



# The Public Surveys at ESO (PS@ESO)

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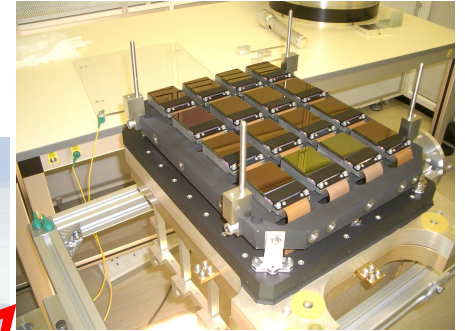


- Survey telescopes at ESO : VISTA and VST\_
- ESO policies & Selection of Public Surveys
- EST management plan
- Public Surveys - Operations
- Guidelines for the Survey Management Plans
- Guidelines for the Validation of Data Products
- Data Reduction Pipelines and Data Centers
- Policies for Archiving Data Products
- ESO public surveys - Science

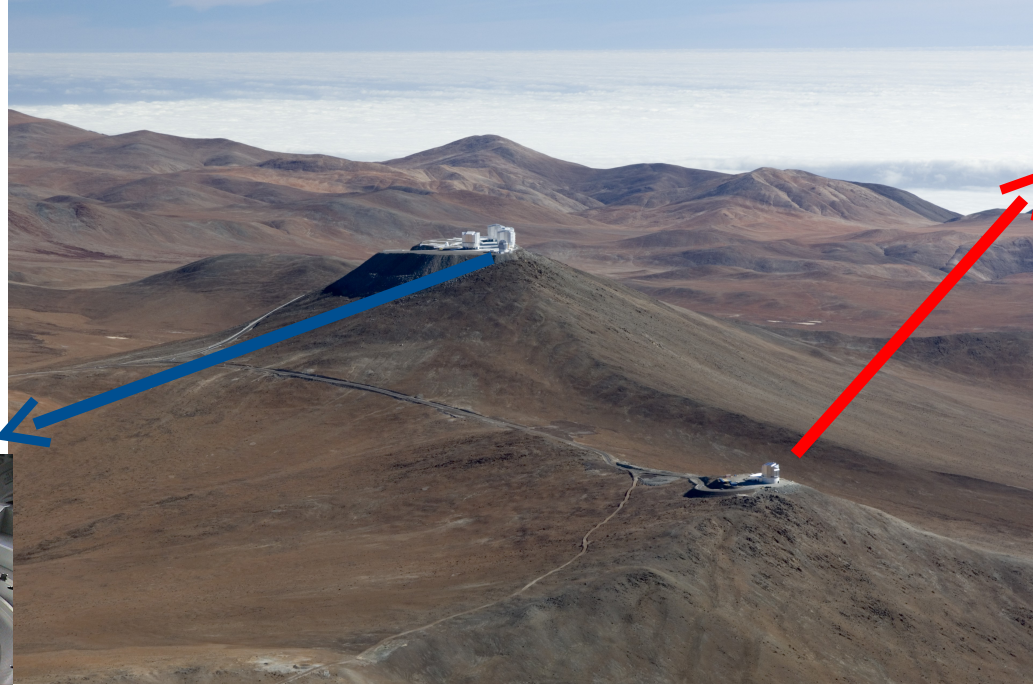
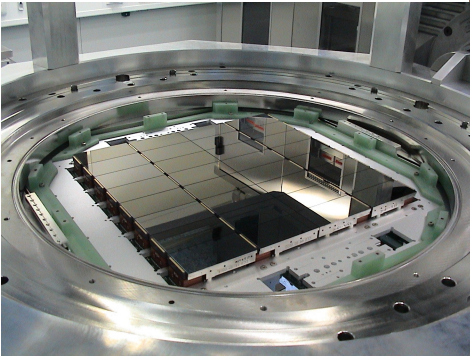


# Survey telescopes: VISTA & VST

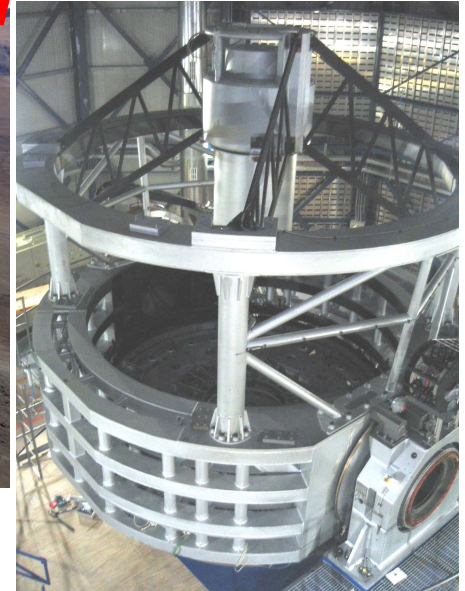
VIRCAM



OmegaCam



VISTA

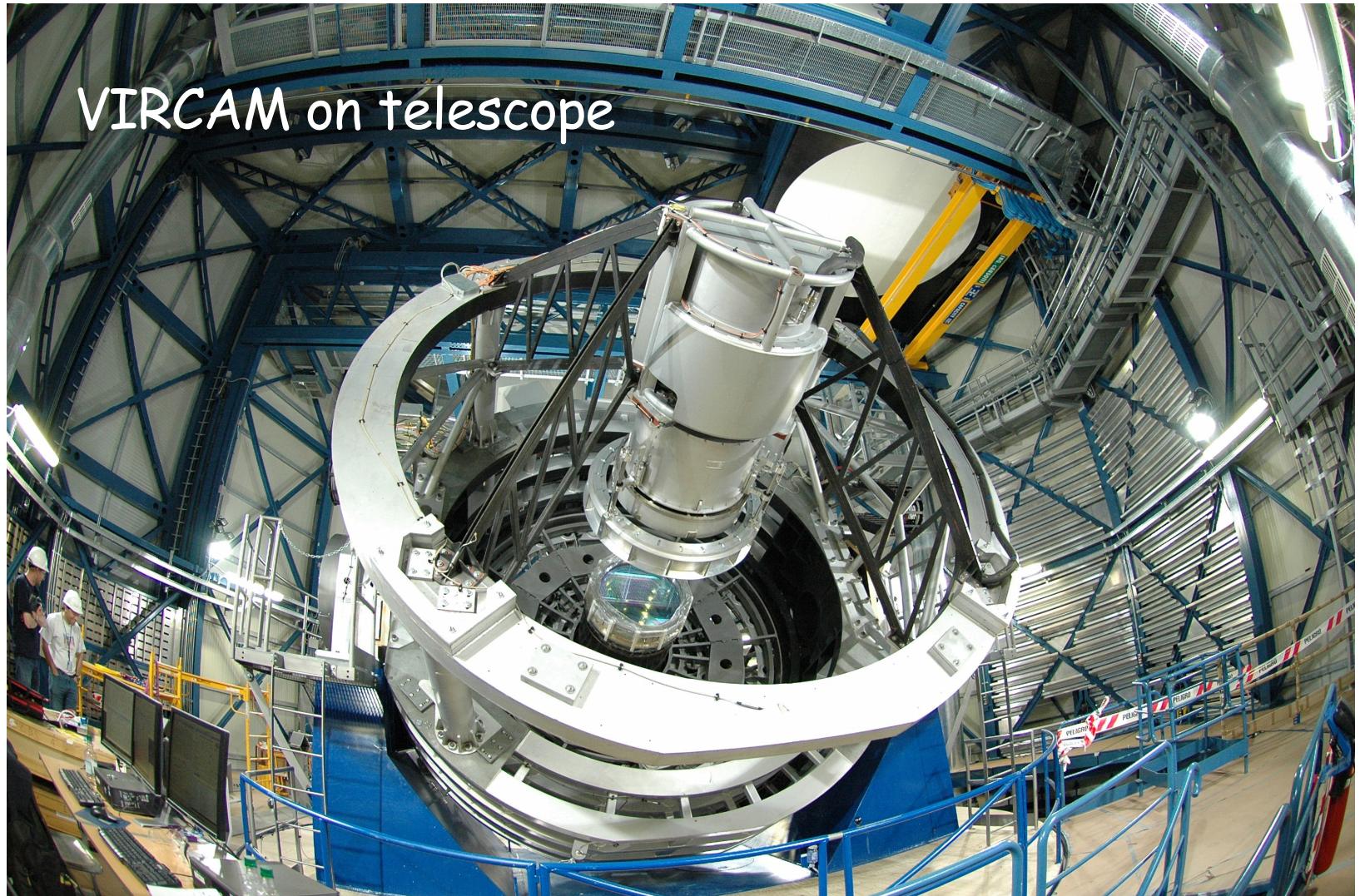


**More than 75% of the ESO time on VST (optical) and VISTA (NIR) will be devoted to Public Surveys. Data taking in SM.**





# Survey telescopes: VISTA & VST



VIRCAM on telescope

DATA MANAGEMENT





## ESO Policies for Public Surveys

Following recommendations by STC and OPC, >75% of the ESO time on VST (optical) and VISTA (NIR) will be devoted to Public Surveys.

ESO does not have the resources (mostly man-power) to conduct Public Surveys on behalf of the community, but it also seems more appropriate if teams interested in the exploitation of surveys are also responsible for delivering the data products to the community.

Therefore, ESO decided to open the **public survey time** on these telescopes to proposals from the community. The ESO public surveys were selected by **the VST and the VISTA Public Survey panels** (Chair: D. Macchetto) - This process is one year long from the letter of interests to the OPC recommendation.



GOAL: best scientific use of all the available telescope time.





# Implementation of ESO Policies

1. After the OPC recommends the Public Surveys (PSs), the PI's submit a management plan to ESO, which will be an important part for ESO's appraisal of the proposal.
2. Guidelines for the Survey Management Plan - VST
3. Guidelines for the Survey Management Plan - VISTA
4. The SMP will be reviewed by the EST, iterated with the PIs and the VLT program scientist. A senior review is held at the completion of the process. The ESO DG will grant final approval, or decide for further actions required.
5. Time allocation after the 1<sup>st</sup> year is subject to the successful outcome of the PSP and OPC review of the PS progress.
6. Time allocation for any additional survey related observations (e.g. spectroscopic follow-up) at other ESO telescopes must be applied for.
7. All available at <http://www.eso.org/sci/observing/p2pp/policies/PublicSurveys/>



# The ESO Survey Team

The EST is composed of the following ESO staff:

Magda Arnaboldi (*Team Leader* - User Support Department) responsible for the review of the SMP, Phase II preparation and tools, PS monitoring and team coordination.

Mark Neeser, Wolfgang Hummel (Quality Control Group within the Data Flow Operations Department; QC scientists) responsible for QC & validation of the data-products.

Joeg Dietrich (ESO fellows - Office for Science) supporting SMP review, Phase II preparation and quality control, PS monitoring.

Piero Rosati (Advanced Data Products Group within the Virtual Observatory Systems Department) responsible for preparing the documentation on data product format guidelines, ingestion of the data products into ESO Science Archive Facility, publishing them in the VO, and advising the PI's on all issues related to this part of the process.

Gaitee Hussain (VISAS) responsible for the scheduling of observations at VISTA and VST



# EST responsibilities

1. Reviewing the survey management plan in all its dimensions.
2. Taking part in the commissioning of VST/VISTA and collaborate to finalize PHASE II tools (SADT, p2pp upgrade).
3. Participation to the definition of the ESO standard calibration plan of OmegaCAM and VISTA, as well as the configuration of the QC parameters in the DFO pipeline.
4. Support the PI's to optimize the scheduling of the observations (Phase II)  
- PS@ESO are carried out in Service Mode!
5. Basic monitoring the progress of the public surveys.
6. Validating Survey Data Products.
7. Issuing and updating guidelines and ESO standards for ingestion and digestion of data products by the ESO archive.





# Public Survey Operations - new tools

P2PP - [http://www.eso.org/observing/p2pp/P2PP\\_future.html](http://www.eso.org/observing/p2pp/P2PP_future.html)

Surveys require the definition of few thousands OBs each semester!

Implementation of scheduling containers:

- Groups
- Timelinks
- Concatenations

The screenshot shows the P2PP v3.0.3 software interface. The 'Obs/Calib Blocks' tab is active, displaying a table with columns: Name, DbaseID, Status, Target, OD, CS, Acquisitor, Finding Ch, and Ephemeris. The table lists several observation blocks, including a group of four 'No name' blocks (IDs 22-25), a 'New Concatenation' of four 'concatened tiles' blocks (IDs 27-30), an 'Elais area in K' block (ID 31), and a 'New Group' of two 'test3\_magda' blocks (IDs 12-13).

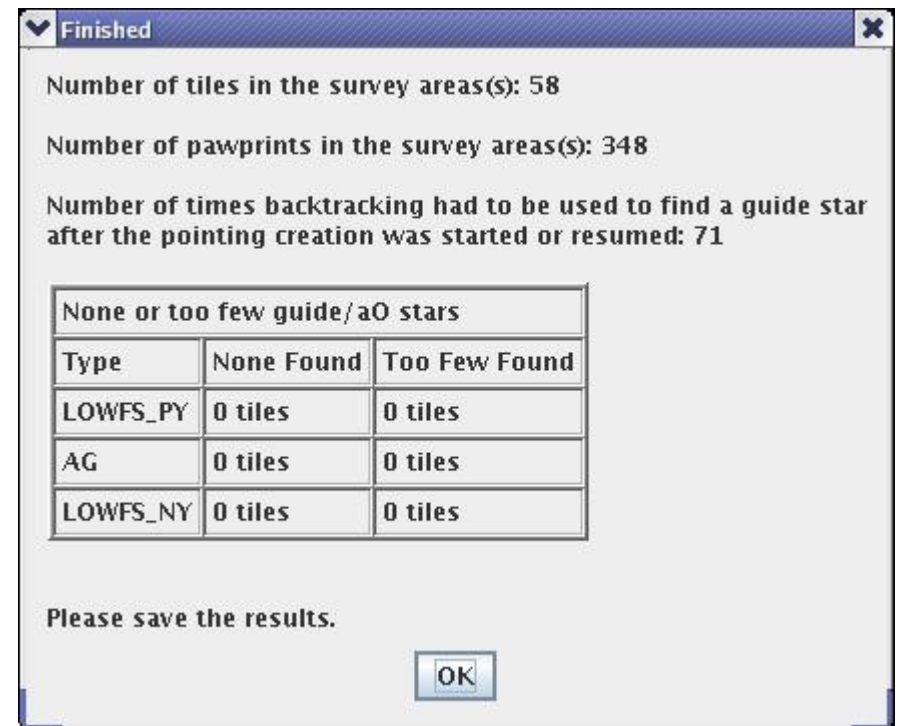
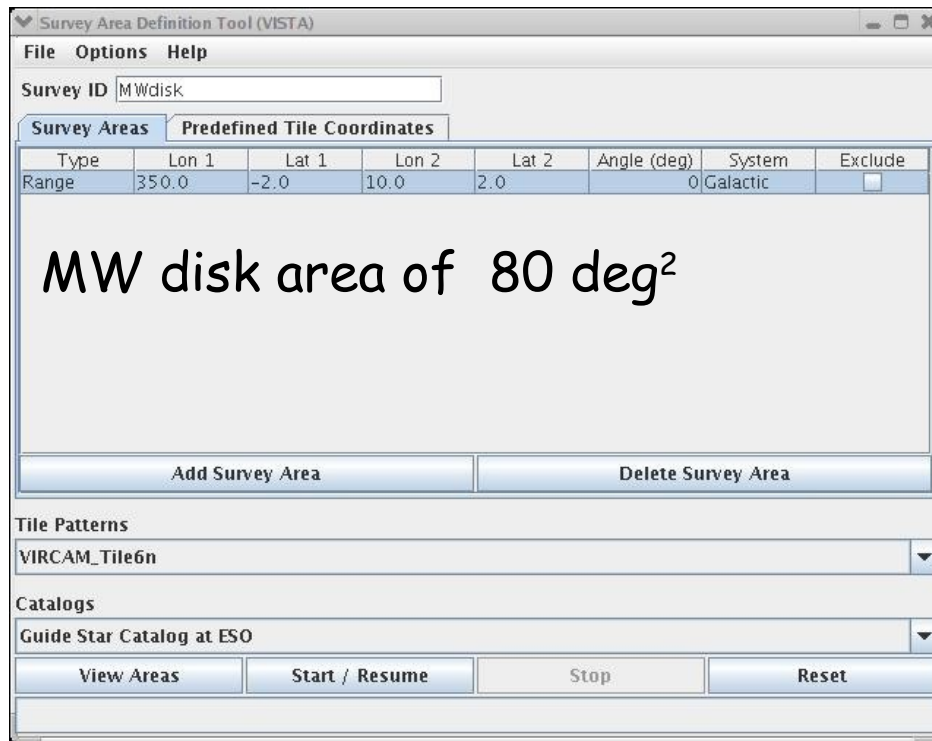
Name	DbaseID	Status	Target	OD	CS	Acquisitor	Finding Ch	Ephemeris
80.A-9252(F) VIRCAM								
80.A-1435(G) VIRCAM								
New Group								
No name1_1	22	(P)artial...	larger ar...	Larger a...	larger ar...			(0)
No name1_2	23	(P)artial...	larger ar...	Larger a...	larger ar...			(0)
No name2_1	24	(P)artial...	larger ar...	Larger a...	larger ar...			(0)
No name2_2	25	(P)artial...	larger ar...	Larger a...	larger ar...			(0)
New Concatenation								
concatened tiles1_1	27	(P)artial...	Elais S1 ...	Elais S1 ...	Elais S1 ...			(0)
concatened tiles1_2	28	(P)artial...	Elais S1 ...	Elais S1 ...	Elais S1 ...			(0)
concatened tiles2_1	29	(P)artial...	Elais S1 ...	Elais S1 ...	Elais S1 ...			(0)
concatened tiles2_2	30	(P)artial...	Elais S1 ...	Elais S1 ...	Elais S1 ...			(0)
Elais area in K								
New Group								
test3_magda1_1	12	(P)artial...	Elais S1	Elais S1 H	Elais S1 H			(0)
test3_magda1_2	13	(P)artial...	Elais S1	Elais S1 H	Elais S1 H			(0)

Current project led by V. Ivanov & EST to model first year of VISTA observations based on a realistic model for Paranal observing conditions & telescope downtime, the new Phase 2 tools, and observing constraints from user cases.



## Public Survey Operations - new tools

- **SADT** - Survey Area Definition Tool - Developed by VISTA consortium  
<http://www.vista.ac.uk/observing/sadt/index.html>





## Public Survey Operations - Timeline for VISTA Phase 2

Standing current timeline for VISTA M1 delivery, PS observations will not start earlier than P82 (after October 2008). **The 1<sup>st</sup> year of VISTA operations will be devoted entirely to public surveys - PSP & OPC recommendation.**

Teams will be asked to submit their OBs for SM observations each semester. Submission of Phase 2 may have similar deadlines as for ESO/VLT standard Phase 2, but for the 1<sup>st</sup> one.

The available time for each survey will be evaluated by the **Survey scheduling project (PI V. Ivanov)**. There may be an oversubscription factor to allow for weather fluctuations and cover all the available telescope resources.

ESO will organize a workshop with survey PI's and 2-3 members of each team to familiarize with the new Phase 2 tools in the Summer of 2008.

New p2pp tool for ESO phase 2 in P83 - all users.

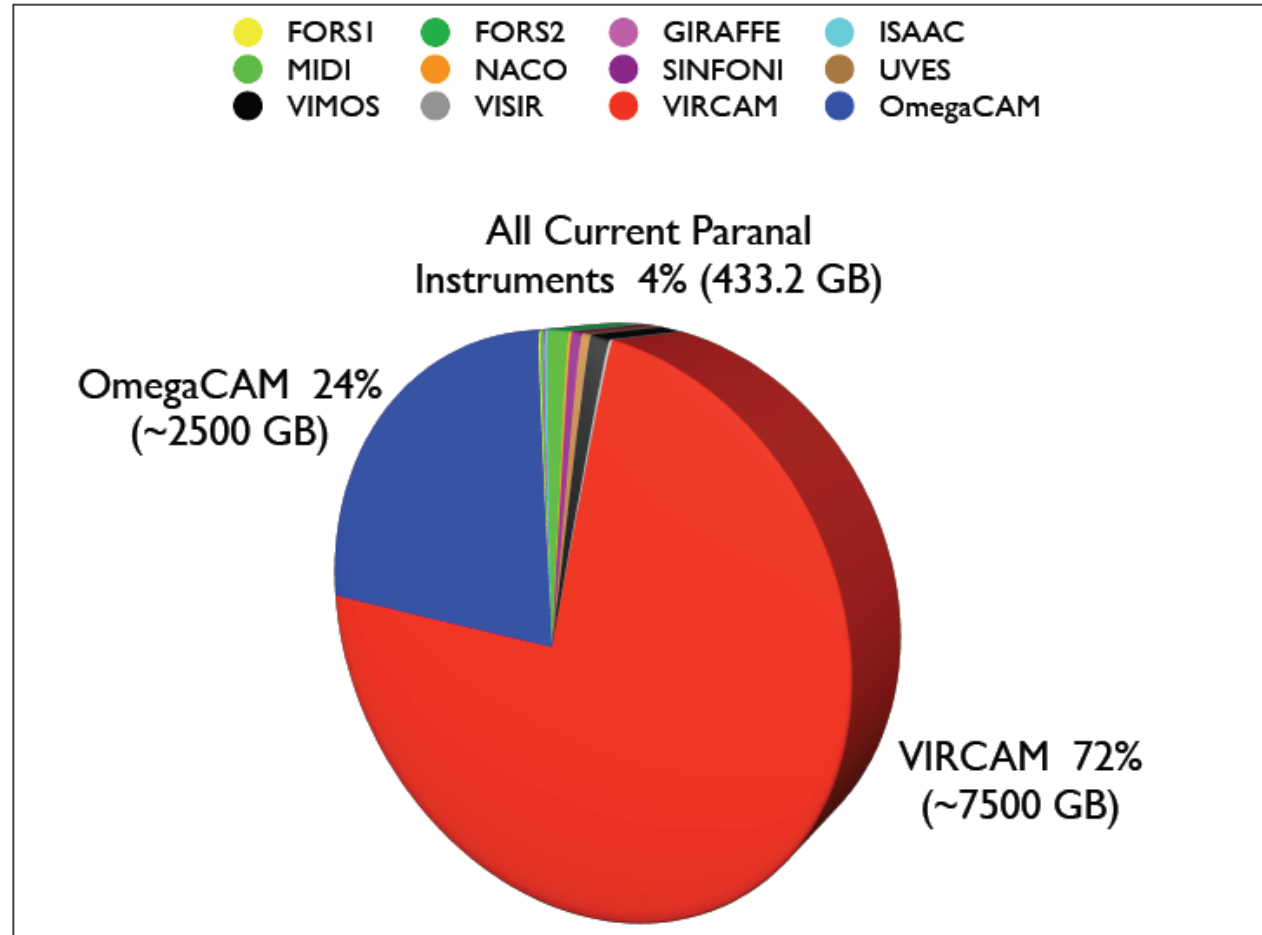




# Public Survey Operations - Data flow

Expected monthly dataflow (raw calibration and science frames) from Survey Telescopes

The plan is for ESO PS raw data to be available from ESO archive as soon as they are ingested





# Guidelines for the Survey management plan VST & VISTA

The PI of an OPC-recommended PS@ESO is asked to submit the SMP document, which consists of the following sections:

2. Survey observing strategy;
3. Survey data calibration needs;
4. Data reduction process;
5. Manpower and hardware capabilities devoted to data reduction and quality assessment;
6. Data quality assessment process;
7. Data products and VO compliance;
8. Timeline delivery of data products to the ESO archive.



# Guidelines for the Validation of Data products

These guidelines are intended to describe the reports and tests which will be requested by the EST from the Survey Teams in order **to verify the declared accuracy/uniformity of the data products from PS before their acceptance and ingestion into the ESO archive.** See:

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

**The data products from a PS consist (mostly) of :**

3. astrometrically and photometrically calibrated, co-added, re-gridded images, along with their respective weight maps, in all of the project-relevant filters;
4. 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.





# Guidelines for the Validation of Data products

The survey team should provide a concise report describing:

- Report on Observations and CCD data reduction: the data acquisition, the pre-reduction (mostly the instrumental signature removal), Regarding the NIR, there is the need to test for and correct linearity effects!
- Astrometry : external catalogue + internal catalogue generated from matched objects in overlapping CCDs (**global astrometry**) .
- Photometry : absolute + relative calibration based on sources from overlapping regions (**uniform zero point across the whole survey area!**). A description of the co-addition process must be provided: whether it is performed after the image is re-sampled, the flux scaling applied, and the algorithm adopted for its execution.

Procedure adopted for the evaluation of the limiting magnitude of the co-added frames and the computed values.



# Guidelines for the Validation of Data products

- **Catalogue Preparation**: a report on the tests on the PSF uniformity across the co-added images; tests for the optimisation of the extraction parameters for the object detection algorithm. Particularly important here is the selection of an optimal photometric aperture;  
**In case of the multi-band surveys**, the Survey Teams must describe the strategy adopted , i.e. whether a particular band is used for the master catalogue, or a  $\chi^2$  image is produced as the detection image; discuss point-like (unresolved) vs. extended (resolved) classification.
- **Data quality assessment**: Stellar colours - Distribution of stars in colour-colour space as a function of magnitude - Effect of crowding - Field galaxy colours - Distribution of galaxies in colour-colour space as a function of magnitude - Galaxy number counts - Clustering properties of extended sources.



# Data Reduction Pipelines and Data Centers- VST surveys

- PIs of VST PS receive a copy of the raw data!
- **Astro-WISE** - <http://www.astro-wise.org> Astronomical Wide-field Imaging System for Europe. Astro-WISE is an environment consisting of hardware and software which has been developed to be able to scientifically exploit the ever increasing avalanche of data produced by science experiments. Astro-WISE is an all-in-one system: it allows a scientist to archive raw data, calibrate data, perform post-calibration scientific analysis and archive all results in one environment. The Astro-WISE information system started out being used for data from one particular astronomical optical wide field imager: OmegaCAM. After this, it has been expanded to include arbitrary optical wide field imagers.
- **TERAPIX** - <http://terapix.iap.fr/> (Traitement Élémentaire, Réduction et Analyse des PIXels de Megacam) is an astronomical data reduction centre dedicated to the processing of extremely large data flows from digital sky surveys.





# Data Reduction Pipelines and Data Centers

## VISTA Surveys

**PIs of VISTA PS do not receive a copy of the raw data** (unless explicitly requested!)

VISTA data flow system (VDFS). <http://www.ast.cam.ac.uk/vdfs/>

Data will be pipeline processed at ESO HQ to generate real-time data quality control parameters and then shipped to Cambridge for full science data processing.

The Cambridge Astronomical Survey Unit ([CASU](http://www.ast.cam.ac.uk/~mike/casu/index.html): <http://www.ast.cam.ac.uk/~mike/casu/index.html>) is responsible for the design and implementation of the data processing aspects of VISTA observations. **PI may access the processed data after the CASU step.**

After processing, the plan is that the VISTA data will be transferred to Edinburgh where the Wide Field Astronomy Unit ([WFAU](http://www.roe.ac.uk/~nch/wfcam/): <http://www.roe.ac.uk/~nch/wfcam/>) will be responsible for the design and implementation of the survey-oriented data reduction.



## Policies for Archiving Data Products

The raw data from the public surveys with OmegaCAM and VIRCAM will be immediately made public worldwide from the ESO archive, **with public users being able to download limited volumes.**

Data products from the ESO public surveys will be available worldwide from the ESO archive. See also:

Virtual Observatory: <http://www.eso.org/org/dmd/vos/>

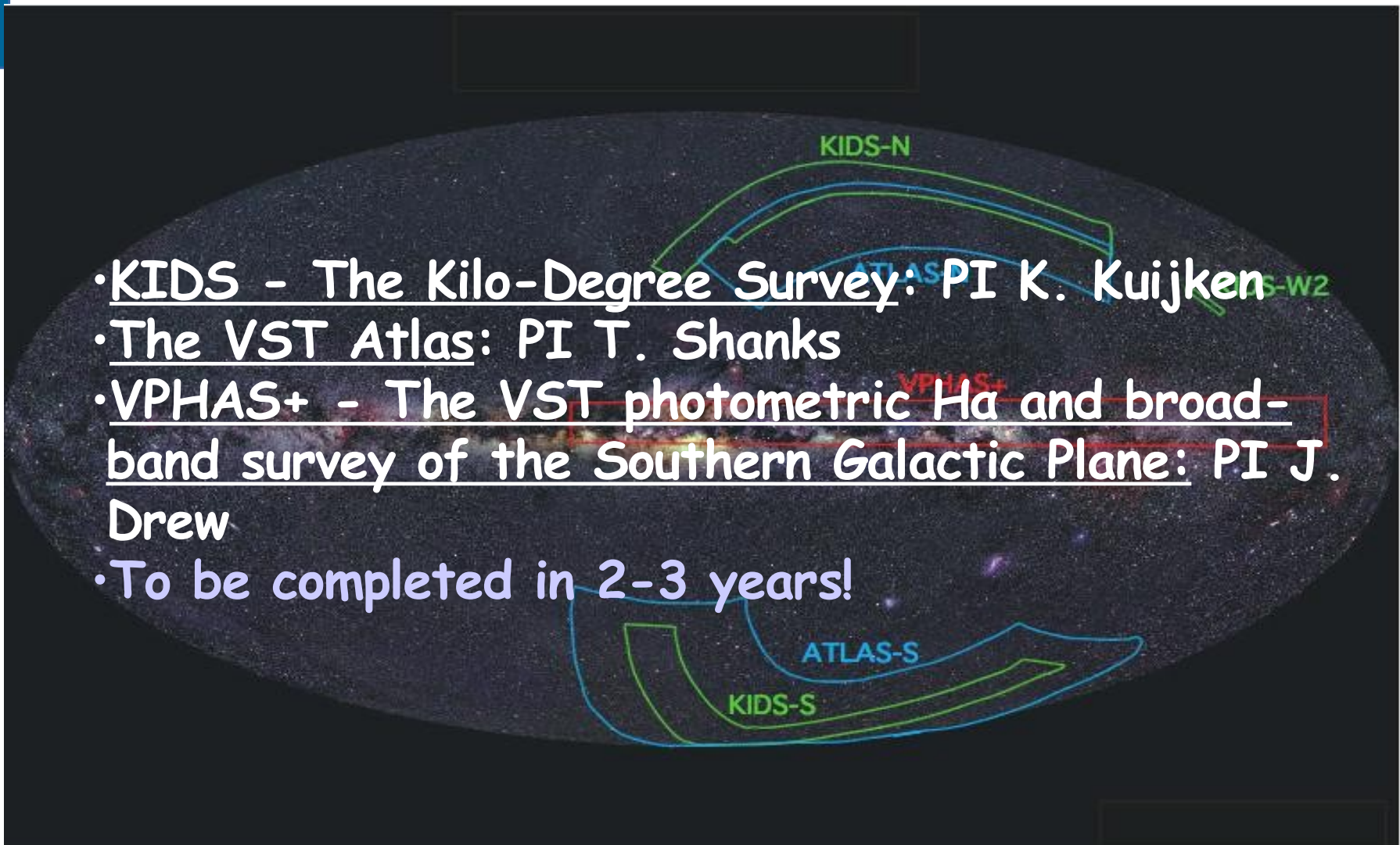
Advanced Data Products Group: <http://www.euro-vo.org/pub/>

The data formats and metadata to be delivered to ESO will be compliant with the Virtual Observatory standards . Specific guidelines will be issued as soon as the ADP ingestion infrastructure is built.

A copy will be available from the Wide field Astronomy Unit at the Royal Observatory Edinburgh archive for the VISTA public surveys.



# ESO public surveys - Science I

- 
- A map of the Southern Galactic Plane showing various survey regions. The regions are outlined in green and blue. Labels include 'KIDS-N' at the top, 'KIDS-S' at the bottom, 'ATLAS-N' and 'ATLAS-S' in the middle, and 'VPHAS+' in red. A label 'KIDS-W2' is also visible on the right side.
- KIDS - The Kilo-Degree Survey: PI K. Kuijken
  - The VST Atlas: PI T. Shanks
  - VPHAS+ - The VST photometric H $\alpha$  and broad-band survey of the Southern Galactic Plane: PI J. Drew
  - To be completed in 2-3 years!

DATA MANAGEMENT



& OPERATIONS DIVISION



# ESO Public Surveys - Science I

Survey	Area deg <sup>2</sup>	Filters	Magnitu de limits	Depth measure
KIDS	1500	u',g',r',i'	24.1,24.6	10σ (AB)
Atlas	4500	u',g',r',i', z'	22.0,22.4,23.4	10σ (AB)
VPHAS+	1800	u',g',Ha, r',i'	21.8,22.5	10σ (AB)



# ESO Public Surveys - Science I

## KIDS - The Kilo-Degree Survey: PI. K. Kuijken (Leiden+18 co-I's).

This massive (1500 sq. deg. in 4 bands) survey targets two areas of the sky where large redshift surveys have taken place : an equatorial strip on the North Galactic Cap, and a patch near the South Galactic Pole.

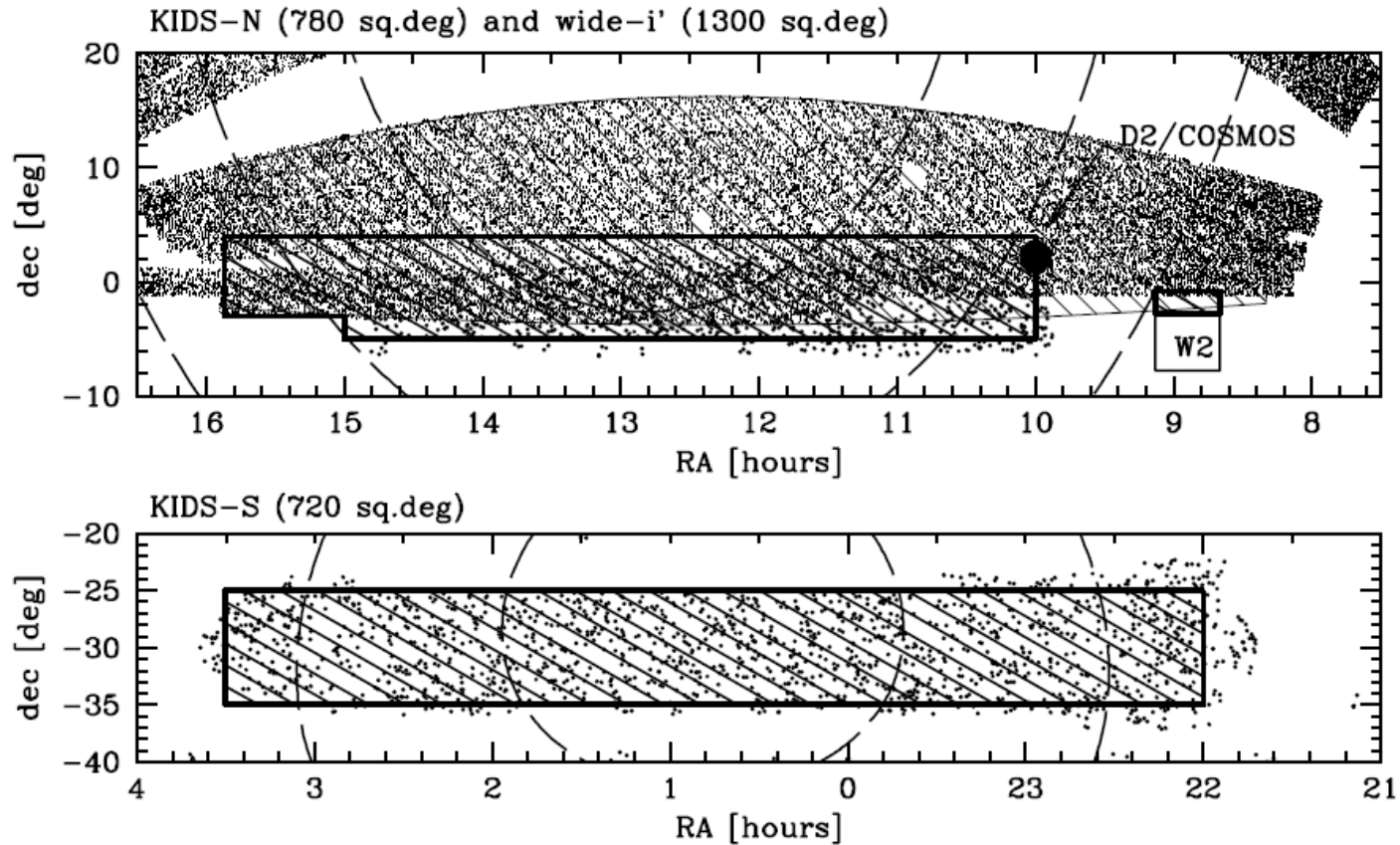
In terms of sensitivity, the KIDS survey, which has been designed with weak lensing as a major goal, lies between the on-going Sloan Imaging Survey (SIS), which is about 2.5 mag. shallower, but covers 7 times the area, and CFHTLS-Wide survey which is roughly 1 mag. deeper, but covers an area 9 times smaller. The image quality of KIDS is expected to be 2 times better than SIS, and slightly better than CFHT.

The KIDS large homogenous data set with photometry from  $u'$  to K and spectroscopy for about 200,000 galaxies will serve to tackle a number of very important problems in cosmology ranging from the detection of high redshift ( $z > 6$ ) QSO's and thousands of clusters at  $z > 1$ , to understanding the structure of galaxy halos as functions of galaxy type and environment.





# ESO Public Surveys - Science II



DATA MANAGEMENT





## ESO Public Surveys - Science I

### The VST Atlas: PI T. Shanks (Durham+25 co-I's).

Aimed at surveying 4500 sq. degrees of the Southern Sky at comparable depths to the Sloan Digital Sky Survey (SDSS).

*This would be the first step at surveying the entire Southern Sky in the optical bands.*

VST atlas covers 2 separate regions:  $10:30 < \alpha < 15:30$  and  $-20 < \delta < -2.5$  and  $21:30 < \alpha < 04:00$   $-50 < \delta < -15$ . To be completed in 3 years.

The science driver is to characterize the dark energy equation of state by detecting the so-called baryon wiggles in the power spectrum of about 450,000,  $z \sim 0.7$  luminous red galaxies for which spectra will be obtained with the new Omega instrument on the AAT.



## VPHAS+ - The VST photometric H $\alpha$ and broad-band survey of the Southern Galactic Plane: PI. J. Drew (Imperial College+27 co-I's).

VPHAS+ will collect broad-band (u',g',r',i') and narrow-band H $\alpha$  photometry across the entire Southern Galactic plane,  $\sim 1800$  sq. degs, within the latitude range  $-5 < b < +5$  degrees, and longitude  $210 < l < 35$ , down to point source magnitudes of 21-22.

This will allow to fully explore all but the most heavily obscured locations in the Galactic plane, thus allowing to chart the star formation history of the Galaxy. The VPHAS+ catalogue will contain more than 200 million objects, and will complement the on-going r',i',H $\alpha$  sister survey in the Northern part of the plane.

VPHAS requires 4 months VST observing time, distributed over 3 years





# ESO public surveys - Science II

- 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, Oxford
- VVV (VISTA Variables in the Via Lactea) PI: Minniti, Catolica
- VIKING (kilo-degree IR galaxy survey) PI: Sutherland, IoA Cambridge
- VMC (Vista Magellanic Survey) PI: Cioni, Edinburgh
- To be completed in 5 years!



# ESO public surveys - Science II

Surveys	Area deg <sup>2</sup>	Filters	Magnitu de limit	Depth measure
Ultra- VISTA VHS	1.5 deep 0.73 20000 deep	Y J H K <sub>s</sub>	26.7 26.6 26.1 25.6 24.1	5σ (AB)
VIDEO	10	Z Y J H	25.7 24.6 24.5 24.0 23.5	5σ (AB)
VVV	520	K <sub>s</sub> Y J H	21.9 21.1 20.2 18.2 18.1	5σ (AB)
VIKING	1500	K <sub>s</sub> Y J H	23.1 22.3 22.1 21.5 21.2	5σ (AB)
VMC	184	K <sub>s</sub> J K <sub>s</sub>	21.9 21.4 20.3	10σ



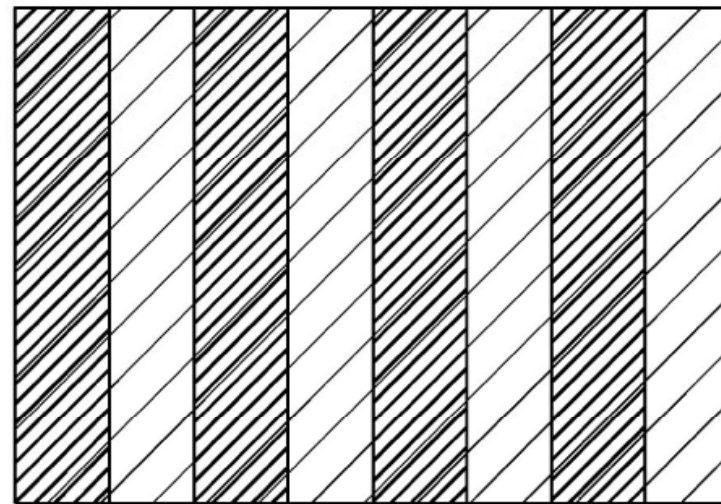


# ESO public surveys - Science II

## • ULTRAVISTA

- survey Y, J, H, K<sub>s</sub>
- Total n. of galaxies: 1.5 degrees
- The first 1.5 degrees
  - Re-ionization
  - Lyman- $\alpha$  forest
  - Need VISTA
- Stellar mass
- Dust-obscured
- High-z quasar
- ~30 Ly-alpha emitters at z=8.8 (NB survey)

## ULTRA-VISTA



1.5 degrees

1 sq. deg

HDF-S



UDF

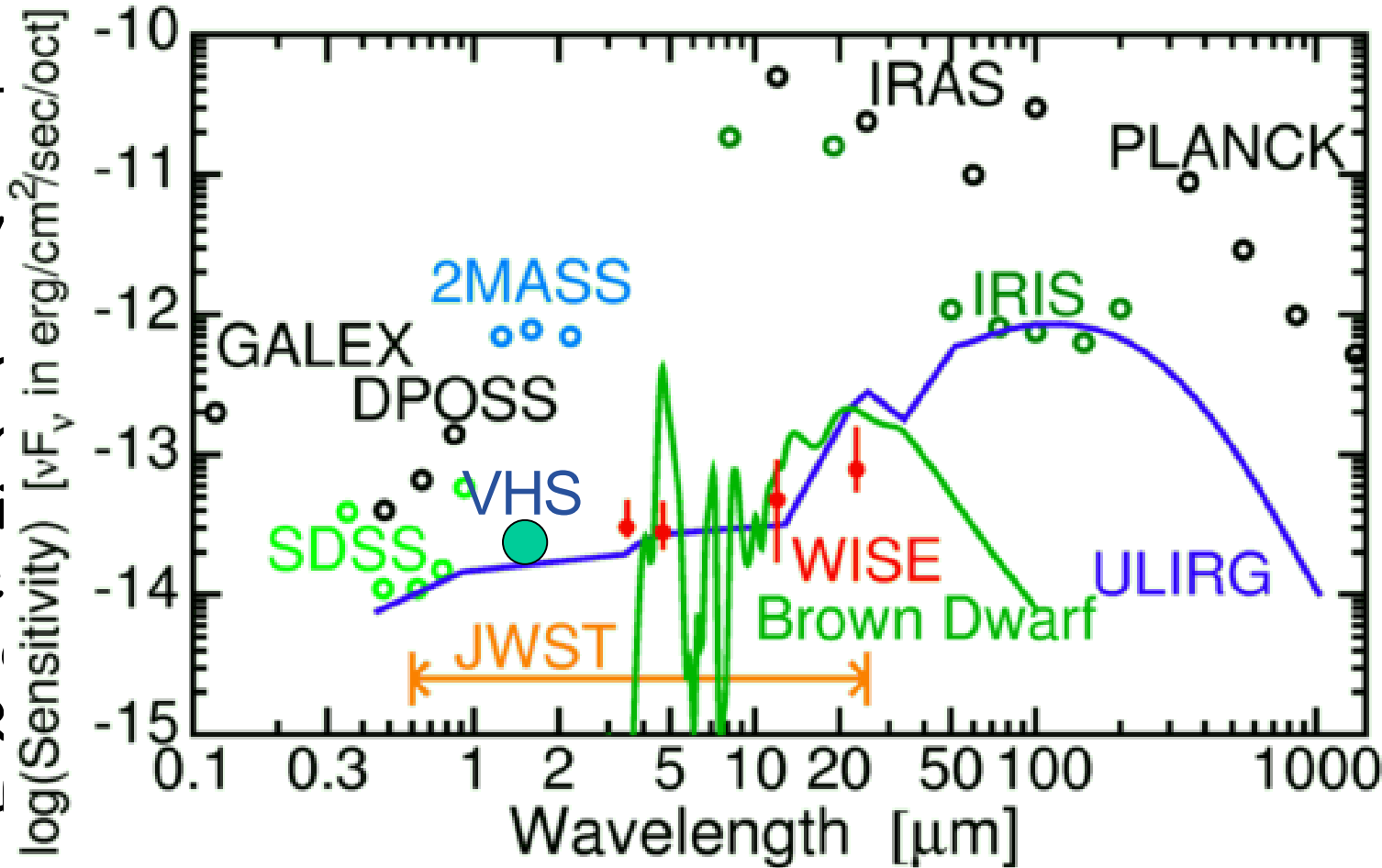


GOODS



# ESO public surveys - Science II

- VHS
- bands
- deeply
- Total
- Low n
- Brown
- Mergi
- Large
- Dark
- IR
- 1st qu



some  
more



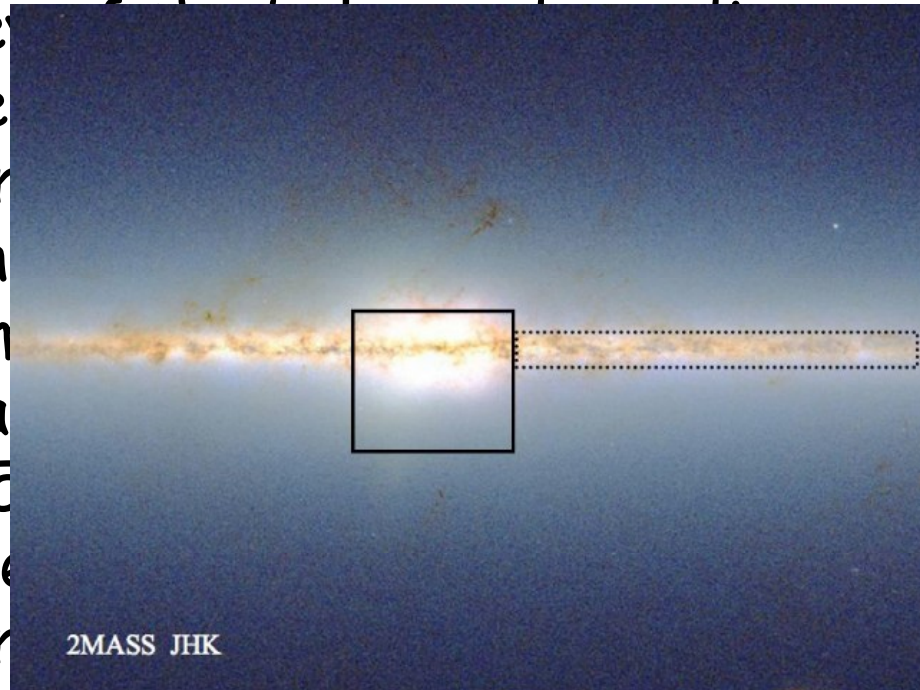
## ESO public surveys - Science II

- **VIDEO** -- 10 sq deg. Z, Y, J, H, Ks - Between VIKING and ultra-deep surveys (in terms of width + area)
- Total n. of nights required in 5 years: 167
- 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 II

- VVV - IR survey of a section of the mid-plane in the Galactic plane (area = 300 sq deg) in Z, Y, J, H, Ks - r
- Total n. of nights
- IR survey can measure dust
- Will find  $10^6$  variables
  - RR Lyrae (>5)
  - Find variables in distances, reddening, rare variable sources, Microlensing
- Look for variables stars in Sag. dwarf





## ESO public surveys - Science II

**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 II

- 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
  - 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 II

End!