VISTA Hemisphere Survey (VHS)

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Durham, Dec 5th 2011
Scientific issues concerning VISTA site choice

Abstract: This report aims to summarise and compare in a quantitative manner the scientific related issues that affect site choice. We include material that characterises the sites that are currently under consideration. Other issues relating to operational cost and logistics which can indirectly affect scientific output in a major manner are not considered.

Comparing the two sites under consideration, we find that:

- the seeing at the two sites is probably similar
- Paranal has 20% more photometric nights than Pachon
- Paranal is a warmer winter site and hence the $K_s$ sky background may be brighter by $\sim0.25-0.34$ mag. If 50% of all time (think of it as bright + some grey time) is spent in $K_s$ this would reduce Paranal’s advantage in terms of the number of winter photometric nights by 6-8%, so it would be 12-14%.
- We conclude that either Pachon or Paranal would make an excellent site for VISTA.
ESO VISTA Public Surveys

• >75% of VISTA time is for large scale Public Surveys
• March, 2006 Initial proposal
  – 16 proposals
  – 6 selected for next phase (includes civil partnership of 4 within Ultra-VISTA)
  – VHS, VIKING, VIDEO, VMC, VVV, Ultra-VISTA

• Nov, 2006; Vista Hemisphere Survey (VHS) was highest scientifically ranked by ESO OPC.

• Nov, 2007 VHS Survey Management (SMP) plan accepted by ESO.
  – Survey management plan requested 3402 clear hours of observing time which assumes 65% observing efficiency
  – 380 clear 9hr nights of service mode observing over a 5 year period.
  – Dry Run observations started Nov 2009; Survey started Mar, 2010

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VHS Science Goals

• The nearest and lowest mass stars
• Galactic structure; formation of the Milky Way
• Evolution of Large scale structure in the Universe; the nature and evolution of Dark Energy
• The physics and baryonic content of the Epoch of Reionization; the discovery of first $z>7$ quasars.

100 times volume of Universe compared with 2MASS
10 times the volume of the Universe compared UKIDSS

• Targets for the VLT, ALMA, ELT, JWST
• Support for ESA Survey Missions:
  – XMM-Newton, Herschel, Planck, GAIA
VHS Components

• VHS Galactic Plane (VHS-GP)
  – $5 < |b| < 30$
  – $8200\text{deg}^2$
  – $J(60\text{sec})$; $K(60\text{sec})$

• VHS-ATLAS (VST-ATLAS PI: Shanks)
  – $5000\text{deg}^2$
  – $Y(60\text{sec})$, $J(60\text{sec})$, $H(60\text{sec})$, $K(60\text{sec})$

• VHS-Dark Energy Survey (VHS-DES)
  – $4500\text{deg}^2$ (excludes $500\text{deg}^2$ from VIKING footprint)
  – $J(120\text{sec})$, $H(120\text{sec})$, $K(120\text{sec})$
The Dark Energy Survey
(US, UK, Spain, Brasil collaboration)

- Telescope; upgraded CTIO 3.9m
- 525 nights over 5 years
- Starting late 2012
- Multiple pass survey so coverage of 5000deg² in first year.
- Field of view
  - 2.3deg diameter; 3.0deg²
- Very red sensitive CCDs
  - QE; 90% at 900nm; 50% at 1µm
- g, r, i, z, Y wavebands

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## VISTA Surveys summary

<table>
<thead>
<tr>
<th>Survey</th>
<th>Area (deg$^2$)</th>
<th>Depths Measure (mag)</th>
<th>Depth (mag)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VHS</td>
<td>18,000</td>
<td>5σ, AB</td>
<td>J=21.2</td>
</tr>
<tr>
<td>1. VHS-DES</td>
<td>4500</td>
<td>5σ, AB</td>
<td>J=21.6</td>
</tr>
<tr>
<td>2. VHS ATLAS</td>
<td>5000</td>
<td>5σ, AB</td>
<td>J=21.2</td>
</tr>
<tr>
<td>3. VHS-GPS</td>
<td>8000</td>
<td>5σ, AB</td>
<td>J=21.2</td>
</tr>
<tr>
<td>VIKING</td>
<td>1,500</td>
<td>5σ, AB</td>
<td>Z=23.1</td>
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<tr>
<td>VVV</td>
<td>520</td>
<td>5σ, Vega</td>
<td>Z=21.9</td>
</tr>
<tr>
<td>VMC</td>
<td>184</td>
<td>10σ, Vega</td>
<td>Y=21.9</td>
</tr>
<tr>
<td>VIDEO</td>
<td>15</td>
<td>5σ, AB</td>
<td>Z=25.7</td>
</tr>
<tr>
<td>Ultra-VISTA</td>
<td>0.70</td>
<td>5σ, AB</td>
<td>NB=26.0</td>
</tr>
</tbody>
</table>

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VISTA Public Survey footprints

VHS
DES
KIDS/VIKING

VIDEO
SDSS SGC
VV
UltraVista

(C) 2010 CASU

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VISTA Surveys Status

Observing dates: 20091015 - 20110303
Cambridge Astronomy Survey Unit

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VHS observations status this week

Each Observing Block (OB) = 1.5deg$^2$

VHS progress: /data/vhs/progress/20111201/179A2010.csv:

- All OBs: 3216
- Unique OBs: 3216
- Valid OBs: 3181
- Completed OBs: 2944
- Pending OBs: 237
- Cancelled OBs: 35

Accepted OBs: 215
Defined OBs: 0
Must repeat OBs: 12
Cancelled OBs: 35
Aborted OBs: 10
Status X OBs: 0

~4500 deg$^2$ observed

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VHS-DES observations status this week

~700 deg² observed

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VHS-ATLAS observations status this week

~700 deg² observed

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UKIDSS LAS Seeing Distribution

![Graph showing seeing distribution with Y, J, H, and K bands.]

<table>
<thead>
<tr>
<th>Band</th>
<th>Median 5%</th>
<th>95% range</th>
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</thead>
<tbody>
<tr>
<td>Y</td>
<td>0.87</td>
<td>0.64 - 1.25</td>
</tr>
<tr>
<td>J</td>
<td>0.84</td>
<td>0.66 - 1.14</td>
</tr>
<tr>
<td>H</td>
<td>0.85</td>
<td>0.61 - 1.23</td>
</tr>
<tr>
<td>K</td>
<td>0.82</td>
<td>0.59 - 1.20</td>
</tr>
</tbody>
</table>

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VHS Seeing distribution

![Graph showing the distribution of seeing with data points and error ranges for different bands: J, H, and K.](image-url)
VHS-DES limiting magnitudes: 60second exposure

<table>
<thead>
<tr>
<th>Band</th>
<th>Proposal</th>
<th>Measured</th>
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</thead>
<tbody>
<tr>
<td>J</td>
<td>21.1</td>
<td>20.9</td>
</tr>
<tr>
<td>H</td>
<td>20.6</td>
<td>20.6</td>
</tr>
<tr>
<td>Ks</td>
<td>20.0</td>
<td>20.3</td>
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</table>
VHS-DES limiting magnitude 2010/2011 season

<table>
<thead>
<tr>
<th>Band</th>
<th>Proposal</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>21.6</td>
<td>20.8</td>
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<tr>
<td>H</td>
<td>21.0</td>
<td>20.4</td>
</tr>
<tr>
<td>Ks</td>
<td>20.4</td>
<td>20.2</td>
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5 sigma limit
120 seconds per band
Some VHSish science verification examples

- SPT clusters at z=1 (Manda Banerji)
- Galactic Structure/Streams
  - GAIA-SPEC ESO Public Spectroscopic Survey target selection (Sergey Koposov)
- z>6.5 QSOs
5 deg x 5 deg patch: vhs_v20101207.fits

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SPT-CLJ0528 (z=0.76)  

SPT-CLJ0546 (z=1.06)

Stellar mass analysis currently ongoing for both clusters (Banerji, Stroe, McMahon, Mohr et al.)
VHS-ATLAS NGP
Stellar density distribution

Sergey Koposov, Eduardo Gonzalez

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Example spectroscopic data for four $z>6.5$ quasars found in last 13 months from UKIDSS and VIKING

Mortlock et al, 2011, Venemans et al, in prep
Optical and IR photometry

Source id: 433792579688

Run: 3909  Rerun: 40  Camera: 3  Field: 278  RA: 237.11543  DEC: +5.8059765

u mag > 23.43
No: 2
ra: 15 48 27.70
Y-J = *****

g mag > 23.91
ymag > *****
dec: +05 48 21.5

r mag > 23.60
jmag > 21.17
Y-J > *****

i mag > 21.17

zmag = 18.37 ± 0.03
Z-J > 0.38

Y-K = *****

Imag > 23.16
Hmag = 19.34 ± 0.08

J-K = 2.79

J-H = 1.83

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‘Example’ z=7 quasar: Combined optical and near IR spectrum

Green line is a composite based on 169 SDSS QSOs with 2.3 < z < 2

z = 7.08

From Mortlock et al 2011, Nature
VHS Data Release 1(DR1)  
CASU(v1.1) processed tiles

<table>
<thead>
<tr>
<th>Component</th>
<th>Unique OBs</th>
<th>Y</th>
<th>J</th>
<th>H</th>
<th>K</th>
<th>All</th>
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<tbody>
<tr>
<td>ATLAS</td>
<td>439</td>
<td>571</td>
<td>546</td>
<td>531</td>
<td>536</td>
<td>2184</td>
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<td>304</td>
<td>351</td>
<td>342</td>
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<td>1037</td>
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<tr>
<td>GPS</td>
<td>543</td>
<td>677</td>
<td></td>
<td>662</td>
<td></td>
<td>1339</td>
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<tr>
<td>All</td>
<td>1286</td>
<td>571</td>
<td>1574</td>
<td>873</td>
<td>1542</td>
<td>4560</td>
</tr>
</tbody>
</table>

- Each OB contains all waveband observations needed for an tile
- Total number of stacked pawprints 27,596
  - Each stack is normally 2-3 dithers/jitters
THE END
EXTRA SLIDES