



ENIGMA

An EC-funded quasar monitoring network

Luisa Ostorero^(*) & Stefan Wagner^(*)
on behalf of the ENIGMA collaboration

^(*) *Landessternwarte Heidelberg, Germany*

Outline

- **The ENIGMA Network**
- **The ENIGMA blazar monitoring facilities**
- **An example of ENIGMA multiwavelength campaign**
- **Possible ENIGMA-AGILE collaboration**
- **Conclusions**

The ENIGMA Network

ENIGMA = **E**uropean
Network for the
Investigation of
Galactic nuclei through
Multifrequency
Analysis

- A network on quasar research funded by the EC
- Period of activity: Nov 2002 - Oct 2006
- 8 teams among the most active in Europe for quasar research
- Program combining new strategies in **empirical** and **theoretical** research towards an understanding of structure and radiation processes of quasars

<http://www.lsw.uni-heidelberg.de/users/swagner/enigma.html>

The ENIGMA Network

ENIGMA Team

Team Leader

- | | |
|---|---------------|
| 1- Landessternwarte Heidelberg
(Germany) | S. Wagner |
| 2- MPIfR, Bonn (Germany) | A. Witzel |
| 3- Tuorla Observatory (Finland) | L. Takalo |
| 4- Metsähovi Radio Observatory
(Finland) | M. Tornikoski |
| 5- Torino Observatory (Italy) | C.M. Raiteri |
| 6- Brera Observatory (Italy) | G. Ghisellini |
| 7- University of Athens (Greece) | K. Tsinganos |
| 8- Cork Institute of Technology | N. Smith |

The ENIGMA Network

ENIGMA Team

Team Leader

Associated Partners (A.P.)

1- Landessternwarte Heidelberg
(Germany)

S. Wagner

O. Kurtanidze (Abastumani Obs., Georgia)
J. Kirk (MPIK, Hedelberg, Germany)

2- MPIfR, Bonn (Germany)

A. Witzel

3- Tuorla Observatory (Finland)

L. Takalo

4- Metsähovi Radio Observatory
(Finland)

M. Tornikoski

5- Torino Observatory (Italy)

C.M. Raiteri

G. Tosti (Perugia University Obs.)

6- Brera Observatory (Italy)

G. Ghisellini

7- University of Athens (Greece)

K. Tsinganos

I. Papadakis (FORTH, Crete, Greece)

8- Cork Institute of Technology

N. Smith

L.Hanlon,B.McBreen (Dept. Exp.
Phys.,UC,Dublin)
D. Gabuzda (Physics Dept., UC Cork)
K. Nolan (IT Tallaght, Dublin)

The ENIGMA Network

ENIGMA Team

Team Leader

Young Researchers

1- Landessternwarte Heidelberg
(Germany)

S. Wagner

D. Emmanoulopoulos
L. Ostorero
E. Ferrero

PhD
post-doc
post-doc

2- MPIfR, Bonn (Germany)

A. Witzel

E. Angelakis
I. Agudo

PhD
post-doc

3- Tuorla Observatory (Finland)

L. Takalo

S. Ciprini

post-doc

4- Metsähovi Radio Observatory
(Finland)

M. Tornikoski

M. Tröller

PhD

5- Torino Observatory (Italy)

C.M. Raiteri

U. Bach
L. Fuhrmann

post-doc
post-doc

6- Brera Observatory (Italy)

G. Ghisellini

K. Katarzynski

post-doc

7- University of Athens (Greece)

K. Tsinganos

J. Gracia

post-doc

8- Cork Institute of Technology

N. Smith

A. Papageorgiou

post-doc


The ENIGMA Science Program

SIX SCIENCE TASKS

- 1) Towards automated, fast, and accurate photometry
- 2) Separating intrinsic and extrinsic Intraday Variability
- 3) Radiation processes at high energies
- 4) Variations of Source Structure and Flux
- 5) Particle acceleration in MHD outflows
- 6) The Power of Jets

The ENIGMA Science Program

SIX SCIENCE TASKS

- 1) Towards automated, fast, and accurate photometry
- 2) Separating intrinsic and extrinsic Intraday Variability
-  3) **Radiation processes at high energies**
- 4) Variations of Source Structure and Flux
- 5) Particle acceleration in MHD outflows
- 6) The Power of Jets

The ENIGMA Science Program

Task 3: Radiation processes at high energies

- Coordinated multi-frequency monitoring is an essential tool for the understanding of radiation mechanisms
- ENIGMA goals:
 - Set up of strategies for coordinated long- and short-term monitoring programs to be conducted in parallel with the European opportunities **XMM**, **INTEGRAL**, **AGILE**, **H.E.S.S.** and **MAGIC**.
 - Carrying out of such coordinated observing campaigns, making use of the first-time availability of a complete wavelength coverage, including radio-, mm-, near-IR, optical, X-ray, and gamma-ray instrumentation
<http://kurp.hut.fi/~mtt/enigma/>
 - Creation of a multifrequency archive
<http://www.astro.utu.fi/enigma.html>



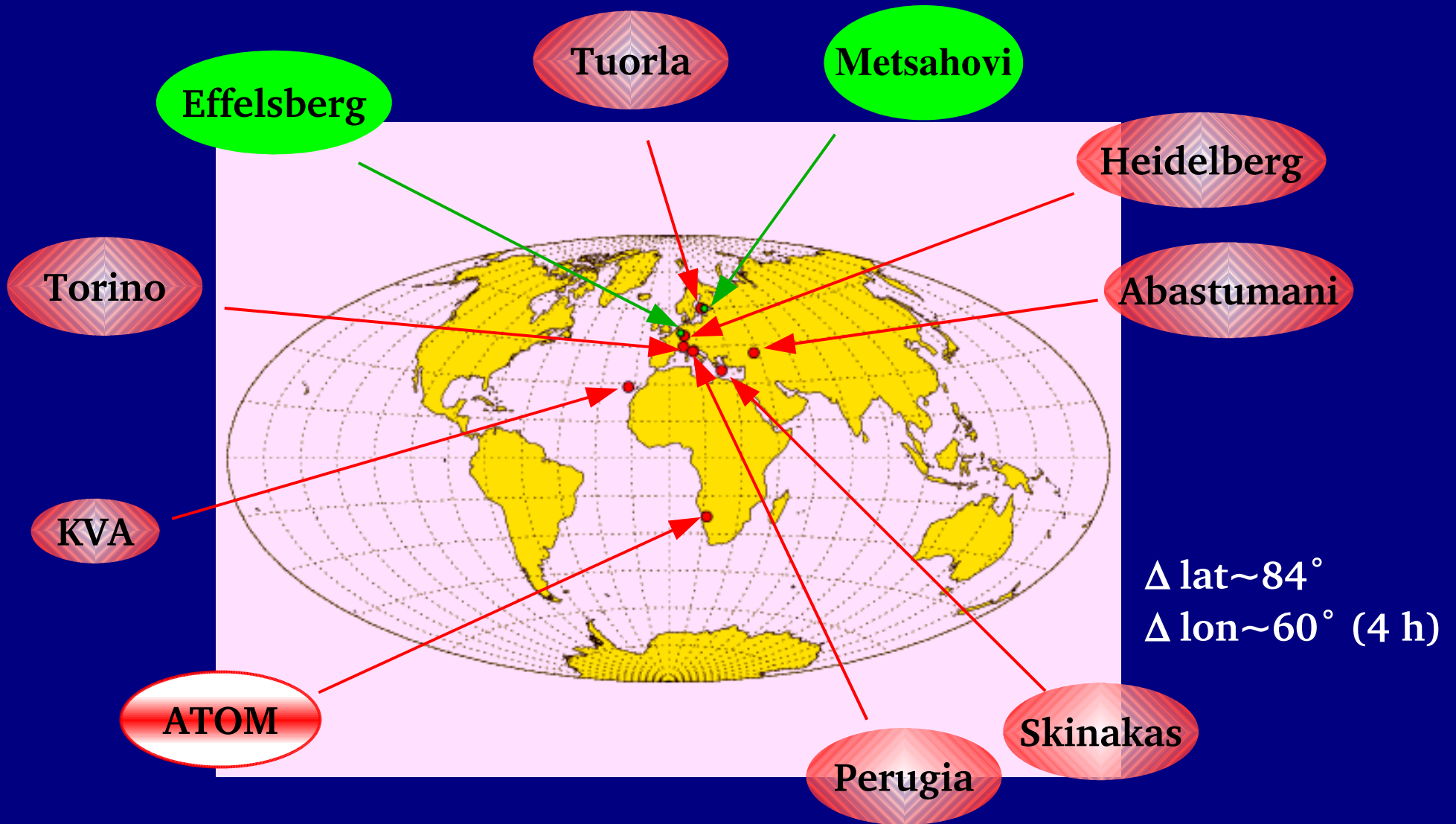
The ENIGMA observing facilities



ENIGMA Team	Telescope (OPT/RAD)	Telescope diam.	Tel. instr. PH/POL/SP	ENIGMA contact person
LSW Heidelberg	Heidelberg, Germany	70 cm	PH	S. Wagner
	ATOM, Namibia	75 cm	PH	S. Wagner
	Abastumani, Georgia	70 cm	PH	O. Kurtanidze (A.P.)
Torino Observatory	Torino, Italy	105 cm	PH	M. Villata
	Perugia, Italy	40 cm	PH	G. Tosti (A.P.)
Tuorla Observatory	Tuorla, Finland	100 cm	PH	L. Takalo
	KVA, La Palma, Spain	35/60 cm	PH/POL	L. Takalo
University of Athens	Skinakas, Crete, Greece	130 cm	PH/SP	I. Papadakis (A.P.)
Metsahovi Radio Observatory	Metsahovi, Finland	14 m		M. Tornikoski
MPIfR, Bonn	Effelsberg, Germany	100 m		T. Krichbaum

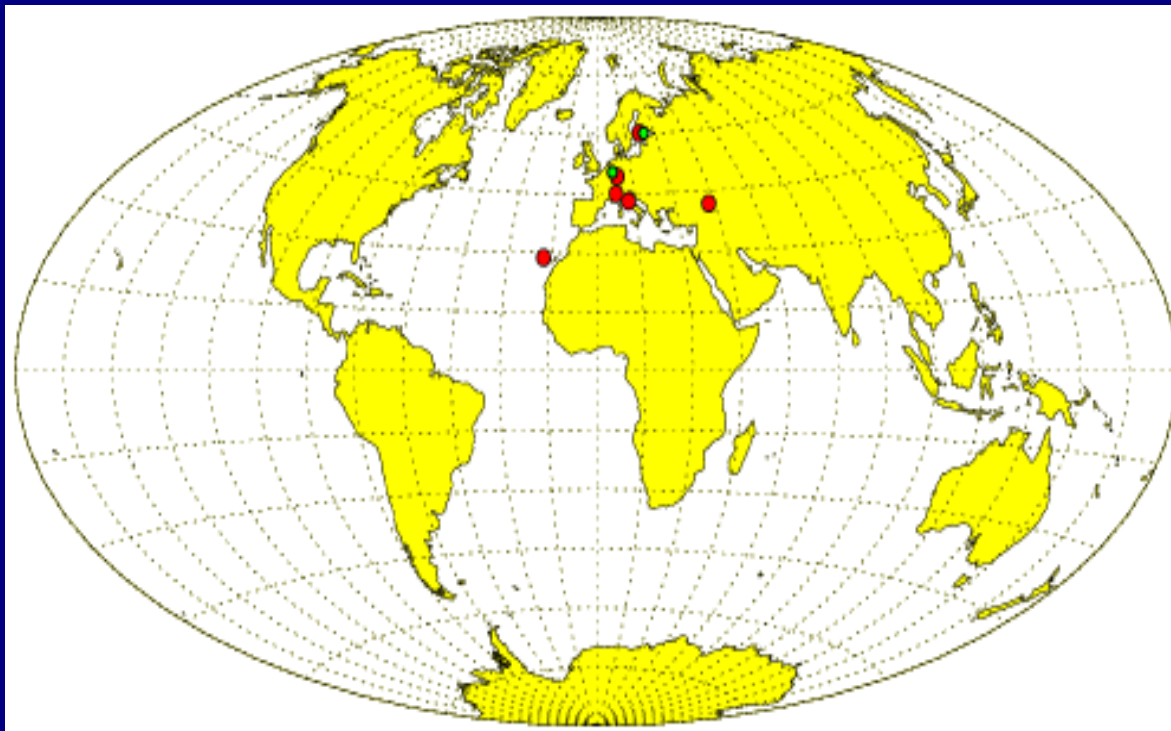


The ENIGMA observing facilities



An example of ENIGMA multi- λ campaign

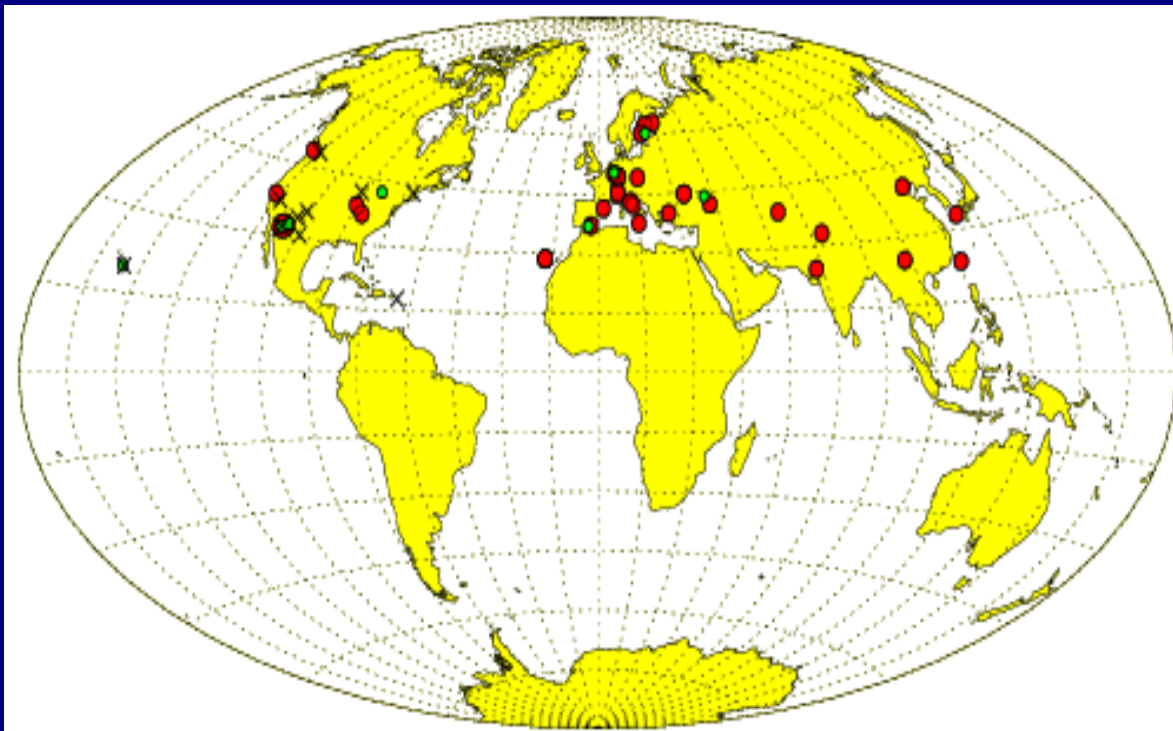
- Target: BL Lac object S5 0716+714 (IDV, high Tb)
- ENIGMA-INTEGRAL observation of \sim 1 week in November 2003
- Simultaneous multiwavelength observations organized by ENIGMA:
 - ENIGMA observing facilities



- 6 optical telescopes (35 cm -1.3 m)
- 2 Radio telescopes

An example of ENIGMA multi- λ campaign

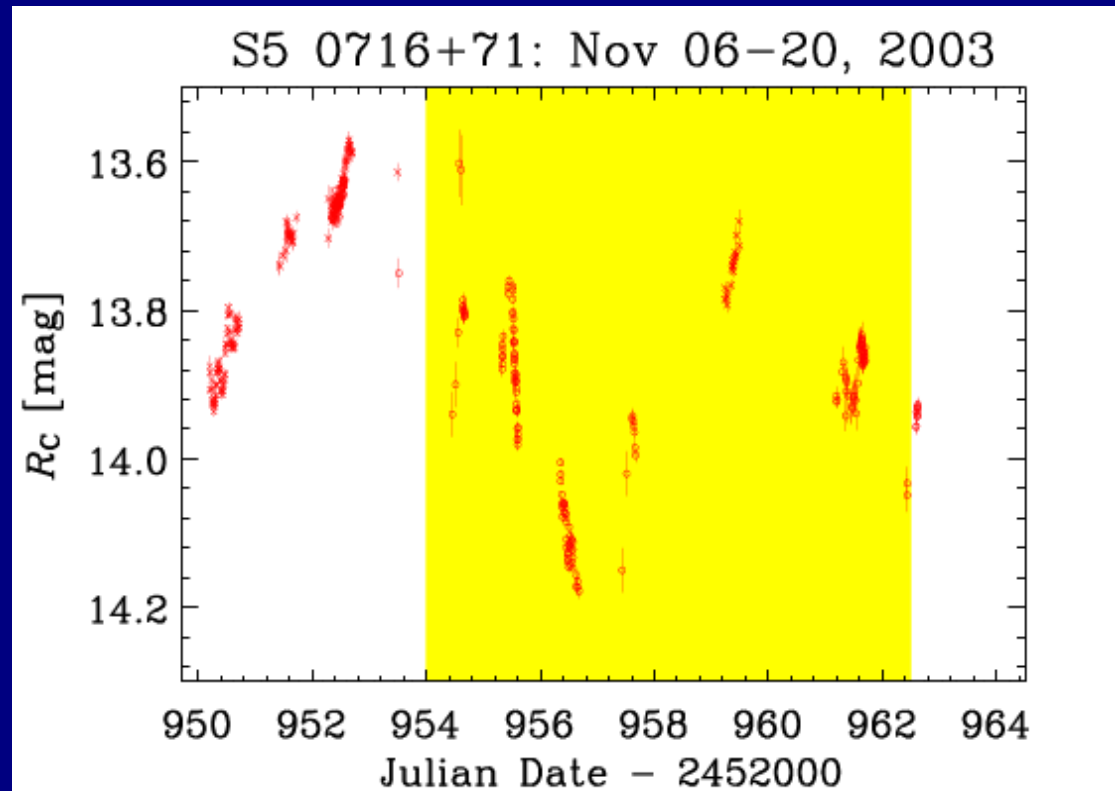
- Target: BL Lac object S5 0716+714 (IDV, high Tb)
- ENIGMA-INTEGRAL observation of \sim 1 week in November 2003
- Simultaneous multiwavelength observations organized by ENIGMA:
 - ENIGMA observing facilities
 - ENIGMA + coordinated observatories + WEBT consortium
(see next presentation)



- 38 Opt/IR telescopes (28 cm–4.2 m)
- 9 Radio/mm/submm telescopes
- X VLBA antennas

An example of ENIGMA multi- λ campaign

Optical R-band light curve during a 2-week period including the INTEGRAL pointing: result of the ENIGMA facilities



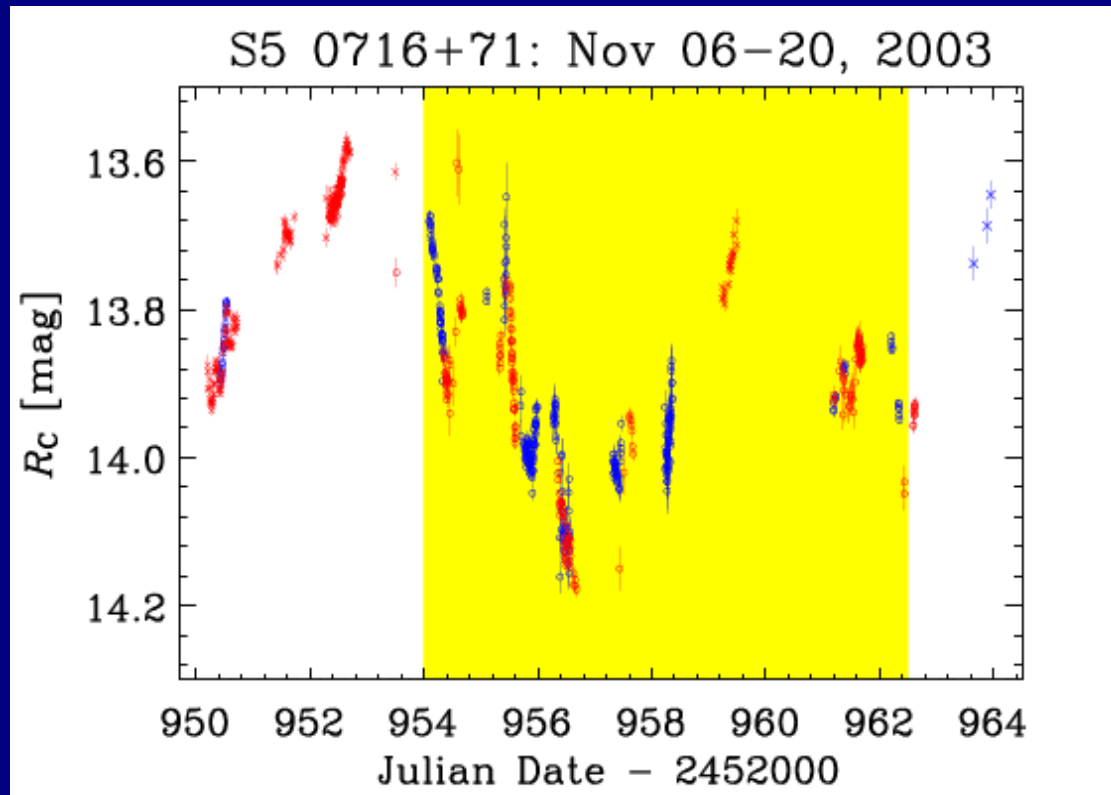
● ENIGMA data

INTEGRAL pointing

6 optical telescopes
~1050 R-band data-points in ~2 weeks

An example of ENIGMA multi- λ campaign

Optical R-band light curve during a 2-week period including the INTEGRAL pointing: result of the **whole collaboration**



● ENIGMA data
● other data

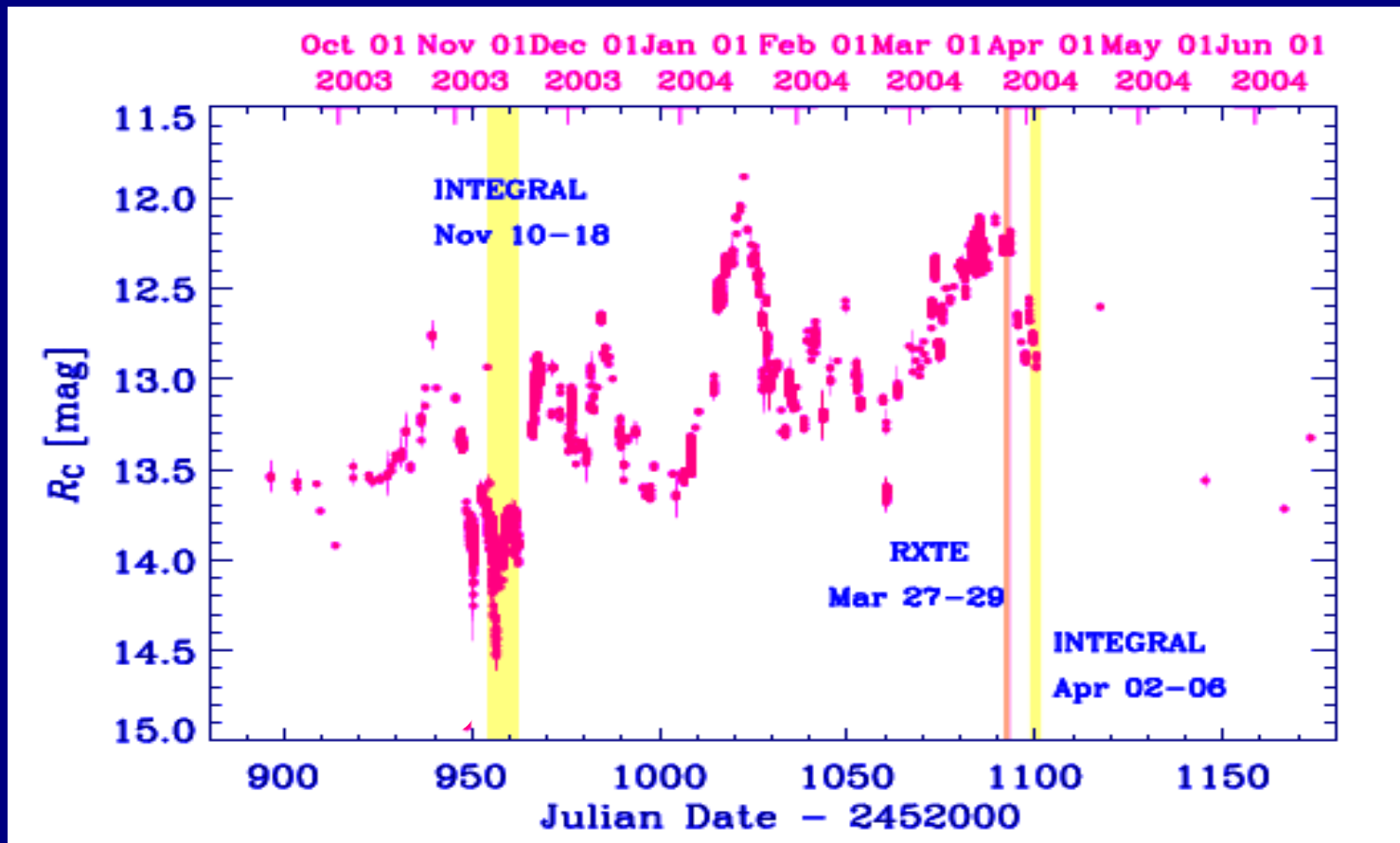
INTEGRAL pointing

13 optical telescopes
~1950 R-band data-points in ~2 weeks

An example of ENIGMA multi- λ campaign

ENIGMA can act as an alert system for high-energy observations

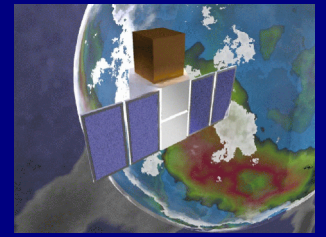
S5 0716+71 : R-band light curve during October 2003 - Jun 2004



38 optical telescopes (whole collaboration)
~ 10.000 R-band data-points in ~8 months



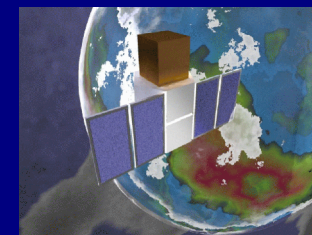
Possible ENIGMA-AGILE collaboration



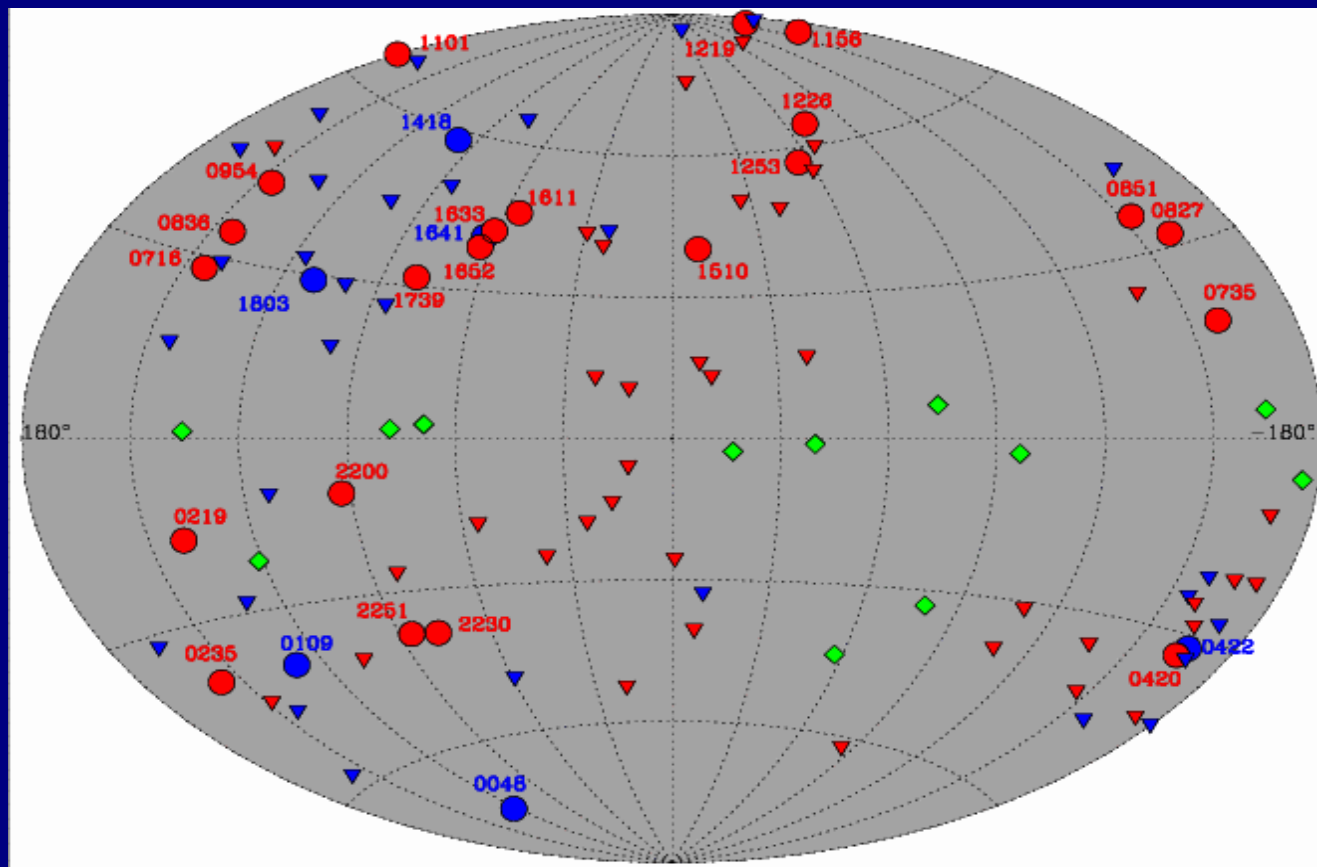
- ENIGMA will be able to carry out multiwavelength follow-up of AGILE observations of blazars until October 2006
- The relevance of the ENIGMA contribution will depend on:
 - AGILE observing strategy during CYCLE-1
 - Weather conditions



Possible ENIGMA-AGILE collaboration



ENIGMA accessible sky

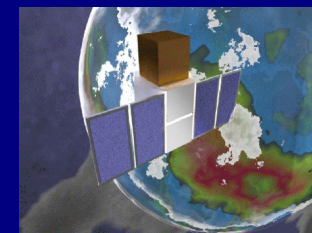


- ENIGMA accessible sky
- ▼ EGRET blazars
- ▼ non-EGRET blazars

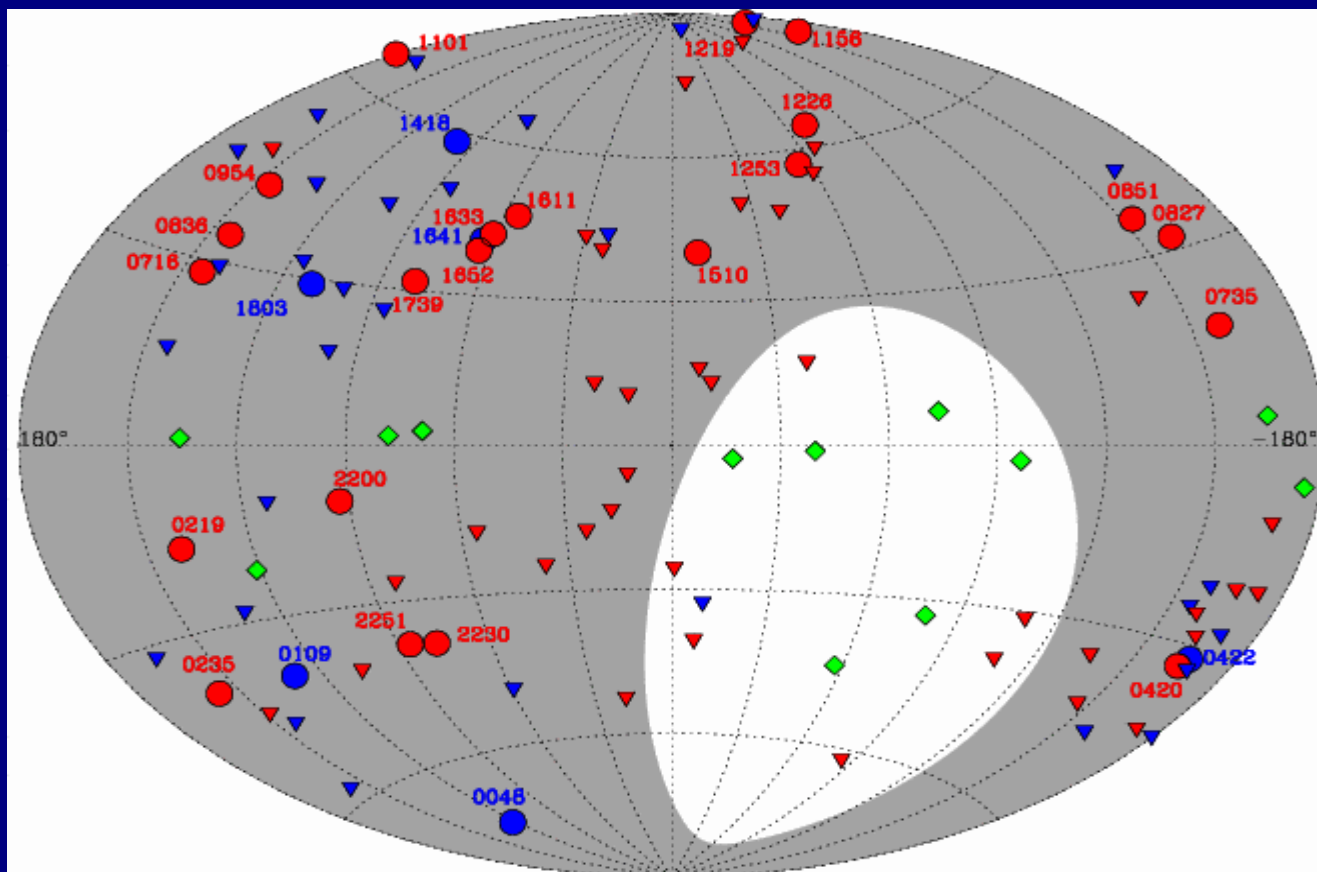
●▼●▼ ~100 blazars monitored by ENIGMA optical observatories



Possible ENIGMA-AGILE collaboration



ENIGMA accessible sky : better monitoring

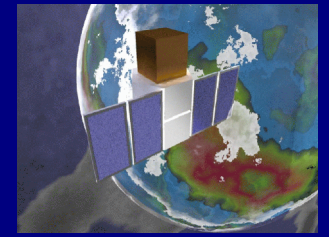


- ENIGMA accessible sky
- ▼ EGRET blazars
- ▼ non-EGRET blazars

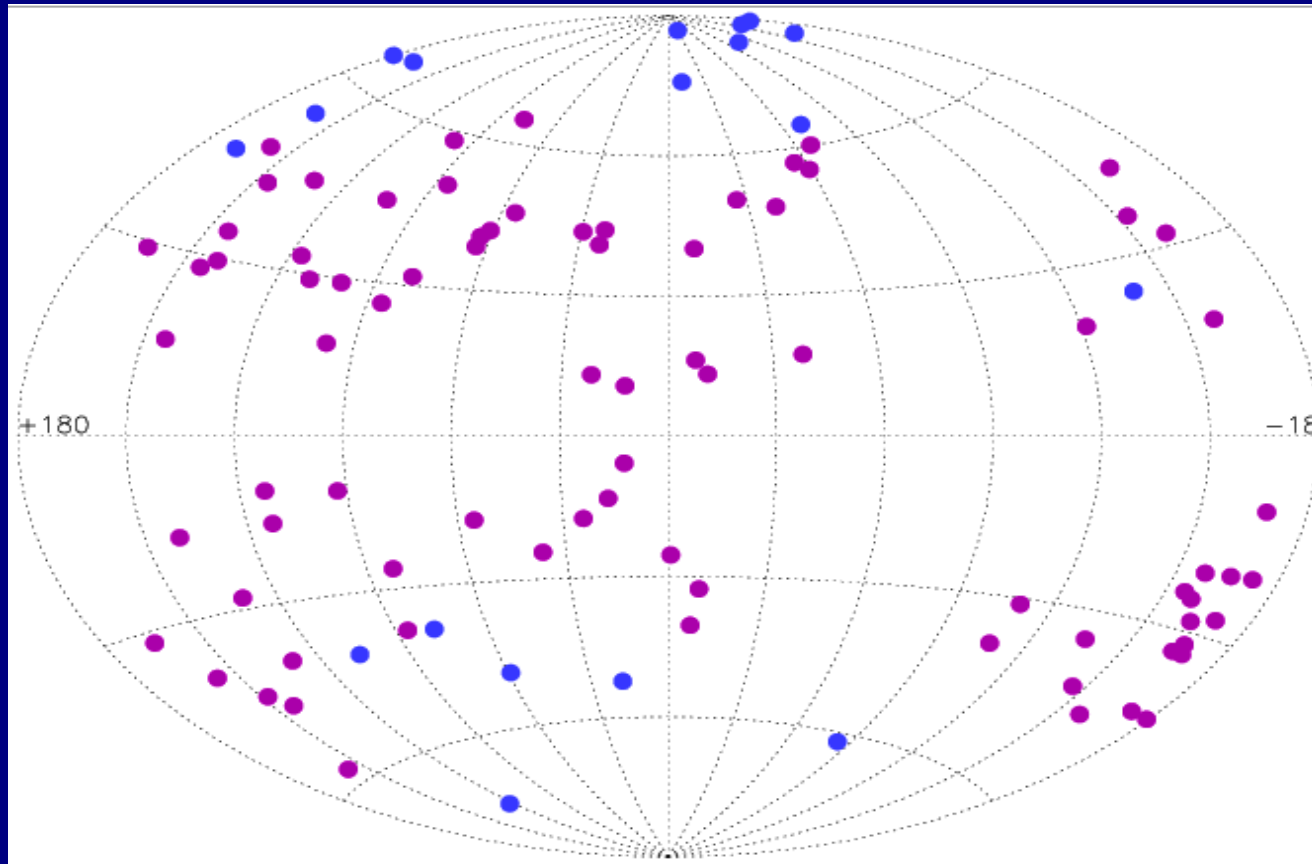
●▼●▼ ~100 blazars monitored by ENIGMA optical observatories



Possible ENIGMA-AGILE collaboration



Possible AGILE Cycle-1 (all-sky): exposures



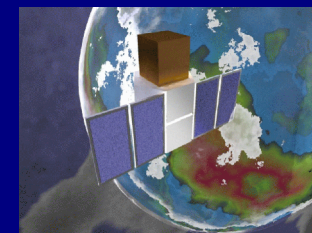
AGILE Cycle-1
exposures
[cm²·sec]

- > 1.e9
- 1.e8 ÷÷ 1.e9

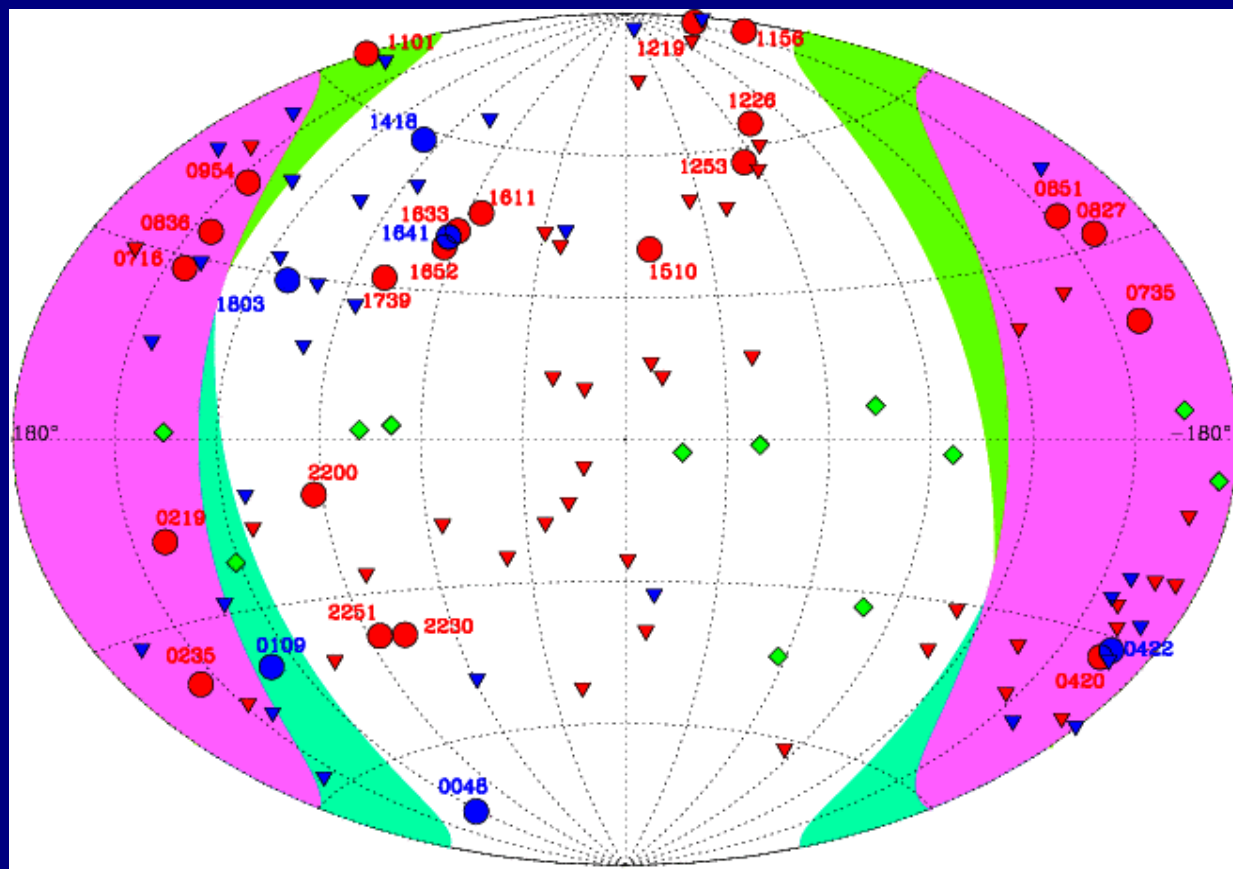
courtesy of S.Vercellone



Possible ENIGMA-AGILE collaboration



Example of AGILE-ENIGMA joint observation



HYP.
~ March 2006

1-month pointing
towards the Crab
region

AGILE observed
sources:

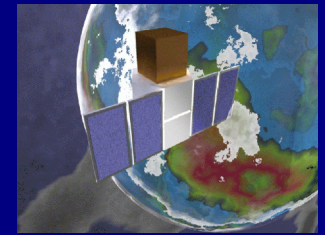
23 EGRET blazars
17 non-EGRET blazars



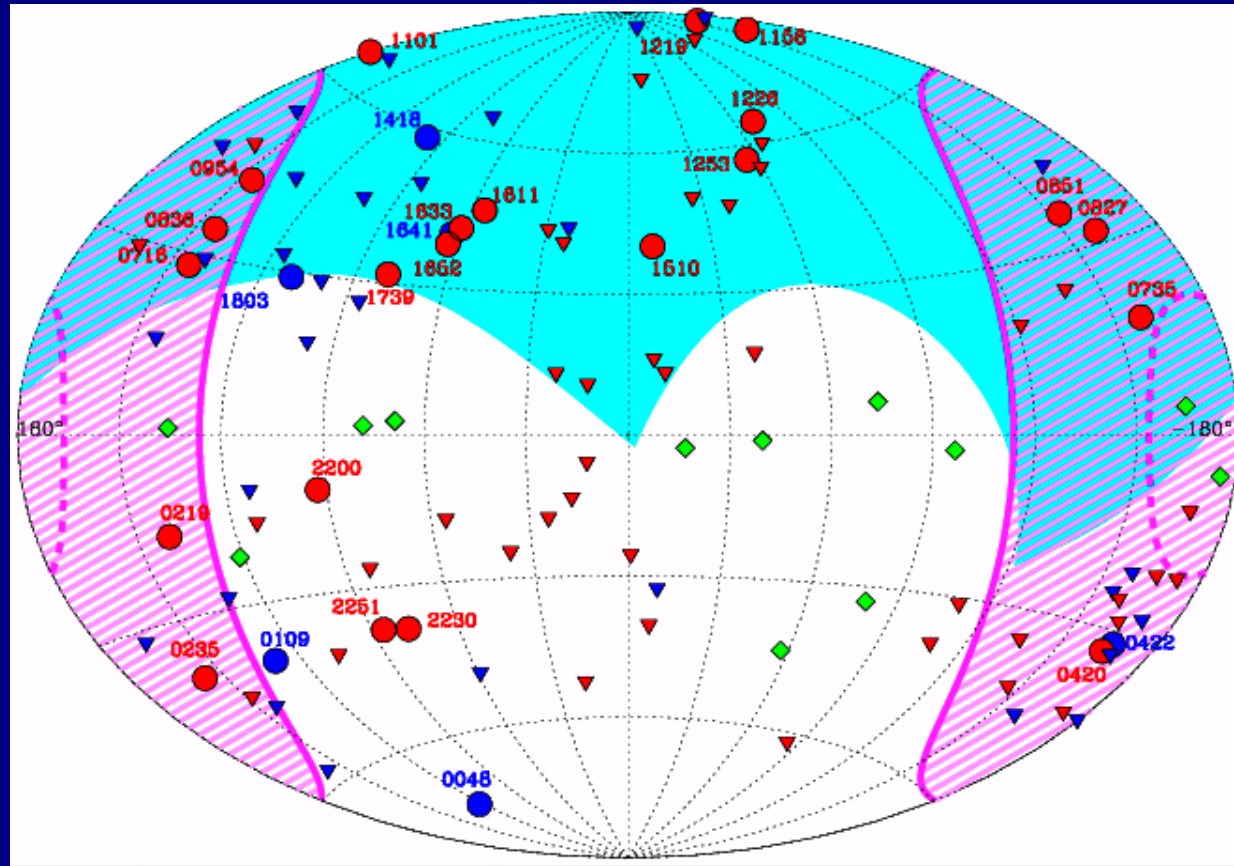
AGILE F.O.V. evolution during the 1-month pointing



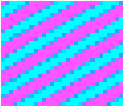
Possible ENIGMA-AGILE collaboration




Example of AGILE-ENIGMA joint observation



HYP.
 ~ March 2006
 1-month pointing
 towards the Crab
 region

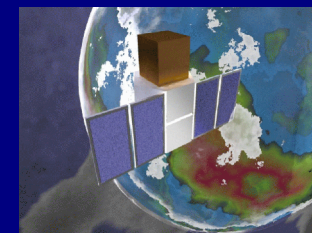
AGILE-ENIGMA
 observable sources: 
 10/23 EGRET blazars
 4/17 non-EGRET blazars

 Night sky which can be well monitored by ENIGMA optical telescopes in March

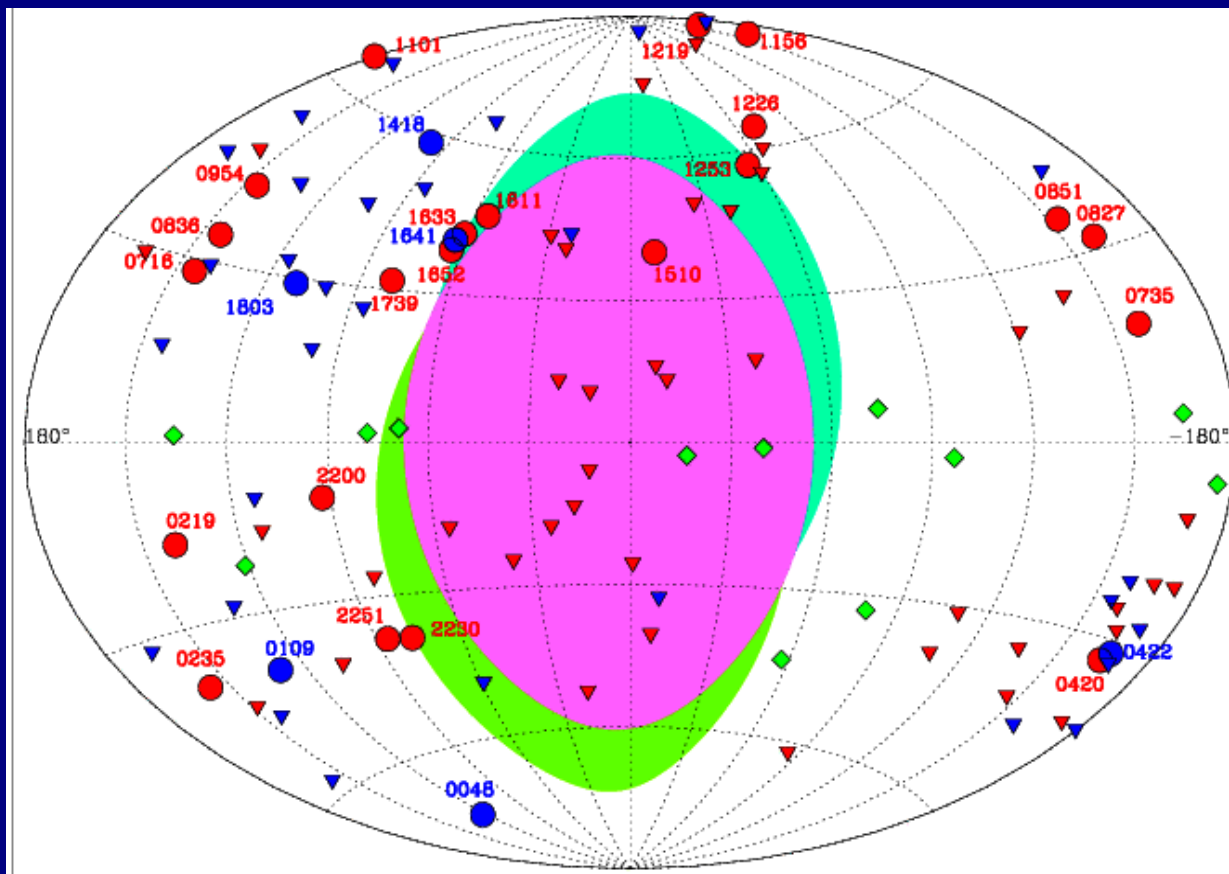
 AGILE F.O.V.



Possible ENIGMA-AGILE collaboration



Example of AGILE-ENIGMA joint observation



HYP.
~ Sep 2006

1-month pointing
towards the
Galactic Center

AGILE observed
sources:

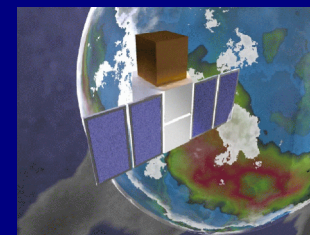
21 EGRET blazars
2 non-EGRET blazars



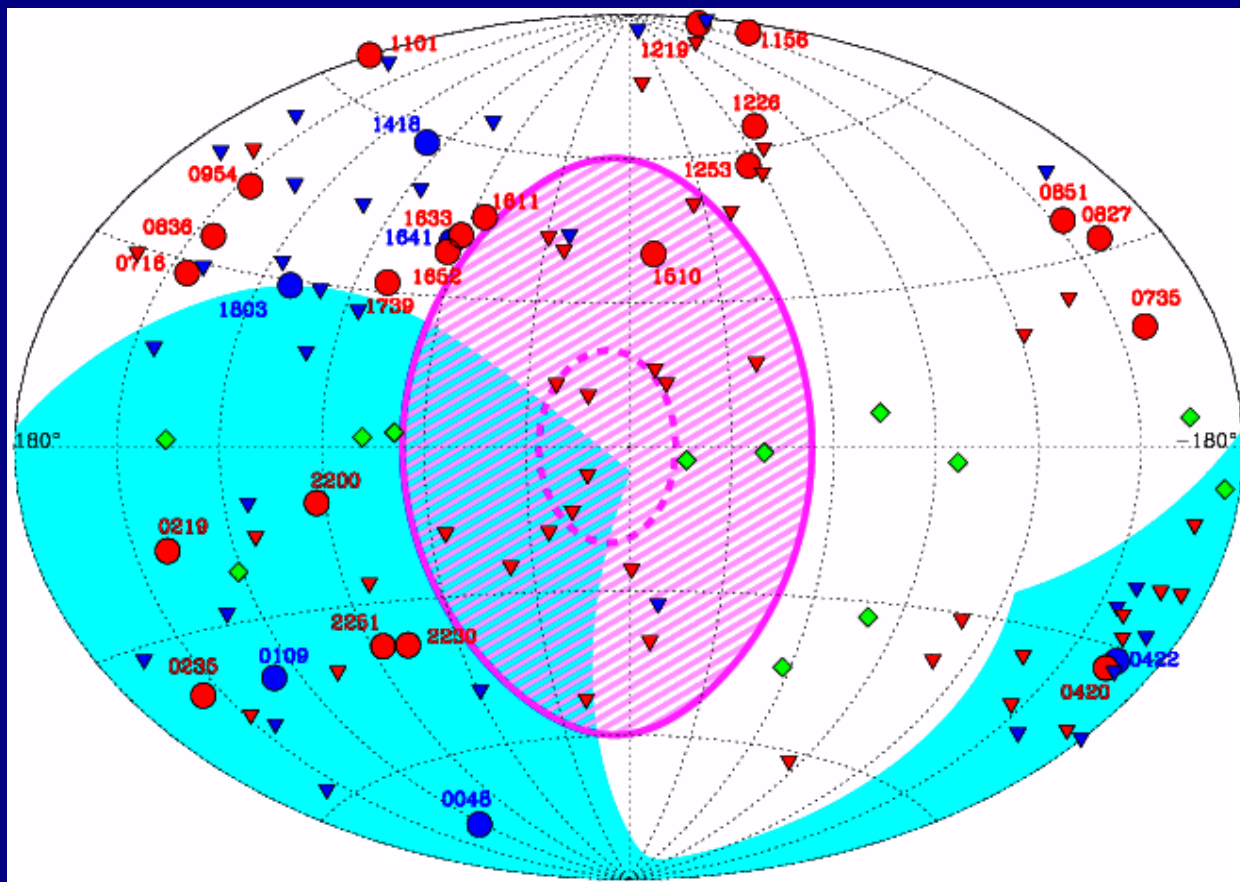
AGILE F.O.V. evolution during the 1-month pointing



Possible ENIGMA-AGILE collaboration

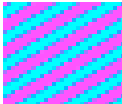


Example of AGILE-ENIGMA joint observation




HYP.
~ Sep 2006

1-month pointing
towards the
Galactic Center

AGILE-ENIGMA
observable sources: 

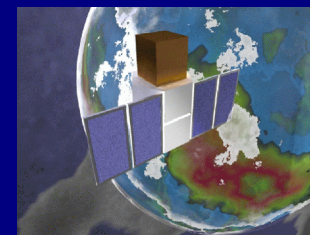
3/21 EGRET blazars
0/2 non-EGRET blazars

 Night sky which can be well monitored by ENIGMA optical telescopes in September

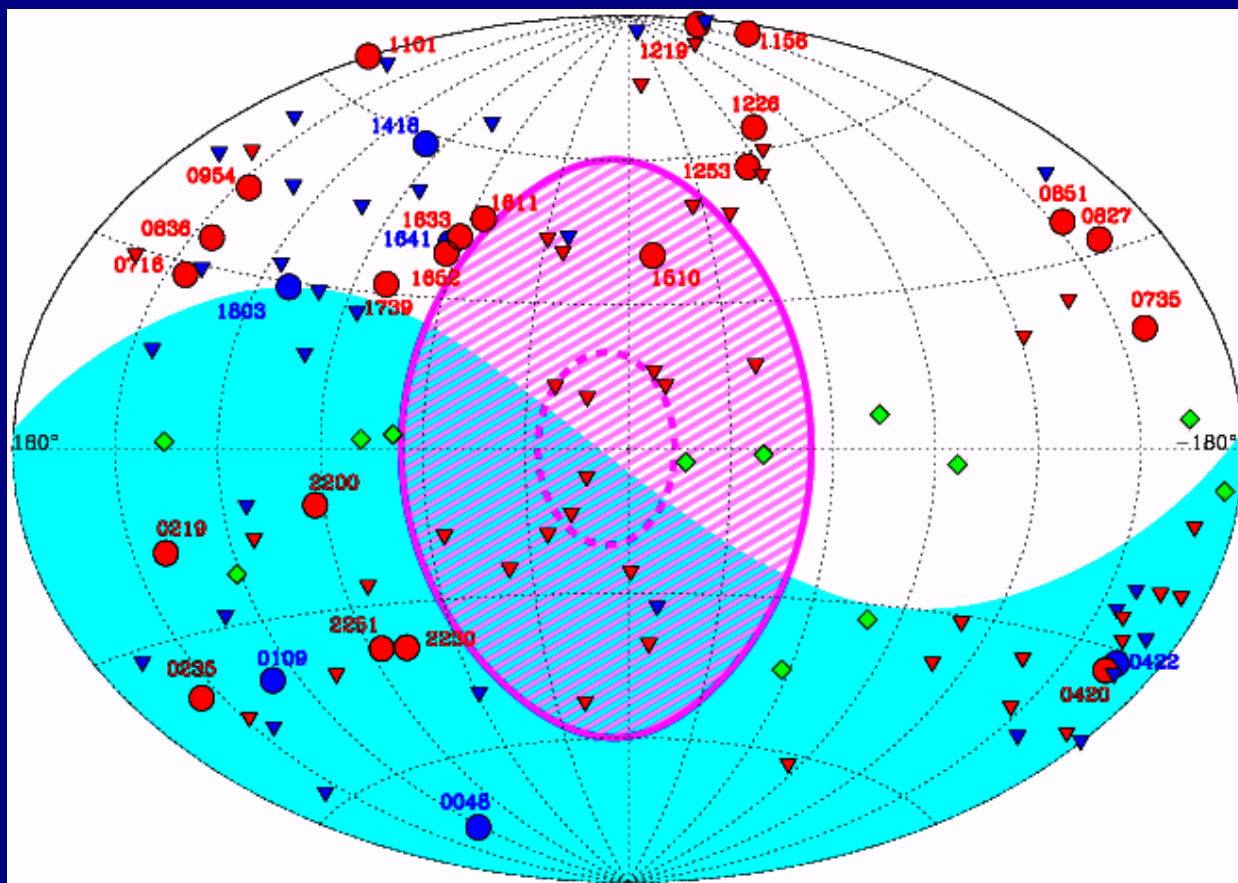
 AGILE F.O.V.



Possible ENIGMA-AGILE collaboration



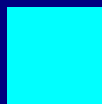
Example of AGILE-ENIGMA joint observation



HYP.
 ~ Sep 2006
 1-month pointing
 towards the
 Galactic Center

AGILE-ENIGMA
 observable sources
 (with Southern
 facilities taken into account)

8/21 EGRET blazars
 1/2 non-EGRET blazars

 Night sky which can be monitored by ENIGMA optical telescopes in September

 AGILE F.O.V.

Conclusions

- The ENIGMA-AGILE collaboration is one of the goals of the ENIGMA Science Program
- ENIGMA can participate in the ground-based multiwavelength follow-up of the AGILE Cycle-1 observations of blazars until October 2006
⇒ Observing facilities: 8 optical telescopes + 2 radio antennas
- ENIGMA can act as an alert system for high-energy observations
- The relevance of the ENIGMA contribution will depend on the AGILE Cycle-1 pointing plan: better follow-up of Northern sources

WEBT

Whole Earth Blazar Telescope

Luisa Ostorero

on behalf of Massimo Villata , President of the WEBT collaboration



*13 optical and multiwavelength campaigns since 1997
with the participation of more than 70 optical and 10 radio and near-IR
telescopes*

WEBT: Whole Earth Blazar Telescope

CONSTITUTION (Dec. 2000)

(from) Art. 2 - Purpose

- The purpose of the WEBT is the organization of optical photometric observations of the celestial bodies called Blazars during optical and multiwavelength campaigns involving observatories located at different longitudes all around the world, in order to obtain a continuous monitoring of the target source and, as final result, a high-temporal-density, high-precision, uninterrupted optical light curve during all the campaign period.
- The WEBT will function as a non-profit worldwide scientific organization, and the results obtained will be published and shared with the international scientific community

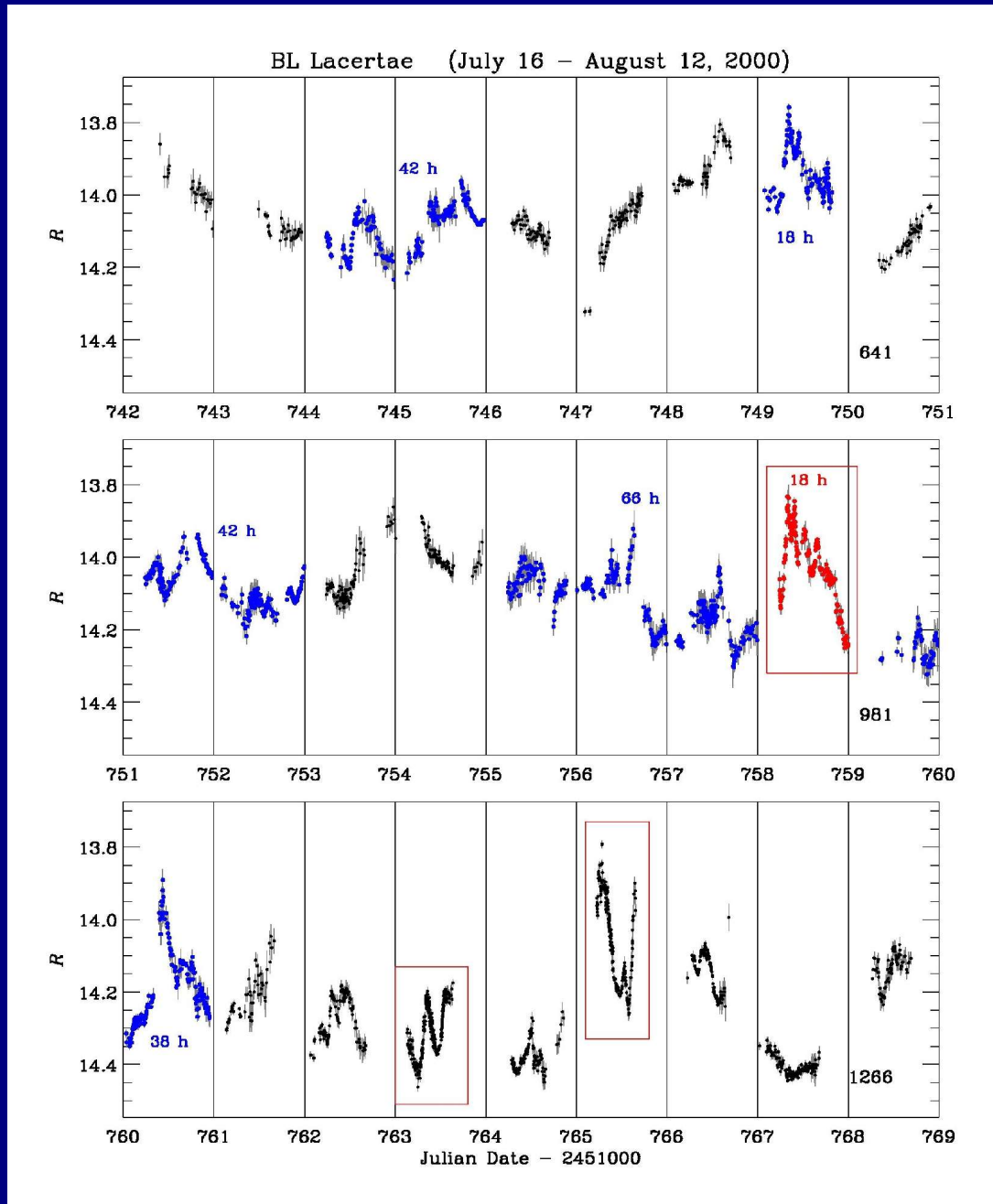
WEBT: Whole Earth Blazar Telescope

CONSTITUTION (Dec. 2000)

(from) Art. 7 – Campaigns

- WEBT campaigns may be proposed to the President by anyone.
- The President may officially endorse the campaign to be a WEBT campaign.
- The President will appoint a Campaign Manager to organize and lead the campaign.
- Duties of the Campaign Manager:
 - recruitment of the observers, creation of a campaign web page (information and instructions, observing strategy, participant list), correspondence with all the observers, informing the participants about the state of the campaign and on the behaviour of the target source from preliminary data reduction, data collection and analysis, plot of the final light curves.
- Duties of the participating observers:
 - informing the Campaign Manager on the instrumentation used and on the state of their observing activity, providing the Campaign Manager with their reduced data or pre-reduced frames within the fixed deadline.
- Campaign results:
 - published in a dedicated paper after consultation and agreement with the Executive Officer for publication.

WEBT: Whole Earth Blazar Telescope



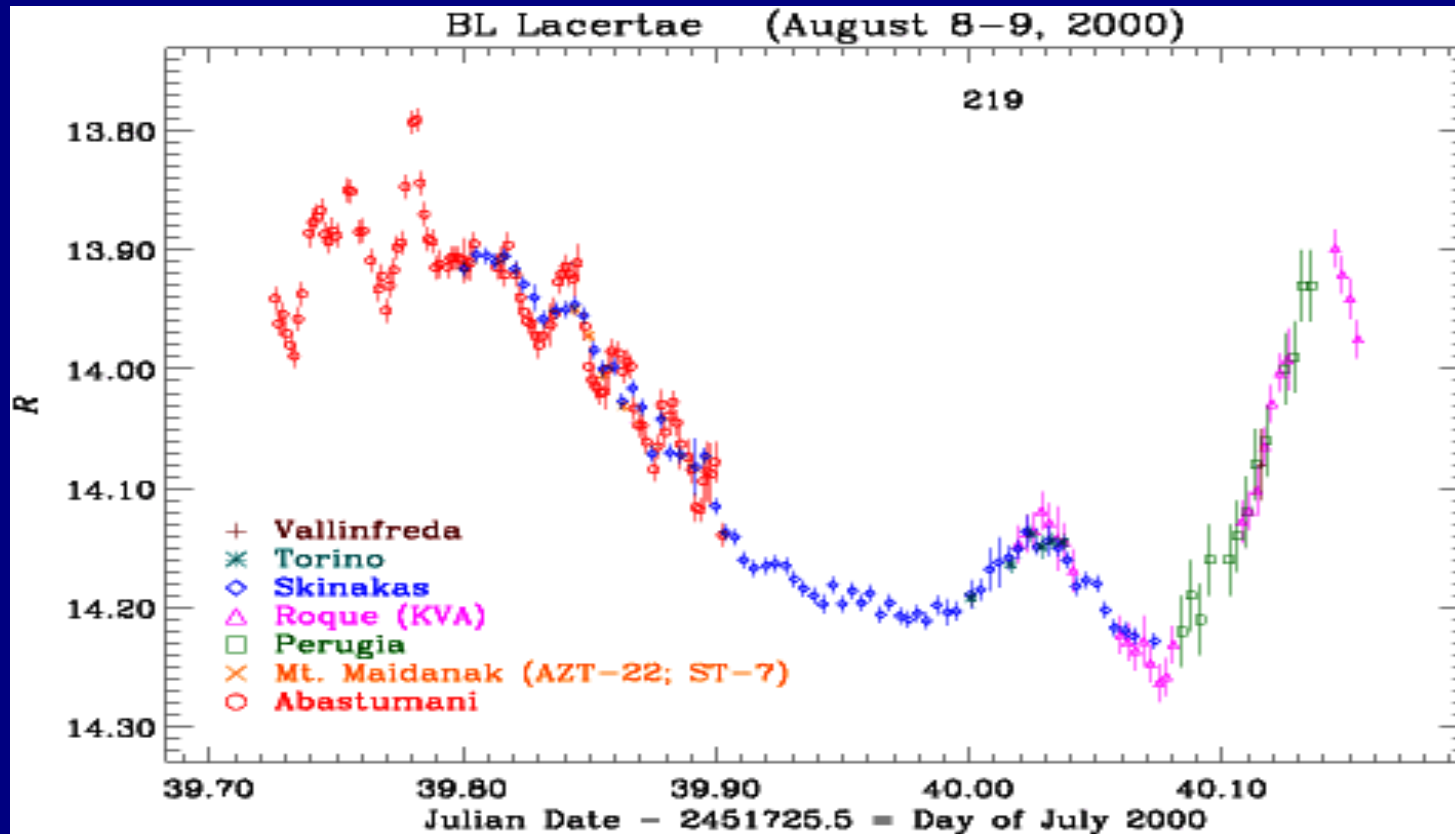
BL Lacertae campaign 2000

Example of a medium-term campaign (~1 month) :

an almost uninterrupted light curve (composed by ~3000 data points) with continuous segments of 1-3 days separated by gaps of few hours (the “Pacific gap”)

(Villata et al. 2002, *A&A*, 390, 407)

WEBT: Whole Earth Blazar Telescope



Focusing on a single segment of ~12 hours, the figure shows how the observing task moves from east to west during the “night”

(Villata et al. 2002, *A&A*, 390, 407)

Thank you for your attention