

# Online Cloud Detection Using Data Streaming From Allsky Cams



SFB 876 Providing Information  
by Resource-Constrained Data Analysis



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# Motivation

- FACT telescope on La Palma
- Controlled remotely
  - Cloudiness affects data
  - Usage of allsky cams
- Future goal: automate operation
- For now: simplify remote operation



Image by JosØLuis Lemus

# Motivation

- Determine “cloudiness” from allsky images
- Quality rating of each data run:
  - Discard bad runs
    - Only data with high rating in analysis
  - Prevent taking data in cloudy areas at all
    - Suggest better source in non-cloudy sky

# Developed Software - Requirements

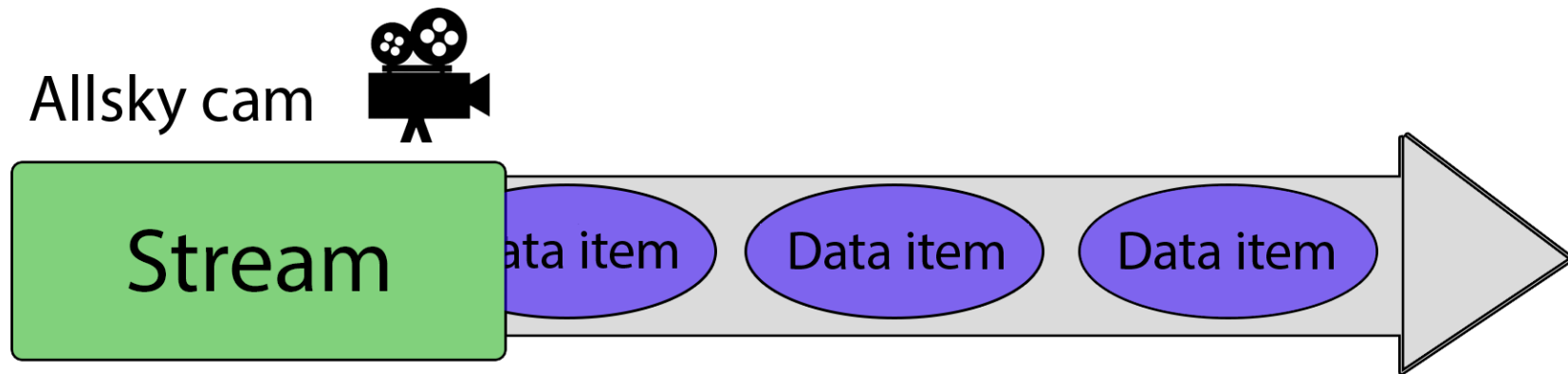
- Online processing of data
- Modular structure
- Preferably multiple input sources at once

# Developed Software - Requirements

- Online processing of data
- Modular structure
- Preferably multiple input sources at once
- “Streams-Framework” <https://sfb876.de/streams>  
chair of artificial intelligence - TU Dortmund

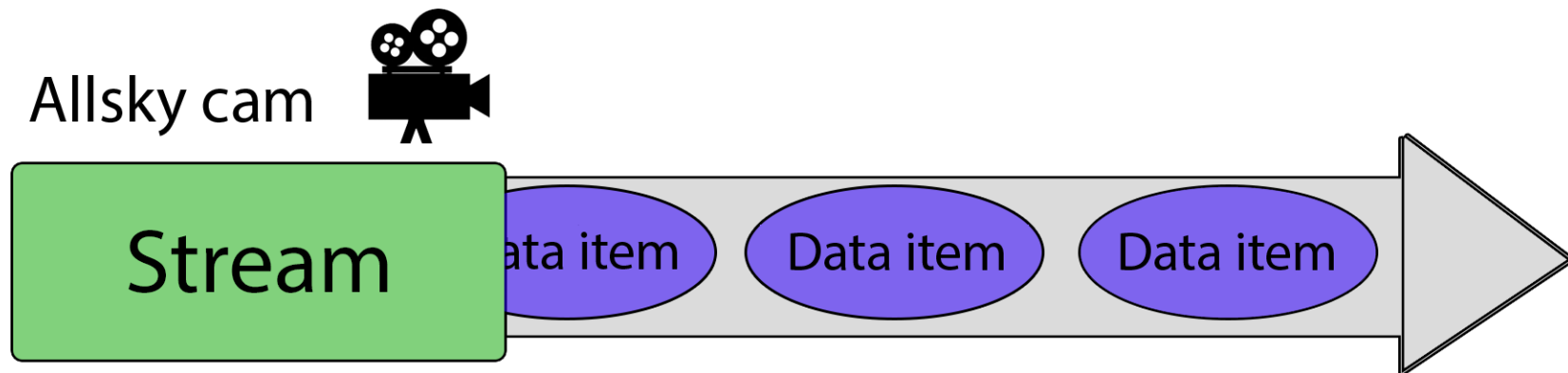
# Streams Framework

- Java: platform independent, only .xml + .jar file



- Stream outputs sequence of data objects
- Data item is set of (key, value) pairs
  - any serializable object

# Streams Framework



```
<stream id="FACT-AllSkyCam" class="fact.skycam.WebImageStream" interval="60s"
url="http://fact-project.org/cam/skycam.php" />
```

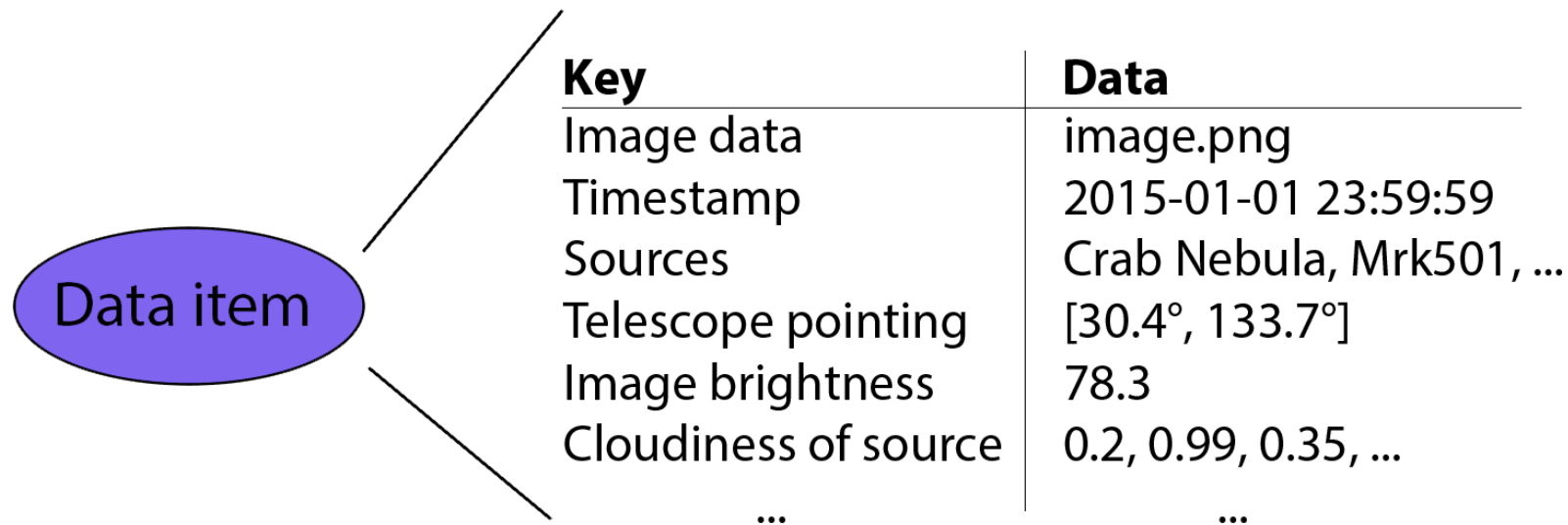
```
<stream id="MAGIC-AllSkyCam" class="fact.skycam.WebImageStream" interval="60s"
url="http://www.magic.iac.es/site/weather/AllSkyCurrentImage.JPG" />
```

```
<stream id="database-AllSkyCam" class="fact.skycam.ImageStream" interval="1s"
directory="/home/fact/storedImages/gtc/2015/" />
```

XML Code

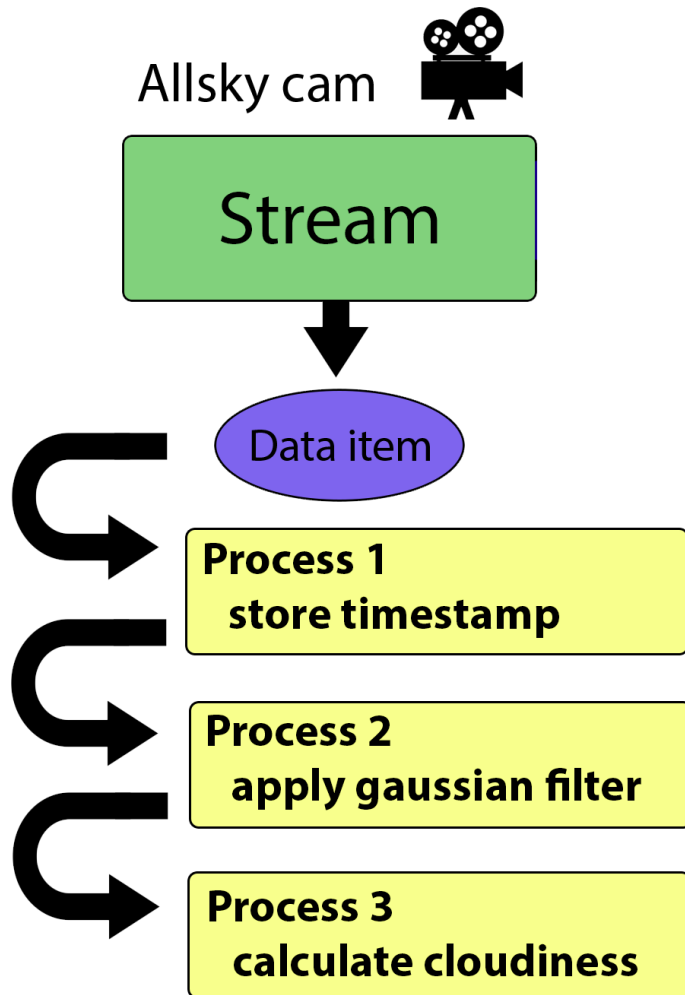


# Streams Framework



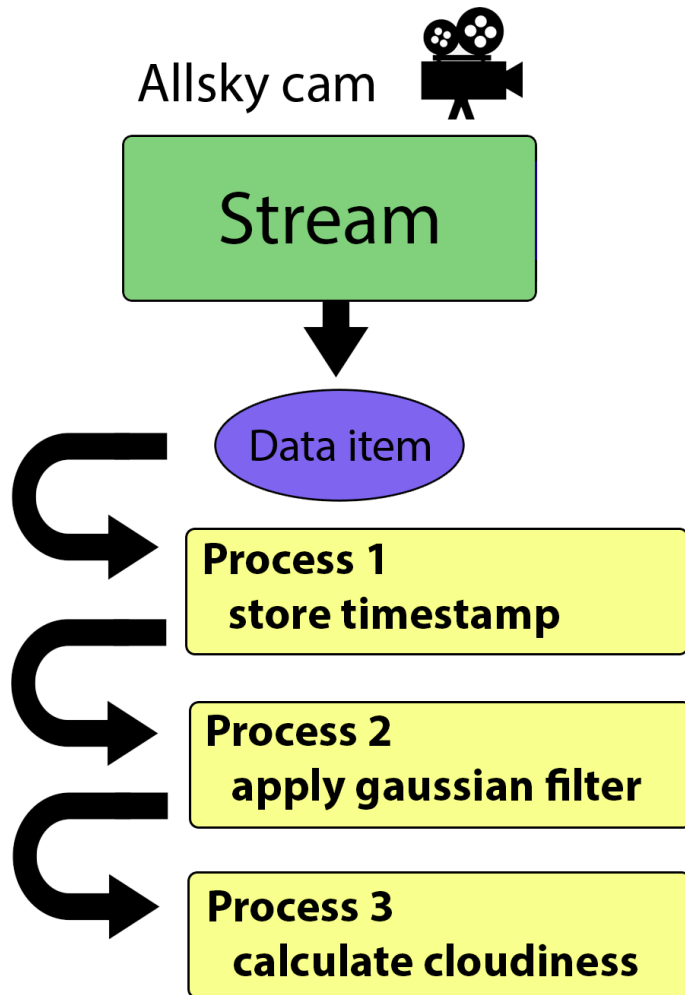
- Data item stores results from each step of the analysis
- Stream of items can be splitted or merged from different sources

# Streams Framework



- Data objects get passed on
- Processor is Java class
  - access to all keys
  - creates new keys

# Streams Framework



## XML Code

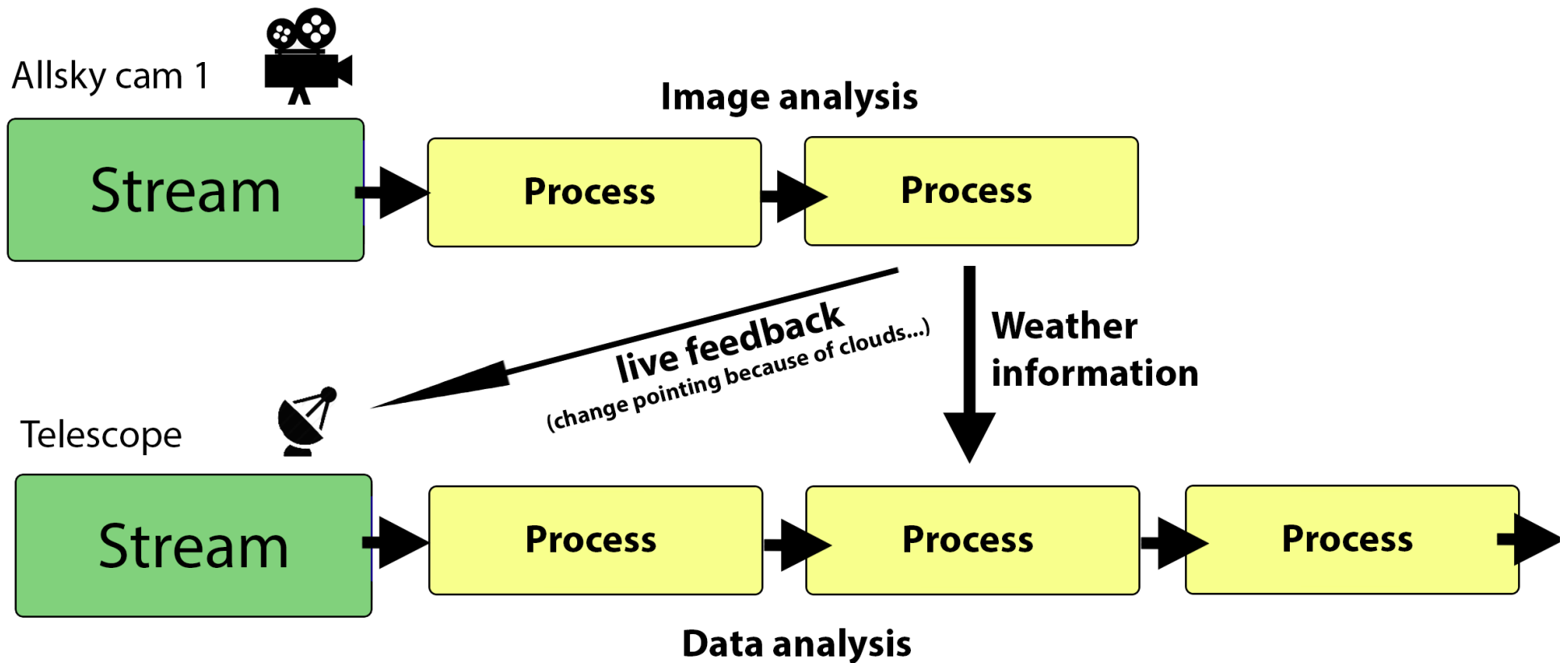
```
<process input="FACT-AllSkyCam">
```

```
<fact.skycam.GetCurrentTime  
  out_key="Timestamp" />
```

```
<fact.skycam.ApplyGaussianFilter  
  inp_sigma="3"  
  out_key="smooth_image" />
```

```
<fact.skycam.CalcCloudiness  
  out_key="cloudinessTotalImage" />
```

# Streams Framework - Goal



# Detecting Clouds

- Appearance of clouds depends on outer influences



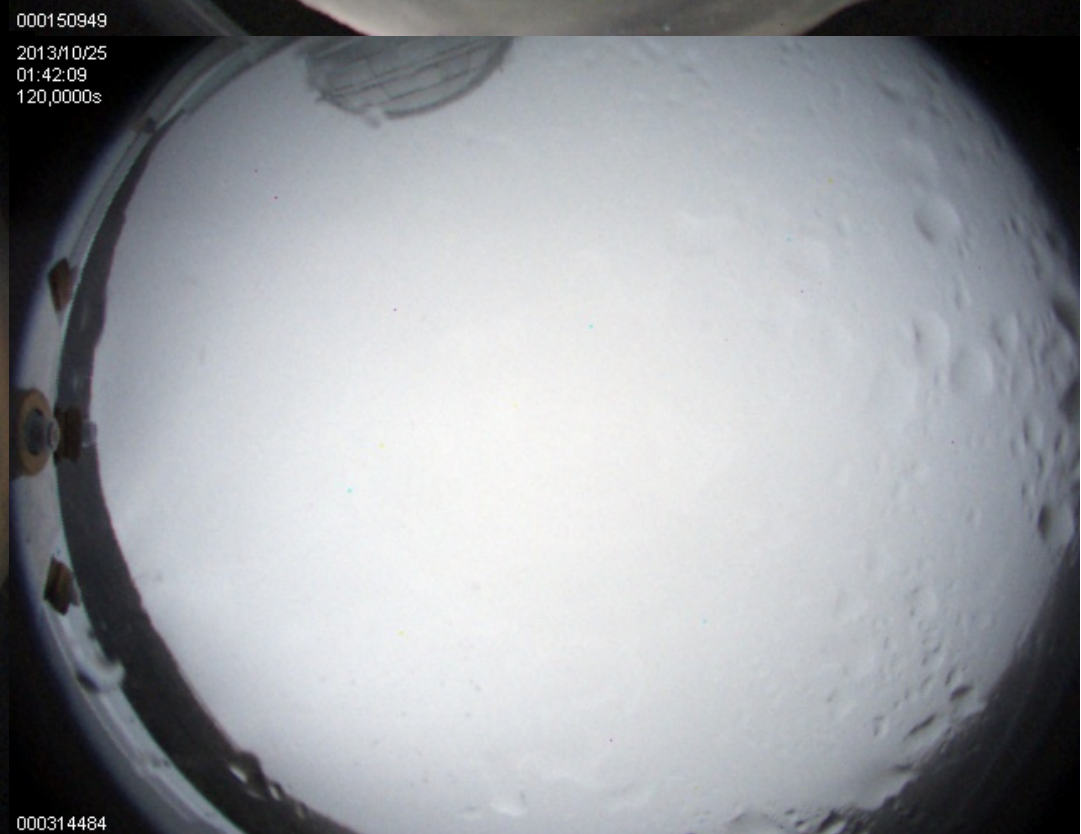
2014/04/07  
23:46:45  
120,000s  
Heater Off



000403864



2013/10/25  
03:55:26  
120,000s



000150949

2013/10/25  
01:42:09  
120,000s

000314484

# Detecting Clouds

- Appearance of clouds depends on outer influences
  - stars remain unchanged (only get covered up)
- ⇒ search for areas without stars





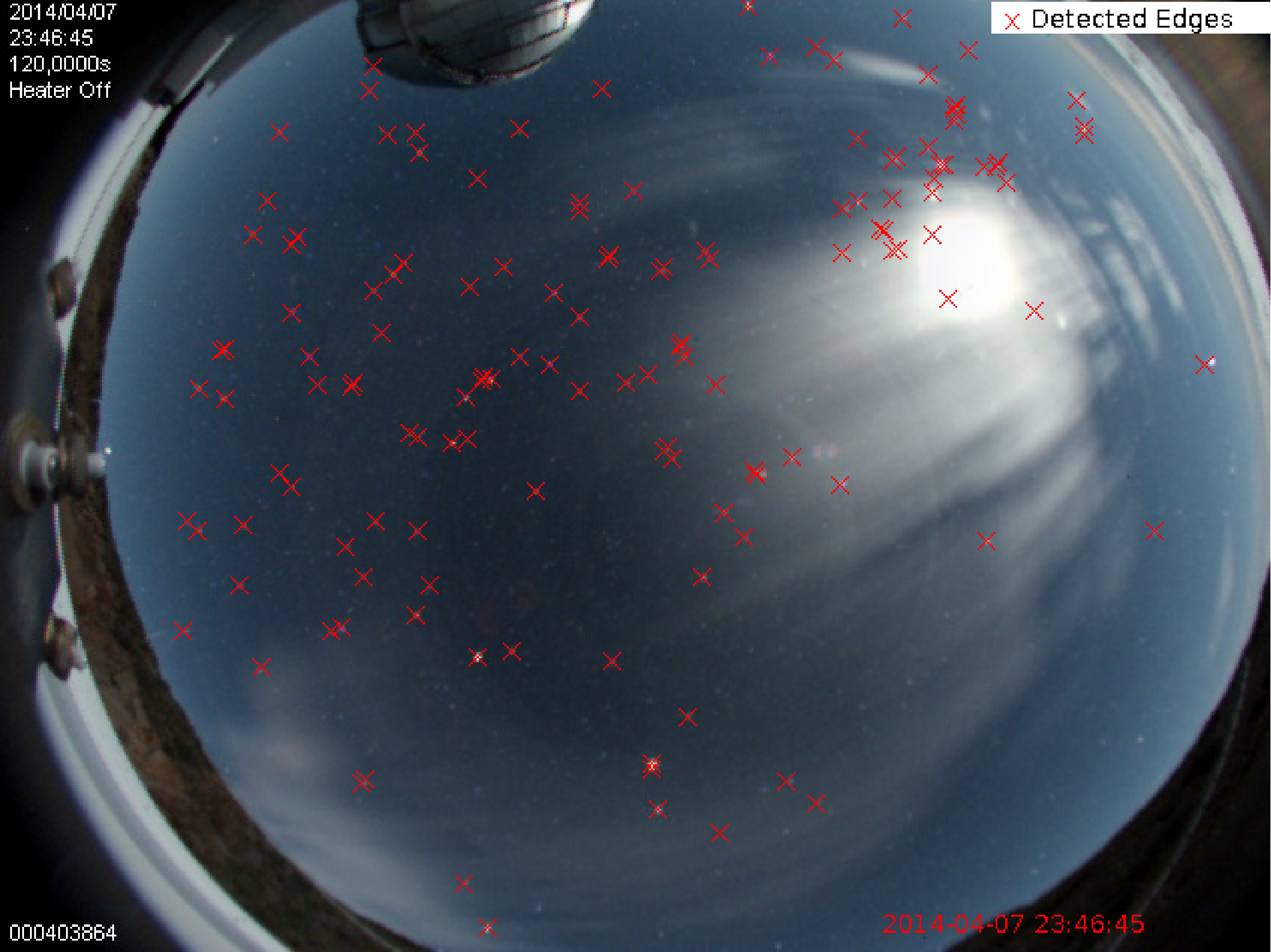
2014/04/07  
23:46:45  
120,0000s  
Heater Off

000403864



2014/04/07  
23:46:45  
120,000s  
Heater Off

x Detected Edges



000403864

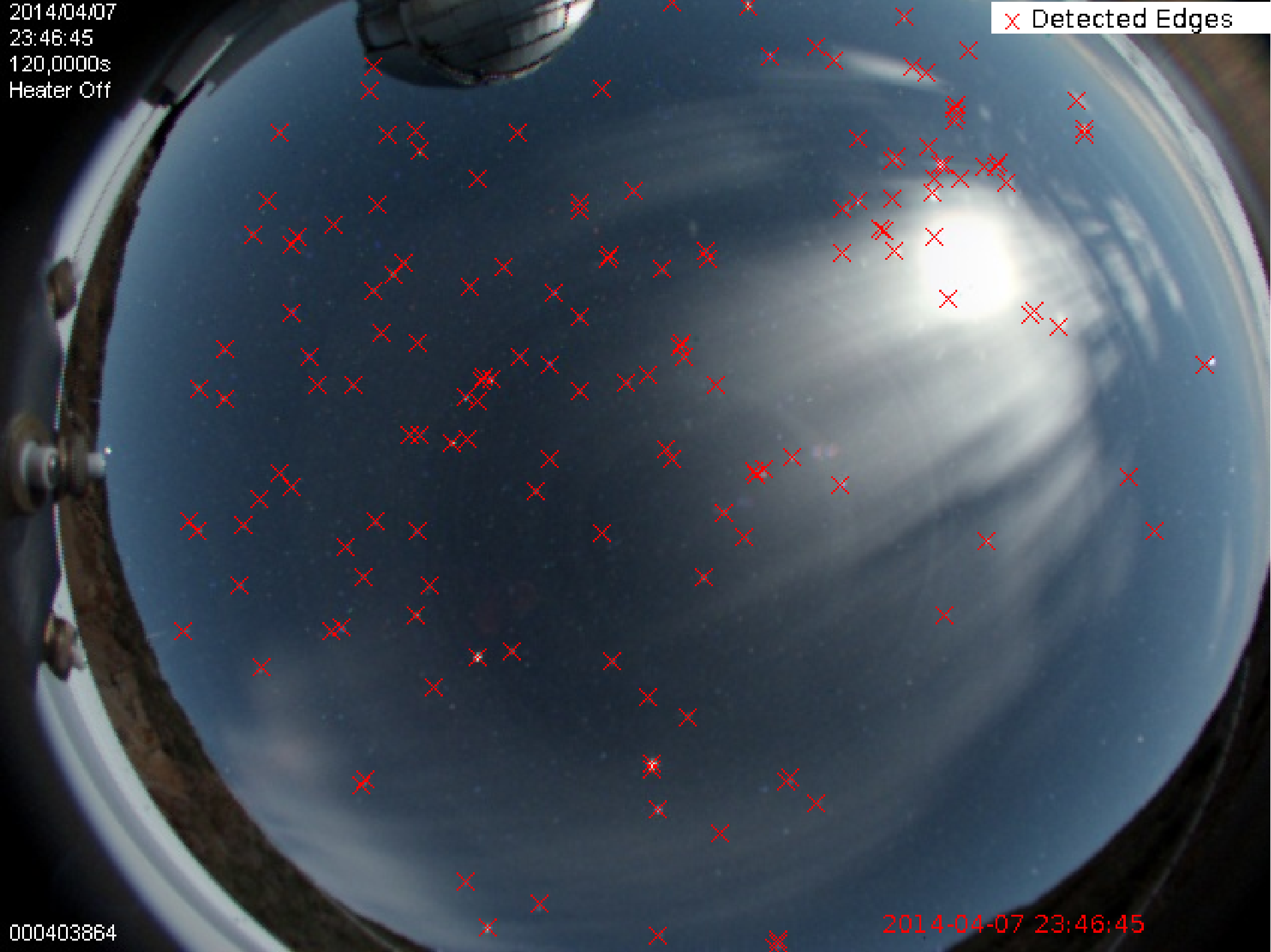
2014-04-07 23:46:45

# Detecting Clouds – By Detecting Stars

- Not all stars get detected (but sufficient)
  - Switching to an other method possible
- Match acquired positions using a star catalogue
  - Here: stars brighter than 4.6 mag

2014/04/07  
23:46:45  
120,000s  
Heater Off

x Detected Edges

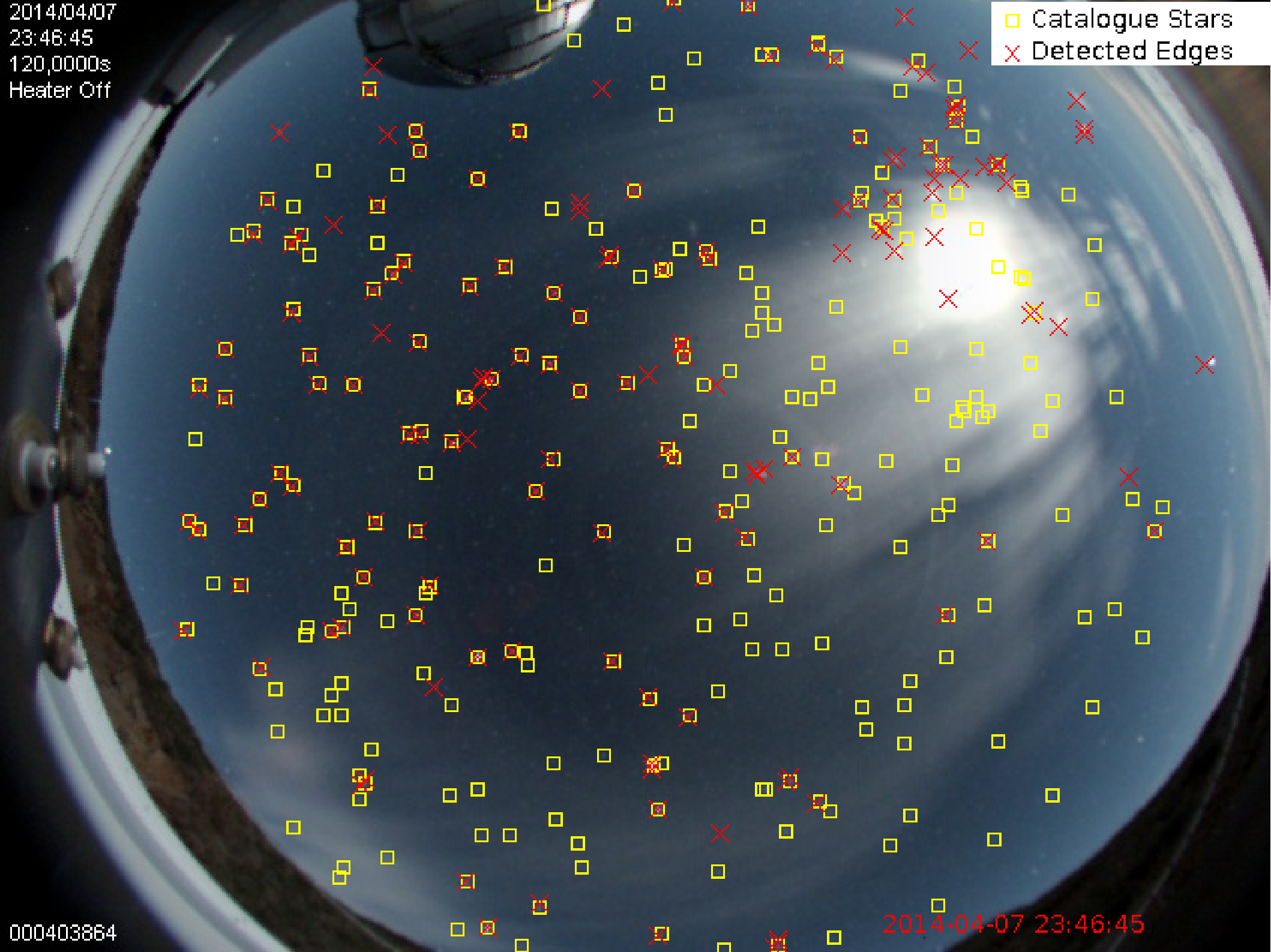


000403864

2014-04-07 23:46:45

2014/04/07  
23:46:45  
120,000s  
Heater Off

□ Catalogue Stars  
× Detected Edges

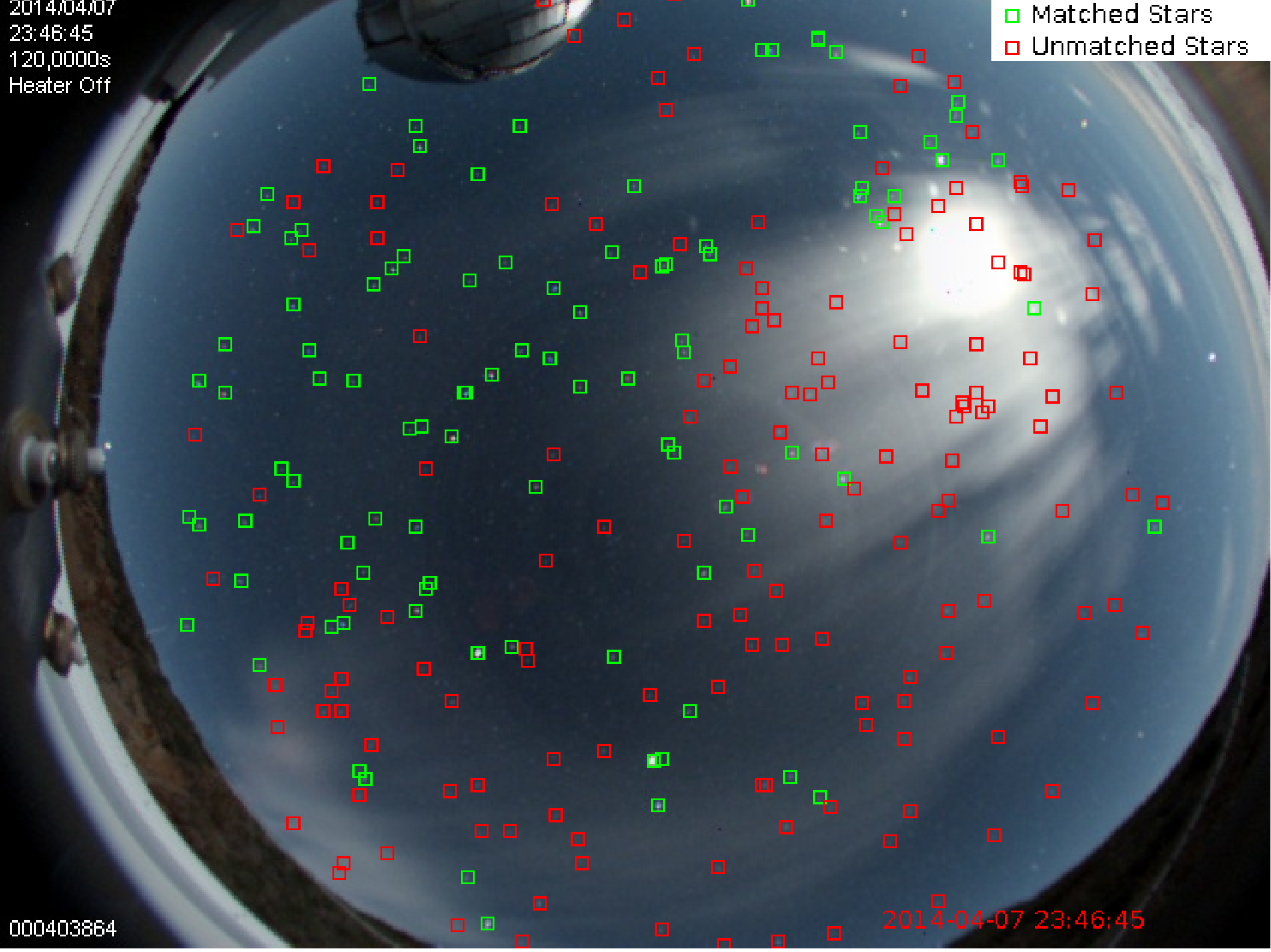


000403864

2014-04-07 23:46:45

2014/04/07  
23:46:45  
120,0000s  
Heater Off

Matched Stars  
Unmatched Stars



000403864

2014-04-07 23:46:45

2014/04/07  
23:46:45  
120,0000s  
Heater Off

□ Clear Sky  
□ Cloudy Sky

000403864

2014-04-07 23:46:45

2014/04/07  
23:46:45  
120,0000s  
Heater Off

□ Clear Sky  
□ Cloudy Sky  
□ Fact Sources

Mrk421  
Mrk501 H1426+428 ES1218+304

000403864

2014-04-07 23:46:45

# Cloudiness

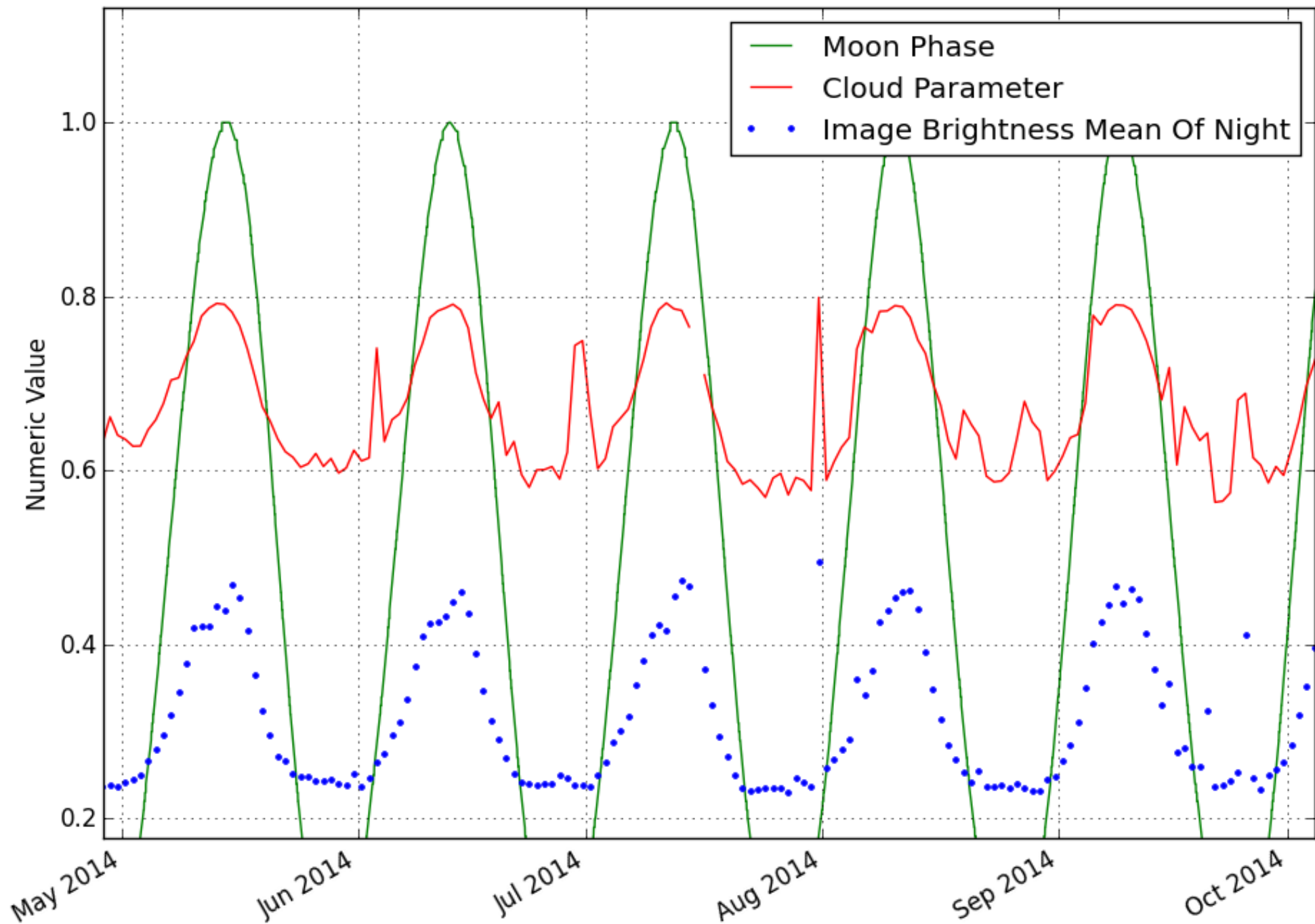
$$q = 1 - \frac{\sum_{i \text{ visible stars}} 2.5^{\text{mag}_i}}{\sum_{j \text{ all stars}} 2.5^{\text{mag}_j}}$$

- Percentage of visible stars weighted by light flux
- Calculate on: whole image, image sector, around sources ...

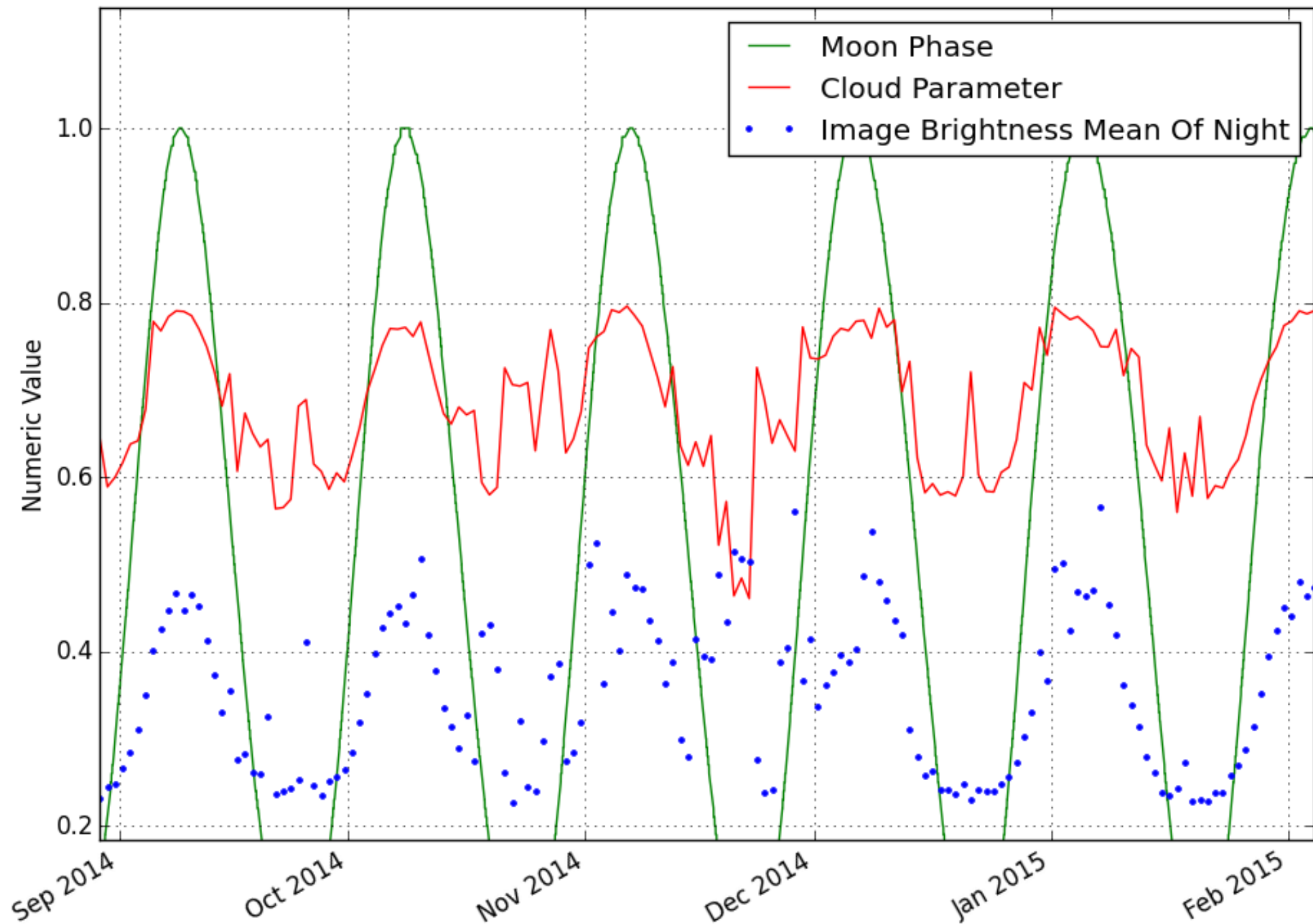


# List of stored Features

- Number of detected stars
- Cloudiness (global image, local areas, ...)
- Image brightness
- Zenith angle of sun and moon
- Moon phase
- Telescope pointing
- ...

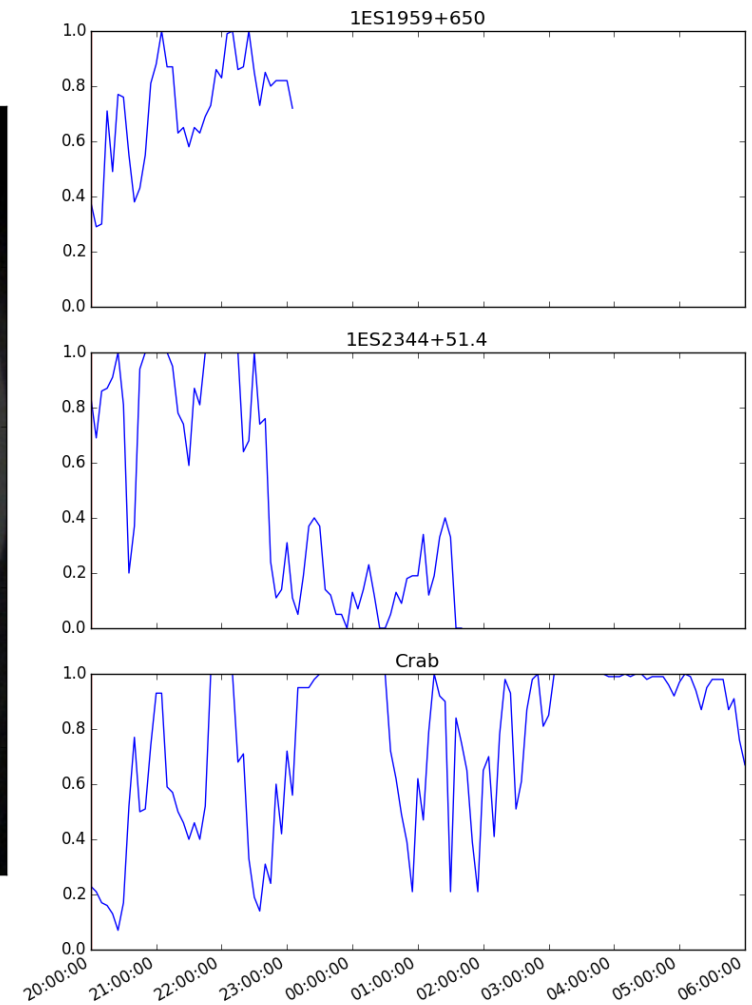
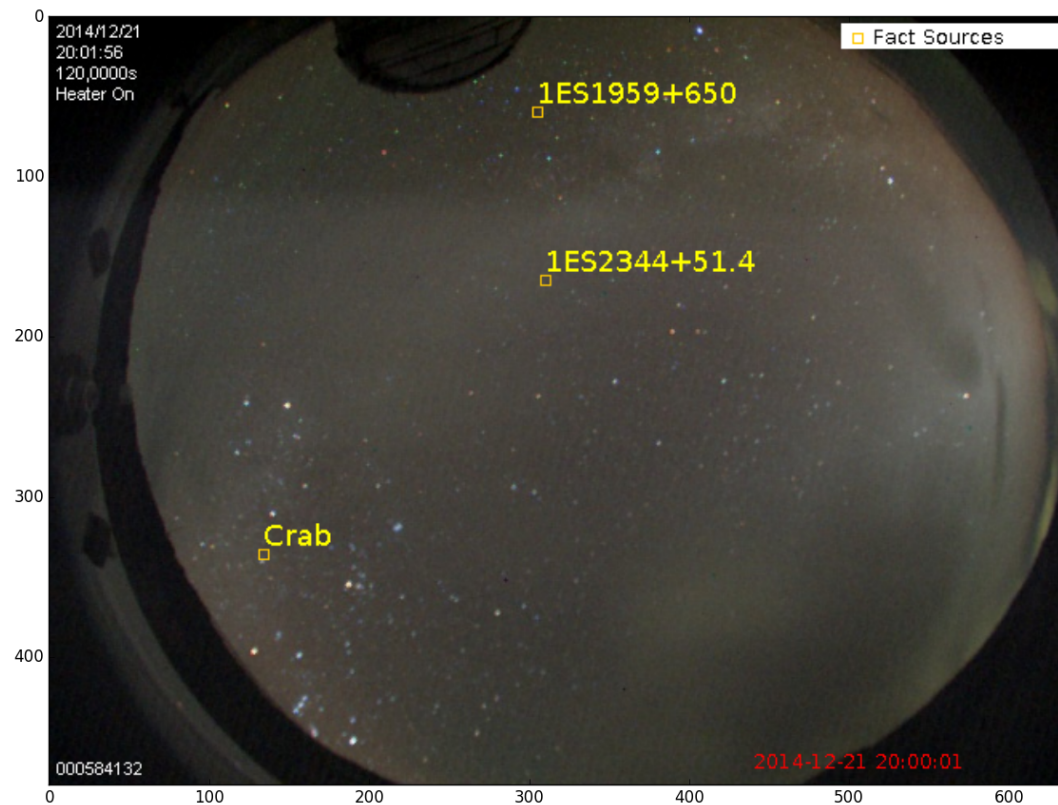


Parameters during summer months



Parameters during winter months

# Video Clip



# Important Camera Properties

- White point balance should be constant
  - Image meta data needs to be stored
  - **Resolution** and **sensor size** as big as possible
- +
- **Time** between images as short as possible
- Most accuracy in prediction of cloud movement