Total Solar Eclipse Expedition to Lybia, Images & Realization

Jindřich Nový
Software Engineer

jnovy@redhat.com

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Contents

- Brief description of the TSE2006 expedition (goals, people)
- Interesting properties of the Sun
- Implementation of remote control software for digital cameras
- Presentation of results

What is TSE2006?

- expedition to Lybia and Turkey to observe the total solar eclipse 29th March 2006 to explore solar corona
- image shooting was automatic via USB interface using the EOS class Canon cameras
- up to 4 cameras were software controlled simultaneously

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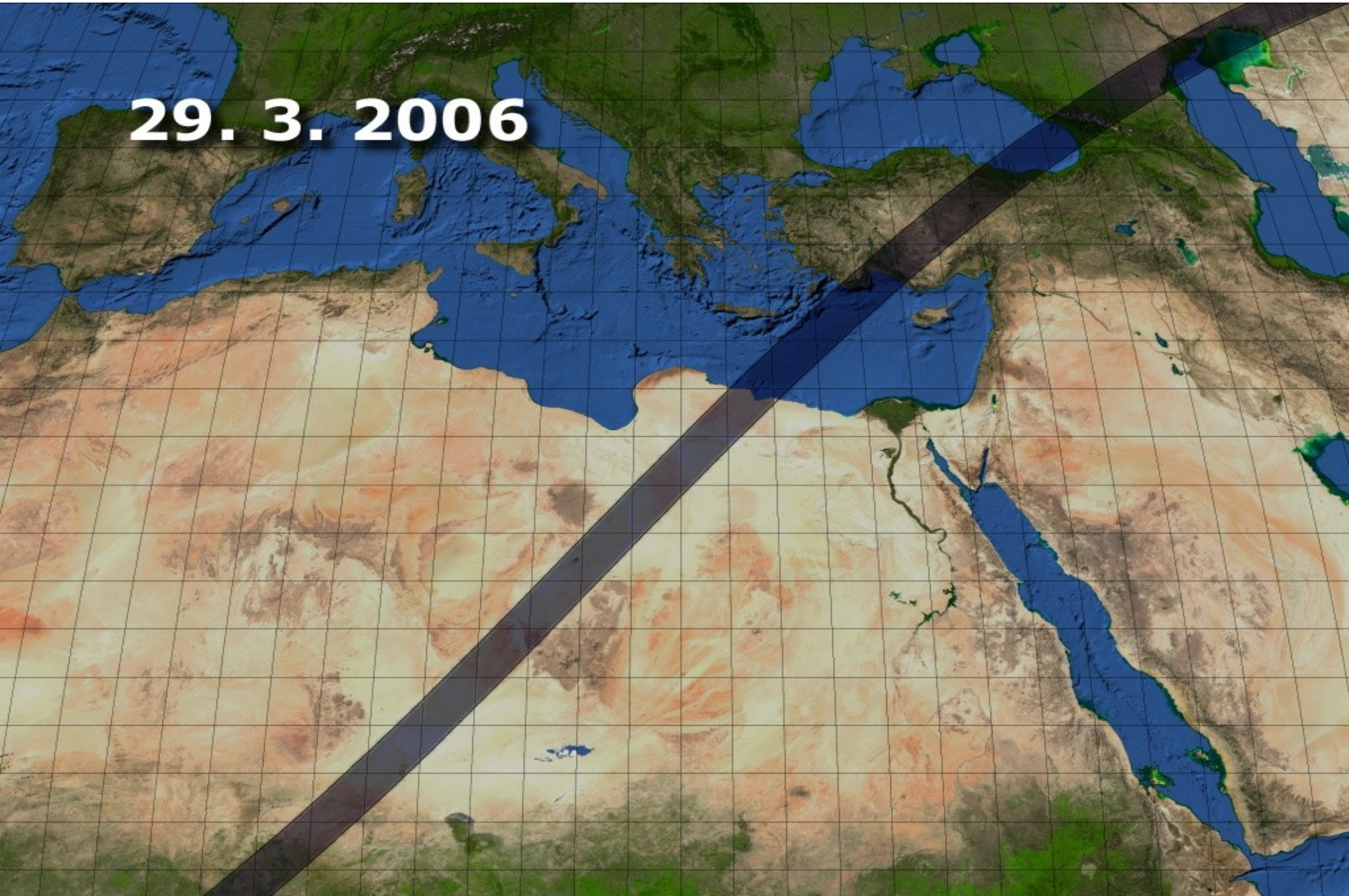
People behind TSE2006

- prof. Miloslav Druckműller- mathematician, solar eclipse expert
- Peter Aniol - astronomer, astronomic mount expert
- dr. Jindřich Nový - software engineer, camera communication expert
- about 30 people from department of Mathematical and Physical Engineering, Brno University of Technology

How Red Hat is involved?

- the camera control software was written by jnovy@redhat.com
- Fedora Core was used as OS on all notebooks

Where the total eclipse was seen?



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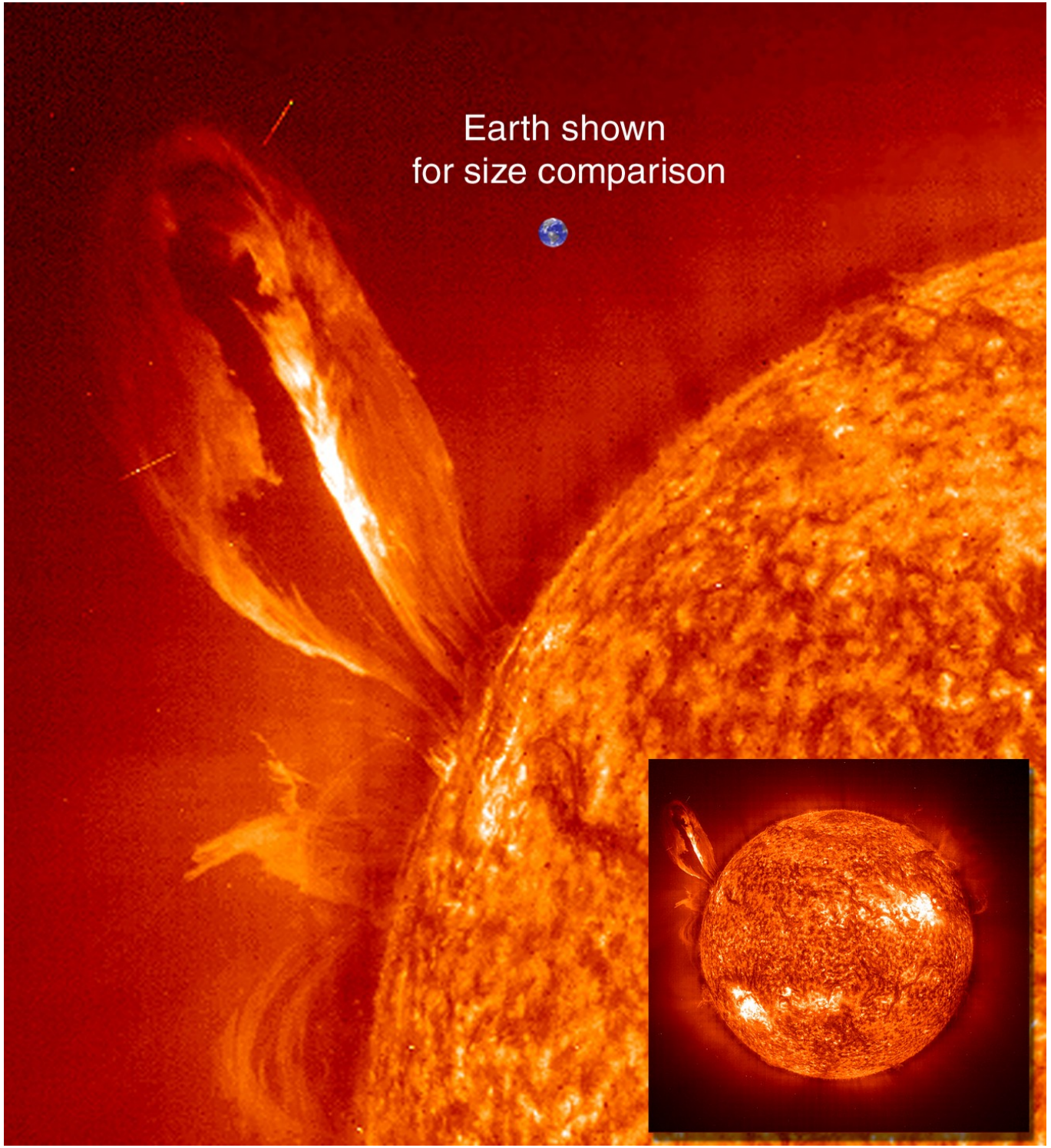
Why we want to research the Sun during the total eclipse when it's not visible?


Earth shown
for size comparison

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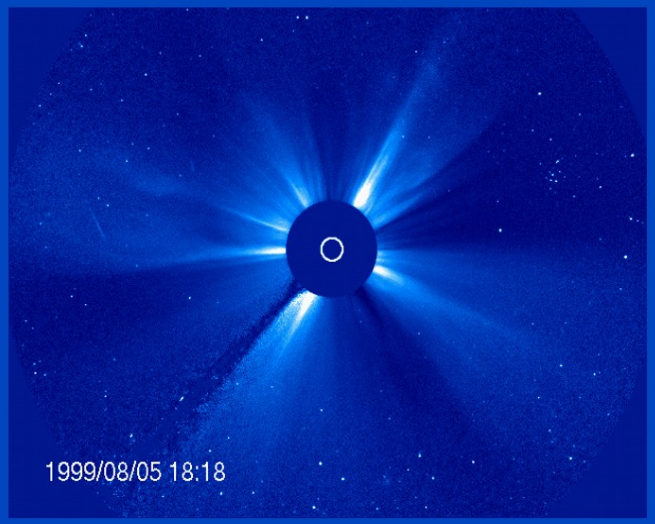
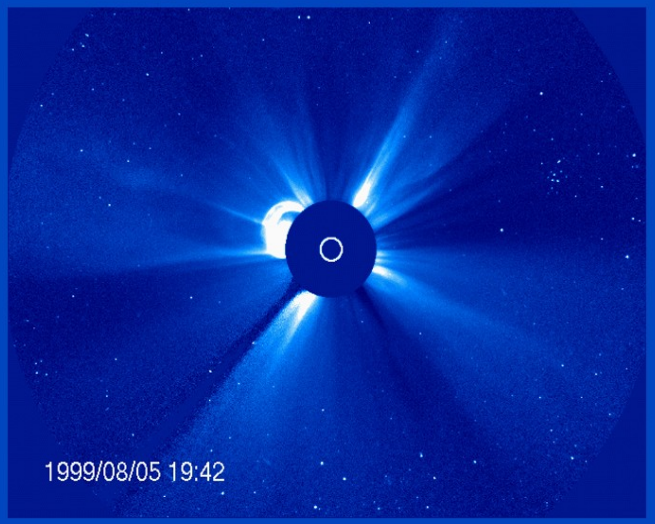
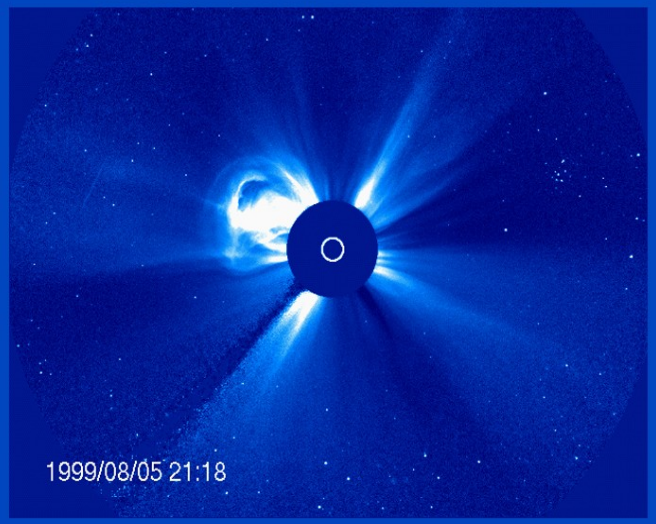
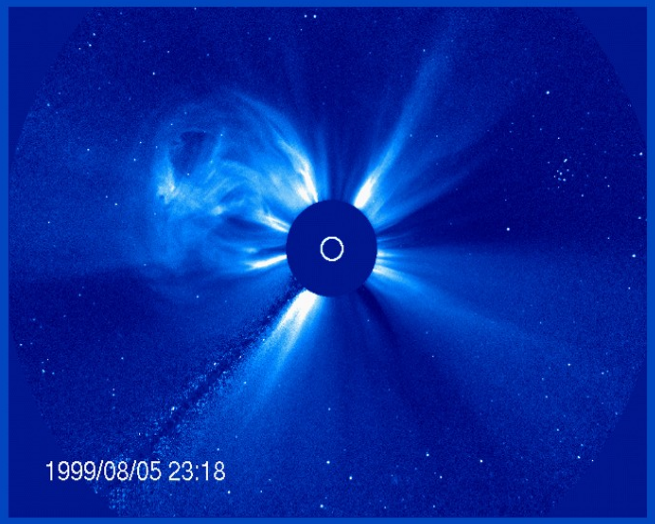
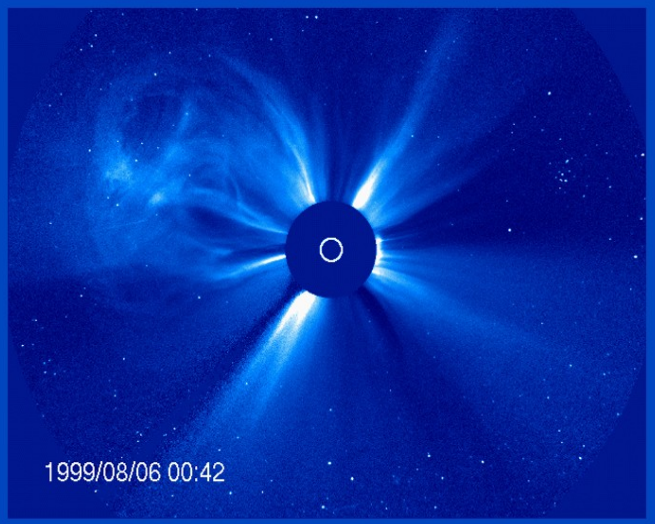
The Solar Corona

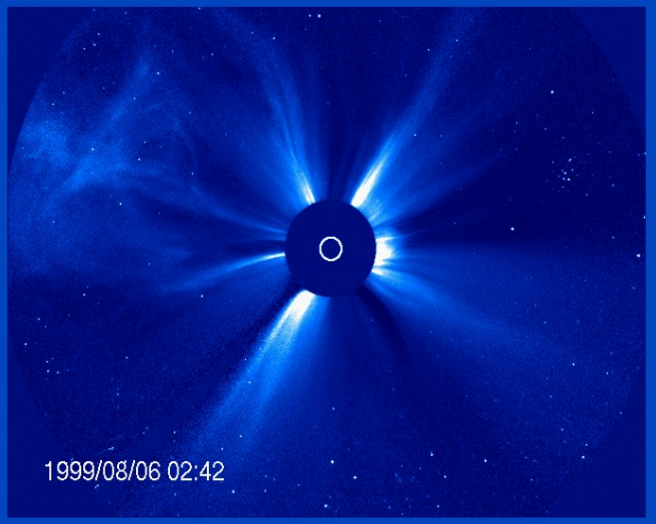












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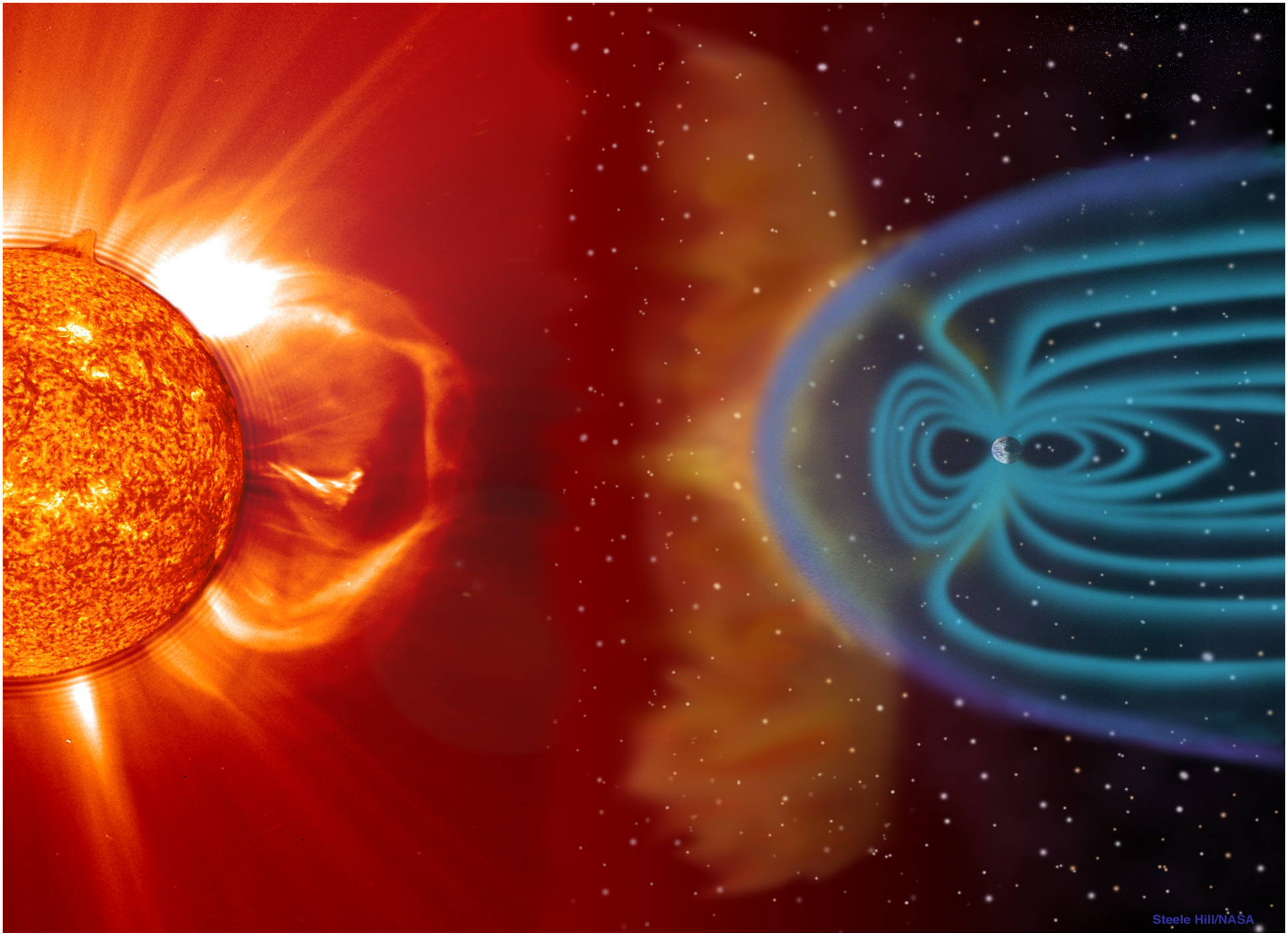
Does the solar flares affect us?



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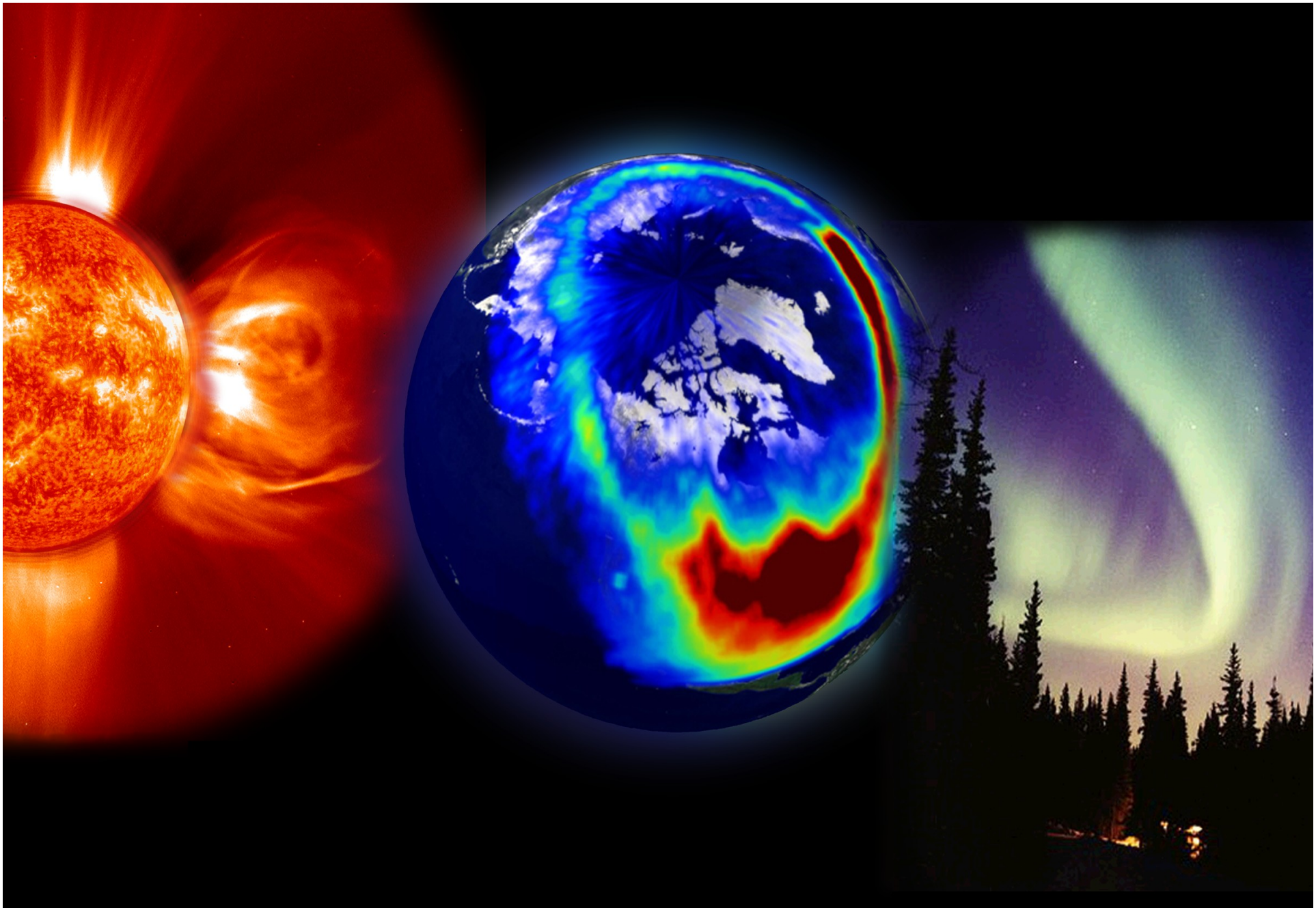
Aurora Borealis



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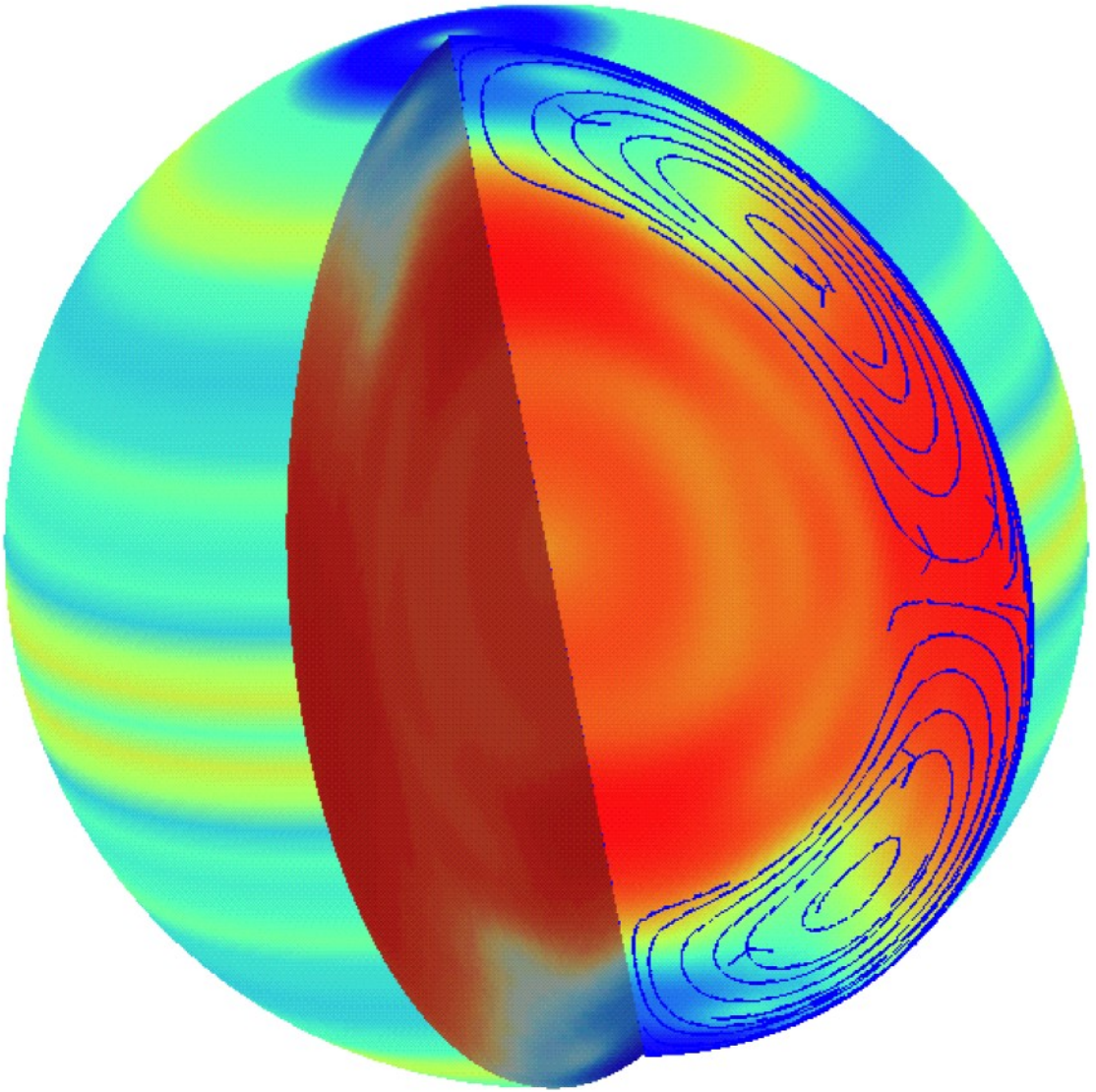
Why does Sun produce flares?



Principles of USB communication

The libusb library is used for low-level communication.

```
# lsusb
Bus 003 Device 001: ID 04a9:3084 Canon EOS 300D DIGITAL
Bus 002 Device 001: ID 04a9:30eb Canon EOS 20D
Bus 004 Device 001: ID 04a9:3101 Canon EOS 5D
Bus 001 Device 001: ID 04a9:30ee Canon EOS 350D DIGITAL
Bus 005 Device 001: ID 0000:0000
```

Communication is performed using handles dependent on transfer types:

Control Transfers

Bulk Transfers

Interrupt Transfers

Principles of USB communication

Control transfers: Used for short communication.

usb_control_msg()

Send a control message to a device.

usb_get_string()

Retrieves a string descriptor from a device.

usb_get_string_simple ()

Retrieves a string descriptor from a device.

usb_get_descriptor()

Retrieves a descriptor from a device's default control pipe

usb_get_descriptor_by_endpoint()

Retrieves a descriptor from a device

Principles of USB communication

Bulk transfers: Used for large data transfers.

usb_bulk_write()

Write data to a bulk endpoint.

usb_bulk_read()

Read data from a bulk endpoint.

Principles of USB communication

Interrupt transfers: Time critical transfers via interrupt pipes.

usb_interrupt_write()

Write data to an interrupt endpoint.

usb_interrupt_read()

Read data from a interrupt endpoint.

What the software is doing?

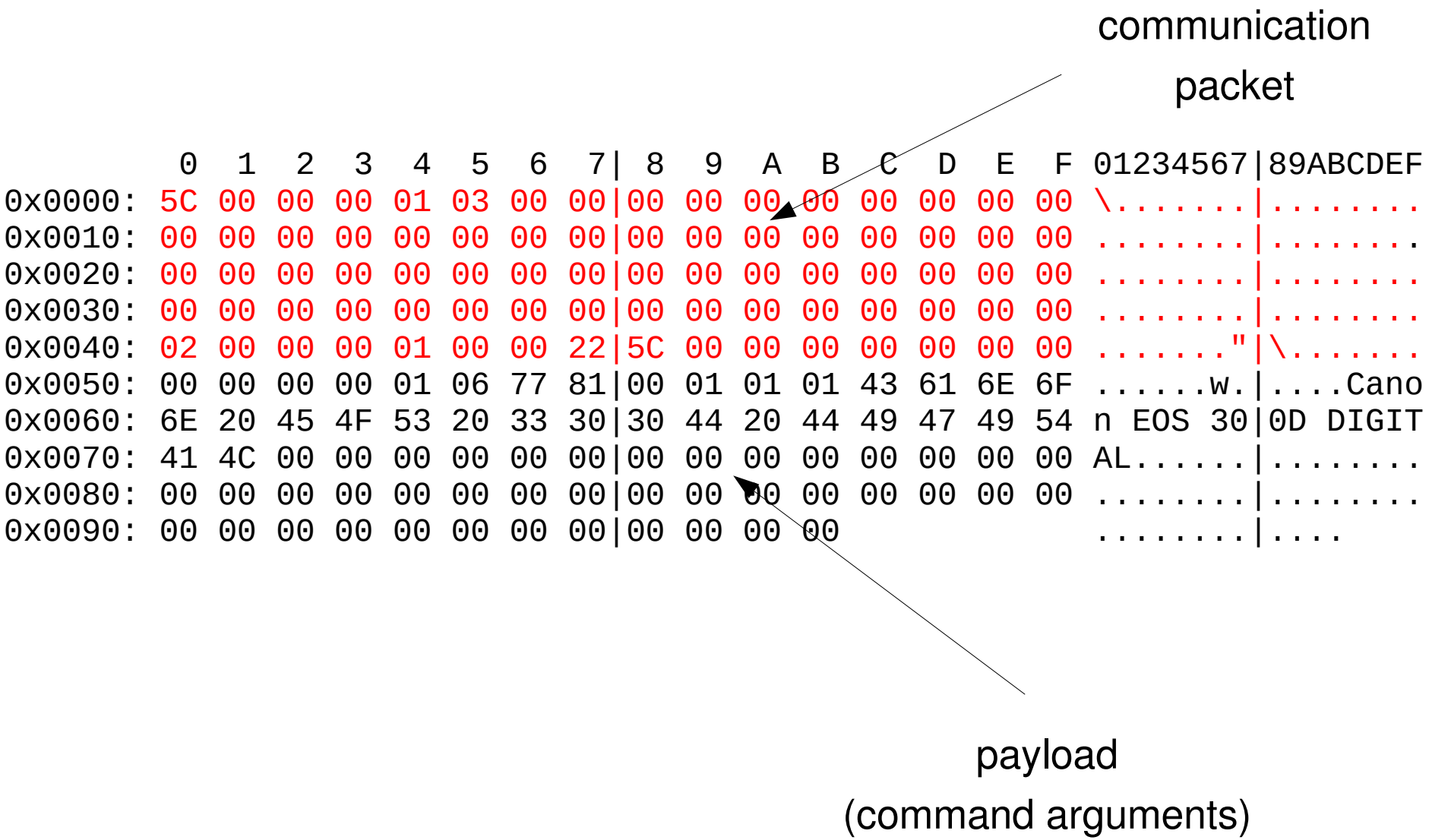
The software was needed to process scripts containing description of frame properties:

```
# Camera 2
# Canon EOS 5D
# 5.6/400mm
# EQ 6 mount

00:00:30.100 iso=100
00:00:51.101 tv=2000
00:00:51.201 shot
00:00:53.303 tv=2000
00:00:53.403 shot
00:00:55.504 tv=2000
00:00:55.604 shot
00:00:57.706 tv=2000
00:00:57.806 shot
00:00:59.907 tv=2000
00:01:00.007 shot
00:01:02.110 tv=1000
00:01:02.210 shot
00:01:04.315 tv=500
00:01:04.415 shot
00:01:06.525 tv=250
00:01:06.624 shot
```

The bulk transfer packet format

The software was needed to process scripts containing description of frame properties:




```
          0  1  2  3  4  5  6  7| 8  9  A  B  C  D  E  F 01234567|89ABCDEF
0x0000: 5C 00 00 00 01 03 00 00|00 00 00 00 00 00 00 00 \.......|........
0x0010: 00 00 00 00 00 00 00 00|00 00 00 00 00 00 00 00 ........|........
0x0020: 00 00 00 00 00 00 00 00|00 00 00 00 00 00 00 00 ........|........
0x0030: 00 00 00 00 00 00 00 00|00 00 00 00 00 00 00 00 ........|........
0x0040: 02 00 00 00 01 00 00 22|5C 00 00 00 00 00 00 00 ......."|\.......
0x0050: 00 00 00 00 01 06 77 81|00 01 01 01 43 61 6E 6F ......w.|....Cano
0x0060: 6E 20 45 4F 53 20 33 30|30 44 20 44 49 47 49 54 n EOS 30|0D DIGIT
0x0070: 41 4C 00 00 00 00 00 00|00 00 00 00 00 00 00 00 AL......|........
0x0080: 00 00 00 00 00 00 00 00|00 00 00 00 00 00 00 00 ........|........
0x0090: 00 00 00 00 00 00 00 00|00 00 00 00             ........|....
```

The Alpha Test Preparation

The Alpha Test Preparation

The Alpha Test Preparation

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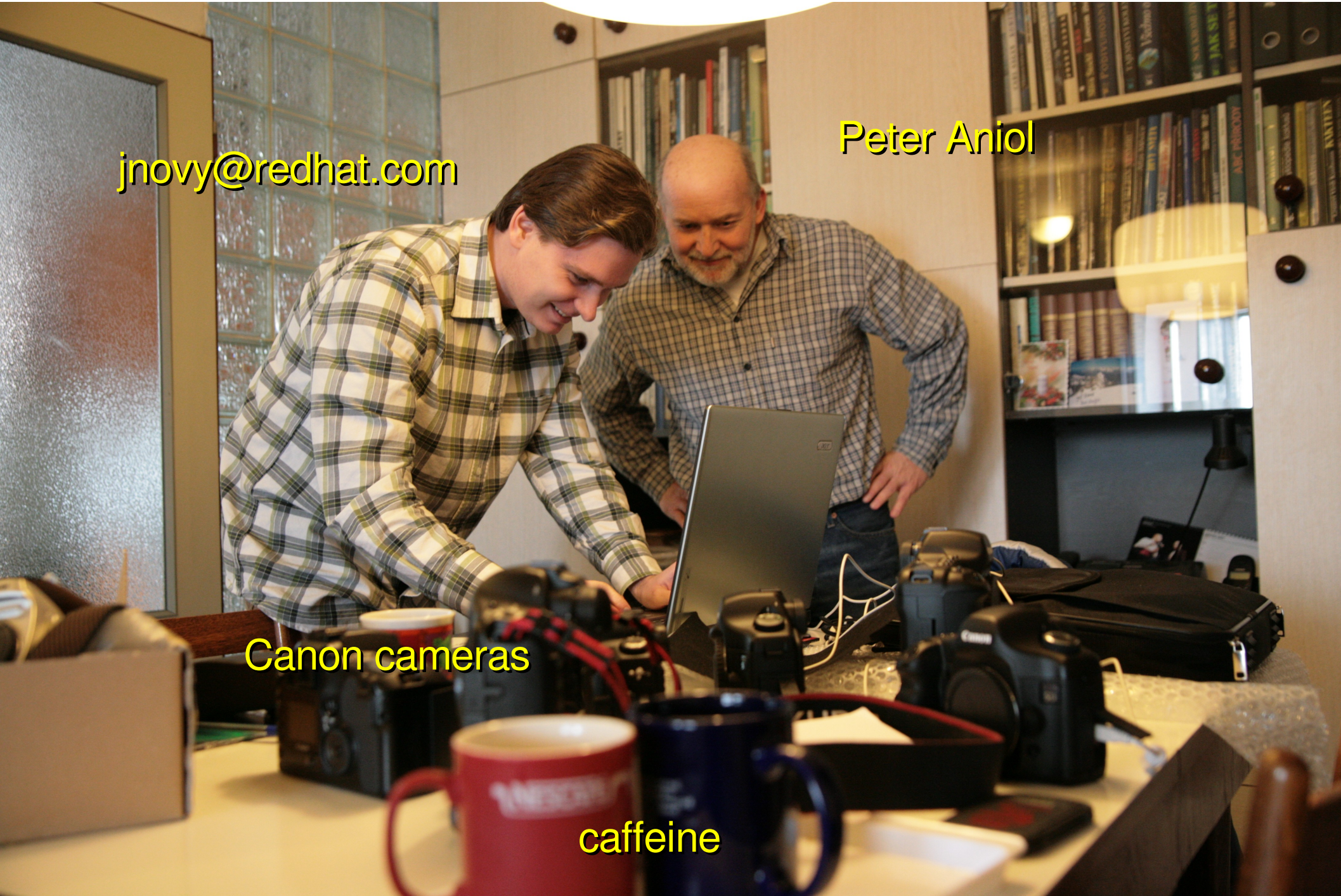
The Alpha Test

The Beta Test Preparation



Used Hardware

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Lybia

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Lybia

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Lybia

redhat.

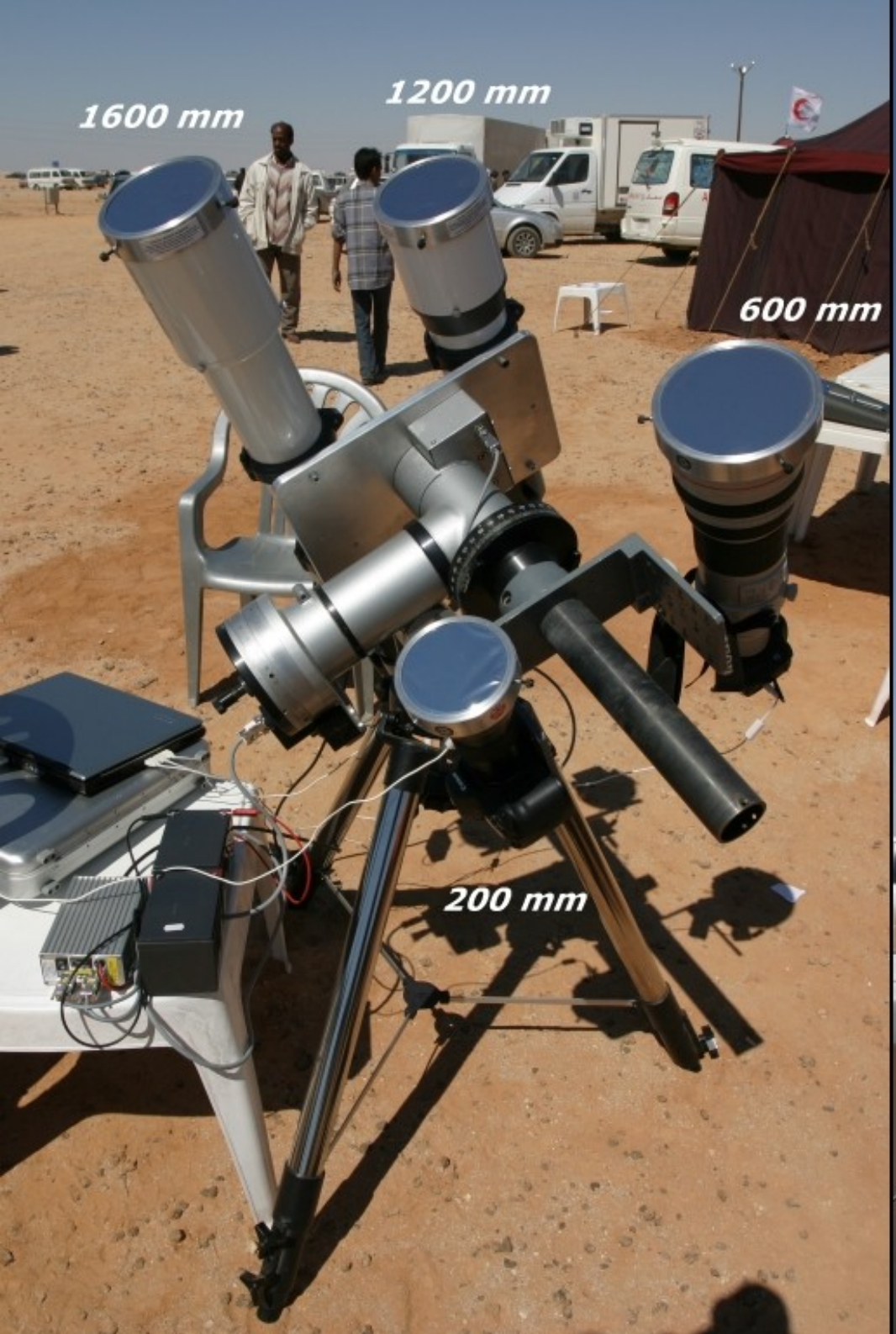
Lybia

redhat

Lybia

redhat

Lybia


1600 mm
1200 mm
600 mm
200 mm


800 mm
400 mm
EQ6
PRO

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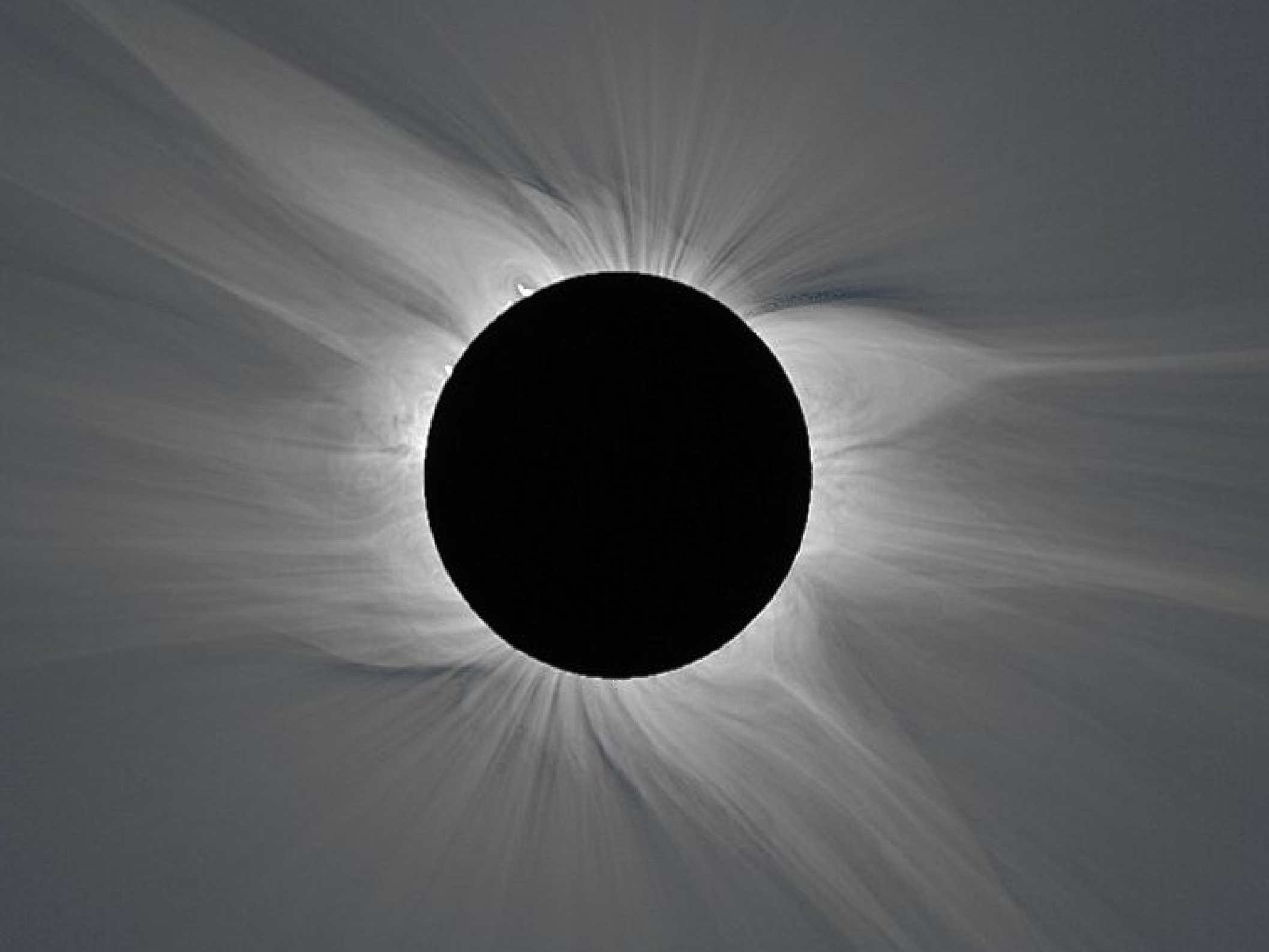
Results?

Taken about 4.5GB of images by 6 cameras in 8Mpix/12Mpix resolution losslessly encoded.



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Where to go next?

Mongolia!