Second Workshop on Robotic Autonomous Observatories

Torremolinos, Málaga, Spain, 5 - 10 June 2011

www.iaa.es/astrorob2011
e-mail: astrorob@iaa.es

ESPAÑA 2011 RUSIA
РОССИЯ И ИСПАНИЯ

Summary

A.F.Żarnecki
University of Warsaw

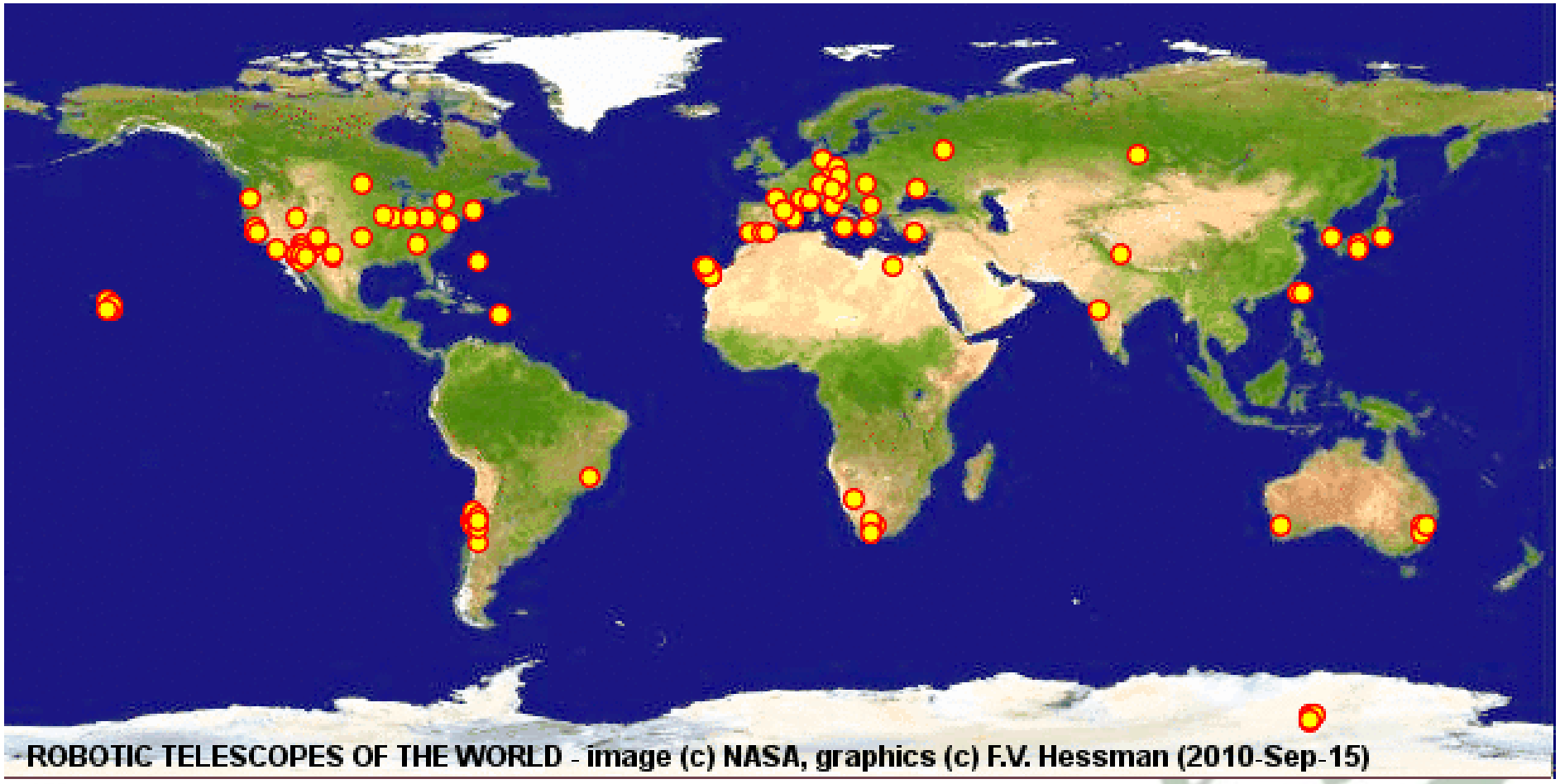
Main Topics

Robotic Astronomy: historical perspective
Existing robotic observatories worldwide
New hardware and software developments
Real-time analysis pipelines
Archiving the data and quality control

SOC

Carl Akerlof (University of Michigan, USA)
Alberto J. Castro-Tirado (IAA-CSIC Granada, Spain; chair)
Lorraine Hanlon (UCD Dublin, Ireland)
René Hudec (ASU AV ČR Ondřejov, Czech Republic)
Alain Klotz (CESR Tolouse, France)
Vladimir Lipunov (Moscow State University, Russia)
Lech Mankiewicz (CFT Warszawa, Poland)
Francisco Manuel Sánchez-Moreno (UPM Madrid, Spain)
Klaus Strassmeier (Astrophysical Institute Potsdam, Germany)
Filippo Zerbi (Oss. Astron. Brera, Italy)

RAO World Map



Apologies for covering only a very small part...

Why do we need robotic telescopes ?

- research

GRB hunting is only ~25%

many more interesting targets

Optical monitoring of FRII-type galaxies

S. Zola, A. Kuźmicz, M. Jamrozy

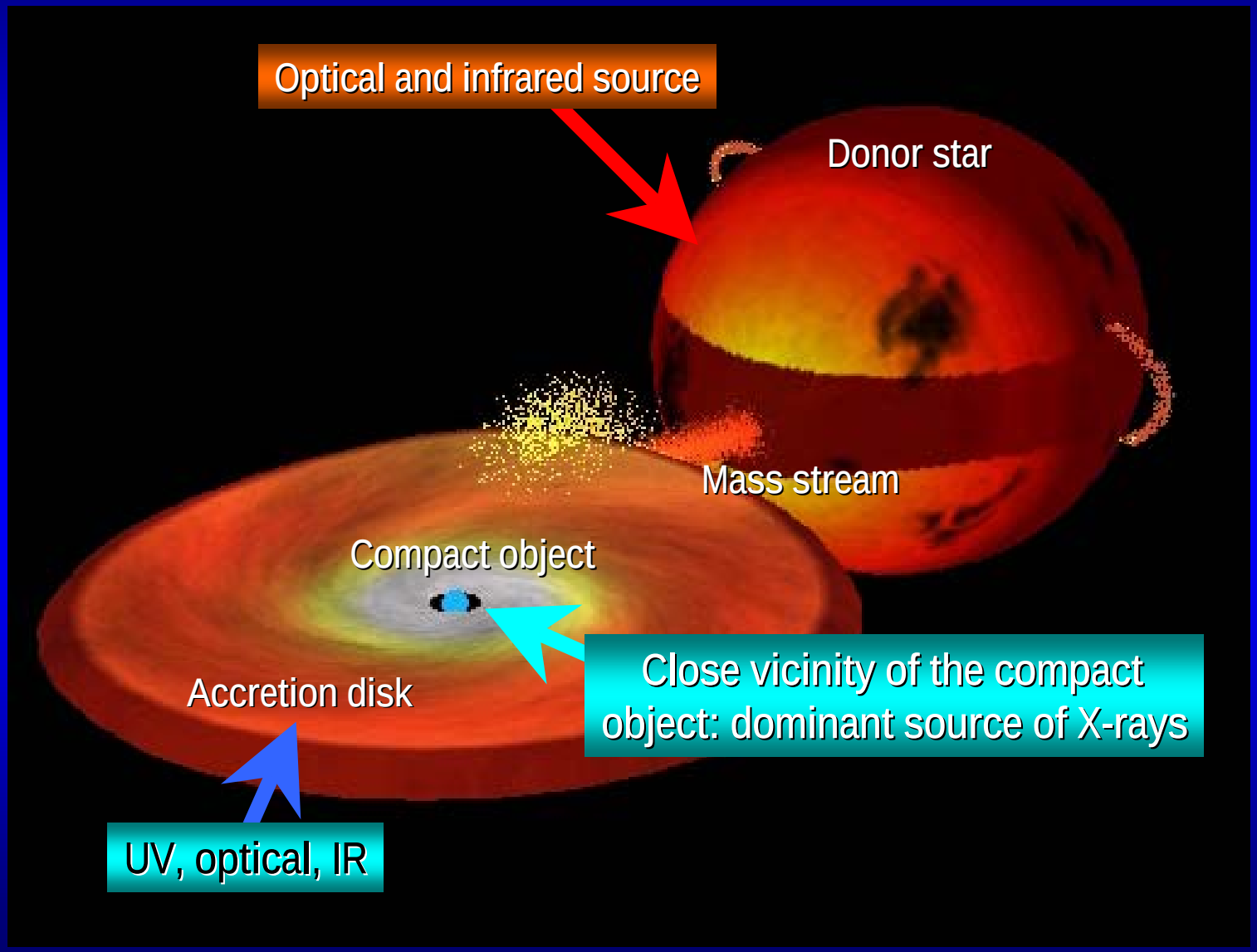
M. Winiarski, M. Dróżdż, T. Szymański, D. Kozieł-Wierzbowska, E. Kuligowska, M. Dróżdż, A. Erdem, M. Siwak, G. Stachowski, M. Kurpińska-Winiarska, D. Jabłeka, W. Ogłoza

OAUJ, SUHORA, COMU

Malaga June 7th, 2011

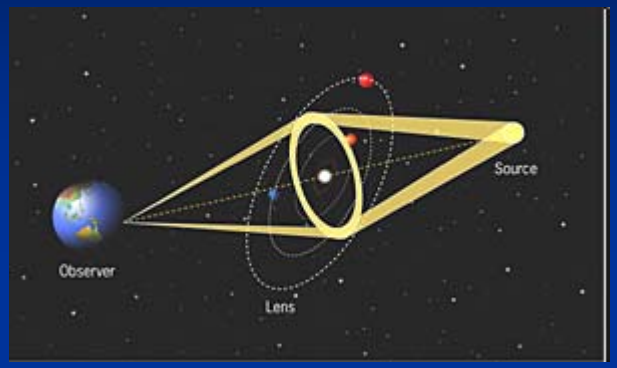
A frame from animation by Cosmovision (led by Dr. Wolfgang Steffen) - (Marscher, A.P., et al., Nature, 2002, 417, 625

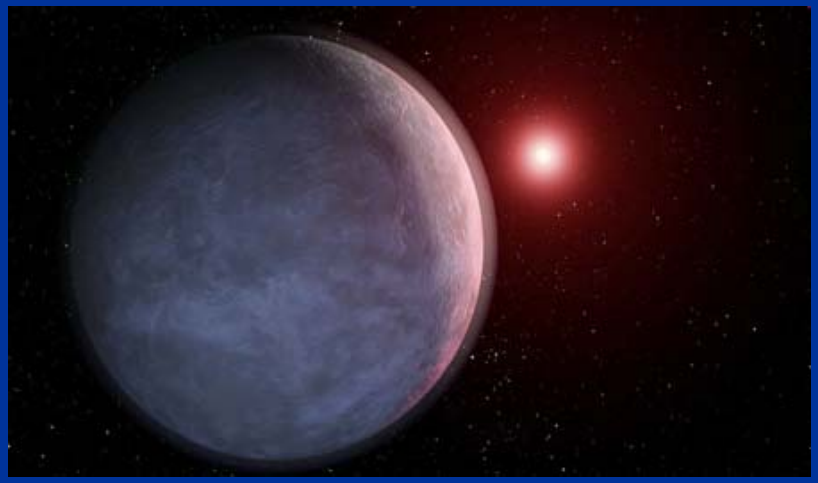
Typical structure of low-mass X-ray binaries (LMXBs) and cataclysmic variables (CVs)



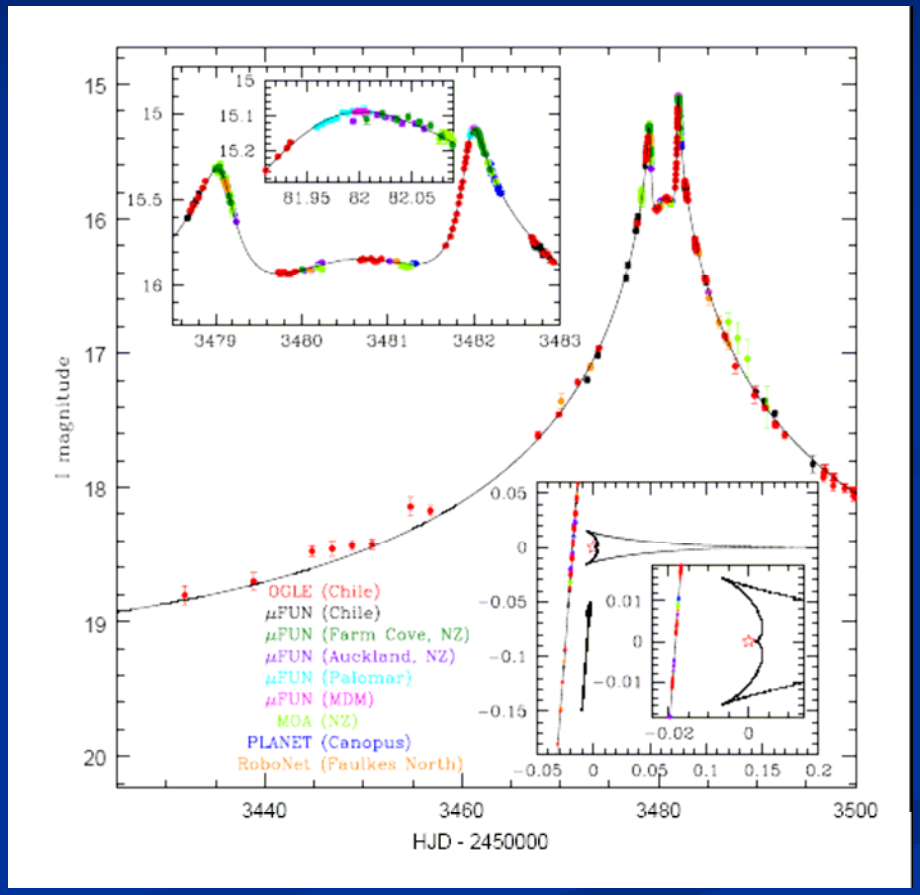
Microlensing Research

Global Network most essential





A 3x Earth mass planet (Bennet et al. 2008)



Jovian mass planet. < 1%
Precision photometry requested.
Udalski et al. (2008)

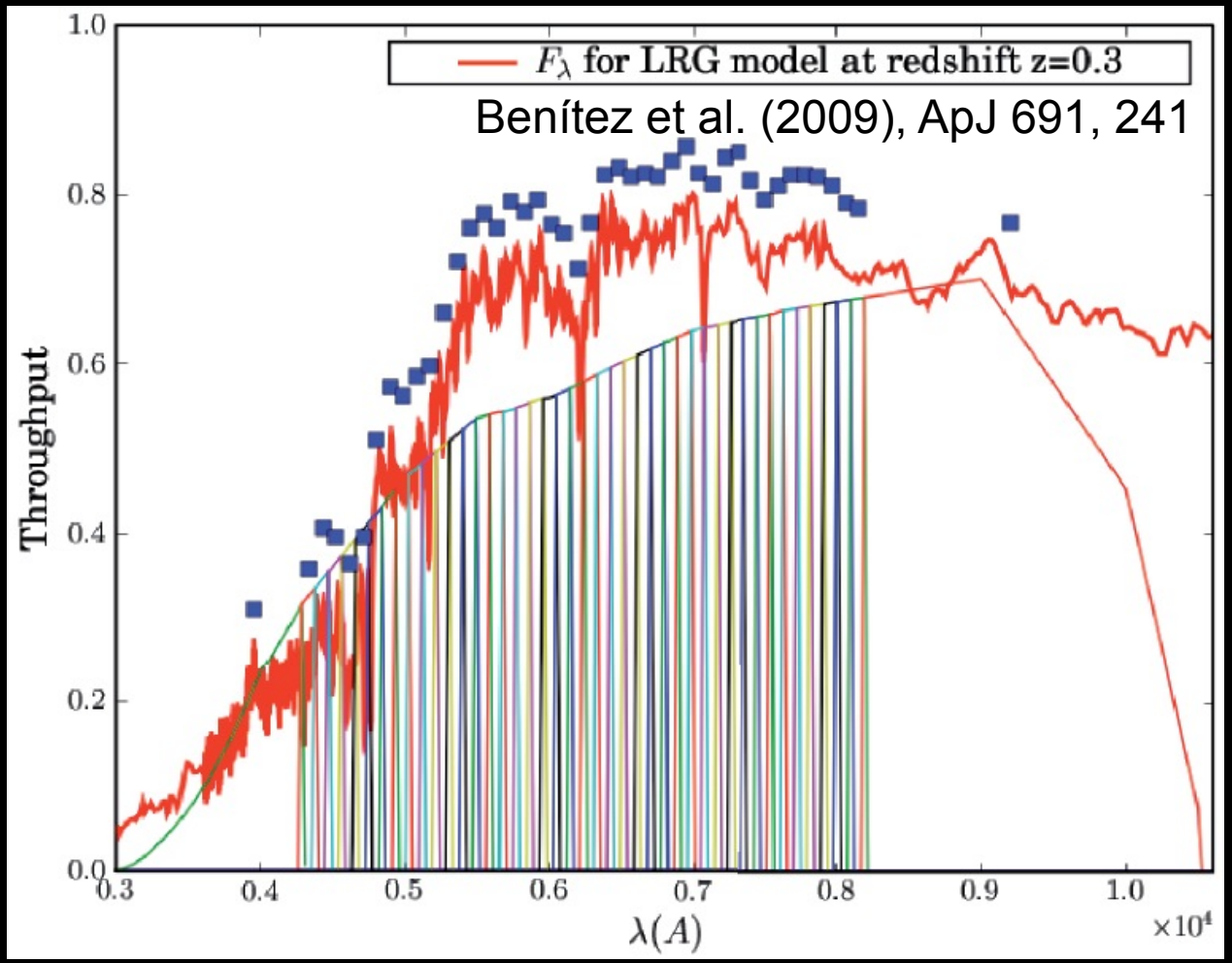
The Javalambre-PAU Astrophysical Survey

Robotic Telescopes at Javalambre

CEFCA
Centro de Estudios de Física del Cosmos de Aragón

SCIENTIFIC MOTIVATION

THE *JAVALAMBRE-PAU ASTROPHYSICAL SURVEY* (J-PAS)



Sky area: 8000 deg^2
56 filters of ~100Å width
Time: 4-5 years

- To determine photo-z's (Δz ~0.3%) for millions of LRGs, to study the *Barionic Acoustic Oscillations* and constrain the equation of state of the *Dark Energy*.

- Many other scientific returns for free: galaxy evolution, SFR evolution, galaxy clusters, 2D stellar populations, Milky Way structure, SNe, GRBs, very low mass objects, exoplanets, Solar System minor bodies…

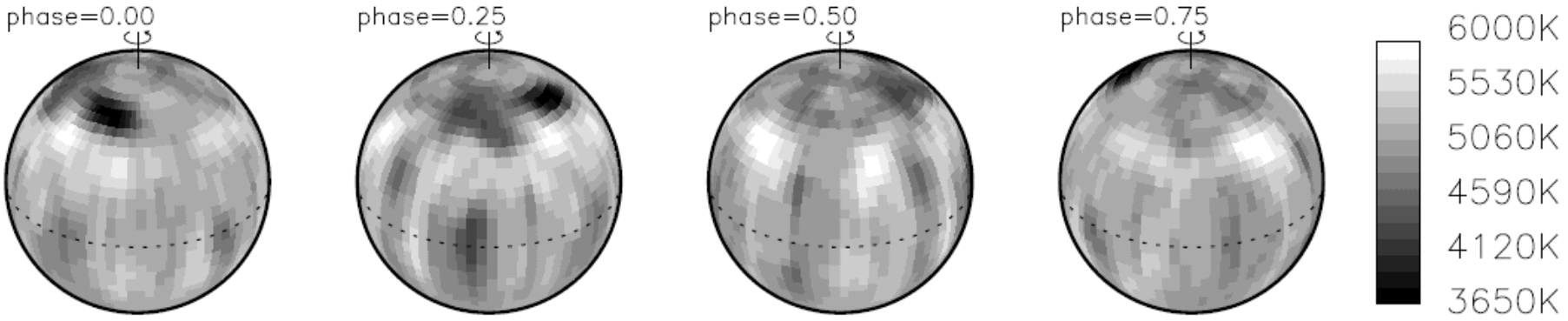
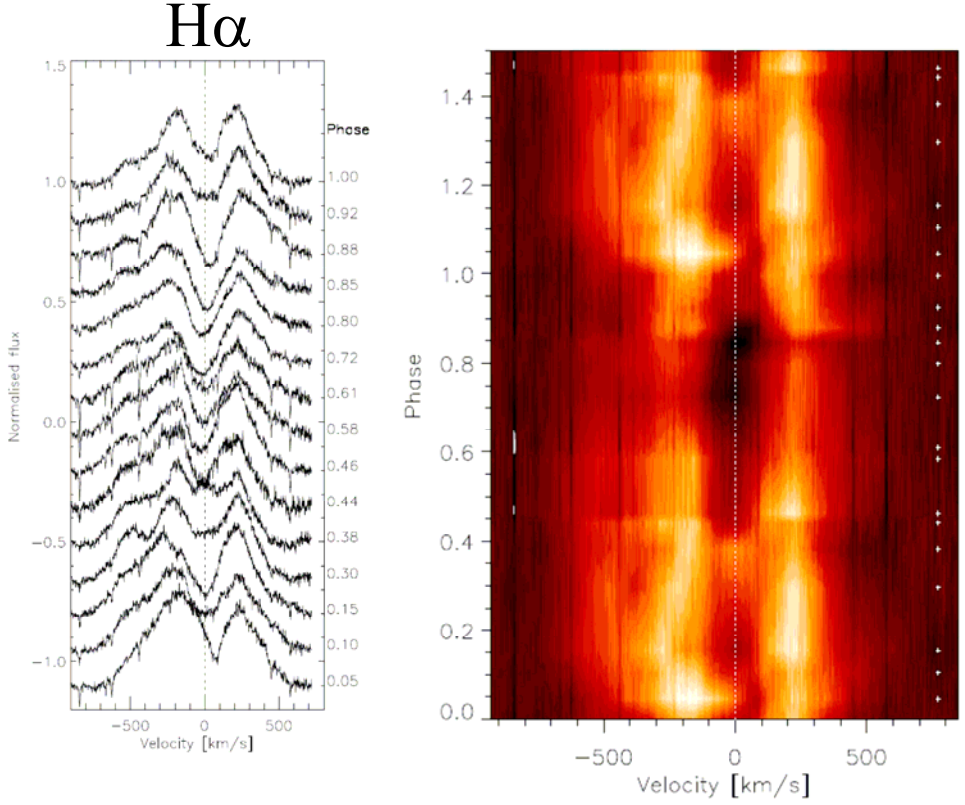
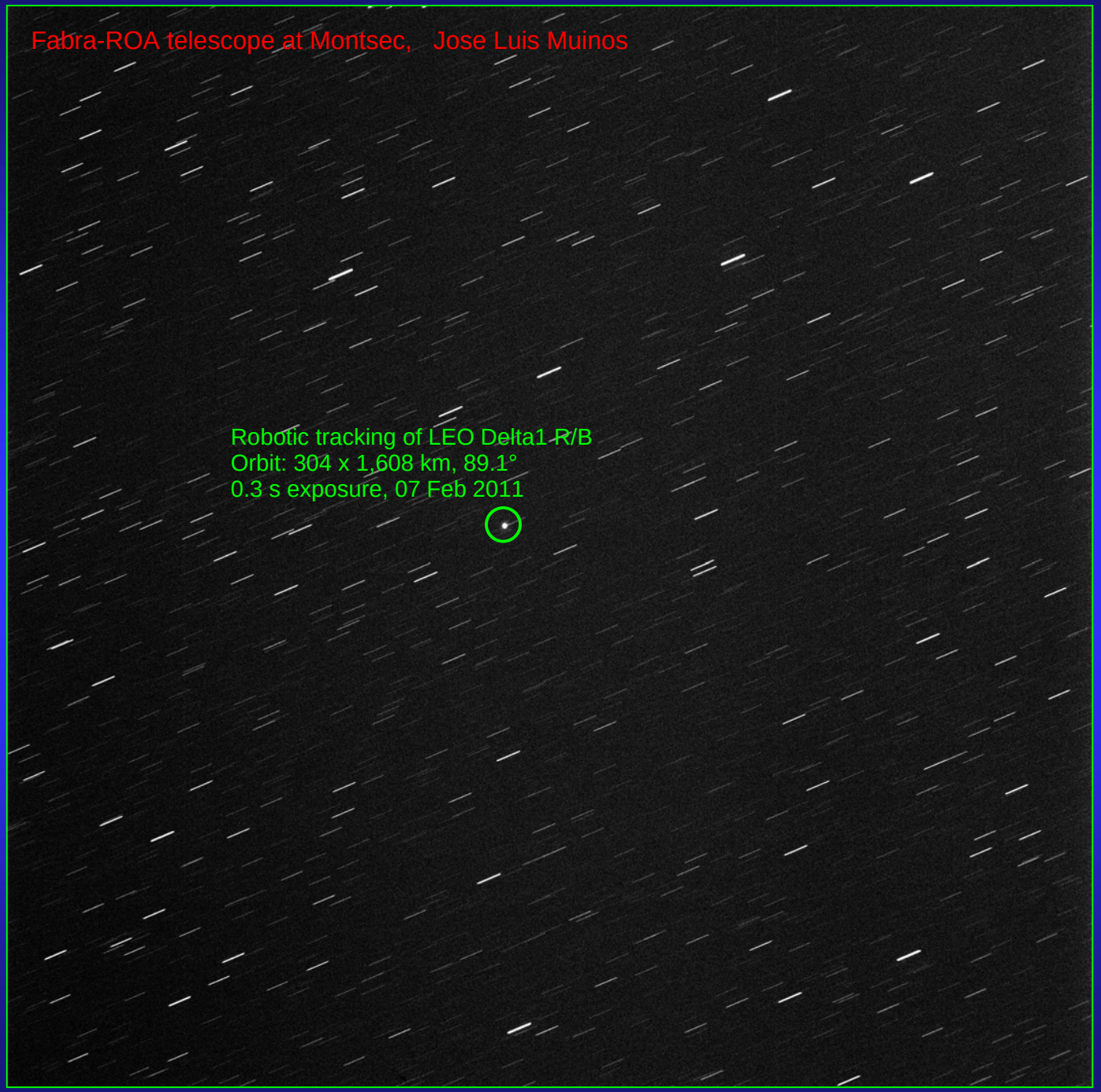


Figure 3. The surface temperature map of FK Com. The surface is shown at four different rotational phases which are 0.25 in phase apart. The gray scale gives the temperature in Kelvin.



* Based on observations collected at the European Southern Observatory, Chile (Prg. 280.D-5075); at the automatic STELLA observatory at Tenerife, Spain; and with the Vienna automatic photometric telescopes Wolfgang and Amadeus, Arizona, USA

† E-mail:hkorhone@eso.org


Fabra-ROA telescope at Montsec, Jose Luis Muinos
Robotic tracking of LEO Delta1 R/B
Orbit: 304 x 1,608 km, 89.1°
0.3 s exposure, 07 Feb 2011

Why do we need robotic telescopes ?

- research

  GRB hunting is only ~25%

  many more interesting targets

- education

  and outreach

  astronomy and science in general

LOG IN

Lech Mankiewicz

ZOONIVERSE
REAL SCIENCE ONLINE

HOME | PROJECTS | ABOUT | EDUCATION | BLOGS | RESEARCHERS | CONTACT

Galaxy Zoo: Hubble

The latest version of the original Zooniverse project. Help astronomers figure out how galaxies form and evolve by classifying their shape. Now with added Hubble galaxies.

JOIN IN

The Zooniverse Community

430,913 people just like you...

Name: Amanda Peters
Age: **38**
Occupation: **I work at a science centre**
Joined Zooniverse: **August 2009**
's Zooniverse: *"I try and come on as much as possible. I enjoy Classifying galaxies as you never know what's going to come up next. I can't observe the sky as I would like to. Galaxy Zoo gives me the chance to do science and view some wonderful pictures of the sky."*

Amanda Peters

I'd like to be featured here too!

Live Projects

- planethunters.org
- THE MILKY WAY PROJECT
- MOON ZOO
- GALAXY ZOO HUBBLE
- oldWeather
- SOLAR STORMWATCH

blackrockcastleobservatory

Niall Smith

"Science isn't just a subject at school, it is a human endeavour."

Objectives of Blackrock Castle Observatory

• To foster an interest in science, engineering and technology, through the medium of astronomy, amongst people of all age groups

•To become a focus for science outreach in Cork

•To develop a robotic astronomical observatory which will perform research in a number of areas, including:

- o Blazars
- o Extra-solar planets
- o Near Earth Objects
- o Gamma Ray Bursts

•To provide facilities for students to complete research programmes for various purposes, from Transition Year Projects to Doctorates.

EMO Green astronomy projects and the community, Nezar Hezam


MOON

Recent developments

New instruments focus on:

- sensitivity and precision
- fast response
- high temporal resolution

What makes a good observing site?

Clear

High

Dry

Cold

Clean

Dark

Low precipitation

No lightning

No forest fires

Low surface wind

Low wind throughout atmosphere

No high level turbulence

Low seismic activity

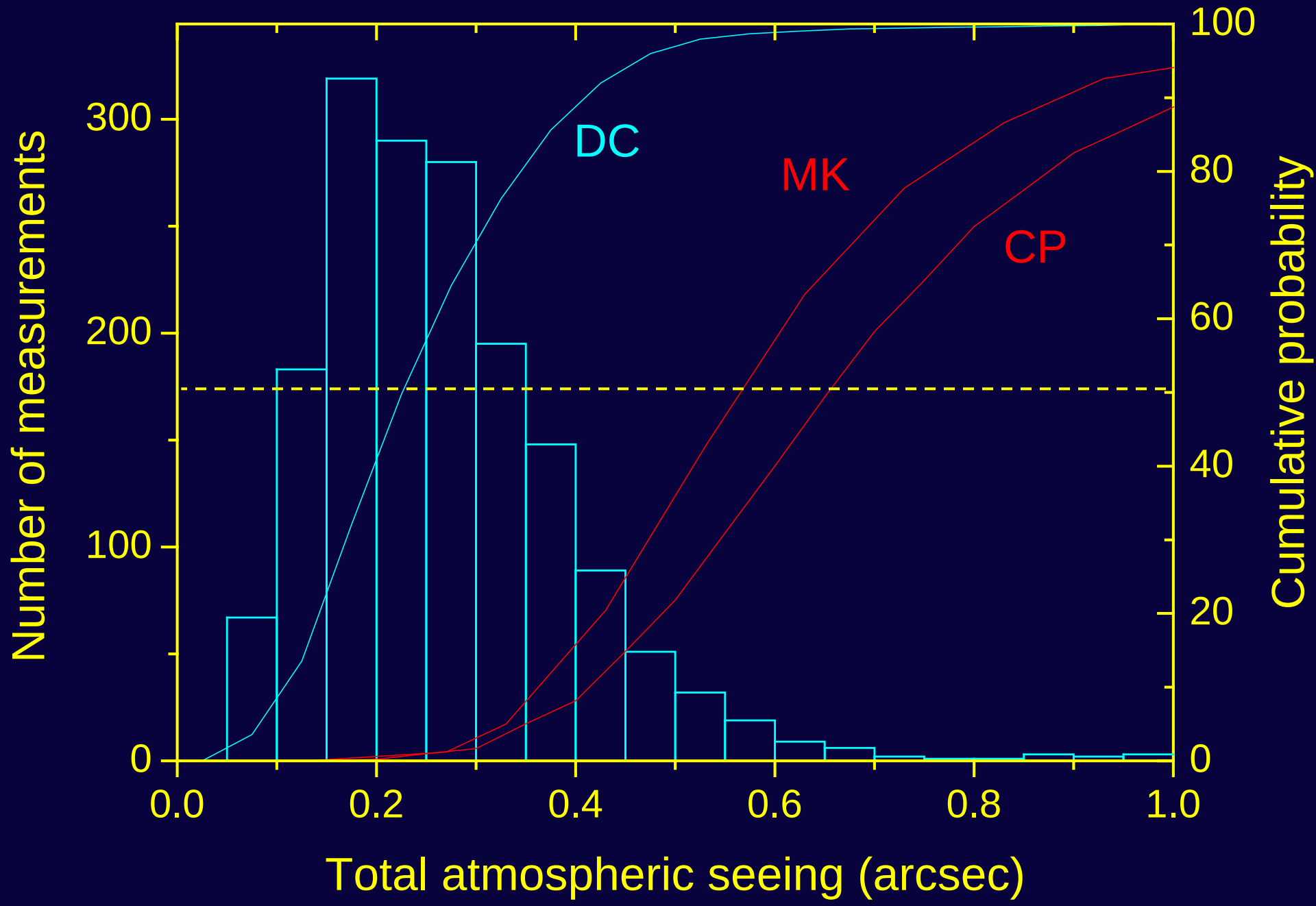
Accessible

Continuous observing possible

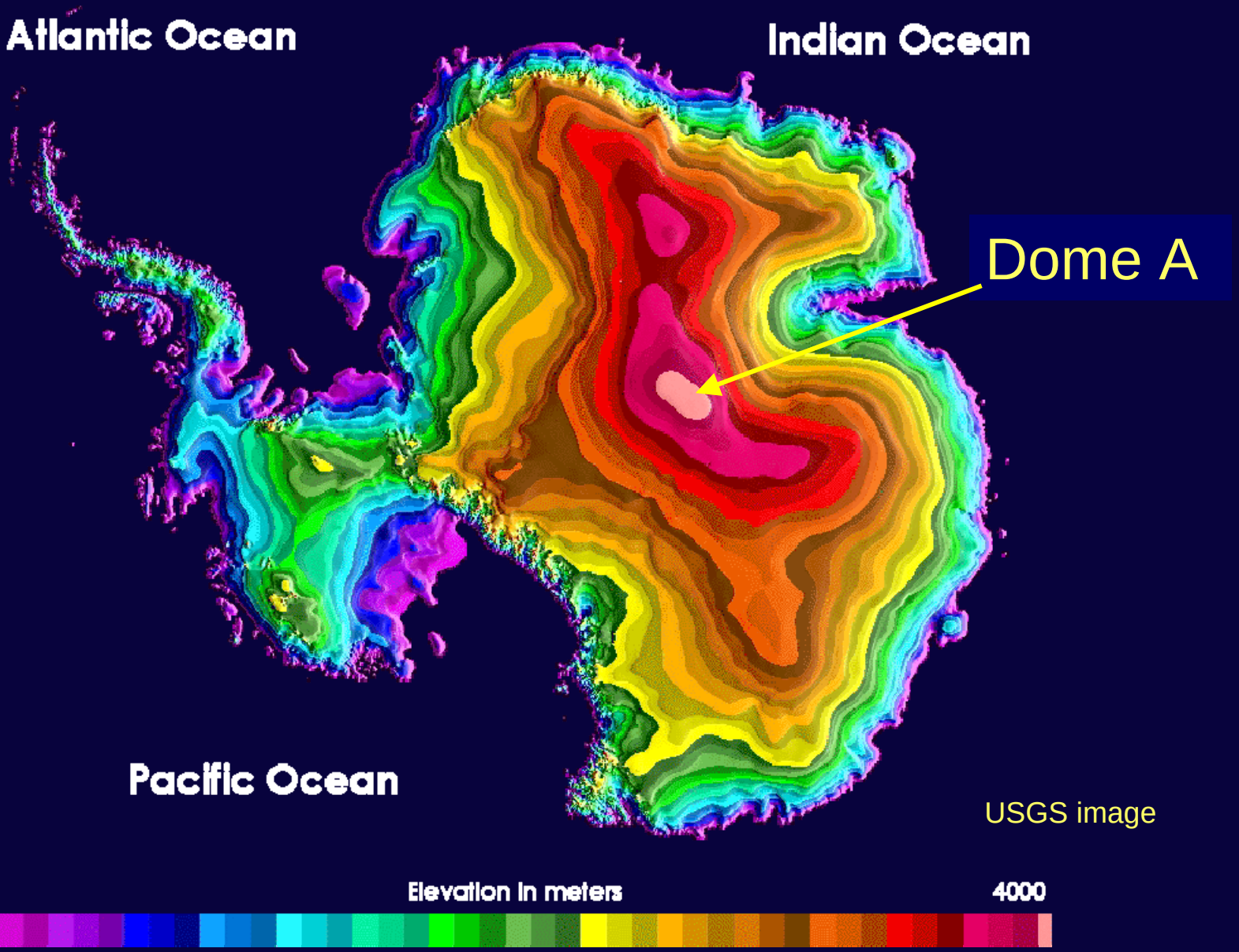
Stable climate

Image: Anna Moore

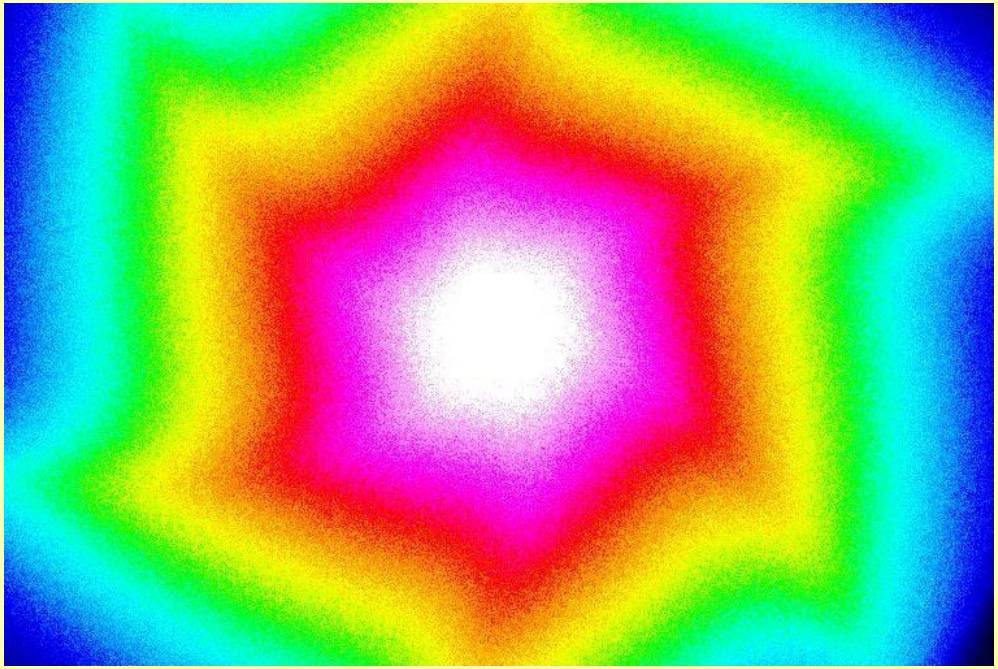
Lawrence, Ashley, Tokovinin, and Travouillon, *Nature,* **431,** 278, (2004)



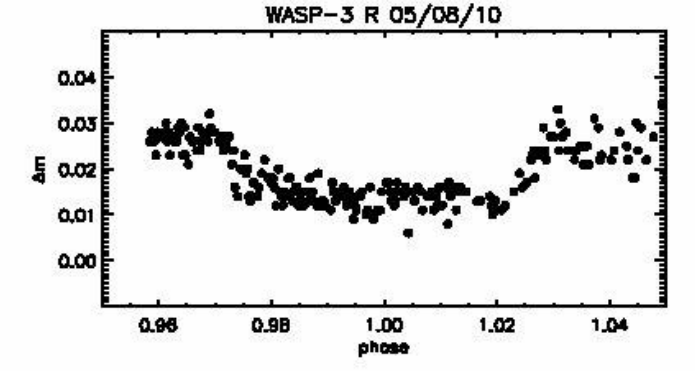
Contour map of Antarctica

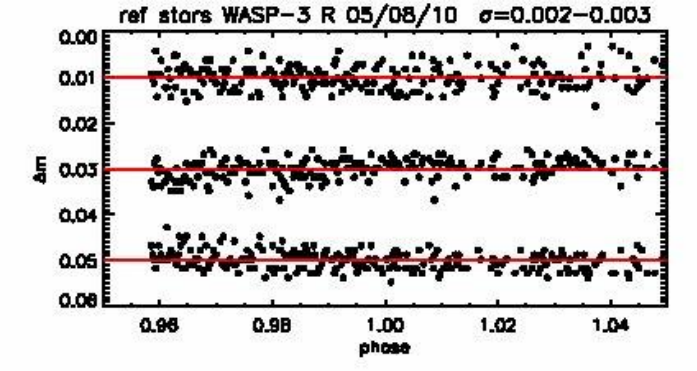


Shutter correction map



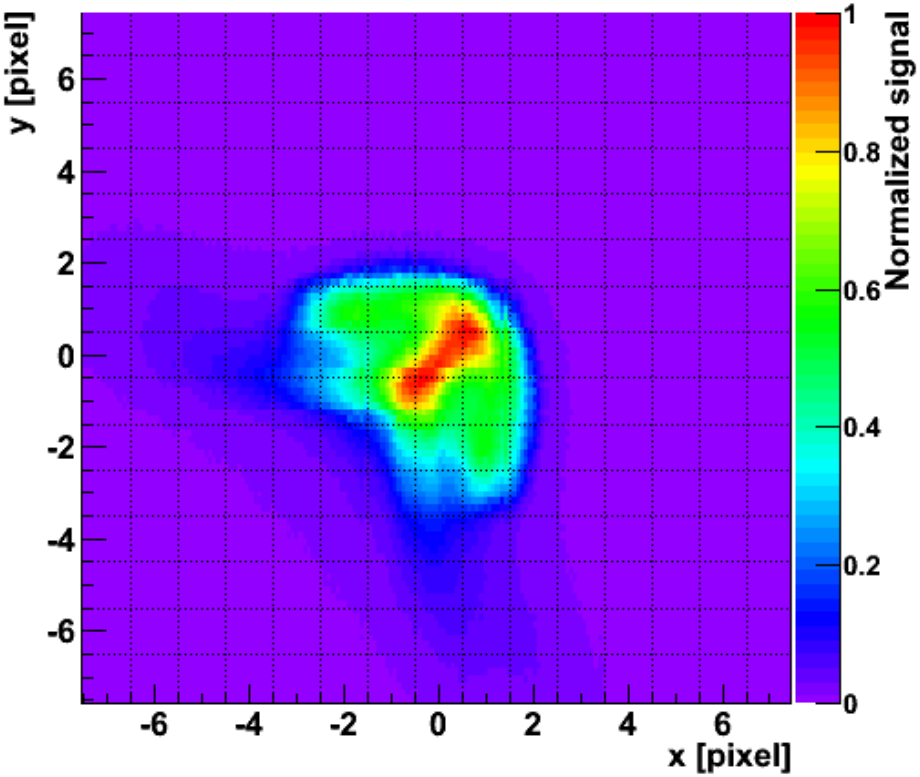
Best results so far

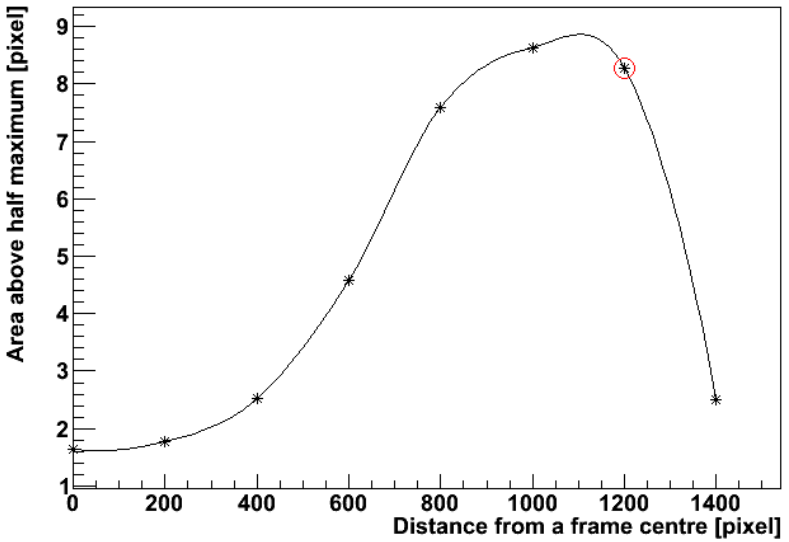




PSF reconstruction

High resolution PSF profile – superposition of the images placed on the net of 20×20 positions on the pixel.





Area above 50% of the maximal signal.

The BOOTES Network Philosophy (II)

Ground-support to space based missions

Very fast slewing speed (> 100 deg/s), easy rescheduling, fast readout (< 1s)

INTEGRAL

2002-

SWIFT

2004-

UFFO @ *Lomonosov*

2012-

Follow up vs. synchronous

Table taken from poster by S. Meehan

Telescope	GRB	T90 (s)	Δ Opt (s)	Peak mag.	Δ Peak (s)	Ref.
ROTSE-I	990123	63	22	8.95	29	GCN 205
ROTSE-IIIb	041219A	520	74	14.9	2880	GCN 2868
Watcher	060526	275.2	36	15.5	112	GCN 5165
PROMPT	060607A	100	40	14.5	140	GCN 5236
Watcher	060904B	172	62	17.1	507	GCN 5510
TORTORA	080319B	50	0	5.3	23	GCN 7502
Watcher	080905B	128	43	15.8	75	GCN 8207

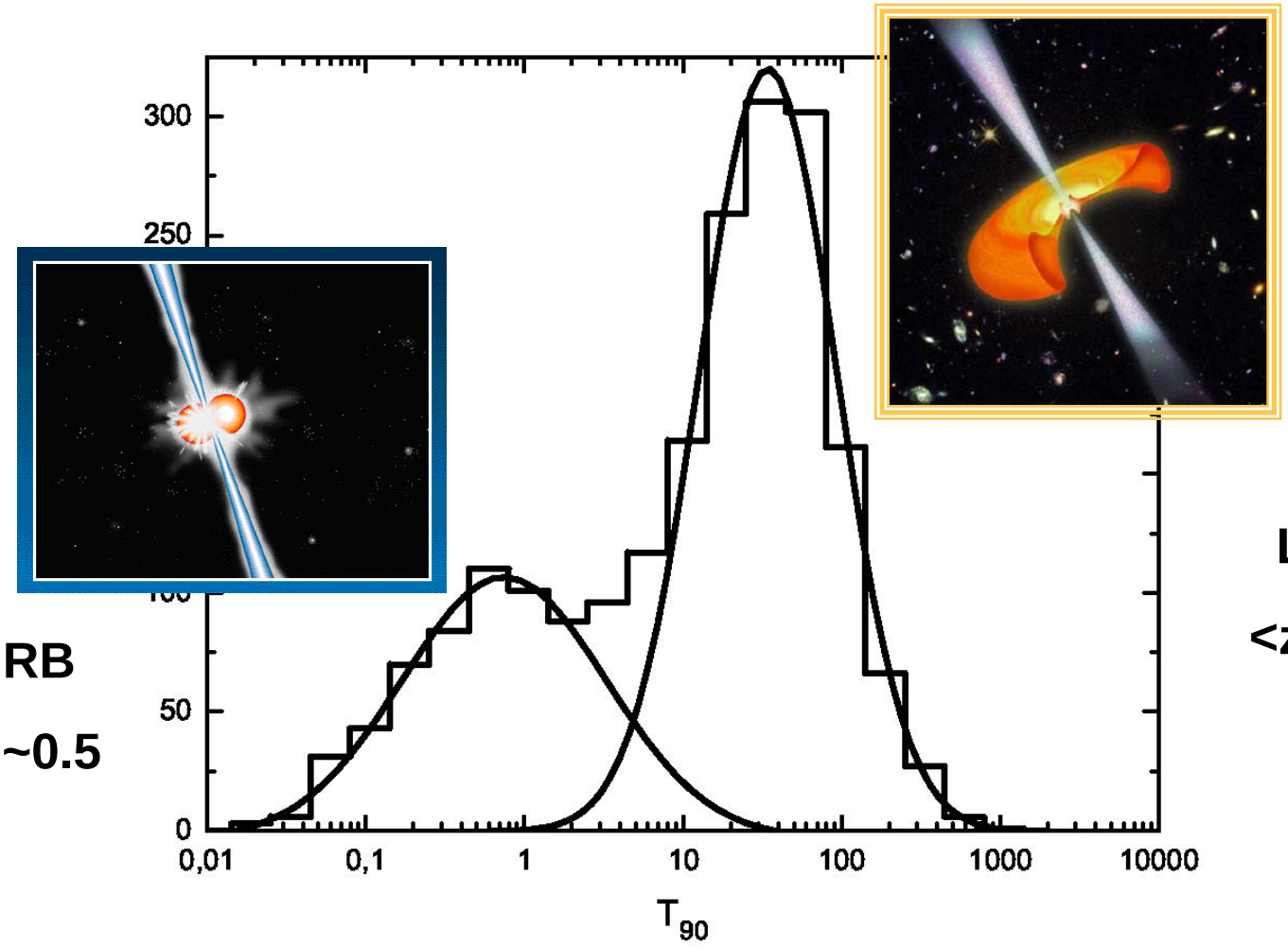
$T_{90} < \Delta$ Opt

We observe the active phase in optic!

Follow up vs. synchronous

- When you hungry you do not ask the whole elephant, you may want take a part (of elephant), e.g. leg or a flap
- If you need to identify some person you need now only some trace and following DNA-analysis
- So, why we need observation of the whole Gamma-Ray Burst?
- We need *simultaneous observation of only part* of prompt emission in gamma-ray and optic.

BATSE: bi-modal duration distribution, short and long GRB



Recent developments

New instruments focus on:

- sensitivity and precision
- fast response
- high temporal resolution

- multi-wavelength measurements
- polarization

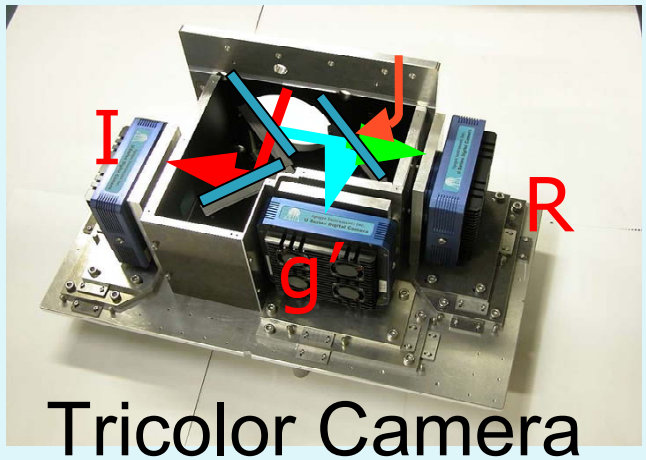
MITSuME

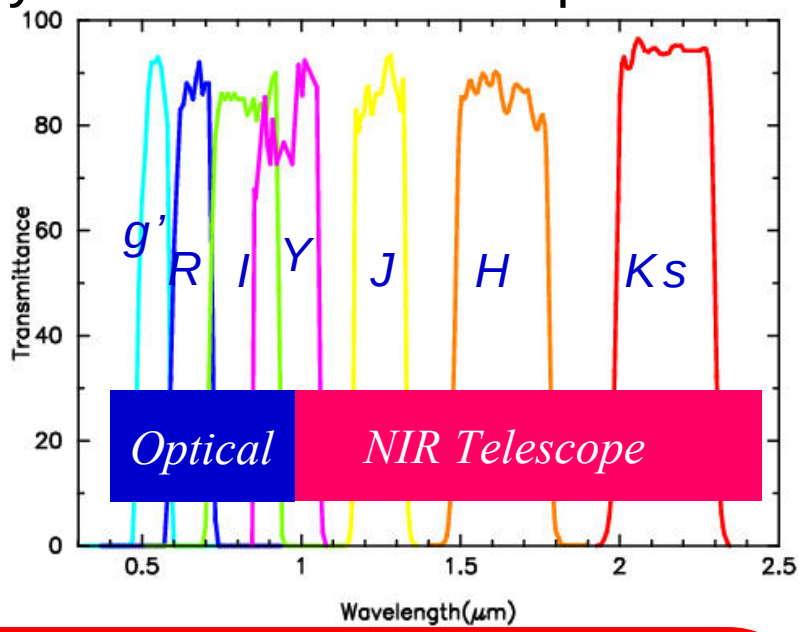
Multi-color Imaging Telescopes for Surveys and Monstrous Explosions

50cm Optical Telescopes

Akeno Observatory, ICRR

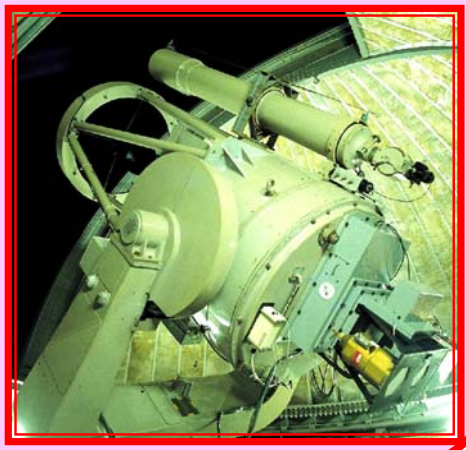
Okayama Astrophysical Observatory, NAOJ





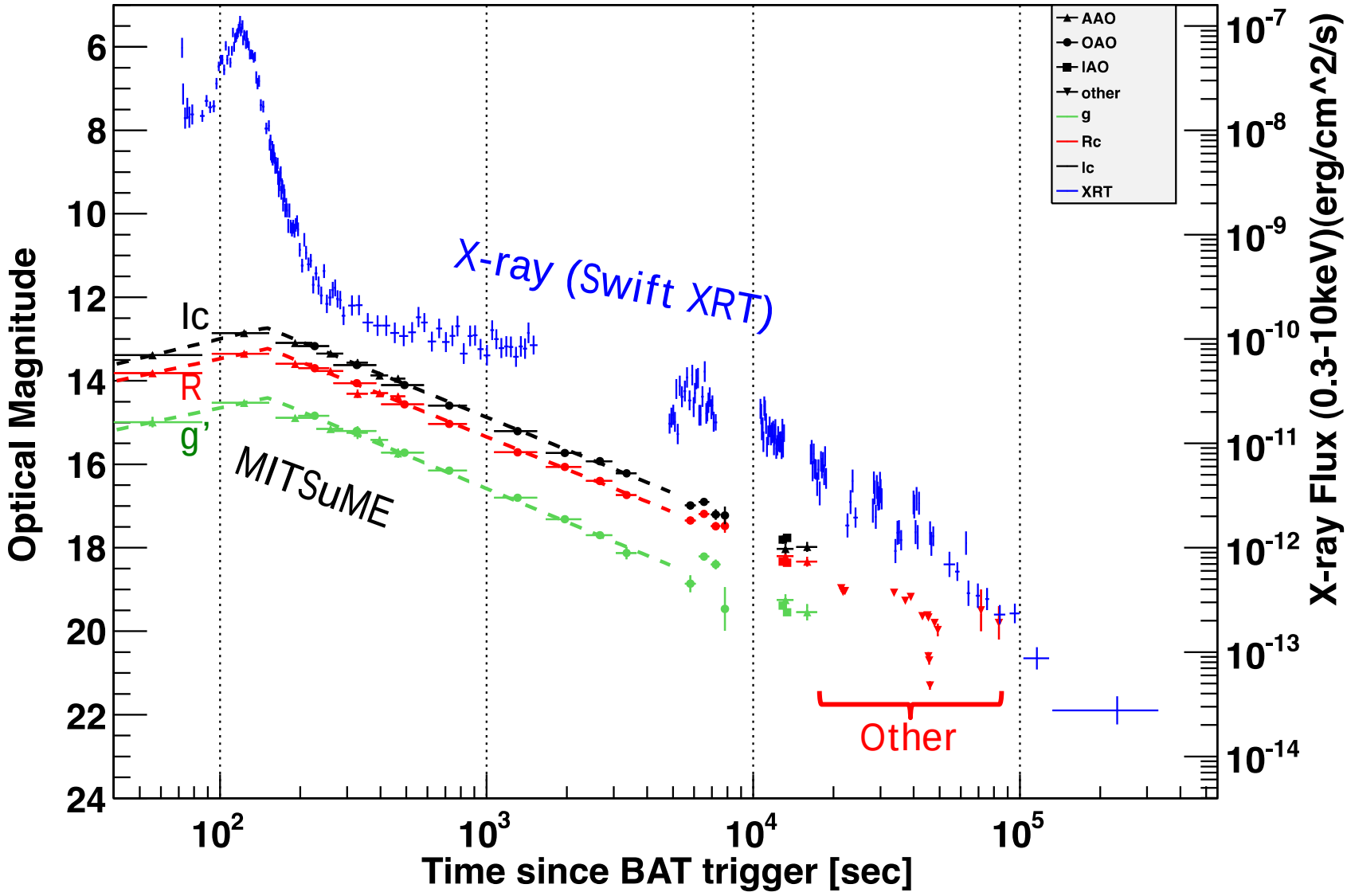
91 cm NIR Telescope

Okayama Astrophysical Observatory, NAOJ



Okayama

GRB100906A: afterglow light curves

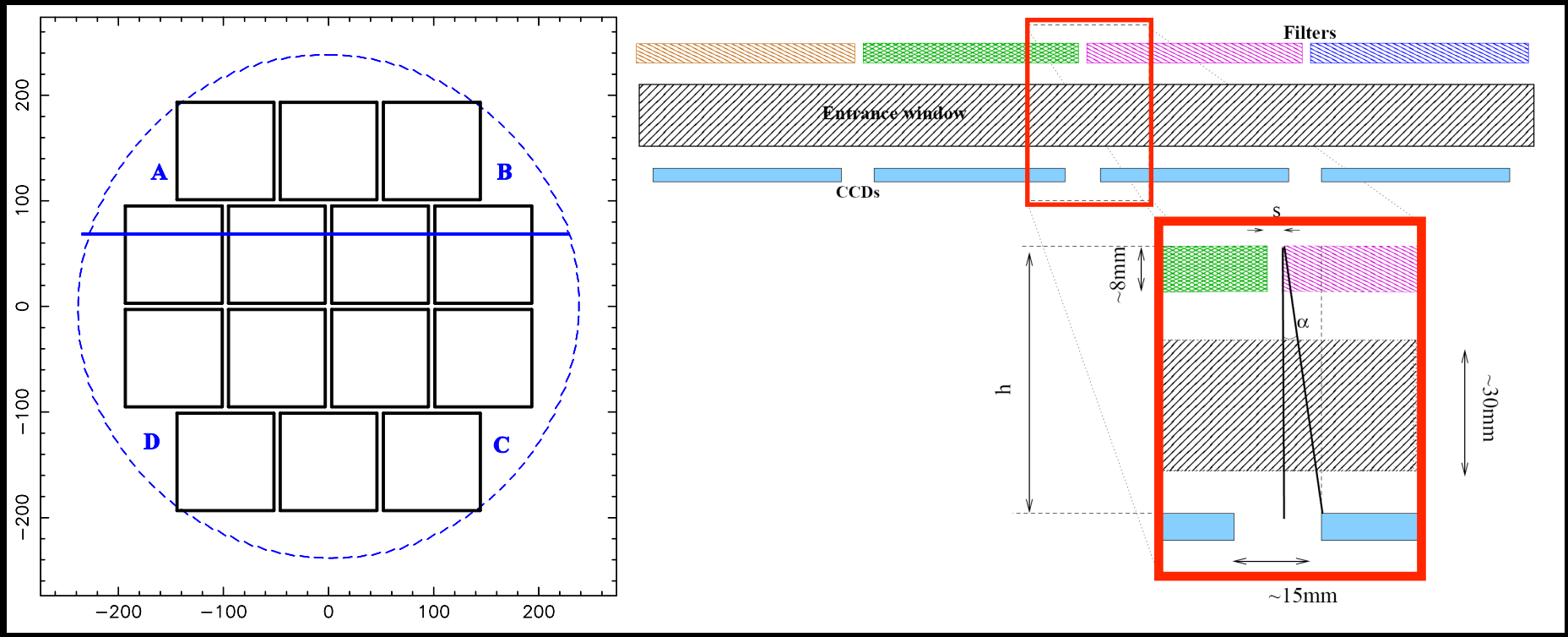


The Javalambre-PAU Astrophysical Survey

Robotic Telescopes at Javalambre

J-PCAM: A PANORAMIC CAMERA @ T250 FOR J-PAS

Using new generation, Large-format CCDs (9.2k × 9.2k) by e2v
Mosaic of 14 CCDs (FoV∅ 476 mm) → ~ 1.2 Gpix



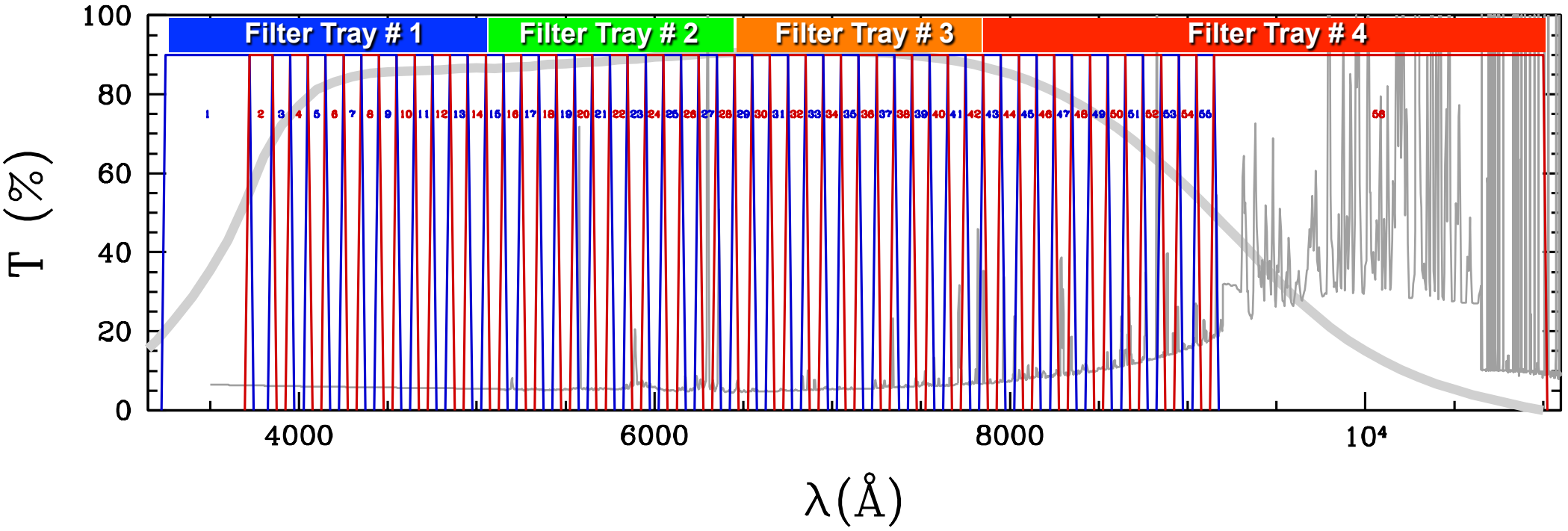
Working in convergent beam

The Javalambre-PAU Astrophysical Survey

Robotic Telescopes at Javalambre

CEFCA
Centro de Estudios de Física del Cosmos de Aragón

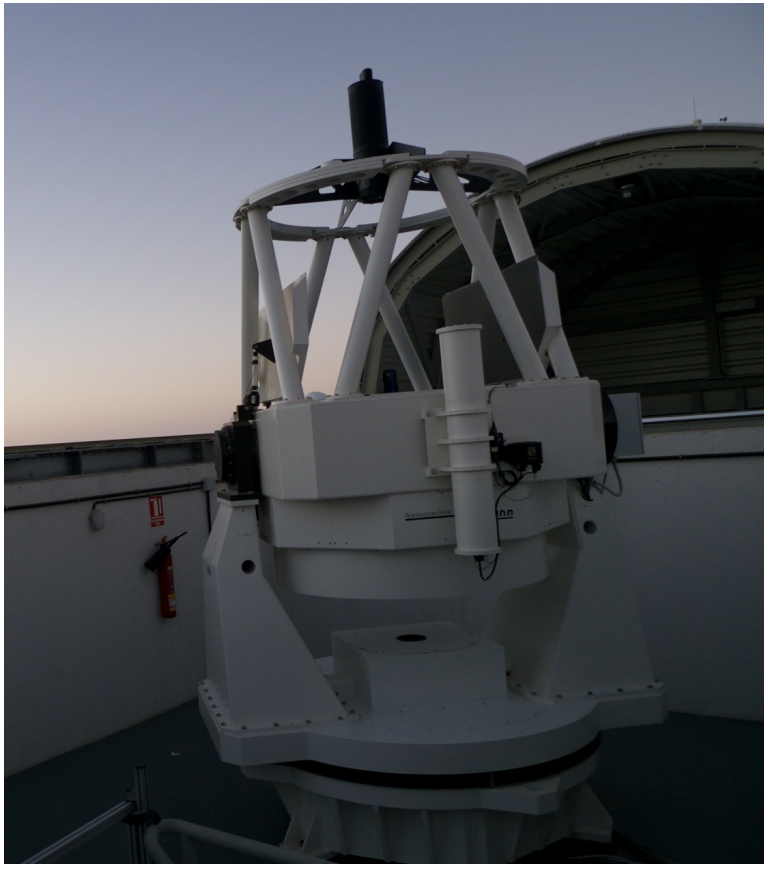
J-PAS FILTERS



The all 56 J-PAS filters can be **simultaneously** located at J-PCam.

J-PAS Strategy to driven by moon phase, seeing, weather conditions, etc.

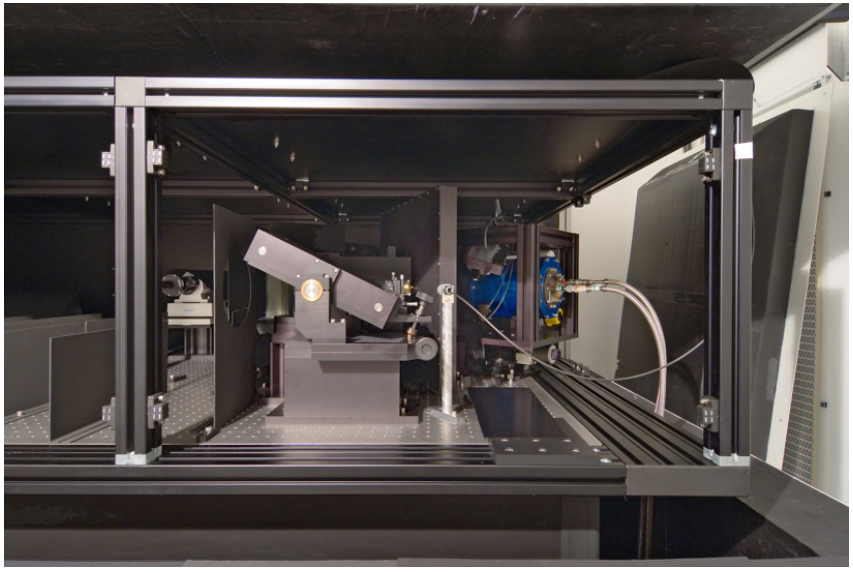
The STELLA/SES telescope



- Second telescope on site, aka STELLA-II
- 1.2m aperture, spherical mirror
- Prime-focus corrector for 1' field
- Alt/Az mount
- Fiber feed for spectrograph since mid 2010

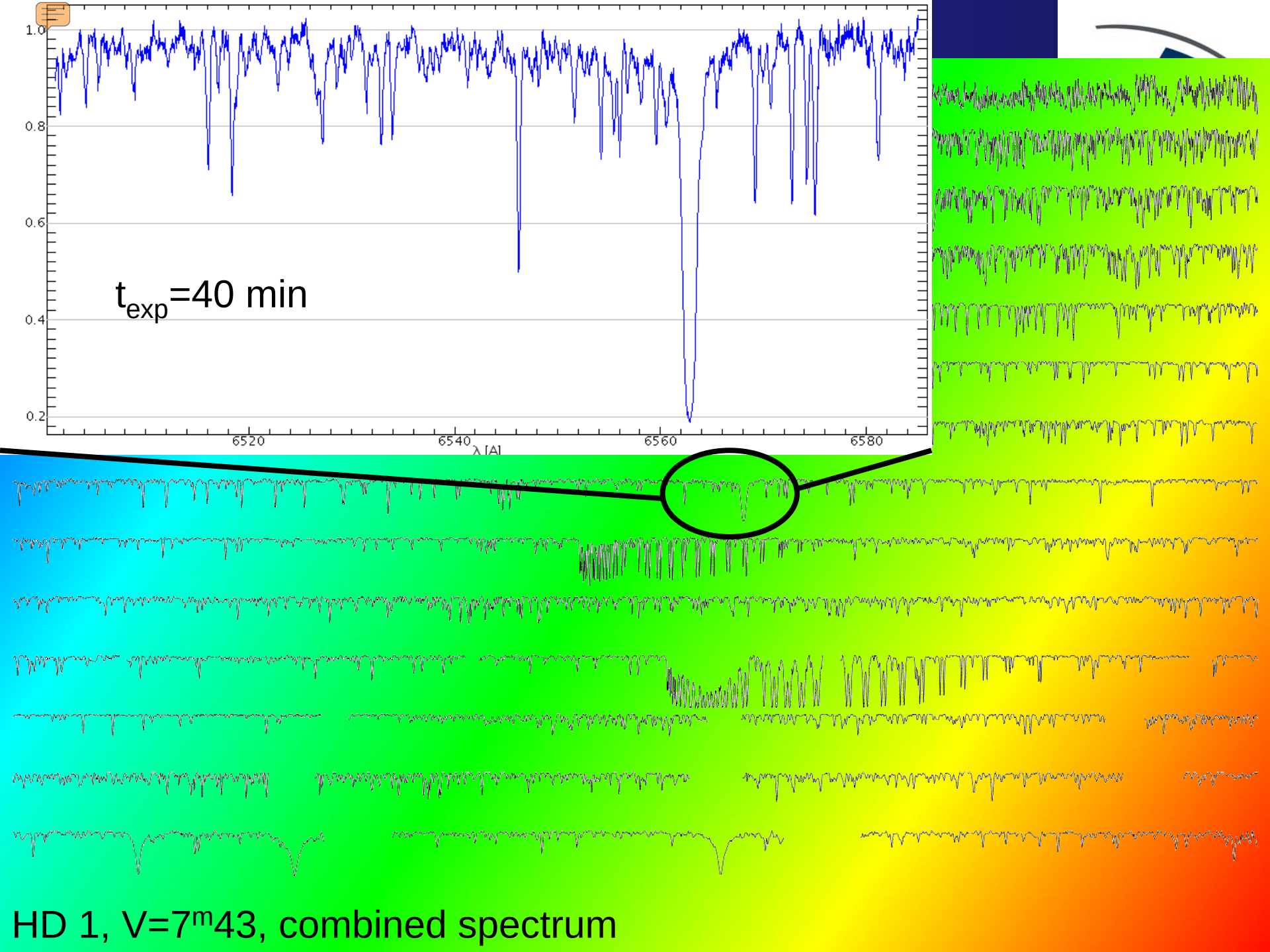
AIP

The échelle spectrograph SES



- Fiber fed, bench mounted
- $\lambda/\Delta\lambda = 50,000$
- Currently 2kx2k detector (order gaps above 700 nm), later 4kx4k pixels
- Closed cycle cooling
- Fixed format: 390 to 900 nm
- Thermally stabilized

AIP



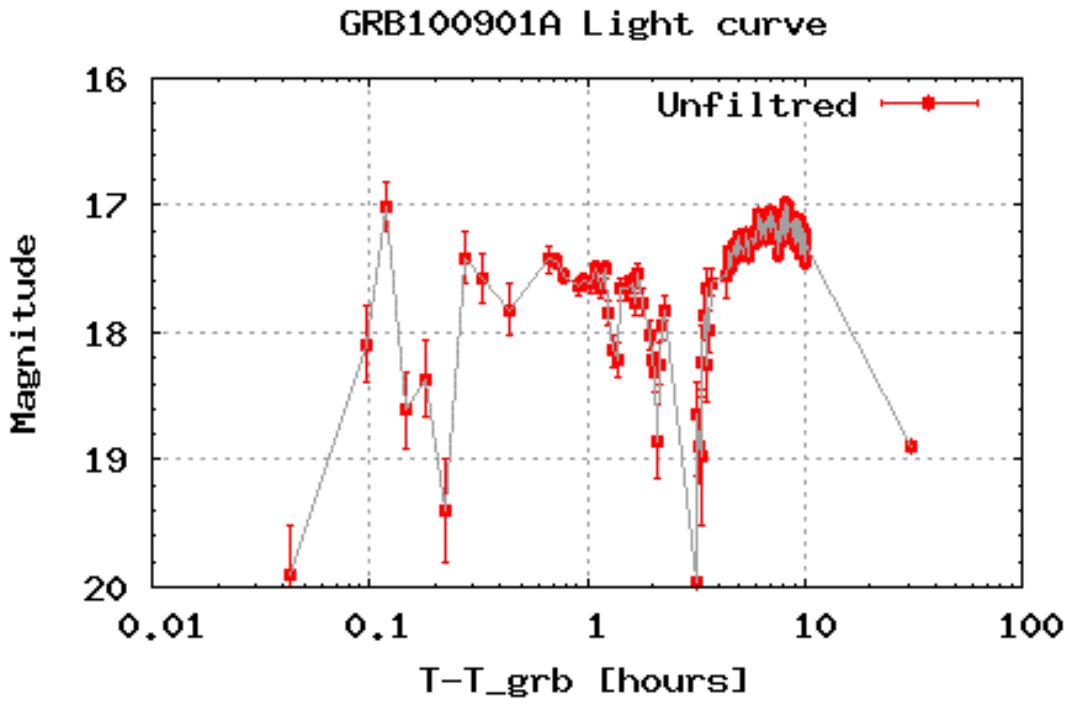
HD 1, V=7^m43, combined spectrum

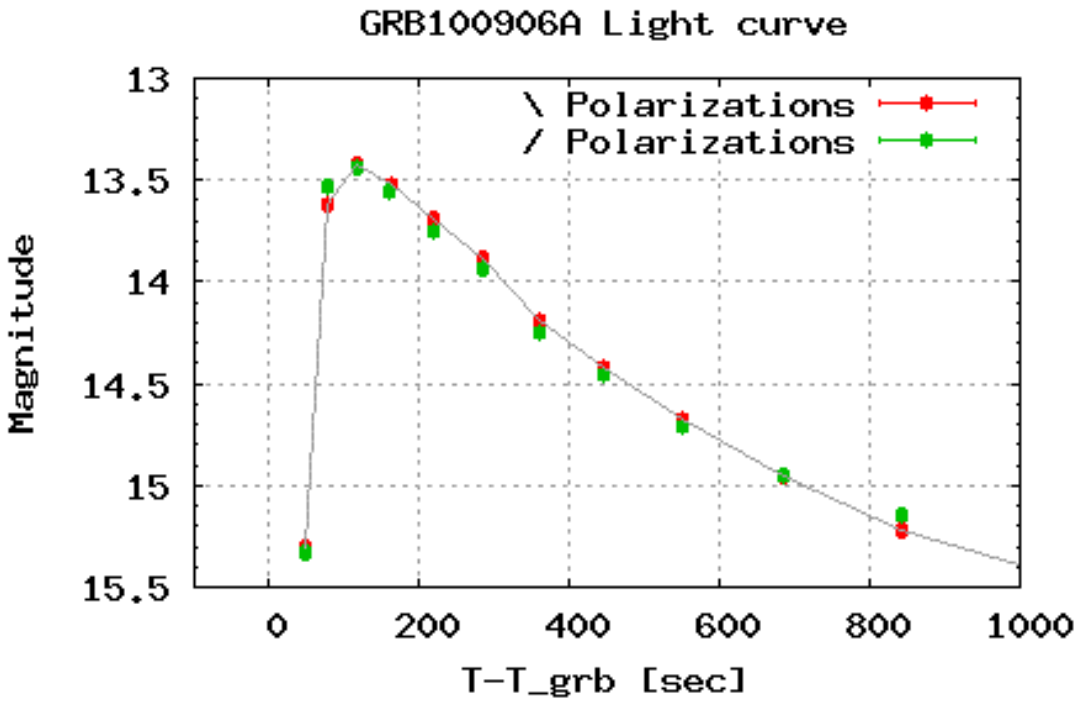
Наблюдение 4-х гамма-всплесков сеть телескопов МАСТЕР

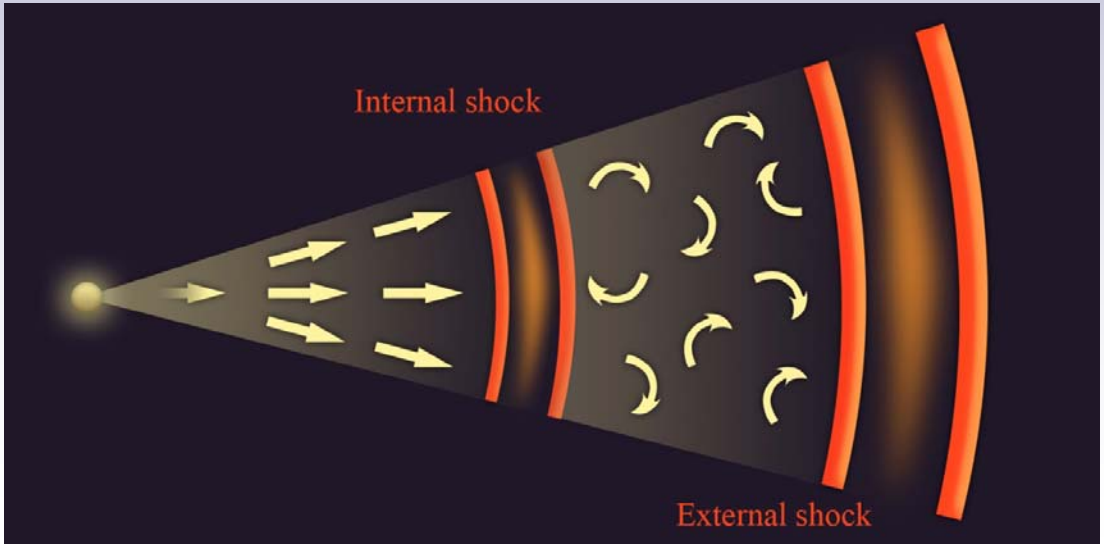
GRB100906A
(gcn11214)

23 s after notice time
38 s after trigger time
gcn 11228

First prompt optical polarization observations


GRB100901A Light curve
Unfiltred
Magnitude
T-T_grb [hours]
16
17
18
19
20
0.01
0.1
1
10
100


GRB100906A Light curve
\ Polarizations
/ Polarizations
Magnitude
T-T_grb [sec]
13
13.5
14
14.5
15
15.5
0
200
400
600
800
1000

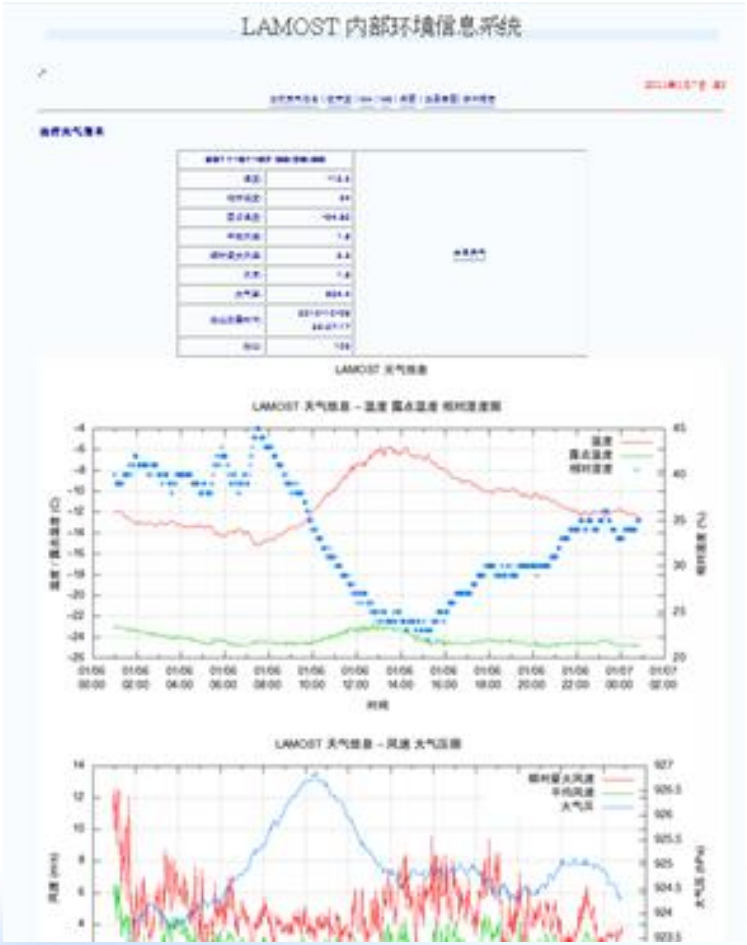

Internal shock
External shock

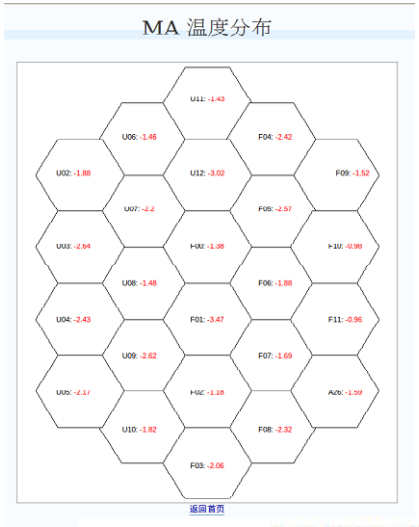
Recent developments

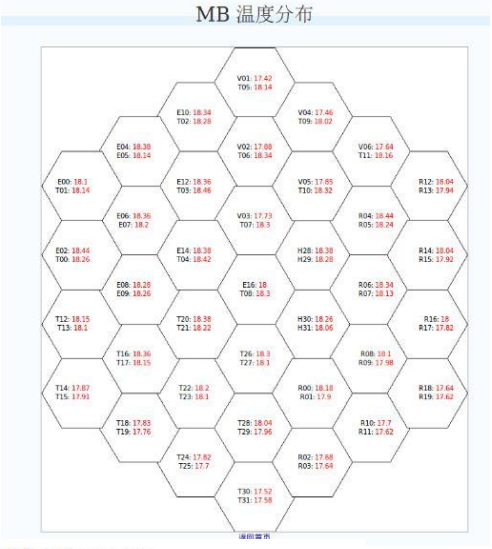
Web access:

- telescope status
- infrastructure monitoring

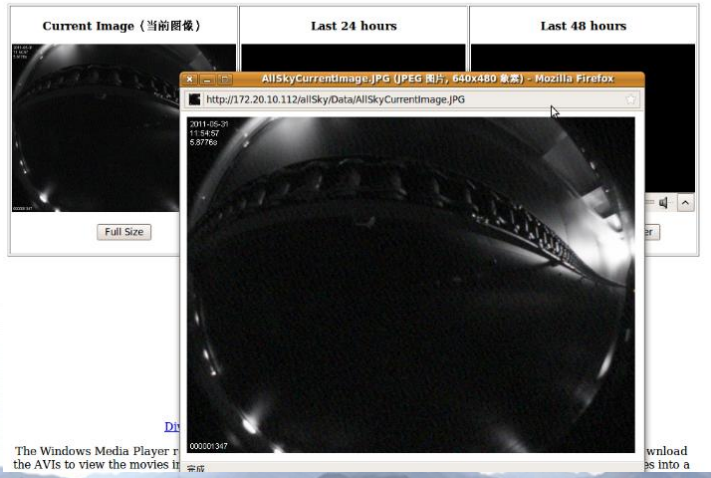
The environment data access



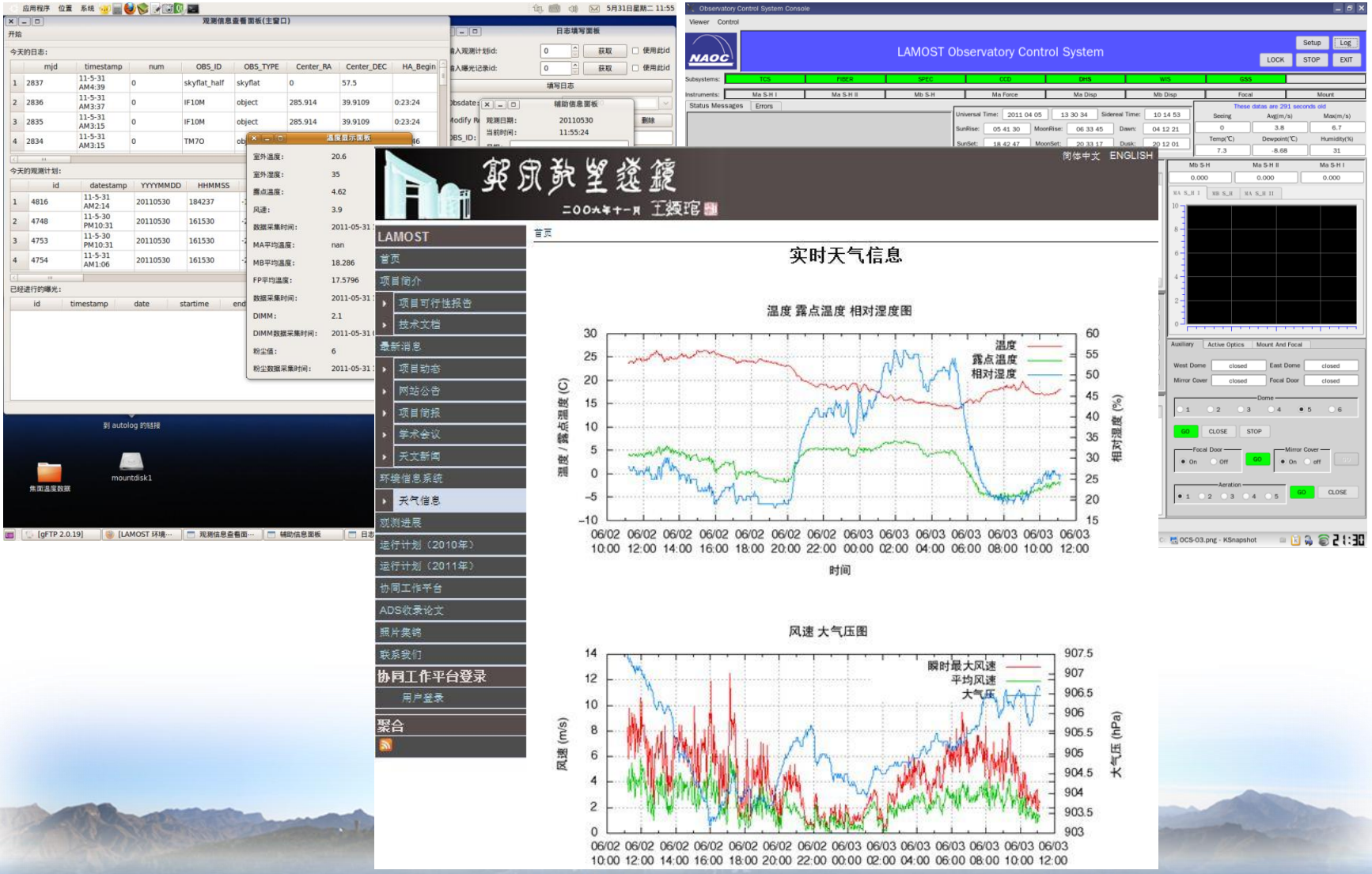




LAMOST All Sky Camera



The environment data access



Наблюдение 4-х гамма-всплесков сетью телескопов МАСТЕР

Recent developments

Web access:

- telescope status
- infrastructure monitoring

- alert response
- on-line image processing results

Response to GCN

GCN Web Page

http://sncwall.hp.phys.titech.ac.jp:2388/

Google

MITSuME GCN web page

Latest Gamma-Ray Bursts	RA [deg]	DEC [deg]	ERROR [arcmin]	NOTICE TYPE	TRIG NUM
GRB 110530-155259	282.0692	61.9286	0.036	XRT_pos	454473
GRB 110530-154459	282.0671	61.9286	0.060	XRT_pos	454473
GRB 110530-153200	282.0449	61.9318	3.000	BAT_pos	454473
GRB 110521-160355	120.1	45.8263	0.036	XRT_pos	453788
GRB 110521-155349	120.1347	45.8273	0.096	XRT_pos	453788
GRB 110521-155226	120.1442		3.000	BAT_pos	453788
GRB 110520-205436	134.3403	56.	0.036	XRT_pos	453747
GRB 110520-204645	134.3420	56.4267		XRT_pos	453747
GRB 110520-202918	134.3751				
GRB 110503-180452	132.7747				
GRB 110503-173753	132.7778				
GRB 110503-173605	132.7998				
GRB 110422-163441	112.0514				
GRB 110422-155559	112.0580				
GRB 110422-154212	111.9949				
GRB 110420-224225	320.0492				
GRB 110420-112624	2.1633				
GRB 110420-110430	2.1609				
GRB 110420-110241	2.1651	-37.8550	3.000	BAT_pos	451757
GRB 110305-065110	260.8806	-15.8023	0.036	XRT_pos	448229
GRB 110305-064339	260.8794	-15.8028	0.060	XRT_pos	448229
GRB 110305-063844	260.8773	-15.7900	3.000	BAT_pos	448229
GRB 110223-213715	150.2341	-68.3018	0.036	XRT_pos	446677

Response to GRB

An entry is automatically generated to each Swift GCN notice with coordinates

Response to GCN

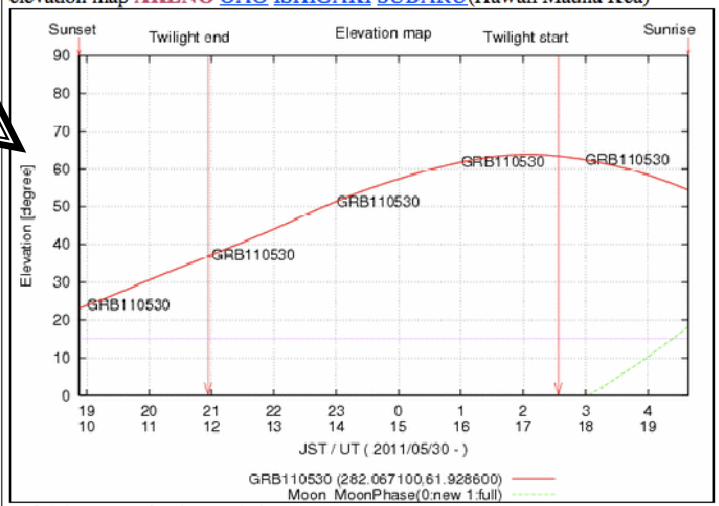
GRB visibility
Elevation of the target and the Moon is calculated for various sites

110530-154459

http://sncwall.hp.phys.titech.ac.jp:2388/gcn11/05/110530-154459/

GRB 110530-154459

elevation map AKENO OAO ISHIGAKI SUBARU(Hawaii Mauna Kea)



MOA(New Zealand Mt.John)
SALT(South Africa)
GTC(the Canary Islands)
HET(America Mt.Fowlker)
VLT(Amerika Mt.Graham)

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JST	11/05/31 00:44:59
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GRB_DEC	61.9286 [deg]
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GRB_ERR	0.060 [arcmin]
DATA_TJD	15711 [TJD]
	11/05/30
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	OKAYAMA	proas-OAO.pdf
	ISHIGAKI	proas-ISHIGAKI.pdf
	SUBARU	proas-SUBARU.pdf
	ASCII MODE DATA	ASCII-NOMAD.dat

GRB information
Contents of the GCN notice

Recent developments

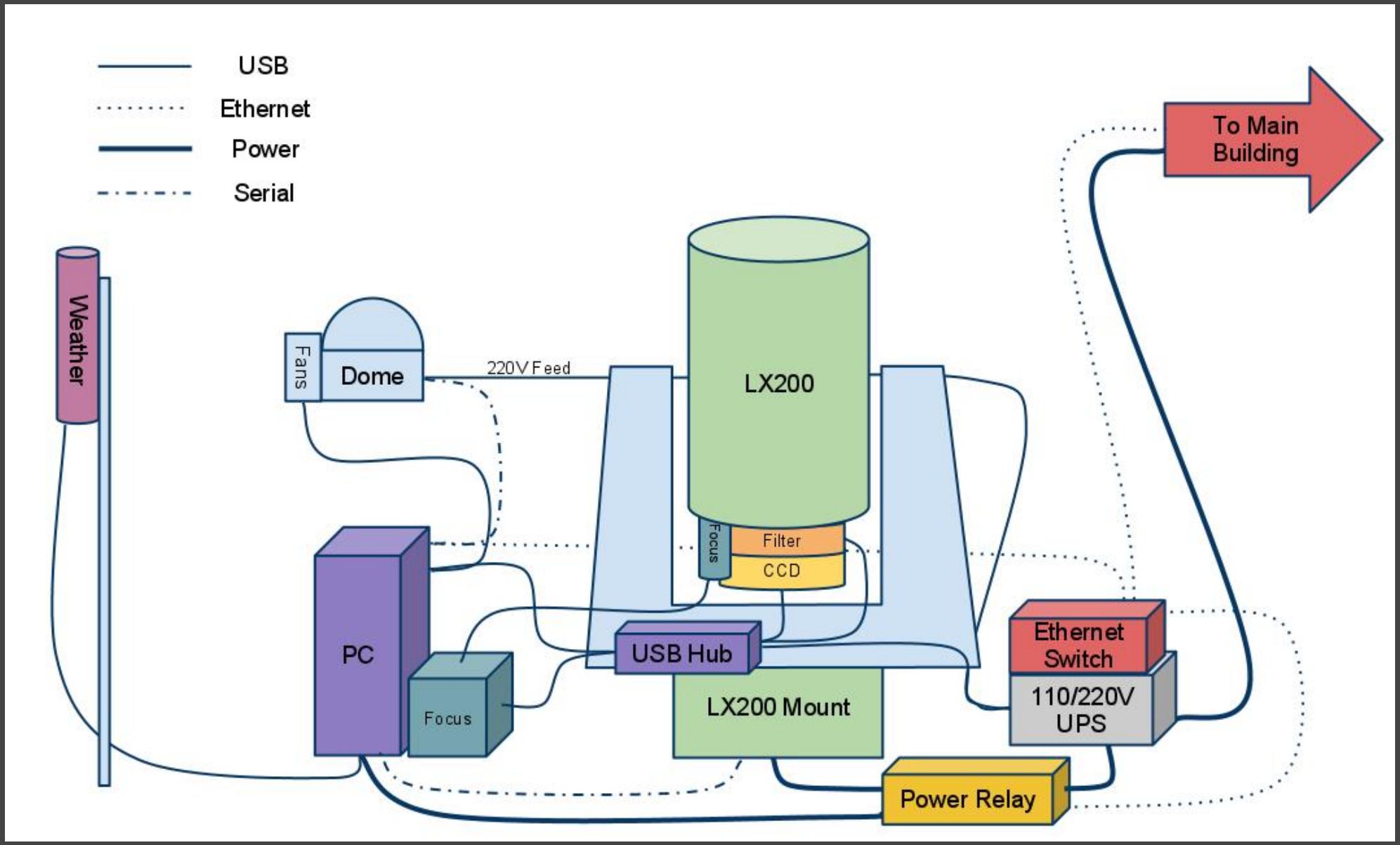
Web access:

- telescope status
- infrastructure monitoring

- alert response
- on-line image processing results

- cost-effective projects

Crowd-sourcing - What are we missing? (Total Cost So Far $57K without first light)



Where do we aim?

Remotely operated telescopes
Robotic autonomous observatories
Robotic intelligent observatories

Where do we aim?

Remotely operated telescopes
Robotic autonomous observatories
Robotic intelligent observatories

Robotic Telescope Networks

MASTER-NET

TOTAL FOV 38 square degrees up to 20-21 mag +4200 sq.degeres, up to 14 mag

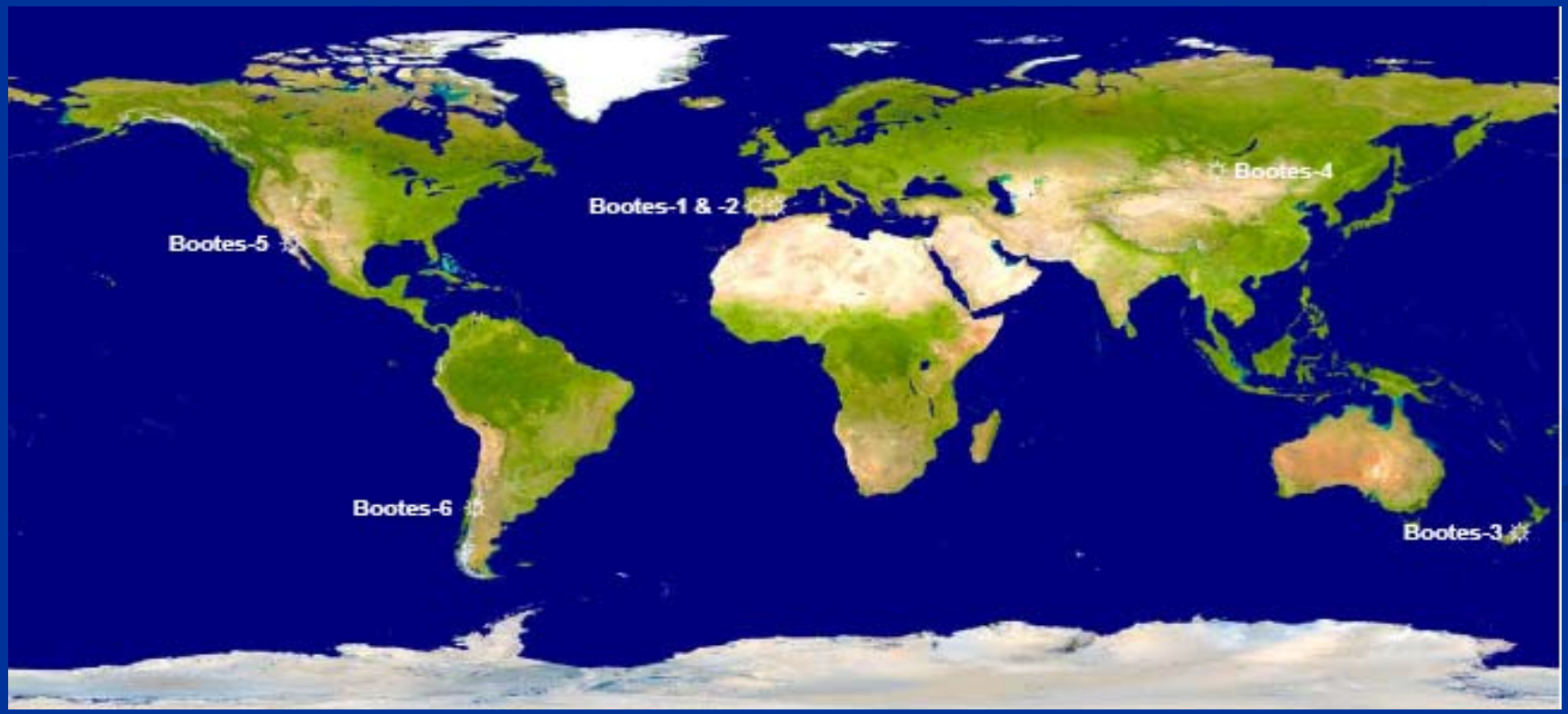
The BOOTES Network Philosophy (I)

Identical telescopes spaced around the Earth

Identical filter sets: g'r'i'ZY

Identical CCD cameras

Impact on several scientific fields and public outreach



Where do we aim?

Remotely operated telescopes
Robotic autonomous observatories
Robotic intelligent observatories

Robotic Telescope Networks

Intelligent Robotic Observatory Networks

GLORIA - http://robtel.eu

FP7-INFRASTRUCTURES-2011-2 (Call 9)

INFRA-2011-1.2.1: e-Science environments

Global Robotic Telescopes Intelligent Array For Citizen Science

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Consejo Superior Investigaciones Científicas

GLORIA - http://robtel.eu

Obj. 1: Create a social network for researching astronomy

Observatory Managers

Four widely spread

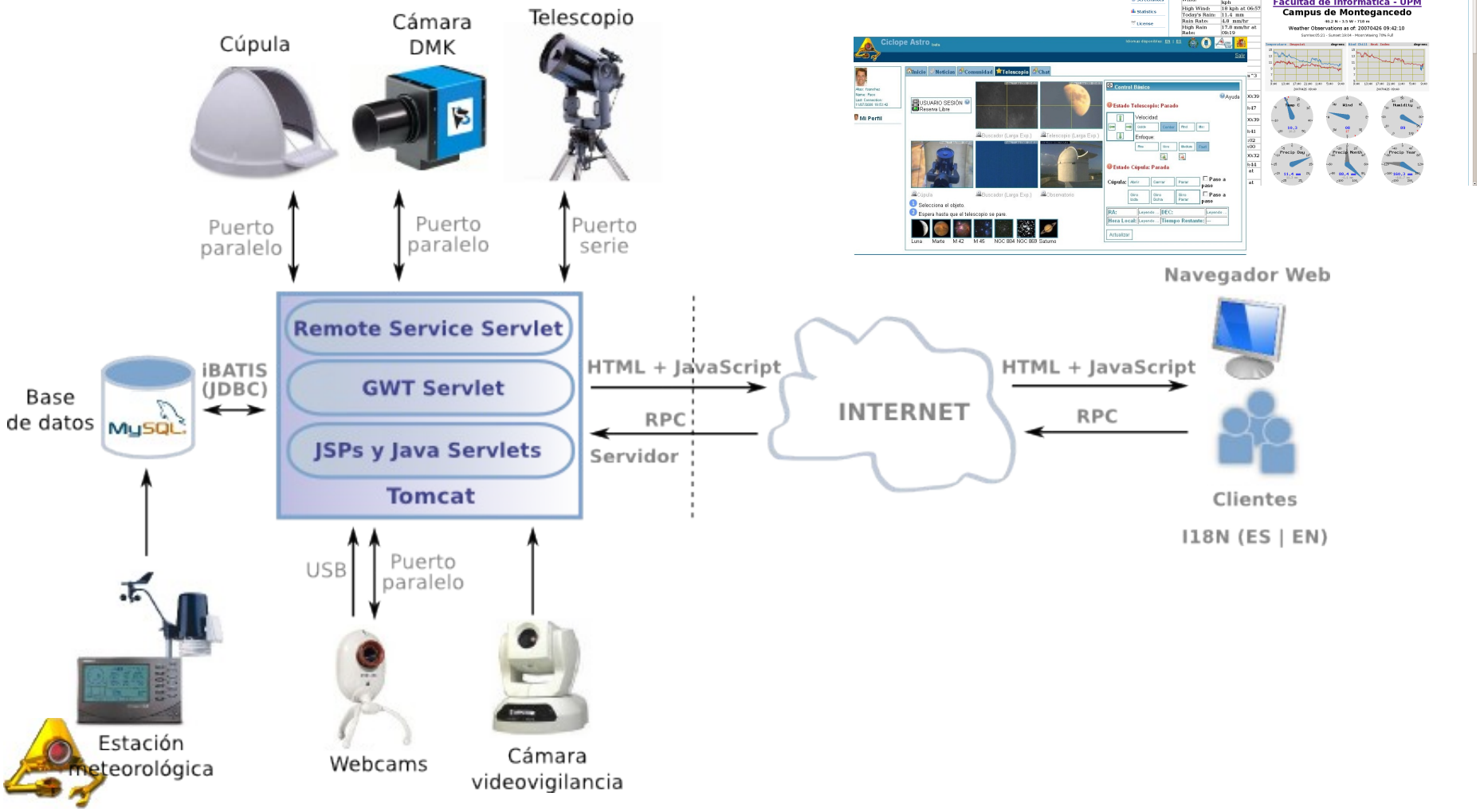
AUDELA: Developed by A. Klotz et al. (Toulouse), starting in 1995. Open source code. Linux/Windows.

ASCOM: Dessigned in 1998, by B. Denny (USA), as an interface standard for astronomical equipment, based on MS's Component Object Model, which he called the Astronomy Common Object Model. Mostly used by amateur astronomers, has been also used by professionals. Windows. Widely used in SN, MP searches.

RTS2: The Robotic Telescope System version 2, is being developed by P. Kubánek, (Ondrejov/Granada) starting in 2000. Open source code. Linux/Windows (command line and graphical interface foreseen). Widely used in GRB searches.

INDI: The Instrument Neutral Distributed Interface (INDI) was started in 2003. In comparison to the Microsoft Windows centric ASCOM standard, INDI is a platform independent protocol developed by E. C. Downey (USA). Open source code. Not so widely spread as the upper layer interface was not done.

Objetive 2: Increase the number of telescopes



Thank you