Observational Astronomy & Data Reduction

Lecture 3:
Planning your Observing Night

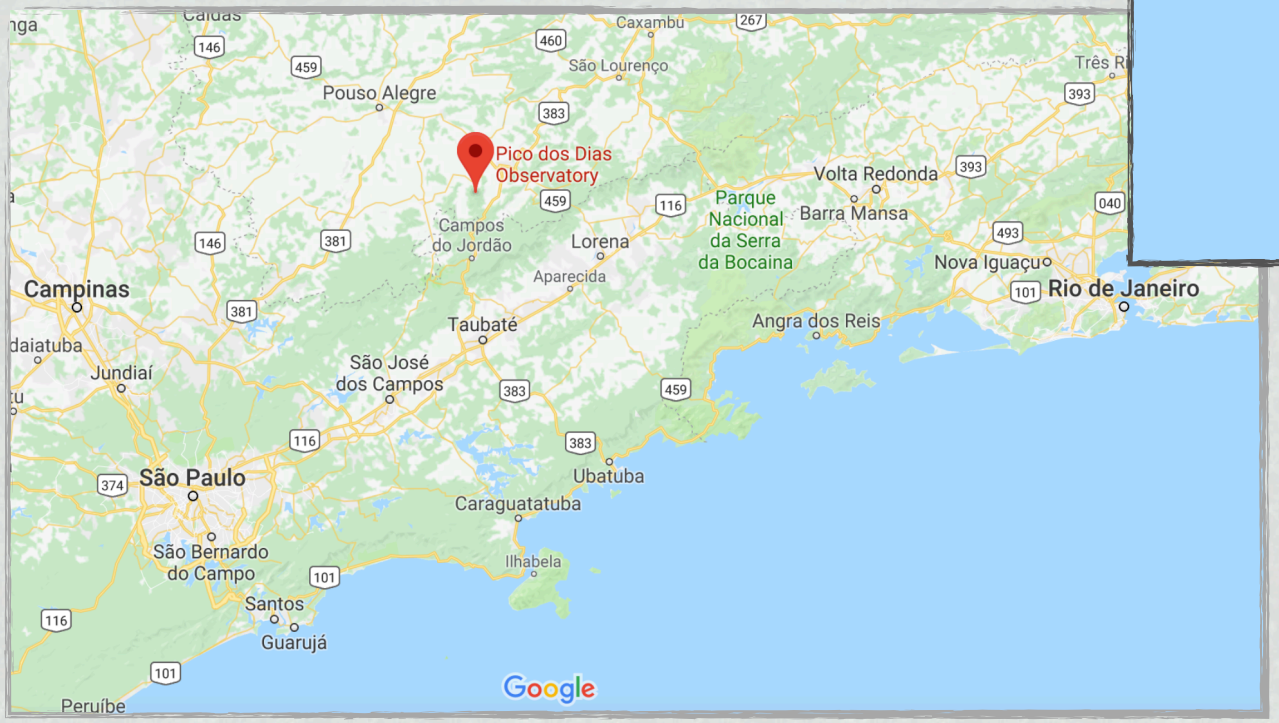
EVERYONE, GO TO:
https://tinyurl.com/ISYA2018-ObservationalAstro

Karín Menéndez-Delmestre
Observatório do Valongo

Remote Observing @ Observatório Pico dos Dias

Localização

- Minas Gerais, Brazil
  - ~350 km from Rio de Janeiro
  - ~250km from São Paulo
- 22.5344° S, 45.5825° W



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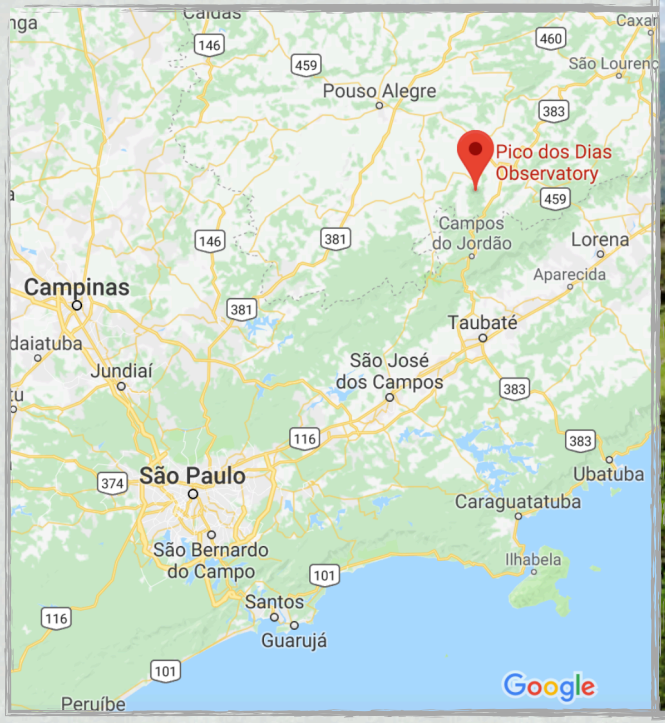
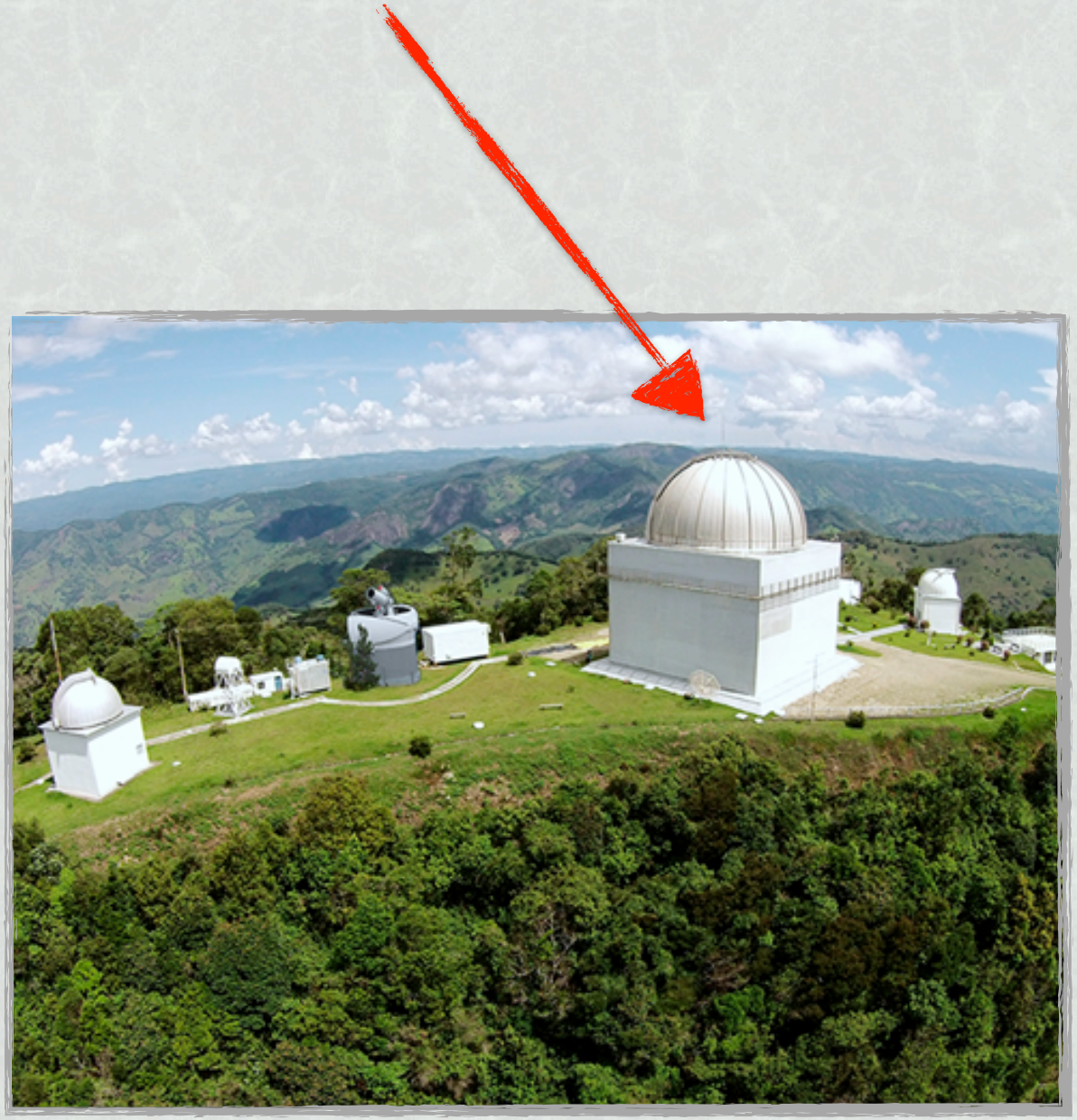
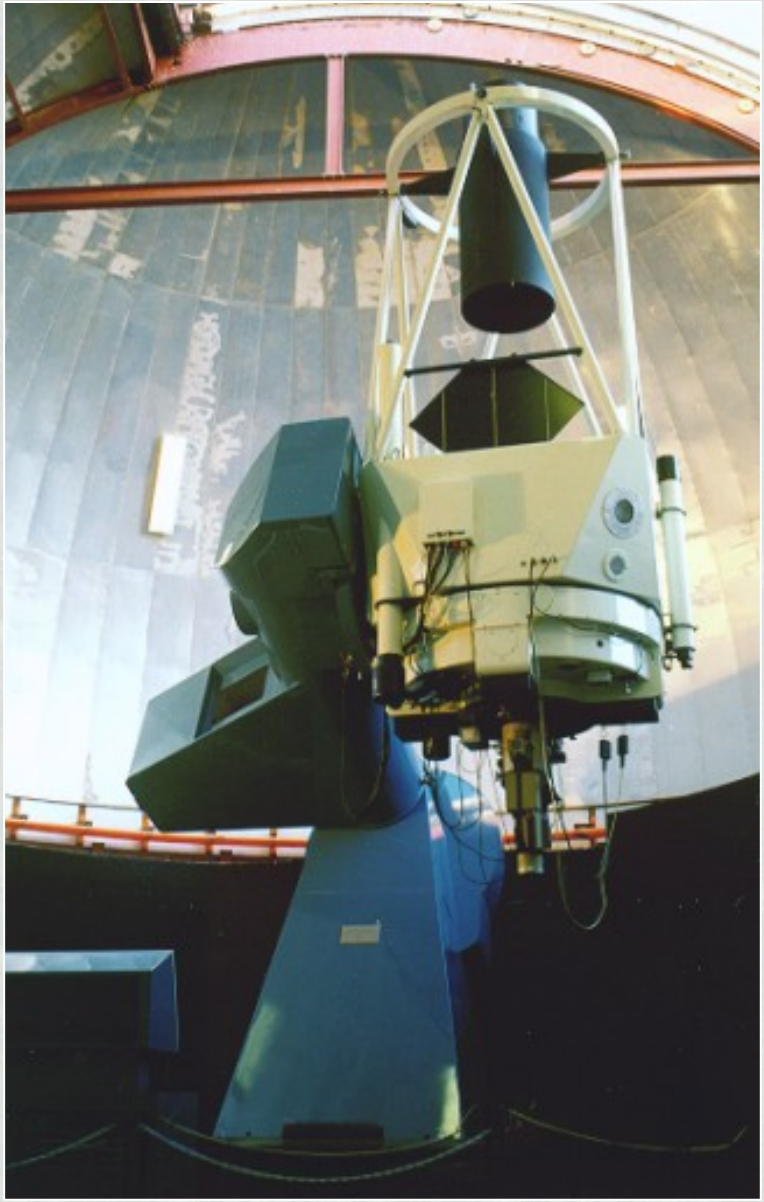


Remote Observing with the Perkin-Elmer 1.6m Telescope



http://www.nitmantiqueira.org.br/portal/index.php/noticias/1195-lna-fecha-acordo-com-instituicao-da-russia-para-monitorar-lixo-espacial

Remote Observing with the Perkin-Elmer 1.6m Telescope



General Properties

- Cassegrain telescope
  - Ritchey-Chrétien variation
  - @ Cassegrain focus: f/10

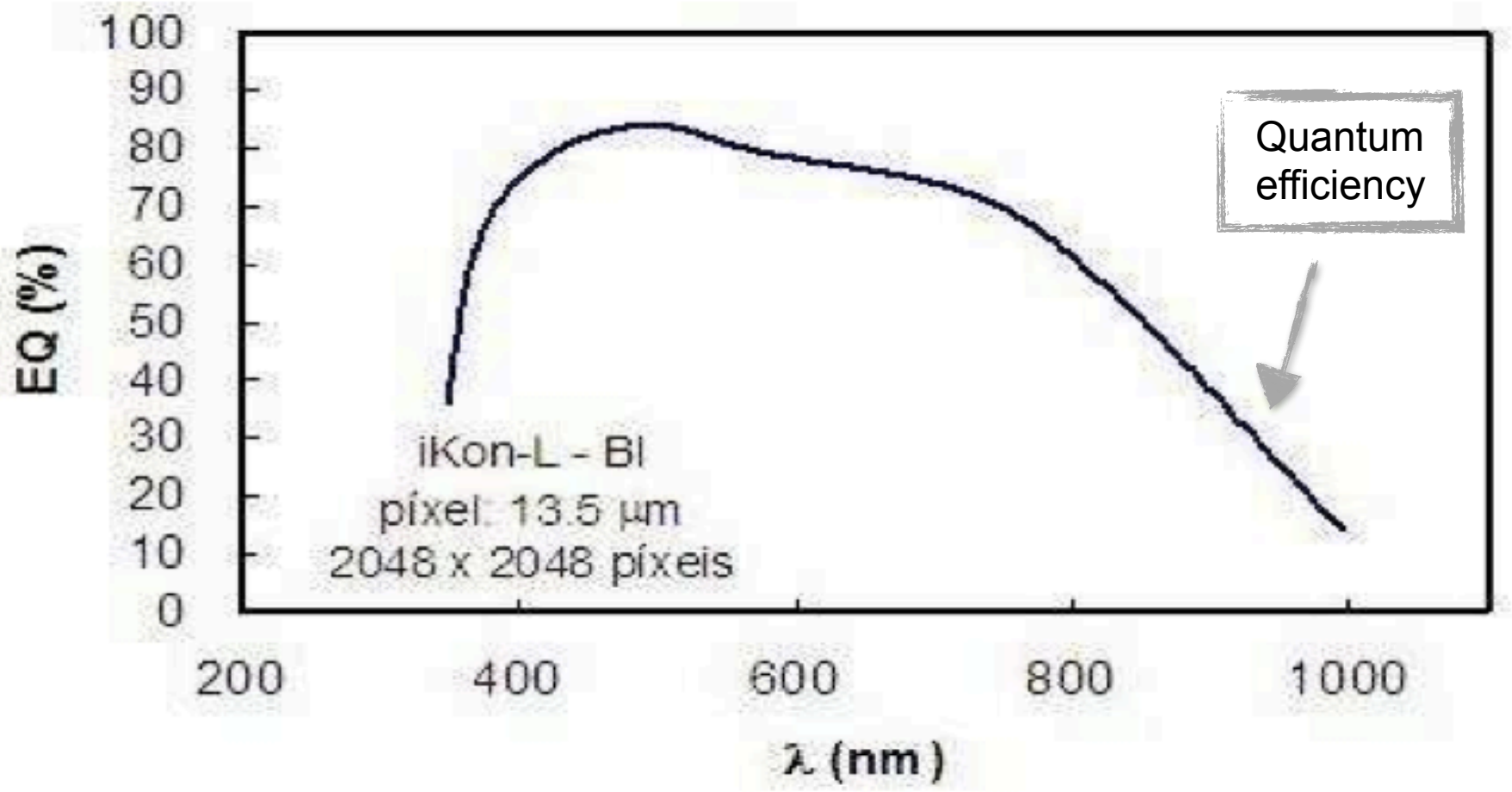
Instrument

- Direct Camera with IKON CCD
  - CCD: 2048 pix x 2048 pix
  - Pixel size:13.5μm x 13.5μm
    - 0.18”/pix
    - From: $h = \theta_{radians} F$
  - FOV: ~6’ x 6’
    - from: $\theta_a \times \theta_b = (a \times b)/F^2$

Imaging with the Direct Cam on the PE/1.6m Telescope

Filters

- Up to 6 filters can be placed on the filter wheel



IKON-L manual: http://www.lna.br/opd/instrum/ccd/manual_ikon.pdf

Imaging with the Direct Cam on the PE/1.6m Telescope

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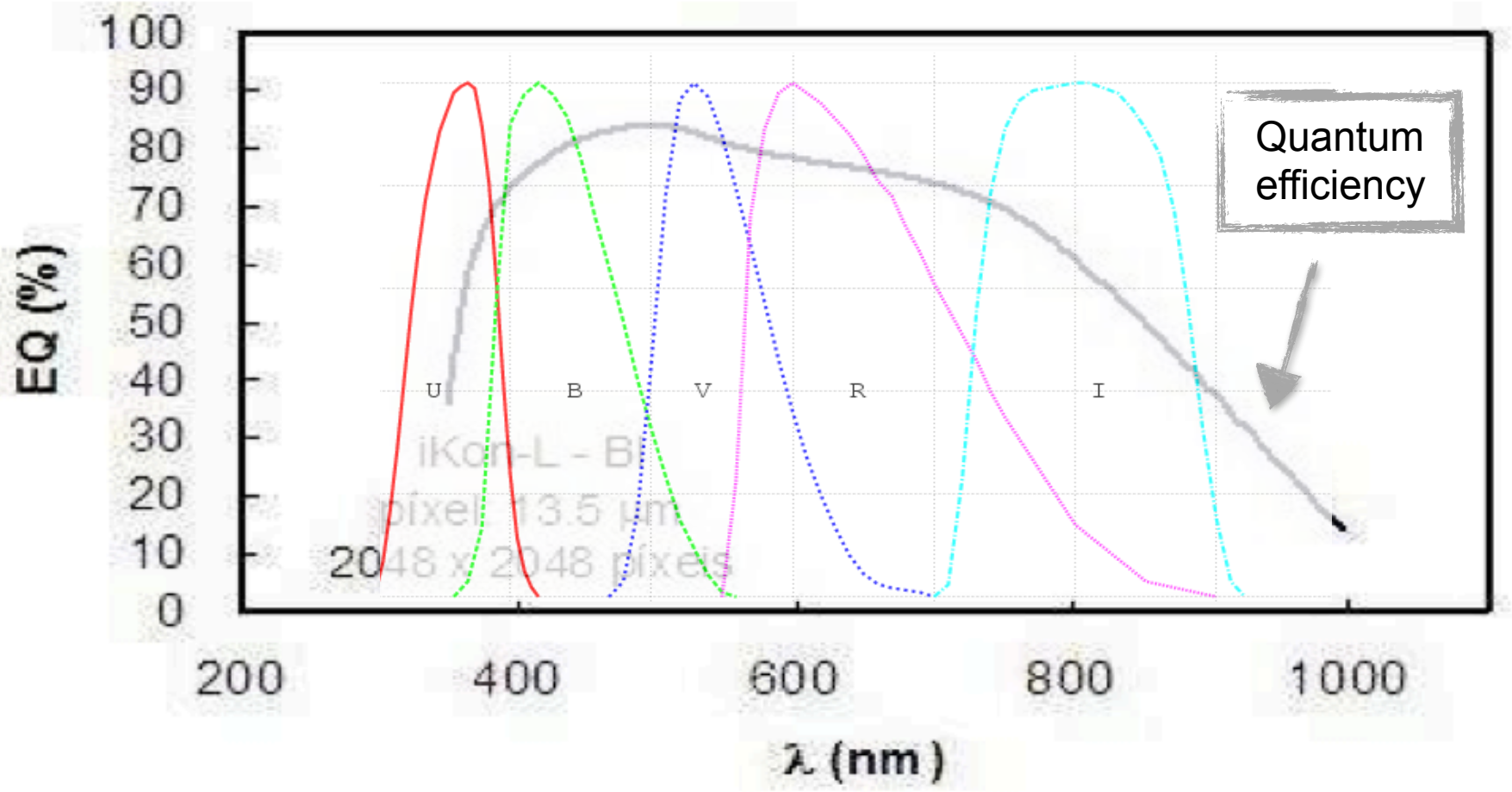


IKON manual: http://www.lna.br/opd/instrum/ccd/manual_ikon.pdf

- Go to the LNA official website: http://www.lna.br/opd/opd.html

- Let’s see what the (current) weather conditions are like

Estacao Meteorologica

Sensor de nuvens

AllSky I

AllSky II

Monitor de seeing

Boletim

Ajuda

Inicio

LNA

O P D - Estação Meteorológica

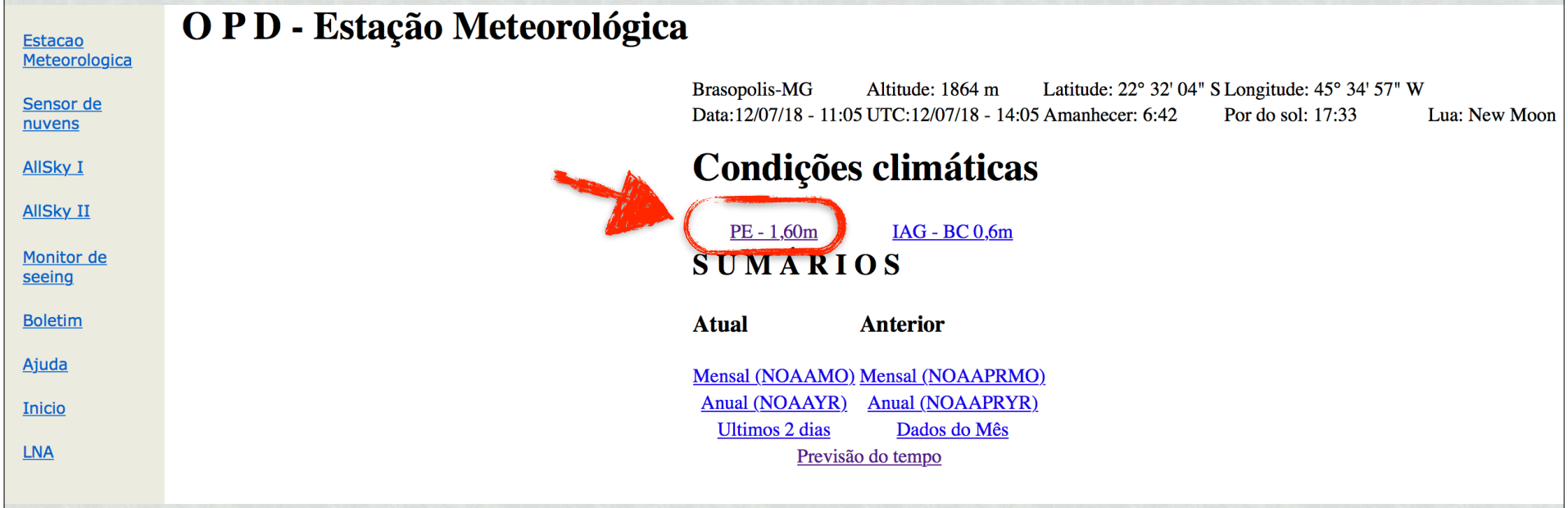
Brasopolis-MG Altitude: 1864 m Latitude: 22° 32' 04" S Longitude: 45° 34' 57" W
Data:12/07/18 - 11:05 UTC:12/07/18 - 14:05 Amanhecer: 6:42 Por do sol: 17:33 Lua: New Moon

CAMERA ALLSKY - OPD
UTC: 12/July/2018 14:12:33

Imagem da Via Láctea, destacando-se a Lua cheia(esquerda) e a cúpula do Telescópio de 1,60 m (LNA, 2008)

Imagem exibida em [765x510] pxs , original em : [1628x1236] pxs

- Let’s see what the (current) weather conditions are like
- We’ll be using the 1.6m Perkin-Elmer (PE) Telescope



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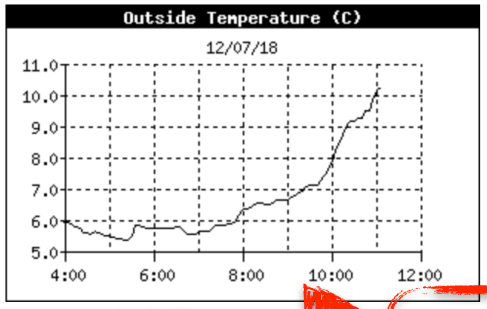
T E M P E R A T U R A

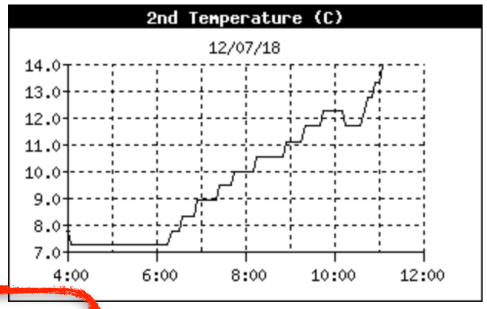
Externa 1,60m

Atual : 10.2 °C
Máxima: 10.2°C em 11:00
Mínima: 4.1°C em 0:00



Interna - Cúpula 1,60 m

Atual : 13.9°C
Máxima: 13.9°C em 11:02
Mínima: 6.1°C em 0:03

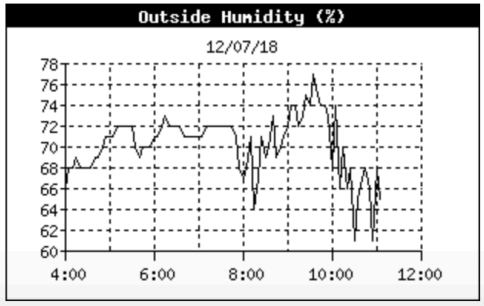


Humidity

U M I D A D E

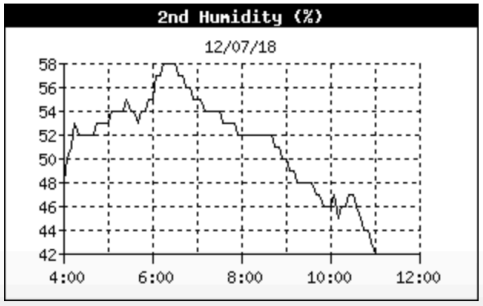
Externa 1,60m

Atual: 63%
Máxima: 85% em 0:00
Mínima: 61% em 10:29



Interna - Cúpula 1,60 m

Atual: 41%
Máxima: 66% em 0:00
Mínima: 41% em 11:07



Max humidity: ~95%
Max Wind: 70km/h

CLASSROOM WORK

Group 1

- **Important times during your observing night:**
  - Sunset
  - twighlight

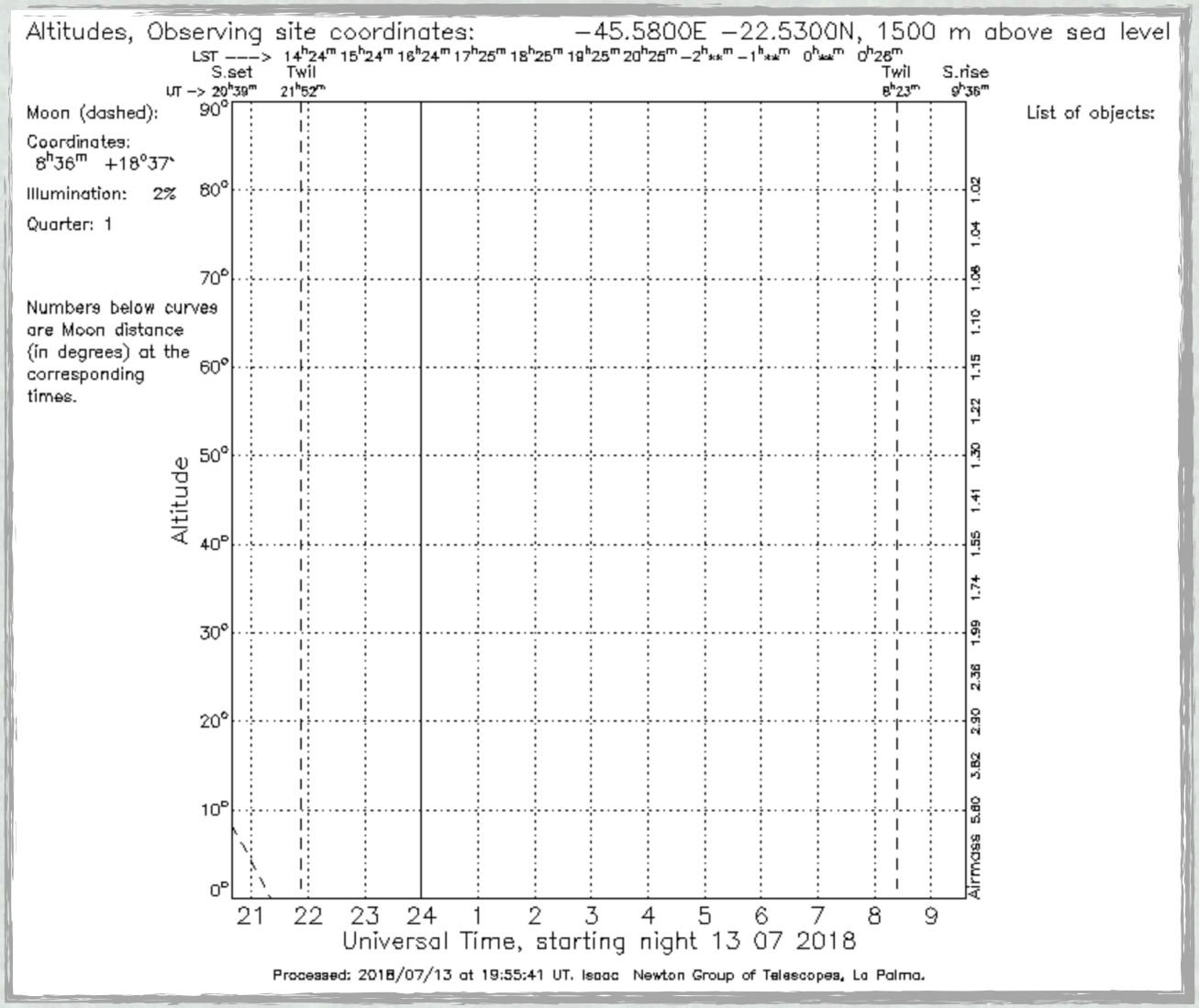
Go to:

http://catserver.ing.iac.es/staralt/

OPD:
longitude latitude:
-45.58 -22.53

Also:

https://www.timeanddate.com/astronomy/@3460834



CLASSROOM WORK

Group 1

- **Important times during your observing night:**
  - Sunset
  - twighlight

21:52
(UT time)

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http://catserver.ing.iac.es/staralt/

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longitude latitude:
-45.58 -22.53

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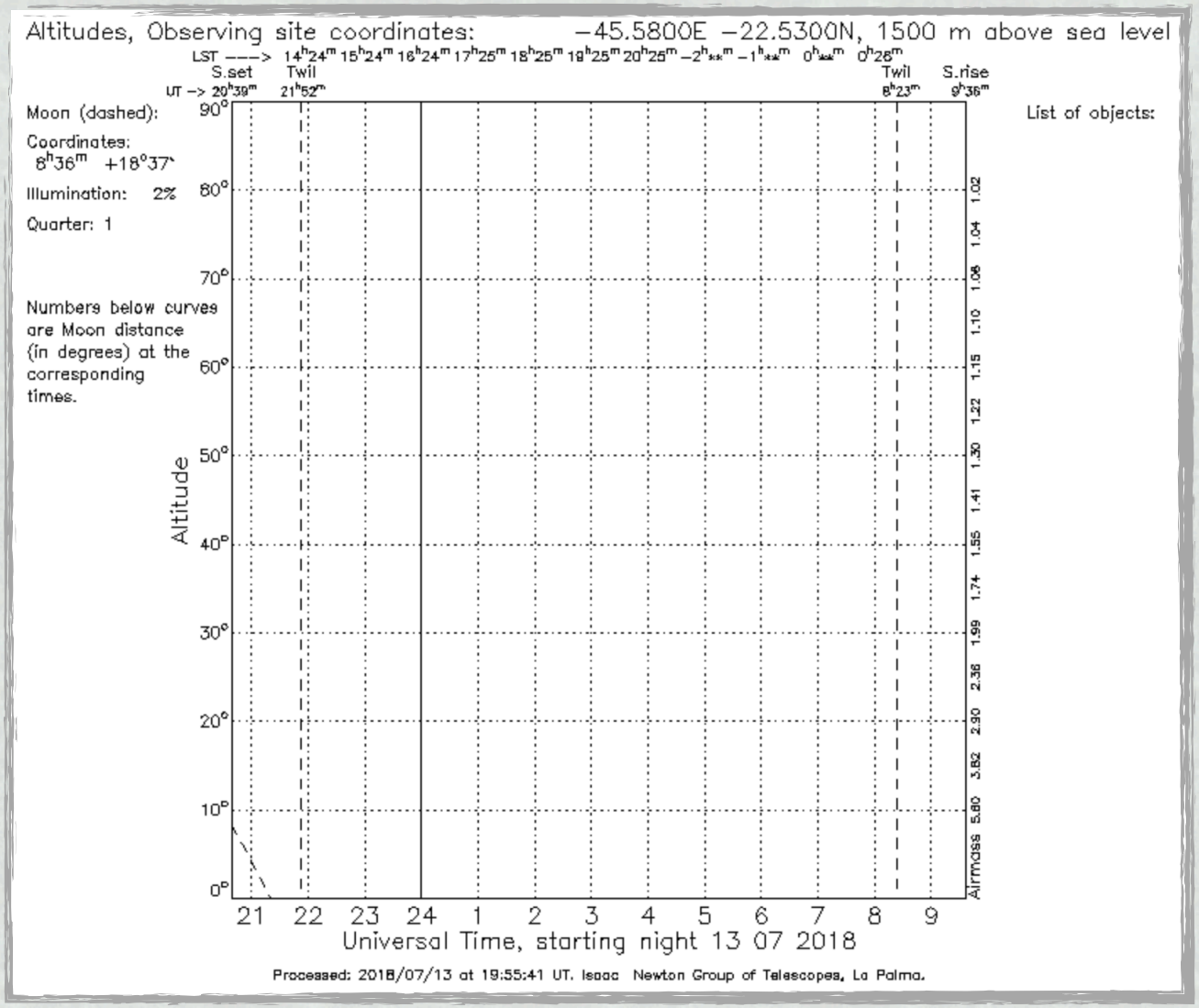

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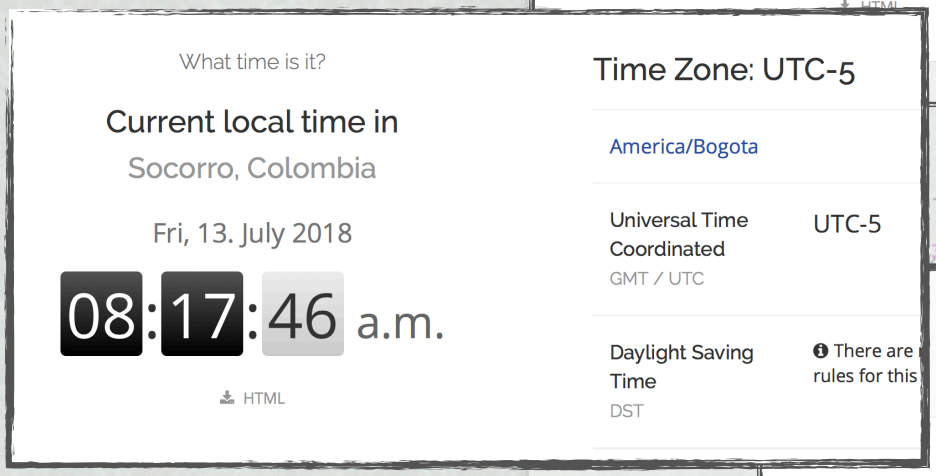

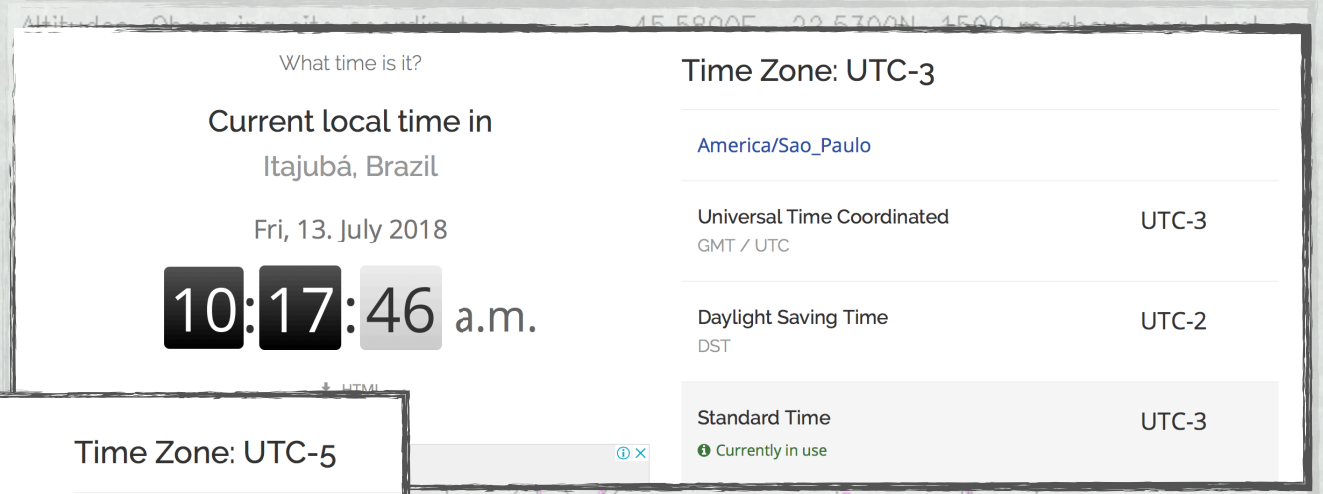

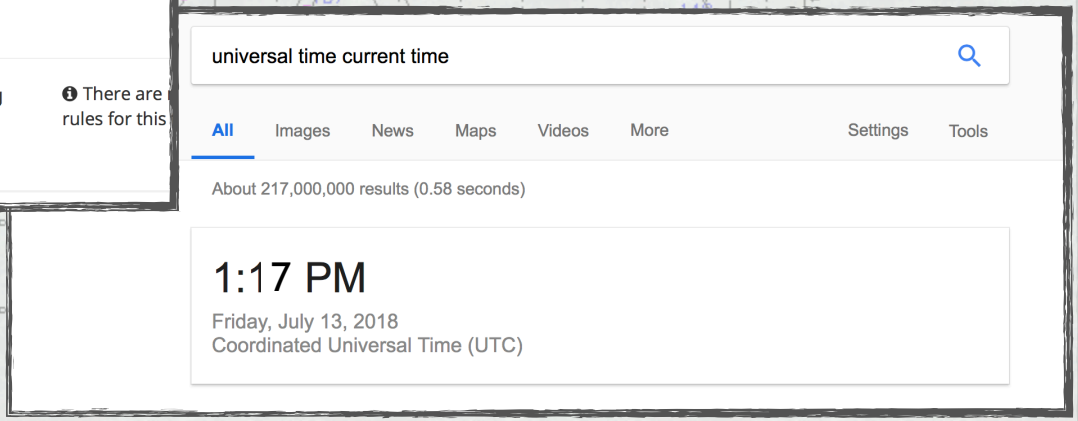

16:52
(Socorro time)

CLASSROOM WORK

Group 2

- **Object selection**
  - Science:
    Micro-variable AGNs (Romero+99):
    https://aas.aanda.org/articles/aas/pdf/1999/06/ds8028.pdf
  - Consider:
    - coordinates
      - B1950 —> J2000
        https://ned.ipac.caltech.edu/forms/calculator.html
    - airmass
      - http://catserver.ing.iac.es/staralt/

Table 1. Observed AGNs

Object	$\alpha_{1950.0}$	$\delta_{1950.0}$	z	m_V	Type
0537 − 441	05 37 21.1	−44 06 45.0	0.894	16.48	RBL
0637 − 752	06 37 23.25	−75 13 38.2	0.651	15.75	RLQ
1034 − 293	10 34 55.9	−29 18 27.0	0.312	16.46	RLQ
1101 − 232	11 01 11.1	−23 13 20.0	0.186	16.55	XBL
1120 − 272	11 20 34.2	−27 13 35.0	0.389	16.80	RQQ
1125 − 305	11 25 04.0	−30 28 14.0	0.673	16.30	RQQ
1127 − 145	11 27 35.6	−14 32 54.0	1.187	16.90	RLQ
1144 − 379	11 44 30.9	−37 55 31.0	1.048	16.20	RBL
1157 − 299	11 57 10.0	−29 55 10.0	0.207	16.40	RQQ
1244 − 255	12 44 06.7	−25 31 25.0	0.638	17.41	RLQ
1256 − 229	12 56 27.6	−22 54 28.0	?	17.30	RBL
1349 − 439	13 49 52.5	−43 57 55.0	?	16.37	RBL
1510 − 089	15 10 08.9	−08 54 48.0	0.360	16.54	RLQ
1519 − 273	15 19 37.3	−27 19 30.0	?	17.70	RBL
2005 − 489	20 05 46.6	−48 58 43.0	0.071	13.40	RBL
2155 − 304	21 55 58.3	−30 27 54.0	0.116	13.09	XBL
2200 − 181	22 00 27.0	−18 16 14.0	1.160	15.30	RQQ
2254 − 204	22 54 00.5	−20 27 43.0	?	16.60	RBL
2316 − 423	23 16 20.9	−42 23 14.0	0.055	16.00	XBL
2340 − 469	23 40 34.2	−46 56 42.0	1.970	16.40	RQQ
2341 − 444	23 41 08.2	−44 23 58.0	1.900	16.50	RQQ
2344 − 465	23 44 02.3	−46 29 10.0	1.890	16.40	RQQ
2347 − 437	23 47 57.5	−43 42 31.0	2.900	16.30	RQQ

CLASSROOM WORK

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Remember? RA range available in the night sky for this time of the year!
RA: 15h —> 23h

1510 − 089	15 10 08.9	−08 54 48.0	0.360	16.54	RLQ
1519 − 273	15 19 37.3	−27 19 30.0	?	17.70	RBL
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Object	$\alpha_{1950.0}$	$\delta_{1950.0}$	z	m_V
1510 − 089	15 10 08.9	−08 54 48.0	.360	16.54
1519 − 273	15 19 37.3	−27 19 30.0	?	17.70
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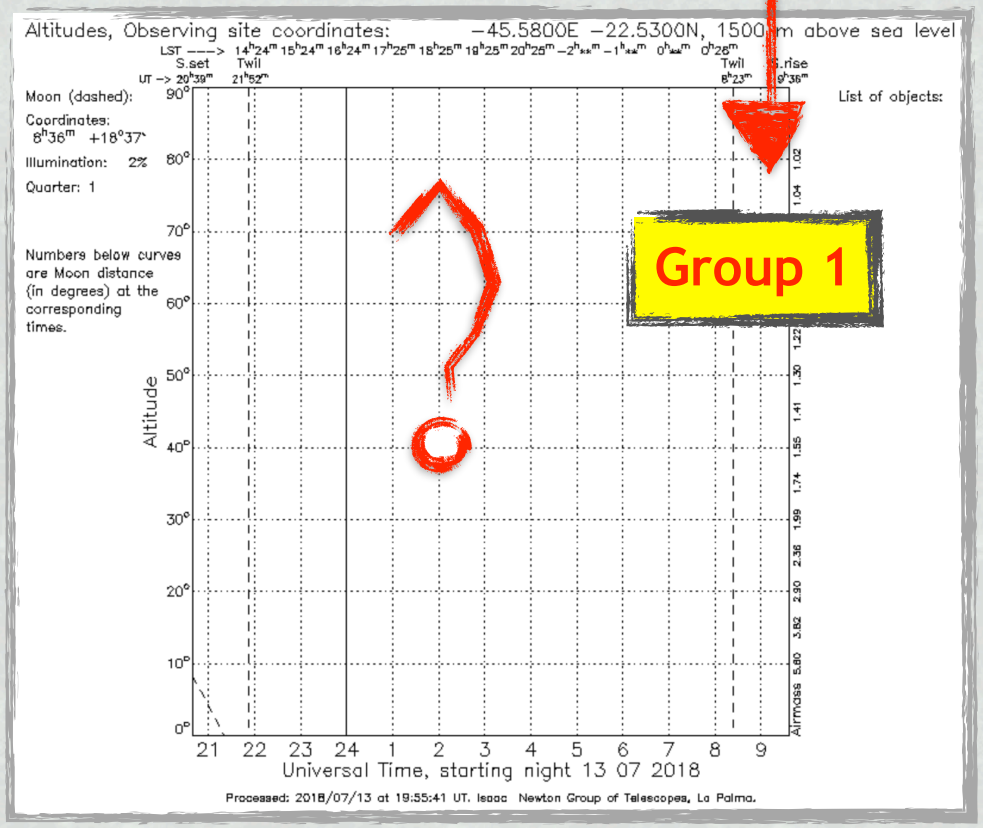

Group 1

CLASSROOM WORK

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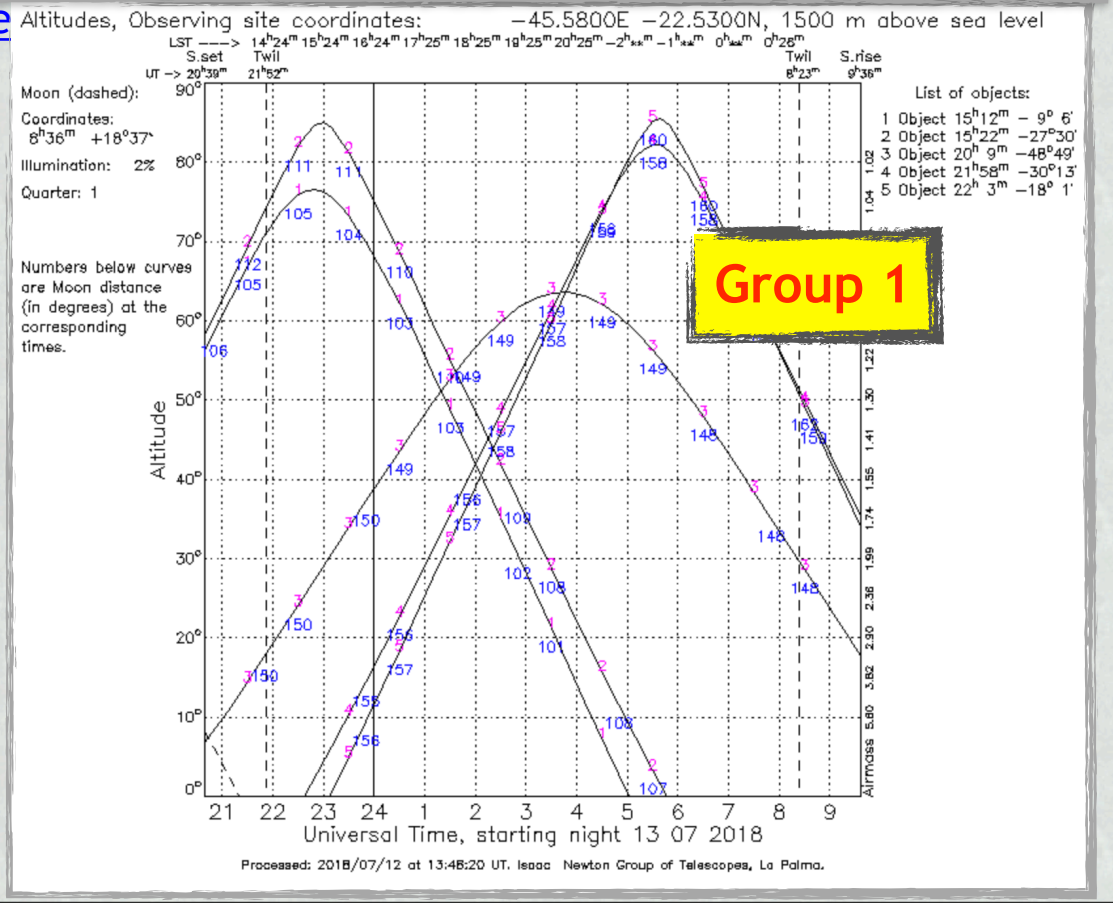
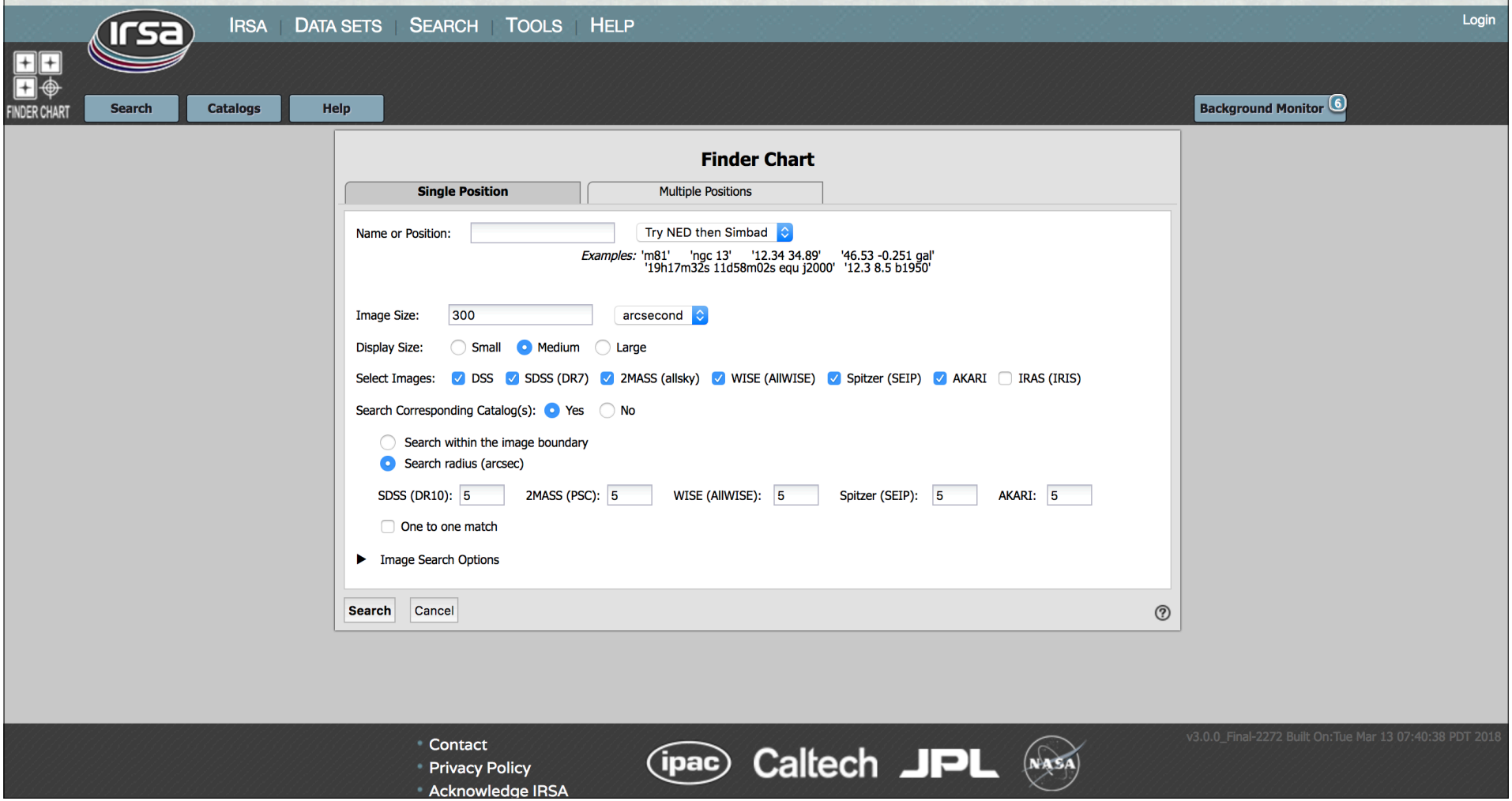
Object	$\alpha_{1950.0}$	$\delta_{1950.0}$	z	mv
1510 − 089	15 10 08.9	−08 54 48.0	0.360	16.54
1519 − 273	15 19 37.3	−27 19 30.0	?	17.70
2005 − 489	20 05 46.6	−48 58 43.0	0.071	13.40
2155 − 304	21 55 58.3	−30 27 54.0	0.116	13.09
2200 − 181	22 00 27.0	−18 16 14.0	1.160	15.30



CLASSROOM WORK

Groups 3, 4

- **Finder charts**
  - IRSA (http://irsa.ipac.caltech.edu/applications/finderchart/)



CLASSROOM WORK

Groups 3, 4

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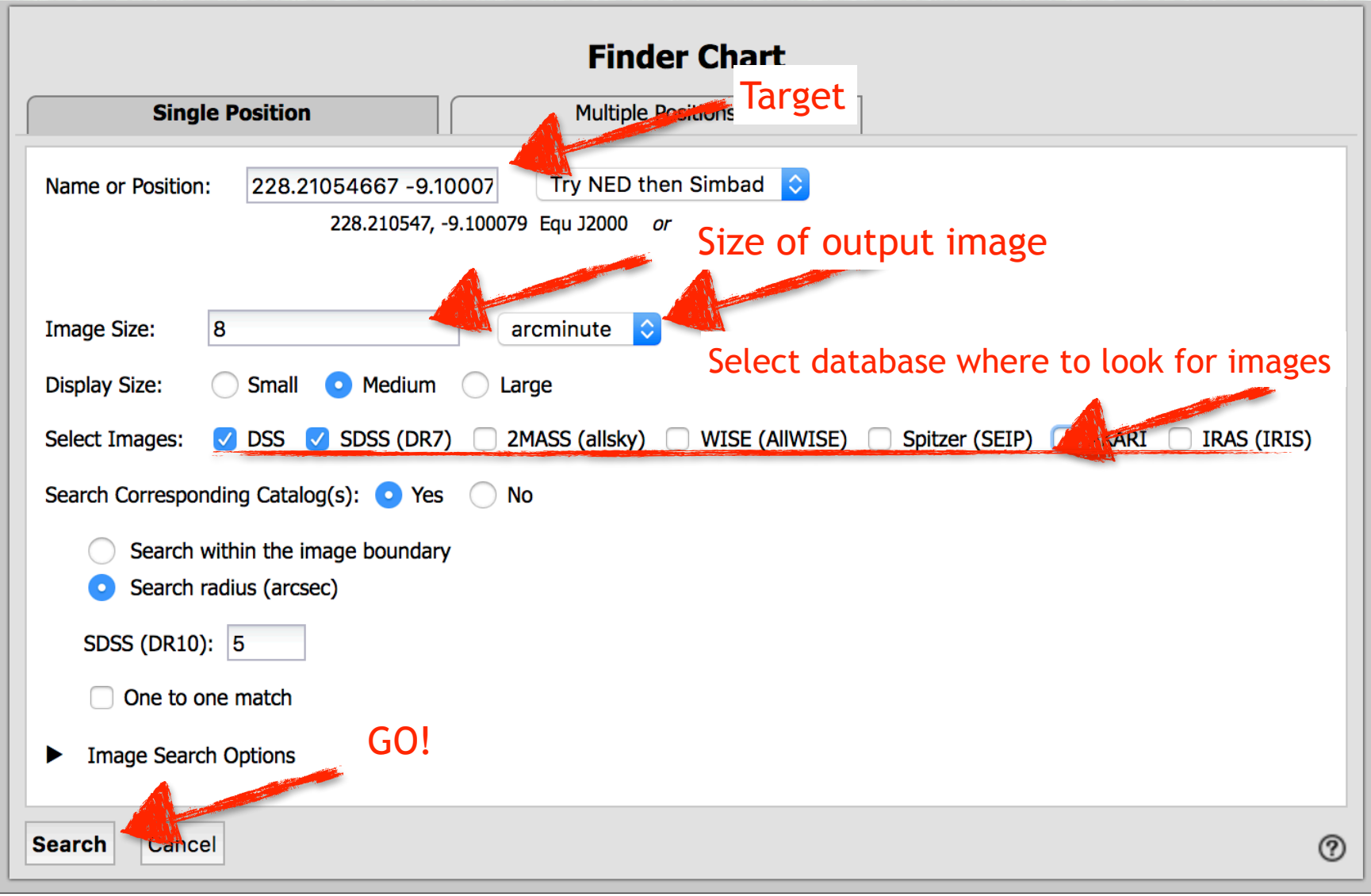

CLASSROOM WORK

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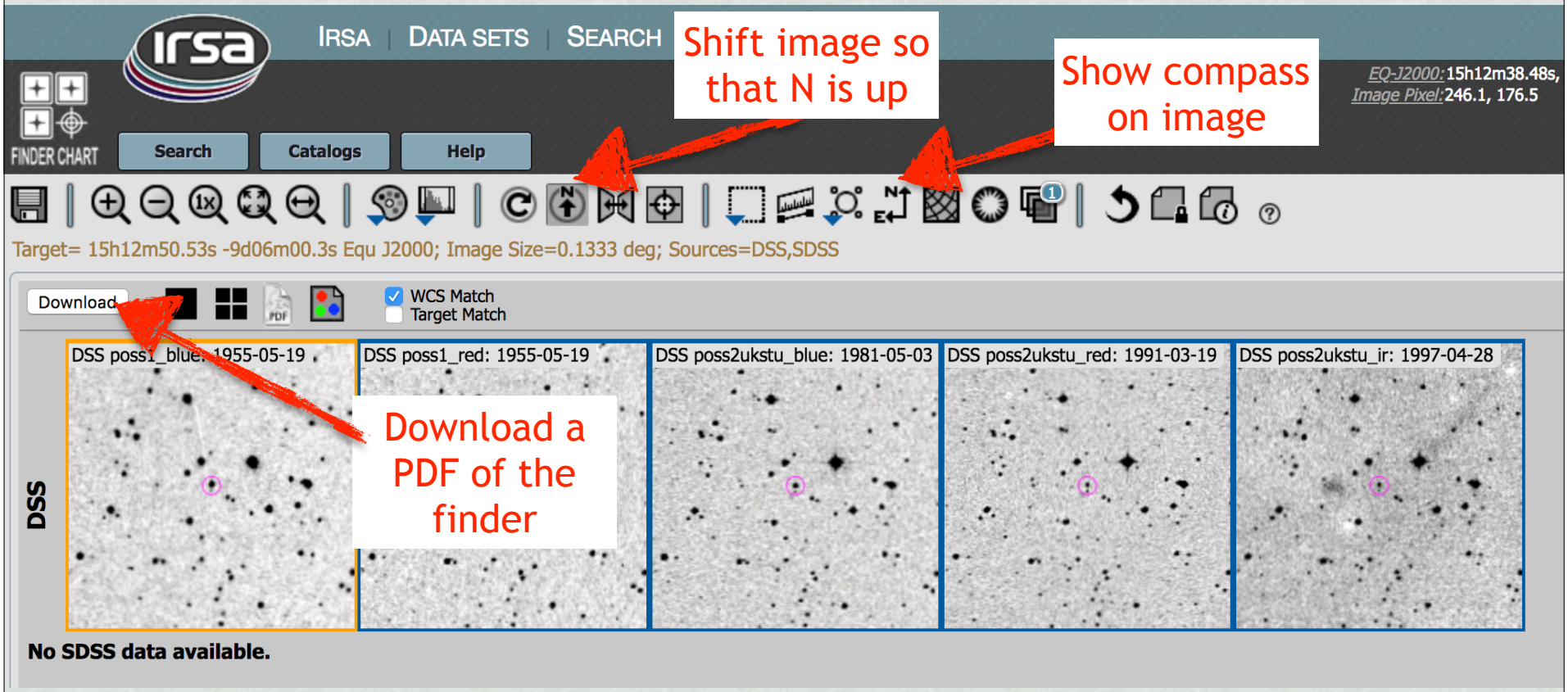
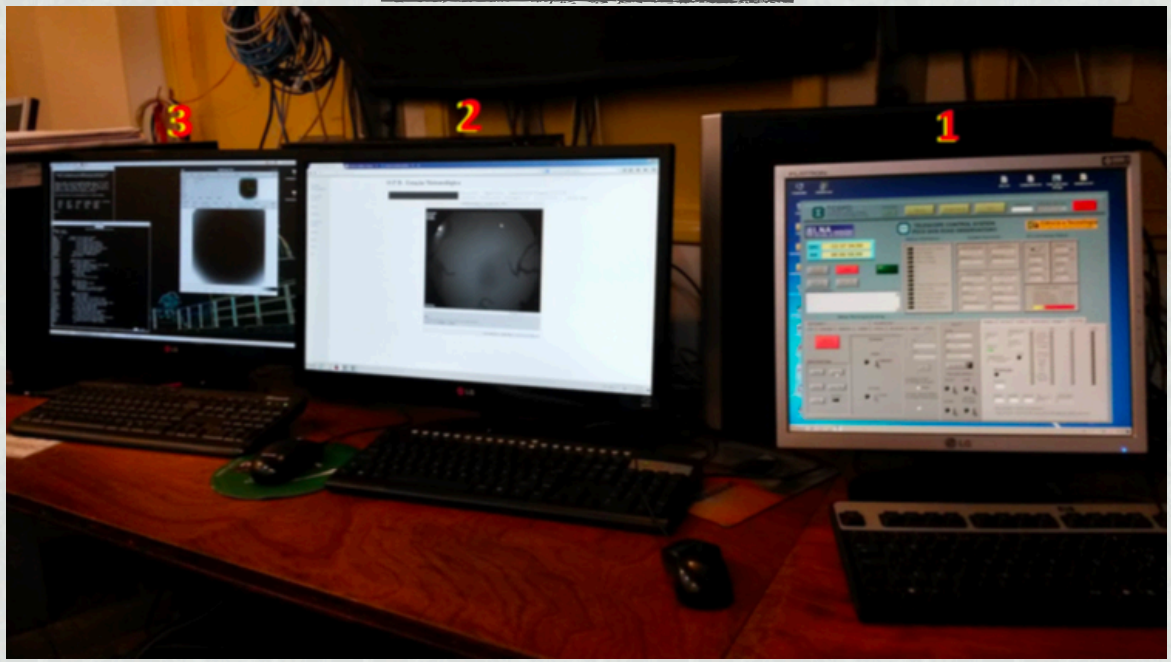


Remote Observing

- We will be virtually connected to the 3 main computers necessary for observing at OPD:
  - *#1:* TCSP software
    - **T**elescope **C**ontrol **S**ystem **P**ico dos Dias Observatory
    - Controls telescope
  - #2: OPDAcquisition
    - Setup for upcoming image
  - *#3:* real-time data manipulation with IRAF, ds9

Groups 7, 8, 9



Remote Observing – before the night starts I.

Prior to observing:

- Create the night's directory where data will be written to
- **Load object list** and make sure that it is properly read
  - *Hint:* download one of the catalogs already present (e.g., BSC) and edit it – this way you make sure to get the format correctly!
  - Double-check that coordinates are correct!
- **Create a log file** – an excel sheet is a good option!
  - You will write up what each produced file is about, in real time!
  - Very valuable as header information is prone to (sleepy-)human-made errors!
  - Define who is responsible for it!

* Observatory guidelines make some recommendations in terms of # of frames (to get a representative "master" after median-combining the individual frames):

http://www.lna.br/opd/instrum/camara/camara.html

Remote Observing – before the night starts I.

Prior to observing:

- ~~Create the night's directory where data will be written to~~ (DONE!)
- ~~**Load object list** and make sure that it is properly read~~ (DONE!)
  - ~~*Hint:* download one of the catalogs already present (e.g., BSC) and edit it – this way you make sure to get the format correctly!~~
  - Double-check that coordinates are correct! **Groups 5**
- ~~**Create a log file** – an excel sheet is a good option!~~ (DONE!)
  - You will write up what each produced file is about, in real time!
  - Very valuable as header information is prone to (sleepy-)human-made errors!
  - Define who is responsible for it! **Groups 6**

Remote Observing – before the night starts II.

<u>Prior to observing:</u> Calibration images

Groups 7, 8, 9

- Bias (25 frames)*
  - Always execute one, check the counts (make sure it's all good) and only then execute the rest
    - Check counts on computer #3 (real-time data manipulation with IRAF, ds9)
    - Avoid saturation, stay under 60% saturation (~65K counts)
  - Make an entry on your logsheet
- Flats (15 frames per filter)*:
  - B-band (~5s) w. medium lamp
  - I-band (~5s) w. weak lamp
- darks (11 frames per exposure time)
  - Will likely need for: 5s, 300s

* Observatory guidelines make some recommendations in terms of # of frames (to get a representative "master" after median-combining the individual frames):

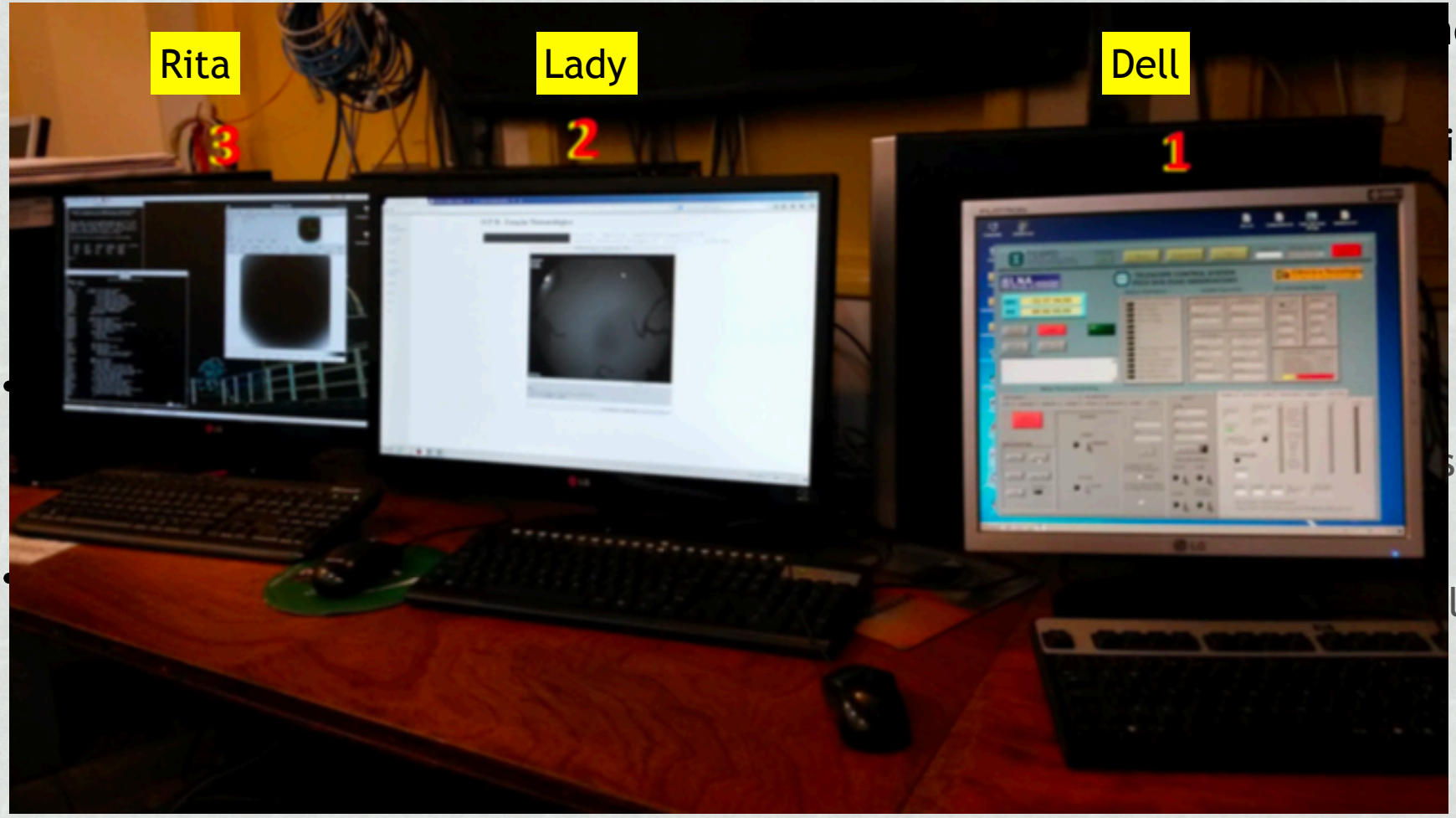
http://www.lna.br/opd/instrum/camara/camara.html

Remote Observing – before the night starts II.

<u>Prior to observing:</u> Calibration images

- Bias (25 frames)*

Groups 7, 8, 9



Remote Observing – once the night starts

Groups 8, 9, 7

- **Global pointing**
  - Choose a bright star, place it at the center of the detector
  - This sets the global pointing for the night.

Remote Observing – once the night starts

Groups 9, 7, 8

- Global pointing
- **Point telescope to 1st science target**
    - To do this: choose object in target list, precess!
    - Move telescope
  - Short exposure (~30s) to recognise field
  - Field recognition (use your finder chart!)
  - Offset to place science target close to center
    - +ve offsets towards East & North
    - Remember: you move the telescope, not the sky!

Remote Observing – once the night starts

- Global pointing
- Point telescope to 1st science target
- **Start exposing on target**
  - 300s/exposure
    - Check counts, verify that we are not saturating on science target, nor on (many) nearby stars
      - We need field stars for additional flux calibration!
  - Go through filters of interest (B, I)
  - Dither!
  - Repeat sequence

Dither Pattern

	ΔRA	ΔDec
pos1*	0	0
pos2	+5"	+10"
pos3	-10"	+5"
pos4	-5"	-10”

* default where telescope places target

Remote Observing – once the night starts

- Global pointing
- Point telescope to 1st science target
- Start exposing on target
  - 300s/exposure
  - Go through filter wheel (B, I)
  - Dither
  - Repeat!
- **Standard star**
    - Choose according to magnitude, airmass (to approximately match that of your science target)
    - ~2 short exposures
        - Verify that the star has not saturated
- 2nd science target… and so on, always sticking a standard star in between to play it safe!

IRAF & ds9 – the very basics

- Here in Socorro:
  - Open a terminal and go to /home/isya/IRAF
  - Open ds9 from the terminal (i.e., type “ds9 &”)
  - On the terminal’s command line, type “ecl”
    - You’re in the IRAF environment!
      - Note: Little hiccup: we’ll have to open images directly using the pull-down menus from ds9
- Once on IRAF, common routines you’ll use (also on remote computer!)
  - *imstat* <file>
    - Get basic statistic on the image/region
  - *display* <file> <frame>
  - *imexamine* <file>
    - e.g., quickly check radial/surface profiles (<r>, <s>) of sources
  - *imarith* <file1> <file2> <operation> <output_file>
  - *imcombine*

<u>Note:</u> for help in any iraf routine, type “help <routine>” on iraf command line

IRAF & ds9 – the very basics

- To use IRAF routines:
  - directly on *iraf* command line by inputing the routine name and main input parameters
  - Explicitly open the parameter list by typing “epar <routine>” on the *iraf* command line.