

***Electromagnetic follow up of
Gravitational waves events
with
VST***



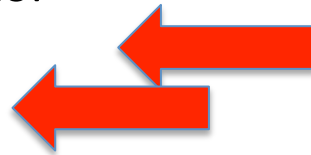
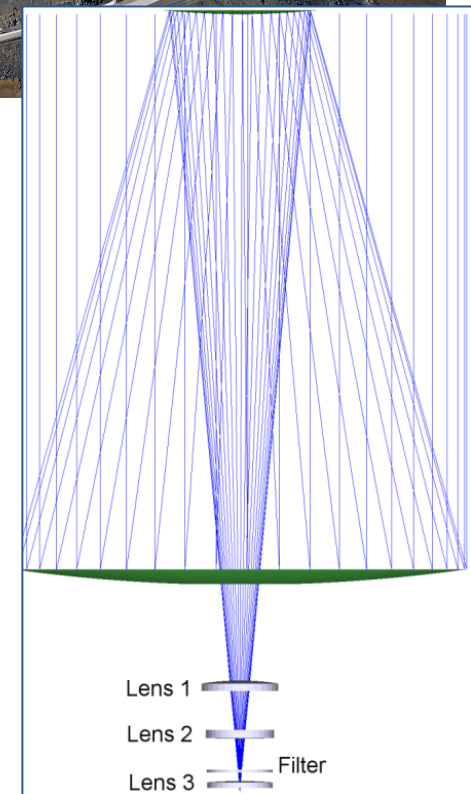
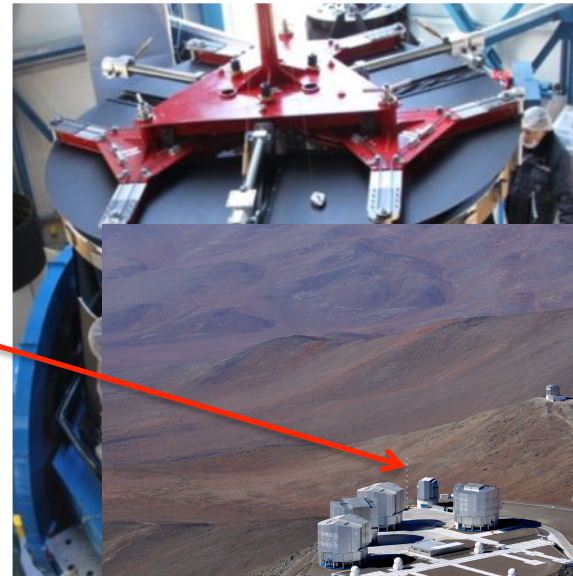
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&
GRAWITA collaboration

INAF-Monte Mario 11-04-2016

VST an INAF telescope @ Paranal

PI M. Capaccioli

- Primary mirror: 2.6m
- Secondary mirror: 0.9m
- F# 5.5
- modified Ritchey-Chretien optical layout
- Field corrector with 3 lenses (2 in the telescope + 1 in the camera)
- ADC with counter-rotating doublet of prisms, exchangeable with 2 lens corrector
- 1.46 deg corrected FoV (\emptyset)
- 80% EE in 0.4"
- Alt-Azimuth mount
- Active M1 shape control (81 active axial support + 3 axial fixed points)
- Active M2 positioning in 5 dof (hexapod)



VST camera OmegaCam

P.I. Konrad Kuijken

OmegaCAM Consortium:
the Netherlands, Germany,
Italy (Padova, Napoli, E. Cappellaro),
ESO

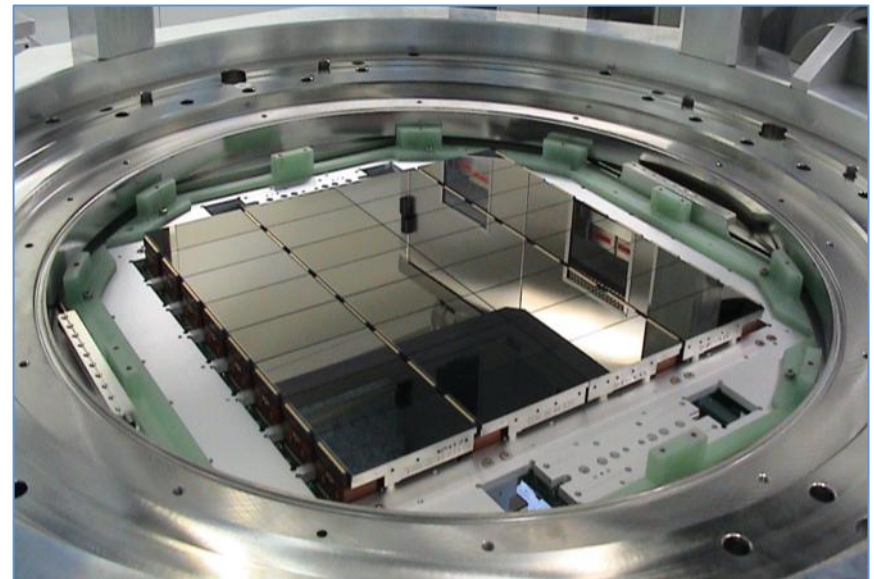
Format: 268 Mpixel mapping a $1^\circ \times 1^\circ$ field

Scale 0.21 arcsec/pixel

32 scientific CCDs + 4 outer CCDs

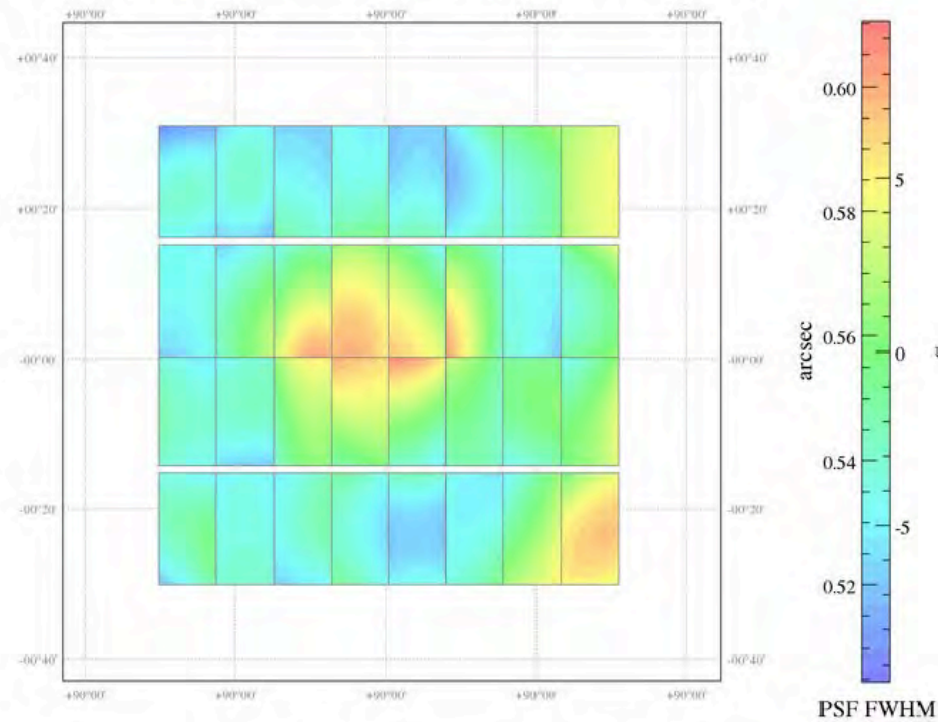
Autoguiding

Image analysis curvature sensor

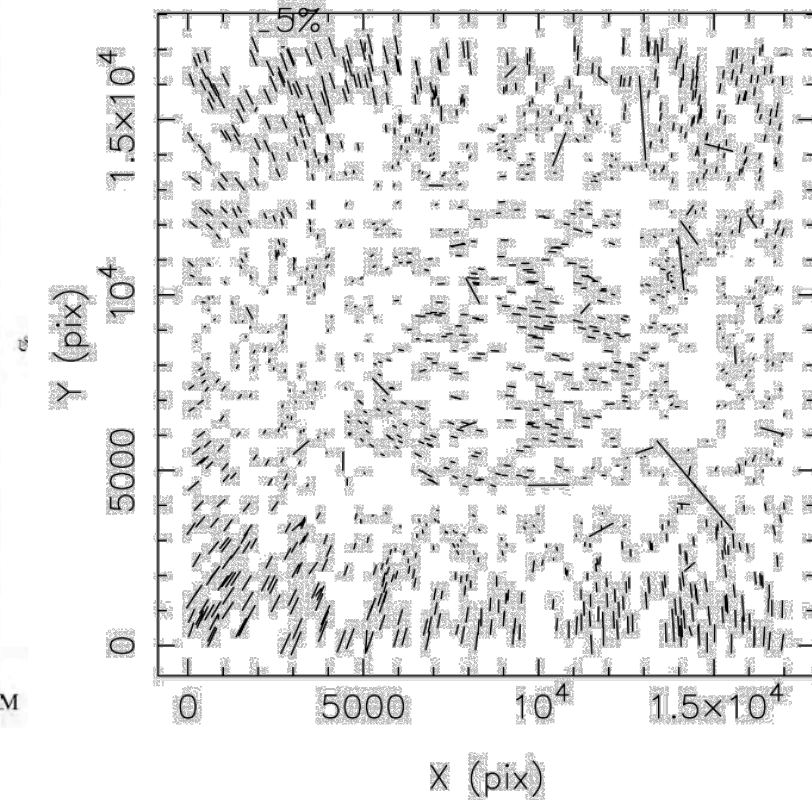


VST Image Quality performance

Field OMEGA.2011-07-27T01:07:2: FWHM map

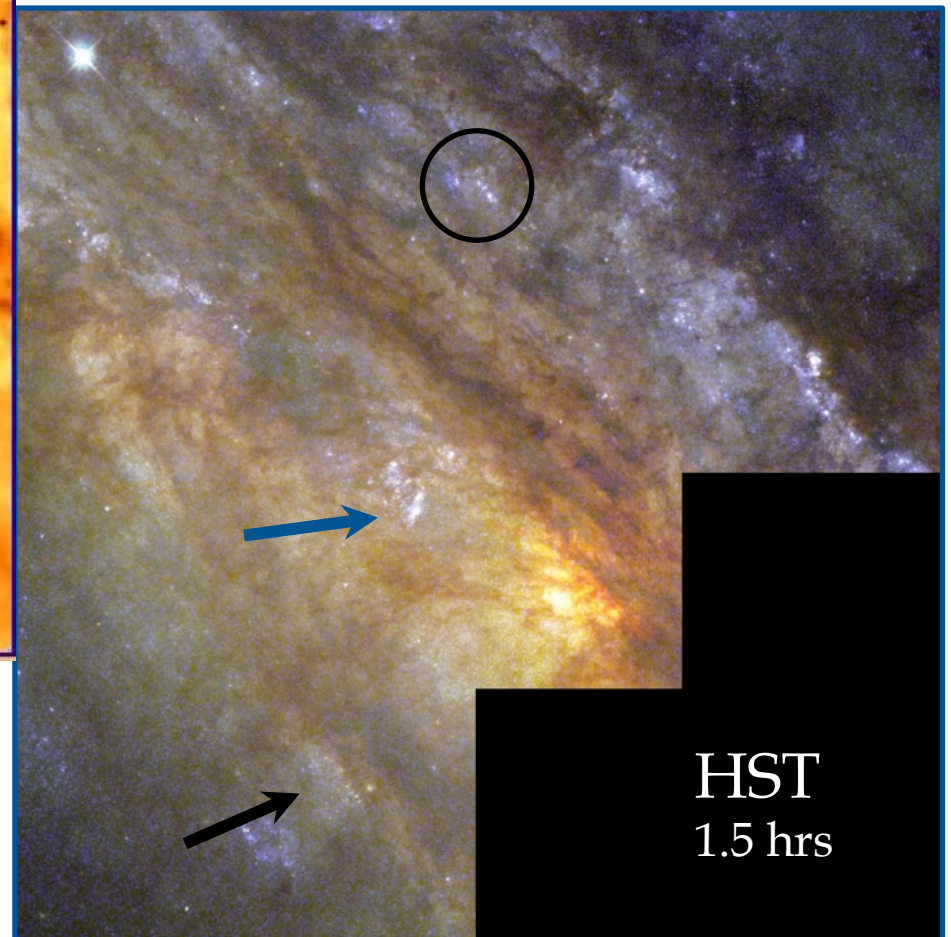
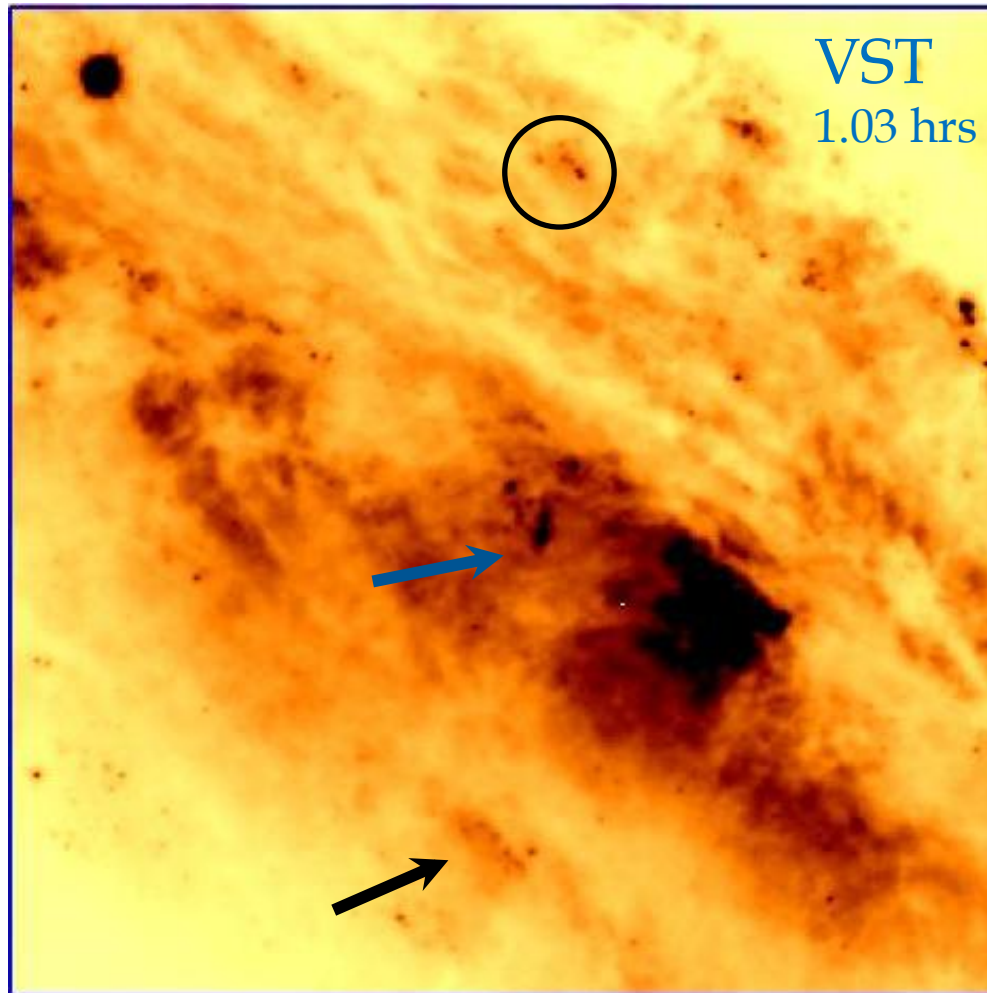


PSF ellipticities -- raw



PSF FWHM = 0.5 arcsec, constant within <10% over the whole field
ellipticity ~ 10%

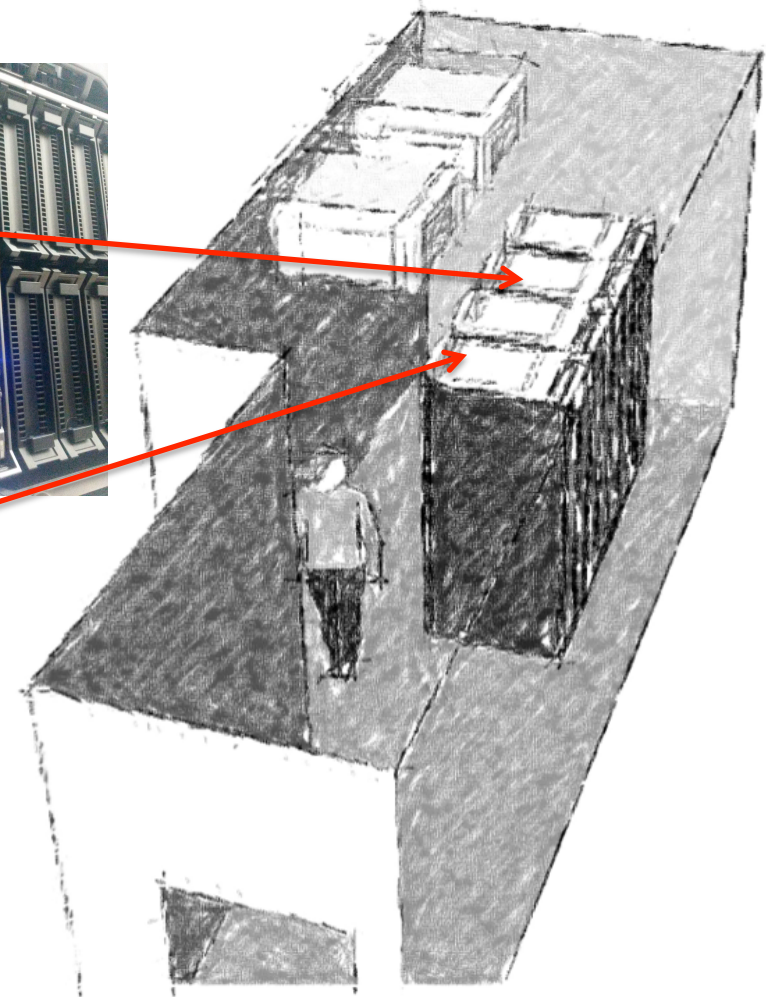
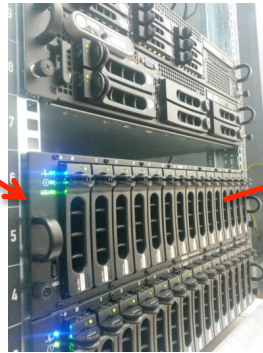
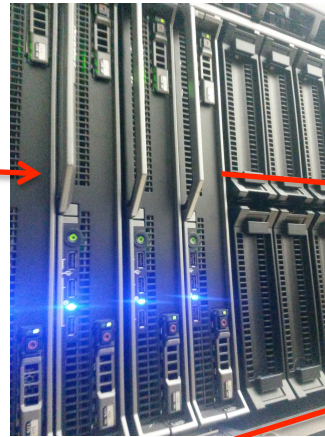
VST vs HST image of the NGC 253



VST Data Center @ INAF Capodimonte

Responsible: A. Grado

- Cluster 312 cores for data processing and analysis
- ~ 500 TB effective storage
- 10 Gb network



Vst Tube

Pipeline to process data

VST-Tube (developed in house, 200K lines)

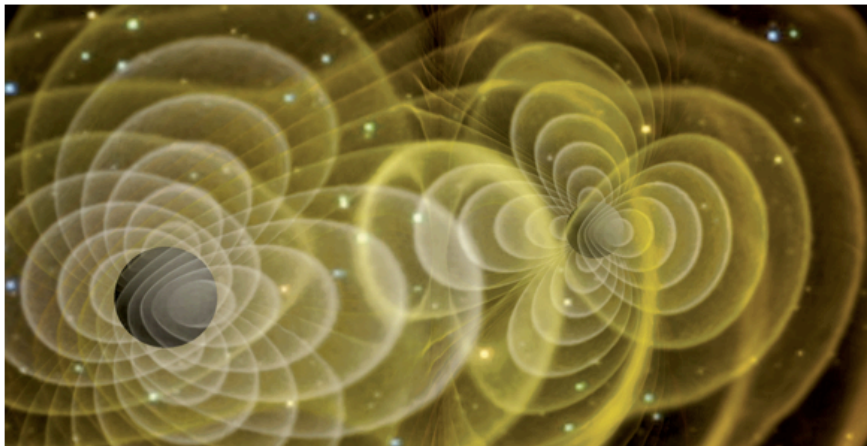
Presently processing data for 14 surveys

Make VST available for GW follow up

- We Started negotiation with ESO to have VST in ToO mode
- We agreed with ESO User Support and Paranal a ToO activation procedure
- After the issue with on line paper New Scientist, ESO DG agreed on remove from the ESO archive all VST GW follow up metadata



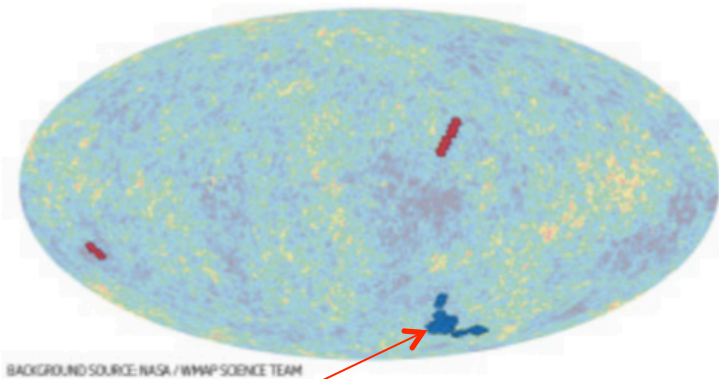
Latest rumour of gravitational waves is probably true this time



LIGO on the lookout

LIGO may have seen at least three possible gravitational wave signals - one in mid-September and two others sometime before 28 December. The map below shows their locations superimposed on the cosmic microwave background - the embers of the big bang - as mapped by NASA's WMAP

● September 2015 ● December 2015

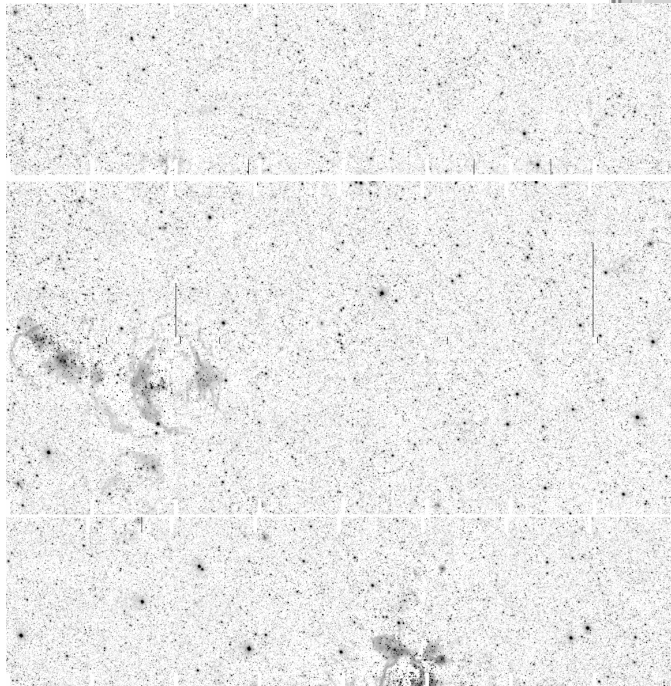


VST follow-up

Data flow and administration info

- as soon as an image is acquired at the telescope is mirrored at the Garching ESO archive
- Polling ESO archive to check if new images are available
- Soon start download to the Naples archive
- Pipeline produces 57039 files for each epoch
- 1.2 TB intermediate and final products for each epoch
- Processing time: 6h17m including catalogs extraction

Observations in filter r_sdss,
2x40 s dithered exposures



Parameter	Value
efringe	NO
Harmonization	2015-09-16/Gain_17-Sep-2015-11h37m10s.fits
Filter	0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48
Filter mode	1
Reduction ID	25-Sep-2015-13h03m58s
Observation ID	25-Sep-2015-13h03m58s
Mosaic ID	25-Sep-2015-13h03m58s
Config file	/opt/VST-tube_1.8.6_gw/config/pipeline_vst_gw.config
Instrument file	/opt/VST-tube_1.8.6_gw/config/instrument_vst_vstuser_new.config
Reduced Science	NO
Science	YES
Mosaic	YES
Pipeline Start	25-Sep-2015-13:03:23
Pre-reduction	00:28:23
Weight and Flag on science files 2015-09-24	01:25:36
SExtractor on science files 2015-09-24	00:48:22
Write Key on science files 2015-09-24	00:01:06
Scamp on science files	00:34:22
Mosaic	00:51:03
Quality Control on Mosaic	00:26:55
Pipeline	06:17:21
Pipeline End	25-Sep-2015-13:10:40
Files Processed	180
Pipeline speed (scientific pixels/sec)	2272 Kpixel/sec

Future

- Increase pipeline speed
- Add image cleaning (bright stars haloes/spikes, satellite tracks, stray light) to reduce spurious detection
- Increase VST efficiency (improve algorithm for telescope images analysis). Discussion started with P. Schipani (VST PM)

Now ToO programs with a total 30h/sem

Increase time allocation for ToO ?

With 3+ interferometers $\sim 10 \text{ deg}^2$
#trigger/deep/2 filters



Good News!

GOOD NEWS!!

On March 17th it was approved a new survey on VST GTO for GW EM follow-up. The Variability Survey Of Nearby Galaxies (**VSONG** PI A. Grado) has 300 h @VST to create templates of galaxies in the nearby Universe.

A long, narrow galaxy, NGC 253, is shown against a dark background filled with stars. The galaxy's core is a bright, glowing red, while the surrounding regions are filled with numerous blue stars, indicating active star formation. The galaxy is oriented diagonally across the frame.

Thanks

NGC253 – VLT Survey Telescope *credit: A. Grado L. Limatola*