Photometric study of the lensed quasar HE0435-1223

Davide Ricci - ARC meeting 11/02/2010

The data

- 2008: 391 images
  - I 132 images
  - R 132 images
  - V 127 images

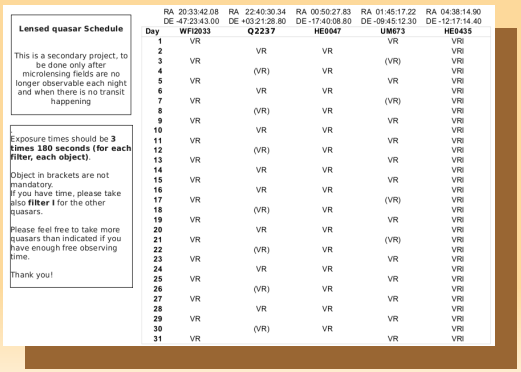
  } 42-43 nights

- 2009: 150 images
  - I: 55 images
  - R: 46 images
  - V: 49 images

  } 16-19 nights

- 2010: schedule ready

Quasar observation is a parallel project of the MiNDSTEp campaign (bulge microlensing)



Lensed quasar Schedule

This is a secondary project, to be done only after microlensing fields are no longer observable each night and when there is no transit happening

Exposure times should be **3 times 180 seconds (for each filter, each object)**.

Object in brackets are not mandatory.
If you have time, please take also **filter I** for the other quasars.

Please feel free to take more quasars than indicated if you have enough free observing time.

Thank you!

	RA 20:33:42.08 DE -47:23:43.00	RA 22:40:30.34 DE +03:21:28.80	RA 00:50:27.83 DE -17:40:08.80	RA 01:45:17.22 DE -09:45:12.30	RA 04:38:14.90 DE -12:17:14.40
Day	WFI2033	Q2237	HE0047	UM673	HE0435
1	VR			VR	VRI
2		VR	VR		VRI
3	VR			(VR)	VRI
4		(VR)	VR		VRI
5	VR			VR	VRI
6		VR	VR		VRI
7	VR			(VR)	VRI
8		(VR)	VR		VRI
9	VR			VR	VRI
10		VR	VR		VRI
11	VR			VR	VRI
12		(VR)	VR		VRI
13	VR			VR	VRI
14		VR	VR		VRI
15	VR			VR	VRI
16		VR	VR		VRI
17	VR			(VR)	VRI
18		(VR)	VR		VRI
19	VR			VR	VRI
20		VR	VR		VRI
21	VR			(VR)	VRI
22		(VR)	VR		VRI
23	VR			VR	VRI
24		VR	VR		VRI
25	VR			VR	VRI
26		(VR)	VR		VRI
27	VR			VR	VRI
28		VR	VR		VRI
29	VR			VR	VRI
30		(VR)	VR		VRI
31	VR			VR	VRI

2010 schedule

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1	VR			VR	VRI
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19	VR			VR	VRI
20		VR	VR		VRI
21	VR			(VR)	VRI
22		(VR)	VR		VRI
23	VR			VR	VRI
24		VR	VR		VRI
25	VR			VR	VRI
26		(VR)	VR		VRI
27	VR			VR	VRI
28		VR	VR		VRI
29	VR			VR	VRI
30		(VR)	VR		VRI
31	VR			VR	VRI

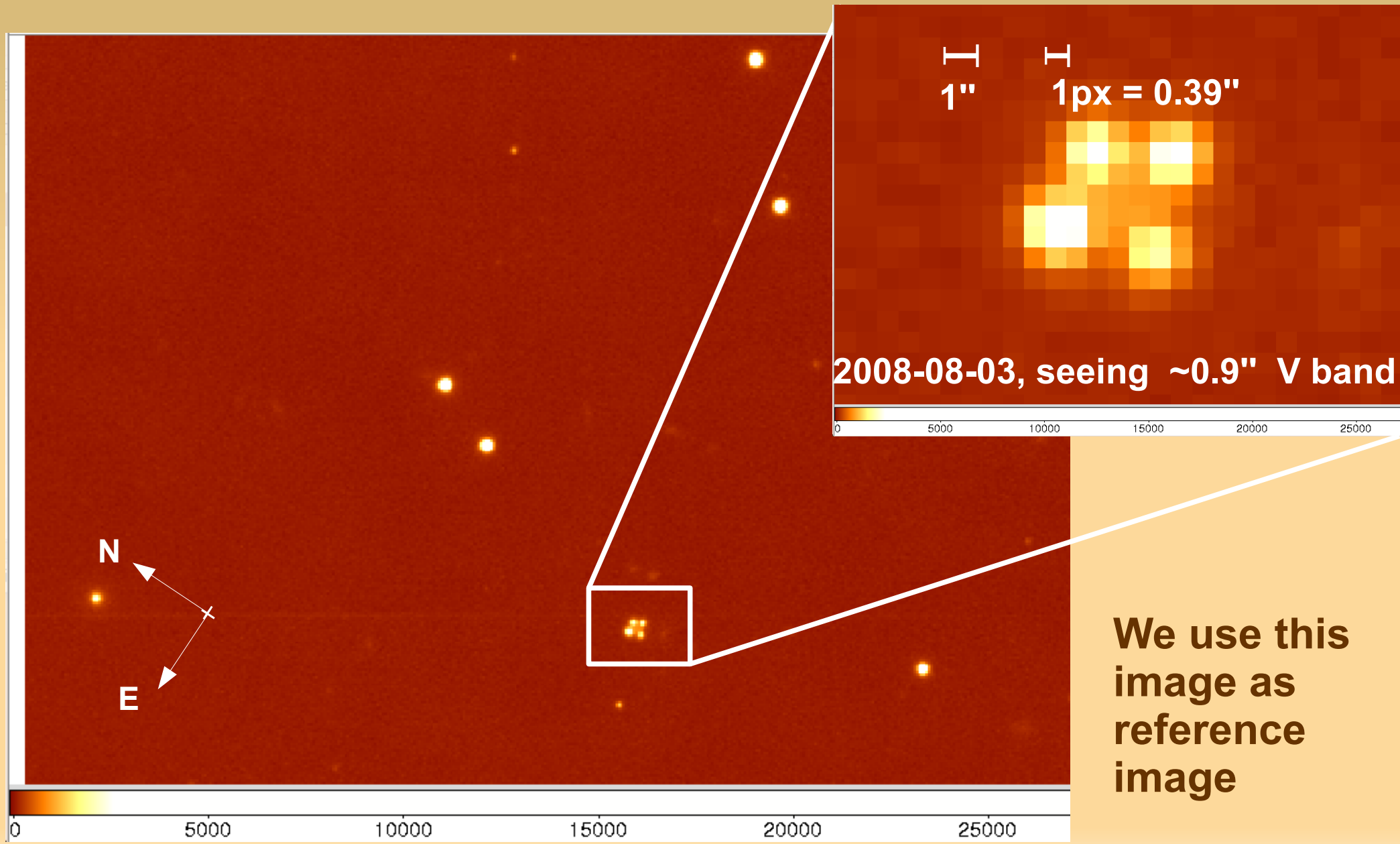
If we had the HST...

...but we have not.

Anyway, we have the 1.54m Danish Telescope @ La Silla and we are PROUD of it :-)

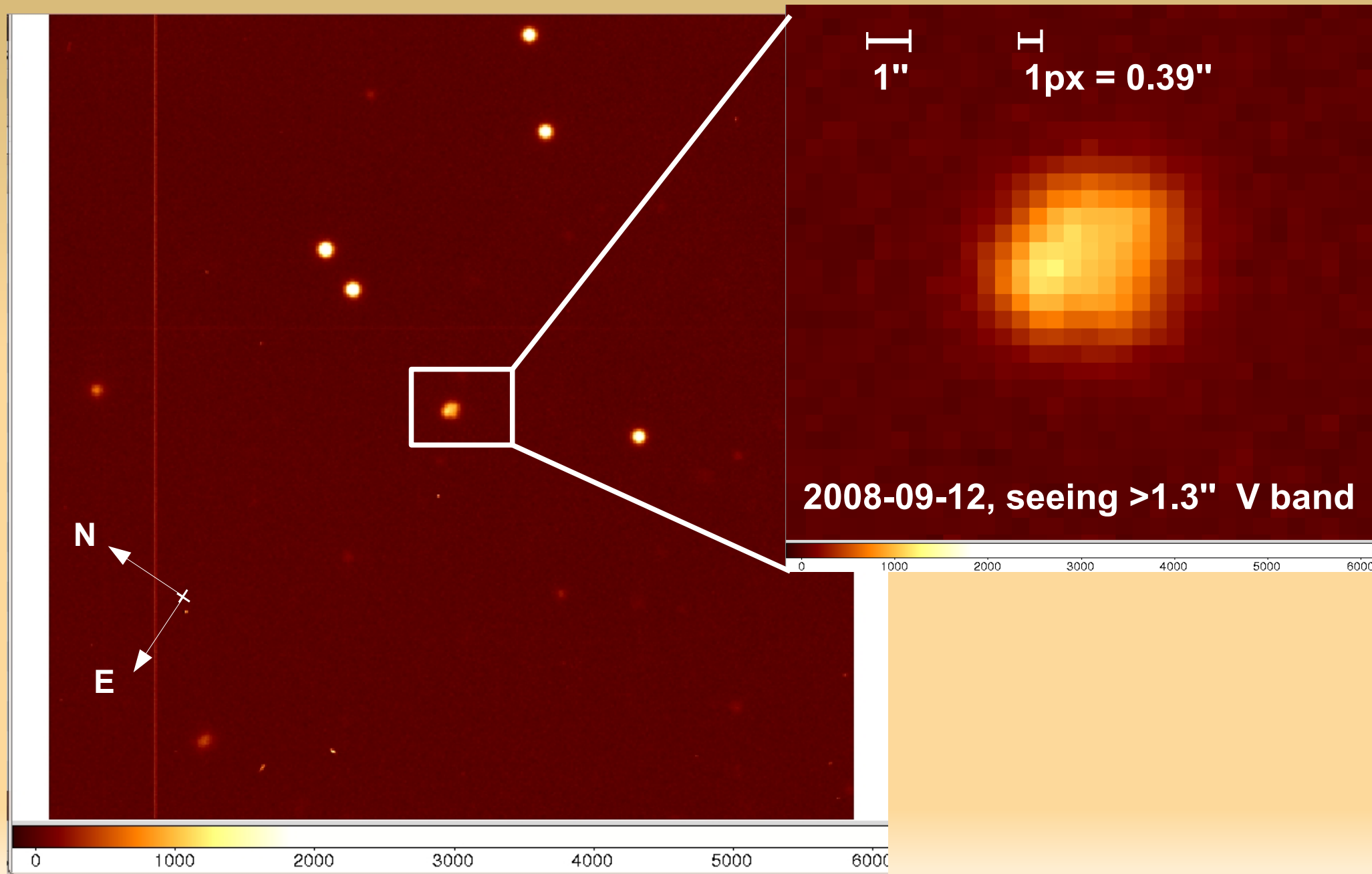
Facilities not provided by HST

A good seeing image

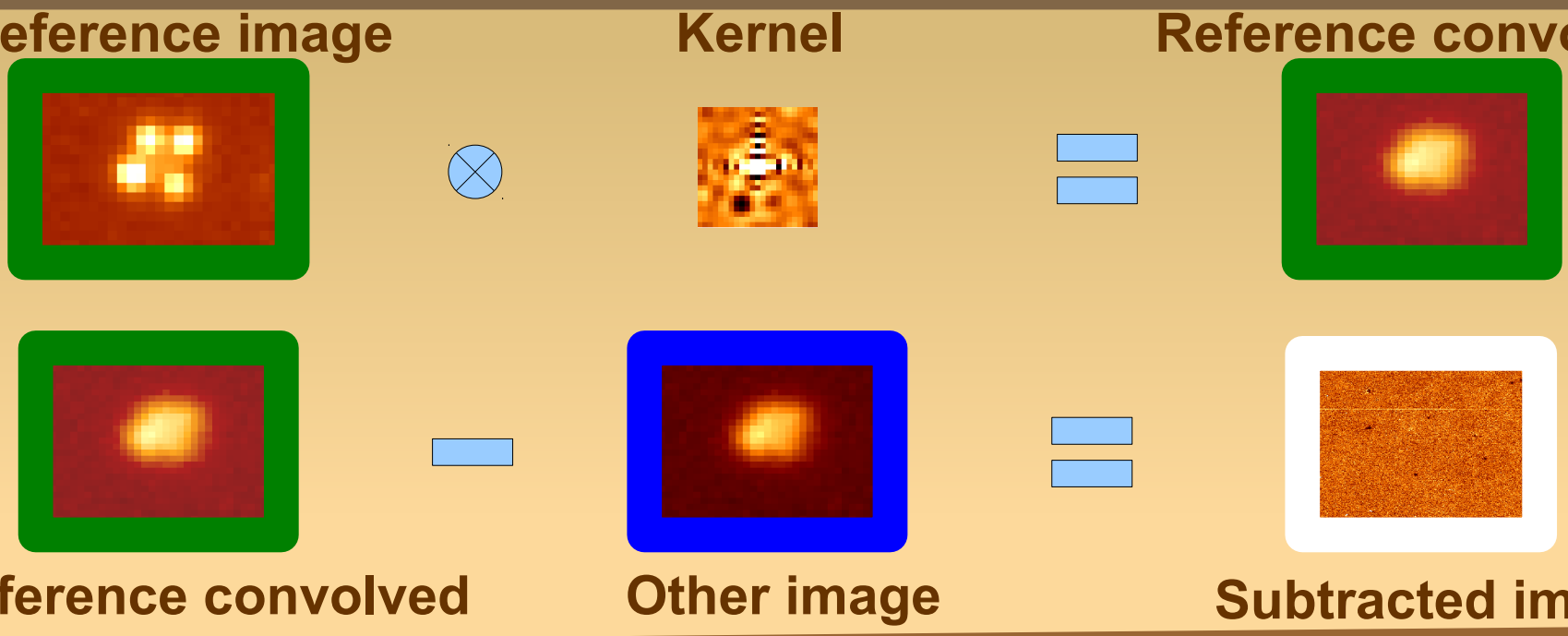


We use this image as reference image

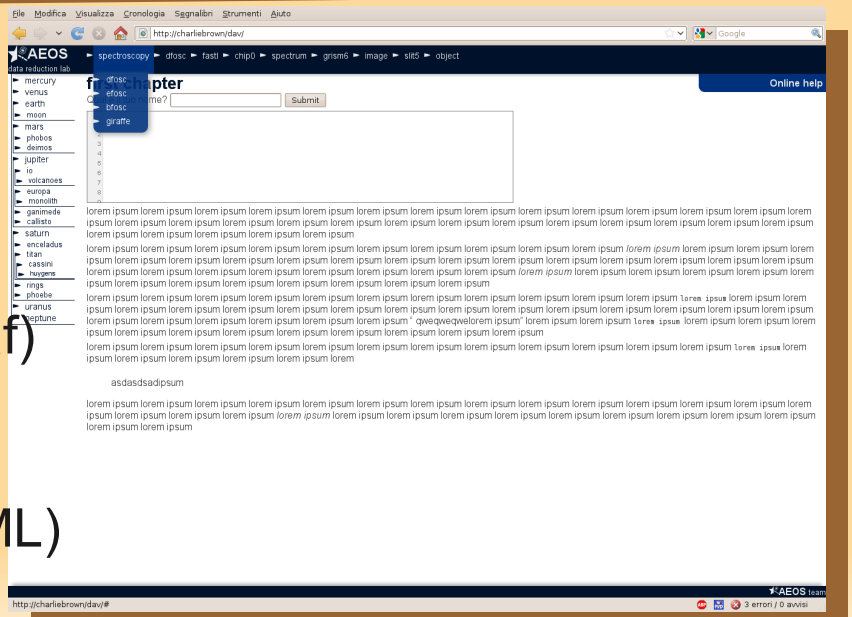
A bad seeing image



Difference imaging

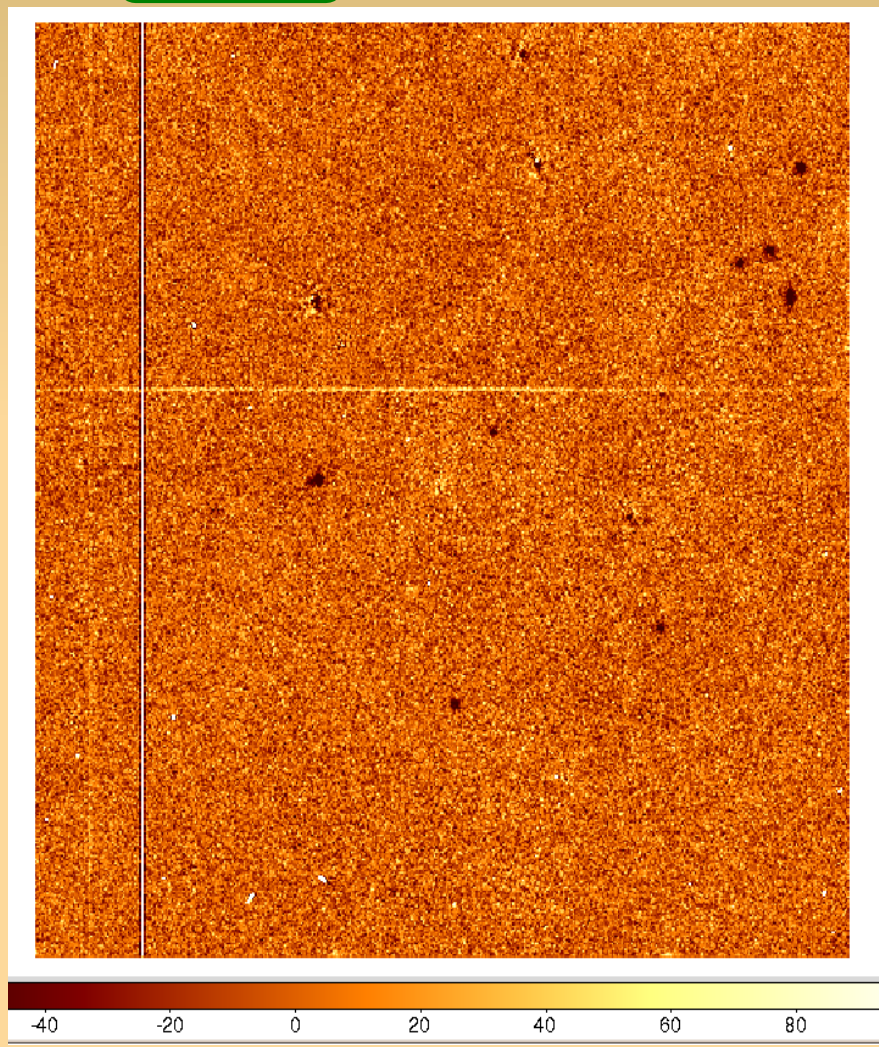


- Development of an integrated C++ pipeline
  - Flatfielding and debiasing
  - Image registration, Background subtraction
  - Kernel → FFT technique (currently under pyraf)
- HTML cross-browser interface
  - “rules” and loops -> AJAX (php+javascript+XML)



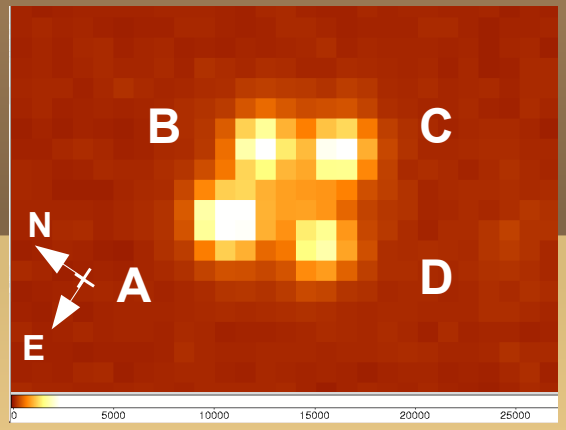
Some subtracted image

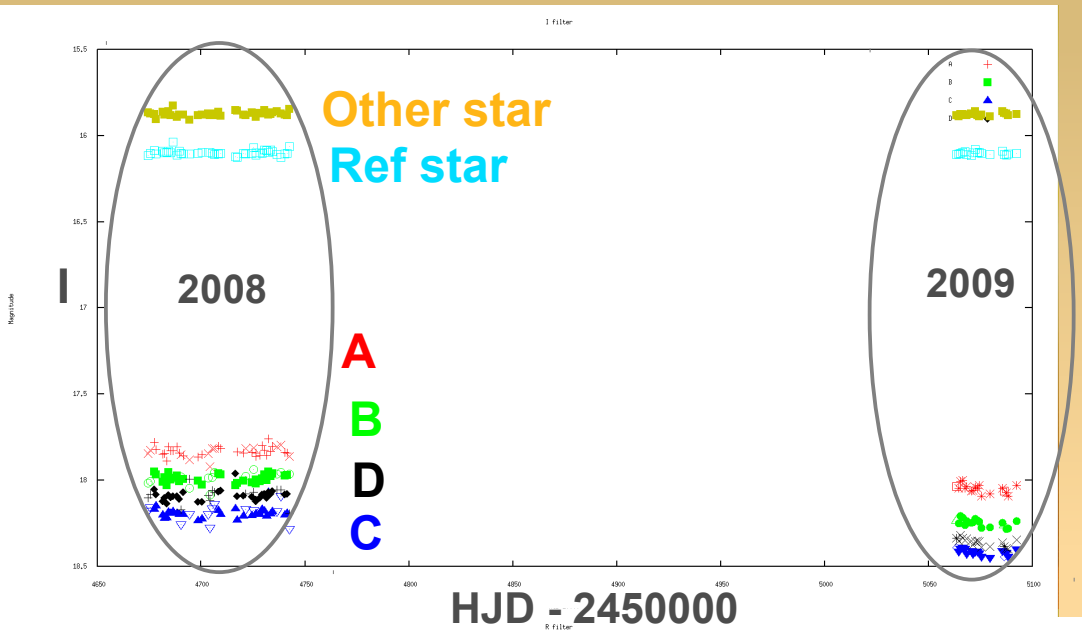
2008-08-03, subtracted
"self-subtraction"

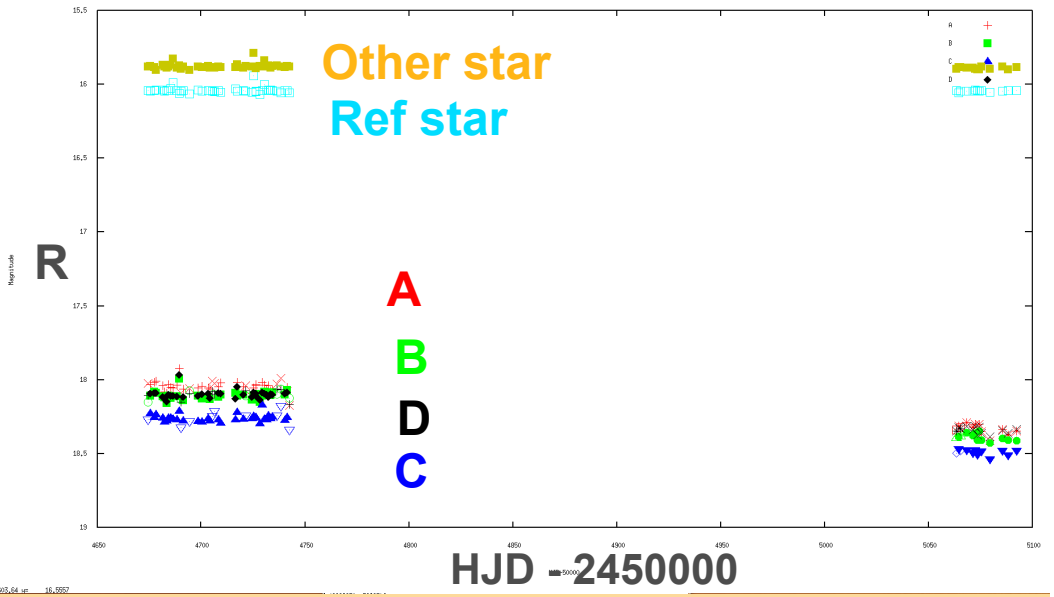


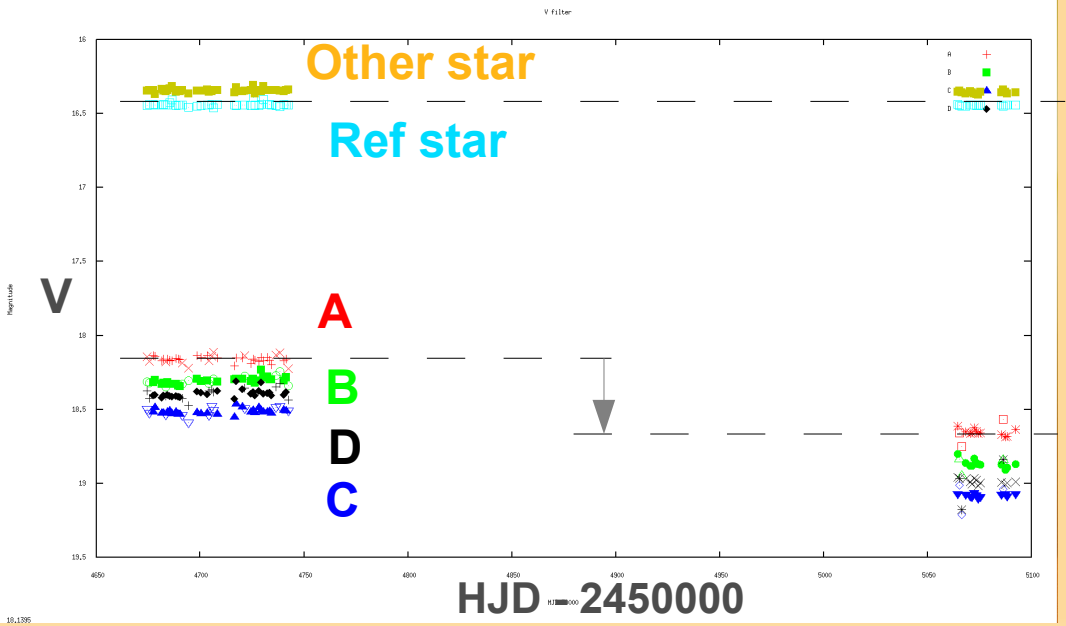
2008-09-12, subtracted

Light curves

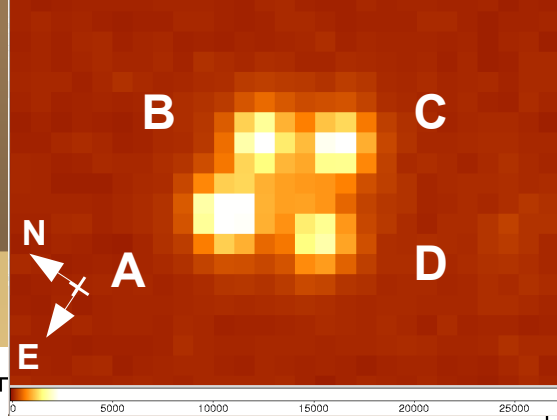


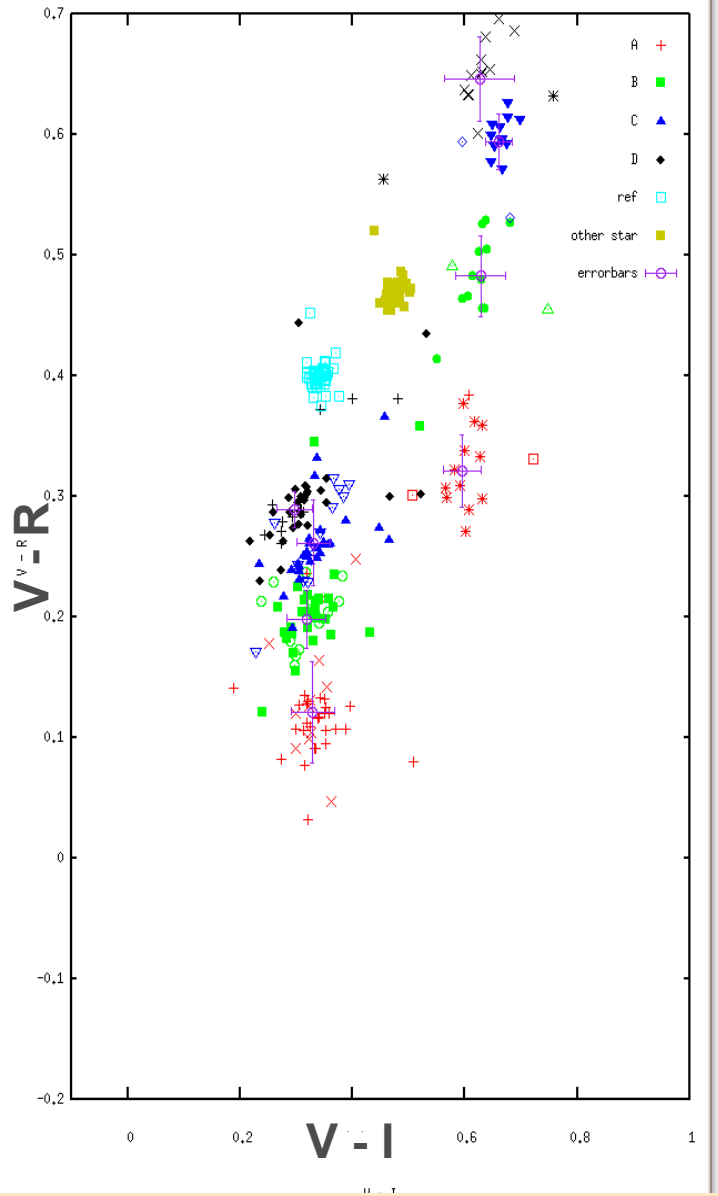


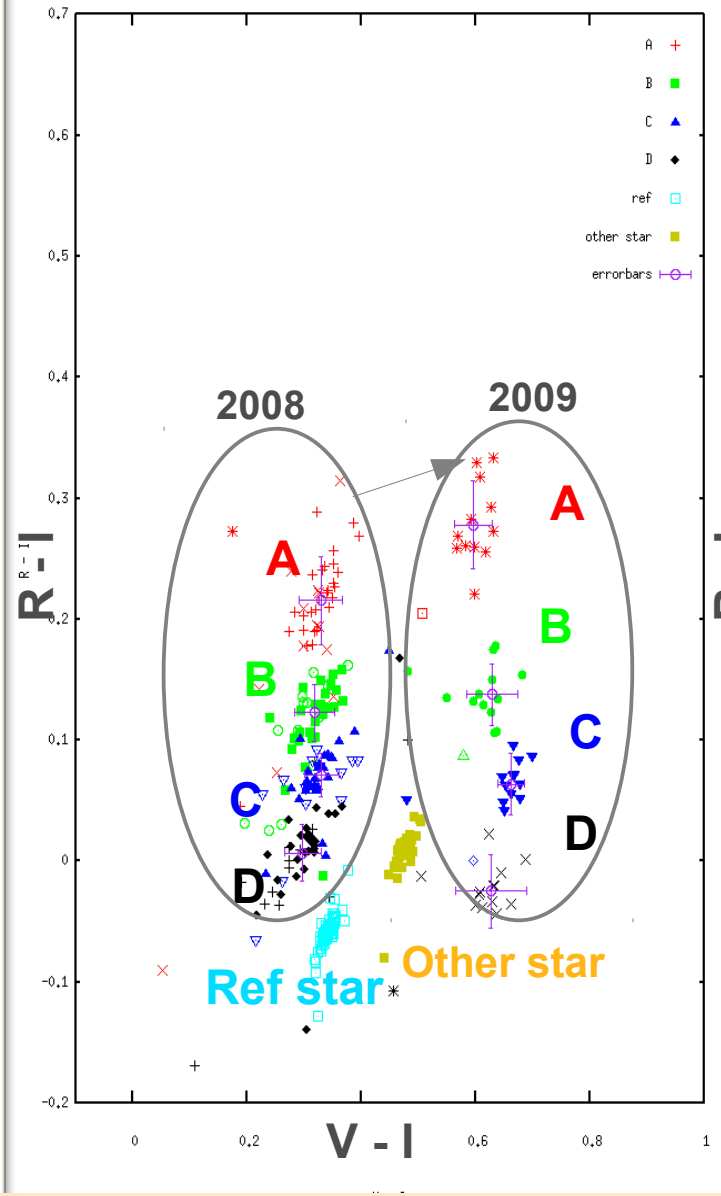


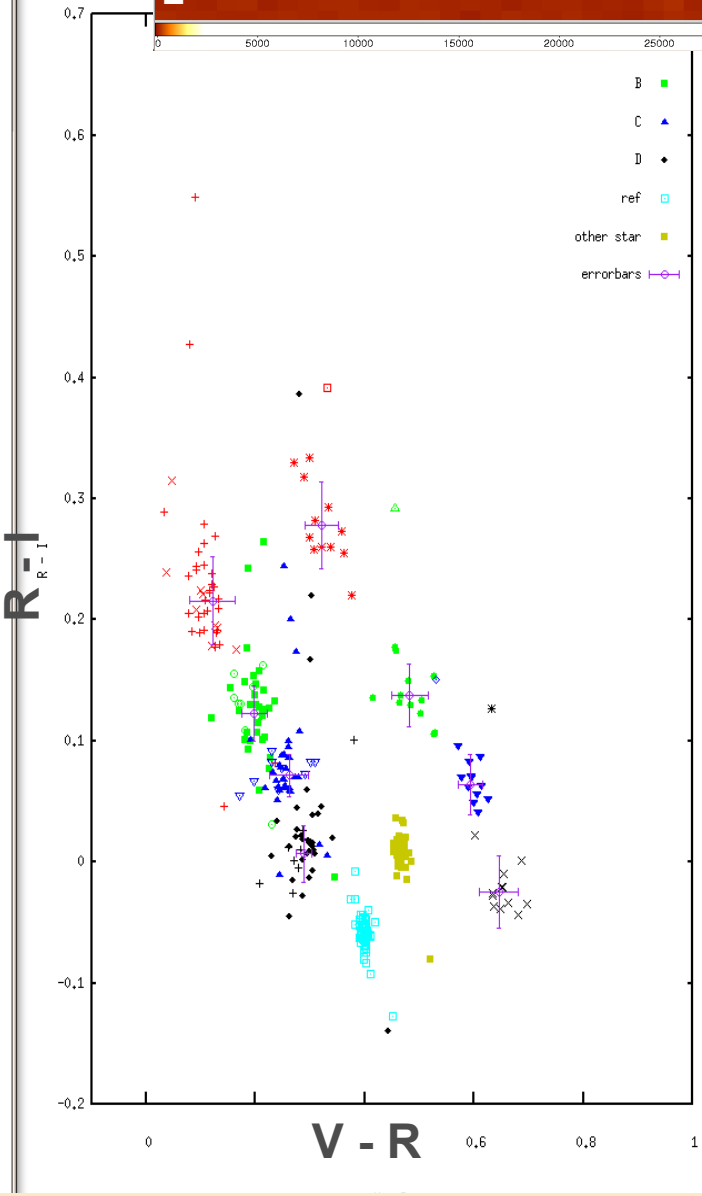


Color-Color diagrams









Further work

- Correct for time delays (Kochanek et al, ApJ 2006)
  - AD = -14.3 days
  - AB = -8.0 days
  - AC = -2.1 days
- Add 2010 data
- Automatize the pipeline
- Improve interface

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Photometric study of the lensed quasar HE 0435–1223

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ABSTRACT

Aims. We present a systematic multi-filter photometric observations of HE0435–1223, carried with the Danish 1.54m telescope at the La Silla Observatory.
Methods. We performed 2 seasons (2008–2009) of monitoring in *VRI* spectral bands and we reduced the data using an integrated C++ software developed in our team
Results. To be continued

Key words. buzzword – buzzword – buzzword

1. Introduction

In the framework of the MiNDSTEp campaign, which has as a main target the systematic observation of bulge microlenses, we developed a parallel project concerning photometric multi-filter observations of several lensed quasars, specifically HE0435–1223, UM673/Q0142–100, Q2237+0305, WFI2033–4723 and HE0047–1756. Here we focus on HE0435–1223 (See Fig. 1), a QSO object observed by Wisotzki et al. (2000) in the course of the Hamburg/ESO digital objective prism survey, and confirmed as a quadruple gravitationally lensed quasar (Wisotzki et al. 2002), initially identifying the lens galaxy as an elliptical with a scale length of $\approx$ 12Kpc at a redshift in the range of $z = 0.3$–0.4. The time delays between the 4 images of the quasar (labelled "A", "B", "C", "D", starting from the brighter one and correlation with the position of the near galaxies, suggested as a remaining explanation the presence of substructures in the lens galaxy.

The first systematic optical monitoring in the only *R* filter, covering the years between 2003 and 2005, was carried out by Kochanek et al. (2006), who provided astrometric measurements compatibles with the previous work, calculated the time delays between the images ($\Delta t_{AD} = -14.37$, $\Delta t_{AB} = -8.00$, $\Delta t_{AC} = -2.10$ days, with errors respectively of 6%, 10% and 35%), and finally confirmed the lens galaxy as an elliptical with a rising rotation curve.

A method to distinguish signatures of microlensing from intrinsic variability and lens galaxy extinction is a good sampled multi-filter photometry carried for several years. This kind of technique was already used on the quasar Q2237+0305 by