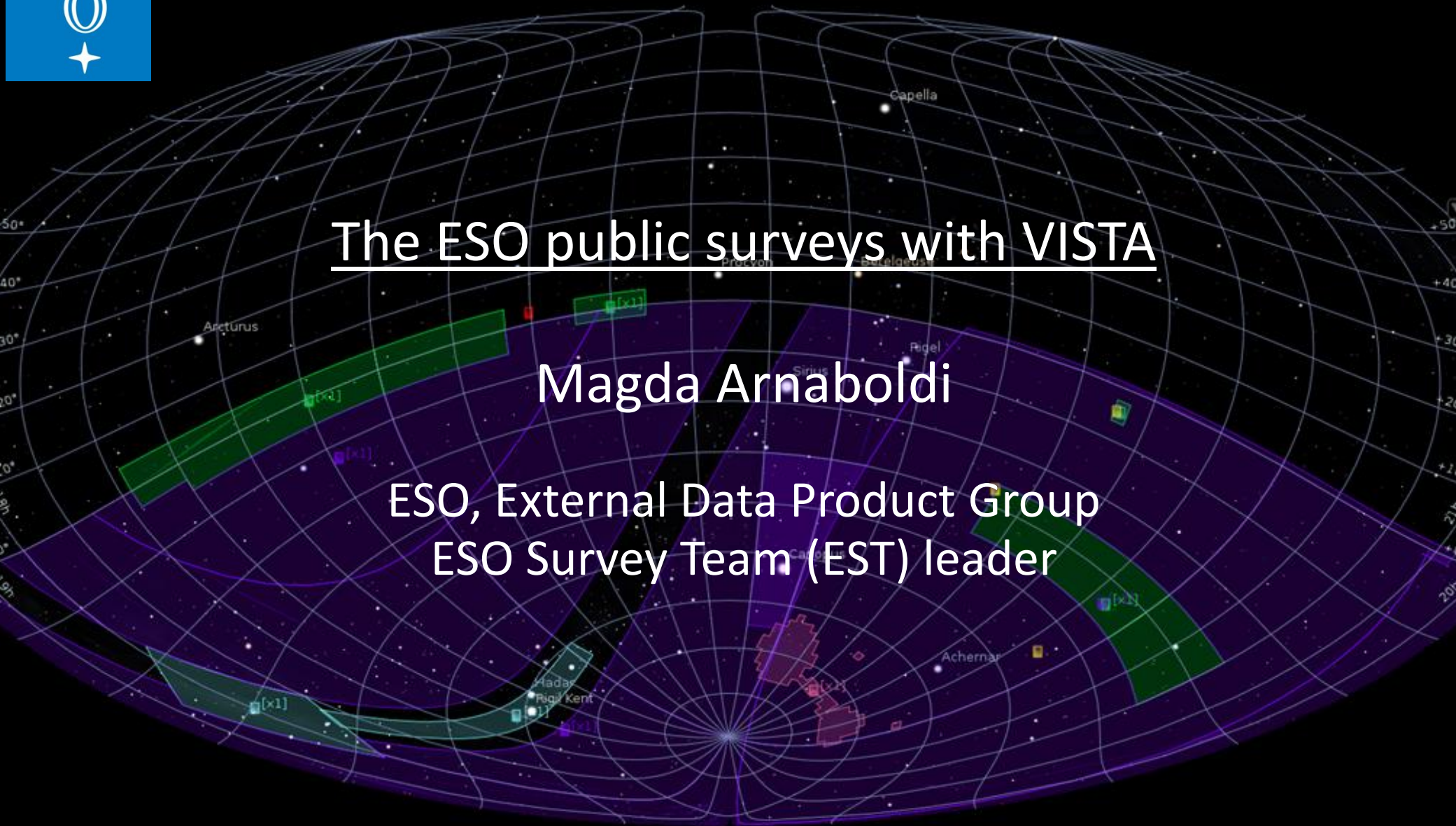




The ESO public surveys with VISTA

Magda Arnaboldi

ESO, External Data Product Group
ESO Survey Team (EST) leader





Outline

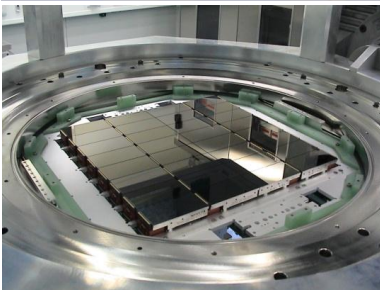
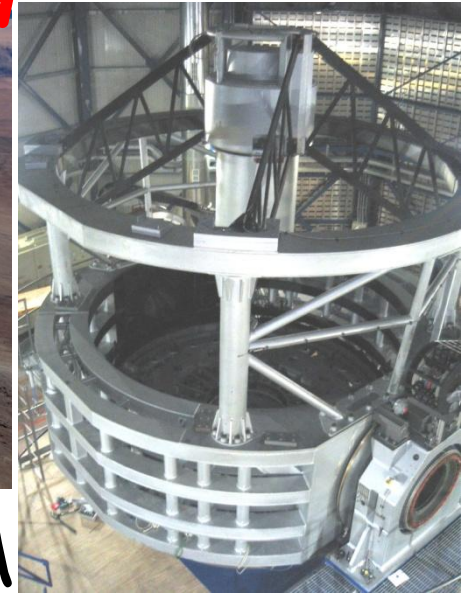
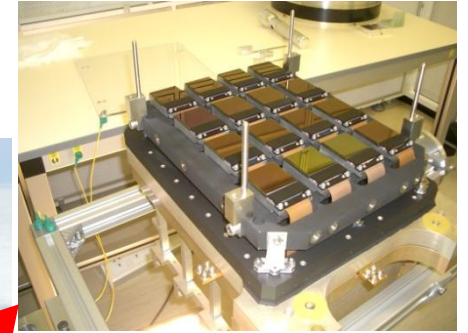
- ESO public surveys
 - ESO survey telescopes: VISTA & VST
 - ESO public survey projects & first results
 - Optical & NIR surveys worldwide
- Phase 2
 - public survey wide & deep
 - preparation for survey observations – SADT, p2pp and OT
 - Start of scientific operations and user support
 - QC on VISTA science data and calibrations
- Phase 3
 - data flow
 - data product types, volumes and delivery timeline
- Conclusions



ESO Survey telescopes: VISTA & VST

VST

VIRCAM



OmegaCam

VISTA

More than 75% of the ESO time on VST (2.5 m, optical) and VISTA (4m,NIR) will be devoted to Public Surveys. Data taking in SM.

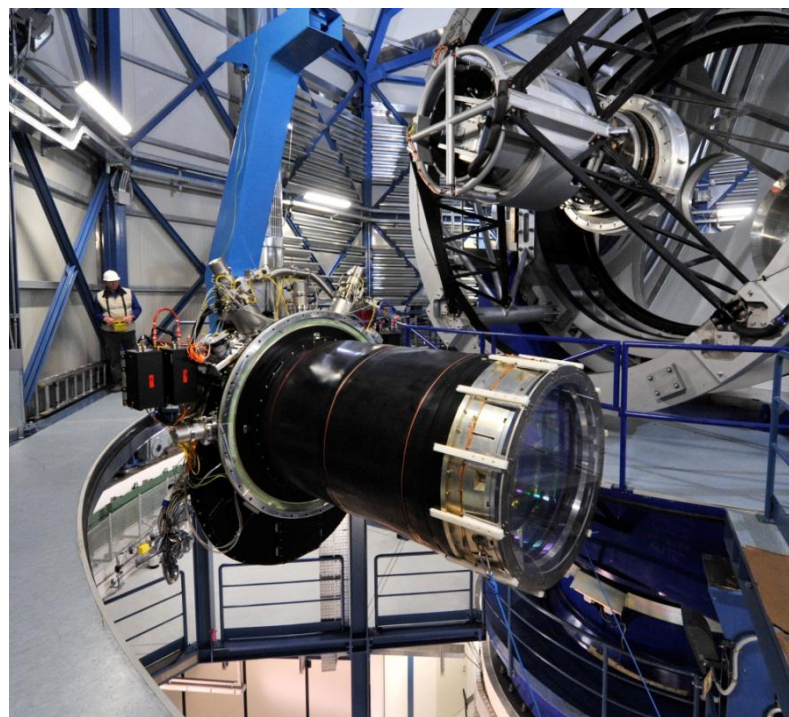


VISTA : mirrors & camera

- Optical design based on an integrated telescope/camera system
- Telescope quasi-Ritchey Chretien
 - ✓ M1 4-m diameter f/1 active concave hyperboloid
 - ✓ M2 1.24-m diameter f/3 convex hyperboloid
- Residual third order spherical aberration for on-axis images introduced by the two mirrors is balanced by residual spherical aberration in the three field corrector lenses in the camera



VISTA : mirrors & camera





ESO Survey Telescopes - timeline

VISTA

- Science verification* on Oct. 15 - Nov. 3, 2009
- Dry runs started from Nov. 4, 2009
- VISTA handover to ESO on Dec. 10, 2009
- First Phase 2 call for VISTA service mode observations on Dec. 22, 2009
- Official start of operations on Apr. 1, 2010
- 2nd Phase 2 call : Aug 2, 2010
- VISTA time is now offered to the community in P87 - see VISTA protected targets/regions for period P87

<http://www.eso.org/sci/observing/policies/PublicSurveys/VISTA87.html>

*M. Arnaboldi et al. 2010, The Messenger, 139, 6



ESO Survey telescopes - timeline



VISTA science verification
The Orion mini-survey
ESO PR 1006, 10.02.2010



ESO Survey telescopes - timeline

ESO PR 1025, 16.06.2010

VISTA science verification
The NGC253 mini-survey



ESO Public Surveys Science - VISTA

- Ultra-VISTA PIs: Dunlop, Edinburgh; Le Fevre, Marseille; Franx, Leiden; Fynbo, Dark Cosmology Centre
- The VISTA Hemisphere Survey (VHS) PI: McMahon, IoA, Cambridge
- VIDEO Survey PI: Jarvis, Hertfordshire
- VVV (VISTA Variables in the Via Lactea) PI: Minniti, Catolica
- VIKING (kilo-degree IR galaxy survey) PI: Sutherland, Queen Mary, Univ of London
- VMC (Vista Magellanic Survey) PI: Cioni, Hertfordshire
- To be completed in 5 years!



ESO Public Surveys Science - VISTA

Deep high z Whole sky Galactic Extragalactic Star Form. History

Surveys	Area deg ²	Area covered in P85	Filters	Magnitude limit	Depth measure
Ultra-VISTA	1.7 d 0.73 u-d	1.7	Y J H K _s Y J H K _s NB	25.7 25.5 25.1 24.5 26.7 26.6 26.1 25.6 24.1	5σ (AB)
VHS	17800	1808	Y J H K _s	21.2 21.1 20.6 20.0	5σ (AB)
VIDEO	12.0	3.5	Z Y J H K _s	25.7 24.6 24.5 24.0 23.5	5σ (AB)
VVV	560	519	Z Y J H K _s	21.9 21.1 20.2 18.2 18.1	5σ (AB)
VIKING	1500	234	Z Y J H K _s	23.1 22.3 22.1 21.5 21.2	5σ (AB)
VMC	180	14	Y J K _s	21.9 21.4 20.3	10σ (AB)



ESO Public Surveys Science - VISTA

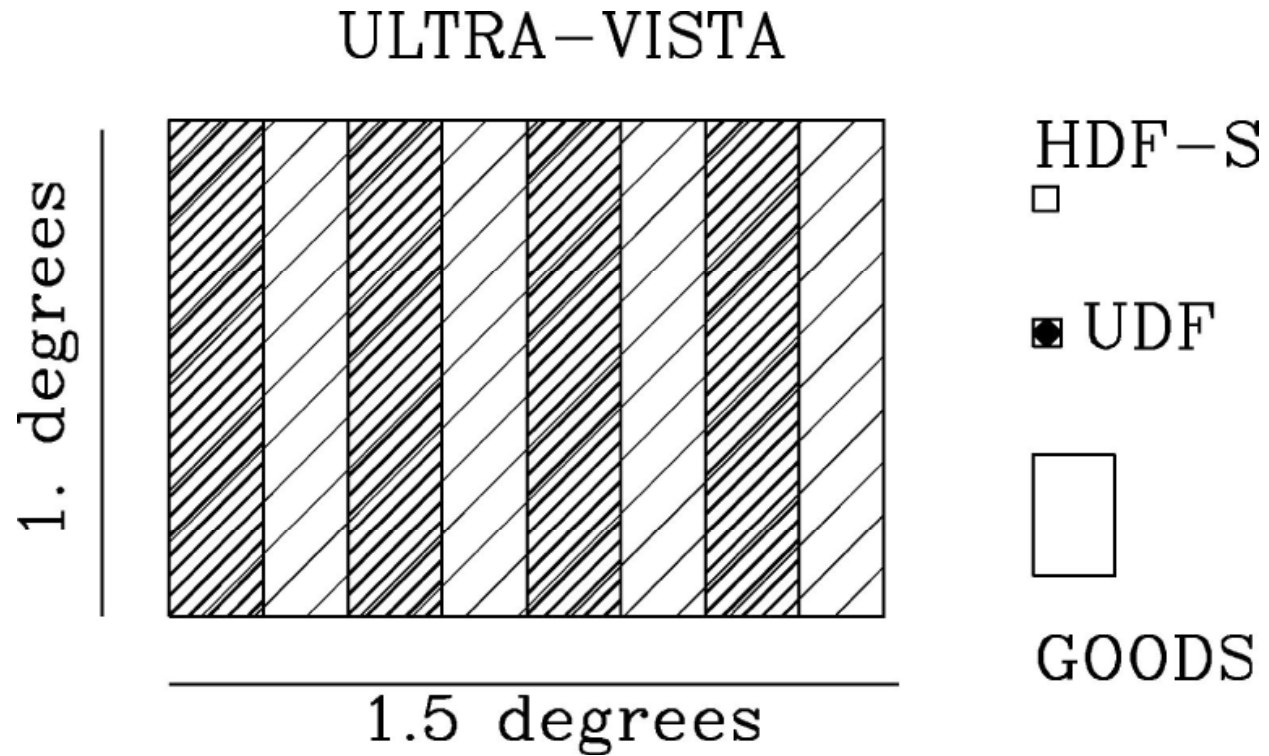
ULTRAVISTA: Deep 1.5 sq deg and Ultra-deep 0.73 sq. deg survey

Y, J, H, Ks, narrow-band (Ly α z \sim 8.8). Total n. of nights in 5 years : 200

- The first galaxies
 - Re-ionization sources?
 - Lyman-break technique only works to z \sim 6
 - Need VISTA for 6<z<10: expect >100 at z>6.5
- Stellar mass build-up 1<z<5
- Dust-obscured star formation
- High-z quasars
- \sim 30 Ly-alpha emitters at z=8.8 (NB survey)

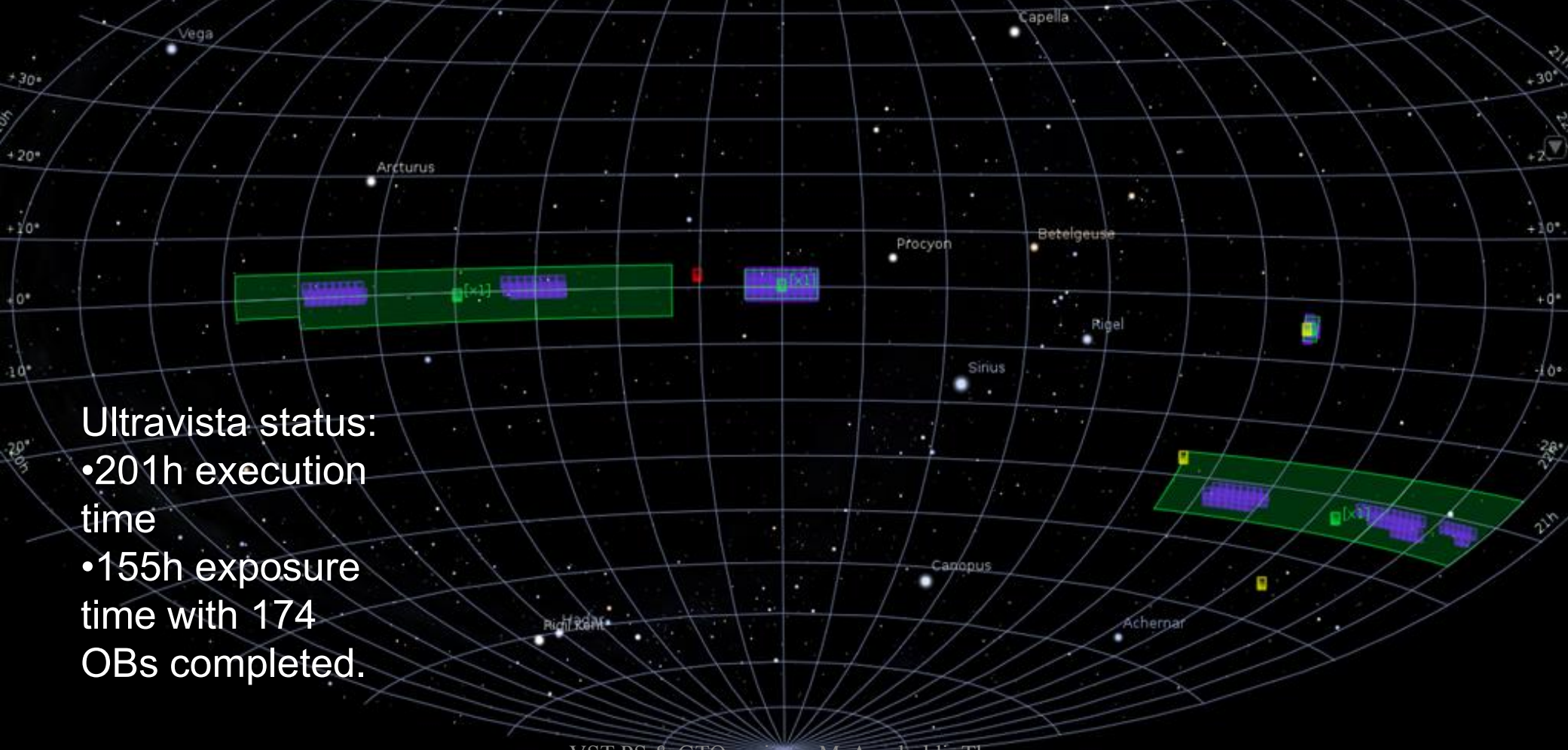


ESO Public Surveys Science – VISTA





ESO Public Surveys Science - VISTA



Ultravista status:
•201h execution
time
•155h exposure
time with 174
OBs completed.



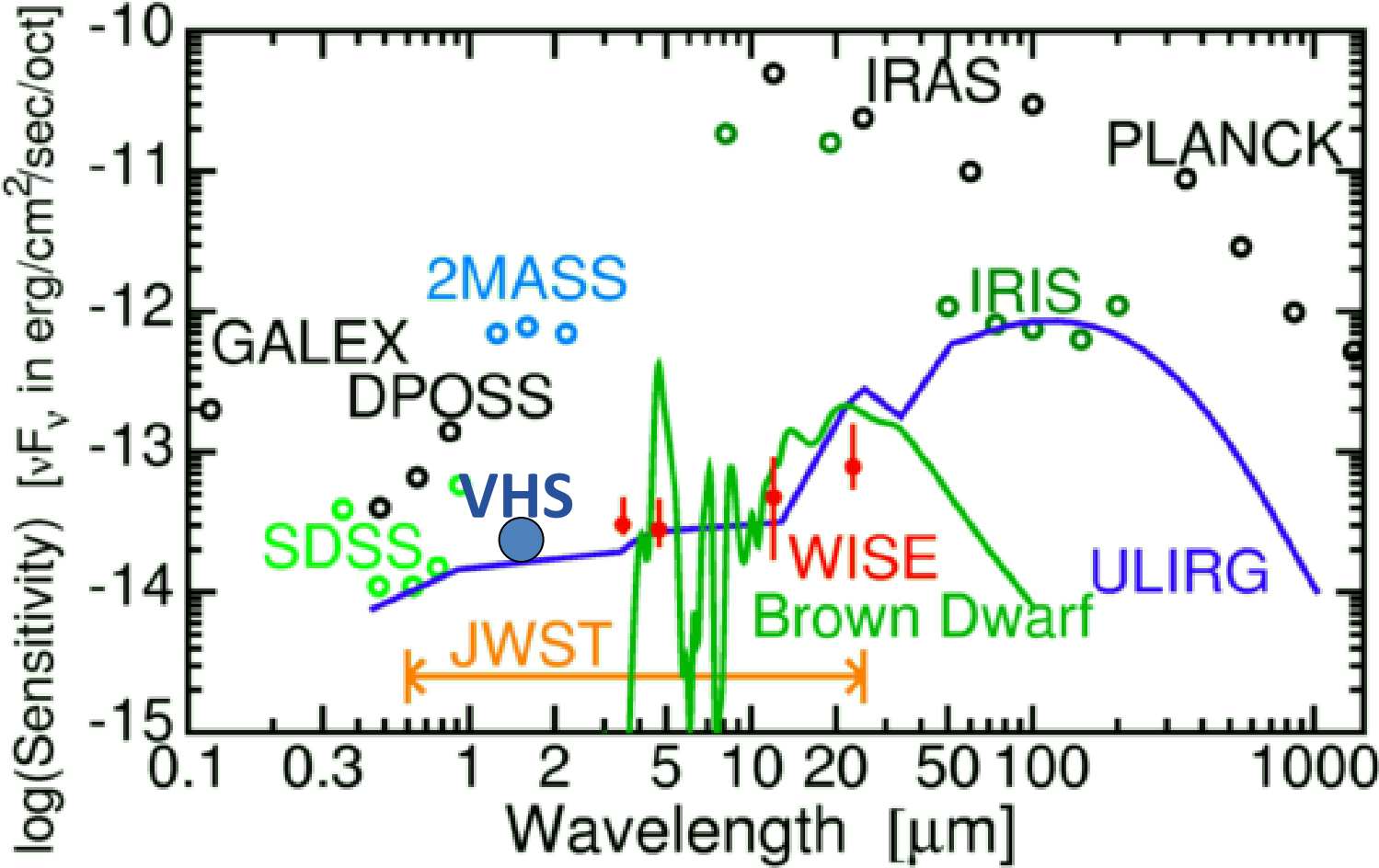
ESO Public Surveys Science – VISTA

VHS : 17800 sq deg \sim 4 mags deeper than 2MASS in some bands
South Galactic Cap (\sim 5000 sq deg) will be imaged more deeply (+ H-band)
Total n. of nights required in 5 years: 346

- Low mass stars and nearby stars
- Brown dwarf / planet transition zone
- Merging history of the Milky Way
- Large scale structure to $z \sim 1$
- Dark energy
- IR complement to Dark Energy Survey
- 1st quasar at $z > 7$ (SDSS only to $z \sim 6.5$)

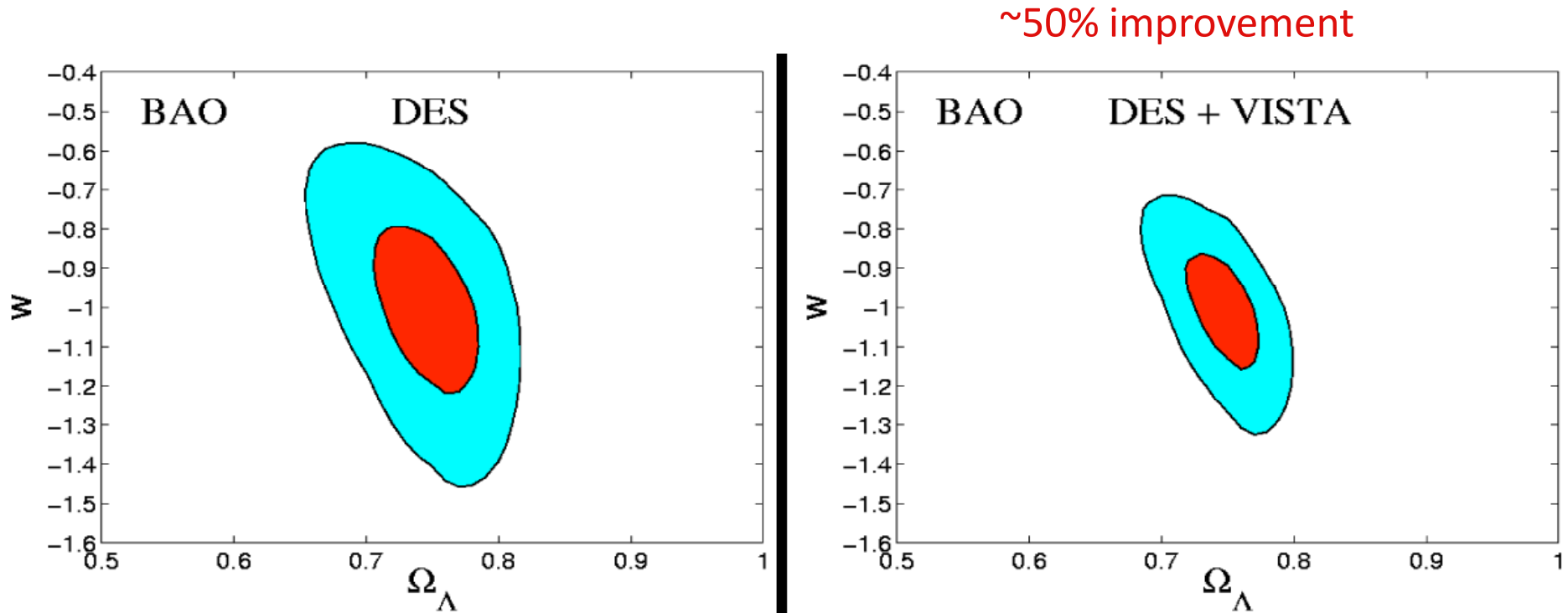


ESO Public Surveys Science – VISTA





ESO Public Surveys Science – VISTA

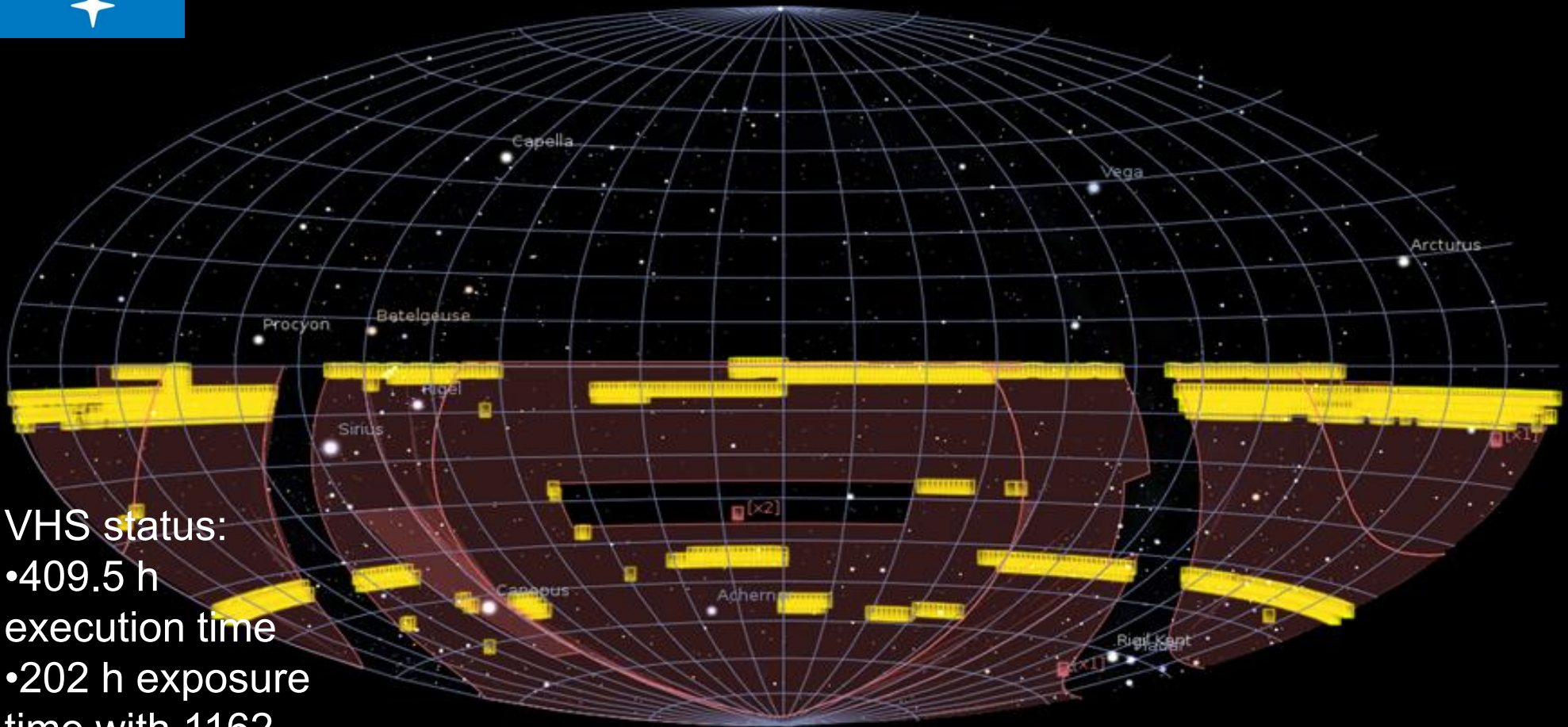


The VISTA Hemisphere Survey (VHS)

PI: McMahon, IoA, Cambridge



ESO Public Surveys Science - VISTA



VHS status:

- 409.5 h execution time
- 202 h exposure time with 1162 OBs completed.



ESO Public Surveys Science - VISTA

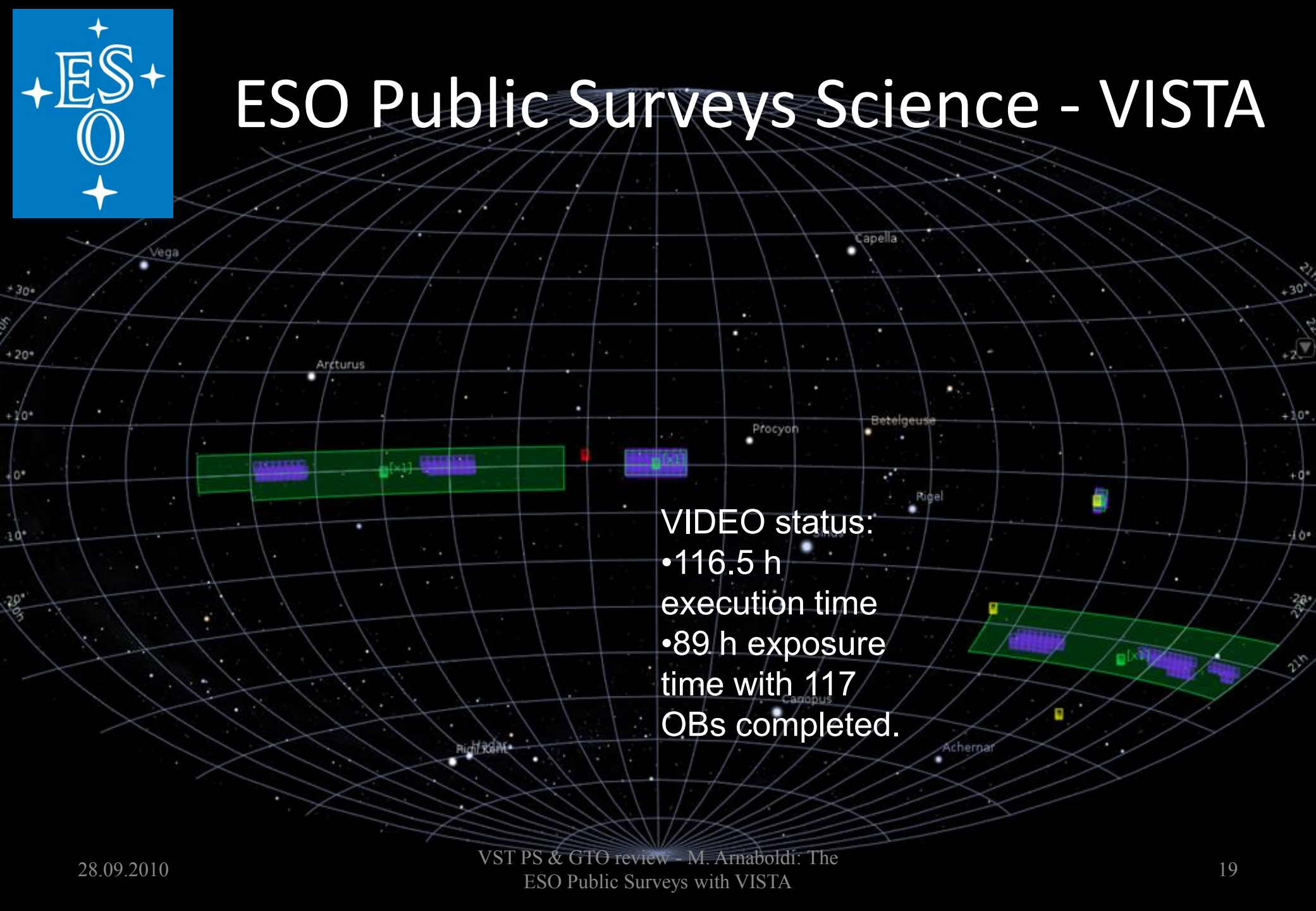
VIDEO -- 12 sq deg. Z, Y, J, H, Ks - Between VIKING and ultra-deep surveys (in terms of width + area). Multi-epoch observations for SN detection. Total n. of nights required in 5 years: 167.

<http://star-www.herts.ac.uk/~mjarvis/video/>

- Galaxy evolution in all environments over 90% of the history of the universe (to $z \sim 4$)
- Structure evolution (cluster evolution)
- AGN (obscured)
- Most massive galaxies
- Observe most active period of gal. formation
- SNe search : Independent of dust obscuration - Expect 250 core-collapse, 100 type Ia



ESO Public Surveys Science - VISTA



VIDEO status:
• 116.5 h
execution time
• 89 h exposure
time with 117
OBs completed.



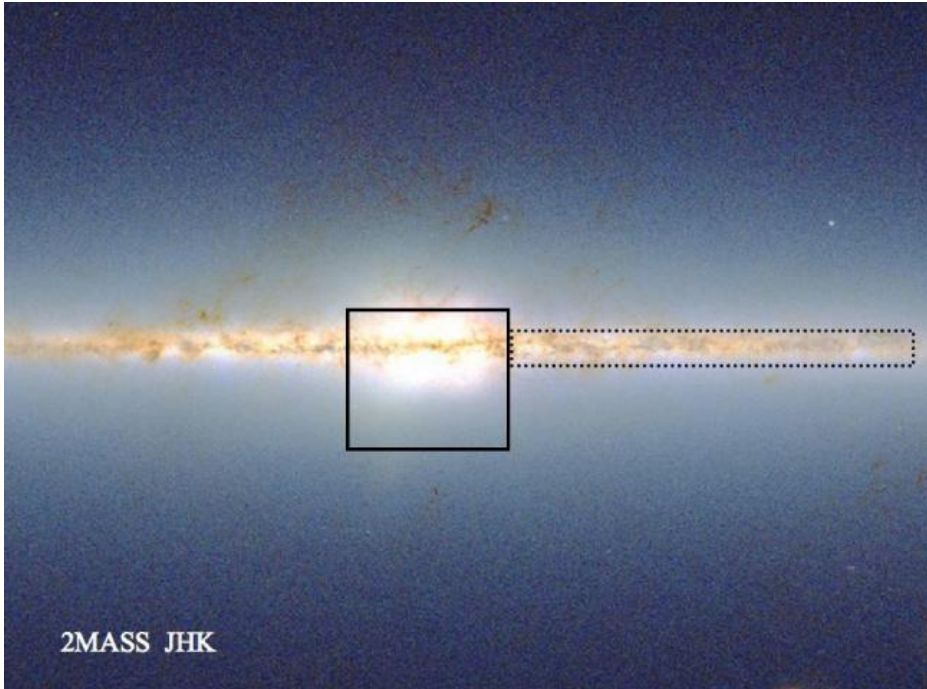
ESO Public Surveys Science - VISTA

VVV - IR survey of the bulge and an adjacent section of the mid-plane in the Milky Way 520 sq. deg (bulge = 300 sq deg) in Z, Y, J, H, Ks - multiple epoch. Total n. of nights required in 5 years: 215. <http://www.vvvsurvey.org>

- IR survey can map entire bulge unlike in the optical (dust)
- Will find 10^6 variable point sources
 - RR Lyrae (>50% of total), type II Cepheids
 - Find variables in known star clusters (obtain distances, reddenings, metallicities): Eclipsing binaries, Rare variable sources, Microlensing
 - Look for variables stars in Sag. dwarf

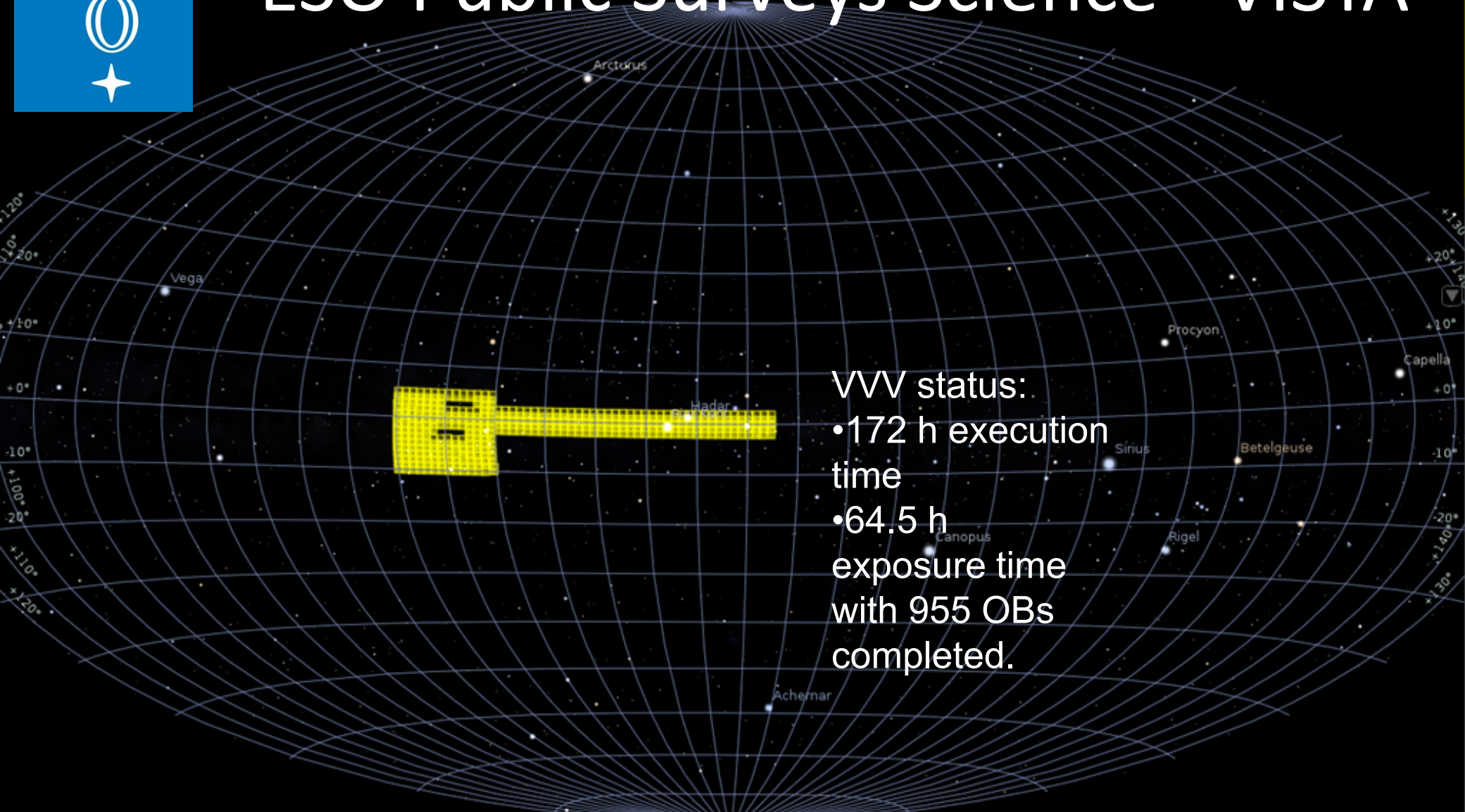


ESO Public Surveys Science - VISTA





ESO Public Surveys Science - VISTA



VVV status:
•172 h execution time
•64.5 h exposure time with 955 OBs completed.



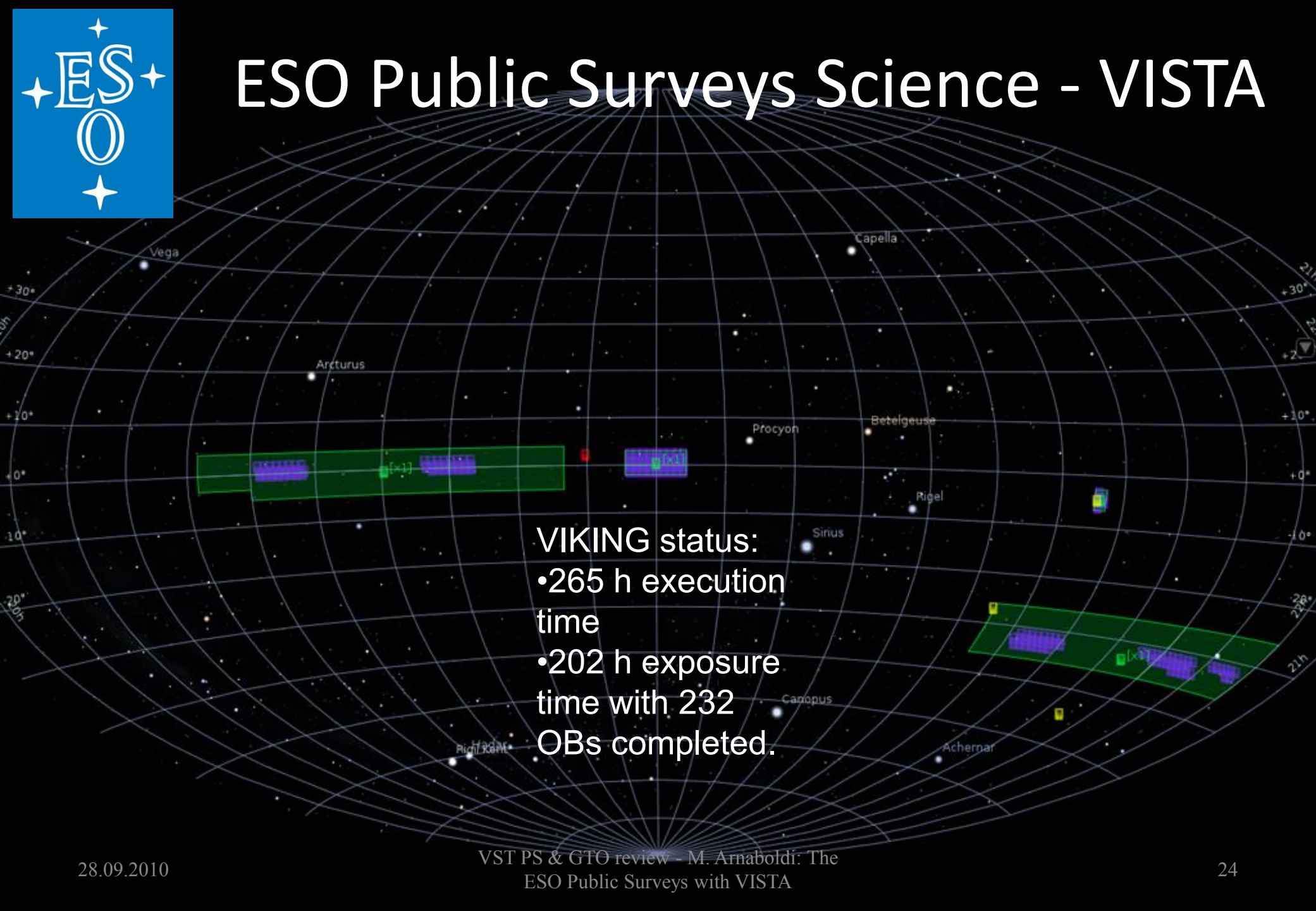
ESO Public Surveys Science - VISTA

VIKING: 1500 sq. deg in Z, Y, J, H, Ks IR complement to KIDS (VST), 2 mags deeper than SDSS, 1.4 mags deeper than UKIDSS-LAS. Total n. of nights required in 5 years: 244

- Extragalactic: Accurate photo-z's (for lensing, BAOs)
- High-z quasars , $z > 1$ clusters
- Star/galaxy separation (lensing)
- Galaxy morphologies (optical + IR)
- Stellar masses Optical sensitive to recent SF
- Galactic structure: VIKING + KIDS can isolate blue horizontal branch, M-giants & carbon stars to trace the halo, ultracool white dwarfs, brown dwarfs



ESO Public Surveys Science - VISTA



VIKING status:
•265 h execution time
•202 h exposure time with 232 OBs completed.



ESO Public Surveys Science - VISTA

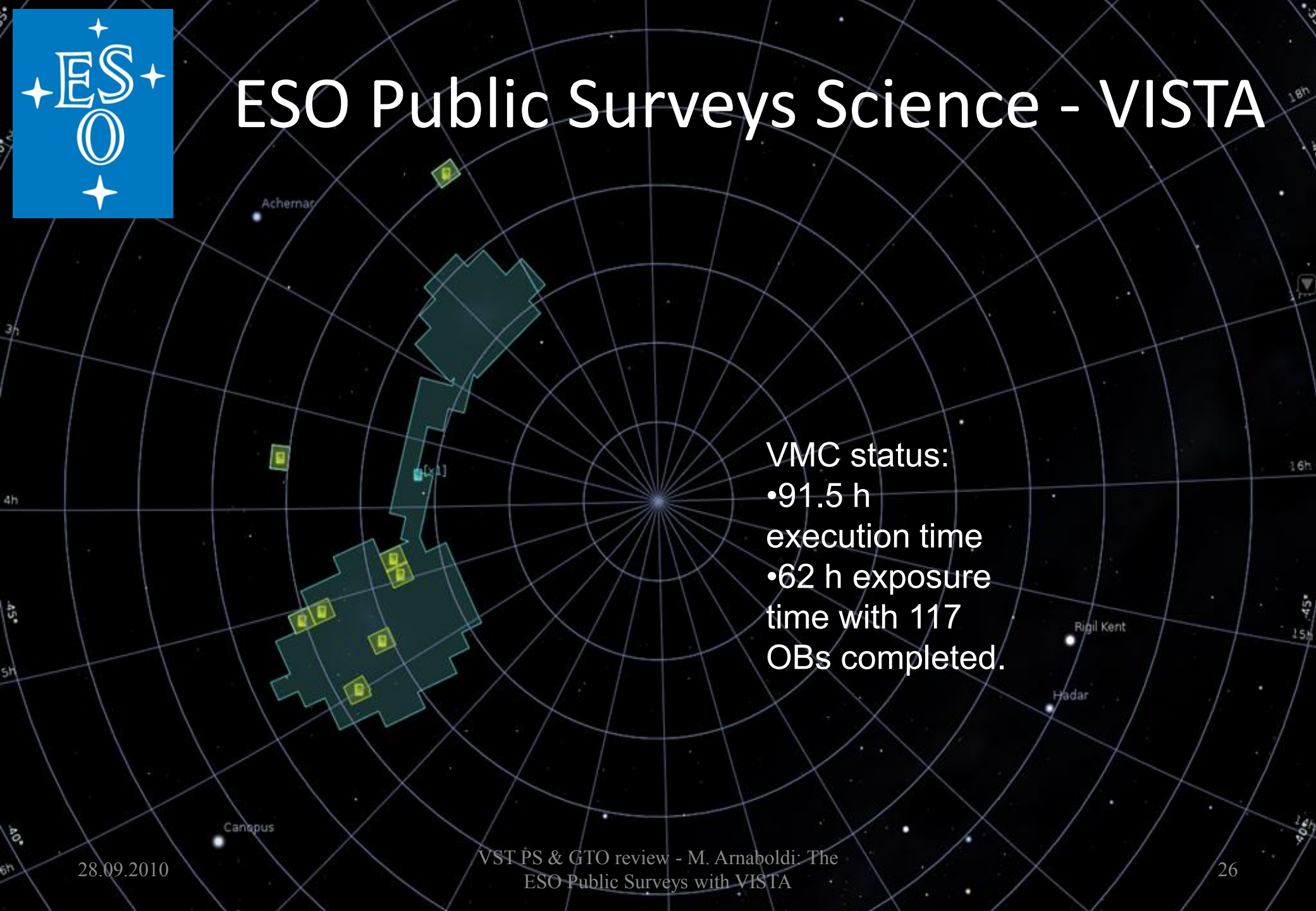
VMC: Y, J, Ks survey of the Magellanic system (LMC, SMC, Bridge & Stream), 184 sq. degrees. Total n. of nights required in 5 years: 200

<http://star.herts.ac.uk/~mcioni/vmc/>

- Resolved stellar populations
- Old populations + active star formation + ongoing merging + nearby = ideal laboratory
- Globally resolved SF history with unprecedented accuracy
- Trace past interactions
- Complements optical (VST GTO program) and kinematical studies of Magellanic system



ESO Public Surveys Science - VISTA

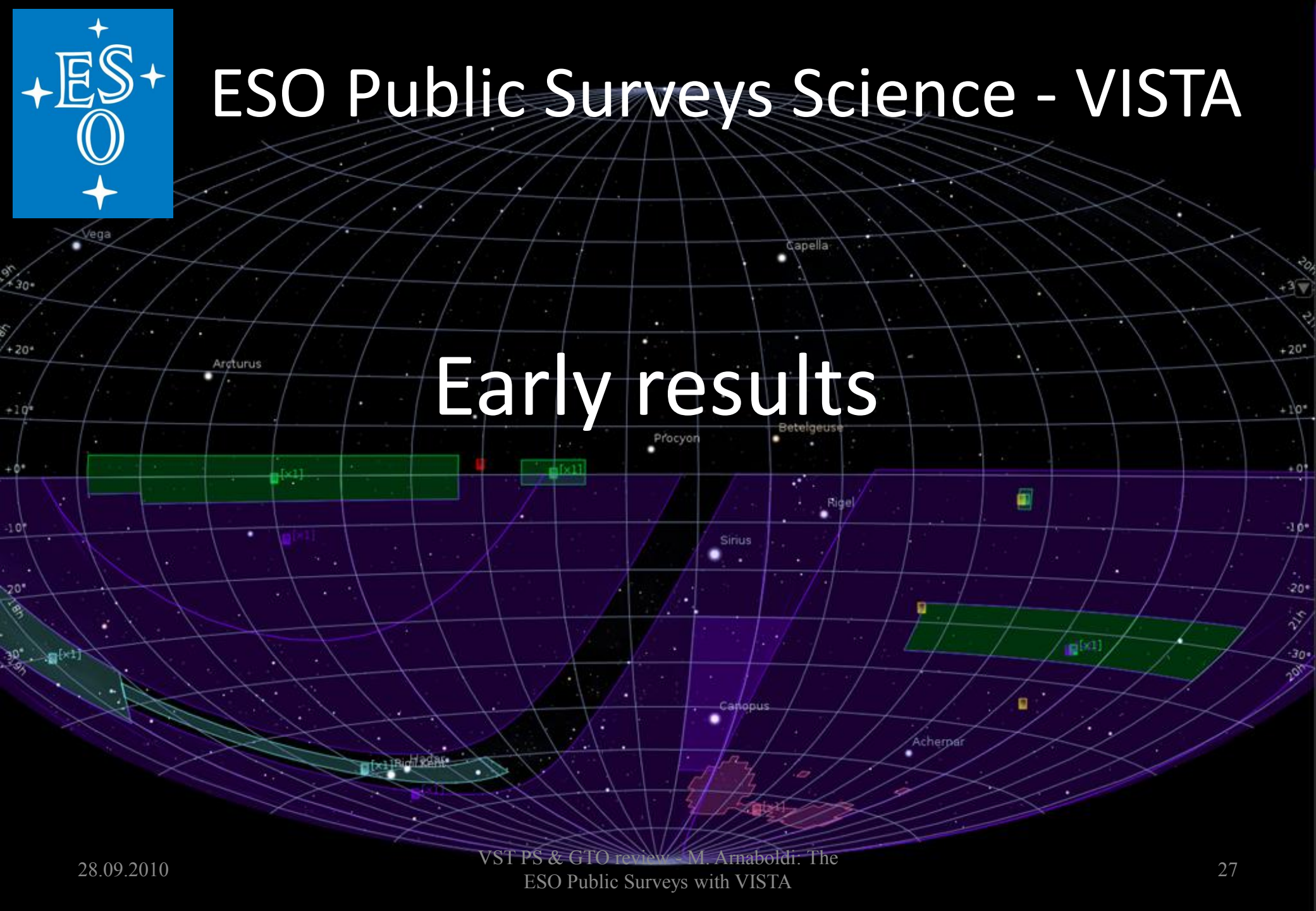


VMC status:
•91.5 h
execution time
•62 h exposure
time with 117
OBs completed.



ESO Public Surveys Science - VISTA

Early results





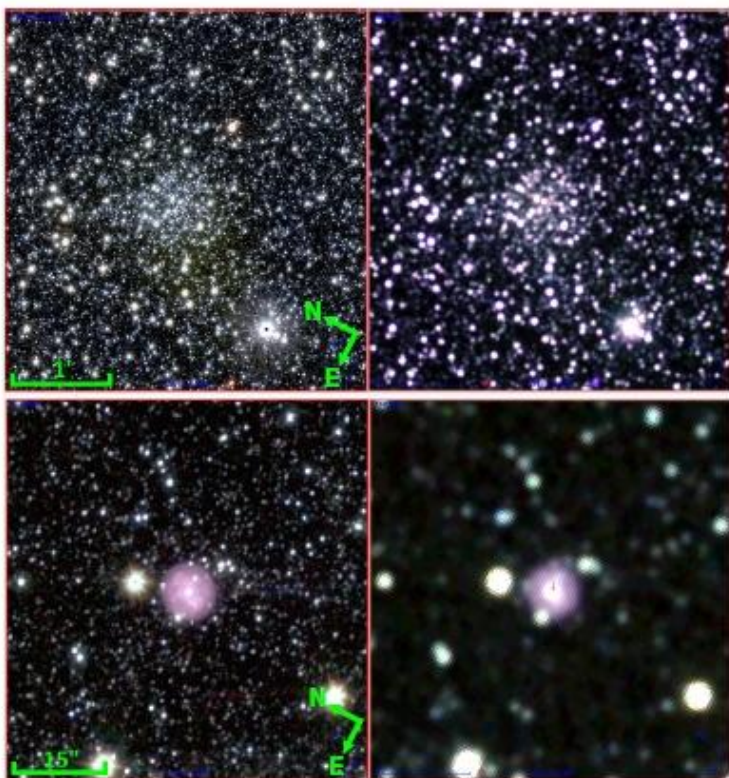
ESO Public Surveys Science - VISTA

VVV first results: The Messenger, Oct. 2010

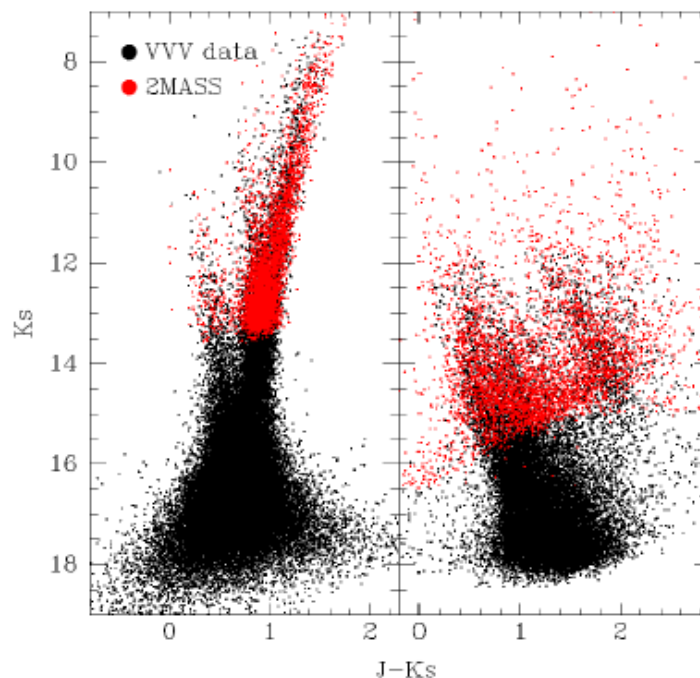
VVV

2MASS

Palomar 6



NGC6629

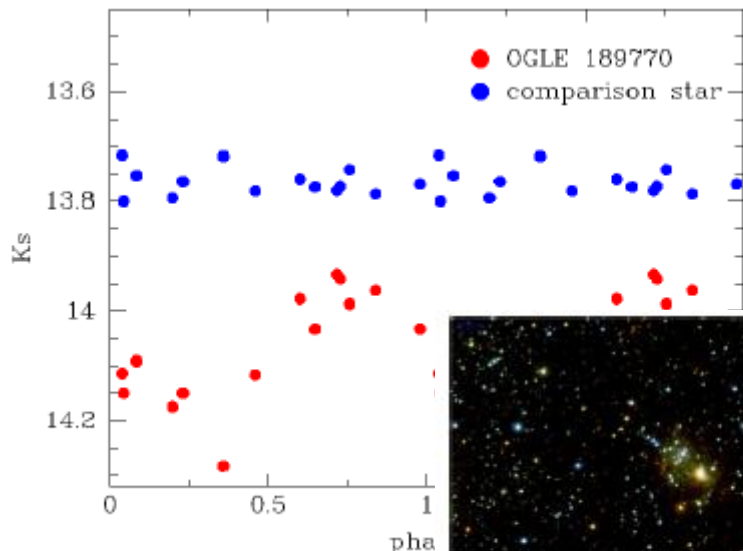


VVV vs. 2MASS - CMD in the bulge (left) and in the disk

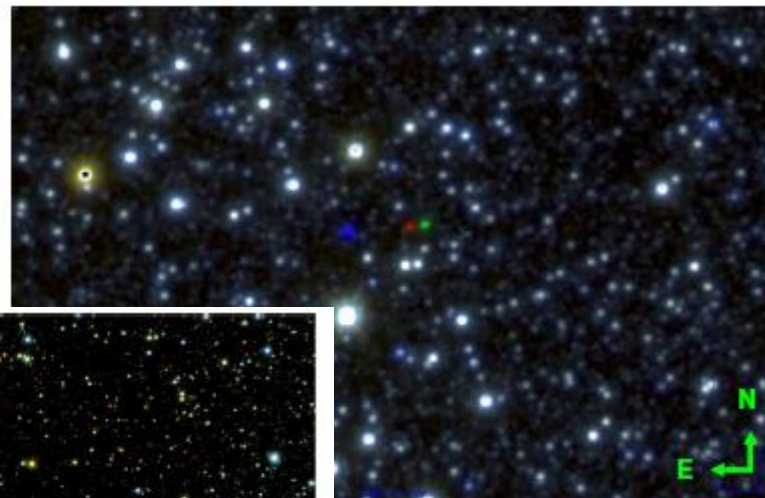


ESO Public Surveys Science - VISTA

VVV first results: The Messenger, Oct. 2010



First VVV light curve
of the variable star OGLE 189770



g object detected in
belt asteroid 199



New cluster candidate in a
disk field identified by VVV



Optical & NIR surveys and telescopes

Survey projects:

- Dark energy survey (DES) project – synergy with VHS (5000 sq deg).
- Pan-STarr1 survey – visible, whole sky
- Stromlo Southern Sky Surveys – visible, whole sky



Optical & NIR surveys and telescopes

	Telescope Diameter	FoV	Etendu [m ² deg ²]	Pixel size [arcsec/pixel]	Wavelength range [μm]
Ground					
SkyMapper	1.4	5.7 deg ²	8.7	0.500	0.32-0.95
Pan-STARRS 1	1.8	2.8°x2.9°	20.6	0.300	0.4-1.15
SDSS	2.5		6.0	0.394	0.33-1.0
MegaCam	3.6	0.96°x 0.94°	9.2	0.187	0.34-0.95
CTIO (DES)	4.0	4.0 deg ²	50	~0.20	0.6-1.0
VISTA	4.0	1.65 deg ²	18.85	0.339	0.88-2.15
SuprimeCam	8.0	34'x27'	12.56	0.200	0.36-1
VLT HAWK-I	8.2	7.5'x7.5'	0.82	0.106	1-2.2
VLT-VIMOS	8.2	4 x 7'x8'	3.2	0.205	0.36-1
<i>LBC@LBT</i>	8.4	23'x23'	8.1	0.230	0.32-1.0
<i>VST</i>	2.6	1 deg ²	5.3	0.210	0.33-1.0
<i>Subaru</i> <i>HyperSuprime</i>	8.0	1.5 deg ²	75.4	0.17	0.36-1
LSST	8.4	3.5 deg ²	193.9	0.200	0.33-1.07



Observing for Public Surveys : wide & deep

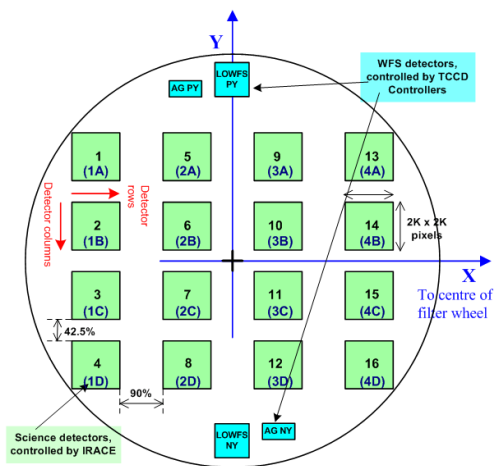
- Only 6 VISTA public survey programs, but very large:
 - 1800 – 3200 hrs per survey
 - Surveys expected to run for 5 years
 - Different observing constraints (moon, seeing, atmospheric conditions, etc).
 - Observing strategies span wide areas & long time-scales
 - Manage # of OBs similar to 1 UT/year in each semester
- The widest area survey: VHS (VISTA Hemisphere Survey)
 - **17,700 sq. degrees, ~3200 hours**
- Survey with most OBs: VVV (VISTA Variables in Via Lactea)
 - **520 sq. degrees, ~80 epochs, ~1930 h; more than 30,000 OBs¹**
- The deepest survey: Ultra-VISTA
 - **0.73 sq. degrees, ~1800 h; 25.6 mag_{AB} (Ks), >26 mag_{AB} (YJH)**

¹VLT average number of science OBs: 2500-5600 /year/UT

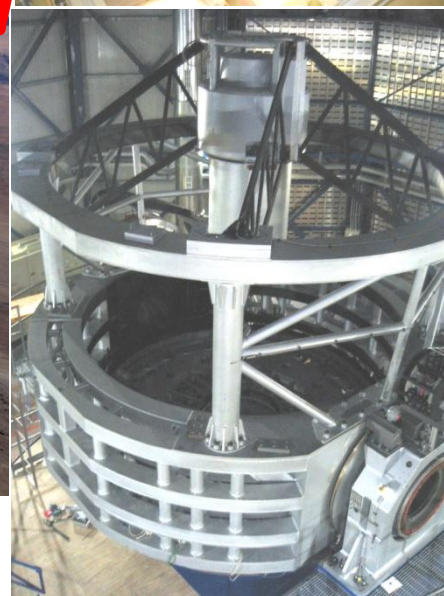
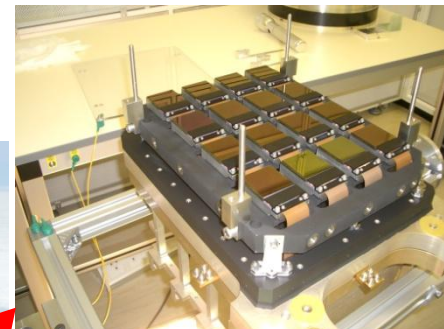
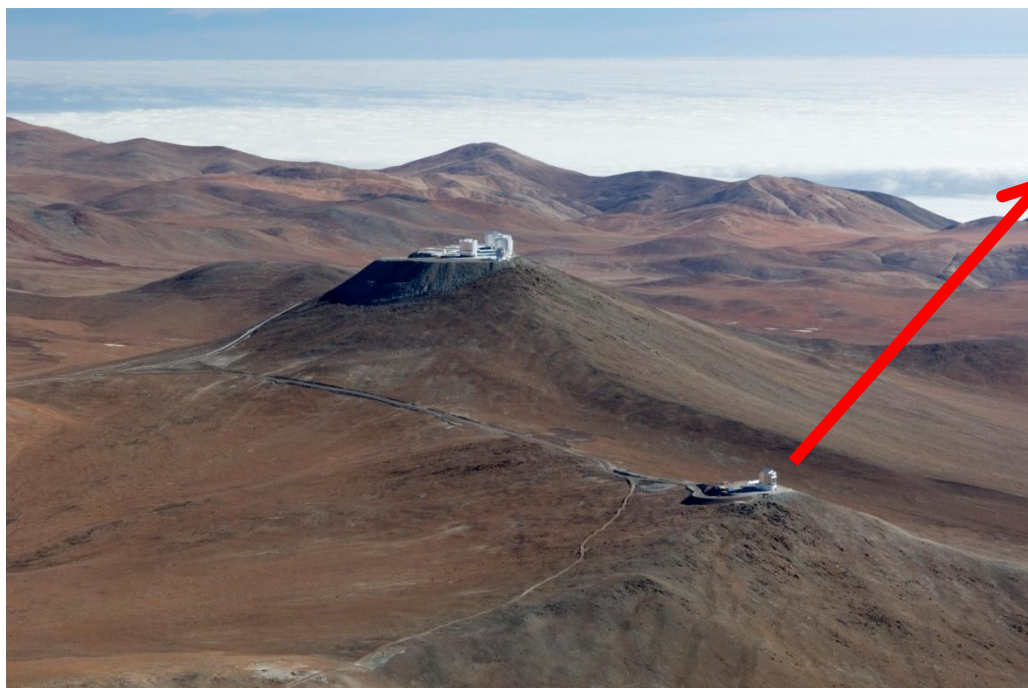


Operation of Survey Telescopes - VISTA

Vista Focal Plane: Geometry



VIRCAM

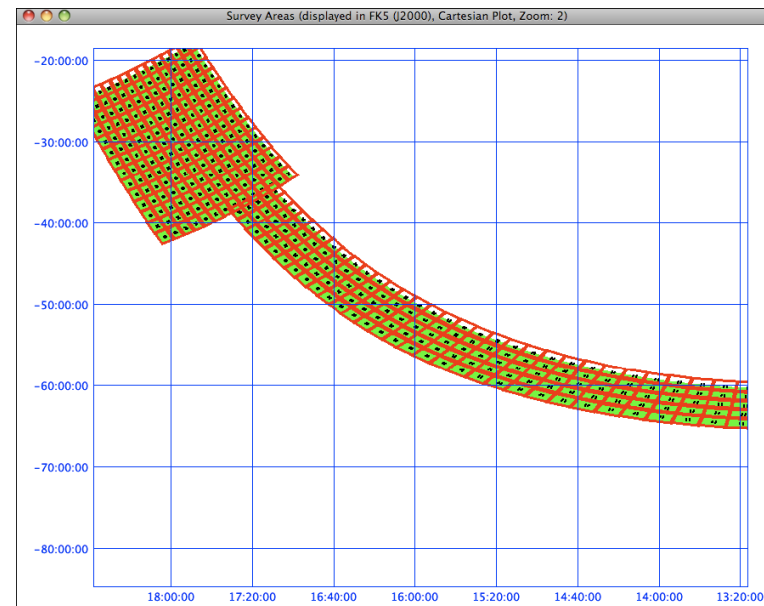
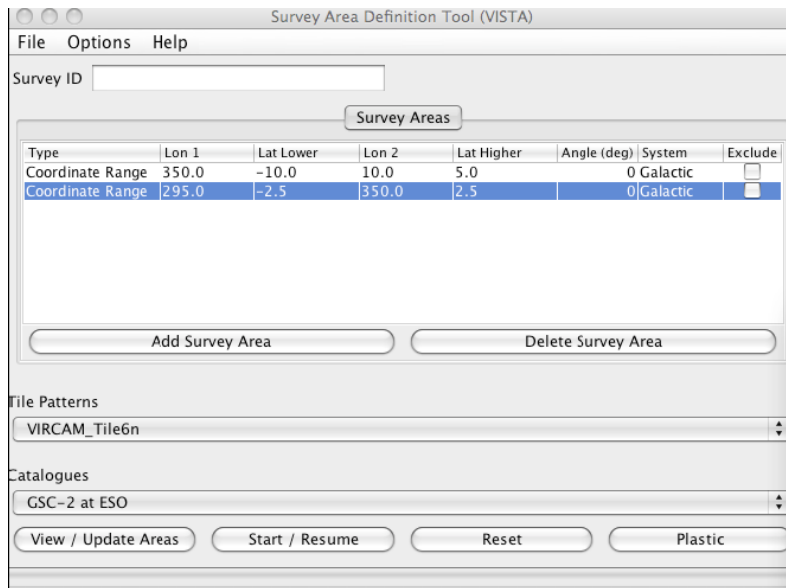


VISTA



Preparation of survey observations - I

- Survey Area Definition Tool (SADT)
- Delivered by UK
- Computes survey geometry, identifies guide stars & active optics stars
- Reviews in 2008 ,2009 and 2010 by EST and USD
- Tested during Science Verification run (October 2009)





Preparation of survey observations - II

New ESO tools: Phase II Proposal Preparation tool - P2PP, and OT version 3.1

Collaborative project between several ESO divisions - SDD/DFI, USD and SciOps

- Design of complex, long-term observing strategy
- Integrated support for SADT
- Automatic generation of many (hundreds!) similar OBs
- Execute efficiently observations according to PIs design: observing strategy becomes part of the OBs definition, not in free-style written README file
- OT : Ranking engine for VISTA – suggest the next OB to be observed
- Integrated QC0 reporting capability
- Full back replication of OB status



P2PP 3.1: scheduling containers

Scheduling Containers



Time Link



Group



Concatenation



P2PP 3.1: scheduling containers

- Time link
 - **A sequence of OBs that has to be executed with minimum and maximum relative time delay**
- Concatenation
 - **A set of OBs that has to be executed back-to-back with no other observation in between**
- Group
 - **A desirable constraint to execute OBs close to each other in time – once the first group OB is executed that group has higher priority than other groups**



Phase 2 for Public Surveys

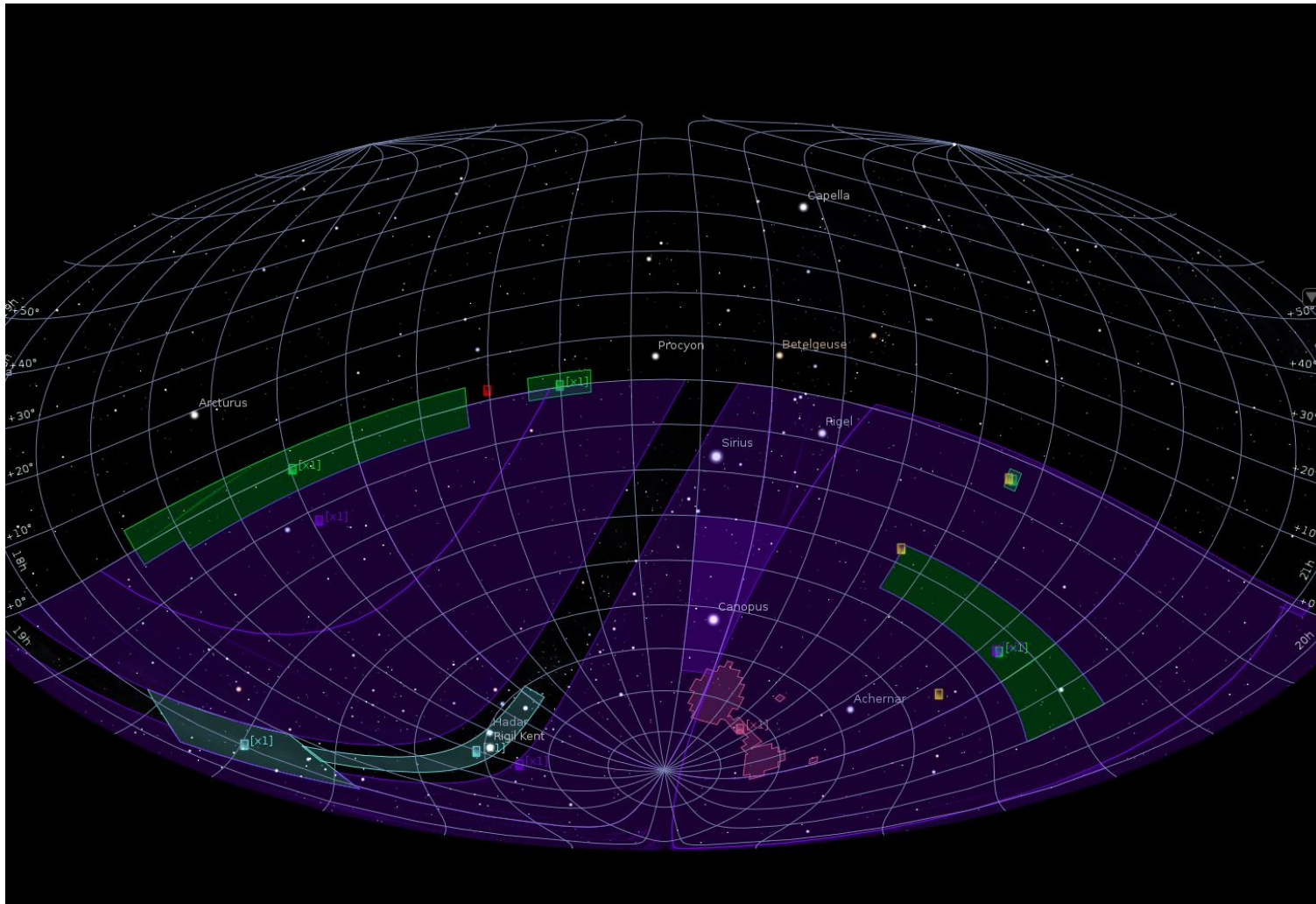
- 1° phase 2: dry runs (Nov. 1, 2009 – Feb 15, 2010)
 - Using “preliminary version of the tools”
 - Total allocation ~550h
 - 800 OBs submitted and reviewed, 67% completed.
- Phase 2 for P84+ (Feb. 15 – Sep. 30, 2010)
 - Using tools tested during the Science Verification
 - 4280 OBs submitted and reviewed¹
 - 6 PIs, USD: 2 astronomers

Apr. 1, 2010 : official start of VISTA science operations

¹equivalent to all service mode OBs for one UT in one year!



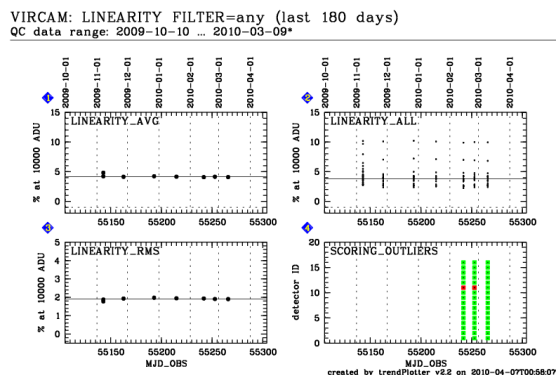
Phase 2 for Public Surveys: survey monitoring and visualization tool





QC on VISTA science data

- QC0 on all science frames – Paranal SciOps
- Garching QC (http://www.eso.org/observing/dfo/quality/index_vircam.html):
 - Production of master calibration files
 - Processing and validation of all calibration:
 - Completeness of calibrations
 - Spot checks on some science frames
 - Instrument trending & health check



VIRCAM Quality Control and Data Flow operations

http://www.eso.org/observing/dfo/quality/index_vircam.html

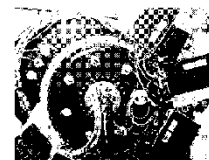


VIRCAM Data Processing and Quality Control

HOME INDEX SEARCH HELP NEWS

QUALITY CONTROL

HOME
 VIRCAM QC
[VIRCAM QC HOME](#)
[TOC](#)
Trending & QC1
[general info](#)
[trending & QC1](#)
[problems](#)



news:

- ▶ 2010-02 start of operations
 - ▶ 2009-10-15 --- 2009-11-02 Science Verification
 - ▶ ESO press releases 2007, 2008, 2009
- Shortcuts to trending plots:
 ▶ | photometric zeropoints | | Go! |

VIRCAM Health Checks

Pipeline
[general info](#)

QC links:

[QC home](#)
[Cal Checker](#)
[Health Checks](#)
[Reference Frames](#)

[QC1 database](#)
[Paranal autrep database](#)
 (ESO internal)

VISTA is the 4.2m Visible and Infrared Survey Telescope for Astronomy on Paranal.

VIRCAM is the VISTA Infrared Camera attached to VISTA.

VIRCAM is operated by ESO to execute public survey programmes. All calibration data from VIRCAM pass Quality Control Garching. They are currently delivered on hard disks to Garching headquarters, with a delay between 4 and 10 days.

- ESO Public Surveys

External links:

- VISTA and VIRCAM
- UK ATC - UK Astronomy Technology Centre
- CASU - Cambridge Astronomical Survey Unit
- WFAU - Wide Field Astronomy Unit Edinburgh

Send comments to sciops@eso.org
Last update: January 18, 2010

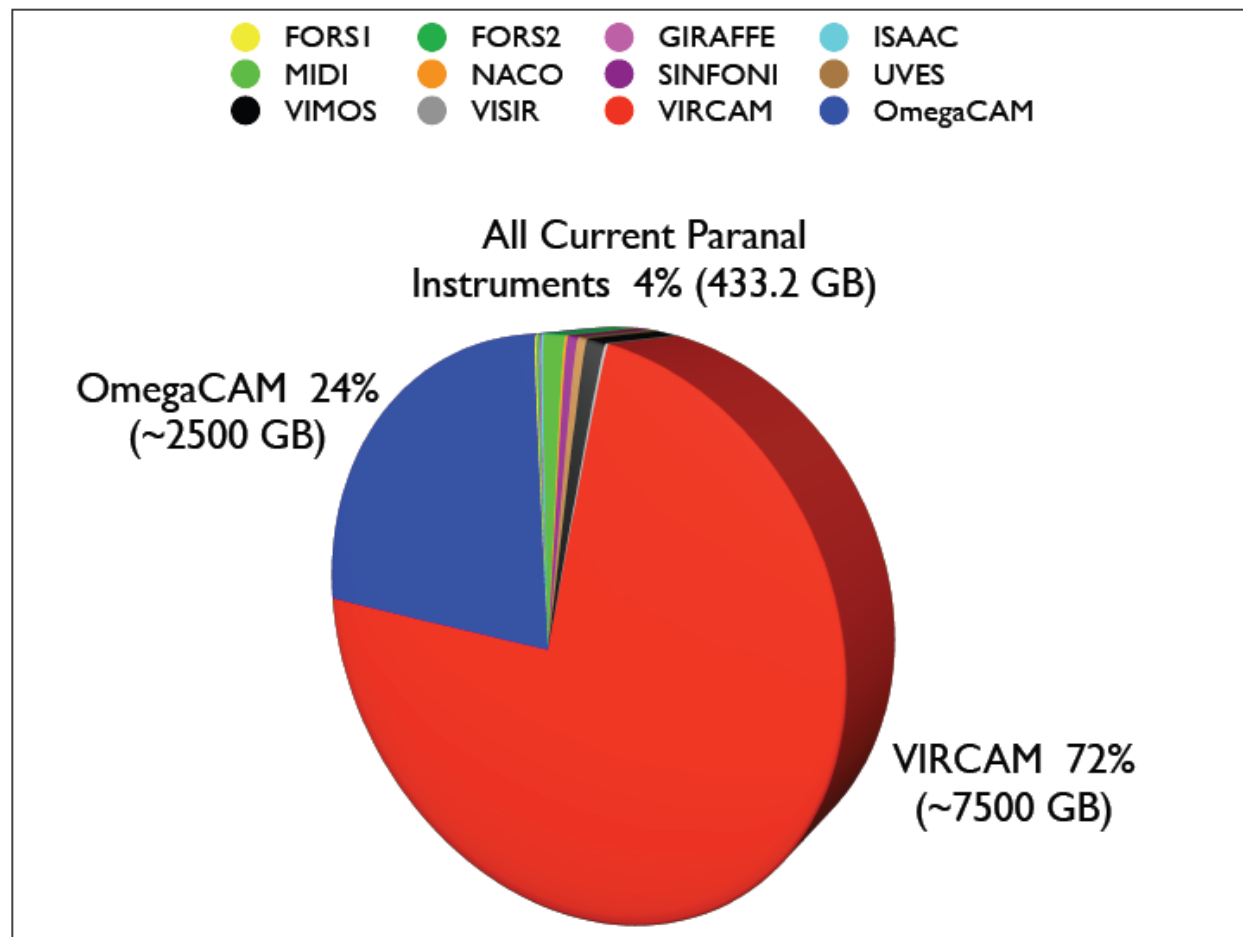




VISTA public surveys data flow - I

Monthly dataflow from UTs and survey telescopes

Survey raw data are available from ESO archive as soon as they are ingested





VISTA public surveys data flow - II

VISTA raw data are copied in the ESO archive and then are shipped to the UK's VISTA Data Flow System (VDFS) pipeline in Cambridge for full science data processing¹.

¹PI do not receive a copy of the data unless they requested so in their Survey Management Plans (SMPs)

CASU: The Cambridge Astronomical Survey Unit

(CASU: <http://www.ast.cam.ac.uk/surveys-projects/vista>) – responsible for 'the processing and calibration of VISTA raw data ².

²PI may access the processed data after the CASU step.

WFAU: After processing, the reduced VISTA data are transferred to the VDFS science archive in Edinburgh , the Wide Field Astronomy Unit

(WFAU: <http://www.roe.ac.uk/~nch/wfcam/>) responsible of the database of products based on the (combined) calibrated data received from CASU..



Phase 3 - I

Phase 3 represents the final step in the execution of ESO Large Programs and Public Surveys; it closes the loop with the community, and is a joint effort of the PIs/ColS with ESO/EDP.

Phase 3 deliveries for Public Surveys:

- survey data products and the QC reports described and agreed upon in the SMPs.
- Timeline for data products delivery is described in the contracts signed by ESO DG and PIs. They are also associated with, and in preparation to, the survey progress reviews by the Public Survey Panel and the reports to the OPC.



Phase 3 – Data product types & volumes

The PS data products

1. Astrometrically and photometrically calibrated, co-added, re-gridded images, along with their respective weight maps, in all of the project-relevant filters.
 2. Aperture-matched source catalogues based on individual or co-added bands.
Associated source catalogues linking the parameters of individual objects across all of the observed filter bands.
 3. Light curves for multi-epoch observations of variable sources
- The structure and format of data products must comply with ESO standards.
 - The data standards applicable to ESO survey data products will be compiled and advertised by ESO/EDP in the second half of 2010.
 - Phase 3 workshop with survey PIs planned for November 30, 2010.



VISTA Public Survey - data volumes

Survey	Image Size (TB)*	Catalogue size (TB)	Total (TB) over 5 years	Total (TB) per period
Ultra-VISTA	0.0068	0.0069	0.014	0.0014
VHS	72.4	2.37	74.8	7.5
VIDEO	0.054	0.018	0.07	0.007
VVV	4.8	7.4	12.2	1.2
VIKING	6.8	0.45	7.3	0.7
VMC	2.6	0.44	3.0	0.3
	Totals:		97	9.7



VST Public Survey - data volumes

Survey	Image Size (TB)	Catalogue size (TB)	Total (TB) over 3 years	Total (TB) per period
KIDS	8.6	0.71	9.3	1.55
ATLAS	25.6	0.33	25.9	4.32
VPHAS+	10.3	1.48	11.8	1.97
Totals:			47	7.84



Conclusions

- ESO science operations for VISTA public surveys started successfully.
- VISTA Paranal – ESO Garching dataflow has been in operation since the beginning of the VISTA commissioning - with raw data copied to the ESO archive and delivered to CASU every two weeks, via USB disks.
- ESO efforts will concentrate on the development of Phase 3 infrastructure (guidelines, standards and tools) for validation and delivery of data products, and the deployment of coordinated query interfaces for the retrieval of catalogs and data products to ease community access to public survey science.