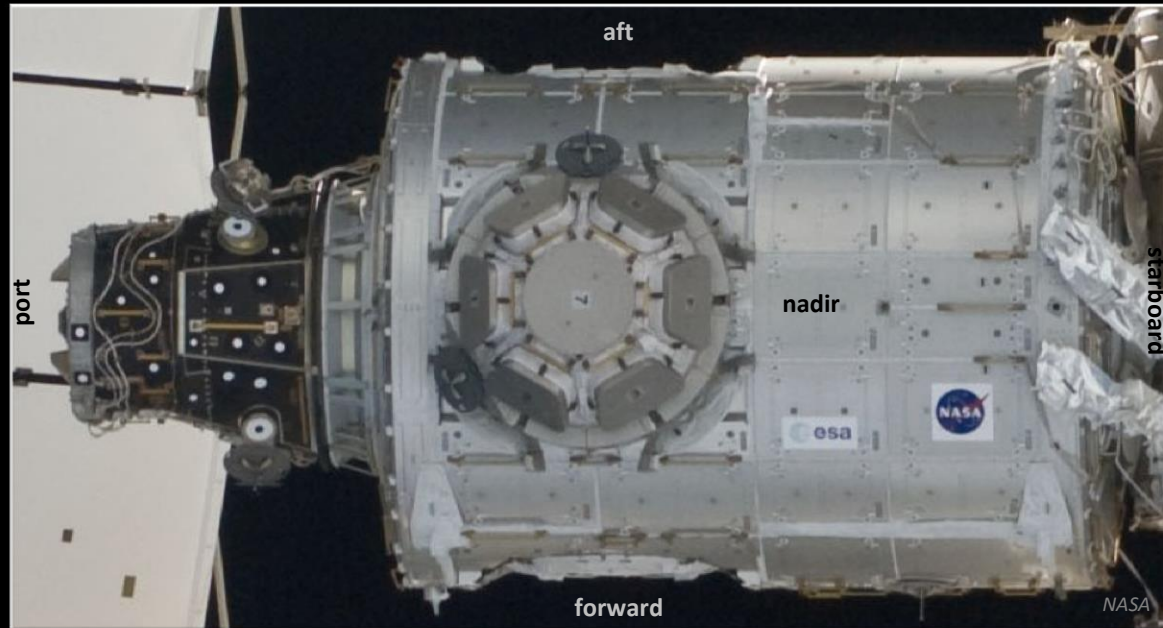
Columbus (orbiting facility)

Harmony (Node 2)

forward



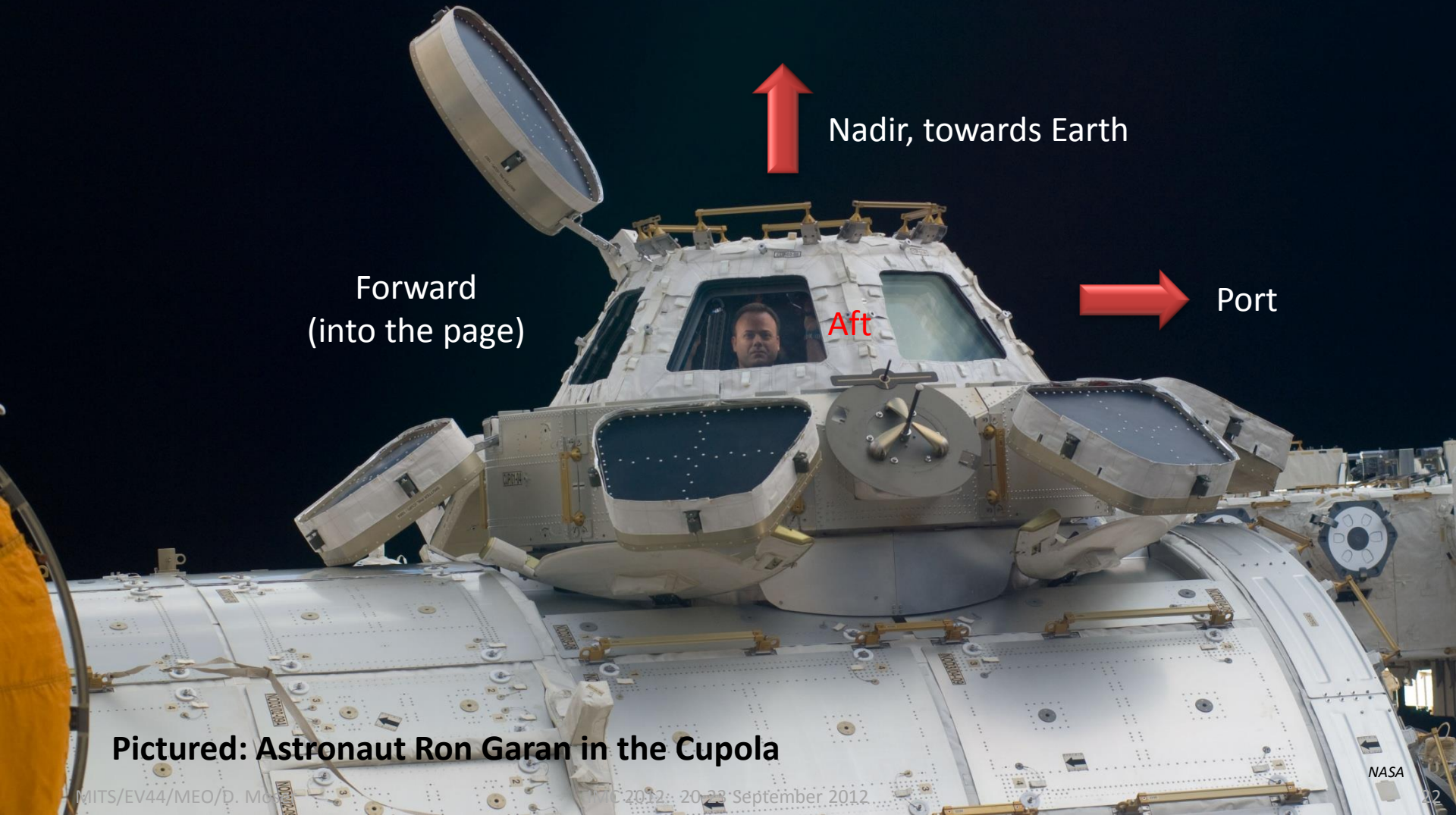
ISS – Cupola



- 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

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

Pass 1 exposure time = 15 s

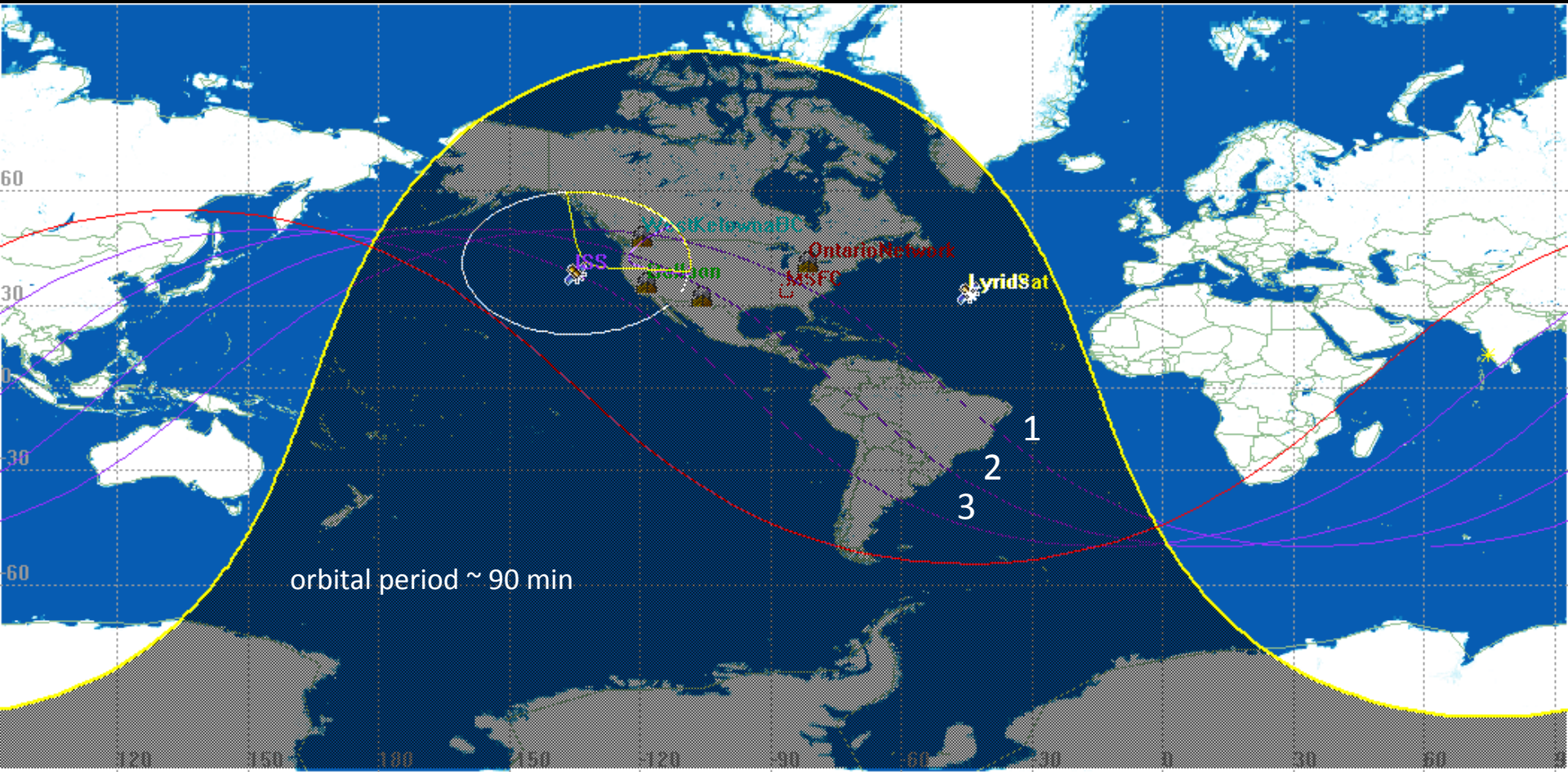
Pass 2-3 exposure time = 5 s

Image quality = Lossless compressed RAW

Image size = 4256 x 2832

ISO 1600

3 ISS Passes over N. America

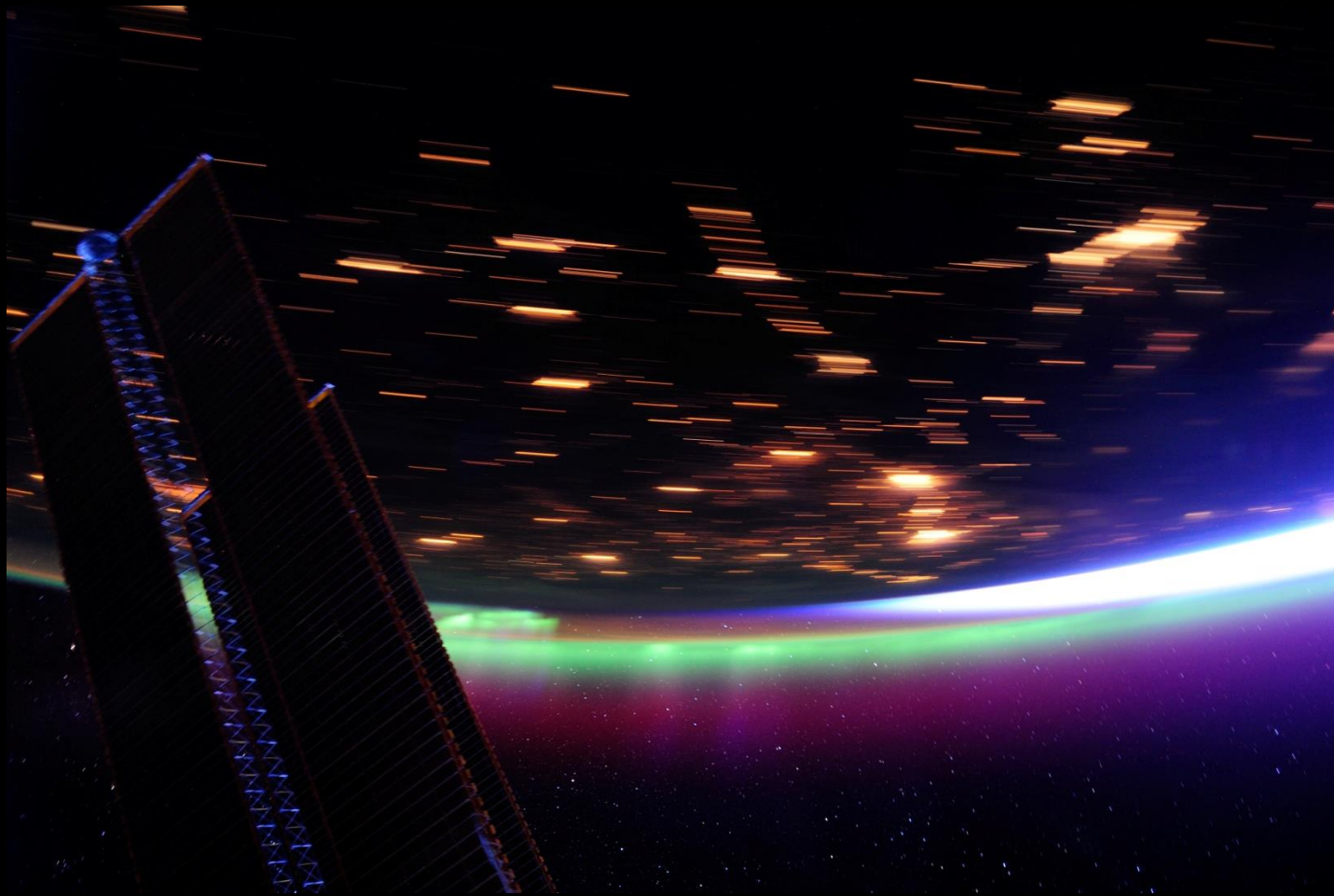


<u>Pass</u>	<u>Target Time</u>	<u>Target</u>
1	3:50 – 4:01 UT	MSFC
2	5:24 – 5:34 UT	New Mexico
3	6:57 – 7:07 UT	California

ISS Image Details

- FOV = 70° horizontal
- 5-15 sec exposures with 1-3 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 port camera, April 22 2012



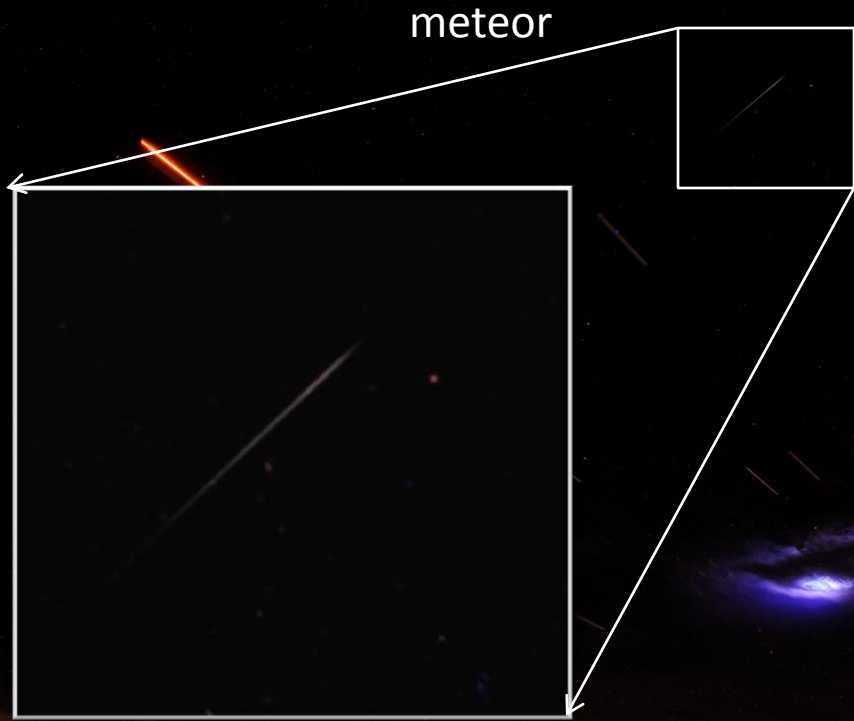
ISS port camera, April 22 2012



ISS aft camera, April 22 2012



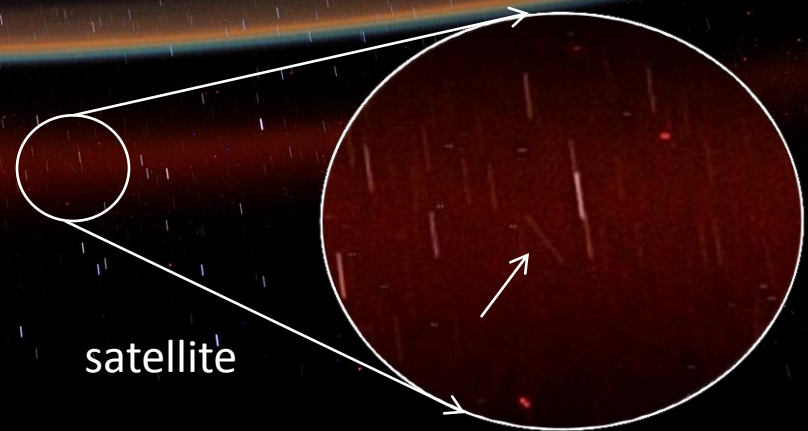
ISS aft camera, April 22 2012



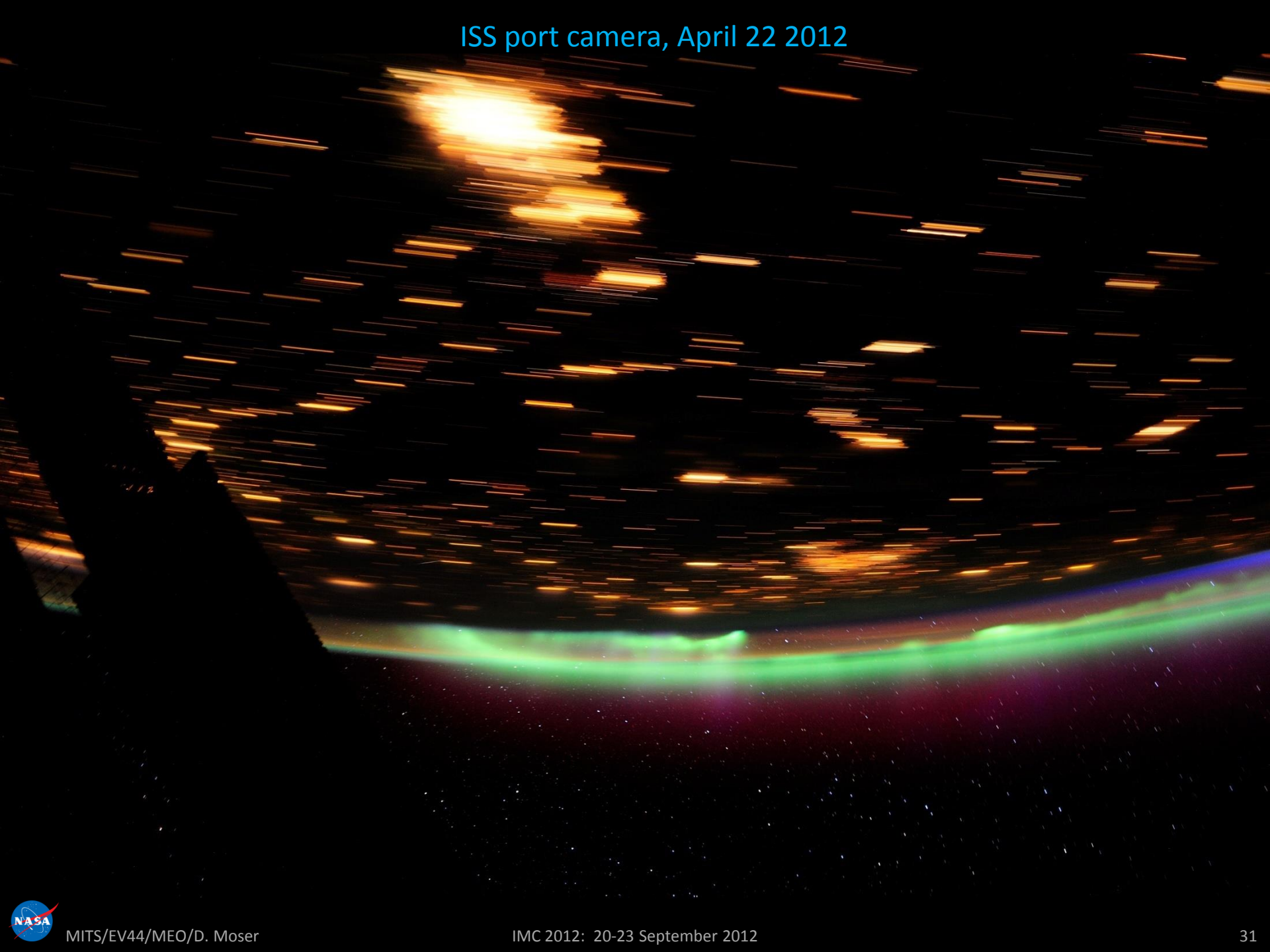
lightning

← airglow →

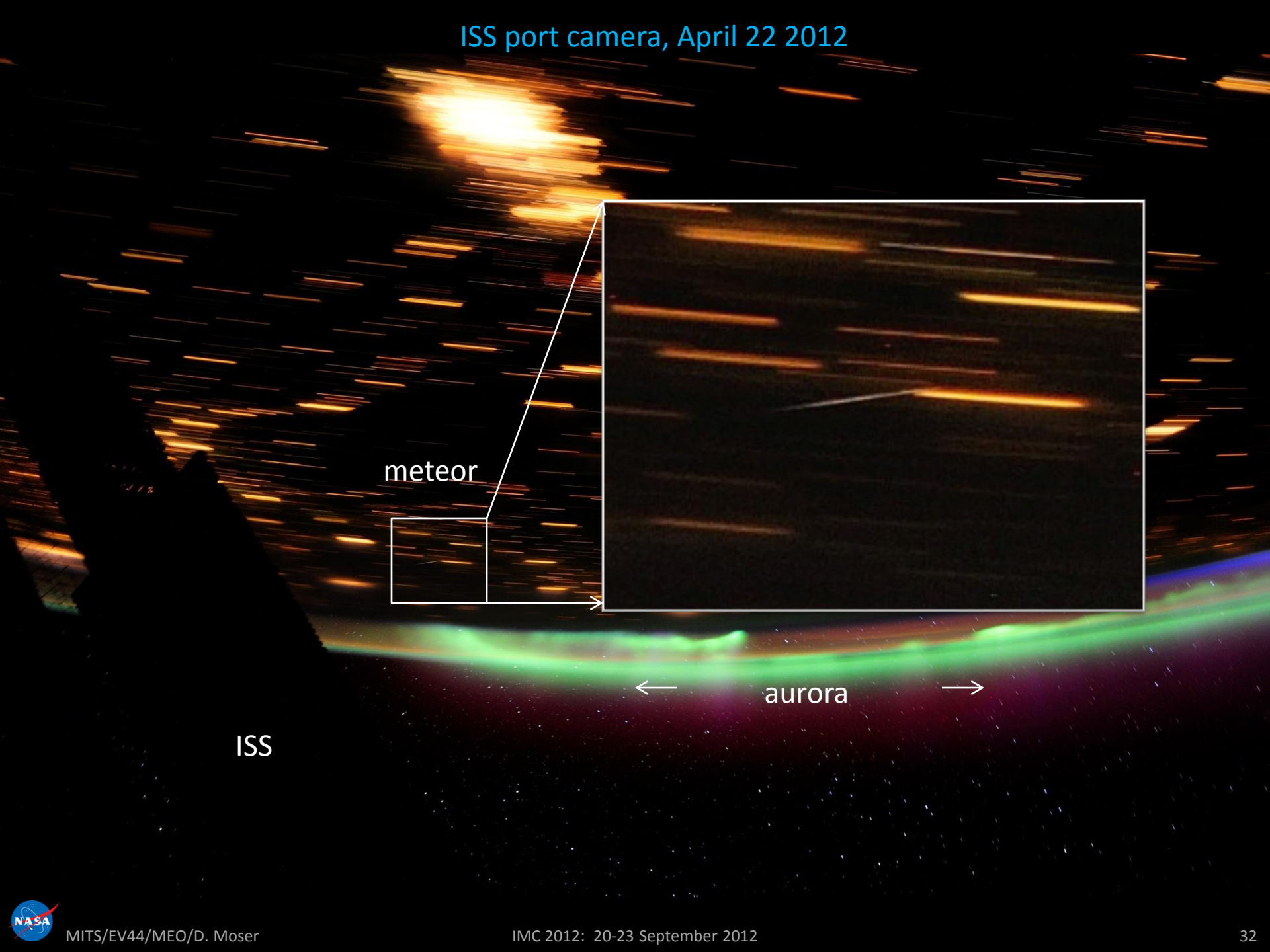
← Appleton anomaly →



ISS port camera, April 22 2012



ISS port camera, April 22 2012



meteor

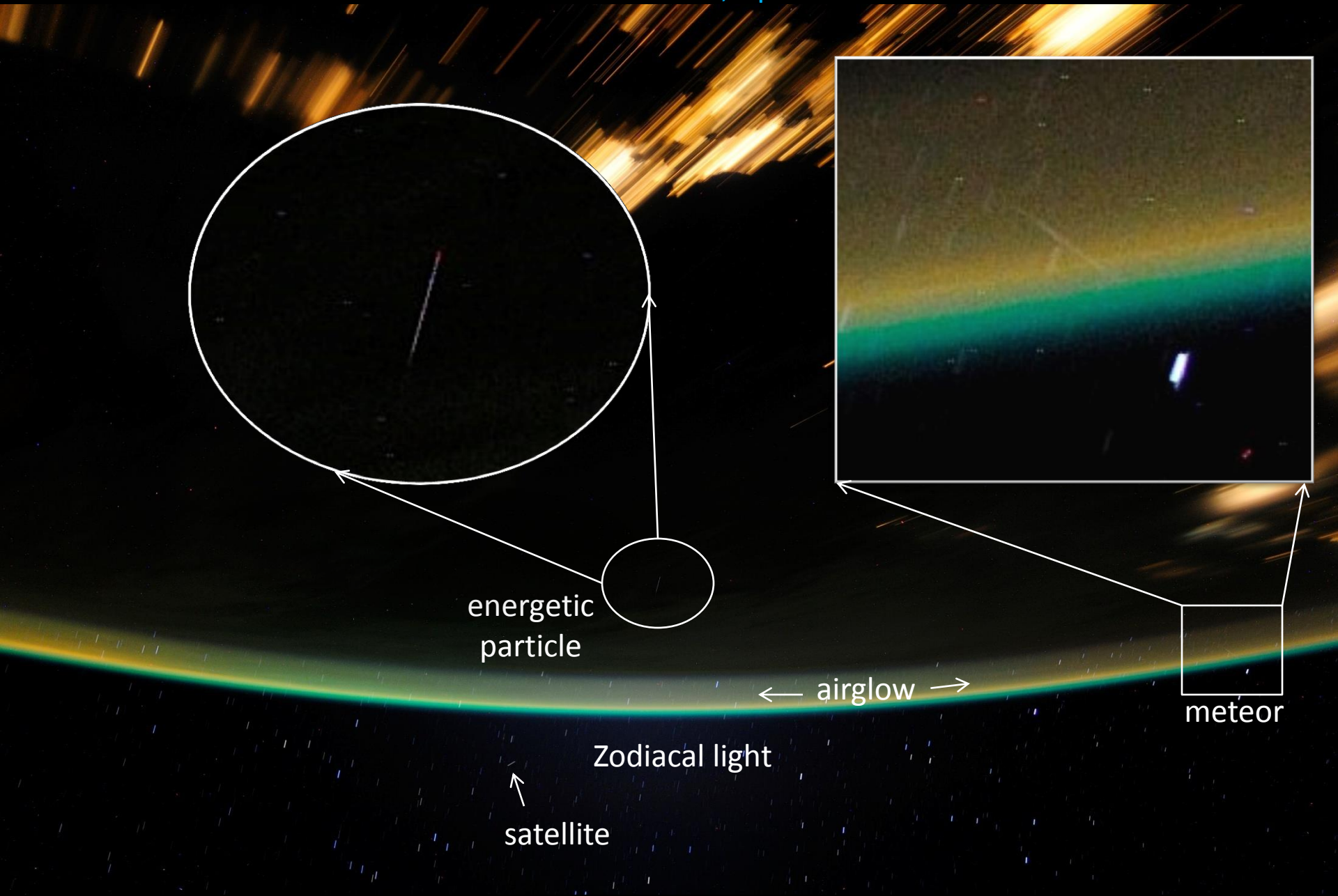
← aurora →

ISS

ISS forward camera, April 22 2012



ISS forward camera, April 22 2012



energetic
particle

← airglow →

meteor

Zodiacal light

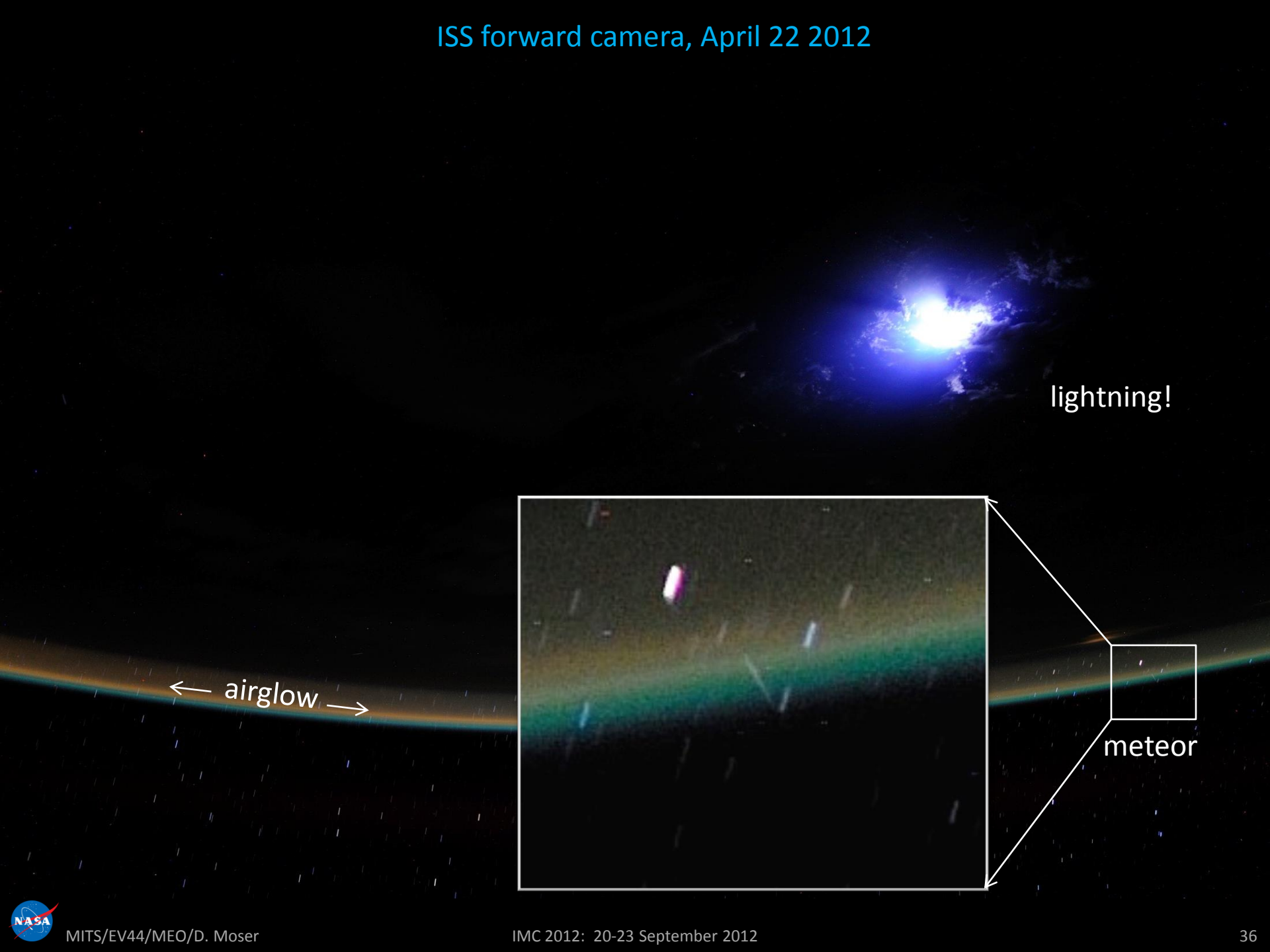
satellite



ISS forward camera, April 22 2012



ISS forward camera, April 22 2012



lightning!

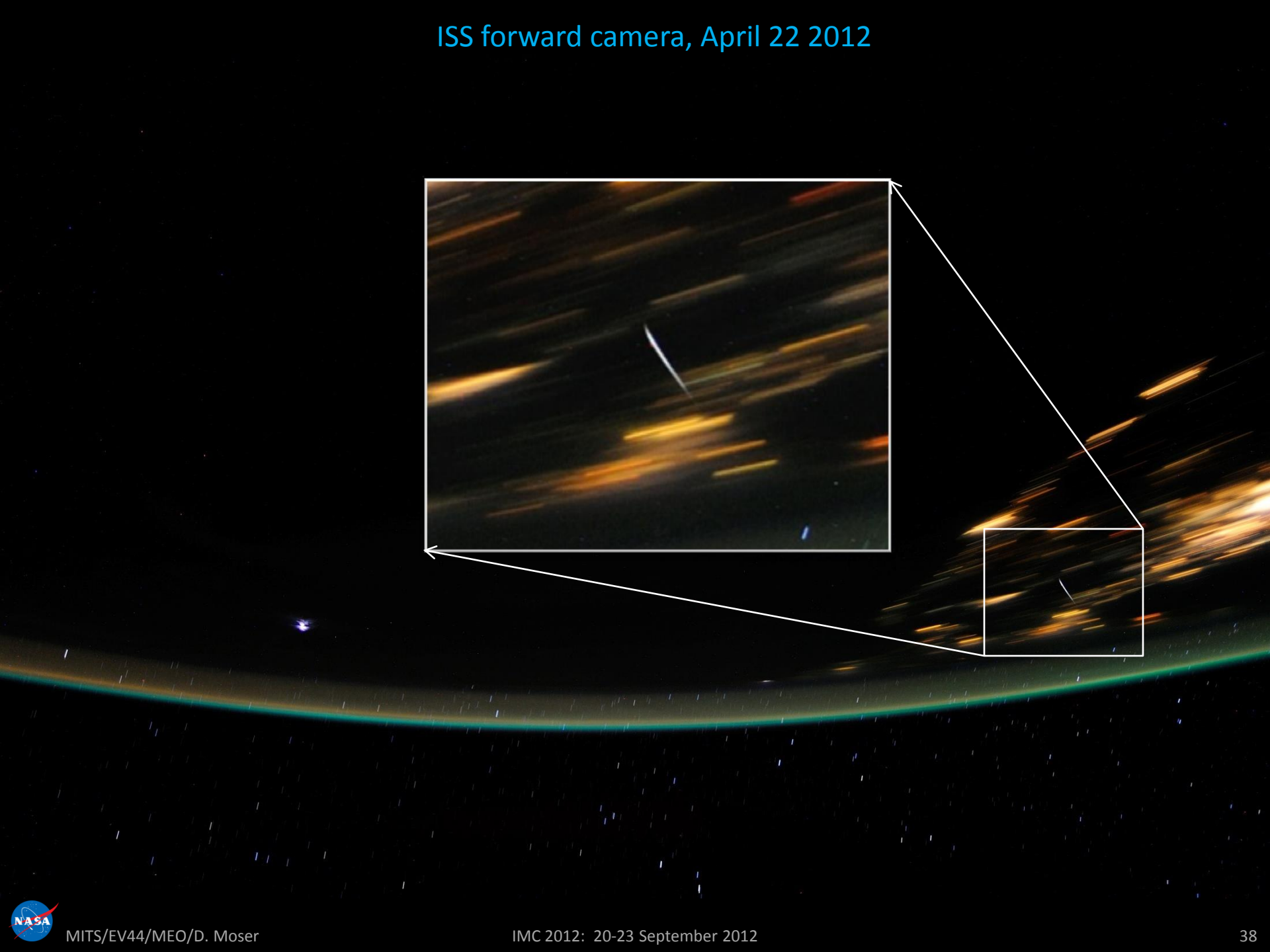
← airglow →

meteor

ISS forward camera, April 22 2012



ISS forward camera, April 22 2012



ISS port camera, April 22 2012

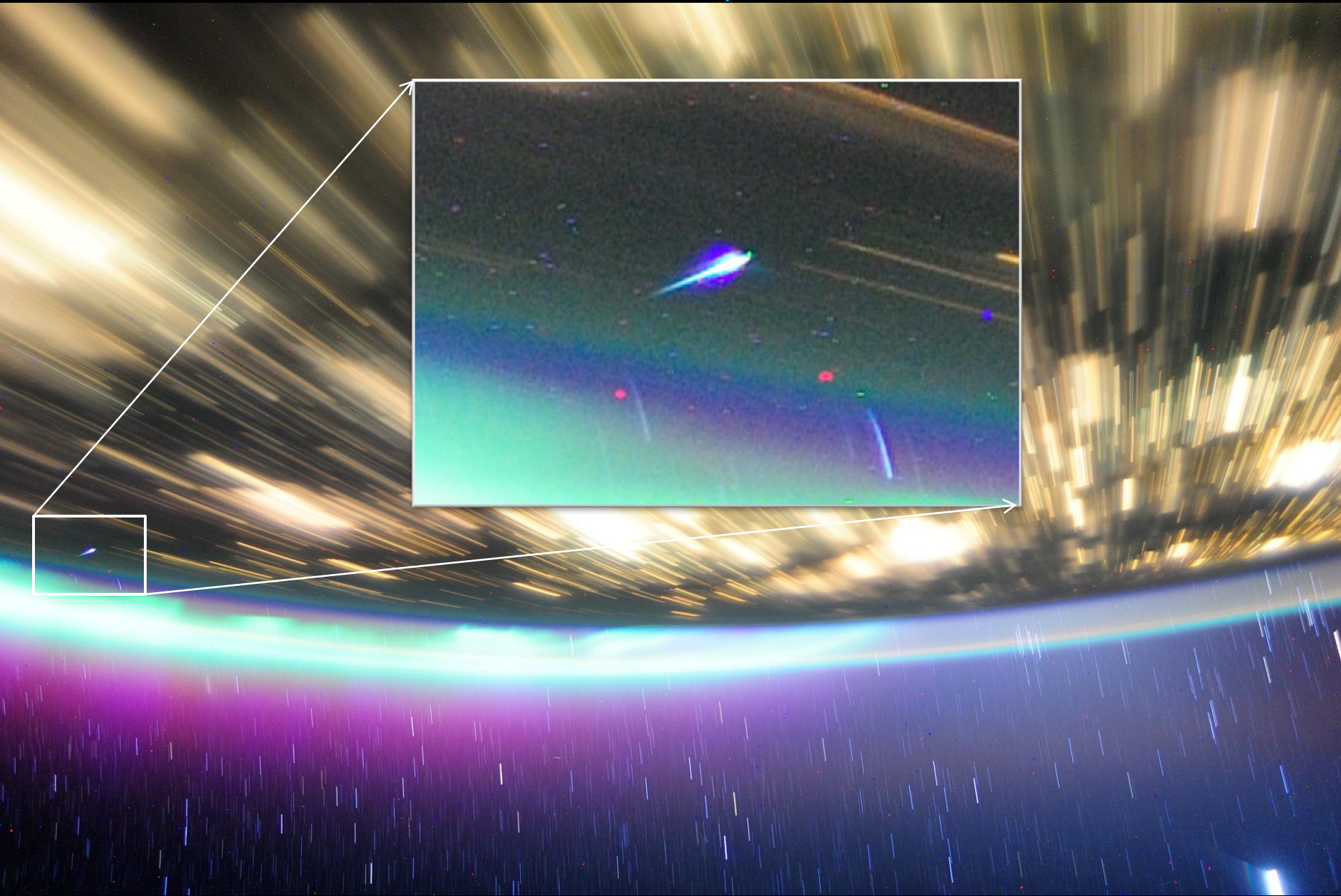


ISS port camera, April 22 2012





ISS aft camera, April 22 2012



ISS Results

ISS Pass	Time span (total time)	Time over ground targets (total time)	Exposure (s)	Num of images received*/ Total num	Num of meteor candidates†
1	3:52 – 4:25 (33 min)	3:50 – 4:01 (11 min)	15	262 / 366	33
2	5:26 – 5:58 (32 min)	5:24 – 5:34 (10 min)	5	942 / 1272	70
3	6:58 – 7:29 (31 min)	6:57 – 7:07 (10 min)	5	881 / 1215	52

* missing the nadir images

† approx evenly split between cameras

Total: 155 meteors observed!

ISS nadir camera, April 22 2012



Results

- Unfortunately no events were simultaneously observed from the ground, balloon, or ISS
- All 3 platforms detected meteors, Lyrids
- Need simult. ground-based observations to confirm Lyrids in balloon and ISS
- Balloon observations successful and inexpensive, though difficult to calibrate
- Many meteors imaged from ISS despite non-optimal meteor cameras & window quality

Acknowledgements

Thanks to the student scientists who worked hard to prepare, launch, and recover the balloon payload!

- Rachel Molina
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