International Centre for Radio Astronomy Research

theSkyNet POGS

A BOINC based, citizen-science project for pixel Spectral Energy Distribution fitting of resolved galaxies in multi-wavelength surveys

Kevin Vinsen (ICRAR, UWA)
David Thilker (JHU)

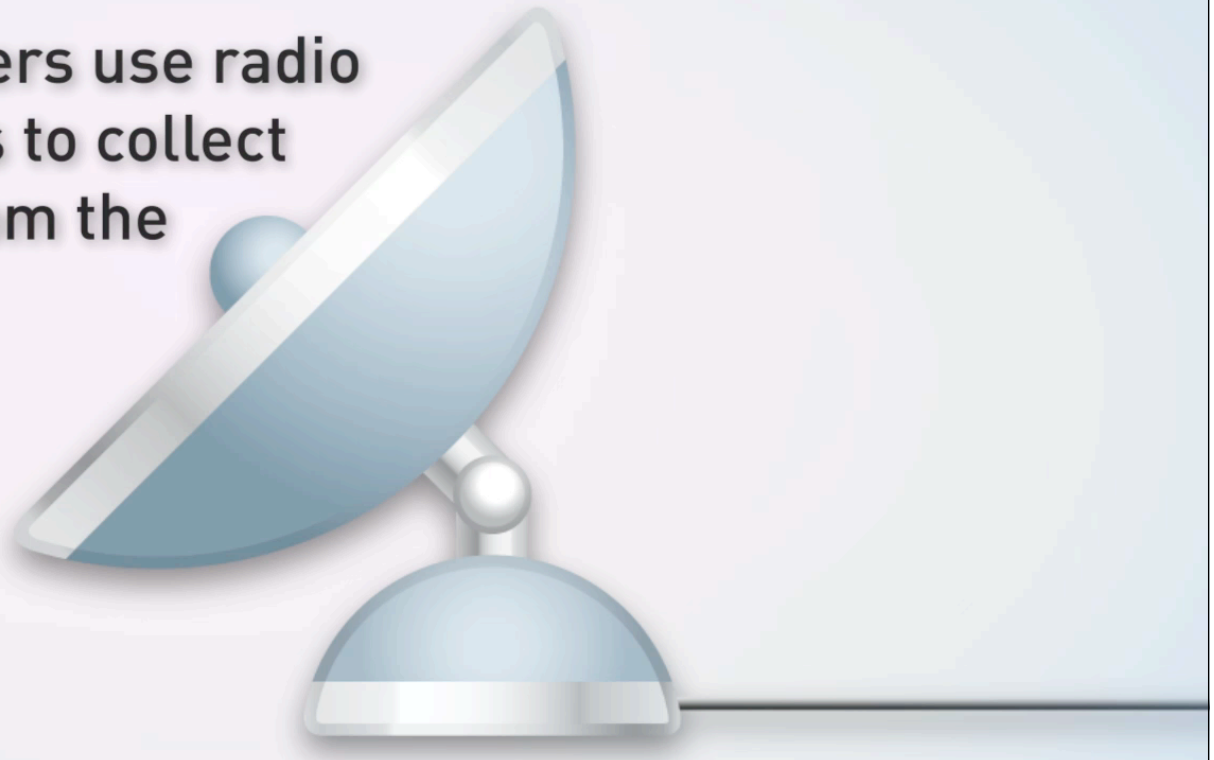
Curtin University

The University of Western Australia
Achieve International Excellence

Why theSkyNet

- SKA and LSST will bring even more data size problems.
- ICRAR looking for an experiment to see if we can off load the computing.
- We wanted a systematic way of processing very large volumes of data.
- So in 2011 we started theSkyNet.

Astronomers use radio telescopes to collect signals from the Universe



theSkyNet Pan-STARRS1 Optical Galaxy Survey (POGS)

- POGS
  - Local low redshift Galaxies only z < 0.1
  - Pan-STARRS1, SDSS, GALEX & WISE
  - SED fit to each pixel
  - It would take between 1,000 and 2,000 years on a modern desktop

arXiv.org > astro-ph > arXiv:1306.1618

Astrophysics > Instrumentation and Methods for Astrophysics

A BOINC based, citizen-science project for pixel Spectral Energy Distribution fitting of resolved galaxies in multi-wavelength surveys

Kevin Vinsen, David Thilker

(Submitted on 7 Jun 2013 (v1), last revised 20 Sep 2013 (this version, v2))

In this work we present our experience from the first year of theSkyNet Pan-STARRS1 Optical Galaxy Survey (POGS) project. This citizen-scientist driven research project uses the Berkeley Open Infrastructure for Network Computing (BOINC) middleware and thousands of Internet-connected computers to measure the resolved galactic structural properties of ~100,000 low redshift galaxies.

What we're trying to do

- Fundamentally panchromatic (UV-opt-IR)
  - Pixel SED fitting for resolved physical interpretation
  - Maps of stellar mass, SFR, etc showing sub-structure of the galaxy.
  - Detailed multi-wavelength parametric galaxy decomposition
  - Atlas of galaxies
- Bulge/disk ratios, scale lengths, break radii
- Citizen-scientist involvement in multiple ways - possible as part of Galaxy Zoo for the next stage

MAGPHYS

- http://www.iap.fr/magphys/magphys/MAGPHYS.html
- da Cunha et al. (2008, MNRAS, 388, 1595)
  - SFH are computed using the Bruzual and Charlot population synthesis code - (2003, MNRAS, 344, 1000)
  - two-component model of Charlot and Fall (2000, ApJ, 539, 718)
- MAGPHYS takes brute force approach to UV-Opt-IR SED fitting
  - Compares data to each possible model in large multi-dimensional parameter space
  - Allows estimation of marginalised probability distribution for each parameter.
  - Far too compute intensive to do pixel-based fits on a single machine
- Distributed computing / citizen-science allows SED processing
  - We feed multi-extension FITS files with resolution matched panchromatic images per galaxy and correct S/N per pixel

What MAGPHYS calculates

Parameter	Description	Parameter	Description
f_{μ}^{SFH}	the fraction of total infrared luminosity contributed by dust in the ambient ISM from the stellar population spectrum model	T_W^{BC}	characteristic temperature of warm dust grains residing in stellar birth clouds
f_{μ}^{IR}	the fraction of total infrared luminosity contributed by dust in the ambient ISM from the infrared spectrum model	ξ_C^{tot}	the total contribution of cold dust grains to the total infrared luminosity of a galaxy
μ	fraction of the total effective V-band absorption optical depth of the dust contributed by the ambient ISM	ξ_{PAH}^{tot}	the total contribution of Polycyclic Aromatic Hydrocarbons (PAH) to the total infrared luminosity of a galaxy
$\hat{\tau}_V$	total effective V-band absorption optical depth of the dust seen by young stars inside birth clouds	ξ_{MIR}^{tot}	the total contribution of mid-infrared continuum emissions to the total infrared luminosity of a galaxy
ψ_S	specific star formation rate	ξ_W^{tot}	the total contribution of warm dust grains to the total infrared luminosity of a galaxy
M_*	the stellar mass of the galaxy	$\mu\hat{\tau}_V$	effective V-band absorption optical depth of the dust in the ambient ISM
L_d^{tot}	total luminosity absorbed and reradiated by dust	M_d	the total dust mass of a galaxy
T_C^{ISM}	characteristic temperature of cold dust grains which can only reside in the ambient interstellar medium	$\psi(t)$	star formation rate

What we record

- Best Fit
- Median - 50th Percentile
- Highest Probability bin
- 2.5th Percentile
- 16th Percentile
- 84th Percentile
- 94.5th Percentile

- And all Probability Distribution Histograms

To date (24-Sept-2013)

- Processing
  - 4,400+ Users (SETI@Home 1.4 million)
  - 11,200+ Computers (Einstein@Home 5.6 million)
  - 8,015+ Galaxies
  - 50 Million+ Pixels

Sign up pogs.theskynet.org/pogs

Tweet Me

theSkyNet POGS - the PS1 Optical Galaxy Survey

Kevin · log out

About theSkyNet POGS - the PS1 Optical Galaxy Survey

English | Français | Русский | Deutsch | Italiano | 中文

TheSkyNet POGS is a research project that uses Internet-connected computers to do research in astronomy. We will combine the spectral coverage of GALEX, Pan-STARRS1, and WISE to generate a multi-wavelength UV-optical-NIR galaxy atlas for the nearby Universe. We will calculate physical parameters such as: star formation rate, stellar mass of the galaxy, dust attenuation, and total dust mass of a galaxy; on a pixel-by-pixel basis using spectral energy distribution fitting techniques. You can participate by downloading and running a free program on your computer.

TheSkyNet POGS is based at The International Centre for Radio Astronomy Research.

- Images you have processed
- Images for all the Galaxies used in the survey
- The Science we are trying to achieve
- The Team

Join theSkyNet POGS - the PS1 Optical Galaxy Survey

- Read our rules and policies
- This project uses BOINC. If you're already running BOINC, select Add Project. If not, download BOINC.
- When prompted, enter **http://pogs.theskynet.org/pogs/**
- If you're running a command-line version of BOINC, create an account first.
- If you have any problems, get help here.

Returning participants

User of the day

[AF] Alliance Francophone
Ceci est le compte générique de l'Alliance Francophone.

Pour plus de détails, venez sur notre forum

News

37.1 TFlops
In more serious news, as of this morning (Perth Time), we are processing at 37.1TFlops a new record.

Thanks, Merci, Danke, Спасибо за поддержку, Arrr that be grand. 19 Sep 2013, 3:21:27 UTC · Comment

International Talk like a Pirate Day
Today is International Talk like a Pirate Day http://www.talklikeapirate.com.

TheSkyNet website offers a Pirate language option http://www.theskynet.org/?locale=arr to celebrate. 19 Sep 2013, 3:16:28 UTC · Comment

More galaxies
I've just queued another 819 PS1 only images of galaxies in NED with RA = 30-40 deg, DEC = -30-80 deg, and NED diameter of 1-3 arcmin. 16 Sep 2013, 2:09:35 UTC · Comment

2nd Birthday
TheSkyNet is celebrating its two year anniversary today with the official launch of a new web site, as well as a range of improvements and new features to make contributing to astronomical research at home more enjoyable, and even easier.

Go and have a look at http://www.theskynet.org. Your email (the one you registered when you joined BOINC) and password will get

Sign up www.theskynet.org

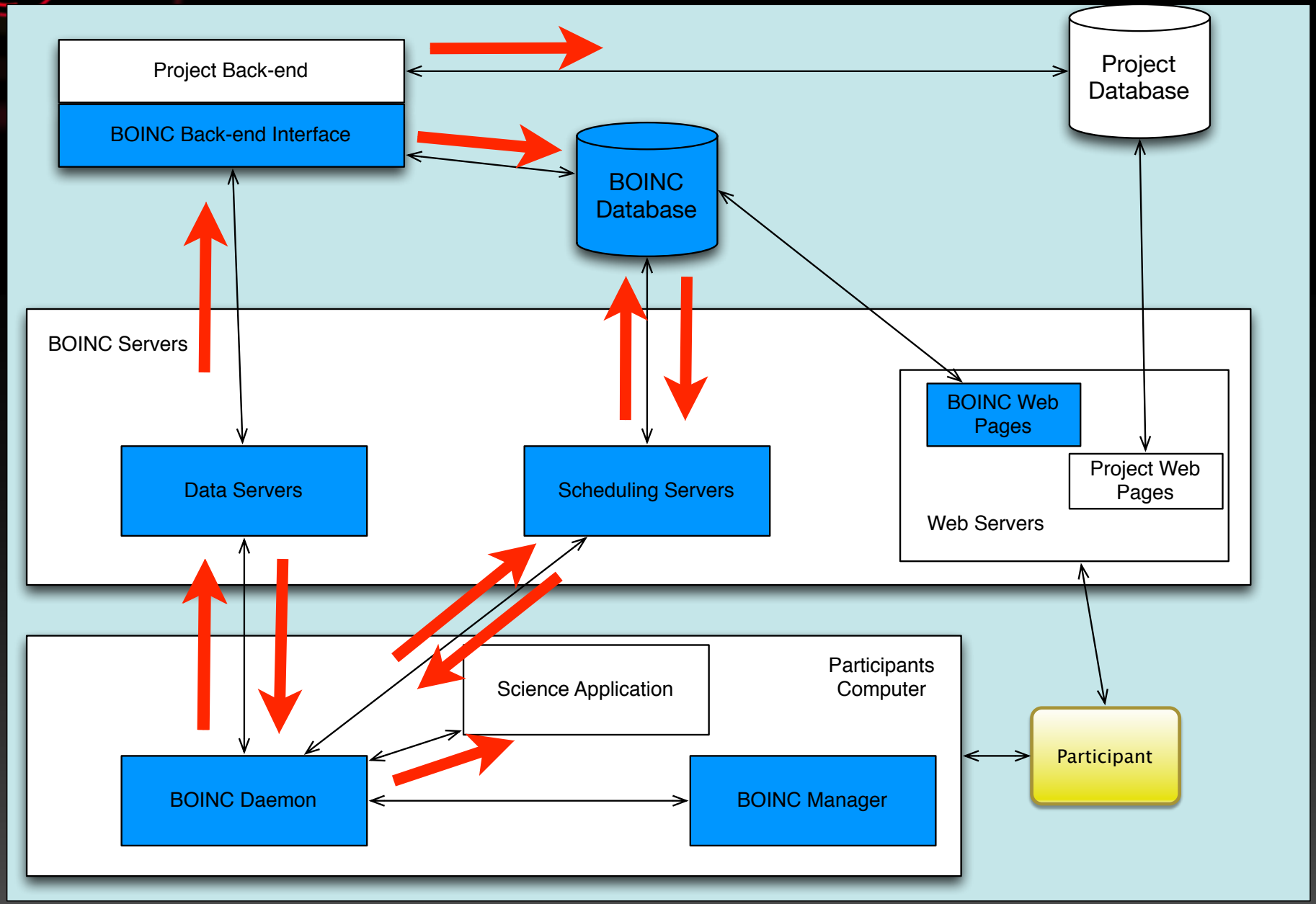
Why BOINC

Titan
US$97 million
17.6 PFlops

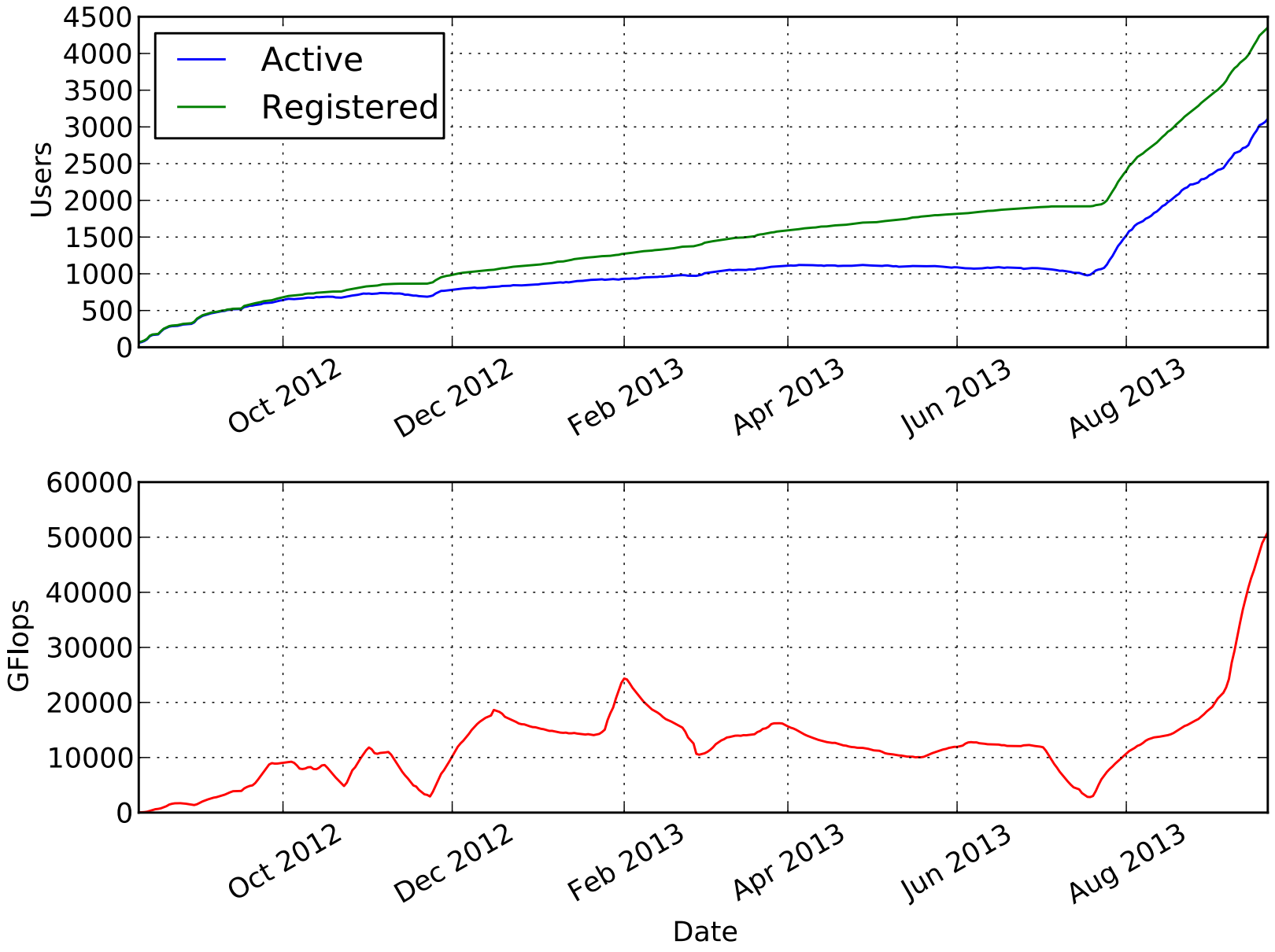
Theoretical
27 PFlops

All BOINC projects 8.3 PFlops of computing power - 8th most powerful supercomputer in the world

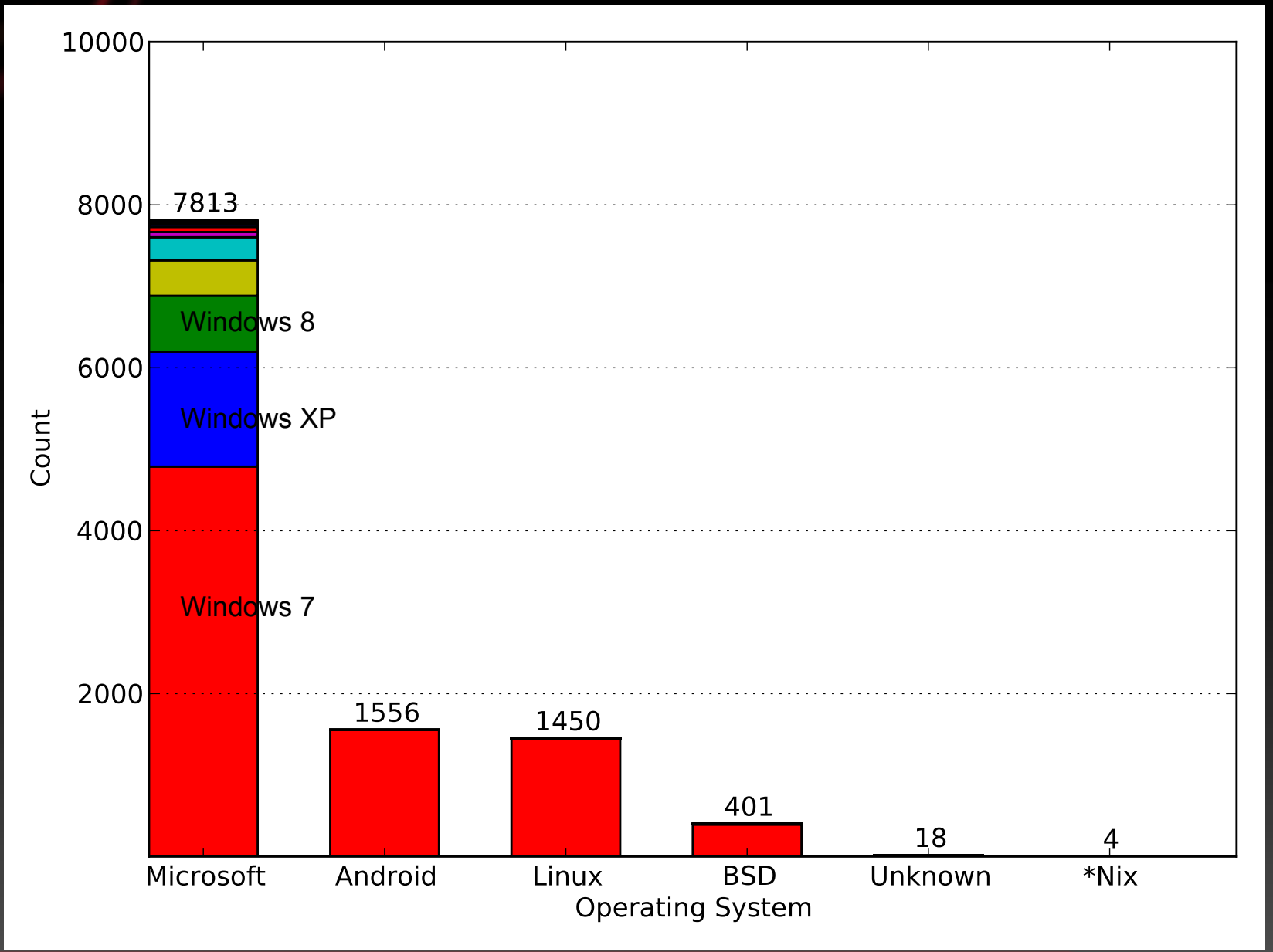
The BOINC Flow



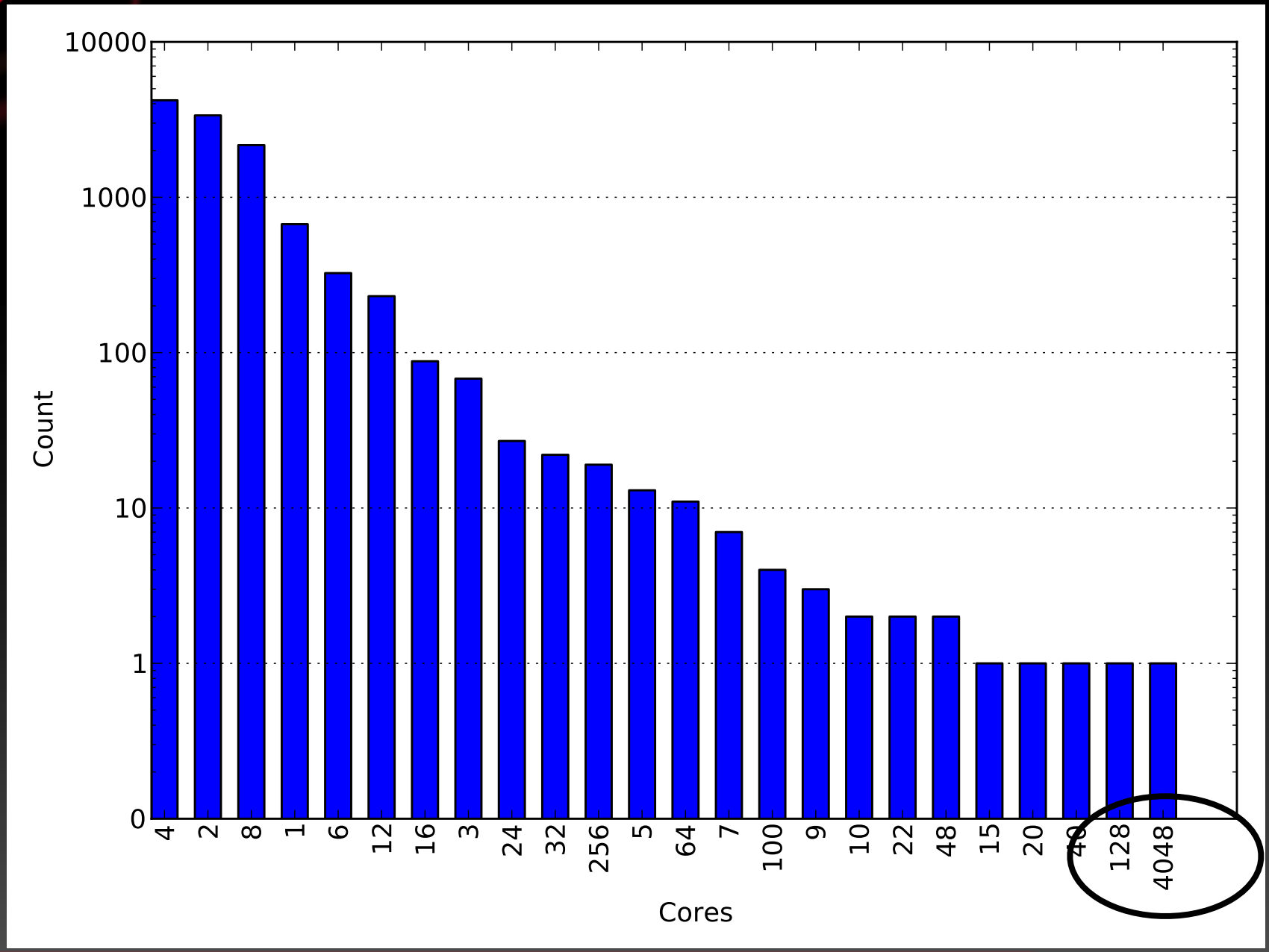
Growth


Active
Registered
Users
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Oct 2012
Dec 2012
Feb 2013
Apr 2013
Jun 2013
Aug 2013
GFlops
60000
50000
40000
30000
20000
10000
0
Oct 2012
Dec 2012
Feb 2013
Apr 2013
Jun 2013
Aug 2013
Date

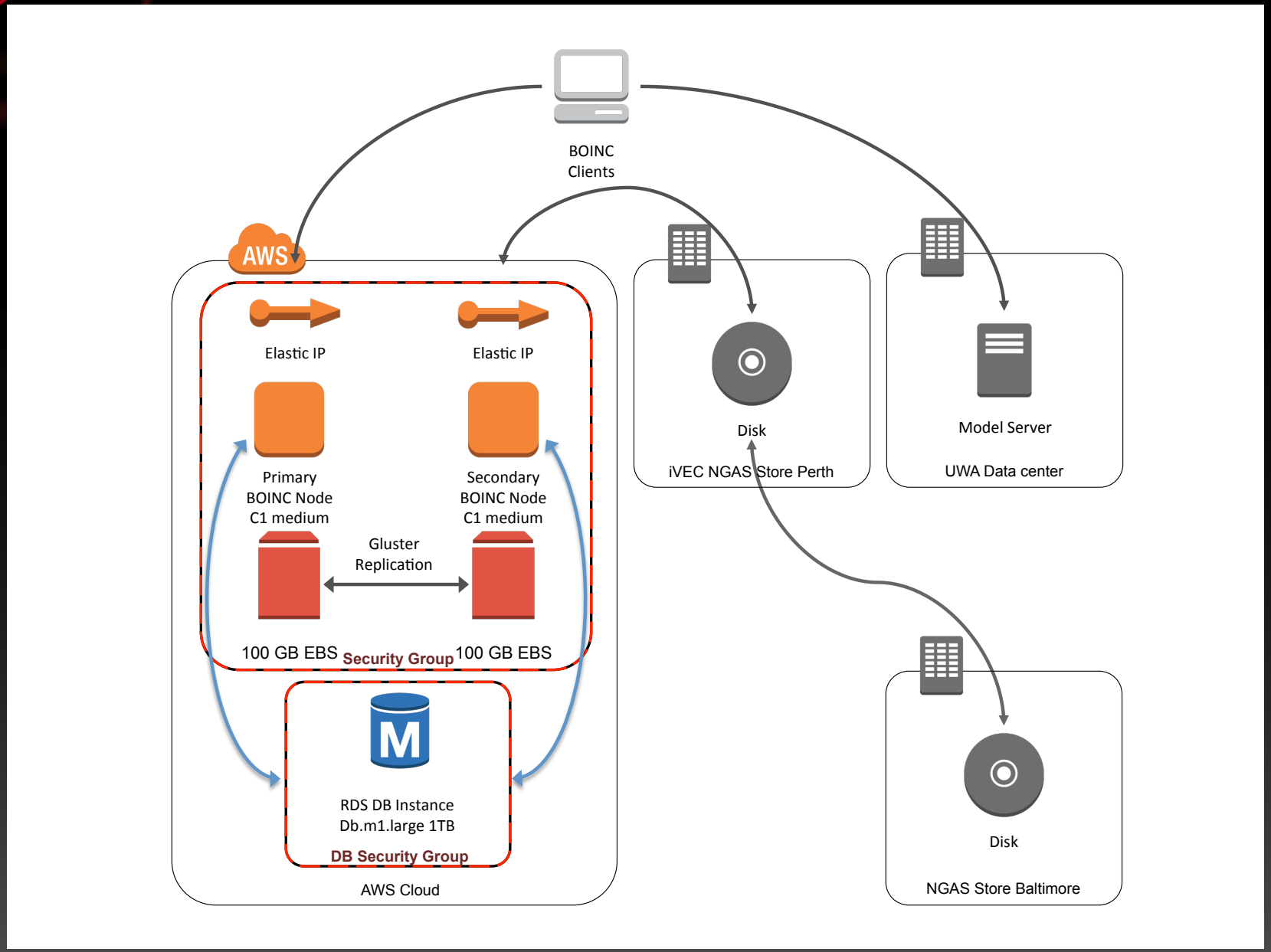
Operating Systems



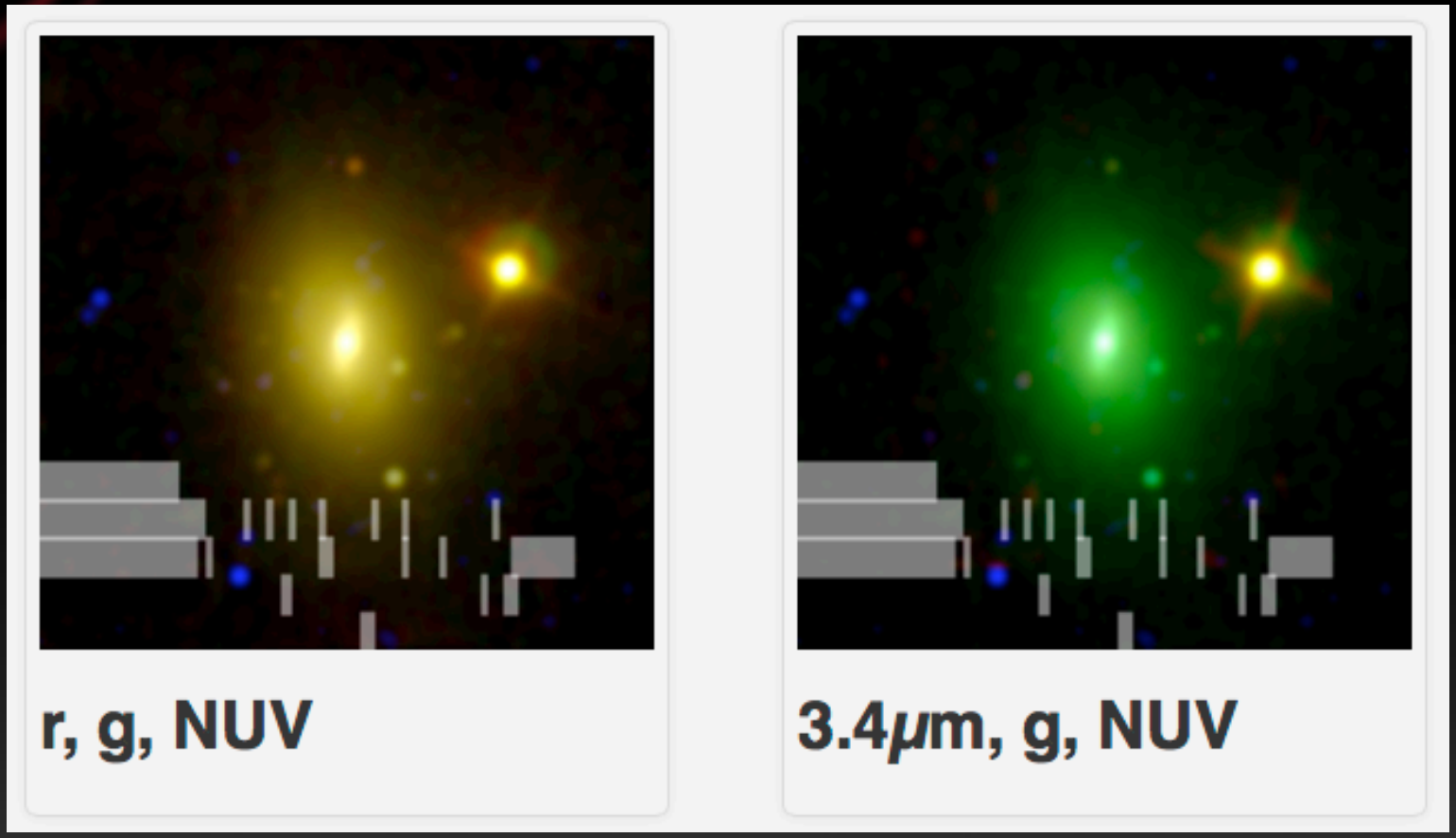
Cores


10000
1000
100
10
1
0
Count
4
2
8
1
6
12
16
3
24
32
256
5
64
7
100
9
10
22
48
15
20
40
128
4048
Cores

AWS Architecture

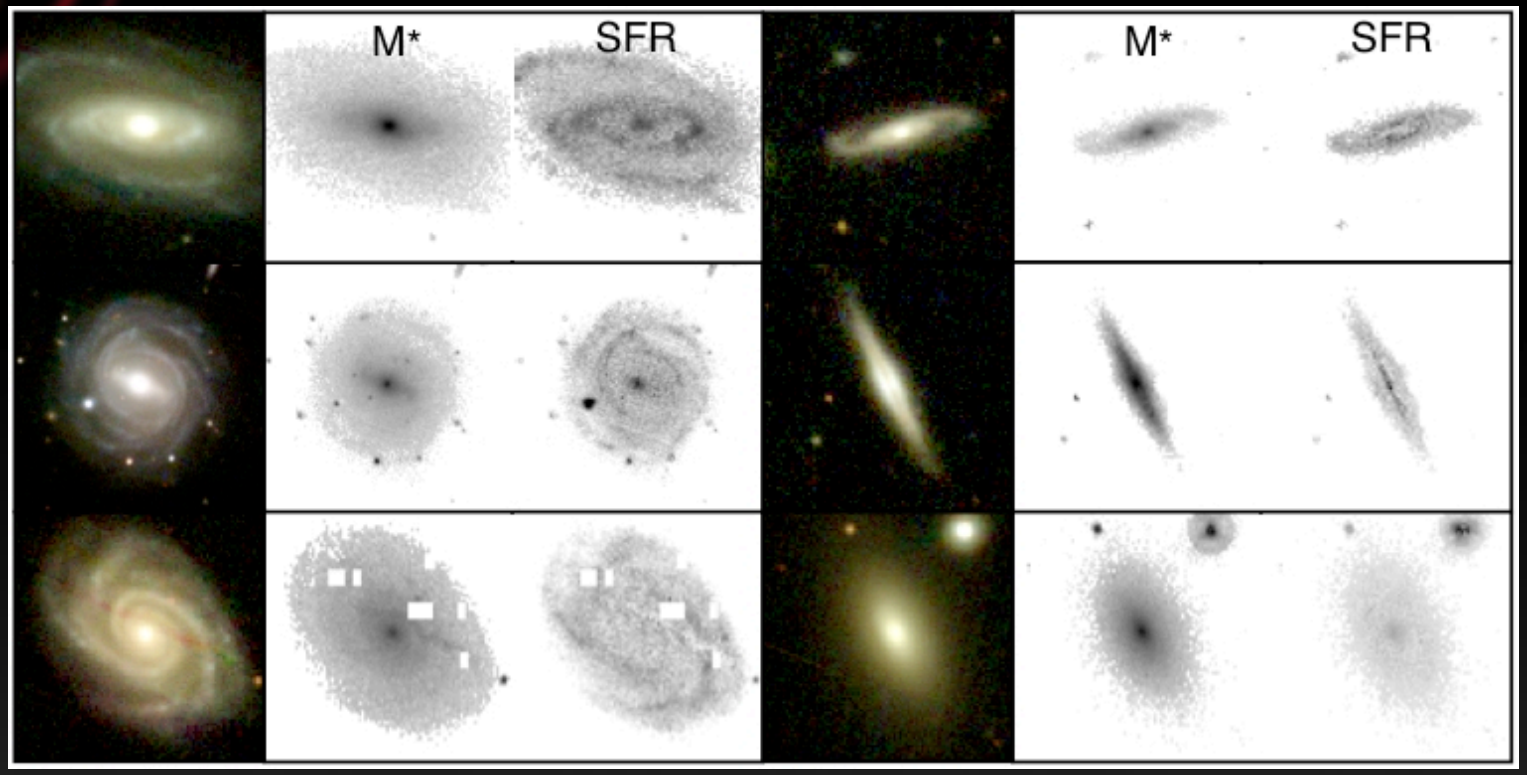


POGS



- Stamp collection incentive for volunteers - Galaxy images with the locations processed by their computer(s) marked

Some results



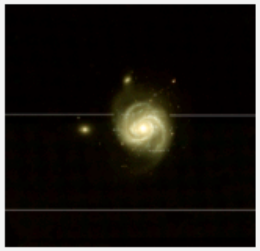
- Test galaxies from PS1 being run at high (1”) resolution

Some are very detailed

Galaxy Info: MESSIER100

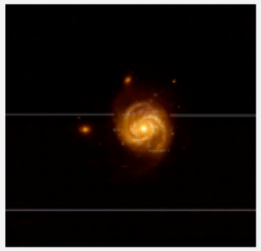
RA	185.729
Dec	15.8225
Redshift	0.00524
Type	SAB(s)bc
Dim	1964 x 1904
%	100.0%
	More Galaxy details

The following are images of the galaxy using four combinations of filters where the bright square or rectangular areas are those where you have been credited with the processing.



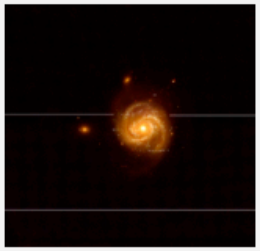
i, r, g

(Click here for the full image. It's a big one)



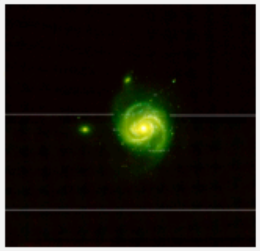
r, g, u

(Click here for the full image. It's a big one)



i, g, u

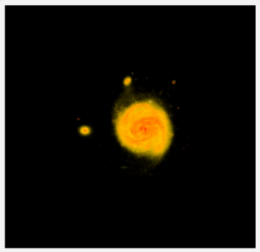
(Click here for the full image. It's a big one)



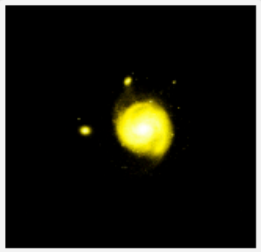
z, r, u

(Click here for the full image. It's a big one)

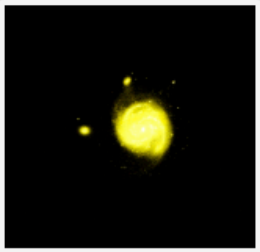
The following images show the results of the calculations performed against this galaxy to date.



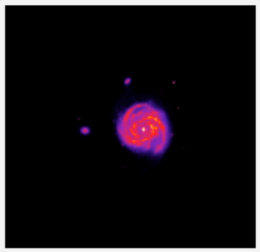
mu



m



ldust



sfr

TheSkyNet

Welcome back, Kevin | Logout | My Dashboard | Language: E

Specials

The Founder

-- theSkyNet Founding Member -- Our approximately 3,000 founding members all signed up in the first 24 hours of theSkyNet on September 13th, 2011.

Share your success!

Arrrrrrrrrr

Get ye some loot ye landlubber. Happy talk like a pirate day 2013 ye scurvy dog. Thanks for crunching some of our information stuff. Now, walk the plank!

Share your success!

2nd Birthday

13-September-2013 We're two years old, and you came to the party. Awww, you're so kind. Thank you! Have a slice of birthday pie.

Share your success!

Beta

An exclusive for helping beta test theSkyNet T2. Thank you to all our amazing beta testers.

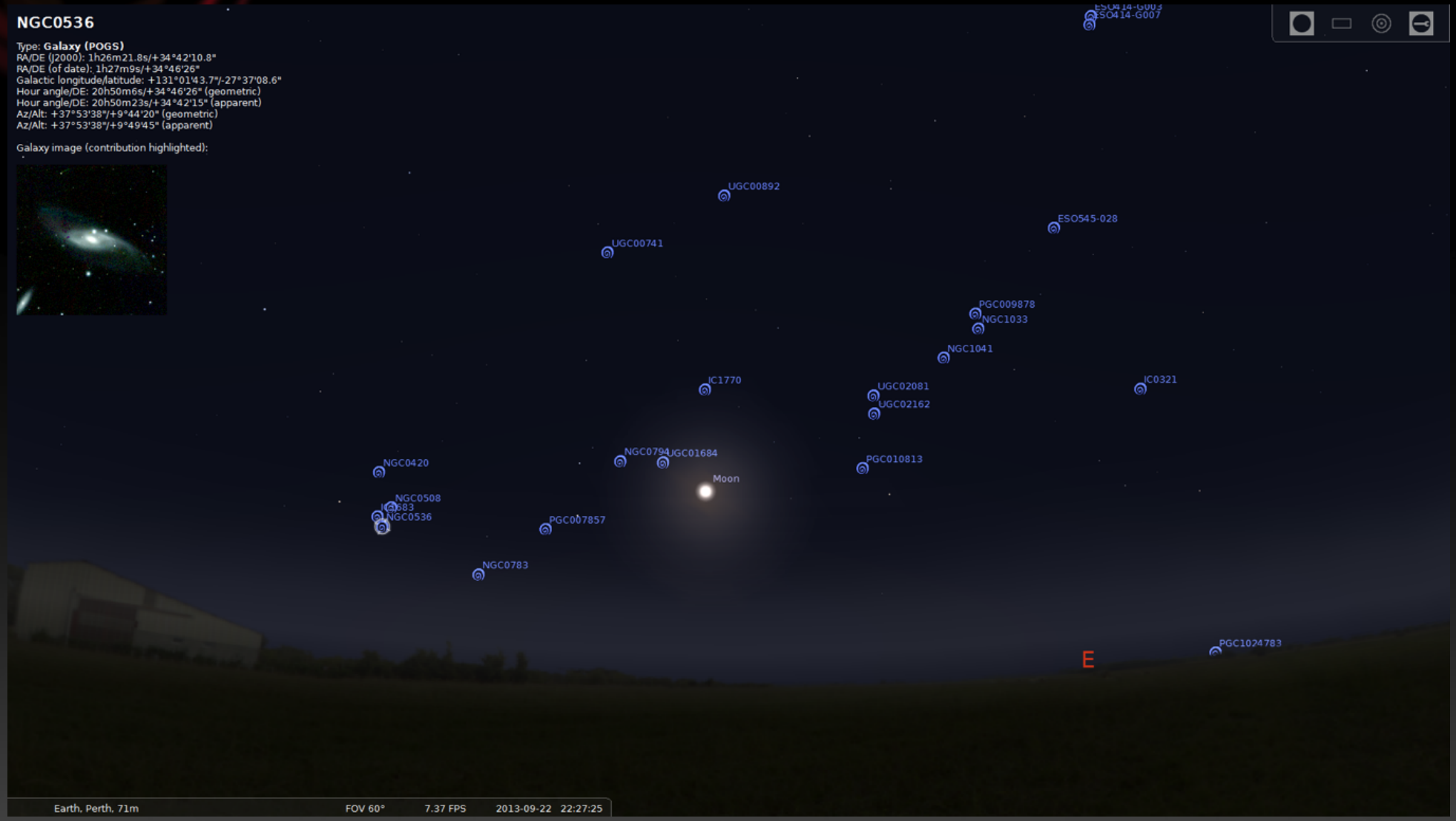
Share your success!

Classic Trophies

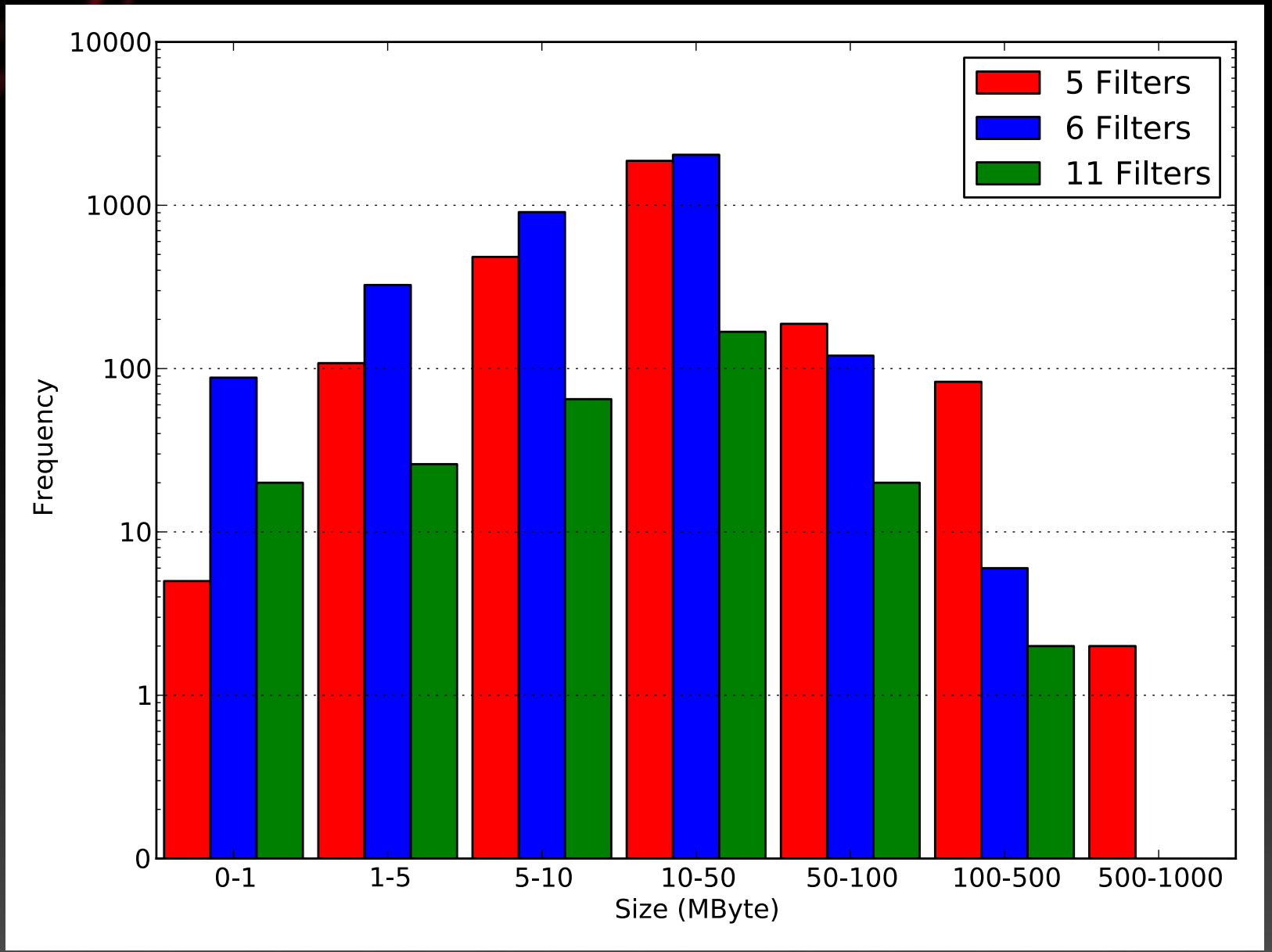
The Space Traveller (3,840,000 cr)

384,000km is the average distance between the Earth and the Moon.

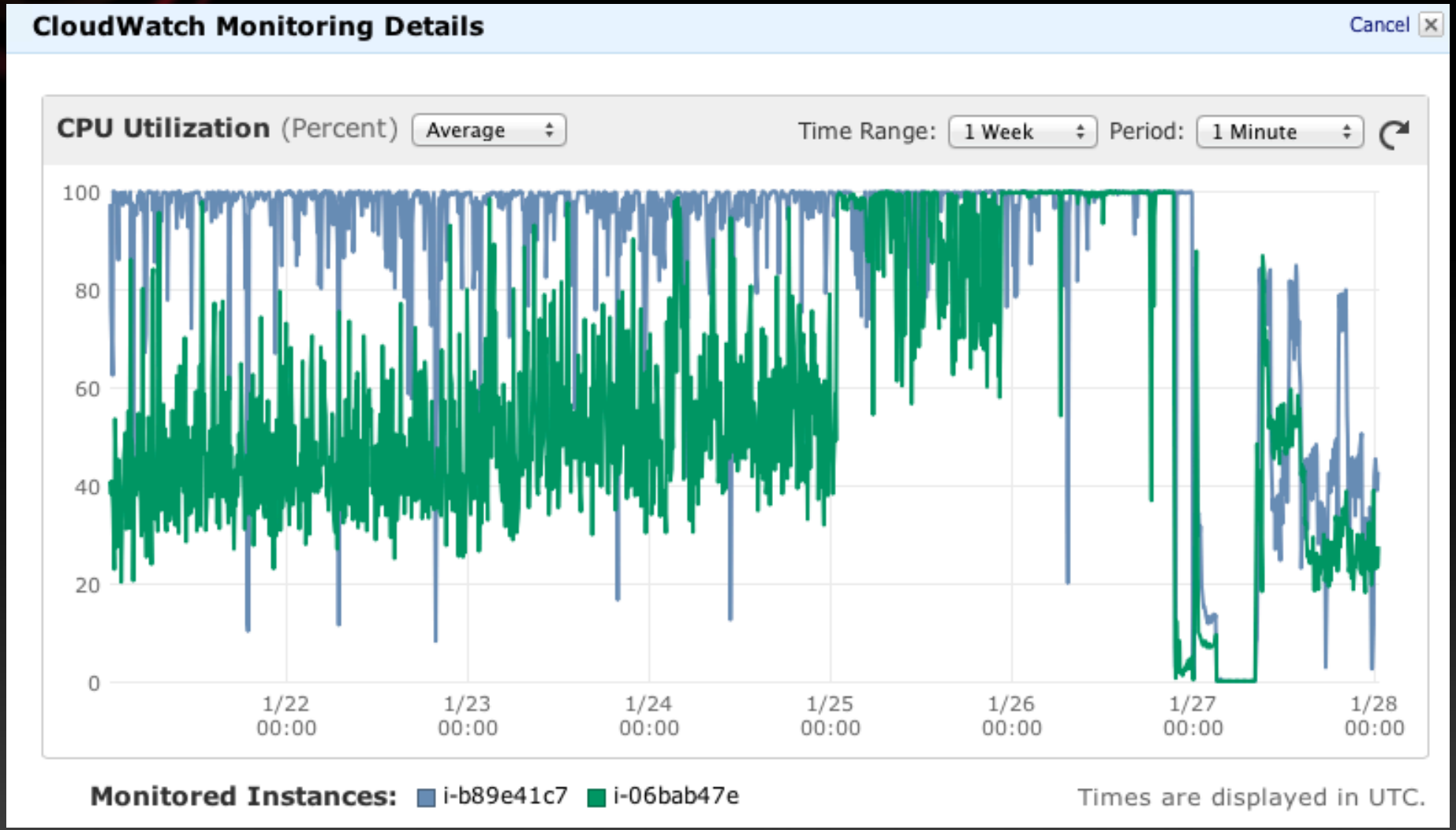
Stellarium Plug-in



HDF5 Files


10000
1000
100
10
1
0
Frequency
5 Filters
6 Filters
11 Filters
0-1
1-5
5-10
10-50
50-100
100-500
500-1000
Size (MByte)

Bad things happen



Coming Soon

- GPU Version of MAGPHYS
- Alternative SED fitting methods
- Ensemble Methods to statistically merge data
- Special un-obfuscated colour maps for astronomers
- IVOA gateway to allow you to request data

Coming Soon II

- 16 more physical parameters

Parameter	Description	Parameter	Description
tform/yr	formation time of the galaxy (years)	t(lastB)	time of the last burst of star formation (yr)
gamma	timescale of exponentially-declining SF (Gyr^-1)	Fb(1e6)	fraction of stellar mass formed in bursts over the last 10^6 yrs
Z/Zo	metallicity (solar units)	Fb(1e7)	fraction of stellar mass formed in bursts over the last 10^7 yrs
SFR(1e6)	SFR averaged over the last 10^6 years (Msun/yr)	Fb(1e8)	fraction of stellar mass formed in bursts over the last 10^8 yrs
SFR(1e7)	SFR averaged over the last 10^7 years (Msun/yr)	Fb(1e9)	fraction of stellar mass formed in bursts over the last 10^9 yrs
SFR(1e8)	SFR averaged over the last 10^8 years (Msun/yr)	Fb(2e9)	fraction of stellar mass formed in bursts over the last $2x10^9$ yrs
SFR(1e9)	SFR averaged over the last 10^9 years (Msun/yr)	age(M)	mass-weighted age (years)
SFR(2e9)	SFR averaged over the last $2x10^9$ years (Msun/yr)	age(r)	r-band light-weighted age (years)

Conclusions

- Doing 110 Galaxies a day at the moment - the whole survey in under three years
- BOINC is very stable
- AWS Bill around $550 a month
- All software available under LGPL
  - https://github.com/ICRAR/boinc-magphys
- BOINC Volunteers are FANTASTIC

- Forums chew up a HUGE chunk of your time

Any Questions

- I'm "hard of hearing" - I wear hearing aids so please speak clearly.

- Contact me at kevin.vinsen@icrar.org