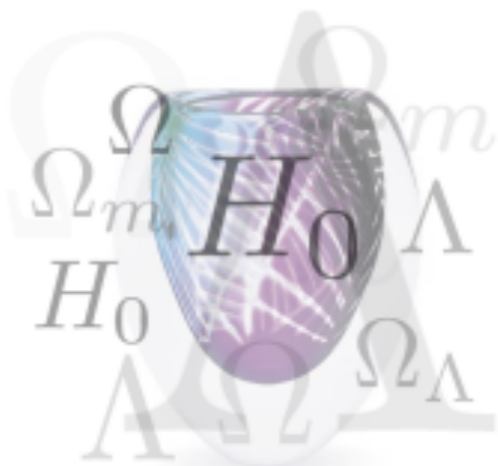


COSMOGRAIL update

F. Courbin , on behalf of COSMOGRAIL

*Laboratoire d'Astrophysique, EPFL
Switzerland*



COSMO *Grail*

Cosmological **Mo**onitoring of **Gra**vitational **L**enses ... to measure “time delays”, to constrain H_0 , to learn about DE

EPFL: G. Meylan, F. Courbin, M. Tewes, Y. Revaz, N. Cantale, V. Bonvin, D. Paraficz

IIA Bangalore: T. Prabhu, C.S. Stalin, R. Kumar, D. Sahu

Univ. Bonn: D. Sluse

Univ. Liège: P. Magain, E. Eulaers, V. Chantry

UzAS Tashkent: I. Asfandiyarov

Univ. Zürich: P. Saha, J. Coles

Univ. Nottingham: S. Dye

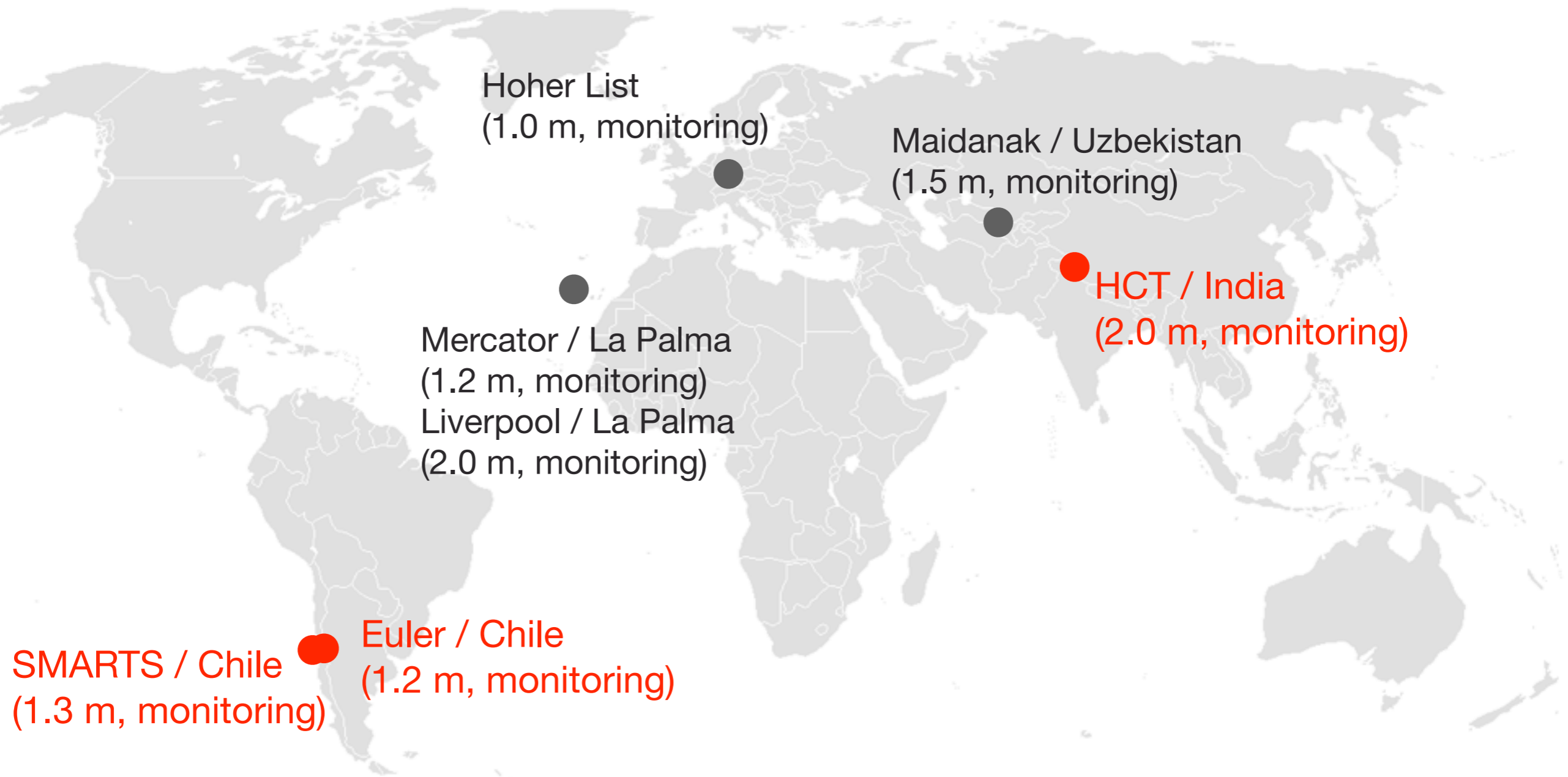
Now also in close collaboration (monitoring, microlensing) with:
C. Kochanek, A. Mosquera (Ohio), C. Morgan, C. MacLeod, L. Hainline (USNA)

And the lens modeling & cosmography experts :

S. Suyu (ASIAA), T. Treu (UC Santa Barbara), M. Auger (Cambridge), P. Marshall (Oxford), S. Hilbert (Stanford), L. Koopmans (Groningen), C. Fassnacht (UC. Davis), R. Blandford (KIPAC), T. Collett (Cambridge), S. Vegetti (MIT)

See <http://cosmograil.org>

COSMOGRAIL monitoring telescopes



Main teams doing lens monitoring joined forces in 2010 :

- 1) EPFL-led COSMOGRAIL team (started in 2004) : Lead time delay work
- 2) Group of C. S. Kochanek (Ohio), using SMARTS 1.3-m : Lead microlensing work

Measurements of time delays (2004+)

- COSMOGRAIL: the COSmological MOnitoring of GRAvItational Lenses
- Dedicated (optical) monitoring program to measure many lensed quasars over a decade or more
- Small telescopes are used, but with high temporal sampling
- Deconvolution technique to sharpen the images

Euler Telescope, La Silla, Chile (1.2m)



Himalayan Chandra Telescope, India (2m)



Mercator Telescope, La Palma, Spain (1.2m)



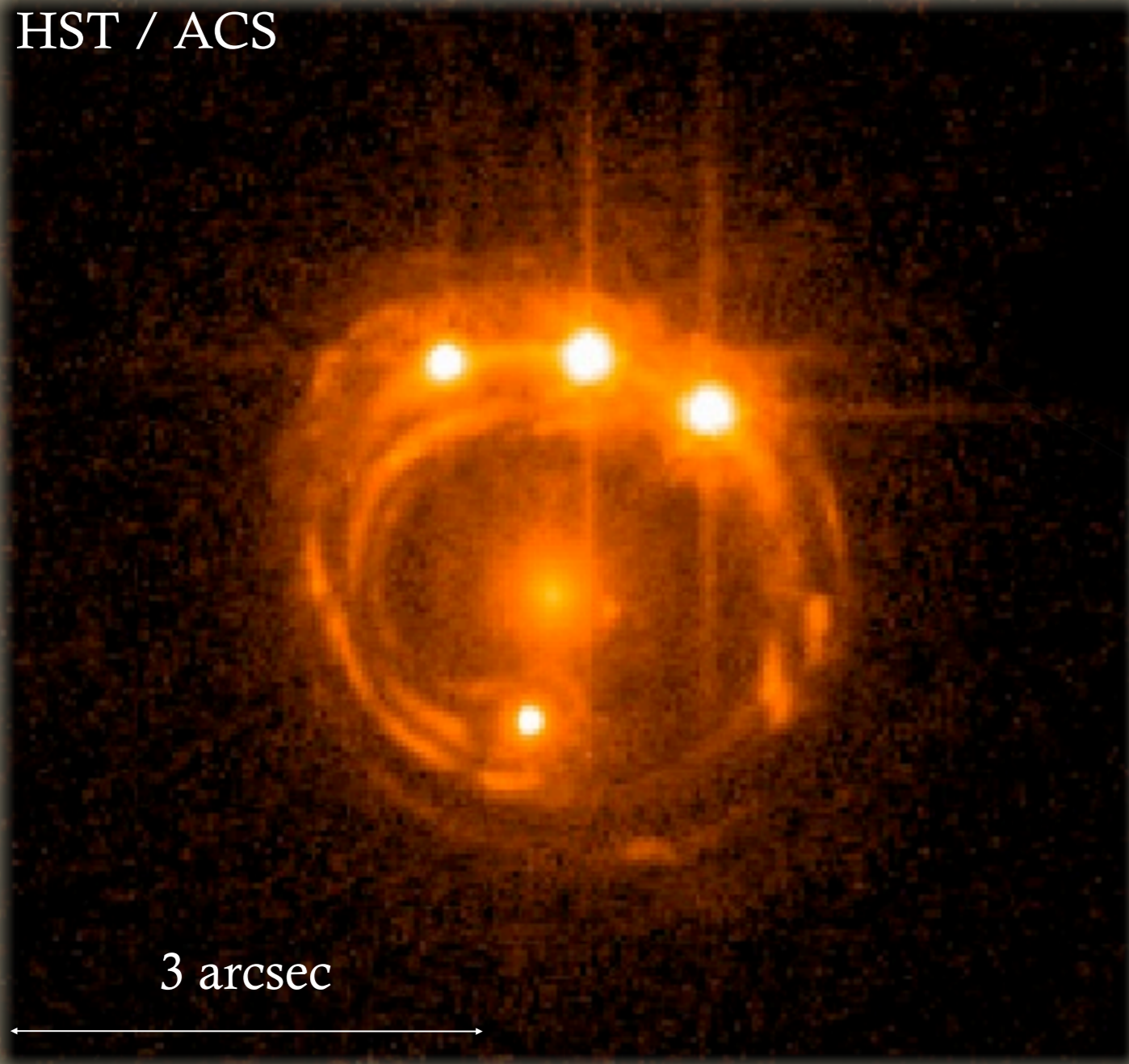
Maidanak observatory, Uzbekistan (1.5m)

COSMOGRAIL

- COSmological MOnitoring of GRAvItational Lenses
- Started in 2004 !
- Based on previous effort with the NOT, the 1.5m Danish at ESO and with the NTT
- Photometry to 0.01 mag rms from image **deconvolution** for $R < 19$
- Between 2 and 4 points per week depending on objects
- **pyCS** curve shifting toolbox (publicly available !) from Tewes et al.
- Motivation: measure time delays with a **few % precision** and realistic **estimate of the systematic errors**.

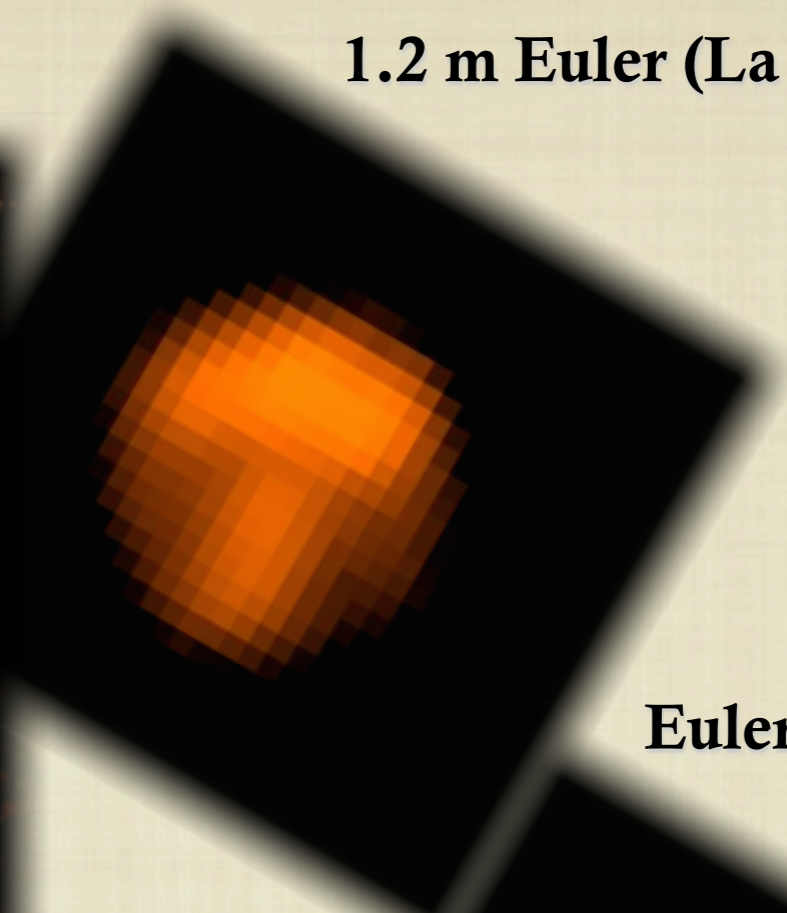
Example of monitoring data

HST / ACS



3 arcsec

1.2 m Euler (La Silla)

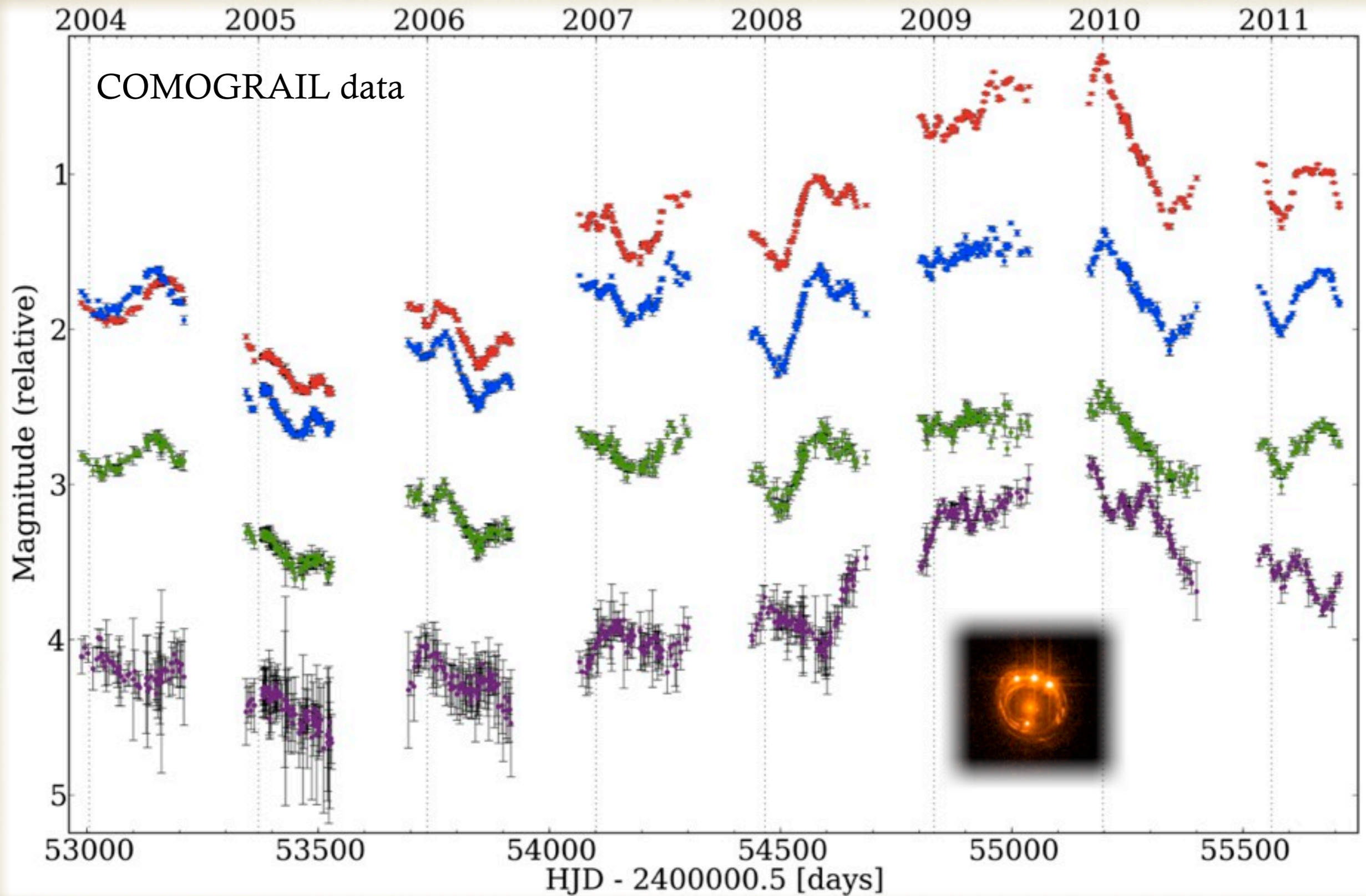


Euler: deconvolved



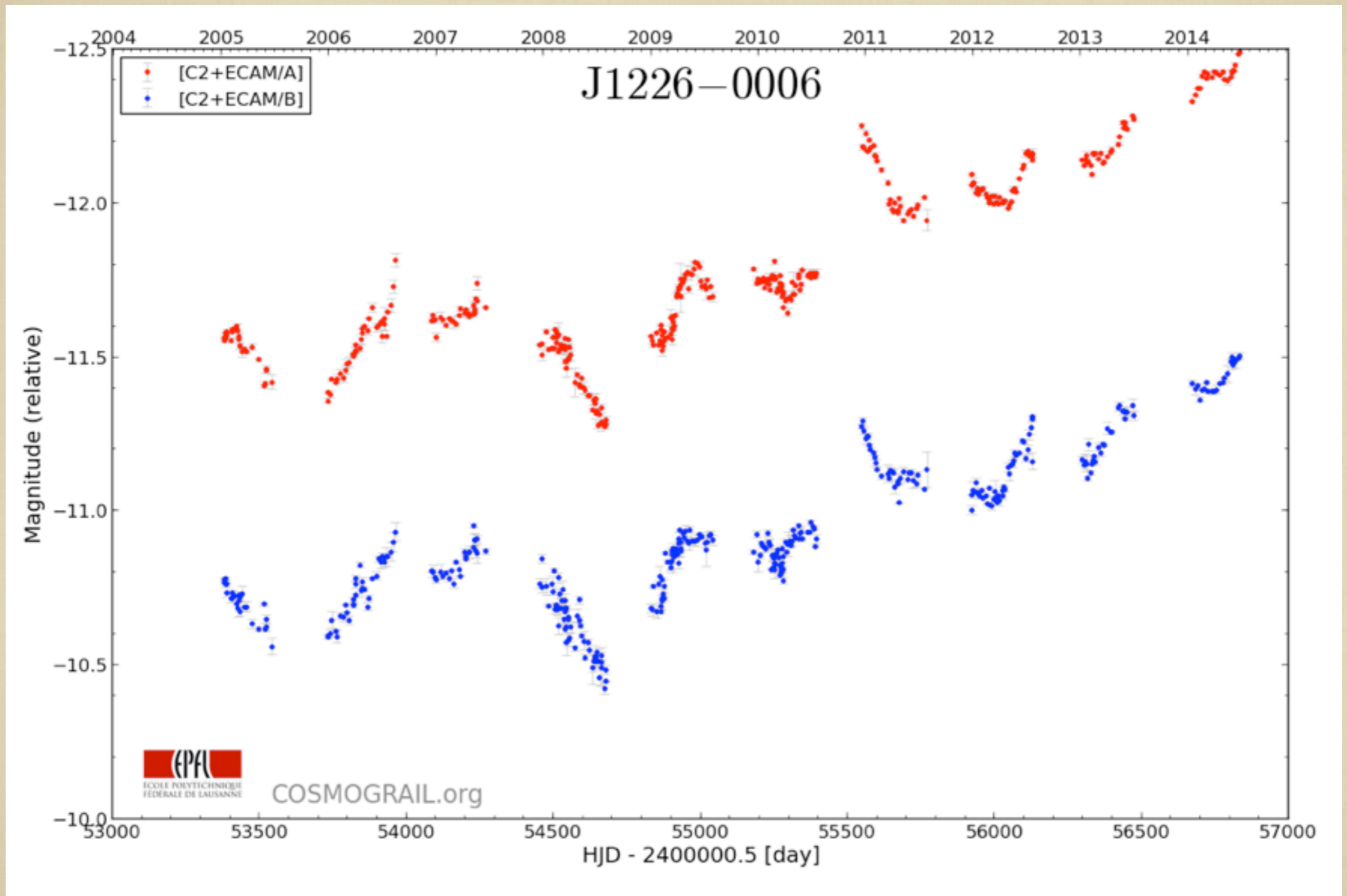
(Sluse et al. 2003, A&A 406, L43,
using data from CASTLE)

RXJ1131-1231

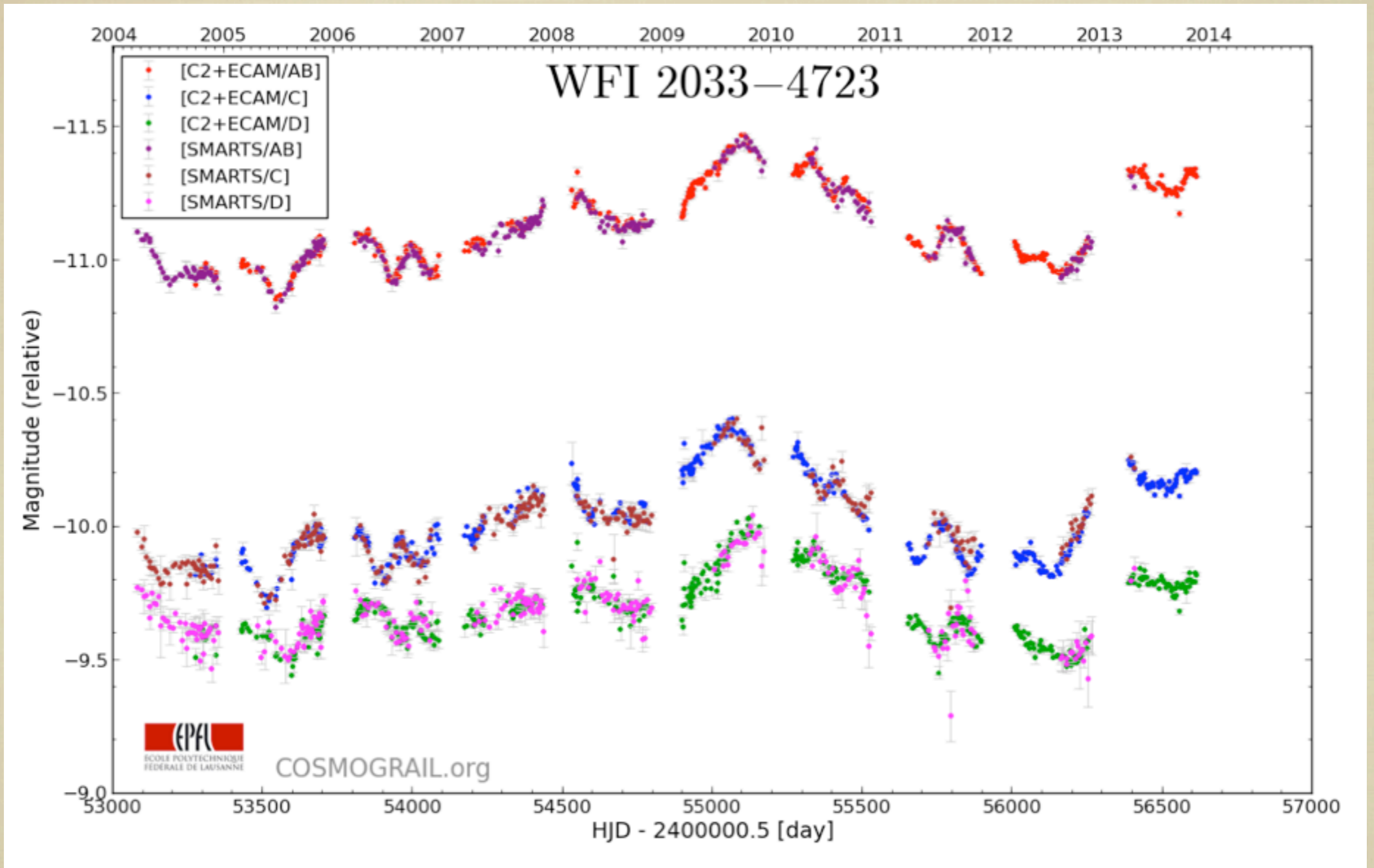


Example of COSMOGRAIL light curve (from M. Tewes PhD thesis, EPFL)

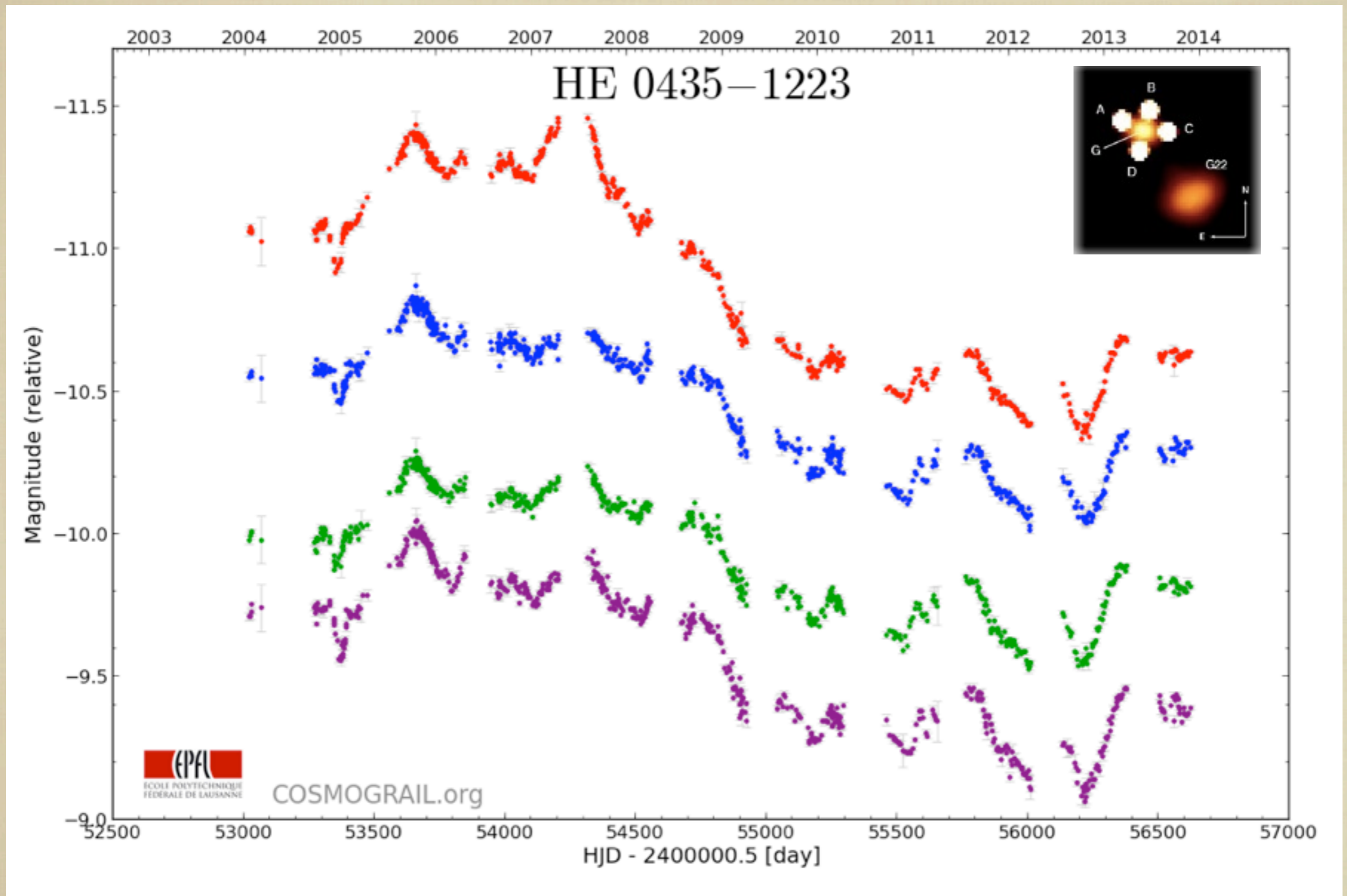
Recent light curves



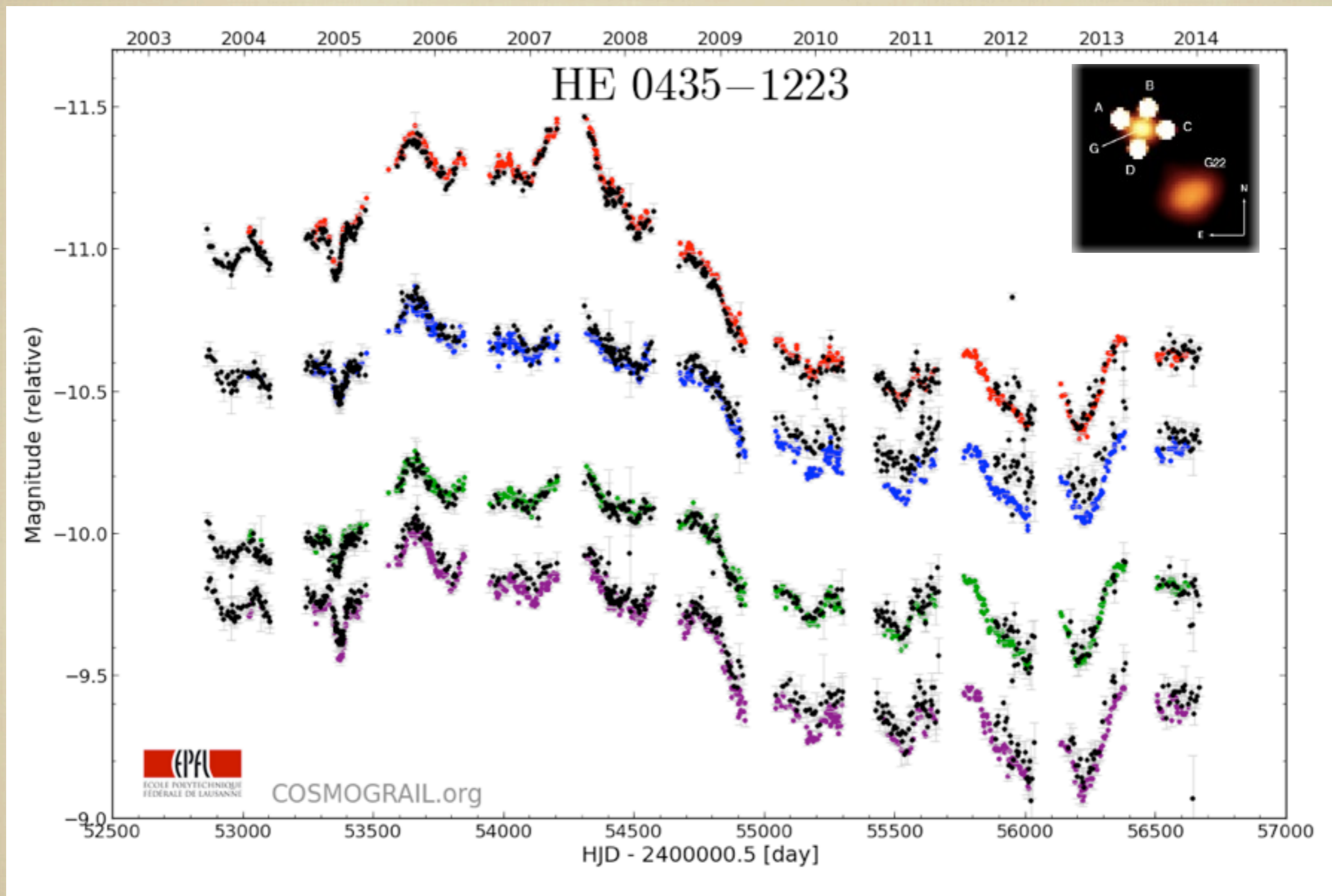
Recent light curves



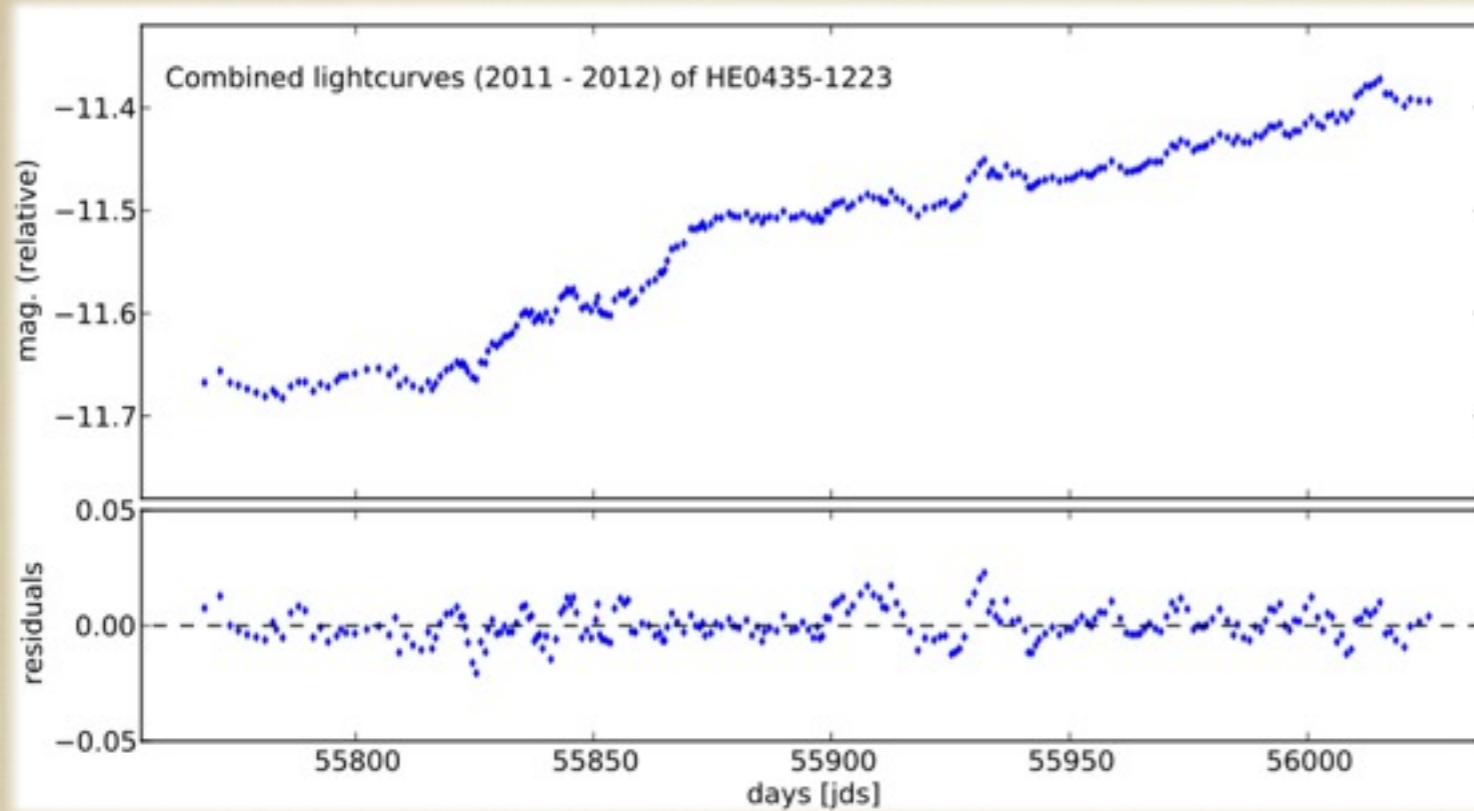
Recent light curves



Recent light curves



Future: high cadence + high SNR (?)

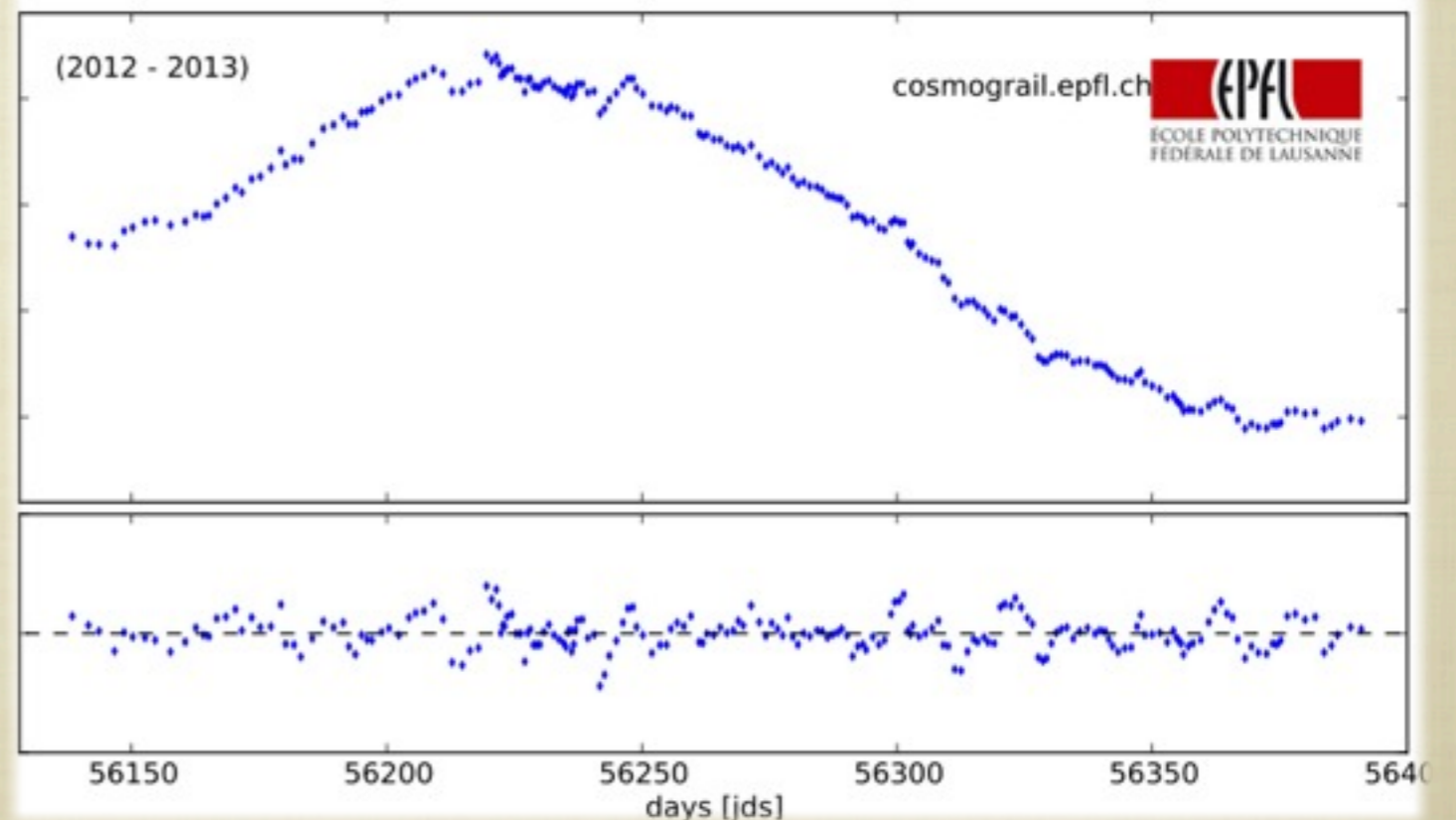


Use small (mmag) variations, shorter than microlensing

Go to larger telescopes WITH flexible scheduling capability.

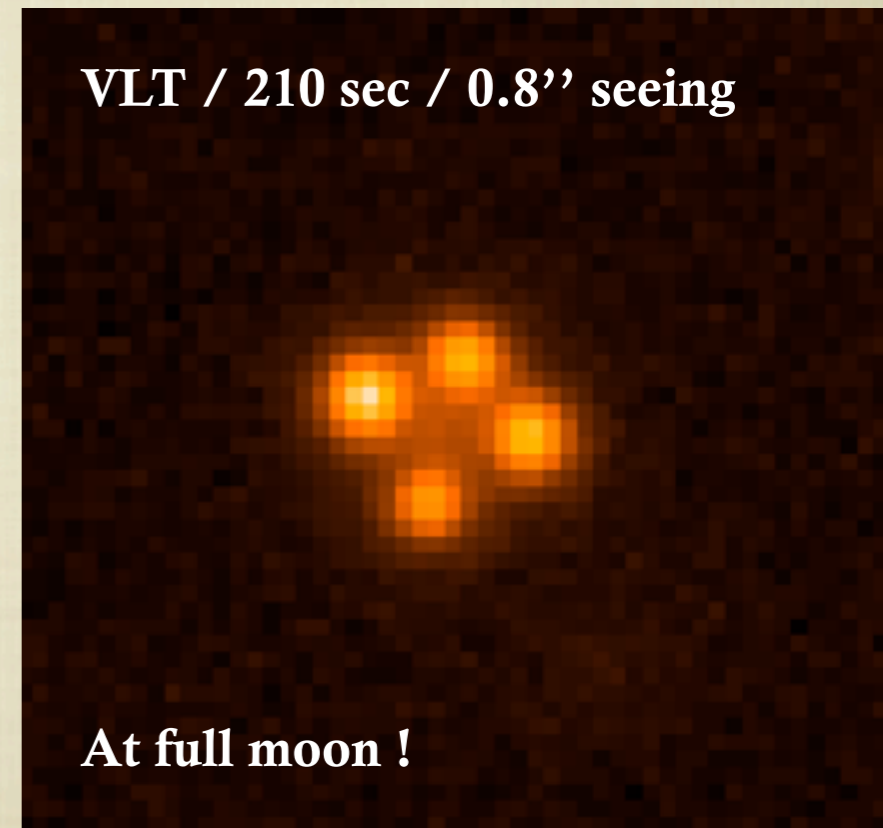
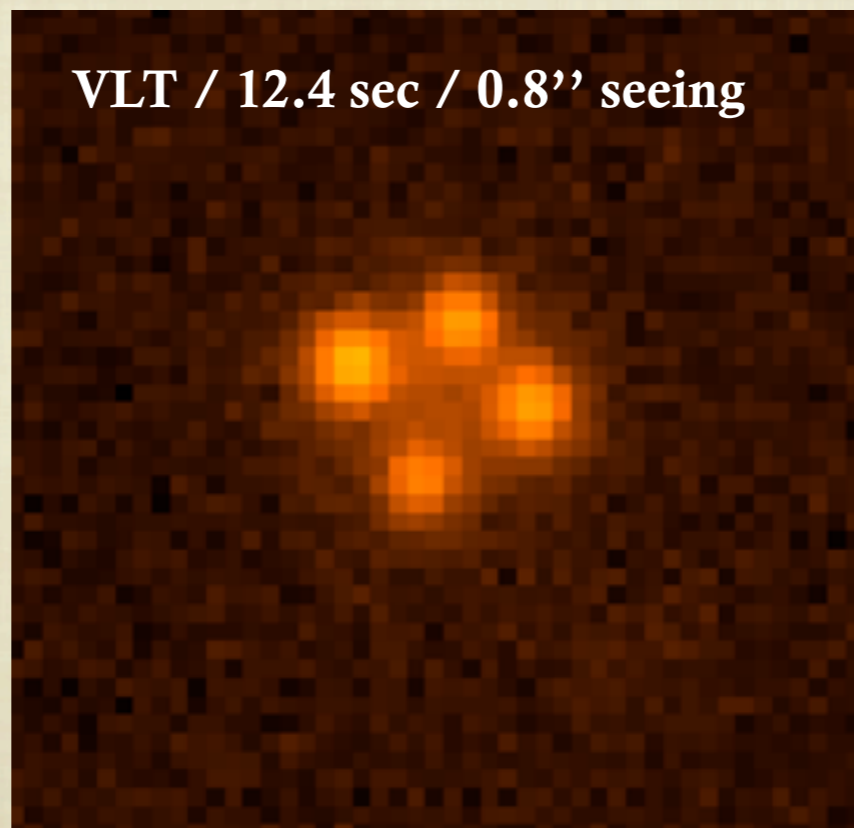
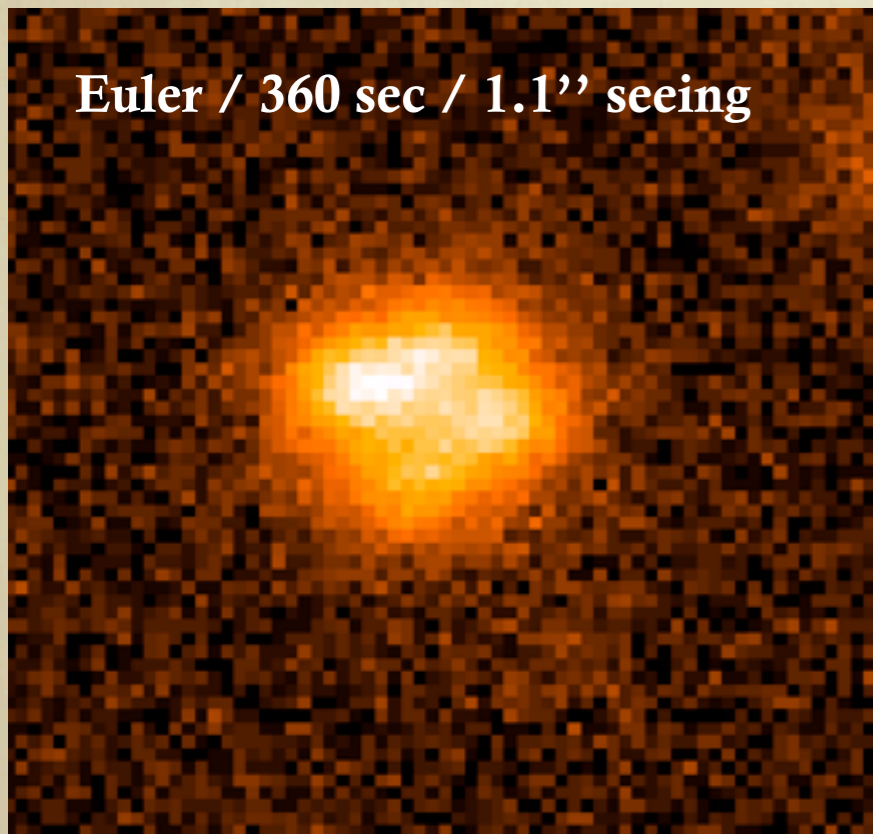
Goal: time delays to 1% in a few months of observations

«Stacked» COSMOGRAIL data for HE 0435-1223



VLT monitoring of HE 0435-1223

- 1 point per day (210 sec exposure) from Oct 2014 to April 2014 (maybe a bit more)
- Simultaneous monitoring with Euler with improved cadence (1 day^{-1}) in Nov-Dec 2014
- + SMARTS (Kochanek) and LCOGT (Moustakas, Keeton)



Using the ESO NTT

- Call for ideas to use the NTT between 2015 and 2019
- We answered the call in March 2014
- **Confirming DES lenses + spectroscopy of line of sight + daily lens monitoring during 4 periods of 3 months + 10% of the time for «fillers»**
- Pre-selected in August 2014
- Submitted formal proposal to ESO OPC on Oct 1, 2014
- Draft agreement between ESO and us being prepared
- News from ESO STS by the end of October 2014
- April 2015: earliest possible start of observations