



# LineA: towards a Brazilian e-Astronomy Center

**Ricardo Ogando**

Observatório Nacional - ON - MCTIC

Laboratório Interinstitucional de e-Astronomia – LineA - MCTIC

On behalf of LineA

<http://www.linea.gov.br/>

# LineA Background

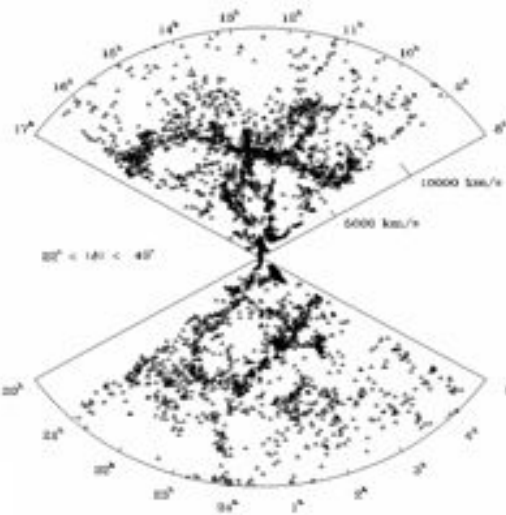


## Instrument Development

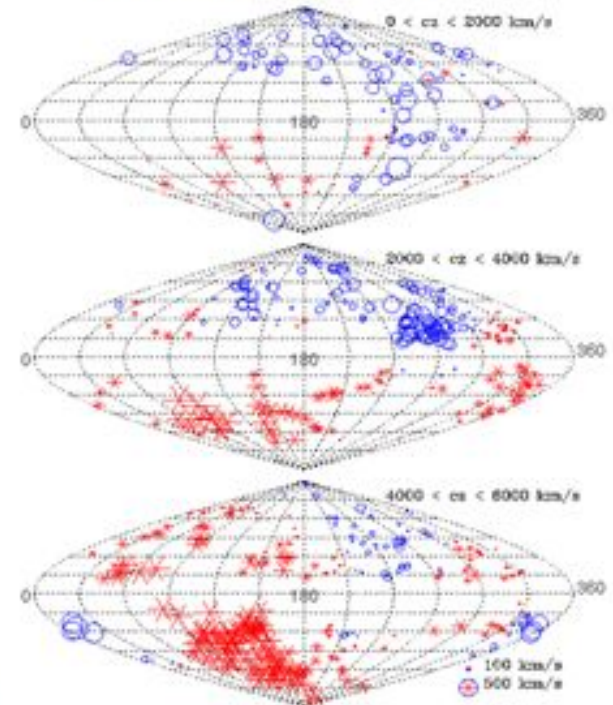
### Reticon



### SSRS 1980-1994



### ENEAR 1989-2001



## PDS: microdensitometer



## Software development



THE OBSERVATÓRIO NACIONAL IMAGE PROCESSING SYSTEM

L.N. da Costa, R.R. de Carvalho, P.S. Pellegrini, R. Chan,  
P. Scheid, C.Rite, M.A. Nunes and D.Nascimento

Department of Astronomy, CNPq-Observatório Nacional  
Brasil

### 1997-2005



# LineA Timeline

2006 - FAPERJ/ON agreement – first funding

2006 - FINEP Grant



2007 - DES-Brazil creation

2007 - DES MoU: US\$ 300k + US\$ 700k software = 10 Staff

2008 - SDSS-III call to Brazilian community and Brazilian Participation Group (BPG) creation

2008 - SDSS-III MoU: US\$ 950k + CasJobs mirror = 17 Staff/PostDocs

**2011 - LineA creation**

*2012 - DES Science Verification*

2014 – LineA renewal triggering

2014 – SDSS-IV agreement



2015 – LSST agreement

2015 – DESI agreement

2015 – LineA review under way.

# Mission

1. Provide logistical and financial support to researchers participating in large international projects
2. Implement and maintain an Astronomical Data Center
3. Develop and maintain a scientific portal for data validation and analysis
4. Help foster education of young researchers in Big Data
5. Contribute to public outreach



unesp

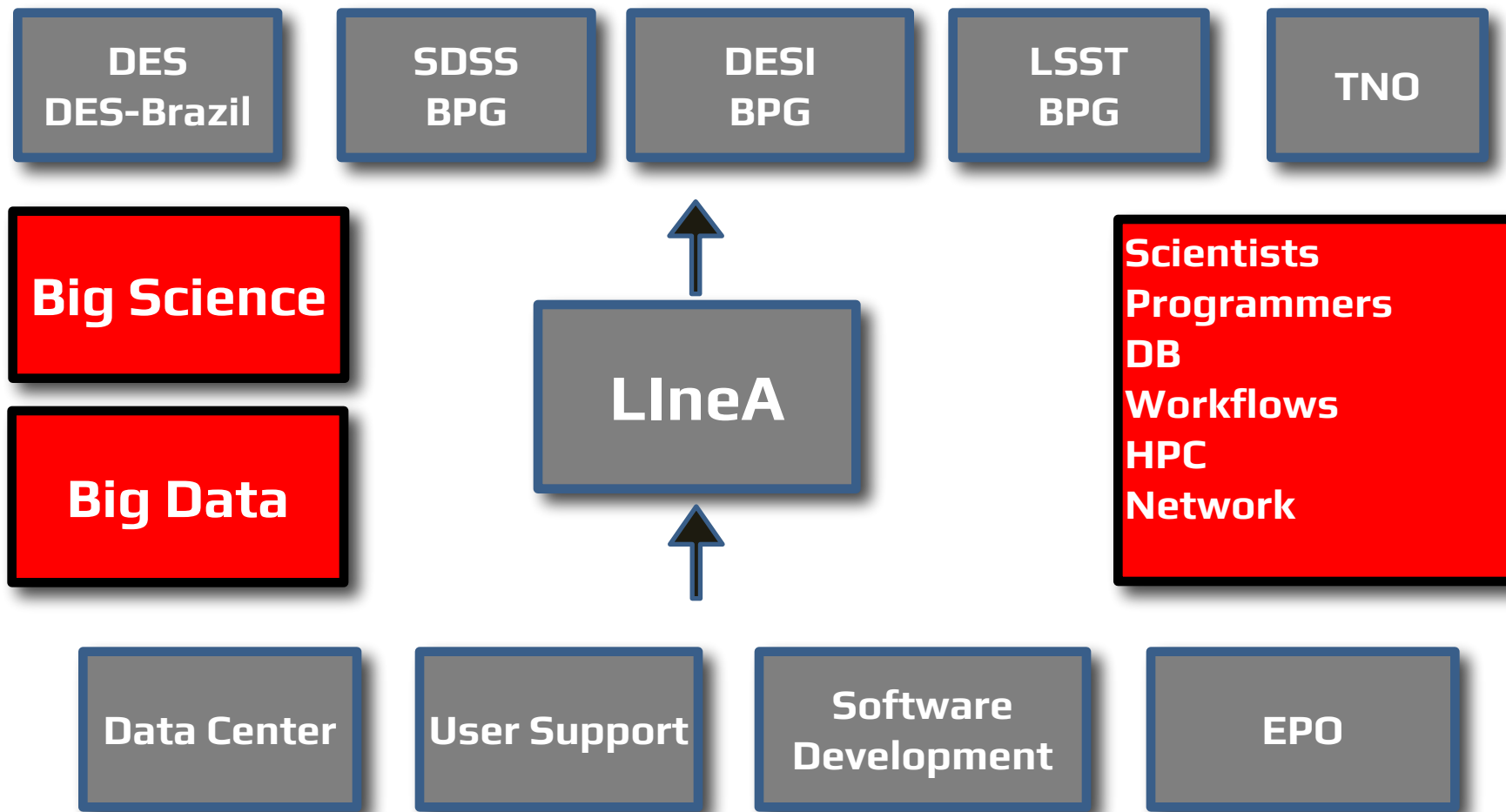
USP



UFRGS

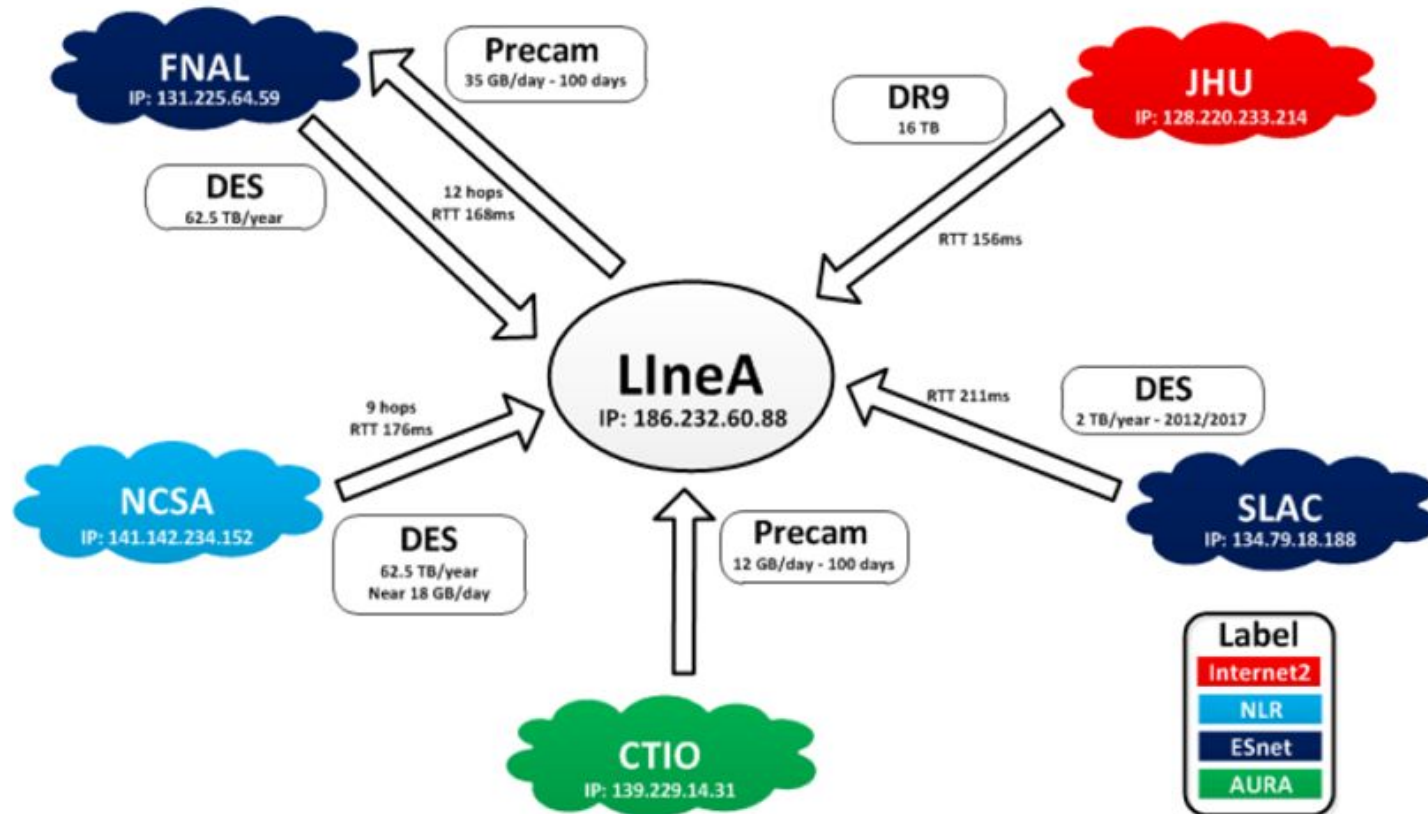


Observatoire  
de la CÔTE d'AZUR





## Data Transfer



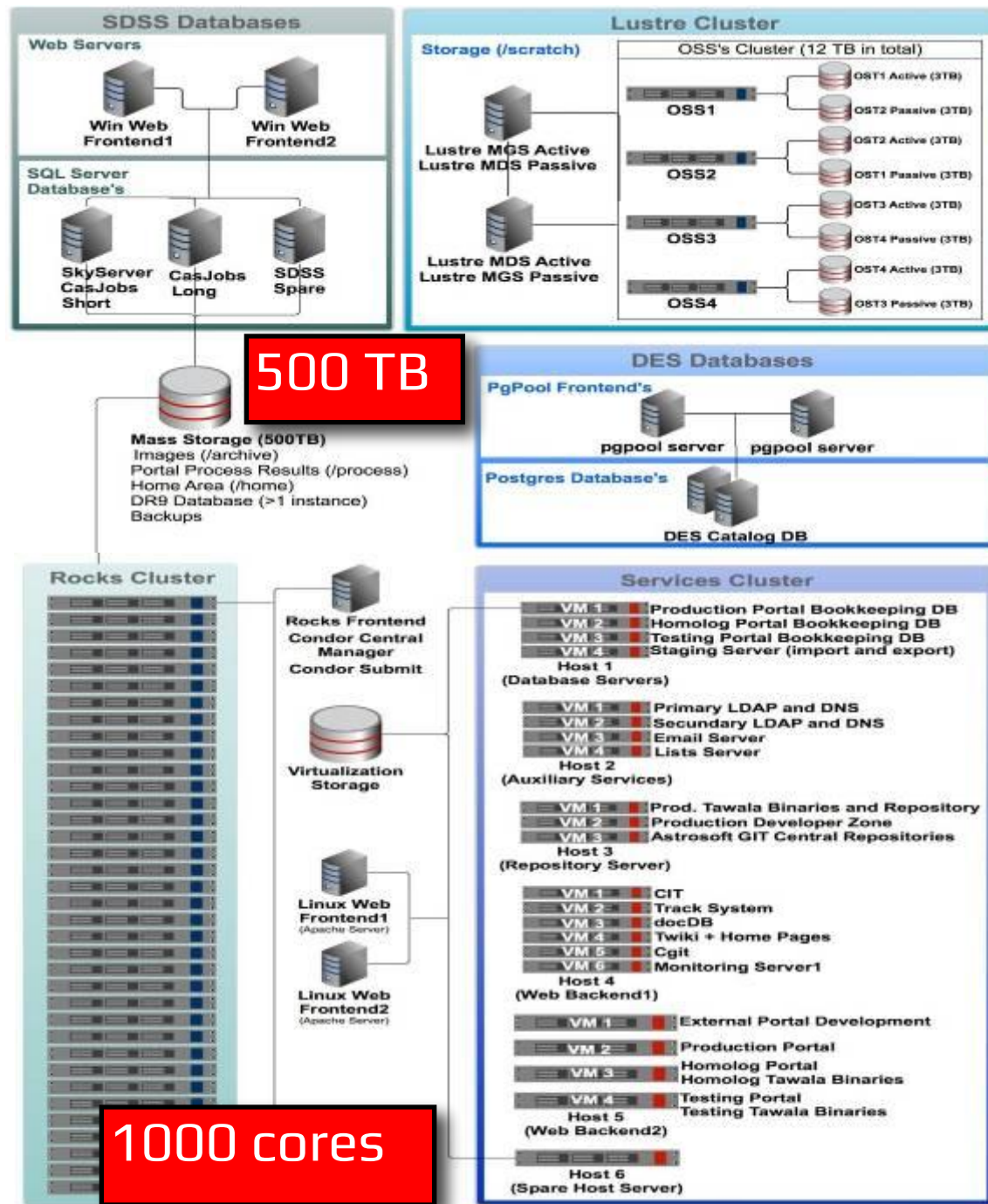
# Processing

1. SDSS Database (MS SQL)
2. Lustre (filesystem)
3. DES Database (Postgres)
4. Mass storage (500TB+new 160TB)
5. Processing Cluster (1000 cores)
6. Service Cluster (VMs)
  - Code development
  - git repository
7. High performance Network
  - Science DMZ
  - Data Transfer System (DTS)
  - Firewall

PoP ⇒ LNCC



Laboratório  
Nacional de  
Computação  
Científica



# Services



# SDSS-III/IV mirror



## SLOAN DIGITAL SKY SURVEY III

# SkyServer **DR13 LineA Mirror**



[Home](#) | [Data](#) | [Schema](#) | [Education](#) | [Astronomy](#) | [SDSS](#) | [Contact Us](#) | [Download](#) | [Site Search](#) | [Help](#)

Welcome to the **DR13 LineA Mirror site!!!**

This website presents data from the Sloan Digital Sky Survey, a project to make a map of a large part of the universe. We would like to show you the beauty of the universe, and share with you our excitement as we build the largest map in the history of the world.

### News

The site hosts data from **Data Release 13 (DR13)**. What's new in **DR13**, what's new on this site and known problems. [More...](#)

SDSS-III is supported by



Powered by **Microsoft**

[Site Traffic](#)  
[Privacy Policy](#)

### Data Access

Navigate

[Quick Look](#) | [Explore](#)

[Finding Chart](#)

[Image List](#)

[Search](#)

[IQS](#) | [SQS](#) | [IRSQS](#)

[SQL Search](#)

[Cross-ID](#)

[CasJobs](#)

### Education

For Educators

[Lesson Plans](#)

[Middle School](#)

[High School](#)

[College Lab Activities](#)

[Instructor Guides](#)

[Student/Public Research](#)

[Galaxy Zoo](#)

[Zooniverse](#)

[Voyages](#)

### Links

[sdss3.org](#)

[Data Release 13](#)

[SDSS-III Science](#)

[Science Archive Server](#)

[About Astronomy](#)

[About the SDSS](#)

[About SkyServer](#)

[VAO](#)

[Credits](#)

### Help

[Start Here](#) | [FAQ](#)

[Glossary](#)

[Tool User Guides](#)

[Cooking with Sloan](#)

[SQL Tutorial](#)

[About the Database](#)

[Schema Browser](#)

[Sample SQL Queries](#)

[Data Release Papers](#)



The coordinates for boundaries of the different regions

| name   | type | epoch | size       | description |
|--------|------|-------|------------|-------------|
| data13 | DR13 | 0     | 1000000000 | DR13 data   |
| data12 | DR12 | 0     | 1000000000 | DR12 data   |
| data11 | DR11 | 0     | 1000000000 | DR11 data   |
| data10 | DR10 | 0     | 1000000000 | DR10 data   |
| data9  | DR9  | 0     | 1000000000 | DR9 data    |
| data8  | DR8  | 0     | 1000000000 | DR8 data    |
| data7  | DR7  | 0     | 1000000000 | DR7 data    |
| data6  | DR6  | 0     | 1000000000 | DR6 data    |
| data5  | DR5  | 0     | 1000000000 | DR5 data    |
| data4  | DR4  | 0     | 1000000000 | DR4 data    |
| data3  | DR3  | 0     | 1000000000 | DR3 data    |
| data2  | DR2  | 0     | 1000000000 | DR2 data    |
| data1  | DR1  | 0     | 1000000000 | DR1 data    |

### Contact Us



DR13

[Home](#) | [Help](#) | [Tutorial](#) | [Chart](#) | [List](#) | [Explore](#) |

### Parameters

|      |           |                                        |
|------|-----------|----------------------------------------|
| name | M101      | <input type="button" value="Resolve"/> |
| ra   | 210.80227 | deg                                    |
| dec  | 54.34895  | deg                                    |
| opt  | GL        |                                        |



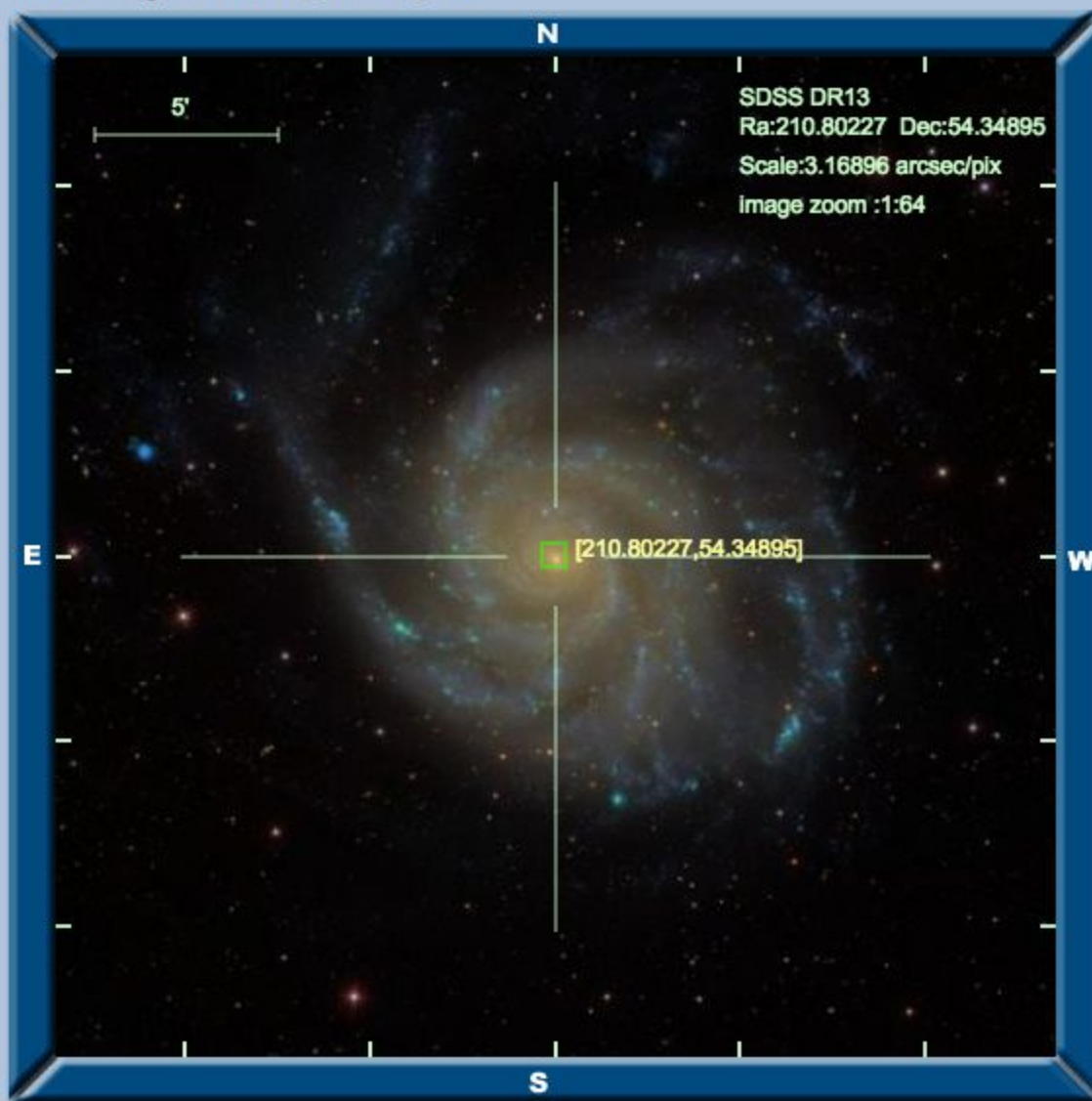
### Drawing options

- ☒ Grid
- ☒ Label
- ☐ Photometric objects
- ☐ Objects with spectra
- ☐ Invert Image

### Advanced options

- ☐ APOGEE Spectra
- ☐ SDSS Outlines
- ☐ SDSS Bounding Boxes
- ☐ SDSS Fields
- ☐ SDSS Masks
- ☐ SDSS Plates

Select Image Source : ☒ SDSS ☐ 2MASS



Click, hold and drag to navigate!!

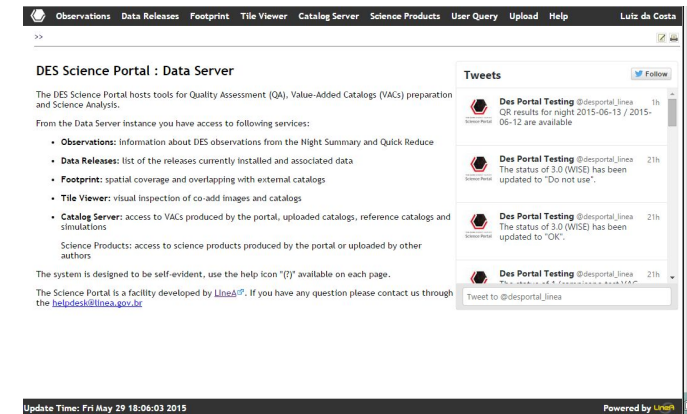
# Sites



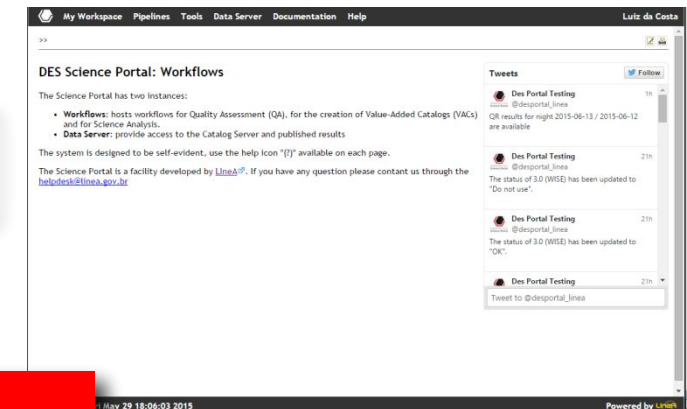
## Real-time System



## Data Mining



## Science Analysis



Over 720 FTE-months of development



# Quick Reduce "Real-time" quality control of DECam images

Angelo Fausti and Luiz da Costa  
CTIO Blanco Control Room



## Observing History

From: 2013-12-05 To: 2013-12-05 Submit

Refresh: ☒

Download data

1 night(s) found.

PSF

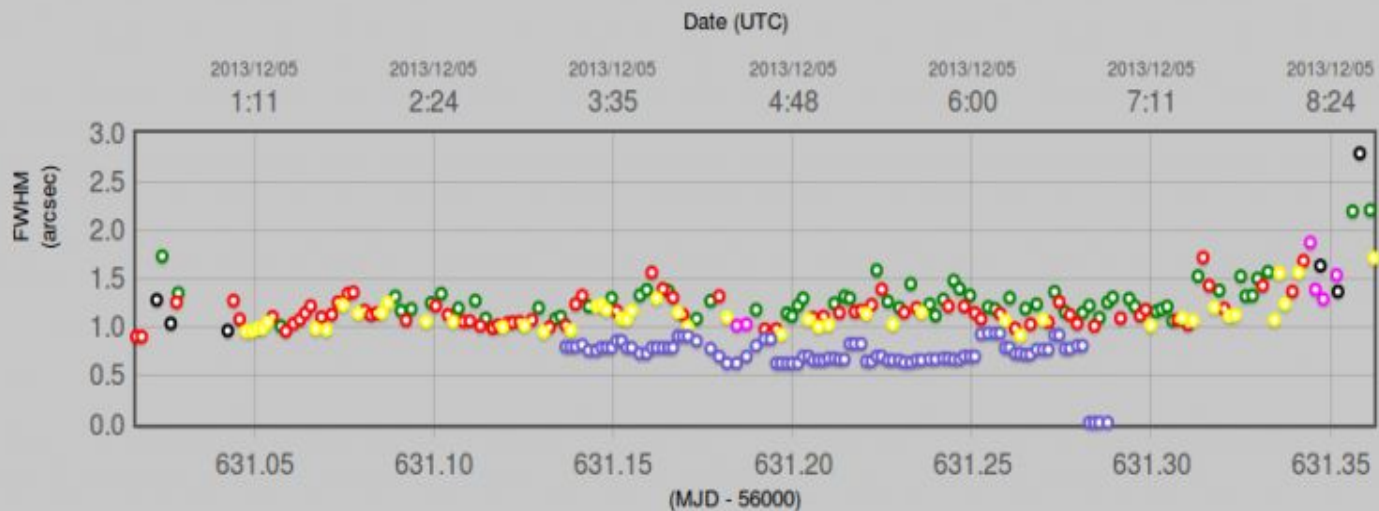
Sky Background

Number Counts

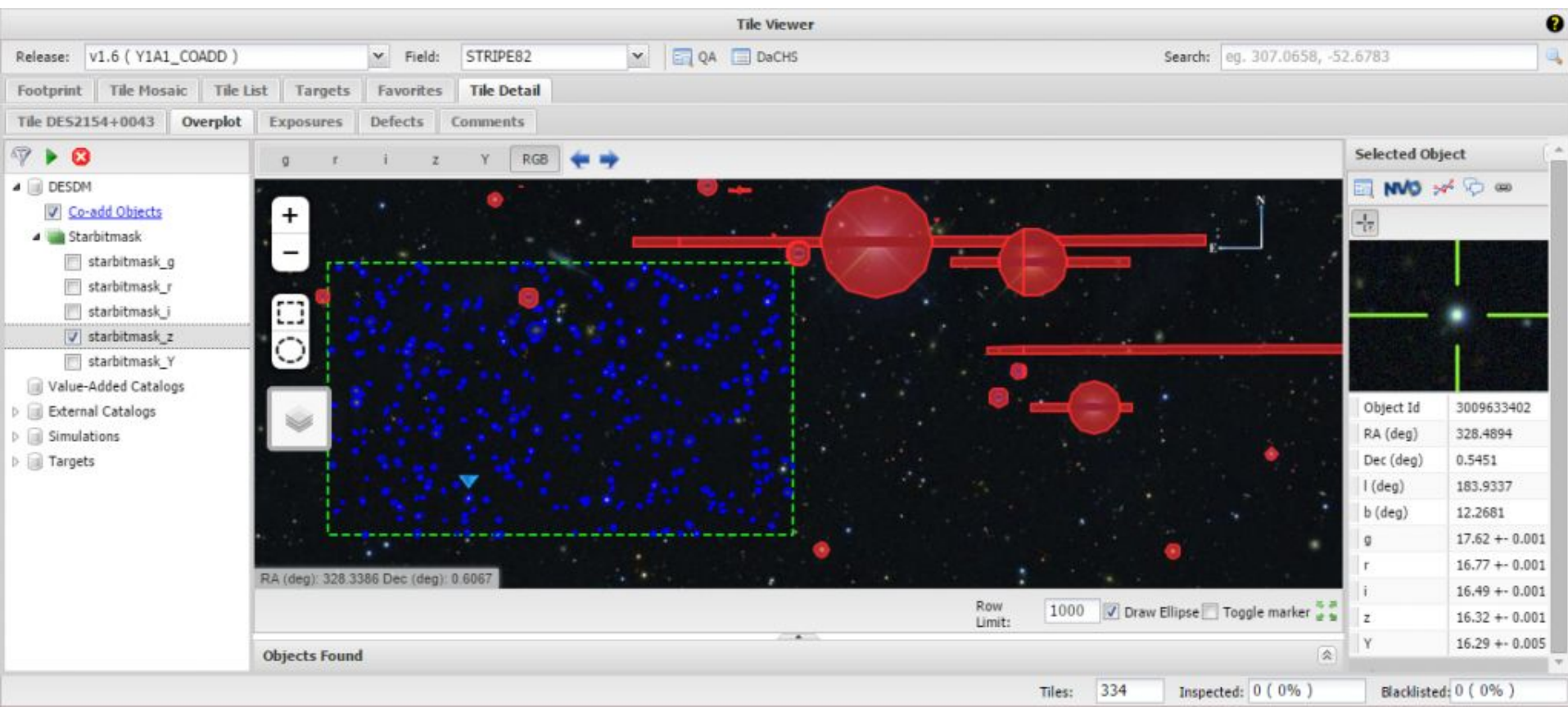
Footprint

Statistics

Tip: click on the data points to open the corresponding QR process.



Data Server  
(see Angelo Fausti's talk tomorrow)  
Monitor survey coverage  
Coadded images quality  
View targets





# Services in Numbers

|                               |        |
|-------------------------------|--------|
| LIneA Users                   | 108    |
| Fermilab: Portal Users        | 182    |
| Fermilab: Portal access/month | 160    |
| LIneA Twiki users             | 219    |
| Services                      | 18     |
| Packages (EUPS)               | 214    |
| Codes in repository           | 690    |
| Documents                     | 523    |
| Helpdesk tickets              | 6.300  |
| LIneA site page hits          | 58.000 |

1. LIneA Data Center
2. CTIO Science Portal (QR)
3. Fermilab/NCSA Science Portal (DS)
4. LIneA Science Portal
5. Webmail
6. Mailing lists
7. GoToMeeting
8. Smartsheet
9. Mailchimp
10. Slack
11. TWiki
12. GIT repository
13. Trello
14. Helpdesk (trac)

# Science

# Projects supported by LIneA



## Dark Energy Spectroscopic Instrument

O Dark Energy Spectroscopic Instrument (DESI) é um levantamento dedicado a observações espectroscópicas de milhões de objetos para o estudo da energia escura. As observações serão feitas durante cinco anos a partir de maio de 2019 no telescópio de 4m do Kitt Peak National Observatory (ver Figura 1) e devem iniciar em 2019....



## Dark Energy Survey

O levantamento Dark Energy Survey (DES) tem por objetivo estudar a natureza da energia escura, descoberta recentemente, que representa da ordem de 70% do conteúdo do Universo, sendo esta responsável pela aceleração de sua expansão. O projeto procura determinar a abundância da energia escura.



## Large Synoptic Survey Telescope

O Large Synoptic Survey telescope (LSST) é um telescópio sendo construído em Cerro Pachón no Chile. Entrar em operação no início da próxima década, o LSST irá mapear em seis bandas, quase a metade do céu visível. O telescópio com um diâmetro de 8,4 metros...



## Sloan Digital Sky Survey - III

O projeto Sloan Digital Sky Survey - III (SDSS-III) é uma colaboração internacional, que produziu vários levantamentos espectroscópicos de extensas regiões do céu, criando amostras estatísticas sem precedentes para a física de partículas. As observações se encerraram em 2014, mas análises científicas ainda continuam sendo feitas.



## Sloan Digital Sky Survey - IV

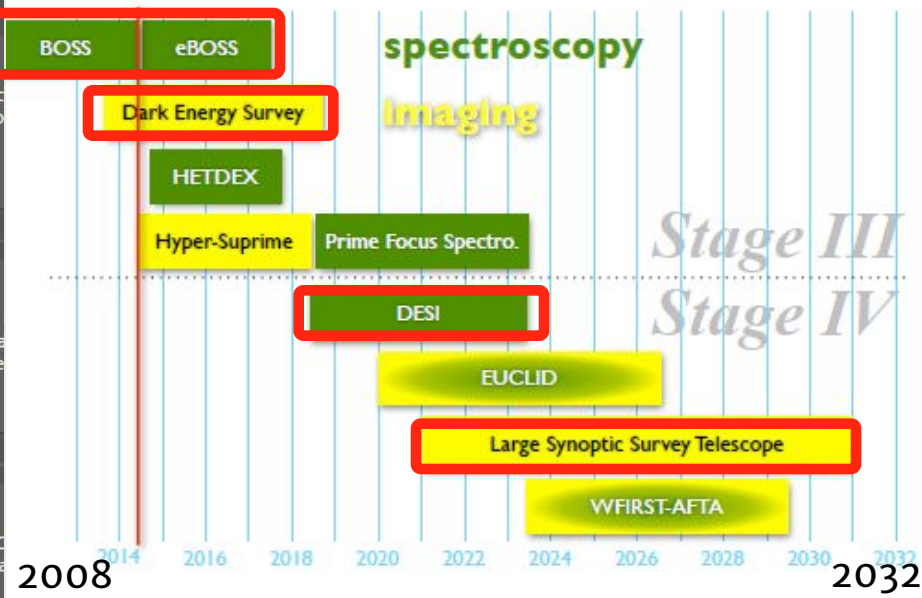
O projeto Sloan Digital Sky Survey - IV (SDSS-IV) é continuação do trabalho feito no SDSS-III. Em paralelo com os levantamentos (eBOSS e APOGEE-2) são extensões naturais de levantamentos realizados no SDSS-III, ainda, um novo levantamento (MaNGA) de 10.000 galáxias próximas utilizando pacotes de fibra óptica.



## Transneptunian Occultation Network

Objetos transnetunianos (TNOs) constituem uma população de pequenos corpos planetários situados além de Netuno, ou seja, estão afastados do Sol mais de 30 vezes a distância que separa a Terra do Sol (cerca de 40 bilhões de quilômetros). Isto faz com que tais objetos tenham sofrido poucas alterações...

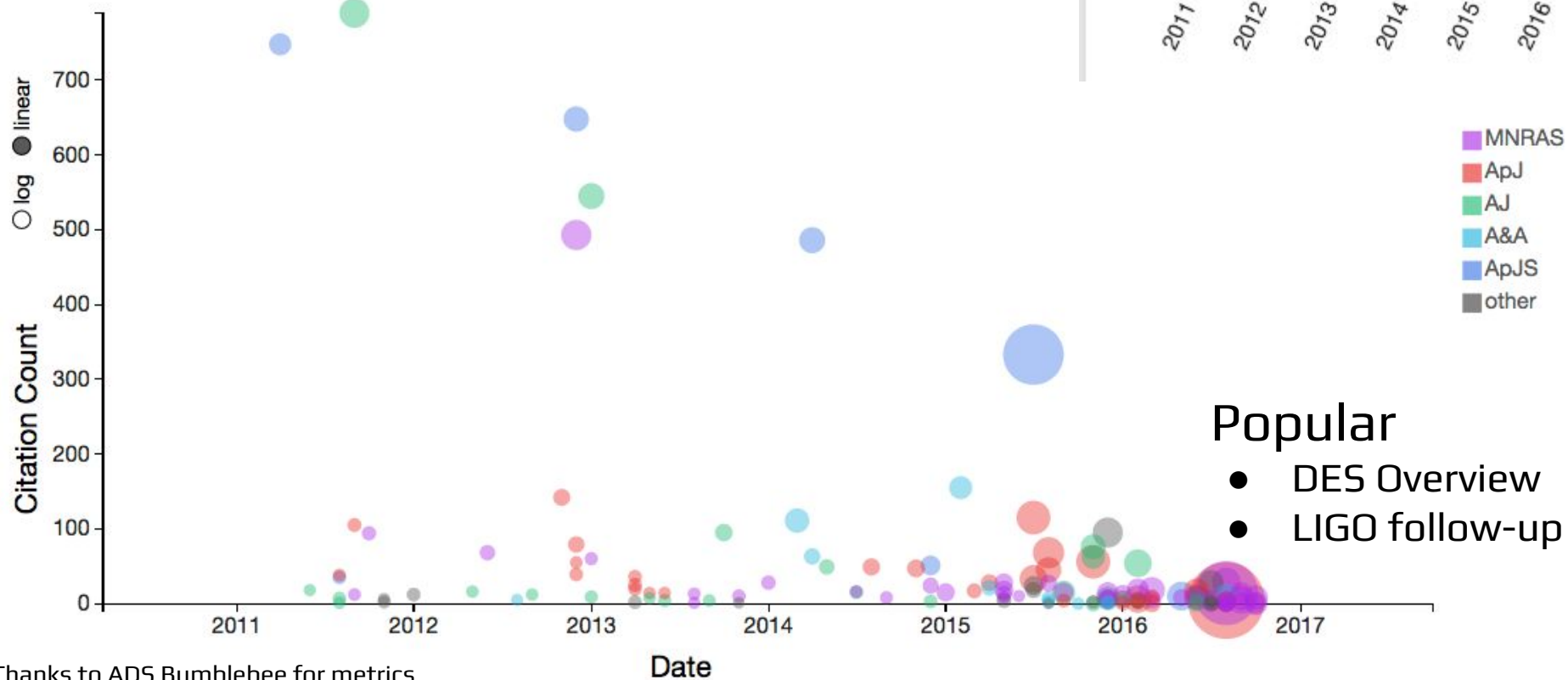
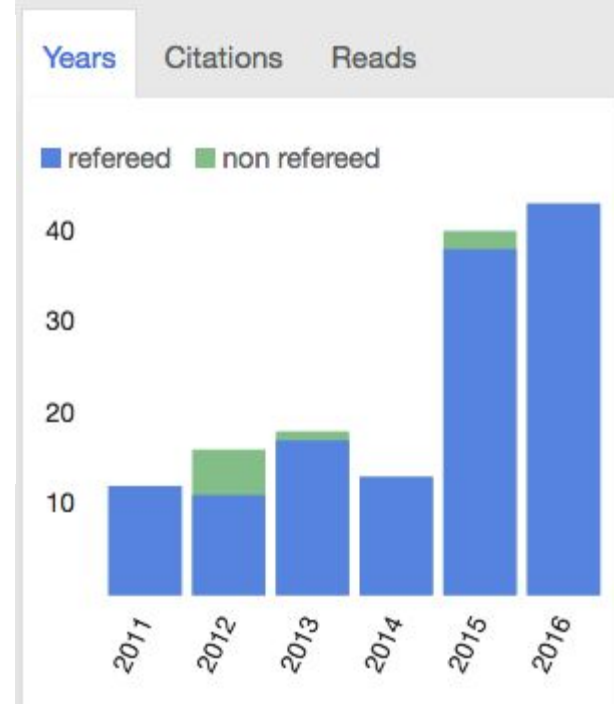
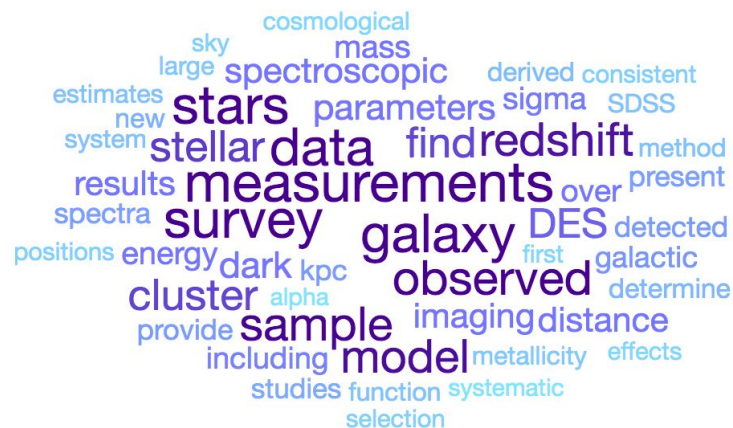
# The dark energy facilities roadmap



- NSF and DOE support
- LBL, SLAC, Fermilab, NCSA, and NOAO participation
- International collaborations
- Dedicated telescope time
- Investment in installments
- Low risk. Excellent cost-benefit
- Several by-products: SS, MW, GE...
- Big Data

15 countries: Germany, Australia, Brazil, Canada, Chile, China, Korea, USA, Spain, France, England, Italy, Japan, Mexico, and Switzerland.

September 2016  
134 papers  
6,932 citations  
H-index = 34



## Popular

- DES Overview
- LIGO follow-up

Thanks to ADS Bumblebee for metrics



# Large Synoptic Survey Telescope (LSST)



## Facts:

- 20,000 square degrees
- 6 filters
- 10 years
- 5 -10 million alerts/night
- 15 TB/night
- Objects = 37 billion
- Sources = 7 trillion (single epoch)
- Images collected = 5.5 million

## MEMORANDUM OF AGREEMENT

Regarding collaboration in the scientific exploitation of data acquired with the Large Synoptic Survey Telescope (LSST) by specified Principal Investigators (PI) and scientists in Brazil as per contributions to the LSST fiber optic networks connecting South America and North America during LSST survey operations,

BETWEEN

**LABORATORIO INTERINSTITUCIONAL DE E-ASTRONOMIA**  
hereinafter referred to as “**LineA**”

AND

**LABORATORIO NACIONAL DE ASTROFISICA**  
hereinafter referred to as “**LNA**”

AND

**REDE NACIONAL DE ENSINO E PESQUISA**  
hereinafter referred to as “**RNP**”

AND

**ACADEMIC NETWORK AT SAO PAULO**  
hereinafter referred to as “**ANSP**”,

AND

**AMERICAS PATHWAYS**  
hereinafter referred to as “**AMPATH**”,

AND

**THE LARGE SYNOPTIC SURVEY TELESCOPE CORPORATION,**  
a United States 501(c)3 non-profit corporation  
incorporated in the State of Arizona  
hereinafter referred to as “**LSSTC**”,

AND

**THE LARGE SYNOPTIC SURVEY TELESCOPE PROJECT OFFICE  
OF THE ASSOCIATION OF UNIVERSITIES FOR RESEARCH IN ASTRONOMY**  
hereinafter referred to as “**LSSTPO**”,

# Building LSST BPG

<http://bpg-lsst.linea.gov.br/>

- Call for LSST BPG Committee
- Call for proposals (Due Oct 1st)
- Room for 10 researchers + 4 post-docs each



[Home](#) [O que é o BPG](#) [Histórico](#) [Participe](#) [Eventos](#) [Q&A](#) [Notícias](#) [Acesso Restrito](#)

## O que é LSST

O Large Synoptic Survey Telescope (LSST) é um telescópio sendo construído em Cerro Pachón no Chile. Previsto para entrar em operação no início da próxima década, o LSST irá mapear em cinco bandas quase metade do céu por um período de 10 anos. Embora originalmente proposto para desvendar a natureza da energia escura, o potencial científico do projeto é enorme como pode ser visto no [LSST Science Book Version 2.0](#)

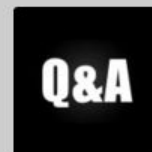


O telescópio possui um diâmetro de 8,4 metros e tem um campo de visada de quase 10 graus quadrados, podendo mapear todo o céu visível em apenas algumas noites. Sua câmera consiste de um mosaico de CCDs com 3.2 bilhões



## Notícias

[+ mais notícias](#)



**LineA/LNA vão organizar sessão de Q&A**

04 de julho de 2016



**SAB convida Chuck Cleaver para reunião da**

# LSST Regional Data Center

| Survey period | Year | Storage (PB) | Processing (TeraFlops) | Processing( # nodes) | Processing (# Cores) | Support servers |
|---------------|------|--------------|------------------------|----------------------|----------------------|-----------------|
|               | 2019 | 618          | 1,5                    | 9                    | 365                  | 1               |
|               | 2020 | 618          | 1,5                    | 9                    | 365                  | 1               |
| 1             | 2021 | 12.735       | 29,0                   | 104                  | 6.543                | 16              |
| 2             | 2022 | 19.180       | 55,4                   | 178                  | 11.888               | 16              |
| 3             | 2023 | 27.286       | 83,2                   | 241                  | 17.326               | 16              |
| 4             | 2024 | 35.518       | 111,9                  | 287                  | 22.372               | 16              |
| 5             | 2025 | 44.075       | 141,6                  | 332                  | 27.300               | 16              |
| 6             | 2026 | 53.006       | 172,1                  | 307                  | 31.965               | 16              |
| 7             | 2027 | 62.332       | 203,4                  | 289                  | 36.200               | 16              |
| 8             | 2028 | 72.076       | 235,2                  | 273                  | 40.193               | 16              |
| 9             | 2029 | 82.189       | 266,9                  | 258                  | 43.993               | 16              |
| 10            | 2030 | 92.691       | 299,0                  | 245                  | 47.172               | 16              |

IT Team of 53 FTEs

# Urgent needs

- Hardware

- 2,000 additional cores (6,000 until 2020)
- 1 PB (5 PB until 2020)
- LNCC infrastructure (e.g. no-breaks)
- Network > 10 Gbps
- DMZ

- People

- Permanently hire key people
- Operator
- 4 Programmers
- Analyst
- Project Manager

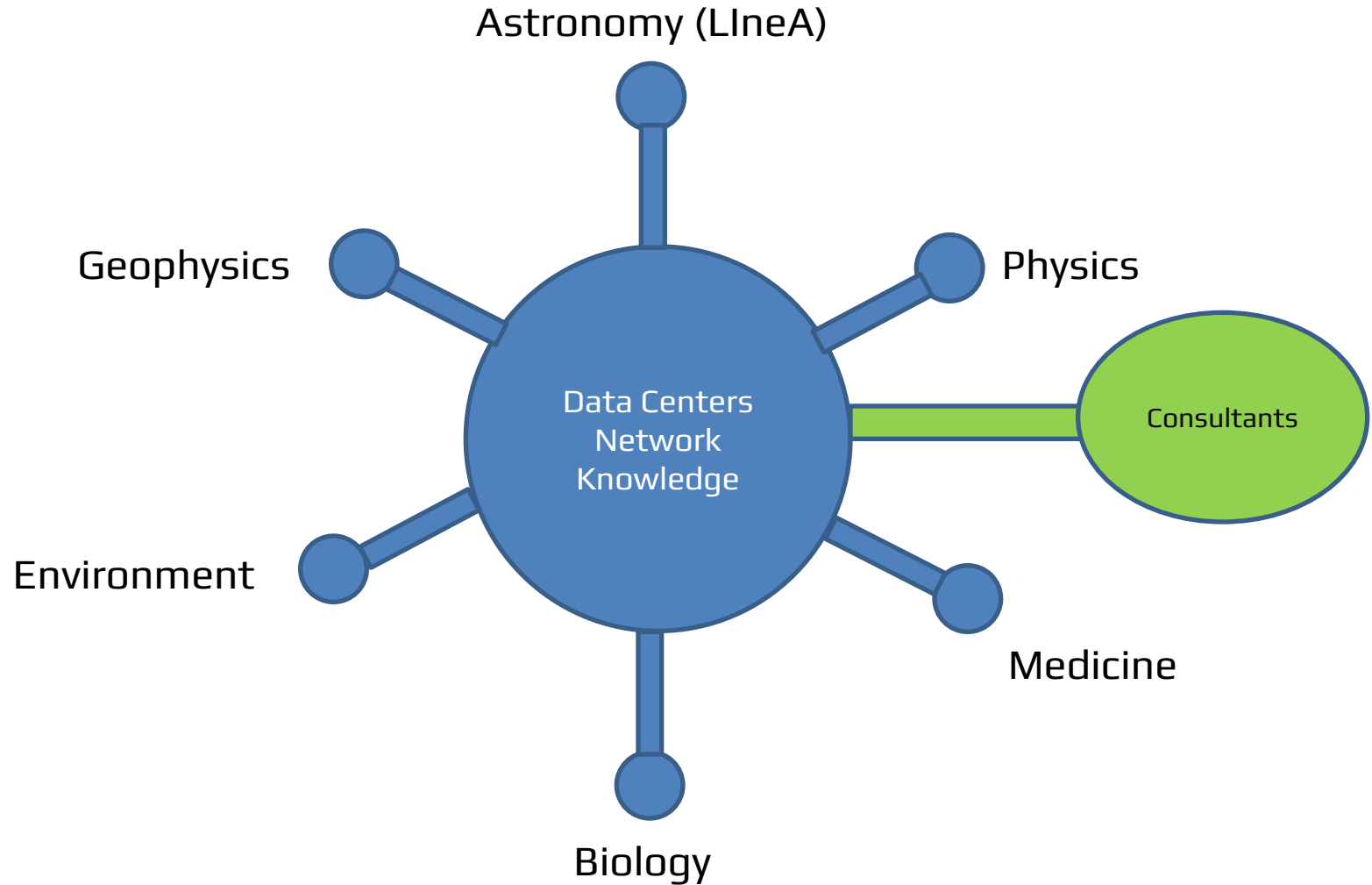


# Next steps

- Management Committee (selection underway)
- Establish rights and duties of participants
- Period 2016-2020
- Data Center creation
- MoU for entire Brazil?

# e-Science Center

Federation of Labs



# Benefits

- 1) Integrated planning
- 2) Coordination
- 3) Shared infrastructure, talents, and knowledge
- 4) Reduce costs
- 5) Optimize human resource allocation
- 6) Keep Knowledge
- 7) Long term data curation
- 8) Organize Big Data meetings
- 9) Support brazilian participation in large projects

# LineA Summary

- Multi-user, multidisciplinary lab, and a research network
- It supports several national and international projects (TNO, DES, SDSS-III, SDSS-IV, DESI, LSST)
- International Data Distribution Center is something new in Brazil (SDSS, DES, e LSST)
- Deploying portals on important US facilities (CTIO, Fermilab, NCSA, KPNO, LBL)
- Technical collaboration with RNP, LNCC, CEFET/RJ, Fermilab, LBL, LSST, NCSA, and SLAC



# Conclusions

- LIneA has a unique role
- It represents a strategy for 20 years of research
- Forming new kind of researcher: data scientist
- Developing and applying tech to deal with Big Data
- High impact science and high quality tech products
- Infrastructure developed over 9 years
- Experience is essential to enable LSST science in Brazil
- An example of an e-Science Center for Astronomy
- Commitments up to at least 2022.

# Thanks