Comparison of ASGARD and UFOCapture

Rhiannon C. Blaauw (Dynetics/Meteoroid Environment Office) and Katherine S. Cruse (West Virginia University/NASA MSGR Intern Program)

The Meteoroid Environment Office is undertaking a comparison between UFOCapture/Analyzer and ASGARD (All Sky and Guided Automatic Realtime Detection). To accomplish this, video output from a Watec video camera on a 17 mm Schneider lens (25 degree field of view) was split and input into the two different meteor detection softwares. The purpose of this study is to compare the sensitivity of the two systems, false alarm rates and trajectory information, among other quantities. The important components of each software will be highlighted and comments made about the detection/rejection algorithms and the amount of user-labor required for each system.

Comparison of ASGARD and UFOCapture

Rhiannon Blaauw

Dynetics Technical Services/MITS

NASA, Marshall Space Flight Center

Huntsville, AL, 35812

rhiannon.c.blaauw@nasa.gov

Katherine Sarah Cruse

West Virginia University

P.O. Box 6201

Morgantown, West Virginia, 26506

kcruse1@mix.wvu.edu

The Meteoroid Environment Office is undertaking a comparison between UFOCapture/Analyzer and ASGARD (All Sky and Guided Automatic Realtime Detection), both software used to detect meteors. To accomplish this, video output from a Watec video camera on a 17 mm Schneider lens (25 degree field of view) was split and input into two computers, one running UFOCapture and the other running ASGARD. The purpose of this study is to compare the sensitivity of the two systems, false alarm rates and ease of use.

1 Introduction

Camera networks are becoming popular as a relatively low cost and low labor way of deriving significant information on meteors. In the last two years, NASA's Meteoroid Environment Office (MEO) has built an all-sky camera network, with plans to expand it over the coming years, and is currently starting a wide-field camera network. There are several software packages that are used for meteor camera networks, two of which were being considered for NASA's wide-field network; UFOCapture and ASGARD (All Sky and Guided Automatic Real-time Detection). UFOCapture is well-tested and well-used software. It was not designed for meteors, but is used frequently in the meteor community. ASGARD is custom-made software for meteor

(c) SonotaCo all rights reserved

detection with all-sky cameras. The MEO's desirable software characteristics were to see the maximum number of meteors while minimizing false alarms and requiring the least amount of human intervention. Also compared here is the user-friendliness of each software and results such as sensitivity, false alarm rates, astrometry, and photometry.

The comparison was performed on a wide-field camera that consists of a 17 mm Schneider lens on a Watec CCD camera that gave a 25 degree field of view. This is the same camera that will be used in the wide-field network, which detects meteors slightly more faint than the all-sky cameras. The output from the camera was split and input into two computer systems, one running UFOCapture and one running ASGARD.

2 Overview of Software

UFOCapture (SonotaCo, 2005) is a multipurpose motion-capture software that is publically available for purchase (http://sonotaco.com/). It runs on Windows 7, XP, or 2000. It is well documented with pre-set files to initialize settings. It is very user-friendly and has an intuitive interface to change the settings.

ASGARD was created at the University of Western Ontario (UWO) in London, Ontario, Canada by Rob Weryk (Brown et al, 2010). It runs on Debian/Linux and thus a basic knowledge of Linux is recommended. It has completely automated analysis – its main benefit – though it is not well documented and has not gone through extensive testing. Several different plugins can be used for the detection process. The user can also specify settings within the plugins; such as how many pixels above background determines whether an event is triggered. There are then sets of rejection algorithms to throw out non-meteor events. This software is not publically available.

Similar to UFOCapture, ASGARD is compatible with several video sources and detects meteors in real-time, but can also be run on pre-recorded video.

3 Comparison of Software and Initial Results

The installation of UFOCapture is simple with an .exe setup file. ASGARD requires knowledge of Linux and is non-trivial. To identify the star field, UFOCapture has a built-in program to make a plate, whereas ASGARD requires a separate program.

ASGARD does not require daily data reduction as it is completely automated and the results are posted daily to a website as well as an e-mail summary. Flagged events are run through the rejection filters which are designed to take out lightning strikes, airplanes, or other non-meteor events. These rejected events are still kept in a separate folder. Meteor events are occasionally misidentified and placed in the reject filter, therefore manually filtering is

recommended. Additionally, ASGARD saves a raw video buffer for a specified amount of time, the length of which is determined by the amount of disk space allocated to the buffer. This allows events to be manually cut out if not originally identified as an event.

Reduction of UFOCapture events requires an additional software, UFOAnalyzer (SonotaCo, 2007), which identifies whether an event is a meteor or not and performs the analysis. This requires daily manual work.

Figure 1 below shows the initial results of the software sensitivity. These results were found without changing settings on either software, our 'out-of-the-box' software. Throughout the first 18 days of the software comparison, ASGARD only detected 39% of the meteors that UFOCapture did.

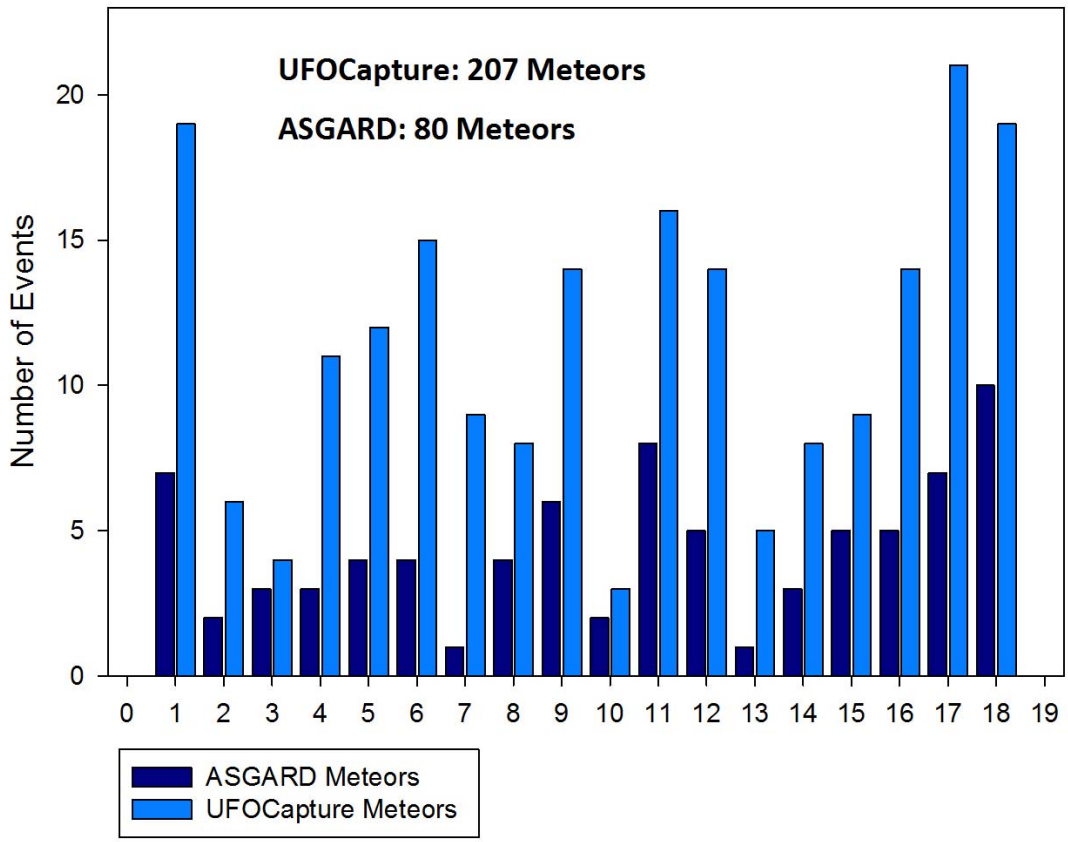


Figure 1: Comparison of the number of meteors detected by ASGARD and UFOCapture in 18 days. These results are found with the software in their original settings.

Along with detecting more meteors, UFOCapture had more false detections with 289 events in the same time period that ASGARD had only 60.

In addition to comparing the sensitivity, we compared the astrometry and photometry. The astrometry was nearly identical between ASGARD and UFOAnalyzer results, as seen in Figure 2. However, when comparing the magnitudes, we see a clear trend that ASGARD is classifying meteors as being more dim than UFOAnalyzer is classifying the same meteor. Figure 3 illustrates this. The average magnitude difference that was given by UFOAnalyzer and ASGARD for the same meteor was 0.8. The discrepancy between the two highlights the need for improvement in the work of meteor photometry.

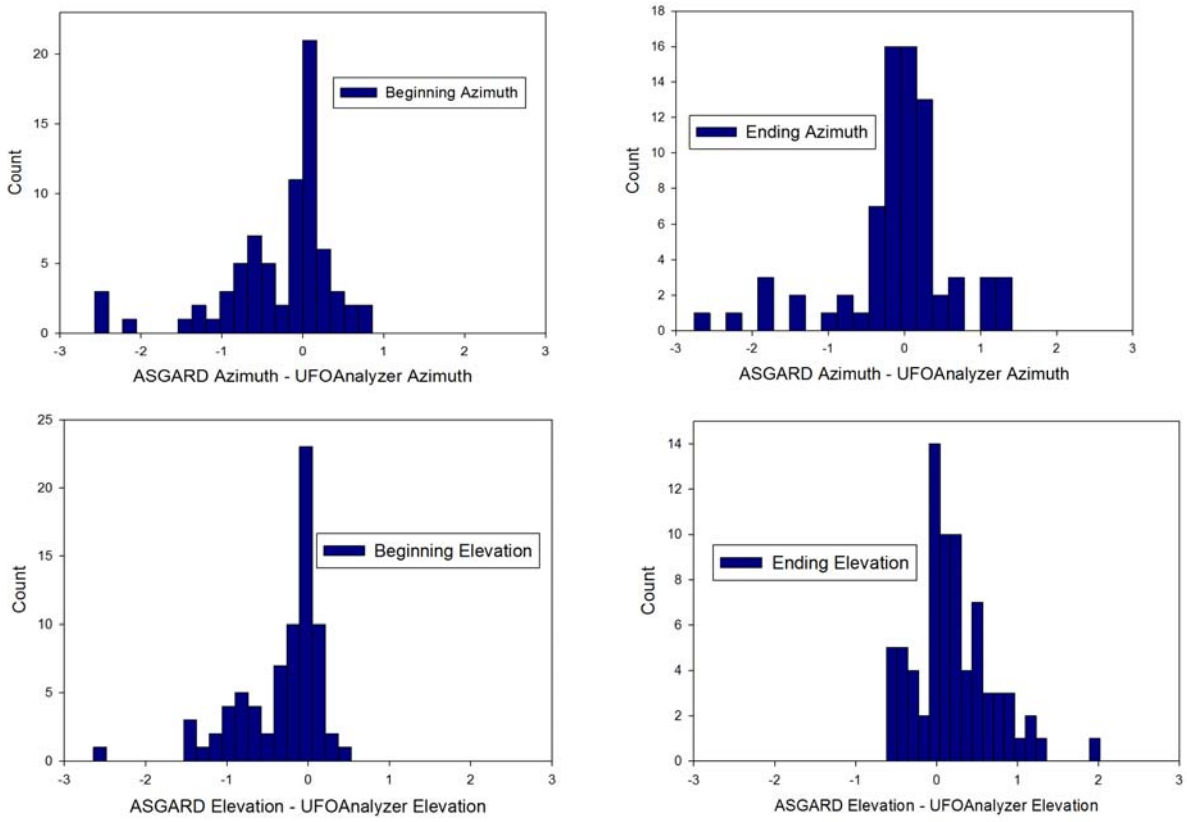


Figure 2: Comparison of astrometry found by ASGARD and UFOAnalyzer. The average beginning azimuth, ending azimuth, beginning elevation, and ending elevation given by ASGARD were 0.29, 0.09, 0.03, and 0.21 (respectively) different than that of UFOAnalyzer.

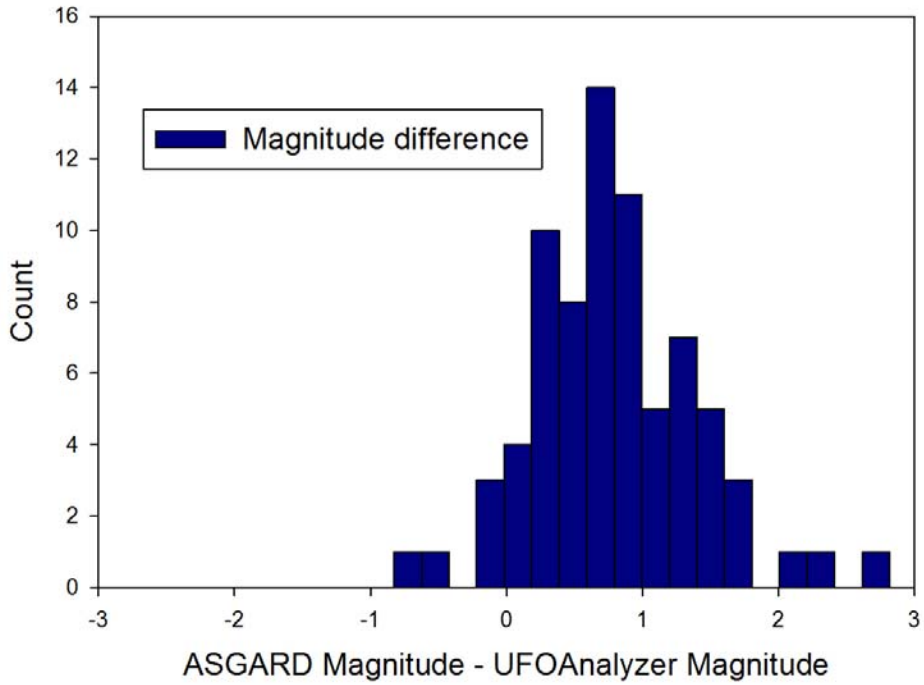


Figure 3: Comparison of photometry found by ASGARD and UFOAnalyzer. The average difference in ASGARD Magnitude to UFOAnalyzer Magnitude is 0.8, with ASGARD consistently giving a higher magnitude.

4 Changes to Software

Due to its high degree of automation, ASGARD became our preferred software. Consequently we attempted to optimize it in order to detect the same number of meteors as UFOCapture. There were several areas in which to change the detection plugin ASGARD was currently using. Our first change was to lower the threshold at which ASGARD identified an event. This increased the number of meteors ASGARD detected by including the fainter ones. Our second main change was to look at the rejection filters and identify which, if any, were removing real meteors. We found that a rejection filter designed to remove flashing airplanes was also removing fast and short meteors. We removed this rejection filter, increasing the number of meteors ASGARD detected.

5 Results

The changes we made to ASGARD produced significantly better results. In a period of 7 nights using the changes in ASGARD described above, UFOCapture saw 153 meteors while

ASGARD saw 112 meteors. ASGARD saw approximately 73% of the meteors that UFOCapture did. Figure 4 illustrates this.

Along with this increase in the number of meteors detected, there was also an increase in the number of false detections, as expected.

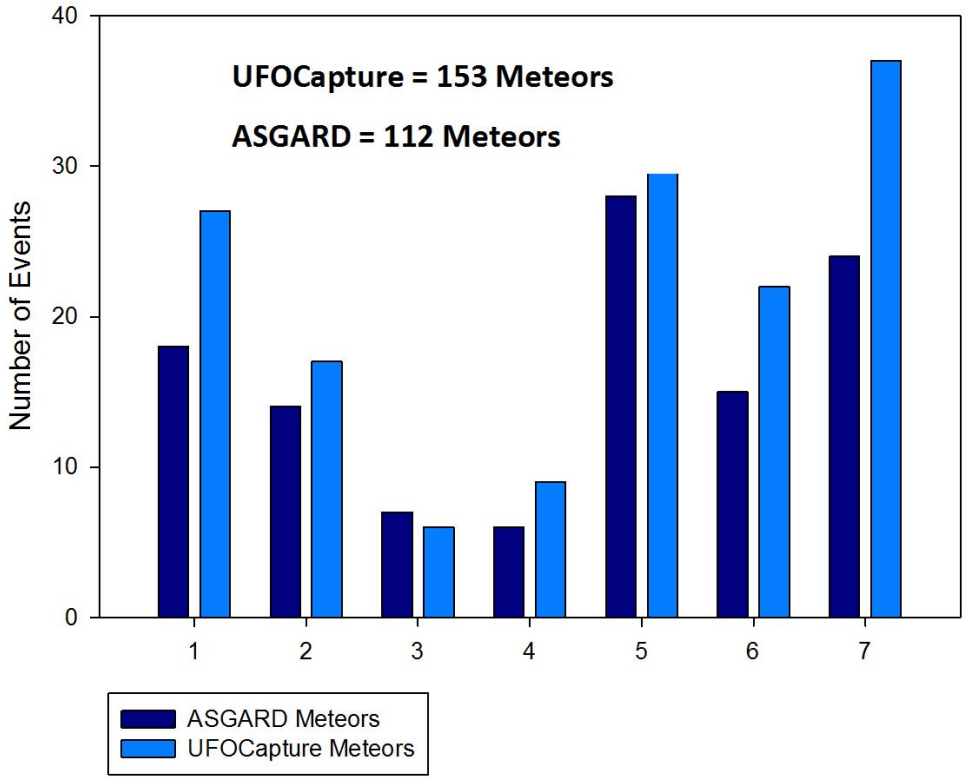


Figure 4: The number of meteors detected by ASGARD and UFOCapture in 7 days after changes in ASGARD were implemented.

6 Conclusions + Future Work

ASGARD's main benefit is its automation. When used on meteor cameras, it requires little to no human intervention on a daily basis. It allows cameras to connect to each other on a main server, synchronize meteors seen, and then perform the analysis. Results are easily accessed in the morning without additional work. It was determined that ASGARD was preferred if it could become as sensitive as UFOCapture.

UFOCapture's main benefit was its sensitivity. It is well-tested software with overall rates initially higher than ASGARD. The install is easy and it is windows-compatible; a huge benefit to those without Linux knowledge.

After making changes to ASGARD in its detection algorithm and rejection algorithms, ASGARD detected a greater percentage of the meteors being seen by UFOCapture than it was originally detecting, but it was still seeing overall less meteors.

Future work in this area is to review different detection plugins, which determine how an event is flagged. The work accomplished here is using ASGARD's basic detection plugin, however there are other plugins available. This work is being carried on presently.

Another area of future work is to improve meteor photometry. When comparing the magnitudes determined by UFOAnalyzer and ASGARD, we found that UFOAnalyzer almost always identified a meteor as being brighter than ASGARD identified that same meteor, on average 0.8 magnitudes. This confirms an issue that is already well-known in the meteor community – that meteor photometry need significant improvement.

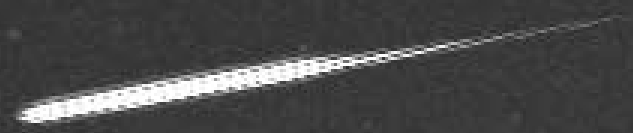
References:

Brown P., Weryk R.J., Kohut S., Edwards E.N., and Krzeminski Z., (2010). "Development of an All-Sky Video Meteor Network in Southern Ontario, Canada The ASGARD System". *WGN*, **38**, 25-30.

SonotaCo (2005). 'UFOCaptureV2 Users Manual". http://sonotaco.com/soft/UFO2/help/english/index.html .

SonotaCo (2007). "UFOAnalyzerV2". http://sonotaco.com/soft/download/UA2Manual_EN.pdf .

Comparison of ASGARD and UFOCapture



PARI, North Carolina, August 4-5, 2011

Rhiannon Blaauw

Katherine Cruse

Meteoroid Environment Office

EV44 NASA MSFC

20110624 02:23:21.385805 UTC (3) HSV_Watec (50A)

Introduction

Set out to compare detection efficiencies between UFOCapture and ASGARD

Compared:

- Sensitivity of the two systems
- False alarm rates
- Astrometry
- Photometry
- Trajectory information
- User-friendliness, and other quantities

Video Input

17 mm Schneider lens (25 degree field of view) on a Watec CCD camera was split and input into the two computer systems, each running either UFO or ASGARD

Cost: Less than $1,000 for Watec CCD + lens + encasing

Detects size range slightly smaller (more faint) than All Sky Cameras. Therefore sees considerably more (up to 30 on a clear night of sporadics).

ASGARD Overview

- All Sky and Guided Automatic Real-time Detection
    - Rob Weryk (UWO)
    - Originally created to run on All-Sky cameras
    - Not publically available

- Runs on Debian GNU/Linux

- Compatible with several video sources (analog video camera interfaces, digital camera interfaces)

- Detects meteors in real-time, but can also run on pre-recorded.

- Detection: Compares video frame-by-frame, pixel-by-pixel. User can specify the level above the background in which an event is triggered. For example, if 12 pixels are above 70 digital units for 2 consecutive frames.
    - Sky brightness affects this
    - Also a rejection algorithm that throws out non-meteor events

UFOCapture Overview

Multipurpose motion-capture software
(including security purposes)

$225-$250 depending on exchange rate

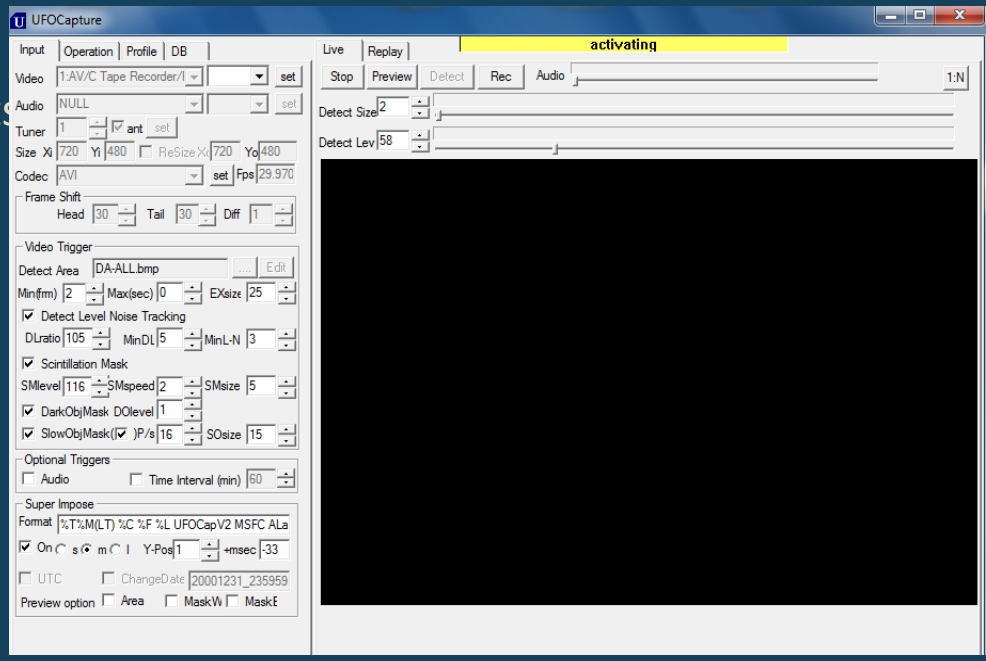
Compatible with many different video inputs

Need PC: Windows XP
or Windows 2000.

Fairly well documented on website.

Preset files to initialize the settings.

Good user-interface to tweak settings.



User-Labor Comparison - Setup

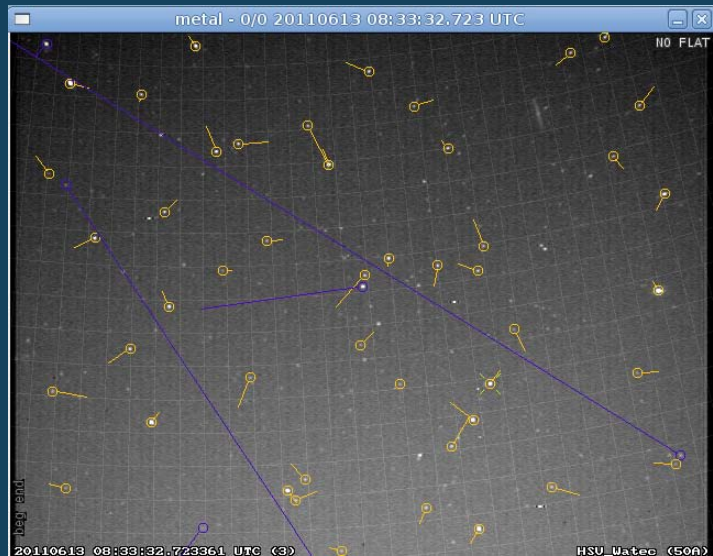
Installation

-UFO has an .exe file

-Asgard requires Linux knowledge. Installation is non-trivial and non-intuitive.

Plates

- ASGARD requires an extra program – METAL
- Need to match up many stars (25+) all around FOV
  - User interface is good, but not intuitive
  - Less than 0.02 residuals
- UFO has it built into main program
  - User interface = very intuitive
  - Fairly automated
  - Less than 0.03 residuals



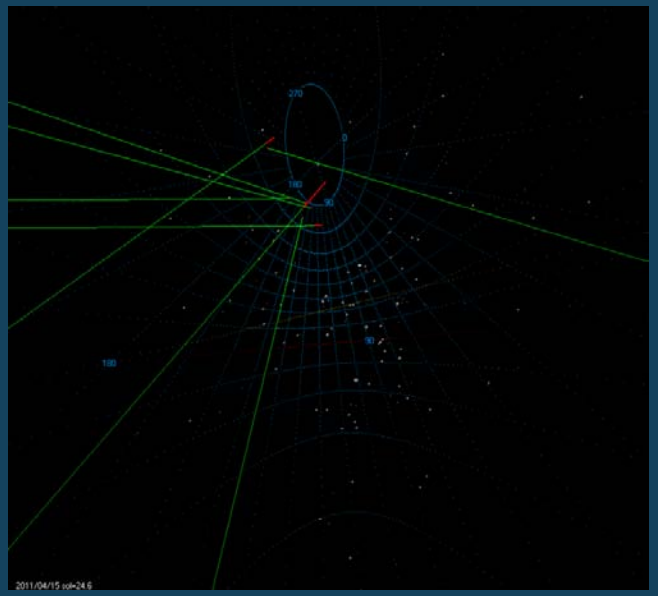
User-Labor Comparison

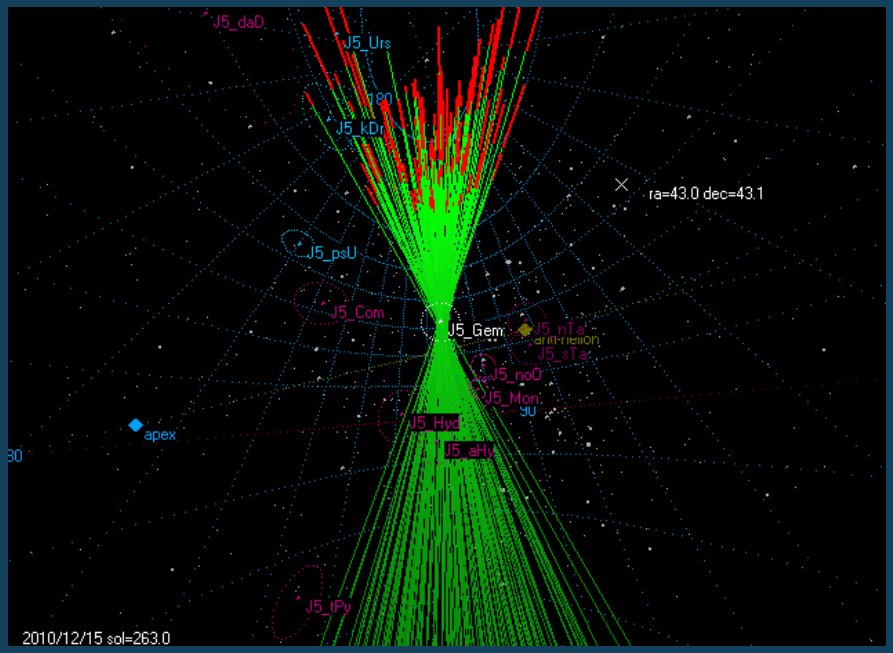
- Daily data reduction
  - UFO requires an additional program:
    - UFOAnalyzer takes all the events UFOCapture has detected, and identifies whether it is a meteor
      - Many events are misidentified – requires filtering through each event
      - Therefore more user-intervention for UFO
  - ASGARD has real-time processing
    - Identifies whether the event is a meteor
    - Put in a separate folder if it is identified to be a non-meteor event

System Output Comparison

UFO

- .csv (time, angular velocity, shower code, start/end RA/DEC, and more)
- .xml (azimuth, elevation, and more)
- Trail map (radiants)
- .avi
- .jpg





System Output Comparison

ASGARD

-.tar (.png of each frame)

-.txt (time, site, plate, the coordinates of the meteor in each frame and its magnitude at that point)

-.avi

-.png

Initial Software Pros/Cons

UFO

Pros
- free, online
- nice interface

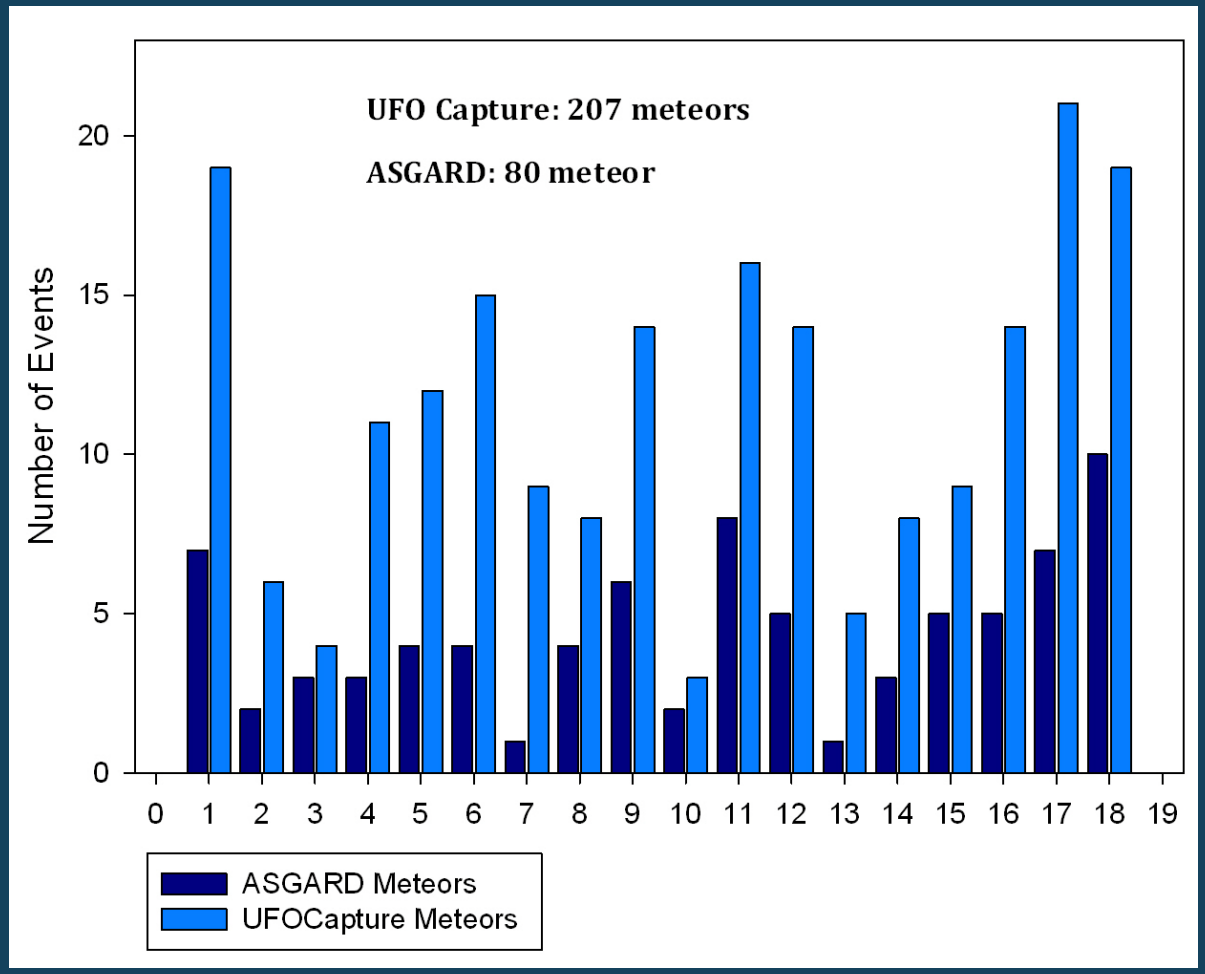
Cons
- manually run Capture's output into Analyzer
  - during lightning storm it takes a while to process
- program occasionally crashes & system needs restarting
  - manual intervention

ASGARD

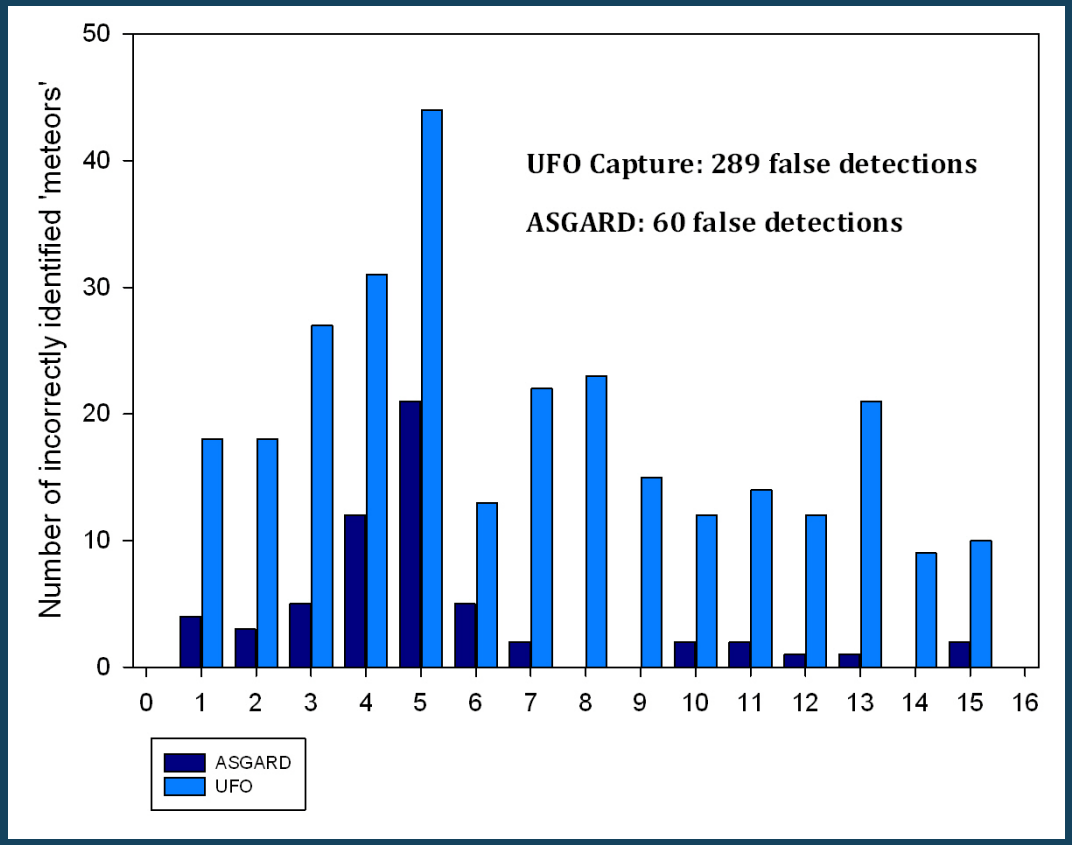
Pros
- video buffer (to go back and look at raw videos later)
- Capture +Analyzing is together.
  - already identifies whether it is a meteor event or not
  - video and txt file stored

Cons
- not well documented
- need METAL to make plates
- azimuth + elevations in slightly different format

Initial Results



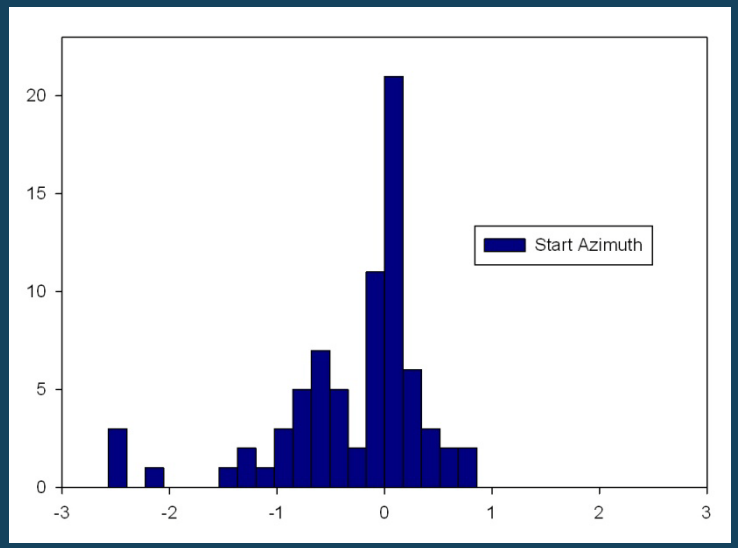
Initial Results

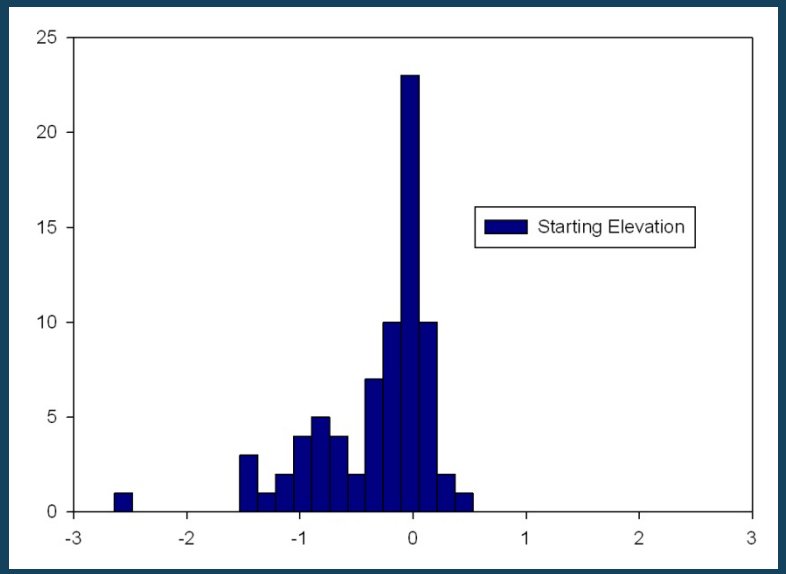


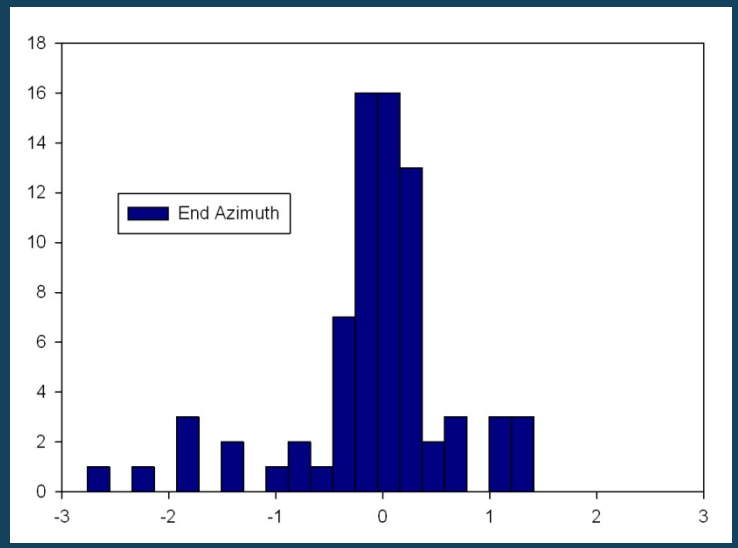
3 nights of lightning storm – not included

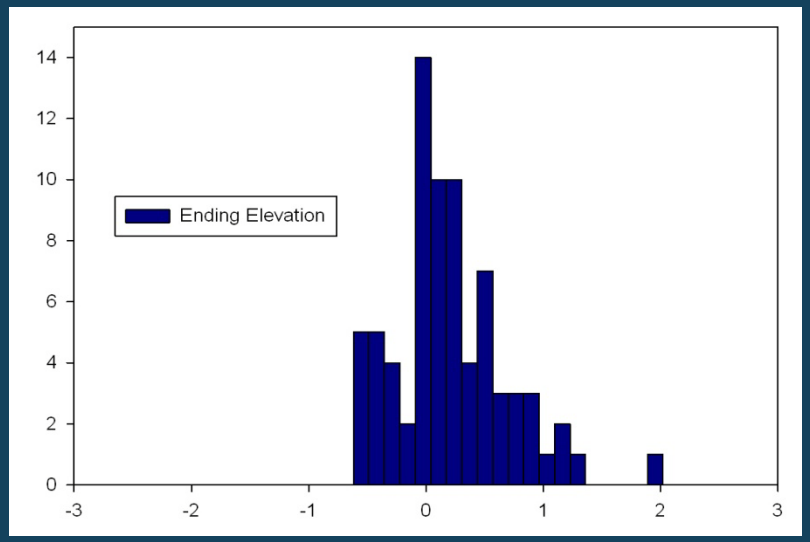
- Hundreds of false alarms for UFO

Initial Results – Astrometry

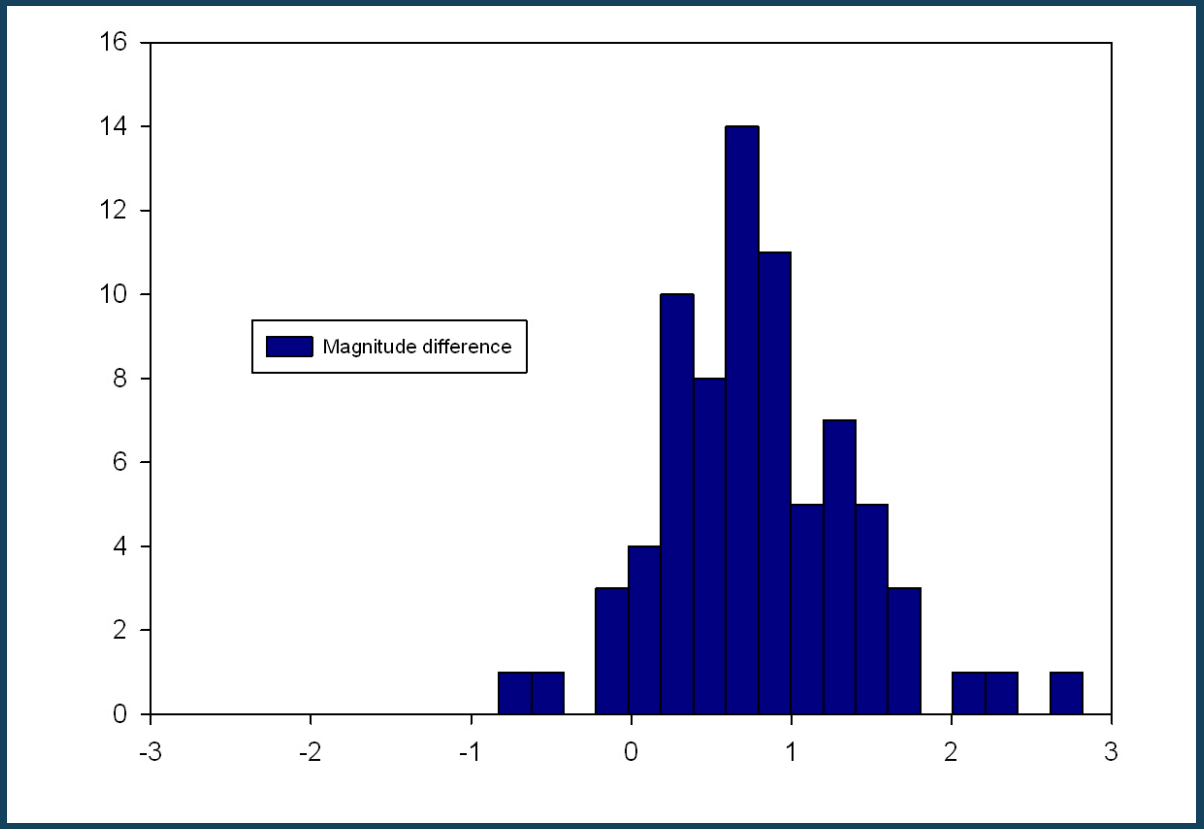








Initial Results - Photometry



Magnitudes not as reliable.

More work needs to be done in this area.

False Alarms

Changes to ASGARD

- Lowering ASGARD ‘threshold’ – the minimum digital unit at which an event is flagged
- Changing detection plugin – affects how an event is triggered. Experimented with other versions.
- Taking out reject filters

Final Results

- To be finished right before conference

Conclusions

ASGARD Benefits: Very automated. Results easily accessed in the morning without doing additional work work.

UFO Benefits: Overall rates considerably higher than ASGARD.

Additional Work: meteor photometry

- More to be added when final results come in